

Original instructions

REVISION 6-17

D5LSP

Service and Repair Manual

FOR SERIAL NUMBER: 732435

SANDVIK

The following three hazard signal words are used throughout this manual to emphasize important instructions. For the purpose of this manual, these signal words are defined as follows:



Indicates a hazardous situation which, if not avoided, will result in death or serious injury.



Indicates a hazardous situation which, if not avoided, could result in death or serious injury.



Indicates a situation which, if not avoided, may result in damage to machinery or components.

California Proposition 65
WARNING:
This Product Contains And, When Used, Produces Chemicals Known To The State Of California To Cause Cancer, And Birth Defects Or Other Reproductive Harm.

SANDVIK MINING SALES AND SERVICE CENTERS

Sandvik - USA and Canada
300 Technology Court S.E.
Smyrna, GA 30082
USA
Tel. 404 589 3800

Sandvik - Chile, S.A.
AV. Presidente Edo
Frei Montalva #9990
Quilicura - Santiago
CHILE
Tel. + 2-676 02 00

Sandvik - Africa Pty. Ltd.
64 Jet Park Road, Jet Industrial Sites,
Boksburg 1459
SOUTH AFRICA
Tel. + 27 11 397 2575

Sandvik - Europe
Hafenstrasse 280
45356 Essen
GERMANY
Tel. + 02 01 178 5300

Sandvik - Australia
Level 3 Kings Row
50-52 MacDougall St.
Milton
AUSTRALIA
Tel. + 61 3637 7400

Sandvik Tamrock Oy - Finland
Pihtisulunkatu 9
FIN-33311 Tampere
FINLAND
Tel. + 35831 2414111

SAFE OPERATING PRACTICES FOR DRILLERS

INTRODUCTION

SANDVIK MINING drilling equipment is carefully designed, tested and manufactured. When operated and serviced by trained and qualified personnel, this machine will give safe and reliable service. There are SANDVIK MINING offices world-wide to answer questions concerning the safe operation and maintenance of this equipment.






To minimize the risk of accidents and injuries, all persons involved in the operation and servicing of this machine **MUST** read and understand the following safety precautions and the manuals developed for this machine.

While we believe that we have properly identified several potential hazards that could result in property damage or injury or death to personnel, there are certain hazards which may be present that we have not contemplated. It therefore is the responsibility of the drill owner, operator and crew to be certain that the drill is properly equipped and safe to operate to assure accident free operation.

Safety Labels and Signals

Signal Words

The following hazard signal words are used throughout this products manuals and decals to emphasize important instructions. These signal words are defined as follows:



 DANGER	
	The DANGER signal word indicates a hazardous situation which, if not avoided, will result in death or serious injury.
 WARNING	
	The WARNING signal word indicates a hazardous situation which, if not avoided, could result in death or serious injury.
NOTICE	
	Indicates a situation which, if not avoided, may result in damage to machinery or components.

General Hazard Symbol



This general hazard symbol identifies important safety messages in this manual. When you see this symbol, be alert; your safety is involved. Carefully read and understand the message that follows this symbol, and inform other users.

User Obligations

 WARNING	
	WARNING! This product may only be operated and maintained by a person who has received proper training and has demonstrated that he or she has the competence and the skills needed for safe and proper operation or maintenance.

The safe use of this product depends on, among other things, a combination of design and construction measures taken by the manufacturer, skills of the operators and protective measures taken by the users. This manual and its instructions are an essential and integral part of this product and must remain in the cab and be available for users. It is important to forward the information contained in this manual on to any subsequent users of this product.

Sandvik prohibits anyone with the access to this machine from consuming, possessing or distributing:

- Intoxicants and narcotics
- Legal or illegal drugs
- Items related to either of these
- Firearms
- Unapproved explosives

This safety information includes the following: transport, assembly, installation, commissioning, use, settings, operation, cleaning, troubleshooting, maintenance and disposal of machinery. If you need more detailed instructions, do not hesitate to contact your local Sandvik representative.

Operators and maintenance personnel should include the following as part of their safety program:



- Use of personal protective equipment (PPE)
- Provision and use of additional safeguards
- Attend regular site safety and safe working procedures training.

Other issues the operators and maintenance personnel should be aware of:

- Mine site organization and supervision
- Workplace safety, including safe working procedures
- Permit-to-work systems

When a Sandvik product has been involved in a near-miss incident or accident, it **MUST** be reported to a Sandvik representative without delay!

The following safety guidelines apply to every person working with this equipment or in its vicinity. Every person is responsible for their own safety and for the safety of their colleagues. In the case of a violation of safety guidelines or regulations, each person is responsible to warn the others and to notify the responsible supervisor.

 WARNING	
	WARNING! The use of non Sandvik authorized replacement parts can cause an uncontrolled risk to the machine's users. The use of non-authorized parts is prohibited. Always use genuine Sandvik parts.

Managing Work Related Hazards

The users must always perform a local risk assessment before every new task. For example: A work shift change or before performing maintenance. This assessment, also known as a Real Time Hazard Analysis,

ensures that the user stops and thinks about what she or he is going to do before starting to work allowing them time to:

- Identify potential hazards that could impact themselves, their colleagues, the environment, the machine and/or work method while they are performing the task.
- Assess the risks and implement the actions needed to eliminate or reduce the risk.

To ensure that only qualified users work with Sandvik equipment, the employer must:

- Validate training methods
- Verify competence and skills
- Monitor and evaluate user performance regularly
- See that all operators of this equipment are thoroughly trained (with special emphasis on safety), competent, physically fit and if required, licensed.
- Assign specific crew members specific safety responsibilities and instruct them how to report any unsafe conditions.
- Enforce the use of protective clothing, eye and hearing equipment.
- See that the operation and maintenance of this drill is in compliance with all Federal, State and local codes, regulations and standards.
- Ensure that the work area is appropriately illuminated when drilling is performed at night.
- Maintain a complete first aid kit at the drill site. At least two members of the drilling crew or personnel in the area where the drill is operated should be familiar with first aid and Cardiac Pulmonary Resuscitation.
- Contact the utility companies for the exact location of underground transmission lines in the drilling area.

The employer should plan for the job by asking:

- Will the drilling take place in wet formations?
- Are there utility lines or structures that must be moved or avoided?
- Are there unusual or extreme weather conditions expected?
- Will drilling be done in night hours?
- Will the machine be propelled on inclines?
- Will drilling be done into difficult formations?
- Has a drilling pattern been developed?
- What is the required depth of the drilling pattern?
- Will special drilling tools be required to complete the job?
- Will vertical or angle drilling be required?



Periodic Safety Inspections

It is important to thoroughly inspect this product before starting to ensure it is safe to operate. Look for defects and damage before any operation so any problems can be reported and fixed.

The operator shall be responsible to ensure:

- The machine is to be checked in accordance with the requirements of the machine operating procedures before, during and after use and operation. The Operator's Manual which should always be located in the cab of the machine.
- Safety features, such as labels, safeguards and others should be checked frequently and repaired immediately, if damaged.
- Check that there are no "lockouts" or "tagouts" attached to the controls.
- Check the machine logbook to see that periodic maintenance and inspections have been performed, and that all necessary repairs have been made.



- After starting the engine, check all indicators, emergency stop, trip devices and gauges for serviceability.
- Check the fire extinguisher (s) for charge and accessibility.
- Clean the cab interior windows if necessary.
- Test all controls for proper operation.
- Check access ladders and decking for damage and slipping hazards such as mud, oil or ice.
- At the end of the shift, the operator must properly secure the drill to prevent the machine from being operated by unauthorized individuals.
- The operator must never permit personnel to ride on the machine except in the passenger compartment.

 DANGER	
	<p>ELECTRICAL SHOCK HAZARD!</p> <p>The operator should treat all power lines as live. Operating near or contacting a power line with any part of the machine can result in electrocution. Do not raise the drilling mast or operate the machine in the vicinity of electrical power lines without checking the minimum safe operating perimeter set by local, state or federal regulations.</p>



- The operator must see that all emergency stops, “operational aids” and “warning signals” are functional before operating.
- The operator must be alert, physically fit, and free from the influences of drugs, alcohol and medications that might impair eyesight, hearing or reactions.
- The operator should not attempt to start, operate or service the drill unless he has been properly trained and read this manual.
- The operator should not operate this equipment if any of its controls display a “lockout” tag.
- If an unsafe condition exists, the operator must place a tag, identifying this condition, on the starting controls and alert other potential users of the drill.
- The operator should not operate the drill without first checking that all personnel protection equipment (PPE) and machinery guards are in place.
- Raising or lowering the mast, and drilling with an unsupported or unlevelled machine can result in excessive structural stress to the machine frames or can cause the machine to overturn.
- Before leaving the operator’s station, all controls must be in the neutral position with all locking and safety devices engaged. Do not allow the drill to operate unattended.
- Do not park or position the machine on grades that exceed the tilt ratings. Park or position the machine on level ground or across (horizontal) grade.
- Park or position the machine to allow the wind to carry engine exhaust fumes away from the operator. Exhaust fumes from diesel engines are lethal.



Periodic Maintenance

Following the preventive maintenance schedule in the Maintenance manual is an essential procedure to ensure and maintain safety and performance of the product. Follow the given instructions for maintenance and inspection for this product.

 DANGER	
	<p>BURN HAZARD!</p> <p>The sudden release of a pressurized lid or hose can spray hot oil.</p> <p>Do not open hydraulic tanks, air reservoirs or hydraulic connections while the machine is running or the systems are under pressure.</p>

- Before entering any enclosure, be sure that the door is secured open. Avoid entrapment; be sure that no one is inside any enclosure before closing and latching the doors. Enclosures can cause suffocation.
- Before starting any service or maintenance work, always perform a safety/risk analysis of the task. Performing maintenance work without the proper tools and personal protection equipment can cause serious injury or death.
- Climbing the mast is a crushing and falling hazard. Climbing the mast may cause serious injury or death. Stay off the mast at all times.

 DANGER	
	SKIN INJECTION HAZARD
	Hydraulic oil under extreme pressure from a small opening can penetrate the skin and inject oil into the body.
	Do not attempt to locate a hydraulic leak by using your hand. If injected, SEEK MEDICAL ATTENTION IMMEDIATELY.

 DANGER	
	HIGH PRESSURE INJECTION HAZARD
	Pressure in hydraulic systems can be retained for long periods of time. If not properly released before maintenance people attempt to work on the hydraulic system, this pressure can let components move or cause hot oil to spray and hose ends to shoot out at high speed.
	Release system pressure before attempting to make adjustments or repairs.

- Carelessness in getting on and off equipment can result in serious injuries. Always wait until the machine has completely stopped. Do not jump on or off. Always use both hands and feet and use the 3-point contact rule.
- Riding the top drive up and down the mast is a crushing hazard. Never ride the top drive for any reason!!! It was not designed to be an elevator.

Personal Protective Equipment (PPE)

Operators, maintenance people and anyone in the vicinity of this product **MUST** wear approved personal protective equipment, which includes but is not limited to:

- Safety helmet
- Goggles
- Hearing protection
- Steel toed boots
- Respirator
- Safety gloves
- Close fitting overalls
- Safety harness
- High visibility vest

Do not wear loose clothing or jewelry that can snag on controls or other components of this machine. Confine long hair.

Special conditions may require the use of additional PPE as specified in safe working procedures.

Limits of This Machine

Intended use of this Rig

This machine is designed for construction and surface mine drilling. The maximum inclination angles for this machine can be found in the 'Tramming Stability' topic of the Operator's manual.

Recommended Operating Conditions



This machine was designed to operate at ambient temperatures of -40°C to +54°C (-40°F to +130°F).

Manners and Conditions In Which This Machine Should NOT Be Used

Never operate this machine with:

- Inadequate training of operator.
- Unauthorized persons in working area.
- Inadequate lighting.
- Inadequate grading.
- Transporting people.
- Defective safety systems.
- Locked-out or tagged-out components

Modifications

 WARNING	
	<p>The installation and use of unauthorized components or modifications to the original design of this machine may cause personal injury or death.</p> <p>Do not modify or install aftermarket components to this machine without approval from Sandvik Mining.</p>

All modifications and corrections not authorized in the maintenance manual or which may affect the maintenance, operation, safety, and availability of the product need to be approved in writing by the manufacturer before implementation. Approval requires careful risk assessment taking into consideration any new risks that the modifications may bring.

Changes and modifications without proper risk assessment, elimination or reduction of risk and without appropriate safety measures may lead to death, serious personal injuries or damage to property.

If modifications and corrections that affect the maintenance, operation, safety, and usability of the product are made without the written permission of the manufacturer, the manufacturer is not responsible for any incidents resulting in death, injury, or property damage brought about by such modifications and corrections.

Should you consider a modification or correction necessary, please contact the Sandvik Alachua, Florida USA facility. No modification is permitted unless you first obtain the written approval of the manufacturer.

Prior to implementing or installing a modification to this product you must supply us with adequate documentation such as:

- Product model/type
- Serial number of product
- Description of the modification or correction
- Related blueprints
- Related photos



- And other necessary materials related to the design change

If a modification or correction as described above has been implemented without the manufacturing factory's permission, its effect on warranty liability will be considered case-by-case. Thus, the warranty application may be rejected altogether.

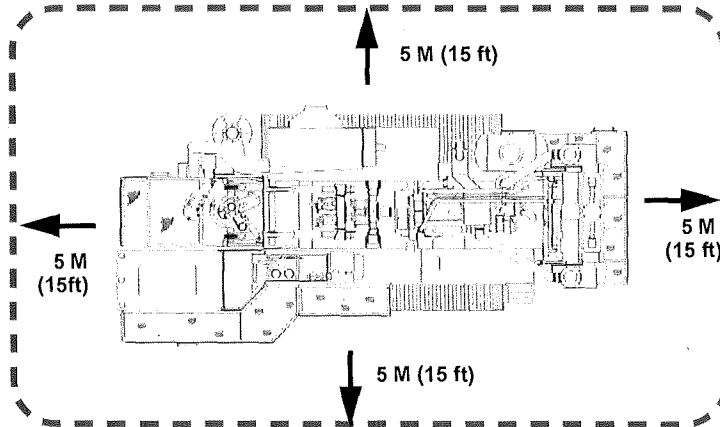
General Hazards



Hazard Zones

Hazards zones when traming the machine and when the machine is in operation are shown below.

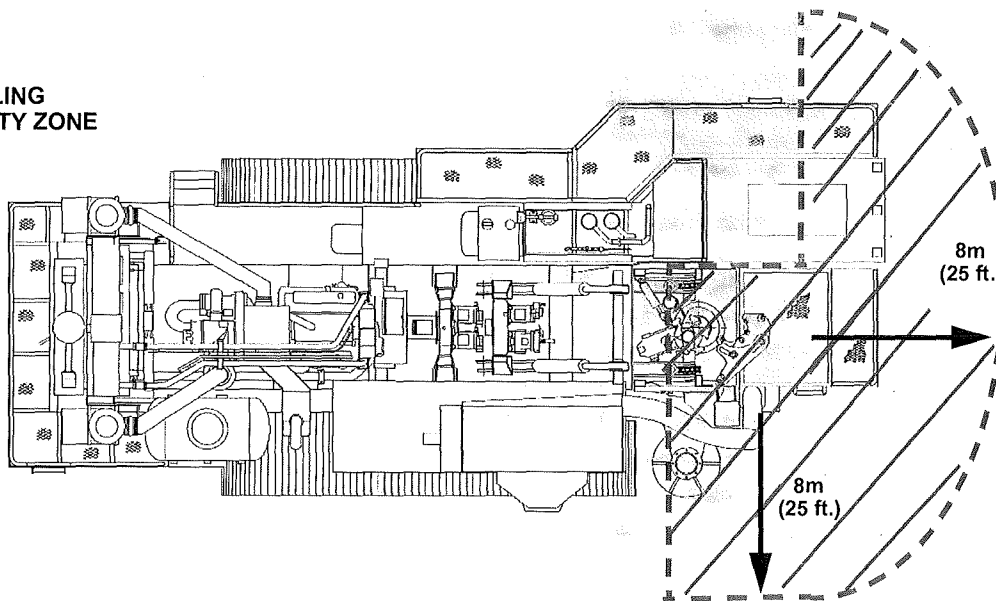
 WARNING	
	<p>It is forbidden for personnel to be in the traming area while the drill is in motion.</p> <p>The operator has limited field of vision when traming.</p> <p>Always use a ground guide when traming the drill. Be sure the traming area is clear of all personnel before traming.</p>

TRAMMING
SAFETY ZONE

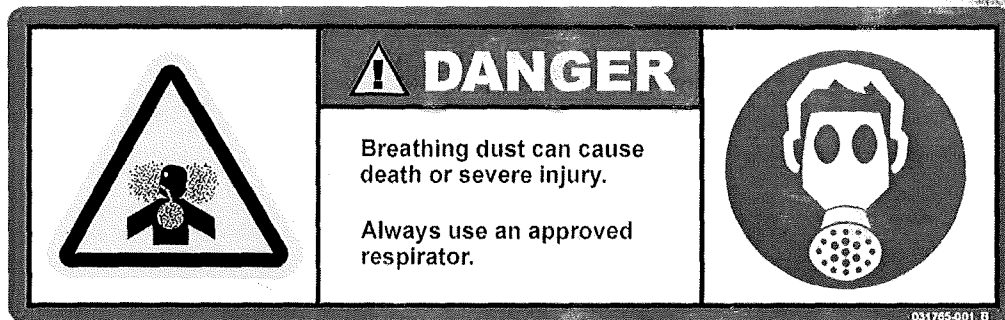


 WARNING	
	<p>While drilling, it is forbidden for personnel to be in the drilling area.</p> <p>Be sure the drilling area is clear of all personnel before drilling.</p>

DRILLING SAFETY ZONE



Dust



Do not operate this machine if the dust suppression system(s) are not in proper working order. Always use an approved respirator when making repairs or inspecting the dust suppression system(s).

Weather Hazards

The following safety precautions were developed to minimize the risk of injury during inclement weather when using Sandvik Mining drilling equipment.

All persons involved in the planning, operation and servicing of Sandvik Mining equipment **MUST** read and understand the following safety precautions, the manuals developed for this machine and the Safe Operating Practices outlined in the front of this manual.

While we believe that we have properly identified several potential hazards that could result in property damage or personnel injury, there are certain hazards which may be present that we have not contemplated.

Bad weather conditions as they relate to this topic include lightning, thunderstorms and severe rainfall.

Management's Responsibilities

High winds, rainfall and cloud cover are often precursors to actual cloud to ground strikes notifying individuals to take action. Many reported lightning accidents occur with sun, clear skies and no rain present at the beginning as the storm approaches because; people ignore these precursors. Generally the lightning threat diminishes with time after the last sound of thunder, but may persist for more than 30 minutes.

It is the responsibility of management to:

- Be aware of daily weather conditions within a 161 km (100 mile) radius of the mine property.
- Determine a plan of action relating to expected bad or unexpected weather conditions.
- Notify equipment operators of impending storms. Communication to equipment operators may be given via two way radio and/or in person.
- Consider that drill operators need ample time to:
 - Retrieve drill pipe from blastholes and well bottom.
 - Lower masts to a horizontal position or position feed rails into feed supports.
 - Give the drill engine an adequate cool down period prior to shutting machine down.
 - Leave machine cabin or operator platform and transport to central meeting location.
- Give equipment operators an all clear signal after the storm has cleared the area.

NOTE: Supervisors! Recognize that equipment operators should be given adequate time to prepare the machine to move to specific locations for safe keeping. Crawler mounted drill machines have a maximum travel speed not exceeding 4.2 kph (2.6 mph).

Rainfall And Flooding

When notified of an impending storm, machine operators should:

- Move the drill machine to higher ground conditions. Never leave a drill machine at the lowest floor position of a mine or quarry or in a low lying ditch that could trap water runoff.
- Move the drill machine to stable ground and away from unstable crests or the face. Never leave a drill machine on the front face of the drill pattern while rain and severe weather pose a threat of loose ground falls or washouts.
- When operating machines in a construction application, equipment operators shall move the drill machine to higher stable ground. Never leave a drill machine in any construction zone roadway, river bed or drainage ditch.
- Move the drill machine to stable ground away from high walls and any threat where rock or water erosion may allow unstable ground to fall or slide.

Thunderstorms And Lightning

A publication written in MSHA Holmes Safety Association Bulletin April 2001 gives a simple flash bang formula to calculate lightning proximity.

The FLASH BANG method is determined by counting the seconds between the visible lightning and the sound of thunder. This delay in seconds when divided by 5 will give an approximate value in miles as to how close the active lightning is to your worksite.

Example: when you see lightning and it takes (10) ten seconds to hear the thunder divide by (5) five. The approximate distance of lightning proximity is 3.2 km (2 miles).

If the flash bang measurement is 30 seconds or less seek shelter immediately and remain indoors, away from electrical devices, water and metal components.

Supervisors must notify equipment operators in a timely manner. This is to allow the drill operator adequate time to perform the required operation principals needed and secure the machine in a safe manner.

- Equipment operators shall retrieve drill pipe from blastholes, secure drilling tools and lower mast to a horizontal position into the mast rest supports. Understand that the mast in a vertical position with drill pipe in the ground is capable of attracting high voltage lightning.

NOTE: *If the operator and machine are inside or near a blast area follow procedures written in USA Federal Metal and Nonmetal Mine Safety Standards 30CFR 56/57/58 manual.*

- Equipment operators shall move the machine to secure ground as noted in the rainfall and flooding description.
- Equipment operators shall give adequate engine cool down period prior to shutting machine down. Adequate engine cool down periods range between 3 to 5 minutes. Follow engine manufacture specifications as a standard.
- Equipment operators shall secure the machine, close doors and windows, leave the machine cabin and dismount the machine in a proper 3 point contact with the boarding ladder.
- Equipment operators shall drive or be transported to a central meeting location away from bad weather and storm conditions.

There are exceptions to the rules when bad weather develops and time does not permit adequate machine preparation - shutdown principals.

Exceptions

If you do get caught in an electrical storm and have little or no time to prepare, remember that, no place is absolutely safe from the lightning threat, however, some places are safer than others.

When operators are inside an enclosed stable structure such as a machine cabin or the truck cab it is recommended that:

- all windows are closed
- all doors closed
- do not touch metal parts
- do not use two way radio communication

NOTE: *Wait inside the enclosed cab as long as it takes for the storm or lightning to subside. Do not attempt to dismount the machine when lightning is in your immediate work area.*

- If lightning is present within a 32 km (20 mile) radius of your location be aware of your surroundings when outdoors. Seek adequate shelter immediately.
- If lightning is present within the 32 km (20 mile) radius, and a decision is made to dismount the machine, use a standard 3 point contact down the boarding ladder to dismount the machine.
- Move away from the machine quickly and into a enclosed vehicle or adequate shelter. Maintain a distance greater than 92 m (100 yards) to prevent electrical draw in the event lightning did strike the mining equipment.
- Static interference on AM radio channels is another indicator as to lightning proximity.
- Lightning detectors are available aftermarket as a measuring instrument to determine lightning proximity. Blasting crews are aware of lightning hazards and may have a lightning detector on site.
- If you are caught in the open with lightning nearby and shelter is not available the safest position to be in is to be crouched down on the balls of your feet. Keep your feet as close to one another as possible.

- Do not allow your hands (or other body parts) to touch the ground. Use your hands to cover your ears and brace for a loud thunderous bang.
- Lightning struck victims carry no electrical charge and should be given first aid treatment immediately!

Machine Maintenance

If lightning does strike a drill machine parked in any position (mast up or down), expect major component failures. A total machine inspection is in order.

Electrical charge should dissipate immediately after impact.

Prior to climbing on board a machine known to have been struck by lightning use the back side of either hand (knuckle side) to lightly touch the boarding ladder.

Reference Material

- MSHA Holmes Safety Association Bulletin April 2001
- Federal Metal and Non-metallic Mine Safety and Health Standards 30CRF 56/57/58 Ninth Edition (1999).
- National weather service (www.noaa.gov)

Hydraulic Pressure Release



Hydraulic circuits maintain pressure after the machine is shutdown. If maintenance to a hydraulic component or hose is to be done, relieve the pressure in the hydraulic system.



Prior to opening a valve hose fitting or removal of a valve assembly note the following:

- Gloves and PPE are worn.
- Release the hydraulic pressure at the hydraulic tank.
- Do not check for leaks with hands.
- The technician must release the hydraulic hose fittings slowly at first to minimize potential high pressure hydraulic oil or PSO pressure squirting out through the hose fitting. Oil will drain out the loosened hose fitting.
- With the hose fitting slightly loose, manually rock the hose from side to side.

- Slowly open the hydraulic hose fitting and alternate the hose fitting to release residual hydraulic oil pressure while maintaining a barrier between the hydraulic fitting and technician.

 WARNING	
	<p>FALLING LOAD HAZARD</p> <p>Breaking a supporting cylinder hydraulic line may allow the supported load to fall causing personnel injury or death.</p> <p>When working with cylinders and any apparent loads they may hold, MECHANICALLY SUPPORT AND SECURE the load prior to performing any repair work.</p> <p>NEVER attempt to work on hydraulic cylinders without adequate safety training. Refer to bulletin SB243A for more information.</p>



Hydraulic pressures may be trapped in the hydraulic system by design. For example the residual pressure may be holding a load. A cylinder with attached components such as the rotary head and drill pipe weight, require some means of residual pressure to hold the oil in check thus holding the load. Removing the pressure may lead to a falling load and a potential safety condition.

1. Determine if mast is vertical or horizontal.
 - If vertical, lock and support the rotary head in position so that it cannot fall.
 - If horizontal, lock the rotary head into position so it does not move.
2. Disconnect the pilot line to the valve.
3. Connect a portable hydraulic pump to the pilot line input on the valve.
4. Pump the portable hydraulic pump to achieve sufficient pressure to open the holding valve and discharge pressure between the holding valve and the cylinder.
5. After pressure has been released, disconnect hose slowly and drain off any residual oil and pressure. Have a pan beneath the valve to catch spilled oil.

Contact your Sandvik representative for a copy of service bulletin SB243A for more information on releasing stored hydraulic circuit pressures.

Fire Safety

Fire Prevention

 DANGER	
	<p>FIRE HAZARD!</p> <p>Smoking and open flame are prohibited in the vicinity of this machine.</p>

Access to fire fighting equipment must be available at all times, particularly during maintenance and repair work.



All fire fighting equipment has to be inspected and serviced regularly and according to local regulations. Damaged fire fighting equipment or partially used fire fighting equipment, have to be exchanged immediately.

All personnel must be trained regularly in fire fighting methods in cooperation with local authorities and rescue organizations. Personnel must also be familiar with various types of fires and the appropriate fire fighting methods. Be aware that some fires must not be extinguished with water.

Flammable products on this machine include:

- Gases emitted from batteries
- Diesel fuel and its vapors
- Hydraulic oil
- Engine oil
- Compressor oil
- Engine starting fluid

Further preventive measures include:

 WARNING	
	<p>FIRE HAZARD!</p> <p>Vegetation, coal dust, oily surfaces, and oily rags can catch fire and cause serious injury or death.</p> <p>Keep the machine clean of vegetation, coal dust, oil, and oily rags.</p>

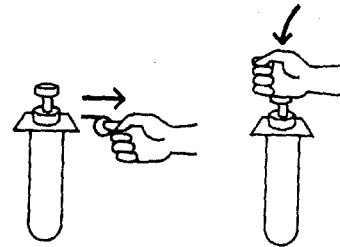
- Clean-up any oil and fuel spills particularly around hot surfaces and heat producing components.
- Check the Fire Suppression System (FSS), if fitted, for damaged hoses or cylinders.
- Check all electrical lines and connections including battery terminals for a tight fit, wear, abrasion, and corrosion.
- Do not use the drilling machine in oil, gas or water well operations unless the well head is properly equipped with blow-out preventers and safety equipment required by law or as recommended in the American Petroleum Institute's document API 54.
- Check all machine ignition points (engine block, exhaust manifolds, mufflers, turbo-chargers, etc.) to make sure they are not in contact with any hoses.
- Keep the batteries secured in their compartment and covered.
- Never inject ether or other starting aids into the engine and compressor intake filter(s). Ether or other aids drawn into the compressor can cause an explosion.
- Do not store flammable fluids on or in the immediate vicinity of the machine.
- Engine oil, hydraulic fluid and compressor oil are flammable. Do not operate a machine with leaking or worn hoses or lines.
- Do not clean washable filter elements with flammable solvents, diesel fuel, kerosene, or gasoline.
- Do not attempt to perform welding repairs until all flammable materials including oil and fuel spills oily rags, and rock and coal dust, have been isolated or removed from the machine.
- Disconnect the battery cables before welding on the machine.
- Keep tools away from exposed live electrical parts such as terminals, to avoid arcing.
- If charging the batteries, always turn the charger off before making or breaking connections to the battery.
- The compound (ethyl ether) used in the engine starting aid system is extremely flammable. Changing the cylinders and servicing this system should be done in a well ventilated area. Do not store or install the cylinders in temperatures above 71° C (160° F).
- The anti-freeze compound (methanol) used in the air line anti-ice systems is flammable. Refill the system with compound only in well ventilated areas, away from heat, open flames and sparks. Do not store or expose this system or the compound to temperatures above 65° C (150° F), or in direct sunlight.

Fire Suppression

IN CASE OF FIRE

When a fire starts, the way you react is very important. As soon as you become aware of a fire, do the following four things:

1. Turn the machine off.
2. Quickly actuate the fire suppression system by pulling the safety ring pin and pushing down the plunger on the actuator.
3. Get away from the machine. Take a hand portable extinguisher along if you can.
4. Stand by with the hand portable extinguisher.



RESULTS

- If you leave the machine running, it may add fuel to the fire or restart the fire with sparks.
- React quickly so the fire is caught before it grows too large.
- By leaving the immediate fire area, you protect yourself from windblown flames, explosions or other dangers created by the fire.
- Heat remaining from the fire could cause reignition after the fire suppression system has discharged. Because of this, it is important that someone stand by, at a safe distance, with a hand portable extinguisher. This standby should be maintained until all possibility of reignition is past.
- Read the attached documents concerning the fire suppression system specific to your drill. Exposure to the fire suppression chemical use during a fire may be a hazard to your health.

Ansul Checkfire 210 Detection and Actuation System

This equipment is monitored with a CHECKFIRE 210 Detection and Actuation System which is typically connected to an ANSUL's A-101 or LVS Fire Suppression System for 24-hour fire suppression. The operator of the equipment should be provided with hands-on training by Authorized ANSUL Distributors or the end user.

This section is a quick-reference guide for basic operation of the CHECKFIRE 210 System. Two buttons on the display module and manual actuators provide operator control.

IN CASE OF FIRE: Manual Actuation

1. Safely bring equipment to complete stop, set brake and shut off engine.
2. Break visual seal and open guard door.
3. Push the red "PUSH To Activate Alarm When Lit" button.
4. Release circuit immediately activates the connected fire suppression system (if included, pressure switch activates auxiliary operation). See Note below.
5. Safely exit equipment and stand-by with supplemental firefighting equipment.
6. Optional manual actuation: Pull ring pin and strike red button on electric or pneumatic manual actuator.

NOTE: The red "PUSH To Activate Alarm When Lit" LED and sounder remain steady-on for 10 sec. during initiation (release) of fire suppression system. Post release: Detection 1 and/or Detection 2, Shutdown, and Release LEDs and sounder continue to pulse 1 x 10 sec. If safe to re-enter equipment, push "DELAY/Reset/Silence" button to silence sounder for two hours.

IN CASE OF FIRE: Automatic System Operation

1. Detector(s) registers alarm condition in hazard area and initiates the time delay notification on display module.
2. "PUSH To Activate Alarm When Lit" plus Detection 1 and/or Detection 2 LEDs plus sounder:
 - a. Pulse 2 x 1 sec. until last 5 sec. of TD1.
 - b. Then pulse 4 x 1 sec. with Shutdown LED at start of final 5 sec. (See DELAY/RESET/SILENCE

- (grey) button below for TD1 restart).
- c. Only Shutdown LED is steady-on for 1 sec. indicating TD1 transferring to TD2 (restart no longer available).
 - d. Pulse 4 x 1 sec. with Shutdown LED during TD2.
 - e. Steady-on 1 0 sec. with Shutdown LED during initiation (release) of fire suppression system (if included, pressure switch activates auxiliary operation).
3. As soon as time delay begins: Safely stop equipment, set brake, shut off engine, and exit. Standby with supplemental firefighting equipment.
 4. Post release: LEDs and sounder pulse 1 x 10 sec.

DELAY/RESET/SILENCE (Gray) Button



1. Restart Time Delay: Press and release for each restart of TD1 during alarm condition. (Limit: 2 restarts or Unlimited.)
2. Must be initiated before last second of TD1. (No response after TD1 until post release.)

NOTE: Press and hold will not extend time delay period.

3. Silence sounder (post discharge or fault notification) for two hours: Press and release to silence sounder; LED fault indication will continue until fault is cleared. Any new fault or detection event will reactivate sounder.

FRONT PANEL INDICATORS

1. Power LED
 - Green steady-on indicates normal external power.
 - Green pulsing 1 x 3 sec. indicates normal Internal power.
 - Amber pulsing 1 x 3 sec. indicates external power fault; system is operating on internal power. Contact Authorized ANSUL Service Technician.
 - Amber pulsing 1 x 1 0 sec. with sounder indicates internal or external power fault. Contact Authorized ANSUL Distributor for service.
 - Off indicates no system power. Contact Authorized ANSUL Distributor for service.
2. All other LEDs
 - LED off indicates normal status.
 - Amber or red pulsing with sounder: Contact Authorized ANSUL Distributor for service.

 WARNING	
	<p>FIRE HAZARD!</p> <p>Any fault indication may cause the fire detection and actuation system to not function properly.</p> <p>Immediately contact an Authorized ANSUL Distributor for service.</p>

Maintenance Information

Before carrying out any maintenance on this product, read and understand the information given in the Maintenance Manual. Make sure that you have the skills and authority needed before starting any maintenance work. The Maintenance Manual supports maintenance personnel in respect of preventive maintenance for this product. Section 4 provides instructions for periodic Mechanical Inspections to the maintenance and operating personnel for components and equipment installed.

Ensure all necessary electrical, hydraulic and air isolations (see 'Isolation and Energy Dissipation') have been carried out prior to starting any maintenance work. Also ensure that necessary original spare parts or materials are available, or can be ordered and supplied in time to meet the work schedule. Note all completed maintenance activities in a maintenance log or maintenance program.

The operator of this machine is also required to perform a series of maintenance tasks before beginning his shift. Section 5 of the Operator's Manual contains the Operator Maintenance Check List and description of how maintenance tasks requiring a low level of technical skill should be carried out.

Maintenance tasks requiring a high level of technical skill include:

- Hydraulic maintenance
- Electrical maintenance
- Crawler maintenance
- Engine maintenance
- Compressor maintenance

Environment

Sandvik actively considers environmental concerns when designing and manufacturing its products. Our equipment is designed to burden the environment as little as possible; examples; the vibration, noise, exhaust, and lubrication/additive emissions of the machine have been minimized. The manufacturing process for our equipment has been designed so that recycled materials are used as much as possible, and the process quality and emissions are considered carefully in selection of the subcontractors. There is an ongoing aim of continually lowering the emissions from the machining of metal, and from painting and assembling this equipment.

These instructions that follow are not binding, but they offer suggestions for appropriate waste disposal procedures. Local authorities always have more detailed instructions and recommendations on the disposal of different materials.

If a known pollutant is accidentally released into the environment, the local authorities must be notified immediately.

Destruction

The end user of the equipment is responsible for its decommissioning. If the end user does not have the ability or the resources to disassemble the equipment, the work must be performed by someone who does possess the necessary knowledge and skills.

Recycling

The equipment body, all the steel constructions, and the copper and aluminum in the electrical wiring are recyclable. The metals can be melted and used as raw material for new products, except for parts that have been in contact with substances that are regarded as hazardous waste. The contaminated parts can usually be simply cleaned or rinsed, after which they can be recycled.

Most plastic parts are recyclable, similarly to the metals. Each plastic part carries information on the material used and a manufacturing date, which can be used for determining whether the part can be recycled.

Disposal

Follow all local laws and regulations when disposing of used machine components.

- Rubber parts are not regarded as hazardous, and they can be disposed of according to normal procedures. Tubes (hydraulics etc.) must be cleaned before they are disposed of.

- Liquids such as fuel and oils should never be drained without suitable catch bins and containers.
- Windshields and other cabin windows are not accepted for conventional glass recycling, but they can be disposed of via normal waste disposal methods.
- Electrical components that are classified as hazardous waste (accumulators, batteries, circuit boards) and other hazardous waste must be delivered to a licensed waste treatment location or be disposed of according to local regulations.
- Air conditioning units, which contain CFC and HCFC compounds, must always be delivered for treatment to a licensed waste disposal facility.

Incident Reporting

If an accident or near-miss occurs with this product, contact your regional Sandvik office. When you contact the office be sure to include the following information:

- Were personnel injured?
- The conditions and potential hazards at the machine location.
- The serial number of the machine.
- Detailed photographs or videos of the incident scene.
- The incident report from the mine operator.

Safe Operating Principals

- Follow local and Governmental Safety regulations.
- Designate a lead assembly person for the assembly process.
- Perform a site specific risk analysis prior to commencing machine assembly.
- Follow the guidelines prescribed in this manual for assembly and commissioning the new drill machine.
- File the required commissioning paperwork as needed to the proper authorities.

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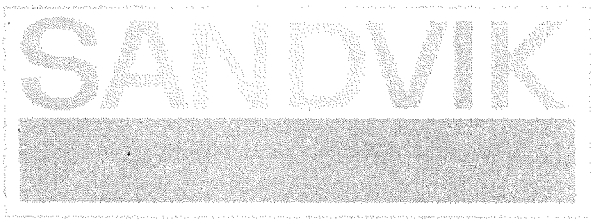
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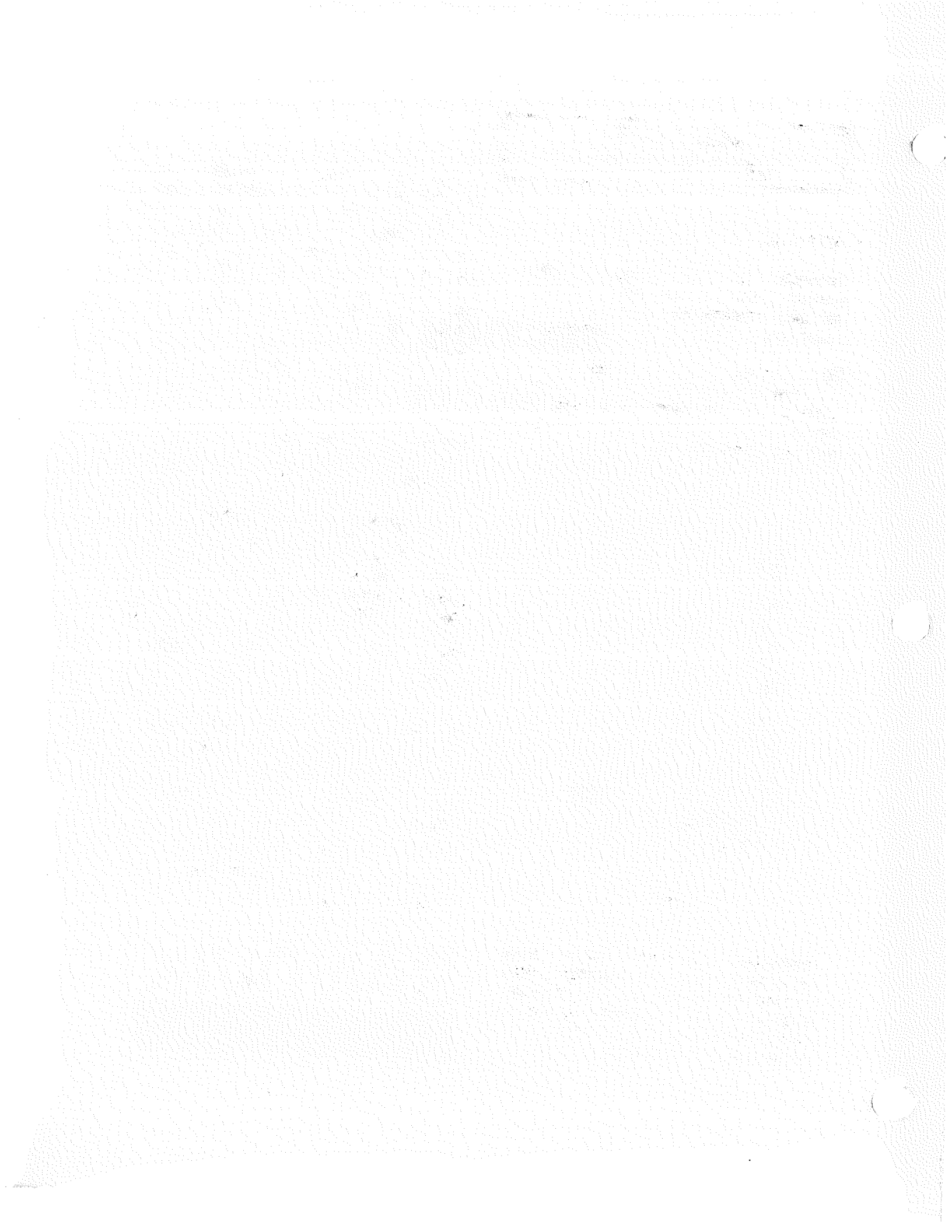
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SECTION 1

INTRODUCTION



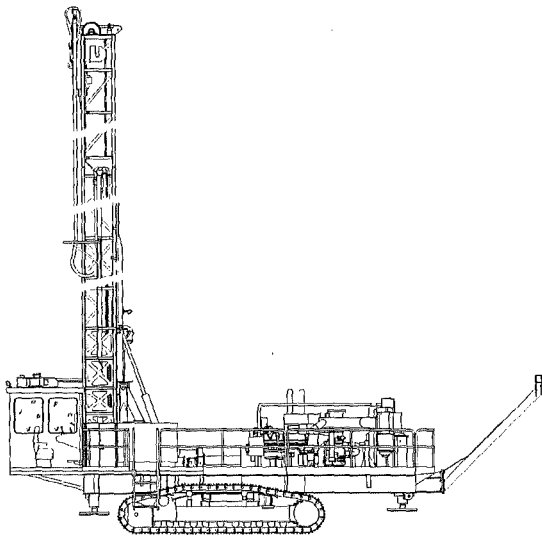


SECTION 1 INTRODUCTION

GENERAL

This manual provides a step-by-step guide to servicing your drill. A thorough study of this manual is recommended before operation or maintenance of the machine is attempted.

Experience indicates that the procedures described herein are preferred practices and that failure to comply with them can materially shorten the useful life of the equipment and/or reduce its standard performance.



D55SP

Some photographs in this manual may show details or attachments that are different from your unit, due to optional equipment and/or advancement of product design. Contact your Driltech dealer for details of lubrication or maintenance not covered in this publication.

The parts manual should be referred to when it is necessary to order repair parts. For prompt and efficient parts service, contact your Sandvik Mining dealer, giving the model and serial number of the machine, along with the part number and description of the items required, as their personnel are fully qualified to assist and advise you on any service or operational problems that may be encountered. Sandvik Mining Field Representatives are also available to you for advice and assistance on special problems.

MACHINE SPECIFICATIONS

Recommended Operating Conditions



The installation and use of unauthorized components or modifications to the original design of this rig may cause personal injury or death.

Do not modify or install aftermarket components to this rig without approval from Sandvik Mining.

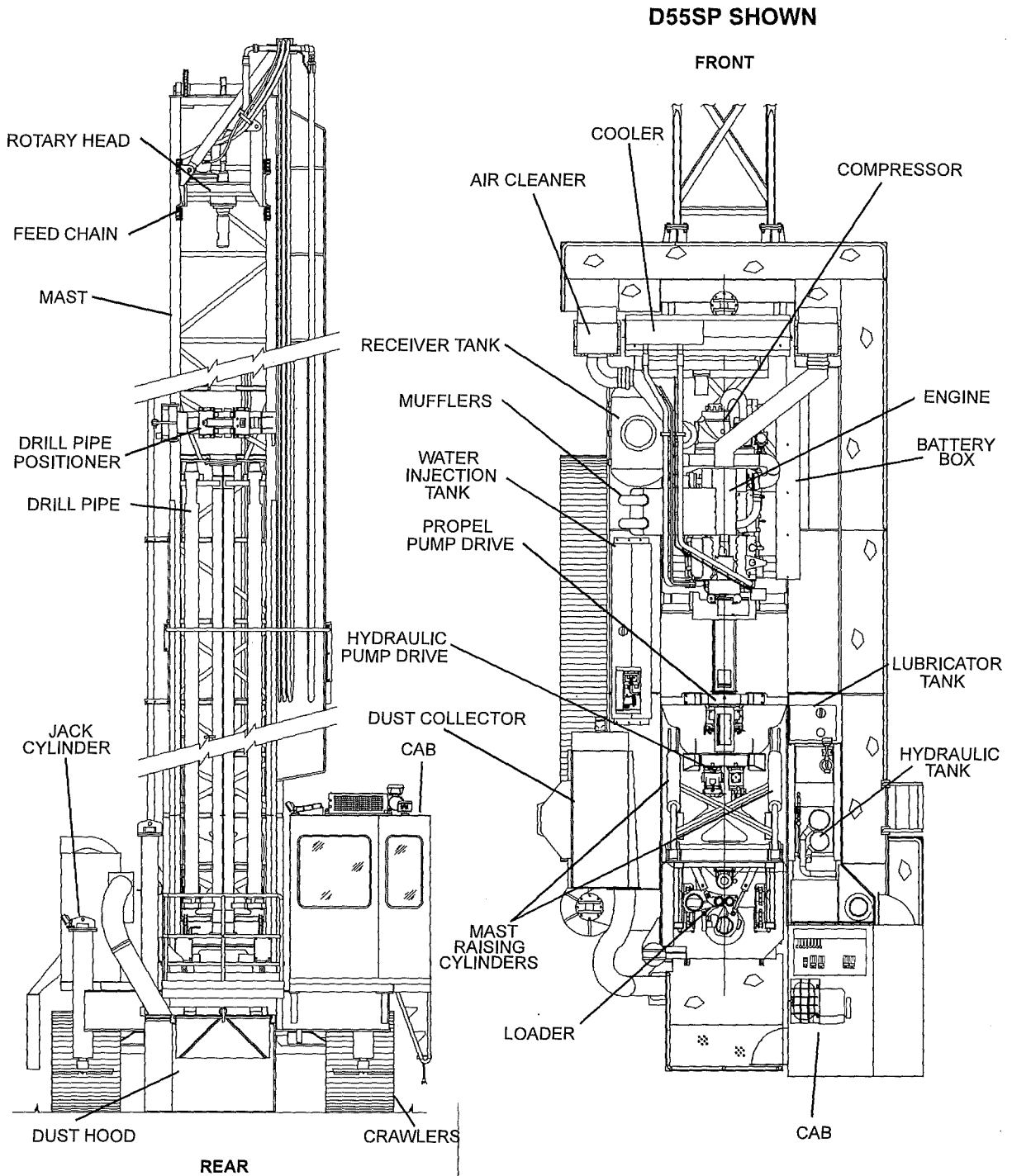
This machine was designed to operate at ambient temperatures of -40°C to $+54^{\circ}\text{C}$ (-40°F to $+130^{\circ}\text{F}$).

Manners and Conditions In Which This Machine Should NOT Be Used

- Inadequate training of operator.
- Unauthorized persons in working area.
- Inadequate lighting.
- Inadequate grading.
- Transporting people.
- Defective safety systems.

NOMENCLATURE/TERMINOLOGY

The terms used on this illustration are used throughout this manual.



D55SP High Pressure (Caterpillar Engine - 1350 cfm) SPECIFICATIONS

<u>DRILL RATING</u>	
Hole Size	6-3/4" to 10" (171 - 254 mm)
Max. 1st pass capacity (Std. tooling)	55' (16.76m)
Total Depth Capacity	105' (32m)
<u>UNDERCARRIAGE</u>	
Type	Caterpillar® - Model 330SL
Length	19' 5" (5.92 m)
Pads (Shoes) Triple Grouser	33.5" (850 mm)
Travel Speed	1.5 mph (2.4 km/h)
Gradeability (Mast Down)	58% (approximately 30°)
Drive HP each track	160 hp (119 kW)
Ground Bearing Pressure (Std. Equipment)	8.7 psi (59.9 kPa)
Width Over Tracks	14' 3" (4.34 m)
Rollers	13 Lower - 2 Upper
<u>DRILL POWER</u>	
Caterpillar	Model 3412E 860 hp (641 kW) 2100 rpm Model C27 800 hp (596 kW) 1800 rpm
Fuel Capacity	600 gallons US (2274 l)
<u>COMPRESSOR</u>	
Type	Two Stage Oil Flooded Screw Type
Manufacturer	Sullair 1350cfm (38.2 m³m) @ 350 psi (24.1 bar)
<u>FEED SYSTEM</u>	
Type	1 Hydraulic Cylinder and Chains
Rated Bit Loading	55,000 lbs (24948 kg)
Rated Pullback	21,680 lbs (9834 kg)
Feed Rate	0-139 fpm (42.4 mpm)
Retract Rate	0-171 fpm (52 mpm)
<u>ROTARY HEAD</u>	
Type	Gear Case Type
Drive Motor	Hydraulic Axial Piston
Maximum Rotary Horsepower	120 hp (89.5 kW)
Standard Rotary Speed/Torque	130 rpm @ 87,130 in-lbs (9846 Nm)
Optional Rotary Speed/Torque	150 rpm @ 72,000 in-lbs (8136 Nm)
<u>TOOL HANDLING EQUIPMENT (Loader)</u>	
Type	Two Single Pocket Swing Type
Number of Positions	1 each
Pipe Sizes	6-1/2" to 7-5/8" (165 to 194 mm)
<u>WEIGHT</u>	
Operating Weight w/Drill Pipe	122,000 lbs (55339 kg)
<u>DIMENSIONS</u>	
Length (mast down)	74'-3" (22.63 m)
Width (operating)	16' 7" (5.05 m)
Height (mast up)	75' 8" (23.06 m)
Height (mast down)	17' 6" (5.33 m)
<u>ELECTRICAL</u>	
Alternator	24VDC 100amp
Air Conditioner	24VDC
Batteries	4 Size 8D @ 12 Volt - 1350 CCA

D55SP High Pressure (Cummins Engine - 1150 cfm) SPECIFICATIONS

<u>DRILL RATING</u>	
Hole Size	6-3/4" to 10" (171 - 254 mm)
Max. 1st pass capacity (Std. tooling)	55' (16.76m)
Total Depth Capacity	105' (32m)
<u>UNDERCARRIAGE</u>	
Type	Caterpillar® - Model 330SL
Length	19' 5" (5.92 m)
Pads (Shoes) Triple Grouser	33.5" (850 mm)
Travel Speed	1.5 mph (2.4 km/h)
Gradeability (Mast Down)	58% (approximately 30°)
Drive HP each track	160 hp (119 kW)
Ground Bearing Pressure (Std. Equipment)	8.7 psi (59.9 kPa)
Width Over Tracks	14' 3" (4.34 m)
Rollers	13 Lower - 2 Upper
<u>DRILL POWER</u>	
Cummins	Model QSK19C 650 hp (485 kW)
Rated Speed	1800 rpm
Fuel Capacity	600 gallons US (2274 l)
<u>COMPRESSOR</u>	
Type	Two Stage Oil Flooded Screw Type
Manufacturer	Sullair 1150cfm (32.8 m³m) @ 350 psi (24.1 bar) @ 1800 rpm
<u>FEED SYSTEM</u>	
Type	1 Hydraulic Cylinder and Chains
Rated Bit Loading	55,000 lbs (24948 kg)
Rated Pullback	21,680 lbs (9834 kg)
Feed Rate	0-139 fpm (42.4 mpm)
Retract Rate	0-171 fpm (52 mpm)
<u>ROTARY HEAD</u>	
Type	Gear Case Type
Drive Motor	Hydraulic Axial Piston
Maximum Rotary Horsepower	120 hp (89.5 kW)
Standard Rotary Speed/Torque	130 rpm @ 87,130 in-lbs (9846 Nm)
Optional Rotary Speed/Torque	150 rpm @ 72,000 in-lbs (8136 Nm)
<u>TOOL HANDLING EQUIPMENT (Loader)</u>	
Type	Two Single Pocket Swing Type
Number of Positions	1 each
Pipe Sizes	6-1/2" to 7-5/8" (165 to 194 mm)
<u>WEIGHT</u>	
Operating Weight w/Drill Pipe	122,000 lbs (55339 kg)
<u>DIMENSIONS</u>	
Length (mast down)	74'-3" (22.63 m)
Width (operating)	16' 7" (5.05 m)
Height (mast up)	75' 8" (23.06 m)
Height (mast down)	17' 6" (5.33 m)
<u>ELECTRICAL</u>	
Alternator	24VDC 100amp
Air Conditioner	24VDC
Batteries	4 Size 8D @ 12 Volt - 1350 CCA

D55SP High Pressure (Cummins Engine - 1350 cfm) SPECIFICATIONS

<u>DRILL RATING</u>	
Hole Size	6-3/4" to 10" (171 - 254 mm)
Max. 1st pass capacity (Std. tooling)	55' (16.76m)
Total Depth Capacity	105' (32m)
<u>UNDERCARRIAGE</u>	
Type	Caterpillar® - Model 330SL
Length	19' 5" (5.92 m)
Pads (Shoes) Triple Grouser	33.5" (850 mm)
Travel Speed	1.5 mph (2.4 km/h)
Gradeability (Mast Down)	58% (approximately 30°)
Drive HP each track	160 hp (119 kW)
Ground Bearing Pressure (Std. Equipment)	8.7 psi (59.9 kPa)
Width Over Tracks	14' 3" (4.34 m)
Rollers	13 Lower - 2 Upper
<u>DRILL POWER</u>	
Cummins	Model QSK19C 750 hp (559 kW)
Rated Speed	2100 rpm
Fuel Capacity	600 gallons US (2274 l)
<u>COMPRESSOR</u>	
Type	Two Stage Oil Flooded Screw Type
Manufacturer	Sullair 1350cfm (38.2 m³m) @ 350 psi (24.1 bar) @ 2100 rpm
<u>FEED SYSTEM</u>	
Type	1 Hydraulic Cylinder and Chains
Rated Bit Loading	55,000 lbs (24948 kg)
Rated Pullback	21,680 lbs (9834 kg)
Feed Rate	0-139 fpm (42.4 mpm)
Retract Rate	0-171 fpm (52 mpm)
<u>ROTARY HEAD</u>	
Type	Gear Case Type
Drive Motor	Hydraulic Axial Piston
Maximum Rotary Horsepower	120 hp (89.5 kW)
Standard Rotary Speed/Torque	130 rpm @ 87,130 in-lbs (9846 Nm)
Optional Rotary Speed/Torque	150 rpm @ 72,000 in-lbs (8136 Nm)
<u>TOOL HANDLING EQUIPMENT (Loader)</u>	
Type	Two Single Pocket Swing Type
Number of Positions	1 each
Pipe Sizes	6-1/2" to 7-5/8" (165 to 194 mm)
<u>WEIGHT</u>	
Operating Weight w/Drill Pipe	122,000 lbs (55339 kg)
<u>DIMENSIONS</u>	
Length (mast down)	74'-3" (22.63 m)
Width (operating)	16' 7" (5.05 m)
Height (mast up)	75' 8" (23.06 m)
Height (mast down)	17' 6" (5.33 m)
<u>ELECTRICAL</u>	
Alternator	24VDC 100amp
Air Conditioner	24VDC
Batteries	4 Size 8D @ 12 Volt - 1350 CCA

D55SP Low Pressure (Cummins Engine - 1600 cfm) SPECIFICATIONS

<u>DRILL RATING</u>	
Hole Size	6-3/4" to 10" (171 - 254 mm)
Max. 1st pass capacity (Std. tooling)	55' (16.76m)
Total Depth Capacity	105' (32m)
<u>UNDERCARRIAGE</u>	
Type	Caterpillar® - Model 330SL
Length	19' 5" (5.92 m)
Pads (Shoes) Triple Grouser	33.5" (850 mm)
Travel Speed	1.5 mph (2.4 km/h)
Gradeability (Mast Down)	58% (approximately 30°)
Drive HP each track	160 hp (119 kW)
Ground Bearing Pressure (Std. Equipment)	8.7 psi (59.9 kPa)
Width Over Tracks	14' 3" (4.34 m)
Rollers	13 Lower - 2 Upper
<u>DRILL POWER</u>	
Cummins	Model QSK19C 650 hp (485 kW)
Rated Speed	1800 rpm
Fuel Capacity	600 gallons US (2274 l)
<u>COMPRESSOR</u>	
Type	Single Stage Oil Flooded Screw Type
Manufacturer	Sullair 1600cfm (45 m³m) @ 100 psi (6.9 bar) @ 1800 rpm
<u>FEED SYSTEM</u>	
Type	1 Hydraulic Cylinder and Chains
Rated Bit Loading	55,000 lbs (24948 kg)
Rated Pullback	21,680 lbs (9834 kg)
Feed Rate	0-139 fpm (42.4 mpm)
Retract Rate	0-171 fpm (52 mpm)
<u>ROTARY HEAD</u>	
Type	Gear Case Type
Drive Motor	Hydraulic Axial Piston
Maximum Rotary Horsepower	120 hp (89.5 kW)
Standard Rotary Speed/Torque	130 rpm @ 87,130 in-lbs (9846 Nm)
Optional Rotary Speed/Torque	150 rpm @ 72,000 in-lbs (8136 Nm)
<u>TOOL HANDLING EQUIPMENT (Loader)</u>	
Type	Two Single Pocket Swing Type
Number of Positions	1 each
Pipe Sizes	6-1/2" to 7-5/8" (165 to 194 mm)
<u>WEIGHT</u>	
Operating Weight w/Drill Pipe	122,000 lbs (55339 kg)
<u>DIMENSIONS</u>	
Length (mast down)	74'-3" (22.63 m)
Width (operating)	16' 7" (5.05 m)
Height (mast up)	75' 8" (23.06 m)
Height (mast down)	17' 6" (5.33 m)
<u>ELECTRICAL</u>	
Alternator	24VDC 100amp
Air Conditioner	24VDC
Batteries	4 Size 8D @ 12 Volt - 1350 CCA

D55SP Low Pressure (Cummins Engine - 2000 cfm) SPECIFICATIONS

<u>DRILL RATING</u>	
Hole Size	6-3/4" to 10" (171 - 254 mm)
Max. 1st pass capacity (Std. tooling)	55' (16.76m)
Total Depth Capacity	105' (32m)
<u>UNDERCARRIAGE</u>	
Type	Caterpillar® - Model 330SL
Length	19' 5" (5.92 m)
Pads (Shoes) Triple Grouser	33.5" (850 mm)
Travel Speed	1.5 mph (2.4 km/h)
Gradeability (Mast Down)	58% (approximately 30°)
Drive HP each track	160 hp (119 kW)
Ground Bearing Pressure (Std. Equipment)	8.7 psi (59.9 kPa)
Width Over Tracks	14' 3" (4.34 m)
Rollers	13 Lower - 2 Upper
<u>DRILL POWER</u>	
Cummins	Model QSK19C 750 hp (559 kW)
Rated Speed	1800 rpm
Fuel Capacity	600 gallons US (2274 l)
<u>COMPRESSOR</u>	
Type	Single Stage Oil Flooded Screw Type
Manufacturer	Sullair 2000cfm (56.6 m³m) @ 100 psi (6.9 bar) @ 1800 rpm
<u>FEED SYSTEM</u>	
Type	1 Hydraulic Cylinder and Chains
Rated Bit Loading	55,000 lbs (24948 kg)
Rated Pullback	21,680 lbs (9834 kg)
Feed Rate	0-139 fpm (42.4 mpm)
Retract Rate	0-171 fpm (52 mpm)
<u>ROTARY HEAD</u>	
Type	Gear Case Type
Drive Motor	Hydraulic Axial Piston
Maximum Rotary Horsepower	120 hp (89.5 kW)
Standard Rotary Speed/Torque	130 rpm @ 87,130 in-lbs (9846 Nm)
Optional Rotary Speed/Torque	150 rpm @ 72,000 in-lbs (8136 Nm)
<u>TOOL HANDLING EQUIPMENT (Loader)</u>	
Type	Two Single Pocket Swing Type
Number of Positions	1 each
Pipe Sizes	6-1/2" to 7-5/8" (165 to 194 mm)
<u>WEIGHT</u>	
Operating Weight w/Drill Pipe	122,000 lbs (55339 kg)
<u>DIMENSIONS</u>	
Length (mast down)	74'-3" (22.63 m)
Width (operating)	16' 7" (5.05 m)
Height (mast up)	75' 8" (23.06 m)
Height (mast down)	17' 6" (5.33 m)
<u>ELECTRICAL</u>	
Alternator	24VDC 100amp
Air Conditioner	24VDC
Batteries	4 Size 8D @ 12 Volt - 1350 CCA

D60KS Low Pressure (Caterpillar and Cummins Engine - 2000 cfm) SPECIFICATIONS

<u>DRILL RATING</u>	
Hole Size	9" to 11" (228 - 279 mm)
Max. 1st pass capacity (Std. tooling)	33' 6" (10.2m)
Max. 1st pass capacity (Special tooling)	36' 6" (11.1m)
Total Depth Capacity	175' (53m)
<u>UNDERCARRIAGE</u>	
Type	Caterpillar® - Model 330EL
Length	17' 5" (5.31 m)
Pads (Shoes) Triple Grouser	33.5" (850 mm)
Travel Speed	1.5 mph (2.4 km/h)
Gradeability (Mast Down)	59% (approximately 28°)
Drive HP each track	160 hp (119 kW)
Ground Bearing Pressure (Std. Equipment)	10.9 psi (75.1 kPa)
Width Over Tracks	14' (4.27 m)
Rollers	11 Lower - 2 Upper
<u>DRILL POWER</u>	
Caterpillar®	Model 3412E DITTA HEUI/ADEM 800 hp (597 kW)
Cummins	Model QSK19C 750 hp (559 kW)
Rated Speed	1800 rpm
Fuel Capacity	600 gallons US (2274 l)
<u>COMPRESSOR</u>	
Type	Single Stage Oil Flooded Screw Type
Manufacturer	Sullair 2000cfm (56.6 m³m) @ 100 psi (6.9 bar) @ 1800 rpm
<u>FEED SYSTEM</u>	
Type	2 Hydraulic Cylinders and Chains
Rated Bit Loading	60,000 lbs (27240 kg)
Rated Pullback	39,000 lbs (17706 kg)
Feed Rate	0-112 fpm (34,16 mpm)
Retract Rate	0-126 fpm (38,4 mpm)
<u>ROTARY HEAD</u>	
Type	Gear Case Type
Drive Motor	Hydraulic Axial Piston
Maximum Rotary Horsepower	190 hp (142 kW)
Standard Rotary Speed/Torque	97 rpm @ 124,700 in-lbs (14,091 Nm)
Optional Rotary Speed/Torque	78 rpm @ 154,200 in-lbs (17,425 Nm)
Optional Rotary Speed/Torque	117 rpm @ 103,180 in-lbs (11,659 Nm)
<u>TOOL HANDLING EQUIPMENT (Loader)</u>	
Type	Carousel (Inside Mast)
Number of Positions	4
Pipe Sizes	7" to 9-5/8" (178 to 244 mm)
<u>WEIGHT</u>	
Operating Weight w/Drill Pipe	130,000 lbs (58968 kg)
<u>DIMENSIONS</u>	
Length (mast down)	51' (15.54 m)
Width (operating)	16' 7" (5.05 m)
Height (mast up)	53' 7" (16.33 m)
Height (mast down)	17' 6" (5.33 m)
<u>ELECTRICAL</u>	
Alternator	24VDC 100amp
Air Conditioner	24VDC
Batteries	4 Size 8D @ 12 Volt - 1350 CCA

D75KS High Pressure (Caterpillar Engine - 1150 cfm) SPECIFICATIONS

<u>DRILL RATING</u>	
Hole Size	6" to 11" (152 - 279 mm)
Max. 1st pass capacity (Std. tooling)	33' 6" (10.2m)
Max. 1st pass capacity (Special tooling)	36' 6" (11.1m)
Total Depth Capacity	175' (53m)
<u>UNDERCARRIAGE</u>	
Type	Caterpillar® - Model 330EL
Length	17' 5" (5.31 m)
Pads (Shoes) Triple Grouser	33.5" (850 mm)
Travel Speed	1.5 mph (2.4 km/h)
Gradeability (Mast Down)	59% (approximately 28°)
Drive HP each track	160 hp (119 kW)
Ground Bearing Pressure (Std. Equipment)	10.9 psi (75.1 kPa)
Width Over Tracks	14' (4.27 m)
Rollers	11 Lower - 2 Upper
<u>DRILL POWER</u>	
Caterpillar®	Model 3412E DITTA HEUI/ADEM 650 hp (485 kW)
Rated Speed	1800 rpm
Fuel Capacity	600 gallons US (2274 l)
<u>COMPRESSOR</u>	
Type	Two Stage Oil Flooded Screw Type
Manufacturer	Sullair 1150cfm (32.8m³m) @ 350 psi (24.1 bar) @ 1800 rpm
<u>FEED SYSTEM</u>	
Type	2 Hydraulic Cylinders and Chains
Rated Bit Loading	75,000 lbs (34,050 kg)
Rated Pullback	43,400 lbs (19,658 kg)
Feed Rate	0-89 fpm (27 mpm)
Retract Rate	0-114 fpm (34.8 mpm)
<u>ROTARY HEAD</u>	
Type	Gear Case Type
Drive Motor	Hydraulic Axial Piston
Maximum Rotary Horsepower	190 hp (142 kW)
Standard Rotary Speed/Torque	97 rpm @ 124,700 in-lbs (14,091 Nm)
Optional Rotary Speed/Torque	78 rpm @ 154,200 in-lbs (17,425 Nm)
Optional Rotary Speed/Torque	117 rpm @ 103,180 in-lbs (11,659 Nm)
<u>TOOL HANDLING EQUIPMENT (Loader)</u>	
Type	Carousel (Inside Mast)
Number of Positions	4
Pipe Sizes	2 @ 5" (127 mm) 2 @ 7" (178 mm)
<u>WEIGHT</u>	
Operating Weight w/Drill Pipe	135,000 lbs (61,236 kg)
<u>DIMENSIONS</u>	
Length (mast down)	51' (15.54 m)
Width (operating)	16' 7" (5.05 m)
Height (mast up)	53' 7" (16.33 m)
Height (mast down)	17' 6" (5.33 m)
<u>ELECTRICAL</u>	
Alternator	24VDC 100amp
Air Conditioner	24VDC
Batteries	4 Size 8D @ 12 Volt - 1350 CCA

D75KS High Pressure (Caterpillar Engine - 1350 cfm) SPECIFICATIONS

<p style="text-align: center;"><u>DRILL RATING</u></p> <p>Hole Size Max. 1st pass capacity (Std. tooling) Max. 1st pass capacity (Special tooling) Total Depth Capacity</p>	<p>6" to 11" (152 - 279 mm) 33' 6" (10.2m) 36' 6" (11.1m) 175' (53m)</p>
<p style="text-align: center;"><u>UNDERCARRIAGE</u></p> <p>Type Length Pads (Shoes) Triple Grouser Travel Speed Gradeability (Mast Down) Drive HP each track Ground Bearing Pressure (Std. Equipment) Width Over Tracks Rollers</p>	<p>Caterpillar® - Model 330EL 17' 5" (5.31 m) 33.5" (850 mm) 1.5 mph (2.4 km/h) 59% (approximately 28°) 160 hp (119 kW) 10.9 psi (75.1 kPa) 14' (4.27 m) 11 Lower - 2 Upper</p>
<p style="text-align: center;"><u>DRILL POWER</u></p> <p>Caterpillar® Caterpillar® Rated Speed Fuel Capacity</p>	<p>Model 3412E DITTA HEUI/ADEM 800 hp (597 kW) Model C27 800 hp (597 kW) 2100 rpm 600 gallons US (2274 l)</p>
<p style="text-align: center;"><u>COMPRESSOR</u></p> <p>Type Manufacturer</p>	<p>Two Stage Oil Flooded Screw Type Sullair 1350cfm (38.2m³m) @ 350 psi (24.1 bar) @ 2100 rpm</p>
<p style="text-align: center;"><u>FEED SYSTEM</u></p> <p>Type Rated Bit Loading Rated Pullback Feed Rate Retract Rate</p>	<p>2 Hydraulic Cylinders and Chains 75,000 lbs (34,050 kg) 43,400 lbs (19,658 kg) 0-89 fpm (27 mpm) 0-114 fpm (34.8 mpm)</p>
<p style="text-align: center;"><u>ROTARY HEAD</u></p> <p>Type Drive Motor Maximum Rotary Horsepower Standard Rotary Speed/Torque Optional Rotary Speed/Torque Optional Rotary Speed/Torque</p>	<p>Gear Case Type Hydraulic Axial Piston 190 hp (142 kW) 97 rpm @ 124,700 in-lbs (14,091 Nm) 78 rpm @ 154,200 in-lbs (17,425 Nm) 117 rpm @ 103,180 in-lbs (11,659 Nm)</p>
<p style="text-align: center;"><u>TOOL HANDLING EQUIPMENT (Loader)</u></p> <p>Type Number of Positions Pipe Sizes</p>	<p>Carousel (Inside Mast) 4 2 @ 5" (127 mm) 2 @ 7" (178 mm)</p>
<p style="text-align: center;"><u>WEIGHT</u></p> <p>Operating Weight w/Drill Pipe</p>	<p>135,000 lbs (61,236 kg)</p>
<p style="text-align: center;"><u>DIMENSIONS</u></p> <p>Length (mast down) Width (operating) Height (mast up) Height (mast down)</p>	<p>51' (15.54 m) 16' 7" (5.05 m) 53' 7" (16.33 m) 17' 6" (5.33 m)</p>
<p style="text-align: center;"><u>ELECTRICAL</u></p> <p>Alternator Air Conditioner Batteries</p>	<p>24VDC 100amp 24VDC 4 Size 8D @ 12 Volt - 1350 CCA</p>

D75KS Low Pressure (Caterpillar Engine - 1300 cfm) SPECIFICATIONS

<u>DRILL RATING</u>	
Hole Size	9" to 11" (228 - 279 mm)
Max. 1st pass capacity (Std. tooling)	33' 6" (10.2m)
Max. 1st pass capacity (Special tooling)	36' 6" (11.1m)
Total Depth Capacity	175' (53m)
<u>UNDERCARRIAGE</u>	
Type	Caterpillar® - Model 330EL
Length	17' 5" (5.31 m)
Pads (Shoes) Triple Grouser	33.5" (850 mm)
Travel Speed	1.5 mph (2.4 km/h)
Gradeability (Mast Down)	59% (approximately 28°)
Drive HP each track	160 hp (119 kW)
Ground Bearing Pressure (Std. Equipment)	10.9 psi (75.1 kPa)
Width Over Tracks	14' (4.27 m)
Rollers	11 Lower - 2 Upper
<u>DRILL POWER</u>	
Caterpillar®	Model 3412E DITTA HEUI/ADEM 650 hp (485 kW)
Rated Speed	1800 rpm
Fuel Capacity	600 gallons US (2274 l)
<u>COMPRESSOR</u>	
Type	Single Stage Oil Flooded Screw Type
Manufacturer	Sullair 1300cfm (36.8m³m) @ 100 psi (6.9 bar) @ 1800 rpm
<u>FEED SYSTEM</u>	
Type	2 Hydraulic Cylinders and Chains
Rated Bit Loading	75,000 lbs (34,050 kg)
Rated Pullback	43,400 lbs (19,658 kg)
Feed Rate	0-89 fpm (27 mpm)
Retract Rate	0-114 fpm (34.8 mpm)
<u>ROTARY HEAD</u>	
Type	Gear Case Type
Drive Motor	Hydraulic Axial Piston
Maximum Rotary Horsepower	190 hp (142 kW)
Standard Rotary Speed/Torque	97 rpm @ 124,700 in-lbs (14,091 Nm)
Optional Rotary Speed/Torque	78 rpm @ 154,200 in-lbs (17,425 Nm)
Optional Rotary Speed/Torque	117 rpm @ 103,180 in-lbs (11,659 Nm)
<u>TOOL HANDLING EQUIPMENT (Loader)</u>	
Type	Carousel (Inside Mast)
Number of Positions	4
Pipe Sizes	7" to 9-5/8" (178 to 244 mm)
<u>WEIGHT</u>	
Operating Weight w/Drill Pipe	135,000 lbs (61,236 kg)
<u>DIMENSIONS</u>	
Length (mast down)	51' (15.54 m)
Width (operating)	16' 7" (5.05 m)
Height (mast up)	53' 7" (16.33 m)
Height (mast down)	17' 6" (5.33 m)
<u>ELECTRICAL</u>	
Alternator	24VDC 100amp
Air Conditioner	24VDC
Batteries	4 Size 8D @ 12 Volt - 1350 CCA

D75KS Low Pressure (Caterpillar & Cummins Engine - 1600 cfm) SPECIFICATIONS

<u>DRILL RATING</u>	
Hole Size	9" to 11" (228 - 279 mm)
Max. 1st pass capacity (Std. tooling)	33' 6" (10.2m)
Max. 1st pass capacity (Special tooling)	36' 6" (11.1m)
Total Depth Capacity	175' (53m)
<u>UNDERCARRIAGE</u>	
Type	Caterpillar® - Model 330EL
Length	17' 5" (5.31 m)
Pads (Shoes) Triple Grouser	33.5" (850 mm)
Travel Speed	1.5 mph (2.4 km/h)
Gradeability (Mast Down)	59% (approximately 28°)
Drive HP each track	160 hp (119 kW)
Ground Bearing Pressure (Std. Equipment)	10.9 psi (75.1 kPa)
Width Over Tracks	14' (4.27 m)
Rollers	11 Lower - 2 Upper
<u>DRILL POWER</u>	
Caterpillar®	Model 3412E DITTA HEUI/ADEM 650 hp (485 kW)
Caterpillar®	Model C27 800 hp (597 kW)
Cummins	Model QSK19C 650 hp (485 kW)
Rated Speed	1800 rpm
Fuel Capacity	600 gallons US (2274 l)
<u>COMPRESSOR</u>	
Type	Single Stage Oil Flooded Screw Type
Manufacturer	Sullair 1600cfm (45 m³m) @ 100 psi (6.9 bar) @ 1800 rpm
<u>FEED SYSTEM</u>	
Type	2 Hydraulic Cylinders and Chains
Rated Bit Loading	75,000 lbs (34,050 kg)
Rated Pullback	43,400 lbs (19,658 kg)
Feed Rate	0-89 fpm (27 mpm)
Retract Rate	0-114 fpm (34.8 mpm)
<u>ROTARY HEAD</u>	
Type	Gear Case Type
Drive Motor	Hydraulic Axial Piston
Maximum Rotary Horsepower	190 hp (142 kW)
Standard Rotary Speed/Torque	97 rpm @ 124,700 in-lbs (14,091 Nm)
Optional Rotary Speed/Torque	78 rpm @ 154,200 in-lbs (17,425 Nm)
Optional Rotary Speed/Torque	117 rpm @ 103,180 in-lbs (11,659 Nm)
<u>TOOL HANDLING EQUIPMENT (Loader)</u>	
Type	Carousel (Inside Mast)
Number of Positions	4
Pipe Sizes	7" to 9-5/8" (178 to 244 mm)
<u>WEIGHT</u>	
Operating Weight w/Drill Pipe	135,000 lbs (61,236 kg)
<u>DIMENSIONS</u>	
Length (mast down)	51' (15.54 m)
Width (operating)	16' 7" (5.05 m)
Height (mast up)	53' 7" (16.33 m)
Height (mast down)	17' 6" (5.33 m)
<u>ELECTRICAL</u>	
Alternator	24VDC 100amp
Air Conditioner	24VDC
Batteries	4 Size 8D @ 12 Volt - 1350 CCA

D75KS Low Pressure (Caterpillar and Cummins Engine - 2000 cfm) SPECIFICATIONS

<u>DRILL RATING</u>	
Hole Size	9" to 11" (228 - 279 mm)
Max. 1st pass capacity (Std. tooling)	33' 6" (10.2m)
Max. 1st pass capacity (Special tooling)	36' 6" (11.1m)
Total Depth Capacity	175' (53m)
<u>UNDERCARRIAGE</u>	
Type	Caterpillar® - Model 330EL
Length	17' 5" (5.31 m)
Pads (Shoes) Triple Grouser	33.5" (850 mm)
Travel Speed	1.5 mph (2.4 km/h)
Gradeability (Mast Down)	59% (approximately 28°)
Drive HP each track	160 hp (119 kW)
Ground Bearing Pressure (Std. Equipment)	10.9 psi (75.1 kPa)
Width Over Tracks	14' (4.27 m)
Rollers	11 Lower - 2 Upper
<u>DRILL POWER</u>	
Caterpillar®	Model C27 800 hp (597 kW)
Caterpillar®	Model 3412E DITTA HEUI/ADEM 800 hp (597 kW)
Cummins	Model QSK19C 750 hp (559 kW)
Rated Speed	1800 rpm
Fuel Capacity	600 gallons US (2274 l)
<u>COMPRESSOR</u>	
Type	Single Stage Oil Flooded Screw Type
Manufacturer	Sullair 2000cfm (56.6 m³m) @ 100 psi (6.9 bar) @ 1800 rpm
<u>FEED SYSTEM</u>	
Type	2 Hydraulic Cylinders and Chains
Rated Bit Loading	75,000 lbs (34,050 kg)
Rated Pullback	43,400 lbs (19,658 kg)
Feed Rate	0-89 fpm (27 mpm)
Retract Rate	0-114 fpm (34.8 mpm)
<u>ROTARY HEAD</u>	
Type	Gear Case Type
Drive Motor	Hydraulic Axial Piston
Maximum Rotary Horsepower	190 hp (142 kW)
Standard Rotary Speed/Torque	97 rpm @ 124,700 in-lbs (14,091 Nm)
Optional Rotary Speed/Torque	78 rpm @ 154,200 in-lbs (17,425 Nm)
Optional Rotary Speed/Torque	117 rpm @ 103,180 in-lbs (11,659 Nm)
<u>TOOL HANDLING EQUIPMENT (Loader)</u>	
Type	Carousel (Inside Mast)
Number of Positions	4
Pipe Sizes	7" to 9-5/8" (178 to 244 mm)
<u>WEIGHT</u>	
Operating Weight w/Drill Pipe	135,000 lbs (61,236 kg)
<u>DIMENSIONS</u>	
Length (mast down)	51' (15.54 m)
Width (operating)	16' 7" (5.05 m)
Height (mast up)	53' 7" (16.33 m)
Height (mast down)	17' 6" (5.33 m)
<u>ELECTRICAL</u>	
Alternator	24VDC 100amp
Air Conditioner	24VDC
Batteries	4 Size 8D @ 12 Volt - 1350 CCA

RECOMMENDED TORQUE VALUES FOR STANDARD HARDWARE - UNC

This table applies to part numbers:

- 001554-___ CAPSCREW, Hex hd
- 005486-___ CAPSCREW, Hex hd
- 001559-___ CAPSCREW, Socket hd
- 001570-___ SCREW, Flat hd socket
- 001577-___ NUT, Hex - regular
- 001575-___ NUT, Hex - heavy
- 001562-___ NUT, Hex - self-locking

Coarse Thread (UNC) Size (Diameter in Inches)	Torque Grade 5 Ft.Lb. (Kg/M)	Torque Grade 8 Ft.Lb. (Kg/M)
1/4	6 (.8)	9 (1.2)
5/16	12-14 (1.5)	17-19 (2)
3/8	22-24 (3)	31-34 (4.5)
7/16	36-39 (5)	50-55 (7)
1/2	54-59 (8)	76-84 (11)
9/16	77-85 (11)	110-120 (15-16.5)
5/8	107-118 (15-16)	153-166 (21-23)
3/4	190-210 (26-29)	270-292 (37-40)
7/8	280-310 (38-43)	437-475 (60-66)
1	425-460 (59-63)	650-710 (90-98)
1-1/8	570-620 (79-86)	930-1000 (128-138)
1-1/4	810-870 (112-120)	1310-1410 (181-195)
1-3/8	1060-1140 (146-157)	1730-1850 (239-256)
1-1/2	1410-1510 (195-209)	2290-2460 (316-340)

NOTE: These torque values are to be used for general assembly procedures. Special torque requirements may be specified on assembly and installation procedures.

NOTE: All fasteners are to be free of dirt and rust at time of assembly. Lubrication is **not** to be applied to threads unless so specified.

RECOMMENDED TORQUE VALUES FOR STANDARD HARDWARE - UNF

This table applies to part numbers:

- 001555-___ CAPSCREW, Hex hd
- 005487-___ CAPSCREW, Hex hd
- 001560-___ CAPSCREW, Socket hd
- 001571-___ SCREW, Flat hd socket
- 001578-___ NUT, Hex - regular
- 001576-___ NUT, Hex - heavy
- 001563-___ NUT, Hex - self-locking

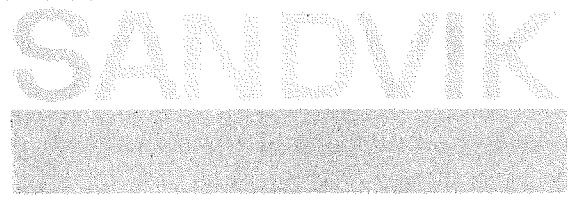
Fine Thread (UNF) Size (Diameter in Inches)	Torque Grade 5 Ft.Lb. (Kg/M)	Torque Grade 8 Ft.Lb. (Kg/M)
1/4	7 (1)	10-11 (1.5)
5/16	14-16 (2)	20-22 (3)
3/8	25-28 (3.5)	35-39 (5)
7/16	39-43 (6)	55-61 (8)
1/2	63-69 (9)	86-94 (12)
9/16	87-95 (12-13)	123-134 (17-18.5)
5/8	126-138 (17-19)	171-187 (24-26)
3/4	213-233 (30-32)	300-328 (42-45)
7/8	312-338 (43-46)	480-520 (66-72)
1	466-504 (64-70)	715-770 (99-106)
1-1/8	640-695 (89-96)	1040-1120 (144-155)
1-1/4	900-960 (124-133)	1460-1560 (202-216)
1-3/8	1210-1300 (167-180)	1970-2100 (272-290)
1-1/2	1585-1700 (167-180)	2570-2750 (272-290)

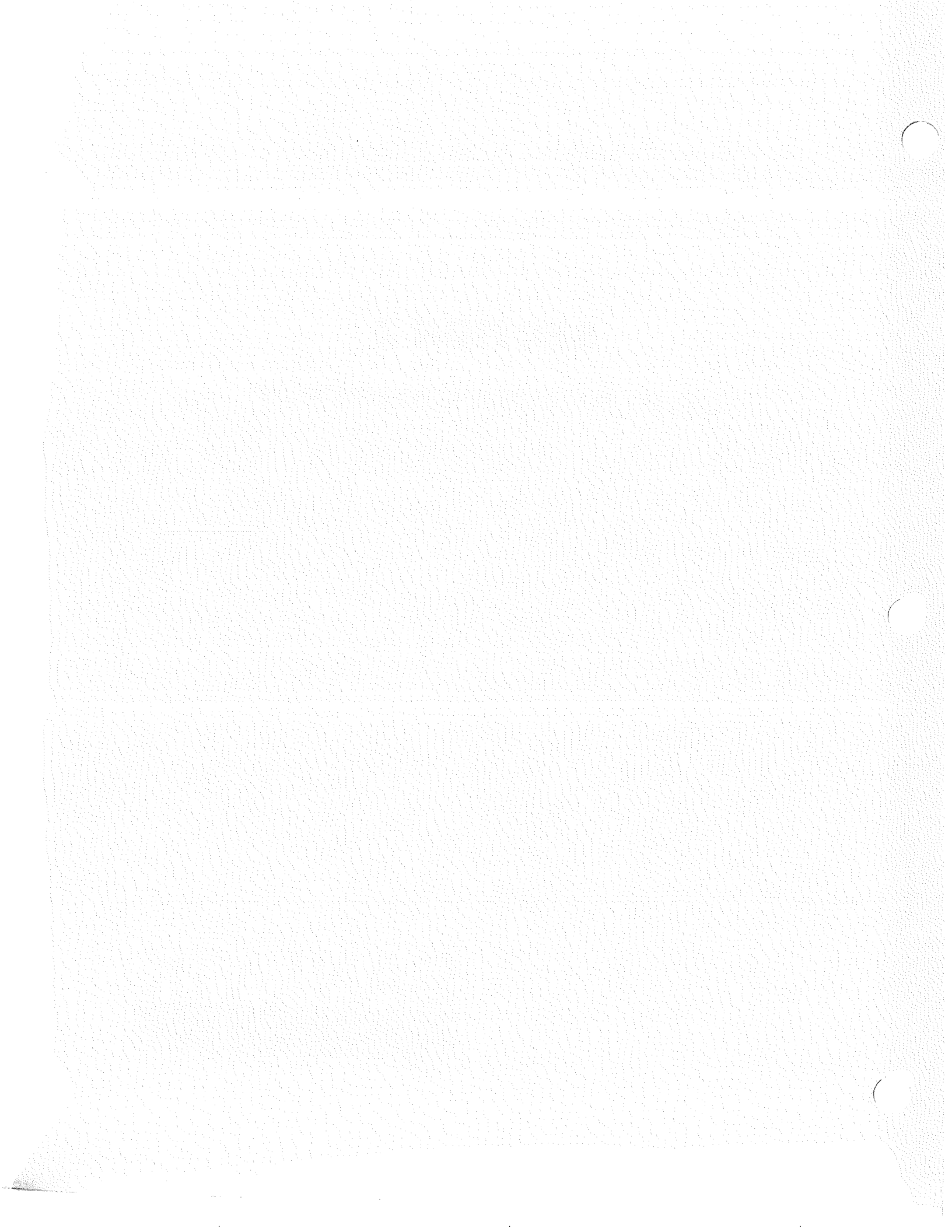
NOTE: These torque values are to be used for general assembly procedures. Special torque requirements may be specified on assembly and installation procedures.

NOTE: All fasteners are to be free of dirt and rust at time of assembly. Lubrication is **not** to be applied to threads unless so specified.

SECTION 2

COOLANT, FUEL & LUBRICANT SPECIFICATIONS





SECTION 2

COOLANT, FUEL and LUBRICANT SPECIFICATIONS

COOLANT SPECIFICATIONS (Caterpillar)

Always use a mixture of approved fill water, antifreeze and Cooling System Conditioner.

Refer to the engine manufacturer for detailed specifications, or Caterpillar® form SEBD0518.

FILL WATER (Caterpillar)

Always add conditioner to coolant water. Never use plain water only in the cooling system.

Acceptable water for use in the preparation of ethylene glycol type antifreeze and water mixture is shown in the follow chart.

ACCEPTABLE WATER

Water Content	50% Antifreeze/ 50% Water	Without Antifreeze
Chlorides	100 ppm or less	50 ppm or less
Sulphates	100 ppm or less	50 ppm or less
Hardness as CaCO ₃	200 ppm or less	100 ppm or less
Dissolved Solids	500 ppm or less	250 ppm or less
pH	6.5 or higher	6.5 or higher

ppm = parts per million

Antifreeze

Always use ethylene glycol-type antifreeze and the correct amount to provide protection to the lowest expected operating environment.

Coolant Conditioner Elements

Coolant conditioner elements should be used to maintain a 3 to 6% concentration of conditioner in the coolant. Use a precharge element when filling the system or changing coolant. Install a new maintenance element after every 250 hours of service.

FUEL SPECIFICATIONS (Caterpillar)

Caterpillar® manufactured diesel engines have the ability to burn a variety of fuels. These fuels are divided into two categories: *Preferred* or *Permissible*.

Preferred fuels provide maximum engine service life and performance. These fuels are distillate fuels and are commonly called; fuel oil, furnace oil, diesel fuel, gas oil or kerosene.

Permissible fuels are crude oils or blended fuels. Use of these fuels can result in higher maintenance costs and reduced engine service life.

Refer to form SEHS7067 from Caterpillar® for a detailed summary of preferred fuels and their specifications.

Cetane Requirement

The minimum fuel cetane number recommended for this engine is 40.

Fuel Cloud Point

Fuel waxing can plug the fuel filters in cold weather. The fuel cloud point must be below the temperature of the surrounding air to prevent filter waxing and power loss. Fuel heating attachments can minimize fuel filter waxing and are available from your Driltech or Caterpillar® dealer.

Fuel Sulphur Content

The percentage of fuel sulphur content will affect the engine oil and filter change intervals (refer to the following chart).

CRANKCASE OIL CHANGE INTERVALS (Caterpillar)

Fuel Sulphur	Oil Change Interval
0.0% to 0.4%	250 Hours
0.4% to 1.0%	125 Hours
1.0% to 1.5%	62 Hours

NOTE!

If the fuel has over 0.5% sulphur content, the CG engine oil must have a Total Base Number (TBN) of 20 times the percentage of fuel sulphur (TBN as measured by the ASTM D-2896 method). If the sulphur content is greater than 1.5% by weight, use an oil with a TBN of 30 and reduce the oil change interval by one half. Consult your Caterpillar® dealer for correct engine oil recommendations.

COOLANT SPECIFICATIONS (CUMMINS)

Testing the coolant with Cummins test kit CC-2602 is recommended twice a year to monitor SCAs (Supplemental Coolant Additive). If the SCA level is above 3 units, test at subsequent oil drain intervals until the concentration is back under 3 units, start installing the correct service filters at each drain interval. If the concentration

is below 1.2 units per gallon, replace the filter and precharge with liquid.

Always use a mixture of approved fill water, and fully formulated antifreeze.

Refer to the Cummins Operation and Maintenance manual for detailed specifications.

FILL WATER (CUMMINS)

Never use plain water only in the cooling system. Water quality is important for cooling system performance. Excessive levels of calcium and magnesium contribute to scaling problems, and excessive levels of chlorides and sulfates cause cooling system corrosion.

WATER QUALITY

MINERAL	MEASUREMENT
Chloride	40 ppm as (Cl)
Sulfur	100 ppm as (SO ₄)
Calcium Magnesium (Hardness)	170 ppm as (CaCO ₃ + MgCO ₃)

ppm = parts per million

Antifreeze (CUMMINS)

Always use a low-silicate ethylene glycol-type antifreeze that meets ASTM D4985 specifications (less than 0.10% silicate, expressed as Na₂SiO₃). The correct amount to provide protection to the lowest expected operating environment.

Coolant Conditioner Elements (CUMMINS)

Correct use of SCAs (Supplemental Coolant Additive) in conjunction with water and antifreeze are needed to protect engines from cooling system problems. The system must be precharged with the correct concentration of SCA.

When coolant is replaced in the field, it must be

replaced with heavy duty coolant precharged with SCAs. In addition, a service coolant filter must be installed. Together, this will result in a total precharge of approximately 1.5 SCA units per gallon of coolant.

FUEL SPECIFICATIONS (CUMMINS)

Cummins Engine Company, Inc. recommends the use of ASTM No. 2 diesel fuel. The use of No. 2 diesel fuel will result in optimum engine performance. At operating temperatures below 0°C (32°F), acceptable performance can be obtained by using blends of No.2 and No.1 diesel fuel. The use of lighter fuels can reduce fuel economy.

The viscosity of the fuel must be kept above 1.3cSt to provide adequate fuel system lubrication.

For a more detailed description of fuel properties, refer to Cummins Engine Bulletin No. 3379001.

CRANKCASE OIL CHANGE INTERVALS (CUMMINS)

The recommended method used to determine the proper oil and filter change interval is the Chart Method (based on known fuel and oil consumption rates). Using the Chart Method will require information listed below to determine the correct oil and filter change interval:

- Fuel Consumption Rate
- Oil Consumption Rate
- Total System Capacity

The Cummins engine Operation and Maintenance manual provides information on determining these rates.

LUBRICANT SPECIFICATIONS

General

The classifications listed below follow S.A.E. J183 classifications. The MIL specifications are USA Military Specifications. The following definitions will be of assistance in purchasing lubricants.

Viscosity Grade	Minimum Ambient Temperature	Maximum Ambient Temperature
SAE 0W-20	-40°C (-40°F)	10°C (50°F)
SAE 0W-30	-40°C (-40°F)	30°C (86°F)
SAE 0W-40	-40°C (-40°F)	40°C (104°F)
SAE 5W-30	-30°C (-22°F)	30°C (86°F)
SAE 5W-40	-30°C (-22°F)	50°C (122°F)
SAE 10W-30	-18°C (0°F)	40°C (104°F)
SAE 10W-40	-18°C (0°F)	50°C (122°F)
SAE 15W-40	-9.5°C (15°F)	50°C (122°F)
SAE 30	0°C (32°F)	40°C (104°F)
SAE 30	5°C (41°F)	50°C (122°F)

cants. The specific classifications for this machine are found on the Lubricant Chart.

Engine Oils (CATERPILLAR) (CH)

Only use oils that meet Engine Service Classification CH (MIL-L-2104D).

At the factory, this machine was filled with BP 15W - 40. Consult the Caterpillar form SEBU5939 for a listing of CH oil brands.

NOTE!

The engine oil and filter should be changed after the first 50 hours of service on new and reconditioned engines.

Engine Oils (CUMMINS) (CH-4)

Only use oils that meet API performance classification CH-4.

At the factory, this machine was filled with BP 15W - 40.

NOTE !

The engine oil and filter should be changed after the first 50 hours of service on new and reconditioned engines.

Lubricating Grease (MPGM)

Use only multi-purpose grease (MPGM) which contains 3 to 5% molybdenum disulphide. NLGI No. 2 Grade is suitable for most temperatures. Use NLGI No. 1 or No. 0 Grade for extremely low temperatures.

Compressor Oils (COMP)

As with any oil **Do not** mix different types of oils. Contamination of synthetic oils with traces of AFT may lead to foaming or plugging of orifices.

When operating between 80 and 100°F (27 and 38°C) and with relative humidity above 80%, a

synthetic hydrocarbon type fluid is recommended. Machines manufactured today are filled with Shell Corena unless the decal on the receiver tank specifies otherwise.

NOTE!

Compressor oil change intervals will change depending on the type of oil used. The oil manufacturers recommendations supersede the recommended interval suggested in this manual.

Hydraulic Oils (HYDO)

Use industrial-type hydraulic oils that are certified by the oil supplier to have anti-wear, -foam, -rust, and -oxidation additive properties for heavy duty usage.

Machines manufactured today are filled with Citgo 32 AW hydraulic oil.

Multipurpose - Type Gear Lubricant (MPL)

Use Gear Lubricant Classification GL-5 (MIL-L-2105B) EP140. Use SHC 75 x 90 in cold ambient conditions and SHC 5 x 90 in arctic conditions.

Refrigeration Oil (REF)

Use an ISO 100 refrigeration oil.

RECOMMENDED LUBRICANT VISCOSITIES										
OUTSIDE TEMPERATURE	°F	-22	-4	+14	+32	+50	+68	+86	+104	+122
	°C	-30	-20	-10	0	+10	+20	+30	+40	+50
ENGINE CRANKCASE CH	SAE 5W -20(SPC)									
	SAE 5W-20									
	SAE 10W									
	SAE 10W-30									
	SAE 15W-40									
	SAE 30									
	SAE 40									
COMPRESSOR COMP <i>Note oil change intervals</i>	-40°F		ISO 32							
			ISO 46							
					ISO 68					
UNDERCARRIAGE, FINAL DRIVE GEARBOX MPL	CD SAE 10W									
	CD SAE 30									
	CD SAE 40W									
	CD SAE 50W									
HYDRAULIC SYSTEM HYDO	32AW									
	46AW									
	68AW									
	100AW									
WATER INJ. PUMP - CH	SAE 30									
	SAE 10W-30									
ROTARY HEAD, WINCH and PUMP DRIVE GEARBOXES MPL	GL-5 EP 90									
	SHC 75W-90									
	SHC 5W-90									
AUTOLUBE PUMP CH	SAE 10W									

EQUIVALENT HYDRAULIC OILS

996

LUBRICANT BRAND NAME	MANUFACTURER	ISO 22	ISO 32-46-68	ISO 100	ISO 150
ACCITE HIDRAULICO MH	PETROLEOS MEXICANOS		X	X	
AMOCO AW OIL	AMOCO OIL CO.		X		
AMOCO RYDON OIL MV	AMOCO OIL CO.		X	X	
ANTECH	EXXON/ESSO		X		
ASHLAND VG	ASHLAND OIL CO.		32		
BARTRAN HV	BP OIL CO.		46 & 68		
BRESLUBE VG	BRESLUBE LTD.-CANADA		X	X	
CANADIAN OIL MOXY T	OIL CANADA		X	X	X
CANVIS AW	BP OIL CO.		X	X	
CHAMPION SUPER GRADE	LOWE OIL		X		
CHEVRON AW	CHEVRON		X		
CITGO AW	CITGO		X	X	X
D-A WEAR GUARD II VG	D-A LUBRICANT CO.-USA		X		
DECOL ANTI-WEAR	SHELL CANADA		X	X	X
DTE 24-25-26	MOBIL OIL CORP.		X		
DURO AW	ARCO		X	X	
EAL SYNDRAULIC	MOBIL OIL CO.		X		
ELF OLNA DS	ELF/ANTAR		X		
ENERGOL HLP-HD SERIES	BP OIL CO.		X	X	
EPPCO UNIVIVERSAL GP	EPPERT OIL CO.		X		
GULF HARMONY AW	GULF R&D		X		
GULF SYNFLUID SL H_AW	GULF USA		X		
HIDRALUB EP	MARAVAN S.A.		X	X	
HARMONY AW	GULF CANADA LTD.		X	X	
HYDRAFLOW PETRO	CANADA		X	X	X
HYDRALUBE AW	LUSCON IND.		X	X	
HYDRELF DS	ELF		46 & 68		
HYSPIIN AWS-AD	CASTROL INC.		X		
HYTAC	DISTAC LUBRICANTS		X	X	
KENOIL R&O AW	KENDALL REFINING CO.		X	X	
LUSCON HD	LUSCON IND.		X	X	
MARATHON MULTI. VG	MARATHON PETROLEUM		X	X	
MOBIL HYD. OIL NZ	MOBIL OIL CO.		X		
MOBIL HYD. OIL ZF	MOBIL OIL CO.		X		
MYSTIK AW/AL	CATO OIL & GREASE CO.		X	X	
NERVOL FLUID SH2	NERVOL		X	X	X

(Page 1 of 2)

LUBRICANT BRAND NAME	MANUFACTURER	ISO 22	ISO 32-46-68	ISO 100	ISO 150
NUTO-H	EXXON/ESSO		X	X	X
NUTO-HP	EXXON/ESSO		32 & 46		
NUTO-H PLUS	EXXON/ESSO		X		
NYCO HYD. OIL	NYCO LUBRICANT CORP.		X	X	
ORLY AGENA	ORLY INTERNATIONAL		X		
ORLY GALA	ORLY INTERNATIONAL		X		
ORLY HYDRO	ORLY INTERNATIONAL		X		
PACER POWER V	PACER LUBRICANT INC.		X	X	X
PARADENE ANTI-WEAR AW	DRYDEN OIL CO. - USA		X	X	X
PEAK HYDRA AW SERIES	PEAK OIL CO.		46 & 68	X	
PEN PREMIUM EP	PENTAGON CORP.		32 & 68	X	
PENNZBELL AW	PENNZOIL PROD. CO.		X	X	
PENNZOIL AW	PENNZOIL PROD. CO.	X	X	X	
PENNZOIL AWX	PENNZOIL PROD. CO.		X	X	
RANDO OIL HD	TEXACO INC. - USA		X		X
ROL ANTELITTERAM HVI	ROL RAFFINERIA		X		
ROYAL AW	EPPERT OIL CO.		X		
ROYAL PREMIUM VG	EPPERT OIL CO.		X		
RYKON OIL	AMOCO OIL CO.		X		
SELCO SF 330	SELCO		X	X	X
SHARLU HYDROFLUIDS AW	SHARJAH NATIONAL LUBE OIL CO. LTD.		X		
SHOSEKI W-R	SHOWA OIL LTD.-JAPAN	X	32, 46 & 56		
STAR PREMIUM VG	EPPERT OIL CO.		X		
SUNVIS 8__WR	SUNCOR or SUNTECK		X	X	X
SUPER BLUE HYD. OIL	AUTOLINE OIL CO.		X	X	X
SUPER HYD. OIL VG	CONOCO		X	X	
TELLUS	SHELL CANADA LTD.		X	X	X
TELLUS	SHELL CO. - USA		X	X	
TERRAPIN IND. OIL	AUTOLINE OIL CO.		X	X	X
TOTAL AZOLI A ZS	J.W.LANE		46 & 68	X	
TRC HYD. OILS VG	TEXACO REFINERY		X		
UNION UNAX AW VG	UNION OIL - USA		32 & 46	X	X
UNIVIS N	EXXON/ESSO		X	X	
UNIVIS N PLUS	EXXON/ESSO		X	X	
UNIVIS SHP	EXXON/ESSO		32 & 46		
YUKONG SUPERVIS	YUKONG LTD.		X		

MINIMUM PERFORMANCE STANDARDS FOR HYDRAULIC OILS

The following are typical properties of hydraulic oils for use in severe duty applications of axial piston and vane pumps. Any oil which meets these or similar properties or which is listed in the approved list of Equivalent Hydraulic Oils may be used.

ISO VISCOSITY GRADE	32 (32AW)	46 (46AW)	68 (68AW)	100 (100AW)
ASTM Viscosity Grade No. (Saybolt)	150	215	315	465
Gravity: API	31.1	30.3	29.5	28.9
Viscosity, Kinematic: cSt 104°F (40.0°C) 212°F (100.0°C)	30.04 5.26	42.70 6.57	62.9 8.43	96 11.03
Viscosity, SSU 100°F (37.8°C) 210°F (98.9°C)	155 43.9	220 48.2	325 54.6	500 64
Viscosity Index, ASTM D 2270	106	105	104	99
Interfacial Tension, D 971 77°F: dyn/cm	31	31	31	32
Flash, P-M: °F (°C)	400 (205)	405 (208)	450 (233)	465 (241)
Flash, OC: °F (°C)	425 (219)	430 (222)	470 (244)	490 (255)
Fire, OC: °F (°C)	455 (235)	470 (244)	500 (260)	545 (285)
Pour: °F (°C)	-25 (-32)	-25 (-32)	-20 (-29)	+5 (+15)
Color, ASTM D 1500	L0.5	L0.5	L1.0	L1.5
Carbon Residue, Ramsbottom: %	0.30	0.30	0.36	0.37
Rust Preventive Test, ASTM D 665 Procedure A, 24 hr Procedure B, 24 hr.	Passes Passes	Passes Passes	Passes Passes	Passes Passes
Neutralization No. ASTM D 974 Total Acid No.	0.68	0.68	0.68	0.68
Oxidation Test, ASTM D 943 Time Oxidized Hr. to 2.0 Acid No.	2000+	2000+	2000+	1500+
Emulsion, FTMS 791 3201, 180°F Dist. Water: Minutes	40-40-0 (3)	40-40-0 (3)	40-40-0 (4)	40-40-0 (6)
Aniline Point, ASTM D 611: °F (°C)	217 (103)	220 (105)	228 (109)	234 (113)

AIR COMPRESSOR LUBRICANT RECOMMENDATIONS

Sandvik Mining and Construction encourages the user to participate in an oil analysis program with the oil supplier. This could result in an oil change interval differing from what is stated in these tables.

NOTE!

Mixing synthetic oils with an ATF may lead to operational problems, foaming, or plugging of orifices. Do not mix different types of fluids.

AMBIENT TEMPERATURE	CHANGE INTERVAL	ISO	LUBRICANT DESCRIPTION
-40°F to +95°F (-40°C to +35°C)	1000 Hours	32	Mobil SHC-624, 924 & 1024
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Chevron HiPerSYN
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Chevron Tegra Synthetic
-40°F to +100°F (-40°C to +38°C)	1000 Hours*	32	Mobil Rarus 424
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Shell Corena PAO
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Royco 432
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Conoco Syncon R&O
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Texaco Cetus PAO
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Valvoline Syn Guard CP
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Petro-Canada Super SCF32
+30°F to +100°F (-1°C to +38°C)	1000 Hours	46	Chevron HiPerSYN
+30°F to +100°F (-1°C to +38°C)	1000 Hours	46	Citgo CompressorGuard
+30°F to +100°F (-1°C to +38°C)	1000 Hours	46	Conoco Syncon R&O
+30°F to +100°F (-1°C to +38°C)	1000 Hours	46	Petro-Canada Super SCF46
+30°F to +100°F (-1°C to +38°C)	1000 Hours	46	Royco 446
+30°F to +100°F (-1°C to +38°C)	1000 Hours	46	Texaco Cetus PAO
+30°F to +100°F (-1°C to +38°C)	1000 Hours	46	Valvoline Syn Guard CP
+30°F to +100°F (-1°C to +38°C)	1000 Hours*	46	Mobil Rarus 425
+80°F to +120°F (+27°C to +49°C)	1000 Hours	68	Conoco Syncon R&O
+80°F to +120°F (+27°C to +49°C)	1000 Hours	68	Mobil SHC-626, 926 & 1026

Low and High Pressure Compressors

When operating between +80 and 100°F (+27 and 38°C) with a relative humidity above 80%, synthetic hydrocarbon type fluid Mobil SHC or equivalent as recommended above should be used.

All lubricant recommendations are based on 1200 rpm maximum WARM-UP speed.

* 500 Hour interval on High Pressure (350 psi) compressors

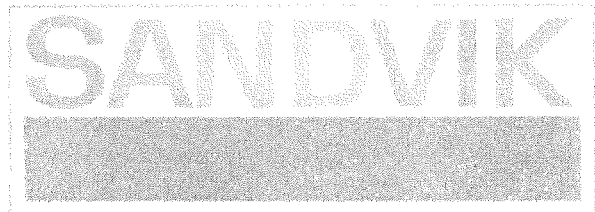
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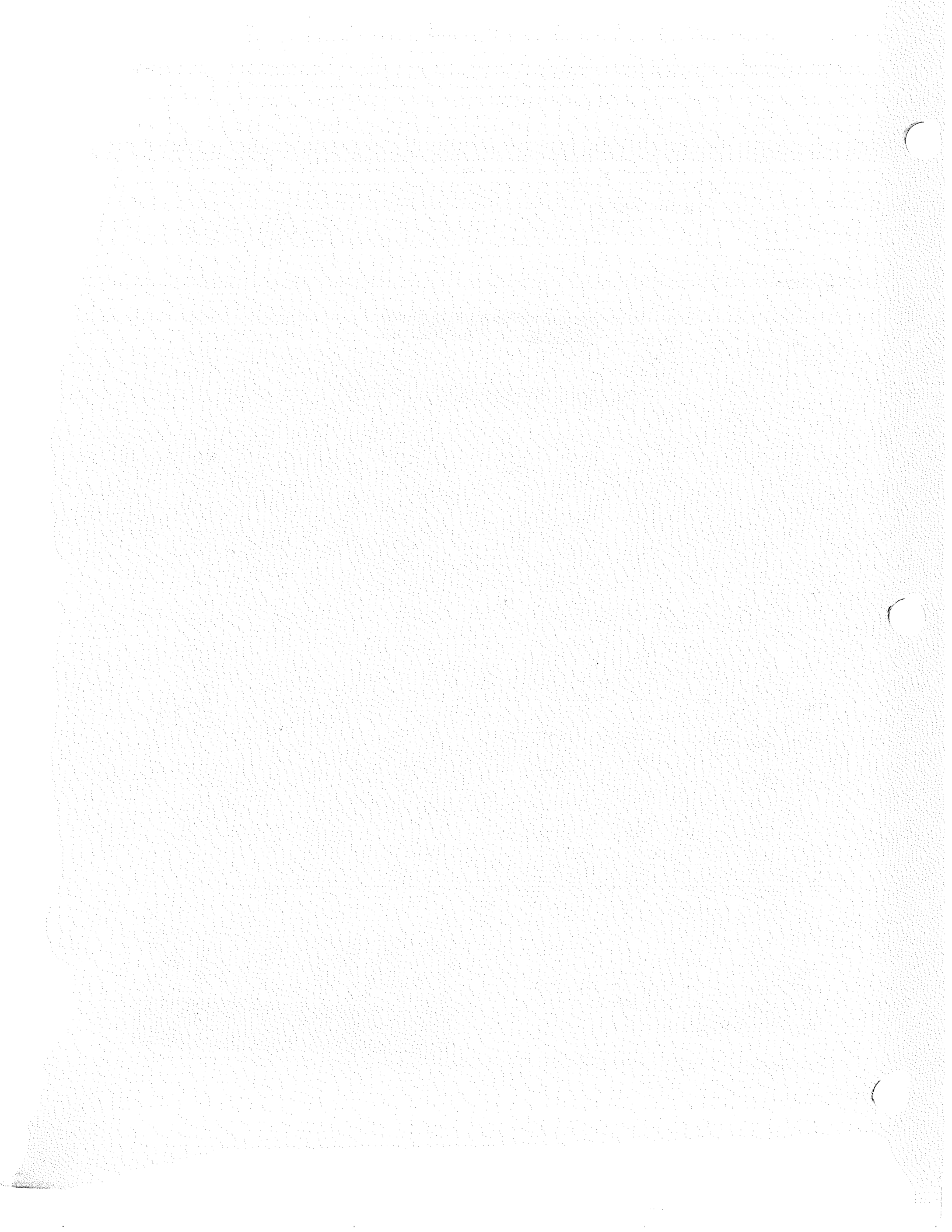
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SECTION 3

CRAWLERS/AIR CONDITIONER





UNDERCARRIAGE (018157-000)

GENERAL

The crawlers used on this machine are a modified version of the crawlers used on Caterpillar's® 330 series excavators.

DUO-CONE SEAL INSTALLATION

The following instructions are for installing Caterpillar® Duo-Cone Seals used in several applications on the machine crawlers.

It is most important that correct assembly and installation procedures are followed when Duo-Cone Seals are used. Many of the Duo-Cone Seal failures are the direct result of one or more mistakes made during assembly or installation of the seal components.



Avoid prolonged skin contact with Trichloroethane. Avoid breathing the vapors in enclosed areas without adequate ventilation and do not smoke. Do not use near open flame or welding operations or other heated surfaces exceeding 482° C (900° F).

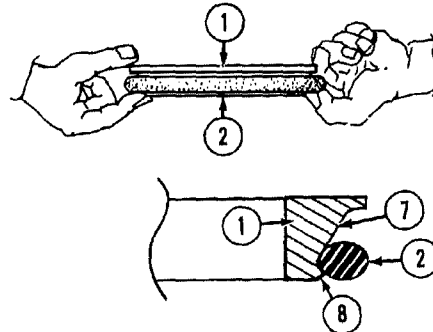
1. Remove any oil film, dust or other foreign matter from toric rubber rings (2) and from ramps (4) and (7) and lips (3) and (8) of both seal rings (1) and housings (5). Use Trichloroethane and clean cloth or paper towels for wiping.

NOTE !

Never permit oil to get on the toric rings or ramps before both seal rings are put together in their final assemblies position.

2. Put toric ring (2) on seal ring (1), at the bot-

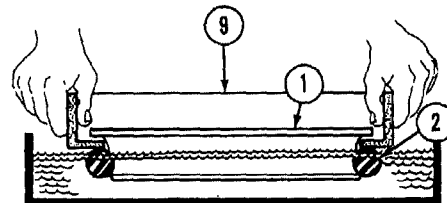
tom of seal ring ramp (7) and against retaining lip (8).



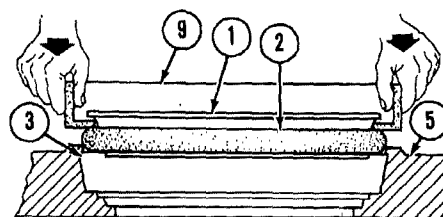
NOTE !

Be sure that toric ring (2) is straight on seal ring (1) and is not twisted. Nicks, cuts and scratches can cause leaks.

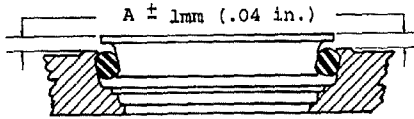
3. Put installation tool (9) onto seal ring (1) with toric ring (2). Lower the rings into a container with Trichloroethane until all surfaces of toric ring (2) are wet.



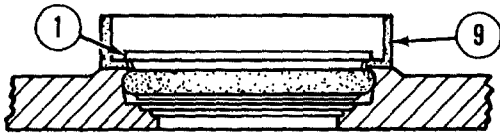
4. With all surfaces of toric ring (2) wet, use installation tool (9) to position seal ring (1) and toric ring (2) squarely against housing (5) as shown. Use sudden and even pressure to pop (push) toric ring (2) under retaining lip (3) of housing (5).



5. Check assembled height (A) in at least four places, 90° apart. The difference in height around the ring must not be more than 1 mm (.04").



6. If small adjustments are necessary, do not push directly on seal ring (1); use installation tool (9).

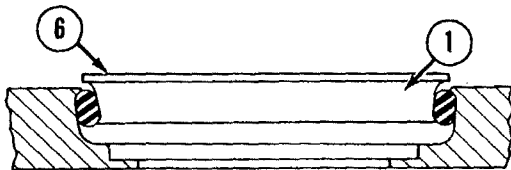


7. Toric ring (2) can twist if it is not wet all around during installation or if there are burrs or fins on retaining lip (3) of housing (5).

NOTE !

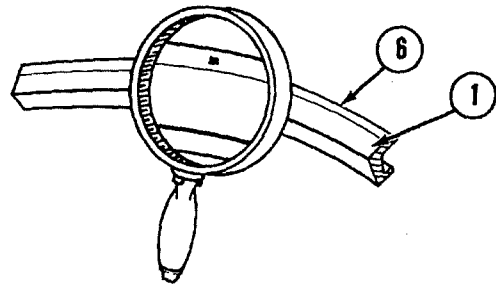
Misalignment, twists and bulges of a toric ring will cause seal failures.

IMPORTANT: Toric rings (2) must never slip on the ramps of either seal rings (1) or seal ring housings (5). To prevent slippage, wait a minimum of two minutes to let the Trichloroethane evaporate before further assembly. Once correctly in place, the toric ring must roll on the ramps only.

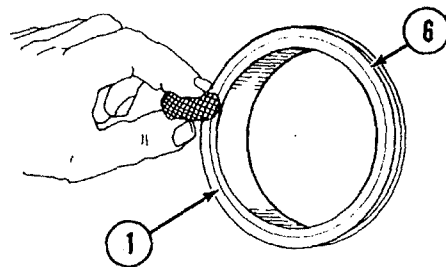


8. Wipe seal faces (6) of seal rings (1) clean. Use a lint free cloth or paper towel. No particles of any kind are permissible on the sealing surfaces. Even a small piece from a paper towel can hold the seal faces apart and cause leak-

age.



9. Put a thin film of clean oil on the seal faces. Use an applicator, a disposable tissue or a clean finger to distribute the oil evenly. Be careful not to get any oil on the rubber toric rings.

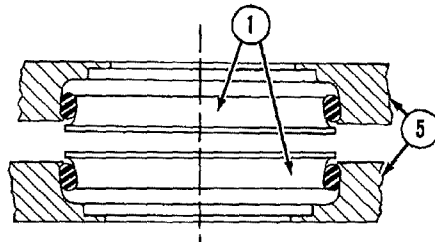


10. Make sure both housings (5) are in correct alignment and are concentric. Move the parts slowly and carefully toward each other.

NOTE !

Do not slam seals together. High impact can scratch or break the seal components.

11. Once in place, fasten all parts tightly.



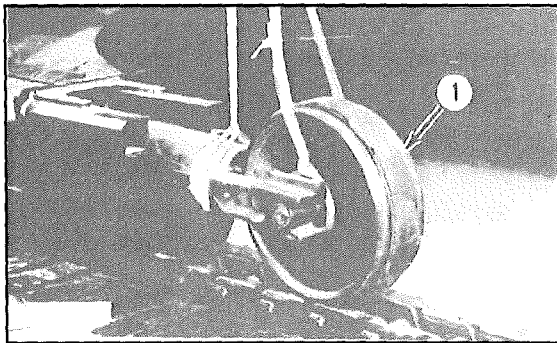
FRONT IDLER (018157-063)

REMOVAL

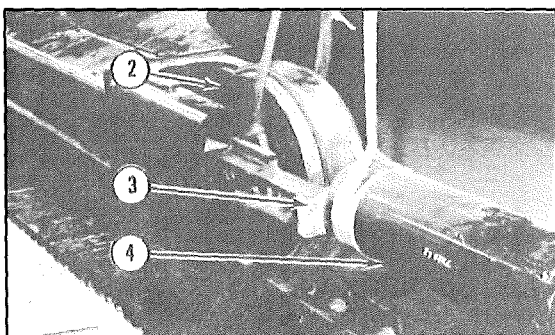
NOTE !

The recoil spring and hydraulic track adjuster are removed at the same time.

1. Refer to the topic "Track Assembly" and separate the crawler track.
2. Using the hydraulic track adjuster, extend the front idler and recoil spring in the undercarriage frame assembly as far out as possible.



3. Using a pry bar, move the front idler and recoil spring assembly (1) partially out of the the frame, and attach lifting straps as shown.



4. Slide front idler and recoil spring out of the undercarriage frame assembly as a unit. The weight of the unit is 383 kg (845 lb).

NOTE!

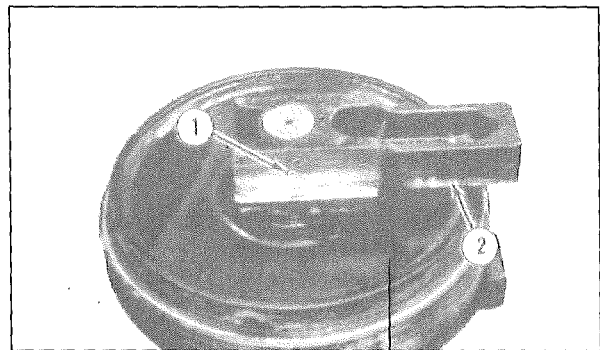
To aid in the disassembly, rotate the idler and spring 180° and slide it back into the frame. Loosen the four bolts (3) but do not remove them at this time. Slide the assembly out of the crawler frame.

5. Remove the four bolts (3) that hold the front idler to the front support for the recoil spring. Separate the front idler from the recoil spring and hydraulic track adjuster. The weight of the front idler is 208 kg (460 lb). The weight of the recoil spring and hydraulic track adjuster as a unit is 175 kg (385 lb).

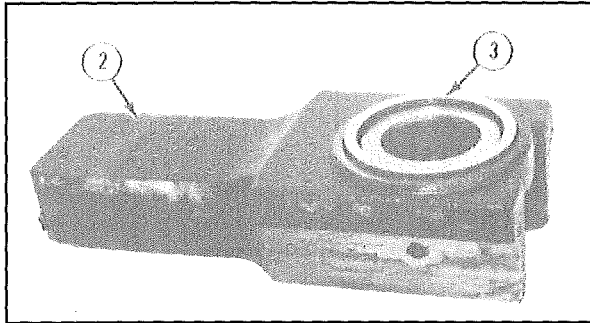
OVERHAUL

Disassembly

1. Thoroughly clean the outside of the front idler prior to disassembly.
2. Remove the fill/drain plug from the front idler. Drain the oil from the idler into a suitable container. The capacity of the idler is 555 ml (19 oz.).
3. Position the front idler on its side as shown below. The weight of the front idler is 208 kg (460 lb).
4. Remove two spring pins (1) from bearings (2). Fasten a hoist to two bearings (2), and remove them from the shaft of the front idler. The weight of each bearing is approximately 34 kg (75 lb).



5. Remove Duo-Cone seals (3) from bearings (2).



4. Temporarily install a bearing (2) on shaft (5). Install the shaft in the front idler. Install the other bearing (2) on the shaft. Check the end play of the shaft. The shaft end play must be 0.26 to 1.26 mm (.010 to .050 in). Remove two bearings (2) and shaft (5) from the front idler.

NOTE !

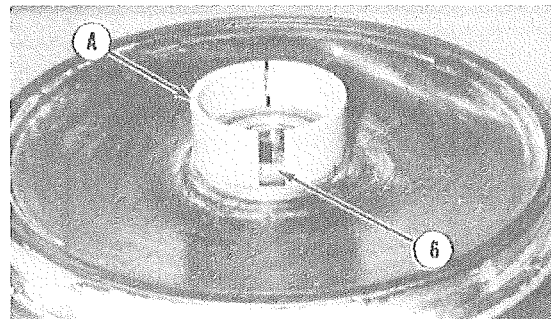
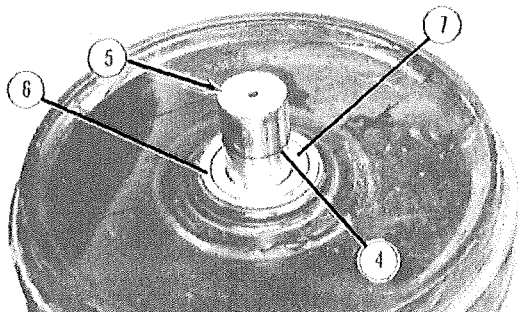
The rubber seals and all surfaces that make contact with the seals must be clean and dry. After installation of the seals, put clean SAE 30 oil on the contact surfaces of the metal seals.

6. Remove shaft (5) from the front idler.
7. Remove two O-ring seals (4) from shaft (5).
8. Remove Duo-Cone seal (6) from each side of the front idler.
9. Remove bushings (7) from each side of the idler.

5. Install a Duo-Cone seal (6) in each side of the idler with tool (A).

NOTE !

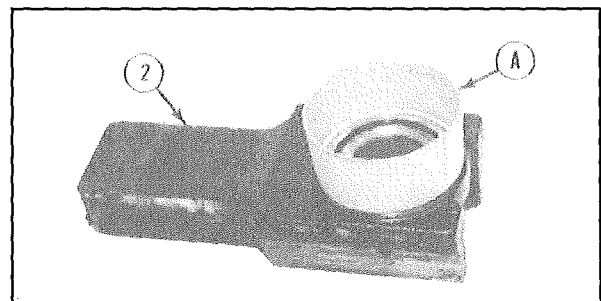
Refer to the Introduction topic of the crawler section of this manual for more information on installing Duo-Cone seals.



6. Install a Duo-Cone seal (3) in each bearing (2) with tool (A).

Assembly

1. Thoroughly clean all parts of the front idler prior to assembly.
2. Check the condition of bushings (7). If the bushings are worn or damaged, use new parts for replacement.
3. Lower the temperature of bushings (7), and install one in each side of the front idler with a press.

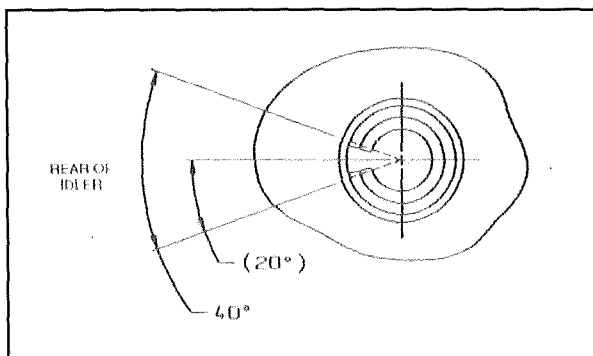


7. Check the condition of O-ring seals (4) used on shaft (5). If the seals are worn or damaged, use new parts for replacement. Install two O-ring seals (4) on shaft (5). Put clean SAE 30 oil

on the seals.

8. Check the condition of spring pins (1) used to hold bearings (2) to shaft (5). If the spring pins are worn or damaged, use new parts for replacement.

9. Install shaft (5) in either bearing (2). Be sure the spring pin hole in the shaft is in alignment with the spring pin hole in the bearing. Also, be sure the marking "R" and the milled surface of the shaft is facing toward the rear of the bearing as positioned in the machine. Install a new spring pin (1) to hold the unit together. Position the slit in the spring pin as shown in the illustration that follows.



10. Install the shaft and bearing in the front idler.

11. Install the other bearing (2) on shaft (5). Be sure the spring pin hole in the shaft is in alignment with the spring pin hole in the bearing. Install a new spring pin (1) to hold the bearing to the shaft.

12. Check the front idler for air leaks. Apply 245 to 265 kPa (35.5 to 38.5 psi) of air to the idler for a minimum of 30 seconds. If the pressure gauge reading does not change in a 30 second time period, it can be assumed there are no leaks in the front idler.

13. Put the front idler in a vertical position. Fill the front idler with 555 ml (19 oz.) of clean SAE 30 oil. Put a thin coat of thread lock on the threads of the fill/drain plug, and reinstall it.

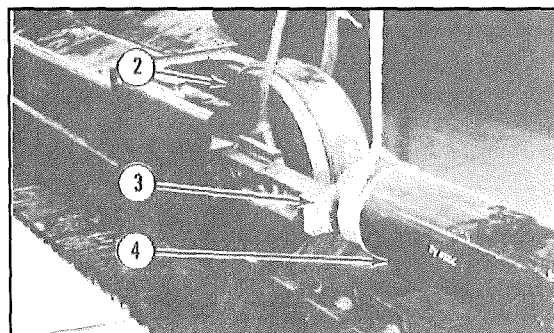
INSTALLATION

1. Be sure the mating surfaces on the front support for the recoil spring and the two bearings for the front idler are clean and free of dirt and debris prior to reassembly.

2. Fasten a hoist to the recoil spring and hydraulic track adjuster. Put the unit in position on the front idler. Temporarily install four bolts (3) that hold the unit together.

3. Fasten a hoist to the front idler and recoil spring and put the unit partially into the crawler frame leaving the bolts (3) exposed. Tighten the bolts.

4. Slide the front idler, recoil spring and hydraulic track adjuster partially into the undercarriage frame assembly leaving bolts (3) exposed. Remove the hoist from the unit. Tighten bolts (3) to 325 Nm (30 ft-lbs).



5. Open the relief valve on the track adjuster only one turn.

6. Pull the assembly out of the crawler frame and install it in its correct position. Using a pry bar, slide the front idler and recoil spring the remainder of the way into the crawler frame assembly.

7. Refer to the topic "Track Assembly" and reconnect the track assembly.

6-10-98

CRAWLER FINAL DRIVE (018157-106)

DESCRIPTION

The final drive has an integral piston motor and a hydraulically released (350 psi / 24 bar) multiple disk brake. It is installed as a complete unit into the crawler frame. The drive and hydraulic motor have independent oil reservoirs. Although the motor is integrated, servicing or replacing the motor can be done without removal of the drive.

The final drive consists of three planetary stages. Each stage incorporates a set of matched planetary gears which provide an equal load distribution. All torque transmitting components are made of forged, quenched and tempered high-alloy steels. External gears are carbonized. Precision roller bearings are used exclusively. Two large, tapered roller bearings support the sprocket. A metal face seal protects the unit against contamination.

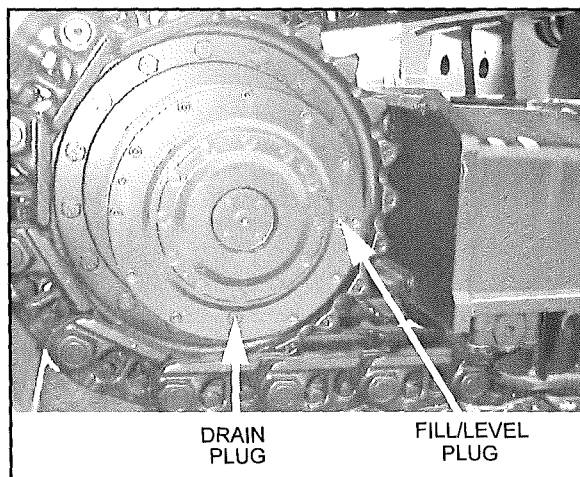
The spring applied, hydraulically released, multiple disk brake is used as a safety brake. The brake is released when pressurized by hydraulic oil. The inner disks (30) are splined to the input coupler (3). The outer disks (29) are splined to the spindle (1). When the brake is not pressurized, both the inner and outer disks are compressed by a spring applied piston (25). When the brake is pressurized, the springs (31 and 32) are compressed between the piston and back-up plate (26), this frees the multiple disks, which in turn, releases and opens the brake.

OVERHAUL

Disassembly

1. Position drive so that one of the drain hole is at the bottom of the end cover and drain the oil

into a suitable container.



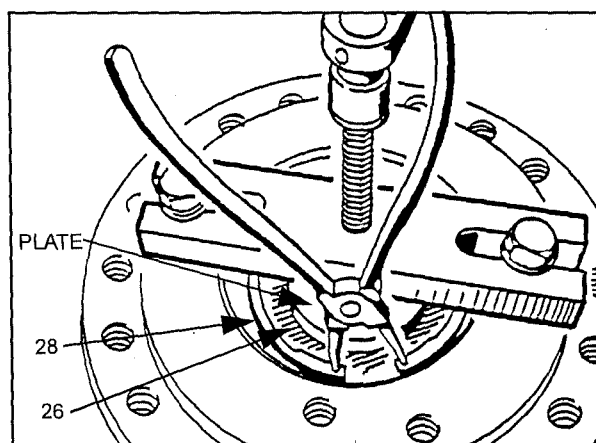
2. Remove bolts (23) holding motor (118) and remove the motor from the drive. Plug all hoses and cap all ports.

3. Remove plug (108) from the drive cover to access and remove screw (109).

NOTE!

This screw does not need to be removed if only the brake disks are being replaced.

4. Compress brake back-up plate (26) and remove snap ring (28). Release pressure on the back-up plate until loose. Remove the back-up plate.



5. Springs (31 & 32) should be removed from brake piston (25) and kept together.
6. Inject pressurized air into the brake release port to help remove brake piston (25).
7. Remove brake disk stack (29 & 30) together with coupling (3), and if screw (109) was removed, remove shaft (87). Inspect the disk stack for wear or burned surfaces. Replace with a brake disk kit and seal kit if any damage is indicated.
8. Remove shaft (87).
9. Position the drive with the motor side facing down.
10. Remove the twelve capscrews (106) and lift cover (104) off. Remove thrust washer (105).
11. Remove the twelve bolts (67) and remove ring gear end cover (51).
12. Remove first stage sun gear (88).
13. Remove first stage planetary assembly (89).
14. Remove snap ring (59) and remove sun gear (52) from first stage planetary assembly (89).
15. Remove second stage planetary assembly (53).
16. Remove snap ring (18) and remove sun gear (17) from second stage planetary assembly (53).
17. Remove the 24 socket head screws (48) and lift ring gear (49) off.
18. Remove snap ring (8), and lift third stage planetary assembly (4) off of spindle (1). Remove thrust washer (100).
19. If face seal (15) on the drive assembly is not leaking, the pre-load on the tapered roller bearings (20, 21) has to be checked to determine

whether further disassembly is required.

20. Rotate ring gear (49) of the drive assembly by hand. Listen carefully for sounds of roughness in the bearings and feel for any tight or loose spots while rotating. The drive should be stiff and have a uniform resistance to rotating. If the bearings do not feel loose or rough, **do not go any farther with the disassembly.**

21. If face seal (15) is leaking, bearings (20 & 21) have rough spots, or ring gear (49) rotates too easily, the tapered roller bearings must be replaced.

22. If face seal (15) was leaking, bearings (20 & 21) and the face seal should be replaced.

NOTE!

We strongly recommend replacement of the face seal any time the tapered roller bearings are adjusted or replaced. Under no circumstances should a new seal part be mated with an old one.

23. Cut spindle nut (19) at dowel pins (44) and remove.

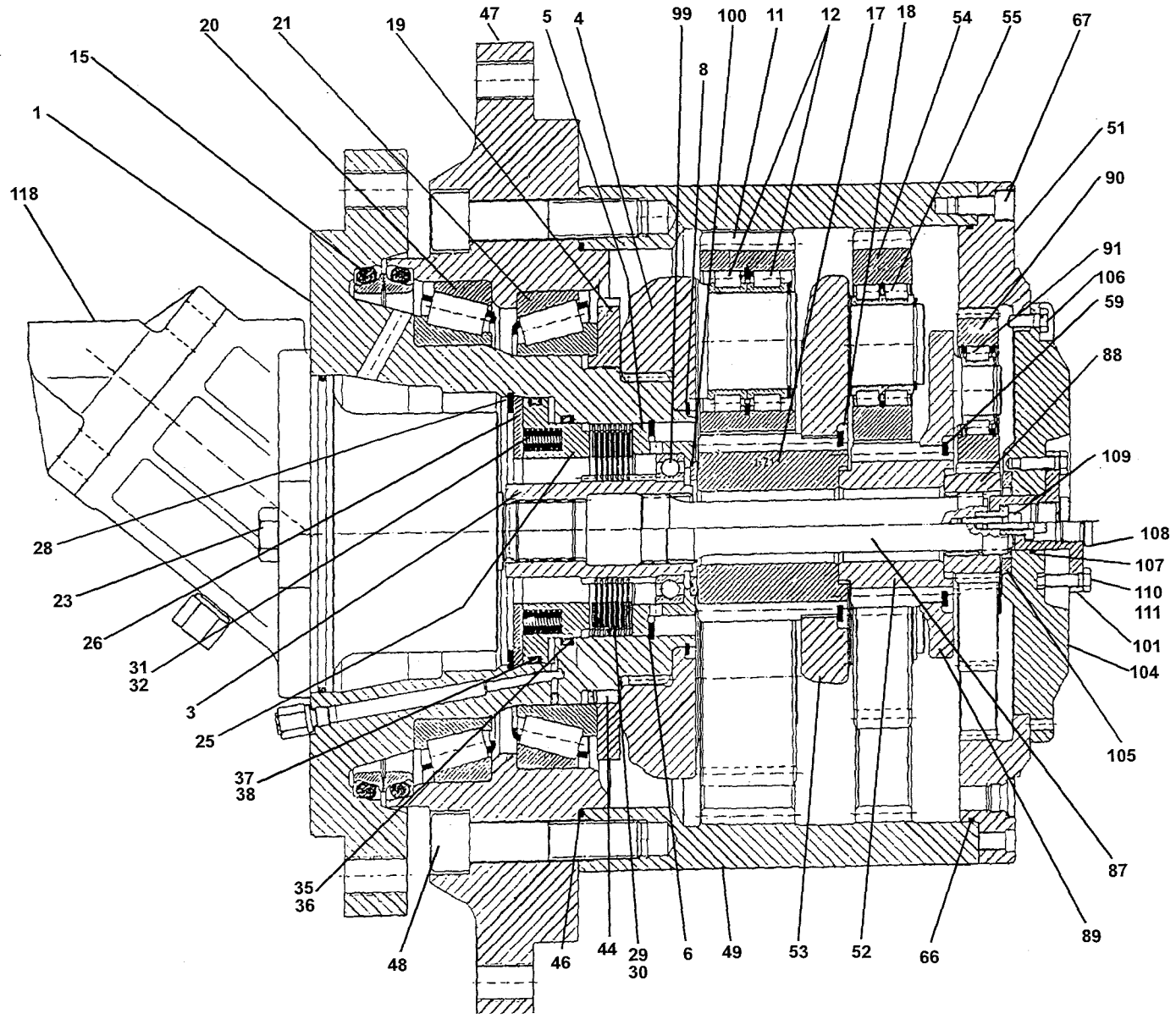
24. Press spindle assembly (1) out of flange (47).

25. Pull bearings (20 and 21) off of spindle (1) and flange (47).

26. Remove snap ring (6) and slide out pilot ring (5) together with bearing (99).

27. Inspect the planetary stage assemblies as complete units. Thoroughly clean the planetary carriers as complete units, and the inside of the drive. Be sure to flush all old oil and contamination from the drive and tapered roller bearings. Thoroughly clean and check both the gearing and the bearings for damage and apply new oil. If the gears or bearings need replacing they must be replaced as complete sets.

28. First stage planetary bearings (91) **must** be replaced in sets of three pieces.



29. First stage planetary gears (90) **must** be changed as a complete set of three. We recommend changing sun gear (88) along with this set of gears.

30. Second stage planetary bearings (55) **must** be replaced in sets of three pieces.

31. Second stage planetary gears (54) **must** be changed as a complete set of three pieces. We recommend changing sun gear (52) along with this set of gears.

32. To remove sun gear (52) from the first stage planetary carrier, remove the snap ring (59).

33. Third stage planetary bearings (12) **must** be replaced in sets of ten pieces.

34. Third stage planetary gears (11) **must** be changed as a complete set of five pieces. We recommend changing sun gear (17) along with this set of gears.

Assembly

Before any assembly of the final drive can take place, the new spindle nut (19) must be lapped onto the threads of spindle (1). Lap the nut onto the threads as follows:

A. Apply a valve lapping compound to the threads of the spindle.

B. The **new** spindle nut (19) should be worked onto and off of the threads until the nut can be easily screwed on and off by hand. This procedure ensures that the best torque setting can be reached when setting pre-load.

C. Thoroughly wash spindle (1) and nut (19) to remove all traces of the compound.

1. Install the cup portions of bearings (20 & 21) in output flange (47). Use a soft brass punch to drive the cups fully against the shoulders.

NOTE!

It is recommended that the cups be cooled with dry ice or liquid nitrogen to help during installation.

2. Press the cone of tapered bearing (20) onto spindle (1).

3. Install one half of face seal (15) in output flange (47) and the other half in spindle (1). **Do not use oil on the O-rings** of the seal during installation.

NOTE!

Be careful not to damage the metal face of the seal or cut the O-rings during installation. Wipe the face of the seal with a lint free cloth to remove any contaminants.

4. Lower the output flange (47) onto the spindle (1). Take care not to damage the seal.

5. Install the cone of the tapered bearing (21) on spindle (1).

6. Apply Loctite #638 to the threads of nut (19).

7. While continuously rotating ring gear output flange (47) in one direction only, tighten spindle nut (19) to 5,531 ft-lb (7,500 Nm). This is required to correctly pre-load the tapered roller bearing.

8. Install dowel pins (44) into nut (19) flush.

9. Install bearing (99) in pilot ring (5). Install the pilot ring in spindle (1) and secure it with snap ring (6).

10. Install thrust washer (100) on pilot ring (5) before placing third stage planetary assembly (4) onto spindle (1).

11. Lock the third stage planetary assembly to the spindle by installing the snap ring (8) onto the end of the spindle.

12. Place O-ring (46) on ring gear (49) before mounting the gear on flange (47). Secure with

screws (48).

13. Install sun gear (17) in planetary (4).

14. Install second stage planetary assembly (53) onto sun gear (17).

15. Lock the second stage planetary assembly to sun gear (17) by installing the snap ring (18).

16. Install sun gear (52) in planetary assembly (53).

17. Install first stage planetary assembly (89), snap ring (59), and sun gear (88) into the drive.

18. Install new O-ring (66) on ring gear end cover (51).

19. Install cover (51) on ring gear (49) and secure with the twelve hex head bolts (67). Torque the bolts to 64 ft-lbs (86 Nm).

20. Install input shaft (87) **from the motor end** of the drive making sure to engage the splines with the sun gear (88).

21. Install coupling (3) over shaft (87) and into bearing (99).

22. Install new back-up rings (35) into spindle (1). Install new back-up rings (38) onto piston (25). Install the back-up rings first and then install the piston seals between the back-up rings. Apply a thin coat of gear lube to piston seals (36 & 37) before installation.

23. Assemble the brake disk stack (item 29 x 8 pieces & item 30 x 7 pieces).

24. Install the assembled piston (25) into the drive making sure to fully seat it against pilot ring (5).

25. Install O-ring (107) in cover (104). Apply Loctite #270 to surface of thrust washer (105) before installing it in the cover.

26. Install cover (104) on ring gear cover (51).

Using a feeler gauge measure the clearance between thrust washer (105) and sun gear (88). Ideally the clearance should be .039 to .078 inch (1 to 2 mm). If necessary replace the thrust washer.

27. Secure cover (104) in place with twelve socket head screws (106). Torque the screws to 15.5 ft-lbs (21 Nm).

28. Install screw (109) and tighten. Install plug (108).

29. Place sleeve (103) in bushing (101) and install in cover (104).

30. Install capscrew (109) and tighten.

31. Install capscrews (110 & 111) and plug (108).

32. Insert springs (31 & 32) into the back of piston (25).

33. Place back-up plate (26) into position on top of springs (31 & 32).

34. Put snap ring (28) in the motor pilot and compress the brake springs sufficiently to install the snap ring (28) into the groove of the spindle.

35. Before installing the motor CHECK THAT THERE IS 1-2 mm OF CLEARANCE BETWEEN THE MOTOR SHAFT AND COUPLER (3).

36. Install motor (118) and install the drive on the crawler frame. Reconnect the hydraulic hoses.

37. Rotate drive so that one fill plug is at 12 o'clock position and the other is at 3 o'clock. Fill drive to bottom of 3 o'clock plug with gear oil. Reinstall plugs.

38. After four hours of operation, recheck the oil level.

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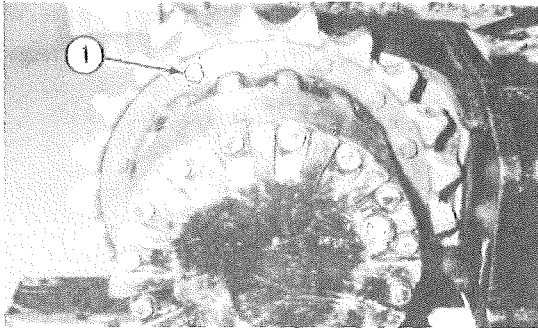
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FINAL DRIVE SPROCKET (018157-107 & -109)

REMOVAL

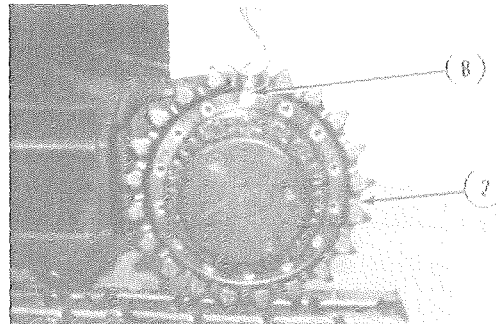
1. Separate the crawler track as described in the topic 'Track Assembly - Separate' in this section.
2. Using the jack cylinders, raise the machine so that the crawlers are not touching the ground.
3. Remove the sixteen bolts (1) that hold the sprocket to the final drive.



4. Fasten an eyebolt (B) and a hoist to sprocket (2) as shown. Remove the sprocket. The weight of the sprocket is 88 kg (195 lb).

INSTALLATION

1. Thoroughly clean the mating surfaces of the sprocket and final drive prior to installation of the sprocket.
2. Fasten eyebolt (B) and a hoist to sprocket (2), and put it in position on the final drive.
3. Put a thin coat of thread lock on the threads of the sixteen bolts (1) that hold the sprocket to the final drive. Install the bolts that hold the sprocket to the final drive. Tighten the bolts to a torque of 900 ± 100 Nm (660 ± 75 lb ft).
4. Lower the machine onto the crawler track and reconnect the track as described in the topic 'Track Assembly - Connect' in this section.



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UPPER TRACK ROLLER (018157-157)

REMOVAL

Remove the upper track rollers from the crawlers as follows:

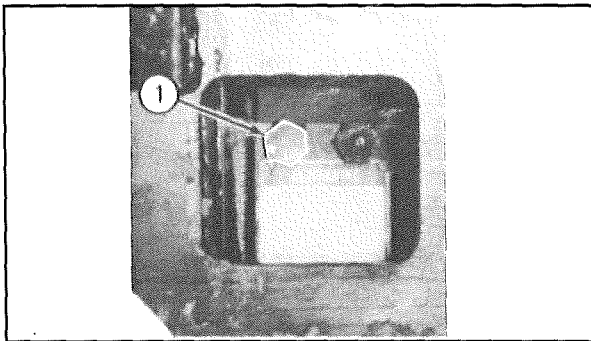
1. Position the machine on a flat level floor.



WARNING

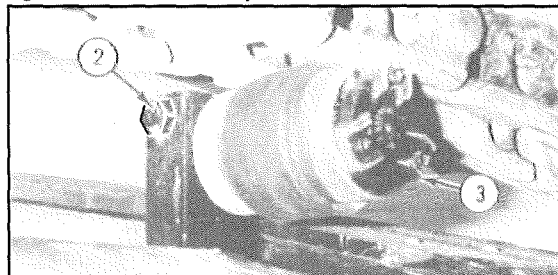
The grease in the track adjusting cylinder is under high pressure. Grease coming out of the relief valve of the track adjuster, which is under high pressure, can penetrate the body causing personal injury or death. When loosening the tension on the track, loosen the relief valve only one turn. Do not visually inspect the relief valve to see if grease is being released from the track adjuster. Instead, watch the track to see if it loosens. If the track does not loosen after opening the relief valve, move the machine forward and backward to release the tension.

2. Release the tension on the track. Loosen relief valve (1) only one turn. If the track does not loosen after opening the relief valve, move the machine forward and backward until the tension is released.

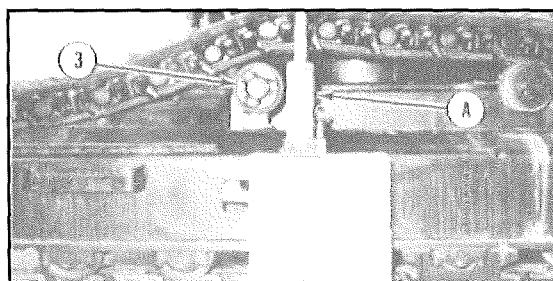


3. Loosen bolt (2) that holds track carrier roller (3) to the mounting bracket on the undercar-

riage frame assembly.



4. Place wood blocks and jack (A) under the track assembly as shown and lift the track assembly off of the track carrier roller.

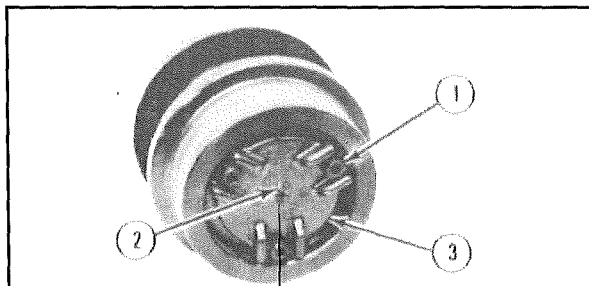


5. Support the roller and remove bolt (2) and track carrier roller (3). The weight of the track carrier roller is 25 kg (55 lb).

OVERHAUL

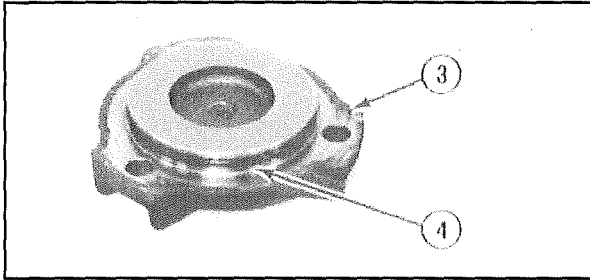
Disassembly

1. Thoroughly clean the outside of the track carrier roller prior to disassembly.
2. Remove plug (2), and drain the oil from the carrier roller into a suitable container. The capacity of the track carrier roller is 210 ml (7oz.).

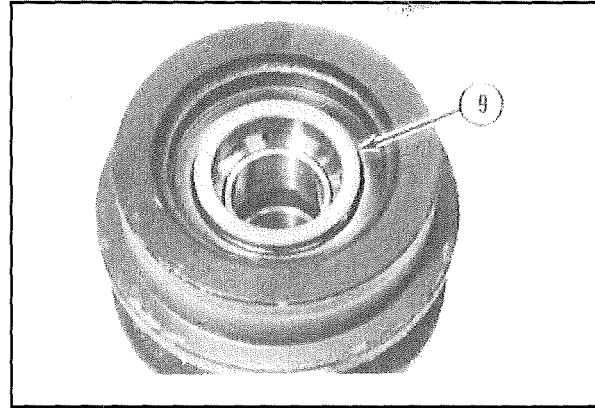


3. Remove the three socket head bolts (1) and cover (3) from the track carrier roller.

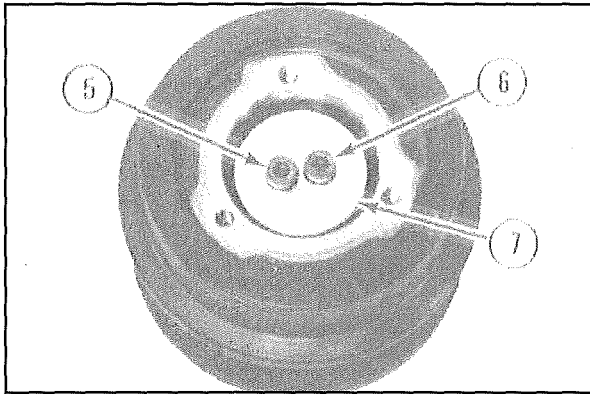
4. Remove O-ring seal (4) from cover (3).



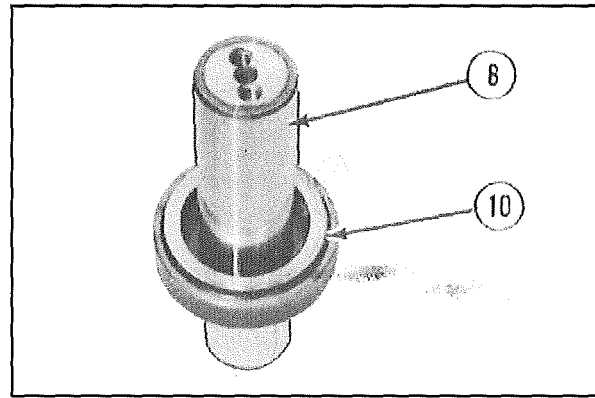
carrier roller.



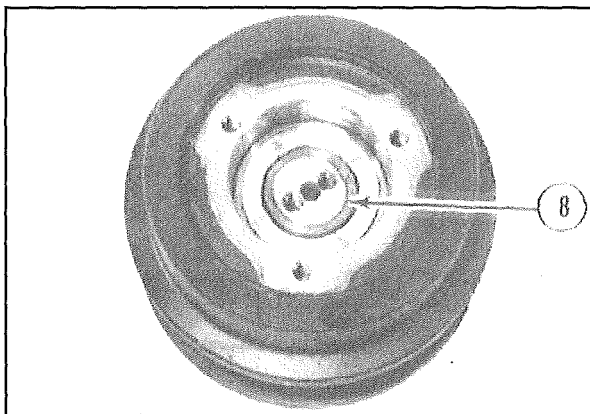
5. Lift the washer off of retainer (7) then remove socket head bolts (5) and (6) and retainer (7) from the end of the shaft assembly.



8. Remove Duo-Cone seal (10) from shaft assembly (8).

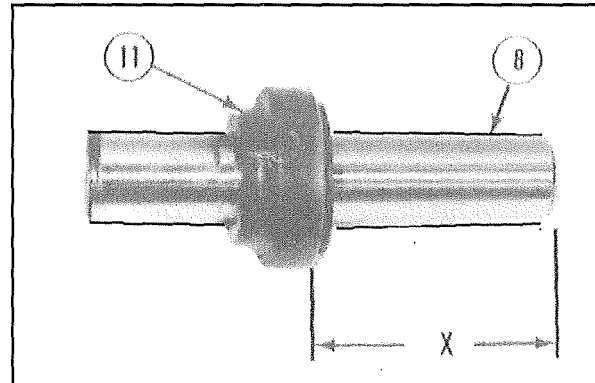


6. Carefully remove shaft assembly (8) from the track carrier roller.

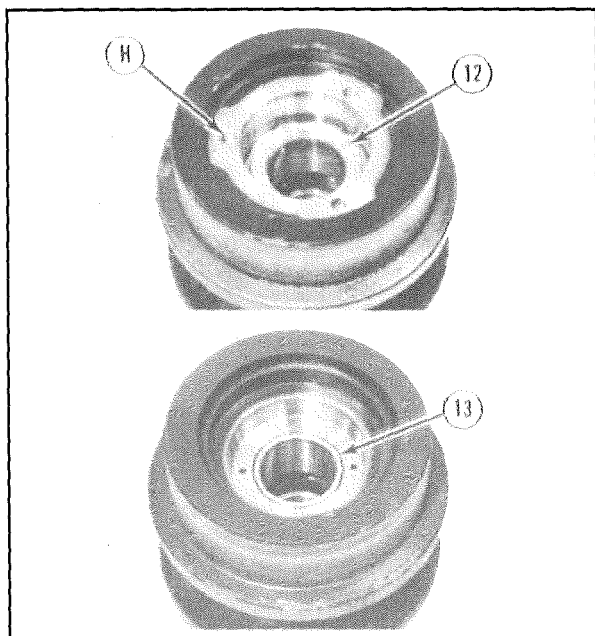


9. Measure distance (X) on the shaft assembly. Record this dimension for assembly purposes. Using a press, push shaft (8) out of collar (11). Remove the O-ring seal from inside the collar.

10. Remove bearings (12) and (13) from the track carrier roller.



7. Remove Duo-Cone seal (9) from the track



Assembly

1. Thoroughly clean all parts of the track carrier roller prior to assembly.

NOTE !

Do not reuse bearings (12) and (13). Use new parts for replacement.

NOTE !

Bearing (13) is a straight bearing.

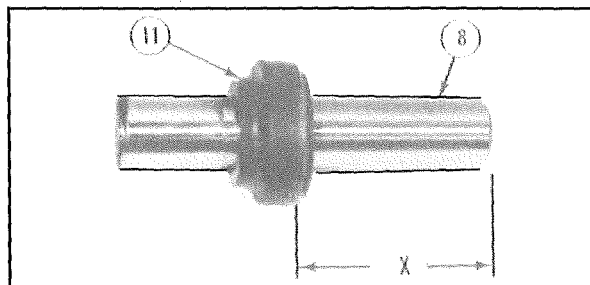
2. Lower the temperature of bearing (13), and install it in the inside bore of the carrier roller with a press. Install the bearing until it is even with the shaft counterbore in the carrier roller.

NOTE !

Bearing (12) has a flange on it.

3. Lower the temperature of bearing (12), and install it in the outside bore of the carrier roller with a press. The outside bore can be identified by the three threaded holes (H) in the track carrier roller. Install the bearing until the flange on the bearing makes contact with the counterbore in the track carrier roller.

4. Check the condition of the O-ring seal used in collar (11). If the seal is worn or damaged, use a new part for replacement. Install the O-ring seal in the collar. Put clean oil on the seal.



5. Using a press, install collar (11) on shaft (8) until dimension (X) is 127.4 ± 0.2 mm ($5.02 \pm .008$ in).

6. Determine shaft end play as follows:

NOTE !

Do not install the Duo-Cone seals in the track carrier roller or collar (11) at this time.

A. Install shaft assembly (8) in the track carrier roller without Duo-Cone seals.

B. Install retainer (7) and socket head bolts (5) and (6) on the end of shaft assembly (8).

C. Use a dial indicator to measure the end play of shaft assembly (8). The end play of the shaft assembly must be 0.25 to 1.25 mm (.0098 to .0492 in). Bearing (12) controls the amount of shaft end play.

D. Disassemble the track carrier roller, but do not remove collar (11) from shaft (8).

NOTE !

The rubber seal and all surfaces that make contact with the seals must be clean and dry. After installation of the seals, put clean SAE 30 oil on the contact surfaces of the metal seals.

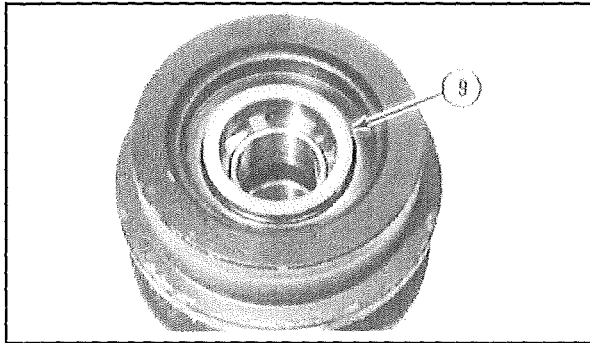
7. Install Duo-Cone seal (10) in collar (11).

NOTE !

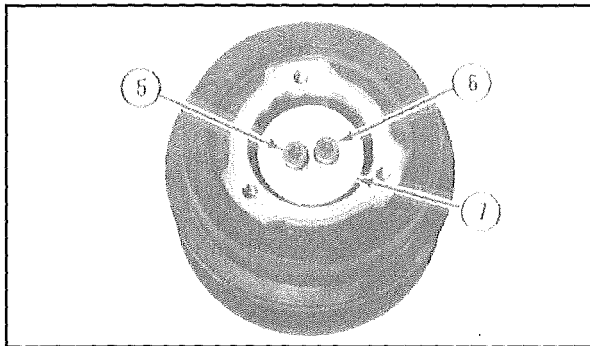
Refer to the Introduction topic of the Undercar-

riage section of this manual for more information on installing Duo-Cone seals.

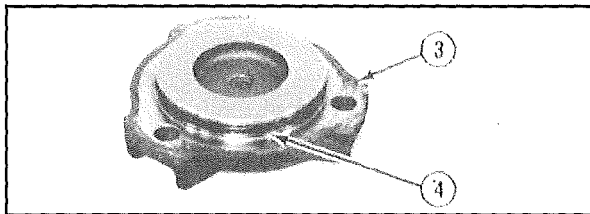
8. Install Duo-Cone seal (9) in the track carrier roller (side without three threaded holes).



9. Carefully install shaft assembly (8) in the track carrier roller. Install retainer (7) and socket head bolts (5) and (6). Install the washer on retainer (7).



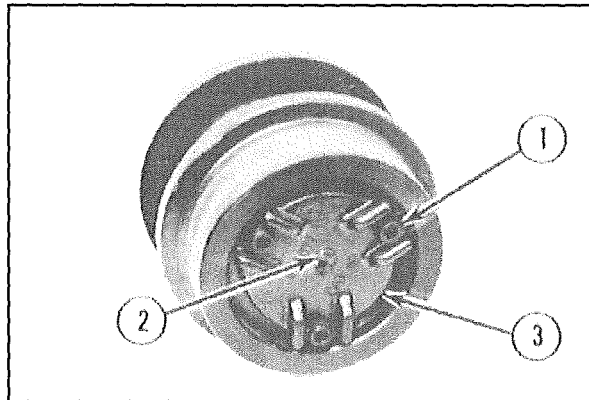
10. Check the condition of O-ring seal (4) used on cover (3). If the seal is worn or damaged, use a new part for replacement. Put clean oil on O-ring seal (4), and install it on cover (3).



11. Install cover (3) on the track carrier roller and three socket head bolts (1) that hold it.

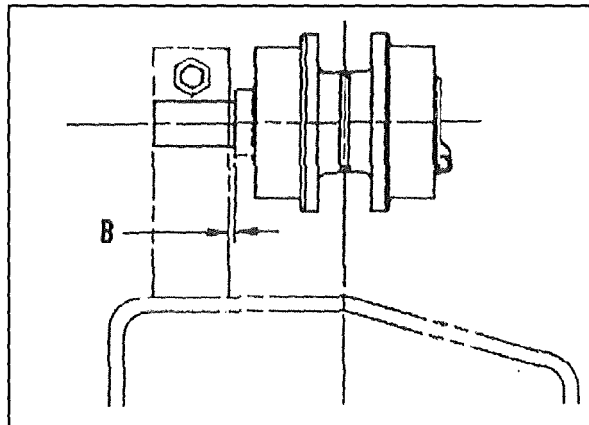
12. Put the track carrier roller in a vertical posi-

tion. Fill the track carrier roller with 210 ml (7oz.) of clean SAE 30 oil. Put a thin coat of Caterpillar pipe sealant on the threads of plug (2). Install plug (2).

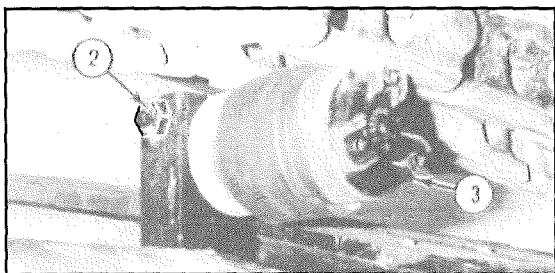


INSTALLATION

1. Be sure the shaft of the track carrier roller and the bore in the mounting bracket on the undercarriage frame assembly is clean and free of dirt.
2. Put the track carrier roller in position in the mounting bracket. Adjust the carrier roller until distance (B), the distance between the outside face of the mounting bracket and the carrier roller is 7.0 ± 0.5 mm ($.28 \pm .02$ in).



3. After adjusting the position of the carrier roller in the mounting bracket, tighten bolt (2).



4. Be sure the carrier roller rotates smoothly by hand. Slowly lower the track assembly on to the carrier roller.

5. Tighten the tension of the track. See the Preventive Maintenance section in the Operators Manual.

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TRACK ASSEMBLY (018157-161)

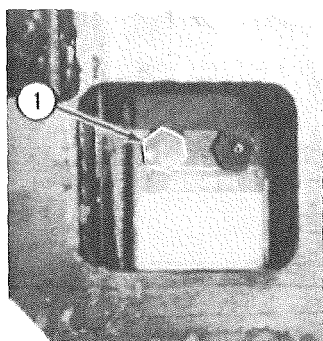
SEPARATING THE TRACK

1. Position the machine on level ground.



The grease in the track adjusting cylinder is under high pressure. Grease coming out of the relief valve of the track adjuster, which is under high pressure, can penetrate the body causing personal injury or death. When loosening the tension on the track assembly, loosen the relief valve only one turn. Do not visually inspect the relief valve to see if grease is being released from the track adjuster. Instead, watch the track assembly to see if it loosens. If the track assembly does not loosen, move the machine forward and backward to release the tension.

2. Release the tension on the track assembly. Loosen relief valve (1) for the track adjuster only one turn. If the track assembly does not loosen after opening the relief valve, move the machine forward and backward until the tension is released.



3. Move the track assembly until the master pin is located between the two upper rollers.
4. Remove the two track shoes directly above the master pin.

5. Using a ram, press the master pin out of the master link and install a pilot pin in its place.

6. Start the machine and position the pilot pin on top of the final drive sprocket.

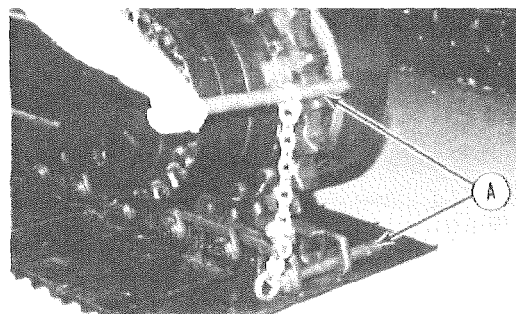
7. Remove the load off of the pilot pin and remove the pilot pin.

8. Fasten a hoist to the rear of the track assembly. Raise the track assembly off of the sprocket and lower the track assembly to the floor.

9. Tram the machine off the track assembly

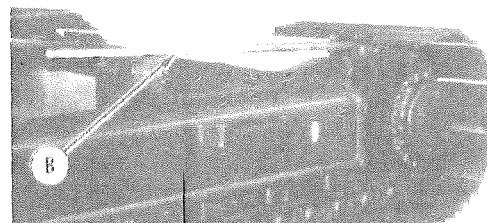
CONNECTING TRACK

1. Install tooling (A) in the track link and on the final drive sprocket as shown below.



2. Start the machine. Move the sprocket forward until the track assembly is pulled up on the sprocket and the end of the track assembly is forward of a vertical line through the center of the sprocket. Remove tooling (A).

3. Install tool (B) between the first bushing in the track link and the sprocket as shown below.



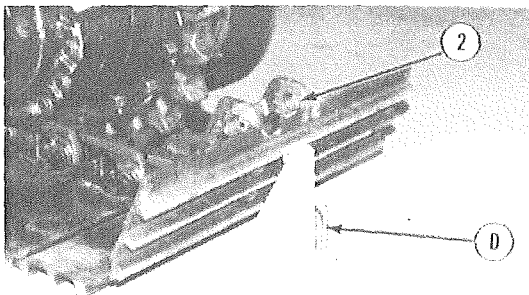
4. Move the sprocket forward. Use tool (B) to guide the track assembly over the carrier rollers and the front idler.

5. Install pin and chain assembly (C) and pin (1) between the links in the ends of the track assembly as shown.



6. Move the track assembly forward or backward until the separation in the track assembly is below a horizontal line through the center of the sprocket.

7. Put multipurpose grease on two track bushings (2), and install them in the track links as shown. The grease will hold the bushings in place.



8. Install tool (D) under the rear of the track assembly as shown. Move the track assembly backwards until the separation in the track assembly closes and the pin bores in both ends of the track assembly are in alignment with each other. The machine may have to be moved back and forth to align the pin bores.

9. Put multipurpose grease in the master pin bores in the track assembly and on the pilot pin. Install the washers and spacers in the master link and install the pilot pin used during track removal. Move the track until the master link is located between the two top rollers.

10. Press in the master pin.

11. Reinstall the track shoes.

12. Tighten the tension of the track. See the Preventive Maintenance section in the Operators Manual.

TRACK ASSEMBLY (018157-272)

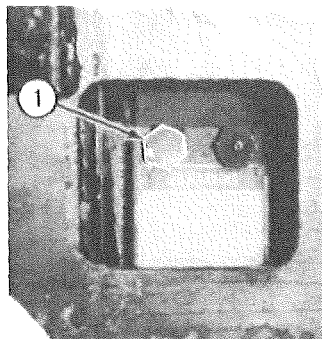
SEPARATING THE TRACK

1. Position the machine on level ground.



The grease in the track adjusting cylinder is under high pressure. Grease coming out of the relief valve of the track adjuster, which is under high pressure, can penetrate the body causing personal injury or death. When loosening the tension on the track assembly, loosen the relief valve only one turn. Do not visually inspect the relief valve to see if grease is being released from the track adjuster. Instead, watch the track assembly to see if it loosens. If the track assembly does not loosen, move the machine forward and backward to release the tension.

2. Release the tension on the track assembly. Loosen relief valve (1) for the track adjuster only one turn. If the track assembly does not loosen after opening the relief valve, move the machine forward and backward until the tension is released.



3. Move the track assembly until the master pin is located between the two upper rollers.

4. Remove the two track shoes directly above the master pin.

5. Using a ram, press the master pin out of the master link and install a pilot pin in its place.

6. Start the machine and position the pilot pin on top of the final drive sprocket.

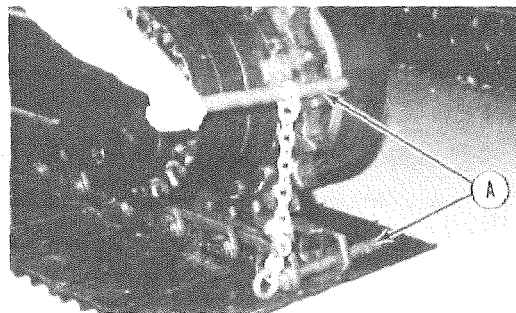
7. Remove the load off of the pilot pin and remove the pilot pin.

8. Fasten a hoist to the rear of the track assembly. Raise the track assembly off of the sprocket and lower the track assembly to the floor.

9. Tram the machine off the track assembly

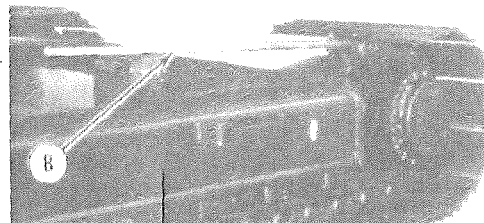
CONNECTING TRACK

1. Install tooling (A) in the track link and on the final drive sprocket as shown below.



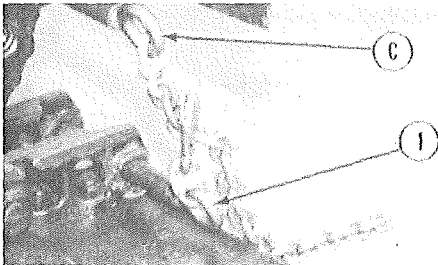
2. Start the machine. Move the sprocket forward until the track assembly is pulled up on the sprocket and the end of the track assembly is forward of a vertical line through the center of the sprocket. Remove tooling (A).

3. Install tool (B) between the first bushing in the track link and the sprocket as shown below.



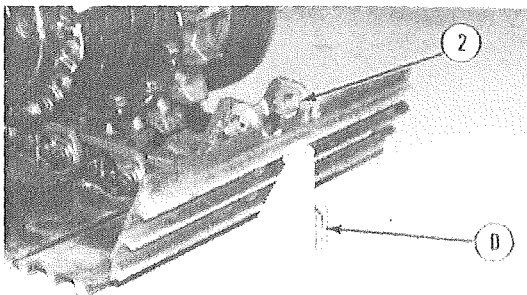
4. Move the sprocket forward. Use tool (B) to guide the track assembly over the carrier rollers and the front idler.

5. Install pin and chain assembly (C) and pin (1) between the links in the ends of the track assembly as shown.



6. Move the track assembly forward or backward until the separation in the track assembly is below a horizontal line through the center of the sprocket.

7. Put multipurpose grease on two track bushings (2), and install them in the track links as shown. The grease will hold the bushings in place.



8. Install tool (D) under the rear of the track assembly as shown. Move the track assembly backwards until the separation in the track assembly closes and the pin bores in both ends of the track assembly are in alignment with each other. The machine may have to be moved back and forth to align the pin bores.

9. Put multipurpose grease in the master pin bores in the track assembly and on the pilot pin. Install the washers and spacers in the master link and install the pilot pin used during track removal. Move the track until the master link is located between the two top rollers.

10. Press in the master pin.

11. Reinstall the track shoes.

12. Tighten the tension of the track. See the Preventive Maintenance section in the Operators Manual.

AIR CONDITIONER

(018146-003)

PREVENTIVE MAINTENANCE

Although the system has been designed for industrial use, it still requires routine service. It will improve performance, reliability and life.

One Week After Initial Start-Up Check the Following:

- Compressor mount, drive, and bracket for alignment, tightness, belt tension.
- System for leaks.
- Mounting bolts for tightness.
- Fastening bolts for tightness.
- Any sign of malfunction.
- Motor brushes for signs of abnormal wear.
- Fans for tightness on shaft.
- Electrical connections for tightness.
- Hoses for signs of chafing or rubbing.

Maintenance Schedule

These are based on an "average" site condition and should be adjusted according to your environment.

8 Hours or Daily

- Clean pressurizer pre-cleaner bowl (refer to the rig Operator's manual).
- Check over system for signs of any abnormality.

100 Hours Bi-Monthly

- Replace the blower return filter (refer to the rig Operator's manual).

250 Hours or Monthly

- All 'Daily' and 'Bi-Monthly' services.
- Leak check.
- Flush out drains.
- Check seals.
- Flush out condenser area and coil.
- Check all connections.
- Check compressor mount, drive and

bracket for alignment, tightness, belt tension.

- Check hoses.

500 Hours or Quarterly

- All 'Daily', 'Bi-Monthly' and 'Monthly' services.
- Check motor brushes and blow out motor.
- Replace pressurizer filter.
- Wash second stage return air filter element.

2000 Hours or Annually

NOTE!

This is probably best scheduled immediately prior to the cooling season.

- All 'Daily', 'Monthly', and 'Quarterly' checks.
- Replace compressor drive belts.
- Clean unit.
- Check motor commutator and brushes and repair, or replace, as required. Condenser motors require particular attention as they are exposed, and if one fails it will cause operational problems with other areas. In most cases, it is cost effective to put 2 new motors in at the start of each year. Motors can typically have 1 brush change, and the second set of brushes will only last half the time of the first.
- Replace internal heater hoses.
- Flush evaporator and condenser coils.
- Check cover seals.
- Check fan blades.

TROUBLESHOOTING

Many of the problems can be diagnosed by tracking the power line throughout the system.

Fault finding is a process of elimination.

PROBLEM	REMEDY
INADEQUATE AIR FLOW	Check supply voltage to unit. Check supply voltage to evaporator fan motor. Check evaporator motor brushes. Clean filters. Check rotation. Check grounding.
INADEQUATE PRESSURIZATION	Change filter element. Check motor operation, direction or brush condition. Check circuit breakers. Check cab door seals.
INADEQUATE COOLING	Check that compressor is cycling on and off. Check refrigerant charge, it should have a full sightglass. If cycling on high pressure, check condenser fans, motors, overcharge, and dirty coil. Check for overcharge (refer to the topic 'Measuring Overcharge'). Check air flow. Check low pressure cycling. Low refrigerant flow indicates a system blockage.
INADEQUATE HEATING	Is the solenoid valve opening? Is the solenoid valve cycling? Check heater hoses at the engine. Purge the heater core of air. Is thermostat calling for cooling?

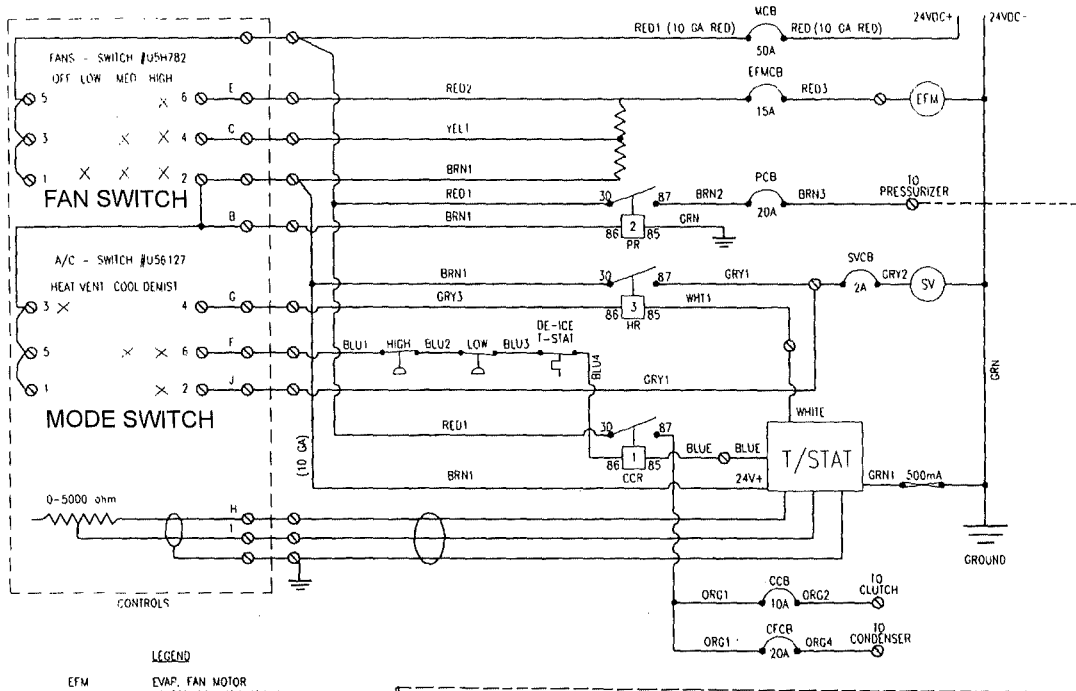
HEAD PRESSURE

Under normal circumstances head pressures should be in the following ranges:

AMBIENT TEMPERATURE °F (°C)	PRESSURE READING psig (bars)
70 (21)	125-175 (8.6-12)
80 (27)	140-180 (9.6-12.4)
90 (32)	150-220 (10.3-15)
100 (38)	180-250 (12.4 - 17.2)
110 (44)	200-270 (13.8-18.6)
120 (49)	220-300 (15-20.7)

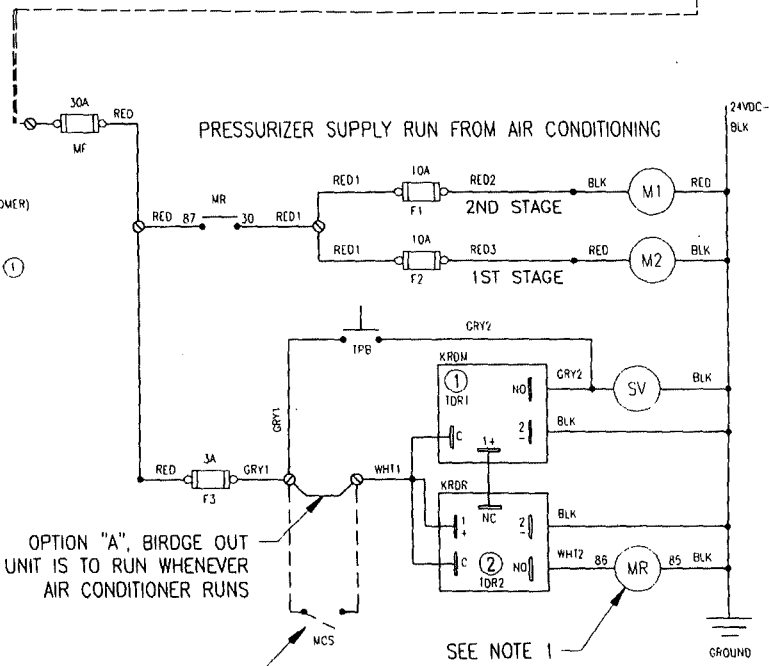
MEASURING REFRIGERANT CHARGE

Refrigerant charge is measured by measuring the temperature of the refrigerant flowing from the condenser. Ideally this temperature should be 10° to 15° cooler than the condensing temperature.



LEGEND

- EFM EVAP. FAN MOTOR
- SV HEATER SOLENOID VALVE
- FR PRESSURIZER RELAY
- HR HEATER RELAY
- CCR CLUTCH RELAY
- CFR CONDENSER FAN RELAY
- MCR MAIN CIRCUIT BREAKER
- EFMCR EVAP. FAN MTR CIRCUIT BREAKER
- FCH PRESSURIZER CIRCUIT BREAKER
- CCB CLUTCH CIRCUIT BREAKER
- CFCB CONDENSER FANS CIRCUIT BREAKER
- SVCR SOLENOID VALVE CIRCUIT BREAKER
- F1, F2, F3 FUSES
- MF MAIN FUSE
- MCS MAIN CONTROL SWITCH (PROVIDED BY CUSTOMER)
- MR MOTOR RELAY
- M1, M2 MOTORS
- SV SOLENOID VALVE
- IDR1 TIME DELAY RELAY (PURGING THE SYSTEM) ①
- IDR2 TIME DELAY RELAY (MOTORS) ②
- IPB TEST PUSH BUTTON SWITCH



OPTION "A", BIRGE OUT
IF UNIT IS TO RUN WHENEVER
AIR CONDITIONER RUNS

OPTION "B", HAVE REMOTE SWITCH
IF SEPERATE CONTROL
IS REQUIRED

SEE NOTE 1

NOTE 1:

RELAY COIL IS NOT REVERSIBLE.
IT MUST BE CONNECTED CORRECTLY (AS SHOWN).

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AIR CONDITIONER

(019148-000)

PREVENTIVE MAINTENANCE

Although the system has been designed for industrial use, it still requires routine service. It will improve performance, reliability and life.

Two Weeks After Initial Start-Up Check the Following:

- Compressor mount, drive, and bracket for alignment, tightness, belt tension.
- System for leaks.
- Mounting bolts for tightness.
- Fastening bolts for tightness.
- Any sign of malfunction.
- Motor brushes for signs of abnormal wear.
- Fans for tightness on shaft.
- Electrical connections for tightness.
- Hoses for signs of chafing or rubbing.

Maintenance Schedule

These are based on an "average" site condition and should be adjusted according to your environment.

8 Hours or Daily

- Clean return air and pressurizer filters.
- Check over system for signs of any abnormality.

250 Hours or Monthly

- All daily services.
- Leak check.
- Flush out drains.
- Check seals.
- Flush out condenser area and coil.
- Check all connections.
- Check compressor mount, drive and bracket for alignment, tightness, belt tension.
- Check hoses.

500 Hours or Quarterly

- All daily and monthly services.
- Check motor brushes and blow out motor.
- Replace pressurizer filter.
- Replace return air filter media.

2000 Hours or Annually

NOTE !

This is probably best scheduled immediately prior to the cooling season.

- All daily, monthly, and quarterly checks.
- Replace compressor drive belts.
- Replace receiver.

NOTE !

On 134a systems this is very important as the synthetic oils absorb far more moisture than the mineral oils used on R12 systems. Although refrigerant hoses should be barrier type, they still allow moisture to be absorbed into the system.

These filters can best be changed by "pumping the system down". With the engine idling, close the valve in the liquid line between the condenser and receiver. Close the lid, and operate on cool until the system cuts out on "Low Pressure" .7 bar (10 psi), and stays cut out. Open the condenser cover and close the valve in the liquid line leading to the TX valve.

The refrigerant between the two valves should be all vapor. The filters can then be removed, replaced and the short section between the valves evacuated, and then pressure charged with 134a.

There should be no need to add more refrigerant, and filter replacement can be done in a fraction of the time and cost if the whole charge was lost.

- Check motor commutator and brushes and repair, or replace, as required. Condenser motors require particular attention as they are exposed, and if one fails it will cause operational problems with other areas. In most cases, it is cost effective to put 2 new motors in at the start of each year. Motors

can typically have one brush change, and the second set of brushes will only last half the time of the first.

- Replace internal heater hoses.
- Thoroughly flush out evaporator and condenser coils and chambers.
- Check and replace cover seals if necessary.
- Check fan blades and replace if damaged.

Power is connected to the multi-pin connector and goes to the MODE switch, then the FAN SPEED (wire 101) or the cooling cycle (wire 108). Circuit breakers protect all motors, and these are located behind the return air filter.

If the button is out, there is an over current problem and it should be checked & repaired.

The clutch cycles on pressure switches through a relay.

Fault finding is a process of elimination.

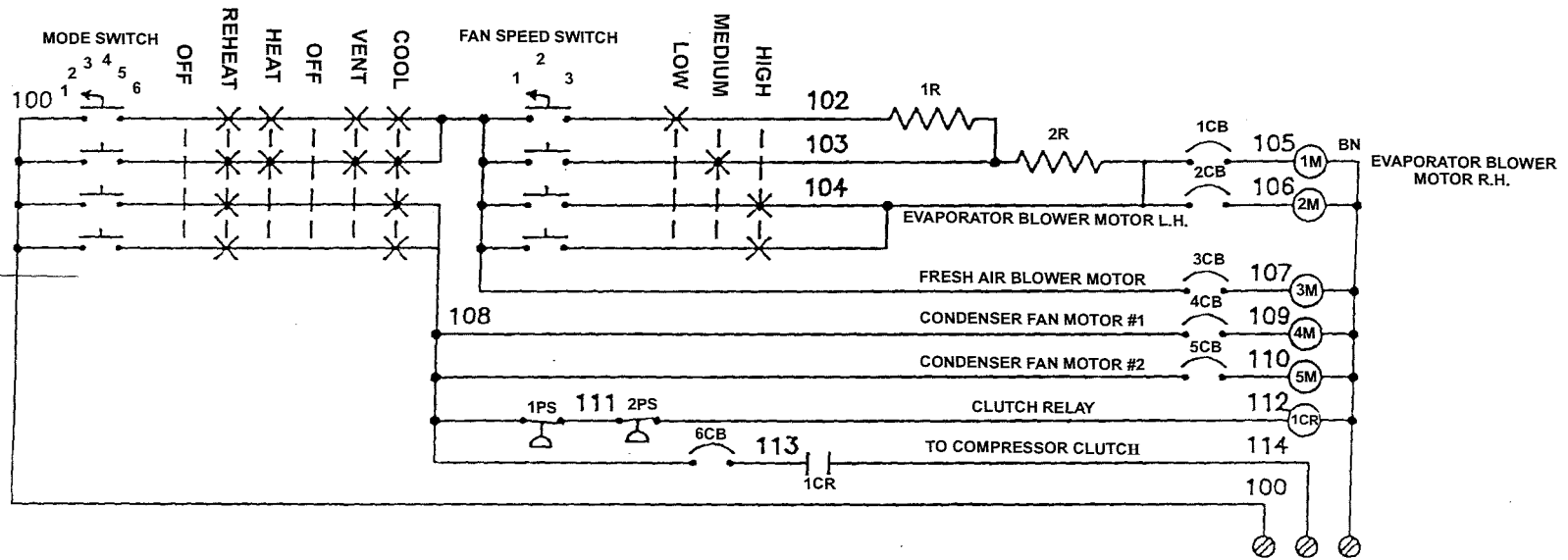
TROUBLESHOOTING

Many of the problems can be diagnosed by tracking the power line throughout the system.

PROBLEM	REMEDY
WILL NOT START	Check supply to Mode Switch in return air plenum, wire 100. Check ground. Check circuit breakers.
FAN SPEED	Check power to 102 on Low, 103 on Med., 104 on High. Check center tapping makes contact with resistor. This may be adjusted to suit. Check if it is cycling on high pressure or low pressure controls. Gauges will indicate which one. If suction cuts down to .7 bar (10 psi); it is low side, if discharge gets to 24 bar(350 psi) it is high side.
INTERMITTENT COOLING. IF IT IS LOW PRESSURE CUT OUT CHECK THE FOLLOWING:	Refrigerant charge, is there a full sightglass? Is there a blockage in the system? (e.g. - drier, TX valve) A blockage can sometime be identified by a drop in temperature after the blockage. Are liquid line valves wide open? Is return air filter blocked? Is evaporator fan running? In right direction? Is evaporator pressure regulator set correctly?
INTERMITTENT COOLING. IF IT IS HIGH PRESSURE CHECK THE FOLLOWING:	Is condenser coil blocked? If so, clean it. Are both fans running? In right direction? Is system overcharged? Full sightglass even after recovering some refrigerant. Are liquid lines valves open? Is there a blockage in the liquid lines. Is there air in the system? Has system been opened and not evacuated properly?
INSUFFICIENT COOLING	Charge, is there a full sightglass? Are condenser area and coil clean? Is TX valve operation satisfactory? Is thermostat calling for cooling? Does compressor have good pressure differential between high and low side at normal speeds? Discharge should be 12-17 bars (175-250 psi) and suction .7-1.7 bars (10-25 psi).

NOTE: 1R = 1 OHM
 2R = 1 OHM
 1CB - 6 CB = 8 AMP

019148-000 SHEET 3 OF 3



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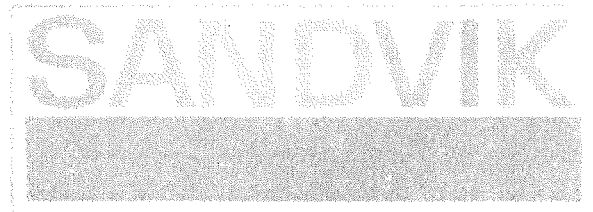
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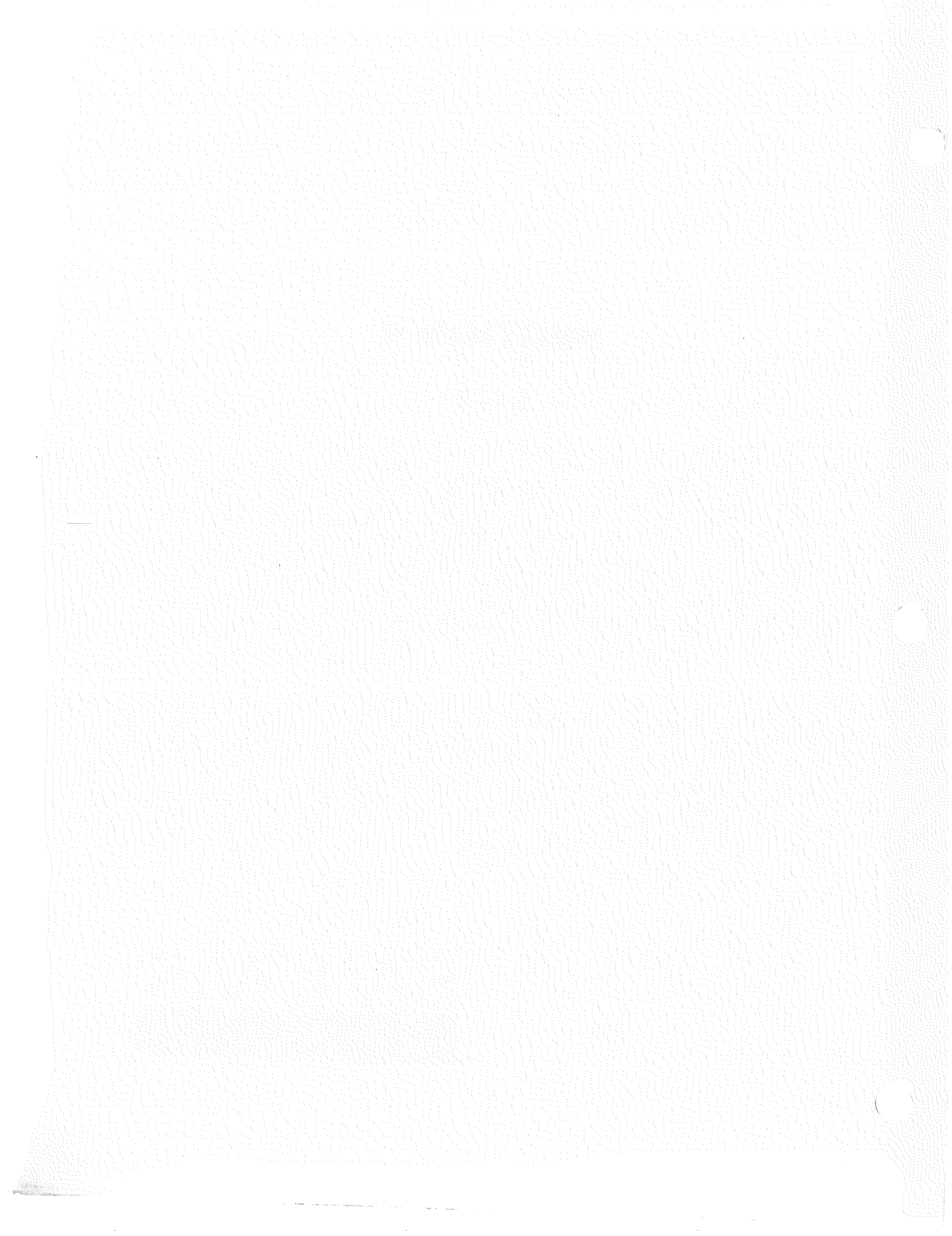
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SECTION 4

ENGINE

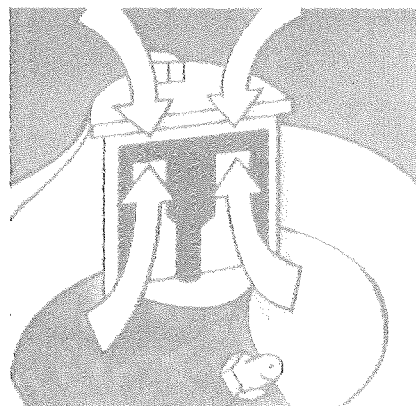




DRIVESHAFT (001022-000)

GENERAL

The following procedures are for driveshafts manufactured by Spicer as the 1550 series. The following topics are discussed; safety, inspection, lubrication, and problem analysis.



SAFETY PRECAUTIONS



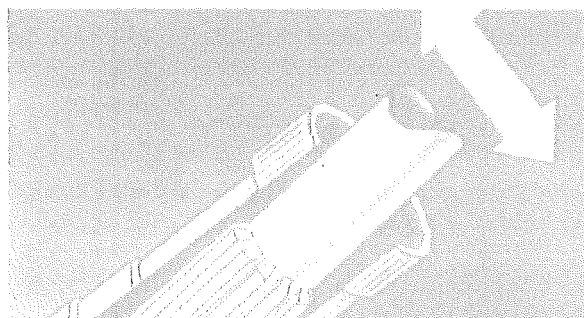
WARNING

Rotating driveshafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

Do not work on driveshaft (*with or without a guard*) when machinery is operating.

If driveshaft is still exposed after installation, install a guard.

3. Check the slip spline for excessive radial movement. Radial looseness between the slip yoke and the tube shaft should not exceed .17 mm (.007 inch).



GENERAL INSPECTION

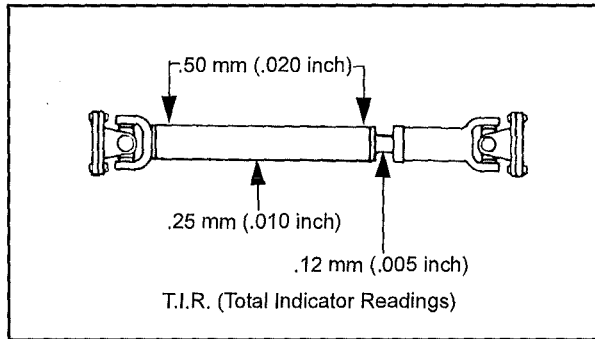
1. Check the mounting hardware torque of companion flanges on both ends of the shaft.
2. Check for excessive wear across the ends of the bearing assemblies and trunnions. This looseness should not exceed .15 mm (.006 inch) maximum.

4. Check the shaft for damaged, bent tubing or missing balance weights. Make certain there is no build up of foreign material on the shaft. If found, foreign material should be removed carefully to avoid damage to the driveshaft.

NOTICE

Do not try to take runout readings from a rotating driveshaft under power!

5. If runout readings should be taken with the driveshaft mounted such that it will rotate by hand.



The runout readings taken at the various locations should not exceed an additional .25 mm (0.010 inch) T.I.R. (Total Indicator Reading) over the manufacturer's specified runout.

FIELD PROBLEM ANALYSIS

U-joint problems, as a rule, are of a progressive nature. They generally accelerate rapidly and result in ruined components.

Some recognizable signs of U-joint deterioration are:

1. Vibration
2. U-joint looseness
3. U-joint discoloration due to excessive heat build-up
4. Inability to purge all four trunnion seals
5. An audible noise or squeal from the drive-line

Lubrication-Related Problems

The most common reasons for U-joint wear are lack of lubrication, inadequate lube quality, inadequate initial lubrication or failure to lubricate properly and often enough. To avoid lubrication-related problems:

1. Lube all fittings including those that are often overlooked, out-of-sight, dirt-covered or difficult to reach.
2. Know how some lube fittings appear differ-

ent from regular lube fittings and require a needle nose attachment for the grease gun.

3. Don't overlook slip yoke lubrication.
4. Use correct lube technique. ***New Lube Must Flow From All Four Bearing Seals.***
5. Use correct lubricant. It should be a recommended type, such as N.L.G.I. Grade 1 or 2 with E.P. additives and high temperature resistance.
6. New U-joints must be lubricated when assembled into the driveshaft yokes.
7. Observe recommended lubrication cycle.

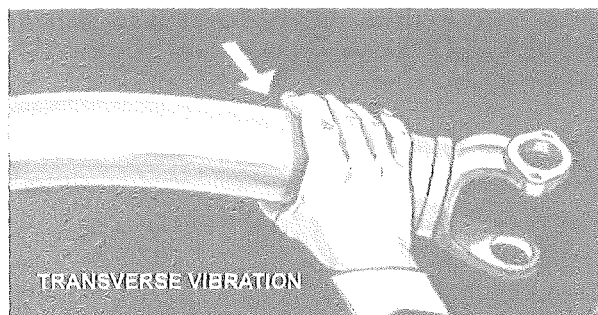
Generally, a lubrication problem is one of two types--brinelling or end galling. The grooves made by the needle roller bearings on the trunnion of the cross are known as brinelling. Brinelling can also be caused by too much torque for the capacity or the U-joint used. End galling is a displacement of metal at the end of the trunnion and can also be related to angularity problems. Both of these problems can be caused by lack of lubrication.

Problems which are not a result of lubrication are associated with the installation, angles and speed of the driveshaft. Fractured parts caused by torque, fatigue and bending are associated with overload, excessively high u-joint angles and driveshaft lengths exceeding critical speed limitations.

Vibration Related Problems

Vibration is a driveshaft problem that can be either transverse or torsional.

Transverse vibration is the result of unbalance acting on the supporting shafts as the driveshaft rotates. When a part having an out-of-balance, or heavy side, is rotated an unbalanced force is created that increases with the square of the speed. The faster the shaft turns, the greater the unbalanced force acting on the shaft.

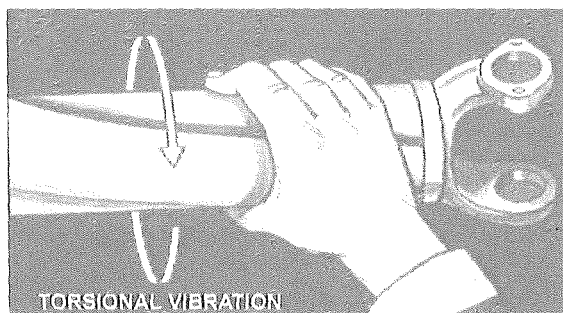


The force produced by this out-of-balance condition tends to bend the supporting members. As the members have a natural frequency of vibration similar to a swinging pendulum, a violent vibration may exist at certain periods when the speed of rotation and the natural frequency of supports coincide.

Each end of the shaft must be balanced individually as each support is responsive to an out-of-balance condition in the portion of the shaft it supports. Out-of-balance affects operating conditions only when rotating.

Transverse vibration caused by a driveshaft out-of-balance will usually emit sound waves that you can hear and mechanical shaking that you can feel. The force from out-of-balance increases with speed, not torque load.

Torsional vibration, although similar in effect to transverse vibration, is an entirely different motion. The transverse vibration is a bending movement, whereas torsional vibration is a twisting motion.



The energy to produce torsional vibration can occur from the power impulses of the engine or from improper U-joint angles. This type of

vibration is difficult to identify but certain characteristics do exist. It causes a noticeable sound disturbance and can occasionally transmit mechanical shaking.

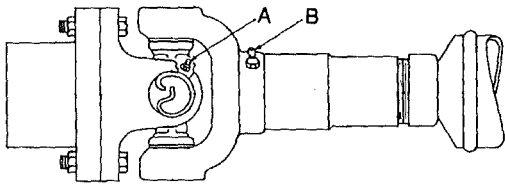
Torsional vibrations can exist at one or more periods any place in the operating range and tend to be more severe at lower speeds. Changes in torque load usually effect the vibration. The nonuniform velocity obtained when a u-joint operates at an angle produces torsional vibration. In a driveline having two or more joints in series, it is desirable to have the individual joint angles arranged such that the net result minimizes nonuniform velocity characteristics over the system. The amount of torsional excitation which can be accepted without causing excessive disturbance depends upon operating speed and characteristics of supporting structures and other units in the driveline and drivetrain system. Other vibrational problems in a driveshaft could be caused by worn or damaged U-joints. These joints must be constantly maintained according to Spicer lubrication specifications.

Repair

The repair of universal shafts should be carried out by our universal driveshaft service experts. Here the overhaul is done by using genuine parts. The repair of universal shafts in the user's own workshop should be undertaken for emergency only and can be done for equipment only where the working speed does not exceed 300 rpm. Above 300 rpm the universal shafts must be balanced. Contact your local Spicer Distributor for Quality Repair Service.

LUBRICATION PROCEDURE

Relubrication cycles vary depending on the application and operating conditions. To obtain maximum life of driveshaft components, lubricate points A and B according to the maintenance schedule included in the rig 'Lubrication and Maintenance Guide' or the 'Operation, Maintenance and Lubrication Manual'.



1. Use the proper lubricant to purge all four seals of each U-joint. This flushes abrasive contaminants from each bearing assembly and assures all four are filled. Pop the seals. Sicer seals are made to be popped.

2. On center twin zerk design or single zerk kits, if any seals fail to purge, move the drive-shaft from side to side and then apply gun pressure. This allows greater clearance on the thrust end of the bearing assembly that is not purging. On two-zerk kits, try greasing from the opposite lube fitting. Check for a fully seated snap ring or burrs on the snap ring or snap ring groove.

3. Because of the superior sealing capability of the seal design there will occasionally be one or more bearing assembly seals that will not purge.

Release seal tension by loosening the bolts holding the bearing assembly that doesn't purge. It may be necessary to loosen the bearing assembly approximately 1.5 mm (.06 inch) minimum. If loosening it does not cause purging, remove the bearing assembly to determine cause of blockage.

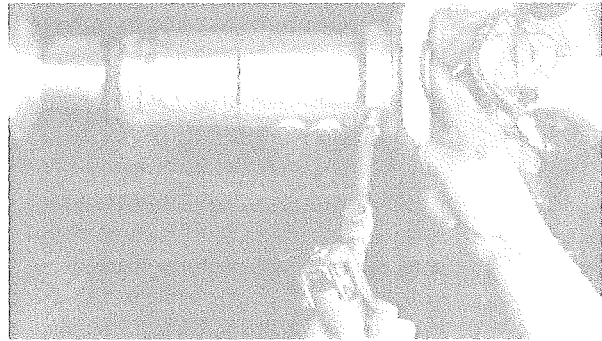
Lubrication for Slip Splines

The lubricant used for U-joints is satisfactory for slip splines. Glidecote and steel splines both use a good E.P. grease meeting N.L.G.I. Grade 2 specifications.

Relube splines at the intervals recommended for U-joints.

1. Apply grease gun pressure to the lube fitting until lubricant appears at the pressure relief hole in the plug at the slip yoke end of the spline.

2. Now cover the pressure relief hole with your finger and continue to apply pressure until grease appears at the slip yoke seal.



NOTICE

In cold temperatures be sure to operate your machine immediately after lubricating. This activates the slip spline and removes the excessive lubricant. Failure to do so could cause the excess lubricant to stiffen in the cold weather and force the plug out. The end of the spline would then be open to collect contaminants and cause the spline to wear and/or seize.

! WARNING

Personal injury or death may result from loss of driveshaft function. If in doubt as to how many times bolts have been removed, replace with new bolts.

AIR CLEANERS - ENGINE and COMPRESSOR (001036-000)

EMPTYING DUST CUPS AND CLEANING PRE-CLEANER TUBES

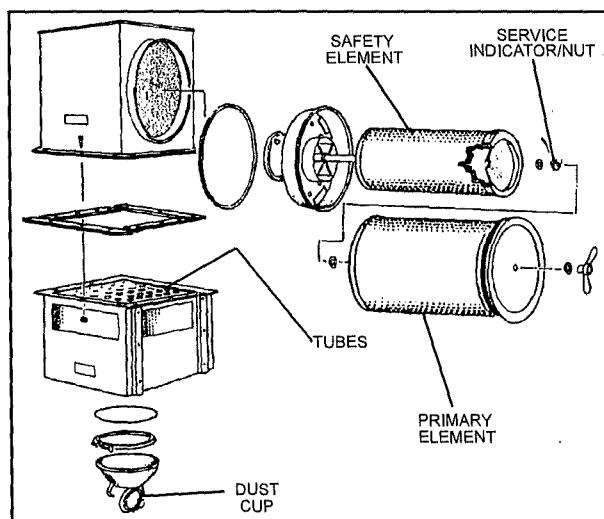
Dust cups should be dumped when 2/3 full or after every 8 hours of machine service.

1. Unlatch the dust cup as shown to remove dust.
2. Loosen the dust cup housing retainer band and remove the housing.

NOTICE

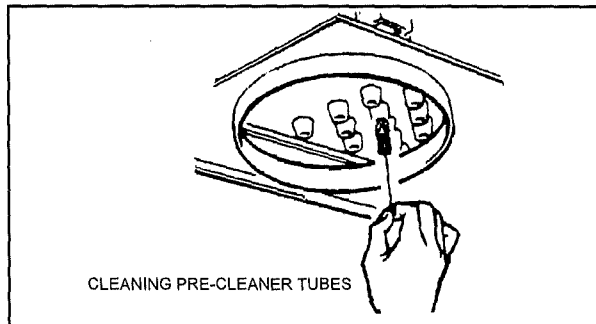
Never clean the air cleaner tubes with compressed air or water with the elements installed in the assembly. Never steam clean the tubes.

3. Light dust plugging of the tubes can be removed with a stiff fiber brush. If heavy plugging is evident, remove the lower body section of the air cleaner and clean with compressed air or hot water not exceeding 160°F (71°C).



4. After cleaning, reassemble the filter making

sure that all connections are sealed properly.



CHANGING ELEMENTS

General

Proper air cleaner servicing will result in maximum protection against dust. Proper servicing can also save time and money by increasing filter life and dust cleaning efficiency. Two of the most common servicing problems are: *Over Servicing* and *Improper Servicing*. Replace or clean elements only when the restriction indicator on the filter or the warning light on the instrument panel indicate to do so. Don't be fooled by filter appearance, the filter should look dirty. Careless servicing procedures can cause contamination. Use the following procedures as a guide to air cleaner maintenance.

Primary Element

1. Loosen the wing nut and gently slide the primary element out of the air cleaner assembly.
2. Inspect the service indicator for the safety element. Remove and replace the element if the indicator is in the red zone.
3. Inspect the inside of the filter housing and if cleaning is required remove the safety element. Be careful not to allow dust to enter the intake duct.
4. If the filter is dented or bunched it must be replaced. Never rap or hit the element to remove dirt. The primary element can be cleaned with compressed air, pressurized water

or washed with detergent. If cleaning the primary element with proceed as follows:

COMPRESSED AIR

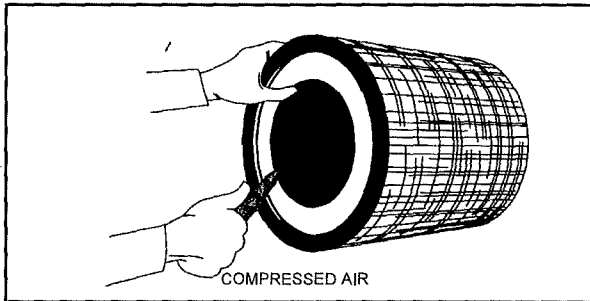


Always use a face shield and protective clothing when using compressed air. Failure to do so can cause eye damage or blindness.

NOTICE

Using compressed air above 30 psi (205 kPa) can damage the filter element.

- A. Blow air **ALONG** (not across) the pleats inside and outside of the element as shown.



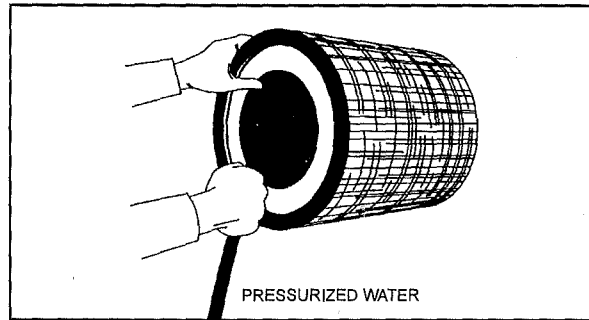
- B. After cleaning, inspect the element with a light bulb as shown. Replace the element if necessary.

PRESSURIZED WATER

NOTICE

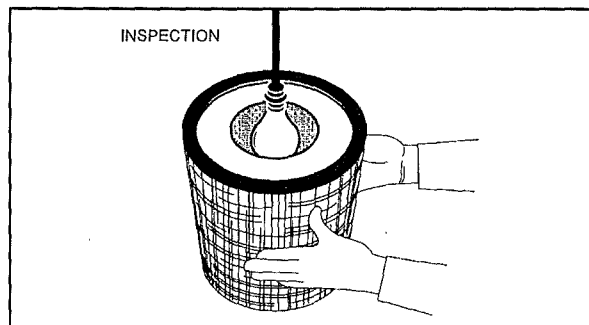
Using compressed water above 40 psi (without nozzle) (280 kPa) can damage the filter element.

- A. Direct water **ALONG** (not across) the pleats inside and outside the element.
- B. Air dry the element **Do Not** dry with a light bulb.
- C. After drying, inspect the element with a light bulb as shown. Replace the element if necessary.



WASHING WITH DETERGENT

- A. Remove excess dust with compressed air or water as described earlier.
- B. Wash the element in warm water with a non-sudsing household detergent or Donaldson D-1400 Washing Compound.
- C. Rise the element with clean water from both sides if necessary.
- D. Let dry in warm circulating air of less than 160°F (71°C).
- E. After drying, inspect the element with a light bulb as shown. Replace the element if necessary.



- 5. Before installing the cleaned or new element press the element gasket to ensure that it has not gotten brittle.
- 6. Slide the primary element over the safety element and tighten the wingnut.
- 7. Inspect all air cleaner and air duct connections for leakage before starting the engine.

Safety Element

The safety element should be replaced every third time the primary element is cleaned or replaced or as indicated by the service indicator in the safety filter hold down nut as shown.

1. Remove the primary element as described earlier.

2. Remove the split pin and nut that hold the safety element in place.

3. Remove and discard the safety element.
The safety element should not be cleaned.

4. Clean the inside of the filter housing especially around the areas of the element sealing surfaces.

5. Install a new safety element.

6. Install the primary element.

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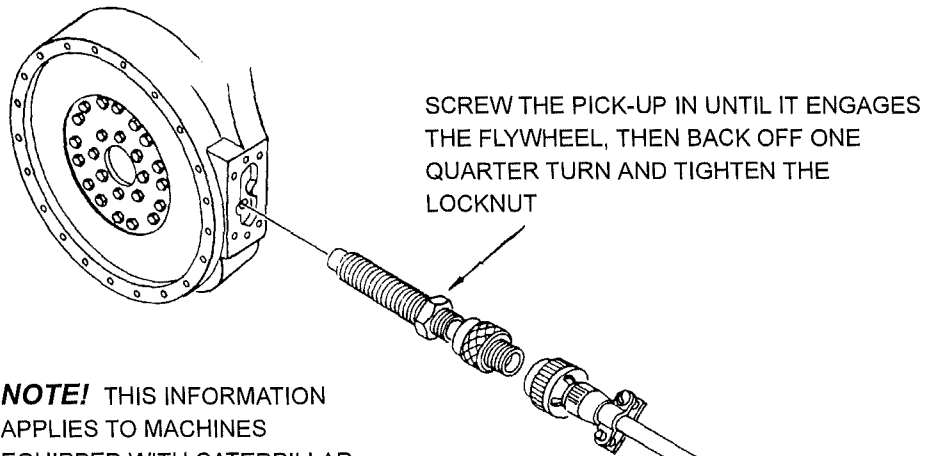
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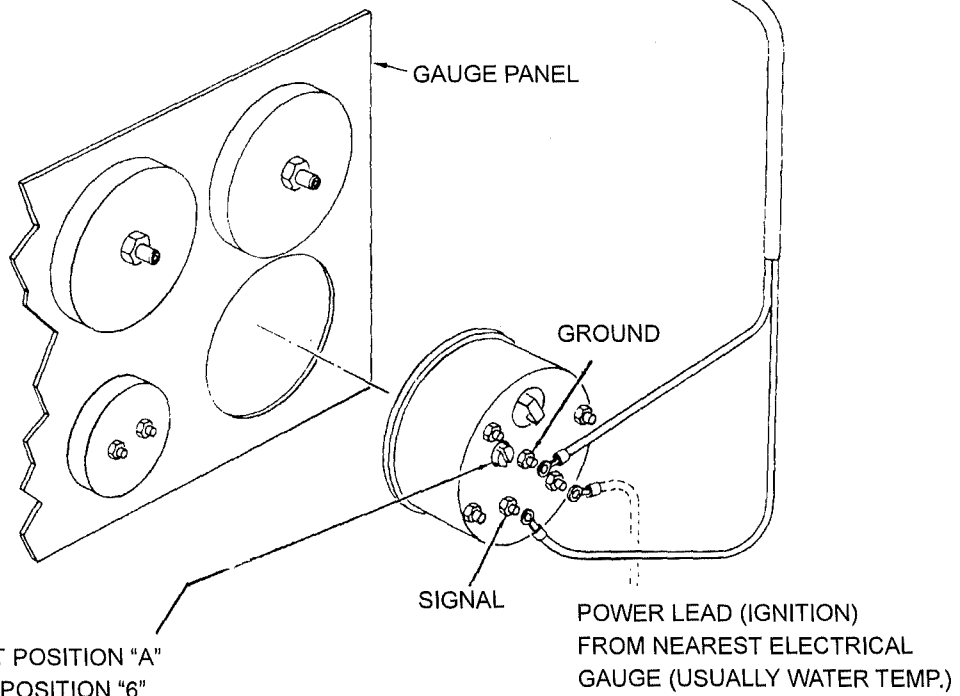
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CATERPILLAR ENGINE TACHOMETER INSTALLATION/ ADJUSTMENT (006269-000)



NOTE! THIS INFORMATION APPLIES TO MACHINES EQUIPPED WITH CATERPILLAR ENGINES ONLY.

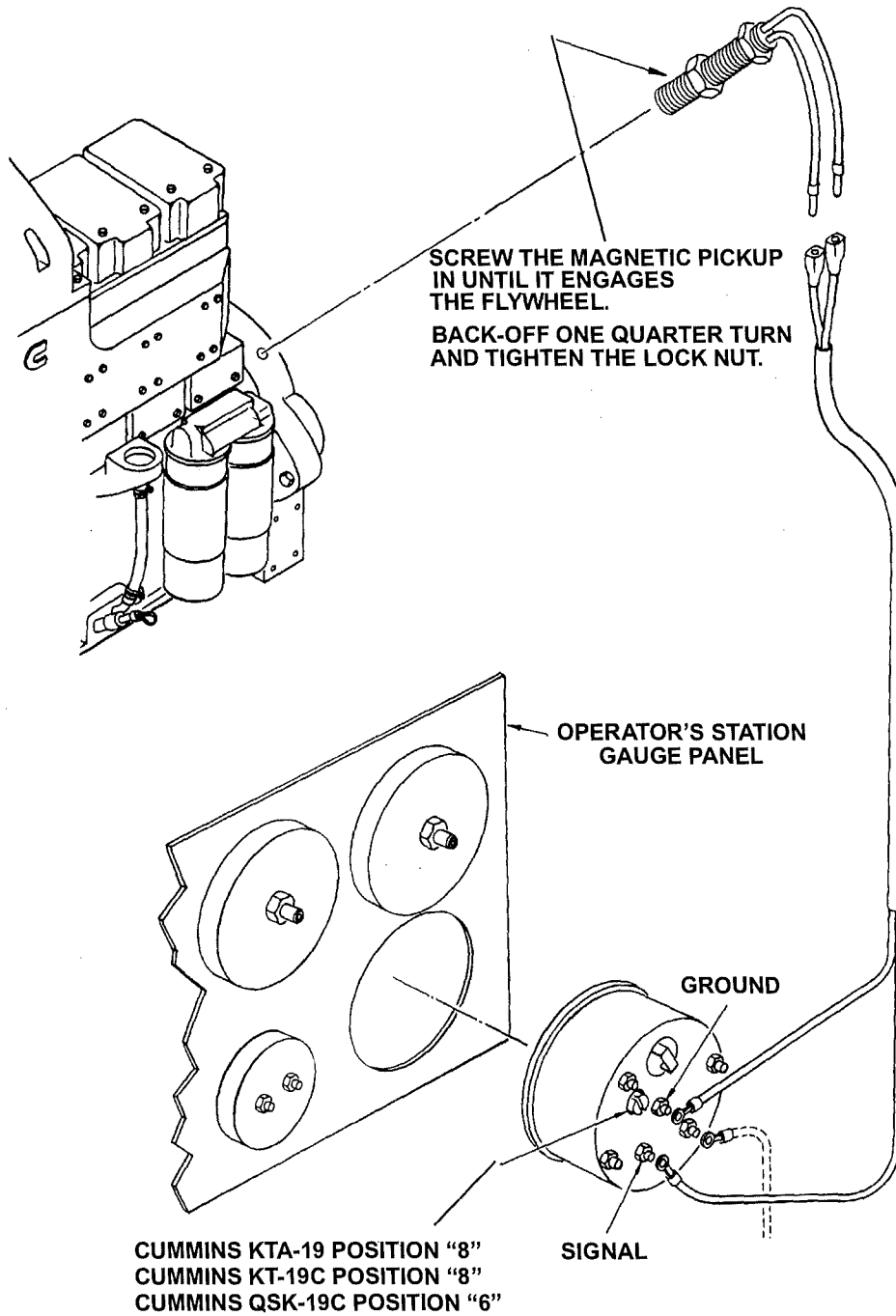


- FOR 3306 - SET AT POSITION "A"
- FOR 3406 - SET AT POSITION "6"
- FOR 3408 - SET AT POSITION "6"
- FOR 3412 - SET AT POSITION "6"
- FOR 3508 - SET AT POSITION "A"
- FOR 3512 - SET AT POSITION "A"

03-09-93



CUMMINS ENGINE TACHOMETER INSTALLATION/ADJUSTMENTS 007672-000



07-25-96

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ENGINE OIL CLEANING CENTRIFUGE (019104-000)

GENERAL

This section addresses the maintenance and troubleshooting of this component.

SERVICE

Servicing intervals will vary with conditions and oils used. Determine what interval best suits your machine and add this component to your preventive maintenance schedule. Always tag the start button to prevent engine start-up.

Service the oil centrifuge as follows:

1. With the oil warm, shut off the engine and allow the turbine assembly (d) to come to a complete stop.



Hot oil or components can cause burns if they contact skin.

2. Loosen the handle on clamp (b). Disengage the tee bolt and using a coin pry off cover (a). Discard the seal (c).
3. Partially lift the turbine assembly (d) from the housing (e) to allow oil to drain from nozzles (o). Remove the turbine assembly after draining.
4. Loosen the knurled nut(h) several turns until the face of the nut projects beyond the bronze bushing face.
5. While holding the bowl (k) of the turbine assembly (d) in one hand, strike the face of the nut (h) with the palm of the other hand to separate the bowl (k) from base (i). **Do not** use a hard surface to strike the nut or damage may result.
6. Finish removing nut (h) and remove bowl (k) together with baffle/screen (m).
7. Examine the dirt deposit in the bowl (k) for signs of engine wear or abnormal operation. A sudden change in the amount or character of the deposit indicates a problem.
8. Wash the baffle/screen (m) and the turbine base (i). Properly dispose of bowl (k) and seal (n).
9. Inspect the top and bottom bushings in the turbine base (i) for wear. Replace the turbine assembly if worn.
10. Inspect the housing assembly (e) for wear at the spindle. Replace the housing assembly if worn.
11. Clean the groove in cover (a) and install a new seal (c).
12. Place baffle/screen assembly (m) over the stem of base (i).
13. Install a new seal (n) over the outer edge of base (i).
14. Slide a new bowl (k) over the stem of base (i) and secure with nut (h). Finger tighten the nut.
15. Install the assembled turbine (d) over the spindle of housing (e). The turbine should rotate freely.
16. Replace the cover assembly (a) and secure with clamp (b). Tighten the clamp by hand, only.
17. Remove and clean the idle cut out valve assembly (s). Replace the valve seal (t) if necessary.
18. Start the engine and check for leaks.

TROUBLESHOOTING

PROBLEM: Centrifuge remove too little dirt.

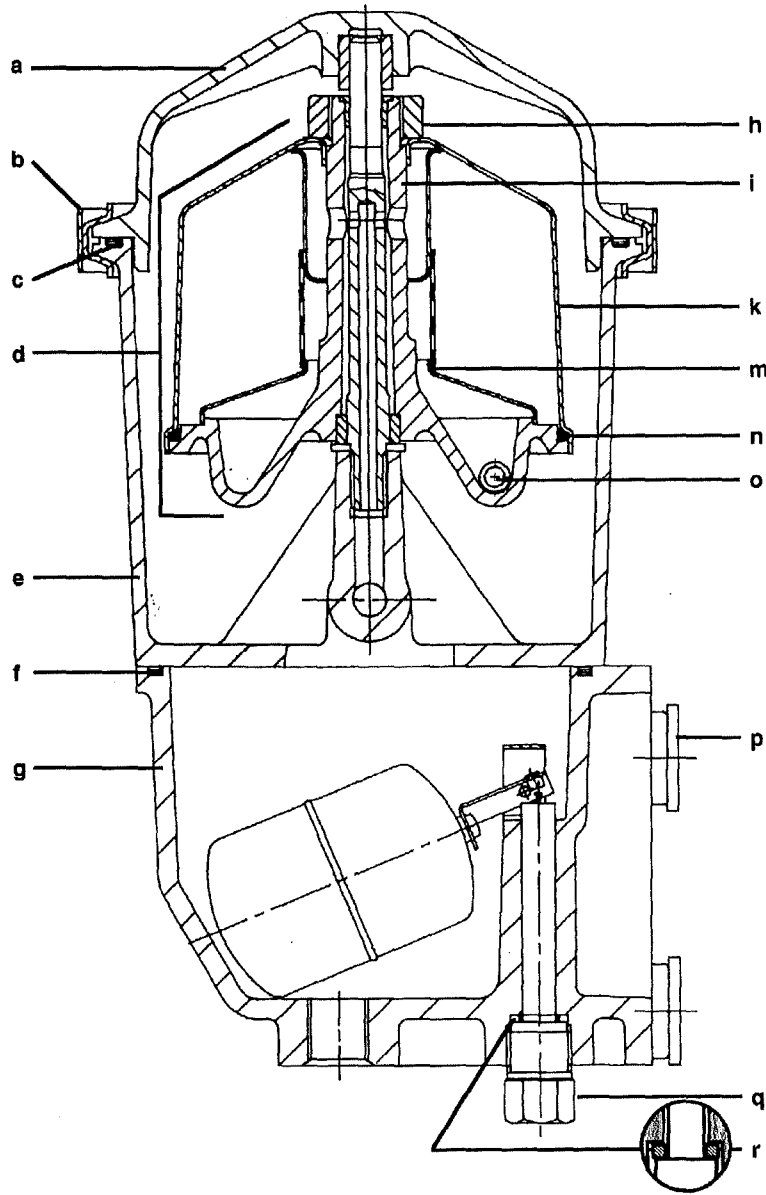
SOLUTION: Check for proper operation.

PROCEDURE: Warm up the engine and bring to RUN speed (high idle). Shut the engine down and immediately listen for the centrifuge turbine spinning. If the turbine is not spinning properly disassemble and install a new turbine assembly.

PROBLEM: Air in the centrifuge flows constantly or not at all or, air bleeds overnight.

SOLUTION: Leaking air valve or cartridge seal.

PROCEDURE: Disconnect the air supply and remove and replace the air valve cartridge (q) and seal (r).

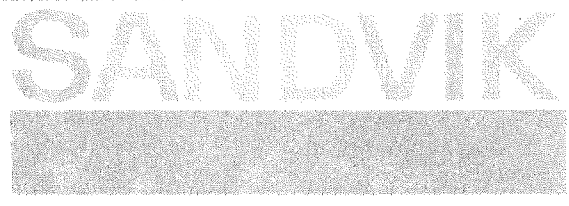


ENGINE OIL CLEANING CENTRIFUGE



SECTION 5

COMPRESSOR/COOLER SYSTEM



ENGINE AND COMPRESSOR SPECIFICATIONS

GENERAL

Sandvik Mining, together with Caterpillar and Cummins engine manufacturers, offer our customers E series, EUI or HEUI and QSK, CELECT series model engines to direct drive compressors (often referred to as the air end).

We have partnered with Sullair Corporation to offer a single stage low pressure rotary screw-compressor package.

DESCRIPTION

Engine horsepower is used to drive the combined volume and pressure from a single stage low pressure air compressor.

Engine horsepower requirements are greater when driving a 2600 cfm air compressor versus the 750 cfm air compressor.

Common engine horsepower (HP) at engine high idle speeds is based on (RPM). The speed rating given is engine loaded high idle speed.

The actual 'TEL' Top Engine Limit calibration will be slightly higher than 1800.

- 450 HP (336kw) @ 1800 RPM
- 500 HP (373 kw) @ 1800 RPM
- 521 HP (389 kw) @ 1800 RPM
- 555 HP (414 kw) @ 1800 RPM
- 630 HP (470 kw) @ 1800 RPM
- 650 HP (485 kw) @ 1800 RPM
- 755 HP (563 kw) @ 1800 RPM
- 800 HP (597 kw) @ 1800 RPM

- 950 HP (708.4 kw) @ 1800 RPM
- 1200 HP (896 kw) @ 1800 RPM

Compressor ratings are based on volumes of air discharged or SCFM standard cubic feet per minute. There are many compressors available for various drilling conditions.

The main concept of the compressor system is to flush drill cuttings away from the rotary type roller, drag or claw drill bit.

Common compressor volumes CFM and maximum pressure ratings PSI available for diesel powered equipment:

- 750 CFM / 100 PSI (21.2 m³ / 6.9 bar)
- 900 CFM / 100 PSI (25.5 m³ / 6.9 bar)
- 1050 CFM / 100 PSI (29.7 m³ / 6.9 bar)
- 1300 CFM / 100 PSI (36.8 m³ / 6.9 bar)
- 1600 CFM / 100 PSI (45.3 m³ / 6.9 bar)
- 2000 CFM / 80 PSI (56.6 m³ / 5.5 bar)
- 2600 CFM / 80 PSI (73.6 m³ / 5.5 bar)
- 3000 CFM / 80 PSI (85 m³ / 5.5 bar)

Electric motor applications are based on AC 6600 volts, 3 phase 50 or 60 Hz.

Up to 900 HP @ 1500 RPM - 50 Hz

Up to 1000 HP @ 1800 RPM - 60 Hz

Common compressor volumes CFM and maximum pressure ratings PSI available for electric drive equipment:

- 2829 CFM / 80 PSI (80 m³ / 5.5 bar)
- 3335 CFM / 80 PSI (94.4 m³ / 5.5 bar)

Engine and compressor packages are compatible for specific drilling applications. Climactic conditions and operating conditions such as altitude, are factors in selecting the proper power group components to fit the overall drilling needs.

When selecting a compressor size and drilling tools, use the following altitude correction chart as shown.

ALTITUDE FEET	ALTITUDE METERS	CORRECTION FACTOR
4000	1200	.86
5000	1500	.82
6000	1800	.79
7000	2100	.76
8000	2400	.73
9000	2700	.70
10000	3000	.68
11000	3400	.65
12000	3700	.63
13000	4000	.60
14000	4300	.58

Use the altitude correction table;

- For drilling applications above 4000 feet (1200 meters).
- When determining actual compressor output or standard cubic feet per minute (SCFM).
- In selecting the correct drill pipe and drill bit dimensions for adequate up hole velocity.

Example:

900 CFM (25.5 m³) @ 5000 feet (1500 meters).
 compressor output = 900 x .82 = 738 SCFM

1600 CFM (45.3 m³) @ 8000 feet (2400 meters).
 compressor output = 1600 x .73 = 1168 SCFM

COMPRESSOR SYSTEMS SPECIFICATIONS (LP)

GENERAL

Low pressure compressor systems specifications are general. The main components listed are designed purchased parts that fit Sandvik Mining blasthole drill machines. The LP drilling concepts are rotary methods, using roller type drill bits.

COMPONENT	SPECIFICATION
COMPRESSOR OIL THERMOSTATS	EXTEND TO CLOSE @ 184° F (84° C) - SULLAIR EXTEND TO CLOSE @ 170° F (76.6° C) - GD
OIL COOLER BYPASS VALVES	2 @ 50 PSI (3.5 BAR) - SULLAIR 1 @ 30 PSI (2.1 BAR) - GD
AIR RECIEVER SAFETY RELIEF VALVE	1 @ 140 PSI (9.7 BAR)
MINIMUM PRESSURE VALVE	1 @ 50 PSI (3.5 BAR) OR 1 @ 60 PSI (4 BAR)
UNLOAD PRESSURE	80 PSI (5.5 BAR) OR 100 PSI (6.9 BAR)
SEPERATOR DIFFERENTIAL INDICATOR (CSP)	1 @ 10 PSI (.70 BAR)
MAIN OIL FILTER BYPASS VALVE (CFP2)	25 PSI (1.7 BAR) or 35 PSI (2.4 BAR)
AIR CLEANER FILTER INDICATOR (CFP1)	1 @ 25 INCHES WATER
AIR/OIL TEMPERATURE SWITCH (CAT) COMPRESSOR PRESSURE SWITCH (COP) D90KS APPLICATION (COP)	230° F (110° C) COMPRESSOR AIR TEMP 35 PSI (2.5 BAR) COMPRESSOR OIL PRESSURE 15 PSI (1 BAR) COMPRESSOR OIL PRESSURE
Y2000 FACTORY FILL COMPRESSOR OIL	SHELL CORENA AW32 / CORENA POA

Specifications listed are consistent on all of our low pressure model machines. Minor changes have taken place for component longevity and to improve operation for the drilling cycle.

Electrical switches on the compressor system are abbreviated descriptions (COP) or (CAT) noted on the machine specific electrical system schematic.

FEATURES AND CUSTOMER PREFERRED OPTIONS ADDED ON FROM THE AIR SYSTEM

FEATURE/OPTION	SPECIFICATION
HYDRAULIC TANK PRESSURIZATION	5 PSI (.3 BAR) RELIEF @ 12 PSI (.8 BAR)
DRY DUST COLLECTION AIR REGULATION	50 PSI (3.5 BAR) RELIEF @ 90 PSI (6.2 BAR)
BIT LUBRICATOR TANK REGULATION	60 PSI (4 BAR)
AIR BLOWDOWN REGULATION	30 PSI (2 BAR)
AUTOMATIC THREAD LUBE REGULATION	80 - 100 PSI (5.5 - 6.8 BAR)
AUTOMATIC GREASE SYSTEM REGULATION	60 - 100 PSI (4 - 6.8 BAR)
CHAIN LUBRICATION SYSTEM REGULATION	60 - 80 PSI (4 - 5.5 BAR)

LOW PRESSURE COMPRESSOR POWER GROUP COMPONENTS

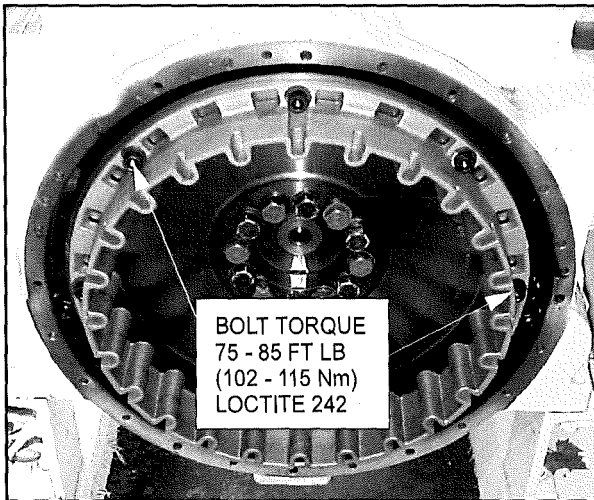
GENERAL

This section will describe the engine, drive coupling and single stage compressor mounting, and the importance of proper engine speeds.

DESCRIPTION

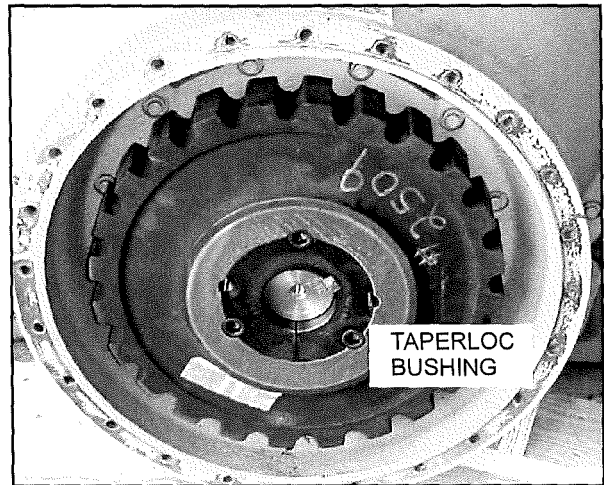
The engine and compressor driven components are purchased parts installed to Sandvik Mining and Construction specifications.

Compressors are direct drive to the customer selected engine by means of aluminum drive ring mounted on the engine flywheel and vulcanized rubber coupling. A taperloc bushing secures the coupling to the compressor shaft.



Replace drive components as one unit. They are a installation kit for a replacement air end.

Refer to service material 008674-000 taperlock bushing installation procedure for any new air end - compressor installation.



The compressor shaft and drive coupling should rotate free after final component installation.

CAUTION

Using a hammer on or applying high forces on the input shaft when installing the coupling can damage the bearings.

It is a recommended practice to add 5 gallons (20 liters) clean compressor oil into the open compressor inlet prior to starting a new or remanufactured air end unit.

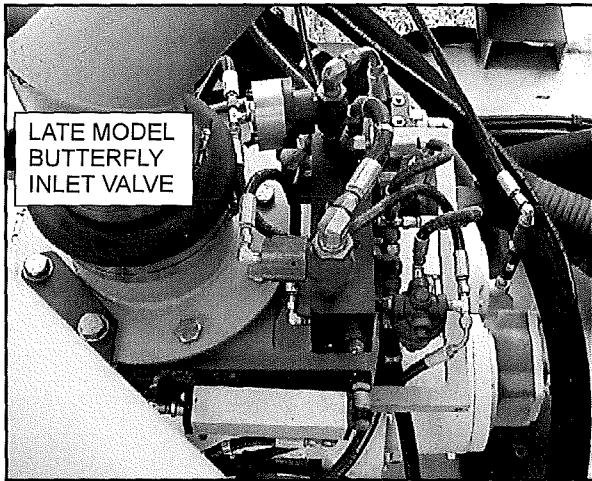
The compressor inlet porting will have a butterfly plate inlet control valve or a single or dual poppet inlet control valve(s) using gaskets as seals between the components.

NOTE!

Butterfly inlet control valves are late model applications currently replaced with single poppet valves.

Single poppet inlet control valves are current applications available on all Sullair application air ends.

Dual poppet inlet control valves are specific to the 90 series machines, available on 2600 CFM (73.6 m³) and larger air systems.

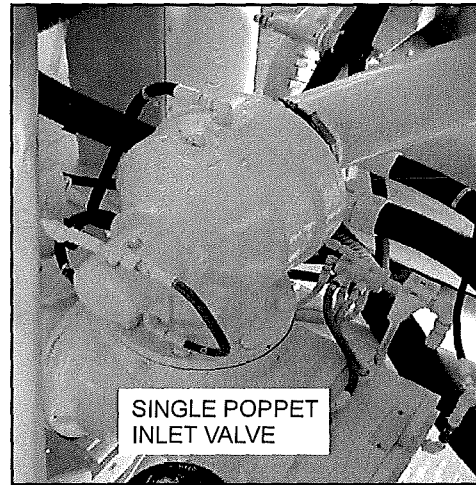


When mounting the inlet control valve, alignment and free acting butterfly plate movement are requirements for correct acting air pressure build-up, (load and unload modes) of operation.

Properly maintain all intake pipe and hump hose connections. Replace worn and weathered rubber seals as needed.

When removing and installing a compressor with warranty consideration it is necessary to:

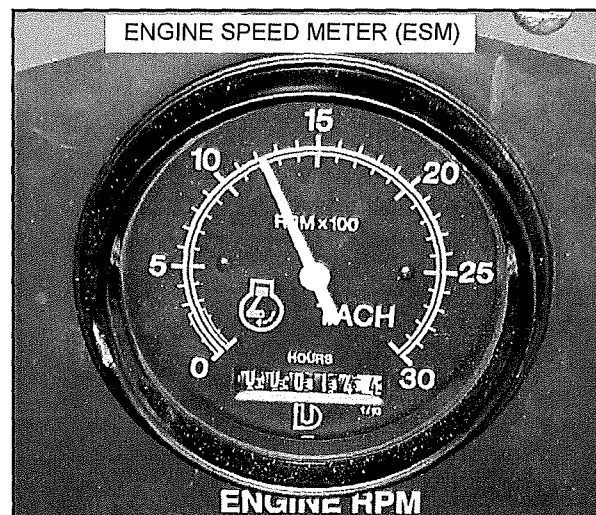
- Locate Equipment Serial Numbers
- Maintain Cleanliness During Component Removal and Return Process
- Follow System Cleaning Procedures
- Replace Worn Components As Needed
- Record Appropriate Documentation For Return To Vendor, Startup Papers Provided With Replacement Air End
- Specify Oil Type
- Follow Common Mechanical Procedures During Compressor Installation, Some Of Which Are Stated Herein



ENGINE SPEED

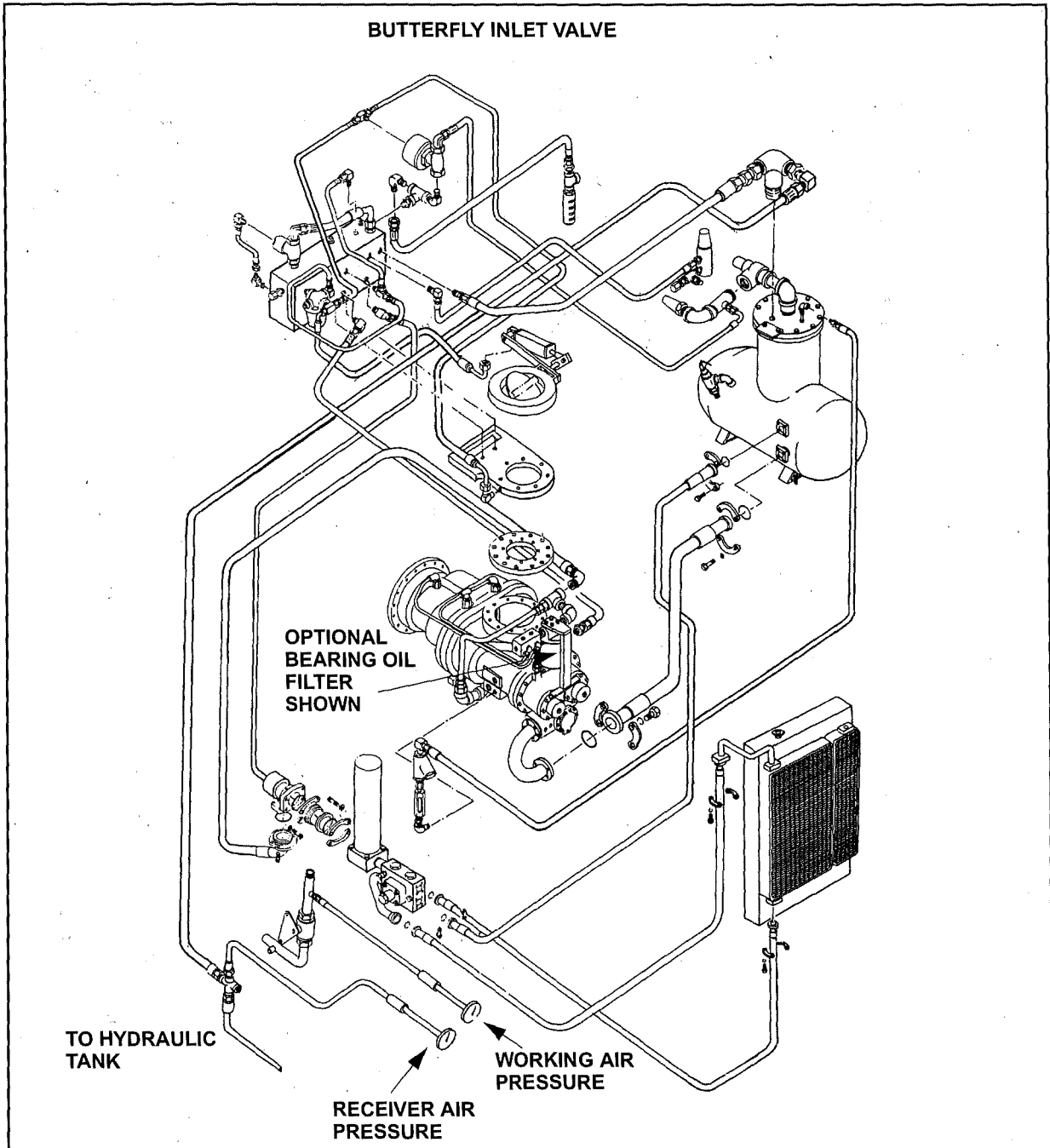
Maintaining the correct engine high and low idle speeds are essential for the compressor, the drive coupling, machine frame cross members, and related equipment longevity.

A minimum **engine low idle speed** of 1200 RPM is essential to maintain drive coupling wear and minimizing machine vibrations.



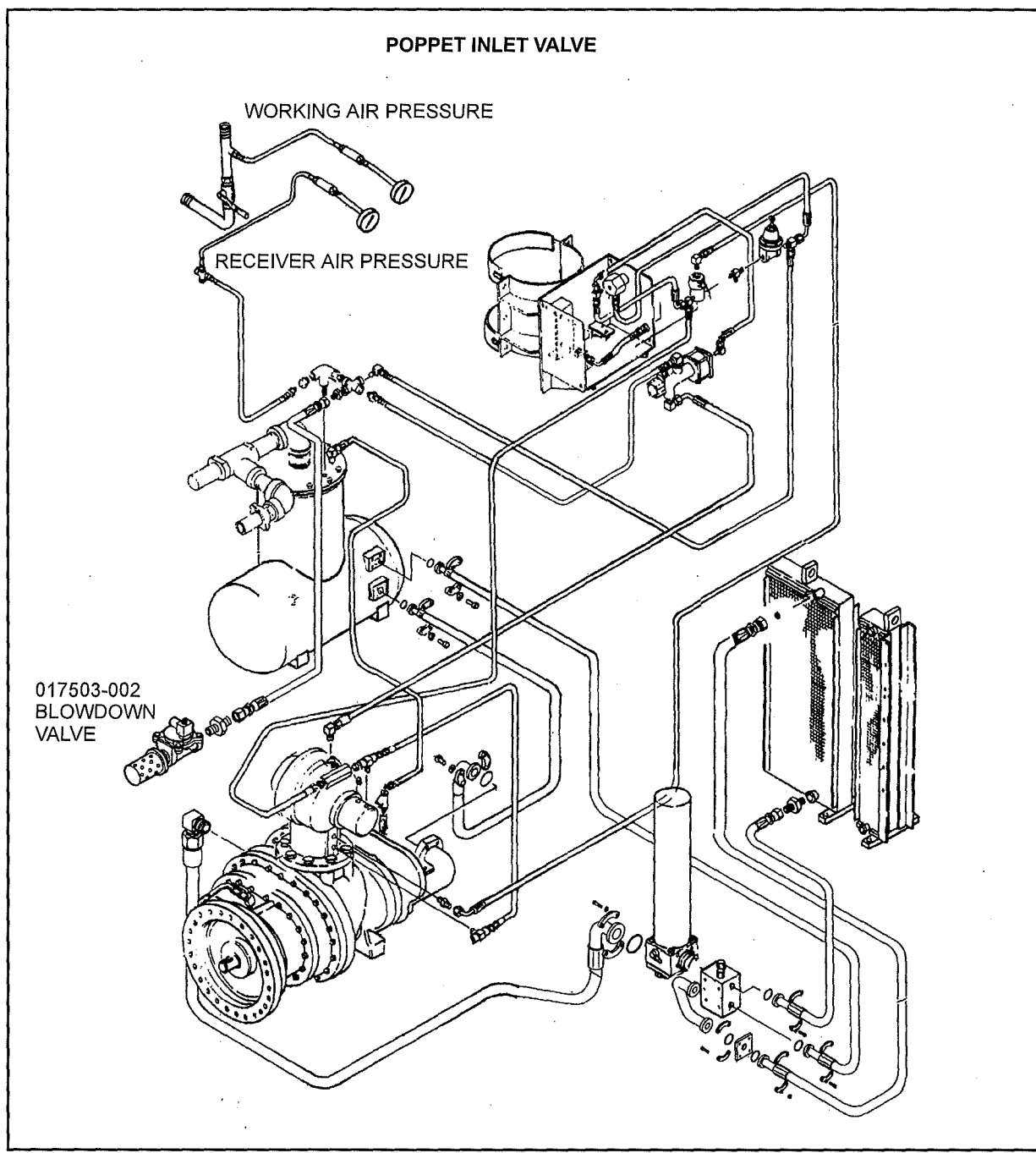
Engine high idle speed settings will vary from machine model. The engine high idle speed is required to deliver the expected compressor air delivery spec (SCFM).

LP COMPRESSOR HOISING CIRCUITS

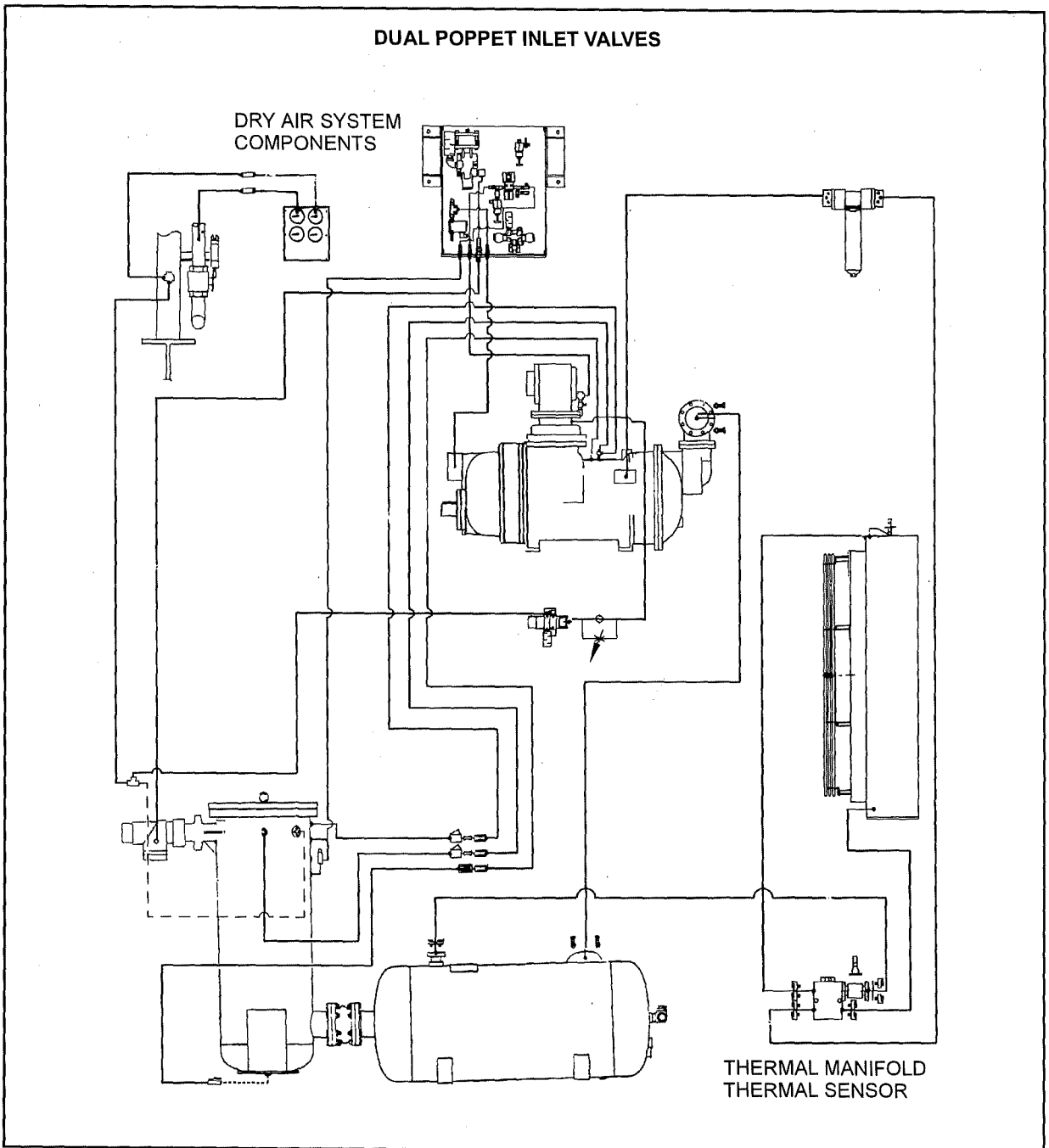


NOTE!
Although there are many variations in components between product models and generations, the concepts remain the same.

POPPET INLET VALVE



The final blowdown valve may be pilot controlled or electric controlled as shown.



A dual poppet inlet control system feature is standard equipment for the D90KS series machines.

This package is a two reservoir air system. The vertical section is the air sump with separator elements.

The application is 2400 cfm and greater sized Sullair single stage low pressure compressor systems. Pressure ratings do not exceed 80 psi (5.5 bar).

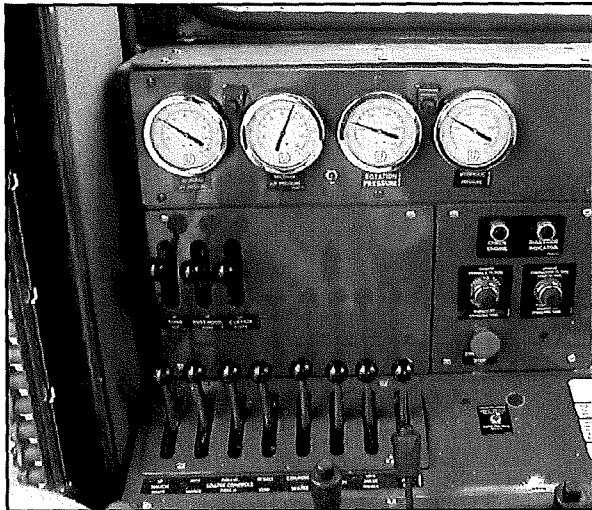
OPERATOR STATION

Pressure gauges on drill operator stations enable a visual reference to drilling functions. Receiver air pressure and working air pressure have different pressure readings.

Receiver air pressure shall not be less than 60 psi (4 bar) or 50 psi (3.5 bar) during a drilling mode. Receiver air pressure shall be regulated for maximum air pressure, no more than 100 psi (6.9 bar) for butterfly and single poppet inlet control valves and 80 psi (5.5 bar) for dual poppet inlet control valves.

Working air pressure is dependant upon

- ground conditions
- drill bit orifices or nozzle sizes
- drilling with dry air or water injection
- annular area for adequate cutting removal
- hole depth
- drill cuttings specific gravity.



When applicable maintain greater than 35 psi (2.4 bar) and less than 70 psi (4.8 bar) working air pressure on the operator panel gauge.

The engine tachometer shall register 1800 or 2100 for a high idle speed.

During the drilling mode the engine typically operates moderately between 185° and 200° F (85 to 93° C). Compressor oil temperatures operate between 185 to 195° F (85 to 90.5° C).

Compressor temperatures should be operated at a minimum of 100° F (37.7° C) above the ambient air temperature.

Note!

It may be necessary to 1) adjust the hydraulic cooling fan speeds and or 2) cover oil coolers and radiator during extreme cold weather conditions to enable adequate fluid flow through the specific heat exchangers.

90 SERIES POWER PACKAGES

GENERAL

Models D90KS and 1190 series machines use diesel or electric power packages. The '90 series' equipment drive power may be tailor made according to customer needs and geographic conditions.

DESCRIPTION

Our '90 series' machines are available with Caterpillar 3500 series, C32 diesel engines or ABB electric motor powered units.

MODEL	DIESEL	ELECTRIC
D90KS	3508/3512/C32	
D90KSP	3508/3512	
1190D	3508/3512	
1190DSP	3508/3512	
1190E		X
1190ESP		X

Component locations are subject to change without notice according to engineering specifications through the product line.

The following pages show generic component locations for both diesel and electric power drill machines manufactured at our Alachua facility in Florida - USA.

3500 SERIES ENGINES

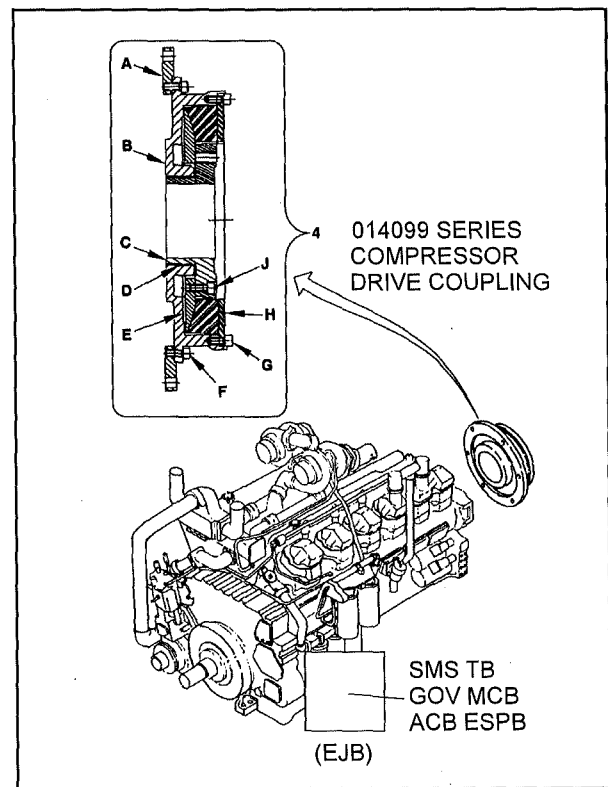
Engine packages are typically specified dependent on altitude and climactic conditions.

Follow all engine operating and maintenance procedures according to the engine manufacture specifications.

The fuel system for the 3500 series engine is governed by a fuel solenoid and a 2301A speed control panel.

Engine Idle Speeds

Low engine idle speed is calibrated for 1200 rpm. The 2301A speed control ramp rate allows idle duration between low idle speed of 1200 rpm through to the high idlespeed calibration of 1850 rpm.



Critical engine performance indicators are monitored through our optional DMS drill monitor system panel. Pressure and temperature switches are common Caterpillar replacement type units available through local dealer support.

Switches ECF (engine coolant flow pressure), ECT (engine coolant temperature) and EOP (engine oil pressure) are wired to the DMS monitor panel.

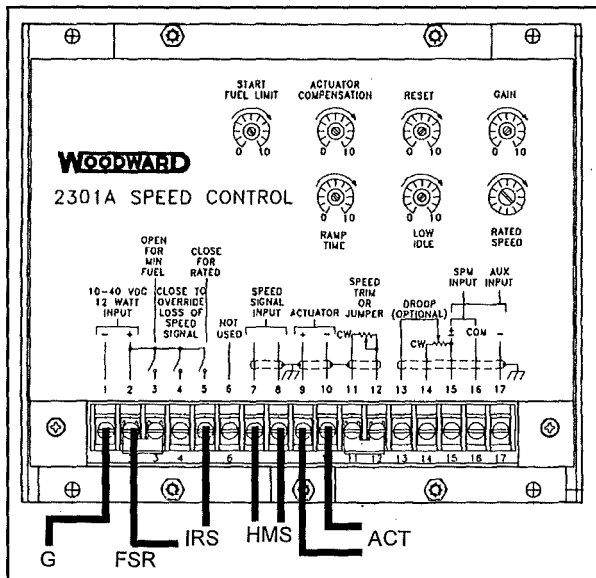
MONITOR CONTACT	SWITCH ACRENEM	SWITCH RATING
M15	EOP	35 PSI
M16	ECT	225° F
M17	ECF	5 PSI

Terminal 21 on the DMS panel enables 24 vdc power to the machines FSR fuel solenoid relay as long as the DMS monitor level 3 shutdown switches listed above are sensing correct temperature or pressures. When terminal 21 loses power the engine will not run.

Refer to the electrical option section of this manual for details and troubleshooting of the DMS circuits.

A sealed junction box near the engine front # 1 cylinder end will house the 2301A speed control panel and engine starter magnetic switches.

When the engine junction box is opened the 2301A Woodward speed control is mounted to the junction box door.



Refer to Caterpillar service manual SENR4676 for 2301A Speed Control Operation, Adjusting And Troubleshooting.

The following table may be used for field diagnostic of the 2301A speed control.

COMPONENT ACRENEM	TEST TERMINAL	EXPECTED READINGS
GOV	T2+ / T1-	24 -35 VDC
HMS	T7 / T8	200 OHMS AC VOLTS
ACT	T9+ / T10-	0 - 6 VDC
IRS	T2 / T5	OPEN LO IDLE CLOSED HI IDLE

The 2301A control box is to control the engine speed. The system measures engine speed constantly and makes necessary corrections to the fuel setting through an actuator connected to the fuel system.

Shielded wires are shown connected to the speed control terminals.

- ACT - Engine Mounted Actuator
- FRS - Fuel Solenoid Relay*
- G - Ground*
- HMS - Hourmeter Sender
- IRS - Idle Run Switch*

* Sandvik Part

The engine speed is detected by the HMS magnetic pickup. As the teeth of the flywheel ring gear go through the magnetic lines of force around the pickup, an AC voltage is made.

NOTE!

The HMS hourmeter sender pickup clearance at the flywheel ring gear tooth should be .022 to .033 inch (0.56 to 0.85 mm).

For field installations the gap should be set while the engine is stopped. Turn the pickup in until the magnet is against a gear tooth. Turn

the pickup out 1/2 turn \pm 30° and tighten the locknut to 50 ft lb (67.8 Nm).

When engine speed increases; the AC signal from the HMS hourmeter sender to the speed control is converted to a DC output signal to the actuator and the engine speed decreases.

When engine speed decreases; the AC signal from the HMS hourmeter sender to the speed control is converted to a DC output signal to the actuator and the engine speed increases.

The actuator is connected on the engine to the fuel system by linkage. It changes the electrical input from the control box to mechanical output that changes the engine fuel setting.

The rated and low idle speeds are set with speed setting potentiometers.

- A. set low idle speed for 1200 RPM.
- B. set high idle speed for 1850 RPM no load.

The ramp time potentiometer controls the amount of time it takes the engine to go from low idle to rated speed. Expected ramp up time should be 500 rpm per second.

The start fuel limit potentiometer is used to control the amount of fuel to the engine during startup. It can be adjusted to make the engine start easier. The fuel limiting function is turned off automatically when the speed control takes over.

The speed fail safe circuit will stop all voltage output to the actuator if the magnetic pickup signal becomes less than 1 VDC or 100 CPM. The engine will not start if the magnetic pickup signal has a failure.

NOTE!
Magnetic pickup failure or slow engine cranking will cause the actuator to move to the FUEL OFF position.

2301A Speed Control Initial Adjustments

Initial calibration for new speed control modules will require the following procedures taken from SENR4676 manual.

1. Set the rated speed potentiometer to minimum setting (ccw)
2. Set the external speed trim if used to mid position
3. Set reset trim to mid position
4. Set gain trim to mid position
5. Set ramp time to minimum (ccw)
6. Set low idle speed to maximum (cw)
7. Set droop trim if used to minimum (ccw)
8. Set actuator compensation potentiometer at 2 on the 0 to 10 scale for diesel engines
9. Set fuel limit to maximum (cw)

Climactic operating conditions such as high altitude may render additional adjustments.

Adjustments to the 2301A speed control and the engine fuel system should only be performed by a qualified fuel and electrical technician.

Contact the local Caterpillar dealer for a generator technician.

COMPRESSOR DRIVE COUPLING

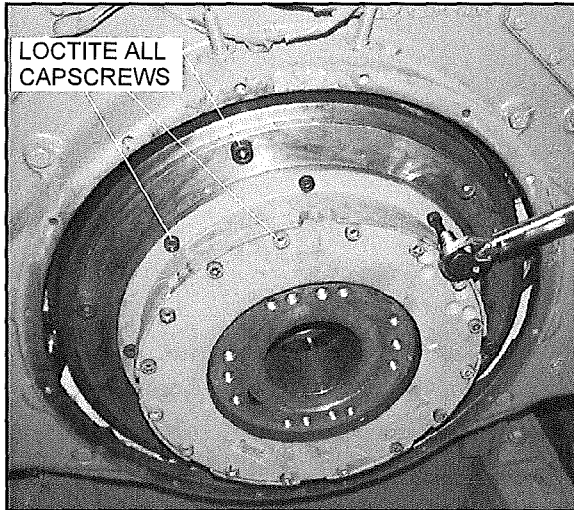
Engine

The 3500 series engines are frame mounted with bolts. During routine maintenance intervals check the front and rear motor mounts.

- Flywheel end bolts 650 - 710 ft lb. (881 - 962 Nm)
- Pulley end bolts 270 - 292 ft lb. (366 - 396 Nm)

- Center bolt 650 - 710 ft lb. (881 -962 Nm)

The 14099 series drive coupling assembly requires proper assembly, alignment and final bolt torque values.



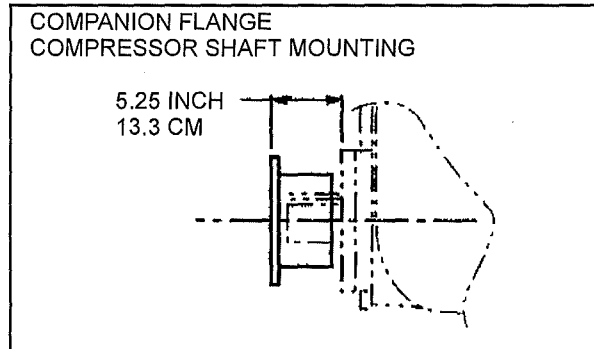
- Drive ring to flywheel 153.-166 ft lb. (207 - 225 Nm)

NOTE!

All mounting hardware should be secured with loctite 242 thread lock compound.

- Housing cover 72 - 80 ft lb. (98 - 108 Nm)
- Housing to drive ring 72 - 80 ft lb. (98 - 108 Nm)

A companion flange and keyway are positioned on the compressor shaft. A 5.25 inch (13.3 cm) measurement is expected between the compressor housing and the companion flange end flat surface.

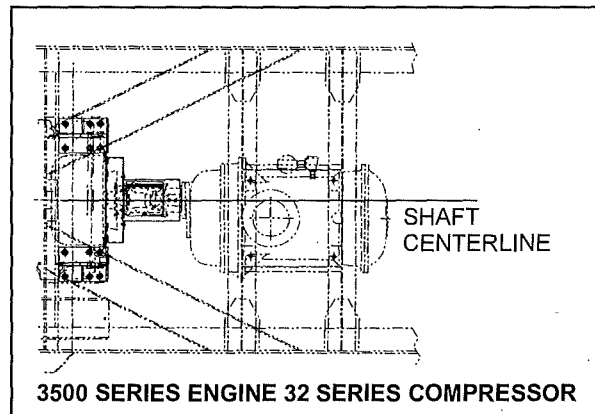


The left to right drive shaft radial alignment is essential for balance and component longevity. Misalignment will cause premature wear, machine vibration and component failures.

The front to rear drive shaft axial alignment is designed to be off center. Shaft alignment should be $\pm 3^\circ$ not to exceed a maximum angle of 30° .

Compressor mounting is rubber grommet shock mounted with flat washer plates and through bolts.

- Mounting pad bolt torque 153 -166 ft lb. (207 - 225 Nm) with secured jam nut.



When the engine or compressor are removed or reinstalled in the field it is advisable to use a dial indicator at the compressor shaft to determine true tolerance for shaft and drive coupling alignment.

Correct left and right side alignment prior to completing the final mounting hardware torque.

LOW PRESSURE COMPRESSOR OIL LUBRICATION

GENERAL

Single stage low pressure application machines utilize contained air pressure to circulating oil through hoses, valves, oil coolers and the single stage air end. This section will describe oil circulation through these components.

DESCRIPTION

Components of the compressed air system are common throughout our low pressure application machines.

- Air receiver tank
- Fluid level sight glasses
- Synthetic compressor fluid
- Safety relief valve
- Minimum pressure valve
- Separator element filter(s)
- Separator differential indicator
- Scavenge oil return system(s)
- Oil temperature thermostats
- Oil cooler bypass valve(s)
- Oil cooler
- Oil stop valve
- Temperature safety switch
- Pressure safety switch option
- Single stage air end
- Discharge check valve
- High temperature hoses

This section will describe oil circulation through these components.

As of January 2000 the factory fill compressor oil is synthetic, Shell Corena AW32 PAO series.

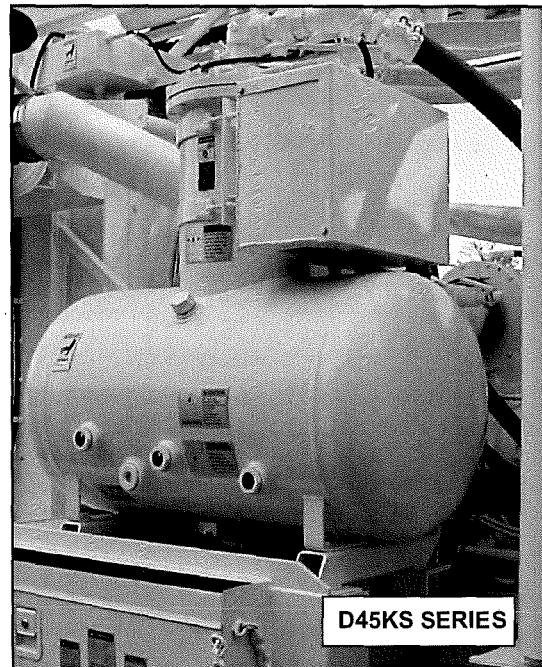
Air Receiver Tank

We use three types of air receiver tank for low pressure drill applications.

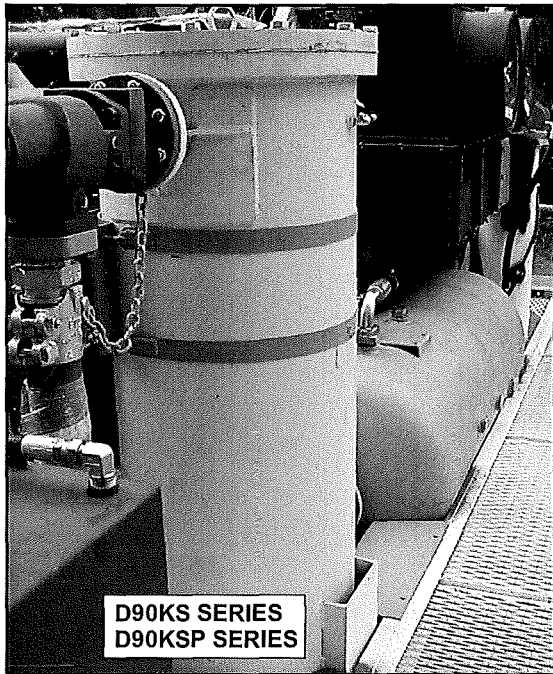
The 'Tee tank' reservoir units use a small vertical section welded to a larger horizontal section. The horizontal section is the oil sump and the vertical section is the air sump with a filter.

Applications are: D25KS, D245S, D40KS, D45KS, D50KS, D55SP, D60KS, D75KS machines.

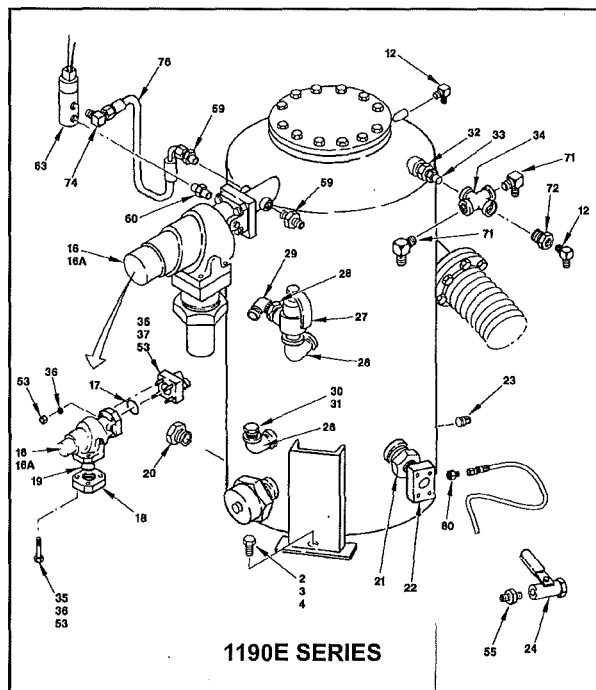
The tee tank is our most commonly used receiver tank.



Due to compressor volume(s) the D90KS and 1190 model machines utilize a two receiver tank system. Both sections are with pressure in standard operation. The vertical section is the air sump and the horizontal section is the oil sump.



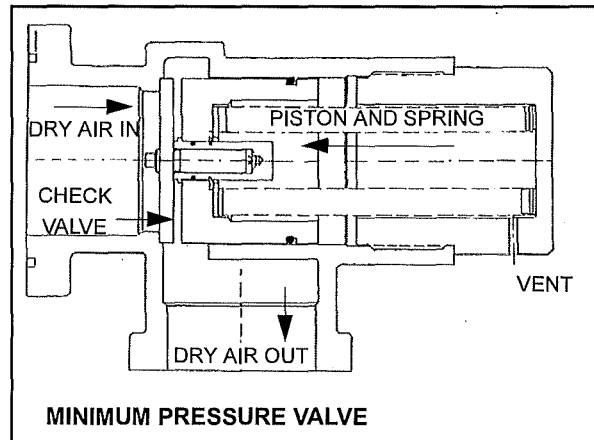
Special application D90KS and 1190E machines with 3000 CFM and greater have the third application air receiver tank. This vertical pressure vessel is the oil and air sump with separation filtration inside.



With all tank designs, fluid levels should be checked 2 minutes after machine shutdown or when the fluid is at rest.

Minimum Pressure Valve

The minimum pressure valve positioned on the vertical section of each type of air receiver tank maintains air pressure inside the tank during the run mode. The minimum air pressure is 50 psi (3.5 bar) or 60 psi (4 bar) which is capable of pushing the oil through all the lubrication parts.



! WARNING

The cap is under spring pressure. Use extreme caution when removing the cap from the body.

Minimum pressure valves should be free of compressor oil. Only dry air should be passing through this valve.

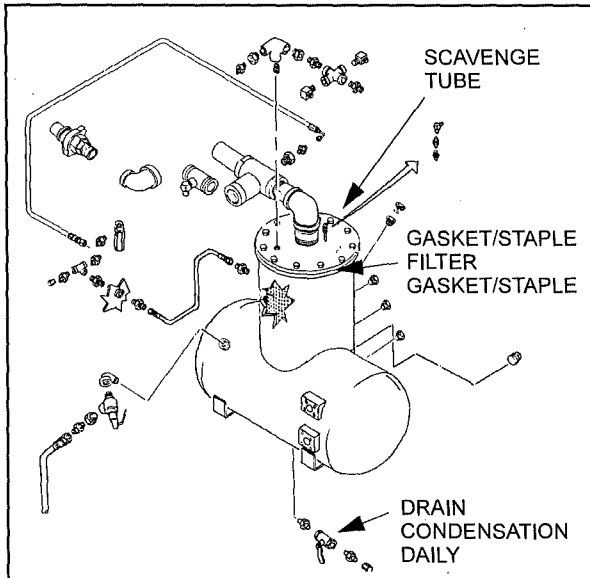
When testing the minimum pressure

1. Operate the machine at the rated high idle speed.
2. Turn the working air on and observe the air receiver pressure gauge on the operator console. Extra gauge ports are available to install a test pressure gauge on the tank(s).

Air pressure inside the air receiver tank should never drop below the preset spring value of the minimum pressure valve.

Separator Element Filter

Inside the vertical section of the air receiver tank there is a single filter element.



The separator element in low pressure applications passes air through the element from the outer to inner air flow direction. The separator element design is to slow down the air movement that contains compressor oil. Oil mist will be trapped on the outer element filter diffusion casing. Air and microscopic oil will pass through the paper pleated filter media.

To eliminate static electricity inside the element filter, the separator element gasket has a (staple type) static ground device.

Do not remove staples from separator element gaskets.

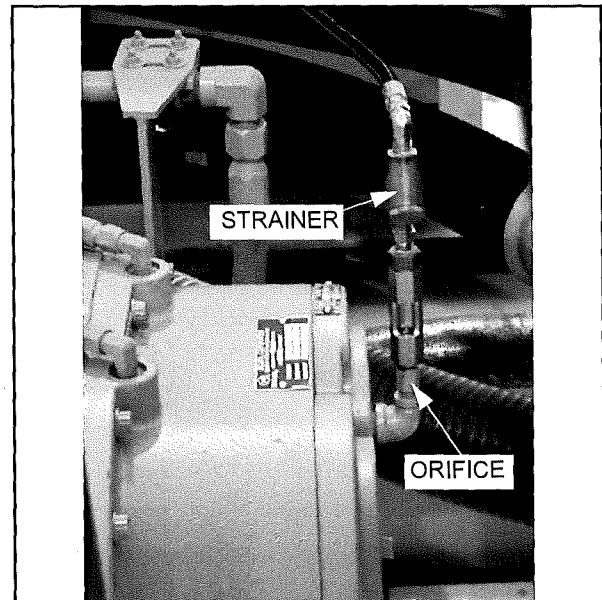
Scavenge Oil Return

An oil return system referred to as a scavenge system enables oil 'carry over', oil that passes through the paper pleat separator element, to be returned to the compressor stator housing.

The scavenge return line will have a strainer screen filter and sight glass with an inline orifice to control the return oil flow.

Oil 'carry over' is dependent on receiver tank pressure. Expect one cup (236 ml) to one quart (.94 l) during drilling conditions.

Compressor component maintenance is recommended at 250 service hour intervals.



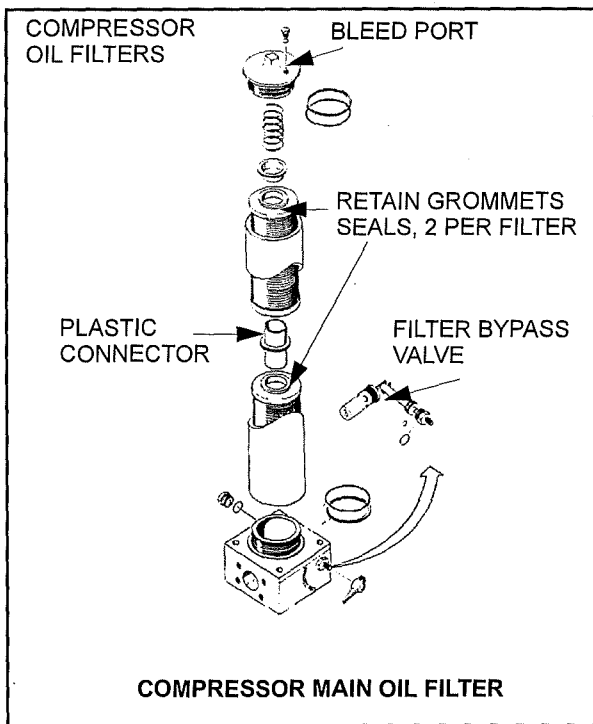
For safety purposes allow a minimum of **2 minutes** after machine shutdown before starting maintenance.

Compressor Main Oil Filters

The filter cover has a bleed port that may be opened prior to filter removal to vent the filter canister of any residual pressure trapped inside the filter assembly after machine shutdown.

When performing routine maintenance observe filter condition. Be sure to retain all grommet seals on both filter elements.

Loose or missing grommets should be located prior to reinstating the machine into service.



Oil cooling is dependant upon the position of the thermal valve. The thermal valves extend approximately 5/8 inch (15 mm) to seat into the manifold bore. As the valves extend they restrict free flowing oil, and force compressor oil into the oil cooler.

In cold ambient conditions when cold oil or fluid viscosity is high during the cold start cycle, two 50 psi (3.5 bar) valves can open that allows free flow cold oil 4 flow paths to the filter assembly and single stage compressor.

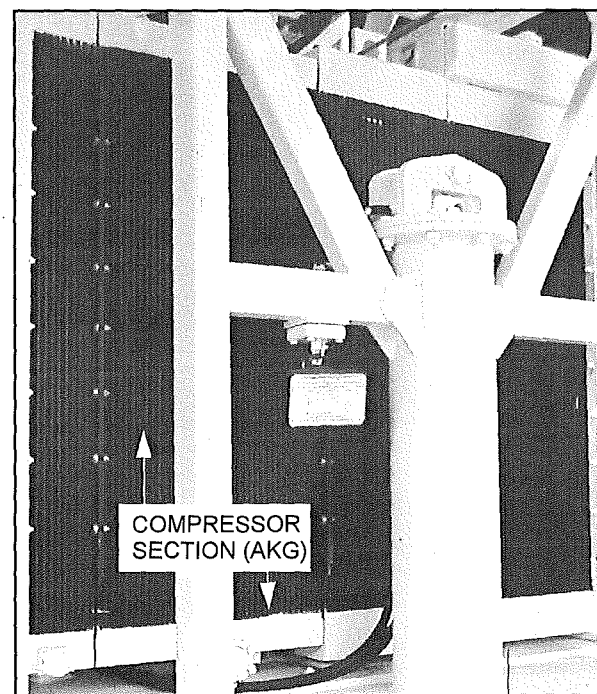
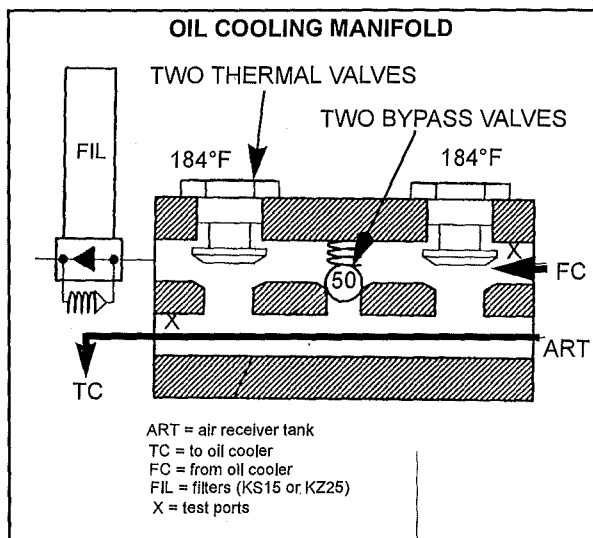
Oil Coolers

Oil coolers are high quality aluminum header and turbulator tube design. Pressure in the cooler is dependant upon the regulated system pressure. When testing oil cooler pressures the gauge readings will be >80 psi up to 110 psi (5.7 to 7.9 bar). Dependent on regulation, the air receiver tank may see as much as 140 psi (9.7 bar).

Thermal Manifold With Bypass

Two thermal valves direct compressor oil to the compressor through the filter assembly and compressor oil cooler depending on fluid temperatures. The thermal valves and the cooler bypass valves are threaded into a manifold with test ports available to test pressure drops as needed.

Flow through the oil cooler is dependant upon the position of the thermal valves, the oil temperature, viscosity, and bypass valve position.



It may become necessary during cold ambient operating conditions to cover the entire cooler cores with a curtain. A cooler curtain will restrict external airflow through the oil cooler which can aid oil flow through the internal turbulator tubes therefore decreasing oil cooler pressure drops.

Expected oil cooler pressure drop, measured as differential pressure drop through the oil cooler.

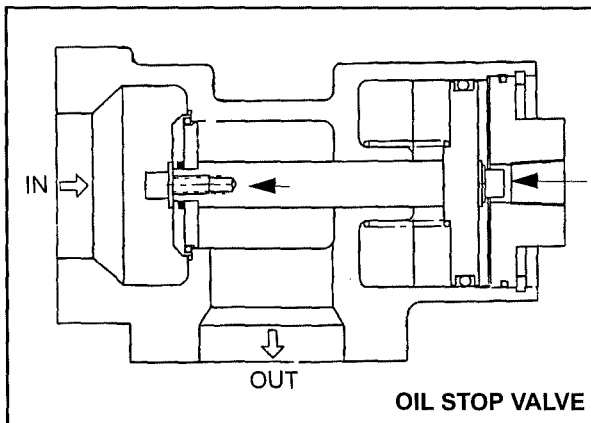
- less than 5 to 15 psi (.3 to 1 bar)
- less than 15 to 35 psi (1 to 2.4 bar)
- above 35 to 50 (2.4 to 3.4 bar)

Expected oil temperature drop, measured as differential temperature drop through the oil cooler.

- 20 to 40° F (-6 to 4.4° C)

Oil Stop Valve

The oil stop valve is mounted near the OUT port of the main compressor filter assembly. The oil stop valve receives a pilot pressure signal equal to the discharge pressure from the air end.



The primary function of the oil stop valve is to maintain compressor oil in the hoses and related components after machine shutdown.

After the oil stop valve, compressor oil circulates to an oil manifold that in design delivers

compressor oil to required lubrication points of the air end. This bearing distribution manifold is last point oil injection. The manifold hoses are sized for flow requirements to the desired point of oil injection. Restrictive orifices in adapters limit oil flow to compressor bearings.

As a option one safety switch referred to as a COP compressor oil pressure switch may be positioned on the bearing distribution manifold.

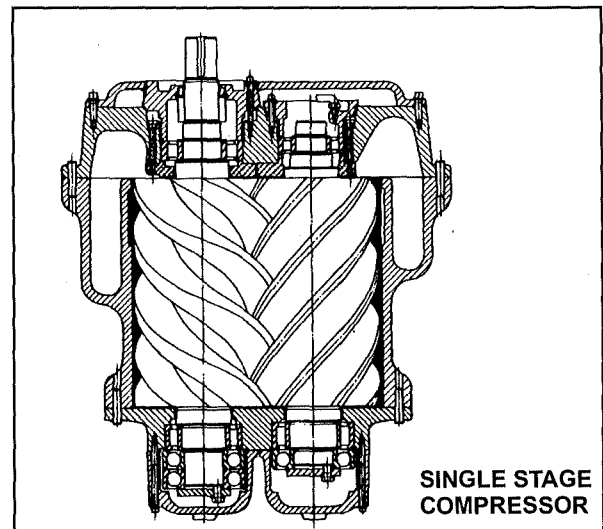
The switch is normal open, closes with pressure. Use the common and normal open contacts. This safety switch will interrupt machine run mode and shut the machine down.

Single Stage Air End

Low pressure compressed air is made available from a matched set of rotating rotor assemblies.

One male and one female rotor are supported in a stator housing by radial and thrust bearings.

The air end output is dependant upon rotor and stator diameter, length, gear ratio, driven speed and oil lubrication.



New and remanufactured air end units are available from your Regional office. Verify machine model and serial number for compressor specification.

During the machine run mode the **compressor oil temperatures should be maintained at a minimum of 100° F (37.7° C) above the ambient condition.** Operators should be aware of compressor operating temperatures. A sensor on the compressor discharge elbow and a gauge on the operators panel allows visual reference to air/oil temperatures.

It is common to see low pressure compressor temperatures operate between 180° - 210° F (82° - 98.8° C) during the loaded drilling cycle. Operating the machine in extreme ambient conditions may require special cooling system components. It may be necessary to:

- Upgrade The Fluid Viscosity Using Either Iso 32 Or Iso 46 Grades.
- Change Thermal Valve Temperature Values.
- Modify The Cooling Fan System By Slowing Or Increasing The Fan Rpm To Spec.
- Restrict Air Flow Over The Oil Coolers With A Cooler Curtain.

Discharge Check Valve

The discharge check valve is mounted on the outlet flange discharge elbow with all butterfly inlet control valve applications.

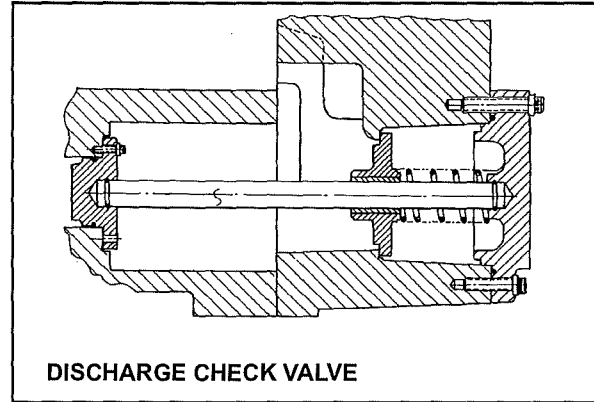
Discharge check valves stop oil in the receiver tank from draining into the compressor after the machine is shutdown.

Without a discharge check valve, air pressure inside the air receiver tank could run the compressor reverse at shutdown.

Discharge check valves are a one way flow valve allowing free flow oil out the discharge hose with hot oil returning to the air receiver tank under pressure. Note that air pressure may be as high as 140 psi (9.7 bar) with oil temperatures capable of 230° F (110° C).

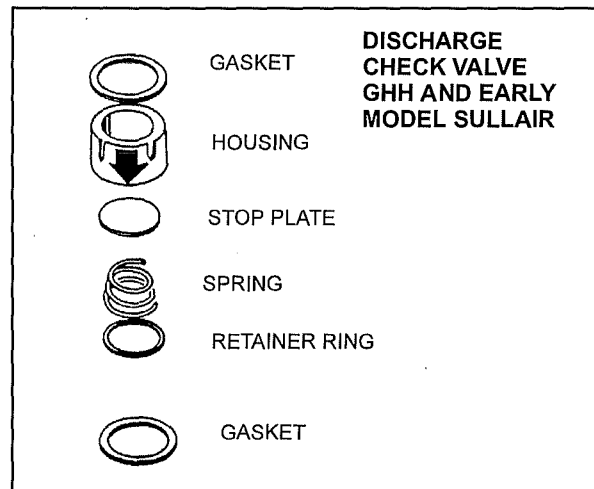
Failure of a discharge check valve could allow fluctuating oil levels, oil collection on air cleaner

elements and may enable the compressor to reverse run at shutdown.



NOTE!

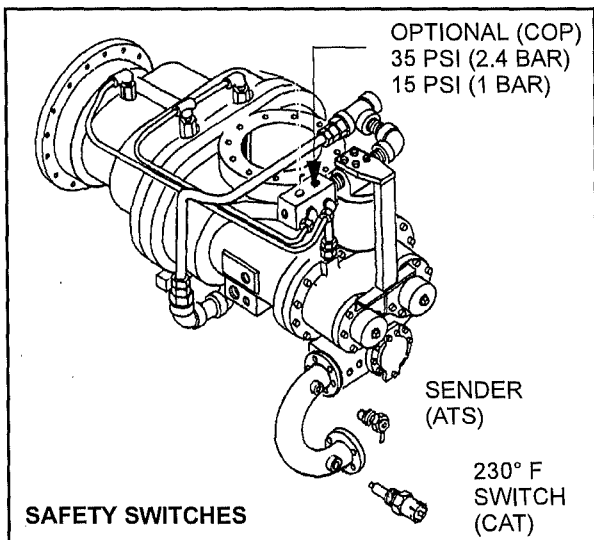
Discharge check valves may be removed from low pressure drill applications that use poppet type air intake systems.



Compressor Safety Switches

Compressors are a major investment. It is recommended to protect the investment with a temperature safety switch.

Electrical switches and a shutdown relay are in a series or parallel circuit to ensure our products have compressor protection.



An optional device that allows the compressor systems to be monitored with one common circuit panel is the drill monitor system (DMS). This panel is mounted on the operator station.

Compressor related monitoring using pre set switches includes:

- CFP1 compressor air filters @ 25" water
- CSP compressor separator differential pressure @ 10 psi (.7 bar)
- CAT compressor air/oil temperature @ 230°F (110° C)
- COP compressor oil pressure @ 35 psi (2.4 bar) or 15 psi (1 bar).

NOTE!

It is not mandatory to have compressor oil pressure monitoring. The COP switch for low pressure drill applications is option used with drill monitoring systems.

COLD WEATHER STARTING

During extreme ambient conditions run modes may be affected due to cold oil in compressor system components.

Machines with drill monitoring and a compressor oil pressure switch may experience shut

down conditions when the bypass switch is released after the engine starts.

Air/oil pressure drop occurs between the air receiver tank and the compressor oil pressure switch due to line loss, oil viscosity and the components in the lubrication system. This deltaP or differential pressure is lessened with warm oil after start up.

It is possible to replace 35 psi (2.4 bar) compressor oil pressure switches with 15 psi (1 bar) switches in extreme applications.

Drill monitor systems (DMS) have a built in non adjustable 30 second delay factored into the circuit board. The delay time sequence starts as soon as power is applied to the panel.

Prelube starters are configured to perform the engine lube cycle prior to powering the DMS panel to assist cold weather starting.

After the engine starts and is running smooth release the bypass button before the DMS time cycle runs out.

Air receiver pressure has to be 10 psi greater than the selected compressor oil pressure switch rating to maintain engine run mode.

SYSTEM CLEANLINESS

Compressor maintenance is recommended at 250 hour intervals. Lubrication and maintenance manuals detail fluids, capacities, filters and general service procedures.

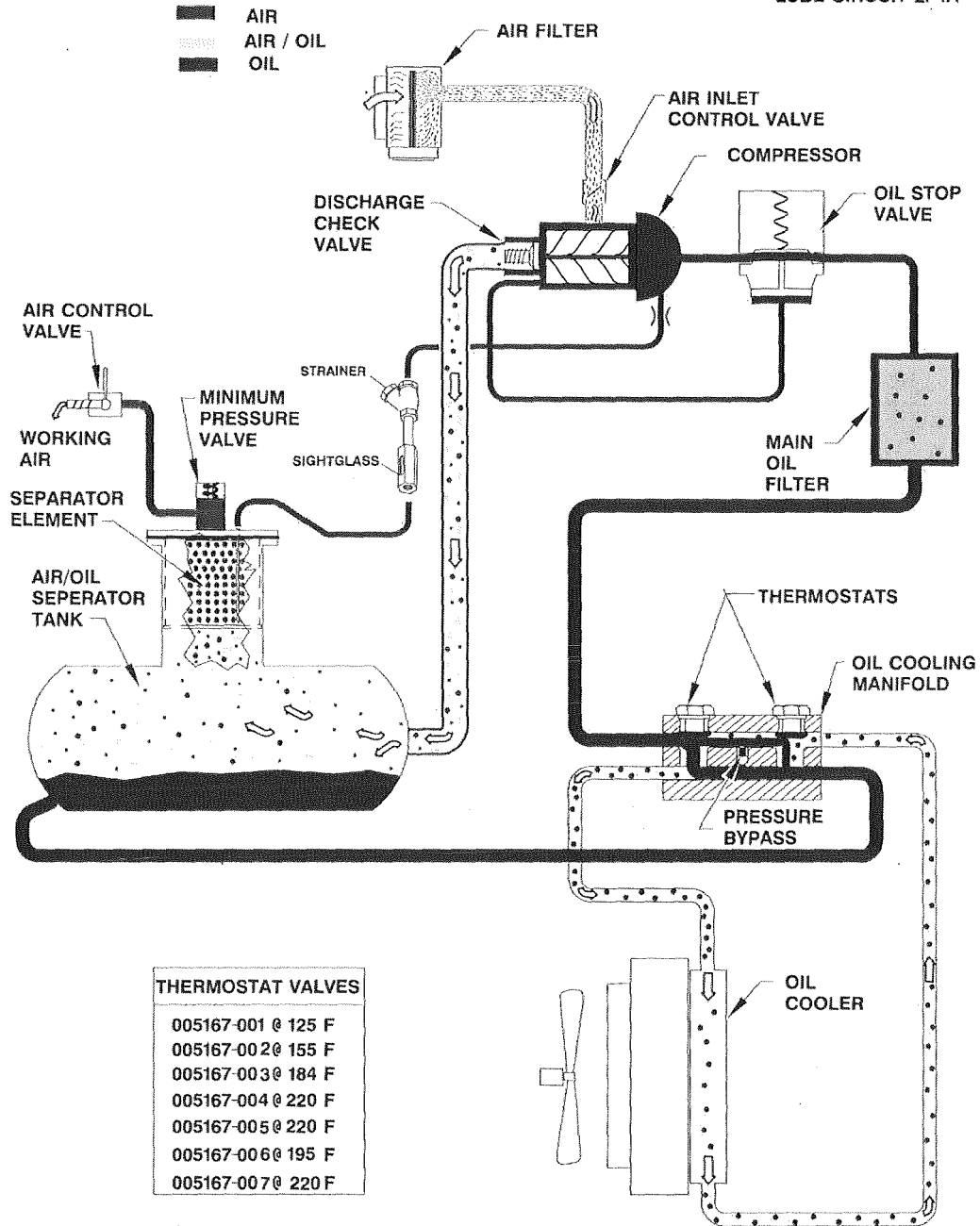
Follow compressor system cleaning procedures as needed during compressor system overhaul.

OIL CIRCULATION DIAGRAMS

The following charts are in generic form to illustrate oil circulation through the compressor components. The air receiver tank is a tee tank.

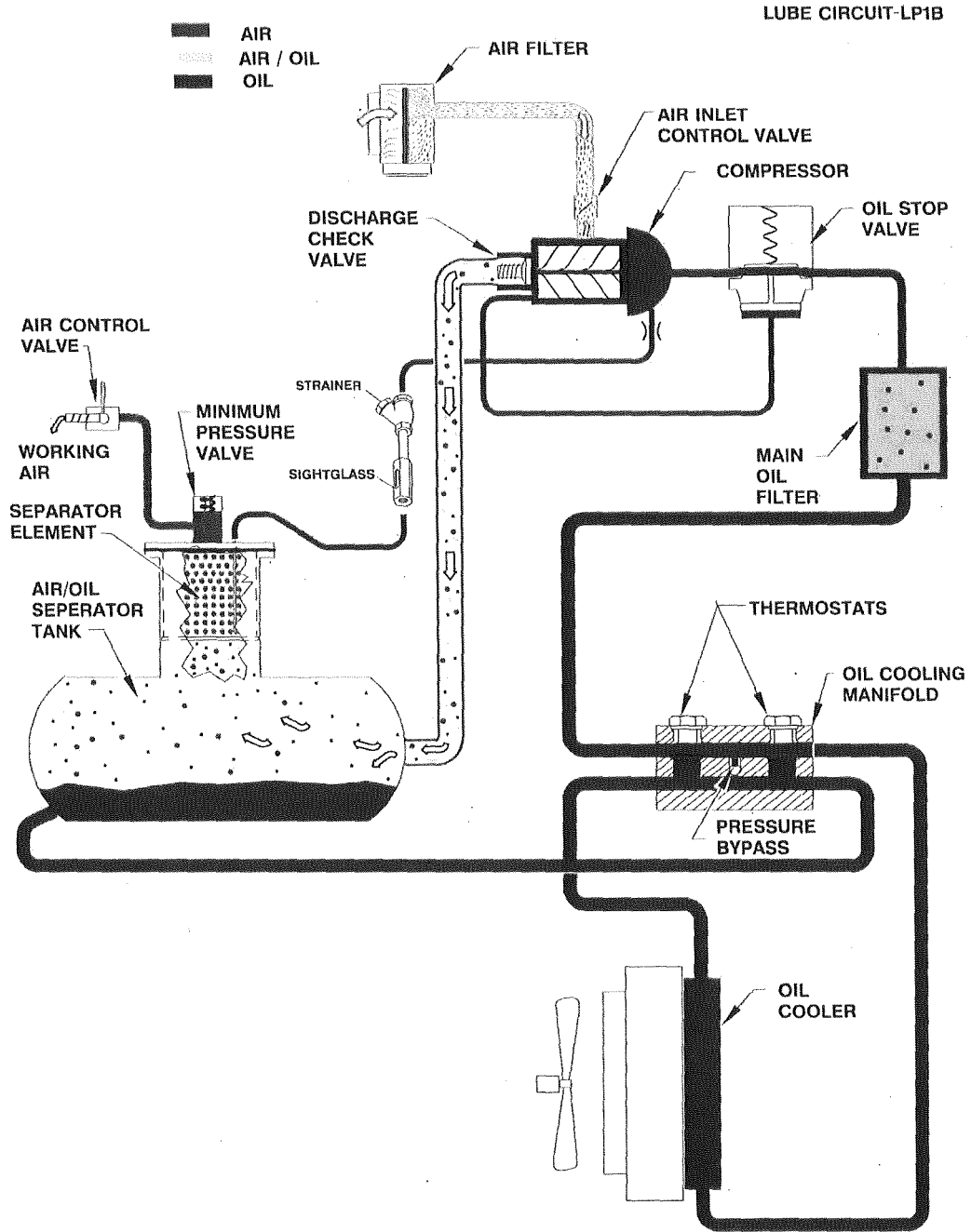
LOW PRESSURE COMPRESSOR SYSTEM FLOW CHART (COOL OIL)

LUBE CIRCUIT-LP1A



ADDITIONAL ILLUSTRATIONS SHOW THE VERTICAL AND TWO RESERVOIR SYSTEMS

LOW PRESSURE COMPRESSOR SYSTEM FLOW CHART (WARM OIL)



ADDITIONAL ILLUSTRATIONS SHOW THE VERTICAL AND TWO RESERVOIR SYSTEMS

AIR COMPRESSOR LUBRICANT RECOMMENDATIONS

Sandvik Mining and Construction encourages the user to participate in an oil analysis program with the oil supplier. This could result in an oil change interval differing from what is stated in these tables.

NOTE!

Mixing synthetic oils with an ATF may lead to operational problems, foaming, or plugging of orifices. Do not mix different types of fluids.

AMBIENT TEMPERATURE	CHANGE INTERVAL	ISO	LUBRICANT DESCRIPTION
-40°F to +95°F (-40°C to +35°C)	1000 Hours	32	Mobil SHC-624, 924 & 1024
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Mobil Rarus 424
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Chevron HiPerSYN
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Chevron Tegra Synthetic
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Shell Corena PAO
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Royco 432
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Conoco Syncon R&O
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Texaco Cetus PAO
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Valvoline Syn Guard CP
-40°F to +100°F (-40°C to +38°C)	1000 Hours	32	Petro-Canada Super SCF32
+30°F to +100°F (-1°C to +38°C)	1000 Hours	46	Chevron HiPerSYN
+30°F to +100°F (-1°C to +38°C)	1000 Hours	46	Citgo CompressorGuard
+30°F to +100°F (-1°C to +38°C)	1000 Hours	46	Conoco Syncon R&O
+30°F to +100°F (-1°C to +38°C)	1000 Hours	46	Petro-Canada Super SCF46
+30°F to +100°F (-1°C to +38°C)	1000 Hours	46	Royco 446
+30°F to +100°F (-1°C to +38°C)	1000 Hours	46	Texaco Cetus PAO
+30°F to +100°F (-1°C to +38°C)	1000 Hours	46	Valvoline Syn Guard CP
+30°F to +100°F (-1°C to +38°C)	1000 Hours	46	Mobil Rarus 425
+80°F to +120°F (+27°C to +49°C)	1000 Hours	68	Conoco Syncon R&O
+80°F to +120°F (+27°C to +49°C)	1000 Hours	68	Mobil SHC-626, 926 & 1026

Low Pressure Compressors

When operating between +80 and 100°F (+27 and 38°C) with a relative humidity above 80%, synthetic hydrocarbon type fluid Mobil SHC or equivalent as recommended above should be used.

All lubricant recommendations are based on 1200 rpm maximum WARM-UP speed.

COMPRESSOR OIL CHANGE PROCEDURE

GENERAL

The following procedure was written for low and high pressure compressors and should be used:

- When a total system cleaning is necessary.
- Severe duty applications.
- Changing brand name, type or viscosity of compressor fluids.

Beginning January 2000, our blasthole drilling machines are shipped from the factory with **Shell Corena AW32** in the compressor system.

In certain areas of the world, this oil may not be available. If this is the case it will be necessary to change to the local available oil. When this occurs it is mandatory to clean the system of the original oil.

Mixing of two different oils can cause operational problems:

- **Oil Foaming**, big air bubbles can cause cavitation on components and make air pockets in the oil cooler restricting oil flow.
- **Overheating**, compressor fluids not flowing through the oil cooler will not dissipate heat.
- **Excessive Oil Carry Over** through the separator element wasting the oil down the drill pipe.

These problems can be reduced or will be non-existent when following the prescribed procedure.

OIL CHANGE PROCEDURE

Before changing brand name oil, contact your Sanvik Mining and Construction Regional Office with the specifications of the oil to be used. This

step is to determine if the oil is correct for the specified compressor.

Draining Oil

Depending on the ambient temperature, it may be necessary to start the machine and warm the compressor prior to changing fluid.

1. Once compressor oil is warm, shut off the machine and remove the key from key switch.
2. Utilize 2 clean 55 gal (208 liters) containers.
3. Connect a hose to the drain valve located on the bottom of the air/oil receiver tank.
4. Open the ball valve to drain compressor oil into the containers. Follow applicable laws prescribed for waste oil recovery.

CAUTION

Starting the engine when the compressor oil has been drained will damage the compressor. Do not allow the engine to start! Lock-Out and Tag-Out

5. Apply emergency stop switches to disable engine starting.
6. Place the key into the key switch, **hold the engine stop button** and roll the engine and compressor over two (2) or three (3) times. This will push out any residual oil that was left in compressor into receiver tank.
7. Remove top and bottom hose from compressor oil cooler to enable oil to drain out of the cooler.
8. Remove the separator filter. Replacing the separator element is dependent on service hour interval. When in doubt or service hours are unknown, replace the separator element.
9. Remove scavenge return line and allow to drain, remove and clean strainer screen, replace screen and tighten.

10. Remove the main compressor filters. The filter canister may be unthreaded from the housing in order to drain oil from filter canister.
11. Remove and drain the pilot hose at the oil stop valve.
12. Remove all oil cooler and tank lines from compressor to drain any oil that may have been left in system.
13. Remove intake piping at compressor inlet.

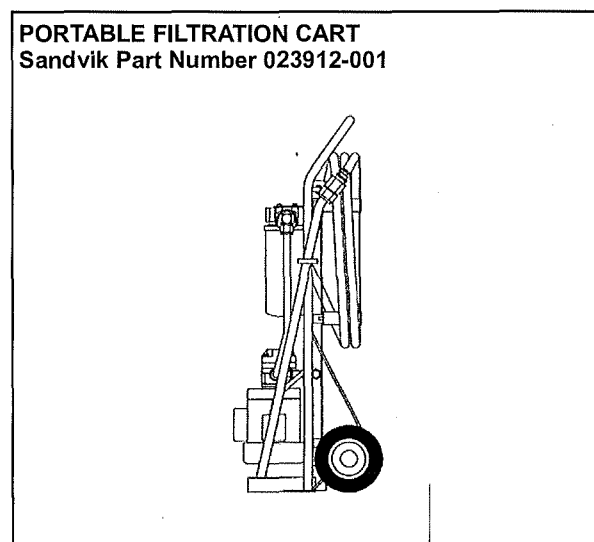
New flange O-rings will be needed for connecting hose ends that have been removed for this procedure.

Adding Oil

1. Pour some new clean compressor oil into the top of the oil cooler permitting it to push any of the existing oil from cooler. Once new oil is coming through oil cooler, attach the top cooler hose.
2. Pour some new clean compressor oil into the intake of the compressor to flush out any original oil.
3. When applicable install the discharge check valve and all hoses that were removed.
4. Pour some oil into the receiver tank to push out any existing oil.
5. Close the drain valve.
6. Install separator filter, with a new gasket, do not remove the static staple that is clipped in the separator gasket. No additional sealants are necessary.
7. Mount the receiver tank cover, torque bolts to spec.
8. For **low pressure applications** install the scavenge return tube and tighten adapters.
9. Connect scavenge return hose to appropriate ports.

10. Install compressor filters making sure the plastic connection piece is installed between the two KS15 or KZ25 series filters.
11. Connect pilot hose to the oil stop valve.
12. Fill air receiver tank with new clean oil to the required level sight glass port, install the fill plug and tighten.
13. Holding engine stop button, roll over compressor and check for any leaks. If evident, repair prior to running the machine.
14. Start engine and run at low idle and check for any leaks. If evident, repair.
15. Permit compressor to run until compressor temperature comes to operating temperature. (Approximately 160° to 200°F).
16. Shut machine down and let set for 15-20 minutes and recheck compressor oil level.
17. Add oil as needed to the proper fluid level sight glass.
18. After several hours of operation and if a foaming problem exists, you may need to drain the oil from the separator tank and refill.

Oil may be transferred from air receiver tank to clean drums using a portable filtration cart as shown.



AIR RECEIVER RESERVOIR SEPARATOR MAINTENANCE

GENERAL

Routine maintenance of air receiver reservoirs requires a skilled maintenance person using safe operating principals and clean working habits.

DESCRIPTION

Sandvik Mining and Construction blasthole drilling equipment generates compressed (working) air for the drilling cycle. This pressurized air is stored in the air receiver tank during the machine run mode.

The compressor system circuit contains a blow-down valve to vent the circuit when the engine is shutdown. When performing routine maintenance it is essential that the machine be turned off for a minimum of 2 minutes prior to starting compressor system maintenance to allow the circuit to vent. Longer periods may be beneficial to allow oil temperatures to drop.

We recommend using the appropriate Sandvik rig Lubrication and Maintenance Guide when performing the 250, 500, 1000 and 2000 hour maintenance programs.

The details given in this section are relating to air receiver reservoir air/oil separator element service specifications.

MACHINE MODEL	COMPRESSOR
D25KS, D245S, T40KS	LOW PRESSURE
D40KS, D45KS, D50KS	LOW PRESSURE
D55SP, D60KS, D75KS	LOW PRESSURE
T60KS	LOW PRESSURE
D90KS, D90KD D90KSP	LOW PRESSURE
1190 SERIES	LOW PRESSURE

There are different reservoirs for high pressure and low pressure compressors. Therefore, the maximum pressure ratings and operating temperature specifications will differ.

It may be a local law that pressure vessels require recertification and this recertification may only be performed with a qualified test procedure by a qualified engineer. Due to the complexity of such laws worldwide Sandvik asks that the customer bare this responsibility as a company standard operating procedure.

Static Discharge

Compressor oil under heat from compression, and velocity may develop static electricity inside the air receiver tank during operating conditions. All models of Sandvik blasthole drill machines will use a static discharge spring or staple. This device makes a secure electrical ground for the separator filter element.

- High pressure applications require a spring installed on the bottom end filter holddown bolt.
- Low pressure applications require a static staple installed on the sealing gasket for the top cover.

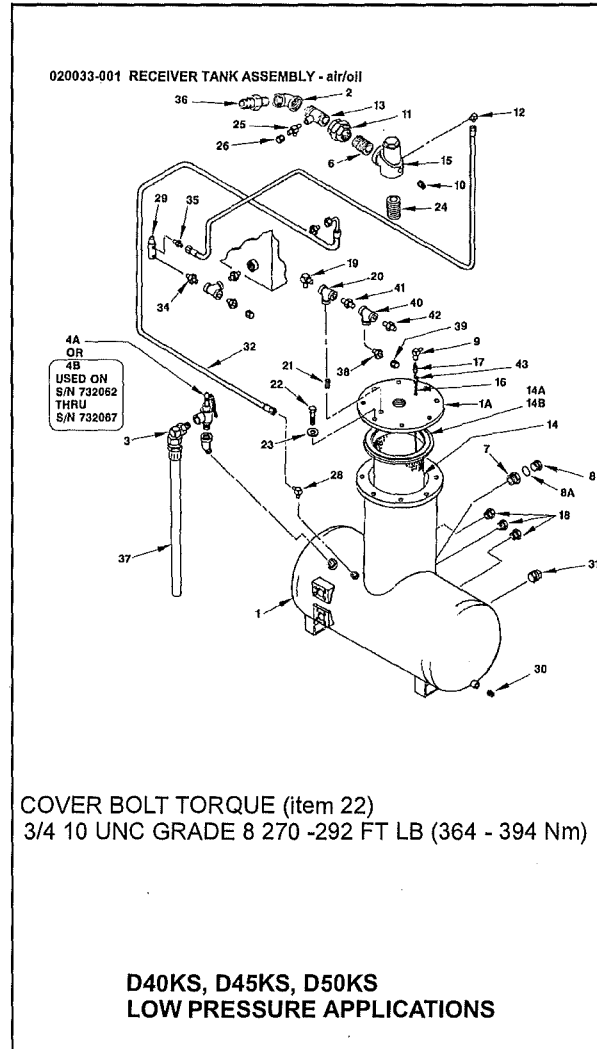
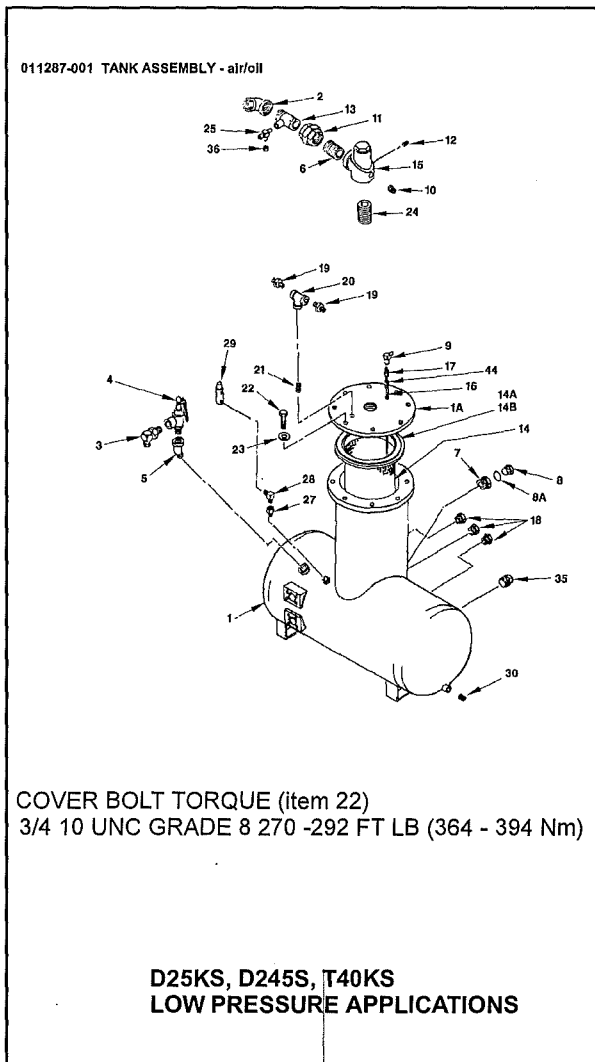


The contained static electricity may have the capacity to ignite the oil and cause the compressor to flash. A machine fire will occur. Do not operate the machine with the static spring or gasket staple removed.

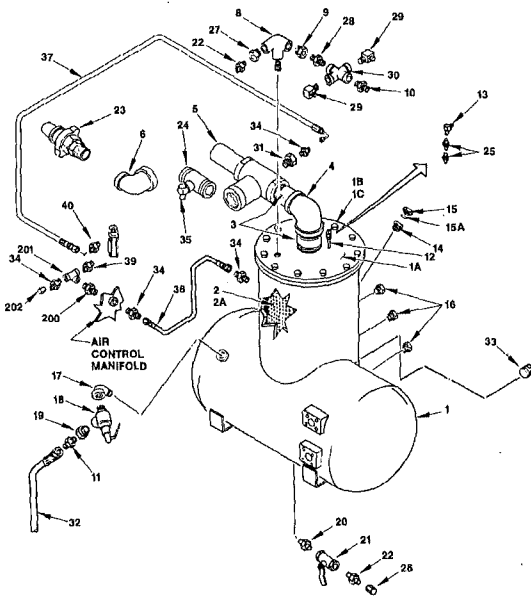
AIR RECEIVER RESERVOIRS

The following pictorial views are from machine specific parts manuals. Please note bolt torque changes per machine models.

Clean the gasket seal surfaces prior to new gasket installation. Do not use a gasket sealant on the reservoir or cover surfaces.



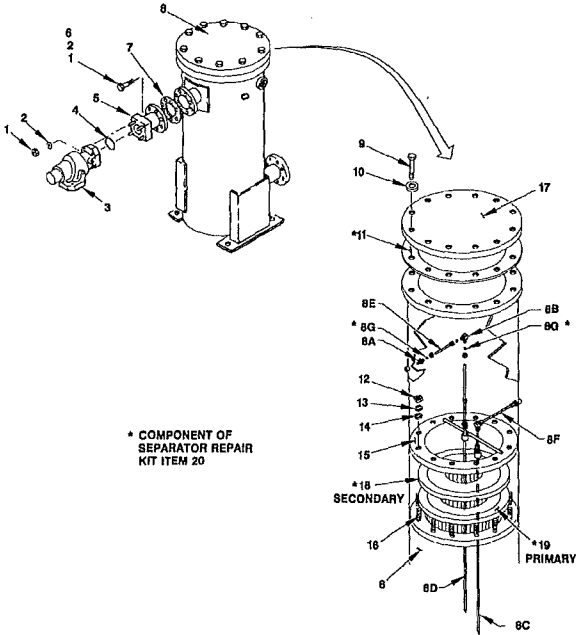
018711-001 TANK ASSEMBLY - air/oil



COVER BOLT TORQUE (item 1B)
3/4 10 UNC GRADE 8 270 -292 FT LB (364 - 394 Nm)

D55SP, D60KS, T60KS, D75KS
LOW PRESSURE APPLICATIONS

016698-003 RECEIVER TANK ASSEMBLY

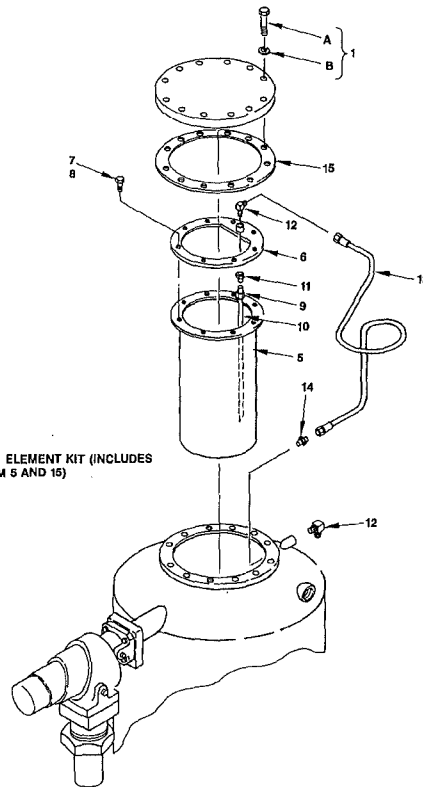


* COMPONENT OF
SEPARATOR REPAIR
KIT ITEM 20

COVER BOLT TORQUE (item 9)
3/4 10 UNC GRADE 8 270 -292 FT LB (364 - 394 Nm)
FILTER HOLDDOWN RETAINER RING
NUT TORQUE (item 12)
3/8 16 UNC 22 - 24 FT LB (29.7 - 32 Nm)

**D90KS, D90KD, D90KSP
LOW PRESSURE APPLICATIONS**

018468-001 RECEIVER GROUP



200 ELEMENT KIT (INCLUDES
ITEM 5 AND 15)

COVER BOLT TORQUE (item 1A)
3/4 10 UNC GRADE 8 270 -292 FT LB (364 - 394 Nm)
FILTER HOLDDOWN RETAINER RING
BOLT TORQUE (item 7)
3/8 16 UNC GRADE 8 31 - 34 FT LB (42 - 45.5 Nm)

**1190 SERIES
LOW PRESSURE APPLICATIONS**

AIR CONTROL SYSTEMS (LP)

GENERAL

The following schematics illustrate the air control systems that pertain to butterfly inlet, single and dual poppet valve intake control systems.

LOW PRESSURE BUTTERFLY INLET SCHEMATIC

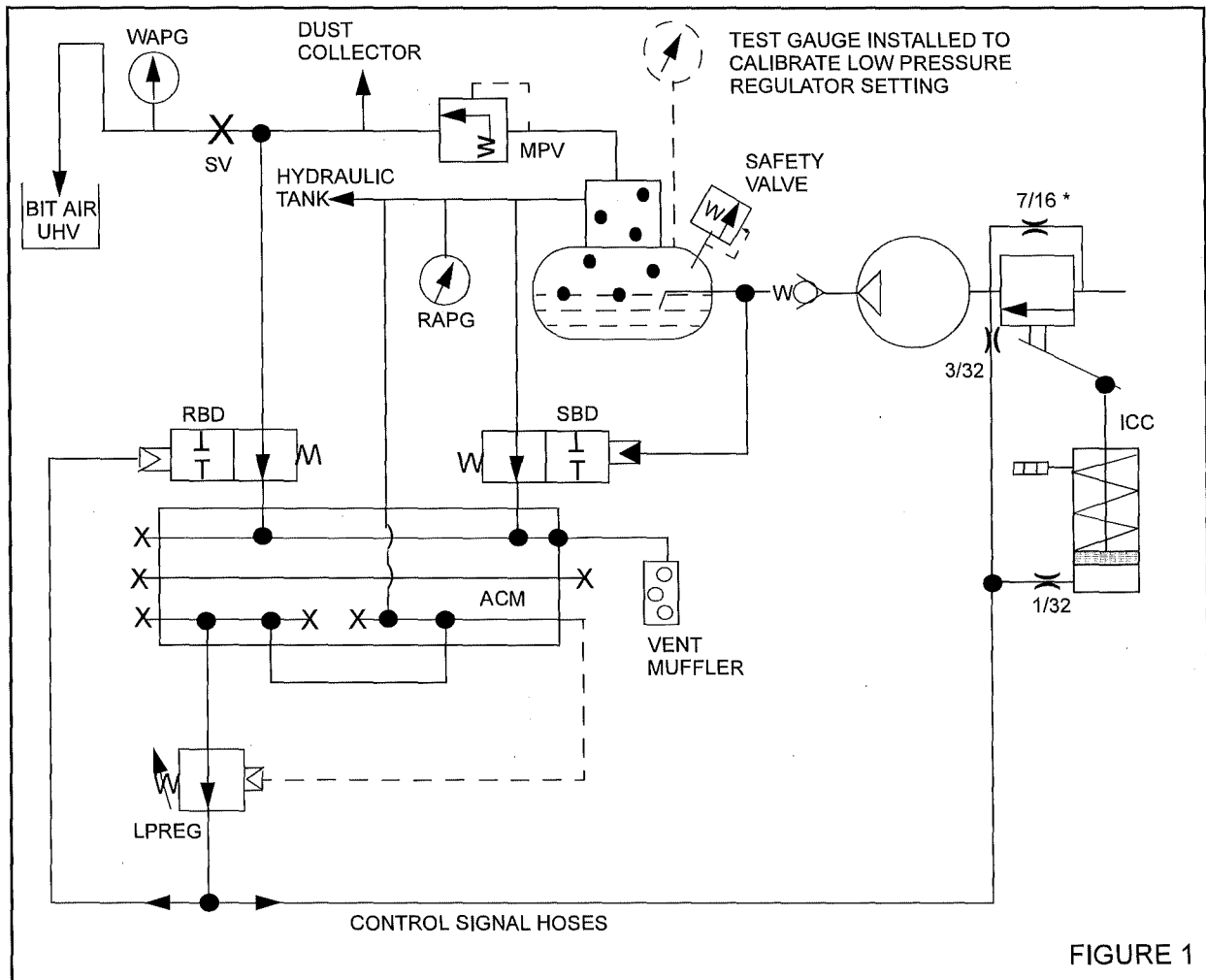
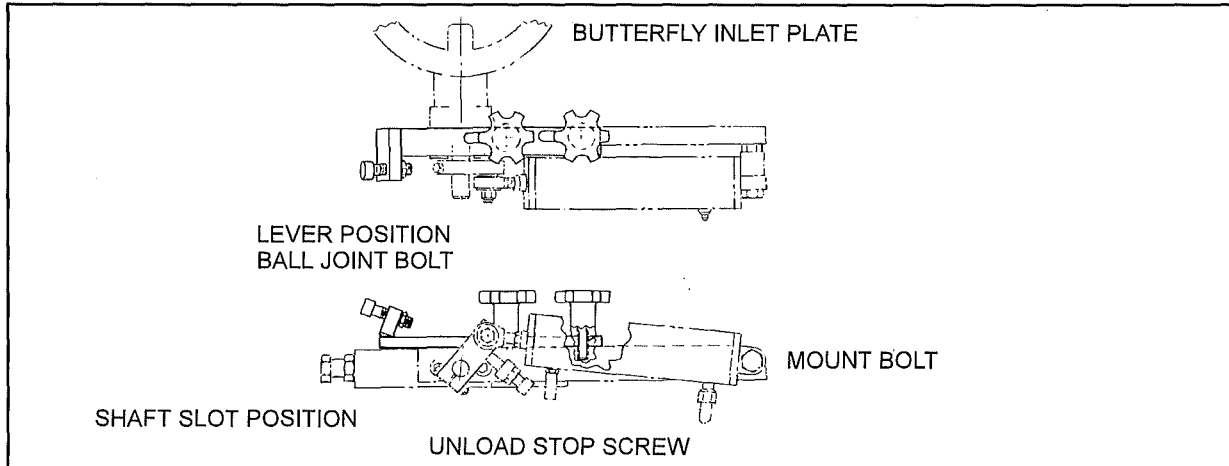


FIGURE 1

Low pressure butterfly inlet controls are held closed for start-up purpose. A spring return inlet control cylinder will extend with compressed air. The cylinder speed is controlled by a .03125 (.793 mm) inlet orifice, the spring end is open to atmosphere through a vent muffler. The inlet control cylinder extends with receiver air pressure passing through a normal open air control regulator. A .09375 (2.381 mm) orifice inside the inlet manifold plate draws air from the control signal hoses when the low pressure regulator closes. The spring return cylinder closes the butterfly inlet plate.

Proper inlet adjustment is critical for machine start-up and receiver air pressures. The inlet cylinder shall be held with a single mounting bolt so that it has a slight amount of side to side play.

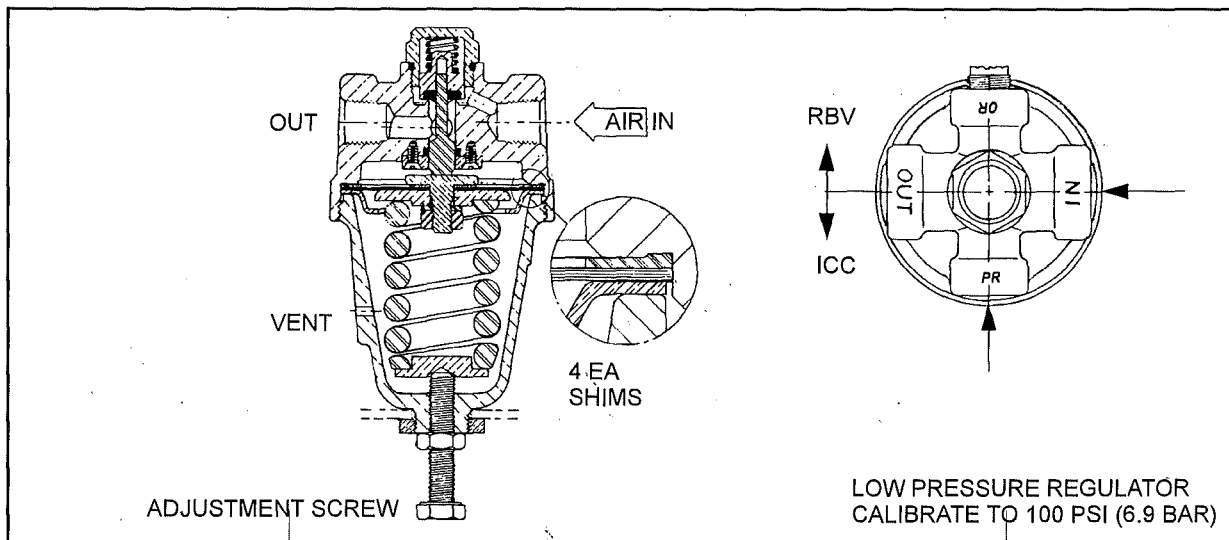
Install a vacuum gauge on the compressor inlet when adjusting the inlet control valve. Remove the inlet control cylinder rod bolt prior to calibrating the inlet components. During machine startup the air pressure will be slow and gradual. Set the engine at high idle speed and calibrate the unload stop screw for the expected inlet vacuum reading between 26 to 28 hg with the butterfly inlet control plate closed.



Connect the inlet control cylinder to the inlet butterfly plate lever. Adjust cylinder ball joint assembly to align with the lever assembly without moving the inlet butterfly plate. Secure the ball joint mounting bolt so that it has a slight amount of side to side play.

When the compressor inlet unload stop screw is in proper calibration the result will be a smooth blowdown operation during the running mode. Air venting out the blowdown muffler is constant without cycling.

Maximum air pressure inside the receiver tank shall be set with the LP regulator, 100 (6.9 bar) is standard setting. Do not exceed 110 psi (7.6 bar).



Calibrating Regulators

Perform air pressure regulator calibration with the machine shut down and receiver air pressure is zero.

Pressure regulator may be calibrated in place on the machine with standard hand tools. It is advisable to install a 500 psi (35 bar) pressure gauge and hose to the test port provided at the air/oil separator indicator.

1. Start the machine.
2. Operate the machine at low engine idle speed to warm fluids and air. Warm compressor oil and air temperature is recommended prior to regulator calibration.
3. Operate machine to specific rated high engine idle speed.
4. Check air pressure gauge for actual air receiver tank air pressure.
5. Adjust low pressure regulator adjustment screw in to increase air pressure to achieve 100 psi (6.9 bar) unload air pressure.

Note:

If air pressure over runs the value reduce the regulator setting and slowly adjust the regulator to the rated pressure value.

6. Check air pressure gauge for actual air receiver tank air pressure.
7. Lower engine idle speed allow adequate engine cool down period prior to stopping machine.
8. Stop the machine per standard operating principals.
9. Allow approximately two to three minutes for the air pressure in the receiver tank to empty to atmosphere. Air will blow to atmosphere through a frame mounted vent muffler.
10. Check receiver air pressure on test gauge for a zero indication prior to service.
11. Remove test pressure gauge from air/oil separator indicator location and cap test port adapter.

Final note:

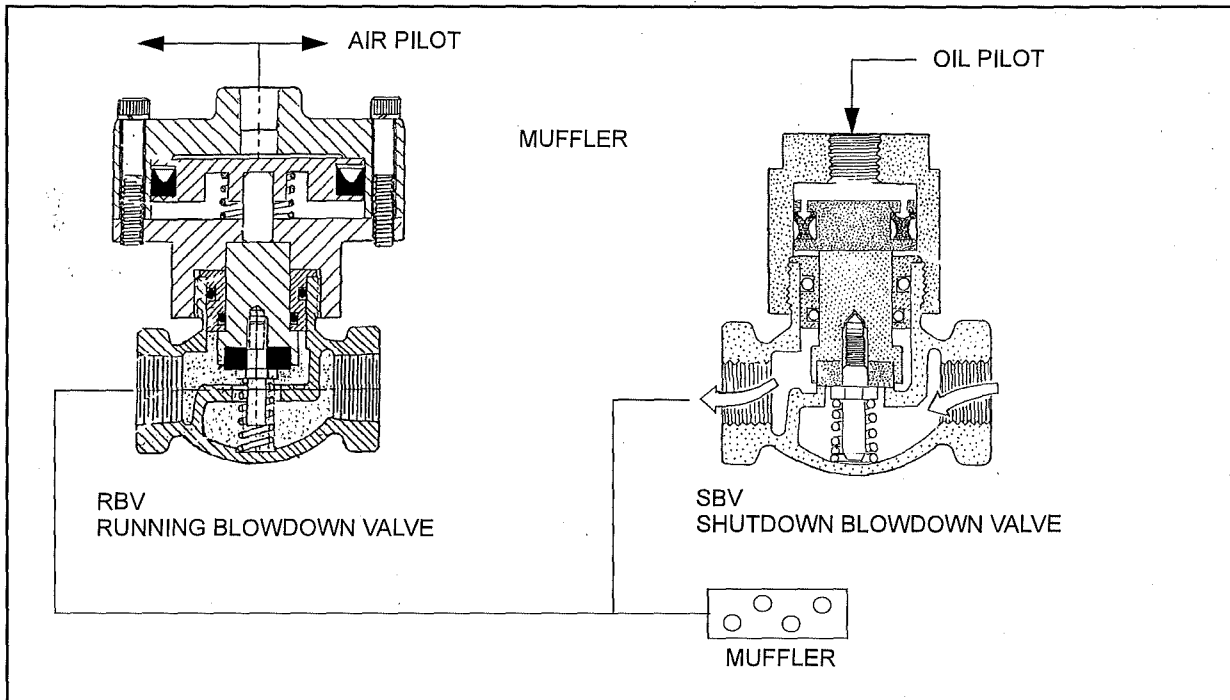
The compressor lubrication system is dependant on operating air pressures. Compressor system air and oil components are subject to system air pressures.

When testing oil coolers, test pressures are relative to air regulated pressures. With the exception of lubrication component pressure drops test pressures will be air receiver tank pressure.

Blowdown Valves

Two valves mounted to the air control manifold enable air receiver tank pressure to vent to atmosphere. As air vents to atmosphere it is silenced with a muffler mounted on the machine frame.

- The shutdown blowdown valve pilots closed for machine run mode and opens upon machine shutdown to empty the air receiver tank
- The running blowdown valve pilots closed during compressor loading or drilling conditions and opens upon compressor unload conditions to maintain a stable air receiver tank pressure.



Maintain the vent muffler to be clean of mud, oil residue and rock dust. When the muffler is restricted it traps air inside the air receiver tank. Operational problems could be over run air regulators, excessive air receiver pressure enabling tank relief valve to open.

Sullair Single Poppet Air Inlet Valve

Poppet control systems are installed on single stage low pressure drilling applications in the D25KS through D75KS product line. The system has under gone several modifications since the drawing shown here, to name a few:

- removal of discharge check valve
- pilot signal for shutdown (final) blowdown valve relocation
- shutdown (final) blowdown sequence
- electric solenoid shutdown (final) blowdown valve

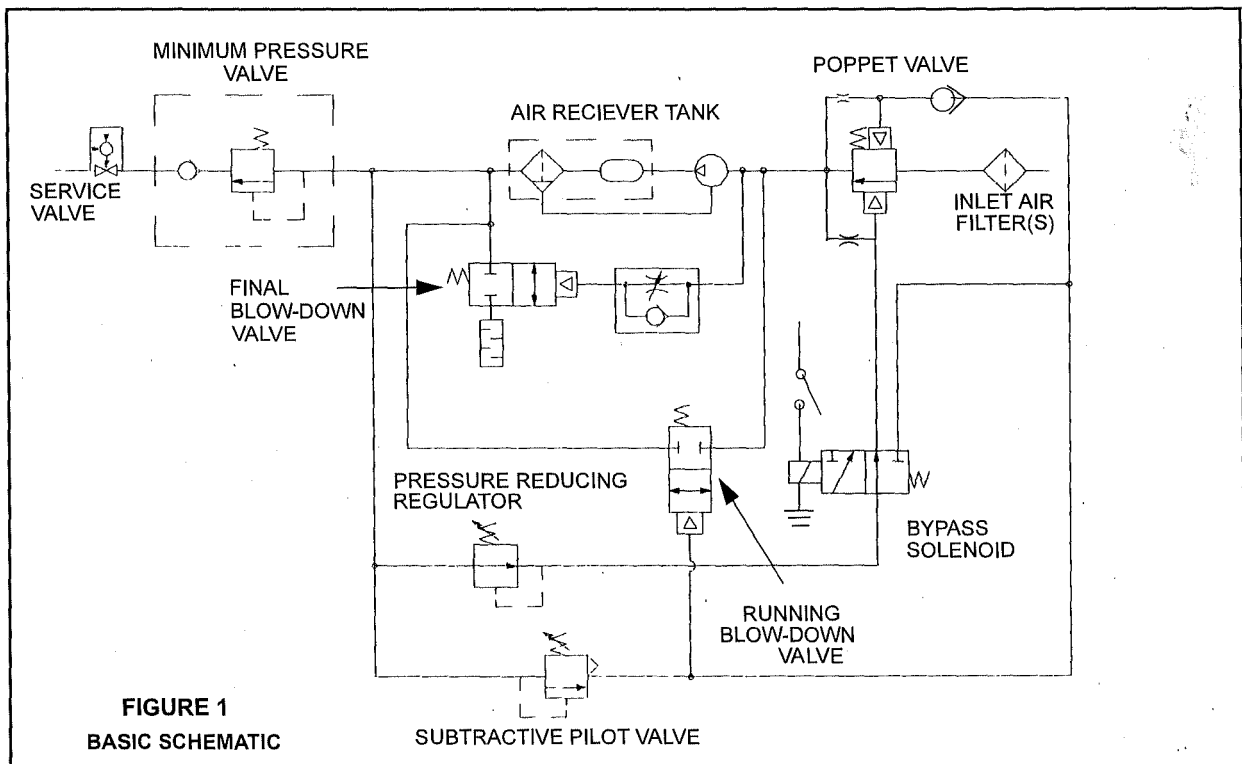
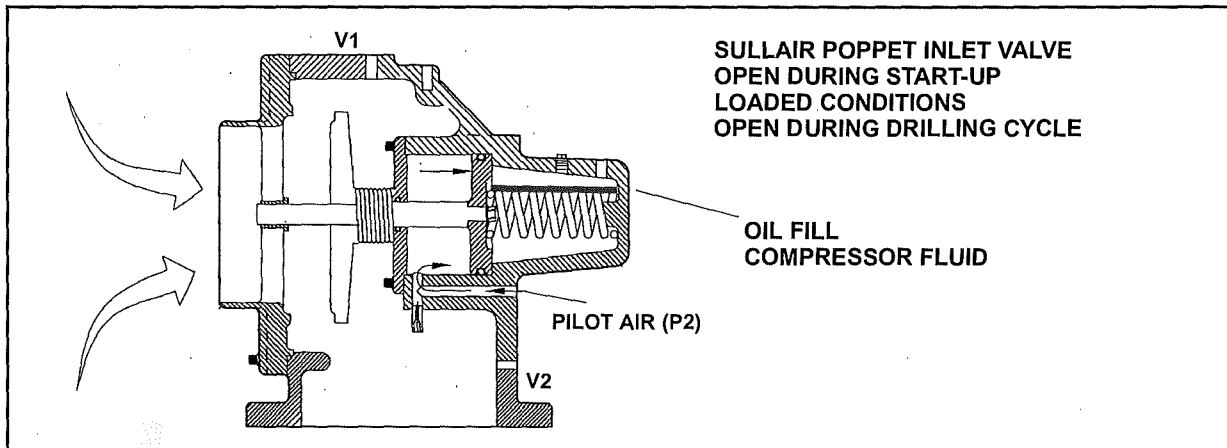
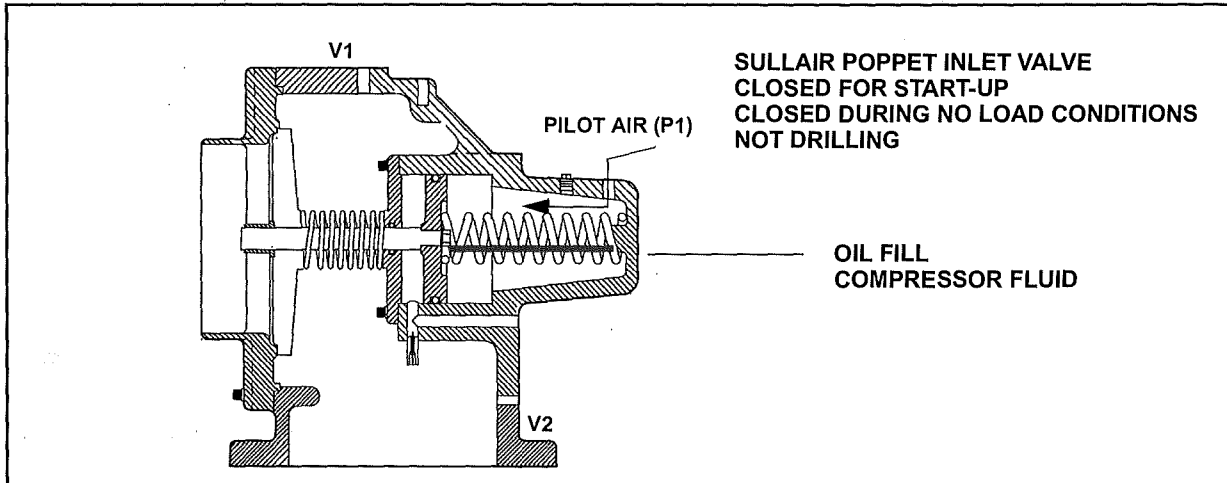


Figure 1 schematic shown as normal condition for all components. Machine is not running. This is a closed inlet valve in an unload condition.

AIR CONTROL VALVES

Poppet Inlet Valve



Maintenance

Poppet inlet control valves should be serviced with compressor oil during routine maintenance procedures with no more than 0.75 US pint (355 ml).

Port Description:

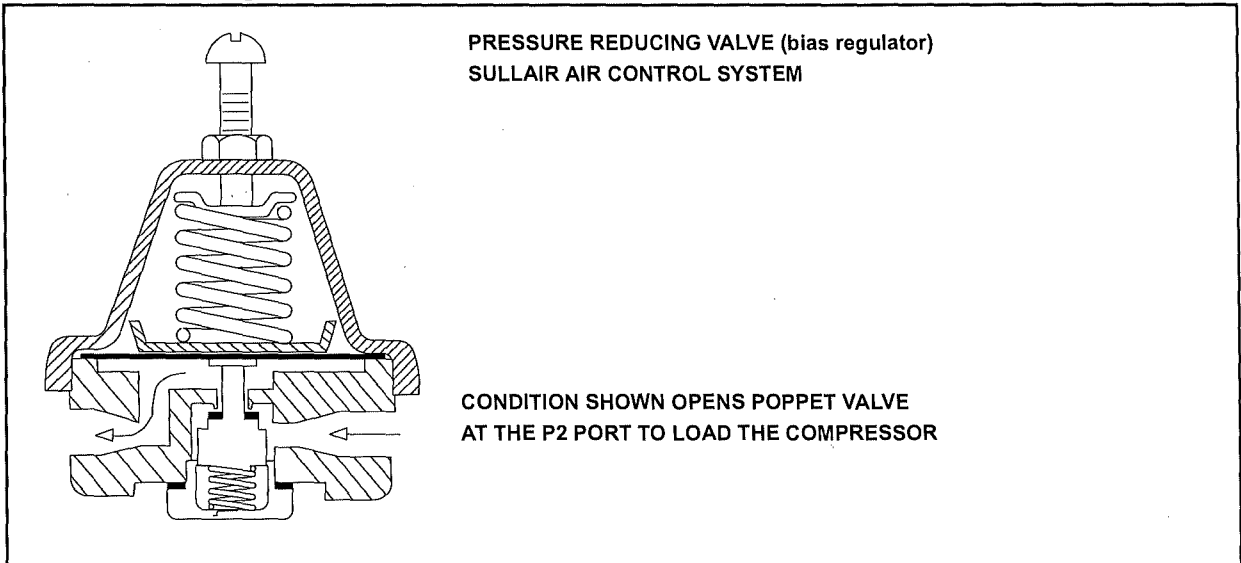
P1 pilot port from bypass solenoid, subtractive pilot regulator, check valve control orifice, V1 port

P2 pilot port from bypass solenoid, pressure reducing regulator

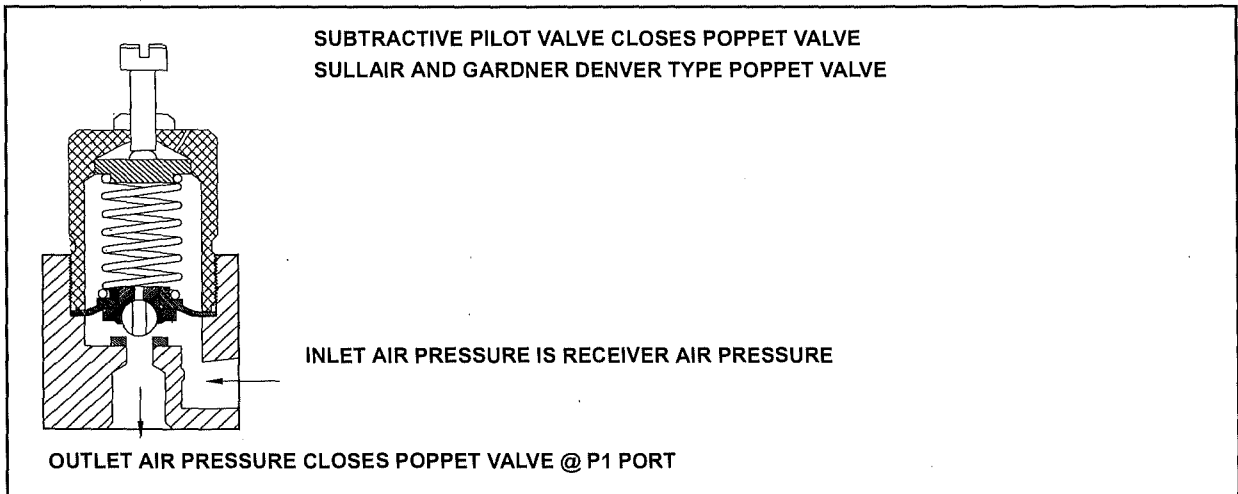
V1 vent port from running blowdown - purge valve

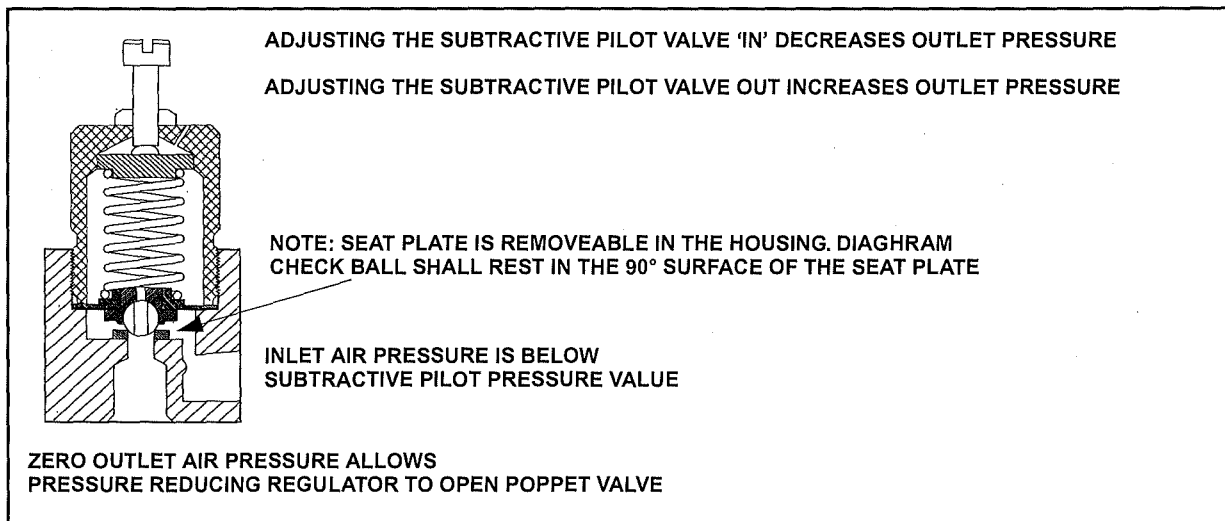
V2 vent port from subtractive pilot valve, check valve, P1 port, pilot shutdown (final) blowdown valve

Pressure Reducing Valve



Subtractive Pilot Valve



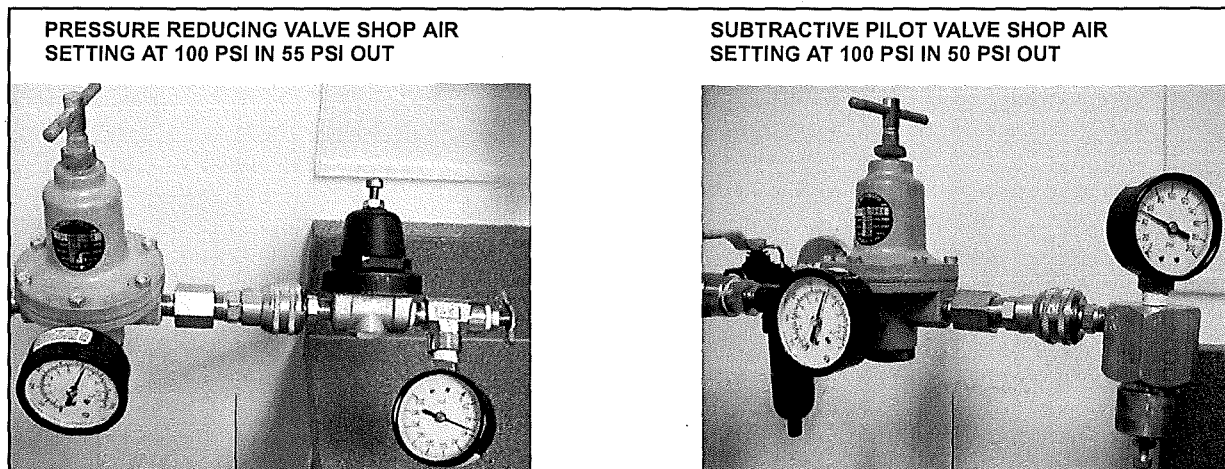


With the receiver tank pressure at 100 psi (6.9 bar) the subtractive pilot valve outlet pressure setting is approximately 5 psi (.34 bar) less than the pressure reducing valve outlet pressure.

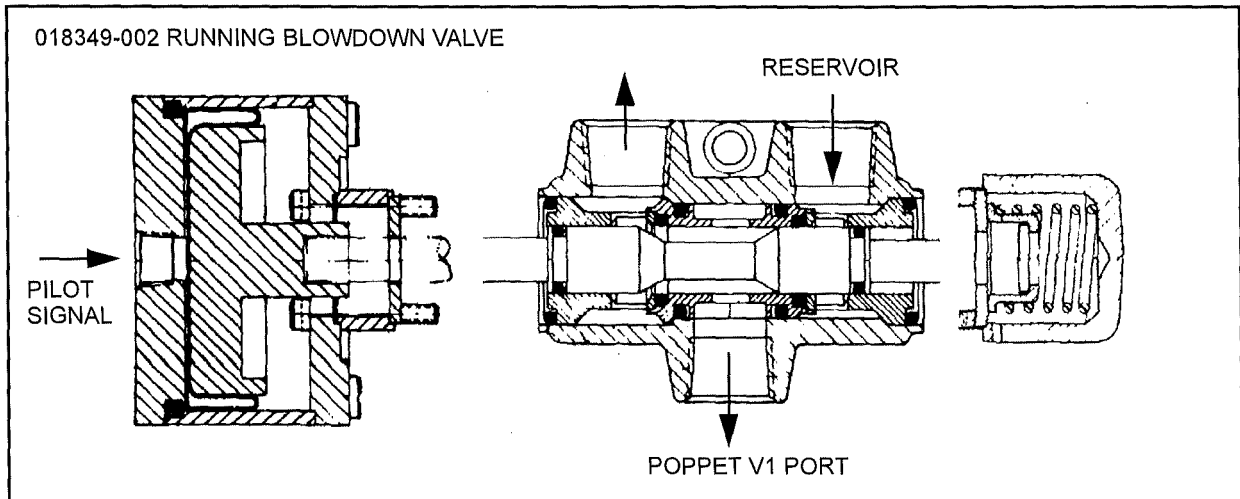
When adjustments are made to the subtractive pilot valve increase or decrease values, a similar adjustment is mandatory for the pressure reducing valve.

For best results make pressure adjustment with an external air source. Shop or service truck supply air is recommended as long as the supply pressure is above desired subtractive pilot valve requirement.

- Attach supply air to the valve inlet port with 300 psi (20 bar) pressure gauge.
- Attach 150 psi (10 bar) pressure gauge to outlet port, the outlet side has to be in a dead head pressure condition
- **Utilize all safe operating principals when servicing air regulation parts. Discharge any unused air from hoses or adapter ports prior to component removal.**



Final Blow Down And Running Blow Down (Purge) Valves



These valves are supplied as normal closed pistons and require a separate pilot signal to open the piston to vent air from the inlet to outlet port.

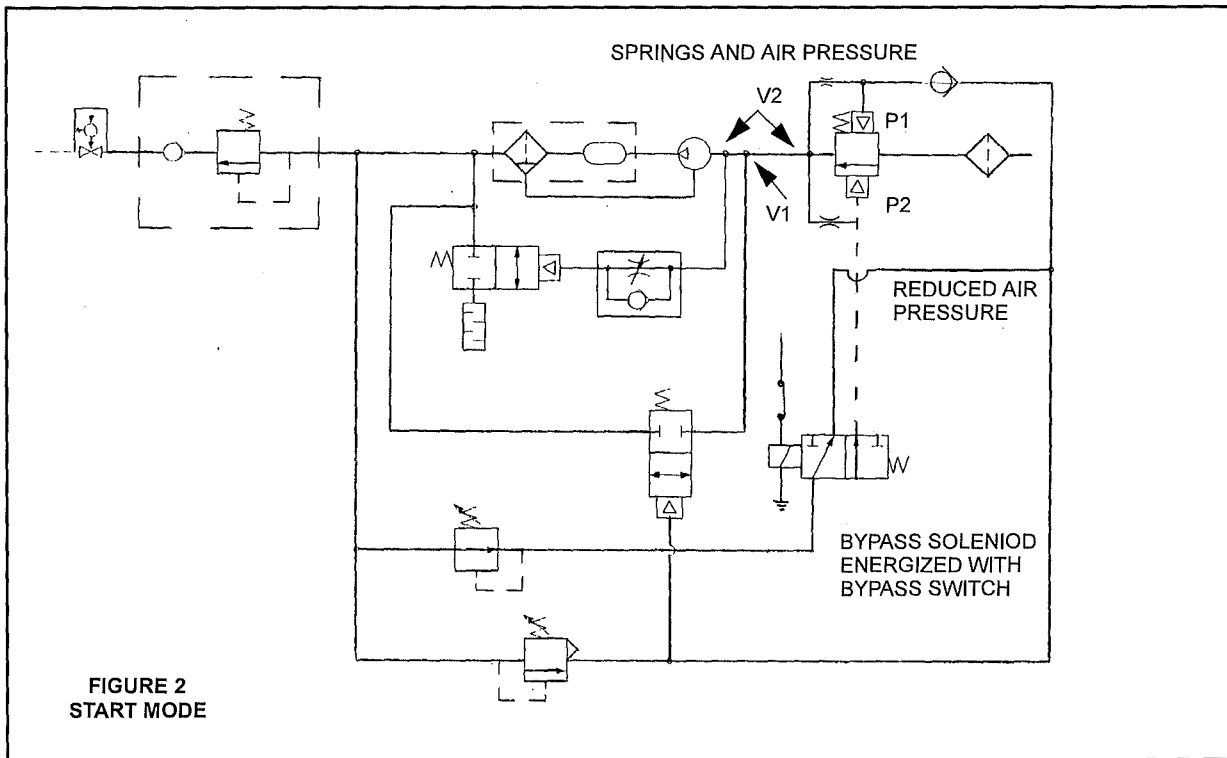
During machine run mode the final blow down valve is spring set closed to maintain air pressure inside the air receiver tank. The pilot end is connected to the compressor inlet cavity which is a vacuum during compressor operation. The absence of pressure at the final blow down valve pilot port allows this valve to maintain a closed position during machine operation.

When the machine is shut down, available receiver air pressure is inside the compressor. The compressor inlet that was a vacuum during operation becomes pressurized at shutdown. Air pressure from the system opens the final blow down valve according to a flow control setting. Air pressure shall vent to atmosphere through a vent muffler positioned on the final blow down outlet port.

One adjustable flow control valve is positioned on the pilot port of the final blow down valve. This flow control valve shall be set 1/4 turn open and locked in this position. Refer to figure six for details.

During machine run mode the running blow down (purge) valve is spring set closed until a pilot signal is received at the valves pilot port. When receiver air pressure opens the subtractive pilot valve, a pilot signal is directed to open the running blowdown valve. Compressed air recirculates from the receiver tank to the poppet inlet control valve (V1) vacuum port.

Maintenance of these valves is limited to seals and orings, no adjustments required.

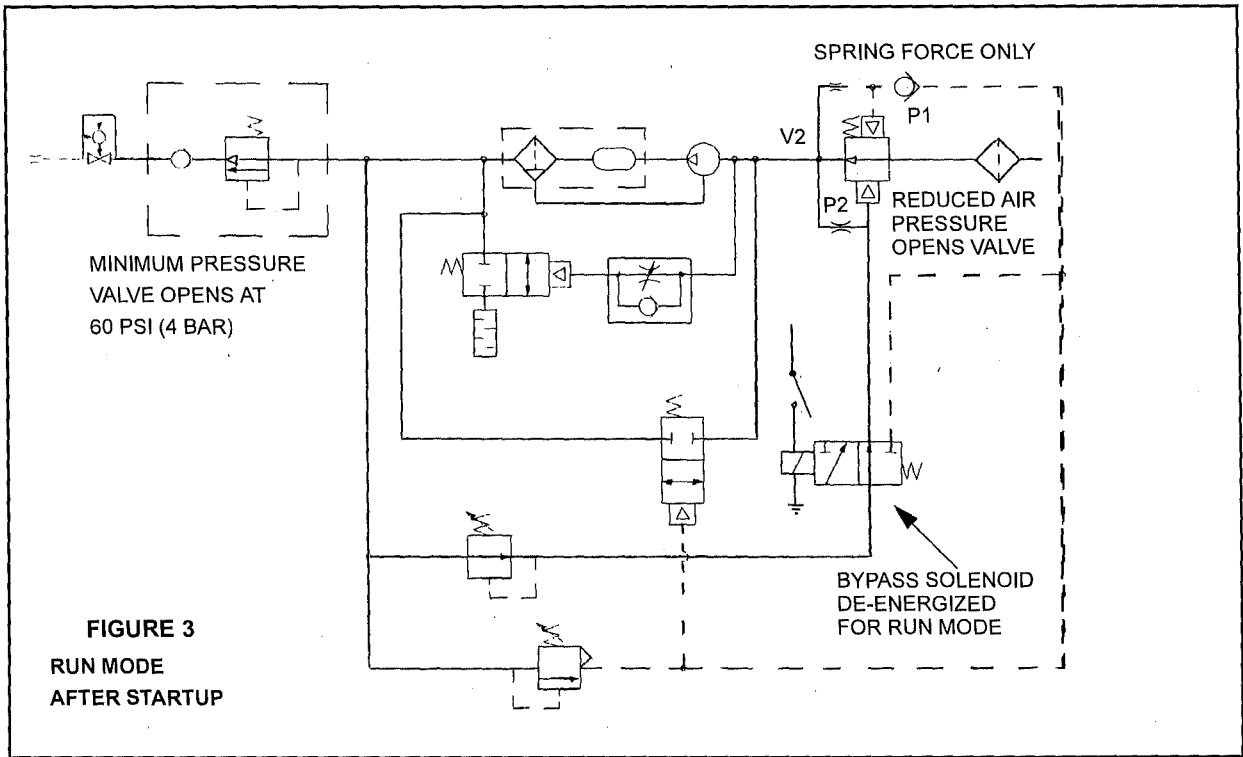


The poppet valve is held closed with reduced air pressure passing through the bypass solenoid, along with spring force in the P1 cavity.

The expected air pressure for start-up mode is approximately 10 to 15 psi during starting and the bypass solenoid is energized with the bypass switch. The low air pressure is a low load for the compressor and engine during the critical start-up mode. The 10 to 15 psi contained in the air receiver tank pushes the oil through the oil lubrication parts to the single stage air end.

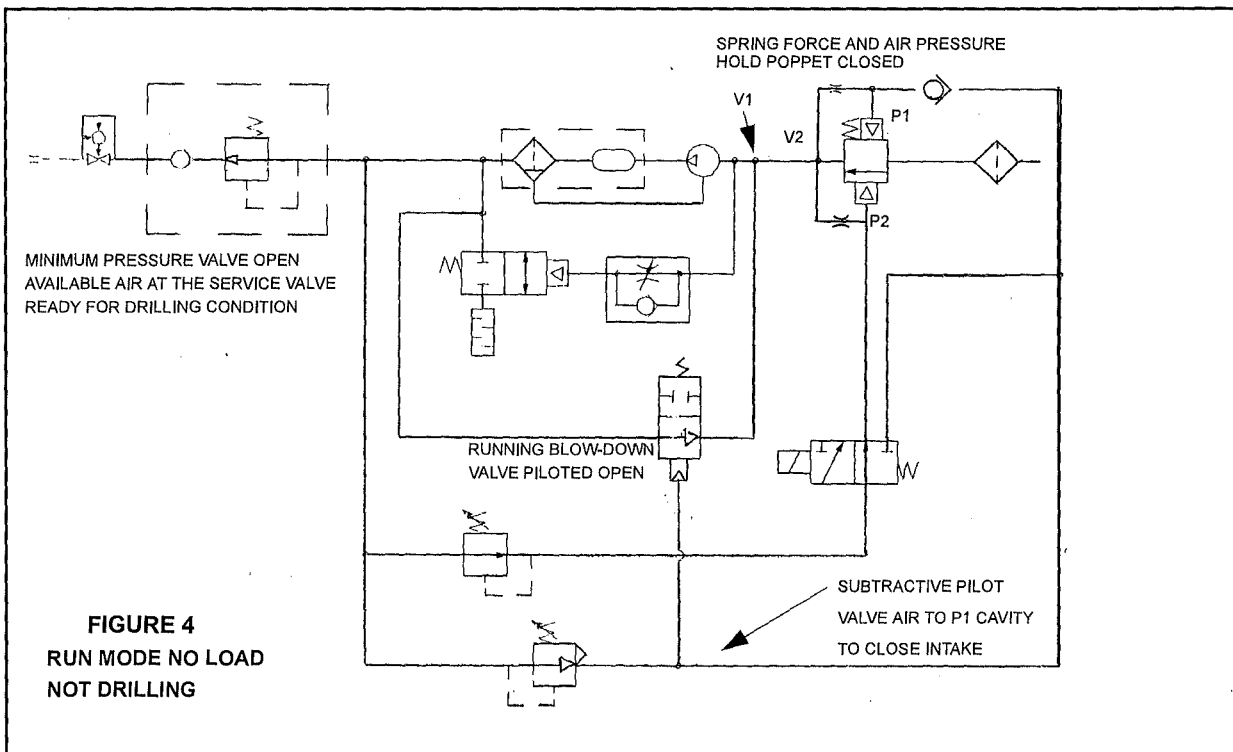
When the engine is running smooth at the rated low idle speed the bypass switch may be disengaged.

Figure 3 shows run mode after start up loading to subtractive pilot valve setting.



When the bypass switch is released the bypass solenoid is de-energized. With the bypass solenoid in the normal condition the reduced air pressure is directed to the P2 cavity on the poppet valve. The air inside the P1 cavity is drawn to intake at the V2 port. A.063 orifice inside one adapter on the P1 adapters allows a restriction for the control and venting features.

Figure 4 shows run mode no load not drilling.



With air pressure inside the air receiver tank at the rated subtractive pilot valve setting it is desired to close the intake.

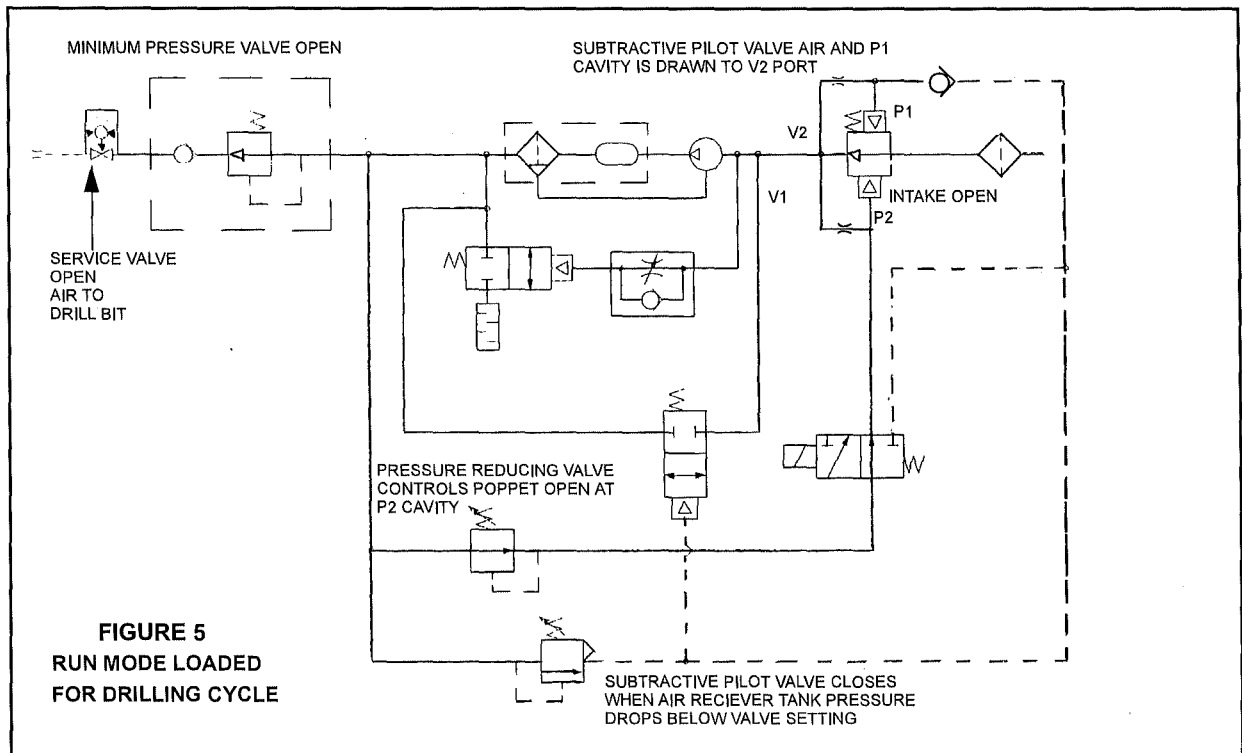
Subtractive pilot valve air is directed to the P1 cavity to close the intake. Spring force assists the closing (add air pressure and 5 psi spring force).

Air pressure present from the pressure reducing valve is forced to the intake through a .090 orifice located inside the poppet valve on the P2 port.

When adjusting maximum air pressure for receiver tank air it is necessary to adjust both regulating valves in steps. If the subtractive pilot valve is adjusted for 5 psi more available air pressure inside the air receiver tank then the pressure reducing valve requires the same increase of air pressure.

This step type adjustment is necessary for proper intake valve opening and closing sequences.

Figure 5 shows run mode loaded for drilling cycle.



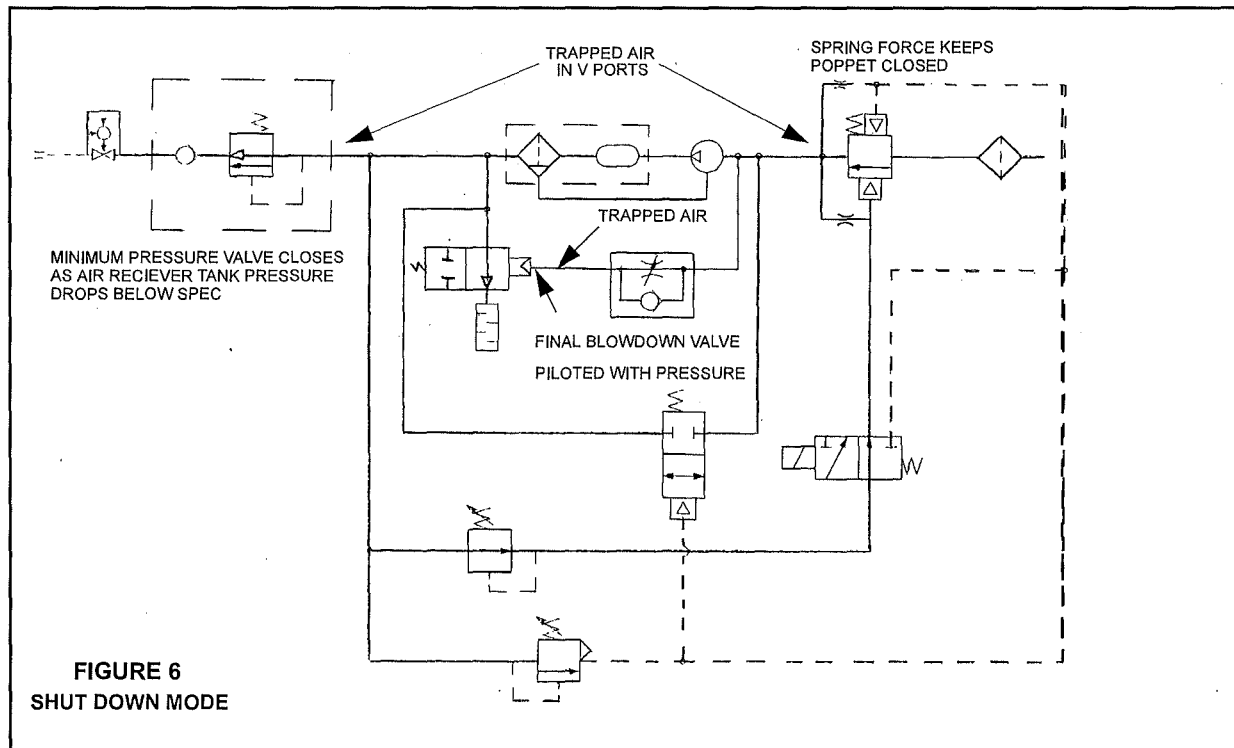
When air receiver tank pressure drops below the subtractive pilot valve setting a pressure difference occurs at the subtractive pilot valve inlet and outlet ports.

With inlet control pressure below the spring force the subtractive pilot valve will close air to the outlet port. The outlet connection to orifice at P1 and an external vent on the valve, air pressure is vented quickly. The poppet valve will open with air pressure in the P2 cavity.

A minimum pressure of 60 psi (4 bar) is maintained in the air receiver tank for adequate oil circulation and lubrication. During the drilling cycle typical air receiver tank pressure is 60 to 75 psi. Pressures may become higher due to drilling conditions.

Bit air or working air for drilling depends on what restrictions are in the drill string and what type of drilling tools are being utilized. Working air pressure is typically 10 to 20 psi (.7 to 1.4 bar) lower than air receiver tank air pressure.

Figure 6 shows shut down mode.



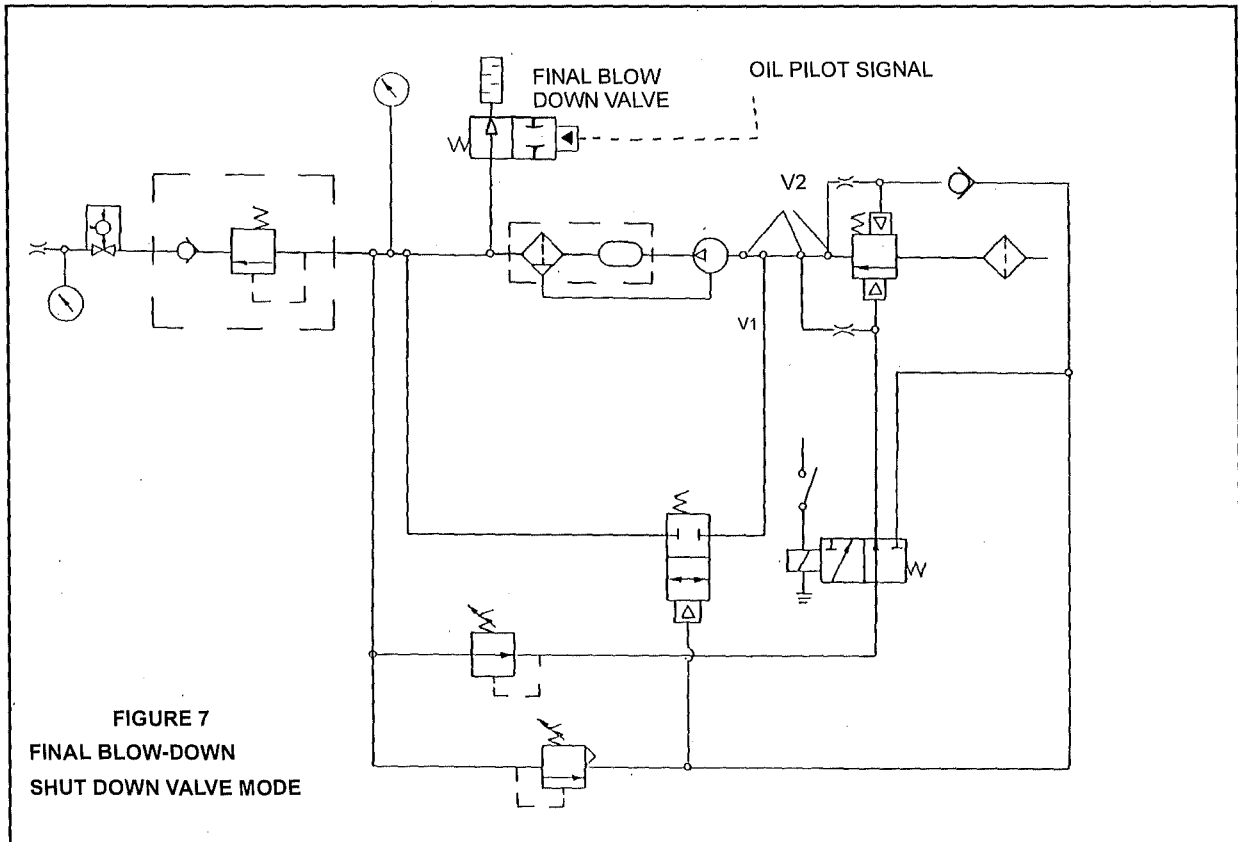
Pressure inside the air receiver tank is available in all directions upon shutdown. With the discharge check valve removed air pressure can flow through the V1 port to a flow control valve. When this flow control is set 1/4 turn open air under pressure will be trapped between the flow control and the pilot port. This trapped air will pilot the final blowdown valve to an open position enabling air pressure to drain from the air receiver tank after shutdown.

WARNING

Depending on the flow control setting, air pressure may be present inside the air receiver tank for long periods even after shutdown. If the flow control valve is too far open or the adjustment is not locked in place caution should be observed when servicing the air receiver tank or compressor oil filters.

MODIFICATIONS

Application: Sullair Inlet Valve



This modification enables a external pilot of engine oil to close the shutdown (final) blowdown valve. The benefit of this modification is that the normal open valve will empty all the available air pressure from the air receiver tank after machine shutdown.

Figure 8 shows electric blow-down modification.

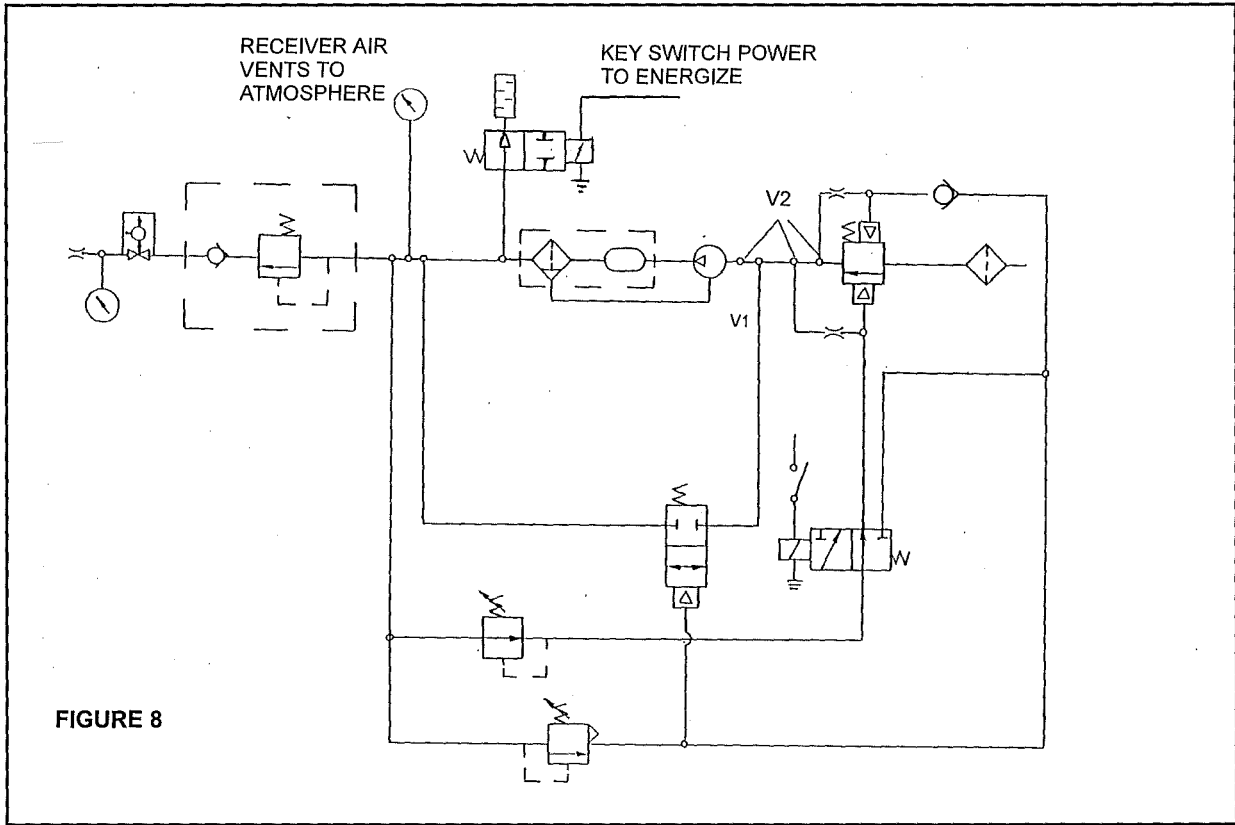


FIGURE 8

This is a new valve in a normal open application. Electric power from the key switch (KS) will energize to close the drain port. It has been installed at the factory on D45KS machines since 6/1998. The solenoid part number is 017503-002 and may be fitted to all poppet inlet control systems for the shutdown (final) blowdown of receiver air pressure.

All other valve applications stay in original configuration.

Troubleshooting Single Poppet Valve Inlet Control Systems

Low pressure compressor systems that require fieldmechanical adjustments most often have either been tampered with or have worn components.

Subtractive pilot valves

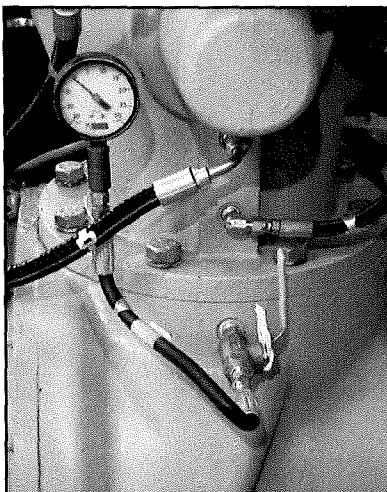
When calibrating a subtractive pilot valve small turns on the set screw make sufficient changes to the outlet air pressure. Turning the set screw in will decrease the outlet supply air value, which in turn will not let the poppet valve respond and close efficiently. The outcome will be over run of air pressure to a point of safety valve discharge air. Factory specs recommend setting the subtractive pilot valve with shop air only per views shown on page 28 of this manual.

Pressure reducing valve

When calibrating a pressure reducing valve small turns on the set screw change the outlet air pressure. Turning the set screw in will increase the outlet supply air value. It may be necessary to modify the factory pressure reducing valve setting of 50 psi to achieve a full piston opening sequence. Pressure reducing valve settings will affect vacuum readings.

Vacuum check

When testing the low pressure poppet intake system it may be necessary to connect a vacuum gauge to the compressor throat. Components shall include a ball valve, short length of hose and vacuum gauge. Close the ball valve for machine start-up and shut down modes.



VACUUM READINGS MAY DIFFER ACCORDING TO

ALTITUDE CONDITIONS ABOVE OR BELOW SEA LEVEL
CLIMACTIC CONDITIONS
COMPRESSOR CONDITION
POPPET VALVE CONDITION

READINGS SHOWN BASED AT 360 FT ABOVE SEA LEVEL

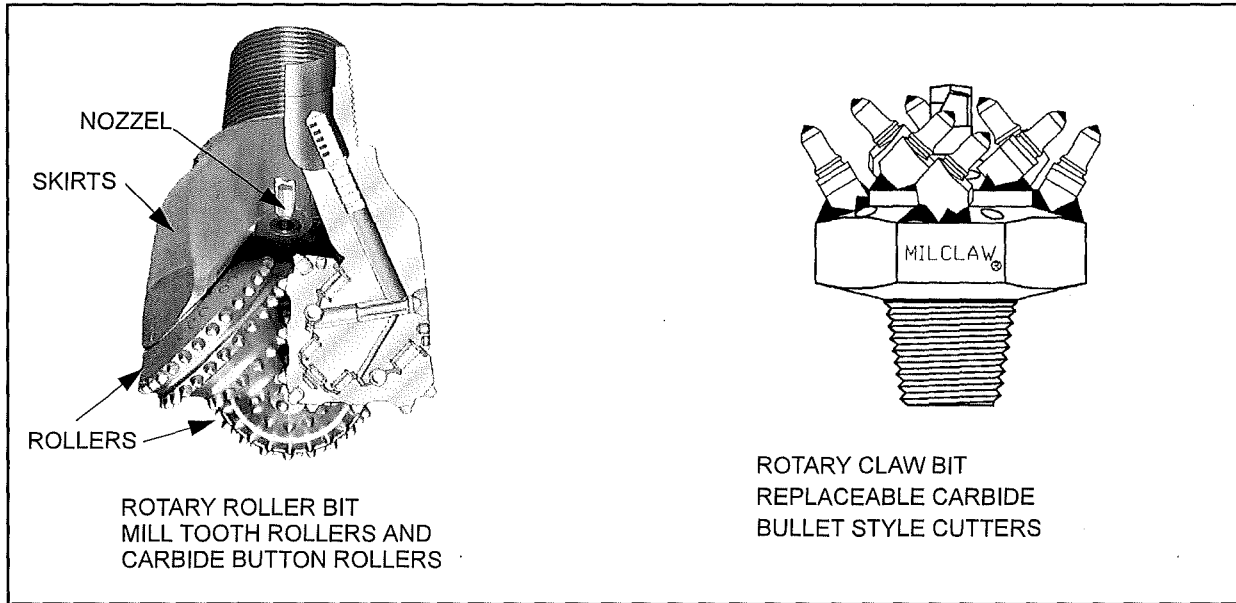
AT START-UP USING BYPASS (20 TO 22 Hg)
AT START-UP RELEASING BYPASS (8 TO 10 Hg)
AT LOW ENGINE IDLE NO LOAD (24 TO 26 Hg)
AT HIGH ENGINE IDLE NO LOAD (26 TO 28 Hg) NOT DRILLING
AT HIGH ENGINE IDLE LOADED (2 TO 4 Hg) DRILLING

Check the poppet valve oil level often. When the oil level is low the piston responds slower and receiver air pressure may overrun the regulated value. If oil levels are continually low, requiring constant refill a seal may be leaking the oil out of the piston valve chamber. This condition may give symptoms of air regulation problems as well.

During cold weather conditions ice build-up inside the poppet valve may lead to operational problems. It may become necessary to install one 022462-001 coalescing filter to the main air line. This filter is used to remove unwanted condensation that typically collects in the air components.

Drill Bit Restriction

Nozzle size or orifices in the air delivery restrict air flow. Check with drill bit manufactures for appropriate nozzle sizes for the mine specific drilling conditions.



Optimum air flushing during the drilling cycle shall be greater than 4000 fpm and up to 9000 fpm of uphole velocity.

High bailing velocity or flushing leads to excess wear on drill tools while in the hole. Drill bit skirts, roller sections, bit subs and lower sections of drill pipe may become sandblasted by abrasive rock conditions

DUAL POPPET INLETS

GENERAL

Dual poppet valves are standard equipment on all 90 series machines with air compressors 2600 CFM and larger.

DESCRIPTION

Refer to service literature 020845-001 publication for full compressor system details relative to dual poppet inlet control valves without volume controls.

The following procedures have been modified to fit training material format herein.

Refer to electrical system training module book 2 part number 023501-034 that details electric pneumatic control valves.

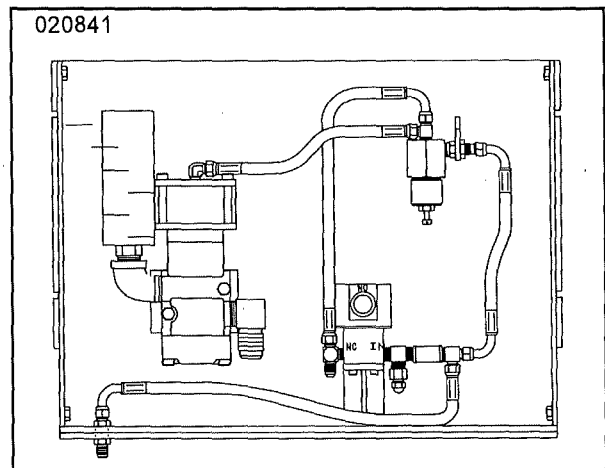
Procedures to calibrate poppet regulation valve are written and provided in this manual on page 32.

COMPRESSOR ADJUSTMENT WITH DUAL POPPET VALVES - LOW PRESSURE

1. Close the main air valve.
2. Start engine and run at low idle (1200 rpm). Air pressure should increase to unload setting 80 psi (5.5 bar) and running blowdown should be open.
3. After warm-up, increase engine speed to full rated rpm (1800 rpm). The inlet valve should be closed.
4. Adjust the needle valve on the back of the air inlet until air can be detected coming out of the muffler located below the needle valve. If compressor hunts or running blowdown valve cycles open and closed, decrease the amount of air escaping from the muffler by turning the

needle valve clockwise.

5. If the inlet valve does not close enough to maintain 80 psi (5.5 bar), then it may be necessary to set the subtractive pilot valve located in the Air Control Assembly box. To set, use a pressure regulator and shop air at 80 psi (5.5 bar) into the valve. Adjust the valve to get 20 psi (1.4 bar) at the valve outlet.



6. The flow control valve, located at the final blowdown valve on the frame, should be set by turning it clockwise until it bottoms out and then turning counter clockwise approximately 1-1/2 turn. If the system does not completely blow down when the machine is shutdown, it may be necessary to turn the flow control clockwise to hold the final blowdown valve open longer. All the air in the system will not escape and could trap approximately 5 psi (.34 bar) in the system.

7. If a compressor capacity test is to be done, open the main air valve. Set the volume control to maximum. Run capacity test. Note: Capacity test must be run with main air valve totally open and the proper size downstream orifice installed.

Optional Variable Volume Control

1. The Variable Volume Control should be tested when the Compressor Capacity test is run.
2. With the Pressure Regulator completely open (counter-clockwise), the compressor should achieve the rated CFM.
3. Turn the valve clockwise approximately three (3) turns. The gauge should read 5 psi (.34 bar) and the inlet vacuum should be approximately 8.5" HG. The capacity should be approximately 2100 CFM.
4. Turn the valve clockwise approximately one (1) more turn to achieve 7 psi (.48 bar) on the gauge. The inlet vacuum should be approximately 13" HG. and the capacity should be approximately 1600 CFM.

START UP

To reduce parasitic load to a minimum on start-up, the compressor should not be trying to compress air. Therefore, the poppet valves must be closed to limit the entry of air to the compressor.

Bypass Solenoid (N.C.)

Normally closed bypass solenoid is energized from the bypass toggle switch during machine start-up. Air pressure passes through restriction partially closing the inlet control valves to reduce air volume delivery and parasitic load during machine start-up.

Poppet Valves

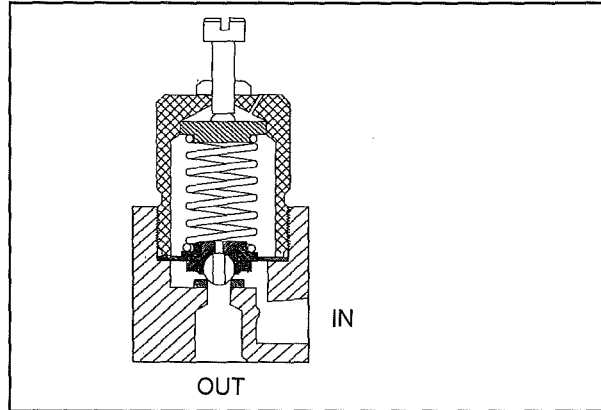
Initially, the poppet valves open slightly due to the vacuum created by the compressor rotor screws. The bypass solenoid routes air pressure to hold the poppet valves closed during machine start-up mode only. Small air will bleed through the needle valve and vent muffler.

Needle valve

Adjustment of this valve to be 1/8 to 1/4 turn

open (3 or 4 on the dial) is essential for proper poppet valve control.

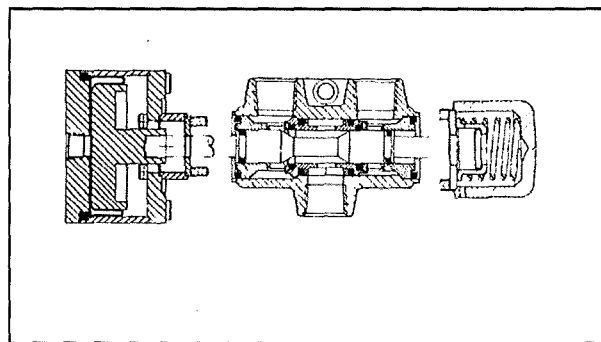
Subtractive Pilot



Remains closed during start-up, opens with receiver tank pressure to close the dual poppet valves.

Running Blowdown

Receives a pilot signal to open from the bypass solenoid during machine start-up and once again when the subtractive pilot valve opens. Air shall vent to atmosphere through a muffler when the running blowdown valve has a active pilot signal.

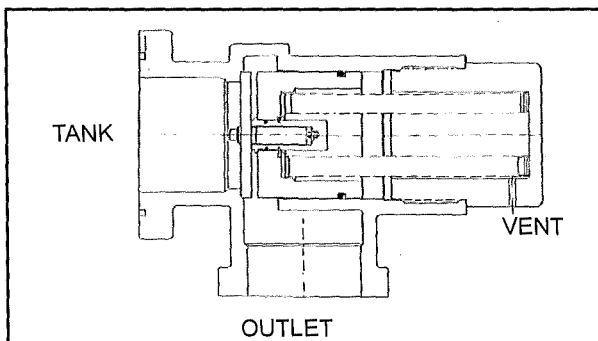


Final Blowdown

Closed during machine run mode. No air shall vent through the muffler to atmosphere.

Minimum Pressure Valve

Closed when receiver air pressure is less than 50 psi (3.5 bar). Opens when receiver air pressure is greater than 50 psi (3.5 bar) to allow down stream air delivery.



RUNNING - COMPRESSOR LOADED (AIR ON TO DRILL A HOLE)

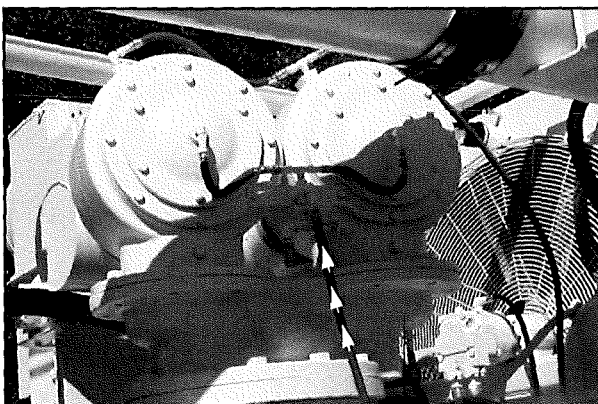
The main requirement here is for a rapid build up of air to achieve system air pressure in the shortest possible time. Therefore the poppet valve should be fully open.

Bypass Solenoid

Remains closed during machine run mode.

Poppet Valves

Opens to load the compressor without air pressure from the subtractive pilot valve. Air has to vent out of the needle valve muffler during compressor load condition.



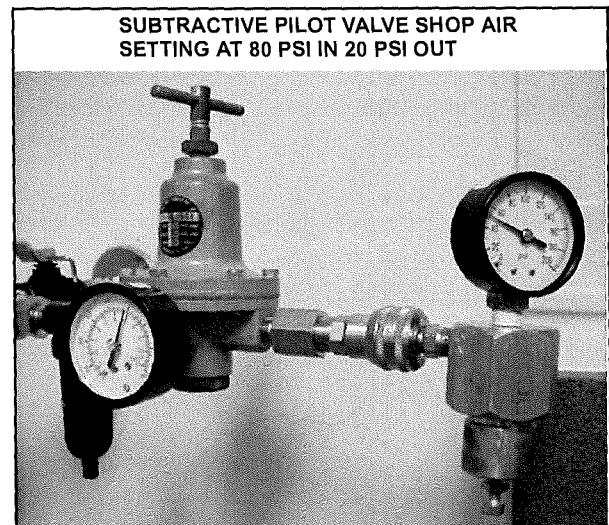
Needle valve

Air pressure drains to atmosphere through the vent muffler and shall not be continual passing during a compressor loaded condition.

Adjustment of this valve to be 1/8 to 1/4 turn open (3 or 4 on the dial) is essential for proper poppet valve control.

Subtractive Pilot Valve

Is closed when air receiver pressure is less than 80 psi (5.5 bar). When the receiver air pressure rises to the setting or 80 psi, it opens a reduced air pressure will close the inlet valves.



Running Blowdown

Has no pilot signal from the subtractive pilot valve. Blowdown valve is closed, no air shall be venting through the muffler to atmosphere.

Final Blowdown

Closed during machine run modes. No air shall vent through the muffler to atmosphere.

Minimum Pressure Valve

Opens while receiver air pressure is greater than 50 psi (3.5 bar), allowing air flow to the drill pipe and drill bit.

Gardner Denver compressor unit

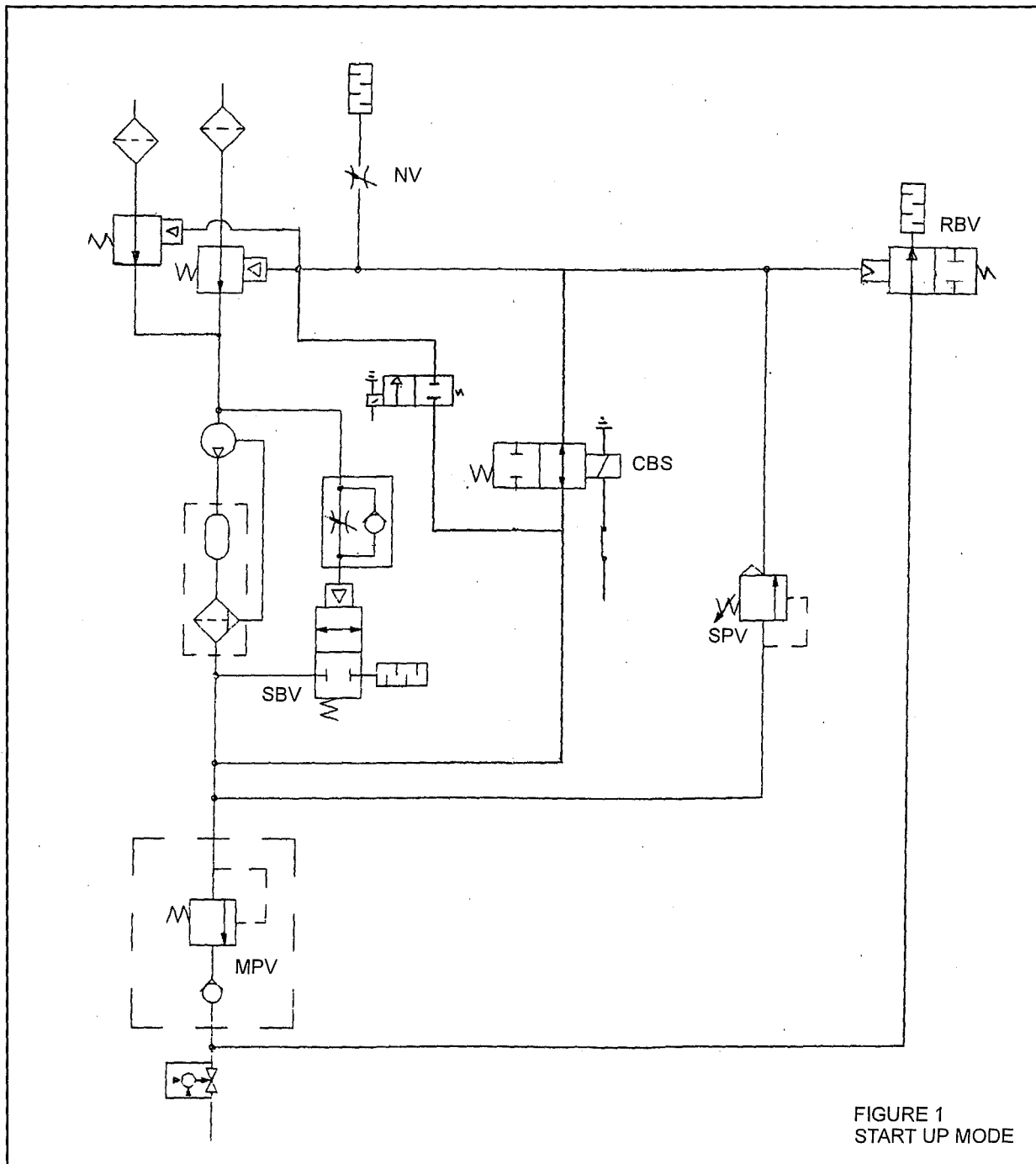
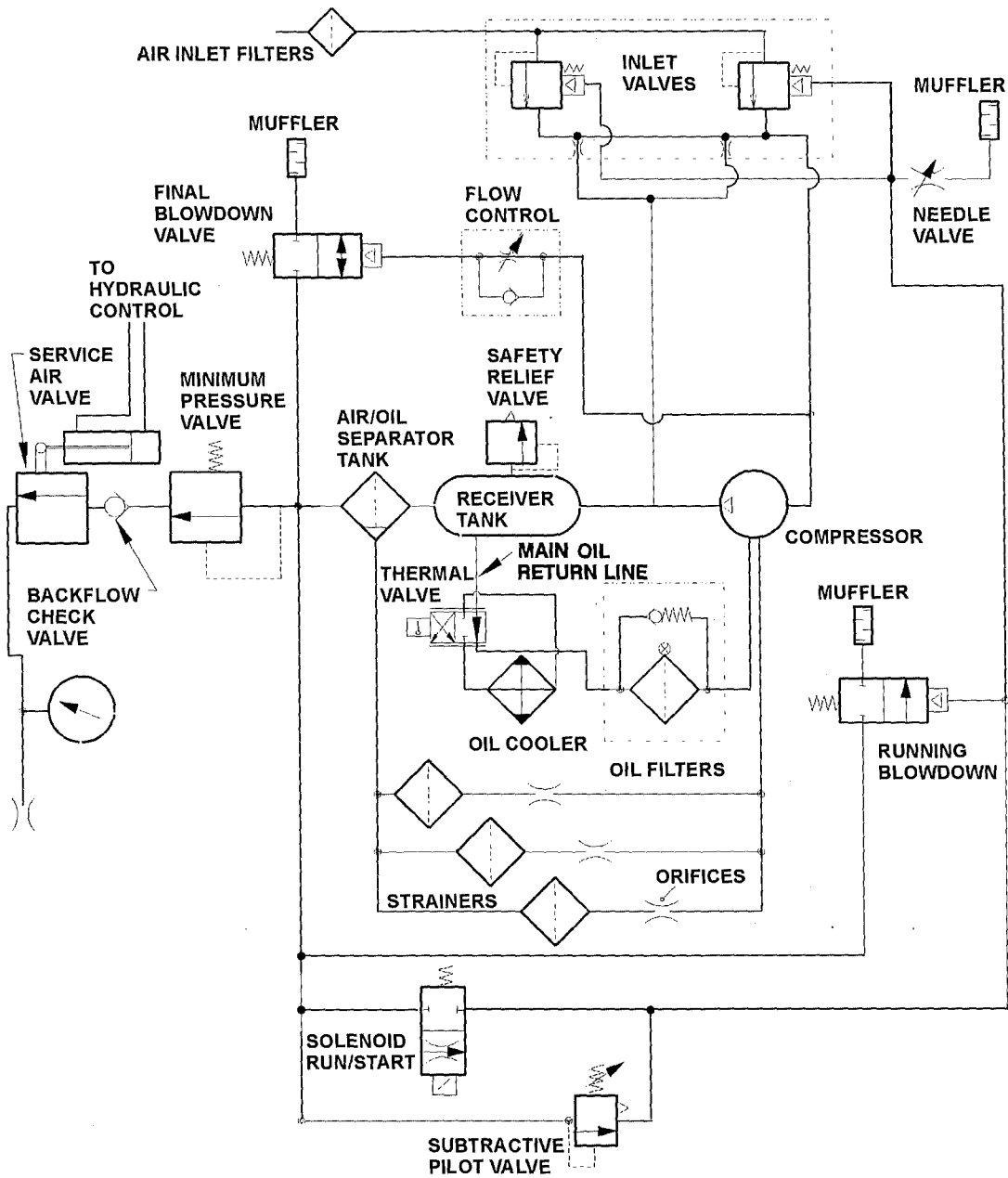


FIGURE 1
START UP MODE

This application is a Gardner Denver compressor unit with dual Gardner Denver inlet valves. The machine application is 1190E models.



21953D
5-11-07

This application is a Sullair 32 series compressor unit with dual poppet inlet valves. The machine applications are: D90KS, D90KSP, 1190D and 1190DSP models.

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VOLUME CONTROLS

GENERAL

Air inlet variable volume limiting options may be fitted to most compressor intake mechanism. This option may be factory mounted or added after-market as a field installation package.

ADJUSTMENTS

There are simple adjustable and technical electronic components. This section will detail the specific components one by one.

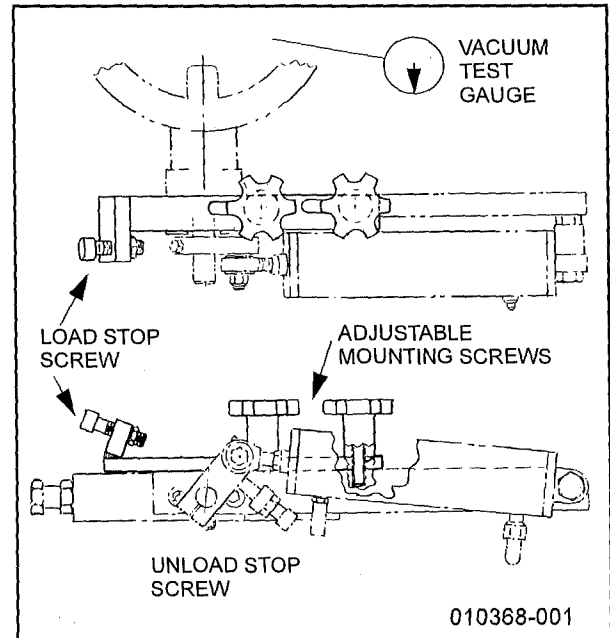
- Single poppet inlet valve volume control (1 limiting) air regulation
- Single poppet inlet valve volume control (2 limiting) air regulation
- Dual poppet inlet valves volume control (1 limiting) air regulation
- Dual poppet inlet valves electronic variable volume control
- Butterfly inlet valve electronic adjustable volume control
- Butterfly inlet valve mechanical adjustment volume control

A butterfly inlet valve will be limited on its opening value with a mechanical stop. Adjustments are necessary when installing this application.

Test equipment required:

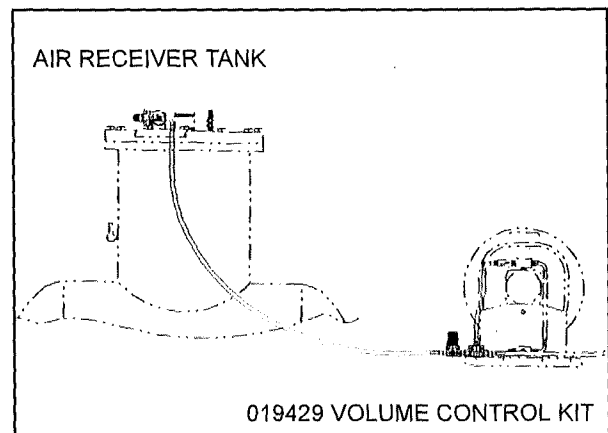
- Vacuum Gauge
- Adapter, Connection Hose
- 9/16 (15mm) Wrench
- Ambient Temperature Gauge

Mechanical Adjustment Type Volume Control Mounted On A Butterfly Inlet Valve.

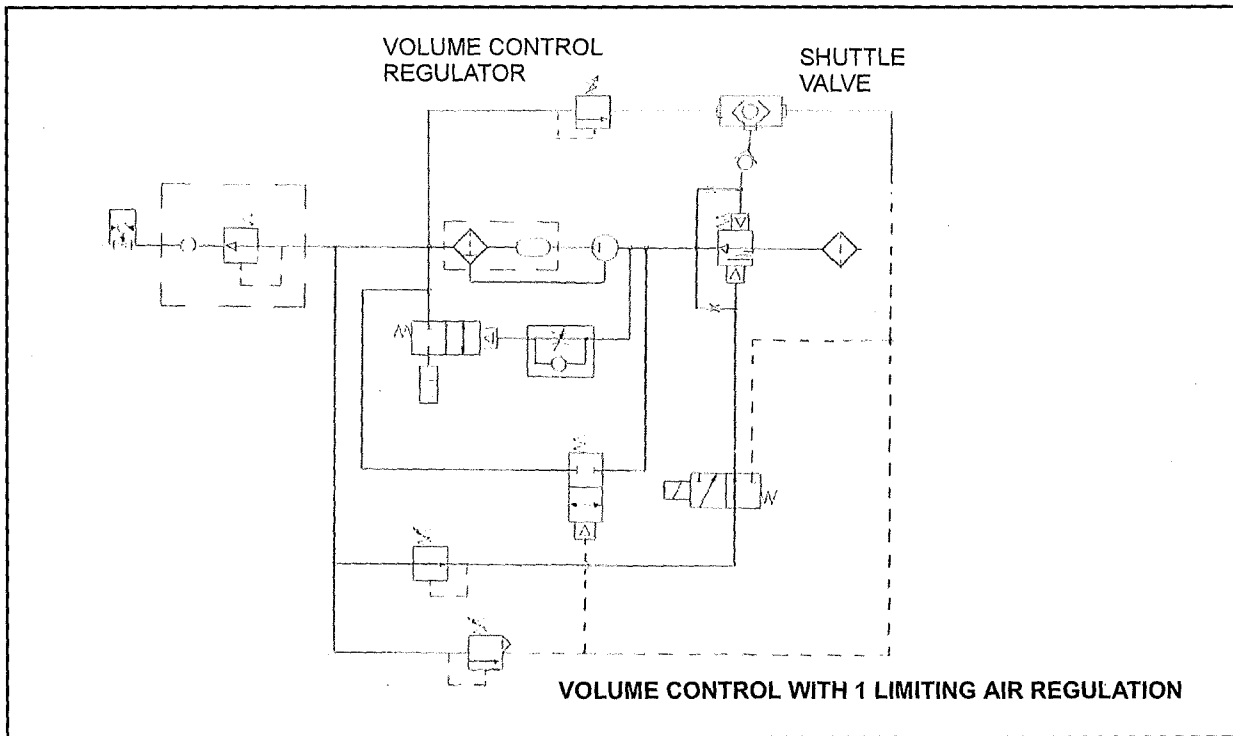


The 010368-001 tool limits the compressor inlet thus limiting the compressor output. The effect is approximate 0 to 30% lower efficiency.

1 Limit Air Regulation For A Single Poppet Inlet Valve



The single poppet inlet control valve will be limiting the compressor load open position. Reduced air pressure will be delivered into the P1 port restricting the poppet piston opening stroke.



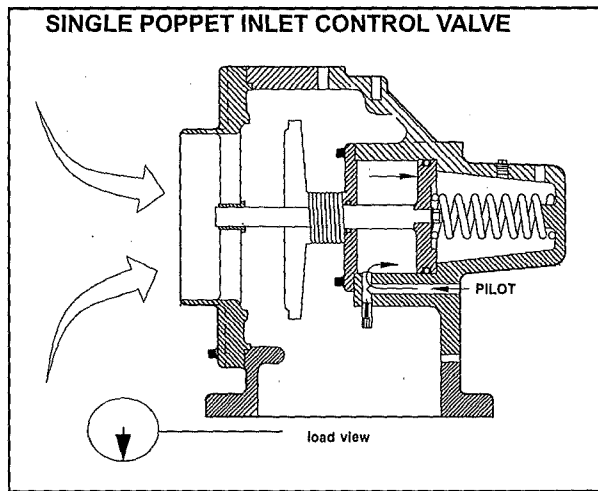
Air regulation remains the same from the subtractive pilot and pressure reducing (bias) regulators.

The volume control air regulator is bracket mounted on the compressor inlet valve. The normal closed regulator may be set between 65 and 95 psi (4.5 to 6.5 bar).

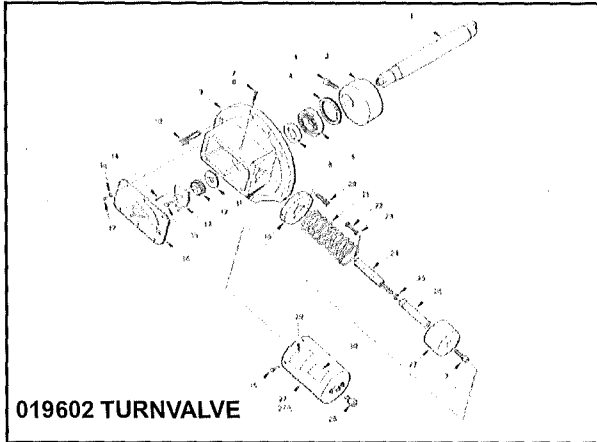
The volume control regulated pressure will fill the P1 piston end of the poppet inlet valve to limit the opening stroke.

With a vacuum gauge installed on the compressor throat, the piston position may be calibrated between 08 hg through 27 hg.

A 3 port shuttle valve at the P1 port allows the greatest air pressure to closed the poppet inlet valve for compressor unload conditions.



Sandvik Mining and Construction 90 series equipment that use the Sullair 2600 CFM compressor units are configured with a pilot piston connected to linkage and shaft positioned on the compressor housing.



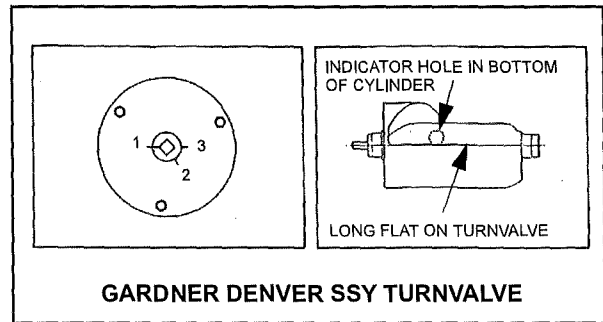
The Sullair turnvalve is controlled by receiver air pressure during machine start up, low idle and high idle operation modes.

When the turnvalve is at full actuation, compressor volume is 60% output capacity. The reduced output translates to horsepower which aids diesel engine start and low idle modes.

When the drill operator turns the drilling air on, volume output increases according to the operator station adjustable volume control selector.

The operating description is explained in the turnvalve assembly variable volume control section of this manual.

Our 1190E series equipment that use the Gardner Denver 3000 CFM compressor units are configured with a SSY turnvalve as a component of the compressor housing.



Maximum CFM is obtained with the turnvalve adjusting screw index mark aligned with the number 1 on the locking plate.

When the turnvalve is in the number 1 position the indicator hole in the bottom of the turnvalve cylinder should be positioned to be tangent with the long flat on the turnvalve.



Do not insert fingers into the indicator hole. use a slender rod or a mirror with proper lighting to determine position of the turnvalve.

Three positions are applicable with the Gardner Denver turnvalve.

- position 1 equals 100% efficiency
- position 2 equals 77% efficiency
- position 3 equals 64% efficiency

Adjustment to the turnvalve should be performed with the machine in the off position, without a compressor load and no air pressure present inside the air receiver tank.

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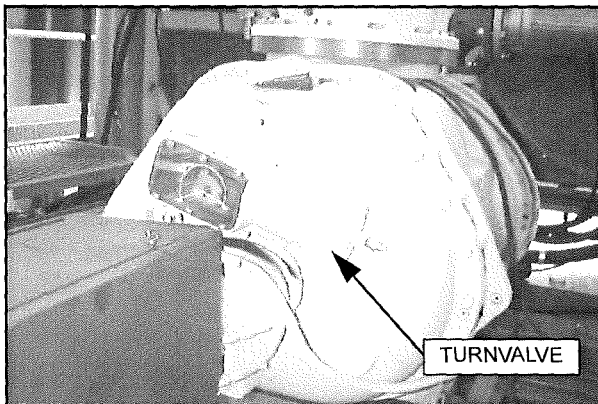
TURNVALVE ASSEMBLY VARIABLE VOLUME CONTROL

GENERAL

Our 90 series machines have the option of a factory installed variable volume control kit as part of the compressor manufacturer installation.

DESCRIPTION

A single piston with linkage controls are positioned on the shaft end of the compressor housing.

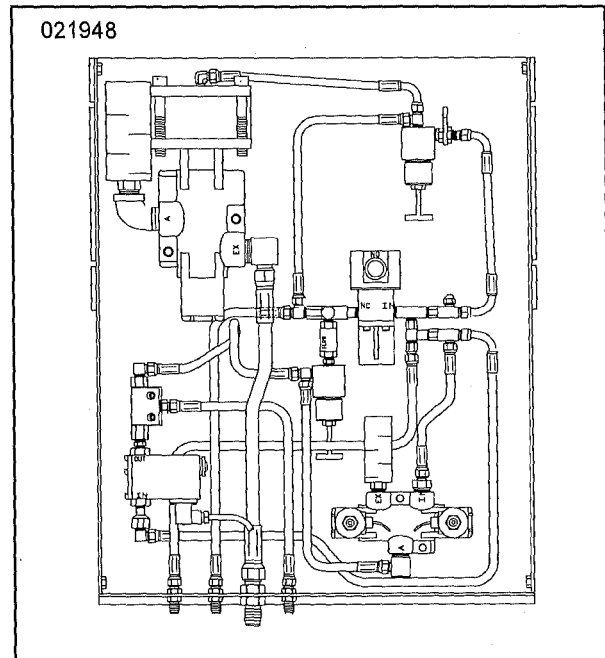


Operators may control the volume with a electronic control from inside the operator cabin.

Refer to service literature 019602-052 publication for full compressor system details. Service literature 019602-052 publication has been modified to fit training material format herein.

The Turnvalve is used to vary the volume of the compressor from its maximum rated value to approximately 50% of maximum. It does this with an internal valve that can have a controlled opening depending on what pressure is applied to the valve. As increasing pressure is applied, the turnvalve progressively opens a port connecting the compression chamber to the com-

pressor inlet allowing some of the intake air to return to the inlet before compression begins. This has the effect of reducing the length of the rotors.



The system used to control the turnvalve position depends on whether working air is required or not. (Compressor loaded or unloaded). When the main valve is closed, no working air required, the turnvalve will be at minimum CFM.

This is accomplished through the use of a three way, two position solenoid operated valve. With the main valve closed regulated air pressure is ported to the turnvalve and reduces the volume to minimum.

Air pressure is applied to the compressor inlet valves to unload the compressor, reducing the tank pressure to approximately 35 psi (2.4 bar). When the main valve is opened an electrical signal is sent to the two way valve causing it to shift which then directs air pressure through a pressure regulator valve before the air pressure gets to the turnvalve.

Regulating this valve between 0 and 18 psi (0 and 1.24 bar) will regulate the compressor volume from maximum to minimum setting. At the

same time, air to the inlet valve through the unloaded pressure control valve is stopped, allowing the receiver air to go to full pressure.

The reduction of the volume, but more importantly the reduction in pressure, results in a horsepower savings when no working air is required during machine start-up, idle, propel and leveling modes and drill pipe changes.

COMPRESSOR ADJUSTMENT WITH TURN-VALVE - LOW PRESSURE APPLICATIONS

1. Close the main air valve.
2. Start engine and run at low idle (1200 rpm). Air pressure should increase to unload setting 35 psi (2.4 bar) and running blowdown should be open. The turnvalve should be at minimum setting reducing the output CFM.
3. If the unloaded pressure does not maintain 35 psi (2.4 bar), the unloaded pressure control valve located in the air control assembly box will have to be calibrated. Use a pressure regulator with shop air of 35 psi (2.4 bar) connected to the valve inlet port. Adjust the valve to get 20 psi (1.4 bar) at the outlet port. After the main air valve is opened and then reclosed, the unloaded pressure will fall to approximately 40 psi (2.75 bar) and then slowly return to 35 psi (2.4 bar).
4. After warm-up, increase engine idle to the full rated speed (1800 rpm). The inlet valve should be closed and the turnvalve at minimum setting.
5. Adjust the needle valve on the back of the air inlet until air can be detected coming out of the muffler located below the needle valve. The receiver pressure will be approximately 35 psi (2.4 bar). If compressor hunts or running blowdown valve cycles open and closed, decrease the amount of air escaping from the muffler by turning the needle valve clockwise. Receiver pressure will remain at 35 psi (2.4 bar).
6. Open the main air valve. Turnvalve should

be partially to totally open and receiver pressure should be 50 psi (3.5 bar) minimum pressure. The volume is dependent on where the variable volume control in the cab is set. Adjust the variable control in the cab and check that turnvalve position is controlled minimum to maximum.

7. If the inlet valve does not close enough to maintain 80 psi (5.5 bar), then it may be necessary to set the subtractive pilot valve located in the Air Control Assembly box. To set, use a pressure regulator and shop air at 80 psi (5.5 bar) into the valve. Adjust the valve to get 20 psi (1.4 bar) at the valve outlet.

8. The flow control valve, located at the final blowdown valve on the frame, should be set by turning it clockwise until it 'bottoms out' and then turning counter clockwise 1-1/2 turns. If the system does not completely blow down when the machine is shutdown, it may be necessary to turn the flow control clockwise to hold the final blowdown valve open longer. All the air in the system will not escape and could trap approximately 5 psi (.34 bar) in the system.

9. Close the main air valve. The receiver pressure should drop to approximately 40 psi (2.75 bar) and slowly return to 35psi (2.4 bar) and the turnvalve should be at the minimum setting.

10. If a compressor capacity test is to be done; open the main air valve, and set the volume control turnvalve to maximum. Run the capacity test.

NOTE!

A capacity test must be run with main air valve totally open and the proper size downstream orifice installed.

Compressor components applicable to low pressure dual poppet inlet valves with the variable volume control option.

START UP

To reduce parasitic load to a minimum during machine start-up the compressor intake can be restricted during initial compression cycle. The poppet valves will be held partially closed, limiting the entry of air to the compressor intake.

Bypass Solenoid (N.C.)

Normally open, the bypass solenoid is energized during machine startup. Air pressure passing through restriction partially closes the inlet control valves to reduce the air volume delivery.

Poppet Valve

Initially, the poppet valve will open slightly due to the vacuum created by the compressor rotor screws. When receiver air pressure built to approximately 35 psi (2.4 bar), the unloaded pressure control valve opens, enabling air pressure to close the inlet valves. Small air will bleed through the needle valve muffler.

Needle Valve

Adjustment of this valve to be 1/8 to 1/4 turn open is essential for poppet valve control.

Subtractive Pilot

Remains closed during start-up.

Running Blowdown

Pilots open as the unload pressure control valve opens. Air will vent to atmosphere through a muffler to control the receiver air pressure to approximately 35 psi (2.4 bar).

Final Blowdown

Closed during machine run modes. No air shall

vent through the muffler to atmosphere.

Minimum Pressure Valve

Closed when receiver air pressure is less than 50 psi (3.5 bar). Opens when receiver air pressure is greater than 50 psi (3.5 bar).

QBI - Regulator

No function.

Three Way Valve (N.O.)

Solenoid is energized through the idle run toggle switch. Air passes to the unloaded pressure control valve and the double check valve to maintain minimum turnvalve setting and receiver air pressure at approximately 35 psi (2.4 bar).

Turnvalve

Is held to minimum setting for low volume air delivery when the three way valve is energized.

RUNNING - COMPRESSOR LOADED (AIR ON TO DRILL A HOLE)

The main requirement is for a rapid build up of air to achieve system air pressure in the shortest possible time. Therefore, the poppet valve should be fully open.

Bypass Solenoid

De-energized and closed during run mode.

Poppet Valve

Full open in a loaded condition.

Needle Valve

Air pressure drains to atmosphere through the vent muffler and shall not be continual passing during a compressor loaded application.

Subtractive Pilot Valve

Is closed when receiver air pressure is less than 80 psi (5.5 bar). When the receiver air pressure rises to the setting or 80 psi (5.5 bar) a reduced air pressure will close the inlet valves.

Running Blowdown

Has no pilot signal from the subtractive pilot valve. Blowdown valve is closed, no air shall be venting through the muffler to atmosphere.

Final Blowdown

Closed during machine run modes. No air shall vent through the muffler to atmosphere.

QBI - Regulator

Supplies reduced air pressure at a various rate to the turnvalve thru a double check valve. Operators control the QBI regulator. This regulates the turnvalve opening and compressor volume delivery.

Three Way Valve

De-energized to close so that no air is delivered to the unloaded pressure control valve or the turnvalve. (QBI exception)

Minimum Pressure Valve

Open while receiver air pressure is greater than 50 psi (3.5 bar) allowing air flow to the drill pipe and drill bit.

Drill Bit Restriction

Nozzle size or orifices in the air delivery restrict air flow. Check with drill bit manufactures for appropriate nozzle sizes for the mine specific drilling conditions.

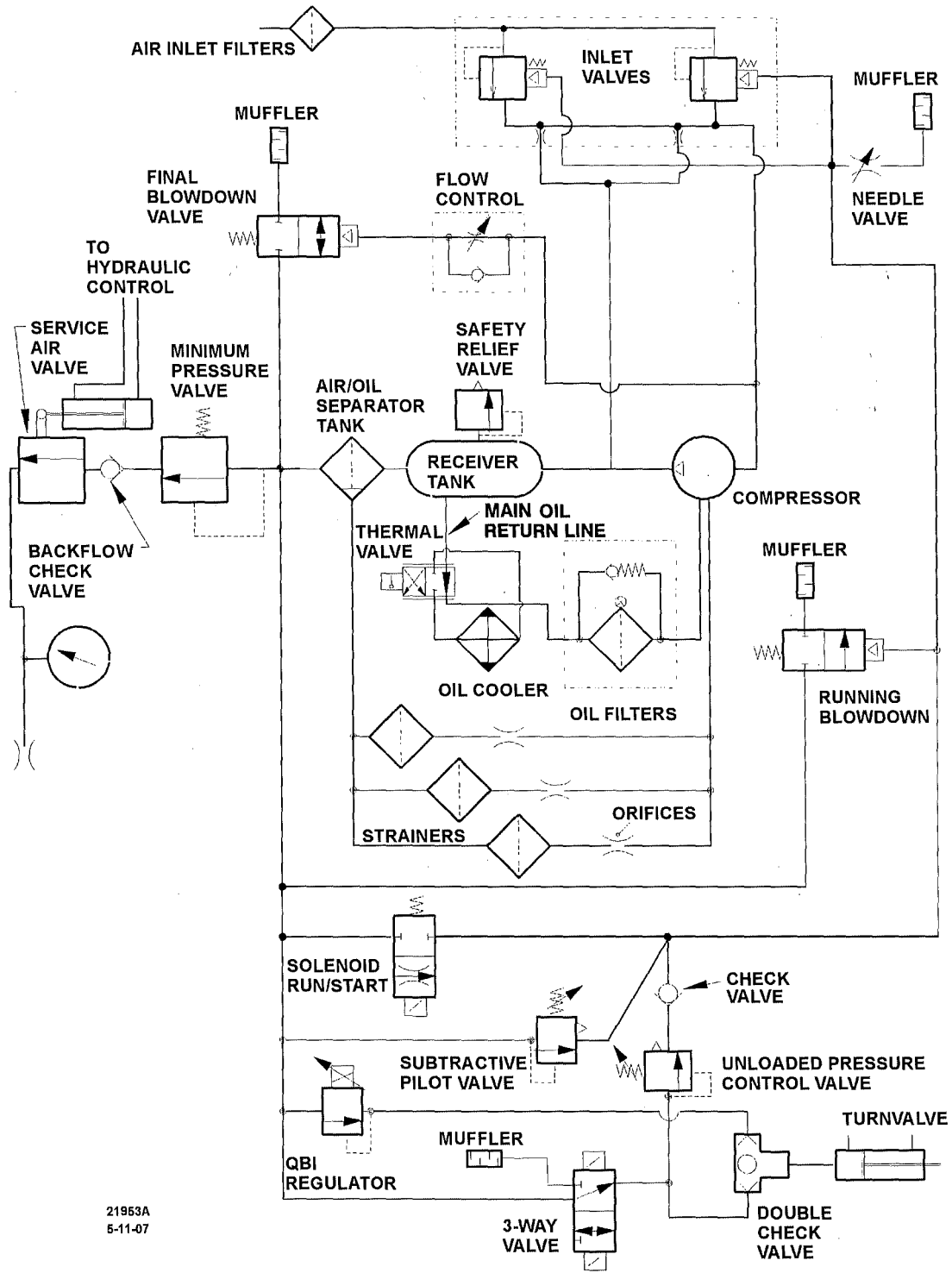
Optimum air flushing during the drilling cycle shall be greater than 4000 fpm and up to 9000 fpm of uphole velocity. Refer to charts provided in the Introduction to blasthole drilling manual (023501-012).

Vacuum tests as they apply to volume configuration.

Numbers quoted are based at sea level conditions and require altitude correction factors pertinent to specific altitude and climactic conditions.

Numbers quoted reflect a new 2600 cfm factory installed air compressor using two inlet control valves operating at the machine specific engine rated high idle speed.

COMPRESSOR OUTPUT	VACUME READING
2674 CFM	-1.0 HG
2519 CFM	-4.6 HG
2128 CFM	-8.6 HG
1634 CFM	-13.0 HG



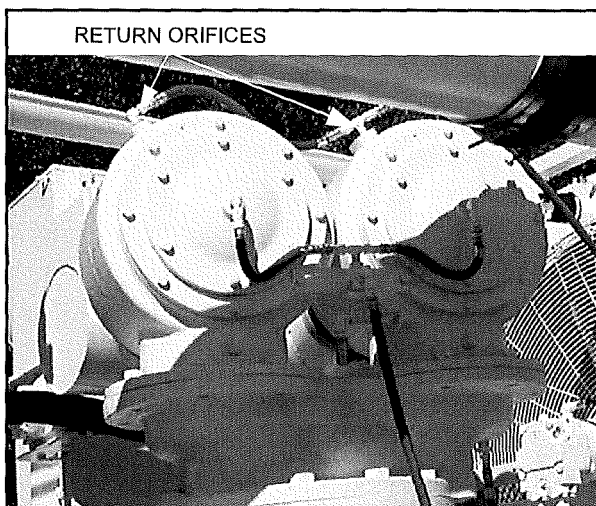
21953A
5-11-67

The dual poppet valve on D90KS and 1190D machines is opened with vacuum when the compressor begins to turn.

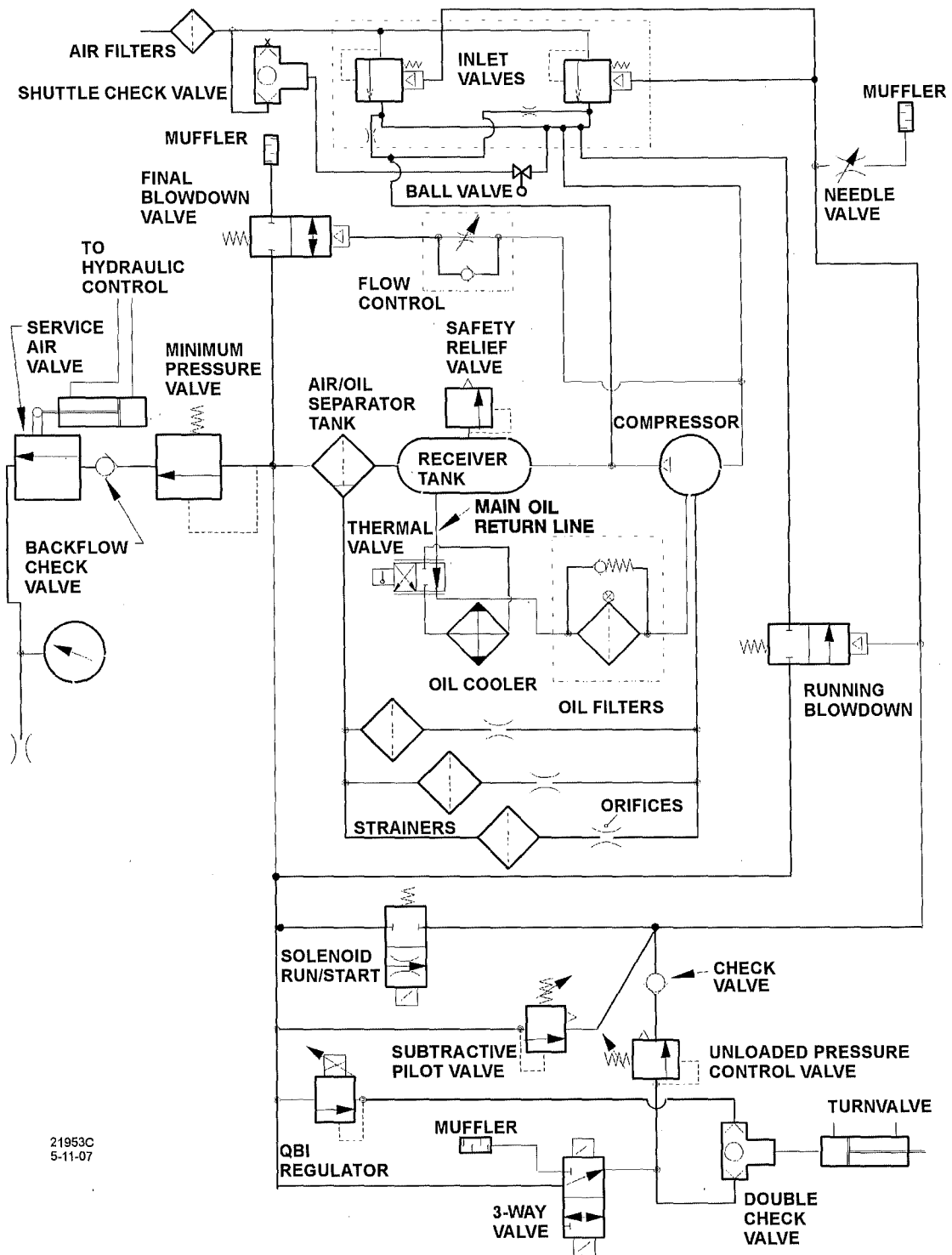
Poppet valves close during start up as air is directed through the compressor bypass solenoid.

Poppet valves close during standby when the subtractive pilot valve opens at regulated pressure.

When the poppet valve is closed vacuum should not exceed 26" Hg. A supply hose from the compressor discharge returns air to the poppet valve and compressor inlet through orifices to maintain 26" Hg.



Excess air blows to atmosphere through the running blowdown valve.

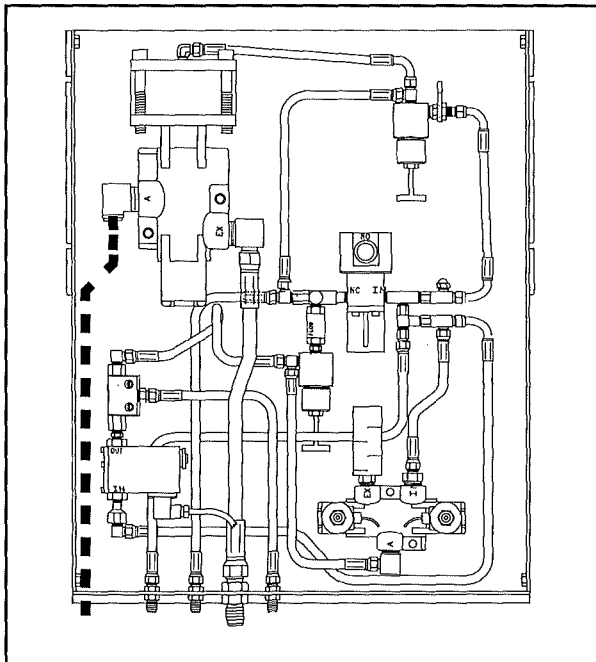


21953C
5-11-07

Compressor vacuum greater than 26" Hg with the poppet valves closed subject the rotors and bearings to move inside the housing resulting in shortened compressor life.

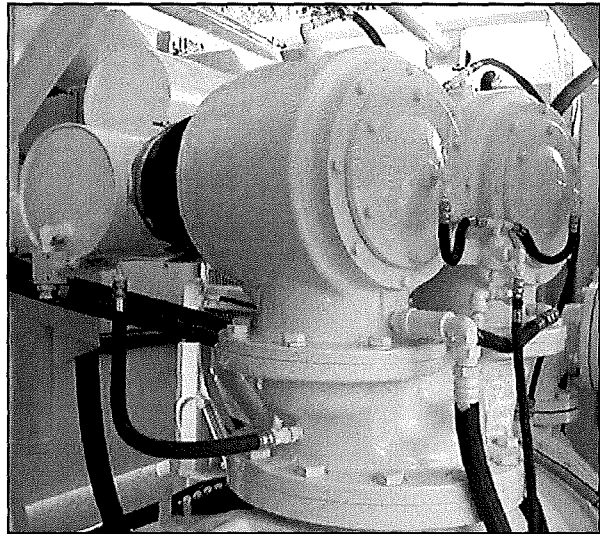
It is recommended to maintain less than 26" Hg with the compressor unloaded in all environments.

Dual poppet replenishing redirects running blow down air discharge to recirculate to the compressor inlet.



Redirecting the running blowdown valve to the poppet inlet assures appropriate vacuum when the poppet valves are closed.

A ball valve and check valve arrangement on the compressor inlet and air filter piping allow for variable inlet vacuum calibrations according to machine options.



A ball valve and check valve arrangement on the compressor inlet and air filter piping enable inlet vacuum calibrations according to machine options.

Dust collector filter cleaning and lubrication systems air pump require air to operate the components.

Open the ball valve to meet the required air consumption of the dust collector and lubrication system. Filtered air is introduced through the closed poppet valve.

ROTARY DRILLING

GENERAL

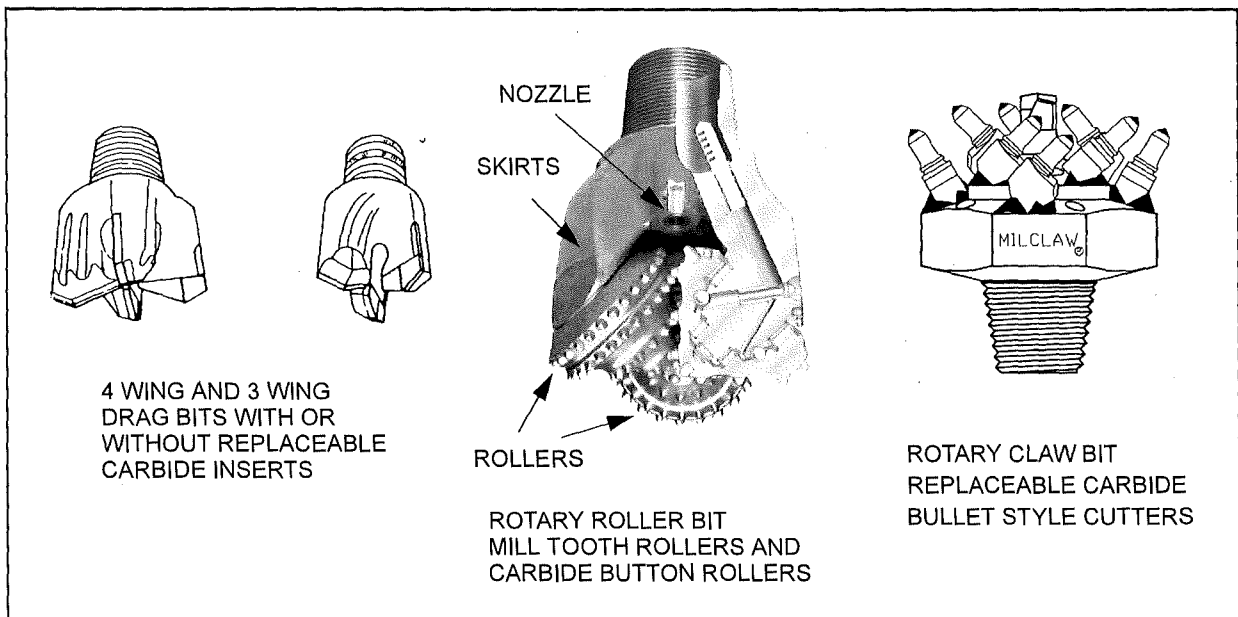
Drill bits are consumable items attached to a drill string and utilized to advance the drill string into earth formations for the purpose of making a blasthole or well hole. Many brand names exist in the market. It is the users choice to purchase the best bit to optimize drill production in the mine specific ground conditions.

DESCRIPTION

Principals of rotary drilling are quite simple. There are three main elements, air delivery, rotation speed and torque and lastly feed force otherwise known as pulldown. The volume of air and the operating pressures are essential for a successful blasthole.

DRILL BITS

The three most common rotary drill bits are the 3 and 4 wing drag bit, the roller or tri cone bit and the claw type drill bits.



Each application drill bit type by manufacture is designed with limitations. The limitations could be rotation speed, feed force and air flushing. Bit manufactures design variations to with stand and perform in differing strata.

Air Delivery

Optimum drill cutting removal is based on proper drill pipe diameter in relation to drill bit diameter (hole size). Annular area is the difference of area between the drill bit and drill pipe diameters.

ANNULUS

DRILL CUTTINGS HAVE TO EXIT THE HOLE
IN ORDER TO ENABLE THE BIT TO PENETRATE
IN THE GROUND FORMATION

AIR VELOCITY CHARTS ARE USED TO
CALCULATE BAILING AIR VELOCITY

IN GENERAL BAILING VELOCITY SHALL BE
GREATER THAN 5000 FPS (25m/s) UP TO
10,000 FPS (50m/s)

INSUFFICIENT CLEARANCE >10,000 FPS

BINDS ROTATION DURING THE DRILLING
CYCLE

CREATES RESISTANCE TO TURN THE BIT
GENERATING HIGHER TORQUE, TIGHTER
THREADS AND LESS POWER

CREATES AIR FLOW RESTRICTION AND
EASIER PLUGGING OF THE DRILL BIT

REQUIRES HIGHER FEED SYSTEM
OPERATING PRESSURES

ACCELERATES WEAR IN ABRASIVE ROCK
CONDITIONS DUE TO INCREASES UP HOLE
VELOCITY

EXCESSIVE CLEARANCE <5000 FPS

ENABLES BIT TO BE UNBALANCED IN THE
HOLE

LEADS TO HOLE DEVIATION

ALLOWS CUTTING TO FALL BACK INTO HOLE

INCREASES BIT WEAR DUE TO CUTTING
REGRIND

INCREASES BIT SUB WEAR TO CUTTING
REGRIND

REDUCES PRODUCTIVITY BECAUSE OF
CUTTING REGRIND

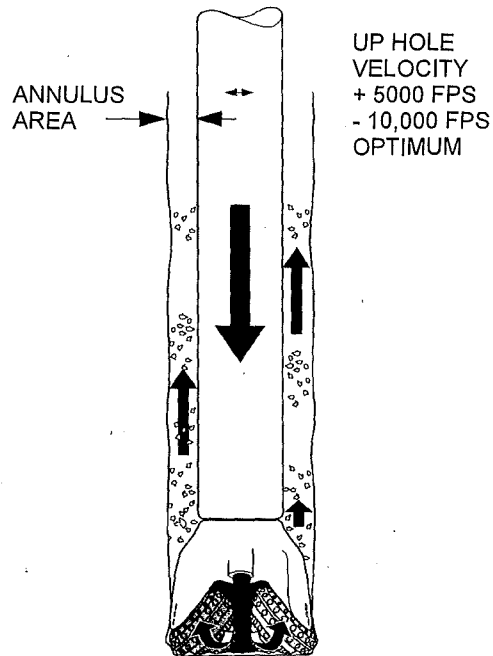


Table 1 and 2 are examples of up hole velocity. This process is used to establish a proper annulus area and sizing the drill bit, drill pipe dimension and compressor size to suit the operating condition.

Table 1: 1300 CFM COMPRESSOR 6 IN 152 MM DRILL PIPE

BIT DIAMETER	3500	4500	5500	6500	7500	8500	9500	10500	11500
9 IN 229 MM			○						
8 5/8 IN 219 MM				○					
7 7/8 IN 200 MM								○	
7 1/2 IN 190.5 MM									○

9 inch (229 mm) drill bit with 6 inch (152 mm) drill pipe = 5200 FPM uphole velocity.

8 5/8 inch (219 mm) drill bit with 6 inch (152 mm) drill pipe = 6200 FPM uphole velocity.

7 7/8 inch (200 mm) drill bit with 6 inch (152 mm) drill pipe = 10,600 FPM uphole velocity.

7 1/2 inch (191 mm) drill bit with 6 inch (152 mm) drill pipe = 11,400 FPM uphole velocity.

Table 1 is a typical D50KS low pressure application machine based on dimensions shown.

Table 2: 2600 CFM COMPRESSOR 8 5/8 IN 219 MM DRILL PIPE

BIT DIAMETER	5500	6500	7500	8500	9500	10500	11500	12500	13500
12 1/4 IN 311 MM			○						
11 1/4 IN 285 MM						○			
10 5/8 IN 270 MM								○	

12 1/4 inch (311 mm) drill bit with 8 5/8 inch (219 mm) drill pipe = 7200 FPM uphole velocity.

11 1/4 inch (285 mm) drill bit with 8 5/8 inch (219 mm) drill pipe = 10,300 FPM uphole velocity.

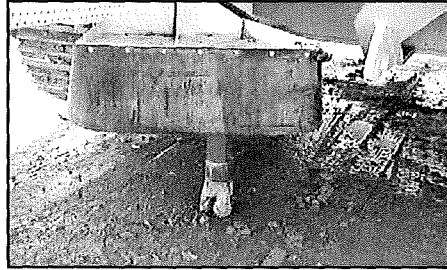
10 5/8 inch (270 mm) drill bit with 8 5/8 inch (219 mm) drill pipe = 12,400 FPM uphole velocity.

Table 2 is a typical D90KS low pressure application machine based on dimensions shown.

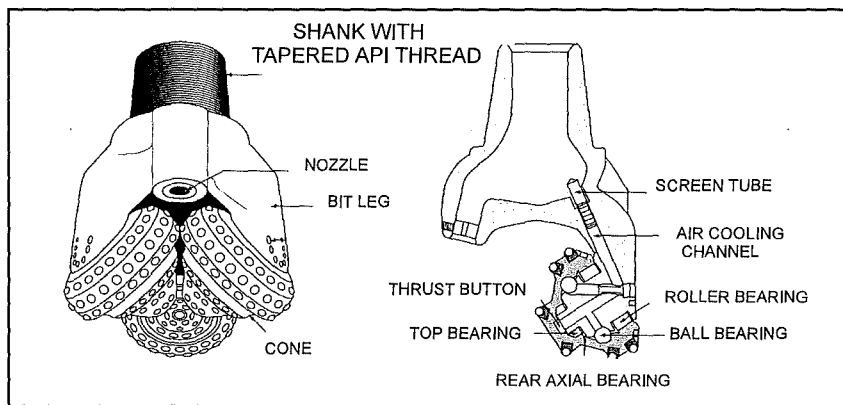
- Factor in altitude corrections as needed.
- Factor in the ground formation, density and abrasiveness of the drilled material.
- Factor in volume control.

Inspecting Drill Bits

Inspect drill bits at the beginning of each shift and as needed according to rock strata. Replace worn or damaged drill bits. Besides lost production damaged drill bits can affect rotation system components and stress the hydraulic system.



In relation to air systems the main factors are air volume and uphole velocity and working air pressure. All components must be balanced in order to optimize the drilling costs.



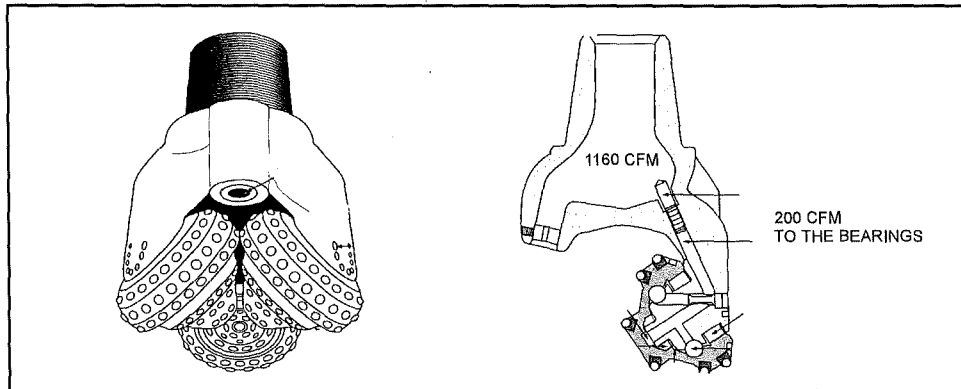
Nozzle selection is a machine specific and site specific requirement.

Nozzle Selection

Nozzles are designed to regulate high energy air at the intersection of adjacent cones to ensure removal of loose rock cuttings and direct air to the bearings for cooling and dust removal.

Careful consideration must be given as to the correct nozzle size to ensure correct operation of the drill bit.

Should the nozzle size be too large in diameter the pressure drop across the drill bit will be too small. This will result in a larger proportion of air flow being directed through the nozzles and a small proportion being directed to the bearings for cooling. Cutting material can be forced into the bearing area reducing the service life of the bearings.



If the nozzle sizes are too small in diameter the air pressure inside the drill bit will be too high causing the compressor to frequently unload resulting in poor flushing and drill performance.

Air Pressure Differential

1. Blow air to atmosphere through drill pipe and bit with nozzles. Check working air pressure gauge.
2. Blow air to atmosphere through the rotary head top sub without drill pipe and bit. Check working air pressure gauge.

Consult your local bit supplier for recommended nozzle sizes.

Adjust nozzle sizes accordingly.

Remove And Replace Nozzles

1. Clean the area around the spring pins and nozzles.
2. Drive the spring out using a 3/16 (5 mm) punch.
3. Remove nozzle from housing
4. Clean nozzle housing
5. Insert new nozzle into housing ensuring that the groove on the nozzle is aligned with the pin hole.
6. Replace spring pin ensuring that the head of the spring pin is flush with the bit surface.

AUXILIARY AIR COMPONENTS

GENERAL

Sandvik Mining and Construction blasthole drilling machines are specified to meet our customer's needs.

The following optional equipment is made available to assist the drilling or maintenance functions of most of the drill product line:

- Dry Dust Collecting Systems
- Automatic Thread Greasing System
- Hydraulic Tank Pressurization
- Automatic Lubrication Systems
- Blow Down Cleaning Attachments
- Bit Lubrication System
- Chain Lubrication System**

DESCRIPTION

Suppressing drilling dust is a mandatory part of equipment operator safety. The two available means for suppressing drill dust are:

- **DRY DUST COLLECTING** systems by way of seals, curtains, suction fan, filter media, collection box with a manual drop vent
- **WATER INJECTION** systems with seals, curtains, various water tank sizes and a water pump with relief valve.

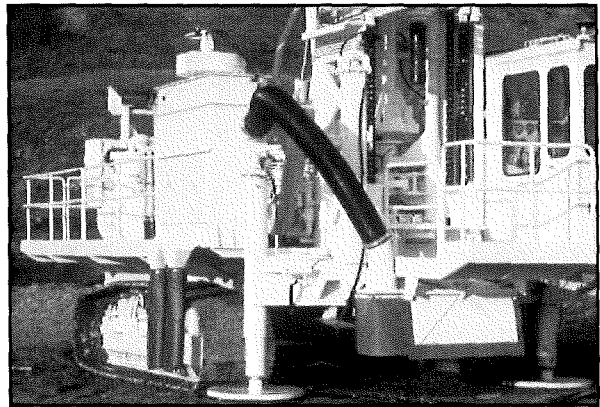
Daily and when required maintenance for either system is the responsibility of the end user.

Dry dust collection systems are one means of suppressing fine drill dust particles omitted during the drilling cycle.

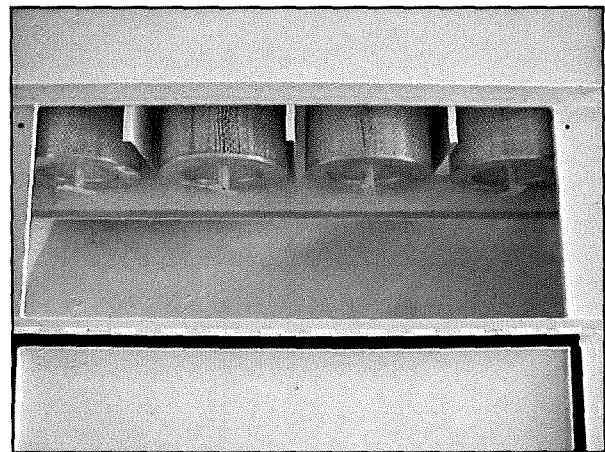
There are many sizes and styles used in the industry. The concept is common throughout.

Dust collection systems have to be tuned for the ground conditions and material being drilled. Certain applications require special attention to customize the dust collecting components. One size dust collector will not fit all applications.

Dust Collection And Dust Suppression



The typical dust collector on our machines is the Drilplex model with 4, 5, 6 or 8 elements.



Dust filters must have a good seal to the housing. Each filter must be hand tightened with a sealed wing nut.

A loose filter, bad filter seal or damaged filter element will emit dust out the fan housing. Dust

blow by will damage dust collector fan and fan housings.

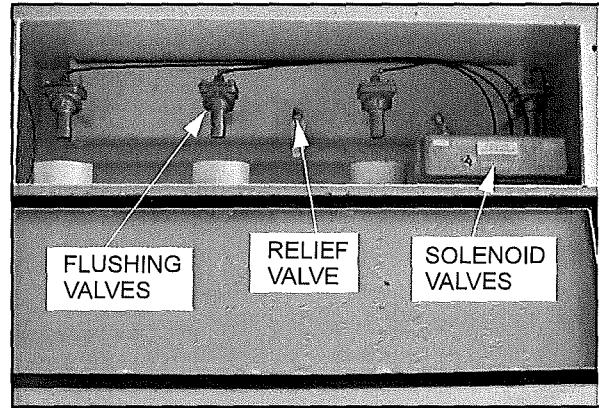
Maintain good door seals. Tighten each door to maintain adequate vacuum inside the dust collector.

The filters are purged with regulated air from the machines air system. Dust collector regulation is adjustable set to 50 psi (3.5 bar).

NOTE!

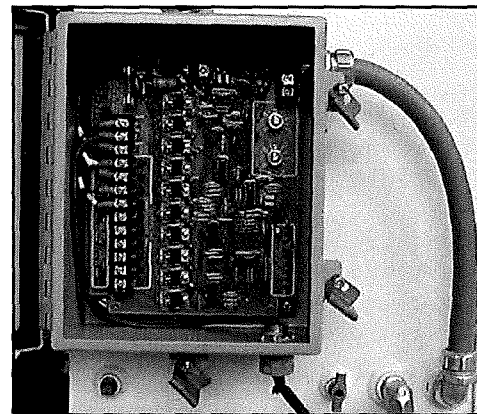
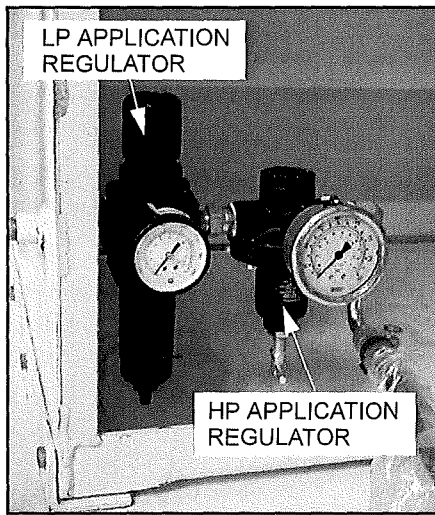
The dust collector air regulator may be backed out to zero air pressure for transportation purpose. Adjust the regulator prior to drilling and dust collecting.

Regulated air is directed to flushing valves and electric solenoids inside the dust collector.



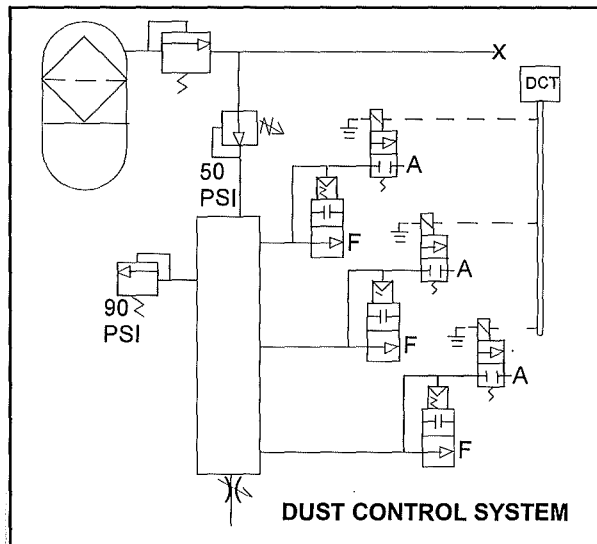
Maintain good door seals. Tighten each door to maintain adequate vacuum inside the dust collector.

Flushing valve repair kits are available. Electric power to the solenoids is a timed system by means of a circuit board.



This sealed dust collector timer junction box houses the circuit board. The timer distributes a off time and on time sequence to one filter at a time.

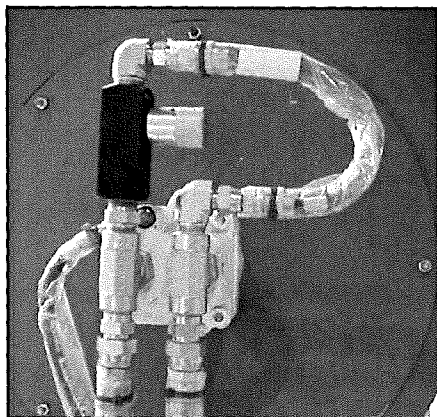
- Adjust on time to enable a quick burst of air to the dust filter. The on time shall be 300 ms.
- Adjust the off time according to material collected. Typical setting is 6 seconds off time.



The circuit board powers one solenoid and LED per flushing valve. The LED illuminates to indicate when it receives a on cycle.

Maintain good door seals. Tighten door to minimize dust and water entry.

A hydraulic motor and fan enable vacuum inside the dust collector housing. The motor speed is partially responsible for dust control.



Fan speed shall not exceed 3000 rpm. Faster fan speeds may over load the filters and not let the filters clean adequately.

Adjust the speed according to ground material.

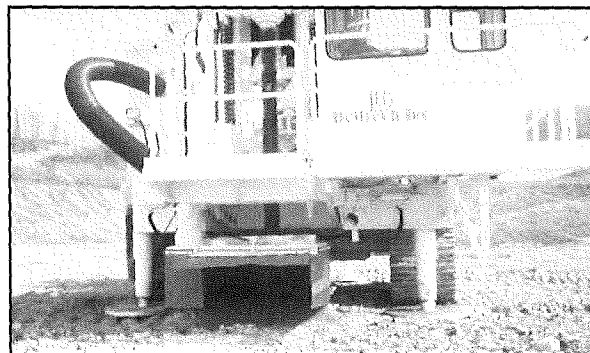
Turn the dust collector fan off between rod changes. Better filter cleaning occurs when the fan is not turning.

Dust Hood

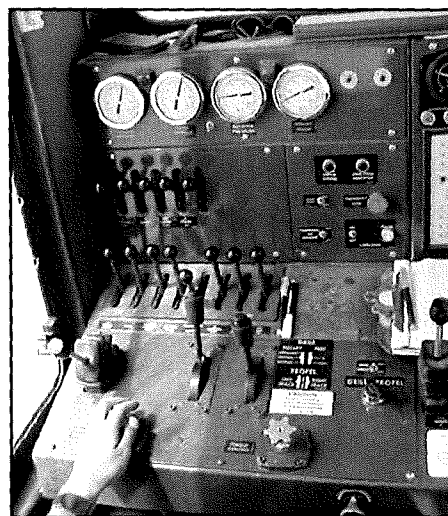
Cylinder actuated dust hoods and dust hood doors allow adequate seals for dust suppression under most drilling conditions.

Depending on application, dust skirts may need to be modified.

It may be necessary to use two dust skirts and overlap them at the corners to enable a relief for drill cutting accumulation.



Operators use a cab mounted control lever or electric switch to turn the dust collector or water injection systems on. Additional controls allow dust hood and dust hood door options.



The drill dust collecting system with fan motor speed, air pressurization, and electrical timed pulse settings are detailed in service literature 007702-000.

Automatic Thread Greasing System

The old method of operators applying thread grease to the drill pipe with a brush still exists.

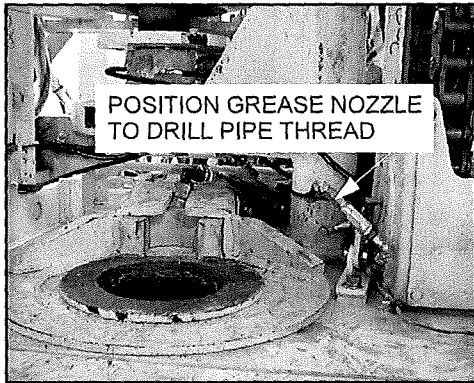
New concepts allow the operator to remain in the operator cab and still apply thread grease the drill pipe.

Special drill pipe thread grease can be pumped by air actuation through hose and adapters onto the drill pipe thread box or pin ends.

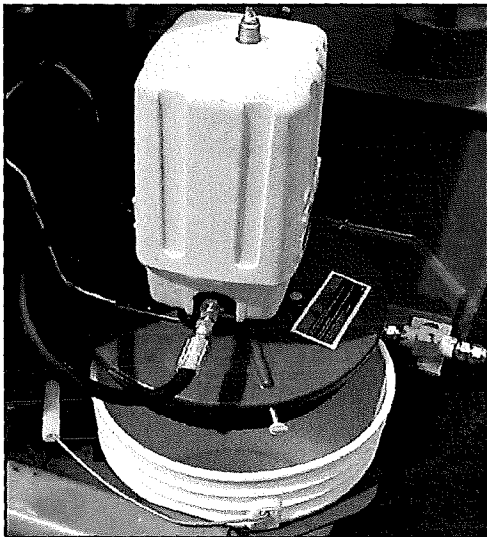
Brand name thread grease:

- Texaco Threadtex
- Kopper Coat by Jet lube
- J89 by Jet lube
- Copper - Part Number 024178-003

Metered air directs thread grease to drill pipe threads near the table bushing.



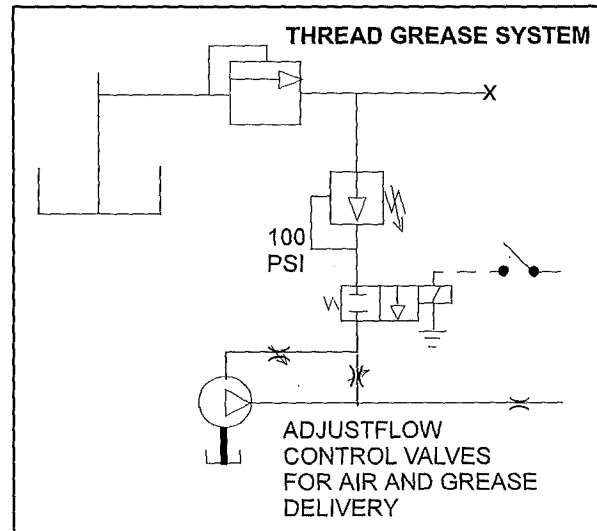
Add thread grease to the container, position the follower plate and pump into the grease and secure the container cover.



Adjustable flow control valves at this pump to meter regulated air pressure to the grease pump and to the injector nozzle located near the table bushing.

Lock flow control valve position.

Regulated air pressure for this pump is between 80 up to 100 psi (5.5 - 6.9 bar)



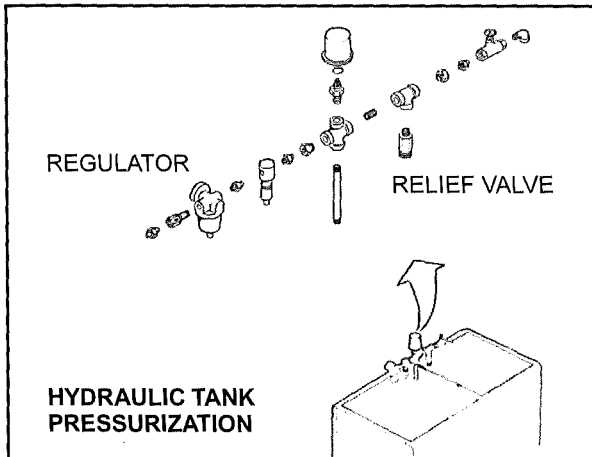
Daily and when required maintenance for the thread grease system is the responsibility of the end user.

Hydraulic Tank Pressurization

All of our blasthole products have air regulation components on the top cover of the hydraulic reservoir.

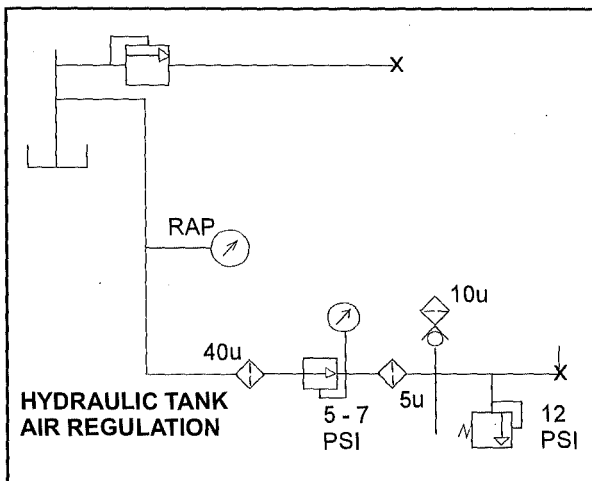
Hydraulic tank pressurization serves two main features.

- Maintain a Positive Pressure Into The Pump Inlet
- Assist In Contamination Control



Machines operating in altitudes above 4000 feet (1200 meters) will need to alter the standard air pressure spec of 5 psi (.3 bar).

Service literature 004756-000 details the adjustment setting procedure for hydraulic tank air regulation parts.



Daily, when required and 500 hour maintenance for hydraulic reservoir pressurization system is the responsibility of the end user.

When servicing the hydraulic reservoir with new oil open the ball valve to vent residual air pressure. This is recommended practice to prevent gasket or seal damage to the cover and inlet supply connections.

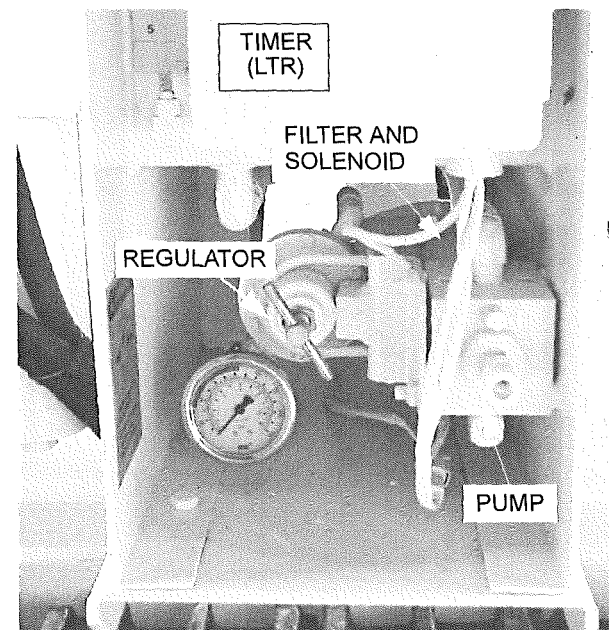
Bit Lubrication System

Low pressure application machines may be fitted with 2 sizes of reservoirs holding 10 gallon (38 liter) or 30 gallon (114 liter) of special lubricant oil referred to as rock drill oil.

When selecting an oil to lubricate bit bearings it is recommended to consider the following;

- Ambient Condition
- Operating Temperature

The lubrication cycle may be adjusted for oil quantity or flow and a timed cycle to inject. Oil is injected into the air system after the service valve.



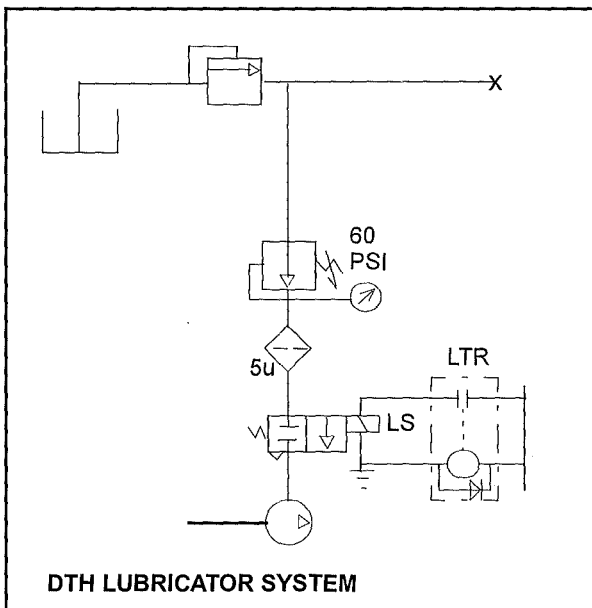
Service literature 011362-000 details the adjustments available to operator and mechanical personnel. Tune the oil injection rate to provide a fine mist or a slight visual film of oil inside the drill pipe or drill bit rollers.

With the machine running the lubricator air regulation system should be stable at 60 psi (4 bar)

Factory setting on the flow control valve is 10 turns out or 1/2 piston volume.

Lubricator timers have adjustable on and off time cycles. Timer relays are located in the lubricator junction box or cab junction box.

- *ON* cycle is the duration of time regulated air pressure is directed to the lube pump and should be set for 2 second intervals
- *OFF* cycle is the time between oil injecting and should be set for 6 to 10 second intervals



Daily maintenance is required. Use sealed and approved clean containers for transporting rock drill oils.

Contaminants inside the lubricator tank may block oil flow to the pump supply port.

Lubricator Pump 011353-000 Service Manual literature details the pump service procedures.

NOTE!

Allow adequate pump chamber fill time for the viscosity of rock drill oil being used. To fast pump cycle times will not allow some grades of rock drill oil (due to viscosity and temperature) to completely fill the pump chamber.

To fast cycle times will over load the piston springs. Spring breakage may occur which will lead to loss of oil flow to the drill bit.

During normal operating rock drill oil will be visual inside the drill pipe connections. It is normal to use 1 quarts (.95 liters) per hour of oil during the drilling cycle.

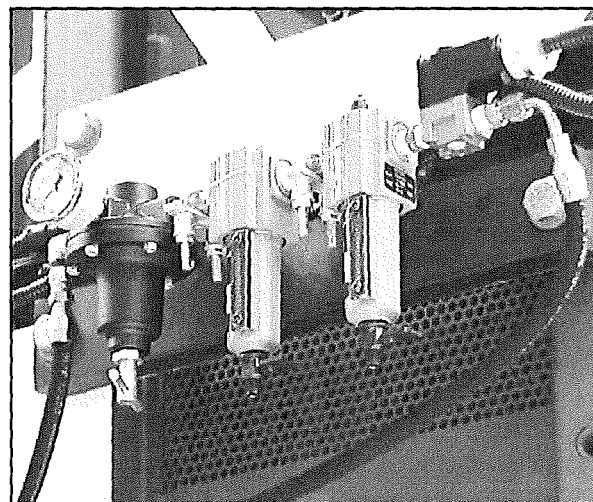
Automatic Grease System

All point lubrication grease systems are available to lubricate cylinder pins, bushings, and rotating bearings for sprockets.

Points that are not lubricated by the automatic system and require manual lubrication are:

- Rotating Drive Shaft Yoke and U-joint Assemblies
- Feed System Traveling Carrier Sprockets
- Air Swivel Joint On Rotary Head Air Piping

This system may be manual, electric or programmable.



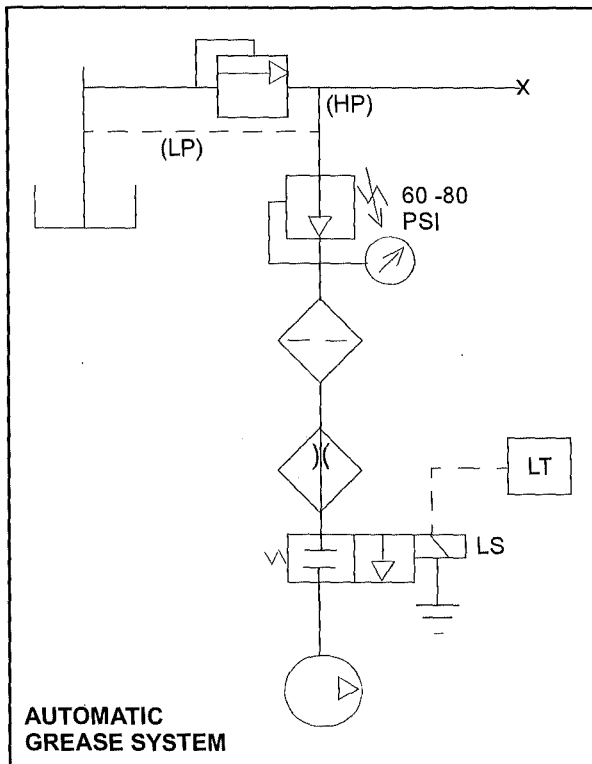
Depending on compressor application the items shown here may be configured slightly different.

The grease pump requires air line lubricant and reduced air pressure. A solenoid will open air to

the grease pump from either the electric timer or the program module.

Electrical power is 24 VDC and may be calibrated to inject grease on a preset timed interval.

Service literature 006113-000 details grease system components.



Daily and when required maintenance is the responsibility of the end user.

Open the water separator drain tap daily to empty collected condensation.

It is recommended to fill the lubricator bowl daily with a quality airline lubricant, SAE 10w or an equivalent air line lubrication oil.

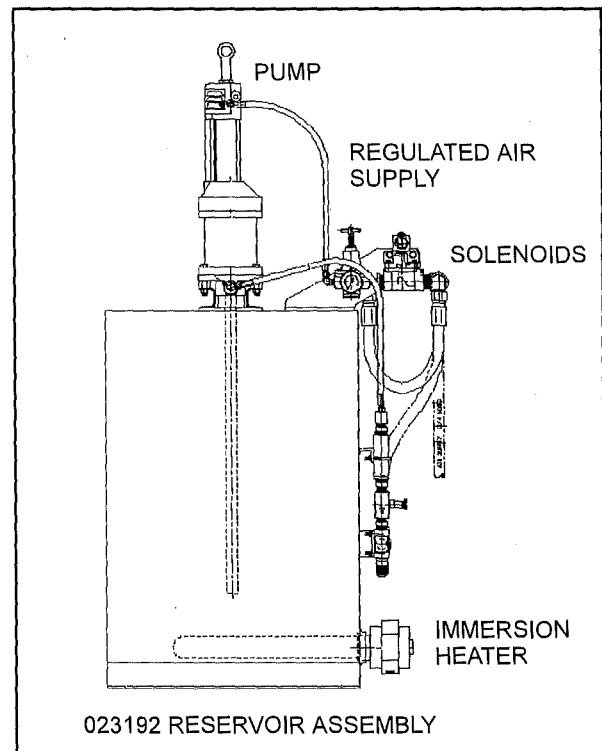
Chain Lubrication System

Chain manufacturers prefer to lubricate moving chain sections with a low volume of chain lubricant.

The chain lubricant can be petroleum based, engine, machine or chain oil proper for the ambient operating condition may be used. Synthetic oil may be utilized in severe operating conditions.

In normal conditions a SAE 20 to SAE 40 weight lubricant is sufficient.

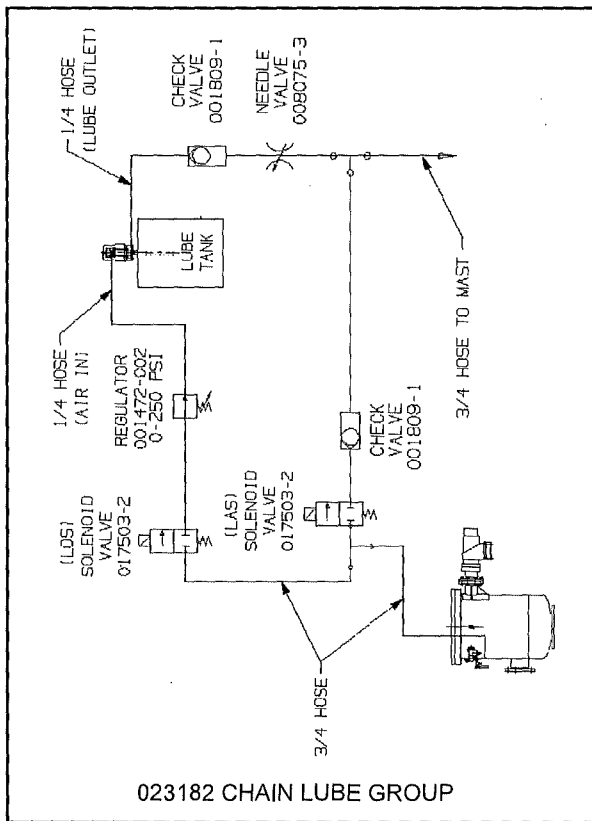
Daily inspection of oil capacity is a must to assure lube pump does not draw air and loose prime. Fill the reservoir as needed based on oil consumption.



Chain lubrication systems are air activated with reduced air pressure from the reservoir. Expected air pressure shall be 60 to 80 psi to operate the pump.

Four nozzles positioned in the mast are pointed toward pull-down and hoist chains to spray lubricant according to operator control.

Operators control the chain lube cycles by a cab mounted double throw toggle switch.



Coalescing filter spare part number 022462-001 may be connected in line for any of the mentioned air regulated components.

The feed system must be free to travel full travel up and down the mast to perform proper chain maintenance.

Control the toggle switch to air mode while operating feed full travel. This cycle pre-cleans the chains with compressed air.

Control the toggle switch to oil mode while operating feed full travel. This cycle lubricates the chains with oil.

Operate the toggle switch to air mode while operating feed full travel. This cycle purges oil from the mast hoses.

Air Line Filtration

Arctic and cold ambient conditions may require air line filtration to separate condensation moisture in the dry air supply lines.

TROUBLESHOOTING LOW PRESSURE COMPRESSOR SYSTEMS

SYMPTOM	PROBABLE CAUSE	ACTION
Machine shuts down with air demand present	Air end low oil pressure and/or high air/oil temperature switch may be defective	Check air/oil discharge temperature switch. Check optional low oil pressure shut down switch on lube manifold
	Airflow through oil cooler insufficient	Check fan RPM, system pressure and flow
	Low oil level in receiver tank	Check center sight gauge on receiver tank and see if oil is in center
	Dirty oil and filters and clogged filters	Change oil and filters Incorrect oil for ambient condition
	Faulty thermostats	Remove thermostats and check
	Faulty safety shut down circuit	Check shut down switches
	Pressure by-pass valves open	Remove and check by-pass valves
Machine will not build up full discharge pressure		Check service lines for external air leaks, open valves and/or bad hoses in control circuit including dust collector systems
	Dirty air filter	Check air intake filters, change if needed
	LP regulator, Pressure reducing regulator and Subtractive pilot valve	Check pressure regulator diaphragm(s) for damage, repair and adjust if needed
Machine will not build up full discharge pressure (continued)	Defective LP pressure regulator	Repair or replace regulator
	Faulty minimum pressure valve	Remove and inspect minimum pressure valve for movement, check seal and repair as needed
	Running blow down valve	Remove, inspect and repair as needed
	Shutdown blow down valve	Remove, inspect and repair as needed
	Air demand greater than supply	Compressor not sized correctly for drill application
	Stuck inlet valve	Check free movement, stroke adjustment and settings of inlet valve Check orifice in bleed muffler on control cylinder applications Ice build up in control signal hoses, install a 022462-001 coalescing filter

<p>Improper unloading with excess pressure buildup causing tank safety relief valve to open</p>	<p>Pressure regulator(s)</p> <p>Butterfly air inlet control</p> <p>Adapter plate</p> <p>Unload stop screw</p> <p>Poppet inlet control</p>	<p>Check pressure regulator(s) setting. Repair or adjust as needed</p> <p>Check adjustment and settings of inlet valve</p> <p>Jammed control linkage</p> <p>Control cylinder sticking or defective</p> <p>Plugged 3/32" orifice in adapter plate</p> <p>Unloaded stop screw adjusted too far "in" allowing intake valve to be open too much</p> <p>Incorrect setting of subtractive pilot valve</p> <p>Incorrect synchronization between subtractive pilot and pressure reducing regulators. Adjust to spec.</p>
<p>Insufficient air delivery</p>	<p>Intake filter</p> <p>Separator filter</p> <p>Pressure regulator</p> <p>Engine</p> <p>Inlet valve</p> <p>Regulating valve synchronization</p> <p>Running blowdown valve</p> <p>Shutdown valve</p> <p>Control line</p>	<p>Check filter and change as needed</p> <p>Plugged air/oil separator, change as needed</p> <p>Check, adjust or replace as needed</p> <p>Check high idle speed</p> <p>Check inlet valve. Inlet valve may be stuck closed</p> <p>Pressure settings of subtractive pilot and pressure reducing valves out of range</p> <p>Check, clean, rebuild as needed</p> <p>Check, clean, rebuild as needed</p> <p>Check for plugged, loose or leaking control line(s), condensation freeze up.</p>
<p>Excess oil consumption</p>	<p>Separator element</p> <p>Oil</p>	<p>Plugged scavenge line strainer or fixed orifice</p> <p>Damaged separator element(s)</p> <p>Hold down nut on element not at 50 FT LB (37 Nm) torque</p> <p>Incorrect oil</p> <p>Foaming of oil</p> <p>Oil level too high</p> <p>Contaminated oil, drain, flush and refill complete system per procedure</p>

Compressor overheating	<p>Oil cooler</p> <p>Weather</p> <p>Thermostats</p> <p>Oil</p> <p>Cooling fan</p> <p>Compressor</p>	<p>External surface dirty</p> <p>Plugged or partially plugged with dirt build-up</p> <p>Oil jelling in cooler due to cold weather conditions. Cooler may need covered or a oil viscosity correction for the ambient conditions</p> <p>Broken or incorrect temperature rating for ambient condition</p> <p>Worn out, replace as needed</p> <p>Low sump oil level</p> <p>Incorrect oil for ambient condition</p> <p>Oil contaminated with water or other matter</p> <p>Mixing of two different oils</p> <p>Low fan speed, check RPM</p> <p>Low fan system pressure</p> <p>Fan pump oil flow to fan motor low</p> <p>Bad fan motor</p> <p>Worn out fan blades</p> <p>Engine RPM low</p> <p>Fan direction is CCW acting as a "sucker"</p> <p>Fan shrouding on cooler letting air around fan blade slip</p> <p>Faulty hydraulic hoses from fan pump to fan motor</p> <p>Faulty oil stop valve</p> <p>Plugged bearing injection lines</p> <p>Collapsed hose or restriction in oil cooling hosing</p>
<p>Compressor system will not shift to different pressure settings</p> <p>D90KS series machines only</p>	Control circuit electrics load/unload solenoid control	<p>Defective solenoid valve or dirt in valves</p> <p>Defective "load/unload" toggle switch</p> <p>Defective wiring from switch to solenoid</p> <p>Pressure regulator adjustment</p> <p>Defective poppet inlet control, regulator adjustment</p>

Compressor oil dumps out air filter during shutdown	Improper shutdown procedure Compressor components	Machine shutting down at high idle RPM during loaded drilling condition Faulty oil stop valve Faulty discharge check valve Foaming oil Oil level in sump over full
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Sandvik Mining and Construction
 13500 NW County Road 235
 Alachua Florida 32615
 386-462-4100

SERVICE LITERATURE

GENERAL

This section will give reference material specification numbers for high pressure and low pressure air systems that are available in Sandvik Mining and Construction blasthole service procedures.

DESCRIPTION

When componets adjustments or repairs are needed it is advisable to use the service procedures.

This section may be updated as new procedures are written.

001036-000 Air Cleaner

001044-173 Lp Air End Shaft Seal Instructions

001111-000 Swivel Seal Housing Packing

001217-000 Air Piping Swivel (Chiksan)

001217-001 Air Piping Swivel (Dover)

001658-000 Hydraulic Tank Pressurization

001670-002 Pressure Relief Vent

001958-121 Hp Air End Shaft Seal Instructions

002428-000 Air Filter/regulator Instructions

003751-000 Side Mount Swivel (Crs) Instructions

004320-000 Air Inlet Valve Adjustment

004756-000 Hydraulic Tank Pressurization

006113-000 Centralized Lube Systems

006113-010 Centralized Lube Systems

006307-000 Air Cleaner Engine/compressor

006477-000 Compressor Clutch Assembly

007702-000 Dust Collector Service (Driltech)

008674-000 Taperlock Bushing Installation

010119-000 Air Inlet Valve Adjustment

010756-101 Dust Collector Service (Tipton)

011060-000 Centralized Lubrication

011353-000 Dth Lube Oil Pump Instructions

011362-000 Lube Oil Injection Instructions

012457-000 Lp Air End Shaft Seal Instructions

015702-000 Dms Instructions/troubleshooting

016708-000 Air Cleaner Engine/compressor

017144-000 Connector Expansion Instructions

017239-000 Air End Shaft Seal Instruction

018190-000 Air Cleaner Engine/compressor

0019602-052 Turn Valve Assembly 90 Series

020247-000 Dust Collector Service (Qmp)

020845-001 Dual Poppet Inlet Valves 90 Series

020965-000 Drill Monitor System Dms

021237-000 Air Cleaner Engine/compressor

021531-001 Dms Dip Switch Chart

021740-000 Cooler Assembly

023260-01A Variable Speed Control

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COMPRESSOR SHAFT SEAL KIT (001958-121)

NOTICE

Disconnect the battery and tag the ignition system to warn others of the servicing being performed.

Disassembly

1. Remove the outer segment of "V" ring (2) from the shaft.
2. Remove the six 1/4" capscrews and the dust shield. Slide the inner segment of "V" ring (2) off of the shaft.
3. Remove the six 5/16 capscrews and remove the oil seal retainer.
4. Remove the remaining components of shaft oil seal assembly (1) from the shaft. The rubber bellows (1D) are bonded to the shaft and have to be broken loose by pushing the whole seal further down the shaft. If tools are used, care should be taken that the shaft is not scratched or damaged in any way.
5. Remove retaining ring (5), seat (1A) and spring pin (6) from the oil seal retainer.

NOTICE

Do not remove, loosen or tamper with the 1/2" bearing retainer screws. These screws maintain the factory set axial end play of the shaft.

Inspection

1. Clean all parts thoroughly and remove all old sealants, gasket material and other foreign matter from and around the bearing, retainer (1F) and oil seal retainer.

2. Check the oil seal retainer and shaft and remove any burrs or sharp edges.
3. Clean the shaft thoroughly with a fine emery cloth to remove any dirt, grime, metal particles, etc.

NOTE !

For units serial no. 5DH20-1 to 7DH20-150 the seal must slide over the keyway. Be sure to round off all sharp edges on keyway before installing the seal.

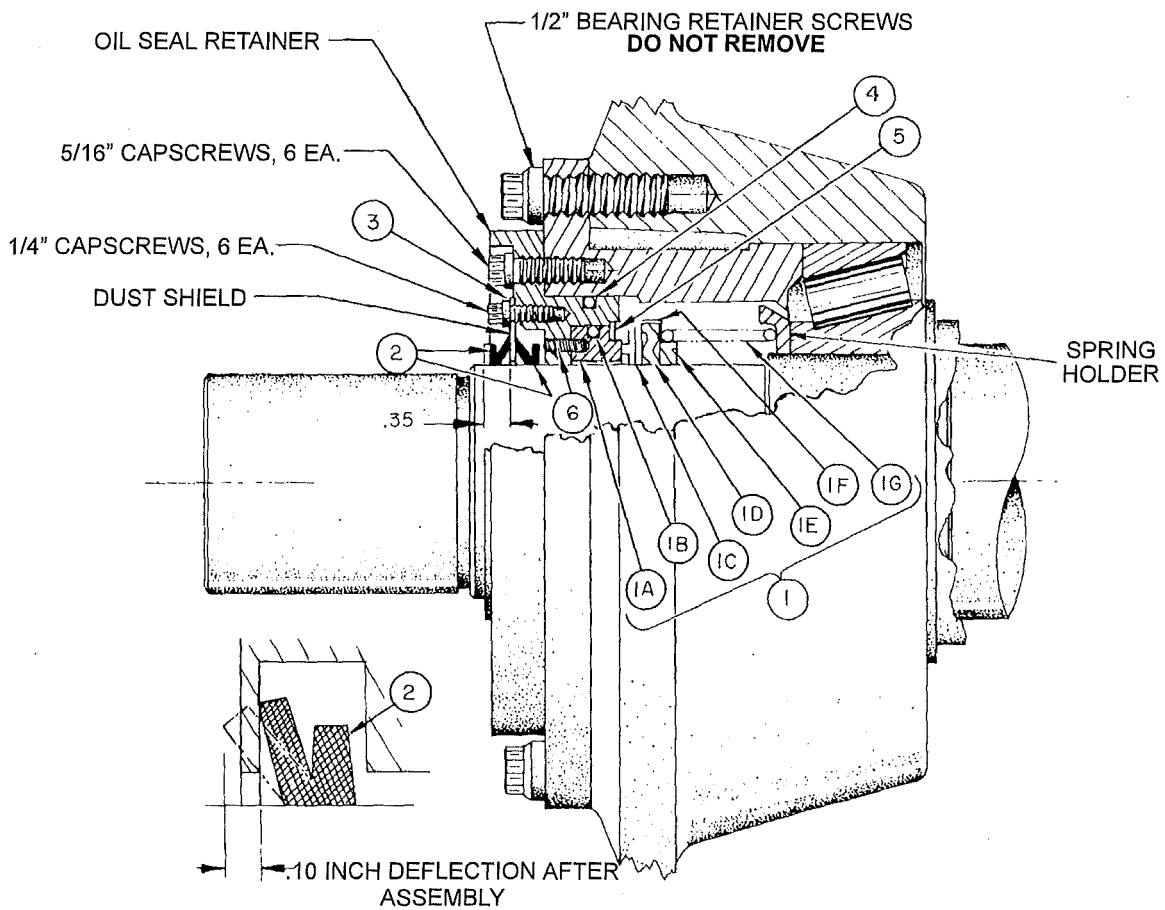
Assembly and Installation

1. If necessary, press spring pin (6) into the oil seal retainer.

NOTICE

Keep fingers off the dry lapped surfaces. The finish of the lapped face is easily damaged and must be handled very carefully. The lapped face can be identified by the highly polished surface.

2. Lightly coat the bore of the oil seal retainer with light clean oil, such as 10W-30 motor oil. Unwrap seat (1A) and take care so the lapped surfaces do not get damaged.
3. Lubricate and install O-ring (1B) in the groove in seat (1A).
4. Align the hole in seat (1A) with pin (6) and gently press the seat into the bore, taking all precautions necessary so lapped face of seat does not get damaged.
5. Install retaining ring (5) into groove to hold seat (1A) in place.



ITEM	QTY.	DESCRIPTION
1	1	SEAL ASSEMBLY - shaft
1A	1	SEAT
1B	1	O-RING - 4-1/2 X 3/32
1C	1	RING - primary
1D	1	BELLOWS
1E	1	BAND - drive
1F	1	RETAINER
1G	1	SPRING
2	2	V - RING
3	1	GASKET - dust shield
4	1	O-RING
5	1	RING - retainer
6	1	PIN - spring, 1/8 X 3/8

6. Coat the shaft with light clean oil, such as 10W-30 motor oil.

NOTE!

If the new shaft seal is furnished with spring holder, it should be discarded.

7. Coat the inside diameter of bellows (1D) and the lapped face of seal with motor oil.

NOTICE

The seal assembly must be started squarely over shaft by hand force against lapped carbon face. If the seal assembly becomes locked on the shaft, remove carefully and start over. Excessive force should not be necessary for assembly.

8. Install spring (1G) and seal assembly over the shaft with the lapped carbon surface facing out. Carefully slide seal down until contact with spring is made.

9. Lubricate and install O-ring (4) over the oil seal retainer.

NOTICE

Oil leakage will occur if the seal the seal assembly is pushed on the shaft too far, causing the rubber bellows to grip the shaft and not allow the spring to exert pressure between the lapped faces.

10. Install the oil seal retainer over the shaft and line up bolt holes. Push the retainer down squarely and slowly against spring force until the oil seal retainer contacts bearing retainer.

11. The seal will then be at its proper operating height. Install the six 5/16" capscrews and torque to 18 ft. lbs. or 2.5 kgm.

NOTICE

Inner "V" ring (2) must not touch the oil seal retainer.

12. Lubricate the inside of "V" rings (2). Adjust the inner ring (2) axially with the lip of the ring facing out, to obtain a dimension of .10" from the surface of oil seal retainer on which the dust shield and gasket (3) are being mounted.

13. Install gasket (3) and the dust shield using six 1/4" capscrews and torque to 11 ft. lbs. or 1.5 kgm.

14. Install the outer "V" ring (2) with the lip toward dust shield and slide onto shaft until compressed to .35 dimension.

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INSTALLATION OF TAPER LOCK BUSHINGS (008674-000)

GENERAL

The following procedures describe the removal and installation of part number 004785 taper lock bushings used on the compressor flex coupling.

Removal

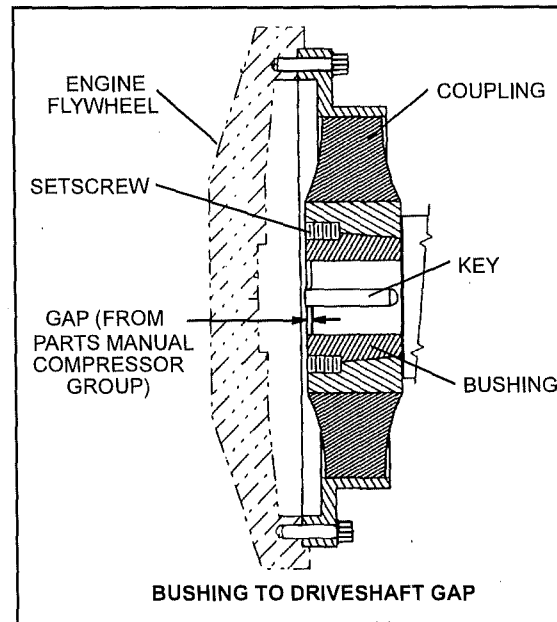
1. Remove the setscrews from the bushing.
2. Insert one of setscrews into the threaded hole in the bushing. Tighten the setscrew to remove bushing.

Installation

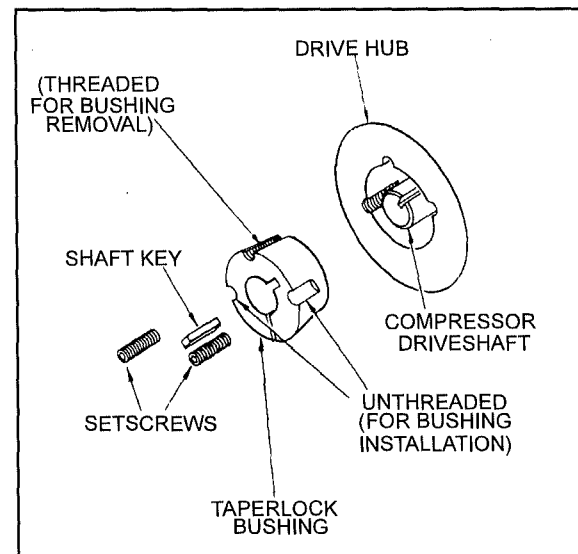
1. Clean the shaft, bore, and the outside of the bushing and hub of all oil, lacquer, and dust.
2. Apply Loctite #RC/609 to shaft keyway and insert the key. Tap the key to ensure it is seated.

NOTE !

If the compressor shaft is equipped with a locational spacer, the taper lock bushing must be seated against the spacer. If spacer is not used, refer to the Parts Manual (Compressor Group) for the proper dimension from end of air end driveshaft to the face of the taper bushing.



3. Insert the bushing into the hub. Match the hole pattern. Two (*) of the taper bushing holes placed 180° (*) apart will not be threaded and they should align with holes in the hub that are threaded.



4. Apply Loctite #242 to the setscrews and thread them into the half threaded holes in the hub. Install the hub and bushing on the shaft.

5. Alternately torque the setscrews to the recommended torque shown in the setscrew torque table.

6. Use no more than a 6 lb. (**) hammer to drive a block, sleeve, or drift against the large end of the bushing.

NOTICE

Do not hammer on the bushing or the compressor shaft.

7. Repeat Steps 5 and 6 until torque wrench reading after hammering is the same as before hammering.

8. Fill all cavities with grease.

* On 004785-011 bushing - holes are 120° apart, (3 untapped holes equally spaced).

** On 004785-011 bushing - use a 12 lb. hammer.

BUSHING PART NUMBER.	WRENCH TORQUE Nm (FT-LBS)
004785-001	49 (67)
004785-002	49 (67)
004785-003	49 (67)
004785-004	26 (36)
004785-005	18 (24)
004785-006	49 (67)
004785-007	26 (36)
004785-008	26 (36)
004785-009	62 (84)
004785-010	49 (67)
004785-011	62 (84)
004785-012	49 (67)
004785-013	105 (142)

SETScrew TORQUE TABLE

COMPRESSOR AIR INLET CONTROL (010119-000)

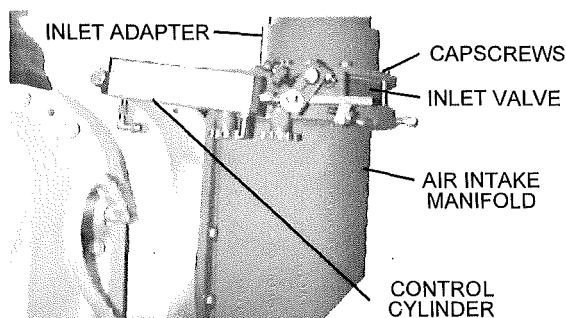
GENERAL

This topic contains procedures for the removal, installation and adjusting of the compressor air inlet control and its linkage.

REMOVAL

To remove the air inlet valve assembly proceed as follows:

1. Loosen the clamps that connect the air inlet piping to the air inlet adapter.
2. Label the air hoses at the inlet control cylinder before removing. Cap and plug the cylinder and hoses.

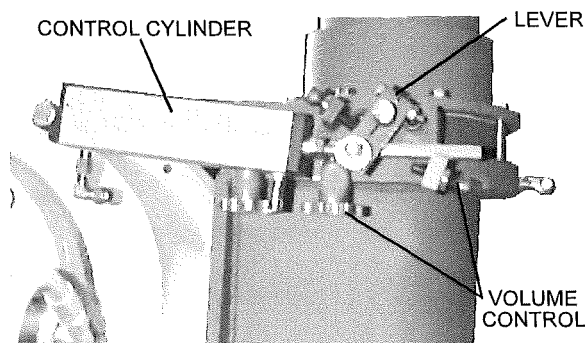


3. Remove the capscrews securing the air inlet adapter to the air intake manifold. Remove the adapter and the inlet control assembly.

DISASSEMBLY

Disassemble the inlet valve assembly as follows:

1. Note the approximate gap of the inlet valve before removing the hardware securing the inlet control cylinder to the cylinder lever.
2. Loosen the hardware securing the cylinder lever to the shaft of the inlet valve and slide the lever assembly off of the shaft.

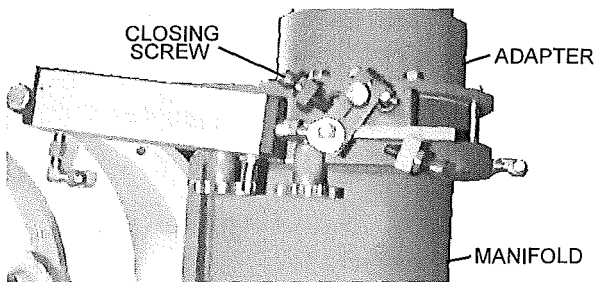


3. Remove the two socket head capscrews which hold the bracket to the inlet valve.
4. Remove the hardware securing the inlet control cylinder to the bracket.

ASSEMBLY and INSTALLATION

Assemble and install the inlet valve assembly as follows:

1. Remove any traces of gasket from the sealing surfaces of the air inlet manifold, the inlet valve and the inlet adapter.
2. Mount the bracket assembly to the inlet valve with the two socket head screws.
3. Mount the inlet control cylinder to the bracket assembly.
4. Slide the cylinder lever onto the shaft of the inlet valve.
5. Connect the control cylinder to the cylinder lever (hand tighten the hardware).
6. Recalling the approximate gap of the inlet valve, tighten the hardware securing the cylinder lever to the inlet valve shaft.
7. Adjust the valve closing adjusting screw so that it touches the cylinder lever.



8. Apply a gasket adhesive to one side of the inlet valve gaskets before installing the gaskets on the valve.

9. Position the inlet assembly on the air intake manifold. Remove the hardware securing the cylinder to the lever and operate the lever to determine that there is no interference between the valve and the intake manifold.

10. Install the air inlet adapter and secure it to the manifold. Tighten the capscrews in a diagonally opposing pattern.

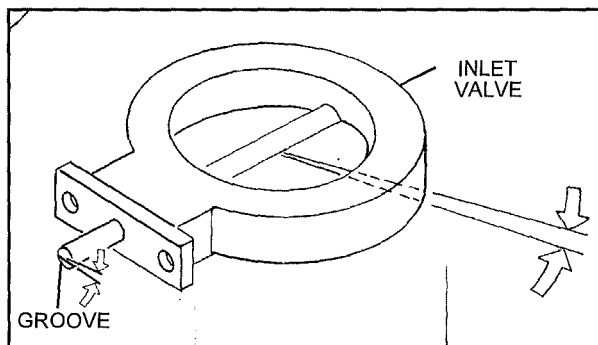
11. Recheck the movement of the valve before tightening the cylinder to lever hardware.

12. Reconnect the air inlet piping.

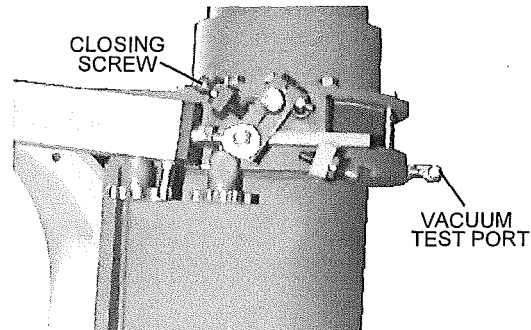
ADJUSTMENT

Adjust the inlet valve assembly as follows:

1. Before beginning to adjust the inlet valve, note the position of the groove in the inlet valve shaft. The angle of the groove equals the angle of the inlet valve. If the groove is horizontal the valve is closed and should be opened slightly.

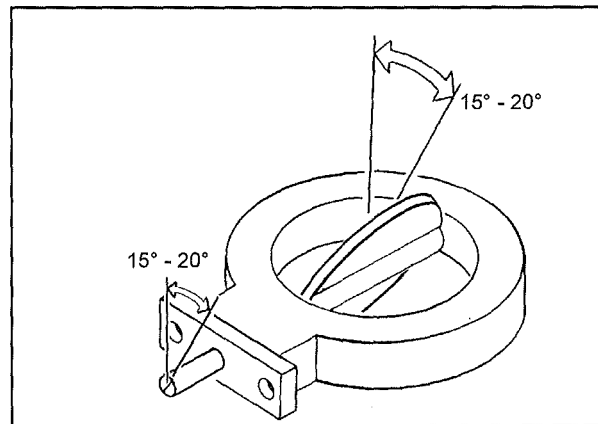


2. Install a vacuum gauge to the fitting on the side of the air intake manifold.



3. Start the machine and adjust the valve closing adjusting screw until a reading of 1 kgs/cm² (28 inches) is achieved on the vacuum gauge.

4. Check the groove in the inlet valve when the valve fully opens. When fully opened the angle should be between 15 to 20° from perpendicular.



5. Adjust the cylinder rod extension as necessary.

AIRENDSHAFTSEALKIT

(012457-000)

GENERAL

The components of the seal kit are numbered S4 through S12 in the figure shown. Item S4 is the seal which includes a seat with O-ring, the carbon ring, a rubber bellows, and a spring. The seal itself is non-serviceable.

DISASSEMBLY

1. Remove screws (S8) and remove V-ring cover (S3) and two V-rings (S5). Discard the V-rings.
2. Remove screws (S9) and remove shaft seal retainer (S1).
3. Remove and discard O-ring (S11) from seal retainer (S1).
4. Remove retaining ring (S6) and shaft seal seat from shaft seal retainer (S1).
5. Check roll pin (S12) to see if it is sheared or bent. If it is damaged in any way, remove it and discard it.



DO NOT loosen or tamper with 1/2" cap-screws (S10). These hold the bearing retainer (S2) in place which maintains the axial end plays of the shaft.

6. Remove seal assembly (S4) from the shaft. The rubber bellows is bonded to the shaft and has to be broken loose by pushing the whole seal further down the shaft. If tools are used, care should be taken that the shaft is not scratched or damaged in any way. When the bond is broken, the seal may be removed easily

INSPECTION AND CLEANING

1. Clean all parts thoroughly and scrape off any gasket material or other foreign debris from the parts.
2. Check the bore edges of the seal retainer (S1) and the bearing retainer (S2) for burrs and break any sharp edges. Make sure the oil supply passage in these parts are open and clean.
3. Remove all burrs and break all sharp edges on the shaft.



New seals must slide over the shaft and any sharp edges will cut the seal. Therefore, the edges MUST be rounded off or broken!

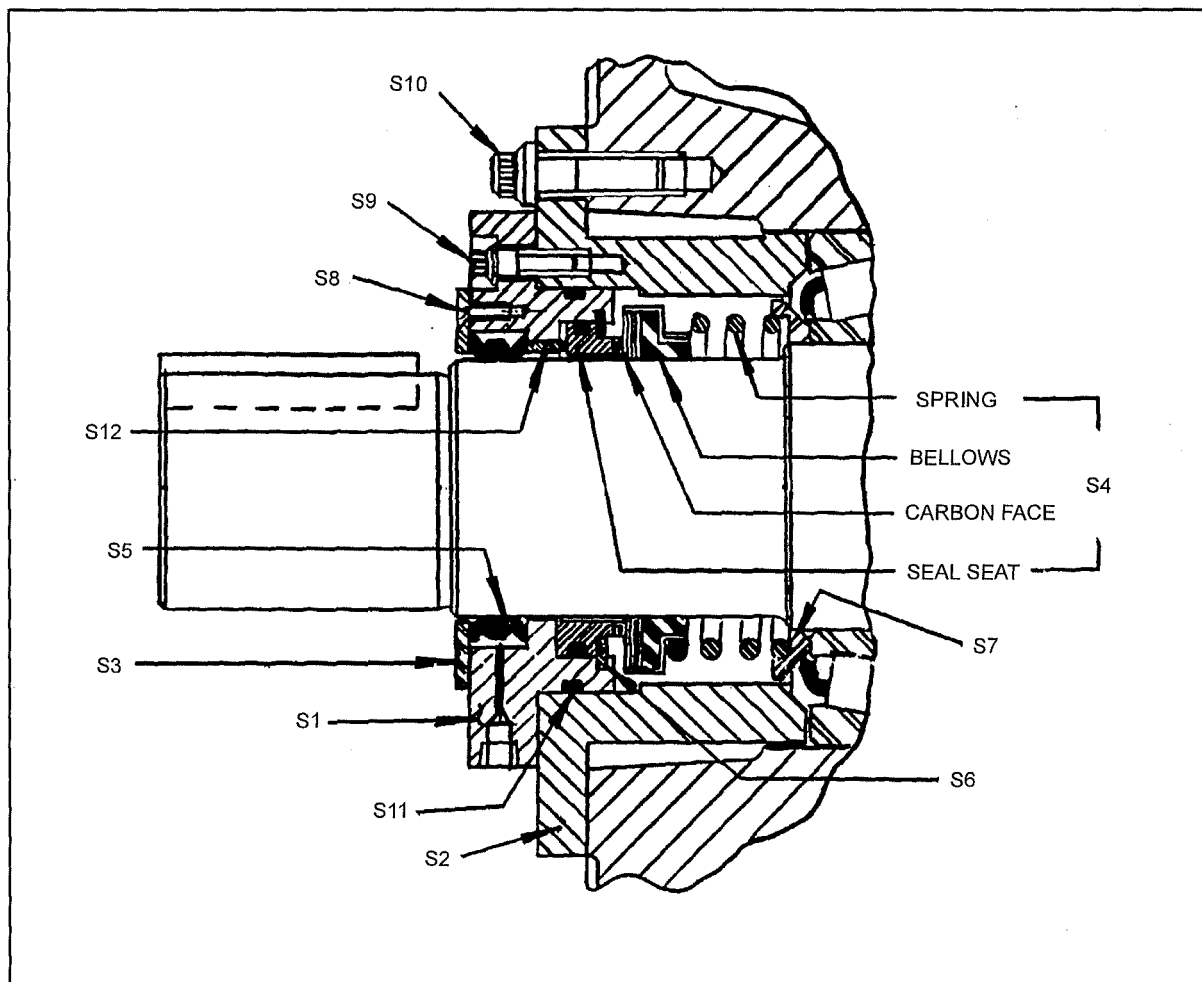
4. Clean the shaft thoroughly with fine emery cloth to remove any dirt, metal particles, etc.

INSTALLATION

1. If a new pin (S12) is required, install it in the seal retainer (S1) flush with the outside surface by tapping it gently with a hammer.
2. Lightly coat the bore of the seal retainer (S1) with lubricant provided in the kit.
3. Unwrap the seat.



The finish of the lapped surface is easily damaged and must be handled carefully. The lapped face can be identified by it's highly polished surface. Fingers should NOT come in direct contact with the lapped surface. Coat the lapped surface of the seal seat with lubricant provided in the kit.



4. Align pin (S12) with the slot in the seal seat. Install the seal seat in the seal retainer (S1) with the lapped surface facing the inside of the compressor. Check to make sure that the seat is evenly seated.

5. Coat the shaft with lubricant provided in the kit.

6. Unwrap the seal assembly. Coat the inside of the rubber bellows with lubricant provided in the kit.

NOTE!

The compressor unit may have a seal ring (S7) installed. If the seal assembly comes with a sheet metal spring holder, throw it away. DO

NOT use it along with the seal ring (S7).

NOTICE

The carbon is easily damaged and must be handled carefully. Fingers should NOT come in direct contact with the lapped surface of the carbon face.

7. Coat the lapped surface of the carbon face with lubricant provided in the kit.

8. Install seal assembly (S4) on the shaft, with the carbon surface facing out, just far enough to assure that the tail section is past the shaft chamfer.

NOTICE

The seal assembly must be started squarely over the shaft by hand force against the carbon face and protecting the face with cardboard. If the seal assembly becomes locked on the shaft, remove it and start over.

Excessive force should not be necessary.

9. Lubricate and install O-ring (S11) in the groove on seal retainer (S1).

10. Coat the lapped surface of the seal seat with lubricant. Install seal retainer (S1) over the shaft and line up the bolt holes.

NOTE!

The 1/8 inch NPT hole located in seal retainer (S1) must be positioned downward toward the feet of the unit to allow oil to drain out. Push down squarely and slowly against the seal assembly until the seal retainer (S1) contacts the bearing retainer (S2). The seal will then be at proper operating height. Hold the seal retainer (S1) in position with one hand while installing two screws (S9) opposite each other. After tightening screws down to 18 ft.-lbs (24 Nm) of torque, assemble the other four screws (S9) to the same torque.

NOTICE

Seal retainer (S1) must be held in position until the two screws (S9) are installed since releasing the assembly may **NOT** allow the spring to exert the correct pressure between the lapped faces of the seat and carbon. This will result in seal failure within a short period of time.

11. Coat the shaft and I.D. of V-rings (S17) with the lubricant provided in the kit.

12. Install V-rings (S17) on the shaft with the lips facing as shown.

13. Install V-ring cover (S3) with four screws (S8)

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COOLER ASSEMBLY (021740-000)

GENERAL

This cooler assembly is made-up of three cores. The radiator core consists of a series of copper cooling tubes and the hydraulic and compressor oil cooler segments consist of aluminum tubes.

RADIATOR CORE

These radiator cores are designed so that they can be made serviceable if replacement tubes are not available. Special rubber plugs, part no. 021740-063, may be placed in header plate holes until the replacement tubes can be installed. Please note the plugs must be installed dry.

External Cleaning

To maintain efficiency and assure maximum life of the radiator core, reasonable care must be taken when cleaning.

For general external cleaning, a high pressure hot water washer can normally be used. **Epoxy coated cores must be cleaned with care** to assure the coating is not damaged. Test your method on a portion of a single tube first.

A high pressure hot water washer can normally be used. Use a "fresh" water supply. Water temperature should not exceed 180°F (82°C). Do not steam clean. The nozzle should be kept approximately 12 inches (30cm) away from the core.

Wash the core thorough and methodically, starting at the top and working towards the bottom. Do not wash in one area for extended periods. The core will be clean when the water exiting the core is clean.

Blow off excess water with air.

Tank Gasket Installation

When installing the gasket between the header plate and the tank, be sure the header plate and tank are free from old gasket material and foreign material. A scraper should be used to clean old gasket material from the sealing surface. A portable wire buffing wheel should be used to polish the sealing surface.

Before installing the gasket, a light coating of grease on both sides of the gasket should be applied to soften the gasket and provide better sealing.

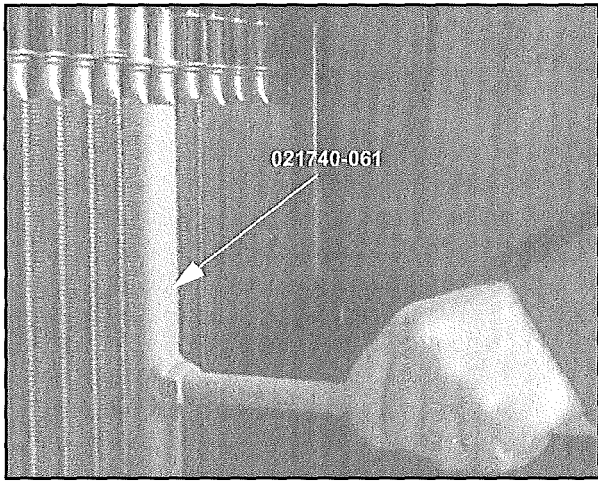
Caution should be taken to avoid overtightening the bolts, which could cause the material to squeeze out from the mating surfaces.

NOTE!

Silicone or gasket sealer may be used on the ends of the tank -- caution must be taken not to use excessive amounts as damage could result to the engine or radiator.

Removing Radiator Tubes

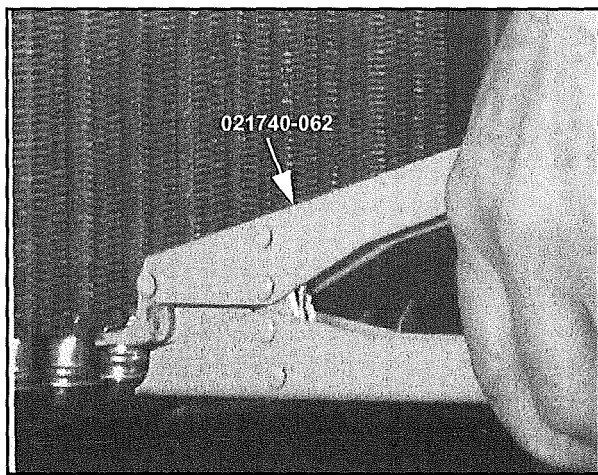
1. First remove the center support bar. For minor repairs, remove only that side you are working on.
2. To assist in the removal of the radiator tubes, if possible, heat the tubes and seals with hot water; then, loosen the tube by using breaker tool No. 021740-061. Preferably, the breaker tool should be placed at the top and bottom, not at the middle, when freeing the tube from the seal. Care should be taken not to damage the tube or the interlocking tabs with excessive twisting.



3. After the tube is free, place the upper jaw of the installation tool No. 021740-062 around the round portion of the tube, just below the flattened portion. Place the lower jaw so that the taper of jaw seats between the seal and metal ferrule not on top of the seal. Squeeze the handles of the tool together and raise the tube only enough to clear the bottom seal.

NOTE!

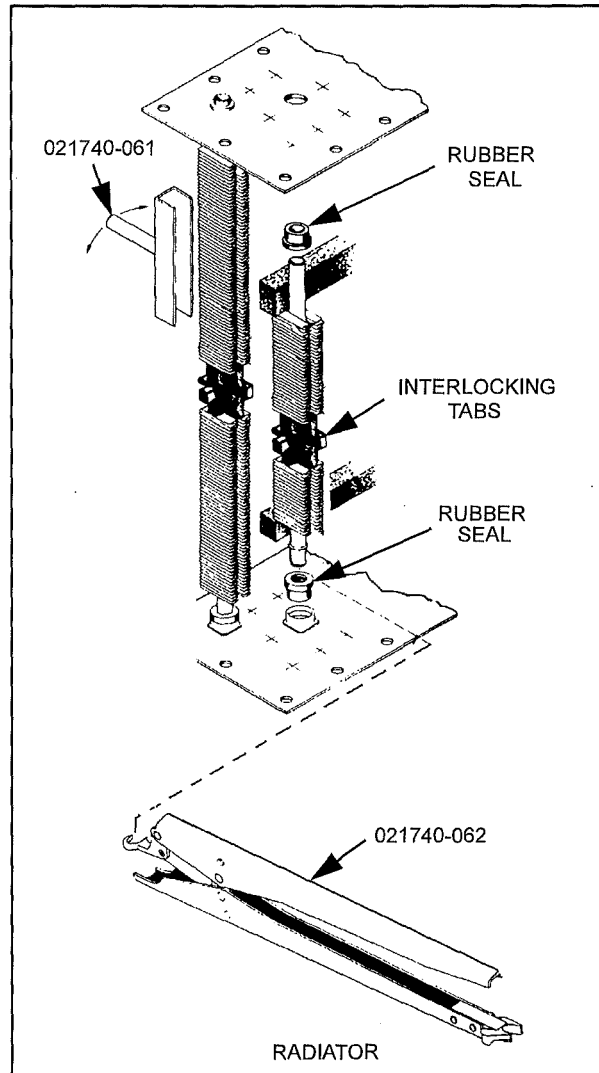
The tube should be raised high enough so that the interlocking tabs clear the adjacent dovetail groove, and also so that the bottom of the tube clears the bottom seal.



4. Pull the tube towards you and firmly downward, using a gentle twisting action to free the

tube from the top seal. Again, care should be taken so that the top of the tube does not bend or kink.

5. Remove all the tubes in the row, repeating the above procedure.



Internal Cleaning

NOTICE

Do not allow the core to be soaked or immersed in caustic solutions.

Most radiator shops use a hot alkaline soap or caustic soda in their boil-out tanks with chemical additives which attack solders. If these tubes are soaked in such a solution, the solder bond between the finning and tube will be adversely affected. If it is known that the particular solution used is not harmful to the solder, then it will not hurt the finning solder used on these tubes. Be sure to rinse the cleaned tubes/core in clean water after removing from the boil-out tank.

If there is any doubt about the cleaning method to be used, try the method on a portion of a single tube first, or contact the manufacturer.

Installing Radiator Tubes

1. After removing and discarding the old seals, the header tube holes should be cleaned of any foreign debris. A 3/4" wire bush placed in an electric or air drill can be used for this purpose. Place the new seals in the clean holes. Seals can be immersed in warm water to ease installation into the plates. Then, using a small hammer gently tap each seal down so that the shoulder of each seal is tight against the metal ferrules on the header plate.

2. Before the original tubes are reinstalled, the tube ends must be clean of foreign material. Buff the tube ends with a polishing wheel and a copper polishing compound. If the debris cannot be removed by buffing, use a wire wheel (6" diameter, .008 wire diameter). Care should be taken not to mar the tube end. After using the wire wheel, buffing the tube ends, as described earlier, will ease the installation of the tubes into the tube plates.

3. Using small amounts of petroleum jelly or mineral oil, coat the inner hole of each seal with a 3/4" diameter soft bristle brush, and the outside ends of each tube. Then, starting at the end of one of the rows of holes, push the top end of a tube (the top end of a tube is the end with the longest round section) into the top header plate seal. Center the bottom end of the tube into the respective seal in the bottom

header plate. Then, push the tube down and into the seal until the formed bead is sealed into the locking groove of the bottom seal. This may be done by grasping tubes by hand and pulling the tube downward until seated, or by using installation tool No. 021740-062. This tool has a semicircular form on the end of the handle. Place this end on the formed bead of the tube and push downward until seated. Now, complete the row of tubes.

Precaution should be taken to make sure the bead is seated into the bottom seal, and that the tubes are straight and aligned to assure maximum air flow.

4. Note that the front tab of the locking tabs should face the front (opposite the fan side) of the core and the side tab should be to your right. The tube should be pushed far enough into the top header plate to allow clearance for the locking tabs at the center, and the tube end at the bottom seal. Use your hands to initially guide the tube ends into the bottom seal, and the locking tabs into the dovetail slots. Once in place, use the end of the installation tool to properly seat the tube into the bottom seal.

5. Install succeeding rows, as per previous procedure. Always make sure that the top and bottom felt baffles are reinstalled, for reference, the top felt baffle is larger than the bottom baffle.

6. Precaution should be taken to be certain that the tubes are centered correctly in the seals. When properly lubricated and centered, the tubes are easily installed, and no scuffing or tearing of the rubber seals occur. Such scuffing and tearing could result in the seal leaking.

7. Using a rubber mallet, gently tap the center support bar into place and secure it to the side member.

OIL COOLERS

External Cleaning

To maintain efficiency and assure maximum life of the oil cooler cores, reasonable care must be taken when cleaning.

For general external cleaning, a high pressure hot water washer, up to 1200 PSI, can be used. Unlike the radiator core, you can and should get right up next to the core with a spray wand. Starting from the air exit side, place the high pressure washer nozzle next to the fin, concentrating on a small area, slowly working from the top down. Make sure you spray straight into the core, not at an angle. Continue washing until the exit water is free of dirt. Repeat from the opposite side.

In some cases it may be best to blow out any dry dirt with a high pressure, up to 1200 psi (83 bars) air gun prior to washing the core with the high pressure hot water washer. If there is any doubt about the cleaning method to be used, try the method on a portion of a single tube first.

Removing Oil Core Tubes

1. After thoroughly cleaning the cooler, blow dry the oil core sections.
2. Remove the retainer clips from the top portion of the tube.
3. With installation tool No. 021740-064, grasp the center portion of the tube. Rotate the tool, so as to break the tube free from the seal then raise the tube only enough to clear the lower seal and swing the tube out just far enough to allow the tube to be pulled down and out of its upper seal.
4. Remove all tubes in the row, repeating the above procedure.

Internal Cleaning

In cases where it is necessary to clean the inside of the oil cooler, the following procedure can be used.

Many radiator shops use a hot alkaline soap or caustic soda in their boil-out tanks with chemical additives. Soaking in high pH solutions may damage the aluminum alloy depending on the exact characteristics of the solution. Solutions that are either too alkaline (pH>9.0) or too acid (pH<5.0) are not recommended.

Remove all the tubes and seals from the oil cooler. Flush the inside of the tanks with a high pressure washer (a mild soap can be used but rinse thoroughly). Blow the excess water out with air and make sure the tanks are dry. The tube holes should be clean and dry.

If necessary, remove the turbulators from the tubes as follows:

- A. Note that the tube ends have been crimped at each end to secure the turbulator inside the tube. Also note that there is a long, unfinned portion of the tube and a short, unfinned portion.
- B. Place the tube end on a piece of hard industrial rubber. Holding the tube upright, insert expansion tool 021740-065 in the end of the tube. Tap the tool lightly with a hammer, forcing the end of the tube open just far enough to allow removal of the turbulator. **Care must be taken not to mushroom the tube ends.** Open both ends in this manner.
- C. Typically, tubulators are removed out of the long unfinned end of the tube with a long nose plier. In this case, the tabs are facing downwards. **Care should be taken not to kink the tubulators.**

NOTE!

Although rare, you may find tubulators inserted the opposite way because of flow direction. If so, remove from the short unfinned end.

D. Clean and flush the tube with a high pressure washer. Blow off with air and make sure the tubes are thoroughly dry.

E. Replace the tubulator by pushing the turbulator through the short, unfinned end of the tube. Push the turbulator far enough into the tube to allow for recrimping.

NOTE!

Depending on tolerances "pushing" the turbulator into the tube may cause kinking. An alternative would be to use a piece of wire with a hook on the end. The turbulator can be pulled into place from the long unfinned end of the tube.

F. Crimp both ends of the tube using tool 021740-066 and a hammer. Lightly tap, forcing the end closed far enough to hold the turbulator securely in place. Take care not to mushroom the tube ends.

G. Check the tube ends for burrs, etc. Lightly buff the tube ends or use a fine emery cloth to remove any debris. Make sure the tube ends are wiped clean prior to installing.

Installing Oil Core Tubes

Before inserting the new or original tubes into the header plates, the new rubber seals must be installed.

NOTICE

When cleaning the aluminum header plates do not damage the hole surface finish.

1. After removing and discarding the old seals, the tube holes should be cleaned of any foreign debris. A 3/4" wire brush placed in an electric or air drill can be used for this purpose.
2. Be sure to clean the inside of the tanks with air before installing the seals. Place the new seals in the clean holes. Then, using a flat bottom mallet, gently tap each seal down so that the shoulder of each seal is resting on the

header plate.

3. Before the original tubes are reinstalled, the tube ends must be clean of foreign material. A fine grit emery cloth or buffing wheel can be used. Precaution should be taken when buffing so as to not mar the tube. Make sure the tube ends are wiped clean prior to installation.

4. Coat the inner hole of each seal and the outside ends of each tube with a small amount of #10 hydraulic oil or petroleum jelly. Cupped washers should be installed prior to installing the tubes.

5. Starting at the end of one of the rows of holes, push the top end of a tube (the top end of the tube is the end with the longest unfinned section) into one upper header plate seal. Place the center bottom end of the tube into the respective hole in the bottom seal. Push the tube down and into the seal until the washer is located on the top of the lower seal. This may be done by grasping the tubes by hand and pulling the tube downward until seated, or by using Installation tool No. 021740-064.

NOTICE

Be sure the tube is properly centered in the seal before pushing the tube in place or seal damage could result.

6. Reinstall the retainer clip between upper two washers. Make sure wings on the retainer clips are parallel with each other to block bypassing air.
7. Before starting a second row of tubes, place the inner tube stabilizer in position. Stabilizers should be lined up with the support bar location.
8. Proceed with installation of the next row of tubes, using same procedure as when installing first row.
9. Remember that tube stabilizers should be located BETWEEN each row of tubes before starting another row of tubes.

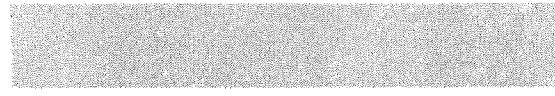
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10. When the tubes are completely installed, fasten the tube stabilizer with a support bracket to the side members.

SECTION 6

AIR PIPING

SANDVIK



AIR PIPING SWIVEL-JOINT CHIKSAN (001217-000)

OVERHAUL

Tools Required:

Adjustable wrench, pliers, screwdriver, and vise.

Disassembly

1. Remove the dust cap on the ball plug.
2. Remove ball plug and o-ring using adjustable wrench.

NOTE !

If castellated ball plug is used, first remove the cotterpin using pliers.

plug hole positioned over a suitable container.

4. Rotate male component. Ball bearings should drop out.

NOTE !

It may be necessary to thin hardened lubricant with petroleum solvent.

5. Separate male and female components after ball bearings have been removed.

NOTICE

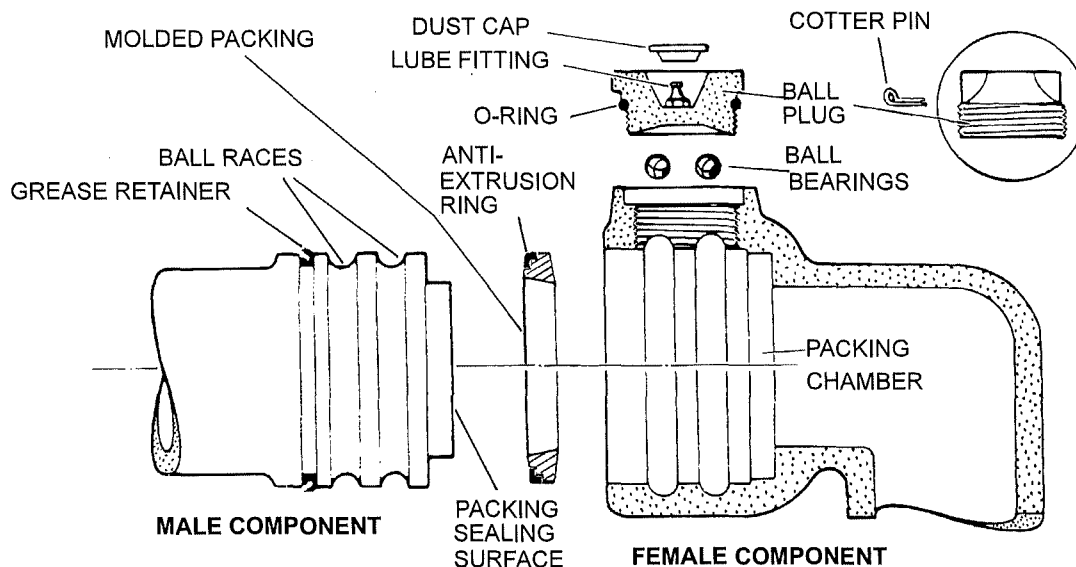
Do not damage machined surfaces when separating components. Protect sealing surfaces at all times.

6. Carefully remove old packing from female packing chamber using screwdriver.

NOTICE

Use extreme care in removing old packing to prevent damage to sealing surfaces.

7. Remove grease retainer from male component.
8. Clean all parts with petroleum solvent.



3. Secure female component in vise with ball

9. Inspect the parts for excessive wear, corrosion or other damage.

A. Inspect ball races for dents, grooves, or other damage.

B. Check male and female components for excessive erosion or corrosion.

C. Carefully inspect the inside surfaces of elbows for evidence of erosion or corrosion.

NOTICE

Replace all parts that show evidence of damage in the ball races, packing seal surfaces, or other areas.

10. Sealing surfaces must be completely smooth. Remove minor scratches or pitting by polishing with fine abrasive.

11. Reclean all parts after polishing to remove metal particles and abrasives.

Assembly

1. Apply a thin coat of lubricant to ball races, sealing surfaces, and new packing.

NOTE !

Make sure correct lubricant is used for intended service conditions.

2. Install the new grease retainer on male component by gently stretching it over the ball races.

NOTE !

Retainer lip must face away from ball races.

3. Install new packing in female component packing chamber.

NOTE !

Anti-extrusion ring must face outward, toward ball races.

4. Secure female component in vise with ball plug hole on top.

5. Insert male component into female component.

6. Look through ball plug hole to align ball races.

7. Drop balls into races. Rotate male component, adding balls until both races are filled with the proper number of balls.

- **Air Swivel - 1-1/2 inch requires 54 steel balls 1/4 diameter**
- **Air Swivel - 2 inch requires 48 steel balls 3/8 diameter**
- **Air Swivel - 3 inch requires 66 balls 3/8 inch diameter**

NOTE !

Count the number of balls installed in each race to be certain that exactly the right number are installed. Incorrect number will cause binding or excessive wear and reduced pressure or structural capacity.

8. Install a new O-ring on ball plug.

9. Insert the ball plug.

NOTE !

For castellated ball plug, tighten until snug. Then, loosen one-quarter turn and insert cotter pin. For hexagon ball plug, tighten to approximately 50 ft. lbs.

10. Lubricate bearings as follows:

A. Use a small, hand-held grease gun to force small amount of lubricant through fitting.

NOTE !

Standard lubricant is Chiksan No. 7.

B. Rotate male component 90° (quarter turn) and add more grease.

C. Repeat step b (above) two more times, lubricating at each quarter turn.

D. Check smoothness of rotation.

NOTICE

Excessive lubrication can cause swivel to bind, distort the anti-extrusion ring and displace the packing. Use only enough lubricant to obtain smooth rotation. If the swivel is more difficult to rotate after greasing than before, or if lubricant is detected on inside of primary packing, or if distortion of packing is noted on inner diameter, disassemble joint and carefully inspect all seals for damage. Replace damaged seals and any packing which has been distorted or displaced into the bore.

11. Install the dust cap.

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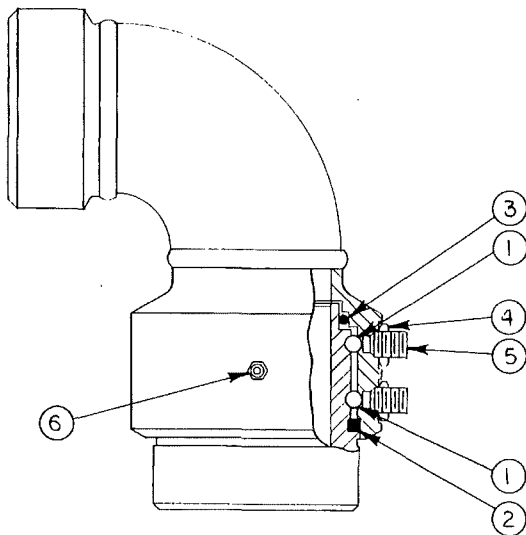
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AIR SWIVEL (001217-001)

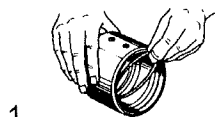
GENERAL

The following instructions apply to a OPW/ Dover type swivel joint only.

ASSEMBLY



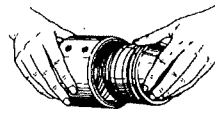
ITEM	QTY.	DESCRIPTION
1	48	BALL - bearing - 3/8"
2	1	SEAL - dust, felt
3	1	O-RING
4	2	NUT jam -
5	2	RETAINER - ball
6	1	FITTING - grease



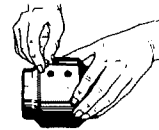
1. Clean the inside of the swivel body carefully. Grease O-ring (3) and install it in the swivel joint body.



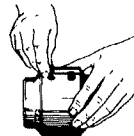
2. Clean the bearing and seal surfaces of the swivel joint tail, then install dust seal (2) around in the groove.



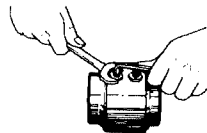
3. Insert the tail into the swivel body holding dust seal (2) snug in groove. Slight hand pressure is required to force the tail into O-ring (3).



4. Ball grooves in the tail must be in line with ball holes in the swivel body to allow easy entry of balls (1) into the bearing races. Slowly rotate the tail back and forth as balls are dropped through the individual holes to fill each bearing race.



5. Thread in ball retainers (5) until contact is made with the ball, back off slightly.



6. Thread jam nuts (4) on retainers (5). Hold ball retainers (5) in position with an allen wrench while locking the jam nuts with an open end wrench. Lubricate.

NOTE!

To disassemble swivel joints, reverse procedure.

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AIR CYLINDER (001690-001)

GENERAL

This hydraulic cylinder is used in several applications. Therefore, the Removal and Installation topics are not included.

NOTE !

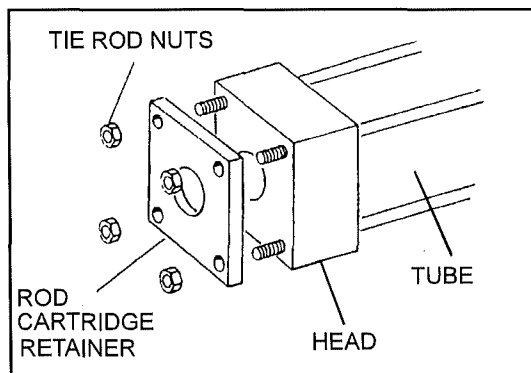
The following procedures are for the cylinders manufactured by Hydro-Line.

OVERHAUL

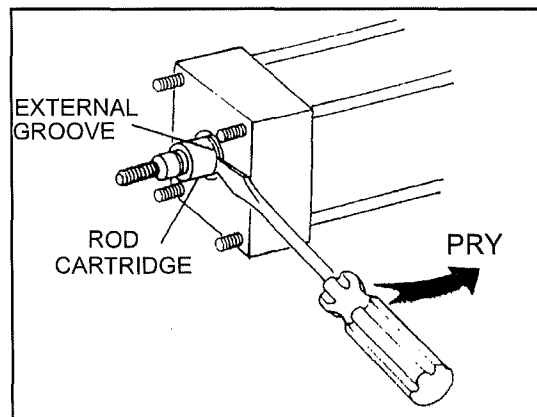
Complete disassembly of this cylinder is not required if replacing the rod cartridge or the tube end seals.

1. Replace the rod cartridge seal as follows:

- A. Remove the tie rod nuts.
- B. Remove the rod cartridge retainer.



- C. Remove the rod cartridge by inserting a screwdriver in the external groove. Pry carefully. See illustration.
- D. Clean the cartridge recess in the head.
- E. Lubricate the inside of the rod cartridge and the outside of the new cartridge prior to assembly.



F. Place the new cartridge on the rod end, being sure to use a twisting motion as you start it onto the rod.

G. Insert the cartridge (now mounted on rod) into head recess.

H. Replace the rod cartridge retainer. Tighten the tie rod nuts to 13.5 Nm (10 ft-lbs) of torque.

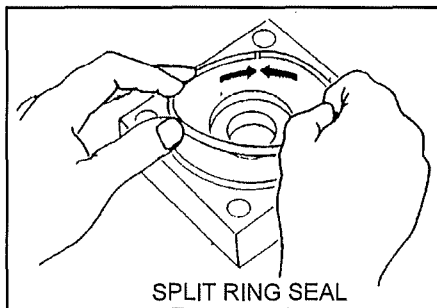
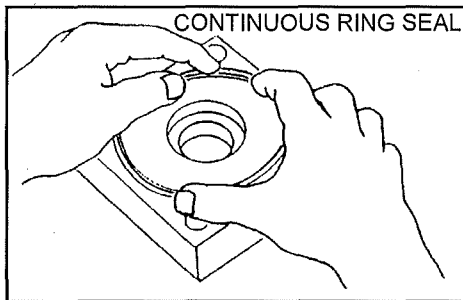
2. To replace the **tube end seals** proceed as follows:

- A. Remove the tie rod nuts at end of cylinder.
- B. Separate the head and cap from the ends of the cylinder.
- C. Discard the used seals and clean all parts thoroughly, including the inside of the tube and the seal grooves in the head and cap.
- D. Lubricate the new tube seals with petroleum jelly to hold them in place before installing them. Make certain the seals are seated fully into their grooves and against outer groove diameter.

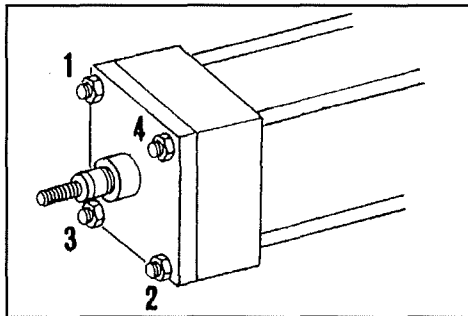
NOTE !

When installing continuous ring type seals, avoid stretching the seal.

When installing split ring type seals, insert the seals with CAUTION to avoid stretching. Be sure to butt the ends of the seals together as you begin to seat a seal in a groove. Hold the ends together and in place with one finger while seating the rest of the seal with your other hand.



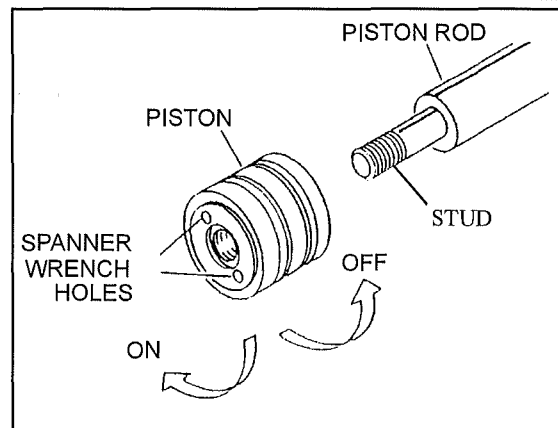
- E. Reassemble the cylinder. Tighten tie rod nuts hand tight only.
 F. Torque tie rod nuts in the order shown.
 G. Recheck the torque 13.5 Nm (10 ft-lbs) in the same order.



3. To **disassemble and assemble the piston and rod assembly** proceed as follows:

- A. Heat the piston and rod to 205°C-233°C (400°F - 450°F).
 B. Using a spanner wrench, remove the piston by turning counter-clockwise.
 C. Unthread the stud from the end of the rod if necessary.
 D. Clean the threads of the rod and piston (or piston nut) thoroughly with solvent and a bristle brush.

- E. Let parts dry.
 F. Apply Uniloc #571 to threads of piston (or piston nut) and rod. All threads must be thoroughly wetted by adhesive.
 G. Assemble the piston onto the rod. Back off 2 turns and look to be sure threads are covered with adhesive. Retighten snugly.



- H. Allow adhesive to cure for 30 minutes before applying test pressure to assembled cylinder.

SECTION 7

HYDRAULIC SYSTEM

SANDVIK



TYPICAL SYSTEMS

GENERAL

This section describes the main hydraulic systems and their design parameters.

DESCRIPTION

Systems are classed as closed loop and open loop. The systems are separated and do not inter-relate with each other.

Propel or Tram Systems

Provide crawler mounted machines with mobility.

- Piston pump and motor(s) are in a closed loop configuration.

Rotation Systems

Turn drilling accessories, drill pipe and drilling tools such as DTH (down the hole hammers and drill bits) or roller type drill bits.

- Piston pump and motor(s) are in the closed loop configuration.

Feed Systems

Feed systems differ from one product to another in the Sandvik family of drills. Four applications are used throughout the product.

- One is a piston pump with cylinder(s) in an open loop circuit.
- One is a vane pump and a piston pump with cylinder(s) in an open loop circuit.
- One is a piston pump with cylinder(s) in a closed loop circuit.
- One is a piston pump and motor, in a closed loop circuit.

Cooling Systems

Required for engine coolant, compressor and hydraulic oils, and as of 1996 intake air for the engines. Two types of cooling fan systems are available.

- Vane pump and motor driving 36" 42" 48" and 52" OD aluminum fan.
- Vane pump and motor driving 42" and 48" and 54" OD steel fan.
- Piston pump and motor, hydraulic controls, 48" and 54" OD steel fan.
- Piston pump and motor, electronic controls, 48" and 54" OD steel fan.

Drilling Accessories

Needed for the drilling cycle require a fixed volume of oil. We refer to the following systems as accessories.

- Vane pump through directional control valves, return filtration, reservoir.

The application is lower, middle, and upper stacker valves directing oil to actuators.

When accessory pumps are in the free flow condition, they are used as a **charge** system, thus giving adequate oil for cylinder replenishment.

Relief valves or individual compensator valves, depending on the component manufacturer protect systems noted.

Back-Pressure

Back pressure is an elevated return pressure system, and may be used as a charge pressure on some Sandik products. When the vane pumps are in the free flow condition the back-pressure setting is the pump(s) relief valve.

- Return oils generating back-pressure are contained in our high-pressure return manifold (HPR).

Hydraulic schematics have abbreviated nomenclature to give details for porting and manifolds within the hydraulic system.

Mud pump systems

Well drill applications may use the option of mud assisted drilling. Mud pump is the application, the hydraulic systems are simple closed loop components attached to the mud pump assembly.

- Piston pump and motor are in a closed loop configuration.

This application is generally limited to the T40KW drill machine used in the well drill markets.

Throughout this manual the terms noted here and systems described above will be used to explaining the specific systems in detail. Flow and pressure values will be specified in the appropriate sections.

Review the specific model machine hydraulic system schematic.

- Major hydraulic components are:
- Denison hydraulic piston pumps and motors
- Denison vane pumps and motors
- Sundstrand piston pumps and motors
- Hydramatic - Rexroth motors
- Sun hydraulic cartridge valves
- Denison directional valves
- Denison relief valves
- General Engineering cylinders

START-UP PROCEDURE

NEW PUMP INSTALLATION

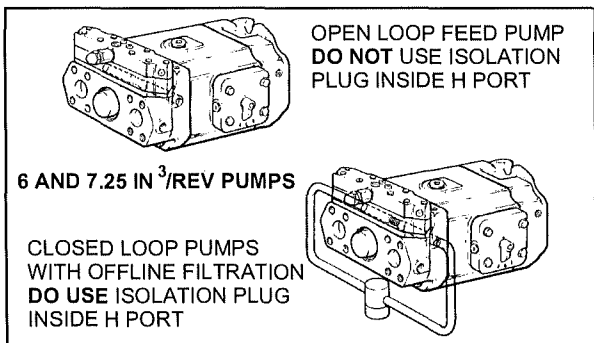
Denison piston pumps require specific set up and run in procedures.

As with any hydraulic system; our systems require total cleanliness from all fluid power components. Adequate time for proper installation, proper refilling of the pump, hoses and components, proper setting of the system pressures are all vital to new pump longevity.

Working conditions are a factor many times forgotten during a machine service and new component installations. Prepare the work area to suit the service work being performed.

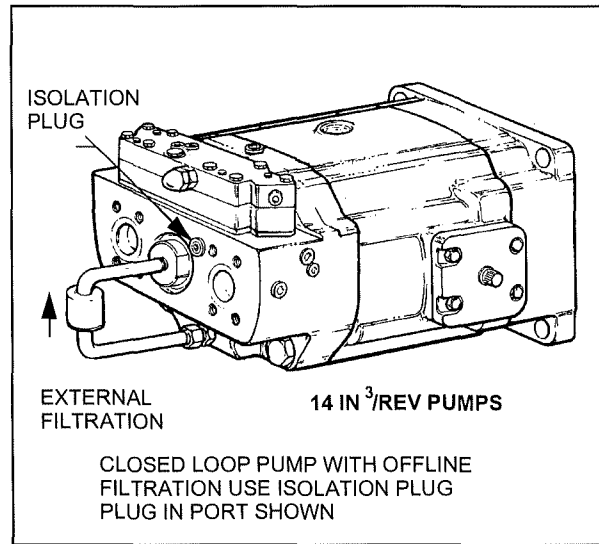
The guide described herein is the recommended procedure, for competent service and mechanical personnel performing new or reconditioned pump service, installation or start-up in the field. It is preferred that work be performed in a controlled environment such as a protected shop.

Install isolation plug in described port location as noted in packaged instructions.



The 6 and 7.25 cubic inch pumps require the plug installation in the H port as described.

The 14 cubic inch pumps require the isolation plug installed in the port cover SAE plug noted herein. This plug does not have a port designation.



Isolation plugs force the gerotor pump oil flow to fine filtration. The main valve block requires the fine filtration.

NOTE!

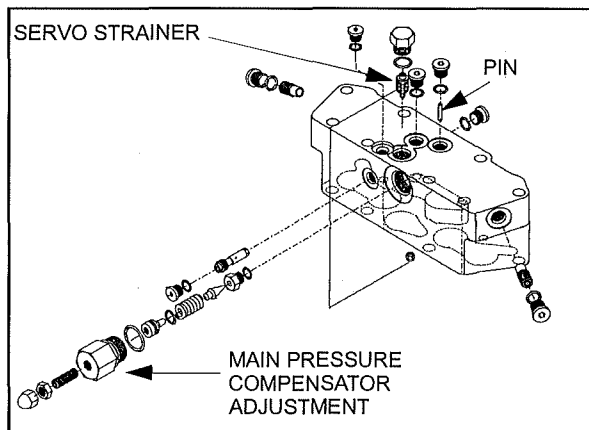
Failure to use the isolation plug in the designated port will at some point enable contaminants to flush into the valve resulting in erratic system controls.

The control valve block consists of relief valves and control features. It is not recommended to open the control valve block in the field.

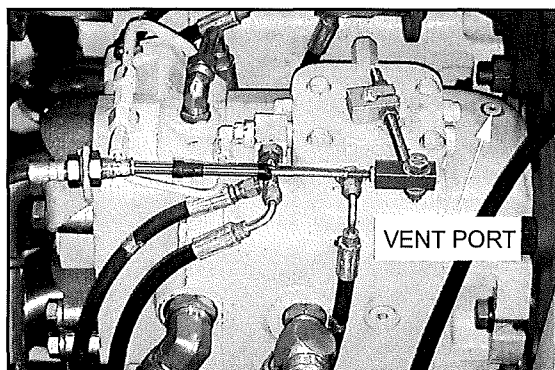
The unit is sold separate. Care must be taken during removal and replacement that dirt or any form of contaminants do not get into the open pump cover.

When installing the adapters in the Denison piston pump, ports 'V' and 'KG' two items are protected.

- The 'KG' port uses a special drilled boss oring adapter P/N 002144-001. It threads over a strainer/filter inside the 'KG' port.
- The 'V' port has a modulating pin inside an offset drilled passage. A flat bottom boss oring adapter is used in the 'V' port.



1. Drain all air from the new pump when filling the hydraulic system with new, clean hydraulic oil from the hydraulic tank. Locate the highest plugged port on the Denison replacement pump.
2. Pumps from 1996 and newer have one plug on the mounting flange end. Open and drain oil until a steady stream of oil exits the open port. Refit the plug after all air is purged from the pump in question.

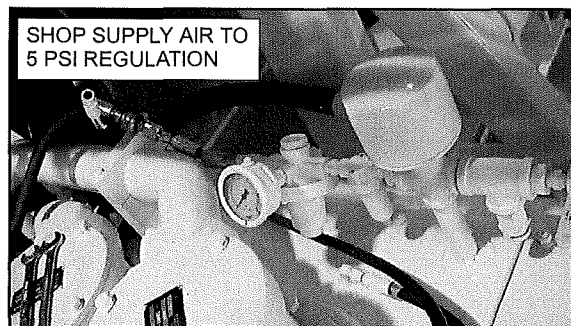


3. Older pumps need air drained as well. Remove the highest SAE plug available, or remove one input stroker cover bolt.

NOTE!

When bolt removal is the only alternative it will be necessary to replace the nylite washer 001330-128 and loosen all bolts. Torque the mounting bolts to spec 30 ft. lb. (40.8 Nm.) in a cross pattern.

4. Fill hydraulic tank to the full mark on the sight glass, taking into account to where the cylinders are positioned. Do not over fill the hydraulic tank. All oil entering the system shall be via the hand pump or the optional service center wiggins quick filling adapter port. Oil entered through these ports will be fine filtered to 10 micron absolute filtration.
5. Use shop air or equivalent compressed air source to pressurize the hydraulic tank through the reservoir mounted air pressurization system. Air pressure at the reduced value of 5 psi should be approximately 10 minutes duration. This time enables all manifolds and any air entrapped in hoses to be purged prior to start-up.



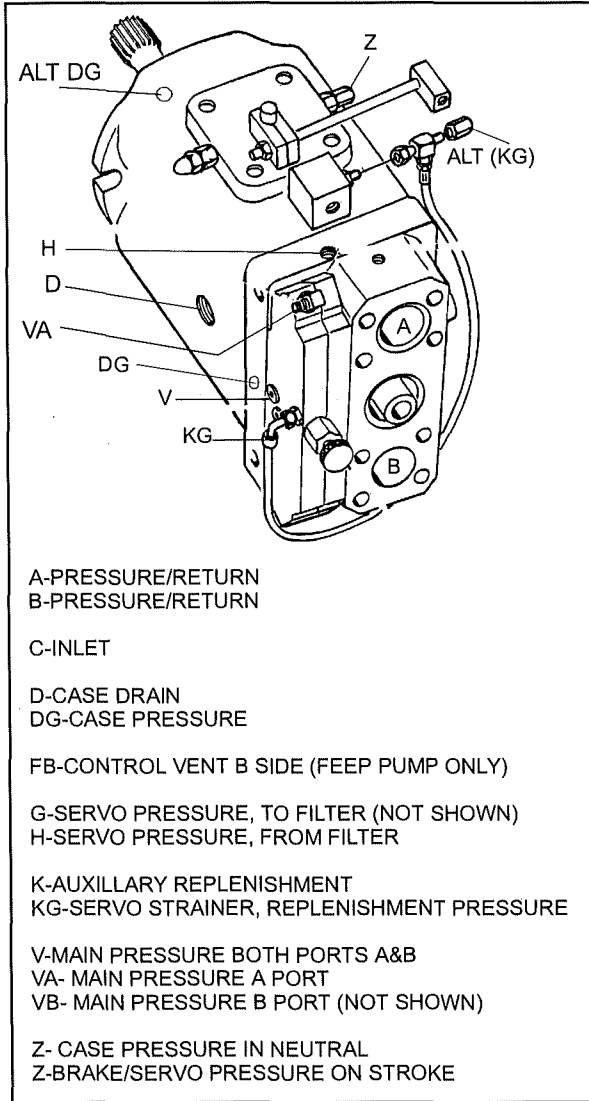
6. Install appropriate pressure gauges at G, KG or extension hose from KG and V, VA or VB ports. Reference pump port locator drawing to identify gauge locations.
7. Copies of performance charts are available in the setting procedure for specific hydraulic systems. Performance charts detail all applicable hydraulic pressures required during the pump testing procedures.
8. Refer to the appropriate performance chart for pump set-up.

Servo pressure readings are from the Denison pump G port and require inline connections for rotation and propel pumps. Do not deadhead the servo pressure in these applications.

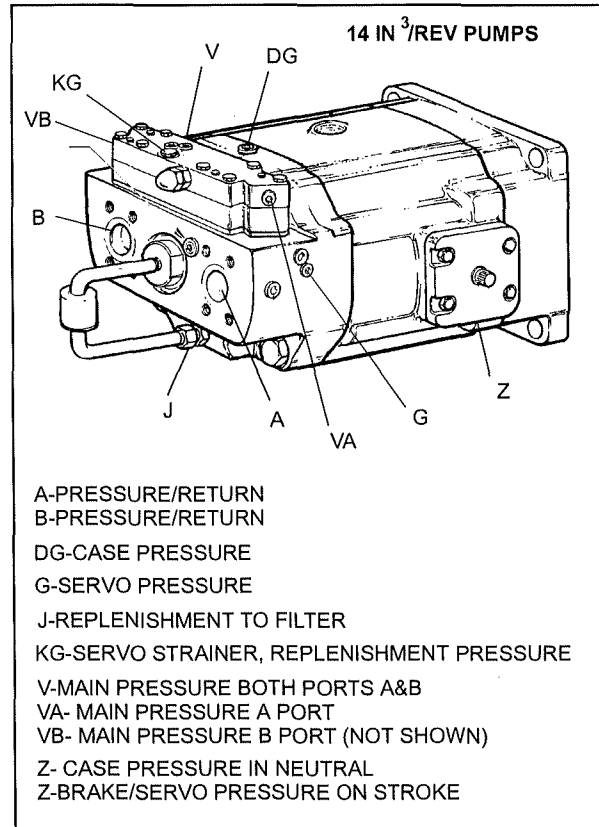
9. Connect a swivel tee and reduce to appropriate hose adapters. Common G port

access is at the inlet port of the off line filter (CC3 or CC7 micron servo filter housing).

10. Feed pumps in the open loop configuration (without off line filtration) may be accessed at the G port directly, without a swivel tee connection. In this application it is possible to deadhead a gauge at the G port.



Applicable pumps may vary slightly in components such as compensator adjustment, neutral adjustment, cross port piping and input controls.



Applicable pumps may vary slightly in components such as compensator adjustment, neutral adjustment, cross port piping and input controls.

The 14 cubic inch series pumps use a 500 series stroker on the input control side of the pump.

Refer to Hydraulic Systems Book 4 for details on set up and hydraulic adjustments of the 500 series stroker unit.

Refer to Electrical Systems Book 2 90 series machines for electrical set up and adjustments of the 500 series stroker unit.

PUMP RUN-IN AND PRESSURE SETTING

1. Replenishing pressure readings are from the KG adapter or extension hose positioned at the propel pump brake and bypass input stroker.
2. Main pressure reading from the common port V or system port VA and VB. Rotation and feed pumps have pressure gauges and remote pressure valves on the operator console connected with hoses to the V ports. Typical propel pump applications do not have main pressure gauges. Machine options may be fitted to propel pump V ports for pressure testing and possible venting when interloc systems are added.
3. Center all pump controls and control cables on the drill console to lessen any hydraulic load during the engine hydraulic startup mode.
4. When the machine engine is started the low engine idle speed is at minimum 1200 rpm. An engine speed meter on the drill console enables a visual check of engine rpm. When in doubt use a photo tachometer and reflective tape on the engine front pulley.
5. Allow engine to idle at low speed and no load for approximately 20 minutes. Do not use the pump controls during this time of run in. The gerotor pump has to fill hose and pipe connections and valves in the circuit. Air trapped in the components will purge to the hydraulic tank through case drain hoses, drain ports or normal circulation during this critical run in period.
6. Pressures on the servo range between (330-580 psi) and replenishing pressure range between (200-300 psi) for rotation and propel pumps in a closed loop application. At low idle these pressures will be slightly lower than actual spec. Allow adequate run in time prior to checking the actual servo and replenishing pressures.
7. For detailed pressures refer to the specific system performance charts provided with system set-up procedures. Actual pressures are noted with engine at high idle speed after adequate run in periods are performed.

NOTE!

Due to machine applications, follow your machine model engine high idle speed. Typical high idle no load engine speeds are 1800, 1900 and 2100 rpm according to machine model.

8. The main system compensator is factory set to the minimum pressure value, approximately 500 psi.
9. Adjustments should be slow increments in 500 psi intervals over a 10-minute time frame. Maximum pressure values are noted in the performance chart spec, and are set by stalling the function.
10. After the 'run in' period and pressures are in spec, lower the engine idle speed to 1200 rpm. Allow adequate cool down period and shut engine off.
11. Remove any pressure gauges installed for the system pressure checks.
12. Re-connect system hoses and hydraulic adapters used during tests per system configuration.
13. **Expected new pump run in process will require between 30 minutes to (1) one service hour depending on work environment, and ambient conditions.**

This procedure does not include Denison pump removal and installation to gearbox.

NEW PUMP INSTALLATION

Sauer Sundstrand axial piston pumps require specific set up and run in procedures.

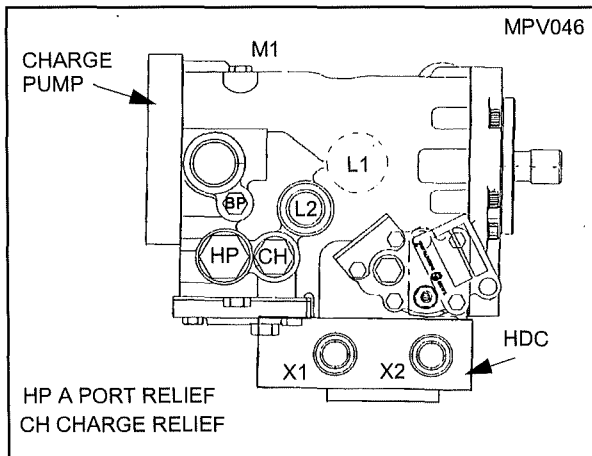
As any hydraulic system; Sandvik systems require total cleanliness from all fluid power components. Adequate time for proper installation, proper refilling of the pump, hoses and components, proper setting of the system pressures are all vital the new pump longevity.

Working conditions are a factor many times forgotten during a machine service and new component installations. Prepare the work area to suit the service work being performed.

The guide described herein is the recommended procedure, for competent service and mechanical personnel performing new or reconditioned pump service, installation or start-up in the field. It is preferred that work be performed in a controlled environment such as a protected shop.

Sandvik crawler mounted machines utilize two models of Sundstrand pumps in a closed loop single direction application.

The 40 series MPV046 is applicable to the D40KS, D45KS, D50KS and early model Gator machines.



The Sandvik application MPV046 pump is used in a single direction output flow. Only one multi function relief valve is used. Be certain that the B port relief is removed prior to start-up.

Main port multi function relief valve

The A port relief valve is a non-adjustable shim type valve preset for 3675 psi (250 bar) positioned under the HP plug.

Note:

MPV046 pumps with the B port relief valve installed is evident upon hydraulic system shut down. The cooling fan and motor rotation stops abruptly at shutdown. Damage to the hydraulic motor can result operating with this condition.

Bypass plug

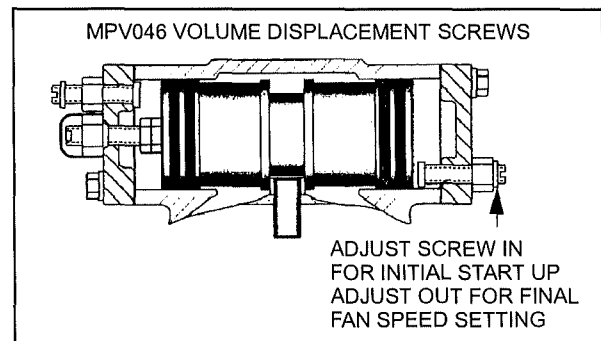
Bypass plug should be full closed, turned in cw rotation maximum torque 7 to 10 ft lb, (9.5 to 13.6 Nm).

Charge system relief valve

The charge pump relief valve is a shim type cartridge positioned under the CH plug. Plug torque is 30 to 70 ft lb (41 to 95 Nm). Charge pressure test port can be utilized at the offline filter connection inlet port or M3 pump port.

Adjustable volume limiters

Adjustable volume displacement stroke limit screws are on either side of the pump. The sealing lock nut requires a 5/16 hex wrench and a flat blade screw driver. Final torque on the nut should be 4 to 7 ft lb (5.4 to 9.5 Nm).



Upon new pump start-up it is required to turn the screw in (cw rotation) 3 revolutions. This step assures that the pump will not have full volume output oil flow during the critical start and run in procedure.

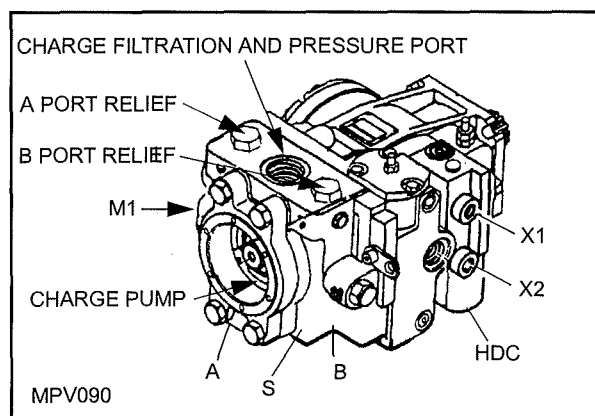
In order to prevent damage to the volume limiter parts make initial adjustments of this screw with the machine turned off and zero charge pressure.

Note:

The volume limiter setting will be calibrated during the pump final adjustments to allow a maximum fan rotation speed.

Refer to cooling fan system setting and performance charts.

The 90 series MPV090 is applicable to the D55SP, D60KS, D75KS D90KS and as a upgrade for the Gator machines.



The multi function relief valve is adjustable through a pressure range 0 to 3600 psi (0 to 250 bar).

The MPV090 pump is operating in a single direction output flow also. The B port multi function valve is backed out (ccw) it's limit and locked secure.

Back out (ccw) the A port multi function valve in order to start from zero. Turn the valve adjustment in (cw) 2.5 to 3 turns. This will allow the MPV090 some operating pressure to turn the fan motor a slow rotation during the initial start up procedure.

Final adjustment to the A port multi function valve will be made during the pump setting procedure.

PUMP RUN-IN AND PRESSURE SETTING

1. Install the inlet supply line to port S. Be certain to allow adequate time to fill the pump with clean hydraulic oil. Open the upper most adapter during the filling process in order to allow air to bleed from the pump. Generally the M1, M2 or case drain L ports are the upper most ports.
2. Install a 1000 psi (60 bar) pressure gauge in the charge pressure pot M3 or the offline filter inlet port.
3. It is recommended that the hydraulic lines for the hydraulic displacement control (HDC) be disconnected at the X1 and X2 ports until after initial start-up.
4. Start the machine and operate at low engine idle speed (1200 rpm).
5. Allow approximately 3 to 5 minutes run time with the HDC hoses disconnected. Monitor the machine fluid temperatures during this run in period as the cooling fan will not be turning during this time. Do not let the machine operate to shutdown temperatures.
6. When charge pressure stabilizes in the 180 to 210 psi (12.5 to 14.5 bar) and the run in period is sufficient stop the machine.
7. Connect the X1 and X2 pilot control hoses to the hydraulic displacement control. If the pilot control hoses are connected to the wrong ports the fan motor will motor rotate.
8. Connect a 5000 psi (350 bar) gauge to the M1 pressure port in order to monitor the main loop pressure during the fan set up procedure.
9. Restart the machine and notice the cooling fan direction of rotation. With correct hydraulic connections the fan rotates (ccw).

If fan does not rotate check the hydraulic hose connections at pump ports A and B or pilot ports X1, X2 and multi function valve setting.

Pressure settings vary depending on machine specific components. Refer to the cooling system section of training module book 5 for performance data.

During the new or remanufactured pump start up and run in procedure it is necessary to monitor charge pressure only.

The charge and system pressures noted in training module book 5 will reflect actual working pressure for the machine specific system.

Knowledge of the closed loop cooling fan system is the final step in setting the external pilot valves used on blasthole cooling fan systems since late 1995.

Pump service, pressure adjustments, and system diagnostics should be performed with properly trained, qualified service technicians.

This procedure does not include Sundstrand pump removal and installation to gearbox.

NEW PUMP INSTALLATION

Denison vane pumps and a Sundstrand gear pump are used for drill related accessories.

As with any hydraulic system, Sandvik systems require total cleanliness from all fluid power components. Adequate time for proper installation, proper refilling of the pump, hoses and components, proper setting of the system pressures are all vital the new pump longevity.

Working conditions are a factor many times forgotten during a machine service and new component installations. Prepare the work area to suit the service work being performed.

The guide described herein is the recommended procedure, for competent service and mechanical personnel performing new or reconditioned pump service, installation or start-up in the field. It is preferred that work be performed in a controlled environment such as a protected shop.

Service literature 008172-000, 008610-000 and 021434-000 detail vane pumps.

Vane and gear type pump applications used on Sandvik hydraulic systems are simple components. The pumps are valve free and without need for pressure gauge installation on pump ports.

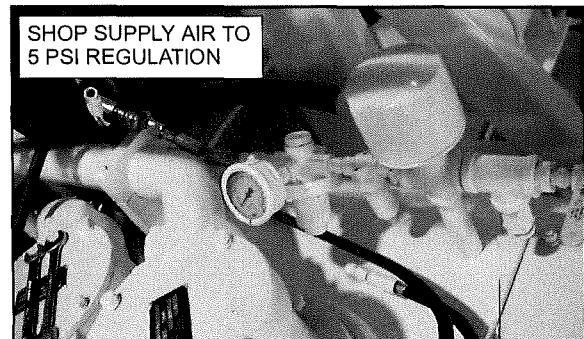
Internal parts of this pump are lubricated by the operating fluid. It is essential to keep the fluid in the system clean. Dirt should not be allowed to accumulate on the pump or around the shaft seal.

It is important that the supply or inlet piping and fittings be tight and in good repair to prevent air from being drawn into the system.

Restrictions and air entering the pump supply will damage the pump during short term operation. Clean and replace supply lines under routine maintenance intervals.

After new or remanufactured pump installation and all hoses are secure it is necessary to fill the pump with oil. Only clean hydraulic oil shall be used. When adding new oil to the reservoir the supply manifolds may have air trapped inside.

Use filtered shop air to pressurize the hydraulic tank through the reservoir mounted air pressurization system. Air pressure at the reduced value of 5 psi should be approximately 10 minutes duration. This time enables all manifolds and any air entrapped in hoses to be purged prior to start-up.



After the air pressurization precharge cycle is complete disconnect all service tools and reconfigure to original spec.

Install one 500 psi (35 bar) pressure gauge on the manifold referred to as HPR. Refer to back pressure systems performance chart in training module book 5.

PUMP RUN-IN AND PRESSURE CHECKS

1. Start machine and operate at low idle speed (1200 rpm) for 3 to 5 minutes. Leave all controls in neutral, do not operate functions.
2. Check hydraulic pressure on HPR at low engine idle speed.
3. After 5 minutes of operating at low idle speed engage engine speed to high idle.
4. Confirm HPR pressure to the back pressure performance chart.

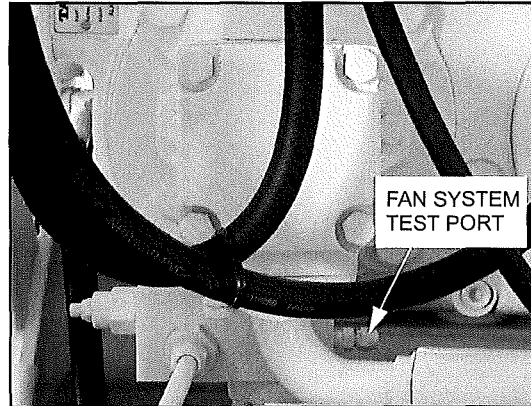
NOTE!

Under severe operating conditions it may be necessary to extend the run in period to as much as 30 minutes.

5. Monitor fluid temperatures during the run in cycle.
6. Operate a function that is a drill accessory (holding wrench, dust hood door, tong wrench).
7. Look and listen to the new pump as it is running. Look for apparent oil leaks. Listen for abnormal noises as it is cycled.
8. Lower the engine idle speed to 1200 and allow adequate cool down cycle.
9. Stop the engine, remove HPR gauge and prepare machine to operate.

Vane pumps used in a open loop cooling fan system should be started in this same manner. It will be necessary to understand the open loop

system theory and system pressures that require checks and/or adjustments.



Pump service, pressure adjustments, and system diagnostics should be performed with properly trained, qualified service technicians.

This procedure does not include Denison or Sundstrand pump removal and installation to the gearbox.

VACUUM MODULES AND PUMPS

When performing routine maintenance on hydraulic systems it may be permitted to use an air or electric powered vacuum accessory.

The intended use would be for O-ring or hose replacement and adapter sealing.

Due to the many variations that a hydraulic pump would need to be replaced it is not advisable to use the vacuum module.

The best practices to follow during pump replacement:

- Drain all fluid into suitable containers.
- Use appropriate service tools for the job.
- Inspect components including hoses.
- Evaluate and clean the system.
- Replace components as needed.

- Reassemble components to manufacture's specifications.
- Follow recommended start up procedures and safe operating principals.

NOTE!

After utilizing a vacuum module or pump and all components are correctly installed it will be necessary to precharge the hydraulic system with the allowable 5 psi air pressurization stated on pages 6 and 11 of this manual.

NEW MOTOR INSTALLATION

The following is a guide relating to new hydraulic motor installations.

It will be in summary form to apply to the Denison, Sundstrand and Rexroth models currently in use on Sandvik rotary blast-hole products.

As previously stated hydraulic service, pressure adjustments, and system diagnostics should be performed with properly trained, qualified service technicians.

- Read and understand the instruction manuals. Identify components and their functions.
- Visually inspect components, related hoses, machine tools and devices for potential hazards.
- Secure drill related accessories such as drill pipe, undercarriage components, feed drive gears and chains prior to hydraulic component removal.
- Have the system hoses been cleaned or replaced properly?
- Make all necessary hose connections using new O-rings on flange adapters.
- Do not secure the replacement motor to the application component. Leave the motor shaft free to turn during the run in process.

- Allowing the proper time stated during the pump run in procedure pages 8, 10, 12 will assist the motor filling procedure.

MOTOR RUN-IN AND PRESSURE CHECKS

- When applicable vent the pump via the remote pressure valve or the pump compensator.
 - Turn the remote pressure valve open (ccw). Turn the pump compensator out (ccw) to lessen the circuit pressure upon start up.
 - When applicable install a charge or servo pressure gauge in the appropriate pump port.
 - When applicable install a pressure gauge in the appropriate main loop port.
 - When applicable place the pump controls in the neutral position.
1. Start the machine and operate the engine at low idle speed (1200 rpm) for the predetermined time.
 2. The longer the system hoses are the longer the run in time should allow.
 3. For applications that allow operator controls turn the pump supply forward and reverse for 3 to 5 minutes each way without a working load.

NOTE:

The entire run in should take between 10 to 30 minutes.

4. Check the pump servo, charge, and replenishment pressures during the forward and reverse cycles. Pressures should be stable in the ranges noted in the specific performance charts.
5. Lower the engine idle and stop the machine in order to make final installation(s) of the hydraulic motor to the drive component.

6. Inspect or replace the drive coupling device.

NOTE!

It is recommended to use a lithium-molybdenum disulfide or similar grease as a shaft and coupling lubricant for the new components. (Mobilux EP111 coupling grease By Mobil)

7. Follow manufactures specifications when mounting the motor to the drive assembly.

NOTE!

The final torque specification for motor mounted hot oil shuttle valves on applicable propel motors is 125 ft lb (92.5 Nm).

8. Hydraulic motors with external mounted hot oil shuttle valves require the installation of a flow meter in the case drain hose connection.

NOTE!

Final setting for external mounted hot oil shuttle valves are 3 to 4 gpm (11.4 to 15.2 lpm).

FINAL MOTOR PRESSURE CHECKS

1. Start engine and run at low idle (1200).
2. Rotate the component without load in order to align a locking device. This procedure is stated in the specific system set up procedures of training module book 5.
3. With the device locked the hydraulic system will be stalled. Maximum pressures can be calibrated.
4. When applicable center the pump to neutral and back out remote pressure control valve (ccw) for minimum system pressure.
5. Engage the engine to the rated high idle speed.
6. Operate the pump control on 20% and monitor the main loop system pressure gauge.

7. Adjust the remote pressure valve or pump compensator (cw) in slow increments to the desired stall pressure stated in training module book 5 performance charts.

8. Secure pressure compensator adjustments and center pump control(s).

9. Disengage the locking device.

10. Lower engine idle speeds allowing adequate cool down period.

11. Stop engine, relieve residual hydraulic pressures, remove test and diagnostic equipment.

12. Reconfigure machine to spec.

NOTE!

Overall this procedure may take 15 to 30 minutes to perform safely and accurately.

The Sundstrand cooling fan motor will not be operated to a stall condition. The motor pressure seen will be a working pressure as stated in the specific performance chart.

SUPPLEMENTAL PUMP COMPONENTS

GENERAL

This section describes valve and manifold assemblies mounted to pump ports 'A' or 'B'.

DESCRIPTION

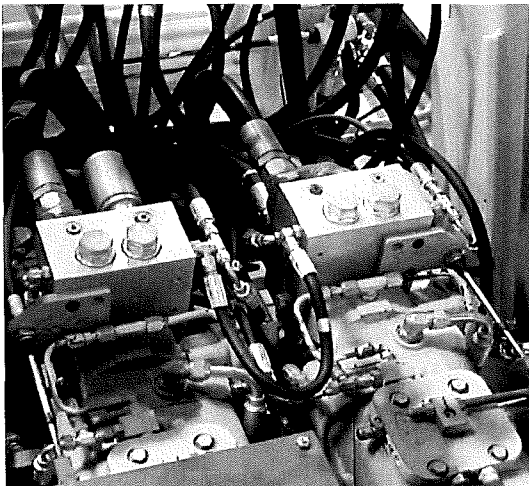
The following products Gator, D25KS, D245S, TM40KW, D55SP(H), D75KS(H) use specific manifolds positioned on Denison pump(s) A and/or B ports.

Proper mounting is essential for the valve positioned in the manifolds to work or shift correctly.

Proper valve installation into the bore so that the valve seats properly and seals the working ports per design is essential to allow oils to move the intended flow path.

As a rule oil takes the path of least resistance. If valves are not properly seated or cannot shift correctly, the system oil may drain or return to hydraulic tank pressure.

The following pictures are views along with mounting torques required when working with the component in question.

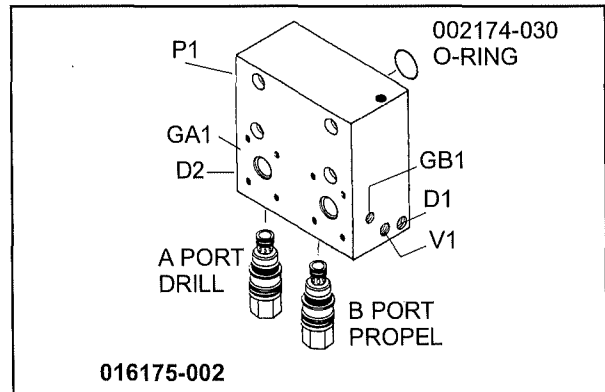


The O-ring part no. 002174-030 is 90-225 series buna n material.

Gator, D25KS, D245S manifolds.

PART NUMBER	MOUNTING TORQUE
016175-001	125 FT LB 170 Nm
016175-002	125 FT LB 170 Nm
016175-004	125 FT LB 170 Nm

The manifolds shown have been used on said products since 1990. There has been a manufacturing change with regards to sequence action for the directional valves.



Regardless of sequence operating characteristics the valves have to be seated properly into the manifold bores.

Identify the drill or propel valves via A or B manifold ports. Proper valve torques into the 016175-000 manifolds are common.

PROPEL (NC) 016175-058	DRILL (NO) 016175-059
150 -160 ft lbs 203 - 217 Nm	150 - 160 ft lb 203 - 217 Nm

Feed systems on high pressure D55SP and D75KS model drills require a 'slow feed' system (DTH applications).

- C55SP2H
- C75K6H

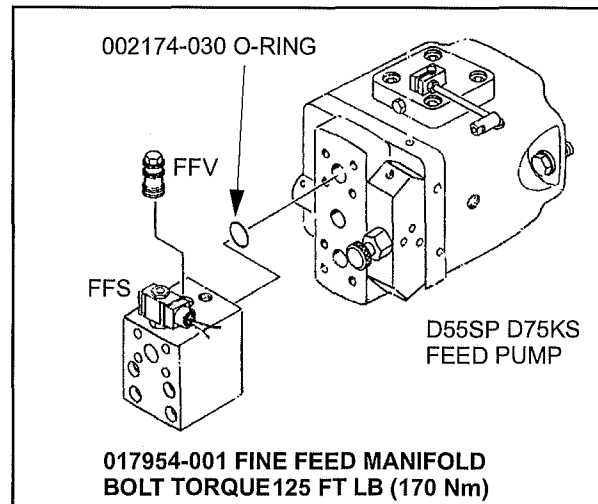
One fine feed manifold p/n 017954-001 is mounted on the 'B' port of the feed pump and one O-ring p/n 002174-030 seals the manifold to the pump port. Discard and replace this O-ring anytime the manifold is removed from the feed pump port 'B'.



Manifold mounting torque is essential for correct cartridge and solenoid operation.

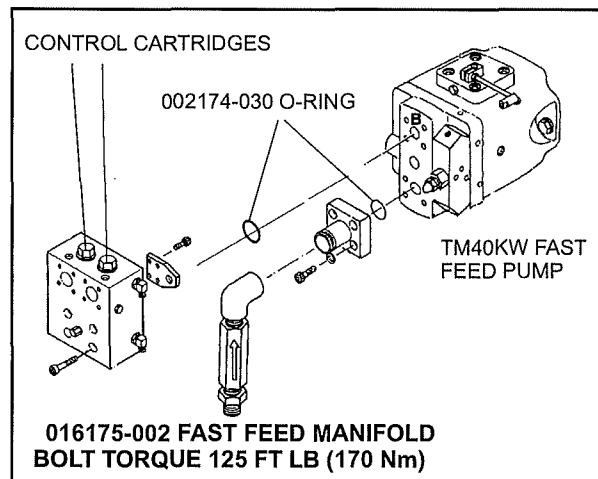
When installing the fine feed manifold onto the feed pump 'B' port, torque the bolts in a cross pattern to 125 ft lbs (170 Nm).

One control cartridge p/n 016175-054 fits into the fine feed manifold and requires a final torque of 150 -160 ft lb (203 -217 Nm). This cartridge is used to limit the feed pump output to the feed cylinder(s) to a 10 gpm (38 lpm) delivery.



The feed pump is used in an open loop application. The feed pump 'A' port is 2" diameter and acts as a supply port. The 'B' port is 1.5 " thus the fine feed manifold can only be mounted on the 'B' port.

Feed systems for the TM40KW have a fast feed pump with a directional control manifold on the B port of the piston pump.

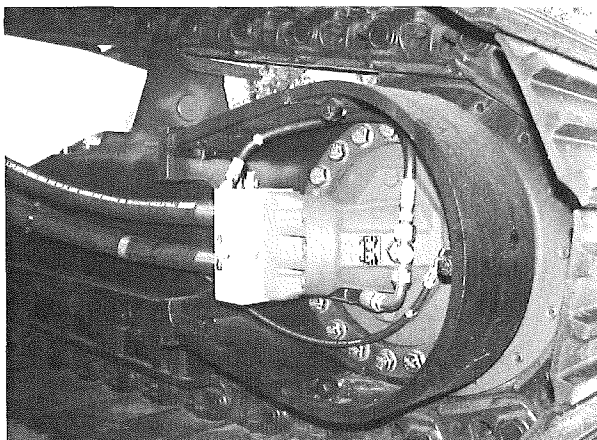


When installing the fast feed manifold onto the feed-pump 'B' port, torque the bolts in a cross pattern to 125 ft lbs (170 Nm).

The two control cartridges fit into the fast feed manifold and requires a final torque of 150 -160 ft lb (203 -217 Nm)

Propel systems and track drive motors on the Caterpillar 330, 330L, 350 and 375 require additional oil cooling and oil filtration in excess of the normal motor case drain oils. In order to allow this function in the closed loop applications one aluminum manifold with two hydraulic valves are mounted to the motor ports

Always use a new set of O-rings to seal between the manifold, motor ports and flange adapters.



NOTE!

The torque values are very important when reinstalling the shuttle valve manifold onto the motor ports or the shuttle valve spool and relief valve into the manifold.

COMPONENT	VALUE
MANIFOLD ONTO MOTOR PORTS	100-110 Ft.Lb. (135-150 Nm)
SHUTTLE VALVE SPOOL INTO MANIFOLD	45-50 Ft.Lb. (60-68 Nm)
RELIEF VALVE INTO MANIFOLD	30-35 Ft.Lb. (40-48 Nm)

Other applications

Driltech equipment manufactured during 1988 through 1994 with Caterpillar 235 series track frames and Rexroth bent axis motors have a different style hot oil shuttle valve than the one shown herein.

Call the Sandvik Regional Service Department when servicing rigs built between 1988 and 1994 models D40KS, D45KS, D50KS, D55KS, D60KS and D75KS with the 235 D6 series track drive motors and hot oil shuttle valves.

The following products use external mounted manifolds with the hot oil shuttle valve and connecting hoses frame mounted.

- Gator products with the 320 series track have shuttle valves mounted on a central valve plate above the left side track frame
- D25KS, D245S products with the 325 series track have the shuttle valves mounted on angle iron support between the mast pedestal frame.

PROPEL SYSTEM

CLOSED LOOP

A main concept of a drill machine is to be mobil. Due to ground conditions in the mining environment and the duration of time spent drilling vs. propelling (tramming) excavator tracks are the primary undercarriages delivered on drill machines today.

A track drive system in a closed loop configuration consists of one axial piston pump, hoses and steel pipes, connecting a fixed displacement motor. Each track assembly has a spring applied hydraulic released brake and a reduction drive inside the final drive assembly.

The Denison piston pump has four (4) pressures, which may need monitored when setting and diagnosing the track drive components. Refer to the propel performance chart for machine model pressure specifications.

The track components will need to be locked in order to stall the pump when checking or setting the system to spec. One method in locking the track drive is to remove the 1/4 hose connection to the brake port of the final drive. This is the preferred method. Some undercarriages do not have an external brake port. With these type track assemblies a large solid pin positioned on one tooth of a drive sprocket will serve as the track lock medium.

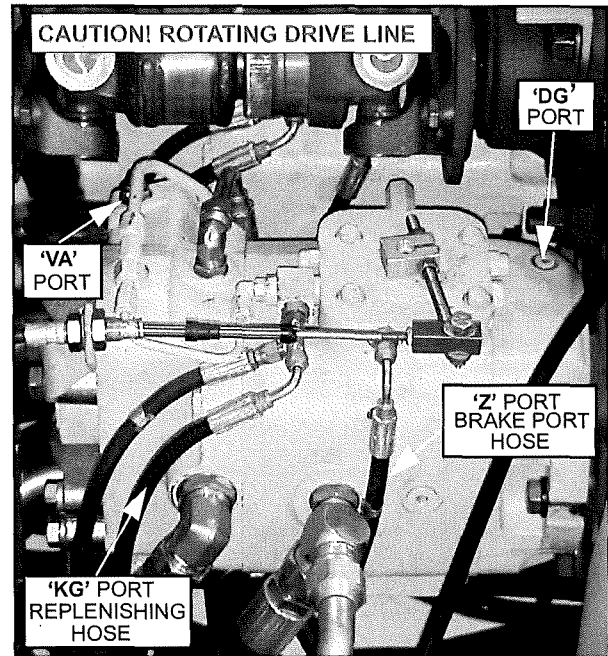
Equipment and operator safety should be a primary concern when connecting any locking medium to the final drive sprocket assembly.

PUMP PRESSURE CHECKING:

No Pressure Adjustment Required.

- Install 5000 psi (350 bar) pressure gauge to VA port of propel pump. Hydraulic test stations have guage connections on HPS1.
- Remove propel cable end from pump input stroker (Optional).

- When applicable remove, cap and plug 'Z' port brake hose at the pump output stroker.



1. Start machine engine or motor.
2. Set the engine to high idle speed.
3. Warm hydraulic oil to > 100° F (37.7° C).

If solid pin method is used, slowly rotate the track sprocket so solid pin rests against track frame.

4. Place propel pump control on stroke approximately 20% (manual or electric).
5. Check pressure gauge value.

Tram interloc features vent pump pressures (check for auxiliary valves near the propel pump gearbox, or mast pedestal).

6. Refer to propel performance chart for appropriate pressure.
7. De-stroke propel pump control to neutral.
8. Counter rotate track and remove solid pin from drive sprocket.

9. Lower engine idle, stop machine.
10. Reconnect brake hose to pump port 'Z' if applicable.
11. Disconnect pressure gauge(s) from pump ports.

Confirm the machine options prior to propel pump diagnostic procedures.

Machine options such as tram interloc, jack/brake interloc, rotary head/brake interloc, and electronic depth counters may interrupt the tram pump pressures by means of pump vent solenoid and brake solenoids.

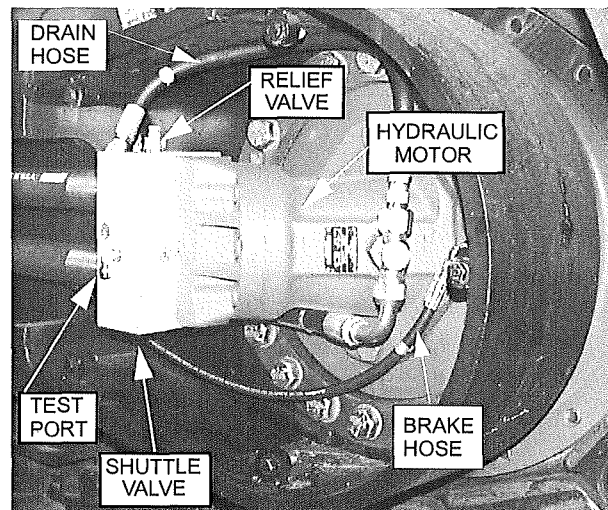
PUMP PRESSURE CHECKING:

Diagnosing Troubleshooting

- Install a swivel tee and 1000 psi, (70 bar) pressure gauge to the 'G' or 'H' port for the servo pressure test. Hydraulic test stations have gauge connections on LPS 1 or 2.
- Install a 500 psi (35 bar) pressure gauge at the 'KG' or 'port or connecting hose with swivel tee or 'alternate KG' for the replenishing pressure test. Hydraulic test stations have gauge connections on LPS 1 or 2.
- Remove, cap and plug 'Z' port brake hose at the pump output stroker if applicable.

1. Start machine engine.
2. Set the engine to high idle speed.
3. Warm hydraulic oil to > 100° F (37.7°C).
4. Slowly rotate the track sprocket so solid pin rests against track frame.
5. Check servo pressure gauge, note the neutral pressure value.
6. Check replenishing pressure gauge, note the neutral pressure value.

7. Place propel pump control on stroke, approximately 20% (manual or electric).
8. Check main pressure gauge value.
9. Check servo pressure gauge; compare to neutral pressure reading.
10. Servo pressures increase with working pressures.
11. Check replenishing pressure gauge; compare to neutral pressure reading.
12. Pump replenishing pressure decreases depending on components such as hot oil shuttle valve settings or hydraulic motor condition.



When main, servo, and replenishing pressures are in spec.

1. Counter rotate track and remove solid pin from drive sprocket.
2. De-stroke propel pump control.
3. Lower engine idle, stop machine.
4. Reconnect brake hose to pump port 'Z' if applicable.

Refer to propel performance chart for pressure specifications.

PROPEL PERFORMANCE CHART

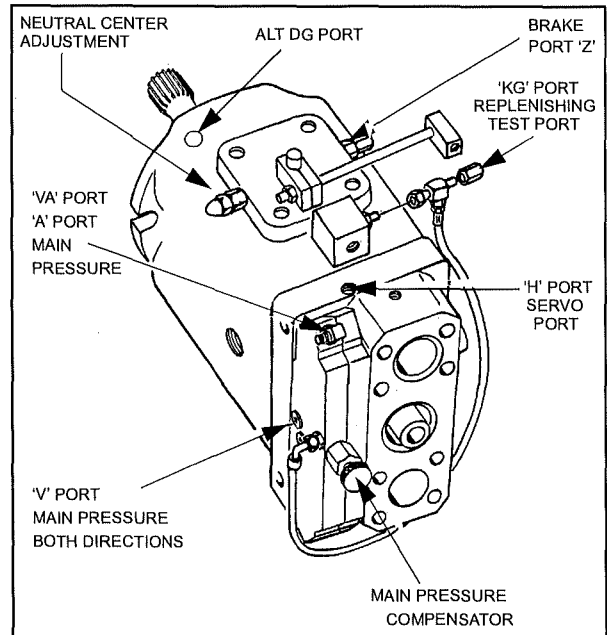
Model	Main psi (bar)	Servo psi (bar)	Replenishment psi (bar)
GATOR*	3000 (207)	330/580 (23/40)	200/300 (14/21)
D25KS	3500 (242)	330/580 (23/40)	200/300 (14/21)
D245S	3500 (242)	330/580 (23/40)	200/300 (14/21)
D40KS	4200 (290)	330/580 (23/40)	200/300 (14/21)
D45KS	4200 (290)	330/580 (23/40)	200/300 (14/21)
D50KS	4200 (290)	330/580 (23/40)	200/300 (14/21)
D55SP*	4200 (290)	330/580 (23/40)	200/300 (14/21)
D60KS*	4200 (290)	330/580 (23/40)	200/300 (14/21)
T60KS	3500 psi (242)	330/580 (23/40)	200/300 (14/21)
D75KS*	4200 (290)	330/580 (23/40)	200/300 (14/21)
D90KS	4200 (290)	330/580 (23/40)	200/300 (14/21)
D90KSP	4200 (290)	330/580 (23/40)	200/300 (14/21)
1190E*	4200 (290)	330/580 (23/40)	200/300 (14/21)

The propel pumps are manual or electric type automatic brake with neutral bypass control features.

Neutral centering adjustments may be made if the pump has unwanted motion in the A or B working ports. Disengage cable end prior to this adjustment.

The Z port hose connects to the track final drive brake assembly. This hose may be interrupted with a solenoid valve for tram interlock features.

The Z port is case pressure while the pump is in neutral. When the pump is controlled on the Z port becomes servo pressure.



Diagnosing pump and motor(s) require case pressure gauge, flow meter installation to case drain connections. Case pressures should not exceed 75 psi. Typical pump case pressures range between 8 to 45 psi.

All pressures are checked with the engine at high idle speed and hydraulic oil > 100° F (37.7° C)

Servo pressure for closed loop applications range between the spec noted. Typical servo pressure at neutral range is 390 to 410 psi (27/28.5 bar) increasing through the servo range according to maximum system pressure.

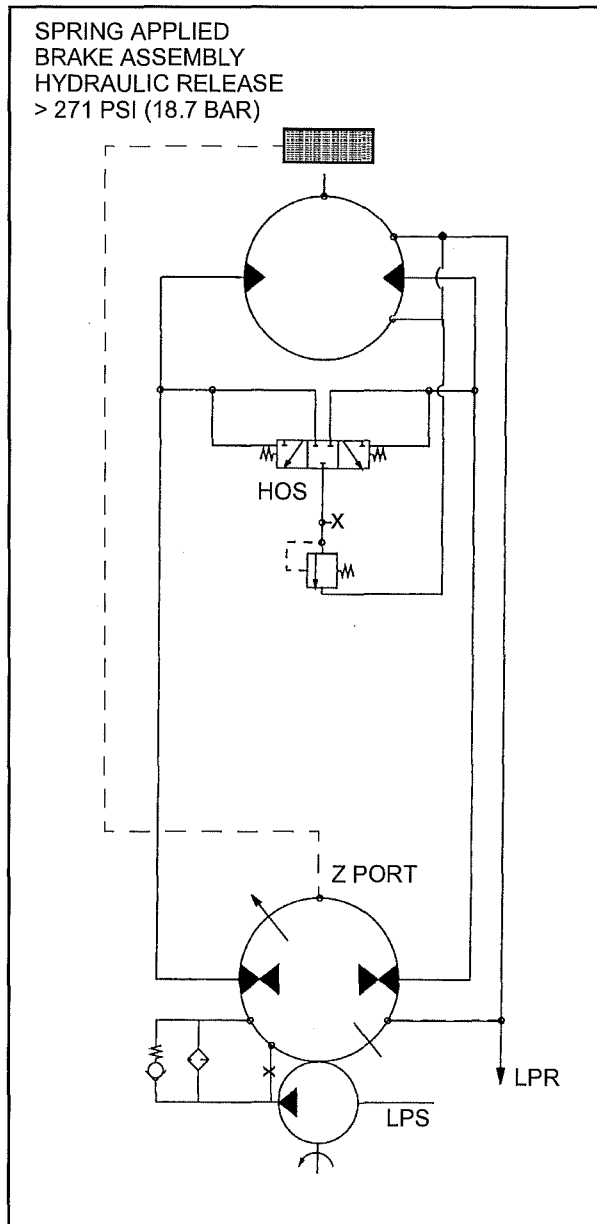
Replenishing pressure for closed loop applications range between the spec noted. Typical replenishing pressure at neutral range is 210 to 220 psi (14.5/15 bar) and will decrease when the actuator is turned on. Absolute lowest replenishing pressure for a rotation system is 180 psi (12 bar) during propel mode.

NOTE!

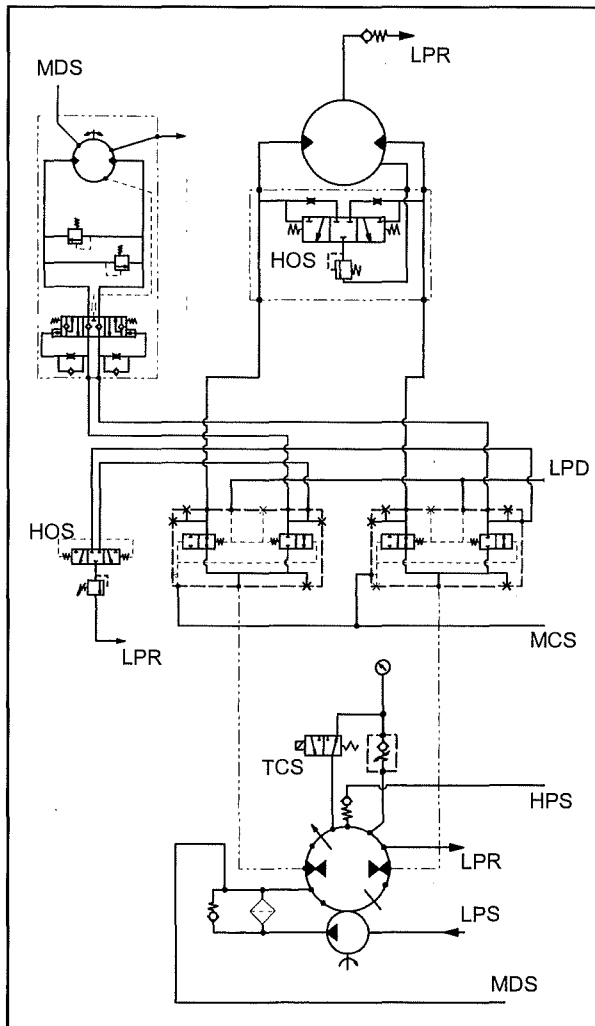
Main pressure * may be slightly higher than noted for additional power due to final drive selection and overall machine weights.

A typical left or right propel system without tram interlock options.

- 'Z' port track brake connection is not applicable to the Gator, D25KS and D245S product.



The Gator, D25KS and D245S equipment use directional control manifolds with cartridge or poppet valves that enable the propel pump to act as the feed or rotation pump.



Nomenclature regarding the propel system components shown here. These names are common throughout the product range.

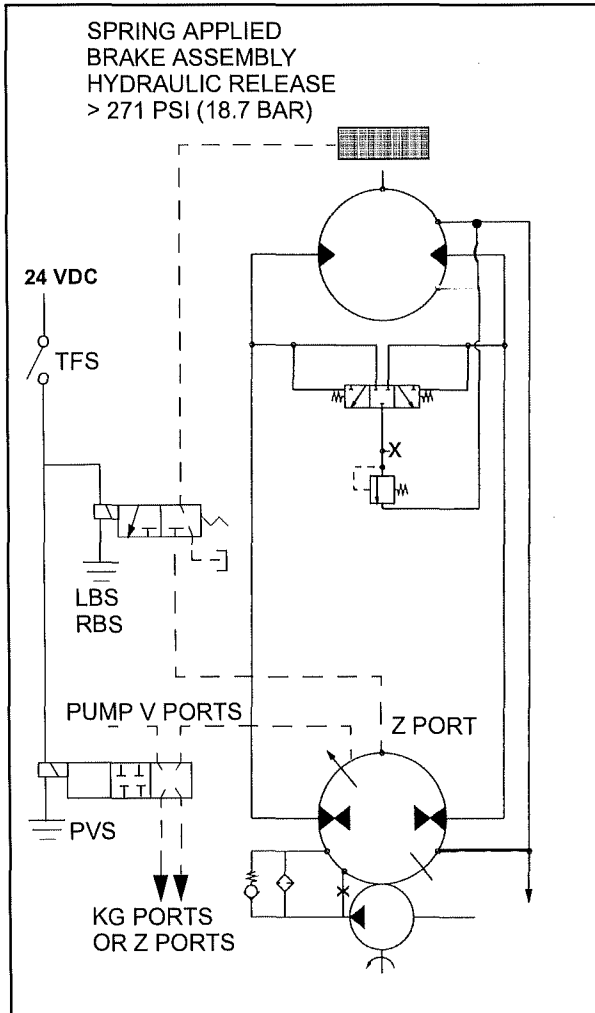
Current model D25KS/D245S use a constant supplied hydraulic pressure as a pilot to shift the cartridge valves from propel to drill modes. The pilot is fan system pressure typically above 2200 psi (152 bar). The fan system pressure is separate from the propel system.

- LPS low pressure supply
- LPR low pressure return
- HOS hot oil shuttle valve

Refer to the supplemental component section of this manual to mount the manifold and valves correctly to the specific pump application.

Tram interloc systems

Machine specific options may allow additional solenoid operated valves to control brake and pump pressures of propel pump systems.



Pump vent solenoid (PVS) vents the propel pumps main system pressure until actuated by either the tram foot switch or control relays.

Left (LBS) and right (RBS) brake solenoids dead head propel pump servo brake pressure until actuated by either the tram foot switch or control relays.

The proper operating sequence for using the tram foot switch (deadman) feature is essential for hydraulic component longevity.

The sequence of operation is:

- Machine ready to tram
- Both propel pump control levers in neutral
- Step on the tram foot switch pedal
- Actuate propel pump control levers forward or reverse as needed
- Center the propel pump control levers to neutral when ready to stop machine
- Step off the tram foot switch pedal

Failure to apply the tram foot switch before operating the propel pump control levers or randomly stepping on and off the tram foot switch with the propel pump control levers actuated will lead to hydraulic seal and relative hydraulic component problems.

Troubleshooting propel systems with tram interloc components may require

- #4 hydraulic cap and plugs
- Electrical meter or test light
- Tram interloc bypass switch actuation
- Understanding of the component locations and pump porting

MACHINE GRADIENT LIMITATIONS

The following sample and performance chart are available in a single format relative to the machine model in the rig operator manual.

⚠ WARNING

Never exceed the maximum inclination angles when parking, drilling or propelling.

MAXIMUM MAST DOWN INCLINATION ANGLES

D55SP GRADIENTS

GRADES	PERCENT
9°	15.8%
11°	19.4%
12°	21.3 %
15°	26.8%
16°	28.7%
17°	30.6%
18°	32.5%
19°	34.4%
20°	36.4%
21°	38.4%
22°	40.4%
23°	42.4%
25°	46.6%
26°	48.8%
27°	51%
29°	55.4%

⚠ WARNING

Never exceed the maximum inclination angles when parking, drilling or propelling.

MAXIMUM MAST UP INCLINATION ANGLES

D55SP GRADIENTS

GRADE IN DEGREES

$\frac{10}{100} = 10\% \text{ SLOPE}$

SLOPE DEGREES = $\frac{\text{VERTICAL RISE DISTANCE}}{\text{HORIZONTAL DISTANCE}}$

TAN x SLOPE = DEGREES

GRADE IN PERCENT

% GRADE IS 100 x SLOPE OR $\frac{100 \times \text{VERTICAL RISE}}{\text{HORIZONTAL DISTANCE}}$

ROTATION SYSTEM

CLOSED LOOP

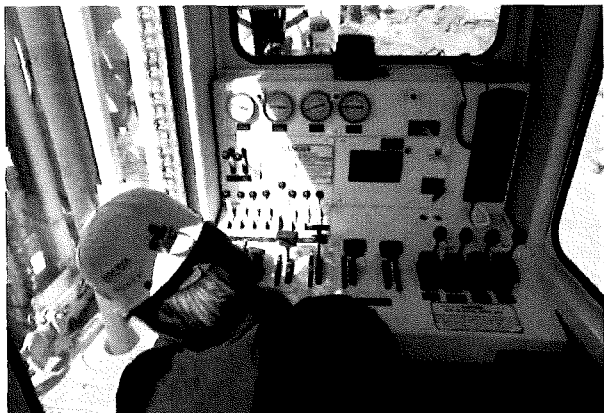
The drill rotation system consists of one axial piston pump, hoses and steel pipes connecting fixed displacement or variable displacement motor(s).

The Denison piston pump has four (4) pressures which may need monitored when setting and diagnosing the rotation components. Refer to the rotation performance chart for specific machine model pressures.

The rotating components will need to be locked in order to stall the pump when checking or setting the system to spec. When ever possible position the top flats of the drill pipe in the holding wrench to lock the rotation.

Equipment and operator safety should be a primary concern when connecting any locking medium to the rotating drill accessories.

Approved locking tools are the holding wrench/deck wrench, jay wrench and flange plugs of adequate port sizes.



PUMP PRESSURE CHECKING:

No Pressure Adjustment Required.

1. Start machine engine.

2. Set the engine to high idle speed.
3. Warm hydraulic oil to > 100° F (37.7°C).
4. Slowly rotate drill pipe to align drill pipe flats and holding wrench.
5. Lock the drill pipe rotation with holding wrench/deck wrench.
6. Adjust (manual or electric) pressure torque control valve ccw to minimum setting.
7. Place rotation pump control on stroke approximately 20% (manual or electric).
8. Check rotation pressure gauge on drill console panel.
9. Adjust (manual or electric) pressure - torque control valve cw, checking rotation pressure gauge for pump compensator value.
10. Refer to rotation performance chart for appropriate pressure
11. If pump pressure is to spec, lessen pressure torque control valve setting ccw.
12. Place rotation pump control to neutral.
13. Unlock holding wrench from drill pipe flats.

Drill operators may set the pressure control valve at any value between 100 psi up to maximum pressure of the pump due to drill pipe, drill bit sizes and ground conditions. It is recommended to be at the higher range.

PUMP PRESSURE CHECKING:

Diagnostic And Troubleshooting

- Install a swivel tee and 1000 psi (70 bar) pressure gauge to the 'G' or 'H' port for the servo pressure test.
- Install a 500 psi (35 bar) pressure gauge at the 'KG' port for the replenishing pressure test.

1. Start machine engine.
2. Set the engine to high idle speed.
3. Warm hydraulic oil to > 100°F (37.7°C).
4. Check servo pressure gauge, note neutral pressure value.
5. Check replenishing pressure gauge, note neutral pressure value.
6. Refer to rotation performance chart for pressure specifications.
7. Slowly rotate drill pipe to align drill pipe flats and holding wrench.
8. Lock the drill pipe rotation with holding wrench/deck wrench.
9. Adjust (manual or electric) pressure - torque control valve ccw to minimum setting.
10. Place rotation pump control on stroke approximately 20% (manual or electric).
11. Check rotation pressure gauge on drill console panel.
12. Adjust (manual or electric) pressure - torque control valve cw, checking rotation pressure gauge for pump compensator value.
13. Check servo pressure gauge, compare to neutral pressure reading.
14. Servo pressures increase with working pressures.
15. Check replenishing pressure gauge, compare to neutral pressure reading.
16. Replenishing pressure decreases depending on component condition.
17. Refer to troubleshooting chart if either pressures are out of spec.

When main, servo, and replenishing pressures are in spec.

18. De-stroke rotation pump control.

19. Unlock holding wrench from drill pipe flats.

ROTATION PERFORMANCE CHART

MODEL	MAIN PSI (BAR)	SERVO PSI (BAR)	REPLENISHMENT PSI (BAR)
GATOR	3000 (207)	330/580 (23/40)	200/300 (14/21)
D25KS	3500 (242)	330/580 (23/40)	200/300 (14/21)
D245S	3500 (242)	330/580 (23/40)	200/300 (14/21)
D35KS	3000 (207)	330/580 (23/40)	200/300 (14/21)
D40KS*	3500 (242)	330/580 (23/40)	200/300 (14/21)
D45KS	3500 (242)	330/580 (23/40)	200/300 (14/21)
D50KS	3500 (242)	330/580 (23/40)	200/300 (14/21)
D55SP*	4200 (290)	330/580 (23/40)	200/300 (14/21)
D60KS*	4200 (290)	330/580 (23/40)	200/300 (14/21)
D75KS**	4200 (290)	330/580 (23/40)	200/300 (14/21)
D90KS**	3500 (242)	330/580 (23/40)	200/300 (14/21)
D90KSP**	3500 (242)	330/580 (23/40)	200/300 (14/21)
1190E**	3500 (242)	330/580 (23/40)	200/300 (14/21)

Diagnosing the pump and motor(s) require case pressure gauge(s) and a flow meter installation to case drain connections.

Typical rotation pump case pressures range between 5 psi at neutral up to 45 psi (.4 to 3 bar) at stall. Case pressure should not exceed 75 psi (5.2 bar).

All pressures are checked with the engine at high idle speed and hydraulic oil > 100° F (38.6° C)

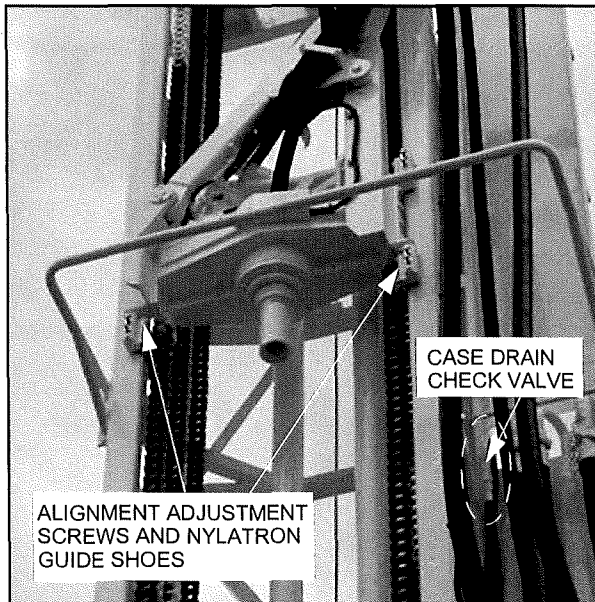
Servo pressure for closed loop applications range between the spec noted. Typical servo pressure at neutral range is 390 to 410 psi (27/28.5 bar) increasing through the servo range according to maximum system pressure.

Replenishing pressure for closed loop applications range between the spec noted. Typical replenishing pressure at neutral range is 210 to 220 psi (14.5/15 bar) and will decrease when the actuator is turned on. Absolute lowest replenishing pressure for a rotation system is 180 psi (12 bar) during drilling mode.

NOTE!

* models **may** be fitted with dual motors for high torque low speed drilling.

** models **are** fitted with dual motors for high torque low speed drilling.

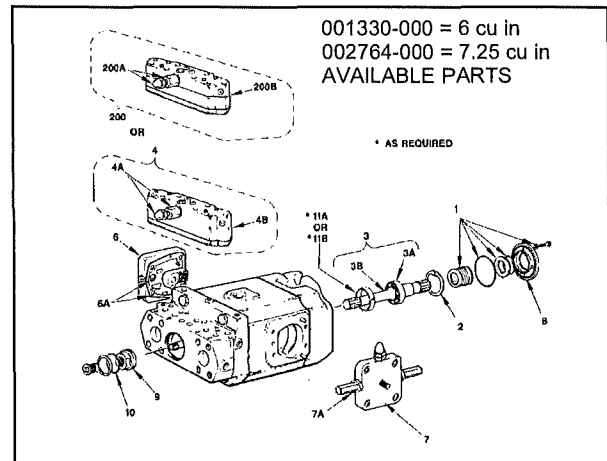


Maintain pressure/return and case drain hoses as needed. Inspect hoses for wear at all points for rubbing. Replace worn hoses as needed and prior to failure.

Flange plugs are available from Sandvik Regional spare parts department and may be used to stall a pump for diagnostic purpose.

FLANGE PLUG PN	FLANGE PLUG SIZE
004762-001	.50 #8-8
004762-002	.75 #12-12
004762-003	1.00 #16-16
004762-004	1.25 #20-20
004762-005	1.50 #24-24
004762-006	2.00 #32-32

Rotation pumps may be stalled at the A and B work ports during diagnostic testing. It is recommended to turn the compensator valve out (ccw) prior to stalling the pump.



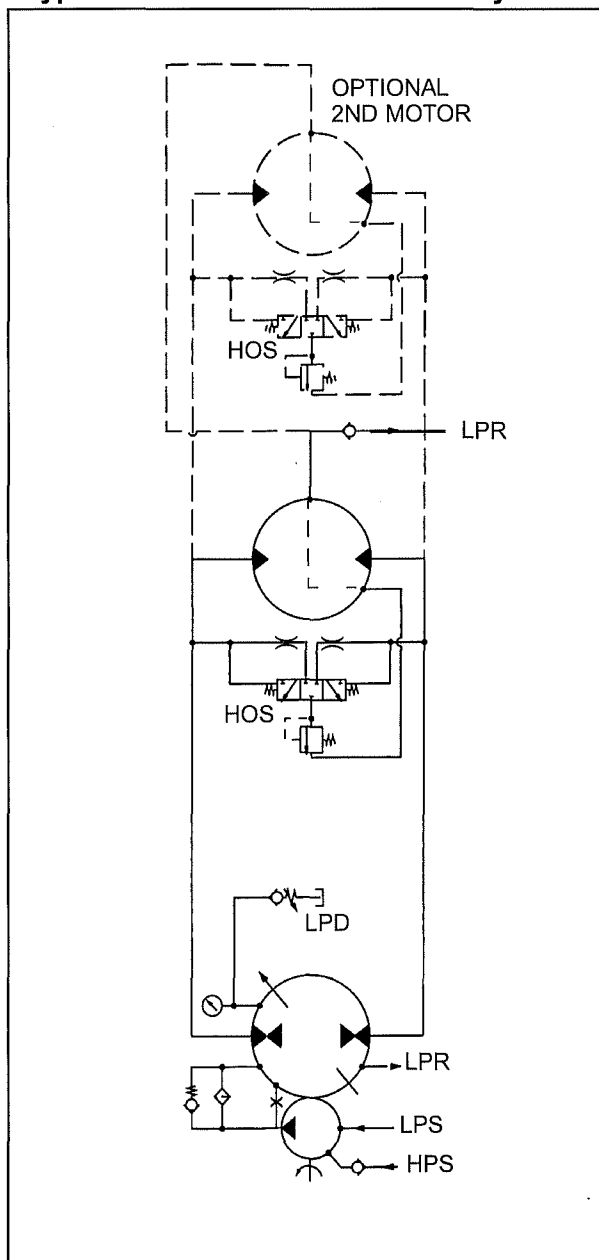
New pump/motor installations

When replacing pump(s) and motor(s) it is recommended to inspect or replace the shaft coupling.

A lithium - molybdenum disulfided or similar coupling grease is recommended for new component shafts. (Mobil EP111)

Rotation motors have a spring washer positioned between the motor flange and the drive coupling. Do not operate the rotary drive system without the spring washer as excessive coupling travel will damage the rotary drive components.

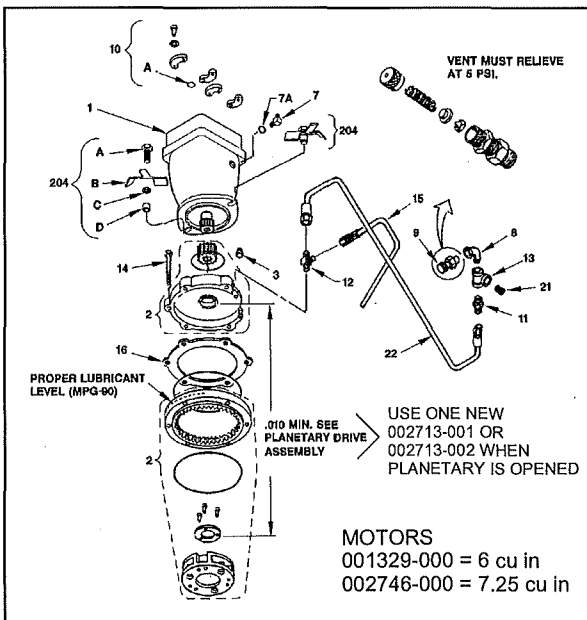
Typical one or two motor rotation system.



Nomenclature regarding the rotation system components shown here. These names are common throughout the product range.

- LPR low pressure return
- LPS low pressure supply
- HPS high pressure supply
- HOS hot oil shuttle valve(s)
- LPD low pressure drain

Rotation motors are two bolt or four bolt flange mounting with different part numbers for the applications.



Rotary Speed And Torque

Motor and planetary are matched as sets to achieve a desired rotation speed and torque for the ground condition.

Planetary sets are identified by part number:

- 001004-001 = 4.89 reduction
- 001079-001 = 3.27 reduction

Pump output flow, number of motors, motor displacement and planetary reduction are the main elements when selecting correct drill pipe, drill bit rotation speed.

#	DISPLACEMENT	PLANETARY REDUCTION	50 GPM MAX RPM	60 GPM MAX RPM	75 GPM MAX RPM	113 GPM MAX RPM
1	6 ³ IN	3.27	160	192	240	****
1	6 ³ IN	4.89	106	127	160	****
2	6 ³ IN	3.27	80	96	120	175
2	6 ³ IN	4.89	53	64	80	118
1	7.25 ³ IN	3.27	132	158	198	****
1	7.25 ³ IN	4.89	89	106	132	****
2	7.25 ³ IN	3.27	61	79	99	145
2	7.25 ³ IN	4.89	45	53	66	97

Match motor(s) and planetary reduction with pump output flow to achieve a desired drill pipe rotation speed.

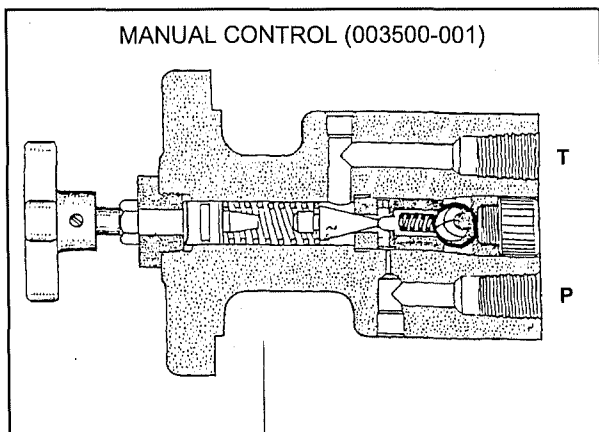
The examples shown are some of the most common applications.

Maximum torque is available through the pressure range of the pump and motor selection.

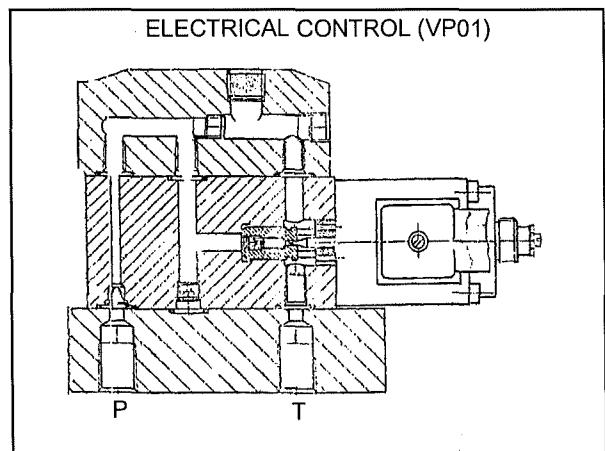
A remote pressure control valve and a pressure gauge connected to the rotation pump main pressure enables torque to be set for drill pipe and bit control in various ground conditions.

Two valve applications are typical on drill machines:

- manual adjustable control



- electrical adjustable control



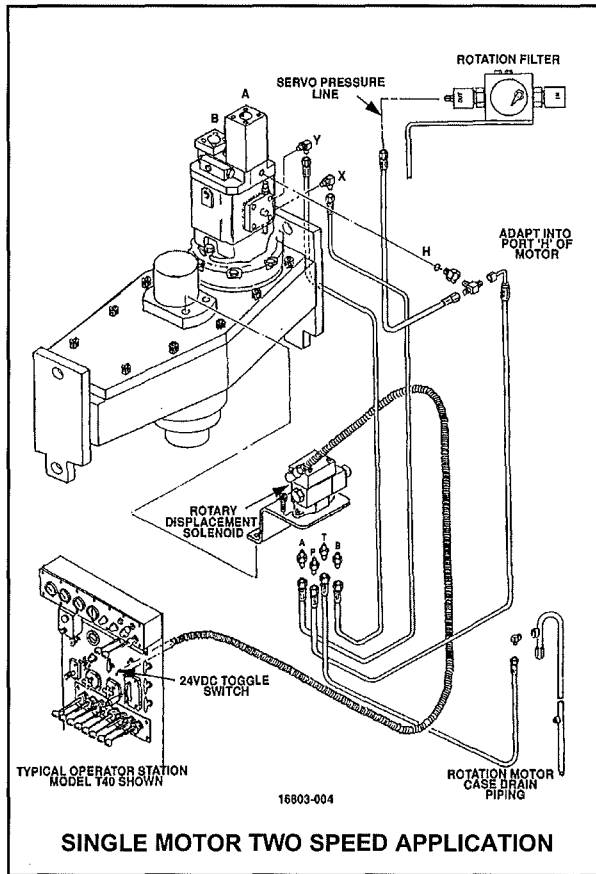
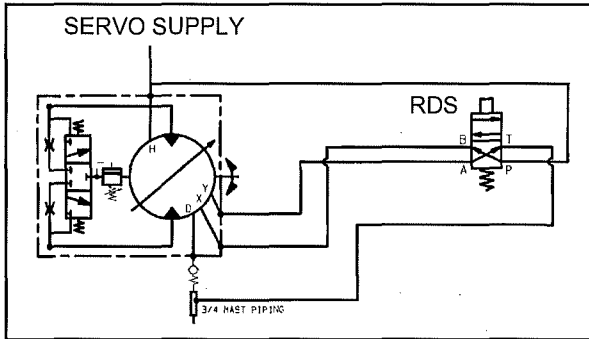
Remote pressure valves may be removed from the pump port during diagnostic checks. When a valve seat is open or damaged due to low input power or common wear, the pumps pressure will take the path to low pressure drain.

Removing the P or T port hose and securing the hose with a pressure type hydraulic plug allows the remote pressure valve to be bypassed. Install a hydraulic cap over the exposed valve port.

Two Speed Rotary Applications

High rotation torque becomes a concern when drilling through different ground formations.

The two speed rotation system allows the operator to change the motor torque and speed output when encountering different ground conditions. Pump volume output remains standard, the motor displacement changes according to operator need.



Under normal operating conditions motors are set to the maximum angle which give a slow speed as standard. when selected servo oil through the rotatary displacement solenoid directs the input control to change cam angles.

HIGH PRESSURE RETURN

BACK-PRESSURE

Vane pump systems free circulate oils through directional valves known in our systems as (stacker valves). Hydraulic oils are directed through these valves during actuation to operate accessories that assist the drilling cycle.

A few of the drill related accessories are:

- drilling air
- mast locking
- drill pipe loader(s)
- dust control and water injection
- angle drill options

After free circulating oil or actuation of stacker valves the hydraulic oil is directed to a return filter canister for fine filtration.

After filtration this oil under pressure is available for the feed pump and rotation pump as replenishing oil.

HYDRAULIC RESERVOIRS

Current Sandvik blasthole machines have 4 variations of the hydraulic reservoir.

- GATOR, D245SP, D560
- D25KS, D245S, T25KW, T35KS
- D40KS, D45KS, D50KS, D55SP, D60KS, D75KS, T40KS, T60KS
- D90KS, D90KSP, 1190E

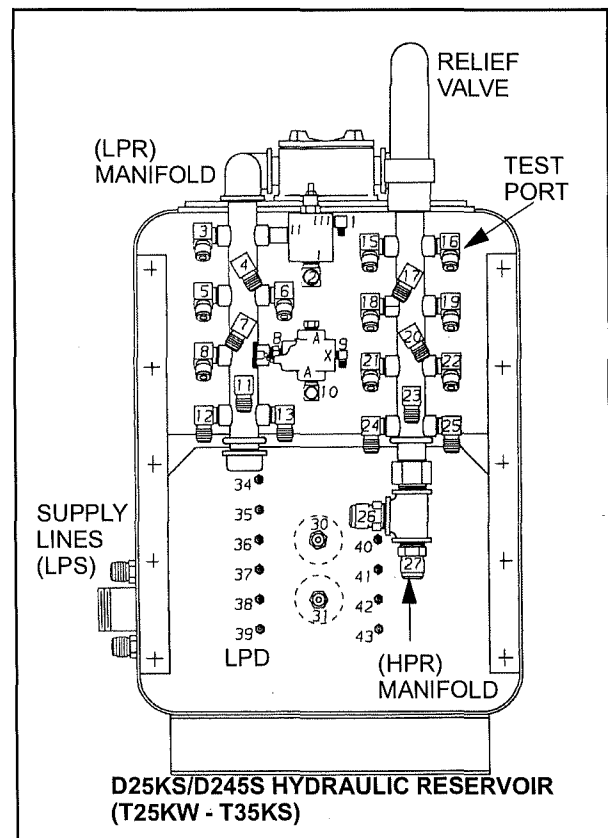
All reservoirs use the following nomenclature:

- LPS low pressure supply
- HPS high pressure supply
- LPR low pressure return

- HPR high pressure return
- LPD low pressure drain

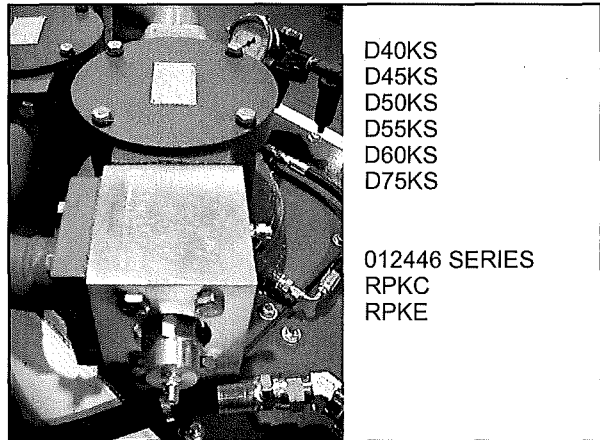
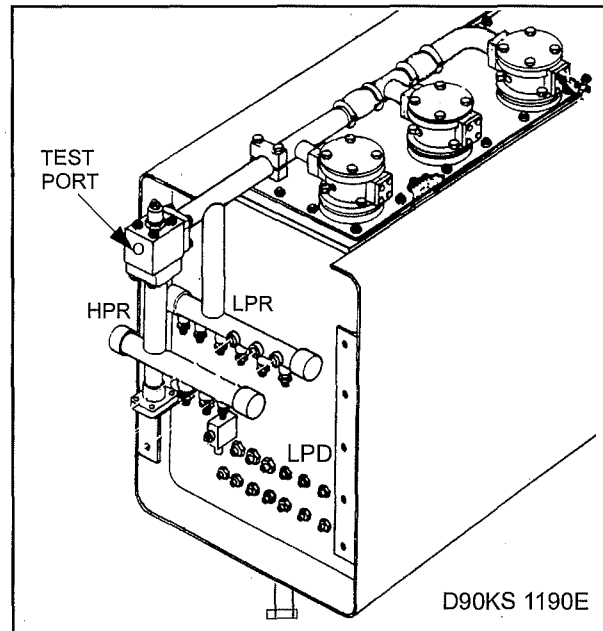
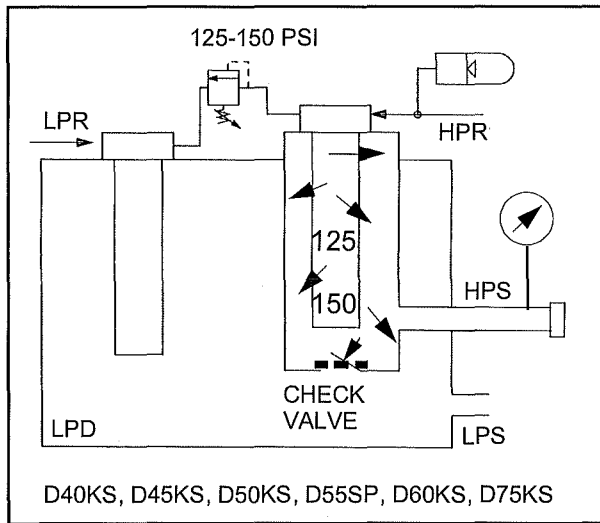
All of our reservoirs use the elevated return pressure from HPR as a replenishment charge pressure for feed pumps.

Maintaining this pressure on regular intervals (500 hour maintenance) will extend feed pump service life.



Pressure spikes from the vane pump stacker valves and feed systems occur during normal operation. Mid-range machines may have one 2.5 gallon accumulator on a mounting plate inside the mast pedestal. One hose will connect the accumulator to the HPR manifold return pipe.

Charge accumulator to specs noted in service literature 004695-000 using (N₂) nitrogen gas only as the filling compound.



CAUTION

HPR/HPS pressure should be lower than pump replenishment pressure. It is recommended that the pump replenishment and HPS pressures maintain a 30 to 50 psi (2 - 3.5 bar) differential.

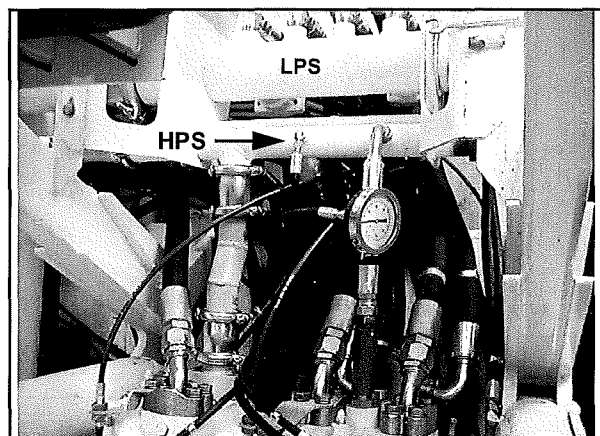
PUMP SPEEDS

The vane pumps are specific for the machine models and the operating systems. Primary pumps utilized for drill accessories are the T6C and T6CC series from Denison hydraulics.

Gearbox ratios determine the pump(s) actual output when the engine is at high idle speed. This feature is factored into the design of a specific model of drill machine.

Low engine speed will generate oil flows however the actuator speed will not be to specifications. Pump output flows should be metered, and any pressure checks or setting of the back-pressure valve should be performed with the engine at the rated high idle speed.

Mid range machines back pressure may be taken at the HPS manifold 2 inch (52mm) high pressure supply manifold positioned between mast pedestal diagonal supports.



Three pressure ports are made available for testing the back-pressure.

- At the back-pressure valve manifold before the filter.
- In the supply pipe referred to as (HPS) after the filter. **Most common test port.**
- In the return pipe referred to as (HPR) before the filter.

CHECKING HPR/HPS PRESSURE:

No Pressure Setting Adjustment Required.

- Install 500 psi (35 bar) gauge at either of three ports noted.
1. Start machine engine.
 2. Set the engine to high idle speed.
 3. Warm hydraulic oils to $> 100^{\circ}\text{F}$ (37.7°C).
 4. Check gauge pressure at selected port position. (HPS manifold)
 5. Operate feed pump control and feed system directional control valve.
 6. Check gauge pressure during feed pump oil consumption.
 7. Refer to HPR/HPS performance chart.
 8. If pressure maintains the desired pressure during feed pump utilization no pressure adjustments are required.

Pressure may be unstable during the feed system actuation. Gauges may bounce during oil demands.

During feed system actuation HPR/HPS pressures vary from 30 to 100 psi (2 to 6.9 bar) above the neutral pressure setting. Pressure spikes in HPR/HPS above 250 psi (17 bar) could cause damage to hydraulic components.

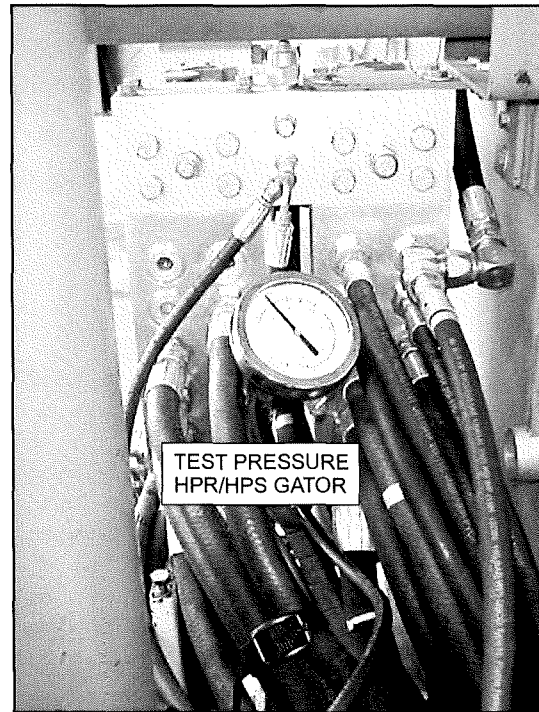


Photo shows a Gator machine test port on the HPR/HPS back pressure manifold. The relief valve setting is 150 psi (10 bar) using a 500 psi (35 bar) gauge for the test.

CHECKING HPR/HPS PRESSURE:

Backpressure Adjustment Required.

- Install 500 psi (35 bar) pressure gauge at either of three ports noted.
1. Start machine engine.
 2. Set the engine to high idle speed.
 3. Warm hydraulic oils to $> 100^{\circ}\text{F}$ (37.7°C).
 4. Check gauge pressure at selected port position.
 5. 9/16 (14mm) wrench, 5/32 (4mm) allen wrench required to adjust. Tools may vary depending on machine model.

6. Loosen lock nut on back pressure valve thread.
7. CW adjustments increase, CCW adjustments decrease pressures.
8. Refer to high pressure performance chart for pressure values.
9. Upon desired pressure range, tighten lock nut on valve thread.
10. Operate feed pump and directional control valve, checking HPS pressure.
11. HPS pressure should not drop below specified pressure.

NOTE!

- During (feed, mast raise, leveling jack) cylinder actuation and the feed pump on full volume output, the back-pressure noted may rise above the spec pressure. This is due to variations in oil volumes returning to the back-pressure valve from the operated cylinder(s).
- When said cylinders are operated in an abusive manner pressure spikes are witnessed in this back-pressure system. In turn these pressure spikes will damage hydraulic components.

Examples of abusive cylinder actuation are, and not limited to:

- Rapid feed cylinder directional changes, up and down.
- Stopping mast raise cylinders with full volume oil, lowering or raising mast.

HPR PERFORMANCE CHART

Pressures noted herein are static pressures. The pressures will raise an lower according to loads within the systems.

MODEL	HPR/HPS psi (bar)
GATOR	150 (10/10.5)
D25KS	175 (12)
D245S	175 (12)
D35KS	150 (10/10.5)
D40KS	125/150 (8.5/10.5)
D45KS	125/150 (8.5/10.5)
D50KS	125/150 (8.5/10.5)
D55SP	125/150 (8.5/10.5)
D60KS	125/150 (8.5/10.5)
D75KS	125/150 (8.5/10.5)
D90KS	175/230 (12/16)
D90KSP	175/230 (12/16)
1190E	175/230 (12/16)

See troubleshooting procedures in the event that back pressure cannot be adjusted and/or maintained during feed pump actuation.

Consult the Sandvik Regional technical support team for help in the event pressure spikes are present at HPR/HPS manifolds during your drilling application.

Operating principals and/or additional spare parts may be required.

ACCUMULATOR (004695-000)

RECHARGING

CAUTION

Overcharging the accumulator bladder can damage the accumulator and hydraulic components. Extreme temperatures can result in incorrect pressure readings. Accumulator charging should only be done when the ambient temperature is between 70 and 100°F (21 and 38°C).

1. Exhaust all hydraulic pressure from the system.

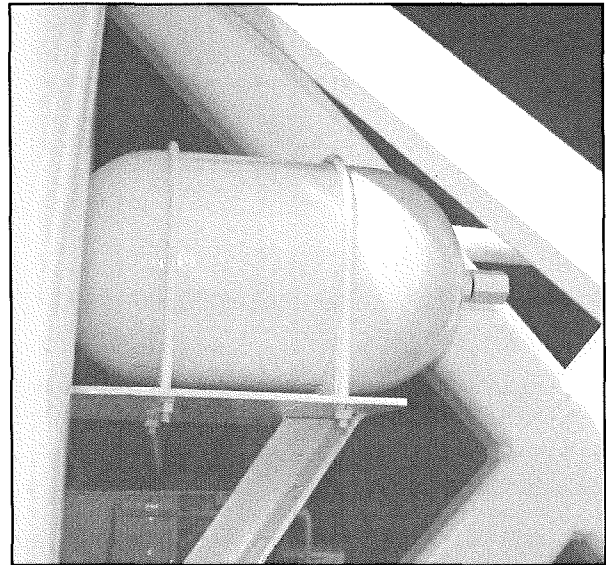
CAUTION

DO NOT use oxygen as a charge gas. Dry nitrogen gas should be used.

2. Remove valve guard and dynaseal.
3. Mount hose assembly gland nut to pressure regulator.
4. Attach a swivel connector to the gas valve. Hand tighten sufficiently to compress gasket swivel connector in order to prevent gas leakage.
5. Precharge bladder slowly to about 10 PSIG before completely tightening the valve stem nut. Use a second wrench on the valve stem flats to react the torque applied to the stem nut.
6. Proceed to inflate accumulator to 100 psi (7 bars) by slowly opening the pressure regulator valve on nitrogen cylinder, closing it occasionally to allow needle on pressure gauge to stabilize (thus giving accurate reading of precharge pressure). When correct precharge has been reached, close pressure regulator valve on nitrogen cylinder securely.

7. The bleeder valve can be used to let out any gas pressure in excess of desired precharge.
8. Replace dynaseal and valve guard.

The accumulator charges should be pressure checked at approximately 100 hour intervals. If the bladder charge cannot be maintained, the complete accumulator must be replaced.



2-18-92

FEED SYSTEM

GENERAL

There are many different configurations of feed systems. This manual details:

- D55SP with fast feed - Rotary application
- D55SP with fine feed - DTH application
- D40KS - DTH drill application
- 90 series cylinder pulldown - Rotary application
- 90 series motor pulldown - Rotary application
- Gator drill/propel - DTH application
- D25KS D245S drill/propel - DTH application

Confirm the specific drill machine system schematic for other applications.

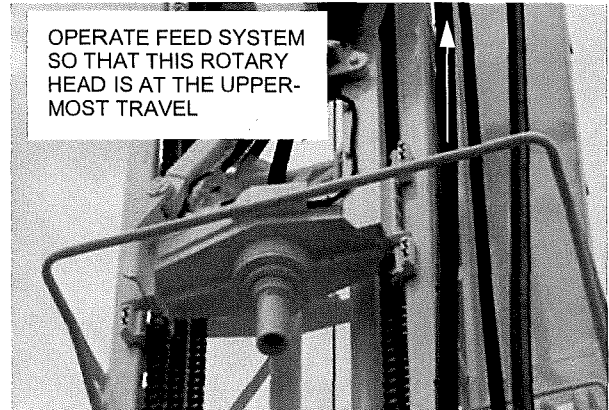
FEED SYSTEMS

Machine models, feed cylinders, pulldown and hoist chains are primary considerations when setting a feed system properly. A feed system performance chart provides product model feed system specifications through the blasthole equipment product range.

The Denison piston pump may be in an open loop or closed loop application. The feed system has to be operated on and put into a stall setting in order to calibrate the maximum system pressure.

When possible test the feed system without the drill pipe connections. Rotary head empty as shown in the following illustration.

The steps noted in this section are to be utilized for all blasthole application feed systems.



Operation and machine safety are of utmost concerns during all hydraulic pressure setting procedures. Stay clear of moving components such as chains, sprockets and table bushings while feed system is in operation.

▲WARNING

Oil under pressure can pierce the skin causing health concerns, or possible death. Do not feel for hydraulic oil leaks with your bare hand. Avoid skin contact whenever possible.

▲WARNING

Hot hydraulic oil may cause sever burns.

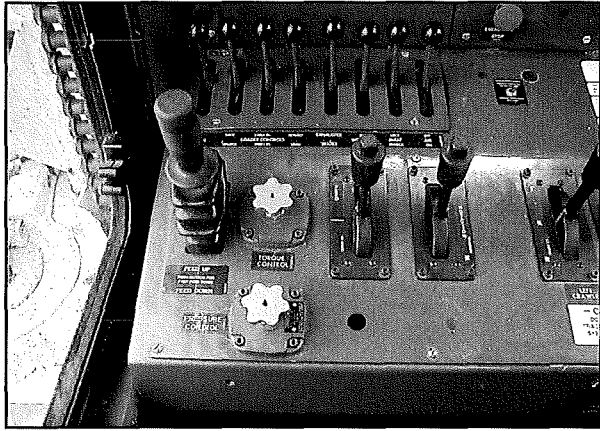
When checking and setting feed pump systems it will be necessary to register the pump servo and high pressure supply pressure as well.

CHECKING PUMP PRESSURE:

No Pressure Adjustment Required:

1. Start machine engine.
2. Set the engine to high idle speed.
3. Warm hydraulic oils to > 100° F (37.7° C).

Gator, D25KS and D245S series machines shall have the drill propel selector (DPS) placed into the drill mode prior to operating either of the feed systems.



4. Place pump control on stroke approximately 20% (manual or electric).
5. Set (manual or electric) feed pressure control ccw to minimum setting.
6. Actuate directional control valve to hoist (forward) position.
7. When feed cylinder(s) are fully retracted and the rotary head contacts top of mast, adjust feed pressure control cw to maximum pressure setting.
8. If feed pump pressure is to spec, lower pressure control setting ccw.
9. Center directional control valve to neutral position.
10. De-stroke feed pump.

CHECKING PUMP PRESSURE:

Diagnostic And Troubleshooting:

- Install 1000 psi (70 bar) pressure gauge to pumps 'G' port for servo pressure.
 - Install 500 psi (35 bar) pressure gauge on HPS manifold (replenishment pressure).
1. Start machine engine.
 2. Set the engine to high idle speed.

If pump is new allow adequate pre-charge time per new pump start-up procedure.

3. Warm hydraulic oil to > 100° F (37.7° C).
4. Place pump control on stroke approximately 20% (manual or electric).
5. Set (manual or electric) feed pressure control ccw to minimum setting.
6. Actuate directional control valve to hoist position.
7. When feed cylinder(s) are fully retracted and the rotary head contacts top of mast, adjust feed pressure control to maximum pressure setting.
8. Remove pump compensator cover nut, loosen lock nut.
9. Adjust pressure compensator in to increase pump stall pressure.
10. Adjust pressure compensator out to decrease pump stall pressure.
11. Adjust pressure to machine model spec per feed performance chart.
12. Monitor servo pressure while setting main pressure.
13. Monitor HPS pressure during setting main pressure.
14. Center directional control valve to neutral position.

When main, servo and HPS pressures are in spec.

15. De-stroke feed pump.

Center the feed pump controls to neutral during propel, machine start and shutdown modes.

All pressures noted are with hydraulic oil > 100° F (37.7° C) engine speed at high idle, auxiliary pressure gauges installed to appropriate ports.

FEED PERFORMANCE CHART

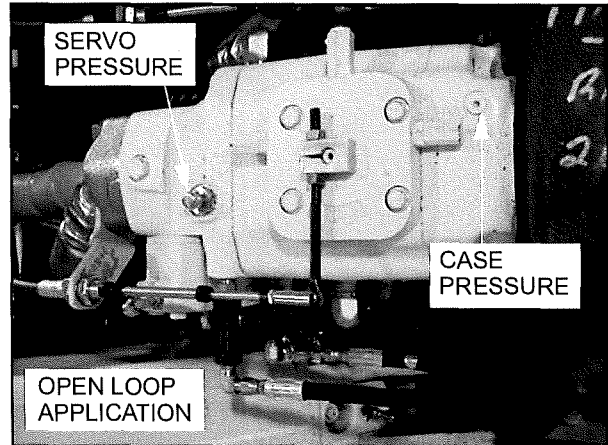
Model	Main Psi (Bar)	Servo Psi (Bar)	HPS Or Replenishment Psi (Bar)
GATOR *	3000 (207)	330/580 (23/40)	200/300 (14/21)
D25KS *	3500 (242)	330/580 (23/40)	200/300 (14/21)
D245S *	3500 (242)	330/580 (23/40)	200/300 (14/21)
D35KS	3000 (207)	N/A	N/A
D40KS	3000 (207)	160/280 (11/19)	125/150 (8.5/10.5)
D45KS	3000 (207)	160/280 (11/19)	125/150 (8.5/10.5)
D50KS	3000 (207)	160/280 (11/19)	125/150 (8.5/10.5)
D55SP	3200 (220)	160/280 (11/19)	125/150 (8.5/10.5)
D60KS	3500 (242)	160/280 (11/19)	125/150 (8.5/10.5)
D75KS	3500 (242)	160/280 (11/19)	125/150 (8.5/10.5)
D90KS *	3500 (242)	330/580 (23/40)	200/300 (14/21)
D90KSP *	3500 (242)	330/580 (23/40)	200/300 (14/21)
1190E *	3500 (242)	330/580 (23/40)	200/300 (14/21)

Products * have closed loop feed systems therefore servo and replenishment pressures will differ between models with the open loop feed system.

Auxiliary pressures to be checked when performing feed system set-up, diagnostic, and troubleshooting.

- High pressure supply (HPS) adjustable from 125 to 150 psi (8.5 - 10.5 bar) on mid range machines and 175 psi (12 bar) other applications noted in the HPR performance chart. This pressure is a open loop pumps replenishment oil at prescribed pressure.

- Open loop pump servo pressure 160 to 280 psi (11 - 19 bar) range. Servo pressure increases with working pressure.



- Closed loop pump servo pressure 330 to 580 psi (23 - 40 bar). Servo pressure increases with working pressure.
- Closed loop pump replenishment pressure 200 to 300 psi (14 - 21 bar). Replenishment pressure decreases due to the condition of the system components.

Piston pump case pressure 5 to 40 psi (.4 - 2.8 bar) dependent on main pressure. Pump case pressure increases with system pressure and should not exceed 75 psi (5.2 bar).

MACHINE LIFT-OFF

A machine safety system designed to limit drilling capacity and over pressure conditions is connected to all feed system applications. The extend side of feed cylinder(s) are monitored during drill conditions.

Lift off components consist of

- one manifold mounted adjustable relief valve
- interconnecting #4 hoses
- inline check valve positioned on open loop feed pump port FB
- inline needle valve connected to open loop feed pump port DG.

Machine lift off relief valve setting can limit the machines down pressure capability.

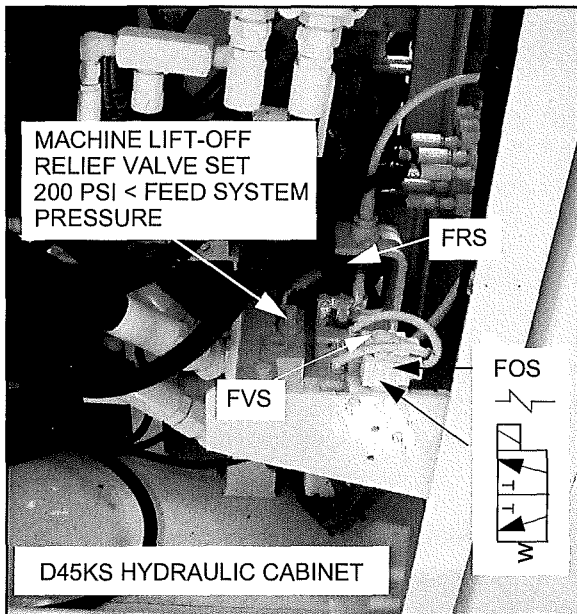
The inline check valve on open loop feed pump applications stops feed pump servo pressure from venting to pump case drain thus affecting pump control.

The needle valve on open loop feed pump applications limit system pressure and derates the feed pump internally. The needle valve must be open 1.5 to 3 turns so the pump will derate.

NOTE!

For open loop feed pump applications lift-off relief valve is positioned on the feed distribution manifold inside the hydraulic cabinet lower left inside corner.

The typical machine lift-off pressure value is 200 psi less than the feed pump main pressure setting for the specific model machine.



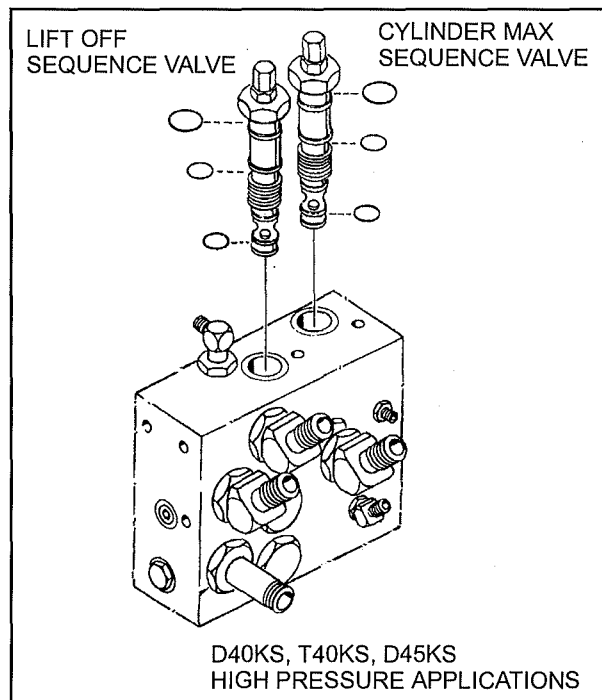
NOTE!

On D40KS and D45KS high pressure drill applications the feed distribution manifold may support a retract side cylinder maximum sequence valve. This valve is protecting feed

cylinders when deep hole drilling applications are used.

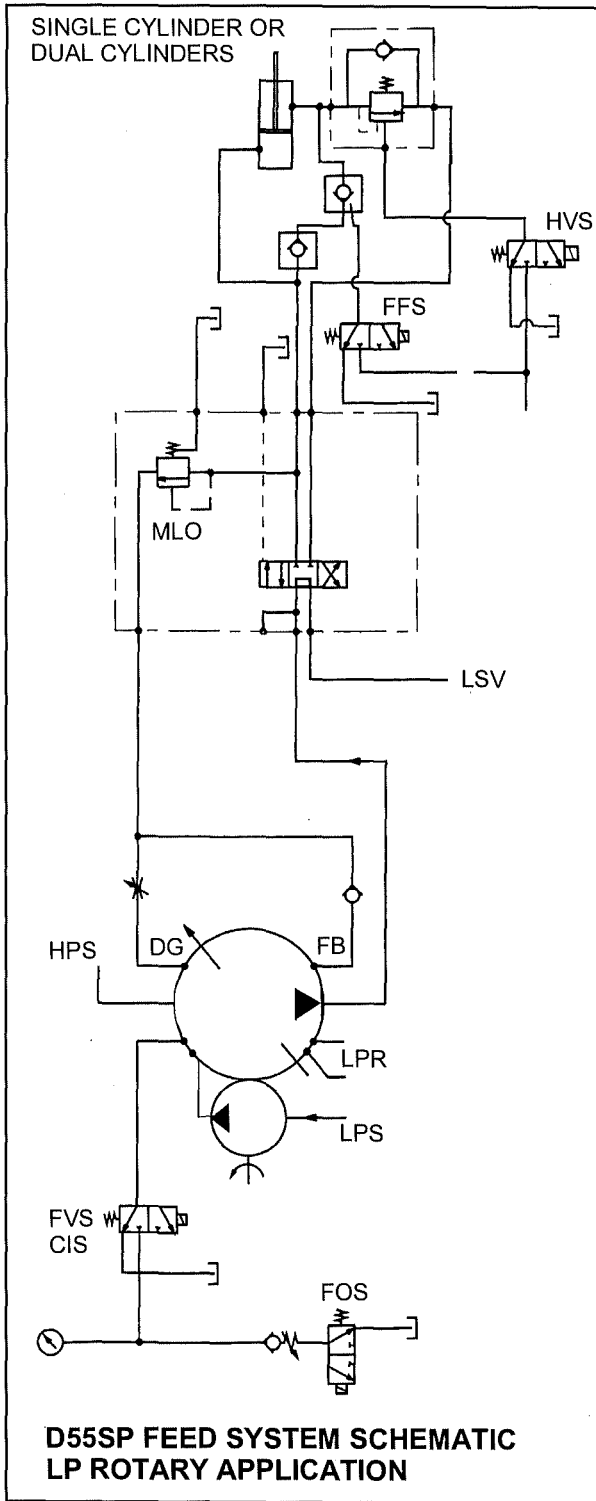
The cylinder maximum sequence valve setting is 4200 psi. Pump pressure have to be altered prior to setting the cylinder maximum sequence valve. Upon proper calibration return feed pump to feed system specs.

The feed distribution manifold for high pressure drill applications may have a additional 3/4 way control valve with cable connections and the additional maximum pressure relief valve.



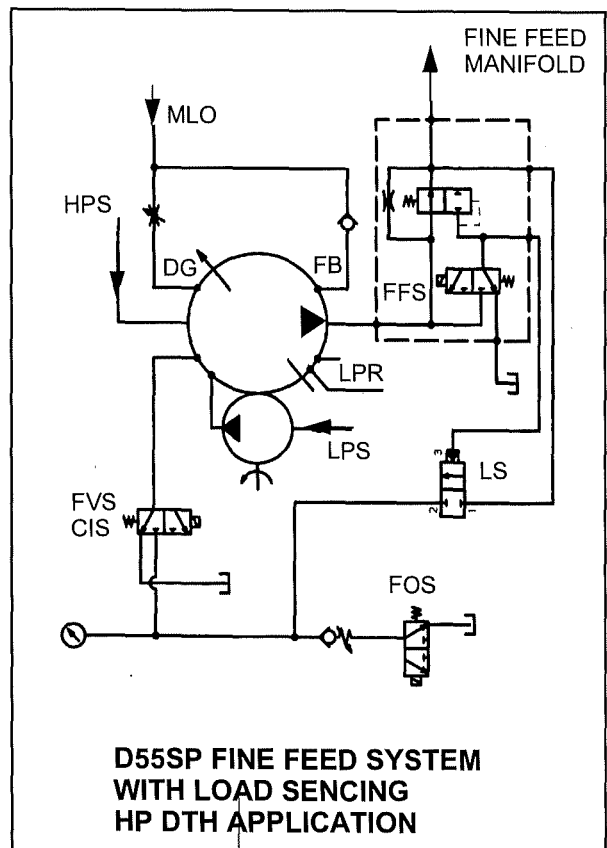
Feed override solenoid FOS and feed vent solenoid FVS part number 002006-101 are shown mounted to support. These hydraulic solenoids are common valves typically used to vent a system pressure or allow pilot pressure to be applied.

Consult machine specific electrical schematic for options.



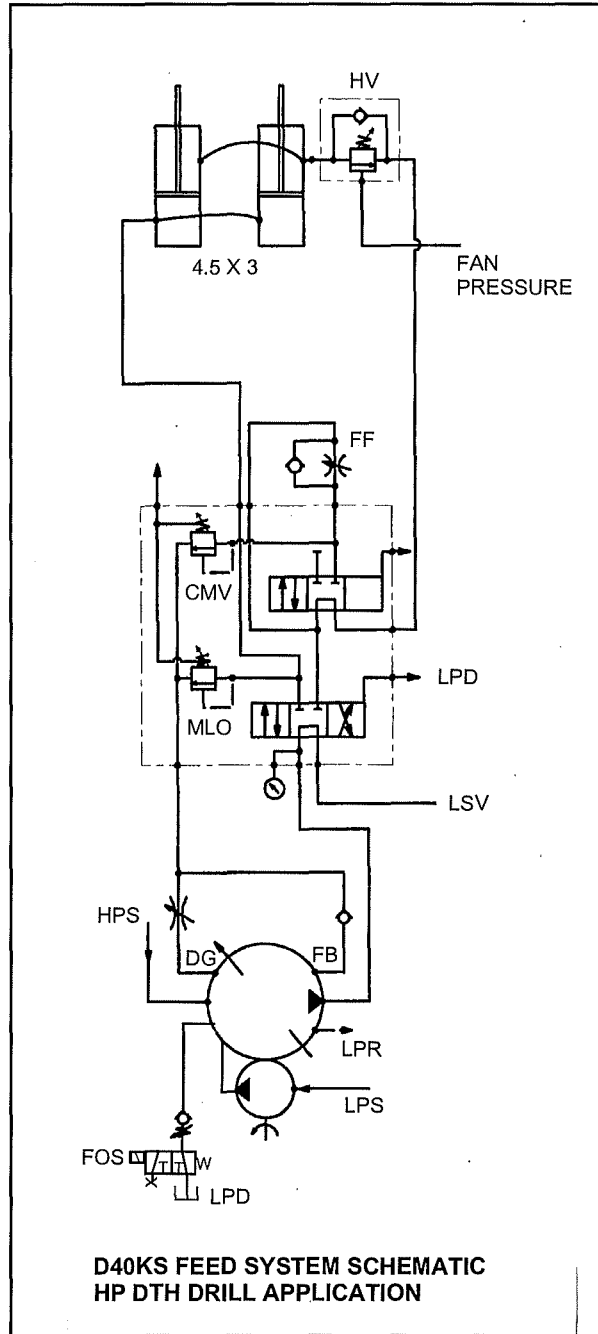
Nomenclature regarding the feed system components shown here. Many of these names are common throughout the product range.

- FOS Feed Override Solenoid
- FF Fine Feed Adjustment
- FFS Fast Feed Solenoid
- FVS Feed Vent Solenoid
- CIS Centralizer Interloc Solenoid
- HVS Holding Valve Solenoid
- HV Holding Valve
- MLO Machine Lift Off (200 psi < feed pump)
- LSV Lower Stacker Valve (2500 psi)
- LPS Low Pressure Supply (5 psi)
- LPR Low Pressure Return (8 - 20 psi)
- LPD Low Pressure Drain
- HPS High Pressure Supply (125 - 150 psi)
- LS Load Sensing
- FFS Fine Feed Solenoid



Feed systems for DTH drill applications have added valves allowing a fine feed or holdback system.

Holdback is generally used when drilling deep holes with high drill string weight. Holdback when used allows the operator a means to stop or hold the drill string weight.



90 Series Feed Systems

Cylinder Pulldown

A 90 series machine application feed system uses a 14 cu in (229.4 cc) pump. Pressures are noted in the feed performance chart.

There are two feed systems applicable to the 90 series machines.

- Multi pass drill applications will use the cylinder pulldown system
- Single pass drill applications are offered with either the cylinder or motor pulldown systems.

90 series multi pass cylinder application feed system require general maintenance of the accumulator and auxiliary valves inside the feed manifolds.

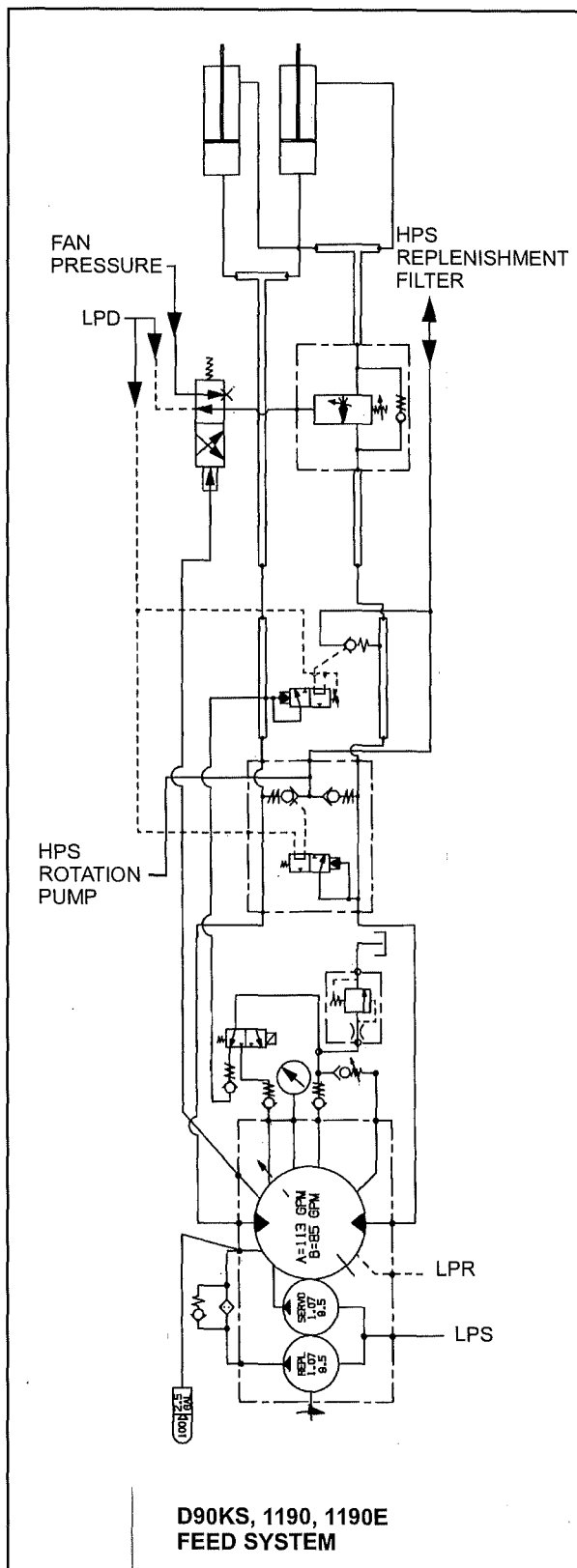
The feed pump for 90 series machines are in a closed loop application. Pump input controls are calibrated with two output flow rates.

- Pulldown mode output flow rate is 113 gpm (429 lpm) equates to 16° stroke limit.
- Hoist mode output flow rate is 85 gpm (323 lpm) equates to 13° stroke limit.

When the output flow limiters exceed the spec the feed system reacts faster when controlled on. Excess output flow may make the feed uncontrollable when the pump is centered.

The following list of hydraulic components may be used to identify and set the specific valves of a cylinder application feed system.

Holding valve: calibration specs are noted in service literature 008738. Holding valves are counterbalance valves for feed cylinders. The concept is to hold the load of rotary head and drill pipe during none drilling modes.



Decompression pilot valve: is a two piece component. The adjustable valve and check valve are mounted on the feed cylinder return pipe. Pilot hoses connect the pilot valve to a check valve. Pressure setting the pilot valve to 600 psi enables feed system pulldown pressure to open the decompression check valve. The decompression check valve allows oil into the feed pump return leg from HPS filtration.

- Install a pressure gauge on the decompression check valve between the pilot valve and check valve. Expected reading to open the check valve is 600 psi.

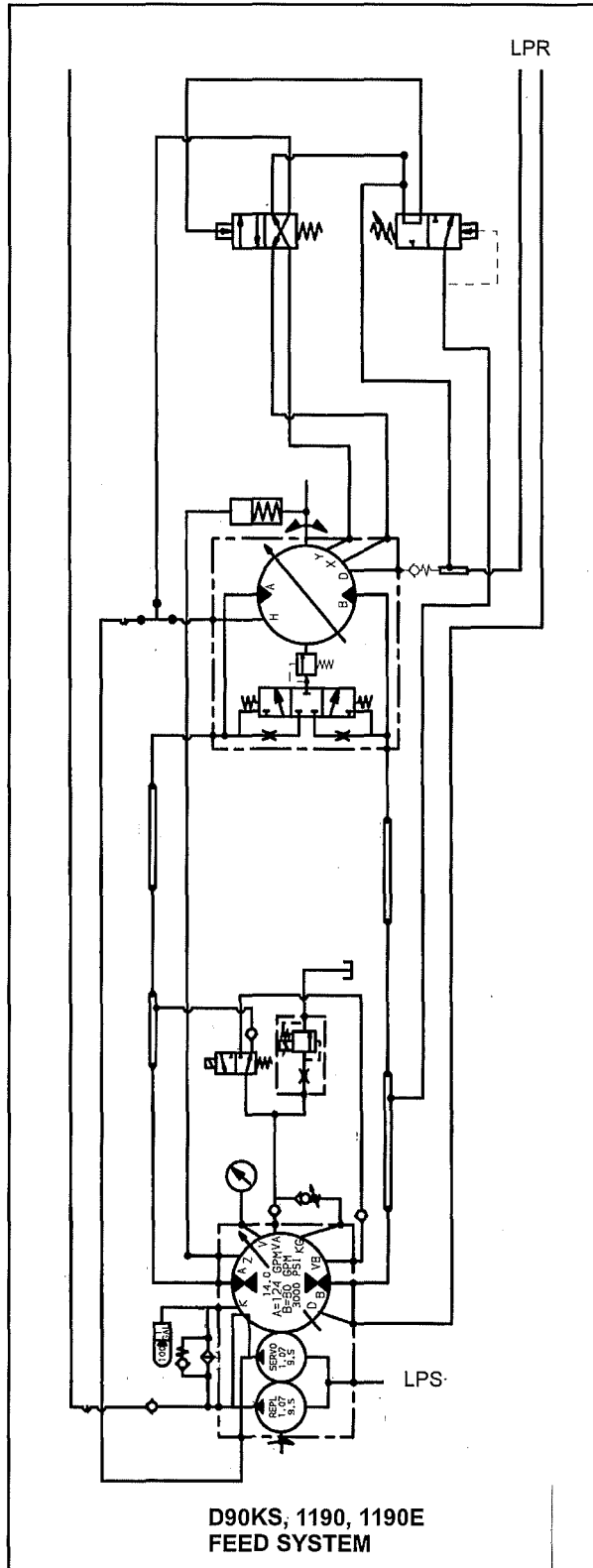
Replenishment check valves: are in a feed manifold due to feed cylinder rod and case area variations.

- It becomes necessary to allow oil into the feed system return leg for adequate replenishment during feed down conditions.
- It becomes necessary to allow oil to exit the return leg during hoist modes. The feed pump can be held over center if too much oil is trapped in the return leg during hoist modes.

Replenishment pilot valve: is applied when feed pump is in the hoist mode only. Valve setting is approximately 1000 psi (70 bar) The pilot valve opens the A port check valve to allow return oil from the feed cylinder a exit to HPR.

- This valve is preset according to the specific part number.

90 Series Motor Pulldown



90 series motor application feed systems require maintenance of accumulator and general hydraulic valves.

Two speed pilot control valve: is located near the motor on the feed gearbox mount.

- Connect a pressure gauge between the pilot valve and servo control valve. Adjust the pilot valve for 1000 psi (70 bar) outlet pressure.

Servo control valve: is located near the motor on the feed gearbox mount. Hoses from the pump servo system allow control oil to the motor X or Y port.

- Motor speed will be slow when servo oil is directed to Y port of the motor input control.
- Motor speed will be faster when servo oil is directed to X port of the motor input control.

Motor actuation may be visible by a slight speed increase for the hoist mode only. The motor output control has a pointer that shall move from 19° to 14° during the hoist mode when the two speed pilot control and servo control valves are operable.

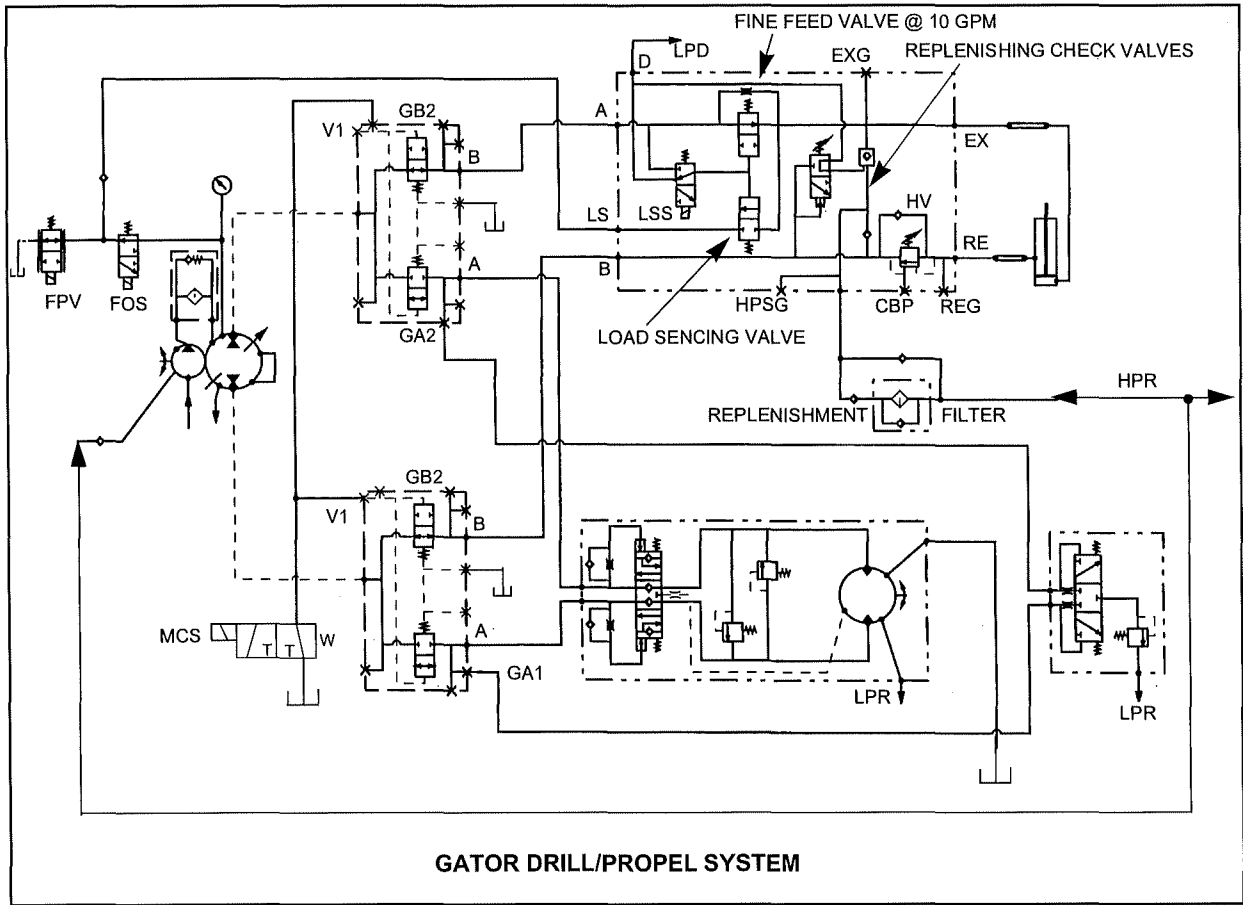
Drill/Propel Applications

The Gator, D25KS and D245S feed systems use a Denison piston pump for propel/rotation and propel/feed systems. Pump mounted manifolds require special torque discussed in the supplemental pump component section of this manual.

Each pump port manifold uses pilot assisted directional control valves to switch pump port flow to the dedicated system.

Fan system pressure in excess of 1800 psi (124 bar) enters manifold port V1 from a remote mount solenoid valve (MCS) during the propel tram mode only.

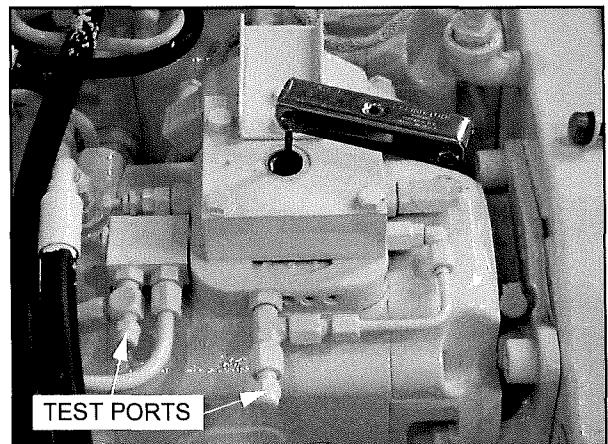
The directional control manifolds must have hoses attached to D1 or D2 ports in order to allow the valves to empty periodically.

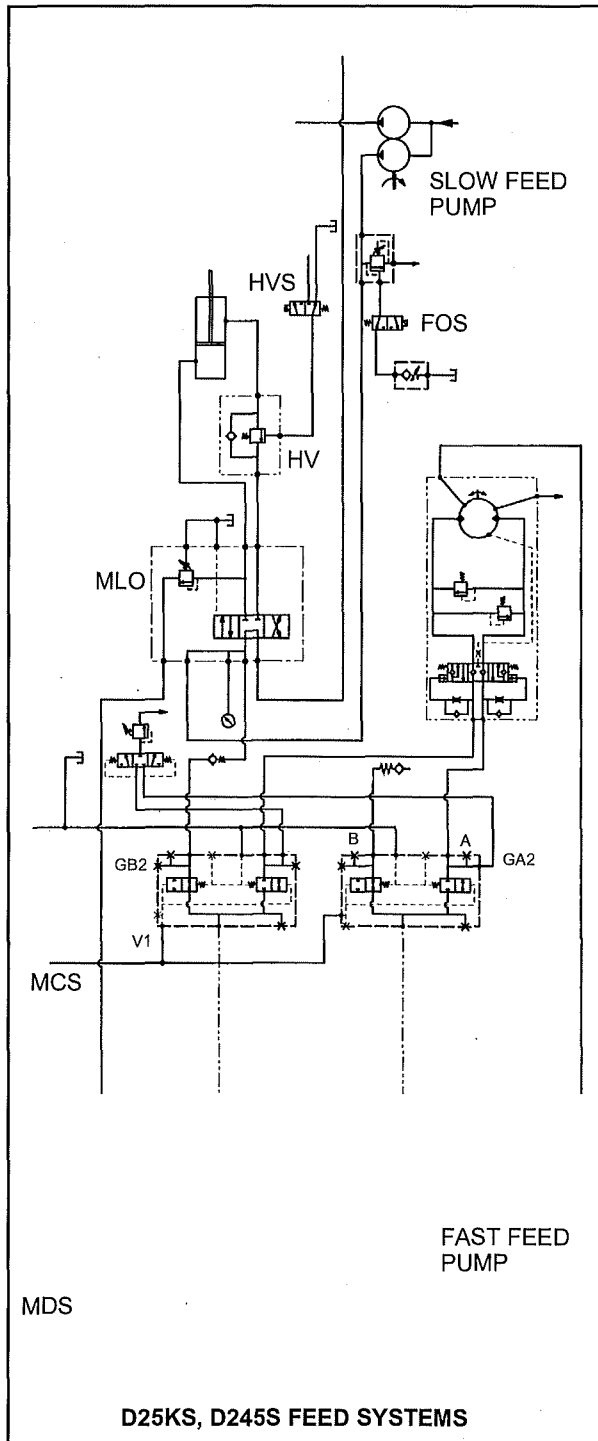


The Gator machine utilizes two 001330 series closed loop application pumps. Each pump is 6 cu in displacement and is controlled by a 900 series electronic displacement control valve.

Input voltage varies according to operator control. Expected voltage is 6 vdc for threshold and 21.5 vdc for max.

The Gator series pump may be manual controlled with standard hand tools.





between the two applications with vane pump principals.

D25KS high pressure applications use one T6CC vane pump

- shaft section - slow feed
- rear section - fan/accessory

D245S high pressure applications use one T6CC and one T6C vane pumps

- shaft section - slow feed
- rear section - fan
- single engine mounted pump - accessory

D25KS and D245S low pressure applications use one T6CC vane pump

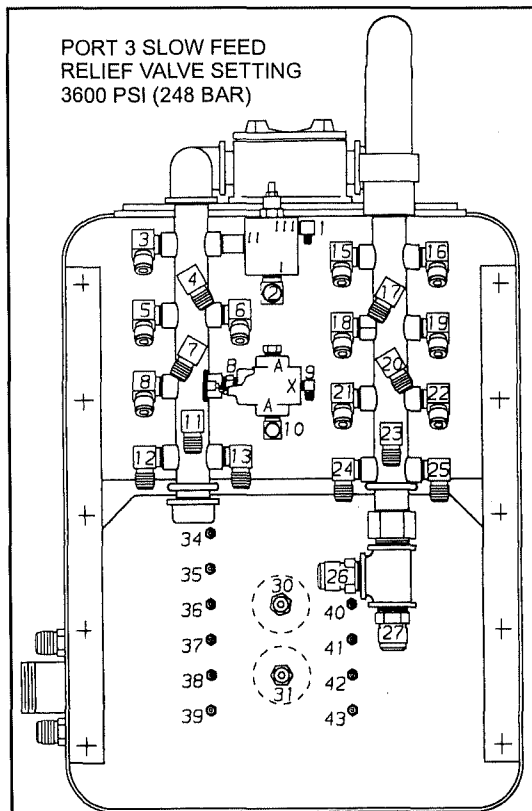
- shaft section - accessory
- rear section - fan

High pressure applications

D25KS and D245S applications with a slow feed system maintain a slow feed relief valve positioned on the low pressure return manifold port 9. The relief setting is 3600 psi (248 bar) set 100 psi over the fast feed pump pressure.

Fast feed pump compensator setting is 3500 psi (242 bar). Refer to the feed system performance chart when calibrating the fast feed system on D25KS and D245S model machines.

The D25KS and D245 machines are based on low pressure rotary or high pressure DTH drilling applications. The hydraulic systems vary



CHECKING PUMP PRESSURE:

No Pressure Adjustment Required:

1. Start machine engine.
2. Set the engine to high idle speed.
3. Warm hydraulic oils to $> 100^{\circ} \text{F}$ (37.7°C).

Gator, D25KS and D245S series machines shall have the drill propel selector (DPS) placed into the drill mode prior to operating either of the feed systems.



4. Actuate directional control valve to hoist (forward) position.
5. When feed cylinder is fully retracted and the rotary head contacts top of mast, adjust feed pressure control cw to maximum pressure setting.
6. If feed pump pressure is to spec, lower pressure control setting ccw.
7. Center directional control valve to neutral position.

Slow feed application specs

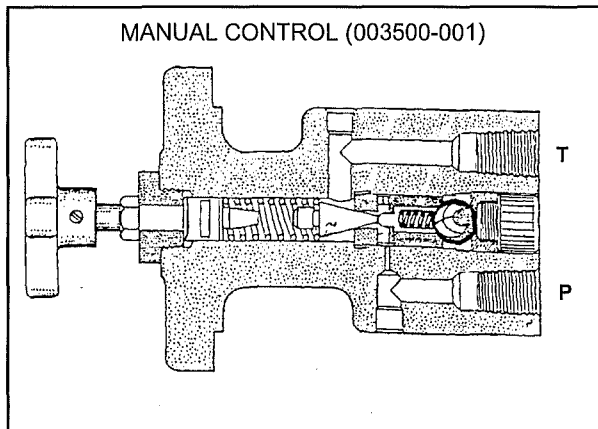
- Slow feed pressure at 3600 psi (248 bar)
- Fast feed pressure at 3500 psi (242 bar)
- Remote pressure valve control setting from 0 through the range.

Remote Pressure Controls

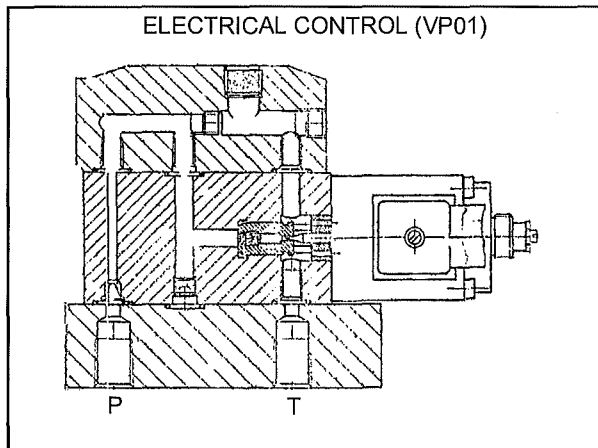
A remote pressure control valve and a pressure gauge connected to the rotation pump main pressure enables torque to be set for drill pipe and bit control in various ground conditions.

Two valve applications are typical on drill machines:

- manual adjustable control



- electrical adjustable control



Remote pressure valves may be removed from the pump port during diagnostic checks.

When a valve seat is open or damaged due to low input power or common wear, the pumps pressure will take the path to low pressure drain.

Removing the P or T port hose and securing the hose with a pressure type hydraulic plug allows the remote pressure valve to be bypassed. Install a hydraulic cap over the exposed valve port.

LOWER STACKER

DIRECTIONAL CONTROL VALVES

The lower stacker valve has two primary functions.

One is to provide oil supply for leveling the machine on uneven ground using (leveling jack cylinders).

Second is to have a sufficient oil supply for filling two (mast raise cylinders).

The components of the lower stacker valve circuit consist of:

- Pump supply oil
- Directional control valves
- Pressure control valve
- Hoses and hard line pipes
- Double acting cylinders
- Pilot check valves
- Counterbalance valves

The lower stacker valve sections are designed to accept large volumes of oil for the purpose of filling large diameter cylinders.

All blasthole equipment with the exception of the 90 series machines the lower stacker valve circuit operates with oil supply from the feed system.

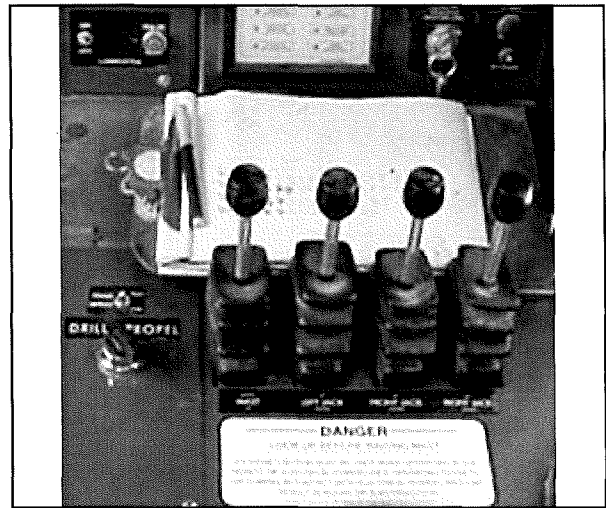
Feed system performance is essential for the appropriate lower stacker oil supply. Feed pump and operator controlled remote pressure valve enable lower stacker valve supply pressure.

Optional override features are available to allow electrical switching that blocks feed pump oil pressure from the remote pressure valve.

Feed override (FOS) feature when actuated enables the feed pump to maintain maximum

pressure with full volume oil supply dependent on pump control position.

- D25KS and D245S machines high pressure drilling applications have a slow feed and fast feed supply oil which will mix vane pump oil with a variable volume fast feed pump.
- D25KS and D245S machines use a drill/propel selector switch (DPS) to enable the piston pumps to independently operate both functions.



- Midrange products D40KS, D45KS, D50KS, D55SP, D60KS, and D75KS utilize a operator controlled variable volume oil supply.

The control of the pump displacement from the operators station can be varied to make slow or fast cylinder travel speed.

Lower stacker valve system pressure may be checked during normal operation from the drill operator station.

This system is not available on the Gator machine. The concept will differ on the D25KS, D245S and all 90 series equipment.

CHECKING LOWER STACKER VALVE PRESSURE:

No Pressure Adjustment Required

Monitor hydraulic pressure gauge on operator control panels.

When checking the lower stacker valve, relief valve setting stall a leveling jack cylinder in the upper most full retract position.

Place the drill/propel mode selector to the **drill mode** for D25KS and D245S machines.

1. Start machine engine.
2. Set the engine to high idle speed.
3. Warm hydraulic oil to > 100°F (37.7° C).
4. Turn feed remote pressure valve full CCW out for minimum pressure.
5. Place feed pump control on partial stroke. This may be to the first stop position.
6. Move and hold the left rear leveling jack control lever forward or up for a retract cylinder condition.
7. Adjust the remote pressure control CW to obtain a system pressure. Continue to adjust remote pressure valve until the pressure stabilizes at the stacker relief valve pressure setting.
8. Cab mounted hydraulic pressure gauge should be at 2500 psi (172 bar)

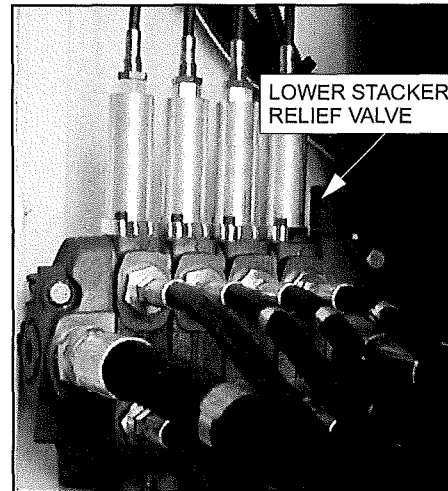
As stated prior the feed pump pressure(s) have to be the greater pressure in order for lower stacker pressure to be obtained.

2500 psi (172) bar is a base pressure for most machine applications. Under certain machine weights it may be necessary to increase the lower stacker relief valve pressure.

The absolute **maximum** pressure for lower stacker valves and cylinders are 3000 psi (207 bar). **Do not exceed 3000 psi (207 bar)**

Pressure Adjustment Required

1. Perform procedures noted.
2. Locate the lower stacker valve inside the hydraulic cabinet.



3. When adjusting pressure do so with **caution** and make small increment adjustments up toward the final setting.
4. Adjusting the set screw CW increases the system pressure. CCW decreases the system pressure available for cylinder working pressure.

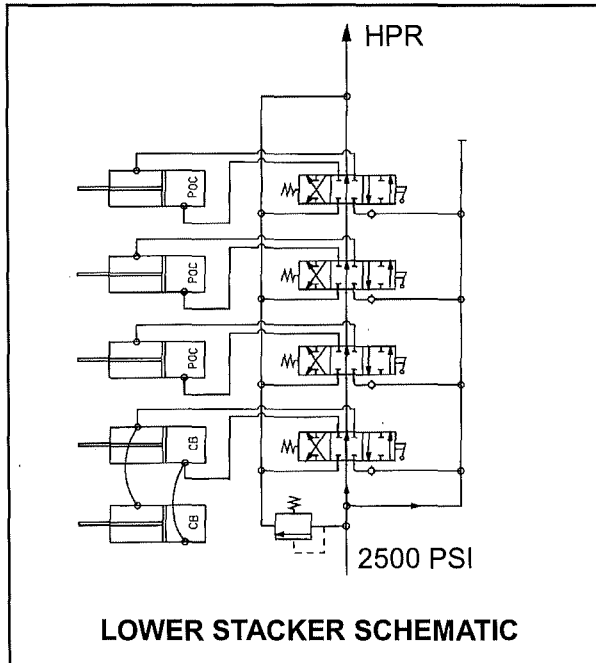
When making pressure adjustments a visual increase or decrease should be evident on a pressure test gauge. If there is no change in pressure value troubleshooting the feed system and/or lower stacker valve may be required.

⚠ WARNING

Opening a pressurized hydraulic line can result in personal injury, death or fire. Never open a working hydraulic system line during any phase of operation.

The lower stacker valve consists of

- one inlet section with a relief valve typically set at 2500 psi (172 bar)
- four or five open center manual controlled spring centered working sections
- one outlet section with return hose to HPR



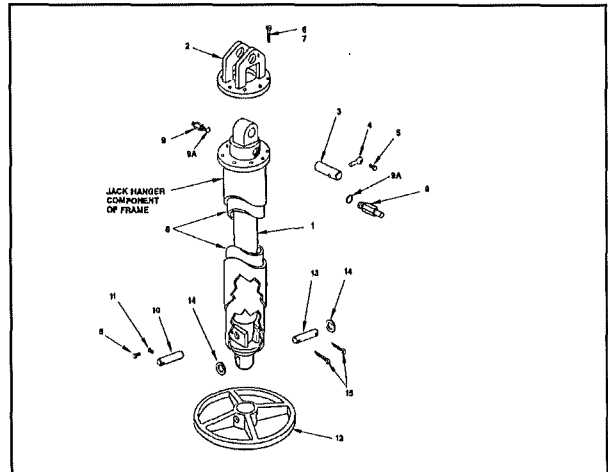
When servicing individual valve sections inspect spool seal surfaces, section mating surfaces, o-ring and back-up seal or quad seal condition, linkage or cable end alignment and adjustments.

Maintain proper tie rod tension for the specific manufacture valve assembly.

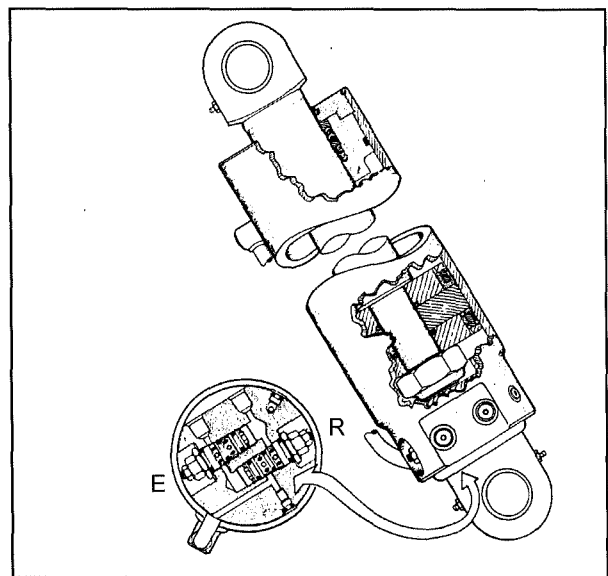
- Commercial Intertech 40 - 45 ft lb (54 - 61 Nm)
- Gresen 40 - 45 ft lb (54 - 61 Nm)
- Apitech 50 ft lb (68 Nm)

Refer to the appropriate service disassembly and repair literature.

Leveling jack cylinders use two check valves with a pilot section separating the extend and retract ports. (POC) represents pilot operated check valves.



Mast raise cylinders use counterbalance valves in the cylinder barrel base end. There are two (CB) valves per cylinder and two cylinders per machine mast. The valve settings differ from extend and retract working ports.



For accurate results adjustments to the mast raise cylinder counterbalance valves may be made with a manifold on a test bench only. Hydraulic systems training module book 4 will reference cylinder and valve adjustment specs.

AUXILIARY LOWER STACKER VALVE APPLICATIONS

The D25KS, D245S and all 90 series applications differ from the mid range blasthole models.

D25KS And D245S Application

The manifolds and valve locations are shown on the reservoir drawing.

- Left side manifold LPR
- Right side manifold HPR
- Port 9 slow feed relief valve
- Port 1 cooling fan relief valve

High pressure drilling applications with a slow feed system maintain a slow feed relief valve positioned on the low pressure return manifold port 9.

This relief setting is 3600 psi (248 bar) set 100 psi (6.9 bar) over the fast feed pump pressure.

Fast feed pump compensator setting is 3500 psi (242 bar). Refer to the feed system performance chart when calibrating the fast feed system on D25KS and D245S model machines.

When checking lower stacker pressures on D25KS, D245S machines the highest pressure are to be noted:

- Slow feed pressure at 3600 psi (248 bar)
- Fast feed pressure at 3500 psi (242 bar)
- Remote pressure valve control setting from 0 through the range.
- Lower stacker relief valve pressure at 2500 psi (172 bar)

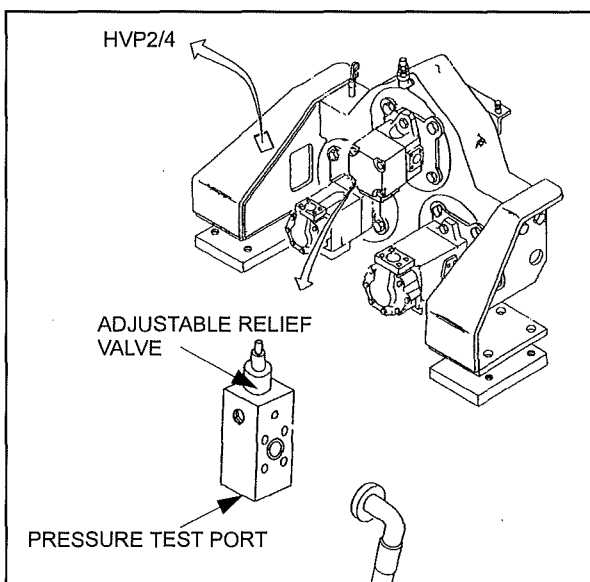
Perform the lower stacker pressure test as stated on page 50 with the left rear leveling jack cylinder retracted.

D90KS And 1190E Application

The D90KS stacker application use fixed displacement vane pumps with or without primary relief valves.

The following gearbox with vane pumps is an example of a 1190E machine. Auxiliary gearbox pump locations differ from 90 series machines in the cooling fan system pump(s) placement on the two bottom mounting pads.

Pump port relief valves as shown can only be set by momentarily stalling the output oil supply. Do not run the system stalled for long periods of time. Estimated test time less than 1 minute.



When the pump port relief valve is used it must be set higher than the lower stacker relief valve setting. External 9170 series relief valves are calibrated to 2600 - 2850 psi (180 - 197 bar).

In preparation for pump relief valve setting remove the oil supply hose at the lower stacker valve inlet port. Trace and mark hoses for proper installation later on.

Use sufficient #12 hydraulic cap and plug sets to plug the pump supply hose.

Primary Relief Valve Pressure Setting And Adjustments.

When applicable install a pressure hose and adequate pressure gauge to the test port provided on the relief valve manifold. Use a test gauge with at least 5000 psi (345 bar) capability.

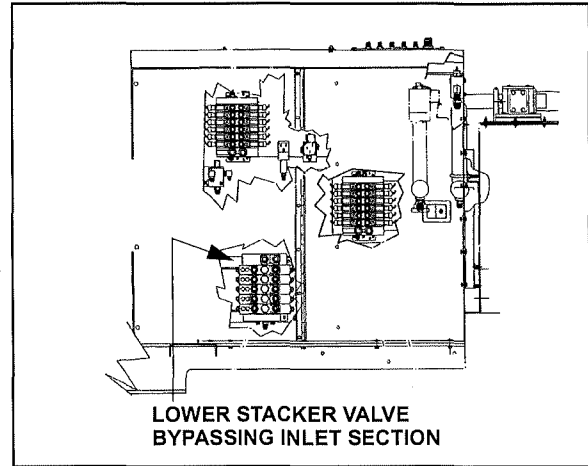
1. Start the machine engine or
2. Start the machine electric motor when applicable (Motor rpm at 1480).
3. Set the engine to high idle speed.
4. Quickly check the gauge pressure.
5. Lower the engine idle speed.
6. Shutdown the machine engine or motor.
7. Adjust the relief valve in to increase and out to decrease the system pressure. Do this adjustment in small estimated increments.
8. Start the machine engine.
9. Set the engine to high idle speed.
10. Quickly re-check the gauge pressure.
11. Final pressure of pump port relief valve should be 2600 - 2850 psi (180 - 197 bar)
12. Lower engine idle speed.
13. Shutdown the machine engine or motor.

Release hydraulic pressure by opening the air pressurization ball valve on the hydraulic reservoir cover.

Follow safe operating principals when working with warm oil under pressure.

14. Connect hoses to the lower stacker valve inlet port as removed.

D90KS and 1190 hydraulic cabinets have the same valve locations.

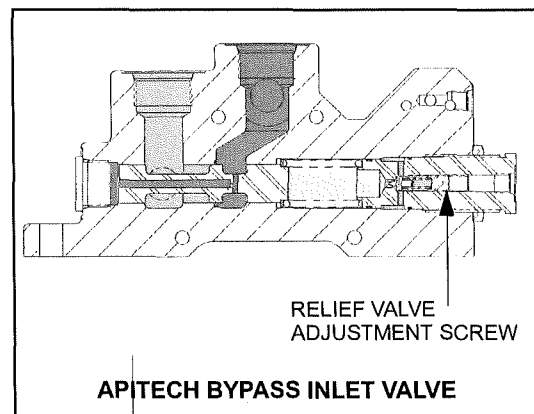


Lower stacker valves will be described in detail in the valves and cylinders book 4.

When setting the lower stacker valve you must

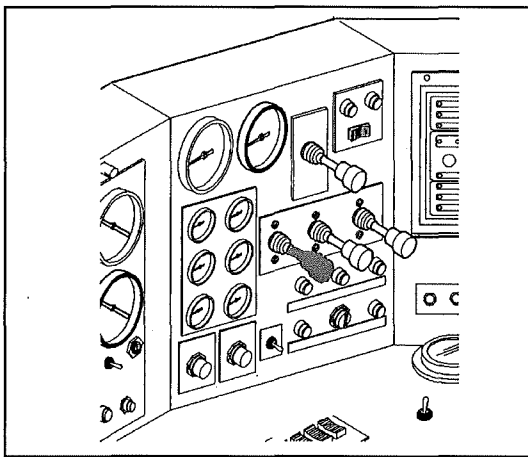
- Locate the bypassing inlet section
- Identify the bypass inlet relief adjustment screw and nut
- Open the center SAE plug to access the relief valve adjustment screw. The plug is located center on the bypass inlet screw.
- Make adjustments to the center screw adjustments only when setting lower stacker relief pressure value.

The following picture is used to illustrate the lower stacker valve bypassing inlet section of the 014492 series Apitech valve.



Checking Lower Stacker Pressure On D90KS And 1190 Machines

1. Start machine engine.
2. Start machine motor if applicable
3. Warm hydraulic oil to > 100°F (37.7°C)
4. Operate left rear leveling jack cylinder control up until hydraulic cylinder is in full retract position.



5. Check lower stacker relief valve setting on operator station hydraulic pressure gauge.

Setting Lower Stacker Pressure On D90KS And 1190E Machines

1. Follow prior procedures.
2. Remove center position SAE plug from bypass inlet adjustment nut.
3. Insert allen wrench into bypass nut assembly.
4. Actuate left rear leveling jack control up until hydraulic cylinder is in full retract position.
5. Hold the leveling jack control, monitor hydraulic pressure..
6. Turn adjustment screw in to increase, out to decrease working pressure.

7. 2500 psi (172 bar) is a base pressure. Machine weight due to options may require higher lower stacker relief valve pressure values.
8. Maximum lower stacker relief valve pressure is 3000 psi (207 bar).

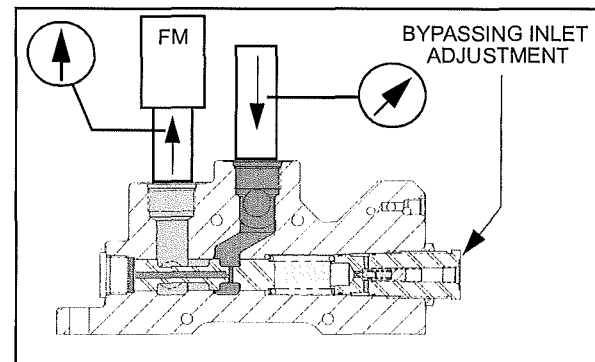
Do not loosen the large lock nut or adjust the large thread bypassing inlet valve.

Changing the bypassing inlet adjustment value will result in:

- Possible loss of oil flow and speed of the cylinder functions
- The loss of working pressure available to operate the leveling jacks and mast raise cylinders
- Heat generation through the valve adding to seal failures and excess noise

Test procedures written from Apitech specify the following set up to be performed on a test bench in a controlled environment.

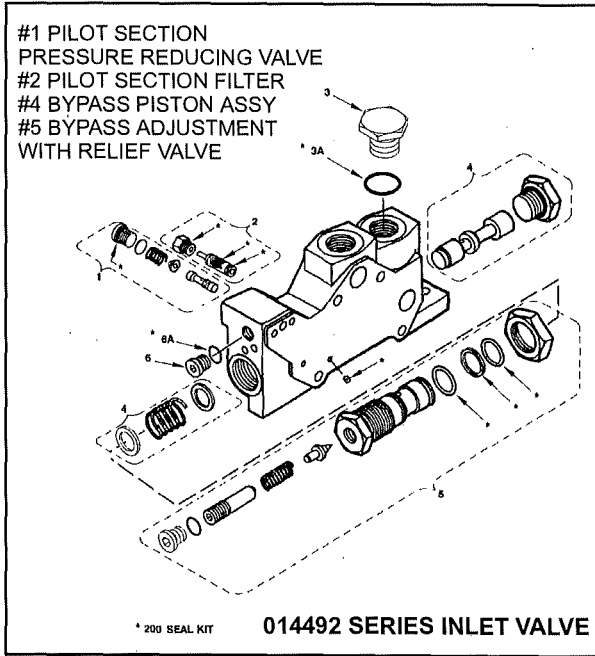
Setting of the Bypassing inlet requires a 60 gpm (228 lpm) flow meter installed on the outlet hose connection.



Install two 500 psi (35 bar) pressure gauges, one connected into the inlet supply hose and one into the outlet return hose.

When perform this test with the valve mounted on the machine do so at idle speed and **do not** operate the stacker valve controls.

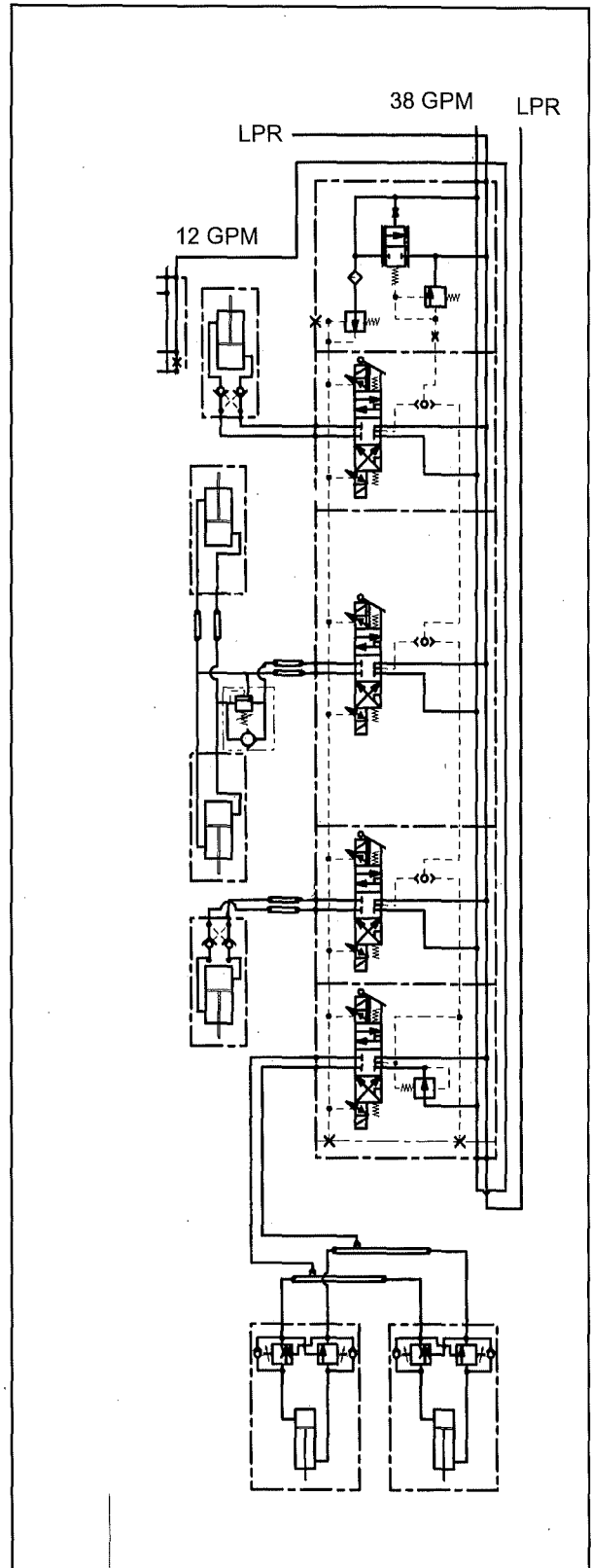
Adjust the bypassing inlet valve large thread nut to obtain 200 psi (14 bar) differential deltaP from inlet to outlet gauge pressure maintaining oil flow through the outlet.



The lower stacker inlet section receives oil from two vane pumps. There is a mixing of 38 gpm (144.4 lpm) and 12 gpm (45.6 lpm) for a combined flow of 50 gpm (190 lpm) for filling the leveling jack and mast raise cylinders.

In neutral mode the 50 gpm (190 lpm) opens the bypass inlet piston and empties to reservoir with minimal pressure drop.

When the bypass piston is miscalibrated system operating pressure can drain to low pressure return limiting the leveling jack and mast raise functions.



A reduced pilot pressure is used to enable electric coil actuation. The pilot section pressure reducing valve is calibrated to allow 200 psi (13.8 bar) for the pulsar coils.

Pilot pressure may be tested at the bypass inlet section PP pilot pressure adapter. The pilot section pressure reducing valve is a non adjustable component.

- excess pressure will damage the pulsar coils and seals.
- low pressure will affect coil actuation limiting performance of all work sections.

Cleaning the pilot section filter may be required when work port sections performance is slow or inoperable.

Each work section may be manual controlled by connecting a service tool to the hex screw within each section.

Each work section have flow limit screws that may limit spool movement to slow a specific function.

ACCESSORY SYSTEMS

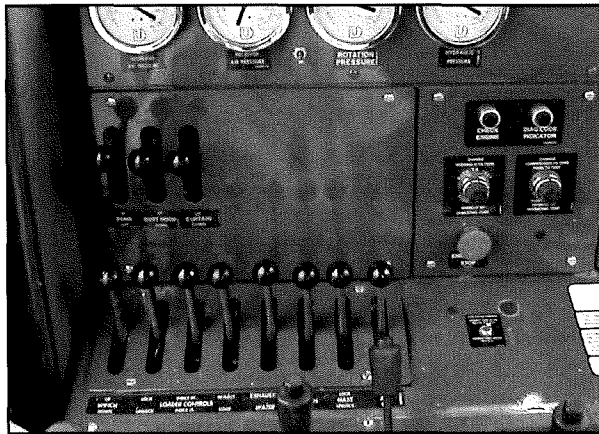
GENERAL

This section describes the functions of the 'upper' and 'middle' stacker valves.

DESCRIPTION

All our blasthole rigs are equipped with vane pumps to deliver oil for non-drilling related functions.

Directional control valves most commonly referred to as stacker valves, are actuated by the machine operator to enable the vane pump oil to run actuators.



Middle stacker valve sections consist of:

- Inlet section with relief valve
- Drilling air on/off control cylinder
- Mast lock cylinder(s)
- Holding wrench (deck wrench) cylinder
- Water injection/dust collector motor(s)
- Loader swing cylinders
- Loader indexing cylinder
- Loader locking cylinder
- Winch motor

- Outlet section (*power beyond plug) with two return lines

When middle and upper stacker valves are connected in series **the middle** stacker valve will have a power beyond plug installed in the outlet section.

The outlet section will have an additional return hose which is relief valve drain to LPR manifold.

Two separate vane pumps supply oil to the middle and upper stacker valves on larger drilling products.

Upper stacker valve are non drilling accessory options. **Sections may vary** according to customer requested options or after market field installations.

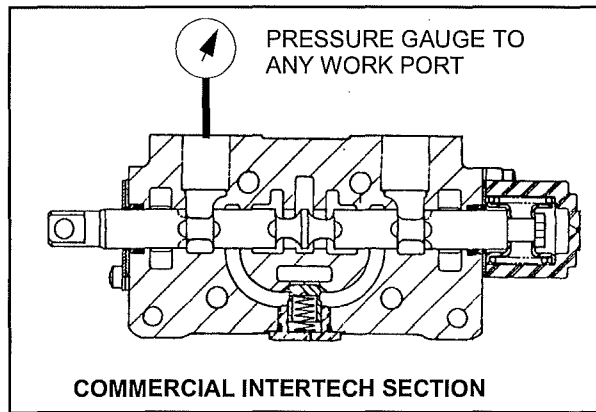
Upper stacker valves consist of any combination of the following options:

- Inlet section with relief valve
- Vee block cylinder (angle drilling)
- Drill pipe support swing cylinder in sequence with clamp cylinder
- Drill pipe centralizer swing cylinder in sequence with clamp cylinder
- Dust hood door cylinder
- Dust hood cylinder
- Power tong swing cylinder
- Power tong break-out cylinder
- Power tong clamp cylinder
- Outlet section with two return lines.

Operator consoles may have from 2 to 8 control levers that move the section spools of the upper stacker valves.

Each directional control valve assembly has one adjustable relief cartridge on the inlet section.

Install a 3000 psi (207 bar) pressure gauge in line or dead headed into a work section.



- Components in the accessory system will be protected by the relief valve.
- Load moving ability will be affected by the relief valve and load sense check valve.
- Motor performance will be limited by the relief and load sense check valve.

Adjusting the relief valve CW in will create more pressure and may effect the hydraulic component life.

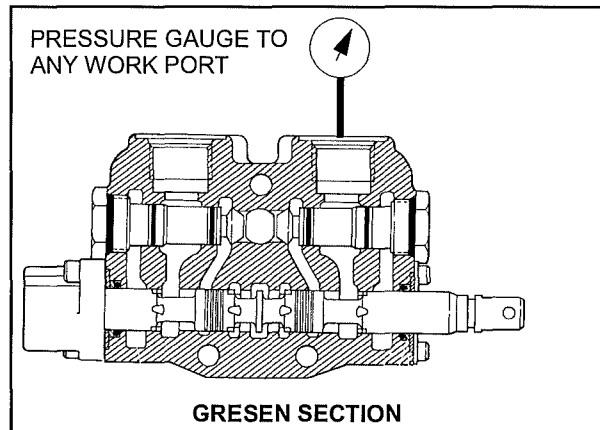
Adjusting the relief valve CCW out will decrease the working ability of the components. It will generate heat which in turn affects seal life.

The only means of checking accessory systems are with a pressure gauge installed inline or in a dead head condition.

Maintain proper tie rod tension for machine specific manufacture valve assemblies.

- Commercial Intertech
- Gresen 32 ft lb (43 Nm)
- Apitech 50 ft lb (68 Nm)

Refer to the appropriate service disassembly and repair literature.



STACKER VALVE PRESSURE:

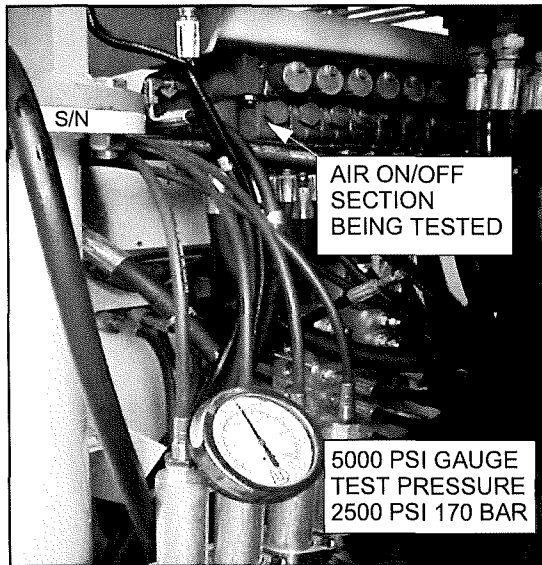
No Pressure Adjustment Required

When machine is shutdown install one appropriate size pressure gauge at any working section outlet adapter using approved pressure fittings and hose. Gauge should be 3000 psi (210 bar).

- Machines with the hydraulic test station option have a pressure hose connection.
- Middle stacker pressure may be checked by selecting HP1 control position 2
- Upper stacker pressure may be checked by selecting HP1 control position 3.

1. Start machine.
2. Set the engine to high idle speed.
3. Warm hydraulic oil to > 100° F (37.7° C).
4. Operate the control handle that has been selected as the test section
5. The pressure hose and gauge will pressurize to the relief value
6. Lower the engine idle speed
7. Stop the machine engine or motor

8. Disconnect test equipment



Sandvik blasthole products maintain relief valve settings for the middle and upper stacker valve accessory components at a base pressure between 2200 to 2500 psi (150 -170 bar).

- Check pressures as needed or at 2000 hour intervals.

STACKER VALVE PRESSURE

Diagnosing And Troubleshooting

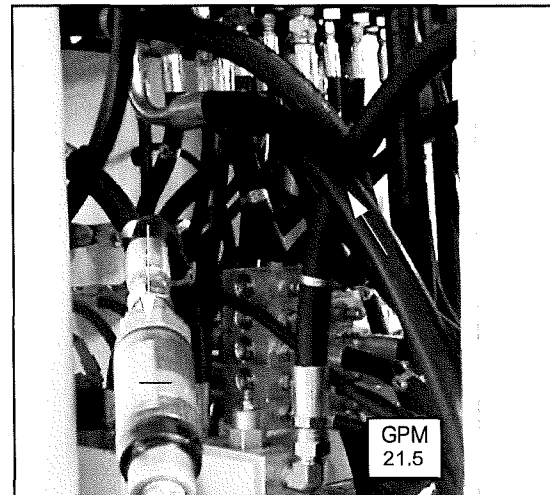
Equipment schematics represent 2500 psi (170 bar). This is a base number and may differ between drill product line.

- Checking flow with a flow meter connected inline between the pump and directional control inlet section.
- When checking flow maintain a pressure gauge on a working section.

NOTE!

Gator, D25KS, D245S, and all 90 series machines use a 3 port adjustable flow divider between the pump output flow and the stacker valve inlet section. The flow divider cartridge is a preset valve for either a 21 or 26 gpm flow

rate. Adjustments to this valve require connection of a inline flow meter as shown below.



1. Start machine engine.
2. Set the engine to high idle speed.
3. Operate the control handle that has been selected as the test section.
4. Check both pressure on the gauge and flow value through the flow meter.
5. Note the hydraulic oil temperature.

When flow values drop 15 to 20 percent under load it is time to remove the vane pump from service.

NOTE!

Failure to service the unit may affect other hydraulic systems. Vane pump oils return to the HPR/HPS manifolds for feed system replenishment as stated in HPR/HPS system setting section of this manual.

Gator Application Accessory Systems

The Gator machine uses a flow divider mounted to the vane pump outlet port. The flow divider splits the flow to the base stacker and HPR manifold. Base and feed stacker valves are electro proportional type control valves.

Electrical input allows proportional oil flow for the desired actuator speeds.

The Gator machines base stacker consists of:

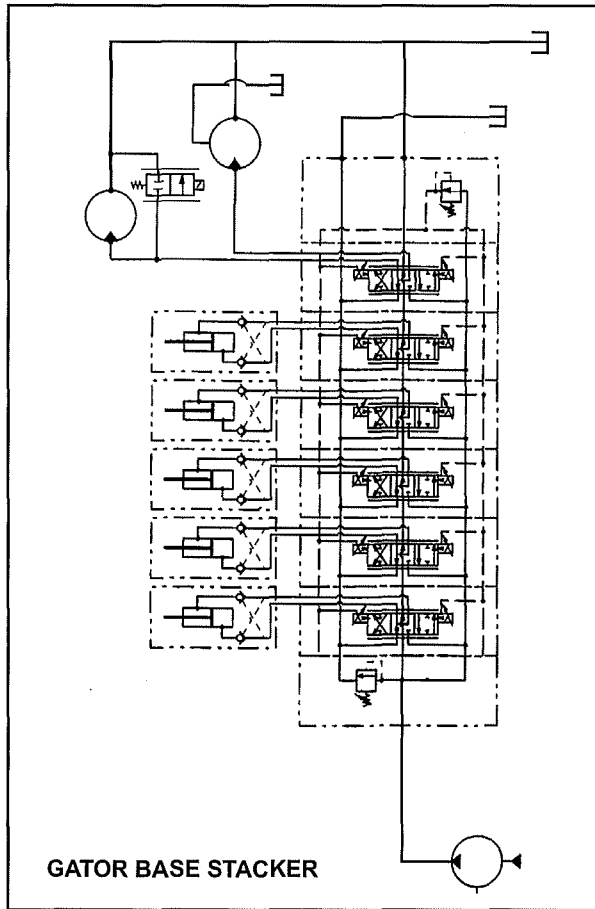
- inlet section with relief valve
- boom lift - up down
- boom swing - left right
- feed dump -
- feed tilt - left right
- feed extend - up down
- water injection dust collector
- outlet section with a pilot pressure reducing valve and power beyond plug

The Gator machine feed stacker consists of:

- inlet section with relief valve
- power tong - swing clamp
- power tong - breakout
- holding wrench - in out
- loader swing - in out
- loader lock - in out
- loader rotate - cw ccw
- centralizer - swing clamp
- dust hood - up down, petrol wrench
- outlet section with a pilot pressure reducing valve and pressure buildup valve

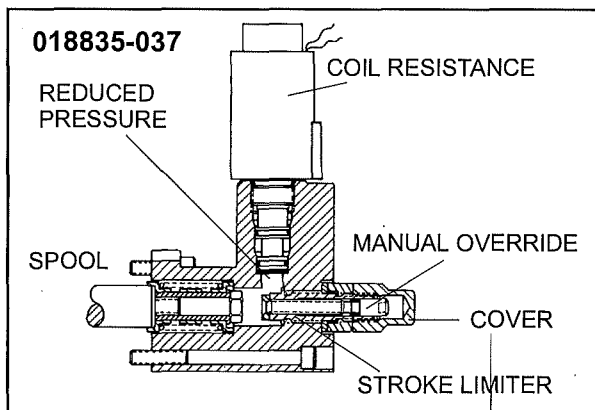
Operator controls are multi function by means of tram relays (TR) located inside the cab junction box of Gator machine cabs.

Refer to Electrical Systems Training Module Book 2 Gator Testing and Adjusting.



Manual override and stroke limiting features are standard components on the Gator machine base and feed stacker valves.

Stroke limiters may be adjusted to provide smooth speed control for a specific cylinder or motor circuit.



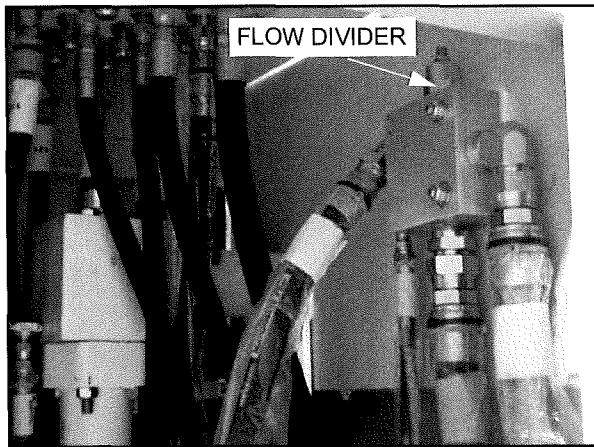
Manual override feature allows testing of the spool section as a troubleshooting method. Adjustment of the manual override CW will move the specific spool to direct oil into the actuator.

Gresen 018835 series directional valves are pilot controlled with a reduced pressure rate of 300 psi (21 bar). Excessive pilot pressure will damage coils and seals.

The pressure reducing valve is mounted inside the outlet section and is non adjustable. Pilot pressure may be taken from a single pressure port on the outlet section.

90 Series Application Accessory Systems

The 90 series machines uses a flow divider mounted inside the hydraulic cabinet. The flow divider splits vane pump flow to the middle and upper stacker sections and HPR manifold.

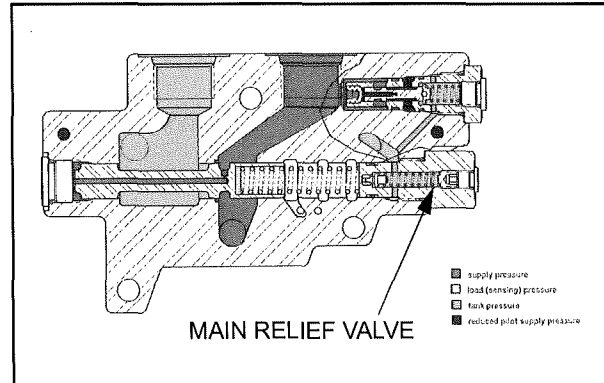


Expected flow to the middle and upper stacker valve sections is limited to 12 gpm (45.6 lpm). Excess flow to HPR is 40 gpm (152 lpm). A flow meter is required to establish proper flow to the stacker valve sections.

Improper adjustments to the flow divider will lead to operational problems for

- stacker valve sections
- cylinder application feed system replenishment

The following picture is used to illustrate the middle and upper stacker valve bypass inlet section of the 018149 series Apitech valve.



In neutral mode the 12 gpm (45.6 lpm) opens the bypass inlet piston and empties to power beyond to be available for the lower stacker function.

When the bypass piston is miscalibrated system operating pressure can drain to low pressure return limiting the valve section functions.

A reduced pilot pressure is used to enable electric coil actuation. The pilot section pressure reducing valve is calibrated to allow 200 psi (13.8 bar) for the pulsar coils.

Pilot pressure may be tested at the bypass inlet section PP pilot pressure adapter. The pilot section pressure reducing valve is a non adjustable component.

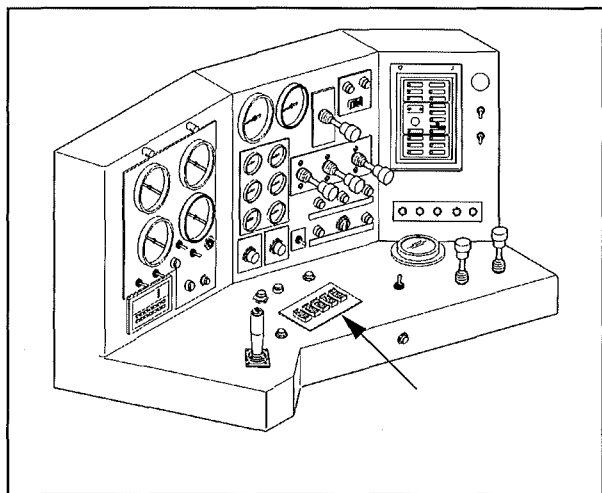
- excess pressure will damage the pulsar coils and seals.
- low pressure will affect coil actuation limiting performance of all work sections.

Cleaning the pilot section filter may be required when work port sections performance is slow or inoperable.

Each work section may be manual controlled by connecting a service tool to the hex screw within each section.

Checking Middle Stacker Pressure On D90KS And 1190 Machines

1. Start machine engine.
2. Start machine motor if applicable
3. Warm hydraulic oil to > 100°F (37.7°C)
4. Operate a single control without pressure limiters to stall a hydraulic cylinder in full retract position.

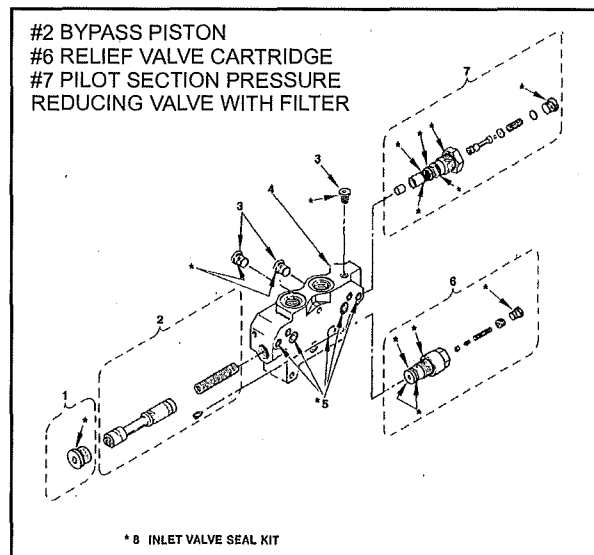


Check middle stacker relief valve setting on operator station hydraulic pressure gauge.

Setting Middle Stacker Pressure On D90KS And 1190E Machines

1. Follow prior procedures.
2. Remove center position #2 SAE plug from relief section plug.
3. Insert 5/32 (3.9 mm) allen wrench into assembly.
4. Actuate control until hydraulic cylinder is in full retract position.
5. Hold the control, monitor hydraulic pressure.
6. Turn adjustment screw in to increase, out to decrease working pressure.

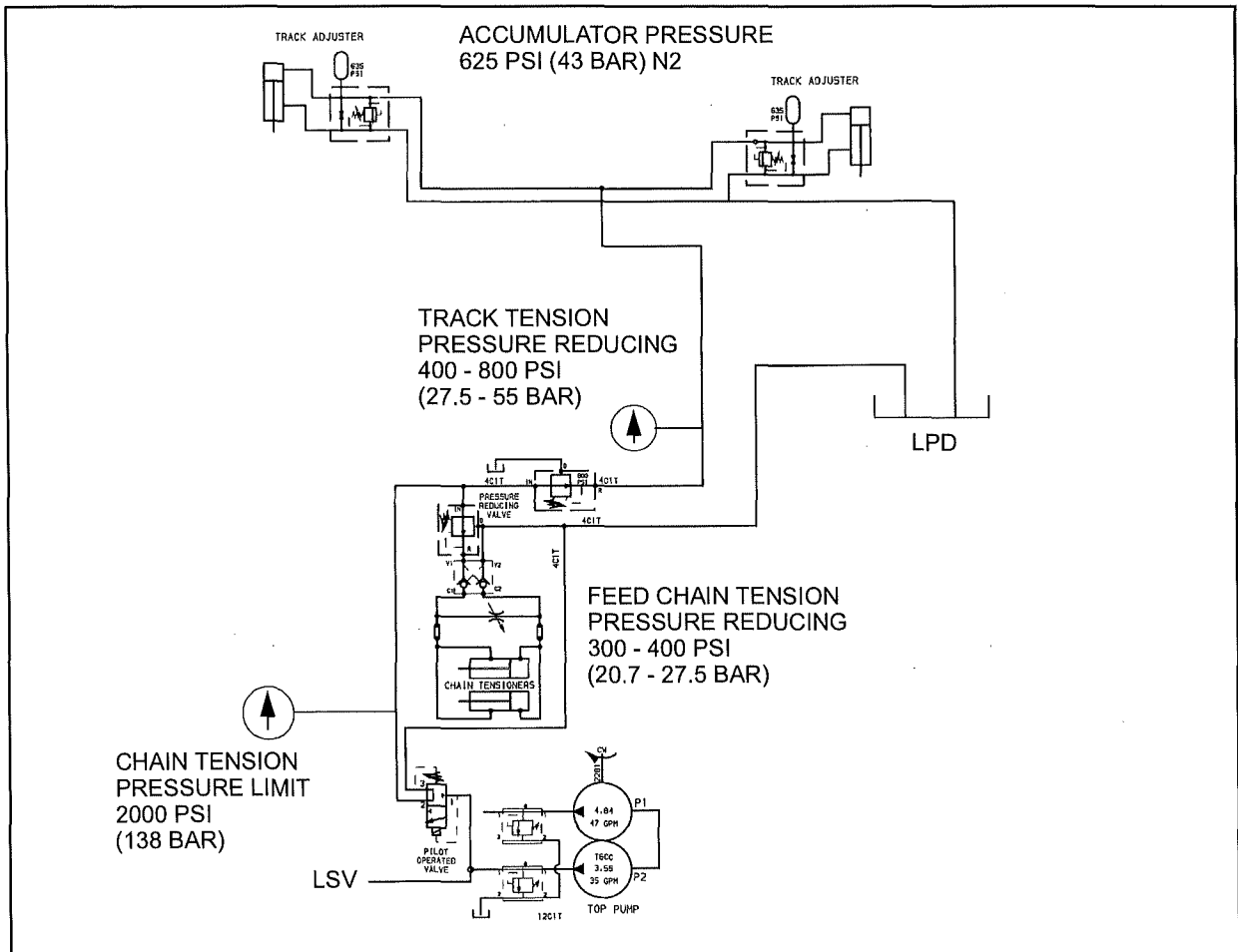
7. 2500 psi (172 bar) is a base pressure. Machine options differ between models. Stacker relief valve pressure values may vary and should not exceed 2500 psi (172 bar).



All middle and upper stacker valves have common pressure limiters and flow limit adjustments.

Dust hood functions use a individual work port pressure limiter. The dust hood cylinder work port pressure limiter is calibrated for 1000 psi (70 bar) for extend mode only.

90 Series Track And Feed Chain System

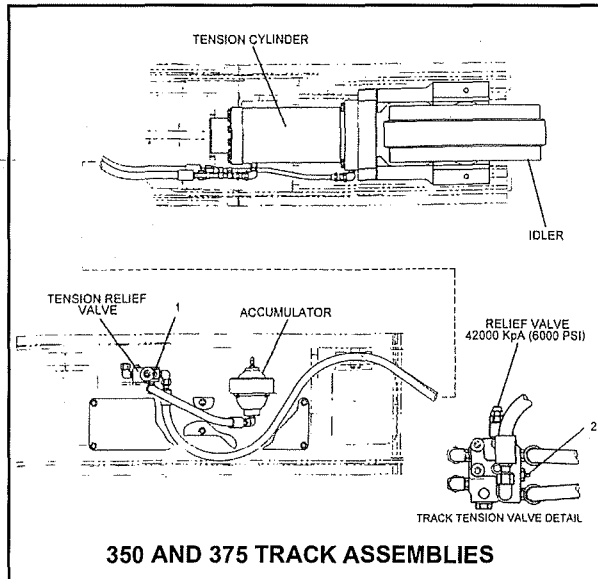


Chain tension limit valve is mounted inside the hydraulic cabinet straight in, top panel. This is the first pressure value to enable chain tensioning when the lower stacker valve is operating above 2000 psi (138 bar).

As the lower stacker valve is actuated pressure less than 2000 psi (138 bar) will not generate a track or feed chain tension mode.

Track tension pressure reducing valve is mounted on the machine frame between the axle and fuel tank, under the front engine mount.

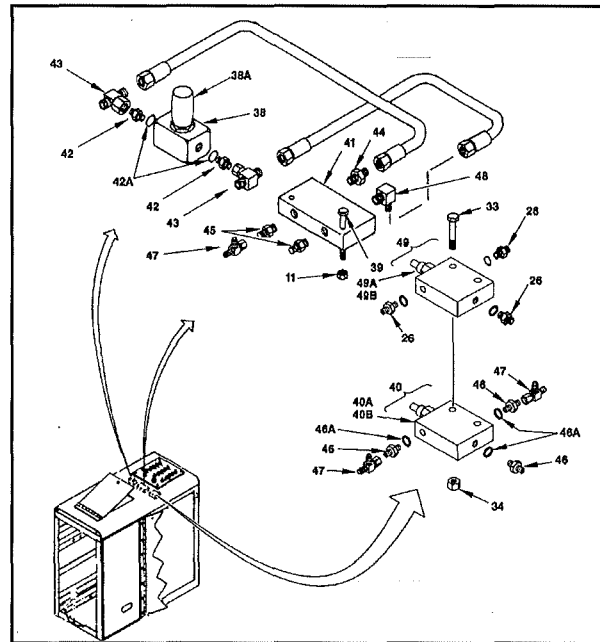
During routine service track tension may be relieved by opening the vent connection inside the track frame.



Each track assembly use a single accumulator as a shock absorber for the idler recoil. Dry nitrogen N2 is the filling gas and should be check on 1000 hour service intervals. extreme ambient operating conditions may require more frequent service intervals.

Feed chain tension pressure reducing valve is mounted inside the hydraulic cabinet on the top panels.

During routine service feed chain tension may be relieved by opening the flow control valve #38.



COOLING SYSTEMS

GENERAL

The following section describes the two types of cooling systems used on Sandvik blasthole rigs.

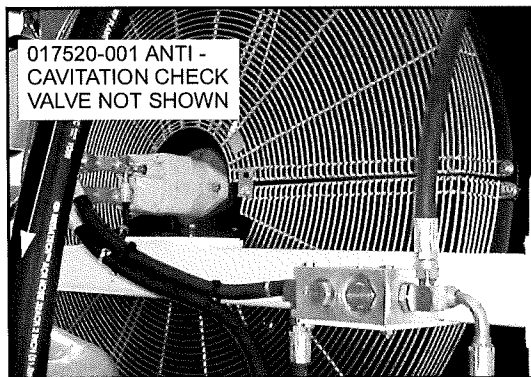
Open loop - Denison vane pump and vane motor. This open loop system has been the primary cooling system throughout our equipment history. It has undergone numerous changes to accommodate the bigger horsepower requirements of the drilling industry.

Closed loop - Sundstrand pump and motor with pilot control valves. This closed loop system has been on mid-range machines since 1995 and has undergone minor changes to the system.

DESCRIPTION

The open loop motor and fan system is shown below is vane pump and vane motor components. The system uses a relief valve, thermal valve with a bypass check valve and oil cooler.

Fan pressure is used as a pilot pressure for various features in the feed system.



New factory installed systems have a reverse flow check valve connected between the high and low pressure ports of the vane motor.

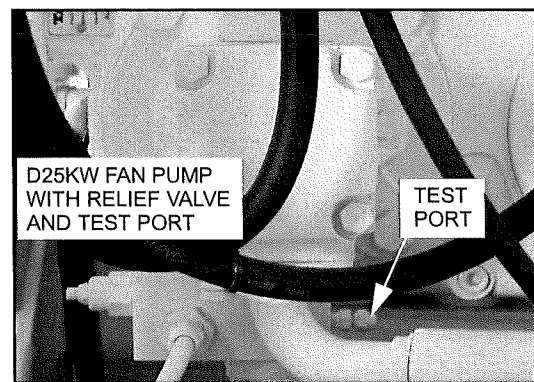
Available as a field modification the anti-cavitation check valve assists the motor after machine shutdown.

The anti-cavitation check valve allows return oil to enter the motor inlet after the hydraulic system stops operation.

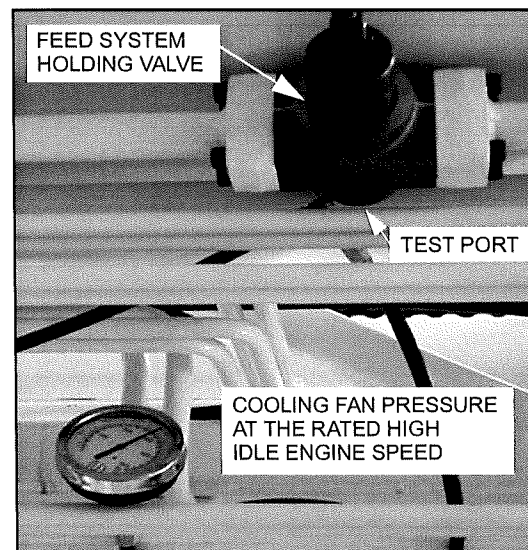
Available as individual parts the 017520-001 check valve uses adapters, hoses and swivel tee adapters to connect the check valve around A and B ports of the vane motor.

This addition has drastically reduced vane motor failure due to cavitation.

The open loop pump is shown.



Pressure test ports may vary from model to model however one location that is easy to access on all products is at the feed system holding valve pilot port connection as shown.

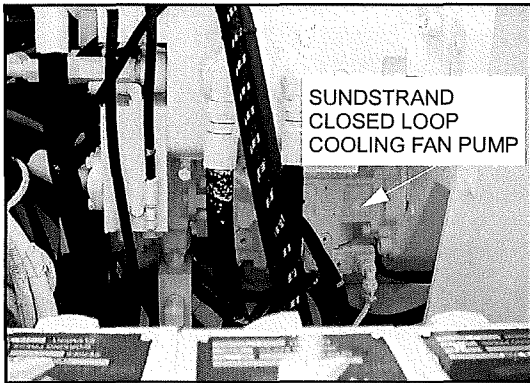


A variable speed cooling system designed in 1995 enables two operating speeds.

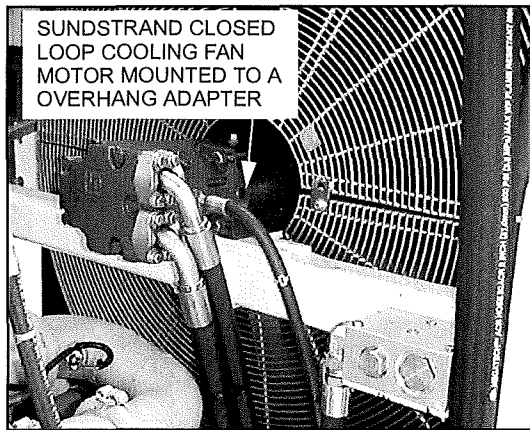
The concept is:

- Slow fan speed for starting and cool operating conditions.
- Fast fan speed when drilling conditions warm fluids and require additional cooling.

One series of the closed loop pump is shown.



The closed loop motor and fan system is shown.



Overhang adapters are oil filled and require periodic maintenance.

FAN TYPES

Fan speed is the primary concern for either of the cooling systems. Pump and motor displace-

ment, working pressure and fan dimension vary from machine models.

When the pump and motors are specified correct the air flow across the radiator and oil coolers range between 1250 to 1400 CFM.

Aluminum airfoil and steel engine type fan blade assemblies are in use. Sizes are as noted.

STEEL	ALUMINUM
NA	36 IN OD 8 BLADE 4 X .4375 X .125 X 24°
42 IN OD 8 BLADE	42 IN OD 8 BLADE 4 X .4375 X .125 X 26°
48 IN OD 8 BLADE	48 IN OD 8 BLADE 4 X .4375 X .125 X 24°
54 IN OD 8 BLADE	54 IN OD 8 BLADE 4 X .4375 X .125 X 19°

NOTE:

It should be observed when working with the aluminum fan that the two center hubs can be loosened in order to replace or reposition each fan blade. Field modifications to the fan blade pitch is not recommended.

The balanced design of the **aluminum fan blades** to the fan hub is essential to allow proper air flow through the coolers.

Proper balance can only be achieved with

- The fan assembly removed from the machine.
- Placed on a flat horizontal surface
- Precision dial indicator used at each of the fan tip ends.
- Improper balance may lead to fan blade failure at it's rated speed.
- Improper fan speeds and blade pitch will redirect unwanted air back into the cooler enabling fluid overheating.
- Fan assemblies are mounted to shafts using taperlock bushings. Spec 008674-000

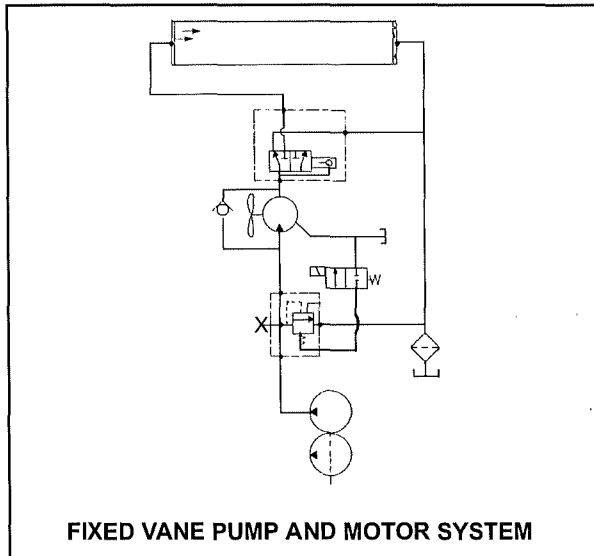
FAN SPEEDS

Check fan speed with reflective tape at the fan hub. Use any brand name photo-tachometer capable of measuring 0 to 2000 rpm.

STEEL	ALUMINUM
36 IN (91 CM) OD 1600 RPM	36 IN (91 CM) OD 1800 - 2200 RPM
42 IN (106 CM) OD 1400 RPM	42 IN (106 CM) OD 1600 RPM
48 IN (122 CM) OD 1200 RPM	48 IN (122 CM) OD 1400 RPM
54 IN (137 CM) OD 1100 RPM	54 IN (137 CM) OD 1050 - 1100 RPM

Steel blade fans 42 inches OD and larger have a maximum fan tip speed. **Do not exceed 1400 rpm with the 48" and 54" steel engine fan.**

Typical open loop fan system schematic:



Setting Fan Circuit Pressure For Open Loop Vane Pump/Motor System Fan Speed

1. Install adequate pressure gauge, adapters and pressure hose (5000 psi 345 bar).
2. Clean the center hub of the fan assembly and place reflective tape on the fan center hub.

3. Position a magnetic photo-tachometer or use a handheld model.
4. Start machine engine.
5. Allow adequate air receiver tank pressure for the type of air compressor system.
6. Set the engine to high idle speed.
7. Check the fan circuit pressure.
8. With the photo-tachometer record the fan RPM.
9. Adjust the fan relief valve. CCW adjustment will decrease the pressure and slow the fan speed. CW adjustment will increase the fan pressure and increase the fan speed.
10. The pump output flow and the motor displacement sizes determine the rated speed at a midrange pressure.

The emphasis is on air flow across the radiator and oil cooler assemblies and this is achieved by proper fan speed according to fan type and dimension.

Factors for a good cooling system:

- Pump shaft speed by means of correct gear-box ratio
- Pump displacement in GPM (LPM)
- Motor displacement receiving the pump output oil
- Fluid condition
- Fan size (OD) outside diameter
- Fan style aluminum vs. steel

The formula for circuit system design

Pump Displacement X pump shaft speed divided by 231 to find pump output flow in (GPM) gallons per minute.

Pump output flow in GPM at estimated 85% efficiency X 231 divided by motor displacement to find motor shaft speed.

It is recommended to maintain a midrange hydraulic pressure such as 2000 to 2500 psi (140 - 170 bar) for best component life.

Sandvik part number, motor designation and displacements for open loop cooling fan systems are shown.

SANDVIK P/N	CAM	DISPLACEMENT
001011-011	M4C024	1.49
001011-009	M4C043	2.84
001011-010	M4C055	3.59
001011-012	M4C067	4.34
001011-013	M4C075	4.89
001978-001	M4D088	5.56
001978-003	M4D113	7.12
001978-005	M4D128	8.08
001978-007	M4D102	6.44
001978-009	M4D138	8.81
017771-001	M4E153	9.67

To assist machine start up modes a 24 vdc solenoid is added to the cooling system relief valve.

The relief valve spring chamber drain port is connected to a normal closed solenoid. This application is referred to as fan bypass.

When the operator turns the key switch on and applies the bypass switch the fan bypass solenoid opens to empty the cooling system relief valve spring chamber to low pressure drain. During this condition the relief valve is open enabling pump flow to empty to high pressure return. The result is low to no fan rpm during critical engine start modes.

Upon releasing the bypass switch the fan should make a noticeable speed increase.

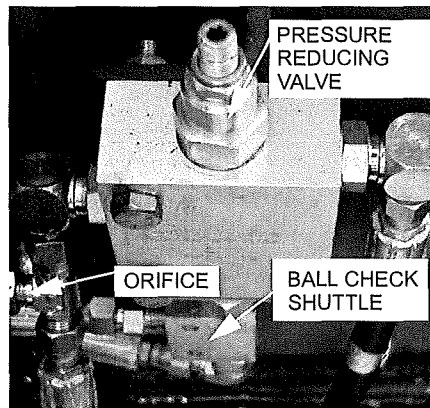
Variable Speed Cooling Fan Systems

Applicable machines: GATOR, D40KS, D45KS, D50KS, D55SP, D60KS, D75KS, D90KS, D90KSP, 1190D.

The system consists of a piston pump and piston motor in a closed loop application.

Servo pressure from the pump assembly is controlled through a pressure reducing valve and an engine mounted thermal valve. Reduced servo pressure enables minimum pump displacement for slow fan speed.

Full servo pressure when the thermal valve closes enable maximum pump displacement for full fan speed.

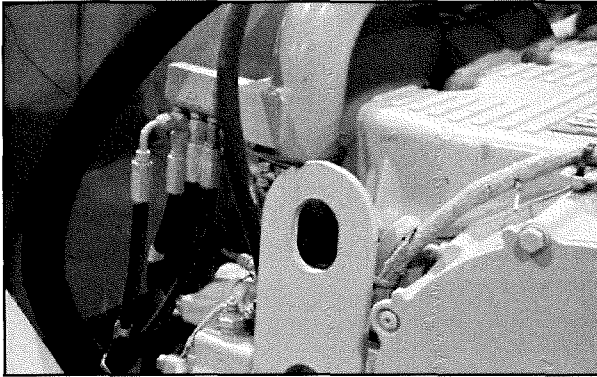


This pressure reducing valve is used to tune the machine for a specific ambient related slow fan speed.

Adjusting the pressure reducing valve ccw out decreases slow fan speed and in cw increases slow fan speed up to pump stroke limit screw calibration.

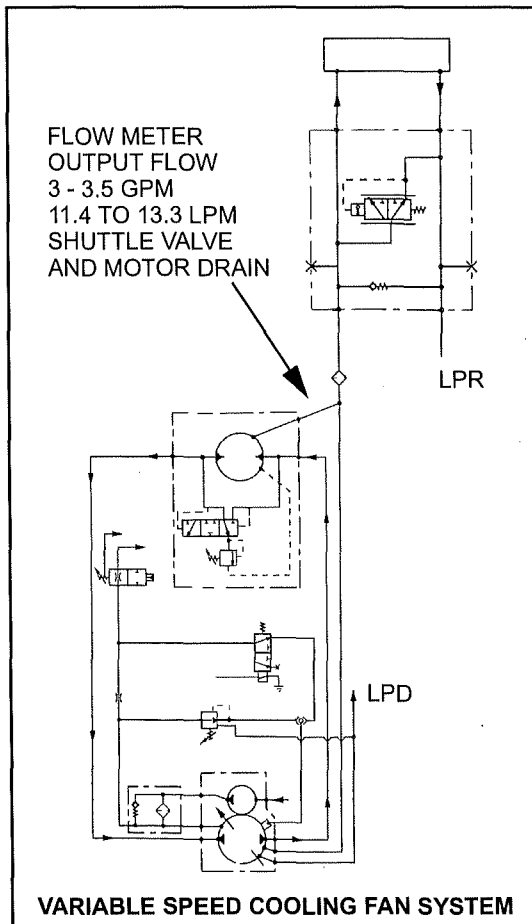
A ball check shuttle valve threaded into the pressure reducing valve port 1 separates reduced servo pressure from maximum servo pressure.

A .063 (1.6 mm) restrictor is used in the pressure reducing valve port 2 adapter. The orifice enables a servo pressure drop for slow fan speed control.



Engine thermal valves sense engine water temperature as hot water above the engine specific thermostat is returned to the radiator.

The thermal valve is normal open so servo pressure after the orifice may empty to low pressure drain allowing reduced servo pressure to control for a specific slow fan speed.



A simplified electronic control system replaces the pilot valving and engine thermal valve. The application requires two thermal sensors, one fan control module, wire connections and a new pump assembly with electronic displacement control.

The application is used on Gator and D75EX machines as of January 2002.

COOLING FAN PERFORMANCE CHART (VARIABLE SPEED APPLICATION)

Closed loop piston application

MODEL	MAIN PUMP	CHARGE PUMP
GATOR	0 -	283 - 310 PSI 20 - 21.3 BAR
D40KS	0 - 2600 PSI 180 BAR	283 - 310 PSI 20 - 21.3 BAR
D45KS	0 - 2600 PSI 180 BAR	283 - 310 PSI 20 - 21.3 BAR
D50KS	0 - 2600 PSI 180 BAR	283 - 310 PSI 20 - 21.3 BAR
D55SP	0 - 3600 PSI 248 BAR	262 - 315 PSI 18.1 - 21.7 BAR
D60KS	0 - 3600 PSI 248 BAR	262 - 315 PSI 18.1 - 21.7 BAR
D75KS	0 - 3600 PSI 248 BAR	262 - 315 PSI 18.1 - 21.7 BAR
D90KS	0 - 3600 PSI 248 BAR	262 - 315 PSI 18.1 - 21.7 BAR

* Due to gearbox ratio this application servo pressure may exceed 315 psi (21.7 bar).

Maintaining adequate servo pressure is the key to getting the piston pump to stroke to full displacement.

Conditions that may affect the pump stroke capability are noted

- Motor hot oil shuttle valve oil flow capacity out the motor case drain
- Pressure reducing valve for setting the desired slow fan speed

- Engine thermal valve position in relation to actual engine temperature (fluid valve or fluid sensor)
- When applicable: Compressor thermal valve position in relation to actual compressor oil temperature (fluid valve or fluid sensor)
- Cold ambient toggle switch position in cold run mode (thermal module sensor setting)

CHECKING THE VARIABLE SPEED COOLING FAN SYSTEM (WITH PILOT CONTROL)

No Adjustments Required

1. Place reflective tape on fan assembly hub.
2. Start machine engine.
3. Warm hydraulic oil to $>100^{\circ}\text{F}$ (37.7°C).
4. Place the cold ambient toggle switch in the above 40°F mode or normal run mode.
5. Check fan speed with engine at low idle speed (>1200 rpm).
6. Expected minimum fan speeds of 350 to 500 rpm with the engine at low idle speed. Due to ambient operating conditions it may become necessary to set the slow fan speed as much as 650 rpm.
7. Set the engine to high idle speed.
8. Engine temperature has to be $>$ engine regulator thermostat range allowing hot coolant return to the radiator.
9. Warm the engine coolant by momentarily covering the radiator with curtain or cardboard material. **Do not operate engine coolant to shutdown temperature.**
10. Check fan speed with engine at high idle and the coolant temperature greater than 195 to 200°F ($90.5 - 93^{\circ}\text{C}$).

11. Expected fan speeds are 1050 to 1200 dependent on fan dimension. Refer to the previous topics for fan type and sizes.



System operating pressure will vary according to fan speed. The load of the motor as it turns the fan, cutting air, should allow the hydraulic pressure to operate between 800 and 2800 psi (55 - 193 bar).

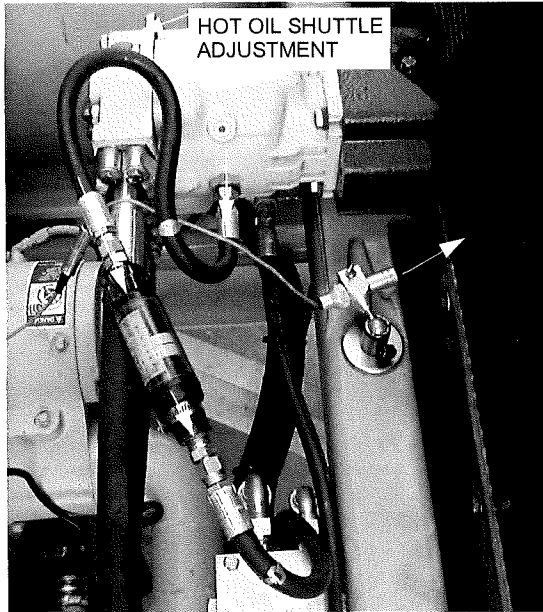
PREPARING TO SET THE VARIABLE SPEED COOLING FAN SYSTEMS

Tools and test equipment:

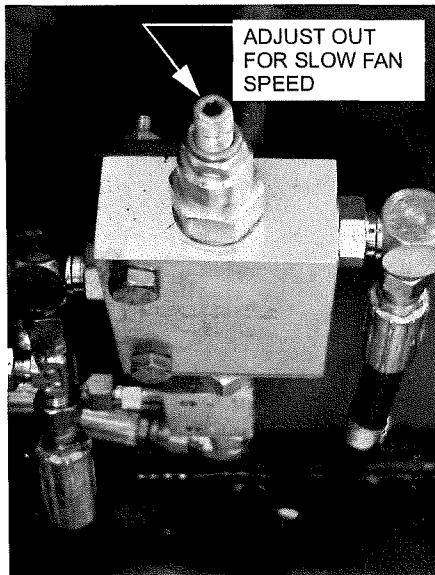
- 0 to 15 GPM (0 - 57 LPM) flow meter with #8 hydraulic JIC adapters
- Short length 24 inch (61 cm) #8 medium pressure hydraulic hose
- Adjustable wrench, 7/8 (22mm) wrench, 9/16 (14mm) wrench, 1/2 (13mm) wrench, flat blade screwdriver
- #4, #8 JIC hydraulic caps and plugs, #4 JIC swivel tee
- Photo-tachometer, reflective tape

Mount test equipment into determined hydraulic system components. Prepare the machine as follows:

1. Install the flow meter into the cooling fan motor case drain line.



2. Place reflective tape on the fan assembly hub.
3. Secure shuttle valve, loosen lock nut, back out adjustment ccw to stop. Secure lock nut.
4. Adjust the pressure reducing valve (ccw) to assure a slow fan speed for start-up. Final adjustments will be made in a later step.



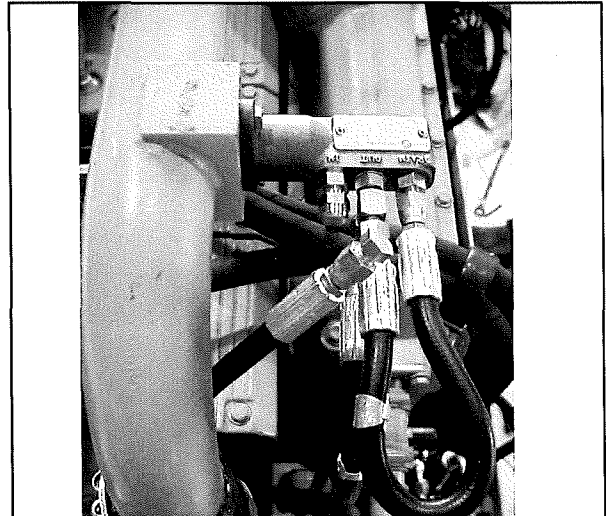
5. Check that the applicable pump stroke limiter is adjusted out (ccw) as viewed on page 73 of this manual.
6. Adjust the stroke limiter in 3 (cw) turns prior to pump start-up.

NOTE!

A toggle switch is operator station mounted. A thermostat module is used in the Gator inside the cab - lower right side - rear cover panel.

7. Actuate the cold ambient toggle switch to cold application or dial thermostat to a setting greater than ambient conditions.
8. Machine is configured to run and calibrate the fan system.

Troubleshooting the cooling fan system may require removing a single connection #4 hose from the engine thermal valve stamped 'IN'.



Use a #4 JIC cap on the thermal valve adapter and a #4 JIC plug in the hose. Use a 500 psi (35 bar) pressure gauge in the thermal valve hose to test fan pump charge pressure.

SETTING THE VARIABLE SPEED COOLING FAN SYSTEM (WITH PILOT CONTROL)

Adjustments Required

1. Start machine engine.
2. Warm hydraulic oil to $>100^{\circ}\text{F}$ (37.7°C). The fan may not be turning or turning very slow. Monitor fluid temperatures, make adjustments as fluid temperatures range between 100° - 195°F . Do not operate machine to a shutdown condition.
3. Check fan speed with engine at low idle speed ($>1200\text{ rpm}$).
4. Adjust the pressure reducing valve (cw) to the maximum limit. The pressure reducing valve is used to adjust a specific slow fan speed.

NOTE!

The fan should make a noticeable speed increase with the adjustment of the pressure reducing valve.

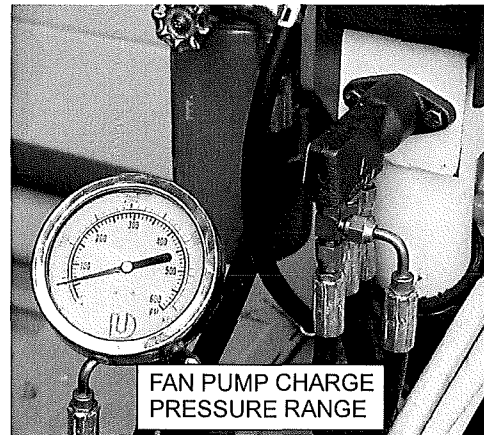
5. Make (cw) adjustment to fan motor hot oil shuttle valve monitoring fan motor case flow for 3 to 3.5 gpm (11.4 to 13.3 lpm).
6. Check the motor case drain flow to spec noted and secure shuttle valve lock nut.
7. When applicable: monitor the pump charge pressure gauge during the motor case drain adjustments.

NOTE!

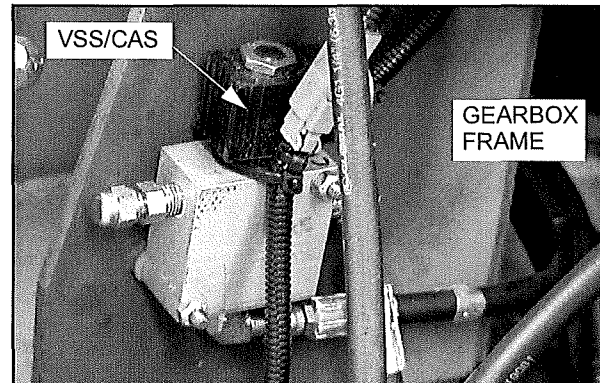
Hot oil shuttle valve setting and excess motor case drain flow can affect the cooling fan pump charge pressure. Charge pressure is used to stroke the pump for maximum output flow.

8. Adjust the pressure reducing valve (ccw) for the final minimum fan speed setting.
9. Expected minimum fan speeds of 350 to 500 rpm with the engine at low idle speed. Due to ambient operating conditions it may

become necessary to set the slow fan speed between 450 and 500 rpm.



10. Actuate the cold ambient toggle switch to normal run application or dial thermostat to a setting lower than ambient conditions or 40°F (4°C) for final setting.



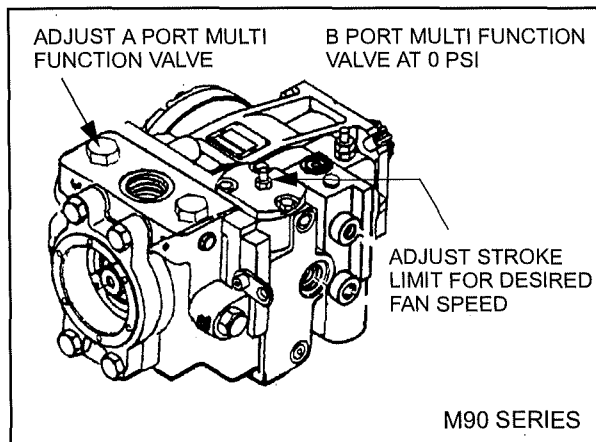
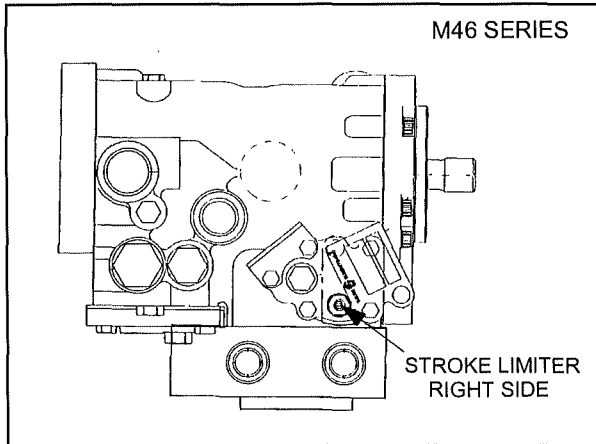
Troubleshooting the cooling fan system may require electric diagnostic or routing the two hoses together bypassing this variable speed solenoid/cold ambient solenoid.

11. Set the engine high idle speed.
12. Check the engine water temperature, the charge pressure and the fan speed.

NOTE!

Maximum fan speed is calibrated at the cooling fan pump stroke limiter adjustment screw.

- Adjust the appropriate stroke limit screw out (ccw) - non working port side of the pump, and monitor the fan speed. Refer to the fan speed charts on page 67.



NOTE!

MPV046 series stroke limiter, torque sealing lock nut to 4 - 7 ft lb (5.4 - 9.5 Nm)
 MPV090 series stroke limiter, torque sealing lock nut to 18 ft lb (24 Nm)

- Perform a final check of the fan speed and charge pressure. Make notes.
- Idle the engine down to the low idle speed, verify slow fan speed and charge pressure. Make notes.
- After an adequate cool down period stop the machine engine.

- Check that the charge pressure gauge zero's, and relieve hydraulic pressure.
- When applicable: remove the pressure gauge from the #4 hose and cap from the engine mounted thermal valve in port.
- When applicable: connect the #4 hydraulic hose to the 'IN' port of the engine mounted thermal valve as original configuration.
- Remove diagnostic test equipment and reconfigure machine hoses to original spec.

NOTE!

Sandvik drawing 019209 hose assembly is shown in spare parts manuals.

Machine is ready to operate under normal operating conditions. It is recommended to:

- restart the machine
- set the engine to high idle speed
- confirm a slow fan speed
- cover the engine radiator momentarily
- monitor the engine fluid temperature until the fan speed increases
- switch the cold ambient toggle switch to the cold operating condition mode
- monitor the fan speed decrease to the slow fan speed setting made to spec
- remove the cover from the engine radiator
- switch the cold ambient toggle switch to the normal operating mode

When troubleshooting the cooling fan system note the engine and compressor fluid temperatures.

If the cooling fan system (pump, motor or control systems) are at fault both fluid temperatures will be high and may enable a shutdown condition.

Check the cold ambient toggle switch position as this feature enables constant slow fan speed.

Extreme cold ambient conditions and cold oil will affect the pilot oil circuit. In extreme cold applications it may be required to increase the pressure reducing valve slow fan speed setting.

Service motor overhang adapter with gear and bearing lubricant appropriate for the ambient conditions.

SETTING THE TWO SPEED COOLING FAN SYSTEM (WITH ELECTRONIC CONTROL)

Use system set up procedures noted herein at this time.

PUMP DRIVE (001003-000)

GENERAL

The type of service and operating conditions will determine the main maintenance interval. However, it is recommended that the oil level be checked weekly, at the same time check for oil leaks. Because the lubricant system is the heart of the unit, *it is especially important that the oil be kept clean.*

PREVENTIVE MAINTENANCE

1. Lock-out and tag-out the starting function.



WARNING

**Rotating shafts and gears can cause injury or death.
Always stop the engine before checking or adding oil.**

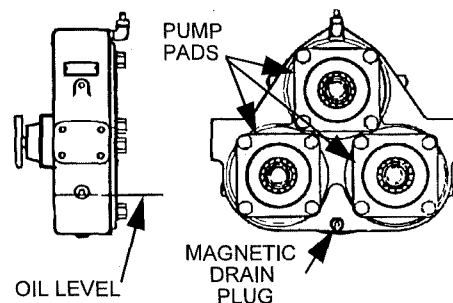
2. Clean the area around the oil fill and level ports before checking or adding oil.
3. It is recommended that lubricating oil be changed after the first 50 hours of service.
4. Thereafter, and under normal operating conditions, it is recommended that the oil be changed after every 500 hours of operation. The oil in the unit should be changed whenever the oil level shows traces of dirt or effects of high temperature, evident by discoloration or strong odor.
5. Drain oil while the unit is still warm, examining for contamination or metal particles.
6. Clean all magnetic drain plugs before replacing.
7. Always use clean oil in clean containers.

8. **Do not overfill.** This will result in overheating and possible malfunction of the unit.
9. Fill with MIL-L-2105C or API-GL-5.
10. Maximum operating oil temperature: 225°F (107°C).

Table 1: Lubricant recommendations

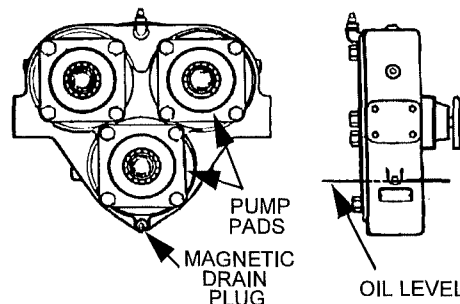
Temperature	Lubricant Grade
Below -10°F (-23°C)	75W
Above -10°F and up to 100°F (37.8°C)	80W-90
Above 100°F (37.8°C)	85W-140

POSITION 1



The oil capacity in position 1 is approximately 4-1/2 quarts (4.02 liters).

POSITION 2



The oil capacity in position 2 is approximately 2-3/4 quarts (2.59 liters).

REMOVAL AND DISASSEMBLY

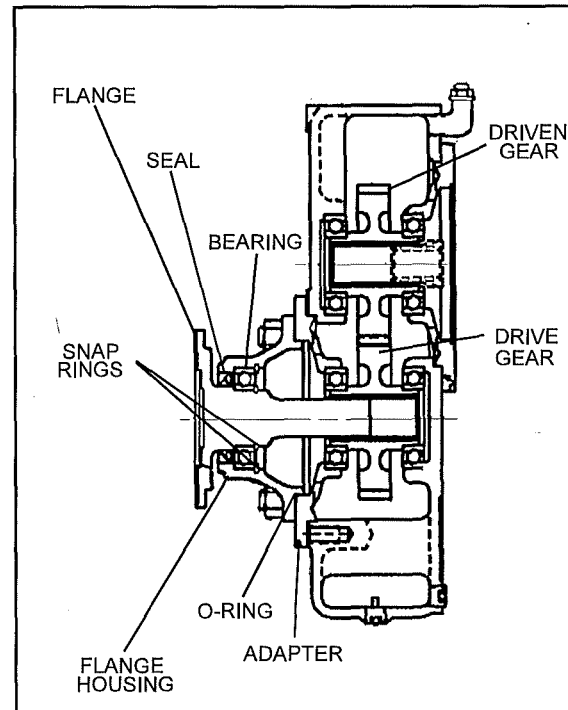
1. Drain the oil as described in the "PREVENTIVE MAINTENANCE" topic.
2. Remove the hardware securing the pumps to the drive and pull the pumps straight back from the pump drive.
3. Disconnect the gearbox driveshaft.
4. Using a suitable lifting device, remove the gearbox mounting hardware and lift the gearbox off of the rig.
5. Position the gearbox so that the pump pads are facing up.
6. Remove the screws securing the pads to the housing and remove the pads (note the location of each pad before removing).
7. Note the location of each of the driven gears before lifting the gears and bearings out of the housing.

NOTE!

It may be necessary to tip the gears slightly to clear the drive gear bearing pocket

8. If necessary, pull the bearings off all the gear hubs.
9. Position the gearbox so that the drive flange is facing up.
10. Remove the nuts securing the flange housing and adapter to the gearbox. Lift the flange housing off of the gearbox.
11. Separate the adapter from the gearbox housing and discard the O-ring.
12. Lift the drive gear and bearings out of the housing:
13. If necessary, remove the inner and outer snap rings from the flange housing to remove the input flange bearing, the flange and the

seal.



14. Clean the inside of the gearbox housing with a suitable solvent.

ASSEMBLY AND INSTALLATION

1. Press the bearings on the drive and driven gear hubs.
2. Lubricate the input flange oil seal before installing it in the flange housing.
3. Install the input flange bearing into the flange housing and secure it in place with the outer snap ring.
4. Lubricate the shaft of the input flange before installing it in the flange housing and securing it with the inner snap ring.
5. With the drive gear and bearings well lubricated, install this assembly in the gearbox housing.

6. Check the cleanliness of the input adapter and the gearbox surfaces. Apply a silicone sealant around the adapter and install it over the mounting studs and the drive gear bearing.
7. Lubricate and install a new O-ring in the adapter before installing the assembled input flange and housing. Tighten the mounting nuts to 150 ft-lbs (202 Nm).
8. Position the gearbox so that the pump cavities are facing up.
9. With the driven gears and bearings well lubricated, install these assemblies in the gearbox housing. Be sure that the gear assemblies are placed in the same position if they were removed and not replaced with new ones.
10. Check the cleanliness of the pump pads and the gearbox surfaces. Apply a silicone sealant around the pads and install them over the driven gear bearings. Tighten the mounting screws to 150 ft-lbs (202 Nm).
11. Using a suitable lifting device, lift the gearbox on to the rig and install the gearbox mounting hardware.
12. Attach the driveshaft and pumps.
13. Refer to the topic "PREVENTIVE MAINTENANCE" and fill the housing with the recommended oil.
14. Start the rig and check for oil leaks.

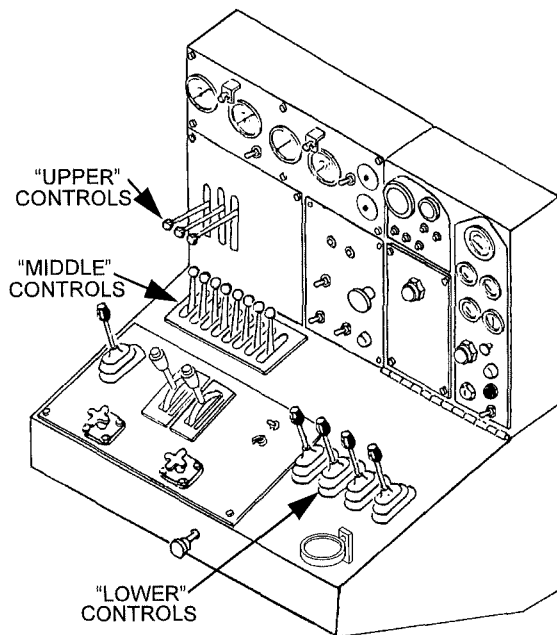
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CONTROL VALVES (STACKERS) (001023-000 & 001024-000)

GENERAL

The following adjustments are for the upper, middle, and lower operator control (stacker) valves.



UPPER & MIDDLE STACKER RELIEF VALVE ADJUSTMENT

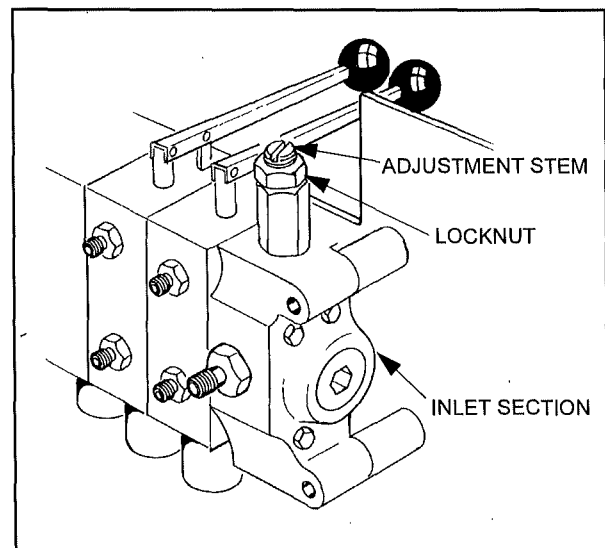
Cartridge type relief valves are located in the inlet sections of both of these valve banks. The pressure settings should be adjusted as follows:

1. Refer to the hydraulic schematic to determine the relief valve pressure settings.
2. Position the machine on level ground.
3. Shut the machine down and operate the controls to release hydraulic pressure in the lines.

WARNING

At operating temperature, hydraulic oil is hot and under pressure. Hot oil can cause burns. To prevent possible personal injury, release the pressure in the hydraulic circuits before any hydraulic lines or components are disconnected or removed.

4. Disconnect a **cylinder** retract line, at the valve or at the cylinder, and connect a 1/4" line with an accurate 5000 psi gauge attached, to the valve.
5. Start the engine and run it at full throttle or high idle.
6. Operate the control lever for the cylinder until the cylinder stalls. Record the gauge reading.
7. Return the control lever to "Neutral" and run the engine at idle.
8. Adjust the relief valve as follows:
 - A. Loosen the locknut.
 - B. Turn the adjusting stem clockwise to increase pressure or counterclockwise to decrease pressure to the valve.



- C. Recheck the setting as described above.
- D. Tighten the locknut.
- 9. Remove the pressure gauge and reconnect the hose.

LOWER STACKER RELIEF VALVE ADJUSTMENT

A cartridge type relief valve is located in the inlet section of this valve bank. The pressure settings should be adjusted as follows:

- 1. Refer to the hydraulic schematic to determine the relief valve pressure settings.
- 2. Position the machine on level ground and raise all "JACK" cylinders.

NOTE!

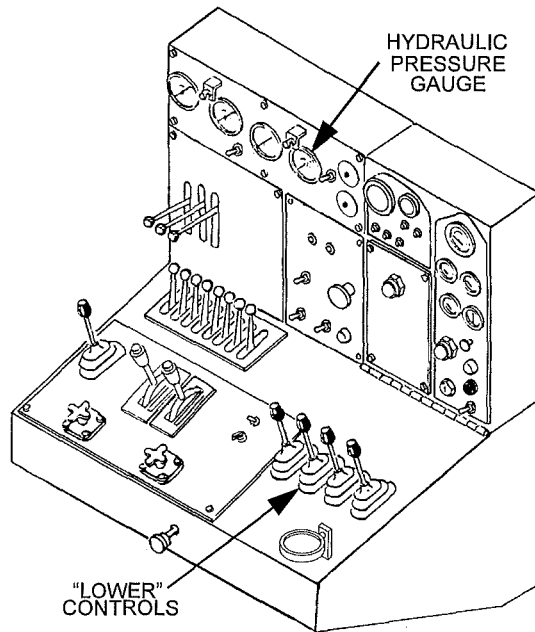
It is not necessary to install a gauge when checking the relief pressure of the lower stacker valve. The "HYDRAULIC PRESSURE" gauge can be used as long as FEED pressure is set higher than the inlet relief.

- 3. Start the engine and run it at full throttle or high idle.
- 4. Operate a "JACK - UP" control lever for the cylinder until the cylinder stalls. Record the reading on the "HYDRAULIC PRESSURE" gauge.
- 5. Return the control lever to "Neutral" and run the engine at idle.

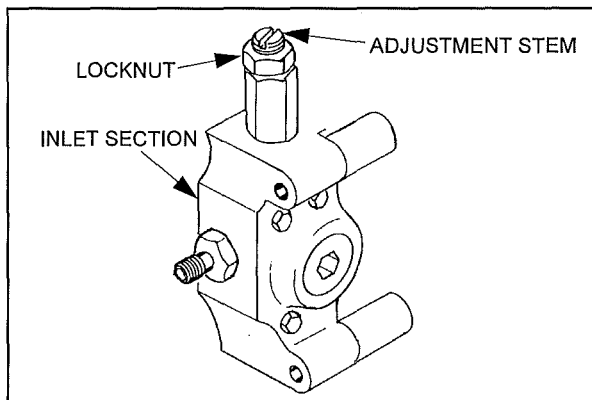
6. Adjust the relief valve as follows:

- A. Loosen the locknut.
- B. Turn the adjusting stem clockwise to increase pressure or counterclockwise to decrease pressure to the valve.

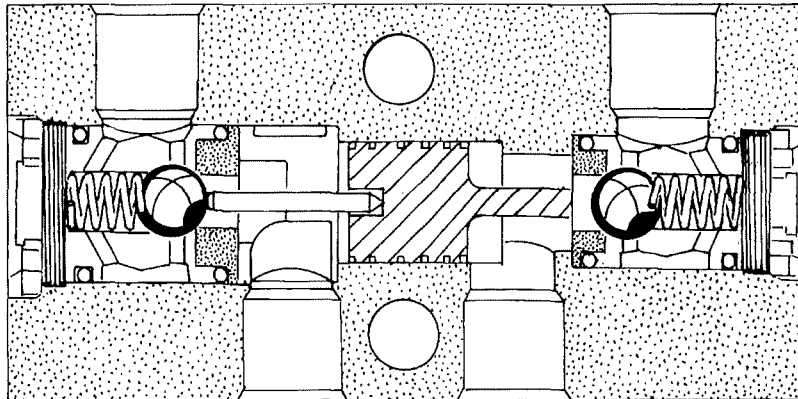
C. Recheck the setting as described above.



D. Tighten the locknut.

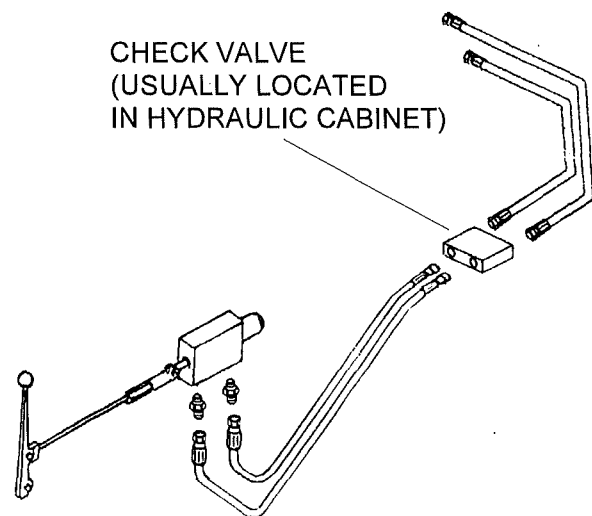


DOUBLE PILOT CHECK VALVE (001316-000)



The double pilot check valve shown above is used as a cylinder 'locking device' to hold certain drill components in its last controlled position. Some of the components you will find this check valve on includes the holding wrench and the drill pipe loader. As an example, when the loader swing control lever is returned to the 'neutral' position, the barrel loader is 'locked' and will not vibrate or drift in either direction until pressure is applied through the control valve.

If the cylinder does vibrate or drift out of its last controlled position, the check valve should be removed, thoroughly cleaned and inspected. As replacement of component parts are not recommended, **the entire check valve should be replaced** if cleaning the valve does not completely restore 'locking' of the component it is used with.



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PUMP & MOTOR SHAFT AND SEAL REPLACEMENT

(001329-, 001330-, 002746-, &
002764-000)

GENERAL

Two types of shaft seals are used on these pumps and motors; a seal assembly that consists of a spring, rubber bellows, and carbon ring, or a more typical oil seal.

CARBON RING - TYPE SEAL

This procedure applies to the following shaft seals with seal kit part numbers:

001330-052
001330-223
001330-416
003785-061
003785-185

Removal

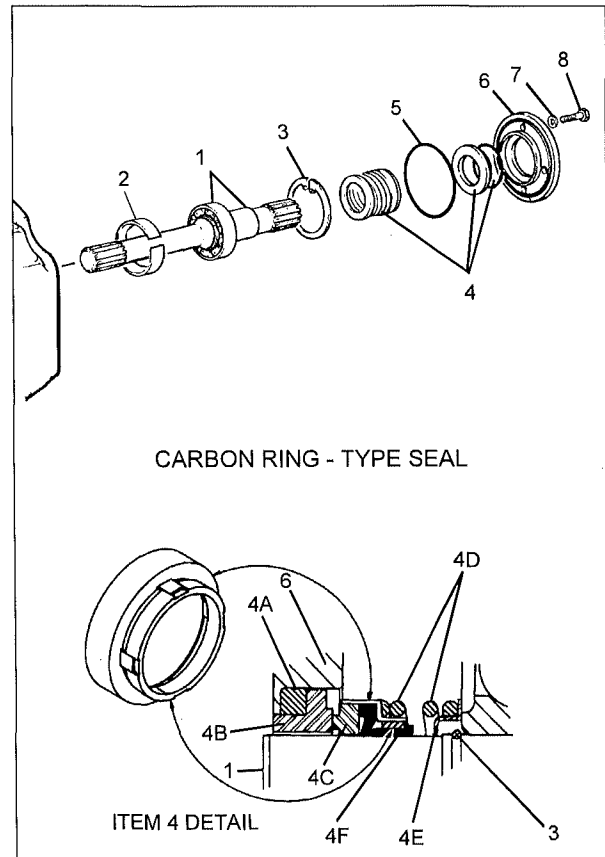
Disassemble and remove the driveshaft as follows:

1. Remove the four screws (8) and gaskets (7) and remove retainer (6) and the stationary section of seal (4).

NOTICE

Do not scratch the seal surfaces on the shaft when removing seal (4).

2. Carefully remove the carbon ring and the remainder of shaft seal (4) from shaft (1).
3. Remove snap ring (3) and pull out shaft and bearing assembly (1). Remove shim (2) where applicable.



Cleaning And Inspection

All parts must be inspected and be free of material defects, dirt, scratches or any foreign material.

After cleaning, all parts must be covered with a light film of clean oil.

Installation

Install the shaft and seal assembly as follows:

NOTICE

Before installing the shaft seal, exercise care to ensure that all of the parts fit together properly. If the rubber ring (F), grips the shaft, spring (D) can disengage the shell of carbon ring (C). Be sure the shell

and the band of the carbon ring are properly engaged before reassembling the seal.

1. Position the pump with the inlet and outlet port block facing down.
2. Lubricate the seal and shaft with clean hydraulic fluid of the same type that will be used in the system. Install the assembled shaft and bearing (1) in the mounting flange and cradle. Be certain that there are no burrs or sharp edges on shaft seal area of the shaft.
3. For a rigid shaft application use the shim (2) that results in least clearance around the shaft bearing.
4. Install snap ring (3) in the mounting flange to retain the shaft assembly. Be certain that the ring is fully seated in the groove. Use the ring that results in the tightest fit.
5. Seal assembly (4) is available as a complete unit only. Assemble the seal as follows:

NOTE !

Seal installation must be completed quickly to avoid the rubber friction ring seizing on the shaft.

F. Place spring retainer (E) over the shaft and against the retaining ring on the shaft assembly.

G. Place spring (D) against retainer (E).

H. Apply grease to the inner surface of rubber friction ring (F) and position the shell containing the rubber friction ring and carbon ring (C) over the shaft with the carbon ring exposed.

I. Apply grease to the square section rubber seal (A) and install on ceramic seat (B).

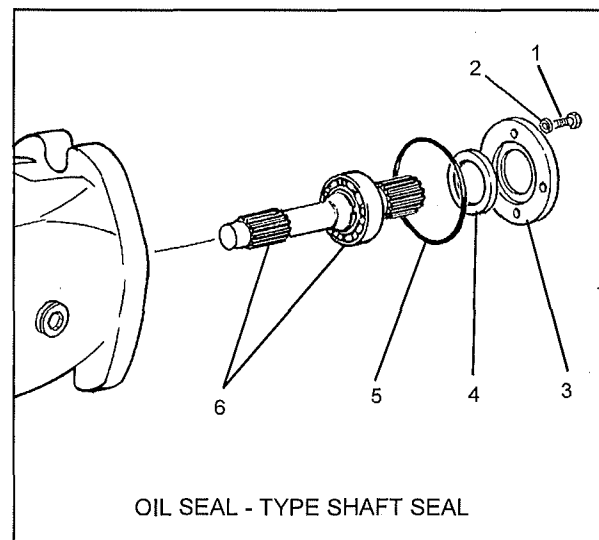
J. Insert the seat and seal in seal retainer (6) with the lapped side of the seat in position to contact the carbon ring.

K. Place the seal retainer assembly and O-ring (5) over the shaft with the lapped surface against the carbon face.

L. Place the four gaskets (7) on the four screws (8) and insert seal retainer (6). Depress the seal retainer only far enough to start the four screws and tighten evenly. Torque to 10 ft. lb. (13.6 Nm).

OIL SEAL - TYPE SHAFT SEAL

This procedure applies to the following shaft seal with seal kit part number: 001329-273



1. Remove the four screws (1) and gaskets (2) and remove retainer (3) and O-ring (5).
2. Remove shaft seal (4) from shaft (6).
3. Remove socket head screw (7) which secures the cam to the housing.

NOTICE

Do not scratch the seal surfaces on the shaft when removing it from the cam.

4. Carefully remove shaft and bearing assembly (6) from the cam.

Cleaning And Inspection

All parts must be inspected and be free of material defects, dirt, scratches or any foreign material.

After cleaning, all parts must be covered with a light film of clean oil.

Installation

Install the shaft and oil seal as follows:

1. Position the cam on the rotating group so that the thick part of the cam is at the bottom of the port block.
2. Insert the small end of shaft and bearing assembly (6) through the bore of the cam and into the splines of the cylinder barrel.
3. Install O-ring (5) into the counterbore in the housing.
4. Using a tapered sleeve tool with an inside diameter of 1.240 inches (31.5 mm) and an outside diameter of 1.395 inches (35.5 mm), install seal (4) over the splines of the shaft.
5. Slide seal retainer (3) over the shaft and against seal (4).
6. Place gaskets (2) over capscrews (1) and install them. Alternately torque the screws to 50 ft-lbs (68 Nm).

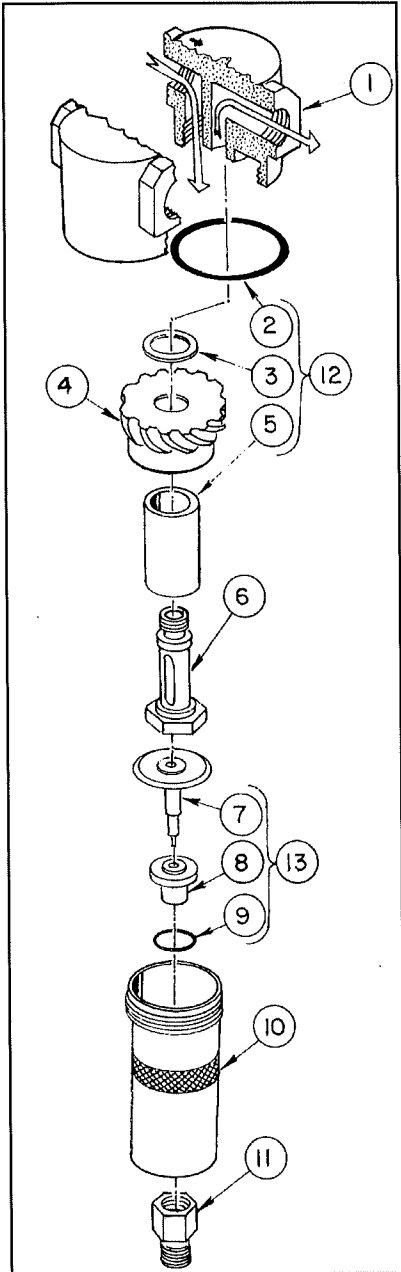
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AIR FILTER (001658-000)



Wash all parts using warm water and soap. Dry parts and blow out internal passages in body using clean, dry compressed air. Blow air through filter element from inside to outside to dislodge surface contaminants. Replace filter element when plugged or dirty.

Table 1: PARTS DESCRIPTION

ITEM	QTY	DESCRIPTION
1	1	BODY
2	1	O-RING - 75-024
3	1	WASHER - rubber
4	1	LOUVER
5	1	ELEMENT - 5 micron
6	1	STUD
7	1	VALVE
8	1	INSERT
9	1	O-RING - 75-012
10	1	BODY
11	1	NUT
12	1	ELEMENT KIT - includes items 2, 3 and 5
13	1	FILTER KIT - automatic drain, includes items 7, 8 and 9

During reassembly, make sure valve lip (7) is turned down. Use a soft, blunt tool such as a piece of cardboard to turn lip down. **Do not scratch the bowl surface when turning the lip down.**

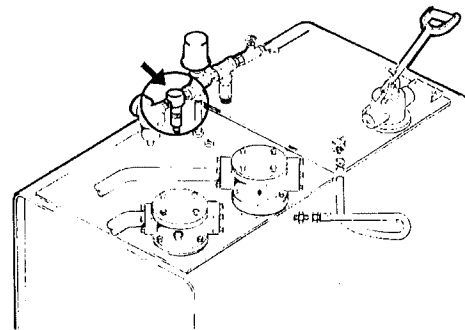


Table 2: RECOMMENDED TOQUE

ELEMENT STUD (ITEM 6)	INCH POUNDS
BOWL (ITEM 1)	5 TO 10
NUT (ITEM 11)	5 TO 8

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HYDRAULIC PUMP (002764-000)

DESCRIPTION

This hydraulic pump is an axial piston pump. Rotation can be either clockwise or counterclockwise.

GENERAL

This topic contains a description of the pump, a troubleshooting table, and instructions for replacing the shaft seal and shaft assembly.

TROUBLESHOOTING

The following table lists some of the difficulties which may be experienced with this piston pump. The table indicates the probable cause and possible remedies for the problem listed.

Problem	Cause	Remedy
Noisy Pump	Air in Fluid	a. Leak in suction line b. Leak at shaft seal c. Low fluid level d. Excessive pressure drop in the inlet line from reservoir e. Suction line strainer acting as an air trap
	Cavitation in pump rotating group	a. Fluid too cold b. Fluid too viscous c. Fluid too heavy d. Dirty return filters
	Misaligned shaft	a. Distortion in mounting b. Axial interference
	Mechanical failure in pump	a. Bearing failure b. Worn parts in displacement control
High Wear in Pump	Excessive loads	a. Reduce pressure settings b. Reduce speeds
	Contaminant particles in fluid	a. Improper filter maintenance b. Introduction of dirty fluid into system c. Dirty reservoir breather d. Improper hose replacement
	Improper fluid	a. Fluid too thin or thick for operating range b. Fluid breakdown c. Incorrect additives in new fluid d. Weak additives do to chemical aging
	Water in fluid	a. Condensation b. Faulty breather c. Leaking cooler d. Incorrect flushing practices
Pressure Shocks	Worn relief valve	a. Repair
	Worn compensator	a. Repair
	Servo pressure too low to maintain control	a. Increase pressure & check pressure drop
	Pump barrel blow-off	a. Check pump hold-down, drain pressure

Problem	Cause	Remedy
Heating Fluid	Excessive leakage	a. Rescheck case drain flow b. Fluid too thin
	Hydraulic reservoir	a. Fluid level too low b. Air in fluid
	Relief valve	a. Set too low (compared to compensator)
	Compensator	a. Set too high (compared to relief)
	Oil cooler	a. Clogged or restricted b. Reduced efficiency due to scale c. Intermittent fluid flow

CARBON RING - TYPE SEAL

This procedure applies to the following shaft seals with seal kit part numbers:

- 001330-052
- 001330-223
- 001330-416
- 003785-061
- 003785-185

Removal

Disassemble and remove the driveshaft as follows:

1. Remove the four screws (8) and gaskets (7) and remove retainer (6) and the stationary section of seal (4).

NOTICE

Do not scratch the seal surfaces on the shaft when removing seal (4).

2. Carefully remove the carbon ring and the remainder of shaft seal (4) from shaft (1).
3. Remove snap ring (3) and pull out shaft and bearing assembly (1). Remove shim (2) where applicable.

Cleaning And Inspection

All parts must be inspected and be free of material defects, dirt, scratches or any foreign material.

After cleaning, all parts must be covered with a light film of clean oil.

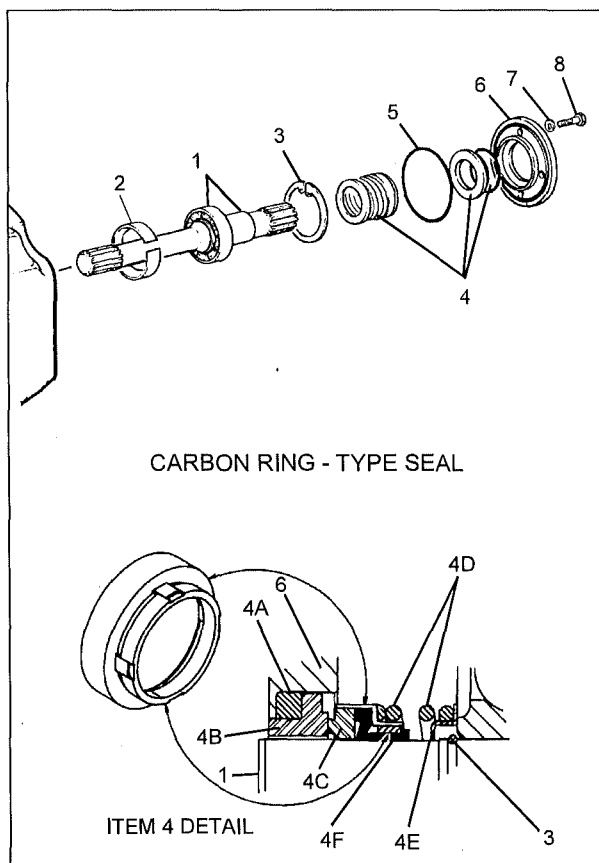
Installation

Install the shaft and seal assembly as follows:

NOTICE

Before installing the shaft seal, exercise care to ensure that all of the parts fit together properly. If the rubber ring (F), grips the shaft, spring (D) can disengage the shell of carbon ring (C). Be sure the shell and the band of the carbon ring are properly engaged before reassembling the seal.

1. Position the pump with the inlet and outlet port block facing down.
2. Lubricate the seal and shaft with clean hydraulic fluid of the same type that will be used in the system. Install the assembled shaft and



CARBON RING - TYPE SEAL

ITEM 4 DETAIL

bearing (1) in the mounting flange and cradle. Be certain that there are no burrs or sharp edges on shaft seal area of the shaft.

3. For a rigid shaft application use the shim (2) that results in least clearance around the shaft bearing.
4. Install snap ring (3) in the mounting flange to retain the shaft assembly. Be certain that the ring is fully seated in the groove. Use the ring that results in the tightest fit.
5. Seal assembly (4) is available as a complete unit only. Assemble the seal as follows:

NOTE !

Seal installation must be completed quickly to avoid the rubber friction ring seizing on the shaft.

F. Place spring retainer (E) over the shaft and against the retaining ring on the shaft assembly.

G. Place spring (D) against retainer (E).

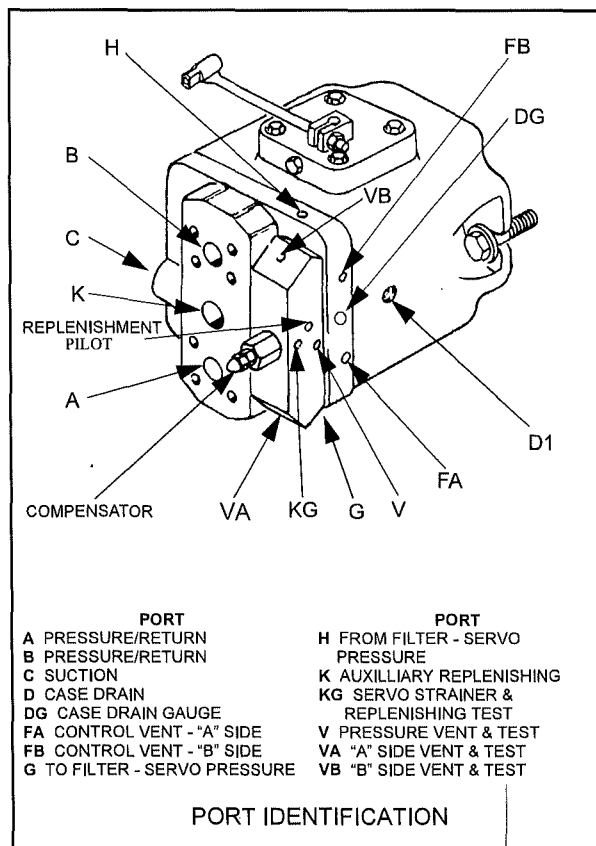
H. Apply grease to the inner surface of rubber friction ring (F) and position the shell containing the rubber friction ring and carbon ring (C) over the shaft with the carbon ring exposed.

I. Apply grease to the square section rubber seal (A) and install on ceramic seat (B).

J. Insert the seat and seal in seal retainer (6) with the lapped side of the seat in position to contact the carbon ring.

K. Place the seal retainer assembly and O-ring (5) over the shaft with the lapped surface against the carbon face.

L. Place the four gaskets (7) on the four screws (8) and insert seal retainer (6). Depress the seal retainer only far enough to start the four screws and tighten evenly. Torque to 10 ft. lb. (13.6 Nm).



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PUMP DRIVE (003837-000)

GENERAL

The type of service and operating conditions will determine the main maintenance interval. However, it is recommended that the oil level be checked weekly, at the same time check for oil leaks. Because the lubricant system is the heart of the unit, *it is especially important that the oil be kept clean.*

PREVENTIVE MAINTENANCE

1. Check unit for operational warning tags.



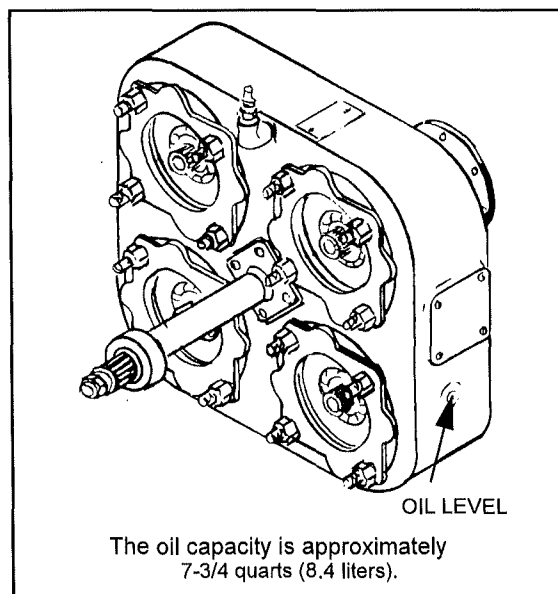
Stop the engine before checking or adding oil.

2. Clean around oil fill before checking or adding oil.
3. It is recommended that lubricating oil be changed after the first 50 hours of service.
4. Thereafter, and under normal operating conditions, it is recommended that the oil be changed after every 500 hours of operation. The oil in the unit should be changed whenever the oil level shows traces of dirt or effects of high temperature, evident by discoloration or strong odor.
5. Drain oil while the unit is still warm, examining for contamination or metal particles.
6. Clean all magnetic drain plugs before replacing.
7. Always use clean oil in clean containers.
8. **Do not overfill.** This will result in overheating and possible malfunction of the unit.

9. Fill with MIL-L-2105C or API-GL-5.
10. Maximum operating oil temperature: 225°F (107°C).

Table 4: Lubricant recommendations

Temperature	Lubricant Grade
Below -10°F (-23°C)	75W
Above -10°F and up to 100°F (37.8°C)	80W-90
Above 100°F (37.8°C)	85W-140



REMOVAL AND DISASSEMBLY

1. Drain the oil as described in the "PREVENTIVE MAINTENANCE" topic.
2. Remove the hardware securing the pumps to the drive and pull the pumps straight back from the pump drive.
3. Disconnect the gearbox driveshaft.

4. Using a suitable lifting device, remove the gearbox mounting hardware and lift the gearbox off of the rig.

5. Position the gearbox so that the pump pads are facing up.

6. Remove the screws securing the pads to the housing and remove the pads (note the location of each pad before removing).

7. Note the location of each of the driven gears before lifting the gears and bearings out of the housing.

NOTE!

It may be necessary to tip the gears slightly to clear the drive gear bearing pocket

8. If necessary, pull the bearings off all the gear hubs.

9. Position the gearbox so that the drive flange is facing up.

10. Remove the nuts securing the flange housing and adapter to the gearbox. Lift the flange housing off of the gearbox.

11. Separate the adapter from the gearbox housing and discard the O-ring.

12. Lift the drive gear and bearings out of the housing.

13. If necessary, remove the inner and outer snap rings from the flange housing to remove the input flange bearing, the flange and the seal.

14. Clean the inside of the gearbox housing with a suitable solvent.

ASSEMBLY AND INSTALLATION

1. Press the bearings on the drive and driven gear hubs.

2. Lubricate the input flange oil seal before installing it in the flange housing.

3. Install the input flange bearing into the flange housing and secure it in place with the outer snap ring.

4. Lubricate the shaft of the input flange before installing it in the flange housing and securing it with the inner snap ring.

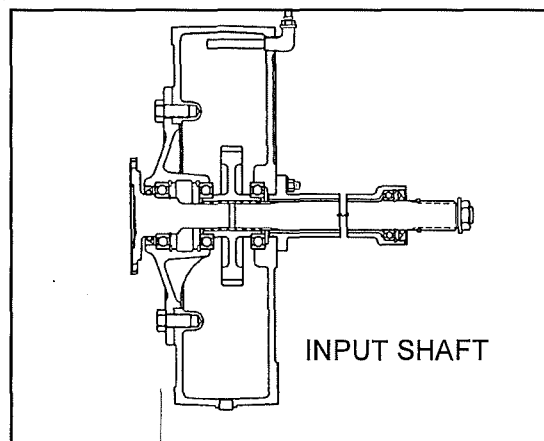
5. With the drive gear and bearings well lubricated, install this assembly in the gearbox housing.

6. Check the cleanliness of the input adapter and the gearbox surfaces. Apply a silicone sealant around the adapter and install it over the mounting studs and the drive gear bearing.

7. Lubricate and install a new O-ring in the adapter before installing the assembled input flange and housing. Tighten the mounting nuts to 150 ft-lbs (202 Nm).

8. Position the gearbox so that the pump cavities are facing up.

9. With the driven gears and bearings well lubricated, install these assemblies in the gearbox housing. Be sure that the gear assemblies are placed in the same position if they were removed and not replaced with new ones.



10. Check the cleanliness of the pump pads and the gearbox surfaces. Apply a silicone sealant around the pads and install them over the driven gear bearings. Tighten the mounting screws to 150 ft-lbs (202 Nm).

11. Using a suitable lifting device, lift the gearbox on to the rig and install the gearbox mounting hardware.

12. Attach the driveshaft and pumps.

13. Refer to the topic "PREVENTIVE MAINTENANCE" and fill the housing with the recommended oil.

14. Start the rig and check for oil leaks.

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ACCUMULATORS

(004695-000/019585-000)

RECHARGING

NOTICE

Only trained personnel should fill nitrogen into accumulators. Overcharging the accumulator bladder can damage the accumulator and hydraulic components. Under charging will affect hoses, hydraulic oil and components. Extreme temperatures can result in incorrect pressure readings. Accumulator charging should only be done when the ambient temperature is between 21 and 38°C (70 and 100°F).

1. Exhaust all hydraulic pressure from the system.

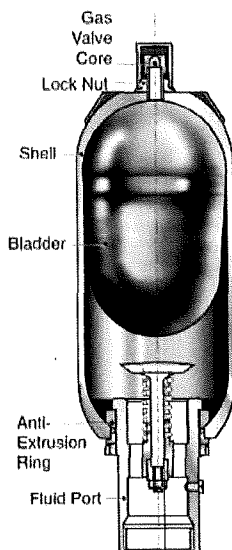


DANGER

EXPLOSION HAZARD

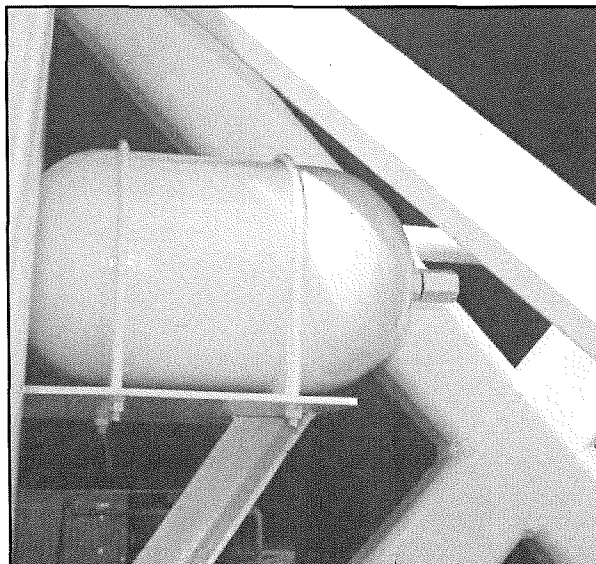
Charging the accumulator bladder with oxygen or shop air will cause an explosion causing personal injury or death. DO NOT use oxygen as a charge gas. Dry nitrogen gas (N₂) should be used.

2. Remove valve guard and dynaseal.



3. Mount hose assembly gland nut to pressure regulator.
4. Attach a swivel connector to the gas valve. Hand tighten sufficiently to compress gasket swivel connector in order to prevent gas leakage.
5. Precharge bladder slowly to about 10 PSIG before completely tightening the valve stem nut. Use a second wrench on the valve stem flats to react the torque applied to the stem nut.
6. Proceed to inflate accumulator to 7/8.2 bar (100/120 psi) by slowly opening the pressure regulator valve on nitrogen cylinder, closing it occasionally to allow needle on pressure gauge to stabilize (thus giving accurate reading of precharge pressure). When correct precharge has been reached, close pressure regulator valve on nitrogen cylinder securely.
7. The bleeder valve can be used to let out any gas pressure in excess of desired precharge.
8. Replace dynaseal and valve guard.

The accumulator charge should be pressure checked at approximately 1000 hour intervals. If the bladder charge cannot be maintained or if oil is present at filling adapter the complete accumulator must be serviced or replaced.

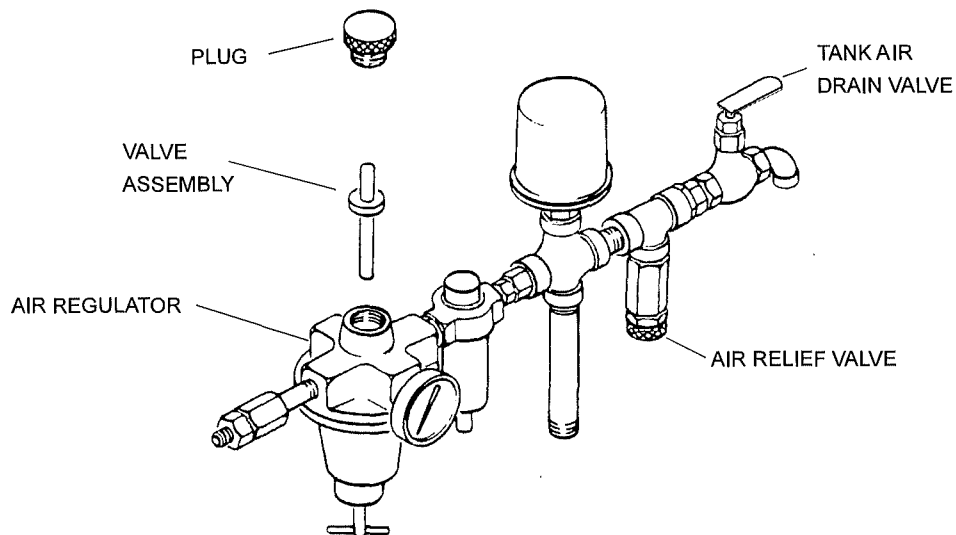


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HYDRAULIC TANK AIR REGULATION SYSTEM (004756-000)



1. Machine must be shutdown and all air pressure released from hydraulic tank through the air drain valve.
2. Install 100 PSI gauge in street elbow on air drain valve. Rotate street elbow so gauge can be easily read. Remove plug from top of air regulator and remove spring and valve assembly. Replace plug. Remove air gauge from air regulator and plug opening.
3. Air relief valve adjusting knob must be turned counterclockwise (CCW) to allow for maximum relief before starting engine. Do not unscrew adjusting knob completely.
4. Start engine and allow compressor pressure to come up to a minimum of 100 PSI receiver tank pressure. Adjust air relief valve to 12-15 PSI by turning adjusting knob clockwise (CW).
5. Release all air from hydraulic tank and reinstall valve assembly and spring in air regulator. Also reinstall the 30 PSI gauge on the air regulator valve and remove test gauge from air drain valve.
6. Restart engine and check air regulator setting. Pressure reading should be no more than 3-7 PSI.
7. Air regulators are preset between 3 and 7 PSI. If excessive reading is obtained regulator must be replaced.

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HYDRAULIC VANE PUMP

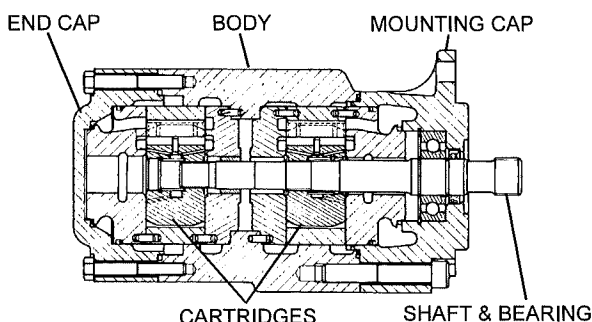
(008172-000)

GENERAL

The following pages cover the description, operation, removal, maintenance overhaul and installation instructions for the vane type hydraulic pump.

DESCRIPTION

The vane pump consists of six basic components: the housing or body, two unitized cartridges consisting of; a rotor, vanes, vane holdout pins, cam ring, bearing, port plate and pressure plate, a shaft and bearing, mounting cap and end cap.



OPERATION

Operation of this hydraulic pump is as follows: The rotors, driven by the shaft, carry the vanes in radial slots. The vanes follow the cam ring through their cycle, two cycles per revolution for each vane; suction-seal-discharge-seal. The rotors are loaded by the vanes only when they are on the major and minor arcs of the cam contour. Diametrical balance of vanes, ports and pressures causes the rotors to see only pure torque loads from the pumping action. The shaft bearings carry the overhung and axial loads imposed by the pump drive.

The inlet flow feeds through ports on both sides of the cartridges as well as through a large port through the cam ring at each suction ramp.

The vanes are held outward in a light but steady contact against the fluid film which separates them from the cam ring. Their radial position changes to follow the cam and to adjust for fluid viscosity, contaminants and component wear.

The rotor is separated from the side plates by the fluid film. The sideplates are clamped axially by an overbalance of the internal pressure forces in the pumping cartridge. They accommodate dimensional changes due to temperature and pressure.

MAINTENANCE

The internal parts of this pump are lubricated by the operating fluid, therefore, preventative maintenance is limited to keeping the fluid in the system clean. Dirt should not be allowed to accumulate on the pump or around the shaft seal. All fittings and bolts should be tight.

NOTE !

It is especially important that the suction or inlet piping and fittings be tight and in good repair to prevent air from being drawn into the system.

In the event the pump does not perform properly or a malfunction occurs, refer to the "Troubleshooting Chart" before proceeding with an overhaul.

TROUBLESHOOTING

The following table lists some of the difficulties which may be experienced with this vane pump. The table indicates the probable cause and possible remedies for the problem listed.

Problem	Cause	Remedy
External Leakage	a. Seal failure. b. Porosity in casting. c. Damaged or defective seal between housing and mounting cap.	a. Replace seal. b. Replace casting. c. Replace seal.
Leakage at Fittings	a. Cracked or damaged flange or fittings. b. Damaged or defective flange threads. c. Damaged or defective O-ring seal. d. Burr on mating surfaces.	a. Replace flange or fittings. b. Replace flange. c. Replace O-ring seal. d. Remove burr.
Loss in Pump RPM Under Load	a. Power source too small for pump being used.	a. Provide larger power source. See HP requirements for pump being used.
Pump Not Delivering Oil	a. Pump does not prime. b. Wrong direction on shaft rotation. c. Tank fluid level too low. d. Fluid inlet line or suction strainer clogged. e. Air leak in suction line. f. Fluid viscosity too heavy to pick up prime. g. Broken pump shaft or internal parts.	a. Bleed air from system. b. Reverse direction of shaft. Convert pump to reverse direction of rotation. (Check rotation arrows on ident. plate & cam ring.) c. Add fluid and check level to be certain suction line is submerged. d. Clean strainer of all foreign material. e. Tighten and seal connections. Replace seals. f. Use lighter viscosity fluid. g. Replace damaged parts per overhaul instructions.
Pump Not Developing Pressure	a. Relief valve setting too low. b. Relief valve sticking open. c. Vane hold out pins not loading vanes. d. Free recirculation of fluid to tank being allowed.	a. Reset relief valve. b. Check for defective or malfunctioning valve. c. Disassemble and check pins & pin bores for burrs or damage. Check for foreign material. d. Check directional control valve for open center or neutral position. Check for open bypass valve.
Noisy or Erratic Operation	a. Air leak at pump inlet or suction lines. b. Housing and mounting cap separation. c. Restricted or clogged inlet line or strainer. d. Excessive pump RPM (cavitation). e. Worn vanes, cam ring or port plates. f. Worn vane holdout pins. g. Worn bearings.	a. Check for air leaks by pouring system fluid around joints and listen for change in sound level. Tighten as required. b. Check bolts for poor torque. c. Clean strainer. d. Provide power source that does not exceed maximum pump RPM recommendations. e. Replace cartridge. f. Replace cartridge. g. Disassemble and replace.
Seal Failure	a. Excessive inlet pressure.	a. Decrease inlet pressure, inlet pressure must not exceed 35 PSI.*

* Except for pumps with S-5 seals. These must not exceed 50 PSI inlet pressure.

VANE PUMP TROUBLESHOOTING TABLE

REMOVAL and INSTALLATION

The following instructions are general and should only be used as a guide in removing and installing this component.

To remove the pump, proceed as follows:

9. Stop the engine and allow the hydraulic oil to cool. Disconnect the battery ground cable and tag the ignition switch to inform others of the maintenance taking place.

10. Clean the area around the pump drive and hose connections.

11. To prevent hydraulic oil from draining out of the pump supply lines, either drain the hydraulic tank or attach a shop vacuum line to the tank's breather opening. Build a vacuum and remove and cap the pump supply line.

12. Tag, disconnect and cap the hoses at the pump. Plug the pump ports to prevent contamination.

13. Securely support the pump with a suitable lifting device before removing the pump attaching hardware.

14. Before installing the pump be sure the mounting surfaces of the pump and pump drive are clean.

15. Once the pump is installed, fill it with clean hydraulic fluid.

16. Start the machine and check the fittings at the pump for leakage.

OVERHAUL

General

The instructions contained in this section cover a complete disassembly, inspection and assembly of the pump. Also in this section is informa-

tion for changing cartridges and changing the shaft and shaft seals.

Drain all fluid from the pump and thoroughly clean the exterior surface. Prepare a clean, lint free surface on which to place the internal parts for inspection.

Changing Cartridges

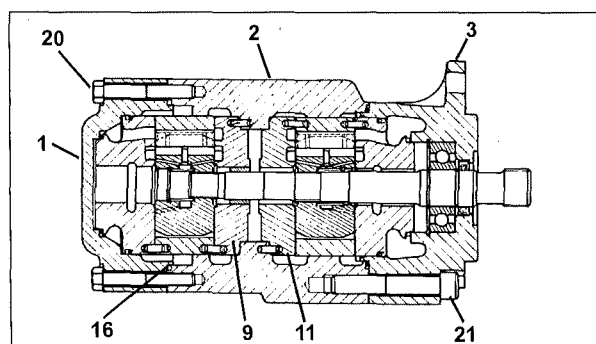
When changing cartridges the following instructions should be observed.

1. Drain all fluid from pump and thoroughly clean exterior surface.

2. Match mark the pump end caps and body. Secure the pump in a vise with the shaft extended down. **Clamp the vise on mounting cap (3), not on body (2).**

3. Remove the seven screws (20) and lift off end cap (1) together with the rear cartridge. Remove seal (16) from the cap.

4. Remove the rear cartridge assembly (P2) from end cap. It may be necessary to use a gear puller with its arms hooked under the rear port plate (9). Take care not to damage the cam ring or port plate.



5. Remove the four screws (21) and separate center housing (2) from mounting cap (3). The shaft assembly and shaft seal parts are removed with the mounting cap. It may be necessary to use a gear puller to remove the front "P1" cartridge by hooking the arms under front port plate (11). Take care not to damage the

ring or mounting cap.

6. Place pump body (2) on end and install the new front cartridge in the housing. Lubricate the O-rings before installation.

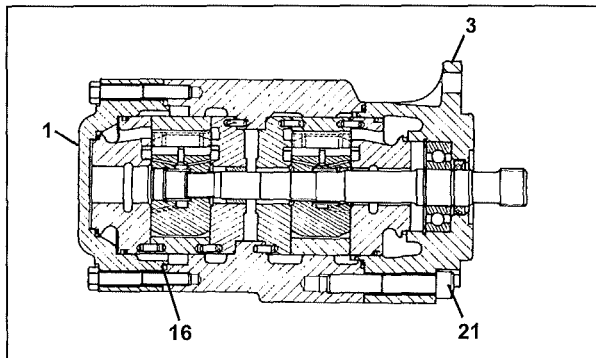
7. Install mounting cap (3) with the attached shaft assembly by inserting the shaft through the cartridge. Rotate the shaft to engage the spline in the rotor.

NOTE !

Align the match marks by turning the mounting cap.

8. Install four screws (21) and alternately tighten two to draw down mounting cap. Torque all four to 158 Nm (118 ft. lbs).

9. Install the rear cartridge in opposite end of housing. Make certain pin in port plate enters drilled hole in housing.



10. Install seal (16) on end cap. Apply hydraulic fluid to all seals to assist in assembly. Install end cap (1) over the cartridge and rotate until the match marks are aligned.

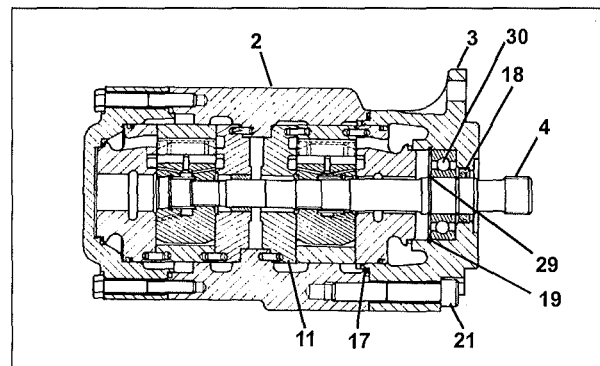
11. Install the seven screws and alternately tighten to draw down the end cap. Torque to 45 ft. lbs. Fill with approved hydraulic fluid.

Changing Shaft or Shaft Seal

Change the shaft or shaft seal as follows:

1. Drain the pump of hydraulic fluid. Secure the pump in a vise. **Clamp the vise on end cap (1), not on body (2).**

2. Remove four screws (21) and separate body (2) from mounting cap (3). The shaft assembly and shaft seal assembly will be removed with the cap. Remove the cartridge assembly from cap (3). It may be necessary to use a gear puller with its arms hooked under port plate (11) to remove the cartridge. Take care not to damage the port plate.



3. Remove O-ring (17) from cap (3). Remove retaining ring (19) and press or drive shaft assembly (4) from the cap. Use a soft faced hammer and gently tap the end of the shaft. Remove seal (18) only if it is to be changed.

NOTE !

Examine ball bearing (30) for wear before removing it from shaft (4). Apply light pressure to the outer race and rotate to check for wear or cracks and excessive looseness. Remove the bearing from the shaft if damaged. Inspect the shaft for damage, especially the seal surface for the shaft seal. Omit the next procedure if bearing removal is not required.

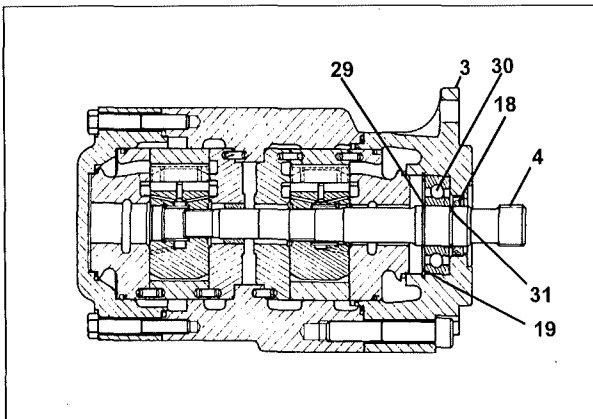
4. Remove retaining ring (29) and press bearing (30) off of shaft (4).

NOTICE

Retaining ring (31) must be removed by passing over the bearing surface of the shaft and NEVER over the shaft seal surface. A

damaged seal surface will cause the shaft seal to leak.

5. If removed, install retaining ring (31) in the groove nearest the input end of shaft (4) by passing the ring over the output end of the shaft. **Do not install it over the input end as this may damage the seal surface next to the groove causing seal leakage.**

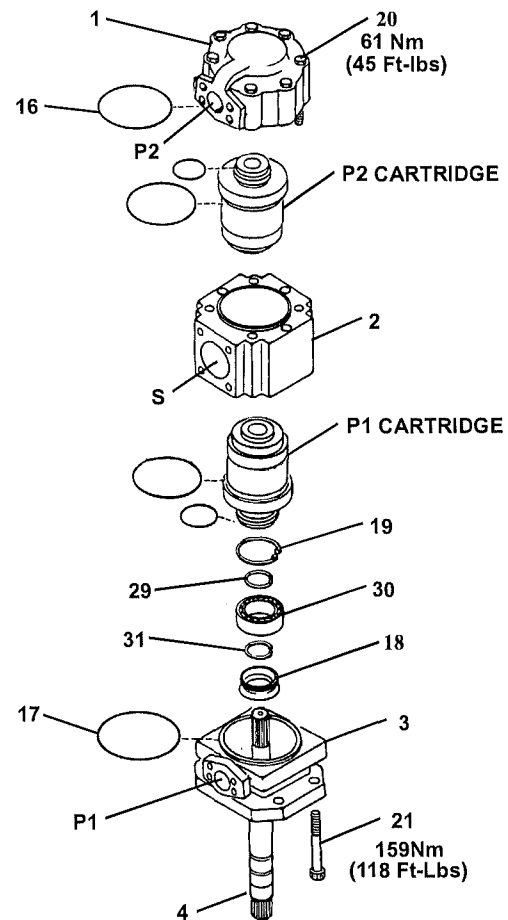


6. Install ball bearing (30) by pressing on the inner race until the bearing is seated against retaining ring (31). Install retaining ring (29). Make sure both rings are fully seated in their grooves.

7. Using a seal driver, press shaft seal (18) into mounting cap (3). Grease the seal lips.

NOTE !

The open face of seal must be toward installation tool. If a sealant is not furnished on the O.D. of the seal apply a light coat of approved sealing compound. Use extreme care not to deposit any of the sealing compound on the seal element or on the shaft.



8. Install a protective sleeve over the splines of shaft (4) and then press on the outer race of ball bearing (30) until it is installed in mounting cap (3).

NOTICE

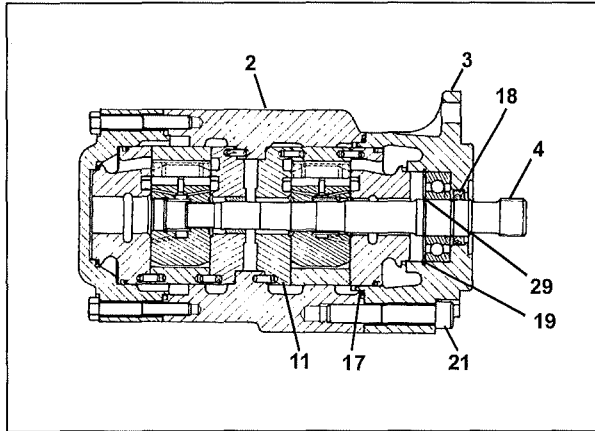
Do not press on the end of shaft (4).

9. Install retaining ring (19) to hold shaft (4) in place. Make sure ring is fully seated in groove.

10. Place the front cartridge in body (2). Install O-ring (17) on mounting cap (3) and insert shaft assembly down through the cartridge engaging the matching serrations.

NOTICE

Take special care the splines of the shaft and rotor engage smoothly. If necessary rotate the shaft slightly to obtain this.



11. Align the match marks and secure cap (3) to body (2) with screws (21). Torque to 159 Nm (118 ft. lbs).

HYDRAULIC CYLINDER (020050-000)

REMOVAL

1. Tag and disconnect the hydraulic hoses at the cylinder. Cap the lines and plug the cylinder ports to prevent the entry of dirt.
2. Unpin and remove the cylinder.
3. Clean the outside of the cylinder and place the cylinder in a clean work area.

OVERHAUL

NOTE!

These procedures were written with the assumption that the cylinder is to be completely disassembled and a new seal kit installed.

Disassembly

1. Support cylinder body (1) at both ends and using a spanner wrench unthread gland (11).

NOTE!

Because of the use of thread compound, it may be necessary to heat the gland to 400°F (205°C) and disassemble hot to break the joint.

2. Place a container under the rod end of cylinder body (1) to catch any oil remaining in the cylinder. Pull the cylinder rod assembly straight out of body (1) to prevent the piston assembly from scoring the cylinder wall.

3. Unthread and remove piston self-locking nut (2). Carefully slide piston (5) and gland (11) off of rod (14).

NOTE!

For models -004, -010, -011, -012, -013, and -015 spacer (15) should also slide off the piston rod.

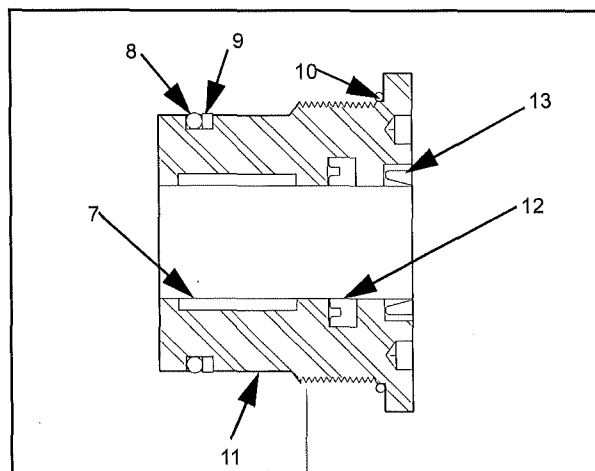
4. Remove O-ring (6), wear rings (3) and 'T' seal (4) from piston (5). Discard these items.
5. Remove wear ring (7), seal (12) and wiper ring (13) from inside gland (11).
6. Remove O-ring (8), back-up ring (9) and dirt ring (10) from the outside of gland (11).

Cleaning and Inspection

1. Clean the threads of the gland and cylinder body with solvent to remove any traces of locking compound.
2. Check the piston and gland for nicks or sharp edges. Polish to remove them.
3. Check the cylinder wall for signs of scoring. Replace if needed.
4. Check the piston rod for distortion. Replace if needed.

Assembly

1. Lubricate each part in clean hydraulic oil before installing it.
2. Install wear ring (7), seal (12) and wiper ring (13) in gland (11) as shown.



3. Install dirt ring (10), back-up ring (9) and O-ring (8) on the outside of gland (11) as shown.
4. Lubricate rod (14) with clean hydraulic oil and slide the assembled gland assembly on the rod.

NOTE!

For models -004, -010, -011, -012, -013, and -015, lubricate and install the spacer on the piston rod.

5. Check the center groove on piston (5) for sharp edges. The shoulders of the groove should have a 15-20° bevel.

6. Using a dull pick, begin walking 'T' seal (4) into position in the center groove of piston (5).

NOTE!

It may be necessary to heat the top ring of the 'T' seal in oil or water to 210°F (100°C) to aid in installing the seal.

7. Install wear rings (3) on the outside of piston (5) and O-ring (6) on the inside.

8. Lubricate the inside of the piston assembly with clean hydraulic oil before positioning it on the end of rod (14).

9. Lubricate the threads of a **new** self-locking nut (2). Install the nut on the end of rod (14) and torque to 90 ft-lbs (122 Nm).

NOTE!

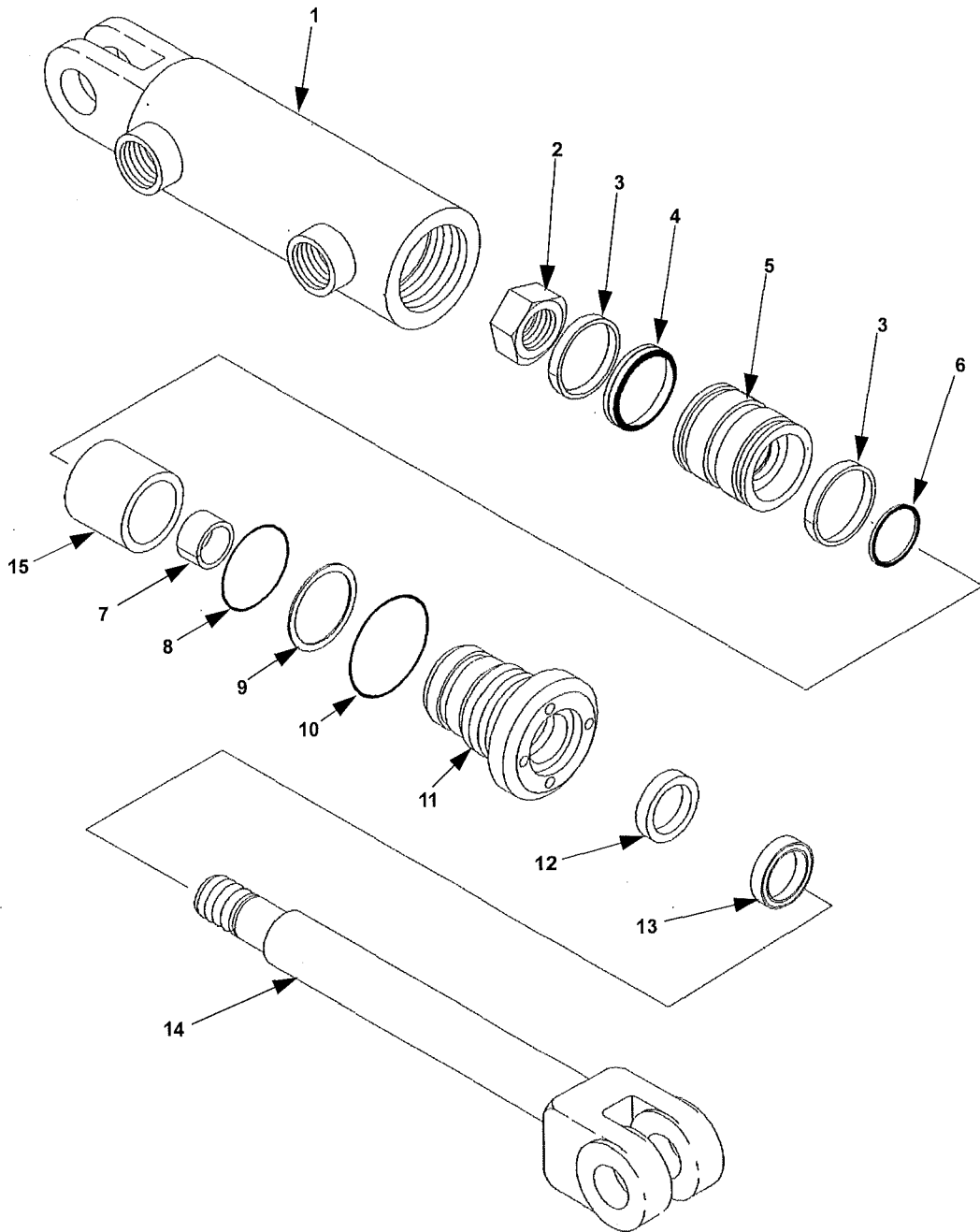
If self-locking nut (2) is being reused, apply Loctite #277 to the threads of the nut before installing it. Allow several hours for the locking compound to cure.

10. Lubricate the gland and piston assemblies and the walls of cylinder body (1) with clean hydraulic oil before installing the piston in the body.

11. Apply Loctite #277 (red) to the threads of gland (11) before threading the gland into cylinder body (1). Using a spanner wrench, torque the gland to a minimum of 175 ft-lbs (237 Nm).

INSTALLATION

1. Pin the cylinder in place.
2. Remove the plugs from the cylinder ports and fill the cylinder with oil.
3. Remove the caps from the hydraulic hoses and connect the hoses.
4. Start the machine and cycle the cylinder to remove air and check for leaks.
5. Retract all hydraulic cylinders and check the oil level in the hydraulic reservoir. Add oil of the type specified in Section 2.



NOTE!
 ITEM 15 IS ONLY USED ON
 CYLINDERS -004, -010, -011,
 -012, -013, & -015.

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HYDRAULIC CYLINDER PISTON LOCK KIT (020058-055)

GENERAL

The following instructions apply to hydraulic cylinders that use one of the following setscrew and plug piston lock arrangements listed below. This arrangement has been upgraded to contain; Loctite 277, Loctite 242, a dog-point setscrew, and a setscrew and steel shear pin.

020058-055
020059-061
020064-058
020065-059
020066-059
020076-059
020077-057
020089-058
020170-061
020170-071
020199-059

Before beginning the piston to rod assembly check both parts for nicks and burrs. Clean the parts and their threads thoroughly.

ASSEMBLY

Assemble the piston to the rod as follows:

1. As required, slide the assembled gland and spacer (4) on piston rod (10).
2. Apply a thin film of clean hydraulic oil to the piston O-ring before installing it in the piston.
3. Begin threading the piston on to the rod stopping when 1 inch (25 mm) of threads remain inside of the piston.

NOTE!

To decrease the amount of curing time from 6 hours to 2, it is recommended that Loctite Primer N be applied to the threads.

4. Apply a 1/4 inch (6 mm) bead of Loctite 277 around one half of the threaded inside diameter of the piston.

5. Using the table below, determine the piston torque required.

NOTE!

The Loctite compound will begin hardening 4-6 minutes after tightening begins.

PISTON TORQUE TABLE

CYLINDER NUMBER	TORQUE FT-LBS	TORQUE Nm
020049-003 & 004	300	407
020051-001	300	407
020056-001 & 003	300	407
020058-001, 2, 3 & 4	350	475
020059-002	350	475
020062-002	300	407
020064-002 & 003	300	407
020065-001 & 002	300	407
020066-001 & 002	300	407
020067-002	300	407
020070-001 & 002	350	475
020071-001 & 002	350	475
020076-001 & 002	350	475
020077-001	300	407
020078-001	450	610
020089-001	350	475
020170-001 & 002	220	296
020199-001 & 003	300	407
022102-001	300	407
022111-001	350	475

6. Using a spanner wrench, tighten the piston to the value determined.

7. Locate the setscrew hole in the piston on the wear ring groove. Use a 5/16" drill bit, drill 1/8 ± 1/16 inch (3 mm ± 1.5 mm) deep into the

threads of the piston rod.

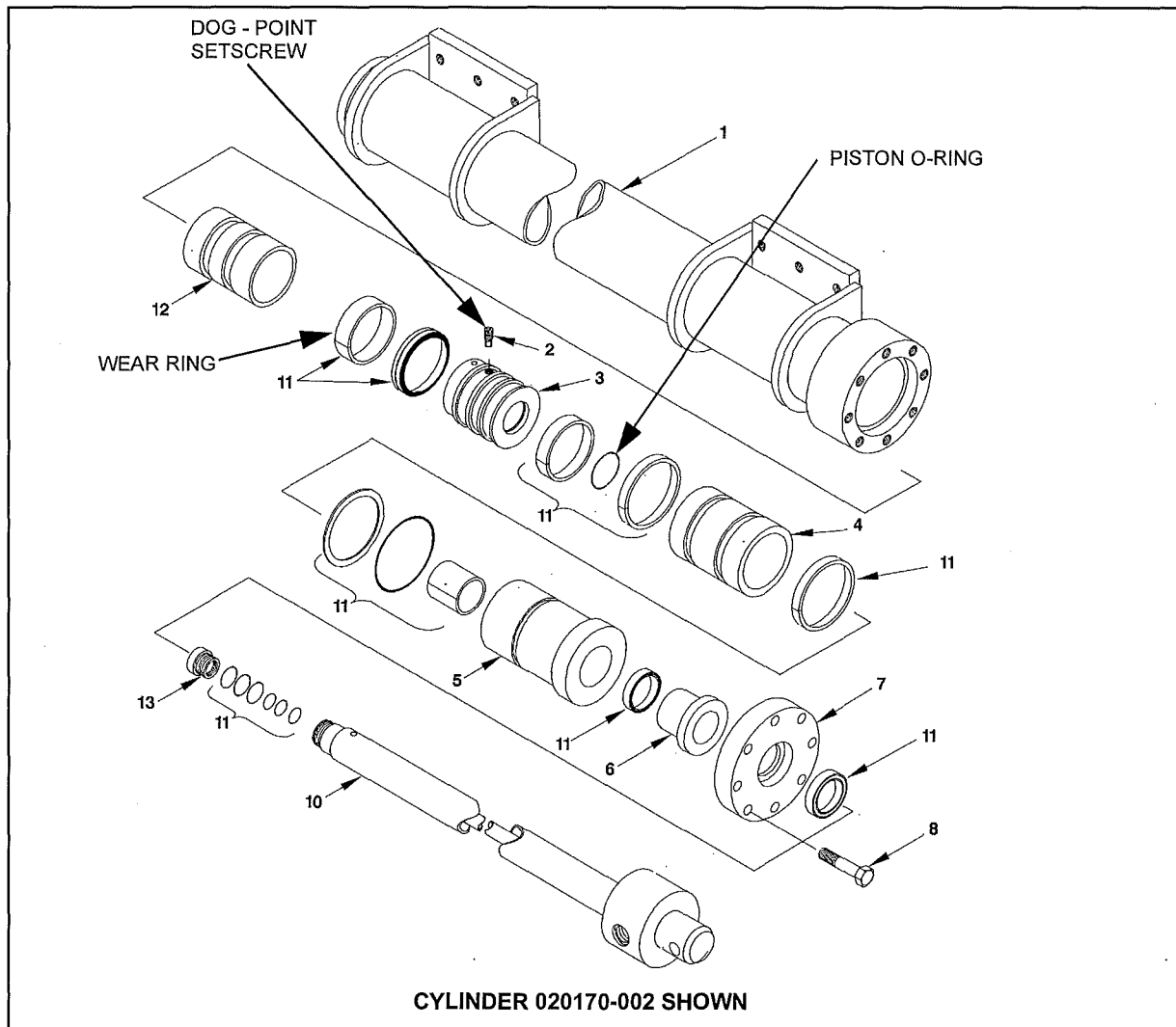
8. Clean the drill shavings out of the hole and insert the dog-point setscrew (2). If this setscrew cannot be threaded in far enough to enable the piston wear ring to be installed correctly then the steel pin and setscrew must be used.

9. If the dog-point setscrew (2) can be used, remove it and apply Loctite 242 to the last 3/4 threads before threading it into piston (3). Torque this setscrew to 18 ft-lbs (24.5 Nm) of torque.

10. If the steel pin and setscrew are used, drop the steel pin into the hole. Apply Loctite 242 to the last 3/4 threads of the screw before threading it into the piston. Torque this setscrew to 18 ft-lbs (24.5 Nm) of torque.

11. Lubricate and install the wear rings and seals over the piston.

12. Allow the Loctite to cure for 6 hours, 2 hours if Loctite N primer was used.



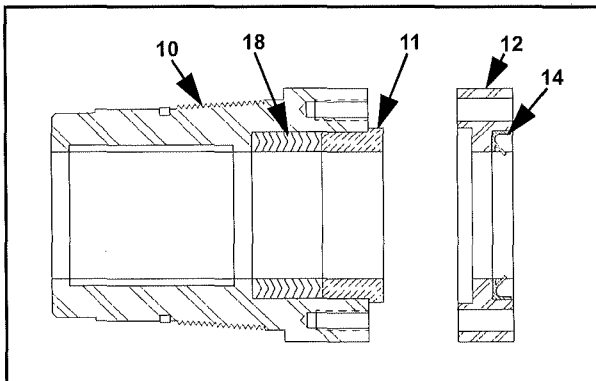
FEED CYLINDER (020059-000)

FIELD ROD SEAL KIT

A rod seal kit is available for this cylinder which allows the rod seal to be replaced without removing the cylinder from the mast.

Install the field rod seal as follows:

1. Lower the mast completely onto the mast rest.
2. Refer to sheet 3 and unthread the eight socket head capscrews (13) securing cylinder gland plate (12) to gland (10).
3. Slide gland plate (12) and gland bearing (11) up rod (15).
4. Remove split bearing (17) and cut U-seal (16) and remove.
5. Lubricate and install field rod seal (18) as shown.



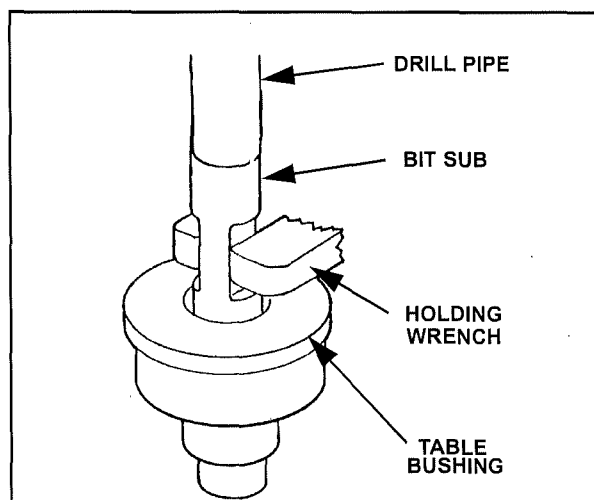
6. Slide gland bearing (11) and gland plate (12) down rod (15).
7. Apply Loctite #242 to the threads of socket head capscrews (13) and tighten to 100 to 115 ft-lbs (135 to 156 Nm).

REMOVAL

NOTE!

It is not necessary to remove the feed cylinder to change the cylinder rod oil seal. Refer to the Parts Manual and order the field rod seal kit.

1. Position the bit sub into the table to allow the holding wrench to engage. Engaging the holding wrench holds the rotary head in place once the feed cylinder is removed.



2. Lower the mast completely onto the mast rest.
3. Tag and disconnect the hydraulic hoses at the cylinders. Cap the lines and plug the cylinder ports to prevent the entry of dirt.
4. Strap the cylinder bodies to the mast. Unpin the cylinder bodies from the lower sprocket carriers.
5. Raise the mast and unstrap the cylinder bodies from the mast.



The rotary head will fall causing injury or death if the bit sub is not held in the holding wrench before disconnecting the feed cylinders. Engage the wrench before removing the cylinder securing strap.

6. Remove the locknuts and strap securing the upper part of the cylinder body to the mast.
7. Attach a lifting strap to the upper part of the cylinder body. Attach the lifting strap to an assist crane.
8. Remove the cylinder rod end pin from the sprocket assembly and remove the cylinders from the machine.
9. Clean the outside of the cylinder and place the cylinder in a clean work area.

OVERHAUL

NOTE!

These procedures were written with the assumption that the cylinder is to be completely disassembled and a new seal kit installed.

Disassembly

1. On a clean workbench, extend the cylinder rod out 5 to 6 ft (15 to 20 m). Place supports at areas to balance the weight of the cylinder.
2. Unthread the eight socket head capscrews (13) securing cylinder gland plate (12) to gland (10).
3. Slide gland plate (12) and gland bearing (11) up rod (15).
4. Remove split bearing (17) and cut U-seal (16) and remove.
5. Support cylinder body (1) at both ends and unthread gland (10).

NOTE!

Because of the use of thread compound, it may be necessary to heat the gland to 400°F (205°C) and disassemble hot to break the joint.

6. Place a container under the rod end of cylinder body (1) to catch any oil remaining in the

cylinder. Pull the cylinder rod assembly (15) straight out of body (1) to prevent the piston assembly from scoring the cylinder wall.

7. Remove wear rings (2) and unthread and remove piston locking screw arrangement (4).

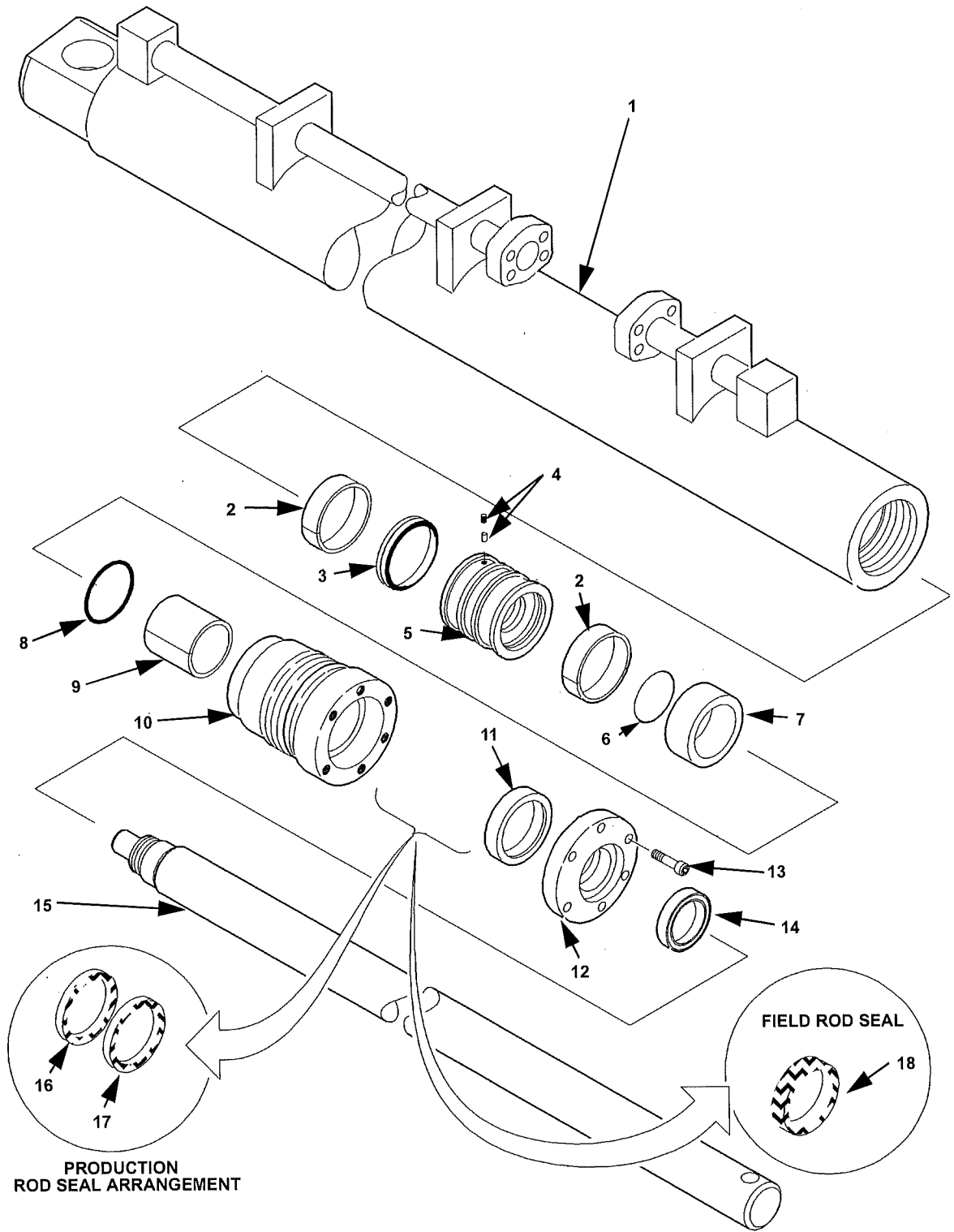
NOTE!

If a setscrew and nylon plug locking arrangement is used it should be discarded. A new arrangement is available and can be obtained by ordering the old number.

8. Unthread piston (5) and slide spacer (7), gland (10), gland bearing (11), and gland plate (12) off of rod (15).
9. Remove O-ring (6) and 'T' seal (3) from piston (5). Discard these items.
10. Remove wiper ring (14) from inside gland plate (12).
11. Remove O-ring (8) from the outside of gland (10).
12. Remove bearing(s) (9), rod seal (16 or 18) and split bearing (17) out of gland (10).

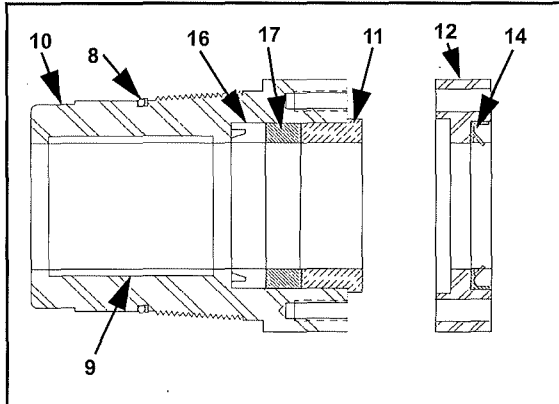
Cleaning and Inspection

1. Clean the threads of the gland, rod, piston and cylinder body with solvent to remove any traces of locking compound.
2. Check the piston and gland for nicks or sharp edges. Polish to remove them.
3. Check the cylinder wall for signs of scoring. Replace if needed.
4. Check the piston rod for distortion. Replace if needed.



Assembly

1. Lubricate each part in clean hydraulic oil before installing it.
2. Install bearing(s) (9) in gland (10).
3. Install seal (16), split bearing (17) and gland bearing (11) in gland (10) as shown.



4. Install O-ring (8) on the outside of gland (10) as shown.
5. Install wiper seal (14) in the end of gland plate (12).
6. Lubricate rod (15) with clean hydraulic oil and slide the assembled gland plate and gland assemblies on the rod.
7. Lubricate and slide spacer (7) on rod (15).
8. Install wear ring (2B) in the piston groove without the setscrew bore.
9. Check the center groove on piston (4) for sharp edges. The shoulders of the groove should have a 15-20° bevel.
10. Begin threading the piston on to the rod stopping when 1 inch (25 mm) of threads remain inside of the piston.

NOTE!

To decrease the amount of curing time from 6 hours to 2, it is recommended that Loctite Primer N be applied to the threads.

11. Apply a 1/4 inch (6 mm) bead of Loctite 277 around one half of the threaded inside diameter of the piston.

NOTE!

The Loctite compound will begin hardening 4-6 minutes after tightening begins.

12. Using a spanner wrench, tighten the piston to 350 ft-lbs (474.5 Nm).

13. Locate the setscrew hole in piston (5) on the wear ring groove. Use a 5/16" drill bit, drill $1/8 \pm 1/16$ inch (3 mm \pm 1.5 mm) deep into the threads of piston rod (15).

14. Clean the drill shavings out of the hole and insert the dog-point setscrew. If this setscrew cannot be threaded in far enough to enable piston wear ring (2) to be installed correctly then the steel pin and setscrew arrangement must be used.

15. If the dog-point setscrew can be used, remove it and apply Loctite 242 to the last 3/4 threads before threading it into piston (5). Torque this setscrew to 18 ft-lbs (24.5 Nm) of torque.

16. If the steel pin and setscrew are used, drop the steel pin into the hole. Apply Loctite 242 to the last 3/4 threads of the screw before threading it into the piston. Torque this setscrew to 18 ft-lbs (24.5 Nm) of torque.

17. Using a dull pick, begin walking 'T' seal (3) into position in the center groove of piston (5).

NOTE!

It may be necessary to heat the top ring of the 'T' seal in oil or water to 210°F (100°C) to aid in installing the seal.

18. Install remaining wear ring (2A) on the outside of piston (5).

19. Allow the Loctite to cure for 6 hours, 2 hours if Loctite N primer was used.

20. Lubricate the gland and piston assemblies

and the walls of cylinder body (1) with clean hydraulic oil before installing the piston in the body.

21. Apply Loctite #277 (red) to the threads of gland (10) before threading the gland into cylinder body (1). Torque the gland to a minimum of 315 ft-lbs (427 Nm).

22. Slide gland plate (12) over the gland. Apply Loctite #242 to the threads of socket head capscrews (13) and tighten to 100 to 115 ft-lbs (135 to 156 Nm).

INSTALLATION

1. With the machine levelled and the mast raised and locked, use an assist crane to lift the feed cylinders to enable the cylinder rods to be pinned to the sprocket carriers. Install the retaining pins and apply Loctite #242 to the threads of the retaining pin capscrews.

2. Install the cylinder body retaining straps.

3. Use additional stepping to secure the cylinders to the mast. Lower the mast completely.

4. Pin the cylinder bodies to the sprocket carriers. Install the retaining pin and apply Loctite #242 to the threads of the retaining pin cap-screw.

5. Remove the plugs from the cylinder ports and the caps from the hydraulic hoses and connect the hoses.

6. Start the machine and cycle the cylinders to remove air and check for leaks.

7. Retract all hydraulic cylinders and check the oil level in the hydraulic reservoir. Add oil of the type specified in Section 2.

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HYDRAULIC VANE PUMP

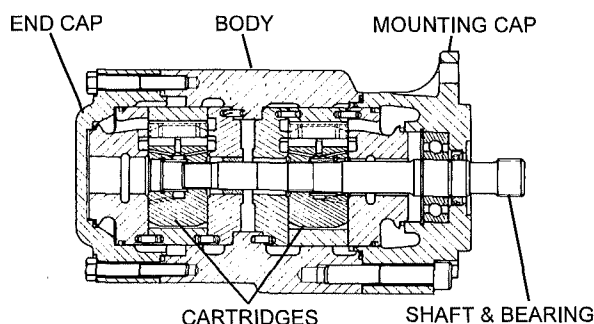
(021434-000)

GENERAL

The following pages cover the description, operation, removal, maintenance overhaul and installation instructions for the vane type hydraulic pump.

DESCRIPTION

The vane pump consists of six basic components: the housing or body, two unitized cartridges consisting of; a rotor, vanes, vane holdout pins, cam ring, bearing, port plate and pressure plate, a shaft and bearing, mounting cap and end cap.



OPERATION

Operation of this hydraulic pump is as follows: The rotors, driven by the shaft, carry the vanes in radial slots. The vanes follow the cam ring through their cycle, two cycles per revolution for each vane; suction-seal-discharge-seal. The rotors are loaded by the vanes only when they are on the major and minor arcs of the cam contour. Diametrical balance of vanes, ports and pressures causes the rotors to see only pure torque loads from the pumping action. The shaft bearings carry the overhung and axial loads imposed by the pump drive.

The inlet flow feeds through ports on both sides of the cartridges as well as through a large port through the cam ring at each suction ramp.

The vanes are held outward in a light but steady contact against the fluid film which separates them from the cam ring. Their radial position changes to follow the cam and to adjust for fluid viscosity, contaminants and component wear.

The rotor is separated from the side plates by the fluid film. The sideplates are clamped axially by an overbalance of the internal pressure forces in the pumping cartridge. They accommodate dimensional changes due to temperature and pressure.

MAINTENANCE

The internal parts of this pump are lubricated by the operating fluid, therefore, preventative maintenance is limited to keeping the fluid in the system clean. Dirt should not be allowed to accumulate on the pump or around the shaft seal. All fittings and bolts should be tight.

NOTE !

It is especially important that the suction or inlet piping and fittings be tight and in good repair to prevent air from being drawn into the system.

In the event the pump does not perform properly or a malfunction occurs, refer to the "Troubleshooting Chart" before proceeding with an overhaul.

TROUBLESHOOTING

The following table lists some of the difficulties which may be experienced with this vane pump. The table indicates the probable cause and possible remedies for the problem listed.

Problem	Cause	Remedy
External Leakage	a. Seal failure. b. Porosity in casting. c. Damaged or defective seal between housing and mounting cap.	a. Replace seal. b. Replace casting. c. Replace seal.
Leakage at Fittings	a. Cracked or damaged flange or fittings. b. Damaged or defective flange threads. c. Damaged or defective O-ring seal. d. Burr on mating surfaces.	a. Replace flange or fittings. b. Replace flange. c. Replace O-ring seal. d. Remove burr.
Loss in Pump RPM Under Load	a. Power source too small for pump being used.	a. Provide larger power source. See HP requirements for pump being used.
Pump Not Delivering Oil	a. Pump does not prime. b. Wrong direction on shaft rotation. c. Tank fluid level too low. d. Fluid inlet line or suction strainer clogged. e. Air leak in suction line. f. Fluid viscosity too heavy to pick up prime. g. Broken pump shaft or internal parts.	a. Bleed air from system. b. Reverse direction of shaft. Convert pump to reverse direction of rotation. (Check rotation arrows on ident. plate & cam ring.) c. Add fluid and check level to be certain suction line is submerged. d. Clean strainer of all foreign material. e. Tighten and seal connections. Replace seals. f. Use lighter viscosity fluid. g. Replace damaged parts per overhaul instructions.
Pump Not Developing Pressure	a. Relief valve setting too low. b. Relief valve sticking open. c. Vane hold out pins not loading vanes. d. Free recirculation of fluid to tank being allowed.	a. Reset relief valve. b. Check for defective or malfunctioning valve. c. Disassemble and check pins & pin bores for burrs or damage. Check for foreign material. d. Check directional control valve for open center or neutral position. Check for open bypass valve.
Noisy or Erratic Operation	a. Air leak at pump inlet or suction lines. b. Housing and mounting cap separation. c. Restricted or clogged inlet line or strainer. d. Excessive pump RPM (cavitation). e. Worn vanes, cam ring or port plates. f. Worn vane holdout pins. g. Worn bearings.	a. Check for air leaks by pouring system fluid around joints and listen for change in sound level. Tighten as required. b. Check bolts for poor torque. c. Clean strainer. d. Provide power source that does not exceed maximum pump RPM recommendations. e. Replace cartridge. f. Replace cartridge. g. Disassemble and replace.
Seal Failure	a. Excessive inlet pressure.	a. Decrease inlet pressure, inlet pressure must not exceed 35 PSI.*

* Except for pumps with S-5 seals. These must not exceed 100 PSI (7 bar) inlet pressure.

VANE PUMP TROUBLESHOOTING TABLE

REMOVAL and INSTALLATION

The following instructions are general and should only be used as a guide in removing and installing this component.

To remove the pump, proceed as follows:

1. Stop the engine and allow the hydraulic oil to cool. Disconnect the battery ground cable and tag the ignition switch to inform others of the maintenance taking place.
2. Clean the area around the pump drive and hose connections.
3. To prevent hydraulic oil from draining out of the pump supply lines, either drain the hydraulic tank or attach a shop vacuum line to the tank's breather opening. Build a vacuum and remove and cap the pump supply line.
4. Tag, disconnect and cap the hoses at the pump. Plug the pump ports to prevent contamination.
5. Securely support the pump with a suitable lifting device before removing the pump attaching hardware.
6. Before installing the pump be sure the mounting surfaces of the pump and pump drive are clean.
7. Once the pump is installed, fill it with clean hydraulic fluid.
8. Start the machine and check the fittings at the pump for leakage.

OVERHAUL

General

The instructions contained in this section cover a complete disassembly, inspection and assembly of the pump. Also in this section is informa-

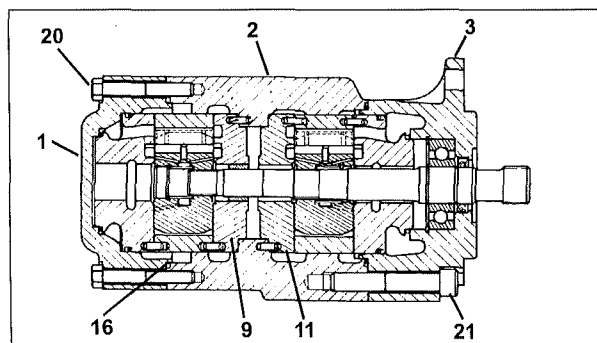
tion for changing cartridges and changing the shaft and shaft seals.

Drain all fluid from the pump and thoroughly clean the exterior surface. Prepare a clean, lint free surface on which to place the internal parts for inspection.

Changing Cartridges

When changing cartridges the following instructions should be observed.

1. Drain all fluid from pump and thoroughly clean exterior surface.
2. Match mark the pump end caps and body. Secure the pump in a vise with the shaft extended down. **Clamp the vise on mounting cap (3), not on body (2).**
3. Remove the seven screws (20) and lift off end cap (1) together with the rear cartridge. Remove seal (16) from the cap.
4. Remove the rear cartridge assembly (P2) from end cap. It may be necessary to use a gear puller with its arms hooked under the rear port plate (9). Take care not to damage the cam ring or port plate.



5. Remove the four screws (21) and separate center housing (2) from mounting cap (3). The shaft assembly and shaft seal parts are removed with the mounting cap. It may be necessary to use a gear puller to remove the front "P1" cartridge by hooking the arms under front port plate (11). Take care not to damage the

ring or mounting cap.

6. Place pump body (2) on end and install the new front cartridge in the housing. Lubricate the O-rings before installation.

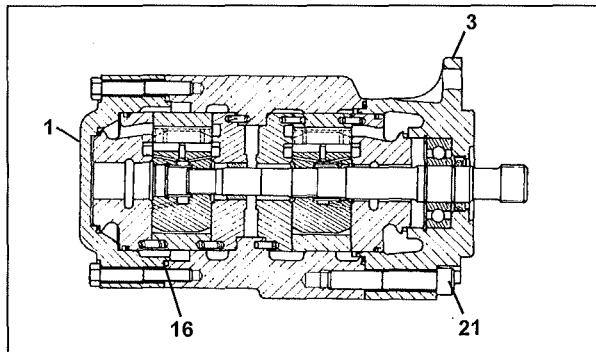
7. Install mounting cap (3) with the attached shaft assembly by inserting the shaft through the cartridge. Rotate the shaft to engage the spline in the rotor.

NOTE !

Align the match marks by turning the mounting cap.

8. Install four screws (21) and alternately tighten two to draw down mounting cap. Torque all four to 158 Nm (118 ft. lbs).

9. Install the rear cartridge in opposite end of housing. Make certain pin in port plate enters drilled hole in housing.



10. Install seal (16) on end cap. Apply hydraulic fluid to all seals to assist in assembly. Install end cap (1) over the cartridge and rotate until the match marks are aligned.

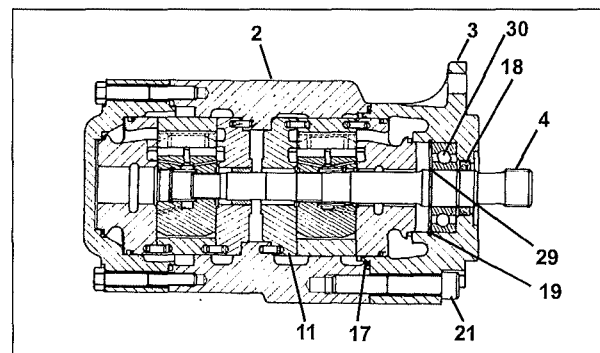
11. Install the seven screws and alternately tighten to draw down the end cap. Torque to 45 ft. lbs. Fill with approved hydraulic fluid.

Changing Shaft or Shaft Seal

Change the shaft or shaft seal as follows:

1. Drain the pump of hydraulic fluid. Secure the pump in a vise. **Clamp the vise on end cap (1), not on body (2).**

2. Remove four screws (21) and separate body (2) from mounting cap (3). The shaft assembly and shaft seal assembly will be removed with the cap. Remove the cartridge assembly from cap (3). It may be necessary to use a gear puller with its arms hooked under port plate (11) to remove the cartridge. Take care not to damage the port plate.



3. Remove O-ring (17) from cap (3). Remove retaining ring (19) and press or drive shaft assembly (4) from the cap. Use a soft faced hammer and gently tap the end of the shaft. Remove seal (18) only if it is to be changed.

NOTE !

Examine ball bearing (30) for wear before removing it from shaft (4). Apply light pressure to the outer race and rotate to check for wear or cracks and excessive looseness. Remove the bearing from the shaft if damaged. Inspect the shaft for damage, especially the seal surface for the shaft seal. Omit the next procedure if bearing removal is not required.

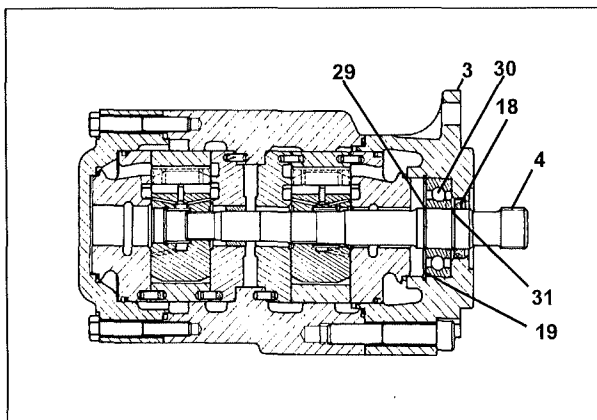
4. Remove retaining ring (29) and press bearing (30) off of shaft (4).

NOTICE

Retaining ring (31) must be removed by passing over the bearing surface of the shaft and NEVER over the shaft seal surface. A damaged seal surface will cause the shaft

seal to leak.

5. If removed, install retaining ring (31) in the groove nearest the input end of shaft (4) by passing the ring over the output end of the shaft. **Do not install it over the input end as this may damage the seal surface next to the groove causing seal leakage.**

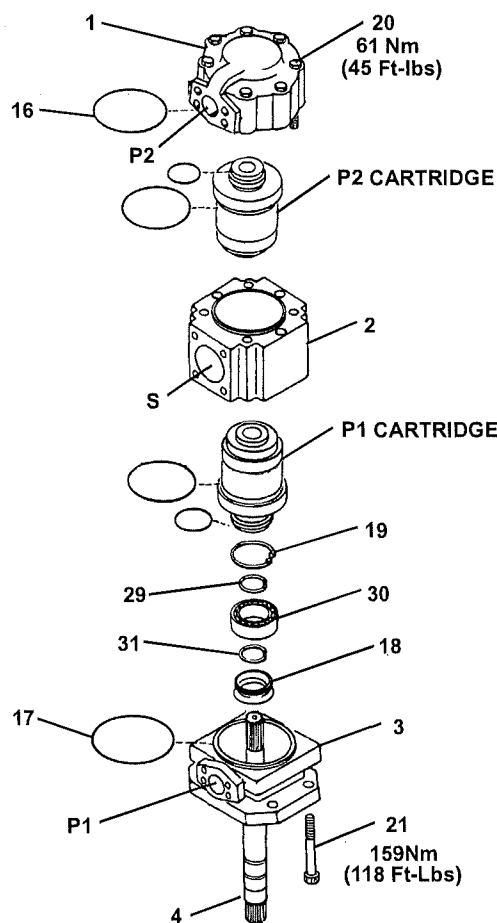


6. Install ball bearing (30) by pressing on the inner race until the bearing is seated against retaining ring (31). Install retaining ring (29). Make sure both rings are fully seated in their grooves.

7. Using a seal driver, press shaft seal (18) into mounting cap (3). Grease the seal lips.

NOTE!

The open face of seal must be toward installation tool. If a sealant is not furnished on the O.D. of the seal apply a light coat of approved sealing compound. Use extreme care not to deposit any of the sealing compound on the seal element or on the shaft.



8. Install a protective sleeve over the splines of shaft (4) and then press on the outer race of ball bearing (30) until it is installed in mounting cap (3).

NOTICE

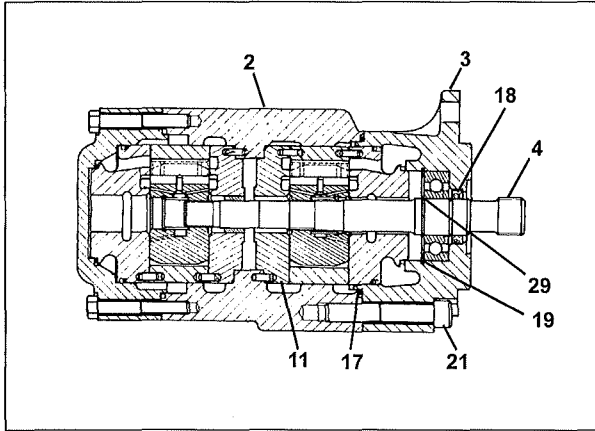
Do not press on the end of shaft (4).

9. Install retaining ring (19) to hold shaft (4) in place. Make sure ring is fully seated in groove.

10. Place the front cartridge in body (2). Install O-ring (17) on mounting cap (3) and insert shaft assembly down through the cartridge engaging the matching serrations.

NOTICE

Take special care the splines of the shaft and rotor engage smoothly. If necessary rotate the shaft slightly to obtain this.



11. Align the match marks and secure cap (3) to body (2) with screws (21). Torque to 159 Nm (118 ft. lbs).

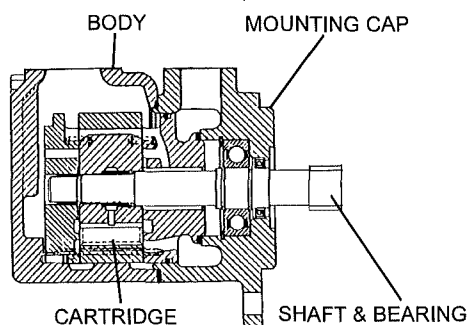
HYDRAULIC VANE PUMP (021435-000)

GENERAL

The following pages cover the description, operation, removal, maintenance overhaul and installation instructions for this vane type hydraulic pump.

DESCRIPTION

This vane pump consists of four basic components: the housing or body, a unitized cartridge consisting of; a rotor, vanes, vane holdout pins, cam ring, bearing, port plate and pressure plate, a shaft and bearing, and the mounting cap.



OPERATION

Operation of this hydraulic pump is as follows: The rotor, driven by the shaft, carries the vanes in radial slots. The vanes follow the cam ring through their cycle, two cycles per revolution for each vane; suction-seal & discharge-seal. The rotor is loaded by the vanes only when they are on the major and minor arcs of the cam contour. Diametrical balance of vanes, ports and pressures causes the rotor pumping action. The shaft bearings carry the overhung and axial loads imposed by the pump drive.

The inlet flow feeds through ports on both sides

of the cartridge as well as through a large port through the cam ring at each suction ramp.

The vanes are held outward in a light but steady contact against the fluid film which separates them from the cam ring. Their radial position changes to follow the cam and to adjust for fluid viscosity, contaminants and component wear.

The rotor is separated from the side plates by the fluid film. The sideplates are clamped axially by an overbalance of the internal pressure forces in the pumping cartridge. They accommodate dimensional changes due to temperature and pressure.

MAINTENANCE

The internal parts of this pump are lubricated by the operating fluid, therefore, preventative maintenance is limited to keeping the fluid in the system clean. Dirt should not be allowed to accumulate on the pump or around the shaft seal. All fittings and bolts should be tight.

NOTE !

It is especially important that the suction or inlet piping and fittings be tight and in good repair to prevent air from being drawn into the system.

In the event the pump does not perform properly or a malfunction occurs, refer to the "Troubleshooting Chart" before proceeding with an overhaul.

TROUBLESHOOTING

The following table lists some of the difficulties which may be experienced with this vane pump. The table indicates the probable cause and possible remedies for the problem listed.

Problem	Cause	Remedy
External Leakage	a. Seal failure. b. Porosity in casting. c. Damaged or defective seal between housing and mounting cap.	a. Replace seal. b. Replace casting. c. Replace seal.
Leakage at Fittings	a. Cracked or damaged flange or fittings. b. Damaged or defective flange threads. c. Damaged or defective O-ring seal. d. Burr on mating surfaces.	a. Replace flange or fittings. b. Replace flange. c. Replace O-ring seal. d. Remove burr.
Loss in Pump RPM Under Load	a. Power source too small for pump being used.	a. Provide larger power source. See HP requirements for pump being used.
Pump Not Delivering Oil	a. Pump does not prime. b. Wrong direction on shaft rotation. c. Tank fluid level too low. d. Fluid inlet line or suction strainer clogged. e. Air leak in suction line. f. Fluid viscosity too heavy to pick up prime. g. Broken pump shaft or internal parts.	a. Bleed air from system. b. Reverse direction of shaft. Convert pump to reverse direction of rotation. (Check rotation arrows on ident. plate & cam ring.) c. Add fluid and check level to be certain suction line is submerged. d. Clean strainer of all foreign material. e. Tighten and seal connections. Replace seals. f. Use lighter viscosity fluid. g. Replace damaged parts per overhaul instructions.
Pump Not Developing Pressure	a. Relief valve setting too low. b. Relief valve sticking open. c. Vane hold out pins not loading vanes. d. Free recirculation of fluid to tank being allowed.	a. Reset relief valve. b. Check for defective or malfunctioning valve. c. Disassemble and check pins & pin bores for burrs or damage. Check for foreign material. d. Check directional control valve for open center or neutral position. Check for open bypass valve.
Noisy or Erratic Operation	a. Air leak at pump inlet or suction lines. b. Housing and mounting cap separation. c. Restricted or clogged inlet line or strainer. d. Excessive pump RPM (cavitation). e. Worn vanes, cam ring or port plates. f. Worn vane holdout pins. g. Worn bearings.	a. Check for air leaks by pouring system fluid around joints and listen for change in sound level. Tighten as required. b. Check bolts for poor torque. c. Clean strainer. d. Provide power source that does not exceed maximum pump RPM recommendations. e. Replace cartridge. f. Replace cartridge. g. Disassemble and replace.
Seal Failure	a. Excessive inlet pressure.	a. Decrease inlet pressure, inlet pressure must not exceed 15 PSI* (0.7 bar).

* Except for pumps with S-5 or HP seals. These must not exceed 100 PSI (7 bar) inlet pressure.

VANE PUMP TROUBLESHOOTING TABLE

REMOVAL and INSTALLATION

The following instructions are general and should only be used as a guide in removing and installing this component.

To remove the pump, proceed as follows:

13. Stop the engine and allow the hydraulic oil to cool. Disconnect the battery ground cable and tag the ignition switch to inform others of the maintenance taking place.

14. Clean the area around the pump drive and hose connections.

15. To prevent hydraulic oil from draining out of the pump supply lines, either drain the hydraulic tank or attach a shop vacuum line to the tank's breather opening. Build a vacuum and remove and cap the pump supply line.

16. Tag, disconnect and cap the hoses at the pump. Plug the pump ports to prevent contamination.

17. Securely support the pump with a suitable lifting device before removing the pump attaching hardware.

18. Before installing the pump be sure the mounting surfaces of the pump and pump drive are clean.

19. Once the pump is installed, fill it with clean hydraulic fluid.

20. Start the machine and check the fittings at the pump for leakage.

OVERHAUL

General

The instructions contained in this section cover a complete disassembly, inspection and assembly of the pump. Also in this section is informa-

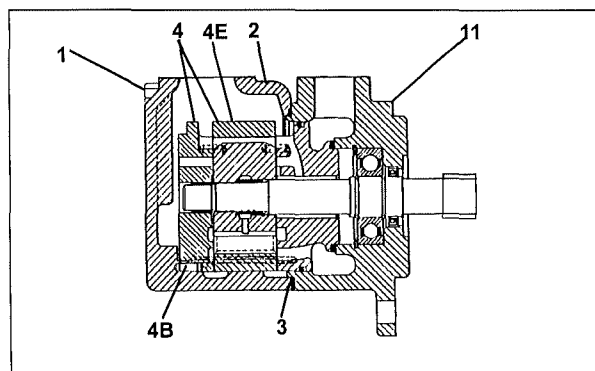
tion for changing cartridges and changing the shaft and shaft seals.

Drain all fluid from the pump and thoroughly clean the exterior surface. Prepare a clean, lint free surface on which to place the internal parts for inspection.

Changing Cartridges

When changing the cartridge the following instructions should be observed.

1. Drain all fluid from pump and thoroughly clean exterior surface.
2. Match mark the pump mounting cap and body. Secure the pump in a vise with the shaft extended down. **Clamp the vise on mounting cap (11), not on body (2).**
3. Remove the four screws (1) and lift off body (2). Remove seal (3) from cap (11).
4. Remove cartridge assembly (4) from mounting cap (11). It may be necessary to use a gear puller with its arms hooked under cam ring (4E). Take care not to damage the cam ring or mounting cap.



5. On a clean workbench install the new cartridge in body (2) making sure that drive lock pin (4B) is properly seated.
6. Lubricate the O-rings before installation. Install mounting cap (11) with the attached shaft assembly by inserting the shaft through the car-

tridge. Rotate the shaft to engage the spline in the rotor.

NOTE !

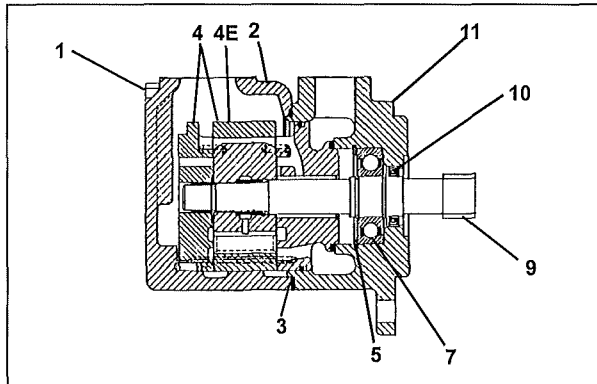
Align the match marks by turning the mounting cap.

7. Install four screws (1) and alternately tighten two to draw down mounting cap. Torque all four to 157 Nm (117 ft. lbs).

Changing Shaft or Shaft Seal

Change the shaft or shaft seal as follows:

1. Drain the pump of hydraulic fluid. Secure the pump in a vise. **Clamp the vise on mounting cap (11), not on body (2).**
2. Remove four screws (1) and separate body (2) from mounting cap (11). Remove cartridge assembly (4). It may be necessary to use a gear puller with its arms hooked under cam ring (4E) to remove the cartridge. Take care not to damage the cam ring or mounting cap.



3. Remove the mounting cap from the vise and remove O-ring (3) from cap (11). Remove retaining ring (5) and using a soft faced hammer gently tap the end of the shaft. Remove seal (18).

NOTE !

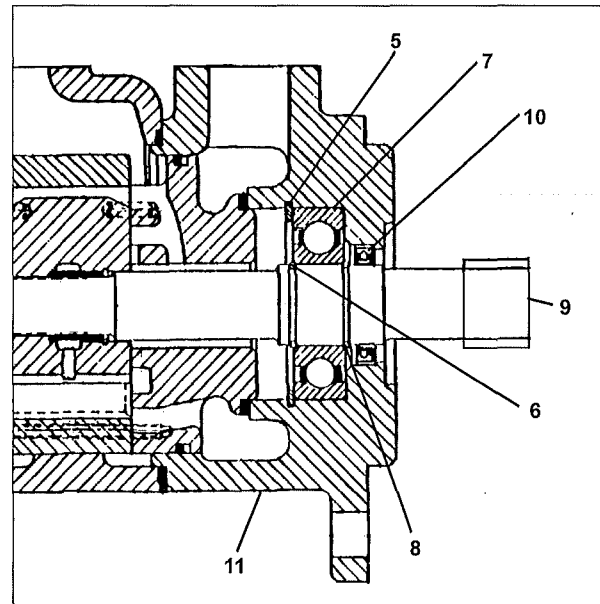
Examine ball bearing (7) for wear before removing it from shaft (9). Apply light pressure to the

outer race and rotate to check for wear or cracks and excessive looseness. Remove the bearing from the shaft if damaged. Inspect the shaft for damage, especially the seal surface for the shaft seal. Omit the next procedure if bearing removal is not required.

4. Remove retaining ring (6) and press bearing (7) off of shaft (9).

NOTICE

Retaining ring (8) must be removed by passing over the bearing surface of the shaft and NEVER over the shaft seal surface. A damaged seal surface will cause the shaft seal to leak.



5. If removed, install retaining ring (8) in the groove nearest the input end of shaft (9) by passing the ring over the output end of the shaft. **Do not install it over the input end as this may damage the seal surface next to the groove causing seal leakage.**

6. Install ball bearing (7) by pressing on the inner race until the bearing is seated against retaining ring (8). Install retaining ring (6). Make sure both rings are fully seated in their grooves.

7. Using a seal driver, press shaft seal (10) into mounting cap (11). Grease the seal lips.

NOTE !

The open face of seal must be toward installation tool. If a sealant is not furnished on the O.D. of the seal apply a light coat of approved sealing compound. Use extreme care not to deposit any of the sealing compound on the seal element or on the shaft.

8. Install a protective sleeve over the splines of shaft (9) and then press on the outer race of ball bearing (7) until it is installed in mounting cap (11).

NOTICE

Do not press on the end of shaft (9).

9. Install retaining ring (5) to hold shaft (9) in place. Make sure the ring is fully seated.

10. On a clean workbench install the cartridge in body (2) making sure that drive lock pin (4B) is properly seated.

11. Lubricate the O-rings before installation. Install mounting cap (11) with the attached shaft assembly by inserting the shaft through the cartridge. Rotate the shaft to engage the spline in the rotor.

NOTE !

Align the match marks by turning the mounting cap.

12. Install four screws (1) and alternately tighten two to draw down mounting cap. Torque all four to 159 Nm (117 ft. lbs).

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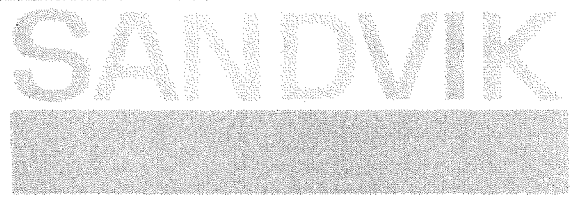
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SECTION 8

MAST/FEED SYSTEM



FEED & HOIST CHAIN (001085-000)

required depending on local conditions. Ideally we believe chain maintenance should be done every 100 hours.

GENERAL

This topic applies to roller chains with the following part number prefixes: 001085, 002556, 002579, 002754, 003884, 005543, 009399, and 016796.

New chain is vacuum lubricated during manufacturing. Lubrication increases chain life by reducing wear and helping to prevent corrosion damage, primarily to the pins. Regular application of a penetrating oil will restore internal lubrication and drive out moisture. Heavy oil or grease provides a barrier to dirt and moisture. The benefits of lubrication outweigh the wear that may occur from abrasion resulting from drilling dirt picked up by the oil on the chain.

Most samples of chain examined after failure show signs of corrosion on the pins and side bars. The pitting that results from corrosion establishes points on the pin surface where cracks and breaks will occur from shock loads or high tensile loads. Lubrication will help prevent corrosion and premature chain failure.

SERVICE INTERVALS

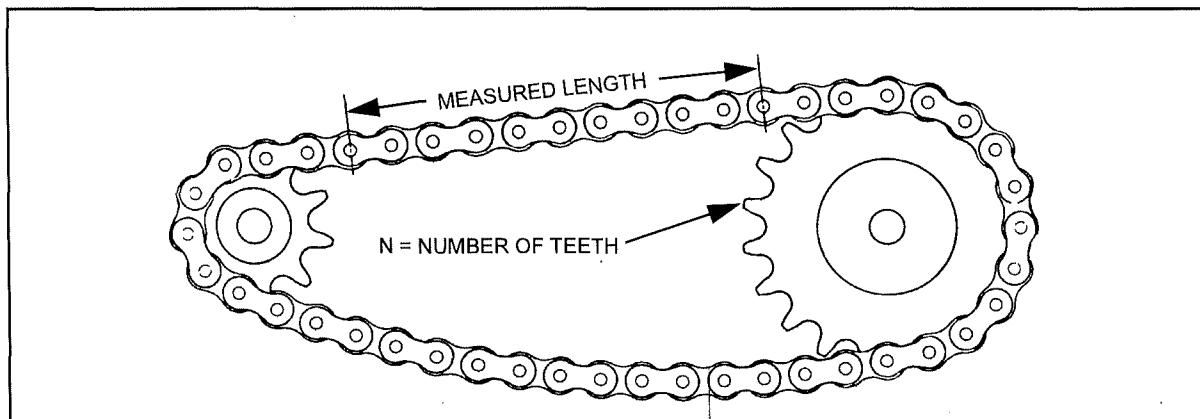
A 250 hour interval is the longest recommended. More frequent intervals may be

INSPECTION

Inspect the chain for cracks, broken, deformed, or corroded parts; and for tight joints or turned pins. If any are found, find and correct the cause of the damage, and **REPLACE THE ENTIRE CHAIN**. Even though the rest of the chain appears to be in good condition, it has been damaged and more failures are likely to occur.

In most roller chain drives, the chain is considered worn out when it has reached 3% wear elongation. With 3% wear, the chain does not engage the sprocket properly and can cause sprocket damage or chain breakage. On drives with large sprockets (more than 66 teeth), allowable wear is limited to $200/N$ (N = no. of teeth on largest sprocket) and may be substantially less than 3%. On fixed-center, nonadjustable drives, allowable wear elongation is limited to about one-half of one chain pitch.

Measure a representative section of chain and if wear elongation exceeds 3% or the functional limit, **REPLACE THE ENTIRE CHAIN**. Do not connect a new section of chain to a worn section.



Chain Part Number	Ansi Chain Number	Chain Pitch Inches (mm)	No. of Pitches	Nominal Inches (mm)	At 3% Wear Inches (mm)
002579-	120	1.500 (38.10)	16	24.00 (610)	24.719 (628)
009399-	140	1.750 (44.45)	14	24.50 (622)	25.250 (641)
001085-	160	2.00 (50.80)	12	24.00 (610)	24.719 (628)
002556-	180	2.250 (57.15)	12	27.00 (686)	27.812 (706)
005543-	200	2.500 (63.50)	10	25.00 (635)	25.750 (654)
003884-	200	2.500 (63.50)	10	25.00 (635)	25.750 (654)
002754-	240	3.000 (76.20)	8	24.00 (610)	24.719 (628)
016796-	240	3.000 (76.20)	8	24.00 (610)	24.719 (628)

Do not run new chain on worn out sprockets because it can cause the chain to wear rapidly. The pitch of the new chain is much shorter than the effective pitch of the worn sprocket, so the total chain load is concentrated on the final sprocket tooth before disengagement. Then, when the chain disengages from the sprocket, the roller is jerked out of the hooked portion of the sprocket tooth and that results in a shock load on the chain as the load is transferred from one tooth to the next

between the rollers and pins.

3. Brush heavy oil on all surfaces after applying the penetrating oil. A 40 weight oil or heavier is recommended, grease can also be used.

MAINTENANCE

Sandvik recommends the following chain care procedures:

NOTICE

When using compressed air to blow chains clean, reduce pressure to 30 psi (2 bars) and wear a face shield.

1. Clean the chains at regularly scheduled intervals. Blow or brush to clean. We do not recommend direct pressure or steam washing because this will remove necessary lubrication.
2. Using a light penetrating oil such as WD-40, brush or spray the cleaned chains. A spray application will more effectively penetrate

FEED & HOIST CHAINS (001085-001)

GENERAL

New chain is vacuum lubricated during manufacturing. Lubrication increases chain life by reducing wear and helping to prevent corrosion damage, primarily to the pins. Regular application of a penetrating oil will restore internal lubrication and drive out moisture. Heavy oil or grease provides a barrier to dirt and moisture. The benefits of lubrication outweigh the wear that may occur from abrasion resulting from drilling dirt picked up by the oil on the chain.

Most samples of chain examined after failure show signs of corrosion on the pins and side bars. The pitting that results from corrosion establishes points on the pin surface where cracks and breaks will occur from shock loads or high tensile loads. Lubrication will help prevent corrosion and premature chain failure.

SERVICE INTERVALS

A 250 hour interval is the longest recommended. More frequent intervals may be required depending on local conditions. Ideally we believe chain maintenance should be done every 100 hours.

INSPECTION

Inspect the chain for cracks, broken, deformed, or corroded parts; and for tight joints or turned pins. If any are found, find and correct the cause of the damage, and **REPLACE THE ENTIRE CHAIN**. Even though the rest of the chain appears to be in good condition, it has been damaged and more failures are likely to occur.

MAINTENANCE

Sandvik Mining and Construction recommends the following chain and sprocket care procedures:



When using compressed air to blow chains clean, reduce pressure to 30 psi (2 bars) and wear a eye protection.

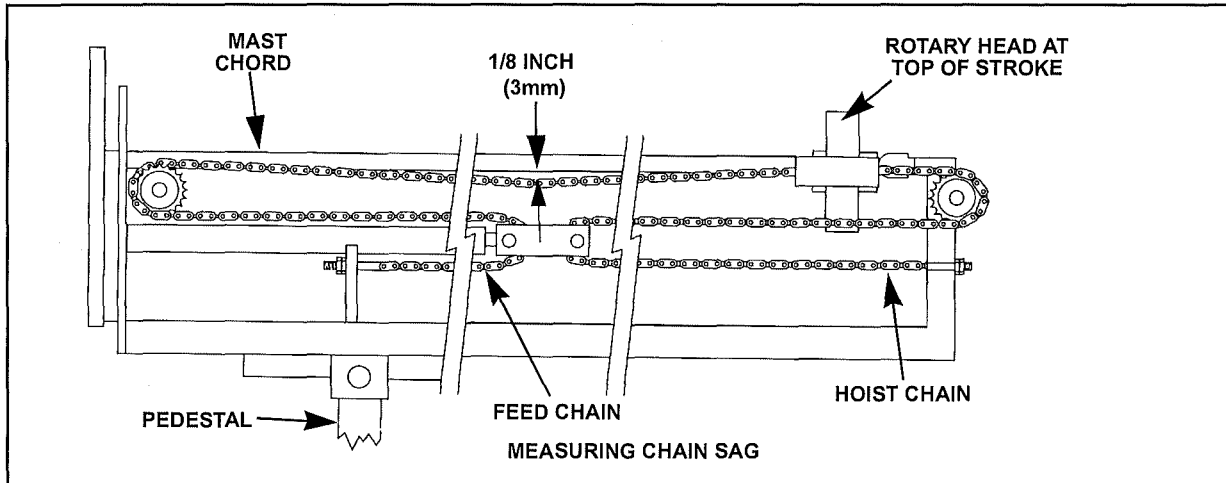
1. Clean the chains at regularly scheduled intervals. Blow or brush to clean. We do not recommend direct pressure or steam washing because this will remove necessary lubrication.
2. Using a light penetrating oil such as WD-40, brush or spray the cleaned chains. A spray application will more effectively penetrate between the rollers and pins.
3. Brush heavy oil on all surfaces after applying the penetrating oil. A 40 weight oil or heavier is recommended, grease can also be used.
4. Inspect sprocket teeth for wear at regular intervals. The bottom sprockets are particularly susceptible to wear because drilling dirt can accumulate around them. When the bottom radius between the teeth wears and deepens, the teeth actually form a wedge that can put tremendous force on the pins and rollers as they travel over the sprocket under load. Sprockets should be inspected and if worn, replaced when the chain is replaced.
5. Sprocket shafts must be greased regularly. At regular intervals check to verify that sprockets are receiving proper lubrication and turning freely.

ADJUSTMENT

Adjustment of the feed system chains is accomplished as follows:

1. Raise the rotary head to the top of the mast.
2. Unlock and lower the mast to the horizontal position.
3. Measurements of the feed chain sag must

be made midway between mast table and rotary head, and from the **bottom edge of the mast chord** to the **top** of the feed chain as shown.



FEED & HOIST CHAINS (SINGLE PASS MASTS) (001085-002)

GENERAL

New chain is vacuum lubricated during manufacturing. Lubrication increases chain life by reducing wear and helping to prevent corrosion damage, primarily to the pins. Regular application of a penetrating oil will restore internal lubrication and drive out moisture. Heavy oil or grease provides a barrier to dirt and moisture. The benefits of lubrication outweigh the wear that may occur from abrasion resulting from drilling dirt picked up by the oil on the chain.

Most samples of chain examined after failure show signs of corrosion on the pins and side bars. The pitting that results from corrosion establishes points on the pin surface where cracks and breaks will occur from shock loads or high tensile loads. Lubrication will help prevent corrosion and premature chain failure.

SERVICE INTERVALS

A 250 hour interval is the longest recommended. More frequent intervals may be required depending on local conditions. Ideally we believe chain maintenance should be done every 100 hours.

INSPECTION

Inspect the chain for cracks, broken, deformed, or corroded parts; and for tight joints or turned pins. If any are found, find and correct the cause of the damage, and REPLACE THE ENTIRE CHAIN. Even though the rest of the chain appears to be in good condition, it has been damaged and more failures are likely to occur.

MAINTENANCE

Sandvik recommends the following chain and sprocket care procedures:



When using compressed air to blow chains clean, reduce pressure to 30 psi (2 bars) and wear a face shield.

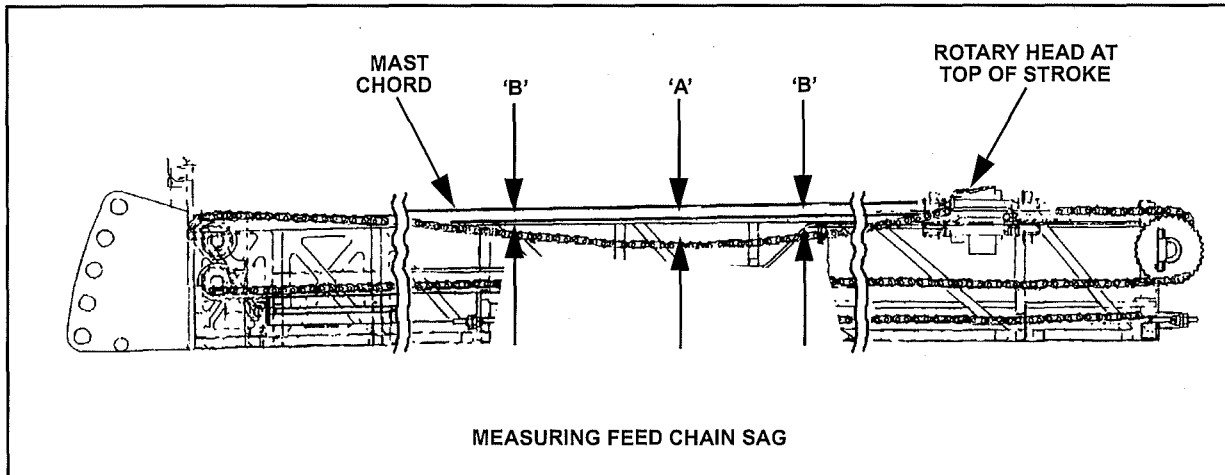


1. Clean the chains at regularly scheduled intervals. Blow or brush to clean. We do not recommend direct pressure or steam washing because this will remove necessary lubrication.
2. Using a light penetrating oil such as WD-40, brush or spray the cleaned chains. A spray application will more effectively penetrate between the rollers and pins.
3. Brush heavy oil on all surfaces after applying the penetrating oil. A 40 weight oil or heavier is recommended, grease can also be used.
4. Inspect sprocket teeth for wear at regular intervals. The bottom sprockets are particularly susceptible to wear because drilling dirt can accumulate around them. When the bottom radius between the teeth wears and deepens, the teeth actually form a wedge that can put tremendous force on the pins and rollers as they travel over the sprocket under load. Sprockets should be inspected and if worn, replaced when the chain is replaced.
5. Sprocket shafts must be greased regularly. At regular intervals check to verify that sprockets are receiving proper lubrication and turning freely.

ADJUSTMENT

as shown.

With the mast lowered and the rotary head at the top of it's travel, check the sag of the chains



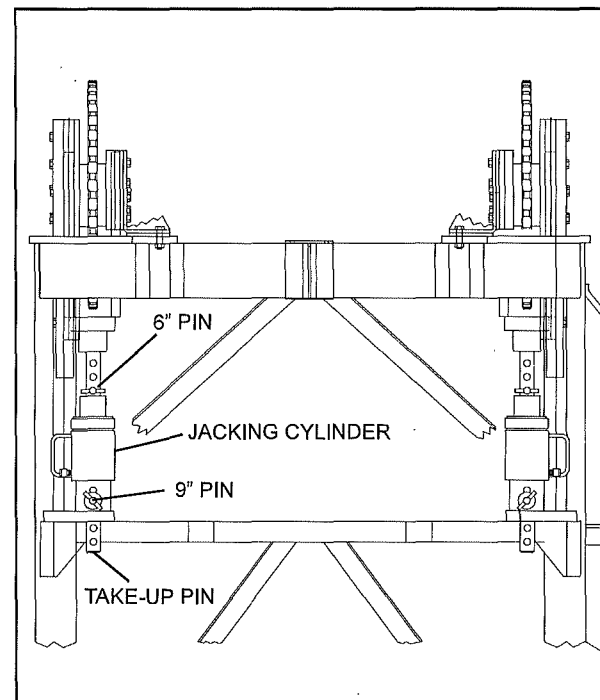
Measurements of the feed chain sag must be made midway between mast table and rotary head, and from the **bottom edge of the mast chord** to the **top** of the feed chain as shown.

A = 3" (76mm) sag at center of mast when not equipped with a drill pipe stabilizer assembly.

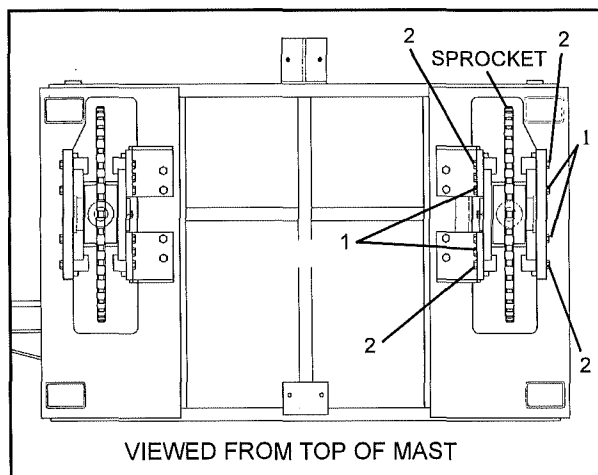
B = 1-1/2" (38mm) sag at 1/3 length from table and 1/3 length from crown of mast when equipped with a drill pipe stabilizer assembly.

ADJUSTMENT

1. Lower the mast fully on the mast rest and tag-out the cab to inform others of the servicing in progress.
2. Install the jacking cylinders on the take-up pins under both sprocket assemblies as shown and secure the take-up pins to the mast with the two 9" retaining pins.



3. Install the two 6" retaining pins in the take-up pins just above the jacking cylinders.
4. Begin removing the twelve holding screws (1) from both sides of a sprocket assembly. **Do not loosen the clamping screws (2) until all the holding screws (1) are removed.**



5. Loosen the eight clamping screws (2) on the outside and the six clamping screws (2) on the inboard side of the sprocket assembly.

6. Repeat steps 4 and 5 for the remaining sprocket assembly.

7. Attach the hand pump hoses to the jacking cylinders and adjust the chain slack to acceptable measurements.

8. Begin tightening the clamping screws (2) then install the holding screws (1) in aligning holes.

9. After all hardware is tightened relieve pressure at the jacking cylinders. Remove the retaining pins from the take-up pins, slide the take-up pins back and remove the jacking cylinders.

10. Stow the jacking cylinders and pins.

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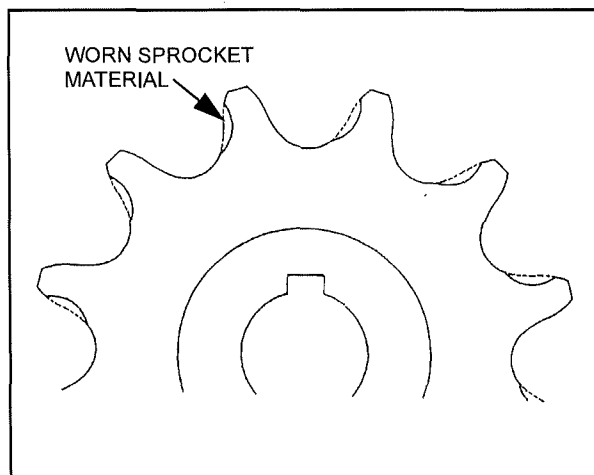
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FEED & HOIST CHAIN SPROCKETS (001085-071)

INSPECTION

Inspect sprockets for chipped, broken, or deformed teeth. If any are found, find and correct the cause of the damage and **REPLACE THE SPROCKET**. Sprockets normally are stronger and less sensitive to damage than chains, but running a worn chain on new sprockets can ruin the sprockets in a short time. This is because a worn chain rides very high on the sprocket teeth and wears the sprocket teeth in an abnormal pattern.

A worn sprocket is not nearly as well defined as a worn chain. However, there are some sprocket characteristics that indicate when a sprocket should be replaced. Check for roughness or binding when a new chain engages or disengages the sprocket. Inspect for reduced tooth thickness and hooked tooth tips. If any of these conditions are present, the sprocket teeth are excessively worn and the sprocket should be replaced.



Do not run new chain on worn out sprockets because it can cause the chain to wear rapidly. The pitch of the new chain is much shorter than the effective pitch of the worn sprocket, so the total chain load is concentrated on the final sprocket tooth before disengagement. Then, when the chain disengages from the sprocket, the roller is jerked out of the hooked portion of the sprocket tooth and that results in a shock load on the chain as the load is transferred from one tooth to the next.

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FEED HOLDING VALVE (008737-001)

GENERAL

This valve applies to both low and high pressure compressor systems. The purpose of this holding valve is to provide a smoother operation of the feed system and to provide a degree of safety in the event of a component failure.

NOTE!

Adjustment procedures and plumbing of the -001 valve are different than 008737-002.

DESCRIPTION

For the holding valve to function properly it must be adjusted correctly. There are two adjustments that can be made on this valve.

A. LOAD HOLDING ADJUSTMENT: The amount of hydraulic load the valve will hold without a pilot signal applied.

B. THROTTLING ADJUSTMENT This controls the amount the valve will open with or without a

pilot signal applied.

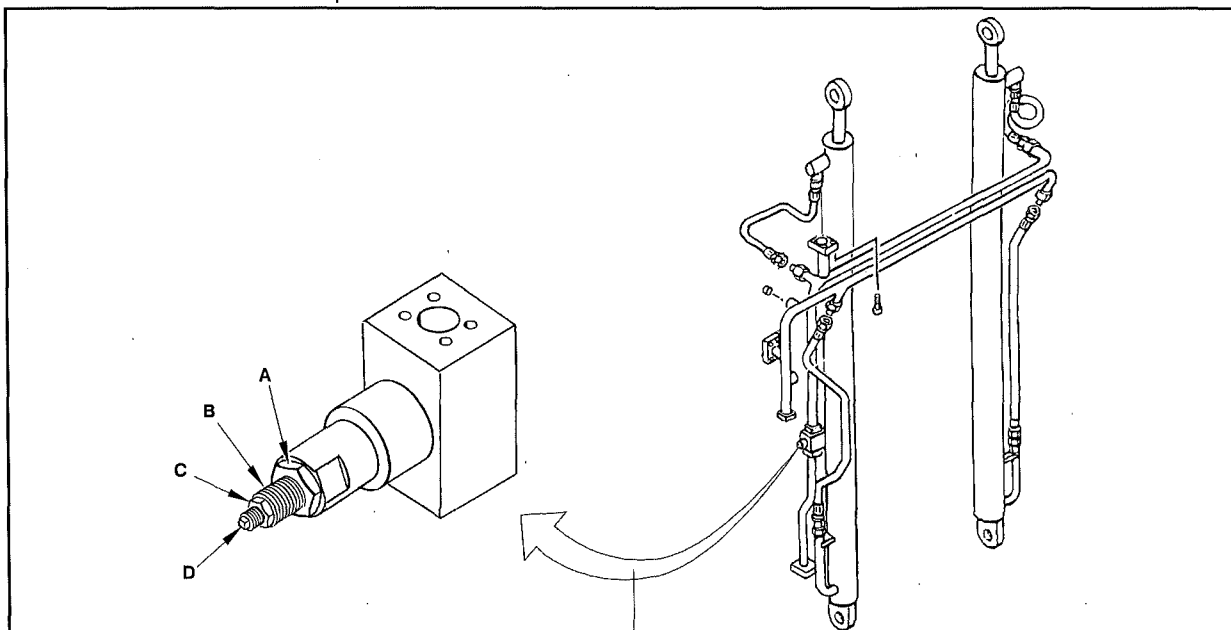


All adjustments to the valve must be done while the machine is shutdown.

The load holding adjustment is set at the factory and should not need adjusting. If it is necessary to change this setting because of repairs to the holding valve, the load not holding, etc., the clockwise adjustment of the large adjusting stem increases load holding and counterclockwise adjustment decreases load holding.

By isolating the pilot signal from the valve the load holding capability of the valve can be checked. This is essentially what happens each time the machine is shutdown. That is, the pilot signal that holds the valve open is removed from the valve.

The throttling adjustment is a more critical adjustment and must be adjusted for each machine. The clockwise adjustment of the small adjusting stem decreases the valve opening and the counterclockwise adjustment increases the valve opening. The maximum amount of allowable adjustment from the full "IN" position is .133" (3.4mm). This is about a 1/4" (6.3mm) to



3/8" (9.5mm) turn of the small adjusting stem. If it is adjusted out beyond this amount all throttling control will be lost.

To check the operation of the valve with machine running and hydraulic oil at operating temperature, lower the rotary head down the mast at full engine RPM and feed pump on full stroke. Hydraulic down pressure should be between 1200 - 1500 PSI (82.7 - 103.4 bars) on all models except the D90 and 1190. Down pressure on the D90 and 1190 models should be 850 PSI (58.6 bars). If it is not in this range, shutdown the machine and readjust the throttling control, then check the operation again.

Pressure readings higher than 1500 PSI (103.4 bars) will result in operating close to the "lift off" relief valve setting on certain machines. If the lift off relief valve opens, the pump will de-stroke and speed will be lost.

Pressure readings somewhat lower than 1200 PSI (82.7 bars) may result in the loss of throttling control.

ADJUSTMENTS



All adjustments to the valve must be done while the machine is shutdown.

1. Adjustment of holding valve should be made with mast in horizontal position and engine stopped.
2. Clean the holding valve and surrounding area. Make sure all paint and dirt is removed from threads before adjusting.
3. Loosen stop nut "A", turn adjustable seal "B" counterclockwise until it stops. Lock stop nut "A".
4. Loosen stop nut "C". Turn adjustable guide

"D" clockwise until it stops, then turn counterclockwise 1/4 turn. Hold all parts from turning when tightening stop nut "C".

5. Final adjustment of adjustable guide "D" may be accomplished after operating feed system. Counterclockwise adjustment allows valves to open and clockwise adjustment decreases valve opening. Do not adjust more than 1/4 turn at a time.

6. Correct adjustment is established when feeding rotary head down at full volume and feed pressure stabilizes at approximately 1500 PSI (103.4 bars).

7. Coat the exposed threads with grease after adjustment is completed.

FEED HOLDING VALVE (008737-002)

GENERAL

The following topics include the description, removal, installation and adjustment of this holding valve assembly.

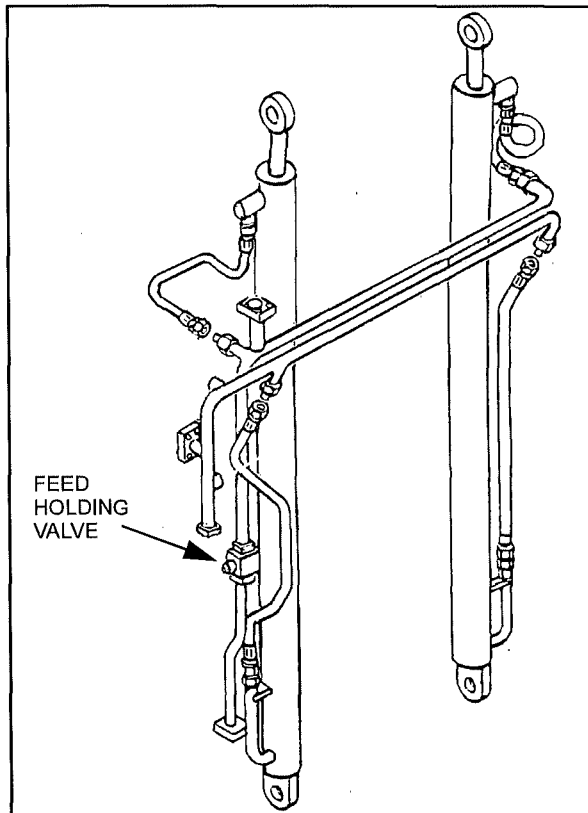
NOTE!

If replacing feed holding valve 008737-001 with 008737-002, refer to parts bulletin PB7A.

DESCRIPTION

This valve applies to both low and high pressure compressor systems.

The purpose of this holding valve is to provide a smoother operation of the feed system and to provide a degree of safety in the event of a component failure.



008737-002

Pilot control oil pressure for the 008737-002 valve is taken from the extend side of the feed cylinder circuit.

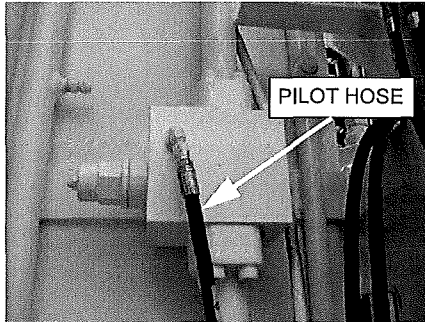
REMOVAL

1. With the mast raised, position the rotary head at the top of mast. Remove any drill pipe attached to the rotary head.
2. Lower the mast and secure it in the mast rest.
3. Shut the engine down.
4. Disconnect the negative battery terminal or open the battery disconnect switches.
5. 'Lock Out Tag Out' the machine to prevent starting.
6. Open the hydraulic tank pressurization ball valve on top of the tank to vent the hydraulic reservoir.
7. Release residual hydraulic pressure from the feed system by activating the feed control handle on the operator station forward/reverse or up/down.
8. Prepare suitable containers to collect oil as some oil will be lost from the mast piping upon valve removal.
9. Remove the holding valve pilot hose from the valve.
10. Remove capscrews holding the pipe flanges to the valve.
11. Remove the holding valve from the feed system mast piping.

INSTALLATION

1. The mast should be in the horizontal position and hydraulic pressure released.

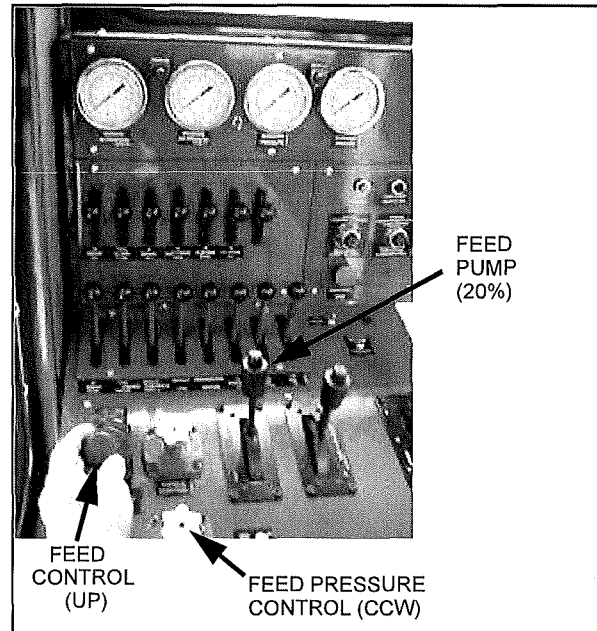
2. Install the feed holding valve into feed system mast piping.
3. Tighten the capscrews securely.



4. Connect the pilot hose to the holding valve.

START PROCEDURE

1. Remove the 'Lock Out Tag Out' devices.
2. Connect the batteries terminal and/or disconnect switches.
3. Start the machine engine per standard operating principals.
4. Bleed air from the feed holding valve pilot line adapter on the valve manifold by loosening the hose end at the holding valve. Tighten the pilot hose adapter.
5. Open the feed pressure control on the operator's station CCW to minimum pressure.
6. Actuate the feed pump control to 20%.
7. Apply the feed control handle to the hoist mode to refill the hydraulic pipes and feed cylinder(s) with clean oil.



ADJUSTMENT

For the feed holding valve to function properly it must be adjusted correctly. There are two adjustments that can be made on this valve.

A. LOAD HOLDING ADJUSTMENT: The amount of hydraulic load the valve will hold without a pilot signal applied.

B. THROTTLING ADJUSTMENT This controls the amount the valve will open with or without a pilot signal applied.



All adjustments to the valve must be done while the machine is shutdown.

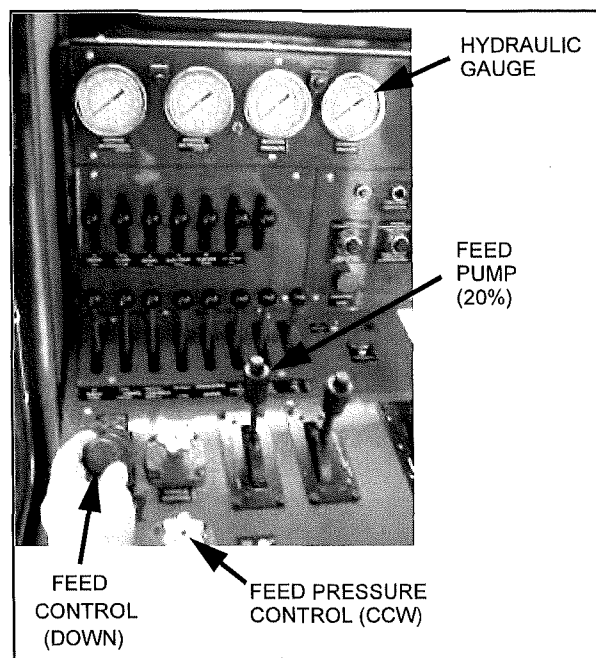
The load holding adjustment is set at the factory and should not need adjusting. If it is necessary to change this setting because of repairs to the holding valve, the load not holding, etc., the clockwise adjustment of the large adjusting stem increases load holding and counterclockwise adjustment decreases load holding.

By isolating the pilot signal from the valve the load holding capability of the valve can be checked. This is essentially what happens each time the machine is shutdown. That is, the pilot signal that holds the valve open is removed from the valve.

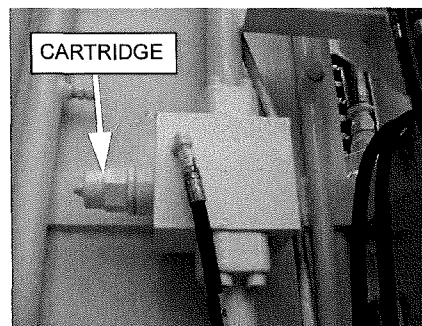
The throttling adjustment is a more critical adjustment and must be adjusted for each machine. The clockwise adjustment of the small adjusting stem decreases the valve opening and the counterclockwise adjustment increases the valve opening. The maximum amount of allowable adjustment from the full "IN" position is .133" (3.4mm). This is about a 1/4" (6.3mm) to 3/8" (9.5mm) turn of the small adjusting stem. If it is adjusted out beyond this amount all throttling control will be lost.

1. Shutdown the machine.
2. Open the hydraulic tank pressurization ball valve to vent hydraulic reservoir.
3. Release residual pressure from feed system by activating feed control handle forward/ reverse or up/down mode from operator station.
4. Remove the pilot hose from the feed manifold orifice or the feed holding valve.
5. Start the machine.
6. Level the machine, raise the mast according to standard operating procedures to the vertical position.
7. Lock the mast according to standard operating procedures.
8. Actuate the feed pump control to 20%.
9. Apply the feed control handle to down mode, rotary head without drill pipe attached will travel down mast chords.
10. Monitor the hydraulic pressure gauge on the

operator station.



11. Expected pressure range 1000 psi (70 bar) and some applications as low as 650 psi (45 bar).
12. Adjustment may be made to the cartridge to obtain 1000 psi (70 bar).
13. Loosen the lock nut with a 9/16 (15mm) wrench.



14. Adjust the cartridge with a 5/32 (4 mm) wrench.
15. Turn the cartridge adjustment screw CCW to

increase pressure, turn CW to decrease pressure.

16. With pressure properly set, tighten the cartridge lock nut.

17. Place the feed control handle in neutral mode.

18. Position the feed pump control to neutral.

19. Shut the machine down.

20. Open the hydraulic tank pressurization ball valve to vent the hydraulic reservoir.

21. Release residual hydraulic pressure from the feed system by activating the feed control handle forward/reverse or up/down mode from the operator station.

22. Reconnect the pilot hose to the adapter at holding valve or the feed manifold.

NOTE!

- Some machine applications may require more or less than 1000 psi (70 bar) holding valve pressure adjustment primarily due to drill string dimension, length and weight. Equipment with fast feed requires the 1000 psi to enable fast feed/regen circuit.
- Some applications may require no pilot pressure assist to the holding valve. With pilot pressure the holding valve is a counterbalance valve, without pilot pressure the holding valve is a relief valve.

CHAIN ADJUSTMENT KIT - 015847-000**Safety****NOTICE**

Make sure that the highest level of system operating pressure does not exceed the lowest pressure rating of any component within the system. Remember: The 80% rule: It is safer to use high pressure tools at 80% of their maximum rating instead of 100%.

The following general instructions and guides will be helpful to determine if your system components are properly connected:

1. Be sure all hydraulic connections, hoses, fittings are rated for the highest pressure your system is capable of generating. Always use hoses and tubing recommended by the manufacturer.
2. Be sure all hydraulic connections are fully tightened. Seal all pipe connections with a high-grade pipe sealer or Teflon® tape.

NOTICE

Teflon® tape is an excellent thread sealer; however, if the improperly applied, pieces may enter the hydraulic system causing malfunctions and damage. Use 1 ½" wraps of tape on each thread. Cut off all loss tape ends.

3. **DO NOT** over-tighten any connections. All connections should be snug and leak free. Excessive tightening will cause strain on the threads and casting which could cause fitting failure at pressures below rated capacity.
4. Fully tighten hydraulic couplers (avoid excessive force). Loose couplers will act as a partial or complete line restriction causing little or no oil flow and resulting in equipment damage or failure.
5. Be sure all hydraulic hoses and fittings are connected to the correct INLET and OUTLET ports of the pump, cylinder, valves and other system components.

! WARNING

Do not exceed equipment ratings. Never attempt to lift a load weighing more than the capacity of the cylinder. Overloading causes equipment failure and possible personal injury. The cylinders are designed for a maximum pressure of 700 bar [10,000 psi]. Do not connect a jack or cylinder to a pump with a higher pressure rating.

Never set the relief valve to a higher pressure than the maximum rated pressure of the pump. Higher settings may result in equipment damage and/or personal injury.

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Recommendations

- **USE HYDRAULIC GAUGES WHICH INDICATE SAFE OPERATION LOADS IN EACH HYDRAULIC SYSTEM** - Gauges are available for use with all hydraulic components (some gauges have a colored band to indicate ranges for each cylinder). **DO NOT** exceed the safe limit of the lowest rated component used within your system.
- **DO NOT DROP HEAVY OBJECTS ON HOSE** - A sharp impact may cause bends or breaks to internal hose wire strands. Applying pressure to the damaged hose will cause the internal flexing which will eventually break the hose strands causing the hose to rupture.
- **DO NOT USE THE HYDRAULIC HOSE TO CARRY HYDRAULIC SYSTEM** - (i.e. pumps, cylinders and valves).
- **DO NOT OVERLOAD CYLINDER** - Never attempt to lift a load which exceeds the capacity of a cylinder or jack. Overloading causes equipment failure and possible personal injury.
- **DO NOT OVEREXTEND CYLINDER** - The cylinder will take full load on the plunger top ring. However, using the full stroke does not supply power and only adds unnecessary strain to the cylinder.
- **AVOID OFF-CENTER LOADS** - Avoid situations where loads are not directly centered on the cylinder plunger. Off centered loads produce considerable strain on cylinder plungers and may slip or fall causing potentially dangerous results. Avoid point loading. Distribute the load evenly across the entire saddle surface.
- **PROVIDE ADEQUATE CLEARANCE** - Always provide clearance for hoses and couplers to avoid moving objects, abrasion or sharp objects.
- **AVOID SHARP BENDS OR KINKS IN HOSE** - Avoid sharp bends and kinks when routing hydraulic hoses. If pressure is applied to a bent or kinked hose, the oil flow will be restricted causing severe backpressure. Also the sharp bends and kinks will internally damage the hose leading to premature failure.
- **KEEP HYDRAULIC EQUIPMENT AWAY FROM OPEN FLAMES AND HEAT** - Excessive heat (above 66° C (150° F)) will soften packing and seals, resulting in fluid leaks. Heat also weakens hose materials and packings. For optimum performance **DO NOT** expose equipment to temperatures of 66° C (150° F) or higher.
- **EXAMINE YOUR WORK AREA BEFORE PRESSURIZING THE HYDRAULIC SYSTEM** - Look for ways to protect yourself and others, and ways to protect your equipment and other property. Keep the components clean at all times.
- **KEEP THE PUMP AND COUPLINGS AS FREE FROM DUST AND DIRT AS POSSIBLE** - Use only approved hydraulic fluid and change the hydraulic fluid often if used in extreme conditions.
- **NEVER STORE SYSTEM IN DIRECT SUNLIGHT OR NEAR A HEAT SOURCE** - Store system in an area where temperatures are between 10-24° C (50-75° F).
- **PERFORM A VISUAL INSPECTION** of all components prior to using equipment.

- **REPLACE WORN COMPONENTS** with "like-kind" equipment that is rated for the maximum hydraulic system pressures.
- **DO NOT** move the hydraulic system by pulling or lifting on the couplings or hose.
- **BEFORE LONG TERM STORAGE**, fully extend and retract the plunger once. Then, store the cylinder upside-down. This will help protect the cylinder from corrosion.

Hydraulic System Assembly

The components described below are connected together to form the hydraulic system as shown.

1. Make hydraulic connections as shown.

NOTE: NPT connections require threaded sealant. Leave first thread bare to prevent sealant or tape from entering the hydraulic system.

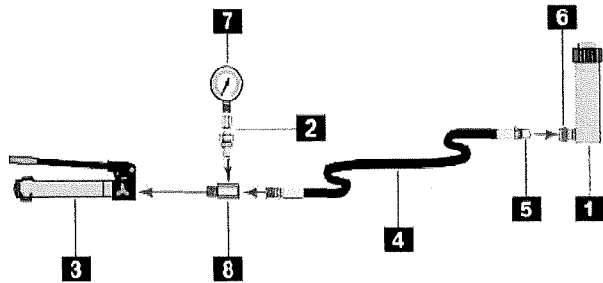
2. Fully hand-tighten all couplers. Loose coupler connections will block the flow of oil between the pump and the cylinder.

NOTE: For easy make/break connections, install a coupler in the gauge adapter port, then use a hose with a coupler end instead of a threaded end.

3. Position the cylinder so that the plunger is pointed down and the cylinder is lower than the pump. Fully extend and retract the cylinder several times, until operation is smooth. To remove air from the cylinder, refer to "Removing Air From The Hydraulic System" section.

4. Install adaptors and attachments as required. (See diagram)

1. Cylinder
2. Coupler
3. Hand Pump
4. Hose
5. Coupler
6. Pipe Adapter
7. Gauge
8. Gauge Adapter



Before Using The Hydraulic System

- Check hoses and couplers. Hose should have a straight run and be free of tangles or kinks. Coupler connections must be fully tightened.
- Check that all connections are tight and leak free. It is especially important to check all coupler connections because, after the system has been pressurized, you will not be able to tighten the couplers by hand and using tools will damage the couplers.
- Remove air from system. (See instructions below)

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- Check oil level in pump reservoir. (See instructions below)
- Never get under a load.
- Use cribbing or blocking for load holding for long periods.
- Do not use hose to lift or pull the Hydraulic System.

Pump Operation

1. To advance cylinder plunger, turn pump release valve clockwise and close finger tight.

NOTICE

To avoid release valve damage, do not use tools to tighten valve.

2. Operate the pump handle to advance the plunger.
3. To retract the plunger, turn the release valve counterclockwise.
4. Pump can be operated from a horizontal or vertical orientation, as long as the hose end is down.

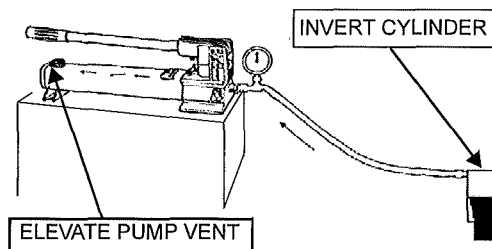
Removing Air From The Hydraulic System

How To Tell If There Is Air In The Hydraulic System

Hydraulic system operation should be instant and smooth. For every pump stroke, the cylinder should rise evenly. If the cylinder movement is erratic or jerky, there may be air in the system.

How To Remove Air From The Hydraulic System

Air will always go to the highest point in the hydraulic system. This includes the inside of the cylinder plunger. To remove air from the system, invert the cylinder and elevate the hand pump with the handle end and vent at the highest point as illustrated in the diagram.



After all hydraulic system components are connected to the hand pump, check the reservoir oil level. Replace the cap and be sure it is closed (not in the vent position). To purge air from the hydraulic system follow the steps below.

1. Turn the pump release valve to closed position. Operate hand pump until cylinder plunger is completely extended.
2. Invert cylinder (plunger end down). Open the pump release valve, as the plunger retracts, the air in the system will be forced into the pump reservoir and replaced by oil. Close the release valve.
3. Turn the cylinder upright. Operate the pump to cycle the cylinder plunger. If air is out of the system, the plunger will advance and retract smoothly. If the plunger is erratic repeat steps 1

through 4.

4. Open the pump fill cap and check the oil level. Fill to the indicator mark on the end cap.

Maintenance

How To Check The Hydraulic System Oil Level

1. To check oil level in the pump, open pump release valve to allow the oil in the cylinder to return to the pump.
2. Remove the fill cap.
3. Add hydraulic oil until level with mark on the rear cap. DO NOT overfill.
 - To function properly all hand pumps require air in the reservoir.
 - If oil level is too high the pump will not operate. Fill only to level indicated on the pump.
 - Over-filling the reservoir may cause the pump to malfunction.
 - Fill the reservoir only when all cylinders have been retracted. If you add oil when the cylinder is extended, the reservoir will overflow or be pressurized when you retract the cylinder.
4. If hydraulic system is used under extremely dirty conditions, frequently drain pump completely and refill with clean hydraulic oil.
5. Install the fill cap and close it.

Hydraulic System Recommendations

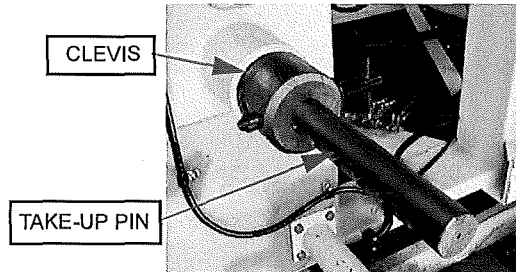
1. Keep the components clean at all times.
2. Keep the pump and couplings as free from dust and dirt as possible. Uses only approved hydraulic fluid and change the hydraulic fluid often if used in extreme conditions.
3. Store system in an area where temperatures are between 10-24° C (50-75° F). Never store system in direct sunlight or near a heat source.
4. Perform a visual inspection of all components prior to using equipment.
5. Replace worn components with "like-kind" equipment that is rated for the maximum hydraulic system pressures.
6. DO NOT move the hydraulic system by pulling or lifting on the couplings or hose.
7. Before long term storage, fully extend and retract the plunger once. Then, store the cylinder upside-down. This will help protect the cylinder from corrosion.

SERVICE and REPAIR MANUAL

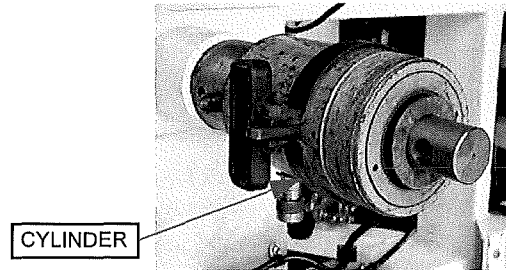
Operation

Refer to your Maintenance Manual for chain adjusting instructions.

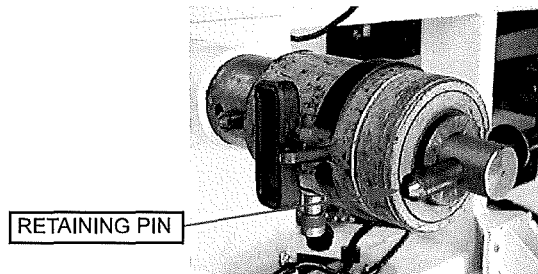
1. Remove any dirt from the surface of the take-up pin with a clean cloth.



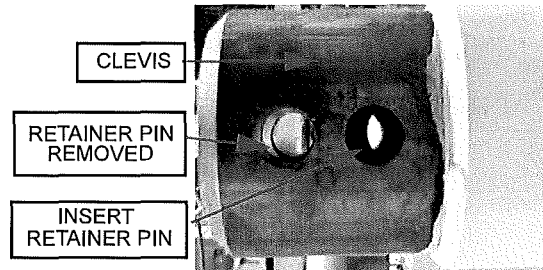
2. Install the cylinder on the take-up pin as shown. Slide the cylinder down to contact the surface of the clevis.



3. Install a washer on a temporary retaining pin and insert it in the take-up pin. Connect the hose and hand pump to the cylinder.



4. Pump the hand pump until the clevis retaining pin can be removed from the clevis. Make the necessary chain adjustment.



5. When the chain adjustment is correct then re-insert the clevis retainer pin to the clevis.
6. Vent the hand pump and cylinder, remove the cylinder retainer pin and cylinder from the take-up pin. Install the hydraulic system on the remaining take-up pin and repeat the chain adjustment procedure.

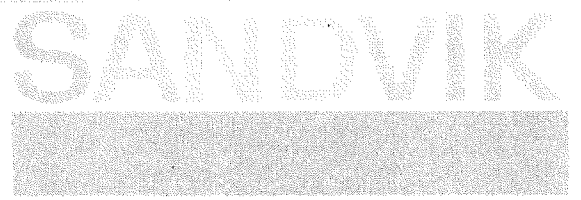
Troubleshooting

PROBLEM	POSSIBLE CAUSE
Cylinder will not advance.	Pump release valve open. Coupler not fully tightened. Oil level in pump is low. Pump malfunctioning. Load is too heavy for cylinder. Cylinder seals leaking.
Cylinder advances part way.	Oil level in pump is low. Coupler not fully tightened. Cylinder plunger binding.
Cylinder advances in spurts.	Air in hydraulic system. Cylinder plunger binding.
Cylinder advances slower than normal.	Leaking connection. Coupler not fully tightened. Pump malfunctioning.
Cylinder advances but will not hold.	Pump malfunctioning. Leaking connection. Incorrect system set-up. Cylinder seals leaking.
Cylinder leaks oil.	Worn or damaged seals. Internal cylinder damage. Loose connection.
Cylinder will not retract or retracts slower than normal.	Pump release valve is closed. Coupler not fully tightened. Pump reservoir overfilled. Narrow hose restricting flow. Broken or weak retraction spring (if equipped). Cylinder damaged internally.
Oil leaking from external relief valve.	Coupler not fully tightened. Restriction in return line.

SERVICE and REPAIR MANUAL

SECTION 9

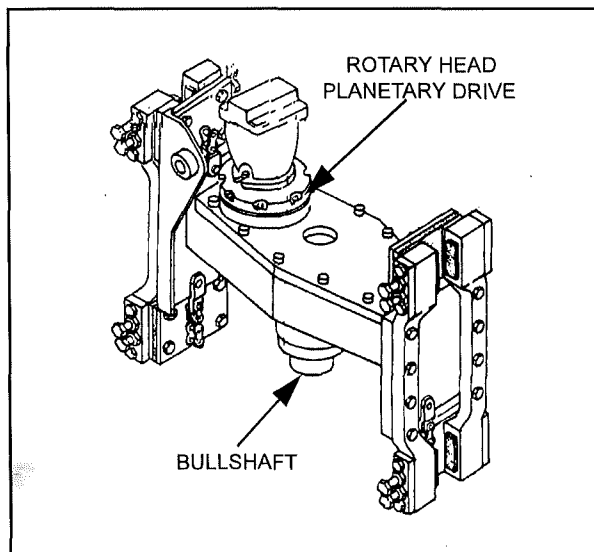
ROTARY SYSTEM



ROTARY HEAD PLANETARY DRIVE (001004-000)

GENERAL

It is recommended that rebuilding of the rotary head planetary drive assembly be done in a machine shop rather than in the field. Refer to the topic "Rotary Head" for instructions on removing and installing the rotary head and planetary drive assemblies.



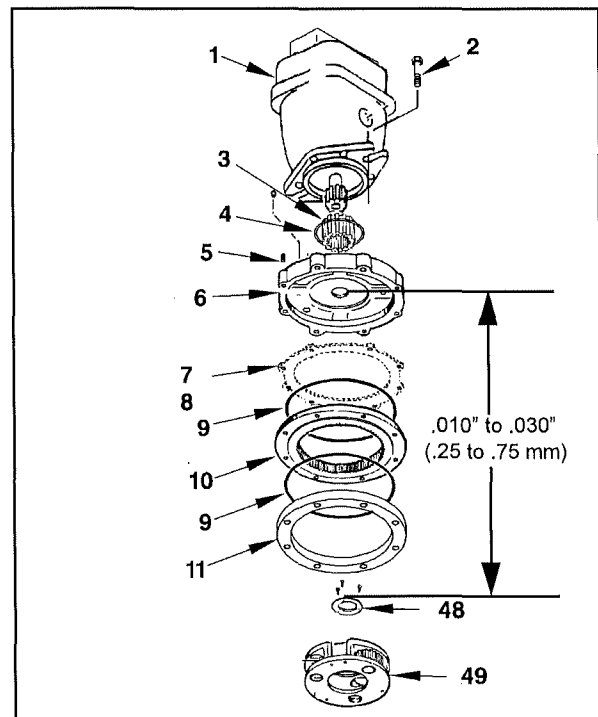
DISASSEMBLY

1. With the rotary head assembly on blocks in the normal operating position. Block the head securely and proceed with disassembly.
2. Remove splined coupling (3) from the planetary gearbox.
3. Remove capscrews (5) from top of planetary drive and remove planetary cover (6), planetary drive ring (10), planetary carrier (49), and planetary adapter (11).

4. Disassemble planetary carrier (49) if necessary.

NOTE!

The planetary gears are a matched set. Do not attempt to mix gears in a carrier.



INSPECTION

All components should be visually checked for cracks or other major problems that would eliminate their usage in the rebuilding of this assembly. All parts should be checked before starting the assembly procedure.

ASSEMBLY

1. Assemble and install the planetary drive on gearbox as follows:
 - A. Coat the lower surface of planetary adapter (11) with Loctite gasket eliminator #515 (001581-005). Position and align the adapter

over bolt holes in the top of the gearbox lid.

B. Grease quad rings (9) and insert in top recess of planetary adapter (11) and on top of planetary ring gear (10).

C. Place planetary sun gear assembly (49) into adapter (11) and install planetary drive ring (10) on top of the adapter. Make sure quad rings (9) are properly seated.

D. Place splined coupling (3) in the center of planetary (49) and rotate the bullshaft to center the planetary gear assembly around input pinion.

E. Coat the threads of capscrews (5) with Loctite 242 and place in position. Tighten the capscrews alternately and torque to 100 ft-lbs (135Nm).

2. Check the clearance of the planetary drive as follows:

A. Remove splined coupling (3).

B. Using a feeler gauge, check the clearance between top thrust washer (48) and the bottom surface of the top end cover ((6). Clearance should be from .010" to .030" (0.25 to 0.75 mm). If clearance is less than .010" (0.25 mm) then proceed as follows:

C. Remove capscrews (5). Holding the planetary assembly, remove end cover (6). **Do not move planetary adapter (11).**

D. Install 1/32" (.8mm) thick gasket (7) or 1/16" (1.6mm) thick gasket (8) as required to act as a spacer on top of planetary drive ring.

E. Grease and install quad ring (9) and end cover (6) and retorque capscrews (5) to 100 ft-lbs (135 Nm).

F. Use the feeler gauge to recheck the clearance.

G. After proper clearance is provided, reinstall splined coupling (3).

ROTARY HEAD AIR SWIVEL SEAL REPLACEMENT (001111-000)

ASSEMBLY AND INSTALLATION

1. Assemble and install upper swivel housing (17) as follows:

NOTE!

For additional instructions refer to page 002153-0 in this manual.

A. Pack and thoroughly grease upper seals (19).

B. Insert seals (19) into housing (17) with the lip of the top seal (19) facing toward the top of the housing and lip of bottom seal (19) towards the bottom of the housing.

C. Place **one** packing (16) in the recess on top of the bullshaft.

D. Coat the lower surface of housing (17) with orange Loctite.

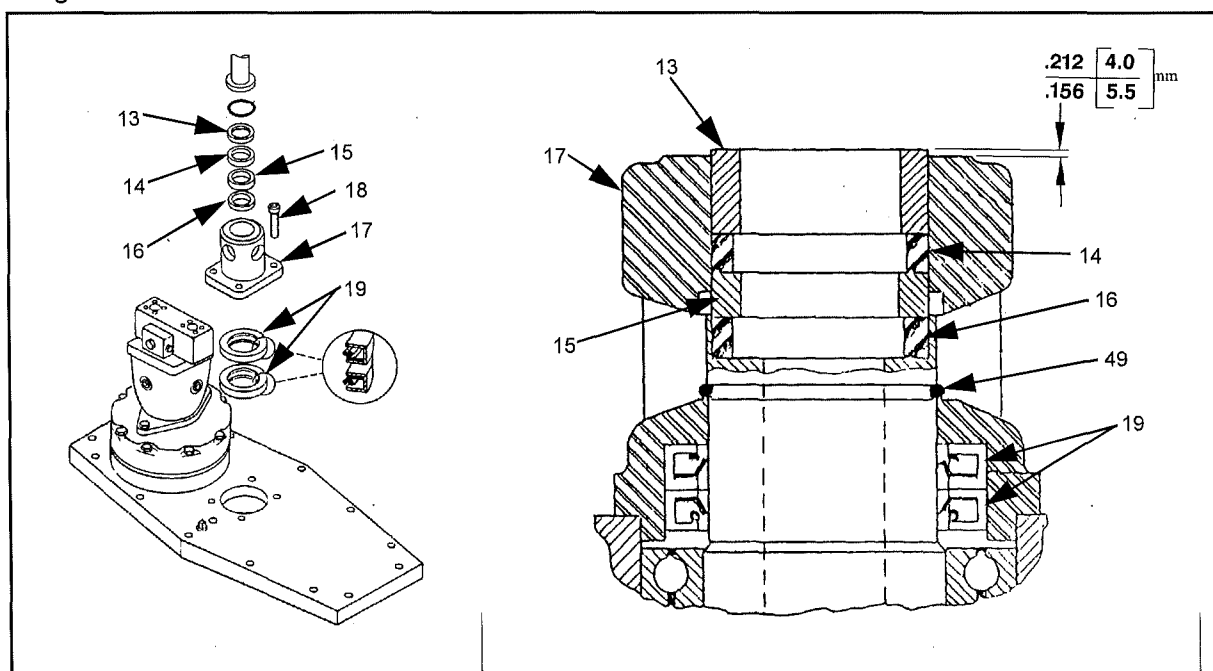
E. Carefully place housing (17) over the bullshaft and push it onto the bullshaft until the seals are past the O-ring groove. Grease O-ring (40) and install on bullshaft through top of the housing. Check alignment of the packing and press the housing into place.

F. Coat the threads of capscrews (18) with blue Loctite and tighten the housing down evenly. Torque to 100 ft- lbs (135Nm).

G. Coat both sides of wear bushing (15) with Never Seize or GP grease and place on top of packing (16) previously placed in the bullshaft. Place remaining packing (14) on top of wear bushing (15).

H. Install one spacer (13) on top of upper packing and install air pipe or flanged hose on top of seal housing. The use of two bolts is sufficient as the flange will be removed after the packing and wear bushing are compressed and seated. Rotate the bullshaft a few turns by hand to help seat the packing.

I. Remove the air flange carefully without disturbing spacer (13). Proper compression of packing will allow the spacer to extend above housing (17) .156" to .212" (4 to 5.5 mm) after



2-11-98

the flange is removed. If the spacer extends more than .212" (5.5 mm) above the housing, replace spacer (13) with a thinner spacer and recheck for proper dimension. Use the spacer which best meets recommended dimensions.

HYDRAULIC MOTOR (001329-000)

DESCRIPTION

This hydraulic motor can be either a fixed or variable displacement, axial piston motor. Rotation is bi-directional.

GENERAL

This topic contains a description of the motor, a troubleshooting table, and instructions for replacing the shaft seal and shaft assembly.

Two types of shaft seals are used on these motors; a seal assembly that consists of a spring, rubber bellows, and carbon ring, or a more typical oil seal.

TROUBLESHOOTING

The following table lists some of the difficulties which may be experienced with this piston motor. The table indicates the probable cause and possible remedies for the problem listed.

Problem	Cause	Remedy
Noisy Motor	Air in Fluid	a. Leak in suction line b. Leak at shaft seal c. Low fluid level d. Excessive pressure drop in the inlet line from reservoir e. Suction line strainer acting as an air trap
	Cavitation in motor rotating group	a. Fluid too cold b. Fluid too viscous c. Fluid too heavy d. Dirty return filters
	Misaligned shaft	a. Distortion in mounting b. Axial interference
High Wear in Motor	Excessive loads	a. Reduce pressure settings b. Reduce speeds
	Contaminant particles in fluid	a. Improper filter maintenance b. Introduction of dirty fluid into system c. Dirty reservoir breather d. Improper hose replacement
	Improper fluid	a. Fluid too thin or thick for operating range b. Fluid breakdown c. Incorrect additives in new fluid d. Weak additives do to chemical aging
	Water in fluid	a. Condensation b. Faulty breather c. Leaking cooler d. Incorrect flushing practices
Pressure Shocks	Worn relief valve	a. Repair
Heating Fluid	Excessive leakage	a. Rescheck case drain flow b. Fluid too thin
	Hydraulic reservoir	a. Fluid level too low b. Air in fluid

CARBON RING - TYPE SEAL

This procedure applies to the following shaft seals with seal kit part numbers:

- 001329-151
- 001330-052
- 001330-223
- 001330-416
- 003785-061
- 003785-185

Removal

Disassemble and remove the driveshaft as follows:

1. Remove the four screws (8) and gaskets (7) and remove retainer (6) and the stationary section of seal (4).

NOTICE

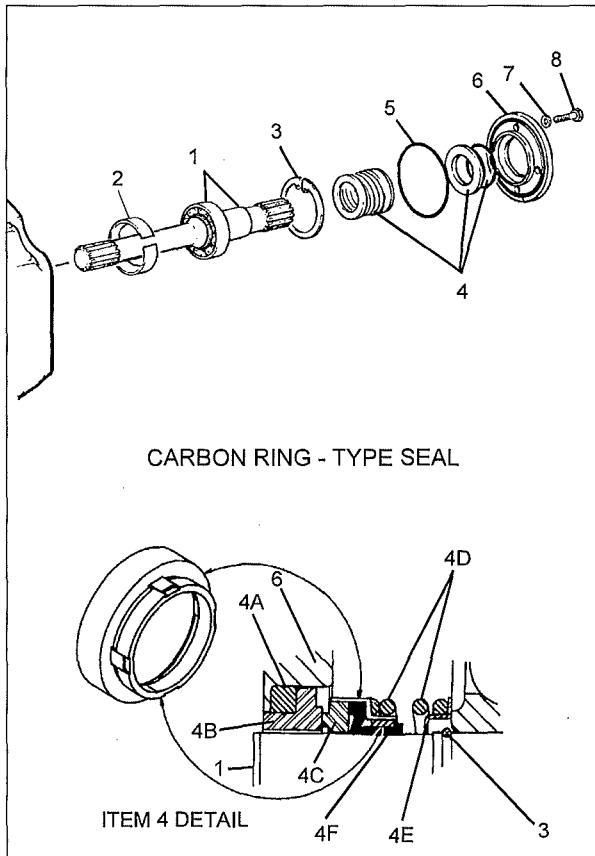
Do not scratch the seal surfaces on the shaft when removing seal (4).

2. Carefully remove the carbon ring and the remainder of shaft seal (4) from shaft (1).
3. Remove snap ring (3) and pull out shaft and bearing assembly (1). Remove shim (2) where applicable.

Cleaning And Inspection

All parts must be inspected and be free of material defects, dirt, scratches or any foreign material.

After cleaning, all parts must be covered with a light film of clean oil.



Installation

Install the shaft and seal assembly as follows:

NOTICE

Before installing the shaft seal, exercise care to ensure that all of the parts fit together properly. If the rubber ring (F), grips the shaft, spring (D) can disengage the shell of carbon ring (C). Be sure the shell and the band of the carbon ring are properly engaged before reassembling the seal.

1. Position the pump with the inlet and outlet port block facing down.
2. Lubricate the seal and shaft with clean hydraulic fluid of the same type that will be used in the system. Install the assembled shaft and bearing (1) in the mounting flange and cradle. Be certain that there are no burrs or sharp edges on shaft seal area of the shaft.

3. For a rigid shaft application use the shim (2) that results in least clearance around the shaft bearing.

4. Install snap ring (3) in the mounting flange to retain the shaft assembly. Be certain that the ring is fully seated in the groove. Use the ring that results in the tightest fit.

5. Seal assembly (4) is available as a complete unit only. Assemble the seal as follows:

NOTE !

Seal installation must be completed quickly to avoid the rubber friction ring seizing on the shaft.

A. Place spring retainer (E) over the shaft and against the retaining ring on the shaft assembly.

B. Place spring (D) against retainer (E).

C. Apply grease to the inner surface of rubber friction ring (F) and position the shell containing the rubber friction ring and carbon ring (C) over the shaft with the carbon ring exposed.

D. Apply grease to the square section rubber seal (A) and install on ceramic seat (B).

E. Insert the seat and seal in seal retainer (6) with the lapped side of the seat in position to contact the carbon ring.

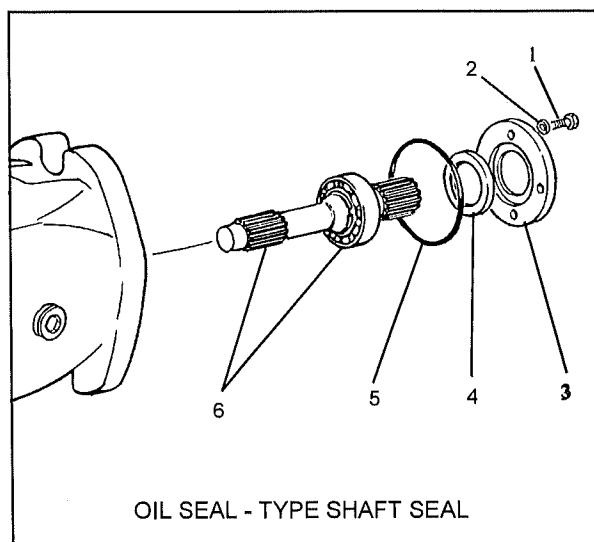
F. Place the seal retainer assembly and O-ring (5) over the shaft with the lapped surface against the carbon face.

G. Place the four gaskets (7) on the four screws (8) and insert seal retainer (6). Depress the seal retainer only far enough to start the four screws and tighten evenly. Torque to 10 ft. lb. (13.6 Nm).

OIL SEAL - TYPE SHAFT SEAL

This procedure applies to the following shaft seal with seal kit part number:

001329-273



1. Remove the four screws (1) and gaskets (2) and remove retainer (3) and O-ring (5).

2. Remove shaft seal (4) from shaft (6).

3. Remove socket head screw (7) which secures the cam to the housing.

NOTICE

Do not scratch the seal surfaces on the shaft when removing it from the cam.

4. Carefully remove shaft and bearing assembly (6) from the cam.

Cleaning And Inspection

All parts must be inspected and be free of material defects, dirt, scratches or any foreign material.

After cleaning, all parts must be covered with a light film of clean oil.

Installation

Install the shaft and oil seal as follows:

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1. Position the cam on the rotating group so that the thick part of the cam is at the bottom of the port block.
2. Insert the small end of shaft and bearing assembly (6) through the bore of the cam and into the splines of the cylinder barrel.
3. Install O-ring (5) into the counterbore in the housing.
4. Using a tapered sleeve tool with an inside diameter of 1.240 inches (31.5 mm) and an outside diameter of 1.395 inches (35.5 mm), install seal (4) over the splines of the shaft.
5. Slide seal retainer (3) over the shaft and against seal (4).
6. Place gaskets (2) over capscrews (1) and install them. Alternately torque the screws to 50 ft-lbs (68 Nm).

ROTARY HEAD PRESSURE RELIEF VENT (001670-002)

GENERAL

The following procedures describe the operation and the adjustment of the rotary head pressure relief vent.

DESCRIPTION

This pressure relief vent is mounted directly or remotely to the rotary head planetary drive assembly. Its purpose is to relieve internal gearbox pressures in excess of 5 psi and to prevent oil from draining out of the gearbox when the mast is in the horizontal position.

If not properly maintained, this vent may stick in the open position causing gearbox oil to escape. Excessive internal gearbox pressure will cause the lower bullshaft seal to leak when the vent is stuck in the closed position.

The vent should be disassembled and cleaned every 250 hours of service and replaced every 1000 hours. Disassembly and assembly should be as shown below.

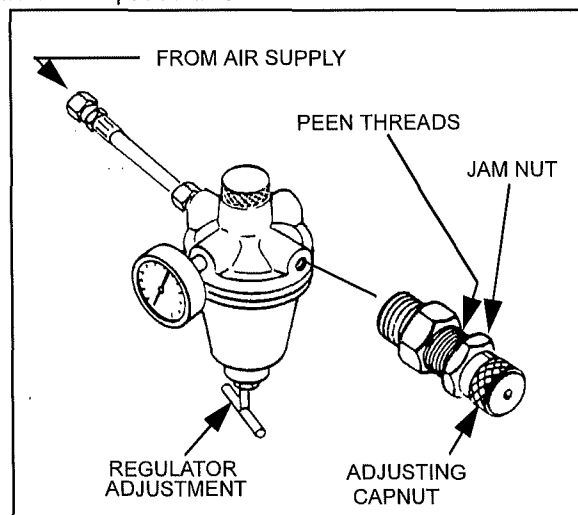
ADJUSTMENT

NOTE !

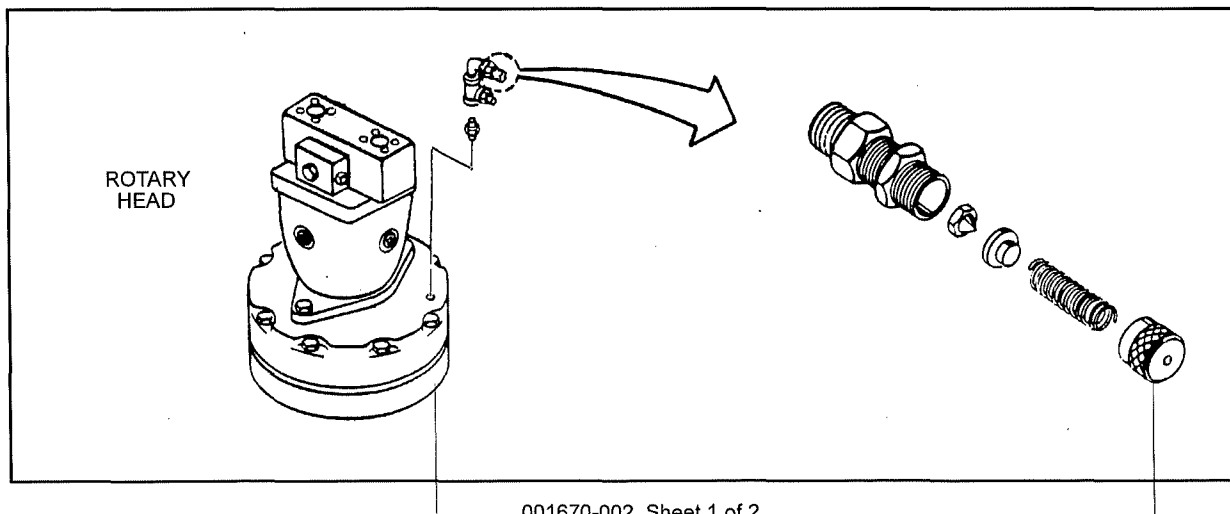
001670-002 relief vents are preset at 5 psi when shipped from the factory.

Adjustment of the vent requires a low pressure output regulator and an air supply. Adjust the relief vent as follows:

1. Attach the regulator inlet port to the air supply and the assembled relief vent to the outlet side of the regulator.
2. Before supplying air to the regulator, loosen the jam nut and turn the adjusting capnut 'IN' to increase pressure.



3. Start the air supply and make slow adjustments to the regulator adjusting screw to



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increase output air pressure to 5 psi.

4. Slowly begin to thread the vent capnut 'OUT' until air begins to pass out the vent.

5. Turn the jam nut into the adjusting capnut and tighten it. Peen (stake) the threads behind the jack nut to prevent the adjustment from changing due to vibration.

ROTARY HEAD (002153-000)

GENERAL

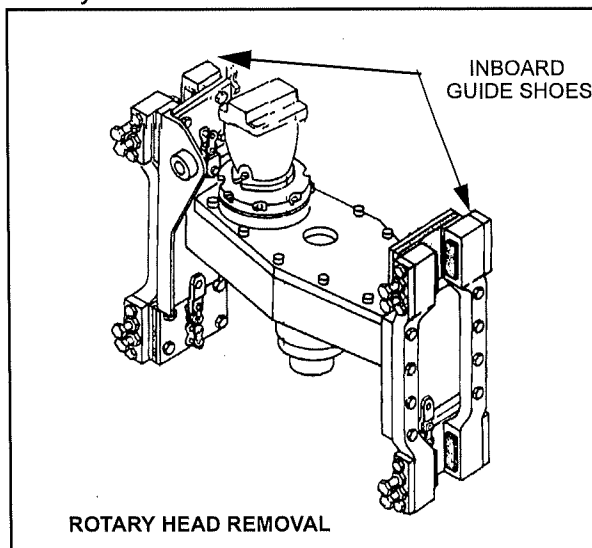
It is recommended that rebuilding of rotary head assembly be done in machine shop rather than in the field due to the necessity of a large press and other equipment required. If forced to repair in the field, the stocking of a bullshaft and bearing assembly is highly recommended.

REMOVAL

1. With the mast resting in the horizontal position slacken the hoist and feed chains.
2. Raise the mast and remove the top sub from the bottom connection of bullshaft (42). Lower the head to the bottom stop of the mast.
3. Remove screws (2) and lift and tie-off motor (1).
4. Remove the hose retaining block from the air piping manifold and remove the air hose.
5. Using a suitable container, drain the gearbox oil by removing plug (35).
6. Remove the inboard guide shoes assemblies from the rotary head to enable the head to swing out
7. Remove two of the item (20) socket head screws from the gearbox lid and attach a lifting eye or chain. Reinstall the screws securely.
8. Attach the winch to hold the head assembly in place. If using an alternate source for lifting, make sure lifting capacity will safely hold 675 kg (1500 lbs).
9. Remove chain connecting links (34) on the top of each side of the head at the sixth link up and also the second chain connecting link on

each side on the bottom of head. It may be necessary to loosen chains to remove connecting links.

10. Remove the head assembly from the mast and thoroughly clean before any further disassembly.



DISASSEMBLY

1. Place the assembly on blocks in the normal operating position. Block the head securely and proceed with disassembly.
2. Remove the air piping manifold, front guide shoes and wear plates.
3. Remove the air breather hose and cap the ends of the hose.
4. Remove splined coupling (3) from the planetary gearbox.
5. Remove capscrews (5) from top of planetary drive and remove planetary (6), planetary drive ring (13) and planetary adapter (11).
6. Remove capscrews (18) from swivel housing (17) and lift the housing vertically to remove.

7. Remove capscrews (20) from top lid of gearbox.

8. Place two of the removed capscrews (20) into the jack-screw holes located at each end of lid. Tighten the capscrews alternately to lift the lid from the gearbox housing.

9. Gearboxes equipped with a bearing locknut will require removal of locknut (28), washer (29), spacer (30), bearing (31) and bullgear spacer (32). If the gearbox is not equipped with the bearing locknut only spacer (32) should be removed.

10. Remove capscrews (46) and drop seal housing (45).

11. Position the gearbox under a press. Support the circular portion of the lower gearbox on a piece of heavy wall pipe with 25 cm (10") ID approximately 22.5 cm (9") long. Center the pipe to allow the bearing assembly (39 and 42) to lower into pipe.

12. To separate bullshaft (42) from bullgear (33) will require the use of a torch equipped with a cherry tip. The bullgear should be heated thoroughly from the center out for a least 10 cm (4 ") to 204°C (400°F). Place a heavy wall 3.75 cm (1-1/2") pipe coupling into the recess in top of bullshaft. Press the bullshaft downward until the bullgear is freed from bullshaft. **Care must be taken to be sure no pressure is applied to thin edge on top of the bullshaft.**

13. Lift gearbox (22) over bullshaft (42).

14. Check main thrust bearings (39). If necessary remove as follows:

A. Unlock tab lockwasher (37) and remove locknut (36), and keyed washer (38). Locknut may have to be heated to facilitate removal.

B. Set the lower end of bullshaft (42) into heavy wall pipe 15 cm (6") ID X 22.5 cm (9") long, resting on the cone of bearing (39). Place a heavy wall 3.75 mm (1-1/2") coupling in the recess on

top of the bullshaft. **Do not apply pressure to thin edge on top of bullshaft.** Apply pressure downward forcing bullshaft out of the bearing.

15. Thoroughly clean all gearbox parts.

INSPECTION

All components should be visually checked for cracks or other major problems that would eliminate their usage in the rebuilding of this assembly. All parts should be checked before starting the assembly procedure.

If the bullshaft dimensions are within tolerance but seal surfaces are worn, a sleeve replacement kit can be installed to replace the upper or lower seal area. See instructions on page no. 009532-0 of this manual.

After all parts and dimensions have been checked the assembly procedure may be started. Replace all seals, packings and O-rings.

Dimensions and Tolerances

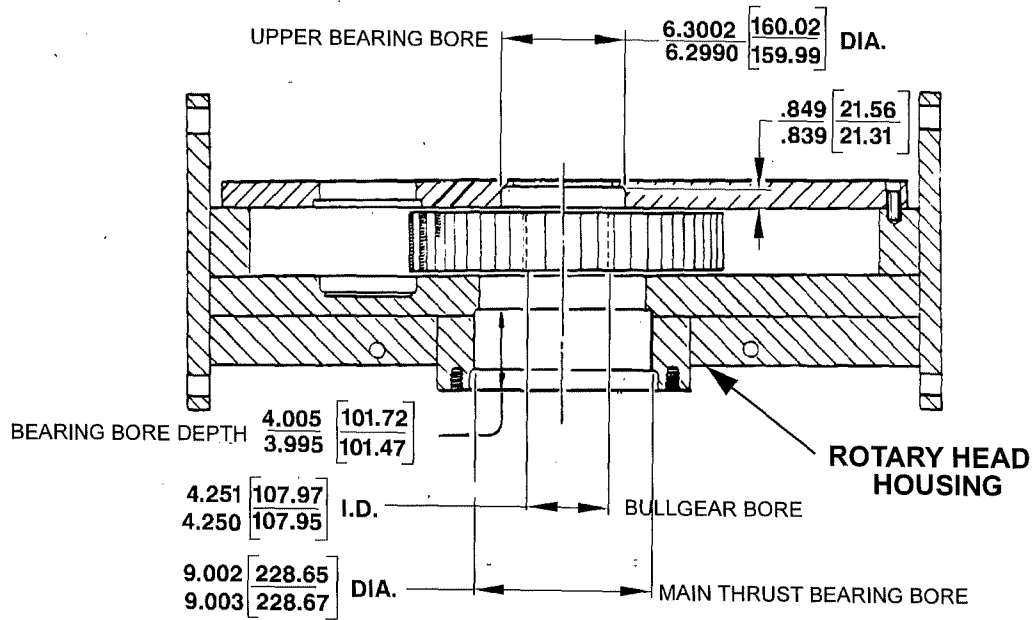
Dimensional tolerances of the bullshaft (42) at the bullgear seat and bullgear ID (33) are critical. These parts are shrink fit to ensure that the bullgear will remain in position during operation.

If your rotary head uses a bullshaft that does not use the bearing and locknut arrangement, we recommend that you replace it at this time.

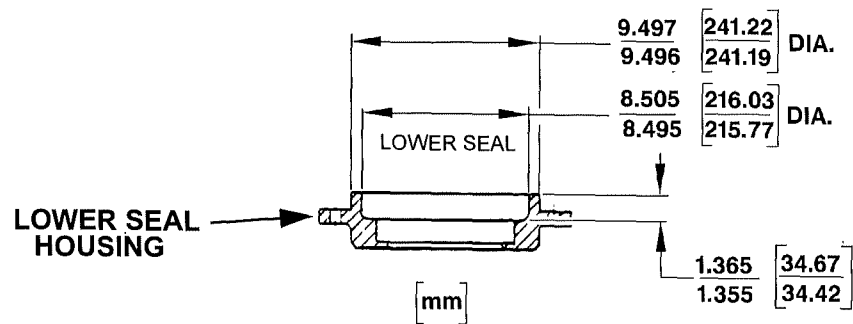
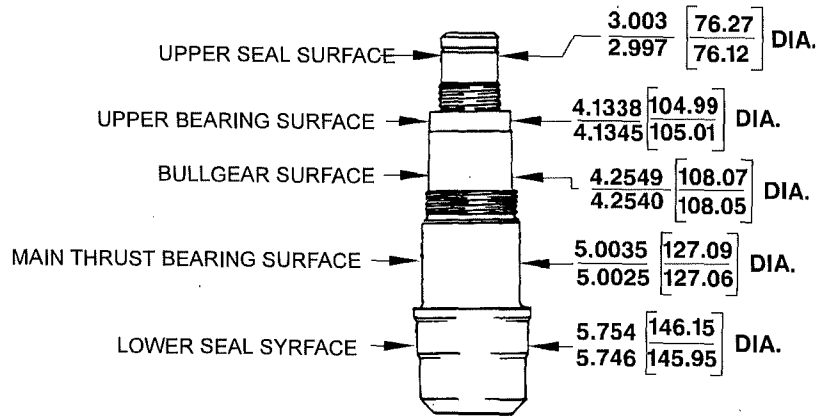
Bearing and bullshaft assemblies are available to replace bullshafts that do not include the top bearing locknut.

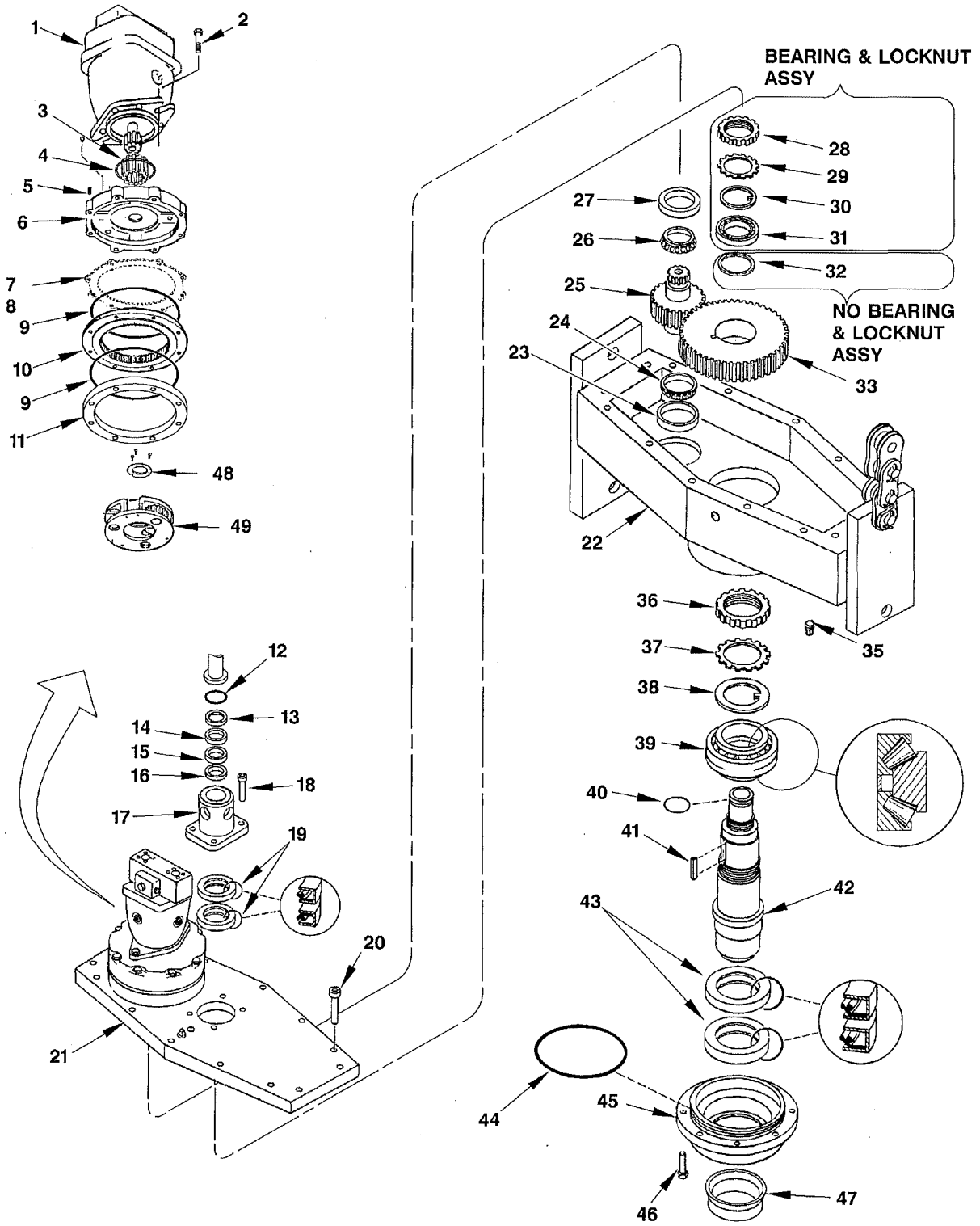
NOTE!

Use of the bullshaft with the locknut also requires the replacement of swivel housing (17).



**BULLSHAFT
(BEARING & LOCKNUT STYLE)**





ASSEMBLY

1. Main thrust bearing (39) should be cleaned and ready for assembly and at normal room temperature.

NOTE!

Bearing spacers are ground to match the bearing as a set. Do not mix bearings or spacers in other bearing assemblies.

2. Assemble main thrust bearing (39) to the bullshaft (42) as follows:

A. Heat bearing assembly (39) in oil or an oven for one 1-1/2 hours at 149 C° (300°F). Check with temperature stick.

B. Thoroughly clean bullshaft (42). All nicks and burrs must be removed before assembly.

NOTICE

Make sure bearing assembly (39) is installed as shown in the exploded view drawing.

C. Install the bearing on the bullshaft. The bearing must seat firmly on the bullshaft shoulder.

D. Allow bearing and bullshaft to cool to normal room temperature.

E. Position the bullshaft with bearing assembled under a press. Place a 13.75 cm (5-1/2") ID pipe X 22.5 cm (9") long carefully over bullshaft resting on top of bearing assembly (39). Press with force of 22,500 to 45,000 kg (25 to 50 tons) to ensure the bearing is properly seated. The bearing should be free to rotate without axial movement of the bearing cup.

F. Install washer (38), tang washer (37) and locknut (36). Tighten as tight as possible and lock in place.

3. Install seals (43) in lower seal housing (45) as follows:

A. Thoroughly clean and remove nicks and burrs from seal housing (45).

B. Grease and pack lower seals (43) thoroughly with #2 EP grease.

C. Assemble both seals with lip up as inserted into seal housing.

D. Press seals firmly into place using 16.25 cm (6-1/2") OD plate.

E. Grease O-ring (44) and install it in the groove in lower seal housing (45).

F. Grease the lower seal surface of bullshaft (42).

4. Install bullshaft (42) in gearbox housing (22) as follows:

A. Thoroughly clean the upper and lower bearing cavities in the gearbox housing. These areas must be absolutely clean and free of any nicks or burrs.

B. Carefully place bullshaft assembly in the center of lower seal housing (45).

C. Place bearing cup (23) into the lower input pinion bearing bore and lightly tap or press into place firmly.

D. Place gearbox (22) over bullshaft (42) and main thrust bearings (39).

E. Coat threads of capscrews (46) with Loctite No. 242 (part no.001581-001).

F. Lift lower seal housing (45) up over bullshaft (42). Make sure that seals are not folded over or damaged and that O-ring (44) does not drop out of the housing groove.

G. Install capscrews (46) and alternately torque to 135Nm (100 ft-lbs) for all 1/2" grade 5 screws, 155 Nm (115 ft-lbs) for all 5/8" grade 8 screws, and 163 Nm (120 ft-lbs) for all 1/2" grade 8 screws.

NOTE!

A gap of 3.1mm (1/8") between seal housing (45) and gearbox (22) is normal.

H. If all instructions have been followed the bullshaft should rotate without any noticeable end play.

5. Install input pinion bearings (24 & 26) as follows:

A. Heat bearing cones (24) and (26) in oil or oven for one hour at 149°C (300°F).

B. Slide bearing cone (26) over the splined end of input pinion (25). Make sure the bearing is completely seated on the shoulder.

C. Leave the remaining bearing cone (24) in oil or oven until after bullgear(33) is installed.

6. Assemble and install bullgear (33) as follows:

NOTICE

Tapped holes (5/8-11 UNC) in top of bullgear (33) are for lifting eyes only. Do not attempt to use these for any purpose other than lifting the bullgear.

A. Bullgear (33) must be heated in oil or an oven for 5 hours at 425°F(218°C). The use of a temperature stick is recommended to assure the bullgear is completely heated at proper temperature

B. Place steel key (41) in bullshaft.

NOTE!

Do not substitute any soft steels for key. Key material must be AISI 4140 HT.

C. Coat the surface of bullgear surface of bullshaft (42) must be "X" with Loctite 680 compound (001581-006).

C. Make sure lower input pinion cup (23) has been installed.

D. Position bullgear (33) over bullshaft (42). A press should be available in case the bullgear does not completely seat to the shoulder on the bullshaft.

E. Place lower input pinion bearing cone (24) into bearing cup (23). Place input pinion (25) into lower input bearing cone. The gears must be meshed properly for proper installation and the pinion lightly tapped until seated.

F. Place gearbox spacer (32) over bullshaft on top of bullgear.

G. Place top bullshaft bearing (31) on bullshaft and tap inner race until tight against spacer or shouldered.

H. Gearboxes using bullshafts with bullgear locknuts must have lockwasher (29) and locknut (28) installed and tightened as tight as possible.

7. Assemble and install gearbox lid (21) as follows:

A. Thoroughly clean gearbox lid (21). All nicks and burrs must be removed.

B. Install bearing cup (27) into the upper pinion opening and tap into place.

C. Coat the sealing surfaces of gearbox (22) with Loctite No. 515 (001581-005).

D. Coat threads of capscrews (20) with Loctite No. 242 (001581-001) and install lid (21). Pull the lid down evenly and torque the capscrews to 272 Nm (200 ft. lbs).

E. Gearboxes built with an inspection plug in lid can be used to measure from the top of the bullgear to the top of the lid to ensure the bullgear is not moving on the shaft. The measurement should be same as the measurement stamped near the inspection hole.

8. Assemble and install the planetary drive on gearbox as follows:

A. Coat the lower surface of planetary adapter (11) with Loctite gasket eliminator #515 (001581-005). Position and align the adapter over bolt holes in top of gearbox lid (21).

B. Grease quad rings (9) and insert in top recess of planetary adapter (11) and on top of planetary ring gear (10).

C. Place planetary sun gear assembly (49) into adapter (11) and install planetary drive ring (10) on top of the adapter. Make sure quad rings (9) are properly seated.

D. Place splined coupling (3) in the center of planetary (49) and rotate the bullshaft to center the planetary gear assembly around input pinion (25).

E. Coat the threads of capscrews (5) with Loctite 242 and place in position. Tighten the capscrews alternately and torque to 135Nm (100 ft-lbs).

9. Check the clearance of the planetary drive as follows:

A. Remove splined coupling (3).

B. Using a feeler gauge, check the clearance between top thrust washer (48) and the bottom surface of the top end cover ((6). Clearance should be from 2.5 to 7.5 mm (.010" to .030"). If clearance is less than 2.5 mm (.010") then proceed as follows:

C. Remove capscrews (5). Holding the planetary assembly, remove end cover (6). **Do not move planetary adapter (11).**

D. Install 1/32" (.8mm) thick gasket (7) or 1.6mm (1/16") thick gasket(8) as required to act as a spacer on top of planetary drive ring.

E. Grease and install quad ring (9) and end cover (6) and retorque capscrews(5) to 135 Nm (100 ft-lbs).

F. Use the feeler gauge to recheck the clear-

ance.

G. After proper clearance is provided, reinstall splined coupling (3).

10. Assemble and install upper swivel housing (17) as follows:

NOTE!

For additional instructions refer to page 001111-0 in this manual.

A. Pack and thoroughly grease upper seals (19).

B. Insert seals (19) into housing (17) with the lip of the top seal (19) facing toward the top of the housing and lip of bottom seal (19) towards the bottom of the housing.

C. Place **one** packing (16) in the recess on top of bullshaft (42).

D. Coat the lower surface of housing (17) with orange Loctite.

E. Carefully place housing (17) over bullshaft (42) and push it onto the bullshaft until the seals are past the O-ring groove. Grease O-ring (40) and install on bullshaft through top of the housing. Check alignment of the packing and press the housing into place.

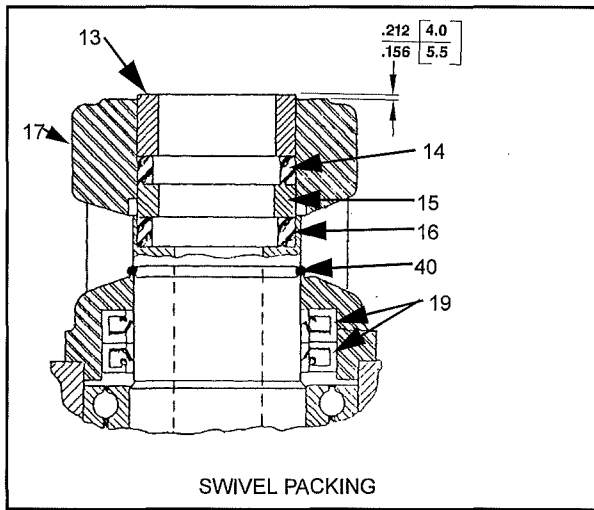
F. Coat the threads of capscrews (18) with blue Loctite and tighten the housing down evenly. Torque to 135Nm (100 ft- lbs).

G. Coat both sides of wear bushing (15) with Never Seize or GP grease and place on top of packing (16) previously placed in bullshaft (42). Place remaining packing (14) on top of wear bushing (15).

H. Install one spacer (13) on top of upper packing and install air pipe or flanged hose on top of seal housing. The use of two bolts is sufficient as the flange will be removed after the packing and wear bushing are compressed and seated. Rotate the bullshaft a few turns by hand to help

seat the packing.

I. Remove the air flange carefully without disturbing spacer (13). Proper compression of packing will allow the spacer to extend above housing (17) 4 to 5.5 mm (.156" to .212") after the flange is removed. If the spacer extends more than 5.5 mm (.212") above the housing, replace spacer (13) with a thinner spacer and recheck for proper dimension. Use the spacer which best meets recommended dimensions.



INSTALLATION

1. Position the rotary head assembly in the mast.
2. Reconnect the chains and install the guide shoes assemblies.
3. Install the rotary head drive motor as follows:
 - A. Grease and install O-ring (4) (component of the planetary drive) into the top of planetary cover (6).
 - B. Splined adapter (3) must be in the planetary drive.
 - C. Position motor (1) on top of planetary drive with the motor case drain outlet towards the

center of the gearbox.

D. Coat the threads of capscrew (2) with Loctite (001581-001) and tighten evenly to approximately 135 Nm (100 ft-lbs) of torque.

E. Reinstall the air vent hose. (Delay tightening of one end of hose until gearbox is filled with oil to let trapped air escape.)

4. Remove the planetary case fill plug and fill gearbox (22) through fill opening with approximately 20.5 l (22 quarts) of EP 90 gear case oil.

5. Refill the planetary assembly until the oil level is at the top of planetary ring gear (10).

6. Oil level must be checked a minimum of one time per week.

7. Drain, flush and refill gear case every 6 months.

8. Adjust the chain tension as required.

HYDRAULIC MOTOR (002746-000)

DESCRIPTION

This hydraulic motor can be either a fixed or variable displacement, axial piston motor. Rotation is bi-directional.

GENERAL

This topic contains a description of the motor, a troubleshooting table, and instructions for replacing the shaft seal and shaft assembly.

Two types of shaft seals are used on these motors; a seal assembly that consists of a spring, rubber bellows, and carbon ring, or a more typical oil seal.

TROUBLESHOOTING

The following table lists some of the difficulties which may be experienced with this piston motor. The table indicates the probable cause and possible remedies for the problem listed.

Problem	Cause	Remedy
Noisy Motor	Air in Fluid	a. Leak in suction line b. Leak at shaft seal c. Low fluid level d. Excessive pressure drop in the inlet line from reservoir e. Suction line strainer acting as an air trap
	Cavitation in motor rotating group	a. Fluid too cold b. Fluid too viscous c. Fluid too heavy d. Dirty return filters
	Misaligned shaft	a. Distortion in mounting b. Axial interference
High Wear in Motor	Excessive loads	a. Reduce pressure settings b. Reduce speeds
	Contaminant particles in fluid	a. Improper filter maintenance b. Introduction of dirty fluid into system c. Dirty reservoir breather d. Improper hose replacement
	Improper fluid	a. Fluid too thin or thick for operating range b. Fluid breakdown c. Incorrect additives in new fluid d. Weak additives do to chemical aging
	Water in fluid	a. Condensation b. Faulty breather c. Leaking cooler d. Incorrect flushing practices
Pressure Shocks	Worn relief valve	a. Repair
Heating Fluid	Excessive leakage	a. Rescheck case drain flow b. Fluid too thin
	Hydraulic reservoir	a. Fluid level too low b. Air in fluid

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CARBON RING - TYPE SEAL

This procedure applies to the following shaft seals with seal kit part numbers:

001329-151
001330-052
001330-223
001330-416
003785-061
003785-185

Removal

Disassemble and remove the driveshaft as follows:

1. Remove the four screws (8) and gaskets (7) and remove retainer (6) and the stationary section of seal (4).

NOTICE

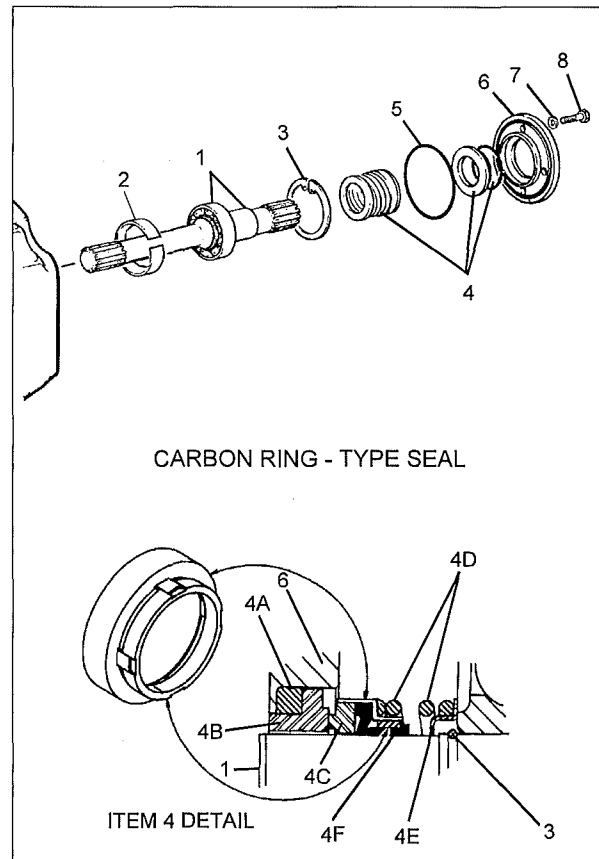
Do not scratch the seal surfaces on the shaft when removing seal (4).

2. Carefully remove the carbon ring and the remainder of shaft seal (4) from shaft (1).
3. Remove snap ring (3) and pull out shaft and bearing assembly (1). Remove shim (2) where applicable.

Cleaning And Inspection

All parts must be inspected and be free of material defects, dirt, scratches or any foreign material.

After cleaning, all parts must be covered with a light film of clean oil.



Installation

Install the shaft and seal assembly as follows:

NOTICE

Before installing the shaft seal, exercise care to ensure that all of the parts fit together properly. If the rubber ring (F), grips the shaft, spring (D) can disengage the shell of carbon ring (C). Be sure the shell and the band of the carbon ring are properly engaged before reassembling the seal.

1. Position the pump with the inlet and outlet port block facing down.
2. Lubricate the seal and shaft with clean hydraulic fluid of the same type that will be used in the system. Install the assembled shaft and bearing (1) in the mounting flange and cradle. Be certain that there are no burrs or sharp edges on shaft seal area of the shaft.

3. For a rigid shaft application use the shim (2) that results in least clearance around the shaft bearing.

4. Install snap ring (3) in the mounting flange to retain the shaft assembly. Be certain that the ring is fully seated in the groove. Use the ring that results in the tightest fit.

5. Seal assembly (4) is available as a complete unit only. Assemble the seal as follows:

NOTE !

Seal installation must be completed quickly to avoid the rubber friction ring seizing on the shaft.

F. Place spring retainer (E) over the shaft and against the retaining ring on the shaft assembly.

G. Place spring (D) against retainer (E).

H. Apply grease to the inner surface of rubber friction ring (F) and position the shell containing the rubber friction ring and carbon ring (C) over the shaft with the carbon ring exposed.

I. Apply grease to the square section rubber seal (A) and install on ceramic seat (B).

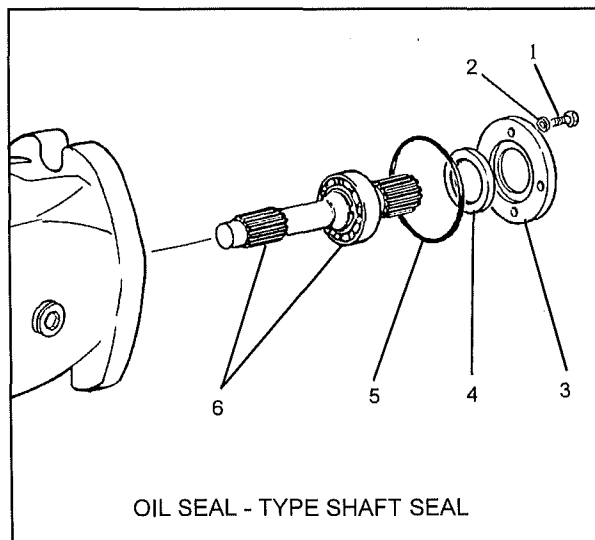
J. Insert the seat and seal in seal retainer (6) with the lapped side of the seat in position to contact the carbon ring.

K. Place the seal retainer assembly and O-ring (5) over the shaft with the lapped surface against the carbon face.

L. Place the four gaskets (7) on the four screws (8) and insert seal retainer (6). Depress the seal retainer only far enough to start the four screws and tighten evenly. Torque to 10 ft. lb. (13.6 Nm).

OIL SEAL - TYPE SHAFT SEAL

This procedure applies to the following shaft seal with seal kit part number:
001329-273



1. Remove the four screws (1) and gaskets (2) and remove retainer (3) and O-ring (5).

2. Remove shaft seal (4) from shaft (6).

3. Remove socket head screw (7) which secures the cam to the housing.

NOTICE

Do not scratch the seal surfaces on the shaft when removing it from the cam.

4. Carefully remove shaft and bearing assembly (6) from the cam.

Cleaning And Inspection

All parts must be inspected and be free of material defects, dirt, scratches or any foreign material.

After cleaning, all parts must be covered with a light film of clean oil.

Installation

Install the shaft and oil seal as follows:

1. Position the cam on the rotating group so

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that the thick part of the cam is at the bottom of the port block.

2. Insert the small end of shaft and bearing assembly (6) through the bore of the cam and into the splines of the cylinder barrel.

3. Install O-ring (5) into the counterbore in the housing.

4. Using a tapered sleeve tool with an inside diameter of 1.240 inches (31.5 mm) and an outside diameter of 1.395 inches (35.5 mm), install seal (4) over the splines of the shaft.

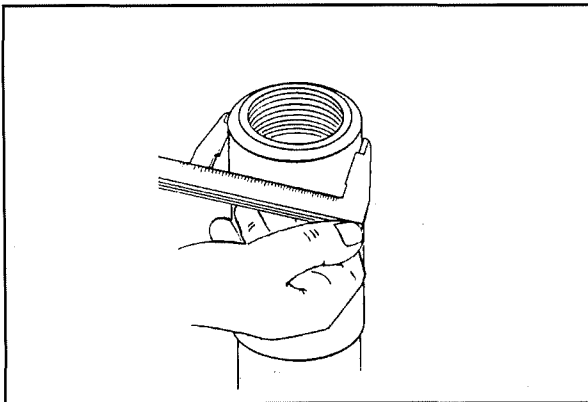
5. Slide seal retainer (3) over the shaft and against seal (4).

6. Place gaskets (2) over capscrews (1) and install them. Alternately torque the screws to 50 ft-lbs (68 Nm).

BULLSHAFT SLEEVE KIT INSTALLATION (009532-000)

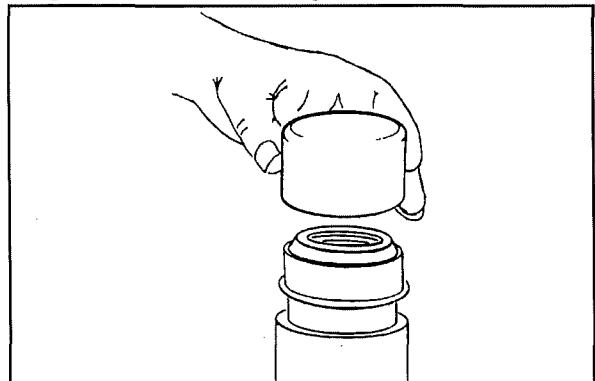
INSTALLATION

1. Clean the surface where the seal contacts the shaft. File down and polish any burrs or rough spots.
2. Measure the diameter where the sleeve will be positioned on an unworn portion of the shaft. Measure in three positions and average the reading in case the shaft is out of round. If the average diameter is within the range for a given sleeve size, there is sufficient press-fit built into the sleeve to keep it from sliding or spinning. No cement is necessary.

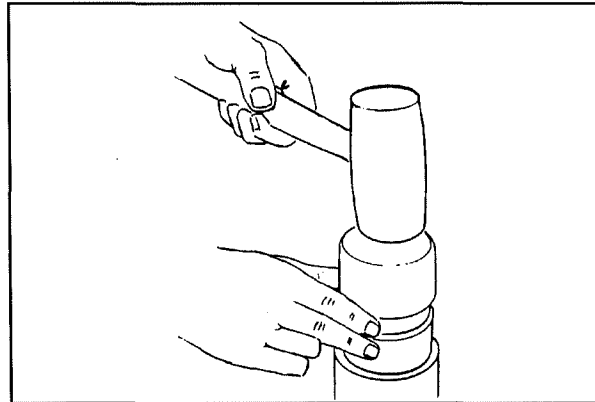


3. If the shaft is deeply scored, fill the groove with epoxy type filler. Install sleeve before the filler hardens.
4. If the groove does not require filling, apply a light layer of nonhardening sealant to the inner surface of the sleeve.
5. Determine how far back the sleeve must be positioned to cover the old seal wear tracks. Measure to the exact point, or mark directly on the surface. The sleeve must be placed over the worn area, not just bottomed or left flush with the end of the shaft.

6. Place installation tool over the sleeve. The flange end of the sleeve goes on the shaft first.

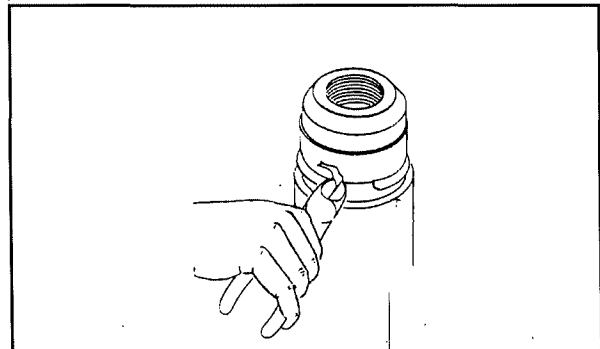


7. Gently pound the center of the tool until the sleeve covers the seal worn surface.



If the installation tool supplied with the sleeve is too short, a length of pipe or tubing with a squared-off, burr-free end can be substituted.

8. Leave the sleeve flange intact unless clearance is required. Use side cutters to pry the flange away from the seal surface and twist it into a coil. The flange will break loose along the pre-cut line.



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9. After the sleeve is installed, check again for burrs which could damage the seal.

10. Lubricate the end of the sleeve when installing the seal.

SLEEVE KIT PART NUMBER	MAXIMUM SHAFT DIAMETER	MINIMUM SHAFT DIAMETER
009532-001	5.754" (146.15mm)	5.746" (145.94mm)
009532-002	3.003" (76.27mm)	2.997" (76.12mm)

ROTARY HEAD (009647-000)

OVERHAUL

Disassembly

NOTE!

Due to the necessity of a large press and other equipment required, it is recommended that rebuilding of the rotary head assembly be done in a machine shop rather than in the field. If forced to repair in the field, the stocking of a bullshaft and bearing assembly is highly recommended.

1. Raise the mast and lock it in position. Lower the rotary head.

Remove the top sub from the bottom of bullshaft (42) and lower the head to bottom stop of the mast.

NOTE!

Refer to 011201-000 for removal and installation of the top sub.

2. Disconnect, plug and cap all hydraulic hoses to motor (1). This will require 2 each 001137-007 plugs, 2 each 01138-007 caps, 1 each 01132-006 plug, and 1 each 001138-006 cap.
3. Remove the hose retaining block from the air piping manifold and remove the air hose.
4. Drain the gearbox oil by removing plug (35) and allowing the oil to drain in a suitable container.
5. Remove rotary head rear guide shoes, spacers and wear plates from the head.
6. Remove two socket head screws (20) from lid (21) and attach lifting eyes or chains. Reinstall capscrews securely.

7. Attach the winch wire rope to the lifting eyes to hold head assembly in place. If using alternate source for lifting other than winch, make sure lifting capacity is safe for 1,500 lbs. (680 kg).

8. Remove the pulldown chain connecting links on each side on the bottom of the head. Loosen the chains to remove connecting links.

9. Remove the hoist chain connecting links (34) from the top of each side of the head at the sixth link up.

10. Remove the rotary head from the mast and thoroughly clean it before any further disassembly.

11. Place the head on blocks in the normal operating position. Block the head securely and proceed with disassembly.

12. Remove the air piping manifold, the front guide shoes and the wear plates.

13. Remove the air breather hose assembly and cap the ends of the hose.

14. Remove capscrews (2) and lift motor (1) from planetary drive (6).

15. Remove splined coupling (3) from planetary gear box.

16. Remove eight capscrews (5) from top of planetary drive (6) and remove the planetary, planetary drive ring (10) and planetary adapter (11).

17. Remove four capscrews (18) from seal housing (17) and lift the seal housing vertically to remove.

18. Remove fourteen capscrews (20) from lid (21).

19. Place two of the removed capscrews (20) into the jack holes located at each end of lid. Tighten the capscrews alternately to lift lid (21)

off of gearbox housing (22).

20. Gearboxes equipped with a bullgear locknut (28) will require removal of the locknut, washer (29), bearing (30), and bullgear spacer (31). If the gearbox is not equipped with the locknut only the spacer should be removed.

21. Remove the eight capscrews (46) and drop lower seal plate (45).

22. Position the gearbox under a press. Support the circular portion of lower gearbox on heavy wall pipe with 12" ID (305 mm) and approximately 12" (30 cm) high. Center the pipe to allow bullshaft/bearing assembly (39 and 42) to drop into the pipe.

23. To remove bullshaft (42) from bullgear (33) without damage will require the use of a torch equipped with a cherry tip. The bullgear should be heated thoroughly 400°F (204°C) from the center out for at least four 4 inches (10 cm). Place a heavy wall 3" (76 mm) coupling into the recess in the top of the bullshaft. Press the bullshaft downward until the bullgear is freed from the bullshaft. Care must be taken to be sure no pressure is applied to the thin edge on top of bullshaft (42).

24. Remove gearbox (22) from over bullshaft (42).

25. Check main thrust bearings (39). If necessary to replace, proceed as follows:

26. Unlock tab lockwasher (37) to remove locknut (36) and keyed washer (38).

NOTE!

The locknut may have to be heated to facilitate removal.

27. Set bullshaft (42) into heavy wall pipe 8" ID (203 mm) X 15" (38 cm) high, resting on bearing cones. Place a heavy wall 3" (76 mm) coupling, minimum 1-1/2" (3.7 cm) high or pipe in the recess on top of the bullshaft. Do not apply pressure to thin edge on top of bullshaft. Apply

pressure downward forcing bullshaft out of bearing.

28. Thoroughly clean all gearbox parts.

Inspection of Components

1. Before any time is spent checking the critical dimensions, the components should be visually checked for cracks or other major problems that would eliminate their usage in the rebuilding of this assembly. All parts should be checked before starting the assembly procedure.

2. After all parts and dimensions have been checked, the assembly procedure may be started. Make sure all seals, packings and O-rings are available as all these items must be replaced.

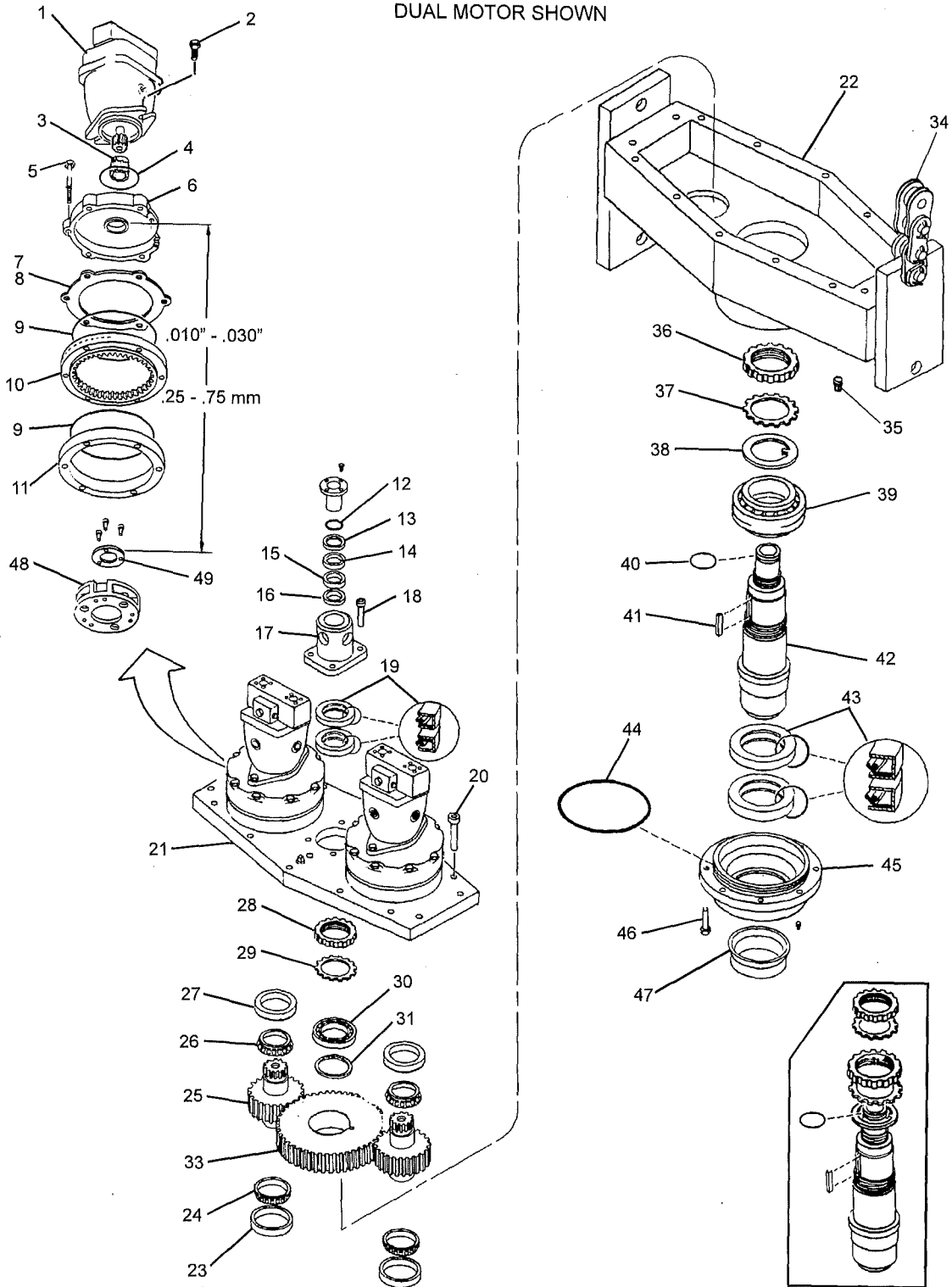
3. Dimensional tolerances of bullshaft (42) at bullgear seat and bullgear ID (33) are critical. The shrink fit as required to ensure that the bullgear will remain in position during operation.

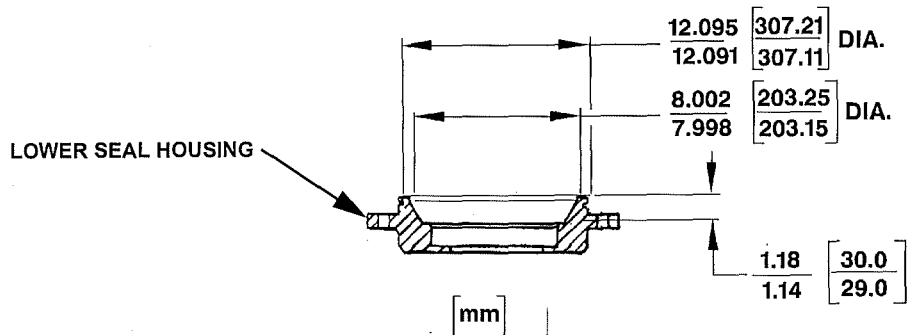
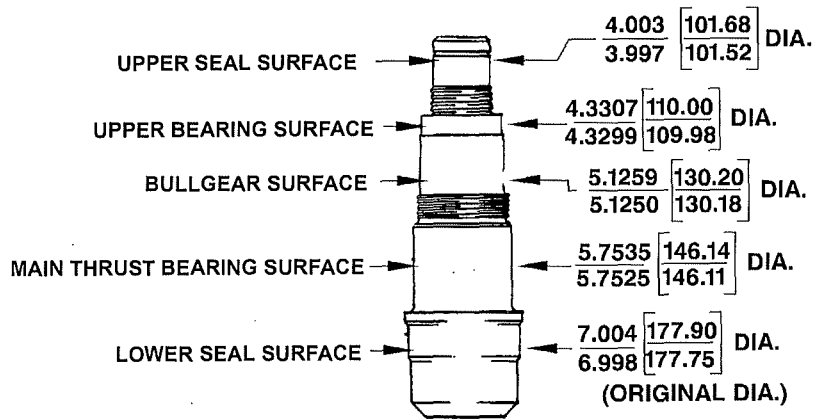
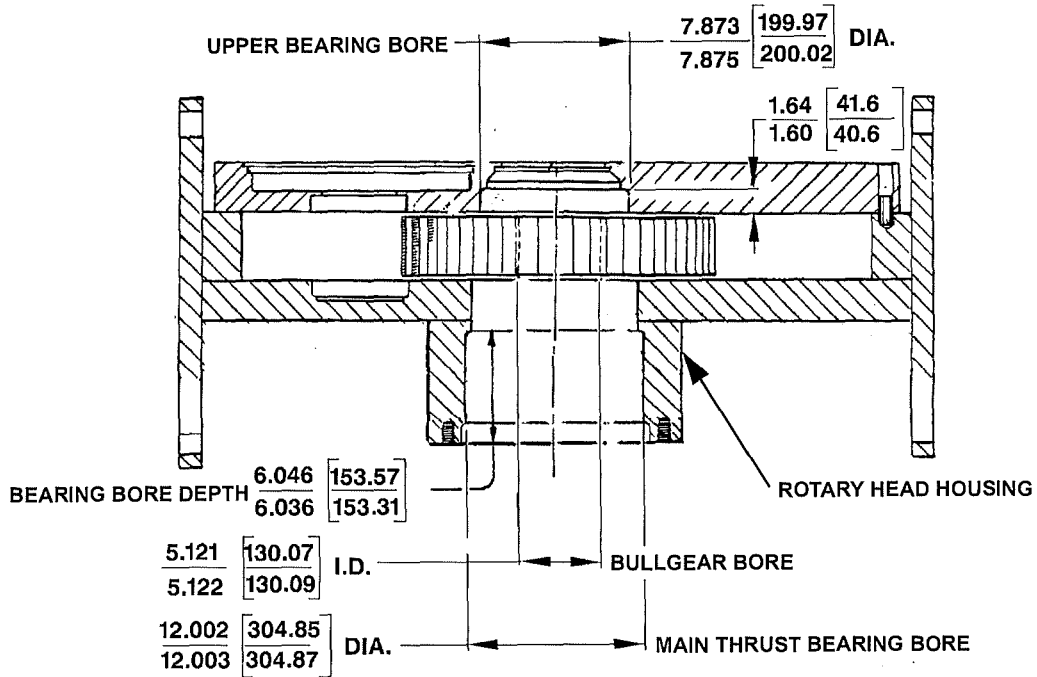
Assembly

1. The following parts need to be heated before installation:

- Heat bearing (39) in oil or oven to 300°F (149°C) for one and 1-1/2 hours. Check with temperature stick.
- Bullgear (33) must be heated in oil or an oven at 425°F (219°C) for a period of five (5) hours. Use of temperature stick is recommended to assure bullgear is completely heated at proper temperature.
- Heat bearing cones (24 and 26) in oil or oven to 300°F (149°C) for one hour.

DUAL MOTOR SHOWN





NOTICE

Mixing bearing spacers can damage the bearings. Bearing spacers are ground to match the bearing as a set. Do not mix bearings or spacers in other bearing assemblies.

2. Thoroughly clean bullshaft (42). All nicks and burrs must be removed before assembly.
3. Install bearings (39) on bullshaft (42). Bearings must seat firmly on the shoulder and must be assembled as shown in the detail drawing.
4. Allow the bearing and bullshaft to cool to room temperature.
5. Place bullshaft (42) with bearing (39) under the press. Place 6" (152.4 mm) ID pipe X 11" (28 cm) long carefully over the bullshaft resting on top of bearing assembly (39). Press with maximum force of 20 tons to ensure the bearing is properly seated. The bearing should be free to rotate without axial movement of the bearing cup.
6. Install keyed washer (38), tab lockwasher (37) and locknut (36). Tighten as tight as possible and lock in place.
7. Thoroughly clean and remove nicks and burrs from seal housing (45).
8. Grease and pack lower seals (43) thoroughly with #2 EP grease.
9. Install both seals (43) with lip up, as shown into seal housing (45) and press the seals firmly into place using 3-3/4" (9.3 cm) diameter plate.
10. Grease O-ring (44) and place in the groove in seal housing (45).
11. Grease the seal contact area of bullshaft (42).
12. Thoroughly clean the upper and lower bearing cavities of housing (22). These areas must

be absolutely clean and free of any nicks and burrs.

13. Carefully place bullshaft assembly (42) in the center of lower seal housing (45).
14. Place bearing cup (23) into lower input pinion bearing cavity and lightly tap or press into place firmly.
15. Place gearbox (22) over bullshaft (42) and main thrust bearings (39).
16. Coat the threads of capscrews (46) with blue Loctite No. 242 (part number 001581-001).
17. Lift lower seal housing (45) up over lower seal area. Make sure that seals (43) are not folded over or damaged, and O-ring (44) does not drop out of the housing groove.
18. Install capscrews (46) and alternately torque to 120 ft-lbs. (162 Nm).

NOTE!

A gap of 1/8" (3 mm) between the seal housing and the gearbox is normal clearance.

19. If all instructions have been followed the bullshaft should rotate without any noticeable end play.
20. Install the heated bearing cone (26) on the splined end of input pinion (25). Make sure the bearing is completely seated on the shoulder.

NOTE!

Leave remaining bearing cone (24) in oil or oven until after bullgear (33) is installed.

NOTICE

The tapped holes (5/8-11 UNC) in the top of the bullgear should not be used for any purpose other than lifting of the bullgear.

21. Place steel key (41) in bullshaft (42). Do not substitute any soft steels for this key. The key material must be AISI 4140 HT.

22. the bullgear contact surface of bullshaft (42) must be coated with Loctite 680 compound (part number 001581-006).

23. Recheck - make sure that bearing cup (23) has been installed.

24. Lift and place the bullgear over the bullshaft. A press should be available in case the bullgear does not completely seat on shoulder of the bullshaft.

25. Place the heated bearing cone (24) into cup (23) and install input pinion into the lower input bearing cone. Gears must be meshed properly for proper installation and pinion lightly tapped until seated.

26. Install bullgear spacer (31) on top of bullgear.

27. Place top bullshaft bearing (30) on bullshaft and tap inner race until tight against spacer (31) or shoulder.

28. Gearboxes using bullshafts with bullgear locknuts must have lockwasher (29) and locknut (28) installed and tightened as tight as possible.

29. Thoroughly clean gearbox lid. All nicks and burrs must be removed.

30. Install bearing cup (27) into the opening in lid (21) and tap into place.

31. Place the heated bearing cone (26) over the top of input pinion shaft (25) and tap lightly until properly seated.

32. Coat the sealing edge of gearbox (22) with purple Loctite No. 515 (part number 001581-005).

33. Coat the threads of capscrews (20) with blue Loctite No.242 (001581-001) and place in lid (21). Pull the lid down evenly and torque the capscrews to 225 ft-lbs. (305 Nm).

34. Gearboxes built with an inspection plug in lid

(21) can be used to measure from the top of bullgear (33) to the top of lid (21) to ensure that the bullgear is not moving on the shaft.

NOTE!

The correct dimension should be the same as the dimension stamped near the inspection hole.

35. Coat the lower surface of planetary adapter (11) with purple Loctite gasket eliminator No. 515 (part number 001581-005). Place and align the adapter over the bolt holes in the top of the gearbox lid.

36. Grease quad rings (9) and insert them in the top recess of planetary adapter (11) and planetary ring gear (10).

37. Place planetary (48) into adapter (11) and install planetary ring gear (10) on top of the adapter. Make sure quad rings are properly seated.

38. Place splined coupling (3) in center of planetary (48) and rotate bullshaft (42) to center planetary gear assembly around input pinion (25).

39. Coat the threads of capscrews (5) with blue Loctite and place in position. Tighten the capscrews alternately and torque to 100 ft-lbs. (135 Nm).

40. Remove splined coupling (3) previously installed. Use a feeler gauge and check the clearance between the top of thrust washer (49) and the bottom surface of the top of the end cover of planetary drive (6) as shown. Clearance should be from .010" to .030" (.25 to .75 mm). If clearance is less than the minimum, proceed as follows:

41. Remove capscrews (5) and remove end cover (6). **Do not move planetary adapter (11).**

42. Install a 1/32" (7) or a 1/16" (8) gasket as required to act as spacer on top of planetary drive ring.

43. Grease and install quad ring (9) and end cover (6) and retorque capscrews (5) to 100 ft-lbs. (135 Nm).
44. Use the feeler gauge and recheck clearance.
45. After proper clearance is provided, reinstall splined coupling (3).
46. Pack and thoroughly grease seals (19). Insert the seals into housing (17) with the lip of the top seal toward the top of housing (17) and lip of bottom seal towards lid (21).
47. Place **one** only packing (16) in the recess in the top of bullshaft (42).
48. Coat the lower contact surface of seal housing (17) with orange Loctite. Carefully place the housing over the bullshaft and push onto the bullshaft until seals are past O-ring groove.
49. Grease O-ring (40) and install on bullshaft (42) through the top of the seal housing. Check alignment of packing and press the housing into place.
50. Coat the threads of capscrews (18) with blue Loctite and tighten housing (17) down evenly. Torque to 115 ft-lbs. (156 Nm).
51. Coat both sides of wear bushing (15) with Never Seize or GP Grease and place on top of packing (16) previously placed in bullshaft (42). Place the remaining packing (14) on top of the wear bushing.
52. Install one spacer (13) on top of upper wear bushing (15) and install air pipe or flanged hose on top of seal housing. Use of two bolts is sufficient as flange will be removed after packing and wear bushing are compressed and seated. Rotate the bullshaft a few turns by hand to help seat packing.
53. Remove the flange carefully without disturbing spacer (13). Proper compression of packing will allow spacer to extend above seal housing .080" to .100" (2 to 2.54 mm) after the flange is removed. If spacer (13) extends more than the maximum above seal housing (17), replace spacer (13) with thinner spacer and recheck for proper dimension. Use spacer which best meets recommended dimensions.
54. Grease and install O-ring (4) (component of the planetary drive) into top of planetary top cover (6).
55. Recheck - splined adapter (3) must be in planetary drive (48).
56. Place motor (1) on top of planetary drive (6) with case drain outlet towards center of gearbox.
57. Coat the threads of capscrew (2) with blue Loctite (001581-001) and tighten evenly to approximately 200 ft-lbs.(271 Nm) of torque.
58. Reinstall the air vent hose. (Delay tightening of one end of hose until gearbox is filled with oil to let trapped air escape.)
59. Grease O-ring (12) and install it on top of seal housing (17). Torque the bolts to 100 ft-lbs (135 Nm).
60. Fill the gearbox through plug opening in planetary drive with approximately 5 gallons (19 liters) of the type of oil listed in the Lubrication section of this manual. Proper oil level is to the top of planetary ring gear.
61. Oil level must be checked a minimum of once a week.
62. Drain, flush and refill gear case every six months or 500 hours of operation.

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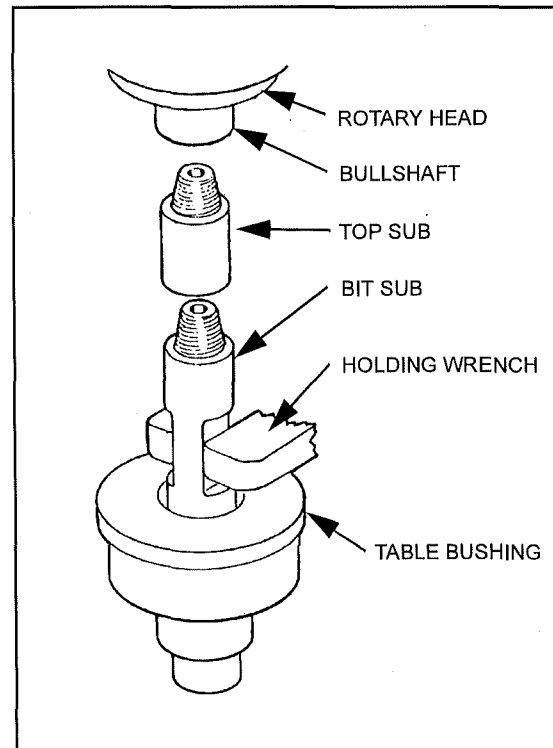
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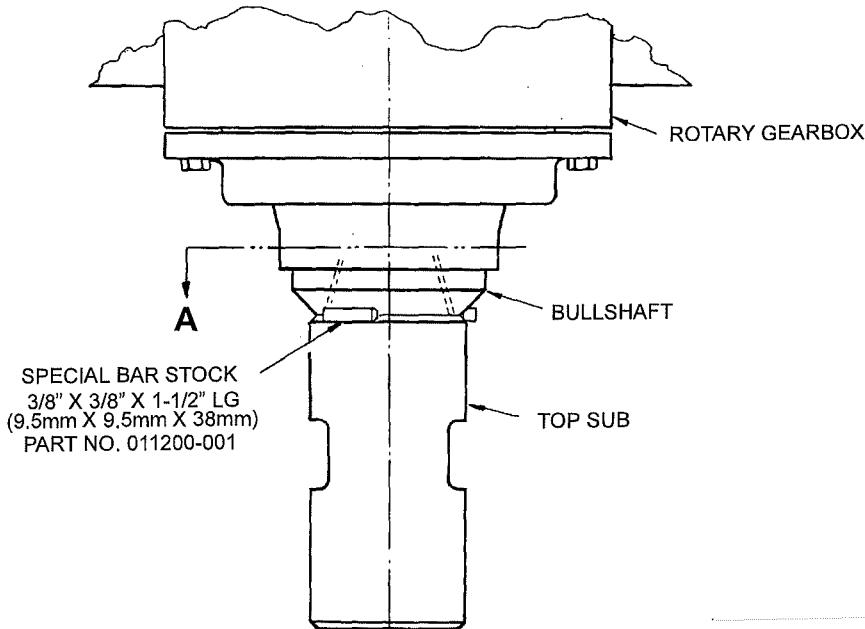
TOP SUB LOCK INSTALLATION (011201-000)

INSTALLATION

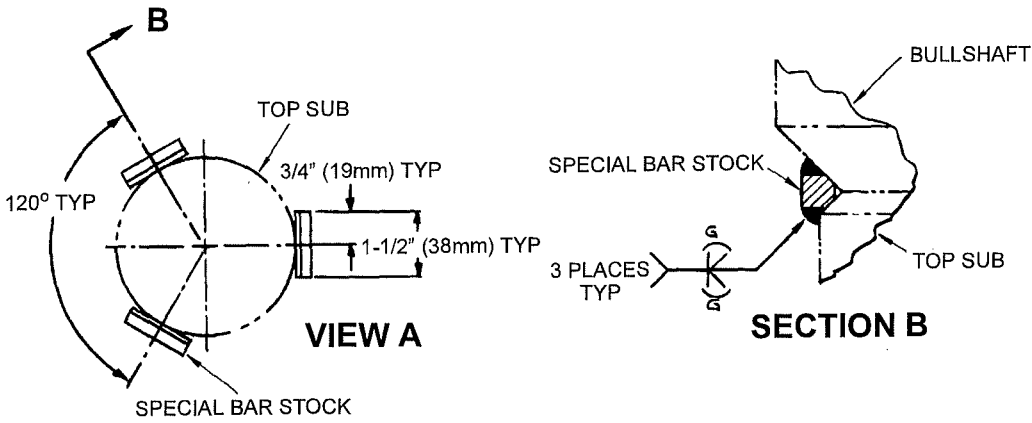
Install the top sub to the rotary head bullshaft as follows:

1. Thoroughly clean the threads in the bullshaft and the top sub pin.
2. Apply joint compound to the bullshaft threads and the top sub pin.
3. Position the bit sub in the table bushing and extend the holding wrench.
4. Apply joint compound on the pin threads of the bit sub.
5. Thread the top sub onto the bit sub and hand tighten only.
6. Position the ENGINE SPEED switch to the 'HIGH' or 'RUN' position.
7. Turn the rotary head TORQUE CONTROL clockwise to the maximum setting.
8. Slowly lower the rotary head onto the top sub. Begin threading the two together and allow the bit sub to slap against the holding wrench three or four times to ensure maximum torque.
9. Refer to the welding diagram and install the bar stock.
10. Loosen the top sub from the bit sub with the tong wrench.



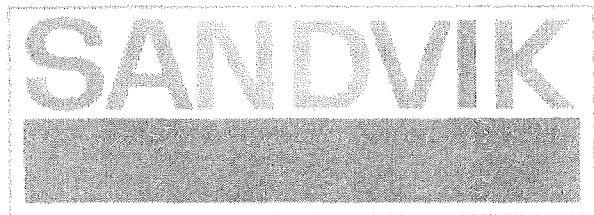


NOTE! BE SURE TOP SUB THREAD IS GREASED WITH ROD DOPE AND POWER TIGHTENED BEFORE WELDING



SECTION 10

WINCH



WINCH 007755-000**General Safety Recommendations**

Safety for operators and ground personnel is of prime concern. Always take the necessary precautions to ensure safety to others as well as yourself. To ensure safety, the prime mover and winch must be operated with care and concern by the operator for the equipment and a thorough knowledge of the machine's performance capabilities. The following recommendations are offered as a general safety guide. Local rules and regulations will also apply.

- Read all warning and caution tag information and
- Be sure of equipment stability before operating become familiar with all controls before operating winch.
- The winches described herein are neither designed nor intended for use or application to equipment used in the lifting or moving of persons.
- Never attempt to clean, oil or perform any maintenance on a machine with the engine running, unless instructed to do so in this manual.
- Never operate winch controls unless you are properly positioned at the operators station and you are sure personnel are clear of the work area.
- Assure that personnel who are responsible for hand signals are clearly visible and that the signals to be used are thoroughly understood by everyone.
- Do not exceed the maximum pressure or flow stated in the winch specifications.
- Operate winch line speeds to match job conditions. Avoid sudden "shock" loads or attempting to "jerk" load free. This type of operation may cause heavy loads in excess of rated capacity, which may result in failure of cable and winch.
- Ground personnel should stay in view of the operator and clear of winch drum. Do not allow ground personnel near winch line under tension. A safe distance of at least 1-1/2 times the length of the cable should be maintained. Never allow anyone to stand under a suspended load.
- Always lower to the mast before servicing, adjusting and/or repairing the winch.
- Inspect rigging, winch and hydraulic hoses at the beginning of each work shift. Defects should be corrected immediately.
- Keep equipment in good operating condition. Perform scheduled servicing and adjustments listed in the "Preventive Maintenance" section of this manual.
- Leather gloves should be used when handling winch cable.
- Never attempt to handle winch cable when the hook end is not free. Keep all parts of body and clothing clear of cable rollers, cable entry area of fairleads and winch drum.

SERVICE and REPAIR MANUAL

- When winding winch cable on the winch drum, never attempt to maintain tension by allowing winch cable to slip through hands. Always use "Hand-Over-Hand" technique.
- Install guarding to prevent personnel from getting any part of body or clothing caught at a point where the cable is wrapped onto the drum or drawn through fairlead guide rollers.
- Do not weld on any part of the winch.
- Do not use knots to secure or attach winch cable. Use correct size cable anchor for cable and pocket in winch drum.
- Use recommended hydraulic oil and gear lubricant.
- An equipment warm-up procedure is recommended for all start-ups and is essential at ambient temperatures below 4°C (+40°F). Refer to "Warm-up Procedure" listed in the "Preventive Maintenance" section of this manual.
- Keep hydraulic system clean and free from contamination at all times.
- The wire rope anchors are capable of supporting the rated load when installed properly. For additional safety, ALWAYS maintain a minimum of five (5) wraps of wire rope on the drum.

Theory Of Operation

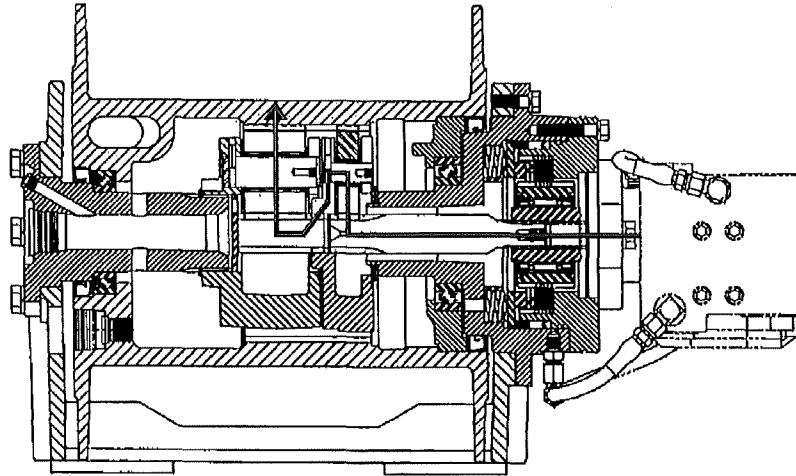
Description Of Winch

The winch has three basic assemblies:

1. Hydraulic motor assembly and brake valve
2. Cable drum assembly
3. Brake cylinder and motor adapter

The hydraulic motor is bolted to the motor adapter which in turn is bolted to the brake cylinder and the winch base. The cable drum assembly is supported by anti-friction bearings which are located by the brake housing at one end and the bearing support at the other end. The ring gear for both planetary sets is machined on the inside surface of the cable drum.

Planetary Gear Train



The hydraulic motor shaft is directly coupled to the inner brake hub which is connected to the input shaft which acts as the sun gear for the primary planetary set. When driven by the input shaft, the primary planet gears walk around the ring gear machined in the cable drum and drive the primary planet carrier.

The primary planet carrier drives the output sun gear which drives the output planet gears. The output planet carrier is splined to the bearing support and cannot rotate. As the output planet gears are driven by the output sun gear, they drive the ring gear/cable drum.

Dual Brake System

The dual brake system consists of a dynamic brake system and a static brake system. The dynamic brake system has two operating components:

1. Brake valve assembly
2. Hydraulic motor

The brake valve is basically a counterbalance valve. The counterbalance valve is mounted to the hoist port of the motor on units with 020, 029 and 039 motors. Units with the 071 motor use a counterbalance valve cartridge in the brake valve block which is bolted to the motor. The operational theory of both systems is the same. A check valve allows free flow of oil to the motor in the haul-in direction and a pilot operated, spring-loaded spool valve blocks the flow of oil out of the motor when the control valve is placed in neutral. When the control valve is placed in the pay-out position, the spool valve remains closed until sufficient pilot pressure is applied to the end of the spool to shift it against spring pressure and open a passage. After the spool valve cracks open, the pilot pressure becomes flow-dependent and modulates the spool valve opening which controls the pay-out speed.

The static brake system has three operating components:

SERVICE and REPAIR MANUAL

1. Spring applied, multiple friction disc brake pack
2. Over-running brake clutch assembly
3. Hydraulic brake cylinder and spring plate

The static brake consists of alternately stacked friction and steel brake discs. The steel brake discs are externally splined to the motor adapter and cannot rotate. The friction discs are internally splined to the outer brake hub of the over-running brake clutch. When compressed by spring force, the brake pack locks the over-running brake clutch outer brake hub to the motor adapter.

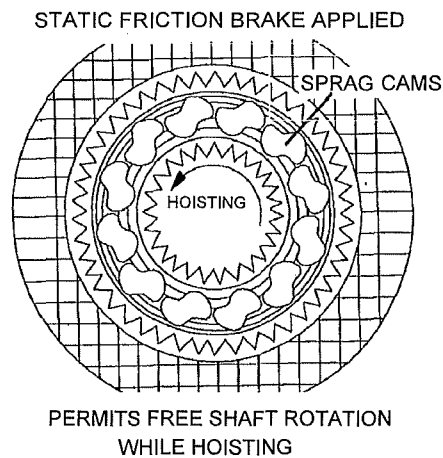
The static brake is released by the pilot pressure at a pressure lower than that required to open the pilot operated brake valve. This sequence assures that dynamic braking takes place in the brake valve and that little, if any, heat is absorbed by the friction brake.

The friction brake is primarily a load holding brake and will provide dynamic braking only during extremely slow operation when there is insufficient flow to open the brake valve.

The sprag type over-running brake clutch is installed between the inner brake race and the outer brake hub. The over-running brake clutch, allows the inner brake race and input shaft to turn freely in the direction to haul in cable and locks up to force the friction brake discs to turn with the inner brake race and input shaft to pay out cable. The brake pack remains fully applied when hauling in cable and must be released by pilot pressure to allow the brake discs to turn freely and pay-out cable.

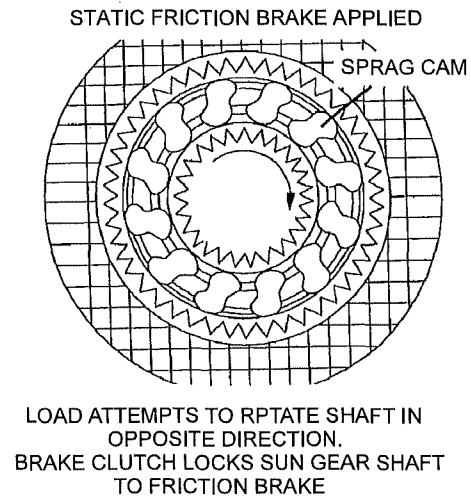
Dual Brake System - Operation

When hoisting or pulling a load, the brake clutch allows free rotation of the inner brake race and input shaft. The sprag cams lay over and permit the inner race to turn free of the outer brake hub. The friction brake remains fully engaged. The winch, in raising a load, is not affected by any braking action during haul-in.



When the haul-in operation is stopped, the load attempts to turn the input shaft in the opposite

direction. This reversed input causes the Sprague cams to instantly engage and firmly lock the inner brake race to the outer brake hub.



When the winch is powered in reverse, to pay-out cable, the motor and gear train will not rotate until sufficient pilot pressure is supplied to open the brake valve. The friction brake within the winch will completely release at a pressure lower than that required to open the brake valve. The extent to which the brake valve opens will determine the amount of oil that can flow through it and the speed at which the load will be lowered. Increasing the flow of oil to the winch motor will cause the pressure to rise and the opening in the brake valve to enlarge, speeding up the descent of the load. Decreasing this flow causes the pressure to lower and the opening in the brake valve to decrease thus slowing the descent of the load.

When the control valve is returned to neutral or "hold", the pilot pressure will drop and the brake valve will close, stopping the load. The friction brake will engage and hold the load after the brake valve has closed.

When lowering a load very slowly for precise positioning, no oil flow actually occurs through the winch motor. The pressure will build up to a point where the friction brake will release sufficiently to allow the load to rotate the motor through its own internal leakage. This feature results in a very slow speed and extremely accurate positioning.

The friction brake receives very little wear in the lowering operation. All of the heat generated by the lowering and stopping of a load is absorbed by the hydraulic oil where it can be readily dissipated.

Overhaul

Service Precautions

- Before any part is removed from the winch, all service instructions should be read and understood.

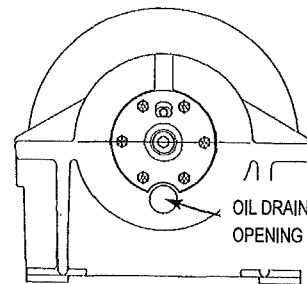
SERVICE and REPAIR MANUAL

- Work in a clean, dust free area as cleanliness is of utmost importance when servicing hydraulic equipment.
- Inspect all replacement parts, prior to installation, to detect any damage which might have occurred in shipment.
- Use only genuine Sandvik replacement parts for optimum results. Never reuse expendable parts such as oil seals and O-rings.
- Inspect all machined surfaces for excessive wear or damage ... *before* reassembly operations are begun.
- Lubricate all O-rings and oil seals with gear oil prior to installation.
- Use a sealing compound on the outside surface of oil seals and a light coat of thread sealing compound on pipe threads. Avoid getting thread compound inside parts or passages which conduct oil.
- Thoroughly clean all parts in a good grade of non-flammable safety solvent. Wear protective clothing as required.

After troubleshooting the winch and its hydraulic system as covered in the "Troubleshooting" section, and the problem is determined to be in the winch, use the following procedure to disassemble the winch.

Disassembly

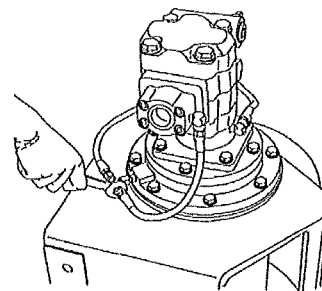
1. Remove the wire rope from the winch drum and align the drain hole in the drum with a hole in the support side plate before removing the hoses and mounting bolts. After the winch is removed from its mounting, thoroughly clean the outside surfaces. To drain the oil, install a short piece of 1 inch pipe in the larger threads of the drain hole. If necessary, insert a bar into the anchor pocket and manually rotate the drum in the direction to hoist a load until the drain holes are aligned.



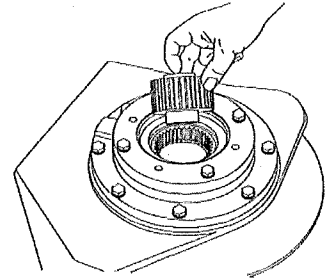
2. Use a 5/16 inch Allen wrench to remove the drain plug through the pipe. Drain the oil into a suitable container and dispose of used oil in an environmentally friendly manner.

3. Begin disassembly by removing the oil level plug and standing the winch on the bearing support end. Tag and remove the hydraulic hoses that connect the brake valve and manifold to the brake cylinder.

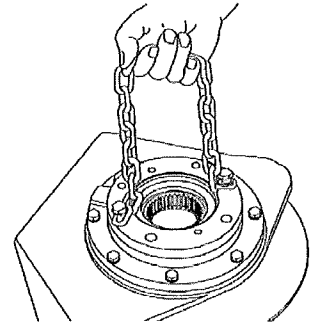
4. Remove the capscrews securing the motor, and lift the motor off the winch. Remove and discard the O-ring installed on the pilot of the motor.



5. Remove the brake clutch assembly from the motor support. Refer to "Brake Clutch Service" for additional information.



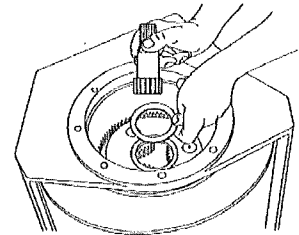
6. Remove the brake cylinder capscrews and install two (2) capscrews and a short piece of chain into the motor mounting bolt holes. Using the chain as a handle, lift the brake cylinder assembly out of the drum and base, being careful to avoid damaging the sealing and bearing surfaces. Refer to "Motor Support-Brake Cylinder Service" for additional information.



7. (BG8A ONLY) Remove the drum closure. Remove and discard the o-ring from the inside of the drum. Remove the seal from the drum closure. (BG8B) The seal is mounted in the drum. Remove the seal and drum closure from the drum.

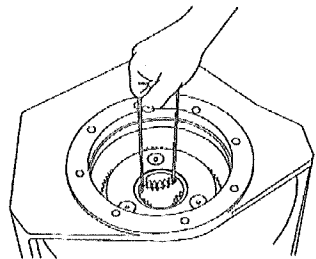
8. Clean and inspect the bearing in the drum closure and replace if required.

9. Remove the primary sun gear and thrust washer from the primary planet carrier. NOTE: 23:1 gear ratio winches have a sun gear adapter in addition to the sun gear shaft.



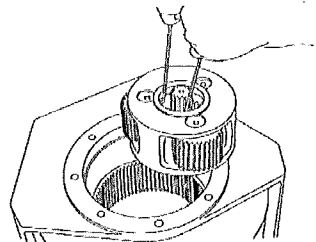
10. Remove the primary planet carrier from the drum. Refer to "Planet Carrier Service" for additional information.

11. Remove the output sun gear and thrust washer from the output planet carrier.



12. Remove the output planet carrier from the drum. Refer to "Planet Carrier Service" for additional information.

13. Remove snap ring from bearing support.



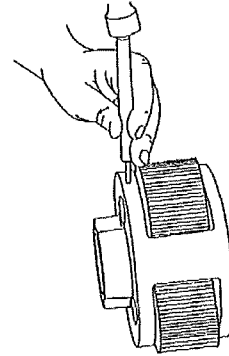
14. Stand winch on motor end with bearing support up; then remove bearing support capscrews and bearing support being careful to avoid damaging the sealing and bearing surfaces.

SERVICE and REPAIR MANUAL

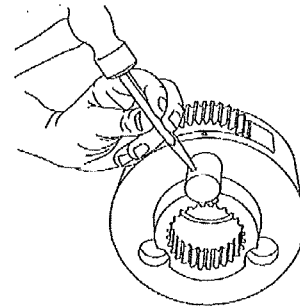
15. Slide drum out of base onto a work bench and remove seal and bearing from support end.
16. Thoroughly clean and inspect drum and base. Check ring gear (machined into inside surface of drum) teeth for nicks, spalling or excessive wear. Replace if wear is greater than 0.015 in. (0.4 mm) when compared to unworn area of teeth.

Output Planet Carrier - Disassembly

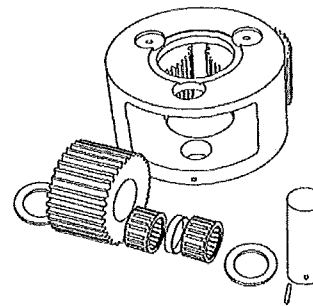
1. Remove the planet gears by driving the roll pins into the center of the planet shafts.



2. Use a punch to drive the roll pins from the planet shafts. Do not reuse the roll pins

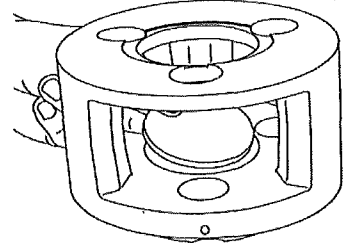


3. Now you can remove the planet shafts, bearings, spacer, thrust washers and gears. Thoroughly clean all parts and inspect for damage and wear. The bearing rollers should not exhibit any irregularities. If the rollers show any sign of spalling, corrosion, discoloration, material displacement or abnormal wear, the bearing should be replaced. Likewise, the cage should be inspected for unusual wear or deformation, particularly the cage bars. If there is any damage that will impair the cage's ability to separate, retain and guide the rollers properly, the bearing should be replaced. The thrust washer contact areas should be free from any surface irregularities that may cause abrasions or friction. The gears and shafts should be inspected for abnormal wear or pit-ting. Replace if necessary..

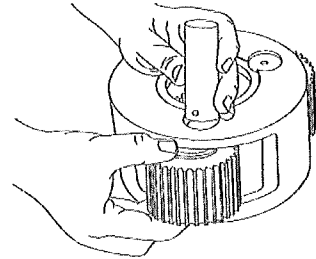


Assembly

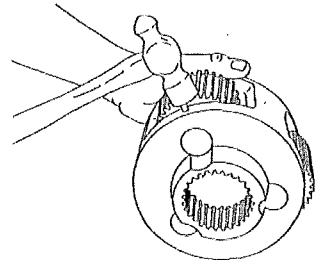
1. Place the output planet carrier on workbench with splined coupling side down. Install output thrust plate in center of carrier.



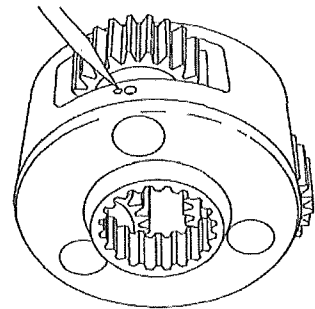
2. Insert two (2) bearings and a bearing spacer into a gear with the spacer between the bearings. Place a thrust washer on each side of the gear and position in a carrier opening. Slide the shaft through the carrier, thrust washer, bearing-gear sub-assembly and remaining thrust washer.



3. Carefully align the pin hole in the carrier with the hole in the planet gear shaft and drive the roll pin into place. Always use NEW roll pins.



4. Note that the roll pin is slightly recessed in the carrier when properly installed. With a center punch, stake the carrier next to the pin hole as shown. This will distort the hole so the pin will not back out. Repeat these steps for each of the three planet gears.



Primary Planet Carrier

1. To service the primary planet carrier, the steps are the same as for the output carrier except there is only one bearing for each gear and no bearing spacer.

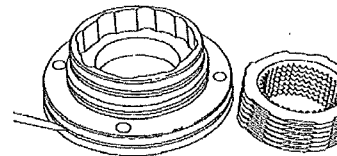
NOTE: All BG8 winches have a round thrust plate between the primary and output sun gears. In winches with a 23:1 ratio, the plate is not contained in the primary planet carrier. In all other ratios, the thrust plate is captive in the carrier assembly.

Motor Support-brake Cylinder Service

NOTE! Starting late 2000, a change to steel brake separator discs from a splined tooth design to a lobed design. This required a change to the motor support and brake cylinder and the addition of a spring spacer. A winch with the lobed discs can be identified by a machined groove on the outside diameter of the motor support. When replacing steel brake discs, the motor support or brake cylinder, care must be taken to properly identify the correct parts. Splined discs and their mating motor support and brake cylinder will remain available as spare parts.

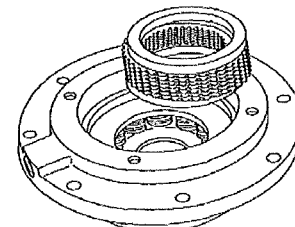
New lobed steel brake separator plates and motor support. Note groove on outside diameter of motor support.

Although most photos in this section show splined discs, all procedures are the same except where specifically noted.

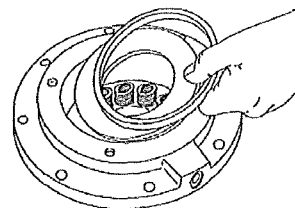


Disassembly

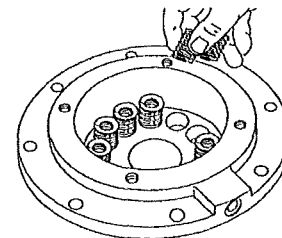
1. After removing the motor support and brake clutch assembly, continue brake cylinder disassembly by removing the spacers, friction brake discs and steel brake discs.



2. Remove the piston back-up ring and pressure plate.

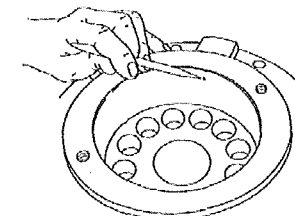


3. Remove the brake springs.

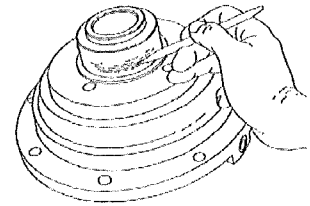


Clean and Inspect

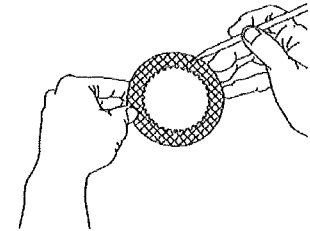
1. Thoroughly clean and inspect all parts at this time. Check brake piston sealing surfaces on brake cylinder and motor support. Be sure brake release port is free of contamination.



2. Check oil seal and bearing surfaces on brake cylinder for damage or wear.



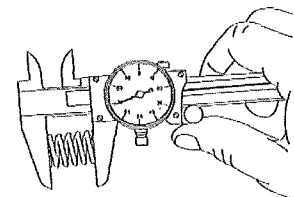
3. Place friction brake disc on flat surface and check for distortion with a straight edge. Friction material should appear even across entire surface with groove pattern visible. Replace friction disc if splines are worn to a point, disc is distorted, friction material is worn unevenly, or groove pattern is worn away.



4. Place steel brake disc on flat surface and check for distortion with a straight edge. Check surface for signs of material transfer or heat. Replace steel disc if splines are worn to a point, disc is distorted or heat discolored.

5. Check brake spring free length; minimum free length is:

Model	Spring minimum free length
BG8A	30.2 mm (1 3/16 in.)
BG8B	23.81 mm (15/16 in.)



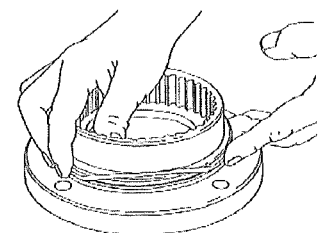
Check springs for any sign of cracking or failure. If a brake spring must be replaced for any reason, then ALL brake springs must be replaced.

NOTICE

Failure to replace brake springs as a set may result in uneven brake application pressure and repeated brake spring failure.

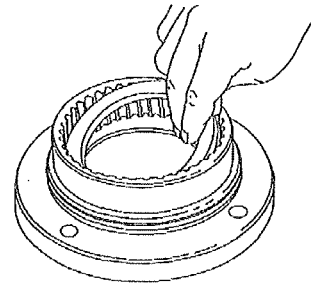
Assembly

1. Begin assembly by placing motor support on workbench with motor mounting surface down. Install new O-ring and back-up ring as shown.



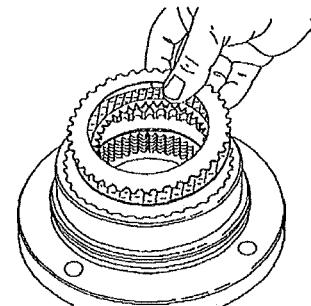
SERVICE and REPAIR MANUAL

2. Install a brake spacer into the motor support. (Not required with lobed discs.)

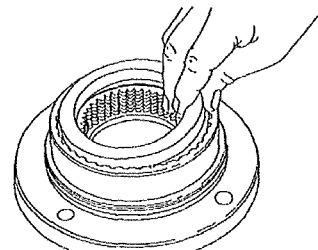


3. Insert first, a steel brake disc against the spacer followed by a friction brake disc then alternate steel and friction discs until seven (7) friction and eight (8) steel discs have been installed. Finish with a steel brake disc on top.

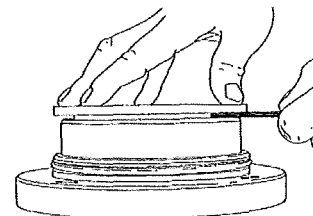
NOTE: It is a good practice to pre-lubricate the discs in light motor oil prior to assembly.



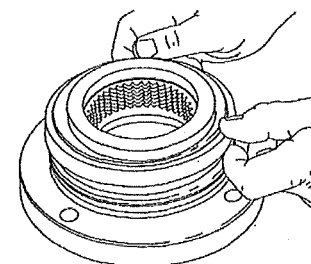
4. Install the remaining brake spacer on top of the last steel brake disc. (This is the only spacer used with lobed discs.)



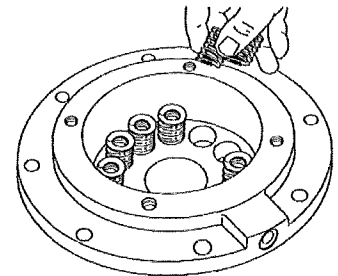
5. To check brake stack height, place pressure plate on top of brake spacer. Hold pressure plate down firmly by hand and measure clearance in three places between motor support and pressure plate. Average gap must measure between .127 in. (3 mm) maximum and .060 in. (1.5 mm) minimum. If the gap exceeds the maximum limit, there are too many brake discs in stack-up or the discs are distorted. If the gap is less than the minimum, there are too few discs in stack-up or the discs are worn out. When stack height is correct, remove pressure plate and continue assembly.



6. Lubricate the brake piston seal and motor support sealing surface with petroleum jelly or hydraulic oil. Install new piston seal to motor support, seal lip down.

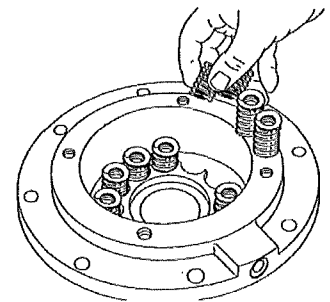


7. Install brake springs into brake cylinder.



OLD STYLE BRAKE CYLINDER

7A. When using the new style brake cylinder with out milled spring pockets, install the spring spacer, then the brake springs.

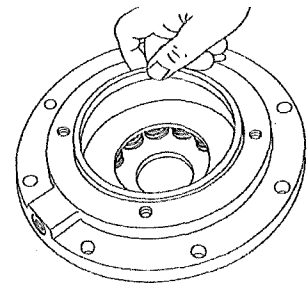


NEW STYLE BRAKE CYLINDER

! WARNING

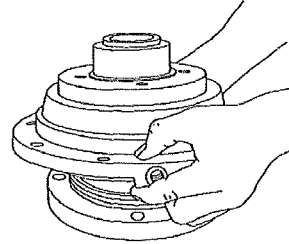
Always use the molded spring spacer with the new brake cylinder. The brake springs must be properly positioned by the spring spacer. Failure to install the spring spacer may allow the springs to contact each other and become damaged. This could result in loss of load control, property damage, injury or death.

8. Install pressure plate into brake cylinder followed by the piston back-up ring. The close-fitting piston back-up ring may be depressed slightly to one side to lodge the back-up ring in the brake cylinder bore and temporarily hold the pressure plate and springs in place while you lower the brake cylinder over the motor support.



SERVICE and REPAIR MANUAL

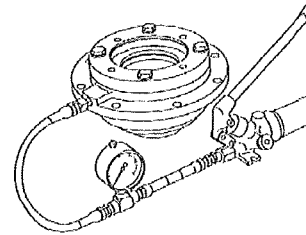
9. Apply petroleum jelly to the entire sealing surface of the brake cylinder and to the piston seal. Install the brake cylinder over the motor support being careful to avoid damaging the piston seal or motor support O-ring. (A press may be necessary to avoid cocking the brake cylinder during installation.)



10. Install motor support capscrews and evenly tighten to recommended torque.

Brake Cylinder Pressure Test

1. Install the -4 J.I.C. fitting into the brake release port. Connect a hand pump with accurate 0-2000 psi (0-13,800 kPa) gauge and shut-off valve to this fitting. Apply 1000 psi (6,900 kPa) to the brake. Close shut-off valve and let stand for five (5) minutes. If there is any loss of pressure in five (5) minutes, the brake cylinder should be disassembled for inspection of the sealing surfaces and brake piston.



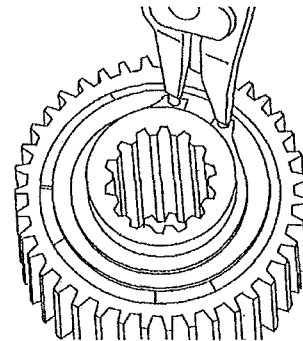
2. WHILE PRESSURE IS APPLIED AND THE BRAKE RELEASED, install the brake clutch assembly in the brake pack, short end of the inner race toward motor. Turn the clutch back and forth as you align the outer race splines with the brake disc splines.

3. Release the pressure on the brake cylinder then remove the brake clutch assembly. The brake cylinder assembly is now complete and ready to be installed in the winch.

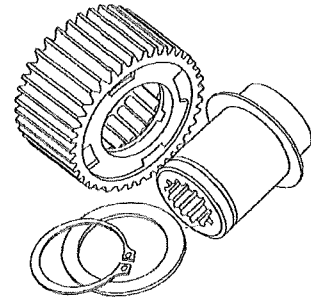
Brake Clutch Service

Disassembly

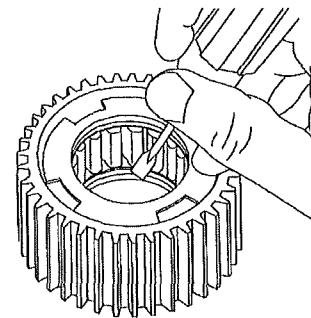
1. Remove the snap ring and sprag bushing retainer from one end only.



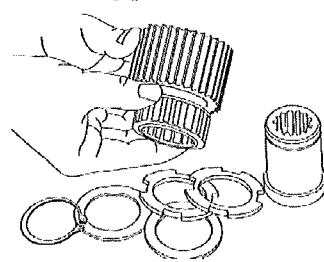
2. Pull the inner race out. Examine the race for scoring, wear or indentations caused by the sprag cams.



3. Use a screwdriver and mallet to remove the sprag bushing from one end of the outer race. There are four special cut-outs in the bushing for this purpose. Be careful not to damage the bushing inside surface. If a bushing's inside surface is damaged or shows wear, replace it.



4. Next, slide the sprag clutch out, inspect the sprag clutch closely for abnormal wear, cracks, pitting or corrosion. Check small clips for breakage or bright spots; the signs of excessive wear. Unless the outer race or remaining sprag bushing is damaged or shows excessive wear, there is no need for further disassembly. If disassembly is necessary, remove the bushing according to the procedure covered in Step No. three (3). All brake clutch assembly parts should be thoroughly cleaned and inspected before assembly.

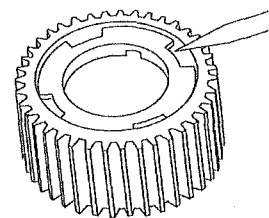


! WARNING

The polished surfaces of the races and sprag cams must be perfectly smooth to insure positive engagement of the clutch. The slightest defect may reduce brake clutch effectiveness, which could result in property damage, severe personal injury or death. The entire brake clutch assembly must be replaced if inner race, outer race and/or sprag cams are defective.

Assembly

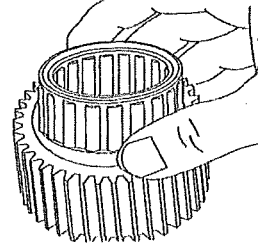
1. Press a sprag bushing into the outer race, using a mechanical or hydraulic press. A flat plate of approximately the same diameter as the bushing flange outside diameter should be placed between the press and bushing during assembly to protect the bushing. Be certain the bushing flange is against the shoulder in the outer race.



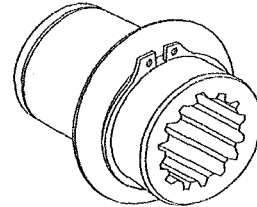
SERVICE and REPAIR MANUAL

2. Turn the assembly over and install the sprag clutch in the bore of the outer race.

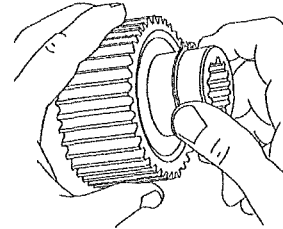
3. Press the remaining bushing into the race. Again, make sure the bushing is against the shoulder.



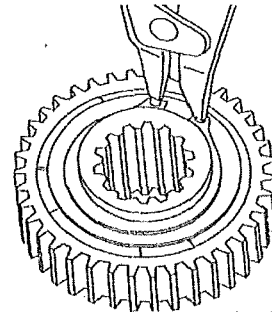
4. Next, install a sprag bushing retainer, then a snap ring on the inner race. Be sure the snap ring is seated in the snap ring groove.



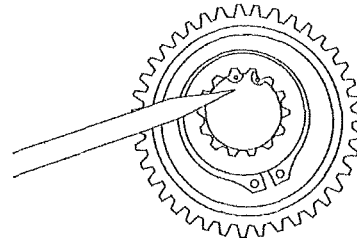
5. Slide the inner race through the bushings and sprag clutch (the race will have to be rotated in the free-wheeling direction to start it through the sprag clutch). If the inner race will not go through the bushings, the bushings have probably been damaged and should be replaced.



6. Turn the assembly over with the snap ring down. Install the second retainer and snap ring. Make certain the snap ring is seated in the groove properly.



7. This is a completed brake clutch assembly.

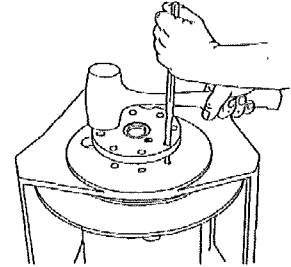


WARNING

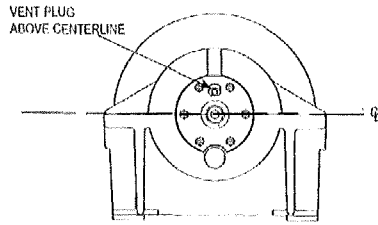
Be certain the snap ring is seated in the groove in the splined bore of the inner race. This snap ring will keep the brake clutch assembly correctly positioned in the center of the friction brake pack. Binding of the brake or brake failure may occur if this snap ring is omitted.

Winch Assembly

1. Place winch base on side with bearing support end up.
2. Install a new bearing in the drum if replacement is necessary. Apply a non-hardening sealant on the outside diameter of a new seal. Install the spring side of the seal toward the bearing, then press into the drum, using a flat plate to avoid distortion. Be sure drain plug is installed securely.



3. Center the drum in the opening of the base. Lubricate the bearing support with petroleum jelly or gear oil and install in base and drum.



NOTICE

Be sure the vent plug is located above the horizontal centerline for the intended application. Oil leak-age may occur if vent is positioned incorrectly.

4. Tighten the bearing support capscrews to the recommended torque.
5. Stand winch on bearing support end and install snap ring on bearing support.

NOTICE

This snap ring will keep the output planet carrier correctly positioned in the winch. Gear train damage may occur if this snap ring is omitted.

6. Install the output sun gear and thrust washer into the output planet carrier.

TIP: 2 pieces of stiff wire with an "L" shaped hook on one end can be used to lower the planet carrier assemblies into the drum.

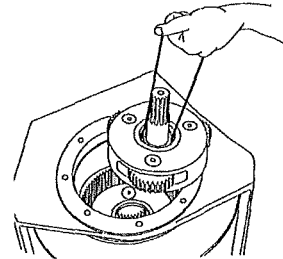
7. Install the output planet carrier into the drum while meshing the planet gears with the ring gear and the planet housing with the bearing support.

SERVICE and REPAIR MANUAL

8. Install the primary sun gear and thrust washer into the primary planet carrier.

NOTE! 23:1 gear ratio winches have a sun gear adapter in addition to sun gear shaft. The thrust plate between the primary and output sun gears is not captive within the carrier assembly. Apply a small amount of oil soluble grease or petroleum jelly to the thrust plate and center it on the output sun gear before installing the primary planet carrier assembly.

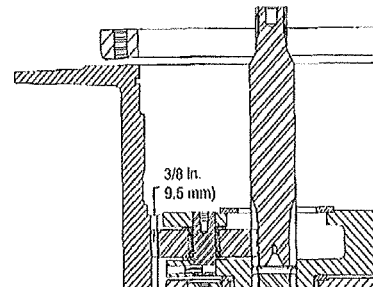
9. Install the primary planet carrier, meshing the planet gears with the ring gear and the planet housing with the output sun gear.



NOTICE

When all components are correctly installed, the primary planet gears will be approximately 3/8 in. (9.5 mm) below the ring gear, as shown above. Binding and damage to the gear train may result if one or more of the thrust washers are incorrectly installed.

DO NOT proceed with assembly if the primary planet gears are not engaged with the ring as shown in the drawing above. Check the location of all thrust washers to be sure they are properly positioned.



10. Install a new bearing in the drum closure if required. **BG8A ONLY:** Apply a non-hardening sealant on the outside surface of a new oil seal. Install with spring side of the seal toward the bearing, using a flat plate to avoid distortion. Install a new o-ring in the drum.

11. Lubricate the drum opening with petroleum jelly or gear oil and install the drum closure into the drum. **BG8B ONLY:** Apply a non-hardening sealant on the outside surface of a new oil seal. Install with spring side of the seal toward the outside of the drum, using a flat plate to avoid distortion.

12. Lubricate the pilot, oil seal and bearing surfaces of the brake cylinder and carefully install brake cylinder into base and drum. Be careful that the brake cylinder pilot fits into the thrust washer on the primary planet carrier. When correctly installed, the brake cylinder will fit against the winch base.

13. Install and tighten brake cylinder capscrews and lockwashers. Tighten to recommended torque.

14. Install the brake clutch assembly. When installed correctly, the cam should turn freely in the opposite direction the drum turns to pull wire rope in. An easy way to check the rotation is to hold the outer race in one hand, and rotate the cam.

15. If the brake discs are misaligned, preventing the installation of the clutch, apply 5170 - 6900 kPa (750-1000 psi) to the brake release port with a hand pump. The brake discs will move freely with the brake released, permitting alignment of the discs, brake clutch and input sun gear.
16. Install a new o-ring on the motor pilot then lubricate with petroleum jelly or gear oil. Engage the motor shaft with the inside race of the brake clutch and lower motor into place. Install and tighten capscrews to recommended torque.
17. Install the hoses and fittings to the brake cylinder release port, manifold and brake valve.
18. After the winch assembly is complete, check all capscrews and fittings to make certain they have been tightened correctly.

Refill the winch with the recommended oil listed under "Preventive Maintenance", and install the oil level plug. Operate the winch slowly in both directions and check for oil leaks and/or unusual sounds from the winch. The winch should operate smoothly in both directions. Refer to "WIRE AND BRAIDED ROPE INSTALLATION" and properly install rope onto the winch drum.

Before returning the winch to full service, a light load should be lifted and held a few feet off the ground to be sure the static brake is functioning properly. The winch should also be able to slowly lower the load in a smooth and controlled manner. If the winch does not perform either of these functions, refer to "TROUBLESHOOTING" for additional information.

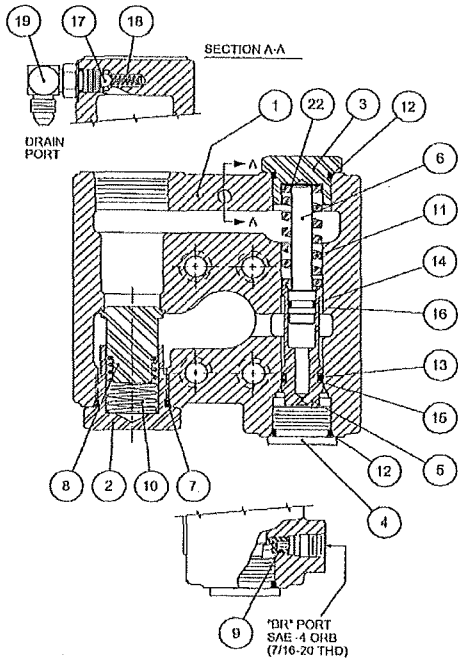
Brake Valve Service

The BRADEN brake valve is a reliable hydraulic valve with internal components manufactured to close tolerances. Due to the close tolerances and mating of components, the valve housing, spool, piston and check poppet are not available as replacement parts.

Before disassembling the brake valve, be sure you have conducted all applicable troubleshooting operations and are certain the brake valve is causing the malfunction.

Thoroughly clean the outside surfaces of the valve and work in a clean dust free area, as cleanliness is of utmost importance when servicing hydraulic components.

SERVICE and REPAIR MANUAL

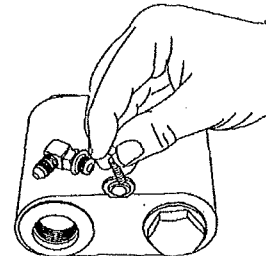
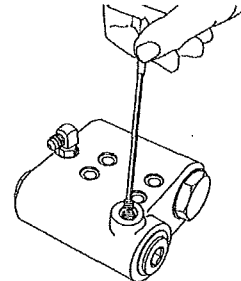


NSS - NOT SERVICED SEPARATELY
REPLACE COMPLETE VALVE ASSEMBLY

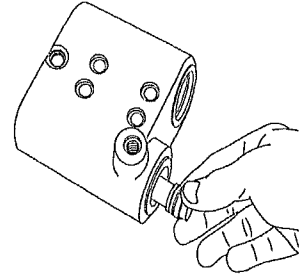
BRAKE VALVE ASSEMBLY		
ITEM	DESCRIPTION	QTY.
1	Valve Housing NSS	1
2	Check Valve Retainer	1
3	Spring Retainer NSS	1
4	Plug NSS	1
5	Spool NSS	1
6	Damper Piston NSS	1
7	O-Ring	1
8	Check Valve Poppet	1
9	Pilot Orifice	1
10	Check Valve Spring	1
11	Spool Spring	1
12	O-Ring	2
13	O-Ring	1
14	O-Ring	1
15	Back-up Ring	1
16	Back-up Ring	1
17	Check Ball 1/4 in.	1
18	Check Ball Spring	1
19	Elbow Fitting	
22	Shim	A.R.

Disassembly

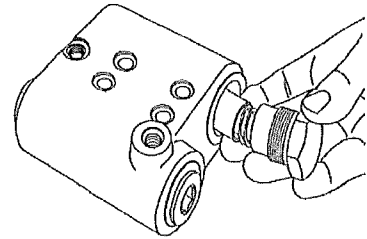
1. Remove the pilot orifice from the brake release (BR) port using a 5/32 in. Allen wrench.
2. Remove the elbow fitting, motor drain check ball and spring.
3. Remove the spool spring retainer and spool spring. Check spring free length. Replace spring if less than 1-15/16 in. (49.2 mm) long.



4. Remove spool plug and carefully remove spool assembly.
5. Remove the damper piston from the spool. The piston will come out slowly, because of a partial vacuum formed as it is removed. Use extreme care to avoid damaging the polished surfaces of the piston or spool.

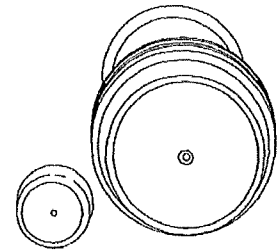


6. Remove the check valve spring retainer, spring and check valve poppet. Check spring free length. Replace spring if less than 1-1/2 in, (38.1 mm) long.



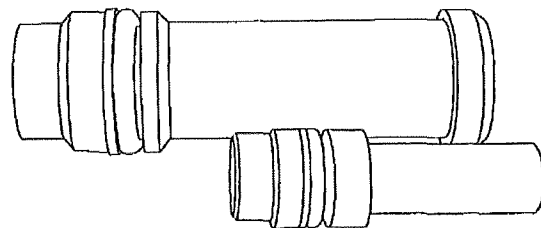
Clean And Inspect

1. Discard all O-rings and back-up rings. Clean all parts in solvent and blow dry. Inspect polished surfaces of spool and damper piston for damage that may cause binding or leakage. Inspect spool bore in valve housing for damage or scoring. Inspect check valve seat in valve housing and check valve poppet. If the spools, bores or valves are damaged, the entire valve must be replaced as these parts are not serviced separately.
2. Inspect the .020 inch orifice in the end of the spool and the pilot orifice to be certain they are open.



Assembly

1. Install new O-rings on the plug and spring retainers.
2. Install new O-rings and back-up rings on the spool and damper piston as shown. It is important that each backup ring is on the correct side of its O-ring. Take care not to cut the O-rings during assembly. Let the spool and damper piston set for ten minutes before installing them in their respective bores. This will allow the O-rings to return to their original size after being stretched.

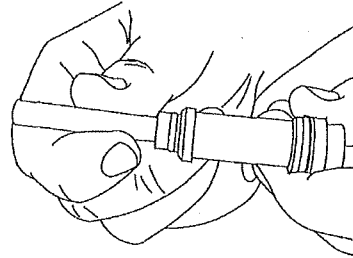


3. Lubricate the spool and damper piston O-rings with hydraulic oil. Carefully install the damper

SERVICE and REPAIR MANUAL

piston into the spool.

4. Lubricate the spool bore and spool O-rings with hydraulic oil. Carefully install the spool into the valve housing. Always install the spool from the plug end as shown to minimize the possibility of damaging the O-ring. Install the plug, spool spring and spring retainer.



5. Install the check valve poppet, spring and check valve spring retainer.

6. Install the motor drain check ball, spring and elbow fitting.

7. Install the pilot orifice into the valve housing.

The brake valve is complete and ready to be installed on the winch motor.

Recommended Fastener Torque

Higher or lower torques for special application will be specified such as the use of spanner nuts, nuts on shaft ends, jam nuts and where distortion of parts or gaskets is critical.

Lubricated torque values based on use of SAE 30wt engine oil applied to atreheads and face of botl or nut.

Avoid using thread lubricants as the applied torque may vary by 10-40% depending upon product used

Bolt Dia. Inches	Thrds. per	Torque (FT-LB)			
		Grade 5		Grade 8	
		Dry	Lub	Dry	Lub
1/4	20 / 28	8	6	12	9
5/16	18 / 24	17	13	24	18
3/8	16 / 24	31	23	45	35
7/16	14 / 20	50	35	70	50
1/2	13 / 20	75	55	110	80
9/16	12 / 18	110	80	150	110
5/8	11 / 18	150	115	210	160

Bolt Dia. Inches	Thrds. per	Torque (FT-LB)			
		Grade 5		Grade 8	
		Dry	Lub	Dry	Lub
3/4	10 / 16	265	200	380	280
7/8	9 / 14	420	325	600	450
1	8 / 14	640	485	910	680
1-1/8	7 / 12	790	590	129	970
1-1/4	7 / 12	112	835	182	136
1-3/8	6 / 12	146	109	238	179
1-1/2	6 / 12	194	146	316	237

Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
<p>A The winch will not lower the load or not lower the loading smoothly.</p>	<p>1. The problem could be a plugged or loose pilot orifice. The pilot orifice is a small pipe plug with a hole drilled through it, located behind the pilot port fitting on the brake valve. If it becomes plugged, it will prevent the pilot pressure, from the manifold, from opening the brake valve. If it becomes loose, it will allow an unregulated amount of oil in to operate the brake valve which cause erratic brake valve operation.</p> <p>2. The friction brake may not be releasing as result of a defective brake cylinder seal.</p> <p><i>NOTE!</i> If the brake cylinder seal is defective you will usually find oil leaking from the winch vent plug.</p> <p>3. Friction brake will not release as a result of damaged brake discs.</p>	<p>Remove the pilot hose and fitting from the brake valve, then use a 5/32" Allen wrench to remove the pilot orifice. The diameter of the orifice is approximately mm (.020"). Clean and install the pilot orifice tightly in the brake valve.</p> <p>Check brake cylinder seal as follows: a) Disconnect the swivel tee from the brake release port. Connect a hand pump with accurate 0-2000 psi gauge and shut off valve to the -4 J.I.C. fitting in the brake release port. b) Apply 1000 psi to the brake. Close shut-off valve and let stand for five minutes. c) If there is any loss of pressure in 5 minutes, the brake cylinder should be disassembled for inspection of the sealing surfaces and replacement of the seals. Refer to "Motor Support-Brake Cylinder Service".</p> <p>Disassemble brake to inspect brake discs. Check stack-up height as described in "Motor Support-Brake Cylinder Service".</p>
<p>B Oil leaks from the vent plug.</p>	<p>1. Same as A2.</p> <p>2. Motor seal may be defective as a result of high system back pressure or contaminated oil.</p>	<p>Same as A2.</p> <p>System back pressure must not exceed 150 psi. Inspect hydraulic system for a restriction in the return line from the control valve to the reservoir.</p> <p>Oil analysis may indicate contamination has worn motor shaft and seal. Thoroughly flush entire hydraulic system and install new filters and oil. Install new motor seal.</p>

SERVICE and REPAIR MANUAL

<p>C Brake will not hold a load with the control lever in neutral.</p>	<ol style="list-style-type: none"> 1. Excessive system back pressure acting on the brake release port. 2. Friction brake will not hold due to worn or damaged brake discs. 3. Brake clutch is slipping. 	<p>Same as Remedy 2 of Trouble B2.</p> <p>Same as Remedy 3 of Trouble A3.</p> <p>Improper planetary gear oil may cause the brake clutch to slip. Drain old gear oil and flush winch with solvent. Thoroughly drain solvent and refill winch with recommended planetary gear oil.</p> <p>Brake clutch may be damaged or worn. Disassemble and inspect brake clutch as described in 'Brake Clutch Service'.</p>
<p>D Winch "chatters" while raising rated load.</p>	<ol style="list-style-type: none"> 1. Same as E2. 2. Hydraulic oil flow to motor may be too low. 3. Controls being operated too quickly. 	<p>Same as remedies for Trouble E2.</p> <p>Same as remedies for Trouble F2.</p> <p>Conduct operator training as required.</p>

<p>E The winch will not hoist the rated load.</p>	<ol style="list-style-type: none"> 1. System relief valve may be set too low. Relief valve needs adjustment or repair. 2. Be certain hydraulic system temperature is not more than 180 degrees F. Excessive hydraulic oil temperatures increase motor internal leakage and reduce motor performance. 3. Winch line pull rating is based on 1st layer of wire rope. 4. Rigging and sheaves not operating efficiently. 	<p>Check relief pressure as follows:</p> <ol style="list-style-type: none"> a) Install an accurate 0-4000 psi (27,580 kPa) gauge into to the port of the brake valve. b) Apply a stall pull load on the winch while monitoring pressure. c) Compare gauge reading to winch specifications. Adjust relief valve as required. <p><i>NOTE:</i> If pressure does not increase in proportion to adjustment, relief valve may be contaminated or worn out. In either case, the relief valve may require disassembly or replacement.</p> <p>Same as remedies for Trouble E2</p> <p>Same as remedies for Trouble F2</p> <p>Refer to winch performance charts for additional information.</p> <p>Perform rigging service.</p>
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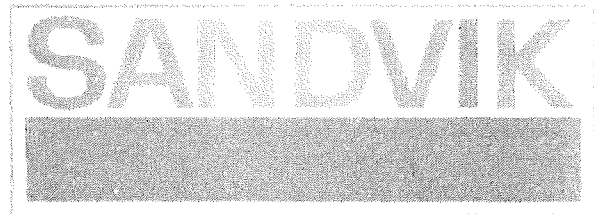
<p>F The winch runs hot.</p>	<ol style="list-style-type: none"> 1. Be certain that the hydraulic system temperature is not more that 180 degrees F. Excessive hydraulic oil temperatures may be caused by: <ol style="list-style-type: none"> a) Plugged heat exchanger. b) Too low or too high oil level in hydraulic reservoir. c) Same as D2 d) Hydraulic pump not operating efficiently. 2. Excessively worn or damaged internal winch parts. 	<p>Thoroughly clean exterior and flush interior. Fill/ drain to proper level.</p> <p>Same as Remedies for Trouble E2. Prime mover low on horsepower or RPM. Tune/adjust prime mover.</p> <p>Check suction line for damage.</p> <p>If pump is belt driven, belts are slipping. Replace. tighten belts/</p> <p>Pump worm, replace pump.</p> <p>Disassemble winch to inspect/replace worn parts.</p>
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SERVICE and REPAIR MANUAL

<p>G The wire rope does not spool smoothly on the drum.</p>	<p>1. Could possibly be using the wrong lay rope. There is a distinct advantage in applying rope of the proper direction of lay. When the load is slacked off, the several coils on the drum will stay closer together and maintain an even layer. If rope of improper lay is used, the coils will spread apart each time the load is removed. Then, when winding is resumed, the rope has a tendency to criss-cross and overlap on the drum. The result is apt to be a flattened and crushed rope.</p> <p>2. The winch may have been overloaded, causing permanent set in the wire rope.</p>	<p>Consult wire rope manufacturer for recommendation of wire rope that best suits your application.</p> <p>Replace wire rope and conduct operator/rigger training as required.</p>
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SECTION 11

DUST CONTROL SYSTEMS



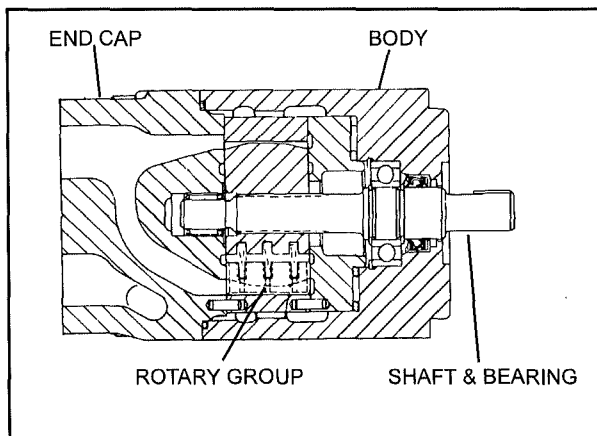
HYDRAULIC VANE MOTOR (001011-000)

GENERAL

The following pages cover the description, operation, removal, maintenance overhaul and installation instructions for this vane type hydraulic motor.

DESCRIPTION

This vane motor consists of four basic components: the housing or body a shaft and bearing, end cap, and a rotating group consisting of; a rotor, vanes, vane springs, cam ring, bearing, port pressure plate,.



OPERATION

During operation, pressurized oil enters one of the ports in the end cap and is directed to both sides of the cam ring assembly through cast ports in the end cap and port plate assemblies. The pressure applied against the vanes forces the rotor to turn and at the same time rotates the shaft. As the rotor turns, the oil moves to the discharge ports in the port plate and end cap. Oil entering the "A" port of the end cap will

force the shaft to rotate in a clockwise direction.

MAINTENANCE

The internal parts of this motor are lubricated by the operating fluid, therefore, preventative maintenance is limited to keeping the fluid in the system clean. Dirt should not be allowed to accumulate on the motor or around the shaft seal. All fittings and bolts should be tight.

In the event the pump does not perform properly or a malfunction occurs, refer to the "Troubleshooting Chart" before proceeding with an overhaul.

TROUBLESHOOTING

The following table lists some of the difficulties which may be experienced with this vane motor. The table indicates the probable cause and possible remedies for the problem listed.

REMOVAL and INSTALLATION

The following instructions are general and should only be used as a guide in removing and installing this component.

To remove the motor, proceed as follows:

1. Stop the engine and allow the hydraulic oil to cool. Disconnect the battery ground cable and tag the ignition switch to inform others of the maintenance taking place.
2. Clean the area around the motor and hose connections.
3. Tag, disconnect and cap the hoses at the motor. Plug the ports to prevent contamination.

Problem	Cause	Remedy
External Leakage	a. Seal failure. b. Porosity in casting. c. Damaged or defective seal between housing and end cap.	a. Replace seal. b. Replace casting. c. Replace seal.
Leakage at Fittings	a. Cracked or damaged flange or fittings. b. Damaged or defective flange threads. c. Damaged or defective O-ring seal. d. Burr on mating surfaces.	a. Replace flange or fittings. b. Replace flange. c. Replace O-ring seal. d. Remove burr.
Loss in Speed Under Load	a. Low inlet pressure. b. Scored port plate or end cap. c. High oil temperature.	a. Check pressure. b. Relap flat to clean-up.
Poor Speed Control	a. Worn rotating group.	a. Replace.
Motor Fails to Start Turning	a. Insufficient torque. b. Excessive motor leakage. c. Worn rotating group. d. Defective O-ring on O.D. of port plate.	a. Increase relief valve setting. b. Check flow from motor outlet. Pressure not loading plate causing plate to move away from cam ring. c. Replace. d. Replace O-ring.
Shaft Play	a. Worn bearings.	a. Replace.
Excessive Noise	a. Worn or damaged rotary group.	a. Inspect for excessive wear.

VANE MOTOR TROUBLESHOOTING TABLE

4. Securely support the motor with a suitable lifting device before removing the motor attaching hardware.

5. Before installing the motor be sure the mounting surfaces of the motor are clean.

6. Once the motor is installed, fill it with clean hydraulic fluid.

7. Start the machine and check the fittings at the motor for leakage.

Drain all fluid from the motor and thoroughly clean the exterior surface. Prepare a clean, lint free surface on which to place the internal parts for inspection.

Disassembly

Disassemble the motor as follows:

1. Drain all fluid from motor and thoroughly clean exterior surface.

2. Match mark the motor end cap and body. Secure the pump in a vise with the shaft extended down.

3. Remove the four screws (1) and lift off end cap (2).

4. Remove seal (3) from end cap (2).

5. If necessary, remove needle bearing (4)

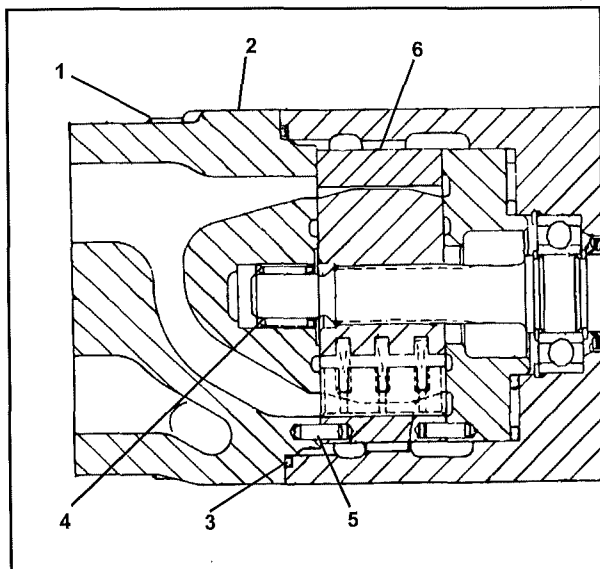
OVERHAUL

General

The instructions contained in this section cover a complete disassembly, inspection and assembly of the motor. Also in this section is information for changing the shaft and shaft seals.

from end cap (2).

6. Remove the dowel pin (5) that secures end cap (2).

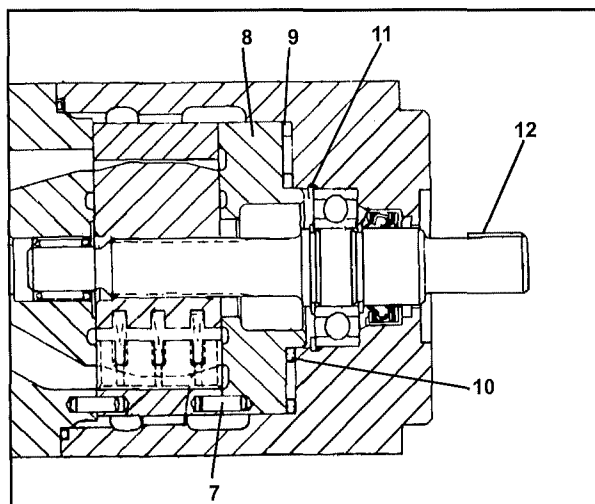


7. Thread two #10-24 screws into the two tapped holes provided as puller holes in cam ring (6) and remove the rotating group assembly.

NOTE !

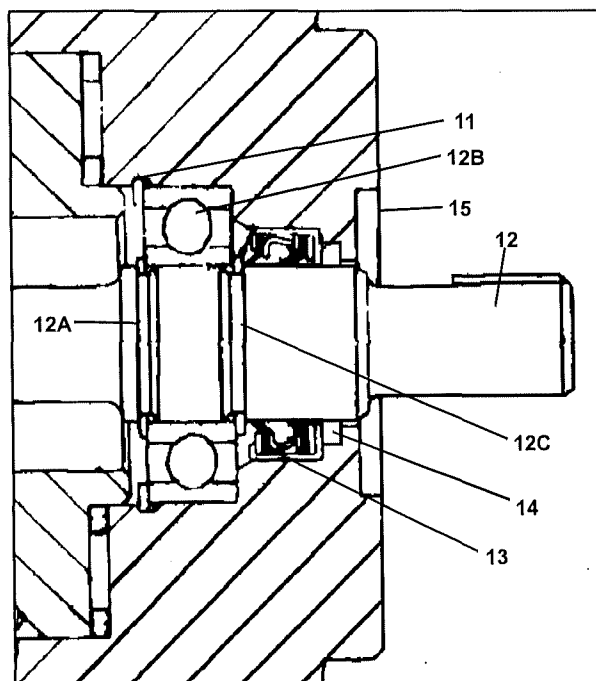
If resistance is encountered while pulling the cam ring out, lightly tap the outside of the motor body while lifting.

8. Remove dowel (7) from port plate assembly (8).
9. Thread two #10-24 screws into the two tapped holes provided as puller holes in port plate (8) and remove the port plate assembly.
10. Remove rubber seals (9 and 10).
11. Remove snap ring (11) and remove shaft and bearing assembly (12) from motor body (15).



NOTE !

Examine ball bearing (12B) for wear before removing it from shaft (12C). Apply light pressure to the outer race and rotate to check for wear or cracks and excessive looseness. Remove the bearing from the shaft if damaged. Inspect the shaft for damage, especially the seal surface for the shaft seal. Omit the next procedure if bearing removal is not required.



12. Remove **inboard** retaining ring (12A) and

press bearing (12B) off of shaft (12C).

NOTICE

The remaining retaining ring (12A) must be removed by passing over the bearing surface of the shaft and NEVER over the shaft seal surface. A damaged seal surface will cause the shaft seal to leak.

13. Remove felt wiper (14) and shaft seal (13) from motor body (15).

Cleaning and Inspection

1. Wash all metal parts in cleaning solvent and dry thoroughly.
2. Inspect seals for wear and brittleness. Discard and replace if necessary.
3. Inspect bearings for wear or flat spots.
4. If the cam ring has excessive wear ripples, the rotary group should be replaced.
5. Inspect the end cap and body castings for cracks.
6. Replace the shaft if damaged splines are present.

Assembly

Always lubricate all seals and bearings in clean hydraulic oil before installation. Assemble the motor as follows:

1. If removed, install retaining ring (12C) in the groove of shaft (9) by passing the ring over the output end of the shaft. Just as in disassembly, **Do not install the ring over the shaft seal surface this may damage the seal surface causing seal leakage.**
2. Install ball bearing (12B) by pressing on the inner race until the bearing is seated against retaining ring (12C). Install retaining ring (12A).

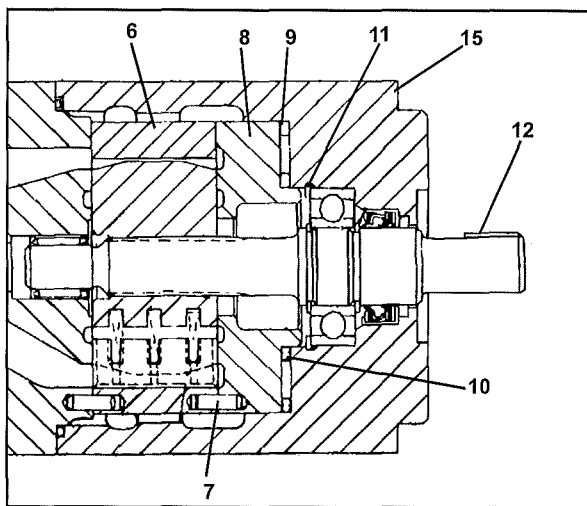
Make sure both rings are fully seated in their grooves.

3. Install felt wiper (14) in motor body (15). Using a seal driver, press shaft seal (13) into place. Grease the seal lips.
4. Press on the outer race of ball bearing (12B) until the shaft assembly is installed in body (15).

NOTICE

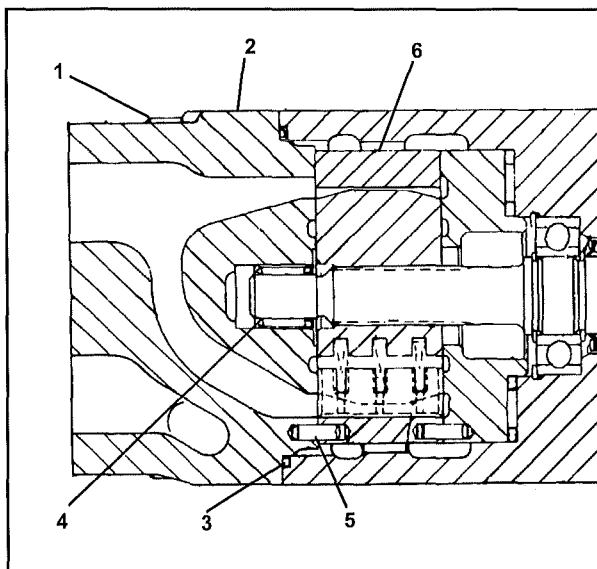
Do not press on the end of shaft (12).

5. Install retaining ring (11) to hold the shaft assembly in place. Make sure the ring is fully seated.
6. On a clean workbench install seals (9 and 10) on the back of port plate (8).



7. Insert dowel pin (7) in the face of port plate (8).
8. Thread two #10-24 screws into port plate (8) to aid in installing it in motor body (15).
9. With the port plate installed, remove the two #10 screws and install them in the cam ring of the assembled rotating group (6). Install dowel pin (5) in the cam ring.
10. Lower rotating group (6) into motor body

(15) making sure that dowel pin (7) seats fully in the cam ring.



11. Lubricate and press needle bearing (4) into end cap (2).

12. Lubricate seal (3) and install it on end cap (2).

13. Install the end cap assembly on motor body (15) and secure it in place with screws (1). Alternately tighten two to draw down mounting cap. Torque all four to 102 Nm (75 ft. lbs).

RELIEF VALVE (001104-000)

GENERAL

This valve assembly is designed for a capacity of 2 to 20 gpm (7.5 to 75.5 lpm) and for pressures from 200 to 700 PSI (13.8 to 48 bars).

The bypass opening in the bottom of the valve must be connected to the overflow line. This line must not have a valve or any other obstruction in it.

The handle on the top of the valve acts as a complete pressure release when it is rotated 180° through the vertical position.

The handle is also used as the means of setting the pressure by turning clockwise to increase the pressure and counterclockwise to decrease the pressure.

INITIAL PRESSURE SETTING

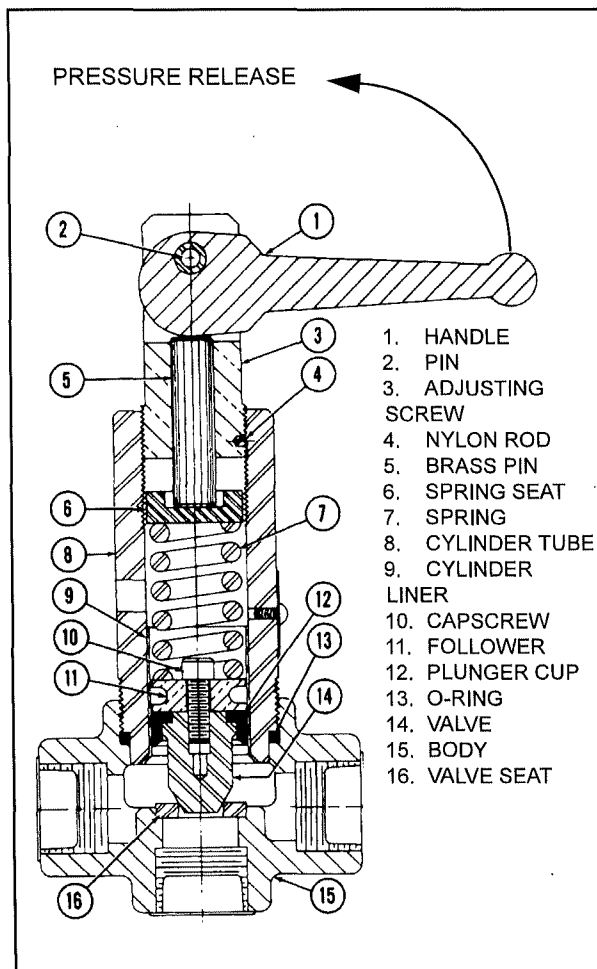
The initial pressure setting should be made as follows:

1. Place handle (1) in the pressure release position.
2. Loosen the pressure setting adjustment by turning adjusting screw (3) until the threads of the screw are showing above the top of cylinder tube (8).
3. Remove the pressure hose from the relief valve and attach a pressure gauge.
4. Start and run the pump at the desired operating speed.
5. Close the bypass by rotating the handle 180° over the top of the regulator. Plunger pin (5) in the center of adjusting screw (3) will not be completely depressed.

NOTICE

Running the adjustment screw all the way down will lock the overflow valve closed.

6. Adjust the regulator to the desired operating pressure by turning adjusting screw assembly (3) clockwise to increase the pressure or counterclockwise to decrease the pressure. Proper settings are 150 PSI (10 bars) on 100 PSI (7 bar) compressors and 300 PSI (20.5 bars) on 250 PSI (17 bar) compressors.
7. To temporarily release the pump operating pressure, flip the handle 180° over the top of the regulator.



OVERHAUL

Disassembly

1. Be sure that all pumping pressure has been released by shifting handle (1) to the "pressure release" position.
2. Unscrew and remove adjusting assembly (3).
3. Unscrew and remove cylinder tube (8) with a pipe wrench.
4. Remove the plunger assembly, spring or springs (7) and seat (6) from the lower end of the cylinder.
5. Discard O-ring (13).

Replacing Cylinder Liner

If the stainless steel cylinder liner (9) is worn, it may be removed with a punch or other suitable tool as follows:

1. Clean the surface where cylinder liner (9) contacts cylinder tube (8).
2. Coat the outside of the new cylinder liner (9) with Permatex or other suitable sealer and press into cylinder tube (8).

NOTE !

Be sure the lower end of the stainless steel liner is flared to match the end of the cylinder tube.

Be sure there are no rough edges inside the installed cylinder liner that would damage the plunger cup.

The cylinder may be purchased complete with liner installed or the liner may be purchased alone for replacement.

Replacing Plunger Cup and/or Valve

1. Grip the plunger assembly in a vise or other suitable holder, being careful not to damage the valve face area.
2. Remove capscrew (10).
3. Clean plunger follower (11) by removing all old grease and dirt.
4. Replace plunger cup (12) and/or valve (14) as needed and reassemble.

Replacing Valve Seat

Valve seat (16) may be replaced by first knocking out the old seat with a punch inserted through the bypass opening.

Clean the seat contact area. Then tap the new seat into place, using a block of wood or brass to avoid damaging the face of the new seat.

Assembly

1. Fill the cavity around plunger follower (11) with lubriplate or grease.

NOTICE

Do not push plunger assembly into cylinder so far that cup passes end of stainless steel liner.

2. Insert the plunger assembly into cylinder tube assembly (8) from the cylinder liner end. Be sure that the plunger assembly travels freely in the cylinder.
3. Put pipe dope on external threads or cylinder assembly (8) and screw back into cylinder body (15).
4. Replace spring/or springs and spring seat (6). Be sure the spring/or springs if/are properly

seated on plunger.

5. Replace adjusting assembly (3) by screwing it into the end of cylinder (8). Be sure plunger pin (5) is in its proper place in the adjusting assembly.

6. When properly reassembled, the adjusting handle can be rotated 180° over the top or turned in either direction to increase or decrease the pressure adjustment.

7. Adjust as outlined in "Initial Pressure Setting" instructions.

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WATER INJECTION PUMP - 002168-001

Safety

 **WARNING**

Many accidents occur every year through careless use of mechanical equipment. You can avoid hazards associated with high pressure equipment by always following the safety precautions listed below.

- **SHUT DOWN OR DISENGAGE** the pump and all accessory equipment before attempting any type of service. Failure to do this could cause electrical shock or injury from moving pump parts or components under high pressure. Always adhere to "Lock Out" and "Tag Out" procedures. For mobile equipment, be sure engines and hydraulics cannot be accidentally started.
- **BLEED OFF ALL PRESSURE** to the pump and piping before performing any maintenance on the pump. Failure to do so may spray water at high pressure or high temperature onto service personnel.
- **NEVER OPERATE THE PUMP WITHOUT A PRESSURE RELIEF VALVE**, rupture disc, or other type of properly sized over pressure safety device installed.
- **ALWAYS USE A PRESSURE GAGE** when operating the pump. The pressure must never exceed the maximum pressure rating of the pump or damage may occur. This damage can cause leakage or structural damage resulting in injury to personnel.
- **ENSURE THAT NO VALVES ARE PLACED BETWEEN THE PUMP AND PRESSURE RELIEF VALVE.** If the pump is started with a closed or restricted valve in line before the pressure relief valve, the pump may exceed the rated or design pressure limits and rupture causing injury to personnel.
- **ALWAYS USE GUARDS** on all belt drives, couplings, and shafts. Guards can prevent personnel from becoming entangled and injured by rotating and reciprocating parts.
- **USE EXTREME CAUTION WITH SOLVENTS** used to clean or degrease equipment. Most solvents are highly flammable and toxic. Observe all safety instructions on packaging.
- **FOLLOW NORMAL ENVIRONMENTAL GUIDELINES WHEN** fluids, lubricants, or solvents are disposed of or spilled.
- **NEVER MODIFY THE PUMP** to perform beyond its rated specifications without proper authorization in writing.

SERVICE and REPAIR MANUAL

Storage

Short Term Storage

If the pump is stored in an indoor, temperature controlled environment for less than six (6) months, no special steps are required to prepare it for storage. As a general rule for pumps in corrosive fluid applications, the fluid end should be drained, flushed with water or other non-corrosive cleanser and compressed air used to blow dry whenever idle.

Short Term Storage for Severe Environments

If the pump has been in service, drain any fluid from pump fluid end, flush the fluid end with water to clean out any of the remaining pumpage and blow dry with compressed air. Pour 1/4 cup of internal rust inhibitor oil described in the Recommended Lubricant Chart, into the suction and discharge ports of fluid end, and then install pipe plugs in openings. Drain the power end (crankcase) oil and remove the oil fill pipe plug. Pour 1/4 to 1/2 cup of internal rust inhibitor oil described in the Recommended Lubricant Chart, into the oil fill hole and then install the filler pipe plug.

Coat all exposed, unpainted metal surfaces (for example, Drive shaft) with preservative oil. Replace the oil fill cap, and then cover the entire pump with a weather resistant covering such as a canvas or plastic tarp or bag.

Returning a Stored Pump to Operation

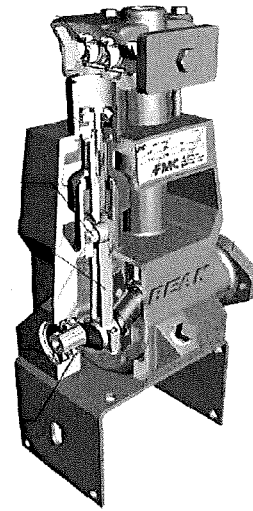
Before operating a pump that has been prepared for storage, drain the preservative and lubricating oil mixture from the power end (crankcase). Reinstall the drain plug, filler pipe plug, and any other components that were removed for storage. Once these steps have been completed, follow the normal pump start up procedures outlined in this manual.

Precautions during Freezing Weather

Freezing weather can cause problems for equipment when pumping water-based fluids that expand in volume when changing from a liquid to a frozen solid state. When water is left in a pump fluid end and exposed to freezing temperatures, the expansion of the water as it freezes can rupture the fluid cylinder or ceramic cylinders of the pump and cause equipment damage. Injury may result when starting equipment that has been damaged.

Whenever the pump is stored or idle in conditions that are near or below freezing, any water based fluids should be removed from the pump. The best way to do this is to run the pump for a few seconds with the suction and discharge lines disconnected or open to atmosphere. This will clear the majority of the fluid from the pumping chamber as well as the suction and discharge manifolds. After the run, blow compressed air through the fluid end to remove all traces of fluid.

As an alternative to the previous procedure, a compatible antifreeze solution can be circulated through the fluid end. RV antifreeze, propylene glycol, is recommended for this purpose. Remember that any fluid that poses an environmental hazard or is toxic must be handled and disposed of properly.



How to Start a Pump

NOTICE

Always take special precautions when starting a pump for the first time or after any extended shutdown. Never assume that someone else has properly prepared the pump and system for operation. Always check each component of the system prior to every start-up.

1. Ensure that the drain plug on the bottom of the pump crankcase is installed.
2. Check the oil level to ensure that the pump is properly filled with 1 quart (0.95 liters) of non-detergent motor oil, gear lube, or a synthetic oil as described in the Recommended Lubricants Chart, and that the oil has not been contaminated with water or other contaminants.
3. If accessible, check the piston rods to ensure that they are free from abrasive particles or debris.
4. Ensure that the pressure relief valve and all accessory equipment have been installed and properly adjusted. Verify that all joints are pressure tight.
5. Open the suction line valve to allow fluid to enter pump. Prime the fluid cylinder if necessary on the initial start up or after the system piping has been drained. The valve covers may have to be cracked open to assist with priming.
6. Check to ensure that power is locked out and tagged out. Turn the pump over by hand if possible to ensure free, unobstructed operation.
7. Make sure that all guards are in place and secure. Verify that all personnel are in safe positions and that system conditions are acceptable for operation.
8. The pump is now ready to start. Shut down immediately if the flow becomes unsteady, pressure fluctuates, or if unusual sounds or vibrations are noted.
9. Take temperature readings of the power end and stuffing boxes. Do not exceed 170°F (77°C) on power end.

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Recommended Lubricants

RECOMMENDED LUBRICANT CHART								
Type of Service	Mineral Oil Lubricant					Synthetic Lubricant *		
	Ambient Temperature	SAE Grade	ISO Viscosity (cSt@ 40°C)	SSU Viscosity	Manufacturer Brand Name	SAE Grade	ISO Viscosity (cSt@ 40°C)	Manufacturer Brand Name
General Service	-18°C to 38°C	30	100	550	Texaco® Meropa 100	5W-40	90.0@40 15.0@100	Shell® Rotella T Synthetic SAE 5W-40
	(0°F to 100°F)				Shell® Omaha 100			
High Ambient Temp. Service	38°C to 54°C	50	250	1165	Texaco® Meropa 68	5W-40	90.0@40 15.0@100	Shell® Rotella T Synthetic SAE 5W-40
	(100°F to 130°F)				Shell® Omaha 220			
Cold Ambient Temp. Service	-18°C to -34°C	20	68	350	Texaco® Meropa 68	5W-40	90.0@40 15.0@100	Shell® Rotella T Synthetic SAE 5W-40
	(0°F to -30°F)				Shell® Omaha 68			
Frequent Stop-Start Operation		40	150	775	Texaco® Meropa 150			
SPECIALTY ITEMS								
Internal Rust Inhibitor					Cortec® VCI 329			
External Rust Preventative					Texaco® Metal Protective Oil L			

*Synthetic lubricants are suggested for high or low temperature service.

Inspection and Preventative Maintenance Chart

Routine maintenance is an essential part of any successful pump installation. Properly maintained water injection pumps are designed to offer years of trouble-free service.

Regular maintenance and inspection will keep your pump operating at peak performance. This pump has been carefully engineered to minimize maintenance requirements and simplify these tasks when they are required. Regular inspections allow operators to become familiar with normal pump operation so they can recognize the signals of potential problems and schedule maintenance. The maintenance chart below should be used as a guideline only. Many applications will require adjustment of the intervals shown in this chart for severe or unusual operating conditions.

Maintenance Chart

Interval	Component	Service	Remarks
Break in Period	Crankcase Oil	Change	Drain and refill with new oil after first 50 hours of operation. Ensure that the magnetic drain plugs are cleaned to remove debris.
	Inlet Strainer	Inspect	Clean if required. The amount of material in the strainer will determine the interval of cleaning.
Daily	Complete Pump	Inspect	General inspection of pump and system to check for proper operation of equipment.
	Piston Cup Sets	Inspect	Check the cylinder liner area of the pump for signs of leakage. Replace piston cups if leakage becomes excessive.
	Pump system	Flush	Required for shutdown when pumping fluids that may harden or corrode the pump if left inside once stopped.
	Crankcase Oil	Inspect	Ensure that the oil is at proper level and has not been contaminated by pumpage or condensation.
2,000 hours	Crankcase Oil	Change	Drain and refill with new oil. Clean magnetic drain plug.
	Connecting Rod Bolts	Inspect	Check the connecting rod bolts with a torque wrench to ensure they are within specification. This should be done in conjunction with oil changes.

Estimated Life Of Wearing Components

The information given here is an estimate of the average wear life of listed components in clean liquid service. It is not a guarantee of life for any given application, but is intended to facilitate maintenance schedules and stocking of spares. The maintenance of the power end lubrication system will influence the life of the power end components. The speed of operation and percent of maximum allowable load will influence the life of both power end and fluid end parts. The

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temperature, abrasiveness, and lubricity of the liquid affect the life of fluid end expendables.

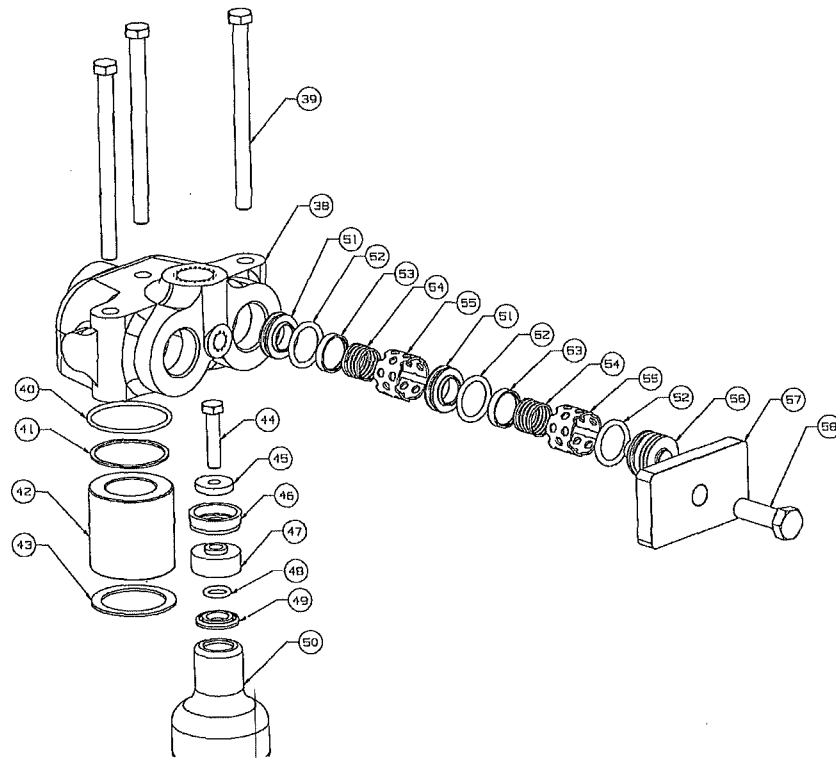
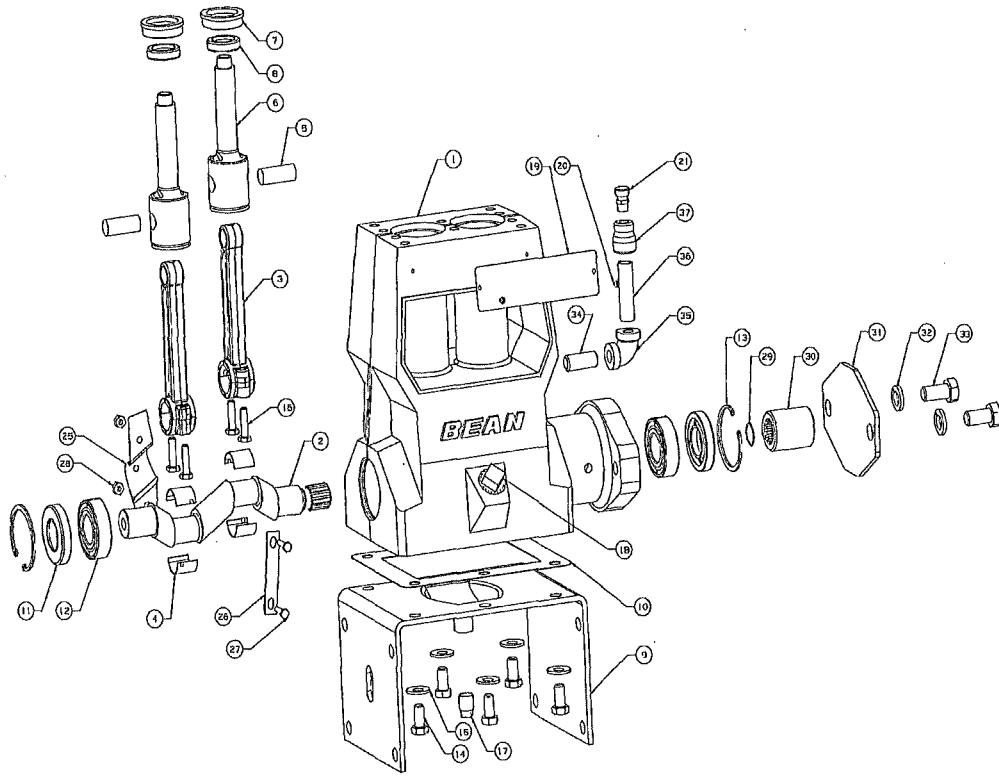
POWER END COMPONENT	ESTIMATED LIFE (Hours)
• End Bearings (Roller or Ball)	40,000
• Wrist Pin Bushings	20,000
• Power End Cover Gasket	10,000
• Connecting Rod Bearings	10,000
• Oil Seal on Crankshaft or Pinion	10,000
• Oil Seal on Piston (Pony) Rod	5,000

FLUID END COMPONENT	ESTIMATED LIFE (Hours)
• Fluid Cylinder	16,000
• Pistons	10,000
• Valve Assembly	8,000
• Ceramic Liners	3,000

Component Parts List

A typical pump configuration is shown below for general reference purposes. This will aid in identifying components for service procedures outlined in the following sections. To order service parts refer to the machine Parts Manual.

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Service Procedures

The following sections illustrate step-by-step instructions for performing most common service procedures of a pump. Read each section before starting service work on the pump. Refer to your machine parts manual for component identification.

Replacing Cup Pistons

WARNING



Ensure that all pressure inside the pump fluid cylinder has been bled off before starting any service work. Lock-out and tag-out the starting components.

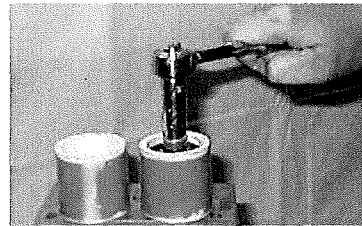
1. Bleed off all pressure and ensure the pump power supply is off and is disconnected (Locked and Tagged out, if applicable).

2. Remove the fluid cylinder (38) from pump by removing the three capscrews (39) holding it to the power frame, then lift the fluid cylinder off the top of the ceramic cylinders (42).

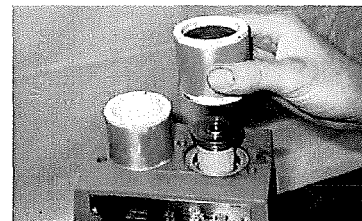


3. Remove the ring seals (41) and O-rings (40) from the top of the cylinders or from the counter bores of the fluid cylinder.

4. Remove the capscrew (44) and piston cup washer (45) from each of the two cylinders.

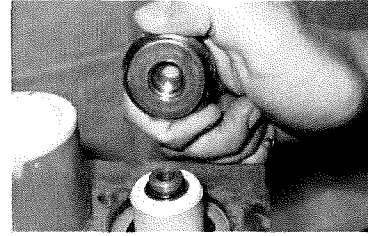


5. Lift the ceramic cylinder (42) off the top of the power frame (1). Friction will usually keep the piston cup (46) inside the cylinder as it is removed. Once the cylinders and pistons are off the pump, take them to a bench and press them out from the top.



6. Remove the piston holder (47) and O-ring (48) from the crosshead shaft (6).

7. Inspect all O-rings, gaskets, seals, and other components for signs of damage or wear. Any damaged components should be replaced at this time. Inspect the ceramic cylinders for cracks or grooves by visual inspection and running thumbnail around the bore of the cylinder. Replace if grooves or cracks are detected. New piston cups will wear quickly if operated in cylinders with rough or grooved bores. **NOTE!** To provide maximum operational time between service, it is recommended that both piston cups, not just the one that shows signs of leakage, be replaced whenever piston service is required.



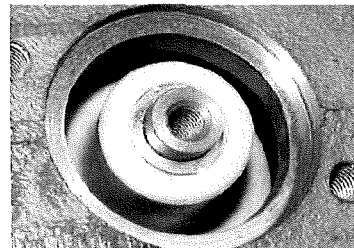
8. Ensure that the umbrella fluid shield (50) is not damaged. A damaged umbrella could allow fluid to contaminate the power end oil. If the umbrella requires replacement, the best way to remove it from the pump is to cut it free with a sharp knife.

NOTE! It is recommended that all associated gaskets or O-rings be replaced at each piston cup service interval.

9. If new umbrellas (50) are required, fold the plastic as shown and insert through the opening of the crosshead bore of the power frame, and over the ends of the crosshead shaft. For easier installation of the umbrella, immerse in boiling water for 2-3 minutes to soften. Use caution to avoid burns or scalding when working with hot water.

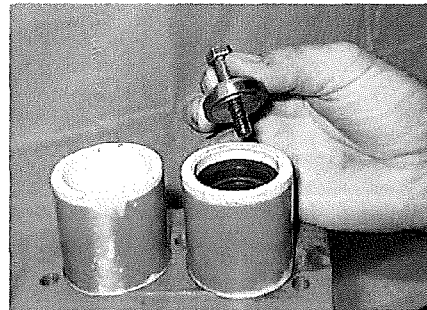
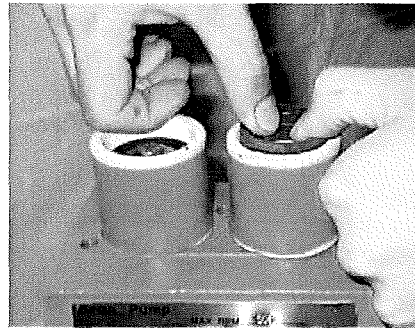


10. Once the umbrellas are installed over the crosshead shaft, lift them up slightly and insert the umbrella washers (49) through the upper opening of the umbrella. Ensure the groove of the washer is facing up.



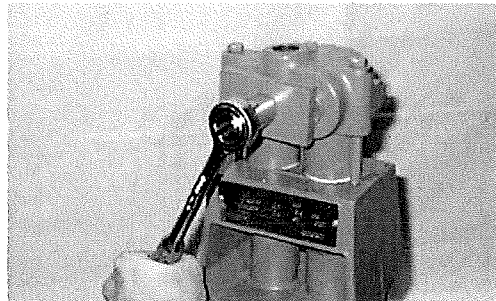
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11. Place O-rings (48) and piston holders (47) in position on ends of crosshead shaft.
12. Place ceramic cylinders (42) and gaskets (43) in counter bore of power frame (1).
13. Apply light oil or glycerin around the OD of the piston cups (46), then place them in the open end of the cylinders. Use thumb to press the cups down firmly into the piston holder of each cylinder.
14. Insert the piston cup washers (45) into the cylinders with the ribbed side facing the piston cup.
15. Secure packing assembly using capscrews (44). Torque to specification per the Fastener Torque Requirements table.
16. Insert top O-ring (40) and ring seal (41) in fluid cylinder counter bore using heavy oil or grease to hold in place.
17. Return fluid cylinder (38) to position over cylinders (42) and ensure that all seals are in place.
18. Replace fluid end capscrews (39). Torque capscrews in 3 stages to values shown in the Fastener Torque Requirements table.

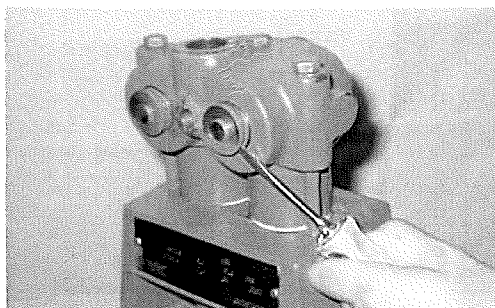


Replacing Suction and Discharge Valves

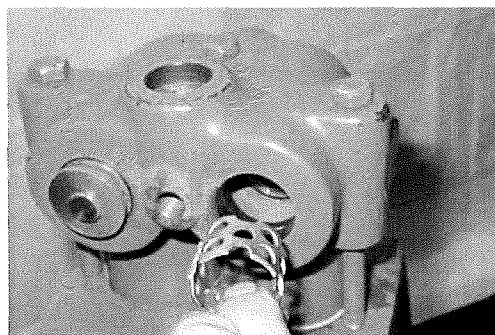
1. Remove capscrew (58) and valve cover clamp (57) from the front of the fluid cylinder (38).



2. Insert the end of a standard screwdriver into the valve cover (56) groove and pry the valve cover away from the fluid cylinder (38).



3. Remove the valve cage (55) and discharge valve disc-spring assembly (53, 54) from both bores of the fluid cylinder (38).



4. Use a finger to reach through the opening at the center of the seat (51) and work the seat loose from the fluid cylinder bore. **NOTE!** The optional Valve Seat Removal tool (see figure below) may be used to simplify this procedure.

5. Use the same procedure to remove the suction valve cage (55), valve disc-spring (53, 54), and valve seat (51), which are located directly under the discharge valve seat.

6. Inspect all valve components and replace as necessary. Note that even small damage or erosion to the sealing area of the valve or the O-ring can adversely affect the performance of the pump.



7. With the O-ring (52) in place on each valve seat (51), place a few drops of light oil around the O-ring to aid in installation. Place a valve seat **SQUARELY** in the back of both counter bores of the fluid cylinder.

8. Place the valve cage (55) on the valve seat (51) and insert the disc-spring assembly (53, 54) inside of the cage on the valve seat.

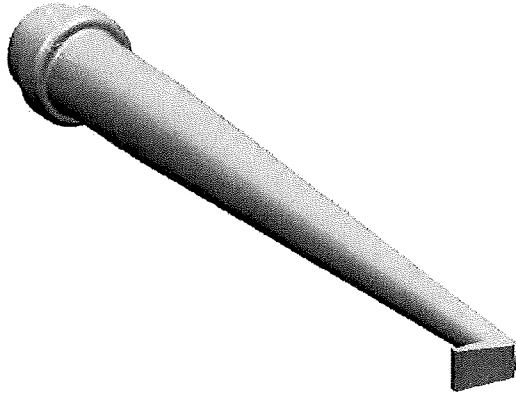
9. Repeat the previous two steps to install the discharge valve seat and the discharge valve cage.

10. Place the valve covers (56), with O-rings (52) on the **BOTTOM** groove in place over the valve assembly.

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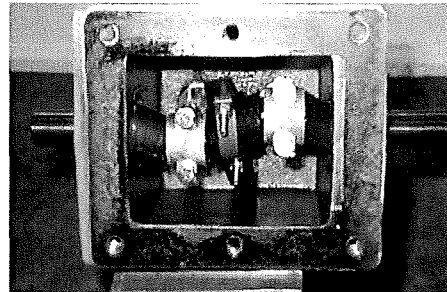
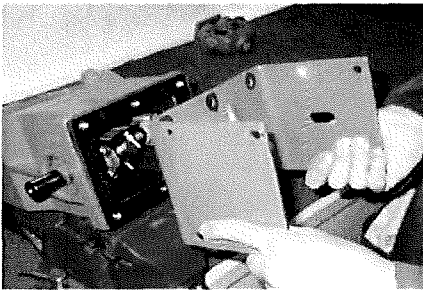
11. Replace valve cover clamp (57) and capscrew (58) and torque to specification per the Fastener Torque Requirements table. **NOTE!** Over-tightening of the capscrew can damage the valve components.

Valve Seat Removal Tool



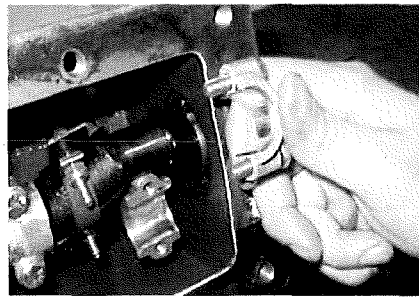
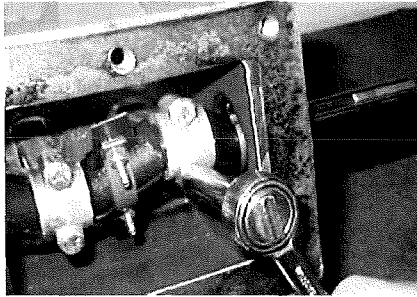
Servicing the Power End

1. Remove bottom drain pipe plug (17) and drain all oil from power frame.
2. Disconnect suction and discharge piping, power source, and remove pump from mounting base.
3. Although it is not required, it is easier to remove the crankshaft (2) if the fluid end and pistons have been removed. To remove the fluid end, follow steps 1-4 from the Replacing Cup Piston section.
4. Remove the six hex head capscrews (14), washers (15), and mounting base (9) from rear of pump. When removing the mounting base from the pump, be careful not to damage oil seal gasket (10) as the mounting base is broken loose.

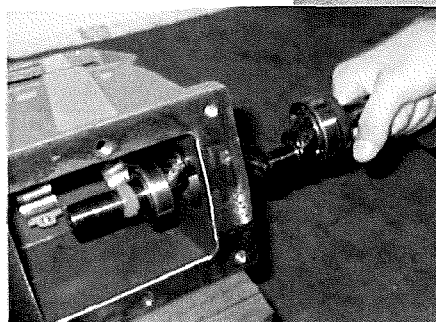
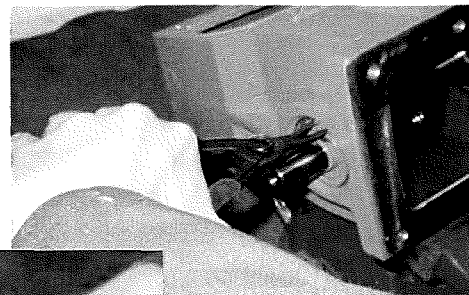


5. Remove capscrews (16) from the connecting rod assemblies (3) and take out the back half of the connecting rod shell bearing (4).

NOTE! Connecting rod halves are not interchangeable and must be reassembled in their original positions. Note the orientation of the machine markings on the connecting rod and cap.



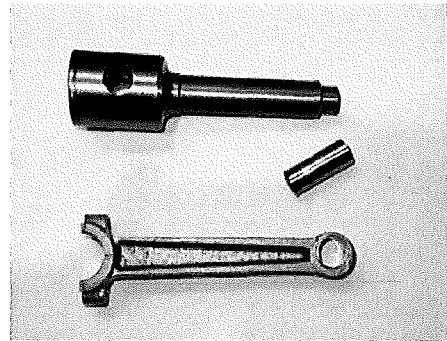
6. Remove the oil slinger (25) from the crankshaft (2). (this model only)
7. Push the connecting rods (3) and crosshead assemblies (6) as far forward into the power frame as possible to provide clearance for the crankshaft.
8. Once the crankshaft is clear of the connecting rods, remove forward half of the split connecting rod bearing.
9. Use snap ring pliers to remove the crankshaft retainer snap ring (13) from each side of the pump.
10. Using a hammer and wood block or rubber mallet, drive the crank shaft (2) and bearings (12) out either side of the power frame.



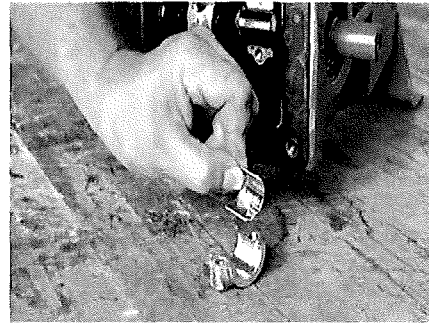
11. If bearing replacement is required, remove bearings from crankshaft using a press. Be sure to provide suitable support for the back side of the bearings during this step. **NOTE!** Never pound directly on the bearings or they may be damaged.
12. Once the crankshaft has been removed, the connecting rods and crossheads can be pulled from the back of the power frame opening.

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13. The wrist pin (5) is a slip fit through the connecting rod (3) and crosshead (6). Check for signs of wear on the pin and connecting rod bushing. For critical clearance dimensions, see the Critical Clearance. Replace the pin if noticeable wear is found. The complete connecting rod assembly must be replaced if the bushing is worn, as the wrist pin bushing is not field replaceable.



14. The split crankshaft shell bearings (4) should be replaced by inserting new half bearings in the connecting rod as shown.



15. When re-assembling the crossheads, wrist pins, connecting rods, and shell bearings, ensure that they are assembled in their exact former orientation and position.

16. Carefully clean and inspect all parts. Replace worn or damaged components as necessary.

17. Install the crosshead and connecting rod assemblies to their original position in the power frame.

18. Install crankshaft with bearings into the power frame.

19. Place the oil seals (11) over the ends of the crankshaft with the lip of the seals facing the inside of the power frame.

20. Seat the snap rings (13) in the grooves in the bearing housing against the oil seals and tap the crankshaft to allow a SLIGHT end play in the crankshaft.

21. Reassemble the connecting rods and shell bearings around the crankshaft. The connecting rod and cap are a matched set. Be sure to properly match the connecting rods and caps back into their original position and orientation. Torque connecting rod bolts per the fastener torque requirements in the Fastener Torque Requirements table.

22. Complete the reassembly by reversing steps 1-8. Torque back cover capscrews (14) per the fastener torque requirements in the Fastener Torque Requirements table.

23. Re-install the drain pipe plug (17) to the back cover.

24. Refill the power frame with oil, and turn the shaft over several revolutions by hand. When piston cups are not installed the pump shaft should rotate freely. See instructions in the How to Start Pump section for oil type and filling directions.

NOTE! This pump require 1 quart (0.95 liters) of oil.

Fastener Torque Requirements

NOTICE

No pump service procedure is complete without ensuring that the fasteners have been properly torqued. Failure to properly tighten the pump bolts could cause the pump to leak or possibly allow the pump to fail. Always use a calibrated torque wrench during the installation of all critical fasteners listed in the Fastener Torque Requirements table below. Values are in foot-pounds (Ft-lb) and Newton meters (N-m). Typical sizes are shown in the table below.

Item	Component			
Power End				
No.	Description	Size	Ft-lbs	(N-m)
1	Connecting Rod Bolts	0.25	7	9
2	Piston Assy. Bolt	0.313	15	20
3	Back Cover Bolts	0.375	15	20
Fluid End				
4	Fluid End Attaching Bolts	0.375	25	34
5	Valve Cover Clamp Bolt	0.500	60	81

Critical Clearances

When maintenance requiring disassembly of the power end is performed, the following clearances should be checked to see if they are within factory specification or within maximum allowable limits. Additional clearance is allowed for component wear. This additional clearance is a maximum of 0.0508 millimeters of total diametral wear that can be added to the clearance values in the Critical Clearances table below. For radial clearance, use 1/2 of the total diametral value. All dimensions are shown in millimeters and inches.

DESCRIPTION	millimeters	inches
Crankshaft Throw Diameter (Stroke)	25.4	1.00
Crankshaft Pin or Journal (OD)	22.16 / 22.14	0.8725 / 0.8715
Connecting Rod / Crank Clearance (Max. total)	0.102	0.004
Crosshead Diameter (OD)	38.10 / 38.05	1.500 / 1.498
Crosshead Cylinder Bore (ID)	38.20 / 38.13	1.504 / 1.501
Crosshead to Bore Clearance (Max Total)	0.152	0.006
Wrist Pin Bushing Bore (ID)	14.27 / 14.22	0.562 / 0.560
Wrist Pin to Bore Clearance (Max. Total)	0.089	0.0035

NOTE! Clearances shown are total diametral values: For radial clearance use 1/2 the value shown.

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Troubleshooting

This chart is designed to aid in the solution of pump and pump system problems. Once the problem has been identified, work through the possible causes and solutions until the problem has been corrected.

SYMPTOM	POSSIBLE CAUSE	REMEDY
No flow from pump	<ul style="list-style-type: none"> -No liquid in reservoir (tank) -Inlet line valve closed -Inlet strainer is totally clogged with debris -Crankshaft is not turning 	<ul style="list-style-type: none"> -Ensure lines are connected and fill tank -Ensure lines are connected and open valve -Clean or replace strainer -Check for power to drive and drive connections
Insufficient pressure from pump (ONLY)	<ul style="list-style-type: none"> -Pump speed is too low -Relief valve improperly adjusted or worn -Insufficient system resistance (worn nozzle) -Worn check valves -Excessive leakage from pump seals 	<ul style="list-style-type: none"> -Check belt tightness or power to motor -Check relief valve and adjust setting -Properly service system -Inspect check valves and repair or replace -Adjust or replace packing or damaged parts
Insufficient flow from pump (ONLY)	<ul style="list-style-type: none"> -Pump speed is too low -Relief valve improperly adjusted or worn -Worn pump valves -Excessive leakage from pump seals -Piston worn -Valve seat washed out in fluid cylinder 	<ul style="list-style-type: none"> -Check belt tightness or power to motor -Check relief valve and adjust setting -Inspect pump valves and repair or replace -Replace piston cup or damaged parts -Replace piston or cylinder -Repair or replace fluid cylinder

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Insufficient flow or pressure AND rough operation (pump pounds or vibrates)	<ul style="list-style-type: none"> -All pump cylinders hot primed -By-pass or relief is piped back to suction -Insufficient NPSHA -Air leaks in suction line or fittings -Air entering booster pump -Pump valve stuck open or closed -Valve assembly damaged or unseated 	<ul style="list-style-type: none"> -Prime all chambers -Pipe back to reservoir (tank) -Provide more NPSH -Correct installation to stop leaks -Correct installation of booster pump -Clean and deburr valve -Properly seat or repair valve
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Pump runs rough, knocks, or vibrates (ONLY)	<ul style="list-style-type: none"> -Broken or weak valve spring -Valve damaged or unseated -Loose piston, or rod -Low oil level in power end -Excessive connecting rod bearing clearance -Worn wrist pin or bearing -Loose sheaves or bushings (v-belt drive) -Insufficient NPSHA -Excessive acceleration head in suction line -Pulsation dampener improperly charged -Inlet line too long or too small in diameter -Worn piston seal allows air ingress (usually observed when booster not used) 	<ul style="list-style-type: none"> -Replace valve spring -Repair/replace valve or re-seat -Tighten loose components -Fill to proper level -Check cap torque or replace bearings -Replace worn components -Tighten loose components -Provide more NPSH -Install suction stabilizer -Charge to proper pressure -Increase suction pipe size -Replace piston seal
Rapid suction pressure fluctuation Piping vibration	<ul style="list-style-type: none"> -Pump cavitation -Air is entering suction line -Same as Pump runs rough above -Excessive pressure variation in discharge -Piping inadequately supported -Excessive short-radius elbows or tees 	<ul style="list-style-type: none"> -Increase suction size or NPSH -Correct installation to stop leaks -See above -Install discharge pulsation dampener -Install supports at proper locations -Correct installation to minimize turns and short-radius fittings

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Pump requires excessive power	<ul style="list-style-type: none"> -Discharge pressure too high -Speed too high -Misaligned coupling -Belts too tight 	<ul style="list-style-type: none"> -Reduce system back-pressure or relief valve -Reduce speed -Correct alignment -Correctly adjust belt tension
Power end overheats (over 180°F) and/or reduced power end component life	<ul style="list-style-type: none"> -Discharge and/or suction pressure too high -Oil level too high or too low -Contaminated power end oil -Incorrect oil viscosity or grade -Misaligned coupling -Belts too tight -Worn or damaged power end bearings 	<ul style="list-style-type: none"> -Reduce pressure or reduce piston and cylinder size -Adjust to correct oil level -Refill with clean oil & eliminate contamination -Fill with correct oil -Correct alignment -Correctly adjust belt tension -Replace damaged bearings
Crank-shaft jerks or starts & stops rotation	<ul style="list-style-type: none"> -Drive belts loose and slipping (if equipped) -System relief valve pressure set too high -Discharge line blocked or partially blocked 	<ul style="list-style-type: none"> -Correctly adjust belt tension -Reduce relief valve pressure setting -Clear obstructions from piping system

Fluid leaking from pump	<ul style="list-style-type: none"> -Piston cups are worn -Piston to rod O-ring damaged -Fluid cylinder bolts not properly tightened -Fluid cylinder O-rings (or gaskets) damaged 	<ul style="list-style-type: none"> -Replace piston cup -Replace O-ring -Properly tighten and torque bolts -Replace damaged O-rings or gaskets
Reduced piston cup life	<ul style="list-style-type: none"> -Highly abrasive particles in fluid -Piston cups run dry -Incorrect cups for fluid type -Pump was run dry for extended time -Worn cup holder -Worn cylinder bore 	<ul style="list-style-type: none"> -Install strainer or filter -Correct problem & replace cup -Change to correct cup -Correct problem and replace cups -Replace cup holder -Replace cylinder

<p>Reduced valve life</p>	<ul style="list-style-type: none"> -Highly abrasive particles in fluid -Cavitation damage -Air leaking into suction line -Suction inlet insufficiently submerged -Relief valve or bypass piped to suction -Valve damaged by improper installation 	<ul style="list-style-type: none"> -Install strainer or filter -Correct problem and replace damaged valves -Correct problem -Increase submergence or baffle to stop vortex -Pipe back to reservoir (tank) -Replace damaged components
<p>Cracked fluid cylinder or broken fluid end bolts</p>	<ul style="list-style-type: none"> -Discharge pressure too high -Hydraulic shock (cavitation or entrained air) -Discharge valve stuck closed -Fluid freezing in fluid cylinder -Material or manufacturing defect -Bolt not properly torqued -Excessive piping loads on fluid end 	<ul style="list-style-type: none"> -Reduce system back pressure or relief valve -Correct piping system problem -Replace damaged components -Change procedure to drain fluid when cold -Replace defective component -Replace fluid cylinder and properly torque -Add supports to piping
<p>Broken crankshaft or connecting rod</p>	<ul style="list-style-type: none"> -Discharge pressure too high -Suction pressure too high -Fluid freezing in fluid end -Hydraulic shock due to cavitation -Material or manufacturing defect 	<ul style="list-style-type: none"> -Reduce system back pressure or relief valve -Reduce suction pressure or piston diameter -Change procedure to drain fluid when cold -Correct piping system problems -Replace defective components
<p>Power end oil is contaminated</p>	<ul style="list-style-type: none"> -Extended operation with failed piston cup -Hi-pressure wash wand near breather or seals -Pony rod seals or umbrella damaged 	<ul style="list-style-type: none"> -Replace piston cup and improve monitoring -Provide shields to protect breather and seals -Replace oil seals or umbrella

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Glossary of Commonly Used Terms

CAPACITY The total volume throughput per unit of time at suction conditions. It includes both liquid and any dissolved or entrained gases. For all practical purposes this can be considered the volume flow rate in the suction pipe. The standard unit of pump capacity is U.S. gallons per minute (GPM) and metric cubic meters per hour (m³/hr).

CAVITATION The state where fluid pressure drops below vapor pressure, causing the liquid to begin to change from a liquid to a gas and boil. Usually occurs in the chamber between the suction and discharge valves during the suction stroke, and often sounds like a mechanical knock. Cavitation results in the formation of gas bubbles, or cavities, in the fluid that cause vibration and damage to components when they collapse.

DAMPENER A device that reduces pressure pulsations in the suction or discharge piping. This may be referred to as a suction stabilizer, accumulator, or surge suppressor.

DISPLACEMENT The volume swept by all pistons or plungers per unit time. This term is typically expressed as gallons per revolution.

FLOODED SUCTION Implies that the level of liquid in the suction vessel is above the centerline of the suction port of the pump.

FLUID END The portion of the pump that converts the linear motion supplied by the power end into fluid flow at pressure. This may also be called the Liquid End. It is called a valve chamber in old literature.

MECHANICAL EFFICIENCY Mechanical efficiency (ME) is the ratio, expressed as a percentage, of pump power output to the pump power input. The mechanical efficiency of reciprocating pumps is very high, typically 85% to 90%.

NPSHA An abbreviation that stands for Net Positive Suction Head Available. NPSHA is the total suction pressure, including allowance for acceleration head, available from the system at the pump suction connection, minus the vapor pressure of the liquid at actual pumping temperature. NPSHA for a reciprocating pump is normally expressed in units of feet of water.

NPSHR An abbreviation that stands for "Net Positive Suction Head Required". This is the minimum total inlet pressure required by the pump for proper operation. This value is a function of pump design and speed and is determined by the pump manufacturer through a specific NPSH test. NPSHA should exceed NPSHR by at least 1.5 meters.

PISTON A type of power pump that uses a cylindrical seal (piston) mounted on a holder to drive fluid through the valves. The piston seal reciprocates within a stationary cylinder.

POWER END The portion of the pump that converts supplied rotary motion into linear motion used by the Fluid End to move the pumpage.

POWER FRAME The major portion of a power pump that encloses and supports all other components of the power (or drive) end. It is called a pump case in old literature.

POWER PUMP A reciprocating pump that drives the pumping element(s) using a slider crank mechanism. Power pumps are piston, plunger, or diaphragm type. All require a driver with a rotating shaft, such as a motor or engine, as a power source.

PUMP VALVE A check valve that allows flow of liquid in one direction. The pumps have a series of two valves, one suction (inlet) and one discharge, per pumping cylinder.

STROKE LENGTH The length of one complete, unidirectional motion of the piston or plunger. Stroke length is usually expressed in inches.

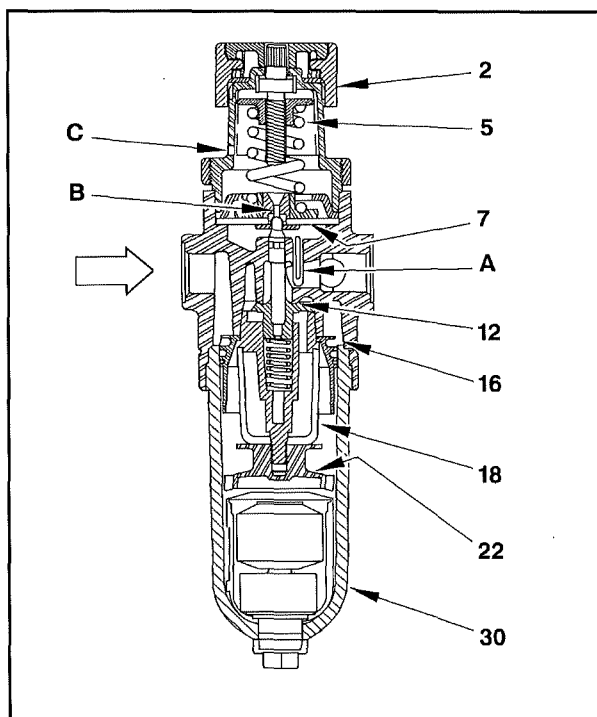
VOLUMETRIC EFFICIENCY Volumetric efficiency (VE) is the ratio of actual pump capacity output to theoretical displacement. The volumetric efficiency is affected by the fluid being pumped and the discharge pressure.

FILTER/REGULATOR (002428-000)

OPERATION

This filter/regulator performs two functions in a compressed air system:

- A. It removes most solid and liquid particles from the compressed air.
- B. It maintains a nearly constant outlet pressure despite changes in the inlet air pressure and changes in downstream flow requirements.



Air entering the filter/regulator is guided into a swirling pattern by the louvers (16). Coarse solid particles and liquids are forced to bowl wall (30) by centrifugal force and drop to the bottom. Baffle (22) creates a quiet zone at the bottom of the bowl and prevents air turbulence from picking up liquids and returning them to the air stream. Air leaving the bowl passes through the filter element (18) where most finer solid particles are retained.

Clean air flows upward from the element to the regulator valve (12). The working parts of the pressure regulator section are diaphragm (7), regulating spring (5), valve (12), and adjustment knob (2). One side of diaphragm (7) is referenced to the outlet (secondary) side of the regulator through aspirator tube (A).

With adjustment knob (2) turned counterclockwise until no load is applied to regulating spring (5), the valve is closed. When adjustment knob (2) is turned clockwise, force is applied to regulating spring (5) which causes diaphragm (7) to move downward and open the valve. The increase in secondary (regulated) pressure acting against the lower (pressure) side of diaphragm (7), creates a force tending to move the diaphragm upward, compressing regulating spring (5). This upward movement will continue until the force exerted by the pressure on the lower side of diaphragm (7) balances the spring force exerted on the upper side. If there is no downstream flow demand, this balance of forces will occur with the valve open just the amount necessary to compensate for the demand, thus maintaining the desired pressure.

The regulator shown is a relieving type and should a secondary overpressure occur, diaphragm will move further upward and open relief passage (B) in the diaphragm. This allows secondary air to escape into the regulator bonnet and to vent (C).

However, the flow capacity of the relief passage is limited, and depending upon the source of the overpressure condition, the outlet pressure might increase to a point significantly higher than the filter/regulator setting. For this reason, the relief feature of a filter/regulator must not be relied upon as an overpressure safety device.

ADJUSTMENT

1. Before turning on system air pressure, turn filter/regulator adjustment counterclockwise until all load is removed from regulating spring.

2. Turn on system air pressure.
3. Turn filter/regulator adjustment (2) clockwise until the desired outlet pressure is reached.
4. To avoid minor readjustment after making a change in pressure setting, always approach the desired pressure from a lower pressure. When reducing from a higher to a lower setting, first reduce to some pressure less than that desired, then bring up to the desired point.
5. Push the lockring on adjusting knob (2) downward to lock the pressure setting. To release, pull the lockring upward. Pressure settings can be made tamper resistant by installing a seal wire in the groove above the lockring.

SERVICING

The liquid level in bowl (30) should always be below baffle (22). If the liquid level rises above the baffle, liquid will be carried downstream. Replace filter element (18) when plugged or dirty.

OVERHAUL

The filter/regulator can be disassembled without removal from the air line. To disassemble, shut off inlet air pressure. Reduce air pressure to zero in lines both upstream and downstream of filter/regulator.

Filter Section

Unscrew and remove bowl(30) and gasket (29). Remove automatic drain items (24, 25, 27, 28) from the bowl. Unscrew and remove baffle (22) and filter element (18).

Clean the bowl using warm water only. Clean other parts using warm water and soap. Blow clean dry air through the filter element from inside to outside to dislodge surface contaminants. Dry the parts and blow out internal passages in the body using clean, dry compressed air. Inspect each part carefully. Replace any parts that are damaged.

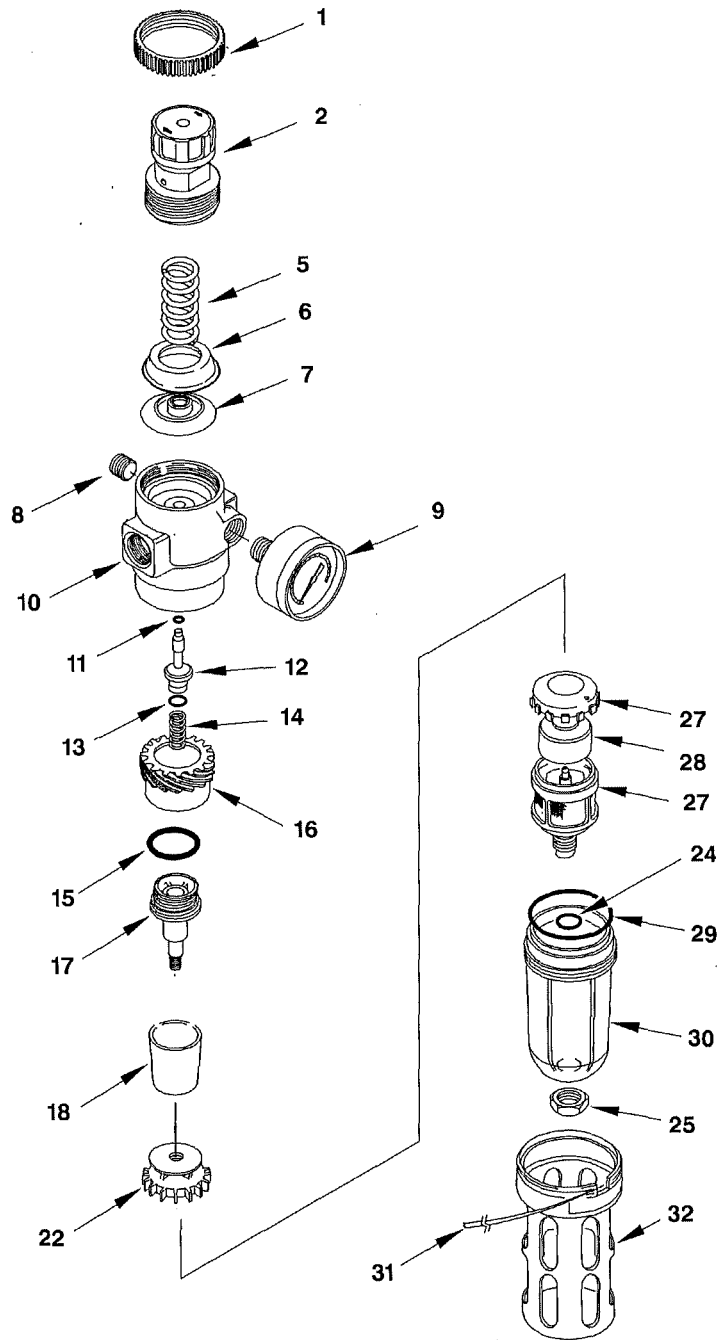
At reassembly, apply a wipe coat of Dow corning 44M grease or equivalent to gasket (29). Tighten baffle (22) 1/4 to 1/2 turn past the point of initial contact with element (18), **DO NOT OVER TIGHTEN**. When reinstalling the automatic drain in bowl, torque retaining nut (25) to 20-25 in-lbs (2.5 Nm). Apply a light coating of antiseize compound (Armite Laboratories Led-Plate No. 250 or equivalent) to the full length of the threads on bowl (32) before assembly to body. Tighten the bowl by hand.

Regulator Section

Turn adjusting knob (2) counterclockwise until all load is removed from regulating spring (5). Unscrew bonnet assembly (2), spring (5), slip ring (6), and diaphragm (7) from body (10). Remove the filter section as described previously. Unscrew and remove centerpost (17) together with gasket (15), louver-deflector (16) and valve spring (14). Pull valve (12) together with O-rings (11 and 13) out of body.

Clean regulator parts using warm water and soap. Do not immerse bonnet assembly (2) for cleaning as lubricant will be removed. Dry parts thoroughly. Inspect all parts carefully. Replace any parts that are damaged.

At reassembly, apply a light coat of Dow Corning 44M grease or equivalent, to O-rings (11 and 13), gasket (15), and to the valve stem bore in body (10) and valve body bore in centerpost (17). Insert valve assembly (11, 12, 13) into body (10). Place louver-deflector (16) and gasket (15) on centerpost (17), drop valve spring (14) in centerpost, install centerpost in body and tighten until snug.



2-10-98

Apply a light coat of Lubriplate 110 or equivalent, to adjusting screw threads inside bonnet (2). Apply a light coat of antiseize compound to the lower half of threads on bonnet (2). Stack diaphragm (7), slipring (6), regulating spring (5) in upper section of body. Screw bonnet (2) into body. Turn adjusting knob counterclockwise to ensure all load is removed from regulating spring. Tighten the bonnet to 25-30 ft-lbs (34-41 Nm) of torque.

Reassemble the filter section as described in this section.

DUST COLLECTOR (007702-000)

GENERAL

For the dust collector to operate efficiently, the following steps should be followed:

! WARNING

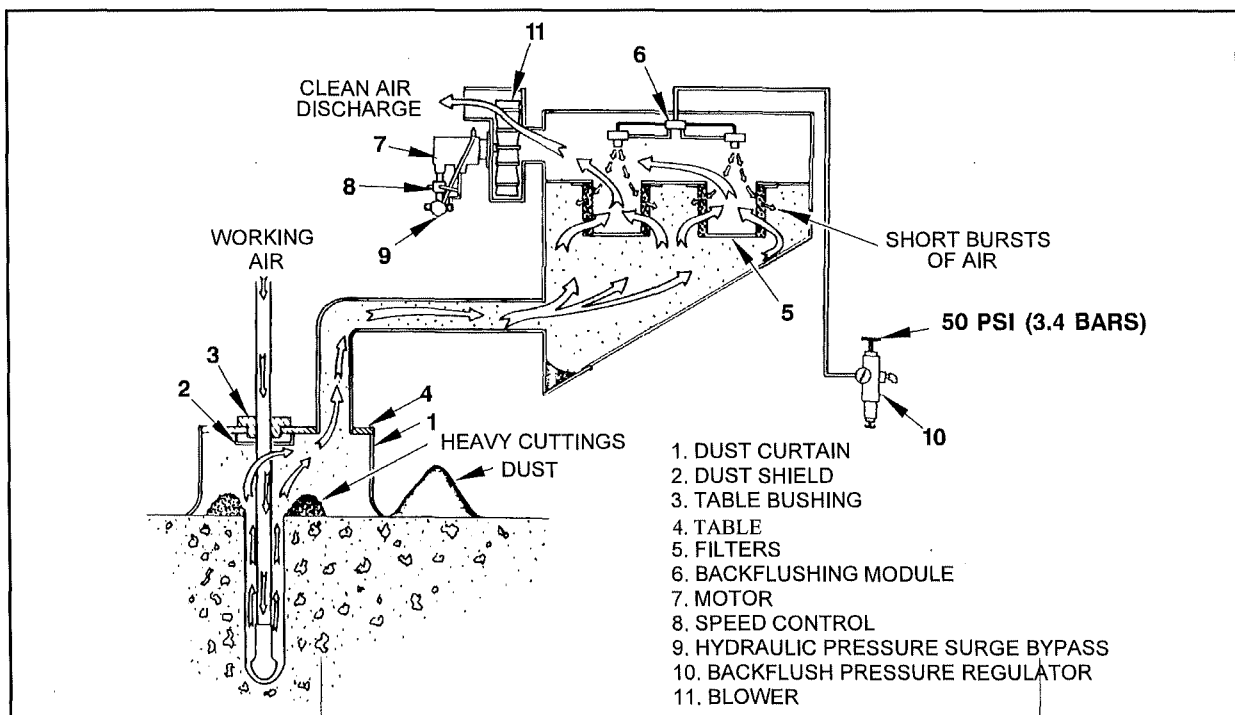
Do not operate blower motor at speeds above 4,000 RPM. The blower may disintegrate causing injury to nearby personnel.

NOTICE

Should visible dust be observed coming from the blower discharge port, immediately turn off blower and check for ruptured filters. Failure to do this will cause blower damage.

- Ensure dust curtains are forming a seal with the ground.

- Ensure that the filter cleaning mechanism is functioning (listen for air pulsation once every 3 to 6 seconds). The pressure regulator should be set at 50 PSI (3.4 bars).
- Start the dust collector when air control valve is placed in OPEN position.
- Stop dust collector when air control valve is placed in CLOSED position.
- Do not operate the dust collector if wet drilling conditions are encountered. Wet dust can clog dust collector air filters.
- When initially setting up blower speed, open adjustable flow control located adjacent to blower motor so the blower is operating very slowly. Gradually increase RPM until dust is no longer coming from the drill table. Checking the RPM with a Frahm Vibratory Reed tachometer is strongly recommended to ensure that fan speed does not exceed 4,000 RPM. Blower speeds should be set to the lowest speed possible that provides dust-free operation.



TROUBLESHOOTING

PROBLEM	SOLUTION
Dust curtain not confining all dust	Dust curtain must touch ground to create seal. Extend dust curtain as required.
Dust being forced up through table bushing around drill pipe	Check for worn table bushing insert or dust shield and/or dust ring. Replace as required.
Fine dust not being dumped through transition chute	Check for caked cuttings holding rubber belting shut or chute plugged by damp dust. Remove all caked dust from hopper and chute.
Filter severely plugged	<p>Remove filters as needed and clean and/or replace. Inspect filter for rupture. If rupture found replace filter.</p> <p>Check regulator pressure gauge for accuracy. Additional pressure may be required to clean filter. Do not exceed 50 PSI.</p> <p>If filters have indication of oil coating check for leakage of blown motor shaft seal. Replace as required.</p>
Backflushing cycle rate too fast or too slow	Timer not adjusted properly. Remove cover of timer for adjustment. Observe flash of "off cycle" light. Turn adjustment screw to have light flash at 6 second intervals.
Filters are not being back-flushed properly	<p>Blowdown diaphragm valves may be defective. If one particular filter is not being cleaned check the blowdown valve for ruptured diaphragm or valve stuck in open or closed position.</p> <p>Check tubing connecting timer solenoid to blowdown valves for leakage.</p>
Flushing section of dust collector full of dust	<p>Check to see that filter is properly tightened against filter retainer. Retainer must also be secure.</p> <p>Check filter for ruptures.</p> <p>Thoroughly clean the flushing section by use of air gun before resuming operation.</p>
Blower speed too slow	<p>Check flow control located adjacent to blower motor for proper setting.</p> <p>Check for defective hydraulic pump of motor. Replace as required.</p>

HYDRAULIC MOTOR

(009999-000)

of the difficulties which may be experienced with this hydraulic motor. The table also lists probable causes and possible remedies. We recommend that you check this table before disassembling the motor.

TROUBLESHOOTING

The troubleshooting table that follows lists some

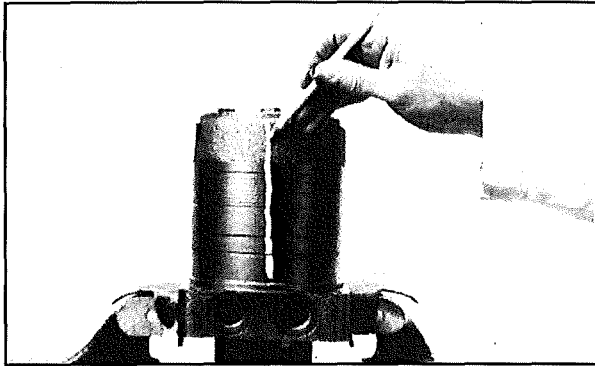
Problem	Cause	Remedy
Oil Leakage	<ol style="list-style-type: none"> Hose fittings loose, worn or damaged. Oil seal rings (4) deteriorated by excess heat. Loose or its sealing area deteriorated by corrosion. Internal shaft seal (16) worn or damaged. Worn coupling shaft (12) and internal seal (16). 	<p>Check & replace damaged fittings or "O" Rings. Torque to specifications.</p> <p>Replace oil seal rings by disassembling motor.</p> <p>(a) Loosen then tighten single bolt to torque specification.</p> <p>(b) Replace bolt.</p> <p>Replace seal. Disassembly of motor unit necessary.</p> <p>Replace coupling shaft and seal by disassembling motor.</p>
Significant loss of speed under load	<ol style="list-style-type: none"> Lack of sufficient oil supply. High internal motor leakage. Severely worn or damaged internal splines. Excessive heat. 	<p>(a) Check for faulty relief valve and adjust or replace as required.</p> <p>(b) Check for and repair worn pump.</p> <p>(c) Check for and use correct oil for temperature of operation.</p> <p>Replace worn rotor set by disassembling motor.</p> <p>Replace rotor set, drive link and coupling shaft.</p> <p>Locate excessive heat source (usually a restriction) in the system and correct the condition.</p>
Low mechanical efficiency or undue high pressure required to operate	<ol style="list-style-type: none"> Line blockage. Internal interference. Lack of pumping pressure. 	<p>Locate blockage source and repair or replace.</p> <p>Disassemble motor, identify and remedy cause and repair, replacing parts as necessary.</p> <p>Check for and repair worn pump.</p>

HYDRAULIC MOTOR TROUBLESHOOTING

DISASSEMBLY AND INSPECTION

1. Place the motor in a soft jawed vise, with coupling shaft (12) pointed down and the vise jaws clamping firmly on the sides of the housing (18) mounting flange or port bosses.

2. Scribe an alignment mark down and across the motor components from end cover (2) to housing (18) to facilitate reassembly orientation where required.



3. Remove the head bolts (1). Inspect the bolts for damaged threads, or sealing rings, under the bolt head. Replace damaged bolts.

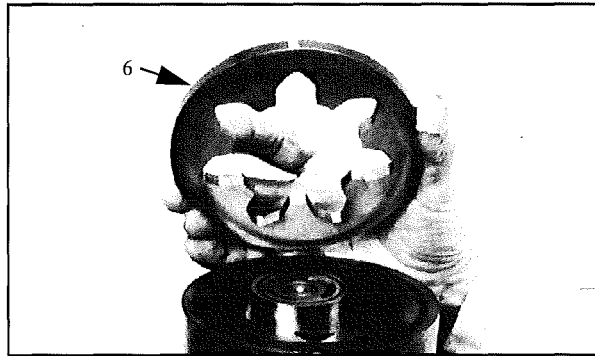
4. Remove end cover assembly (2) and seal ring (4). Discard the seal ring.

5. Thoroughly wash end cover (2) in a suitable solvent and blow dry. Inspect the end cover for cracks and the bolt head recesses for good bolt head sealing surfaces.

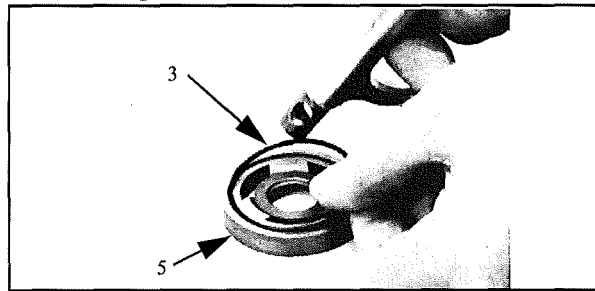
6. Remove commutator ring (6). Inspect commutator ring for cracks, or burrs.

NOTE!

A polished pattern (not scratches) on the cover from rotation of the commutator (5) is normal. Discoloration would indicate excess fluid temperature, thermal shock, or excess speed and require system investigation for cause and close inspection of end cover, commutator, manifold, and rotor set



7. Remove commutator (5) and seal ring (3). Remove seal ring from commutator, using an air hose to blow air into ring groove until seal ring is lifted out and discard seal ring. Inspect commutator for cracks or burrs, wear, scoring, spalling or brinelling.

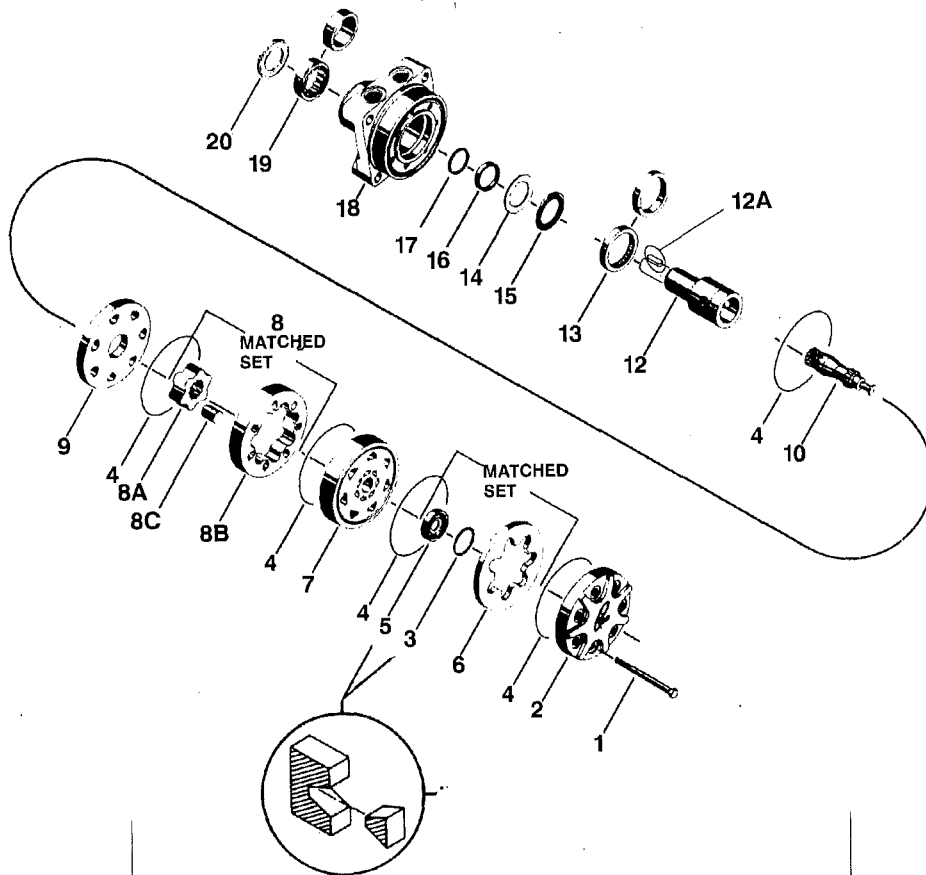
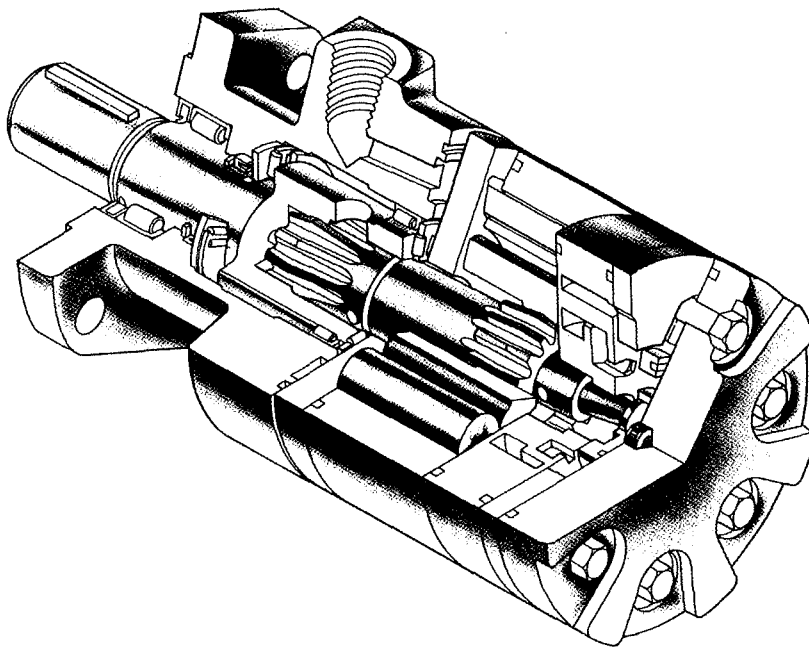


8. Remove manifold (7) and inspect for cracks, surface scoring, brinelling or spalling. A polished pattern on the ground surface from commutator or rotor rotation is normal. Remove and discard the seal rings (4) that are on both sides of the manifold.

NOTE!

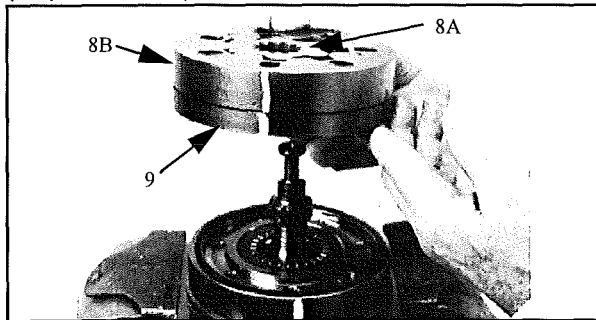
The manifold is constructed of plates bonded together to form an integral component not subject to further disassembly for service. Compare configuration of both sides of the manifold to ensure that same surface is reassembled against the rotor set

9. Remove rotor set (8) and wearplate (9) together to retain the rotor set in its assembled form, maintaining the same rotor vane (8C) to stator (8B) contact surfaces.



NOTE!

The drive link (10) may come away from the coupling shaft (12) with the rotor set, and wearplate. You may have to shift the rotor set on the wearplate to work the drive link out of the rotor (8A) and wearplate.



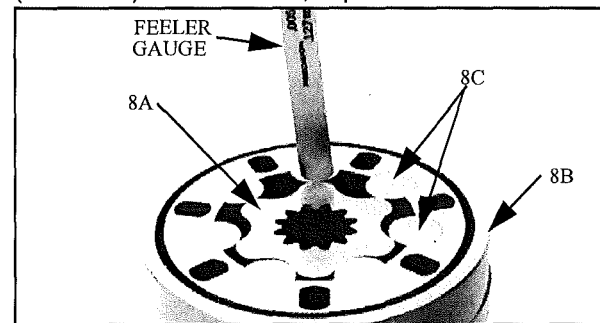
10. Inspect the rotor set in its assembled form for nicks, scoring, or spalling on any surface and for broken or worn splines. If the rotor set component requires replacement, the complete rotor set must be replaced as it is a matched set. Inspect the wearplate for cracks, brinelling, or scoring. Discard seal ring (4) that is between the rotor set and wearplate.

NOTE!

The rotor set (8) components may become disassembled during service procedures. Marking the surface of the rotor and stator that is facing UP, with etching ink or grease pencil before removal from the motor will ensure correct reassembly of rotor into stator and rotor set into the motor. Marking all rotor components and mating spline components for exact repositioning at assembly will ensure maximum wear life and performance of the rotor set and the motor.

11. Place rotor set (8) and wearplate (9) on a flat surface and center rotor (8A) in stator (8B) such that two rotor lobes (180° apart) and a roller vane (8C) centerline are on the same stator centerline. Check the rotor lobe to roller vane clearance with a feeler gauge at this common centerline. If there is more than .005 inches

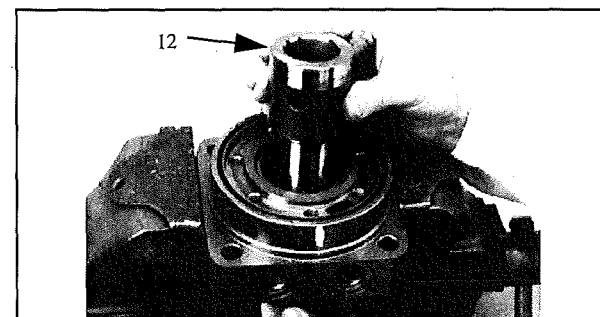
(0.13 mm) of clearance, replace the rotor set.



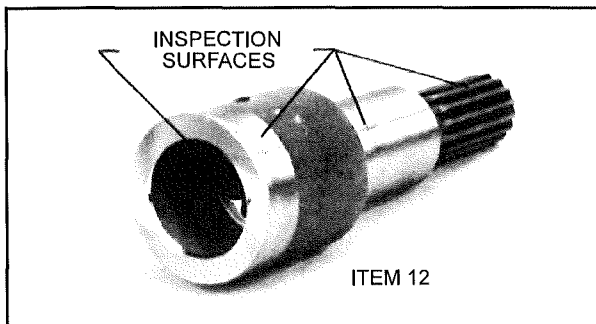
12. Remove drive link (10) from coupling shaft (12) if it was not removed with rotor set and wearplate. Inspect drive link for cracks and worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts. Remove and discard seal ring (4) from housing (18).

13. Check the output end of coupling shaft (12) to be sure you have removed all signs of rust and corrosion which might prevent its withdrawal through the seal and bearing. Crocus cloth or fine emery paper may be used.

14. Remove coupling shaft (12), by pushing on the output end of shaft. Inspect coupling shaft bearing and seal surfaces for spalling, nicks, grooves, severe wear or corrosion and discoloration.

**NOTE!**

Minor shaft wear in seal area is permissible. If wear exceeds .020 inches (0.51 mm) diametrically, replace coupling shaft.

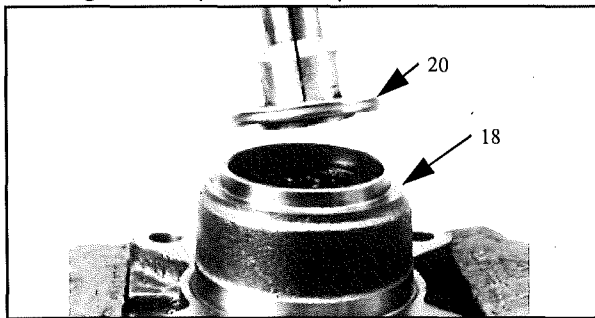
**NOTE!**

A slight "polish" is permissible in the shaft bearing areas. Anything more would require coupling shaft replacement.

15. Remove thrust bearing (15) and thrust washer (14). Inspect for wear, brinelling, corrosion and a full complement of retained rollers.

16. Remove seal (16) and back up washer (17) from housing (18). Discard both.

17. Remove housing (18) from vise, invert it and remove and discard seal (20). A blind hole bearing or seal puller is required.



18. Inspect housing (18) assembly for cracks, the machined surfaces for nicks, burrs, brinelling or corrosion. Remove burrs that can be removed without changing dimensional characteristics. Inspect tapped holes for thread damage.

19. If the housing (18) assembly has passed inspection to this point, inspect the housing bearings/bushings (19) and (13) and if they are captured in the housing cavity the thrust washers (14) and thrust bearing (15). The bearing

rollers must be firmly retained in the bearing cages, but must rotate and orbit freely. All rollers and thrust washers must be free of brinelling and corrosion.

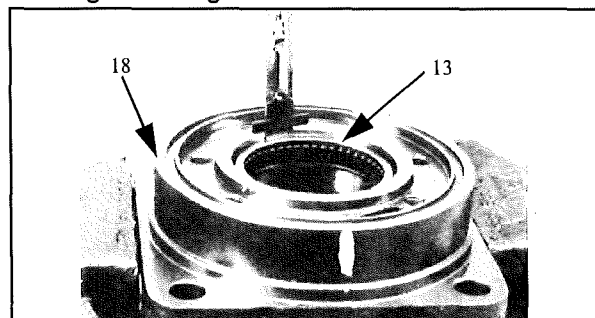
NOTE!

The bushing (19) or (13) to coupling shaft diameter clearance must not exceed .010 inch (.025 mm). A bearing, bushing, or thrust washer that does not pass inspection must be replaced.

20. If the bearings, bushing or thrust washers must be replaced use a bearing puller to remove bearing/bushings (19) and (13) from housing (18) without damaging the housing. Remove thrust washers (14) and thrust bearing (15) if they were previously retained in the housing by bearing (13). Discard the bearing/bushing (19) and (13).

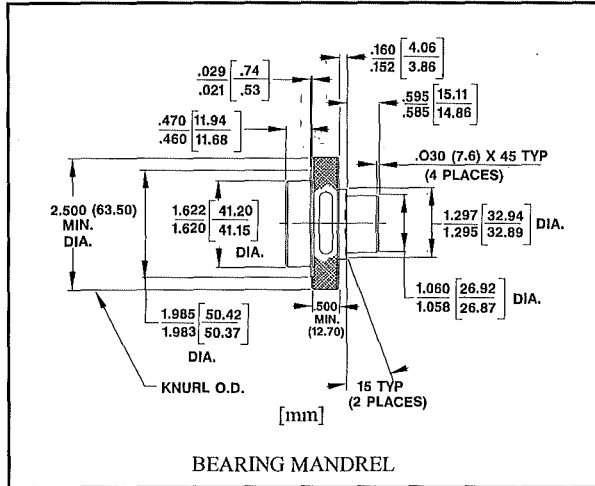
NOTE!

The depth or location of bearing/bushing (13) in relation to the housing wearplate surface and the depth or location of bearing/bushing (19) in relation to the beginning of bearing/bushing counterbore should be measured and noted before removing the bearings/bushings. This will facilitate the correct reassembly of new bearings/bushings.

**ASSEMBLY****NOTICE**

If the bearing mandrel specified is not available and alternate methods are used to press in bearing/bushing (13) and (19) the

bearing/bushing depths specified must be achieved to ensure adequate bearing support and correct relationship to adjacent components when assembled.



1. If housing (18) bearing components were removed for replacement, thoroughly coat and pack the outer bearing/bushing (19) with clean corrosion resistant grease. Press the new bearing/bushing into the counterbore at the mounting flange end of the housing, using the bearing mandrel which will control the bearing/bushing depth of 0.151/0.161 inches (3.84/4.09 mm) from the end of the bearing counterbore.

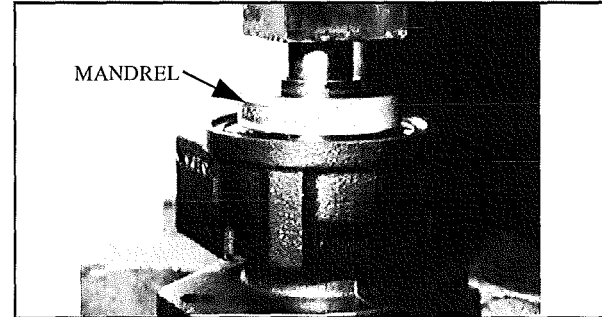
NOTE!

Bearing mandrel must be pressed against the lettered end of bearing shell. Take care that the housing bore is square with the press base and the bearing/bushing is not cocked when pressing a bearing/bushing into the housing.



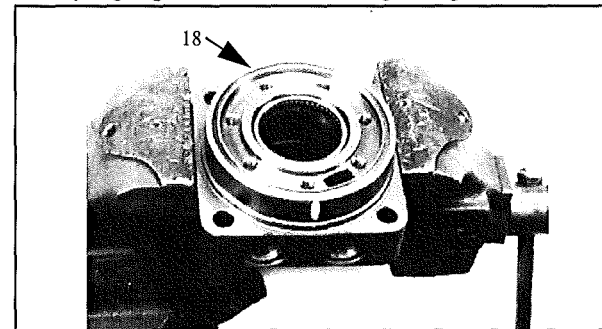
2. Bearing/bushing (19) and (13) can now be pressed into its counterbore in housing (18)

flush to .03 inch (.76 mm) below the housing wearplate contact face. Use the opposite end of the bearing mandrel that was used to press in the outer bearing/bushing.



3. Press the dirt and water seal (20) into the housing (18) outer bearing counterbore until it is flush.

4. Place housing (18) assembly into a soft jawed vise with the coupling shaft bore down, clamping against the mounting flange.



5. Assemble the back up washer (17) and the seal (16) with the seal lip facing toward the inside of the motor into their respective counterbores in housing (18).

6. Assemble thrust washer (14) then thrust bearing (15).

NOTE!

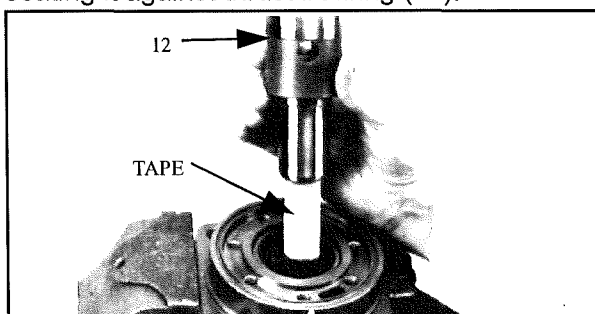
The coupling shaft will be seated directly against the thrust bearing.

7. Apply masking tape around the keyway on shaft (12) to prevent damage to seal (16).

NOTICE

The outer bearing (19) is not lubricated by the system's hydraulic fluid. Be sure it is thoroughly packed with the grease (included in each seal kit).

8. Be sure that a generous amount of clean corrosion resistant grease has been applied to the lower (outer) housing bearing/bushing (19). Install the coupling shaft (12) into housing (18), seating it against thrust bearing (15).



NOTE!

The coupling shaft (12) will be flush or just below the housing wearplate surface.

9. Apply a small amount of clean grease to a seal ring (4) and insert it into the housing (18) seal ring groove.

NOTE!

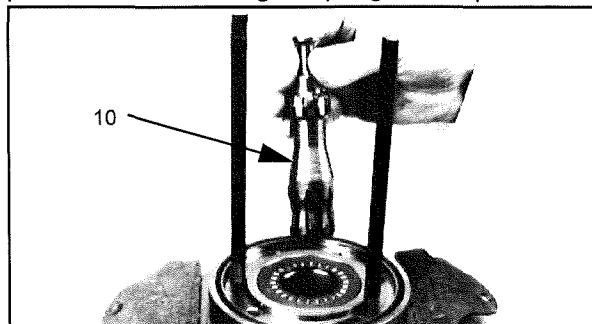
One or two alignment studs screwed finger tight into housing (18) bolt holes, approximately 180° apart, will facilitate the assembly and alignment of components as required in the following procedures. The studs can be made by cutting off the heads of either 3/8-24 UNF 2A or 5/16-24 UNF 2A bolts as required that are over .5 inch (12.7 mm) longer than the bolts (1).

10. Install drive link (10) the long splined end down into the coupling shaft (12) and engage the drive link splines into mesh with the coupling shaft splines.

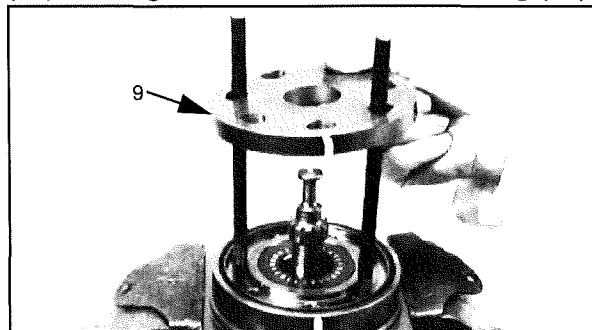
NOTE!

Use any alignment marks put on the coupling shaft and drive link before disassembly to

assemble the drive link splines in their original position in the mating coupling shaft splines.



11. Assemble wearplate (9) over the drive link (10) and alignment studs onto the housing (18).



12. Apply a small amount of clean grease to a seal ring (4) and assemble it into the seal ring groove on the wearplate side of the rotor set stator (8B).

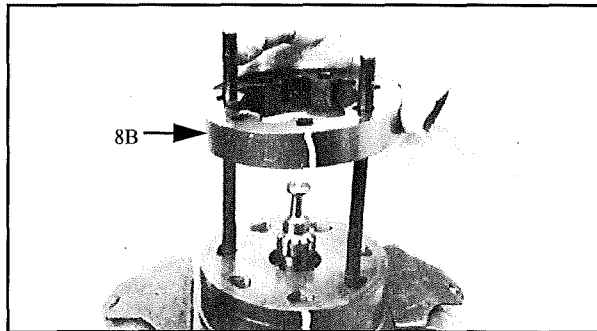
13. Install the assembled rotor set (8) onto wearplate (9) with rotor (8A) counterbore and seal ring side down and the splines into mesh with the drive link splines.

NOTE!

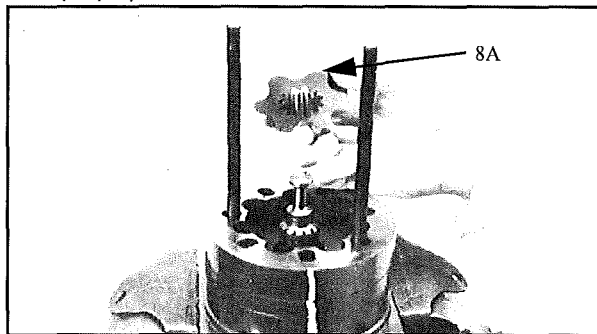
It may be necessary to turn one alignment stud out of the housing (18) temporarily to assemble rotor set (8) or manifold (7) over the drive link.

If necessary, use the following procedures to assemble the rotor and vane assembly.

A. Place stator (8B) onto wearplate (9) with seal ring (4) side down. Be sure the seal ring is in place.



B. Assemble the rotor (8A), counterbore down if applicable, into stator (8B), and onto wear-plate (9) with rotor splines into mesh with drive link (19) splines.

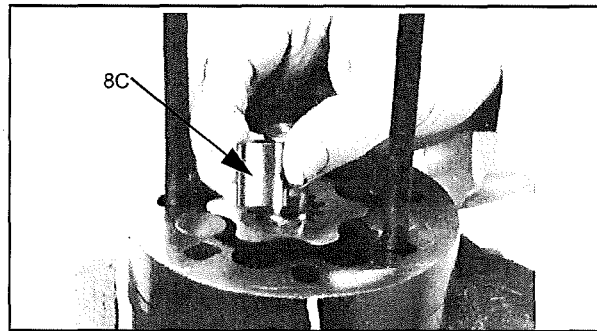


NOTE!
If the manifold side of the rotor was etched during disassembly, this side should be up. If the rotor is not etched and does not have a counterbore, use the drive link spline contact pattern apparent on the rotor splines to determine the rotor side that must be against the wearplate.

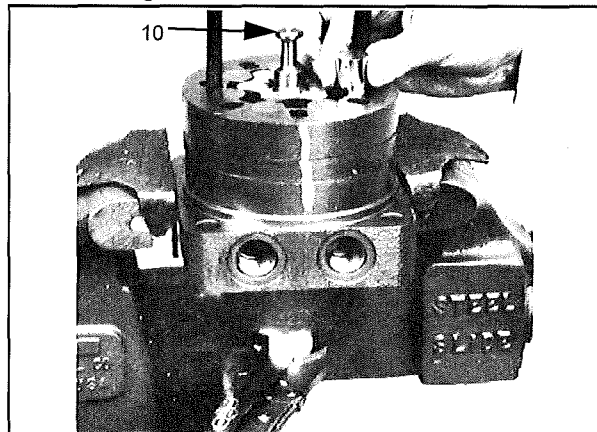
NOTICE

Excessive force used to push the rotor vanes into place could shear off the coating applied to the stator vane pockets.

C. Assemble six vanes (8C), or as many vanes that will readily assemble into the stator vane pockets.



D. Grasp the output end of coupling shaft (12) with locking pliers or other appropriate turning device and rotate coupling shaft, drive link and rotor to seat the rotor and the assembled vanes (8C) into stator (8B), creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force.



E. Remove the two assembled bolts (1) if used to retain stator and wearplate.

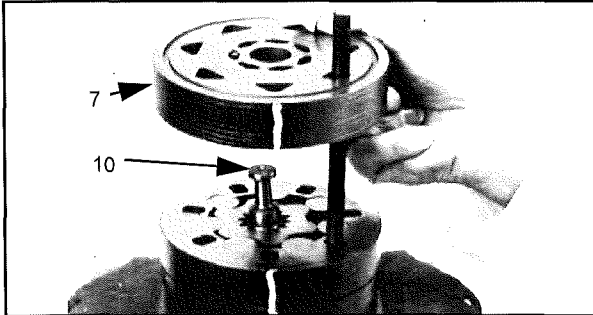
14. Apply clean grease to the seal ring (4) and assemble it in the seal ring groove in the rotor set contact side of manifold (7).

NOTICE

Manifold (7) is made up of several plates bonded together permanently to form an integral component. The manifold surface that must contact the rotor set has it's series of irregular shaped cavities on the largest circumference or circle around the inside

diameter. The polished impression left on the manifold by the rotor set is another indication of which surface must contact the rotor set.

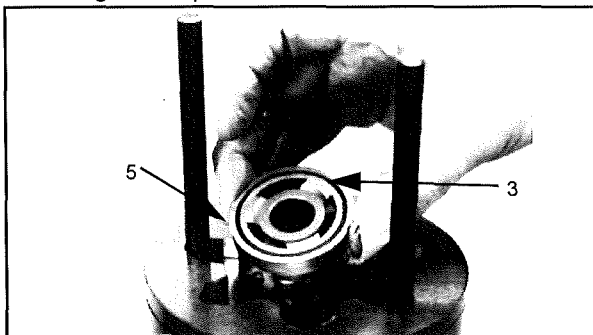
15. Assemble the manifold (7) over the alignment studs and drive link (10) and onto the rotor set. Be sure the correct manifold surface is against the rotor set.



16. Apply grease to the seal ring (4) and insert it in the seal ring groove exposed on the manifold.

17. Assemble the commutator ring (6) over alignment studs onto the manifold.

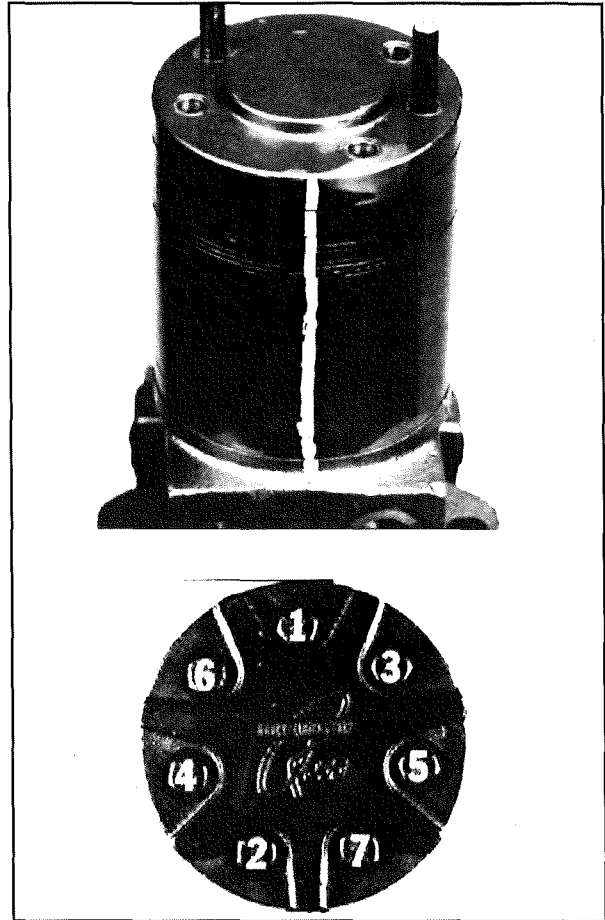
18. Assemble the seal ring (3) flat side up, into commutator (5) and assemble commutator over the end of drive link (10) onto manifold (7) with seal ring side up.



19. Assemble the seal ring (4) into end cover (2) and assemble end cover over the alignment studs and onto the commutator set.

20. Assemble the bolts (1) and screw in finger tight. Remove and replace the two alignment studs with bolts after the other bolts are in place. Alternately and progressively tighten the

bolts to pull the end cover and other components into place with a final torque of 22-26 ft. lbs. (30-35 N m).



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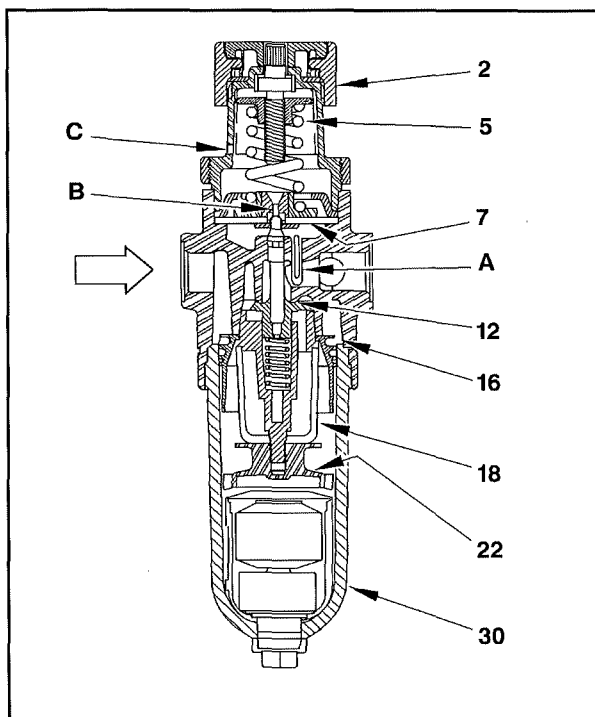
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FILTER/REGULATOR (010756-101)

OPERATION

This filter/regulator performs two functions in a compressed air system:

- A. It removes most solid and liquid particles from the compressed air.
- B. It maintains a nearly constant outlet pressure despite changes in the inlet air pressure and changes in downstream flow requirements.



Air entering the filter/regulator is guided into a swirling pattern by the louvers (16). Coarse solid particles and liquids are forced to bowl wall (30) by centrifugal force and drop to the bottom. Baffle (22) creates a quiet zone at the bottom of the bowl and prevents air turbulence from picking up liquids and returning them to the air stream. Air leaving the bowl passes through the filter element (18) where most finer solid particles are retained.

Clean air flows upward from the element to the regulator valve (12). The working parts of the pressure regulator section are diaphragm (7), regulating spring (5), valve (12), and adjustment knob (2). One side of diaphragm (7) is referenced to the outlet (secondary) side of the regulator through aspirator tube (A).

With adjustment knob (2) turned counterclockwise until no load is applied to regulating spring (5), the valve is closed. When adjustment knob (2) is turned clockwise, force is applied to regulating spring (5) which causes diaphragm (7) to move downward and open the valve. The increase in secondary (regulated) pressure acting against the lower (pressure) side of diaphragm (7), creates a force tending to move the diaphragm upward, compressing regulating spring (5). This upward movement will continue until the force exerted by the pressure on the lower side of diaphragm (7) balances the spring force exerted on the upper side. If there is no downstream flow demand, this balance of forces will occur with the valve open just the amount necessary to compensate for the demand, thus maintaining the desired pressure.

The regulator shown is a relieving type and should a secondary overpressure occur, diaphragm will move further upward and open relief passage (B) in the diaphragm. This allows secondary air to escape into the regulator bonnet and to vent (C).

However, the flow capacity of the relief passage is limited, and depending upon the source of the overpressure condition, the outlet pressure might increase to a point significantly higher than the filter/regulator setting. For this reason, the relief feature of a filter/regulator must not be relied upon as an overpressure safety device.

ADJUSTMENT

1. Before turning on system air pressure, turn filter/regulator adjustment counterclockwise until all load is removed from regulating spring.

2. Turn on system air pressure.
3. Turn filter/regulator adjustment (2) clockwise until the desired outlet pressure is reached.
4. To avoid minor readjustment after making a change in pressure setting, always approach the desired pressure from a lower pressure. When reducing from a higher to a lower setting, first reduce to some pressure less than that desired, then bring up to the desired point.
5. Push the lockring on adjusting knob (2) downward to lock the pressure setting. To release, pull the lockring upward. Pressure settings can be made tamper resistant by installing a seal wire in the groove above the lockring.

SERVICING

The liquid level in bowl (30) should always be below baffle (22). If the liquid level rises above the baffle, liquid will be carried downstream. Replace filter element (18) when plugged or dirty.

OVERHAUL

The filter/regulator can be disassembled without removal from the air line. To disassemble, shut off inlet air pressure. Reduce air pressure to zero in lines both upstream and downstream of filter/regulator.

Filter Section

Unscrew and remove bowl(30) and gasket (29). Remove automatic drain items (24, 25, 27, 28) from the bowl. Unscrew and remove baffle (22) and filter element (18).

Clean the bowl using warm water only. Clean other parts using warm water and soap. Blow clean dry air through the filter element from inside to outside to dislodge surface contaminants. Dry the parts and blow out internal passages in the body using clean, dry compressed air. Inspect each part carefully. Replace any parts that are damaged.

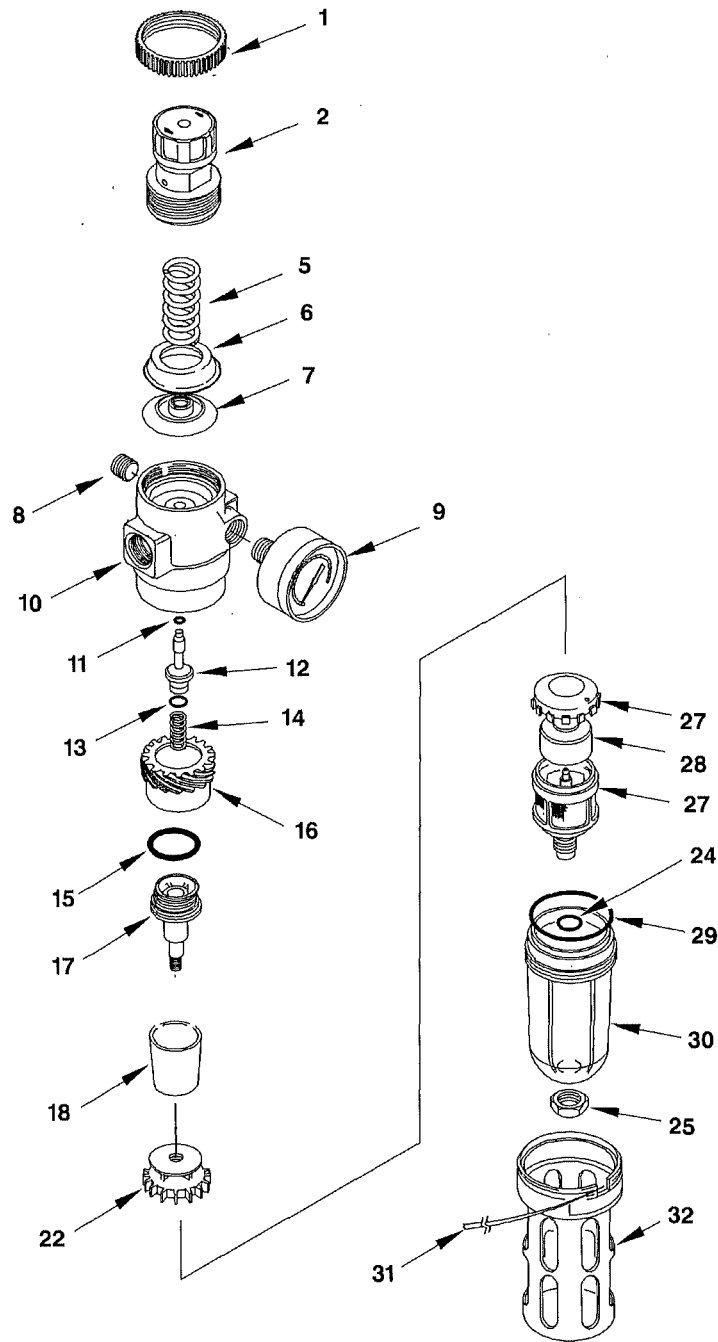
At reassembly, apply a wipe coat of Dow corning 44M grease or equivalent to gasket (29). Tighten baffle (22) 1/4 to 1/2 turn past the point of initial contact with element (18), **DO NOT OVER TIGHTEN**. When reinstalling the automatic drain in bowl, torque retaining nut (25) to 20-25 in-lbs (2.5 Nm). Apply a light coating of antiseize compound (Armitte Laboratories Led-Plate No. 250 or equivalent) to the full length of the threads on bowl (32) before assembly to body. Tighten the bowl by hand.

Regulator Section

Turn adjusting knob (2) counterclockwise until all load is removed from regulating spring (5). Unscrew bonnet assembly (2), spring (5), slip ring (6), and diaphragm (7) from body (10). Remove the filter section as described previously. Unscrew and remove centerpost (17) together with gasket (15), louver-deflector (16) and valve spring (14). Pull valve (12) together with O-rings (11 and 13) out of body.

Clean regulator parts using warm water and soap. Do not immerse bonnet assembly (2) for cleaning as lubricant will be removed. Dry parts thoroughly. Inspect all parts carefully. Replace any parts that are damaged.

At reassembly, apply a light coat of Dow Corning 44M grease or equivalent, to O-rings (11 and 13), gasket (15), and to the valve stem bore in body (10) and valve body bore in centerpost (17). Insert valve assembly (11, 12, 13) into body (10). Place louver-deflector (16) and gasket (15) on centerpost (17), drop valve spring (14) in centerpost, install centerpost in body and tighten until snug.



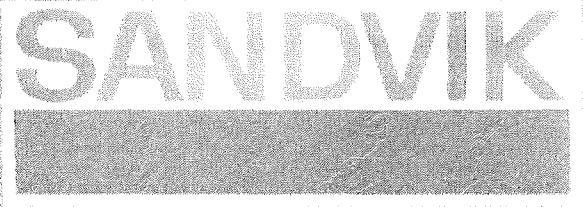
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Apply a light coat of Lubriplate 110 or equivalent, to adjusting screw threads inside bonnet (2). Apply a light coat of antiseize compound to the lower half of threads on bonnet (2). Stack diaphragm (7), slipring (6), regulating spring (5) in upper section of body. Screw bonnet (2) into body. Turn adjusting knob counterclockwise to ensure all load is removed from regulating spring. Tighten the bonnet to 25-30 ft-lbs (34-41 Nm) of torque.

Reassemble the filter section as described in this section.

SECTION 12

AIR LUBRICATOR SYSTEM



LUBRICATOR PUMP (011353-000)

GENERAL

The following procedures describe the operation and the overhaul of the air lubricator pump.

OPERATION

Lubricant enters through pump port 'F', filling pumping chamber 'G'. Pressurized air is applied at cylinder port 'H' moving the piston assembly forward, blocking the inlet and forcing the lubricant out through check valve 'J'.

Piston stop 'A' controls the quantity of discharge by limiting piston stroke. This piston is spring returned to the prime position when the motivat-

ing force is relieved from port 'H'. Residual pressure at port 'H' must fall below 2 PSI to permit full return stroke of the piston.

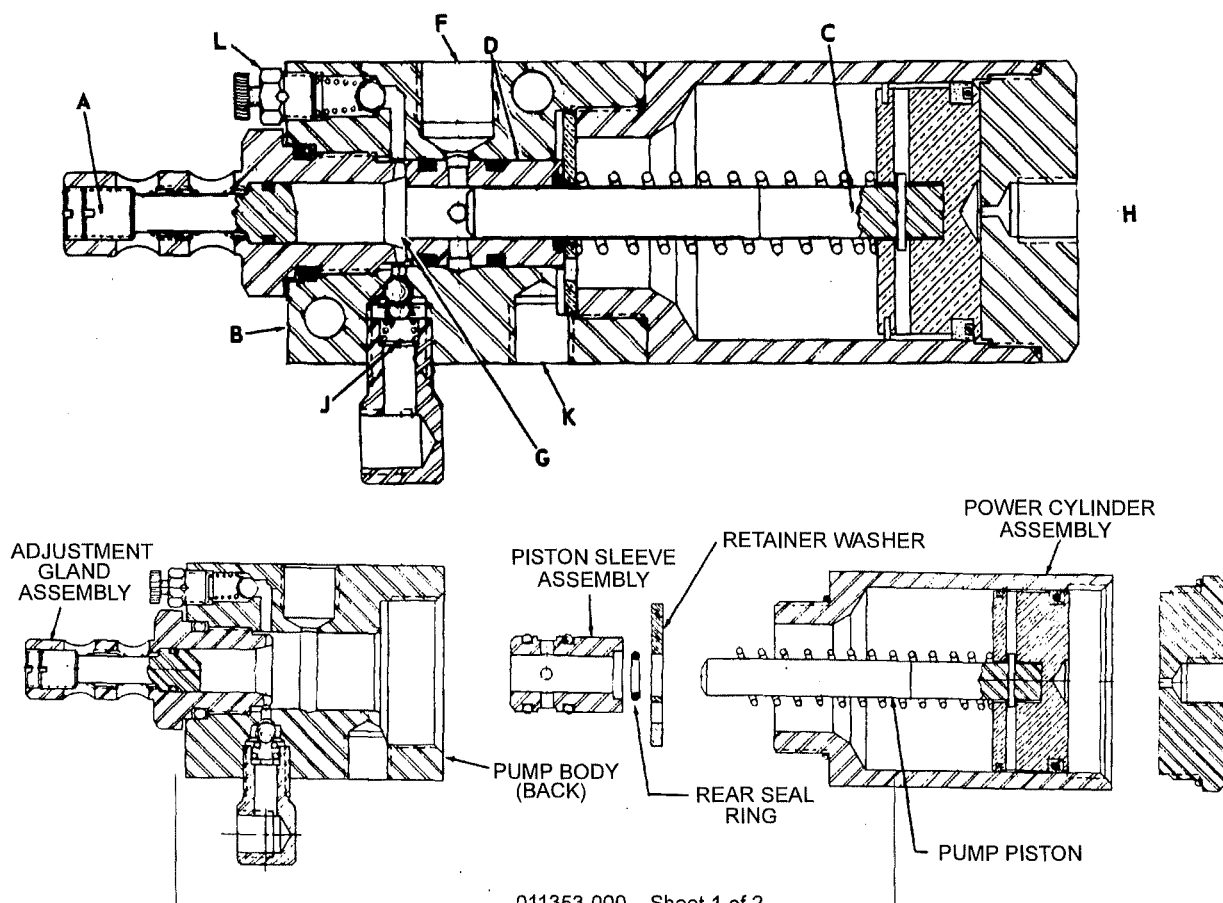
Air bleed 'L' is provided for purging the pumping chamber. The stainless steel ball used in the air bleed serves as a spare for the ball used in the outlet check valve assembly 'J'.

OVERHAUL

It is important that the pump be disassembled and assembled in the order described below to avoid damage to the piston sleeve O-rings.

Disassembly

1. Unthread and remove the power cylinder assembly.
2. Remove the retainer washer.



3. Unthread and remove the adjustment gland assembly.

NOTICE

Never remove the piston sleeve out of the adjustment gland end of the pump body. Sleeve o-rings will be sheared by cross ports in the pump body.

4. Push the piston sleeve assembly out the back of the pump body.

Assembly

1. Install the adjustment gland assembly. **Do not tighten fully.**
2. Install the piston sleeve assembly. Be sure rear seal ring is in place before installing retainer washer.
3. Assemble the power cylinder assembly, guiding the pump piston carefully into the piston sleeve assembly. Engage and fully tighten.
4. Snug up the adjustment gland last until it bottoms tightly against the piston sleeve assembly.

OIL INJECTION LUBRICATOR (011362-000)

GENERAL

The following topics aid in determining and adjusting the flow rate of air lubricating oil.

RECOMMENDED LUBRICATION

Correct lubrication during drilling operation is extremely important. Inadequate lubrication is a major cause of hammer wear and failure.

'Rock drill' oil is the only lubricant recommended by Sandvik for use in the Hammerdril® XL. Use the grade of rock drill oil that is proper for the climatic and operating conditions at the drill site. Use the following chart as a guide for selecting the proper grade rock drill oil to use.

When using new drill pipe or pipe that has not previously been coated with oil, pour a quart/liter of rock drill oil down the drill pipe each time a new joint of drill pipe is added.

One method to ensure the hammer is getting the recommended amount of oil to operate efficiently is to calculate '.15 -.25 quarts of oil per hour divided by 100 CFM'.

Example: XL 6/BA with a 3/8" choke uses 1335 SCFM.

$$\frac{1335 \times .2}{100} = 2.7 \text{ qts/hr}$$

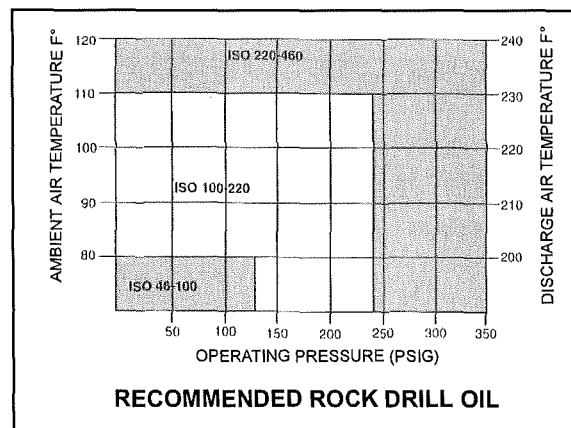
Check oil levels each shift. Monitor the oil delivery to the hammer by looking at oil dripping from the bit after each hole is drilled.

NOTE!

It is recommended that when drilling with water or foam injection, to use the next higher grade of Rock Drill oil. An alternative would be to increase the quantity of oil injected. Always consult the hammer manufacturer's specifications. Upon completing the drilling cycle, always

purge water from the hammer and cycle new clean Rock Drill oil into the hammer.

The hammer will not be damaged by too much oil, but it will be damaged by not enough oil.



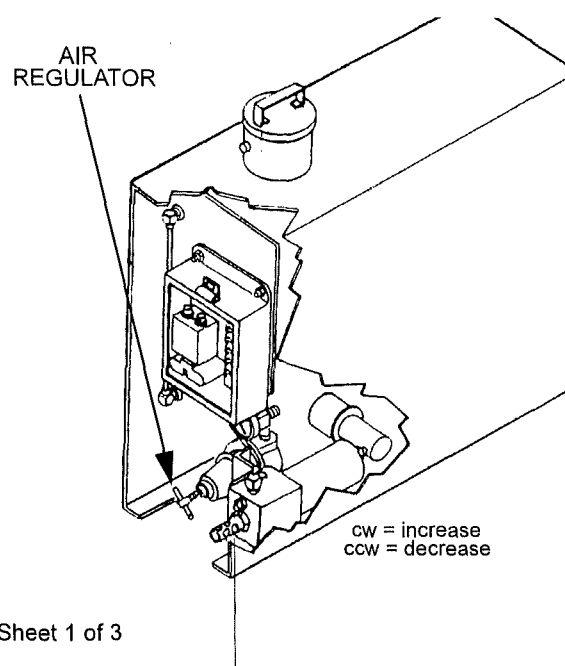
ADJUSTMENT

Air Pressure

The operating air pressure to the lubricator pump should be adjusted to the following:
Minimum Operating Air Pressure - 60 psi (4 bars)

Maximum Operating Air Pressure - 200 psi (13.8 bars)

Standard Air Regulator Setting - 60 psi (4 bars)



Pump Volume and Timer

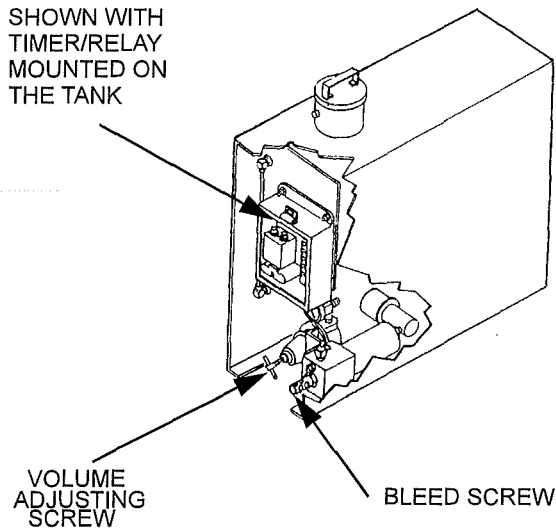
Adjust pump output volume as follows:

1. Add oil to the pump reservoir as required.
2. Using a screwdriver, thread the volume adjusting screw in (cw) completely and then out (ccw) per the following table.

PUMP STROKE SETTING	GPH (LPH)
* 10 Turns CCW	0.62 (2.3)
16 Turns CCW	1.00 (3.8)
20 Turns CCW	1.25 (4.7)

* Original factory setting.
Above values with timer set at 2 second intervals.

3. Open the air bleed screw in the pump.



4. Start the machine and place the lubricator switch in the 'ON' position.

NOTE!
The 'Working Air' must be 'ON' in Gator model

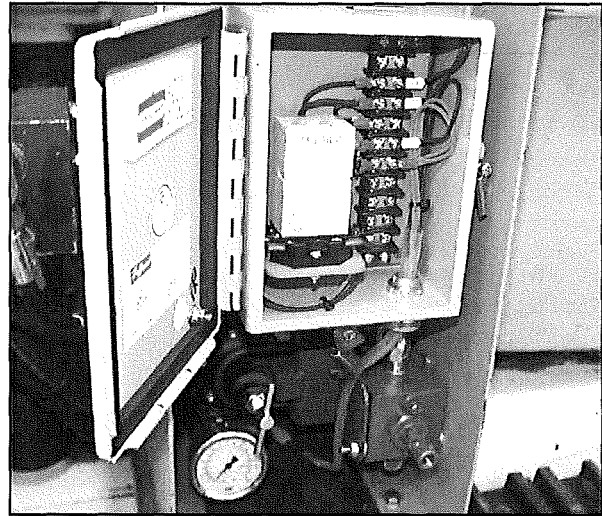
machines.

5. On machines with a 2 dial timer mounted on the lubricator tank, changes in the pump output can be made with the time 'OFF' knob but should not be attempted unless the pump stroke adjustment is not set at the desired output or cycle time is out of adjustment.

6. On machines with a 4 dial timer, part number 022397-001, adjust the timer to 20 cycles per minute as follows:

'T on'
white dial = 1-10s
blue dial = 1

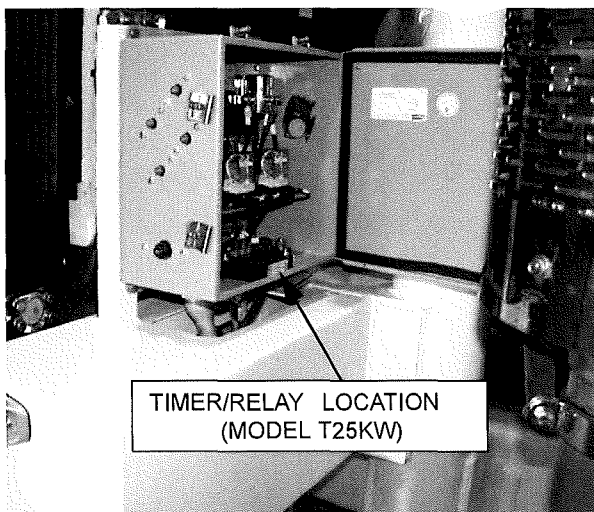
'T off'
white dial = 1-10s
blue dial = 2 to 6 (depending on oil grade)



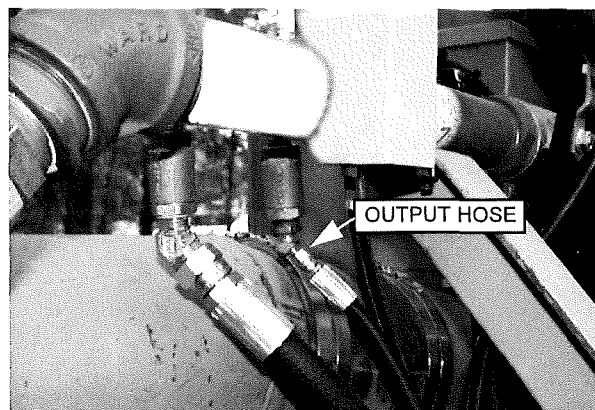
NOTE!
The timer/relays (022397-001 and 008765-003) mounted on the lubricator tank have been replaced. If ordered, a 025501-052 timer kit will be supplied.

7. To calibrate a 2 dial timer (025501-001) proceed as follows:

8. Locate the relay/timer, mounted in the engine control box on model T25KW machines and in the circuit breaker box in the cab.



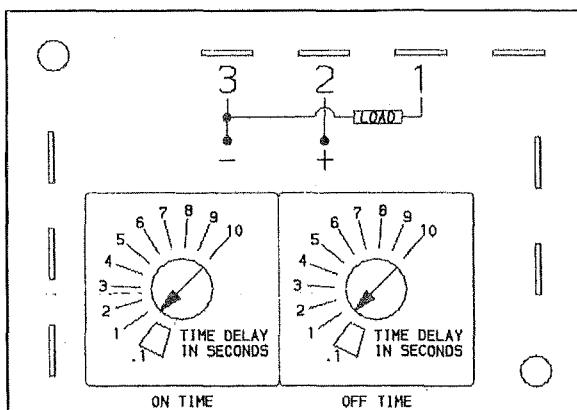
TIMER/RELAY LOCATION
(MODEL T25KW)



OUTPUT HOSE

9. Set the 'OFF TIME' to 6 to 8 seconds.

10. Set the 'ON TIME' to 1.5 to 2 seconds.



NEW TIMER 025501-001

11. Check the lubricator pulse light for the on/off cycle operation.

12. Tighten the pump bleed screw.

13. Remove the output hose connection at the air discharge piping to bleed the hose and ensure oil flow.

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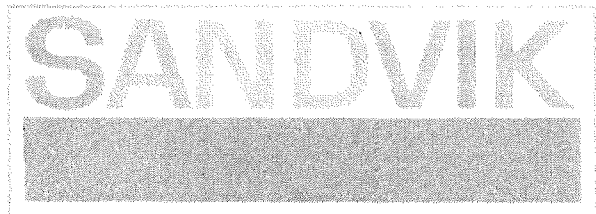
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SECTION 13

OPTIONAL SYSTEMS



FIRE SUPPRESSION SYSTEM

(006120-000 & 008836-000)

GENERAL

This topic gives descriptions of the fire suppression systems, how they operate, it explains what to do in case of fire, how to recharge the chemical tank and how to maintain the system.

DESCRIPTION

Two types of fire suppression systems are available; Manual and Electric Detection and Actuation.

MANUAL

This fire suppression system consists of three major components: a container to store the dry chemical extinguishing agent; an actuation device to trigger the system; and a delivery system to carry the dry chemical from the storage container to the fire.

The basic agent storage system is a tank filled with Ansul FORAY (monoammonium phosphate base) dry chemical which is effective on Class A, B and C fires. A gas expellant cartridge provides pressurization of the dry chemical upon actuation.

The dry chemical extinguishing agent is delivered from the tank through the hydraulic hose and pre-set nozzles into the fire prone areas or onto the fire prone surfaces.

ELECTRIC DETECTION AND ACTUATION

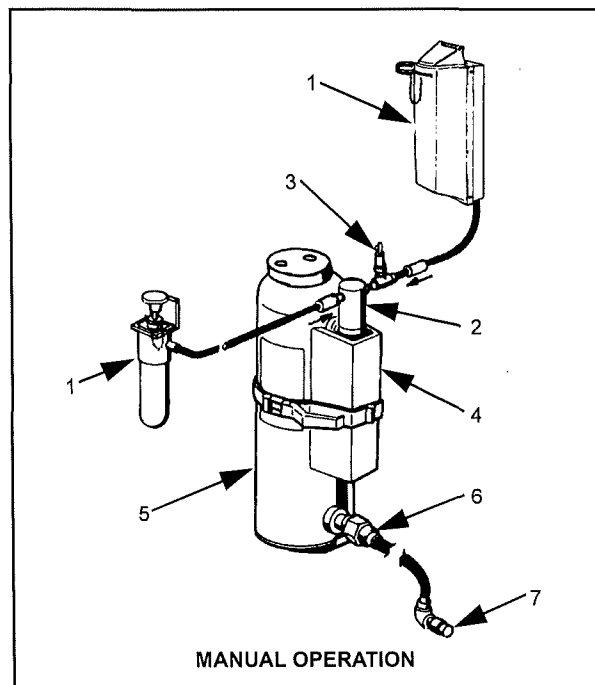
This fire suppression system consists of detection wire, a manual actuation device, a control module, a container to store the dry chemical extinguishing agent, and a delivery system to carry the dry chemical from the storage container to the fire.

The basic agent storage system is a tank filled with Ansul FORAY (monoammonium phosphate base) dry chemical which is effective on Class A, B and C fires. A gas expellant cartridge provides pressurization of the dry chemical upon actuation.

The dry chemical extinguishing agent is delivered from the tank through the hydraulic hose and pre-set nozzles into the fire prone areas or onto the fire prone surfaces.

OPERATION

Discharge of the fire suppression system is initiated manually from a remote actuator (1) or electrically when detection lines signal the system control module (refer to the figures).



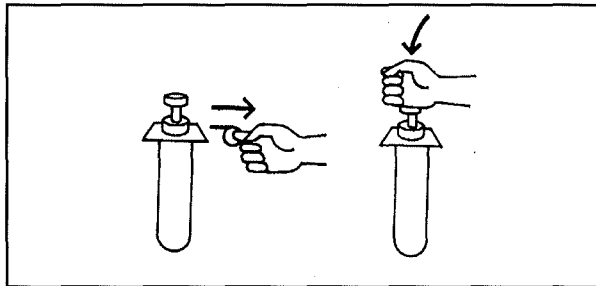
Depressing the actuator plunger punctures the seal on the cartridge. The released pressure is transmitted to the pneumatic actuator/cartridge receiver (2). A safety relief valve (3) at this point prevents too large an actuation pressure build-up. The pressure causes a seal in the expellant gas cartridge (4) to be pierced. This releases

the expellant gas which is then transmitted to the dry chemical tank (5) where it fluidizes the dry chemical before carrying it to the fire hazard. A bursting disc in the union assembly (6) prevents the flow of dry chemical until sufficient pressure is built up within the dry chemical tank. When the proper pressure is reached, the disc breaks allowing the gas/dry chemical mixture to flow to the nozzle(s) (7). The pressure at the nozzle(s) causes the nozzle cap to pop off or the self-closing cap to open and the dry chemical to be discharged.

IN CASE OF FIRE!

When a fire starts, the way you react is very important. As soon as you become aware of a fire, do the following four things:

1. Turn the machine off.
2. Quickly actuate the fire suppression system by pulling the safety ring pin and pushing down the plunger on the actuator.



3. Get away from your machine. Take a hand portable extinguisher along if you can.
4. Stand by with the hand portable extinguisher.

Results

If you leave the machine running, it may add

fuel to the fire or restart the fire with sparks.

React quickly so the fire is caught before it grows too large.

By leaving the immediate fire area, you protect yourself from windblown flames, explosions or other dangers created by the fire.

Heat remaining from the fire **could** cause re-ignition after the fire suppression system has discharged. Because of this, it is important that someone stand by, at a safe distance, with a hand portable extinguisher. This standby should be maintained until all possibility of re-ignition is past.

When a fire suppression system discharges, there is considerable noise accompanied by clouds of dry chemical. While breathing foreign particles is not pleasant, the agent FORAY is non-toxic and exposure during a fire will not harm you.

After the Fire is Out

Machinery should not be restarted until it has been serviced and cleaned (water may be used to remove the dry chemical). **Immediately** recharge the fire suppression system. You needed it once, you may need it again.

RECHARGE

1. Pull the ring on the safety relief valve to relieve actuation pressure.
2. Disconnect the actuation system hose at the cartridge receiver/actuator assembly.
3. Open the bursting disc union assembly.
4. Remove the dry chemical tank from its bracket.
5. Replace the ruptured bursting disc with the new disc. **FLAT SIDE OF DISC MUST FACE**

TANK. Verify that the proper disc is being used by referring to this machine's parts manual for the part number. Assemble the bursting disc union, wrench tighten.

6. Fill the tank to rated capacity with Ansul FORAY dry chemical as specified on the nameplate.

7. Clean the fill opening threads and gasket, and the fill cap threads. Coat the gasket lightly with a good grade of high heat resistant grease.

8. Secure the fill cap, hand tighten.

9. Loosen the bolts(s) on the expellant gas cartridge bracket or remove the cartridge guard.

10. Unscrew and remove the empty expellant gas cartridge.

11. Make certain that the puncture pin on the pneumatic actuator/cartridge receiver is fully retracted.

12. Obtain a new expellant gas cartridge and verify the proper part number by referring to this machine's parts manual. Weigh the new cartridge. The weight must be within 1/2 ounce of the weight stamped on the cartridge.

13. Screw the fully charged expellant gas cartridge into the pneumatic actuator/cartridge receiver, hand tighten.

14. Secure the expellant gas cartridge assembly in its proper position in the bracket with the cartridge retaining bolt(s) or return the cartridge guard.

15. Return the tank to its bracket and secure it.

16. Check all hose and fittings for mechanical damage. Replace any hose that has been exposed to fire.

17. Check the nozzles for mechanical damage. Clean them and install blow-off caps or silicone grease.

18. Pull up the button on the dashboard actuator(s) or the lever on the remote actuator(s) and insert the ring pin.

19. Remove the spent cartridge.

20. Obtain a new actuation gas cartridge and verify the proper part number by referring to this machine's parts manual. Weigh the new cartridge. The weight must be within 1/4 ounce of the weight stamped on the cartridge.

21. Connect the actuation system hose at the cartridge receiver/actuator assembly, wrench tighten.

22. Attach a lead and wire seal to the ring pin and actuation button or lever.

23. Install new detection wire (Electric Systems).

24. Notify operating personnel suppression system is back in service and record date of recharge.

MAINTENANCE

Daily Checks (Electric systems only)

1. Visually verify that the GREEN battery LED is flashing once every three seconds (replace the battery as required) and that no other LED is flashing on the control module.

2. Check that the detection lines are secure and not damaged.

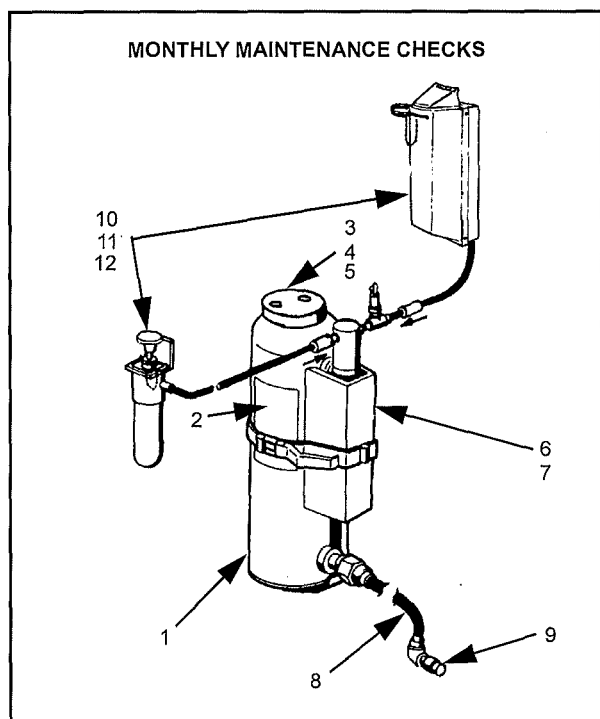
Monthly Checks (Electric and Manual systems)

To provide reasonable assurance that your fire suppression system is charged and operable:

The following figures are keyed to the maintenance steps.

1. Note the general appearance of the system components for mechanical damage or corrosion.
2. Check the nameplate(s) for readability.
3. Remove the fill cap.
4. Make certain the tank is filled with free-flowing Ansul FORAY dry chemical to a level of not more than 3 inches from the bottom of the fill opening.
5. Secure the fill cap, hand tighten.

9. Check the nozzle openings -- slot on F-1/2 nozzle should be closed (capped) with silicone grease or covered with plastic blow-off cap (4120).
10. Remove the cartridge from the manual actuator(s), and examine the disc -- the seal should be unruptured.
11. Return the cartridge to the manual actuator(s) assembly, hand tighten.
12. Replace any broken or missing lead and wire seals and record date of inspection.



6. Remove the expellant gas cartridge and examine the disc -- the seal should be unruptured.
7. Return the cartridge to the pneumatic actuator/cartridge receiver, hand tighten and secure in the bracket.
8. Check the hose, fittings and nozzles for mechanical damage and cuts.

Semi-Annual Checks (Electric and Manual systems)

To provide maximum assurance that your fire suppression system will operate effectively and safely:

1. Perform the monthly maintenance procedures.
2. Examine the fill cap gaskets for elasticity -- clean and coat lightly with a good grade of high heat resistant grease.
3. Inspect the threads on the fill cap and in the fill opening for nicks, burrs, cross-threading, rough or feathered edges.
4. Check the pressure relief vent in the fill opening threads for obstruction.
5. Engage the bursting disc union (wrench tighten).

NOTICE

Overtightening can damage the bursting disc.

6. Loosen the bolt(s) which restrain the cartridge or remove the extinguisher cartridge guard assembly.

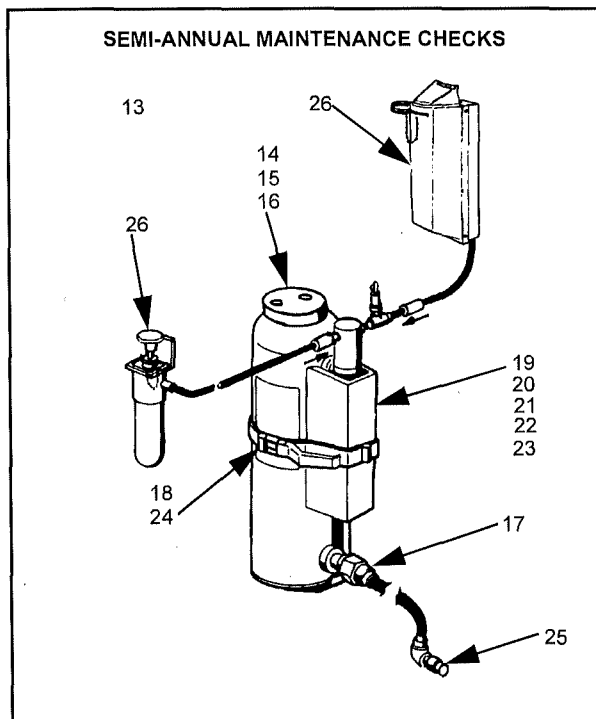
7. Inspect the expellant gas cartridge assembly for evidence of mechanical damage or corrosion.

8. Unscrew the cartridge from the pneumatic actuator/cartridge receiver and weigh it. Replace if its weight is not within 1/2 ounce of the weight stamped on the cartridge.

9. Inspect the threads on the cartridge and in the pneumatic actuator/cartridge receiver for nicks, burrs, cross-threading, rough or feathered edges.

13. Check the nozzle openings-- the slot should be closed (capped) with silicone grease or covered with plastic blow-off cap.

14. Check the remote actuator -- remove the cartridge and weigh (replace if weight is 1/4 ounce less than stamped on the cartridge). Inspect the threads on the cartridge and in the actuator for nicks, burrs, cross-threading, rough or feathered edges. Check pressure safety vent in actuator body for obstruction. Examine the actuator cartridge gasket for elasticity -- clean and coat lightly with a good grade of high heat resistant grease. Pull the ring pin and operate the actuator button several times to check for free movement.



10. Check the pressure vent in the pneumatic actuator/cartridge receiver for obstruction.

11. Examine the cartridge receiver gasket for elasticity. Clean and coat lightly with a good grade of high heat resistant grease. Return the cartridge pneumatic actuator/cartridge receiver, hand tighten.

12. Be sure the dry chemical tank is firmly mounted in its bracket.

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THREAD GREASE LUBRICATOR

(015587-001)

ASSEMBLY

1. Assemble the drum cover to the pump as follows:

- A. Remove the cover nut from the top of the pump. Lift the air motor cover from the pump.
- B. Remove the four screws holding cover bottom to the pump outlet body.
- C. Hold pump with pump outlet body resting securely on the inner surface of the cover-bottom. Insert end of pump tube through hole in drum cover. Line up holes in the drum cover, cover-bottom and pump outlet body.

2. Push the insert through follower with the small cone of the wiper body facing up. Place the insert retainer over the insert and align the holes on the insert and insert retainer. Secure the assembly with four self tapping screws.

3. Remove the drum top and insert the follower into the drum against the surface of the lubricant.

4. Insert the pump into the lubricant drum.

- A. Guide end of pump tube into the follower insert.

- B. Lower the pump tube into the lubricant drum until the drum cover rests on the top bead of the drum.

5. Assemble the lubricant hose to the pump outlet body. Connections must be leakproof.

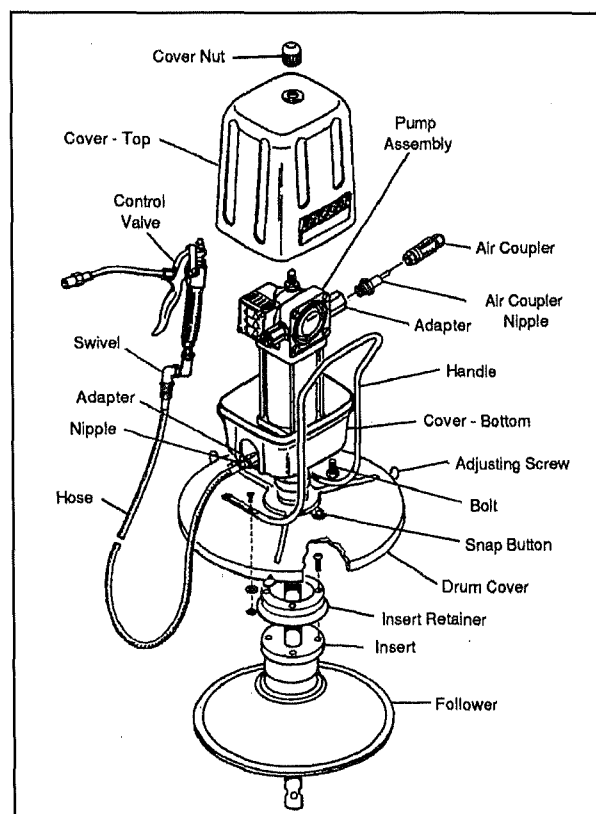
6. Replace air motor cover.

- A. Place the cover over the airmotor and position it over cover-bottom.

- B. Replace the cover nut on the pump stud to hold the airmotor cover securely in place.

- C. Assemble the nipple and adapter through the hole in side of airmotor cover and into airmotor. This connection must be leakproof.

7. Connect the air coupler to an air hose of sufficient length so the lubrigun can be used to cover the entire lubrication area.



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DRILL MONITOR SYSTEM (DMS) (015702-000)

The Drill Monitor System provides warning signals to the operator or automatically shuts down the machine (for critical out-of-limit conditions) in the event that the monitored conditions are not within safe limits. The system is provided with a thirty second delay for start up, a system test push button, audible alarm, and a "first out" indication for shut downs.

There are three different levels of fault sensing:

Level 1. Flashing amber light.

Level 2. Flashing amber light and audible alarm.

Level 3. Flashing red light, audible alarm, and machine shutdown.

The audible alarm can be silenced at any time by means of a silence push button. The light will continue to flash until the fault condition is cleared. Only one level three fault will be indicated at any one time (first out). This will allow the cause of the shutdown to be easily determined. Level three faults can be converted to alarm only, if desired, by an external wiring change.

SYSTEM OPERATION

In the event of a machine shutdown, after the problem is rectified, it is necessary to turn off the key switch at the start panel momentarily to reset the system and restart the 30 second time delay to start the engine.

The system operation should be checked once per shift by turning on the key switch and waiting 30 seconds to verify that a shutdown fault is indicated and that the fuel system is de-energized.

NOTE!

The click of the shutdown relay (SDR) contacts and the fuel system should be audible both ON and OFF (DMS pins 20 and 21).

Periodically a more comprehensive test should be made to verify that the sensors actuate at the proper settings and that disconnecting or grounding (depending on whether the sensor is normally open or normally closed) a sensor will indicate a fault.

NOTE!

On machines equipped with an engine electronic control module (ECM), engine oil pressure and coolant temperature and flow are monitored by the (ECM).

SYSTEM TEST

1. Before applying power to the monitor system, verify that all sensors are properly installed and that the wiring is correct.
2. On the backs of the monitor panels -002 and -003, ensure that DIP switches 1, 2, 5 and 8 are in the 'ON' position. For machines equipped with a low pressure compressor (100 psi - 6.9 bar), switch 12 should also be 'ON'.

NOTE!

On DMS panels 015702-002 and -003, the DIP switch numbers correspond to the sensor connected to the terminal labeled two digits higher than the switch number. (The sensors connected to terminals 3, 4, 7 and 10 are 'OPEN' under normal conditions and terminal 14 is 'OPEN' on machines with low pressure compressors.)

3. On the backs of the monitor panels -004 and -005, ensure that DIP switches 3, 4, 7 and 10 are in the 'ON' position. For machines equipped with a low pressure compressor (100 psi - 6.9 bar), switch 14 should also be 'ON'.
4. Turn the ignition key switch to 'ON' and verify that terminals 1 20 and 21 are +24 volts and the engine fuel solenoid has energized. After 30

seconds in the 'ON' position; the ALTERNATOR light should illuminate, the alarm should sound, the fuel solenoid should de-energize and the following lights should illuminate:

- COMPRESSOR OIL PRESSURE
- ENGINE OIL PRESSURE
- ENGINE COOLANT FLOW*

Push the ALARM SILENCE button.

5. Turn the ignition key switch to 'OFF' - then back to 'ON', and push the LAMP TEST button. All lights should illuminate. Release the button. Repeat step 2 after 30 seconds.

6. Turn the ignition key switch to 'OFF'. Connect jumper wires from terminals 13, 15 and 17 to ground to prevent the timed shutdown from activating. Check the operation of each monitored point as follows:

COMPRESSOR AIR FILTER

- A. Connect a jumper wire from M3 to ground-- COMPRESSOR AIR FILTER light illuminates.
- B. Disconnect jumper wire -- light off.

ENGINE AIR FILTER

- A. Connect a jumper wire from M4 to ground -- ENGINE AIR FILTER light illuminates.
- B. Disconnect jumper wire -- light off.

FUEL LEVEL

- A. Disconnect wire M5 from terminal 5 -- FUEL LEVEL light illuminates.
- B. Reconnect wire -- light off.

ENGINE COOLANT LEVEL

- A. Disconnect wire M6 from terminal 6 -- ENGINE COOLANT LEVEL light illuminates.
- B. Reconnect wire -- light off.

COMPRESSOR SEPARATOR

- A. Connect a jumper wire from M7 to ground -- COMPRESSOR SEPARATOR light illuminates.
- B. Disconnect jumper wire -- light off.

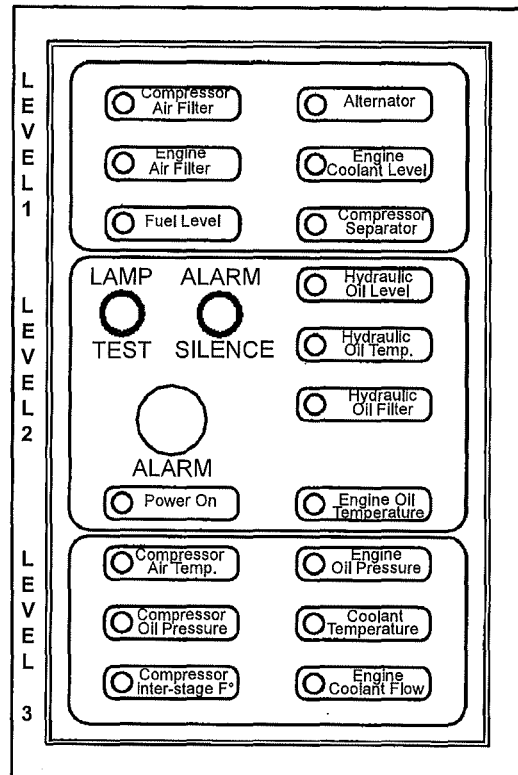
HYDRAULIC OIL LEVEL

- A. Disconnect wire M8 from terminal 8 -- HYDRAULIC OIL LEVEL light illuminates and alarm sounds.

- B. Push ALARM SILENCE button -- alarm off.
- C. Reconnect wire -- light off.

HYDRAULIC OIL TEMPERATURE

- A. Disconnect wire M9 from terminal 9 -- HYDRAULIC OIL TEMPERATURE light illuminates and alarm sounds.
- B. Push ALARM SILENCE button -- alarm off.
- C. Reconnect wire -- light off.



HYDRAULIC OIL FILTER PRESSURE

- A. Connect a jumper wire from M10 to ground -- HYDRAULIC OIL FILTER PRESSURE light illuminates and alarm sounds.
- B. Push ALARM SILENCE button -- alarm off.
- C. Reconnect wire -- light off.

ENGINE OIL TEMPERATURE

- A. Disconnect wire M11 -- ENGINE OIL TEMPERATURE light illuminates and alarm sounds.
- B. Push ALARM SILENCE button -- alarm off.
- C. Reconnect wire -- light off.

NOTE!

The following tests will de-energize the engine fuel solenoid. Reconnecting the wire should not cause the light to illuminate. It will be necessary to turn the ignition key to 'OFF, then 'ON' and wait 30 seconds between the testing of each point.

COMPRESSOR AIR TEMPERATURE

- A. Disconnect wire M12 from terminal 12 -- COMPRESSOR AIR TEMPERATURE light illuminates, and alarm sounds and fuel solenoid off.
- B. Push ALARM SILENCE button -- alarm off.
- C. Reconnect wire -- light still illuminated.
- D. Turn ignition key to 'OFF' then 'ON' -- light off.
- E. Reconnect wire 12.

COMPRESSOR OIL PRESSURE

- A. Disconnect the temporary ground wire from terminal 13 -- COMPRESSOR OIL PRESSURE light illuminates, and alarm sounds and fuel solenoid off.
- B. Push ALARM SILENCE button -- alarm off.
- C. Reconnect wire -- light still illuminated.
- D. Turn ignition key to 'OFF' then 'ON' -- light off.
- E. Replace temporary ground wire.

ENGINE OIL PRESSURE *

- A. Disconnect the temporary ground wire from terminal 15 -- ENGINE OIL PRESSURE light illuminates, and alarm sounds and fuel solenoid off.
- B. Push ALARM SILENCE button -- alarm off.
- C. Reconnect wire -- light still illuminated.
- D. Turn ignition key to 'OFF' then 'ON' -- light off.
- E. Replace temporary ground wire.

ENGINE COOLANT TEMPERATURE *

- A. Disconnect wire M16 from terminal 16 -- ENGINE COOLANT TEMPERATURE light illuminates, and alarm sounds and fuel solenoid off.
- B. Push ALARM SILENCE button -- alarm off.
- C. Reconnect wire -- light still illuminated.
- D. Turn ignition key to 'OFF' then 'ON' -- light off.

ENGINE COOLANT FLOW *

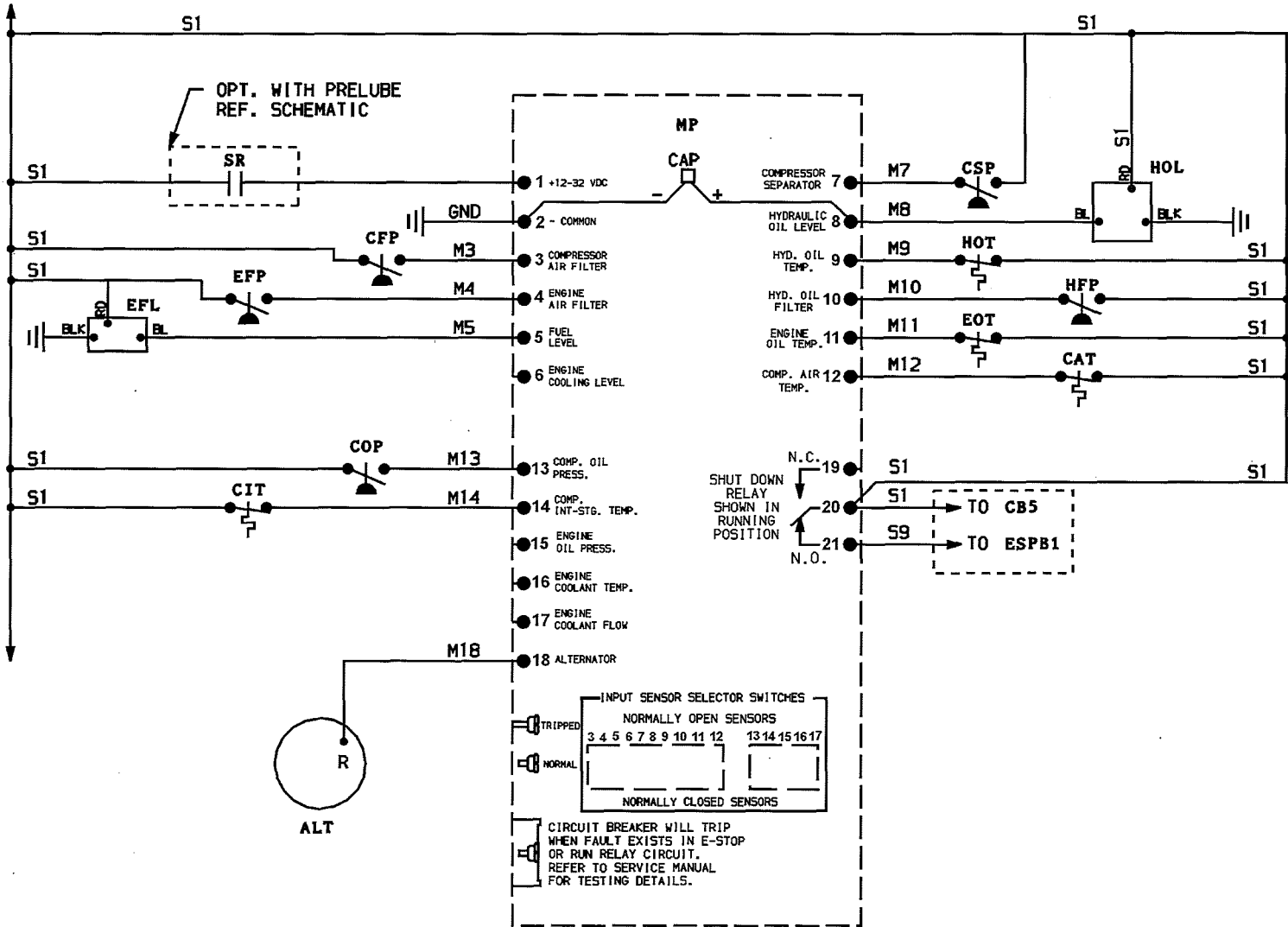
- A. Disconnect the temporary ground wire from terminal 17 -- ENGINE COOLANT FLOW light illuminates, and alarm sounds and fuel solenoid off.
- B. Push ALARM SILENCE button -- alarm off.
- C. Reconnect wire -- light still illuminated.
- D. Turn ignition key to 'OFF' then 'ON' -- light off.
- E. Reconnect the temporary ground wire.

ALTERNATOR

Verify the ALTERNATOR indicator light with the engine off by connecting a 12 volt supply to terminal 18 -- the ALTERNATOR light should go off. To check the alternator light with the engine running, disconnect wire M18 from terminal 18 - - the light should illuminate.

If all the above conditions are met and all the sensors are operational, remove the ground jumpers from terminals 13, 15 and 17. The engine can now be started. After starting the engine and the 30 second delay has elapsed, make one final check by disconnecting one of the level three sensors and verify the engine shutdown system and proper indication. (Wire M12, M13, M14, M15, M16 or M17.)

Panel Part Numbers 015702-004 and -005



DMS DIP SWITCH POSITION REFERENCE GUIDE

There are two DMS panel circuit board label designs. Part numbers 015702-002 and -003 use the same design and do not have a circuit breaker. Part numbers 015702-004 and -005 are the same design and include a circuit breaker. Both designs contain circuit board DIP switch settings that will differ with model, engine and compressor options, and these switch positions are based on a *RUN* condition.

Non-Circuit Breaker Panel DIP Switch Settings (015702-002 and -003)

Labeling

These circuit boards are labeled as follows:

- **Input sensor selector DIP switches 1- 15**
- **ON (up) for N.O. input sensors**
- **OPEN (down) for N.C. input sensors**

The following charts represent DMS - DIP switch positions based on history from 1991 to current applications. Note the machine model, application and vintage for proper DIP switch positions.

Boxes 1 – 15 representing (O) as DIP switch positions relative to the type of level, temperature or pressure switches used based on machine run modes for various equipment noted.

Low Pressure applications 1991 - 1996 engines with mechanical fuel system
D25KS/D240S/D245S, D40KS/D45KS/D50KS, D55SP, D60KS/D75KS

DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ON	O	O	O	O	O	O		O				O			
OPEN							O		O	O	O		O	O	O

High Pressure applications 1991 - 1996 engines with mechanical fuel system
D25KS/D245S, D40KS/D45KS, D55SP/D75KS

DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ON	O	O	O	O	O	O		O							
OPEN							O		O	O	O	O	O	O	O

Low Pressure applications 1996 to current electronic fuel systems
D25KS/D245S, D45KS/D50KS, D55SP/D75KS, DR460

DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ON	O	O	O	O	O	O		O				O	O	O	
OPEN							O		O	O	O				O

High Pressure applications 1996 to current electronic fuel systems
D25KS/D245S, D45KS, D55SP/D75KS

DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ON	○	○	○	○	○	○		○					○	○	
OPEN							○		○	○	○	○			○

Low Pressure applications 3508 MEUI fuel system
D90KS/D90KSP, 1190D/1190DSP

DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ON	○	○	○	○	○	○		○				○			
OPEN							○		○	○	○		○	○	○

Low Pressure applications 3512 MEUI fuel system
D90KS/D90KSP, 1190D/1190DSP

DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ON	○	○	○	○	○	○		○				○	○		
OPEN							○		○	○	○			○	○

Low pressure applications with electric motor
1190E/1190ESP

DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ON	○	○	○	○	○	○		○	○			○			○
OPEN							○			○	○		○	○	

Switch Ratings (Panels 015702-002 and -003)

The following switch ratings are based on new component parts. The normal contact position is without fluid, temperature or pressure. Refer to DMS - DIP switch positions relative to run mode.

1. Level sensors are normal open NO without fluid, close with fluid.
2. Temperature switches are normal closed NC and open with increasing temperature above the specific rate.
3. Pressure switches are normal open NO and close with pressure above the specific rate, low pressure allows switch to open.

Machine specific parts manuals contain switch locations and part numbers.
DMS groups 015802 and 020954 detail wire connection and switch locations.

Low Pressure applications

D25KS/D240S/D245S, D40KS/D45KS/D50KS, D55SP/D60KS/D75KS, DR460

TERMINAL / DIP SWITCH	ABBREVIATION	DESCRIPTION	CONTACTS	RATING
3 / 1	CFP	COMPRESSOR AIR FILTER PRESSURE	NO	22" H2O
4 / 2	EFP1/EFP2	ENGINE AIR FILTER PRESSURE	NO	22" H2O
5 / 3	EFL	ENGINE FUEL LEVEL	NO	N/A
6 / 4	ECL	ENGINE COOLANT LEVEL	NO	N/A
7 / 5	CSP	COMPRESSOR SEPARATOR PRESSURE	NO	10 PSI dP
8 / 6	HOL	HYDRAULIC OIL LEVEL	NO	N/A
9 / 7	HOT	HYDRAULIC OIL TEMPERATURE	NC	215° F
10 / 8	HFP	HYDRAULIC FILTER PRESSURE	NO	22 PSI
11 / 9	EOT	ENGINE OIL TEMPERATURE	NC	250° F
12 / 10	CAT	COMPRESSOR AIR TEMPERATURE	NC	230° F
13 / 11	CIT	COMPRESSOR OIL PRESSURE	NO	35 PSI 15 PSI
14 / 12	CIT	COMPRESSOR INTERSTAGE TEMPERATURE	NO	N/A
15 / 13	EOP	ENGINE OIL PRESSURE	NO	N/A
16 / 14	ECT	ENGINE COOLANT TEMPERATURE	NO	N/A
17 / 15	ECF	ENGINE COOLANT FLOW	NO	5 PSI
18 / none	ALT	ALTERNATOR CHARGE	X	24 VDC

High Pressure applications

D25KS/D240S/D245S, D40KS/D45KS, D55SP/D75KS

TERMINAL / DIP SWITCH	ABBREVIATION	DESCRIPTION	CONTACTS	RATING
3 / 1	CFP	COMPRESSOR AIR FILTER PRESSURE	NO	22" H2O
4 / 2	EFP1/EFP2	ENGINE AIR FILTER PRESSURE	NO	22" H2O
5 / 3	EFL	ENGINE FUEL LEVEL	NO	N/A
6 / 4	ECL	ENGINE COOLANT LEVEL	NO	N/A
7 / 5	CSP	COMPRESSOR SEPARATOR PRESSURE	NO	10 PSI dP
8 / 6	HOL	HYDRAULIC OIL LEVEL	NO	N/A
9 / 7	HOT	HYDRAULIC OIL TEMPERATURE	NC	215° F
10 / 8	HFP	HYDRAULIC FILTER PRESSURE	NO	22 PSI
11 / 9	EOT	ENGINE OIL TEMPERATURE	NC	250° F
12 / 10	CAT	COMPRESSOR AIR TEMPERATURE	NC	265° F
13 / 11	CIT	COMPRESSOR OIL PRESSURE	NO	90 PSI
14 / 12	CIT	COMPRESSOR INTERSTAGE TEMPERATURE	NC	250° F
15 / 13	EOP	ENGINE OIL PRESSURE	NO	N/A
16 / 14	ECT	ENGINE COOLANT TEMPERATURE	NO	N/A
17 / 15	ECF	ENGINE COOLANT FLOW	NO	5 PSI
18 / none	ALT	ALTERNATOR CHARGE	X	24 VDC

Low Pressure applications Caterpillar 3508
D90KS/D90KSP, 1190D/1190DSP

TERMINAL / DIP SWITCH	ABBREVIATION	DESCRIPTION	CONTACTS	RATING
3 / 1	CFP	COMPRESSOR AIR FILTER PRESSURE	NO	22 " H2O
4 / 2	EFP1/EFP2	ENGINE AIR FILTER PRESSURE	NO	22" H2O
5 / 3	EFL	ENGINE FUEL LEVEL	NO	N/A
6 / 4	ECL	ENGINE COOLANT LEVEL	NO	N/A
7 / 5	CSP	COMPRESSOR SEPARATOR PRESSURE	NO	10 PSI dP
8 / 6	HOL	HYDRAULIC OIL LEVEL	NO	N/A
9 / 7	HOT	HYDRAULIC OIL TEMPERATURE	NC	215° F
10 / 8	HFP	HYDRAULIC FILTER PRESSURE	NO	22 PSI
11 / 9	EOT	ENGINE OIL TEMPERATURE	NC	250° F
12 / 10	CAT	COMPRESSOR AIR TEMPERATURE	NC	230° F
13 / 11	COP	COMPRESSOR OIL PRESSURE	NO	35 PSI 15 PSI
14 / 12	CIT	COMPRESSOR INTERSTAGE TEMPERATURE	NO	N/A
15 / 13	EOP	ENGINE OIL PRESSURE	NO	35 PSI
16 / 14	ECT	ENGINE COOLANT TEMPERATURE	NO	230° F
17 / 15	ECF	ENGINE COOLANT FLOW	NO	5 PSI
18 / none	ALT	ALTERNATOR CHARGE	X	24 VDC

Low Pressure applications Caterpillar 3512
D90KS/D90KSP, 1190D/1190DSP

TERMINAL / DIP SWITCH	ABBREVIATION	DESCRIPTION	CONTACTS	RATING
3 / 1	CFP	COMPRESSOR AIR FILTER PRESSURE	NO	22 " H2O
4 / 2	EFP1/EFP2	ENGINE AIR FILTER PRESSURE	NO	22" H2O
5 / 3	EFL	ENGINE FUEL LEVEL	NO	N/A
6 / 4	ECL	ENGINE COOLANT LEVEL	NO	N/A
7 / 5	CSP	COMPRESSOR SEPARATOR PRESSURE	NO	10 PSI dP
8 / 6	HOL	HYDRAULIC OIL LEVEL	NO	N/A
9 / 7	HOT	HYDRAULIC OIL TEMPERATURE	NC	215° F
10 / 8	HFP	HYDRAULIC FILTER PRESSURE	NO	22 PSI
11 / 9	EOT	ENGINE OIL TEMPERATURE	NC	250° F
12 / 10	CAT	COMPRESSOR AIR TEMPERATURE	NC	230° F
13 / 11	COP	COMPRESSOR OIL PRESSURE	NO	35 PSI 15 PSI
14 / 12	CIT	COMPRESSOR INTERSTAGE TEMPERATURE	NO	N/A
15 / 13	EOP	ENGINE OIL PRESSURE	NC	35 PSI
16 / 14	ECT	ENGINE COOLANT TEMPERATURE	NO	230° F
17 / 15	ECF	ENGINE COOLANT FLOW	NO	5 PSI
18 / none	ALT	ALTERNATOR CHARGE	X	24 VDC

Low Pressure applications with electric motor
1190E/1190ESP

TERMINAL / DIP SWITCH	ABBREVIATION	DESCRIPTION	CONTACTS	RATING
3 / 1	CFP	COMPRESSOR AIR FILTER PRESSURE	NO	22 " H2O
4 / 2	UV	UNDervOLTAGE	NO	- 10%
5 / 3	X	X	X	X
6 / 4	RPH	REVERSE PHASE SEQUENCE	NO	X
7 / 5	CSP	COMPRESSOR SEPARATOR PRESSURE	NO	10 PSI dP
8 / 6	HOL	HYDRAULIC OIL LEVEL	NO	X
9 / 7	HOT	HYDRAULIC OIL TEMPERATURE	NC	215° F
10 / 8	HFP	HYDRAULIC FILTER PRESSURE	NO	22 PSI
11 / 9	MWT	MOTOR WINDING TEMPERATURE	NO	130° C
12 / 10	CAT	COMPRESSOR AIR TEMPERATURE	NC	230° F
13 / 11	COP	COMPRESSOR OIL PRESSURE	NO	10 PSI
14 / 12	X	X	X	X
15 / 13	MMF	MOTOR MANAGER FAULT	X	X
16 / 14	HF	HOUSE FAN	X	TRIP
17 / 15	X	X	X	X
18 / none	COF	COMPRESSOR OIL FILTER	NO	35 PSI

Reference data

Diesel applications 015802-001, -002, -003, -004, -005, -006

Electric applications 020954-001, -002

Circuit Breaker Panel DIP Switch Settings (015702-004 and -005)

Labeling

These circuit boards are labeled as follows:

- Input sensor selector DIP switches 3- 17
- Normally Open N.O. input sensors - Up
- Normally Closed N.C. input sensors - Down

The following charts represent DMS - DIP switch positions based on history from 1991 to current applications. Note the machine model, application and vintage for proper DIP switch positions.

Boxes 3 – 17 representing (O) as DIP switch positions relative to the type of level, temperature or pressure switches used based on machine run modes for various equipment noted.

Low Pressure applications 1991 - 1996 engines with mechanical fuel system
D25KS/D240S/D245S, D40KS/D45KS/D50KS, D55SP, D60KS/D75KS

DIP	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
N.O.	O	O	O	O	O	O		O				O			
N.C.							O		O	O	O		O	O	O

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High Pressure applications 1991 - 1996 engines with mechanical fuel system
 D25KS/D245S, D40KS/D45KS, D55SP/D75KS

DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
N.O.	0	0	0	0	0	0		0							
N.C.							0		0	0	0	0	0	0	0

Low Pressure applications 1996 to current electronic fuel systems
 D25KS/D245S, D45KS/D50KS, D55SP/D75KS, DR460

DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
N.O.	0	0	0	0	0	0		0				0	0	0	
N.C.							0		0	0	0				0

High Pressure applications 1996 to current electronic fuel systems
 D25KS/D245S, D45KS, D55SP/D75KS

DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
N.O.	0	0	0	0	0	0		0					0	0	
N.C.							0		0	0	0	0			0

Low Pressure applications 3508 MEUI fuel system
 D90KS/D90KSP, 1190D/1190DSP

DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
N.O.	0	0	0	0	0	0		0				0			
N.C.							0		0	0	0		0	0	0

Low Pressure applications 3512 MEUI fuel system
 D90KS/D90KSP, 1190D/1190DSP

DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
N.O.	0	0	0	0	0	0		0				0	0		
N.C.							0		0	0	0			0	0

Low pressure applications with electric motor
 1190E/1190ESP

DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
N.O.	0	0	0	0	0	0		0	0			0			0
N.C.							0			0	0		0	0	

Switch Ratings (Panels 015702-004 and -005)

The following switch ratings are based on new component parts. The normal contact position is without fluid, temperature or pressure. Refer to DMS - DIP switch positions relative to run mode.

1. Level sensors are normal open NO without fluid, close with fluid.
2. Temperature switches are normal closed NC and open with increasing temperature above the specific rate.
3. Pressure switches are normal open NO and close with pressure above the specific rate, low pressure allows switch to open.

Machine specific parts manuals contain switch locations and part numbers.
DMS groups 015802 and 020954 detail wire connection and switch locations.

Low Pressure applications

D25KS/D240S/D245S, D40KS/D45KS/D50KS, D55SP/D60KS/D75KS, DR460

TERMINAL & DIP SWITCH	ABBREVIATION	DESCRIPTION	CONTACTS	RATING
3	CFP	COMPRESSOR AIR FILTER PRESSURE	NO	22" H2O
4	EFP1/EFP2	ENGINE AIR FILTER PRESSURE	NO	22" H2O
5	EFL	ENGINE FUEL LEVEL	NO	N/A
6	ECL	ENGINE COOLANT LEVEL	NO	N/A
7	CSP	COMPRESSOR SEPARATOR PRESSURE	NO	10 PSI dP
8	HOL	HYDRAULIC OIL LEVEL	NO	N/A
9	HOT	HYDRAULIC OIL TEMPERATURE	NC	215° F
10	HFP	HYDRAULIC FILTER PRESSURE	NO	22 PSI
11	EOT	ENGINE OIL TEMPERATURE	NC	250° F
12	CAT	COMPRESSOR AIR TEMPERATURE	NC	230° F
13	CIT	COMPRESSOR OIL PRESSURE	NO	35 PSI 15 PSI
14	CIT	COMPRESSOR INTERSTAGE TEMPERATURE	NO	N/A
15	EOP	ENGINE OIL PRESSURE	NO	N/A
16	ECT	ENGINE COOLANT TEMPERATURE	NO	N/A
17	ECF	ENGINE COOLANT FLOW	NO	5 PSI
18 - No DIP	ALT	ALTERNATOR CHARGE	X	24 VDC

High Pressure applications

D25KS/D240S/D245S, D40KS/D45KS, D55SP/D75KS

TERMINAL / DIP SWITCH	ABBREVIATION	DESCRIPTION	CONTACTS	RATING
3 / 1	CFP	COMPRESSOR AIR FILTER PRESSURE	NO	22" H2O
4 / 2	EFP1/EFP2	ENGINE AIR FILTER PRESSURE	NO	22" H2O
5 / 3	EFL	ENGINE FUEL LEVEL	NO	N/A
6 / 4	ECL	ENGINE COOLANT LEVEL	NO	N/A
7 / 5	CSP	COMPRESSOR SEPARATOR PRESSURE	NO	10 PSI dP
8 / 6	HOL	HYDRAULIC OIL LEVEL	NO	N/A
9 / 7	HOT	HYDRAULIC OIL TEMPERATURE	NC	215° F
10 / 8	HFP	HYDRAULIC FILTER PRESSURE	NO	22 PSI

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11 / 9	EOT	ENGINE OIL TEMPERATURE	NC	250° F
12 / 10	CAT	COMPRESSOR AIR TEMPERATURE	NC	265° F
13 / 11	CIT	COMPRESSOR OIL PRESSURE	NO	90 PSI
14 / 12	CIT	COMPRESSOR INTERSTAGE TEMPERATURE	NC	250° F
15 / 13	EOP	ENGINE OIL PRESSURE	NO	N/A
16 / 14	ECT	ENGINE COOLANT TEMPERATURE	NO	N/A
17 / 15	ECF	ENGINE COOLANT FLOW	NO	5 PSI
18 / none	ALT	ALTERNATOR CHARGE	X	24 VDC

Low Pressure applications Caterpillar 3508
D90KS/D90KSP, 1190D/1190DSP

TERMINAL / DIP SWITCH	ABBREVIATION	DESCRIPTION	CONTACTS	RATING
3 / 1	CFP	COMPRESSOR AIR FILTER PRESSURE	NO	22 " H2O
4 / 2	EFP1/EFP2	ENGINE AIR FILTER PRESSURE	NO	22" H2O
5 / 3	EFL	ENGINE FUEL LEVEL	NO	N/A
6 / 4	ECL	ENGINE COOLANT LEVEL	NO	N/A
7 / 5	CSP	COMPRESSOR SEPARATOR PRESSURE	NO	10 PSI dP
8 / 6	HOL	HYDRAULIC OIL LEVEL	NO	N/A
9 / 7	HOT	HYDRAULIC OIL TEMPERATURE	NC	215° F
10 / 8	HFP	HYDRAULIC FILTER PRESSURE	NO	22 PSI
11 / 9	EOT	ENGINE OIL TEMPERATURE	NC	250° F
12 / 10	CAT	COMPRESSOR AIR TEMPERATURE	NC	230° F
13 / 11	COP	COMPRESSOR OIL PRESSURE	NO	35 PSI
				15 PSI
14 / 12	CIT	COMPRESSOR INTERSTAGE TEMPERATURE	NO	N/A
15 / 13	EOP	ENGINE OIL PRESSURE	NO	35 PSI
16 / 14	ECT	ENGINE COOLANT TEMPERATURE	NO	230° F
17 / 15	ECF	ENGINE COOLANT FLOW	NO	5 PSI
18 / none	ALT	ALTERNATOR CHARGE	X	24 VDC

Low Pressure applications Caterpillar 3512
D90KS/D90KSP, 1190D/1190DSP

TERMINAL / DIP SWITCH	ABBREVIATION	DESCRIPTION	CONTACTS	RATING
3 / 1	CFP	COMPRESSOR AIR FILTER PRESSURE	NO	22 " H2O
4 / 2	EFP1/EFP2	ENGINE AIR FILTER PRESSURE	NO	22" H2O
5 / 3	EFL	ENGINE FUEL LEVEL	NO	N/A
6 / 4	ECL	ENGINE COOLANT LEVEL	NO	N/A
7 / 5	CSP	COMPRESSOR SEPARATOR PRESSURE	NO	10 PSI dP
8 / 6	HOL	HYDRAULIC OIL LEVEL	NO	N/A
9 / 7	HOT	HYDRAULIC OIL TEMPERATURE	NC	215° F
10 / 8	HFP	HYDRAULIC FILTER PRESSURE	NO	22 PSI
11 / 9	EOT	ENGINE OIL TEMPERATURE	NC	250° F
12 / 10	CAT	COMPRESSOR AIR TEMPERATURE	NC	230° F
13 / 11	COP	COMPRESSOR OIL PRESSURE	NO	35 PSI
				15 PSI
14 / 12	CIT	COMPRESSOR INTERSTAGE TEMPERATURE	NO	N/A
15 / 13	EOP	ENGINE OIL PRESSURE	NC	35 PSI
16 / 14	ECT	ENGINE COOLANT TEMPERATURE	NO	230° F
17 / 15	ECF	ENGINE COOLANT FLOW	NO	5 PSI
18 / none	ALT	ALTERNATOR CHARGE	X	24 VDC

10-15-09

Low Pressure applications with electric motor
1190E/1190ESP

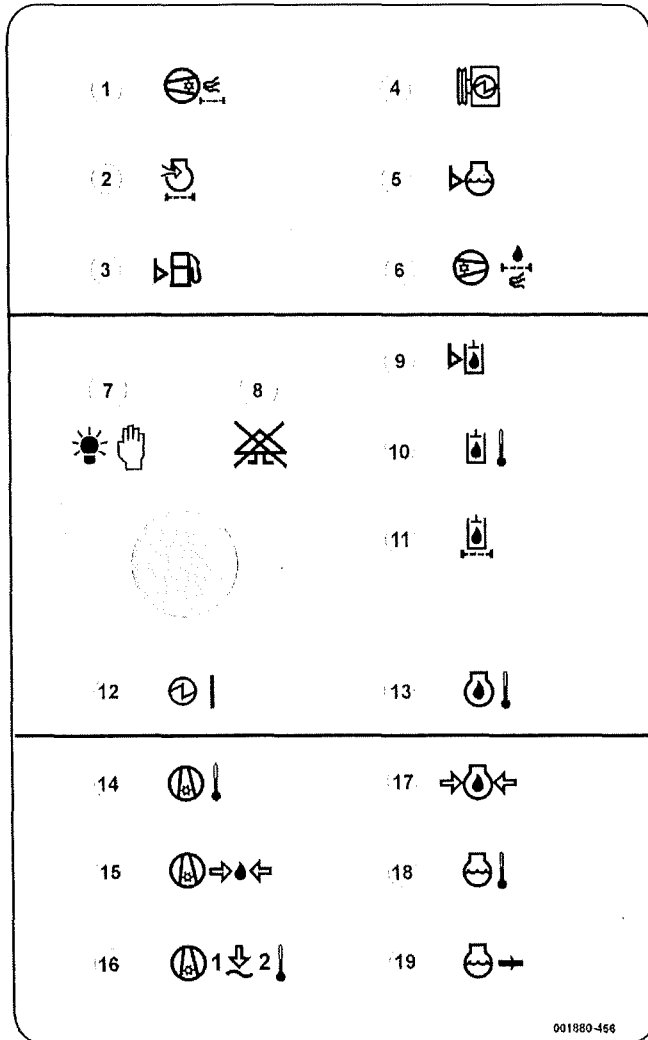
TERMINAL / DIP SWITCH	ABBREVIATION	DESCRIPTION	CONTACTS	RATING
3 / 1	CFP	COMPRESSOR AIR FILTER PRESSURE	NO	22 " H2O
4 / 2	UV	UNDERVOLTAGE	NO	- 10%
5 / 3	X	X	X	X
6 / 4	RPH	REVERSE PHASE SEQUENCE	NO	X
7 / 5	CSP	COMPRESSOR SEPARATOR PRESSURE	NO	10 PSI dP
8 / 6	HOL	HYDRAULIC OIL LEVEL	NO	X
9 / 7	HOT	HYDRAULIC OIL TEMPERATURE	NC	215° F
10 / 8	HFP	HYDRAULIC FILTER PRESSURE	NO	22 PSI
11 / 9	MWT	MOTOR WINDING TEMPERATURE	NO	130° C
12 / 10	CAT	COMPRESSOR AIR TEMPERATURE	NC	230° F
13 / 11	COP	COMPRESSOR OIL PRESSURE	NO	10 PSI
14 / 12	X	X	X	X
15 / 13	MMF	MOTOR MANAGER FAULT	X	X
16 / 14	HF	HOUSE FAN	X	TRIP
17 / 15	X	X	X	X
18 / none	COF	COMPRESSOR OIL FILTER	NO	35 PSI

Reference data

Diesel applications 015802-001, -002, -003, -004, -005, -006

Electric applications 020954-001, -002

DMS Decal ISO Symbols (001880-456)

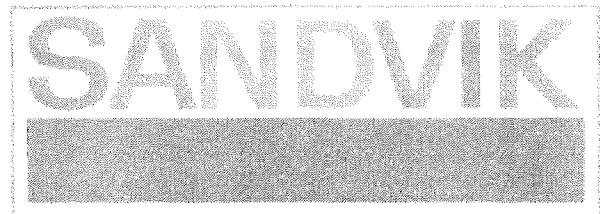


- 1. Restricted Compressor Air Filter Element
- 2. Restricted Engine Air Filter Element
- 3. Low Fuel Level
- 4. Alternator
- 5. Low Engine Coolant Level
- 6. Restricted Compressor Air/Oil Separator Element
- 7. Test Lamp
- 8. Alarm Silence
- 9. Low Hydraulic Oil Level
- 10. Hydraulic Oil Temperature
- 11. Restricted Hydraulic Oil Filter Element
- 12. Power On
- 13. High Engine Oil Temperature
- 14. High Compressor Air Temperature
- 15. Low Compressor Oil Pressure
- 16. High Compressor Inter-Stage Temperature (High Pressure Compressors)
- 17. Low Engine Oil Pressure
- 18. High Engine Coolant Temperature
- 19. Engine Coolant Flow

001880-456

SECTION 14

ELECTRICAL SYSTEM





THE HUMAN BODY AND ELECTRICAL SHOCK

GENERAL

Personnel safety should be the main concern when working with any AC or DC electrical system or circuit.

DESCRIPTION

Most circuits in any surface mine are of sufficient voltage to overcome your body's resistance. Therefore the miner must be able to recognize and avoid coming into contact with an electrical source.

When a person is electrocuted, he/she becomes the path of least resistance for the electrical source to ground and in effect becomes a part of the circuit.

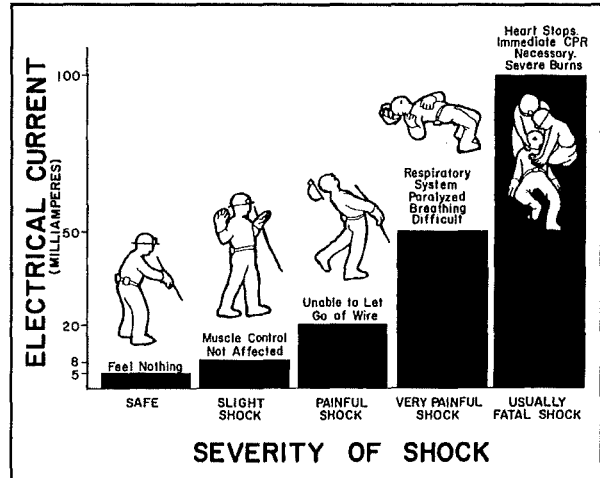
Properly grounded equipment is the best way to prevent electrical shock. Another effective means is insulation by means of rubber gloves and boots, rubber mats, insulated platforms and guards around cables.



Handling electrical equipment with wet hands or while standing in water will cause electrocution. Handle all electrical equipment in a dry environment.

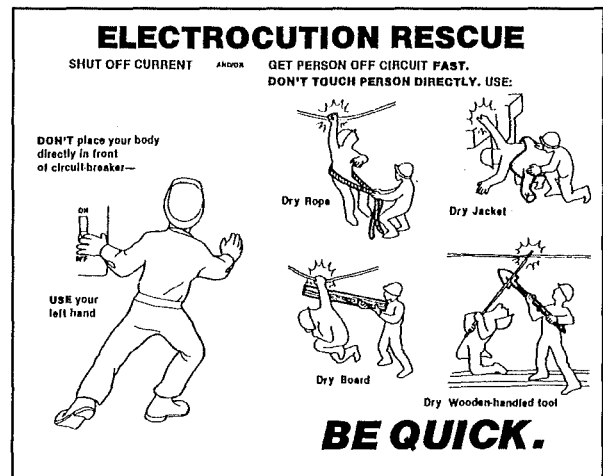
The killing factor in electrical shock is current. Current is measured in amps and is determined by voltage. Ordinary household appliances require currents high enough to kill a person. Current necessary to operate a 100 watt light bulb is (eight 8) to (ten 10) times the fatal amount.

- 5 milliamp (safe)
- 8 milliamp (slight shock)
- 20 milliamp painful shock
- 50 milliamp (very painful shock)
- 100 milliamp (possible fatal shock)



One milliamper (ma) is 1/1000 of an amp.

If a fellow worker becomes part of an electrical circuit and cannot let go of the source, **DO NOT** rush over and grab him/her. You can become part of the electrical shock as well. **Instead**, disconnect the power to the circuit. If this is not possible, remove the person from contact by using something insulated to PUSH or PULL the person away while protecting yourself.



In the event of accidental electrical contact call for help and apply the appropriate first aid measures.

Federal law requires that any repair, installation, or testing of electrical equipment be done by or under the supervision of a qualified electrician.

All disconnecting devices must be tagged out of service prior to work being performed.

Follow any lock out and tag out procedures recommended by the mine site. Do not attempt to operate the equipment until all lockout devices are cleared by a shift supervisor(s).

All persons performing maintenance work shall have a separate lock and signed tag connected to the multi lock.

Appropriate ground fault management systems should be employed at the mine and made available to the specific machine.

Sandvik urges that each miner responsible to perform maintenance or operating duties on a drill machine utilize the appropriate personnel protective equipment - PPE deemed necessary to perform the duties of the job or task assigned.



HIGH VOLTAGE AC or DC powered equipment should be de-energized prior to and during maintenance work performed on the electrical system(s).

Only electricians specifically trained to work with high voltage circuits should be permitted to perform electrical maintenance.

OHM'S LAW and ELECTRICAL CIRCUITS

Ohms Law

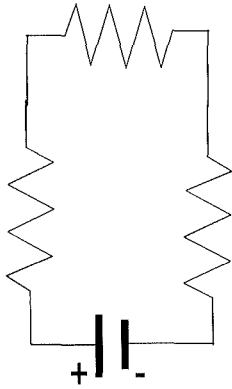
Ohms law expresses the relationship between the current (I), the voltage (E), and the resistance (R) in a circuit. Ohms law can be expressed in three different ways and can be applied to the entire circuit or to any part of a circuit. When any two factors are known the third unknown factor can be calculated from Ohms law.

$I = \frac{E}{R}$	AMPERES = $\frac{\text{VOLTS}}{\text{OHMS}}$
$E = IR$	VOLTS = AMPERES X OHMS
$R = \frac{E}{I}$	OHMS = $\frac{\text{VOLTS}}{\text{AMPERES}}$

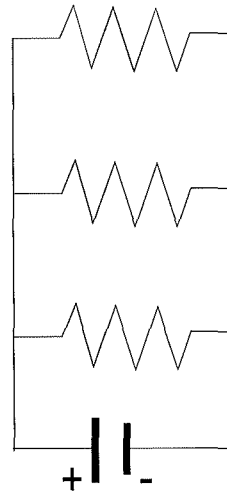
Ohms law is factored into the design of electrical and electronic systems. Specific components are selected to meet the design essentials to make the components last for hours of maintenance free operation.

ELECTRICAL CIRCUITS

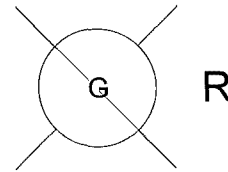
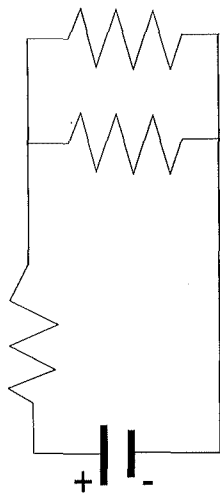
SERIES



PARALLEL



SERIES PARALLEL



FUNDAMENTALS OF ELECTRICITY

GENERAL

Basic electrical terms mentioned in this training module are common to the industry.

DESCRIPTION

The following terms apply to basic electric systems.

- VOLTAGE
- ELECTRONS
- RESISTANCE
- OHMS
- CURRENT
- AMPERES

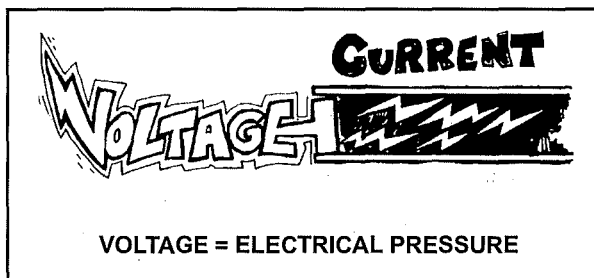
The following terms are common electrical system tools used to diagnose electrical components and the overall system performance:

- VOLTMETER
- AMMETER
- OHMMETER

In simple terms:

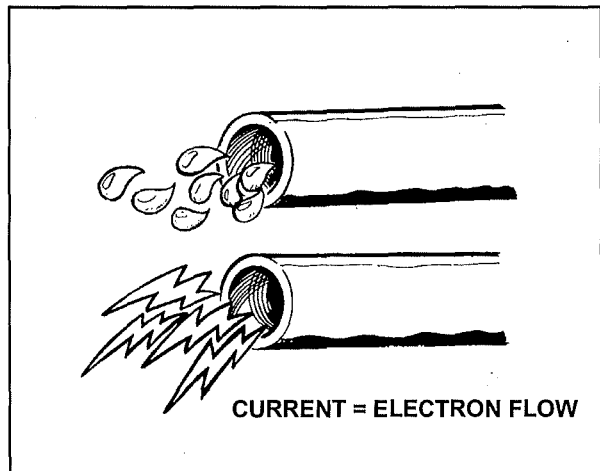
VOLTAGE

Voltage provides the electrical pressure, or force that causes the current or electrons to flow. The voltage is the difference in electrical pressure between two points in a circuit. Electrical voltage is measured in "volts".



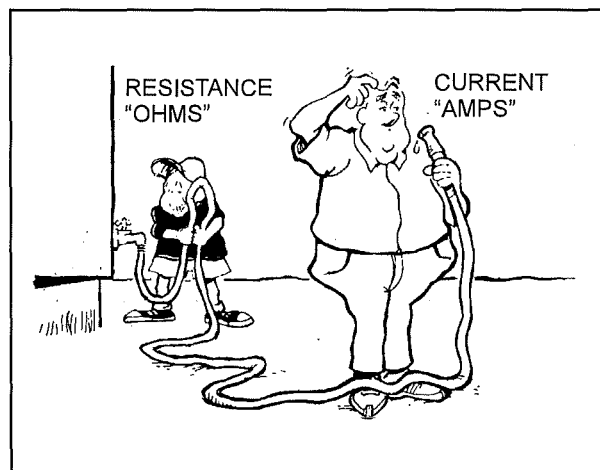
CURRENT

Electrical current is the flow, or movement of electrons. This movement can be compared to the flow of water through a pipe. Without pressure (voltage) the current will not flow. Electrical current is measured in amperes or "amps".



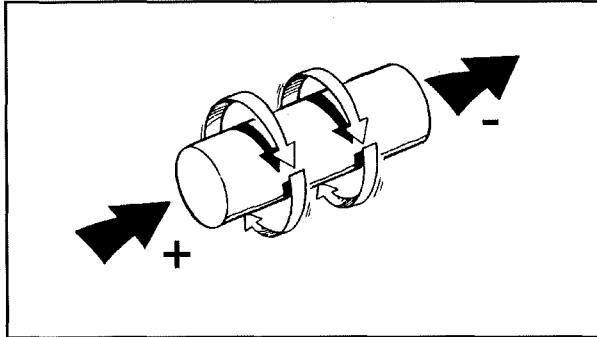
RESISTANCE

Resistance is simply a restriction of current flow. Increasing resistance reduces current flow which can be detected by voltage decreases or loss in the electrical circuit. Electrical resistance is measured in "ohms".



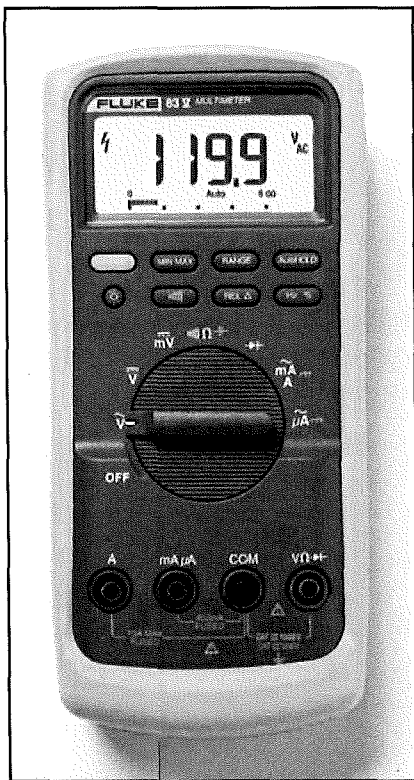
MAGNETIC FIELD

A magnetic field is produced when current is forced through a conductor. The magnetic field and direction of flow are factors to consider when using test equipment such as ammeters.



TEST EQUIPMENT

The use of test meters is an invaluable and essential aid in diagnosing troubles in an electrical circuit. If values of voltage, current and resistance are not measured with suitable test meters, only a guess can be made as to what type of defect exist in the circuit.



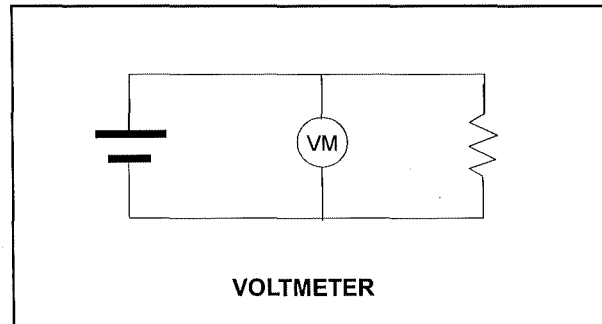
DIGITAL MULTIMETER

The Fluke 83V meter shown is a multimeter. It has capability to measure AC and DC volts, millivolts, amps, milliamps, ohms, diodes. Other features are frequency, capacitance, duty cycles and temperature.

VOLTMETER

The voltmeter is used to measure the electrical pressure in the circuit. Analog and digital models are available. It is suggested to use the digital type.

In a DC circuit voltmeters are always connected across (in parallel with) a part of the circuit.



Voltmeters measure the difference in electrical potential or pressure between the points where the voltmeter leads are attached. Typical leads are red for positive (+) and black for negative (-) polarity.

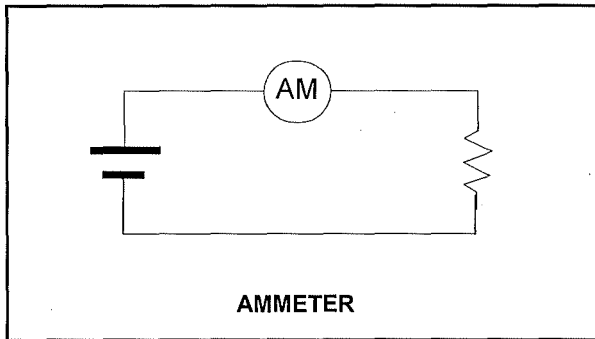
Common 24 volt systems may read (0 - 32) volts.

Common 12 volt systems may read (0 - 16) volts.

AMMETER

The ammeter is used to measure the amount of current flow. It is suggested to use a digital type ammeter.

Ammeters generally require opening the circuit so the ammeter can be connected in series to measure the current flow.



In a DC circuit amps and milliampere are two common circuit flows.

OHMMETER

The ohmmeter is used to measure resistance in the circuit.

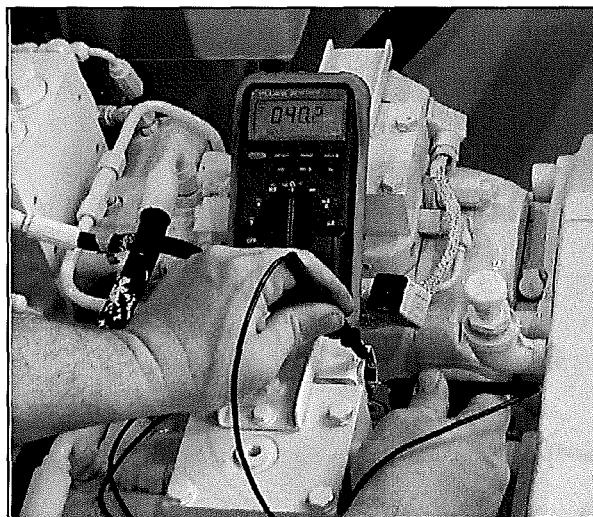
Ohmmeters are connected across the unit or portion of the circuit of which the resistance is to be measured.

The ohmmeter has it's own power source, usually a small battery or fuse which forces current through the circuit to be measured.

Never connect a ohmmeter to an external source of voltage. Battery, fuse or meter movement damage may occur.

Coil Testing

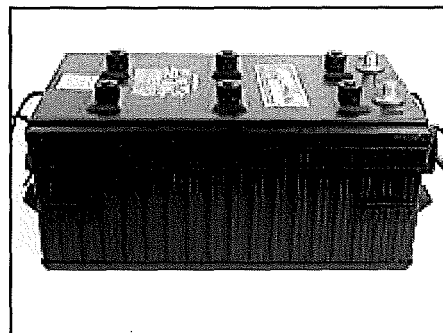
When testing the coil resistance take note of the meter reading. In Ohm mode a good coil will register some reading such as 40 ohm as shown by this meter. If the meter reading indicates OL or some number less than the coil spec a new coil is in order.



Make certain that the socket connector is sealed from contaminants and the contact terminals are clean and tight. Dirt, rust and loose connections lead to interruptions in the electric flow to the device resulting in erratic or intermittent control.

Battery Specific Gravity Test

This test is performed with a hydrometer, which is the most accurate hand held tool for determining the state of charge of a lead acid battery.



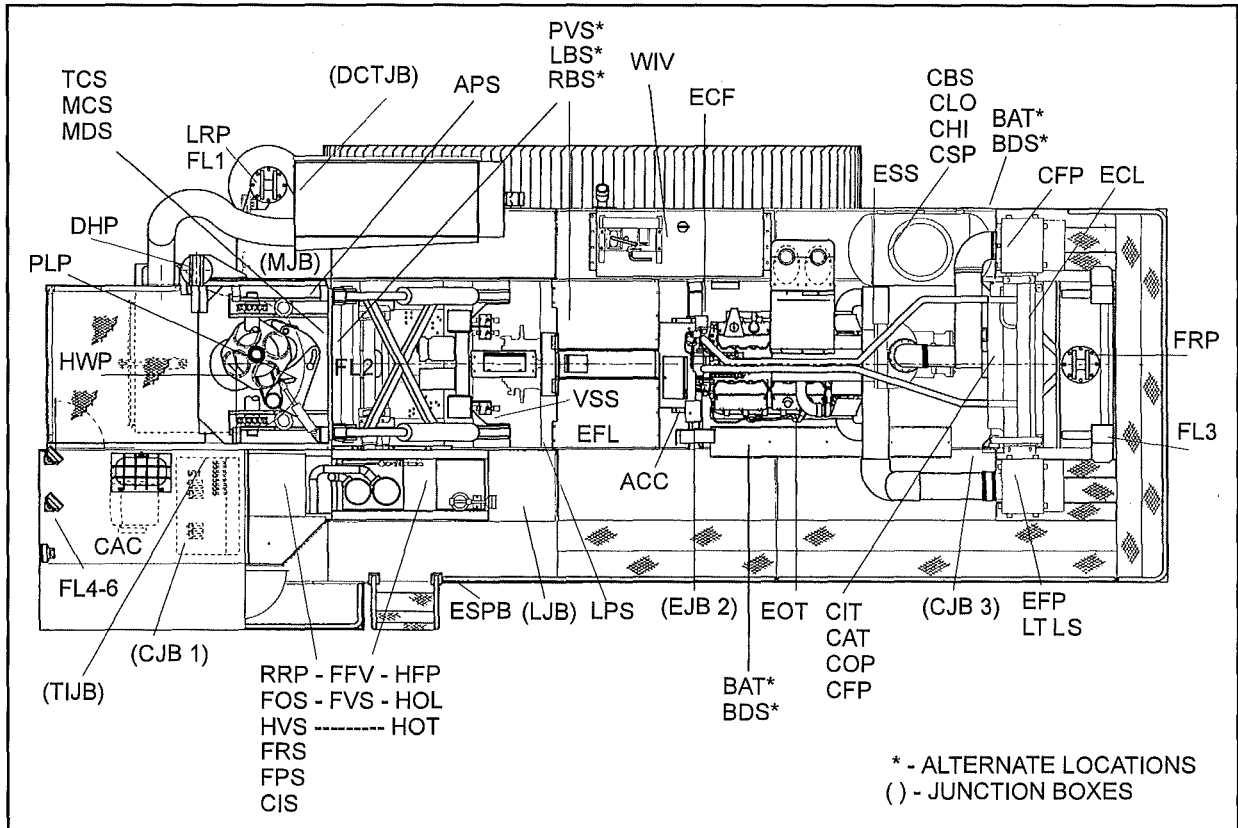
1. Draw electrolyte into the hydrometer a few times so that the float reaches the same temperature as the electrolyte. This will increase the accuracy of your readings.
2. Hold the hydrometer vertically so that the float is free and does not touch the inner walls of the barrel.
3. Hold the hydrometer so that the liquid is level in the barrel and at eye level.
4. When you draw the electrolyte, make sure that the hydrometer is full.
5. Check each individual battery cell. If the specific gravity varies more than .050 or "50 points" among the cells while the battery is at a 75% state of charge or above, then the battery is bad and should be replaced. The cells that have a specific gravity of 50 points less than the highest cell are bad cells. A hydrometer reading of 1.265 or greater at 80°F indicates a full charge for Interstate batteries. To determine the battery's state of charge, compare the hydrometer reading to the Specific Gravity Chart.
6. To get the most accurate hydrometer reading, you should adjust your hydrometer reading according to the temperature. If the electrolyte temperature is ABOVE 80°F, ADD .004 (called "four points") to the hydrometer reading for each 10 degrees above 80°F. If the electrolyte temperature is BELOW 80°F, SUBTRACT four points from the hydrometer reading for each 10 degrees below 80°F.

Specific Gravity Specification

1.265	100%
1.225	75%
1.190	50%
1.155	25%
1.120	00%

COMPONENT LOCATION

CRAWLER MACHINE GENERAL OVERVIEW



Crawler mounted machines use common electrical component locations. Asterisk * in the general location drawing indicate alternate location.

Maintenance for electrical systems include:

- learn the equipment electrical system prior to performing any electrical service
- follow electrical safety guidelines respective to company policy
- keeping the junction box doors closed and sealed from moisture
- periodic checks inside the junction box for terminal wire connections, tighten components as needed
- clean inside junction box with low pressure dry compressed air
- replace corroded wire terminals
- replace corrosion inhibitors 015411-001 annually
- maintain a good seal for the wire bundle entering the cab through the fire wall
- eliminate any wire harness contact points that rub against hard surfaces
- maintain cab and engine control module braided ground strap
- when applicable locate wire harnesses away from contaminating fluids, (oils and fuels)
- test each battery, battery cables and the charging system annually using approved test equipment and skilled personnel

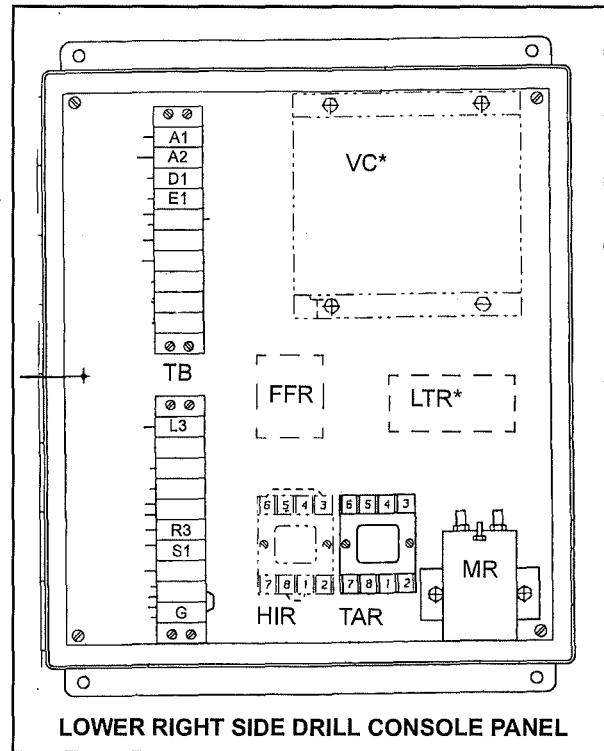
WIRE/SIZE	APPLICATION
E 14/16	12 VDC CONTROLS (EDC D90KS)
B 3/0	BATTERY POWER
S 14/16	CAB STARTING ENGINE RUN CIRCUIT PROTECTION
M 14/16 (16)	DRILL MONITOR SYSTEM (DMS)
R 14/16	MACHINE TRAM/DRILL FEATURES
J 14	OPERATOR FEATURES AND OPERATING OPTIONS
F 14/16 (16)	MACHINE LEVELING DRILLING FEATURES/OPTIONS
D 14	COLD WEATHER OPTIONS
C 14	DRILL/PROPEL FEATURE*
C 14	DRILL AUTOMATION*
N 14/16	24/12 ACCESSORIES*
P 14/16	24/12 ACCESSORIES*
T 14/16 (16)	DEPTH COUNTER OPTIONS
G 3/0 2/4/6	BATTERY/ALTERNATOR GROUND
G 10/14/16	GROUND

There are some variations between machine models. Verify wire and application with machine specific electrical group and schematics.

Electrical schematics and assembly drawings are available for each model of blasthole machine.

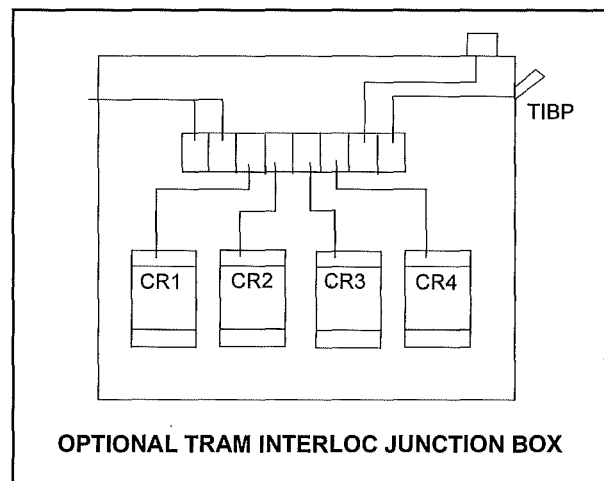
Electric schematics are used in conjunction with this manual for training purposes. Electric schematics show all options available to the end product.

Each machine is customer specific and may not require all options available. When using electrical schematics it will be necessary to understand the machine specification. This is achieved by the machine serial number.

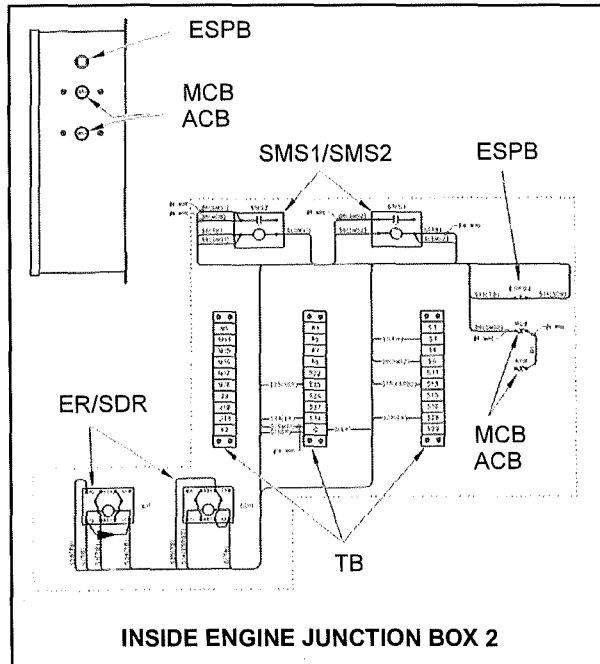


Machine features such as tram interloc, jack brake tram interloc and rotary head - jack brake interloc requires a junction box positioned in the operator cab lower left side under the operator console.

Proximity switches, relays and a floor mounted foot pedal enable the tram feature. The tram interloc components have a power indicator and a bypass feature for diagnostic purpose.



ENGINE POSITION



The engine junction box will support the engine starting, engine run and circuit protection components.

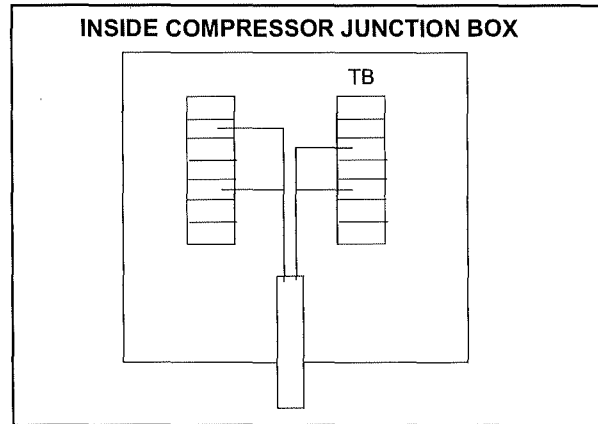
The machine frame is the ground. All DC power happens due to selected components having a constant ground to the machine frame.

SMS are magnetic solenoids that actuate with key switched power from the starter push button. One magnetic solenoid per engine starter. The contacts allow battery current from B6 wire to B3 and B4 wires to the engine starter solenoid.

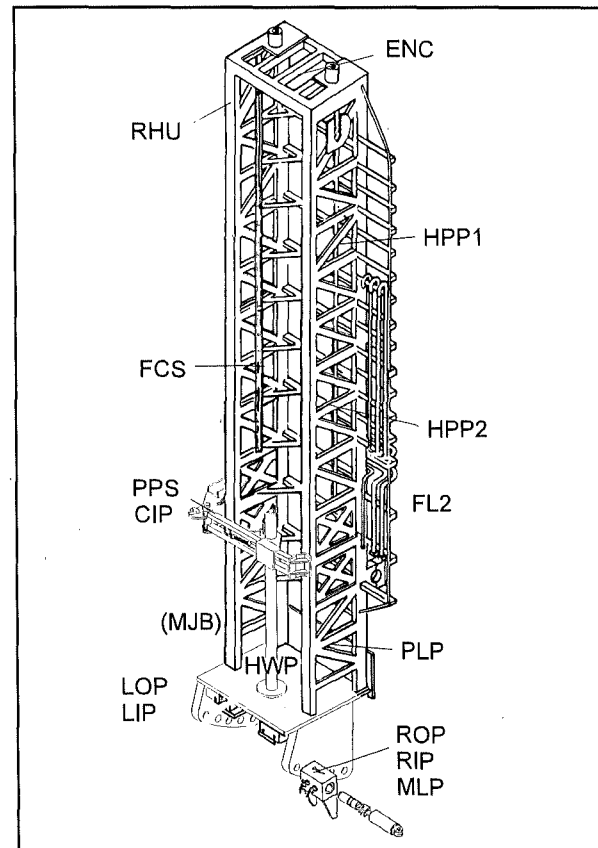
ACB is a circuit breaker from the engine supplied alternator. They are 105 amp or 80 amp rated and special application 175 amp.

MCB is the main circuit breaker for the entire machine supply current. If the main circuit breaker opens all machine power is lost.

COMPRESSOR POSITION



MAST AND COMPONENTS



Wires from switches positioned inside the mast should have power and ground contacts brought back to the mast junction box or operator cab junction box for proper frame grounding.

ELECTRONIC ENGINES

Crawler mounted operator controls are a desk type panel with hydraulic and electrical systems.

GENERAL

Sandvik blasthole drills use two quality engine manufacturers:

- Caterpillar
- Cummins

Both suppliers provide service through competent world-wide distributor networks.

DESCRIPTION

The Sandvik blasthole drills require engine horsepower that both manufactures are capable of delivering.

Engines manufactured from 1993 to 1995 may have been served with either the Woodward or Barber Coleman type speed controls.

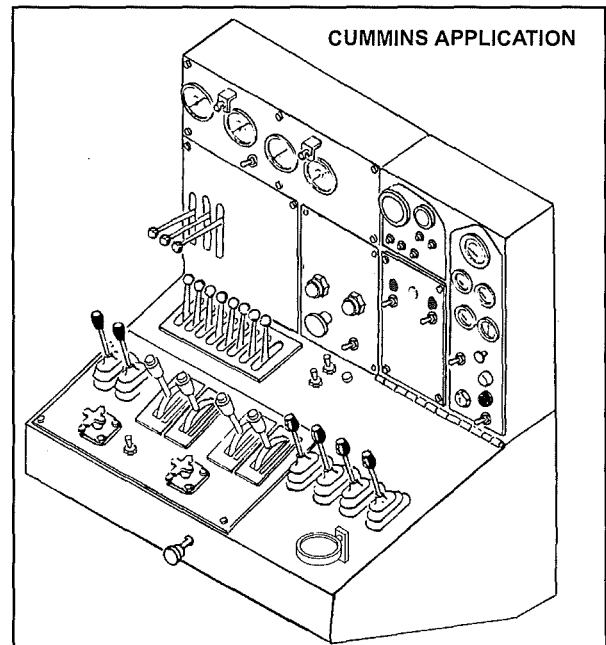
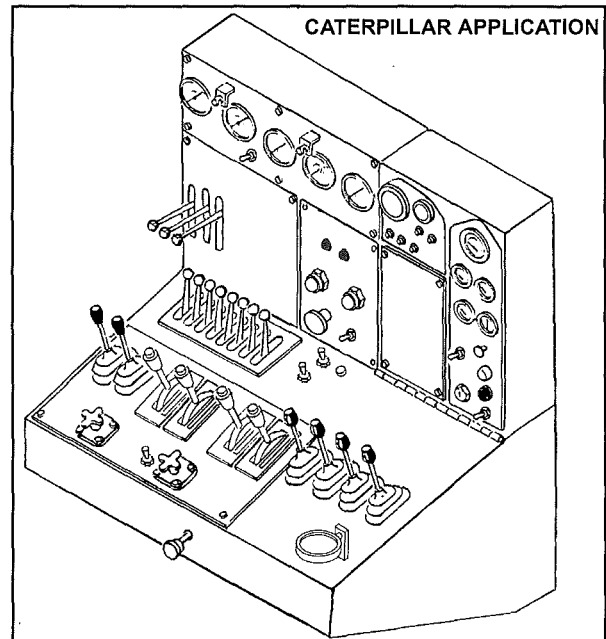
In 1995 and early 1996 to present the engine manufacturers converted to electronically controlled engines with high pressure fuel systems

At present all of our blasthole equipment utilizes electronic fuel systems.

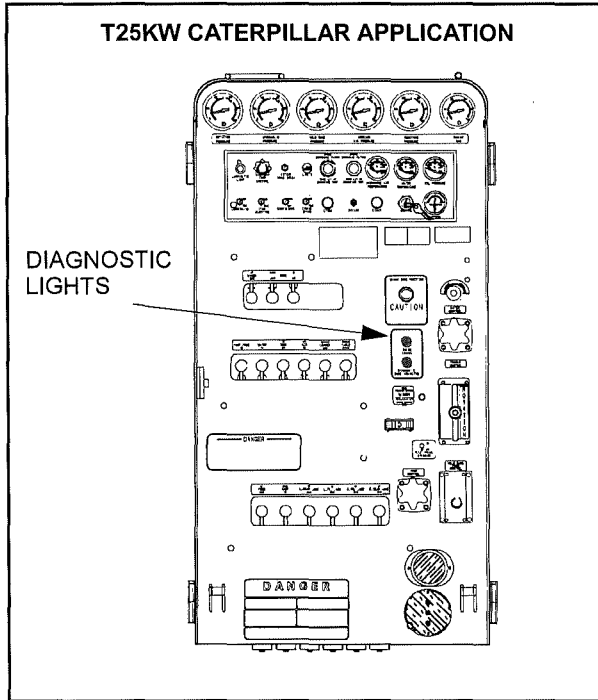
Light indicators at the operator station allow the operator a means to monitor the engine ECM. A data link connection enables diagnostic test equipment installation.

In the event that the check engine light is on and the diagnostic indicator light is flashing the operator should take appropriate measures.

Refer to engine data section of this manual or the engine specific diagnostic code retrieval specs.



Truck model equipment operator controls are a verticle panel with hydraulic and electrical systems.



CATERPILLAR EUI ENGINE DATA

SENSOR DESCRIPTIONS

EUI = electronic unit injection fuel system.

HEUI = hydraulic electronic unit injection fuel system.

ATMOSPHERIC PRESSURE SENSOR

Measures crankcase pressure 0-116 kpa or 0-17 psi (5vdc)

Atmospheric pressure sensing is used to reduce smoke emissions at high altitudes.

BOOST PRESSURE SENSOR

Measures intake manifold pressure 20-340kpa or 3-49psi (5vdc)

Boost pressure is used to reduce smoke emissions during acceleration.

COOLANT LEVEL SENSOR

Optional customer parameter selected.

COOLANT TEMPERATURE SENSOR

Mounted on water outlet housing measures the temperature of the engine coolant. Coolant temperature sensing is used to determine a cold mode operation for 6 cylinder engines. In cold mode timing is advanced and fuel delivery is limited. 3406E engines also have a three-cylinder cutout feature during cold mode operation. Cold mode operation is activated whenever the coolant temperature is below 63° F (17° C) and the engine is not cranking. Cold mode remains active until the coolant temperature rises above 63° F (17° C) or until the engine has been running for 5 minutes.

FUEL TEMPERATURE SENSOR

Monitored to adjust fuel rate calculations and for fuel temp power corrections when fuel temps exceed 86° F (30° C). Max power correction is at 158° F (70° C). Fuel temps exceeding 194° F (90° C) for ten minutes log a diagnostic code.

FUEL PRESSURE SENSOR

Monitors filtered fuel pressure following engine start from 0-690 kpa (0-100psi). With the engine at operating temperature, **typical fuel pressure** can vary from 310 kpa (45 psi) at low idle to 448 kpa (65psi) at rated rpm. The fuel check valve is designed to open between 413 and 438 kpa, (60-65 psi) to control fuel pressure. The fuel transfer pump has a internal relief valve designed to open around 620 kpa (90 psi) This valve will not be open during normal operation.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR

Adjusts injection timing. High intake manifold temp warning diagnostic code is triggered at 176° F (80° C). Very high temp warning diagnostic code is at 230° F (110° C).

OIL PRESSURE SENSOR

Monitors oil pressure in the gallery following engine start. Pressures from 0-690kpa or 0-100 psi. (5vdc)

SPEED/TIMING SENSOR

Determines both engine speed and fuel injection timing by magnetic sensor to camshaft connection. Primary and secondary units apply (12vdc). If one sensor fails replace both units.

DIAGNOSTIC LAMP

Communicates engine status or operational problems. Two digit diagnostic codes are given with one-second pauses between code digits. A three-second pause occurs between codes. Additional diagnostic codes may follow after the 3-second pause.

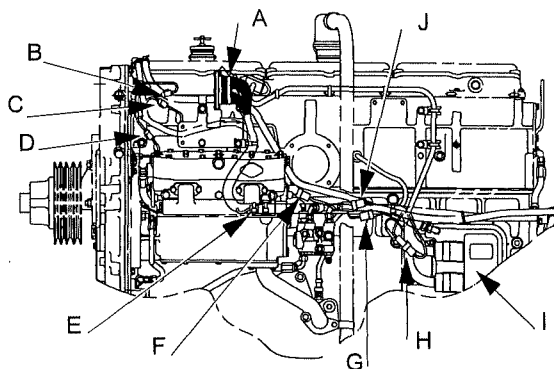
ETHER INJECTION SYSTEM

The engine ECM controls the ether system to improve the cold starting capability. The ECM uses the Coolant Temperature Sensor to control ether injection. The ECM uses actual engine rpm to determine if ether should be injected. The ether control logic assumes a "continuous" ether system is being utilized and the duration of injection is a linear function of coolant temperature. The automatic ether injection circuit turns ON the relay driver when the following conditions are met. The engine speed must be

between 30 rpm and 1500 rpm and the coolant temperature is between -40° to $+50^{\circ}$ F (-40° to $+10^{\circ}$ C). The ether injection time is selected from a linear relationship between these temperatures. The end points of this function are -40° F (-40° C) for 130 seconds, 50° F ($+10^{\circ}$ C) for 15 seconds.

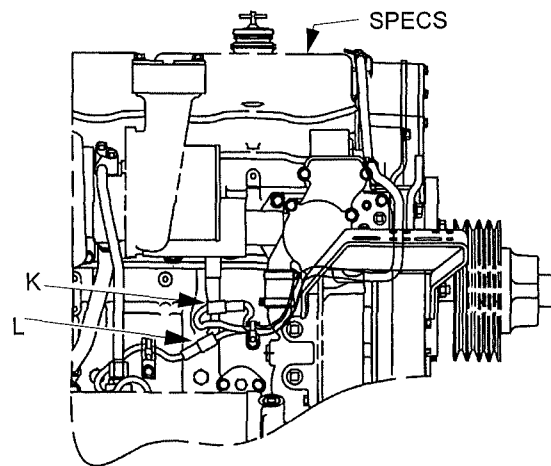
Manual ether injection can occur between 30 and 1500 rpm if the coolant temperature is below 150° F ($+60^{\circ}$ C) for maximum time duration of 2 minutes. This function is a customer supplied override switch.

3406E CATERPILLAR ENGINE SENSORS (LEFT)



- A CUSTOMER CONNECTOR
- B TOP SPEED/TIMING SENSOR
- C INLET AIR MANIFOLD PRESSURE SENSOR
- D BOTTOM SPEED/TIMING SENSOR
- E FUEL PRESSURE SENSOR
- F FUEL TEMPERATURE SENSOR
- G INLET AIR TEMPERATURE SENSOR
- H TIMING CALIBRATION SENSOR
- I ELECTRONIC CONTROL MODULE (ECM)
- J ATMOSPHERIC PRESSURE SENSOR

3406E CATERPILLAR ENGINE SENSORS (RIGHT)



- K COOLANT TEMPERATURE SENSOR
- L OIL PRESSURE SENSOR

Troubleshooting the engine requires a skilled engine technician familiar with electronic fuel systems and the computer program Cat (ET) Engine Technician.

A check engine and diagnostic light installed on the machine operator panel will enable active fault codes to be seen when they occur. The sequence of flashes represents the system diagnostic message.

The first sequence of flashes represents the first digit of the diagnostic code. After a two second pause a second sequence of flashes will occur which represent the second digit of the diagnostic code.

Active diagnostic flash codes may be displayed with the engine running or with the ignition key in the on position, engine off.

Operators should take appropriate measures when a diagnostic light is flashing a two digit code.

FAULT CODES

FLASH CODE	DESCRIPTION	SHUT DOWN	SER	SCH SER
72	CYLINDER 1 FAULT		X	
72	CYLINDER 2 FAULT		X	
73	CYLINDER 3 FAULT		X	
73	CYLINDER 4 FAULT		X	
74	CYLINDER 5 FAULT		X	
74	CYLINDER 6 FAULT		X	
21	8 VOLT SUPPLY ABOVE NORMAL			X
21	8 VOLT SUPPLY BELOW NORMAL			X
47	IDLE SHUTDOWN OCCURRENCE			
46	LOW OIL PRESSURE WARNING	X	X	
24	OIL PRESSURE SENSOR OPEN CIRCUIT			X
24	OIL PRESSURE SENSOR SHORT CIRCUIT			X
46	VERY LOW OIL PRESSURE	X	X	
25	BOOST PRESSURE READING STUCK HIGH			X
25	BOOST PRESSURE SENSOR OPEN CIRCUIT			X
25	BOOST PRESSURE SENSOR SHORT CIRCUIT			X
64	HIGH INTAKE MANIFOLD TEMP WARNING			X
38	INTAKE MANIFOLD TEMP SENSOR OPEN CIRCUIT			X
38	INTAKE MANIFOLD TEMP SENSOR SHORT CIRCUIT			X
64	VERY HIGH INTAKE MANIFOLD TEMPERATURE			X
26	ATMOSPHERIC PRESS SENSOR SHORT CIRCUIT			X
26	ATMOSPHERIC PRESS SENSOR OPEN CIRCUIT			X
61	HIGH COOLANT TEMP WARNING		X	
27	COOLANT TEMP SENSOR OPEN CIRCUIT			X
27	COOLANT TEMP SENSOR SHORT CIRCUIT			X
61	HIGH COOLANT TEMPERATURE WARNING		X	
51	INTERMITTENT BATTERY		X	

FLASH CODE	DESCRIPTION	SHUT DOWN	SER	SCH SER
65	HIGH FUEL TEMPERATURE WARNING			X
13	FUEL TEMPERATURE SENSOR OPEN CIRCUIT			X
13	FUEL TEMPERATURE SENSOR SHORT CIRCUIT			X
63	FUEL FILTER RESTRICTION WARNING		X	
63	HIGH FUEL PRESSURE			
35	ENGINE OVERSPEED WARNING			
34	LOSS OF SPEED TIMING SENSOR/ENGINE RPM SIGNAL	X1	X	
62	LOW COOLANT LEVEL WARNING		X	
21	5 VOLT SUPPLY ABOVE NORMAL			X
21	5 VOLT SUPPLY BELOW NORMAL			X
53	ECM ERROR/FAULT		X	
72 PE	PERSONALITY MODULE FAULT		X	

Engines are factory programmed to shutdown under common Caterpillar switch parameters.

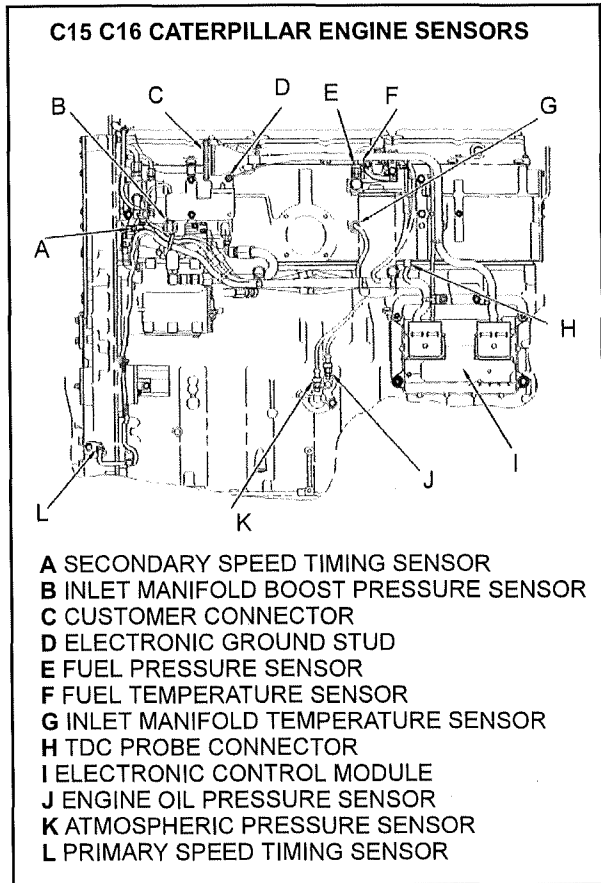
- high coolant temperature approximate range 221° F (105° C)
- water temp regulator fully open @ 208° F (98° C).
- low oil pressure is dependent on engine idle speed, the approximate range is 32 psi @ 1200 rpm and 43 psi @ 2000 rpm.
- engine oil temperature should not exceed 239° F (115° C).

Additional reference materials:

Caterpillar Electronic Troubleshooting Guide SENR 1012 and Troubleshooting manual SENR 1073 for industrial engines.

Caterpillar 3406E Industrial engine, Systems Operation Testing and Adjusting manual SENR 1067 has necessary information for troubleshooting and maintaining the engine systems.

C15 and C16 model engines have replaced 3406E models on blasthole equipment.



The difference between 3406E and the C15, C16 and C18 model engines on Sandvik blast-hole application machines is that the 'C' series engines monitor fuel pressure and coolant level.

Contact Sandvik technical support in relation to field upgrades from 3406E to 'C' series engines.

Event Codes

Events refer to engine operating conditions such as low oil pressure or high coolant temperature. Logged events usually indicate a mechanical problem instead of electronic system problem.

FLASH CODE	DESCRIPTION OF CODE
35	ENGINE OVERSPEED WARNING
46	LOW OIL PRESSURE WARNING
46	LOW OIL PRESSURE DERATE
46	LOW OIL PRESSURE SHUTDOWN
61	HIGH ENGINE COOLANT TEMPERATURE WARNING
61	HIGH ENGINE COOLANT TEMPERATURE DERATE
61	HIGH ENGINE COOLANT TEMPERATURE SHUTDOWN
62	LOW ENGINE COOLANT LEVEL WARNING
63	FUEL FILTER RESTRICTION DERATE
63	FUEL FILTER RESTRICTION WARNING
63	HIGH FUEL PRESSURE
64	HIGH INLET TEMPERATURE DERATE
64	HIGH INLET TEMPERATURE WARNING
65	HIGH FUEL TEMPERATURE DERATE
65	HIGH FUEL TEMPERATURE WARNING

3408E - 3412E FAULT CODES

FLASH CODE	DESCRIPTION	SHUT DOWN	SER	SCH SER
71	CYLINDER 1 FAULT		X	
72	CYLINDER 2 FAULT		X	
73	CYLINDER 3 FAULT		X	
74	CYLINDER 4 FAULT		X	
75	CYLINDER 5 FAULT		X	
76	CYLINDER 6 FAULT		X	
77	CYLINDER 7 FAULT		X	
78	CYLINDER 8 FAULT		X	
81	CYLINDER 9 FAULT		X	
82	CYLINDER 10 FAULT		X	
83	CYLINDER 11 FAULT		X	
84	CYLINDER 12 FAULT		X	
13	FUEL TEMPERATURE			X
14	INJECTION ACTUATION PRESSURE CONTROL VALVE OPEN CIRCUIT			X
14	INJECTION ACTUATION PRESSURE CONTROL VALVE SHORT TO GROUND			X
17	BATTERY VOLTAGE		X	
21	ANALOG SUPPLY OPEN/SHORT TO GROUND			X
21	ANALOG SUPPLY SHORT TO + BATTERY			X
21	DIGITAL SUPPLY SHORT TO + BATTERY			X
21	DIGITAL SUPPLY SHORT TO GROUND			X
22	INJECTION ACTUATION PRESSURE SIGNAL OPEN/SHORT TO + BATTERY			X
22	INJECTION ACTUATION PRESSURE SIGNAL SHORT TO GROUND			X
42	ATMOSPHERIC SPRES-SURE SENSOR CALIBRATION			X
42	SPEED/TIMING SENSOR CALIBRATION		X	
42	BOOST PRESSURE SENSOR CALIBRATION			X
24	OIL PRESSURE SIGNAL OPEN/SHORT + BATTERY			X
24	OIL PRESSURE SIGNAL SHORT TO GROUND			X
25	BOOST PRESSURE SIGNAL ABOVE NORMAL			X

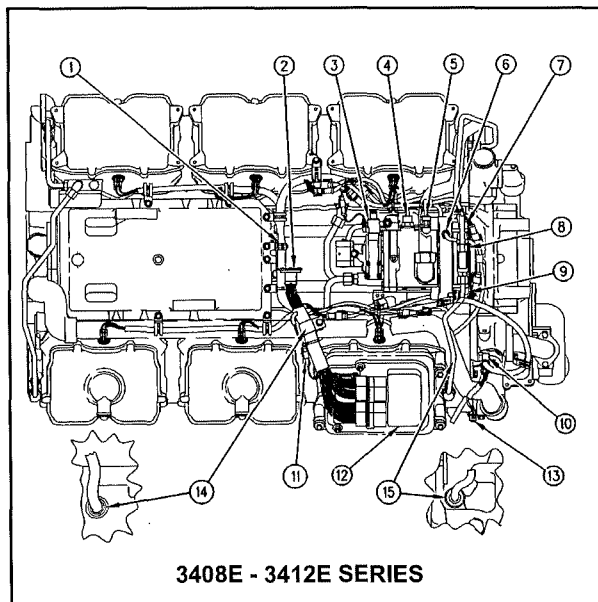
FLASH CODE	DESCRIPTION	SHUT DOWN	SER	SCH SER
25	BOOST PRESSURE SIGNAL OPEN SHORT TO + BATTERY			X
25	BOOST PRESSURE SIGNAL SHORT TO GROUND			X
38	INTAKE MANIFOLD TEMP SENSOR OPEN CIRCUIT			X
38	INTAKE MANIFOLD TEMP SENSOR SHORT CIRCUIT			X
26	ATMOSPHERIC PRESSURE SIGNAL OPEN/SHORT + BATTERY			X
26	ATMOSPHERIC PRESSURE SIGNAL SHORT TO GROUND			X
27	COOLANT TEMP SIGNAL OPEN/SHORT TO + BATTERY			X
27	COOLANT TEMP SIGNAL SHORT TO GROUND			X
37	FUEL TEMPERATURE SIGNAL OPEN/SHORT TO + BATTERY			X
37	FUEL TEMPERATURE SIGNAL SHORT TO GROUND			X
	OIL TEMP SIGNAL OPEN/SHORT TO + BATTERY			X
	OIL TEMP SIGNAL SHORT TO GROUND			X
34	LOSS OF PRIMARY SPEED/TIMING SIGNAL		X	
34	PRIMARY SPEED/TIMING SIGNAL OPEN/SHORT TO + BATTERY			X
34	PRIMARY SPEED/TIME-ING SIGNAL ABNORMAL			X
34	LOSS OF SECONDARY SPEED/TIMING SIGNAL			X
34	SECONDARY SPEED/TIMING SIGNAL OPEN/SHORT TO + BATTERY			X
34	SECONDARY SPEED/TIMING SENSOR SHORT TO GROUND			X
37	FUEL PRESSURE SIGNAL OPEN SHORT TO + BATTERY			X
37	FUEL PRESSURE SIGNAL SHORT TO GROUND			X
53	INTERNAL ECM FAULT		X	

If an engine misfires and a loss of power occurs a fault code should be displayed on the operators panel. This situation may require machine shutdown and diagnostic tools to be attached to the ECM for analysis.

Engines are factory programmed to shutdown under common Caterpillar switch parameters.

- high coolant temperature approximate range
- water temp regulator fully open
- low oil pressure is dependent on engine idle speed, the approximate range is 32 psi @ 1200 rpm and 43 psi @ 2000 rpm.
- engine oil temperature should not exceed

3408E and 3412E HEUI fuel systems



1. cylinder head grounding stud
2. customer connector with Sandvik wires
3. injection actuation pressure control valve
4. oil temperature sensor
5. oil pressure sensor
6. atmospheric pressure sensor
7. secondary speed/timing sensor
8. fuel temperature sensor
9. primary speed/timing sensor
10. coolant temperature sensor

11. tc probe connector

12. electronic control module (ECM)

13. coolant flow switch connector

14. injection actuation pressure sensor

15. turbocharger outlet pressure sensor

Event Codes

Events refer to engine operating conditions such as low oil pressure or high coolant temperature. Logged events usually indicate a mechanical problem instead of electronic system problem.

FLASH CODE	DESCRIPTION OF CODE
21	HIGH INJECTOR ACTUATION PRESSURE
35	ENGINE OVERSPEED WARNING
37	LOW FUEL PRESSURE WARNING
46	LOW OIL PRESSURE WARNING
46	LOW OIL PRESSURE SHUTDOWN
61	HIGH ENGINE TEMPERATURE WARNING
61	HIGH ENGINE TEMPERATURE SHUTDOWN
62	LOW ENGINE COOLANT WARNING

Additional reference materials:

Caterpillar operation and maintenance manual SEBU6960-003 and SEBU6960-04.
Caterpillar Electronic Troubleshooting Guide SENR 1012 and Troubleshooting manual SENR 1073 for industrial engines.

CUMMINS QSK19 SERIES CELECT ELECTRONIC CONTROLS

DESCRIPTION

Cummins engines detect two types of fault codes.

There are engine electronic fuel system fault codes and engine protection system fault codes.

All fault codes recorded will either be

- active (fault code is presently active on engine) or
- inactive (fault code was active at some time, but is not presently active).

Active fault codes may be read using the check engine (amber) and diagnostic light (red) on the drill console. Inactive fault codes may be read with a laptop only.

To check for active fault codes:

- Turn the key switch to the off position.
- Move the diagnostic switch to the on position.
- Turn the key switch to the on position.
- If active fault codes are available the check engine light will begin flashing a three digit code with one second pauses between digits.

The lights will remain off during normal engine operation.

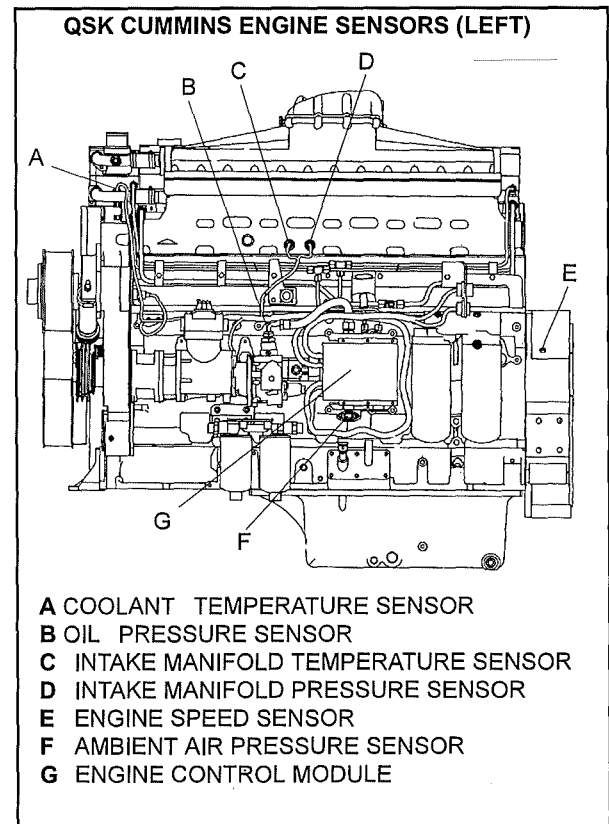
- Red light on while engine is running, stop the engine in a safe manner as soon as possible. This fault may be engine disabling.
- Amber light on the engine can still be run but may lose some system features which may

result in a power loss condition. The failure must be repaired as soon as convenient.

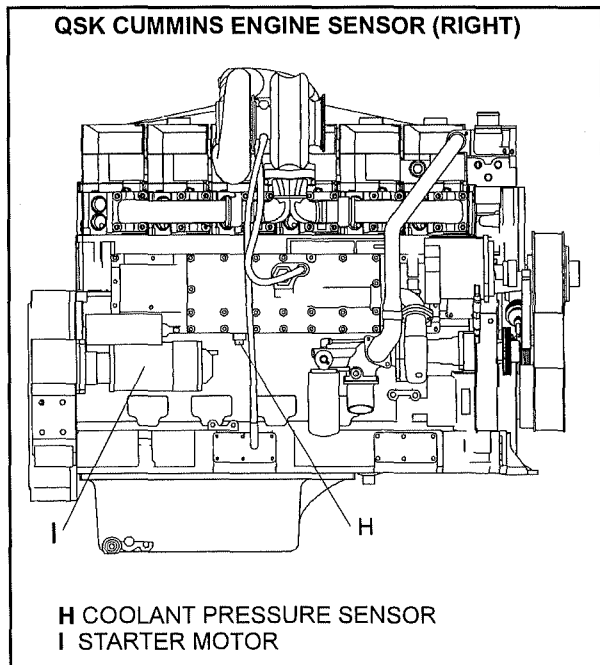
Cummins engine protection system monitors the QSK series engines for:

- High coolant temperature
- Low coolant level (optional)
- Low coolant pressure
- High fuel temperature
- High intake manifold temperature
- Low/very low oil pressure
- High blow by pressure

SENSORS POSITIONED ON THE ENGINE



Some external components will be at different locations for different engine models.



Troubleshooting the engine requires a skilled engine technician familiar with electronic fuel systems.

Three lights positioned on the machine operator panel will enable active fault codes to be seen when they occur. The sequence of flashes represents the system diagnostic message.

The first sequence of flashes represents the first digit of the diagnostic code. There will be a 1 second pause between flashes. Codes are in a three digit numeric sequence.

Diagnostic retrieving may be performed using the toggle switch labeled increment/decrement.

FAULT CODES

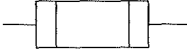

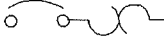







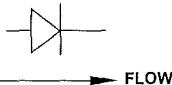

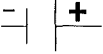




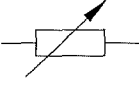
FAULT CODE	DESCRIPTION	EFFECT
111	ELECTRONIC CONTROL MODULE - MEMORY FAILED	RED LIGHT
115	ENGINE SPEED SENSOR - BOTH SIGNALS LOST	RED LIGHT SHUTDOWN
122	BOOST PRESSURE SENSOR - COMPONENT SHORT HIGH (> 4.72 VDC)	AMBER LIGHT
123	BOOST PRESSURE SENSOR - COMPONENT SHORT LOW (< 0.33 VDC)	AMBER LIGHT
135	OIL PRESSURE SENSOR - COMPONENT SHORT HIGH (> 4.88 VDC)	AMBER LIGHT
141	OIL PRESSURE SENSOR - COMPONENT SHORT LOW (< 0.31 VDC)	AMBER LIGHT
143	OIL PRESSURE SENSOR - DATA BELOW NORMAL RANGE	ENGINE PROTECTION
144	ENGINE COOLANT TEMP SENSOR - COMPONENT SHORT HIGH (. 4.95 VDC)	AMBER LIGHT
145	ENGINE COOLANT TEMP SENSOR - COMPONENT SHORT LOW (< 0.21 VDC)	AMBER LIGHT
151	ENGINE COOLANT TEMP SENSOR - DATA ABOVE NORMAL (212° f 100° c)	ENGINE PROTECTION
153	INTAKE MANIFOLD TEMP SENSOR - COMPONENT SHORT HIGH (> 4.88 VDC)	AMBER LIGHT
154	INTAKE MANIFOLD TEMP SENSOR - COMPONENT SHORT LOW (< 0.08 VDC)	AMBER LIGHT
155	INTAKE MANIFOLD TEMP SENSOR - DATA ABOVE NORMAL (220° f 104° c)	ENGINE PROTECTION
221	AMBIENT AIR PRESSURE SENSOR - COMPONENT SHORT HIGH (> 4.78 VDC)	AMBER LIGHT
222	AMBIENT AIR PRESSURE SENSOR - COMPONENT SHORT LOW (< 0.20 VDC)	AMBER LIGHT
234	ENGINE SPEED - DATA ABOVE NORMAL	RED LIGHT
254	FUEL SHUT OFF VALVE - COMPONENT SHORT LOW (< 17 VDC)	RED LIGHT
261	FUEL TEMPERATURE SENSOR - DATA ABOVE NORMAL (> 160° f 71° c)	ENGINE PROTECTION
263	FUEL TEMPERATURE SENSOR COMPONENT SHORT HIGH (> 4.94 VDC)	AMBER LIGHT
265	FUEL TEMPERATURE SENSOR COMPONENT SHORT LOW (< 0.21 VDC)	AMBER LIGHT
343	ELECTRONIC CONTROL MODULE - INTERNAL COMMUNICATOR ERROR	AMBER LIGHT
346	ELECTRONIC CONTROL MODULE - POWER ERROR	AMBER LIGHT
415	OIL PRESSURE SENSOR - DATA INDICATES VERY LOW OIL PRESSURE	ENGINE PROTECTION
441	BATTERY VOLTAGE UNSWITCHED - DATA BELOW NORMAL (12VDC)	AMBER LIGHT
442	BATTERY VOLTAGE UNSWITCHED - DATA ABOVE NORMAL (38 VDC)	AMBER LIGHT
451	FUEL PRESSURE SENSOR - COMPONENT SHORT HIGH (> 4.78 VDC)	RED LIGHT

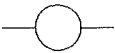








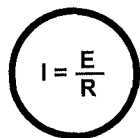
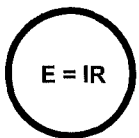
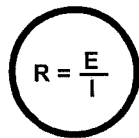
FAULT CODE	DESCRIPTION	EFFECT
452	FUEL PRESSURE SENSOR - COMPONENT SHORT LOW (< 0.15 VDC)	RED LIGHT
554	FUEL PRESSURE SENSOR - IN RANGE FAILURE (< 0.50 / > 1.83 VDC)	AMBER LIGHT
555	HIGH BLOW BY PRESSURE (> 14.5 IN H2O)	ENGINE PROTECTION
719	BLOW BY PRESSURE SENSOR - COMPONENT SHORT HIGH (> 4.94 VDC)	AMBER LIGHT
729	BLOW BY PRESSURE SENSOR - COMPONENT SHORT LOW (< 0.29 VDC)	AMBER LIGHT

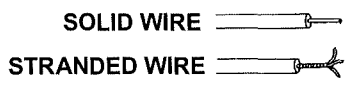
Reference material Quantum wiring diagram bulletin no. 3666133-02, Operator and maintenance manual QSK19 series engine bulletin no. 3666120-02 (publication 020235-000)

ELECTRIC SCHEMATIC SYMBOLS

(TYPICAL SYMBOLS USED ON BLASTHOLE DRAWINGS)

 <p style="text-align: center;">FUSE</p>	 <p style="text-align: center;">THERMAL OVERLOAD (BREAKER)</p>	 <p style="text-align: center;">CIRCUIT BREAKER</p>
 <p style="text-align: center;">PUSH BUTTON (N.O.)</p>	 <p style="text-align: center;">PUSH BUTTON (N.C.)</p>	 <p style="text-align: center;">SWITCH (N.O.)</p>
 <p style="text-align: center;">PRESSURE SWITCH (N.O.)</p>	 <p style="text-align: center;">TEMPERATURE SWITCH (N.C.)</p>	 <p style="text-align: center;">LEVEL SWITCH (N.C.)</p>
 <p style="text-align: center;">FLOW SWITCH (N.O.)</p>	 <p style="text-align: center;">DIODE</p>	 <p style="text-align: center;">RHEOSTAT</p>
 <p style="text-align: center;">BATTERY</p>	 <p style="text-align: center;">ALTERNATOR/ (MOTOR/GENERATOR)</p>	 <p style="text-align: center;">GAUGE</p>
 <p style="text-align: center;">LIMIT SWITCH (N.O.)</p>	 <p style="text-align: center;">LIMIT SWITCH (N.C.)</p>	 <p style="text-align: center;">VARIABLE RESISTOR</p>

		
COIL	SOLENOID	LIGHT
		
CONTACT (N.O.)	CONTACT (N.C.)	GROUND
		
PLUG & SOCKET	COIL (INDUCTOR)	CAPACITOR
		
I = AMPERES	E = VOLTS	R = OHMS

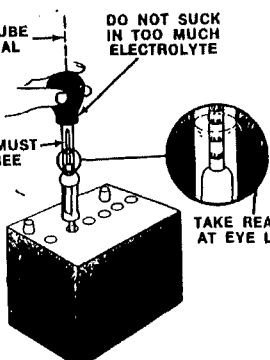


HOLD TUBE VERTICAL

DO NOT SUCK IN TOO MUCH ELECTROLYTE

FLOAT MUST BE FREE

TAKE READING AT EYE LEVEL



Specific Gravity Reading (Adjusted)	State of Charge
1.260	100%
1.230	75%
1.200	50%
1.170	25%
1.140	Very Little
1.110	Discharged

CIRCUIT SCHEMATICS

GENERAL

Sandvik blasthole equipment uses common electrical components and similar design circuits.

DESCRIPTION

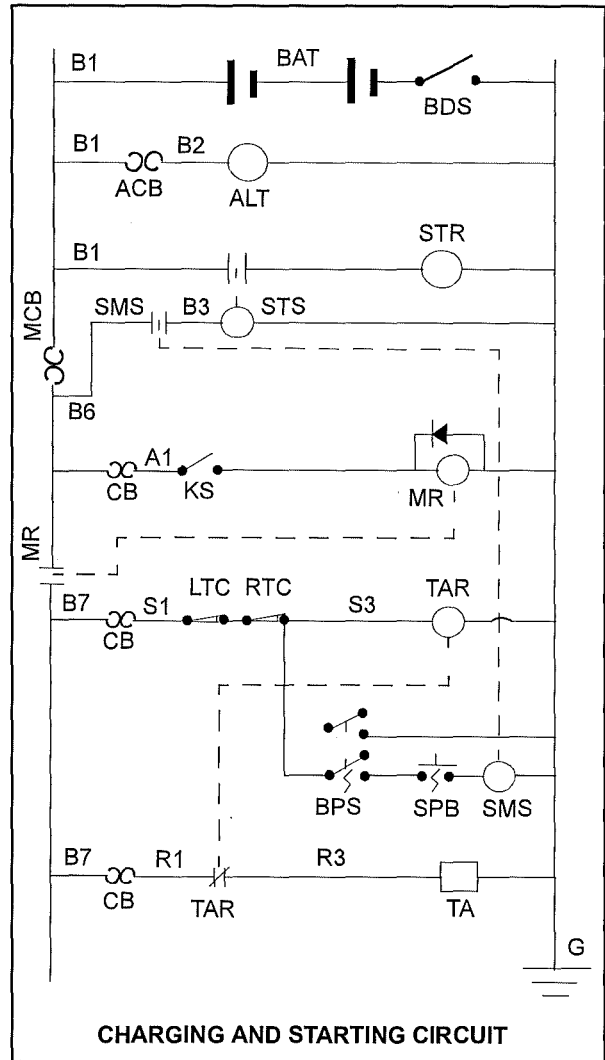
This section will show specific systems that are currently used across the product line.

When ever possible the wire number will be shown in this section training schematics. If the wire number is not shown the circuit is not common across the product line.

Blasthole charging and starting circuits consist of the following components:

- 2 - 12 volt batteries in series to enable a 24 volt circuit. (BAT, BDS, RS)
- Alternators are 75, 100 and 175 amp capacity, with circuit protection. (ALT, ACB)
- Main circuit breaker enables 80, 105 or 180 amp overload protection. (MCB)
- Key switch that enables operator monitoring and main relay power for the machine run mode. (KS)
- Neutral safety switches interrupt the start mode if propel levers are off neutral. (LTC, RTC)
- Bypass and start push buttons allow the machine operator starting control. (BPS, SPB)
- Manual ether injection for cold weather starting. Engine parameters enable or interrupt this feature. (EPB)
- Starter magnetic switches, one for each starter motor circuit. (SMS)

- Starter solenoids, one for each starter motor (STS).
- 50MT starter motors one or two depending on operating condition. (STR) Pre-lube type starter motors are available for special operating conditions.



The components in this charging and start circuit are positioned on the engine, in the engine junction box (EJB2), in the operator cab (CJB1) and operator panel (OPJB).

Maintain the battery and charging system and related cables per 250 hour service instructions.

The specific gravity of the batteries should be checked between seasons. Ambient conditions will effect battery capacity when a load is induced.

Battery life may be affected by:

- dirt
- corrosion
- frayed cables
- overfilling
- loose hold down
- cell connector corrosion
- sealing compound defect
- cracked cell cover
- cracked case
- low electrolyte

Battery test equipment includes a hydrometer. When possible maintain battery electrolyte in a 1.270 specific gravity range.

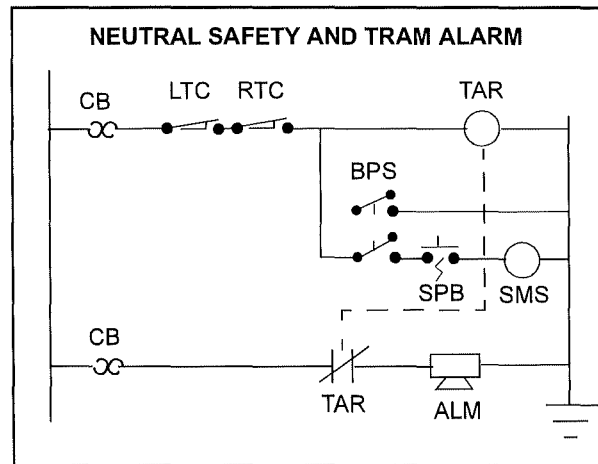
This may be achieved with 64% H₂O and 36% acid H SO. Use distilled water as the filling solution.

When replacing a battery cable, cut the cable length as short as possible and route as direct as allowable. Avoid sharp turns and bending.

Pre-lube starter may be fitted to the engine for cold weather operating conditions. The starter solenoid operates a gear pump. Engine oil will circulate through the engine block to a normal closed 4 psi (.3 bar) oil pressure switch.

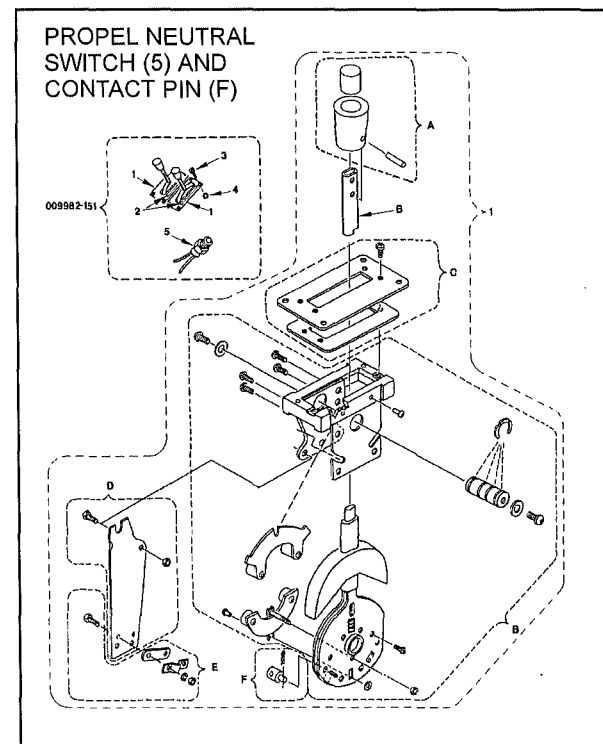
When the start button is actuated prelube will occur until engine oil pressure opens the switch. There will be a two second pause prior to engine start mode.

Neutral safety and tram alarms are mandatory for crawler mounted drill machines. Due to the cable or electronic controls that command pump displacement a safety interlock is placed on the left and right tram controls that will interrupt the machine starting system.



Neutral safety switches are a component of all tram control levers.

Cable operated tram levers have the neutral switches positioned on the center cam frame and a square pin is positioned on the rotating cam of the same lever.



Electronic tram controls have a microswitch positioned on the frame near the rotating cam.

Due to operating conditions and operator comfort drill machines may be fitted with specific electrical systems.

These options are a mix of proximity switches, magnetic switches, control relays, and hydraulic solenoid valves.

The following will be the most common options fitted to machine applications.

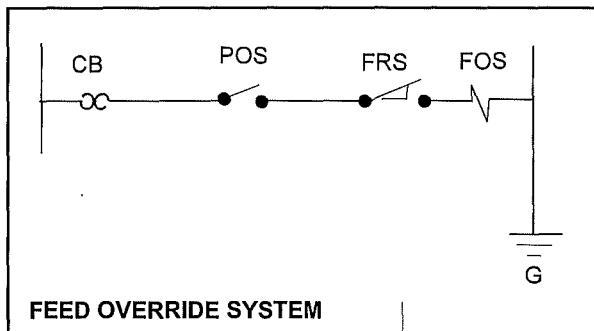
- Feed override (POS, FRS, FOS)
- Fast feed (FFS)
- Tram interlock (TFS, PVS, LBS, RBS)
- Head/jack/brake interlock (LRP, RRP, FRP, RHU, CR1-4, PVS, LBS, RBS)
- Head loader interlock (FCS, PLP, HIR, FVS)

Options listed are customer specific. These options may be fitted to machines in the field by competent mechanical persons. Installations may require minor welding common hand tools, basic hydraulic and electrical system experience.

Feed override

The feed override operating principal is to enable maximum feed pump pressure when retracting drill pipe from a drilled blasthole.

Dependant on the type of feed pump the maximum pressure allows the pump to be controlled from 0 through its specific output flow rate when maximum pressure is achieved.

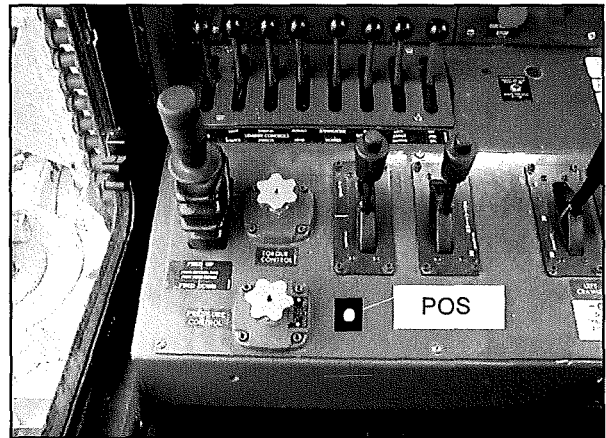


Operators select the feed override mode. The sequence shall start with the feed pump in neutral

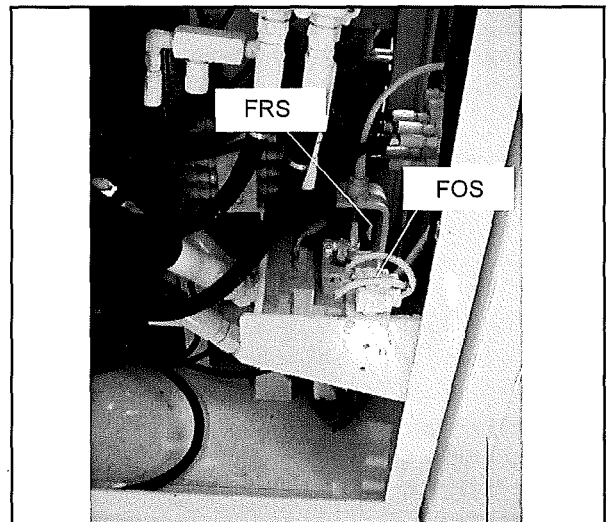
- apply the pressure override toggle switch
- move the feed control valve to the hoist position
- select the appropriate feed pump speed with the feed pump control

Note!

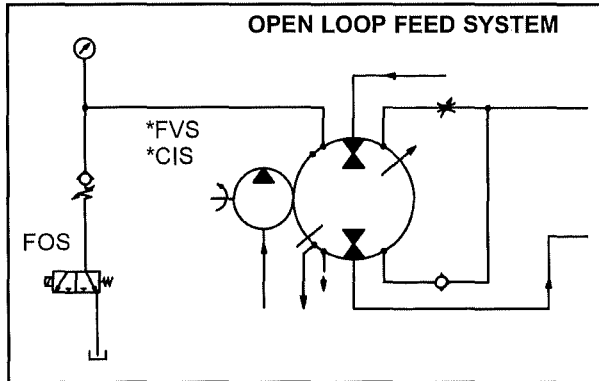
When stopping the feed system the feed speed must be slowed prior to centering the feed control valve or switching the pressure override switch.



The hydraulic valves are situated inside the hydraulic cabinet lower left side corner.



The hydraulic systems for feed vary slightly between machine applications. This example shows the most common open loop application.



It is preferred that the feed override solenoid be added after the remote pressure control valve in open loop piston pump applications.

Confirm feed override solenoid placement on D25KS, D245S and all 90 series machines.

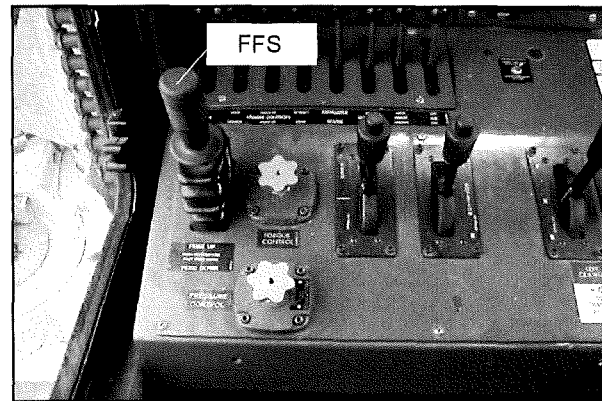
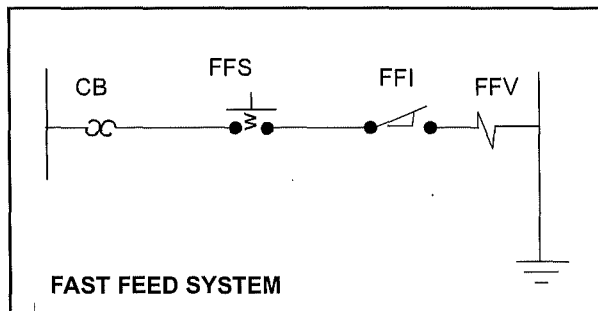
Fast feed

Fast feed is a systems designed to increase the feed cycle time when extending the feed cylinder(s) and lowering the rotary head for multi-pass drilling applications.

Operators select this feature with a thumb controlled switch attached to top of the feed control handle.

Note!

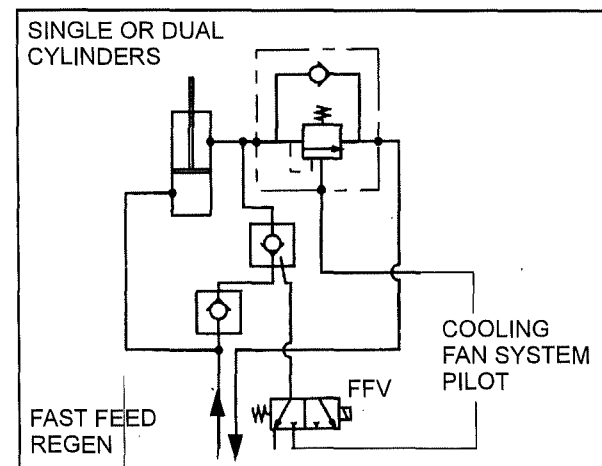
The application shall be used to lower the rotary head when it is empty of drill pipe.



The sequence for fast feed operation shall be

- select the feed control handle to the down position
- set the feed pump control to the desired speed value from zero through full control forward
- actuate the thumb control for fast feed
- release the thumb control to resume normal feed speed
- center the feed pump control to slow the feed system when preparing to stop or change directions
- place the feed control handle in the center position

Do not use fast feed with drill pipe connected to the rotary head.



Tram interlock(s)

Crawler mounted equipment that are subjected to varying ground terrains may require a secondary operator control as a safety feature.

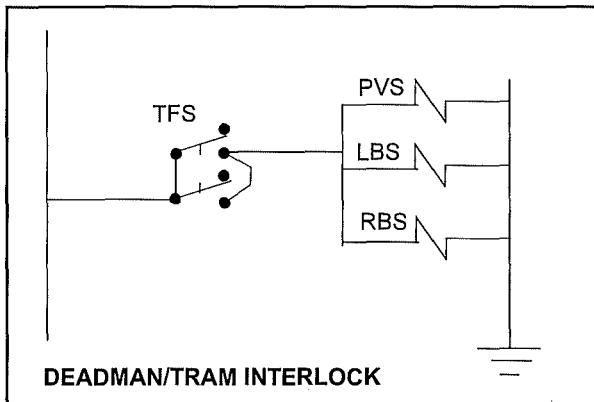
In the drill machine applications the terms deadman and tram interlocks refer to the secondary operator control system.

Most often the tram interlock is a combination of electrical and hydraulic valves that enable the propel pump and final drive brake systems to operate when conditions are correct.

Components of the tram interlock consist of

- pump vent solenoid
- left brake solenoid*
- right brake solenoid*
- tram foot switch*
- tram interlock junction box*
- control relays*
- proximity switches

Tram interlock may be a basic system or additional relays and switches may be attached for added machine component safety



The sequence of operating the basic tram interlock system

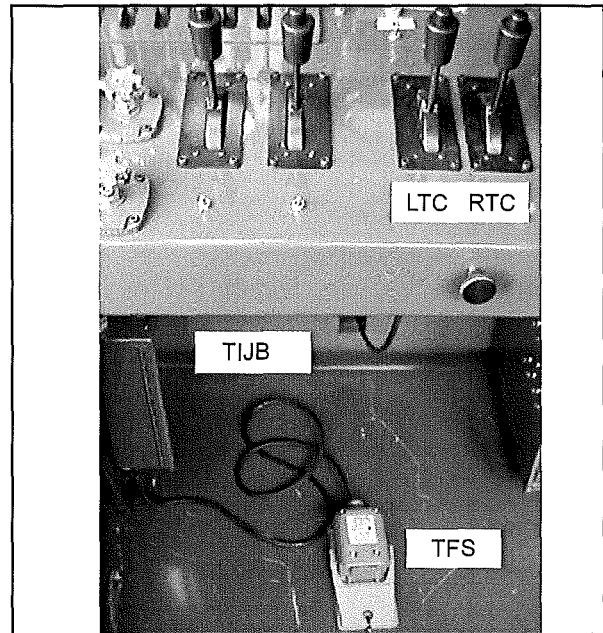
- step on the tram foot switch (TFS)

- operate the tram control levers (LTC/RTC) forward or reverse as needed
- center the tram control levers to neutral position to stop the machine travel
- step off the tram foot switch

When stepping on the tram foot switch 24 VDC power will energize the pump vent solenoid and when applicable the left and right brake solenoids.

As the solenoid coils energize the hydraulic spools move, propel pump main pressure is blocked and the servo pressure can release the track brake enabling the tram mode.

Tram foot switches and terminal contact pins are subject to corrosion from work shoes and environmental conditions. Clean or replace terminal contacts and wire ends as needed.

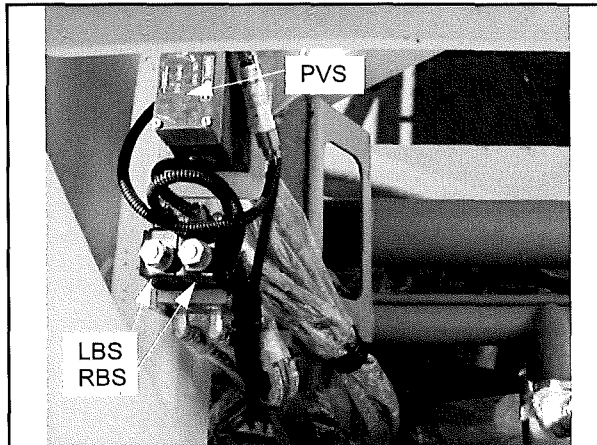


Applications used with leveling jacks may be jack/brake interloc.

Applications used to protect drill pipe and leveling jacks may be head/jack/brake interloc.

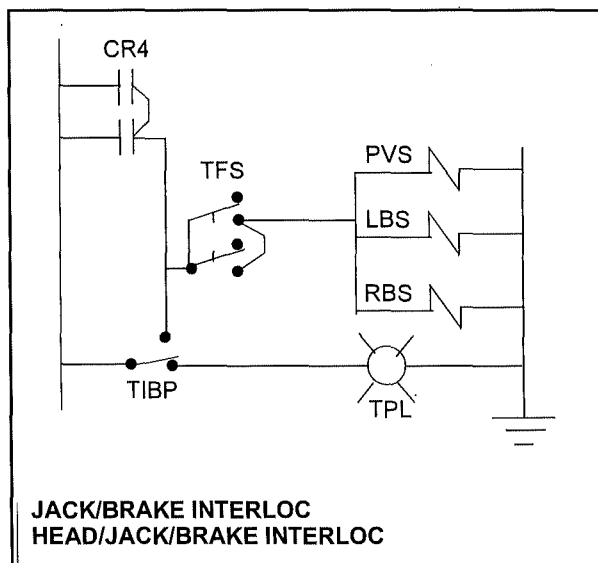
A tram interlock junction box supports 4 control relays, terminal strips a power light and bypass switch.

Control relays are connected in series with leveling jack proximity switches and a rotary head position switch. The bypass feature may be used during system diagnostic or troubleshooting.

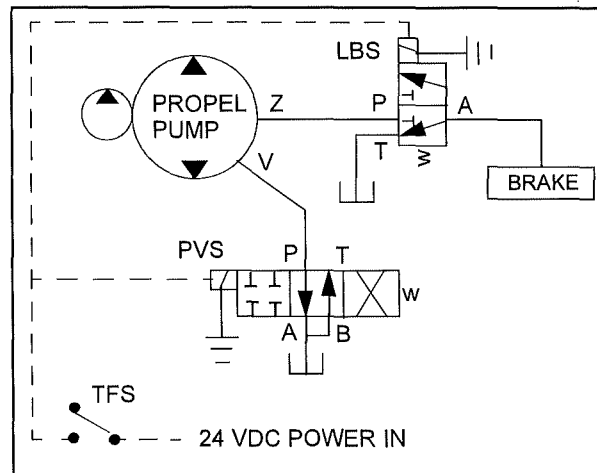


All leveling jacks shall be in the retracted position and the rotary head shall be up or near the crown of the mast to enable tram interlock.

With head/jack/brake interlock the sequence of operating remains the same as long as the head and jacks are up.

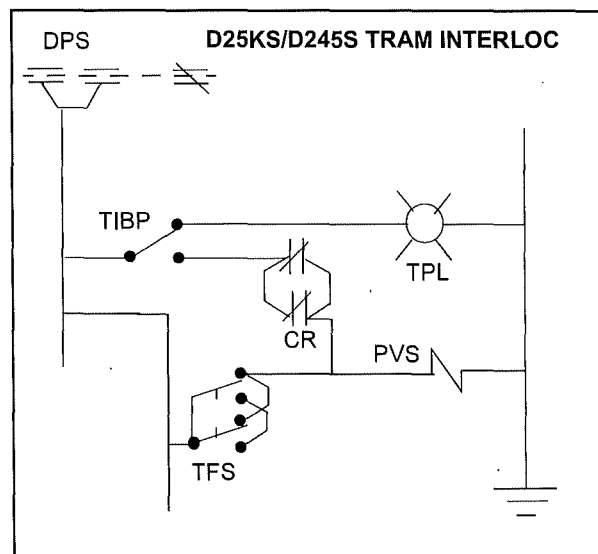


Hydraulic systems that use independent propel pumps need to supply servo oil to the track brake and deadhead system pressure to enable the machine tram mode.



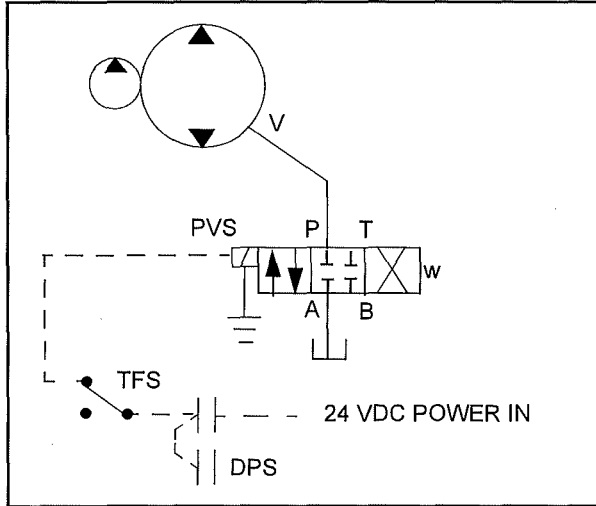
Tram interlocks may be configured differently according to machine model and machine options. Confirm machine specific serial number to verify exact electrical and hydraulic connections.

Specific to D25KS and D245S machines the electrical system is powered through the drill selector switch.



Hydraulic systems that use dual purpose pumps (propel/drill functions) do not supply servo oil to

the track brake meaning brake solenoids are not required. The pump vent solenoid has to deadhead system pressure to enable the machine tram mode.



If electrical systems cannot apply the hydraulic components the hydraulic system may be terminated momentarily for diagnostic purpose. Pressure type #4 series hydraulic caps, plugs and unions are required.

Head loader interloc

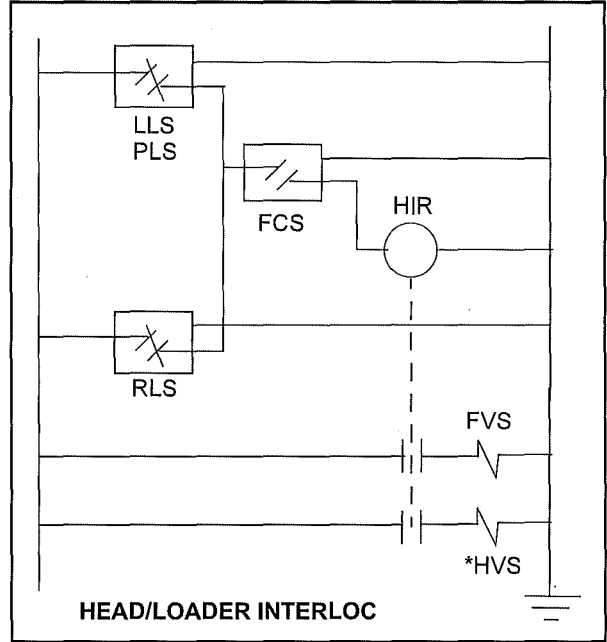
A feature to protect the rotary head from contacting drill pipe loaders is referred to as head loader interloc.

Proximity switches are placed in the mast frame, one for each drill pipe bader. The loader bottom section seat plate will make contact with the proximity switch. Proximity switches are magnetic sensing and offer a LED light to check sensitivity.

Sensing distance is 3/8 inch (10mm). Wire length may be cut to fit the application. Deutch connectors are used to connect switches into the wire harness.

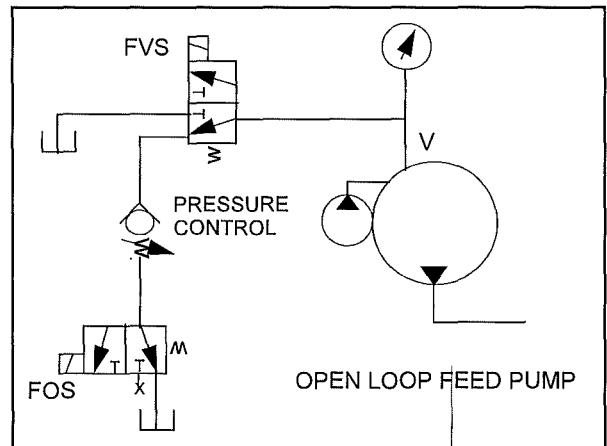
Proximity switches have three 18 gage wires. One each brown power in, black output to relay or control and blue ground.

The proximity switch black output wire actuates a control relay circuit that enables or disables the hydraulic system feed pump pressure.



The left and/or right loader switch are normal closed until it senses metal. Upon sensing metal the loader proximity switch goes open. The FCS feed carrier switch and HIR head interloc relay are not energized.

When the feed vent solenoid becomes energized via loader proximity switch and head interloc relay, hydraulic pressure through the feed vent solenoid vents feed pump pressure to drain.



Centralizer, vee block and pipe positioner

Machines with extended masts and angle drill options use drill pipe guides. The guides are operator selected. Use the pipe guide or centralizer in full extend or retract positions only.

A drill pipe centralizer is used to stabilize two piece drill pipe connections when used in a single pass drill method. The centralizer is placed mid section of a single pass mast assembly.

Vee block and pipe positioner are angle drill accessories. The intended use is to stabilize drill pipe during the change procedure.

When the operators use these items for their intended principal drill pipe alignment will be proper for connecting drill pipe threads.

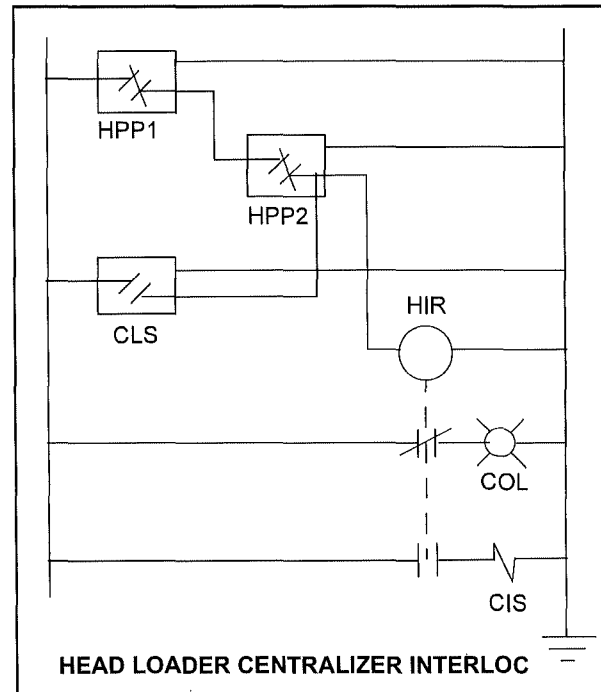


Caution:

The rotary head may come in contact with the pipe guide or centralizer if not full retract or extend position.

A combination of proximity switches, control relays and solenoid valves may be used as a safety to protect these items. This circuit will give notice to the operator that the guides are in position.

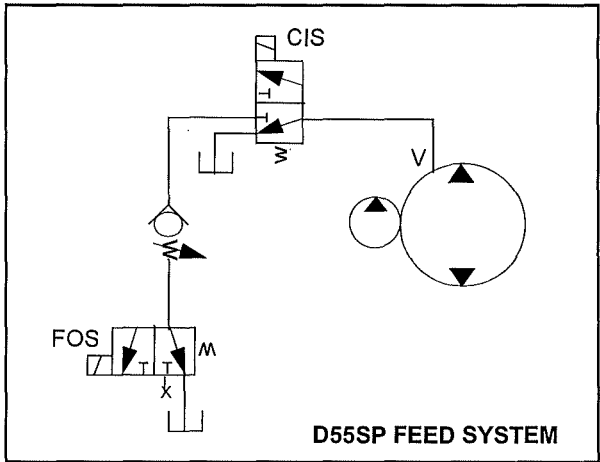
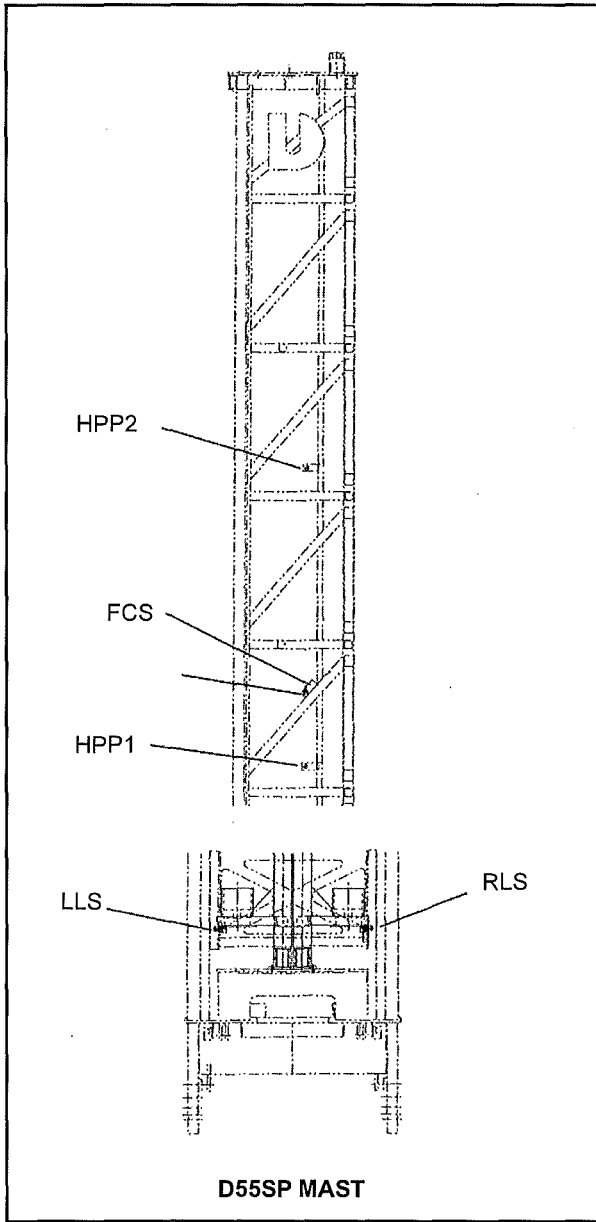
The safety circuit may be a visual indicator light or it may vent the feed pump to stop hydraulic system operation.



When the centralizer is out the CLS proximity switch closes and powers the HIR to energize the CIS solenoid and turn the light off.

When the centralizer is in the CLS proximity switch opens. Both HPP proximity switches power the HIR to energize the CIS solenoid and turn off the light.

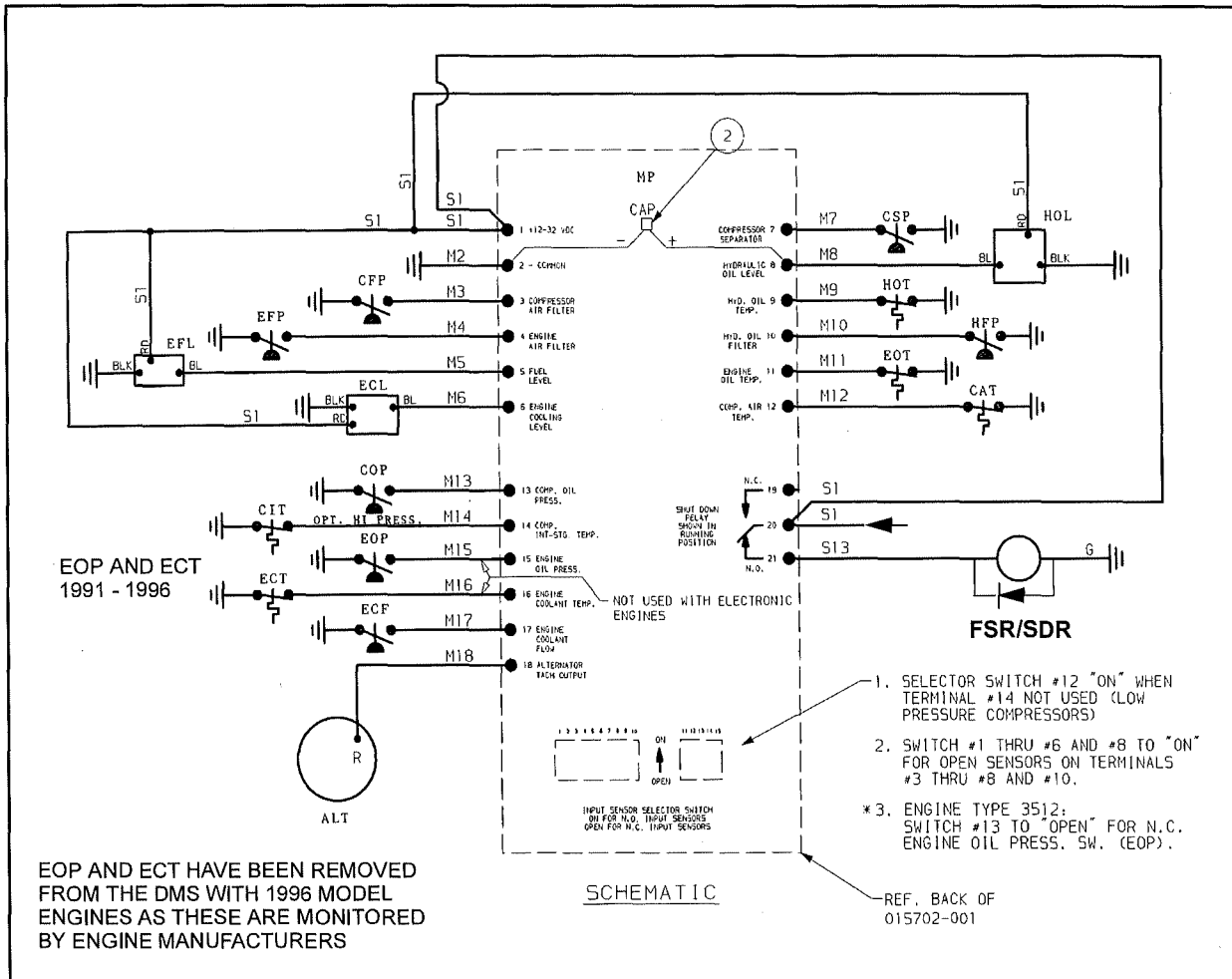
When the feed system carrier sprocket moves into the HPP proximity switch range the HPP proximity switch opens and breaks power to the HIR. When the HIR de-energizes the CIS vents the feed pump to zero and the light comes on in the cab to alert the operator.



Note!
 When the feed pump pressure is near zero the feed and hoist circuits and lower stacker circuits are affected.

Hydraulic systems will vent the feed pump to a near zero pressure and stop the feed down mode until the centralizer position is corrected.

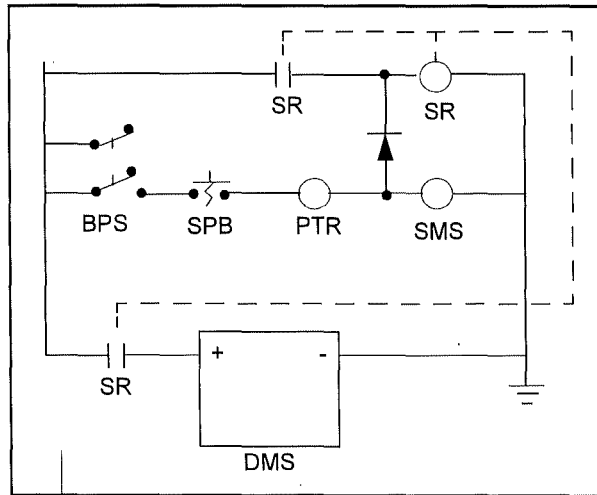
Drill Monitor System.



Power to the DMS is initiated from the key switch and the main relay as standard.

When customer options include a prelube starter system power to the DMS is initiated after the prelube cycle occurs. A self latching relay (SR) enables power to the DMS.

The DMS power light will illuminate after the prelube time cycle completes. Continue to hold the bypass switch after the start cycle until engine runs smooth at low idle.



ELECTRICAL COMPONENT SPECIFICATIONS

GENERAL

Electrical components are purchased parts from various vendors. Sandvik engineers determine ratings and capacities required for the dedicated circuits.

DESCRIPTION

The following table may not show every component and may be modified on a as needed basis.

We reserve the right to change electrical components on a as needed basis when new or improved components become available.

Component abbreviations and descriptions will be shown and the specifications will be given for troubleshooting purpose only.

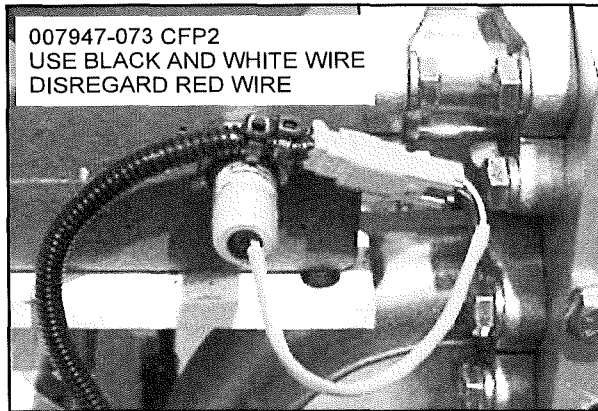
ABBREVIATION	AC/DC VOLTAGE	RESISTANCE
FLS	24/ 28VDC	FULL 33,5 ± 6 EMPTY 240 ± 20
ATS	0 - 24VDC	250OHM
WTS	0 - 24VDC	2 OHM
ESS		
RSS		
BAT	8D/12VDC/1400CCA	
CR	0 24VDC	51 MA/4720HM
FOS	0 - 24VDC	33 - 450HM
LTR		
CLO	1.8 - 265VDC	9.5WATT
CHI	1.8 - 265VDC	9.5WATT
EDC	12 AND 24 VDC	
LRP	12/48 - 24VDC	200MA/200Hz
MR	12/36 - 24VDC	53OHM/25°C
OPS		
RHU	0 - 24VDC	10AMP
FRS	0 - 30VDC	5AMP CONT 3AMP INT@28VDC

ABBREVIATION	AC/DC VOLTAGE	RESISTANCE
FL	0 - 24VDC	70 WATT
SMS	0 - 36VDC	65AMP CON 120 AMP INT
FLG	0 - 24VDC	33,5 - 240OHM
CB	0 - 30VDC	10 - 175 AMP
CR 8 PIN	12VDC 24VDC	10AMP 20AMPS@28VDC
CR 11 PIN	24VDC	10AMPS
LTPS (500)	0 - 12VDC	25 - 290HM
RTPS (500)	0 - 12VDC	25 -290HM
FPV	0 - 24 VDC	
RPV	0 - 24 VDC	
LTPS (900)	0 - 24VDC	110HM
RTPS (900)	0 - 24VDC	110HM
QB1 COMMAND SIGNAL	15 - 24VDC 0 - 10VDC	250 mA 4 - 20 mA
CBS	2.5 - 220VDC	16WATT
MCS	0 - 24VDC	33 - 450HM
TCS	0 - 24VDC	33 - 450HM
MDS	0 - 24VDC	33 - 450HM
FVS	0 - 24VDC	33 - 450HM
RRP	12/48VDC	200MA/200Hz
FRP	12/48VDC	200MA/200Hz
CAT	24VDC	5AMP@24VDC
CIT	24VDC	5AMP@24VDC
PVS	(19.2/28.8) 24VDC	20MA/31W
LBS	0 - 24VDC	33 - 450HM
RBS	0 - 24VDC	33 - 450HM

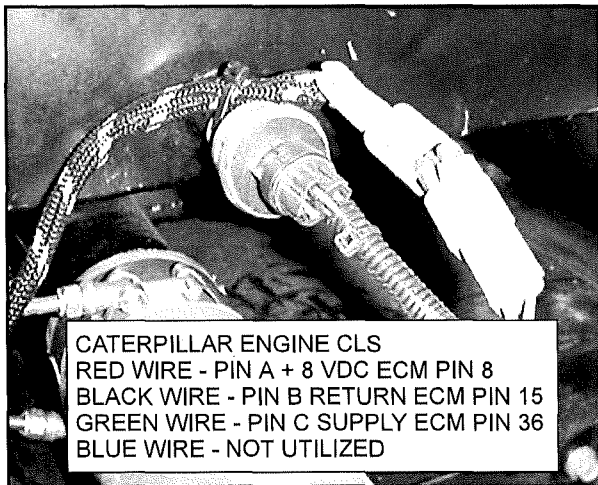
Purchased electrical components need to be properly connected into our wiring systems.

Common electrical components connections.

Compressor filter pressure switch 007947-073 has three wires standard and we only uses two of the three wires.



The engine coolant level sensor differ from the hydraulic and diesel fuel sensors. Oil and water type sensors are not interchangeable.

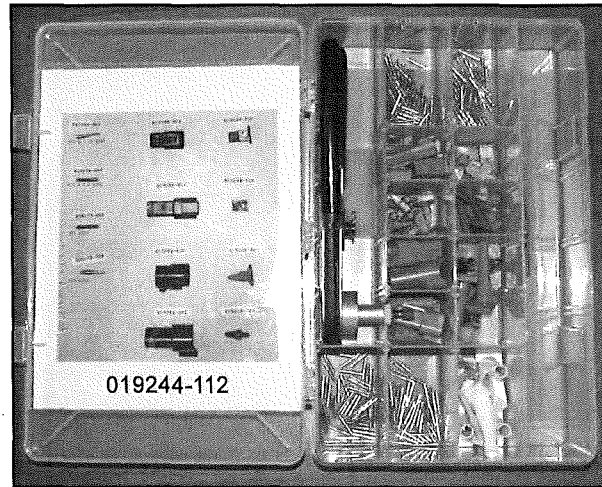


Level sensors for engine coolant, diesel fuel and hydraulic oil have three wire connectors.

Tier two Caterpillar engines of the C15 and C16 models have the engine coolant sensor configured to the engine control module. Low coolant level creates a logged code in the ECM.

It is recommended to make secure sealed connections with approved Deutsch type two and three pin connectors.

Our Deutsch kit part number 019244-112.



ELECTRICAL SYSTEMS COMPONENT DESCRIPTIONS

Blasthole abbreviated nomenclature and components for 12, 24 vdc and (AC) systems.

ABREVIATION/COMPONENT	ABREVIATION/COMPONENT	ABREVIATION/COMPONENT
A	B	COP COMPRESSOR OIL PRESSURE SW.
ACB ALTERNATOR CIRCUIT BREAKER	BAT BATTERY	CP CONTROL PANEL
ACC AIR CONDITIONING CLUTCH	BCH BOOM CONTROL HORIZONTAL	CPM CIRCULATING PUMP/MOTOR
ACH AUXILLARY CAB HEATER	BCV BOOM CONTROL VERTICLE	CPS CENTRALIZER PROXIMITY SWITCH
ACT ACTUATOR 3508	BDS1 BATTERY DISCONNECT SWITCH 1	CR CONTROL RELAY
ACT ANALOG COOLANT TEMPERATURE	BDS2 BATTERY DISCONNECT SWITCH 2	CSP COMPRESSOR SEPERATOR PRESS.
ACV AIR CONTROL VALVE	BL BOOM LOWER	CSW COMPRESSOR HI/LO SWITCH
AD ANGLE DISPLAY	BMS BLOWER MOTOR SWITCH	CTS COMPRESSOR TEMPERATURE SW.
ADH ANGLE DISPLAY HORIZONTAL	BPS BYPASS SWITCH	CUP CAB RAMP UP PUSHBUTTON
ADV ANGLE DISPLAY VERTICLE	BR BOOM RAISE	D
AET ANALOG ENGINE TEMPERATURE	BS BASE STACKER	DCP DUST COLLECTOR PURGE SWITCH
AJO ANTI JAM ON SWITCH	BS BOTTOM STACKER	DCS DUST COLLECTOR SOLENOIDS
AJP ANTI JAM PRESSURE SWITCH	BSL BOOM SWING LEFT	DCT DUST COLLECTOR TIMER
ALB AUTO LEVEL BOX	BSR BOOM SWING RIGHT	DH DOG HOUSE
ALC AUTO LEVEL CONTROLS	C	DHL DUST HOOD LIGHT
ALF AUTO LEVEL OFF SWITCH	CAC CAB AIR CONDITIONER	DHU DUST HOOD UP PROXIMITY SW.
AJP ANTI JAM PRESSURE SWITCH	CAP CAPACITOR	DI DIODE
ALT ALTERNATOR	CAT COMPRESSOR AIR TEMPERATURE	DIA DIAGNOSTIC LIGHT
AOF AIR VALVE OFF	CB CIRCUIT BREAKER(S)	DIS DIAGNOSTIC SWITCH
AON AIR VALVE ON	CBD COMPRESSOR BLOWDOWN SWITCH	DL DOME LIGHT
APS1 AIR PRESSURE SWITCH 2	CBS COMPRESSOR BYPASS SOLENOID	DLD DOME LIGHT DIMMER
APS2 AIR PRESSURE SWITCH 2	CBV COMPRESSOR BLOWDOWN VALVE	DLS DOME LIGHT SWITCH
AR AUTO LEVEL RELAY	CC COMMON CONNECTOR	DMS DRILL MONITOR SYSTEM
AS ANGLE SENSOR	CDN CAB RAMP DOWN PUSHBUTTON	DNR DOWN RELAY
ASI AUTO TONG SWING IN	CFL COMPRESSOR FILTER LIGHT	DP DRILLER PANEL
ASO AUTO TONG SWING OUT	CFP1 COMPRESSOR AIR FILTER PRESS.	DPH DIESEL PREHEATER
ASW AIR ON/OFF SWITCH	CFP2 COMPRESSOR OIL FILTER PRESS.	DPL DIESEL PREHEATER LIGHT
ATC AUTO TONG CLAMP	CFS CONTROL OFF SWITCH	DPS DIESEL PREHEATER SWITCH
ATG AIR TEMPERATURE GAUGE	CHI COMPRESSOR HIGH SOLENOID	DPS DRILL PROPEL SELECTOR SWITCH
ATR ANTI JAM TIMER RELAY	CIT COMPRESSOR INTERSTAGE TEMP	DR DRILL RELAY(S)
ATS AIR TEMPERATURE SENSOR	CKE CHECK ENGINE LIGHT	DSW DUST/WATER SOLENOID
ATU AUTO TONG UNCLAMP	CLO COMPRESSOR LOW SOLENOID	E
AVC AIR VALVE CONTROLER	COL CONSOLE ON LIGHT	ECF ENGINE COOLANT FLOW SW.
AVS AIR VALVE SWITCH	CON CONNECTOR	ECL ENGINE COOLANT LEVEL SW
ECM ENGINE CONTROL MODULE	FECV FEED EXT CONT VERTICLE	FTR FEED TILT RIGHT CONTROLLER

ABREVIATION/COMPONENT	ABREVIATION/COMPONENT	ABREVIATION/COMPONENT
ECP ENGINE COOLANT PREHEATER	FED FEED EXTEND DOWN STROKER	FVS FEED VENT SOLENOID
ECT ENGINE COOLANT TEMPERATURE	FEU FEED EXTEND UP STROKER	G
EDC ELECTRONIC DEPTH COUNTER	FFR FAST FEED RELAY	GCS GROUND/CAB SELECTOR SWITCH
EFFL ENGINE FUEL FILTER LIGHT	FFS FAST FEED SWITCH	GDN GRND/RAMP DOWN PUSHBUTTON
EFFS ENGINE FUEL FILTER SWITCH	FFV FAST FEED SOLENOID VALVE	GEN GENERATOR SWITCH
EFL ENGINE FUEL LEVEL	FIL FOAM INJECTION LIGHT	GL GAUGE LIGHT
EFP ENGINE AIR FILTER PRESSURE	FIP FOAM INJECTION PUMP	GLS GAUGE LIGHT SWITCH
EIS ETHER INJECTION SWITCH	FIS FOAM INJECTION SWITCH	GOV ELECTRONIC GOVERNOR MODULE
EMB ENGINE MODULE BREAKER	FJC FRONT JACK CONTROLLER	GP GAUGE PANEL
ENC ENCODER	FJL FRONT JACK LIGHT	GS GENERATOR SOLENOID
EOP ENGINE OIL PRESSURE	FJS FRONT JACKS PRESSURE SWITCH	GUP GRND/RAMP UP PUSHBUTTON
EOT ENGINE OIL TEMPERATURE	FL FLOOD LIGHT	H
EP ENGINE PANEL	FLG FUEL LEVEL GAUGE	HBS HOLDBACK SOLENOID
EPB ETHER PUSHBUTTON	FLS FUEL LEVEL SENDER	HC HOIST CONTROL
EPS ENGINE PRESSURE SWITCH	FOR FEED OVERRIDE RELAY	HDS HOOD DOOR SWITCH
ER ETHER RELAY	FOS FEED OVERRIDE SOLENOID	HFP HYD FILTER PRESSURE SWITCH
ESL ENGINE STOP LIGHT	FPA FEED PRESSURE AMPLIFIER BOARD	HIR HEAD INTERLOC RELAY
ESM ENGINE SPEED METER	FPC FEED PRESSURE CONTROL	HMS HOUR METER SENDER
ESO ETHER SOLENOID	FPD FEED PUMP DOWN COIL	HOL HYDRAULIC OIL LEVEL
ESPB EMERGENCY STOP PUSHBUTTONS	FPL FRONT JACK PRESSURE LIGHT	HOT HYDRAULIC OIL TEMPERATURE
ESS ENGINE SPEED SENSOR	FPL FILTER PRESSURE LIGHT	HPP HEAD POSITION PROXIMITY
ETR ETHER TIMER RELAY 3508	FPS FILTER PRESSURE SWITCH	HPP1 HEAD POSITION PROXIMITY 1
ETS1 ENGINE TEMPERATURE SWITCH	FPS FEED PUMP STROKER	HPP2 HEAD POSITION PROXIMITY 2
ETS2 ENGINE TEMPERATURE SWITCH	FPU FEED PUMP UP COIL	HRS HOOD RETRACT SWITCH
F	FPV FEED PRESSURE VALVE	HSW HOLDBACK SWITCH
FBPB FAN BYPASS PUSHBUTTON	FRF FEED REPLENISHMENT FILTER	HWI HOLDING WRENCH IN CONTROL
FBS FAN BYPASS SOLENOID	FRHL FRONT/REAR HI/LO LEVEL SENSOR	HWO HOLDING WRENCH OUT CONTROL
FC FEED CONTROLLER	FRL FRONT JACK LIGHT	HWS HOLDING WRENCH SWITCH
FCH FEED CONTROLLER HORIZONTAL	FRP FRONT JACK PROXIMITY SWITCH	HVS HOLDING VALVE SOLENOID
FCM FEED CONTROL MODULE	FRS FEED RETRACT SWITCH	HWI HOLDING WRENCH IN CONTROL
FCS FEED CYLINDER SWITCH	FS FUEL SOLENOID	I
FCV FEED CONTROLLER VERTICLE	FS FEED STACKER	IL INSTRUMENT LIGHT
FDV FEED DUMP FORWARD SOLENOID	FSP FIRE SUPPRESSION PRESSURE SW.	ILS INSTRUMENT LIGHT SWITCH
FDR FEED DUMP REVERSE SOLENOID	FSS FUEL SOLENOID RELAY	INC INCREMENT/DECREMENT SWITCH
FEC FEED EXTEND CONTROLLER	FTC FEED TRAM CONTROLLER	IP INSTRUMENT PANEL
FECH FEED EXT CONT HORIZONTAL	FTL FEED TILT LEFT CONTROLLER	IRS IDLE RUN SWITCH
IL INSTRUMENT LIGHT	LT LUBE TIMER	P

ABREVIATION/COMPONENT	ABREVIATION/COMPONENT	ABREVIATION/COMPONENT
ILS INSTRUMENT LIGHT SWITCH	LTC LEFT TRAM CONTROLLER	PBI POWER BREAK IN CONTROL
INC INCREMENT/DECREMENT SWITCH	LTPS LEFT TRAM PUMP STROKER	PBC POWER BREAKOUT CLAMP
IP INSTRUMENT PANEL	LTR LUBE TIMER RELAY	PBL PLUGGED BIT LIGHT
IRS IDLE RUN SWITCH	LTS LUBE TIMER SOLENOID	PBS PLUGGED BIT SOLENOID
ITR IDLE TIMER RELAY	LU LOADER UNLOCK CONTROL	PBU POWER BREAKOT UNCLAMP
J	M	PGI PIPE GUIDE IN CONTROL
JB JUNCTION BOX 1 (CAB)	MCB MAIN CIRCUIT BREAKER	PGO PIPE GUIDE OUT CONTROL
JB JUNCTION BOX 2 (ENGINE)	MCS MODE CONTROL SOLENOID	PGS PIPE GUIDE SWITCH
JB JUNCTION BOX 3 (COMPRESSOR)	MDS MOTOR DISPLACEMENT SOLENOID	PHDL PRESET HOLE DEPTH LIGHT
JB JUNCTION BOX (MAST)	MJB MAST JUNCTION BOX	PITH PIPE IN THE HOLE SWITCH/LIGHT
K	ML MAP LIGHT	PL PANEL LIGHTS
KS KEY SWITCH	MLC MAST LOCK CONTROLLER	PL1 PANEL LIGHT1
L	MLD MAST LOCK DISENGAGE LIGHT	PL2 PANEL LIGHT 2
LBS LEFT BRAKE SOLENOID	MLE MAST LOCK ENGAGE LIGHT	PLC PROGRAM LOGIC CONTROLLER
LEL LEVEL LIGHT	MLS MAIN LIGHT SWITCH	PLP PIPE LOADER PROXIMITY
LFP LEFT FRONT PROXIMITY SWITCH	MP MONITOR PANEL (DMS)	PLS PANEL LIGHT SWITCH
LFS LEFT FRONT JACK LIMIT SWITCH	MR MAIN RELAY	PM PRESSURIZATION MOTOR
LIP LEFT INSIDE PROXIMITY SWITCH	MRC MAST RAISE/LOWER CONTROLLER	POS PRESSUR OVERRIDE SWITCH
LL LOADER LOCK CONTROLLER	MS MIDDLE STACKER	PPD PICKUP POT DOWN CONTROL
LLS LOADER LOCK SWITCH	MS MICROSWITCH	PPU PICKUP POT UP CONTROL
LLT LUBRICATOR LIGHT	MSS MODE SELECTOR SOLENOID	PS PRESSURE SWITCH
LOP LEFT OUT PROXIMITY SWITCH	MSW MODE SELECTOR SWITCH	PTS PRELUBE TIMER SOLENOID
LPS LUBE PRESSURE SWITCH	O	PVS PUMP VENT SOLENOID
LRHL LEFT/RIGHT HI/LO LEVEL SENSOR	OFS ON/OFF SOLENOID	R
LRJC LEFT REAR JACK CONTROLLER	OPG OIL PRESSURE GAUGE	RAD RADIO
LRL LOADER ROTATE LEFT CONTROL	OPS OIL PRESSURE SENDER	RBS RIGHT BRAKE SOLENOID
LRL LEFT REAR JACK LIGHT	ORS OVERRIDE SWITCH	RC ROTATION CONTROLLER
LRP LEFT REAR PROXIMITY SWITCH	OTA OVER TILT ALARM	RCS ROTARY CONTROL SWITCH
LRR LOADER ROTATE RIGHT CONTROL	OTL OVER TILT LIGHT	RDS REMOTE DEADMAN SWITCH
LRS LEFT REAR JACK LIMIT SWITCH	OTM OVER TILT MODULE	RES RESISTER
LS LUBE SOLENOID	OTP OVER TILT PRESSURE SWITCH	RFL RIGHT FRONT JACK LIGHT
LSB LIGHT SWITCH BREAKER	OTR OVER TILT RELAY	RFP RIGHT FRONT PROXIMITY SWITCH
LSI LOADER SWING IN CONTROL	OTS OVER TILT SENSOR	RFS RIGHT FRONT JACK LIMIT SWITCH
LSO LOADER SWING OUT CONTROL		RHE RHEOSTAT
LSS LOAD SENCE SOLENOID		RHM ROTARY HOUR METER
LSW LUBRICATOR SWITCH		RHU ROTARY HEAD UP PROXIMITY SW.
RIP RIGHT INSIDE PROXIMITY SWITCH	STS1 STARTER SOLENOID 1	WAL WARNING ALARM

ABREVIATION/COMPONENT	ABREVIATION/COMPONENT	ABREVIATION/COMPONENT
RJL RIGHT JACK UP LIGHT	STS2 STARTER SOLENOID 2	WAM WASHER MOTOR
RLS RAISE/LOWER SELECTOR SWITCH	SS SEAT SWITCH	WAS WASHER SWITCH
RMS ROTARY MOTOR SOLENOID	T	WCS WINCH CONTROL SWITCH
ROP RIGHT OUSIDE PROXIMITY SWITCH	TA1 TRAM ALARM	WGB WINCH GROUND CONTROL BOX
ROS ROTATION OVERRIDE SOLENOID	TA2 TRAM ALARM	WIA WATER INJECTION AMPLIFIER
RPA ROTATION PRESSURE AMPLIFIER	TAL TRAM ALARM	WAL WARNING ALARM
RPC ROTATION PRESSURE CONTROL	TAR TRAM ALARM RELAY	WAM WASHER MOTOR
RPF ROTATION PUMP FORWARD COIL	TB TERMINAL BOARD	WS WIPER SWITCH
RPR ROTATION PUMP REVERSE COIL	TCS TORQUE CONTROL SOLENOID	WSW WARNING ALARM SWITCH
RPS ROTARY PRESSURE SWITCH	TFS TRAM FOOT SWITCH	WTG WATER TEMPERATURE GAUGE
RPV ROTARY PRESSURE VALVE	TGS THREAD GREASE SOLENOID	WTS WATER TEMPERATURE SENDER
RRA ROTATION RATE AMP BOARD	TGSW THREAD GREASE SWITCH	
RRJC RIGHT REAR JACK CONTROLLER	TIBP TRAM INTERLOC BYPASS	
RRL RIGHT REAR JACK LIGHT	TIJB TRAM INTERLOC JUNCTION BOX	
RRP RIGHT REAR PROXIMITY SWITCH	TIM TAMROCK INTEGRATED MEASURING	ELECTRIC MACHINE APPLICATION (DC)
RRS RIGHT REAR JACK LIMIT SWITCH	TOL TIMER ON LIGHT	B
RS REMOTE START	TPB TEST PUSHBUTTON	BB BUS BAR
RSD RIGHT STRUT DISENGAGE	TPL TRAM POWER LIGHT	C
RSE RIGHT STRUT ENGAGE	TR TRAM RELAY(S)	CC COMMON CONNECTOR
RSM ROTARY SPEED METER	TS TIMER SWITCH	CDI CABINET DOOR INTERLOC SWITCH
RSS ROTARY SPEED SENSOR	U	CIG CIGARETTE LIGHTER
RTC RIGHT TRAM CONTROLLER	UPR UP RELAY	CPT CONTROL POWER TRANSFORMERS
RTPS RIGHT TRAM PUMP STROKER	V	CRB CABLE REEL BYPASS SWITCH
RTS REMOTE TRAM SELECTOR	VC VOLTAGE CONVERTER	CRH CABLE REEL HEATER
S	VM VOLT METER	CRI CABLE REEL INTERLOC RELAY
SDR SHUTDOWN RELAY	VSF VARIABLE SPEED FAN SWITCH	CRJB CABLE REEL JUNCTION BOX
SJB STROKER JUNCTION BOX	VSS VARIABLE SPEED SOLENOID	CRM CABLE REEL MOTOR
SL STROBE LIGHT	VVS1 VARIABLE VOLUME SOLENOID 1	CROT CABLE REEL OVER TRAVEL SW.
SLS STROBE LIGHT SWITCH	VVS2 VARIABLE VOLUME SOLENOID 2	CRSS CABLE REEL SLACK SWITCH
SMS1 STARTER MAGNETIC SWITCH	W	CT CURRENT TRANSFORMER
SMS2 STARTER MAGNETIC SWITCH	WAL WARNING ALARM	D
SPB STARTER PUSH BUTTON	WAM WASHER MOTOR	DH DOG HOUSE
SPS STACKER PRESSURE SWITCH	WAS WASHER SWITCH	DJB DOG HOUSE JUNCTION BOX
STB SOLENOID TERMINAL BOARD	WCS WINCH CONTROL SWITCH	E
STR1 STARTER MOTOR	WGB WINCH GROUND CONTROL BOX	EL ELECTRIC LIGHT
STR2 STARTER MOTOR	WIA WATER INJECTION AMPLIFIER	ELP ELECTRIC LIGHTING POWER SUPPLY
EMH ELECTRIC MOTOR HEATER	S	

ABREVIATION/COMPONENT	ABREVIATION/COMPONENT	ABREVIATION/COMPONENT
EMJB ELECTRIC MOTOR JUNCTION BOX	SH SPACE HEATER	
F	SI SAFETY INTERLOC	
FJB FRONT JUNCTION BOX	T	
FLU FLUORESCENT LIGHT	TC THERMOSTAT CONTROL	
FLUS FLUORESCENT LIGHT SWITCH	THER THERMOSTAT	
G	U	
GFM GROUND FAULT MONITOR	UVR UNDER VOLTAGE RELAY	
H		
HBB HEATER BREAKER BOX		
HF HOUSE FAN 1-3		
HVJB HIGH VOLTAGE JUNCTION BOX		
L		
LCB LOAD CENTER BOX		
LJB LIGHTING JUNCTION BOX		
LLC LIGHTIN LOAD CENTER		
LML LEFT MAST JUNCTION BOX		
M		
MCC MOTOR CONTROLLER CABINET		
MCP MOTOR CONTROL POWER		
MD MAIN DISCONNECT SWITCH		
MH MACHINE HOUSE		
MM MOTOR MANAGER		
MMF MOTOR MONITOR FAULT		
MMS MAIN MOTOR STOP 1-3		
MPS MAIN POWER SWITCH		
MWT MOTOR WINDING TEMPERATURE		
R		
REC RECEPTACLE		
RPH REVERSE PHASE SEQUENCE		
RSP REMOTE START PANEL		
RST REMOTE START PUSHBUTTON		
RTD MOTOR TEMP SENSORS 1-6		
RTR REEL TIMING RELAY		

SERVICE LITERATURE

GENERAL

This section will give reference material specification numbers for electrical systems that are available in blasthole service procedures.

DESCRIPTION

When component adjustments or repairs are needed it is advisable to use the service procedures.

This section may be updated as new procedures are written.

Hupp Air Conditioner/Heater 002712-051

Engine ETS HP Application 003171-000

Engine ETS LP Application 004318-000

Centralized Lubrication 006113-000

Tachometer Installation Caterpillar 006269-000

Engine ETR LP Application 006814-00

Engine ETR HP Application 006814-002

Tachometer Installation Cummins 007672-000

Air Conditioner - Sigma 008692-000

Voltage Converter 011017-000

Centralized Lubrication 011060-000

Lubricator 011362-000

Controller Adjustment 014441-000

Electronic Monitoring System 014985-000

Engine ETR HP Application 015351-000

Amplifier Board Adjustment 015509-000

Drill Monitor System 015702-000

Solenoid Service 017503-000

Auto Level CPU 018009-000

Automatic Leveling 018083-000

Sigma Air Conditioner/Heater 018146-000

Sigma Air Conditioner/Heater 018146-001

Engine Perkins 3.152 Genset 019105-001

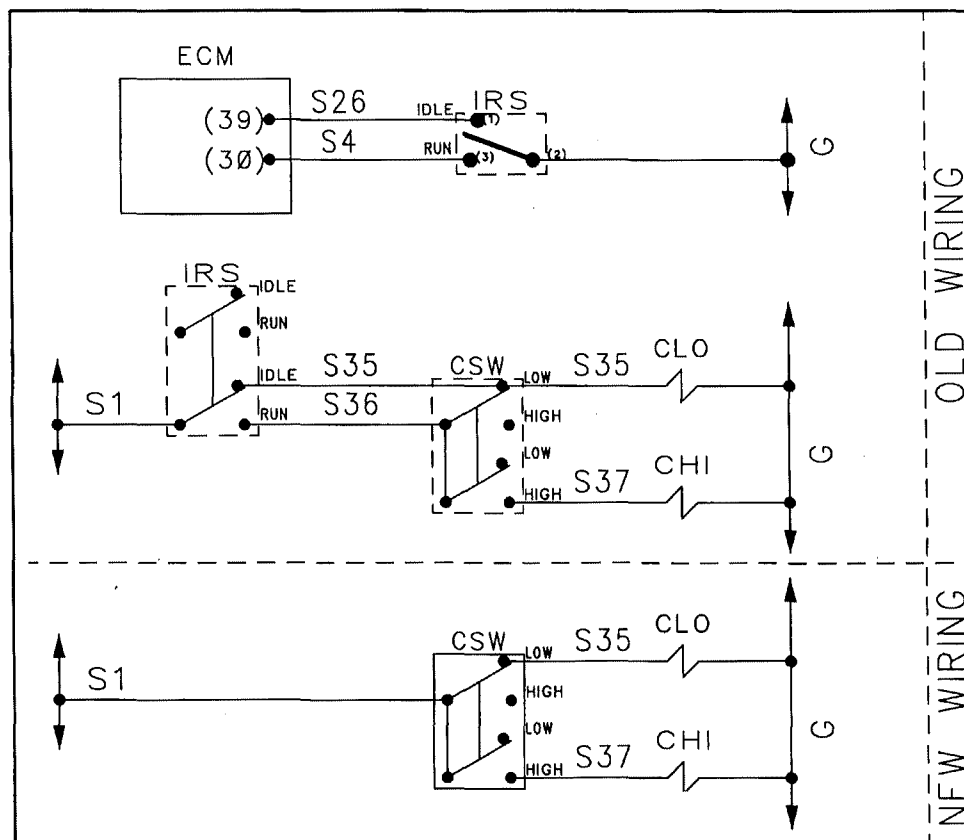
Engine Perkins 4.236 Genset 019105-002

Sigma Air Conditioner/Heater 019148-000

Auto Level Schematic 019699-000

DMS Dip Switch Chart 021531-001

VARIABLE SPEED CONTROL (023260-01E)



D55SP, D60KS and D75KS WITH CATERPILLAR ENGINE

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