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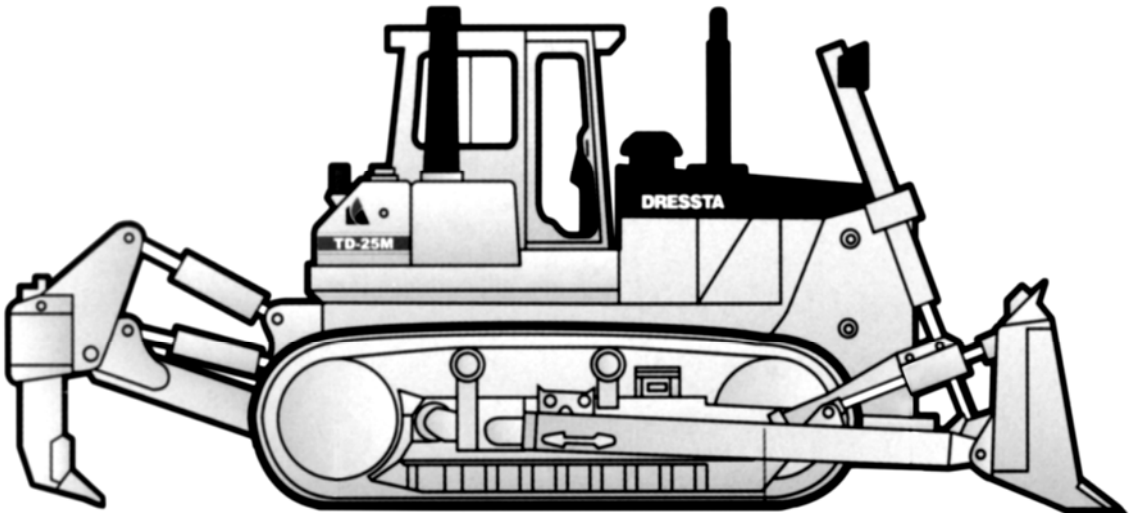
SMTD25MEX07/1E

SERVICE MANUAL

TD-25M

EXTRA

SERIAL NUMBERS 75001 AND UP



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SECTION 1

INTRODUCTION

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INTRODUCTION

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SAFETY PRECAUTIONS

1. GENERAL

The instructions contained in this service manual are for information and guidance of service personnel who are responsible for overhaul and repair of the machine.

Due to a continuous program of research and development, some procedures, specifications and parts may be altered in a constant effort to improve this machine. Some illustrations are of a general application of this model and may not show your machine and component parts accurately in all details.

It is our policy to improve our products whenever it is possible and practical to do so. We reserve the right to make changes or add improvements at any time without incurring any obligation to install such changes on products sold previously.

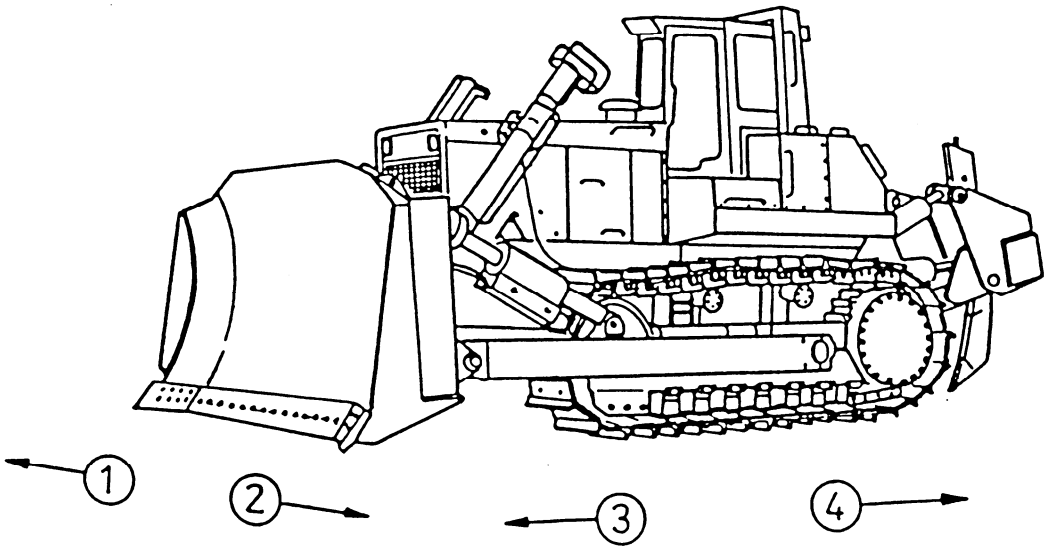

Fig. 1.1. TD-25 Series M EXTRA Crawler Tractor

1. Right Hand Side of the Machine
2. Left Hand Side of the Machine
3. Front of the Machine
4. Rear of the Machine

Throughout this manual there will be two types of cross references. One type is to a heading in another section. The other is to a heading within the same section. Unless it is otherwise stated, references will be to the same section. Refer to the section contents page at the beginning of the individual sections for specific page numbers.

Throughout this manual the use of the terms “Left”, “Right”, “Front” and “Rear” must be understood to avoid confusion when following instructions. “Left" and “Right" indicate the left and right sides of the machine when facing forward in the operator's seat, refer to Fig. 1.1.

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INTRODUCTION

SAFETY PRECAUTIONS

Throughout this manual the following warning symbols and notes are used to warn the persons against danger.

DANGER! This sign and the text in bold letters used throughout this Manual indicates an emergency, which, if not avoided, will result in serious injury or death. This sign calls your attention to a most serious danger.

WARNING! This sign and the text in bold letters used throughout this Manual indicates an emergency, which, if not avoided, may result in injury or death.

CAUTION: This sign and the text in bold letters used throughout this Manual indicates an emergency, which, if not avoided, may result in minor injury.

Besides above, two words are used thorougout the manual related to possible damage of machine units, its functioning or facilitating the maintenance, beneficiary influence on machine operation and period to overhaul.

IMPORTANT: *This sign and text in italics is used throughout this manual to call your attention to key problems for machine operation. Failure to follow such instructions may result in damage of the machine and heavy material losses.*

NOTE: *This sign and text in italics is used throughout this manual to call your attention to important function having influence on the right functioning of the machine or for informational purposes.*

WORK SAFETY – FOLLOW THESE RULES

This symbol and text with bold letters is used throughout this manual to call your attention to instructions concerning your personal safety. Observe and follow these instructions. Be certain anyone operating and servicing this machine is aware of these rules. Failure to follow these rules may result in injury or death.

WARNING: The machine can only be operated and serviced by a person who is familiar with OPERATOR'S MANUAL and SERVICE MANUAL, knows operation of the machine and its mechanisms, experienced and properly licensed to operate such machines.

The instructions and information given in this section do not cover all you ought to know to operate the machine safely. Detailed instructions regarding operational safety appear in the following sections of this manual. Carefully observe and follow all instructions provided in this manual.

Human error is an important factor in most equipment-related injuries. Haste, carelessness and lack of training are the primary causes of injuries.

Most operating injuries occur because of excessive speed, loss of control, failure to observe warning signs, slipping or falling while entering for dismounting, a lack piles on roadways, lack of a ROPS or seat belt, or not watching in the direction of travel.

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SAFETY PRECAUTIONS

Most maintenance injuries occur during welding or when using hammers or wrenches. The most common faults are improper work position, a slipped tool, missed aim, a broken tool, flying chips and no welding hood.

Think before you act. A careful operator or maintenance man is the best insurance against an accident.

Always wear proper safety equipment. Avoid wearing jewelry and loose fitting clothing; they could catch on moving parts, which could result in serious injury or death. Hard hat, sturdy rough-soled work shoes or safety shoes, ear protectors, reflective clothing, safety glasses and heavy gloves may be required. Consult your employer for specific safety equipment requirements.

Each job site and application may have personal safety requirements. Carefully evaluate your particular application and machine for equipment such as heater and defroster, all windshield wipers, warning lights, side view and rearview mirrors, back-up alarms, fire extinguisher, rotating beacons and additional lights. If in doubt, contact your distributor.

It is recommended that the machine be equipped with a fully charged fire extinguisher and the first aid kit. All personnel should be instructed in fire extinguisher proper usage. Recharge immediately after use.

The fire extinguisher is to be placed in an operator’s cab to the right of his seat. Fig. 1.2 shows the fire extinguisher location.

It is placed in a holder preventing uncontrolled movement during machine operation. In case of a fire the extinguisher can be easily removed from the holder. The extinguisher is provided with a label containing the instructions of its use and application. The operator should be familiar with these instructions.

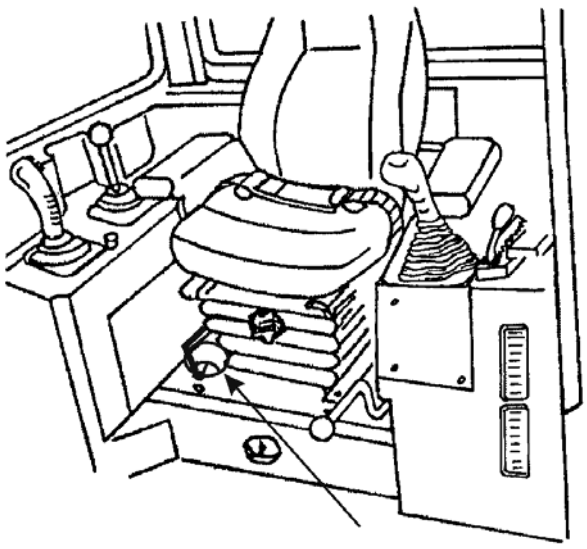

Fig. 1.2. Fire Extinguisher Location in Machine

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INTRODUCTION

SAFETY PRECAUTIONS

Electrical system is 24-volt negative ground.
Each machine is equipped with a booster receptacle that is to be used during the engine start up with a booster battery. When the use of the booster receptacle socket is impossible in out-of-normal situations, follow the precautions given below to prevent chances of injury or damage to electrical circuits.

1. Turn the electrical master switch to the OFF position.
2. Attach one end of jumper cable to the positive terminal of booster battery and other end to the positive terminal of machine battery.
3. Attach one end of second cable to the negative terminal of booster battery and other end to the machine's frame away from the battery.
4. To remove cables, reverse above sequence exactly to avoid sparks near the battery.

A frozen battery can explode when the booster cables are attached. NEVER check battery charge by placing a metal object across the battery posts. The sparks could cause an explosion. Use a voltmeter or areometer for checking.

Every machine is factory equipped with a safety belt mounted to the operator’s seat.

2. BEFORE STARTING THE ENGINE

Never start the engine indoors unless proper exhaust ventilation is provided to remove deadly exhaust gases. Once the engine is operating, move the machine outdoors as soon as possible. Exhaust gases are dangerous and can cause unconscious-ness and death.

Always place the drive train neutral lock lever in locked position and apply the parking brake before starting the engine.

The operator must be alert, physically fit and free from the influences of alcohol, drugs or medications that might affect his eyesight, hearing, reactions or judgment.

Observe and know the use of alternate exits from the operator compartment.

Safety must always be the operator's most important concern. He must refuse to operate when he knows it is unsafe and consult his supervisor when safety is in doubt.

Do not jump onto or of the machine. When mounting or leaving the machine always use two feet and one hand or one foot and two hands to ensure contact with machine steps, holders or rails.

Do not use controls or hoses as hand holds when climbing on or off the machine. Hoses and controls can move and do not provide solid support. Movement of the controls may cause inadvertent and unexpected movement of the machine or its equipment.

Follow all machine-mounted safety signs before starting, operating, maintaining or servicing the machine.

Be sure the area of the operator's compartment, all mounting steps and grab handles are free of oil, grease, loose objects, ice and mud to lessen the possibility of slipping. Remove or secure all maintenance and personal items so they will not interfere with the operator or jam the controls.

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SAFETY PRECAUTIONS

Perform a visual check of the machine before starting the engine. Look for such things as improper fluid levels, oil leaks, and loose, damaged or missing parts. Do not start the engine until any unsafe conditions are corrected. Secure all caps and filler plugs.

Know and understand the traffic flow patterns of your job and obey flagman, signs and signals.

Before entering the operator's compartment, clear the immediate area surrounding the machine of personnel and obstructions. Walk completely around the machine. After entering the operator's compartment, sound the horn to clear the immediate area of the machine.

Check work area for hazardous conditions. Due to the danger of fire and explosion, never check or fill the fuel tank or the batteries near the burning or smoking materials, open fire or spark conditions due to fire hazard or explosion.

3. OPERATION

Check the work area for hazardous conditions. Be alert for soft ground conditions, especially when working on slopes, near drop-offs or excavations or fill material, which could lead to sudden land collapse and tipping of the machine.

At night and at times of poor visibility, carefully check the work area before moving in with the machine. Use all lights provided.

Keep the windshield, windows and mirrors (if equipped) clean.

Before starting the engine, be sure you understand all control functions. Check all controls, including the brakes, decelerator, steering and transmission. Check all gauges, warning lights and safety devices. Correct any malfunctions.

Only one person, the operator, should be permitted to ride on the machine when it is in operation.

Perform an operational check of the machine in a safe area before putting it to work.

Keep operating controls, hands and shoes free of grease, water and mud to insure positive control functions.

Because the machine is ROPS equipped, for your personal protection, wear your seat belt.
Before driving the machine, adjust the seat and fasten the seat belt. The seat belt should fit snugly and flow around the hips to lessen the chance and severity of injury in the event of an accident.
Never wear the seat belt across the abdomen.

Check overhead clearance carefully before operating the machine in areas with low overhead clearance, such as guy wires, power lines, bridges, low-hanging tree branches and building entrances or exits. These overhead obstructions could cause an accident.

After starting the engine, but before moving the machine, warn nearby personnel by giving a couple of short horn blasts.

During the brake lock test, be sure that there are no people in the immediate area of the machine, and that the same is free from obstacles. As the brakes do not brake the machine, stop the machine operation immediately and remove the cause of the defect.

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SAFETY PRECAUTIONS

Be sure that the rear screen is securely fastened to the ROPS structure before operating the winch. Operating without correctly installed screen could result in serious injuries. Operate the winch from the driver's seat only. Always engage the parking brake before winching, if the machine is stopped. Use caution when installing or removing cable from the winch. Keep all persons clear of a cable under tension. Never use a cable that is damaged. Failure to follow these instructions could result in serious injuries.

Never mix gasoline, gasohol and/or alcohol with diesel fuel. This practice creates an extreme fire hazard and under certain conditions an explosion, which could result in personal injury or death.

Do not smoke when refueling or servicing the machine. A fire could result.

Never place gasoline or diesel fuel in open pan.

Never remove the fuel tank filler caps or refill the fuel tanks while the engine is running or hot or when the machine is indoors. Fumes are dangerous, a spark or flame could result in a fire or explosion.

Observe instruments and warning lights frequently. Report any defects or unusual noises in machine during operation. Be alert to the location of other personnel. Do not operate if exposed personnel enter the immediate work area. Warn all ground persons to leave the area of the machine.

On machines equipped with a suction fan or a reversible fan in the suction position, periodically check the engine exhaust system for leaks. Exhaust gases are dangerous to the operator.

Do not operate the machine in a condition of extreme fatigue or illness.

Be sure chains or cables and their anchor points are strong enough to handle the expected load. Inspect carefully chains and cables for flaws before using them.
Always wear gloves when handling cables and chains. Avoid looping or knotting a cable or chain.
Do not pull with a kinked chain or cable as excessively high stress in bent area may cause chain or cable failure. Cables or chains for towing or winching should be fastened to attachment points designed to this purpose only.
Be sure the attachment pins are securely inserted immediately before pulling with the chain or cable.
Stand clear of chains or cables under load.

Keep engine exhaust system and exhaust manifold clear of combustible material for your personal protection.

Know the locations of underground cables, water mains, gas lines, etc. A ruptured gas line or cut electrical cable could result in personal injury or death.

When leaving the machine unattended for any length of time, make sure the blade is completely lowered, the engine is stopped, the parking brake is applied, and the electrical master switch is in the "off" position and drive train neutral lock lever is in locked position. If the machine is equipped with a cab make sure that the cab door is locked.

Before operating the machine read and know the Operator's Manual and ALL SAFETY GRAPHICS.

The roll-over protective structure (ROPS) provides the operator's protection in the event of machine rollover or upset. This structure is designed to bend during rollover to protect the operator from sudden impact loads.

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SAFETY PRECAUTIONS

When operating the machine, look in the intended direction of travel and the immediate machine operational area to be sure personnel or allied equipment does not interfere with the machine work pattern.

Never try to get on or off the machine while it is moving. A serious injury or death could result.

Never shift the transmission into neutral when traveling downhill. The machine may go out of control and a rollover could result or the transmission, torque converter or engine could be damaged when the transmission is again placed in gear. Always put the transmission in low gear before starting downhill. Use the decelerator and brake pedal to slow the machine.

Avoid side hill travel whenever possible. Drive straight up and down the slope. If the machine starts slipping sideways on a grade, turn downhill immediately.

If possible avoid crossing obstacles such as ridges, rocks or logs. If you can't avoid them, reduce speed and ease over the obstacle at an angle.

A machine's weight and the vibration it creates can cause the edge of a high wall to collapse. Keep your machine away from the edges of banks and excavations. If it is not possible to avoid turn the machine front towards the bank edge or excavation.

Travel slowly in congested areas or on rough ground, slopes or near drop-offs or on snow, ice or slippery surfaces.

Maintain a safe distance between your machine and other vehicles according to the condition of the road and load.

Never hold the hydraulic controls in their extreme position after the equipment has reached its maximum travel. This could cause overheating of the hydraulic system.

Do not adjust the seat position while the machine is in motion. A loss of control may result. Completely stop the machine, place drive train neutral lock lever in locked position, apply and lock the parking brake and then adjust the seat.

Never use the blade as a brake except in an emergency.

Carry the blade low for maximum stability and visibility.

Where noise exposure during machine exploitation or after repair operations exceeds levels defined by proper health and safety authorities and applicable standards wear authorized ear protective equipment.

4. MAINTENANCE

Servicemen and their helpers only are allowed to remain at operator’ s post while maintaining or repairing the machine.
Authorized personnel only is allowed to control, maintain or repair a machine.

Do not hurry. Haste could result in accident.

Load things into the machine from the ground level before mounting the machine.

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INTRODUCTION

SAFETY PRECAUTIONS

Loosen the radiator cap slowly to relieve all pressure in the system and use caution when removing the caps.

Pressurized Reservoir; loosen the filler cap slowly to relieve reservoir pressure to prevent possible injury. Always vent the hydraulic system before working on any hydraulic component. Have all equipment resting on the ground or blocked.

Before removing any hydraulic component in machine without pitch, lift the blade and ripper and shut the engine off. Relieve all hydraulic system pressure by moving control lever(s) in various directions. Additionally, in machine equipped with pitch, turn starting switch key in position “1” (refer to Operator’s Manual), depress the blade pitch button and move the blade control lever in various directions. Then lower equipment on the ground.

Never work beneath the blade and/ or ripper without proper blocking. Improper blocking could result in serious injuries.

When service or maintenance requires access to areas that cannot be reached from the ground, use a ladder or platform. If such ladders or platforms are not available, use the machine hand holds and steps provided. Perform all service or maintenance carefully.

Do not attempt to make repairs that you do not understand. Consult your distributor. Use only approved parts for repairs and maintenance. Failure to do so could compromise your personal safety and machine performance and reliability.

Use only approved parts for repairs and maintenance show in your parts catalog. Failure to do so could compromise your personal safety and machine performance and reliability.

Never align holes with fingers or hands. Use a proper aligning tool.

Be sure all used tools are in good condition. Do not use tools which are worn, bent or have mushroomed heads. Use the proper tool for the job. Remove sharp edges and burrs from reworked parts.

For field service, move machine to level ground if possible and blocks the tracks. If work is absolutely necessary on an incline, block the machine and its attachments securely. Move the machine to level ground as soon as possible.

Before working on the machine, turn OFF the electrical system master switch and remove the starting switch key so no one will start it unexpectedly.

Do not carry loose objects in pockets that might catch on the machine or fall unnoticed into open compartments.

Before working on any part of the engine or electrical system, disconnect the battery ground cable. Tag the cable and all controls to alert personnel that work is in progress.

When it is necessary to make any checks or adjustments with the engine operating, always use two people. One trained person must be in the operator's seat to safeguard the second person making the checks or adjustment.

As an added precaution, when making checks or adjustments with the engine operating, apply the parking brake.

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SAFETY PRECAUTIONS

Never stand on the tracks or near the blade while the engine is operating.

If the engine is running and the side doors are open or removed be careful of rotating parts such as the fan and belts that can cause serious injury.

Do not clean or lubricate the machine subassemblies while the engine is operating. The parts in motion when contacted can cause personal injury.

Use a non-toxic, nonflammable commercial solvent for cleaning parts, unless otherwise specified. Never use gasoline, diesel fuel, kerosene or other flammable solvents for cleaning part.

Excessive or repeated skin contact with sealant or solvents may cause skin irritation. In case of skin contact, remove sealant or solvent promptly by washing with soap and water. Follow the manufacturer's advice whenever cleaning agents or other chemicals are used.

Lower blade and ripper before making hydraulic adjustments. To prevent personal injury, be sure no personnel are standing in the way of the blade and/or ripper when it is being lowered.
Never allow anyone to walk under or be near unblocked raised equipment.

Provide proper ventilation when operating in a closed building to avoid danger of exhaust gases. Exhaust gases are dangerous and can cause unconsciousness and death.

Hydraulic fluid escaping under pressure from a very small hole can be almost invisible, yet have sufficient force to penetrate the skin. Use a piece of cardboard or wood to search for suspected leaks. Do not use hands. If injured by escaping fluid, see a doctor at once. Serious infection or reaction can occur if proper medical treatment is not administered immediately.

When welding, wear proper protective equipment such as a helmet, dark safety glasses, protective glasses near welding. DO NOT look at the arc without proper eye protection.

Wear proper protective equipment such as goggles or safety glasses with side shields, hard hat, safety shoes and heavy gloves when metal or other particles are apt to fly or fall.

Lift and handle all heavy parts with a lifting device of proper capacity. Be sure parts are secured by proper slings and hooks. Use lifting eyes if provided. Warn people in the area to stand clear.

Do not attempt to repair the ROPS protective structure after an accident. Repaired structures do not provide the original strength and protection. Contact your distributor for information on structure replacement. Do not cut, drill, weld, grind the ROPS protective structure as all these operations have a detrimental effect on its structure and safety.

When using compressed air for cleaning parts, wear goggles or safety glasses with side shields. Use an air nozzle, which limits the pressure to 200 [kPa].

Do not use an open flame to check for leaks or fluid levels anywhere around the machine.

Keep work area clean and dry. Remove oil and water spills immediately.

Do not pile up oily or greasy rags. They are a fire hazard. Store them in an approved, closed metal container.

Use a soft iron or nonferrous hammer to install or remove ripper point. It is dangerous to hammer on the point. Wear safety glasses with side shields or goggles to reduce the chances of injury.

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SAFETY PRECAUTIONS

Batteries give off a highly inflammable gas. Never allow sparks or open flame near the batteries. A fire or explosion could occur. Do not charge batteries in a closed area. Provide proper ventilation to guard against accidental explosion of an accumulation of the explosive gas given off in the charging process. When installing batteries be sure the electrical master switch is locked in the OFF position. Be sure to connect the positive cable to the positive terminal and the negative (ground) cable to the negative terminal.

Ether starting fluid is flammable. Follow the precautions printed on the container. An explosion can result if sparks or flame contact the ether in the container or if the container is stored in an area in which the temperature exceeds 70 [°C]. Observe the following precautions:

1. Follow the correct method for starting the engine. Refer to Section 4, "STARTING THE ENGINE" in OPERATOR'S MANUAL.
2. Do not use the ether injector when the ambient temperature is above freezing.
3. For your own personal safety, always remove the ether container when welding, grinding or fusing a torch on the machine.
4. Do not let ether come in contact with your skin, as it can cause localized freezing.
5. Do not breathe the hazardous ether vapor.
6. Keep the fluid container out of the reach of children.
7. Never puncture the fluid container or put it into a fire. Dispose of empty container as per attached instruction to the container.
8. Do not store fluid containers in the operator's compartment.

Never mix gasoline, gasohol or alcohol with diesel fuel. This creates an extreme fire or explosion hazard, which could result in personal injury or death.

Do not use bleach, color dye or solvents on the seat belt webbing. This may cause a severe loss of tensile strength. This could cause the webbing to break resulting in personal injury. It is recommended that the seat belt be cleaned only with warm water and mild detergent.

5. WHEN PARKING

If parking on or near traffic lanes cannot be avoided, provide appropriate flags, barriers, flares and warning signals. Also provide advance-warning signals in the traffic lane for approaching traffic. Park the machine in a non-operating and non-traffic area. Park machine on level ground whenever possible. If you must park on a slope, park at right angles to the slope. Apply and lock the brake pedal.

Never leave the machine unattended with the engine running.

When leaving the machine unattended, slowly lower the hydraulic equipment to the ground and place drive train neutral lock lever in locked position, shut off the engine, apply and lock the parking brake. Relieve any pressure in the hydraulic system by moving the controls in all directions. Turn off the electrical system master switch. Take the keys out both from the electrical system master switch and the starter switch. Always lock up machine when leaving it unattended, including any anti-vandalism attachments.

Do not jump off the machine.

When operating in bad weather and storm lightening is nearby, dismount and seek shelter away from the machine. Lightening will be attracted to the machine and can cause serious injury or death.

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SAFETY PRECAUTIONS

When the machine is to be loaded onto a transport truck and trailer do so carefully. Load only when the trailer is level. The steel track shoes will slide easily on the trailer. When the machine is properly positioned tie it securely with a rope and block with wooden pieces so it cannot move on the trailer. For more detailed information refer to OPERATOR"S MANUAL.

Keep your head, body, legs, hand, fingers away from the blade and ripper when they are in a raised position.

Do not allow the hydraulic system to support the mounted equipment without its proper blocking when leaving the machine unattended, to eliminate the possibility of an expected drop of the blade or ripper.

SERVICE INFORMATION

6. SERIAL NUMBERS

For complete description and location of the machine serial number, the blade serial number, the ripper serial number and the engine serial number, refer to SECTION 1, INTRODUCTION in OPERATOR'S MANUAL.

All other components having serial numbers are each equipped with a separate stamped serial number plate.

Use machine serial numbers when requesting information or ordering parts and proper numbers from PARTS CATALOGUE.

7. INSPECTION AND REPAIR

Bearings

Inspect for evidence of overheating, cracks, scores, pitting and general wear and replace if necessary. Serviceable bearings must be cleaned, soaked in fresh lube and wrapped in grease proof material.

Gasket and Seals

Always use new gaskets and seals during assembly and installation. Use extreme caution to avoid damage to seals or gaskets during these operations. Use sleeves or tape when seals have to be passed over threads or splines. Pack lip type seals with fresh grease prior to installation. Felt dust seals must be soaked in light clean oil before assembly.
DO NOT roll an O-ring during installation. To correctly install, position at one point and using a blunt tool, stretch into position. DO NOT stretch any more than is required for proper installation.

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SERVICE INFORMATION

Gears and Splines and Welds or Castings

Check splines with their mating parts for wear. Check gears and splines for pitting, burrs, broken or missing teeth. Burrs can be removed with a fine stone, but care must be taken so that only burr is removed and gear or spline profile is not changed. Check all weld for cracks, twisting and misalignment. Check castings for cracks and distortion.

Piping and Hoses

Check all fittings for leaks and thread damage. Check steel piping for cracks and chafing. Check hoses for chafing, twisting or perishing, etc.

Relief Valves

Before commencing work on hydraulic system, check that relief valves are opening at their correct pressures. Pressures are listed and information on how to check and adjust pressures in SERVICE MANUAL.

Lubrication

During assembly, running or wear surfaces must be coated with specified lube. Refer to OPERATOR'S MANUAL. Use sufficient lube to prevent seizing, scoring or excessive wear on initial operation. Failure to provide starting lube may result in serious damage.

8. ELECTRONIC CIRCUITS PROTECTION DURING WELDING AT THE MACHINE

Welding on a Vehicle With an Electronic Controlled Fuel System and CMCV One Lever Controlled Drive System.

The welding at the engine or engine installed components is not recommended.
However, if a welding within the machine is unavoidable, proceed as follows:

- Disconnect both the negative (-) and positive (+) battery cables from the battery.
- Disconnect both the ECM connector at the engine LH side and the CMCV connector within the operator pod LH column. To do it, remove the left armrest, unscrew and remove the cover plate with a module, disconnect the connectors for the module power leads.
- Do not connect the welder ground cable to the ECM cooling plate or ECM itself.
- Attach the welder ground cable no more than 0.6 [m] away from the part being welded.

LOCTITE USAGE

9. LOCTITE USAGE

Type and application places of LOCTITE are showed in specific procedures of Service Manual.

For surface preparation, application, setting time before placing in operation, removal and application in low temperature refer to directions for use of LOCTITE.

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STANDARD TORQUES

10. BOLT IDENTIFICATION CHART

Type / Class	Description	Head Marking
Type 5 Inch Thread	Three radial lines on top and none on side of head. Medium carbon steel quenched and tempered.	
Type 5.2 Inch Thread	Three radial lines on top and none on side of head. Low carbon boron steel quenched and tempered.	
Type 8 Inch Thread	Six radial lines on top and none on side of head. Medium carbon or carbon alloy steel quenched and tempered.	
Type 8.2 Inch Thread	Six radial lines on top and none on side of head. Low carbon boron steel quenched and tempered.	
Class 5.8 Metric Thread	Marked on top or side of head. Low or medium carbon steel.	
Class 8.8 Metric Thread	Marked on top or side of head. Medium carbon or carbon alloy or low carbon boron steel quenched and tempered.	
Class 10.9 Metric Thread	Marked on top or side of head. Medium carbon or carbon alloy or low carbon boron steel quenched and tempered.	

11. TORQUE VALUES FOR STANDARD FASTENERS

The following charts provide tightening torque for general purpose applications using original equipment standard hardware as listed in the PARTS CATALOGUE for the machine involved. DO NOT SUBSTITUTE.

Special torques and applications which are nonstandard are listed separately on a SPECIAL NUT AND BOLT TORQUE charts in further Sections of the manual.

A torque value to a tolerance of ± 10 [%] of the chart value should be achieved for a satisfactory applications.

Torque Values for Standard English Fasteners

Original equipment standard hardware is defined as Type 8, coarse thread bolts and nuts and thru hardened flat washers (Rockwell “C” 38-45), all phosphate coated and assembled without supplemental lubrication (as received) condition. The torques shown below also apply to the following: phosphate coated bolts used in tapped holes in steel or gray iron; phosphate coated bolts used with phosphate coated prevailing torque nuts (nuts with distorted threads or plastic inserts); phosphate coated bolts used with copper plated weld nuts.
Markings on bolt heads or nuts indicate material grade ONLY and are NOT to be used to determine required torque.

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STANDARD TORQUES

GENERAL APPLICATION TORQUES	
Nominal Thread [in]	Standard Torque [Nm]
1/4	10
5/16	21
3/8	38
7/16	60
1/2	92
9/16	130
5/8	180
3/4	325
7/8	520
1	780
1 1/8	1110
1 1/4	1565
1 3/8	2050
1 1/2	2720
1 3/4	3380
2	5080

Torque Values for Standard Metric Fasteners

Original equipment standard hardware is defined as coarse thread metric class 10.9 bolts and class 10.0 nuts and thru hardened flat washers (Rockwell “C” 38-45), all phosphate coated and assembled without supplemental lubrication (as received) condition. The torques shown below apply to phosphate coated bolts designed for 60 % yield strength.
The torques shown below also apply to the following: phosphate coated bolts used in tapped holes in steel or gray iron; phosphate coated bolts used with phosphate coated prevailing torque nuts (nuts with distorted threads or plastic inserts), phosphate coated bolts used with copper plated weld nuts.
Markings on bolt heads or nuts indicate material grade ONLY and are NOT to be used to determine required torque.

GENERAL APPLICATION TORQUES	
Nominal Thread [mm]	Standard Torque [Nm]
6	10
7	16
8	23
10	46
12	80
14	125
16	200
18	275
20	385
22	530
24	670
27	980
30	1330
33	1790
36	2325
39	3010

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STANDARD TORQUES

12. SPLIT FLANGE CONNECTIONS

The following chart provides the tightening torques for split flange connections used in hydraulic systems. Flanges and fitting shoulders should fit squarely. Install all bolts, finger tight, then torque evenly. Over torquing bolts will damage the flanges and/or bolts, which may cause leakage.

Flange Size [in]*	Bolt Size [in]	Bolt Torque Newton Meter [Nm]
1/2	5/16	20 - 24
3/4	3/8	30 - 37
1	3/8	37 - 47
1-1/4	7/16	47 - 61
1-1/2	1/2	62 - 79
2	1/2	75 - 88
2-1/2	1/2	107 - 123
3	5/8	187 - 203
3-1/2	5/8	159 - 180

(*) – Inside diameter of hydraulic tube or hose fitting

13. HYDRAULIC TUBES AND FITTINGS

The torque figures are recommended for plain, cadmium or zinc plated fittings, dry or wet installations. Swivel nuts either swaged or brazed. These torques are not recommended for tube with wall thickness of 0.89 [mm] or less.

Size	Tubing O.D. [in]	Thread size [in]	Torque values for 37 [°] flared fittings [Nm]	Torque values for O-ring boss plugs, locknuts and 37 [°] flared fittings [Nm]
4	1/4	7/16–20	12–16	8–14
5	5/16	1/2 –20	16–20	14–20
6	3/8	9/16–18	29–33	20–27
8	1/2	3/4 –16	47–54	34–42
10	5/8	7/8–14	72–79	47–54
12	3/4	1-1/16–12	104–111	81–95
14	7/8	1-3/16–12	122–138	95–109
16	1	1-5/16–12	149–163	108–122
20	1–1/4	1-5/8–12	190–204	129–156
24	1–1/2	1-7/8–12	217–237	163–190
32	2	2-1/2–12	305–325	339–407

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STANDARD TORQUES

14. HOSE CLAMPS

The following chart provides the tightening torques for hose clamps used in all rubber applications (radiator, air cleaner, operating lever boots, hydraulic system, etc.).

Clamp Type and Size	TORQUE ± 0.6 [Nm]	
	Radiator, Air Cleaner, Boots, Etc. [Nm]	Hydraulic System [Nm]
“T” Bolt (Any Diameter)	6.2 to 7.3	—
Worm Drive - 1-3/4 in Open Diameter and Under	2.2 to 3.3	4.5 to 5.6
Worm Drive - Over 1-3/4 in Open Diameter	4.5 to 5.6	—
Worm Drive - All “Ultra-Title”	10.7 to 11.8	4.5 to 5.6

15. TORQUE VALUES FOR AIR CONDITIONING TUBES AND FITTINGS

SWAGED 45 [°] CONNECTIONS

SIZE	THREAD SIZE [in]	TORQUE VALUES FOR MATERIALS [Nm]			
		STEEL-STEEL	BRONZE –STEEL	COPPER-STEEL	ALUMINUM-STEEL
1/4	7/16–20	16 – 23	15 – 20	15 – 20	12 – 18
3/8	5/8–18	27 – 33	23 – 38	23 – 38	20 – 25
1/2	3/4–16	47 – 54	38 – 46	38 – 46	28 – 36
5/8	7/8–14	61 – 68	45 – 53	45 – 53	34 – 42
3/4	1-1/16–12	72 – 80	49 – 57	49 – 57	45 – 53
3/4	1-1/16–14	72 – 80	49 – 57	49 – 57	45 – 53

16. TORQUE VALUES FOR AIR CONDITIONING O-RING CONNECTIONS

SIZE	THREAD SIZE [in]	TORQUE VALUES FOR MATERIALS [Nm]
		STEEL-STEEL
1/4	7/16–20	15 – 25
3/8	5/8–18	27 – 33
1/2	3/4–16	40 – 48
5/8	7/8–14	47 – 54
3/4	1-1/16–12	54 – 61
3/4	1-1/16–14	54 – 61

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SECTION 5

STEERING

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STEERING

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GENERAL

1. DESCRIPTION 1

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GENERAL

1. DESCRIPTION

The machine is equipped with a steering system consisting of a steering drive located in the rear main frame and a two speed steering valve mounted on the rear main frame cover. Brake pedal cable mechanically and drive train control valve hydraulically operate the steering valve. Oil pressure from the drive train control valve is directed to the steering valve to operate the steering drive unit.

For further detailed information on the hydraulically controlled steering system refer to SECTION 7, DRIVE TRAIN; SECTION 7C TRANSMISSION and SECTION 7E, STEERING DRIVE.

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SECTION 6

COOLING SYSTEM

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COOLING SYSTEM

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GENERAL

1. DESCRIPTION

Five cooling systems are used on this machine. First system cools the air, after compressing in engine turbocharging system, second system cools engine coolant, third cools drive train oil, fourth system cools the fuel of engine fuel system. All four systems use the modular radiator, which is mounted on front part of the machine. Separated cooler is used for cooling oil in the hydraulic motor fan drive system. Air flow through the radiators is provided by the hydraulic motor driven suction fan.

Engine Cooling Systems

Engine intake system is equipped in air-to-air heat exchanger (charge air cooler (CAC) to reduce intake manifold temperature. The CAC system includes air ducting from the turbocharger compressor outlet to the CAC air inlet, and from the CAC air outlet to the engine intake manifold.
The charge air cooler is located on the left side of the modular radiator.

The engine cooling system used on this machine is a closed, deaerated with separate auxiliary tank. Pressure type system permits operation at extreme angle without loss of coolant through the overflow tube. The cooling system also permits operation at higher engine temperatures without boiling. The cooler is located on the right side of the modular radiator.

The fuel cooler in the drain line is mounted to make sure the correct fuel temperature is met.
The fuel cooler is located on the right side bottom of the modular radiator.

For detailed information on the engine cooling system components, refer to the Engine Operation and Maintenance Manual QSX15 Engines, Bulletin No 3666423; Troubleshooting and Repair Manual QSX15 Engines, Bulletin 3666239 and Troubleshooting Repair Manual Electronic Control System QSX15 Engines, Bulletin No.3666259.

Drive Train Oil Cooling System

The drive train cooling system uses an oil to air heat transfer type oil cooler to cool the oil used in the drive train components: transmission, torque converter and steering.
The drive train oil cooler is located on the left side of the modular radiator near to CAC.

Fan Drive Hydraulic Motor Oil Cooling System

The fan drive oil cooling system uses an oil to air heat transfer type oil cooler, to cool the oil used in the fan drive hydraulic system. The oil cooler is located on the right side top of engine compartment mounted to the modular radiator.

2. OPERATION

Engine Cooling Systems (Refer to Fig. 6.1)

Intake Air Cooling

Intake air after passing thru the screen air filter and air filter elements is suck into the turbocharger (21). Compressed and heated air from the turbocharger is directed to the charge air cooler CAC (1) (heat exchanger). CAC is connected with the turbocharger outlet and engine intake connection (22) with the tubes (18, 20) and special vibration resistant hump hoses (19). The hot air enters to the cooler core (1) and flows down through tubes. Heat is dissipated to the air being forced past the outside of the core tubes by the hydraulic motor driven fan. CAC system is designed to achieve 60 [°C] intake manifold temperatures at a 25 [°C] ambient temp.

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Engine Cooling

An engine mounted belt driven centrifugal type pump suck the coolant thru the inlet tube (15) from the radiator bottom manifold and pumps it through engine oil cooler cavity, engine block and cylinder heads passages. Then, hot coolant is directed to the thermostats housing and parallel connected coolant filter.

When the engine is cold, the thermostats are closed, which prevents circulation of low temperature coolant through the radiator core. The coolant circulates only through the engine passages, thru the engine bypass tube and coolant pump.

When the engine reaches operating temperature, which is determined by the thermostats, the thermostats open the passage for coolant flow thru the tubes (6) to the upper radiator manifold. The temperature of the coolant controls the extent of the thermostats opening, and also controls the amount of coolant circulation. The hot coolant enters the radiator upper manifold and flows down through tubes in the radiator core (5) where the heat is dissipated to the air being forced past the outside of the core by the hydraulic motor driven fan.

Engine thermostats housing and radiator core is vented to auxiliary tank (3) mounted on the top of assembly with the vent hoses (4) and (13). Auxiliary tank have fill line (14) connection to the coolant outlet tube.
The auxiliary tank have an automotive type radiator cap with a built in pressure-vacuum relief valve. The relief valve of the cap is incorporated to maintain a minimum and maximum pressure in the cooling system. The valve allows excess air and vapor to escape through an overflow tube (23) at a pressure of 45 - 55 [kPa].

Drive Train Oil Cooling System

The oil used in drive train system is directed to the inlet hose (17) of the oil cooler (2) as it leaves the torque converter. The heat from the oil is dissipated to the air being forced past the outside of the core tubes by the hydraulic motor driven fan. The oil is then directed to the lubrication purpose of transmission with the hose (16).

Fuel Cooling System

The engine uses high pressure injection system increasing fuel temperature. Inline connected fuel cooler (10) is mounted to the drain line to maintain fuel temperature below 71 [°C]. The heat from the fuel is dissipated to the air being forced past the outside of the core tubes by the hydraulic motor driven fan. The fuel is then directed to the fuel tank with the hose (11).

Hydraulic Motor Fan Drive Oil Cooling System

Torque converter mounted and driven hydraulic oil pump is pumping oil to the fan drive hydraulic motor, then oil is directed to the oil cooler (7) thru the hose (9). The heat from the oil is dissipated to the air being forced past the outside of the core tubes by the hydraulic motor driven fan. The oil is then directed to the hydraulic oil tank thru the hose (8).
Hydraulic motor speed is controlled by the three sensors located in the engine intake air system, engine cooling system and drive train system.

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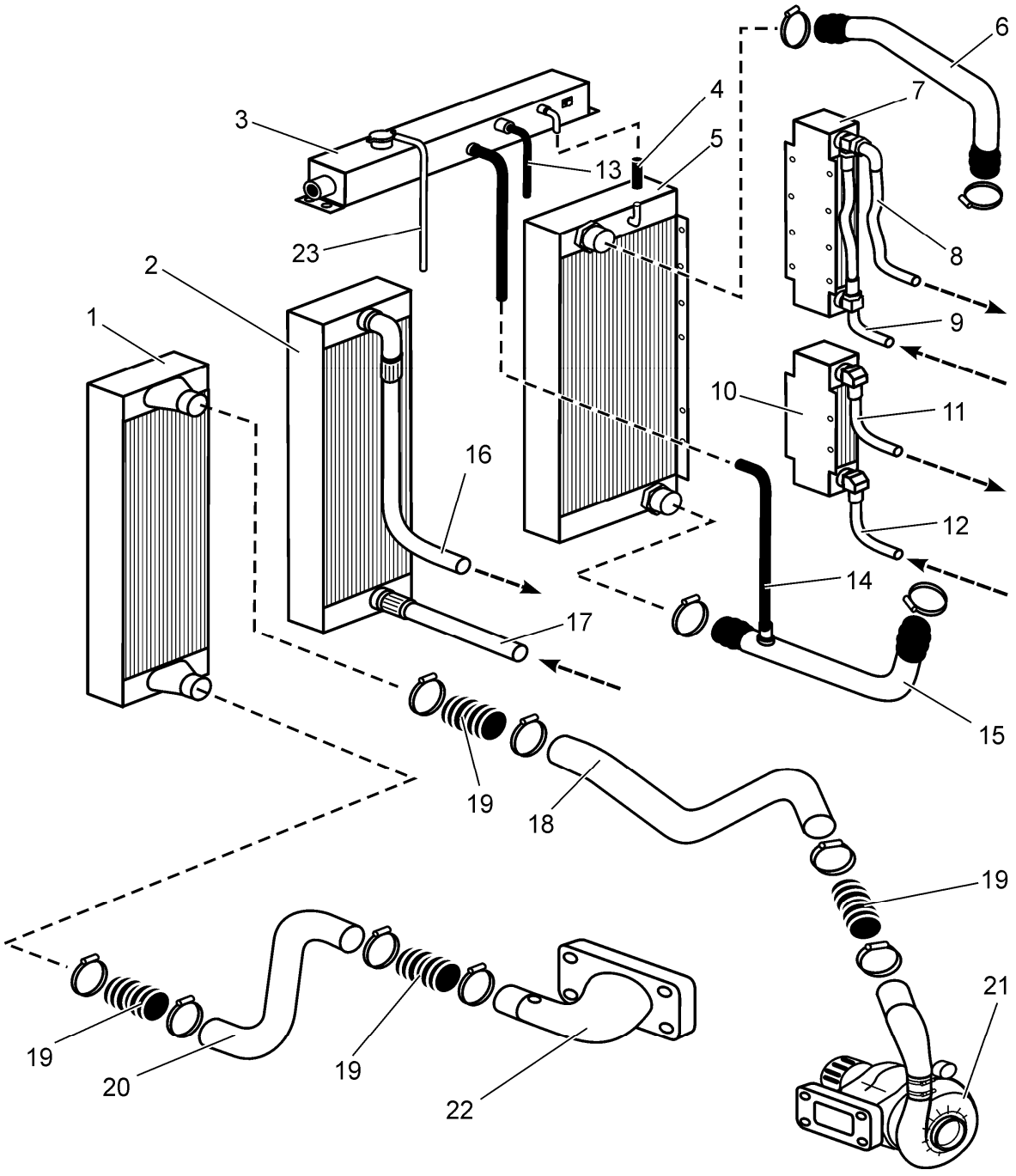

Fig. 6.1. Modular Cooling Systems Connections

1. Charge Air Cooler (CAC)
2. Drive Train Oil Cooler
3. Auxiliary Tank
4. Radiator Core Vent Hose
5. Radiator Core
6. Coolant Inlet Tube
7. Hydraulic Motor Oil Cooler
8. Oil Outlet Hose
9. Oil Inlet Hose
10. Fuel Cooler
11. Fuel Outlet Hose
12. Fuel Inlet Hose
13. Engine Vent Hose
14. Cooling System Fill Hose
15. Coolant Outlet Tube
16. Oil Outlet Hose
17. Oil Inlet Hose
18. Air Inlet Tube
19. Hump Hose with Clamps
20. Air Outlet Tube
21. Turbocharger
22. Engine Intake Connection
23. Overflow Hose

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COOLING SYSTEM

3. SPECIFICATIONS

Engine Cooling System

Capacity . . . . . 56 [l]
Coolant pump type . . . . . Centrifugal
Standard thermostat range . . . . . 82 to 93 [°C]
Minimum recommended coolant temperature . . . . . 70 [° C]
Maximum allowable top tank temperature . . . . . 102 [°C]
Minimum recommended pressure cap . . . . . 50 [kPa]
Fan drive speed range . . . . . .Below 400 [RPM]
High 1520 – 1600 [RPM]

Engine radiator:

Type . . . . . Fins and flat tubes
Core . . . . . Replaceable
Test pressure . . . . . 150 [kPa]

Charge Air Cooler

Type . . . . . Fins and flat tubes
Core . . . . . Replaceable
Test pressure . . . . . 300 [kPa]
Maximum allowable pressure drop across CAC and piping . . . . . 101 [kPa]

Drive Train Oil Cooler

Type . . . . . Fins and flat tubes
Core . . . . . Replaceable
Test pressure . . . . . 1500 [kPa]

Fuel Cooler

Type . . . . . Fins and flat tubes
Core . . . . . Replaceable
Test pressure . . . . . 750 [kPa]

Fan Drive Hydraulic Motor Oil Cooler

Type . . . . . Fins and flat tubes
Core . . . . . Replaceable
Test pressure . . . . . 750 [kPa]

Special Nut and Bolt Torque Data:

Radiator bracket mounting bolts. . . . . 50-60 [Nm]
Fan mounting bolt. . . . . 38-42 [Nm]

(Torques given are for bolts and nuts lubricated with SAE-30 engine oil.)

NOTE: *Except for the special torque shown, all bolts and nuts are to be given a standard torque. Refer to “STANDARD TORQUES “ in Section 1, "INTRODUCTION."*

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4. SERVICE DIAGNOSIS

Intake Air Cooling System

COMPLAINT	
PROBABLE CAUSE	REMARKS
Engine Power Output Low	
1.Air leak between the turbocharger and intake manifold.	Check the CAC system piping connections for leakage. Replace damaged parts.
2. CAC restricted.	Inspect the air cooler for external and internal restrictions / clogging.
3. Damaged fan blades.	Replace fan.
4. Fan drive hydraulic system problem	Refer to Section 10.
5. Engine overloaded.	Review operating instructions in the Operator's Manual.

Engine cooling system

COMPLAINT	
PROBABLE CAUSE	REMARKS
Overheating Due to Restricted Air Flow	
1. Clogged radiator.	Flush with steam for external clogging.
2. Damaged fan blades.	Replace fan.
3. Fan drive hydraulic system problem.	Refer to Section 10.
4. Engine overloaded.	Review operating instructions in the Operator's Manual.
Overheating Due to Poor Circulation	
1. Low coolant level.	Fill cooling system to proper level.
2. Tank cap not securely tightened to seal the pressure system.	Remove radiator cap and inspect. Replace cap if gasket is worn. Tighten radiator cap to maintain pressure in system.
3. Pressure relief valve on tank cap is faulty. Coolant pressure escaping.	Replace cap. Do not repair or replace any relief valve parts.
4. Faulty thermostat(s).	Check thermostat(s) for operation. Replace if faulty. Refer to Troubleshooting and Repair Manual QSX15 Engines.
5. Restriction in radiator core.	Make a cooling system pressure test. Flush the cooling system chemically. Refer to Troubleshooting and Repair Manual QSX15 Engines.
6. Coolant pump problem	Make a cooling system pressure test. Remove coolant pump and recondition. Refer to Troubleshooting and Repair Manual QSX15 Engines.
Internal Leakage	
1. Warped cylinder head.	Replace cylinder head and gasket. Torque head bolts as specified in the Troubleshooting and Repair Manual QSX15 Engines.
2. Engine oil cooler cracked.	Remove oil cooler, perform pressure test. Refer to Troubleshooting and Repair Manual QSX15 Engines.

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COOLING SYSTEM

COMPLAINT	
PROBABLE CAUSE	REMARKS
External Leakage	
1.Defective connections in cooling system.	Check or replace defective hoses and clamps as required.
2. Radiator leaks.	Remove the radiator. Repair or replace as necessary. Make a pressure test.
4. Defective coolant pump seal.	Inspect the coolant pump body for indication for coolant leakage at the weep hole. Remove pump, replace defective parts. Refer to Troubleshooting and Repair Manual QSX15 Engines.
5. Cracked or warped cylinder head.	Replace cylinder head and gasket. Torque head bolts as specified in Troubleshooting and Repair Manual QSX15 Engines.
6. Cylinder block cracked or porous.	Repair or replace defective block. Refer to Troubleshooting and Repair Manual QSX15 Engines.
Engine Runs Cold	
1. Extremely cold weather.	Cover radiator.
2. Coolant temperature gauge or sensor faulty.	Replace sensor or temperature gauge.
3. Thermostat inoperative.	Replace. Refer to Troubleshooting and Repair Manual QSX15 Engines.

Drive Train Cooling System

COMPLAINT	
PROBABLE CAUSE	REMARKS
Drive Train Oil Overheating	
1. Operating too long in low efficiency ranges.	Review operating instructions in the Operator's Manual.
2. Clogged radiator.	Flush with steam for external clogging.
3. Temperature gauge or sensor faulty.	Replace sensor or temperature gauge.
4. Torque converter problem.	Refer to Section 7.
5. Transmission problem.	Refer to Section 7.
6. Steering problem.	Refer to Section 7.

5. REMOVAL

1. Position machine in place which makes it possible to use lifting device for lifting of disassembled assembles.

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lever is locked and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

2. Turn electrical master switch to "OFF" position.
3. Loosen the clamp and remove the air precleaner (4, Fig. 6.2). Disassemble the aspirator tube between the air precleaner and muffler.

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4. Remove the exhaust tube assy (3, Fig. 6.2).
5. Remove bolts and disassemble side enclosure (2).
6. Remove bolts securing the hood (1). Remove the hood assembly from the machine.
7. Attach a suitable lifting device to the crankcase guard, remove the hardware and lower the guard on the ground to give the access to the bottom radiator mounting points.

WARNING! This procedure requires extreme caution. Use suitable blocking equipment while under confines of machine.

Fig. 6.2. Hood and Engine Enclosure

1. Hood
2. Side Enclosure
3. Exhaust Tube
4. Air Precleaner

8. Drain coolant from cooling system. Refer to Operator's Manual.
9. Loosen the clamp and remove vent hose (5, Fig. 6.3) from the auxiliary tank and attach it to engine.

IMPORTANT*: Disconnected lines must be capped with the correct size plastic caps or clean corks. Openings must never be plugged with rags. This practice could easily introduce dirt or lint in to critical components of the system.*

10. Disconnect wire harness connector from the coolant level switches (6, Fig. 6.3) and (3, Fig. 6.7), and secure it to frame.
11. Loosen the clamp and remove coolant fill hose (3, Fig. 6.3) from the auxiliary tank.
12. Remove hydraulic hose (2) from drive train oil cooler. Secure hose in an upright position to frame.
13. Tag and remove hose (7) from fan drive hydraulic motor oil cooler. Secure hose in an upright position to frame.
14. Loosen the clamps and remove coolant tube (4) between the radiator and engine outlet.

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15. Loosen the clamps and remove tube (1) from the cooler (CAC) and engine turbocharger.
16. Tag and remove engine vent hose (5) from the auxiliary tank and attach them to engine.

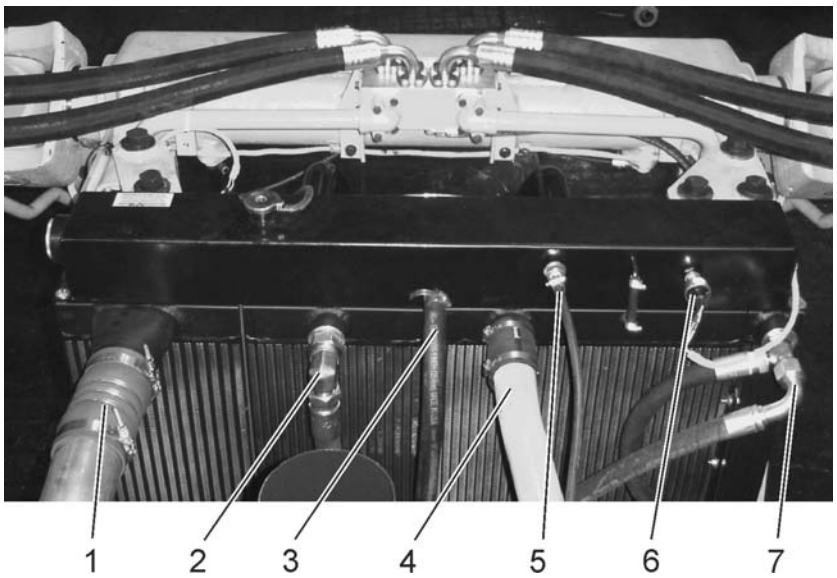

Fig. 6.3. Radiators Assy Connections (upper)

1. Air Tube (CAC inlet)
2. Hose (Outlet)
3. Cooling System Fill Hose
4. Coolant Inlet Tube
5. From Engine Vent Hose
6. Coolant Level Switch
7. Hose Outlet)

17. Tag and remove hydraulic hose (1, Fig. 6.4) from fan drive hydraulic motor oil cooler. Secure hose in an upright position to frame.

NOTE: *Small quantity of oil from oil cooler should be drained to the suitable container.*

18. Tag and remove fuel hose (2, Fig. 6.4) from the fuel cooler. Secure hose in an upright position to frame.

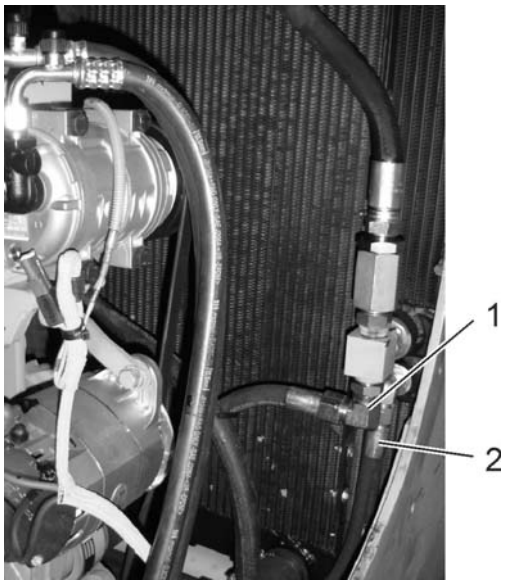

Fig. 6.4. Fan Drive Hydraulic Motor Oil Cooler and Fuel Cooler Connections

1. Hydraulic Hose (inlet)
2. Fuel Hose (outlet)

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19 Loosen the clamps and remove tube (1, Fig. 6.5) from the cooler (CAC) and engine intake manifold.

20. Remove hydraulic hose (2) from drive train oil cooler. Secure hose in an upright position to frame.

NOTE: *Small quantity of oil from drive train oil cooler should be drained to the suitable container.*

21. Loosen the clamps and remove coolant outlet tube (2, Fig. 6.5) from the radiator and engine inlet.

22. Tag and remove fuel hose (4) from the fuel cooler. Secure hose in an upright position to frame.

NOTE: *Small quantity of fuel from fuel cooler should be drained to the suitable container.*

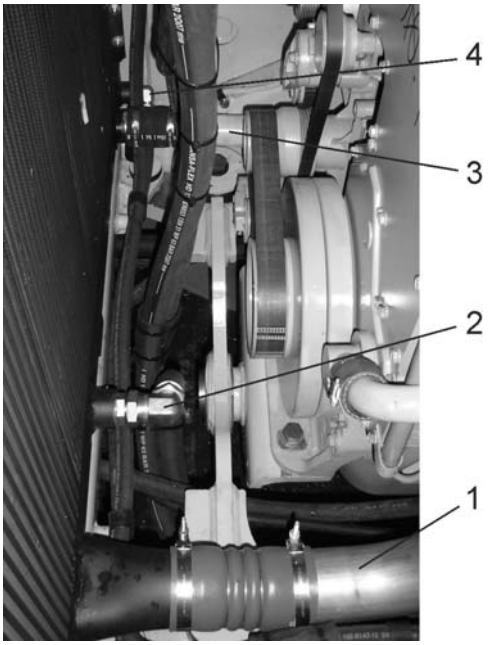

Fig. 6.5. Radiators Assy Connections (lower)

1. Air Outlet Tube (CAC outlet)
2. Hydraulic Hose (inlet)
3. Coolant Tube (outlet)
4. Fuel Hose (inlet)

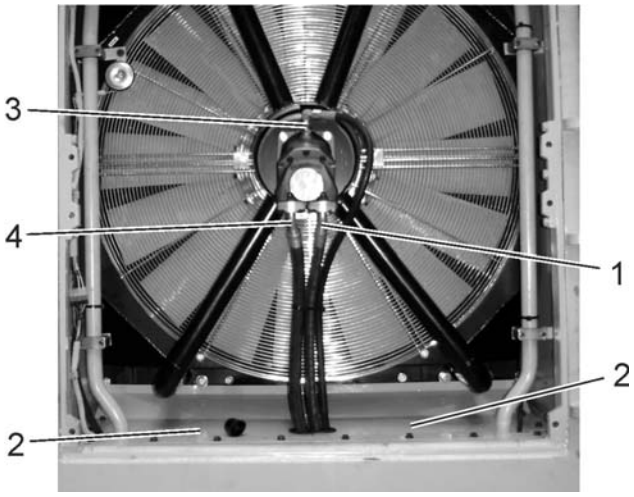

Fig. 6.6. Fan Drive Hydraulic Motor Disassembly Points

1. Hydraulic Hose (inlet)
2. Air Baffles
3. Hydraulic Hose (drain)
4. Hydraulic Hose (outlet)

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23. Remove bolts securing front radiator door, and swing them open. Remove upper and lower air baffles (2, Fig. 6.6).
24. Tag and remove hydraulic hoses (1, 3 and 4, Fig. 6.6) from fan drive hydraulic motor. Secure hoses in an upright position to frame.
25. Use the slings to lift the radiator. Wrap the slings around the radiator bottom plate and tighten.

IMPORTANT: *Do not use the hydraulic motor bracket for radiator assy hoisting.*

26. Unscrew bolts (1, Fig. 6.7) securing radiator to plate (2).
27. Unscrew bolts (2, Fig. 6.8) securing radiator assy to channel (1) at the bottom.
28. Carefully hoist the radiator assy up and over frame. Position assy horizontally hydraulic motor up, using suitable height wooden pads.

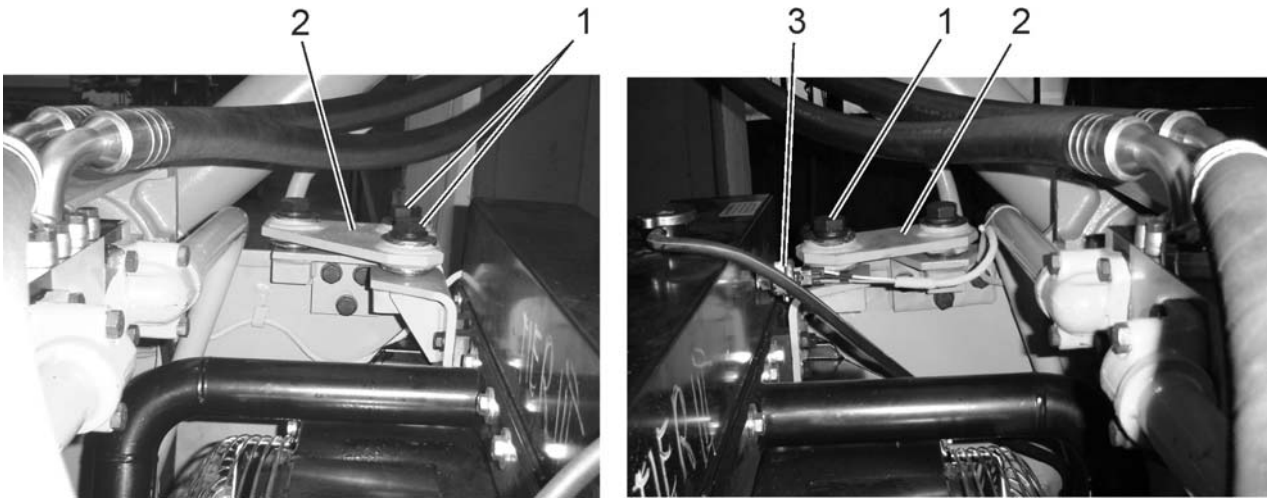

Fig. 6.7. Radiator Assy Disassembly Points LH and RH (upper brackets)

1. Bolts
2. Plate (link)
3. Coolant Level Switch

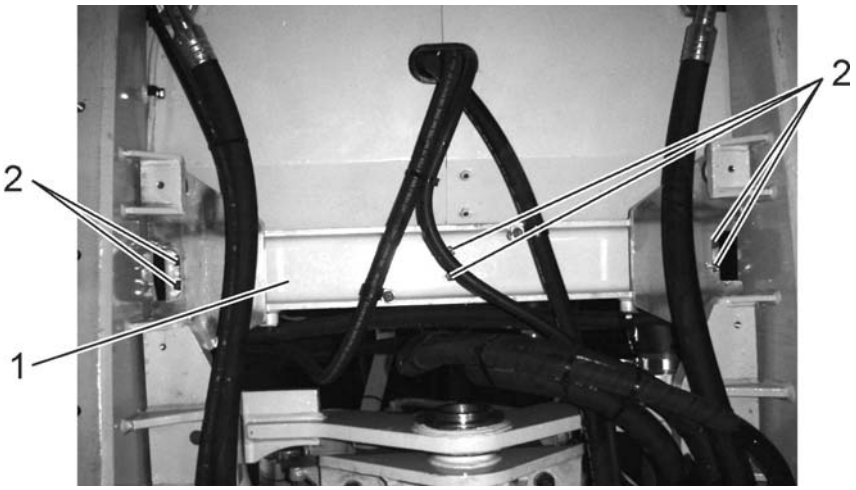

Fig. 6.8. Radiator Assy Disassembly Points (bottom view)

1. Radiator Assy Channel (bracket)
2. Mounting Bolts

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6. DISASSEMBLY (Refer to Fig. 6.9)

NOTE: *If any problem occurs with the particular element (core) of the radiator assy, it is possible to remove a single core required repairing without disassembly of all elements.*

Charge air cooler removing

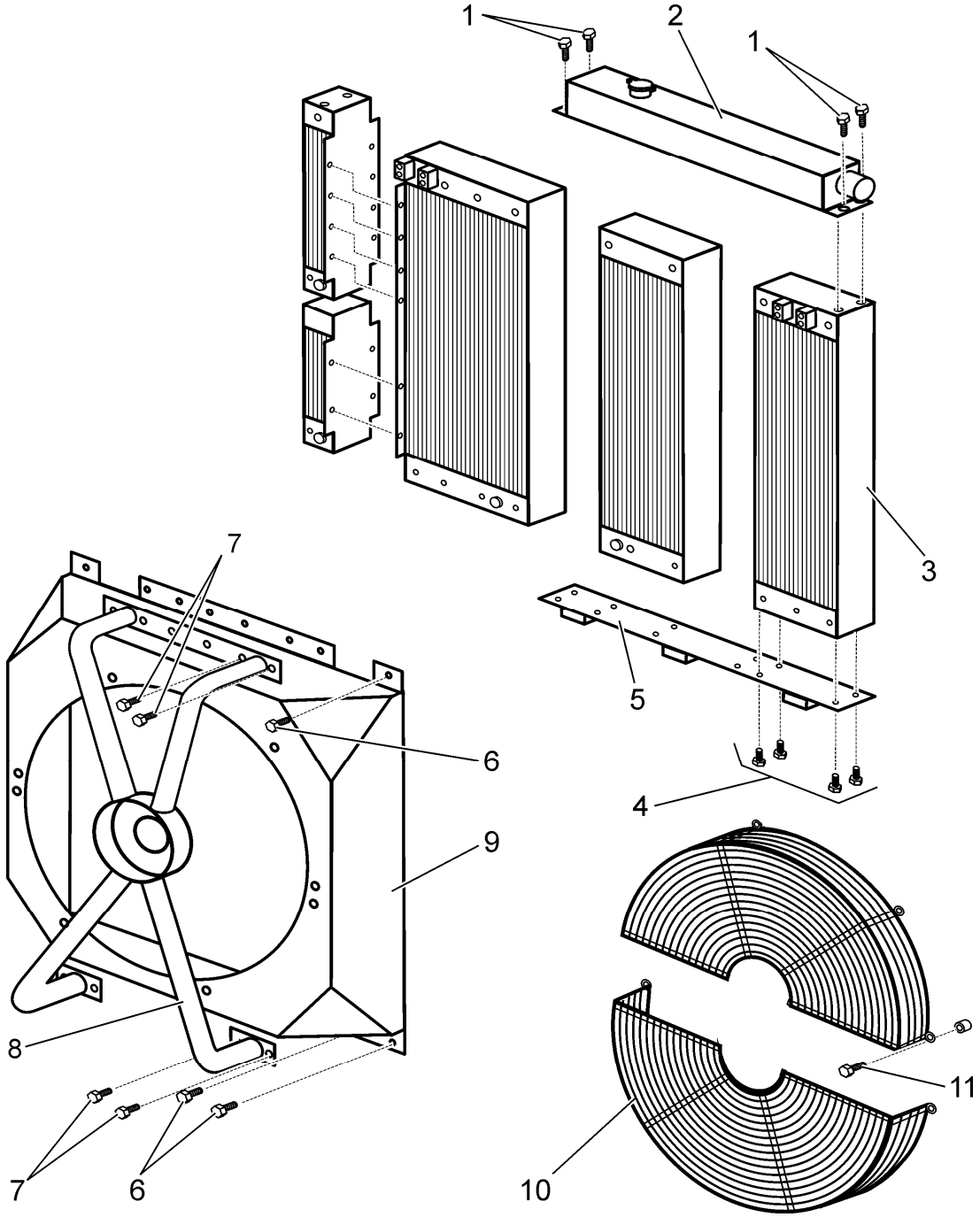

Fig. 6.9. Radiators Assy Exploded View

1. Bolts
2. Auxiliary Tank
3. Charge Air Cooler (core)
4. Bolts
5. Bottom Plate
6. Bolts
7. Bolts
8. Fan Drive Hydraulic Motor Bracket
9. Fan Shroud
10. Fan Guard
11. Bolt

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1. Remove vent line (4, Fig. 6.1) between auxiliary tank and radiator. Remove bolts (1) securing auxiliary tank (2) to radiator core and remove them.
2. Remove bolts (4) securing air cooler (3) to bottom plate (5).
3. Remove bolts (7) securing fan drive hydraulic motor bracket (8) to cooler (3).
4. Remove bolts (6) securing fan shroud (9) to cooler (3).
5. Remove air cooler (3).
6. Remove plastic or rubber seals from the slots between the coolers and discard them.
7. Remove bolts (11) and fan guard (10) and bolts securing bracket (8) to engine radiator to gain access to fan mounting nut if necessary.

NOTE: *To remove other elements (cores) of the radiator assy, follow the procedure described above.*

7. INSPECTION AND REPAIR

1. Examine of cores for damage. Straighten bent fins if possible to avoid air flow restrictions. Clean cores outside with compressed air or water with additives no aggressive for aluminum. The direction of cleaning stream should be parallel to the fins in order to avoid damage. Cover the hydraulic motor during the cleaning procedure.
2. Inspect top and bottom particular radiator for cracks.
3. Inspect all hoses for cracks or rupture and install new when in doubt.
4. Inspect the radiator cap.
5. Inspect shock absorber and rubber pads for wear.
6. Perform pressure test particular cooler if necessary.
7. Check and repair fan shroud and fan guard for cracks.
8. Check fan for cracks and other damage. Do not repair. Replace for new one.

NOTE: *Elements (cores) of the radiator assy, are mounted (welded) and have to be replaced by new if unrepairable.*

NOTE: *Elements (cores) of the radiator assy, are made of aluminum, any repair required is to be done in experienced workshop.*

8. REASSEMBLE (Refer to Fig. 6.9)

Charge air cooler mounting

1. Position cooler (3) on place, and insert a new plastic or rubber seal into the slot between the next cooler.
2. Install bolts (6 and 7) securing cooler (3) to fan drive hydraulic motor bracket (8) and fan shroud (9).

NOTE: *Do not tighten bolts at this stage.*

3. Install bolts (4) securing cooler (3) to bottom plate (5).
4. Position auxiliary tank (2), install bolts (1). Reinstall vent line (4, Fig. 6.1) between auxiliary tank and radiator.
5. **Tighten all bolts with care. Apply standard torques values for aluminum.**
6. Reinstall fan guard (10) with bolt (11) and bracket (8) if removed.

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9. INSTALLATION

NOTE: *Before mounting radiator assy remove bolts and washers (1, Fig. 6.10) and inspect rubber shock absorber (2) of radiator channel (3) for wear.*

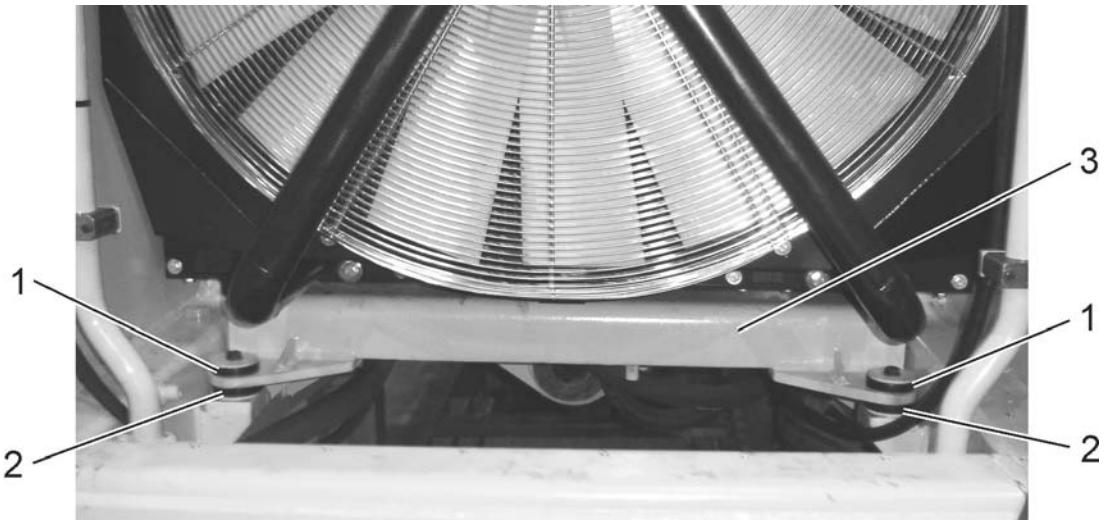

Fig. 6.10. Radiator Assy Lower Bracket (front view)

1. Bolts and Washer
2. Rubber Shock Absorber
3. Radiator Assy Channel (bracket)

1. Use the slings to lift the radiator. Wrap the slings around the radiator bottom plate and carefully hoist the radiator assy up and over frame. Position radiator assy on the channel and install bolts (1, Fig. 6.8) securing assy to channel (2) at the bottom initially.

IMPORTANT: *Do not use the hydraulic motor bracket for radiator assy hoisting.*

2. Reinstall brackets (3, Fig. 6.7) to frame with the bolts. Install plate (2) linking two brackets with the bolts (1) Tighten bolts securing the radiator assy to the bottom channel. Remove lifting slings.
3. Reinstall hydraulic hoses (1, 3 and 4, Fig. 6.6) to the fan drive hydraulic motor.
4. Reinstall fuel hose (4, Fig. 6.5) to the fuel cooler.
5. Reinstall coolant tube (3) to the radiator and engine inlet. Tighten the clamps.
6. Reinstall hydraulic hose (2) to the drive train oil cooler.
7. Reinstall tube (1) to the air cooler (CAC) and engine intake manifold. Tighten the clamps.
8. Reinstall fuel hose (2, Fig. 6.4) to the fuel cooler.
9. Reinstall hydraulic hose (1) to fan drive hydraulic motor oil cooler.
10. Reinstall tube (1, Fig. 6.3) to the air cooler (CAC) and engine turbocharger. Tighten the clamps.
11. Reinstall coolant tube (4) between the radiator and engine outlet. Tighten the clamps.
12. Reinstall hydraulic hose (6) to fan drive hydraulic motor oil cooler.
13. Reinstall hydraulic hose (2) to the drive train oil cooler.
14. Reinstall coolant fill hose (3) to the auxiliary tank. Tighten the clamp.
15. Reconnect wire harness connector to the coolant level switches (6, Fig. 6.3) and (3, Fig. 6.7).

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16. Reinstall vent hose (5, Fig. 6.3) to the auxiliary tank. Tighten the clamp.
17. Refill cooling system with the coolant. Refer to Operator’s Manual.
18. Start the engine. After reaching operating temperatures, check all disconnected previously lines: cooling, fuel and hydraulic systems for leaks. Stop the engine. Check the coolant level, drive train oil level and hydraulic oil level as described in Operator's Manual.

WARNING! Before working on the machine be sure to turn "OFF" master switch and take key out to prevent accidental starting.

19. Attach a suitable lifting device to the crankcase guard. Lift the guard and install the bolts.

WARNING! This procedure requires extreme caution. Use suitable blocking equipment while under confines of machine.

20. Install air baffles (2, Fig. 6.6). Close front radiator door, install the bolts.
21. Position the hood (1, Fig. 6.2), install the bolts and tighten.
22. Reassemble side enclosure (2).
23. Reassemble the exhaust tube assy (3).
24. Reassemble the aspirator tube between the air precleaner and muffler. Install air precleaner (4).

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SECTION 7

DRIVE TRAIN

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DRIVE TRAIN

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DRIVE TRAIN

SERVICE /SPECIAL TOOLS

1. SERVICE /SPECIAL TOOLS

DESCRIPTION	TOOL NUMBER
Digital Optical Tachometer	3377462
Test Pressure Gauges Kit	910-50-0005

GENERAL

2. DESCRIPTION

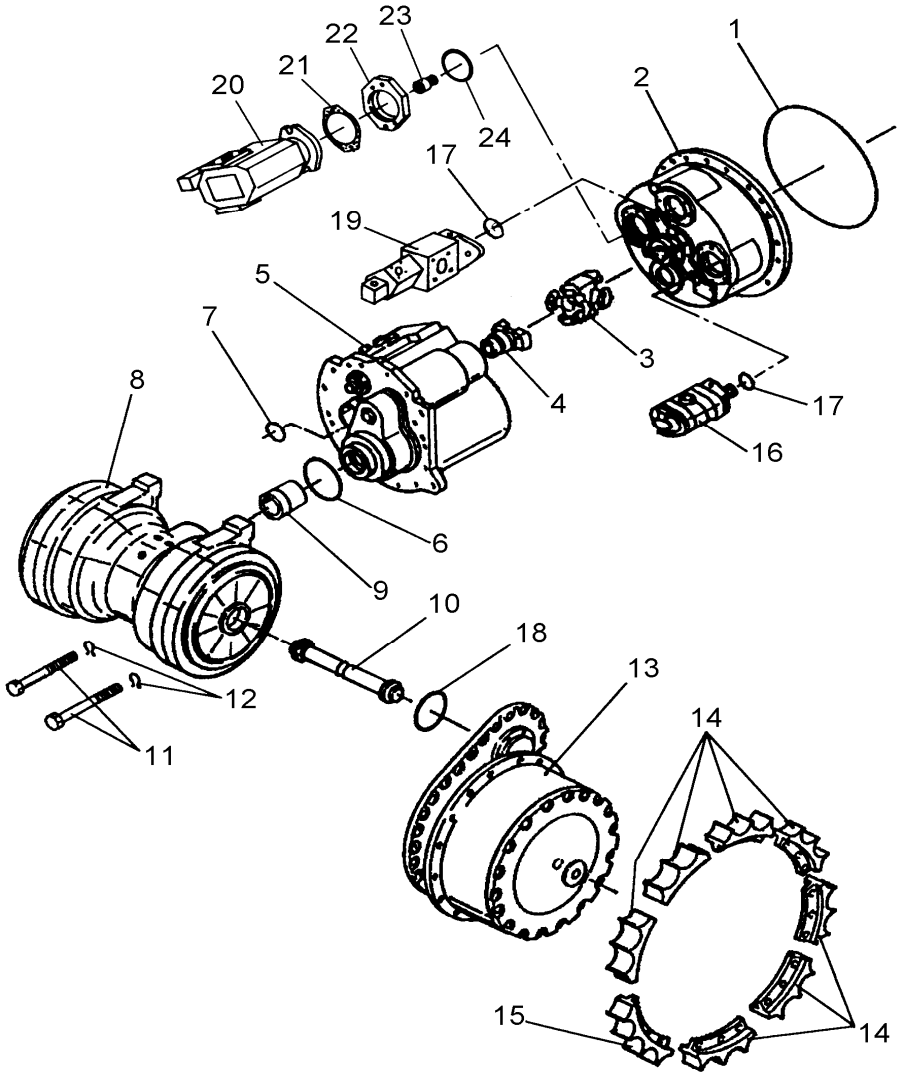

Fig. 7.1. Drive Line

1. O-Ring
2. Torque Converter
3. Drive Shaft
4. Transmission Input Yoke
5. Transmission
6. O-Ring
7. O-Ring
8. Steering Drive
9. Drive Pinion Sleeve
10. Steering Drive Output Shaft
11. Bolt
12. Retaining Ring
13. Final Drive
14. Sprocket Drive Segment
15. Sprocket Drive Segment
16. Charge and Scavenge Pump
17. O-Ring
18. O-Ring
19. Equipment Pump
20. Fan Drive Pump
21. Gasket
22. Connector Plate
23. Connector
24. O-Ring

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GENERAL

Power from the engine is transmitted through a flywheel drive ring to the torque converter (2). Drive shaft (3) couples the output flange of the torque converter with input yoke (4) of transmission (5). The converter delivers torque according to the variation in load on the oil used as the medium, and transmits the power to the transmission (5). When the transmission is engaged, power is transmitted from the output shaft of the transmission to the pinion shaft of steering drive (8), and by steering drive clutches to the steering drive output shaft (10), then through final drives (13) and sprockets (14 and 15) to the tracks.

3. DRIVE TRAIN MAIN COMPONENTS

The torque converter (2, Fig. 7.1) contains a single stage, single phase, three element converter assembly and a drive gear to drive the drive train charge and scavenge pump, the equipment pump and the fan drive pump. The torque converter main function is to multiply engine torque.

The transmission (5) is designed to provide high speed shifting by use of hydraulically actuated clutch packs. It has three forward and three reverse speeds. Gears are mounted on four shafts: directional (input) shaft, range (output) shaft, countershaft and reverse idler shaft.

The steering drive (8) is a unit constructed into a housing similar to a transmission. This design affords ease of assembly and service. The machine is equipped with the two speed steering drive. The two speed steering drive contains one low range clutch pack, one high range clutch pack, one brake clutch pack and a planetary on each side of the machine. The low and high range clutch packs are hydraulically applied and spring released whereas the brake clutch packs are spring applied and hydraulically released. An inner planetary provides the reduction in speed for the low range. If a hydraulic failure occurs or the engine is stopped, the steering drive will automatically apply the brakes.

The final drive (13) consist of a set of spur gears and a planetary on each side at the rear of the machine. Power is transmitted from the steering drive to each of the final drives. Double reduction in the final drive is accomplished by a pinion to bullgear arrangement for the first reduction and a planetary set for the final reduction.

OPERATION

4. DRIVE TRAIN SYSTEM VALVES

Drive Train Control Valve (12, Fig.'s 7.2 and 7.3)

The drive train control valve is a manually controlled direction, range and steering control valve. The valve is used to direct main oil pressure to the transmission range selector valve for transmission control and to the steering control valve for range and steering control. A detent mechanism holds the control lever in the desired transmission direction.
Main pressure from the charge pump through hydraulic damper, pressure filter and drive train neutral lock solenoid valve enters the drive train control valve at the "M" port and is distributed to the direction and steering spools. When the control lever is in the centered "neutral" position, oil is active at the selected steering ports but is blocked at the direction spools.

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OPERATION

When the control lever is moved forward, the pivot ring depresses the Forward direction spool directing oil to the “F” port at the bottom of the valve. The “F” pressurized oil is also directed internally to the base of the Reverse spool which pushes the Reverse spool up to the pivot ring. This action creates a hydraulic detent holding the lever forward.
When pulling the control lever to neutral or reverse, the pivot ring pushes down on the Reverse spool which displaces the hydraulic detent oil. At the same time the Forward spool follows the pivot ring up and mid way through its stroke the forward pressure is cut off as well as the reverse hydraulic detent, allowing the valve to go into neutral. If the lever is pulled all the way to reverse the same sequence of events happens for the reverse hydraulic detent.

Steering is accomplished in two ways: by moving the control lever to the left or right or by shifting the HI-LO speed range switches. The two steering methods can be used together and in any combination.

When the machine is started with both speed range switches in LO-LO positions both tracks are in LO-LO. With the lever pushed to forward the machine travels in FWD, LO-LO (both tracks in LO-LO). Initial movement of the lever to the right drops right LO clutch steering pressure causing the right steering clutch to be in a neutral condition. The neutral condition is indicated by a “feel point” or effort increase in the control lever movement. Further movement of the lever further decreases pressure at the right brake, which is moved to the end of the lever stroke will result in a pivot turn to the right. By shifting both range switches to their upper position both tracks shift up to HI-HI (both tracks in HI-HI). If traveling in HI-HI and the lever is pulled to the right the following occurs. The initial lever movement lowers signal pressure causing a sequence valve to automatically shift the right track from HI to LO. With further lever travel to the right the right LO track will go to the neutral condition as indicated by the “feel point” as discussed earlier. Further lever movement will result in a pivot turn. As the lever is moved back to the upright position the LO clutch engages and then up into HI. Speed range switch steering results in full power turns.

With the lever pushed to forward and both speed range switches in LO-LO positions the machine travels in FWD, LO-LO (both tracks in LO-LO). By shifting the right switch to HI position, the right track shifts up to HI. Both machine tracks are engaged, while the right track features the higher speed and, as a result, the machine will make a gradual turn to the left. To cause the machine to make a gradual turn to the right proceed in similar manner by controlling the left hand track power. The machine will make a gradual turn so long as one of the speed range switches gets reactivated. Then the machine will revert to straight travel in a range it was engaged in prior to the gradual turn activation.

A transmission range gear is selected by pushing the drive train control lever up-shift and down-shift buttons.

For a complete Machine Speed and Direction Changes description and operation, refer to OPERATOR’S MANUAL.

Two Speed Steering Valve (Fig.’s 7.4, 7.5 and 7.6)

The two speed steering valve contains three valves. Two of them: upper LC, RC, FB and lower HI-LO are mounted above rear main frame cover and one - manifold J under this cover.

The upper valve consists of three basic sections: LC left clutch section, RC right clutch section and the FB foot brake section.

The LC and RC clutch sections control the flow of oil to the clutch packs to drive each track individually. Both of the sections contain a metering spools which are each held in the rear drive position by pilot pressure CL and CR respectively from the drive train control valve.

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OPERATION

The FB foot break section, contains one spool which is held in the drive position by a return spring. When in this position, oil pressure from the LC and RC sections enters the foot brake section FB and is evenly split into two separate circuits, one for the LB brake clutch pack and one for the RB brake clutch pack of steering drive SD. When the foot brake is applied, the spool in this section moves forward and begins to dissipate the oil pressure to both brake clutch packs simultaneously.

The lower valve consist of two sections LH and RH. Each of section contains HI-LO spool, which is controlled by solenoid valve SOL and a sequence valve SEQ. These two pairs of valves SOL and SEQ are placed in one housing of HI-LO valve. This HI-LO valve housing is bolted to the back of the lower steering valve housing.

Each of sections performs two functions: shifts the HI-LO range spool to HI position when the solenoid valve SOL is actuated making a high range track speed, and shifts HI-LO range spool from high to low when solenoid valve is off making a low range track speed.

In case one HI-LO range spool is shifted a gradual turn is making. The left and right steering pilot pressures enter the HI-LO valve and remains unique to their individual left or right side. The steering pilot pressure first enters the sequence valve SEQ. When the steering pilot pressure is above 1370 [kPa], the pilot pressure connects to the solenoid valve SOL. With pilot pressure to the solenoid SOL, it may send pilot pressure to the HI-LO spool when the solenoid SOL is energized and it causes, the HI-LO spool shifts to the high position.

The purpose of the sequence valve SEQ is to automatically downshift the HI-LO spool from High to Low when the main oil pressure decays from the full pressure of 1860 [kPa] to below 1370 [kPa]. When the sequence valve SEQ shifts, it disconnects the pilot pressure to the solenoid valve so that causes the HI-LO spool moves to the (LO) position.

When the right speed range switch of the drive train control lever is in its upper position (HI) and the left rocker switch in its lower (LO) position (Fig. 7.5) the drive train electronic controller (EC) chooses the correct solenoid selections to result in the gradual left turn. The EC controller upshifts or downshifts the appropriate track to complete the turn.

When the control lever is moved to the right pivot position (Fig. 7.6), the CR pilot pressure drive train control valve decreases. This dropping pilot pressure activates the metering spool, moving it forward. The oil pressure to RC and RB clutch is cut off. These right clutches are now connected to the drain and dozer is pivoting turn right.

When the both rocker switches are in its upper positions (HI) both solenoids SOL are energized. Both solenoids direct pilot oil to both HI-LO spools causing the HI - LO spools to shift to HI position. Main oil pressure from the metering spools by HI LO spools sections is directed to both the HI range clutches ports.

The manifold J covers one spool and spring. The purpose of this manifold is to automatically shift off the low range clutches when the main oil pressure decays from the full pressure of 1860 [kPa] to below 860 [kPa].

Switching Valve (10, Fig.'s 7.2 and 7.3)

The switching valve provides a pressure connection for the main low pressure and clutch low oil pressure warning light switch, allowing enters either "M" - main pressure to the switch, when the drive train control lever is in the neutral position, or "PC" – gear clutch pressure when the drive train control lever is in the forward or reverse position.

Gear Shifting Valve (11, Fig.'s 7.2 and 7.3)

Gear shifting valve is an electronically controlled transmission range gears valve. The valve housing contains two solenoids: one for the second gear (11A) and the other one – for the third gear (11B). When the machine is started both solenoids are de-energized and drive begins in the default condition of transmission that is in the first gear position. When the up-shift control button is pressed once the second gear solenoid is energized and the second gear is selected. With pressed up-shift button once again the third gear is selected (the third gear solenoid is energized).

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OPERATION

Drive Train Neutral Lock Solenoid Valve (17, Fig.'s 7.2 and 7.3)

The drive train neutral lock solenoid valve blocks flow to the drive train control valve when the drive train neutral lock lever is in the lock position, and allows flow to drive train control valve when the drive train neutral lock lever is in the unlock position. The drive train neutral lock solenoid valve contains normally closed solenoid valve. When starting the machine the neutral lock lever is in the lock position and the solenoid valve is deenergized. The oil under main pressure enters the neutral lock solenoid valve. The normally closed solenoid valve blocks the flow. In this condition the drive train control valve and transmission is not operational. When the neutral lock lever is moved to the unlocked position, an electric switch is closed sending power to the solenoid valve. The energized solenoid valve opens and directs flow to the drive train control valve. The drive train control valve and transmission is now operational.

Priority Valve (18, Fig.'s 7.2 and 7.3)

The purpose of the priority valve is to maintain a steady pressure to the transmission and steering valve. Transmission pump flow enters the priority valve. The regulated pressure branches off and is connected to the drive train neutral lock solenoid valve. When the priority pressure of 1890 [kPa] setting is met, the valve opens and flow continues on to the pressure regulator valve mounted on the transmission.

The Pressure Regulator Valve, the Rate of Rise Valve and the Range Selector Valve are described in a separate section. For a complete description and operation, refer to SECTION 7C.

HYDRAULIC OIL FLOW

5. TRANSMISSION SYSTEM OIL FLOW (Refer to Fig.'s 7.2 and 7.3)

The rear part of main frame (9) is the common oil reservoir for torque converter, transmission and steering drive. When the engine is running, oil is drawn out from the bottom of the main frame (9), through suction strainer (2) and onto the rear charge element (3) of drive train charge and scavenge pump.

The charge element (3) of drive train charge and scavenge pump delivers oil flow through hydraulic damper (22), pressure oil filters (5) and priority valve (18) to the M port of pressure regulator valve (15) and to steering control valve by line (19). This charge pump element delivers also oil flow through unlocked drive train neutral lock solenoid valve (17) to drive train control valve (12). Oil from the pressure regulator valve (15) M port is directed through two internal passages in transmission manifold to rate of rise valve (14) and through one passage to P port of range selector valve (13). Oil from the pressure regulator valve (15) M port is also directed by hoses to gear shifting valve (11) and switching valve (10),

The main pressurized oil directed to drive train control valve (12) enters the M port and can be directed out to either the F or R port. When this oil is directed out of one of these ports, it is routed by hose to range selector valve (13) to shift the valve directional spool and switch spool. These spools are visible in lower part of valve (13).

When this shift occurs, the main pressurized oil is directed to rate of rise valve (14) by P, P1 ports of range selector valve (13) and is passed onto the FR and PC ports of range selector valve (13).

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HYDRAULIC OIL FLOW

Rate of rise valve (14) supplies oil first to the FR port of the range selector valve (13) and then to the PC port of range selector valve (13).

The main pressurized oil entering the FR port of range selector valve (13) is directed either to the FC port or RC port and onto the transmission (1) forward or reverse range clutch pack. The pressurized oil entering the PC port of range selector valve (13) is directed either to the 1C, 2C or 3C port and onto the transmission first, second or third speed clutch pack. A transmission speed gear is selected by gear shifting valve (11) controlled by suitable buttons of drive train control valve lever.

For a more complete description and operation of the main regulator valve, the rate of rise valve, the range selector valve and the drive train control valve, refer to SECTION 7C.

Legend for Fig.'s 7.2 and 7.3

1 Transmission
2. Suction Strainer
3. Drive Train Charge Pump
4. Drive Train Scavenge Pump
5. Pressure Filters
5A. Drive Train Oil Pressure Filters" Warning Light
6. Torque Converter
6A. Drive Train System Oil Temperature Gauge
7. Oil Cooler
8. Suction Strainer
9. Main Frame
10. Switching Valve
10A. Low Transmission Main Pressure and Low Clutch Oil Pressure Warning Light
11. Gear Shifting Valve
11A. 2nd Gear Solenoid Valve
11B. 3rd Gear Solenoid Valve
12. Drive Train Control Valve
12A. Gear and Range Display
13. Range Selector Valve
14. Rate of Rise Valve
15. Pressure Regulator Valve
16. Pressure Diagnostic Center
17. Drive Train Neutral Lock Solenoid Valve
18. Priority Valve
19. To Steering Control Valve
20. To Steering Drive Lubricating
21. To Lower Steering Valve
22. Hydraulic Dampers
23. Drive Train Electronic Controller
24. Engine RPM Sensor
25. Transmission Input Shaft RPM Sensor
26. FWD&RWD Travel Pressure Switch
27. Ripper Shank Pin Control System Connection

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HYDRAULIC OIL FLOW

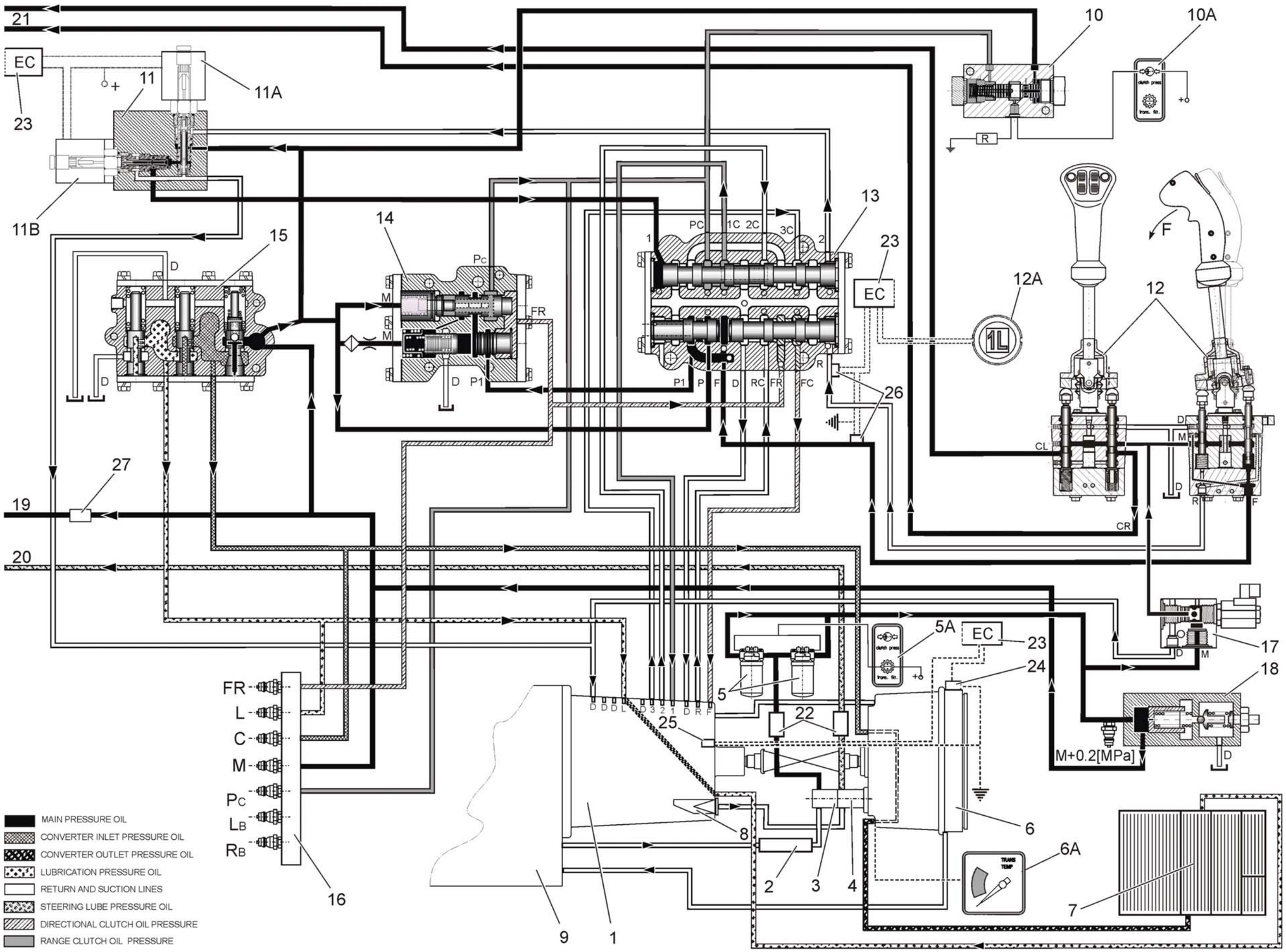

Fig. 7.2. Drive Train Hydraulic Oil Flow with Trans First Forward - TWO SPEED STEERING DRIVE

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HYDRAULIC OIL FLOW

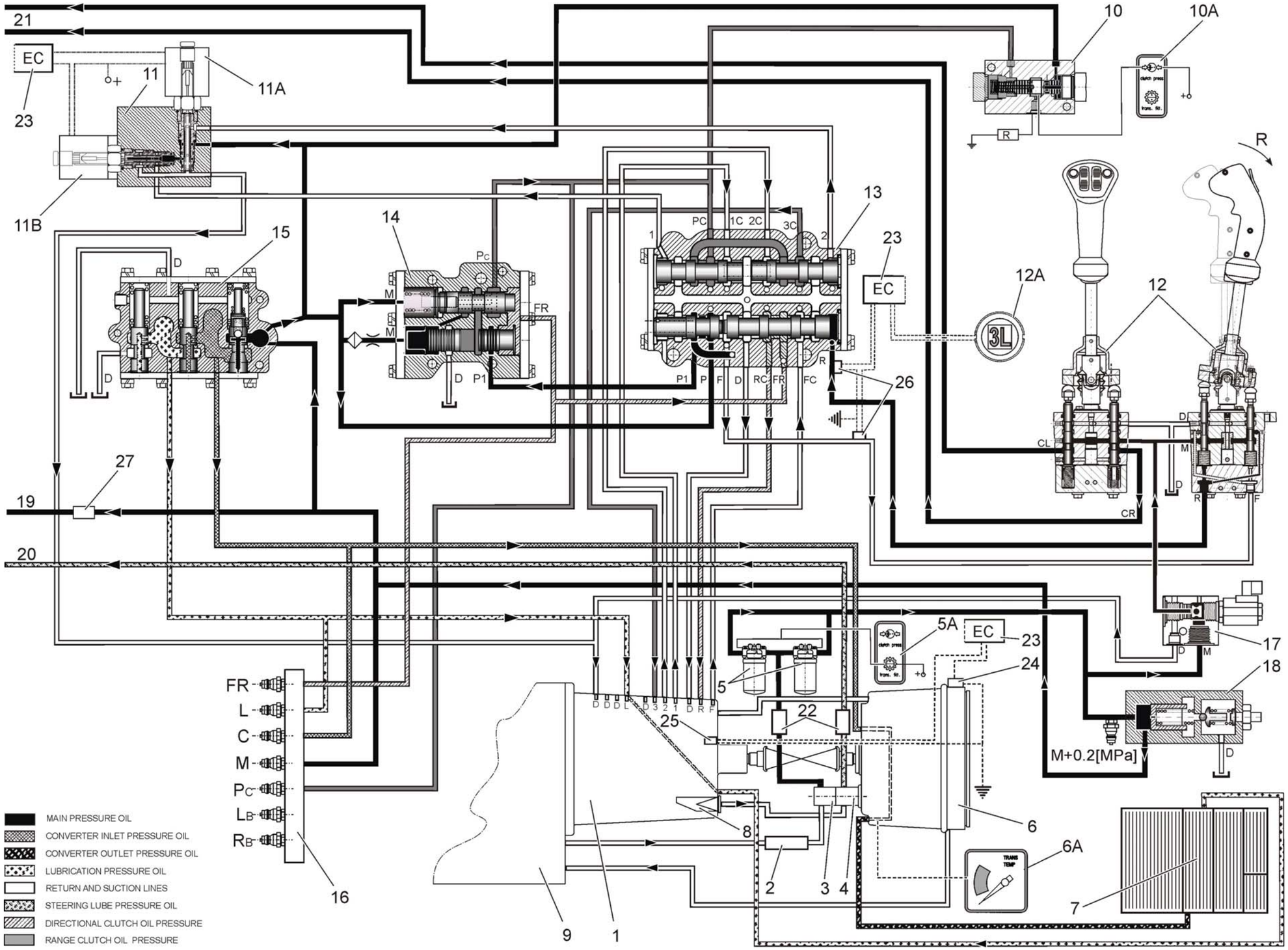

Fig. 7.3. Drive Train Hydraulic Oil Flow with Trans Third Reverse - TWO SPEED STEERING DRIVE

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6. TORQUE CONVERTER AND LUBRICATION OIL FLOW (Refer to Fig.'s 7.2 and 7.3)

Pressurized oil from the C port of middle torque converter section pressure regulator valve (15) is directed by hose to the inlet port of torque converter (6). After the pressurized oil is used for torque multiplication, it exits the torque converter at the outlet port and is directed by hose to the inlet port of oil cooler (7), which is located in one block of radiators.

The cooled oil from the outlet port of oil cooler (7) is regulated by the lubrication spool L in pressure regulator valve (15) and then directed to the transmission (1) for lubrication purpose.

Cooler outlet oil travels into the transmission clutches for clutches cooling and shafts lubrication.

This oil after cooling and lubrication of transmission collects in the transmission sump. From the bottom of transmission (1) is then scavenged by hose through an in-line oil strainer (8) and onto the scavenge element (4) of drive train charge and scavenge pump. From the scavenge pump element (4) of drive train pump outlet the oil is delivered through hydraulic damper (22) to the steering drive for internal lubrication purpose by line (20, Fig.'s 7.2 and 7.3). Then oil eventually drains back into the bottom of the main frame (9).

Leakage of oil from the torque converter (6) is gravity drained by hose from engine flywheel housing back to the main frame (9). For a more complete description and operation of the torque converter, refer to SECTION 7B, TORQUE CONVERTER.

7. STEERING SYSTEM OIL FLOW Refer to Fig.'s 7.4 to 7.6)

Pressurized oil M enters the inlet port of steering valve and is available for steering and braking. The pressurized oil at inlet port of steering valve housing in neutral position of spools allows pressurized oil from steering valve through the steering valve manifold and onto the drive and brake clutch packs in steering drive.

This steering drive M oil pressure functions on a range 1790 – 1930 [kPa]. The drive clutch packs are actuated on a range of 690 – 1930 [kPa] and the brake clutch packs are released on a range 620 – 1930 [kPa]. When the pressure is dissipated below 690 [kPa], the drive clutch packs release and then the brake clutch packs begin to engage when the pressure is dropping as hitherto.

When the drive train control lever is moved forward (rearward), oil pressure is directed to both the low range clutch packs and the brake clutch packs. When the low range clutch packs are engaged, it locks the sun gears of the inner planetary to the stationary steering drive housing. Power from the pinion shaft, transmitted through the bevel gear and ring gears, turns the planet gears which are forced to walk around the locked sun gears. This action causes the planet gears to rotate the planet carrier output shafts and sprocket drives.

When the drive train control lever is in forward (rearward) position and both the high speed range switches are toggled into HI position, oil pressure is directed to both the high range clutch packs and the brake clutch packs. When the high range clutch pack is engaged, the low range sun gear is unlocked, planets are rotating free. Power to the tracks is transmitted from the pinion shaft to the bevel gear, through the engaged drive clutch packs to the output shafts and on to the sprocket drives.

When the foot brake is applied, oil pressure to both brake clutch packs is released. As the pressure drops, springs engage both brakes simultaneously. However, the oil pressure to the drive clutch packs is not released and the torque converter does the slipping, the foot brake will hold the machine stationary with the transmission in second or third gear but not in first gear at high idle.

To make a left gradual turn, shift the right speed range switch to its upper (HI) position and shift the left speed range switch in its lower (LO) position during machine is moving forward or rearward. The electronic controller will select the left track to low range and the right track to high range.

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HYDRAULIC OIL FLOW

Power to the left track is transmitted from the pinion shaft to the bevel gear, thru the inner planetary, to the output shaft and out to the sprocket drive. Power to the right track is transmitted from the pinion shaft to the bevel gear and from high range clutch directly to the output shaft and sprocket drive. A right gradual turn is the opposite.

To make a left pivot turn, shift the drive train control lever in the full left position during machine is moving forward or rearward. The left track is stationary. Power to the right track is transmitted from the pinion shaft to the bevel gear, thru or without inner planetary to the output shaft and out to the sprocket drive. A right pivot turn is the opposite.

The two speed steering drive consists of two drive circuits for each side of the machine. The following describes the operation of both sides.

STARTING AND LOW RANGE STRAIGHT TRAVEL (Fig. 7.4).

When the dozer is started with both speed range switches in LO-LO positions, both tracks are in low speed range. Main pressure M from the transmission pressure regulator valve enters the upper valve clutches section LC and RC inlet ports, around the metering spools and on to the HI-LO sections. Here the oil is divided in two circuits, one to the foot brake FB and one to the HI-LO spools. At the foot brake FB released, the oil enters the inlet port around the foot brake spool and out to disengage the brake clutch packs LB and RB. The lower valve contains two HI – LO spools, one for each side of the machine. These spools are controlled by the high-low solenoids SOL. At the HI-LO spools in the LO position, the oil is directed by steering manifold J shifted to the right to engage the LO drive clutch packs.

GRADUAL TURN LEFT (Fig. 7.5).

When the drive train control lever is in drive position with the left speed range switch in its lower (LO) position and the right speed range switch in its upper (HI) position, the left side steering drive is working as described above, but on the right side high-low range solenoid SOL is energized. The solenoid direct pilot oil pressure to right side of HI-LO spool causing the HI-LO spool to shift to HI range. Oil pressure from the RC clutch section enters the spool bores and is directed out the HI range port. In this way the right LO clutch pack is released and the right HI clutch pack is engaged. The machine gradually turns left.

When both speed range switches are in HI-HI positions, both left and right high-low range solenoids SOL are energized. Both solenoids direct pilot oil to both HI-LO spools causing the HI-LO spools to shift to HI range. Oil pressure from the both clutch sections enters the spool bores and is directed out to the high range clutches.

PIVOT TURN RIGHT (Fig. 7.6)

When the drive train control lever is in drive position and it is slowly moved to the pivot position the metering spool in rear side of this clutch section of the valve begins to meter the main pressure to the drain annulus, thereby reducing the pressure at the RC clutch annulus which is connected to both the LO drive and RB brake clutch packs. As the pressure is reduced, the drive clutch pack releases first and next the brake clutch pack begins to engage. When the drive train control lever is moved completely to the right pivot position, the pilot pressure CR is dropping down and activates the metering spool, moving it forward and stops the main oil flow. Then all the pressure is completely dissipated to the drain annulus, from the right side of the drive and brake clutches. Machine is in a right brake condition. The machine pivots turn right.

For a more complete description and operation of the steering valve and the steering drive, refer to SECTION 7E.

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HYDRAULIC OIL FLOW

Legend for Fig.'s 7.5, 7.6 and 7.7.

M	- Main Pressure
CR	- Brake Clutch (Right) Pilot Pressure
CL	- Brake Clutch (Left) Pilot Pressure
LC	- Left Clutch Section
RC	- Right Clutch Section
HI-LO	- High-Low Range Section
SOL	- HI-LO Range Solenoid
SEQ	- Sequence Valve Cartridge
FB	- Foot Brake Section
EC (23)	- Drive Train Electronic Controller
J	- Steering Manifold
SD	- Steering Drive

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HYDRAULIC OIL FLOW

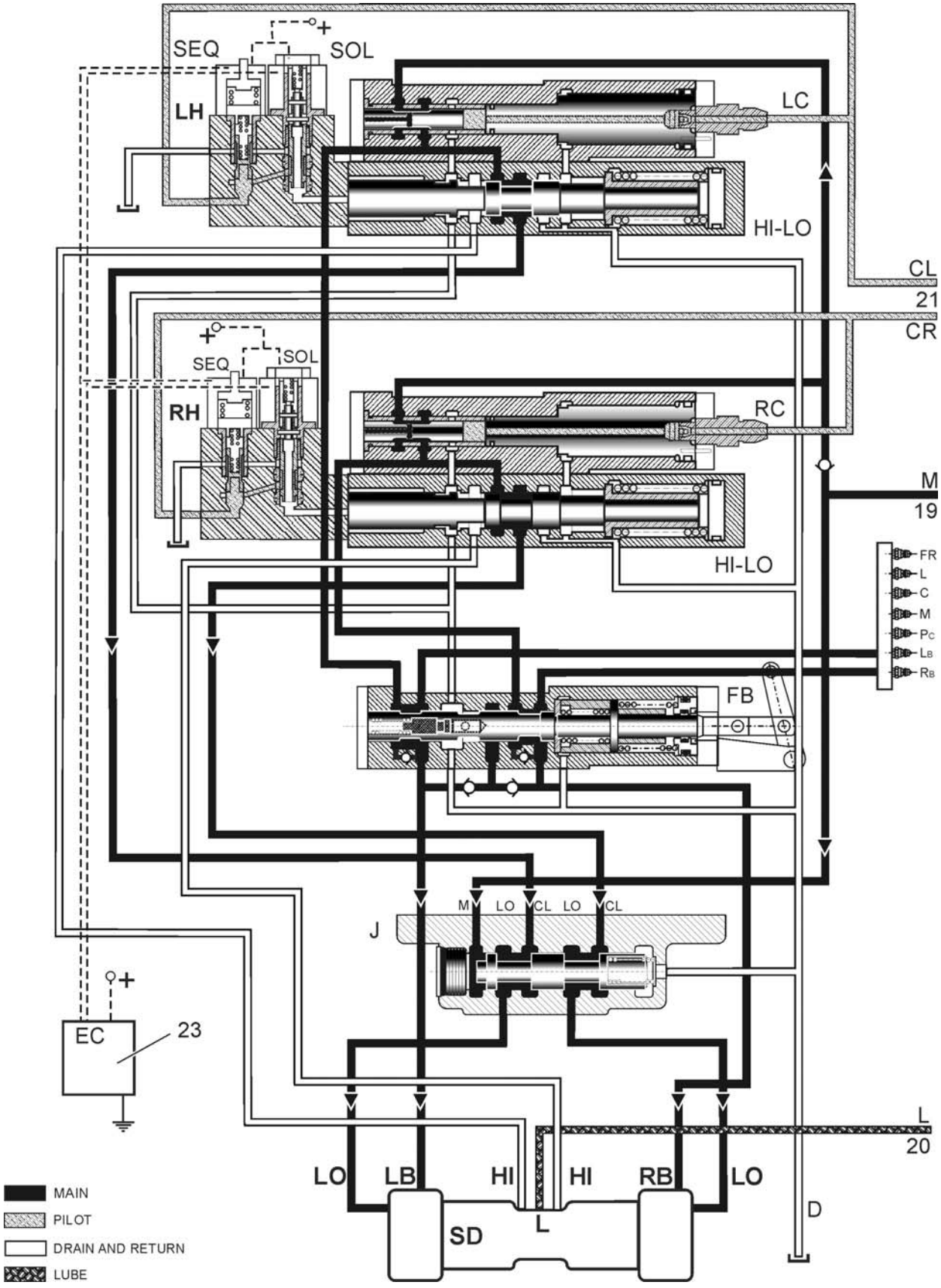

Fig. 7.4. Starting and LO Range Straight Travel

TWO SPEED STEERING DRIVE

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HYDRAULIC OIL FLOW

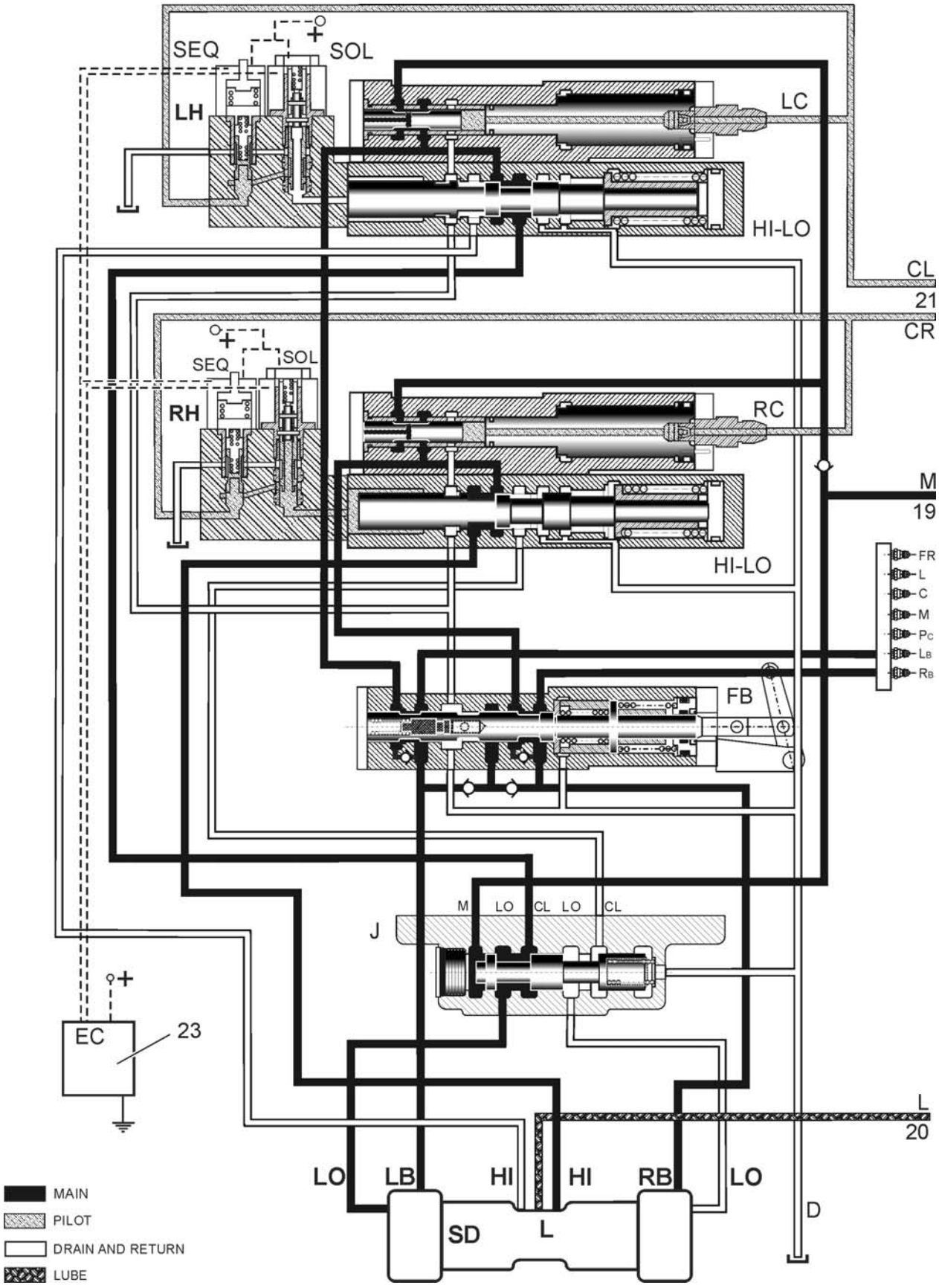

Fig. 7.5. Gradual Left Turn

TWO SPEED STEERING DRIVE

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HYDRAULIC OIL FLOW

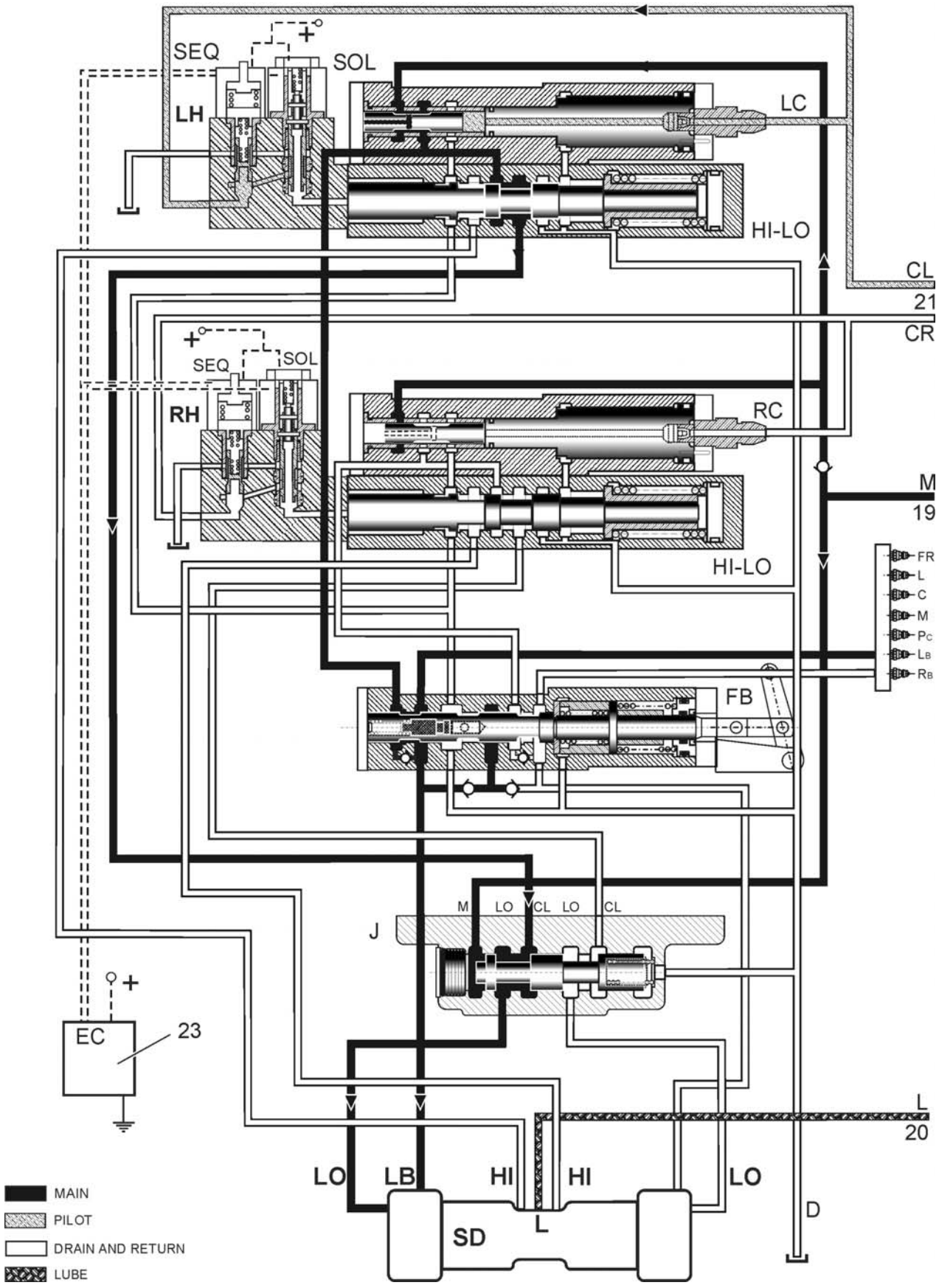

Fig. 7.6. Pivot Turn Right

TWO SPEED STEERING DRIVE

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SERVICE DIAGNOSIS

8. TROUBLE SHOOTING

COMPLAINT	
PROBABLE CAUSE	**REMEDY**
Main Low Pressure and Clutch Low Oil Pressure Warning Light Glows Red (Drive Train Control Lever in Neutral, Engine Run, Oil Worm)	
1. Low main pressure	Refer to DIAGNOSTIC CHART in Par. 10, below.
2. Pressure switch malfunction	Check and replace switch.
3. Switching valve malfunction	Check valve. Repair or replace.
Clutch Low Oil Pressure Warning Light Glows Red (Drive Train Control Lever in Forward or Reverse, Engine Run, Oil Worm)	
1. Low pressure at gear	Refer to DIAGNOSTIC CHART in Par. 10, below.
No Gear/Direction Engagement	
1. Low main and/or gear pressure	Refer to “Main Low Pressure and/or Clutch Low Oil Pressure Warning Light Glows Red” above
High Torque Converter Oil Temperature (Gauge on Instrument Panel)	
1. Low main frame oil level	Check according to OPERATOR’S MANUAL.
2. Temperature gauge or sensor malfunction	Replace gauge or sensor.
3. Operating too long in low efficiency ranges	Review operating instructions in OPERATOR’S MANUAL.
4. Clogged oil cooler	Clean according to OPERATOR’S MANUAL.
5. Clogged drive train suction filter	Remove and clean.
6. Leakage on suction line	Check suction line for tightness
7. Transmission problem	Check transmission temperature and clutches oil pressure. Refer to DIAGNOSTIC CHART in Par. 10, below.
8. Torque converter oil leakage excessive	Refer to SECTION 7B, TORQUE CONVERTER.
9. Clogged or restricted torque converter oil line (T.C. oil pressure O.K.)	Clean and check for correct routing.
10. Steering drive or brake clutches damaged	Refer to DIAGNOSTIC CHART in Par. 10, below.
Loss of Power under Load	
1. Low oil level	Check oil level in rear frame and fill as necessary.
2. Engine not up to rated performance	Perform stall speed test. Refer to Par. 11.
3. Low transmission clutches oil pressures	Check oil pressures. Refer to Par. 10, TRANSMISSION AND TORQUE CONVERTER OIL PRESSURE TEST.
4. Transmission oil level too high	Check operation and condition of scavenge circuit.
5. Slipping clutch packs in transmission and/or steering drive	Refer to Par. 12, DRIVE TRAIN CLUTCH TEST.
6. Excessive torque converter oil leakage	Refer to SECTION 7B, TORQUE CONVERTER.

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SERVICE DIAGNOSIS

COMPLAINT	
PROBABLE CAUSE	**REMEDY**
Slow or Erratic Transmission Clutch Engagement	
1. Low transmission oil pressures	Check oil pressures. Refer to Par. 10, TRANSMISSION AND TORQUE CONVERTER OIL PRESSURE TEST.
2. Rate of rise valve malfunction	Check valve and screen under valve. Install new valve housing gasket.
3. Range selector valve malfunction	Check valve. Repair or replace.
No 2nd and/or 3rd Gear Engagement	
1. Electrical or electronic system malfunction	Refer to SECTION 8, ELECTRICAL
Erratic Operation in Preselection or Self-Reduction Gear Mode	
1. Electrical or electronic system malfunction	Refer to SECTION 8, ELECTRICAL

9. SPECIFICATIONS

Charge and Scavenge Pump

Type . . . . . gear, dual element
Capacities @ 2094 engine rpm:
Front (scavenge) section . . . . . 275 l/min
Rear (charge) section . . . . . 206 l/min

Transmission Test Oil Pressures

Main oil pressure (M) . . . . . 1790 – 1930 [kPa]
Torque converter inlet oil pressure (C):
In neutral . . . . . 790 - 930 [kPa]
In gear . . . . . 790 - 930 [kPa]
Lubrication oil pressure (L):
In neutral . . . . . 280 - 450 [kPa]
In gear . . . . . 240 - 350 [kPa]
Transmission forward and reverse clutch oil pressures (FR):
In neutral . . . . . 0 [kPa]
In gear . . . . . Main (M) minus 0 – 70 [kPa]
Transmission first, second and third speed clutch oil pressures:
In neutral . . . . . 0 [kPa]
In gear . . . . . Main (M) minus 100 – 170 [kPa]

Steering Test Oil Pressures

Main oil pressure (M) . . . . . 1790 – 1930 [kPa]
Right or left drive clutch . . . . . Main (M) minus 0 – 35 [kPa]
Right or left brake clutch . . . . . Main (M) minus 0 – 35 [kPa]

Torque Converter

Stall Speed:
Converter only . . . . . 1680 – 1820 [RPM]
Converter and hydraulic . . . . . 1520 – 1680 [RPM]

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SERVICE DIAGNOSIS

10. TRANSMISSION AND TORQUE CONVERTER OIL PRESSURE TEST (Refer to Fig. 7.7)

WARNING! Be sure the area around the machine is clear of personnel and obstructions as the vehicle may move during these tests. If the machine starts to move, fully depress the decelerator pedal and shift the drive train control lever to NEUTRAL.

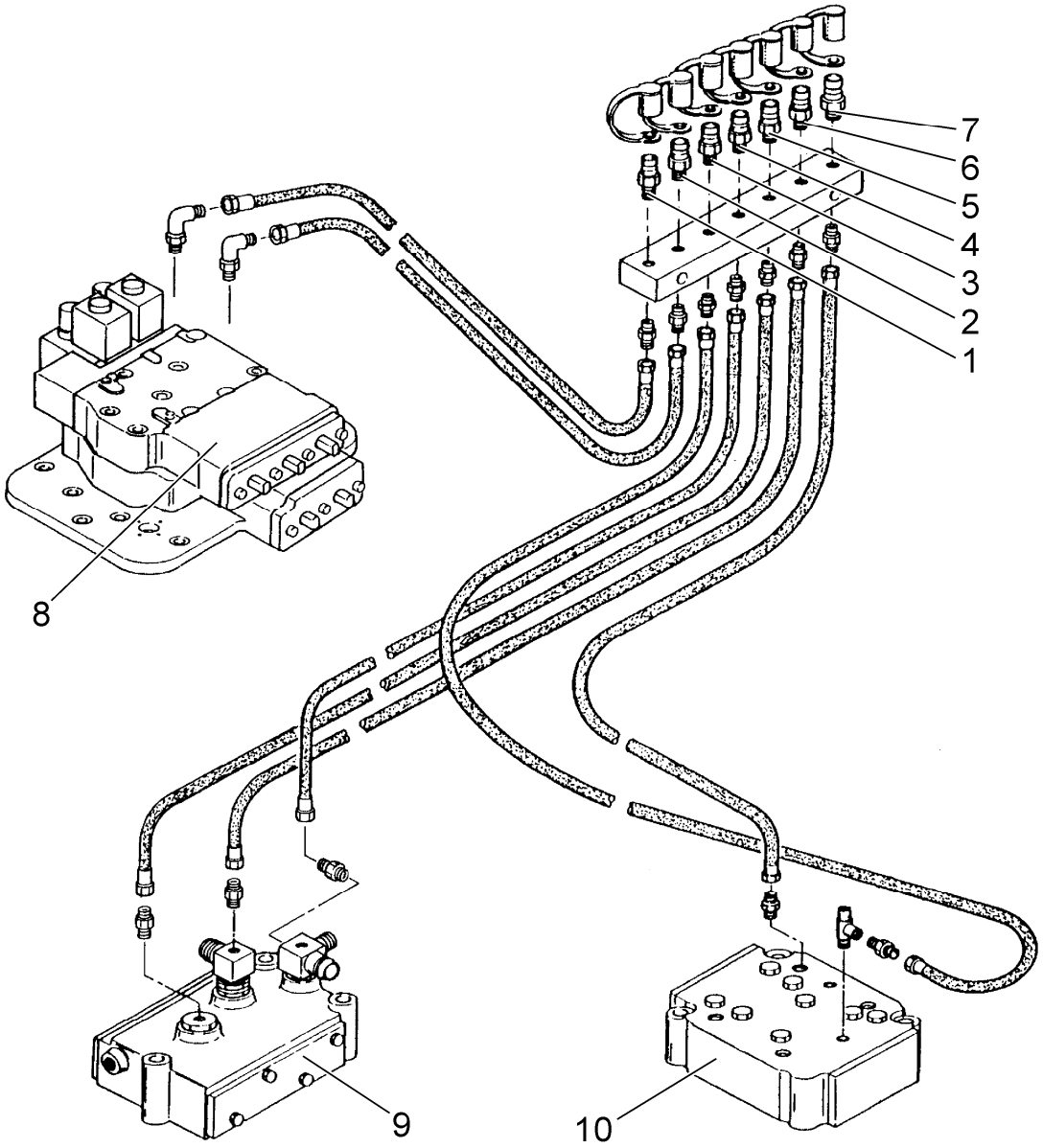

Fig. 7.7. Pressure Gauge Connect Points

1. Right Brake (RB)
2. Left Brake (LB)
3. Range Clutch (PC)
4. Main (M)
5. Converter (C)
6. Lubrication (L)
7. Directional Clutch (FR)
8. Two Speed Steering Valve
9. Pressure Regulator Valve
10. Range Selector Valve

1. Open the door at the left hand side of the platform. Remove the protective covers from quick disconnect fittings and connect the Test Pressure Gauges Kit (refer to SERVICE /SPECIAL TOOLS) to the pressure regulator valve (quick disc. fittings 4, 5 and 6) and range selector valve (quick disc. fittings 3 and 7) ports shown in Fig. 7.7.

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SERVICE DIAGNOSIS

NOTE: *Tag each test gauge to avoid confusion when performing these checks.*

NOTE: *The following pressure checks should be performed with the engine running at full throttle and oil at operating temperature. To obtain operating temperature, shift to third forward with the foot brake applied until the temperature gauge pointer reaches the high side. Then shift to neutral until the temperature gauge pointer drops to the midpoint. Repeat this procedure until the midpoint will be in green range*

Transmission and Torque Converter Test Oil Pressure Chart

GEAR RANGE	TEST PORT DESCRIPTION (All readings are given in [kPa])				
	MAIN (M)	TORQUE CONV. (C)	LUBE (L)(*)	RANGE CLUTCH (PC)	DIRECT CLUTCH (FR)
Neutral	1790 - 1930	790 - 930	280 - 450	0	0
Forward First	1790 - 1930	790 - 930	240 - 350	M minus 100 - 170	M minus 0 - 70
Forward Second	1790 - 1930	790 - 930	240 - 350	M minus 100 - 170	M minus 0 - 70
Forward Third	1790 - 1930	790 - 930	240 - 350	M minus 100 - 170	M minus 0 - 70
Reverse First	1790 - 1930	790 - 930	240 - 350	M minus 100 - 170	M minus 0 - 70
Reverse Second	1790 - 1930	790 - 930	240 - 350	M minus 100 - 170	M minus 0 - 70
Reverse Third	1790 - 1930	790 - 930	240 - 350	M minus 100 - 170	M minus 0 - 70

NOTE: *With the engine running at low idle the M, PC and FR pressure readings are slightly less than those shown in the above chart. However C and L pressure readings are much lower than those shown in the above chart with the same conditions.*

(*) **IMPORTANT:** *Additionally measure the L pressure with the engine running at low idle. Never operate the machine, if the L pressure reading is 0.0 [kPa].*

WARNING! Be sure the area around the machine is clear of personnel and obstructions as the vehicle may move during these tests. If the machine starts to move, fully depress the decelerator pedal and shift the drive train control lever to NEUTRAL.

2. With the drive train control lever in neutral, brake pedal is applied and the engine running at high idle, observe the readings of the pressure test gauges. The readings should be the pressures as shown in the above chart. Fully depress the decelerator pedal.

   With the engine running at low idle, steering in low (high) range, shift the drive train neutral lock lever to its unlocked position and the drive train control lever into transmission forward first and slowly release the decelerator pedal, machine is moving. With the engine running at high idle, shift the transmission through second and third forward gear range, steering both low and high range, machine stands still. Observe the readings of the pressure test gauges. The readings should be the pressures as shown in the above chart. Oil pressures should increase and decrease rapidly when engaging and disengaging clutch packs. Fully depress the decelerator pedal and shift the transmission in neutral.

   Repeat this step for each transmission reverse gear range.

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3. Shift the drive train control lever into neutral and move the drive train neutral lock lever to ON position. Place the engine speed control lever in the low idle position and stop the engine.
4. If the readings are within these ranges with the oil at operating temperature, proceed with STEERING SYSTEM OIL PRESSURE CHECK, Par. 13 in this Section.
5. If the readings are not within these ranges with the oil at operating temperature, refer to the following diagnostic chart.

Transmission and Torque Converter Diagnostic Chart

PROBLEM	PROBABLE CAUSE
1. Low main oil pressure	a. Low oil level in rear frame. Refer to OPERATOR'S MANUAL. b. Clogged suction oil filter. Refer to OPERATOR'S MANUAL. c. Leaking pump inlet lines. d. Fatigued or broken main spool springs in regulator valve. e. Incorrect number of shims at main spool in pressure regulator valve. Each shim changes the pressure by approximately 35 [kPa]. DO NOT use more than a total three shims. f. Safety check ball or spring in pressure regulator valve malfunction. g. Steering system leaking. Perform STEERING SYSTEM SUPPLY PRESSURE TEST described in this Section. h. Defective rear section of pump.
2. High main oil pressure	a. Main regulator spool stuck. b. Incorrect priority valve adjustment after repairing or replacement.
3. Low torque converter oil pressure	a. Low main oil pressure. Refer to problem 1 above. b. Clogged suction oil filter. Refer to OPERATOR'S MANUAL. c. Leaking pump inlet lines. d. Stuck converter spool in pressure regulator valve. e. Fatigued or broken converter spool spring in pressure regulator valve. f. Incorrect number of shims at converter spool in pressure regulator valve. Each shim changes the pressure by approximately 25 [kPa]. DO NOT use more than a total three shims. g. Internal leak in converter. Check sleeve hub and output shaft seal rings. h. Defective rear section of pump.
4. High torque converter oil pressure.	a. Restricted or blocked oil passage or line. b. Restricted oil cooler.
5. Low transmission lubrication oil pressure.	a. Low torque converter oil pressure. Refer to problem 3 above. b. Fatigued or broken lubrication spool spring in pressure regulator valve. c. Stuck lubrication spool in pressure regulator valve. d. Incorrect number of shims at lube spool in pressure regulator valve. Each shim changes the pressure by approximately 7 [kPa]. DO NOT use more than a total three shims.

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SERVICE DIAGNOSIS

PROBLEM	PROBABLE CAUSE
6. Low or zero, each (FR) directional and (PC) range clutch oil pressure.	a. Low main oil pressure. Refer to problem 1 above. b. No or low signal oil pressure from drive train control valve. Tee in a 3000 [kPa] test pressure gauge at the **F** or **R** port on the range selector valve and check for oil pressure. If low, repair or replace the drive train control valve. c. Stuck switch spool in range selector valve. d. Rate of rise valve damaged. e. Screen under rate of rise valve clogged.
7. Low or zero pressure at both forward and reverse clutch	a. Leaking manifold seal ring between F and R gear on input shaft. Perform “Five Penny” Test described in this Section.
8. Low or zero pressure at both 2nd and 1st or 1st and 3rd	a. Leaking manifold seal ring gear on output shaft (between 2 and 1 or 1 and 3). Check manifold and seal rings condition; refer to SECTION 7C, TRANSMISSION. b. Perform “Five Penny” Test described in this Section.
9. Low or zero one of F or R clutch pressure	a. No or low signal oil pressure from drive train control valve. Tee in a 3000 [kPa] test pressure gauge at the F or R port on the range selector valve and check for oil pressure. b. Range selector valve directional spool damaged. c. Leaking one of manifold outside seal gear (F, R) on input shaft. Perform Five Penny Test described in this Section. d. Leaking one of directional clutch pack. Perform Five Penny Test described in this Section.
10. Low or zero one of 1st, 2nd or 3rd clutch pressure	a. Faulty solenoid valve on gear shifting valve (2nd or 3rd). b. Range selector valve range spool damaged. c. Leaking one of outside manifold seals on output shaft (for 2nd or 3rd gear only). Check manifold and seal rings condition; refer to SECTION 7C, TRANSMISSION. d. Perform “Five Penny” Test described in this Section.

11. TORQUE CONVERTER STALL SPEED CHECK

WARNING! Be sure the area around the machine is clear of personnel and obstructions as the machine may move during this check.

1. Use the Digital Optical Tachometer (refer to SERVICE /SPECIAL TOOLS in this Section).
2. With the engine speed at full throttle and the foot brake applied, shift the transmission into third forward and record the stall speed RPM.
3. If the stall speed meets specifications, proceed with Par. 12, DRIVE TRAIN CLUTCH TEST.
4. If the stall speed does not meet specifications, refer to the following chart.

Torque Converter Stall Speed Chart

PROBLEM	PROBABLE CAUSE
1. Stall speed too high	a. Engine injection pump defective or improperly adjusted. b. Refer to Par. 12, DRIVE TRAIN CLUTCH TEST.
2. Stall speed too low	a. Too low engine power. Refer to ENGINE REPAIR MANUAL.

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SERVICE DIAGNOSIS

12. DRIVE TRAIN CLUTCH TEST

NOTE: *Before performing the drive train clutch test, the drive train oil pressures should be checked. Refer to Par. 10, TRANSMISSION AND TORQUE CONVERTER OIL PRESSURE TEST and to Par. 13, STEERING SYSTEM OIL PRESSURE CHECK in this Section.*

WARNING! Be sure the area around the machine is clear of personnel and obstructions as the machine may move during this test. If the machine starts to move, fully depress the decelerator pedal and shift the transmission to NEUTRAL. Do not hold the machine in a stall condition for more than ten seconds after the pointer of the converter oil temperature gauge is within the RUN range.

1. Apply the brake pedal and lock it. Remove the front center floor plate in the operator's platform.
2. Start the engine. Place the engine speed control lever in the high idle position and depress the decelerator pedal to decrease the engine speed. Move the drive train neutral lock lever to the OFF position.
3. Shift the drive train control lever into forward second gear range with the steering drive in the high range and in low range clutch engagement position; gradually release the decelerator pedal and check for drive shaft rotation. With the engine running at high idle, shift the transmission into forward third gear range and again, check for drive shaft and final drive sprocket rotation.
4. Fully depress the decelerator pedal and shift the transmission into reverse third gear range. Gradually release the decelerator pedal and again, check for drive shaft and final drive sprocket rotation.
5. Fully depress the decelerator pedal and shift transmission into neutral. Move the drive train neutral lock lever to the ON position. Place the engine speed control lever in the low idle position and release the decelerator pedal. Stop the engine.
6. If the drive shaft and final drive sprocket did NOT rotate, the operational condition of the drive train clutches is satisfactory, with the possible exception of a slipping first gear range clutch in the transmission.
7. If the drive shaft and/or final drive sprocket did rotate, refer to the following diagnostic chart.
8. Reinstall the front center floor plate in the operator's platform.

Drive Train Clutch Diagnostic Chart

PROBLEM	PROBABLE CAUSE
1. Final drive sprocket stationary and drive shaft turns in all transmission gear ranges in LO or HI range	Slipping LO or HI drive clutches in steering drive.
2. Final drive sprocket stationary and drive shaft turns in forward and reverse second gear range only	Slipping second gear range clutch in transmission.
3. Final drive sprocket stationary and drive shaft turns in forward and reverse third gear ranges	Slipping third gear range clutch in transmission.
4. Final drive sprocket stationary and drive shaft turns in forward third gear range but not in reverse third	Slipping forward directional clutch in transmission.
5. Final drive sprocket stationary and drive shaft turns in reverse third gear range but not in forward third	Slipping reverse directional clutch in transmission.
6. Final drive sprocket rotates	Slipping brake clutch in steering drive.

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13. STEERING SYSTEM OIL PRESSURE CHECK

1. Stop the engine and open the door at the left hand side of the platform.
2. Connect the Test Pressure Gauges Kit (refer to SERVICE /SPECIAL TOOLS in this Section) to right and left brake quick disconnect fittings (1 and 2, Fig. 7.7) on the diagnostic center and to the RC and LC test ports (1 and 3, Fig. 7.8) on the steering valve. Tag each test gauge with the corresponding description to avoid confusion when performing these checks.

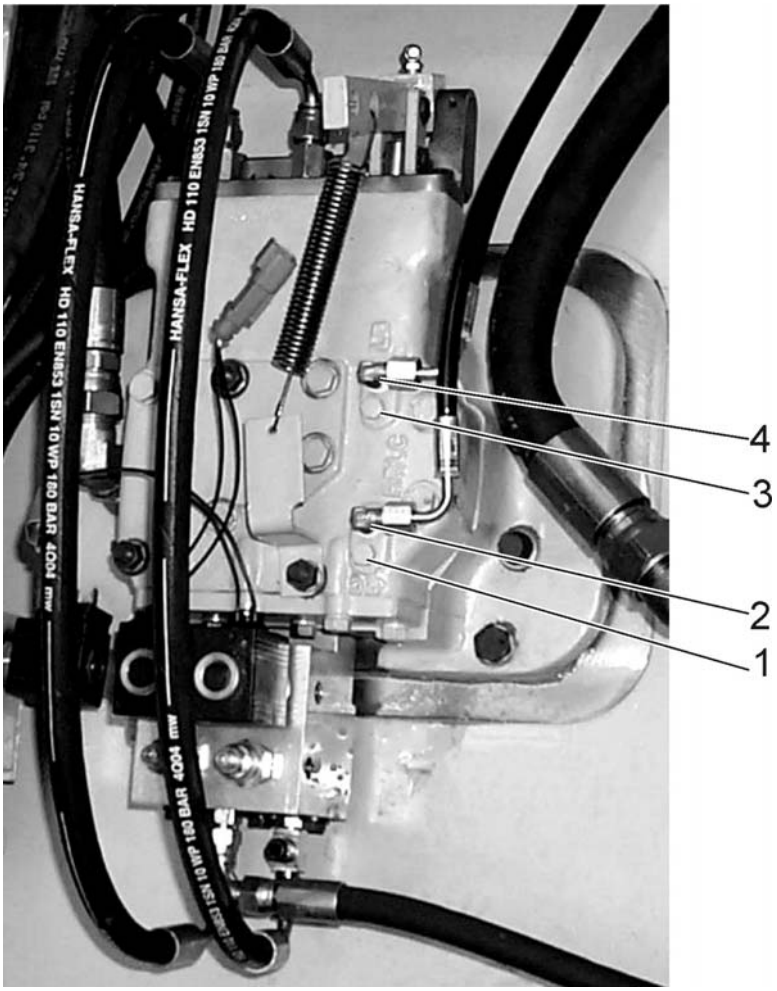

Fig. 7.8. Pressure Gauge Connect Points

1. Right Clutch (RC)
2. Right Brake (RB)
3. Left Clutch (LC)
4. Left Brake (LB)

NOTE: *The following pressure checks should be performed with the engine running at full throttle and oil at operating temperature. To obtain operating temperature shift to third forward with the foot brake applied until the temperature gauge pointer reaches the high side. Then shift to neutral until the temperature gauge pointer drops to the midpoint. Repeat this procedure until the midpoint will be in green range.*

3. Run the engine at full throttle and check the gauge readings with those in the following chart.

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SERVICE DIAGNOSIS

Steering System Test Oil Pressure Chart

DRIVE TRAIN CONTROL LEVER OR BUTTONS POSITIONS AND BRAKE PEDAL POSITIONS	TEST PORT DESCRIPTION				
	MAIN [kPa]	LH CLUTCH [kPa]	LH BRAKE [kPa]	RH CLUTCH [kPa]	RH BRAKE [kPa]
1. Both tracks in low range clutch engagement (both LO/HI range switches in their lower position). Control lever in neutral.	1790 - 1930	Main minus 0 - 35	Main minus 0 - 35	Main minus 0 – 35	Main minus 0 - 35
2. Both tracks in high range clutch engagement (both LO/HI range switches in their upper position). Control lever in neutral.	1790 - 1930	Main minus 0 - 35	Main minus 0 - 35	Main minus 0 – 35	Main minus 0 - 35
3. Left track in low range clutch engagement and right track in pivot or brake (both LO/HI range switches in their lower position). Control lever fully shifted to the right.	1790 - 1930	Main minus 0 - 35	Main minus 0 - 35	0 (%)	0 (%)
4. Left track in low range clutch engagement and right track at feel point (both LO/HI range switches in their lower position). Initial movement of the control lever to the right.	1790 - 1930	Main minus 0 - 35	Main minus 0 - 35	590 – 760 (%)	590 - 760 (%)
5. Left track in pivot or brake and right track in low range clutch engagement (both LO/HI range switches in their lower position). Control lever fully shifted to the left.	1790 - 1930	0 (%)	0 (%)	Main minus 0 – 35	Main minus 0 - 35
6. Left track at feel point and right track in low range clutch engagement (both LO/HI range switches in their lower position). Initial movement of the control lever to the left.	1790 - 1930	590 - 760 (%)	590 - 760 (%)	Main minus 0 – 35	Main minus 0 - 35
7. Both tracks in low range clutch engagement (both LO/HI range switches in their lower position). Control lever in neutral and foot brake pedal fully applied.	1790 - 1930	Main minus 0 - 35	0 (#)	Main minus 0 – 35	0 (#)
8. Both tracks in low range clutch engagement (both LO/HI range switches in their lower position). Control lever in neutral and foot brake pedal at feel point.	1790 - 1930	Main minus 0 - 35	450 - 520	Main minus 0 – 35	450 - 520

(%) - Oil pressure drop should be gradual with control lever movement.
(#) - Oil pressure drop should be gradual with brake pedal movement.

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SERVICE DIAGNOSIS

Steering Drive Diagnostic Chart

PROBLEM	PROBABLE CAUSE
1. No clutch and brake pressures.	a. Low main pressure. Refer to “Transmission and Torque Converter Diagnostic Chart” above.
2. Low or zero right or left clutch pressure with drive train control lever in low range.	a. RH or LH hose in rear main frame leaking. b. RH or LH low range piston seal ring leaking. c. Steering valve gasket leaking.
3. Low or zero right or left clutch and brake pressure with drive train control lever in low and high range.	a. RH or LH metering spool in upper steering valve seized. b. Steering valve gasket leaking.
4. Low or zero right or left clutch pressure with drive train control lever in high range.	a. RH or LH hose in rear frame leaking. b. RH or LH solenoid valve or sequence valve faulty. c. Steering valve gasket leaking. d. High range piston seal rings leaking.
5. Low or zero right or left brake pressure.	a. RH or LH hose in rear main frame leaking. b. Brake piston seal ring leaking.

14. STEERING SYSTEM FUNCTIONAL CHECK

Before performing the steering system function check, the steering valve pressures must be checked. Refer to Paragraph 13, STEERING SYSTEM OIL PRESSURE CHECK.

With machine on level and hard ground and with the Test Pressure Gauges Kit (refer to SERVICE /SPECIAL TOOLS in this Section) still connected to right and left brake quick disconnect fittings on the diagnostic center and to the RC and LC test ports on the steering valve (Refer to Step 2, in Paragraph 13 of this Section) start the engine. Set the engine speed at low idle, engage the transmission in third forward and proceed as follows:

Brake Release and Engagement Pressure Check

1. Hold the drive train control lever fully shifted to the left in the LH brake position.
2. Increase the engine speed until the RH track begins to creep.
3. Apply the foot brake slowly and record the RB brake clutch pressure (gauge connected to RB on the diagnostic center) when the track stops creeping.
4. Slowly release the foot brake and record the RB brake clutch pressure (gauge connected to RB on the diagnostic center) when the track begins to creep.
5. Repeat steps 1 through 4 for the LB brake clutch by actuating the foot brake with the drive train control lever fully shifted to the right in the RH brake position and record the LB brake clutch pressure (gauge connected to LB on the diagnostic center).
6. The pressures obtained should be between 550 – 690 [kPa].

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15. TRANSMISSION “FIVE PENNY” DIAGNOSTIC TEST

This test is designed to assist in the diagnosis of a problem with the machine transmission and to help determine if the transmission needs to be removed and disassembled or if the problem is in the hydraulic components which are external to the transmission assembly.

If there is complaint of low pressure or slippage in the transmission, pressure test should be performed and pressures of all circuits must be recorded for future comparisons; refer to TRANSMISSION AND TORQUE CONVERTER OIL PRESSURE TEST in this Section. If the pressure test shows that there is low pressure in one or more circuits, then “Five Penny” Test may be done.

“Five Penny” Test Procedure

1. Remove the range selector valve; refer to RANGE SELECTOR VALVE in TRANSMISSION, SECTION 7C.

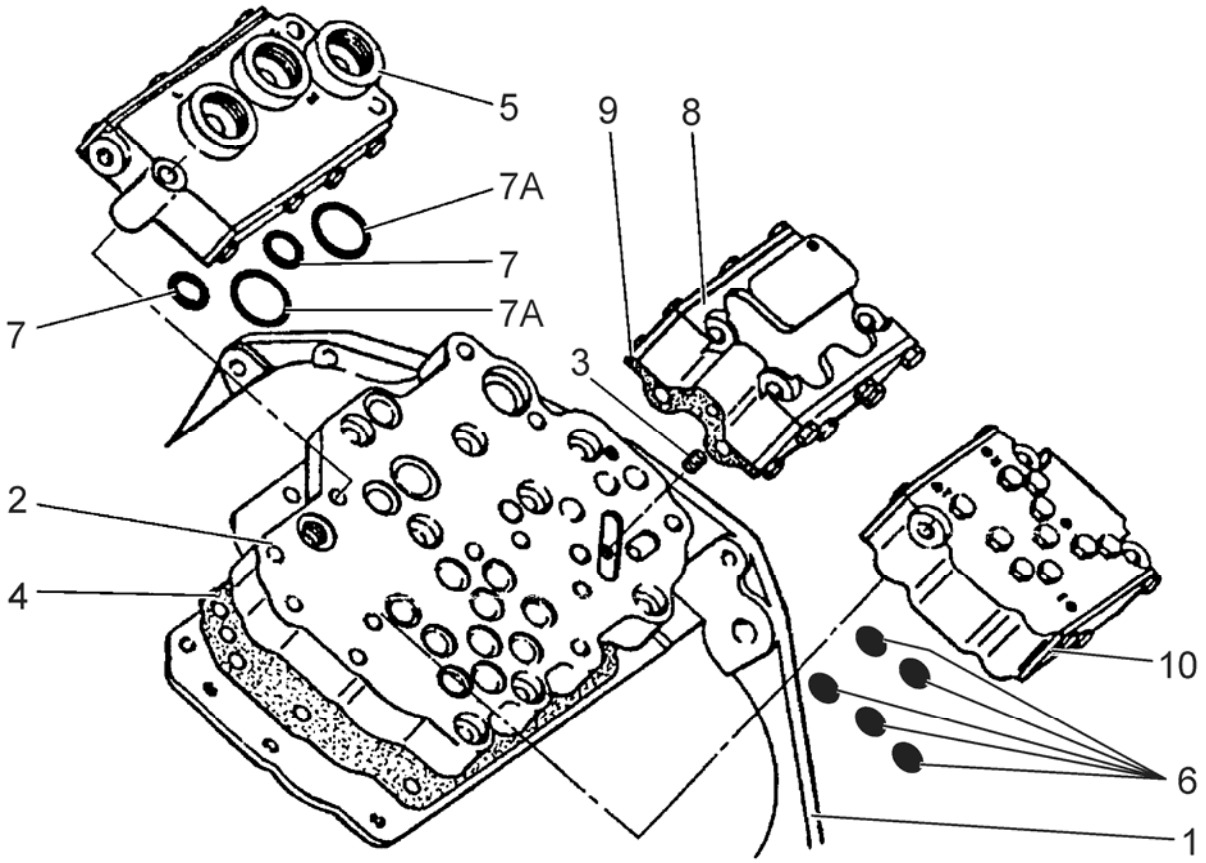

Fig. 7.9. Pennies (Disks) Placing on the Underside of the Range Selector Valve

1. Transmission Assy
2. Transmission Manifold
3. Orifice Strainer
4. Manifold Gasket
5. Pressure Regulator Valve
6. Penny Coins (or Small Disks ϕ 21.3 [mm] dia. and 2 [mm] thick)
7. O-Ring
7A. O-Ring
8. Rate of Rise Valve
9. Rate of Rise Valve Gasket
10. Range Selector Valve

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2. Use pennies (or small metal disks having ϕ 21.3 [mm] and 2 [mm] in diameter and thickness respectively) (6, Fig. 7.9) and place them over the ports for FC, RC, 1C, 2C, 3C on the underside of the range selector valve (10) (the US penny will just fit inside transmission manifold (2) ports O-rings, so they will be held in place). Reinstall the valve and tighten it down, with coins (or metal disks) in place. This effectively shuts off any flow to the clutch packs so no clutch engagement is possible, but the lube flow is not interrupted, so there is no danger of damage to the transmission during this test.
3. Start the engine and take all drive train pressures again. The pressures should be taken in all ranges and in both directions; refer to TRANSMISSION AND TORQUE CONVERTER OIL PRESSURE TEST in this Section. Shut off the engine.
4. If the pressures which were low on the first test are NOW correct , the problem is internal to the transmission and it will have to be removed and repaired (for more details refer to Transmission and Torque Converter Diagnostic Chart in this Section).
5. If the pressures are still low, the problem is outside of transmission, probably in the transmission valves.
6. Remove the pennies or metal disks; reinstall the range selector valve with O-rings, refer to RANGE SELECTOR VALVE in TRANSMISSION, SECTION 7C.

16. STEERING SYSTEM SUPPLY PRESSURE TEST

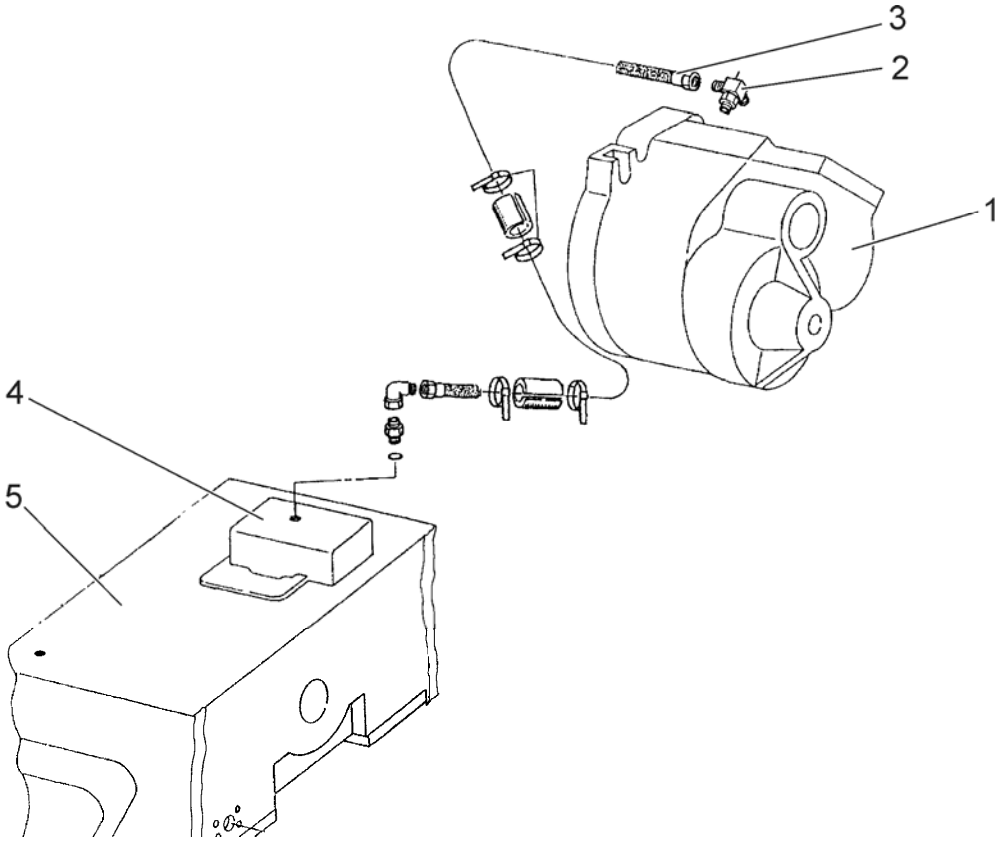

Fig. 7.10. Steering System Supply Pressure Test

1. Transmission
2. Hydraulic Tee
3. Steering Valve Supply Hose
4. Steering Valve
5. Rear Main Frame

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1. If main pressure M, supplying the steering valve, is low, disconnect supply hose (3, Fig. 7.10) from the pressure regulator valve and plug the tee (2), to ensure that the M pressure is not connected to any leakage in the steering system.
2. Start the engine and take the M main pressure again. Refer to TRANSMISSION AND TORQUE CONVERTER OIL PRESSURE TEST in this Section. Shut off the engine.
3. If the pressures is correct with the steering valve blocked and incorrect with the steering valve connected, then the steering system needs to be further checked. Refer to STEERING SYSTEM OIL PRESSURE CHECK in this Section.
4. Remove plug from the tee (2) and reconnect supply hose (3) to the pressure regulator valve.

17. PRIORITY VALVE PRESSURE CHECK AND ADJUSTMENT PROCEDURE

The priority valve is located at the machine L.H. side, under the drive train system filters, behind the diagnostic center (see Fig. 7.11).

The valve is not under normal diagnostic procedure. In case of valve repair or replacement check the pressure and adjust it if needed. Refer to procedures described below.

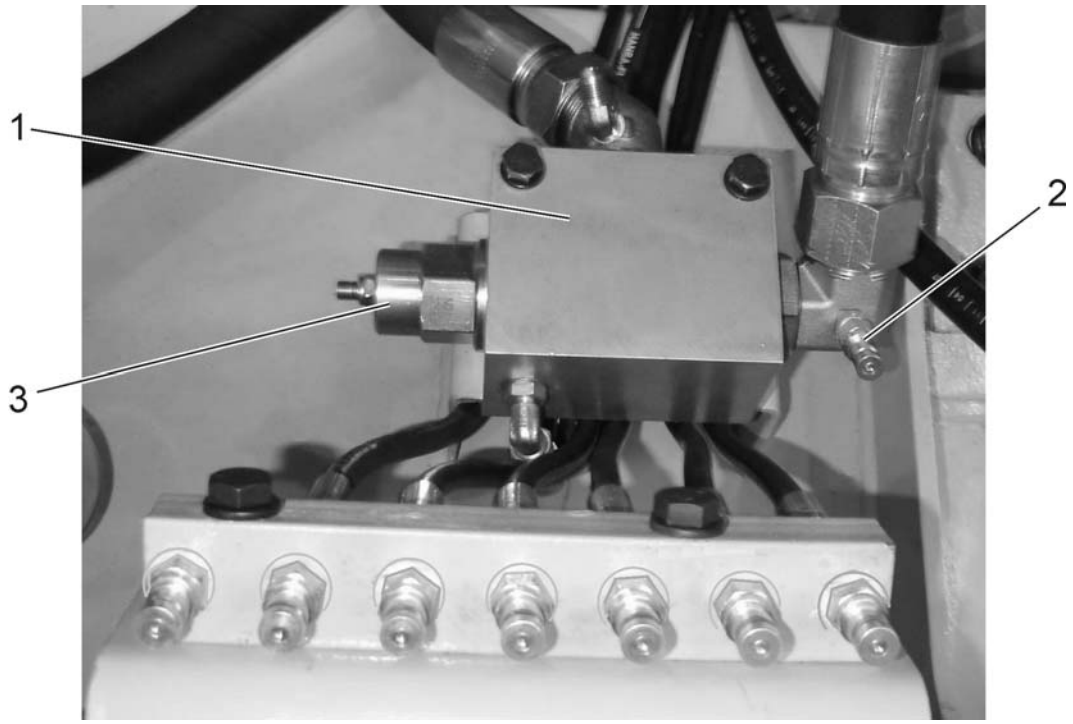

Fig. 7.11. Pressure Gauge Connect Point

1. Priority Valve
2. Quick Disconnect Fitting
3. Priority Valve Pressure Regulator

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SERVICE DIAGNOSIS

Priority Valve Pressure Check

The check is to be carried out at the engine maximum RPM.

1. Check the “M” pressure at the diagnostic center of the drive system, refer to **Transmission And Torque Converter Oil Pressure Chart** in this SECTION.
2. Remove the protective cap from quick disconnect fitting (2, Fig. 7.11) mounted in the elbow at the priority valve (1).
3. Connect the pressure gauge (refer to SERVICE /SPECIAL TOOLS in this Section) to the quick disconnect fitting (2) and take pressure. The pressure gauge is to register “M” + 0.2 [MPa].
4. If the pressure taken is outside the specifications, the priority valve pressure regulator (3) calls for adjustment. Refer to **Priority Valve Pressure Adjustment Procedure** below.
5. Disconnect the pressure gauge and restore the protective cap.

Priority Valve Pressure Adjustment Procedure

The check is to be carried out at the engine maximum RPM.

1. Connect the pressure gauge and check priority valve pressure as described in **Priority Valve Pressure Check** above.
2. To adjust priority valve pressure regulator (2, Fig.7.12), loosen the counter nut (4) and turn the adjusting screw (3) to get the specified pressure (refer to **Priority Valve Pressure Check** procedure above).
3. Tighten the counter nut (4) to the pressure regulator (2) after adjustment. Recheck the priority valve pressure and disconnect the pressure gauge.

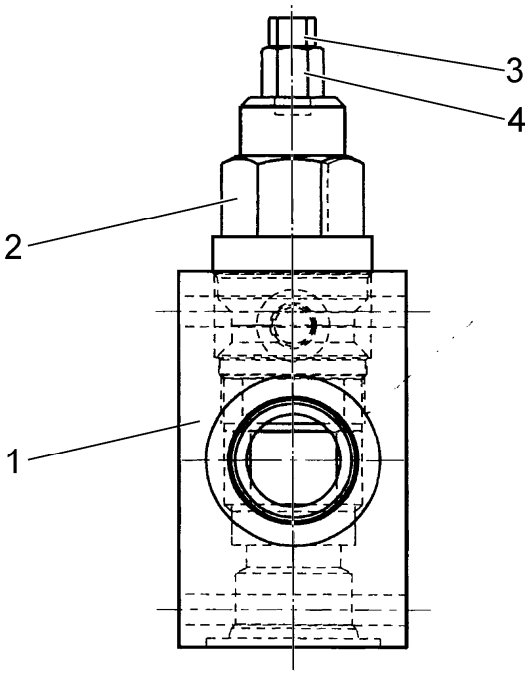

Fig. 7.12. Pressure Gauge Connect Point

1. Priority Valve
2. Priority Valve Pressure Regulator
3. Adjusting Screw
4. Counter Nut

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SECTION 7B

HYDRAULIC TORQUE CONVERTER

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HYDRAULIC TORQUE CONVERTER SECTION 7B

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SERVICE /SPECIAL TOOLS

1. SERVICE /SPECIAL TOOLS

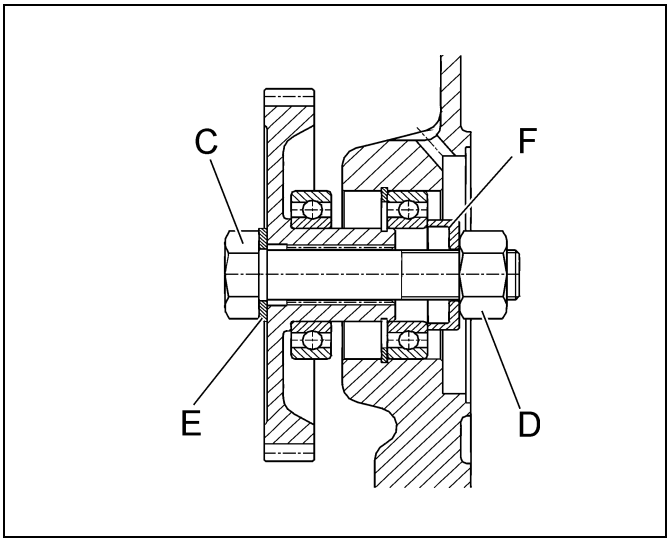
TOOL FOR DRIVEN GEAR MOUNTING

C – Bolt M24 x 130 – 8.8-B-Fe/Zn5
601-02-2629-6-02

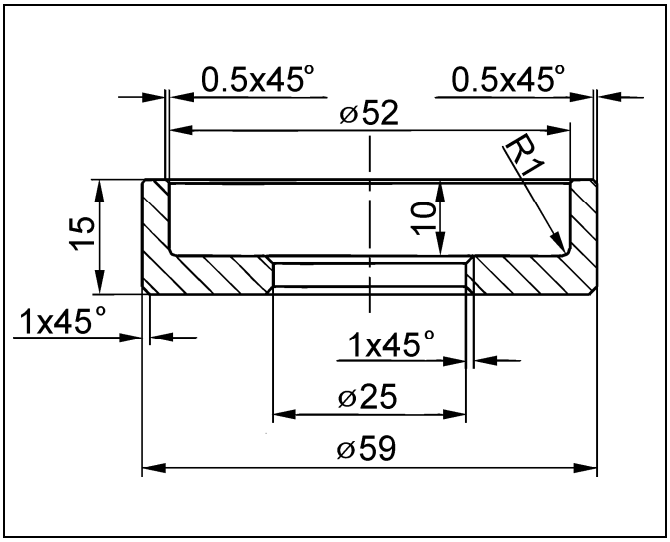
D – Nut M24-5-B-Fe/Zn5
603-01-2262-0-02

E – Round Washer A-25.8
612-48-1170-0-02

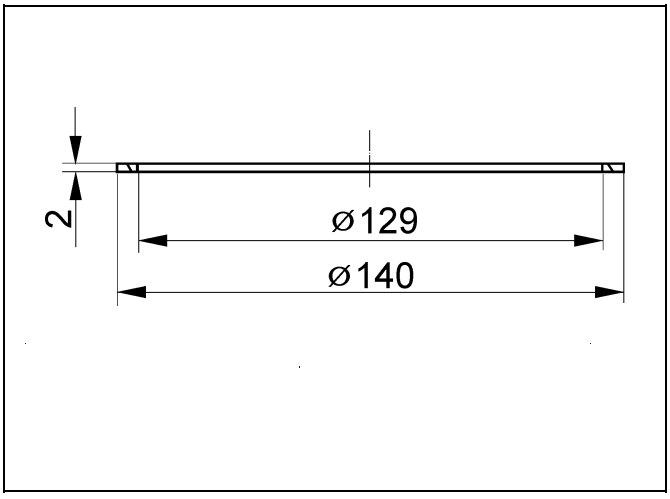
F – Special Washer (per Drawing)



SPECIAL WASHER (F)



TOOL FOR HOUSING COVER BEARING SEATING (WASHER G)



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HYDRAULIC TORQUE CONVERTER

GENERAL

2. DESCRIPTION AND OPERATION (Refer to Fig.'s 7B.1 and 7B.2)

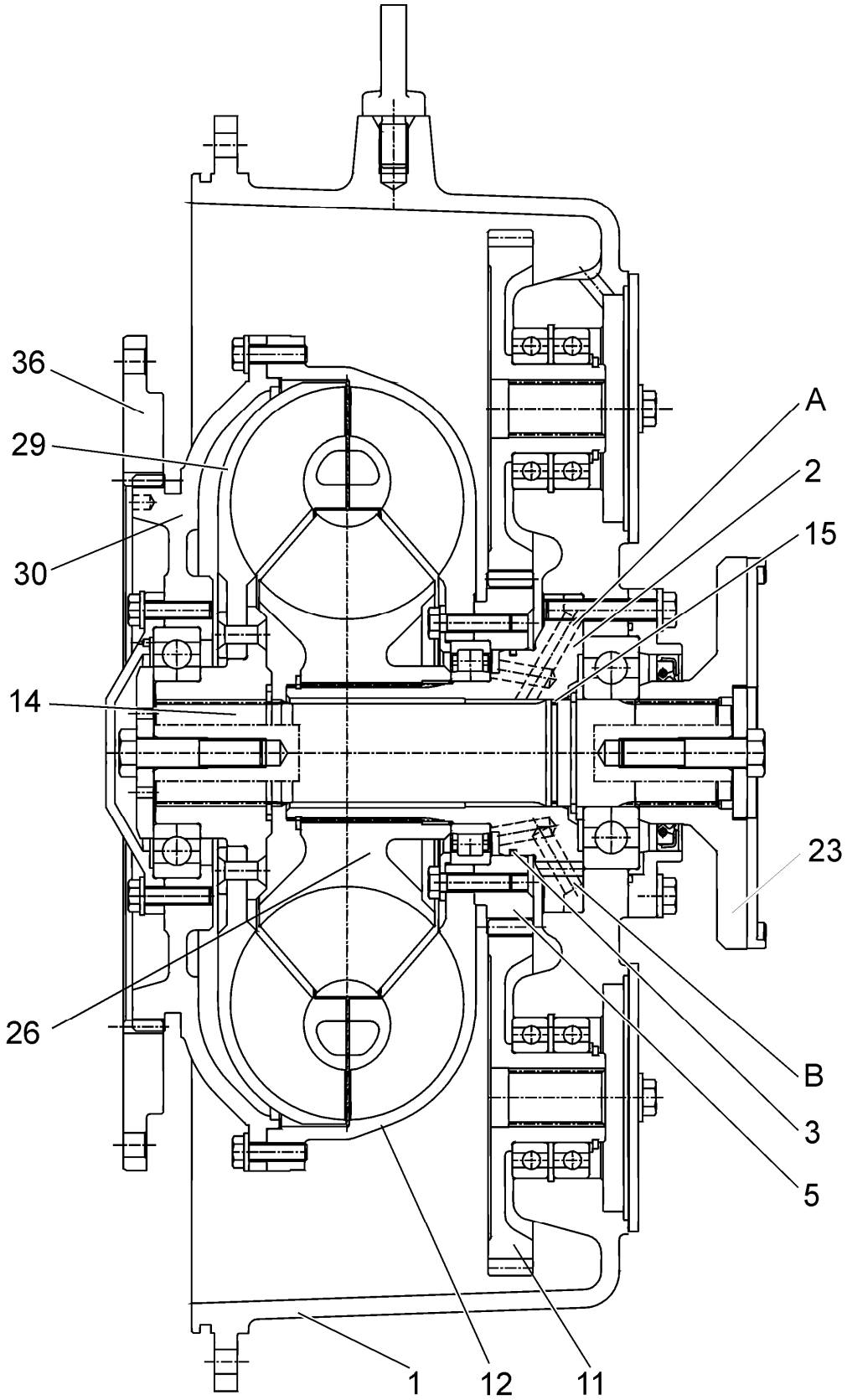

Fig. 7B.1. Cross Section View of Torque Converter

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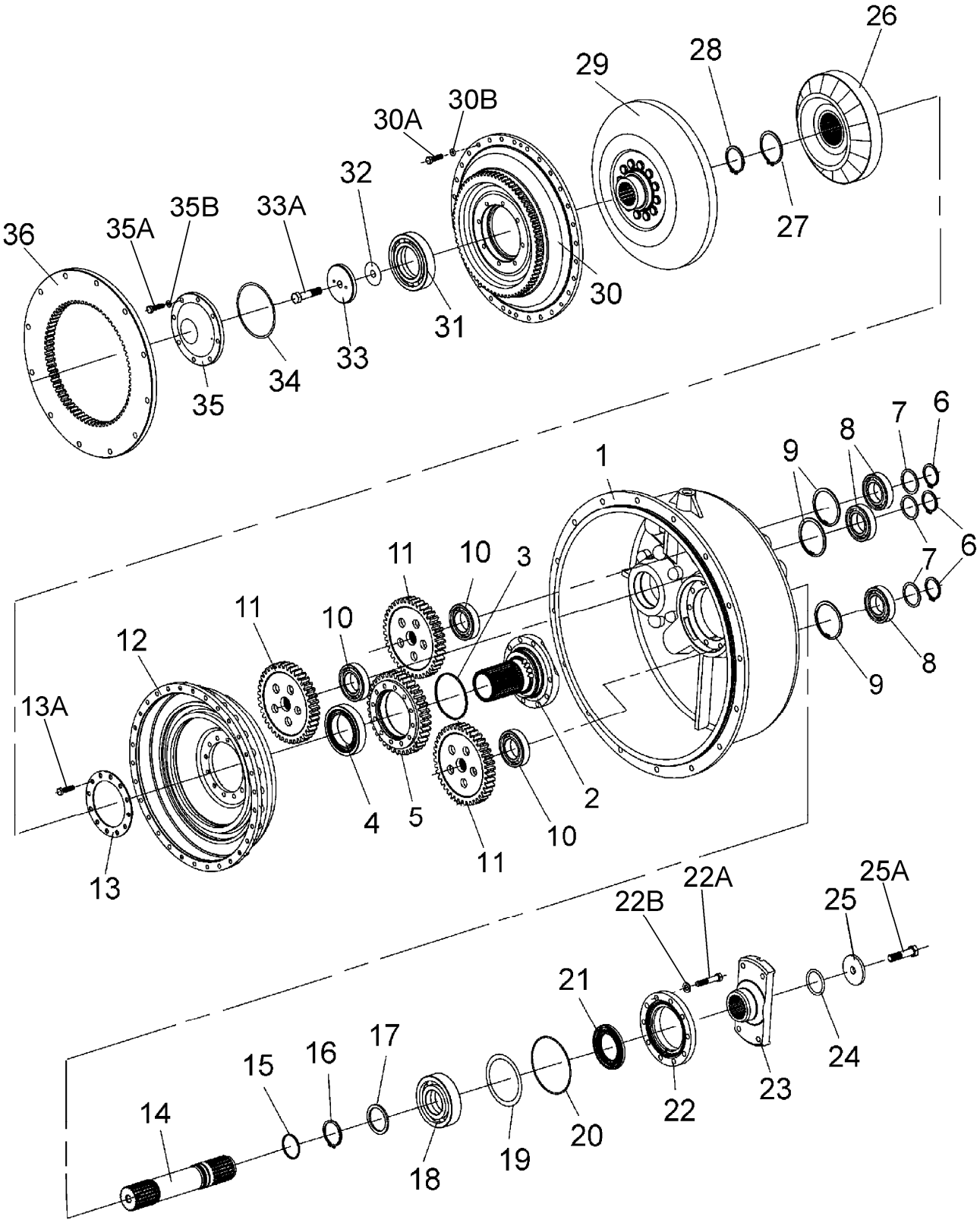

Fig. 7B.2. Exploded View of Tor

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HYDRAULIC TORQUE CONVERTER

GENERAL

Legend for Fig.'s 7B.1 and 7B.2

1. Converter Housing
2. Ground Sleeve Hub
3. Seal Ring
4. Roller Bearing
5. Drive Gear
6. Retaining Ring
7. Spacer Washer
8. Ball Bearing
9. Retaining Ring
10. Ball Bearing
11. Driven Gear
12. Impeller
13. Thrust Washer
13A. Bolt
14. Output Shaft
15. Seal Ring
16. Retaining Ring
17. Spacer Washer
18. Ball/Single Row Bearing
19. Shims
20. O-Ring
21. Seal Ring
22. Rear Cover
22A. Bolt
22B. Washer
23. Output Flange
24. O-Ring
25. Thrust Washer
25A. Bolt
26. Stator
27. Retaining Ring
28. Retaining Ring
29. Turbine Assy
30. Drive Housing
30A. Bolt
30B. Washer
31. Ball/Single Row Bearing
32. Shims
33. Thrust Washer
33A. Bolt
34. Shims
35. Housing Cover
35A. Bolt
35B. Washer
36. Gear Ring

A – TC Oil Outlet
B – TC Oil Inlet

This machine is equipped with a single stage, single phase torque converter, bolted directly to the engine flywheel housing. The torque converter automatically varies the output required at the tracks to meet the changing load requirements of the machine. Engine power is transferred by the converter with little change in torque when the load is light. When a heavy load is encountered, the torque multiplication becomes greater, but with a resulting loss of machine speed. It is important to note that the converter does not increase engine horsepower, but does increase the amount of torque available at the tracks.

Converter housing (1) is flange-mounted to the machine engine. Engine power is transferred through drive housing (30) driven by the engine flywheel. Impeller (12) bolted to drive housing (30) drives drive gear (5), which, in turn, drives gear pumps through driven gears (11) that supply oil both to machine drive train and its hydraulic equipment. Turbine assy (29) is splined to the output shaft (14) on one hand and there is the output flange (23) splined to the output shaft (14) on the other hand. The stator (26) is mounted between the impeller and turbine assy splined to the stationary ground sleeve hub (2). There is no direct mechanical connection between the impeller and turbine or stator.

Operating engine turns bladed impeller (12) bolted to drive housing (30). At the same time external gear pump is powered from the engine and supplies oil to impeller blades. The impeller draws fluid from the opening surrounding the hub and ejects it from its blades at high velocity. The turbine (29) is positioned opposite the impeller and its blades receive the full impact of this velocity. Oil exits from the turbine in the opposite direction of rotation from that of the impeller. The turbine divides the oil flow between converter discharge passage as one oil stream, while the other oil stream impacts stator (26) blades, giving a surplus torque charging the turbine (29). The curved blades of the stator (26) re-directs the flow back to the impeller in the same direction as the impeller is moving, completing the cycle. This constant gain in energy of impeller flow oil and stator reaction torque increase the energy received by the turbine with the result of torque multiplication at output shaft (14) and output flange (23) of the torque converter.

Torque multiplication is determined by the speed of the turbine in relation to the impeller. A ball thrown at a paddle will strike it with more force if the paddle is stationary than it will if the paddle is moving in the same direction as the ball. Similarly, when the turbine (29) is rotating as fast as the impeller (12), the oil passes easily through the turbine applying little or no force to the blades. As the output shaft slows down, the fluid strikes the turbine blades with more force. The maximum striking force of the fluid is reached when the turbine is stopped. This occurs in the machine when the output shaft is stalled by a heavy load.

Seal rings (3) and (15) at oil inlet and outlet, respectively separate oil high pressure chamber from the other torque converter work volume. These seal rings and their condition are crucial to torque converter leakage rate and consequently, torque converter loss rate and its efficiency.

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GENERAL

3. SPECIFICATIONS

Torque converter weight . . . . . 170 [kG]
Torque converter admissible leakage rate . . . . . 3 - 7 [lpm]
Torque converter stall speed:
Converter only . . . . . 1680 – 1820 [RPM]
Converter and hydraulic . . . . . 1520 – 1680 [RPM]

Special Bolt Torque Data

NOTE: *Torques given are for bolts and nuts lubricated with SAE-30 engine oil.*

Impeller to drive gear mounting bolts . . . . . 48 - 58 [Nm]
Impeller to drive housing mounting bolts . . . . . 41 - 51 [Nm]
Housing cover to drive housing mounting bolts . . . . . 48 - 58 [Nm]
Rear cover and ground sleeve hub to housing mounting bolts . . . . . 72 - 88 [Nm]
Output flange thrust washer mounting bolt . . . . . 83 - 101 [Nm]
Bearing thrust washer mounting bolt . . . . . 83 - 101 [Nm]
Gear ring to flywheel mounting bolts . . . . . 83 - 101 [Nm]
Universal joint mounting bolts . . . . . 136 [Nm]
Torque converter mounting bolts . . . . . 110 [Nm]

4. SERVICE DIAGNOSIS

COMPLAINT	
PROBABLE CAUSE	**REMEDY**
Loss of Oil from Torque Converter	
Leaking connections	Operate the engine at part throttle and inspect all lines and connections for leaks. Tighten or replace parts as necessary.
Leaking converter	Check all the bolts and nuts and gasket joints while the system is under pressure. Replace parts if necessary.
a). Converter rear	Replace leaking broken seal rings: at rear cover or O-ring at output flange.
b). Converter front or through cranking motor	Replace O-ring at housing or cranking motor.
Grinding or Scraping Noise Inside Converter Housing	
Bearing failure allowing the turbine or impeller blades to strike the fixed stator	Replace bearings, turbine, impeller and stator as necessary.
High Torque Converter Oil Temperature (Gauge on Instrument Panel)	
See SERVICE DIAGNOSIS in SECTION 7	
Loss of Power	
See SERVICE DIAGNOSIS in SECTION 7	

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5. TORQUE CONVERTER INTERNAL LEAKAGE TEST (Refer to Fig. 7B.3)

NOTE: *The following oil leakage check should be performed with the engine running at full throttle and oil at operating temperature. To obtain operating temperature, shift to third forward with the foot brake applied until the temperature gauge pointer reaches the high side. Then shift to neutral until the temperature gauge pointer stops. Repeat this procedure until the moment that the gauge pointer, on dropping, stops at the green zone.*

1. Shift the drive train control lever to the NEUTRAL and move the drive train lock lever to ON position. Turn the electrical master switch to the OFF position and take out of the key from the master switch to prevent accidental starting.

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

2. Remove the transmission case guard from the bottom of the machine.

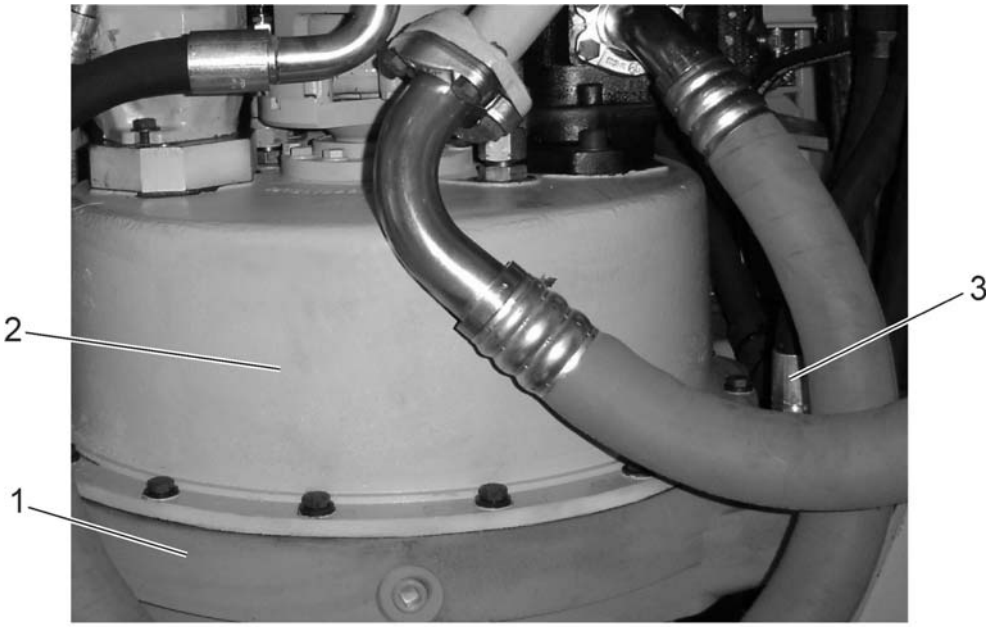

Fig. 7B.3. Drain Hose End Disconnecting (Bottom View)

1. Engine Flywheel Housing
2. Torque Converter
3. Torque Converter Drain Hose

3. Disconnect the torque converter drain hose end (3) from the engine flywheel housing (1). Cap the hole of the hose end (3).
4. Take the disconnected hose end (3) out of the machine. Connect new hose to the flywheel housing hole and put it in a separate container. Turn the electric master switch ON and start the engine with the drive train control lever in NEUTRAL position and drive train control lock lever in locked (ON) position.

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GENERAL

5. Operate the engine at full throttle and be filling the container for 30 seconds, omitting the initial, stronger oil flow-out.
6. Stop the engine and turn the electric master switch OFF. Disconnect the hose from flywheel housing (1). Reconnect the drain hose end (3) to the engine flywheel housing (1). Reinstall transmission case guard to the bottom of the machine.
7. Carry out a measurement of the drained oil.

   A. If volume of oil is less than 3.5 [l] (7 [l], per minute), the internal leakage of torque converter is allowable.

   B. If volume of oil is more than 3.5 [l] (7 [l], per minute), the internal leakage of torque converter exceed the limit. The torque converter should be removed from the machine and repaired.

TORQUE CONVERTER

6. REMOVAL

IMPORTANT: *Before removing the torque converter perform diagnostics of failures according to the description in Paragraph 4 in this SECTION, and check for oil leaks according to Paragraph 5 in this SECTION, so as to be sure that the disassembly torque converter is advisable.*

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic caps. If these caps are not available, tape or clean rubber corks may be used. Hydraulic openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components of the machine. Also tag all disconnected lines to facilitate correct and easier installation.*

1. Turn the master switch to the OFF position and take out the key.
2. Remove the transmission case guard from the bottom of the machine. Drain the equipment hydraulic reservoir as described in the OPERATOR'S MANUAL.
3. Remove the ROPS/FOPS structure (if equipped), cab and platform. Refer to SECTION 13 for this procedure.
4. Disconnect the breather hose (5, Fig. 7B.4) from the torque converter (6).
5. Remove the equipment pump (1). Refer to SECTION 10A for removing procedure.
6. Disconnect the electrical harness (4) from the torque converter oil temperature sensors (2). Disconnect the oil cooler hose (6) from torque converter tee connector. Remove the tee connector with torque converter oil temperature sensors (2) from the torque converter (7).
7. Remove the charge and scavenge pump (8). Refer to SECTION 7C for this procedure.
8. Remove the fan drive pump (3). Refer to SECTION 10A for this procedure.

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HYDRAULIC TORQUE CONVERTER

TORQUE CONVERTER

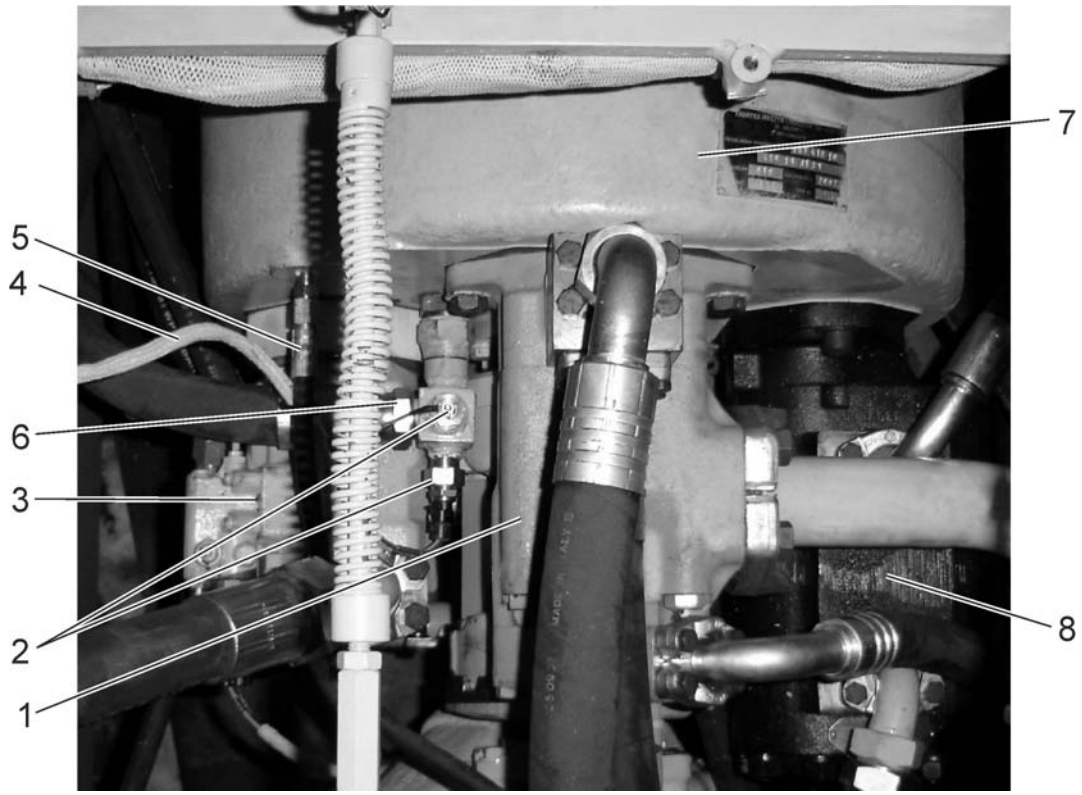

Fig. 7B.4. Upper Torque Converter Disconnecting Points

1. Hydraulic Equipment Pump
2. Torque Converter Oil Temperature Sensors
3. Fan Drive Pump
4. Electrical Harness
5. Torque Converter Breather Hose
6. Oil Cooler Hose
7. Torque Converter
8. Charge and Scavenge Pump

9. Disconnect torque converter supply hose (7, Fig. 7B.5) from the torque converter (2).
10. Disconnect torque converter drain hose (8) from the flywheel housing.
11. Disconnect the scavenge suction tube (5) and transmission lube inlet hose (3) from transmission.

NOTE: *Before removing the universal joint, wire the bearing cap to prevent bearings from falling off the spider trunnion.*

12. Remove the universal joint (4) between the torque converter and transmission:
    a. Unscrew four bolts connecting the joint to the torque converter flange.
    b. Unscrew four bolts connecting the joint to the transmission flange.

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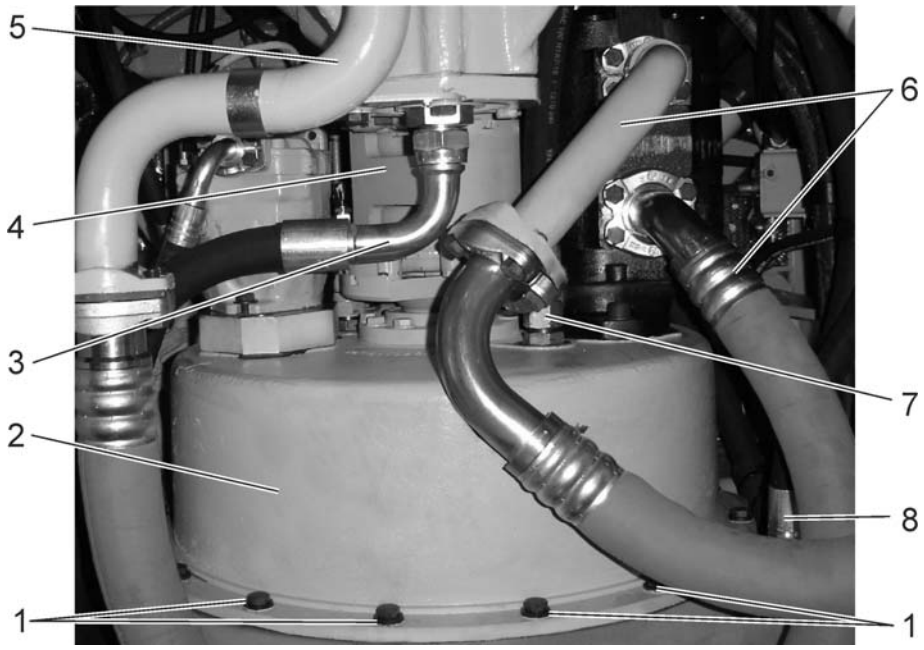

Fig. 7B.5. Lower Torque Converter Disconnecting Points

1. Mounting Bolts
2. Torque Converter
3. Transmission Lube Inlet Hose
4. Universal Joint
5. Scavenge Suction Tube
6. Charge and Scavenge Pump Outlet Hoses
7. Torque Converter Supply Hose
8. Torque Converter Drain Hose

13. Remove two bolts (1) securing converter housing to flywheel housing at 2 and 10 o'clock positions and replace with aligning studs 1/2″ - 13 of 100 to 130 [mm] in length. Remove remaining bolts. Fasten the hoist to lift the torque converter (Fig. 7B.6). While lifting the torque converter pry it and displace backwards by about 130 [mm], so that its weight (170 [kG]) be transferred to the hoist and let the torque converter clear of the flywheel housing and aligning studs. Take up the torque converter.

NOTE: *Cover the opening at the flywheel housing to prevent dirt and dust from entering.*

14. Remove the O-ring from the converter housing flange.

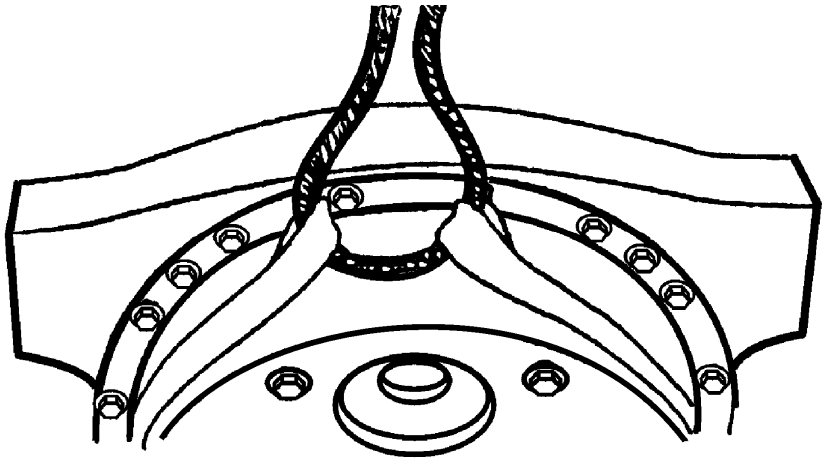

Fig. 7B.6. Removing Torque Converter

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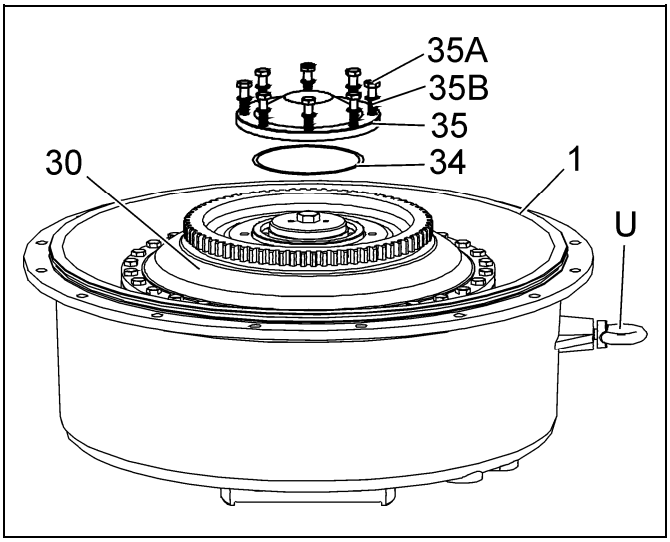
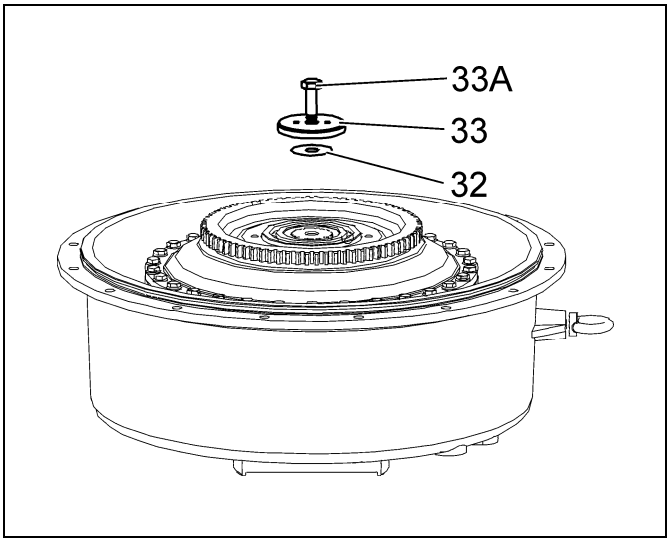
TORQUE CONVERTER

7. DISASSEMBLY

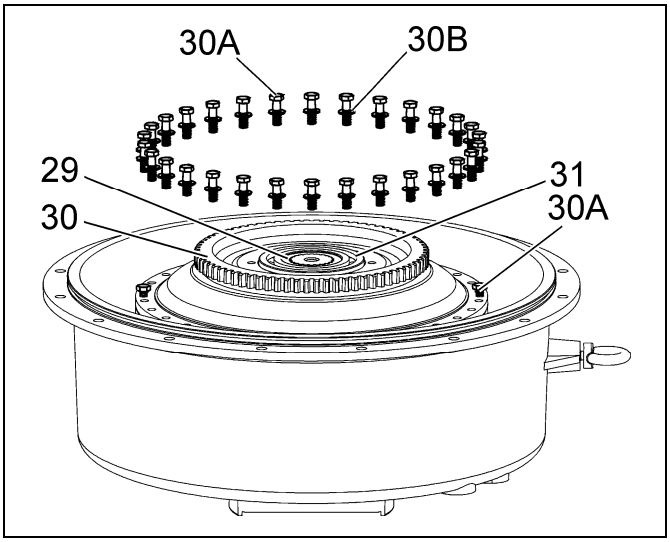
1. Screw eyebolt (U) into converter housing (1). Torque the eyebolt to 22 ÷ 27 [Nm]. Place the torque converter on a bench so the drive housing (30) is up. Remove bolts (35A) with washers (35B). Remove housing cover (35) with shims pack (34). Keep the shims (34) with the cover (35) for further reuse.



2. Remove bolt (33A), then remove thrust washer (33) and shims (32). Keep shims (32) with washer (33) for further reuse.



3. Mark the impeller (12) position in relation to drive housing (30) to keep the position of rotational parts after reassembly. Remove bolts (30A) with washers (30B) securing housing (30) to impeller (12). Screw two bolts (30A) into two threaded holes facing each other in the housing flange. Screw the bolts in a regular way until the housing (30) clears the impeller flange. Remove the housing (30) with bearing (31) and turbine assy (29).



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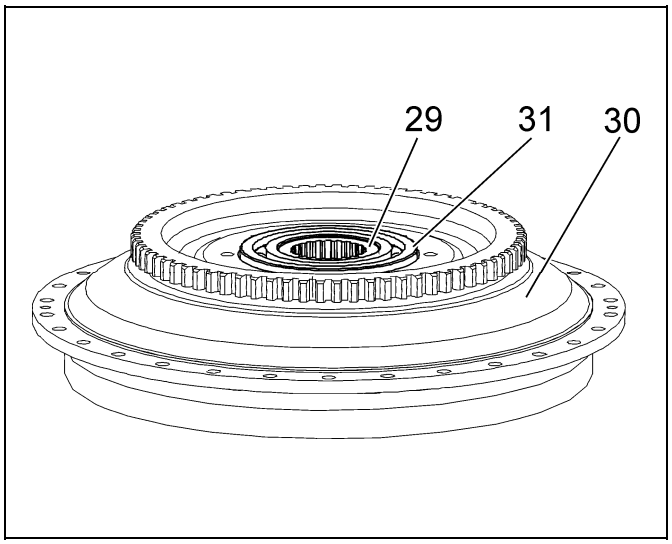
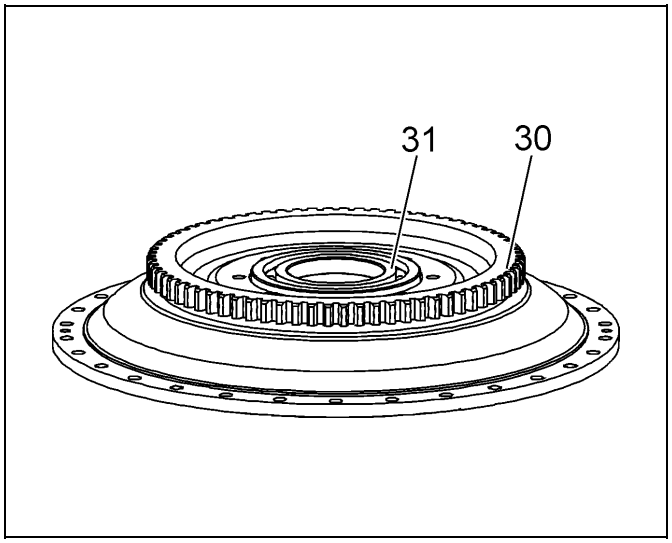
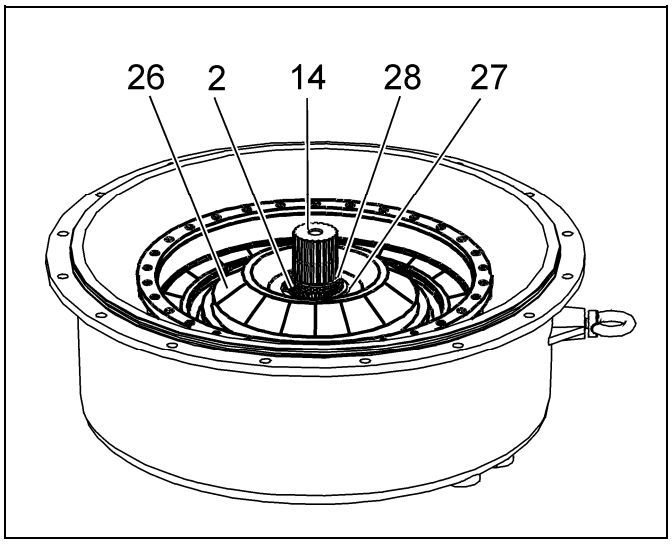
4. Drive turbine assy (29) out the bearing (31) using 60 to 79 [mm] dia. driver.



5. Press bearing (31) out of drive housing (30) using 122 to 127 [mm] dia. driver supporting it against the bearing (31) outer race.



6. Remove the retaining ring (28) from the output shaft (14) and retaining ring (27) from ground sleeve hub (2). Remove stator (26) from ground sleeve hub (2).



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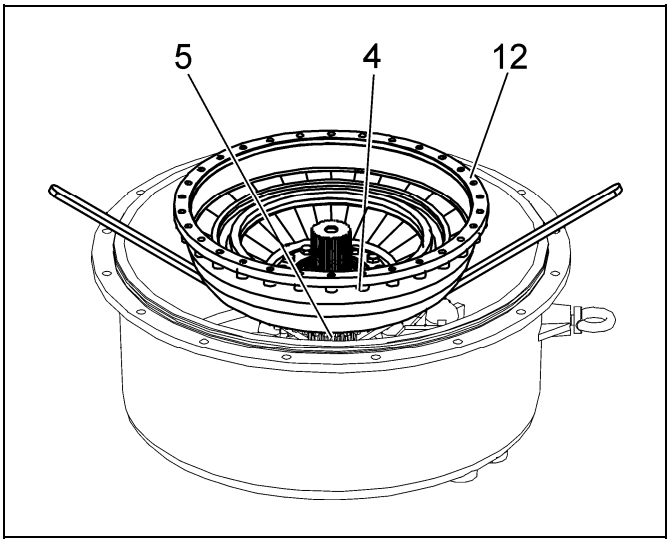
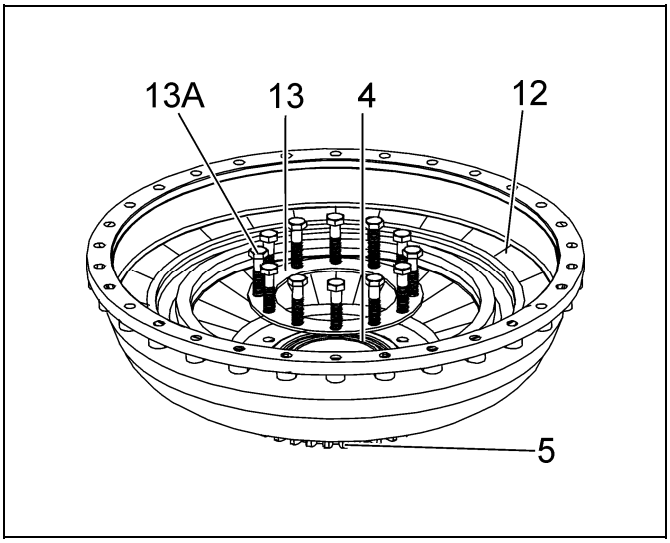
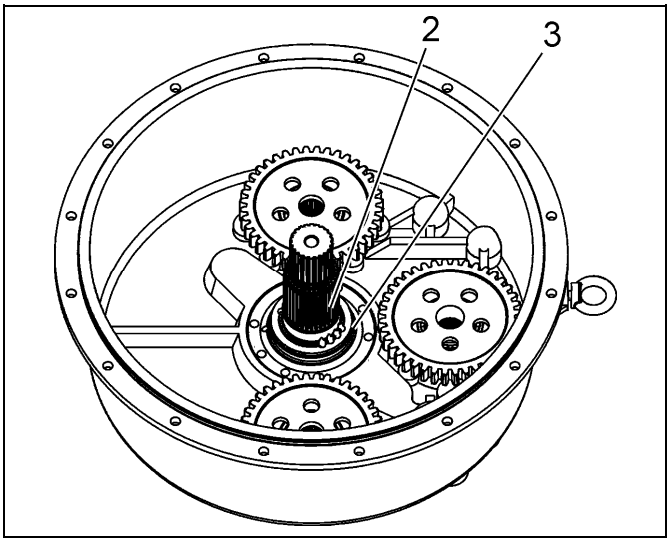
7. Remove impeller (12) with bearing (4) and drive gear (5) using two levers.



8. Remove bolts (13A) securing impeller (12) to the drive gear (5). Remove thrust washer (13). Tap the drive gear (5) and bearing (4) out of the impeller (12). Press bearing (4) out of drive gear (5) using 114 [mm] dia. driver supporting it against the bearing (4) outer race.



9. Remove seal ring (3) from ground sleeve hub (2).



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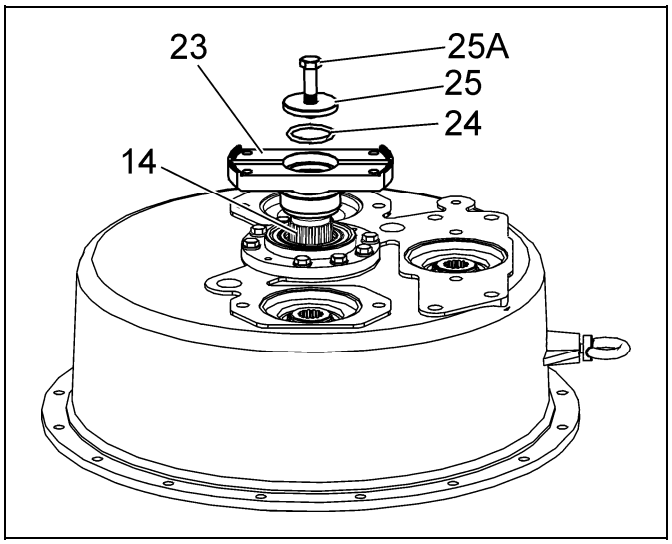
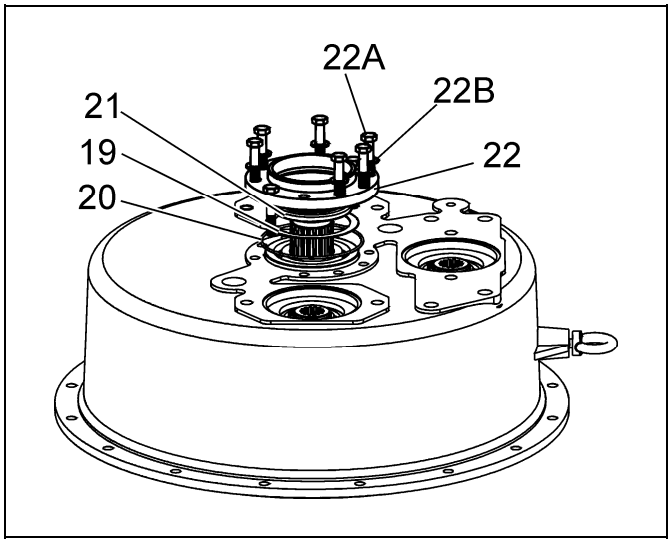
10. Turn the housing (1) over Remove bolt (25A), thrust washer (25) and O-ring (24). Remove output flange (23) from output shaft (14).



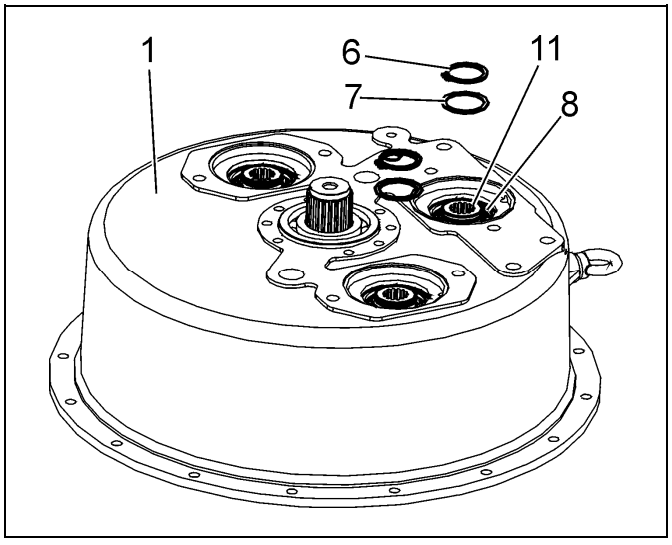
11. Remove bolts (22A) with washers (22B) securing rear cover (22) to housing (1). Screw two bolts (22A) into two threaded holes facing each other in the cover (22). Screw the bolts in a regular way to remove the rear cover (22). Remove O-ring (20). Press seal ring (21) out of rear cover (22) using suitable driver. Remove shims (19) and keep with cover (22) for further reuse.



12. Remove retaining ring (6) and spacer washer (7) from driven gear (11). Drive the gear (11) out of ball bearing (8) using 35 [mm] to 49 [mm] dia. driver. Keep bearing (8) in housing (1) bore.

    Repeat for remaining driven gears (11).

NOTE: *Take care not to intermix the spacer washers (7) and retain them with suitable gears (11) for further reuse.*



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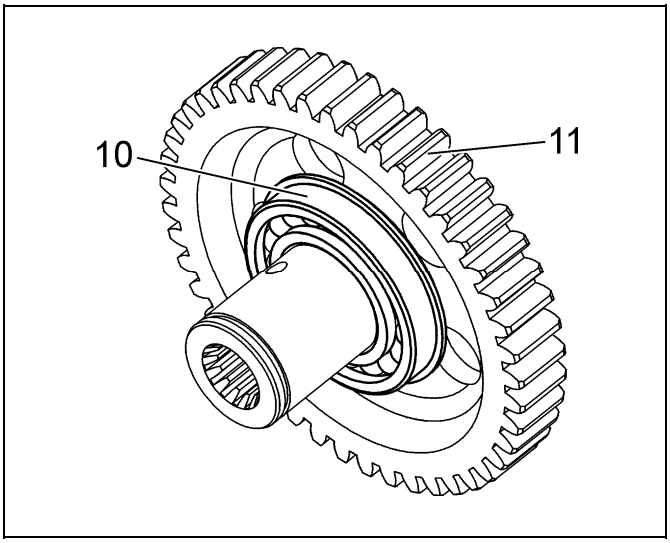
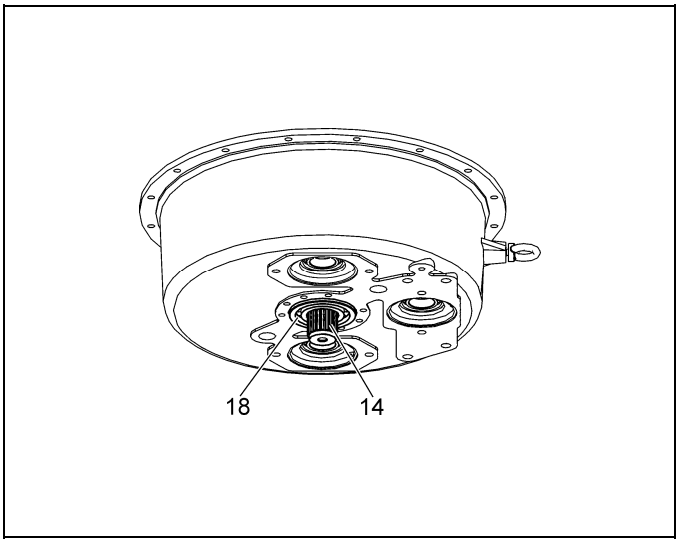
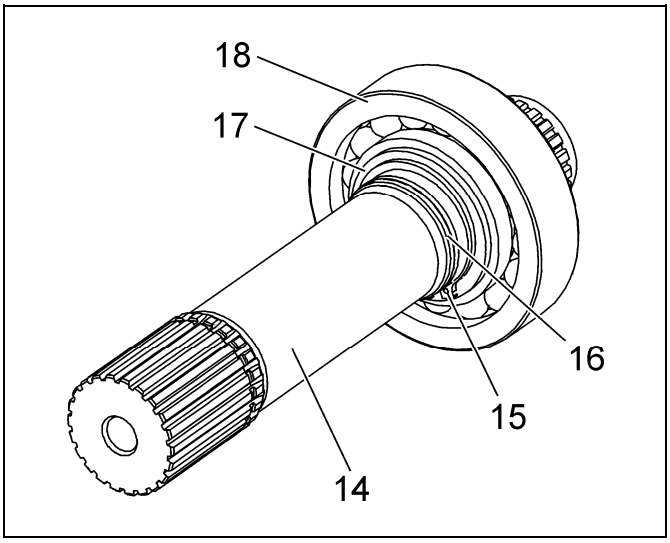
13. If bearings (10) replacement is necessary, remove bearings (10) from gears (11) with a suitable puller.



14. Turn the converter housing (1) over with its output or rear side down. Working from inside housing (1), tap on the end of output shaft (14) with a hammer and a block of wood until bearing (18) is free.



15. Remove seal ring (15), retaining ring (16) and spacer washer (17) from output shaft (14). Tap the shaft (14) out of ball bearing (18) with a hammer and soft metal driver.



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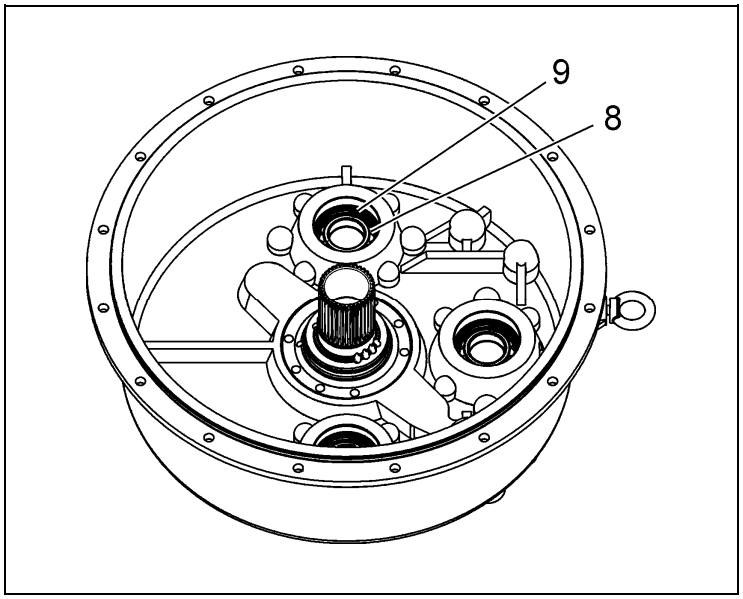
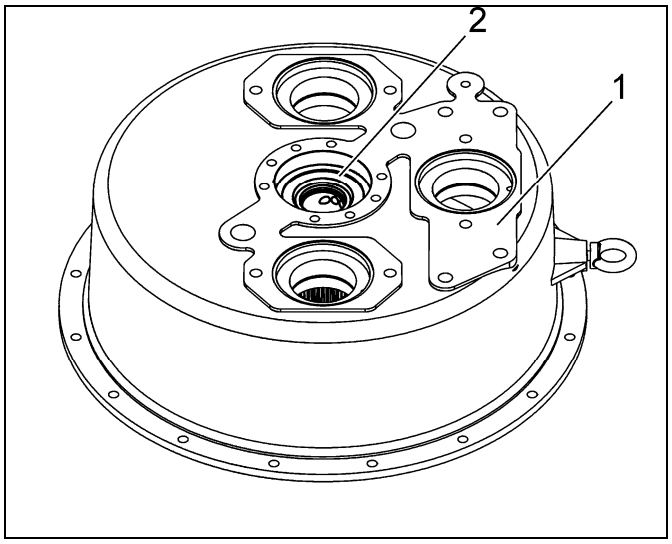
TORQUE CONVERTER

16. Remove inner retaining ring (9) from housing (1) bore. Remove bearing (8) from housing (1) using 80 to 89 [mm] dia. driver supporting it against the bearing (8) outer race.

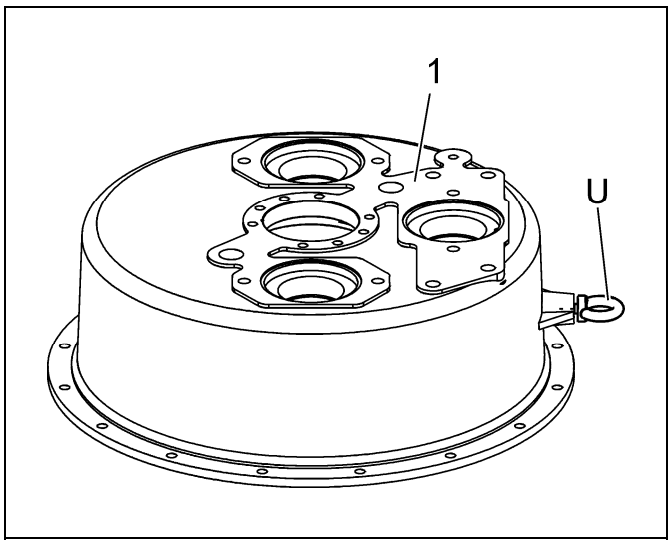
    Repeat for remaining housing bores.



17. Turn the torque converter housing (1) with its output or rear side up. Remove ground sleeve hub (2) from converter housing (1) using 120 to 130 [mm] dia. driver. If bearing (4) replacement is necessary, remove bearing inner race from ground sleeve hub (2).



18. If converter housing (1) needs to be replaced or repaired, unscrew eyebolt (U).



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8. INSPECTION AND REPAIR

1. Wash all components thoroughly in a suitable solvent after the torque converter has been disassembled. Dry thoroughly with compressed air or a clean cloth. Clean thoroughly all sealing surfaces that were coated with LOCTITE for assembly purposes. Use caution so the metal surface remains undamaged. Check all the oil passages for lack of passage obstructions with compressed air.

IMPORTANT: *Do not spin dry bearings with compressed air.*

2. Inspect all bearings condition. Replace all bearings that do not rotate freely or show excessive clearance.
3. It is recommended that new O-rings and oil seals be installed whenever the torque converter is disassembled for service. Replace definitely teflon seal ring (3) at the converter input and cast iron seal ring (15) at the converter output when excessive oil leakage occurs during the test.
4. Inspect all splined connections for excessive clearance caused by wear surfaces, surface dents, burrs or other damages and replace if necessary. Especially, inspect both splined connections between output shaft (14) and turbine assy (29), and between shaft (14) and output flange (23).
5. Replace all torque converter gears and flywheel gear that tooth are worn excessively or damage. Mating gear surfaces may show increased smoothness but any gear spalling is not allowable.
6. Check thoroughly all bearings shaft journals and bores where bearings are seated to ensure that there are no worn out spots due to rotation of inner bearing race on its shaft or bearing outer race in its bore. If the check reveals that either the bearing rotates on its shaft journals or it rotates in its bore it is seated in, both the bearing and its mating part must be replaced. Especially, inspect mating surface between output shaft (14) and bearing (18).
7. Check turbine assy (29) riveted joints. If any rivet loose exists the entire turbine assy must be replaced.
8. Inspect the blades of impeller (12), stator (26) and turbine assy (29) for mechanical damage. If the blades are excessively worn or damaged, the entire assembly must be replaced.
9. Inspect thoroughly drive gear (5) inner bore that mates with seal ring (3). Drive gear (5) inner bore and seal ring (3) contact surface shall not be grooved. If drive gear (5) inner bore is grooved by the seal ring (3) the gear (5) must be replaced
10. Inspect ground sleeve hub (2) bore wear interacting with cast iron seal ring (15). The hub must be replaced if it is grooved by the seal ring.
11. If any contact signs are visible on the hub surface with both drive gear (5) bore surface and shaft (14), the hub must be replaced.
12. Output flange (23) shall not be grooved by seal ring (21) while contact surface smoothing and darkening are admissible.
13. Replace the converter housing (1) if cracks, thread stripping or bearing bores damages occurs.

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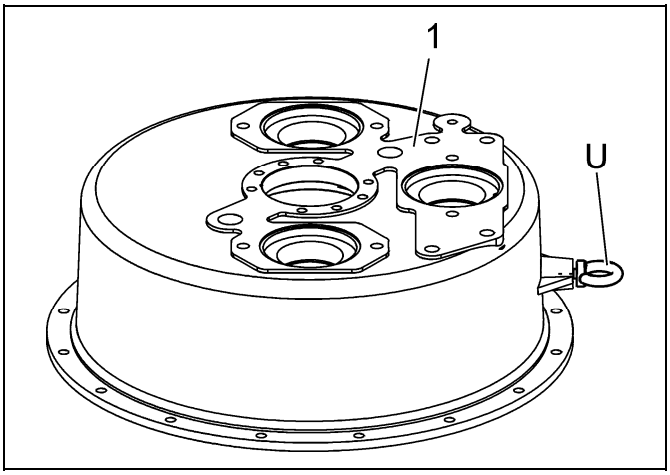
TORQUE CONVERTER

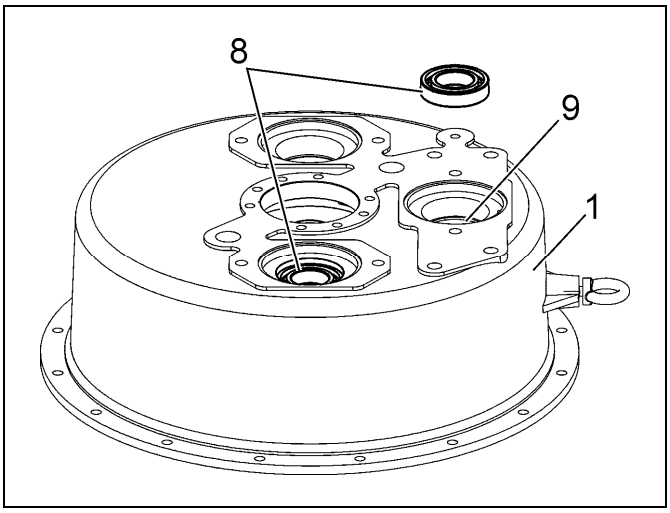
9. REASSEMBLY

1. Screw eyebolt (U) into converter housing (1) if replaced.

   Torque the eyebolt to 22 ÷ 27 [Nm].



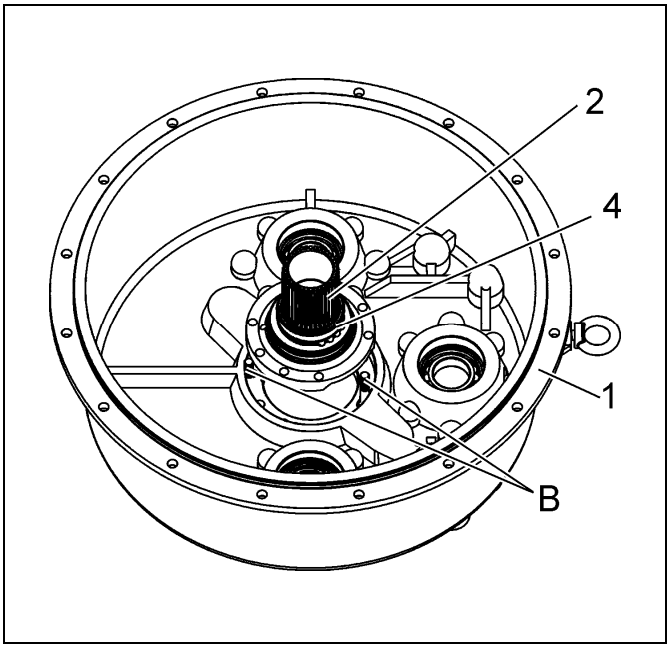
2. Place the converter housing on a bench with its output or rear side up. Install retaining rings (9) into housing bores. Using the 80 to 89 [mm] dia. driver against the outer race of ball bearing (8), tap the bearing until it bottoms on the ring (9). Repeat this procedure for the remaining bearings.



3. Turn converter housing (1) over. Clean and degrease surfaces both ground sleeve hub (2) flange and hub seat in converter housing (1). Apply LOCTITE #510 to ground sleeve hub (2) and install it in a way that the hub flange openings line up with their counterparts in converter housing (1). The inner race of bearing (4) must be seated on ground sleeve hub (2) before sleeve assembly.

NOTE: *If the ground sleeve hub (2) was removed, pack it in dry ice or freeze to temperature of –30 [ºC] for 30 [min] prior to assembly*.

To ensure the correct hub installation insert two M12 bolts (B) 50 [mm] length into ground sleeve hub to eliminate the existing clearance.



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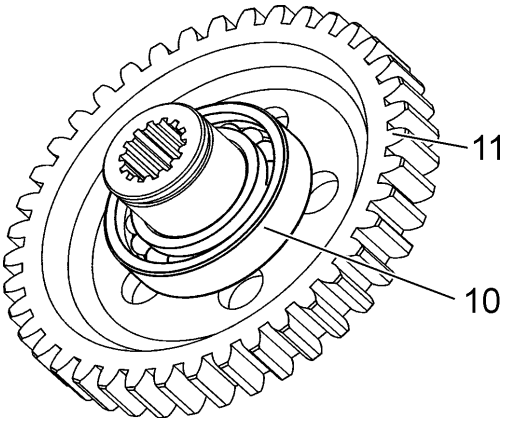
TORQUE CONVERTER

4. If removed, press ball bearing (10) on driven gear (11) hub, until it bottoms.

   Repeat for remaining gears, if necessary.

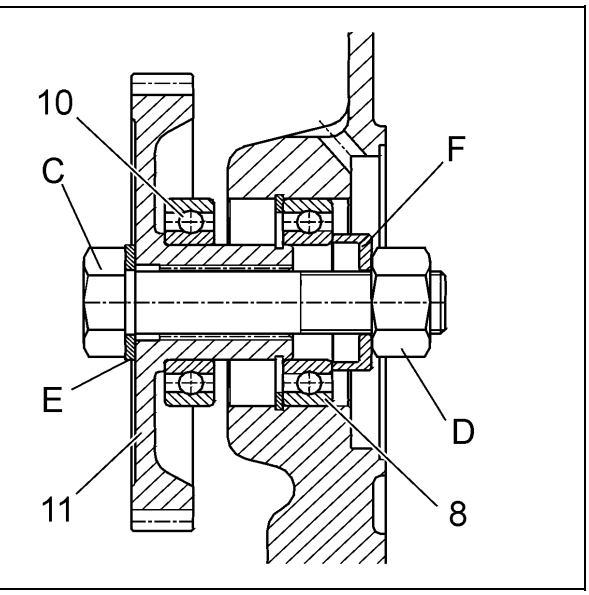


5. Install gear (11) with bearing (10) into bearing (8) seat. Press the gear in up to resistance is felt until the retaining ring groove in the gear appears.

NOTE: *For this operation use a driven gear pusher set (see Service/ Special Tools in this Section) which consists of bolt (C), nut (D), washer (E) and special thrust washer (F). The special washer (F) shall support against ball bearing's (8) inner race.*

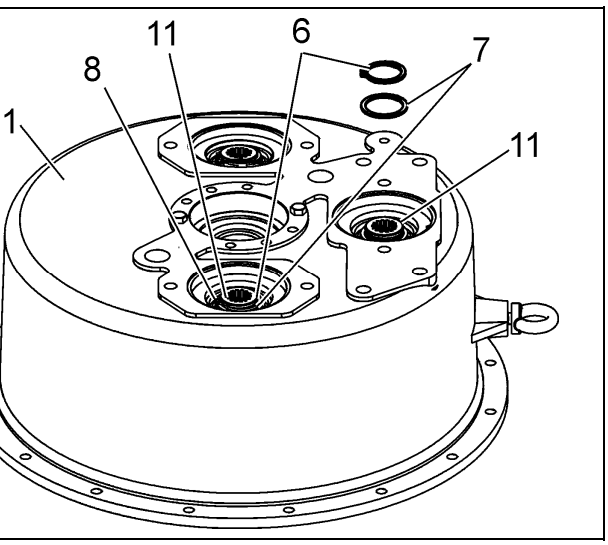
Repeat for remaining gears.

NOTE: *Inspect bearings preload. Bearings should rotate freely.*



6. If one of driven gears (11), bearings (8 and 10) and housing (1) have not been replaced use previously removed spacer washers (7) suitable for each gear. Install spacer washer (7) on the driven gear (11) hub, then install retaining ring (6).

   Repeat for remaining gears.



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TORQUE CONVERTER

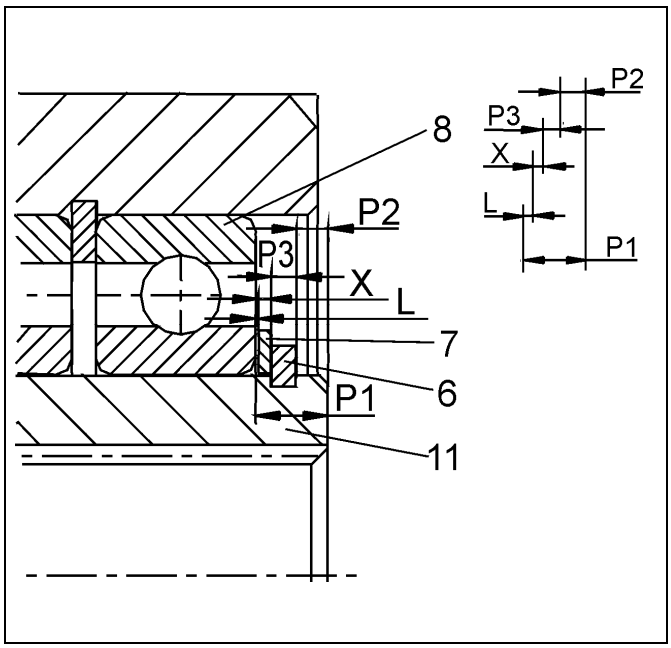
7. If one of driven gears (11), bearings (8 and 10) or housing (1) have been replaced the following readjustment procedure must be done:
- Measure retaining ring (6) thickness (P3);
- Measure the (P2) distance of driven gear (11) face to retaining ring (6) edge;
- Measure the (P1) distance of ball bearing face (8) to driven gear (11) face after drive gear (11) installing;

Select the spacer washer (7) with thickness (X) so the (L) gap between the bearing (8) and retaining ring (6) obtains the dimension of 0.0 - 0.3 [mm]. Use the following formula:

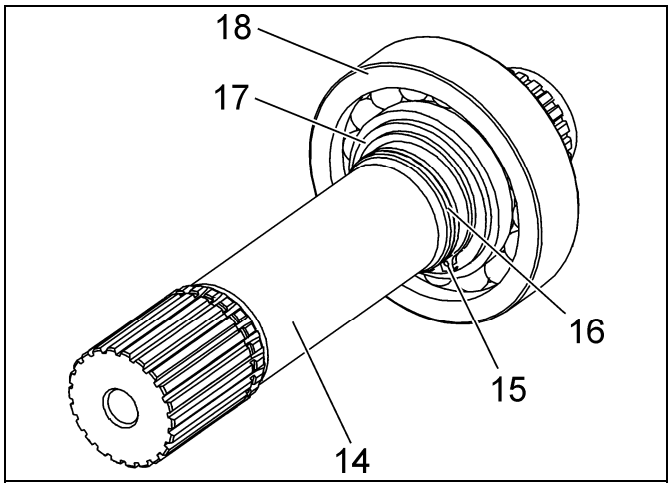
$$L(0.0 \div 0.3) = P1 - P2 - P3 - X$$

Install spacer washer (7) on the driven gear (11) hub, then install retaining ring (6).

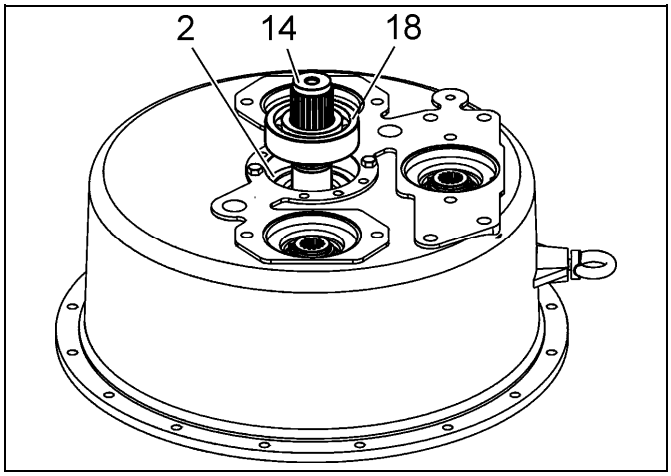
Repeat for remaining gears.



8. Install retaining ring (16) and spacer washer (17) on output shaft (14). Press the output end of shaft (14) into bearing (18) until the bearing seats against the retaining ring (17). Install seal ring (15).



9. Insert shaft (14) into ground sleeve hub (2) from the output end of housing (1). Seat the bearing (18) inside the housing using a suitable driver until the outer race of bearing (18) bottoms the hub (2).



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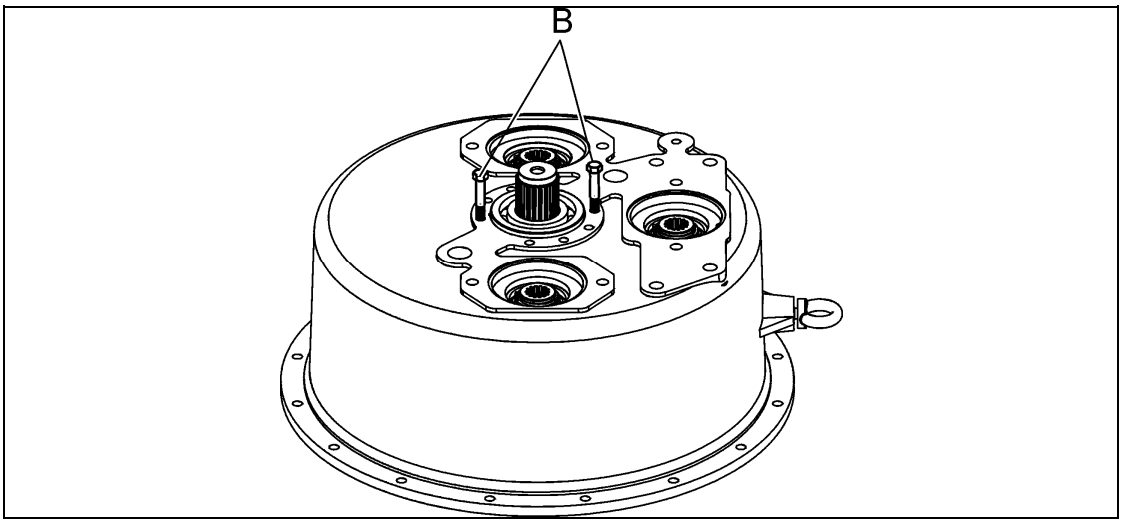
HYDRAULIC TORQUE CONVERTER

TORQUE CONVERTER

10. Remove bolts (B) securing hub (2).



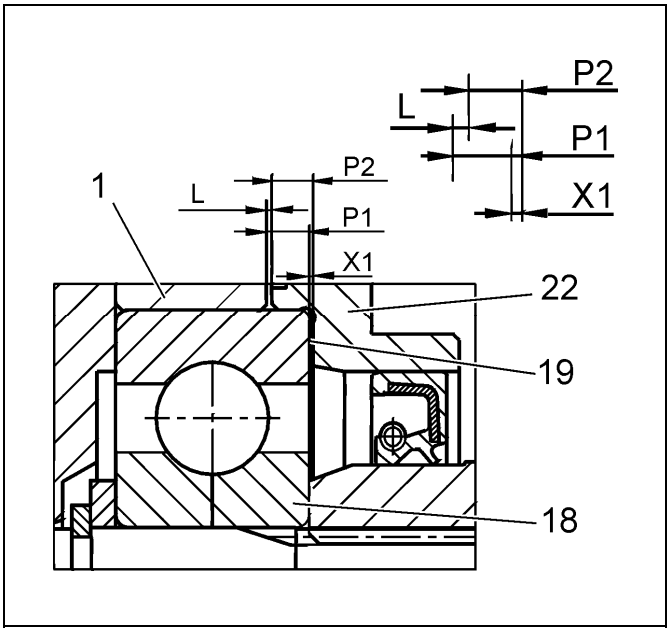
11. If rear cover (22), bearing (18) and housing (1) have not been replaced use previously removed shim pack (19).
If rear cover (22), bearing (18) or housing (1) have been replaced the following procedure must be followed:

- Measure the (P1) distance of ball bearing (18) face to housing (1) contacting face.
- Measure the (P2) distance of the bore chamber at rear cover (22).

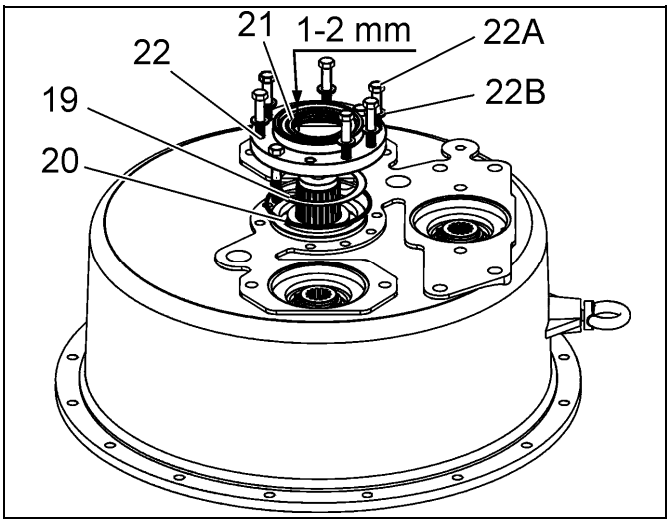
Select shims pack thickness (19) so the (X1) gap between the housing and rear cover obtains the dimension of 0.0 ÷ 0.1 [mm].

$$L(0.0 \div 0.1) = P1 + X1 - P2$$

Using virgin lead to measure the appropriate distance is acceptable too.



12. Press seal ring (21) into rear cover (22) until it is 1 ÷ 2 [mm] out of cover outer flange. The seal lip should face toward the converter when the rear cover (22) is installed. Next, install the shim pack (19) previously disassembled or selected in Step 11. Install O-ring (20) in the cover groove. Install cover (22) and secure it with bolts (22A) and washers (22B). Apply LOCTITE #243 to the bolts (22A) and torque to 72 ÷ 88 [Nm].



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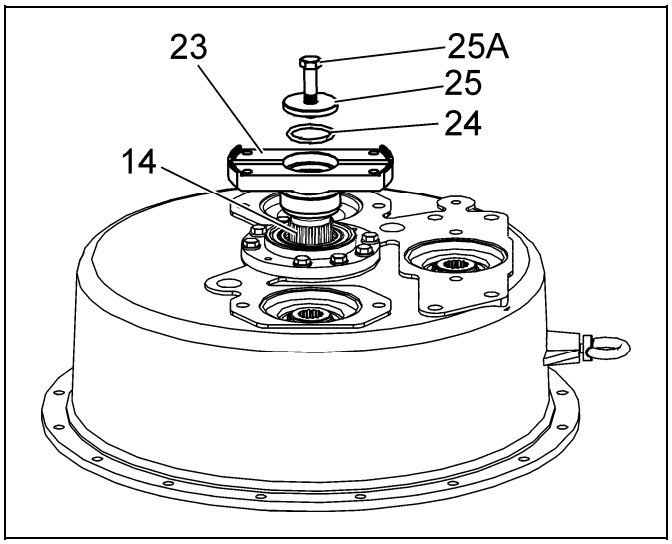
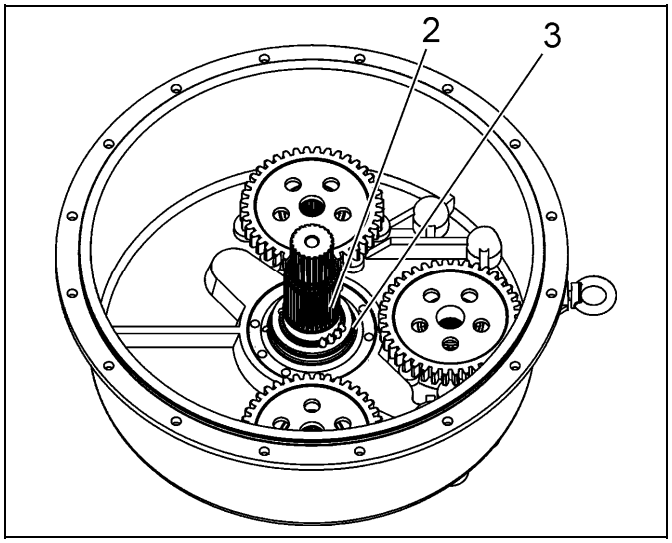
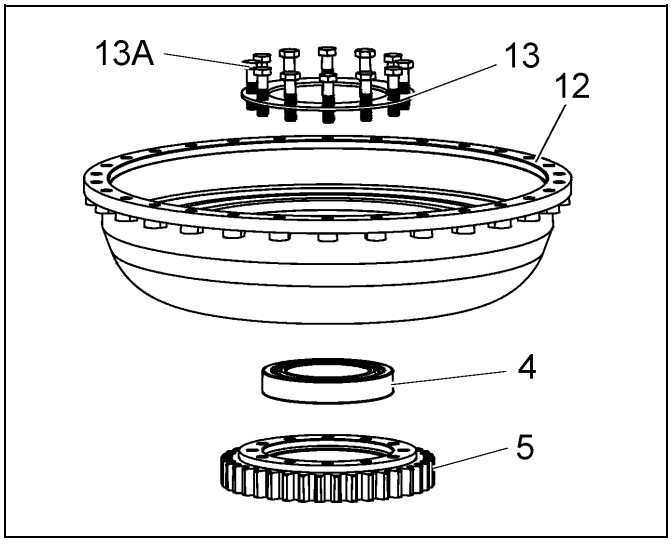
13. Install output flange (23), O-ring (24) and thrust washer (25) onto shaft end (14). Secure with the bolt (25A). Apply LOCTITE #243 to the bolt (25A) and torque to 83 ÷ 101 [Nm].



14. Turn converter housing (1) over with the gear up. Install seal ring (3) in the groove of ground sleeve hub (2). Coat lightly the ring with oil.



15. Press roller bearing (4) into drive gear (5). Install impeller (12) on bearing (4) and then thrust washer (13). Secure impeller (12) to drive gear (5) with the bolts (13A). Apply LOCTITE #243 to the bolts and torque to 48 ÷ 58 [Nm].



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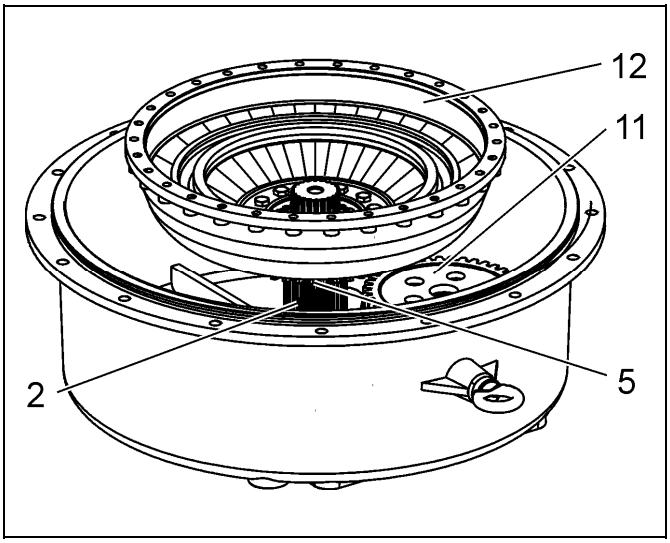
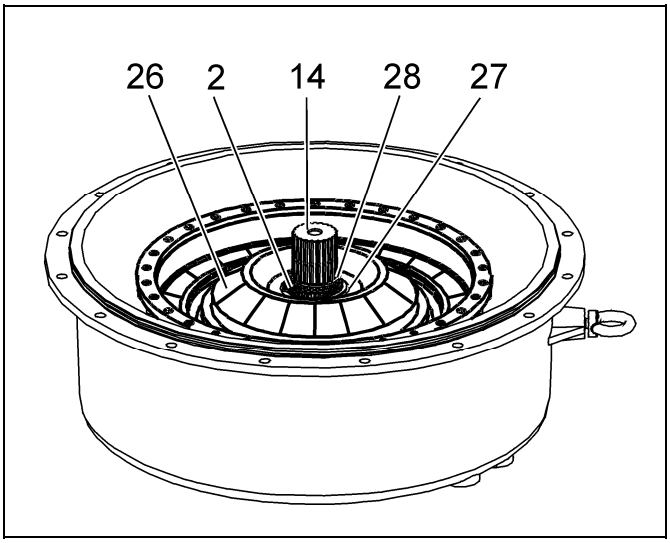
16. Lower the assembly with impeller (12) into housing (1) sliding the assembly onto ground sleeve hub (2). As the assembly is lowered into housing (1), drive gear (5) meshes with driven gears (11).

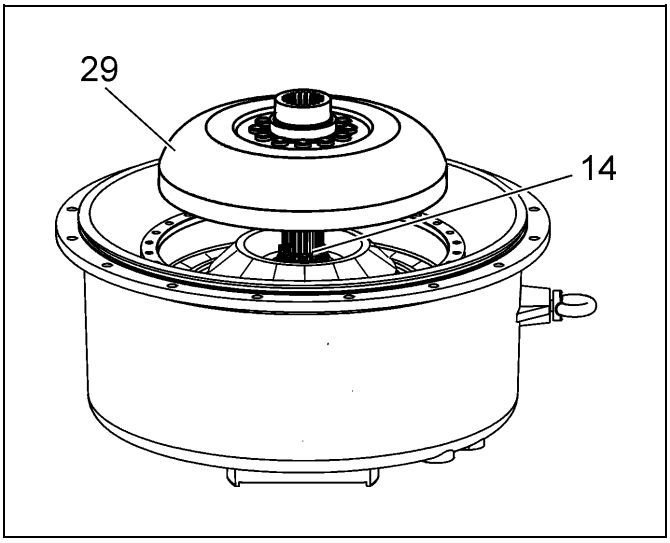
IMPORTANT: *If at any point when contact is made, the resistance is felt, rotate the assembly holding up the impeller lightly. Take care when the assembly passes over the seal ring (3).*



17. Install stator (26) on the ground sleeve hub (2), secure with retaining ring (27). Install retaining ring (28) into output shaft (14) groove.



18. Install turbine assy (29) on the output shaft (14) end.



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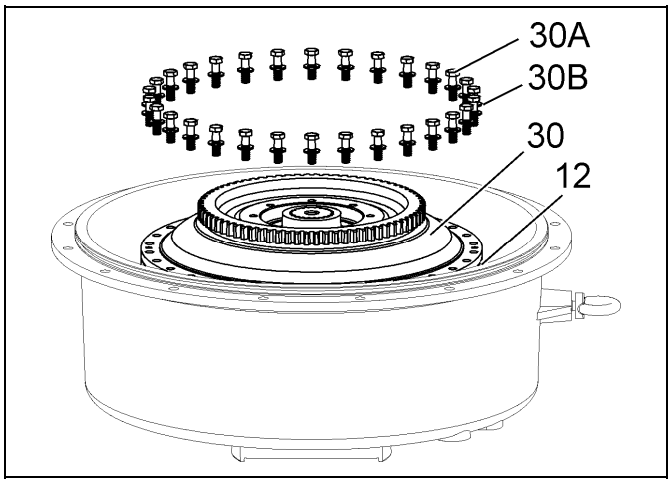
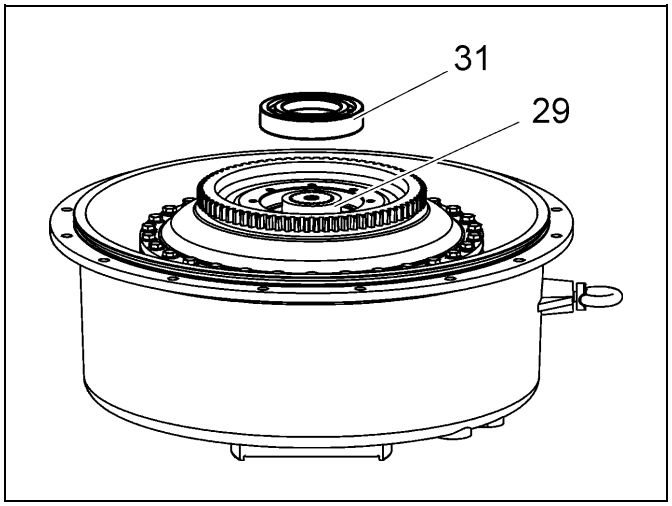
19. Install drive housing (30) over turbine (29). Position properly drive housing (30) in relation to impeller (12) according to match marks made during disassembly. Secure the housing to the impeller with bolts (30A) and washers (30B). Apply LOCTITE #243 to the bolts and torque to 41 ÷ 51 [Nm].



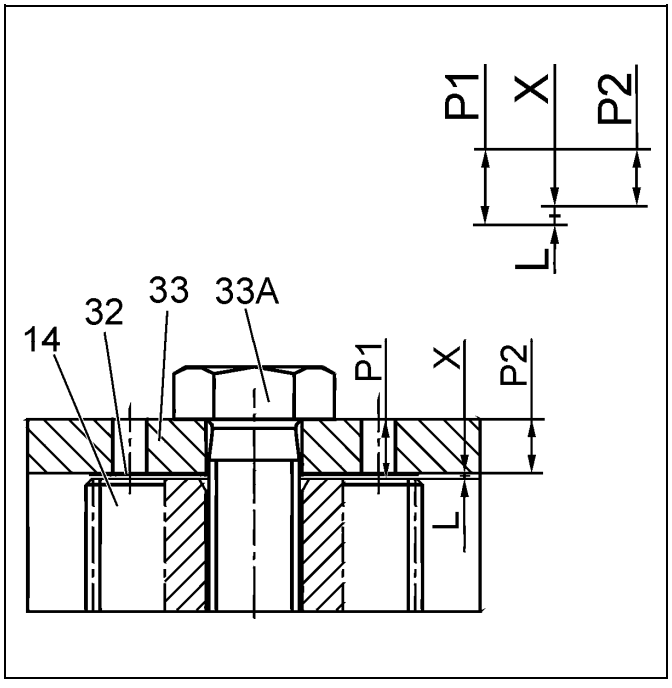
20. Press ball bearing (31) on hub of turbine assy (29).Install thrust washer (33) on the inner race of bearing (31) and tighten the washer to shaft (14) withbolt (33A) using finger pressure. Then loosen bolt (33A) and retighten with torgue of 15 to 20[Nm].

NOTE: *Be sure bearing inner race (31) bottoms turbine (29) hub After bolt (33A) retightening.*



21. If bearing (31) and washer (33) have not been replaced use previously removed shim pack (32).
If bearing (31) or washer (33) have been replaced, proceed as follows. Take the (P1) distance of shaft (14) face to thrust washer (33) contacting face.
Untighten bolt (33A) and measure the (P2) thickness of the thrust washer (33). Select shim pack (32) thickness, so the (L) gap between the thrust washer (33) and shaft (14) will get 0,09 ÷ 0,18[mm].
Using virgin lead to measure the appropriate distance is acceptable

L (0.09 ÷ 0.18) = P1 - P2 - X [mm]



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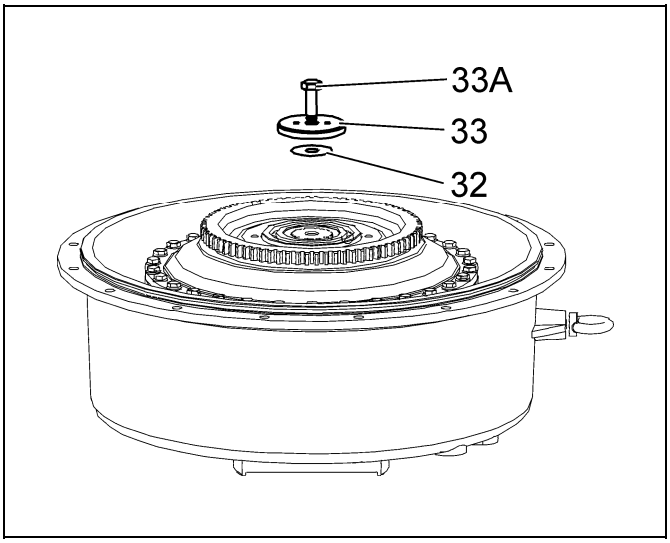
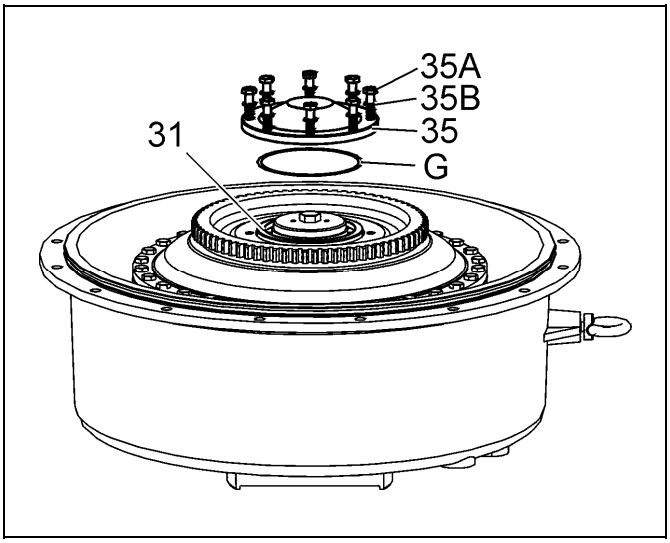
22. Install the shim pack (32), previously disassembled or selected in Step 21, on the top surface of output shaft (14). Install thrust washer (33) and secure it to the shaft with the bolt (33A). Apply LOCTITE #243 to the bolt and torque to 83 ÷ 101 [Nm].



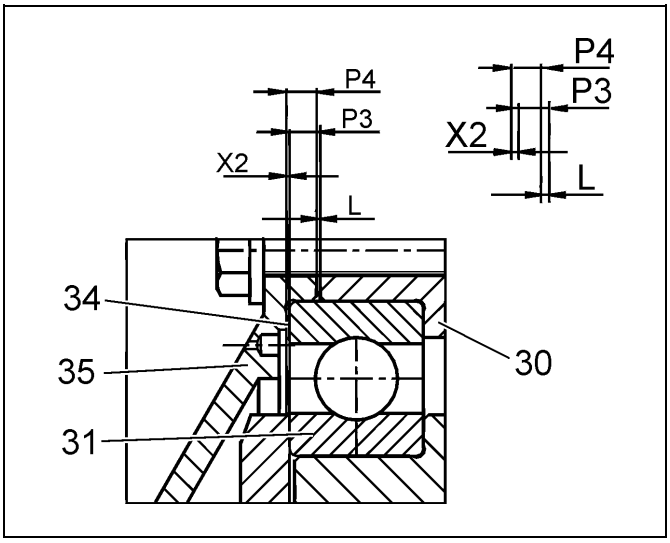
23. If bearing (31) and housing cover (35) have not been replaced use previously removed shim pack (34).
If one of parts (31 or 35) have been changed proceed as follows for checking and obtaining proper end gap. Place washer (G) (see Service/Special Tools in this Section) of minimum thickness of 2 [mm] onto ball bearing (31). Install housing cover (35) on ball bearing (31) and torque the cover to drive housing (30) with bolts (35A) and washers (35B) to be sure bearing (31) is properly seated in drive housing (30) bore.



24. Remove cover (35) and washer (G). Measure the (P4) distance within housing cover (35) and the (P3) distance between ball bearing face (31) and drive housing (30) faying face. Select shims pack (34) thickness (X2) so the (L) gap between bearing (31) and cover (35) gets the dimension of 0.0 to 0.1 [mm]. Using virgin lead to measure the distance is acceptable too.

L (0.0 ÷ 0.1) = P3 + X2 – P4

NOTE: *Be sure bearing outer race (31) bottoms the bore chamber of drive housing (30).*



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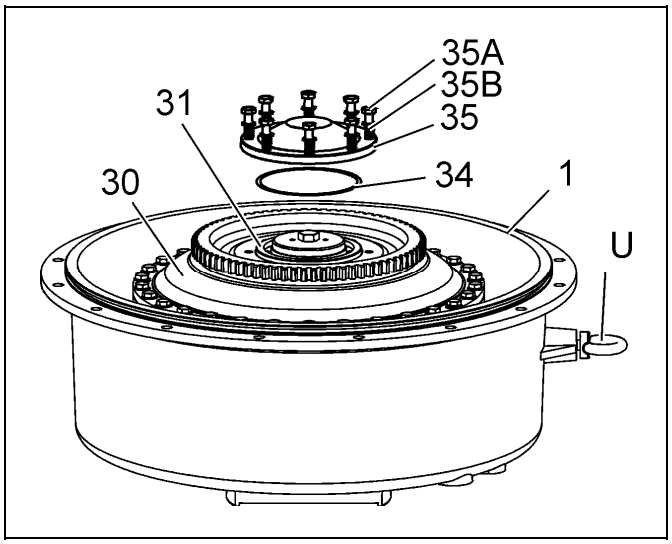
25. Install shims pack (34) on the outer race of bearing (31). Install housing cover (35), secure with the bolts (35A) and washers (35B). Apply LOCTITE #243 to the bolts and torque to 48 ÷ 58 [Nm].



NOTE: *Make sure the shims forming the pack are centrally placed on the bearing outer race so none of them will get clamped between the housing cover and the drive housing.*

NOTE: *Remove eyebolt (U) prior to torque converter machine installation*.

26. If gear ring (36) was replaced, install new gear ring (36) to flywheel and secure with bolts. Apply LOCTITE #243 to the bolts and torque to 83 ÷ 101 [Nm].

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9. INSTALLATION

IMPORTANT: *All gaskets and any collapsed hoses or damaged connections must be replaced with new. Whenever a sealing ring is required at a disconnected line, it is recommended that a new sealing ring be installed.*

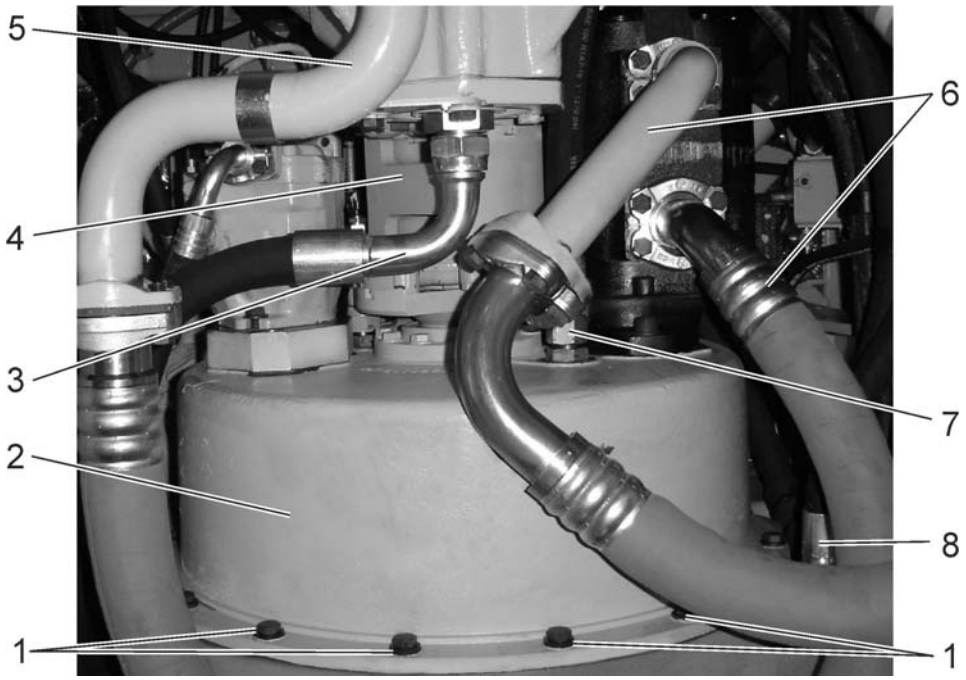

Fig. 7B.7. Lower Torque Converter Reconnecting Points

1. Mounting Bolts
2. Torque Converter
3. Transmission Lube Inlet Hose
4. Universal Joint
5. Scavenge Suction Tube
6. Charge and Scavenge Pump Outlet Hoses
7. Torque Converter Supply Hose
8. Torque Converter Drain Hose

1. Remove the covering from the engine flywheel housing. If flywheel gear ring (36, Fig. 7B.1 or Fig. 7B.2) was replaced install new gear ring and secure with bolts applying LOCTITE #243. Torque bolts to 83 – 101 [Nm].
2. Thoroughly clean the mating surfaces of the torque converter housing and the engine flywheel housing. Install a new O-ring on the converter housing flange.
3. Install of 100 to 130 [mm] two aligning studs at 10 and 2 o'clock positions in flywheel housing. Fasten the hoist and raise the torque converter into position on the aligning studs. Move the torque converter toward the engine until the torque converter drive housing gear meshes with the drive gear in the flywheel housing. Secure the torque converter to the flywheel housing. Torque the bolts (1, Fig. 7B.7) with washers to 110 [Nm].

IMPORTANT: *As the converter housing enters the flywheel housing, be sure the O-ring is properly seated in the groove of the converter housing.*

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WARNING! Remove the wire used to keep the bearings from falling from the spider trunnions. If installing a new spider and bearing assembly, remove the soft iron strap attached to the bearing caps. This will eliminate the possibility of the straps or wire breaking loose from the caps and causing personal injury when the engine is running.

4. Install the universal joint (4) between torque converter and transmission. Torque the mounting bolts to 136 [Nm].

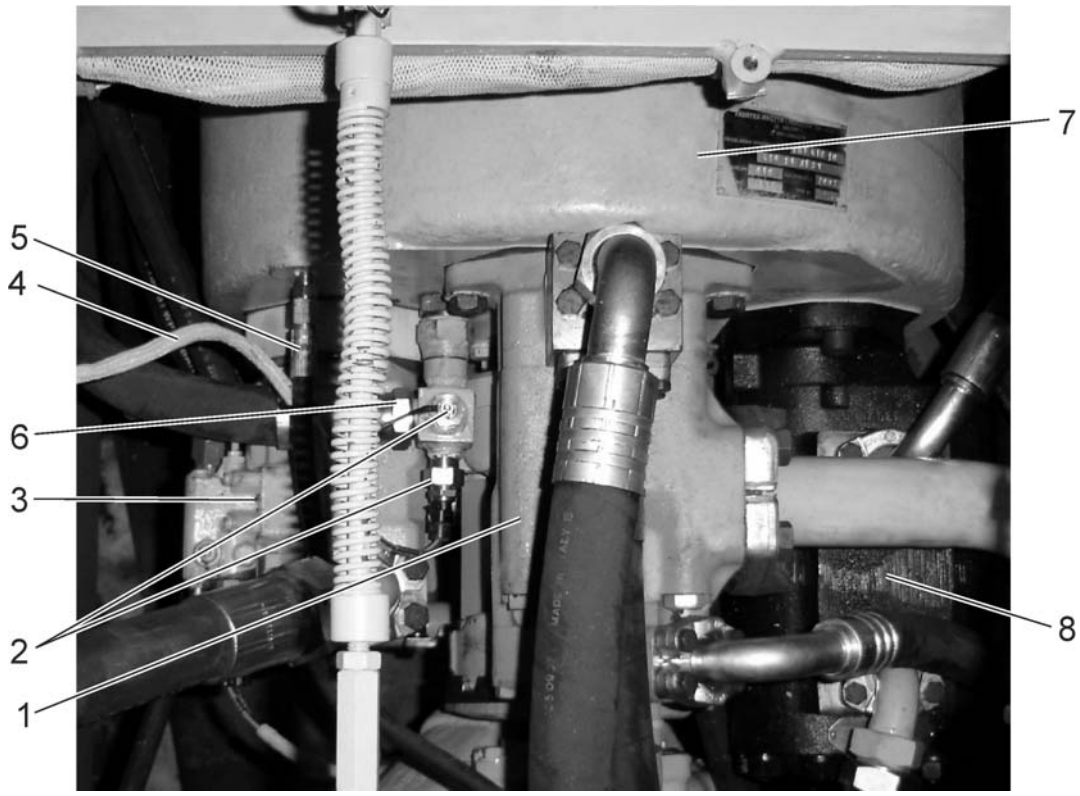

Fig. 7B.8. Upper Torque Converter Reconnecting Points

1. Hydraulic Equipment Pump
2. Torque Converter Oil Temperature Sensors
3. Fan Drive Pump
4. Electrical Harness
5. Torque Converter Breather Hose
6. Oil Cooler Hose
7. Torque Converter
8. Charge and Scavenge Pump

5. Install transmission lube inlet hose (3) and the scavenge suction tube (5) to the transmission.
6. Connect torque converter drain hose (8) to the flywheel housing.
7. Connect the torque converter supply hose (7) to the torque converter (2).
8. Install the fan drive pump (3, Fig. 7B.8). Refer to SECTION 10A for this procedure.
9. Install the charge and scavenge pump (8). Refer to SECTION 7C for this procedure.
10. Install the tee connector with the oil temperature sensors (2) to the torque converter (7). Connect oil cooler hose (6) to the tee connector. Connect the electrical harness (4) to the torque converter oil temperature sensors (2).

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11. Install the equipment pump (1). Refer to SECTION 10A for this procedure.
12. Connect the breather hose (5) to the torque converter (7).
13. Install the platform, cab and ROPS/FOPS structure (if equipped). Refer to SECTION 13 for this procedure.
14. Fill the equipment hydraulic reservoir as described in the OPERATOR'S MANUAL.
15. Place the drive train control lock lever in the locked (ON) position. Start the engine and visually check hoses and connections for leakage.

NOTE: *It is recommended that the transmission oil filter be serviced after the first 50 hours of operation. Refer to the OPERATOR'S MANUAL for procedure. Thereafter, service the filter at the normal scheduled interval.*

16. Install the center floor plate and transmission case guard.

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SECTION 7C

TRANSMISSION

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TRANSMISSION

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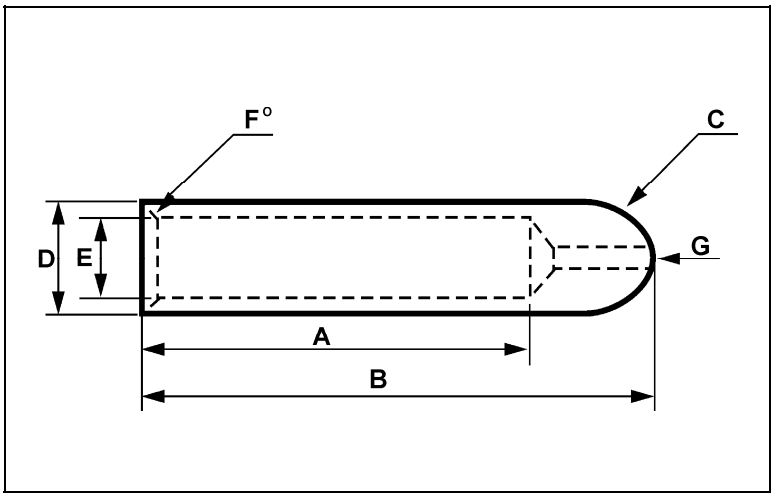
SERVICE /SPECIAL TOOLS

1. SERVICE /SPECIAL TOOLS

DESCRIPTION	TOOL NUMBER
Directional clutch shaft (input shaft) pusher /pulling bolt	1/2”-13UNC
Directional clutch shaft (input shaft) pusher /pulling bolt washer	1/2”
Directional clutch shaft (input shaft) eyebolt	1/2”- 3UNC
Range clutch shaft (output shaft) pusher /pulling bolt	5/8”-13UNC
Range clutch shaft (output shaft) pusher /pulling bolt washer	5/8”
Range clutch shaft (output shaft) eyebolt	5/8”-13UNC
Countershaft pusher /pulling bolt	1/2”-13UNC
Countershaft pusher /pulling bolt washer	1/2”
Countershaft eyebolt	1/2”-13UNC
Ball bearing	5/8”
Directional clutch shaft (input shaft) seating bearing puller	1.547.0220
Range clutch shaft (output shaft) seating bearing puller	1.547.0220
Countershaft seating bearing puller	1.547.0221
Charge and scavenge pump seal retainer installation sleeve	Fabricate acc. to dwg below

PUMP SEAL RETAINER INSTALLATION SLEEVE



All external surfaces must be free of scratches and burrs.

Installation sleeve dimensions

	Dim. **A**	Dim. **B**	Radius **C**	Dia. **D**	Dia. **E**	Chamfer **F°**	Dia. **G** Drill Through Hole
[mm]	117.5	146	9.5	$35.027^{+0.000}_{-0.051}$	$31.979^{+0.051}_{-0.000}$	30[º]	6.35

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2. DESCRIPTION

The transmission is designed to provide gears shifting by using hydraulic actuated clutches. It has three forward and three reverse speeds. The transmission is bolted to the front of the rear part main frame, and is coupled to the torque converter by a drive shaft with a universal joint on each end. The drive shaft rotates the transmission input shaft. The transmission also contains an output shaft, a counter shaft and a reverse idler shaft.

Directional Clutch Shaft (Input Shaft)

The directional (input) shaft rotates on two tapered roller bearings. The shaft consists of forward and reverse drive gears, which ride on caged roller bearings and are welded to the dual hydraulic clutch pack assembly.

Countershaft

The countershaft rotates on two tapered roller bearings. The shaft consists of forward and reverse driven gears and first speed driver gear. The reverse driven gear is splined to the rear of the shaft and held in place by retaining rings. It is in constant mesh with the reverse idler gear and the second speed driven gear. The forward driven gear is splined to the center of the shaft and held in place by retaining rings. It is in constant mesh with the forward drive gear and the third speed driven gear. The first speed driver gear is splined to the front of the shaft and held in place by retaining rings. It is in constant mesh with the first speed driven gear.

Reverse Idler Shaft

The reverse idler shaft is bolted to the transmission cover in a fixed position. The shaft consists of a reverse idler gear which rides on two tapered roller bearings and is in constant mesh with the reverse driver gear and the reverse driven gear.

Range Clutch Shaft (Output Shaft)

The range (output) shaft rotates on two tapered roller bearings. The shaft consists of first, second and third speed driven gears which ride on caged roller bearings. The first speed driven gear is welded to the single hydraulic clutch pack assembly. The second and third speed driven gears are welded to the dual hydraulic clutch pack assembly.

Pressure Regulator Valve

The pressure regulator valve (5, Fig. 7C.1) contains three spools. The main spool limits the pressure at output side of the charge pump to 1790 - 1930 [kPa]. The oil at this pressure is used for clutch pack engagement. Excess oil from the main spool is channeled to the converter spool, then to the lubrication spool.
The converter spool limits the pressure in the torque converter inlet to 790 - 930 kPa. Oil leaving the converter is directed to the oil cooler. From the cooler, the oil is directed back to the lubrication spool in the pressure regulator valve. This oil and the excess oil dumped by the converter spool is used to lubricate the transmission. The lube oil pressure is limited to 280 - 450 [kPa]. Excess lube oil is dumped into the transmission sump. It should be noted that lube pressure will be lower in gear than it is in neutral.

Range Selector Valve

This valve (10, Fig. 7C.1) consists of one switch spool, one directional selector spools and two range selector spools which are hydraulically controlled. In "forward", oil pressure is exerted between the switch spool and directional selector spool, causing the short switch spool to compress the spring and the long directional selector spool to remain in place.

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In "reverse", oil pressure is exerted on the end of the long directional selector spool, causing both spools to move against the spring. In "first or second" (transmission gears), oil pressure is applied against one of the range selector spools causing it to compress the spring. In "third", no oil pressure is applied and the range selector spools are held in place by the spring. When the spools are shifted, oil pressure from the rate of rise valve (3) enters the range selector valve and exits through openings not covered by the spool and on to the transmission to engage the clutch packs: one directional and one range clutch pack.

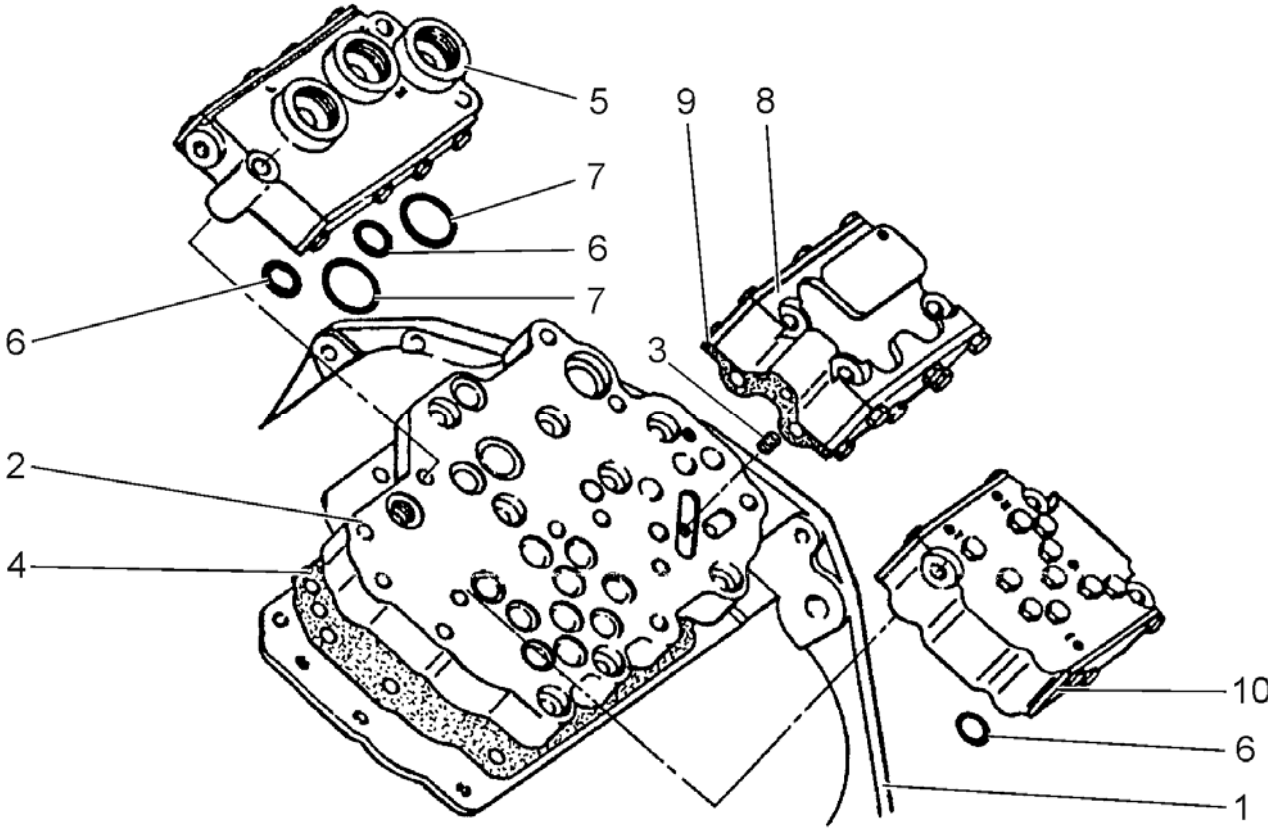

Fig. 7C.1. Transmission and Valves Location

1. Transmission Assy
2. Transmission Manifold
3. Orifice Strainer
4. Manifold Gasket
5. Pressure Regulator Valve
6. O-Ring
7. O-Ring
8. Rate of Rise Valve
9. Rate of Rise Valve Gasket
10. Range Selector Valve

Rate of Rise Valve

Rate of rise valve (8, Fig. 7C.1) sequences the flow and regulates the pressure of the oil to the directional and range clutch packs during shifting. When a directional shift occurs, oil from the range selector valve (10) enters the rate of rise valve and is first directed to the directional clutch pack. When this clutch pack is full, the pressure rises and opens the sequence spool to allow the range clutch packs to fill while the pressure to the directional clutch pack remains the same. When the range clutch pack is full, the pressure in all the packs begins to raise evenly. Because the pressure in the directional clutch pack is greater, it fully engage before the range clutch pack, allowing any slippage to occur only in the latter. This deleted engagement time is created by modulating piston and allows a smooth shift without shock.

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3. SPECIFICATIONS

Transmission

Type . . . . . Power Shift
Number of forward speed 3
Number of reverse speed 3

Directional Clutch Shaft (Input Shaft)

Shaft end play . . . . . 0.18 - 0.28 [mm]
Reverse clutch pack:
Number of friction discs (internally splined clutch plates) 15
Number of separator plates (externally splined clutch plates) 14
Thickness of friction disc . . . . . 2.46 - 2.61 [mm]
Thickness of separator plate . . . . . 2.05 - 2.15 [mm]
Forward clutch pack:
Number of friction discs (internally splined clutch plates) 13
Number of separator plates (externally splined clutch plates) 12
Thickness of friction disc . . . . . 2.46 - 2.61 [mm]
Thickness of separator plate . . . . . 2.05 - 2.15 [mm]
Friction disc and separator plate must be flat within . . . . . 0.05 [mm]

Range Clutch Shaft

Shaft end play . . . . . 0.18 - 0.28 [mm]
First speed clutch pack:
Number of friction discs (internally splined clutch plates) 14
Number of separator plates (externally splined clutch plates) 13
Thickness of friction disc . . . . . 2.76 - 2.92 [mm]
Thickness of separator plate . . . . . 2.23 - 2.33 [mm]
Second speed clutch pack:
Number of friction discs (internally splined clutch plates) 13
Number of separator plates (externally splined clutch plates) 12
Thickness of friction disc . . . . . 2.76 - 2.92 [mm]
Thickness of separator plate . . . . . 2.23 - 2.33 [mm]
Third speed clutch pack:
Number of friction discs (internally splined clutch plates) 12
Number of separator plates (externally splined clutch plates) 11
Thickness of friction disc . . . . . 2.76 - 2.92 [mm]
Thickness of separator plate . . . . . 2.23 - 2.33 [mm]

Countershaft

Countershaft end play . . . . . 0.18 - 0.28 [mm]

Special Bolt and Nut Torque Data

Universal joint mounting bolts . . . . . 136 [Nm]
Transmission mounting bolts . . . . . 920 [Nm]
Reverse idler shaft mounting bolt . . . . . 325 [Nm]
Baffle mounting bolts . . . . . 38 [Nm]
Housing to cover mounting bolts . . . . . 92 [Nm]
Directional clutch shaft pusher /pulling bolt . . . . . 108 [Nm]
Range clutch shaft pusher /pulling bolt . . . . . 217 [Nm]
Countershaft pusher /pulling bolt . . . . . 108 [Nm]

NOTE: *Except for the special torques shown, all bolts and nuts are to be given a standard torque. Refer to SECTION 1.*

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Springs

SPRING	Free Length [mm]	Test Length [mm]	Test Load [N]	Total Number of Coils
Pressure Regulator Valve:				
Torque Converter Spool Spring	71.5	50.8	278 - 300	14
Lube Spool Spring	81.6	50.8	96 – 109	19
Main Spool Ball Spring	21.1	15.4	75 – 83	9
Main Spool Inner Spring	49.8	35.0	193 - 207	12.5
Main Spool Outer Spring	76.5	52.5	380 - 398	13.5
Rate of Rise Valve:				
Piston Spring (Inner)	74.6	69.3	89 - 98	14
Piston Spring (Outer):	43.0	37.7	89 - 98	5.9
Reducing Spring	37.5	19.1	160 - 178	5.2
Sequence Spool Spring	71.1	25.4	35.6	7.7
Range Selector Valve:				
Clutch Selector Spool Spring	48.7	35.5	249	13
Range Selector Spool Spring	48.7	35.5	249	13
Transmission:				
Range Clutch Pack Springs	66.8	53.8	200 – 218	13.5
Directional Clutch Pack Springs	42	34	84 – 92	9.5

TRANSMISSION

4. REMOVAL

NOTE: *It is suggested that Paragraph 8, TROUBLE SHOOTING in SECTION 7 be reviewed and the pressure checks in Paragraph 10, TRANSMISSION AND TORQUE CONVERTER OIL PRESSURE TEST be taken before removing the transmission. In this manner, hydraulic malfunctions can be pinpointed and corrected at time of teardown.*

NOTE: *In case of directional or range shaft seal rings and/or manifold failure it is possible to replace damaged parts without removing the transmission. For replacement of damaged parts fist remove transmission case guard from bottom of machine. Replace respective seal rings and/or manifold. Refer to relative Paragraphs in this Section.*

NOTE: *There is possibility removing the transmission without removing the range selector valve and pressure regulator valve. In this case tag the hoses of drive train control valve, diagnostic center, steering valve and gear shifting valve, and disconnect these hoses from pressure regulator valve and range selector valve.*

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *When disconnecting hydraulic lines for any reason, they should be properly capped with the correct size plastic cap. If these caps are not available, tape or clean rubber corks may be used. Hydraulic openings must never be plugged with rags. This practice could easily introduce dirt or lint into critical hydraulic components of the machine. Tag all disconnected oil lines to facilitate easier installation.*

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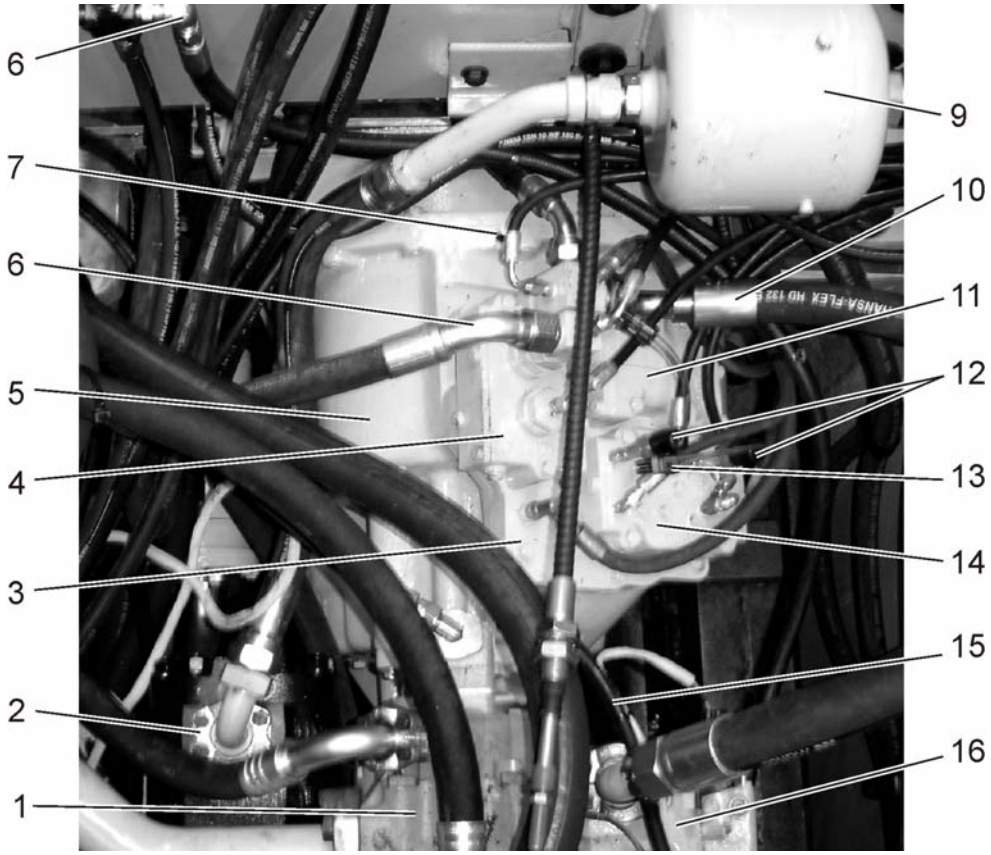

Fig. 7C.2. Transmission Disconnecting Points (Top View)

1. Hydraulic Equipment Pump
2. Charge and Scavenge Pump
3. Transmission Manifold
4. Pressure Regulator Valve
5. Transmission
6. TC Supply Hose
7. Eyebolt Hole
8. Fan Motor Drain Hose
9. Hydraulic Damper
10. Pressure Regulator Valve Supply Hose
11. Rate of Rise Valve
12. Pressure Switches
13. Electrical Harness
14. Range Selector Valve
15. TC Breather Hose
16. Fan Drive Pump

1. Drain the main frame as described in the OPERATOR'S MANUAL.
2. Remove the transmission case guard from bottom of machine.

WARNING! This procedure requires extreme caution. Use suitable blocking equipment while under confines the machine.

3. Remove the ROPS, cab and platform. Refer to SECTION 13, SUPERSTRUCTURE.
4. Disconnect the breather hose (15, Fig. 7C.2) from the transmission (5).
5. Disconnect fan motor drain hose (8) from the cross located on the rear ROPS bracket.
6. Remove the equipment pump (1). Refer to SECTION 10A for removing procedure.
7. Disconnect the electrical harness (13) from the pressure switches (12) located on the range selector valve (14) and remove pressure switches (12).
8. Remove hydraulic damper (9) mounted on the rear ROPS bracket.
9. Disconnect supply hose (10) from the pressure regulator valve (4). Disconnect torque converter supply hose (6) from the pressure regulator valve (4).
10. Remove the hardware securing the range selector valve (14) and pressure regulator valve (4) to the manifold (2) located on top of the transmission (5). Tie the valves (with hoses still attached) up out of the way.

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Fig. 7C.3. Transmission Disconnecting Points (Bottom View)

1. Transmission
2. Suction Strainer Assy
3. Universal Joint
4. Lube Hose
5. Bracket
6. Transmission Scavenge Tube

11. Unscrew bolts securing the bracket (5, Fig. 7C.3) to the transmission (1). Disconnect the transmission scavenge tube (6) from the transmission (1).
12. Remove the strainer (2, Fig. 7C.4) from the transmission (1).
13. Disconnect lube hose (4, Fig. 7C.3) from the transmission (1).
14. Unscrew bolts securing suction strainer (3, Fig. 7C.5) to the main frame (4) and move suction strainer out of the way.
15. Disconnect the electrical harness from input shaft RPM sensor (5). Remove the sensor (5) from the transmission housing.

NOTE: *Before removing the universal joint, wire or tape the bearing caps to prevent them from falling off the spider trunnions.*

16. Remove the bolts securing the universal joint (3, Fig. 7C.3) to the torque converter output flange and the transmission drive yoke. Remove the universal joint (3).
17. Install eyebolts in the threaded hole (7, Fig. 7C.2) 1/2”-13UNC-2B located in the top of the transmission (5).

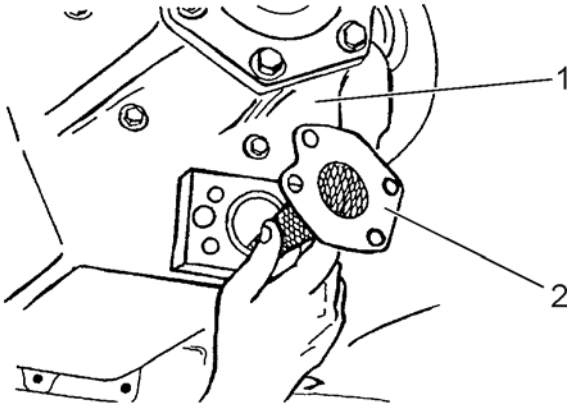

Fig. 7C.4. Scavenge Pump Strainer

1. Transmission 2. Strainer

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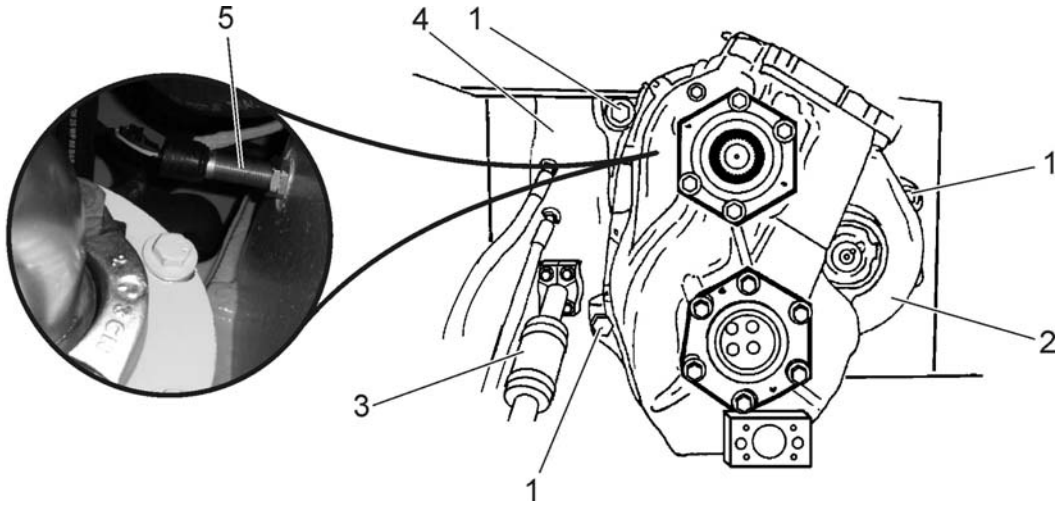

Fig. 7C.5. Transmission Disconnecting Points

1. Mounting Bolt
2. Transmission
3. Suction Strainer Assy
4. Main Frame
5. Transmission Input Shaft RPM Sensor

18. Attach a suitable hoist and sling with a lift hook to the eyebolt in the transmission.
19. Take up the slack in the hoist and remove the three bolts (1, Fig. 7C.5) securing the transmission (2) to the main frame (4). Move the transmission forward to free the output shaft from the steering drive. Lift the transmission up of the machine.

NOTE: *Cover the opening in the main frame to prevent dirt and dust from entering.*

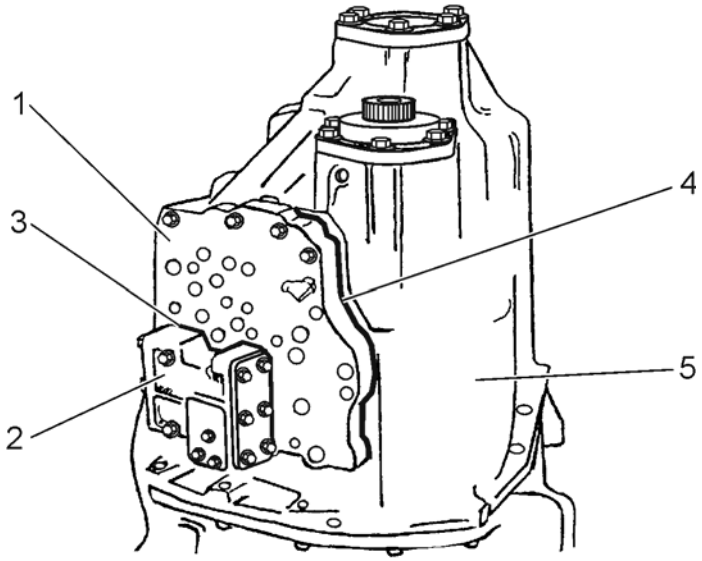

Fig. 7C.6. Removing Transmission Manifold

1. Transmission Manifold
2. Rate of Rise Valve
3. Rate of Rise Valve Gasket
4. Manifold Gasket
5. Transmission

20. Position the transmission assembly on a stand so that transmission cage is up as shown on Fig. 7C.6. Remove the rate of rise valve (2, Fig. 7C.6) with gasket (3).
21. Remove the orifice strainer (3, Fig. 7C.1).
22. Remove the manifold (1, Fig. 7C.6) and manifold gasket (4) from the transmission (5).

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5. DISASSEMBLY

Transmission Housing and Cover (Refer to Fig. 7C.7)

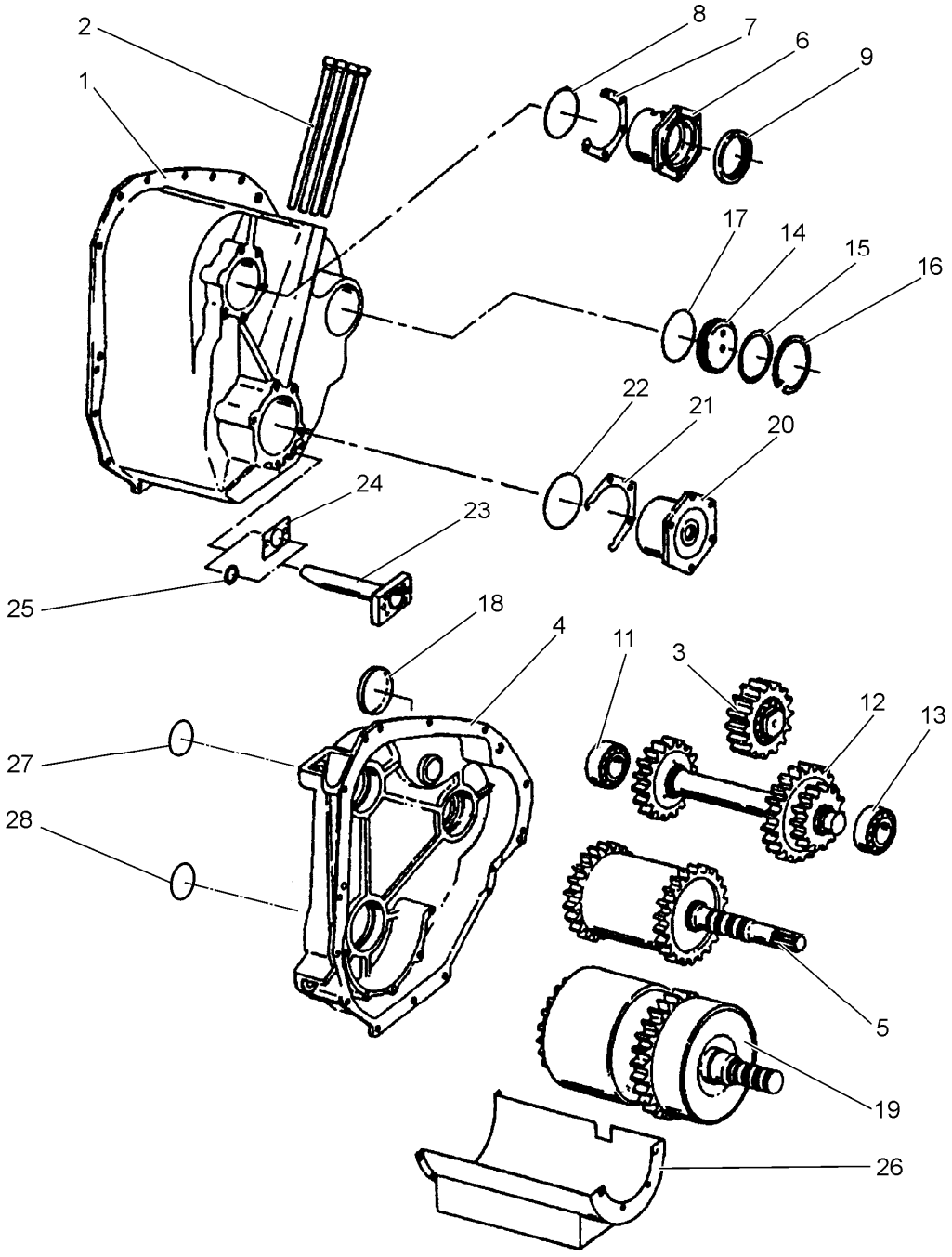

Fig. 7C.7. Exploded View of Transmission

1. Housing
2. Tube
3. Reverse Idler Gear
4. Cover
5. Directional Clutch Shaft
6. Manifold
7. Shim
8. O-Ring
9. Oil Seal
11. Tapered Roller Bearing
12. Countershaft
13. Tapered Roller Bearing
14. Shaft Cover
15. Shim
16. Retaining Ring
17. O-Ring
18. Seal Sleeve
19. Range Clutch Shaft
20. Manifold
21. Shim
22. O-Ring
23. Sump Pipe
24. Gasket
25. O-Ring
26. Baffle
27. O-Ring
28. O-Ring

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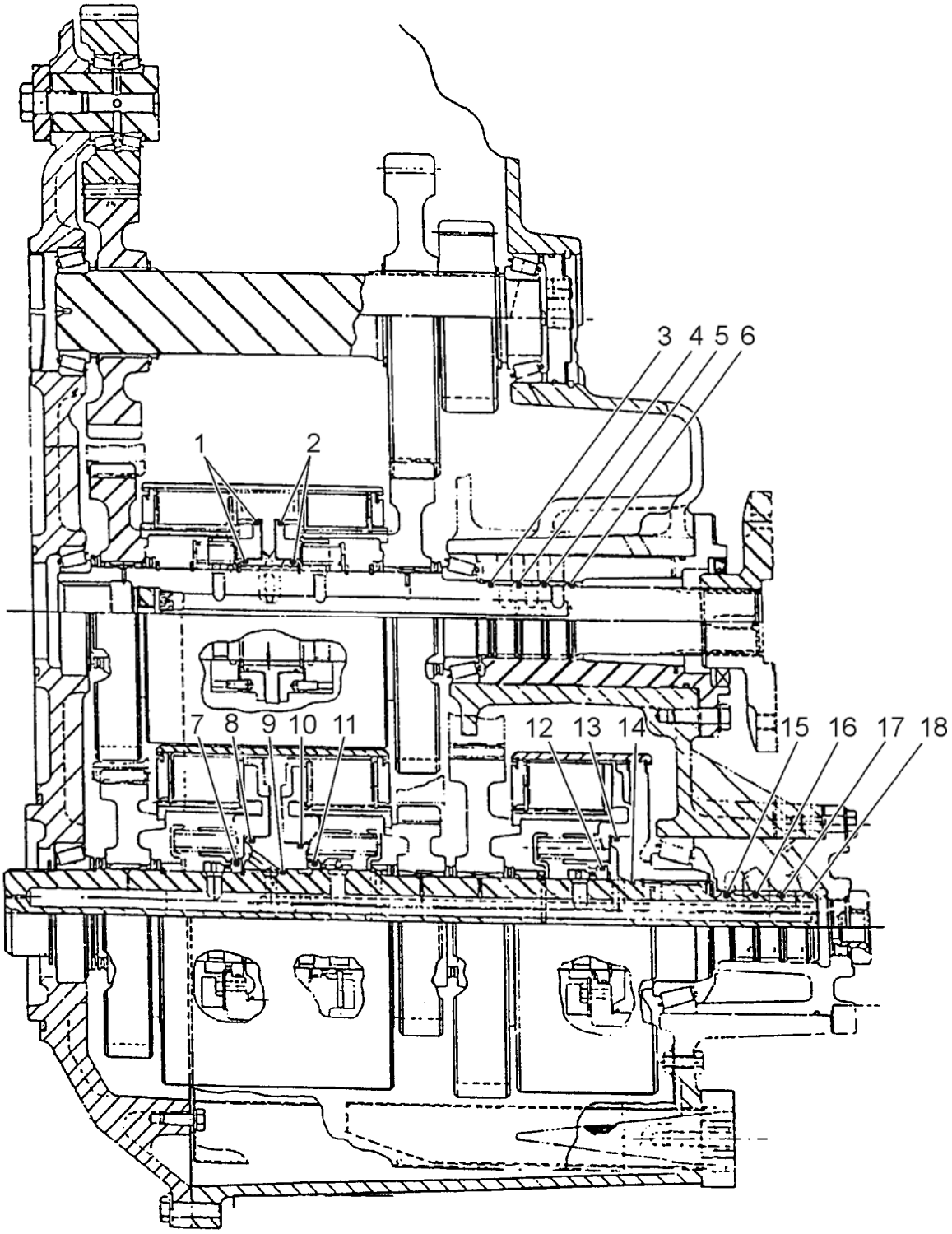

Fig. 7C.7A. Cross Section View of Transmission

1. Reverse Piston Seal Rings
2. Forward Piston Seal Rings
3. Manifold Seal Ring
4. Manifold Seal Ring
5. Manifold Seal Ring
6. Manifold Seal Ring
7. Lube Sleeve Seal Ring
8. 2nd Piston Seal Rings
9. Shaft Seal Rings
10. 3rd Piston Seal Rings
11. Lube Sleeve Seal Ring
12. Lube Sleeve Seal Ring
13. 1st Piston Seal Rings
14. Shaft Seal Rings
15. Manifold Seal Ring
16. Manifold Seal Ring
17. Manifold Seal Ring
18. Manifold Seal Ring

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1. Remove the tubes (2) from the housing (1).
2. Remove the hardware securing manifold (20) and remove the manifold and shims (21). Keep shims (21) with the manifold for proper installation.

NOTE: *Manifold can be removed with a pry bar as shown in Fig.7C.8.*

3. Remove O-ring (22) from manifold (20).
4. Remove the hardware securing manifold (6) and remove the manifold and shims (7). Refer **NOTE** above. Keep shims (7) with the manifold for proper installation.
5. Remove O-ring (8) and oil seal (9) from manifold (6).
6. Remove the two plugs from cover (14). Remove retaining ring (16) and shims (15). Thread a bolt into the center hole of cover (14) and remove the cover as shown in Fig. 7C.9. Remove O-ring (17) from the cover (14). Keep shims (15) with the cover for proper installation.

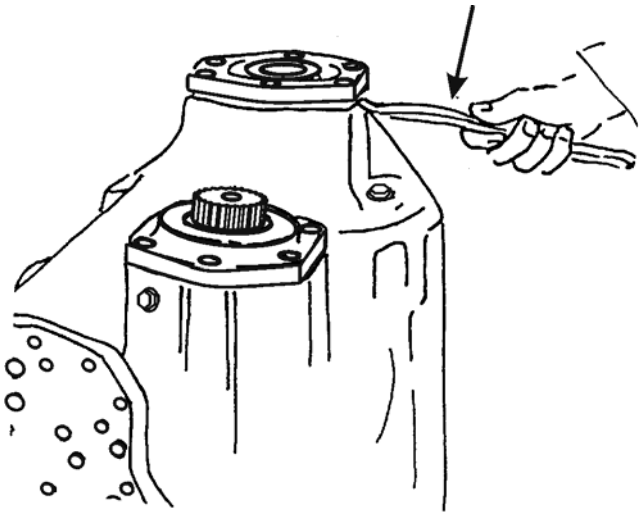

Fig. 7C.8. Manifold Removing

Fig. 7C.9. Countershaft Cover Removing

7. Remove the bolts securing sump pipe (23) and remove the pipe with gasket (24) and O-ring (25).

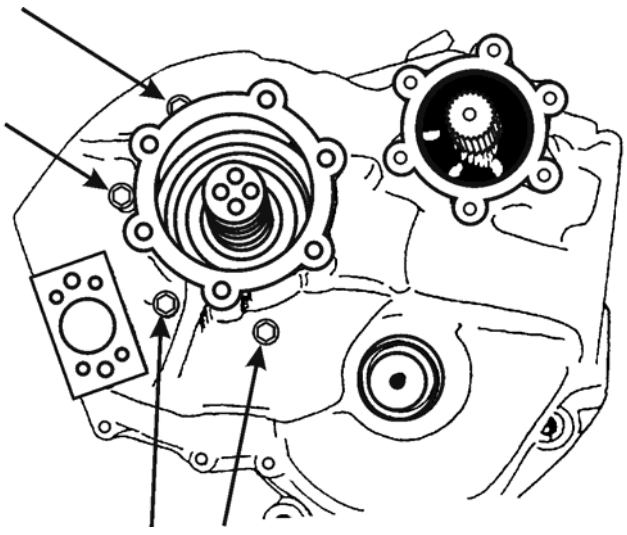

Fig. 7C.10. Baffle to Housing Bolt

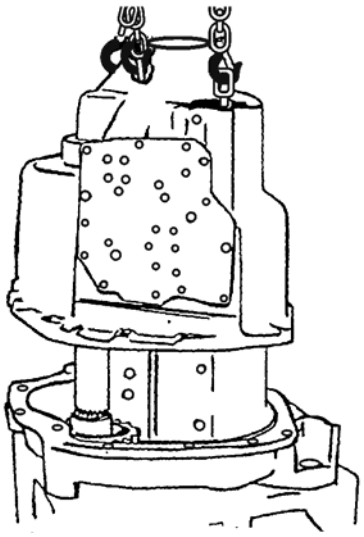

Fig. 7C.11. Transmission Housing Removing

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8. Remove the four bolts and washers securing baffle (26) to housing (1) (Refer to Fig. 7C.10).
9. Remove the bolts and washers securing cover (4) to housing (1). Attach a hoist to housing (1) and apply tension to the hoist. Tap along the seam with a soft mallet until the cover is free of the housing (1). Remove the housing as shown in Fig. 7C.11.
10. Remove the five bolts with washers securing baffle (26) to cover (4). Remove the baffle as shown in Fig. 7C.12.
11. Install an eyebolt 5/8”-13 UNC in the end of range clutch shaft (19) and hoist it up far enough to allow removal of shafts (5 and 12) as shown in Fig. 7C.13.

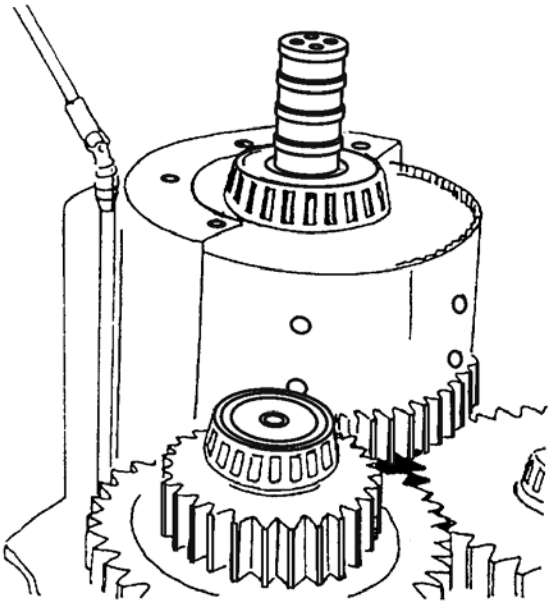

Fig. 7C.12. Baffle to Cover Bolt

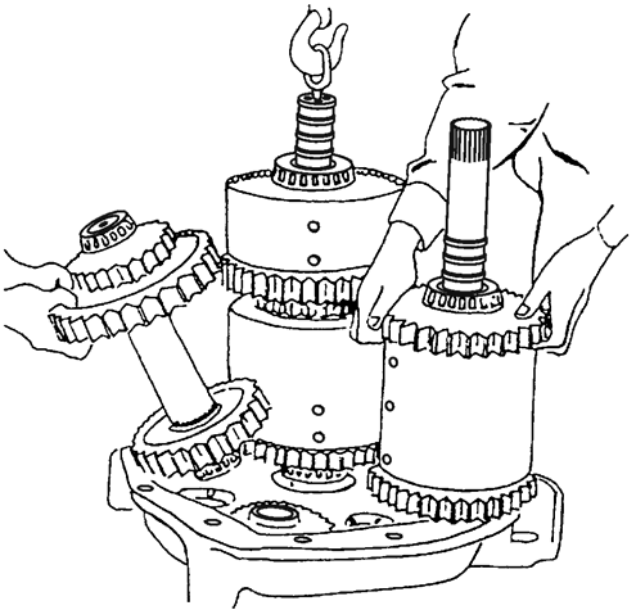

Fig. 7C.13. Removing the Shafts

Reverse Idler Shaft (Refer to Fig. 7C.15)

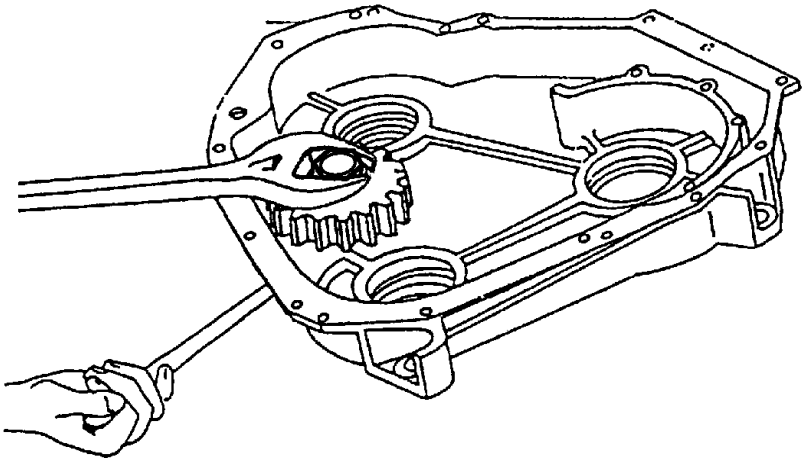

Fig. 7C.14. Removing Reverse Idler Shaft

12. Remove the bolt (7) securing plate (6) as shown in Fig. 7C.14. Remove plate (6) and O-ring (8). Tap the reverse idler shaft (1) from the cover.

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13. Place the shaft assembly in a press so the shaft (1) points up and the gear (2) supports the assembly. Using a suitable driver, press the shaft out of the gear. One bearing cone (3) will be pressed off with the gear.
14. Remove the spacer (4) from shaft (1).
15. If bearing(s) or gear replacement is necessary remove the bearing cups from both ends of the gear.

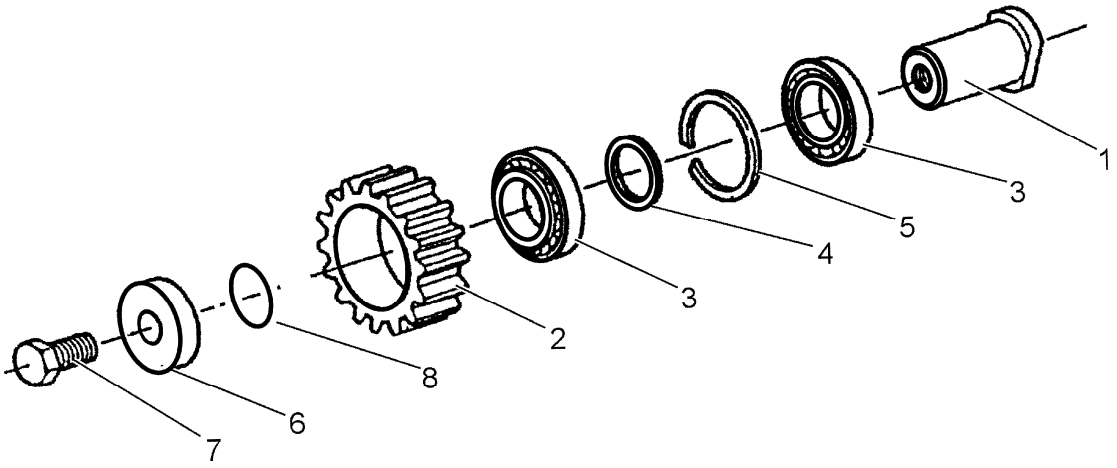

Fig. 7C.15. Reverse Idler Shaft

1. Reverse Idler Gear Shaft	3. Tapered Roller Bearing	5. Retaining Ring	7. Bolt
2. Reverse Idler Gear	4. Bearing Cone Spacer	6. Plate	8. O-Ring

NOTE: *An internal retaining ring (5) separates the two cups inside gear (2).*

16. If bearing or shaft replacement is necessary, press bearing cone (3) off shaft (1).

Countershaft (Refer to Fig. 7C.16)

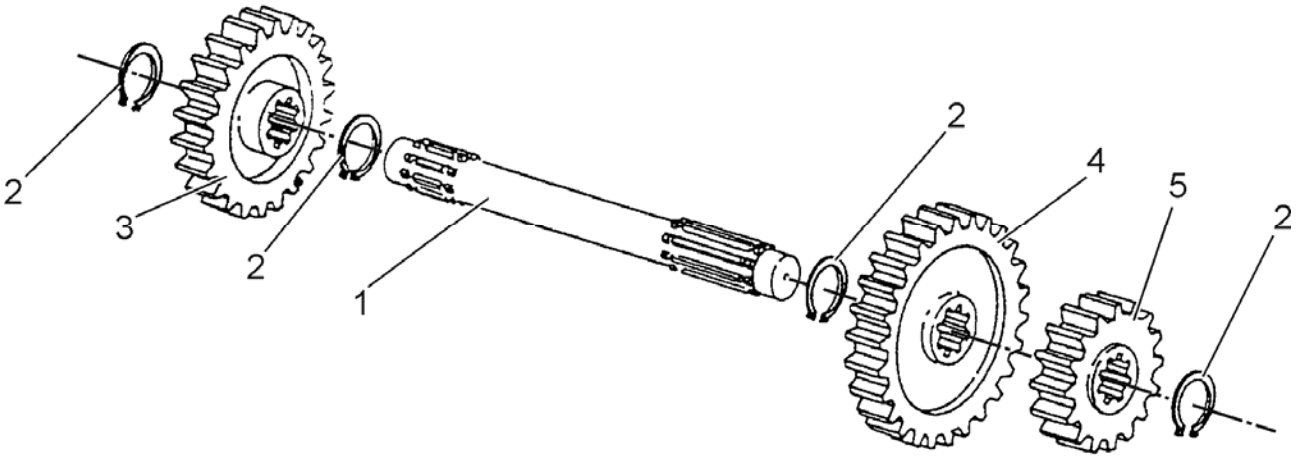

Fig. 7C.16. Exploded View of Countershaft

1. Countershaft	3. Reverse Idler Gear	5. First Drive Gear
2. Retaining Ring	4. Forward Driven Gear	

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17. Set the shaft on a stand so that gear (5) is up. Remove bearing cone (13, Fig. 7C.7) as shown in Fig.7C.17.
18. Turn the shaft over the stand so that gear (3) is up. Remove retaining ring (2) from its groove and slide the retaining ring and gear (3) down onto gear (4) as shown in Fig. 7C.18.

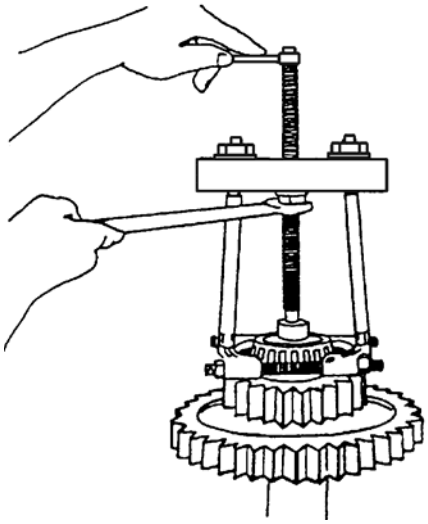

Fig. 7C.17. Removing Bearing Cone

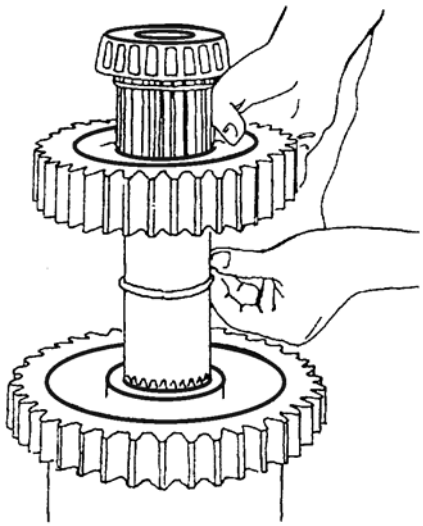

Fig. 7C.18. Lowering Reverse Driven Gear

19. Remove bearing cone (11, Fig. 7C.7) as shown in Fig.7C.19. Disassemble component parts in the order (2, 3, 2, 2, 4, 5 and 2) using a press.
20. If bearings (11 and 13, Fig. 7C.7) were replaced, remove bearing cup (11) from cover (4) and remove bearing cup (13) from housing (1).

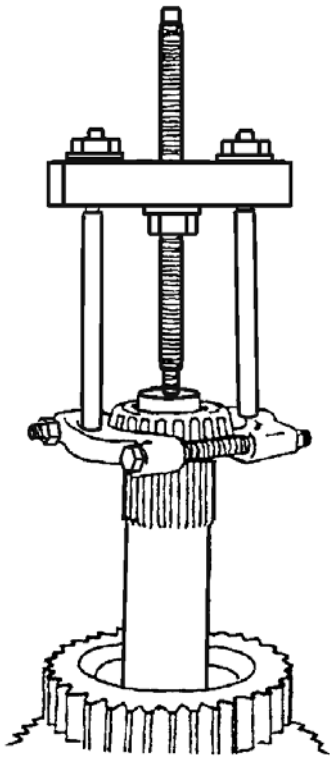

Fig. 7C.19. Removing Bearing Cone

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Directional Clutch Shaft (Input Shaft) (Refer to Fig. 7C.20)

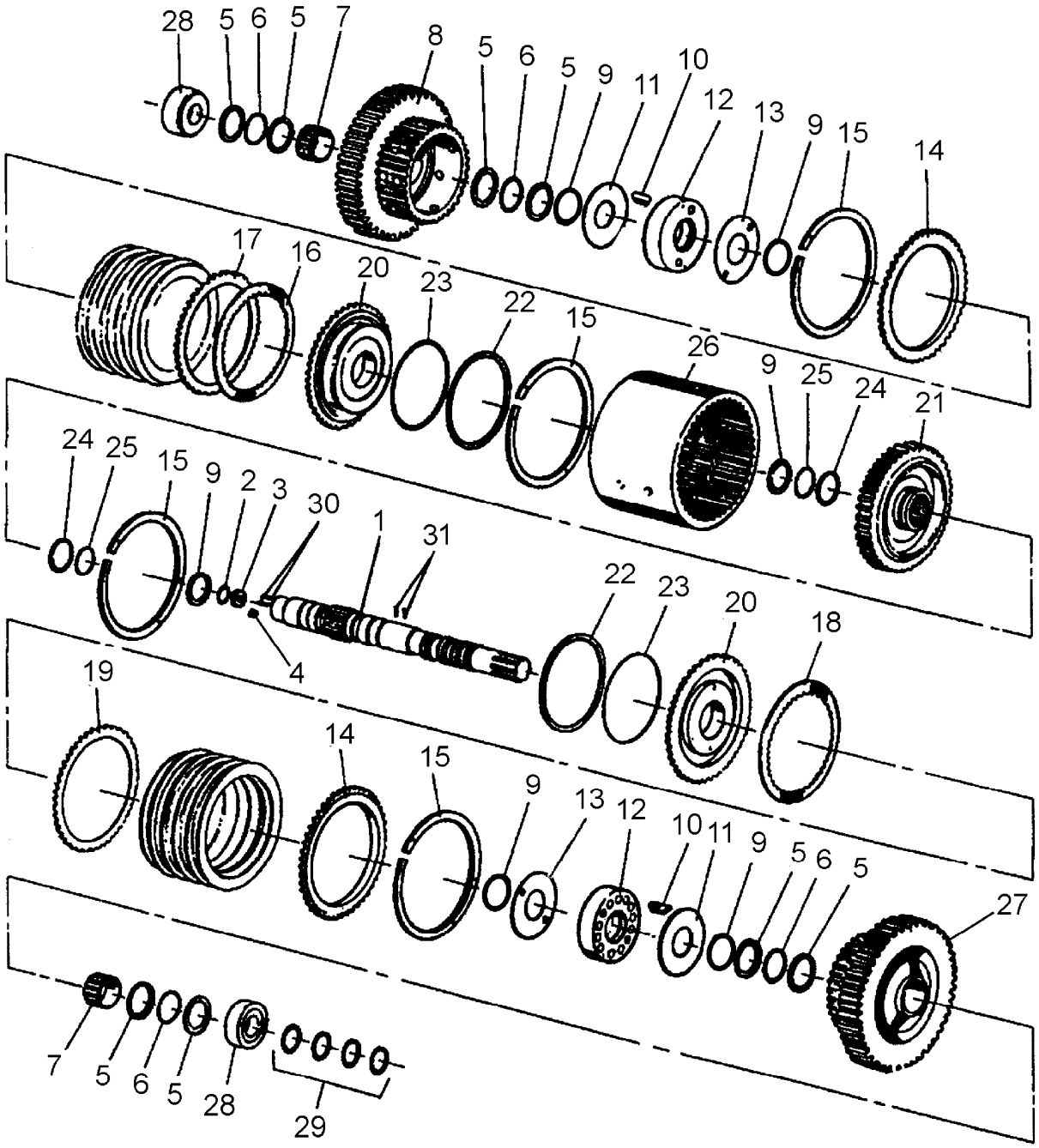

Fig. 7C.20. Exploded View of Directional Clutch Shaft

1. Input Shaft
2. Retaining Ring
3. Shaft Adapter
4. Metering Plug
5. Thrust Race
6. Thrust Bearing
7. Roller Bearing
8. Reverse Driver Gear
9. Retaining Ring
10. Piston Spring
11. Spring Plate
12. Lube Sleeve Assy
13. Spring Retainer Plate
14. Clutch Support Plate
15. Retaining Ring
16. Friction Disc
17. Separator Plate
18. Friction Disc
19. Separator Plate
20. Clutch Piston
21. Clutch Hub
22. Seal Ring
23. O-Ring
24. Seal Ring
25. O-Ring
26. Clutch Drum
27. Forward Driver Gear
28. Tapered Roller Bearing
29. Shaft Seal Ring
30. Dowel Pin
31. Spring Pin

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21. Place the shaft in a suitable stand so that the reverse driver gear (8) is up. Remove bearing cone (28) using the gear (8) as the puller as shown in Fig. 7C.21.

NOTE: *Bearing cup (28) was removed with cover (4, Fig. 7C.7). If bearing replacement is necessary, remove bearing cup from the cover.*

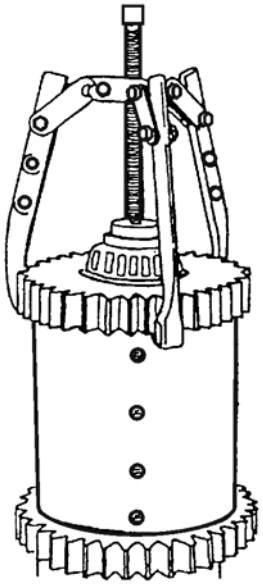

Fig. 7C.21. Removing Bearing Cone

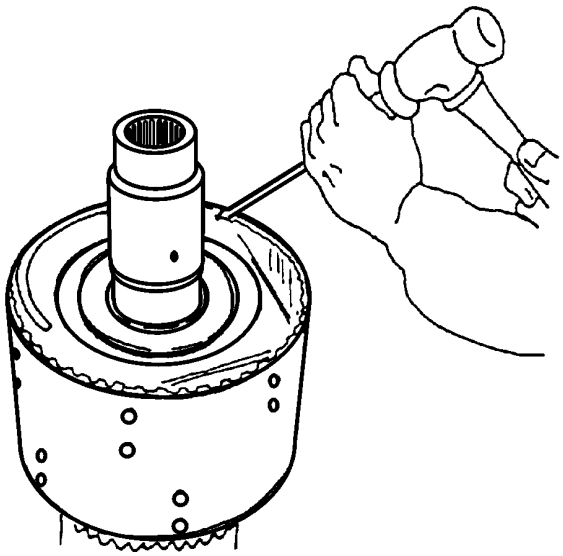

Fig. 7C.22. Removing Retaining Ring

22. Disassemble component parts (5, 6, 5, 8, 7, 5, 6 and 5) in sequence indicated.
23. Remove retaining ring (15) as shown in Fig. 7C.22.
24. Lift parts (14, 16 and 17) out of drum (26).
25. Compress springs (10) by pressing down on plate (11) with C clamp as shown in Fig. 7C.23 and remove retaining ring (9).

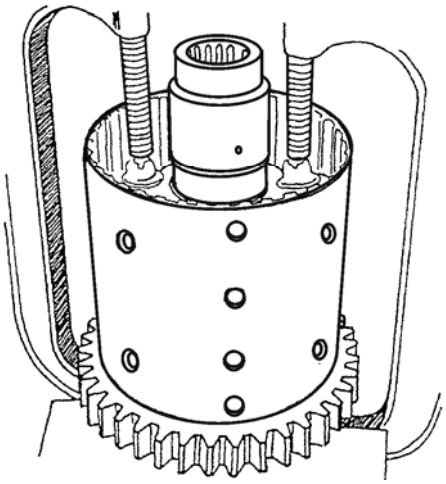

Fig. 7C.23. Compressing Piston Springs

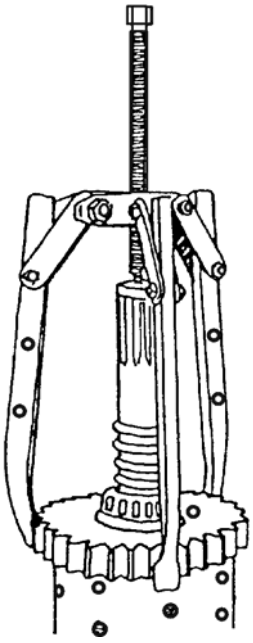

Fig. 7C.24. Removing Bearing Cone

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26. Disassemble component parts (11, 10, 12, 13 and 9) in sequence indicated.
27. Lay the shaft on its side and apply compressed air in center port closest of shaft (1) to remove piston (20). Remove seal ring (22) and O-ring (23) from piston (20).
28. Place the shaft in the stand so that forward driver gear (27) is up. Remove the seal rings (29) from shaft (1).
29. Remove bearing cone (28) using the gear (27) as the puller as shown in Fig. 7C.24.

NOTE: *Bearing cup (28) was removed with housing (1, Fig. 7C.7). If bearing replacement is necessary, remove bearing cup from the housing.*

30. Disassemble component parts (5, 6, 5, 7, 5, 6 and 5) in sequence indicated.
31. Remove retaining ring (15) as shown in Fig. 7C.25.
32. Remove component parts (14, 18 and 19) in sequence indicated.
33. Compress springs (10) by pressing down on plate (11) with C clamps as shown in Fig. 7C.25A and remove retaining ring (9).
34. Disassemble component parts (11, 10, 12, 13, and 9) in sequence indicated.

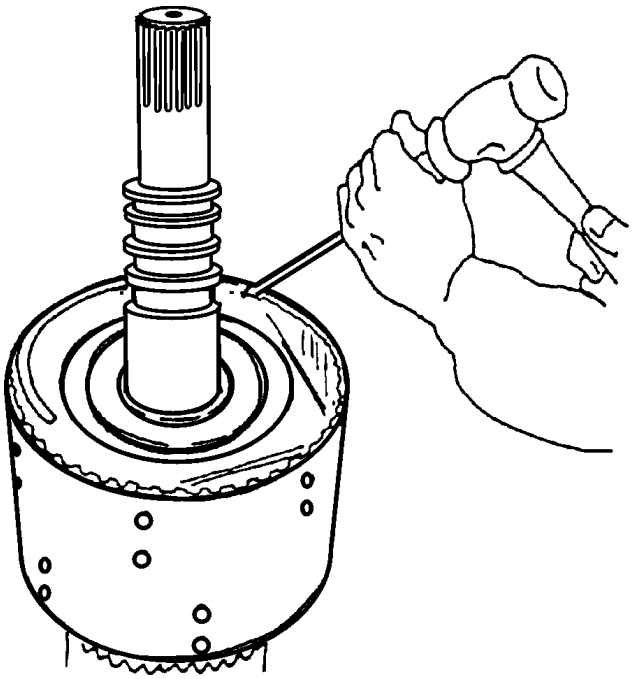

Fig. 7C.25. Removing Retaining Ring

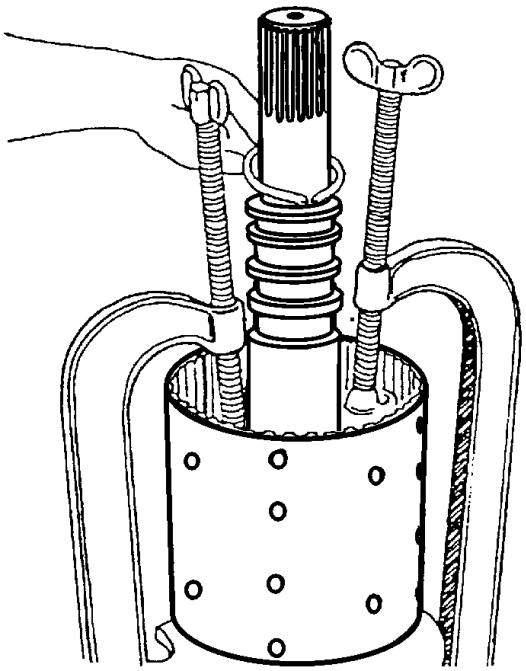

Fig. 7C.25A. Compressing Piston Springs

35. Lay the shaft on its side and apply compressed air in the shaft hole closest to the clutch pack to remove piston (20). Remove seal ring (22) and O-ring (23) from piston (20).
36. Remove retaining ring (15) and remove the shaft (1) from drum (26). Second retaining ring (15) need not be removed unless replacement is necessary.
37. Remove snap ring (9) and press hub (21) off the shaft (1).
38. Remove component parts (24 and 25) from hub (21). Second retaining ring (9) from shaft need not be removed unless replacement is necessary. Disassemble component parts (2, 3, 30, 4 and 31) in sequence indicated.
39. If bearings (28) were replaced, remove bearing cup (28) from cover (4, Fig. 7C.7) and remove second bearing cup (28) from housing (1, Fig. 7C.7).

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Range Clutch Shaft (Output Shaft) (Refer to Fig. 7C.26)

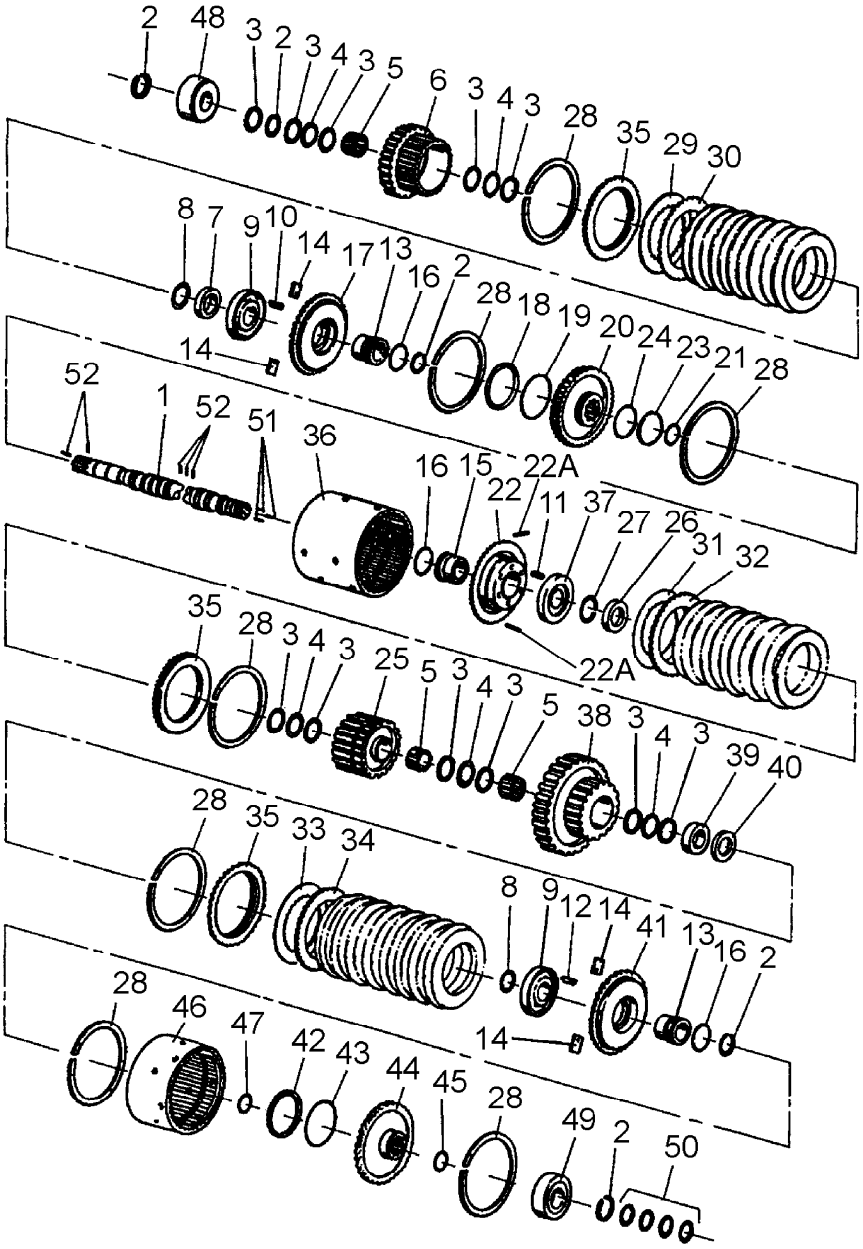

Fig. 7C.26. Exploded View of Range Clutch Shaft

1. Output Shaft
2. Retaining Ring
3. Thrust Washer
4. Thrust Bearing
5. Roller Bearing
6. Second Clutch Gear
7. Spacer Ring
8. Retaining Ring
9. Spring Retainer Plate
10. Return Spring
11. Return Spring
12. Return Spring
13. Sleeve
14. Retainer Plate
15. Sleeve
16. O-Ring
17. Second Clutch Piston
18. Seal Ring
19. O-Ring
20. Second and Third Hub
21. Seal Ring
22. Third Clutch Piston
22A. Dowel Pin
23. Seal Ring
24. O-Ring
25. Third Clutch Gear
26. Spacer
27. Retaining Ring
28. Retaining Ring
29. Friction Disc
30. Separator Plate
31. Friction Disc
32. Separator Plate
33. Friction Disc
34. Separator Plate
35. Clutch Support Plate
36. Second and Third Drum
37. Retainer Plate
38. First Clutch Gear
39. Bushing Spacer
40. Spacer Ring
41. First Clutch Piston
42. Seal Ring
43. O-Ring
44. First Gear Hub
45. Retaining Ring
46. First Gear Drum
47. O-Ring
48. Tapered Roller Bearing
49. Tapered Roller Bearing
50. Seal Ring
51. Dowel Pin
52. Spring Pin

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40. Place the shaft in a suitable stand so that the single clutch pack is up.
41. Remove seal rings (50) and retaining ring (2) from the shaft (1). Remove retaining ring (28) and retaining ring (45).
42. Remove first gear hub (44) with bearing cone (49) as shown in Fig. 7C.27. Remove seal ring (42) and O-ring (43) from hub (44). Do not remove bearing cone (49) unless replacement is necessary.

NOTE: *Bearing cup (49) was removed with housing (1, Fig. 7C.7). If bearing replacement is necessary, remove bearing cup from the housing.*

43. Remove O-ring (47) from output shaft (1) and remove retaining ring (28) from drum (46).
44. Compress springs (12) by pressing down on piston (41) with C clamps as shown in Fig. 7C.28 and remove retaining ring (2).

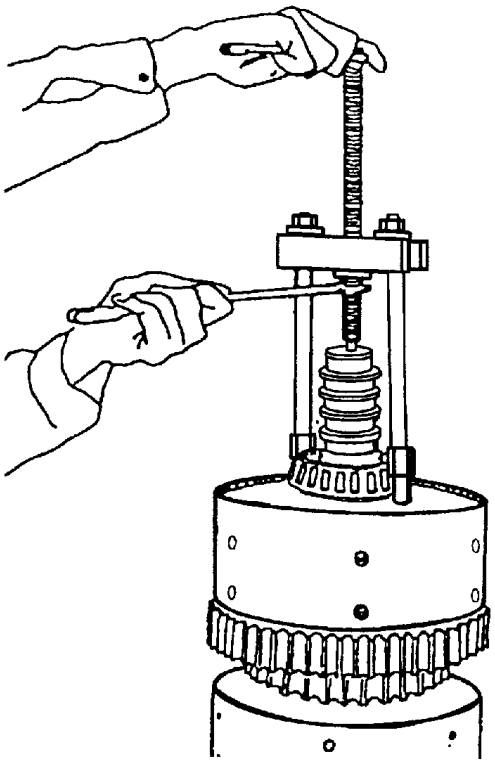

Fig. 7C.27. Removing Hub with Bearing Cone

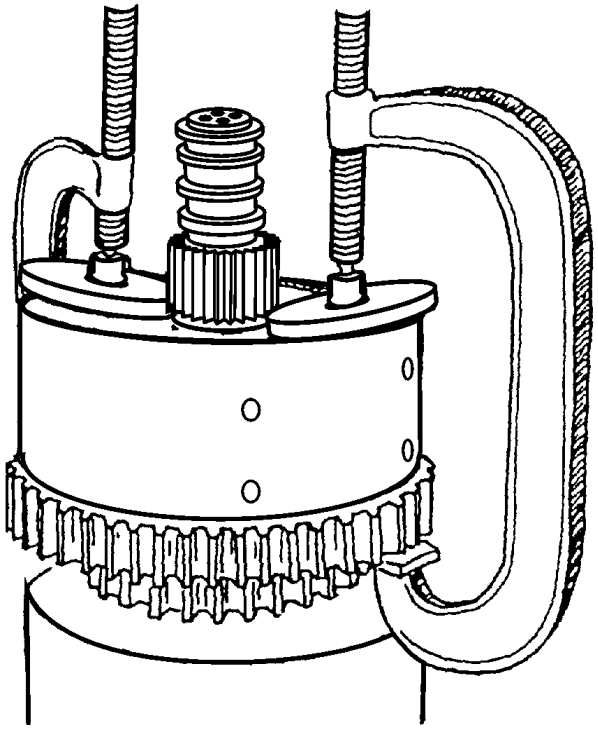

Fig. 7C.28. Compressing Return Springs

45. Remove parts (41, 14, 13, 16, 33, 34, 28, 35 and 46) as an assembly by lifting drum (46) off the output shaft (1). Set the assembly on a bench and disassemble component parts (41, 14, 13, 16, 33, 34, 28, 35 and 46) in the sequence indicated.
46. Disassemble component parts (12, 9, 8, 40, 39, 3, 4, 3, 38, 5, 3, 4, 3, 25, 5, 3, 4, 3 and 26) in the sequence indicated.
47. Remove retaining ring (28) as shown in Fig. 7C.29.
48. Disassemble component parts (35, 31 and 32) in reference number sequence.
49. Compress springs (11) by pressing down on plate (37) with C clamps as shown in Fig. 7C.30 and remove retaining ring (27).
50. Remove plate (37) and springs (11) from the output shaft (1).
51. Lay the shaft on its side and remove piston (22) from the output shaft assembly.

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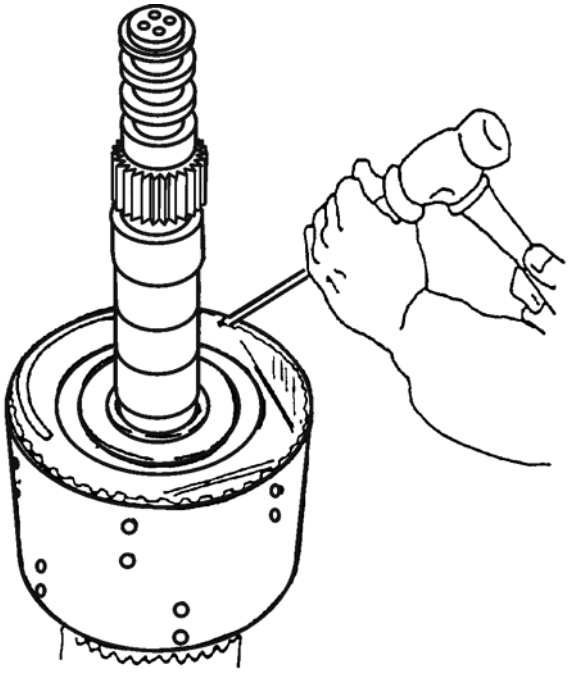

Fig. 7C.29. Removing Retaining Ring

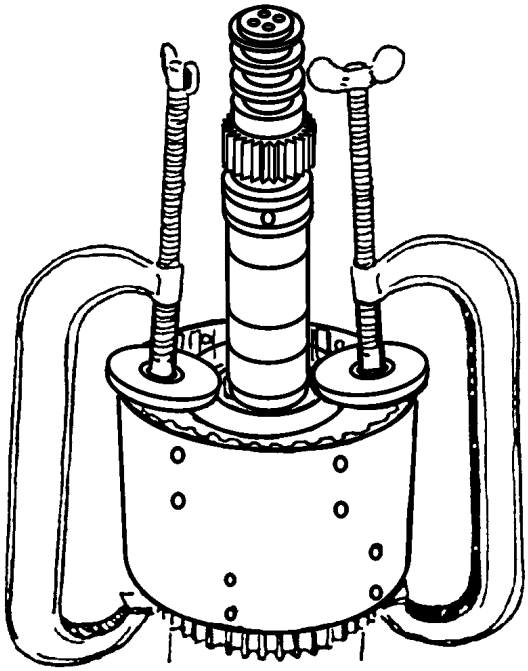

Fig. 7C.30. Compressing Return Spring

52. Drive pins (22A) out of piston (22) as shown in Fig. 7C.31. Remove sleeve (15) from the piston (22) and remove O-ring (16) from the sleeve.
53. Place the shaft in the stand so that second clutch gear (6) is up and remove retaining ring (2).
54. Remove the bearing cone (48) with a bearing puller as shown in Fig. 7C.32.

NOTE: *Bearing cup (48) was removed with cover (4, Fig. 7C.7). If bearing replacement is necessary, remove bearing cup from cover.*

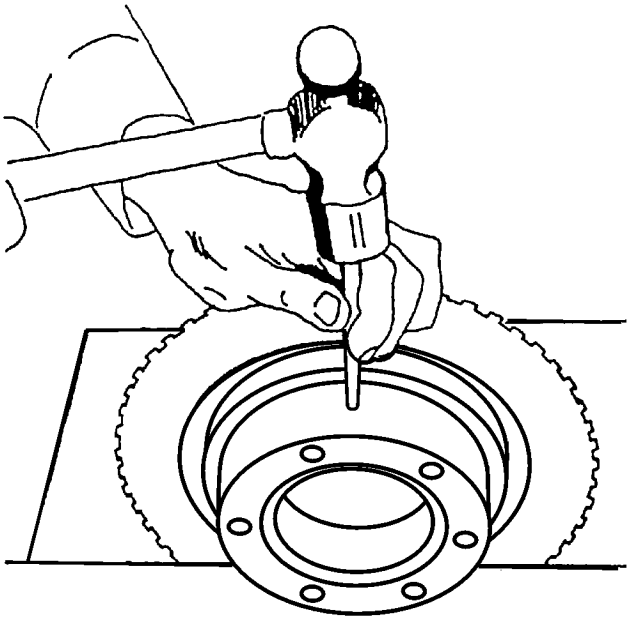

Fig. 7C.31. Removing Dowel Pins

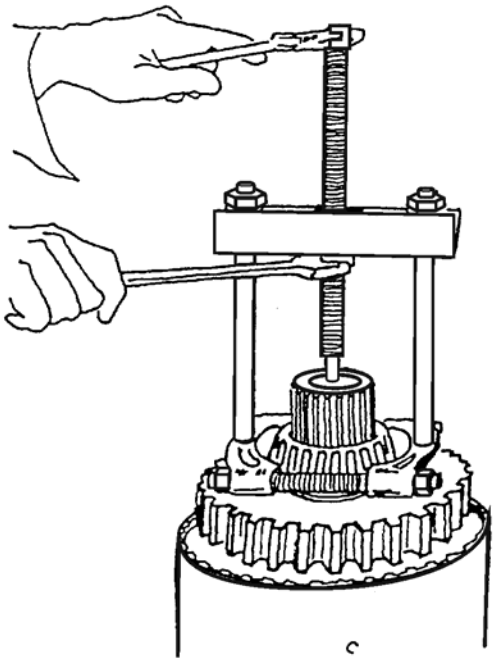

Fig. 7C.32. Removing Bearing Cone

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55. Disassemble component parts (3, 2, 3, 4, 3, 6, 5, 3, 4 and 3) in the sequence indicated.
56. Remove retaining ring (28) as shown in Fig. 7C.29.
57. Disassemble component parts (35, 29, and 30) in reference number sequence.
58. Compress springs (10) by pressing down on plate (9) with C clamp as shown in Fig. 7C.33 and remove retaining ring (8).

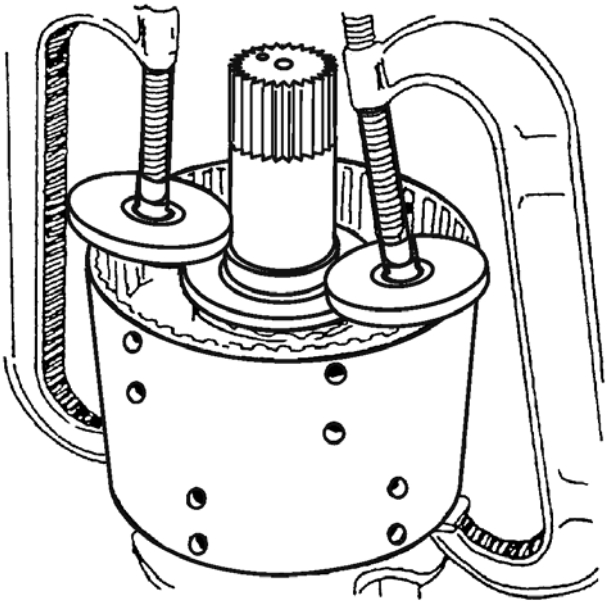

Fig. 7C.33. Compressing Return Spring

59. Disassemble component parts (7, 9, 10, 17, 14, 13, 16, and 28) in sequence indicated.
60. Lift the shaft out of drum (36). Second retaining ring (28) need not be removed from drum (36) unless replacement is necessary.
61. Remove retaining ring (2) and disassemble component parts (18, 19, 20, 23, 24 and 21) in sequence indicated. If necessary, remove parts (51, 52 and 1).

6. INSPECTION AND REPAIR

1. It is recommended that new O-rings be installed whenever the transmission is disassembled for service.
2. Wash all parts thoroughly in a suitable solvent. Dry thoroughly with compressed air or a clean cloth.

NOTE: *Do not spin dry bearings with compressed air.*

3. Inspect bearings for excessive wear or damage and replace if necessary. Reusable bearings should be soaked in clean oil and wrapped with clean paper until ready for reassembly.
4. Inspect the gears for worn, chipped or broken teeth. Replace if wear is excessive or teeth are damaged.
5. Inspect the splines on the shafts and on the gears and drums for wear. Replace shafts if wear is excessive. Slight burrs can be smoothed down with a stone.

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6. Flush all oil passages of the input and output shafts. Be sure all lube holes are clean and free of obstruction.
7. Inspect the clutch plates for excessive wear or warpage and replace if necessary.
8. Using an oil stone, remove any burrs that might damage sealing surfaces or increase wear to close tolerance parts.
9. Check the compression springs for damage and fatigue. If they do not fall within the tolerances given in Paragraph 3, SPECIFICATIONS, they must be replaced.
10. Flush and clean all oil lines and the oil cooler to assure a clean hydraulic system.

7. REASSEMBLY

Range Clutch Shaft (Output Shaft) (Refer to Fig. 7C.26)

1. If removed, install pins (51 and 52) into shaft (1).

NOTE: *Press in five spring pins (52) to shaft holes down to depth of 1.3 [mm] from shaft surface. Do not damage the shaft surface during this process.*
Press in two dowel pins (51) to shaft holes down to shaft surface. Press in third dowel pin (51) to shaft hole down to a depth of 30.5 [mm] from shaft surface. Do not damage the shaft surface during this process.

2. Install seal ring (21) on shaft (1). Reassemble component parts (24, 23, 19 and 18) on hub (20) in sequence indicated.
3. Install the hub assy (20) on the shaft (1) and secure with retaining ring (2).
4. If removed, install retaining ring (28) in the narrower of the two center grooves of drum (36).

NOTE: *When reassembling carefully place the second and third hub (20) over the shaft, insuring the hub clutch oil supply holes are aligned with the shaft oil supply holes.*

5. Install shaft (1), manifold end first, in drum (36) and secure with second retaining ring (28).
6. Install sleeve (13) with new O-ring (16) on the shaft (1).
7. Position retainer plates (14) on piston (17). Apply LOCTITE 262 to the bolts and secure the plates. Torque the bolts to 37 [Nm].
8. Place the shaft assembly (1) in a suitable stand so that the splined end of the shaft is up. Install piston assy (17) on the shaft (1).
9. Install ten springs (10) in second clutch piston (17). Position plate (9) over the springs (10) and compress the springs by pressing down on plate with C clamps as shown in Fig. 7C.34. Install spacer ring (7) and retaining ring (8) remove the C clamps.
10. Alternately install one internally splined friction disc (29) and one externally splined separator plate (30) in drum (36). There are thirteen discs (29) and twelve plates (30) used in this clutch pack.
11. Reassemble component parts (35, 28, 3, 4 and 3) in sequence indicated.
12. Position second clutch gear (6) over the end of the shaft (1). Be sure all the internally splined discs (29) are aligned in drum (36) and that the gear meshes with all the discs.
13. Install bearing (5) in the bore of gear (6). Install component parts (3, 4, 3, 2 and 3) in sequence indicated.
14. Heat bearing cone (48) to 135 [°C] for 45 minutes and install on the shaft (1) until it bottoms. To assure cone is seated, keep pressure against the cone until it cools down a few seconds.

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15. Install retaining ring (2) on the shaft (1).
16. Turn the shaft assembly over in the stand so that the splined end is down.
17. Install sleeve (15) with new O-ring (16) in third clutch piston (22) and install dowel pins (22A) Install piston assy (22) on the shaft (1).
18. Install six springs (11) in third clutch piston (22). Position plate (37) over the springs (11) and compress by pressing down on plate with C clamps as shown in Fig. 7C.35. Install retaining ring (27) and remove C clamps.

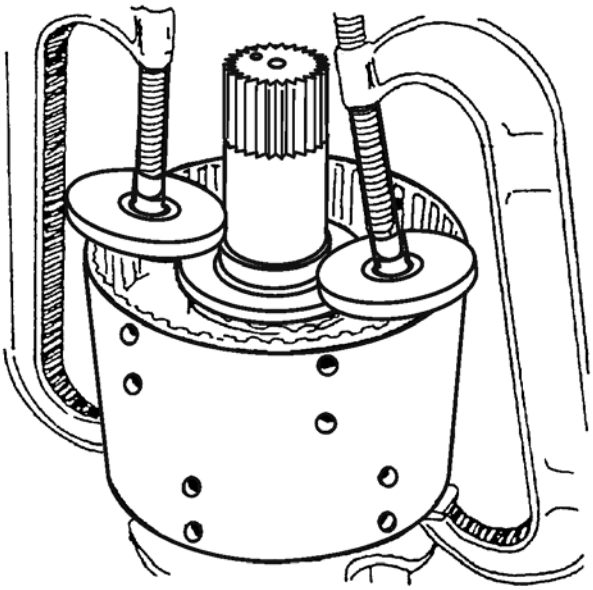

Fig. 7C.34. Compressing Return Springs

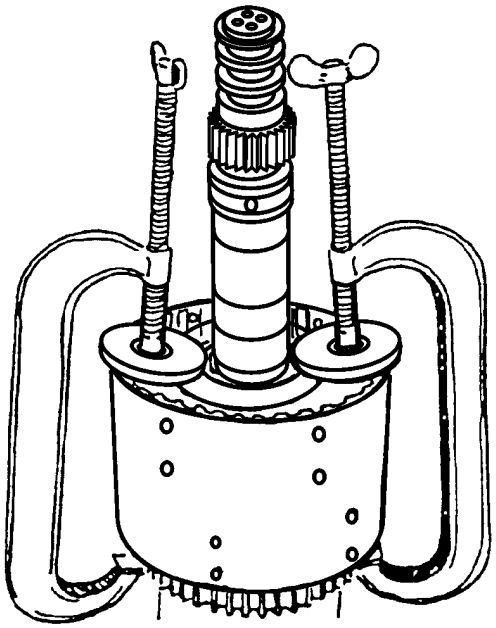

Fig. 7C.35. Compressing Return Springs

19. Alternately install one internally splined friction disc (31) and one externally splined separator plate (32) in drum (36). There are twelve discs (31) and eleven plates (32) used in this clutch pack. Install clutch support plate (35).
20. Install spacer (26), thrust bearing (4) with thrust races (3) on the shaft (1).
21. Position third clutch gear (25) over the end of the shaft (1). Be sure all the internally splined discs (31) are aligned in drum (36) and that the gear meshes with all the discs. Install retaining ring (28).
22. Install bearing (5) in the bore of gear (25).
23. Install thrust bearing (4) with thrust races (3), bearing (5) and first clutch gear (38) on the shaft (1). Install following thrust bearing (4) with races (3), bushing (39), spacer ring (40), retaining ring (8) and spring retainer plate (9).
24. Position clutch support plate (35) in drum (46) and install retaining ring (28).
25. Position drum (46) over the end of the shaft so that the support plate (35) is down and resting on first clutch gear (38).
26. Alternately install one internally splined friction disc (33) and one externally splined separator plate (34) in drum (46). There are fourteen discs (33) and thirteen plates (34) in this clutch pack.
27. Install sleeve (13) with new O-ring (16) in the bore of first clutch piston (41). Position retainer plates (14) on piston (41). Apply LOCTITE 262 to the bolts and secure the plates. Torque the bolts to 37 [Nm].
28. Coat springs (12) with grease and inserts them in first clutch piston (41). Position the piston assy (41) over the shaft (1) so the springs (12) rest inside plate (9).

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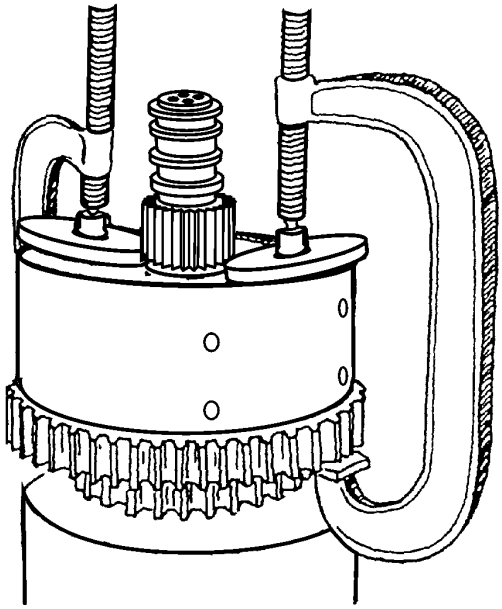

Fig. 7C.36. Compressing Return Springs

29. Compress springs (12) as shown in Fig. 7C.36 and install retaining ring (2).
30. Install retaining ring (28) in drum (46). Install O-ring (47) on shaft (1). Install new O-ring (43) and seal ring (42) on hub (44). Install hub (44) into drum (46) and secure with retaining ring (28) and retaining ring (45).
31. If bearing cone (49) was removed, heat new bearing cone to 135 [°C] for 45 minutes and install on first gear hub (44) until it bottoms. To assure cone is properly seated on hub (44), keep pressure against the cone until it cools down a few seconds.
32. Reassemble component parts (2 and 50) in sequence indicated.
33. If bearings (48 and 49) were replaced, press new bearing cup (48) in cover (4, Fig. 7C.7) and press new bearing cup (49) in housing (1, Fig. 7C.7) with depth not less than 0.04 [mm].

Directional Clutch Shaft (Input Shaft) (Refer to Fig. 7C.20)

34. If removed, install pins (30 and 31) into the shaft (1). Install metering plug (4).

NOTE: *Press in spring pins (31) to shaft holes down to depth of 1.3 [mm] from shaft surface. Do not damage the shaft surface during this process.*

35. Press in dowel pins (30) to shaft holes down to shaft surface. Press in metering plug (4) to shaft holes down to a depth of 30.5 [mm] from shaft surface. Do not damage the shaft surface during this process.
36. Reassemble adapter shaft (3) and secure with retaining ring (2).
37. Install retaining ring (9) if it was removed. Heat the hub (21) to 200 [°C] and press it on the shaft (1) until it bottoms on retaining ring (9). Reinstall second retaining ring (9). Install new O-rings (25) and new seal rings (24) on hub (21).
38. If removed, install retaining ring (15) in the narrower of the two center grooves of drum (26).
39. Install the hub (21) with shaft (1), end with adapter (3) first, in drum (26) and secure with second retaining ring (15).

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40. Place the shaft in a suitable stand so that the splined end is up.
41. Install new O-ring (23) and seal ring (22) on clutch piston (20) and install piston on hub (26).
42. Install spring retainer plate (13) and sleeve (12) on shaft (1). Install fourteen springs (10) and spring retainer plate (11).
43. Compress springs (10) by pressing down on plate (11) with C clamps as shown in Fig. 7C.37 and install retaining ring (9).
44. Alternately install one internally splined friction disc (18) and one externally splined separator plate (19) in drum (26). There are thirteen friction discs (18) and twelve plates (19) used in this clutch pack.

IMPORTANT: *The internally splined friction discs must be thoroughly oiled (with same oil as used in the transmission) prior to assembling in the drum. Because the facing is porous and absorbs oil, a light oiling with an oil can may not be sufficient. Whenever possible, the plates must be soaked for at least two minutes, in a container of clean transmission oil. If facilities are not available for soaking, a heavy oiling on both surfaces may be sufficient.*

45. Install clutch support plate (14) with retaining ring (15). Install retaining ring (9) and thrust bearing (6) with thrust races (5).
46. Position forward driver gear (27) over the end of the shaft (1). Be sure all the internally splined discs (18) are aligned in drum (26) and that the gear meshes with all the discs.
47. Install bearing (7) in the bore of gear (27).
48. Reassemble thrust bearing (6) with thrust races (5).
49. Heat bearing cone (28) to 135 [°C] for 45 minutes and install on the shaft (1) until it bottoms. To assure cone is seated, keep pressure against the cone until it cools down a few seconds.
50. Install seal rings (29) on the shaft (1).
51. Turn the shaft assembly over in the stand so that the splined end is down.
52. Install new O-ring (25) and new seal ring (24) on hub (21). Install new O-ring (23) and seal ring (22) on clutch piston (20) and install the piston in drum (26).
53. Reassemble component parts (9, 13, 12A, 12, 10 and 11) in sequence indicated.
54. Compress springs (10) by pressing down on plate (11) with C clamps as shown in Fig. 7C.38 and install retaining ring (9).

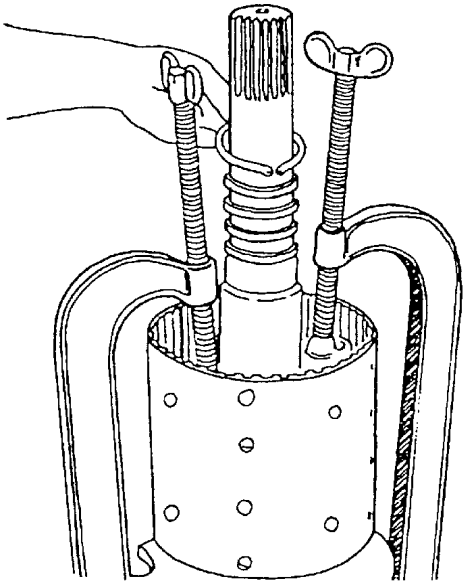

Fig. 7C.37. Compressing Return Springs

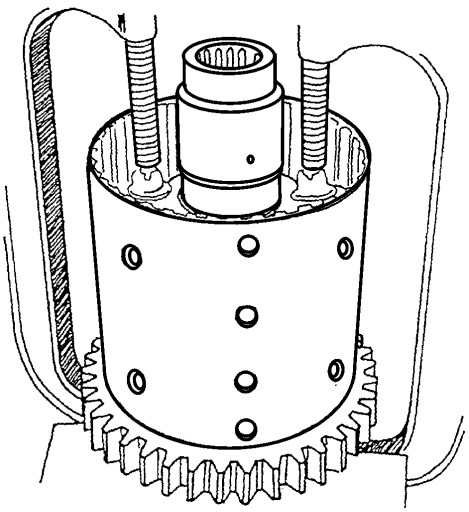

Fig. 7C.38. Compressing Return Springs

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55. Thoroughly oil friction discs (16) as described above. Alternately install one internally splined friction disc (16) and one externally splined separator plate (17) in drum (26). There are fifteen discs (16) and fourteen plates (17) used in this clutch pack.
56. Install clutch support plate (14) with retaining ring (15). Install retaining ring (9) and thrust bearing (6) with thrust races (5).
57. Position reverse driver gear (8) over the end of the shaft (1). Be sure all the internally splined discs (16) are aligned in drum (26) and that the gear meshes with all the discs.
58. Install bearing (7) in the bore of gear (8).
59. Reassemble thrust bearing (6) with thrust races (5).
60. Heat bearing cone (28) to 135 [°C] for 45 minutes and install on the shaft (1) until it bottoms. To assure cone is seated, keep pressure against the cone until it cools down a few seconds.
61. If bearings (28) were replaced, press new bearing cup (28) in cover (4, Fig. 7C.7) and press new bearing cup (28) in housing (1, Fig. 7C.7) with depth not less than 0.04 [mm].

Countershaft (Refer to Fig. 7C.16)

62. Install retaining rings (2) on shaft (1) if removed. Install gear (3) on shaft (1). Install retaining ring (2).
63. Install gear (4) first, then install gear (5) on shaft (1). Install retaining ring (2).

NOTE: *Gears (3,4 and 5) preheating up to to 120 [°C] max is allowed.*

64. Heat bearing cones (11 and 13, Fig. 7C.7) to 135 [°C] for 45 minutes and install on the shaft (1) until bottom. To assure cones are seated, keep pressure against the cones until they cool down a few seconds.
65. If bearings (11 and 13, Fig. 7C.7) were replaced, press new bearing cup (11) in cover (4) and press new bearing cup (13) in housing (1) with depth not less than 0.04 [mm].

Reverse Idler Shaft (Refer to Fig. 7C.15)

66. If bearings (3) or gear (2) were replaced, check that retaining ring (5) is properly seated in the groove inside gear (2) and press one bearing cup (3) in the gear bore until it bottoms on retaining ring (5). Turn the gear (2) over and press the second bearing cup (3) in the gear bore until it bottoms on retaining ring (5).
67. If bearings (3) or shaft (1) was replaced, heat bearing cone (3) to 135 [°C] for 45 minutes and install on shaft (1) until it bottoms. To assure cone is seated, keep pressure against the cone until it cools a few seconds.
68. Install spacer (4) on the shaft (1) and insert the shaft through gear (2).
69. Heat second bearing cone (3) to 135 [°C] for 45 minutes and install on shaft (1) until it bottoms against spacer (4). To assure cone is seated, keep pressure against the cone until it cools a few seconds.
70. Insert the shaft assembly (1) into the transmission cover (4, Fig. 7C.7).
71. Install O-ring (8) and plate (6) on the outside of the transmission cover (4, Fig. 7C.7) and secure with bolt (7). Torque the bolt to 325 [Nm].

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Transmission Housing and Cover (Refer to Fig. 7C.7)

72. Position cover (4) on a stand as shown in Fig. 7C.39. Attach a hoist to the eyebolt 5/8”-13 UNC range clutch assy (19) and lower the shaft on cover (4). Do not set the shaft all the way down.
73. Install shafts (5 and 12) on cover (4) as shown in Fig. 7C.39 and lower shaft (19) all the way down. Remove the hoist and eyebolt.
74. Position baffle (26) on cover (4) and secure with the five bolts and washers. Torque the bolts with washers to 38 [Nm]. To secure one of the bolts a long extension with a swivel adapter can be inserted in the baffle opening as shown in Fig. 7C.40.

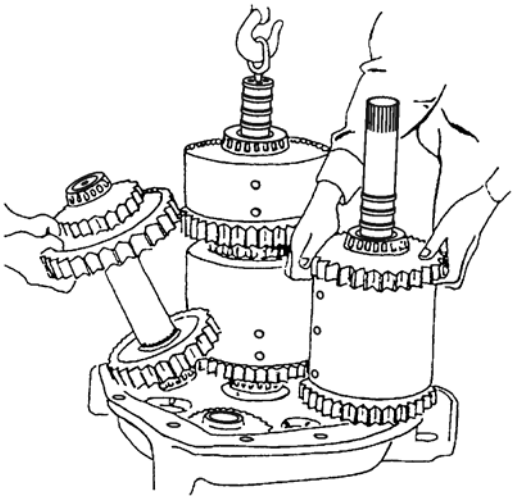

Fig. 7C.39. Shafts Installation

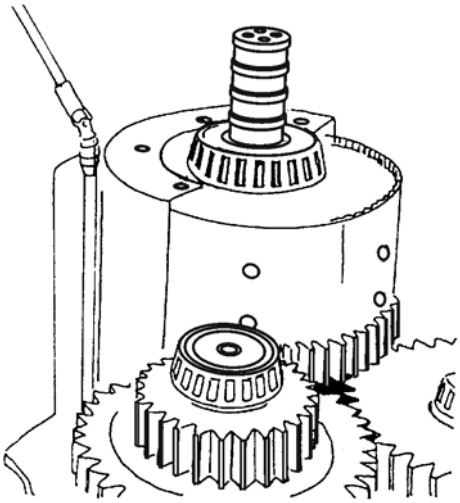

Fig. 7C.40. Baffle to Cover Bolt

75. Insert tubes (2) through the openings in housing (1).
76. Apply LOCTITE #515 to the mating surfaces of cover (4) and housing (1) according to the instructions on the container. Hoist the housing (1) as shown in Fig. 7C.41 and lower it over the shafts, guiding the ends of shafts into their proper bearing cups. Install mounting bolts and washers securing housing (1) to cover (4). Torque the bolts with washer to 92 [Nm].
77. Secure baffle (26) to housing (1) with four bolts and washers previously removed as shown in Fig. 7C.42. Torque the bolts with washer to 38 [Nm].
78. Install sump pipe (23) with gasket (24) and O-ring (25). Secure with two bolts.

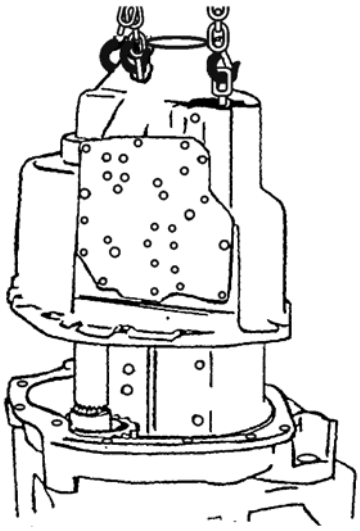

Fig. 7C.41. Transmission Housing Installation

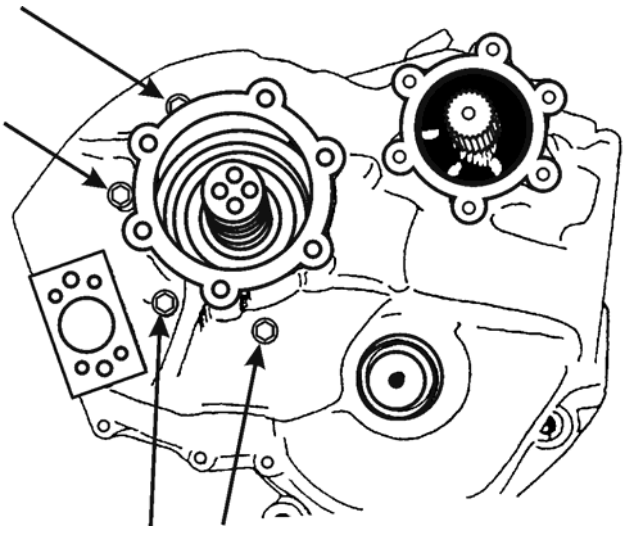

Fig. 7C.42. Baffle to Housing Bolt

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Bearing Adjustment and Checking Procedure

NOTE: *When placing the manifold over the shaft insure the clutch oil supply holes are aligned, if applicable. Never exert a downward force on the manifold as this will damage to seal rings. Support the majority of weight of the manifold during this process. Do not allow the manifold to free fall. If the manifold does not slide fully into place without encountering resistance, lightly tap side of manifold from side to side to align it properly.*

Continue to tap and align manifold sides until the manifold drops over each seal ring. If the manifold fails to drop easily into place, it is an indication that the seal rings may not have been centered on the shaft and may be damaged. If damage is suspected, remove the manifold, inspect the seal ring and repeat the procedure.

Adjust directional clutch (input) shaft, range clutch (output) shaft and countershaft end play to 0.18 – 0.28 [mm]. Lightly grease the directional clutch shaft manifold and range clutch shaft manifold outside diameter and leave O-rings off cover and manifold. To give an excessive initial end play condition for input shaft, when installing the input shaft manifold use an oversize shim pack of 3.05 [mm]. For the range clutch shaft manifold use an oversize shim pack of 4.06 [mm]. With directional clutch shaft manifold and range clutch shaft manifold installed and inclusion of oversize shim packs under the flanges and retained by two opposite bolts, tightened to 80 [Nm] a push / pull operation should be performed to insure that bearing cups and cones are seated in their desired locations.

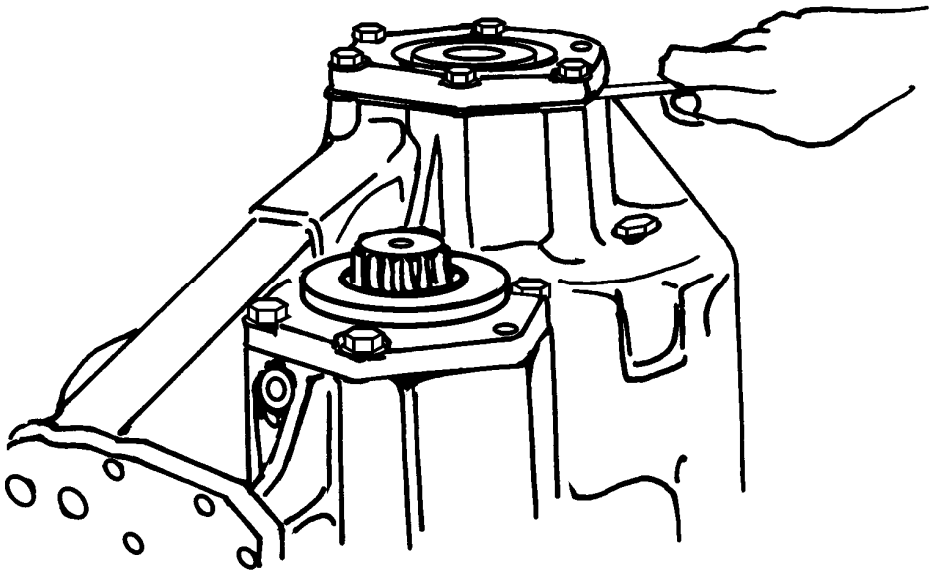

Fig. 7C.43. Measuring Cover and Manifold Gap for Determining Shim Thickness

Tools required for seating cones and cups are puller bridge and 5/8” ball bearing for seating output, input and countershaft bearings in pushing operation.

DIRECTIONAL CLUTCH SHAFT (INPUT SHAFT)

A. Input (Push) Seating Cups in Cover and Housing and Rear Cone on Directional Clutch (Input) Shaft (Refer to Fig. 7C.44)

NOTE: *Directional shaft assembly must have its bearing cones pressed solidly against its respective shoulder before end play (float) is adjusted.*

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1. Place the 5/8” ball bearing in the machining pilot center on the directional clutch shaft (3). Install the puller bridge (2) and pusher bolt (1) 1/2”-13 UNC as shown in Fig. 7C.44. Torque the pusher bolt (1) to 108 [Nm]. Remove pusher bolt (1), puller bridge (2) and 5/8” ball bearing.

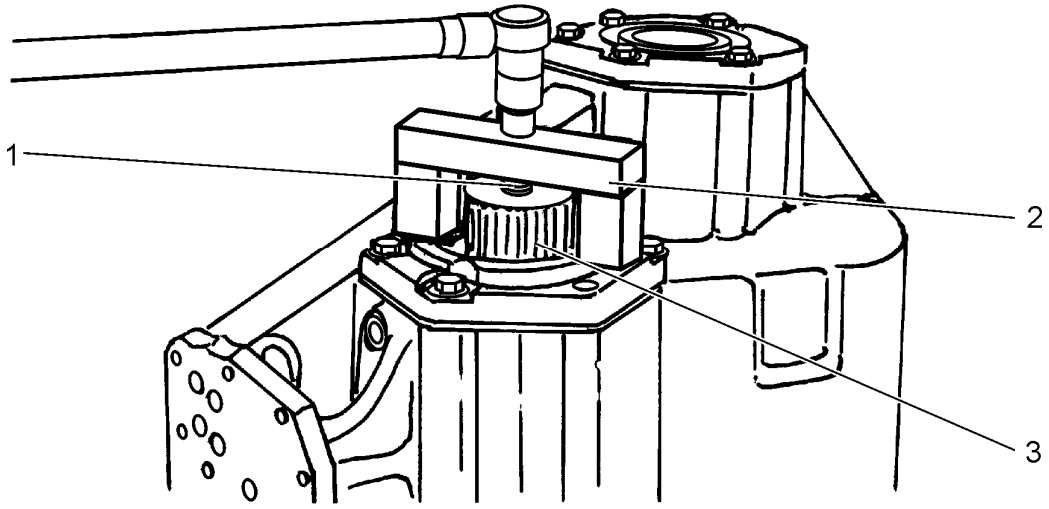

Fig. 7C.44. Transmission Directional Clutch Shaft “Push” Operation

1. Pusher Bolt 2. Puller Bridge 3. Directional Clutch Shaft

B. Input (Pull) Seating Front Cone on Directional Clutch (Input) Shaft (Refer to Fig. 7C.45)

2. Assemble an oversize shim pack of 3.05 [mm] from shims (7, Fig. 7C.7) and position on manifold (6). This will give an excess end float condition. Install directional shaft manifold (6) with oversize shim pack. Do not install O-ring (8) at this time.
3. Install the puller bridge (2) and pulling bolt (1) 1/2”-13 UNC with washer 1/2” into the shaft end as shown in Fig. 7C.45. Torque the pulling bolt (1) with washer to 108 [Nm]. Remove pulling bolt, washer and puller bridge.

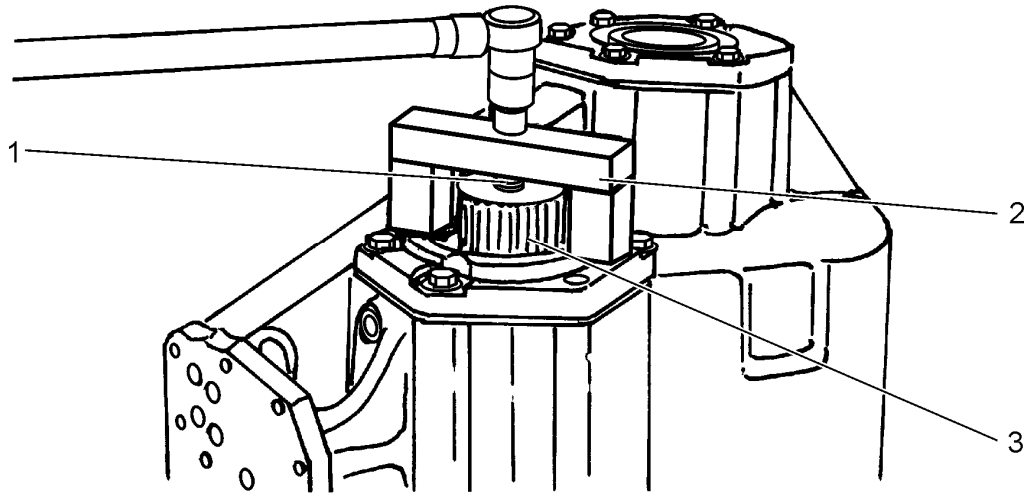

Fig. 7C.45. Transmission Directional Clutch Shaft “Pull” Operation

1. Pulling Bolt with Washer 2. Puller Bridge 3. Input Shaft

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C. Adjusting Directional Clutch Shaft Bearing End Play (Refer to Fig. 7C.46)

4. Thread an eyebolt (4) 1/2”-13 UNC in the end of the directional clutch shaft (1). Rotate and tap the shaft down using a plastic mallet. Install a dial indicator (2) and zero the dial. With a lever (3) or hoist raise the shaft, noting the vertical movement of end play (Fig. 7C.46). Add or remove shims to achieve the desired end play 0.18 – 0.28 [mm]. Rotate and tap the shaft down using a plastic mallet and recheck end play setting. It is important when adjusting end play that the front directional clutch shaft bearing cup be maintained in a position where it is always being pushed with the shaft manifold toward the bearing cone when shims are removed to adjust end play. This is necessary because the bearing cup shoulders on the directional clutch shaft manifold. If it is determined that end play adjustment falls below the specification and extra shims need to be added, the shaft must be pulled up again with an oversize shim pack as shown in Fig. 7C.45 to shoulder the bearing cup on the input shaft manifold. Use caution here not to damaged the input shaft manifold seal rings with repositioning the input shaft manifold.
5. After the correct end play has been established, install the directional clutch shaft manifold O-ring (8, Fig. 7C.7). Install mounting bolts and torque to 80 [Nm]. Recheck end play after directional clutch shaft manifold bolts are installed. Install oil seal (9, Fig. 7C.7).

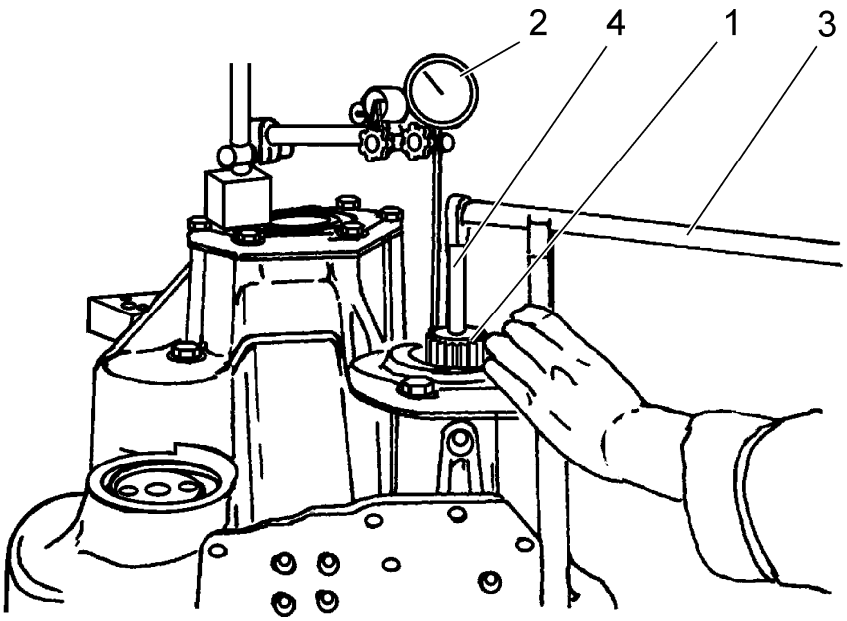

Fig. 7C.46. Transmission Directional Clutch (Input) Shaft – Checking Shaft End Play

1. Input Shaft
2. Dial Indicator
3. Lever
4. Eyebolt

COUNTERSHAFT

D. Countershaft (Push) Seating Rear Bearing Cups and Cones in Cover (Refer to Fig. 7C.47)

NOTE: *Countershaft assembly must have its bearing cones pressed solidly against its respective shoulder before end play (float) is adjusted.*

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1. Place 5/8” ball bearing in the machining pilot center on the countershaft and install puller (1) as shown in Fig. 7C.47. Do not install countershaft cover (14, Fig. 7C.7) into its bore in transmission housing. Thread a bolt 1/2”-13 UNC into the puller and seat it against the ball and torque bolt to 108 [Nm] to force the shaft down. Remove bolt, puller and 5/8” ball bearing.

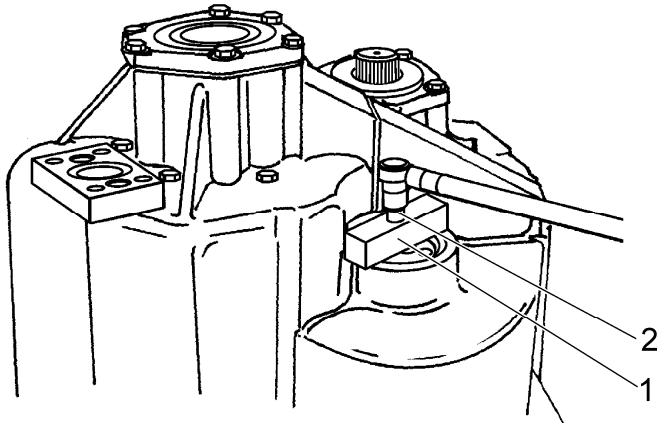

Fig. 7C.47. Transmission Countershaft “Push” Operation

1. Puller 2. Pusher Bolt

E. Front Bearing Seating (Pull) on Countershaft (Refer to Fig. 7C.48)

2. Assemble an oversize shim pack of 0.76 [mm] from shims (15, Fig. 7C.7) and position on the countershaft cover (14, Fig. 7C.7) against the front bearing cup. This will give an excess end float condition. Install countershaft cover (14, Fig. 7C.7) into its bore in transmission housing without O-ring (17, Fig. 7C.7).
3. Install the puller (1) and thread a pulling bolt 1/2”-13 UNC with washer 1/2” through puller and countershaft cover into the end of the shaft as shown in Fig. 7C.48. Torque the bolt to 108 [Nm] to seat the bearing cone on the countershaft. Remove the pulling bolt with washer and puller.

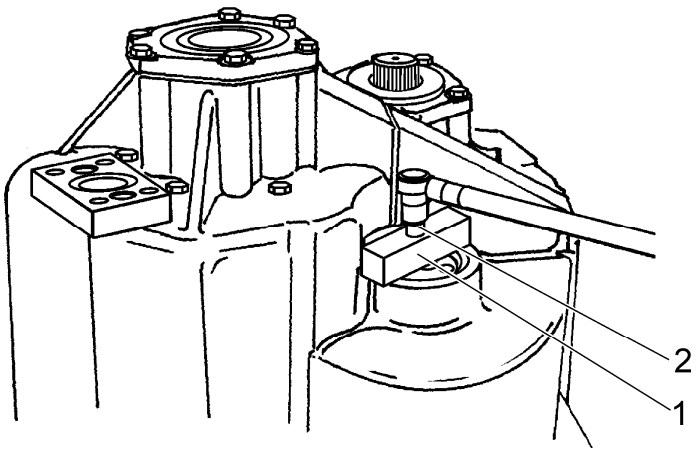

Fig. 7C.48. Transmission Countershaft “Pull” Operation

1. Puller 2. Pulling Bolt with Washer

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F. Adjusting Countershaft Bearing End Play (Refer to Fig. 7C.49)

4. Thread an eyebolt (1) 1/2”-13 UNC in the end of the countershaft. Rotate and tap the shaft down using a plastic mallet. Install a dial indicator (3) and zero the dial. With a lever (2) or hoist raise the shaft, noting the vertical movement of end play (Fig. 7C.49). Add or remove shims to achieve the desired end play 0.18 – 0.28 [mm]. Rotate and tap the shaft down using a plastic mallet and recheck end play setting.
5. It is important when adjusting end play that the front countershaft bearing cup be maintained in a position where it is always being pushed with the cover toward the bearing cone when shims are removed to adjust end play. After the correct end play has been established, install the O-ring (17, Fig. 7C.7) on the cover (14, Fig. 7C.7). Recheck end play after shims (15, Fig. 7C.7) and retaining ring (16, Fig. 7C.7) are installed. Reinstall two plugs in shaft cover (14, Fig. 7C.7).

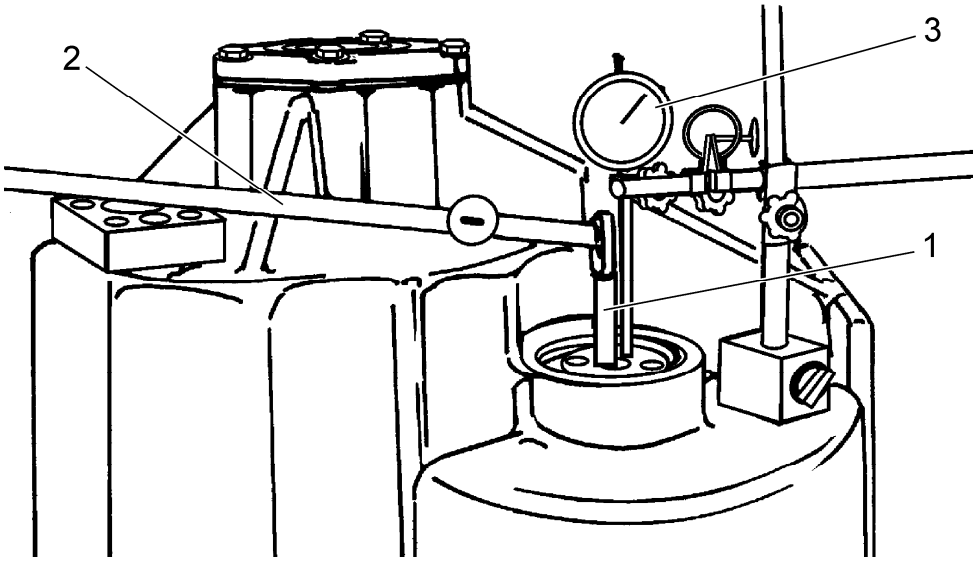

Fig. 7C.49. Transmission Countershaft – Checking Shaft End Play

1. Eyebolt
2. Lever
3. Dial Indicator

RANGE CLUTCH SHAFT (OUTPUT SHAFT)

G. Rear Bearing Seating (Push) on Range Clutch (Output) Shaft (Refer to Fig. 7C.50)

NOTE: *Range shaft assembly must have its bearing cones pressed solidly against its respective shoulder before end play (float) is adjusted.*

1. Place the 5/8” ball bearing in the machining pilot center on the output shaft. Install the puller (1) and pusher bolt (2) 5/8”-13 UNC as shown in Fig. 7C.50. Torque the pusher bolt to 217 [Nm]. Remove pusher bolt, puller and 5/8” ball bearing.

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H. Front Bearing Seating (Pull) on Range Clutch (Output) Shaft (Refer to Fig. 7C.51)

2. Assemble an oversize shim pack of 4.06 [mm] from shims (21, Fig. 7C.7) and position on range clutch shaft manifold (20, Fig. 7C.7). This will give an excess end float condition. Install range clutch shaft manifold (20, Fig. 7C.7) with oversize shim pack, being sure to align manifold over shaft without damaging previously installed seal rings. Do not install O-ring (22, Fig. 7C.7) at this time.

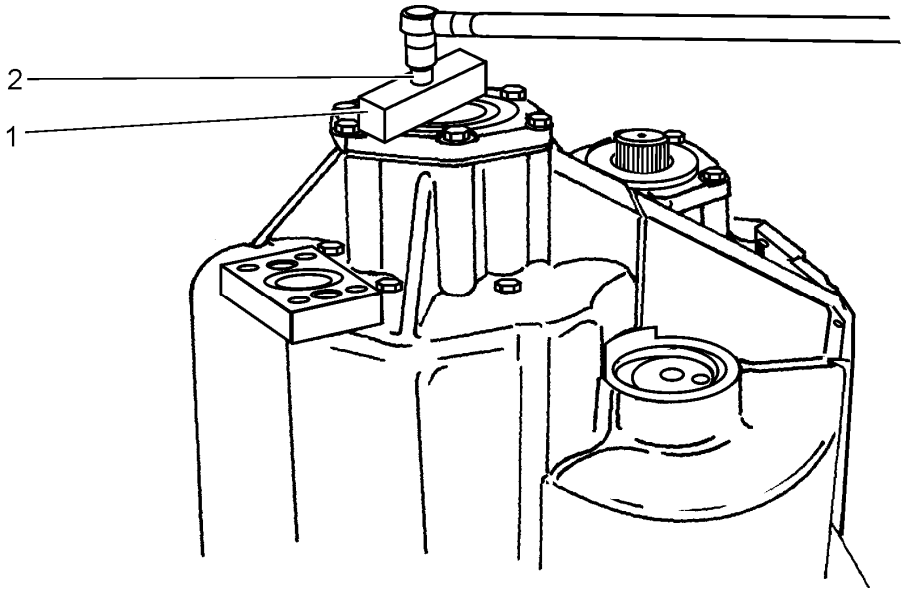

Fig. 7C.50. Transmission Range Clutch Shaft “Push” Operation

1. Puller 2. Pusher Bolt

3. Install the puller and pulling bolt 5/8”-13 UNC with washer 5/8” as shown in Fig. 7C.51. Torque the pulling bolt to 217 [Nm]. Remove the pulling bolt (2) with washer and puller.

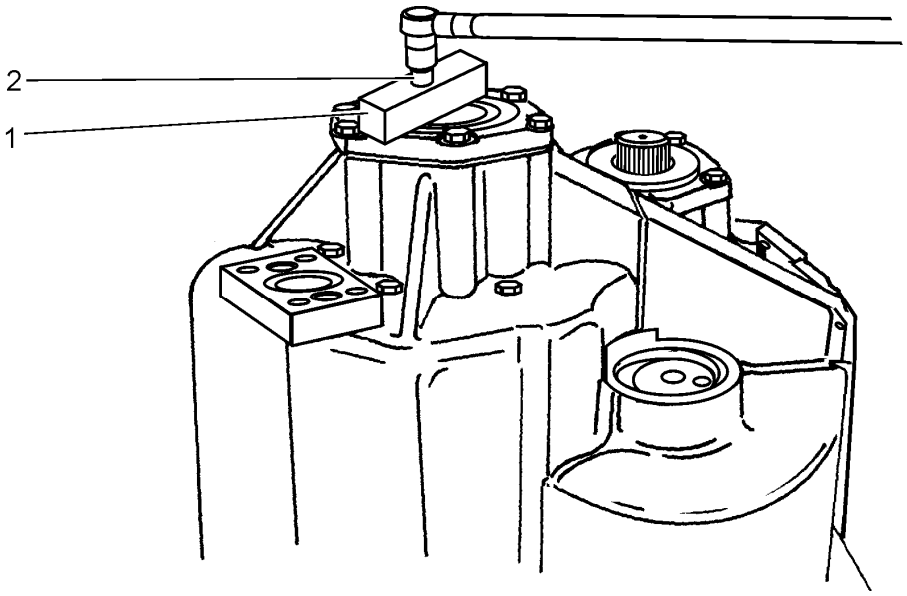

Fig. 7C.51. Transmission Range Clutch Shaft “Pull” Operation

1. Puller 2. Pulling Bolt

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I. Adjusting Range Clutch (Output) Shaft Bearing End Play

4. Thread a bolt (1) 5/8”-13 UNC in the end of the output shaft. Rotate and tap the shaft down using a plastic mallet. Install a dial indicator (2) and zero the dial. With a lever (3) or hoist raise the shaft, noting the vertical movement of end play (Fig. 7C.52). Add or remove shims to achieve the desired end play 0.18 – 0.28 [mm]. Rotate and tap the shaft down using a plastic mallet and recheck end play setting.
5. It is important when adjusting end play that the front range clutch shaft bearing cup be maintained in a position where it is always being pushed with the manifold toward the bearing cone when shims are removed to adjust end play. This is necessary because the bearing cup shoulders on the manifold. If it is determined that end play adjustment falls below the specification and extra shims need to be added, the shaft must be pulled up again with an oversize shim pack as shown in Fig. 7C.50 to shoulder the bearing cup on the manifold. Use caution here not to damaged the manifold seal rings with repositioning the manifold.
6. After the correct end play has been established, install O-ring (22, Fig. 7C.7) on manifold (20, Fig. 7C.7). Install mounting bolts and torque them to 80 [Nm]. Recheck end play after manifold bolts are installed.

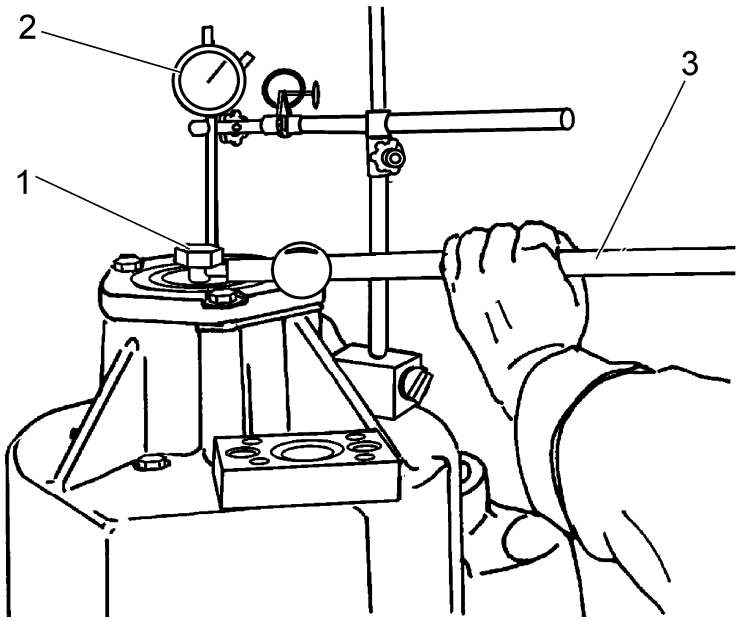

Fig. 7C.52. Transmission Range Clutch Shaft – Checking Shaft End Play

1. Bolt 2. Dial Indicator 3. Lever

8. INSTALLATION

1. Be sure the mating surfaces of the transmission manifold (2, Fig. 7C.1) and transmission (1) are clean and free of any old gasket material. Install the manifold (2) with new gasket (4). Install the orifice strainer (3).
2. Be sure the mating surfaces of the rate of rise valve (8) and transmission manifold (2) are clean and free of any old gasket material. Install the rate of rise valve (8) with new gasket (9).
3. Remove the covering from the rear main frame opening.

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4. Be sure the O-rings (27 and 28, Fig. 7C.7) are properly seated. Position the transmission close by the machine and attach the hoist to lifting eyebolt installed in the threaded hole (7, Fig. 7C.2) 1/2”-13UNC-2B. Position the transmission (2, Fig. 7C.5) into place and move it back toward the main frame (4), being sure the output shaft splines with the steering drive pinion shaft sleeve. Secure the transmission (2) to the main frame (4) with the hardware previously removed. Torque the mounting bolts (1) to 920 [Nm].
5. Remove the hoisting equipment. Remove the lifting eyebolt from the top of the transmission.
6. Be sure the mating surfaces of the range selector valve (10, Fig.7C.1), pressure regulator valve (5) and transmission manifold (2) are clean. Reinstall the valves (with hoses still attached) with new mounting O-rings (6 and 7) on the transmission manifold (2).
7. Install the transmission drive yoke on the splines of the input shaft. Install the universal joint (3, Fig. 7C.3) between the torque converter and transmission (1). Secure the universal joint to the transmission drive yoke and to the torque converter output flange. Torque the bolts to 136 [Nm].

CAUTION! Remove the wire or tape used to keep the bearings from falling from the spider trunnions. If installing a new spider and bearing assembly, remove the soft iron strap attached to the bearing caps. This will eliminate the possibility of the straps or wire breaking loose from the caps and causing personal injury when the engine is running.

8. Install input shaft RPM sensor (5, Fig. 7C.5) into transmission (2). Carefully screw the sensor (5) in as far as it will go and until it just touches directional shaft drum. Undo the sensor 1 3/4 turns and lock it with a lock nut. Reconnect the electrical harness to the RPM sensor (5).
9. Install suction strainer (3) to the main frame (4).
10. Reconnect the lube hose (4, Fig. 7C.3) to the transmission.
11. Install the strainer (2, Fig. 7C.4) to the transmission (1). Reconnect the transmission scavenge tube (6, Fig. 7C.3) to the transmission (1) and install bracket (5) to the output shaft manifold.
12. Reconnect torque converter supply hose (6, Fig. 7C.2) to the pressure regulator valve (4). Reconnect supply hose (10) to the pressure regulator valve (4).
13. Reinstall hydraulic damper (9) on the rear ROPS bracket.
14. Install pressure switches (12) to the range selector valve (14). Reconnect the electrical harness (13) to the pressure switches (12).
15. Install the equipment pump (1) on the torque converter. Refer to SECTION 10A for this procedure.
16. Reconnect fan motor drain hose (8) to the cross located on the rear ROPS bracket.
17. Reconnect the breather hose (15) to the transmission (5).
18. Install the ROPS, cab and platform, refer to SECTION 13, SUPERSTRUCTURE.
19. Refill the main frame as described in the OPERATOR’S MANUAL. Start the engine. Check for leakage. If the main and range clutch oil warning lamp is lighting, make inspection and repair.
20. Check the oil pressures in the transmission as described in SECTION 7, Paragraph 10, TRANSMISSION AND TORQUE CONVERTER OIL PRESSURE TEST.
21. Install the front center floor plate and the transmission case guard.
22. Check the rear frame oil level and add if necessary.
23. After first 50 hours of operation change the pressure filters.

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PRESSURE REGULATOR VALVE

9. REMOVAL AND DISASSEMBLY (Refer to Fig. 7C.53 and 7C.54)

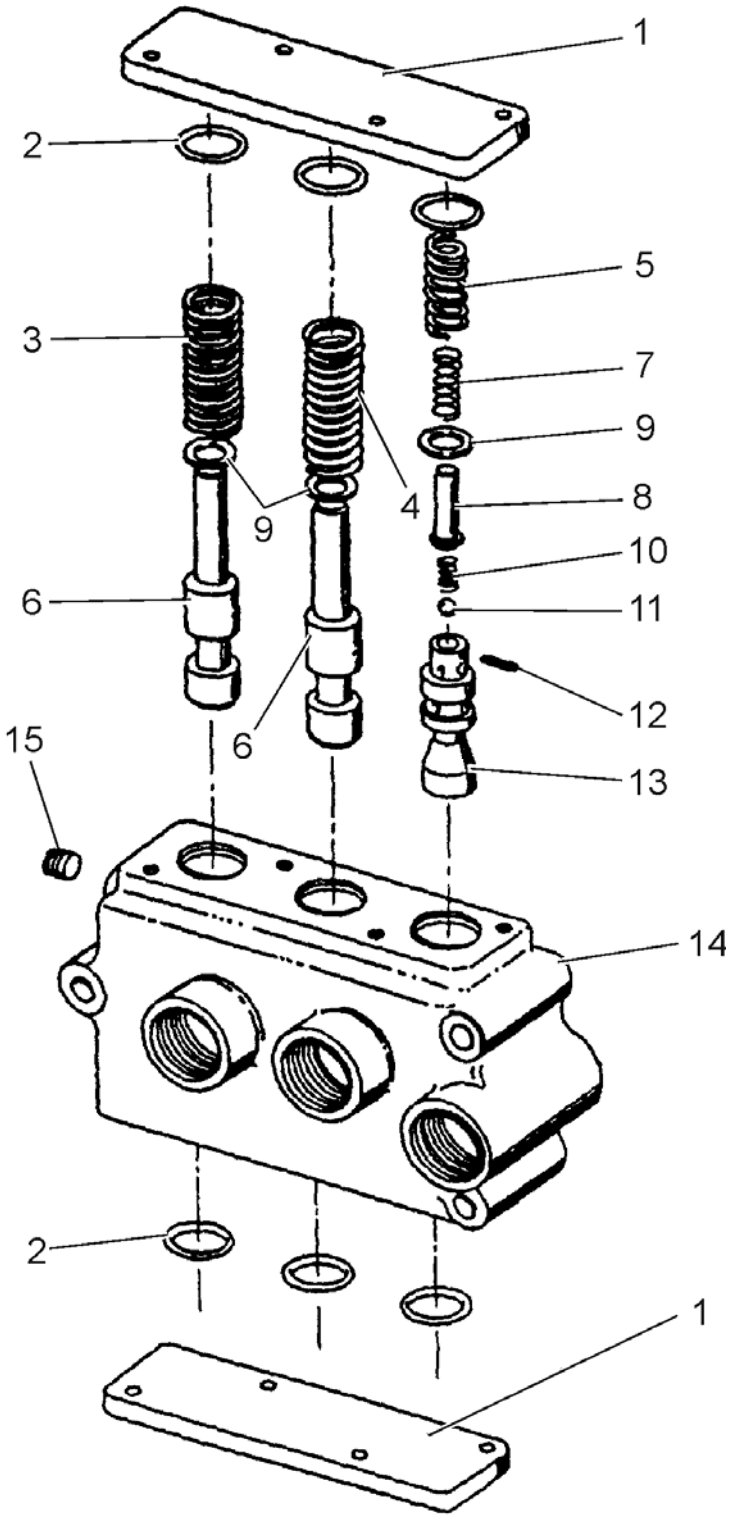

Fig. 7C.53. Exploded View of Pressure Regulator Valve

1. End Cover
2. O-Ring
3. Lube Spool Spring
4. Torque Converter Spool Spring
5. Main Spool Outer Spring
6. Lube or Torque Converter Spool
7. Main Spool Inner Spring
8. Spring Guide Pin
9. Shim
10. Ball Spring
11. Check Ball
12. Spring Pin
13. Main Spool
14. Valve Housing
15. Port Plug

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PRESSURE REGULATOR VALVE

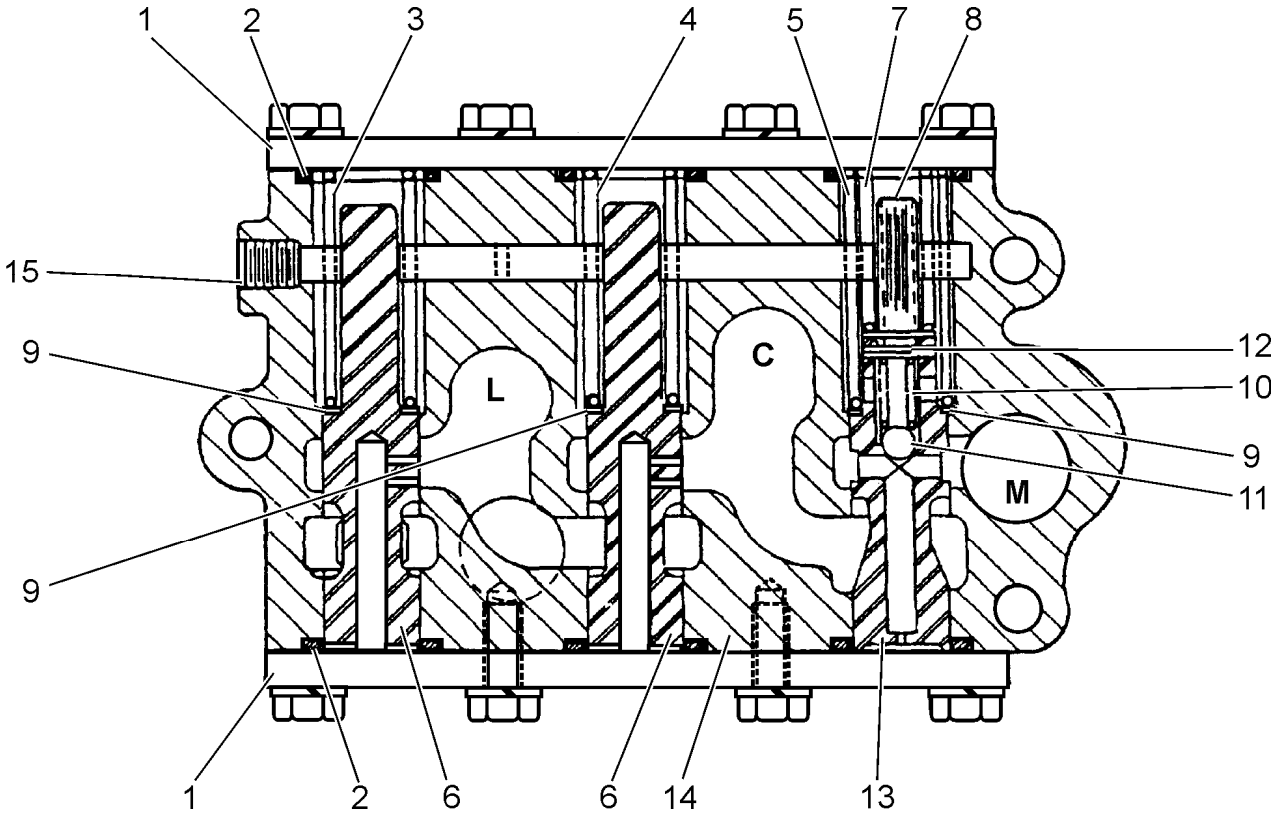

Fig. 7C.54. Cross Section of Pressure Regulator Valve

1. End Cover
2. O-Ring
3. Lube Spool Spring
4. Torque Converter Spool Spring
5. Main Spool Outer Spring
6. Lube or Torque Converter Spool
7. Main Spool Inner Spring
8. Spring Guide Pin
9. Shim
10. Ball Spring
11. Check Ball
12. Spring Pin
13. Main Spool
14. Valve Housing
15. Port Plug

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *When disconnecting hydraulic lines for any reason, they should be properly capped with the correct size plastic cap. If these caps are not available, tape or clean rubber corks may be used. Hydraulic openings must never be plugged with rags. This practice could easily introduce dirt or lint into critical hydraulic components of the machine. Tag all disconnected oil lines to facilitate easier installation.*

1. Remove floor mat (cab equipped machines). Remove the bolts securing the center floor plate between seat and instrument panel and remove the plate.
2. Disconnect the hoses at the pressure regulator valve and tag them.
3. Remove the bolts and washers securing the valve to top of the transmission manifold. Remove the valve assembly and mounting O-rings.
4. Disassemble component parts (1, 2, 3, 4, 5, 7, 9, 8, 6 and 13) in sequence indicated.

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PRESSURE REGULATOR VALVE

WARNING! Spring loaded assembly. Covers must be held to relieve spring pressure. Use extreme care when assembling.

NOTE: *When removing springs, spools (6) and shims from valve housing, tag them according to their location*.

5. Disassemble component parts (10, 11 and 12) of spool (13) in sequence indicated.
6. If necessary, remove port plug (15) from the valve housing (14).

10. INSPECTION AND REPAIR

1. It is recommended that all new O-rings be installed upon reassembly of the valve.
2. Clean all parts in a suitable solvent and blow dry with compressed air. Be sure all oil passages in the valve housing and spools are clean and free of obstructions.
3. Inspect the parts for excessive wear and replace if necessary.
4. Inspect the condition of the springs. If they are damaged or do not fall within the specifications shown in Paragraph 3, SPECIFICATIONS, they must be replaced.

11. REASSEMBLY AND INSTALLATION (Refer to Fig. 7C.53 and 7C.54)

NOTE: *Lubricate the spools and valve bores with transmission oil upon reassembly*.

1. Apply LOCTITE Pipe Sealant #569 to plug (15) and install in the valve housing (14) if removed.
2. Reassemble component parts (11, 10 and 12) of spool (13) in reverse numerical order.
3. Reassemble component parts (13, 6, 8, 9, 7, 5, 4, 3, 2 and 1) in sequence indicated. Tighten the bolts securing covers (1) to a torque 26-28 [Nm].

NOTE: *Be sure springs are assembled in the correct bore of the valve and the same amounts of shims are installed as were removed from each bore.*

4. Position the valve and O-rings on top of the transmission manifold and secure with bolts and washers. Torque the bolts to 42 - 50 [Nm].
5. Reconnect the hoses at the pressure regulator valve.
6. Check the oil level in the main frame as described in the OPERATOR'S MANUAL.

IMPORTANT: *As soon as the engine starts, observe the transmission main and range clutch oil pressure lamp on the dash. If lights, immediately turn off engine.*

7. Start the engine. Check for leaks. Check the oil pressures as described in SECTION 7, Paragraph 10, TRANSMISSION AND TORQUE CONVERTER OIL PRESSURE TEST.
8. Install the center floor plate between seat and instrument panel. Install the floor mat, if cab equipped.

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RANGE SELECTOR VALVE

12. REMOVAL AND DISASSEMBLY (Refer to Fig. 7C.55 and 7C.56)

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *When disconnecting hydraulic lines for any reason, they should be properly capped with the correct size plastic cap. If these caps are not available, tape or clean rubber corks may be used. Hydraulic openings must never be plugged with rags. This practice could easily introduce dirt or lint into critical hydraulic components of the machine. Tag all disconnected oil lines to facilitate easier installation.*

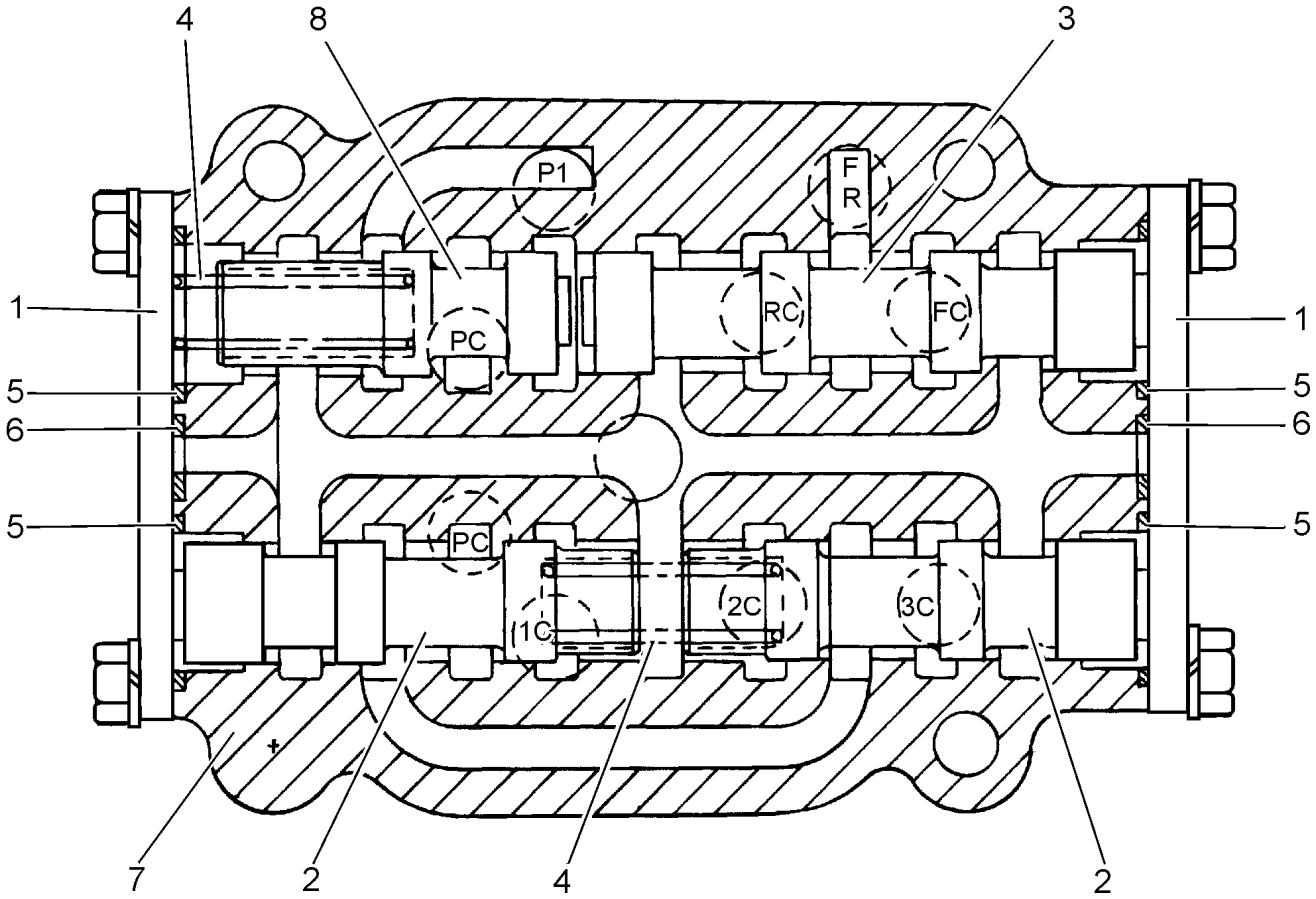

Fig. 7C.55. Cross Section of Range Selector Valve

1. End Cover
2. Range Selector Spool
3. Directional Spool
4. Return Spring
5. O-Ring
6. O-Ring
7. Valve Housing
8. Switch Spool

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RANGE SELECTOR VALVE

1. Remove floor mat (cab equipped machines). Remove the bolts securing the center floor plate between seat and instrument panel and remove the plate.
2. Disconnect the hoses at the range selector valve and tag them.
3. Remove the bolts and washers securing the valve assembly to the top of the transmission manifold. Remove the valve assembly and mounting O-rings.
4. Disassemble component parts (1, 5, 6, 2, 4, 8 and 3) in sequence indicated.

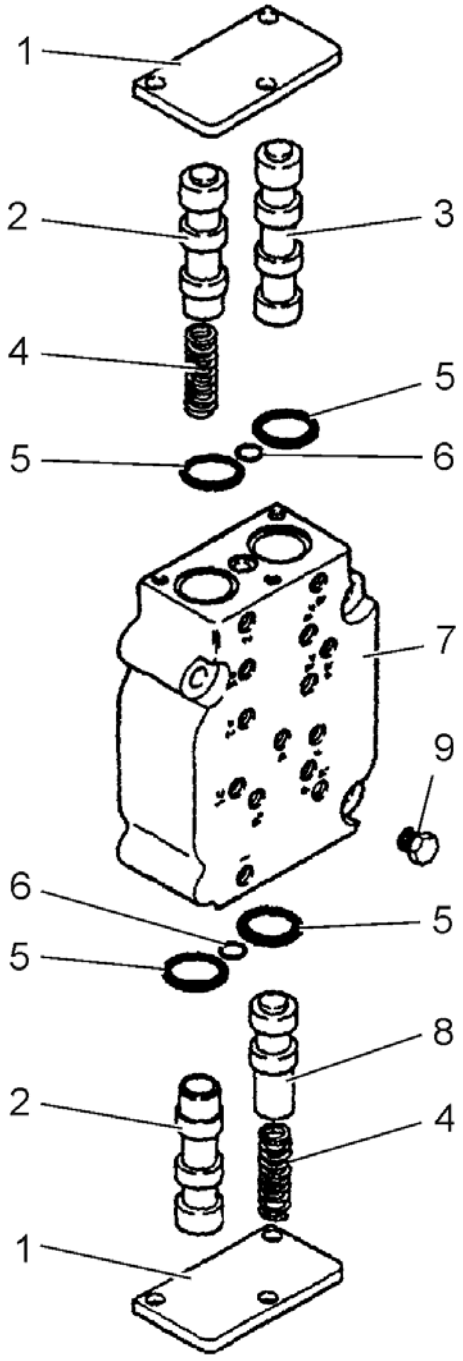

Fig. 7C.56. Exploded View of Range Selector Valve

1. End Cover
2. Range Selector Spool
3. Directional Spool
4. Return Spring
5. O-Ring
6. O-Ring
7. Valve Housing
8. Switch Spool
9. Port Plug

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RANGE SELECTOR VALVE

13. INSPECTION AND REPAIR

1. It is recommended that all new O-rings be installed upon reassembly of the valve.
2. Clean all parts in a suitable solvent and blow dry with compressed air. Be sure all the oil passages in the valve housing are clean and free of obstructions.
3. Inspect the parts for excessive wear and replace if necessary.
4. Inspect the condition of the springs. If they are damaged or do not fall within the specifications shown in Paragraph 3, SPECIFICATIONS, they must be replaced.

14. REASSEMBLY AND INSTALLATION (Refer to Fig. 7C.55 and 7C.56)

NOTE: *Lubricate the spools and valve bores with transmission oil upon reassembly.*

1. Reassemble component parts in the sequence (3, 8, 4, 2, 4, 2, 6, 5 and 1). Tighten the bolts securing covers (1). Torque the bolts to 26 - 28 [Nm].
2. Position the valve and O-rings on top of the transmission manifold and secure with bolts and washers. Torque the mounting bolts to 32 [Nm].
3. Reconnect the hoses at the range selector valve.
4. Check the oil level in the main frame as described in the OPERATOR'S MANUAL.

IMPORTANT: *As soon as the engine starts, observe the transmission main and range clutch oil pressure lamp on the instrument panel. If lights, immediately turnoff the engine.*

5. Start the engine. Checks for leaks. Check the oil pressures as described in Paragraph 10, TRANSMISSION AND TORQUE CONVERTER OIL PRESSURE TEST in SECTION 7.
6. Install the center floor plate between seat and instrument panel. Install the floor mat, if cab equipped.

RATE OF RISE VALVE

15. REMOVAL AND DISASSEMBLY (Refer to Fig. 7C.57 and 7C.58)

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

1. Remove floor mat (cab equipped machines). Remove the bolts securing the center floor plate between seat and instrument panel and remove the plate.
2. Remove the bolts and washers securing the valve assembly to the top of the transmission housing. Remove the valve assembly and gasket. Discard the gasket.
3. Disassemble component parts in the sequence indicated by the reference numbers in the illustration. Discard gaskets (2).

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16. INSPECTION AND REPAIR

1. Clean all parts in a suitable solvent and blow dry with compressed air. Be sure all the oil passages in the valve housing are clean and free of obstructions.
2. Inspect the parts for excessive wear and replace if necessary.
3. Inspect the condition of the springs. If they are damaged or do not fall within the specifications shown in Paragraph 3, SPECIFICATIONS, they must be replaced.

NOTE: *Springs (3 and 8) appear to be identical, however they are different. Intermixing will result in loss of range clutch pressure and loss of directional pressure.*

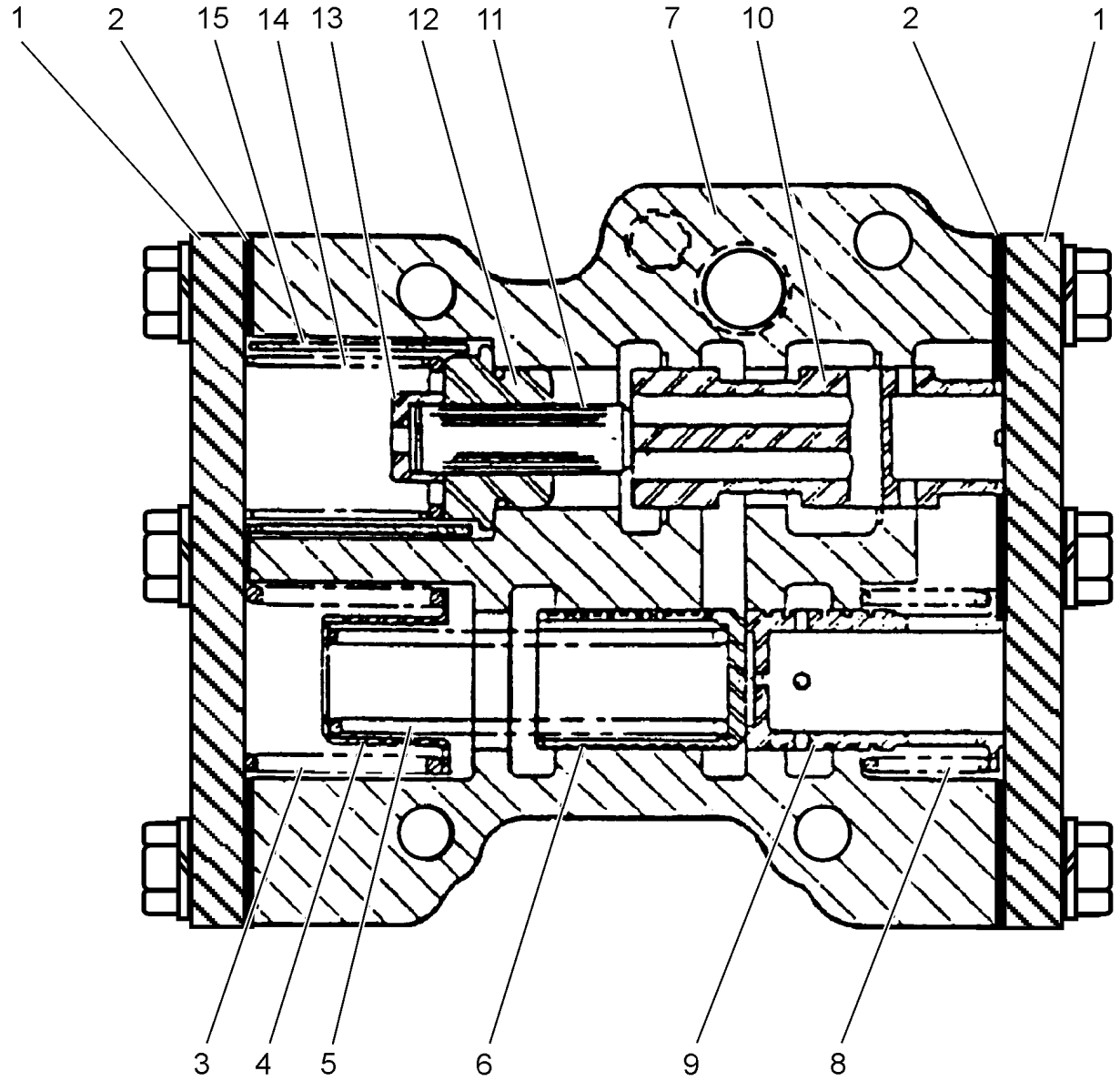

Fig. 7C.57. Cross Section of Rate of Rise Valve

1. End Cover
2. Gasket
3. Outer Piston Spring
4. Spring Retainer
5. Inner Piston Spring
6. Modulating Piston
7. Valve Housing
8. Reducing Spring
9. Reducing Spool
10. Sequence Valve Spool
11. Dowel Pin
12. Sequence Valve Spacer
13. Sequence Valve Disc
14. Sequence Spool Spring
15. Spring Spacer

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RATE OF RISE VALVE

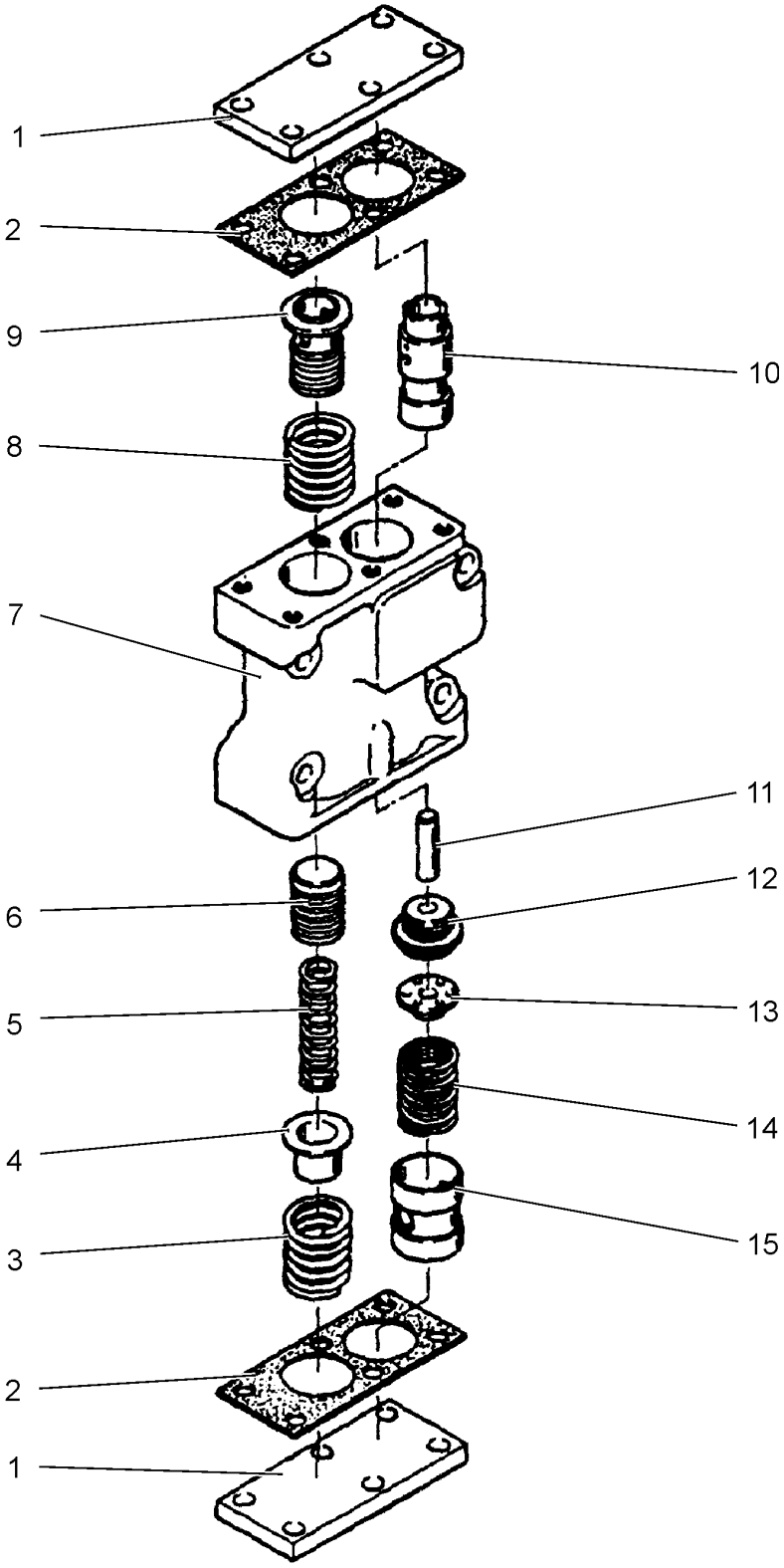

Fig. 7C.58. Exploded View of Rate of Rise Valve

1. End Cover
2. Gasket
3. Outer Piston Spring
4. Spring Retainer
5. Inner Piston Spring
6. Modulating Piston
7. Valve Housing
8. Reducing Spring
9. Reducing Spool
10. Sequence Valve Spool
11. Dowel Pin
12. Sequence Valve Spacer
13. Sequence Valve Disc
14. Sequence Spool Spring
15. Spring Spacer

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RATE OF RISE VALVE

17. REASSEMBLY AND INSTALLATION (Refer to Fig. 7C.57 and 7C.58)

NOTE: *Lubricate the spools and valve bores with transmission oil upon reassembly.*

1. Reassemble component parts in the reverse sequence indicated by the reference numbers in the illustration, using new gaskets (2). Tighten the bolts securing covers (1) to a torque of 26 to 28 [Nm].
2. Install the valve with a new gasket on top of the transmission manifold.
3. Check the oil level in the main frame as described in the OPERATOR'S MANUAL.

IMPORTANT: *As soon as the engine starts, observe the transmission main and range clutch oil pressure lamp on the instrument panel. If lights, immediately turn off the engine.*

4. Start the engine. Checks for leaks. Test pressure to verify rate of rise valve is sequencing shifts. Check the oil pressures as described in Paragraph 10, TRANSMISSION AND TORQUE CONVERTER OIL PRESSURE TEST in SECTION 7.
5. Install the center floor plate between seat and instrument panel. Install the floor mat, if cab equipped.

DRIVE TRAIN CONTROL VALVE

18. REMOVAL

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *When disconnecting hydraulic lines for any reason, they should be properly capped with correct size plastic cap. If these caps are not available, tape or clean rubber corks may be used. Hydraulic openings must never be plugged with rags. This practice could easily introduce dirt or lint into critical hydraulic components of machine. Tag all disconnect oil lines to facilitate easier installation.*

1. Unscrew bolts (4, Fig. 7C.59) and remove L.H. enclosure (3) with L.H. door.
2. Disconnect the electrical harness from the filter base. Unscrew bolts (3, Fig. 7C.60) fastening filters bracket (2) to the ROPS bracket and allow the bracket (2) with filters (4) to be supported by the hoses.
3. Unscrew bolts (2, Fig. 7C.59) and remove access cover (1) in order to obtain access to mounting points of the drive train control valve.

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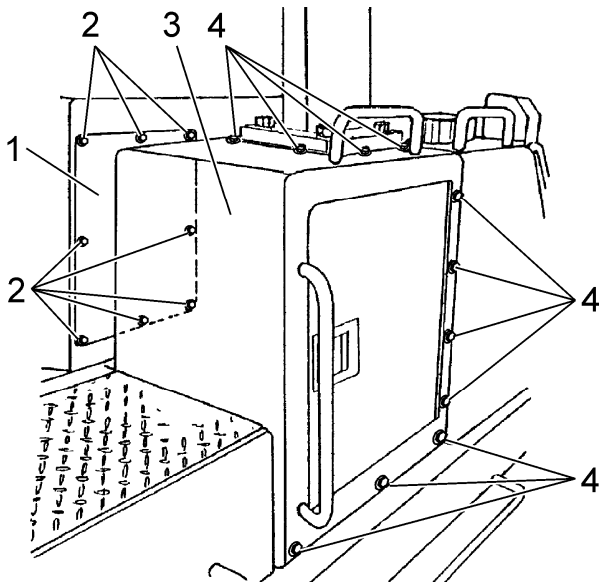

Fig. 7C.59. Disassembly Access Cover to Drive Train Control Valve

1. Access Cover
2. Bolts
3. L.H. Enclosure
4. Bolts

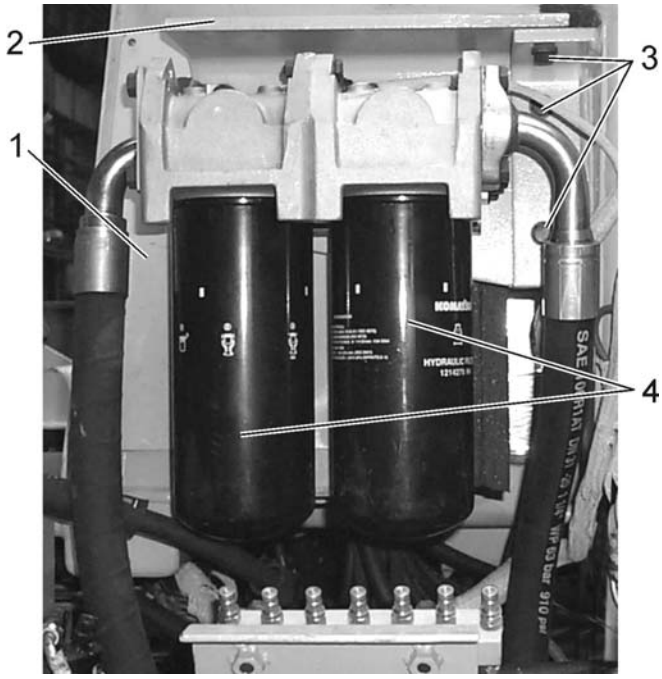

Fig. 7C.60. Drive Train Pressure Filters Removal

1. Access Cover
2. Filter Bracket
3. Bracket Mounting Bolts
4. Filters

4. Disconnect drive train control lever harness (3, Fig. 7C.62).
5. Remove the screws (2, Fig. 7C.61) and remove cover (1).

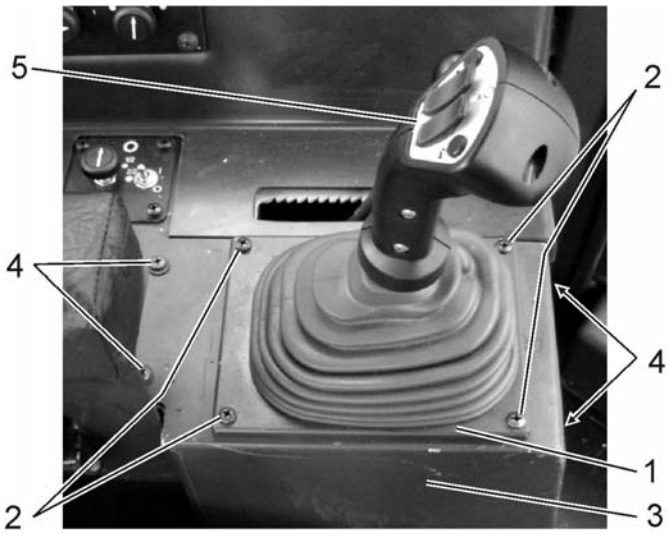

Fig. 7C.61. Disassembly Console to Access Drive Train Control Valve

1. Cover
2. Screws
3. Valve Console
4. Bolts
5. Control Lever

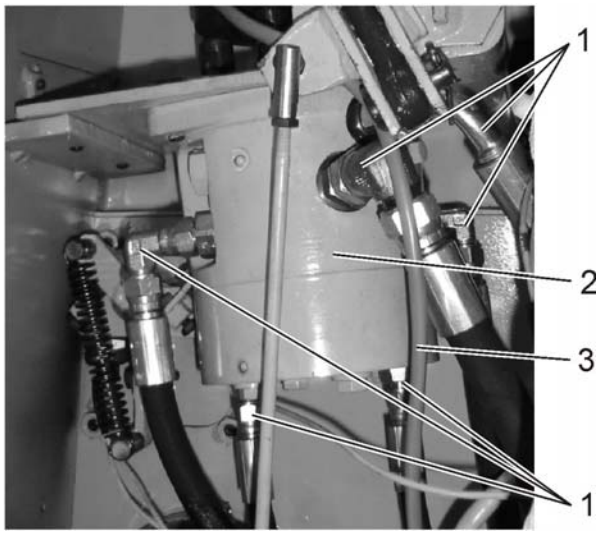

Fig. 7C.62. Drive Train Control Valve Disconnecting Points

1. Hoses
2. Drive Train Control Valve
3. Control Lever Harness

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6. Remove two stiffener plates and unscrew control lever (5, Fig. 7C.61) with attached boot and electrical harness.
7. Disconnect and tag all hoses (1, Fig. 7C.62) connected to the drive train control valve (2).
8. Unscrew four mounting bolts (4, Fig. 7C.61) securing valve console (3) to the platform and remove console (3) out of the platform.
10. Unscrew four mounting bolts (1, Fig. 7C.63) securing valve bracket (2) to the platform and remove the valve with bracket from the platform. Unscrew three mounting bolts (3) securing drive train control valve (4) to valve bracket (2) and remove the bracket (2) out of the valve (4).

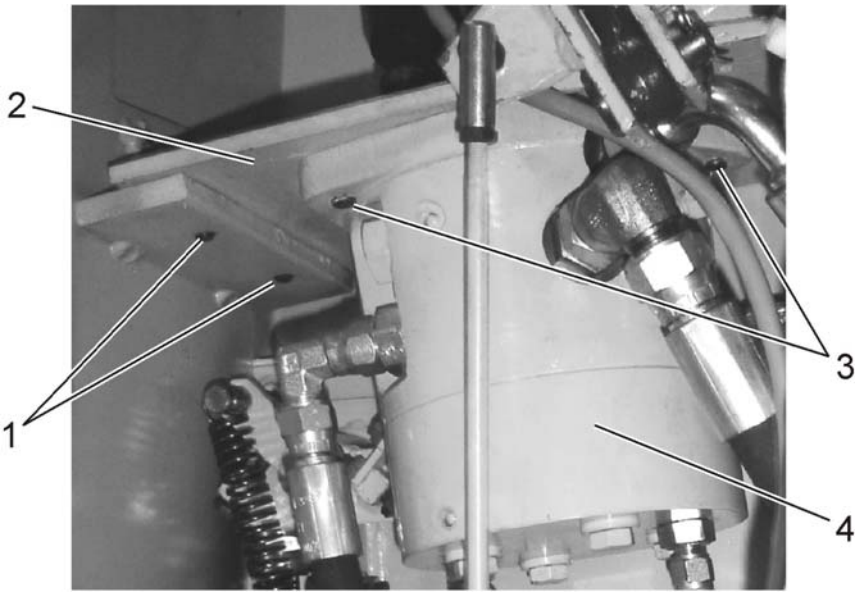

Fig. 7C.63. Drive Train Control Valve Disconnecting Points

1. Mounting Bolts
2. Valve Bracket
3. Mounting Bolts
4. Drive Train Control Valve

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DRIVE TRAIN CONTROL VALVE

19. DISASSEMBLY (Refer to Fig.'s 7C.64 and 7C.65)

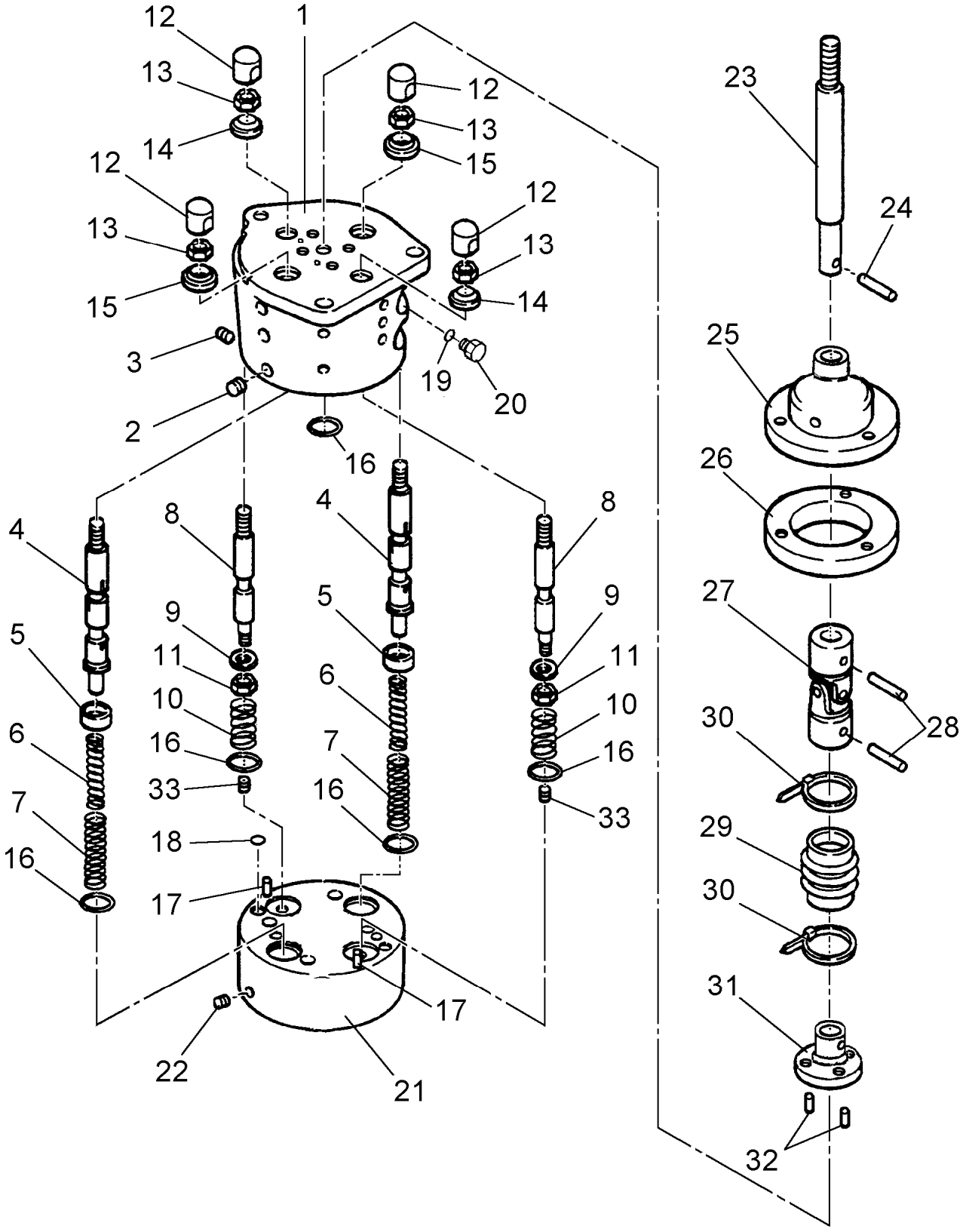

Fig. 7C.64. Exploded View of Drive Train Control Valve

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DRIVE TRAIN CONTROL VALVE

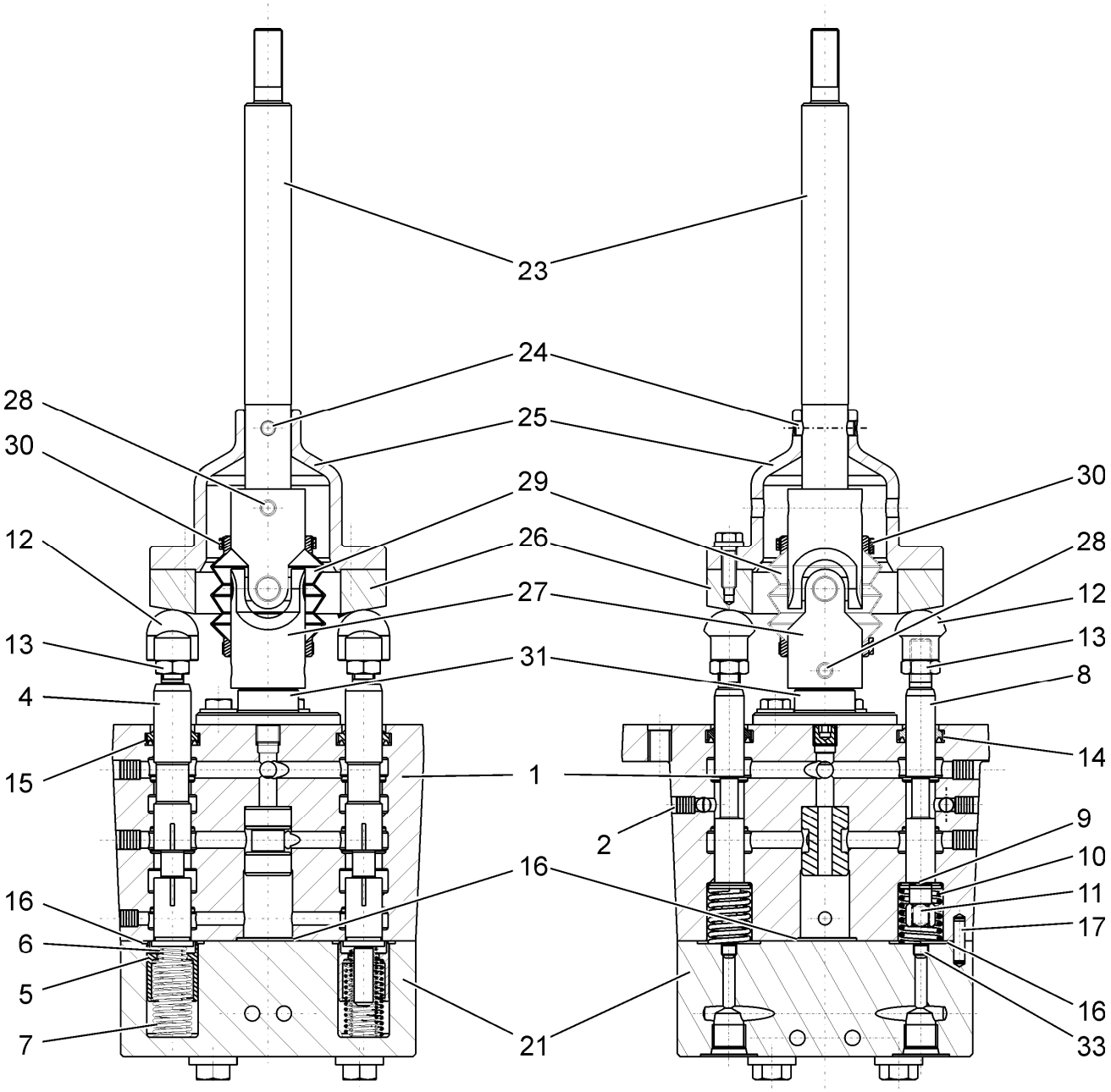

Fig. 7C.65. Cross Section View of Drive Train Control Valve

Legend for Fig. 7C.64 and Fig. 7C.65

1. Housing Assy
2. Port Plug
3. Port Plug
4. Steering Spool
5. Guide Sleeve
6. Inner Spring
7. Outer Spring
8. Directional Spool
9. Thrust Washer
10. Directional Spool Spring
11. Stop Nut
12. Rocker End
13. Jam Nut
14. Seal Ring
15. Seal Ring
16. O-Ring
17. Dowel Pin
18. O-Ring
19. O-Ring
20. Plug
21. Bottom Cover
22. Port Plug
23. Lever
24. Dowel Pin
25. Joint Housing
26. Pivot Ring
27. Universal Joint
28. Dowel Pin
29. Universal Joint Boot
30. Strip
31. Joint Base
32. Dowel Pin
33. Orifice Plug

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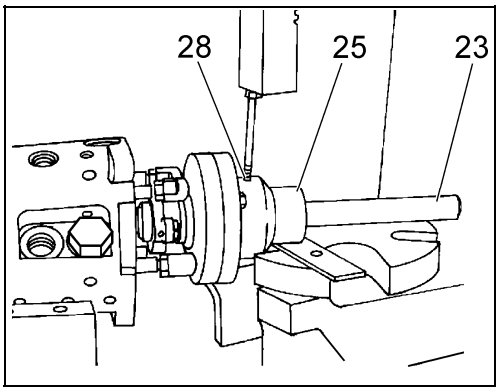
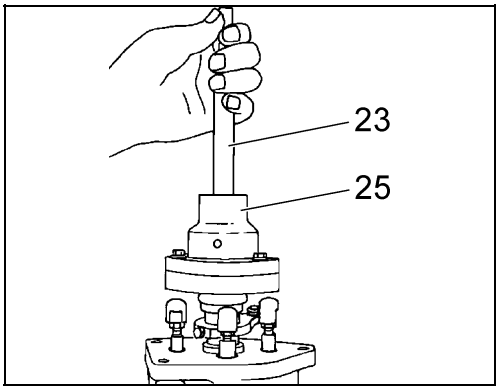
DRIVE TRAIN CONTROL VALVE

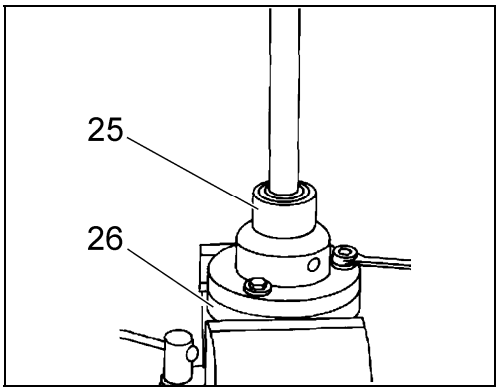
1. Position the valve in press with the hole in the joint housing (25) aligned with the dowel pin (28) in the lever (23). Apply the press and drive the pin out clearing the housing with lever.



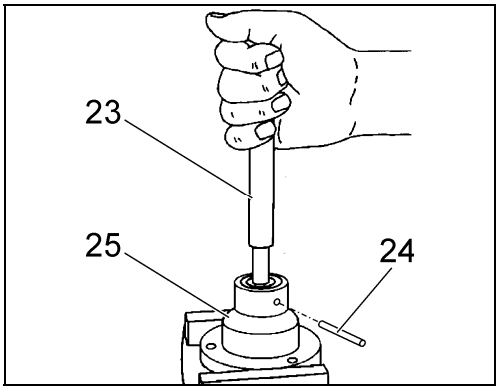
2. Remove the lever (23) with the joint housing (25) from the valve.



3. Position the assembly in a vise. Remove the hardware and separate the housing (25) from the pivot ring (26).



4. Drive the dowel pin (24) out from the housing (25). Remove the lever (23) from the joint housing (25).



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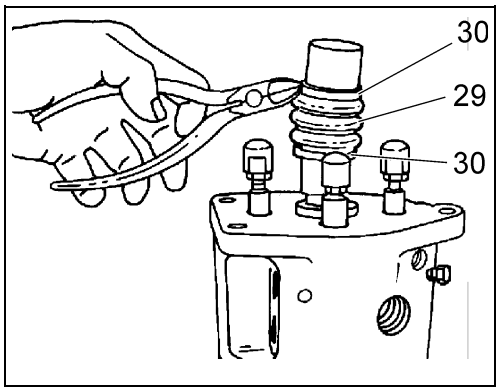
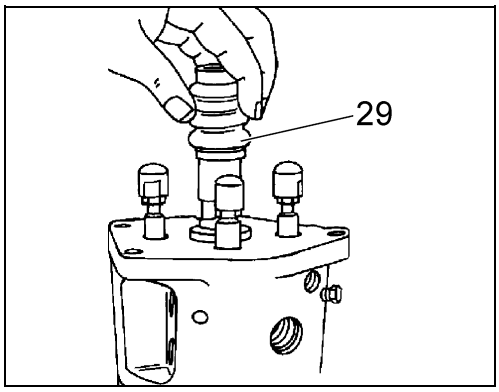
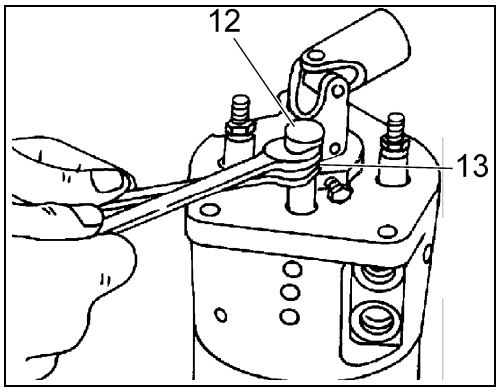
5. Cut and remove the tie straps (30) from the joint boot (29).



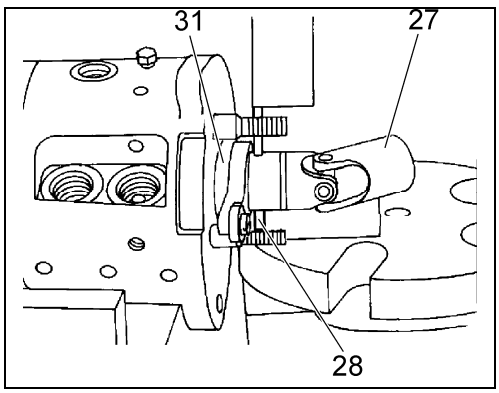
6. Remove the boot (29) from the universal joint.



7. Remove the spool rocker end (12) and jam nut (13) from each spool.



8. Position the assembly in a vise. Remove the dowel pin (28) connecting the universal joint (27) to the joint base (31).



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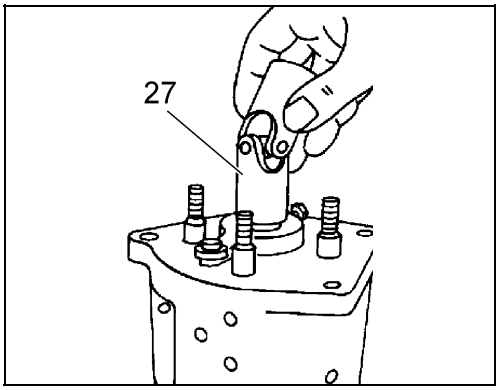
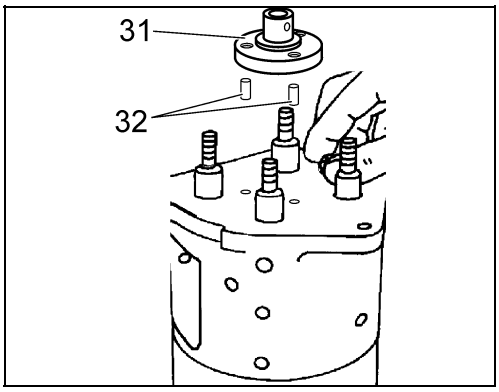
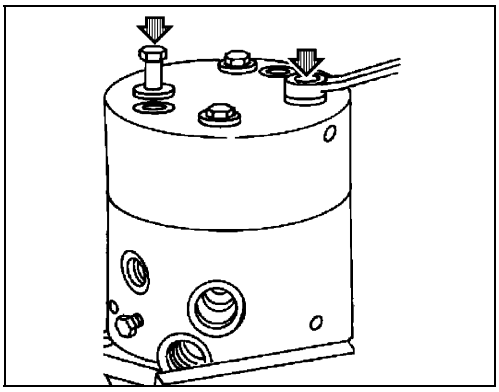
9. Remove the universal joint (27).



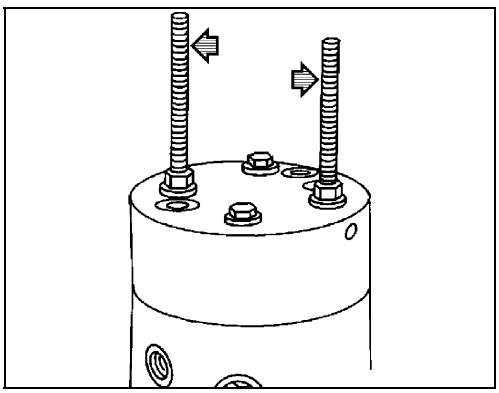
10. Unscrew four bolts and remove the joint base (31). If required, remove two dowels pins (32) from the base (31).



11. Turn the valve over and remove the two opposite side mounting bolts.



12. Install two threaded rods with washers and nuts to the vacated mounting holes.



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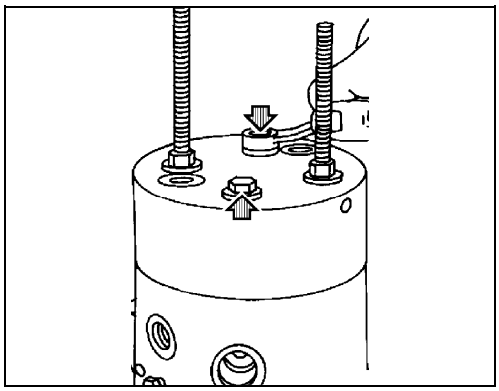
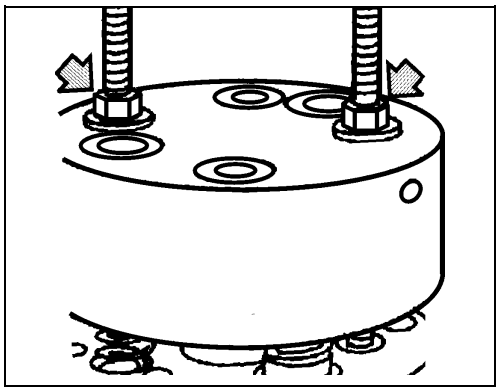
13. Remove remaining two mounting bolts.

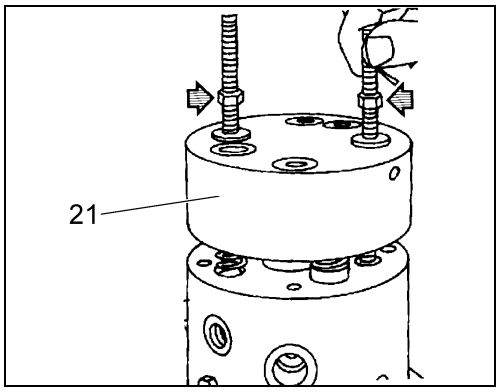


14. Let off each nut until all spring tension is relieved.

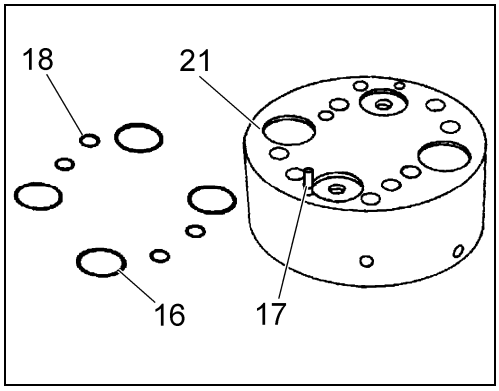
WARNING! Spring loaded assembly. Cover must be held to relieve spring pressure. Use extreme care when disassembling.



15. Remove the threaded rods and the bottom cover (21) from the valve.



16. Remove and discard the O-rings (16 and 18) from the bottom cover (21). If necessary, remove dowel pin (17).



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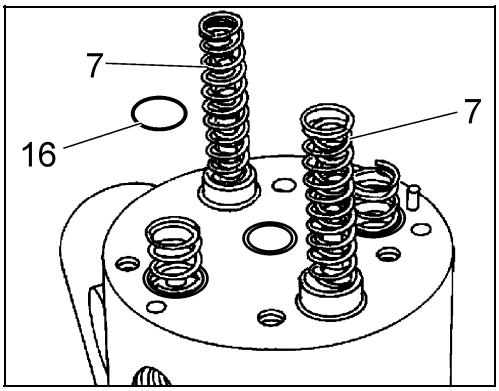
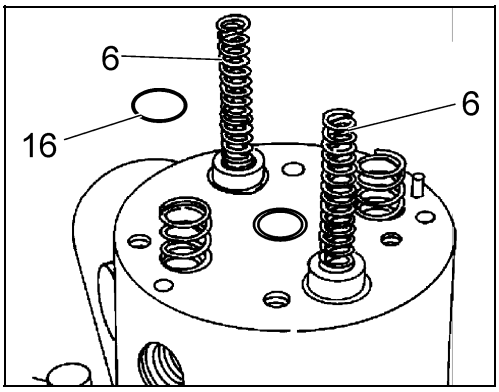
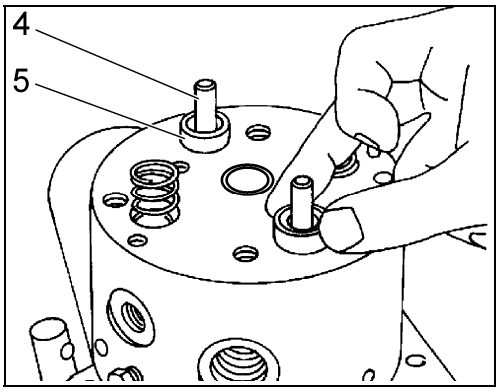
17. Remove and discard O-ring (16) from the valve housing. Remove the outer springs (7).



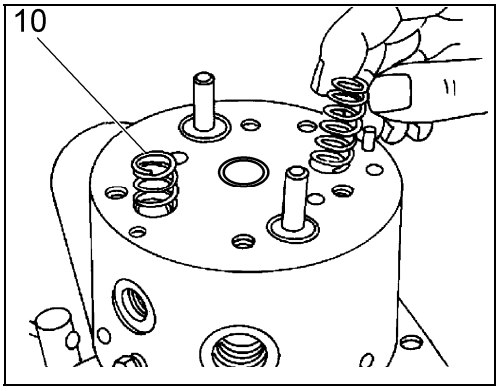
18. Remove the inner springs (6).



19. Remove the guide sleeve (5) from each steering spool (4).



20. Remove the directional spool springs (10) at each directional spool in the valve housing.



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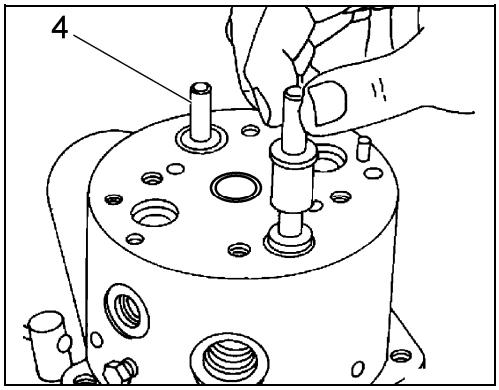
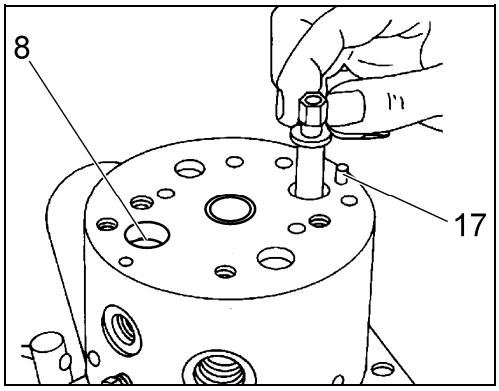
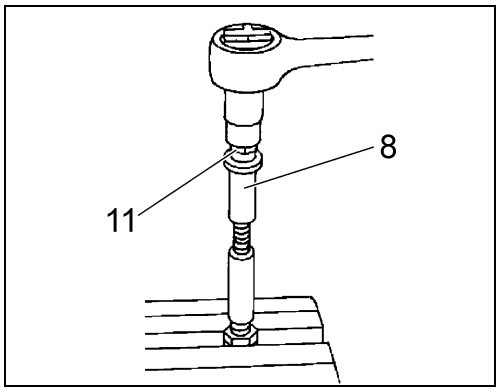
21. Remove the two steering spools (4) from the valve housing.



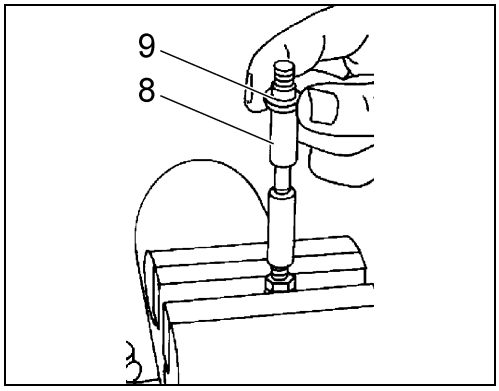
22. From under the valve housing, push the directional spool (8) up and out of the valve body. Repeat for remaining spool. If necessary, remove dowel pin (17).



23. Install two 3/8”NC nuts on the directional spool (8) and position in a vise. Remove the loctited stop nut (11) from the spool. Repeat for remaining spool.



24. Remove the thrust washer (9) from the spool (8). Repeat for remaining spool.



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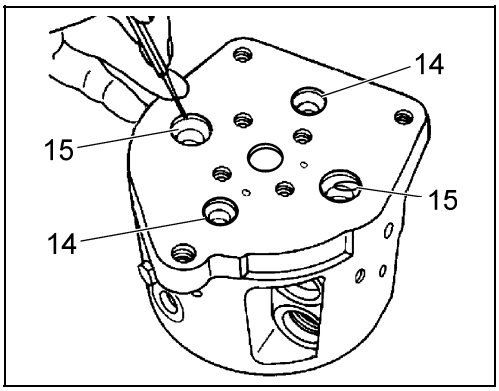
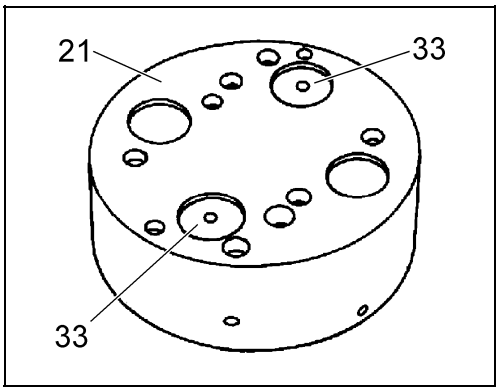
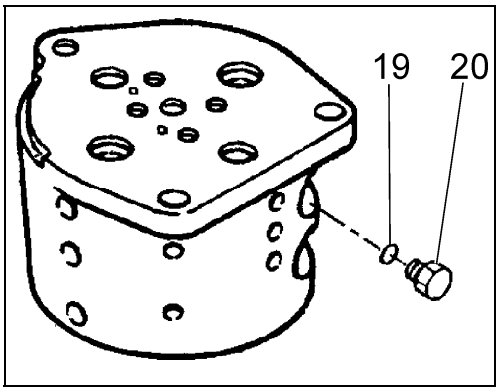
25. Remove and discard seal rings (14 and 15) from the valve housing.



26. Remove the orifice plugs (33) from the bottom cover (21).



27. Remove two plugs (20) with O-rings (19), if necessary.



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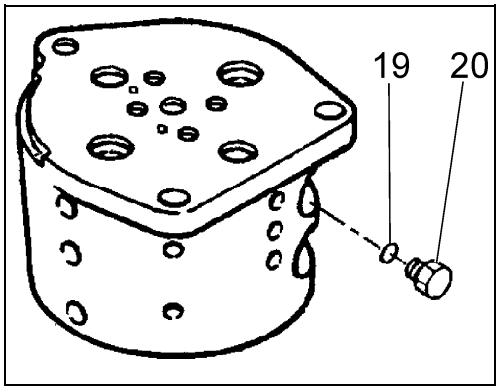
20. INSPECTION AND REPAIR

1. Clean all parts in a suitable cleaning solvent and blow dry with compressed air. Be sure all the oil passages in the valve spools and valve body are clean and free of obstructions.
2. Inspect the parts for excessive wear or scratches and replace if necessary.
3. All the sealing rings must be replaced.
4. Clean threads with a stiff brush and solvent. Check for damage.
5. Inspect the condition of the springs. If they are wore or damaged, they must be replaced.
6. Inspect the pivot ring and spool rocker ends for excessive wear or scratches and replace if necessary.

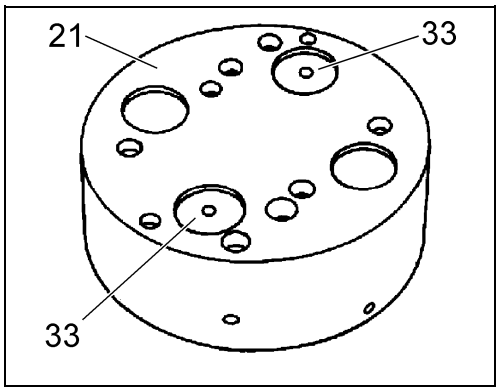
21. REASSEMBLY (Refer to Fig.'s 7C.64 and 7C.65)

IMPORTANT: *Sealing rings should be lubricated with petroleum jelly for ease of assembly. The valve spools and theirs bores should also be lightly lubricated.*

1. Install two plugs (20) with O-rings (19), if removed.



2. Install the orifice plugs (33) into the bottom cover (21). Torque the plugs to 2.7 [Nm].



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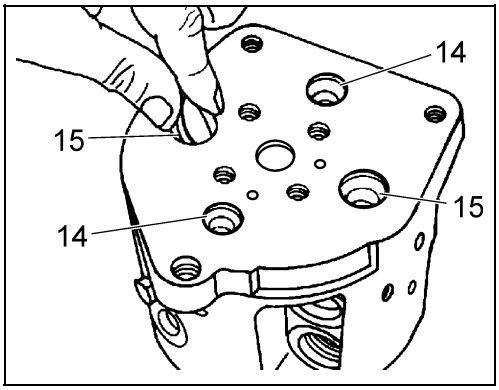
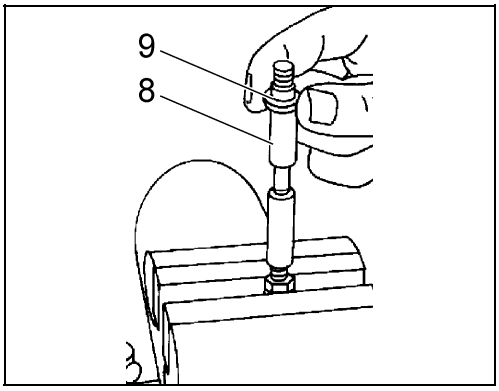
3. Install new seal rings (14 and 15), with the U cup portion facing down, to the spool bores in the valve housing.

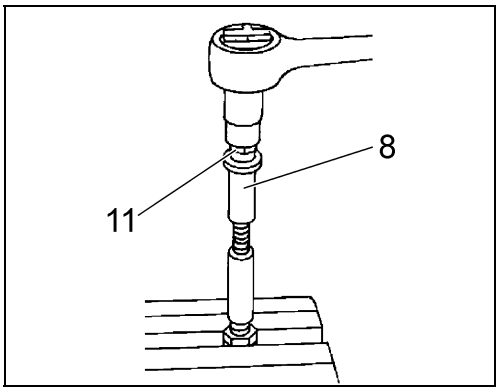


4. With the directional spool nutted in a vise, install the thrust washer (9).

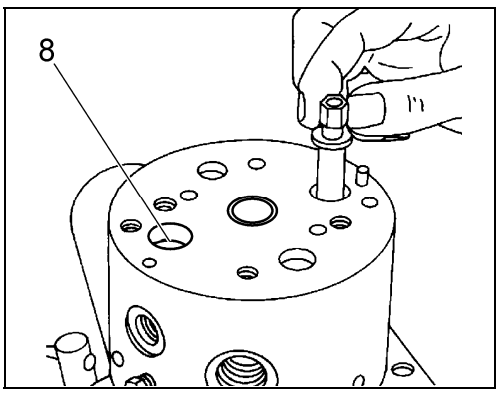


5. Apply LOCTITE #242 to the nut threads, and install the stop nut s (11). Torque the nuts to 22 [Nm].

Repeat Step 4 through 5 for remaining spool.



6. Install the directional spool (8) into the valve housing using a slight turning motion to aid the spool pass through the seal ring. Repeat for remaining spool. If removed, install dowel pin (17).



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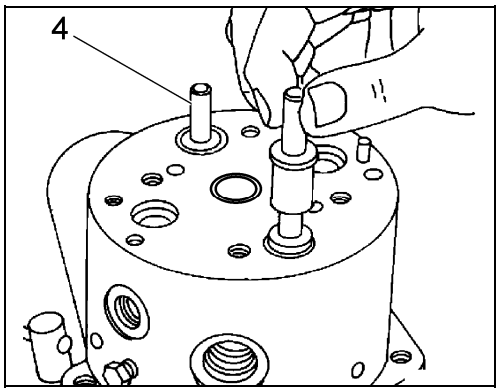
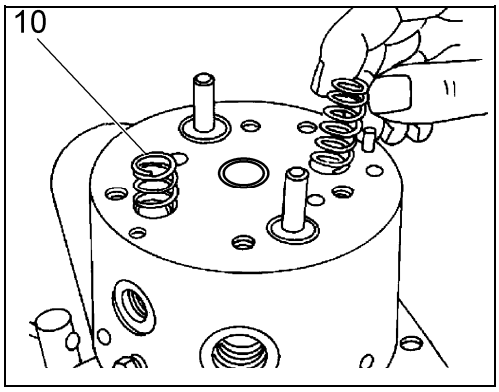
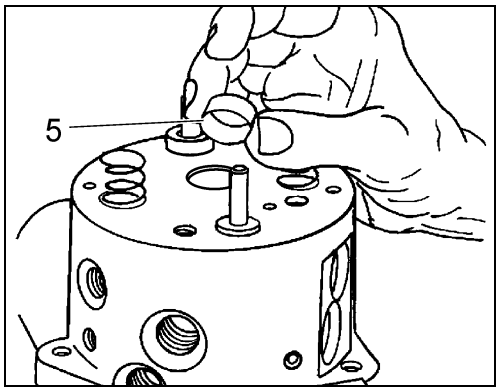
7. Install the steering spool (4) into the valve housing using a slight turning motion to aid the spool pass through the seal ring. Repeat for remaining spool.



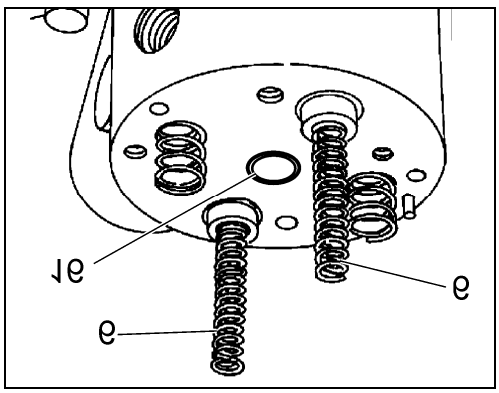
8. Install the directional spool springs (10) in the recessed bores.



9. Install the guide sleeves (5) over the steering spools with the recessed area towards the valve housing.



10. Install O-ring (16) into valve housing. Install the inner springs (6) to the steering spools.



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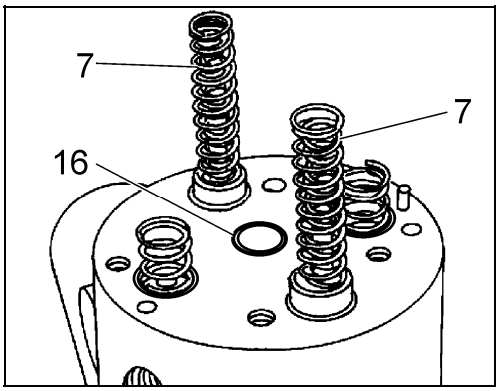
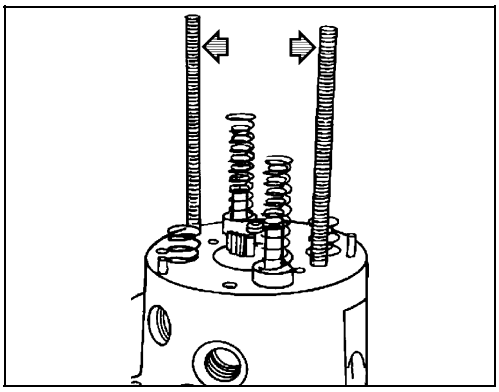
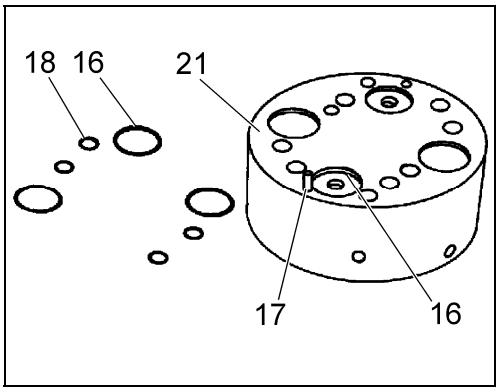
11. Install the outer springs (7) to the steering spools.



12. Install two threaded rods to valve housing.

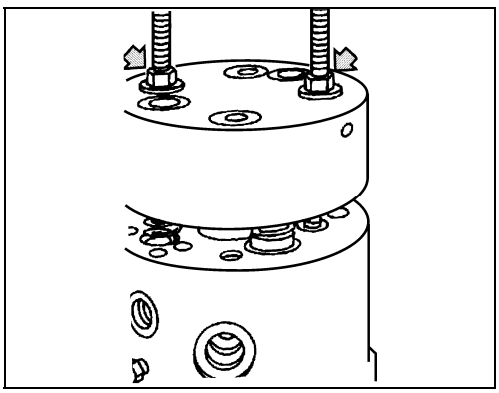


13. Install new O-rings (16 and 18) to the bottom cover (21). If removed, install dowel pin (17).



14. Position the bottom cover (21) over the threaded rods, with the offset dowel pin holes to the dowel pins (17). Draw down equally on the nuts until the cover is flush.

NOTE: *Be careful not to bind the cover to the dowel pin.*



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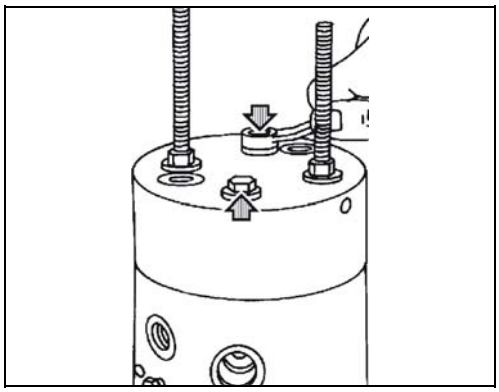
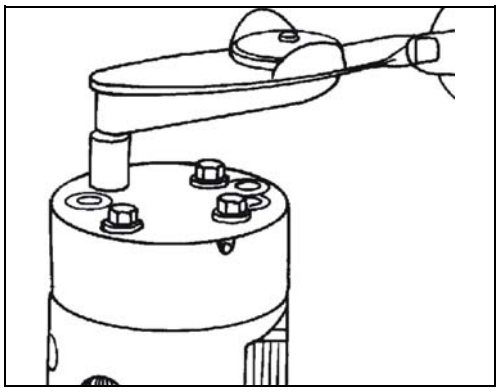
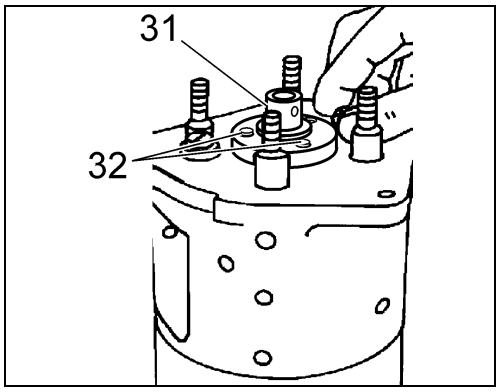
15. Install two mounting bolts at the open holes. Remove the threaded rods and install the remaining bolts.



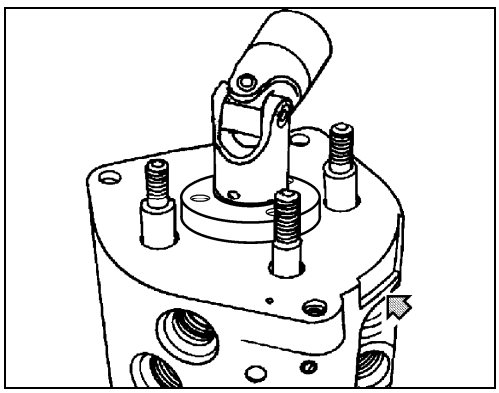
16. Torque the mounting bolts to 38 [Nm].



17. If removed, install two dowel pins (32). Install joint base (31) to the valve housing, aligning the base dowel pins with the offset recess in the valve housing. Torque the bolts to 11 [Nm].



18. Slide the universal joint (27) over the joint base (31).



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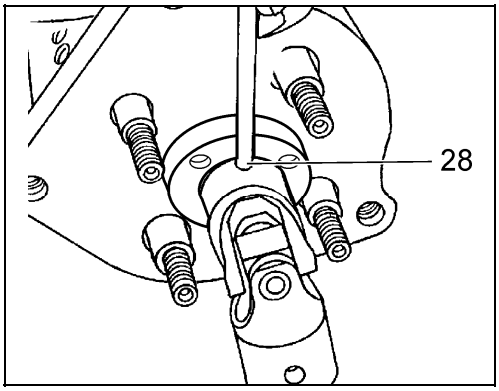
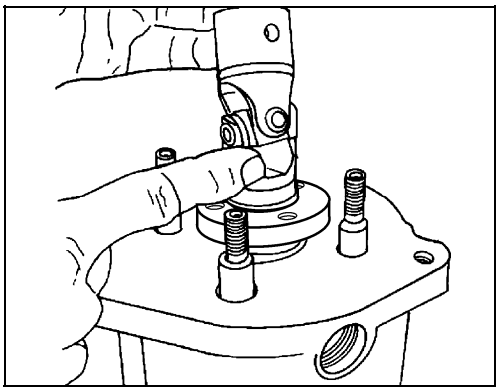
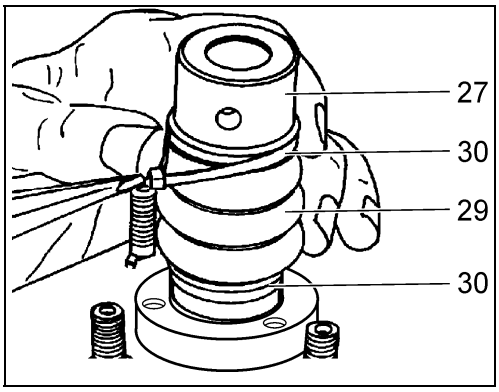
19. Drive the dowel pin (28) in making sure it is countersunk at each end.



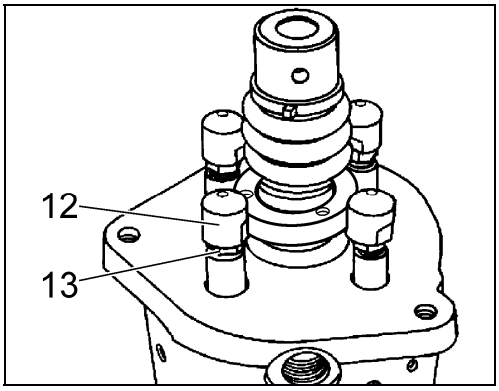
20. Apply a generous amount of grease (refer to OPERATOR'S MANUAL) to the universal joint.



21. Install the boot (29) over the universal joint (27) and secure with the tie straps (30).



22. Install the jam nuts (13) and the spool rocker ends (12) to each spool.



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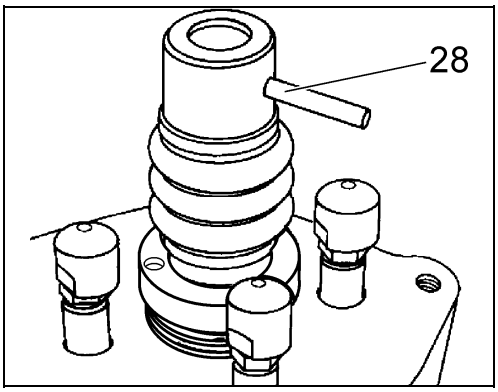
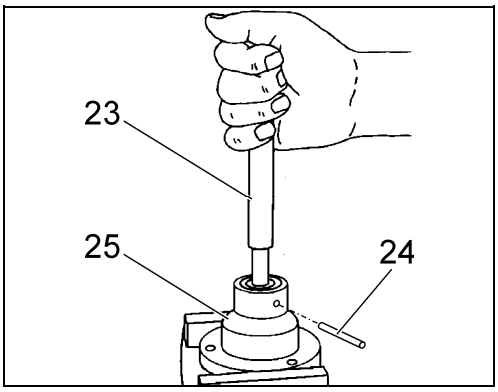
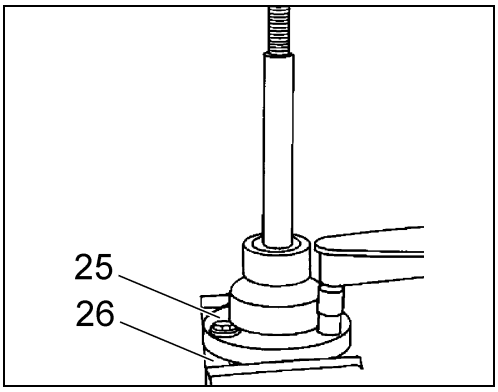
23. Start the dowel pin (28) into the universal joint.



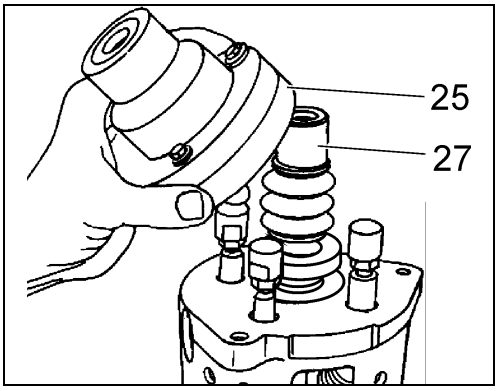
24. Install the lever (23) into the housing (25) and align with the dowel pin (24). Drive the pin into the housing so that it completely clears the housing.



25. Attach the joint housing (25) to the pivot ring (26) and torque the bolts to 11 [Nm].



26. Install the joint housing (25) over the universal joint (27) and align the dowel pin opening in the universal joint with the opening in the joint housing.



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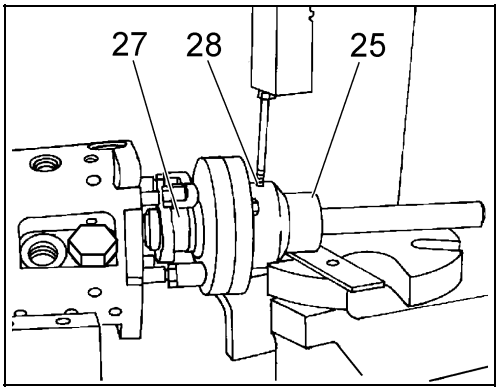
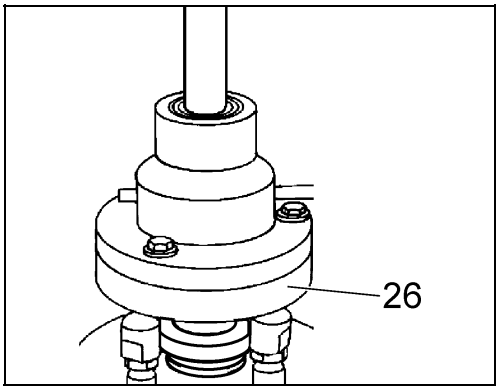
27. Drive the pin (28) into joint housing (25) to join the housing with the universal joint (27) so that it completely clears the housing (25).

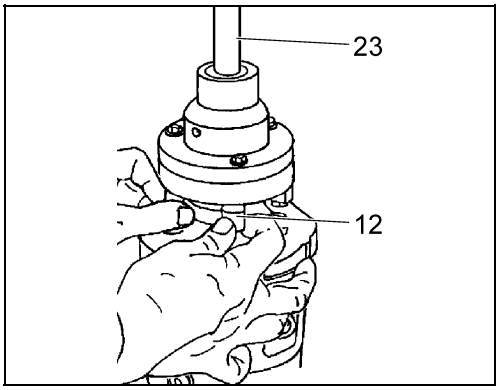


Drive Train Control Valve Adjustment

28. Apply a generous amount of grease (refer to OPERATOR'S MANUAL) to the pivot ring (26) surface.



29. Run all four spool rocker ends (12) up against the pivot ring until the lever (23) is vertical with no free play between the pivot ring surface and rocker ends.



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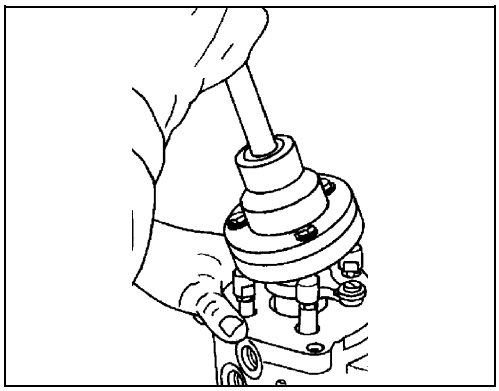
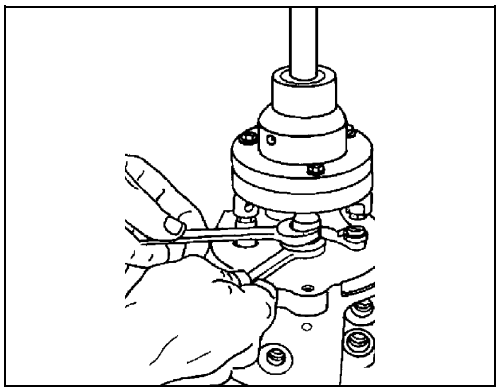
30. Move the lever fully in all directions to seat the steering and directional spools against their springs. Recheck for free play between the pivot ring and rocker ends and correct as necessary.



31. Tighten the jam nuts to the spool rocker ends. Torque the nuts to 32 – 37 [Nm].



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22. PRESSURE TEST

Drive train control valve pressure test. (Refer to Fig's. 7.1 and 7.2 in SECTION 7)

1. Install drive train control valve in the platform console as described in steps 1 to 6, Paragraph 23, INSTALLATION in this Section.
2. Install Pressure Test Kit gauges (refer to SERVICE /SPECIAL TOOLS in Section 7, DRIVE TRAIN) in respective pressure lines.
3. Apply parking brake. Start the engine.
4. "FWD - RWD" pressure test.
   a. Shift the drive train control lever from neutral (N) to forward (FWD) position. The hydraulic detent is to hold the lever within 7 [°] ÷ 9 [°]; this hydraulic detent must be operational within 3 [°] ÷ 5 [°]. The "F" test point pressure must be M-0.07 [MPa] and 'R" test point pressure must be 0.0 [MPa]. Shift the lever back to the neutral position; the hydraulic detent must release the lever within 3.5 [°] ÷ 6.5 [°].
   b. Repeat this procedure for the rearward (RWD) drive train control lever position. The pressures must be the same respectively.
   c. The pressures in test points "F" and "R" must be 0.0 [MPa] for control lever in neutral (N) position.
5. Left and right steering pressure test (starting from neutral (N) position).
   a. The pressures in test points "CR" and "CL" must be M-0.07 [MPa] for drive train control lever in neutral (N) position.
   b. Gradually shift the lever from neutral (N) position to the right (RH) direction.
      - with the lever being shifted from 1.6 ± 1 [°] to 5.0 ± 1 [°] initially, the "CR" test point pressure in should be dropping gradually from M-0.07 [MPa] to 0.63 [MPa], followed by the pressure gradually drop to 0.35 [MPa] with lever shifted from 5.0 ± 1 [°] to 10.0 ± 1 [°].
      - finally the "CR" point pressure should be dropped gradually to 0.0 [MPa] with lever at the right extreme position. During this procedure the "CL" test point pressure must be M-0.07 [MPa].
   c. Repeat this procedure for left (LH) direction. The "CL" point pressures should be identical as for RH direction respectively.
6. If the pressures are outside specified above, control valve should be repaired or replaced.
7. Shut off the engine and, in case of successful test pressure results, continue installation as described in Paragraph 23, INSTALLATION in this Section.

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23. INSTALLATION

1. Install drive train control valve (4, Fig. 7C.63) into the valve bracket (2) and secure with three mounting bolts (3).
2. Put the valve bracket (2) with drive train control valve mounted into position, and install the assembly to the platform with four bolts (1).
3. Install valve console (3, Fig. 7C.61) into platform and secure with bolts (4).
4. Turn on control lever (5) with attached boot and electrical harness. Install two stiffener plates along with control lever.
5. Reconnect control lever harness (3, Fig. 7C.62).
6. Reconnect all hoses (1) to the drive train control valve (2).
7. Install bracket (2, Fig. 7C.60) with filters (4) to the ROPS bracket and secure with bolts (3). Reconnect the electrical harness to the filter base.

WARNING! Be sure the area around the machine is clear of personnel and obstructions as the vehicle may move during these test. If the machine starts to move, fully depress the decelerator pedal and shift the drive train control lever to NEUTRAL.

8. Reinstall cover (1, Fig. 7C.61) and secure with bolts (2).
9. Apply parking brake. Start the engine. Move the drive train control lever through all the lever positions and check connections for leaks.
10. Install access cover (1, Fig. 7C.59) and secure with bolts (2).
11. Reinstall L.H. enclosure (3) on the left hand side and secure with bolts (4).
12. Check the oil level in the rear main frame as described in the OPERATOR”S MANUAL, add oil if required.

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24. REMOVAL

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *When disconnecting hydraulic lines for any reason, they should be properly capped with the correct size plastic cap. If these caps are not available, tape or clean rubber corks may be used. Hydraulic openings must never be plugged with rags. This practice could easily introduce dirt or lint into critical hydraulic components of the machine. Tag all disconnected oil lines to facilitate easier installation.*

1. Remove floor mat (cab equipped machines) and center floor plate from between operator's seat and instrument panel.
2. Remove the transmission case guard from the bottom of the machine.

WARNING! This procedure requires extreme caution. Use suitable blocking equipment while under confines the machine.

3. Drain main frame as described in the OPERATOR'S MANUAL.
4. Disconnect brake control cable.
5. Disconnect the lube steering drive hose (2, Fig. 7C. 66) and main pressure filters hose (4) from the top of pump (3).

Fig. 7C.66. Charge and Scavenge Pump Disconnect Points (Top View)

1. Pump Mounting Bolt
2. Lube Steering Drive Hose
3. Charge and Scavenge Pump
4. Main Pressure Filters Hose

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6. Disconnect the main suction tube (2, Fig. 7C. 67) and scavenge suction pump hose (4) from the bottom of pump (3).
7. Attach a suitable sling to the pump and remove the two mounting flange bolts (1, Fig. 7C.66 and 1, Fig. 7C.67). Pull the pump free of the torque converter and lower it out the bottom of the machine. Remove and discard the pump mounting O-ring.

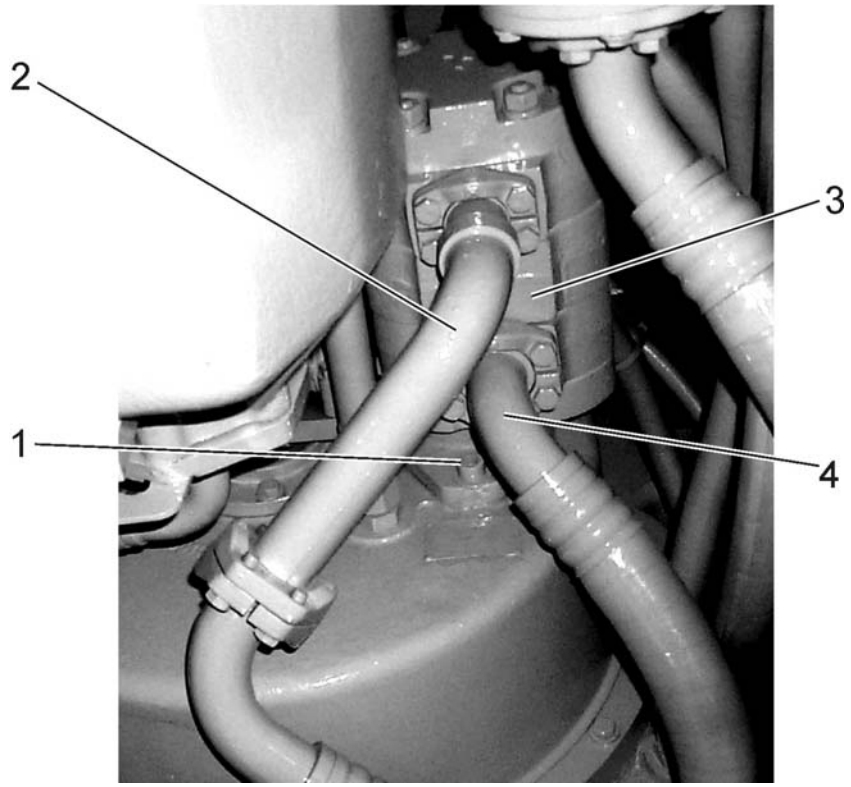

Fig. 7C.67. Charge and Scavenge Pump Disconnect Points (Bottom View)

1. Pump Mounting Bolt
2. Main Suction Tube
3. Charge and Scavenge Pump
4. Scavenge Suction Pump Hose

25. DISASSEMBLY (Refer to Fig. 7C.68)

IMPORTANT: *If prying off sections becomes necessary take extreme care not to mar or damage machined surfaces. Excessive force while prying can result in misalignment and seriously damage parts.*

NOTE: *Gears are closely matched, therefore they must be kept together as sets when removed from a unit. Handle with care avoid damage to the journals or teeth.*

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CHARGE AND SCAVENGE PUMP

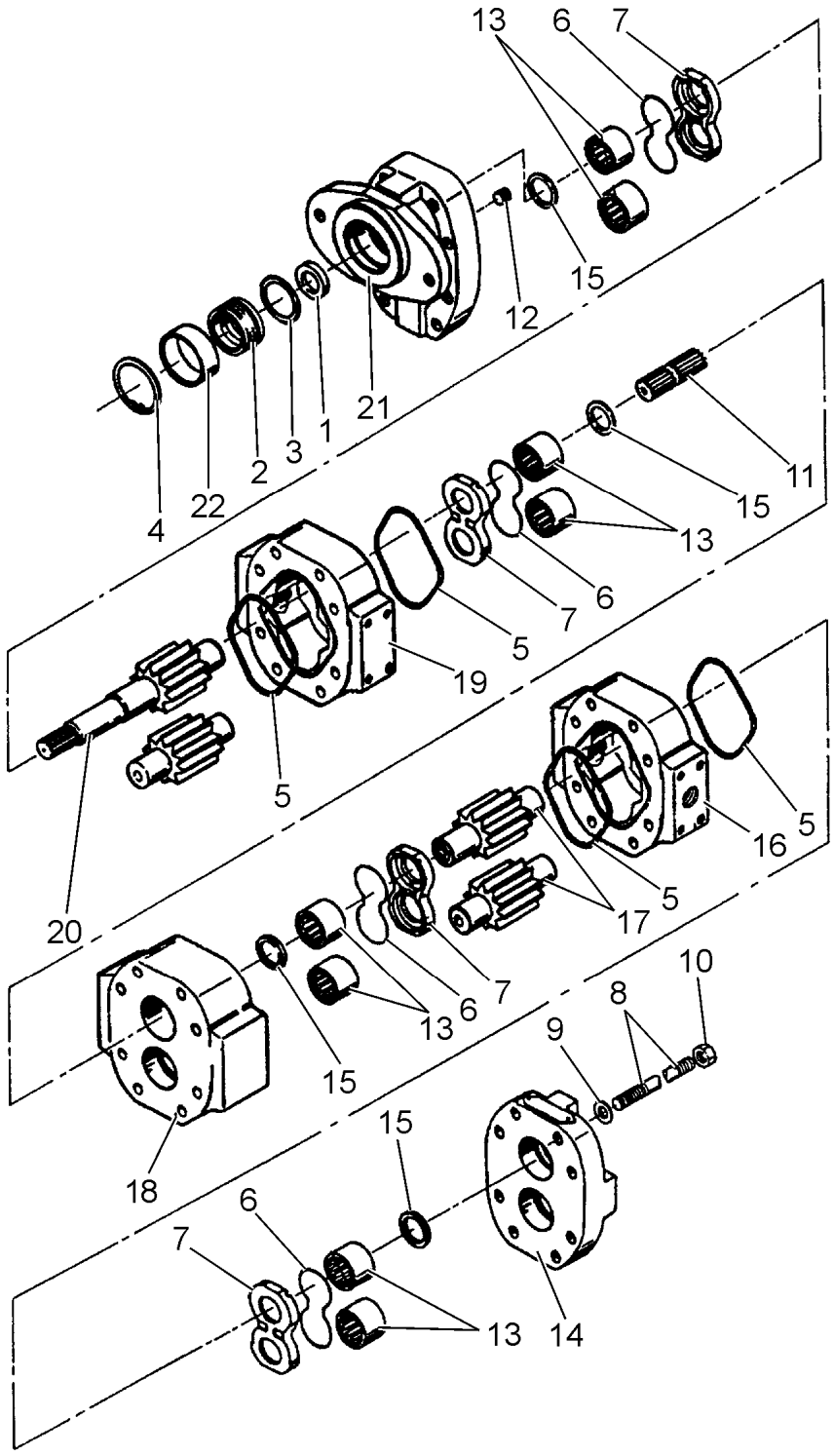

Fig. 7C.68. Exploded View of Charge and Scavenge Pump

1. Shaft Oil Seal
2. Seal Retainer
3. O-Ring
4. Retaining Ring
5. Housing Seal
6. Channel Seal
7. Wear Plate
8. Stud
9. Washer
10. Nut
11. Shaft Coupling
12. Port Plug
13. Needle Bearing
14. Rear Housing
15. Seal Ring
16. Driven Gear Housing
17. Driven Gear Set
18. Bearing Housing
19. Drive Gear Housing
20. Drive Gear Set
21. Front Housing
22. Retainer Spacer

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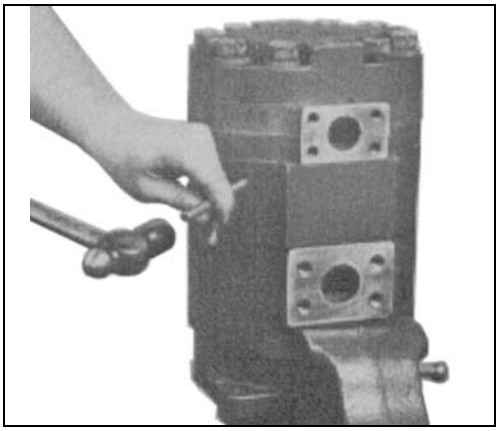
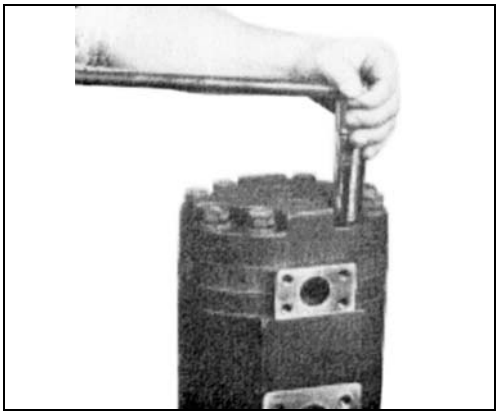
CHARGE AND SCAVENGE PUMP

1. Place the pump in a wise with the drive shaft: pointing down. Index mark two pump sections with a punch. Be sure to align these marks when reassembling.

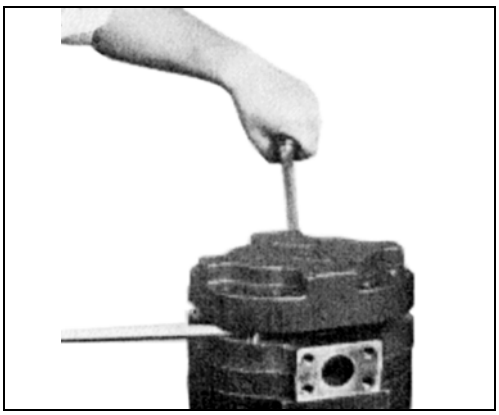


NOTE: *Do not grip on or near any machined surfaces during assembly or disassembly.*

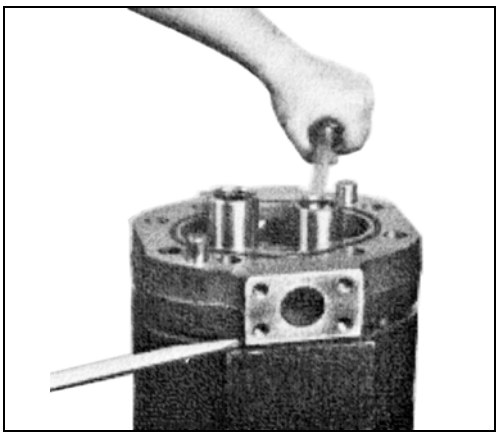
2. Remove the 8 hex nuts (10) and washers (9) with a socket wrench.



3. Lift off the rear housing (14). If necessary to pry loose, be careful not to damage the machined surfaces. If the wear plate (7) remains in the gear housing (16), it can be tapped out later with a wooden hammer handle. Be careful not to distort the wear plate (7).



4. Lift the gear housing (16) from the gears (17). If necessary to pry loose, take care not to damage machined surfaces.



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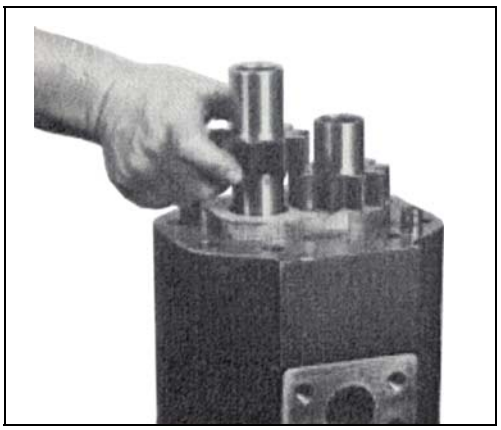
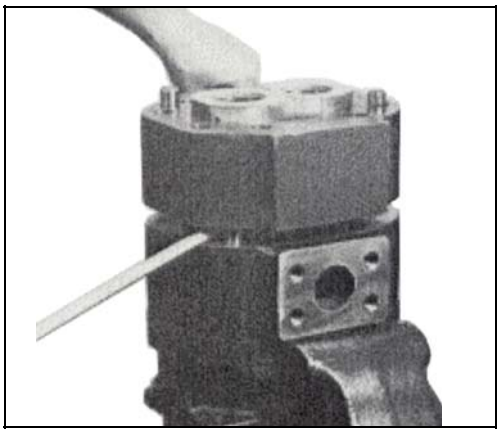
CHARGE AND SCAVENGE PUMP

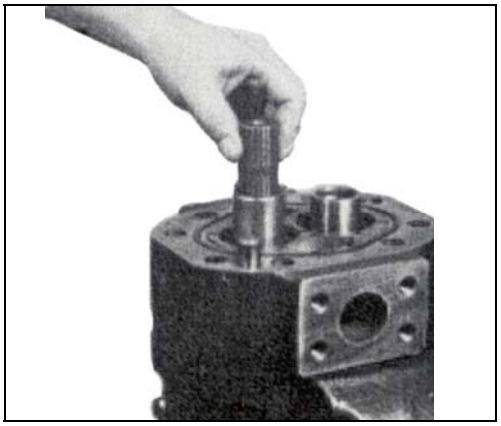
5. Remove the drive and driven gears (17). Keep the gears set (17) together because they are a matched set. Examine and replace if necessary. See Paragraph 26, INSPECTION AND REPAIR in this SECTION.



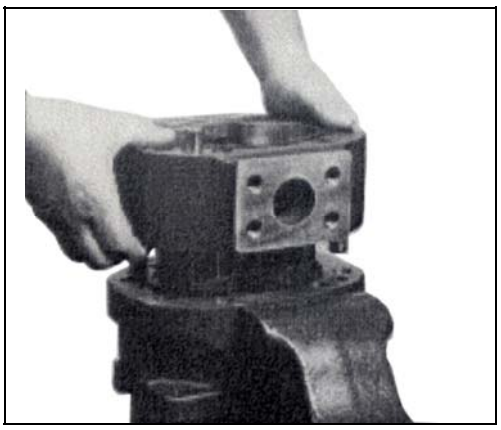
6. Lift or pry off the bearing housing (18). Take care not to damage the machined surfaces.



7. Remove the coupling shaft (11).



8. Lift or pry off the first section gear housing (19). Be careful not to damage machined surfaces. Remove wear plate (7) as described in Step 3.



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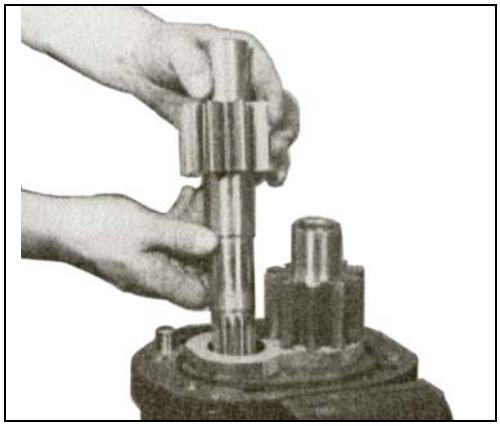
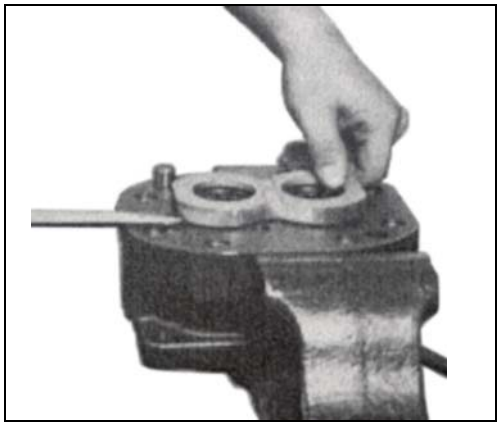
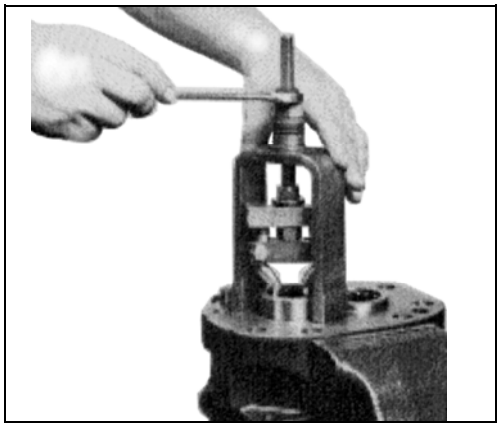
9. Remove the drive and driven gears (20). Keep the gears set (20) together because they are a matched set. Examine and replace if necessary. See Paragraph 26, INSPECTION AND REPAIR in this SECTION.



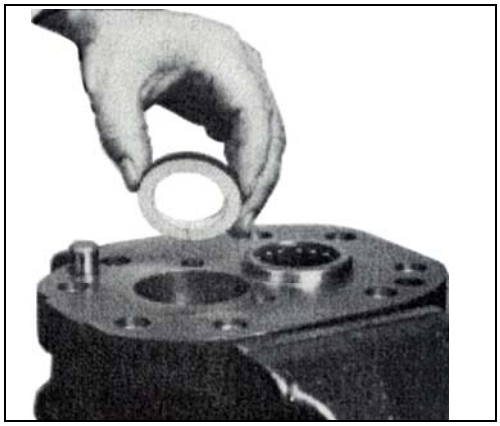
10. Pry the wear plates (7) from the front housing (21), rear housing (14) or bearing housing (18) with a screw driver or similar tool. Avoid distorting the wear plates (7). Remove and discard all rubber channel seals (6) and housing seals (5).



11. Examine all needle bearings (13) for wear and discoloration. If replacement is necessary, pull the bearings (13) with a bearing puller. Any sign wear or discoloration calls for replacement.



12. It is generally advisable to replace seal rings (15) when rebuilding unit. To replace, remove the drive gear bearing with a bearing puller and remove seal ring from bottom of bearing bore. Check all seal ring bores in unit for abnormal wear. If worn, replace those sections.



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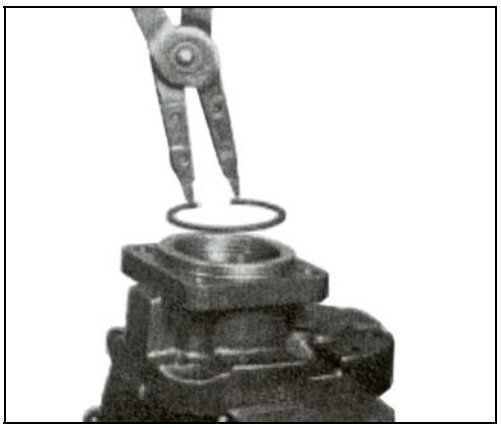
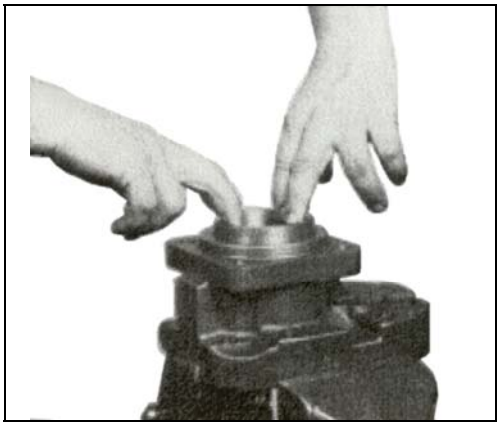
CHARGE AND SCAVENGE PUMP

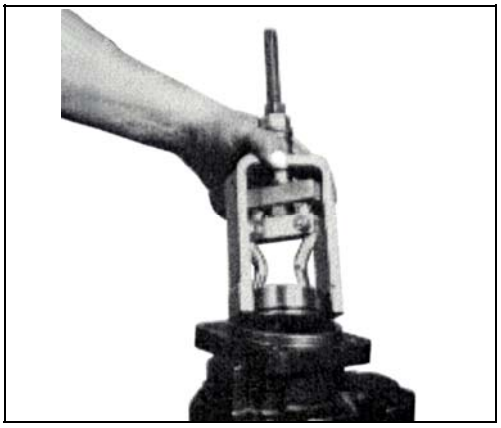
13. Grip the front housing (21) in the vise with the mounting face up. Remove the retaining ring (4) with retaining ring pliers.



14. Remove the retainer spacer (22).



15. Remove the seal retainer (2) and seal with a light duty bearing puller. Remove and discard O-ring (3).



16. Tap the shaft seal (1) from the seal retainer (2) and discard. Clean seal bore with solvent to remove old sealant. If bore is scored, smooth with fine grade emery paper. It is generally advisable to replace the seal retainer (2).

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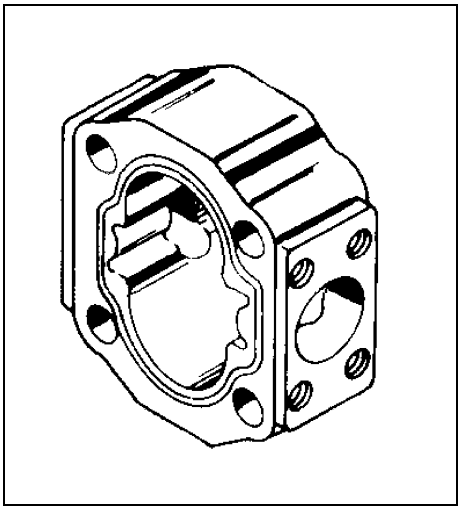
26. INSPECTION AND REPAIR

1. Discard all seals, O-rings and wear plates and replace with new ones during reassembly.
2. Wash all parts thoroughly in a suitable solvent. Dry thoroughly with compressed air.
3. Check all parts of pump separately with the following suggestions.

A. Gear Housing

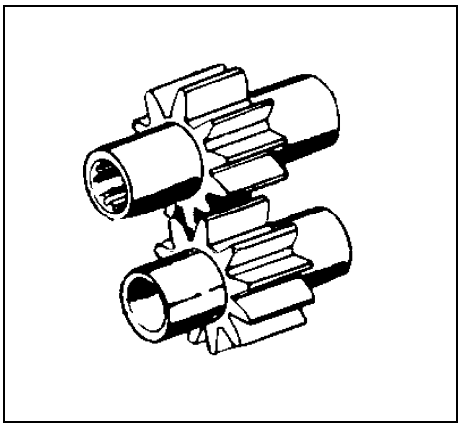
Wear in excess of 0.13 [mm] cut-out necessitates replacement of the gear housing.
Place a straight-edge across bore. If you can slip a 0.13 [mm] feeler gage under the straight-edge in the cut-out area, replace the gear housing.
Pressure pushes the gears against the housing on the low pressure side. As the hubs and bearings wear, the cut-out becomes more pronounced. Excessive cut-out in a short period of time indicates excessive oil contamination. Withdraw oil sample and check it and main frame for dirt.
Where cut-out is moderate, 0.13 [mm] or less, gear housing is in good condition, and both ports are of the same size, housing may be flopped over and reused.



B. Gears

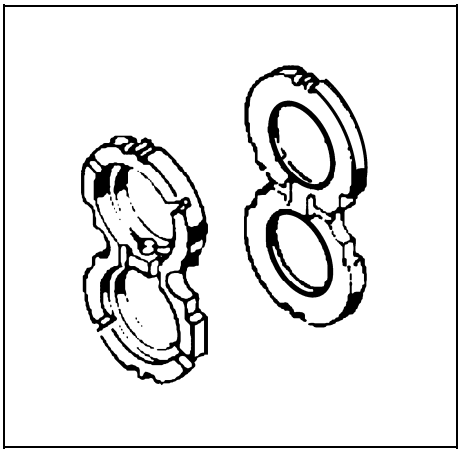
Any wear on gear hubs detectable by touch, or in excess of 0.05 [mm] necessitates replacement. Nicking, grooving, fretting of teeth surfaces or head discoloration also necessitates replacement. Scoring, grooving or burring of outside diameter of teeth generally means replacement is necessary unless damage is light and can be stoned off.

NOTE: *Gears assemblies must be replaced in pairs*.



C. Wear plates

The wear plates seal the gear section at the sides of the gears. Wear here will allow internal slippage, that is, oil will bypass with in the pump. 0.05 [mm] maximum wear is allowable. Replace wear plates if they are scored, eroded, pitted or discolored. Check center of wear plates where the gears mesh. Erosion here indicates oil contamination. Pitted wear plates indicate cavitation or oil aeration. Discolored wear plates indicate overheating, probably insufficient oil.



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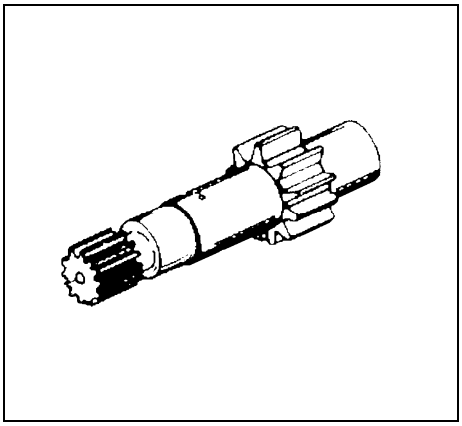
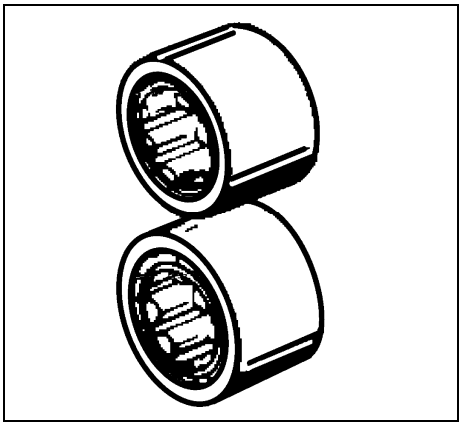
CHARGE AND SCAVENGE PUMP

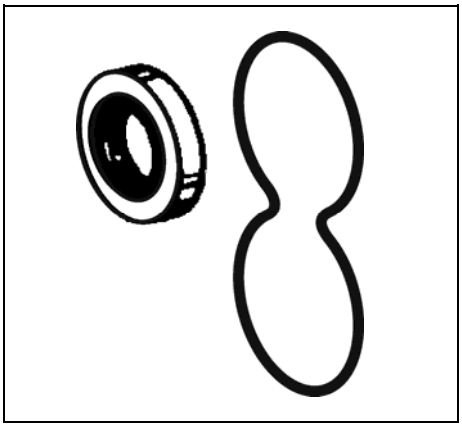
D. Drive shafts
Replace if there is any wear detectable by touch in the seal areas or at the drive coupling. 0.05 [mm] wear is the maximum allowable.
Wear in the shaft seal areas indicate oil contamination and shaft replacement is required. Wear or damage to splines, keys or keyways necessitates replacement.



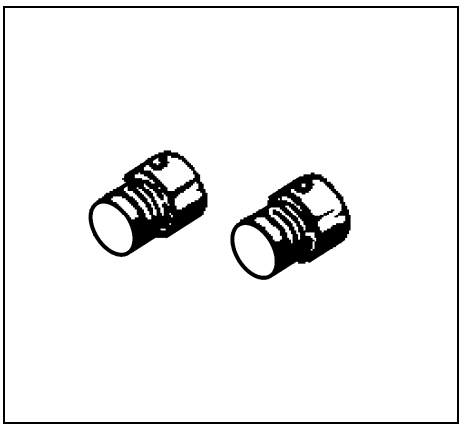
E. Bearings
If gears are replaced, bearings must be replaced. Bearings should fit into bore with a light press fit. A neat hand fit is allowable. If bearings can fall out, bore may be oversize.



F. Seals and gaskets
Replace all rubber and polymer seals whenever disassembling pump. Include all O-rings, channel seals behind wear plates, shaft seal and gasket seals.



G. Plug
Make sure the pressure side of the front housing is plugged.



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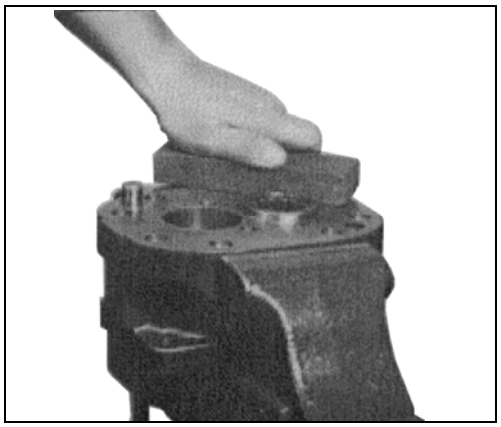
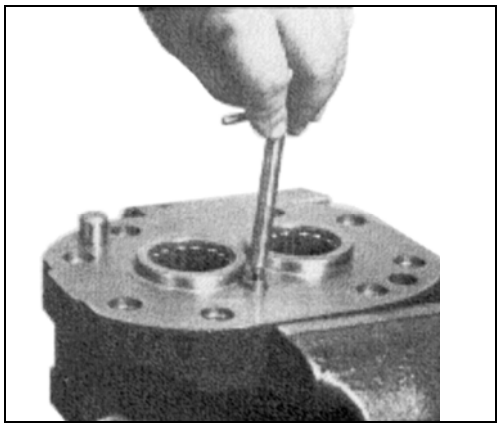
27. REASSEMBLY

1. Stone off all cast machined surfaces with a medium grit carborundum stone (to remove any burrs as a result of disassembly). If bearings have been removed, deburr bearing bores. Rinse parts in a solvent. Air blast all parts and wipe with a clean, lintless cloth before starting reassembly.

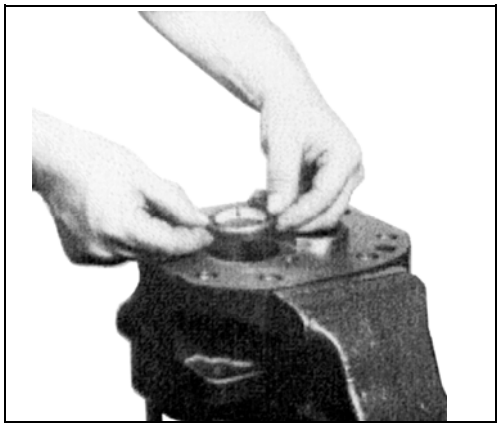


2. Grip the front housing (21) in the vise with the mounting face down. Examine the plug (12), to be sure it is tightly in place. Replace only if parts is damaged or missing.

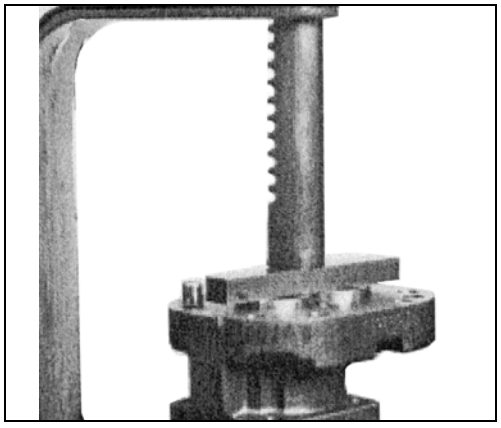


ASSEMBLY STEPS 3, 4, 5 AND 6 APPLY TO FRONT HOUSING, BEARING HOUSING AND REAR HOUSING.

3. If seal rings (15) are being replaced, insert into bottom of drive gear bearing bore flat side down. The notch in the seal ring MUST BE VISIBLE. This is a check to be certain the notched side is next the bearing.



4. If any bearings (13) have been removed from the front housing (21), rear housing (14) or bearing housing (18), replace the bearings (13) by pressing them into the bearing bore with an arbor press.



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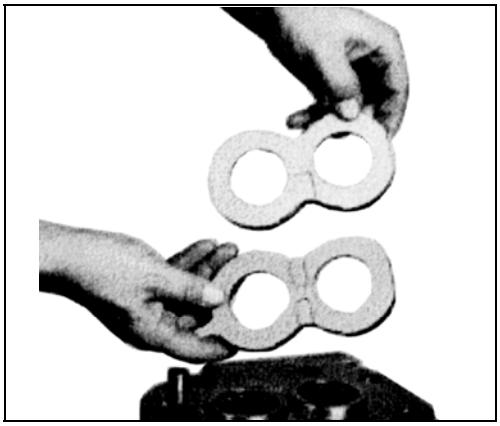
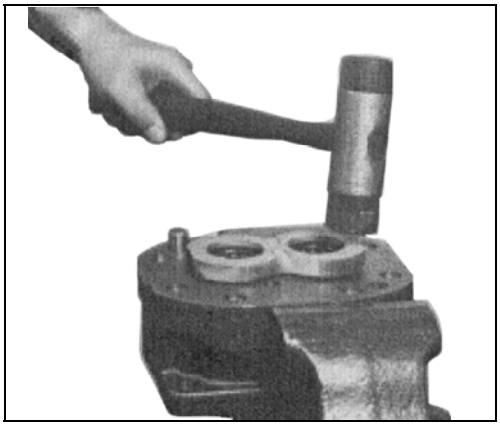
CHARGE AND SCAVENGE PUMP

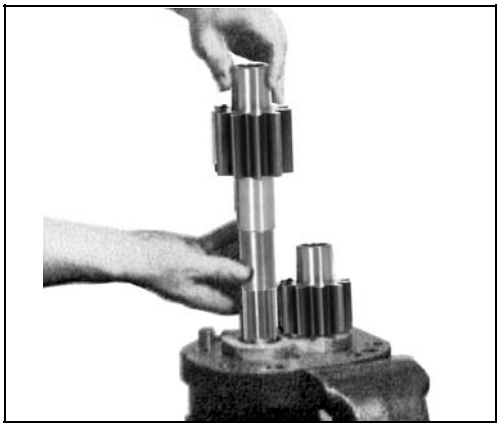
5. Check all wear plates (7) for wear. Replace if necessary (see Paragraph 26, INSPECTION AND REPAIR in this SECTION). Note pump wear plates (7), that have a single relief pocket must be installed with this pocket on the pressure side.



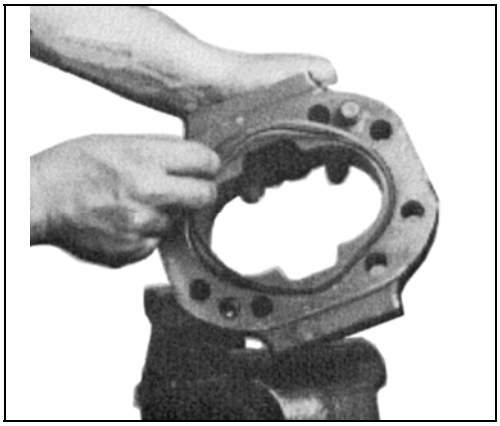
6. Grease channel seals (6) and insert into the middle slots in the wear plate (7). With the channel seals (6) down, place the wear plate (7) over the bearings (13). Tap the wear plate (7) down firmly against the machined surface with a soft hammer. Tap wear plate (7) with a soft hammer to about 0.8 [mm] from the machined surface.



7. Insert the integral shaft and gear (20). Push down until the gear is tight against the wear plate (7). Insert the matched driver gear (20).



8. Grease the new housing seals (5) and insert them into the grooves in both sides of gear housings (16 and 19).



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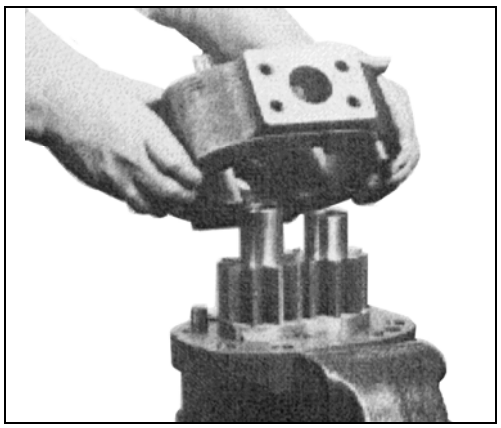
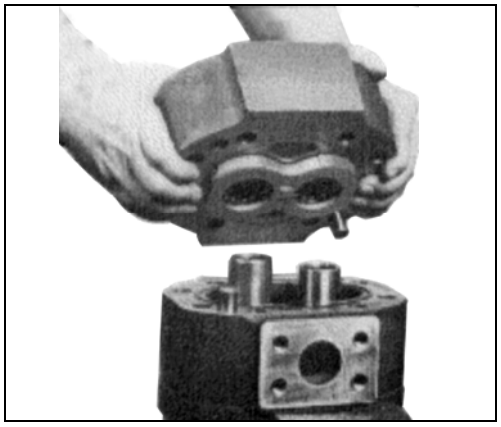
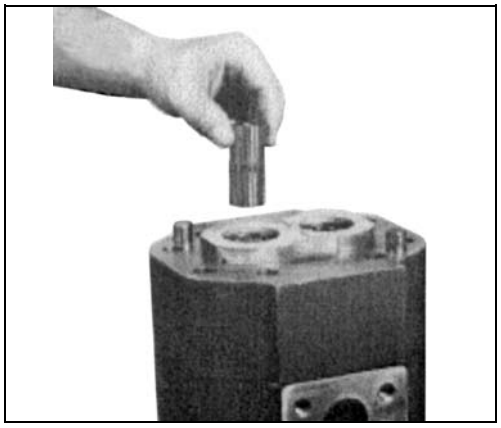
9. Slide the first section gear housing (19) over the gear set (20) and tap it with a soft hammer until it rests tightly against the front housing (21). Be careful not to pinch the housing seal (5). Squirt oil over the gears to provide initial lubrication when pump is started.



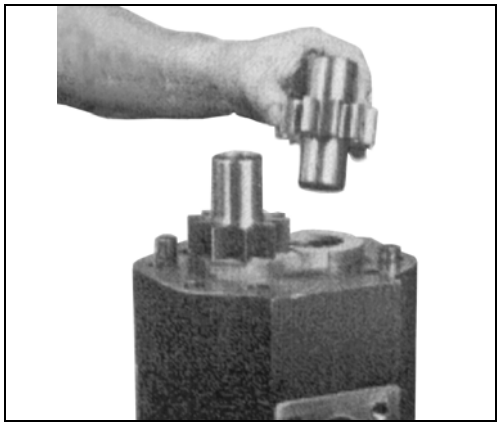
10. Position the bearing housing (18) with wear plates (7) on the gear housing (19) so that the needle bearings (13) receive the journals of the drive and driven gears (20). Make sure that the index marks (See Step 1. Disassembly) are properly aligned. Tap the bearing housing (18) tight with a soft hammer.



11. Insert the coupling shaft (11) in the spline of the drive gear (20).



12. Insert the drive and driven gears (17) of the second section in their respective bearings (13). Push down tightly against the wear plate (7).



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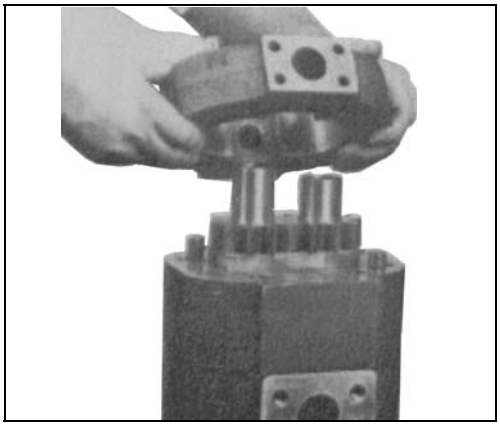
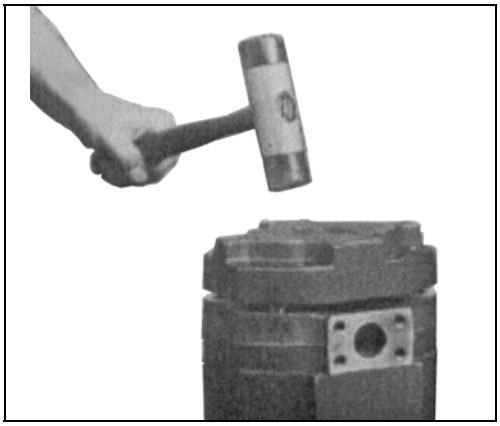
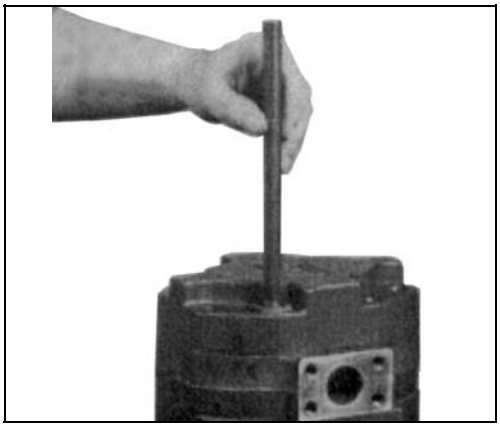
13. Slide the second section gear housing (16) over the gear set (17) and tap it tight against the bearing housing (18) with a soft hammer. Be careful not to pinch the housing seal (5). Squirt oil over the gears to provide initial lubrication when pump is started. Line up the holes in the 2 castings. When parts are parallel squeeze them together or gently tap alternately with a plastic hammer until parts move smoothly together.
    Do not force.



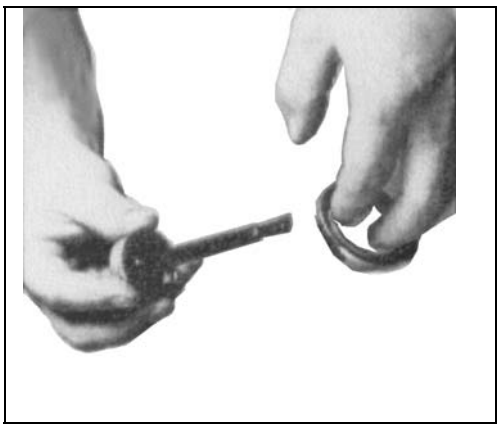
14. Place the rear housing (14) over the gear journals and tap tightly against the gear housing (16). Be careful not to pinch the housing seal (5).



15. Thread the 8 studs (8) and nuts (10) with washers (9) into the front housing (21) and snug up alternately or cross-corner. Rotate the drive shaft with a 6" wrench to make sure there is no binding in the pump. After the nuts (10) are tight and it is sure there is no internal binding, torque the diagonally opposite nuts (10) to 270 [Nm].



16. Coat the outside of the seal (1) with Permatex Aviation Form-A-Gasket 3D or equivalent. With the metal side of the seal down, press it into the seal retainer (2) with a 70 [mm] diameter bar and an arbor press. Be careful not to damage the lip of the seal (1).



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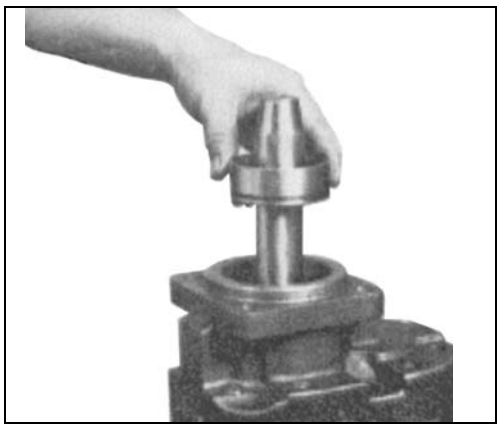
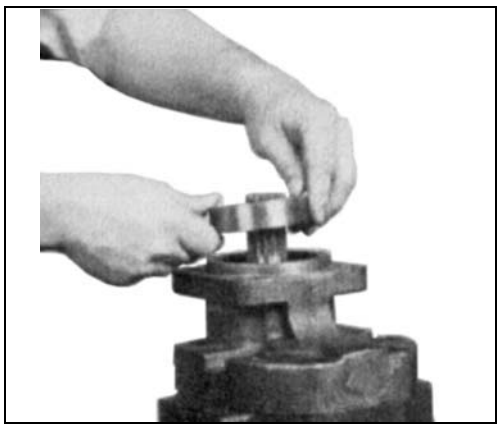
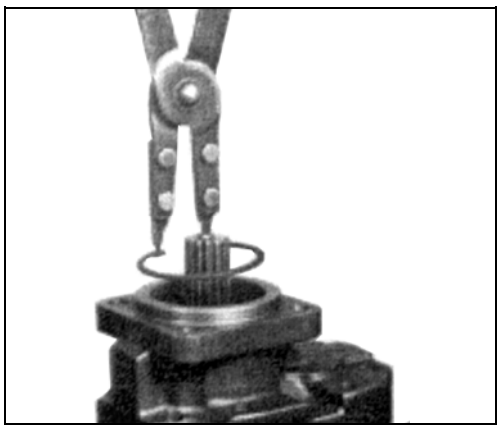
17. Grease and install the new O-ring (3) on the seal retainer (2). Lightly oil the installation sleeve (see Paragraph 1, SERVICE/SPECIAL TOOLS in this SECTION) and twist into the seal (1). Slide the sleeve over the drive shaft and push the seal retainer (2) into place.



18. Drop in the retainer spacer (22). The spacer may need to be lightly tapped into the spacer bore.



19. Install the retaining ring (4) in the groove.



28. INSTALLATION

1. Position the charge and scavenge pump (3, Fig. 7C.66) with new mounting O-ring on the torque converter flange. Using bolts (1, Fig. 7C.67 and 1, Fig. 7C.66) previously removed secure the pump to torque converter.

IMPORTANT: *Before connecting any lines to the pump, fill all ports with clean oil to provide initial lubrication and avoid the unit damage.*

2. Reconnect scavenge suction pump hose (4, Fig. 7C.67) and main suction tube (2) to the bottom of pump (3).

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3. Reconnect main pressure filters hose (4, Fig. 7C.66) and lube steering drive hose (2) to the top of pump (3).
4. Reconnect brake control cable.
5. Refill the main frame as described in the OPERATOR'S MANUAL.
6. Start the engine as described in the OPERATOR'S MANUAL and check for leaks.
7. Check the rear main frame oil level as described in the OPERATOR'S MANUAL and add if necessary.
8. Stop the engine and install the floor plate and the transmission case guard to the bottom of machine.

GEAR SHIFTING VALVE

29. REMOVAL

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *Disconnected hydraulic lines must be properly capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Remove all dirt accumulation from the main frame cover. Tag disconnected lines to facilitate faster and correct installation.*

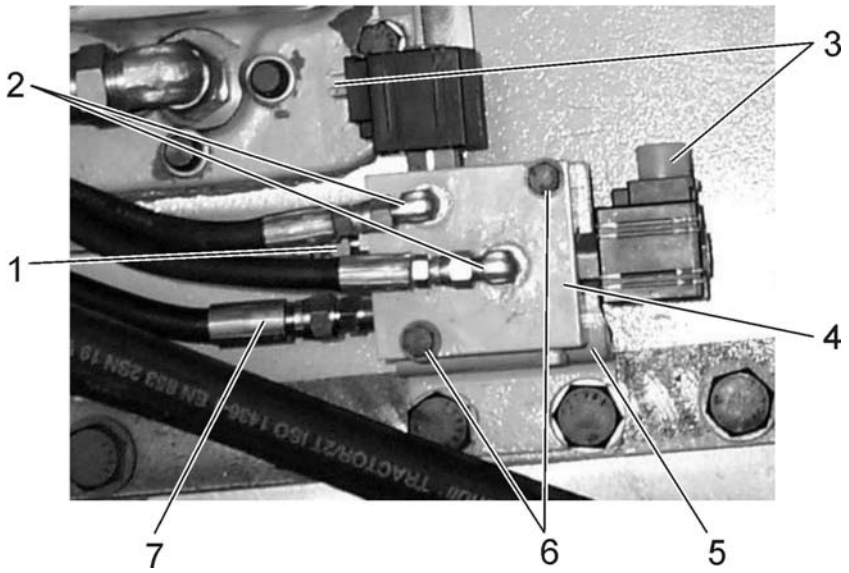

Fig. 7C.69. Gear Shifting Valve Disconnect Points

1. Drain Hose
2. Control Hoses
3. Wiring Harnesses (Removed)
4. Gear Shifting Valve
5. Bracket
6. Bolts
7. Pressure Supply Hose

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GEAR SHIFTING VALVE

1. Turn electrical master switch to OFF position and take it out.
2. Unscrew bolts (5, Fig. 7E.1) securing rear plate (3) and remove the plate from the machine.
3. Disconnect wiring harnesses (3, Fig. 7C.69) at two solenoids.
4. Disconnect two control hoses (2).
5. Unscrew two bolts (6) and separate gear shifting valve (4) from the bracket (5).
6. Disconnect drain hose (1) and pressure supply hose (7) and remove the valve out of machine.

30. DISASSEMBLY

1. Unscrew the solenoid coils from the solenoid valves (1 and 2, Fig. 7C.70). Remove the solenoid valve (1 and 2) bodies from the valve housing (3). Remove and discard the valve seal kit and replace with new.
2. Remove plug (4), if necessary.

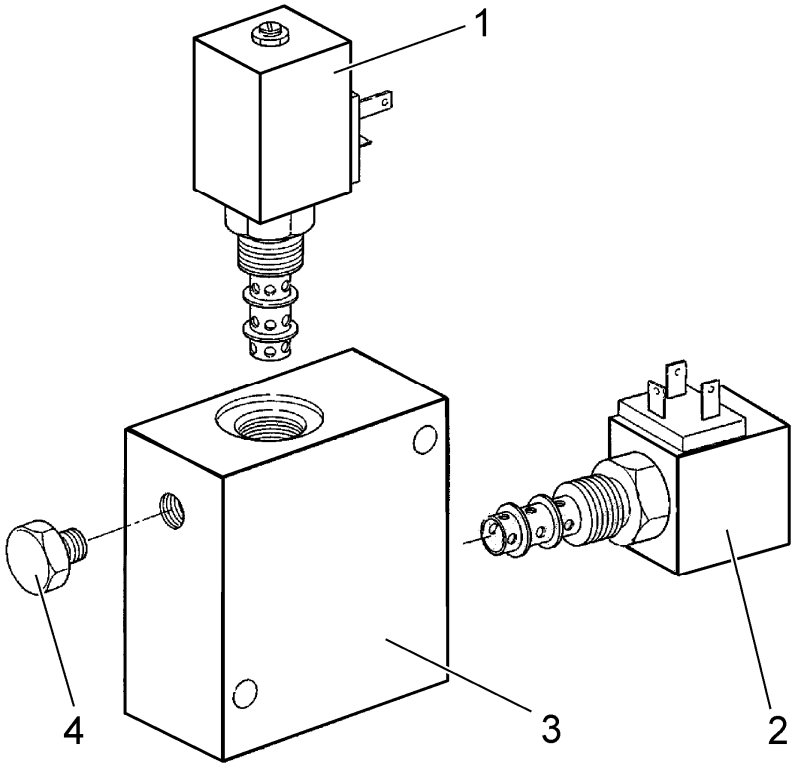

Fig. 7C.70. Exploded View of Gear Shifting Valve

1. Solenoid Valve 3rd Gear
2. Solenoid Valve 2nd Gear
3. Valve Housing
4. Plug

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31. INSPECTION AND REPAIR

1. It is recommended that all new O-rings and seal rings be installed upon reassembly of the valve.
2. Clean all parts in a suitable solvent and blow dry with compressed air. Be sure all oil passages in the valve bodies and spools are free of obstructions.
3. Inspect parts for excessive wear and replace if necessary.
4. Clean threads with a stiff brush and solvent. Check for damage.

32. REASSEMBLY

1. Apply LOCTITE PIPE SEALANT to the threads of plug (4, Fig. 7C.70) and install it, if removed.
2. Install a new seal kit to the solenoid valve (1 and 2) bodies. Install the solenoid valves bodies to the valve housing (3). Torque the solenoid valve (1 and 2) bodies to 20.5 • 22.5 [Nm]. Install the solenoid coils on valve bodies and torque them to 4.3 • 4.8 [Nm].

33. INSTALLATION

1. Temporarily secure the gear shifting valve (4, Fig. 7C.69) to the valve bracket (5). Reconnect the pressure supply hose (7) and drain hose (1) to the valve and then install the gear shifting valve (4) to the bracket (5) with two mounting bolts (6).
2. Reconnect two control hoses (2) to the valve housing.
3. Reconnect two wiring harnesses (3) to the solenoids.
4. Start the engine and operate with drive train control lever. Check for leaks and functioning.
5. Reinstall the rear plate (3, Fig. 7E.1).

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34. REMOVAL AND DISASSEMBLY

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *Disconnected hydraulic lines must be properly capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Remove all dirt accumulation from the main frame cover. Tag disconnected lines to facilitate faster and correct installation.*

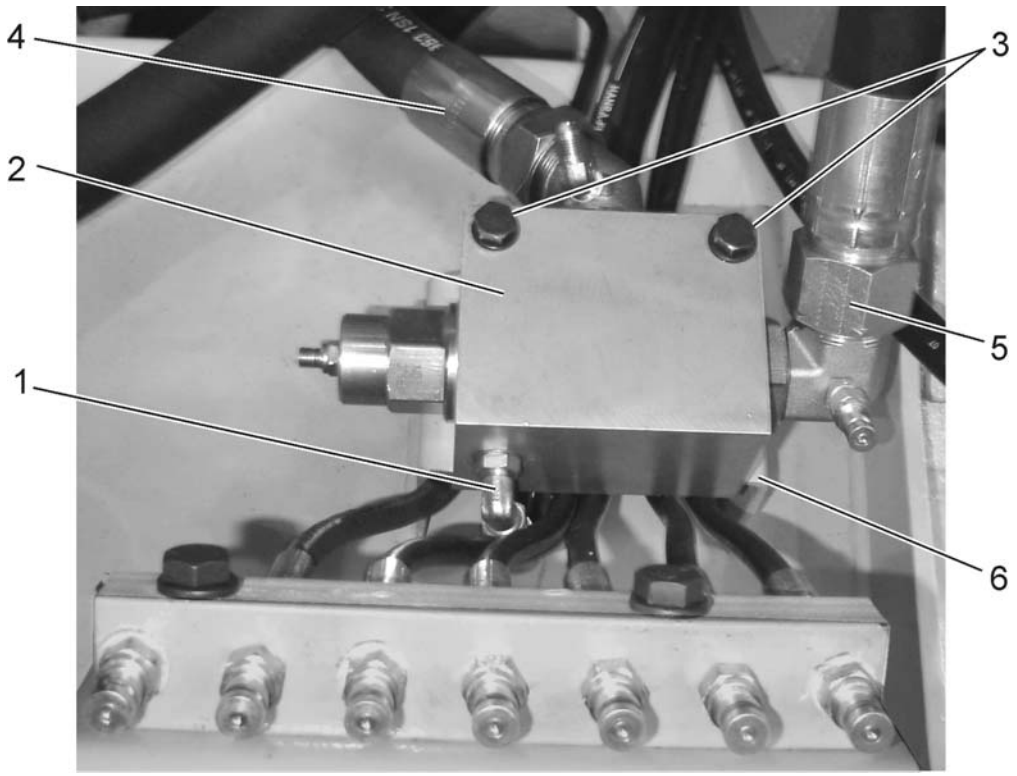

Fig. 7C.71. Priority Valve Disconnect Points

1. Drain Hose
2. Priority Valve
3. Mounting Bolt
4. Priority Valve to Transmission Hose
5. Pressure Supply Hose
6. Bracket

1. Turn electrical master switch to OFF position and take it out.
2. Open LH filter compartment door.
3. Disconnect drain hose (1, Fig. 7C.71), supply hose (5) and priority valve to transmission hose (4) at the priority valve (2).
4. Unscrew two bolts (3) and separate priority valve (2) from LH fender bracket (6).
5. Lift the valve from the machine and remove attached hydraulic connectors, if necessary.
6. Remove the pressure regulator (1 Fig. 7C.72) from the valve housing (2). Remove and discard the valve seal kit and replace with new.

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PRIORITY VALVE

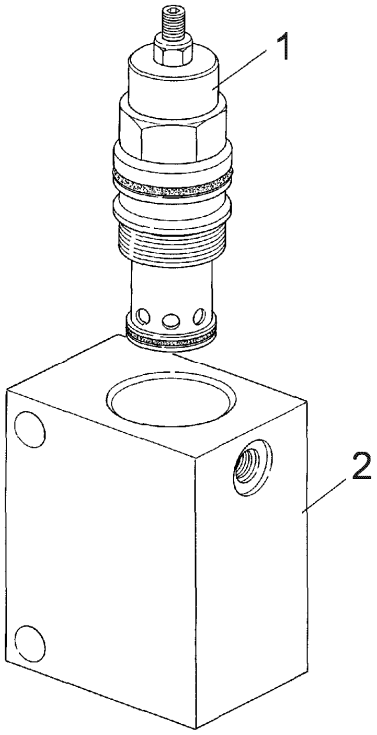

Fig. 7C.72. Exploded View of Priority Valve

1. Pressure Regulator 2. Valve Housing

35. INSPECTION AND REPAIR

1. It is recommended that all new seal rings be installed upon reassembly of the valve.
2. Clean all parts in a suitable solvent and blow dry with compressed air. Be sure all oil passages in the valve housing and regulator are free of obstructions.
3. Inspect parts for excessive wear and replace if necessary.
4. Clean threads with a stiff brush and solvent. Check for damage.

36. REASSEMBLY AND INSTALLATION

1. Install a new seal kit to the pressure regulator body (1, Fig. 7C.72).
2. Install the pressure regulator into the valve housing (2). Torque the regulator body (1) to 465 ÷ 500 [Nm].
3. Secure the gear shifting valve (4, Fig. 7C.71) to the LH fender bracket (6) with two mounting bolts (3).
4. Reconnect the priority valve to transmission hose (6), pressure supply hose (5) and drain hose (1) to the valve (2).
5. Start the engine and operate with drive train control lever. Check for leaks and functioning.
6. Check the priority valve pressure and adjust, if necessary. Refer to PRIORITY VALVE PRESSURE CHECK AND ADJUSTMENT PROCEDURE in SECTION 7, DRIVE TRAIN.
7. Shut off the engine and close LH filter compartment door.

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TRANSMISSION

DRIVE TRAIN LOCK SOLENOID VALVE

37. REMOVAL AND DISASSEMBLY

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *Disconnected hydraulic lines must be properly capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Remove all dirt accumulation from the main frame cover. Tag disconnected lines to facilitate faster and correct installation.*

1. Unscrew bolts (4, Fig. 7C.73) and remove L.H. enclosure (3) with L.H. door.
2. Disconnect the electrical harness from the filter base. Unscrew bolts (3, Fig. 7C.74) fastening filters bracket (2) to the ROPS bracket and allow the bracket (2) with filters (4) to be supported by the hoses.
3. Unscrew bolts (2, Fig. 7C.73) and remove access cover (1) in order to obtain access to mounting points of the drive train lock solenoid valve.

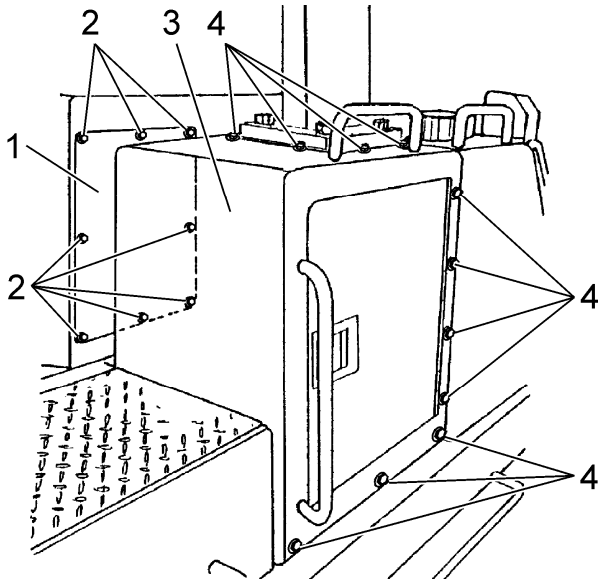

Fig. 7C.73. Disassembly Access Cover to Drive Train Control Valve

1. Access Cover
2. Bolts
3. L.H. Enclosure
4. Bolts

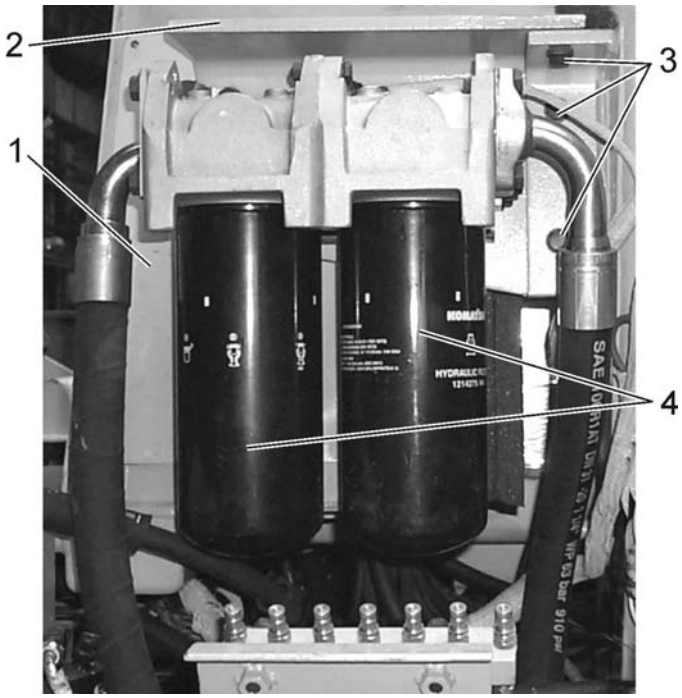

Fig. 7C.74. Drive Train Pressure Filters Removal

1. Access Cover
2. Filter Bracket
3. Bracket Mounting Bolts
4. Filters

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DRIVE TRAIN LOCK SOLENOID VALVE

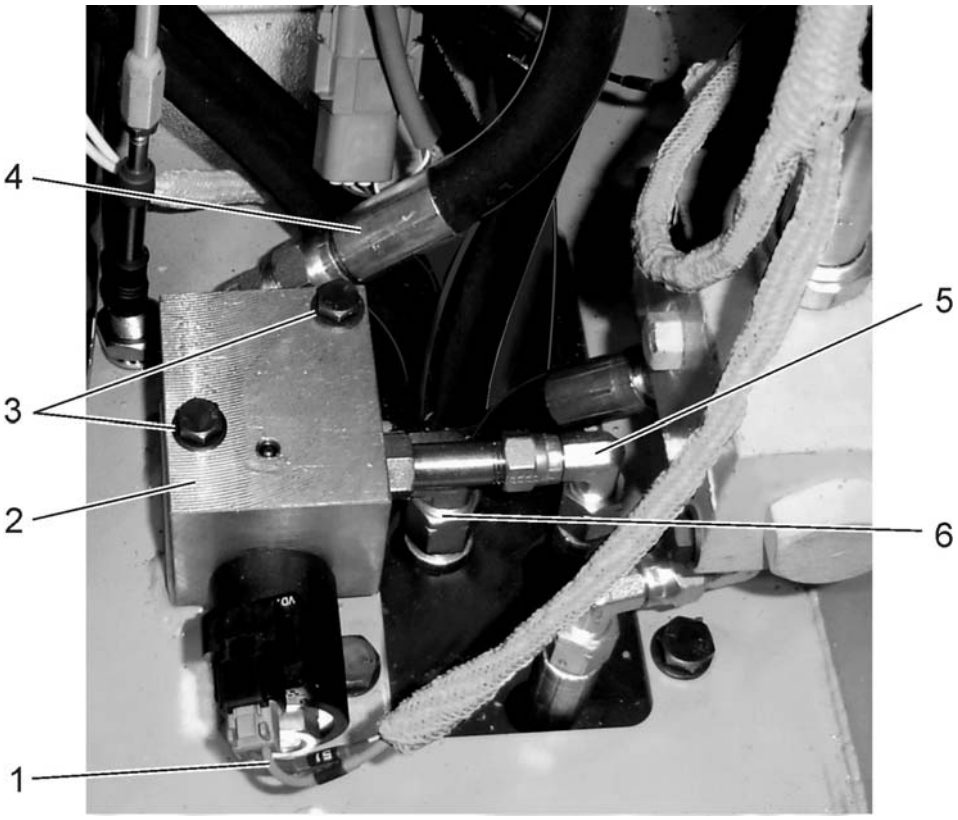

Fig. 7C.75. Drive Train Lock Solenoid Valve Disconnect Points

1. Harness
2. Drive Train Lock Solenoid Valve
3. Mounting Bolts
4. Solenoid Lock Valve to Drive Train Control Valve Hose
5. Drain Hose
6. Pressure Supply Hose

4. Disconnect drive train lock solenoid valve harness (1, Fig. 7C.75).
5. Disconnect drain hose (5), supply hose (6) and lock solenoid valve to drive train control valve hose (4) at the lock solenoid valve (2).
6. Unscrew two bolts (3) and separate solenoid lock valve (2) from LH fender.
7. Lift the valve from the machine and remove attached hydraulic connectors, if necessary.
8. Unscrew the solenoid coil from the lock solenoid valve (2). Remove the solenoid valve cartridge from the valve manifold (1, Fig.7C.76). Remove and discard the valve seal kit and replace with new.
9. Remove plug (3), if necessary.

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DRIVE TRAIN LOCK SOLENOID VALVE

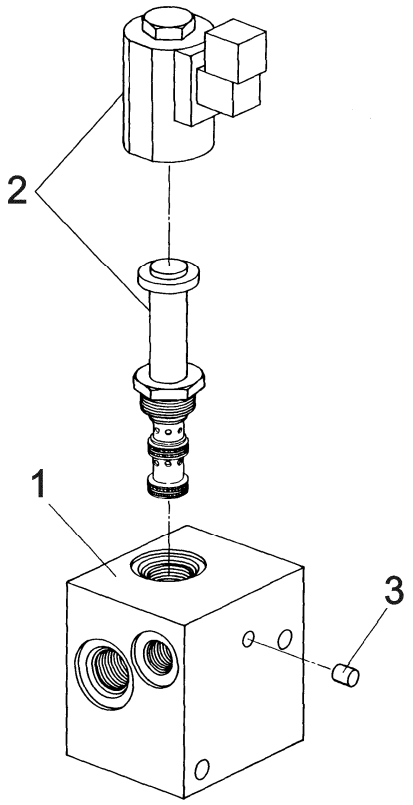

Fig. 7C.76. Explode View of Drive Train Lock Solenoid Valve

1. Manifold
2. Solenoid Valve
3. Port Plug

38. INSPECTION AND REPAIR

1. It is recommended that all new seal rings be installed upon reassembly of the valve.
2. Clean all parts in a suitable solvent and blow dry with compressed air. Be sure all oil passages in the valve manifold and valve cartridge are free of obstructions.
3. Inspect parts for excessive wear and replace if necessary.
4. Clean threads with a stiff brush and solvent. Check for damage.

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39. REASSEMBLY AND INSTALLATION

1. Apply LOCTITE PIPE SEALANT to the threads of plug (3, Fig. 7C.76) and install, if removed.
2. Install a new seal kit to the solenoid valve cartridge (2) Install valve cartridge to the valve manifold (1). Torque the cartridge to 20.5 ÷ 22.5 [Nm]. Install the solenoid coil on valve cartridge and torque the nut to 5.4 ÷ 8.1 [Nm].
3. Secure the lock solenoid valve (2, Fig. 7C.75) to the LH fender with two mounting bolts (3).
4. Reconnect hose (4), pressure supply hose (6) and drain hose (5) to the lock solenoid valve (2).
5. Reconnect lock solenoid valve harness (1) to the valve (2).

WARNING! Be sure the area around the machine is clear of personnel and obstructions as the vehicle may move during these test. If the machine starts to move, fully depress the decelerator pedal and shift the drive train control lever to NEUTRAL.

6. Start the engine and operate with drive train control lock lever. Check for leaks and functioning. Shut off the engine.
7. Reinstall cover (1, Fig. 7C.73) and secure with bolts (2).
8. Install bracket (2, Fig. 7C.74) with filters (4) to the ROPS bracket and secure with bolts (3). Reconnect the electrical harness to the filter base.
9. Reinstall L.H. enclosure (3) on the left hand side and secure with bolts (4).

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SECTION 7E

STEERING DRIVE

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STEERING DRIVE

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TWO SPEED STEERING VALVE

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SERVICE/SPECIAL TOOLS

1. SERVICE/SPECIAL TOOLS

DESCRIPTION	TOOL NUMBER
Steering drive output shaft retainer bolt	1/2”-13UNC-2B
Steering drive output shaft bolt	5/8”-11UNC-2B
Fuel tank lifting eyebolts	1”NCX1-1/2”
Return spring retainer bolts	3/8”-16UNC
High range clutch piston eyebolts	3/8”-16x1 3/4”
Bevel gear hub eyebolts	5/8”-11x1 1/4”
High range clutch piston springs compressing bolts	3/8”-16UNCx6”
Low range clutch piston springs compressing stud	3/8”-16UNCx3 1/2”
Main frame cover lifting eyebolts	1/2”-13UNC-2B
Steering drive assembly rotational stand	1.851.0027
Bevel gear bearing preload checking tool	1.249.0017
Bevel gear bearing preload checking tool adapter socket	1.264.0025
Pinion shaft bearing preload checking tool	1.249.0017
Pinion shaft bearing preload checking tool adapter socket	1.264.0024

GENERAL

2. DESCRIPTION

The steering system on this machine consists of a two speed steering drive located in the main frame and a two speed steering valve mounted on the rear main frame cover.

The oil pressure from drive train control valve operates hydraulically and brake pedal cable operates mechanically the steering valve. Electronic controller operates electrically the steering valve through drive train control valve buttons. Oil pressure from the steering valve is directed to the steering drive to operate the range and brake clutch packs. The steering drive consists of an individual circuit for each side of the machine: one drive low range clutch pack, one drive high range clutch pack, one brake clutch pack and one planetary for each side. The drive high and low clutch packs are hydraulically applied and spring released whereas the break clutch packs are spring applied and hydraulically released. The planetary provides the gear reduction in speed for low range. If a hydraulic failure occurs or the engine is stopped, the brake clutches in the steering drive will automatically apply.

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STEERING DRIVE

GENERAL

3. SPECIFICATIONS

Steering Drive

Backlash, bevel gear with pinion gear . . . . . 0.25 - 0.33 [mm]
Bevel gear bearing preload . . . . . 1.5 ± 0.5 [Nm]
Pinion shaft bearing preload . . . . . 1.5 ± 1.5 [Nm]
Pinion shaft end clearance (measured between end of pinion shaft and raised edge of carrier) shown in [mm] and stamped on rear end of pinion shaft with tolerance of . . . . . ± 0.04 [mm]
Shaft end play . . . . . 0.13 - 0.25 [mm]

Brake clutch pack:

Number of friction discs (internal splined plates) 5
Number of clutch plates (external splined plates) 6
Thickness of friction disc . . . . . 4.2 - 4.4 [mm]
Thickness of separator plate . . . . . 2.24 - 2.34 [mm]

High range clutch pack:

Number of friction discs (internal splined plates) 5
Number of clutch plates (external splined plates) 4
Thickness of friction disc . . . . . 4.2 - 4.4 [mm]
Thickness of clutch plate . . . . . 2.24 - 2.34 [mm]

Low range clutch pack:

Number of friction discs (internal splined plates) 6
Number of clutch plates (external splined plates) 7
Thickness of friction disc . . . . . 4.2 - 4.4 [mm]
Thickness of clutch plate . . . . . 2.24 - 2.34 [mm]

Special Nut and Bolt Torques
(Torques given are for bolts and nuts lubricated with SAE-30 engine oil)

Oil slinger to clutch plate retainer mounting bolts (LOCTITE 262 applied) . . . . . 11 [Nm]
Clutch plate retainer to bevel gear hub mounting bolts . . . . . 108 [Nm]
Bevel gear to bevel gear hub mounting bolt . . . . . 255 [Nm]
Pinion gear housing to main housing mounting bolts . . . . . 108 [Nm]
Nut lock ring to main housing mounting bolts . . . . . 54 [Nm]
Ring gear to clutch plate retainer mounting bolts . . . . . 54 [Nm]
Planet gear bearing scoop to planet carrier mounting bolts . . . . . 54 [Nm]
Sleeve retaining washer to output shaft sleeve mounting bolts . . . . . 54 [Nm]
Low range clutch retainer and brake plate retainer to main housing mounting bolts . . . . . 108 [Nm]
Retainer cover to low range clutch retainer mounting bolts . . . . . 81 [Nm]
Lifting eye to retainer cover mounting bolts . . . . . 108 [Nm]
Bearing retainer to retainer cover mounting bolts . . . . . 54 [Nm]
Piston retainer hub to clutch plate retainer mounting bolts . . . . . 54 [Nm]
Retainer cover port plug . . . . . 51 [Nm]
Steering drive mounting bolts . . . . . 920 [Nm]
Main frame cover mounting bolts . . . . . 455 [Nm]
Fuel tank mounting bolts . . . . . 520 [Nm]
Drawbar mounting bolts . . . . . 3100 ± 5 [%] [Nm]

NOTE: *Except for the special torques shown, all bolts and nuts are to be given a standard torque. Refer to SECTION 1.*

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GENERAL

Springs Data

Description	Free Length [mm]	Test Length [mm]	Test Load [N]	Total Number of Coils
Steering Drive:				
Brake piston applying spring	87.2	77.5	1104 - 1189	9
High range clutch return inner spring	34.4	25.4	384 - 416	6.5
High range clutch return outer spring	37.6	25.4	564 - 610	5
Low range clutch piston return spring	57.2	38.1	367 - 398	10
Upper Steering Valve:				
Brake spool outer spring	55.5	36	608	6.5
Brake spool inner spring	57	34.3	200	9.5
Brake spool poppet spring	41.7	27.4	72.4 – 81.3	13
Lower Steering Valve:				
HI-LO spool return spring	88.4	63.7	218 - 227	8.5
Manifold:				
Manifold spool spring	49.8	30.9	334	10

STEERING DRIVE

4. REMOVAL

IMPORTANT**:** *It is suggested that the checks in Paragraph 13, SECTION 7, STEERING SYSTEM OIL PRESSURE CHECK and Paragraph 14, SECTION 7, STEERING SYSTEM FUNCTIONAL CHECK be made before removing the steering drive. In this manner, hydraulic malfunctions can be pinpointed and corrected at time of teardown.*

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lever is in NEUTRAL position, drive train neutral lock lever is in ON position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT**:** *Disconnected hydraulic lines must be properly capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Remove all dirt accumulation from the main frame cover. Tag disconnected lines to facilitate faster and correct installation*.

1. Turn the electrical master switch to OFF position and take the key out.
2. Remove transmission case guard from bottom of machine.

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STEERING DRIVE

WARNING! This procedure requires extreme caution. Use suitable blocking equipment while under confines the machine.

3. Drain rear main frame as described in the OPERATOR'S MANUAL.
4. If equipped with ripper, be sure the ripper is lowered to the ground, disconnect and cap hydraulic ripper hoses.
5. Disconnect wires of rear lamp (1, Fig. 7E.1), backup alarm (2) and fuel level sensor (8).
6. Unscrew bolts (6, Fig. 7E.1) securing rear plate (7) and remove plate from machine. Unscrew bolts (4) securing rear plate (5) and remove plate from machine.

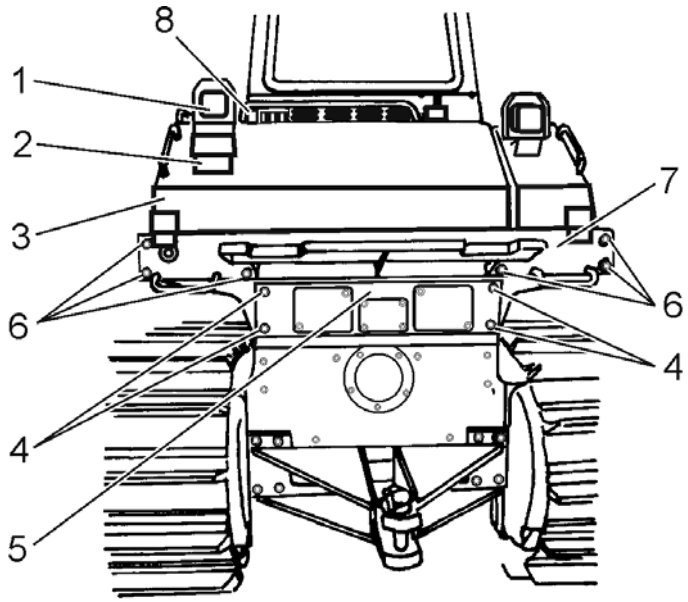

Fig. 7E.1. Rear of Machine

1. Rear Lamp
2. Backup Alarm
3. Fuel Tank
4. Bolts
5. Rear Plate Assy
6. Bolts
7. Rear Plate Assy
8. Fuel Level Sensor

7. Open the fuel drain valve (6, Fig. 7E.2) and drain the fuel tank (5). Close the drain valve (6).
8. Disconnect fuel supply hose (7) and fuel return hose (8) from the fuel tank (5).
9. Replace two plugs, located in the top of the fuel tank (3, Fig. 1E.1) with two threaded eye bolts 1”NCx1-1/2”. Attach a suitable hoist to the eye bolts, remove fuel tank mounting bolts (13, Fig. 7E.2) from bottom of fuel tank and lift off the tank using the hoist.
10. Remove the main frame oil dipstick and filler tube (11, Fig. 7E.2) with breather (10).
11. Disconnect drain hoses (14) and two drive train control valve drain hoses.
12. Remove the steering valve (9) as described in Paragraph 9, REMOVAL in this SECTION.
13. Remove the gear shifting valve (2) as described in Paragraph 29, REMOVAL in SECTION 7C.
14. Disconnect two hoses and unscrew three mounting bolts to remove hydraulic damper (12).
15. Unscrew two cover bolts (15) to remove gear shifting valve bracket (1). Unscrew remaining cover bolts (15).

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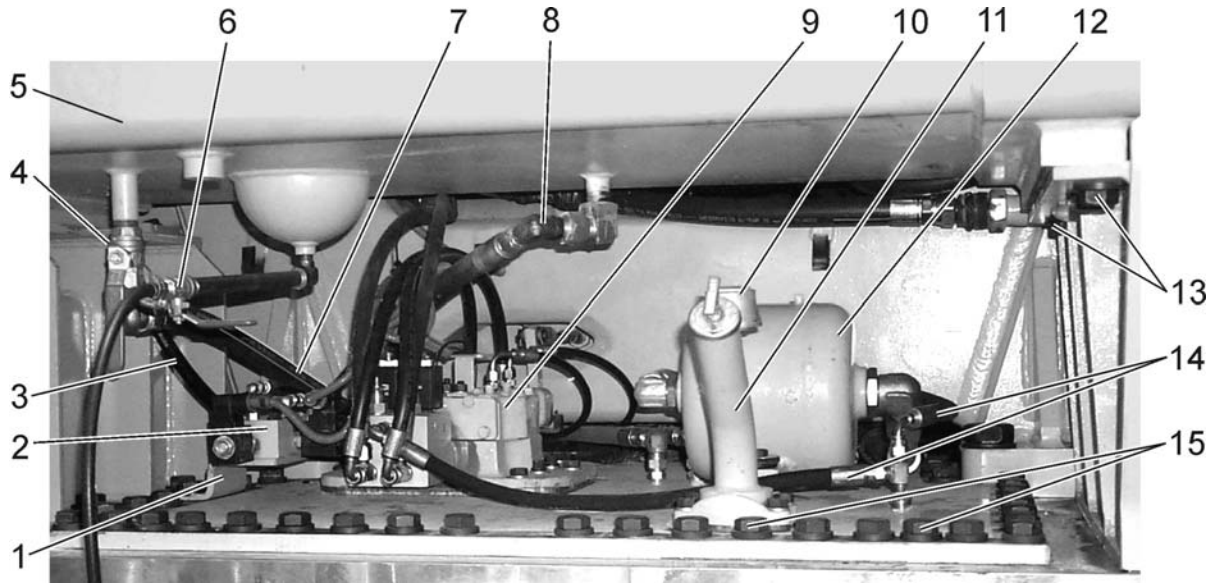

Fig. 7E.2. Fuel Line Disconnecting Points

1. Gear Shifting Valve Bracket
2. Gear Shifting Valve
3. Fuel Tank Breather Hose
4. Fuel Supply Valve
5. Fuel Tank
6. Fuel Drain Valve
7. Fuel Supply Hose
8. Fuel Return Hose
9. Steering Valve
10. Breather
11. Oil Dipstick and Filler Tube
12. Hydraulic Damper
13. Fuel Tank Mounting Bolts
14. Drain Hoses
15. Main Frame Cover Bolts

16. Install two lifting eye bolts 1/2”-13UNC-2B (2, Fig. 7E.3) and remove the main frame cover (1).
17. Remove the lube tube (3, Fig. 7E.4) from the steering drive (2) and from the front surface of main frame (1). Temporarily secure the steering manifold (2, Fig. 7E.9) to the bracket (17).

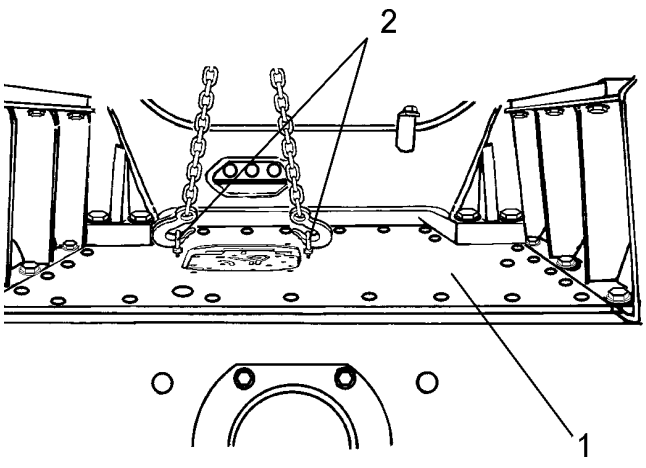

Fig. 7E.3. Main Frame Cover Removing

1. Cover
2. Lifting Eye Bolts

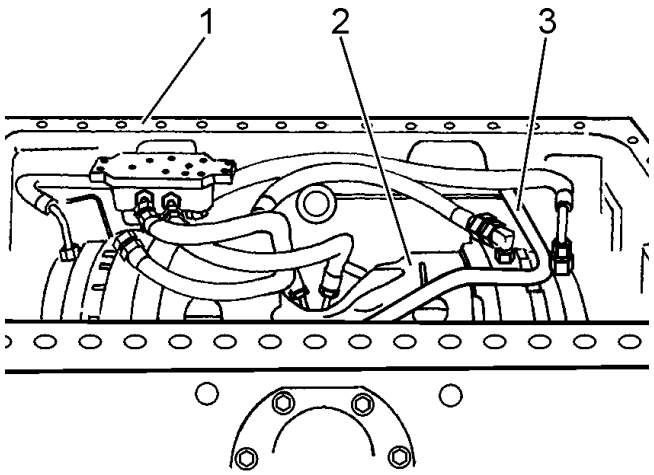

Fig. 7E.4. Removing Steering Drive Lube Tube

1. Main Frame
2. Steering Drive
3. Lube Tube

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18. Remove the pinion gear access cover with shims from the final drive cover. Remove retaining ring (1, Fig. 7E.5) that secures shaft retainer (2) in the pinion gear. Thread a bolt 1/2”-13UNC-2B in retainer (2) and pull it out of the pinion gear.
19. Thread a bolt 5/8”-11UNC-2B in the steering drive output shaft and pull it free of the steering drive as shown in Fig. 7E.6.
20. Repeat steps 18 and 19 on the opposite side of the machine.

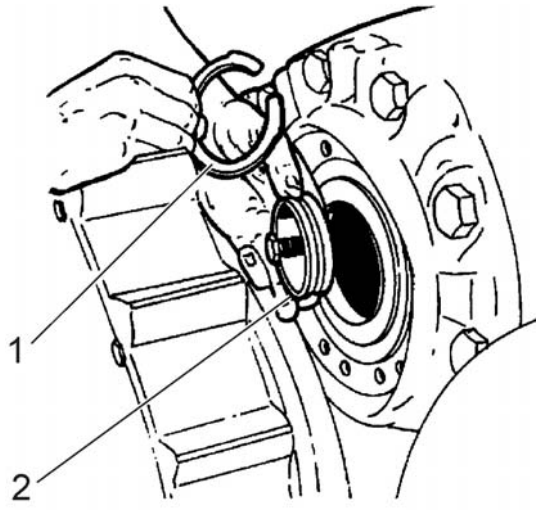

Fig. 7E.5. Removing Output Shaft Retainer

1. Retaining Ring 2. Shaft Retainer

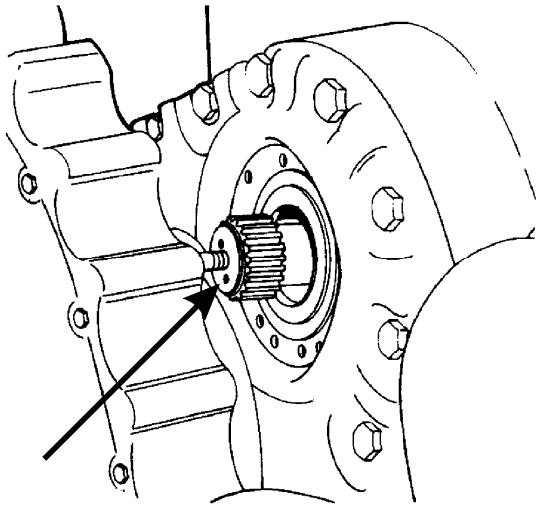

Fig. 7E.6. Removing Output Shaft from Steering Drive

21. Attach a hoist with an adjusting sling to the four steering drive lifting eyes as shown in Fig. 7E.7 and take up the slack.

NOTE: *An adjusting sling must be used so that the steering drive can be tilted and leveled.*

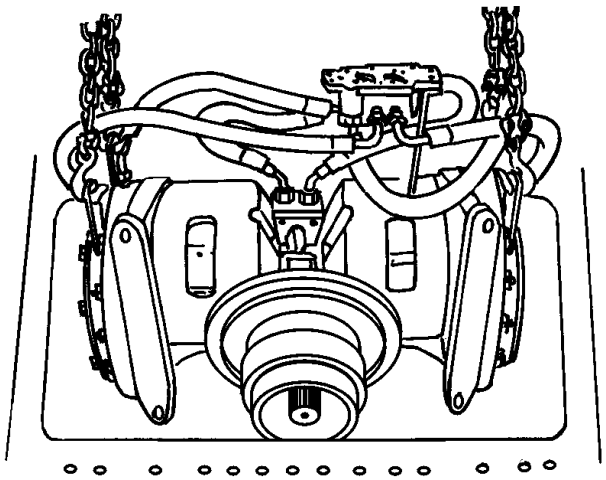

Fig. 7E.7. Removing Steering Drive

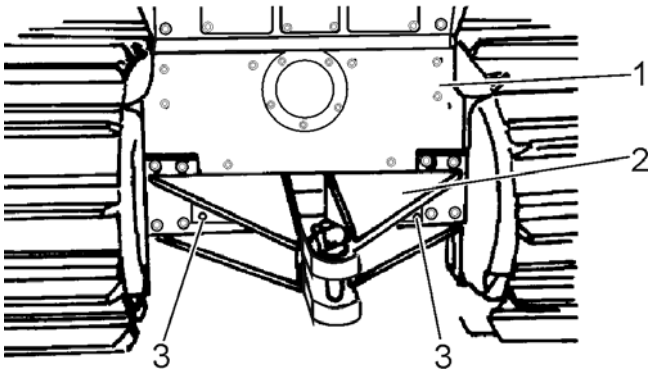

Fig. 7E.8. Steering Drive Disconnecting Points

1. Main Frame 2. Drawbar 3. Plugs

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22. Unscrew the upper bolts (19, Fig. 7E.9) securing the steering drive (1) to the front surface of the main frame.
23. If necessary, remove drawbar (2, Fig. 7E.8) from main frame (1). Remove the plugs (3) from the rear surface of the main frame (1).
24. Getting through a rear frame opening install a socket on head of the lower bolt (21, Fig. 7E.9) securing steering drive (1). Getting through the plug hole (3, Fig. 7E.8) join extension rod 1.541.0151-700 with the socket. Unscrew the lower bolt (21, Fig. 7E.9) securing the steering drive (1) to the front surface of the main frame.
25. Repeat Step 24 for second lower bolt (21, Fig. 7E.9).
26. Move the steering drive back as far as possible, being sure the spline sleeve (Fig. 7E.7) stays with the steering drive pinion shaft. Lift the steering drive out of the rear frame.
27. Remove retaining rings (20, Fig. 7E.9) securing lower bolts (21) to the steering drive (1) and remove bolts (21).
28. Disconnect the manifold hoses, connectors and elbows from steering drive and remove the manifold with hoses (refer to Fig. 7E.9).

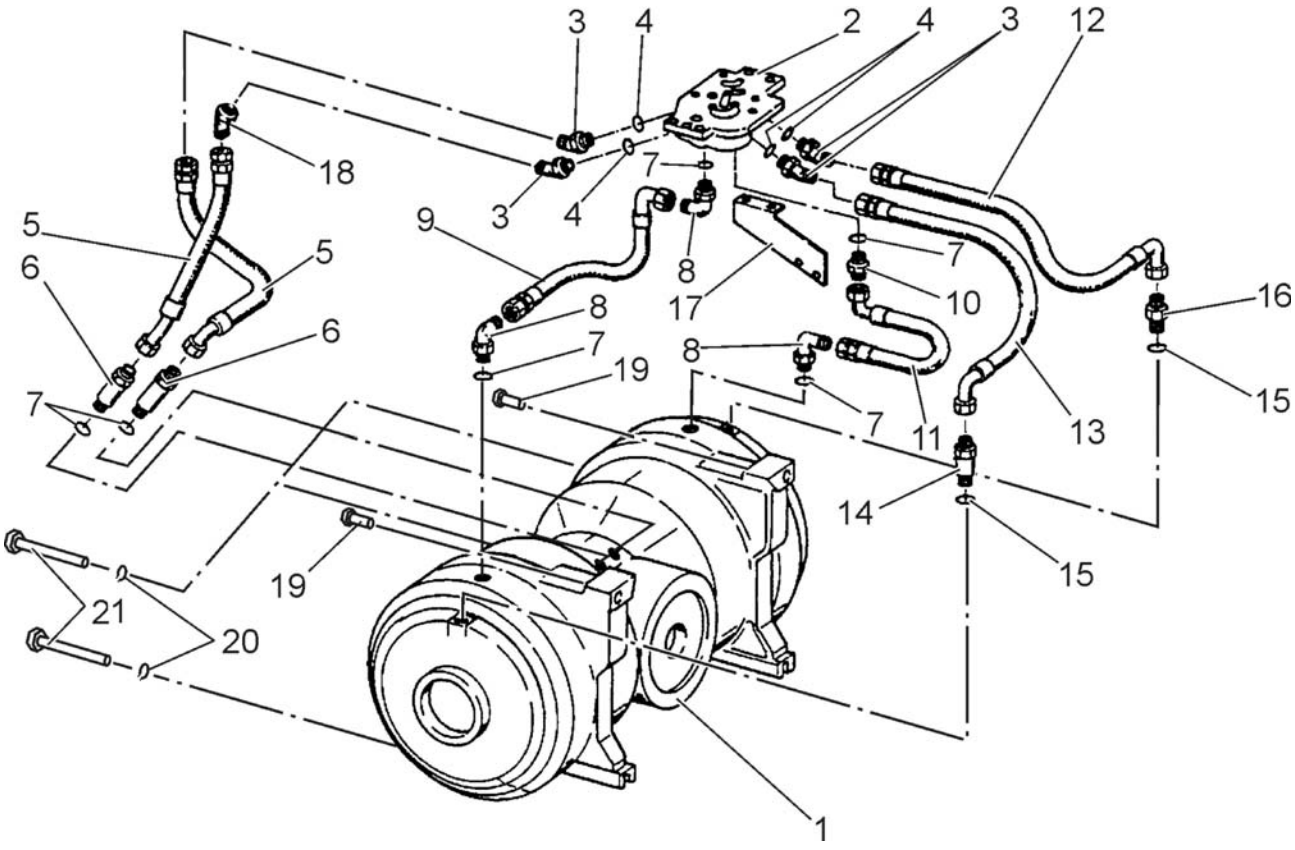

Fig. 7E.9. Two Speed Steering Drive with Hoses

1. Two Speed Steering Drive
2. Steering Manifold Assy
3. Elbow
4. O-Ring
5. Hose, Manifold to HI Range Clutch
6. Connector
7. O-Ring
8. Elbow
9. Hose, Manifold to Brake
10. Connector
11. Hose, Manifold to Brake
12. Hose, Manifold to LOW Range Clutch
13. Hose, Manifold to LOW Range Clutch
14. Connector
15. O-Ring
16. Connector
17. Bracket
18. Elbow
19. Upper Bolt
20. Retaining Ring
21. Lower Bolt

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5. DISASSEMBLY (Refer to Fig. 7E.11)

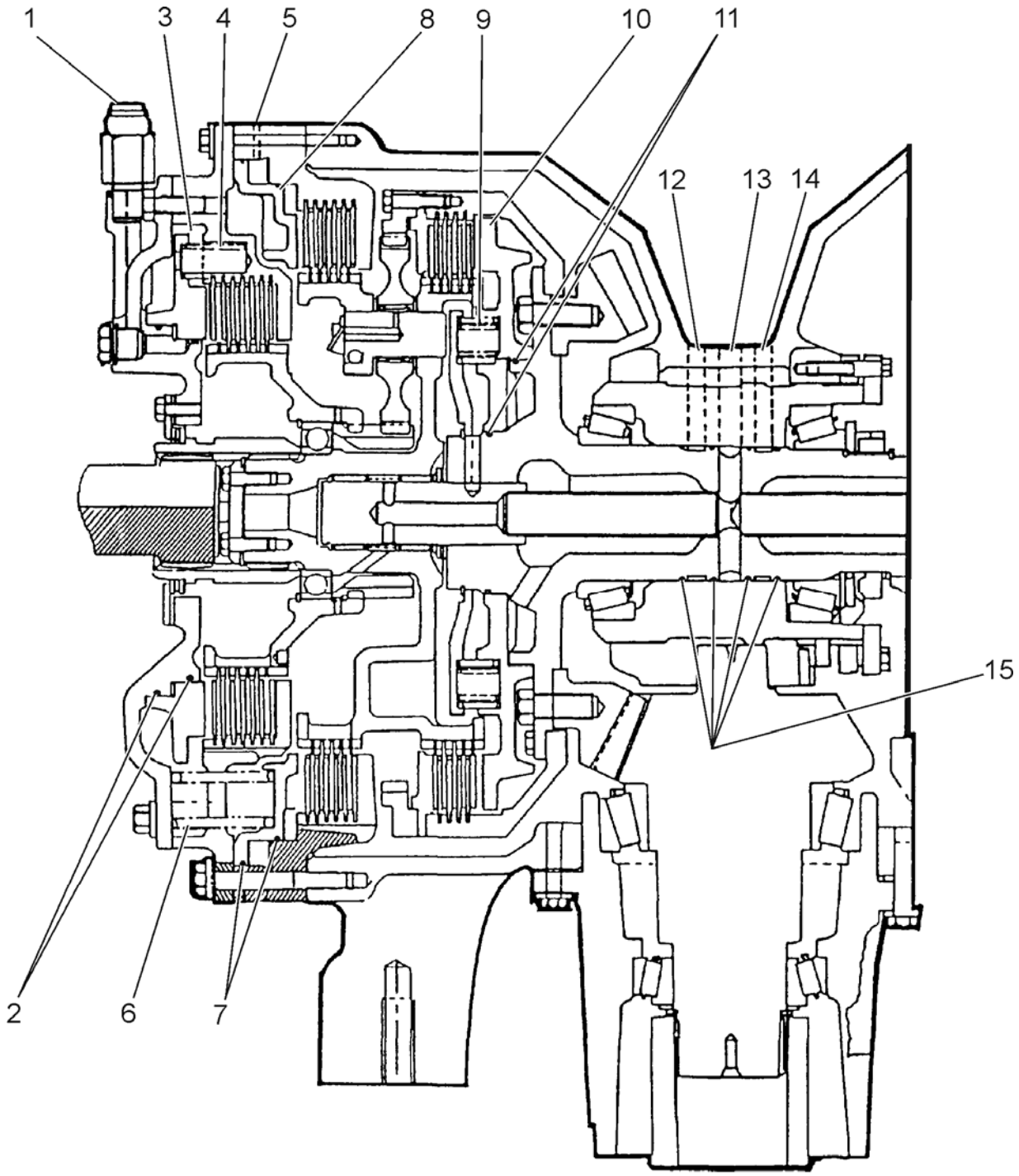

Fig. 7E.10. Cross Section View of Two Speed Steering Drive

1. Right Low Clutch Port
2. Right Low Piston Seal Rings
3. Right Low Clutch Piston
4. Right Low Piston Return Springs
5. Right Brake Port
6. Right Brake Applying Springs
7. Right Brake Piston Seal Rings
8. Right Brake Piston
9. Right High Piston Return Springs
10. Right High Clutch Piston
11. Right High Piston Seal Rings
12. Right High Clutch Port
13. Lube Port
14. Left High Clutch Port
15. Manifold Seal Rings

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STEERING DRIVE

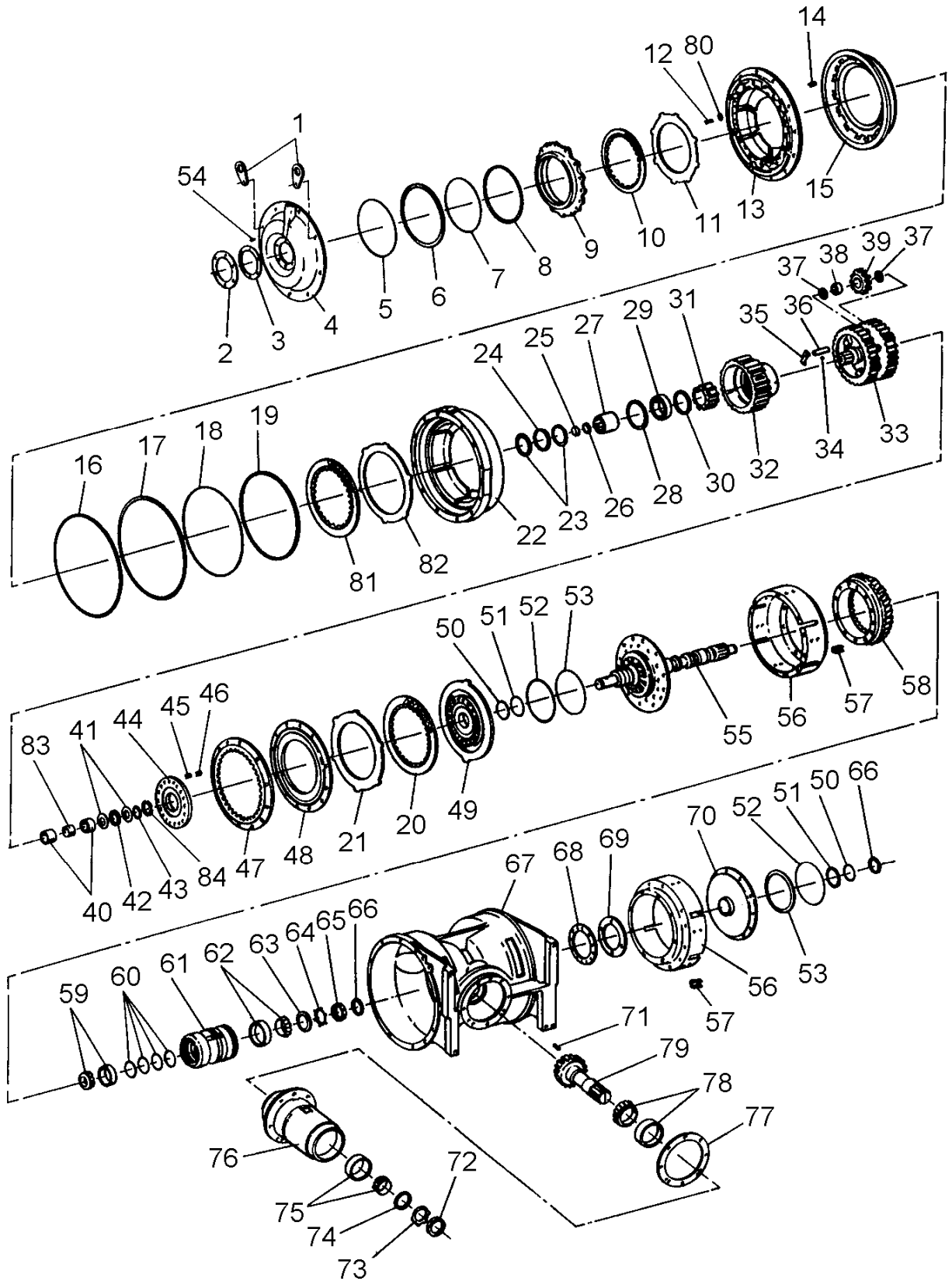

Fig. 7E.11. Exploded View of Two Speed Steering Drive

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STEERING DRIVE

Legend for Fig. 7E.11.

1. Lifting Eye
2. Bearing Retainer
3. Bearing Retainer Shim
4. Retainer Cover
5. O-Ring
6. Piston Seal Ring
7. O-Ring
8. Piston Seal Ring
9. Low Range Clutch Piston
10. Friction Disc
11. Clutch Plate
12. Piston Return Spring
13. Low Range Clutch Plate Retainer
14. Brake Piston Applying Spring
15. Brake Piston
16. O-Ring
17. Brake Piston Seal Ring
18. O-Ring
19. Brake Piston Seal Ring
20. Friction Disc
21. Clutch Plate
22. Brake Plate Retainer
23. Thrust Race
24. Thrust Bearing
25. Sleeve Retaining Washer
26. Sleeve Retaining Ring
27. Output Shaft Sleeve
28. Bearing Retainer Ring
29. Ball Bearing
30. Sun Gear Retaining Ring
31. Sun Gear
32. Sun Gear Hub
33. Planet Carrier
34. Chrome Steel Ball
35. Planet Gear Bearing Scoop
36. Planet Gear Shaft
37. Thrust Washer
38. Planet Gear Bearing
39. Planet Gear
40. Planet Carrier Roller Bearing
41. Planet Carrier Thrust Race
42. Planet Carrier Thrust Bearing
43. Return Spring Retaining Ring
44. Return Spring Retainer
45. Clutch Return Inner Spring
46. Clutch Return Outer Spring
47. Ring Gear
48. Ring Gear Adapter
49. High Range Clutch Piston
50. Clutch Piston Seal Ring
51. O-Ring
52. Clutch Piston Seal Ring
53. O-Ring
54. Port Plug
55. Bevel Gear Hub
56. Clutch Plate Retainer
57. Oil Slinger
58. Bevel Gear
59. Tapered Bearing
60. Gear Hub Sealing Ring
61. Bearing Carrier
62. Tapered Bearing
63. Tongued Washer
64. Lock Washer
65. Lock Nut
66. Piston Retainer Ring
67. Main Housing
68. Adjusting Nut
69. Nut Lock Ring
70. Piston Retainer Hub
71. Dowel Pin
72. Retaining Ring
73. Thrust Washer
74. Spacer
75. Tapered Bearing
76. Pinion Gear Housing
77. Support Housing Shim
78. Tapered Bearing
79. Pinion Shaft Gear
80. Piston Return Spring Shim
81. Friction Disc
82. Clutch Plate
83. Bearing Spacer
84. Return Spring Retaining Ring Shims

NOTE: *For steering drive disassembly use rotational stand 1.851.0027.*

1. Set the assembly on end so that the right hand side is up. Remove bearing retainer (2) and bearing retainer shims (3). Keep the shims with the retainer for proper installation.
2. Remove the bolts with washers securing retainer cover (4) to brake plate retainer (13) and remove lifting eyes (1). Exert pressure on the cover while removing the bolts, to counteract the spring tension.
3. Lift parts (4 through 9) off as an assembly. To remove low range clutch piston (9) from retainer cover (4), apply compressed air to the port in the cover.
4. Remove seal rings (6 and 8) and O-rings (5 and 7) from cover (4).
5. Remove springs (12 and 14) from brake plate retainer (13). If equipped, remove shims (80). Keep shims with springs for proper installation.
6. Remove thrust races (23) and thrust bearing (24) from output shaft sleeve (27).
7. Remove the bolts with washers securing brake plate retainer (13) and lift the retainer with friction discs (10) and clutch plates (11) from the assembly. Remove the discs (10) and plates (11) from the retainer (13).
8. To remove brake piston (15) from brake plate retainer (22), apply compressed air as shown in Fig. 7E.12.
9. Remove seal rings (17 and 19) and O-rings (16 and 18) from brake piston (15).
10. Lift brake plate retainer (22) with brake friction discs (81) and brake clutch plates (82) from the assembly. Remove the discs (81) and plates (82) from the retainer (22).

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11. Remove parts (25 through 83) as an assembly. Set the assembly on the bench with output shaft sleeve (27) up.
12. Remove the bolts securing sleeve retaining washer (25). Pull output shaft sleeve (27) together with sleeve retaining washer (25) and sleeve retaining ring (26) off the shaft of planet carrier (33). Remove sleeve retaining washer (25) from output shaft sleeve (27). Sleeve retaining ring (26) need not be removed unless replacement is necessary.
13. Pull sun gear hub (32) together with parts (28 through 31) off the shaft of planet carrier (33).
14. Remove bearing retainer ring (28) from sun gear hub (32). Place the sun gear hub (32) in a press with sun gear (31) up and press sun gear (31), together with ball bearing (29) and retaining ring (30), out of sun gear hub (32). Remove retaining ring (30) from sun gear (31).
15. To remove the planet gear (39), remove the bolts with washers securing planet gear bearing scoop (35) and remove the scoop. Turn planet carrier (33) over and drive planet gear shaft (36) from planet gear (39) and planet carrier (33). When removing shaft (36), be careful not to lose chrome steel ball (34). Slide planet gear (39) to the outside, placing one hand under the gear as the thrust washers (37) and planet gear bearing (38) are free to drop out. Remove planet gear bearing (38) from planet gear (39).
16. Remove the two remaining planet gears (39) from the planet carrier (33) in the same manner as described in Step 15.
17. Remove clutch hub roller bearings (40) and bearing spacer (84) from planet carrier (33).
18. Remove clutch hub thrust races (41) and thrust bearing (42) from bevel gear hub (55).

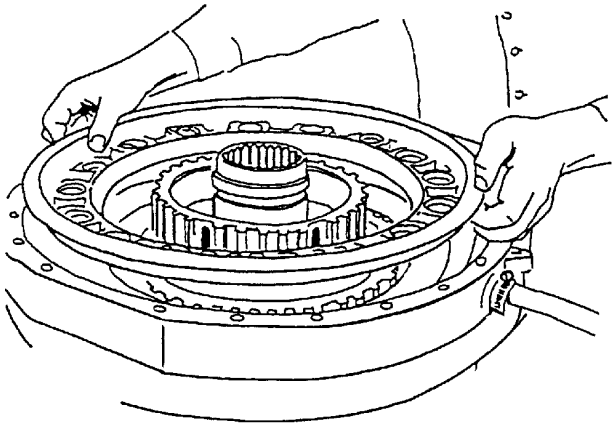

Fig. 7E.12. Removing Brake Piston

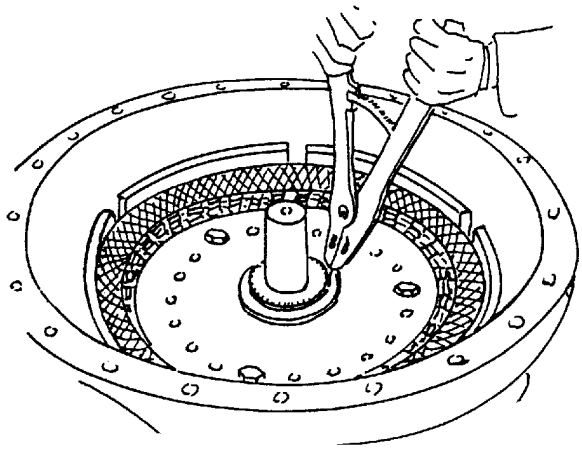

Fig. 7E.13. Removing Spring Retaining Ring

19. Install three bolts 3/8”-16UNC through in return spring retainer (44) and thread them into the tapped holes in high range clutch piston (49). Tighten bolts to compress springs (45 and 46) and remove return spring retaining ring (43) and shims (84) (if equipped) (Fig. 7E.13). Evenly release the spring tension and remove the bolts.
20. Remove return spring retainer (44) and springs (45 and 46).
21. Remove bolts securing ring gear (47) and ring gear adapter (48) to clutch plate retainer (56). Remove ring gear (47), adapter (48), clutch plates (21) and friction discs (20).
22. Thread two eye bolts 3/8”-16UNC into the tapped holes in high range clutch piston (49) as shown in Fig. 7E.14 and remove the piston.
23. Turn the assembly over and repeat Steps 1 through 22 on the left side.

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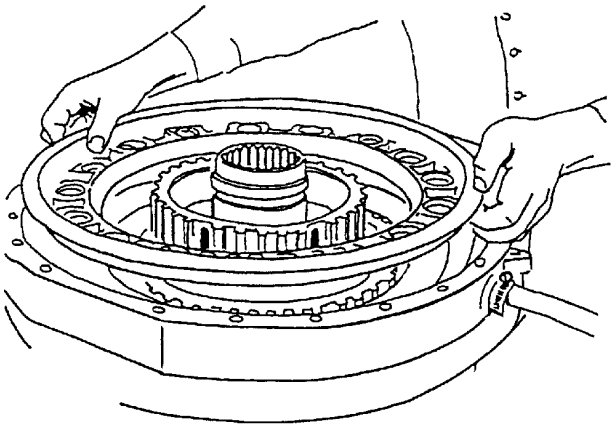

Fig. 7E.14. Removing Clutch Piston

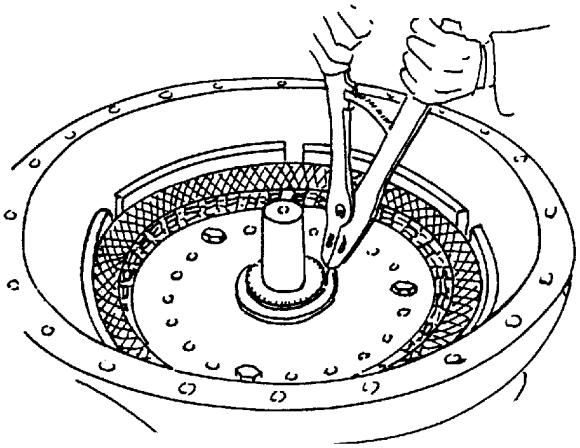

Fig. 7E.15. Removing Plate Retainer

24. Remove piston retainer ring (66) from bevel gear hub (55).
25. Install two eye bolts 3/8”-16x1 3/4” into the tapped holes in clutch plate retainer (56) and lift assy out as shown in Fig. 7E.15.
26. Remove the bolts securing clutch plate retainer (56) to piston retainer hub (70) and separate them. Remove oil slingers (57) from clutch plate retainer (56). Remove seal rings (50 and 52) and O-rings (51 and 53) from piston retainer hub (70).
27. Remove the bolts securing nut lock ring (69) to housing (67) and remove the nut lock ring and adjusting nut (68).

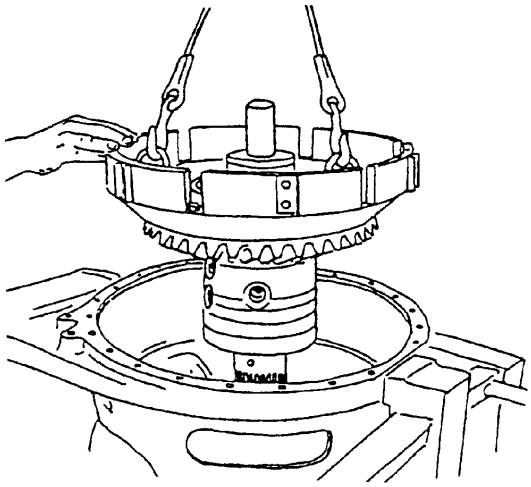

Fig. 7E.16. Removing Bevel Gear Hub

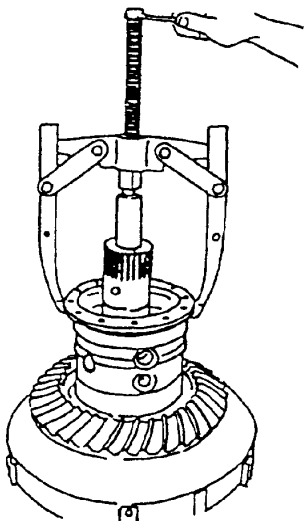

Fig. 7E.17. Removing Bearing Carrier

28. Turn housing (67) over. Remove two of the bolts that secure gear (58) to bevel gear hub (55) and install eyebolts 5/8”-11x1 1/4”. Attach a hoist to the eyebolts and lift parts (50 through 66) out as an assembly as shown in Fig. 7E.16.
29. Remove piston retainer ring (66) from bevel gear hub (55). Bend up the tabs of lock washer (64) and remove lock nut (65), lock washer (64) and tongued washer (63).

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30. Thread adjusting nut (68) on bearing carrier (61) and install a bearing puller as shown in Fig. 7E.17. Pull up bearing carrier (61) to unseat cone of tapered bearing (62). Remove the bearing cone and bearing carrier (61). Remove adjusting nut (68) from bearing carrier (61).
31. Remove gear hub sealing rings (60) from bevel gear hub (55). Remove bevel gear (58) and clutch plate retainer (56) from bevel gear hub (55). Remove oil slingers (57) from clutch plate retainer (56). Remove seal rings (50 and 52) and O-rings (51 and 53) from bevel gear hub (55).
32. If tapered bearing (59 and 62) replacement is necessary, remove cone of tapered bearing (59) from bevel gear hub (55) and remove cups of tapered bearings (59 and 62) from bearing carrier (61).
33. Remove the bolts securing pinion gear housing (76) to housing (67). If equipped, remove the support housing shims (77). Keep shims with pinion gear housing for proper installation. Remove parts (72, 73, 74, 75, 76, 78 and 79) as an assembly.
34. Remove retaining ring (72), thrust race (73) and spacer (74) from pinion shaft gear (79). Press pinion shaft gear (79) out of housing (76). When the shaft is pressed out, bearing cone of tapered bearing (75) can be lifted out of housing (76).
35. Press cone of tapered bearing (78) off shaft gear (79). If bearing replacement is necessary, remove bearing cups of bearings (75 and 78) from housing (76).
36. If pin replacement is necessary, remove pin (71) from housing (67).

6. INSPECTION AND REPAIR

1. It is recommended that new O-rings and seal rings be installed whenever the steering drive is disassembled for service.
2. Clean all parts thoroughly in a suitable solvent. Dry thoroughly with compressed air or a clean cloth.

NOTE: *Do not spin bearings with the compressed air.*

3. Inspect bearings for excessive wear or damage and replace if necessary. Reusable bearings should be soaked in clean oil and wrapped with clean paper until ready for reassembly.
4. Inspect the gears for wear or chipped or broken teeth. Replace if wear is excessive or teeth are damaged.
5. Inspect all splines for wear. Replace parts if wear is excessive. Slight burrs can be smoothed down with a stone.
6. Inspect the separator and friction plates for excessive wear or warpage and replace if necessary.
7. Using an oil stone, remove any burrs that might damage sealing surfaces or increase wear to close tolerance parts.
8. Check the compression springs for damage and fatigue. If they do not fall within the tolerances given in Paragraph 3, SPECIFICATIONS, they must be replaced.
9. The rear main frame cover mounting surfaces must be cleaned with proper solvent and inspected for scratches, irregularities, and flatness. (Maximum out of flat between any two consecutive mounting holes to be 0.25 [mm]). If the cover does not meet this requirement, the cover should be replaced.

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7. REASSEMBLY (Refer to Fig. 7E.11)

1. Position housing (67) in rotational stand 1.851.0027.
2. If dowel pin (71) was removed, install new pin in housing (67).
3. Install O-rings (51 and 53) and clutch piston seal rings (50 and 52) on bevel gear hub (55) as shown in Fig. 7E.18.

NOTE: *Install all O-rings and seal rings as shown in Fig. 7E.18.*

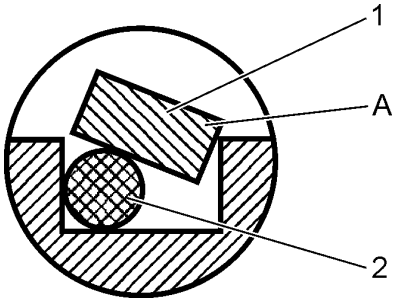

Fig. 7E.18. O-Rings and Seal Rings Installation

1. Seal Ring 2. O-Ring A. Pressed in from Seal Ring Installation Side

4. Position oil slingers (57) on clutch plate retainer (56). Apply LOCTITE #262 to the bolts and torque to 11 [Nm].
5. Install clutch plate retainer (56) on bevel gear hub (55) and torque the bolts to 54 [Nm]. Install bevel gear (58) on bevel gear hub (55) and torque the bolts to 255 [Nm]. Bevel gear (58) may be heated to 120 [°C] for easier assembly.
6. If cone of tapered bearing (59) was removed, heat the bearing cone to 135 [°C] for 45 minutes and install on gear hub (55) until it bottoms. To assure cone is seated, keep pressure against the cone until it cools a few seconds.
7. If cups of tapered bearing (59 and 62) were removed, press the cups in bearing carrier (61).
8. Install gear hub sealing rings (60) in the grooves of bevel gear hub (55). Before installing the sealing rings (60) coat with grease. Install bearing carrier (61) on the bevel gear hub (55).
9. Install cone of tapered bearing (62) on bevel gear hub (55) until it contacts cup of tapered bearing (62). Install tongued washer (63) and lock washer (64). Thread lock nut (65) on finger tight.

NOTE: *Steps 10 and 11 are optional methods of checking bearing carrier rolling torque.*

10. **I Method:** Wrap a cord around the 178 [mm] diameter of carrier (61) and attach a fish scale as shown in Fig. 7E.19. Take a reading of the drag (Newtons pull) needed to keep the carrier rolling at an even pace. Tighten lock nut (65) until of reading of 11 – 22 [N] is obtained.

NOTE: *The initial pull needed to start the carrier rolling will be greater. Do not use this reading for adjustment.*

11. **II Method:** Using tool 1.249.0017 with socket 1.264.0025 as shown in Fig. 7E.19A and check the bearing carrier rolling moment. Tighten lock nut (65) until a reading of 1.5 ± 0.5 [Nm] is obtained.

NOTE: *The initial pull needed to start the carrier rolling will be greater. Do not use this reading for adjustment.*

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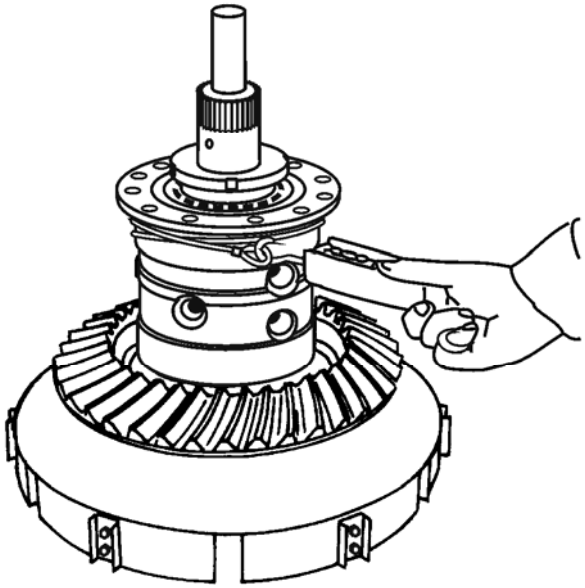

Fig. 7E.19. Checking Bevel Gear Bearing Preload (I Method)

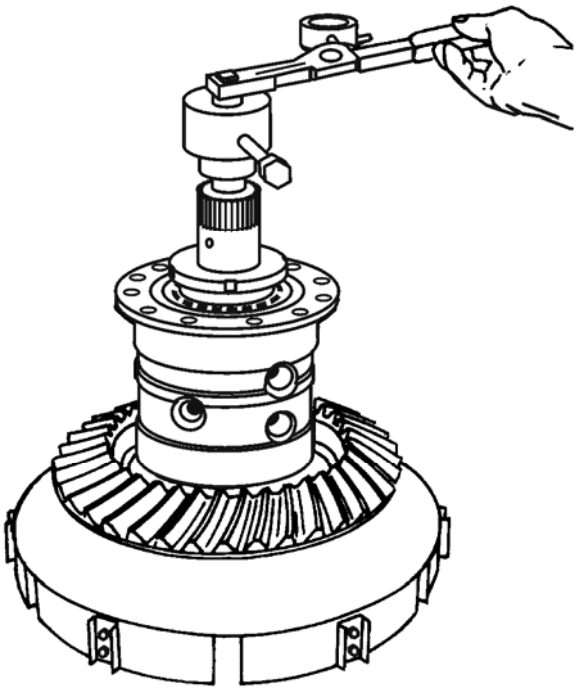

Fig. 7E.19A. Checking Bevel Gear Bearing Preload (II Method)

12. Bend back the tabs of lock washer (64). Install piston retainer ring (66) in the groove of bevel gear hub (55).
13. If tapered bearings (75 and 78) were replaced, press new cups of tapered bearings in housing (76) until they bottom.

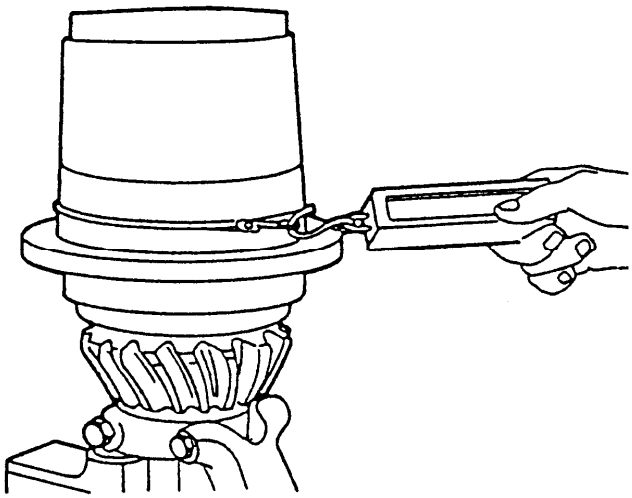

Fig. 7E.20. Checking Pinion Shaft Bearing Preload (I Method)

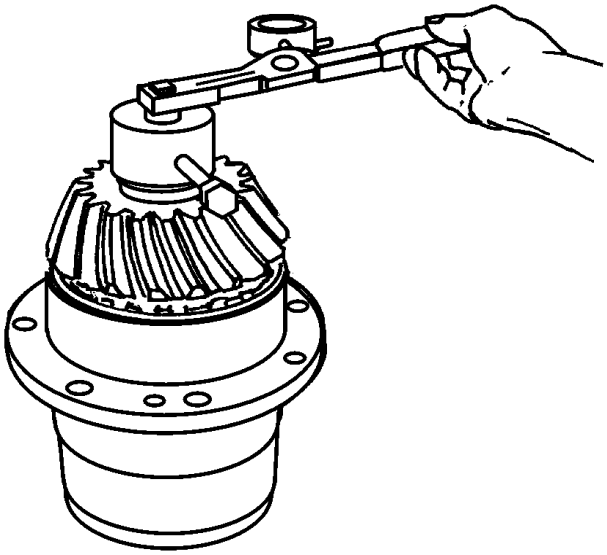

Fig. 7E.20A. Checking Pinion Shaft Bearing Preload (II Method)

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14. Press cone of tapered bearing (78) on pinion shaft gear (79) until it bottoms. Insert pinion shaft gear (79) in flange end of pinion gear housing (76). Place the assembly in a press and install cone of tapered bearing (75) on the shaft. If necessary, use a drift to drive the tapered bearing cone (75) far enough past the retaining ring groove to permit installation of spacer (74), thrust race (73) and retaining ring (72).
15. Install thrust race (73) and one retaining ring (72) out of five types available.

NOTE: *Steps 16 and 17 are optional methods of checking pinion shaft gear rolling torque.*

16. **I Method:** Wrap a cord around the 203 [mm] diameter of pinion gear housing (76) and attach a spring scale as shown in Fig.7E.20. Take a reading of the drag (newtons pull) needed to start the housing rolling. A reading 0 – 29.5 [N] should be obtained. If the reading is higher, a smaller retaining ring (72) must be installed. If the reading is lower, a larger retaining ring (72) must be installed.
17. **II Method:** Pinion gear shaft adjustment procedure.

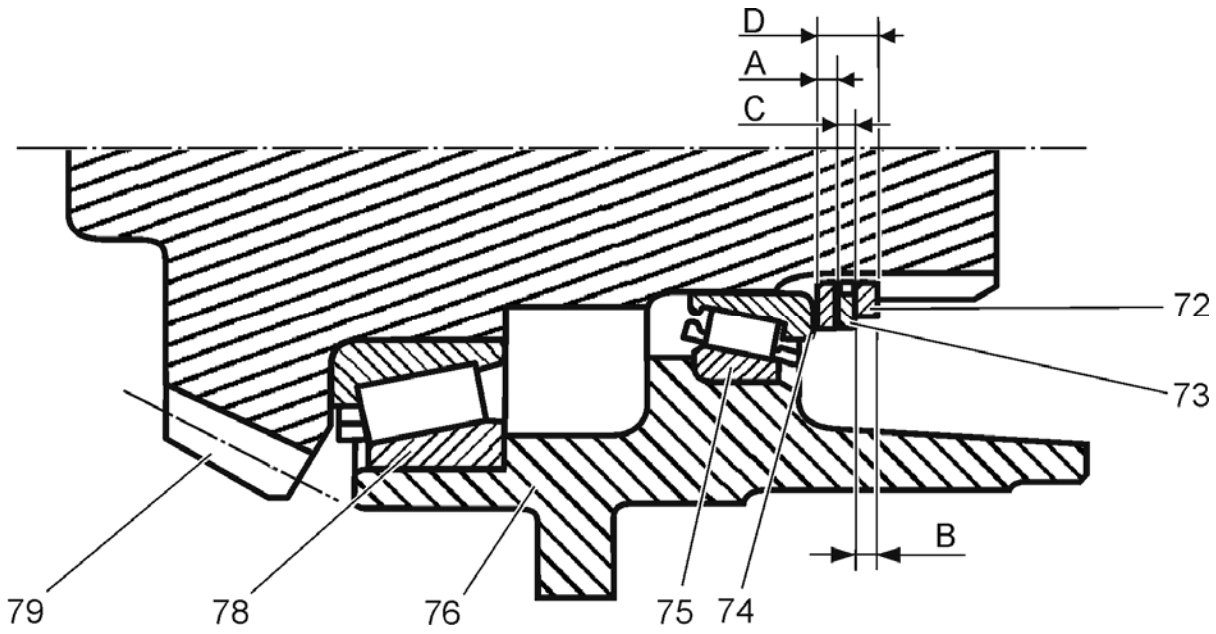

Fig. 7E.20B. Pinion Gear Shaft Adjustment

72. Retaining Ring
73. Thrust Race
74. Spacer
75. Tapered Bearing
76. Pinion Gear Housing
78. Tapered Bearing
79. Pinion Gear Shaft
A. Spacer Thickness
B. Retaining Ring Thickness
C. Thrust Washer Thickness
D. Distance Between Spacer and Ring Groove Surface

a). Refer to Fig. 7E.20A for pinion gear shaft assy position on an installation table. Measure the initial pinion gear shaft (79) rolling torque with a 1.249.0017 tool equipped with a 1.264.0024 socket. The rolling torque should range between 0.5 to 6 [Nm]. If the initial rolling torque reading falls outside this range, press the bearing (75) in until the correct reading is achieved.

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b). Remove retaining ring (72) and thrust race (73) that were previously installed. Measure the D distance as shown in Fig. 7E.20B. Take the measurement in four 90 [°] spaced places. Select a thrust race (73) and one of five retaining rings (72) in a way that their total thickness shall equal to D dimension.

Check the pinion gear shaft (79) rolling torque with a 1.249.0017 tool equipped with a 1.264.0024 socket. If the rolling torque ranges between 0.5 to 2 [Nm] do not use a new retaining ring (72), the assembly is ready.
If the rolling torque ranges between 2 to 3 [Nm], install a retaining ring (72) that has 0.05 [mm] less in thickness that the ring that was used for measurements.
If the rolling torque ranges between 3 to 6 [Nm], install a retaining ring (72) that has 0.05 to 0.1 [mm] less in thickness that the ring that was used for measurements.
All retaining rings (72) are within maximum tolerance range equal to ± 0.05 [mm] and make possible to get the correct thickness.

Following are examples of thrust race (73) and retaining ring (72) selection and installation:

For D dimension equal to 6.4 [mm] and a torque equal to 1.5 [Nm] install a 3.18 [mm] thrust race (73) and a 3.22 [mm] retaining ring (72) to get a total thickness equal to 6.4 [mm]. In that case nothing is to be added to a 6.4 [mm] dimension.
For D dimension equal to 6.2 [mm] and a torque equal to 0.5 [Nm] install a 3.18 [mm] thrust race (73) and a 3.05 [mm] retaining ring (72) to get a total thickness equal to 6.23 [mm]. In that case 0.03 [mm] was added.
For D dimension equal to 6.3 [mm] and a torque equal to 4.5 [Nm] install a 3.18 [mm] thrust race (73) and a 3.05 [mm] retaining ring (72) to get a total thickness equal to 6.23 [mm]. In that case 0.07 [mm] was removed.

c). Apply a force of 25000 [N] to a cone bearing inner ring (75) to get a 0.13 [mm] bearing shift towards the assy inner side to facilitate selected retaining ring (72) and thrust race (73) installation. Make use of a 2.5 [T] hydraulic press to get a required force.

d). Place the pinion gear shaft (79) on pinion gear housing (76) and tap pinion gear shaft end (79) with a 1 [kg] brass hammer to ensure a positive contact of thrust race (73) and retaining ring (72) installed before a final pinion gear shaft (79) rolling torque measurement. Make use of a 1.249.0017 tool equipped with a 1.264.0024 socket to measure the rolling torque that for new bearings should be equal to 1.5 ± 1.5 [Nm].

NOTE: *If you install bearings that were used previously, adjust the rolling torque to get a reading ranging from 0 to 1.5 [Nm].*

e). Some cases need a thrust race (73) and retaining ring (72) total thickness in excess of 6.4 [mm]. If this is a case add spacer (74) to thrust race (73) and select a correct retaining ring (72) in such a way that their total thickness makes possible to get the correct rolling torque.

Following are examples that make use of spacer (74) necessary:

For D distance equal to 6.5 [mm] and rolling torque of 2.8 [Nm] place a 0.38 [mm] spacer (74), a 3.12 [mm] thrust race (73) and 2.95 [mm] retaining ring (72). That results in total thickness eqal to 6.45 [mm]. In that case 0.05 [mm] was removed.
For D distance equal to 6.7 [mm] and rolling torque of 5.6 [Nm] place a 0.38 [mm] spacer (74), a 3.12 [mm] thrust race (73) and a 3.1 [mm] retaining ring (72). That results in total thickness eqal to 6.6 [mm]. In that case 0.1 [mm] was removed.

NOTE: *Due to thrust race (73) and retaining ring (72) thickness tolerance pay a particular attention while selecting these elements to account for their actual thickness.*

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18. Set housing (67) down so that the right hand side is up. Attach a hoist to the two eyebolts 5/8”-11x1 1/4” in the bevel gear hub (55) as shown in Fig. 7E.21 and lower it into housing (67) being sure that dowel pin (71) engages the slot in bearing carrier (61).

NOTE: *Do not lower the bevel gear hub assembly all the way down. Leave it supported by the hoist.*

19. Install pinion gear housing (76) to housing (67) with the same amount of shims (77) previously removed. Torque the bolts to 108 [Nm].
20. Lower bevel gear hub (55) and remove the hoist.
21. Working through the opening in the top of housing (67) measure the gap between the end of pinion shaft gear (79) and the raised edge of bearing carrier (61) as shown in Fig. 7E.22. This gap volume “A” is etched on the front of the pinion shaft gear. If necessary, remove or add shims (77) to obtain correct gap, with tolerance $\pm$ 0.04 [mm].
22. Set housing (67) down in its normal position and install adjusting nut (68) on bearing carrier (61) hand tight.

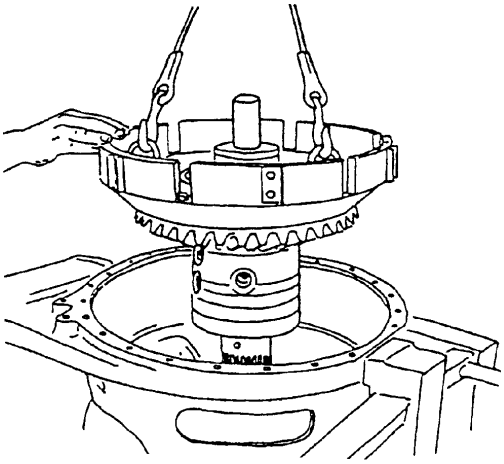

Fig. 7E.21. Bevel Gear Hub Installation

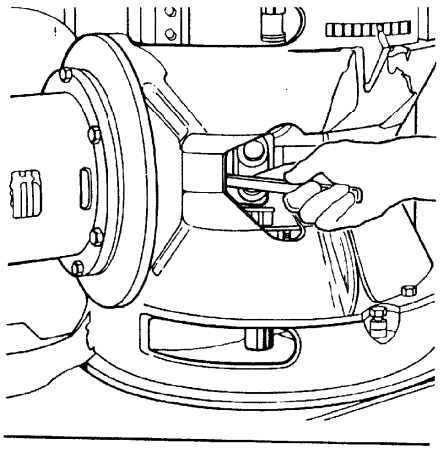

Fig. 7E.22. Checking Pinion Shaft End Gap

23. Adjust the bevel gear and pinion shaft gear backlash as follows:
    a). Tighten adjusting nut (68) until the bolt holes in the nut line up with the bolt holes in housing (67) and there is little or no gear backlash. It is necessary to tap on opposite end of bevel gear hub (55) while tightening adjusting nut (68). Install nut lock ring (69) and torque the bolts to 54 [Nm].
    b). Position a dial indicator on outer surface of main housing (67) so that the pointer rests against the heel of a bevel gear tooth as shown in Fig. 7E.22A.
    c). Hold the pinion shaft stationary and turn the bevel gear to the limit of its movement. Set the indicator to zero. Next move the bevel gear to its limit of free play while holding the pinion shaft stationary and note the indicator reading.
    d). Repeat Steps b). and c). at four equidistant points on the bevel gear and adjust for minimum backlash at tightest point.
    e). To change the gear backlash, remove nut lock ring (69) and turn adjusting nut (68). Backlash is changed in increments of 0.08 [mm] by turning nut (68) until the next bolt pattern lines up between nut (68) and housing (67). Adjust the gear backlash to suit “Bl” reading etched at front of pinion shaft and bevel gear face. Reinstall nut lock ring (69) and torque the bolts to 54 [Nm]. Recheck gear backlash.

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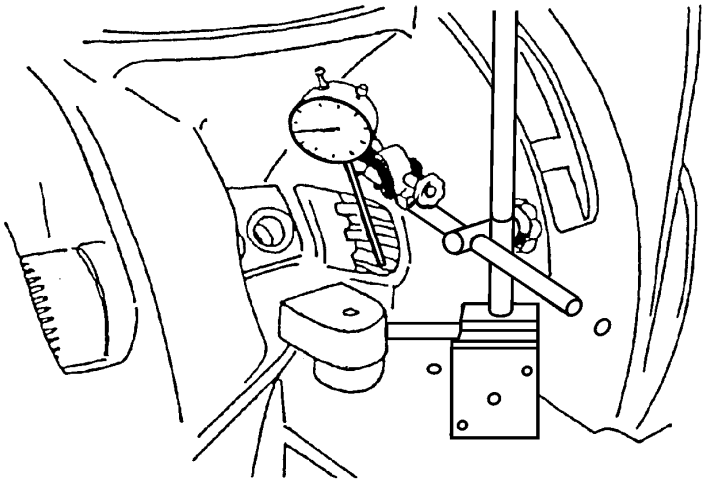

Fig. 7E.22A. Checking Bevel Gear and Pinion Backlash

24. Set housing (67) on end so that the right hand side is up.

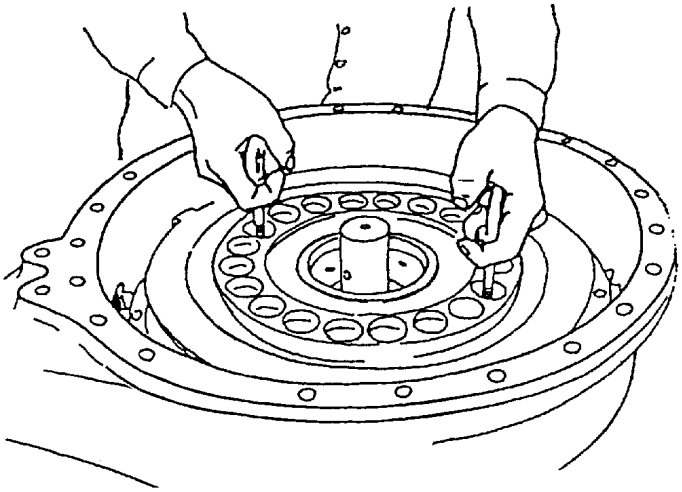

Fig. 7E.23. Clutch Piston Installation

25. Install the high range clutch piston (49) in clutch plate retainer (56) the same way as for removal (refer to Fig. 7E.23). Use eyebolts 3/8”-16UNC.

NOTE: *When a need to replace separator plates for high range and brakes clutches arises check their thickness. Separate the plates to get to sets: one grouping the plates smaller in thickness and the other composed of remaining plates. Use the plates smaller in thickness and the plates bigger in thickness to serve the brake clutches and high range clutches, respectively.*

NOTE: *Thoroughly oil all of the internally splined friction discs with same oil as used in the main frame prior to assembling in the retainer.*

26. Install spacers (A, Fig. 7E.24) in holes of clutch plates (21). Alternately install one internally splined friction disc (20) and one externally splined clutch plate (21) in clutch plate retainer (56). Start from friction disc (20). While installing externally splined clutch plate (21) note that every other plate is to be displaced 60 [º] in relation to the proceeding plate so that tabs of two successive externally splined plates form an entire circumference. Install ring gear adapter (48) and ring gear (47) on clutch plate retainer (56) and torque the bolts to 54 [Nm].

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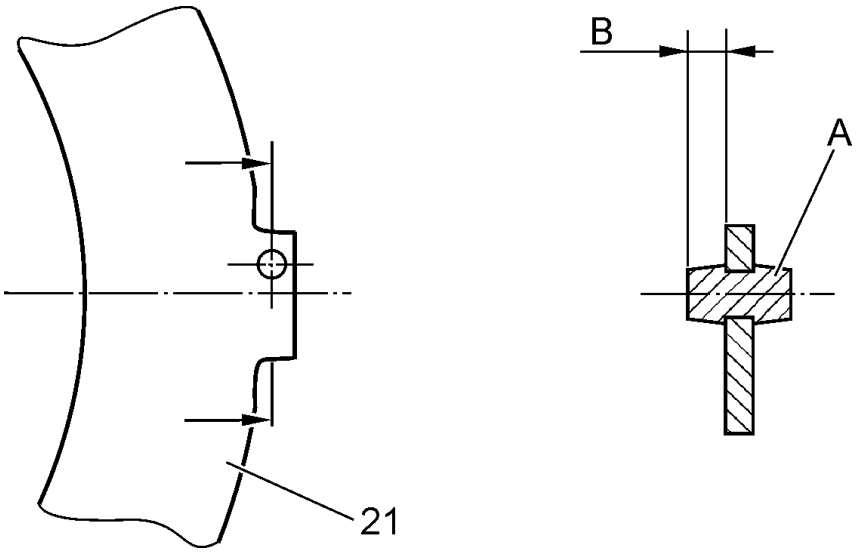

Fig. 7E.24. Clutch Plate Spacers Assembly

A. Spacers 21. Clutch Plates

B . . . . . Three spacers, distribution at 120 [°] 5.5 [mm]

27. Shims (84) may be required between the return spring retainer (44) and the return spring retaining ring (43). To determine if necessary, and how many, proceed as follows:
   a). Place four clutch return outer springs (46) into the four high range clutch piston (49) pockets with tapped holes in center. Place the return spring retainer (44) over the piston with its four holes centered above the four springs.
   b). Compress the springs and install the spring retaining ring (43).
   c). Screw into four topped holes, four bolts (3/8”-16UNCx6” with a minimum of 32 [mm] thread) (A, Fig. 7E.25), 90 [°] apart until they bottom. Torque the bolts to 13.6 [Nm]. This will cause the piston to make contact with the clutch pack.
   d). Determine the average distance (A, Fig. 7E.25A) between the high range clutch piston (49) and the return spring retainer (44). To obtain this figure, use a depth gauge (B, Fig. 7E.25A) to measure the distance C from the clutch piston to the outer edge of the spring retainer in two places.

$$\frac{C_1 + C_2}{2} = C$$

Then remove the return spring retainer (44) and measure the retainer thickness D with a micrometer in two places.

$$\frac{D_1 + D_2}{2} = D$$

Subtract the retainer thickness D from the total distance. C – D = A

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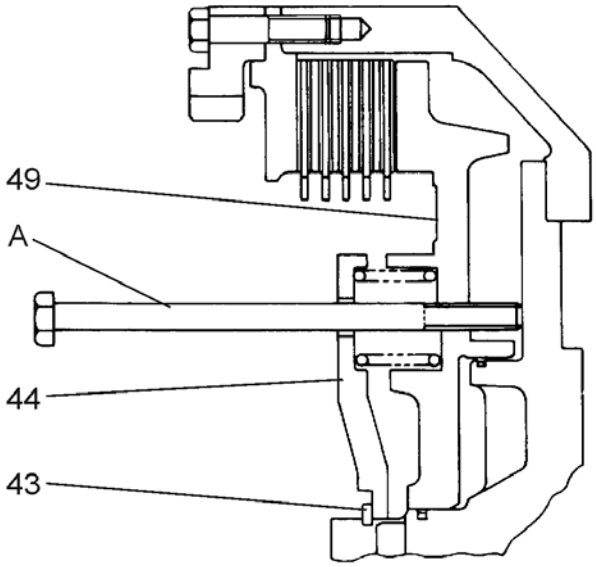

Fig. 7E.25. Checking for Shims

A. Bolt (3/8”-16UNCx6”)
43. Return Spring Retaining Ring
44. Return Spring Retainer
49. High Range Clutch Piston

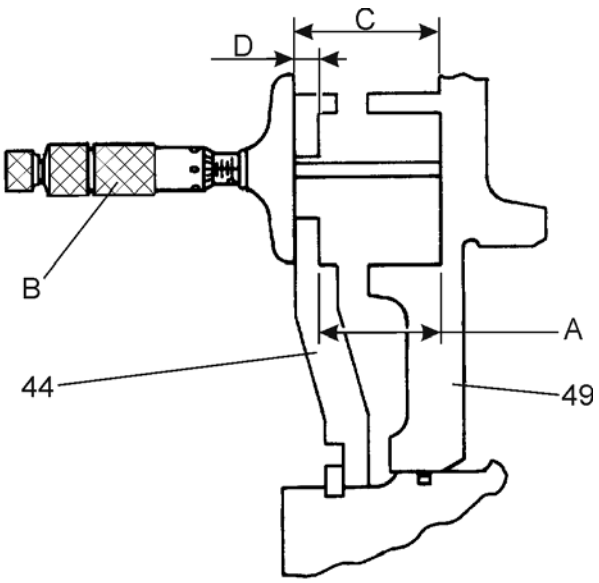

Fig. 7E.25A. Measuring Depth

A. Distance Between Retainer and Piston
B. Depth Gauge
C. Distance Between Piston and Spring Retainer Outer Edge
D. Retainer Thickness
44. Return Spring Retainer
49. High Range Clutch Piston

e). If the average distance (A, Fig. 7E.25A) is below 25.4 [mm], shimming is not required. If the distance is more than this figure, add shims (84) as necessary to bring distance as close to a figure of 25.4 [mm] as possible. Each shim (84) is 0.5 [mm]. No more than three shims (84) should be required.

28. Position clutch return springs (45 and 46) on high range clutch piston (49) and place spring retainer (44) on top of the springs. Using three bolts 3/8”-16UNC compress return springs (45 and 46) as shown in Fig. 7E.26 and install spring retaining ring (43) and shims (84) (if required). Remove the three bolts. Springs must rest in counterbores of spring retainer (44).

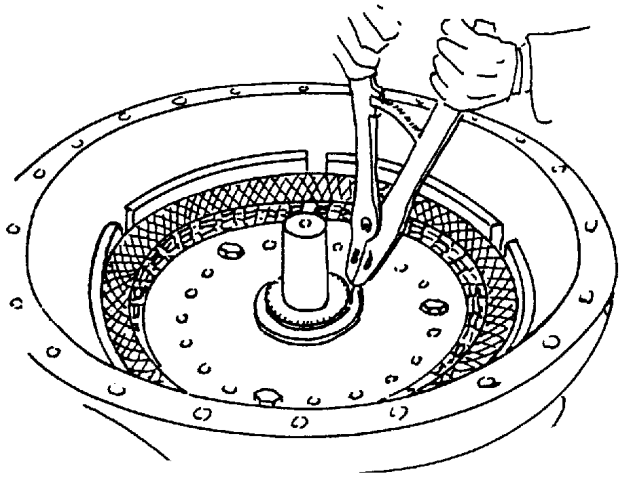

Fig. 7E.26. Spring Retaining Ring Installation

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29. Install clutch hub thrust race (41), clutch hub thrust bearing (42) and clutch hub thrust race (41) on bevel gear hub (55).
30. Position planet gear (39) with planet gear bearing (38) installed on the outer diameter of planet carrier (33). Place on complete assembly in the carrier.
31. Use a round tool to center planet gear (39) and thrust washers (37) with the shaft bore in planet carrier (33) before installing planet gear shaft (36). Tap the shaft with ball (34) into the planet carrier (33), aligning the ball with the slot in the carrier. Install bearing scoop (35) and torque the bolts to 54 [Nm].
32. Install the remaining two planet gears (39) in the same manner described in Steps 30 and 31.
33. Install sun gear retaining ring (30) on sun gear (31) and install the gear in sun gear hub (32). Press ball bearing (29) in sun gear hub (32) until it bottoms on sun gear (31). Install bearing retainer ring (28) in groove of sun gear hub (32).
34. Press hub assembly on planet carrier (33) until ball bearing (29) bottoms. Be sure sun gear (31) meshes with planet gears (39).
35. Check that sleeve retaining ring (26) is properly seated in output shaft sleeve (27). Install output shaft sleeve (27) onto the shaft of planet carrier (33), taper end first, until retaining ring (26) is against the shaft. Install sleeve retaining washer (25) on shaft sleeve (27) and torque the bolts to 54 [Nm].

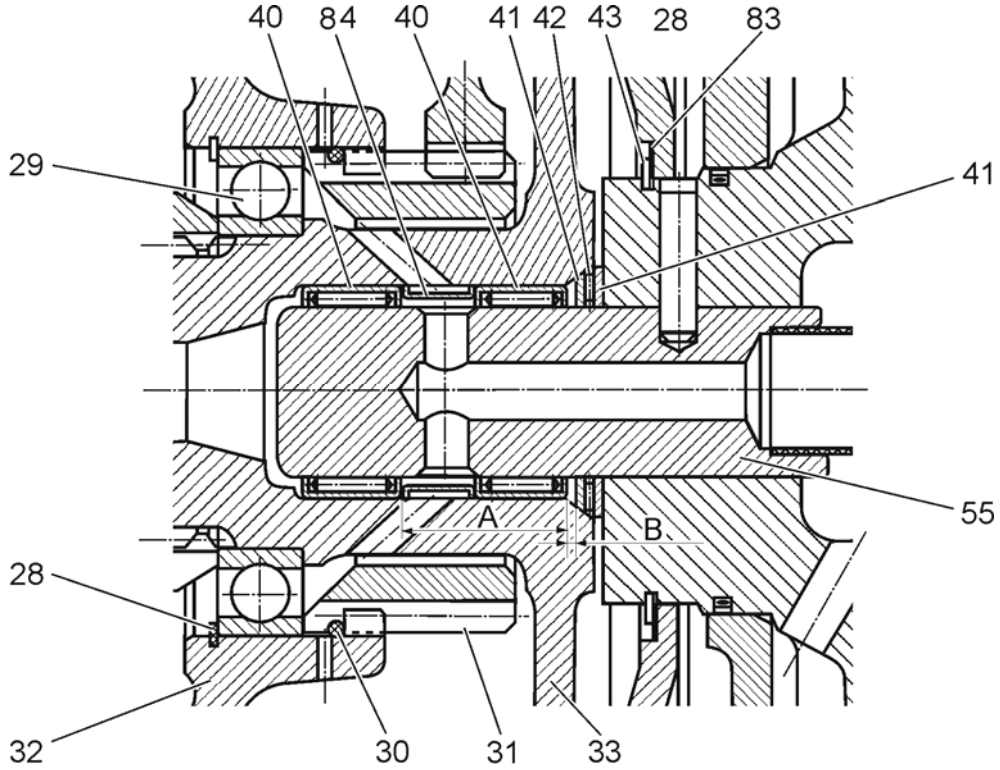

Fig. 7E.27. Roller Bearing Installation

28. Bearing Retaining Ring
29. Ball Bearing
30. Sun Gear Retaining Ring
31. Sun Gear
32. Sun Gear Hub
33. Planet Carrier
40. Clutch Hub Roller Bearing
41. Clutch Hub Thrust Race
42. Clutch Hub Thrust Bearing
43. Return Spring Retaining Ring
55. Bevel Gear Hub
83. Bearing Spacer
84. Return Spring Retaining Ring Shims

A. . . . . 45.75 ± 0.8 [mm]
B. . . . . 2.54 ± 0.25 [mm]

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36. Install roller bearings (40) and spacer (83) in planet carrier (33) so that one roller bearing is 45.75 ± 0.8 [mm] below the thrust bearing counterbore surface and the second bearing is 2.54 ± 0.25 [mm] below the thrust bearing counterbore surface (refer to Fig. 7E.27).
37. Slowly lower the carrier assembly into housing (67), being sure the splines of planet carrier (33) mesh with the splines of the friction discs (20) and planet gears (39) mesh with gear (47).
38. Position brake plate retainer (22) on main housing (67) so the port on the retainer is in line with the port on housing (67).

NOTE: *Thoroughly oil all of the internally splined friction discs with same oil as used in the main frame prior to assembling them in the retainer.*

39. Install spacers (A, Fig. 7E.24) in holes of clutch plates (82). Alternately install one externally splined clutch plate (82) and one internally splined friction disc (81) in brake plate retainer (22). Start from externally splined clutch plate (82). While installing externally splined clutch plate (82) note that every other plate is to be displaced 60 [º] in relation to the proceeding plate so that tabs of two successive externally splined plates form an entire circumference.
40. Install O-rings (16 and 18) and brake piston seal rings (17 and 19) on brake piston (15) as shown in Fig. 7E.18. Install brake piston (15) on brake plate retainer (22).
41. Position low range clutch plate retainer (13) on top of brake plate retainer (22). Secure both retainers to housing (67) and torque bolts with washer to 108 [Nm].
42. Oil friction discs (10) (refer to **NOTE** above). Install spacers (A, Fig. 7E.24) in holes of clutch plates (11). Alternately install one externally splined clutch plate (11) and one internally splined friction disc (10) in low range clutch plate retainer (13). Start from externally splined clutch plate (11). While installing externally splined clutch plate (11) note that every other plate is to be displaced 60 [º] in relation to the proceeding plate so that tabs of two successive externally splined plates form an entire circumference.
43. Position brake piston return springs (14) on brake piston (15).
44. Shims (80) may be required behind the spring (12). To determine if necessary, and how many, proceed as follows:
    a). Place four clutch springs (12) into the four pockets with tapped holes in center of the low range clutch plate retainer (13).
    b). Place the low range clutch piston (9) over the springs (12). Thread four studs 3/8”-16 UNC x 3 1/2” (A, Fig. 7E.28), into four of the pockets 90 [°] apart. Screw the studs approximately 9.5 [mm] into the retainer. Using a washer and a nut, pull the piston against the clutch pack. Torque the nuts to 13.6 [Nm].
    c). Determine the average distance (B, Fig. 7E.29) between the low range clutch piston (9) and the low range clutch plate retainer (13). To obtain this figure, use a depth gauge (A, Fig. 7E.29) to measure the distance C from the outer edge of the piston to the retainer in two places.

$$\frac{C_1 + C_2}{2} = C$$

Then remove the piston (9) and measure the piston thickness D with a micrometer in two places.

$$\frac{D_1 + D_2}{2} = D$$

Subtract the piston thickness D from the total distance. $C - D = B$

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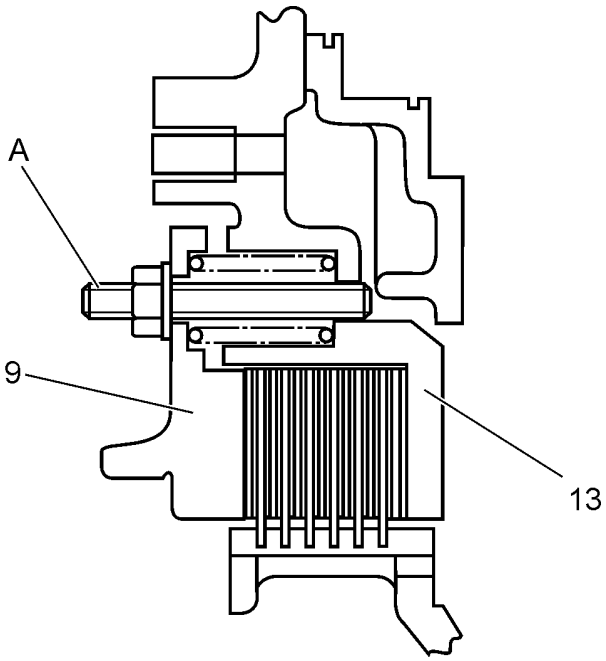

Fig. 7E.28. Checking for Shims

A. Stud (3/8”-16UNCx3 1/2”)
9. Low Range Clutch Piston
13. Low Range Clutch Plate Retainer

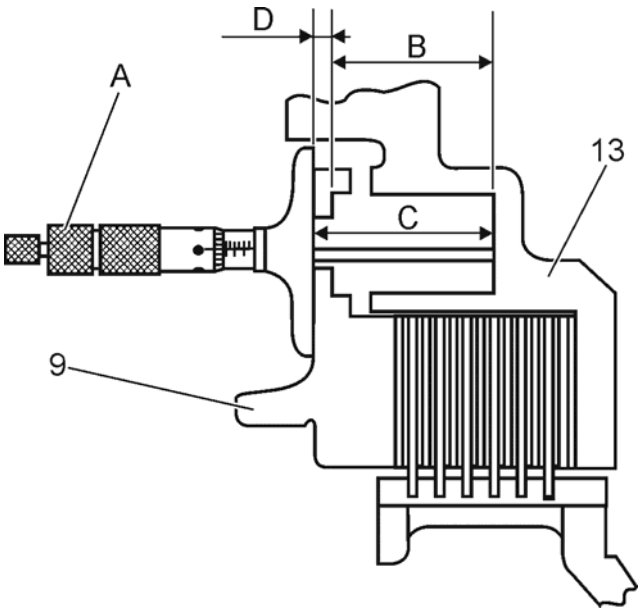

Fig. 7E.29. Measuring Depth

A. Depth Gauge
B. Distance Between Piston and Retainer
C. Distance Between Piston and Piston Outer Edge
D. Piston Thickness
9. Low Range Clutch Piston
13. Low Range Clutch Plate Retainer

d). If the distance (B, Fig. 7E.29) is below 38.10 [mm], shimming is not required. If the distance is more than this figure, add shims (80) as necessary to bring distance as close to a figure of 38.10 [mm] as possible. Each shim (80) is 0.5 [mm] thick. The shims (80) are to be placed on retainer side of each spring.

e). Remove the studs from the retainer.

45. Place the piston return springs (12) and shims (80) (if required) onto the brake plate retainer (13). Make sure that the springs nest in counterbores. Position the low range clutch piston (9) on top of piston return springs (12).
46. Position thrust race (23), thrust bearing (24) and second washer race (23) on output shaft sleeve (27).
47. Install O-rings (5 and 7) and piston seal rings (6 and 8) on retainer cover (4) as shown in Fig. 7E.18. Install retainer cover (4) on low range clutch plate retainer (13) and torque the bolts with washers to 81 [Nm].
48. Install the lifting eye (1) to the retainer cover (4) and torque the bolts with washer to 108 [Nm].
49. Position the same amount of bearing retainer shims (3) that were previously removed on retainer cover (4). Using a depth gauge as shown in Fig. 7E.30, measure the difference between the surface of thrust race (23) and the surface of bearing retainer shims (3). Thrust race should be 0.13 - 0.25 [mm] below shims. Add or subtract shims to obtain 0.13 - 0.25 [mm] gap.
50. Add the correct amount of shims determined in Step 49. Install bearing retainer (2) and torque the bolts to 54 [Nm].
51. Turn the assembly over.

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52. Install O-rings (51 and 53) and clutch piston seal rings (50 and 52) on piston retainer hub (70) as shown in Fig. 7E.18. Position oil slingers (57) on clutch plate retainer (56). Apply LOCTITE 262 to the bolts and torque to 11 [Nm].
53. Install plate retainer (56) on piston retainer hub (70) and torque the bolts to 54 [Nm].
54. Install piston retainer hub (70) on bevel gear hub (55) until it bottoms. Install piston retainer ring (66) in the groove of bevel gear hub (55).
55. Repeat Steps 25 through 50 on the left side.

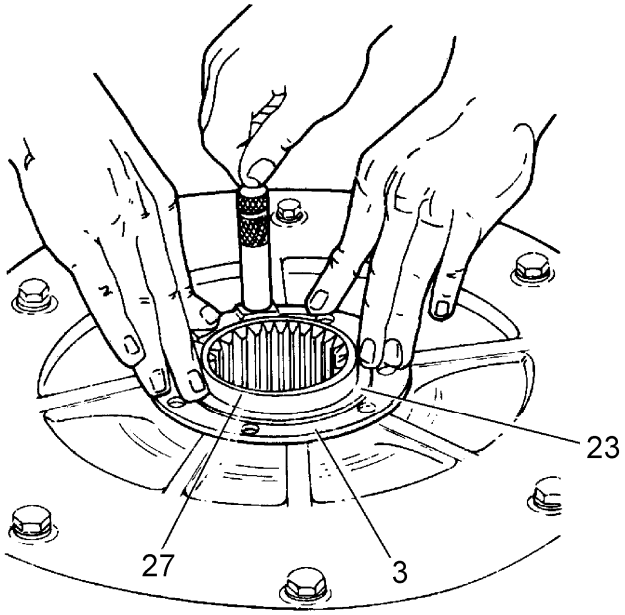

Fig. 7E.30. Checking Output Shaft Sleeve End Play

3. Bearing Retainer Shims 23. Thrust Race 27. Output Shaft Sleeve

8. INSTALLATION

1. Set steering drive down flat so that lifting eyes are up. Connect the connectors, elbows and manifold hoses to the steering drive (refer to Fig. 7E.9). Temporarily secure steering manifold (2, Fig. 7E.9) to the bracket (17). Reconnect all hoses to steering drive.
2. Be sure the steering drive output shafts are pulled out of steering drive and spline sleeve is on pinion shaft.

NOTE: *The output shafts can not be installed once the steering drive is in place.*

3. Thoroughly clean the mating surfaces of the main frame and the steering drive.
4. Install the lower bolts (21, Fig. 7E.9) to the steering drive (1) and secure bolts against slipping out with retaining rings (20).
5. Attach a hoist with an adjusting sling to the steering drive as shown in Fig. 7E.7. Raise steering drive up and over main frame and lower it into place. Move the steering drive forward and rock it until the spline sleeve engages the transmission output shaft.
6. Secure the steering drive (1, Fig. 7E.9) to the front surface of main frame with the upper bolts (19) with washers. Torque the upper bolts to 920 [Nm].

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7. Getting through a rear frame opening install a socket on head of the lower bolt (21). Getting through the plug hole (3, Fig. 7E.8) and join extension rod 1.541.0151-700 with the socket and screw lower bolt (21, Fig. 7E.9). Repeat this procedure for second lower bolt (21). Torque the lower bolts to 920 [Nm].
8. Remove the hoist from the steering drive. Install the plugs (3, Fig. 7E.8) to the rear surface of the main frame (1). If removed, install the drawbar to the rear surfaces of the main frame (1).

NOTE: *If the rear frame suction tube has been loosened during removal, reinstall at this point.*

9. With a bolt 5/8”-11UNC-2B installed in the end of the steering drive output shaft, slide the shaft in so it splines first with the sprocket drive pinion gear and then with the steering drive. Remove the bolt (refer to Fig. 7E.6).

NOTE: *If the shaft will not spline with the steering drive, slightly rotate the sprocket with a floor jack positioned under a rear track grouser.*

10. With a bolt 1/2”-13UNC-2B threaded in output shaft retainer (2, Fig. 7E.5), install the retainer with new O-ring in the pinion gear of sprocket drive. Remove the bolt and install retaining ring (1). Reinstall the pinion access cover with shims on the sprocket drive cover.
11. Repeat Steps 9 and 10 on the opposite side of the machine.
12. Remove steering manifold (2, Fig. 7E.9) from bracket (17). Reinstall lube tube (3, Fig. 7E.4) between the steering drive (2) and the front surface of the main frame (1).
13. Install two lifting eye bolts 1/2”-13UNC-2B (2, Fig. 7E.3) to the cover (1).
14. Thoroughly clean the mating surfaces of the main frame and cover. Apply LOCTITE #504, to the cover surfaces only. Using a hoist and position the cover on the main frame, being careful not to get excessive amounts of LOCTITE inside the rear main frame. Install the hardware previously removed. Install bracket (1, Fig. 7E.2) of gear shifting valve (2) and secure with bolts (15). Torque the bolts (15) to 455 [Nm].
15. Install hydraulic damper (12) and reconnect two hoses to damper (12).
16. Install the gear shifting valve (2) as described in Paragraph 33, INSTALLATION in SECTION 7C.
17. Install the steering valve (9) as described in Paragraph 13, INSTALLATION in this SECTION.
18. Reconnect drain hoses (14) and two drive train control valve drain hoses.
19. Install the main frame oil dipstick and filler tube (11) with the breather (10).

IMPORTANT: *Before installing the fuel tank, pressure test the rear main frame-to-cover seal (after specified set-up time of liquid gasket) by introducing air through the breather opening. Maximum pressure should not exceed 35 [kPa]. Use soap solution around the edge of the rear main frame cover. If air bubbles occur, mark the area of leakage, remove the cover and repeat steps 14 to 18.*

20. Attach a hoist to eye bolts 1” NCx1-1/2” and position the fuel tank (5) on rear of machine. Secure the tank with the bolts (13) previously removed.
21. Reconnect fuel return hose (8) and fuel supply hose (7) to the fuel tank (5).
22. Fill the fuel tank as described in the OPERATOR'S MANUAL. Open fuel supply valve (4) and check for leaks.
23. Reconnect wires of rear lamp (1, Fig. 7E.1), backup alarm (2) and fuel level sensor (8).
24. If equipped, connect hydraulic ripper hoses.
25. Fill the rear frame as described in the OPERATOR'S MANUAL.

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26. Start the engine and operate drive train control lever and foot brake. Check for leaks and functioning.
27. Reinstall the rear plates (5 and 7, Fig. 7E.1).
28. Reinstall transmission case guard at the bottom of machine.

WARNING! This procedure requires extreme caution. Use suitable blocking equipment while under confines the machine.

29. Check the oil pressures in the steering drive as described in SECTION 7.

TWO SPEED STEERING VALVE

9. REMOVAL (Refer to Fig. 7E.31)

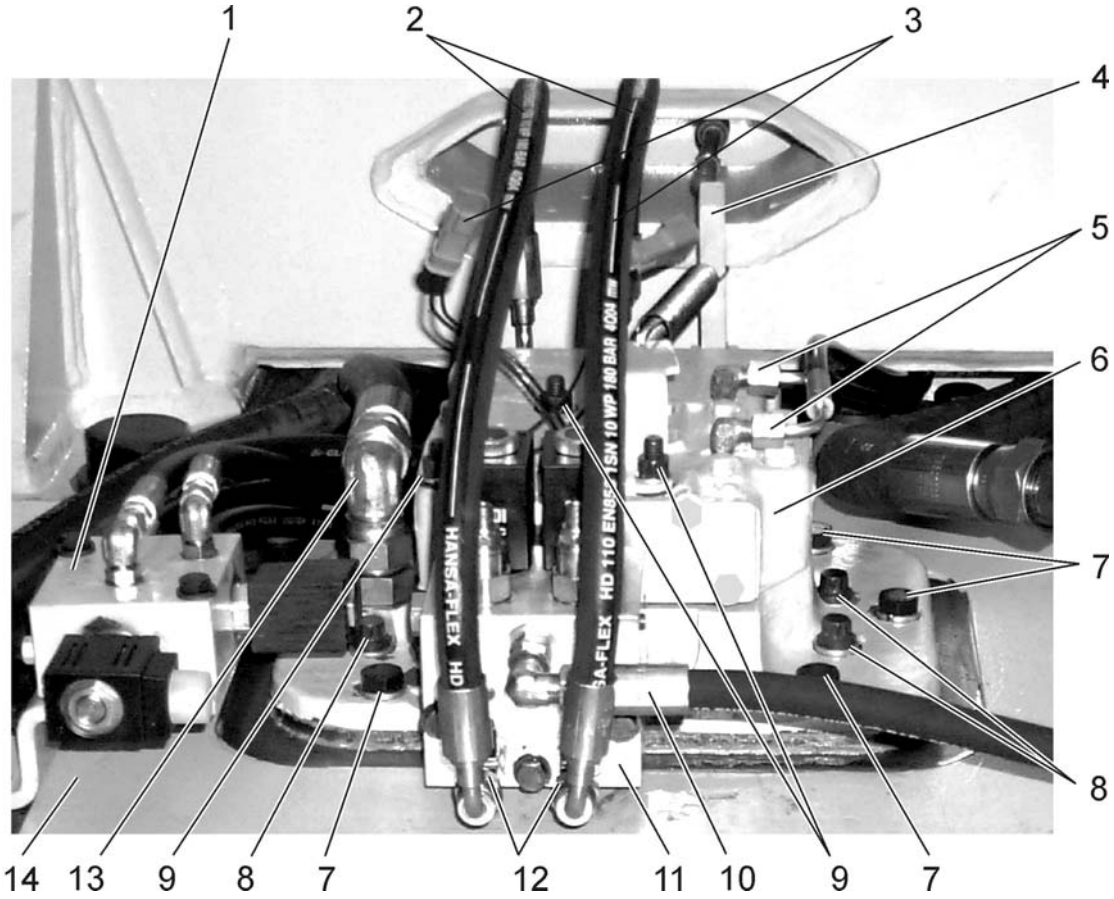

Fig. 7E.31. Two Speed Steering Valve Disconnect Points

1. Gear Shifting Valve
2. Pilot Hoses (Short)
3. Solenoids Wiring Harnesses
4. Brake Lever
5. Pressure Check Hoses
6. Two Speed Steering Valve
7. Bolts
8. Bolts
9. Stud Nuts
10. Drain Hose
11. HI-LO Valve
12. Pilot Hoses (Disconnected)
13. Supply Hose
14. Main Frame Cover

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TWO SPEED STEERING VALVE

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lever is in NEUTRAL position, drive train lock lever is in ON position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT**:** *Disconnected hydraulic lines must be properly capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Remove all dirt accumulation from the main frame cover. Tag disconnected lines to facilitate faster and correct installation.*

1. Turn electrical master switch to OFF position.
2. Perform Steps 5 to 9 as described in Paragraph 4, REMOVAL in this SECTION.
3. Disconnect wiring harnesses (3) at two solenoids of Hi-Lo valve (11).
4. Disconnect clevis from the brake lever (4).
5. Disconnect two pilot hoses (12) at the steering valve (6), drain hose (10) at the HI-LO valve (11) and two short pilot hoses (2).
6. Disconnect pressure supply hose (13) and two pressure check hoses (5).
7. Unscrew the three stud nuts (9). Remove ten bolts (7 and 8) from both sides securing the steering valve (6) to the main frame cover (14) and remove the valve. Discard the gasket.

NOTE: *Cover the steering valve opening to prevent dirt from entering the system.*

10. DISASSEMBLY

Linkage and Valves (Refer to Fig. 7E.32)

1. Disconnect and remove the brake lever (11) with shaft (10), links (12) and pins (13) from the lever bracket (9).
2. Remove roller bearings (14) and lube fitting (15), if necessary.
3. Remove the lever bracket (9) from the lower steering valve (5).
4. Remove the six bolts securing upper steering valve (1) to lower steering valve (5) and separate it. Remove and discard the valve gasket (2).
5. Remove large ball (3) and two small balls (4) from the lower steering valve (5).

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TWO SPEED STEERING VALVE

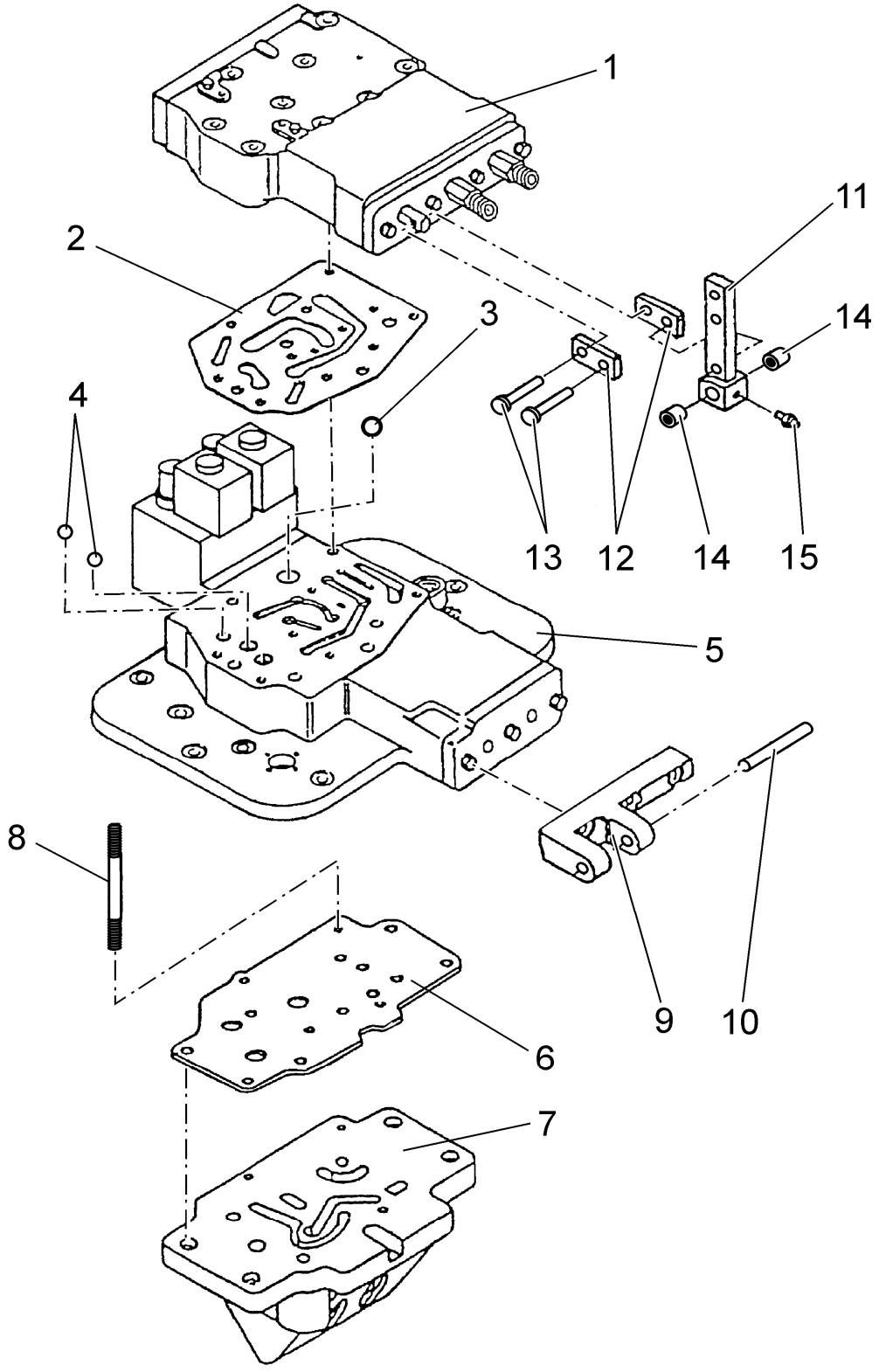

Fig. 7E.32. Exploded View of Two Speed Steering Valve

1. Upper Steering Valve
2. Valve Gasket
3. Ball (Large)
4. Ball (Small)
5. Lower Steering Valve
6. Manifold Gasket
7. Steering Manifold
8. Stud with Washer and Nut
9. Lever Bracket
10. Lever Shaft
11. Brake Lever
12. Lever to Valve Link
13. Lever Pins
14. Roller Bearings
15. Lube Fitting

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STEERING DRIVE

TWO SPEED STEERING VALVE

Upper Steering Valve (Refer to Fig. 7E.33)

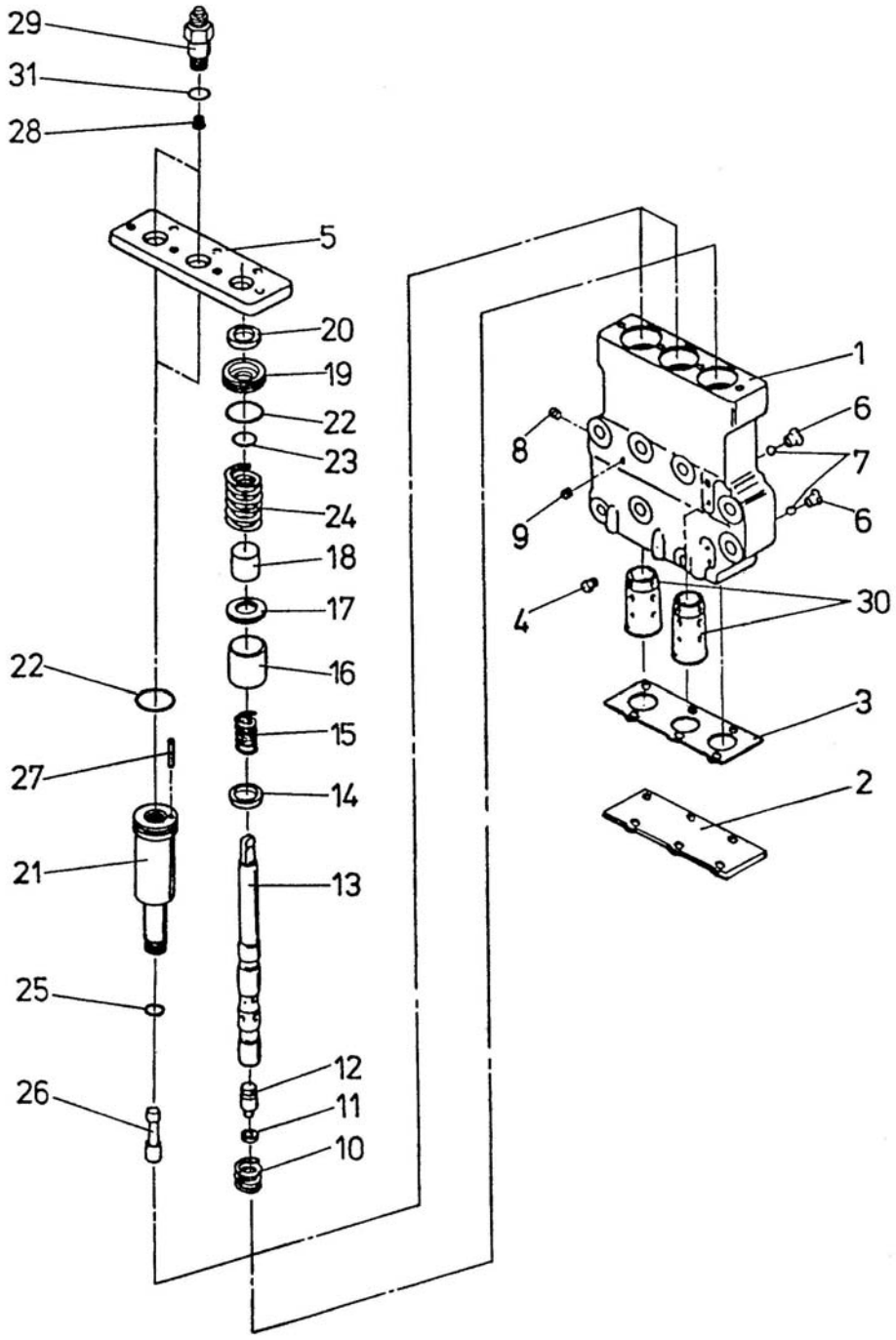

Fig. 7E.33. Exploded View of Upper Steering Valve

1. Valve Housing
2. Rear Cover
3. Gasket
4. Plug
5. Front Cover
6. Check Ball Body
7. Check Ball
8. Port Plug
9. Port Plug
10. Spool Spring
11. Shim
12. Spool Poppet
13. Brake Spool
14. Spring Washer
15. Inner Spool Spring
16. Inner Spring Stop
17. Spring Spacer
18. Outer Spring Stop
19. End Cap
20. Wiper Seal
21. Pilot Tube
22. Outer O-Ring
23. Inner O-Ring
24. Outer Spool Spring
25. O-Ring
26. Metering Spool
27. Dowel Pin
28. Nozzle
29. Connector
30. Metering Spool Sleeve
31. O-Ring

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6. Remove rear cover (2) from the rear of valve housing (1). Exert pressure on the cover to counteract the spring tension. Discard gasket (3).

WARNING! Spring loaded assembly. Assembly must be held with bracket to relieve spring pressure. Use extreme care when disassembling

7. Remove metering spools (26) and spool sleeves (30) from rear of housing (1) using care so not to scratch or score inside diameter of sleeves (30). Remove spring (10), shims (11), and poppet (12) from brake spool (13) in housing (1).
8. Unscrew hydraulic connectors (29) with O-rings (31) . Remove nozzles (28). Remove cover (5) from front of housing (1).
9. Remove the brake spool (13) with items (14 through 20 and 22, 23, 24) from the valve. Remove parts as an assembly by pulling spool (13) out front of housing (1).
10. Remove end cap (19) with the seals. Remove and discard the wiper seal (20) and the inner (23) and outer (22) O-rings and discard them.
11. Remove the outer spool spring (24) and the spring spacer (17).
12. Remove the inner spring stop (16) and outer spring stop (18).
13. Remove inner spool spring (15) and the spring washer (14).
14. Pull the left and right pilot tubes (21) out of the valve housing (1). Remove and discard O-rings (22 and 25) from pilot tubes (21).
15. Remove plugs or fittings (4) from top of housing (1). Remove the check ball body (6) and check ball (7) from the valve housing (1), if necessary.
16. Inspect parts for excessive wear and replace if necessary. Metering spools (26) should slide freely inside spool sleeves (30). Closely inspect the inside diameter of spool sleeves (30) for nicks, scratches, etc. and replace if necessary.
17. Inspect the condition of the springs. If they are damaged or do not fall within specifications as given in Paragraph 3 SPECIFICATIONS in this SECTION, they must be replaced.

Lower Steering Valve (Refer to Fig. 7E.34)

18. Remove the Hi-Lo valve (2) from the rear of the lower steering valve. Remove and discard the gasket (10) between valve.

WARNING! Spring loaded assembly. Assembly must be held with tool to relieve spring pressure. Use extreme care when disassembling.

19. Remove cover (3) from front of valve housing (1). Exert pressure on valve housing to counteract spring tension.
20. Pull out the plugs (8) with outer O-rings (9) by pulling spools (4) out of the valve housing (1). Discard the O-rings.
21. Remove items (4 thru 7) as an assembly by pulling spools (4) out front of valve housing (1).
22. Remove the spool springs (7).
23. Remove the spring spacer (6) and spring seats (5).

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TWO SPEED STEERING VALVE

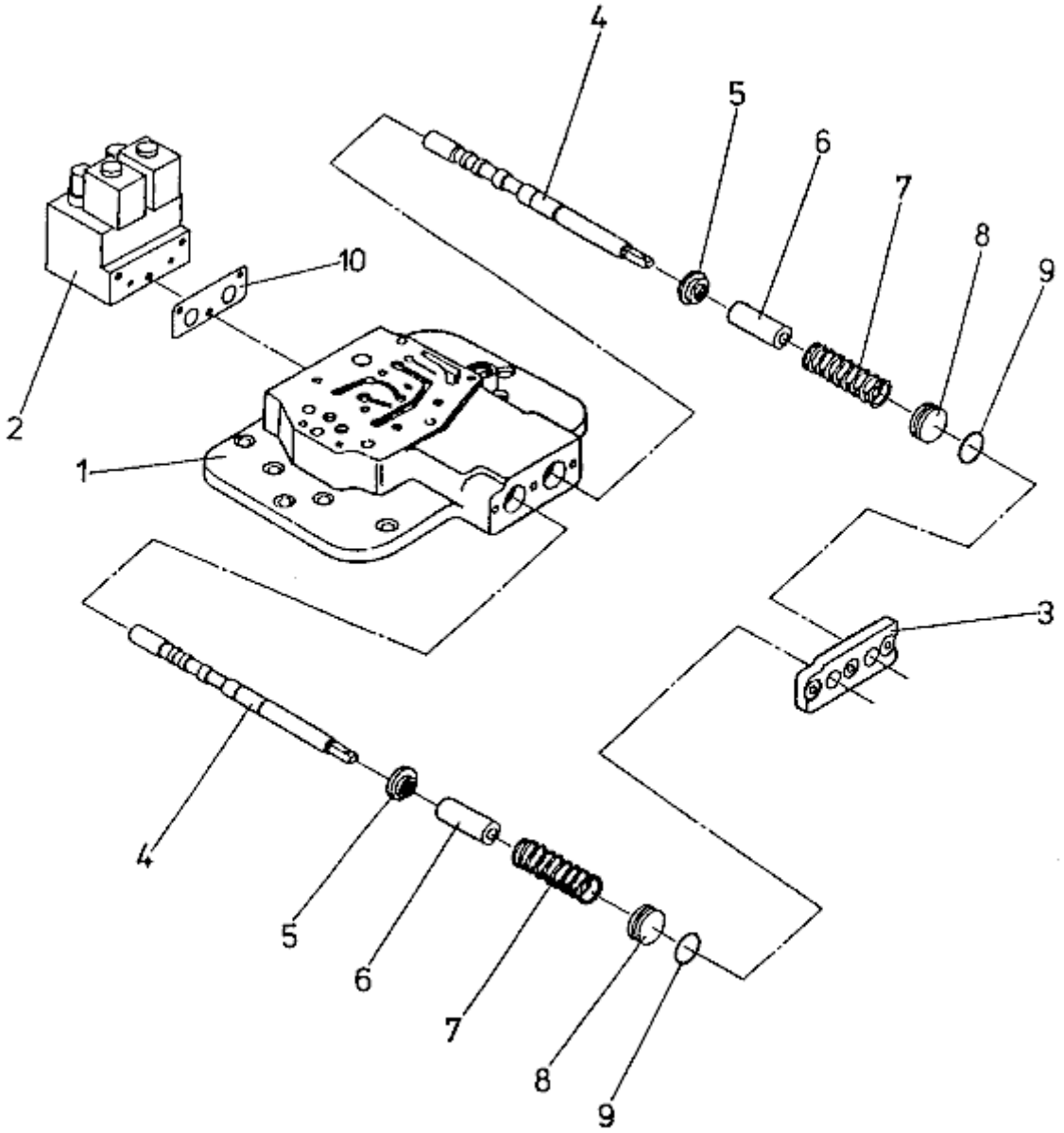

Fig. 7E.34. Exploded View of Lower Steering Valve

1. Valve Housing
2. Hi-Lo Valve
3. Front Cover
4. Valve Spool
5. Spring Seat
6. Spring Spacer
7. Spool Spring
8. Plug
9. Outer O-Ring
10. Rear Cover Gasket

Hi-Lo Valve (Fig. 7E.35)

24. Remove the sequence valves (3) from the valve housing (1). Remove and discard the valve seal kit.
25. Unscrew the solenoid coil from the solenoid valve (2). Remove the solenoid valve (2) bodies from the valve housing (1). Remove and discard the valve seal kit.
26. Remove nozzles (5) from the valve housing (1). Remove plugs (4) and clip (6), if necessary.

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TWO SPEED STEERING VALVE

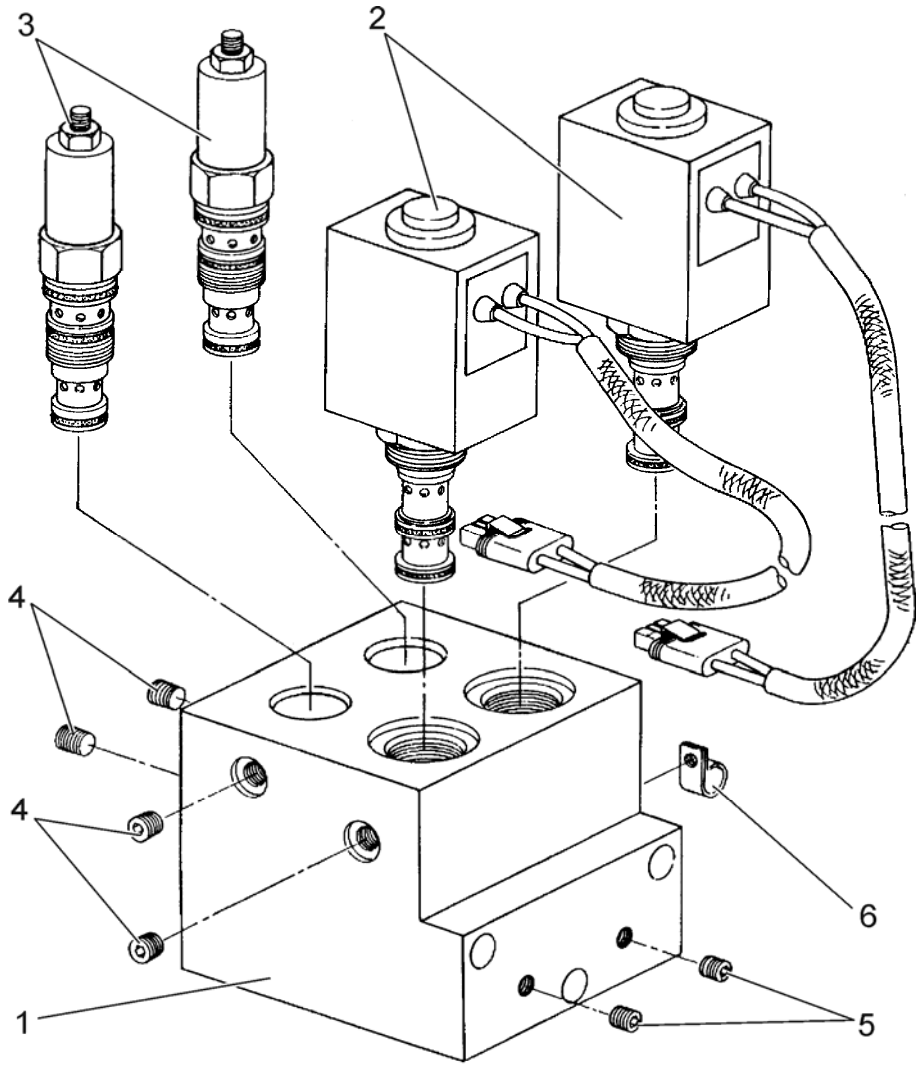

Fig. 7E.35. Exploded View of Hi-Lo Valve

1.	Valve Housing	3.	Sequence Valve	5.	Nozzle
2.	Solenoid Valve	4.	Plug	6.	Clip

11. INSPECTION AND REPAIR

1. It is recommended that all new O-rings and seal rings be installed upon reassembly of the valve.
2. Clean all parts in a suitable solvent and blow dry with compressed air. Be sure all oil passages in the valve bodies and spools are free of obstructions.
3. Inspect parts for excessive wear and replace if necessary (refer to **NOTE**).

NOTE: *The oil inlet port of the lower valve housing may show signs of wear caused from the ball PEENING the valve section each time pressure re-enters the valve. Do not replace the valve section when this appearance is observed*.

4. Inspect the condition of the springs. If they are damaged or do not fall within the specification shown in Paragraph 3, SPECIFICATIONS, they must be replaced.
5. Clean threads with a stiff brush and solvent. Check for damage.

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12. REASSEMBLY

Hi-Lo Valve (Refer to Fig. 7E.35)

1. Install nozzles (5) in the valve housing (1). If removed, install plugs (4) and clip (6).
2. Install a new seal kit to the solenoid valve (2) body. Install the solenoid valves (2) bodies to the valve housing (1). Torque the solenoid valve bodies to 44 • 56 [Nm]. Install the solenoid coils on valve (2) bodies and torque them to 5 • 7 [Nm].
3. Install a new seal kit to the sequence valve (3). Install the sequence valves (3) to the valve housing (1). Torque the sequence valve bodies (3) to 45 • 50 [Nm].

Lower Steering Valve (Refer to Fig. 7E.34)

4. Install the spring spacers (6) and spring seats (5) on valve spools (4).
5. Install the spool springs (7) on front end of spools (4) and slide spool into front of valve housing (1).
6. Install new O-rings (9) on plugs (8) and install them into front of valve housing (1).
7. Install the front cover (3) using cover bolts until the cover (3) rests against the valve housing (1).
8. Reinstall the Hi-Lo valve (2) with gasket (10) at the rear of lower steering valve housing (1).

Upper Steering Valve (Refer to Fig. 7E.33)

NOTE: *If replacement of housing balls (8 and/or 9) are required, press the new ball 0,25-0,75 [mm] below the surface of housing (1).*

9. Apply LOCTITE PIPE SEALANT to the threads of port plugs (4) and the hose fittings (if removed) and install the plugs and fittings in the top of housing (1).
10. Install the check balls (7) into the housing (1) bores. Coat the check ball body (6) threads with LOCTITE #262 and install into the housing (1). Torque the check ball bodies (6) to 32 [Nm].
11. Install new O-rings (22 and 25) to left and right pilot tubes (21). Install the pilot tubes into the valve housing (1).
12. If removed, install dowel pins (27) in pilot tubes (21)
13. Install the spring washer (14) and inner spool spring (15) over brake spool (13).
14. Install the inner spring stop (16), spring spacer (17), outer spring stop (18) and outer spool spring (24).
15. Install the wiper seal (20) and the inner (23) and outer (22) O-rings to the end cap (19). Reinstall the end cap (19) with seals to the brake spool (13).
16. Reinstall the brake spool (13) with mounted parts into the valve housing (1).
17. Install the front cover (5) to the housing (1). Compress the spring tension and secure the front cover (5) with bolts.
18. Reinstall metering spool sleeves (30) into valve housing (1).
19. Lightly lubricate metering spools (26) and install them into sleeves (30) with the rifle, drilled hole positioned toward the rear of the housing (1).
20. At the end of brake spool (13) install the spool poppet (12) with originally removed shims (11). Install the spool spring (10) toward the rear of the housing (1).
21. Prior to installation of rear cover (2), verify metering spools (26) move freely in spool sleeves (30). Use a new gasket (3) and secure rear cover (2) to housing (1).

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Linkage and Valves (Refer to Fig. 7E.32)

22. Put the balls (3 and 4) into their seats in the lower steering valve (5).
23. Install new gasket (2) between upper (1) and lower steering valve (5). Install six bolts and torque them to 52 [Nm].
24. Install lever bracket (9) to the lower steering valve (5).
25. If removed reinstall bearings (14) and lube fitting (15) into brake lever (11).
26. Reinstall brake lever (11) with shaft (10) and links (12) with pins (13) to the lever bracket (9) and upper steering valve brake spool respectively.

13. INSTALLATION (Refer to Fig. 7E.31)

1. Remove covering from the steering valve opening in the main frame and install steering valve as follows:
   A. Install a new gasket (6, Fig. 7E.32) over studs (8)
   B. Thoroughly clean the mating surfaces of the main frame cover and steering valve. Apply LOCTITE #504 to rear main frame cover in a continuous bead on centerline of valve mounting holes (refer to Fig. 7E.36).
   C. Lower steering valve (6 Fig.7E. 31) onto studs. Secure valve (6) with three nuts (9) and washers on studs and ten bolts (7 and 8).

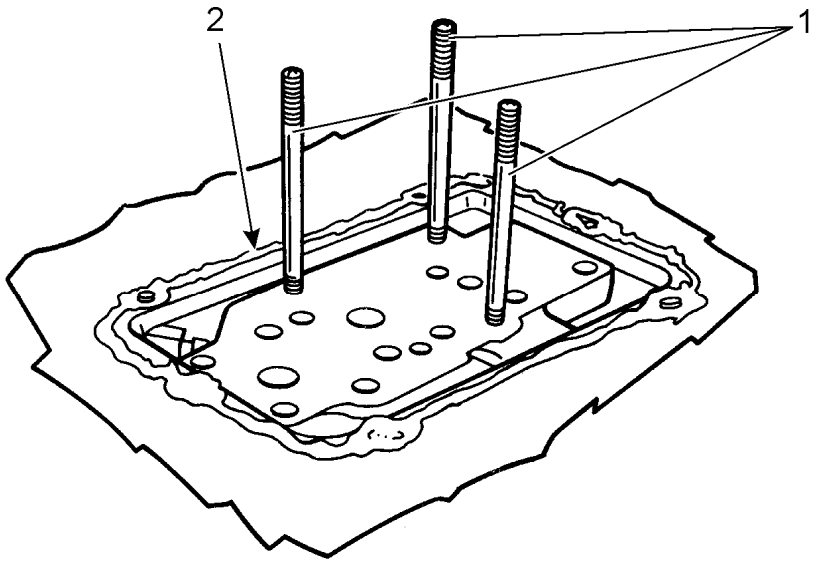

Fig. 7E.36. LOCTITE to Rear Cover

1. Stud 2. LOCTITE #504 Gasket Eliminator

2. Reconnect pressure supply hose (13) and two pressure check hoses (5).
3. Reconnect two pilot hoses (12) and two short pilot hoses (2) to the steering valve (6) and drain hose (10) to the Hi-Lo valve (11).
4. Reconnect clevis with brake control cable to the brake lever (4).
5. Reconnect wiring harnesses (3) to the two solenoids.

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6. Pressure test rear main frame (after specified set-up time of liquid gasket) as follows:
   A. Remove rear main frame breather and introduce air through breather opening. Maximum pressure should not exceed 35 [kPa].
   B. Use a soap solution around edge of rear main frame cover, power take off cover, steering valve and mounting bolts. If bubbles occur, mark area of leakage, remove part and check for proper surface finish and flatness, reseal and recheck. Reinstall rear main frame breather.
7. Perform Steps 19 to 22 as described in Paragraph 8, INSTALLATION in this SECTION.
8. Remove the rear main frame inspection cover. Check if it is free of leaks at hydraulic hoses that connect the steering manifold to the steering drive.

IMPORTANT: *The steering drive bottom manifold can leak in normal operation. The leaks can have the following figures:*

- *steering valve inactive: maximum total leak – 2.5 [l/min],*
- *with one gear shifting/ range change operation or master brake application the leaks can total – 17 [l/min].*

14. STEERING VALVE BRAKE SECTION TEST AND ADJUSTMENT

1. Install a 3000 [kPa] pressure gauge in right or left brake port of diagnostic center. Gauge should have a hose of sufficient length to reach operators compartment. Start machine and run engine at idle speed.
2. Release parking brake lock and place drive train control lever in neutral position. Press foot brake pedal down lightly until a resistance is felt in downward travel of pedal. At this point read pressure gauge, pressure showing on gauge is FEEL POINT pressure. Refer to Paragraph 13, STEERING SYSTEM OIL PRESSURE CHECK in SECTION 7.
3. Add or deduct shims (11, Fig. 7E.33), to increase or reduce feel point pressure. To do this remove valve rear cover (2) and gasket (3). Remove poppet (12), and add or deduct shims (11). Each shim will raise FEEL POINT pressure 35 [kPa]. Reinstall valve rear cover (2), with a new gasket (3). Recheck feel point pressure.

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15. REMOVAL

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lever is in NEUTRAL position, drive train lock lever is in ON position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *Disconnected hydraulic lines must be properly capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Remove all dirt accumulation from the main frame cover. Tag disconnected lines to facilitate faster and correct installation.*

1. Remove the steering valve as described in Paragraph 9, REMOVAL in this Section.
2. Double nut and remove the three studs from manifold.
3. Remove the main frame cover as described in Step 10 to 16 Paragraph 4, REMOVAL, in this Section.
4. Secure the steering manifold to the manifold bracket located on the top left of the steering drive. Disconnect hoses from steering manifold and remove the manifold out of machine.

16. DISASSEMBLY (Refer to Fig. 7E.37)

1. Remove plug (5) with O-ring (4) from housing (1). Remove O-ring from plug.
2. Pull spool (3) and spring (2) from housing (1).

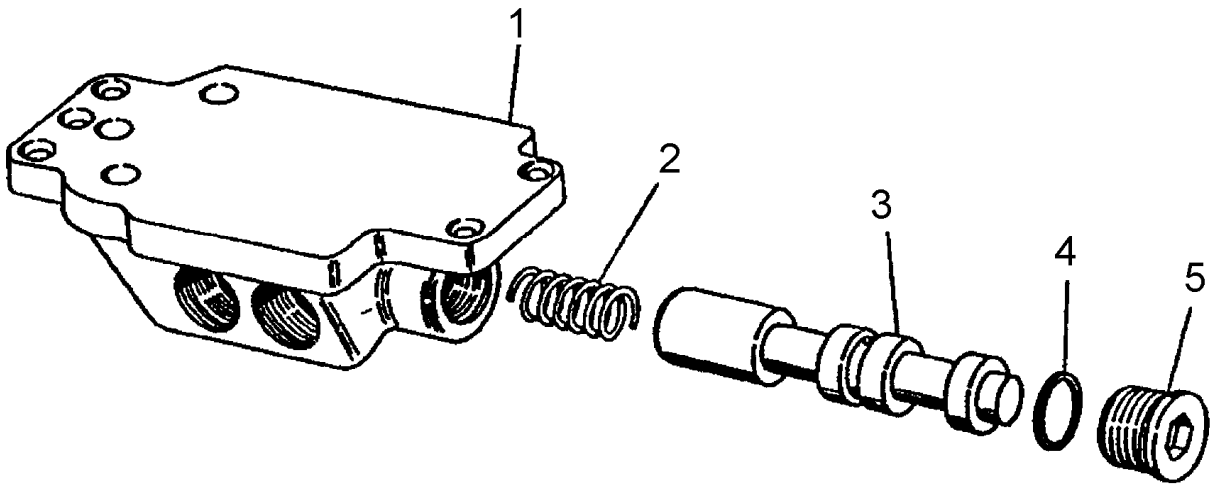

Fig. 7E.37. Exploded View of Steering Manifold

1. Manifold Housing
2. Spool Spring
3. Manifold Spool
4. O-Ring
5. Spool Plug

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17. INSPECTION AND REPAIR

1. It is recommended that new O-ring be installed whenever the steering manifold is disassembled for service.
2. Wash all parts thoroughly in a suitable solvent. Dry thoroughly with compressed air.
3. Inspect machined surfaces of the manifold and spool for scoring, damage or excessive wear.
4. Inspect the condition of the return spring. If damaged or if it does not fall within the specifications shown in Paragraph 3, SPECIFICATIONS, it must be replaced.
5. The rear main frame cover mounting surfaces must be cleaned with proper solvent and inspected for scratches, irregularities and flatness. Maximum out of flat between any two consecutive mounting holes to be 0.25 [mm]. If the cover does not meet this requirement, the cover should be replaced.

18. REASSEMBLY (Refer to Fig. 7E.37)

1. Insert spring (2) into the end of spool (3).
2. Slide spool (3) into the housing (1), spring end first.
3. Assemble new O-ring (4) onto plug (5). Secure into housing (1).

19. INSTALLATION

1. Temporarily secure the steering manifold to the manifold bracket located on the top left of the steering drive. Reconnect the hoses to the junction manifold and then free the manifold from the bracket.
2. Install three studs (1, Fig. 7E.36) to the manifold.

NOTE: *The manifold bracket is only used to correctly position and hold the manifold in place during hose installation.*

3. Perform Steps 13 to 19 as described in Paragraph 8, INSTALLATION in this SECTION.
4. Install the steering valve as described in Paragraph 13, INSTALLATION in this SECTION.

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SECTION 7F

FINAL DRIVE

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FINAL DRIVE

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SERVICE/SPECIAL TOOLS

1. SERVICE/SPECIAL TOOLS

DESCRIPTION	TOOL NUMBER
Output Shaft Retainer Removing Bolt	1/2”-13UNC-2B
Steering Drive Output Shaft Removing Bolt	5/8”-13UNC-2B
Planetary Carrier Housing Puller Bolt	5/8”- 11UNC-2B
Planetary Carrier Housing Lifting Eye Bolt	5/8”- 11UNC-2B
Sprocket Hub Lifting Eye Bolt	7/8”- 9 x 2 3/4”
Thrust Button Technological Bolt	3/8”- 16UNC-2B

GENERAL

2. DESCRIPTION (Refer to Fig.’s 7F.7 and 7F.8)

The final drive assembly consists of a set of spur gears and a planetary assembly on each side at the rear of the machine. Power is transmitted from the steering drive, through the output shaft to the final drive pinion gear (5). The output shaft is splined to the steering drive output shaft sleeve at one end and to the final drive pinion gear (5) at the other end. The final drive pinion gear (5) is meshed with the final drive bull gear (13), which provides the first gear reduction.

The final drive bull gear (13), which is supported in the drive cover (17) by a double-row spherical roller bearing (15), is splined to the sun gear shaft (33). Three planet gears (42) are meshed with the sun gear shaft (33), which is splined to the bull gear (13) and are also meshed with the planetary ring gear (32).

The ring gear hub (29) is splined to the drive cover (17) and is fixed with the planetary ring gear (32), keeping the ring gear stationary during operation. The planet gears provide the second gear reduction. Two tapered roller bearings (39) support each planet gear (42) on its shaft (38). The shafts are housed in the planetary carrier housing (35). The planetary carrier housing (35) and the sprocket drive segments (44) are both attached to the sprocket hub (22) which is supported on the final drive cover (17) by two tapered roller bearings (19 and 27).

As the final drive bull gear and sun gear (5, Fig. 7F.2) revolves, it causes the planet gears (1) to rotate on their shafts. The planet gears (1), being meshed with the stationary ring gear (2), cause the planetary carrier housing (3), sprocket hub and sprocket drive segments (4) to rotate in direction A driving the machine in direction B (Fig. 7F.2).

The final drive assembly has its own lubrication and is sealed against leakage and dirt.

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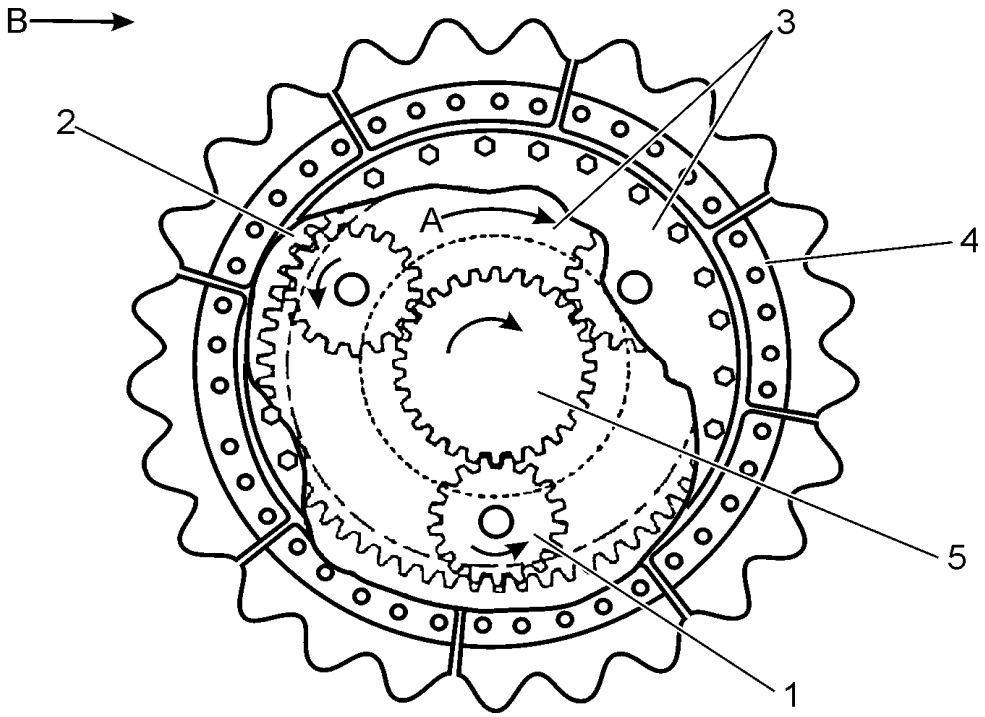

Fig. 7F.2. Planetary Drive

1. Planet Gear
2. Ring Gear
3. Planetary Carrier Housing
4. Sprocket Drive Segment
5. Sun Gear

3. SPECIFICATIONS

Special Bolt and Nut Torque Data

Oil seal shield to sprocket hub mounting bolts	125 [Nm]
Sprocket drive segment to sprocket hub mounting nuts	900 [Nm]
Retainer plate to planetary ring gear mounting bolts	125 [Nm]
Bearing retainer plate to ring gear hub mounting bolts	350 [Nm]
Planetary carrier housing to sprocket hub mounting bolts	730 [Nm]
Pinion gear housing to drive cover mounting bolts	180 [Nm]
Final drive to rear main frame mounting bolts	920 [Nm]
Pinion gear access cover to pinion gear housing mounting bolts	125 [Nm]
Track roller shield mounting bolts	845 [Nm]
Sprocket guard and deflector mounting bolts:	
Upper guard	520 [Nm]
Deflector	845 [Nm]
Lower deflector	845 [Nm]

NOTE: *Except for special torques shown, all bolts and nuts are to be given a standard torque. Refer to the STANDARD TORQUES in SECTION 1, INTRODUCTION.*

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4. SERVICE DIAGNOSIS

COMPLAINT	
PROBABLE CAUSE	**REMEDY**
Final Drive Overheating	
1. Improper or insufficient lubrication	Use proper grade and amount of lubricant. Check for leaks.
2. Bearing seizure	Remove final drive and inspect for damaged bearings.
Noise	
1. Improper, dirty or insufficient lubricant	Use proper grade and amount of clean lubricant.
2. Bearings scored or damaged	Replace bearings.
3. Worn or damaged gears	Inspect all gears and replace as necessary.
Lubricant Leakage	
1. Lubricant leaks at drain plugs or level plug	Tighten plug or replace sealing ring as necessary.
2. Lubricant leaks between final drive cover and rear main frame or between planetary carrier housing and sprocket hub	Clean sealing surfaces and apply liquid gasket.
3. Lubricant leaks between sprocket hub and final drive cover	Replace oil seal.
Excessive Wear on Sprockets	
1. Tracks run too loosely	Adjust the tracks.
2. Tracks worn excessively	Install new tracks.
3. Track frame out of alignment or damaged	Repair or install new track frame.
Final Drive Lubricant Level to High	
1. Oil seal damaged between rear frame and final drive	Change oil seal.
2. Oil seal output shaft surface damaged	Change the shaft and oil seal.

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5. REMOVAL AND INSTALLATION

NOTE: *Track chain replacement should be accompanied by sprocket drive segments replacement. Follow this procedure if you replace sprocket drive segment only.*

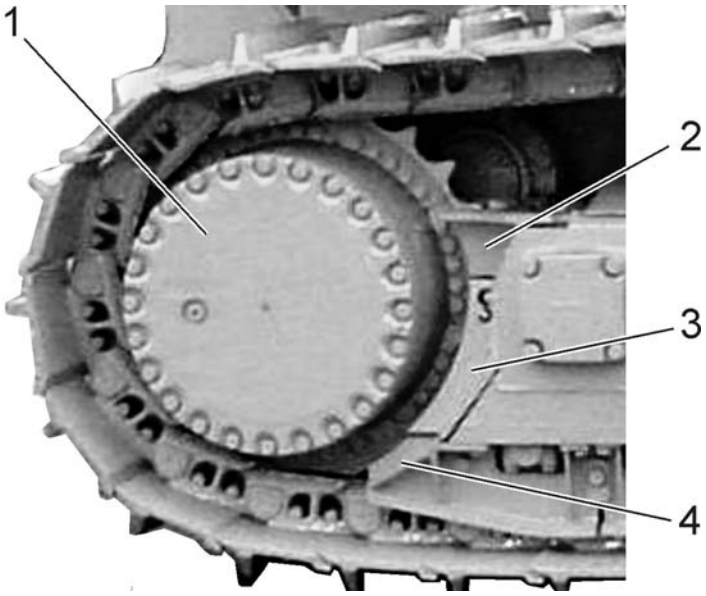

Fig. 7F.3. Sprocket Drive Segment Shields

1. Final Drive
2. Upper Sprocket Guard (L.H. & R.H.)
3. Sprocket Deflector (L.H. & R.H.)
4. Lower Sprocket Deflector (L.H. & R.H.)

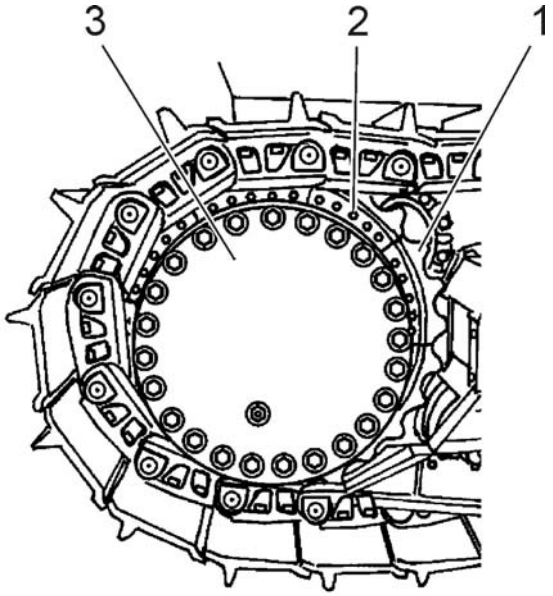

Fig. 7F.4. Removing Sprocket Drive Segments

1. Sprocket Drive Segment
2. Nuts
3. Final Drive

1. Remove both L.H. and R.H. upper sprocket guards (2, Fig. 7F.3). Remove outer sprocket deflector (3) and outer lower sprocket deflector (4).
2. Change the sprocket drive segments, proceed as follows:
   a. Remove the bolts and nuts with washers (2, Fig. 7F.4) securing sprocket drive segment (1) to sprocket hub. Remove sprocket drive segment.
   b. In place of the dismounted segment install a new segment and secure it with nuts and washers. Torque the nuts to 900 [Nm].
   c. Drive the dozer to position another sprocket drive segment in place as shown in Fig. 7F.3. Continue the procedure according to points **"a"** and **"b"**.
   d. Replacement of the other segments is followed as point **c**.
2. Install the outer lower sprocket deflector (4, Fig. 7F.3) and secure with hardware. Torque the bolts to 845 [Nm].
3. Install the outer sprocket deflector (3, Fig. 7F.3) and secure with hardware. Torque the bolts to 845 [Nm].
4. Install the upper sprocket guards (2, Fig. 7F.3) and secure with hardware. Torque the bolts to 520 [Nm].

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6. REMOVAL AND INSTALLATION (Refer to Fig. 7F.7 and 7F.8)

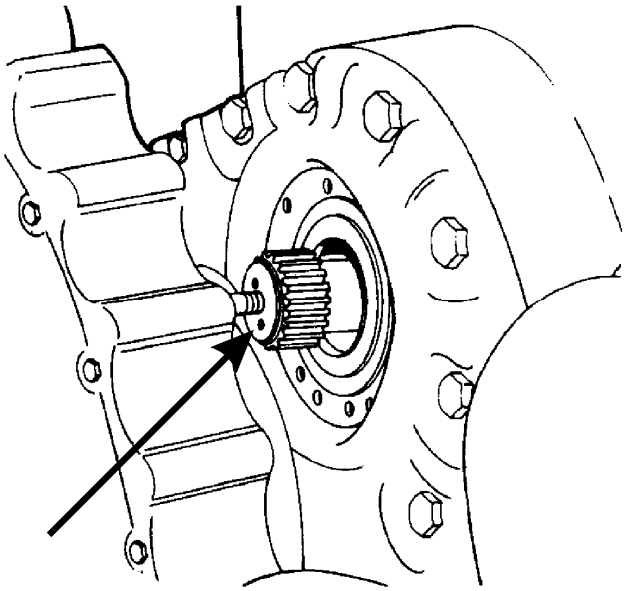

Fig. 7F.5. Pulling Output Shaft

Removal

1. Remove cover (11) with shims (10) from cover (17). Keep shims (10) with cover (11).
2. Remove retaining ring (2) that secures shaft retainer (3) in the pinion gear (5). Thread a bolt 1/2”-13UNC-2B in shaft retainer (3) and pull it out of pinion gear (5). Remove O-ring (4) from retainer (3). Thread a bolt 5/8”-11UNC-2B in the steering drive output shaft and pull it free of final drive as shown in Fig. 7F.5.

Installation

3. With a bolt 5/8”-11UNC-2B installed in the end of the steering drive output shaft, slide the shaft in so it splines first with the final drive pinion gear and then with the steering drive. Remove the bolt.

NOTE: *If the shaft will not spline with the steering drive, slightly rotate the sprocket.*

4. With a bolt 1/2”-13UNC-2B threaded in shaft retainer (3), install the shaft retainer with new O-ring (4) in pinion gear (5). Remove the bolt and install retaining ring (2).
5. Reinstall cover (11) with shims (10). Use the LOCTITE #120 under and above shims (10). Torque bolts with washer to 125 [Nm].

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7. REMOVAL (Refer to Fig.'s 7F.7 and 7F.8)

1. Move machine until drain plug (25) in hub (22) is in its bottom position. Drain final drive system through this plug and final drive compartment drain plug in bottom of side rear main frame.
2. Remove track chain, refer to SECTION 15. It is not necessary to remove track chain from under machine.
3. Remove sprocket guards and deflectors (2, 3 and 4, Fig. 7F.3).
4. Jack up rear of unit enough for sprocket to clear track chain. Block under main frame.

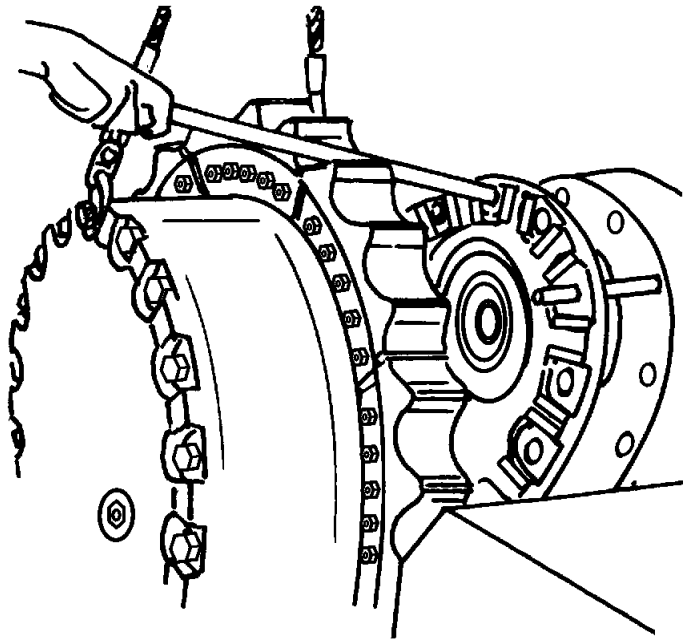

Fig. 7F.6. Removing Final Drive

5. Loosen the top final drive mounting bolt and the top sprocket drive segment mounting bolt. Attach a hoist at these two bolts as shown in Fig. 7F.6. Remove one of the final drive cover mounting bolts and insert a brass drift in the hole as shown in Fig. 7F.6. The drift will support the cover when it is first freed from the main frame.
6. Remove the remaining final drive cover mounting bolts and free the cover from the main frame. Insert a pry bar as shown in Fig. 7F.6 to hold the cover up as it clears the drift. Pull the final drive assembly away from the main frame. Remove the pry bar and let cover (17) swing down slowly.

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FINAL DRIVE ASSEMBLY

8. DISASSEMBLY (Refer to Fig.'s 7F.7 and 7F.8)

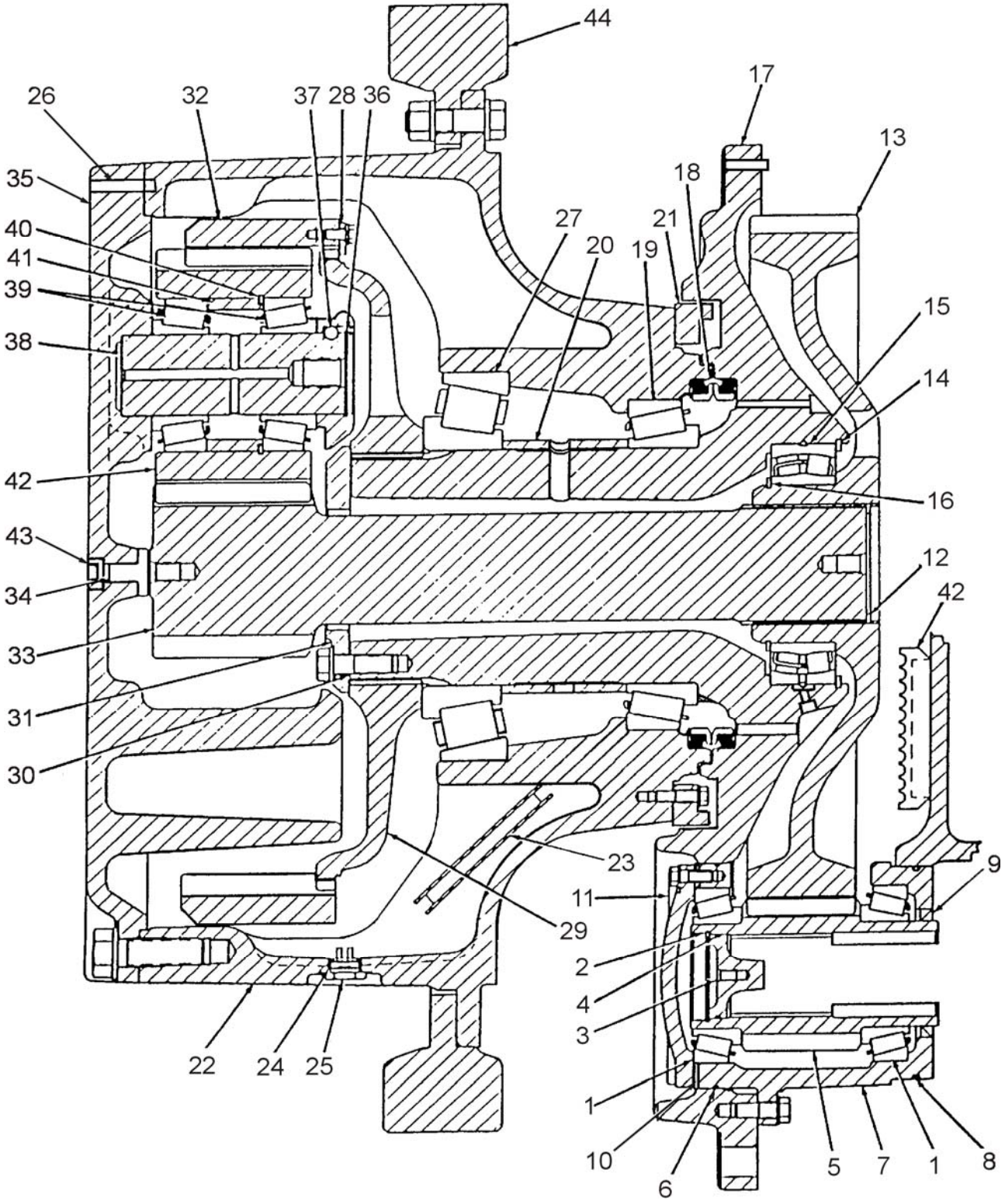

Fig. 7F.7. Cross Section View of Final Drive

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FINAL DRIVE

FINAL DRIVE ASSEMBLY

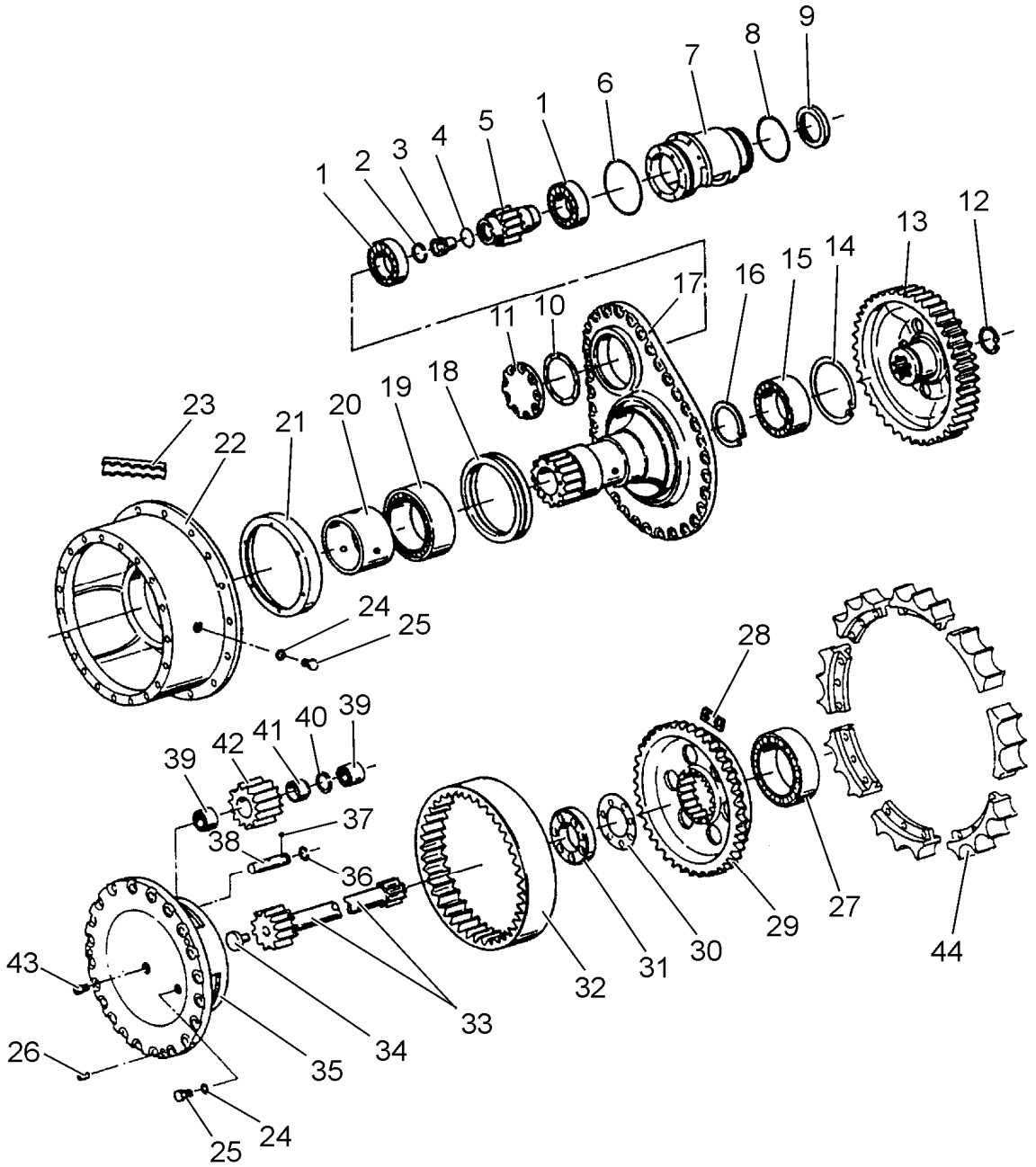

Fig. 7F.8. Exploded View of Final Drive

1. Tapered Roller Bearing
2. Retaining Ring
3. Output Shaft Retainer
4. O-Ring
5. Pinion Gear
6. O-Ring
7. Pinion Gear Bearing Housing
8. O-Ring
9. Oil Seal
10. Shim
11. Pinion Gear Access Cover
12. Retaining Ring
13. Bull Gear
14. Retaining Ring
15. Bull Gear Bearing
16. Retaining Ring
17. Drive Cover
18. Oil Seal Kit
19. Tapered Roller Bearing
20. Bearing Spacer
21. Oil Seal Shield
22. Sprocket Hub
23. Bar Magnet
24. Plug Gasket
25. Drain or Filler Plug
26. Cork Plug
27. Tapered Roller Bearing
28. Retainer Plate
29. Ring Gear Hub
30. Shim
31. Bearing Retainer Plate
32. Planetary Ring Gear
33. Sun Gear Shaft
34. Thrust Button
35. Planetary Carrier Housing
36. Retaining Ring
37. Steel Ball
38. Planetary Gear Shaft
39. Tapered Roller Bearing
40. Retaining Ring
41. Bearing Spacer
42. Planetary Gear
43. Port Plug
44. Sprocket Drive Segment

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FINAL DRIVE ASSEMBLY

1. Set final drive assembly down on housing (35) so that gear (13) is up.
2. Rotate bull gear (13) so retaining ring (14) hooks are showing. Through hole in gear remove ring up out of its groove.
3. Remove bolts and washers securing housing (7) to cover (17). Attach a hoist to bull gear hub (Fig. 7F.9) and lift slowly until gear (13) contacts housing (7). Install two mounting bolts (11A, Fig. 7F.16) of cover (11) as the jack screws in holes provided in housing (7) and free housing from cover (17). Remove housing (7).

NOTE: *If disassembly of pinion gear assembly is necessary, refer to PINION GEAR in this Section.*

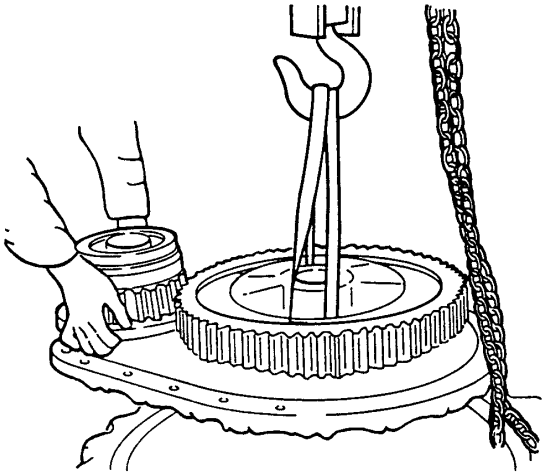

Fig. 7F.9. Pinion Gear Assembly

4. Lift drive gear assembly (13, 14, 16, 12 and 15) from shaft (33). Remove retaining rings (12 and 16), bearing (15) and retaining ring (14) from gear (13). It is impossible to remove bearing (15) without damaging it.
5. Turn assembly over and support it on cover (17). Remove bolts securing housing (35) to hub (22). Remove protective corks (26) from three puller holes and install puller bolts 5/8”-11UNC-2B. Loose housing from hub and remove puller bolts. Install lifting eyebolts 5/8”-11UNC-2B (Fig. 7F.10) in puller holes, attach a hoist and remove housing.

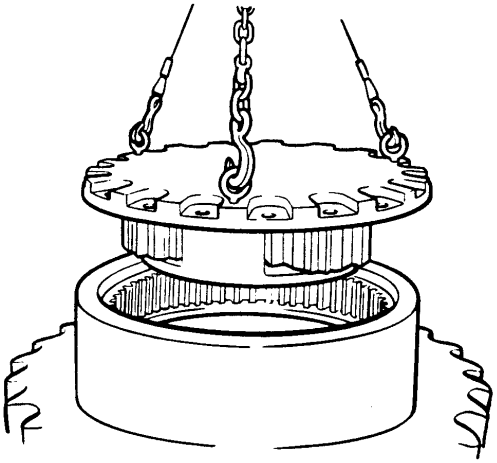

Fig. 7F.10. Planetary Carrier Housing

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FINAL DRIVE ASSEMBLY

NOTE: *If disassembly of planetary is necessary, refer to PLANETARY CARRIER HOUSING in this Section.*

6. Install an eyebolt 5/8”-11UNC-2B in the end of shaft (33) and lift shaft straight up. Remove bearing retainer plate (31) and shims (30). Keep shims together for proper installation.

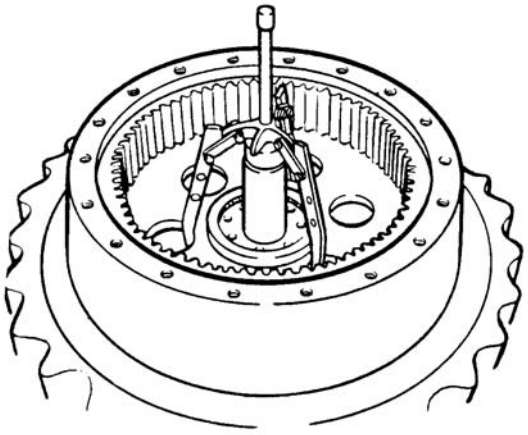

Fig. 7F.11. Ring Gear Removing

7. Using a puller and driver as shown in Fig. 7F.11, remove ring gear assembly (29 and 32) from cover (17). Heat ring gear hub assembly (29) to 260 [°C] with a torch if necessary. Separate ring gear (32) from hub (29) by removing retainer plates (28).
8. Install four eyebolts 7/8”-9x2 3/4” 90 [°] apart in hub (22) as shown in Fig. 7F.12. and attach a hoist to two opposite eyebolts. Install a bar in two remaining eyebolts and position a hydraulic ram under bar. Use ram to free bearing cone (27) from shaft of cover (17) and lift hub (22) off with hoist. If replacement is necessary, remove bearing cups (19 and 27), and sprocket drive segments (44) from hub (22). Remove oil seal (18).

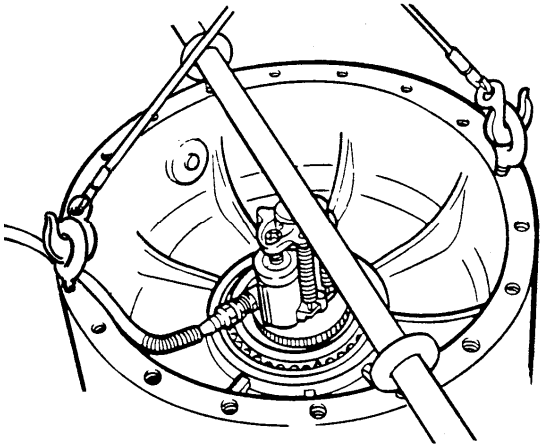

Fig. 7F.12. Sprocket Hub

9. Lift spacer (20) from cover (17). Bearing cone (19) should not be removed from cover (17) unless replacement is necessary. Shield (21) need not be removed unless replacement or cleaning is necessary.

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9. INSPECTION AND REPAIR (Refer to Fig.'s 7F.7 and 7F.8)

1. It is recommended that new O-rings and oil seals be installed whenever the final drive is disassembled for service.
2. Make a preliminary inspection of all parts before cleaning to detect discrepancies which may not show up once the parts are cleaned. Examine the oil for metal particles, dirt and other foreign material. Check for foreign material in the bearings which will cause excessive wear.
3. Wash all parts thoroughly in a suitable solvent and dry thoroughly with compressed air or a clean cloth.

NOTE: *Do not spin bearings with compressed air.*

4. Inspect bearings for scores, cracks and wear. Replace if necessary. Reusable bearings should be soaked in clean oil and wrapped with clean paper until ready for reassembly.
5. Using coarse paper, a file or a hand grinder, remove any corrosion or hardened foreign material that may exist on the seal bore surfaces of hub (22) and cover (17). Do this carefully to avoid changing the dimensions of the bore.
6. Thoroughly scrape the final drive mating surfaces clean. Be careful not to scratch these finished surfaces or sealing may become ineffective.
7. Inspect the ring gear, ring gear hub, sun gear and planetary gear teeth for damage or wear. Inspect the ring gear hub and sun gear splines for excessive wear or damage. Slight burrs can be smoothed down with a stone.
8. It is recommended that new oil seal kit (18) be installed whenever the final drive is disassembled. Refer to SEAL INSPECTION under METAL TYPE FACE SEALS in SECTION 14, SUSPENSION.

10. REASSEMBLY (Refer to Fig.'s 7F.7 and 7F.8)

1. Support cover (17), flange down. If sprocket hub bearings were replaced, heat inner bearing cone (19) to 150 [°C] and install on cover until it is solid against shoulder with small diameter of taper up. To assure cone is against shoulder, make a final press after cone has reasonably cooled down. Inner bearing cone (27) will be installed later. Install spacer (20) on cover (17).
2. Install oil seal shield (21) on sprocket hub (22) and torque bolts to 125 [Nm]. If removed, press bearing cups (19 and 27) into hub. If removed, install sprocket drive segments (44) on hub and torque nuts to 900 [Nm]. Coat metal rings of oil seal (18) with a light film of oil and reinstall them on drive cover (17) and sprocket hub (22). Refer to SEAL INSTALLATION under METAL TYPE FACE SEALS in SECTION 14, SUSPENSION. If removed install plug (25) and gasket (24).

NOTE: *Do not at any time handle metal face type oil seal with greasy, oily or dirty hands.*

NOTE: *Before installing oil seal assembly, be sure seal contacting surfaces of drive cover and sprocket hub are clean, also that rubber rings of seal assembly are correctly positioned on metal rings. Refer to instructions furnished with oil seal.*

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3. With aid of a hoist, position sprocket hub assembly on cover (17) being sure bearing cup (19) seats properly on cone. Check if hub spins freely. Install ring gear (32) on hub (29) and secure with retainers (28) and bolts. Torque bolts to 125 [Nm]. Heat bearing cone (27) to 150 [°C] and install bearing cone (27) on shaft of cover (17) until it bottoms against spacer. Heat ring gear hub assembly to max. 260 [°C]. Install heated ring gear hub assembly on shaft splines of cover (17) until it bottoms on bearing cone (27). Install retainer plate (31) and the same thickness of shims (30) which were removed and torque to 120 [Nm]. After parts cooled release torque and retorque 350 [Nm].

NOTE: *If hub (29), bearings (19 and 27), hub (22) or spacer (20) were replaced the following readjustment procedure must be done using retainer plate (31):*

Install retainer plate (31, Fig. 7F.13) without shims (30). Torque five old bolts (31A, Fig. 7F.13) to 230 [Nm] while rotating hub (22) to assure proper seating of its bearings. Release torque and remove retainer plate, after all parts have cooled down.

4. For proper shimming do as follows:

   Put symmetrical 5 pcs. of virgin leads on the drive cover (17). Install retainer plate (31, Fig. 7F.13) and retorque five old bolts (31A, Fig. 7F.13) equally spaced to 120 [Nm]. Remove the retainer plate (31) and determine the average thickness of virgin leads. Subtract 0.076 to 0,1 [mm] from this thickness and assembly a shim pack (30) of this size. Install shims (30) and retainer plate (31) as shown in Fig. 7F.14. Torque the ten new bolts to 350 [Nm].

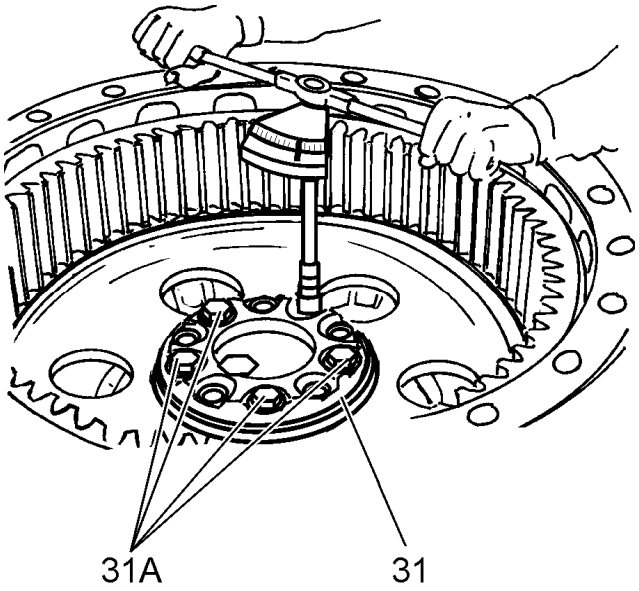

Fig. 7F.13. Retainer Plate Installation

31. Retainer Plate 31A. Bolt

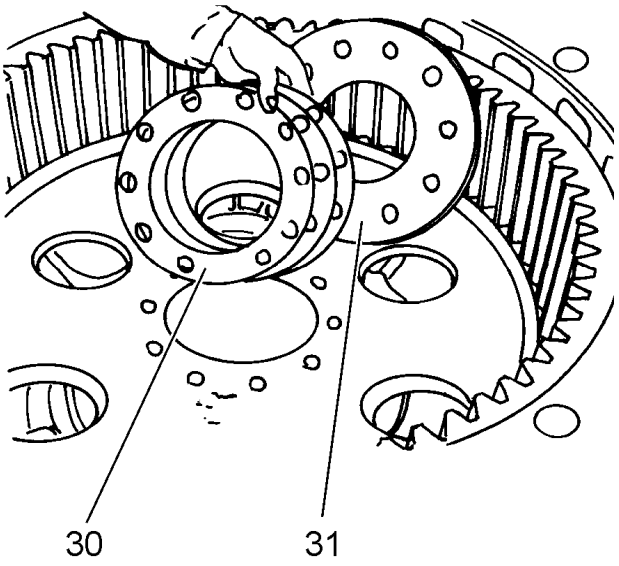

Fig. 7F.14. Retainer Plate and Shims Installation

30. Shim 31. Retainer Plate

5. Install shaft (33) through cover (17). Install the thrust button (34) in housing (35). Apply a technological bolt 3/8”-16UNC-2B to secure thrust button (34) in housing (35). Apply LOCTITE #120 to matching surface of hub (22). Attach a hoist to housing (35) and lower housing on hub (22) being sure gears (42) mesh with sun gear and ring gear and check oil level plug is placed 90[°] left from drain plug. Secure housing (35) to hub (22) and torque bolts to 730 [Nm]. Install protective corks (26) in puller holes. Remove the technological bolt and install plug (43).

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FINAL DRIVE ASSEMBLY

6. Turn final drive over and set it on housing (35). Install retaining ring (12) into gear (13). Place retaining ring (14) over the spindle on bull gear (13) but don't install it. Heat bearing (15) to 80 - 90 [°C] and install on spindle of bull gear (13). Install retaining ring (16).
7. Attach a hoist to gear (13) and partly lower it onto shaft (33).

NOTE: *If pinion gear was disassembled, refer for reassembling to PINION GEAR in this SECTION*

8. Position pinion gear housing assembly (7) with new O-ring (8) on cover (17) and tap it down with a soft faced hammer. Lower gear (13) and using a drift on outer race of bearing (15), tap bearing evenly in bore of cover (17). Secure housing (7) to cover (17) and torque bolts to 180 [Nm].
9. Install retaining ring (14) into groove of sprocket drive cover (17) through holes in gear. Install the output shaft into pinion gear (5)

11. INSTALLATION (Refer to Fig.'s 7F.7 and 7F.8)

1. Be sure the sealing surfaces of the final drive cover and the machine frame are clean of the old gasket and apply LOCTITE #120 to both mounting surfaces.
2. Attach a hoist to the final drive as shown in Fig. 7F.6. Rotate cover (17) up into position and hold with a pry bar. Position the steering unit output shaft in gear (5). Move the final drive into position using the drift as a guide as shown in Fig. 7F.6. Remove the pry bar and push the final drive in all the way. If the shaft will not spline with the final drive, slightly rotate the sprocket. Install the final mounting bolts and remove the drift. Torque the bolts to 920 [Nm].
3. Remove the hoist and install the bolts removed for attaching the hoist.
4. Remove the blocking from under the rear frame and slowly lower the unit until the sprocket drive segments rests on the track chain. Remove the jack. Install the track chain, refer to SECTION 15.
5. Install the outer lower sprocket deflector (4, Fig. 7F.3) and secure with hardware. Torque the bolts to 845 [Nm].
6. Install the outer sprocket deflector (3, Fig. 7F.3) and secure with hardware. Torque the bolts to 845 [Nm].
7. Install the upper sprocket guards (2, Fig. 7F.3) and secure with hardware. Torque the bolts to 520 [Nm].
8. Be sure the drain plug in the sprocket hub and the frame are installed and tight. Fill the final drive as described in the OPERATOR'S MANUAL.
9. Check final drive for operation and leakage.

PLANETARY CARRIER HOUSING

12. REMOVAL (Refer to Fig.'s 7F.7 and 7F.8)

1. Drain final drive system through drain plug (25) in hub (22) and final drive compartment drain plug in bottom of side rear main frame.
2. Remove two bolts securing planet carrier housing (35) to hub (22). Attach a hoist (A) at these two bolts as shown in Fig. 7F.15. Remove the remaining planet carrier housing mounting bolts and free the housing (35) from the hub (22). Remove planet carrier housing (35) from final drive. Remove thrust button (34) from housing (35).

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PLANETARY CARRIER HOUSING

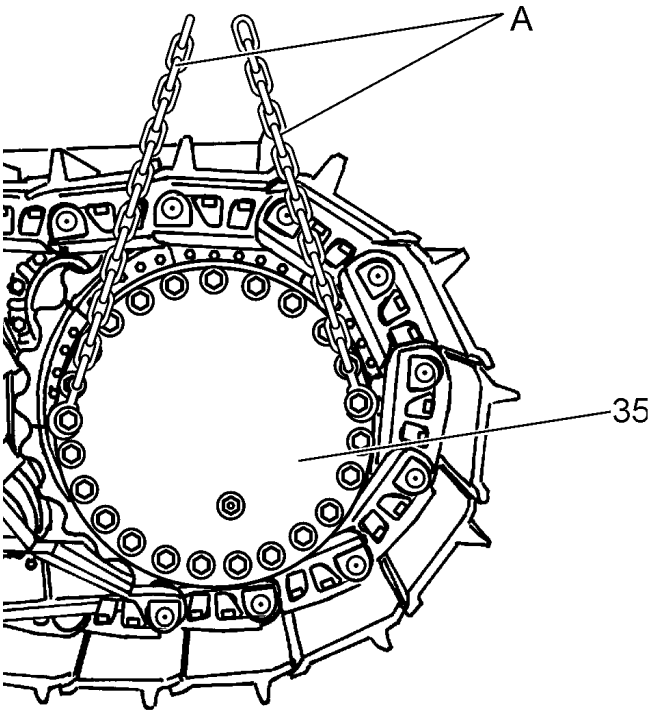

Fig. 7F.15. Planet Carrier Housing Removing

35. Planet Carrier Housing A. Hoist

13. DISASSEMBLY (Refer to Fig.'s 7F.7 and 7F.8)

1. Place assembly on a bench planet gear side up. Remove retaining ring (36) and install an eyebolt 1"-8UNC in the end of shaft (38) and pull it out of the carrier housing (35).
2. Slide gear (42), bearings (39) and spacer (41) from carrier housing (35). If necessary remove retaining ring (40). Use care not to loose steel ball (37). Disassemble remaining two planet gear assemblies in same manner. Remove plug (25) and discard gasket (24). Remove plug (43).

14. INSPECTION AND REPAIR

1. Make a preliminary inspection of all parts before cleaning to detect discrepancies which may not show up once the parts are cleaned. Examine the oil for metal particles, dirt and other foreign material. Check for foreign material in the bearings which will cause excessive wear.
2. Wash all parts thoroughly in a suitable solvent. Dry thoroughly with compressed air or a clean cloth.

NOTE: *Do not spin dry with compressed air.*

3. Inspect bearings for excessive wear or damage and replace if necessary. Reusable bearings should be soaked in clean oil and wrapped with clean paper until ready for reassembly.
4. Thoroughly scrape the final drive mating surfaces clean. Be careful not to scratch these finished surfaces or sealing may become ineffective.
5. Inspect the planet gear shaft and planet gear bore for wear and replace if necessary.

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PLANETARY CARRIER HOUSING

15. REASSEMBLY (Refer to Fig.'s 7F.7 and 7F.8)

1. Slide bearing spacer (41) and bearings (39), one from each side, into planet gear. Verify spacer (41) is seated over retaining ring (40) in gear.
2. Assemble planet gear assembly into carrier housing (35). Align gear assembly with shaft hole in carrier housing and install shaft (38) with ball (37). Secure shaft with retaining ring (36). Assemble remaining two planet gear assemblies in same manner.
3. Install the plug (25) with new gasket (24) into the carrier housing (35).

16. INSTALLATION (Refer to Fig.'s 7F.7 and 7F.8)

1. Install the thrust button (34) in planet carrier housing (35). Apply a technological bolt 3/8"-16UNC-2B to secure thrust button (34) in planet carrier housing (35). Apply LOCTITE #120 to matching surface of hub (22). Attach a hoist (A) to planet carrier housing (35) as shown in Fig. 7F.15 and position the housing into hub (22). Being sure gears (42) mesh with sun gear and ring gear.
2. Secure housing (35) to hub (22) with hardware previously removed. Torque bolts to 730 [Nm]. Remove the technological bolt and install plug (43).
3. Fill the final drive as described in the OPERATOR'S MANUAL.

PINION GEAR

17. REMOVAL (Refer to Fig.'s 7F.7 and 7F.8)

1. Remove final drive as described in Paragraph 7, REMOVAL under FINAL DRIVE in this Section. Set final drive down on housing (35) so that gear (13) is up.
2. Rotate bull gear (13) so retaining ring (14) hooks are showing. Through hole in gear remove ring up out of its groove.
3. Remove bolts and washers securing housing (7) to cover (17). Attach a hoist to bull gear hub as shown in Fig. 7F.9. and lift slowly until gear (13) contacts housing (7). Install two mounting bolts (11A, Fig. 7F.16) of cover (11) as the jack screws in holes provided in housing (7) and free housing from cover (17). Remove housing as shown in Fig. 7F.9.

18. DISASSEMBLY (Refer to Fig.'s 7F.7 and 7F.8)

1. Place housing (7) in a press so that oil seal (9) is up. Place a suitable driver on end of gear (5) and press gear with left bearing cone (1) and right bearing cone (1) out of housing (7). Bearing cones and cups (1) need not be removed unless replacement is necessary. Remove oil seal (9) and O-rings (6 and 8) from housing (7).

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PINION GEAR

19. INSPECTION AND REPAIR

1. It is recommended that new O-rings and oil seal be installed whenever the final drive is disassembled for service.
2. Make a preliminary inspection of all parts before cleaning to detect discrepancies, which may not show up once the parts are cleaned. Examine the oil for metal particles, dirt and other foreign material. Check for foreign material in the bearings which will cause excessive wear.
3. Wash all parts thoroughly in a suitable solvent. Dry thoroughly with compressed air or a clean cloth.

NOTE: *Do not spin dry with compressed air.*

4. Inspect bearings for excessive wear or damage and replace if necessary. Reusable bearings should be soaked in clean oil and wrapped with clean paper until ready for reassembly.
5. Inspect the pinion splines and gear teeth for damage. Slight burrs can be smoothed down with a stone. If the pinion gear teeth are worn, the pinion and possibly the drive gear will have to be replaced.
6. Thoroughly scrape the final drive mating surfaces clean. Be careful not to scratch these finished surfaces because sealing may become ineffective.

20. REASSEMBLY (Refer to Fig.'s 7F.7 and 7F.8)

1. If bearings (1) were replaced, install bearing cones (1) on gear (5) until they are solid against shoulder.

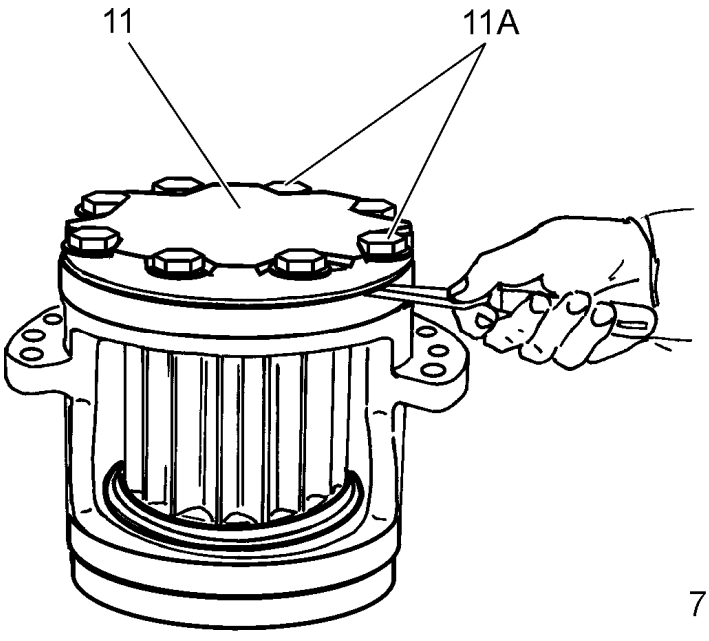

Fig. 7F.16. Gap Measuring

11. Cover
11A. Mounting Bolt

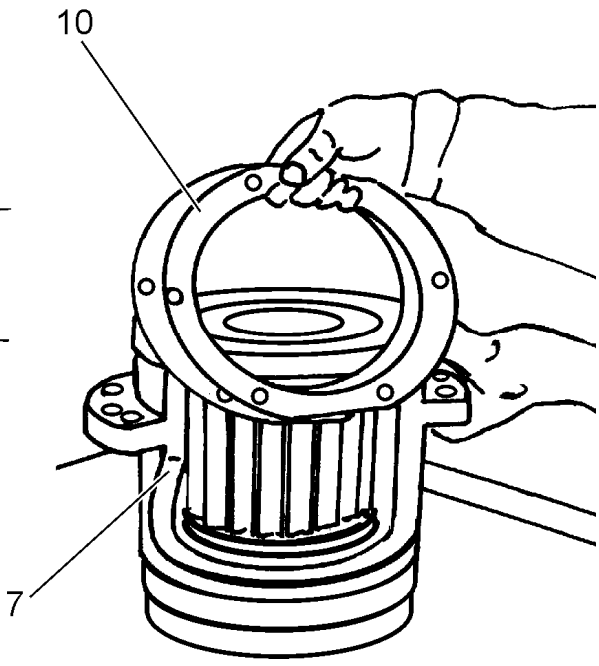

Fig. 7F.17. Shims Installation

7. Pinion Gear Housing
10. Shim

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2. Press right cup (1) into housing (7) against the shoulder. Insert pinion gear (5) into housing (7). Install gear until cone (1) seats in cup. Press left cup (1) into housing (7). Left cup (1) must be installed in housing in such a way that its face protrudes about 4 [mm] of housing mounting face. Use cover (11, Fig. 7F.16) and four bolts (11A) as a driver.
3. Measure the gap under cover (11) in four places as shown in Fig. 7F.16. Assembly a shim pack (10, Fig. 7F.17) of averaging reading of this gap ± 0,025 [mm] and install them under cup. Torque eight bolts (11A) with washer to 125 [Nm].
4. Preload of bearings can be checked by wrapping a string around pinion gear teeth and using a spring scale. Rolling gear pull should not exceed 25 to 40 [N] rolling pull.
5. If it is found that the rolling gear pull with spring scale exceeds maximum, an assembly error (cocking) of bearing cones and/or cups may have been made. The complete assembly should then be inspected for any misassembly of parts. Unscrew bolts.
6. Apply LOCTITE #120 under and above shims (10). Torque eight bolts with washer to 125 [Nm].
7. Install oil seal (9) and O-rings (6 and 8) on housing (7).

21. INSTALLATION (Refer to Fig.'s 7F.7 and 7F.8)

1. Attach a hoist to bull gear (13) and partly lift it. Position housing (7) on cover (17) and tap it down with a soft faced hammer. Lower bull gear and using a drift on the outer race of bearing (15) tap bearing evenly in the bore of cover (17). Secure housing (7) to cover (17) with the hardware previously removed and torque bolts to 180 [Nm].
2. Install retaining ring (14) into groove of final drive cover (17) through holes in gear.
3. Install the final drive as described in Paragraph 11, INSTALLATION, under FINAL DRIVE, in this SECTION.

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SECTION 8

ELECTRICAL

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ELECTRICAL

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SERVICE /SPECIAL TOOLS

1. SERVICE /SPECIAL TOOLS

DESCRIPTION	TOOL NUMBER
Volt/Ammeter	Locally purchased
Electronic Battery Tester	Locally purchased

GENERAL

2. DESCRIPTION

A 24 [V] negatively grounded electrical system is used, consisting of a tractor circuit and cab circuit.
Four 12 [V] batteries connected in series - parallel supply the 24 [V].
A master switch located on the positive side of the electrical circuit, is used to cut out the electrical power.
The lights are sealed type and are controlled by the light switches on the cab panel.
The circuits are protected by automatic reset circuit breakers. In the event of a short circuit or ground, the circuit breaker will open before damage occurs and will continue to open and close until the trouble clears or is corrected. The circuit breaker will then return and stay in its normal closed position. As a guide for identifying the various electrical units and for tracing the electrical cables and connections, refer to the WIRING DIAGRAMS in this SECTION.

***IMPORTANT**: Never disconnect the alternator, master switch or batteries while the alternator is in operation.*

Surfaces under all terminals must be clean, and good electrical connections must be established after assembly. All clips must grip cables tightly to prevent vibration and rapid cable wear.

CAUTION! When installing batteries, be sure to connect the ground cable to the negative (-) terminal.
Before working on any part of the electrical system turn the master switch in the "OFF" position and take key out from both the master switch and starting switch to prevent accidental starting.

WIRING DIAGRAM

3. ELECTRICAL SYSTEM (Fig. 8.1)

Electrical tractor system consists of starting circuit, charging circuit, fan circuit, drive train control circuit, equipment circuit, warning lamps circuit and accessories circuit.

a. Starting Circuit

The electric system master switch (71) located in the positive lead of batteries (64) must be in the “ON” position to complete the battery circuit for starting power. When the starting key is turned in the starting switch (39) to “START”, current flows from battery to starting switch (39) and by one of circuit breaker (40) 10 [A] to start-up lock switch (13). If the drive train lock lever is in “ON” (locked) position, current flows by start-up lock switch (13) closed contacts to solenoid of starting magnetic switch (60).

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WIRING DIAGRAM

The cranking motor (25) solenoid is actuated by closed contacts of magnetic starting switch (60) and it draws the cranking motor spool in, engaging the drive gear for the starter and connecting the battery cable to motor for cranking. Both the magnetic switch and starter solenoid are spring tensioned to remain in the "disengaged" position. When the starting switch (39) is released, both units are released, breaking the circuit.

IMPORTANT: *When the booster battery is used for engine startup, electric system master switch must be in the ON position. Alternator can be damaged when the engine startup takes place with the master switch in the OFF position.*

b. Charging Circuit

The charging circuit contains the alternator (24) and the batteries (64). Once the engine is running, the alternator output is used to supply the power demands as well as recharge the batteries. An integral regulator is located in alternator itself. The integral regulator senses the entire system draw and compensates by increasing or decreasing the voltage output.

c. Fan Circuit

Three temperature sensors supply engine electronic control module (ECM) with control signals, which, in turn, control fan pump solenoid (51).The fan speed will ramp up or down depending on the systems' temperature.
In a situation when the drive train oil temperature is below 92 [°C], the engine coolant temperature is below 85 [°C] and engine inlet air temperature is below 45 [°C] the fan is working at minimum speed below 400 [RPM]. At the same time the fan pump solenoid (51) is supplied from electronic control module ECM (8) by the max signal. When the temperature in drive train oil is raising the resistance of sensor (50) is decreasing and signal from ECM is dropping. The fan starts to work at higher speed. Engine air inlet temperature sensor and engine cooling temperature sensor (refer to Electrical Diagram at Troubleshooting and Repair Manual QSK Engine Fuel System) are connected to ECM (8) too. When air inlet temperature or cooling temperature rises the fan starts to work at higher speed too. The fan will work at max speed ~1560 RPM when drive train oil temperature reach 115 [°C] or engine inlet air temperature reach 61 [°C] or engine cooling temperature reach 95 [°C]. Authorized Cummins Engine Service is provided with a program for checking the signals sourced by the following sensors: both the engine intake air and coolant temperatures as well as the fan pump coil power supply signal.

d. Drive Train Control Circuit

With the engine started, the machine remains stationary as drive train lock is actuated. The drive train lock lever shifted upwards (unlocked) will cause drive train system lock switch (101) to activate, and, as a result, the drive train system lock solenoid valve will energize. Consequently, pressurized oil will enter the drive train control valve. The following features are available with the drive train control lever (9) which incorporates both the (UP, DN) buttons and (LH, RH) switches.

1. Gears upshift and downshift. To do it, press the UP or DN button. Once the UP button has been pressed, the gear will be upshifted that 2nd or 3rd gear will be engaged. The DN button pressed will downshift the gears to a lower gear in a sequence. The first gear is a default gear after the engine start-up. The solenoid valves (98 and 99) will be deenergized at that point. The second gear will be engaged when the solenoid valve (99) is reenergized; while the third gear requires the solenoid valve (98) to get reenergized. The drive train electronic controller (10) is in charge of solenoid valves being reenergized or deenergized. The time duration the control button is depressed has no bearing on gear shifting.

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2. The LH and RH speed range switches make possible for machine speed range to be chosen (low or high). HI-LO range solenoid valves (96 and 97) will get reenergized thru the controller (10) when both speed range switches are shifted in HI position. Shifting both speed range switches in LO position will cause the both solenoid valves to revert to their neutral position (deenergized) with the resultant LO range to be activated.
3. The RH speed range switch shifted to its upper (HI) position and the LH switch in its lower (LO) position will make possible to do a gradual turn to the left. In that case the RH solenoid valve (96) thru controller (10) will get reenergized while the LH solenoid valve (97) will get deenergized. With the LH speed range switch shifted to its upper (HI) position and the RH switch in its lower (LO) position the right gradual turn will be made with the LH solenoid valve (97) reenergized and RH solenoid valve (96) deenergized. The machine will make a gradual turn so long as one of the speed range switches gets reactivated. Then the machine will revert to straight travel in a range it was engaged in prior to the gradual turn activation.
4. The travel direction will be hydraulically engaged with the lever shifted forward or rearward. If rearward is engaged at the same time pressure switch (61) will get energized with a signal being passed to the backup alarm (93).
   The display (56) powered from the controller (10) will indicate both the gear and range engaged.

e. Equipment Circuit

The machine is always equipped with blade floating position electromagnetic latch (31) located at the blade control valve. The electromagnetic latch is energized by the starting switch (39) in position ON from accessory supply magnetic switch (59).
The machine can also be equipped with dozer equipment provided with a blade tilt and pitch. In this case the blade control lever is provided with a button (29) and solenoid valve (27) is mounted. If the button (29) is depressed this will cause the solenoid (51) to energize by relay (4). It is not possible to activate both blade pitch and tilt at the same time.

f. Warning Lamps Circuit

The warning lamps are activated through suitable switches, which are as follows: lamp (A) is activated through switch (33 and/or 34), lamp (C) through switch (14), lamp (D) through switch (65), lamp (E) through switch (19), lamp (F) through sensors (3) and relay (5). At the same time as lamps (E and/or 47) come on, the buzzer (48) will sound. The lamps are checked through the starting switch (39) and diodes assembly (53).

g. ECM Circuit

Engine and fan electronic control module (8) (ECM) together with components wired to the module and designated with a dashed line are outlined in Troubleshooting and Repair Manual QSK Fuel System.

h. Accessories Circuit

This circuit supplies power to the lights, fuel solenoid valve, ether solenoid valve, instruments and any accessory items on the machine. Automatic reset circuit breakers are used to protect them.

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WIRING DIAGRAM

Legend for machine wiring diagram (Fig. 8.1)(earlier version):

1. Front Dozer Headlamps at Blade Cylinders
2. Horn
3. Coolant Level Sensors
4. Blade Dual Tilt / Pitch Relay
5. Coolant Level Sensors' Relay
6. Low Engine Oil Pressure Signaling Relay
7. Water in Fuel Sensor at Fuel Filter (if equipped)
8. Engine and Fan Electronic Control Module (ECM)
9. Drive Train Control Lever
10. Drive Train Electronic Controller
11. Gear Presetting Mode Switch
12. Auto-downshift Mode Switch
13. Start-Up Lock Switch
14. Low Transmission Main Pressure and Range Clutches Pressure Warning Light Switch
15. Time Delay Module
16. Engine Oil Pressure Sensor
17. Fuses 10 [A] – ECM Power Supply
18. Engine RPM Sensor
19. Clogged Air Cleaner Vacuum Warning Light Switch
20. Coolant Temperature Sensor
21. Ether Solenoid Valve Temperature Switch (+4 [ºC])
22. Ether Solenoid Valve
23. Air Conditioner Compressor Electromagnetic Clutch
24. Alternator
25. Cranking Motor
26. Receptacle [24V]
27. Blade Pitch Solenoid Valve Coil
28. Blade Dual Tilt Solenoid Valve Coil
29. Blade Pitch Solenoid Valve Button
30. Blade Dual Tilt Solenoid Valve Button
31. Float Position Latch Electromagnet
32. Horn Pushbutton
33. Hydraulic System Return Filters' Warning Light Switch
34. Hydraulic Pilot System Filter Warning Light Switch
35. RH Rear Lamp
36. Ether Solenoid Valve Switch
37. Cab Headlamps Switch
38. Machine Headlamps Switch
39. Starting Switch
40. Machine Automatic Circuit Breakers
41. Portable Lamp Receptacle
42. Engine ECM Memory Activation Momentary Switch
43. Engine ECM Failure Code Display Momentary Switch
44. Fuel Level Gauge
45. Hourmeter
46. Fan Drive System Filter Clogging Warning Light
47. Low Engine Oil Pressure Warning Light
48. Alarm (Low Engine Oil Pressure or Coolant Level)
49. Drive Train Oil Temperature Gauge Sensor
50. Drive System Oil Temperature Sensor that Controls Fan RPM

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WIRING DIAGRAM

51. Fan Drive Pump Solenoid Valve
52. Gauge Cluster
53. Diode Assy
54. Transmission Input Shaft RPM Sensor
55. Engine RPM Control Potentiometer
56. Gear and Range Display
    - 1 – First Gear
    - 2 – Second Gear
    - 3 – Third Gear
    - H – High Range
    - L – Low Range
57. Engine (ECM) Electronic Module Connector
58. Main Automatic Circuit Breaker 80 [A]
59. Equipment Power Supply Magnetic Switch
60. Engine Starting Magnetic Switch
61. Reverse Travel Pressure Switch
62. Forward Travel Pressure Switch
63. Window Washer Pumps
64. Batteries
65. Drive Train Pressure Filters' Clogging Warning Light Switch
66. Fan Drive System Filter's Clogging Warning Light Switch
67. Over current Protection
68. ROPS side Lamps (option)
69. Fuse – 15[A] – Voltage Converter Circuit
70. Fuse – 10[A] - Operator's Seat Suspension System Power Supply
71. Electric System Master Switch
72. 24 [V]/12 [V] Voltage Converter
73. Radio (option)
74. Radio Antenna (option)
75. RH Door Wiper
76. Radio Speakers (option)
77. Cab Rear Lamps
78. Rear Wiper
79. Defroster Fans (option)
80. Cab Front Lamps
81. Front Wiper
82. Dome Light
83. LH Door Wiper
84. Air Conditioner/ Heater Blower Switch
85. Door Window Wipers Switch and Washer Button
86. Cab Window Wiper Switch and Washer Button
87. Cab Automatic Circuit Breakers
88. Condenser Fans
89. Heater/ Air Conditioner Valve Control Potentiometer
90. Condenser Fans Power Supply Relay
91. Air Conditioner/ Heater
92. Operator's Seat Suspension System Pump (option)
93. Backup Alarm
94. RH Rear Lamp

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95. Fuel Level Sensor
96. RH H-L Solenoid Valve
97. LH H-L Solenoid Valve
98. Third Gear Solenoid Valve
99. Second Gear Solenoid Valve
100. Drive Train System Lock Solenoid Valve
101. Drive Train System Lock Relay Proximity Switch
102. Drive Train System Lock Solenoid Valve and Electronic Controller Start-Up Relay

Gauge cluster components:

A – Hydraulic Oil Filters and Pilot System Filter Warning Light
C - Low Transmission Main Pressure and Range Clutches Pressure Warning Light
D – Drive Train Oil Filter Warning Light
E – Air Cleaner Vacuum Warning Light
F – Low Coolant Level Warning Light
H – Coolant Temperature Gauge
J – Drive Train Oil Temperature Gauge
K – Engine Oil Pressure Gauge
L – Gauges Illumination Lights
M – Voltmeter
N – Engine Warning Light “STOP”
P – Engine Warning Light “WARNING”
R – Engine Warning Light “FLUID”

Wire color code

Code	Color
R	Red
T	Amber
W	White
Y	Yellow
B	Black
BR	Brown
G	Gray
O	Orange
P	Pink
V	Violet
DB	Dark Blue
LB	Light Blue
DG	Dark Green
LG	Light Green
GR	Green

Wire cable marking:

W/LG – 38D wire color code/ cable designation

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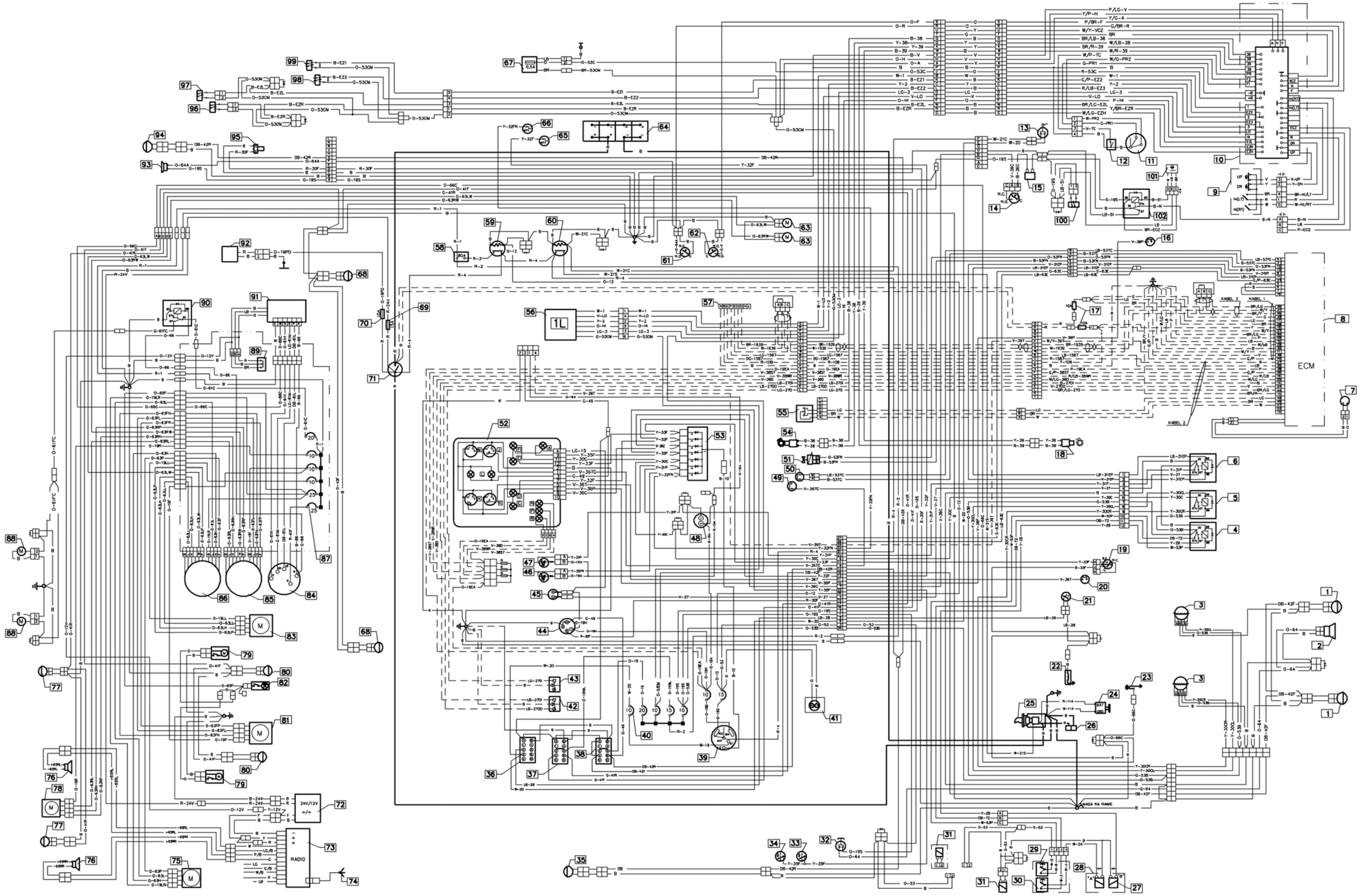

Fig. 8.1. Wiring Diagram (earlier version)

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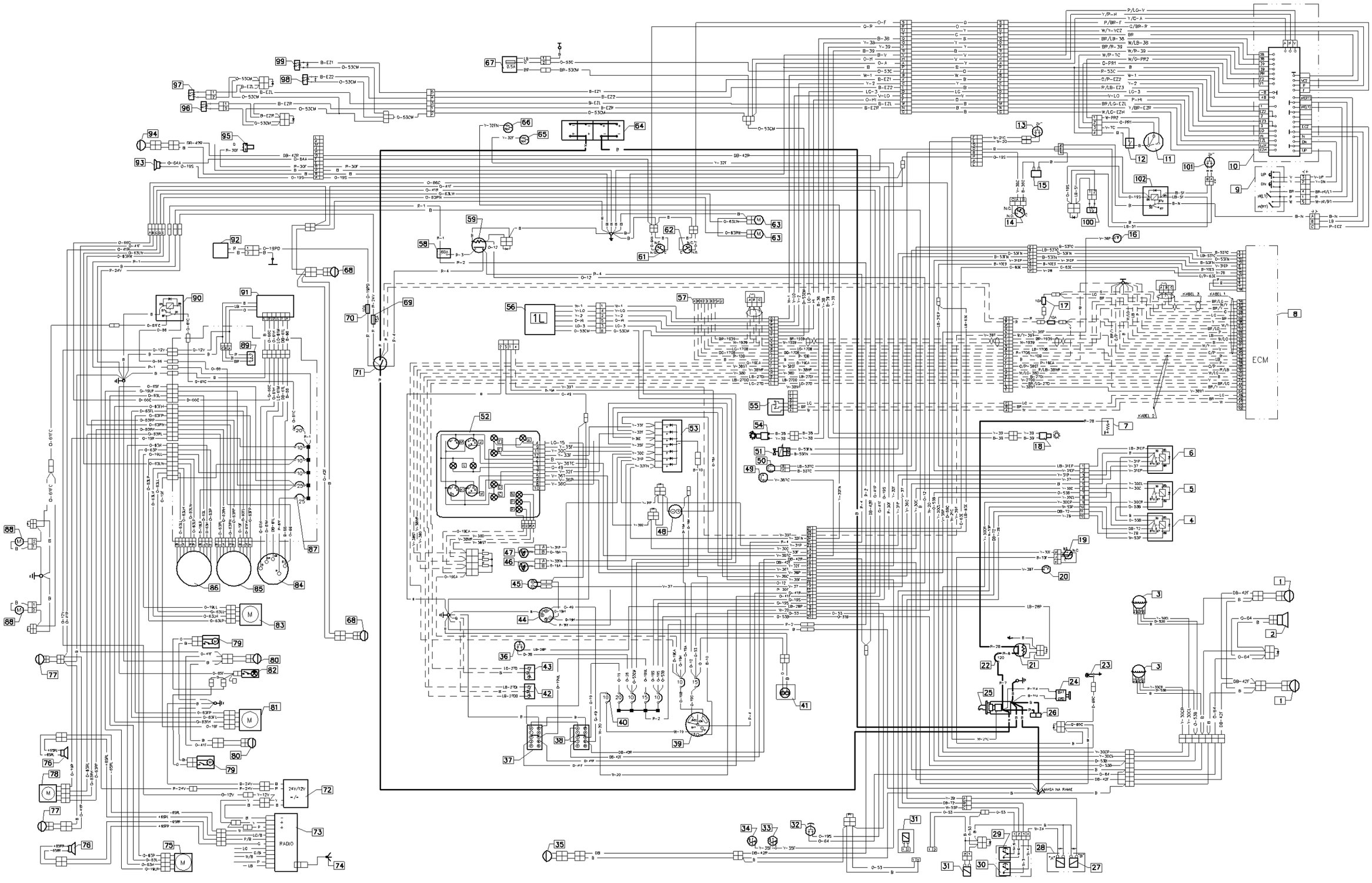

Fig. 8.1A. Wiring Diagram (later version)

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WIRING DIAGRAM

Legend for machine wiring diagram (Fig. 8.1A)(later version):

1. Front Dozer Headlamps at Blade Cylinders
2. Horn
3. Coolant Level Sensors
4. Blade Dual Tilt / Pitch Relay
5. Coolant Level Sensors' Relay
6. Low Engine Oil Pressure Signaling Relay
7. Engine Intake Air Preheater
8. Engine and Fan Electronic Control Module (ECM)
9. Drive Train Control Lever
10. Drive Train Electronic Controller
11. Gear Presetting Mode Switch
12. Auto-downshift Mode Switch
13. Start-Up Lock Switch
14. Low Transmission Main Pressure and Range Clutches Pressure Warning Light Switch
15. Time Delay Module
16. Engine Oil Pressure Sensor
17. Fuses 10 [A] – ECM Power Supply
18. Engine RPM Sensor
19. Clogged Air Cleaner Vacuum Warning Light Switch
20. Coolant Temperature Sensor
21. Engine Intake Air Preheater Magnetic Switch
22. Engine Intake Air Preheater Circuit Breaker
23. Air Conditioner Compressor Electromagnetic Clutch
24. Alternator
25. Cranking Motor
26. Receptacle [24V]
27. Blade Pitch Solenoid Valve Coil
28. Blade Dual Tilt Solenoid Valve Coil
29. Blade Pitch Solenoid Valve Button
30. Blade Dual Tilt Solenoid Valve Button
31. Float Position Latch Electromagnet
32. Horn Pushbutton
33. Hydraulic System Return Filters' Warning Light Switch
34. Hydraulic Pilot System Filter Warning Light Switch
35. RH Rear Lamp
36. Engine Intake Air Preheater Button
37. Cab Headlamps Switch
38. Machine Headlamps Switch
39. Starting Switch
40. Machine Automatic Circuit Breakers
41. Portable Lamp Receptacle
42. Engine ECM Memory Activation Momentary Switch
43. Engine ECM Failure Code Display Momentary Switch
44. Fuel Level Gauge
45. Hourmeter
46. Fan Drive System Filter Clogging Warning Light
47. Low Engine Oil Pressure Warning Light

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48. Alarm (Low Engine Oil Pressure or Coolant Level)
49. Drive Train Oil Temperature Gauge Sensor
50. Drive System Oil Temperature Sensor that Controls Fan RPM
51. Fan Drive Pump Solenoid Valve
52. Gauge Cluster
53. Diode Assy
54. Transmission Input Shaft RPM Sensor
55. Engine RPM Control Potentiometer
56. Gear and Range Display
    - 1 – first gear
    - 2 – second gear
    - 3 – third gear
    - H – High Range
    - L – Low Range
57. Engine (ECM) Electronic Module Connector
58. Main Automatic Circuit Breaker 80 [A]
59. Equipment Power Supply Magnetic Switch
60.
61. Reverse Travel Pressure Switch
62. Forward Travel Pressure Switch
63. Window Washer Pumps
64. Batteries
65. Drive Train Pressure Filters' Clogging Warning Light Switch
66. Fan Drive System Filter's Clogging Warning Light Switch
67. Over current Protection
68. ROPS side Lamps (option)
69. Fuse – 15[A] – Voltage Converter Circuit
70. Fuse – 10[A] - Operator's Seat Suspension System Power Supply
71. Electric System Master Switch
72. 24 [V]/12 [V] Voltage Converter
73. Radio (option)
74. Radio Antenna (option)
75. RH Door Wiper
76. Radio Speakers (option)
77. Cab Rear Lamps
78. Rear Wiper
79. Defroster Fans (option)
80. Cab Front Lamps
81. Front Wiper
82. Dome Light
83. LH Door Wiper
84. Air Conditioner/ Heater Blower Switch
85. Door Window Wipers Switch and Washer Button
86. Cab Window Wiper Switch and Washer Button
87. Cab Automatic Circuit Breakers
88. Condenser Fans
89. Heater/ Air Conditioner Valve Control Potentiometer
90. Condenser Fans Power Supply Relay
91. Air Conditioner/ Heater
92. Operator's Seat Suspension System Pump (option)
93. Backup Alarm
94. RH Rear Lamp

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95. Fuel Level Sensor
96. RH H-L Solenoid Valve
97. LH H-L Solenoid Valve
98. Third Gear Solenoid Valve
99. Second Gear Solenoid Valve
100. Drive Train System Lock Solenoid Valve
101. Drive Train System Lock Relay Proximity Switch
102. Drive Train System Lock Solenoid Valve and Electronic Controller Start-Up Relay

Gauge cluster components:

A – Hydraulic Oil Filters and Pilot System Filter Warning Light
C - Low Transmission Main Pressure and Range Clutches Pressure Warning Light
D – Drive Train Oil Filter Warning Light
E – Air Cleaner Vacuum Warning Light
F – Low Coolant Level Warning Light
H – Coolant Temperature Gauge
J – Drive Train Oil Temperature Gauge
K – Engine Oil Pressure Gauge
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M – Voltmeter
N – Engine Warning Light “STOP”
P – Engine Warning Light “WARNING”
R – Engine Warning Light “FLUID”

Wire color code

Code	Color
R	Red
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W	White
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O	Orange
P	Pink
V	Violet
DB	Dark Blue
LB	Light Blue
DG	Dark Green
LG	Light Green
GR	Green

Wire cable marking:

W/LG – 38D wire color code/ cable designation

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WIRING DIAGRAM

3A. DRIVE TRAIN CONTROL SYSTEM

3A.1. DRIVE TRAIN CONTROL SYSTEM STRUCTURE

The system will incorporate the following components:

- drive train hydraulic control valve;
- drive train system control lever that incorporates switches and buttons;
- solenoid valves: for gear shifting and steering drive range change (EZ2 and EZ3), (EZL and EZR), respectively;
- active gear and for range display (D) (two speed steering drive);
- (DTEC) drive train microprocessor controller (ST);
- the (WB) gear presetting mode switch;
- the (WO) auto downshift mode switch;
- magnetic sensors for engine RPM, torque converter output RPM and machine motion speed, if necessary, being (CS) and (CIW), respectively;
- motion direction pressure switches (WF and WR);
- over voltage & current protection module (EPD).

3A.2. DRIVE TRAIN CONTROL SYSTEM OPERATION PRINCIPLE

a. General

The drive control is done in two different ways. First, hydraulically, with a valve control lever of the drive control system that actuates suitable valves; the other being a combination of electrical and electronics with control lever imbedded buttons/ rocker switches assisted with a microprocessor controller, sensors and switches and solenoid valves.
The motion direction is changed with a control lever shifted forward or rearward while this lever tilted sideways will steer the machine what is accomplished with selection and steering valves operation, respectively.
The microprocessor controller is responsible for the following: gear change, speed range change, gradual turns (different ranges being used for both tracks), auto downshift and gear presetting.

b. Description to signal diodes incorporated in the drive train electronic controller

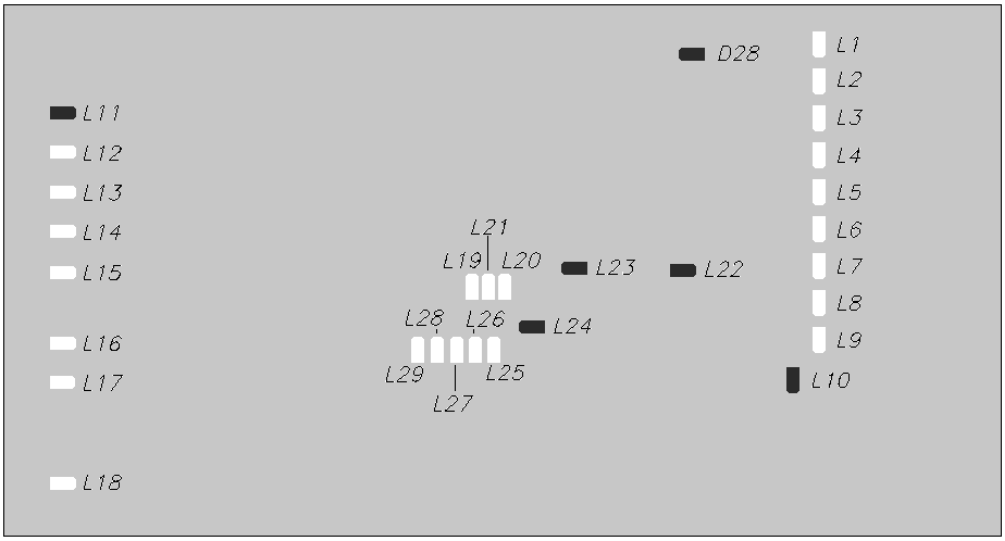

Fig. 8.1A. LEDs arrangement on the electronic controller

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WIRING DIAGRAM

Drive control system is provided with a LED array that presents the controller current operation status which facilitates the controller diagnosis. Below find LED function description whose labeling will be referred to later in this instruction.

- **D28** – service signal light that is used during the controller programming only;
- **L1** – ON, when the up shift button (*Up*) at the control lever is depressed;
- **L2** – ON, when the downshift button (*Dn*) at the control lever is depressed;
- **L3** – ON, when the drive train neutral lock lever is in locked position.
- **L4** – OFF, not used in SUREGRIP control lever;
- **L5** – OFF, not used in SUREGRIP control lever;
- **L6** – ON, when the LH switch is at the high range;
- **L7** – ON, when the RH switch is at the high range;
- **L8** – ON, when the machine moves forward – the WF forward motion sensor activated;
- **L9** – ON, when the machine moves reverse – the WR reverse motion pressure switch will get activated;
- **L10** – not used
- **L11** – not used
- **L12** – ON, when the solenoid valve *EZR* is activated which means;

the machine operates at the high range (*L 6, L7 L13* and *L14* are ON also)

or

the machine has been operated at the high range straight on (*L6*, *L7*, *L12*, *L13* and *L14* were ON*)* and with the LT left switch changed from the high to low range that is a gradual turn to the left (*L13*, *L14* and *L6* came OFF while both *L15* and *L7* are still ON) and if the drive train neutral lock lever is in unlocked position, (*L3* LED is OFF);

or

the machine has been operated at the low range straight on (*L15* was ON) and with the RT right switch changed from the low to high range that is a gradual turn to the left (*L7* ON) and if the if the drive train neutral lock lever is in unlocked position, (*L3* LED is OFF);

- **L13** – ON, when the solenoid valve *EZL* is activated which means;

the machine operates at the high range (*L 6, L7 L12* and *L14* are ON also)

or

the machine has been operated at the high range straight on (*L6*, *L7*, *L12*, *L13* and *L14* were ON*)* and with the RT right switch changed from the high to low range that is a gradual turn to the right (*L12*, *L14* and *L7* came OFF while both *L15 and L6* are still ON) and if the drive train neutral lock lever is in unlocked position, (*L3* LED is OFF);

or

the machine has been operated at the low range straight on (*L15* was ON) and with the left switch changed from the low to high range that is a gradual turn to the right (*L6* ON) and if the drive train neutral lock lever is in unlocked position, (*L3* LED is OFF);

- **L14** – ON, when the machine operates at the high range, *L15* must not be ON;
- **L15** – ON, when the machine operates at the low range, *L14* must not be ON;
- **L16** – ON, when the 3rd gear was engaged, *L17* and *L18* must not be ON;
- **L17** – ON, when the 2nd gear was engaged, *L16* and *L18* must not be ON;
- **L18** – ON, when the 1st gear was engaged, *L16* and *L17* must not be ON;
- **L19, L20, L21** – are used to learn the machine type code (different wiring). Refer to Table 8.1.

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WIRING DIAGRAM

Table 8.1. Machine type code:

Machine Type	Deutsch connector pin voltage providing power to controller [V]			LED ON		
	A	H	V	**L20**	**L21**	**L19**
TD-15M EXTRA	0	0	0	NO	NO	NO
TD-20M EXTRA	24	0	0	YES	NO	NO
TD-25M EXTRA	24	24	0	YES	YES	NO
TD-40E EXTRA	24	24	24	YES	YES	YES

- **L22** – ON, when the controller is fed with a pulse train coming from the torque converter output CIW magnetic sensor; this pulse train is a must for correct operation of auto downshift;
- **L23** – ON, when the controller is fed with a pulse train coming from the engine CS magnetic sensor; this pulse train is a must for correct operation of auto downshift;
- **L24** – ON, when the machine type code wiring is faulty, being corrupted connection integrity, at least at one lead to Deutsch connector pins A, H, V providing power to the controller. Diodes *L19, L20* and *L21* dim will give a hint to which lead is at fault:
  - *L20* – dim diode means that lead connection to pin A of controller Deutsch connector is corrupted;
  - *L21* – dim diode means that lead connection to pin H of controller Deutsch connector is corrupted;
  - *L19* – dim diode means that lead connection to pin V of controller Deutsch connector is corrupted;
- **L25** – ON, when the auto downshift mode was activated – *WO* switch contacts shorted;
- **L26, L27** – not used;
- **L28** – ON, when „2/2” presetting mode II was activated;
- **L29** – ON, when „1/2” presetting mode I was activated;

3A.3. ELECTRONIC CONTROLLER OPERATION AFTER POWER UP

a. Power up with the control system operative

In order for the control system to operate correctly the following must be met:

- power ranging 18 [V] ≤ U ≤ 36 ± 0.5 [V]
- EPD protection “ON”
- the system is fed with a pulse train coming from RPM magnetic sensors
- correct machine type coding.

b. Electronic controller operation after power up and prior to starting the engine

After power up to the controller, letter “L” is to display immediately on the display RH position at the instrument panel with the machine equipped with a two speed steering drive, while the electronic controller based green diode **L15** for a low range will come ON. After ca. one second the controller processor is to end self test and to start the program execution. The LH position of two digit display or single digit display is to show “1” (for machines equipped with a single speed steering drive, while the electronic controller based green diode **L18** will come ON

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The same will be true if the presetting mode switch is set in its “1/2” position (yellow diode **L29** ON). The same status will be if one of the range switches of the control lever is in the LO range and the other in HI. If two switches are set to HI range then “L” displayed will change to “H” after a second elapsed. Have in mind that the display will dim at a startup only.
After power up when the presetting mode switch is in “2/2” position (a yellow diode **L28** will come on) “2” gear will display and the solenoid valve *EZ2* will get activated. Then diode **L18** will blink (for a fraction of a second), then it will come off and a green diode **L17** will come on.

After power up with the drive train neutral lock lever in the locked position and the locked position switch is operative and adjusted correctly, the yellow diode **L3** will come on. After power up, depending on a machine type, the yellow diodes **L19**, **L20**, **L21** will come on brightly, (refer to Table 8.1), what witnesses to machine type correct code.
A yellow diode **L25** may come on too what will signal that the auto downshift mode is operative.

c. Controller operation after engine startup

After engine startup the red diodes **L22** and **L23** have to be ON what will signal that the controller has been fed with a pulse train from the magnetic sensors.

d. Power up with the control system inoperative

NOTE: *Bear in mind that if magnetic sensors for torque converter output RPM (CIW) or engine RPM (CS) are replaced then the drive control system may malfunction in case the sensors relative position has been disturbed.*

1. If at power up only “L” displays, check J, P pins of the Deutsch connector providing power to the controller for voltage presence.

   a) If U < 18 [V], the controller processor operation has been held up by power supply watchdog. Turn the control system off, check the cause for voltage down, clear the fault and restart the power supply.

   b) If the voltage is OK, and the green diode **L18** will not come on, then EPD has tripped as a result of system over voltage, short circuit or overloading condition. EPD will cut power to the controller. When this happens only machine “limp home” mode is possible. (1^{st} gear and low range).
   For EPD to restore the controller power, cut the power to the drive control system, clear the short (overloading) cause or source of disturbance and then restore power to the drive control system; if with the power restored after a 7 second power down the “L” would display only that means the cause for EPD tripping has not been cleared.

2. If at power up and gear up shift with high range the controller will downshift automatically with subsequent range reduction to “1L”, and symbols for gear and range will display, then voltage calls for recheck.

   a) At momentary power down to below 18 [V], the controller processor will reset and then restart. A 10 [A] automatic circuit breaker - and/or its wiring - which protects the entire drive control system, solenoid valves included, can be at fault.

   b) With the over voltage U > 36 [V], the alternator (alternator voltage regulator) which sets the outputted voltage level can be at fault.

3. If at power up all or a single yellow diode **L19**, **L20**, **L21** fails to come on at full brightness and the red diode **L24** will come on, this means that the machine type coding is at fault - at least one of the pins A, H, V (refer to Table 8.1) got corrupted.

4. If a single solenoid valve is at fault, take a voltage check at the solenoid valve coil’s terminals. DO NOT take a voltage to the machine ground.

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3A.4. DRIVE TRAIN CONTROL SYSTEM OPERATION AT GEAR SHIFTING

The gear shifting system features several operation modes having different priorities.

a. Manual gear shifting mode

Manual gear shifting mode is provided with a least priority. It is sketched in Fig. 8.1B.

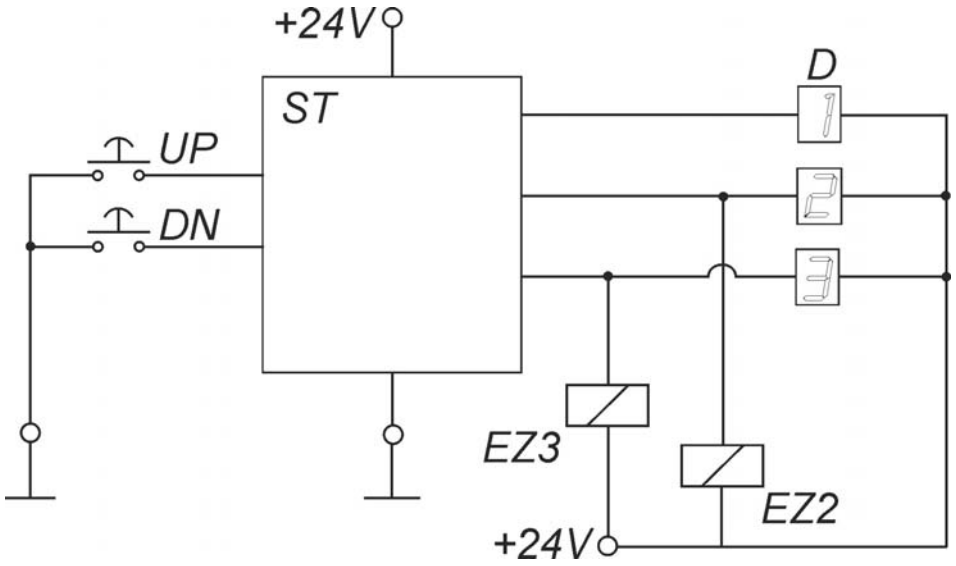

Fig. 8.1B. Manual gear shifting system schematic

UP – Up shift Button
DN – Down-shift Button
ST – Electronic Controller
D – Display
EZ2 – 2nd Gear Solenoid Valve
EZ3 – 3rd Gear Solenoid Valve

Set the gear change mode switch *WB* to the “deactivated” position and deactivate the auto downshift mode at the instrument panel to choose this mode of operation. Diodes **L29**, **L28** and **L25** are not to come on. The gear change can take place (as per controller algorithm) if at the power up the drive train neutral lock lever is in its locked position. There are two lever incorporated buttons for a gear change. Depress the *Up* button to up shift and a *Dn* button to downshift. Depress this button once for a gear to be changed; however if you keep depressing the button this will not change the controller status – if the operator wants a gear change that involves two gears, he is to depress the suitable button twice. Only one button can be depressed at a time; the controller will ignore any attempt to depress more buttons than one.

When the *Up* button is depressed it is accompanied with a yellow diode **L1** coming on; the same is true when the *Dn* button is depressed, then diode **L2** will come on. Depending on a current state, when the up shift takes place, the microprocessor controller is to behave as described below:

- when the actual gear was the first gear – the display will change from “1” to “2”, diode **L18** will come off and **L17** will come on, the second gear solenoid valve *EZ2* will energize, while that for third gear *EZ3* will de-energize;
- when the actual gear was the second gear – the display will change from “2” to “3”, diode **L17** will come off and **L16** will come on, the third gear solenoid valve *EZ3* will energize, while that for third gear *EZ2* will de-energize;

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- when the actual gear was the third gear – the controller will do nothing, the display will continue to show “3”, the third gear solenoid valve *EZ3* will energize while that for the second gear will not, the **L16** diode will come on, and **L17** and **L18** will come off.

Similarly for downshift, the controller is to behave as described below:

- when the actual gear was the third gear – the display will change from “3” to “2”, diode **L16** will come off and **L17** will come on, the second gear solenoid valve *EZ2* will energize, while that for third gear *EZ3* will de-energize;
- when the actual gear was the second gear – the display will change from “2” to “1”, diode **L17** will come off and **L18** will come on, the second and third gear solenoid valves *EZ2* and *EZ3,* respectively will de-energize;
- when the actual gear was the first gear – the controller will do nothing, the display will continue to show “1”, the second and third gear solenoid valves *EZ2* and *EZ3*, respectively will de-energize, the **L18** diode will come on, and **L17** and **L16** will come off.

b. Auto downshift mode

Auto downshift mode is provided with a higher priority in the gear change system. *WO* switch (position „I” at the instrument panel) is used to activate this function; this is accompanied with a yellow diode **L25** coming on. Figure 8.1C sketches all components and their setup for this function to be operative.

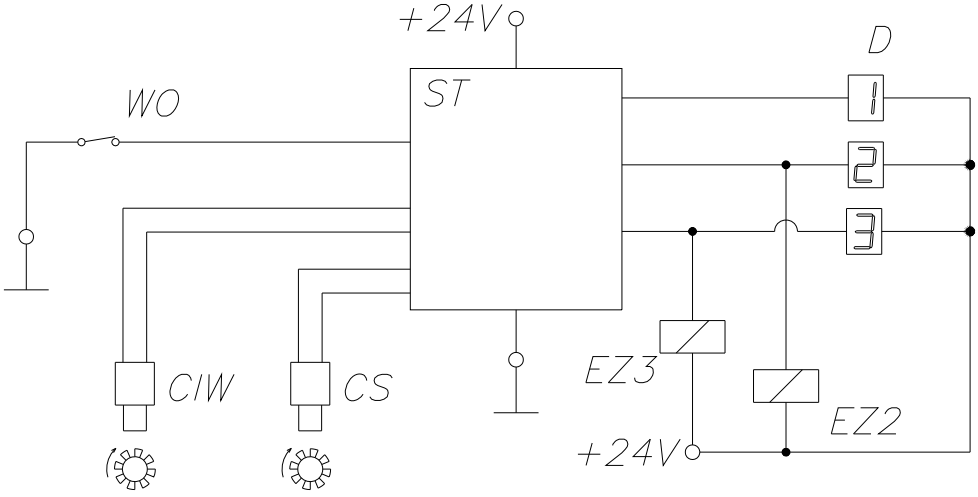

Fig. 8.1C. Auto Downshift Mode and Components Setup Schematic

WO – Auto Downshift Mode Switch
CIW – Torque Converter Output RPM Magnetic Switch
CS – Engine RPM Magnetic Switch
ST – Electronic Controller
D – Display
EZ2 – 2nd Gear Solenoid Valve
EZ3 – 3rd Gear Solenoid Valve

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There are two extra magnetic switches beside the *WO* switch mentioned above in the auto downshift system.

- engine RPM (CS);
- torque converter output RPM (CIW)

Based on the pulse train coming from these sensors the microprocessor controller will compute the torque converter kinematics ratio. If the controller is fed with a pulse train from the *CS* sensor, the red diode **L23** is to come on. Similarly, if the pulse train from *CIW* sensor is fed, then **L22** will come on.

The controller will operate as described below depending on the torque converter kinematics ratio.

- if the ratio ranges from 0.75 to 1 – a manual gear change is possible with *Up* and *Dn* buttons as described above;
- if the ratio ranges from 0.40 to 0.75 - a manual downshift is possible with *Dn* button as described above; however the controller will not allow for up shift with *Up* button;
- if the ratio is less than 0.40, and the machine rides in say, the third gear, the controller will automatically downshift and after about 5 seconds will recheck the ratio. If the ratio is still below 0.40 (the machine is riding in the second gear), another downshift will take place, diodes will come on as per algorithm described for a manual downshift. Manual up shift will be deactivated unless the ratio is over 0.75, regardless of the gear engaged (excluding third gear).

It goes without saying that with the auto downshift mode disabled, the manual up shift is immediately activated, regardless of the ratio.

c. Presetting mode

Presetting mode is provided with the highest priority in a gear change system. Generally, presetting allows the machine motion at well predefined gears; gear can be defined regardless the machine motion forward or reverse. The controller ignores *Up* and *Dn* buttons in this gear change mode. The auto downshift mode is not operational either, regardless the *WO* switch position. Machines are provided with two presetting modes which can be chosen with a gear mode change switch (presetting) *WB* that can be found at the instrument panel.

1/2 Presetting mode

In this mode the *WB* switch is set to *1/2* position which in turn, will cause a yellow diode **L29** to come on. The machine will move forward in the first gear (green diode **L18** will come on, **L17** and **L16** will come off, while solenoid valves *EZ2* and *EZ3* will get deactivated), and in the second gear reverse (diode **L17** will come on, **L18** and **L16** will come off, *EZ2* activated, *EZ3* deactivated). The display will show the active gear, while the motion direction will be signaled with a suitable diode. There are two pressure switches in the drive control system that will provide information to the microprocessor controller on the machine motion direction. *WF* – which will shot the controller to the machine ground in case the machine would move forward; its operation will cause the yellow diode **L8** to come on, as well as *WR* - which will shot the controller to the machine ground in case the machine would move reverse; its operation will cause the yellow diode **L9** to come on. When the machine is stopped both sensors will not provide any signal to the controller and diodes **L8** and **L9** will be off. Fig. 8.1D. provides a control system schematic in this operation mode.

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WIRING DIAGRAM

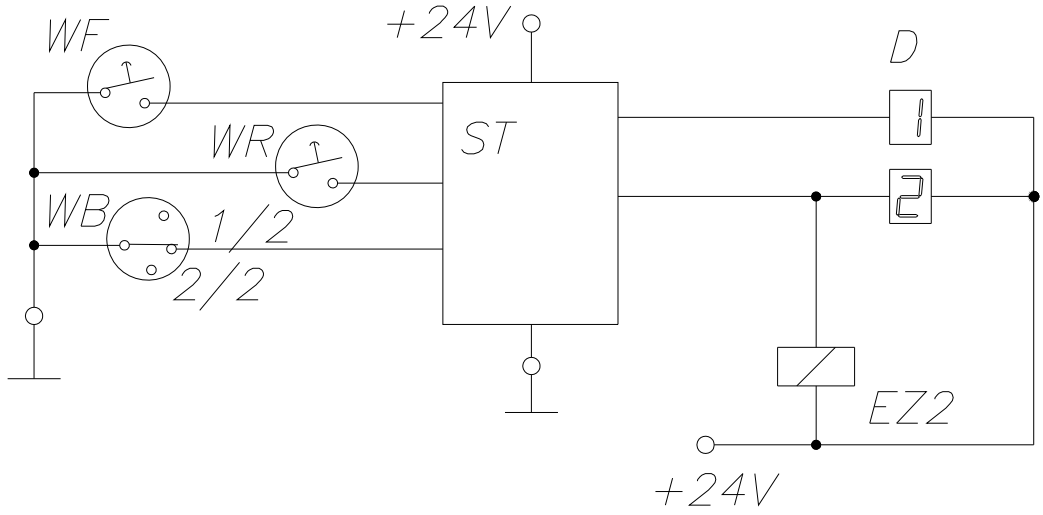

Fig. 8.1D. Control System Schematic for 1/2 Presetting Mode

WF – Machine Forward Pressure Switch
WR – Machine Reverse Pressure Switch
WB – Gear Presetting Mode Switch
ST – Electronic Controller
D – Display
EZ2 – 2nd Gear Solenoid Valve

2/2 Presetting mode

In this mode the *WB* switch is set to *2/2* position which in turn, will cause a yellow diode **L28** to come on. Machine will move forward and reverse in the second gear. The actual gear is displayed. The second gear solenoid valve *EZ2* is activated, while *EZ3* is deactivated, diode **L17** will come on, while **L16** and **L18** will come off. Fig. 8.1E. provides a drive control system schematic in this operation mode.

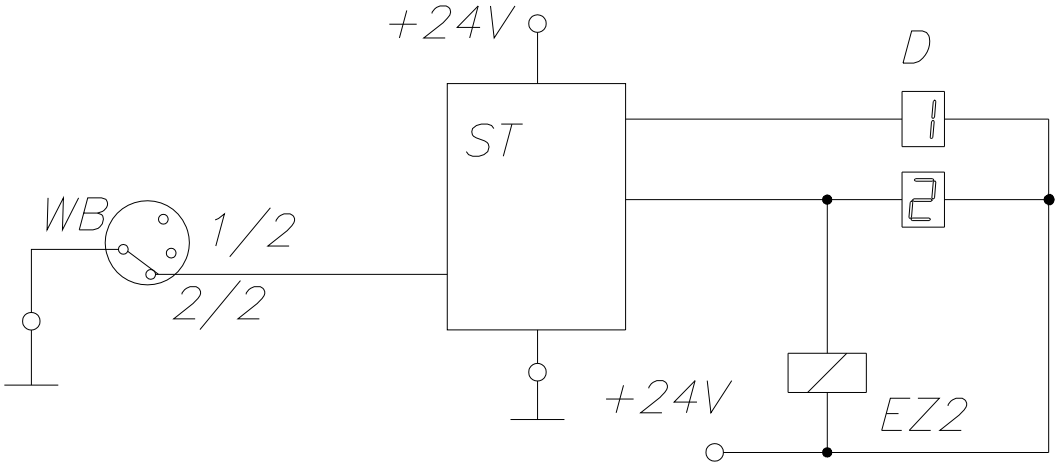

Fig. 8.1E. Control System Schematic for 2/2 Presetting Mode

WB – Gear Presetting Mode Switch
ST – Electronic Controller
D – Display
EZ2 – 2nd Gear Solenoid Valve

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3A.5. DRIVE TRAIN CONTROL SYSTEM OPERATION AT SPEED RANGE CHANGE

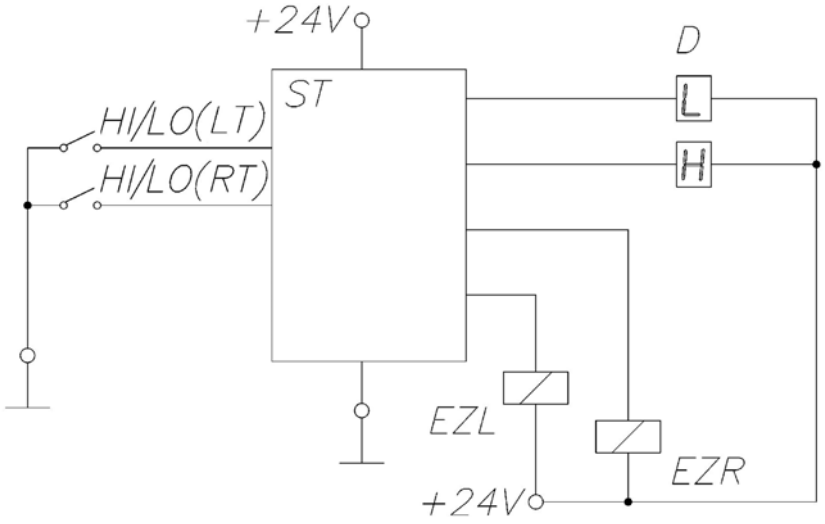

Fig. 8.1F. Speed Range and Gradual Turn Control Schematic

HI/LO(LT) – Left Track Speed Range Rocker Switch
HI/LO(RT) – Right Track Speed Range Rocker Switch
ST – Electronic Controller
D – Display
EZR – Solenoid Valve for Right Track Steering Drive Range Change
EZR – Solenoid Valve for Left Track Steering Drive Range Change

This lever features two rocker type switches.
The high range is active when the both switches are in positions of high speed range. The microprocessor controller will activate the *EZL* and *EZR* solenoid valves what will be signaled with green diodes **L13** and **L12** which will come on, respectively. The display RH position is to show “H”, diode **L14** is to come on, while **L15** is to remain off. The low range is active when both switches are in positions of low speed range. The microprocessor controller will deactivate the *EZL* and *EZR* solenoid valves what will be acknowledge with green diodes **L13** and **L12** which will come off. The display RH position is to show “L”, diode **L15** will come on, while **L14** will come off. When the rocker switches are in different positions, machine will make a gradual turn, the description of which will follow later in the text.

3A.6. DRIVE TRAIN CONTROL SYSTEM OPERATION WHILE MAKING GRADUAL TURNS

The following description refers to Fig.8.1F.
The machine will turn if one of the rocker switches is set to high speed range and the other – in low speed range. During gradual turn the display RH position will show “L” and diode **L15** will come on, while **L14** will come off.
If *HI/LO(LT)* switch is set to high speed range which, in turn, will cause a yellow diode **L6**, to come on, and *HI/LO(RT)* switch is set to low speed range (diode **L7** will come off), then the microprocessor controller will activate the *EZL* solenoid valve – a diode **L13** will come on. The *EZR* solenoid valve will remain deactivated – the **L12** diode will come off. The result will be machine right gradual turn.
Similarly, if *HI/LO(RT)* switch is set to high speed range which, in turn, will cause a yellow diode **L7**, to come on, and *HI/LO(LT)* switch is set to low speed range (diode **L6** will come off), then the microprocessor controller will activate the *EZR* solenoid valve – a diode **L12** will come on. The *EZL* solenoid valve will remain deactivated – the **L13** diode will come off. The result will be machine left gradual turn.

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SERVICE DIAGNOSIS

4. SERVICE DIAGNOSIS

When performing any service diagnosis on the electrical system, refer to the wiring diagram to identify the various electrical components and for tracing the wiring of the problem circuit.
Before performing tests, check the following;

a. Battery terminals are clean and tight.
b. All component connections and grounding connections are clean and tight.
c. The master switch is “ON” unless using a tester with its own power supply such as ohmmeter which must never be connected to battery voltage.
d. That the key start switch is in the proper position when checking a circuit that receives its power through this switch. Refer to the wiring diagram.

WARNING! Avoid accidental engine starting. Tag the cab panel to alert other personnel that work is being performed on the machine with the master switch in position “ON”.

COMPLAINT	
PROBABLE CAUSE	REMEDY
Engine will not Crank or Crank Slowly	
1. Weak batteries	Check the condition of each battery. Refer to ”Testing and Maintenance the Battery” in this Section
2. Dirty or loose power cable connections	Clean all connections and tighten
3. Defective starting switch, 10[A] circuit breaker, start-up lock switch, cranking motor solenoid switch, cranking motor, master switch	By process of elimination, check for voltage using a voltmeter or check lamp, beginning at the power source and step by step until problem is found. Refer to Starting Circuit in Paragraph 3 in this Section
Transmission Control Malfunction	
1. Gears and ranges cannot be changed. Limp home mode inoperative.	Damaged: Drive train lock solenoid valve or its relay or proximity switch. Refer to Wiring Diagram.
2. Gears and ranges cannot be changed. Limp home mode operative.	Refer to Electronic Controller Operation After Power Up above
3. Electrical problem in direction or range drive circuit	Refer to Drive Train Control Circuit in Paragraph 3 in this Section and to Drive Train Control System above in this Section.
4. Hydraulic or mechanical problem in transmission or valves	Refer to “SERVICE DIAGNOSIS” in SECTION 7 “DRIVE TRAIN” and to SECTION 7C “TRANSMISSION”
Cooling Systems Fan Control Malfunction	
1. Electrical problem in fan control circuit	Refer to Fan Circuit in Paragraph 3 in this Section
2. Problem in fan drive system	Refer to “SERVICE DIAGNOSIS” in SECTION 10 “HYDRAULIC”

NOTE: *For electrical switches location on the machine refer to their system.*

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5. SPECIFICATIONS

Manufacturer type . . . . . Delco Remy 20SI 24 [V] / 50 [A]
Adjusted voltage at external temp. 26 [°C] . . . . . 27.4 ± 0.4 [V]
Adjusted load parallel to the battery . . . . . 2 [kW]
Permissible voltage spread at 10 [A] and 2000 [RPM] . . . . . 27.4 ± 0.4 [V]
Permissible voltage change at 5000 [RPM] and load (5 - 95 [%]) max of current . . . . . -0.8 [V]
Current [A] at [RPM] . . . . . 12/2000 [A] / [RPM]
26/3000 [A] / [RPM]
35/4000 [A] / [RPM]
41/5000 [A] / [RPM]
50/6000 [A] / [RPM]

Voltage setting at 10 [A] and 5000 [RPM] . . . . . 27.4 ± 0.6 [V]

Bolts torgues values:

M8x1.25 SAE Grade 5 . . . . . 29 [Nm]
M8x1.25 SAE Grade 8 . . . . . 37 [Nm]
M10x1.5 SAE Grade 5 . . . . . 57 [Nm]
M10x1.5 SAE Grade 8 . . . . . 72 [Nm]

6. INTRODUCTION

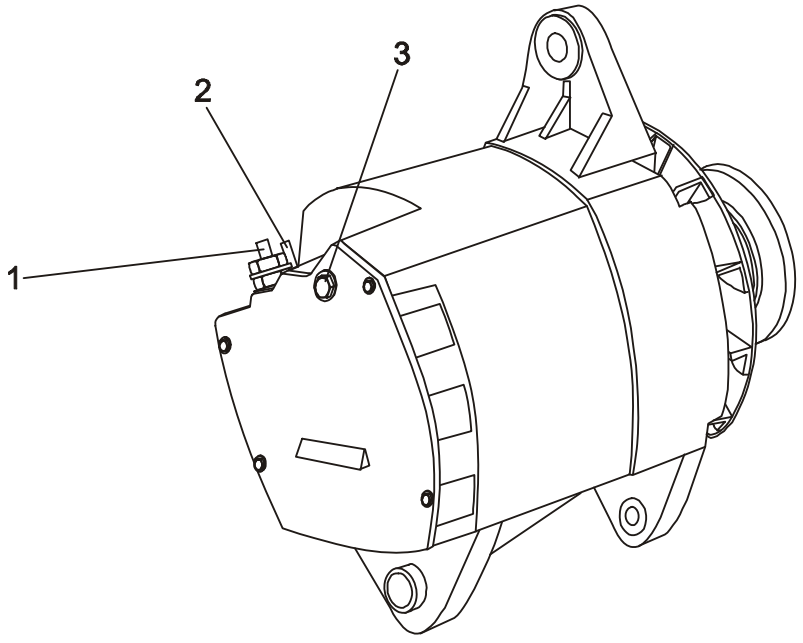

Fig. 8.3. View of Alternator

1. Pos. or Output Terminal
2. Relay Terminal
3. Ground Screw

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The Integral Charging System shown in Fig. 8.4 is a brushless unit featuring a built-in voltage regulator. The only movable part in the assembly is the rotor, which is mounted on a ball bearing at the drive and a roller bearing at the rectifier end. All current-carrying conductors are stationary. These conductors are the field winding, the stator windings, the six rectifying diodes, and the regulator circuit components. A fan located on the drive end provides airflow for cooling. The bearings are sealed so no periodic lubrication is required.
Only one wire is needed to connect the Integral Charging System to the battery, along with an adequate ground return. An “R” terminal is provided for use in some circuits to operate auxiliary equipment.

7. OPERATING PRINCIPLES

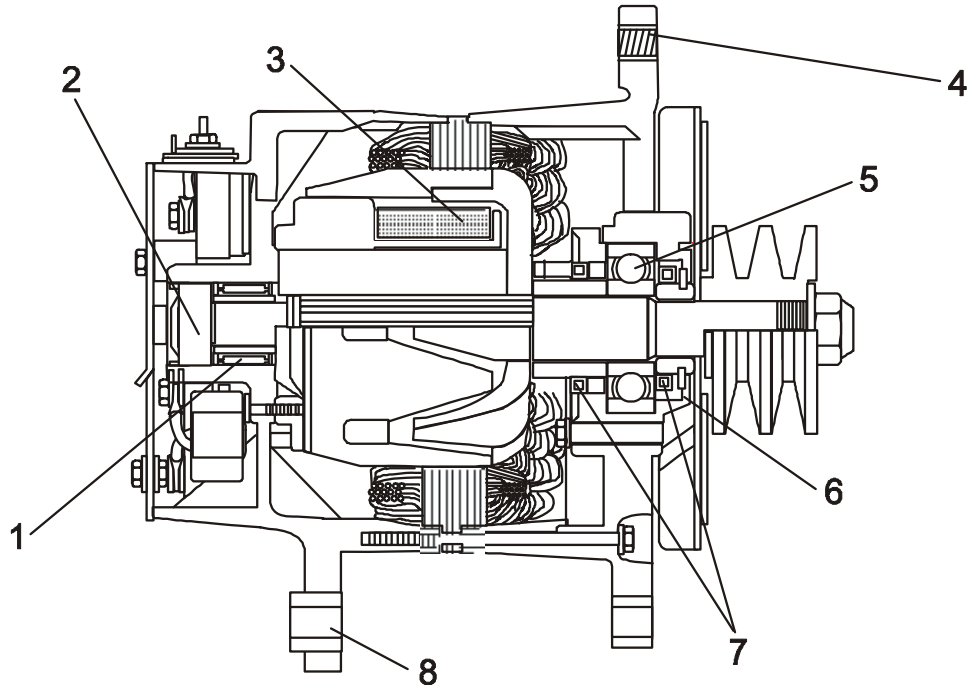

Fig. 8.4. Cross Sectional View Integral Charging System

1. Heavy - Duty Roller Bearing with Lip Seal
2. Grease Reservoir
3. Stationary Field Coil (Brushless Construction)
4. Steel Thread Insert
5. Double Sealed Heavy - Duty Ball Bearing
6. Labyrinth Seal
7. Felt Seals
8. Adjustable Steel Bushing

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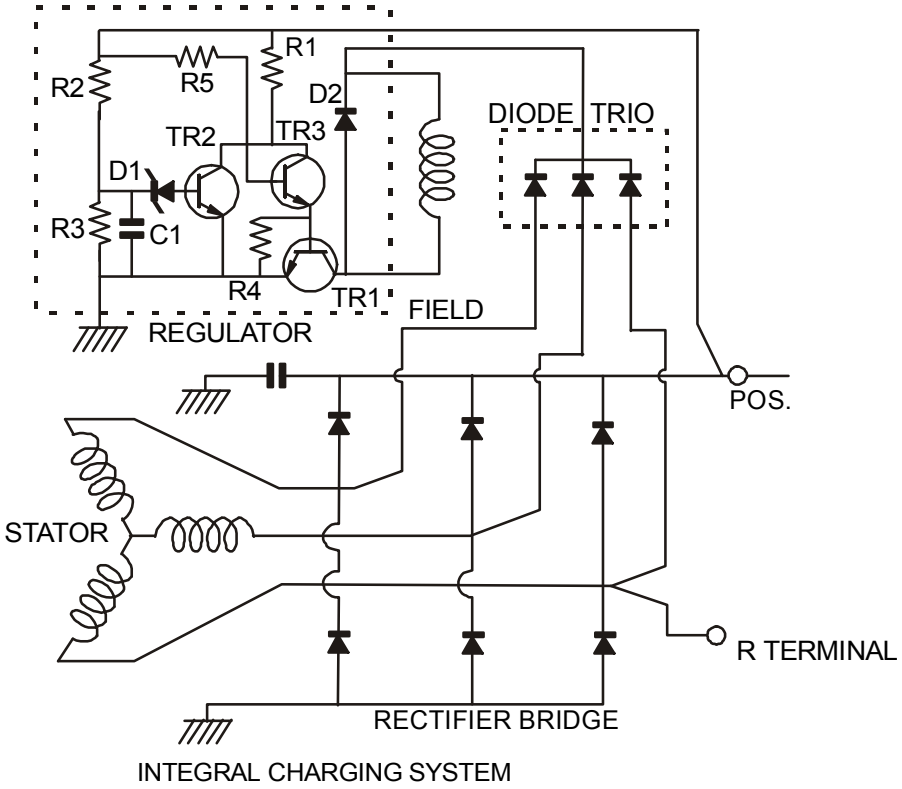

Fig. 8.5. Alternator Wiring Diagram

A wiring diagram is shown in Fig. 8.5. The basic operating principles are explained as follows:

The base-emiter of transistors (TR3 and TR1) is connected to the battery through resistor (R5), thus turning these transistors on. Also, resistors (R2 and R3) are connected to the battery, but the discharge current of the battery is very low because of the resistance values of (R2, R3, R5, TR1 and TR3).

With the generator operating, A.C. voltages initially are generated in the stator windings by residual magnetism in the rotor. The diodes in the rectifier bridge change the stator A.C. voltages to a D.C. voltage which appears between ground and the POS. terminal. As speed increases, current is provided for charging the battery and operating electrical accessories.
The stator also supplies D.C. field current through the diode trio, the field, (TR1), and then through the diodes in the rectifier bridge back to the stator.

As the speed and voltage increase the voltage between (R2) and (R3) increases to the value where zener diode (D1) conducts. Transistor (TR2) then turns on and (TR1) and (TR3) turn off. With (TR1) off, the field current and system voltage decrease and (D1) then blocks current flow causing (TR1) and (TR3) to turn back on. The field current and system voltage increase and this cycle then repeats many times per second to limit the voltage to the adjusted value.

If the connection between POS. and (R2) should become open-circuit (TR3) and (TR1) will turn off, thus preventing high system voltage.

Capacitor (C1) smoothes out the voltage across (R3), resistor (R4) prevents excessive current through (TR1) at high temperatures, and diode (D2) prevents high-induced-voltages in the field windings when (TR1) turns off.

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8. TROUBLESHOOTING PROCEDURES

a. Energizing Speed

The energizing speed is the rpm at which the regulator turns on to energize the field coil. This speed is higher than some speeds at which output can be obtained. Therefore, when checking output at low speeds, increase the speed until the regulator turns on, then reduce the speed to check the output. No output can be obtained until the regulator turns on. Once the regulator turns on, it will remain turned on until the engine is stopped.

b. Rated Voltage

The Integral Charging System output preferably should be checked at the RATED VOLTAGE given below. However, it is permissible to check the output in amperes at any voltage within the OPERATING RANGE listed below, since the current output will be quite close to the value that would be obtained at RATED VOLTAGE. The voltage should never be allowed to rise above the OPERATING RANGE for any length of time.

SYSTEM VOLTAGE	RATED VOLTAGE	OPERATING RANGE
24	28.0	26.0 - 30.0

It should be noted that the voltage may be below the OPERATING RANGE if the battery is in a low state of charge. However, as the battery receives a charge, the voltage will rise to some value within the OPERATING RANGE.

c. Magnetizing the Rotor

The rotor normally retains magnetism to provide voltage buildup when the engine is started. After disassembly or servicing, however, it may be necessary to reestablish the magnetism. To magnetize the rotor, connect the Integral Charging System to the battery in a normal manner, then momentarily connect a jumper lead from the **battery positive post to the Integral Charging System relay terminal,** identified in Fig. 8.3. This procedure will restore the normal residual magnetism in the rotor.

A basic wiring diagram is shown in Fig. 8.6. On 24-Volt systems, two 12-Volt batteries will be connected in series.

1. Insure that an undercharged condition has not been caused by accessories having been left on for extended periods.
2. Check the drive belt for proper tension.
3. If a battery defect is suspected, check per the applicable Battery Test.
4. Inspect the wiring for defects. Check all connections for tightness and cleanliness, including the cable clamps and battery posts.
5. Connect a voltmeter from POS. terminal on Integral Charging System to ground. A zero reading indicates an open between voltmeter connection and battery.
6. With all accessories turned off, increase engine speed as required to obtain maximum voltage reading.
7. If voltage exceeds 30 Volts on a 24-Volt system remove Integral Charging System for repair as covered below under heading of INTEGRAL CHARGING SYSTEM REPAIR.

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8. If previous Steps 1 through 7 check satisfactorily, check Integral Charging System as follows:
   a. Disconnect battery ground cable.
   b. Connect an ammeter in the circuit at the POS. terminal of the Integral Charging System.
   c. Reconnect battery ground cable.
   d. Turn on accessories. Connect carbon pile across one battery.
   e. Operate engine at moderate speed as required, usually 4000 alternator [RPM] or more, and adjust carbon pile as required, to obtain maximum current output.

IMPORTANT: *Initial voltage buildup is by residual magnetism in the rotor. Increase the speed as required to obtain maximum current output.*

   f. If ampere output is within 10 Amperes of rated output as stamped on alternator frame, Integral Charging System is not defective.
   g. If ampere output is not within 10 Amperes of rated output as stamped on Integral Charging System frame, remove the Integral Charging System for repair as covered in section entitled INTEGRAL CHARGING SYSTEM REPAIR.

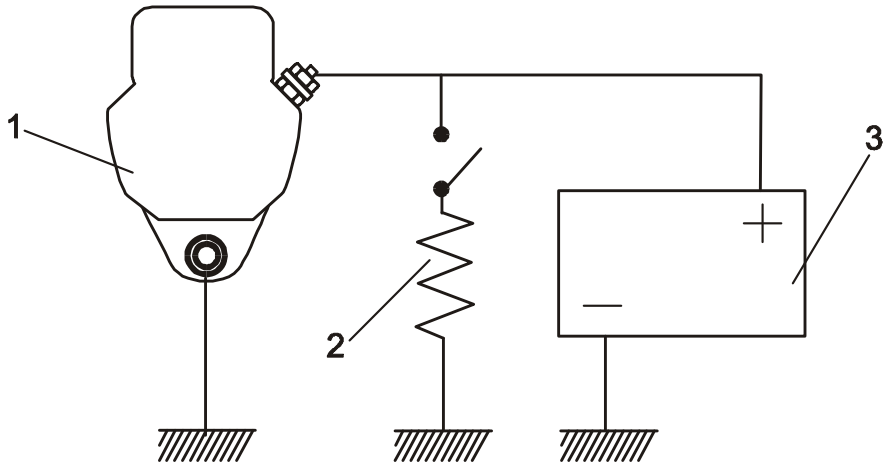

Fig. 8.6. Basic Wiring Diagram

1. Integral Charging System
2. Vehicle Loads
3. Battery

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9. INTEGRAL CHARGING SYSTEM REPAIR

Component parts and connections are shown in Fig. 8.7.

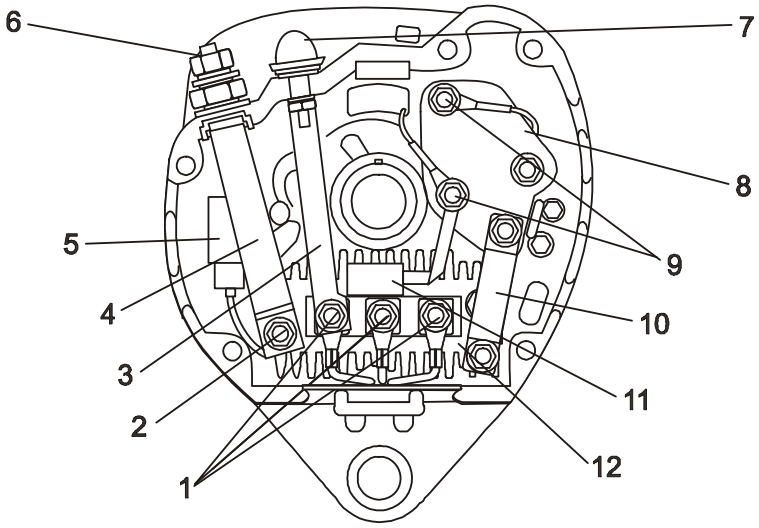

Fig. 8.7. Rectifier End Frame, 20-SI (Cover Plate Removed)

1. Stator Leads
2. Capacitor Lead
3. Relay Terminal Connector
4. Output Terminal Connector
5. Capacitor
6. Output Terminal
   - Nut
   - Lock Washer
   - Washer
   - Nut
   - Lock Washer
   - Washer
   - Insulated
   - Washer
7. Relay Terminal
   - Bushing
   - Washer
   - Bushing
   - Washer
   - Connector
   - Washer
   - Nut
8. Regulator
9. Two Field Leads Two Insulated Screw
10. Connector
11. Diode Trio
12. Rectifier Bridge

a. Regulator Check

The regulator cannot be checked with an ohmmeter. Use an approved regulator tester available from various test equipment manufacturers.

b. Diode Trio Check

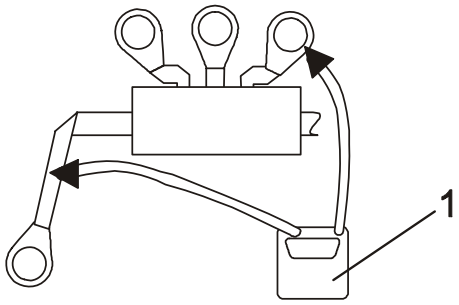

Fig. 8.8. Checking Trio

1. Ohmmeter

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To check the diode trio, remove it from the end frame assembly by detaching the nuts and attaching screw.

NOTE: *The insulating washer on the screw is assembled over the top of the diode trio connector.*

Connect an ohmmeter having a $1^1/_2$-Volt cell to the single connector and to one of the three connectors, (Fig. 8.8). Using the lowest range scale, observe the reading. Then reverse the ohmmeter leads to the same two connectors. If both readings are the same, replace the diode trio. A good diode trio will give one high and one low reading. Repeat this same test between the single connector and each of the other two connectors.

c. Rectifier Bridge Check

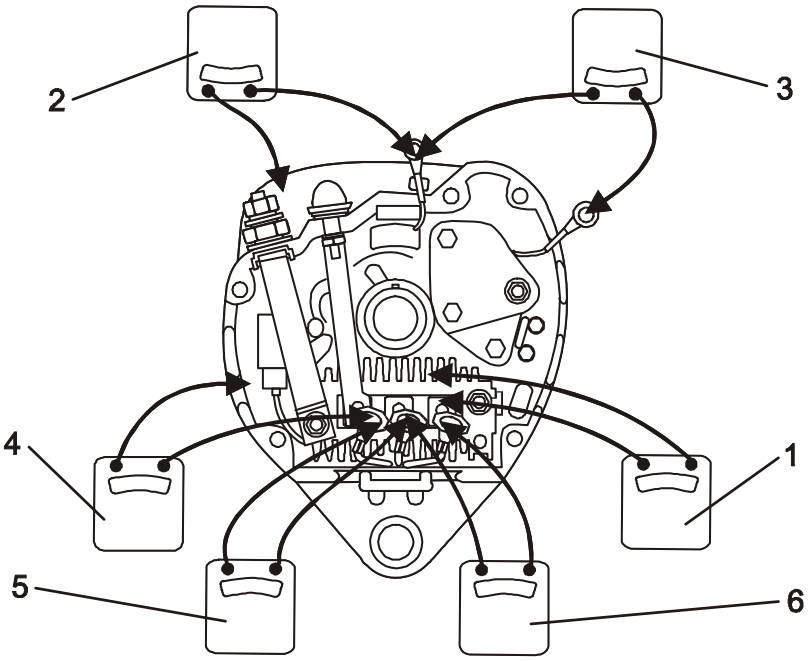

Fig. 8.9. Checking Components

1. Ohmmeter
2. Ohmmeter
3. Ohmmeter
4. Ohmmeter
5. Ohmmeter
6. Ohmmeter

Omit for overcharged battery. To check the rectifier bridge, connect the ohmmeter to a heat sink and one of the three terminals (Step 1, Fig. 8.9). Then reverse the lead connections to the same heat sink and same terminal. If both readings are the same, replace the rectifier bridge by detaching the necessary screws and nuts. A good rectifier bridge will give one high and one low reading. Repeat this same test between the same heat sink and the other two terminals, and between the other heat sink and each of the three terminals. This makes a total of six checks, with two readings taken for each check.

d. Field Coil Checks

To check for grounds, connect an ohmmeter to one field coil lead and to the end frame as illustrated in (Step 2, Fig. 8.9). If ohmmeter reading is low, the field coil is grounded.
To check for opens, connect an ohmmeter to the two field coil leads as shown in (Step 3, Fig. 8.9). If ohmmeter reading is high (infinite), the field coil is open.

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The winding is checked for short circuits by connecting a battery and ammeter in series with the field coil. Note the ammeter reading. If reading is in range (3.3 - 4.0 [A]) the field coil is good. An ammeter reading above the specified value indicates shorted windings. An alternate method is to check the resistance of the field by connecting an ohmmeter to the field coil (Step 3, Fig. 8.9). If the resistance reading is below the specified value, the winding is shorted. The specified resistance value can be determined by dividing the voltage by the current given above. To replace the field coil, see the Par. below entitled Disassembly and Repairing.

e. Stator Checks

Omit for overcharged battery. The stator windings may be checked with a 110-Volt test lamp or an ohmmeter. If the lamp light, or if the meter reading is low when connected from any stator lead to the frame, the windings are grounded (Step 4, Fig. 8.9).
If the lamp fails to light, or if the meter reading is high when successively connected between each pair of stator leads, the windings are open (Steps 5 and 6, Fig. 8.9).
A short circuit in the stator windings is difficult to locate without laboratory test equipment due to the low resistance of the windings. However, if all other electrical checks are normal and the generator fails to supply rated output, shorted stator windings are indicated.

f. Disassembly and Repairing (Fig. 8.10)

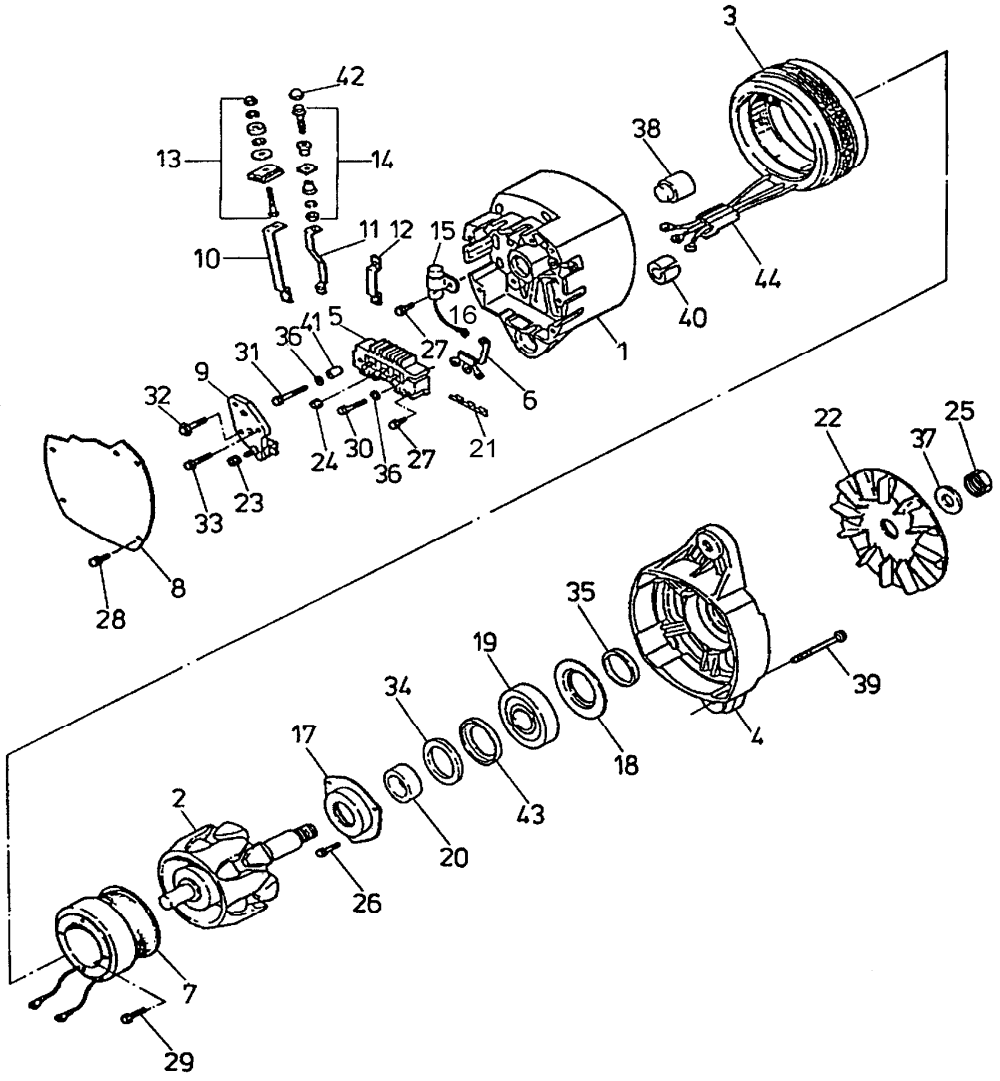

Fig. 8.10. Exploded View of Alternator

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Legend for Fig. 8.10

1. Housing Rectifier
2. Rotor
3. Stator
4. Frame
5. Rectifier Bridge
6. Diode Trio
7. Field Coil and Support
8. End Cover
9. Regulator and Resistor
10. Output Terminal Connector
11. Relay Terminal Connector
12. Regulator Connector
13. Output Terminal Package
14. Relay Terminal Package
15. Capacitor
16. Capacitor Mounting Bracket
17. Retainer Plate (Inside)
18. Retainer Plate (Outside)
19. Ball Bearing
20. Inside Collar
21. Insulator
22. Fan and Baffle
23. Nut
24. Nut
25. Nut
26. Bolt
27. Bolt
28. Bolt
29. Bolt
30. Bolt
31. Bolt
32. Bolt
33. Bolt
34. Washer
35. Washer
36. Washer
37. Washer
38. Rectifier Housing Bearing
39. Bolt
40. Pivot Bushing
41. Mounting Screw Bushing
42. Relay Terminal Cup
43. Felt Washer Cup
44. Grommet

1. Remove bolts (28) and end cover (8).
2. Remove fan (22) and pulley.
3. Remove 4 thru-bolts (39).
4. Separate drive end frame (4) and rotor (2) from rectifier end frame (1) and stator (3).
5. Press rotor (2) from end frame (4).
6. Remove inside collar (20) from rotor (2).
7. To replace drive end frame bearing (19):
   a. Remove four retaining plate (17) attaching bolts (26).
   b. Remove retainer plate (17) and felt washer (34).
   c. Push on race to remove bearing (19).
   d. Replace or re-use retainer plate (18), felt washer cup (43) and felt washer (34 and 35).
   e. Press in new bearing (19) against outer race.
   f. Soak felt washer (34 and 35) with light oil.
   g. Assemble retainer (18) with bolts.
   h. Assemble inside collar (20) over shaft.
   i. Assemble outside collar (21) under felt washer (35) next to bearing (19) while supporting outside collar (21).
   j. Press rotor (2) into drive end frame (4).
8. To replace rectifier housing bearing (38):
   a. Push out bearing (38) from either end.
   b. Use a thin wall tube in space between grease cup and housing to push bearing (38) in to dimension as shown in Fig. 8.11.

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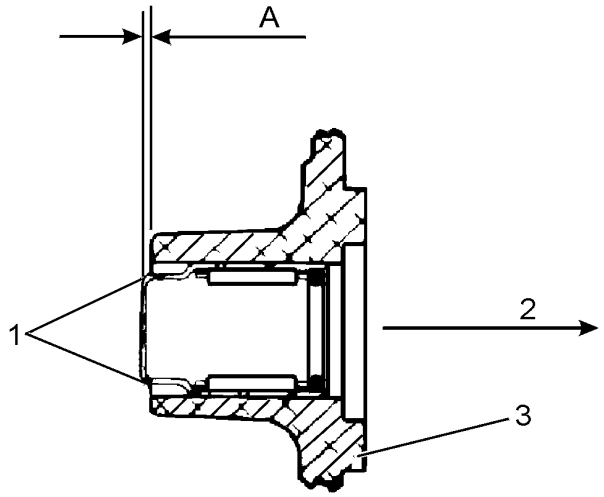

Fig. 8.11. Installing Bearing

1. Use Thin Wall Tube in Space Between Grease Cup and Housing to Push Bearing into Dimension Shown
2. Drive End
3. Partial View Rectifier End Frame

A . . . . . 2.5 [mm]

BATTERY

10. SAFETY PRECAUTIONS

a. Handling Battery Acid

1. When working with acid, wear a face shield, protective clothing, galosh, gloves.
2. Avoid spilling or splashing electrolyte as it can destroy clothing and burn the skin.
3. If electrolyte is spilled or splashed on clothing or the body, it should be neutralized immediately and then rinsed with clean water. A solution of baking soda or household ammonia and water may be used as a neutralizer.
4. When handling a battery avoid spew electrolyte through the vent.
5. If electrolyte splashed into the eyes, force the eye open and flood it with cool, clean water for approximately fifteen minutes, and doctor should be called immediately.
6. Do not place a battery or acid within the reach of children. If acid is taken internally drink large quantities of water or milk. Follow with milk of magnesia, beaten egg or vegetable oil.
7. To prepare electrolyte always pour the concentrated acid slowly into the water, not the water into the acid. Except for lead or lead lined containers, use nonmetallic receptacles and/or funnels. Do not store acid in excessively warm locations or in direct sunlight.

b. Danger of Exploding Battery

1. Keep sparks, flames, burning cigarettes or other ignition sources away at all times, because batteries expel explosive gases.
2. Never lean over battery during charging, testing or Jump Starting operations.
3. Do not break live circuits at the terminals of batteries.
4. Make certain the battery cable clamps are making good connections.
5. Be careful that tools or metallic objects do not fall across the battery terminal.

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c. Charging a Battery

1. The compartment in which the battery is being charged should be well ventilated.
2. Do not charge a battery unless you are thoroughly familiar with manufacturer's instructions.
3. Do not put a battery on charge unless you are wearing safety goggles and a face shield.
4. Turn the charge rate switch and timer to the OFF position before connecting the leads to the battery. Next, connect the charger leads to the battery terminals, red positive (+) lead to positive terminal and black negative (–) lead to negative terminal. Now, turn on the charger and slowly increase the charging rate until the desired ampere value is reached. If smoke or dense vapor comes from the battery, shut off the charger and reject the battery. If violent gassing or spewing of electrolyte occurs, reduce or temporarily halt the charging.
5. Never touch the charger leads when the charger is ON. Always turn the charger OFF before removing a charger lead from the battery.

11. ELECTROLYTE STATE OF CHARGE

A battery with a fully charged specific gravity of 1.265 corrected to 26.7 [°C] contains an electrolyte with approximately 36 [%] sulfuric acid by weight or 25 [%] by volume. Pure sulfuric acid has a specific gravity of 1.835. The specific gravity can be measured directly with a hydrometer or determined by the stabilized voltage.

The state-of-charge battery shows the chart below.

Charge Level	Specific Gravity	Voltage
100 [%]	1.265	12.68
75 [%]	1.225	12.45
50 [%]	1.190	12.24
25 [%]	1.155	12.06
Discharged	1.120	11.89

Never take a hydrometer reading immediately after water is added to the cell. The water must be thoroughly mixed with electrolyte, by charging. If a reading is being taken immediately after prolonged cranking, it will be higher than the true value.

A correction factor must be applied for any specific gravity reading made when the electrolyte temperature is not 26.7 [°C].

A correction factor of 0.004 specific gravity is used for each 5.5 [°C] change in temperature, (0.004 are added to the each 5.5 [°C] increment above 26.7 [°C] and 0.004 are subtracted for each 5.5 [°C] increment below 26.7 [°C]).

12. ELECTROLYTE IN TROPICAL AND ARCTIC CLIMATES

a. Tropical Climate

Batteries used in temperature climates have a fully charged specific gravity in the 1.250 to 1.280 range. A fully charged electrolyte specific gravity of 1.210 to 1.230 is used in tropical climates. This increases the service life of the battery.

b. The State of Charge Batteries at Various Climate

The state OFF charge batteries at various climate shows chart below.

State of charge	Specific gravity in arctic climate	Specific gravity in tropical climate
100 [%]	1.265	1.225
75 [%]	1.225	1.185
50 [%]	1.190	1.150
25 [%]	1.155	1.115
Discharged	1.120	1.080

c. Arctic Climate

Batteries used in arctic climate use stronger electrolyte of 1.290 to 1.300. Higher specific gravity decrease the service life of the battery.

As the battery approaches the discharged condition, the easier it is for its electrolyte to freeze.

d. Electrolyte Freezing Point

Electrolyte freezing point shows chart below.

Freezing point	Specific gravity
-10 [°C]	1.120
-27 [°C]	1.200
-54 [°C]	1.255
-65 [°C]	1.270

13. TESTING AND MAINTENANCE THE BATTERY

a. Visual Inspection

Visually inspect the outside of the battery for obvious damage such as a cracked or broken case or cover which would allow electrolyte loss. If top of a battery is dirty, secure vent plugs, clean it with a brush dipped in ammonia or soda solution. After foaming stops, flush of battery with clean water. Check for terminal damage. Brighten terminal contact surfaces with steel wool or a stiff brush. Check the condition of the battery cables.

b. Electrolyte Levels and State of Charge

In abnormal conditions (above 32 [°C] and below 0 [°C]) it is recommended to check electrolyte level frequently, to prevent electrolyte within cells from evaporating below top of plates. Although these batteries are designed to preclude the need to add water, the volume of reserve electrolyte above the plates may eventually be depleted. In most cases, this will signal the end of the battery´s useful life. If electrolyte levels are found to be low or a battery is in a deep state of discharge, check for charging system malfunction and/or loose battery trays and hold-down clamps. Add water before proceeding further. The state-of-charge of low water loss batteries can be determined with an accurate voltmeter.

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1. If the stabilized open circuit voltage is below 12.2 [V], charge the battery as described under BATTERY CHARGING until an open circuit voltage at least 12.4 [V] is obtained (after surface charge has been taken off). When a hydrometer reading can be taken, a value of 1.225 at 26.7 [°C] can be used instead of the 12.4 voltage reading. After the battery is charged, proceed to Step 3.
2. If the state-of-charge of a battery cannot be determined, it must be charged. After the battery is charged, proceed to Step 3.
3. Remove surface charge by attaching test leads to the terminals and applying a load 475 [A] (1/2 of the Cold Cranking Amperes at -18 [°C]) rating of the battery for 15 seconds. The battery can be tested with the Electronic Battery Tester, number 15-550, or carbon pile load tester. Proceed to Load Procedure.
4. If the stabilized voltage of the battery was 12.4 [V] or above when it was first examined, proceed to Load Procedure.

c. Load Procedure

NOTE: *This procedure is valid only if the battery is at or above the state of charge specified in Electrolyte Levels and State of Charge.*

The load test procedure is conducted to determine if the battery has adequate electrical performance or must be replaced.

1. Connect the voltmeter and load test leads to the battery terminals, making sure the load switch is in the OFF position
2. Apply a load test 475 [A] (1/2 of the Cold Cranking Amperes at -18 [°C]) rating of the battery. Read voltage after 15 seconds with load connected, remove load. Estimate or measure battery temperature and compare voltage reading with the Voltage Chart.

Voltage Chart

Estimated Electrolyte Temperature	Minimum Required voltage is under 15 second load
21 [°C] and above	9.6
16 [°C]	9.5
10 [°C]	9.4
4 [°C]	9.3
-1 [°C]	9.1
-7 [°C]	8.9
-12 [°C]	8.7
-18 [°C]	8.5

If the voltage is less than the minimum specified, replace the battery. If the voltage meets or exceeds the specified minimum, return it to service.

d. Charging Low Water Loss Batteries

Refer to SAFETY PRECAUTIONS. If, when charging the battery, violent gassing or spewing of electrolyte occurs, or the battery case feels hot 52 [°C], reduce or temporarily halt charging to avoid damaging the battery. For best results, batteries should be charged while the electrolyte is at room temperature 13 - 30 [°C]. Since age, state of charge of batteries vary. Time and attention must be given to batteries during any charging process.

The charge a battery is equal to the charge rate in amperes multiplied by the time in hours. Thus a five ampere rate applied to a battery for ten hours would be a 50 ampere-hour charge to the battery. To fully recharge a battery, you must replace the ampere-hours or ampere-minutes removed from it: plus an extra 20 [%] charge.

14. BATTERY CHARGING GUIDE

Recommended Rate and Time for Fully Discharged Condition

Rated Battery Capacity	Charge	
Above 126 to 170 Minutes	2.75 hours at 30 Amperes	3 hours at 25 Amperes
	4 hours at 20 Amperes	5.5 hours at 15 Amperes

Determine the state-of-charge of the battery with a hydrometer or open circuit voltmeter. The best method of making certain a battery is fully charged, is to measure the specific gravity of a cell once per hour. The battery is fully charged when the cells are gassing freely at low charging rate and less than 0.003 change in specific gravity occurs over a three hour period.
When any battery is being charged, periodically measure the temperature of the electrolyte, if the temperature exceeds 52 [°C], or if violent gassing or spewing of electrolyte occurs, the charging rate must be reduced or temporarily halted.

The battery generally cannot be fully charged the fast charge method. But it will receive sufficient charge (70 to 90 [%]) for practical service. To completely recharge a battery, follow the fast charge with a slow charge until to change in specific gravity occurs over a three hour period.
A battery with electrolyte specific gravity of 1.225 or above, should never be charged at a high rate. If the battery is badly sulfated, the temperature may rise rapidly soon after it is placed on charge. As the sulfate starts to break up, the charge rate in amperes will increase noticeably. These batteries should be placed on a slow charge. If a battery is to be recharged overnight (16 hours), a timer or voltage controlled charger is recommended. If a battery cannot be restored to a fully charged condition by slow charging, it should be rejected. The slow charge conditions are above in Battery Charging Guide. The temperature of a normal battery may rise above the desired maximum of 52 [°C] if it reaches the fully charged state and is left on charge.

15. BATTERY STORAGE

Low water loss batteries have excellent shelf life due to their low self-discharge rates. Batteries should be stored in a cool, dry place. Storage above 27 [°C] increases self-discharge. If batteries are discharged, the electrolyte may freeze when stored below -7 [°C].

Battery stock must be rotated on a strict "first-in, first-out" basis.

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Batteries in stock should be recharged when the stabilized voltage falls to 12.2 [V] or specific gravity drops below 1.240. If good stock rotation and inventory control have been maintained, the battery may be installed without charging. However, if the battery stabilized voltage is less than 12.2 [V] it should be recharged before installation.

16. BATTERY PRIMERY RATINGS

Battery ratings include: Cranking Performance Amperes (CRANKING AMPS @ 32° F), Cold Cranking Amperes (CCA) and Reserve Capacity (RC).

1. Cranking Performance Amperes (CRANKING AMPS @ 32° F)
   The Cranking Performance Amperes is the discharge load in amperes that a new, fully charged battery operating at 0 [°C] (32° F) can deliver for 30 seconds and maintain a voltage above 7.2 [V].

2. Cold Cranking Amperes (CCA)
   The Cold Cranking Amperes is the discharge load in amperes that a new, fully charged battery operating at -17.8 [°C] can deliver for 30 seconds and maintain a voltage above 7.2 [V].

3. Reserve Capacity (RC)
   The Reserve Capacity Rating is the number of minutes a new, fully charged battery at 26.7 [°C] can be discharged at 25 [A] until its voltage drops below 10.5 [V].

17. COLD ENGINE CRANKING PERFORMANCE

Effect of temperature and oil viscosity on ENGINE CRANKING PERFORMANCE

1. Battery capacity is greatly reduced by cold. The reduction in cranking power when the temperature drops from 26.7 [°C] to 0 [°C] is 65 [%] or -18 [°C] is 40 [%].
2. Stiff engine oil adds to the load of starting. With the use of single-viscosity winter-grade SAE 20W oil the cranking power requirement rises about 2-1/2 times on the drop in temperature from 27 [°C] to -18 [°C]. Note that a nearly-discharged battery at -18 [°C] has less than 1/10 the available cranking power of a fully charged battery at 27 [°C].

18. DRY CHARGE ACTIVATION

1. Before attempting to activate a battery read and understand the SAFETY PRECAUTIONS in this chapter.
2. Battery and acid must be at a temperature of 15 [°C] to 38 [°C] at time of filling.
3. Remove the plugs and fill each cell to level 21 - 27 [mm] above the top edge plates. Electrolyte gravity should be 1.265 $\pm$ 0.005 at temperature 27 [°C].
4. Wait for minimum 20 minutes to soake plates. Add additional electrolyte to proper level. It is recommended wait for 3 hours after filling of battery.
5. Charge battery no more than 7 [A] for 30 minutes. Battery is ready if specific gravity is 1.250 or more at temperature 15.5 [°C].
6. Check electrolyte level and add distillated water if need.

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7. Dry charged batteries may be placed in service immediately after activation. However, to insure good performance these additional steps are recommended.
   Check the specific gravity of all cells. Under good storage conditions, the electrolyte specific gravity on activating a dry-charged battery will drop approximately 0.010 and temperature will rise 4 [°C] to 5.6 [°C] within twenty minutes of filling the battery. A battery under these conditions requires little boost charging. However, should the specific gravity drop 0.030 or more with a corresponding increase in temperature, the negative plates have been oxidized and the battery should be fully recharged before use. Also, the battery should be recharged if one or more cells gas violently after the addition of electrolyte. After electrolyte is added, check the open circuit terminal voltage of the battery. If battery reads less than 10 [V] this indicates a reverse cell, an "open" circuit or a shorted cell, and the battery should be replaced.

19. TYPICAL CAUSE OF BATTERY FAILURE

1. Is the battery being used in the application for which it was designed.
2. Does the hold-down hardware fit the battery properly.
3. Has the battery required frequent water addition in one or more cells? Excessive water loss in one cell may indicate a short. Excessive water loss in all cells may indicate overcharging, a worn out battery, or both.
4. Is the electrolyte cloudy, discolored, or contaminated with foreign material? Cloudy electrolyte can indicate active material shedding due to overcharge or vibration. Electrolyte contamination can cause high self-discharge rates and poor performance.
5. Are alternate plates dark and light colored? In a charged cell, the positive plates should be dark in color and the negative plates light. If all plates are very light, severe undercharging could be indicated.
6. Is voltage regulator setting correct? A high voltage regulator setting can cause excessive gassing and water loss, thermal runaway, and eventual damage to plates and separators. If the voltage regulator setting is too low, the battery will be in constant state of discharge.

20. VISUAL INSPECTION OF BATTERY

a. Inspection Before Disassembly

The following will describe a procedure which could be used to make an internal examination of a battery which has failed. First, the battery is fully charged: at least an attempt is made to fully charge it. The specific gravity of the electrolyte in each cell is recorded. The battery open circuit voltage is recorded. All cell voltages should be recorded. The battery is allowed to stand for three days and the specific gravity readings are recorded a second time. An excessive specific gravity drop (35 points) in one or more cells is an indication that shorts exist in those cells. If two adjacent cells have gravity readings considerably lower than the others, it is a good indication that electrical leakage exists between the two cells and is discharging them. If the container and/or cover is cracked it could be due to abuse (an impact blow), freezing or the battery exploded. High temperatures may permit the container to bulge.

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b. Inspection After Disassembly

The next step is to pour the electrolyte from the battery and remove the cover by sawed off the battery with a hacksaw or band saw. The next step is to cut the intercell connections. This can be done with a bolt cutter. The elements can now be lifted from the container. Remove the element from the cell with the lowest specific gravity electrolyte. Squeeze the element gently and let excess acid drain from it. Examine the sides of the element for treeing shorts between positive and negative plates. These are generally caused by misalignment of the plates and separators. Check for broken or bent grid frames shorting against an adjacent plate. Look under the plate straps to see if there is a lead rundown from the strap to a plate beneath it. Determine if the top of a grid frame has broken and moved upward until it is shorting against a plate strap. Remove the plates from the plate strap with a hacksaw.

1. POSITIVE PLATE; If the plate has a distinct zone of white sulfate near the top this was caused by a low electrolyte level. Restoring the electrolyte level will not help the sulfated area. Uniform shedding over the entire surface of the positive plates is normal for a battery after long service. When material has shed from the plate in small chunks, it could be due to vibration, too high a charging rate on a sulfated plate, or the battery freezing while it was discharged. Continued overcharging oxidizes the positive grids and reduces the cross-section of the wires. If the plate is hard when scratched, or has areas of white sulfate on it, the battery has stood in a discharged condition.
2. NEGATIVE PLATES; The sponge lead of the negative plate is normally a slate gray color. If you rub the back of your thumbnail or a spatula across a good negative plate, this will create a path of metallic sheen. If a metallic sheen is not created, the negative material is inactive.
   A partially charged negative plate has sandy appearance. If the negative plate material of a fully charged battery appears sandy, the plates are worthless. This condition may result from operation of the battery while the element was shorted. It can be caused by high gravity acid and high temperature conditions prevail for some time, the negative plate material may become soft. If negative plates have a white discoloration, it is probably due to an accumulation of lead sulfate.
   The sulfate could result from a low electrolyte level or being in a low state of charge for a considerable length of time. Negative plates that are severely cracked can be the cause of failure. This is typically caused by many repeated, shallow discharge-recharge cycles. The positive plates may eventually be destroyed by the overcharging, although the prime reason for the battery failure could have been the negative plates.
3. SEPARATORS; Hold the separators in front of a bright light and visually inspect for holes, dendrites, or active material through the pores of the separator web, or other visible damage.

CRANKING MOTOR 42 MT

21. SPECIFICATIONS

Manufacturer type	Delco Remy 42 MT
Maximum power	10.4 [NP]
Supply voltage	24 [V]
Noise housing bolts torque	190 - 250 [Nm]

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No-Load Test

Volts	20
Min. Amperes	50
Max. Amperes	90
Min. [RPM]	6300
Max. [RPM]	8400

Solenoid Checks

Pull-in Winding:

Amperes	8.5 - 10.0
Volts	5
Ohms	0.5 - 0.59

Hold-in Winding

Amperes	11 - 15
Volts	20
Ohms	1.3 - 1.8

22. INTRODUCTION

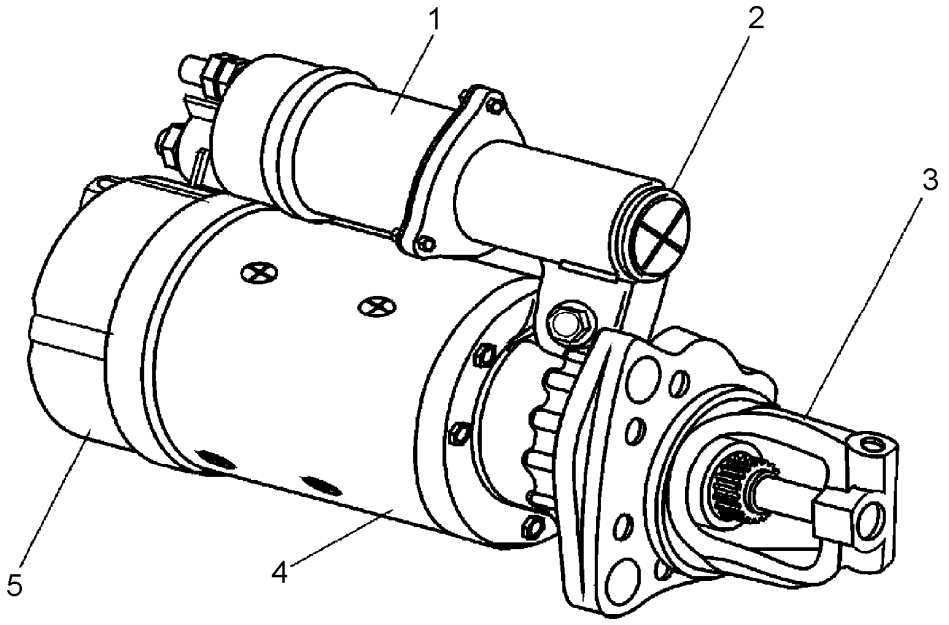

Fig. 8.12. View of Cranking Motor

1. Solenoid
2. Lever Housing
3. Nose Housing
4. Field Frame
5. End Cap

Heavy duty cranking motors have a shift lever in lever housing (2, Fig. 8.12) and plunger in solenoid (1) that are totally enclosed to protect them from exposure to dirt, icing conditions and splash. The nose housing (3) can be rotated to obtain a number of different solenoid (1) positions with respect to the mounting flange.

Lubrication is provided to the sintered bronze bushings by an oil saturated wick (3, 9 and 14, Fig. 8.13). Oil can be added to each wick by removing an oil reservoir cup which is accessible on the outside of the motor.

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The pinion is moved into mesh with the ring gear by the action of the solenoid. The pinion remains engaged until the solenoid circuit is interrupted. In case of a butt engagement the motor will not be energized to prevent damage to the pinion and gear teeth.

Under normal operating conditions, no maintenance will be required between engine overhaul periods. At time of engine overhaul, motors should be disassembled, inspected, cleaned, and tested as described in succeeding paragraphs.

As shown in the cross-sectional view of Fig. 8.13, the nose housing is attached to the lever housing by means of bolts located around the outside of the housing. To relocate the housing, it is only necessary to remove the bolts, rotate the housing to the desired position, and reinstall the bolts. In this type of assembly, the lever housing and the commutator end cap are attached to the field frame independently by bolts entering threaded holes in the field frame.

23. OPERATING (Fig.'s 8.12 and 8.13)

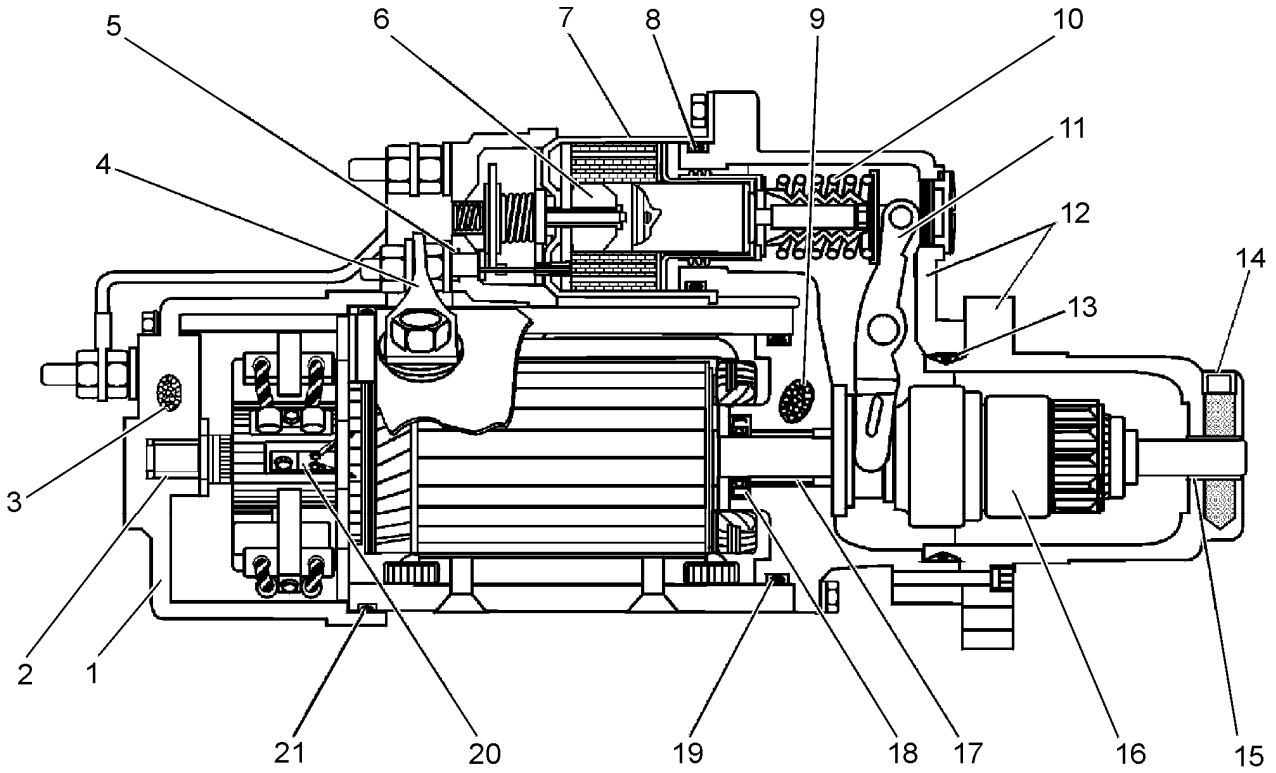

Fig. 8.13. Cross - Sectional View of Cranking Motor

1. Removable End Cap for Inspection
2. Bronze Bearing
3. Oil Wick
4. Connector Strap
5. Gasket
6. Low - Friction Bushing
7. Seamless, One - Piece Solenoid Case
8. O-Ring
9. Oil Wick
10. Sealing Boot
11. Totally Enclosed Shift Mechanism
12. Two - Piece Housing
13. O-Ring
14. Oil Wick
15. Bronze Bearing
16. Heavy - Duty 7-Roll Drive
17. Bronze Bearing
18. Shaft Seal
19. O-Ring
20. One - Piece Brush
21. O-Ring

NOTE: *The starting circuit was explained in WIRING DIAGRAM Paragraph. 3, Machine Electrical System in this Section.*

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The solenoid windings are energized and the resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear and the solenoid main contacts to close, and cranking takes place. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened, at which time the return spring causes the pinion to disengage. To prevent excessive overrun and damage to the drive and armature windings, the switch must be opened immediately when the engine starts.

A cranking period for all types of motors should never exceed 30 seconds without stopping to allow the motor to cool.

24. TROUBLESHOOTING THE CRANKING CIRCUIT

If the cranking system is not performing properly, make the following check to help determine which part of the circuit is at fault.

a. Battery

To determine the condition of the battery, follow the testing procedure outlined in this Section, BATTERY. Insure that the battery is fully charged. **The wiring, switches, and cranking motor cannot be checked if the battery is defective or discharged.**

b. Wiring

Inspect the wiring for damage. Inspect all connections to the cranking motor, solenoid, magnetic switch, any other control switch, and battery, including all ground connections. Clean and tighten all connections as required.

The cranking system cannot operate properly with excessive resistance in the circuit.

c. Magnetic Switch, Solenoid and Control Switches

Inspect all switches to determine their condition. From the Electrical Dozer System determine which circuits should be energized with the starting switches closed. Use a voltmeter to detect any open circuits.

d. Motor

If the battery, wiring and switches are in satisfactory condition, and the engine is known to be functioning properly, remove the motor and follow the test procedures outlined below.

A cranking motor is designed for intermittent duty only, and should never be operated for more than 30 seconds at a time. After 30 seconds, the cranking must be stopped for at least two minutes to allow the motor to cool.

With the cranking motor removed from the engine, the armature should be checked for freedom of rotation by prying the pinion with a screwdriver. Tight bearings, a bent armature shaft, or a loose pole shoe screw will cause the armature does not turn freely. If the armature does not turn freely the motor should be disassembled immediately. However, if the armature does rotate freely, the motor should be given a no-load test before disassembly.

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e. No-Load Test (Fig. 8.14)

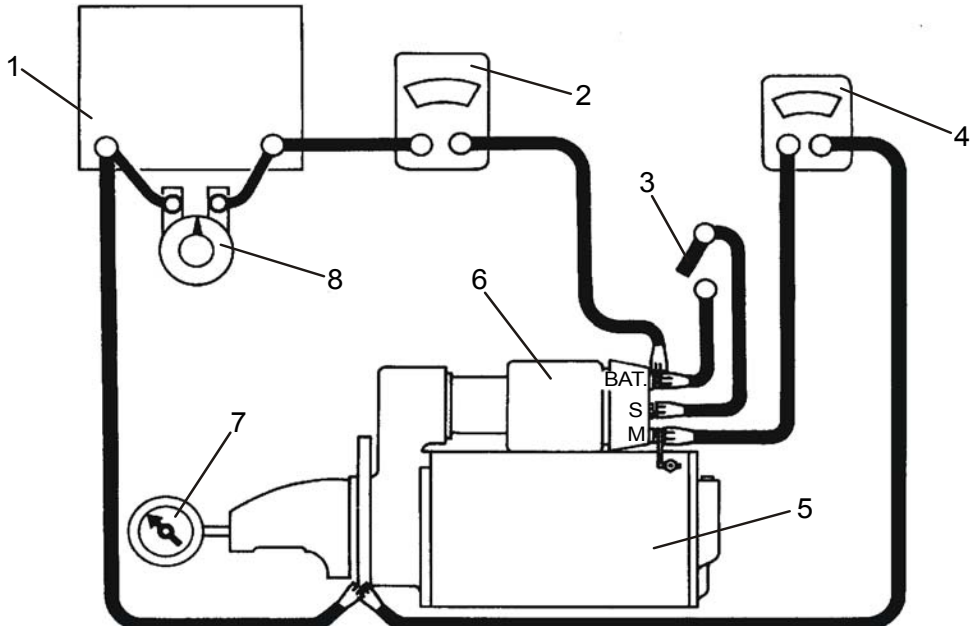

Fig. 8.14. No-Load Test Circuit

1. Battery
2. Ammeter
3. Switch
4. Voltmeter
5. Cranking Motor
6. Solenoid
7. RPM Indicator
8. Carbon Pile

Connect a voltmeter from the motor terminal to the motor frame, and use an [RPM] indicator to measure armature speed. Connect the motor and an ammeter in series with a fully charged battery of the specified voltage, and a switch in the open position from the solenoid battery terminal to the solenoid switch terminal. Close the switch and compare the [RPM], current, and voltage reading with the specifications in this Section. It is not necessary to obtain the exact voltage specified in these specifications, as an accurate interpretation can be made by recognizing that if the voltage is slightly higher the [RPM] will be proportionately higher, with the current remaining essentially unchanged. However, if the exact voltage is desired, a carbon pile connected across the battery can be used to reduce the voltage to the specified value. Connect the carbon pile to only one of the 12-Volt batteries. If the specified current draw does not include the solenoid, deduct from the ammeter reading the specified current draw of the solenoid hold-in winding. Make disconnections only with the switch open. Interpret the test results as follows:

f. Interpreting Results of Tests

1. Rated current draw and no-load speed indicates normal condition of the cranking motor.
2. Low free speed and high current draw indicate:
   a. Too much friction-tight, dirty, or worn bearings, bent armature shaft or loose pole shoes allowing armature to drag.
   b. Shorted armature. This can be further checked on a growler after disassembly.
   c. Grounded armature or fields. Check further after disassembly.
3. Failure to operate with high current draw indicates:
   a. A direct ground in the terminal or fields.
   b. "Frozen" bearings (this should have been determined by turning the armature by hand).

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4. Failure to operate with no current draw indicates:
   a. Open field circuit. This can be checked after disassembly by inspecting internal connections and tracing circuit with a test lamp.
   b. Open armature coils. Inspect the commutator for badly burned bars after disassembly.
   c. Broken brush springs, worn brushes, high insulation between the commutator bars or other causes which would prevent good contact between the brushes and commutator.
5. Low no-load speed and low current draw indicate:
   a. High internal resistance due to poor connections, defective leads, dirty commutator and causes listed above under Number 4.
6. High free speed and high current draw indicate shorted fields.

   If shorted fields are suspected, replace the field coil assembly and check for improved performance.

g. Disassembly

Normally the cranking motor should be disassembled only so far as is necessary to make repair or replacement of the defective parts. As a precaution, it is suggested that safety glasses be worn when disassembling or assembling the cranking motor.

1. Note the relative position of the solenoid, lever housing, and nose housing so the motor can be reassembled in the same manner.
2. Disconnect field coil connector from solenoid motor terminal, and ground return lead from solenoid if present.
3. On motors which have brush inspection plates, remove the plates and then remove the brush lead screws. This will disconnect the field leads from the brush holders.
4. Remove the attaching bolts and separate the commutator end frame from the field frame.
5. Separate the nose housing and field frame from lever housing by removing attaching bolts.
6. Remove armature and clutch assembly from lever housing.
7. Separate solenoid from lever housing by pulling apart.

h. Cleaning

The drive, armature and fields should not be cleaned in any degreasing tank, or with grease dissolving solvents, since these would dissolve the lubricant in the drive and damage the insulation in the armature and field coils. All parts except the drive should be cleaned with mineral spirits and a brush. The drive can be wiped with a clean cloth.

If the commutator is dirty may be cleaned with No. 00 sandpaper. NEVER USE EMERY CLOTH TO CLEAN COMMUTATOR.

i. Brushes and Holders Servicing

Inspect the brushes for wear. If they are worn excessively when compared with a new brush, they should be replaced. Make sure the brush holders are clean and the brushes are not binding in the holders. The full brush surface should ride on the commutator to give proper performance. Check by hand to insure that the brush springs are giving firm contact between the brushes and commutator. If the springs are distorted or discolored, they should be replaced.

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j. Armature Servicing

If the armature commutator is worn, dirty, out of round, or has high insulation, the armature should be put in a lathe so the commutator can be turned down. As a final step in this procedure, the commutator should be sanded lightly with No. 00 sandpaper.

The armature should be checked for opens, short circuits and grounds as follows:

k. Checking

1. Opens - Opens are usually caused by excessively long cranking periods. The most likely place for an open to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections. Poor connections cause arcing and burning of the commutator bars as the cranking motor is used. If the bars are not too badly burned, repair can often be effected by resoldering or welding the leads in the riser bars (using rosin flux), and turning down the commutator in a lathe to remove the burned material.

2. Short Circuits - Short circuits in the armature are located by use of a growler. When the armature is revolved in the growler with a steel strip such as hacksaw blade held above it, the blade will vibrate above the of the armature core in which the short circuit is located. Shorts between bars are sometimes produced by brush dust or copper between the bars. These shorts can be eliminated by cleaning out the slots.

3. Grounds - Grounds in the armature can be detected by the use of a 110-Volt test lamp and test points. If the lamp lights when one test point is placed on the commutator with the other point on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure which is often brought about by overheating of the cranking motor produced by excessively long cranking periods or by accumulation of brush dust between the commutator bars and the steel commutator ring.

l. Field Coil Checks

The various types of circuits used are shown in the wiring diagrams of Fig. 8.15. The field coils can be checked for grounds and opens by using a test lamp.

Grounds-if the motor has one or more coils normally connected to ground, the ground connections must be disconnected during this check. Connect one lead of the 110-Volt test lamp to the field frame and the other lead to the field connector. If the lamp lights, at least one field coil is grounded which must be repaired or replaced. This check cannot be made if the ground connection cannot be disconnected.

Opens - Connect test lamp leads to ends of field coils. If lamp does not light, the field coils are open.

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CRANKING MOTOR 42 MT

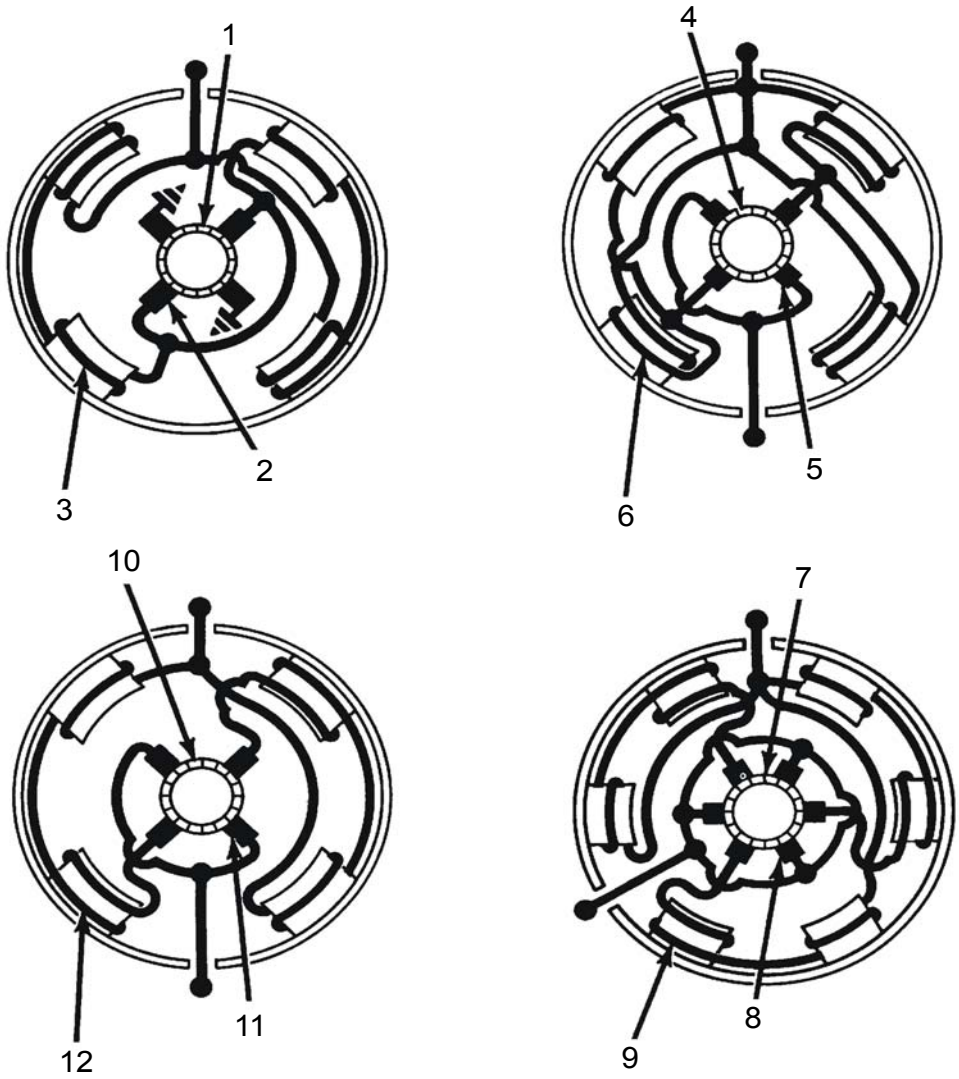

Fig. 8.15. Internal Motor Circuits

1. Commutator
2. Brush
3. Series Coil (4)
4. Commutator
5. Brush
6. Series Coil (4)
7. Commutator
8. Brush
9. Series Coil (6)
10. Commutator
11. Brush
12. Series Coil (4)

m. Field Coil Removal

Field coils can be removed from the field frame assembly by using a pole shoe screwdriver. A pole shoe spreader should also be used to prevent distortion of the field frame. Careful installation of the field coils is necessary to prevent shorting or grounding of the field coils as the pole shoes are tightened into place. Where the pole shoe has a long lip on one side and a short lip on the other, the long lip should be assembled in the direction of armature rotation so becomes the trailing (not leading) edge of the pole shoe.

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n. Solenoid Checks

A basic solenoid circuit is shown in Fig. 8.16. With all other leads disconnected, the solenoid windings can be checked by making test connections as covered below. As shown in Fig. 8.17, make connections to the S and ground return terminals. If needed, use the carbon pile to decrease the battery voltage to the value specified in this Section and compare the ammeter reading with the **holding winding specifications**. A high reading indicates a shorted winding and a low reading indicates excessive resistance. To check the pull-in winding connect from the solenoid switch terminal to the solenoid motor terminal (Fig. 8.18). Compare with the **pull-in winding specification.** A high reading indicates a shorted pull-in winding, and a low reading indicates excessive resistance. To avoid excessive heating, leave the pull-in winding connected no more than 10 seconds at a time. The current will decrease as the heating increases.

To check for grounds, move battery lead from M. terminal (Fig. 8.18) to a clean metal ground on the solenoid case, (not shown). Ammeter should read zero. If not, hold-in or pull-in winding is grounded.

NOTE: *If needed to reduce the voltage to the specified value, connect the carbon pile between the battery and the **M** terminal as shown. If the carbon pile is not needed, connect a jumper directly from the battery to the **M** terminal.*

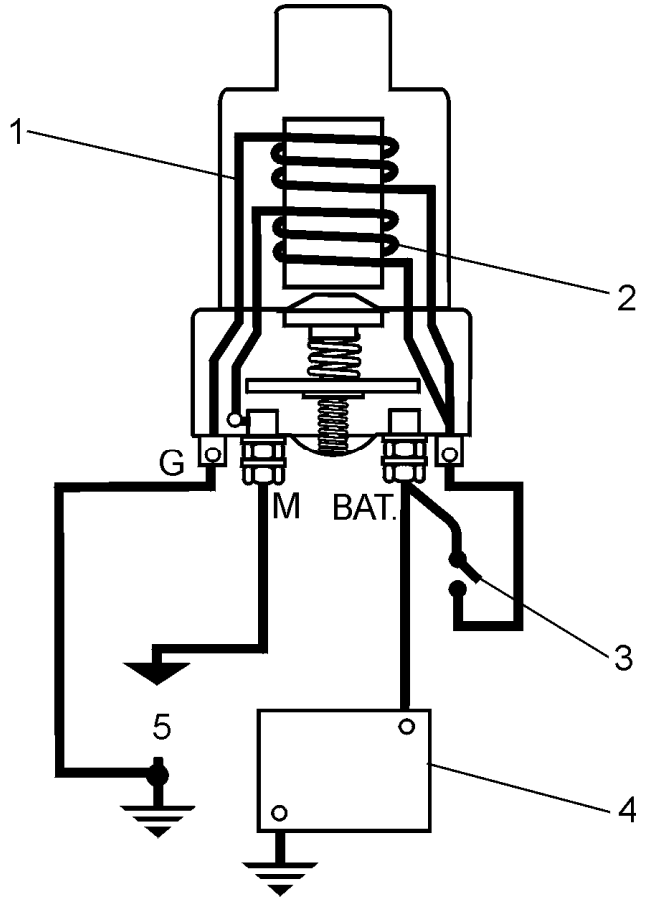

Fig. 8.16. Solenoid Circuit with Ground Return Terminals

1. Hold - In Winding
2. Pull - In Winding
3. Start Switch
4. Battery
5. To Motor Windings

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CRANKING MOTOR 42 MT

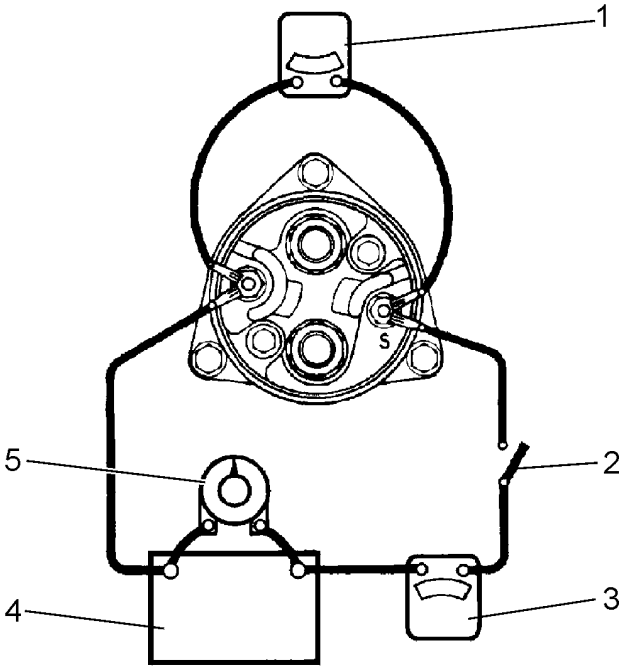

Fig. 8.17. Testing Hold-in Windings Solenoid

1. Voltmeter
2. Switch
3. Ammeter
4. Battery
5. Carbon Pile

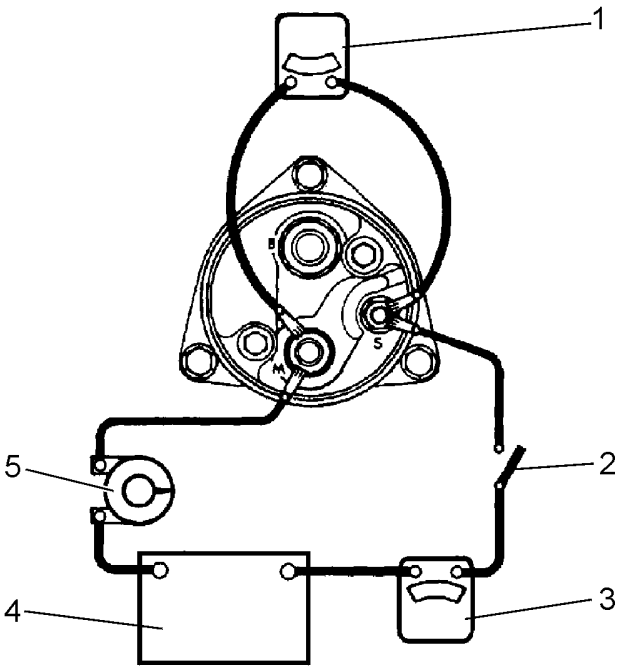

Fig. 8.18. Testing Pull-in Windings Solenoids

1. Voltmeter
2. Switch
3. Ammeter
4. Battery
5. Carbon Pile

WARNING! To prevent overheating, do not leave the pull-in winding energized more than 10 seconds. The current draw will decrease as the winding temperature increases.

A magnetic switch can be checked in the same manner by connecting across its winding.

o. Brushes Reassembly

To reassemble the brush plate assembly with brushes onto the field frame with armature in place, lift the brushes up so the spring contacts the **side** of the brush. Assemble to the field frame with the attaching screw. Lift up springs, and position brushes onto cummutator.

p. Lubrication

All bearings, wicks and oil reservoirs should be saturated with SAE 20 oil. Place a light coat of lubricant Delco Remy No. 1960954 on the washer located on the shaft between the armature and shift lever housing.

Sintered bronze bearings used in these motors have a dull finish, as compared to the early type machined, cast bronze bearings which had a shiny finish.

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Before pressing the bearing into place, dip it in SAE 20 oil. Also, tangent wicks should be soaked with SAE No. 20 oil. Insert the wick into place first, and then press in the bearing.

DO NOT DRILL, REAM OR MACHINE sintered bearings in any way!
These bearings are **supplied to size.** If drilled or reamed, the I.D., (Inside Diameter) will be too large, also the bearing pores will be sealed over.

It is not necessary to cross-drill a sintered bearing when used with a tangent wick. Because the bearing is so highly porous, oil from the wick touching the outside bearing surface will bleed through and lubricate the shaft.

Middle bearings are **support** bearings and prevent armature deflection during cranking. As compared to end frame bearings, the clearance between middle bearing and shaft is large and the clearance provides a loose fit when assembled.

r. Pinion Clearance

To check pinion or drive clearance follow the steps listed below.

1. Make connections as shown in Fig. 8.19.
2. **Momentarily** flash a jumper lead from ground return terminal to terminal MTR (Fig. 8.19). The drive will now shift into cranking position and remain so until the battery is disconnected.
3. Push the pinion or drive back towards the commutator end to eliminate slack movement.
4. Measure the distance between drive and housing (Fig. 8.20).
5. Adjust clearance by removing plug and turning shaft nut (Fig. 8.20).

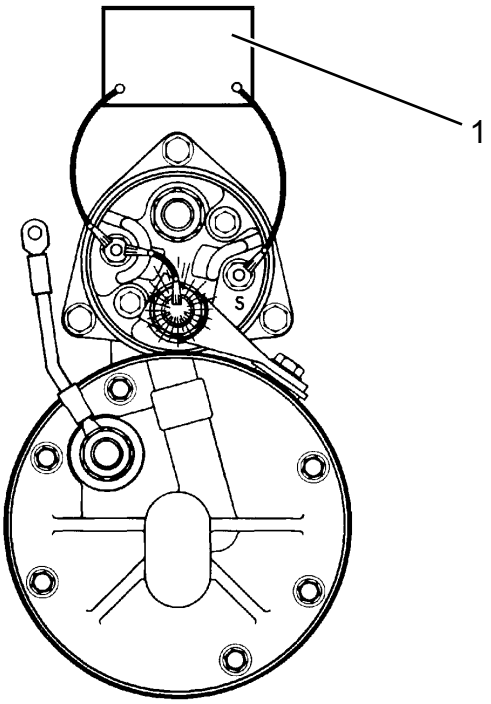

Fig. 8.19. Checking Pinion Clearance Circuit

1. Battery

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CRANKING MOTOR 42 MT

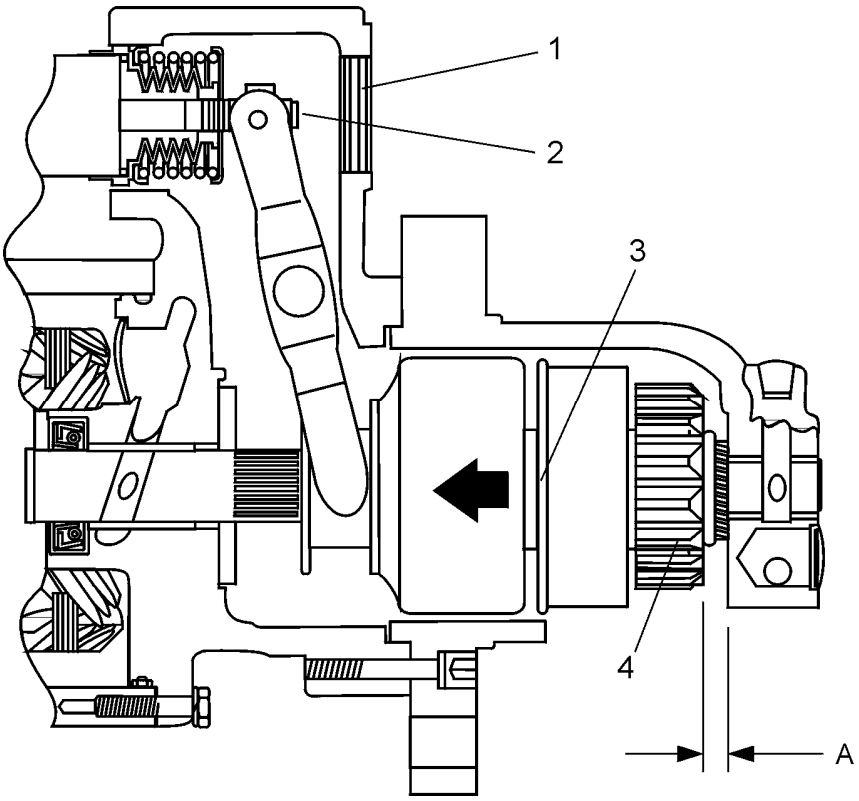

Fig. 8.20. Measuring Pinion Clearance

1. Plug Remove
2. Shaft Nut (Turn to Adjust Pinion Clearance)
3. Press on Drive to Take Up Movement
4. Pinion

A . . . . . 8.3 – 9.9 [mm]

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CRANKING MOTOR 39 MT

NOTE: *New Delco Remy 39MT HD cranking motor for applications up to 16 liters replaces the old 42MT cranking motor.*

25. SPECIFICATIONS

Manufacturer type ..... Delco Remy 39 MT HD
Maximum power ..... 9.7 [HP]
Supply voltage ..... 24 [V]
Pinion tooth 12
Noise housing bolts torque (SAE3 – 3 Bolt 120 degree) ..... 43÷53 [Nm]

The technical and design features of the 39MT HD cranking motor as compared to the 42MT cranking motor are:

- Soft start engagement,
- Solid link solenoid,
- High solenoid barrier,
- Wet seal for both dry and wet flywheel housings,
- Enhanced reliability and durability.

NOTE: *The soft start engagement feature of the 39MT-HD increases the in-rush and steady-state current draw requirements compared to the 42MT. Due to the location of switches and safety equipment of some applications, the control side wiring is critical for the 39MT-HD. The Integral Magnetic Switch (IMS, see Fig. 8.23) option, when used with the current magnetic switch reduces the control side current draw for these type of applications. The IMS option provides the opportunity to use a shorter wiring run and reduces the number of attachment points. This should result in a higher quality installation.*

The 39MT HD cranking motor has the similar power as the 42MT, with the same battery configuration, but is a smaller, lighter package size as summarized in Table 1 below:

Table 1

Cranking motor	Weight [kg]	Frame OD [mm]	Mounting Length- flange to motor body [mm]	Mounting Length- flange to ground stud [mm]
39MT HD	~14	114	303	361
42 MT	~26	130	358	393

In general, the electrical requirements for the 39MT HD cranking motor are the same as to the 42MT except for the cranking motor solenoid relay current.

The design features and electrical requirements are summarized in Table 2 below.

Table 2

Profile	42 MT	39MT HD
Cranking motor Solenoid Relay Current	N.A. / 75 [A]	200 / 50* [A]
Cranking Circuit Resistance	Max. 0.002 [Ohm]	Max. 0.002 [Ohm]
Control Circuit Voltage Drop at 20 [°C]	Max. 2 [V]	Max. 2 [V]
Engagement	Positive	Soft Start
Ventilation Orientation	Not Applicable	+/- 30 [°]
Solenoid barrier	Normal or High	High
Seal	Wet or Dry	Wet

* - in-rush / steady-state current

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CRANKING MOTOR 39 MT

The 39MT HD cranking motor has metric threads and nuts for all connections Fig. 8.21. The tightening torques for the electrical connections on the cranking motor terminal are typically as follows (See Table 3).

Table 3

Terminal	Size	Torque [Nm]
Ground Terminal	M12 x 1.75	24.0 ÷ 28.0
Solenoid Battery Terminal – B+	M12 x 1.75	24.0 ÷ 28.0
Solenoid Switch Terminal – “S”	M5 x 0.8	2.0 ÷ 2.5
Switch Terminal – “M”	M6 x 1.0	2.4 ÷ 3.0

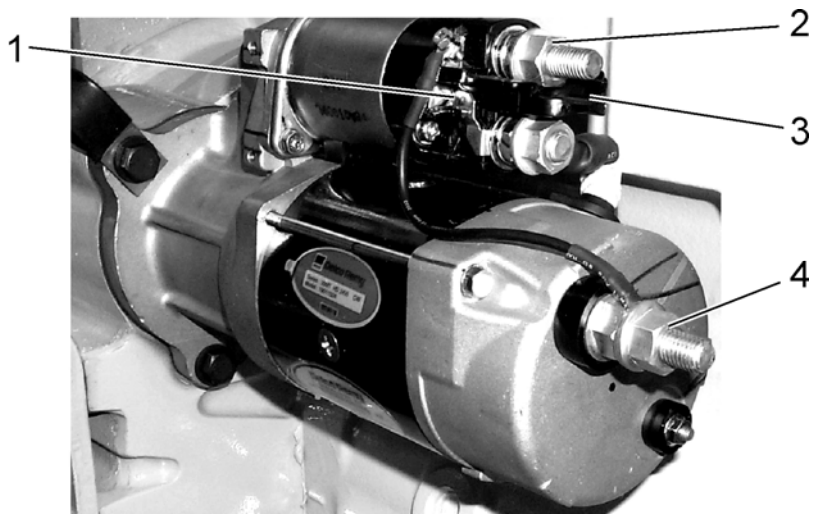

Fig. 8.21. Connection of 39MT HD Cranking Motor

1. Switch Terminal - “M”
2. Solenoid Battery Terminal - B+
3. Solenoid Switch Terminal - “S”
4. Ground Terminal

The 39MT HD cranking motor is more efficient than the earlier 42MT model, providing more output torque for stronger starts with a new planetary gear reduction design. This reduction also reduces heat build-up in the cranking motor. The open construction of the new 39MT HD allows for the release of any condensation that has formed or contamination that has penetrated the device, increasing the reliability of the motor. The smaller size of the 39MT HD provides better clearance, visibility, and access.

The Delco Remy electrical "Soft Start" system slowly rotates the pinion until it is properly engaged to the ring gear before cranking. This feature provides an additional measure of protection from the inputs that can cause pinion chipping and milling which can result in cranking motor failure.

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CRANKING MOTOR 39 MT

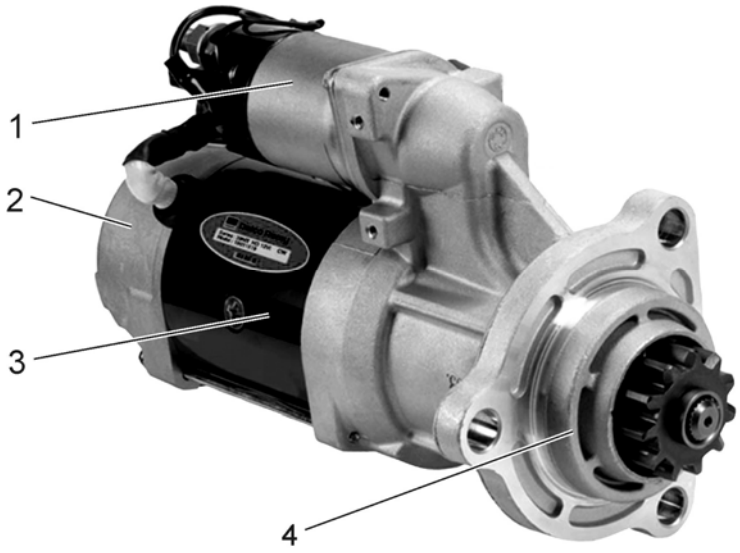

Fig. 8.22. View of 39MT HD Cranking Motor

1. Solenoid
2. End Cap
3. Field Frame
4. Nose Housing

The 39MT HD utilizes a diecast aluminum nose housing (4, Fig. 8.22) to interface with the engine flywheel housing while the 42MT utilizes a cast iron nose housing. The lower compressive yield of the aluminum nose housing requires the use of a mounting washer to prevent brinnelling. In addition to the new mounting hardware, a lower torque value is required as compared to the 42MT cranking motor.

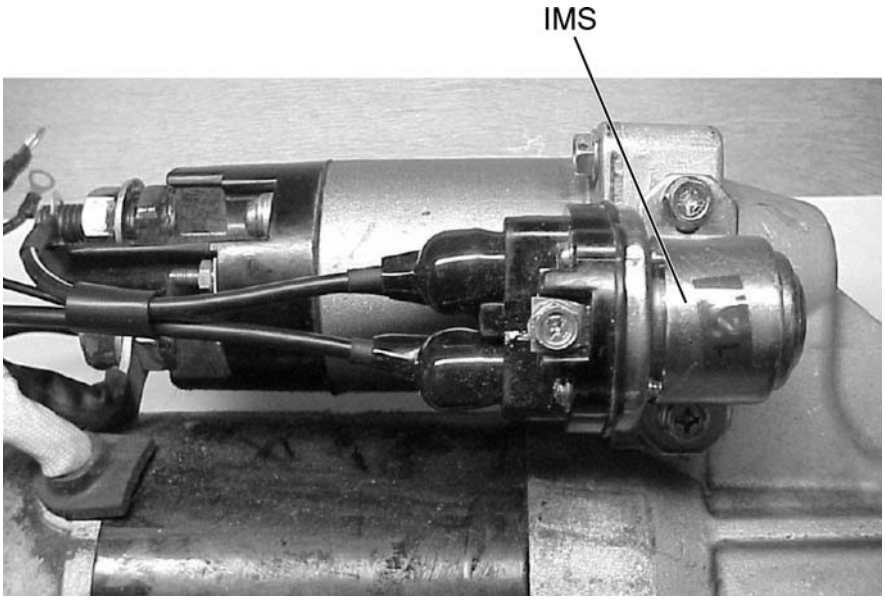

Fig. 8.23. View of 39MT Cranking Motor with Integral Magnetic Switch

IMS- Integral Magnetic Switch

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SECTION 9

FRAME

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SERVICE /SPECIAL TOOLS

1. SERVICE /SPECIAL TOOLS

DESCRIPTION	TOOL NUMBER
Aligning Pin to Plug Installation	Fabricate Fig. 9.1

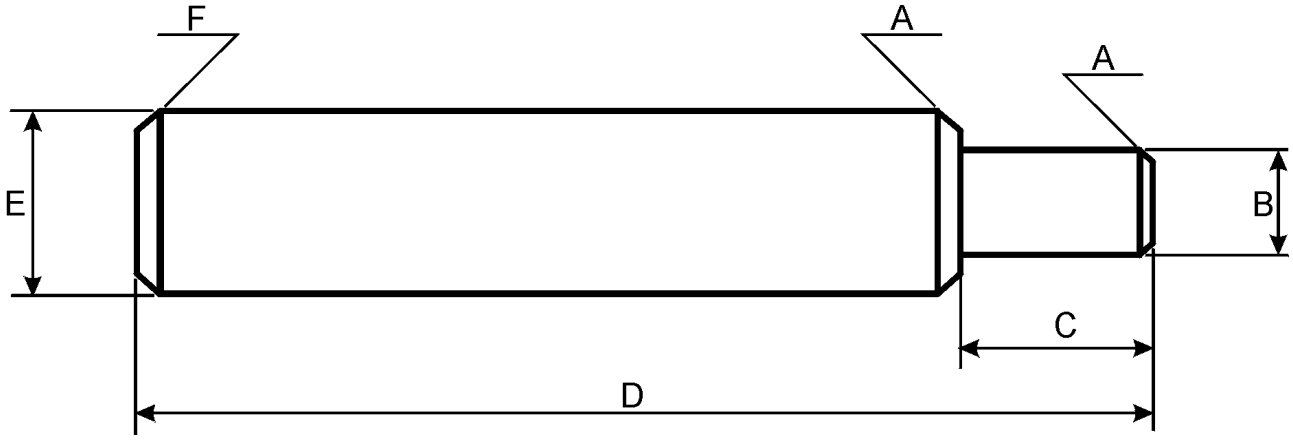

Fig. 9.1. Aligning Pin to Plug Installation

A. . . . . 2 x 45 [°]
B. . . . . ∅ 9 - 0.2 [mm]
C. . . . . 8 - 0.2 [mm]
D. . . . . 400 [mm]
E. . . . . ∅ 28 [mm]
F. . . . . 4 x 45 [°]

GENERAL

2. DESCRIPTION

The main frame provides solid support and protection for individual drive train components. It is a one piece weldment consisting of the front frame, rear frame, equalizer bar tunnel and radiator guard.

The front section supports the engine and torque converter and includes an equalizer bar cross tunnel for attaching and housing the equalizer bar and an integral radiator guard for mounting the radiator.

The rear section consists the double wall side steel castings and supports the transmission, the steering drive and final drives. Cross members including equalizer bar tunnel, join the box section side members into rigid and durable structure. Hence, working loads applied to the rear frame by rear mounted attachments or to the crosstube by the blade, are distributed through the frame side members to the undercarriage not affecting the drive train components.

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FRAME

GENERAL

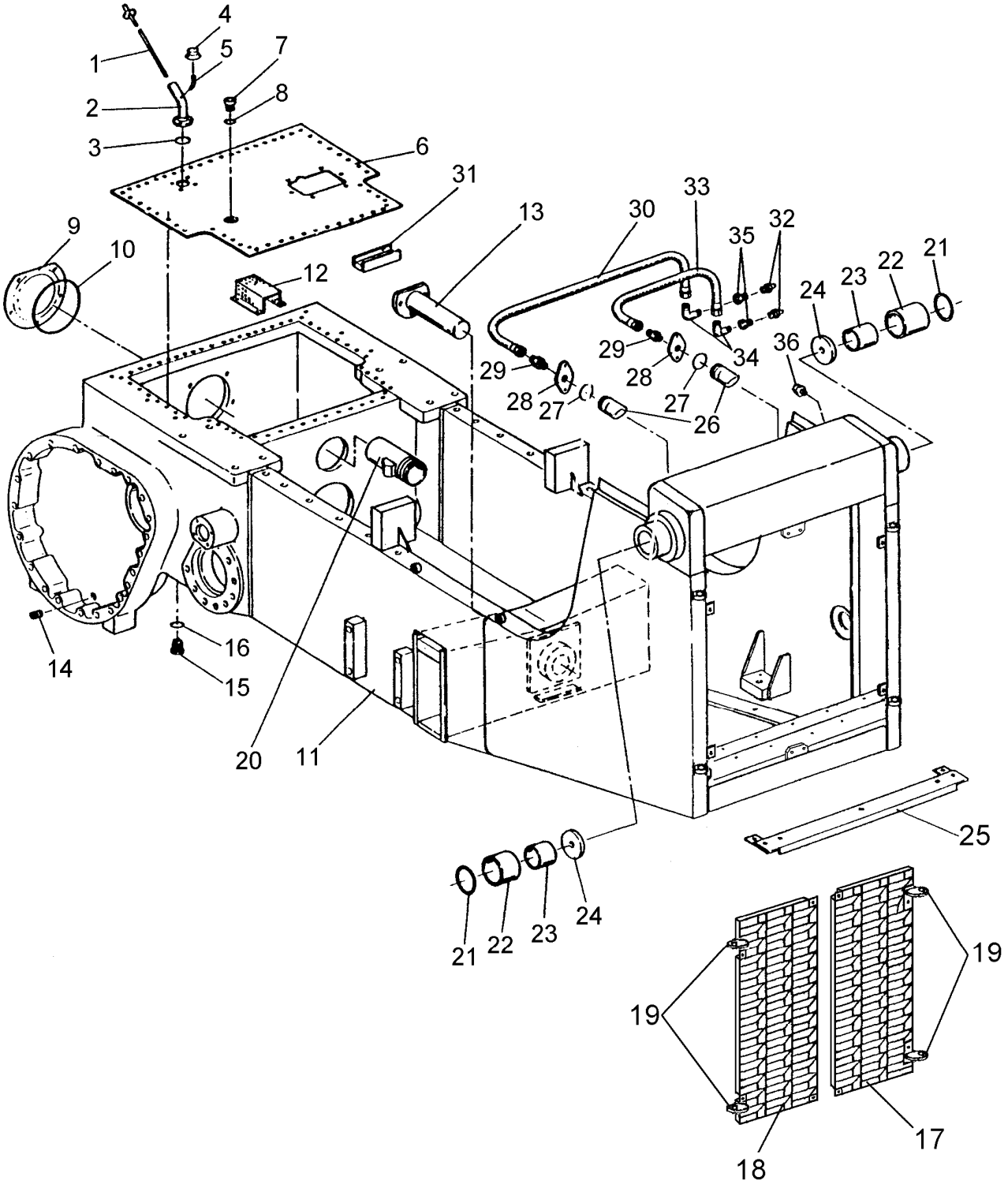

Fig. 9.2. View of Frame

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GENERAL

Legend for Fig. 9.2

1. Oil Level Gauge
2. Oil Filler Tube
3. O-Ring
4. Breather
5. Elbow
6. Rear Frame Cover
7. Plug
8. O-Ring
9. Inspection Cover
10. O-Ring
11. Main Frame
12. Shield
13. Pin
14. Magnetic Plug
15. Drain Plug
16. O-Ring
17. Louver L.H. Door
18. Louver R.H. Door
19. Door Hinge
20. Power Take Off Standpipe
21. Wiper Ring
22. Tube Outer Bushing
23. Tube Inner Bushing
24. Plug
25. Lower Bracket
26. Lift Yoke Retainer
27. O-Ring
28. Cover
29. Connector
30. Hose
31. Magnet
32. Lube Fitting
33. Hose
34. Elbow
35. Connector
36. Plug

3. WELDING

WARNING! When welding, wear proper protective equipment, such as a helmet, dark safety glasses, protective clothing, gloves and safety shoes. DO NOT look at the arc without proper eye protection.

Successful welding repairs require some knowledge of the materials being worked, use of the correct type and size of welding electrode and preparation of material to be welded. The alloy steels used in the construction of this machine have a low carbon content but have been heat treated to obtain maximum strength, hardness and wear resistance. To retain their strength, the steel members must not be subjected to high residual temperatures.

Any repair welding performed on the frame must be classified as a critical weld. Special attention must be given to the size, strength and surface quality of the repair.

FRAME

4. MAINTENANCE

A periodic inspection of the frame sections should be made to detect weld cracks, broken welds or damaged brackets. Special attention should be given to the seals bushings, guard and covers are in good condition.

To keep rust and corrosion to a minimum, periodic painting of abrasions and bare metal is recommended.

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5. SPECIFICATIONS

Inner bushing bore after pressing . . . . . ∅ 108.08 + 0.15 [mm]
Outer bushing bore after pressing . . . . . ∅ 114.43 + 0.15 [mm]
Inner bushing installation depth . . . . . 189 ± 1.5 [mm]
Outer bushing installation depth . . . . . 14 ± 1.5 [mm]
Plug installation depth . . . . . 315 ± 1.5 [mm]

6. REMOVAL

1. Remove blade lift cylinder (refer to SECTION 10C).
2. Remove the lift cylinder yokes (refer to SECTION 17).
3. Apply puller and remove outer bushing (22, Fig. 9.2) and inner bushing (23) from crosstube. If necessary, remove plug (24) from crosstube.
4. Use extreme care as not to nick, scratch or deface bushing bores in crosstube.

7. INSTALLATION

1. Thoroughly clean inner and outer bushing bores in crosstube before installing new plug and bushings.
2. If removed, install plug (24, Fig. 9.2) in the crosstube using press and aligning pin, refer to SERVICE /SPECIAL TOOLS, Paragraph 1 in this SECTION.
3. Slide new inner tube bushing (23, Fig. 9.2) into crosstube inner bushing bore. Properly align bushing with bore and apply press to push bushing 189 ± 1.5 [mm] deep.
4. Slide new outer bushing (22) into crosstube outer bushing bore. Properly align bushing with bore and apply press to push bushing 14 ± 1.5 [mm] deep.
5. Measure inner and outer bushing bores after they have been pressed into position. Inner bushing bore after pressing into crosstube bore should be ∅ 108.08 + 0.15 [mm]. Outer bushing bore after pressing into crosstube bore should be ∅ 114.43 + 0.15 [mm]. Hone bushing to size if they are above specification.
6. Liberally coat bushing bores and lift yoke bushing surfaces with fresh grease.
7. Install the lift cylinder yoke (refer to SECTION 17).
8. Install blade lift cylinder (refer to SECTION 10C).
9. Lubricate crosstube bushings; refer to OPERATOR'S MANUAL.

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SECTION 10

HYDRAULICS

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HYDRAULICS

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SERVICE /SPECIAL TOOLS

1. SERVICE /SPECIAL TOOLS

DESCRIPTION	TOOL NUMBER
Digital Optical Tachometer	337 7462
Test Pressure Gauges Kit	910-50-0005

GENERAL

2. DESCRIPTION

The hydraulic system generally consists of the equipment hydraulic system and fan drive hydraulic system, which are interconnected to share a common hydraulic reservoir for efficient operation.

Equipment Hydraulic System (Fig.'s 10.1 and 10.2)

The equipment hydraulic system of the machine includes control, blade and ripper equipment circuits and it will depend upon the application and the attachments ordered. Fig.10.1 and Fig. 10.2 illustrate what is available and are to be used to trace the hydraulic oil flow. Following is a brief description of the hydraulic components.

Hydraulic Reservoir

The reservoir is bolted to the right fender next to the fuel tank. It is a one piece welded assembly with a 100 mesh magnetic suction strainer, and an external 170 [kPa] pressure 2 [kPa] vacuum relief breather. This vacuum relief valve will protect the pumps from cavitation as well as maintaining pressure in the reservoir. Refer to the OPERATOR'S MANUAL for service of this valve.
The reservoir acts as a storage tank for the dozer equipped hydraulic system oil. The remainder of oil fills the lines and system components.

Hydraulic Equipment Pump

The positive displacement three element pumping cartridges are of the rotary vane type with shaft side loads hydraulically balanced. The pump is flange mounted to the torque converter and is driven by the converter accessory drive gear. The flow rate depends on the pump speed at which it is driven. For a further description of pump operation, refer to PUMPS in SECTION 10A.

Control System

The control valves used in this system are mounted on the right fender. This system utilizes either a one or three spool valve depending on whether or not a ripper is used and tilt control valve which will or tilt/pitch control valve which depend on optional equipment. The valves are controlled by pilot pressure and actuated by the pilot control valves mounted in the operator's compartment.

Hydraulic Cylinders

The blade and ripper cylinders are the single stage double acting type. Hydraulic pressure is introduced through ports at either end to actuate the piston.

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One Spool Control Valve

A one spool control valve is used on machines not equipped with a ripper and it is controlled by pilot lines from the blade pilot control valve. The valve inlet cover contains an adjustable pilot operated main pressure relief valve which is used to by pass fluid from the pump back to the reservoir when the fluid pressure exceeds the relief valve setting. The spool is a spring centered, four position type with the FLOAT position being magnetically detented at the blade pilot control valve. Incorporated in the valve section is a spring loaded check valve which assures smooth operation when the spool is moved from hold to an operating position. An anticavitation valve is located in the blade lower circuit.

Three Spool Control Valve

A three spool control valve is used on machines equipped with a ripper and it is controlled by pilot lines from the equipment pilot control valves. The valve inlet cover contains an adjustable pilot operated main pressure relief valve which is used to by pass fluid from the pump back to the reservoir when the fluid pressure exceeds the relief valve setting. The blade lift section is a spring centered, four position type with the FLOAT position being magnetically detented at the blade pilot control valve. The ripper lift section is used for raising or lower the ripper. The ripper pitch section is used for pitching the ripper forward or rearward. The two ripper section spools are spring centered, three position type. Incorporated in all the sections are spring loaded check valves assure smooth operation when the spool is moved from hold to an operating position. An anticavitation valves are located in the blade lift section and ripper lift section lower circuits.

Blade Tilt Control Valve or Blade Tilt/Pitch Control Valve

This single spool valve consists of an inlet and outlet portion. The inlet portion spool is a three position type spring centered. A load check valve is located within the valve. A main relief valve is located in the port adjacent to the spool cover. An adjustable pilot operated main pressure relief valve is used to by pass oil from the pump back to reservoir when oil pressure exceeds the relief valve settings. The tilt (tilt/pitch) valve contains a high pressure carry over tube which directs tilt (tilt/pitch) pump flow by unloading valve to the main control valve when no demand on the tilt (tilt/pitch) circuit occurs. The valve is controlled by pilot pressure which is actuated by pilot blade control valve.

Quick Drop Valve

The quick drop valve is used for accelerated power when lowering of the blade is required. The valve is front frame mounted and is located in the engine compartment inside of right side of frame wall. This hydraulically operated valve allows the blade to drop at a faster rate by diverting return oil through a spool to supplement the blade cylinder input oil from the piston side being used to lower the blade. The valve only diverts the return oil when the vacuum pressure is created in the piston side chamber. It occurs during lowering the blade with inadequate oil supply.

Directional Valve

This valve is used so as to control the unloading valve which, in turn, directs the oil from the tilt pump to the sink at the oil pressure higher than 14 [MPa] in the cylinders lift positions of both the ripper and the blade.

Unloading Valve

The unloading valve includes: the main spool which connects, or cuts off the tilt pump to the sink, the spool which connects the tilt pump to the main control valve (one or three spool), and the sleeve which controls the spools. The purpose of this valve is to direct the oil to the main control valve when the tilt cylinder does not act and to unload the engine in the movement described above in Directional Valve description, switching the tilt pump over to the sink.

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GENERAL

Pilot Pressure Valve

This valve serves two basic functions. First, it controls maximum oil pressure available for the blade and ripper (if equipped) control valve pilot circuits. Second, it provides the means for lowering the blade or ripper with a dead engine or no pilot pump flow.

Shuttle Valve Circuit

In a pilot controlled hydraulic system, pilot pressure is required to move the main control valve spools to actuate the cylinders. If the pilot pump would stop working for any reason while the blade or ripper was raised or the machine is raised on blade lift cylinders or if there would be no pilot flow available to lower the blade, ripper or machine, an alternate hydraulic power source is needed. It will be available from within the both side of blade or one side of ripper cylinder circuits.

Blade Double Tilt / Pitch Solenoid Valve (Blade Double Tilt / Pitch Attachment)

The two-coil solenoid valve is used for switching the oil from blade tilt/pitch valve to blade cylinders. In neutral position the solenoid valve sends oil to cylinder to get tilt the blade. When the blade double tilt solenoid is energized by switch, the coil shifts the solenoid spool to right position to get double tilt. The blade pitch solenoid is energized when the pitch button is pushed and the coil shifts the spool to the left position.

Blade Pilot Control Valve

This valve is a manually controlled for the blade lift, lower and tilt, mounted under vertical plate cover at right side of operator’s seat in the operator’s compartment. The valve is used to direct pilot oil pressure to the blade lift and tilt valve sections for blade control. When the lever is released, it will return to neutral. A magnetic detent mechanism holds the control lever in the FLOAT position. Pilot pressure enters the control valve at the P port and is distributed through the passages to the metering spools. When the lever is in the centered (NEUTRAL) position, oil is active in the passages, but is blocked at the metering spools.
When the lever is moved to any direction, the pivot plate actions the pivot plunger. The plunger depresses the plunger actuator which, in turn, engages metering spool. In that way the metering spool opens the pilot pressure oil to the blade lift section or tilt valve. When the lever is released it will return to neutral. However, it will remain in the FLOAT position held by the magnet located in the valve retaining plate. The lever has to be manually released from the FLOAT position.

Ripper Pilot Control Valve

This valve is a manually controlled for ripper lift, lower and pitch, mounted under vertical plate cover at right side of operator’s seat in the operator’s compartment. The valve is used to direct pilot oil pressure to the ripper lift and pitch valve sections for ripper control. When the lever is released, it will return to neutral. Pilot pressure enters the control valve at the P port and is distributed through the passages to the metering spools, oil is active in the passages, but is blocked at the metering spools.
When the lever is moved to any direction, the pivot plate actions the plunger actuator which engages the metering spool. In that way the metering spool opens the pilot pressure oil to the ripper lift or pitch valve section. When the lever is released it will return to neutral.

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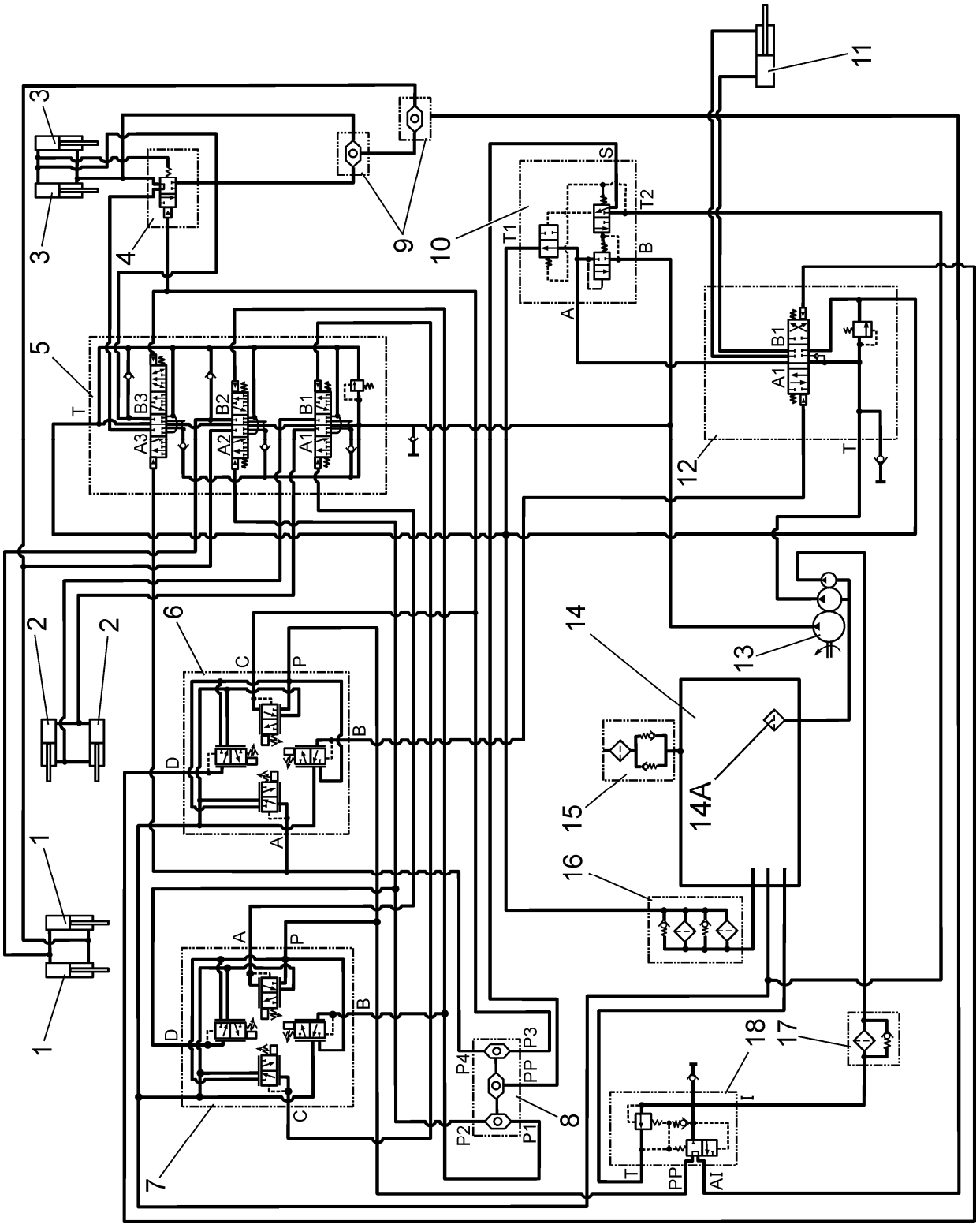

Fig. 10.1. Hydraulic Schematic, Blade Tilt Attachment

1. Ripper Lift Cylinder
2. Ripper Pitch Cylinder
3. Blade Lift Cylinder
4. Quick Drop Valve
5. Three Spool Control Valve
6. Blade Pilot Control Valve
7. Ripper Pilot Valve
8. Directional Valve
9. Shuttle Valves
10. Unloading Valve
11. Blade Tilt Cylinder
12. Blade Tilt Control Valve
13. Hydraulic Three Section Vane Pump
14. Hydraulic Reservoir
14A. Suction Strainer
15. Breather Valve
16. Return Filters
17. Pilot Pressure Filter
18. Pilot Pressure Valve

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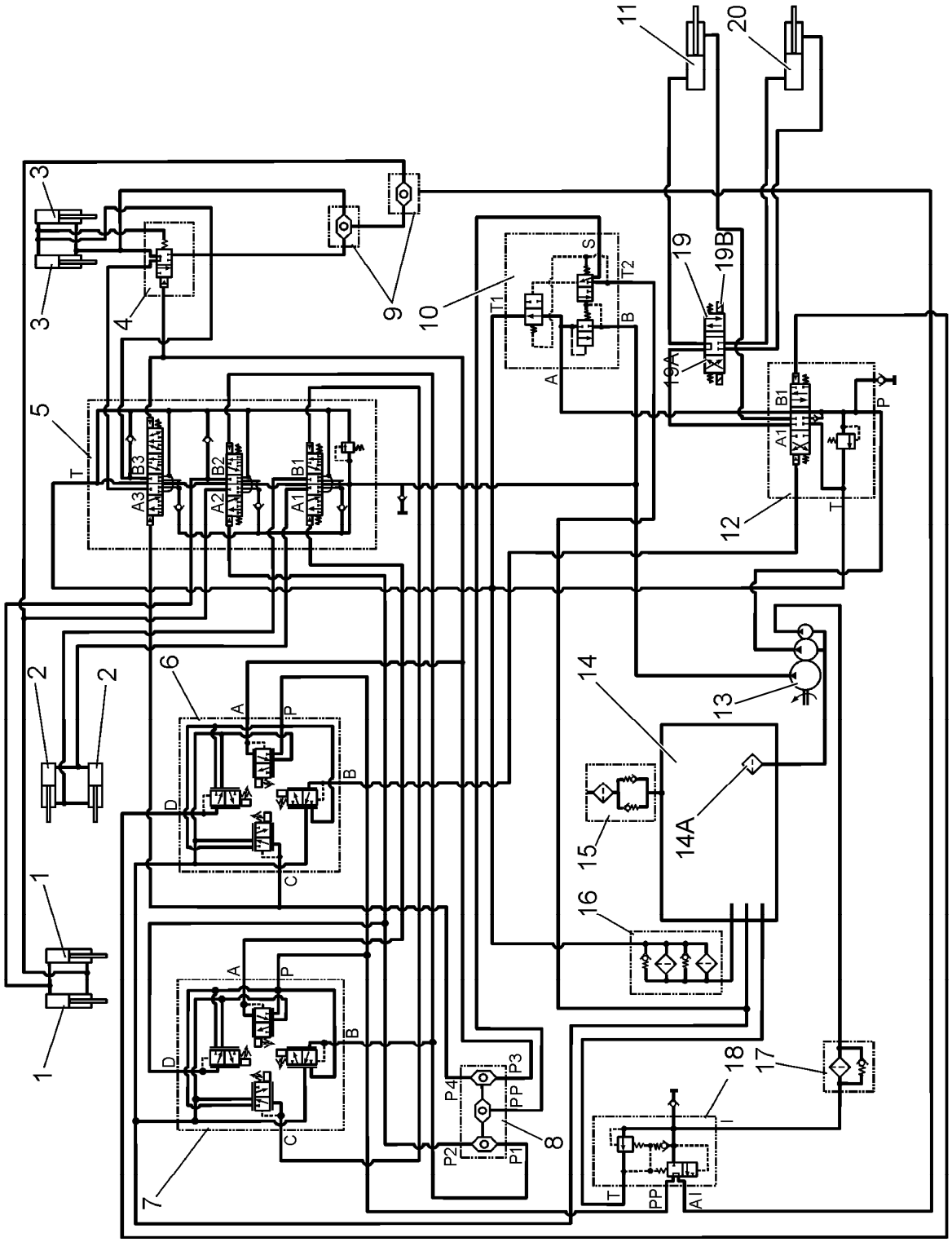

Fig. 10.2. Hydraulic Schematic, Blade Tilt/Pitch Attachment

1. Ripper Lift Cylinder
2. Ripper Pitch Cylinder
3. Blade Lift Cylinder
4. Quick Drop Valve
5. Three Spool Control Valve
6. Blade Pilot Control Valve
7. Ripper Pilot Control Valve
8. Directional Valve
9. Shuttle Valves
10. Unloading Valve
11. Blade Tilt/Pitch Cylinder
12. Blade Tilt/Pitch Control Valve
13. Hydraulic Three Section Vane Pump
14. Hydraulic Reservoir
14A. Suction Strainer
15. Breather Valve
16. Return Filters
17. Pilot Pressure Filter
18. Pilot Pressure Valve
19. Double Tilt/Pitch Solenoid Valve
19A. Pitch Solenoid Valve
19B. Double Tilt Solenoid Valve
20. Blade Double Tilt/Pitch Cylinder

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HYDRAULICS

GENERAL

Fan Drive Hydraulic System (Figs. 10.3, 10.4, 10.5 and 10.6)

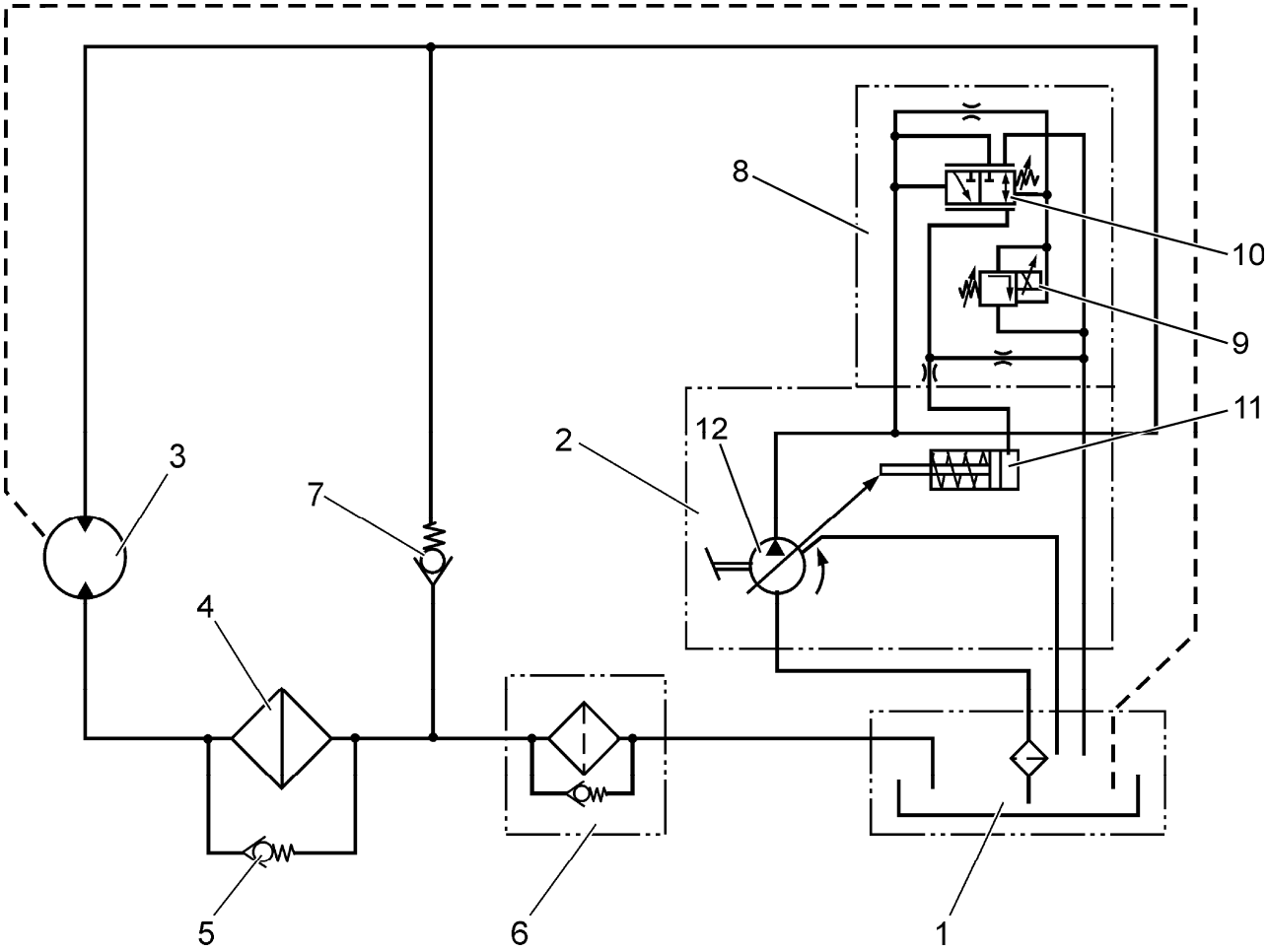

Fig. 10.3. Fan Drive Hydraulic Diagram

1. Hydraulic Reservoir with Suction Strainer
2. Fan Drive Pump with Control Module
3. Fan Hydraulic Motor
4. Oil Cooler
5. By-pass Valve
6. Return Filter
7. Check Valve
8. Electro-hydraulic Pressure Control Module
9. Proportional Valve Solenoid
10. Pressure Valve
11. Pump Control Cylinder Piston
12. Axial Piston Variable Pump

Generally, the fan drive system consists of mechanical and hydraulic portions. Mechanical portion of the fan drive system is detailed in SECTION 6, COOLING SYSTEM.
The hydraulic portion of the fan drive system consists of the common hydraulic reservoir (1), the fan drive pump with control module (2) mounted on the torque converter accessory drive (13), the fan drive hydraulic motor (3), check valve (7) and hydraulic oil cooler (4) with bypass valve (5). The fan drive axial piston variable pump (12) is controlled by electro - hydraulic pressure control module (8) mounted on the pump (12).

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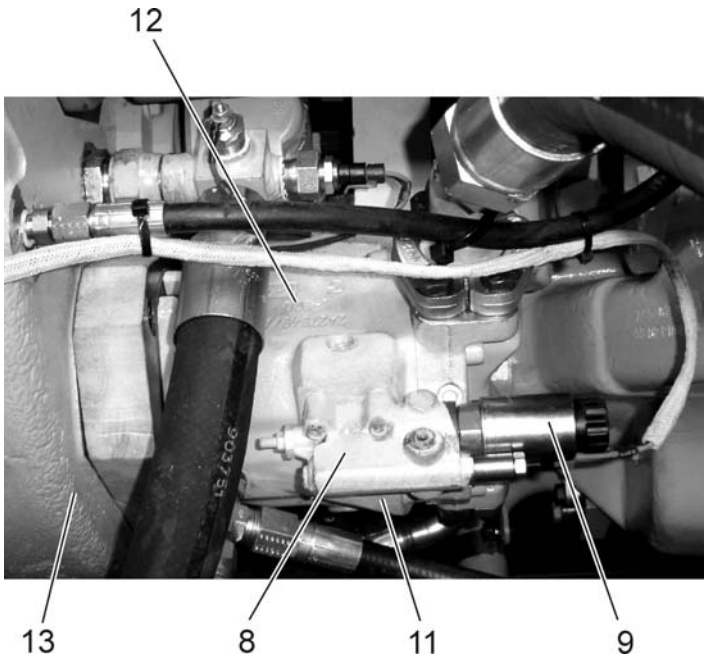

Fig. 10.4. Fan Drive Pump with Control Module (2) Location

8. Electro-hydraulic Pressure Control Module
9. Proportional Valve Solenoid
11. Pump Control Cylinder Piston
12. Axial Piston Variable Pump
13. Torque Converter

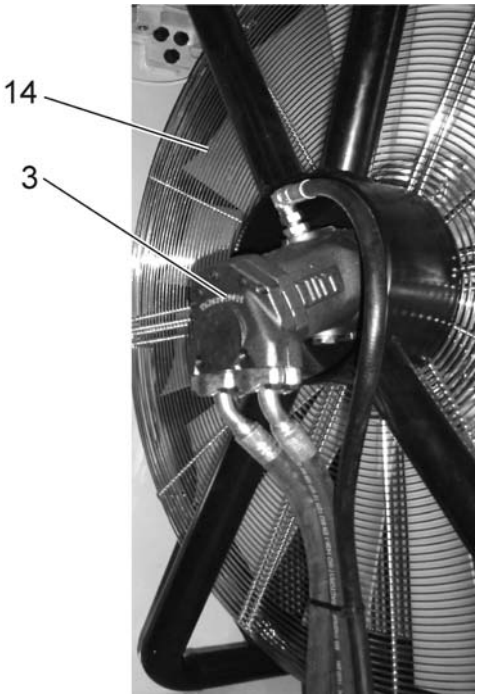

Fig. 10.5. Fan Hydraulic Motor

3. Fan Hydraulic Motor
14. Fan (see SECTION 6)

At engine start-up, solenoid (9) of pump control module (8) is energized through the engine electronic control module (ECM). At this moment fan hydraulic motor (3) drives the fan with minimum rotating speed. In case any temperature raises in one of following systems: drive train system, engine cooling system or engine charge air system, the temperature sensors placed in respective system lines send the signals to the engine ECM. Next, the engine ECM generates and send the control signal to the control module solenoid (9).

The control module solenoid (9) controls the variable pressure valve (10). The pressure valve (10) actuates pump cylinder piston (11). Pump (12) varies oil flow rate passing to the hydraulic motor (3), which drives the fan (14) from minimum to maximum speed range (refer to SPECIFICATION in this Section).

The fan drive pump output pressure depends on the current intensity to the control module solenoid (9). If pump pressure drops below actual pressure, the pump will try to increase its displacement, hence the flow, to satisfy fan drive system demand. If the pressure reaches this pressure, the pump will adjust its displacement to the required system flow (no excess).

With the inverse proportional control maximum pump pressure level will go to standby at maximum solenoid current, and to maximum pressure at zero current (failsafe in case ECM failure).

Overriding the current signal is an adjustable hydromechanical setting of maximum pressure.

For detailed description of the fan electrical control refer to Paragraph 3, MACHINE ELECTRICAL SYSTEM in SECTION 8, ELECTRICAL.

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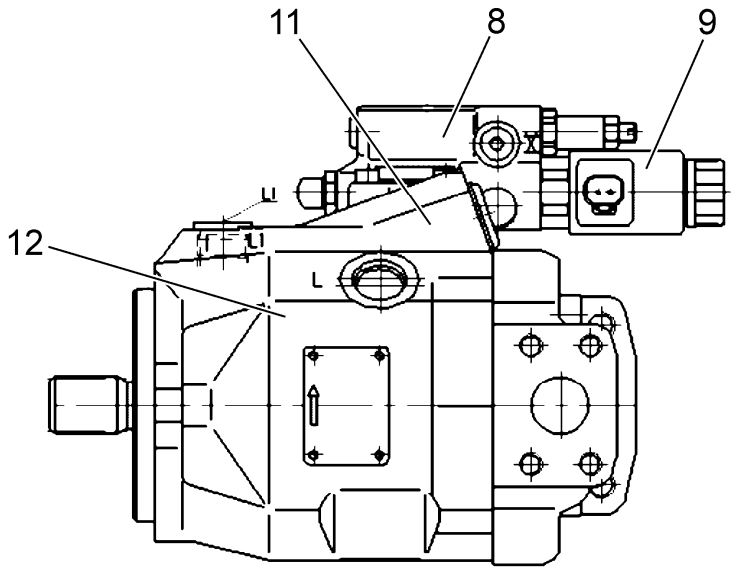

Fig. 10.6. Fan Drive Pump with Control Module

8. Electro-hydraulic Pressure Control Module
9. Proportional Valve Solenoid
11. Pump Control Cylinder Piston
12. Axial Piston Variable Pump

3. SPECIFICATIONS

Hydraulic Pump

Front Section @ 2145 [RPM] . . . . . 178 [l/min]
Middle Section @ 2145 [RPM] . . . . . 102 [l/min]
Pilot Rear Section @ 2145 [RPM] . . . . . 33 [l/min]

Pressure Settings

Main Pressure Relief Valve . . . . . 16900 – 17600 [kPa]
Tilt Pressure Relief Valve . . . . . 18350 – 19100 [kPa]
Pilot Control Pressure Relief Valve . . . . . 2400 – 2560 [kPa]
Fan Drive System Pressure Relief Valve . . . . . 25000 [kPa]
Fan Drive System Standby Pressure . . . . . 1400 [kPa]

Fan Drive Performance

Minimum speed . . . . . below 400 [RPM]
At temperatures:
- Engine coolant . . . . . 85 [°C]
- Engine charge air . . . . . 45 [°C]
- Drive train system oil . . . . . 92 [°C]

Maximum speed . . . . . 1520 – 1600 [RPM]
At temperatures:
- Engine coolant . . . . . 95 [°C]
- Engine charge air . . . . . 61 [°C]
- Drive train system oil . . . . . 115 [°C]

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4. SERVICE DIAGNOSIS

This portion has been prepared to serve as a guide in locating the source of problems that may be encountered with hydraulic assy. In diagnosing problems it should be remembered that it is possible for a given symptom to be caused by any one of a number of deficiencies. It is also possible for a given deficiency to cause any one or more of various symptoms.

The following chart gives predominant symptoms and their primary causes, based on our experiences. When a number of possible causes of a complaint are given, they are listed in a logical sequence for checking and corrective action.

Tests given in TESTS AND ADJUSTMENTS are used to further pinpoint the problem.

Equipment Hydraulic System

COMPLAINT	
PROBABLE CAUSE	**REMARKS**
Noisy Operation, Oil Foaming	
1. Low oil level	Check level at sight gauge and fill as necessary. Check for external leaks and tighten or replace parts as necessary.
2. Oil viscosity too dense	Use recommended oil. Refer to OPERATOR'S MANUAL.
3. Dirty oil strainer in reservoir	Clean.
4. Dirty reservoir pressure/vacuum relief valve	Clean.
5. Air leakage into hydraulic suction lines	Apply shave cream to all suction connections, and tighten where cream disappears.
Blade Lift Cylinder Drops	
1. Faulty one of blade lift circuit assembly	Refer to Paragraph 6, BLADE LIFT CYLINDER DRIFT TEST.
Ripper Lift Cylinders Drops	
1. Faulty one of ripper lift circuit assembly	Refer to Paragraph 7, BLADE LIFT CYLINDER and RIPPER LIFT CYLINDER DRIFT TEST
Blade Tilt Circuit or Blade Tilt/Pitch Circuit Weak or Slow	
1. Internal leak in tilt or tilt/ pitch cylinder	Refer to Par. 9, PISTON PACKING TEST.
2. Internal leak in tilt control relief valve	Refer to Par. 5, RELIEF VALVE PRESSURE TEST.
3. Middle (blade tilt) section pump worn out	Refer to SECTION 10A, PUMPS.
Blade Lift and Ripper Cylinders Weak and/or Slow Movement	
1. Internal leak in main control relief valve	Refer to Par. 5, RELIEF VALVE PRESSURE TEST.
2. Front section pump worn out	Refer to SECTION 10A, PUMPS.
All Cylinders No or Slow Movement	
1. Insufficient oil supply	Refer to Noisy Operation Oil Foaming.
2. Pilot supply valve out of order	Refer to SECTION 10B, PILOT PRESSURE VALVE.
3. Rear pilot pump worn out	Refer to SECTION 10A, PUMPS.

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COMPLAINT	
PROBABLE CAUSE	**REMARKS**
One Blade Lift or Tilt or Ripper Circuit Slow and/or No Movement	
1. Pilot control valve plunger out of order	Refer to SECTION 10B, PILOT CONTROL VALVE.
2. Control valve spool section out of order	Refer to SECTION 10B, ONE or THREE SPOOL or TILT (PITCH/TILT) CONTROL VALVE.
Blade Pitch Cylinders No Movement	
1. The pitch valve solenoid problem	Check 24V on solenoid and spool movement.
Blade Double Tilt Cylinders No Movement	
1.The double tilt valve solenoid problem	Check 24V on this solenoid and spools movement.
Ripper Pitch or Lift, Blade Tilt or Tilt/Pitch or Double Tilt/Pitch Cylinders Drop	
1. Problem in one of system	Refer to Paragraph 8, PISTON PACKING TEST.
Momentary Drop when Actuated from Hold	
1. Scored or worn load check valve or seat	Replace.
2. Load check held of its seat	Clean system. Check for foreign matter.
Oil Overheating	
1. Oil level too low	Fill to proper level.
2. Very light oil in a hot climate	Used recommended oil per the OPERATOR'S MANUAL.
3. Excessive feathering of controls	Review operating instructions in OPERATOR'S MANUAL.
Short Life of Pump	
1. Aeration or cavitation	Refer to Noisy Operation, Oil Foaming.
2. Reservoir pressure vacuum valve filter clogged	Clean or wash filter.
Blade and Ripper Cannot Be Lowered after Engine Shutdown	
1. Stuck spool or fatigued spring in pilot pressure valve	Repair or replace parts as necessary. Refer to SECTION 10B, PILOT PRESSURE VALVE

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Fan Drive System

COMPLAINT	
PROBABLE CAUSE	**REMARKS**
Inadequate Cooling in the Following Systems: Drive Train System, Engine Cooling System or Engine Charge Air System	
1. Fan rotating speed out of specification	1. Refer to Fan Circuit in SECTION 8, ELECTRICAL. 2. Solenoid valve coil faulty or one of control module valves faulty. Replace control module. 3. Axial piston pump faulty. Replace pump.

TEST AND ADJUSTMENT

5. EQUIPMENT SYSTEM RELIEF VALVES PRESSURE TESTS

Fig. 10.7. Pressure Check Connect Port

1. One or Three Spool Control Valve
2. Main Pressure Quick Disconnect Fitting
3. Blade Tilt (Tilt/Pitch) Pressure Quick Disconnect Fitting
4. Blade Tilt (Tilt/Pitch) Control Valve
5. Pilot Pressure Quick Disconnect Fitting
6. Pilot Pressure Valve

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TEST AND ADJUSTMENT

This machine is provided with three control valve pressure relief valves, one in tilt (tilt/pitch) control valve, one in blade lift and ripper control valve and one in pilot pressure valve. Tilt relief testing and adjustment must proceed lift and ripper relief valve adjustment in order to obtain correct pressures Pressure checks should be performed with oil at operating temperature. To bring temperature up, move equipment control lever through all positions and bottom cylinders for a few seconds in each position.

NOTE: *Bottoming a cylinder for a short period of time will not damage hydraulic system; but an extended period will produce excessive heat and result in quick oil deterioration.*

Blade Tilt (Tilt/Pitch) Relief Valve Pressure Test

1. Open the door from right side and connect an 40 [MPa] gauge with quick coupler (see SERVICE /SPECIAL TOOLS in this Section) to the quick disconnect fitting (3, Fig. 10.7).
2. Once operating temperature is reached, run engine at high idle and slowly move tilt lever into a power position until cylinder is in an extreme position. Read and record pressure on test gauge at which relief valve unloads. Repeat with engine at low idle. Obtained pressures should range from 18350 tro 19100 [kPa]; if not proceed as follows:

   If both low and high idle readings are similar but not as specified, system is operating correctly but relief valve must be adjusted. Refer to Step 3.

   If relief pressure is within 18350 - 19100 [kPa] at high idle but cannot be reached at low idle, refer to Paragraph 10, PRESSURE DIAGNOSTIC CHART in this SECTON.
3. Remove acorn nut (1, Fig. 10.8) and outer seal washer (3) of relief valve. Loosen jam nut (9) and turn adjusting screw (10) clockwise to increase pressure or counterclockwise to decrease pressure. After correct pressure is obtained, retighten jam nut (9) while holding adjusting screw (10) from turning. Install acorn nut (1) with outer seal washer (3). Recheck oil pressure.
4. Remove test gauge from the quick disconnect fitting and close the door from right side.

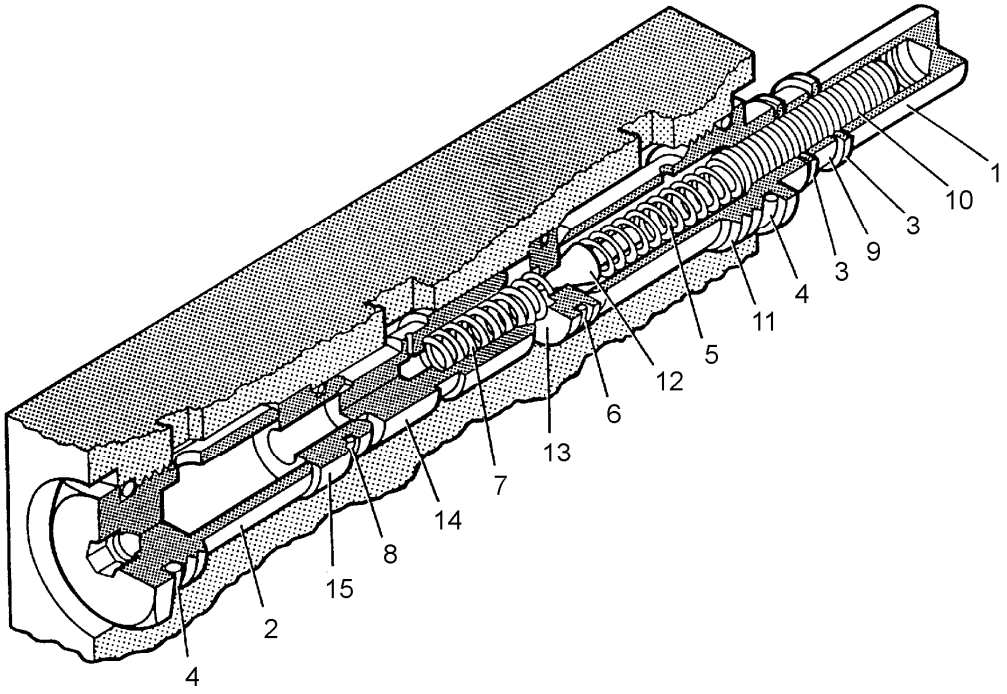

Fig. 10.8. Tilt Relief Valve

1. Acorn Nut	5. Pilot Poppet Spring	9. Jam Nut	13. Pilot Popper Seat
2. End Cap	6. O-Ring	10. Adjusting Screw	14. Main Poppet
3. Seal Washer	7. Main Poppet Spring	11. End Cap	15. Main Poppet Seat
4. O-Ring	8. O-Ring	12. Pilot Poppet	

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TEST AND ADJUSTMENT

Blade Lift and/or Ripper Relief Valve Pressure Test

Open the door from right side and connect an 40 [MPa] gauge with quick coupler (see SERVICE / SPECIAL TOOLS in this Section) to the quick disconnect fitting (2, Fig. 10.7) and proceed as follows.

NOTE: *One spool control valve only; because of relief poppets in blade lift cylinders, raise supply line must be capped or piston rod must be stopped in the middle position. Lower blade to ground. Open the door from right side and disconnect end raise hose from control valve (1, Fig. 10.7). Install a plug with O-ring and secure with hose split flanges at control valve. Cap disconnected hose.*

1. ONE SPOOL VALVE; Once operating temperature is reached, run engine at full throttle and slowly move blade lift control lever to raise position. Read and record pressure on gauge at which relief valve unloads.
2. THREE SPOOL VALVE; Once operating temperature is reached, run engine at full throttle and slowly move ripper lift control level into a power position until cylinders are in extreme position. Read and record pressure on gauge at which relief valve unloads. Repeat this procedure with ripper pitch control lever.
3. Repeat Step 1 or 2 with engine at low idle. Read and record pressure on gauge at which relief valve unloads.

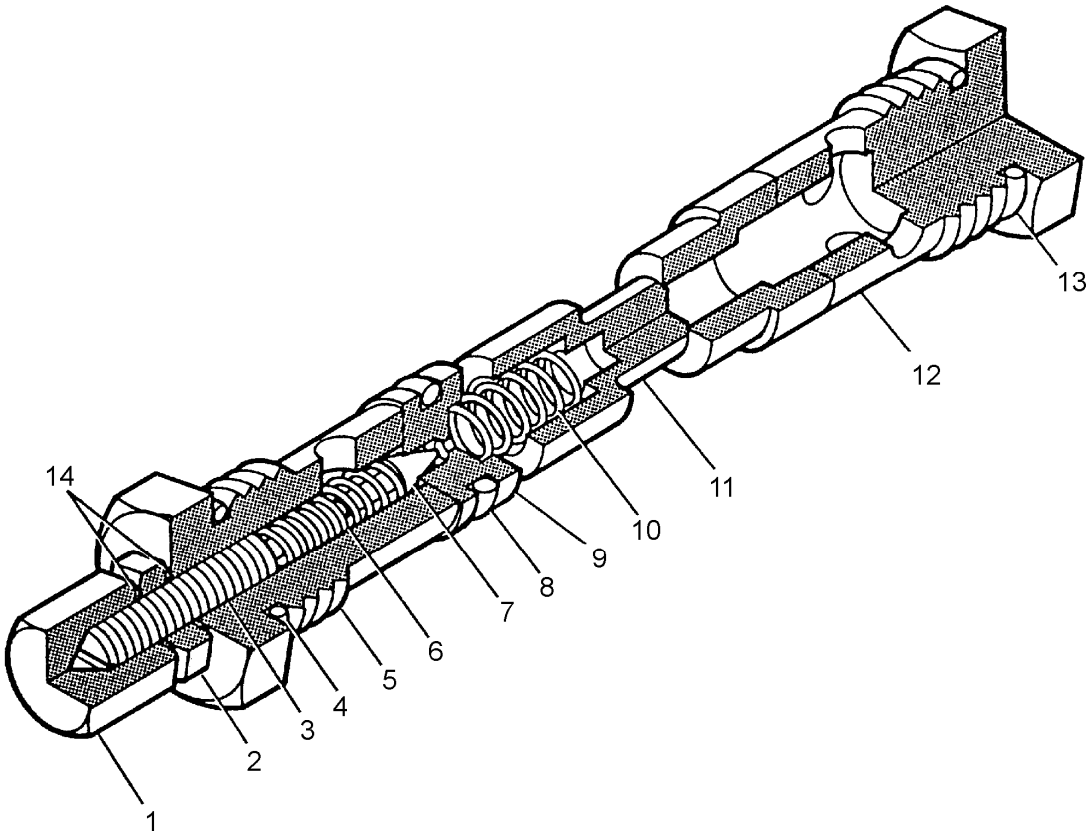

Fig. 10.9. One or Three Spool Control Valve Relief Valve

1. Acorn Nut
2. Jam Nut
3. Adjusting Screw
4. O-Ring
5. End Cap
6. Poppet Spring
7. Relief Poppet
8. O-Ring
9. Pilot Relief Seat
10. Check Valve Spring
11. Check Valve
12. End Cap
13. O-Ring
14. Washer

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4. Pressure obtained in Steps 1 or 2 and 3 should range over 16900 to 17600 [kPa], if not proceed as follows:

   If both low and high idle pressure readings are alike but not as specified, system is operating correctly but relief valve must be adjusted. Proceed to Step 5. If relief pressure is 16900 - 17600 [kPa] at high idle but cannot be reached at low idle, refer to Paragraph 10, PRESSURE DIAGNOSTIC CHART in this SECTION.

5. Remove acorn nut (1, Fig. 10.9) and outer washer (14) and loosen jam nut (2). Turn adjusting screw (3) clockwise to increase pressure or counterclockwise to decrease pressure. After correct pressure is obtained, lock jam nut (2) and install outer washer (14) and acorn nut (1). Recheck oil pressure.
6. ONE SPOOL CONTROL VALVE; Remove plug from raise supply port and reconnect supply hose to valve port.
7. Remove test gauge from the quick disconnect fitting and close the door from right side.

Pilot Pressure Relief Valve Pressure Test

1. Open the door from right side and connect an 4 [MPa] gauge with quick coupler (see SERVICE /SPECIAL TOOLS in this Section) to the quick disconnect fitting (5, Fig. 10.7) and proceed as follows.
2. Once operating temperature is reached, run engine at full throttle and read and record pressure on gauge at which relief valve unloads.
3. Repeat Step 2 with engine at low idle.
4. Pressure obtained in Steps 2 and 3 should be 2400 – 2560 [kPa], if not proceed as follows:

   If both low and high idle pressure readings are similar but not as specified, system is operating correctly but pilot pressure valve must be repaired. Proceed to SECTION 10B, VALVES. If relief valve pressure is within 2400 – 2560 [kPa] at high idle but cannot be reached at low idle, refer to SECTION 10A, PUMPS.

5. Remove test gauge from the quick disconnect fitting and close the door from right side.

6. BLADE LIFT CYLINDERS DRIFT TEST (MACHINE WITHOUT RIPPER)

The problem of cylinders drift can be traced to two main causes, which are internal and external leakage. External leakage is not detailed here, since it can be visually. Internal leakage is not always readily pinpointed to its source and may require a series of tests to isolate the problem.

There are six places that might be a source of leakage; one of hydraulic cylinders might be leaking past piston packing or piston poppet(s), control valve could leak at spool and/or quick drop valve spool could be stuck, shuttle valve(s) could leak, pilot pressure valve could leak or blade pilot control valve could leak.

Following is a series of tests to trace the source of internal leakage.

1. Raise and lower blade through its full travel to wash out any foreign material which might prevent piston by pass poppets from seating. Oil temperature should be 82 - 88 [°C].
2. Lower the ripper to the ground.
3. Fully raise blade and move lever to LOWER position releasing it to HOLD before blade drops to ground.
4. Perform blade lift cylinders drift test. Check cylinders for drift, rods should travel out of cylinders no more than 18 [mm] per minute.

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TEST AND ADJUSTMENT

NOTE: *The 18 [mm] per minute figure represents the accumulative allowable loss of cylinders, control valve and valves.*

5. If cylinders drift is more than 18 [mm] per minute lower blade and follow below mentioned procedure. Refer to HYDRAULIC CHART Fig. 10.10.
6. Fully lower the blade to raise the front side of machine up. Slightly move the lever to LOWER position and release it to HOLD. Perform blade lift cylinders drift test. Check cylinders for drift. If cylinders drift is much less than checked in point 4 the problem is inside of one blade cylinder. Refer to PISTON PACKING TEST.
7. If cylinders drift is still the same plug the pilot pressure valve (18) at point **PP**. If cylinders drift is much less than checked in point 4, blade pilot control valve is faulty. Repair or replace the valve. Refer to BLADE PILOT CONTROL VALVE in SECTION 10B. If cylinders drift is still the same proceed to next point.
8. Plug the pilot pressure valve (18) at point **AI**. If cylinders drift is much less than checked in point 4, pilot pressure valve is faulty. Repair or replace the valve. Refer to PILOT PRESSURE VALVE in SECTION 10B. If cylinders drift is still the same proceed to next point.
9. Raise the blade and support it on some bracket. Plug the one spool control valve in point "**a**". Go back with machine to free the blade. Stop the machine and check for drift. If cylinders drift is much less than checked in point 4, control valve is faulty. Repair or replace the valve. Refer to ONE SPOOL CONTROL VALVE in SECTION 10B. If cylinders drift is still the same, the quick drop valve is faulty. Repair or replace the valve. Refer to QUICK DROP VALVE in SECTION 10B.
10. When proceeding tests are completed, vent hydraulic system and add oil as necessary. Refer to the OPERATOR'S MANUAL. Visually check for oil leakage.

7A. BLADE LIFT CYLINDERS AND RIPPER LIFT CYLINDERS DRIFT TEST (MACHINE WITH RIPPER) /BLADE AND RIPPER LIFT CYLINDERS ARE DROPPING/

There are three places that might be a source of leakage for both ripper and blade cylinders; pilot pressure valve could leak, ripper pilot control valve could leak or blade pilot control valve could leak.

Following is a series of tests to trace the source of internal leakage.

1. Raise and lower ripper and blade through its full travel. Oil temperature should be 82 - 88 [°C].
2. Lower the blade to the ground.
3. Fully raise ripper and move lever to LOWER position releasing it to HOLD before ripper drops to ground.
4. Perform ripper lift cylinders drift test. Check cylinders for drift, rods should travel out of cylinders no more than 16 [mm] per minute.
5. Lower the ripper to the ground.
6. Fully raise the blade and move the blade lift lever to LOWER position releasing it to HOLD before the blade drops to the ground
7. Perform blade lift cylinders drift test. Check cylinders for drift, rods should travel out of cylinders no more then 18 [mm] per minute.

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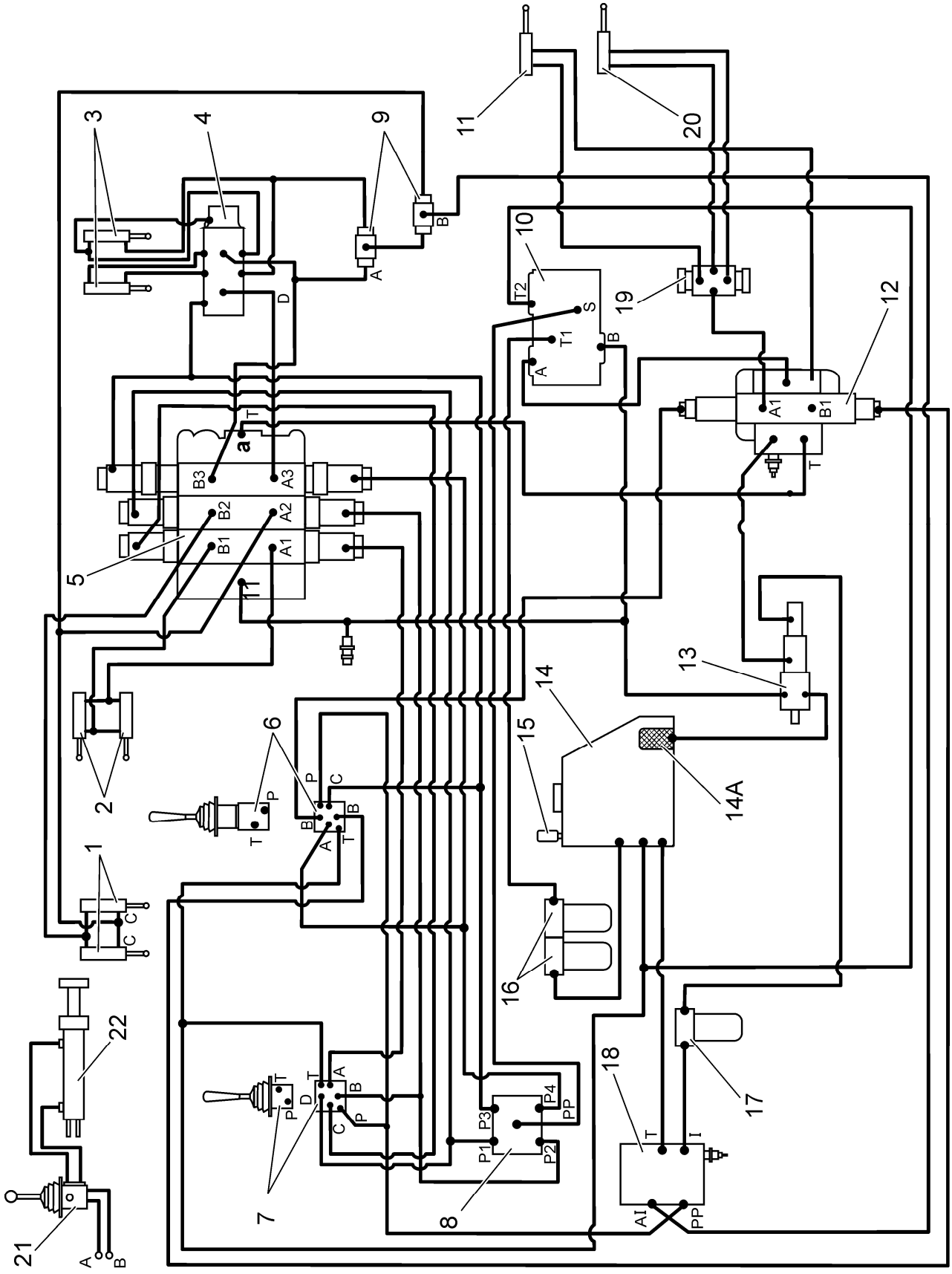

Fig. 10.10. Hydraulic Chart, Blade Tilt/Pitch Attachment

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TEST AND ADJUSTMENT

Legend for Fig. 10.10

1. Ripper Lift Cylinder
2. Ripper Pitch Cylinder
3. Blade Lift Cylinder
4. Quick Drop Valve
5. Three Spool Control Valve
6. Blade Pilot Valve
7. Ripper Pilot Valve
8. Directional Valve
9. Shuttle Valves
10. Unloading Valve
11. Blade Tilt/Pitch Cylinder
12. Blade Tilt Control Valve
13. Hydraulic Pump Assy
14. Hydraulic Reservoir

14A. Suction Strainer

15. Breather Valve
16. Return Filters
17. Pilot Pressure Filter
18. Pilot Pressure Valve
19. Double Tilt /Pitch Solenoid Valve
20. Blade Double Tilt/Pitch Cylinder
21. Pin Puller Valve
22. Pin Puller Cylinder

A. Oil Supply from Pressure Regulator Valve **M** Port Located at Steering Valve
B. Drain to Rear Frame

8. If ripper cylinders drift is more than 16 [mm] per minute and blade cylinders drift is more than 18 [mm] per minute lower the blade and ripper and follow below mentioned procedure. Refer to HYDRAULIC CHART Fig. 10.10.
9. Plug blade pilot control valve (6) at point **P**. If cylinders drift is much less than checked in point 4 or 7, blade pilot control valve is faulty. Repair or replace the valve. Refer to BLADE PILOT CONTROL VALVE in SECTION 10B. If cylinders drift is still the same proceed to next point.
10. Plug ripper pilot control valve (7) at point **P**. If cylinders drift is much less than checked in point 4 or 7, ripper pilot control valve is faulty. Repair or replace the valve. Refer to RIPPER PILOT CONTROL VALVE in SECTION 10B. If cylinders drift is still the same, pilot pressure valve is faulty. Repair or replace the valve. Refer to PILOT PRESSURE VALVE in SECTION 10B.
11. When proceeding tests are completed, vent hydraulic system and add oil as necessary. Refer to the OPERATOR'S MANUAL. Visually check for oil leakage.

7B. RIPPER LIFT CYLINDERS DRIFT TEST /BLADE LIFT CYLINDERS ARE NOT DROPPING/

There are two places that might be a source of leakage; one of hydraulic cylinder could leak post piston packing and second of control valve could leak at its spool.

Following is a test to trace the source of internal leakage.

1. Raise and lower ripper and blade through its full travel. Oil temperature should be 82 - 88 [°C].
2. Lower the blade to the ground.
3. Fully lower the ripper to raise the rear of machine up.
4. Slightly move the lever to LOWER position releasing it to HOLD before machine drops to ground.
5. Perform ripper lift cylinders drift test. Check cylinders for drift, rods should travel out of cylinders no more than 16 [mm] per minute.
6. If ripper cylinders drift is less than 16 [mm] per minute one of cylinders is leaking. Proceed to PISTON PACKING TEST in this SECTION to find which one is foulty.
7. If ripper cylinders drift is more than 16 [mm] per minute control valve spool is leaking. Proceed to CONTROL VALVE in SECTION 10B.
8. When proceeding tests are completed, vent hydraulic system and add oil as necessary. Refer to the OPERATOR'S MANUAL. Visually check for oil leakage.

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8. CYLINDER TIME CYCLE

Blade Tilt

NOTE: *Before performing cylinder time cycle, perform PISTON PACKING TEST to insure that cylinder is satisfactory. If cylinder is satisfactory, but tilt circuit is weak or slow, problem could be either hydraulic pump or tilt relief valve. Loss of flow can be caused by tilt relief valve not sealing, allowing oil to flow into reservoir passage.*

To check pump, following time cycles should be observed when tilting blade to left and to right.

1. Lift blade off ground and run engine at full throttle. Position the blade 300 [mm] over the ground with tilt/pitch cylinders piston rods pulled out in their midposition; and next place the blade in its extreme double tilt left position.
2. Starting with blade in its extreme double tilt left position, put control lever in RIGHT DOUBLE TILT and read and record time it takes blade to reach its extreme position. Tilt cycle should take not more then 2.2 seconds. Starting with blade in its extreme double tilt right position, put control lever in LEFT DOUBLE TILT and read and record time it takes blade to reach its extreme left position. Double tilt cycle should take not more than 2.4 seconds too. Repeat left to right and right to left several times and take an average of readings.
3. If average cycle times are more than above mentioned, middle pump should be repaired or replaced as necessary.

NOTE*: In case of fully retracted blade tilt cylinders maximum cylinder time cycle can reach 16.0 seconds.*

Blade Lift

NOTE*: Before performing cylinder time cycle test, perform cylinder blade tilt test to insure that middle pump is correct.*

NOTE*: Before performing cylinder time cycle test, perform blade lift cylinder drift test to insure that control valve, cylinders and valves are performing satisfactorily.*

If there is no excessive drift when blade lift control is in HOLD position, but slow load speed, slow response or low power is present in RAISE position, problem could be either hydraulic pump or pressure relief valve. Loss of flow can be caused by pressure relief valve not sealing, allowing oil to flow into return to reservoir passage. Refer to Paragraph 5, RELIEF VALVE PRESSURE TEST.
To check pump, following time cycles should be observed when raising blade.

1. Position machine so that blade will not touch ground in its fully lowered position. Run engine at full throttle.
2. Starting with blade in its fully lowered position, put control lever in RAISE and record time it takes blade to reach full raised position. Repeat this procedure several times and average time readings.
3. Lift cycle should take not more than 3.5 seconds. If average cycle time is more than 3.5 seconds, front pump should be repaired or replaced as necessary.

NOTE: *This check should be made only in blade raising cycle.*

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TEST AND ADJUSTMENT

Ripper Lift

NOTE: *Before performing cylinder time cycle test, perform cylinder blade tilt test to insure that middle pump is correct.*

NOTE: *Before performing cylinder time cycle test, perform ripper lift cylinder drift test to insure that control valve, cylinders and valves are performing satisfactorily.*

If there is no excessive drift when ripper lift control is in HOLD position, but slow load speed, slow response or low power is present in RAISE position, problem could be either hydraulic pump or pressure relief valve. Loss of flow can be caused by pressure relief valve not sealing, allowing oil to flow into return to reservoir passage. Refer to Paragraph 5, RELIEF VALVE PRESSURE TEST.
To check pump, following time cycles should be observed when raising ripper.

1. Position machine so that ripper will not touch ground in its fully lowered position. Run engine at full throttle.
2. Starting with ripper in its fully lowered position, put control lever in RAISE and record time it takes ripper to reach full raised position. Repeat this procedure several times and average time readings.
3. Lift cycle should take not more than 1.8 seconds. If average cycle time is more than 1.8 seconds, front pump should be repaired or replaced as necessary.

NOTE: *This check should be made only in ripper raising cycle.*

9. PISTON PACKING TEST

Blade Tilt or Blade Tilt/Pitch and Ripper Cylinders Test

1. Position machine so that cylinder(s) to be tested can be completely extended. Start engine, completely extend cylinder(s) and place control lever in HOLD. Stop engine. Remove rod end hose.

WARNING! During next step, pressurized oil may be expelled from cylinder.

2. Hydraulically extend cylinder(s) again and check rod end port of cylinder(s) for oil flow.

NOTE: *Check tilt cylinder for tilt/pitch model from both sides*.

Blade Lift Cylinder Test

1. Disconnect the one of blade lift cylinder piston rod from the blade. Start the engine and retract cylinder to position slightly extended. Stop the engine. Tie the end of rod to the head of cylinder. Remove rod end hose.

WARNING! During next step, pressurized oil may be expelled from cylinder.

2. Hydraulically extend cylinder(s) again and check rod end port of cylinder(s) for oil flow.

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10. PRESSURE DIAGNOSTIC CHART

PROBLEM	PROBABLE CAUSE
Low pressure at low idle only for one cylinder pair, blade or ripper	One of cylinders leaking. Refer to Paragraph 6, BLADE LIFT CYLINDERS DRIFT TEST or , Paragraph 9, PISTON PACKING TEST.
Low pressure at low idle for both blade lift and ripper cylinders	Worn front pump. Refer to SECTION 10A, PUMPS.
Low pressure at low and high idle for both blade lift and ripper cylinders	Main relief valve not sealing. Dismantle relief valve for inspection and repair. Refer to SECTION 10B, VALVES.
Low pressure at low idle only for one movement tilt or double tilt (if equipped)	One of cylinders leaking. Refer to Paragraph 9, PISTON PACKING TEST.
Low pressure at low idle for both movement tilt and double tilt	Worn middle pump. Refer to SECTION 10A, PUMPS.
Low pressure at low and high idle for both movement tilt and double tilt	Tilt relief valve not sealing. Dismantle relief valve for inspection and repair.
Low pressure at low idle for pilot valves	Worn rear pilot pump. Refer to SECTION 10A, PUMPS.
Low pressure at low and high idle for pilot valves	Pilot pressure valve problem. Dismantle valve for inspection and repair. Refer to SECTION 10B, VALVES.

11. FAN DRIVE SYSTEM PERFORMANCE TEST

WARNING! Be sure the area in front and behind the machine is clear of personnel and obstructions. DO NOT allow anyone near the trucks or on the access steps during this test.

NOTE: *Performing test will require two people, one person to operate the machine, the second person to time the machine's performance.*

1. Start the cold engine. Use a Digital Optical Tachometer (see SERVICE /SPECIAL TOOLS) to record fan minimum speed. Do it with the engine coolant, engine charge air and drive train system oil temperatures below minimum values given in SPECIFICATIONS in this Section.
2. Apply torque converter stall speed procedure (refer to SECTION 7, DRIVE TRAIN) to warm up the drive train oil until the fan speed starts to rise from its minimum speed; record this oil temperature. Further warm up the oil until fan has smoothly reached its maximum speed at required oil temperature. Record fan maximum speed at the maximum speed oil temperature. With oil temperature still raising the fan speed should stay at maximum speed level. Refer to SPECIFICATIONS in this Section.
3. If any recorded fan velocities is out of specifications or the fan fails to operate steplessly between minimum and maximum speed range, refer to "Fan drive system diagnosis" in Paragraph 4, SERVICE DIAGNOSIS in this Section.

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SECTION 10A

PUMPS

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PUMPS

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SERVICE /SPECIAL TOOLS

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SERVICE /SPECIAL TOOLS

1. SERVICE /PECIAL TOOLS

DESCRIPTION	TOOL NUMBER
Shaft Seal Driver	Fabricate Fig. 10A.1
Cartridge V Block	Fabricate Fig. 10A.2

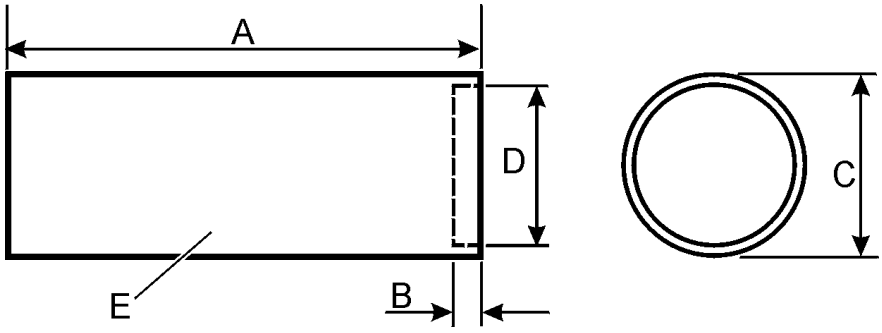

Fig. 10A.1. Shaft Seal Driver

A. . . . . 90 [mm]
B. . . . . 8.4 [mm]
C. . . . . 45 [mm]
D. . . . . 41.2 [mm]
E. . . . . Material - Tubular Stock

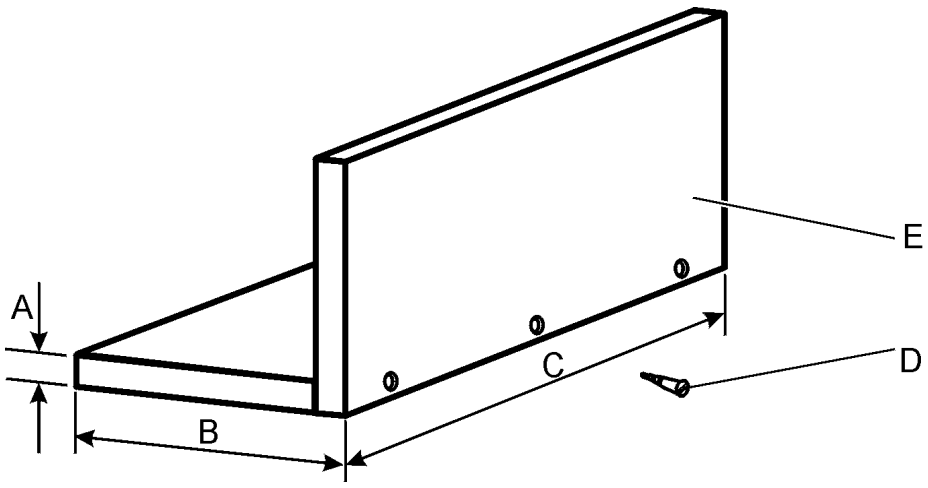

Fig. 10A.2. Cartridge V Block

A. . . . . 19 [mm]
B. . . . . 95 [mm]
C. . . . . 305 [mm]
D. . . . . Wood Screw
E. . . . . Material - Clean Wood With Smooth Finish Surface

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2. DESCRIPTION AND OPERATION (Refer to Fig. 10A.7)

The equipment pump rotary vane type consists principally of an inlet housing, three outlet bodies, a drive shaft and three pumping cartridges. The single inlet port feeds all three pumping cartridges.

Front and Center Pumping Cartridges

The principle components of a cartridge are an elliptical rotor ring, a slotted rotor splined to the drive shaft, an inlet and outlet support plate fitted with four special seal pack subassemblies, two flex side plates and ten vanes and inserts fitted to the rotor slots. Fluid enters the cartridge through the inlet port and is discharged through the outlet of flex side plate and support plate to the outlet ports.

The rotor is driven within the rotor ring by the pump driveshaft, which is coupled to the torque converter accessory drive gear. As the rotor turns, centrifugal force on the vanes, aided by under vane pressure fed from the outlet port, causes the vanes to follow the elliptical inner surface of the rotor ring. Radial movement of the vanes and turning of the rotor causes the chamber volume between the vanes to increase as the vanes pass the inlet sections of the rotor ring. This results in a low pressure condition which allows atmospheric pressure to force fluid into the chambers. An additional inlet fluid exists through a drilled hole in the rotor ring. This hole connects the inlet port directly to the inlet areas of the rotor ring and provides an additional flow path for fluid to get into the cartridge.

Fluid is trapped between the vanes and carried past a sealing land to the outlet section of the rotor ring. As the outlet section is approached, the chamber volume decreases and fluid is forced out into the system. System pressure is fed under the vanes, assuring their sealing contact against the rotor ring during normal operation. In the intra-vane cartridge, full system pressure is continuously applied only to the area between the vane and insert. This area is small and thrust is correspondingly light. During vane travel through pressure areas, full system pressure is applied against the bottom area of the outer vane. The valving of pressure to and from the bottom area of the vane is through holes drilled in the rotor. This selective application of pressure maintains the vane in substantially constant radial hydraulic balance in all positions. Vane tip wear is compensated automatically.

As the vane wears, pressure moves the vane father out in the rotor slot holding the vane tip against the rotor ring. The pump ring is shaped so that two pumping chambers are formed 180 [^{o}] apart. Thus, opposing hydraulic forces which develop side loads on the shaft cancel out to form a hydraulic balance.

The flex side plates for both inlet and outlet are symmetrical. Pressure is fed behind each side plate into two kidney shaped cavities, which are sealed by special seal pack subassemblies. The two flex side plates and their associated kidney shaped cavities function in the following manner. As pressure also builds up in the outlet, pressure also builds up in the cavities. The pressure in the cavities hold the flex side plates in hydraulic balance against the rotor and provide optimum running clearance for minimum internal leakage and minimum friction. The flex side plates also provide passages for feeding under vane pressure to the space between the vane and insert. The bronze faces of the flex side plates ride next to the rotor and provide excellent wear and cold start characteristics. The inlet and outlet support plates hold the flex side plates in position and contain passages which allow fluid pass from the inlet to the pumping cartridge and from the cartridge to the outlet port.

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EQUIPMENT PUMP

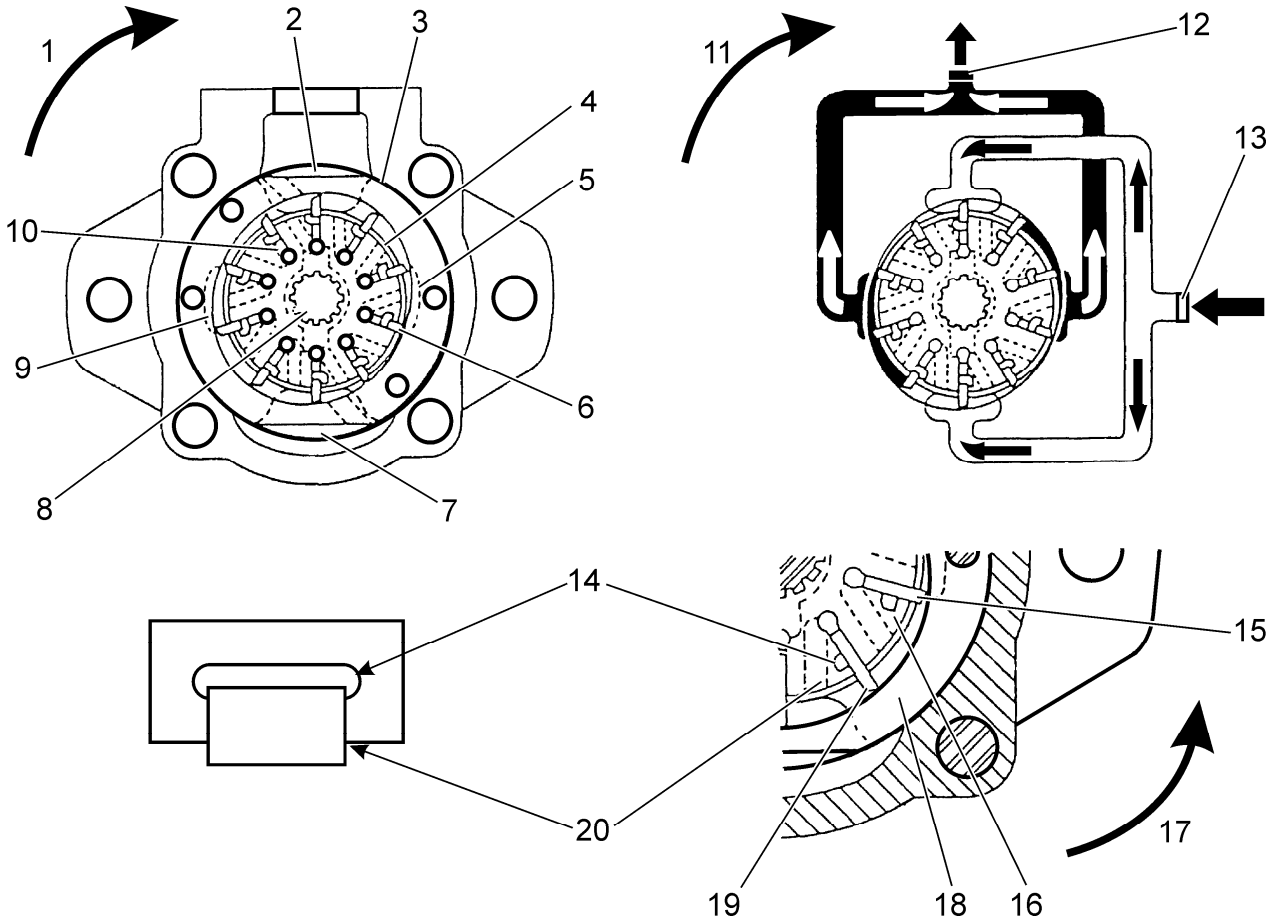

Fig. 10A.3. Vane Pump Operation

1. Rotation
2. Inlet
3. Rotor Ring
4. Rotor
5. Outlet
6. Vane
7. Inlet
8. Shaft
9. Outlet
10. Insert
11. Rotation
12. Outlet
13. Inlet
14. Pressure to insert
15. Vane
16. Rotor
17. Direction of Rotation
18. Rotor Ring
19. Sharper Edges Lead Direction of Rotation
20. Pressure to Bottom of Vane

Rear Pumping Cartridge (Refer to Fig. 10A.7)

This pump is used to develop hydraulic oil for the operation of the pilot valve control system. The positive pumping cartridge is the rotary vane type with shaft side loads hydraulically balanced. The flow rate depends on the pump speed at which it is driven. The pump consists of a ported end cover (39) and a pumping cartridge. Components of the pumping cartridge are an elliptical rotor ring (43), a slotted rotor (41) splined to fit the drive shaft, twelve vanes (42) to fit the rotor slots, a wear plate (48) and a pressure plate (46) with spring (45). The pumping cartridge is sandwiched between the end cover (39) and the rear cover (2). A bushing pressed in the pressure plate supports the drive shaft and centers the rotor within the cam ring. As the shaft is driven, the rotor and vanes generate flow by carrying fluid around the elliptical rotor ring contour. Fluid enters the cartridge via the inlet housing port through the porting in the housing walls through the porting in cartridge B's outlet support plate (7) through the center of the rear cover and past the wear plate and is discharged through the pressure plate into the end cover outlet port.

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EQUIPMENT PUMP

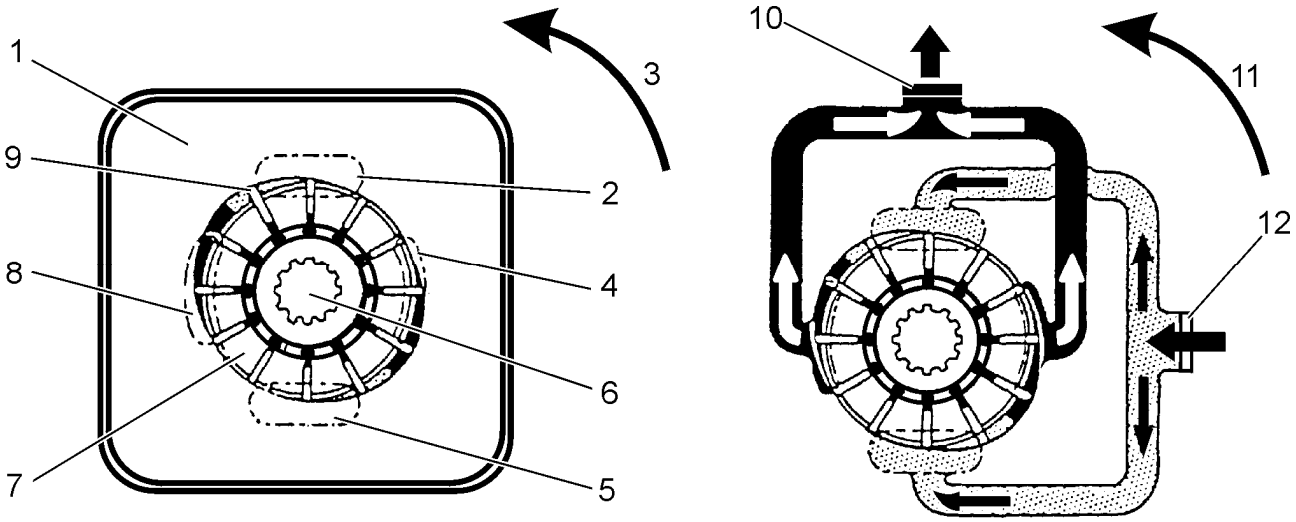

Fig. 10A.4. Vane Pump Cartridge Action

1. Rotor Ring	4. Outlet	7. Rotor	10. Outlet
2. Inlet	5. Inlet	8. Outlet	11. Rotation
3. Rotation	6. Drive Shaft	9. Vane	12. Inlet

As previously mentioned, fluid flow is developed by the pumping cartridge (Fig. 10A.4). The rotor is driven within the rotor ring by the drive shaft. As rotor turns, centrifugal force causes the vanes to follow the elliptical inner surface of the rotor ring. Radial movement of the vanes and turning of the rotor cause the chamber volume between the vanes to increase as the vanes pass the inlet section of the rotor ring. This results in a low pressure condition which allows atmospheric pressure to force fluid into the chambers. Fluid outside the inlet is at atmospheric pressure or higher.

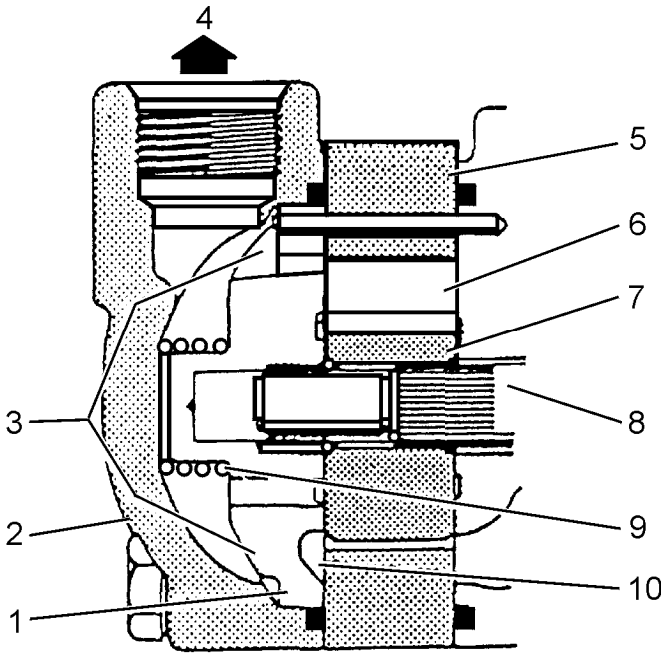

Fig. 10A.5. Cutaway of Pumping Chamber

1. Pressure Plate	5. Rotor Ring	8. Shaft
2. Cover	6. Vane	9. Spring
3. Back Pressure in System Effective Here	7. Rotor	10. Pressure in Cartridge
4. Discharge		

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This fluid is trapped between the vanes and carried past the large diameter or dwell section of the rotor ring. As the outlet section is approached, the rotor ring diameter decreases and the fluid is forced out into the system. System pressure is fed under the vanes, their sealing contact against the rotor ring. The rotor ring is shaped so that the two pumping chambers are formed diametrically opposed. Thus, hydraulic forces which would impose side loads on the shaft are cancelled.

The pressure plate seals the pumping chamber as shown in Fig.10A.5. A spring holds the plate against the cartridge until pressure builds up in the system. System pressure is effective against the area at the back of the plate, which is larger than the area exposed to the pumping cartridge. Thus an unbalanced force holds the plate against the cartridge, sealing the cartridge and providing proper running clearance for the rotor and vanes. This pump is designed for left hand (counterclockwise) rotation as viewed from the shaft end.

3. SPECIFICATIONS

Special Bolt Torque Data

End cover to rear cover mounting bolts . . . . . 55 ± 5 [Nm]
Rear cover to inlet cover mounting bolts . . . . . 95 ± 5 [Nm]
Center cartridge kit retaining bolts . . . . . 5 ± 0.5 [Nm]
Inlet cover to outlet housing mounting bolts . . . . . 205 ± 10 [Nm]
Front cartridge kit retaining bolts . . . . . 15 ± 0.5 [Nm]

NOTE: *Except for the special torques shown, all bolts and nuts are to be given a standard torque. Refer to SECTION 1.*

4. SERVICE DIAGNOSIS

COMPLAINT	
PROBABLE CAUSE	REMARKS
Pump Not Delivering Fluid	
1. Coupling or shaft sheared or disengaged	Disassemble pump and check shaft and cartridges for damages. Repair or replace as necessary.
2. Fluid inlet line in reservoir restricted	Check the strainer for dirt and/or contamination. Clean as necessary.
3. Fluid viscosity to heavy to pick up prime	Completely drain system, refer to OPERATOR'S MANUAL. Add new filtered oil of proper viscosity.
4. Air leaks at inlet pump not priming	Check inlet connections to determine where air is being drawn in. Tighten any loose connections. Check the fluid in reservoir.
5. Vane(s) stuck in rotor slots	Disassemble pump. Check for dirt or metal chips. Clean parts thoroughly and replace any damaged pieces. Flush system and refill with clean fluid.

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EQUIPMENT PUMP

Insufficient Pressure Build Up	
1. System relief valve problem	Refer to SECTION 10.
2. Complete loss of flow from pump	Disassemble and repair or replace pump.
Pump Making Noise	
1. Pump inlet partially blocked	Service the inlet strainer. Check oil condition and if necessary drain and flush system. Refill with clean oil.
2. Air leaks at inlet or shaft seal, oil reservoir probably foamy	Check inlet connections and seal to determine where air is being drawn in. Tighten any loose connections replace seal if necessary. Check the level of oil in the reservoir.
3. Coupling misalignment	Check if shaft seal bearing or other parts have been damaged. Replace any damaged parts. Realign coupled shafts.

The troubleshooting guide lists common difficulties experienced with vane pumps and hydraulic systems. It also indicates probable causes and remedies for each of the troubles listed. It should always be remembered that many apparent pump failures are actually failures of other parts of system. Causes of improper operation is best diagnosed with adequate equipment and a through understanding of the complete hydraulic system.

5. REMOVAL (Refer to Fig. 10A.6)

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic caps. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate proper installation.*

1. Drain the hydraulic system of oil as described in OPERATOR`S MANUAL.
2. Remove floor mat (cab equipped machines) and center floor plate from between operator's seat and instrument panel.
3. Disconnect brake control cable; refer to SECTION 13, SUPERSTRUCTURE. Disconnect decelerator pedal control cable and remove decelerator pedal assy from the platform; refer to SECTION 12, POWER.
4. Disconnect two hoses (2 and 6) from the hydraulic block (4).
5. Disconnect: suction tube (7), blade tilt control valve hose (8) and pilot control system hose (9) from the top of the pump (1).

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EQUIPMENT PUMP

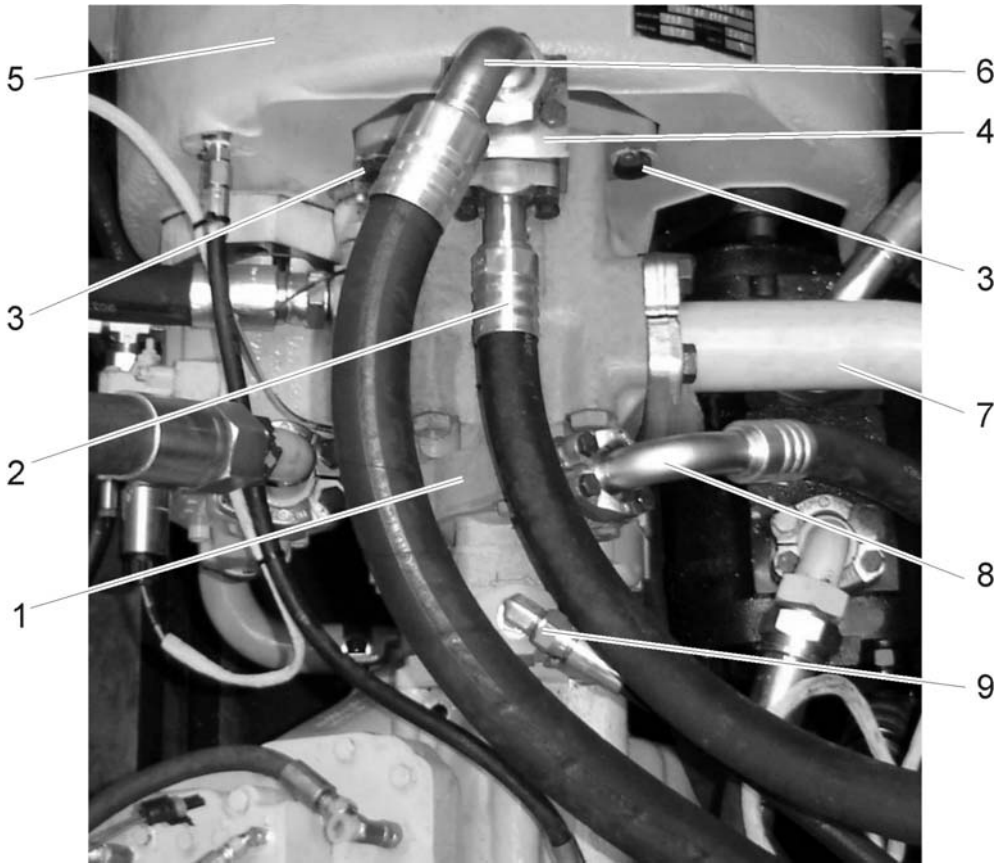

Fig. 10A.6. Equipment Pump Disconnecting Points

1. Equipment Pump Vane Type
2. Unloading Valve Hose
3. Mounting Bolt with Washer
4. Hydraulic Block
5. Torque Converter
6. One or Three Spool Control Valve Hose
7. Suction Tube from Reservoir
8. Blade Tilt Control Valve Hose
9. Pilot Control System Hose

NOTE: *The equipment pump removing procedure requires two people for appropriate handling of sling with pump during pump lift out of machine.*

6. Attach a suitable sling to equipment pump (1). The sling must be installed to give the best possible balance. Place tension on the hoist. Unscrew two mounting flange bolts with washers (3). Handle the pump (1) with care to pull the pump clear of torque converter (5) and lift out of machine.
7. Remove the O-ring from the equipment pump housing flange. Unscrew the four bolts and remove the hydraulic block (4) from the pump.

NOTE: *Cover the opening at the torque converter housing to prevent dirt and dust from entering.*

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6. DISASSEMBLY (Refer to Fig. 10A.7)

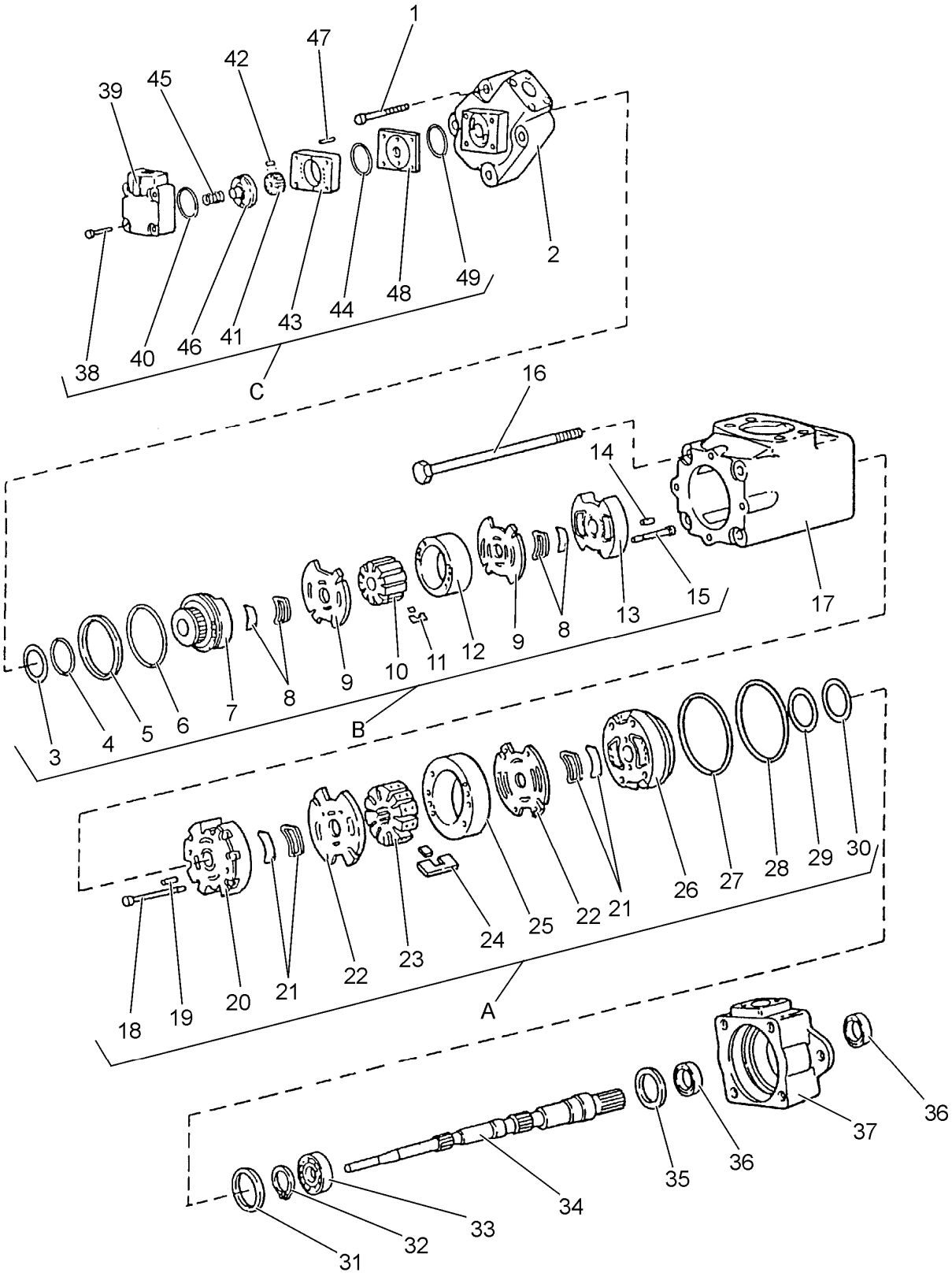

Fig. 10A.7. Exploded View of Equipment Pump

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EQUIPMENT PUMP

Legend For Fig. 10A.7

A. 178 l/min. at 2145 RPM Cartridge
B. 102 l/min. at 2145 RPM Cartridge
C. 33 l/min. at 2145 RPM Cartridge

1. Mounting Bolt
2. Rear Cover
3. Backup Ring
4. O-Ring
5. Seal Ring
6. O-Ring
7. Outlet Support Plate
8. Seal Pack
9. Flex Side Plate
10. Rotor
11. Vane Kit
12. Rotor Ring
13. Inlet Support Plate
14. Dowel Pin
15. Mounting Bolt
16. Mounting Bolt
17. Inlet Housing
18. Mounting Bolt
19. Dowel Pin
20. Inlet Support Plate
21. Seal Pack
22. Flex Side Plate
23. Front Rotor
24. Vane Kit
25. Rotor Ring
26. Outlet Support Plate
27. O-Ring
28. Seal Ring
29. O-Ring
30. Backup Ring
31. Spiral Lock Ring
32. Retaining Ring
33. Ball Bearing
34. Drive Shaft
35. Washer
36. Shaft Oil Seal
37. Outlet Housing
38. Mounting Bolt
39. End Cover
40. O-Ring
41. Rotor
42. Vane Kit
43. Rotor Ring
44. O-Ring
45. Spring
46. Pressure Plate
47. Dowel Pin
48. Wear Plate
49. O-Ring

Be sure is done in a clean area. Clean unit thoroughly with a solvent. Remove all sharp edges from splins, drill points, key ways and end of shaft. Match mark sections to ensure correct reassembly. To aid you in disassembly and reassembly, pump should be retained in some manner. We recommend use of a steel plate bolted to and extending over edge of a work bench. Plate should have a hole large enough for adapter flange pilot to drop through, and two holes matching location of mounting holes in adapter flange. Pump can now be firmly fixed to plate by bolts. This is especially helpful in removal and torquing of bolts.

1. Position pump, shaft end down, into a suitable stand (Fig. 10A.8). Match mark end cover (39) to rear cover (2), rear cover (2) to inlet housing (17) and inlet housing (17) to outlet housing (37).

CAUTION! Spring loaded assembly. Assembly must be held to relieve spring pressure. Use extreme care when disassembling.

2. Remove two mounting bolts (38) across from each other. Slowly remove remaining bolts until tension is off spring (45) then remove bolts. Remove end cover (39) with O-ring (40). Lift wear plate (48) with rotor ring (43), rotor (41) and pressure plate (46) off of pump and separate parts (Fig. 10A.9). Remove dowel pins (47) from rear cover (2). Discard three O-rings (40, 44 and 49).

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EQUIPMENT PUMP

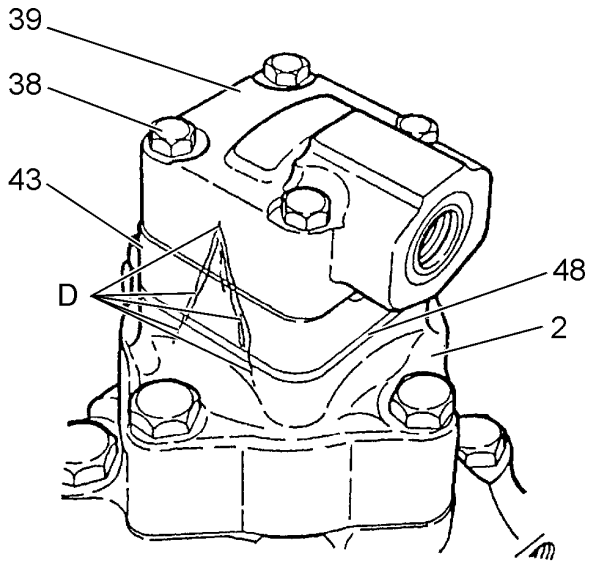

Fig. 10A.8. End Cover

D. Match Marks
2. Rear Cover
38. Mounting Bolt
39. End Cover
43. Rotor Ring
48. Wear Plate

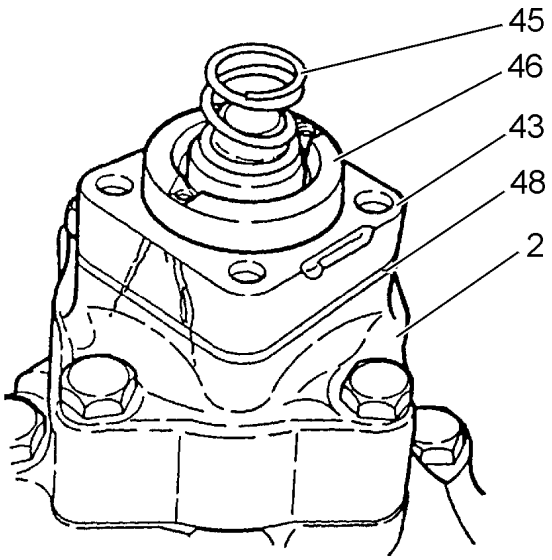

Fig. 10A.9. Spring and Pressure plate

2. Rear Cover
43. Rotor Ring
45. Spring
46. Pressure Plate
48. Wear Plate

3. Remove mounting bolts (1) and lift end cover (39) off of pump (Fig. 10A.10). Lift cartridge kit (B, Fig. 10A.11) out of pump and put off to side for later disassembly. Pry with a screwdriver if necessary but be sure to stone off any burrs raised with screwdriver. Remove mounting bolts (16) and lift inlet housing (17) off of outlet housing (37). Lift cartridge kit (A, Fig. 10A.12) out of pump and put off to side for later disassembly. Refer to CARTRIDGE KITS for service.

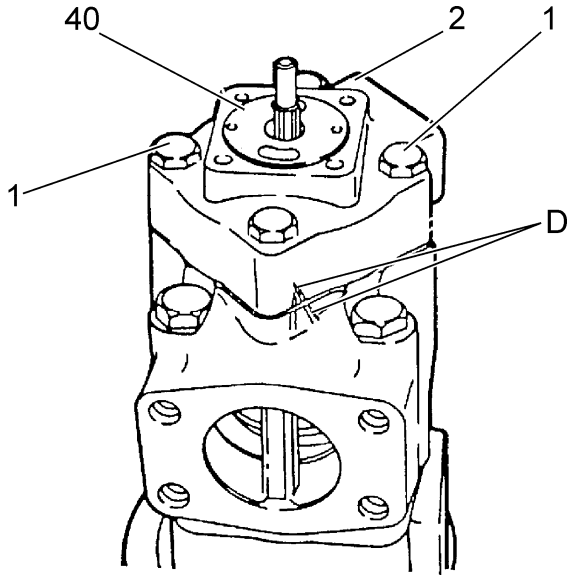

Fig. 10A.10. Rear Cover

D. Match Marks
1. Mounting Bolt
2. Rear Cover
40. O-Ring

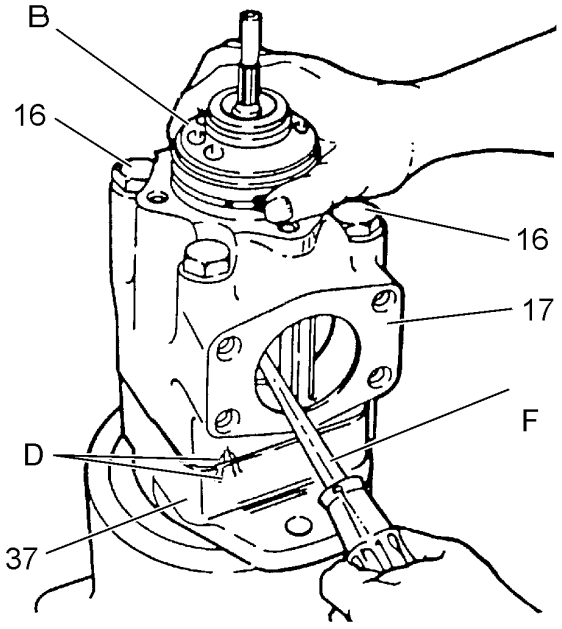

Fig. 10A.11. Cartridge B

B. Cartridge Kit B
D. Match Marks
F. Pry with Screwdriver
16. Mounting Bolt
17. Inlet Housing
37. Outlet Housing

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EQUIPMENT PUMP

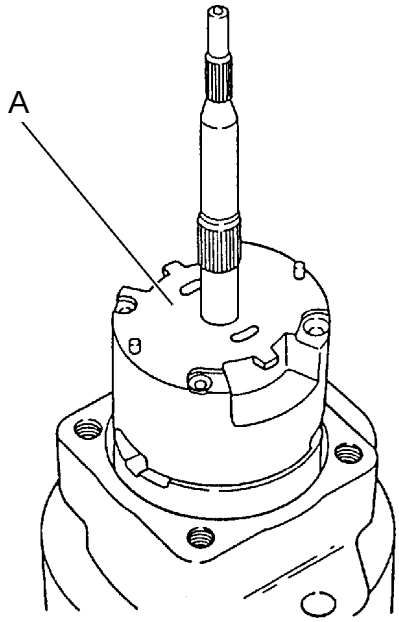

Fig. 10A.12. Cartridge A

A. Cartridge Kit A

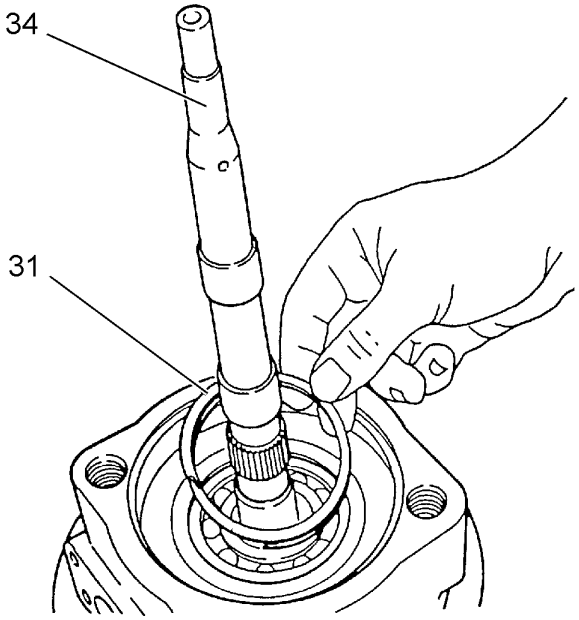

Fig. 10A.13. Spiral Lock Ring and Shaft

31. Spiral Lock Ring 34. Drive Shaft

4. Remove spiral lock ring (31) (Fig. 10A.13). Slide shaft (34) with bearing (33) out of outlet housing (37). If necessary, remove retaining ring (32) and press bearing (33) off of shaft. Remove washer spacer (35, Fig.10A.14) from outlet housing and drive shaft seal (36) out being careful not to damage seal mounting bore area.

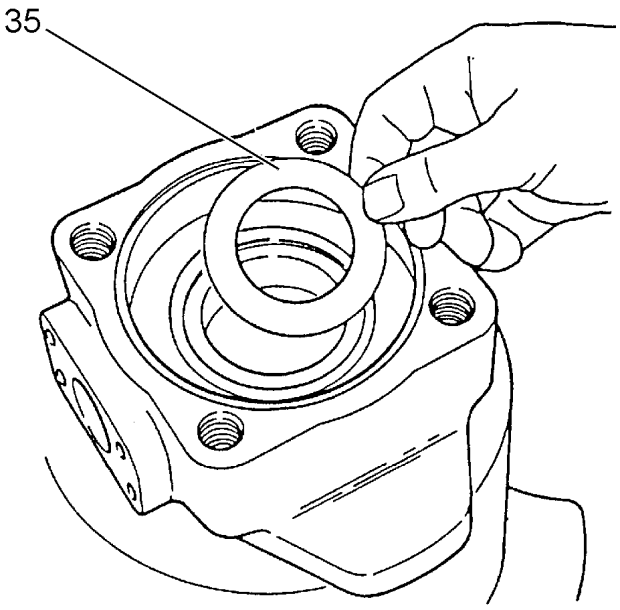

Fig. 10A.14. Spacer Washer

35. Washer

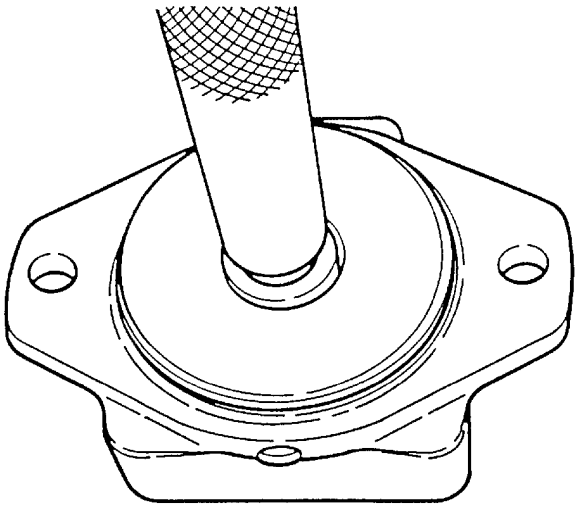

Fig. 10A.15. Seal Removal

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7. CARTRIDGE KITS

NOTE: *Both cartridge kits are similar in appearance with the only differences being in size and capacity. Unless otherwise notated, all reference numbers are a referral to Fig. 10A.7. Service the two cartridge kits one at a time.*

1. Remove back up ring (3 or 30), O-ring (4 or 29) and square seal ring (5 or 28) from outlet support plate (7 or 26). O-ring (6 or 27) will stay with respective covers.
2. Scribe a line across outer surface of cartridge kit (Fig. 10A.16). Scribe marking will provide a reference for parts during reassembly. Position cartridge on a flat surface (outlet support plate 7 or 26 down) and remove mounting bolts (15 or 18).

NOTE: *Do not slide outlet flex side plates (9 or 22) across rotor ring (12 or 25) and rotor (10 or 23). Burrs on ring or rotor can cause deep scratches in soft bronze surface.*

3. Slide inlet support plate (13 or 20) and seal packs (8 or 21) off of cartridge. DO NOT allow inlet flex side plates (9 or 22) to slide with support plate. Refer to Fig. 10A.17. Raise inlet flex side plate (Fig. 10A.18) just enough to lift up and away without sliding.

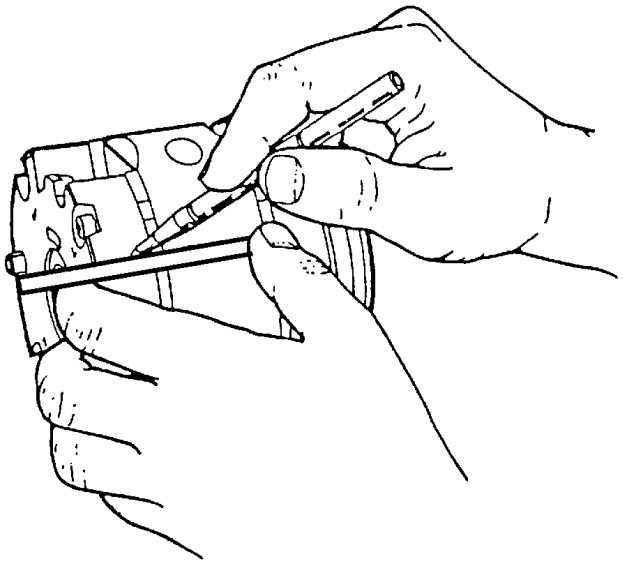

Fig. 10A.16. Scribing Cartridge

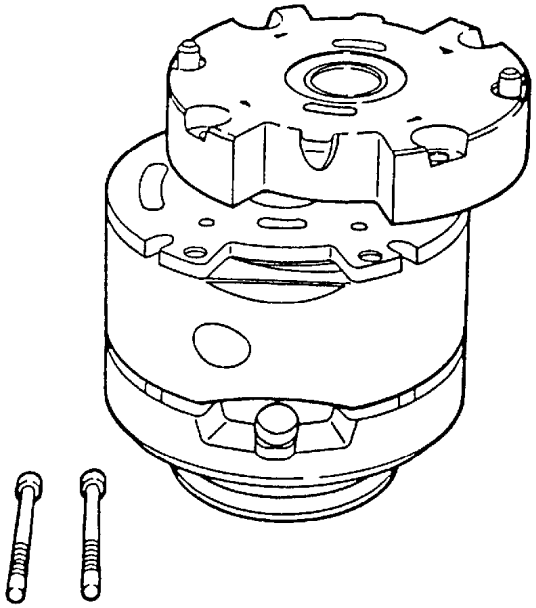

Fig. 10A.17. Inlet Support Plate

4. Place a small clean piece of wood over exposed rotor ring (12 or 25) and rotor (10 or 23). Reverse position of cartridge (Fig. 10A.19). Slide outlet support plate (7 or 26) and seal pack (8 or 21) off of outlet flex side plate (9 or 22). DO NOT allow outlet flex side plate to move across rotor ring or rotor. Move outlet flex side plate off center (Fig. 10A.24) just enough to lift up and away without sliding.

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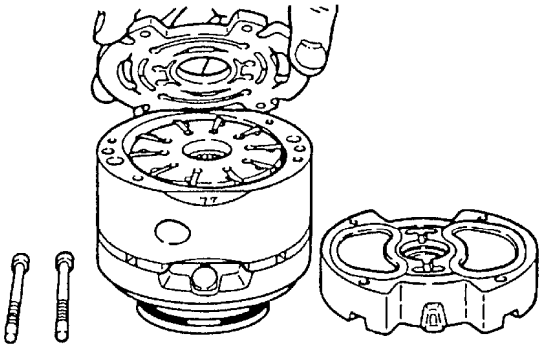

Fig. 10A.18. Inlet Flex Side Plate

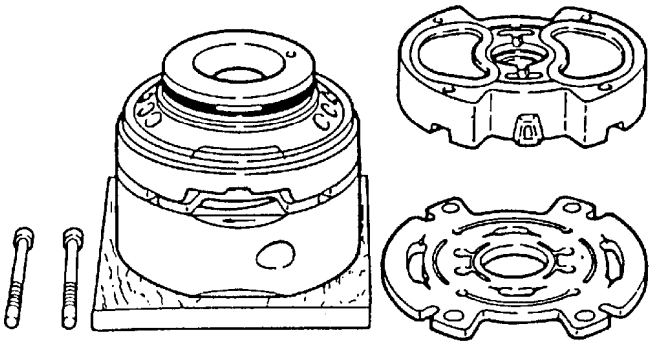

Fig. 10A.19. Reverse Cartridge

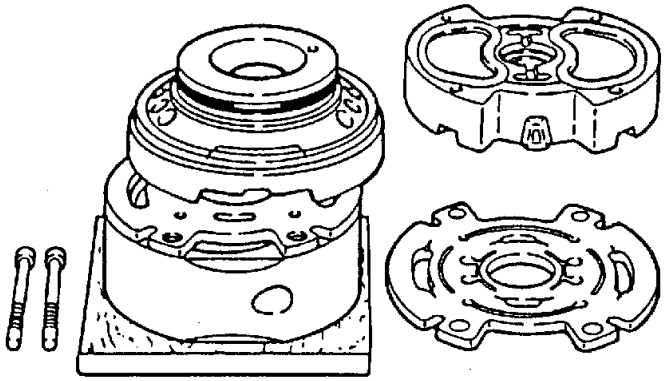

Fig. 10A.20. Outlet Support Plate

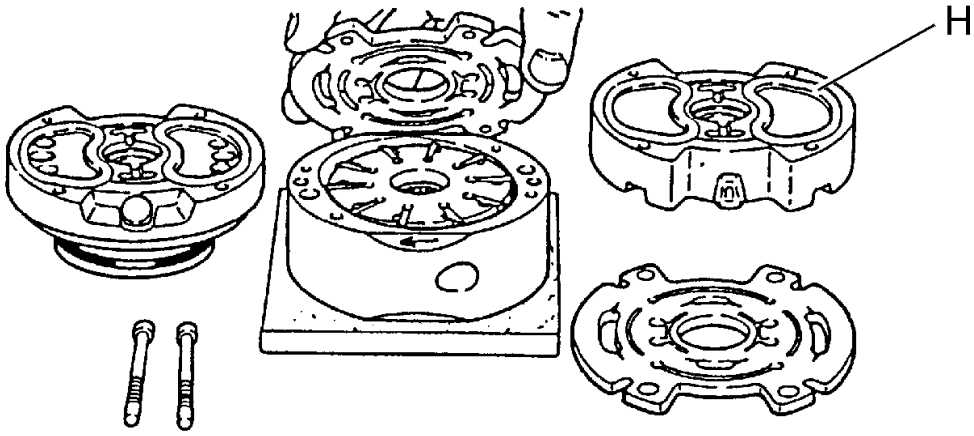

Fig. 10A.21. Outlet Flex Side Plate

H. Seal Packs

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5. Lift rotor ring (12 or 25) away from rotor (10 or 23) and vanes (11 or 13). Locate arrow (Fig. 10A.22) stamped into rotor periphery. Remove vanes and insert in order starting at arrow. Keep them in order for inspection.

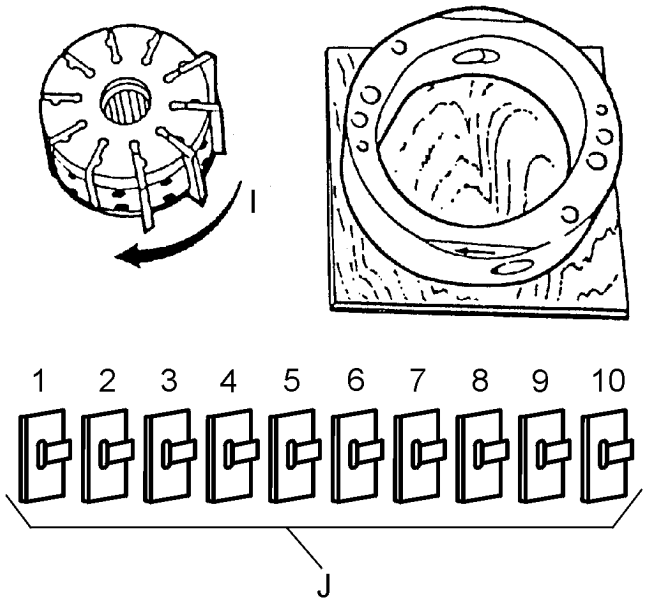

Fig.10 A.22. Vane Removal

I. Rotor J. Vanes and Inserts

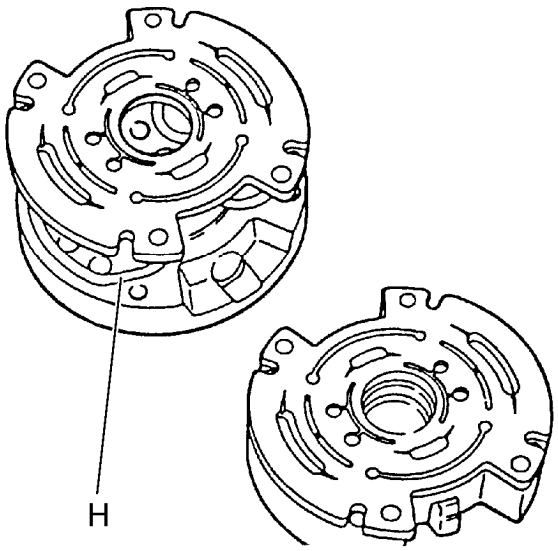

Fig.10A.23. Flex Side Plates

H. Seal Packs

6. Discard seal pack (8 or 21), back up ring (3 or 30), O-rings (4 and 6 or 27 and 29) and square seal ring (5 or 28) and replace with parts from new seal kit. Check cartridge wear surfaces for pick up, scoring and excessive wear. Slight heat discoloration of flex side plate bronze surfaces is normal. Score marks deeper than 0.025 [mm] and scratches deeper than 0.051 [mm] indicate a new part is needed. Slight scoring and/or scratches can be removed with an oiled "Arkansas" stone. Inspect both sides of each vane and insert in order. If pick up, heavy wear or scoring is found, inspect rotor, replaced scored parts. Inspect rotor ring for vane chatter marks, wear and/or scratches. Replace if scoring is evident. All cartridge kit parts must be free of burrs. Stone mating surfaces of each part with an oiled "Arkansas" stone prior to assembly.

NOTE: *Direction of rotation is viewed from shaft end: right hand rotation is clockwise, left hand rotation coounterclockwise. This pump is assembled for counterclockwise rotation. Assemble cartridge kit **A** in direction of rotation notated. Assemble cartridge **B** in reverse of cartridge **A**: left hand (ccw) rotation, cartridge **A** for left hand rotation and cartridge **B** for right hand rotation.*

NOTE: *Coat all parts except seals and back up rings with clean oil to facilitate assembly and provide initial start up. Use small amounts of petroleum jelly to hold seals in place during assembly.*

7. Position inlet and outlet support plates (13 and 7 or 20 and 26) on flat surfaces as shown in Fig. 10A.23. Install seal packs (8 or 21) into cavities with seal retainer surface up (O-ring facing into cavity). Place side flex plates (9 or 22) over each support plate with bronze wear surface facing up. Align scribe marks to insure correct flex plate is used with support plate. Bronze wear surface must face rotor when assembled.

NOTE: *Flex side plates develop a wear pattern with rotor and vanes and should not be interchanged.*

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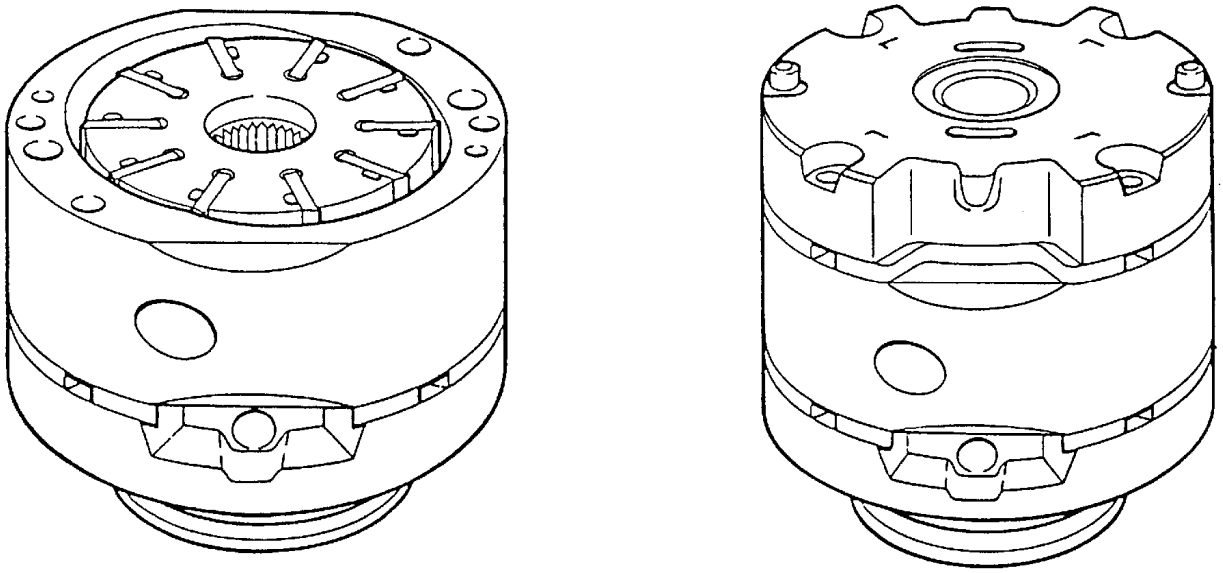

Fig. 10A.24. Cartridge Reassembly

8. For right hand rotation, cartridge **B**, set rotor (10) on a clean flat wooden board with arrow pointing right. For left hand rotation, cartridge **A**, set rotor (23) on a clean flat wooden board with arrow pointing left. Assemble vanes and inserts (11 or 24) into rotor in reverse order with sharp chamfer edge of each vane leading in direction of rotation. All vanes must move freely in rotor slots with no evidence of binding.
9. Assemble rotor ring (12 or 23) over rotor and vanes with arrow pointing in same direction as rotor. Lubricate top surface of rotor and vanes liberally with clean oil. Locate scribe mark on ring, outlet support plate (7 or 26) and flex side plate (9 or 22). Hold support plate and side plate together and assemble over rotor ring and rotor with scribe marks in line. Hold cartridge together to prevent movement and turn assembly over so outlet support plate rests on a flat surface and wooden board is up. Remove board.
10. Lubricate exposed surface of rotor and vanes with clean oil. Locate scribe marks on inlet support plate (13 or 26) and flex side plate (9 or 22). Hold inlet support plate and flex side plate together and assemble over exposed rotor ring, rotor and vanes. Assure that scribe marks are in line.

NOTE: *Cast in arrows located next to mounting bolts (15 or 18) indicate cartridge direction of rotation. The O.D. of all component parts of cartridge kit must be in line with each other or cartridge kit will bind during assembly.*

11. Align cartridge kit (A or B) as follows:

    Install mounting bolts (15 or 18) into cartridge until snug. Using V block (refer to SERVICE/ SPECIAL TOOLS in this SECTION) position cartridge on its side. Loosen bolts enough to allow each section of cartridge to come into alignment within V block. Torque cartridge kit **B** bolts to 5 ± 0.5 [Nm] and cartridge kit **A** bolts to 15 ± 0.5 [Nm].

12. Check rotor for binding by inserting index finger through shaft opening of inlet support plate. Hold cartridge kit in a horizontal shaft position and lift rotor with finger. Rotor should move freely back and forth within cartridge. If rotor binds, open kit, clean and stone all possible areas of bind and reassemble using aforementioned procedures. Rotor must move freely within cartridge when assembled.

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8. INSPECTION AND REPAIR (Refer to Fig. 10A.7)

NOTE: *All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerance of the parts makes this requirement very important. Clean all removed parts using a commercial solvent that is compatible with the system oil. Compressed air may be used in cleaning but it must be filtered to remove water and contamination.*

1. Discard the shaft seals (36), seal rings (5 and 28), O-rings (4, 6 and 27, 29 and 40, 49), back-up rings (3 and 30), wear plates (46, 48) and seal packs (8 and 21) subassemblies. Use a new seal kit for reassembly. Wash the metal parts, blow them dry with air and place on a clean surface for inspection.
2. Check the pumping cartridges wear surfaces for pickup, scoring and excessive wear. Slight heat discoloration of the flex side plates (9 and 22) bronze surface is normal. Score marks deeper than 0.025 [mm] and scratches deeper than 0.05 [mm] indicate a new part is needed. Slight scoring and/or scratches can be removed with an oiled “Arkansas” stone.

NOTE: *DO NOT use a dry stone on the bronze surface or scratches will result.*

3. Inspect both sides of each vane and insert in order. If pickup, heavy wear or scoring is found, inspect the appropriate rotors (10, 23 and 41) slot. Replace scored parts.
4. Inspect rotor rings (12, 25 and 43) for vane chatter marks, wear and/or scratches. Replace if scoring is evident.

NOTE: *Replacement rotor rings (12, 25 and 43) width must be identical to the ring being replaced or reduced life and/or output flow will result. The minimum rotor ring (12, 25 or 43) to rotor (10, 23 or 41) clearance limits is 0.03 [mm].*

NOTE: *All pumping cartridge (A, B and C) parts must be free of burrs. Stone the mating surfaces of each part with an oiled “Arkansas” stone prior to assembly.*

NOTE: *Pre-assembled replacement cartridge kits are available. If the old cartridge is worn extensively, a new kit should be used.*

5. Vane and rotors (10, 23 and 41) wear can be checked by inserting the vane in the rotor slot and checking for excessive play. Replace rotor (10, 23 or 41) and vane kit (11, 24 or 42) if wear is evident.
6. Rotate ball bearing (33) while applying pressure to check for wear, looseness and pitted or cracked races.
7. Inspect seal and bushing mating surfaces on drive shaft (34) for scoring or wear. Replace the shaft if marks cannot be removed by light polishing.

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9. REASSEMBLY (Refer to Fig. 10A.7)

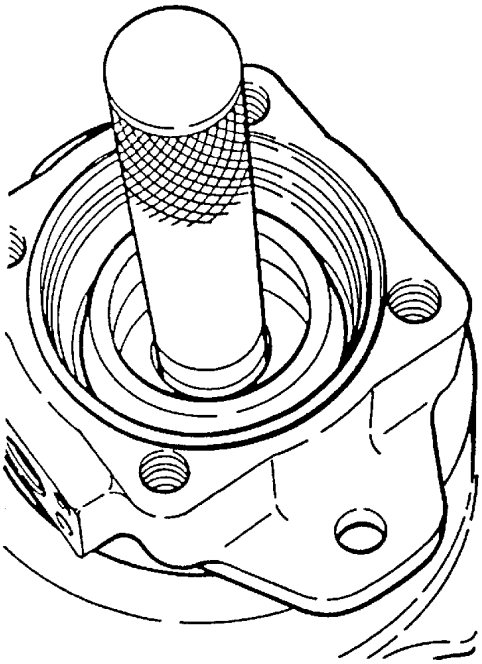

Fig. 10A.25. Seal Installation

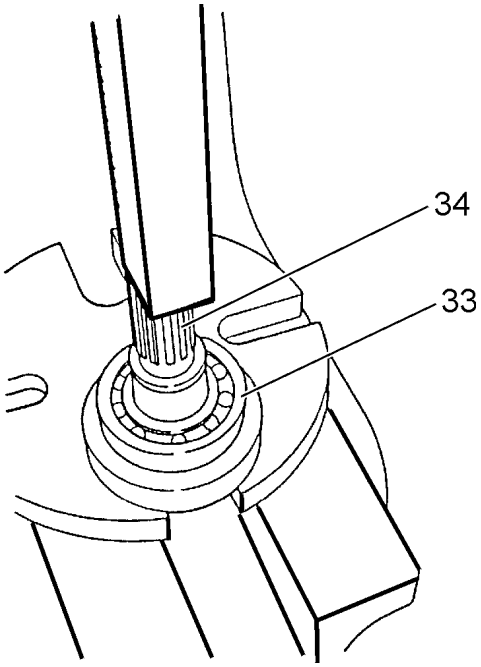

Fig. 10A.26. Pressing Bearing On

33. Ball Bearing 34. Drive Shaft

1. Position outlet housing (37) shaft end down. Lubricate shaft seal (36) with petroleum jelly and place into position within outlet housing, garter spring up. Using seal installing tool (Fig. 10A.25), (refer to SERVICE/ SPECIAL TOOLS in this SECTION), bottom seal into outlet housing against shoulder. Install washer (35, Fig. 10A.14) over seal. Press bearing (33, Fig. 10A.26) onto shaft (34) and secure with retaining ring (32). Use a "bullet" or plastic tape over shaft splines to prevent damage to seal. Lubricate shaft end with petroleum jelly and carefully push shaft through seal until bearing bottoms in outlet housing and secure with spiral lock ring (31, Fig. 10A.13).
2. Install square cut sealing ring (28) into outlet housing. Install O-ring (29) and back up ring (30) onto cartridge kit (**A**, Fig. 10A.12) outlet support plate hub. Carefully install cartridge kit (**A**) over shaft and into outlet housing with one of the chamfers on ring in alignment with outlet port. Install O-ring (27) over cartridge and into groove in outlet housing.
3. Install inlet housing (17, Fig. 10A.11) in position; move back and forth until cartridge pins drop into alignment holes within cover. Turn cover slightly until scribe marks and bolt holes are in line. Oil and torque mounting bolts (16) 205 ± 10 [Nm]. Turn pump shaft by hand to verify freedom of cartridge.

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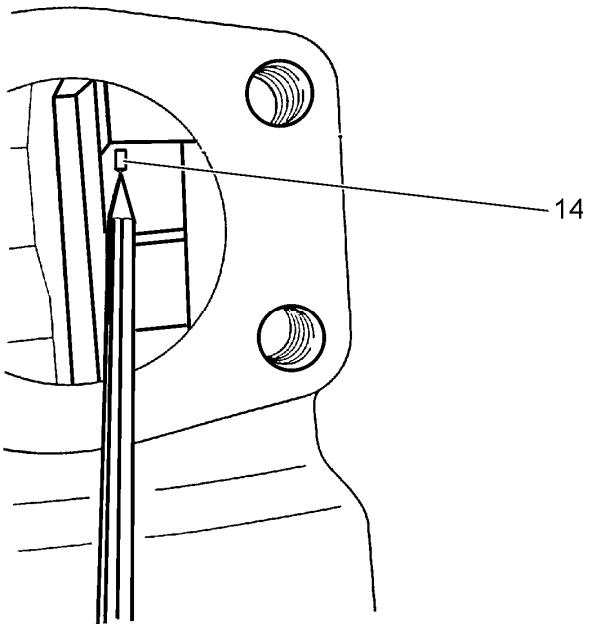

Fig. 10A.27. Locating Pin

14. Dowel Pin

4. Install square cut sealing ring (5) into outlet cover (2). Install O-ring (4) and back up ring (3) onto cartridge kit (**B**, Fig. 10A.11) outlet support plate (7) hub. Carefully install cartridge kit (**B**) over shaft and into inlet housing and turn slightly to bring into alignment pin holes and cartridge alignment pins (Fig. 10A.27). Install O-ring (6) into outlet cover. Making sure square cut sealing ring is in place within cover, orient cover with scribe marks and gently slide cover over cartridge. Be careful not to cut seals or pinch O-rings during cover installation. Install mounting bolts (1, Fig. 10A.10) and torque to 95 ± 5 [Nm]. Turn pump shaft by hand to verify freedom of cartridge.
5. Position dowel pins (47) into rear cover (2). Liberally coat O-ring (49) with petroleum jelly and install into rear cover. Position wear plate (48) with O-ring (44) groove side up and coat with clean oil. Position rotor (41) with vanes (42) on plate and place rotor ring (43) over rotor aligning scribe marks. Position sub assembly over dowels aligning rotor with shaft, dowel pins with holes and scribe marks. Apply a liberal coat of clean oil to rotor and vanes and verify rotor and vane freedom of movement. Install pressure plate (46) with spring (45) on shaft. Install end cover (39) with O-ring (40), aligning scribe marks, and secure with mounting bolts (38). Torque to 54 ± 7 [Nm].

10. INSTALLATION (Refer to Fig. 10A.28)

IMPORTANT: *All gaskets and any collapsed hoses or damaged connections must be replaced with new. Whenever a sealing ring is required at a disconnected line, it is recommended that a new sealing ring be installed.*

1. Remove the covering from the torque converter housing. Thoroughly clean the mating surfaces of the torque converter housing and the equipment pump housing.
2. Install the hydraulic block (4) to the pump and secure with four bolts.
3. Install a new O-ring on the equipment pump housing flange.

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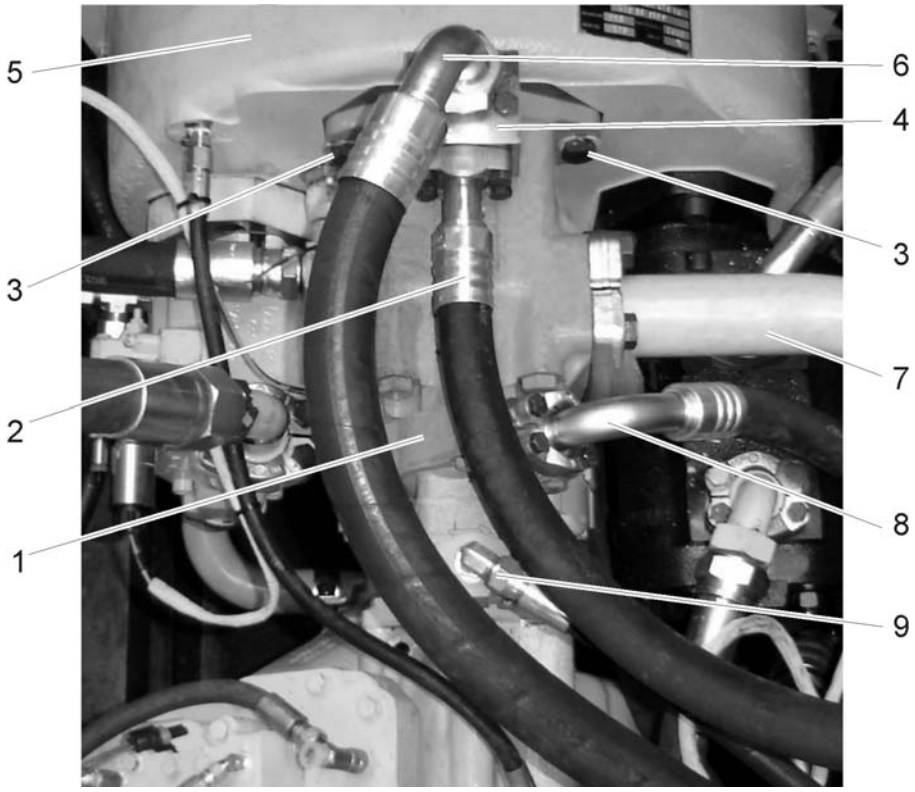

Fig. 10A.6. Equipment Pump Disconnecting Points

1. Equipment Pump Vane Type
2. Unloading Valve Hose
3. Mounting Bolt with Washer
4. Hydraulic Block
5. Torque Converter
6. One or Three Spool Control Valve Hose
7. Suction Tube from Reservoir
8. Blade Tilt Control Valve Hose
9. Pilot Control System Hose

IMPORTANT: *As the equipment pump housing enters the torque converter housing, be sure the O-ring is properly seated in the groove of the equipment pump housing.*

NOTE: *The equipment pump installing procedure requires two people for appropriate handling of sling with pump during pump lift off to the machine.*

4. Attach a suitable sling to equipment pump (1). The sling must be installed to give the best possible balance. Handle the pump with care to install the pump (1) to the torque converter (5) and secure with bolts and washers (3).

IMPORTANT: *Before connecting any lines to the pump, fill all ports with clean oil before start to provide initial lubrication and avoid the unit damage.*

5. Reconnect pilot control system hose (9), tilt control valve hose (8) and: suction tube (7) to the equipment pump (1).
6. Reconnect two hoses (2 and 6) to the hydraulic block (4).
7. Install decelerator pedal assy to the platform. Reconnect decelerator pedal control cable. Refer to SECTION 12, POWER

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8. Reconnect brake control cable; refer to SECTION 13, SUPERSTRUCTURE..
9. Refill hydraulic reservoir as described in the OPERATOR'S MANUAL.
10. Start the engine and carefully press the quick disconnect check points at blade valves to remove the air from hydraulic system. Check for external leaks in the hydraulic system.
11. Check the oil level in hydraulic reservoir and add oil if necessary.
12. Stop the engine. Install the center floor plate and floor mat (if equipped).

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SECTION 10B

VALVES

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VALVES

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SERVICE /SPECIAL TOOLS

1. SERVICE /SPECIAL TOOLS

DESCRIPTION	TOOL NUMBER
Digital Optical Tachometer …….....	337 7462.

CONTROL VALVE

2. DESCRIPTION

The control valves used in this system are mounted to a bracket at the right side in front of the reservoir. Either one or three spool control valve is used in the system depending on the equipment. The valves are controlled by pilot lines from the pilot valves.

The control valve is a directional hydraulic valve. Each section directs oil to the appropriate hydraulic cylinder controlling the action of a certain equipment. Each section controls one hydraulic circuit.

Three spool control valve is controlled with two pilot valves. The blade pilot valve controls the blade lifting and lowering. The ripper pilot valve controls the ripper.

In the neutral position of the pilot valves the oil flows freely through the spool without any response of the appropriate equipment. If a pilot valve is shifted the oil flow is directed to the cylinder causing the desired response of the equipment. All the operating positions except the blade FLOAT position are not detented and all the spools of the valve are spring centered for return to the HOLD position.

All sections are assembled between the inlet and outlet cover. All section housings are of the same design although the spools differ in their functioning.

A machine can be equipped with one or three spool control valve. Regardless of the number of sections each control valve has both the inlet and outlet cover.

Incorporated in the inlet cover is a relief valve, which is used to by-pass oil from the pump back to the reservoir when the oil pressure exceeds the relief valve setting. Blade lift section and ripper lift section are equipped with anticavitation valves. Each valve spool has a corresponding check valve which provides smooth movement of the load when the spool position is changed from the HOLD position to an operating one.

3. REMOVAL

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lever is in NEUTRAL position, drive train lock lever is in ON position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

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CONTROL VALVE

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate their proper installation.*

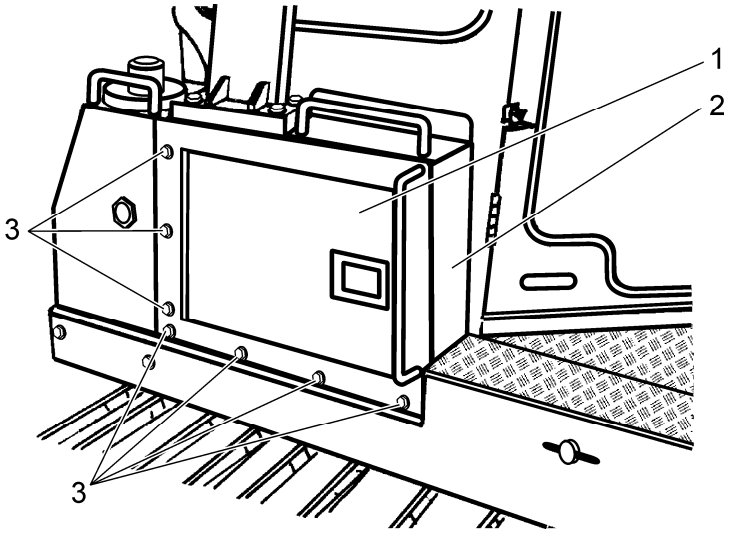

Fig. 10B.1. Disassembly R.H. Enclosure

1. R.H. Door
2. R.H. Enclosure
3. Bolts

1. Drain the hydraulic system of oil as described in OPERATOR'S MANUAL.
2. Unscrew bolts (3, Fig. 10B.1) and remove R.H. enclosure (2) with R.H. door (1).
3. Remove return filters (2, Fig. 10B.2) to gain access to control valve (1).

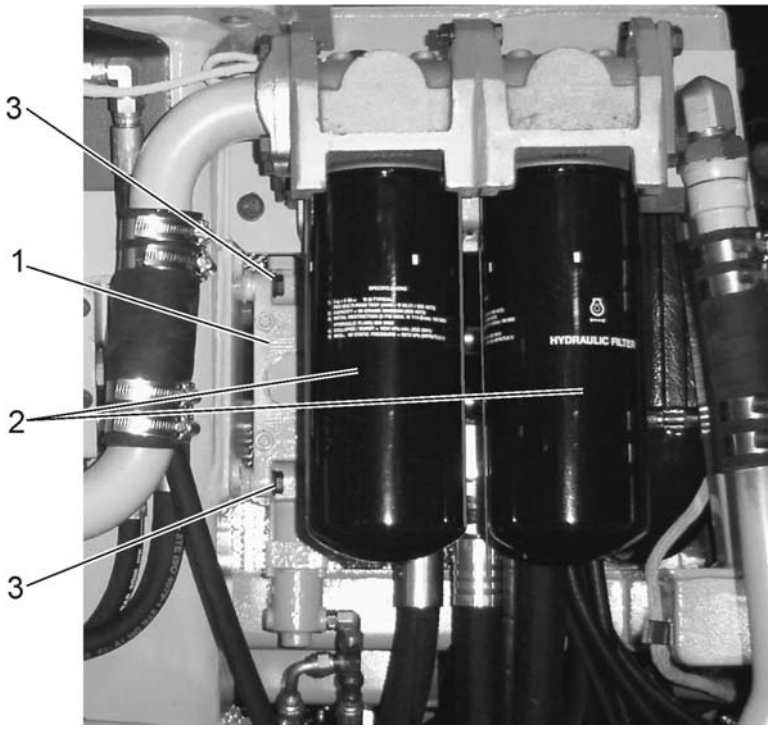

Fig. 10B.2. Hydraulic Return Filters Removal

1. One Spool or Three Spool Control Valve
2. Hydraulic Return Filters
3. Mounting Bolt with Washer

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CONTROL VALVE

NOTE: *To make easier control valve removal unscrew bolts securing R.H. console cover to the platform R.H. console (4, Fig. 10B.4) and remove the access cover to gain access to control valve (3).*

4. Disconnect hose (3, Fig. 10B.3) from inlet hose (5) hydraulic connector.
5. Disconnect valve inlet hose (5) from control valve (9).
6. Disconnect reservoir return tube (6) from control valve (9).
7. Disconnect outlet hoses (8) from blade lift section of control valve (9).
8. THREE SPOOL CONTROL VALVE: Disconnect outlet hoses (8) from ripper lift and pitch sections of control valve (9).
9. Disconnect upper pilot hoses (1) and lower pilot hoses (7) from control valve (9).
10. Protect the control valve (9) with a wooden plank against gravitating. Remove three bolts and washers (3, Fig. 10B.2 and 2, Fig.10B.4) securing valve to the bracket (4, Fig. 10B.3) and remove it from machine using suitable hoist.

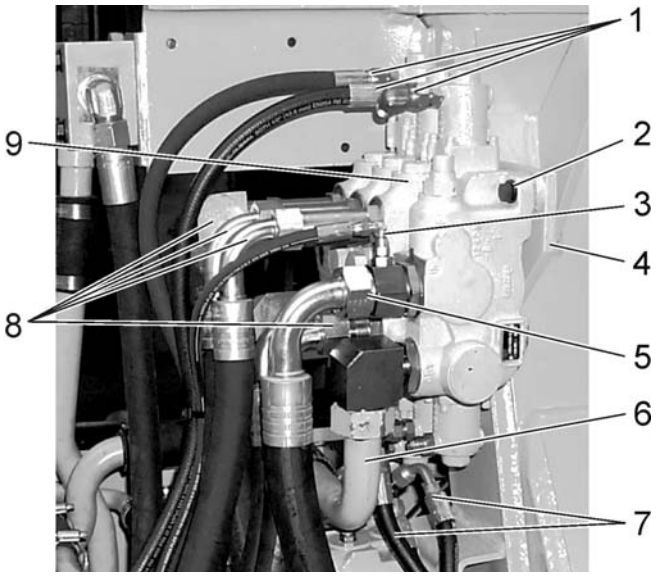

Fig. 10B.3. Control Valve Disconnect Points

1. Pilot Hoses (Upper)
2. Mounting Bolt with Washer
3. Quick Disconnect Fitting Hose
4. Bracket
5. Inlet Hose
6. Reservoir Return Tube
7. Pilot Hoses (Lower)
8. Outlet Hoses
9. One or Three Spool Control Valve

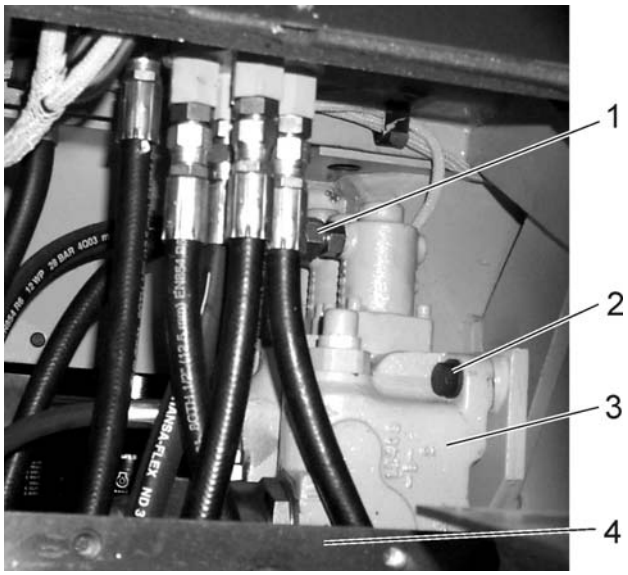

Fig.10B.4. Control Valve Disconnect Points (Cab Inside View)

1. Pilot Hose
2. Mounting Bolt with Washer
3. One or Three Spool Control Valve
4. Platform R.H. Console

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CONTROL VALVE

4. DISASSEMBLY

NOTE: *It is recommended to mark all control valve sections before removal for proper assembly.*

1. Remove all hydraulic connectors threaded into the control valve.
2. Position the control valve on a work bench with the mounting studs (1, Fig. 10B.5) facing up.
3. Remove four nuts (2) from the mounting studs (1).
4. Remove the outlet cover plate (10) from the valve bank. Remove and discard intersection seal rings.
5. Remove the blade lift section (9) from the valve bank. Remove and discard the between section seal rings. Refer to BLADE LIFT SECTION, Paragraph 8 in this Section.
6. THREE SPOOL CONTROL VALVE: Remove the ripper lift section (8) from the valve bank. Remove and discard the between section seal rings. Refer to RIPPER LIFT SECTION, Paragraph 9 in this Section.
7. THREE SPOOL CONTROL VALVE: Remove the ripper pitch section (7) from the valve bank. Remove and discard the between section seal rings. Refer to RIPPER PITCH SECTION, Paragraph 10 in this Section.
8. Remove the relief valve (6) from the inlet cover (3). Refer to MAIN PRESSURE RELIEF VALVE, Paragraph 11 in this Section.
9. Remove the port plugs (4 and 12) from the inlet (3) and outlet (10) covers. Remove and discard O-rings (5 and 11).

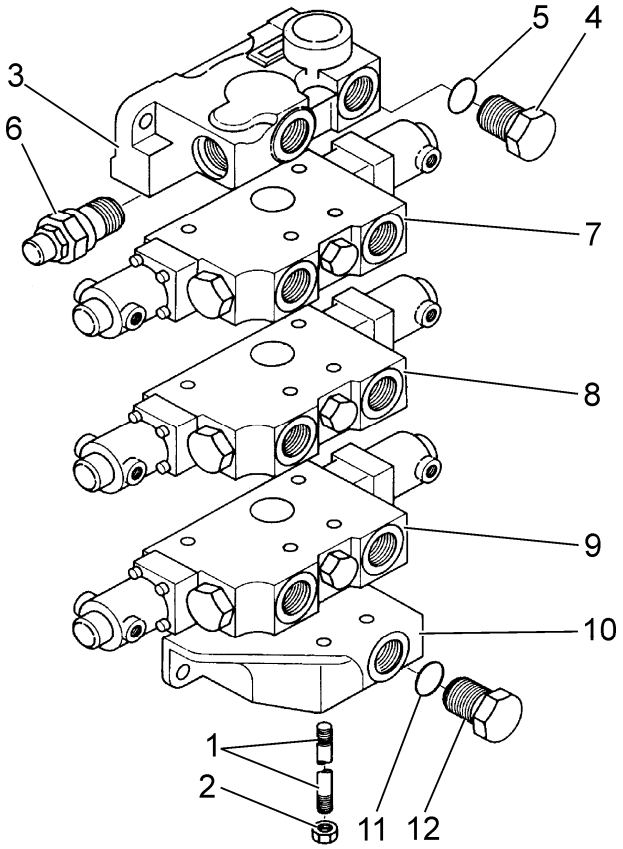

Fig. 10B.5. Exploded View of Control Valve

1. Mounting Stud	4. Plug	7. Ripper Pitch section	10. Outlet Cover Plate Assy
2. Nut	5. O-Ring	8. Ripper Lift Section	11. O-Ring
3. Inlet Cover Plate Assy	6. Relief Valve	9. Blade Lift Section	12. Plug

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CONTROL VALVE

5. INSPECTION AND REPAIR

1. It is recommended that new seal rings be installed whenever the control valve is disassembled for service.
2. Make a preliminary inspection of all parts before cleaning to detect discrepancies which may not show up once the parts are cleaned. Examine the oil for metal particles, dirt and other foreign material.
3. Wash all the parts thoroughly in suitable solvent and dry with compressed air or a clean cloth.

6. REASSEMBLY

1. Install the port plug (12) with new O-ring (11) to the outlet cover (10) port. Position O-ring (11) properly in its groove to prevent its damage. Torque the plug to 45 – 53 [Nm].
2. Install the relief valve (6) and port plug (4) with new O-ring (5) to the inlet cover plate (3). Position O-ring (11) properly in its groove to prevent its damage. Torque the relief valve to 45 – 53 [Nm]. Torque the plug to 129 – 156 [Nm].
3. Oil the threads of the mounting studs (1) and install into the inlet cover (3).
4. ONE SPOOL CONTROL VALVE: Install the between section seals. Slide the blade lift section (9) on the studs (1) up against the inlet cover (3).
5. THREE SPOOL CONTROL VALVE: Install the between section seals. Slide the blade lift section (9), ripper lift section (8) and ripper pitch section (7) on the studs (1) up against the inlet cover (3).
6. Install the outlet cover (3) on the studs (1) against the ripper pitch section (7). Oil the nut (2) threads and install to the mounting studs (1). Tighten the stud nuts to 68 – 82 [Nm].
7. Install all hydraulic connectors previously removed.

NOTE: *If the stud nuts are not tightened to the above specified torque value, valve spools seizure or O-ring displacement can occur.*

7. INSTALLATION

NOTE: *Clean hydraulic system suction filter prior to valve installation.*

1. Attach a hoist with a suitable sling to control valve (9, Fig. 10B.3) and position control valve on machine. Install three bolts with washers (3, Fig. 10B.2 and 2, Fig.10B.4) and secure control valve (8, Fig. 10B.3) to mounting bracket (4).
2. Reconnect lower pilot hoses (7) and upper pilot hoses (1) to control valve (9).
3. Reconnect outlet hoses (8) to blade lift section of control valve (9).
4. THREE SPOOL CONTROLVALVE: Reconnect outlet hoses (8) to ripper lift and pitch sections of control valve (9).
5. Reconnect reservoir return tube (6) to control valve (9). Reconnect valve inlet hose (5) to control valve (9). Reconnect hose (3) to inlet hose (5) hydraulic connector.
6. Install return filters (2, Fig. 10B.2).
7. Reinstall R.H. enclosure (2, Fig. 10B.1) with R.H. door (1) and secure it with bolts (3).
8. Refill the hydraulic system and vent it as described in the OPERATOR'S MANUAL.
9. Check the operation of the control valve by shifting the control levers into all operating positions. Check and correct possible leakage.
10. Adjust the main pressure relief valve as described in SECTION 10, RELIEF VALVES PRESSURE TESTS,. Close the door (1).

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CONTROL VALVE

8. BLADE LIFT SECTION

Description

Blade lift section is a spring centered, four position type with the FLOAT position being electro-magnetically detented at the blade pilot valve. Incorporated in valve section is a spring loaded check valve which assures smooth operation when the spool is moved from hold to an operating position. An anticavitation valve is located in the lower part of section.

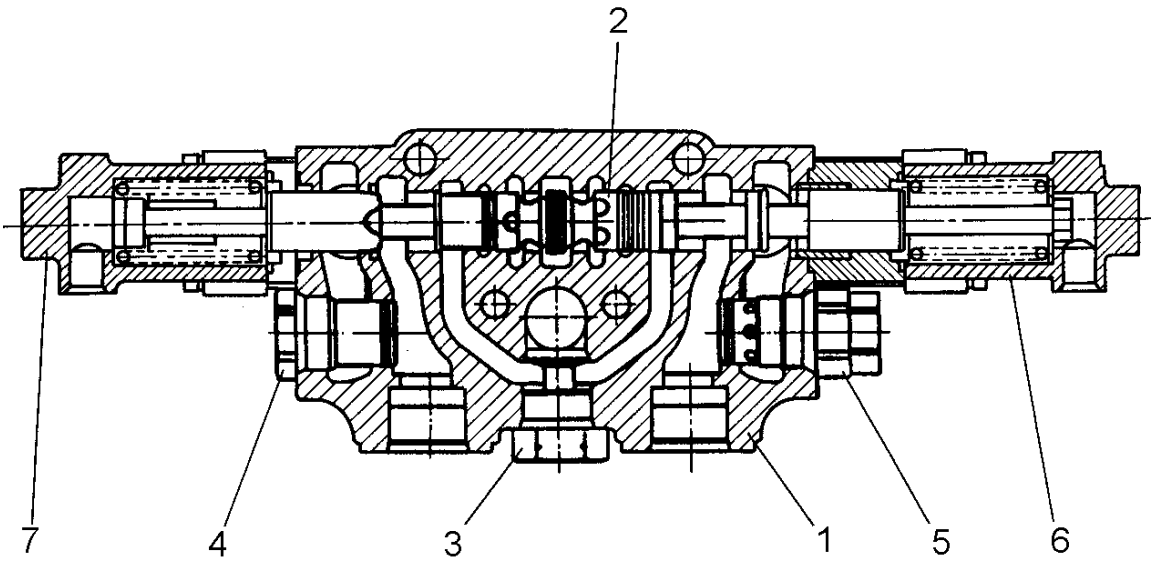

Fig. 10B.6. Cross Section View of Blade Lift Section

1. Section Housing
2. Float Spool
3. Check Load Valve
4. Port Plug
5. Anticavitation Valve
6. Hydraulic Remote Positioner
7. Hydraulic Remote Positioner

Disassembly

1. Remove the check load valve (3, Fig. 10B.6), the port plug (4) and the anticavitation valve (5). The anticavitation valve (5), the plug (4) and the check valve (3) are the only replacable parts.
2. If needed, remove the float spool positioners (6 and 7) bolts and then remove float spool (2).

Inspection and Repair

1. Wash all parts thoroughly in a suitable solvent. Dry thoroughly with compressed air.
2. Discard all O-rings and seals and replace them with new ones.
3. Inspect all parts for scoring, damage or excessive wear. If float spool (2) or section housing bore (1) are worn out too much, the whole section must be replaced as these parts are not available separately.
4. Lubricate with engine oil SAE10W all clean parts that can be reinstalled.

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CONTROL VALVE

Reassembly

1. Reassemble the parts in the reverse order to that of their disassembly.
2. Tighten the spool positioners (6 and 7) mounting bolts to 12 - 15 [Nm].
3. Tighten the anticavitation valve (5), check load valve (3) and port plug (4) to 45 - 53 [Nm].

9. RIPPER LIFT SECTION

Description

The ripper lift section valve is used for raising or lower the ripper. The section valve is a spring centered spool, three position type. Incorporated in the valve section is a spring loaded check valve which assures smooth operation when the spool is moved from hold to an operating position. An anticavitation valve is located in the lower part of section.

Disassembly

1. Remove the check load valve (3, Fig. 10B.7), the port plug (4) and the anticavitation valve (5). The anticavitation valve (5), the plug (4) and the check valve (3) are the only replacable parts.
2. If needed, remove the float spool positioners (6 and 7) bolts and then remove float spool (2).

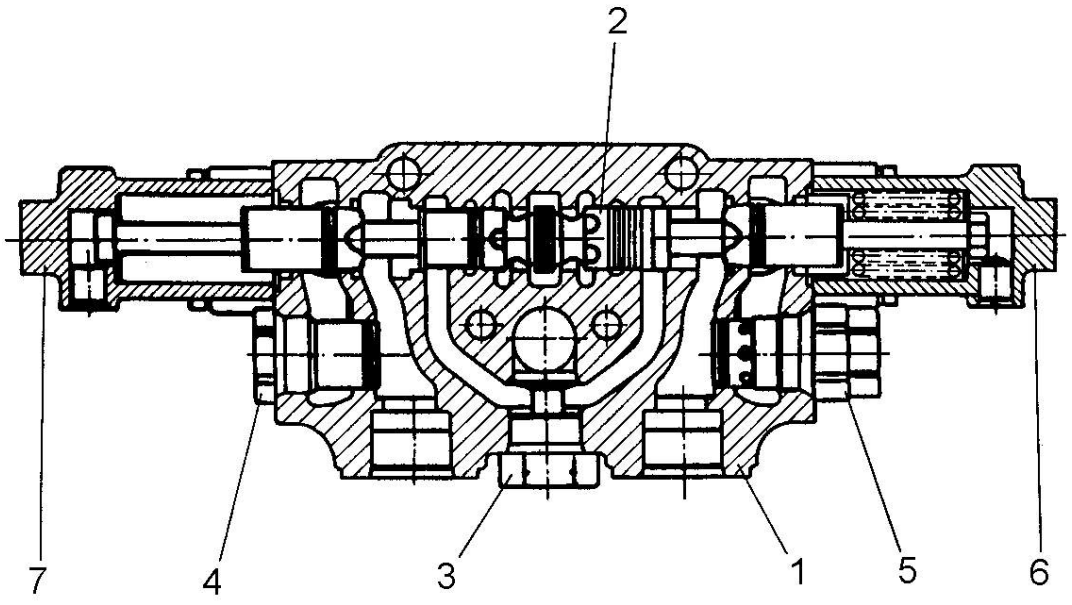

Fig. 10B.7. Cross Section View of Ripper Lift Section

1. Section Housing
2. Float Spool
3. Check Load Valve
4. Port Plug
5. Anticavitation Valve
6. Hydraulic Remote Positioner
7. Hydraulic Remote Positioner

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CONTROL VALVE

Inspection and Repair

1. Wash all parts thoroughly in a suitable solvent. Dry thoroughly with compressed air.
2. Discard all O-rings and seals and replace them with new ones.
3. Inspect all parts for scoring, damage or excessive wear. If float spool (2) or section housing bore (1) are worn out too much, the whole section must be replaced as these parts are not available separately.
4. Lubricate with engine oil SAE10W all clean parts that can be reinstalled.

Reassembly

1. Reassemble the parts in the reverse order to that of their disassembly.
2. Tighten the spool positioners (6 and 7) mounting bolts to 12 - 15 [Nm].
3. Tighten the anticavitation valve (5), check load valve (3) and port plug (4) to 45 - 53 [Nm].

10. RIPPER PITCH SECTION

Description

The ripper pitch section valve is used for pitching the ripper forward or rearword. The section valve is a spring centered spool, three position type. Incorporated in the valve section is a spring loaded check valve which assures smooth operation when the spool is moved from hold to an operating position.

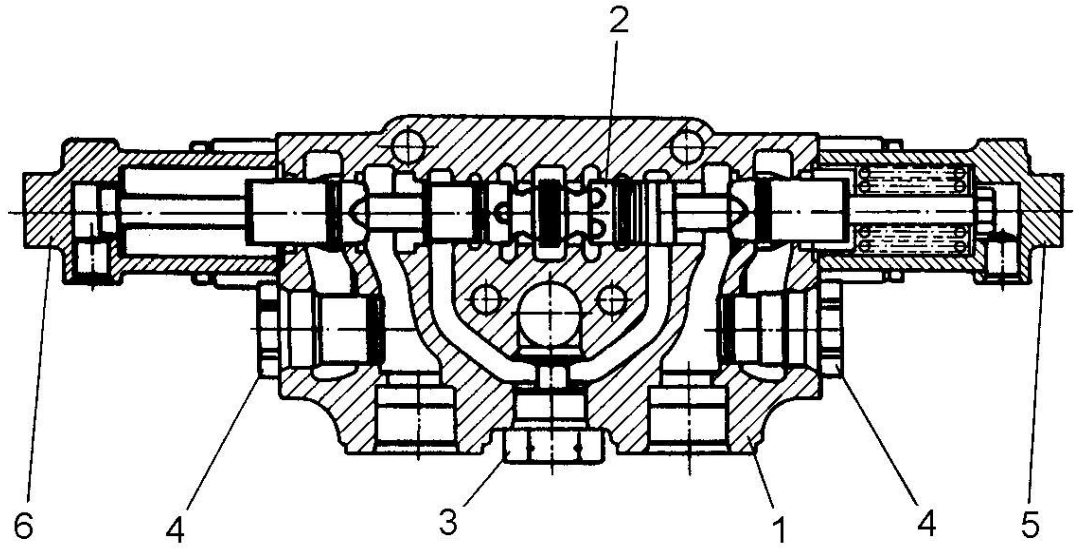

Fig. 10B.8. Cross Section View of Ripper Pitch Section

1. Section Housing
2. Float Spool
3. Check Load Valve
4. Port Plug
5. Hydraulic Remote Positioner
6. Hydraulic Remote Positioner

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CONTROL VALVE

Disassembly

1. Remove the check load valve (3, Fig. 10B.8) and the port plugs (4). The plugs (4) and the check valve (3) are the only replacable parts.
2. If needed, remove the float spool positioners (5 and 6) bolts and then remove float spool (2).

Inspection and Repair

1. Wash all parts thoroughly in a suitable solvent. Dry thoroughly with compressed air.
2. Discard all O-rings and seals and replace them with new ones.
3. Inspect all parts for scoring, damage or excessive wear. If float spool (2) or section housing bore (1) are worn out too much, the whole section must be replaced as these parts are not available separately.
4. Lubricate with engine oil SAE10W all clean parts that can be reinstalled.

Reassembly

1. Reassemble the parts in the reverse order to that of their disassembly.
2. Tighten the spool positioners (5 and 6) mounting bolts to 12 - 15 [Nm].
3. Tighten the check load valve (3) and port plugs (4) to 45 - 53 [Nm].

11. MAIN PRESSURE RELIEF VALVE

Removal and Disassembly

1. Remove main pressure relief valve (6, Fig. 10B.5) from inlet cover (3), if not removed earlier.
2. Position the relief valve in a vise, adjusting end up. Remove the tamper proof cover. While holding the adjusting screw (1, Fig. 10B.9), remove the jam nut (2) and flat washer (3).

WARNING! Spring loaded assembly. Assembly must be held with bracket to relieve spring pressure. Use extreme care when disassembling.

3. Remove the adjusting screw (1).
4. Remove the pilot poppet (4) and the spring (5).
5. Remove the pilot poppet housing (6).
6. Remove the main poppet spring (7).
7. Remove the main poppet (8) with the filter screen (9).
8. Remove the seal ring (10) and the backup ring (11) from the main poppet (8) and discard.
9. Remove the seal ring (12) from the pilot poppet housing (6) and discard.
10. Remove the seal ring (13) from the adjusting screw (1) and discard.

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CONTROL VALVE

11. Remove the seal ring (14) and backup ring (15) from inside the valve housing (19) and discard.
12. Remove the seal rings (16 and 17) and backup ring (18) on the outside of the valve housing (19) and discard.

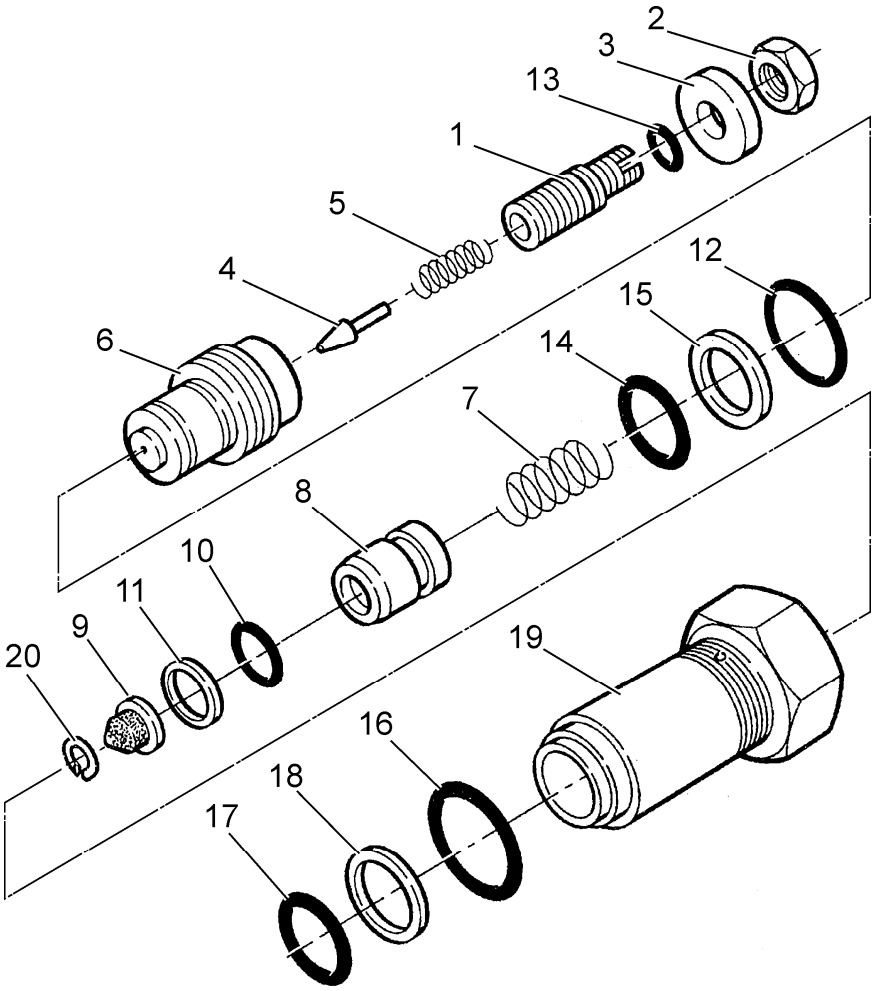

Fig. 10B.9. Exploded View of Main Pressure Relief Valve

1. Pressure Adjusting Screw
2. Adjusting Screw Jam Nut
3. Flat Washer
4. Pilot Poppet
5. Pilot Poppet Return Spring
6. Pilot Poppet Housing
7. Main Poppet Spring
8. Main Poppet
9. Orifice Screen
10. Seal Ring
11. Backup Ring
12. Seal Ring
13. Seal Ring
14. Seal Ring
15. Backup Ring
16. Seal Ring
17. Seal Ring
18. Backup Ring
19. Valve Housing
20. Retaining Ring

Inspection and Repair

1. Wash all parts thoroughly in a suitable solvent. Dry thoroughly with compressed air.
2. Discard all seals and replace them with new ones.
3. Due to the close tolerances of the working parts, the main relief valve internal parts are not serviced. If service other than the seals is required, replace the complete relief valve.
4. Lubricate with engine oil SAE 10W all clean parts that can be reinstalled.

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CONTROL VALVE

Reassembly and Installation

1. Install seal rings (16 and 17) and backup ring (18) on the outside of the valve housing (19).
2. Install seal ring (14) and backup ring (15) down inside the valve hosing (19).
3. Install seal ring (13) to the adjusting screw (1).
4. Install seal ring (12) to the pilot poppet housing (6).
5. Install seal ring (10) and backup ring (11) to the main poppet (8).
6. Install the main poppet (8) with the orifice screen (9) into the valve housing (19).
7. Install the main poppet spring (7)
8. Install the pilot poppet housing (6). Tighten housing (6) to 11 – 16 [Nm].
9. Install the pilot poppet (4) and the return spring (5).
10. Install the adjusting screw (1) half way into the pilot poppet housing (6).
11. While holding the adjusting screw (1), install jam nut (2).
12. Tighten valve housing (19) to 45 – 53 [Nm].
13. Final adjustment of the main pressure valve will have to be made with the three/one spool control valve reinstalled into machine. Refer to EQUIPMENT SYSTEM RELIEF VALVES PRESSURE TESTS, Paragraph 5 in SECTION 10.
14. Tighten the jam nut (1) to 11 - 16 [Nm].
15. Reinstall tamper proof cover after adjusting procedure.

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PILOT PRESSURE VALVE

12. SPECIFICATIONS (Refer to Fig.'s. 10B.10 and 10B.11)

Spring Data

Adjusting Spool Spring (18):

Free Length ..... 57 [mm]
Test Length ..... 33.9 [mm]
Test Load ..... 356 ± 18 [N]
Number of Coils 9

Controlling Spool Spring (3):

Free Length ..... 54 [mm]
Test Length ..... 28.6 [mm]
Test Load ..... 66 ± 6 [N]
Number of Coils 14

Relief Valve Spring (13):

Free Length ..... 21.7 [mm]
Test Length ..... 15 [mm]
Test Load ..... 67 ± 3 [N]
Number of Coils 10

13. DESCRIPTION (Refer to Fig.'s. 10B.10 and 10B.11)

The pilot pressure valve serves two basic function. The first is to supply a controlled pressurized oil for blade and ripper pilot control valves. The second is to supply pilot pressure, to allow the blade and/or ripper to be lowered in a dead engine situation.

When the engine is running, pilot pump flow enters port **P**. Spool (10) is a pressure regulator spool set to regulate **P** pressure. **P** pressure enters the right end of the spool (10) through the pilot orifice. This pressure moves spool to the left into the regulating spring (18). When sufficient pressure is reached the spool moves to the left and allows oil to flow to tank through the **T** port. In the event of cold oil, a cold oil relief ball (12) is provided located in the center left end of the spool (10). The cold oil relief limits pressure spikes at start up.

As **P** pressure builds it also pushes against the right end of the pilot supply spool (5). The right hand spool diameter is less than the spool bore allowing pilot oil to flow past this clearance and push the spool (5) to the left. The pilot supply spool (5) shifts to the left against its spring (3). **P** pressure is now open to **PP**. **PP** supplies pressure to the pilot valves for blade and ripper controls.

When the engine is off, both spools (5 and 10) shift to the right. In this condition the pilot supply spool (5) directs oil from port **AI** to **PP**. **AI** is connected to the shuttle network from the blade and ripper cylinders. If a blade or ripper cylinder is off of the ground or the equipment is powered into the ground then the trapped cylinder pressure is used through the shuttle network as pilot supply pressure. The stored pressure from the cylinders enters port **AI** and passes out **PP** to the pilot valves.

Legend for Fig.'s. 10B.10 and 10B.11

1. Plug
2. O-Ring
3. Pilot Supply Spool Spring
4. Body
5. Pilot Supply Spool
6. O-Ring
7. Plug
8. Plug
9. O-Ring
10. Pressure Regulating Spool
11. Pin
12. Ball
13. Relief Valve Spring
14. Plug
15. O-Ring
16. Sleeve
17. Shim(s)
18. Regulating Spool Spring
19. O-Ring
20. Plug

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PILOT PRESSURE VALVE

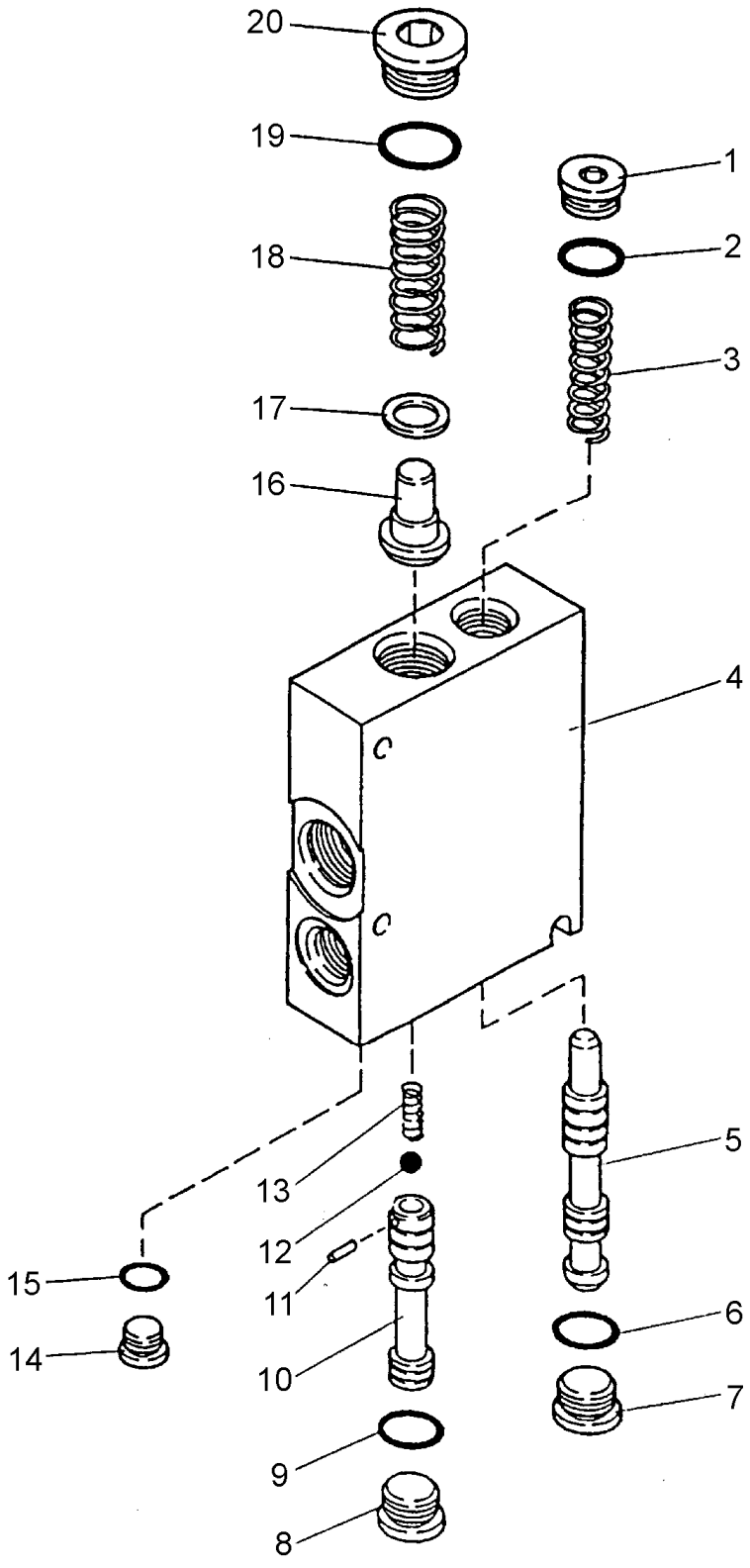

Fig. 10B.10. Exploded View of Pilot Pressure Valve

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PILOT PRESSURE VALVE

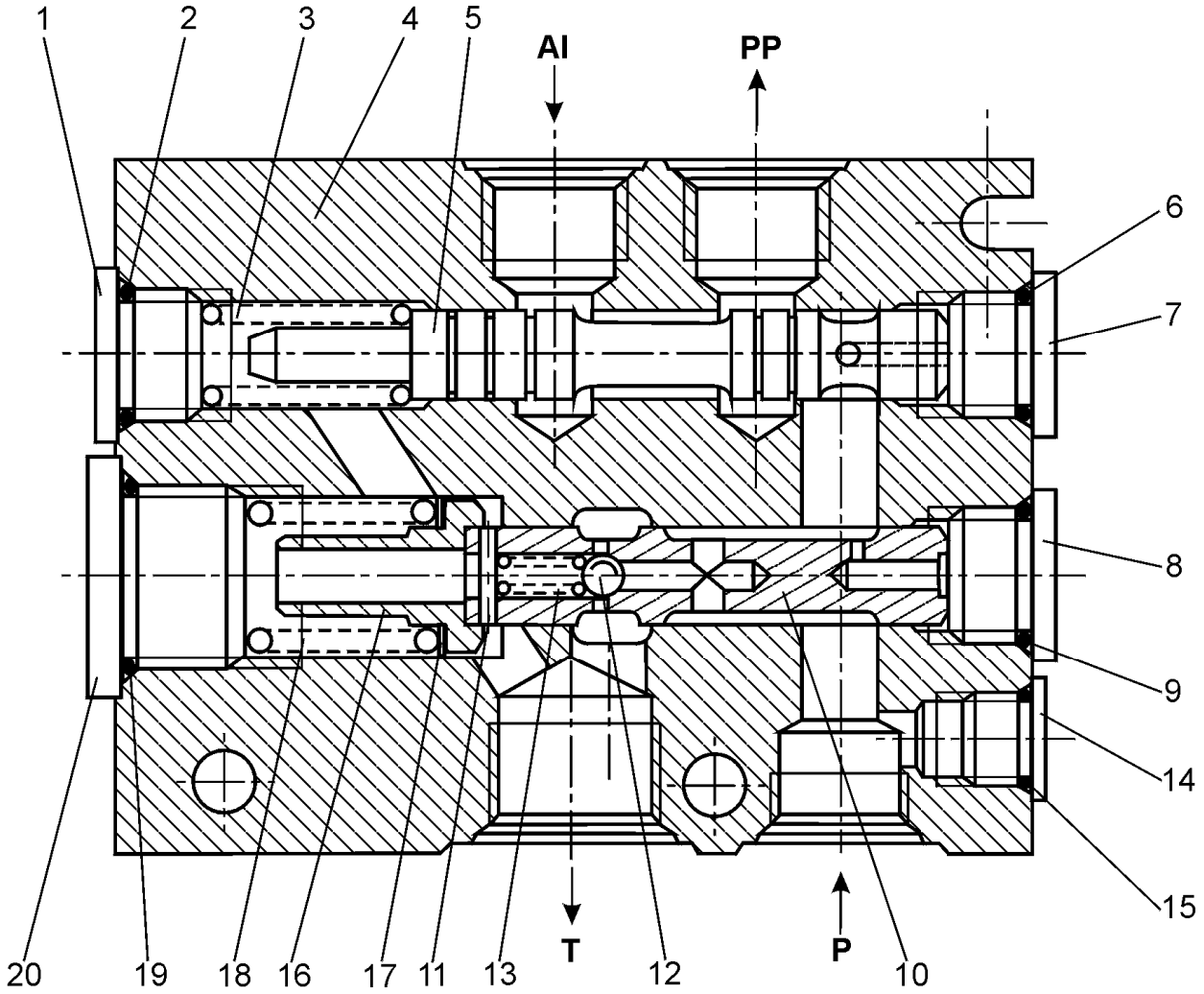

Fig. 10B.11. Cross Section View of Pilot Pressure Valve

14. REMOVAL AND INSTALLATION (Refer to Fig. 10B.12)

NOTE: *When disconnecting hydraulic lines for any reason, they should be properly capped with correct size plastic caps. If these cap are not available, tape or clean rubber corks may be used. Hydraulic openings must never be plugged with rags. This practice could easily induce dirt, lint or contaminants into critical hydraulic components. Tag disconnected lines to facilitate correct and faster installation.*

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

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PILOT PRESSURE VALVE

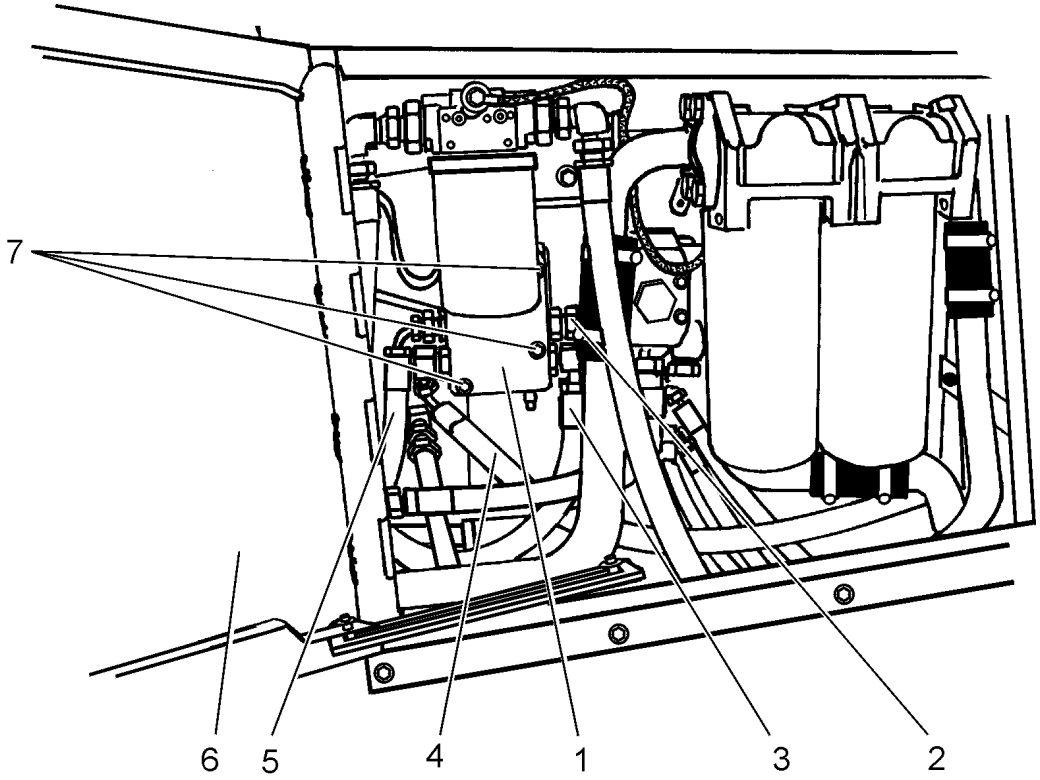

Fig. 10B.12. Pilot Pressure Valve Disconnecting Points

1. Pilot Pressure Valve
2. Hose
3. Hose
4. Hose
5. Hose
6. Right Rear Door
7. Bolts with Washers

1. Open the right rear door (6). Disconnect and plug all hoses (2, 3, 4 and 5) at sides of pilot pressure valve (1) and move out of the way. Remove mounting bolts with washers (7) securing pilot pressure valve (1) to mounting bracket. Remove the pilot pressure valve out of the machine.
2. Installation is reverse of removal.

15. SERVICE (Refer to Fig.'s. 10B.10 and 10B.11)

1. Slowly unscrew plug (1) and remove O-ring (2) and spring (3) from body (4). Unscrew plug (7) and remove O-ring (6) and pull out spool (5).
2. Unscrew plug (20) and remove O-ring (19), spring (18), shim(s) (17) and sleeve (16) from body (4).
3. Unscrew plug (8) and remove O-ring (9) and spool (10) from body. Unscrew plug (14) and remove O-ring (15) from body.
4. Push out pin (11) from spool (10) and remove spring (13) and ball (12).
5. Check all springs against specifications. If springs are damaged or do not meet said specifications, replace them. Check free movement of spools and their surfaces for wear, scores or scratches and replace if necessary.
6. Replace all O-rings. Lubricate parts with clean oil. Reassembly parts in reverse order of disassembly steps 1, 2, 3 and 4.

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QUICK DROP VALVE

16. SPECIFICATION (Refer to Fig.'s 10B.14 and 10B.15)

Spring Data

Spool Inner Spring (6):

Free Length	92.6 [mm]
Test Length	36.5 [mm]
Test Load	303 [N]
Number of Coils	11

Spool Outer Spring (7):

Free Length	91 [mm]
Test Length	40.5 [mm]
Test Load	872 [N]
Number of Coils	9

17. DESCRIPTION

The quick drop valve is used for accelerated power when lowering of the blade is required. The valve is bolted to the main frame at the right side of the engine. This hydraulically operated valve allow the blade to drop at a faster rate by diverting return oil through a spool to supplement the blade cylinder input oil from the piston side being used to lower the blade. The valve diverts the return oil when the pilot control valve is in the lower position.

18. REMOVAL AND INSTALLATION (Refer to Fig. 10B.13)

NOTE: *When disconnecting hydraulic lines for any reason, they should be properly capped with correct size plastic caps. If these caps are not available, tape or clean rubber corks may be used. Hydraulic openings must never be plugged with rags. This practice could easily introduce dirt, lint or contaminants into critical hydraulic components. Tag disconnected lines to facilitate correct and faster installation.*

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

1. Remove engine shield from bottom of the machine.
2. Disconnect hoses (3 and 4) from quick drop valve (1). Unscrew bolts (8) and disconnect hoses (9 and 10).
3. Disconnect three hoses (7, 13 and 14) from quick drop valve (1).
4. Disconnect two hoses (11 and 12) from quick drop valve (1). Unscrew elbows, tee and connectors from quick drop valve (1). Remove and discard old O-rings.
5. Unscrew four bolts (5) with washers securing plate (6) to frame (2). Remove valve (1) together with plate (6).
6. Unscrew three bolts with washer securing quick drop valve (1) to plate (6) and remove valve from plate.
7. Installation is reverse of removal.

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QUICK DROP VALVE

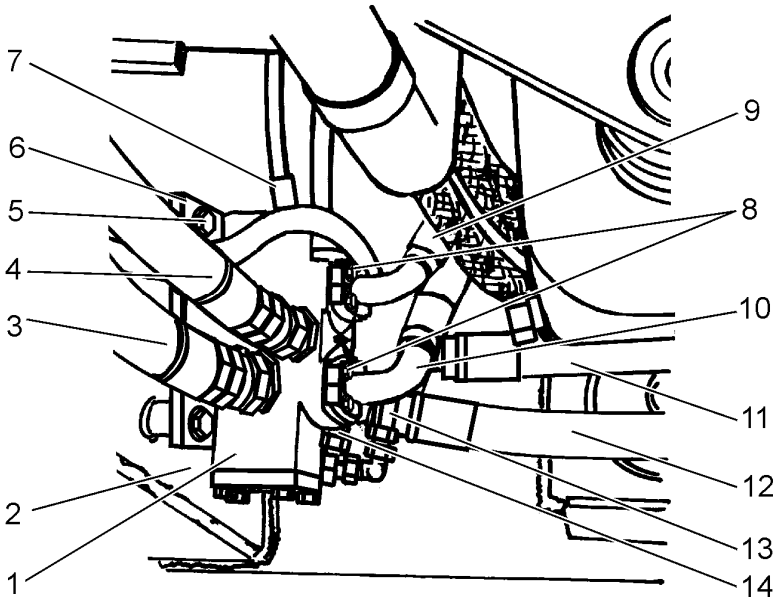

Fig. 10B.13. Quick Drop Valve Disconnecting Points
View from under Machine on the Right Frame

1. Quick Drop Valve	4. Hose	7. Hose	10. Hose	13. Hose
2. Frame	5. Bolt	8. Bolts	11. Hose	14. Hose
3. Hose	6. Mounting Plate	9. Hose	12. Hose	

19. SERVICE

1. Disassemble parts in sequence (1, 2, 9, 8, 7, 6, 5, 4, Fig. 10B.14 and 10B.15). Check springs against specifications, if springs are damaged and/or do not meet said requirements, replace them. Clean all remaining parts. If either a spool or housing bore is worn or scored allowing excessive internal leakage, install a new control valve. Replace O-rings (2 and 8).
2. Reassemble parts in opposite sequence indicated in Step 1. Lubricate all parts with clean oil.
3. Attach the valve with all external hydraulic connectors if previously disconnected, using new O-rings.

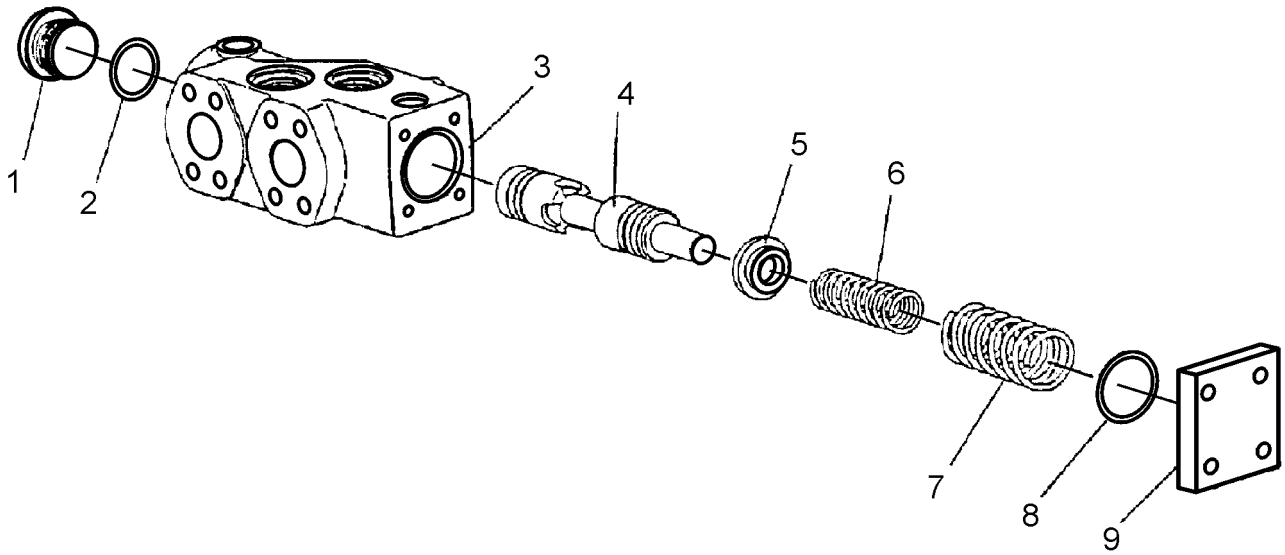

Fig. 10B.14. Exploded View of Quick Drop Valve

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QUICK DROP VALVE

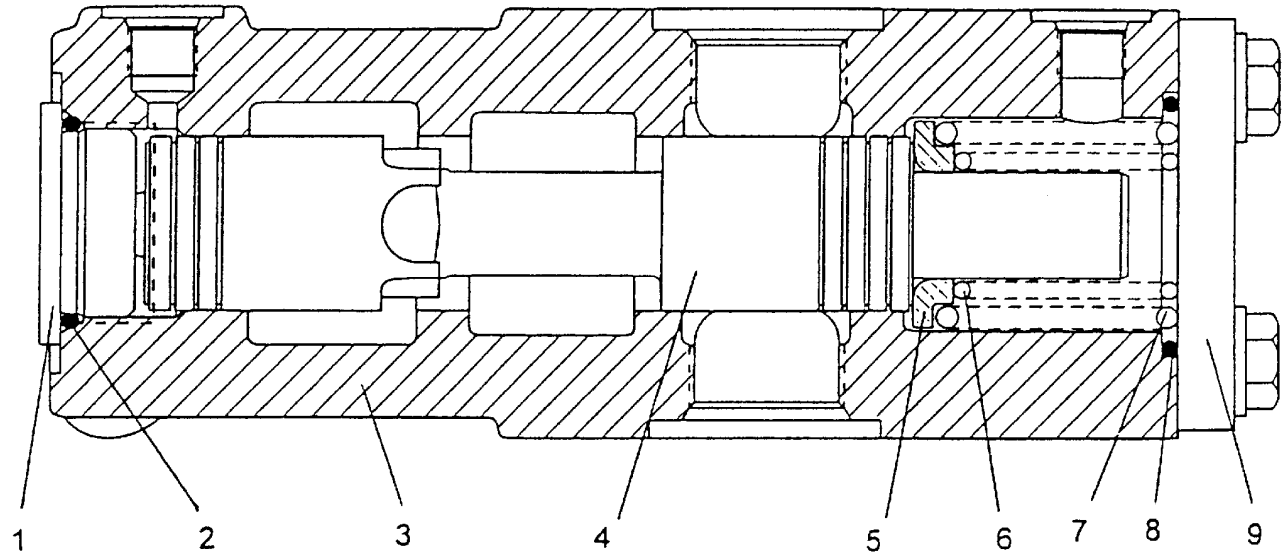

Fig. 10B.15. Cross Section View of Quick Drop Valve

Legend for Fig. 10B.14 and 10B.15

1. Plug	4. Spool	7. Spring
2. O-Ring	5. Retainer	8. O-Ring
3. Body	6. Spring	9. Cover, Bolts, Washers

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UNLOADING VALVE

20. SPECIFICATIONS (Refer to Fig.'s. 10B.17 and 10B.18)

Spring Data

Main Spool Outer Spring (9)
- Free Length ..... 99 [mm]
- Test Length ..... 51 [mm]
- Test Load ..... 667 ± 22 [N]
- Number of Coils 12

Main Spool Inner Spring (8)
- Free Length ..... 65.4 [mm]
- Test Length ..... 45 [mm]
- Test Load .....102 [N]
- Number of Coils 12

Slide Bumper Spring (12):
- Free Length ..... 45 [mm]
- Test Length ..... 25.4 [mm]
- Test Load .....43 [N]
- Number of Coils 10

Controlling Slide Spring (17):
- Free Length..... 96 [mm]
- Test Length ..... 60 [mm]
- Test Load .....445 [N]
- Number of Coils 11

21. REMOVAL AND INSTALLATION (Refer to Fig. 10B.16)

NOTE: *When disconnecting hydraulic lines for any reason, they should be properly capped with correct size plastic caps. If these cap are not available, tape or clean rubber corks may be used. Hydraulic openings must never be plugged with rags. This practice could easily induce dirt, lint or contaminants into critical hydraulic components. Tag disconnected lines to facilitate correct and faster installation.*

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

1. Unscrew bolts with washer and remove platform center access plate.
2. Disconnect all hoses (2,3,4 and 5) and tube (1) from the valve (8).
3. Unscrew four bolts (7) with washer securing plate (6) to frame and remove valve (8) together with plate.
4. Unscrew all connectors from valve (8). Remove and discard old O-rings.
5. Unscrew three bolts with washer securing unloading valve (8) to plate (6) and remove valve from plate.
6. Installation is reverse order of removal.

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UNLOADING VALVE

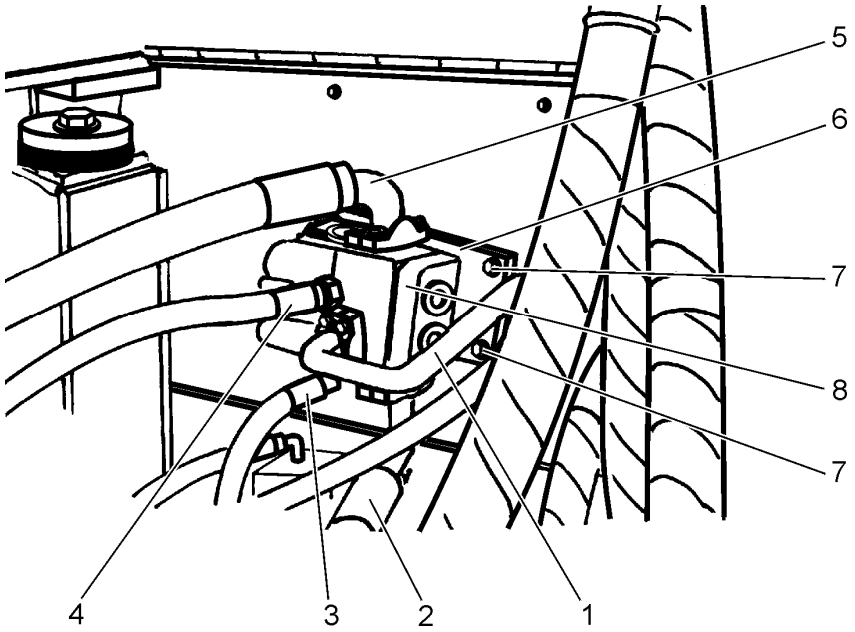

Fig.10B.16. Unloading Valve Disconnecting Points

1. Tube
2. Hose
3. Hose
4. Hose
5. Hose
6. Mounting Plate
7. Bolts
8. Unloading Valve

22. SERVICE (Refer to Fig. 10B.17 and 10B.18)

1. Unscrew bolts securing cover (21) to housing (1). Remove the cover and gasket (20).
2. Remove spring (17), pin (19) and sleeve (18). Remove retainer (10), springs (9 and 8) and spring retainer (7).
3. Unscrew two plugs (4) from other side of the valve housing and remove spool bumper (11) and spring (12).
4. Using a suitable soft metal bar push out slide sleeve (13) together with controlling spool (14), washer (15) and spring retainer (16).
5. From other section push out spool (6).
6. If required, unscrew plug (2).
7. Check all springs against specification. If they don't meet specification, replace. Check free movement of spools and spools for scores.
8. Discard all O-rings and gasket and replace them for new. Lubricate parts with clean oil. Reassembly parts in reverse order of disassembly Steps 6 to 1.

Legend for Fig.'s 10B.17 and 10B.18

1. Housing
2. Plug
3. O-Ring
4. Plug
5. O-Ring
6. Main Spool
7. Spring Retainer
8. Spring
9. Spring
10. Spring Retainer
11. Spool Bumper
12. Spring
13. Sleeve
14. Controlling Spool
15. Washer
16. Spring Retainer
17. Spring
18. Sleeve
19. Pin
20. Gasket
21. Cover

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UNLOADING VALVE

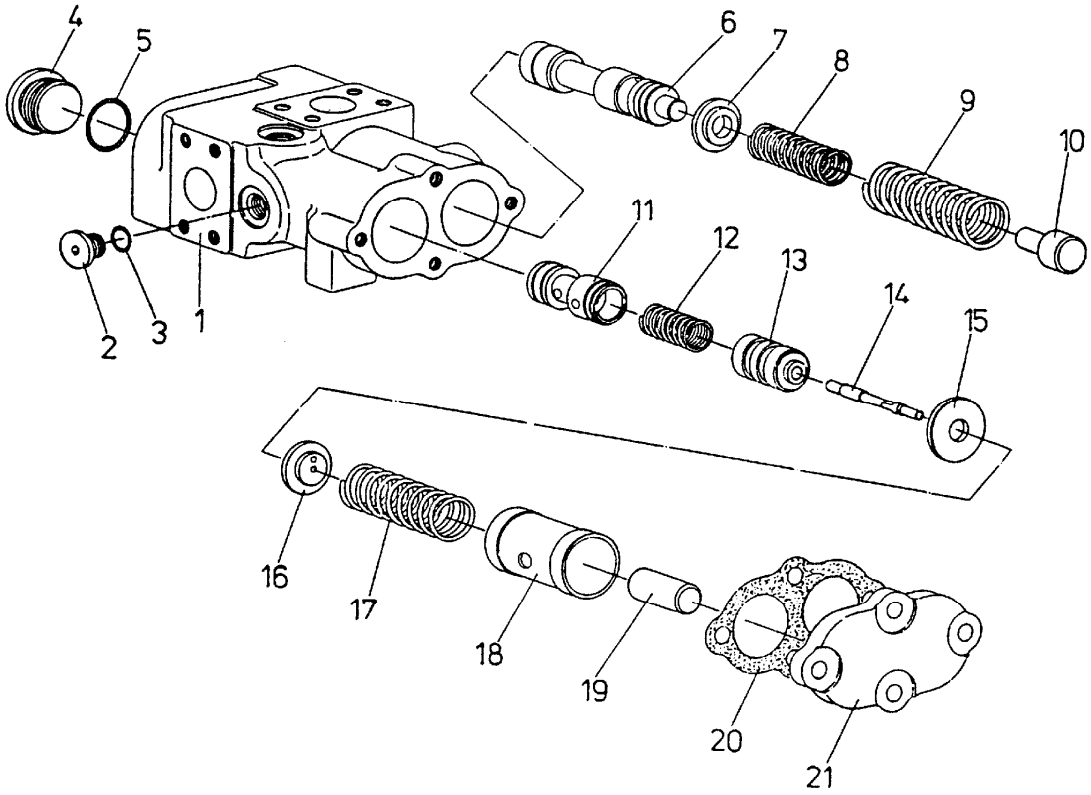

Fig. 10B.17. Exploded View of Unloading Valve

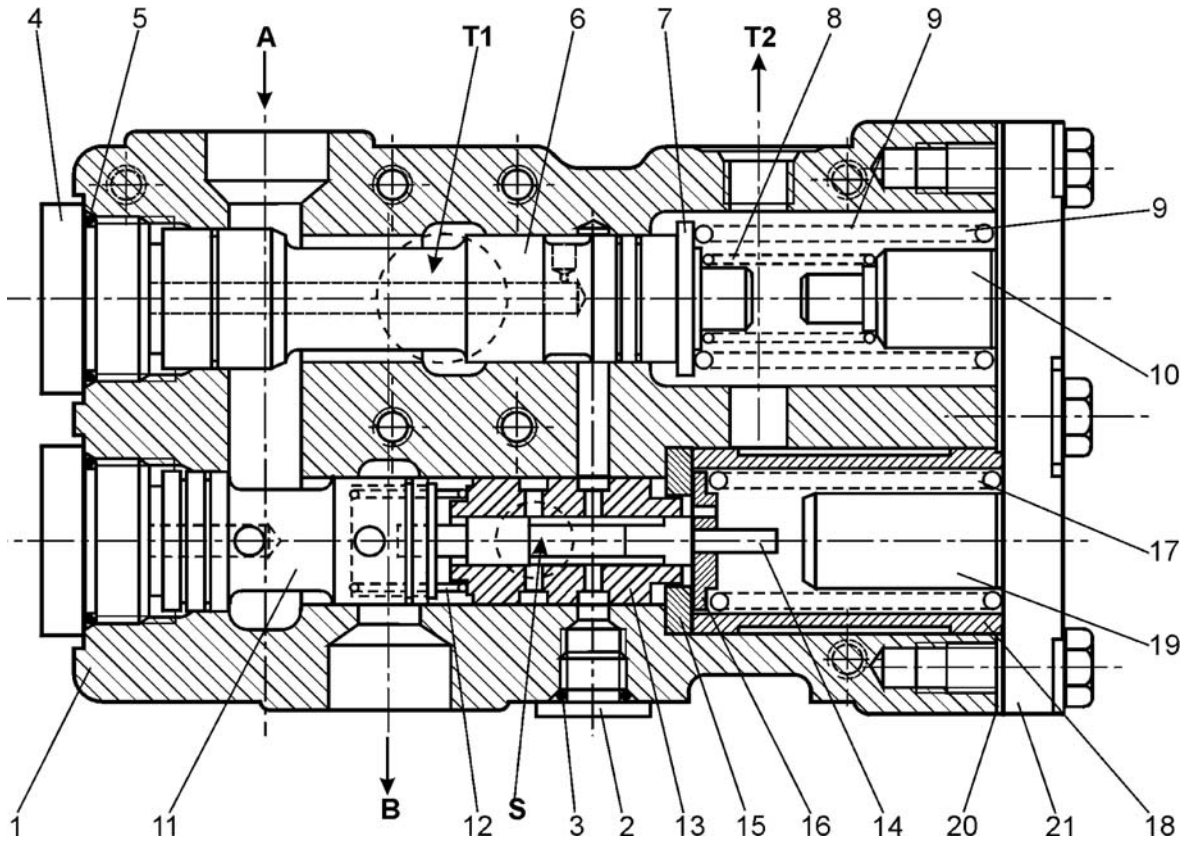

Fig. 10B.18. Cross Section View of Unloading Valves

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SECTION 10C

CYLINDERS

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CYLINDERS

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BLADE LIFT CYLINDER

1. REMOVAL

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate proper installation.*

1. Disconnect the lift cylinders (7, Fig. 10C.1) at the blade (2) by removing the cylinder rod pins (1) and drive out the mounting pins (1) on both side of the dozer. Secure the lift cylinders (7) to the frame with the cylinders hangers.
2. Start the engine and hydraulically retract both the cylinder rods (6). Shut off the engine. Using wire, secure the cylinder rod ends (6) of both cylinders to the cylinders (7).
3. Disconnect hoses (5) at the cylinder manifold (9).

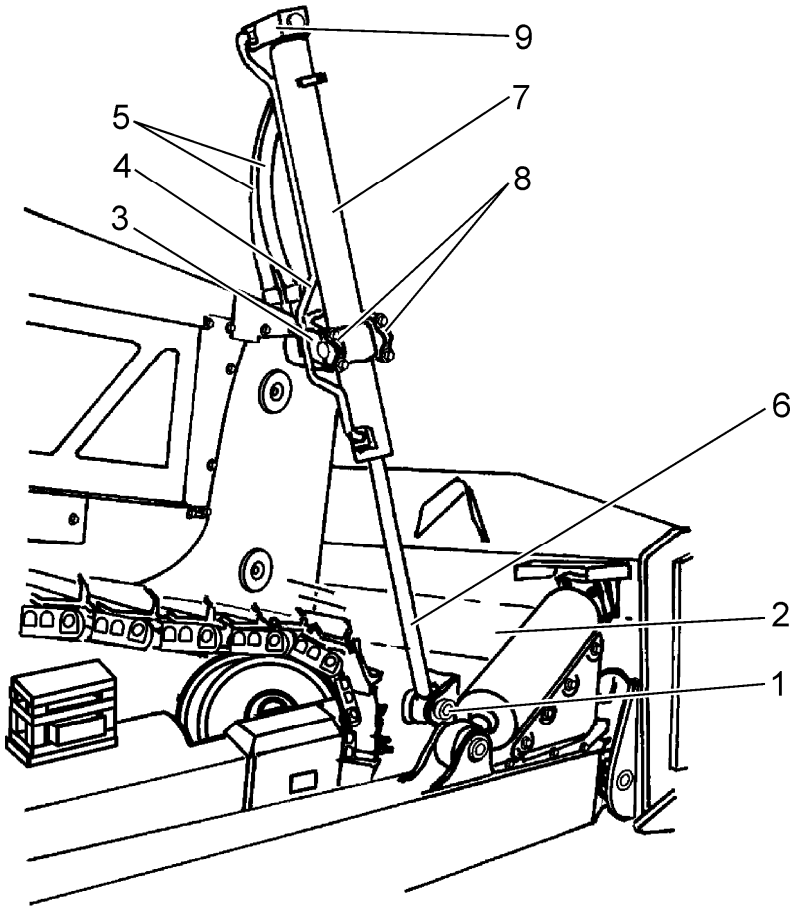

Fig. 10C.1. Blade Lift Cylinder Removal

1. Cylinder Rod Pin
2. Blade
3. Lift Yoke
4. Tube
5. Hoses
6. Cylinder Rod
7. Blade Lift Cylinder
8. Yoke Cap
9. Cylinder Manifold

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4. Attach a hoist sling to the cylinder. The hoist must be installed to give the best possible balance. Place tension on the hoist and check for contact between the hoist and the manifold tube on the cylinder which could result in damage to the tubing.

NOTE: *The bearing caps are matched with the ears of the yoke. If not marked, stamp letters A and B on the caps (1) and corresponding yoke ears (2) in the areas shown in Fig. 10C.2. Identification marks to be in the same area, either side or end as shown bellow.*

5. Remove the bolts securing the yoke caps (8, Fig. 10C.1) to the mounting lift yoke (3) and remove the yoke caps with pins. Keep pins with yoke caps for proper installation. Remove the cylinder hangers and remove the blade lift cylinders (7) from machine.

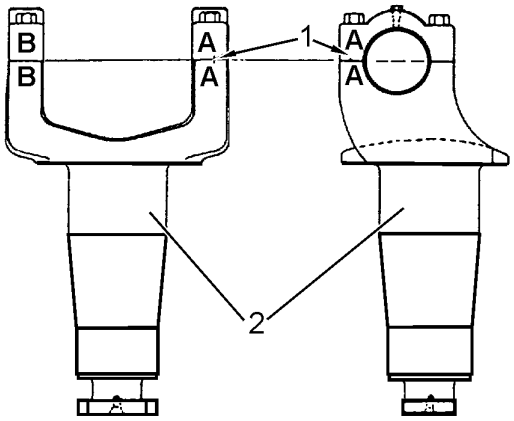

Fig. 10C.2. Yoke and Cap Stamp Marks

1. Yoke Caps 2. Lift Yoke

2. DISASSEMBLY (Refer to Fig.'s 10C.3 and 10C.4)

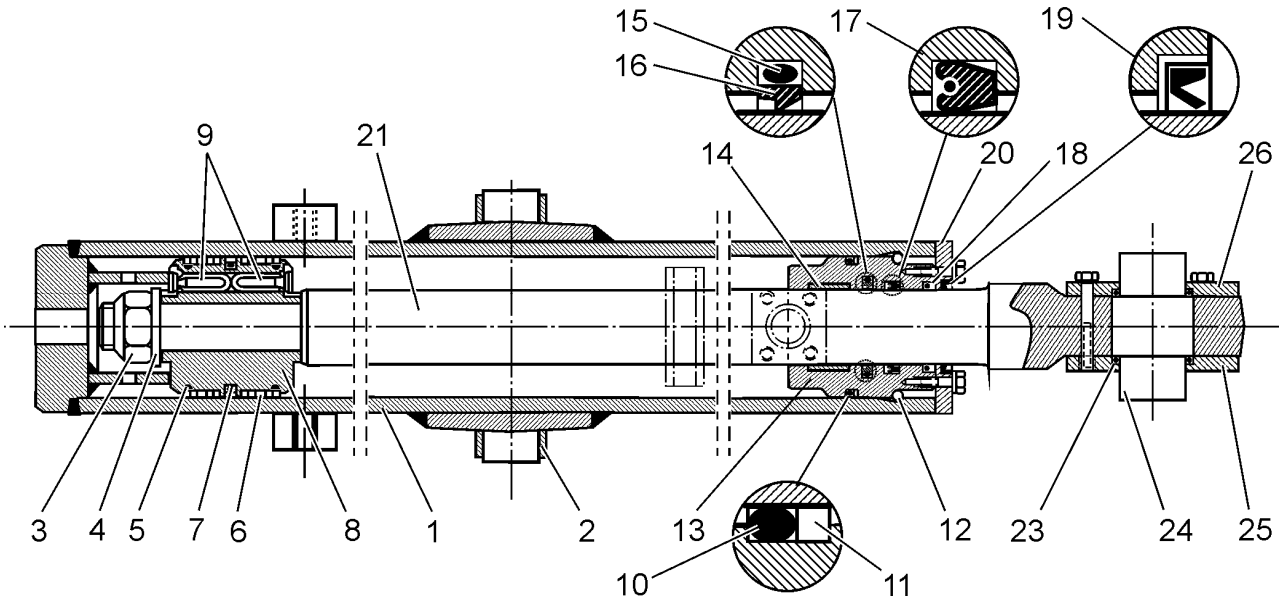

Fig. 10C.3. Cross Section View of Blade Lift Cylinder

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BLADE LIFT CYLINDER

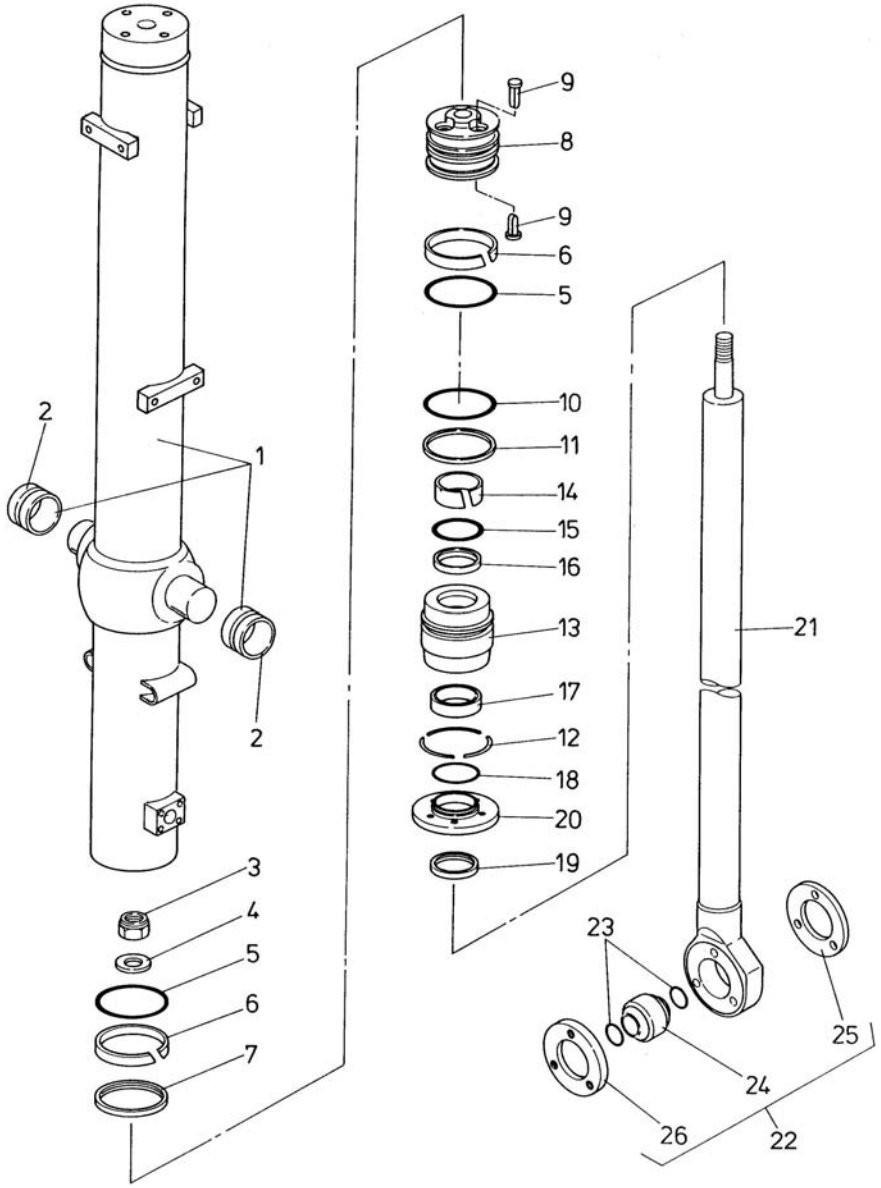

Fig. 10C.4. Exploded View of Blade Lift Cylinder

Legend for Fig.'s 10C.3 and 10C.4

1. Cylinder Housing
2. Cylinder Bushing
3. Nut
4. Washer
5. O-Ring
6. Wear Ring
7. Seal Ring
8. Piston
9. Relief Poppet
10. O-Ring
11. Backup Ring
12. Lock Ring
13. Cylinder Gland
14. Wear Ring
15. O-Ring
16. Buffer Ring
17. Seal Ring
18. O-Ring
19. Wiper Ring
20. End Cover
21. Cylinder Rod
22. Cylinder Rod Assy
23. O-Ring
24. Rod Bearing
25. Retainer Plate
26. Retainer Plate

1. Steam clean or wash the cylinder with solvent before disassembly. Remove the wire securing the cylinder rod to the cylinder housing.
2. Remove the tube (4, Fig. 10C.1) and cylinder manifold (9) from cylinder (7).
3. Attach a hoist to the cylinder rod eye as shown in Fig. 10C.5, using a strap to protect the bearing in the rod eye. Raise the cylinder up and secure it to the hoist frame. Using the hoist, pull the cylinder rod out to approximately 1/2 stroke.

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BLADE LIFT CYLINDER

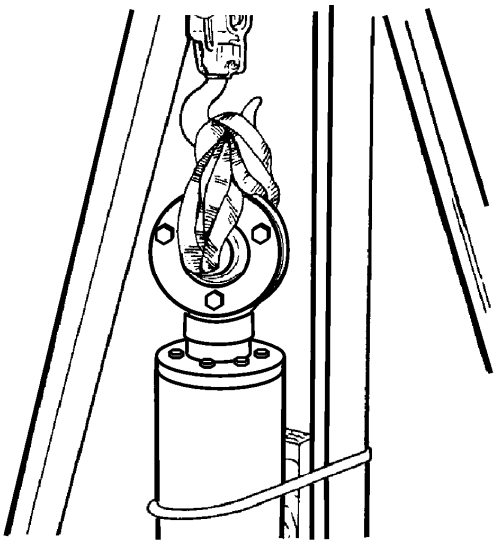

Fig. 10C.5. Securing Cylinder to Hoist

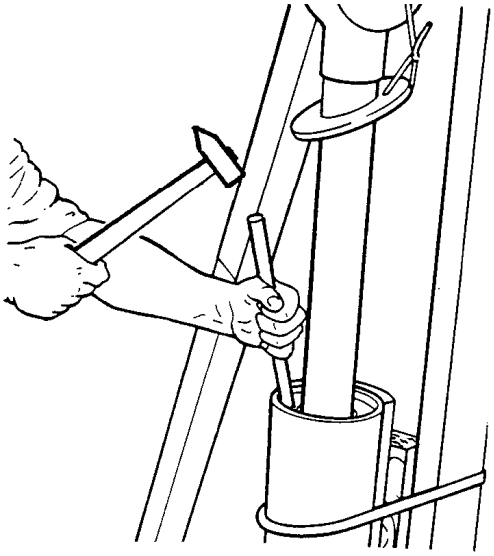

Fig. 10C.6. Relieving Tension on Lock Ring

4. Remove bolts with washer securing cover (20) to gland (13) and tie the cover up to the rod eye as shown in Fig. 10C.6.
5. Using a brass drift as shown in Fig. 10C.6, drive gland (13) into housing (1) until the tension of the lock ring (12) is off.
6. Remove three piece lock ring (12) from housing (1) and pull the cylinder rod assembly (21) out of the housing with the hoist.
7. Remove the piston rod nut (3) as shown in Fig.10C.7.
8. Remove washer (4) and piston (8) from the cylinder rod (21). Remove the relief poppets (9), wear rings (6), O-rings (5) and piston seal (7) from piston (8).
9. Slide gland (13) from the cylinder rod (21). Remove O-ring (10), backup ring (11), wear ring (14), O-ring (18), seal ring (17), buffer ring (16) and O-ring (15) from gland (13). Slide cover (20) off of rod (21) and remove wiper ring (19) from cover.
10. Unscrew bolts securing retainer plates (25 and 26) to the cylinder rod (21) and remove the retainer plates. Remove O-rings (23) from the bore of bearing (24).

NOTE: *It will be necessary to hold the eye end of the rod stationary when removing the nut. A suggested method is to clamp the eye end of the piston rod in a hydraulic press and use a torque multiplier as shown in Fig. 10C.7, or an impact tool.*

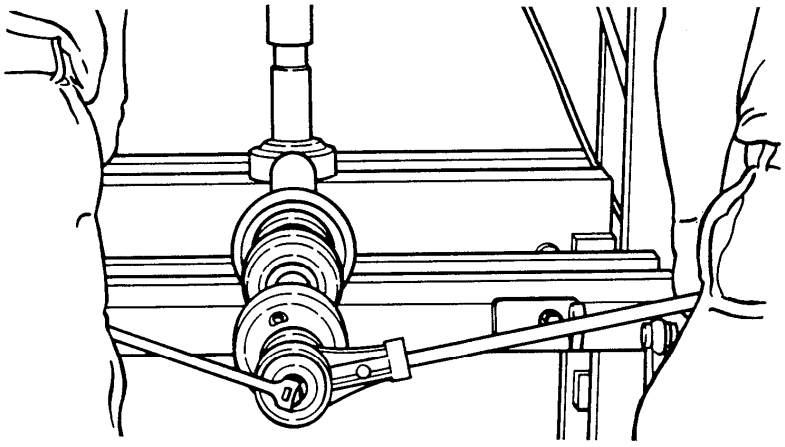

Fig. 10C.7. Removing Piston Rod Nut

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11. If bearing (24) needs replacement, press out the old bearing from cylinder rod eye.
12. If necessary, remove the yoke bushings and cylinder bushings (2) from cylinder trunnions.

3. INSPECTION AND REPAIR

1. It is recommended that all new O-rings, backup rings, wear rings, packing and seals be installed when the lift cylinder is disassembled.
2. Wash all parts in a suitable solvent and air dry. Lubricate machined surfaces of usable parts to protect them.
3. Inspect the cylinder housing for roundness through its length. If a tight spot is noticed when removing the piston, the area of binding should be given particular attention. A cylinder housing that is out-of-round should be replaced.
4. Check the cylinder housing and cylinder rod for scratches or grooves. Shallow scratches can be polished out with fine emery cloth and oil so a smooth surface is presented to the packing.
5. Inspect all sealing ring grooves for scratches, burrs or other damage. ”Dress-up” grooves or replace part as necessary.
6. Inspect tapped holes for damaged threads.
7. If the piston rod eye bearing was removed, remove all rust, scale or paint from the bore in the piston rod eye.
8. Inspect the cylinder mounting bushings for excessive wear or damage and replace if necessary.
9. Inspect the poppets and their seats in the piston.

4. REASSEMBLY (Refer to Fig.’s 10C.3 and 10C.4)

1. Install wiper ring (19), lip facing out, into cover (20) and position cover onto cylinder rod (21).

IMPORTANT: *Outer end of gland is determined as bolts end and inside end as facing piston.*

2. Coat the bores and grooves of gland (13) with grease. Install seal ring (17) by squeezing the side of the seal together and starting the seal into the groove. Then work the remainder in with the thumbs. DO NOT use a screwdriver as it will damage the seal. Install O-ring (18) into gland (13).
3. Install O-ring (15) and buffer ring (16) (notched edge facing in) into gland (13) and follow with wear ring (14). Install O-ring (10) and backup ring (11) into gland (13). Slide gland (13) onto rod (21), tapped holes toward rod eye.
4. Install piston seal (7) onto piston (8). Install O-rings (5) and wear rings (6) on each end of piston (8). Install relief poppets (9), three each end, into piston (8) and slide piston onto cylinder rod (21). Secure with washer (4) and nut (3). Clamp rod assembly into press as shown in Fig. 10C.7. Using a multiplier torque piston nut to 720 - 780 [Nm].
5. Secure cylinder housing (1) to hoist frame. Attach hoist to rod eye and lower rod assembly into housing (1) using extreme care not to damage wear rings (6) and piston seal (7). Once piston (8) has entered housing, drive rod 1/2 stroke.
6. Tie cover (20) to rod eye to provide working clearance. Start gland assembly (13) into housing (1) and drive in just below lock ring groove in housing. Install lock ring (12) into housing groove. Install two puller bolts 3/8”NC x 1-1/4” and nuts (Fig. 10C.8) and thread into gland. Tighten nuts to draw gland up against lock ring. Remove puller arrangement. Coat inner cylinder housing surface over the gland with high temperature type 230 HHT grease 1 [mm] in thickness. Secure cover (20) to gland (13) and torque bolts with washer to 46 [Nm].

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CYLINDERS

BLADE LIFT CYLINDER

IMPORTANT: *The bearing must be installed in the bore of the piston rod as shown in Fig.10C.9.*

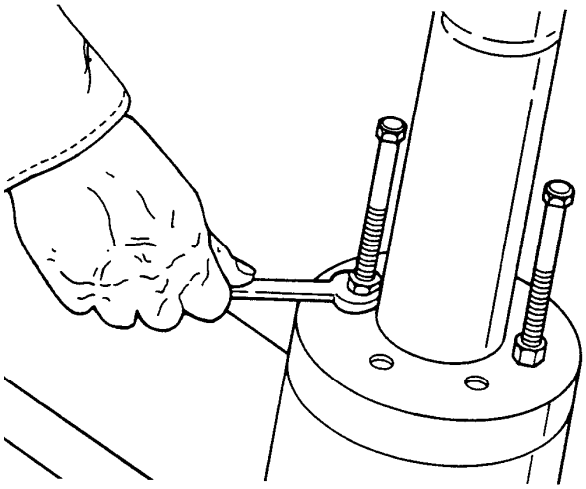

Fig. 10C.8. Seating Gland with Lock Ring

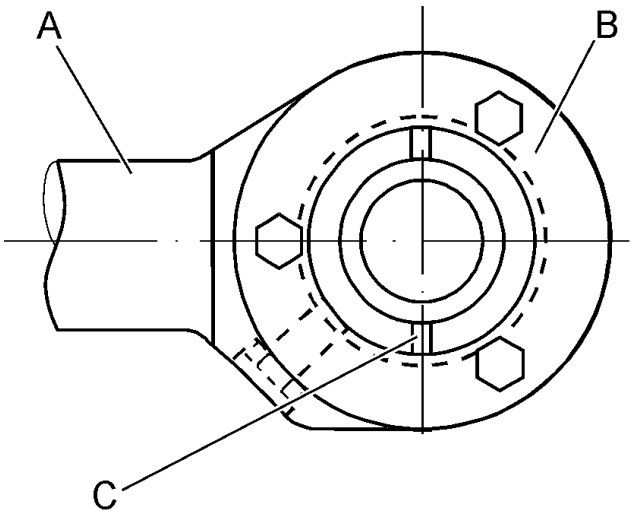

Fig. 10C.9. Cylinder Rod Bearing Installed
A. Cylinder Rod
B. Retainer Plate
C. Install Bearing with Slots Positions as Shown

7. If bearing (24) was removed, press the new bearing in the rod eye. Install new O-rings (23) into bore of bearing (24). Install retainer plates (25 and 26). Torque the bolts to 130 [Nm].
8. If removed, install new cylinder bushings (2) onto cylinder housing yokes.
9. Install the cylinder manifold (9, Fig.10C.1) and tube (4) to the cylinder (7). Using wire, secure the rod end (6) to the cylinder (7).

5. INSTALLATION

1. Attach a hoist sling to the blade lift cylinder (7, Fig. 10C.1) as was done in removal procedure and position it in the lift yoke (3).
2. Check to be sure pins protrudes 3 [mm] from the machined surfaced of yoke caps (8).
3. Slip yoke caps (1, Fig. 10C.2), marked sides appropriately matched to lift yoke (2) A to A and B to B.
4. Secure the yoke caps (8, Fig. 10C.1) to the lift yoke (3). Check to be sure that pins are still engaged in the hole in the yoke bushings. Torque the mounting bolts with washer to 450 [Nm].
5. Secure the lift cylinders (7) to the frame with the cylinders hangers. Remove the hoist sling.
6. Connect the cylinder hoses (5) to the cylinder manifold (9).
7. Remove the wire securing the cylinder rod ends (6) of both cylinders to the cylinders (7). Start the engine and extend the cylinder rods as necessary to connect rod pins (1) to the blade (2).
8. Disconnect the lift cylinder hangers from the frame and extend the cylinders rods until the eyes line up with brackets on the rear of the blade. Insert the lift cylinder mounting pins (1) through the bracket, aligning the lock hole in the pins with the lock holes brackets. Secure the pins (1) with the locking hardware.
9. Vent the hydraulic system and add oil as necessary, refer to the OPERATOR'S MANUAL. Visually check for oil leakage.
10. Cycle cylinder a few times. Recheck cylinder and cover bolt torque.

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BLADE TILT CYLINDER

6. REMOVAL

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate proper installation.*

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

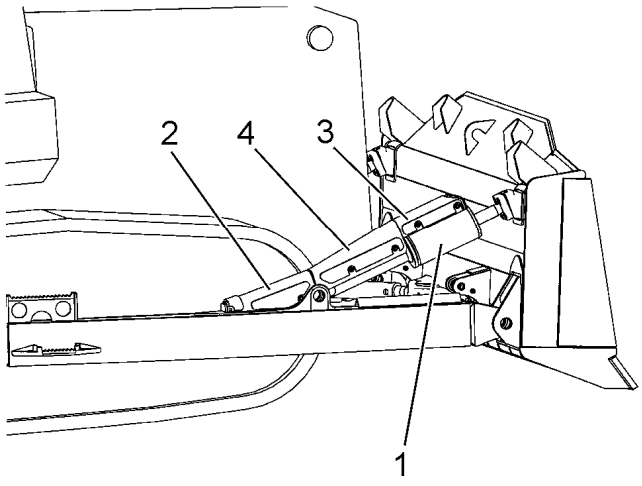

Fig. 10C.10. Blade Tilt Cylinder Guard

1. Blade Tilt Cylinder
2. Lower Guard
3. Upper Guard
4. Center Guard

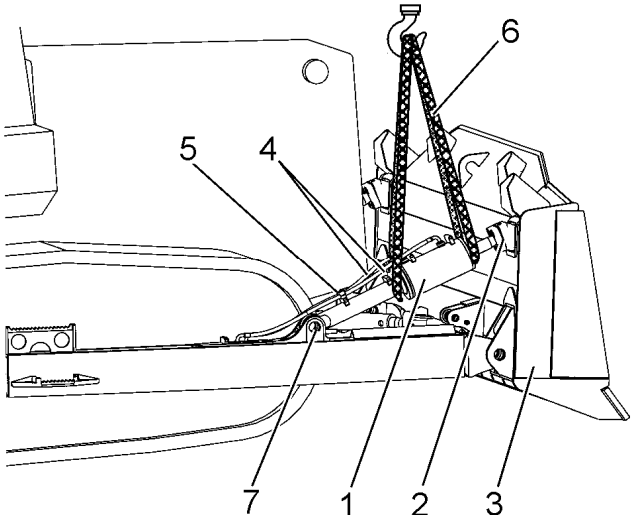

Fig. 10C.11. Blade Tilt Cylinder Removal (R.H. Side)

1. Blade Tilt Cylinder
2. Socket Cap
3. Blade
4. Hoses
5. Hose Clamp
6. Hoist Sling
7. Pin

1. Remove the upper guard (3, Fig. 10C.10), lower guard (2) and center guard (4) from tilt cylinder (1) at R.H. side of the machine.
2. Unscrew bolts with washer securing hose clamp (5, Fig.10C.11) to the tilt cylinder (1) and remove the clamp.
3. Disconnect hoses (4, Fig.10C.11) from tilt cylinder (1) and position out of way.
4. Attach a hoist sling to blade tilt cylinder (1). The hoist must be installed to give the best possible balance. Place tension on the hoist.
5. Remove bolts with washers securing socket cap (2) and move socket cap of blade (3). Keep shims with blade (3).
6. Remove mounting hardware securing pin (7) to the bracket on push arm and remove pin (7). Remove tilt cylinder (1) from machine.

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7. DISASSEMBLY (Refer to Fig.'s 10C.12 and 10C.13)

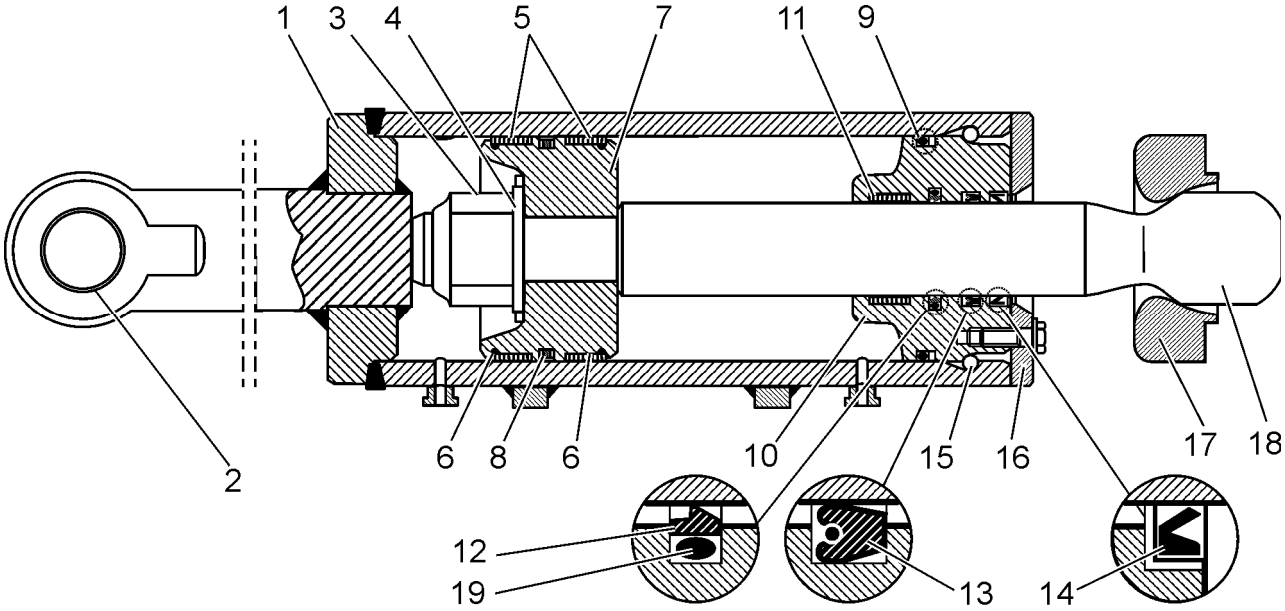

Fig. 10C.12. Cross Section View of Blade Tilt Cylinder

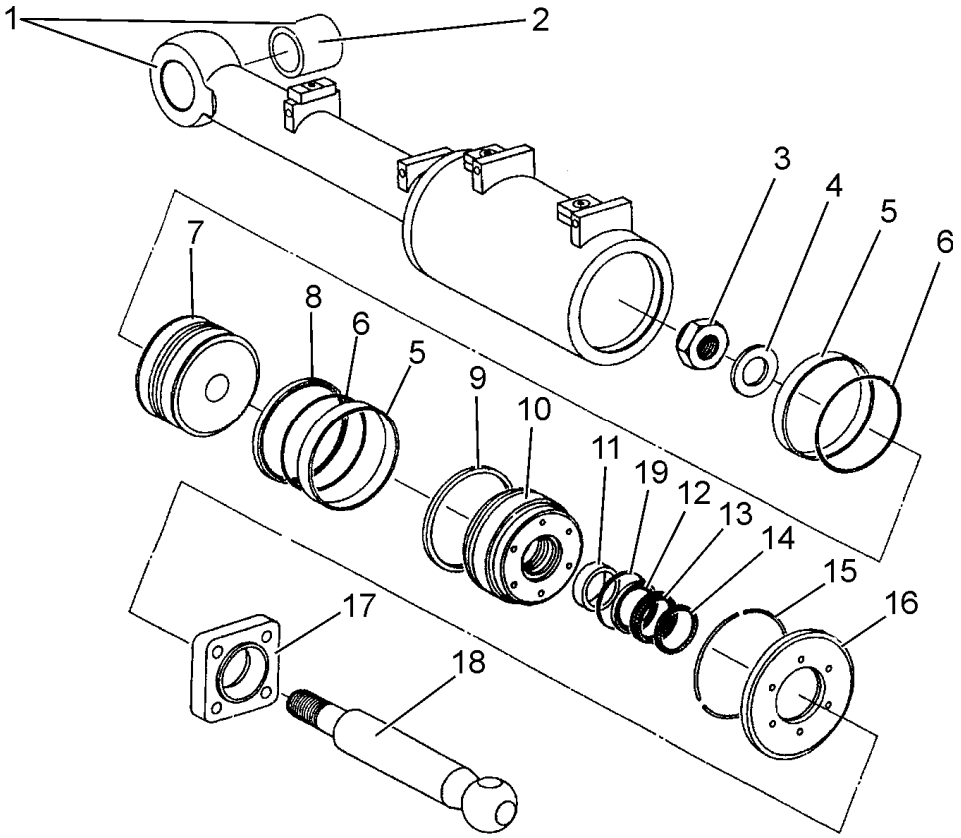

Fig. 10C.13. Exploded View of Blade Tilt Cylinder

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BLADE TILT CYLINDER

Legend for Fig.'s 10C.12 and 10C.13

1. Cylinder Housing
2. Cylinder Bushing
3. Nut
4. Washer
5. Wear Ring
6. O-Ring
7. Piston
8. Piston Seal
9. Seal Ring
10. Cylinder Gland
11. Wear Ring
12. Buffer Ring
13. Seal Ring
14. Wiper Ring
15. Lock Ring
16. Cover
17. Socket Cap
18. Cylinder Rod
19. O-Ring

1. Steam clean or wash the cylinder with solvent before disassembly.
2. Attach a hoist sling to the socket cap as shown in Fig.10C.14. Raise the cylinder up and secure it to the hoist frame.

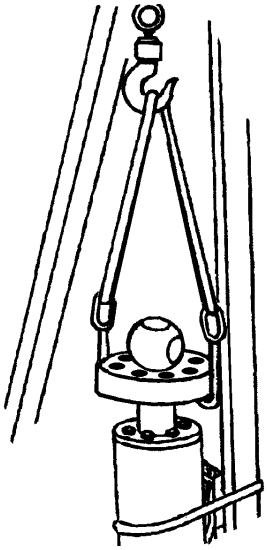

Fig. 10C.14. Securing Cylinder to Hoist

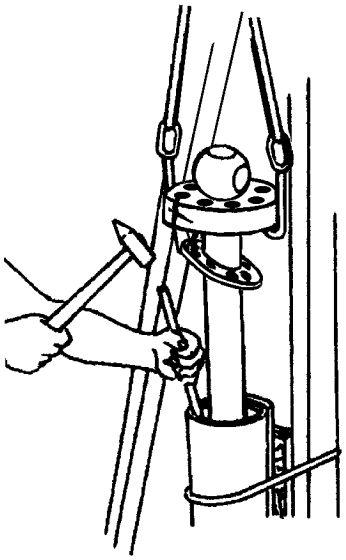

Fig. 10C.15. Relieving Tension on Lock Ring

3. Using the hoist, pull the cylinder rod out to approximately 1/2 stroke.
4. Remove the bolts and washer securing cylinder cover (16) to gland (10) and tie the cover up to the socket cap as shown in Fig. 10C.15, to provide working clearance.
5. Using a brass drift as shown in Fig. 10C.15, drive gland into cylinder housing (1) until the tension of the lock ring (15) is off.
6. Remove three piece lock ring (15) from cylinder housing and pull rod assembly out of cylinder housing (1).
7. Remove piston rod nut (3).

NOTE: *It will be necessary to hold the ball end of the rod stationary when removing the nut. A suggested method is to clamp the ball end of the piston rod in a hydraulic press and use a torque multiplier as shown in Fig. 10C.16, or an impact tool.*

8. Remove washer (4) and piston (7) from cylinder rod (18). Remove wear rings (5), O-rings (6) and piston seal (8) from the piston (7).
9. Slide gland (10) from cylinder rod (18). Remove wear ring (11), seal ring (9), wiper ring (14), seal ring (13) and buffer ring (12) with O-ring (19) from gland (10).
10. Slide cover (16) and socket cap (17) off of cylinder rod (18).
11. If necessary, remove the cylinder bushing (2) from cylinder housing (1).

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CYLINDERS

BLADE TILT CYLINDER

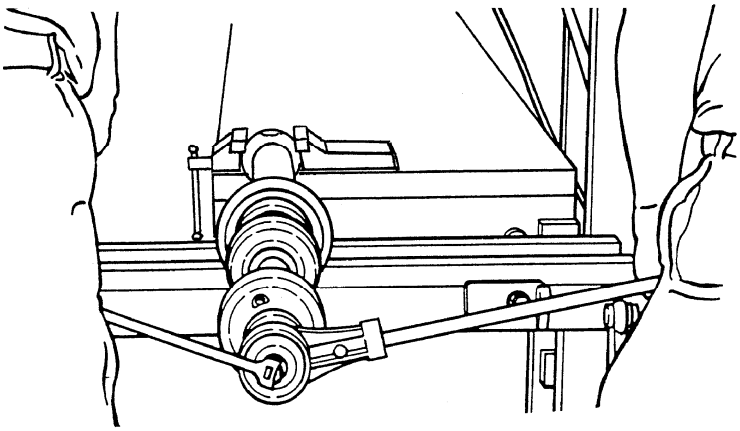

Fig. 10C.16. Removing Piston Rod Nut

8. INSPECTION AND REPAIR

1. It is recommended that all new O-rings, wear rings, seals and wiper rings be installed when the cylinder is disassembled.
2. Wash all parts in a solvent and air dry. Lubricate machined surfaces of usable parts to protect them.
3. Inspect the cylinder housing for roundness throughout its length. If a tight spot is noticed when removing the piston, the area of binding should be given particular attention. A cylinder housing that is out-of-round should be replaced.
4. Check the cylinder housing and piston rod for scratches or grooves. Shallow scratches can be polished out with fine emery cloth and oil so a smooth surface is presented to the packing.
5. Inspect all sealing ring grooves for scratches, burrs or other damage. "Dress-up" grooves or replace as necessary.
6. Inspect tapped holes for damaged threads.
7. If the housing eye bushings were removed, remove all rust, scale or paint from the bushing bore.

9. REASSEMBLY (Refer to Fig.'s 10C.12 and 10C.13)

1. Position socket cap (17) and cover (16) onto cylinder rod (18).

IMPORTANT: *Outer end of gland is determined as bolt end and inside end as facing piston.*

2. Coat the bore and grooves of gland (10) with fresh grease. Install seal ring (13) by squeezing the side of the seal together and starting the seal into the groove. Then work the remainder in with the thumbs. DO NOT use a screwdriver as it will damage the seal.
3. Install O-ring (19) with buffer ring (12), notched edge facing in, into gland (10) and follow with wear ring (11). Install seal ring (9) onto gland (10). Install wiper ring (14) and slide gland (10) onto rod (18). The tapped holes in gland (10) must face toward the rod ball.
4. Install piston seal (8) onto piston (7). Install O-rings (6) and wear rings (5) on each end of piston (7). Install and slide piston onto rod (18). Secure with washer (4) and nut (3). Clamp ball rod into press as shown in Fig. 10C.16. Using a multiplier torque piston nut (3) to 3250 [Nm].

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BLADE TILT CYLINDER

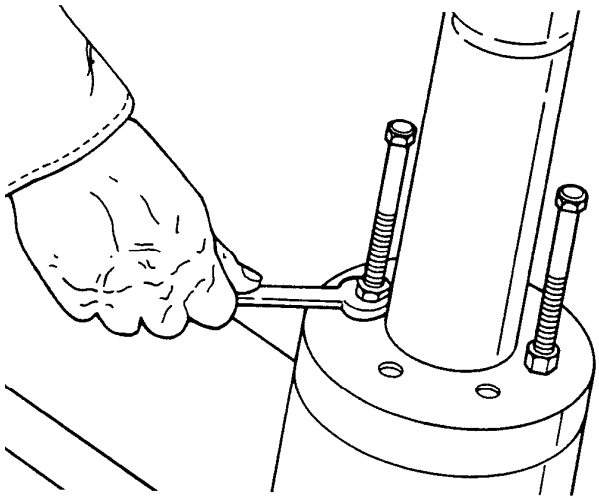

Fig. 10C.17. Seating Gland with Lock Ring

5. Secure cylinder housing (1) to hoist frame. Attach hoist to socket cap (17) and lower rod assembly into housing (1) using extreme care not to damage wear rings (5) and piston seal (8). Once piston (7) has entered housing, drive rod 1/2 stroke.
6. Tie cover (16) to socket cap (17) to provide working clearance. Start gland assembly (10) into housing (1) and drive in just below lock ring groove in housing. Install lock ring (15) into housing groove. Install two puller bolts 1/2”NC - 1-3/4” and nuts (Fig. 10C.17) and thread into gland. Tighten nuts to draw gland up against lock rings. Remove puller arrangement and lift cover (16). Coat inner cylinder housing surface over the gland with high temperature type 230 HHT grease 1 [mm] in thickness. Secure cover (16) to gland (10) and torque bolts with washer to 110 - 120 [Nm].
7. If removed, install the cylinder bushing (2) to cylinder housing (1).

10. INSTALLATION

1. Attach a hoist sling to the blade tilt cylinder (1, Fig.10C.11) as was done in removal procedure.
2. Position the housing eye of the tilt cylinder into the bracket on the push arm at R.H. side of the machine. Install pin (7) into push arm bracket and secure with hardware.
3. Install cylinder rod ball in socket of blade (3). Install socket cap (2) and evenly tighten bolts to 270 [Nm]. Measure gap between socket cap and socket and remove bolts. Install a shims pack of measured gap plus an additional shim for clearance. Each shim is 0.75 [mm] thick. Install bolts with washers and torque to 845 [Nm]. Remove the hoist sling.
4. Connect the hoses (4, Fig. 10C.11) to blade tilt cylinder (1) and install hose clamp (5) to the tilt cylinder (1).
5. Vent the hydraulic system and add oil as necessary, refer to the OPERATOR'S MANUAL. Visually check for oil leakage.
6. Cycle cylinder a few times and recheck cylinder and cover bolts torque.
7. Install center guard (4, Fig. 10C.10), lower guard (2) and upper guard (3) to the blade tilt cylinder (1).

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BLADE TILT AND PITCH CYLINDER

11. REMOVAL

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate proper installation.*

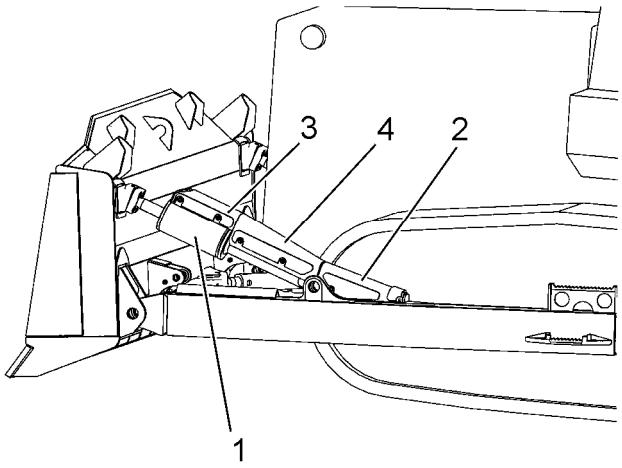

Fig. 10C.18. Blade Tilt/Pitch Cylinder Guard

1. Blade Tilt/Pitch Cylinder
2. Lower Guard
3. Upper Guard
4. Center Guard

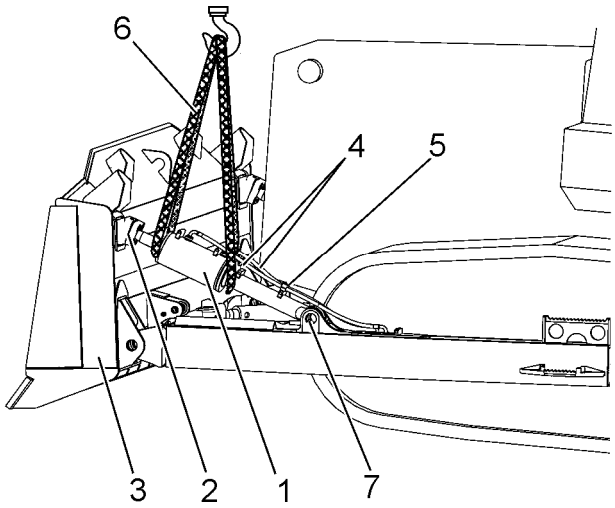

Fig. 10C.19. Blade Tilt/Pitch Cylinder Removal (L.H. Side)

1. Blade Tilt/Pitch Cylinder
2. Socket Cap
3. Blade
4. Hoses
5. Hose Clamp
6. Hoist Sling
7. Pin

1. Remove the upper guard (3, Fig. 10C.18), lower guard (2) and center guard (4) from tilt/pitch cylinder (1) at L.H. side of the machine.
2. Unscrew bolts with washer securing hose clamp (5, Fig. 10C19) to the tilt/pitch cylinder (1) and remove clamp.
3. Disconnect hoses (4, Fig. 10C.19) from tilt/pitch cylinder (1) and position out of way.
4. Attach a hoist sling to blade tilt/pitch cylinder (1). The hoist must be installed to give the best possible balance. Place tension on the hoist.
5. Remove bolts with washer securing socket cap (2) and move socket cap of blade (3). Keep shims with blade (3).
6. Remove mounting hardware securing pin (7) to the bracket on push arm and remove pin. Remove tilt/pitch cylinder (1) from machine.

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BLADE TILT AND PITCH CYLINDER

12. DISASSEMBLY (Refer to Fig.'s 10C.20 and 10C.21)

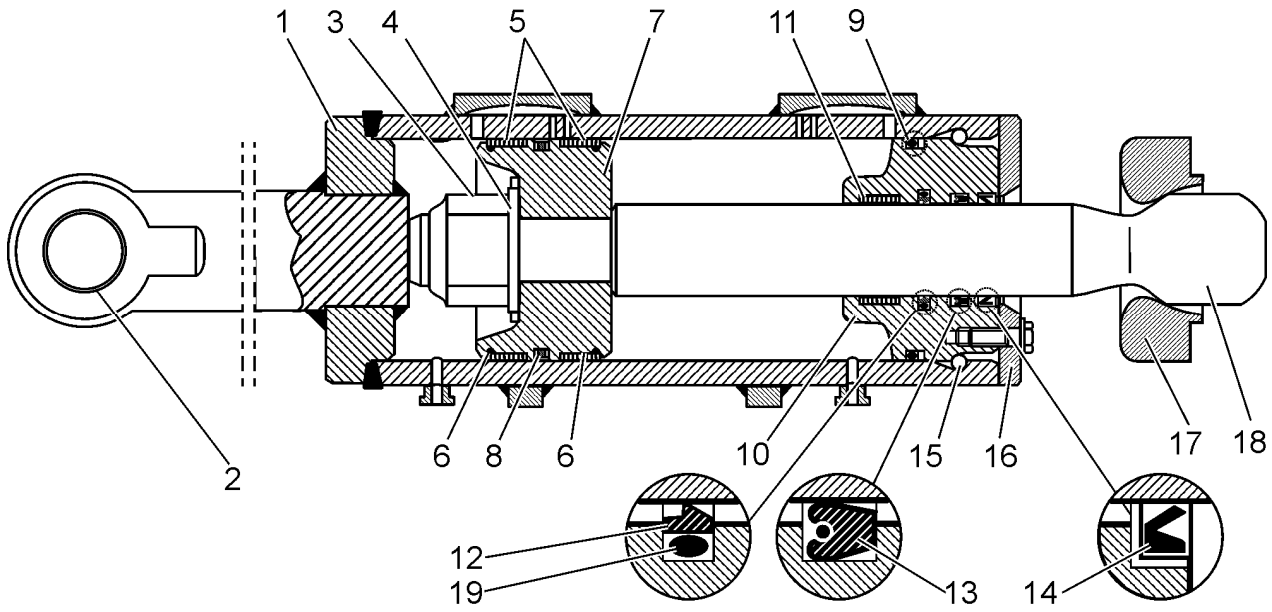

Fig. 10C.20. Cross Section View of Blade Tilt/Pitch Cylinder

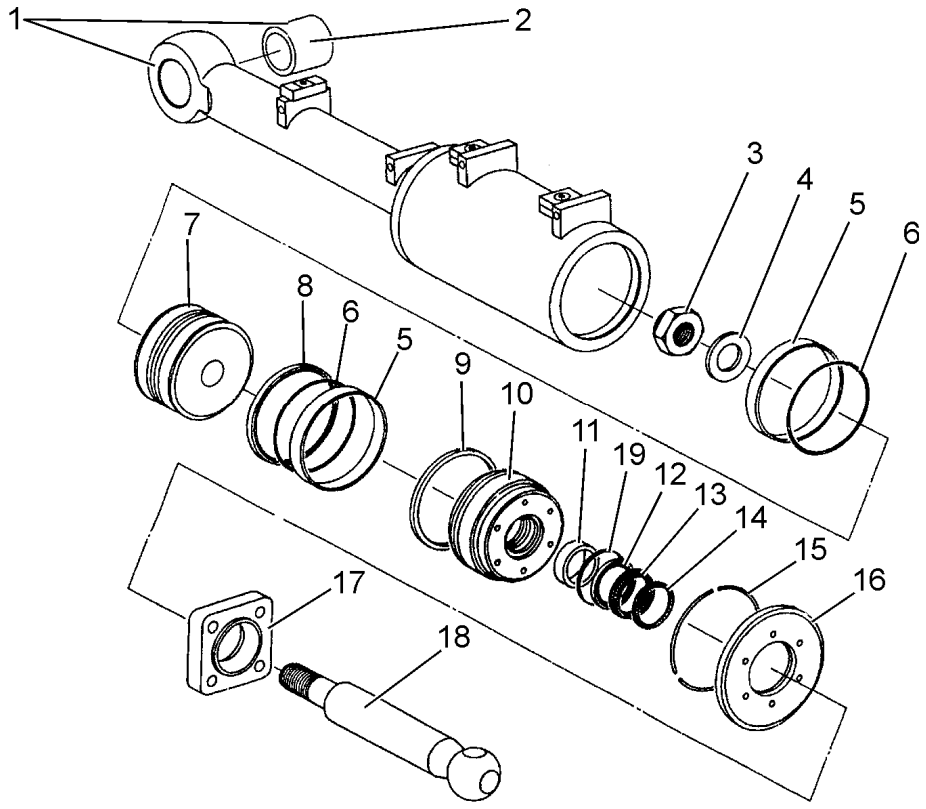

Fig. 10C.21. Exploded View of Blade Tilt/Pitch Cylinder

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BLADE TILT AND PITCH CYLINDER

Legend for Fig.'s 10C.20 and 10C.21

1. Cylinder Housing
2. Cylinder Bushing
3. Nut
4. Washer
5. Wear Ring
6. O-Ring
7. Piston
8. Piston Seal
9. O-Ring
   Backup Ring
10. Cylinder Gland
11. Wear Ring
12. Buffer Ring
13. Seal Ring
14. Wiper Ring
15. Lock Ring
16. Cover
17. Socket Cap
18. Cylinder Rod
19. O-Ring

1. Steam clean or wash the cylinder with solvent before disassembly.
2. Attach a hoist sling to the socket cap as shown in Fig.10C.22. Raise the cylinder up and secure it to the hoist frame.

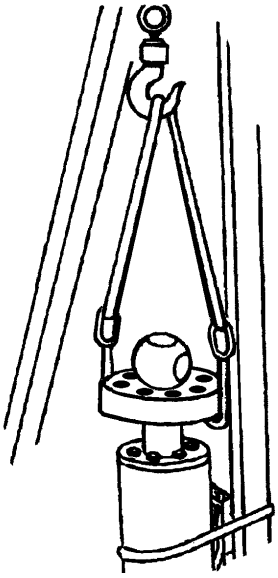

Fig. 10C.22. Securing Cylinder to Hoist

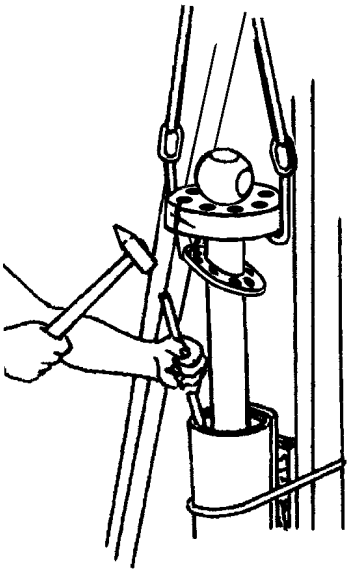

Fig. 10C.23. Relieving Tension on Lock Ring

3. Using the hoist, pull the cylinder rod out to approximately 1/2 stroke.
4. Remove the bolts and washer securing cylinder cover (16) to gland (10) and tie the cover up to the socket cap as shown in Fig. 10C.23, to provide working clearance.
5. Using a brass drift as shown in Fig. 10C.23, drive gland into cylinder housing (1) until the tension of the lock ring (15) is off.
6. Remove three piece lock ring (15) from cylinder housing and pull rod assembly out of cylinder housing (1).
7. Remove piston rod nut (3).

NOTE: *It will be necessary to hold the ball end of the rod stationary when removing the nut. A suggested method is to clamp the ball end of the piston rod in a hydraulic press and use a torque multiplier as shown in Fig. 10C.24, or an impact tool.*

8. Remove washer (4) and piston (7) from cylinder rod (18). Remove wear rings (5), O-rings (6) and piston seal (8) from the piston (7).
9. Slide gland (10) from cylinder rod (18). Remove wear ring (11), O-ring with backup ring (9), wiper ring (14), seal ring (13) and buffer ring (12) with O-ring (19) from gland (10).
10. Slide cover (16) and socket cap (17) off of cylinder rod (18).
11. If necessary, remove the cylinder bushing (2) from cylinder housing (1).

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BLADE TILT AND PITCH CYLINDER

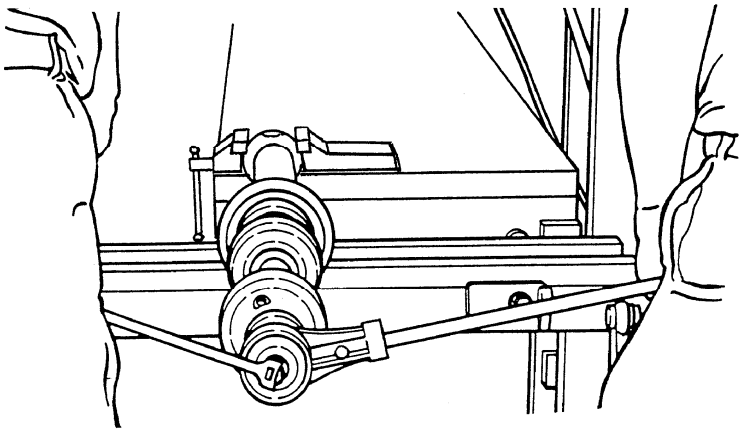

Fig. 10C.24. Removing Piston Rod Nut

13. INSPECTION AND REPAIR

1. It is recommended that all new O-rings, wear rings, seals and wiper rings be installed when the cylinder is disassembled.
2. Wash all parts in a solvent and air dry. Lubricate machined surfaces of usable parts to protect them.
3. Inspect the cylinder housing for roundness throughout its length. If a tight spot is noticed when removing the piston, the area of binding should be given particular attention. A cylinder housing that is out-of-round should be replaced.
4. Check the cylinder housing and piston rod for scratches or grooves. Shallow scratches can be polished out with fine emery cloth and oil so a smooth surface is presented to the packing.
5. Inspect all sealing ring grooves for scratches, burrs or other damage. "Dress-up" grooves or replace as necessary.
6. Inspect tapped holes for damaged threads.
7. If the housing eye bushings were removed, remove all rust, scale or paint from the bushing bore.

14. REASSEMBLY (Refer to Fig.'s 10C.20 and 10C.21)

1. Position socket cap (17) and cover (16) onto cylinder rod (18).

IMPORTANT: *Outer end of gland is determined as bolt end and inside end as facing piston.*

2. Coat the bore and grooves of gland (10) with fresh grease. Install seal ring (13) by squeezing the side of the seal together and starting the seal into the groove. Then work the remainder in with the thumbs. DO NOT use a screwdriver as it will damage the seal.
3. Install O-ring (19) with buffer ring (12), notched edge facing in, into gland (10) and follow with wear ring (11). Install O-ring with backup ring (9) onto gland (10). Install wiper ring (14) and slide gland (10) onto rod (18). The tapped holes in gland (10) must face toward the rod ball.
4. Install piston seal (8) onto piston (7). Install O-rings (6) and wear rings (5) on each end of piston (7). Install and slide piston onto rod (18). Secure with washer (4) and nut (3). Clamp ball rod into press as shown in Fig. 10C.24. Using a multiplier torque piston nut (3) to 3250 [Nm].

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5. Secure cylinder housing (1) to hoist frame. Attach hoist to socket cap (17) and lower rod assembly into housing (1) using extreme care not to damage wear rings (5) and piston seal (8). Once piston (7) has entered housing, drive rod 1/2 stroke.

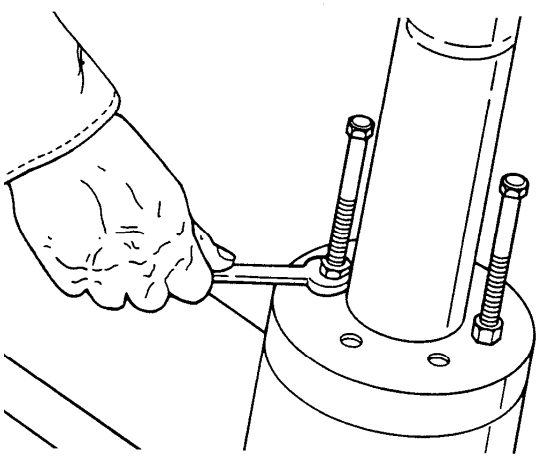

Fig. 10C.25. Seating Gland with Lock Ring

6. Tie cover (16) to socket cap (17) to provide working clearance. Start gland assembly (10) into housing (1) and drive in just below lock ring groove in housing. Install lock ring (15) into housing groove. Install two puller bolts 1/2”NC x 1-3/4” and nuts (Fig. 10C.25) and thread into gland. Tighten nuts to draw gland up against lock rings. Remove puller arrangement and lift cover (16). Coat inner cylinder housing surface over the gland with high temperature type 230 HHT grease 1 [mm] in thickness. Secure cover (16) to gland (10) and torque bolts with washer to 110 - 120 [Nm].
7. If removed, install the cylinder bushing (2) to cylinder housing (1).

15. INSTALLATION

1. Attach a hoist sling to the blade tilt/pitch cylinder (1, Fig. 10C.19) as was done in removal procedure.
2. Position the housing eye of the tilt/pitch cylinder into the bracket on the push arm at L.H. side of the machine. Install pin (7) into push arm bracket and secure with hardware.
3. Install cylinder rod ball in socket of blade (3). Install socket cap (2) and evenly tighten bolts to 270 [Nm]. Measure gap between socket cap and socket and remove bolts. Install a shims pack of measured gap plus an additional shim for clearance. Each shim is 0.75 [mm] thick. Install bolts with washers and torque to 845 [Nm]. Remove the hoist sling.
4. Connect the hoses (4, Fig. 10C.19) to blade tilt/pitch cylinder (1) and install clamp (5) to tilt/pitch cylinder.
5. Vent the hydraulic system and add oil as necessary, refer to the OPERATOR'S MANUAL. Visually check for oil leakage.
6. Cycle cylinder a few times and recheck cylinder and cover bolts torque.
7. Install center guard (4, Fig. 10C.18), lower guard (2) and upper guard (3) to the blade tilt/pitch cylinder (1).

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BLADE DOUBLE TILT AND PITCH CYLINDER

16. REMOVAL

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate proper installation.*

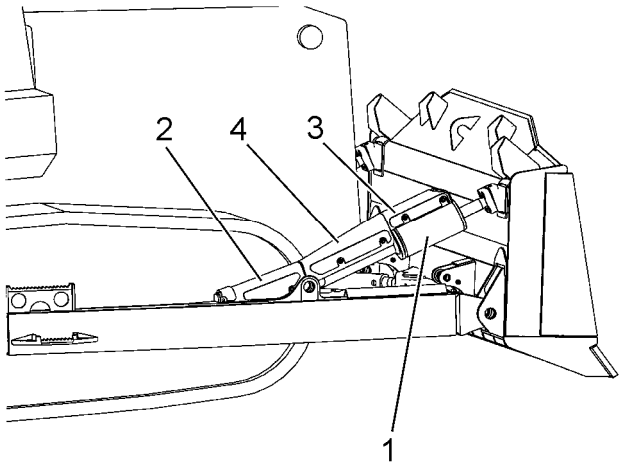

Fig. 10C.26. Blade Double Tilt and Pitch Cylinder Guard

1. Blade Double Tilt and Pitch Cylinder
2. Lower Guard
3. Upper Guard
4. Center Guard

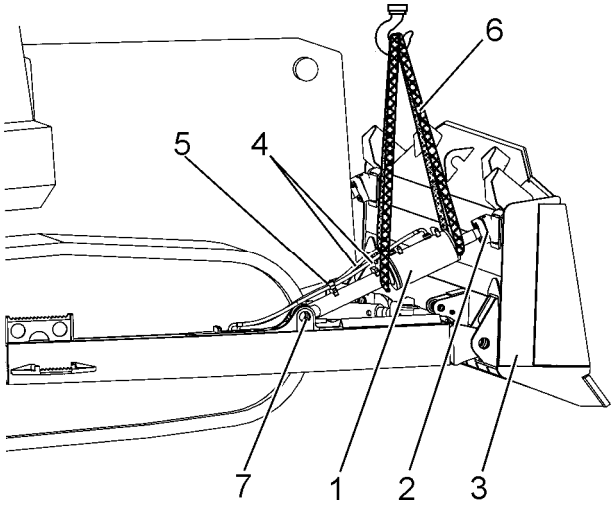

Fig. 10C.27. Blade Double Tilt and Pitch Cylinder Removal (R.H. Side)

1. Blade Double Tilt and Pitch Cylinder
2. Socket Cap
3. Blade
4. Hoses
5. Hose Clamp
6. Hoist Sling
7. Pin

1. Remove the upper guard (3, Fig. 10C.26), lower guard (2) and center guard (4) from double tilt and pitch cylinder (1) at R.H. side of the machine.
2. Unscrew bolts with washer securing hose clamp (5, Fig. 10C.27) to the double tilt and pitch cylinder (1) and remove clamp.
3. Disconnect two hoses (4) from double tilt and pitch cylinder (1) and position out of way.
4. Attach a hoist sling (6) to blade double tilt and pitch cylinder (1). The hoist must be installed to give the best possible balance. Place tension on the hoist.
5. Remove bolts with washers securing socket cap (2) and move socket cap of blade (3). Keep shims with blade (3).
6. Remove mounting hardware securing pin (7) to the bracket on push arm and remove pin. Remove double tilt and pitch cylinder (1) from machine.

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BLADE DOUBLE TILT AND PITCH CYLINDER

17. DISASSEMBLY (Refer to Fig.'s 10C.28 and 10C.29)

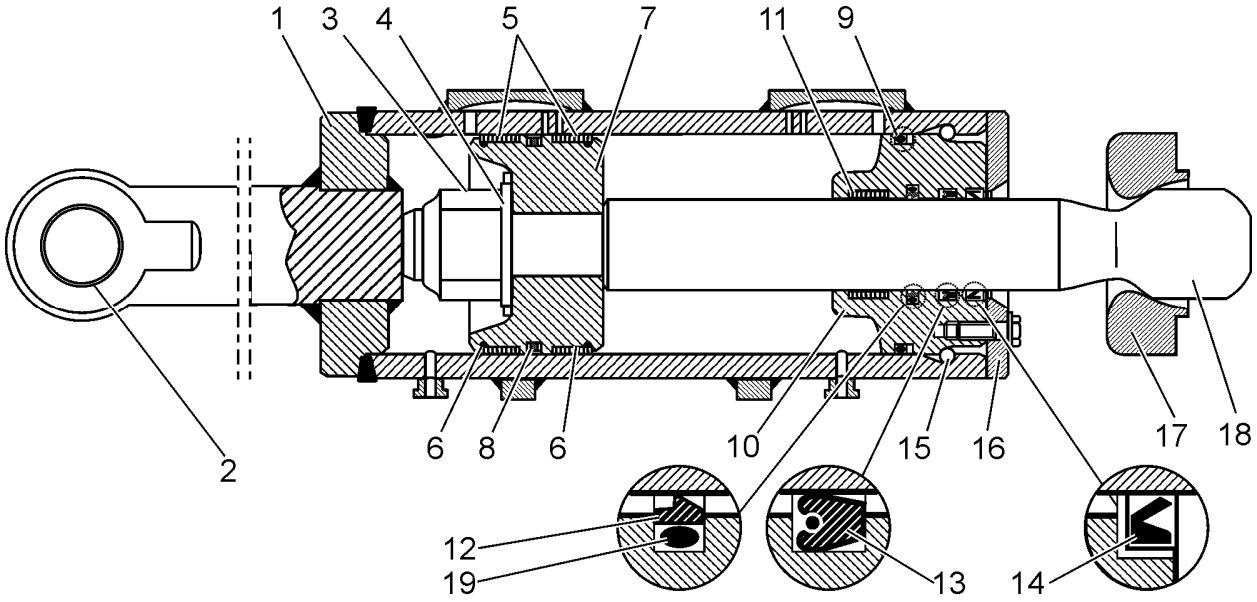

Fig. 10C.28. Cross Section View of Blade Double Tilt and Pitch Cylinder

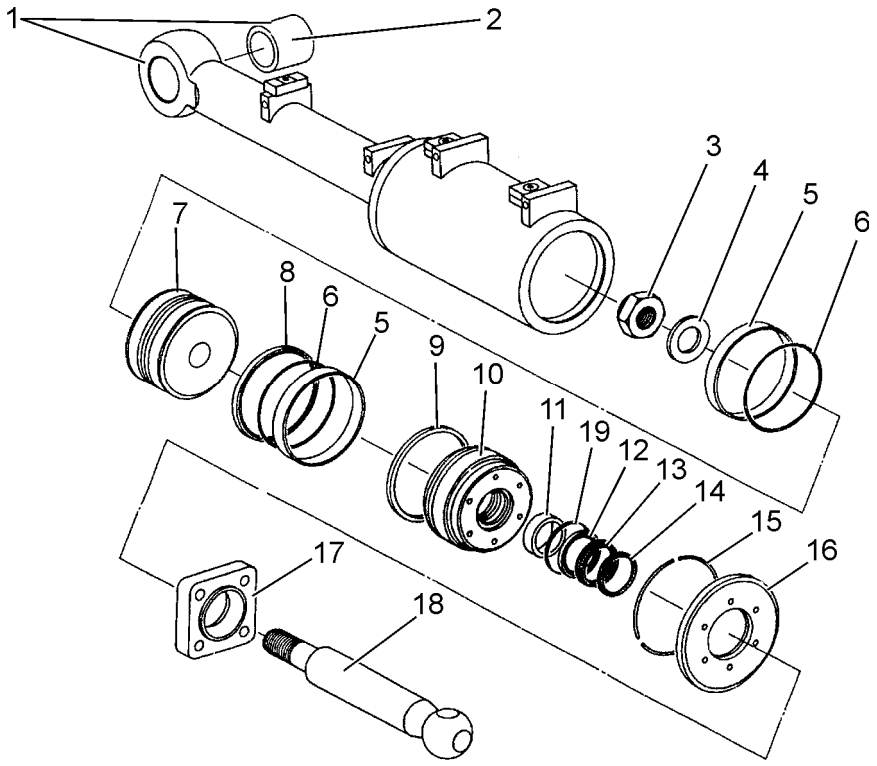

Fig. 10C.29. Exploded View of Blade Double Tilt and Pitch Cylinder

Legend for Fig.'s 10C.28 and 10C.29

1. Cylinder Housing
2. Cylinder Bushing
3. Nut
4. Washer
5. Wear Ring
6. O-Ring
7. Piston
8. Piston Seal
9. O-Ring Backup Ring
10. Cylinder Gland
11. Wear Ring
12. Buffer Ring
13. Seal Ring
14. Wiper Ring
15. Lock Ring
16. Cover
17. Socket Cap
18. Cylinder Rod
19. O-Ring

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BLADE DOUBLE TILT AND PITCH CYLINDER

1. Steam clean or wash the cylinder with solvent before disassembly.
2. Attach a hoist sling to the socket cap as shown in Fig. 10C.30. Raise the cylinder up and secure it to the hoist frame.
3. Using the hoist, pull the cylinder rod out to approximately 1/2 stroke.

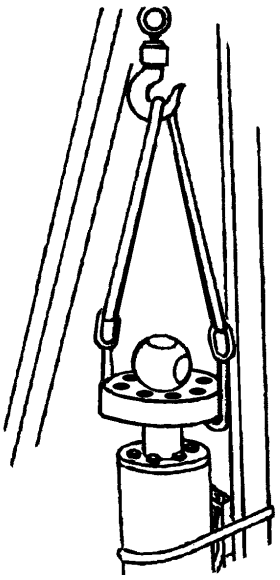

Fig. 10C.30. Securing Cylinder to Hoist

4. Remove the bolts and washer securing cylinder cover (16) to gland (10) and tie the cover up to the socket cap as shown in Fig. 10C.31, to provide working clearance.
5. Using a brass drift as shown in Fig. 10C.31, drive gland into cylinder housing (1) until the tension of the lock ring (15) is off.

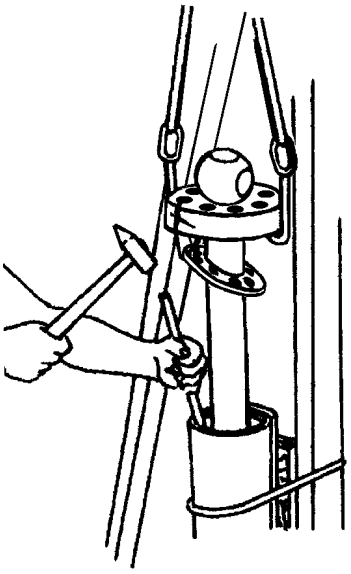

Fig. 10C.31. Relieving Tension on Lock Ring

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6. Remove three piece lock ring (15) from cylinder housing and pull rod assembly out of cylinder housing (1).
7. Remove piston rod nut (3).

NOTE: *It will be necessary to hold the ball end of the rod stationary when removing the nut A suggested method is to clamp the ball end of the piston rod in a hydraulic press and use a torque multiplier as shown in Fig. 10C.32, or an impact tool.*

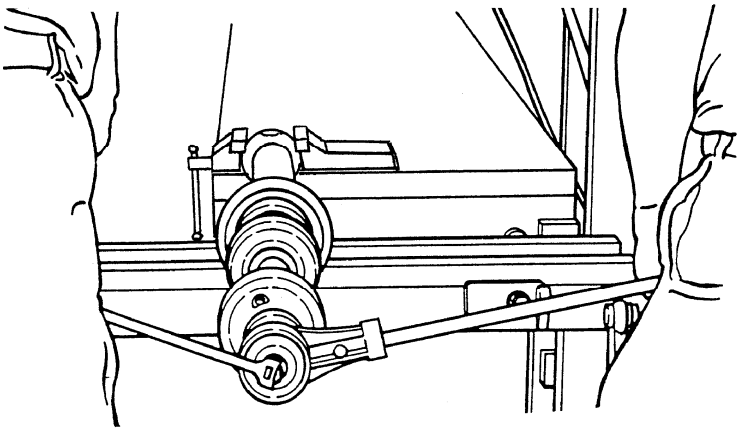

Fig. 10C.32. Removing Piston Rod Nut

8. Remove washer (4) and piston (7) from cylinder rod (18). Remove wear rings (5), O-rings (6) and piston seal (8) from the piston (7).
9. Slide gland (10) from cylinder rod (18). Remove wear ring (11), O-ring with backup ring (9), wiper ring (14), seal ring (13) and buffer ring (12) with O-ring (19) from gland (10).
10. Slide cover (16) and socket cap (17) off of cylinder rod (18).
11. If necessary, remove the cylinder bushing (2) from cylinder housing (1).

18. INSPECTION AND REPAIR

1. It is recommended that all new O-rings, wear rings, seals and wiper rings be installed when the cylinder is disassembled.
2. Wash all parts in a solvent and air dry. Lubricate machined surfaces of usable parts to protect them.
3. Inspect the cylinder housing for roundness throughout its length. If a tight spot is noticed when removing the piston, the area of binding should be given particular attention. A cylinder housing that is out-of-round should be replaced.
4. Check the cylinder housing and piston rod for scratches or grooves. Shallow scratches can be polished out with fine emery cloth and oil so a smooth surface is presented to the packing.
5. Inspect all sealing ring grooves for scratches, burrs or other damage. "Dress-up" grooves or replace as necessary.
6. Inspect tapped holes for damaged threads.
7. If the housing eye bushings were removed, remove all rust, scale or paint from the bushing bore.

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19. REASSEMBLY (Refer to Fig.'s 10C.28 and 10C.29)

1. Position socket cap (17) and cover (16) onto cylinder rod (18).

IMPORTANT: *Outer end of gland is determined as bolt end and inside end as facing piston.*

2. Coat the bore and grooves of gland (10) with fresh grease. Install seal ring (13) by squeezing the side of the seal together and starting the seal into the groove. Then work the remainder in with the thumbs. DO NOT use a screwdriver as it will damage the seal.
3. Install O-ring (19) with buffer ring (12), notched edge facing in, into gland (10) and follow with wear ring (11). Install O-ring with backup ring (9) onto gland (10). Install wiper ring (14) and slide gland (10) onto rod (18). The tapped holes in gland (10) must face toward the rod ball.
4. Install piston seal (8) onto piston (7). Install O-rings (6) and wear rings (5) on each end of piston (7). Install and slide piston onto rod (18). Secure with washer (4) and nut (3). Clamp ball rod into press as shown in Fig. 10C.32. Using a multiplier torque piston nut (3) to 3250 [Nm].
5. Secure cylinder housing (1) to hoist frame. Attach hoist to socket cap (17) and lower rod assembly into housing (1) using extreme care not to damage wear rings (5) and piston seal (8). Once piston (7) has entered housing, drive rod 1/2 stroke.

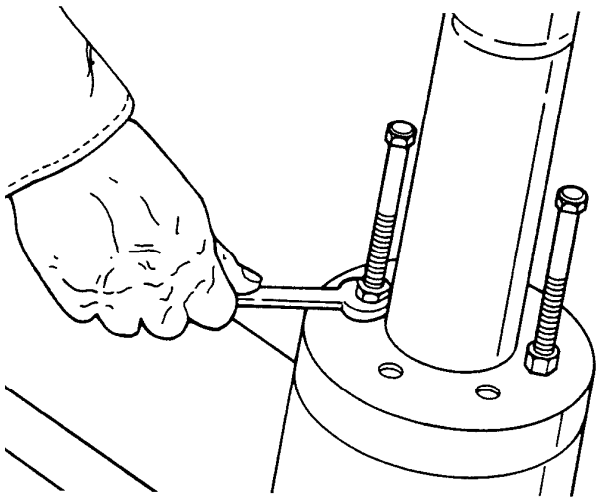

Fig. 10C.33. Seating Gland with Lock Ring

6. Tie cover (16) to socket cap (17) to provide working clearance. Start gland assembly (10) into housing (1) and drive in just below lock ring groove in housing. Install lock ring (15) into housing groove. Install two puller bolts 1/2"NC - 1-3/4" and nuts (Fig. 10C.33) and thread into gland. Tighten nuts to draw gland up against lock rings. Remove puller arrangement and lift cover (16). Coat inner cylinder housing surface over the gland with high temperature type 230 HHT grease 1 [mm] in thickness. Secure cover (16) to gland (10) and torque bolts with washer to 110 - 120 [Nm].
7. If removed, install the cylinder bushing (2) to cylinder housing (1).

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BLADE DOUBLE TILT AND PITCH CYLINDER

20. INSTALLATION

1. Attach a hoist sling (6) to the blade double tilt and pitch cylinder (1, Fig. 10C.27) as was done in removal procedure.
2. Position the housing eye of the double tilt and pitch cylinder into the bracket on the push arm at L.H. side of the machine. Install pin (7) into push arm bracket and secure with hardware.
3. Install cylinder rod ball in socket of blade (3). Install socket cap (2) and evenly tighten bolts to 270 [Nm]. Measure gap between socket cap and socket and remove bolts. Install a shims pack of measured gap plus an additional shim for clearance. Each shim is 0.75 [mm] thick. Install bolts with washers and torque to 845 [Nm]. Remove the hoist sling (6).
4. Connect two hoses (4) to blade double tilt and pitch cylinder (1) and install hose clamp (5) to double tilt and pitch cylinder.
5. Vent the hydraulic system and add oil as necessary, refer to the OPERATOR'S MANUAL. Visually check for oil leakage.
6. Cycle cylinder a few times and recheck cylinder and cover bolts torque.
7. Install center guard (4, Fig. 10C.26), lower guard (2) and upper guard (3) to the blade double tilt/pitch cylinder (1).

RIPPER LIFT AND PITCH CYLINDERS

21. REMOVAL

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate proper installation.*

Ripper Lift Cylinder Removal

1. Remove bolts and plate securing pin (7, Fig. 10C.34) to toolbeam (8).
2. Disconnect rod end hose (10) from pitch cylinder (11). Remove tube clamp and disconnect head end tube (12) from pitch cylinder (11).
3. Lift ripper pitch cylinder (2, Fig. 10C.35) and secure to fuel tank holder (1).
4. Disconnect rod end hose (3, Fig. 10C.34) from lift cylinder (9). Remove tube clamp and disconnect head end tube (2) from lift cylinder (9).
5. Attach a hoist to lift cylinder. Hoist must be installed to give the best possible balance. Place tension on the sling.
6. Remove bolts and plate securing pin (6) to toolbeam (8). Using a pry bar move pin outward until rod eye is clear.
7. Remove bolts and plate securing pin to frame (4). Using a pry bar move pin outward until housing eye is clear.
8. Remove lift cylinder (9) from ripper.

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RIPPER LIFT AND PITCH CYLINDERS

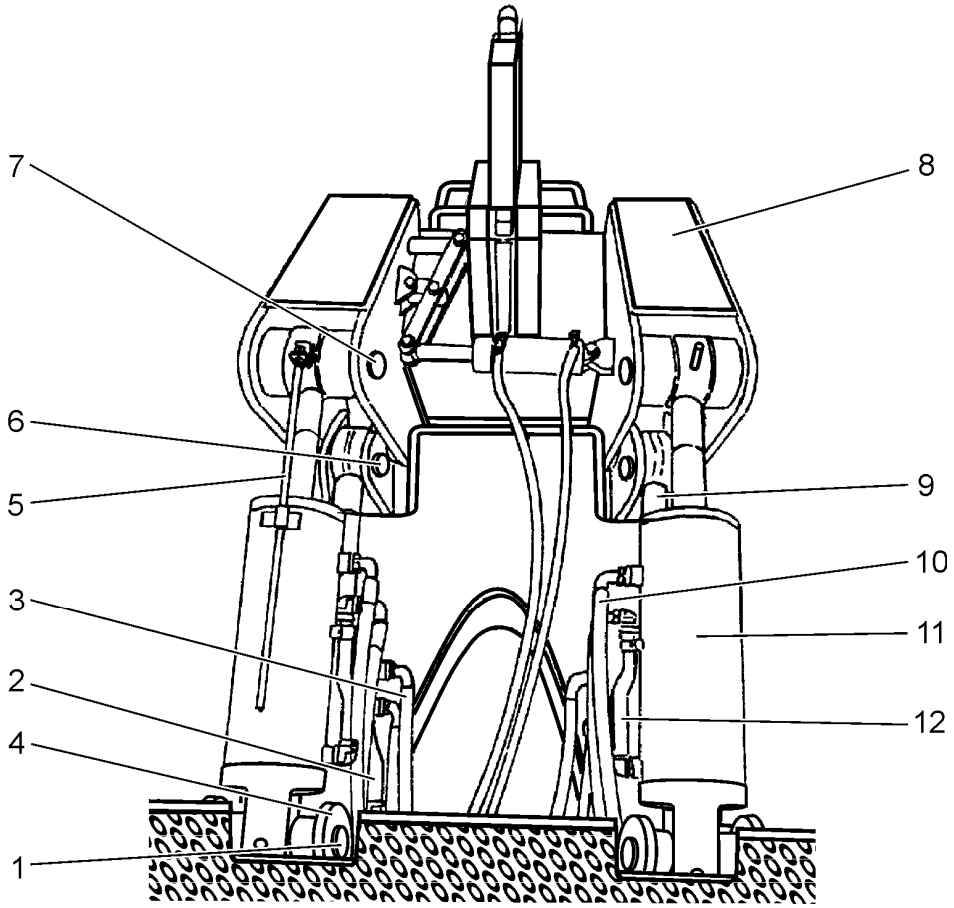

Fig. 10C.34. Ripper Lift Cylinder or Pitch Cylinder Removal

1. Pin
2. Head End Tube
3. Rod End Hose
4. Frame
5. Indicator Rod
6. Pin
7. Pin
8. Toolbeam
9. Lift Cylinder
10. Rod End Hose
11. Pitch Cylinder
12. Head End Tube

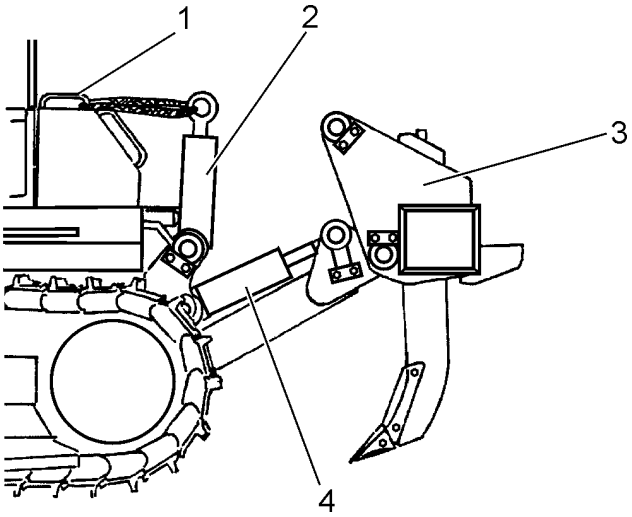

Fig. 10C.35. Ripper Lift Cylinder Removal

1. Fuel Tank Holder
2. Ripper Pitch Cylinder
3. Ripper
4. Ripper Lift Cylinder

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RIPPER LIFT AND PITCH CYLINDERS

Ripper Pitch Cylinder Removal

1. RIGHT PITCH CYLINDER ONLY: Remove indicator rod (5, Fig. 10C.34) from the rod eye and cylinder housing.
2. Disconnect rod end hose (10) from pitch cylinder (11). Remove tube clamp and disconnect head end tube (12) from pitch cylinder (11).
3. Attach a hoist to cylinder. Hoist must be installed to give the best possible balance. Place tension on the sling.
4. Remove bolts and plate securing pin (7) to toolbeam (8). Using a pry bar move pin outward until rod eye is clear.
5. Remove bolts and plate securing pin (1) to frame (4). Using a pry bar move pin outward until housing eye is clear.
6. Remove pitch cylinder (11) from ripper.

22. DISASSEMBLY (Refer to Fig.'s 10C.36 and 10C.37)

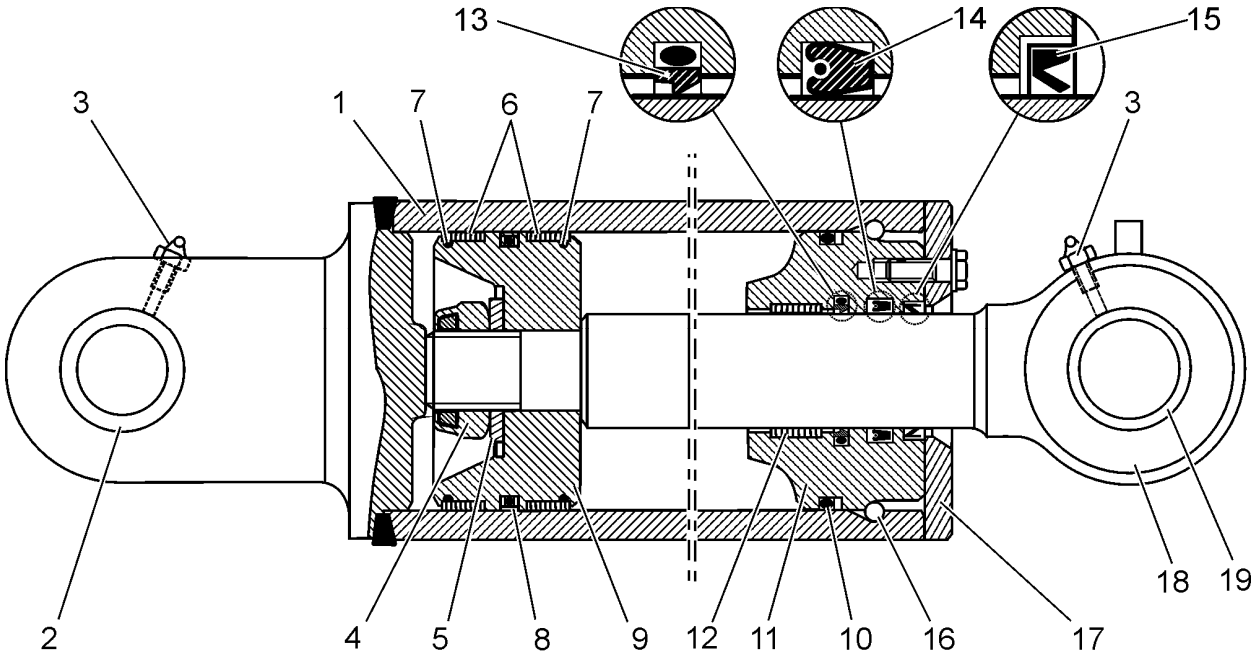

Fig. 10C.36. Cross Section View of Ripper Lift and Pitch Cylinder

Legend for Fig.'s 10C.36 and 10C.37

1. Cylinder Housing
2. Cylinder Bushing
3. Lube Fitting
4. Nut
5. Washer
6. Wear Ring
7. O-Ring
8. Piston Seal
9. Piston
10. O-Ring and Backup Ring
11. Cylinder Gland
12. Wear Ring
13. O-Ring and Buffer Ring
14. Seal Ring
15. Wiper Ring
16. Lock Ring
17. Cover
18. Cylinder Rod
19. Rod Bushing

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RIPPER LIFT AND PITCH CYLINDERS

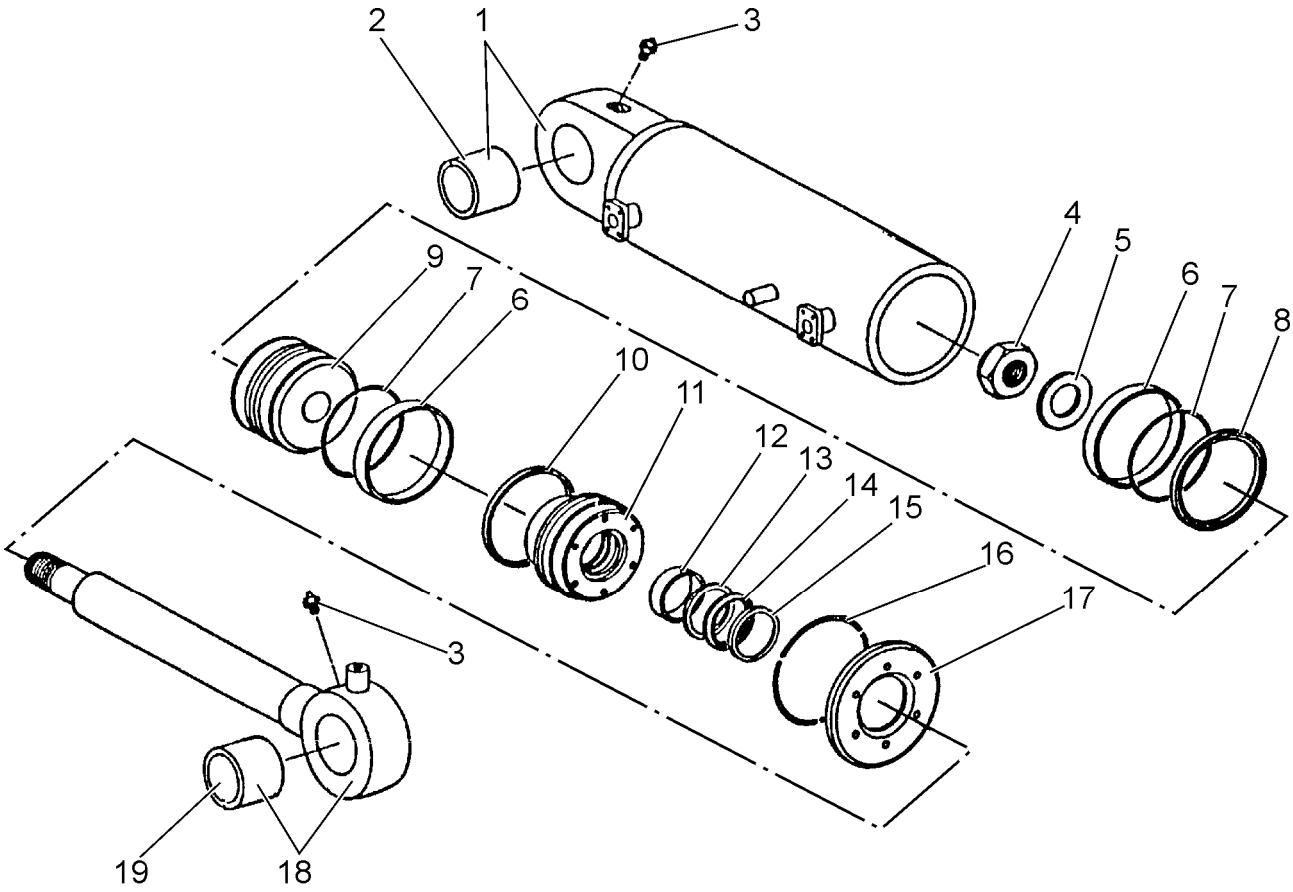

Fig. 10C.37. Exploded View of Ripper Lift and Pitch Cylinder

1. Steam clean or wash the cylinder with solvent before disassembly.
2. Attach a hoist to rod eye as shown in Fig. 10C.38, using a strap to protect the bearing in eye. Raise the cylinder up and secure it to the hoist frame. Pull the cylinder rod out to approximately 1/2 stroke.
3. Remove hardware securing cover (17) to gland (11). Tie cover up to the rod eye as shown in Fig. 10C.39. to provide working clearance.
4. Using a brass drift as shown in Fig. 10C.39, drive gland into cylinder housing (1) until the tension is off the lock ring (16). Remove lock ring (16) from cylinder housing and pull rod assembly out of housing.

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RIPPER LIFT AND PITCH CYLINDERS

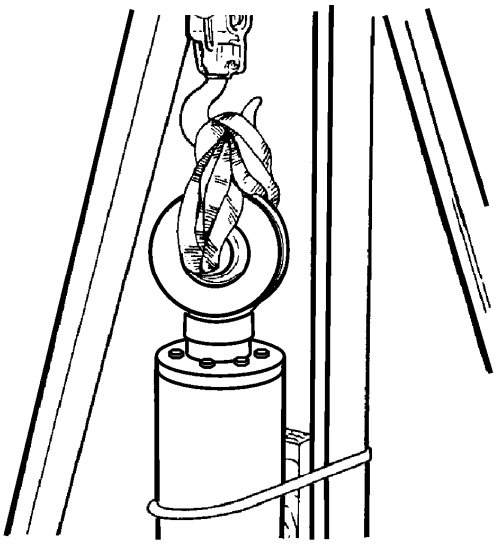

Fig. 10C.38. Securing Cylinder to Hoist

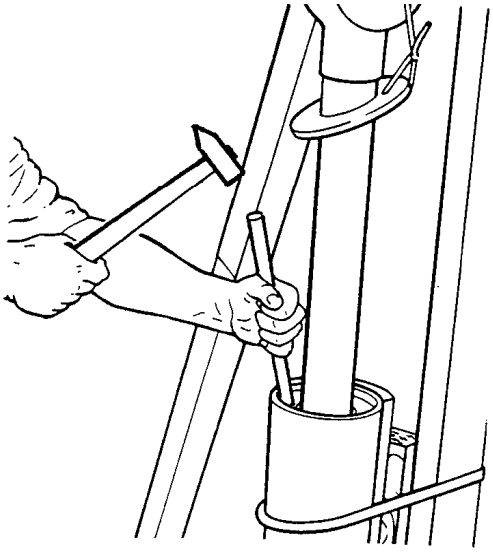

Fig. 10C.39. Relieving Tension on Lock Ring

5. Remove piston rod nut (4) as shown in Fig. 10C.40.

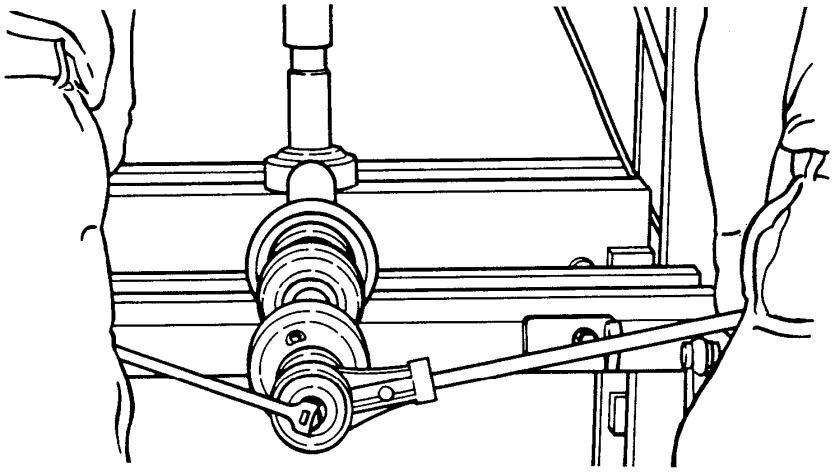

Fig. 10C.40. Removing Piston Rod Nut

NOTE*: It will be necessary to hold the eye end of the rod stationary when removing the nut. A suggested method is to clamp the eye end of the piston rod in a hydraulic press and use a torque multiplier as shown in Fig. 10C.40, or an impact tool.*

6. Remove washer (5) and piston (9) from rod (18). Remove wear rings (6), O-rings (7) and piston seal (8) from piston (9).
7. Slide gland (11) from rod (18). Remove O-ring with backup ring (10), wear ring (12), buffer ring with O-ring (13), wiper ring (15) and seal ring (14) from gland (11). Slide cover (17) off of rod (18).
8. If bushings (2 and 19) needs replacement, press out the old bushings from cylinder housing (1) and cylinder rod eye.

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RIPPER LIFT AND PITCH CYLINDERS

23. INSPECTION AND REPAIR

1. It is recommended that all new O-rings, wear rings, seals and wiper ring be installed when the cylinder is disassembled.
2. Wash all parts in a solvent and air dry. Lubricate machined surfaces of usable parts to protect them.
3. Inspect the cylinder housing for roundness throughout its length. If a tight spot is noticed when removing the piston, the area of binding should be given particular attention. A cylinder housing that is out-of-round should be replaced.
4. Check the cylinder housing and piston rod for scratches or grooves. Shallow scratches can be polished out with fine emery cloth and oil so a smooth surface is presented to the packing.
5. Inspect all sealing ring grooves for scratches, burrs or other damage. "Dress-up" grooves or replace as necessary.
6. Inspect tapped holes for damaged threads.
7. If the housing or rod eye bushings were removed, remove all rust, scale or paint from the bushing bore.

24. REASSEMBLY (Refer to Fig.'s 10C.36 and 10C.37)

1. Position cover (17) onto cylinder rod (18).

IMPORTANT: *Outer end gland is determined as bolts end and inside end as facing piston.*

2. Coat bores and grooves of gland (11) with fresh grease. Install seal ring (14) by squeezing the side of the seal together and starting the seal into the groove. Then work the remainder in with the thumbs. DO NOT use a screwdriver as it will damage the seal.
3. Install O-ring with buffer ring (13), notched edge facing in, into gland (11) and follow with wear ring (12). Install O-ring with backup ring (10) and wiper ring (15) into gland (11). Slide gland (11) onto rod (18), tapped holes toward rod eye.
4. Install piston seal (8) onto piston (9). Install O-rings (7) and wear rings (6) on each end of piston (9). Install piston (9) onto rod (18). Secure with washer (5) and nut (4). Clamp rod assembly into press as shown in Fig. 10C.40. Using a multiplier and torque the nut to 3240 [Nm].
5. Secure cylinder housing (1) to hoist frame. Attach hoist to rod eye and lower rod assembly into housing (1) using extreme care not to damage wear rings (6) and piston seal (8). Once piston has entered housing, drive rod 1/2 stroke.
6. Tie cover (17) to rod eye to provide working clearance. Start gland (11) into housing (1) and drive in just below lock ring groove in housing. Install lock ring (16) into housing groove. Insert two puller bolts 1/2"NC x 1-3/4" with nuts (Fig. 10C.41) and thread into gland. Tighten nuts to draw gland up against lock ring (16). Remove puller arrangement and lift cover (17). Coat inner cylinder housing surface over the gland with high temperature type 230 HHT grease 1 [mm] in thickness. Secure cover (17) to gland (11) and torque the bolts with washer to 75 - 90 [Nm].
7. If removed, press new bushings (2 and 19) to cylinder housing (1) and to cylinder rod (18).

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RIPPER LIFT AND PITCH CYLINDERS

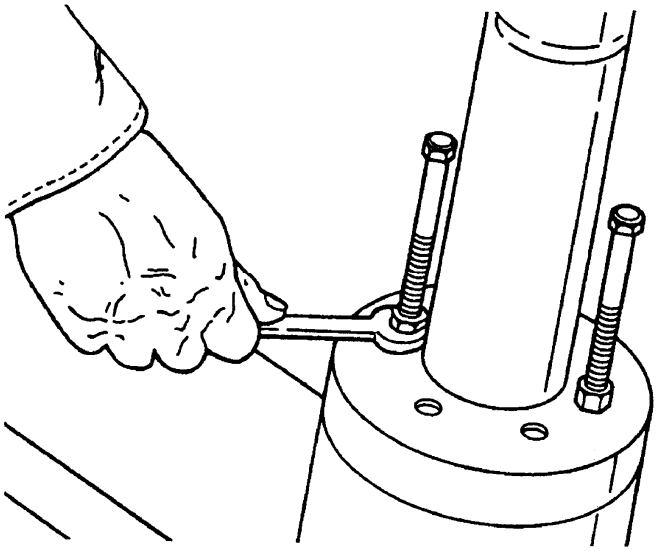

Fig. 10C.41. Seating Gland with Lock Ring

25. INSTALLATION

Ripper Lift Cylinder Installation

1. Attach a hoist to the lift cylinder, position housing eye to frame (4, Fig. 10C.34). Install pin and secure with plate and hardware.
2. Position cylinder rod eye in toolbeam (8). Install pin (6) and secure with plate and hardware.
3. Connect rod end hose (3) and head end tube (2) with tube clamp to cylinder (9).
4. Remove the securing from fixed pitch cylinder and position rod eye in toolbeam (8). Install pin (7) and secure with plate and hardware.
5. Connect rod end hose (10) and head end tube (12) with tube clamp to pitch cylinder (11).
6. Vent the hydraulic system and add oil as necessary, refer to OPERATOR'S MANUAL. Visually check for oil leakage.
7. Cycle cylinder a few times and recheck cylinder cover bolts torque.

Installation Ripper Pitch Cylinder

1. Attach a hoist to the pitch cylinder, position housing eye to frame (4, Fig. 10C.35). Install pin (1) and secure with plate and hardware.
2. Position cylinder rod eye in toolbeam (8). Install pin (7) and secure with plate and hardware.
3. Connect rod end hose (10) and head end tube (12) with tube clamp to pitch cylinder (11).
4. RIGHT PITCH CYLINDER ONLY: Install indicator rod (5) to the rod eye and cylinder housing.
5. Vent the hydraulic system and add oil as necessary, refer to OPERATOR'S MANUAL. Visually check for oil leakage.
6. Cycle cylinder a few times and recheck cylinder cover bolts torque.

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RIPPER PIN PULLER CYLINDER

26. REMOVAL (Refer to Fig. 10C.42)

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate proper installation.*

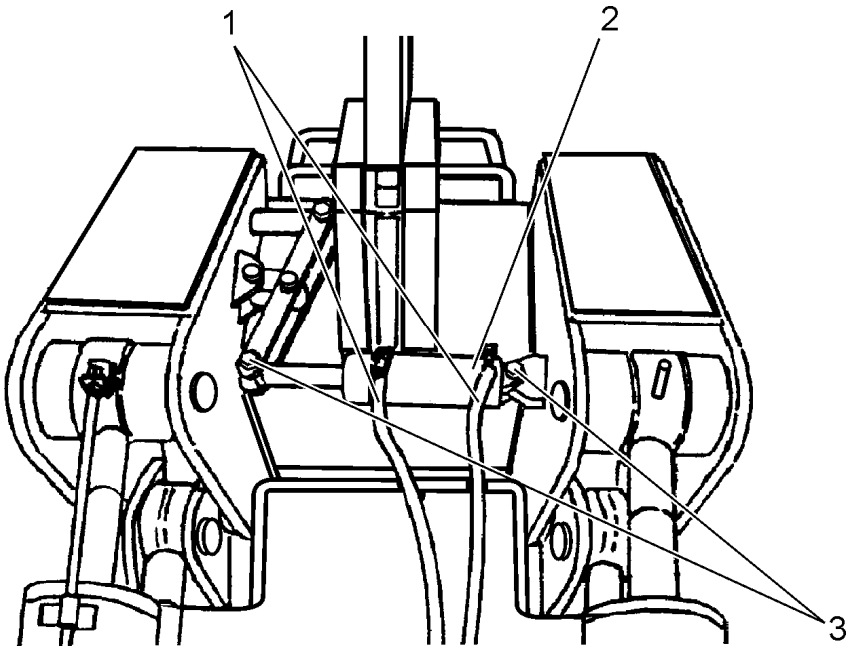

Fig. 10C.42. Pin Puller Cylinder Removal

1. Cylinder Hoses
2. Pin Puller Cylinder
3. Mounting Bolts

1. Disconnect cylinder hoses (1) from cylinder (2).
2. Remove bolts (3) and remove pin puller cylinder (2) from ripper.

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RIPPER PIN PULLER CYLINDER

27. DISASSEMBLY (Refer to Fig.'s 10C.43 and 10C.44)

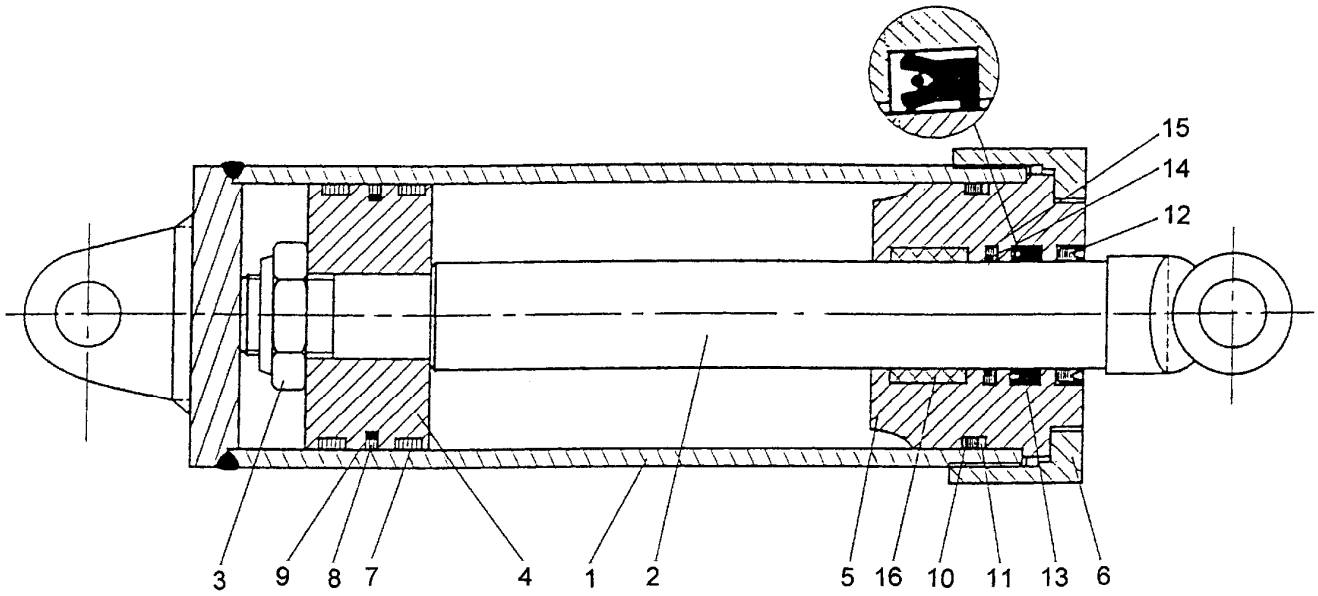

Fig. 10C.43. Cross Section View of Pin Puller Cylinder

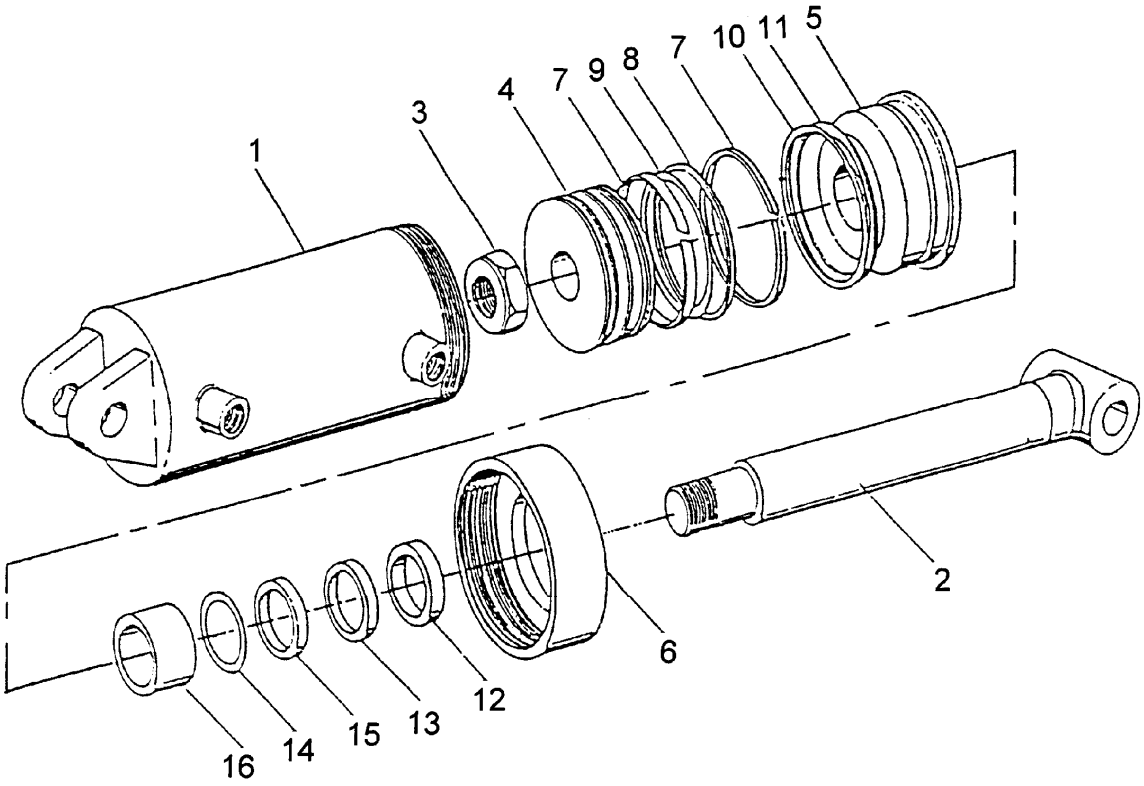

Fig. 10C.44. Exploded View of Ripper Pin Puller Cylinder

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RIPPER PIN PULLER CYLINDER

Legend For Fig.'s 10C.43 and 10C.44

1. Cylinder Housing	5. Cylinder Gland	9. O-Ring	13. Seal Ring
2. Cylinder Rod	6. Housing Nut	10. O-Ring	14. O-Ring
3. Piston Nut	7. Wear Ring	11. Backup Ring	15. Buffer Ring
4. Piston	8. Piston Seal	12. Wiper Ring	16. Wear Ring

1. Steam clean or wash cylinder with solvent before disassembling.
2. Secure cylinder housing in holding device. Remove nut (6) from cylinder housing (1). Pull rod (2) with internal components out of cylinder housing.
3. Clamp rod in holding device. Remove nut (3) and slide piston (4) off of rod (2).
4. Remove wear rings (7), piston seal (8) and O-ring (9) from piston (4).
5. Slide gland (5) off of rod (2). Remove wiper ring (12), backup ring (11), O-ring (10), seal ring (13), buffer ring (14), O-ring (15) and wear ring (16) from gland (5).
6. Discard all software (O-rings, seals etc.) and replace with new seal kit. Check cylinder housing for roundness throughout its length and if out of round, replace. Check all parts for scores, nicks or scratches and replace as necessary. Shallow scratches can be polished out with a fine emery cloth.

28. REASSEMBLY (Refer to Fig.'s 10C.43 and 10C.44)

1. Coat bores and grooves of gland (5) with fresh grease. Install seal ring (13) by squeezing sides of seal together and starting seal into the groove. Then work remainder in with thumbs. DO NOT use a screwdriver as it will damage seal. Install O-ring (14), buffer ring (15), wear ring (16), backup ring (11) and O-ring (10). Install wiper ring (12), lips facing out, into gland (5).
2. Install O-ring (9), seal ring (8) and wear ring (7) onto piston (4).
3. Position nut (6) on rod (2). Slide gland (5) and piston (4) on rod (2) and secure with nut (3). Torque nut to 135 - 175 [Nm].
4. Install rod (2) into housing until piston enters housing. Insert rod cylinder bottom. Thread nut (6) to cylinder housing (1). Torque nut to 1080 - 1150 [Nm].

29. INSTALLATION (Refer to Fig. 10C.42)

1. Install cylinder (2) to ripper and secure with bolts (3).
2. Connect hoses (1) to cylinder (2).
3. Vent the hydraulic system and add oil as necessary, refer to the OPERATOR'S MANUAL. Visually check for oil leakage.
4. Cycle cylinder a few times and recheck nut torque.

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CYLINDERS

BLADE TILT CYLINDER (G-2)

30. REMOVAL, INSTALLATION AND SERVICE

Removal, installation and service of the blade tilt cylinder (G-2) is similar to the blade tilt cylinder shown in this Section.
Details for blade tilt cylinder (G-2) can be found in relevant Sections of PARTS CATALOGUE and OPERATOR'S MANUAL.

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SECTION 10E

RESERVOIRS AND FILTERS

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RESERVOIRS AND FILTERS

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5. REASSEMBLY 5
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HYDRAULIC RESERVOIR

1. DESCRIPTION (Refer to Fig. 10E.1)

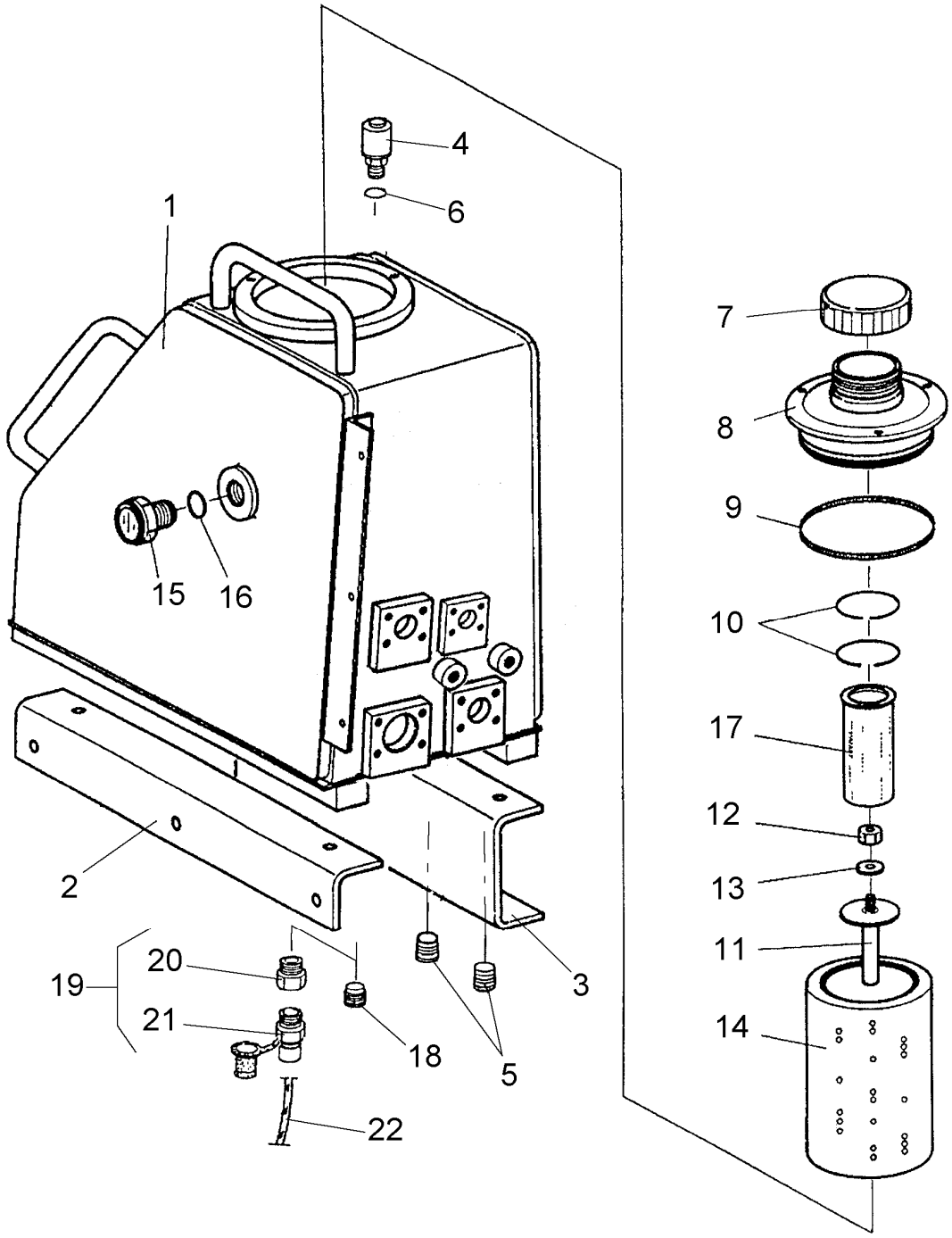

Fig. 10E.1. Exploded View of Hydraulic Reservoir

1. Hydraulic Reservoir
2. Bracket
3. Bracket
4. Breather Valve
5. Plug
6. O-Ring
7. Filler Cap
8. Reservoir Cover
9. O-Ring
10. Strainer Retaining Ring
11. Tube
12. Nut
13. Washer
14. Strainer
15. Sight Gauge
16. O-Ring
17. Filler Strainer
18. Magnetic Plug
19. Ecology Oil Drain Valve
20. Hydraulic Connector
21. Drain Valve
22. Drain Hose

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RESERVOIRS AND FILTERS

HYDRAULIC RESERVOIR

The reservoir is bolted to the right fender next to the fuel tank. It is a one piece welded assembly (1) with strainer (14), filler strainer (17), breather valve (4), magnetic plug (18) or drain valve (19), sight gauge (15) and various parts for suction lines.

The reservoir acts as a storage tank for the majority of the dozer equipped hydraulic system oil. The remainder of oil fills the lines and system components. The breather valve (4) protects the pumps from the cavitating as well as maintaining pressure in the reservoir. Refer to the OPERATOR'S MANUAL for service of this valve.

2. REMOVAL

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lever is in NEUTRAL position, drive train lock lever is in ON position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic caps. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate proper installation.*

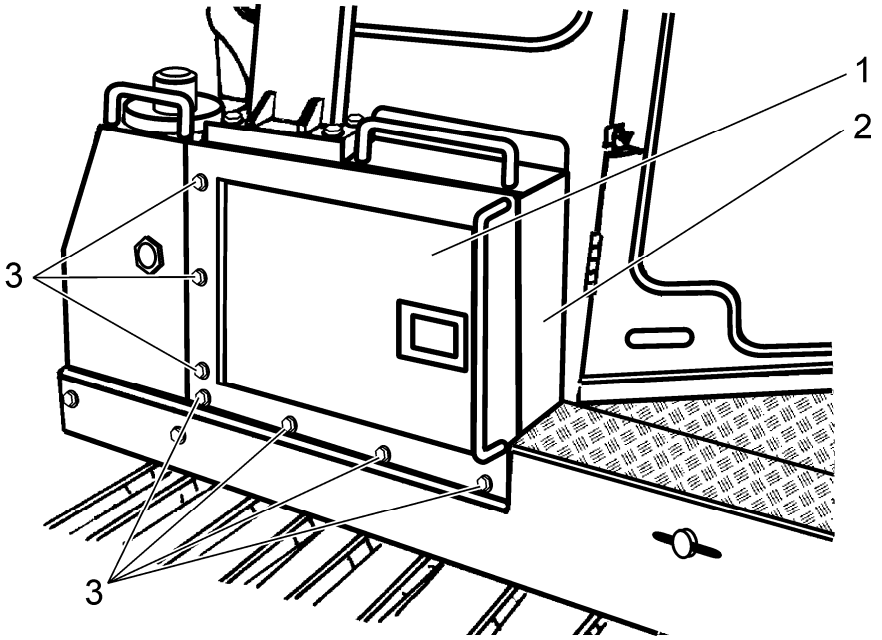

Fig. 10E.2. Disassembly R.H. Enclosure

1. R.H. Door
2. R.H. Enclosure
3. Bolts

1. Drain the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
2. Disconnect wire harness of rear lamp.
3. Unscrew bolts (3, Fig.10E.2) and remove R.H. enclosure (2) with R.H. door (1).

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HYDRAULIC RESERVOIR

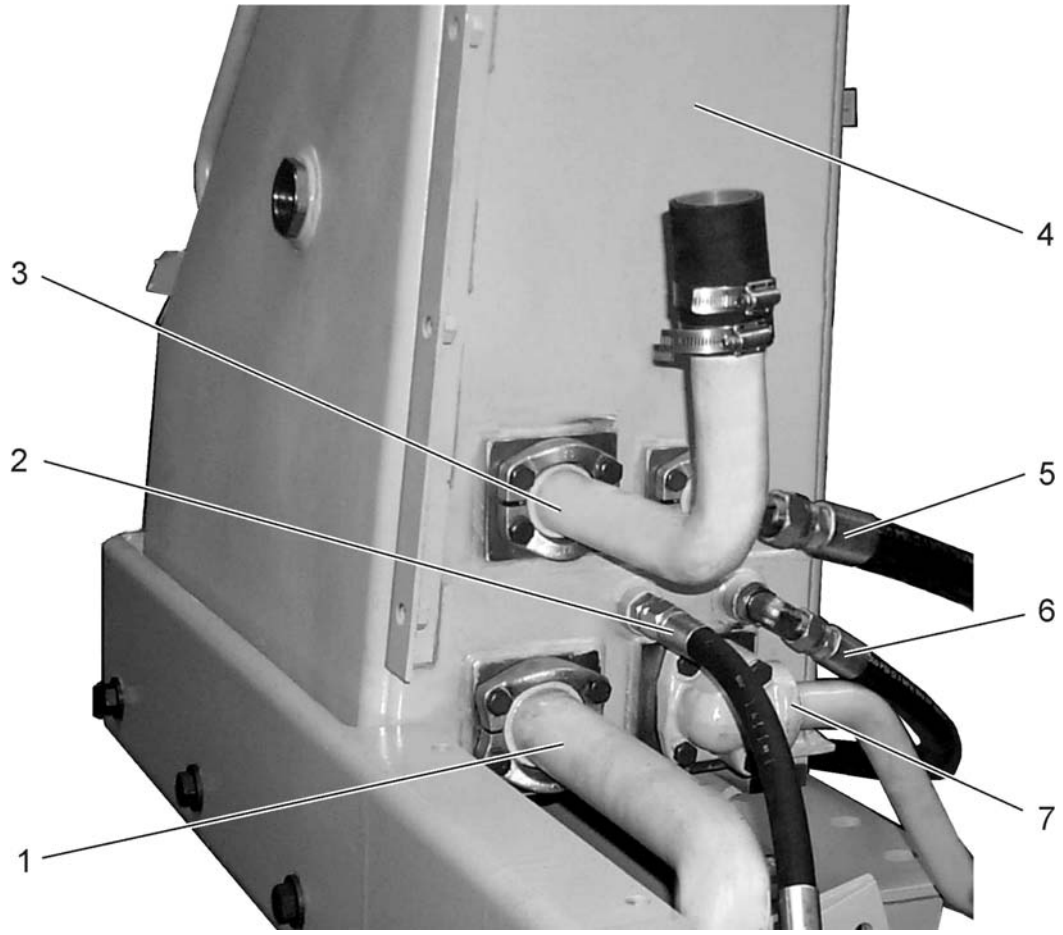

Fig. 10E.3. Hydraulic Reservoir Disconnecting Points

1. Suction Tube (to Equipment Pump)
2. Return Hose
3. Return Tube (from Equipment Return Filters)
4. Hydraulic Reservoir
5. Return Hose (from Fan Return Filter)
6. Return Hose
7. Suction Tube (to Fan Drive Pump)

4. Disconnect suction tube (1, Fig.10E.3) and return tube (3) from the reservoir (4). Remove and discard old O-rings.
5. Disconnect two return hydraulic hoses (2 and 6), return hose (5) and suction tube (7) from the reservoir (4). Remove and discard old O-rings. Cap the reservoir ports to prevent entry of dirt.
6. Attach a suitable hoist sling to holder mounted on the reservoir (4). Remove reservoir (4) mounting bolts from the bottom of reservoir and lift the reservoir up using the hoist. Remove the reservoir from the machine.

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HYDRAULIC RESERVOIR

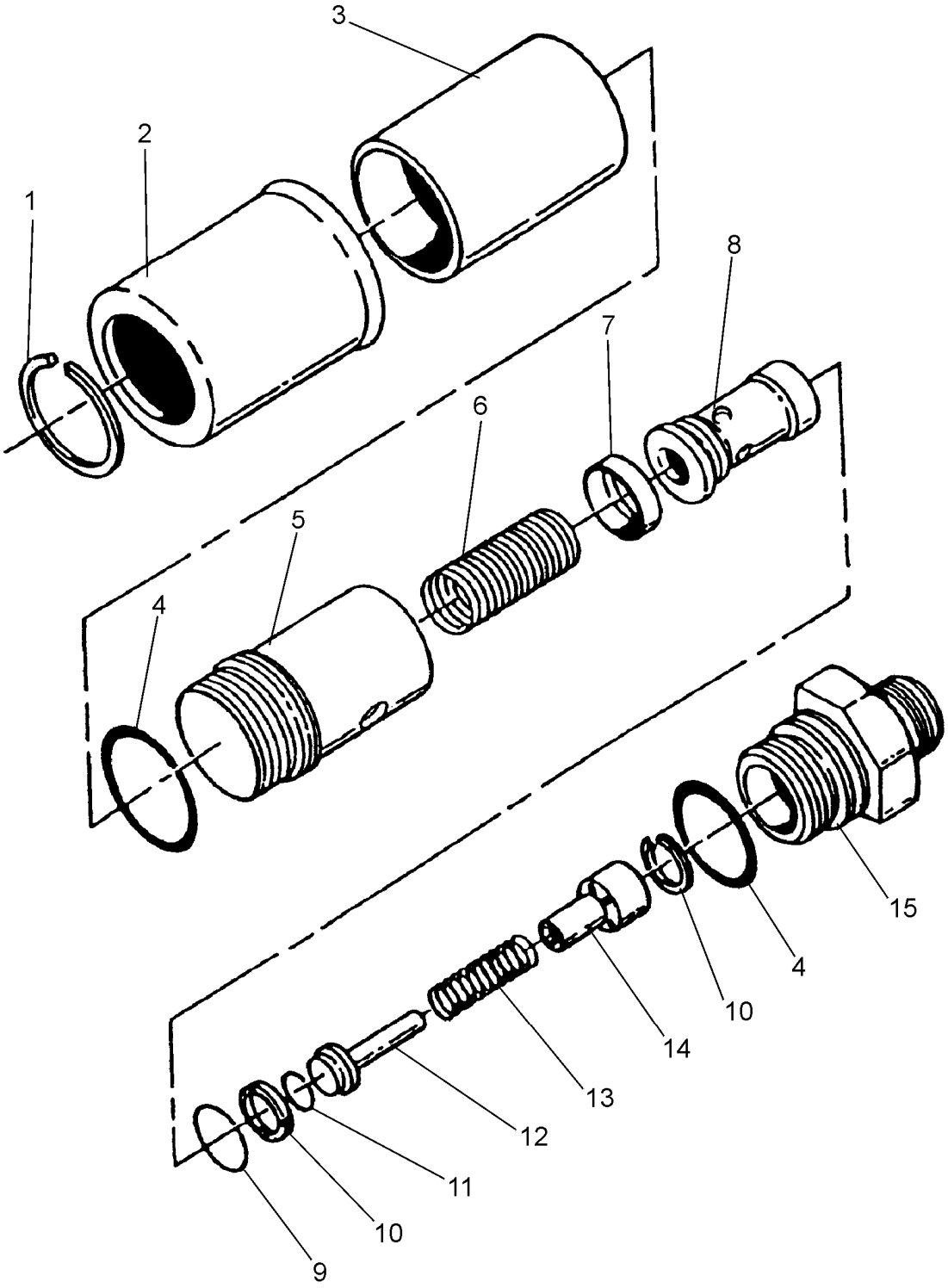

Fig. 10E.4. Exploded View of Vacuum Pressure Relief Valve

1. Retainer Ring
2. Cover
3. Ceramic Filter
4. Gasket
5. Cover
6. Spring
7. Retainer
8. Sleeve
9. O-Ring
10. Ring
11. O-Ring
12. Poppet
13. Poppet Spring
14. Poppet Guide
15. Valve Housing

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HYDRAULIC RESERVOIR

3. DISASSEMBLY (Refer to Fig. 10E.1)

1. Remove the breather valve (4).

If necessary, disassemble the component parts of the breather valve (4) in the sequence indicated by the reference numbers in Fig. 10E.4.

2. Remove the upper strainer snap ring (10) and filler strainer (17).
3. Unscrew three bolts securing cover (8) and remove the cover (8) with snap ring (10) and O-ring (9). If necessary, remove the lower strainer snap ring (10) and O-ring (9) from cover (8).
4. Unscrew nut (12) with washer (13) and remove the strainer assembly (14).
5. Unscrew the sight gauge (15) with O-ring (16), if necessary.
6. Unscrew the plugs (5) from the reservoir (1), if necessary.

4. INSPECTION AND REPAIR

1. It is recommended that all new O-rings be installed when the reservoir is disassembled.
2. Before cleaning the reservoir, inspect the residue in the tank. Check for deposition of foreign particles that could indicate a component failure of system.
3. Clean and dry all parts thoroughly. Clean the strainers (14 and 17, Fig. 10E.1) in a suitable solvent and air dry.
4. Inspect the reservoir and all fittings for signs of wear or damage.
5. Be sure all parts move freely in the breather valve. Clean or replace the breather valve ceramic filter (3, Fig. 10E.4).
6. Check the springs (6 and 13, Fig. 10E.4) for damage, distortion or weakens.

5. REASSEMBLY (Refer to Fig. 10E.1)

1. Install the plugs (5) to reservoir (1), if removed.
2. Install the sight gauge (15) with O-ring (16), if removed.
3. Install the strainer assembly (14) inside the reservoir (1) and secure with washer (13) and nut (12).
4. Install the O-ring (9) and lower strainer snap ring (10) to cover (8), if removed.
5. Install the cover (8) with O-ring (9) and lower snap ring (10) to the reservoir (1). Secure the cover (8) with three bolts.
6. Install the filler strainer (17) and upper strainer snap ring (10) to the cover (8).
7. Install the breather valve (4).

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RESERVOIRS AND FILTERS

HYDRAULIC RESERVOIR

6. INSTALLATION

1. Attach a hoist sling to holder mounted on the reservoir (4, Fig. 10E.3) and position the hydraulic reservoir on rear of the machine. Secure the reservoir (4) with the bolts previously removed.
2. Reconnect suction tube (7), return hose (5) and two return hydraulic hoses (2 and 6) to the reservoir (4).
3. Reconnect suction tube (1, Fig.10E.2) and return tube (3) to the reservoir (4).
4. Reinstall R.H. enclosure (2, Fig. 10E.2) with R.H. door (1) and secure it with bolts (3).
5. Reconnect wire harness of rear lamp.
6. Fill the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
7. Start the engine, move the hydraulic controls in all directions and visually check hoses and connections for leakage, check oil level and add oil if needed.

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SECTION 12

POWER

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POWER

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1. DESCRIPTION

The machine is powered by Cummins QSX15-C, 6-cylinder, heavy duty, turbocharged with charge air cooler (CAC) diesel engine. This engine is a low speed, four cycle, four valve per cylinder type, using a 24 [V] direct starting system. The engine has integrated fuel system module (IFSM), high pressure injection (HPI) direct injection fuel system. For further information on a subject of the engine refer to the Engine Operation and Maintenance Manual QSX15 Engines, Bulletin No 3666423; Troubleshooting and Repair Manual QSX15 Engines, Bulletin 3666239 and Troubleshooting and Repair Manual Electronic Control System QSX15 Engines, Bulletin No.3666259.

2. SPECIFICATIONS

Special Bolt and Nut Torque Data

Air precleaner mounting clamp . . . . . 14 – 20 [Nm]

Air cleaner hose clamps . . . . . 10 – 12 [Nm]

Air intake bumper hose clamps . . . . . 7 – 9 [Nm]

Alternator terminals:

- No.10-24 ground terminal . . . . . 1.7 – 2.8 [Nm]
- ¼" -28 positive terminal . . . . . 6 – 8 [Nm]

Battery terminals . . . . . 34 – 42 [Nm]

Cranking motor:

- No.10-32 switch terminal . . . . . 1.8 – 3.4 [Nm]
- ½" -13 ground terminal . . . . . 27 – 35 [Nm]
- ½" -13 battery terminal . . . . . 27 – 35 [Nm]

Engine front mounting bolts to frame . . . . . 800 – 900 [Nm]

Engine rear mounting bolts to frame . . . . . 800 – 900 [Nm]

Torque converter to flywheel housing bolts . . . . . 100 – 120 [Nm]

Gear ring to the flywheel housing . . . . . 115 – 125 [Nm]

Air conditioner compressor bolts to bracket . . . . . 55 – 65 [Nm]

(Torques given are for bolts and nuts lubricated with SAE-30 engine oil.)

NOTE: *Except for the special torques shown, all bolts and nuts are to be given a standard torque. Refer to the „STANDARD TORQUE DATA CHART" in Section 1, „GENERAL."*

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3. AIR INDUCTION SYSTEM TEST

1. Remove the end cover from the air cleaner. Remove both filter elements from the air cleaner. See Operator's Manual.
2. Using duct tape, mask outside diameter of the safety (small) element. Sealing must be air tight. Reinstall the tapped element only and end cover.
3. Remove the air cleaner warning light switch (1, Fig. 12.1). Tee in a 0 to 100 [kPa] pressure gauge.
4. Remove the plug (3) from the air intake connection (2). Connect a manually regulated compressed air supply.
5. Adjust the air regulator until the pressure gauge registers 20 [kPa]. If pressure cannot be reached, it may be necessary to rotate the engine crankshaft over slightly until a minimal leakage occurs past the engine valves.

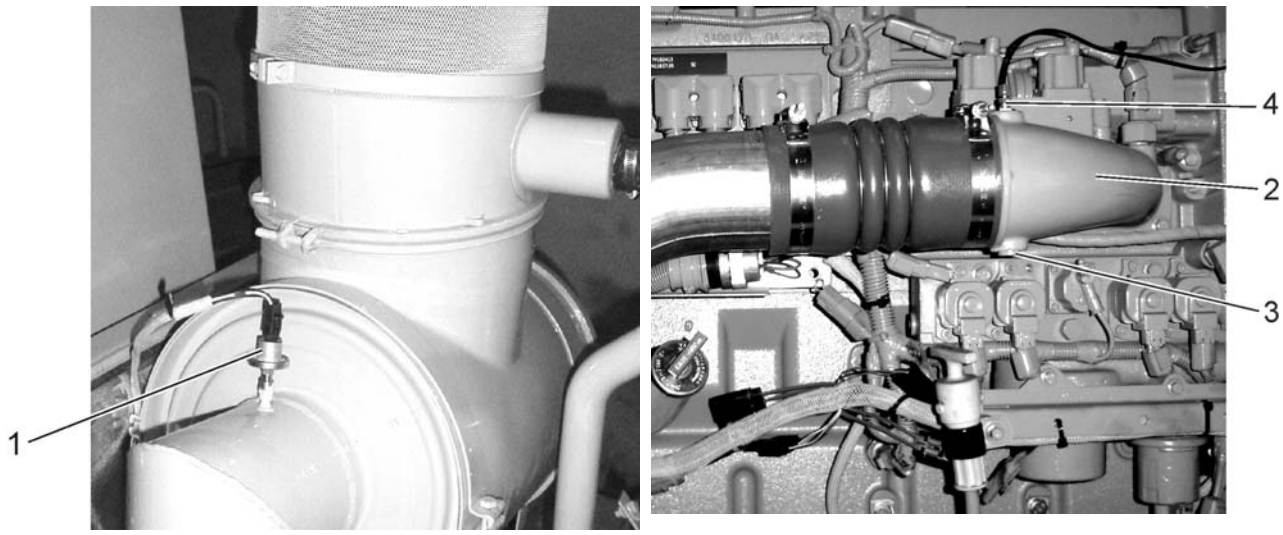

Fig. 12.1. Air Induction System Service Points

1. Air Cleaner Warning Light Switch
2. Air Intake Connection
3. Plug (M14x1.5)
4. Ether Injector Nozzle

6. Using a soap solution and a paint brush, coat the following places and check for leaks (Fig. 12.2):
   a. Air cleaner body surfaces around the outlet tube connections.
   b. Air cleaner restriction indicator warning light switch to air cleaner.
   c. All clamped hose connections between air cleaner outlet, including connections at turbocharger, charge air cooler (CAC) to intake manifold flange.
7. No leakage is permitted between the air cleaner and suction side of the turbocharger and between turbocharger outlet elbow, charge air cooler and intake manifold flange. If leakage at the joints is detected, tighten hose clamps. If leakage still persists, remove the parts to determine cause. Inspect and replace worn parts as necessary and retest.
8. Remove the filter element and remove the duct tape. Inspect the seals for damage. Reinstall both elements and the end cover.

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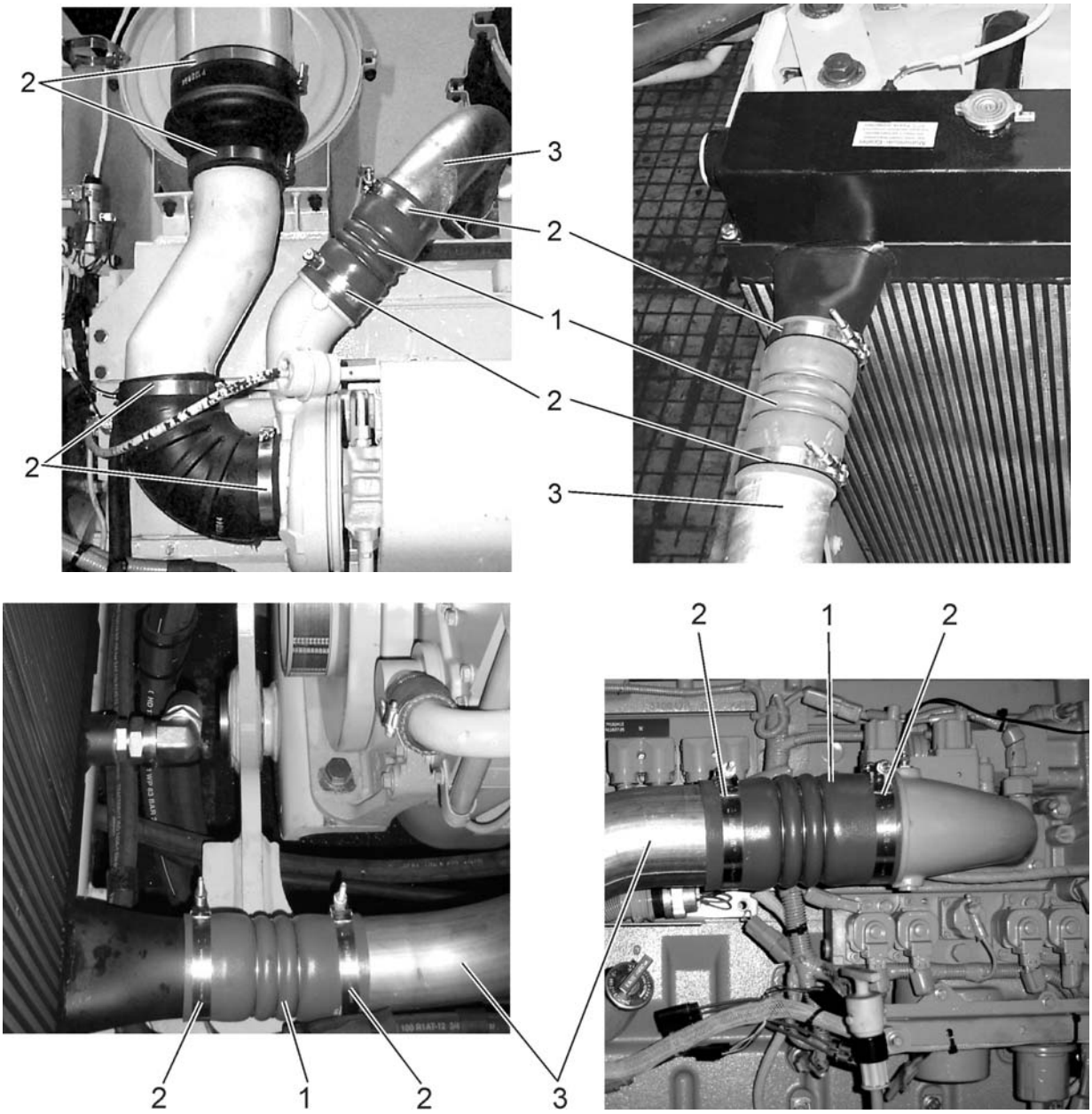

Fig. 12.2. Engine Charge Air Cooler (CAC) Connection Check Places

1. Bumper Hose
2. Clamps
3. Air Transfer Tubes

Charging system restriction flow test

1. Perform the charge air cooler system performance tests with engine running:
   - check pressure drop test (internal flow air restriction)
   - ambient and intake air temperature differential (efficiency of cooling system)

   due to significant influence for the engine performance, durability and emission compliance. For detailed procedure, refer to Engine Manual.

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4. CONTROLS ADJUSTMENTS

WARNING! The following checking and adjusting procedures are to be performed with the engine stopped unless otherwise stated. Whenever it is necessary to have the engine running, be sure the neutral lock lever and the brake pedal are locked in applied position.

ENGINE NOT RUNNING ADJUSTMENTS (Refer to Fig. 12.3)

Engine Control Adjustments – (mechanical parts)

General

NOTE: *Engine speed control lever must be adjusted correctly before checking operation of decelerator.*

Before performing the adjustments, remove all dirt accumulation from the control linkage. Check and replace worn parts (i.e. pins, flexible connections, ball joints, springs) if required.

After adjustment has been performed, machine must be checked out in actual operation for proper functioning.

WARNING! For your personal protection never perform unassisted any adjustments with engine running. Always have another experienced person helping in the operator's compartment when adjustments must be done with the engine running.

WARNING! When removing or installing the measuring equipment, or during measuring engine speed, be careful not to touch any high temperature parts or rotating parts.

1. Remove the center floor plate in operator's compartment.
2. Disconnect wire harness connector (18) from the potentiometer (17).
3. Remove bolts (11) and remove bracket (25) with control elements from under the pod.
4. Check that the nuts (10) are not loosen. Remove pin (12) and (21).
5. Check that the plate (16) and potentiometer (17) are not loosen.
6. Check that the control lever (1) is moving without restriction from forward (LO) to backward (HI) position.
7. Check that the potentiometer control lever (19) is mounted properly and rocking angle is equal in both sides in relation to the vertical axle (app. 25 degree either side). Adjust as required.
8. Move control lever (1) in forward position (LO). Loosen lock nut (14). Adjust length of control rod (15) with clevis (13) to align the holes. Install clevis (13) to the intermediate lever (20), with the pin (12). Tighten the lock nut (14).
9. Install pin (21), position control lever (1) in rear position (HI).
10. Loosen lock nuts (9). Check and adjust the cable (26) with link (8) to 0.0 [mm] gap at point "D". Tighten the lock nut (9).

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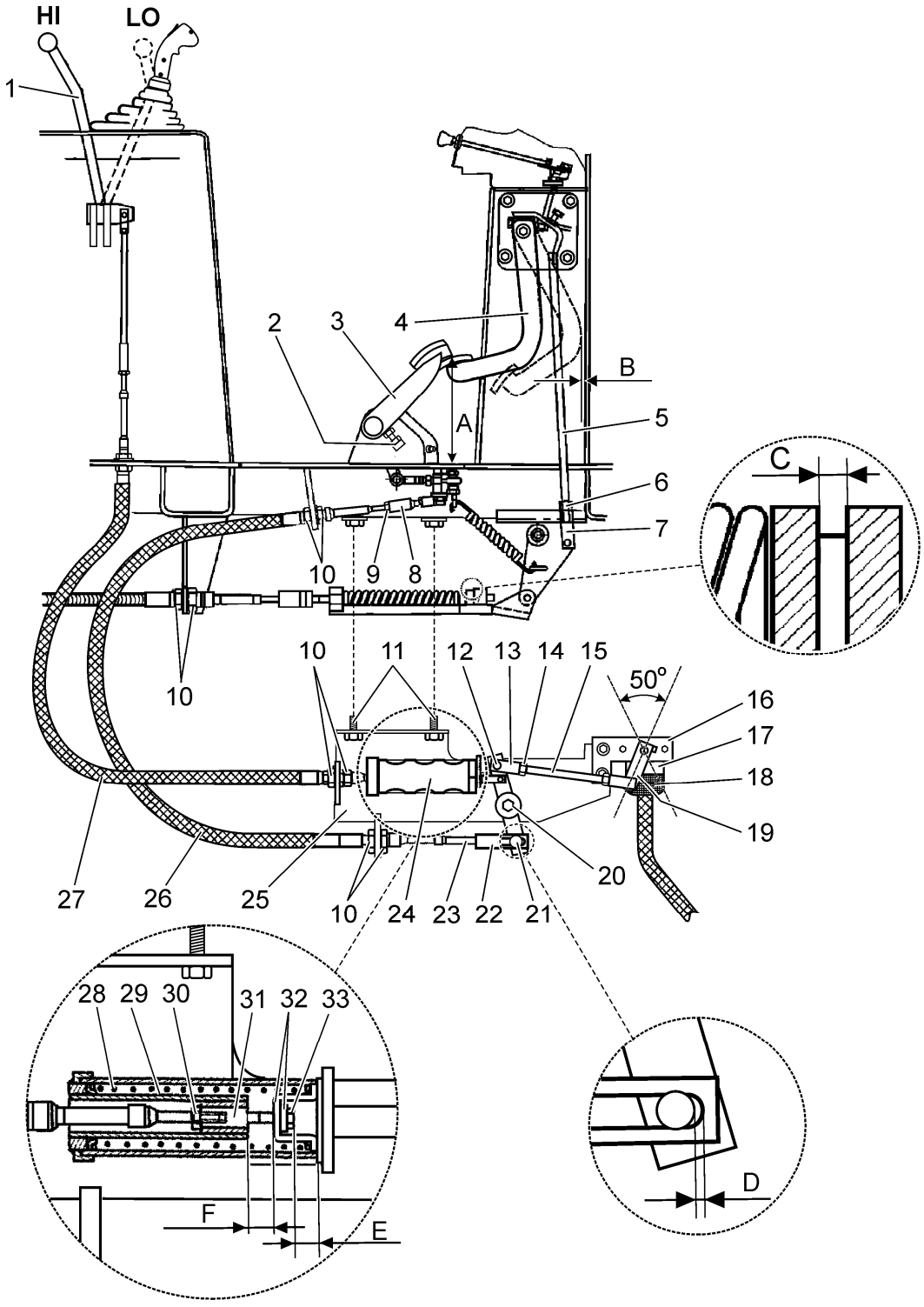

Fig. 12.3. Engine Controls

1. Control Lever
2. Adjusting Bolt
3. Decelerator Pedal
4. Brakł Pedal
5. Control Rod
6. Lock Nut
7. Clevis
8. Link
9. Lock Nut
10. Nuts
11. Bolts
12. Pin
13. Clevis
14. Lock Nut
15. Control Rod
16. Plate
17. Potentiometer
18. Wire Harness Connector
19. Control Lever
20. Intermediate Lever
21. Pin
22. Clevis
23. Lock Nut
24. Spring Enclosure
25. Bracket
26. Control Cable
27. Control Cable
28. Spring
29. Bushing
30. Lock Nut
31. Link
32. Washer and Cup
33. Nut

A. Dimension 185 to 188 [mm]
B. Gap 6 [mm]
C. Gap 2 - 3 [mm]
D. Gap 0.0 [mm]
E. Dimension 19.5 [mm]
F. Dimension 10.5 [mm]

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NOTE: *Force to depress decelerator pedal (3) should be 63 to 77.5 [N]. If the force is out of specification replace decelerator pedal control cable (26) and check operation. If the system is still operating improperly, loosen nut (10) and disconnect a spring enclosure (24) from the intermediate lever (20). Remove control cable (27) from the bracket (25). Remove end plate of spring enclosure (24). Remove nut (33), washer and cup (32). Remove end of the control cable (27) from the bushing (29). Remove spring (28) and check the spring free length for 336 [mm], replace if damaged or worn. Install the spring (28) in to the spring enclosure (24). Install cup and washer (32) with nut (33). Check "F" dimensions for 10.5 [mm] and "E" for 19.5 [mm], relocate link (31) and tighten lock nut (30) to obtain these dimension if necessary. Reassemble end plate of spring enclosure (24). Reassemble control cable (27) to the bracket (25), torque the nut (10) to 60 to 80 [Nm]. Reassemble the spring enclosure (24) to the intermediate control lever (20). Perform adjustment as described above step 2 to 9.*

11. Reinstall bracket (25) to pod with bolts (11). Reconnect wire harness connector (18) to the potentiometer (17).

Brake pedal adjustment

1. Depress brake pedal (4) to obtain gap "B" 6.0 [mm] between the pedal arm and instrument panel console wall. In this position brake spool of the steering valve (Refer to SECTION 7E) should be fully moved out. If the brake spool is not fully moved out, loosen lock nut (6) and make adjustment of rod (5) with clevis (7). Tighten lock nut (6).
2. Press brake pedal (4) to the resist. Check if "C" gap 2 to 3 [mm] is obtained.
3. Release brake pedal (4) and check "A" dimension (between floor and pedal center top) which should be 185 to 188 [mm]

Engine Running

1. With control lever (1) in the forward position (LO), check to make sure engine is running at designated low idle speed 700 - 800 [RPM].
2. With control lever (1) in the rearmost position (HI), check to make sure engine is running at designated high idle speed 2000 - 2200 [RPM].
3. If designated speed is not reached, check the wire harness and potentiometer resistances as described below in ENGINE CONTROL POTENTIOMETER CIRCUIT CHECK-IN.
4. Place control lever (1) in the rearmost position (HI). Adjust decelerator pedal adjusting bolt (2) so that when decelerator pedal (3) is pressed 40 [mm], specified decelerated engine speed is obtained 1100 - 1200 [RPM]. Stop the engine.

ENGINE CONTROL POTENTIOMETER CIRCUIT CHECK-IN (electrical parts)

General

Before performing the potentiometer circuit check, turn key to the "ON" position. Check that there are not throttle position sensor fault code(s) (refer to Troubleshooting Fault Codes in Troubleshooting and Repair Manual Electronic Control System QSX15 Engines, Bulletin No.3666259.

Inspect visually wire harness and connectors for damaged pin(s). Dry connector by using electrical contact cleaner P/N 3824510.

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1. Measure the resistances of potentiometer circuit (3, Fig. 12.4), 50 pin connector (1) is as follows (refer to wiring diagram):
   - from pin No. 48 to pin No. 47 - 2000 to 3000 [Ω]
   - from the supply and the signal:
   - from pin No. 47 to pin No. 49 control lever position - low RPM 1500 to 3000 [Ω]
   - from pin No. 47 to pin No. 49 control lever position - high RPM 250 to 1500 [Ω]
   - from pin No. 47 to engine block ground – more than 100K [Ω]
   - from pin No. 48 and 49 to all pins of 50 and 31-pins connectors – more than 100K [Ω]

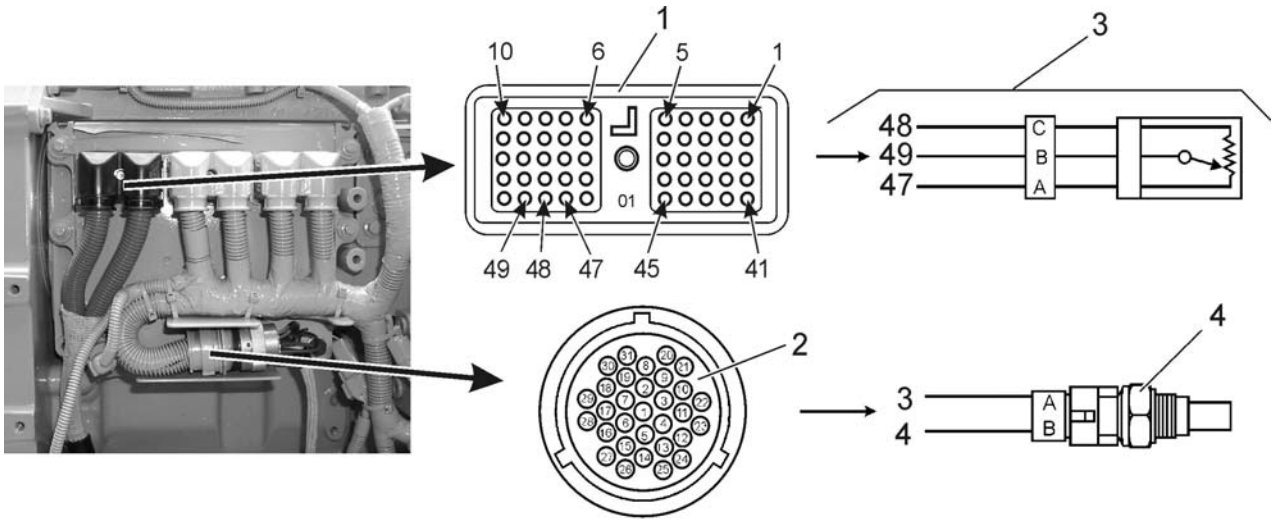

Fig. 12.4. Engine Control Interface Connectors

1. 50 Pin Connector (view of harness connector)
2. 31 Pin Connector
3. Potentiometer Circuit
4. TC Oil Temperature Sensor
5. Pin No 48 + 5VDC Supply
6. Pin No 49 Signal
7. Pin No 47 Return

After checking has been performed, machine must be checked out in actual operation for proper functioning.

NOTE: *If potentiometer is changed or after calibration downloaded move the control lever (1, Fig. 12.3) (key switch ON) thought its complete travel 3 times. This procedure calibrates the new potentiometer with the ECM.*

NOTE: *If designated engine speeds are not achieved contact with Authorized Cummins Service.*

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5. REMOVAL

1. Position the machine in a place which makes it possible to use a lifting device for lifting of disassembled assemblies.

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF and brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

2. Turn the electrical master switch to the „OFF" position.

3. Disassemble engine radiator as described in section 6 COOLING SYSTEM.
4. Disassemble rear doors and shields assembly on both side of engine compartment.
5. Disconnect the engine wire harness connectors (1, Fig. 12. 5). Unscrew the nut and remove socket from the bracket. Disconnect the engine potentiometer control wire harness connector (2) and engine speed sensor connector (6). Secure plugs and sockets against dirt and damage.

NOTE: *One of the two engine wire harness connectors is located behind the fuel filter.*

IMPORTANT: *Disconnected electrical connectors must be capped with the correct size plastic cap. Protect connectors from dirt and humidity as this can cause an problems in engine control system.*

6. MACHINES EQUIPPED WITH ETHER INJECTOR: Disconnect the nylon pipe from the nozzle (4, Fig. 12.1) and secure to hood support.

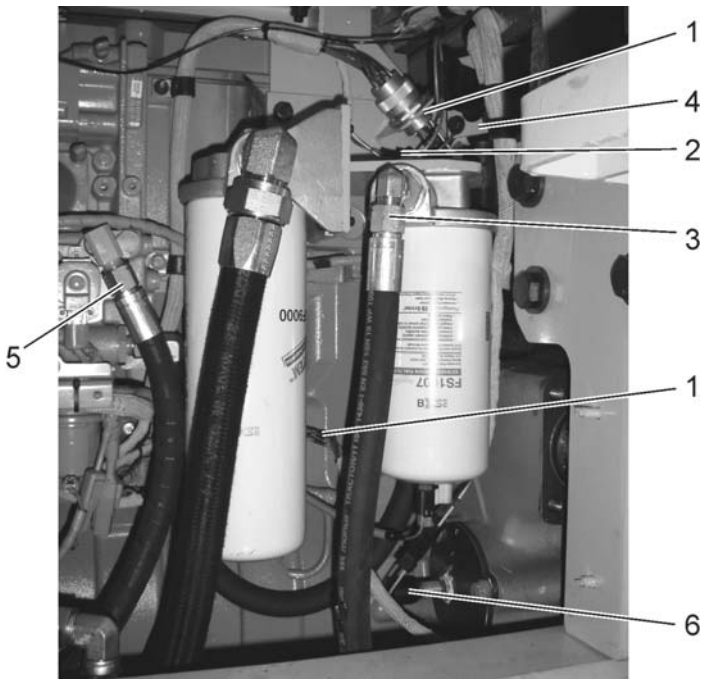

Fig. 12.5. Electrical and Fuel System Disconnecting Points (LH side).

1. Wire Harness Connectors
2. Engine Potentiometer Control Wire Harness Connector
3. Fuel Supply Hose
4. Lifting Bracket
5. Fuel Return Hose
6. Engine Speed Sensor Wire Harness Connector

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7. Close the valve under the fuel tank, remove fuel supply hose (3, Fig. 12.5) from the fuel filter head.

IMPORTANT: *Disconnected hydraulic or fuel lines must be capped with the correct size plastic cap. If these caps are not available, tape or clean rubber corks may be used. Hydraulic or fuel openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic or fuel system components. Also tag all disconnected lines and wires for easier installation.*

8. Remove fuel return hose (5, Fig. 12.5) from the fuel module and secure it to the frame.
9. MACHINES EQUIPPED WITH A/C SYSTEM: Disconnect the connector (1, Fig. 12.6) from the magnetic clutch of the A/C system compressor. Remove A/C compressor and alternator drive belt. Remove bolts (2) securing A/C compressor (3) to the bracket. Remove compressor with attached hoses. Do not disconnect the hoses of the compressor. Disconnecting the hoses causes gas escape out of air conditioner system. Secure disassembled assembly out of the way.

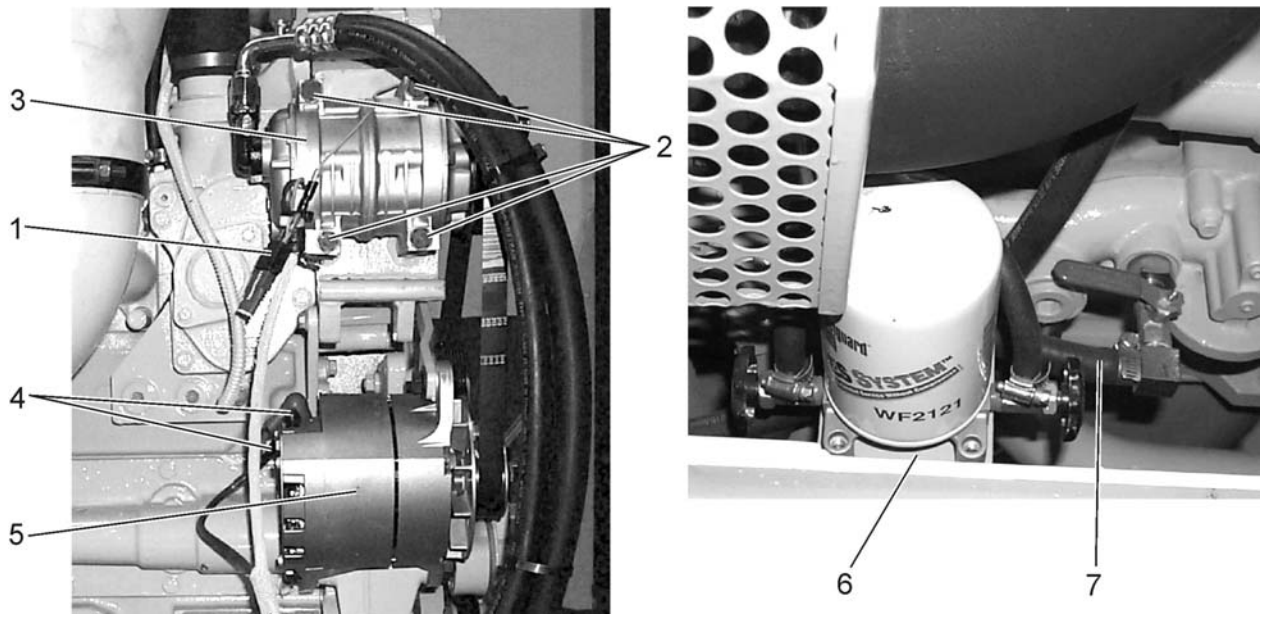

Fig. 12.6. Engine Disconnecting Points (RH front)

1. Wire Connector
2. Bolts
3. A/C Compressor
4. Cables
5. Alternator
6. Coolant Filter Bracket
7. Cab Heater Return Hose

10. Remove cables (4) from the alternator (5). Secure wire harness out of the way.
11. Remove bolts securing coolant filter bracket (6) to frame. Wire bracket to engine.
12. Remove cab heater return hose (7) from valve.

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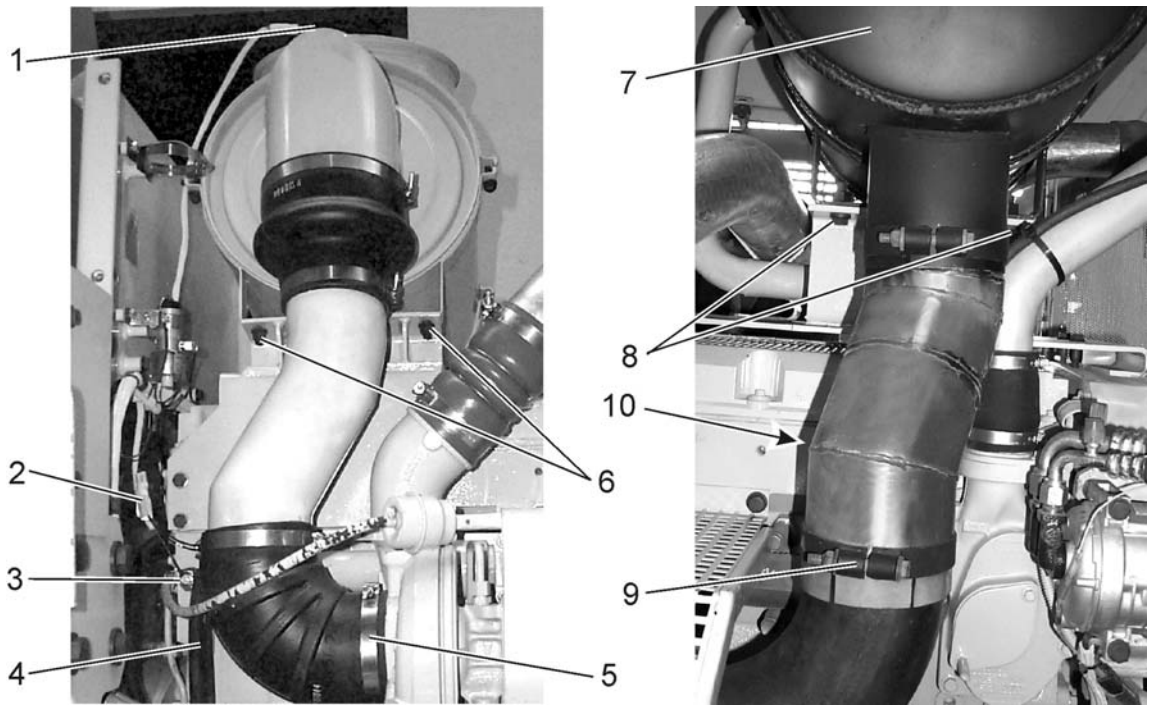

Fig. 12.7. Engine Disconnecting Points (RH rear)

1. Air Cleaner Warning Light Switch
2. Wire Connector
3. Coolant Temperature Sensor
4. Cab Heater Supply Hose
5. Clamp
6. Bolt
7. Muffler Assy
8. Bolts
9. Clamp
10. Lifting Bracket (front)

13. Disconnect the wires connector from air cleaner warning light switch (1, Fig. 12.7). Secure the wire to the hood support.
14. Disconnect the wire connector (2) of the ether solenoid valve temperature switch.
15. Disconnect the wire from the coolant temperature sensor (3).
16. Remove cab heater supply hose (4) from valve.
17. Loosen hose clamp (5), remove air cleaner mounting bolts (6). Remove air cleaner assy out of the way.

IMPORTANT: *Tape or plug turbocharger openings to prevent from entering the dirt or rags.*

18. Loosen tube clamp (9, Fig. 12.7), remove muffler mounting bolts (8). Remove muffler assy (7).
19. Remove the cranking motor cables positive (+), ground (-) (1 and 2 Fig. 12.8), and wire harness (3).

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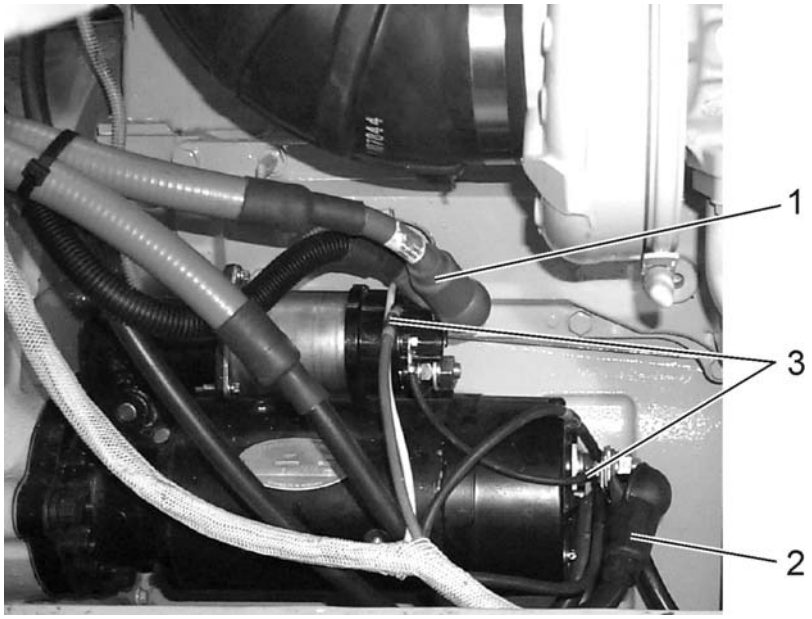

Fig. 12.8. Cranking Motor Disconnecting Points (RH side)

1. Positive Cable (+) 2. Ground Cable (-) 3. Wire Harness

20. Remove floor plate in the cab. Remove the transmission case guard to gain the access to the torque converter fasteners.

WARNING! This procedure requires extreme caution. Use suitable blocking equipment while working under the machine.

21. Remove hose and tube (4, Fig. 12.9) from the drive train system pump. Wire hose in upright position.
22. Remove oil inlet hose (3) from torque converter.
23. Remove torque converter drain hose (5) from the flywheel housing.

Fig. 12.9. Torque Converter Disconnecting Points (bottom side)

1. Fan Drive System Hydraulic Pump
2. Bolt
3. Hose (inlet)
4. Hose and Tube (inlet)
5. Drain Hose (leakage)

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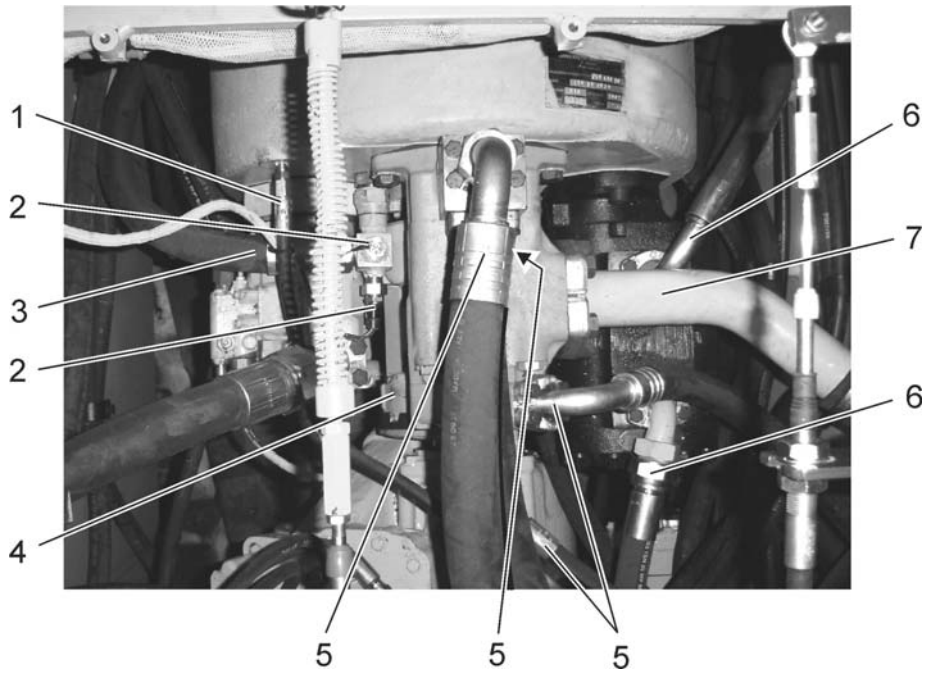

Fig. 12.10. Torque Converter Disconnecting Points (upper side)

1. Vent Hose
2. Oil Temperature Sensors
3. Hose (outlet)
4. Drive Shaft
5. Hoses (outlet)
6. Hoses (outlet)
7. Tube (inlet)

24. Disconnect wires from the oil temperature sensors (2, Fig. 12.10).
25. Remove vent hose (1) from the torque converter.
26. Remove outlet hose (3) from the torque converter.
27. Remove two bolts (2, Fig. 12.9) securing fan drive system pump (1). Separate pump from the plate connector of the torque converter and wire pump to the pod.
28. Remove bolts securing drive shaft (4, Fig. 12.10) to the torque converter output shaft.
29. Drain the hydraulic reservoir as described in Operator's Manual.
30. Remove hoses (5) from the hydraulic pump. Wire hoses in upright position.
31. Remove tube (7) from the hydraulic system pump.
32. Remove hoses (6) from the drive train system pump. Wire hoses in upright position.
33. Unscrew bolts (1, Fig. 12.11) securing front engine bracket (3) to frame.
34. Remove bolts (5) (both sides) and remove bar (4) to gain access to the rear engine brackets.
35. Unscrew bolts securing rear engine brackets (6) to frame on both sides.
36. Install an engine lifting attachment to engine lifting brackets (4, Fig. 12.5) and (10, Fig.12.7).

NOTE*: Engine flywheel housing is critically close to the equalizer bar tunnel. For this reason it is hard to dismount torque converter off engine. We recommend dismounting the engine complete with the torque converter.*

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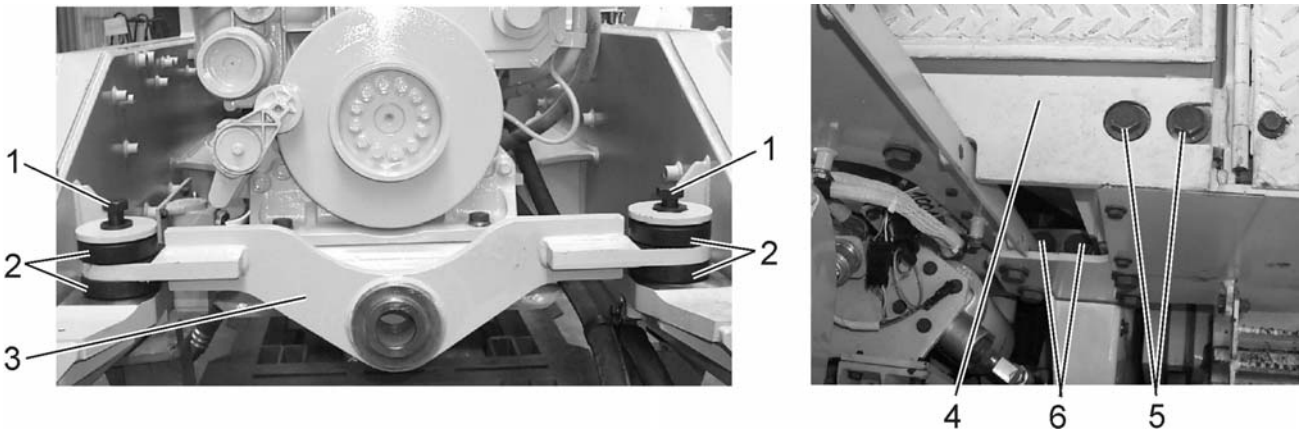

Fig. 12.11. Front and Rear Engine Brackets

1. Bolts
2. Rubber Bushings
3. Front Engine Bracket
4. Bar
5. Bolts
6. Engine Bracket Bolts (rear)

NOTE: *Whenever possible, a load adjusting sling should be used to remove the engine. With an adjusting sling, engine can be tilted or leveled as required, reducing job time, effort and hazard.*

WARNING! The wet weight of QSX15 engine with torque converter is 2000 [kg]. The engine lifting equipment must be designed to safely lift the engine.

37. Raise engine with torque converter up (approximately 10 [cm]. Make a visual inspection around engine to be sure that all disconnects required for engine removal have been made. Guide the engine with torque converter forward. Then lift and turn assy round vertical axis until torque converter with pumps is outside of machine frame.
38. Position engine into the suitable engine support stand.

NOTE: *After engine is removed from machine, it should be placed on a prepared block frame support.*

39. Install the hoist to the torque converter and pumps. Remove bolts securing torque converter to the flywheel housing and separate it.

6. ENGINE REPAIR

For detailed information pertaining to maintenance or engine repair, refer to the Engine Operation and Maintenance Manual QSX15 Engines, Bulletin No 3666423, Troubleshooting and Repair Manual QSX15 Engines, Bulletin 3666239 and Troubleshooting Repair Manual Electronic Control System QSX15 Engines, Bulletin No.3666259.

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7. INSTALLATION

1. Install new seal ring in the torque converter housing groove.

IMPORTANT*: Whenever a seal ring is required at a disconnected line, it is recommended that a new seal ring be installed.*

2. Install the hoist to the torque converter and pumps. Lift and guide the torque converter with pumps into position until torque converter housing properly seated in flywheel housing. Install bolts securing torque converter to the flywheel housing and torque all bolts to 100 to 120 [Nm].

IMPORTANT: *As converter housing enters flywheel housing, be sure seal ring is properly seated in groove of converter housing.*

NOTE: If gear of the converter does not seat in to engine flywheel, use socket wrench to turn the crankshaft of engine until the torque converter gear properly meshes in the flywheel.

3. Install an engine lifting attachment to the engine lifting brackets (4, Fig. 12.5) and (10, Fig.12.7). Hoist the engine assy above frame, lower and guide the assy into position. Before lowering the engine on the brackets, introduce the bolts (1 and 6, Fig. 12.11) securing assembly into the threaded holes of the brackets. Torque the rear and front bolts to 800 – 900 [Nm]. Remove engine lifting attachment.

WARNING! The wet weight of QSX15 engine is 2000 [kg]. The engine lifting equipment must be designed to safely lift the engine.

4. Reinstall bar (4, Fig. 12.11) with the bolts (5) (both sides).
5. Reinstall hoses (6, Fig. 12.10) to the drive train system pump.
6. Reinstall tube (7) to the hydraulic system pump.
7. Reinstall hoses (5) to the hydraulic system pump.
8. Reinstall bolts securing drive shaft (4) to the torque converter output shaft.
9. Use a new gasket and reinstall fan drive system pump (1, Fig 12. 9) to the plate connector of the torque converter with the two bolts (2).
10. Reinstall outlet hose (3, Fig. 12.10) to the torque converter.
11. Reinstall vent hose (1) to the torque converter.
12. Reconnect wires to the oil temperature sensors (2).
13. Reinstall torque converter drain hose (5, Fig. 12.9) to the engine flywheel housing.
14. Reinstall oil inlet hose (3) to the torque converter.
15. Reinstall hose and tube (4) to the drive train system pump.
16. Reinstall the cranking motor cables positive (+), ground (-) (1 and 2 Fig. 12.8), and wire harness (3).
17. Remove plugs from the turbocharger openings. Position muffler assy (7, Fig. 12.7). Install muffler mounting bolts (8), tighten tube clamp (9).
18. Position air cleaner assy on the brackets. Install mounting bolts (6), tighten hose clamp (5).
19. Install cab heater supply hose (4) to valve.
20. Reconnect the wire to the coolant temperature sensor (3).
21. Reconnect the wires connector (2) of the ether solenoid valve temperature switch.
22. Reconnect the wire connector to air cleaner warning light switch (1).

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23. Install cab heater return hose (7, Fig. 12.6) to valve.
24. Reinstall coolant filter bracket (6) to frame with the bolts.
25. Reinstall cables (4) to the alternator (5).
26. MACHINES EQUIPPED WITH A/C SYSTEM: Position compressor (3, Fig. 12.6), install the bolts (2) securing A/C compressor to the bracket. Reconnect the wire (1) to the magnetic clutch of the A/C system compressor. Reinstall A/C compressor and alternator drive belt.
27. Reinstall fuel return hose (5, Fig. 12.5) to the fuel module.
28. Reinstall fuel supply hose (3) to the fuel filter head.
29. MACHINES EQUIPPED WITH ETHER INJECTOR: Reconnect the nylon pipe to the nozzle (4, Fig. 12.1).
30. Install socket to the bracket with the nut. Reconnect the engine wire harness connectors (1, Fig. 12. 5). Reconnect the engine potentiometer control wire harness connector (2) and engine speed sensor connector (6).
31. Reassemble rear doors and shields assembly on both sides of engine compartment.
32. Reassemble radiator assy as described in section 6 COOLING SYSTEM.
33. Refill the equipment hydraulic reservoir as described in Operator's Manual.
34. Open the fuel valve under the fuel tank.
35. Turn the master switch to "ON" position. Start the engine. Visually check all connections for leakage. Stop the engine, turn the master switch to "OFF" position. Check coolant level and rear frame oil level. Refer to Operator's Manual.
36. Install floor plate in the cab.
37. If necessary perform engine control system adjustments as described in Par. 4, ENGINE CONTROL ADJUSTMENTS.
38. Working under machine, install transmission case guard and crankcase guard. Use lifting device for lifting heavy guards.

WARNING! This procedure requires extreme caution. Use suitable blocking equipment while under confines of machine.

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SECTION 13

SUPERSTRUCTURE

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SUPERSTRUCTURE

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GENERAL

1. DESCRIPTION

The TD-25M Extra dozer is equipped with 6-sided, 2-door cab symmetrically located on the machine. The cab is installed to the shock absorber mounted platform, separated from the engine compartment to reduce noise. The platform is supported in four points to the crossbeam assembly and front bar mounted to the main frame.
The operator's compartment is fully protected by structure ROPS and cab FOPS (the structure protecting against rolling over of machine and falling rocks).
The cab and ROPS are easy removable for transport if required.

2. SPECIFICATION

Special Torque Data:
Main Harness Connector Nut to Platform . . . . . 0.7 [Nm]
Battery Terminals . . . . . 31 [Nm]
Master Switch Mounting Nut . . . . . 51 [Nm]
Cab to Platform Mounting Bolts. . . . . 80 [Nm]
ROPS Mounting Bolts . . . . . 1500 [Nm]

(Torques given are for bolts and nuts lubricated with SAE-30 engine oil.)

NOTE: *Except for the special torques shown, all bolts and nuts are to be given a standard torque. Refer to the „STANDARD TORQUE DATA CHART" in Section 1, „GENERAL".*

3. CAB REMOVAL

1. Position machine in place which makes it possible to use a lifting device for lifting of disassembled assembles.
2. Turn electrical master switch to "OFF" position.

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lever is locked in neutral position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

3. Use lifting device to remove the ROPS structure. Unscrew the bolts them (1, Fig. 13.1) securing ROPS to the crossbeam assembly (five bolts on each side) and remove.
4. Remove the armrest, rear, left and right plastic shields in the cab.
5. Disconnect electrical connectors for two cables (1 and 2, Fig. 13.2), supply (+) and ground (-) of the cab electrical system.
6. Disconnect heater control potentiometer wire harness plug (3) and A/C heater switch wire harness plug (5).
7. Disconnect cab head lamps wire harness plug (4) and ROPS lamps plug (6).

NOTE: *Disconnected electrical harnesses plugs must be protected against dirt, oil, grease and water.*

8. Secure control panel (7) with wire harness to the cab.
9. Remove floor plate (2, Fig. 13.6) and disconnect hoses from the wipers washer tanks (1, Fig. 13.4). Remove hoses up thru platform hole and attach them to the cab.

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SUPERSTRUCTURE

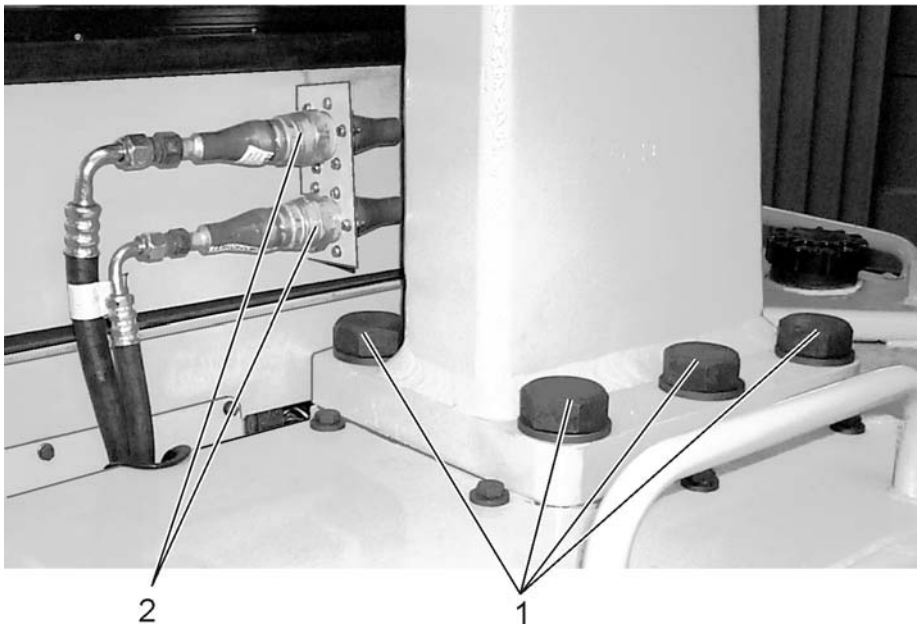

Fig. 13.1. A/C System Condenser and ROPS Disconnecting Points (LH side)

1. Bolts 2. A/C System Quick Couplings

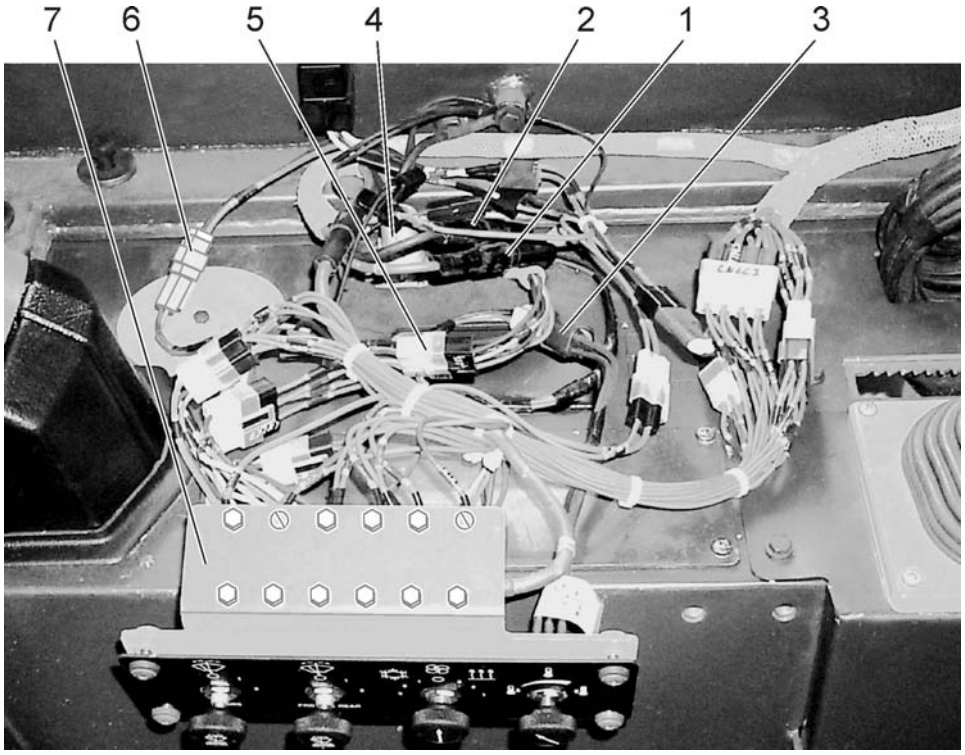

Fig. 13.2. A/C System Condenser Disassembly Points

1. Supply Cable (+)
2. Ground Cable (-)
3. Heater Control Potentiometer Plug
4. Front and Rear Lamps Plug
5. A/C Heater Control Switch Plug
6. ROPS Lamps Plug
7. Control Panel

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10. Remove Quick couplings cover and disconnect quick couplings (2, Fig. 13.1) of A/C system, protect them against dirt.
11. Attach the hoist to the cab lifting points (2, Fig. 13.3)
12. Unscrew front bolts (1, Fig. 13.3) at both sides of the cab and rear bolts (3) securing cab to the platform. Lift and remove the cab. Position cab assy in prepared stand, protect cab seal gasket (5) against damage.

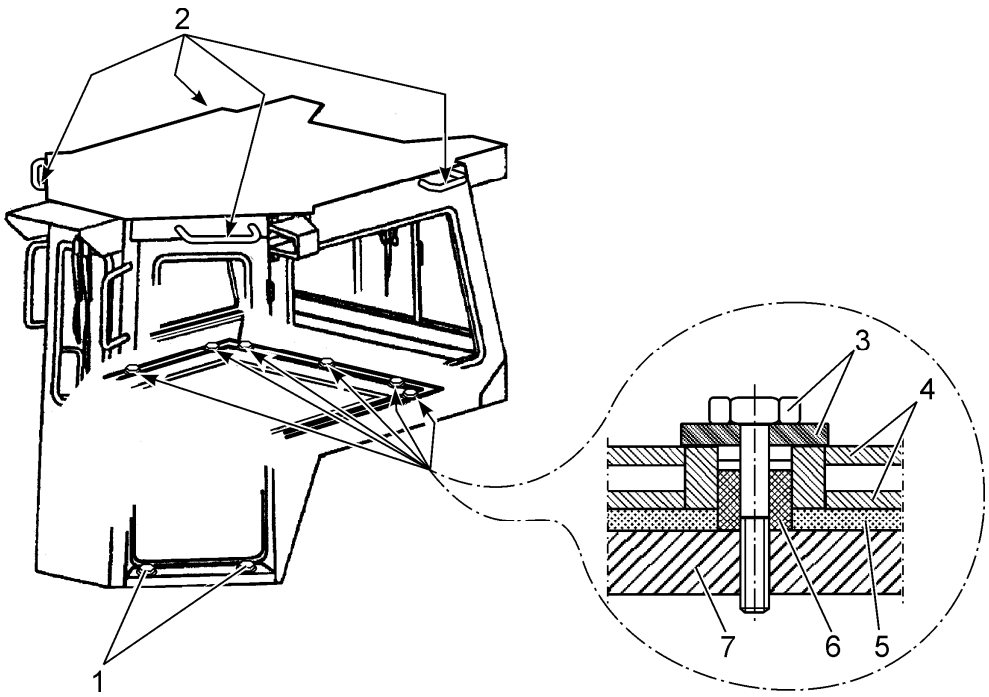

Fig. 13.3. Cab Mounting Points to Pod Assy

1. Front Bolts
2. Cab Lifting Points
3. Bolts with Washers
4. Cab Element
5. Seal Gasket
6. Threaded Sleeve
7. Pod

4. POD REMOVAL

1. Remove the operator's seat.
2. Remove R.H. console cover (4, Fig. 13.6), unscrew the bolts securing the blade control pilot valve (5) and ripper control pilot valve (7) to the mounting plate. Pull the valves down.
3. Pull the horn push button (6) down.
4. Disconnect brake control cable (2, Fig. 13.4). Remove brake control cable from the bracket under pod.
5. Disconnect wire harness plug (3, Fig 13.4) of the engine control potentiometer.
6. Remove the plate from instrument panel column and disconnect electrical connectors for two cables (4 Fig. 13.7) of the instrument panel supply. Disconnect wire harness plugs (2). Unscrew the nut and remove one socket down from the platform hole.
7. Remove the transmission pressure filters cover and L.H. console cover plate in order to gain access to the hydraulic connections of drive train control valve (1, Fig. 13.5) pilot lock valve (5) and switching valve (7).

NOTE: *Remove the transmission filters bracket bolts and swing filters assy out to the to gain easier access to the hydraulic and electrical connections in L.H. console.*

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8. Tag and remove the hoses (6, Fig. 13.5) from the pilot lock valve (5) and switching valve (7).

NOTE: *When disconnecting hydraulic lines for any reason, they should be properly capped with correct size plastic cap. If these caps are not available, tape or clean rubber corks may be used. Hydraulic openings must never be plugged with rags. This practice could easily introduce dirt or lint into critical hydraulic components of machine. Tag all disconnect oil lines to facilitate installation.*

9. Tag and remove the hoses (2, 3 and 4) from the drive train control valve. Remove the frame on the bottom of console. Pool the hoses down from console.

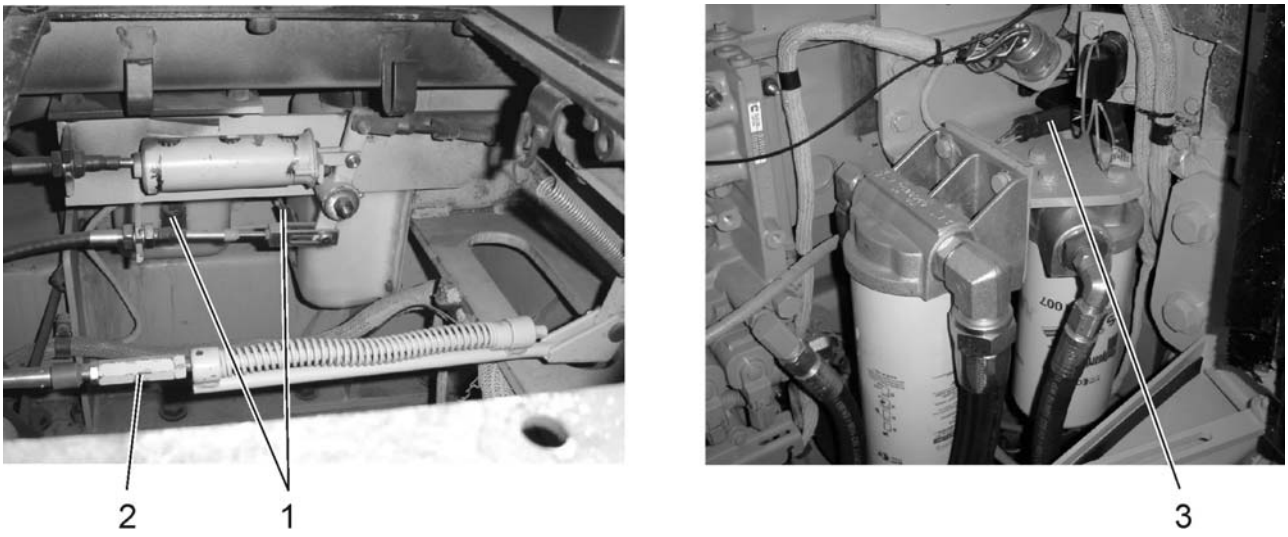

Fig. 13.4. Disassemble Points Under the Pod

1. Wiper Washer Tanks
2. Brake Control Cable
3. Engine Control Potentiometer Plug Wire Harness Plug

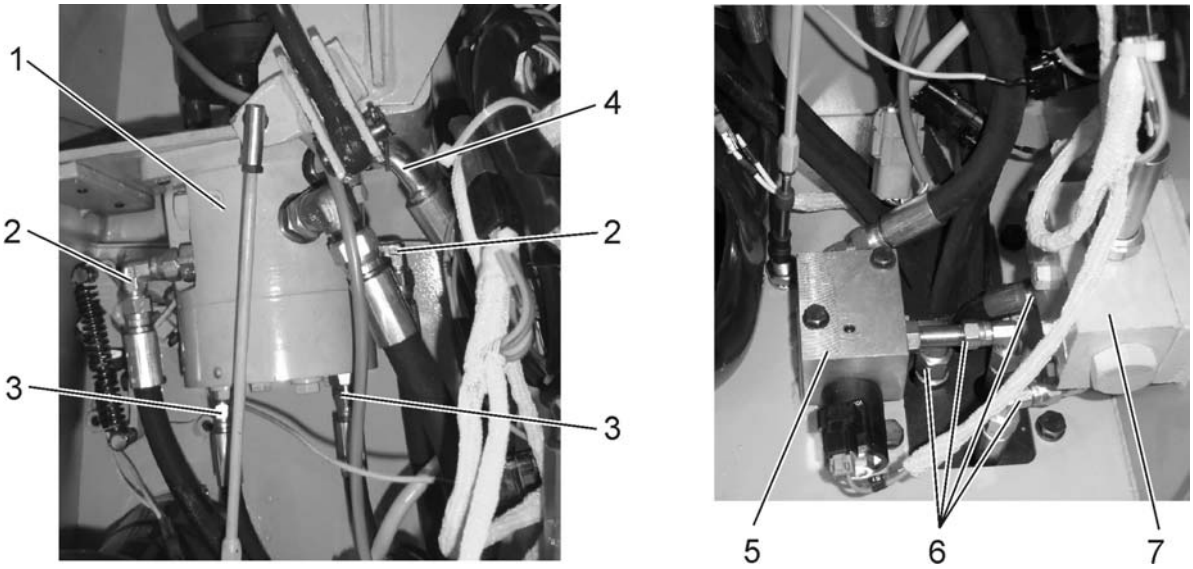

Fig. 13.5. Lock Valve and Control Valve Disconnecting Points (LH console)

1. Drive Train Control Valve
2. Hoses (steering control)
3. Hoses (forward – rear)
4. Hose (Drain)
5. Pilot Lock Valve
6. Hydraulic Hoses
7. Switching Valve

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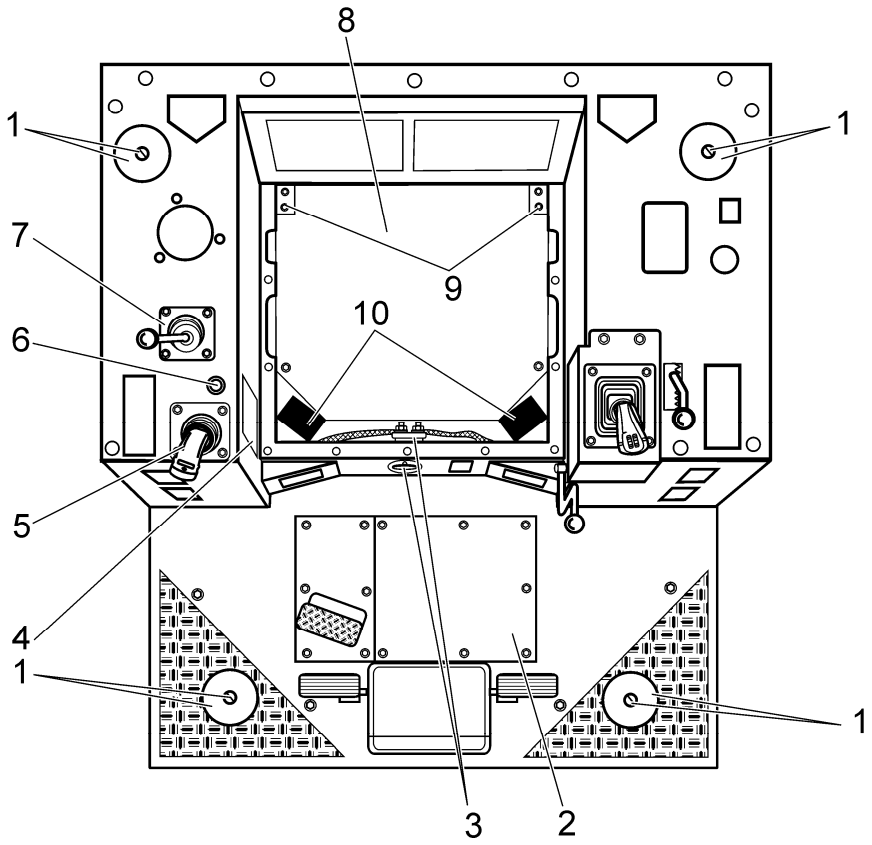

Fig. 13.6. Pod Assy Disassembly Points

1. Bolt and Plate
2. Floor Plate
3. Master Switch
4. R.H. Console Cover
5. Blade Control Pilot Valve
6. Horn Push Button
7. Ripper Control Pilot Valve
8. A/C Heater Assy
9. Conditioner Mounting Hardware
10. Air Hoses

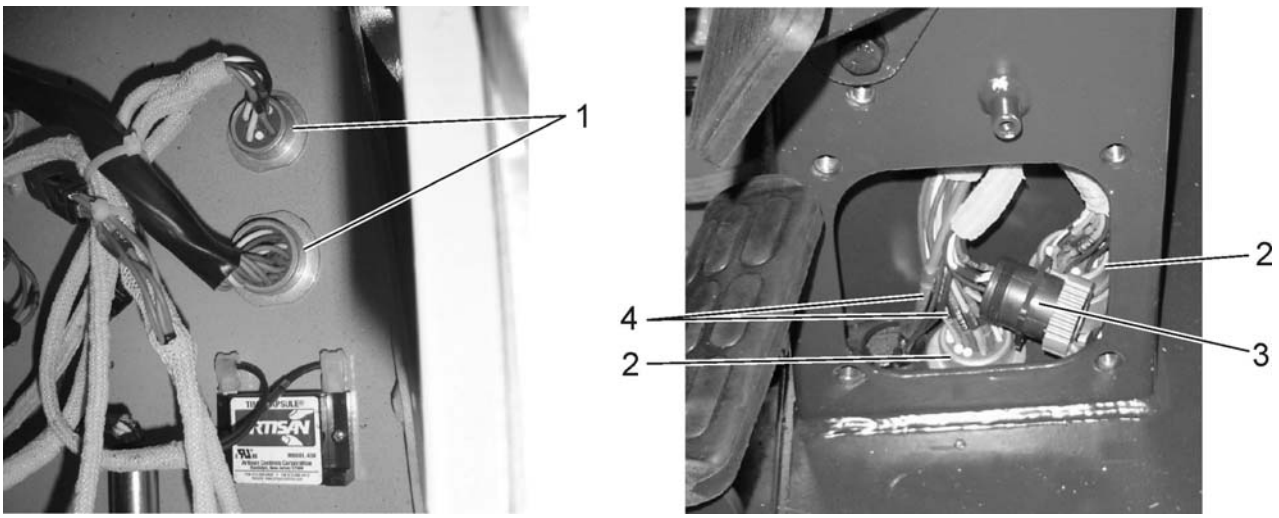

Fig. 13.7. LH Console and Instrument Panel Column electrical Connections

1.Wire Harness Sockets
2. Wire Harness Plugs
3. Engine Data Link Connector
4. Instrument Panel Supply and Ground Cables

10. Remove wire harness plugs from the sockets (1, Fig. 13.7).

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11. Remove the A/C heater compartment cover. Disconnect air conditioner hoses (10, Fig. 13.6), Disassembly mounting hardware (9), turn and carefully lower conditioner (8) down. Do not remove the hoses of the air conditioner (evaporator). Removing the hoses causes gas escape out the A/C system.
12. Disconnect ground (-) cable from the battery. Remove master switch (3) with cables.
13. Disassemble bolt and plate (1) covering the platform mounting bolts. Remove platform mounting bolts (4, Fig. 13.8) and plate (3). Attach the hoist and lift pod. Make a visual inspection around the pod to be sure that all disconnects required for pod removal have been made.
14. Raise the pod enough to separate the frame. Place the platform on suitable support stand.
15. Protect the air conditioner assy (8) against damage.
16. Disassemble bolt and nut (7, Fig. 13.8), rubber shock absorber (1) and plate (2) if necessary.

5. INSPECTION

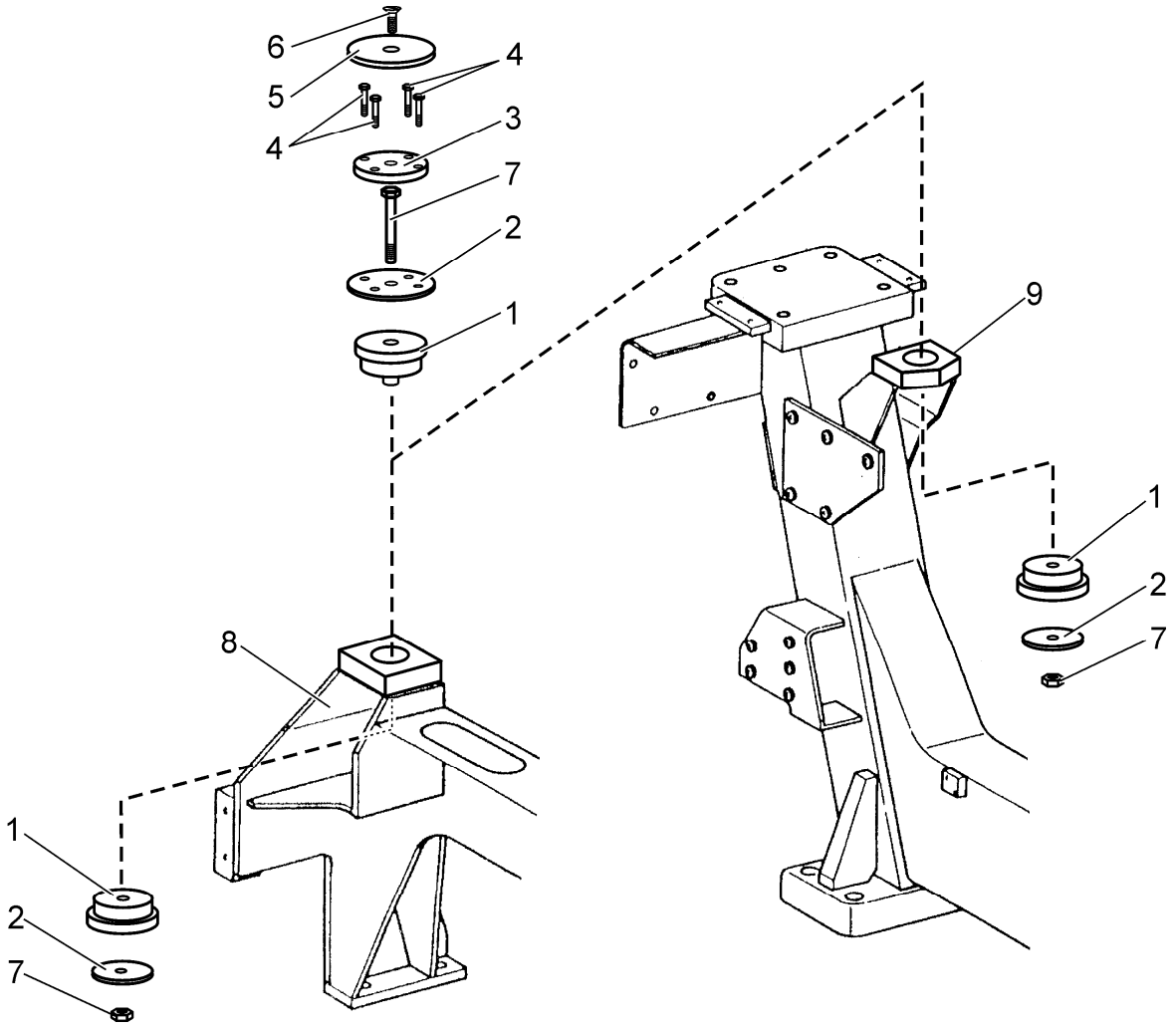

Fig. 13.8. Front and Rear Support of Platform

1. Rubber Shock Absorber
2. Plate
3. Plate
4. Bolts
5. Cover Plate
6. Bolt
7. Bolt and Nut
8. Front Bracket
9. Rear Bracket

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1. Check the ROPS structure and cab for cracks.
2. Check and complete the lacking insulation's elements of cab and pod.
3. Check and replace if necessary rubber shock absorber of the pod.
4. Inspect the electrical harness for damage and repair if necessary.
5. Inspect, repair or replace all control system elements (links, cables, springs, levers and connections) if damaged.

6. POD REASSEMBLY

1. Reassembly rubber shock absorber (1, Fig. 13.8) and plates (2) with bolt and nut (7) to the front (8) and rear (9) brackets of pod.
2. Raise the pod and carefully put on the brackets.
3. Install plate (3, Fig. 13.8) and bolts (4). Assemble cover plate (5) with bolt (6).
4. Install master switch (3, Fig. 13.6) with cables, torque nut to 51 [Nm]. Reconnect negative (-) cable to the battery. Torque nut to 31 [Nm].
5. Lift up air conditioner heater assy (8), reassemble mounting hardware (9) and air conditioner hoses (10). Reassemble A/C heater compartment cover.
6. Reinstall the frame with the hoses on the bottom of console. Reinstall the hoses (2, 3 and 4, Fig. 13.5) to the drive train control valve.
7. Reinstall the hoses (6) to pilot lock valve (5) and switching valve (7).
8. Reinstall wire harness plugs to the sockets (1, Fig. 13.7).
9. Reinstall one wire harness socket in the platform hole, torque the nuts to 0.7 [Nm]. Reconnect wire harness plugs (2). Reconnect electrical connectors for two cables (4) of the instrument panel supply. Install the plate.
10. Reconnect wire harness plug (4, Fig. 13.4) of the engine control potentiometer.
11. Reinstall brake control cable to the bracket under pod. Reconnect brake control cable (3).
12. Pull the horn push button (6, Fig. 13.6) up.
13. Pull the valves up. Install the bolts securing the blade control pilot valve (5) and ripper control pilot valve (7) to the mounting plate. Install R.H. console cover (4, Fig. 13.6).
14. Install the operator's seat.

7. CAB REASSEMBLY

1. Attach the hoist to the cab lifting points (2, Fig. 13.3), position the cab on the platform. Install bolts (1) (on both sides of the cab) and hand tighten. Turn back the threaded sleeve (6) at mounting points (3), so there is no contact with the platform surface. Torque bolts (1) to 80 [Nm] at both sides of the cab.
2. Screw in threaded sleeve (6) until it comes to contact with the pod surface. Install the bolts with washers (3) and torque to 80 [Nm]. Check the seal gasket (5) between the cab (4) and pod (7) for defects in spots where dust could penetrate inside the cab.

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NOTE: *Sequence of cab to platform securing bolts torquing described in points 1and 2 is to be followed strictly. Any change in torquing procedure may lead to cab stress and deformation.*

3. Reconnect A/C system quick couplings (2, Fig. 13.1), install the couplings cover.
4. Thread wipers hoses down thru hole in the platform and reconnect hoses to the wipers washer tanks (1, Fig. 13.4).
5. Reconnect cab head lamps wire harness plug (4, Fig. 13.2) and ROPS lamps plug (6).
6. Reconnect heater control potentiometer wire harness plug (3) and A/C heater switch wire harness plug (5).
7. Reconnect electrical connectors for two cables (1 and 2), supply (+) and ground (-) of the cab electrical system.
8. Install left, right and rear plastic shields in the cab. Install the armrest.
9. Position ROPS structure. Install the bolts (1, Fig. 13.1) securing ROPS to the crossbeam assembly (five bolts on each side) and torque them to 1500 [Nm].
10. Turn electrical master switch to „ON” position. Start the engine. Refer to Operator’s Manual. Check for leaks disconnected previously hydraulic lines of drive train control valve (1, Fig. 13.5) pilot lock valve (4) and switching valve (7). Stop the engine.
11. Install console cover plate and transmission pressure filters cover.
12. Install floor plate (2, Fig. 13.6) in the cab.

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SECTION 14

SUSPENSION

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SUSPENSION

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SERVICE/SPECIAL TOOLS

1. SERVICE/SPECIAL TOOLS

DESCRIPTION	TOOL NUMBER
Undercarriage Components Measurement Kit	910-50-0200
Pivot Shaft Seal Tool (Sleeve)	1.547.0358
Pivot Shaft Seal Tool (Ring)	1.547.0397
Track Spring Bolt	1.559.0221 No 96
Spring Compression Tool	1.559.0221
Tool for pivot shaft seal driving into seal shield	1.547.0359

GENERAL

NOTE: *The following procedures covers of a suspension from right side of the machine only. The procedures are the same for left side.*

2. DESCRIPTION

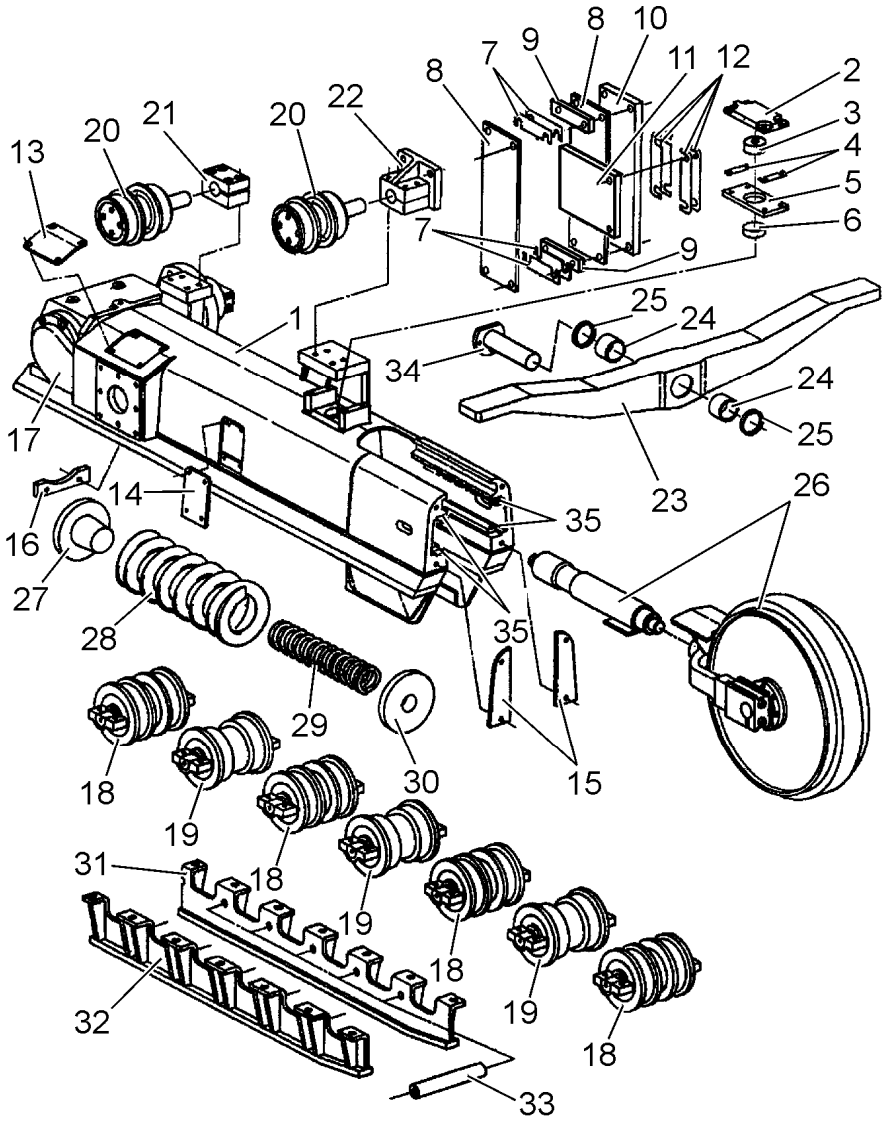

Fig. 14.1. Exploded View of Right Track Assembly

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SUSPENSION

GENERAL

Legend for Fig. 14.1

1. Track Frame with Bushings
2. Equalizer Bar End Cover
3. Rubber Wear Pad
4. Shims
5. Equalizer Bar Plate
6. Wear Pad
7. Shims
8. Wear Plate
9. Spacer Block
10. Retainer Plate
11. Guide Plate
12. Shims
13. Cover
14. Cover
15. End Plates
16. Track Spring Retainer
17. Pivot Shaft Assy
18. Double Flange Track Roller
19. Single Flange Track Roller
20. Top Idler
21. Rear Top Idler Mounting Block
22. Front Top Idler Mounting Block
23. Equalizer Bar
24. Equalizer Bar Bushing
25. Seal Ring
26. Track Adjuster with Front Idler
27. Track Spring Rear Seat
28. Track Outer Spring
29. Track Inner Spring
30. Track Spring Front Seat
31. Left Track Shield
32. Right Track Shield
33. Bushing Spacer
34. Pin
35. Guide Plate

The track frame assembly consists of a sturdy one-piece track frame of heavy steel construction. The track frame have seven track rollers and two track top idlers on each side. The track frame coil inner and outer springs are provided in each track for tensioning the track. This type of track springs permits the front idlers to recoil under shock loads, exert no tension on the track in normal operation position. Track frames are mounted on each side of the dozer, and they support the weight of the dozer on the track rollers.

The track frames are mounted at the main frame both side of machine. A guide bracket is welded to the frame to provide proper spacing between the two tracks. The track frames are attached at the rear of the dozer to the pivot shafts. Each track is free to oscillate vertically independently of the other track. The equalizer bar contacts both sides of the track frame.

The sprockets pull the track chain around the track rollers, up and over the top idlers and the front idlers. The front idlers are attached to the front idler forks located between the two channels of the track frames. The front idlers slide back and forth on the track frame to take up shock loads. The front idlers are also adjustable backward and forward for the purpose of adjusting the track chain tension.

3. SPECIFICATIONS

Front Idler

Front idler housing flange height . . . . . 22.9 ± 0.4 [mm]
Front idler maximum permissible housing flange height . . . . . 33 [mm]
Bushing ID (assembled in idler) . . . . . 128.06 ± 0.1 [mm]
Front idler bore . . . . . 134 ± 0.025 [mm]

Top Idler

Idler rolling diameter
(rolling diameter is diameter at point of contact with track chain) . . . . . 208.3 ± 0.8 [mm]
Maximum permissible wear of top idler rolling diameter . . . . . 19.2 [mm]

Track Roller

Track roller rolling diameter
(rolling diameter is diameter at point of contact with track chain) . . . . . 241 ± 0.7 [mm]
Maximum permissible wear of track roller rolling diameter . . . . . 25.1 [mm]

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GENERAL

Track Frame Guide

Wear plate thickness:

- New . . . . . 10 – 0.25 [mm]
- Maximum wear . . . . . 3 [mm]

Guide plate thickness:

- New . . . . . 40 – 0.25 [mm]
- Maximum wear . . . . . 3 [mm]

Equalizer bar

Wear pad thickness . . . . . 24 [mm]

Track Frame

Inner bushing:

- Bushing ID (before press) . . . . . 165 ± 0.03 [mm]
- Bushing ID (after press) . . . . . 165.115 – 165.35 [mm]
- Pivot shaft OD . . . . . 165 - 0.04 [mm]
- Bushing OD . . . . . 190.13 – 190.176 [mm]
- Track frame housing ID . . . . . 190 ± 0.025 [mm]

Outer bushing:

- Bushing ID (before press) . . . . . 131.1 ± 0.03 [mm]
- Bushing ID (after press) . . . . . 130.785 – 130.999 [mm]
- Pivot shaft OD . . . . . 130.517 – 130.557 [mm]
- Bushing OD . . . . . 150.190 – 150.253 [mm]
- Track frame housing ID . . . . . 150 ± 0.025 [mm]

Track Springs

Outer track spring:

- Free length . . . . . 721 – 736 [mm]
- Test length . . . . . 771 [mm]
- Test load . . . . . 267.9 [kN]
- Number of working coils 10.4
- Weight of spring . . . . . 200 [kg]

Inner track spring:

- Free length . . . . . 723 – 736 [mm]
- Test length . . . . . 610 [mm]
- Test load . . . . . 48.95 [kN]
- Number of working coils 17.7
- Weight of spring . . . . . 32 [kg]

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SUSPENSION

GENERAL

Front Idler Guide Bars

Upper guide bar wear limit:
- New bar height . . . . . 22.2 –0.15 [mm]
- Minimum guide bar thickness . . . . . 20.3 [mm]
- Maximum wear limit . . . . . 2 [mm]

Bottom guide bar wear limit:
- New bar height . . . . . 22.2 –0.15 [mm]
- Minimum guide bar thickness . . . . . 20.3 [mm]
- Maximum wear limit . . . . . 2 [mm]

Track Chain Guide Bars

Track chain guide bar wear limit:
- New bar height . . . . . 22.2 –0.15 [mm]
- Minimum guide bar thickness . . . . . 20.3 [mm]
- Maximum wear limit . . . . . 2 [mm]

Special Nut and Bolt Torque Data
(Torques given are for bolts and nuts lubricated with SAE-30 engine oil)

Front Idler

Bushing retainer bolts . . . . . 170 [Nm]
Fork and mounting block bolts . . . . . 730 [Nm]
Drain plug . . . . . 20 - 50 [Nm]

Top Idler

Front top idler mounting block bolts . . . . . 845 [Nm]
Rear top idler mounting block bolts . . . . . 845 [Nm]
Drain plug . . . . . 20 - 50 [Nm]
Top idler cover mounting bolts . . . . . 35 [Nm]

Track Roller

Roller retainer bolts . . . . . 135 [Nm]
Roller shaft bracket bolts . . . . . 845 [Nm]
Sprocket rock deflector bolts . . . . . 845 [Nm]
Shield bolts . . . . . 845 [Nm]
Drain plug . . . . . 20 - 50 [Nm]

Track Frame Guide

Front top idler mounting bracket bolts . . . . . 845 [Nm]
Guide plate bolts . . . . . 1500 [Nm]
Retainer plate bolts . . . . . 1500 [Nm]

Equalizer bar

Equalizer bar end cover bolts . . . . . 520 [Nm]

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GENERAL

Track Adjuster

Check filler valve torque . . . . . 68 [Nm]
Safety relief valve torque . . . . . 68 [Nm]

Pivot Shaft

Pivot shaft mounting bolts . . . . . 2750 [Nm]
Pivot shaft cover mounting bolts . . . . . 845 [Nm]
Pivot shaft retaining plate mounting bolts . . . . . 845 [Nm]
Pivot shaft seal shield with snap ring mounting bolts . . . . . 125 [Nm]

NOTE: *Except for the special torques shown all bolts and nuts are to be given a standard torque. Refer to SECTION 1.*

4. SERVICE DIAGNOSIS

COMPLAINT	
PROBABLE CAUSE	**REMARKS**
Track Chain Comes Off During Operation	
1. Track chain loose	Adjust track tension.
2. Rock in track assembly	Clean out the tracks.
3. Front idler worn	Inspect front idler for wear. Replace if necessary.
4. Front idler misaligned	Correct alignment of the front idler.
Machine Creeps to One Side	
1. Track loose on one side	Adjust the track chain tension.
2. Track shoes loose	Tighten bolts to proper torque.
Track Chain Loose	
1. Track not properly adjusted	Adjust the track tension.
2. Sprocket worn	Inspect sprocket for worn teeth or damage. If wear is excessive, replace the sprocket rim.
3. Track links or bushings worn	Inspect track links and bushings for wear or damage. Replace any damaged parts if necessary.
Excessive or Uneven Wear of Track, Track Rollers, Track Idlers, Front Idler and Sprocket	
1. Improper track tension	Adjust the track tension.
2. Damaged sprocket	Replace the sprocket carrier or sprocket drive segments, if necessary.
3. Front idler misaligned	Correct alignment of front idler.
4. Track rollers do not turn	Internal seizure. Remove and replace defective parts.
5. Track idler does not turn	Internal seizure. Remove and replace defective parts.

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SUSPENSION

GENERAL

COMPLAINT	
PROBABLE CAUSE	**REMARKS**
Lubricant Leakage	
1. Leakage at track roller	Remove track roller and repair.
2. Leakage at track idler	Remove, inspect and replace defective parts.
3. Leakage at front idler	Remove the front idler, and make necessary repairs.
4. Leakage at pivot shaft	Remove, inspect and repair or replace defective parts.
Front Idler Does Not Turn	
1. Insufficient lubrication	Use correct amount of lubricant.
2. Mud packed around idler	Remove the mud.
Top Idlers Do Not Turn	
1. Insufficient lubrication	Use correct amount of lubricant.
2. Mud packed against idler	Remove the mud.
3. Internal seizure	Remove, inspect, clean and replace if necessary.
Track Rollers Do Not Turn	
1. Work in mud conditions with roller shield	Remove shield.
2. Insufficient lubrication	Use correct amount of lubricant.
3. Bushings seized	Remove faulty roller and replace bushing.
4. Packed dirt between roller and track frame	Remove packed dirt and check lubrication of roller.
Machine Loses Power	
1. Track chains too tight	Adjust track chains. Tight track chains will cause machine to lose up to 75 percent of horsepower.
Track Shoe Bolts Break	
1. Bolts not properly tightened	Tighten bolts to proper torque.
2. Bolt head snap off	Track shoes out-of-flat. Replace track shoes.

5. CHECKING UNDERCARRIAGE WEAR

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train neutral lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

Undercarriage components have a certain dimension when new. As wear occurs the dimension will decrease (or increase in the case of track pitch and front idler flange height) until a decision must be made whether to rebuild or recondition components, replace them or run them to destruction. The 100 [%] dimension is the dimension of the component when an new. The 0 [%] dimension is the point at which either maintenance must take place or the components run to destruction. Before inspecting an undercarriage, the track tension on both sides must be tightened. To do this, blocks of wood or metal should be placed in the sprocket tooth under the track chain as shown in Fig. 14.2. The machine should then be moved backward so the sprocket can grab the block and tighten the chain. This pulls the chain tight and up off the top idler.

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GENERAL

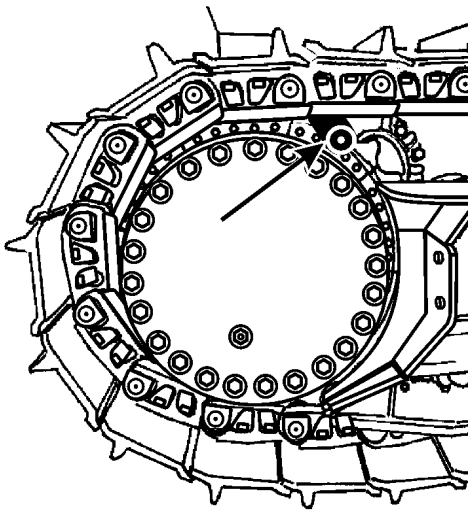

Fig. 14.2. Tightening Track Chain

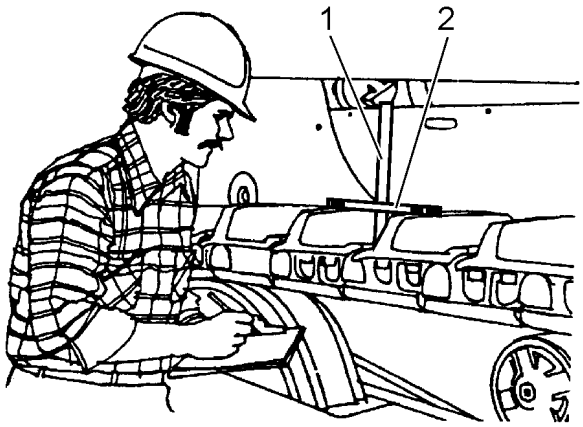

Fig. 14.3. Measuring Grouser Height

1. Scale 2. Squeeze Bar

Track Shoe Grouser Height (Fig. 14.3)

Clean off all materials on shoe plate and grouser tops. Lay squeeze bar (2) across grousers approximately 1/4 of way in from end of shoe. Insert about 300 [mm] scale (1) in squeeze bar (2) (refer to SERVICE/SPECIAL TOOLS in this Section) so that scale is against top of track plate and take a reading. Measure two or more shoes to get an average and compare with dimensions given, refer to SPECIFICATIONS in SECTION 15.

Link Height (Fig. 14.4)

Clean out all materials between links. Place squeeze bar (1) across center of links. Insert about 300 [mm] scale (2) in squeeze bar (1) (refer to SERVICE/SPECIAL TOOLS in this Section) so that scale is against bottom of track shoe plate and take a reading. Measure two or more place along chain to get an average and compare with dimensions given, refer to SPECIFICATIONS in SECTION 15.

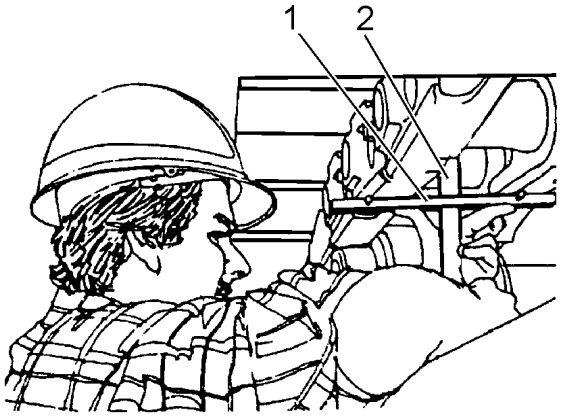

Fig. 14.4. Measuring Link Height

1. Squeeze Bar 2. Scale

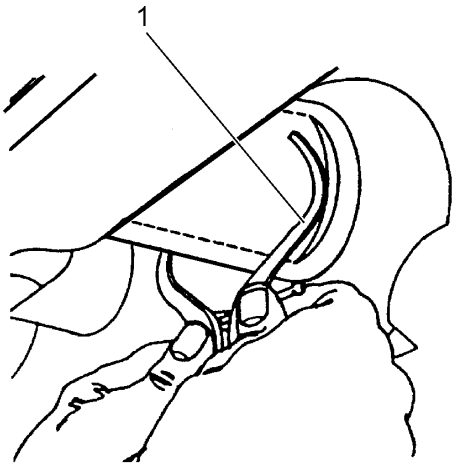

Fig. 14.5. Measuring Bushing OD

1. Outside Caliper

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Bushing Outside Diameter (Fig. 14.5)

Close 100 [mm] outside caliper (1) (refer to SERVICE/SPECIAL TOOLS in this Section) around bushing with a minimum amount of drag, making certain that one of caliper tips is positioned in forward drive side wear area. Slide caliper off bushing and measure distance between caliper tips using about 300 [mm] scale. Repeat on the reverse drive side wear area. Measure two or more bushings to get an average and compare with dimensions given, refer to SPECIFICATIONS in SECTION 15. Whichever wear is greater, determines percentage of wear remaining.

Internal Pin and Bushing Wear (Pitch) (Fig. 14.6)

With track chain tight, place end of 3000 [mm] tape (refer to SERVICE/SPECIAL TOOLS in this Section) on front one track pin and measure length of four links to front of fifth track pin. Compare with dimensions given, refer to SPECIFICATIONS in SECTION 15.

Front Idler Flange Height (Fig. 14.7)

Insert about 300 [mm] scale (1) in squeeze bar (2) (refer to SERVICE/SPECIAL TOOLS in this Section). Rest squeeze bar (2) on top of flange and push scale down until it makes contact in middle of treat area as shown and take a reading. Compare with dimensions given, refer to SPECIFICATIONS in this Section.

Fig. 14.6. Measuring Track Pitch

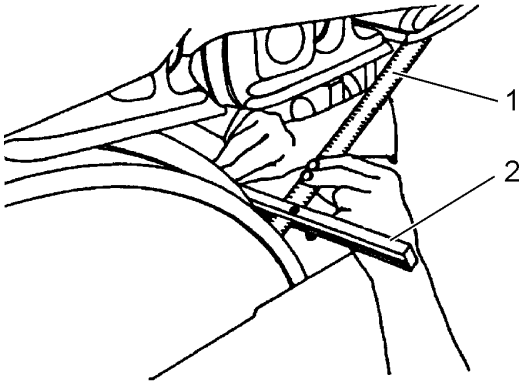

Fig. 14.7. Measuring Flange Height

1. Scale 2. Squeeze Bar

Track Roller Rolling Diameter (Fig. 14.8)

Place tips of 300 [mm] caliper (1) (refer to SERVICE/SPECIAL TOOLS in this Section) against tread area of roller. Adjust caliper so a slight drag is present when caliper is removed. Using about 300 [mm] scale (2) measure distance between caliper tips. Compare with dimensions given, refer to SPECIFICATIONS in this Section. Repeat steps on remaining rollers.

Top idler rolling diameter (Fig. 14.9)

Place tips of 300 [mm] caliper (1) (refer to SERVICE/SPECIAL TOOLS in this Section) snugly around tread area of top idler and remove. Using about 300 [mm] scale, measure distance between caliper tips. Compare with dimensions given, refer to SPECIFICATIONS in this Section.

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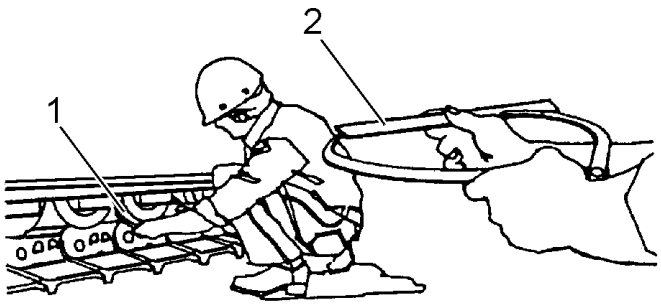

Fig. 14.8. Measuring Track Roller Rolling Diameter

1. Caliper 2. Scale

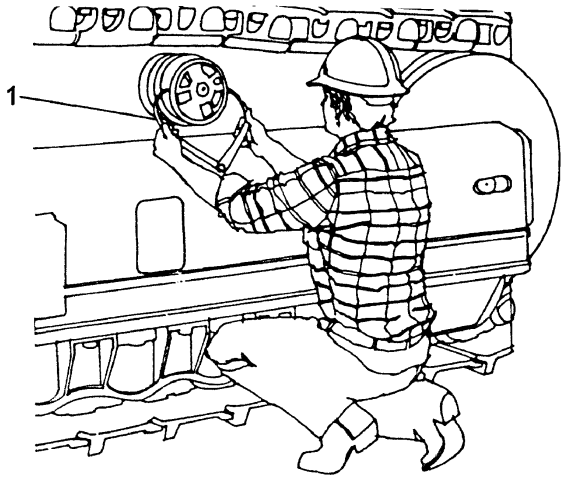

Fig. 14.9. Measuring Top Idler Rolling Diameter

1. Caliper

FRONT IDLER

6. DESCRIPTION

The front idler provides a freely rotating, guiding support of the track chain. The idler is supported on replaceable wear bars which slide on the track frame channels. This sliding feature helps protect the track frame components by allowing the track springs to absorb shock loads. The idlers are heat-treated steel castings and rotate around bushing. The idlers are equipped with metal face-type seals which maintain a leak and dirt-proof seal.

7. REMOVAL

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

CAUTION! Lift and handle all heavy parts with a lifting of proper capacity. Be sure parts are secured by proper slings and hook. Use lifting eyes if provided. Warn people in the area to stand clear.

1. Remove the track chain (3, Fig. 14.10) as described in SECTION 15. It is only necessary to lift chain free from front idler. Remove front idler covers (1) from the track frame (2).
2. Be sure the relief valve (1, Fig. 14.11) is unscrewed one full turn to avoid entering a vacuum in the cylinder.
3. Move the front idler and attach a hoist to front idler (4, Fig. 14.10) and fork. Remove front idler with fork from track frame.

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SUSPENSION

FRONT IDLER

WARNING! After front idler and fork clears track frame, it will swing down. Stay clear of the area.

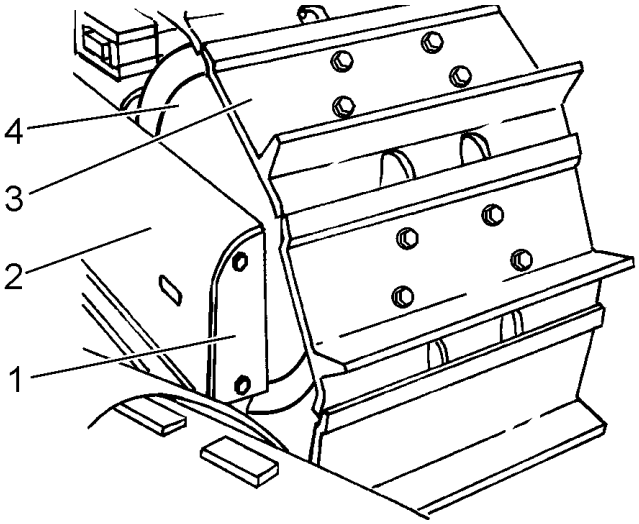

Fig. 14.10. Front Idler

1. Front Idler Cover
2. Track Frame
3. Track Chain
4. Front Idler

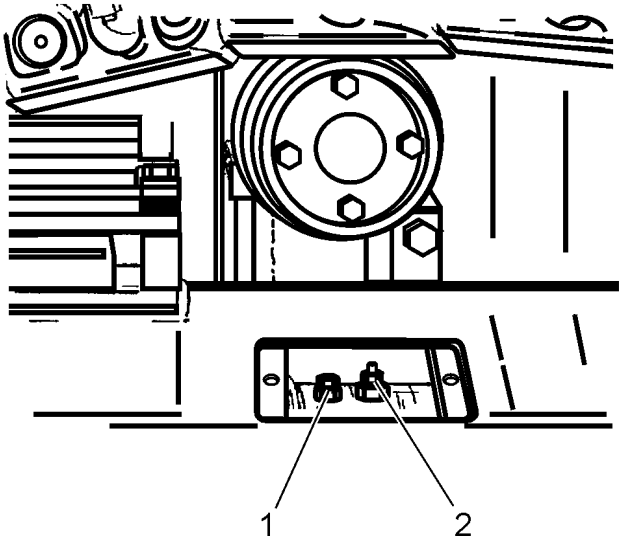

Fig. 14.11. Track Adjuster

1. Relief Valve
2. Lubrication Fitting (Ball Check Valve)
3. Track Frame

8. DISASSEMBLY (Refer to Fig.'s 14.13 and 14.14)

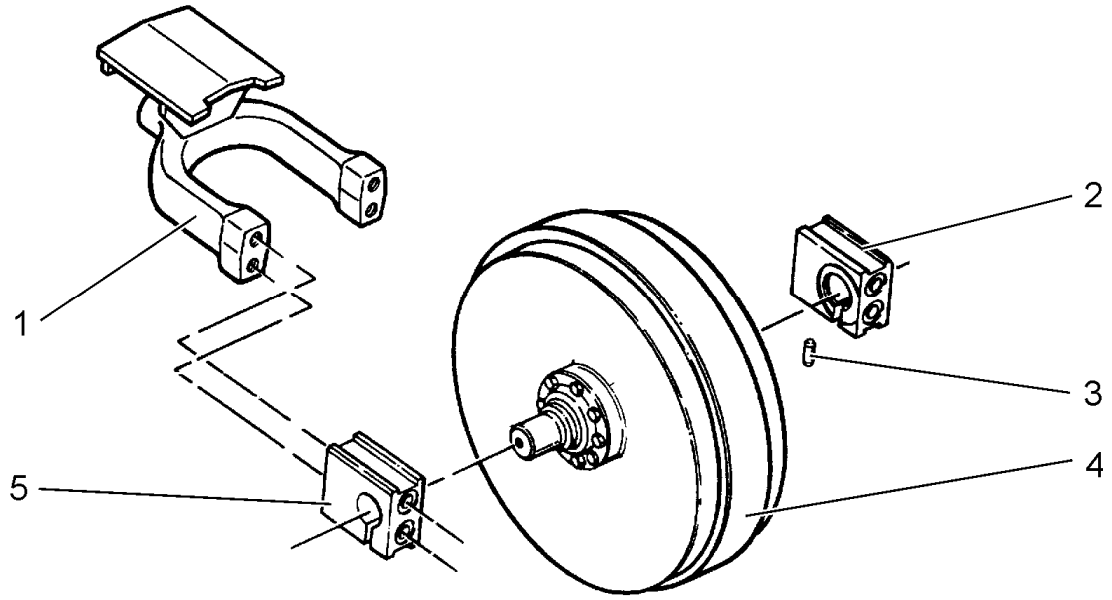

Fig. 14.12. Front Idler and Fork

1. Fork Assy
2. Left Front Idler Block
3. Pin
4. Front Idler
5. Right Front Idler Block

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FRONT IDLER

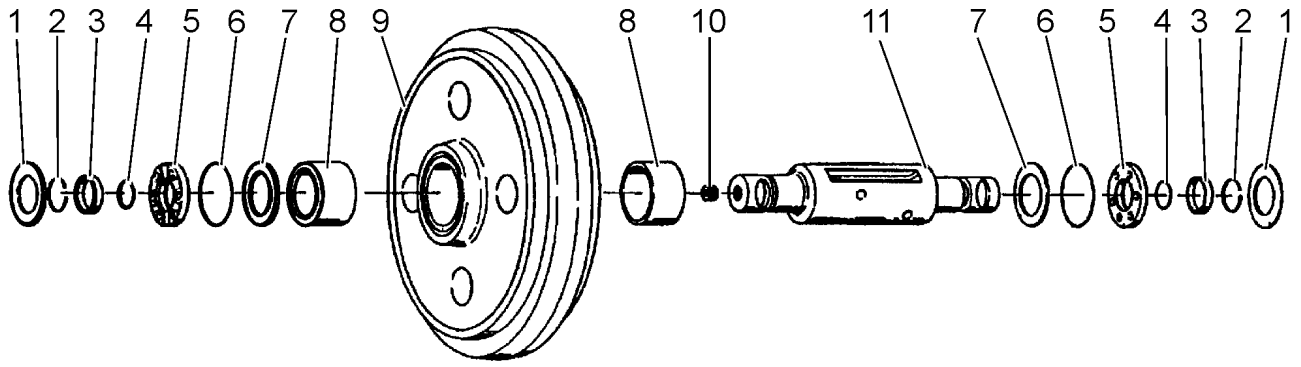

Fig. 14.13. Exploded View of Front Idler

1. Front Idler Seal Retainer
2. O-Ring
3. Seal Kit
4. Retaining Ring
5. Front Idler Bushing Retainer
6. O-Ring
7. Thrust Washer
8. Front Idler Bushing
9. Front Idler Housing with Bushing
10. Drain Plug
11. Front Idler Shaft

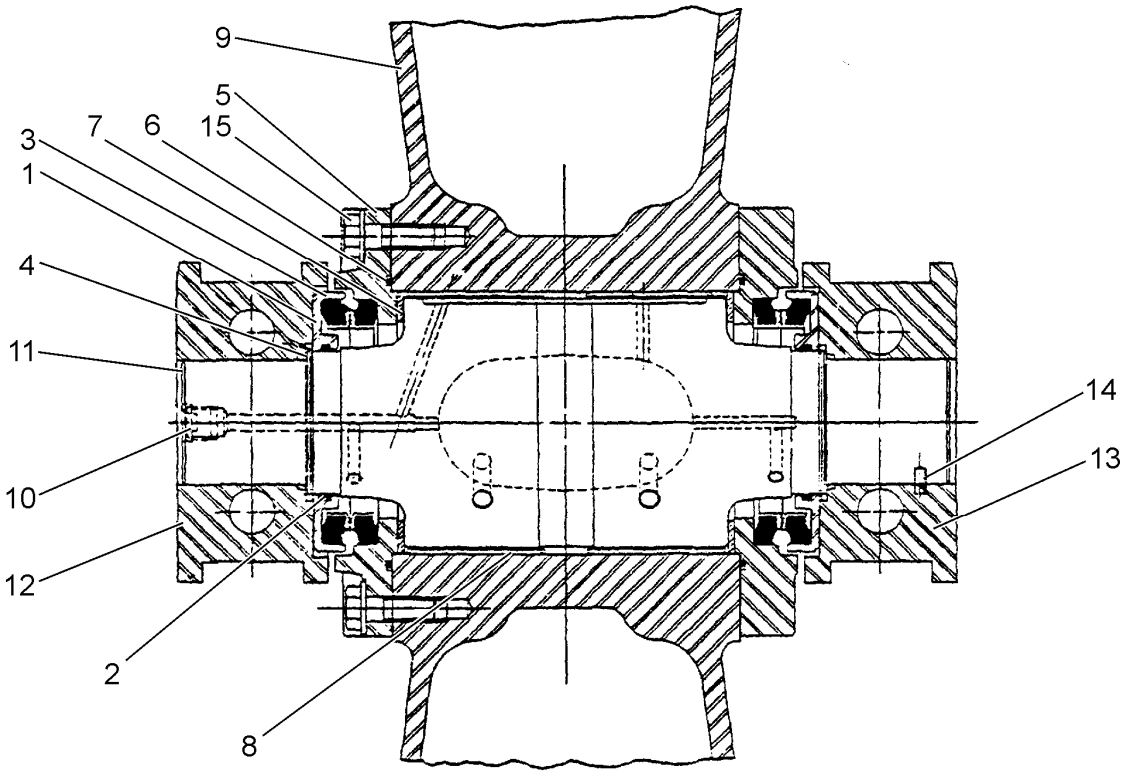

Fig. 14.14. Cross Section View of Front Idler

1. Front Idler Seal Retainer
2. O-Ring
3. Seal Kit
4. Retaining Ring
5. Front Idler Bushing Retainer
6. O-Ring
7. Thrust Washer
8. Front Idler Bushing
9. Front Idler Housing with Bushing
10. Drain Plug
11. Front Idler Shaft
12. Left Front Idler Block
13. Right Front Idler Block
14. Pin
15. Bolt with Washer

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SUSPENSION

FRONT IDLER

1. Remove hardware and fork (1, Fig. 14.12) from front idler (4). Using large pry bar, relief block clamping tension on front idler (4). Remove the blocks (2 and 5). Remove the pin (3) from idler shaft.
2. Remove the plug (10) and drain oil from front idler. Remove the retaining ring (4) and slide seal retainer (1) with O-ring (2) and half seal kit (3) off shaft (11). One half of the seal kit (3) will remain in bushing retainer (5). Remove second half kit seal (3) from bushing retainer (5) and keep both halves together. Repeat this step for other side of idler.

NOTE: *Keep original mated metal rings as a set. Do not mix a metal ring from oil seal in one side of idler with one from oil seal on other side.*

3. Remove mounting hardware and bushing retainer (5) with O-ring (6) from each side of idler. Remove washer (7). Position idler in press and remove shaft (11). Bushing (8) are a press fit in front idler housing (9) and must not be removed unless replacement is necessary.

9. INSPECTION AND REPAIR

1. It is recommended that new O-rings be installed whenever the front idler is disassembled for service.
2. Wash all parts thoroughly in a suitable solvent. Dry thoroughly with compressed air.
3. Inspect the idler shaft, bushing, washer and idler for cracks, scores or excessive wear.
4. Check the clearance limits given in Fig. 14.15.
5. Inspect the blocks (2 and 5, Fig. 14.12).

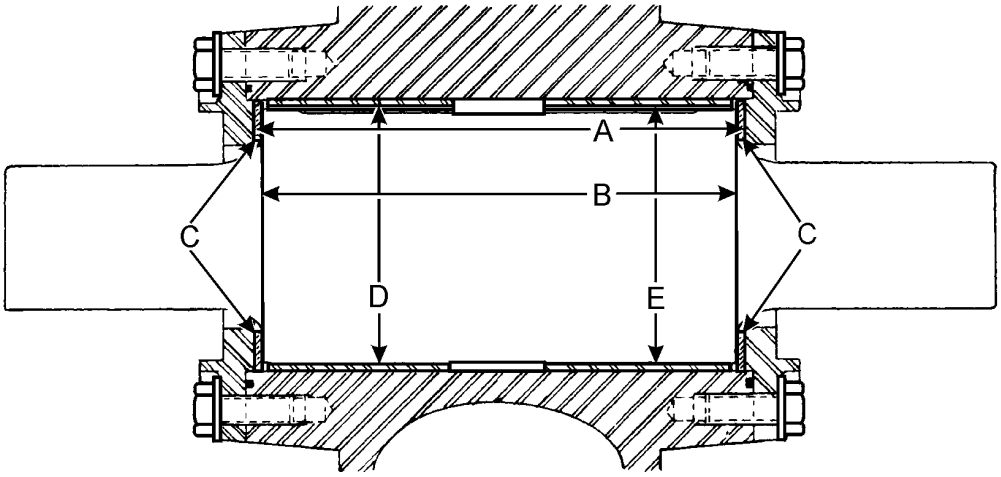

Fig. 14.15. Front Idler Bushing Clearances

A. Distance between seal retainer surfaces . . . . . 170.45 ± 0.2 [mm]
B. Width of idler shaft bushing surface . . . . . 164.1 ± 0.08 [mm]
C. Washer thickness . . . . . 3.17 ± 0.07 [mm]
D. Bushing inside diameter (assembled) . . . . . 128.06 ± 0.1 [mm]
E. Idler shaft diameter . . . . . 127.725 ± 0.025 [mm]
Diametral clearance (D - E) . . . . . 0.35 ± 0.1 [mm]
End clearance A - (B + 2C) . . . . . 0.6 ± 0.3 [mm]

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6. Inspect the front idler guide bar for distortion or excessive wear. If not within SPECIFICATION remove bars, refer to FRONT IDLER GUIDE BAR in this Section.
7. Check the track chain guide bar for distortion or excessive wear. If not within SPECIFICATION remove bars, refer to TRACK CHAIN GUIDE BAR in this Section.
8. It is recommended that new seal kits (3) be installed whenever the front idler is disassembled. Refer to SEAL INSPECTION under METAL TYPE FACE SEALS in this Section.

10. REASSEMBLY (Refer to Fig.'s 14.13 and 14.14)

1. If replacing bushings (8), coat 25 [mm] of outer end of idler bore and leading edges of bushing OD with LOCTITE #609. Press bushing (8) in to depth as indicated in Fig. 14.16.
2. Place washer (7) in front idler housing bore so it is flat against bushing (8). Apply a small amount of grease to O-ring (6) and install in groove in bushing retainer (5). Secure bushing retainer (5) to front idler housing (9) and torque bolts 170 [Nm].
3. Turn assembly around and apply a thin coat of engine oil to inside of bushings. Insert shaft (11) in front idler housing (9). Repeat Step 2 on opposite side of front idler housing (9).

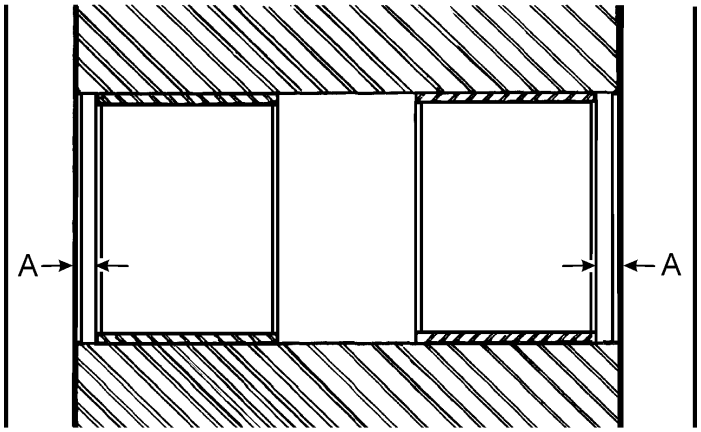

Fig. 14.16. Bushing Installation

A . . . . . 7.06 + 0.64 [mm]

4. Check that front idler end clearance is within tolerance given in Fig. 14.15. From side of roller dial indicator is to be mounted, push roller shaft into housing to be sure it is bottomed against washer. Place indicator base on idler housing with indicator pointer resting against end of the shaft (Fig. 14.17). Set the indicator at zero. Push shaft toward indicator until it bottoms and take a reading. If reading obtained is below specification, check measured surfaces (A, B, C, Fig. 14.15) for squareness. If above specifications, check parts for excessive wear.

NOTE: *Do not at any time handle metal face type oil seal with greasy oily or dirty hands. Idler must not be filled with lubricant until idler track frame are in position.*

5. Apply a small amount of grease on O-ring (2) and install in groove seal retainer (1). Before installing seal kit (3), be sure seal contacting surfaces of retainers (1 and 5) are clean and dry. Also that rubber rings of seal assembly are correctly positioned on metal rings. Refer to SEAL INSTALLATION under METAL TYPE FACE SEALS in this Section. Install seal retainer (1) and secure with retaining ring (4). Repeat Step 5 on opposite side of idler.

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SUSPENSION

FRONT IDLER

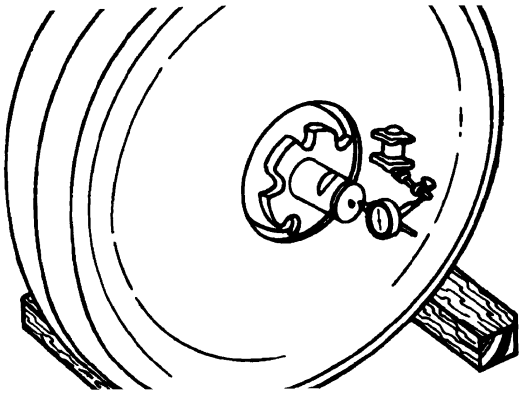

Fig. 14.17. Idler Shaft End Clearance

6. Use only SAE 30 engine oil or equivalent (refer to OPERATOR'S MANUAL) to lubricate front idlers. Insert lubricator nozzle all way into shaft until it enters small fill hole in center of shaft. Pump lubricant in until air is forced out and lubricant back flows freely out plug hole in shaft. Then quickly remove lubricator nozzle and torque lubrication plug to 20 - 50 [Nm]. Before installing the plug (10), apply LOCTITE #592 to the plug threads. When reusing a pipe plug, clean the plug before applying new LOCTITE to assure a tight seal.

NOTE: *When reassembling front idler to blocks and fork, drain plug must be facing to outside and roll pin to the inside.*

7. Coat bores of mounting blocks (2 and 5, Fig. 14.12) with grease. Install the dowel pin (3) into front idler shaft. Install blocks onto idler shaft and secure with fork (1) and hardware. Torque fork bolts to 730 [Nm].

11. INSTALLATION

1. Lubricate the guides inside track frame.
2. Using a hoist and sling position front idler and fork onto guide bars up against adjuster cylinder.
3. Tighten the relief valve (1, Fig. 14.11) to 68 [Nm].
4. Install the front idler covers (1, Fig. 14.10) to the track frame (2).
5. Install the track chain (3), refer to SECTION 15.
6. Adjust the track chain tension, refer to the ADJUSTING TRACK TENSION in SECTION 15.

HYDRAULIC TRACK ADJUSTER

12. DESCRIPTION

The hydraulic track adjuster is supported between the track spring front seat and rear of the front idler fork. Lubricant is introduced into the cylinder by the use of a lubrication fitting on top of the cylinder. This lubricant acting upon the piston and adjusting rod forces the idler fork and idler forward for track chain adjustment.

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HYDRAULIC TRACK ADJUSTER

13. REMOVAL

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

CAUTION! Lift and handle all heavy parts with a lifting of proper capacity. Be sure parts are secured by proper slings and hook. Use lifting eyes if provided. Warn people in the area to stand clear.

1. Remove the track chain as described in SECTION 15.
2. Remove the front idler, refer to Paragraph 7, REMOVAL in this Section.
3. Remove hydraulic track adjuster from front of track frame by sliding it out front of track frame.

14. DISASSEMBLY (Refer to Fig. 14.18)

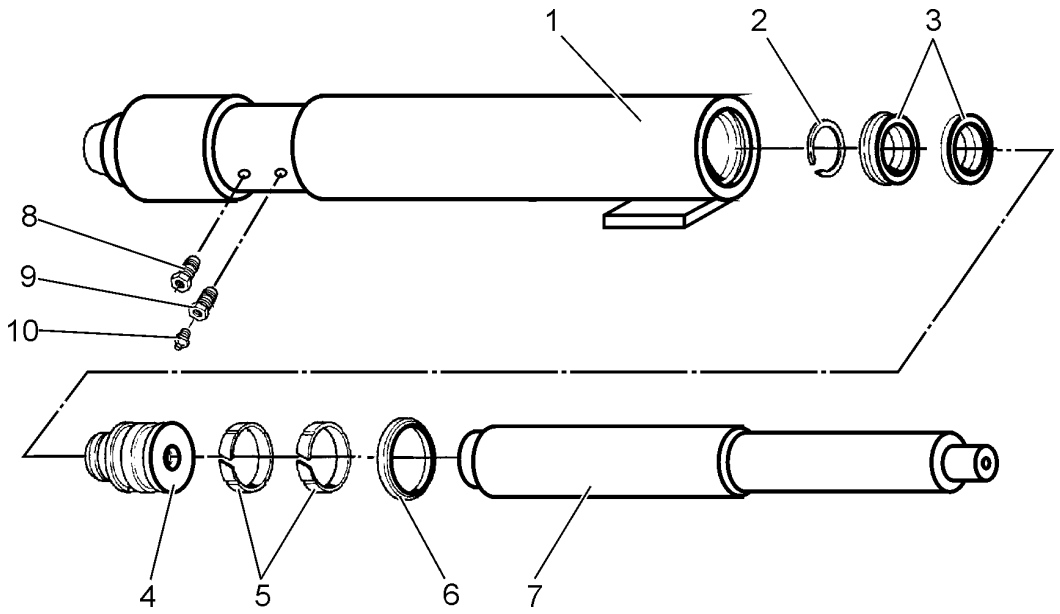

Fig. 14.18. Exploded View of Track Adjuster

1. Hydraulic Track Adjuster
2. Retaining Ring
3. Piston Seal
4. Adjuster Cylinder Piston
5. Wear Ring
6. Rod Wiper
7. Cylinder Rod
8. Relief Valve
9. Ball Check Valve
10. Lube Fitting

1. Pull rod (7) out of track adjuster (1). Remove the rod wiper (6) from the track adjuster bore.
2. Remove piston (4) from track adjuster (1).
3. Remove retaining ring (2) and piston seal (3) wear rings (5) from piston (4).
4. Remove lube fitting (10), ball check valve (9) and relief valve (8) from track adjuster (1).

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15. INSPECTION AND REPAIR (Refer to Fig. 14.18)

1. It is recommended that a new wear ring (5), rod wiper (6) and piston seal (3) be installed whenever the track adjuster is disassembled.
2. Wash all parts thoroughly in a suitable solvent. Dry completely with compressed air.
3. Inspect parts (1, 4 and 7) for excessive wear or damage and replace if necessary.
4. Inspect the blocks (2 and 5, Fig. 14.12) for damage or excessive wear and replace if necessary.
5. Inspect the guide bar (35, Fig. 14.1) for damage or excessive wear and replace if necessary, refer to FRONT IDLER GUIDE BARS in this Section.

16. REASSEMBLY (Refer to Fig. 14.18)

1. If removed, install two new wear rings (5) onto piston (4). Position wear rings (5) on piston (4) with cuts 180 [°] apart. Install piston seal (3) on piston (4) so that U cup of seal will be facing towards taper (retaining ring groove) end of piston.
2. Install retaining ring (2) in groove on piston (4).
3. Place a small amount of grease in bore of track adjuster (1). Insert piston assembly, seal end first, into track adjuster bore until it bottoms, so that all air be expelled. Grease appears through valve openings in track adjuster (1).
4. Thread lube fitting (10) into ball check valve (9).
5. Install ball check valve (9) and relief valve (8) on track adjuster (1) and torque to 68 [Nm].
6. Coat track adjuster bore with grease. Install a new rod wiper (6) into groove on track adjuster bore. Lip on rod wiper should face outward.
7. Install rod (7), large undercut end first, slowly and evenly into track adjuster bore until it bottoms. If too much grease was installed in track adjuster behind piston, rod wiper (6) may be forced out as rod is inserted. If this happens, remove rod and reinstall rod wiper and rod.

17. INSTALLATION

1. Slide track adjuster (rod end toward front idler) into front of track frame.
2. Install front idler, refer to INSTALLATION, Paragraph 11, in this Section.
3. Install the track chain as described in SECTION 15.
4. Adjust the track chain tension as described in SECTION 15.

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TOP IDLER

18. DESCRIPTION

The upper section of the track between the sprocket and the front idler is supported by two top idlers. The top idlers are mounted on bracket which are part of the track frame. The idlers revolve on heat-treated replaceable steel shafts, which are secured to the track frame block with a bolts (Fig. 14.20). The idlers are sealed against the entrance of dirt, water and the loss of lubricant by a seal and O-rings.
The idlers are equipped with tapered roller bearings and a metal face type seal.

19. REMOVAL

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

CAUTION! Lift and handle all heavy parts with a lifting of proper capacity. Be sure parts are secured by proper slings and hook. Use lifting eyes if provided. Warn people in the area to stand clear.

1. Release the track tension, refer to RELIEVING TRACK TENSION in SECTION 15.

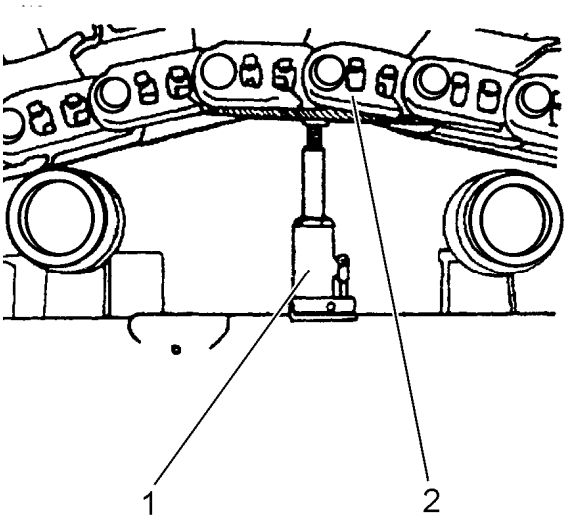

Fig. 14.19. Raising Track Chain

1. Jack 2. Track Chain

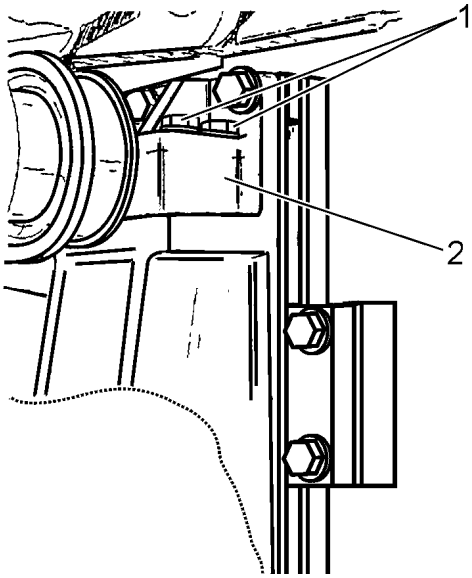

Fig. 14.20. Top Idler

1. Mounting Bolts 2. Front Top Idler Block

2. Position a jack (1, Fig. 14.19) on top of the track frame. With a wooden block placed on the jack seat, raise the track chain (2) until it is clear of the top idlers.
3. Loosen four bolts (1, Fig. 14.20) securing block (2) and spread block with a chisel. Pull the top idler from the block.

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SUSPENSION

TOP IDLER

20. DISASSEMBLY (Refer to Fig. 14.21)

1. Remove plug (1) and drain top idler. Remove spring pin (13) from seal retainer (12). Remove seal retainer (12) and half seal kit (11) from idler assembly. If oil seal inner rubber ring does not come off with seal, it can easily be pulled from idler bore. Remove second half seal kit (11) and O-ring (10) from retainer (12).
2. Turn idler assembly on its side and remove cover (2) and O-ring (3). Remove retaining ring (4) from idler shaft.
3. Place idler in a press so that it is supported by housing (7) and long shaft end is down. Press shaft (6) out of housing and remove bearing cone (5). If bearing cone (8) needs to be replaced, press cone off shaft (6). Bearing cups (5 and 8) need not be removed from housing (7) unless replacement is necessary.
4. Using coarse paper, a file or a hand grinder, remove any corrosion or hardened foreign material that may exist on seal bore surfaces of housing (7) and retainer (12). Do this carefully to avoid changing dimensions of bore.

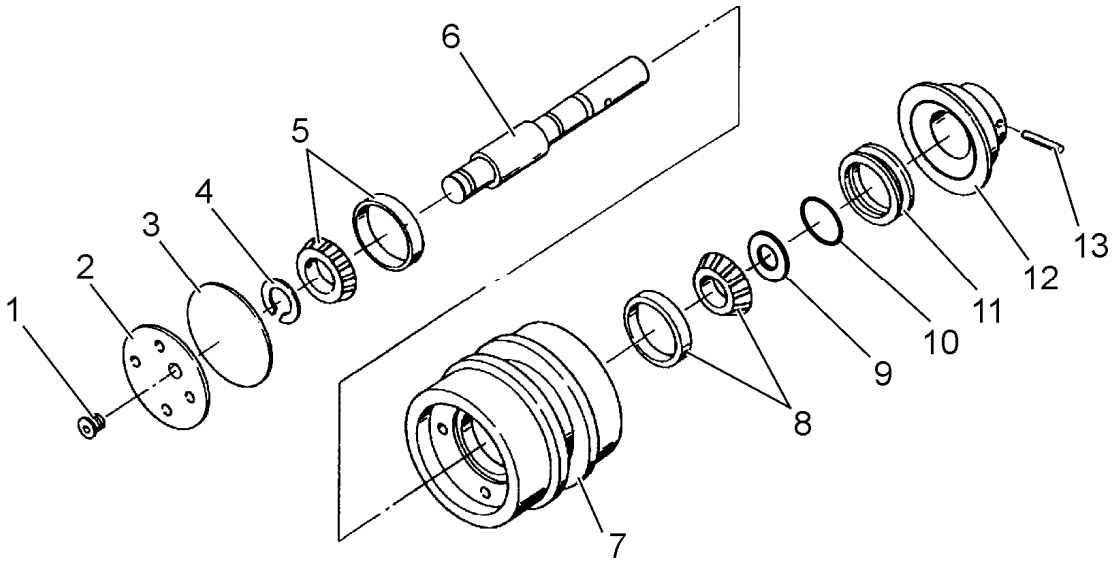

Fig. 14.21. Exploded View of Top Idler

1. Drain Plug
2. End Cover
3. O-Ring
4. Retaining Ring
5. Tapered Roller Bearing
6. Top Idler Shaft
7. Top Idler Housing
8. Tapered Roller Bearing
9. Bearing Spacer
10. O-Ring
11. Seal Kit
12. Seal Retainer
13. Spring Pin

21. INSPECTION AND REPAIR

NOTE: *Clean all parts thoroughly in a dry cleaning solvent, especially the inside of the idler. Blow all parts dry with compressed air.*

1. Inspect the bearings for cracks, scores and wear. Replace if necessary. Soak in oil, wrap and cover all re-usable bearings until ready for assembly.

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2. Check the bearing bores in the idler housing for scoring or other evidence of bearings turning in their bores. Inspect for cracks or other damage. Inspect the idler shaft for excessive wear or damage. Replace shaft if necessary. Slight burrs can be smoothed down with a stone.
3. Replace all O-rings with new.
4. It is recommended that new seal kit (11) be installed whenever the top idler is disassembled. Refer to SEAL INSPECTION under METAL TYPE FACE SEALS in this Section.

22. REASSEMBLY (FIG. 14.21)

NOTE: *To ease assembly, apply a small amount of oil, same as used to fill idler, to bearing cup bores of housing (7) and bearing cone diameters of shaft (6) prior to bearing installation.*

1. If bearing replacement was necessary press new bearing cups (5 and 8) into idler housing (7) until they bottom in bore. If bearing cone (8) was removed, press cone into shaft (6) until it is against shaft shoulder.
2. Insert shaft in idler housing (7) and position assembly in a hydraulic press so that it is supported by shaft (6). Press bearing cone (5) onto shaft (6). Install retaining ring (4). With assembly still supported by shaft (6), rotate idler housing. If it does not turn freely, tap end of shaft with a brass mallet to set bearings.
3. Install bearing spacer (9) on shaft (6) and into housing (7). Place assembly on a bench, cover plate end down. Apply a thin coating of grease to O-ring (10) and install it in retainer (12).

NOTE: *Do not at any time handle seal kit (11) with greasy, oily or dirty hands. Track idler must not be filled with lubricant until idler and track frame are in position on machine.*

4. Before installing seal assembly, be sure seal contacting surfaces of idler housing bore and seal retainer are clean. Also that rubber rings of seal assembly are correctly positioned on metal rings. Install seal. Refer to SEAL INSTALLATION under METAL TYPE FACE SEALS in this Section.
5. Install seal retainer (12) on shaft (6) so that seal bore of retainer uniformly envelops oil seal rubber ring. Position seal retainer (12) so spring pin (13) holes in shaft (6) and retainer are aligned. Install pin (13) into retainer (12) and peen over metal area around pin hole. Install cover (2) with O-ring (3) on top idler assembly. Torque cover bolts to 35 [Nm].
6. Fill idler with recommended lubricant. Refer to OPERATOR'S MANUAL for recommended lubricant. Clean threads of plug (1) and apply LOCTITE Pipe Sealant with Teflon #592. Install plug in cover (2) and torque to 20 - 50 [Nm].

23. INSTALLATION

1. Spread block of the track frame bracket with a chisel and slide the top track idler shaft into top idler block (2, Fig. 14.20) so that spring pin (13, Fig. 14.21) is in a horizontal position. Align track idler with front idler and other track idler as described in Paragraph 51, TRACK FRAME ALIGNMENT, in this Section. Remove chisel from top idler block and secure block to the track frame bracket. For the first torque the bolts (1, Fig. 14.20) located closer to the dozer centerline (two bolts for each top idler mounting block) and then torque the others. Torque bolts to 845 [Nm].
2. Lower track chain onto idlers and remove jack. Adjust track chain tension, refer to SECTION 15.

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SUSPENSION

TRACK ROLLER

24. DESCRIPTION

The track rollers are attached to the underside of the track frames and carry the weight of the dozer. The rollers are heat-treated steel forging, and rotate around bushings. The rollers are equipped with metal face type seals which maintain a leak and dirt-proof seal.

Rollers have single or double flanges, and they are positioned in the track frame as shown in Fig. 14.32.

25. REMOVAL (Refer to Fig. 14.22)

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

CAUTION! Lift and handle all heavy parts with a lifting of proper capacity. Be sure parts are secured by proper slings and hook. Use lifting eyes if provided. Warn people in the area to stand clear.

1. Release the tension in the track chain, refer to ADJUSTING TRACK TENSION in SECTION 15.
2. Wedge a steel plate between the frame and equalizer bar.
3. Remove the track roller rock shields and / or sprocket rock deflector.
4. Place a jack under the front frame and also place one under the rear main frame. Place a heavy steel plate between the jacks and the frames. This will prevent any damage being done to the rear main frame. Run up the jacks until the rollers are free of the track approximately 150 [mm].
5. Remove the bolts (1, Fig. 14.22) securing the track roller bracket (2) to the track frame.
6. If there is not enough track chain slack to remove the roller, position two small jacks (3) between the track and track frame. Jack up until sufficient clearance exists to remove the track roller.

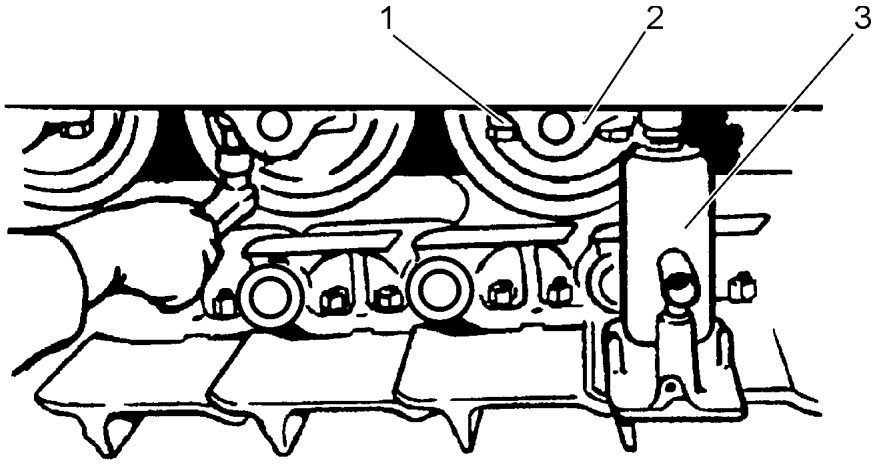

Fig. 14.22. Removing Roller

1. Bolt 2. Roller Bracket 3. Small Jacks

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26. DISASSEMBLY (Refer to Fig.'s 14.23 and 14.24)

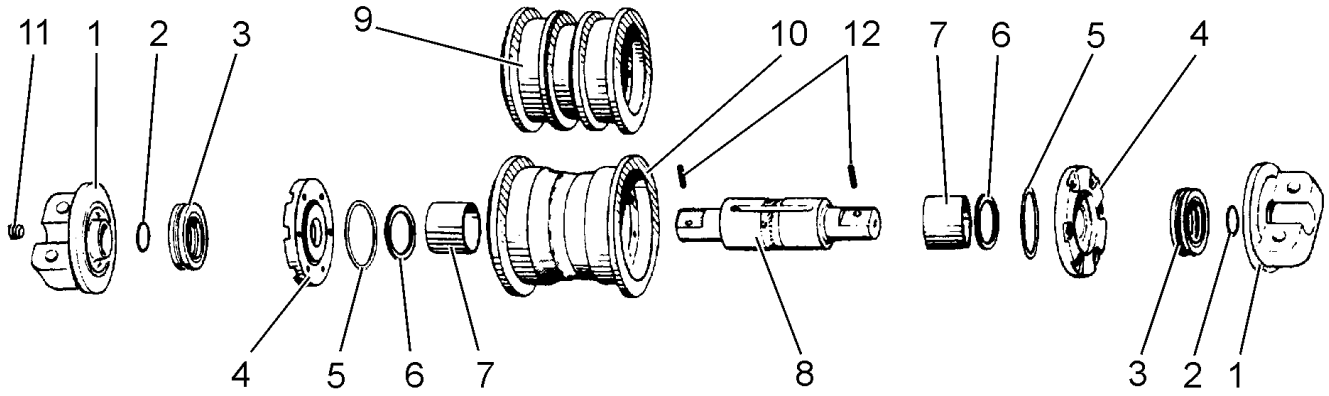

Fig. 14.23. Exploded View of Track Roller

1. Roller Bracket
2. O-Ring
3. Seal Kit
4. Roller Retainer
5. O-Ring
6. Thrust Washer
7. Track Roller Bushing
8. Track Roller Shaft
9. Track Roller Housing (Double Flange)
10. Track Roller Housing (Single Flange)
11. Drain Plug
12. Spring Pin

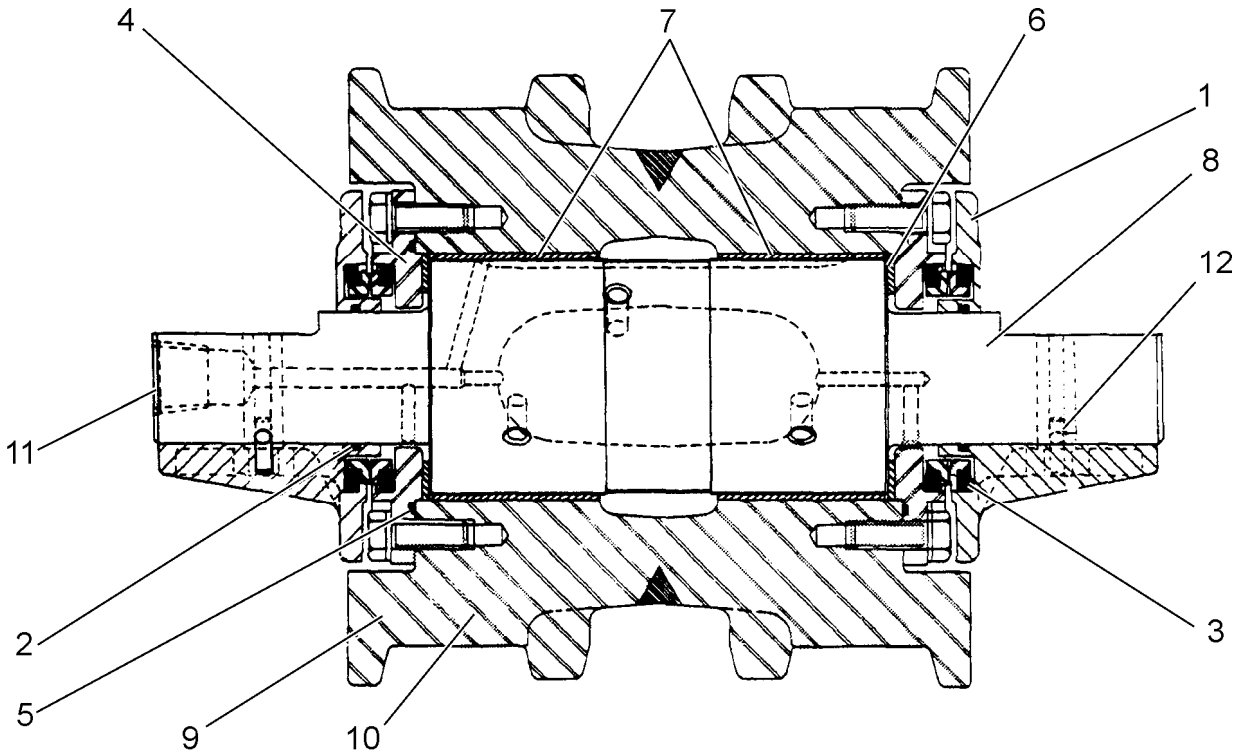

Fig. 14.24. Cross Section View of Track Roller

1. Roller Bracket
2. O-Ring
3. Seal Kit
4. Roller Retainer
5. O-Ring
6. Thrust Washer
7. Track Roller Bushing
8. Track Roller Shaft
9. Track Roller Housing (Single Flange)
10. Track Roller Housing (Double Flange)
11. Drain Plug
12. Spring Pin

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TRACK ROLLER

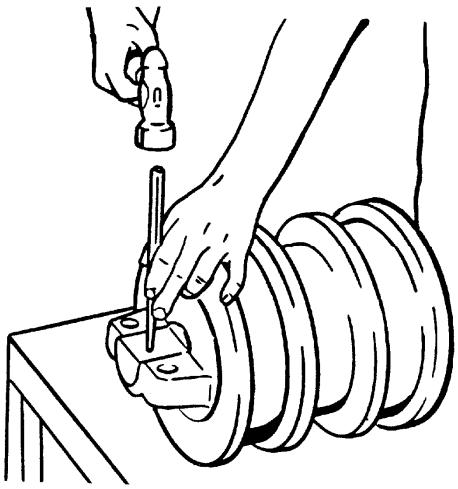

Fig. 14.25. Removing Spring Pin

1. Remove drain plug (11) and drain track roller. Drive out spring pin (12) securing the bracket (1) on each side of the shaft (8) as shown in Fig. 14.25.
2. Remove the track roller shaft brackets (1) with the O-rings (2) and the stators of the seals kit (3). Discard the O-rings. Remove the seal kit stators from the brackets and discard the rubber rings.
3. Remove the bolts securing the roller retainers (4) to each side of the roller housing and remove the retainers with O-rings (5) and the rotors of the seals kit (3). Discard the O-rings (5). Remove the seal kits from the retainers.

IMPORTANT: *Keep original mated metal rings as a set, Do not mix a metal ring from the oil seal on one side of the roller with a metal ring from the oil seal on the opposite side of the roller.*

4. Remove the washers (6). With parts removed from both sides of the roller housing, remove the shaft (8) from the roller housing and bushings (7).
5. The bushings (7) are pressed into the roller housing. When replacement is necessary, they can be pressed from position.

27. INSPECTION AND REPAIR

1. Wash all the parts thoroughly in a solvent and dry with compressed air. Wash all the bushings. Clean and flush out the bore of the track roller, as well as the oil passage in the roller shaft.
2. Replace all O-rings with new.
3. Inspect the roller shafts, bushings and rollers for cracks, scores or excessive wear. Refer to Paragraph 28, REASSEMBLY for installing new bushings.
4. Determine if the washers are worn beyond the limits given in Fig. 14.26. If worn, replace with new.
5. Check the end clearance and diametral clearance given in Fig. 14.26.
6. It is recommended that new seal kits (3) be installed whenever the track roller is disassembled. Refer to SEAL INSPECTION under METAL TYPE FACE SEALS in this Section.

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TRACK ROLLER

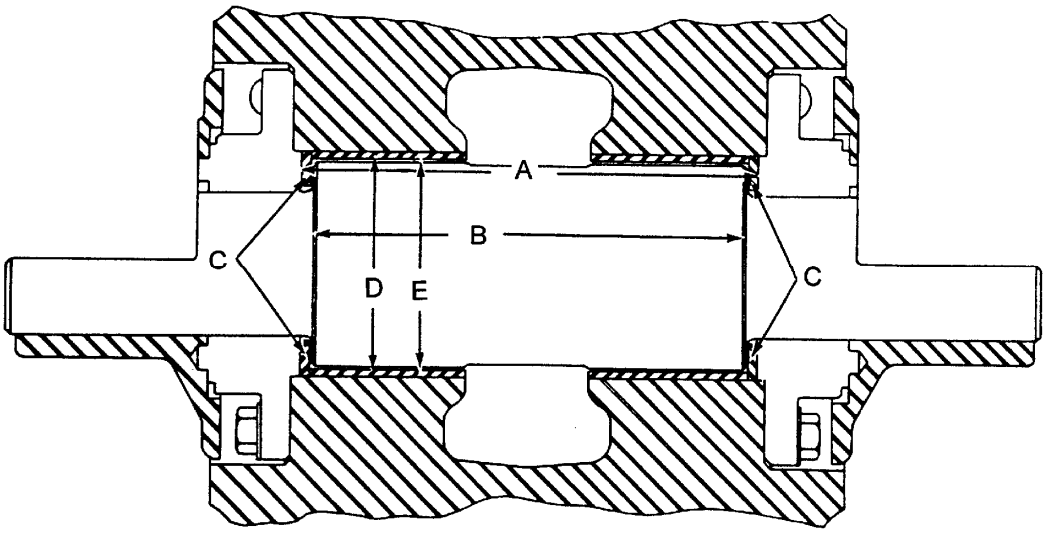

Fig. 14.26. Track Roller Bushing Clearance

A. Distance Between Seal Retainer Surfaces	216.2 ± 0.15 [mm]
B. Width of Idler Shaft Bearing Surfaces	209.35 ± 0.05 [mm]
C. Thrust Washer Thickness (each)	3.14 ± 0.04 [mm]
D. Bushing Inside Diameter (assembled)	105.3 ± 0.05 [mm]
E. Roller Shaft Diameter	104.93 ± 0.05 [mm]
Diametral Clearance (D-E)	0.35 ± 0.1 [mm]
End Clearance A-(B+2C)	0.6 ± 0.3 [mm]

28. REASSEMBLY (Refer to Fig.'s 14.23 and 14.24)

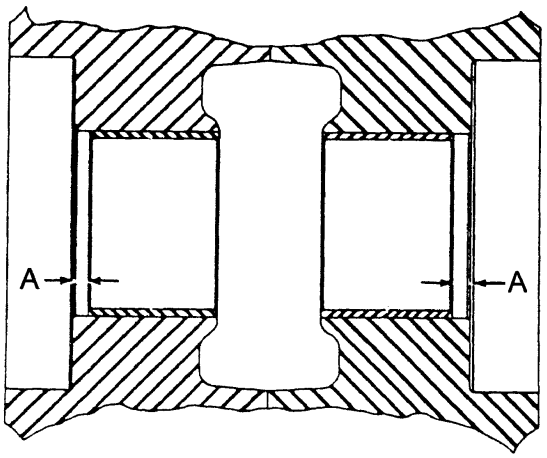

Fig. 14.27. Bushing Installation

A. Bushing Pressed Below Edge of Roller Bore	7.06 ± 0.64 [mm]

1. If replacing bushings (7), coat 25 [mm] of outer end of roller bore and leading edges of bushing OD with LOCTITE #601. Press bushing in as indicated in Fig. 14.27.

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TRACK ROLLER

IMPORTANT: *Do not at any time handle the oil seal with greasy, oily dirty hands. The track rollers must not be filled with lubricant until the rollers and track frame are in position on the dozer.*

2. Before installing seal kit assembly, be sure seal contacting surfaces of retainer and track roller shaft bracket are clean. Also that rubber rings of seal assembly are correctly positioned on metal rings. Refer to SEAL INSTALLATION under METAL TYPE FACE SEALS in this Section.
3. Install the washer (6) in the roller bore. Apply a small amount of grease to O-ring (5) and install in groove in retainer (4). Apply LOCTITE #262 to threads and secure the retainer to the roller housing. Torque the bolts to 135 [Nm]. To prevent roller assembly from moving as bolts are torqued, a strap can be used to secure roller housing to bench as shown in Fig. 14.28.

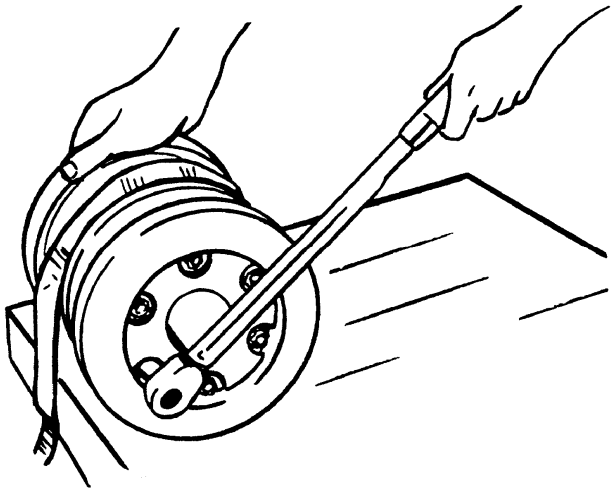

Fig. 14.28. Torquing Bolts

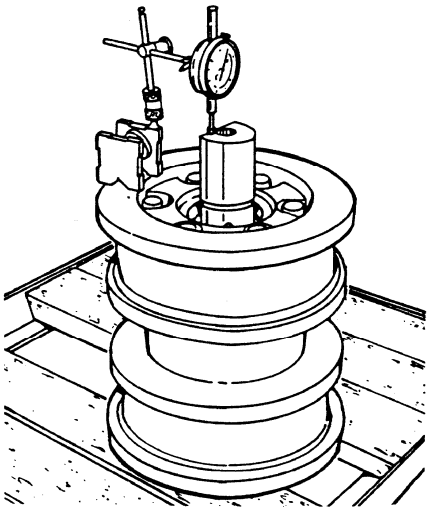

Fig. 14.29. Roller end Clearance

4. Insert the shaft (8) into the roller housing so the end of the shaft with drain plug (11) is on the same side as the two drilled holes in the roller housing. Install the washer (6), O-ring (5) and retainer (4) on the opposite side of the roller housing as was done previously.
5. Check that track roller end clearance is within tolerance given in Fig. 14.26. From side of roller dial indicator is to be mounted to, push roller shaft into housing to be sure it is bottomed against washer (6). Place dial indicator magnetic base on roller housing with indicator pointer resting against end of shaft. Set indicator at zero (Fig. 14.29). Pull up on shaft until it bottoms and take a reading. If reading obtained is below specification, check surfaces (A, B and C, Fig. 14.26) for squareness. If above specifications, check parts for excessive wear.
6. Install the seal kit (3) as described in SEAL INSTALLATION under METAL TYPE FACE SEAL in this Section.
7. Install the O-ring (2) into the groove on the inside of the roller bracket (1) and lubricate the O-ring with chassis lubricant.
8. Install roller bracket (1) on shaft (8). Apply hand pressure to roller bracket (1) as shown in Fig. 14.30 until spring pin holes are aligned. Install spring pin (12) until it is slightly below bracket surface and peen over bracket casting to maintain its position. Repeat on opposite side of roller.
9. Fill track roller with recommended lubricant. Refer to OPERATOR'S MANUAL for recommended lubricant. Clean threads of plug (11) and apply LOCTITE Pipe Sealant with Teflon #592. Install plug in track roller shaft (8) and torque to 20 - 50 [Nm].

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TRACK ROLLER

29. INSTALLATION

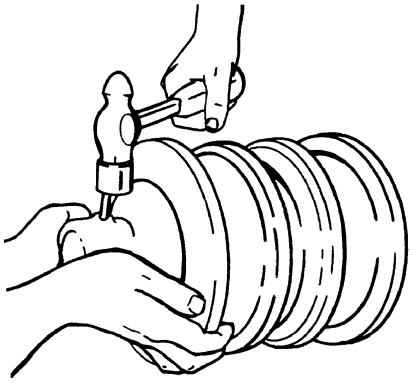

Fig. 14.30. Installing Spring Pin

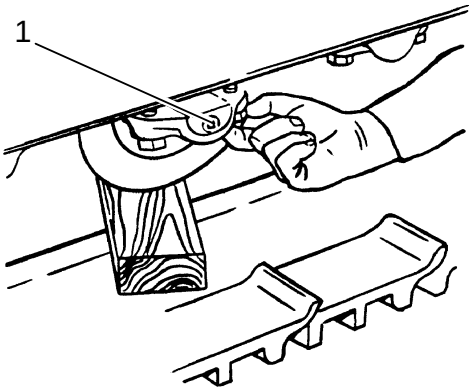

Fig. 14.31. Installing Roller

1. Drain Plug

1. Clean the inside and lower faces of the track frame inner and outer rails in the areas that contact the brackets when the roller are installed.

NOTE: *When securing the track roller shaft bracket to the track frame, install the forward bolt with just enough force to bring the bracket in contact with the frame rail. Install the rear bolt completely and torque. Apply full torque to the front bolt. Torque bolts to 845 [Nm].*

2. Install the roller assembly in the track frame so that the end of the shaft for the drain plug (1, Fig. 14.31) is to the outside of the dozer.
3. Remove the small jacks from between the track frame.
4. Release the jacks under the front frame and rear main frame slowly until the slot in the track frame and track roller are in position.
5. Secure the roller in position by installing bolts through the track roller shaft brackets and into the track frame. Tighten the bolts evenly. Release the jacks the rest of the way.
6. Remove the steel wedge from between the equalizer bar and the track frame.
7. Install the roller shield and / or sprocket rock deflector. Torque bolts to 845 [Nm].
8. Adjust the track chain tension, refer to ADJUSTING TRACK TENSION in SECTION 15.

30. ARRANGEMENT OF TRACK ROLLERS (Refer to Fig. 14.32)

The seven-roller track frame uses a total of four double-flange and three single-flange track rollers on each side. Track rollers 2, 4 and 6 on each side of dozer have single flanges (SF) and 1, 3, 5 and 7 have double flanges (DF).

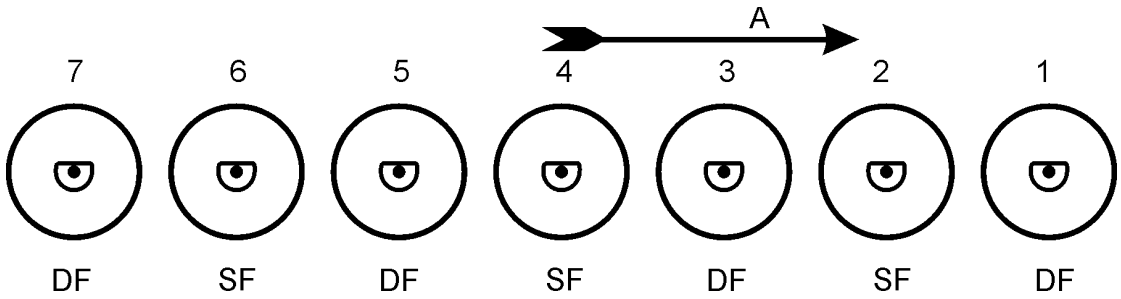

Fig. 14.32. Track Roller Arrangement

SF - Single Flanged DF – Double Flanged A. Front of Machine

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SUSPENSION

TRACK FRAME GUIDE

31. DESCRIPTION

The track frame guides allow the track frames to oscillate vertically on guide plates. The guide plates are secured to the guide bracket, which is a welded part of the front frame, by four bolts. The wear plates and guide spacers are secured between the track frame and guide retainer by bolts.

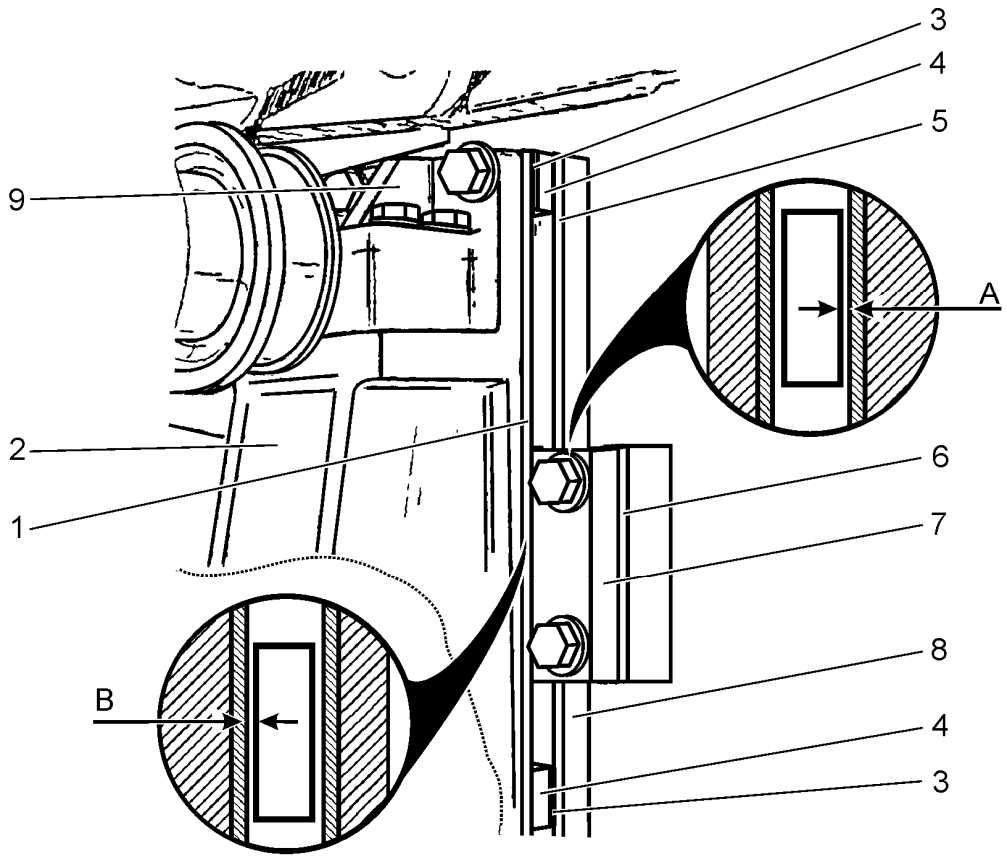

Fig. 14.33. Track Frame Guide

1. Wear Plate
2. Track Frame
3. Shims
4. Spacer Block
5. Wear Plate
6. Shims
7. Guide Plate
8. Retainer Plate
9. Front Top Idler Mounting Bracket

32. REMOVAL (Refer to Fig. 14.33)

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

CAUTION! Lift and handle all heavy parts with a lifting of proper capacity. Be sure parts are secured by proper slings and hook. Use lifting eyes if provided. Warn people in the area to stand clear.

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TRACK FRAME GUIDE

NOTE: *Track frame does not have to be removed to service track frame guides.*

NOTE: *When the track frame guides are disassembled in order their repair or replace, shims must be applied and clearance adjustment (A and B, Fig. 14.33) to 1.0 [mm] must be followed.*

NOTE: *When the track frame guides are disassembled in order repair or replace of other parts of the machine, the guides must be checked for excessive wear and replace, if necessary. At assembly new or old guides adjust clearance (A and B, Fig. 14.33) to 1.0 [mm].*

1. Remove the track chain as described in SECTION 15. Position suitable blocking under front and rear of track frame. Remove front top idler, refer to Paragraph 19, REMOVAL in this Section.
2. Remove bolts securing retainer plate (8) to track frame and front top idler block (9) and remove plates (8 and 5), spacer blocks (4), shims (3) and plate (1). Keep shims with spacer blocks for proper installation.
3. Remove bolts securing plate (7) to machine frame and remove plate with shims (6). Keep shims with plate for proper installation.

33. INSPECTION AND REPAIR

1. Wash all parts thoroughly in a suitable solvent. Dry thoroughly with compressed air.
2. Check the guide bracket for broken welds. Any track frame guide parts that are damaged must be replaced with new parts.
3. Inspect the wear plates and the guide plate for excessive wear, refer to SPECIFICATIONS in this Section. Replace if necessary.

34. INSTALLATION (Refer Fig. 14.33)

1. Secure plate (7) to machine frame with same thickness of shims (6) as were removed. Torque bolts to 1500 [Nm].
2. Position plate (1) between track frame and plate (7). Insert top bolts through holes in front top idler block and plate (1) and install spacer block (4). Position plates (5 and 8) between plate (7) and machine frame and loosely secure with bolts. Install shims (3) between spacer block (4) and plate (1).
3. Working from underneath machine, position spacer block (4) between plates (1 and 5) and insert hardware. Install shims (3) between spacer block (4) and plate (5). Torque all bolts 1500 [Nm].
4. Measure clearances A and B (Fig. 14.33). If total of clearances is 6.5 [mm] or more, adjust by removing shims (3) from between spacer blocks (4) and plates (1 and 5). Remove enough shims to reduce the total clearance (A+B) to 1.0 [mm]. Keep the removed shims for future use. If removal of all shims (3) will not provide a total clearance of less than 6.5 [mm], replace worn plates (1 and 5) and guide plate (7) as required. Reinstall shims and repeat check. Lubricate track frame guides. Apply grease into clearance A and B.
5. Install front top idler, refer to Paragraph 23, INSTALLATION, in this Section. Remove blocking under front and rear track frame. Install the track chain as described in SECTION 15.

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SUSPENSION

EQUALIZER BAR

35. DESCRIPTION

The equalizer bar supports the front of the dozer and permits track oscillation. The equalizer bar is fitted with bushings to take the wear as the track frame oscillates. The ends of the equalizer bar ride on wear pads inserted into the track frames and plates.

36. REMOVAL (Refer to Fig. 14. 34)

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

CAUTION! Lift and handle all heavy parts with a lifting of proper capacity. Be sure parts are secured by proper slings and hook. Use lifting eyes if provided. Warn people in the area to stand clear.

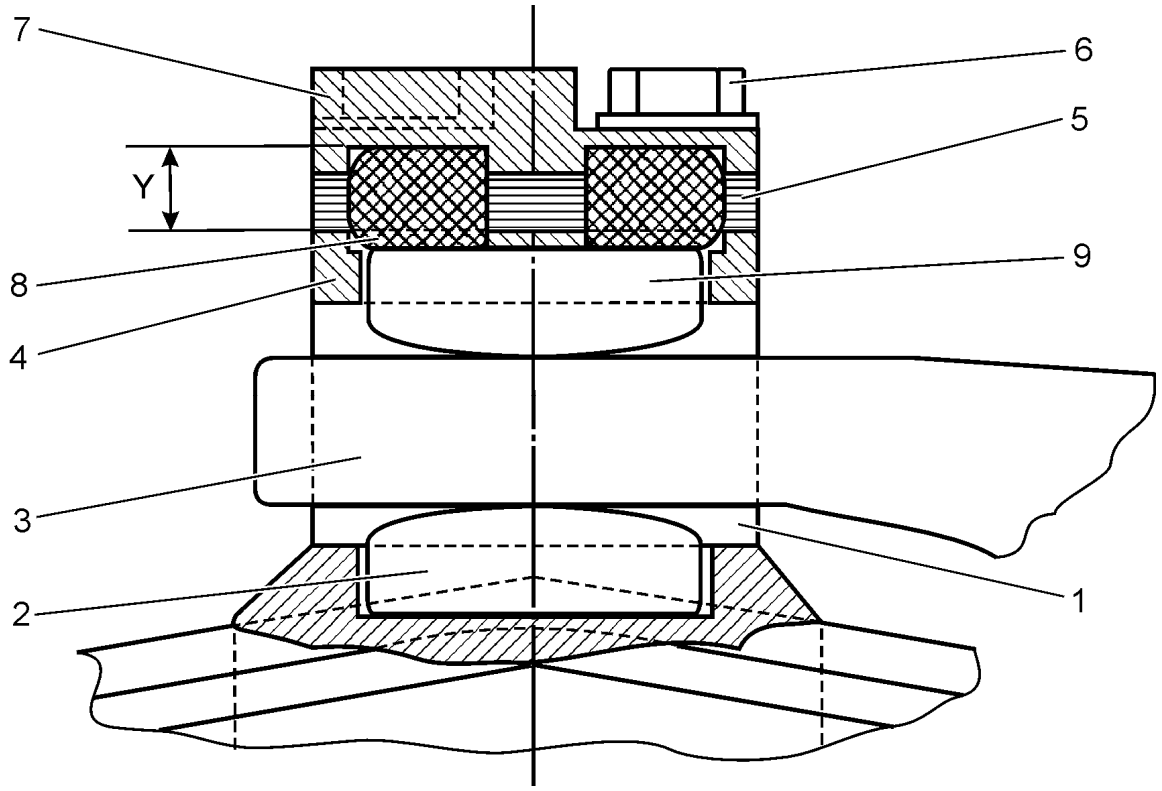

Fig. 14.34. Equalizer Bar

1. Track Frame Bracket
2. Wear Pad
3. Equalizer Bar
4. Equalizer Bar Plate
5. Shims
6. Bolts with Washer
7. Equalizer Bar End Cover
8. Insert
9. Wear Pad

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EQUALIZER BAR

1. Remove crankcase guard and transmission case guard.
2. Unscrew bolts (6) with washers and remove cover (7) with shims (5). Keep shims with cover for proper installation. Remove insert (8), plate (4) and wear pad (9). Repeat this procedure on the opposite side of the machine.
3. Jack up front of machine until weight is off equalizer bar and install blockings or jack stands under main frame.
4. Unscrew bolts securing shaft (34, Fig. 14.1) and push shaft out of equalizer bar tunnel.
5. Remove equalizer bar (23, Fig, 14.1) out either side of tunnel. If replacement is necessary remove seal ring (25) and press bushings (24) out of equalizer bar (23). If replacement is necessary remove two shaft bushings located inside equalizer bar tunnel.
6. Take off wear pads (2) from track frame brackets (1).

37. INSPECTION AND REPAIR

1. Wash all parts thoroughly in a suitable solvent. Dry thoroughly with compressed air.
2. Inspect equalizer bar, plates, wear pads and inserts for excessive wear or damage and replace if necessary.

38. INSTALLATION (Refer to Fig. 14. 34)

1. If shaft bushings in tunnel were removed install new bushings in equalizer bar tunnel. If bushings (24, Fig. 14.1) were removed, press new bushings into equalizer bar (23) until flush and install new seal rings (25).
2. Be sure wear pads (2) are in place on track frame brackets (1).
3. Insert equalizer bar (23, Fig. 14.1) in tunnel and align shaft holes. Lightly grease shaft (34) and install in tunnel. Secure the shaft with bolts to the machine. Torque bolts to 520 [Nm].
4. Jack up front of machine, remove blockings or jacks and lower front of machine until equalizer bar (3) rests on wear pads (2).
5. Install plate (4), wear pad (9), insert (8) and cover (7) with shims (5). Torque bolts (6) with washer to 520 [Nm]. Repeat this procedure on the opposite side of the machine.
6. If one of parts (2, 3, 4, 7, 8 and 9) was replaced, install new parts as described above (Step 1 to 5) without torquing bolts (6):
   a. Screw bolts up to the first resistance.
   b. Measure the gap Y between plate (4) and cover (6) from both sides of insert (8).
      Determine the number S of shims (5) for both sides as shown below:

$$S = \frac{Y - 10}{1.5}$$

      max. number of shims 15 x 2 pcs. for one side
      1.5 [mm] - thickness of one shim
   c. Install shims (5) and torque the bolts (6) with washer to 520 [Nm].
7. Follow the same steps for the other end of the equalizer bar (3).

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SUSPENSION

FRONT IDLER GUIDE BARS

39. DESCRIPTION

The front idler guide bars provide free displacement of the idler blocks of the front idler. The upper and lower guide bars are welded to the track frame.

40. REMOVAL (Refer to Fig. 14.35)

1. Remove track chain, refer to SECTION 15.
2. Remove front idler assembly, refer to FRONT IDLER in this Section.

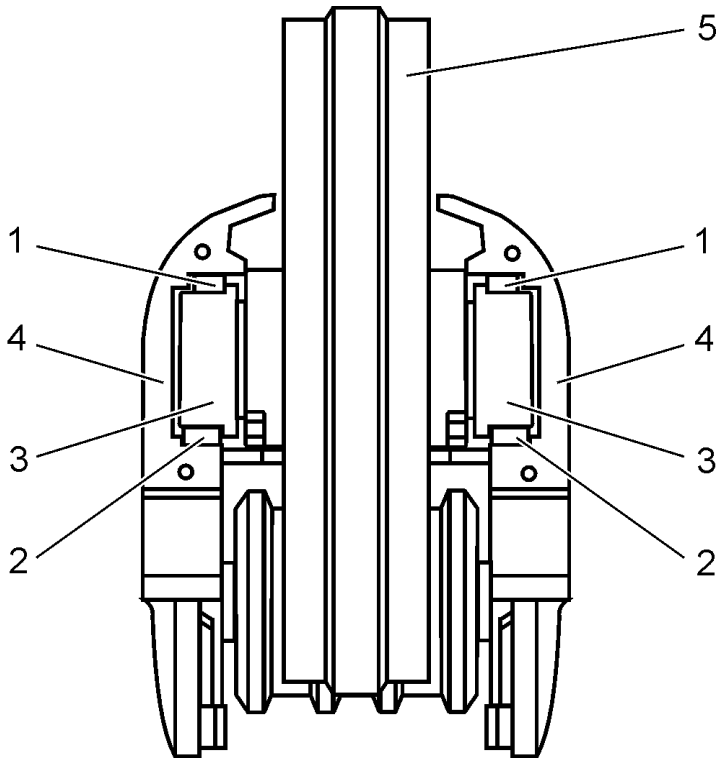

Fig. 14.35. Front Idler Lower and Upper Guide Bars

1. Upper Guide Bar
2. Lower Guide Bar
3. Front Idler Block
4. Track Frame
5. Front Idler

41. INSPECTION AND REPAIR

1. Inspect the front idler guide bars for distortion or excessive wear, refer to Paragraph 3, SPECIFICATIONS in this Section. Any guide bars are damaged or worn must be replaced with new parts.

NOTE: *Do not replace only one bar. Replace as a set.*

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FRONT IDLER GUIDE BAR

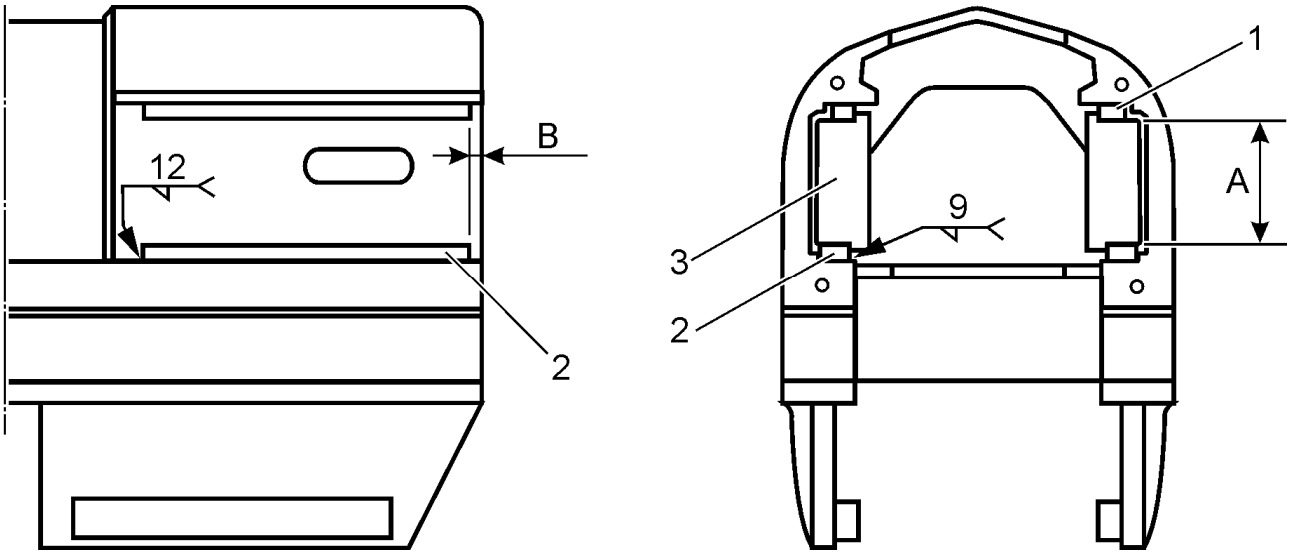

Fig. 14.36. Front Idler Guide Bars

1. Upper Guide Bar
2. Lower Guide Bar
3. Idler Block

A. Minimum Distance Between Upper and Lower Guide Bars . . . . . 166.1 ± 0.05 [mm]
B. Guide Bar Distance from Track Frame Edge . . . . . 43.5 ± 1.5 [mm]

42. INSTALLATION (Refer to Fig. 14.35)

1. Position upper and lower guide bars (1 and 2) to track frame (4).
2. Prior to positioning new guide bar to the track frame preheat guide bar to 180 - 230 [°C]. Position new guide bar to dimensions shown in Fig. 14.36 and clamp in place. Lay a 6 [mm] weld along the length of the bars. Lay a 12 [mm] weld along the front and rear ends of the bars.
3. Measure distance (A, Fig. 14.36) between upper guide bar (1) and lower guide bar (2) on both sides.
4. Lubricate guide bars inside track frame.
5. Install the front idler assemble, refer to FRONT IDLER in this Section.
6. Install the track chain, refer to SECTION 15.
7. Adjust the track tension, refer to the ADJUSTING TRACK TENSION in SECTION 15.

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43. DESCRIPTION

There are two track chain guide bars in the front part of the track frame (under the front idler guide bars). The track chain guide bars are responsible for suitable guidance of the track chain in the front part of the track frame. They are welded to the track frame interior.

44. REMOVAL (Refer to Fig. 14.37)

ALL WELDS TO BE 6 [mm]

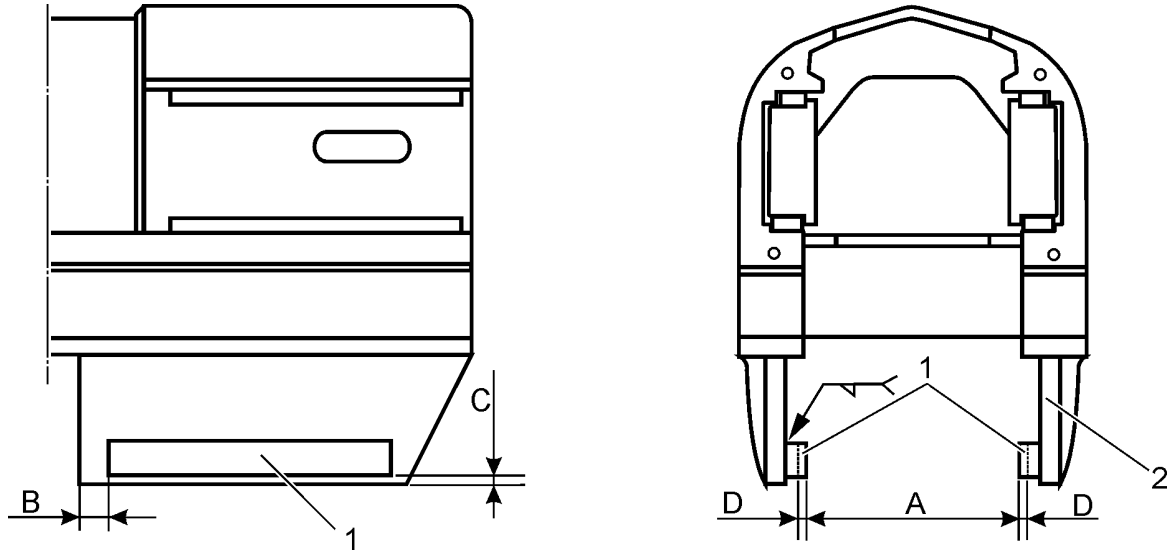

Fig. 14.37. Front Idler Guide Bars

1. Track Chain Guide Bars 2. Track Frame

A. Minimum Distance Between Track Chain Guide Bars . . . . . 297.2 ± 1.5 [mm]
B. Track Chain Guide Bar Distance from Track Frame Edge . . . . . 10 ± 1.5 [mm]
C. Track Chain Guide Bar Distance from Track Frame Edge . . . . . 9 ± 1.5 [mm]
D. Guide Bar Wear Limit . . . . . 2 [mm]

1. Remove track chain, refer to SECTION 15.
2. Remove front idler assembly, refer to FRONT IDLER in this Section.
3. If the guide bars (1) are worn (refer to Inspection and Repair below), cut the welds out from the track frame. Smooth the mating surface at the frame for new guide bars to be fitted.

45. INSPECTION AND REPAIR

1. Inspect the track chain guide bars for distortion or excessive wear, refer to Paragraph 3, SPECIFICATIONS in this Section. Any guide bars are damaged or worn must be replaced with new parts.

NOTE: *Do not replace only one bar. Replace as a set.*

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TRACK CHAIN GUIDE BAR

46. INSTALLATION (Refer to Fig. 14.37)

1. Position the track chain guide bars (1) to the track frame (2).
2. Prior to positioning the track chain guide bars to the track frame preheat guide bar to 180 – 230 [^{o}C]. Position new track chain guide bars to dimensions shown in Fig.14.37 and clamp in place. Lay a 6 [mm] weld along the length, front and rear ends of the bars.
3. Measure distance (A) between the track chain guide bars (1).
4. Install the front idler assemble, refer to FRONT IDLER in this Section.
5. Install the track chain, refer to SECTION 15.
6. Adjust the track tension, refer to the ADJUSTING TRACK TENSION in SECTION 15.

TRACK FRAME AND PIVOT SHAFT

47. DESCRIPTION

Track Frame

Each track frame has seven track rollers and two track top idlers attached to it. The track spring housing is a permanent welded part of the track frame, with the heavy coil springs being trapped within it. The track frames are attached at the rear to the pivot shaft and at the front to the track frame guides. A guide bracket is welded to each side of the front frame to provide the proper spacing between the two tracks. A hydraulic track adjuster and coil springs are located between the two channels of the track frame and slide back and forth to take up shock loads and for adjusting the track chain tension.

Pivot Shaft

The pivot shaft supports the rear track frame and permits free track oscillation in conjunction with the guides frame. It is fitted with bushings to take the wear as the frames oscillate. One end of the shaft is bolted to the main frame, while the other is bearing mounted to the track frame. The bearing is lubricated in an oil reservoir within the track frame.

48. REMOVAL AND DISASSEMBLY (Refer to Fig.'s 14.40 and 14.41)

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

CAUTION! Lift and handle all heavy parts with a lifting of proper capacity. Be sure parts are secured by proper slings and hook. Use lifting eyes if provided. Warn people in the area to stand clear.

IMPORTANT**:** *Disconnected hydraulic lines must be properly capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Remove all dirt accumulation from the main frame cover. Tag disconnected lines to facilitate faster and correct installation*.

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SUSPENSION

TRACK FRAME AND PIVOT SHAFT

1. Remove blade with push arm, refer to SECTION 17.
2. Machines with “TILT” only (connection at RH side), and with “TILT/PITCH” (connection at both sides). Unscrew bolts and pull the trunnion (1, Fig. 14.38) out with hoses (4). Unscrew the separate flanges (3) that secure hydraulic hoses (4) to the trunnion (1). Remove O-rings (2) and discard them. Remove cover (14, Fig. 14.41) from the track frame (1), pull the hoses (4, Fig. 14.38) out of the frame and tie them up out of the way.
3. Remove track chain, refer to SECTION 15. It is necessary to remove tracks from under machine.
4. Remove front idler assembly, refer to FRONT IDLER in this Section.
5. Remove inner and outer sprocket rock deflectors from rear of track frame.
6. Install blocks in equalizer bar tunnel on each side of machine to prevent movement of equalizer bar. Remove equalizer bar elastic suspension, refer to EQUALIZER BAR in this Section.

NOTE: *Whenever possible, an adjusting sling should be used to remove track frame. With an adjusting sling, track frame can be tilted or leveled as required, reducing job time, effort and hazard.*

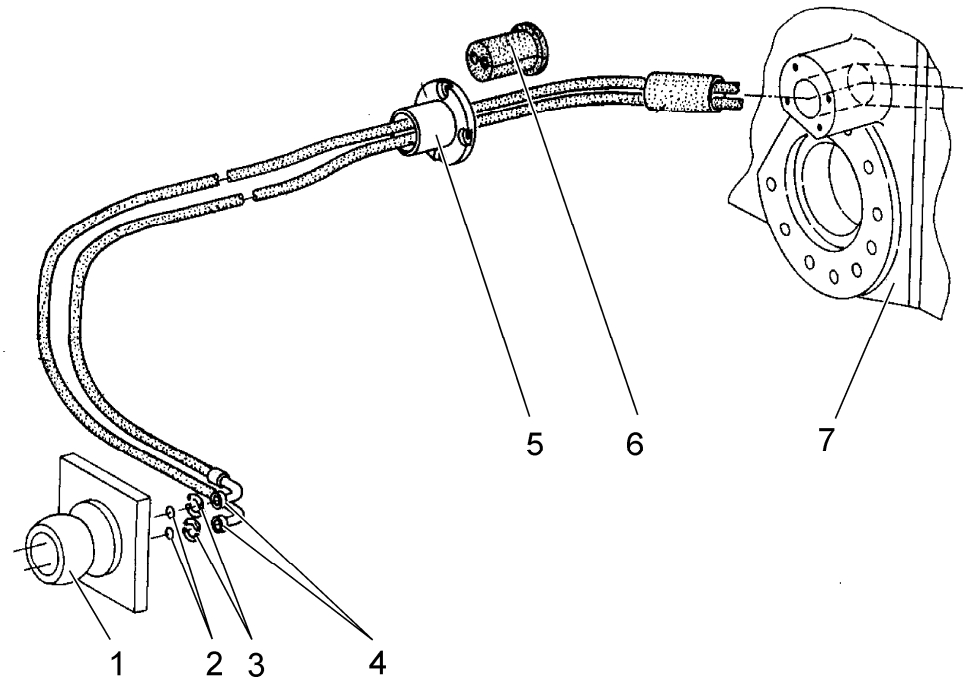

Fig. 14.38. Blade Tilt (or Tilt/Pitch) Hydraulic Hoses Disconnection

1. Trunnion
2. O-Ring
3. Split Flange
4. Hydraulic Hose
5. Flange Guard
6. Hose Guard
7. Main Frame

7. Remove guide plate and shims from main frame, refer to TRACK FRAME GUIDE in this Section. Keep shims with guide plate for proper installation.
8. Jack front and rear of machine up and block it securely. Machine should be raised high enough for track rollers and shields to clear chain. Attach a hoist to two track idlers as shown in Fig. 14.39. Lift track frame load off pivot shaft and track chain.

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TRACK FRAME AND PIVOT SHAFT

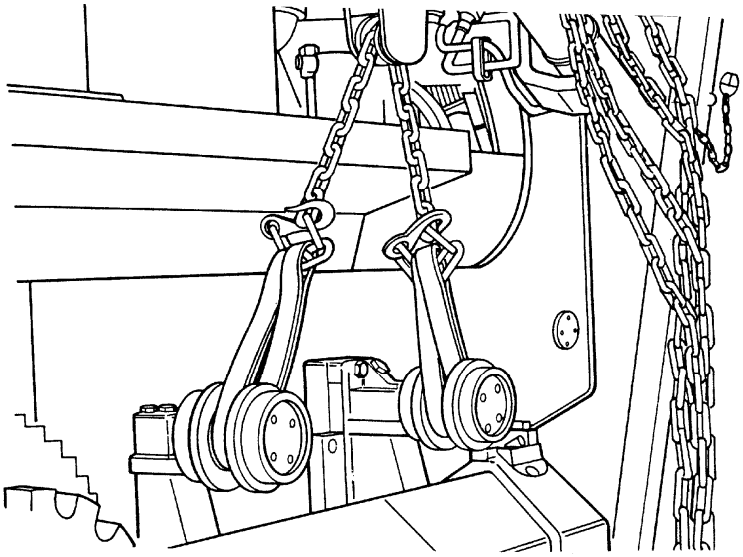

Fig. 14.39. Track Frame Removal

9. Unscrew bolts with washers securing cover (2, Fig.'s 14.40 and 14.41) to the track frame (1) and remove cover (2) with O-ring (13). Discard O-ring (13).
10. Remove outer wear washer (7), retaining plate (6), inner wear washer (7) and shims (8) from end of pivot shaft (5). Keep shims (if present) with plate (6) to facilitate installation.
11. Unscrew bolts with washers securing the snap ring (4) and seal shield (3) to the track frame (1) and move back ring (4).
12. Using a pry bar between track frame and main frame, move track frame out horizontally. Swing track frame from pivot shaft and away from machine.

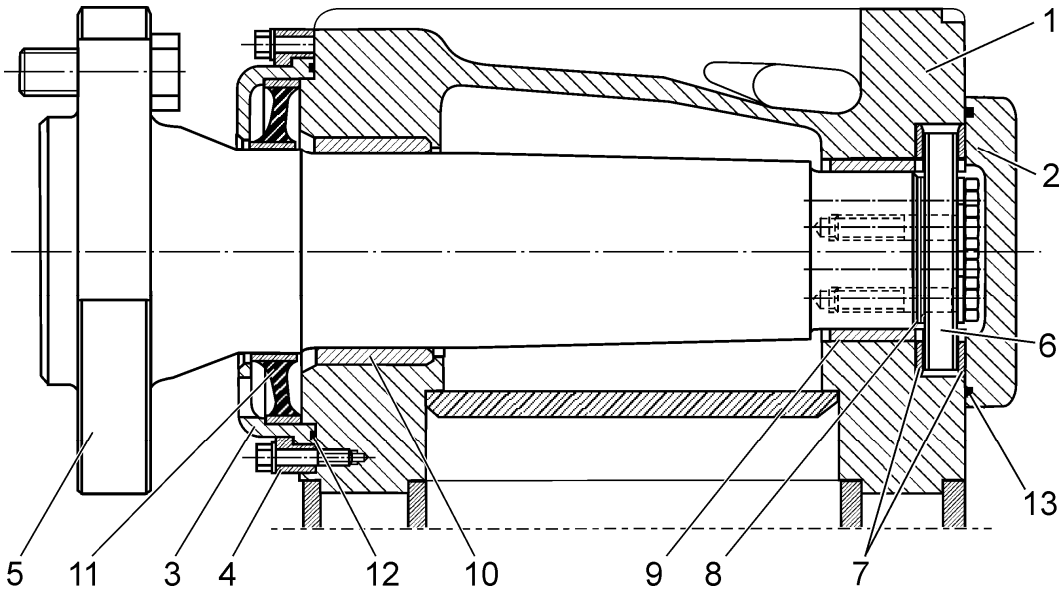

Fig. 14.40. Cross Section View of Track Frame and Pivot Shaft

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SUSPENSION

TRACK FRAME AND PIVOT SHAFT

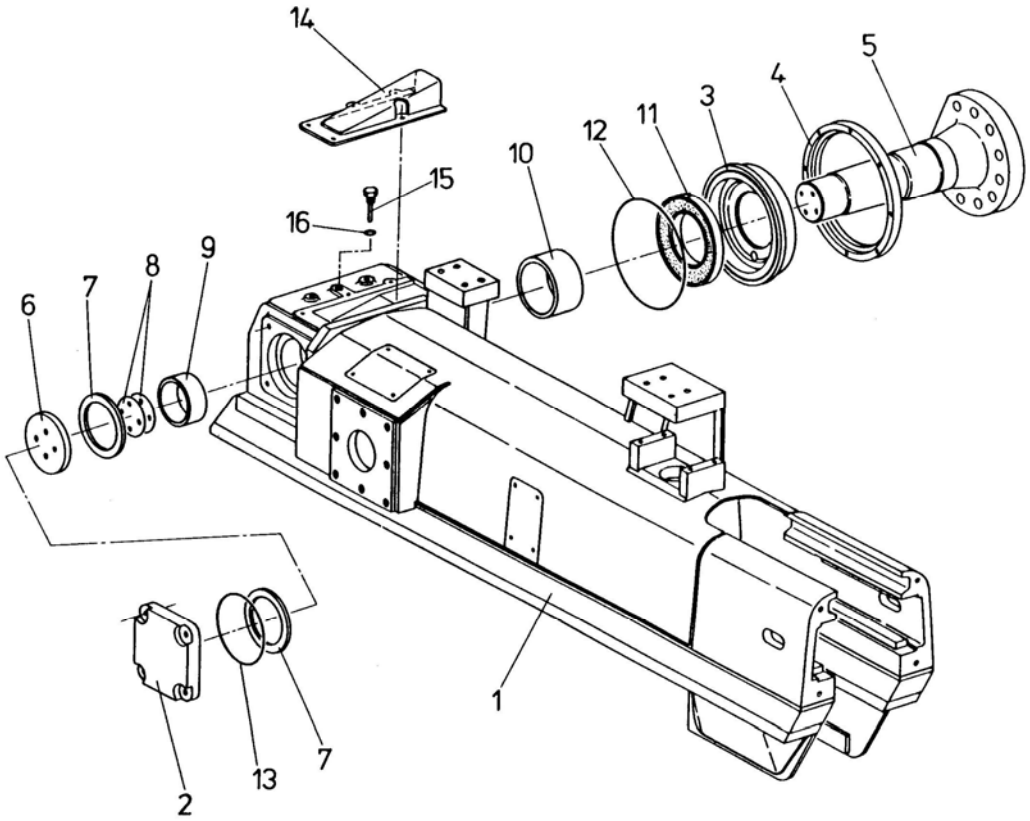

Fig. 14.41. Exploded View of Track Frame and Pivot Shaft

Legend For Fig.'s. 14.40 and 14.41

1. Track Frame	5. Pivot Shaft	9. Bushing	13. O-Ring
2. Shaft Cover	6. Retaining Plate	10. Bushing	14. Cover
3. Seal Shield	7. Wear Washer	11. Pivot Shaft Seal	15. Oil Level Dipstick
4. Snap Ring	8. Shim	12. O-Ring	16. O-Ring

13. Use the knife to cut the rubber insert of the seal (11) to separate outer and inner rings.
14. Remove O-ring (12) and seal shield (3) with outer ring of seal (11) inside. Discard O-ring (12) and seal shield (3) with outer part of seal (11).
15. Preheat the seal inner ring (11) to remove inner ring stuck to the pivot shaft (5). To do it, use suitable puller.
16. Remove snap ring (4) from the pivot shaft (5).
17. Remove the track rollers. Refer to TRACK ROLLER in this Section.
18. Remove top idlers and top idler mounting brackets, if required. Refer to TOP IDLER in this Section.
19. If bushings (9 and 10) need replacement, they can be removed with aid of a portable hydraulic press.
20. Remove the pivot shaft (5) from machine as follows:
    a. Attach a hoist sling to the pivot shaft. The hoist must be installed to give the best possible balance. Place tension on the hoist.
    b. Unscrew bolts securing the pivot shaft to the machine. Remove the pivot shaft from machine.

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TRACK FRAME AND PIVOT SHAFT

49. INSPECTION AND REPAIR

1. It is recommended that all new O-rings and oil seals be installed when track frame removing.
2. Check surface for sharp corner. If necessary, grind and polish. Remove LOCTITE from stuck surfaces and clean with proper solvent
3. Inspect wear washers, retaining plates, shaft seals, seal shields, pivot shaft and bushings for damage or excessive wear.
4. Inspect guide bars for distortion or broken welds. If replacement is necessary, cut bars off track frame and replace.
5. Inspect the track frame for damage and excessive warpage.

50. REASSEMBLY AND INSTALLATION (Refer to Figs 14.40 and 14.41)

1. Install the pivot shaft (5) to machine as follows:
   a. Attach a hoist sling to the pivot shaft. The hoist must be installed to give the best possible balance. Position the pivot shaft to the main frame.
   b. Secure the pivot shaft to the main frame. Torque the bolts to 2750 [Nm].
2. Put the snap ring (4) on pivot shaft (5).
3. Install the pivot shaft seal (11) on pivot shaft (5) as follows (Fig. 14.42):

NOTE: *Take care at seal (11) installation not to damage the rubber parts of seal.*

   a. Cover with LOCTITE #609 the outer seal (11) surfaces and press the seal into new seal shield (3); refer to Fig. 14.42.
   b. Cover with LOCTITE #609 the pivot shaft (5) mounting surface and install pivot shaft seal (11) with seal shield (3) on pivot shaft (5). The seal shield water and impurities evacuation bore (B) ∅ 25 [mm] is to point downwards.

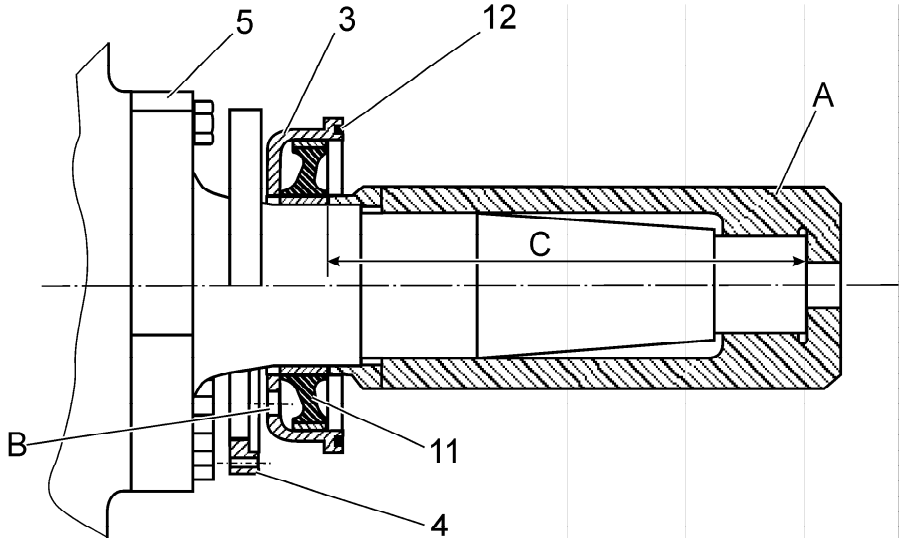

Fig. 14.42. Pivot Shaft Seal Installation

3. Seal Shield
4. Snap Ring
5. Pivot Shaft
11. Pivot Shaft Seal
12. O-Ring
A. Pivot Shaft Seal Tool (Sleeve and Ring)
B. Seal Shield Water and Impurities Evacuation Bore ∅ 25 [mm]

C . . . . . 488.5 ± 0.8 [mm]

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c. First, slide the ring 1.547.0397 of pivot shaft seal tool (A) on the shaft and then slide the sleeve 1.547.0358. Press seal (11) with its seal shield (3) onto pivot shaft (5) in such a way that the tool (A) sleeve thrust face contacted the shaft face, as shown in Fig. 14.42. Check this position by tool hole. Take off the tool. Once the seal (11) took its position its distance (C) to the shaft face is to be equal to 488.5 ± 0.8 [mm].

4. Coat O-ring (12) with HIPOL 85W/140 oil or equivalent (refer to OPERATOR'S MANUAL) and insert into seal shield (3) groove.
5. If bushing (9 and 10) were removed, apply LOCTITE Primer T or N on outside surface of bushings and allow to dry completely. Be sure bore of track frame is clean and dry. Coat 35 [mm] of outer edge of track frame bore and leading edge of bushing with LOCTITE #609. Press bushings into track frame until each are flush with outside edges of track frame.

NOTE: *Bushings must be pressed in within five minutes after applying Loctite #609.*

6. Assemble the track rollers to the track frame. Refer to TRACK ROLLER in this Section.
7. Install the front top idler mounting bracket (22, Fig. 14.1) with the guide mounting face flush with the post on the track frame (1). Install rear top idler mounting bracket (21).
8. Attach a hoist to the track frame (1) and keeping it horizontal, position it over pivot shaft (5).
9. Install track frame guide plate with same thickness shims were removed,
10. With the track frame in horizontal position secure snap ring (4) with seal shield (14) to the track frame (1). Torque bolts with washers to 108 [Nm].
11. Install inner wear washer (7) to the track frame. Position shim pack (8) on end of pivot shaft (5) and secure the retaining plate (6). Remove or add enough shims (8) to align the center line of the last track roller with the center line of the sprocket, refer to TRACK FRAME ALIGNMENT in this Section. Install plate (6) and torque bolts to 845 [Nm].
12. Install outer wear washer (7) in track frame (1). Install cover (2) with O-ring (13) and torque bolts to 845 [Nm].
13. Remove hoist from track frame. Remove blocking from machine and lower machine onto track chain.
14. Install guide plate to main frame with same thickness shims were removed, refer to TRACK FRAME GUIDE in this Section. Torque bolts to 1500 [Nm].
15. Install equalizer bar, refer to EQUALIZER BAR in this Section. Remove blocks from equalizer bar tunnel on each side of machine.
16. Refill the pivot shaft housing as described in the OPERATOR'S MANUAL. Install O-ring (16) in groove of oil level dipstick (15). Install dipstick (15) to pivot shaft housing.
17. Install front idler assembly, refer to FRONT IDLER in this Section.
18. Whenever a new track frame or guide plates are installed, track frame alignment must be checked, refer to TRACK FRAME ALIGNMENT in this Section.
19. Install inner and outer sprocket rock deflectors to rear of track frame and track chain, refer to TRACK CHAIN in SECTION 15.
20. Machines with "TILT" only (connection at RH side), and with "TILT/PITCH" (connection at both sides). Using flanges (3, Fig. 14.38) and O-rings (2) reconnect hoses (4) to the trunnion (1). Install trunnion (1) to track frame (1, Fig. 14.41) and torque the bolts to 845 [Nm]. Install cover (14) and secure it.
21. Install blade with push arm, refer to SECTION 17.

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51. TRACK FRAME ALIGNMENT (Fig. 14.43)

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

***IMPORTANT*:** *Disconnected hydraulic lines must be properly capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Remove all dirt accumulation from the main frame cover. Tag disconnected lines to facilitate faster and correct installation*.

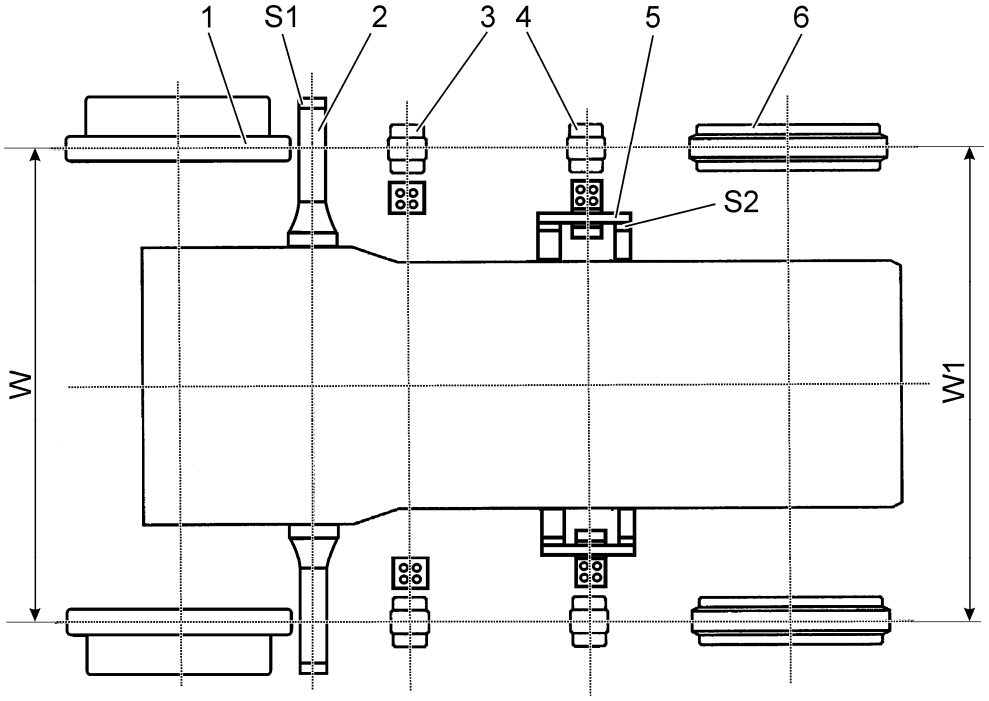

Fig. 14.43. Track Frame Alignment

1. Sprocket	4. Front Top Idler	S1 – Pivot Shaft Shims
2. Pivot Shaft	5. Guide Plate	S2 – Guide Plate Shims
3. Rear Top Idler	6. Front Idler	W, W1 - Gauge

W, W1 . . . . . 2140 [mm]

CHECKING ALIGNMENT

1. Operate machine on level terrain, stopping machine in forward direction.
2. Remove blade with push arm, refer to SECTION 17. Jack front and rear of machine up and block it securely.
3. Measure distances at Y1 and Y2 inside edge of track roller (6, Fig. 14.44) outside flange to outside edge of sprocket (7) on both sides of machine. Measure (W, Fig. 14.43) distance between center line of sprockets and W1 distance between front idlers. These should both check out to 2140 [mm].

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4. Study these measurements and determine which direction track frame or frames must be moved to obtain proper alignment in relationship to sprocket. Track frame alignment is correct when center line dimensions W between sprockets are equal to center line dimensions W1 of front idler and sprocket indexes Y1 and Y2 correctly with inside of center flanges of rear roller are equal within ± 0.8 [mm]. If alignment is not correct, proceed as follows:

CORRECTING ALIGNMENT

5. Check the front top idler (4, Fig. 14.43) mounting bracket with the guide mounting face flush with the post on the track frame. Install top idlers, if removed. Refer to TOP IDLER in this Section.
6. Position the wear plates (1 and 5, Fig. 14.33). Assemble the spacer blocks (4) and retainer plate (8) with the guide plate (7) temporarily held in place. Use shims (3) at spacer blocks (4) as required to get a clearance of 1 [mm] maximum between the guide plate (7) and one of the wear plates (1 or 5). Refer to TRACK FRAME GUIDE in this Section.
7. Keeping the track frame horizontal align the last track roller with the sprocket by equalizing the distances Y1 and Y2 within ± 0.8 [mm], refer to Fig. 14.44. Determine the shims (3) at the end of pivot shaft (2) so that the shim outer face is flush with inner wear washer (4) surface. At final alignment must be Y1 = Y2 ± 0.8 [mm]. Refer to TRACK FRAME AND PIVOT SHAFT in this Section. Torque all the bolts.

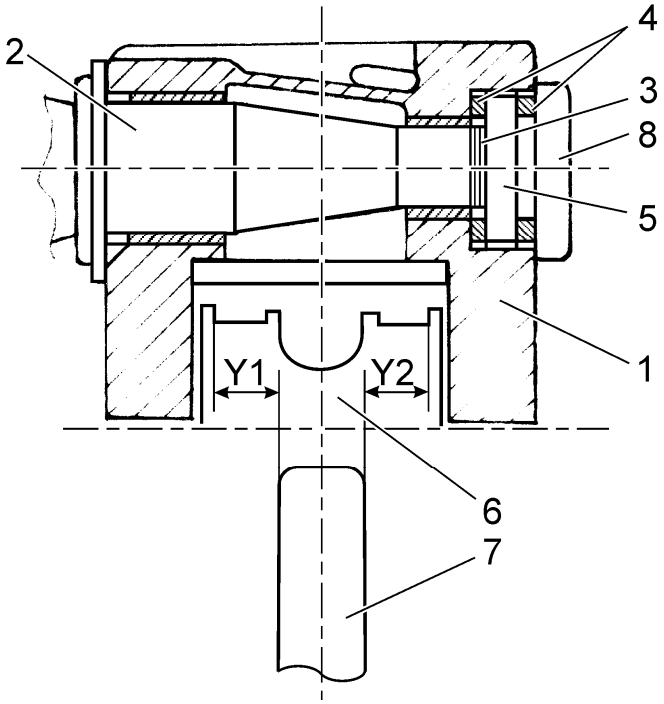

Fig. 14.44. Rear Track Frame Alignment

1. Track Frame
2. Pivot Shaft
3. Shims
4. Wear Washer
5. Retaining Plate
6. Track Roller
7. Sprocket
8. Shaft Cover

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8. Determine the number of shims (5, Fig. 14.34), refer to EQUALIZER BAR in this Section. Install the shims (5) and cover (7) and secure with hardware. Torque the bolts to 520 [Nm].
9. Oscillate track frame (2, Fig. 14.33) up and down three or four times to ensure frame is moving freely. Add shims (S2, Fig. 14.43 or 6, Fig. 14.33), as required, to fill the gap between guide plate (7) and mounting face of main frame and secure with hardware. Refer to TRACK FRAME GUIDE in this Section.

NOTE: *Do not force track frame inward or outward.*

10. Loosen upper spacer block (4, Fig. 14.33) mounting bolt. Attach a piece of strong cord (1, Fig.14.45) between centerline of sprocket (2) and centerline of front idler (3). Align the front and rear top idlers (4) so that the centerline of both top idlers (4) lie exact to ± 0.8 [mm] from the line passing through the sprocket centerline and front idler centerline. Torque all the bolts. Refer to TOP IDLER in this Section.
11. If necessary, refill the track frame pivot shaft housing as described in the OPERATOR'S MANUAL.
12. Install blade with push arm, refer to SECTION 17.

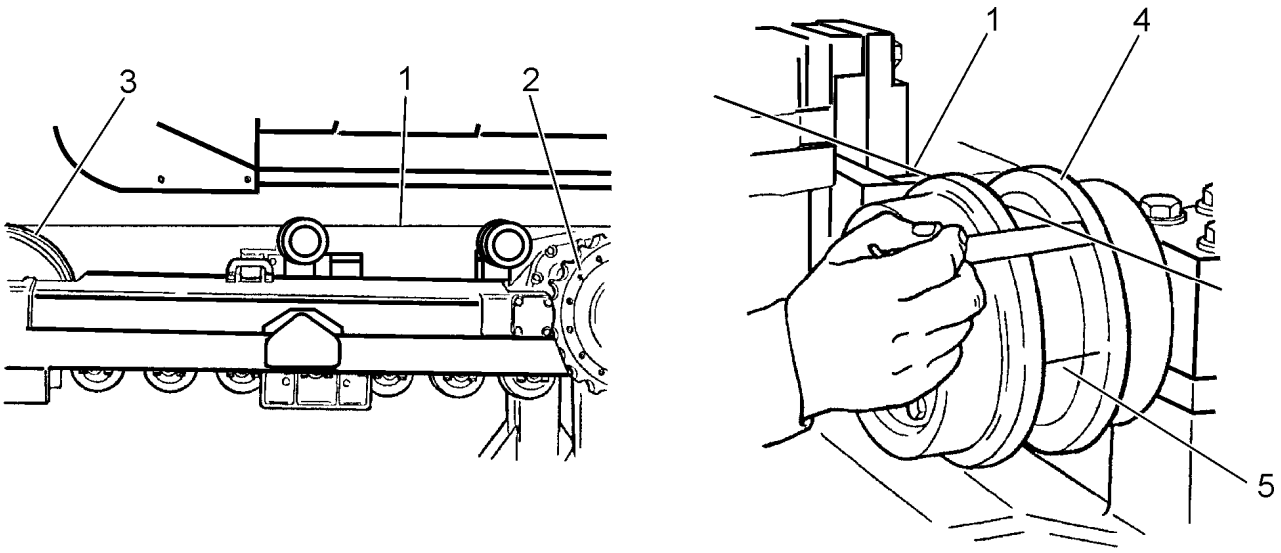

Fig. 14.45. Track Frame Alignment

1. Cord
2. Sprocket
3. Front Idler
4. Top Idler
5. Inside Edge

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SUSPENSION

TRACK SPRINGS

52. DESCRIPTION

There are two track springs installed in the track frame. These track springs of specified strength are responsible for correct track tension. They permit the front idlers to recoil under shock loads, but exert no tension on the track in normal operation position. Inner and outer track springs are contained in a welded housing, which is a permanent part of the track frame. Track springs are compressed and trapped in the ends of the housing between a front and rear seat. The rear of the adjusting rod bears against the track springs front seat.

53. REMOVAL AND DISASSEMBLY

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train control lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

CAUTION! Lift and handle all heavy parts with a lifting of proper capacity. Be sure parts are secured by proper slings and hook. Use lifting eyes if provided. Warn people in the area to stand clear.

***IMPORTANT*:** *Disconnected hydraulic lines must be properly capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Remove all dirt accumulation from the main frame cover. Tag disconnected lines to facilitate faster and correct installation*.

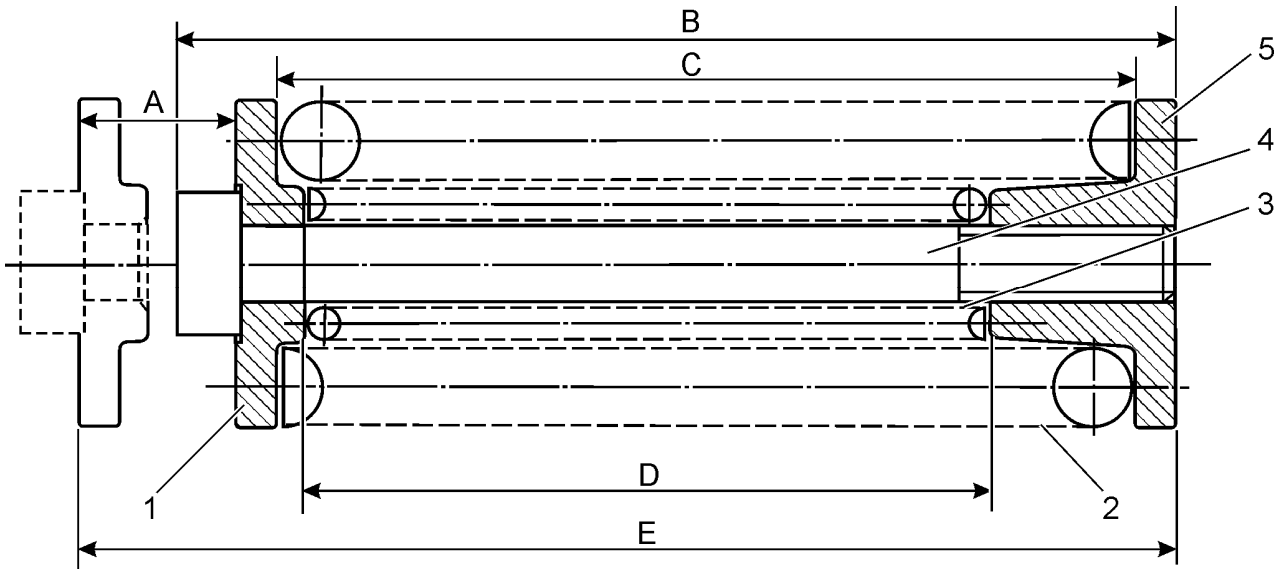

Fig. 14.46. Track Springs

1. Track Spring Front Seat
2. Track Outer Spring
3. Track Inner Spring
4. Spring Bolt
5. Track Spring Rear Seat

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TRACK SPRINGS

A. Recoil Distance . . . . . 44 [mm]
B. Assembly Installation Length . . . . . 836 [mm]
C. Outer Spring Length at Installation . . . . . 726 [mm]
D. Inner Spring Length at Installation . . . . . 566 [mm]
E. Installed Length in Track Frame . . . . . 840 [mm]
Spring Load at Bolt Installation . . . . . 435.6 [kN]

1. Remove the track chain, refer to SECTION 15 for this procedure.
2. Remove the front idler, refer to FRONT IDLER in this Section.
3. Remove the track frame, refer to TRACK FRAME AND PIVOT SHAFT in this Section.
4. Position track frame on 300x300 [mm] blocks as shown in Fig. 14.47 and remove all track rollers, refer to TRACK ROLLER in this Section.
5. If springs are broken, use a torch and cut in pieces for removal.

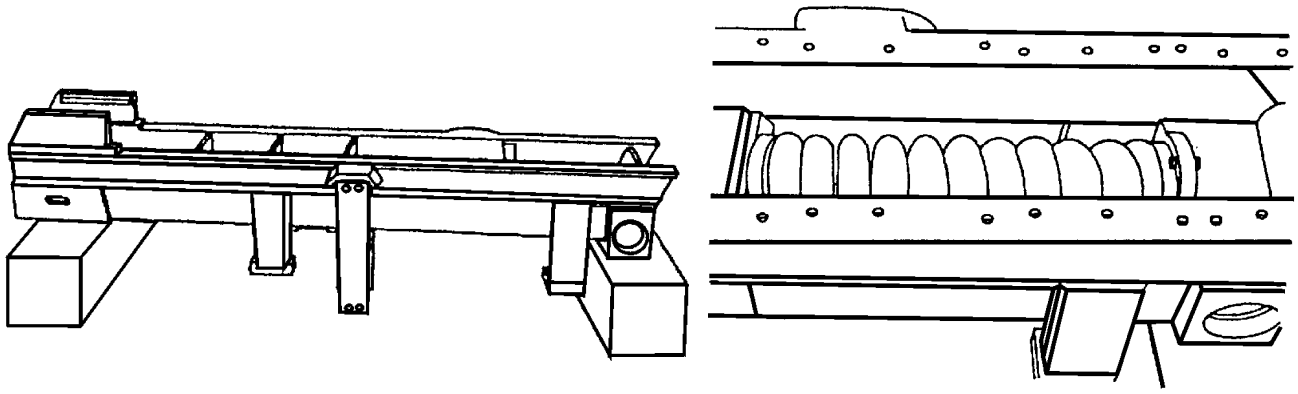

Fig. 14.47. Track Frame Position

6. Install springs bolt (4, Fig. 14.46) 1.559.0221 No 96 through front of track frame. Through hole in bottom plate, thread bolt into track springs rear seat (5). Tread the bolt in until an installation dimension equal to 836 [mm] has been reached (B, Fig. 14.46).
7. Position lifting sling (1, Fig. 14.48), centering around track spring (2) and attach to hoist (4). Remove springs (2) from track frame (3).

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TRACK SPRINGS

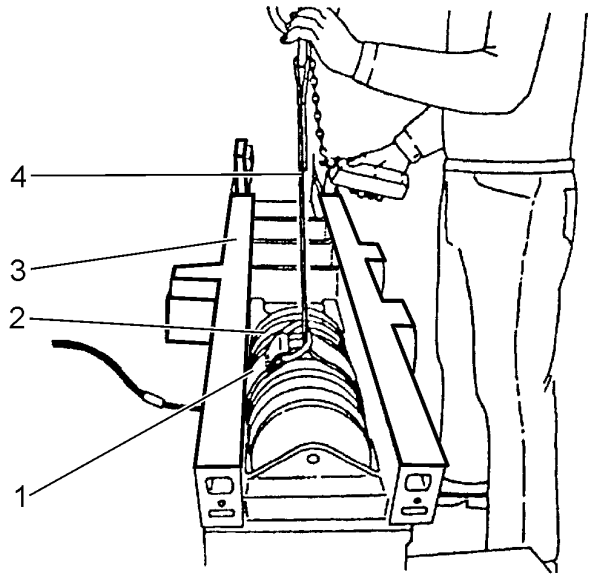

Fig. 14.48. Track Spring Removal

1. Lifting Sling
2. Track Springs
3. Track Frame
4. Hoist

8. Put the spring set removed into 1.559.0221 spring compression tool. Slowly thread the spring bolt out (4, Fig. 14.46) until the springs are completely free.
9. Remove the spring bolt (4) from tool, the spring front seat (1), spring rear seat (5), outer spring (2) and inner spring (3).

54. REASSEMBLY AND INSTALLATION

1. Put the outer and inner spring (2 and 3, Fig. 14.46), spring rear seat (5) and the spring front seat (1), into 1.559.0221 spring compression tool.
2. Install the spring bolt (4) into the spring compression tool and thread the bolt in until the bolt contacts rear spring seat (5). Thread the bolt in until an installation dimension equal to 836 [mm] (B) has been reached.
3. Attach the sling to the spring's assembly and install them into track frame. Slowly thread the spring bolt out (4) until the track springs have been completely released in the track frame and remove the bolt.
4. Install track rollers to track frame, refer to TRACK ROLLER in this Section.
5. Install track frame to machine, refer to TRACK FRAME AND PIVOT SHAFT in this Section.
6. Install the front idler, refer to FRONT IDLER in this Section.
7. Install the track chain, refer to SECTION 15 for this procedure.

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55. SEAL INSPECTION

IMPORTANT: *Do not intermix metal sealing rings; keep original mated rings as a set. Do not drop, bump or roughly handle these rings. Cleanliness is critical. Do not handle with dirty or greasy hands.*

1. Inspect the condition of the seal metal rings as described in the following steps to determine if existing kit seal could be reused or if a completely new seal is needed.

1A. Check condition of rubber seal rings. If any sign of wear, scratches, nicks, cuts, etc. replace complete seal. Inspect condition of metal ring seal surfaces as follows. Highly polished surfaces of rings must be free of chips, pocks and deep scratches.

1B. The narrow, highly polished sealing band must be within outer half of the sealing face (see Figs. 14.49 and 14.50).

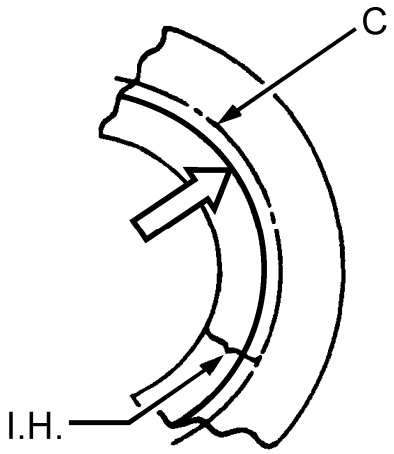

Fig. 14.49. Metal Ring Acceptable for Rebuild

Arrow (⇨) shows narrow highly polished sealing band concentric with I.D. and O.D. and within outer half of sealing face.

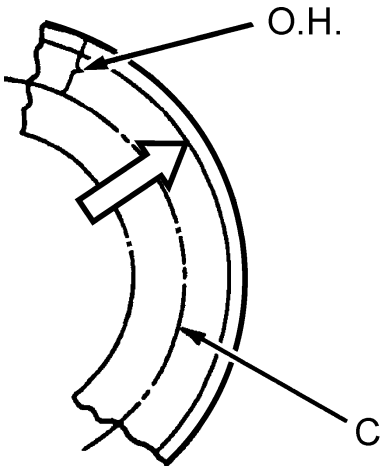

Fig. 14.50. Metal Ring Acceptable for Rebuild

Arrow (⇨) shows narrow sealing band within inner half of sealing face.

C – Center of Sealing Face
O.H. – Outer Half of Sealing Face
I.H. – Inner Half of Sealing Face

1C. The narrow band must be uniform and be concentric with the I.D. and O.D. (see Figs. 14.50 and 14.51).

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METAL TYPE FACE SEALS

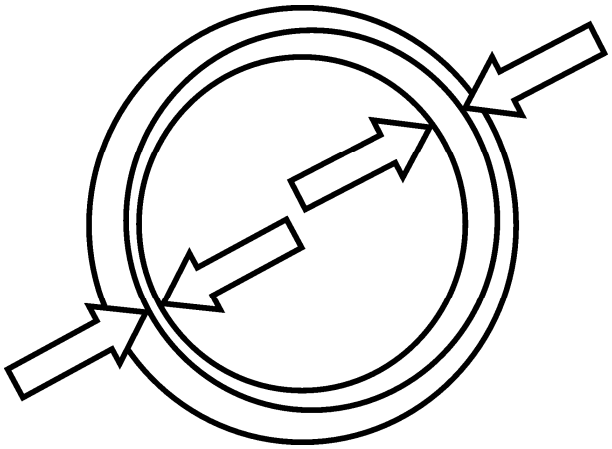

Fig. 14.51. Metal Ring Not Acceptable for Rebuild

Arrows (⇨) show sealing band not concentric with I.D. and O.D.

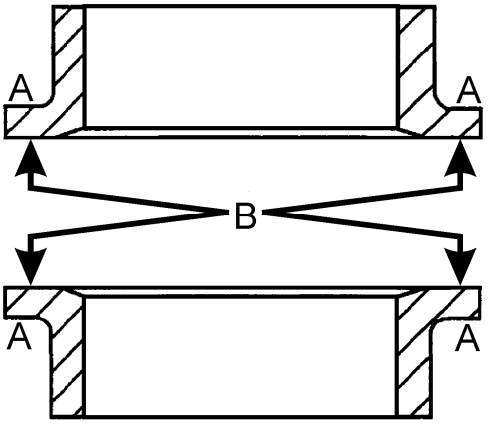

Fig. 14.52. Rubber Ring and Sealing Surfaces of Metal Face Type Oil Seal

A – Rubber Ring Surfaces
B – Sealing Faces

2. If the metal rings do not conform to the specifications described, discard seal and replace with new. If the metal rings do conform, they must be cleaned and checked as follows:

2A. Remove any corrosion or hardened material that may exist on surface **A** (see Fig. 14.52). Use a scraper and/or any stiff bristled fiber brush to remove this material from entire surface.

2B. Wash the metal rings with non flammable solvent to remove all oil and wipe dry. Use a lint free wiper to remove all traces of oil or grease from all surfaces

2C. Apply a thin coat of clean SAE 30 oil on sealing face only (see Fig. 14.52) of metal rings. Do not allow oil to wet other surfaces. Slide sealing faces of two metal rings together.

2D. If the rings have been properly cleaned and oiled, the bottom ring should cling to the top ring for a minimum of two seconds when the top ring is picked up and held an 30 [mm] above a table surface. Failure to meet this requirements indicates that the metal rings are unusable or dirty. Repeat Steps 2A. through 2D. to verify this condition. If separation condition persists, discard seal kit and replace with new.

2E. Cover usable metal rings in a lint free wrapping until ready for installation. Refer to SEAL INSTALLATION under METAL TYPE FACE SEALS in this Section for the proper handling and installation of a new seal kit.

56. SEAL INSTALLATION

NOTE: *Cleanliness is critical when handling seals. never handle seal with greasy, oily or dirty hands. Keep the seals in their original packages until ready for assembly. Do not do not drop, bump or roughly handle the metal sealing rings as the mating surfaces of these ring shave a highly polished finish that could be damaged by careless handling.*

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METAL TYPE FACE SEALS

1. Brake shrinkable protector plastic, if exist. Remove any corrosion or hardened material that may exist on surface (1, Fig. 14.53) that contact rubber rings. Use a non petroleum base solvent and wipe dry with a lint free wrapper. Make sure outer edge (2) is free of burrs.
2. Carefully remove shrinkable plastic and gently "slide" (1, Fig. 14.54) two seal halves apart. Be careful not to scratch or damage seal faces. Do not cut or damage rubber rings. Metal ring faces must not be damaged or contaminated. Check to be sure rubber rings are seated flush against inside shoulder (2) of metal ring.

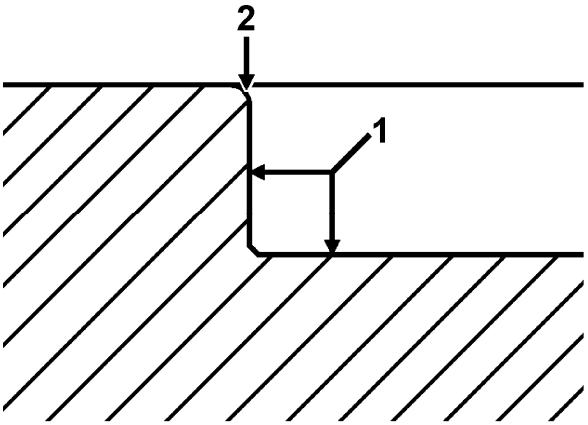

Fig. 14.53. Metal Ring Surfaces Checking

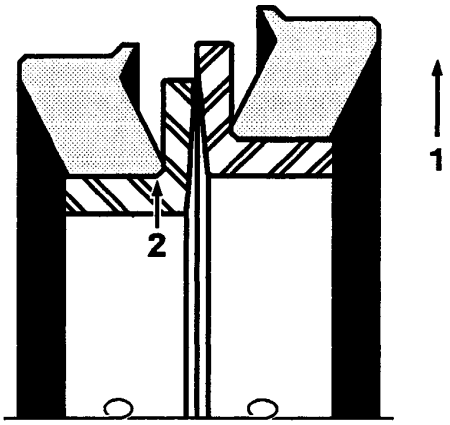

Fig. 14.54. Metal Ring Faces Checking

3. Install one seal half (1, Fig. 14.55) into receptacle (2) so protruding lip just contacts seal bore. Press with both clean hands (180 [°] apart) against metal ring until rubber ring is evenly seated against bore shoulder. Make sure seal is not cocked in bore. Repeat procedure for other seal half (3) and receptacle (4). Wipe both metal ring sealing faces clean (5) with a lint free wiper. Apply a light coat, just enough to wet faces, of clean lubricant (6) to seal faces of metal rings.
4. Final installation assembly will energize seal as shown in Fig. 14.56, so that rubber rings load seal and drive mating metal rings together.

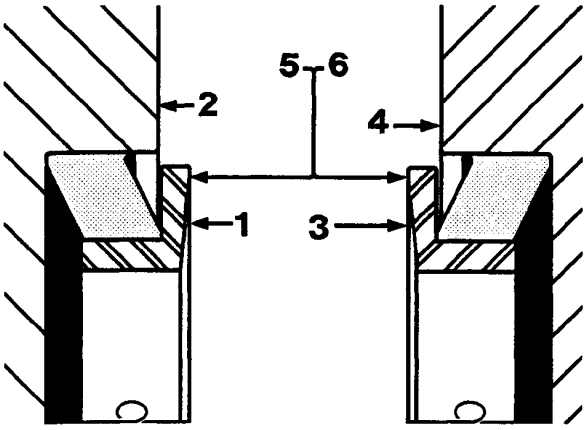

Fig. 14.55. Seal Kit Preparing for Installation

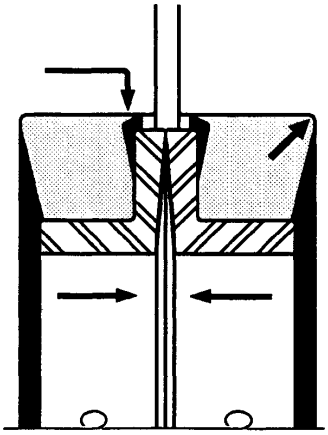

Fig. 14.56. Seal Kit Final Installation

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SECTION 15

TRACK OR WHEELS

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TRACKS OR WHEELS

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SERVICE / SPECIAL TOOLS

1. SERVICE /SPECIAL TOOLS

DESCRIPTION	TOOL NUMBER
Seal Tester and Lubricator	1262363H91
Vacuum Pump	5P2420
150 [Ton] Portable Track Press	DR11-809
Or 100 [Ton] Hydraulic Portable Track Press (Hand Pump)	910-50-0300
Or 100 [Ton] Hydraulic Portable Track Press (Power-Driven Pump)	910-50-0400
Auxiliary tooling for 100 [Ton] Hydraulic Track Press	910-50-0500
Twin Head Hydraulic Track Table Press and Small Hydraulic Ram	Purchase Locally
Plug mounting tool	15.547.0007
Pin hole punching header	15.547.0008

TRACK CHAIN

2. DESCRIPTION

The track assembly is composed of a track chain and track shoes. The track chain consists of drop-forged, heat-treated steel links which are held together by bushings and pins to form a continuous chain. The bushings and pins are a press-fit in the links, with the pins pivoting inside of the bushings. The left and right track chains are interchangeable. Each track has a split master link. Spring seal washers (dry sealed tracks) are used in the counterbored portion of the link to seal against the entrance of abrasives. Seals and O-rings (lubricated tracks) are used to seal counterbored portion of the link. The track shoes are attached to the track links, and they are held in place with special heat-treated bolts and nuts.

3. SPECIFICATIONS

Pin and Bushing

Pin and bushing (pitch) (4 link) . . . . . 1001.8 ± 0.4 [mm]
Maximum permissible track chain pitch wear (4 link) . . . . . 13 [mm]

Track Shoe

Track shoe grouser height . . . . . 76.2 [mm]
Maximum permissible grouser wear . . . . . 25.4 [mm]
Number of track shoes (one track) 38

Track Link

Track link height . . . . . 139.7 ± 0.1 [mm]
Maximum permissible track link wear . . . . . 12.8 ± 0.1 [mm]

Track Pin Bushing

Track pin bushing OD . . . . . 82.3 [mm]
Maximum permissible track pin bushing wear:
OD dry sealed tracks . . . . . 3.1 [mm]
OD lubricated tracks . . . . . 6.1 [mm]

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TRACKS OR WHEELS

TRACK CHAIN

Track chain tension:

Dry sealed tracks:
in normal . . . . . 25 - 38 [mm]
in mud or snow . . . . . 38 - 50 [mm]
Lubricated tracks:
in normal . . . . . 38 - 64 [mm]
in mud or snow . . . . . 64 - 76 [mm]

Special Bolt Torque Data
(Torques given are for bolts and nuts lubricated with SAE-30 engine oil)

NOTE: *Except for the special torques shown all bolts and nuts are to be given a standard torque. Refer to SECTION 1.*

Track Shoe

Track shoe and split link bolts
Mounting moment . . . . . 650 ± 70 [Nm] + 120 [°] of turn
Checking moment . . . . . 1100 [Nm]

4. SERVICE DIAGNOSIS

For service diagnosis of the tracks refer to SERVICE DIAGNOSIS in SECTION 14.

5. MAINTENANCE

The track links have only one wearing surface which contacts the track rollers, front idler and track idlers. However, it usually becomes necessary to replace pins and bushings before the links wear out, and it is a matter of judgement then whether the links are good enough to justify a new set of pins and bushings. Only the wear on the outside of the bushings is visible. Wear on the pins and interior of the bushings is indicated by track ”stretch” (forward adjustment of the front idler). The amount of wear can be determined by measuring the pitch length of the track (distance between centers of pins) under tension and comparing it with the new and maximum allowable pitch lengths listed in Paragraph 3, SPECIFICATIONS in this Section.

Sprocket wear must also be considered in conjunction with track chain wear. Wear of the sprocket teeth decreases the pitch length of the sprocket, while wear of pins and bushings increases the pitch length of the track. The results are that the pitch lengths of the sprocket and track become more and more out-of-phase, and the bushings ride higher on the sprocket teeth. Combined wear of sprocket and track should never be allowed to reach this point as spinning of the sprocket may result and cause serious breakage. Whenever new or rebuilt chains are installed, the sprocket rims should also be replaced or interchanged to present the better side of the teeth to the bushings.

Never remove one link to bring a ”stretched” track to within the range of proper track adjustment. A track that is worn badly enough to take up the length of one link, will be so far out of pitch that the increased wear on the sprocket will far more than offset the saving obtained by the removal of one link in the track chain. Refer to **Rotating the Track Pins and Bushings** in Paragraph 7, TRACK CHAIN REPAIR.

Improper track tension and loose track shoes will cause damage and premature wear to the track. Periodically inspect the track shoe bolts. If necessary, install new bolts and tighten to the proper torque (Fig. 15.2). Inspect the tension of the track chain, and tighten if necessary (Fig. 15.1).

When new tracks or track shoes are installed, the track tension and track shoe bolts must be checked after first 10 hours of operation and adjusted if necessary.

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Checking Track Tension

Place a wooden block approximately 300 [mm] in height, under the foremost track shoe lug. Drive the machine forward until the track chain is tight along the ground and around the sprocket. Apply and lock the brake; stop the engine. Stand on the track between the front idler and the first track idler to accumulate all the chain slack at this point. Place a straightedge on the track so the ends rest over the front idler and track idler. With a ruler, measure the clearance between the bottom of the straightedge and the top of the shoe grouser at the midway point between the idlers. If this clearance is not to specifications adjust track tension according to specifications in Paragraph 2.

Adjusting Track Tension (Refer to Fig. 15.1)

Track chains are adjusted by hydraulic pressure. Lubricant is introduced into the hydraulic cylinder (which is attached to the front end of the track spring housing) by the use of a lubrication fitting (2). This lubricant, acting upon the piston within the hydraulic cylinder, forces the front idler fork and front idler forward for track adjustment. The relief valve port (1) is used to relieve the hydraulic pressure.

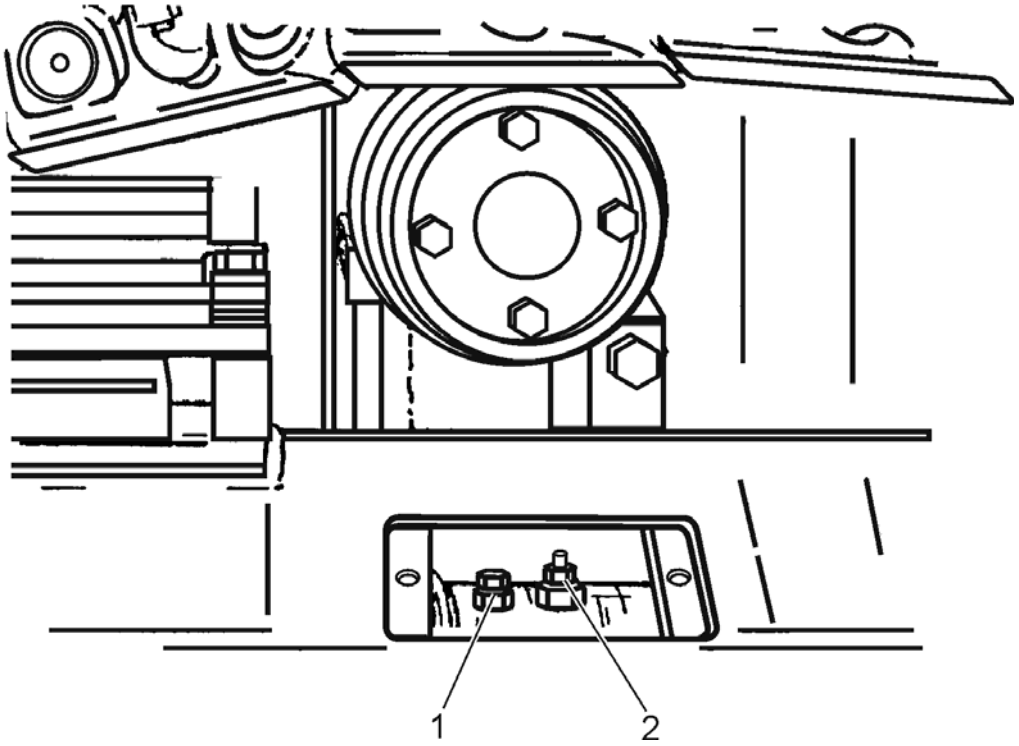

Fig. 15.1. Track Adjuster

1. Relief Valve 2. Lubrication Fitting (Ball Check Valve)

DANGER! To avoid possible injury, always stand to the side of the relief valve and fitting when making track adjustment. The pressure in the front idler fork is held by the relieve and ball check valves. A loose or improper thread fit of either of these parts can allow them to be ejected by the pressure of lubricant, causing possible injury. When relieving track tension, never loosen these valves more than 2 – 2 ½ turns.

If adjustment becomes necessary, remove the bolts securing the track adjuster cover to the track frame and proceed as follows:

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TRACKS OR WHEELS

TRACK CHAIN

Increasing Track Tension (Refer to Fig. 15.1)

WARNING! Before adding lubricant for track adjustment, be sure the ball check (2) and relief (1) valves are properly torqued to 61 - 75 [Nm].

1. Connect the lubricator nozzle to the fitting (2).
2. Determine the amount of adjustment necessary, and add lubricant to obtain proper track chain tension. It is advisable to move the machine forward and backward slightly to be sure the correct tension has been obtained.

Relieving Track Tension (Refer to Fig. 15.1)

1. Before relieving track tension, insert a wire through the relief passages in the manifold to clear them of any possible obstruction.
2. Loosen the relief valve (1) one-half to one full turn. This opens a relief passage for the pressurized lubricant. If lubricant does not escape through the relief passage, loosen the ball check (2) one-half to one full turn to allow the pressurized lubricant to escape from the second relief passage.

DANGER! Use extreme care when relieving pressure with the following emergency method. If loosened excessively, the cylinder pressure can eject the ball check or relief valve. NEVER loosen the relief valve or ball check more than a total of 2 1/2 turns.

3. Should the relief passages become blocked, unscrew the relief valve (1) an additional 1-1/2 to 2 turns (2-1/2 turns in total). If lubricant still does not appear, tighten the relief valve and unscrew ball check (2) an additional 1-1/2 to 2 turns (2-1/2 total turns).
4. When the proper tension has been obtained, tighten the ball check and/or relief valve to 61 - 75 [Nm] torque.
5. After all adjustments are completed, secure the track adjuster cover to the track frame.

Track Shoe Bolts

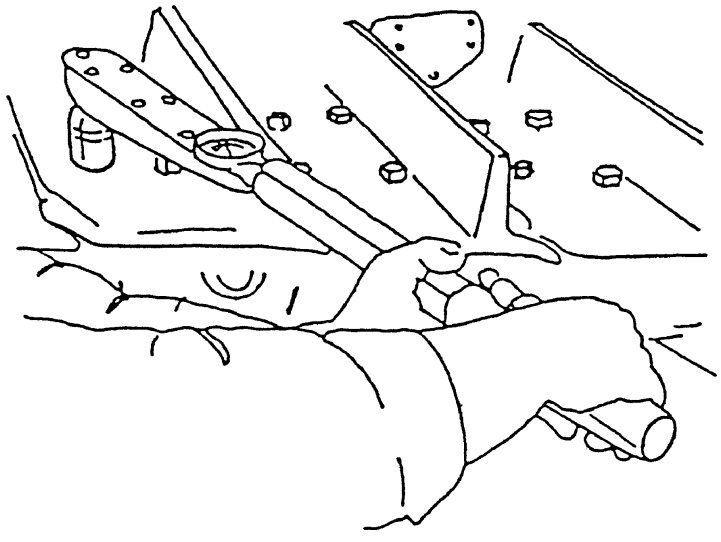

Fig. 15.2. Checking Track Shoe Bolts Torque

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TRACK CHAIN

On a new track chain, the track shoe bolts must be checked after the first 10 hours of operation or until it becomes evident that the shoes have become permanently set (Fig. 15.2). Check if the bolts are tightened to 1100 [Nm]. If not, strike the heads of the bolts several heavy blows with a hammer when retightening them.

NOTE: *If tight loosen or removed shoe bolt torque the one to 650 ± 70 [Nm] + 120 [°] of turn.*

CAUTION! As a safety measure, use goggles to protect your eyes while striking bolts.

IMPORTANT: *Do not use common bolts in the track shoes.*

6. REMOVAL

1. Move the machine forward until split link is located on front lower half of front idler as shown in Fig. 15.3 and block up under track.

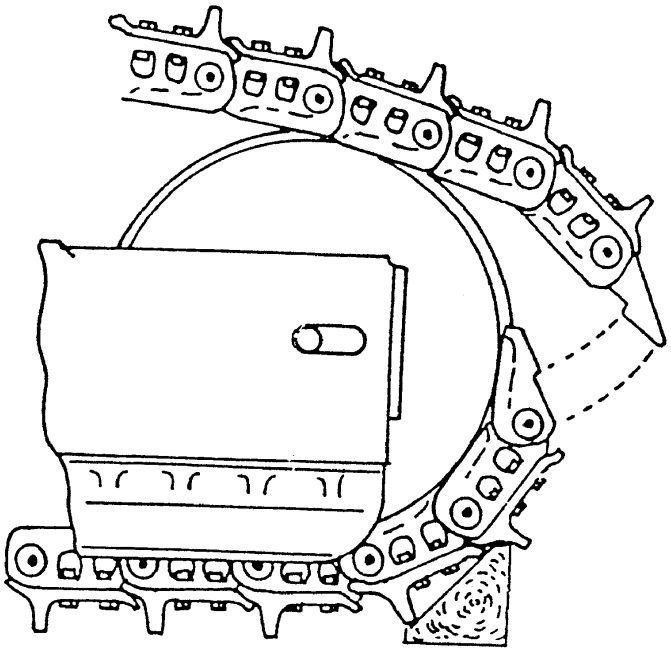

Fig. 15.3. Removing Split Link

CAUTION! Before disconnecting track chain, be sure to first relieve pressure on hydraulic track adjuster. This must be done for safety reasons even if there is the slack in chain. To insure that there is no pressure against the idler, pry the front idler and fork back away from the front idler stops.

2. Remove the master link track shoe bolts.

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TRACKS OR WHEELS

TRACK CHAIN

DANGER! Everyone must be clear and well away from the track chains and dozer before performing step 3 and 4. When the sprocket rotates, the track chain will roll rearward, falling to the ground, which can cause serious bodily injury or death.

3. Start the machine and slowly turn the sprocket. Continue to rotate the sprocket slowly until upper section of the track chain is on the ground and free of sprocket.
4. Place a plank flush against the rear of the track when the track is flat on the ground as shown in Fig. 15.4. The plank should be approximately the same thickness as the track and long enough so that the entire dozer can rest on the plank. If a new track is to be installed, remove the old chain as described above, and place the new chain on the ground ahead of the dozer, with the open link end flush against the front of the old chain.

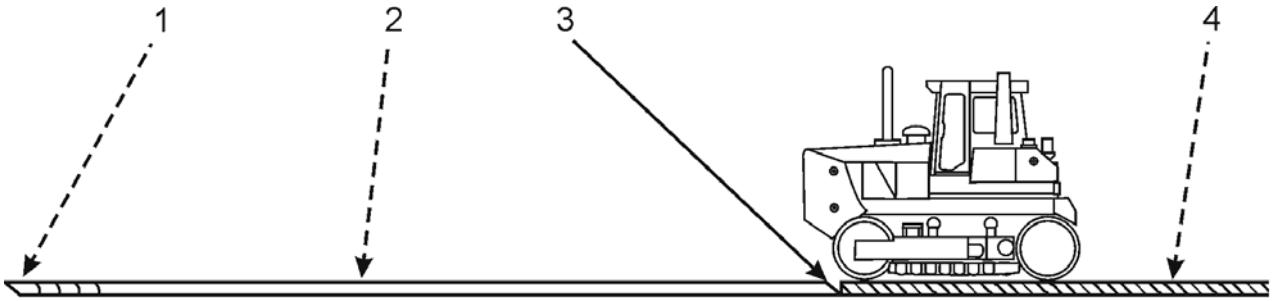

Fig. 15.4. Removing Track Chain

1. End with Wearing Surface
2. New Track
3. End with No Wearing Surface
4. Plank or Old Track

7. TRACK CHAIN REPAIR

To repair or replace worn track pins, bushings or links, a hydraulic track press will be necessary. The operation and procedure instructions for each track press will vary, so specific disassembly instructions will be found with the manufacturer's operational instructions.

Sprocket wear must also be considered in conjunction with track chain wear. Wear of sprocket teeth decreases pitch length of track. Results are that pitch lengths of sprocket and track become more and more out-of-phase; and bushings ride higher on sprocket teeth. Combined wear of sprocket and track should never be allowed to reach this point as spinning of sprocket may result and cause serious breakage. Whenever new or rebuilt track chains are installed sprockets should also be replaced.

Never remove one link to bring a stretched track to within range of proper track adjustment. A track that is worn badly enough to take up length of one link will be so far out of pitch that increased wear on sprocket will far more than offset saving obtained by removal of one link in track chain. Refer to CHECKING UNDERCARRIAGE WEAR in SECTION 14.

LUBRICATED TRACK SYSTEM

Sealed and lubricated track pins have a hollow center which is used as an oil reservoir. A cross-drilled passage permits oil to enter bushings for lubrication of pins, bushings and oil seals. If seals become dry, dirt can enter and cause sealing surface of bushing to wear. Track chains are factory lubricated; no oil level checks are necessary.

Leaking joints can be detected by any of following methods:

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TRACK CHAIN

Oil leakage noted at joint area, very difficult on units operating in field. Hand feel for warm or hot bushings after machine has been running. Check for extending chain pitch. Squeaking while going around front idler or sprocket. When it has been determined which joint is leaking, joint should be identified for repair. One method of identification is to spray paint squeaking joint.

NOTE: *Two methods of repairing a track are available. One method is to repair complete chain using a twin-head hydraulic track table press. Another method is to rebuild only leaking chain joints using a portable 100 or 150 [ton] track press (Refer to SERVICE / SPECIAL TOOLS).*

COMPLETE CHAIN REBUILD

Disassembly

1. Using a slow-speed drill and a 12 [mm] drill bit, remove rubber plugs (10, Fig. 15.5) from pins (4). Position track chain on track press so that bushing end (non-threaded end) of split link (8 and 9) is toward rams. Remove track shoes.
2. Install disassembly adapters on ram heads. Advance track and tower table so split link drops into saddle. Press pin out of left link (8), then press pin out of right (9) link. Remove loose split links from press.
3. Advance track so next link drops into saddle. Press pin (4) and bushing (3) out of right link (6), then press pin and bushing out of left link (7). Remove loose links, bushing and pin from press.
4. Repeat step 3. with remaining sections of chain. Remove seals (11) from track links. Inspect parts for wear/damage or improper assembly. Discard any parts which would adversely affect rebuild.
3. Tag all mating parts to if need be installation.

Reassembly

1. Dress up parts with emery cloth as required. Clean parts. On new or reused pins, mark an index mark (1, Fig. 15.6) on lube hole end (2) of pins on opposite side of cross-drilled hole (3).
2. Install assembly adapters on ram heads. Bolt halves of split links together and position them on press assembly adapters. Position a bushing in press saddle. Press links onto bushing until bushing is seated against assembly adapter. Remove bolts securing two halves together. Advance track on press and position a pin in assembled bushing. Apply a coat of oil on ends of bushing with tissue (not your fingers) as shown in Fig. 15.8, being careful not to get it on pin surface. Position next bushing in press saddle. Check that seal halves are properly assembled as shown in Fig. 15.7.
3. Install O-rings (2, Fig. 15.7) and seals (1) and thrust rings (7) in counterbore of next chain links (6 and 7, Fig.15.5) and apply LOCTITE #680 sparingly in outer half of pin bore of links (6 and 7) as shown in Fig. 15.9. Position links on press assembly adapter. Check that index mark (1, Fig.15.6) is at bottom. Lube holes (2) must all face in same direction.
4. Press links (6 and 7, Fig.15.5) onto pins (4) and bushings (3) being sure that link counterbore and bushing face are seated against thrust ring (5). Do not exceed force indicated as this can damage ring (5). Do not adjust links for bolt hole location. Before chain is moved to next position, pressurize joint with 350 [kPa] of air pressure. After pressure holds for 10 [sec], place a special purpose rubber plug in end of pin of assembled joint using mounting tool (refer to SERVICE/SPECIAL TOOLS).Tap it in until it is flush or slightly below chamber of pin hole.
5. For final check of each seal use seal tester or vacuum pump (refer to SERVICE/ SPECIAL TOOLS). Insert lubricator nozzle of tool through plug. Pull a vacuum of 70 ± 5 [kPa] and hold for 10 [sec]. In event that vacuum cannot by held, either seal to bushing face or chain pin to link bore mating surfaces are leaking. To determine which side is leaking, pressurize joint with 350 [kPa] of air pressure, apply soap solution to both seal areas and check for soap bubbles. After finding which side is leaking, joint must be rebuilt. If vacuum holds for 10 [sec], fill evacuated pin with oil under 100 to 170 [kPa] to obtain required oil level 54 to 74 [mm] below the end face of the pin.

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TRACK CHAIN

Use oil recommended in OPERATOR'S MANUAL with 0.02% red dye. Remove lubricator. Remove special purpose plug and install proper plug (10, Fig. 15.5) using mounting tool (refer to SERVICE/SPECIAL TOOLS). Tap it in until it is 3 [mm] below chamfer edge of pin hole. After installing plug punch the pin hole around its chamfer edge using header (refer to SERVICE/SPECIAL TOOLS) to prevent plug from escaping.

NOTE: *Once joint is lubricated, there is no way of checking for leaks.*

6. Install track shoes on chain. Prepare chains for transport back to machine.

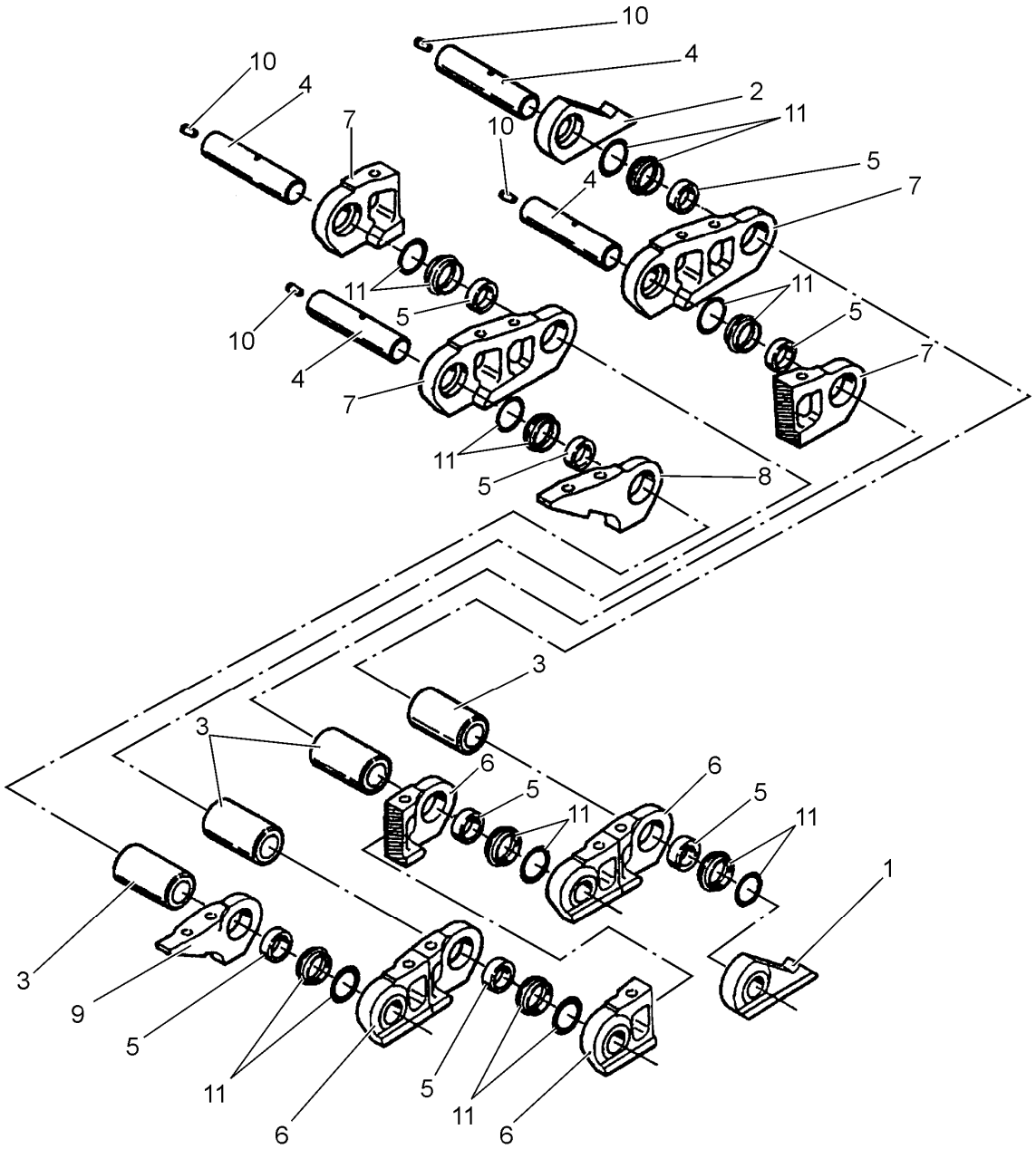

Fig. 15.5. Exploded View of Lubricated Track System

1. Master Split Link - Pin R.H. Down
2. Master-Split Link - Pin L.H. Down
3. Link Bushing
4. Link Pin
5. Thrust Ring
6. Right Chain Link
7. Left Chain Link
8. Master-Split Link - Bushing L.H. Upper
9. Master-Split Link - Bushing R.H. Upper
10. Pin Plug
11. Chain Seal

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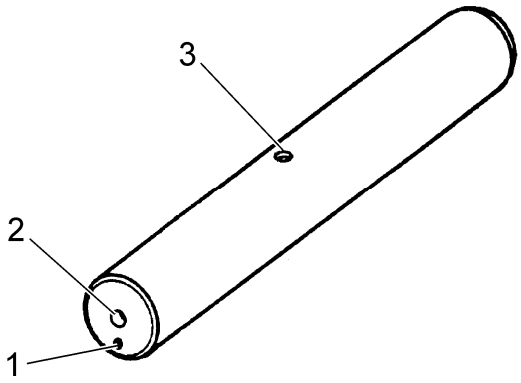

Fig. 15.6. Pin

1. Index Mark
2. Lube Hole
3. Cross-Drilled Hole

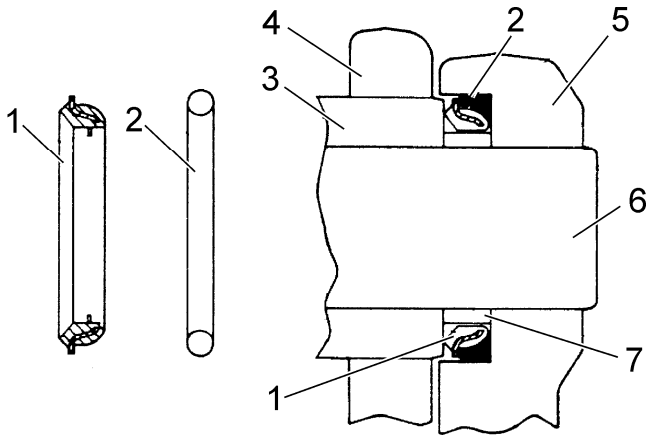

Fig. 15.7. Seal Assembly

1. Track Seal
2. O-Ring
3. Bushing
4. Track Link
5. Track Link
6. Pin
7. Thrust Ring

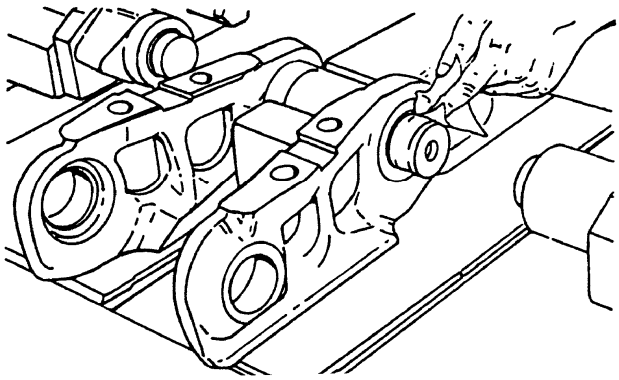

Fig. 15.8. Coat of Oil to Bushing

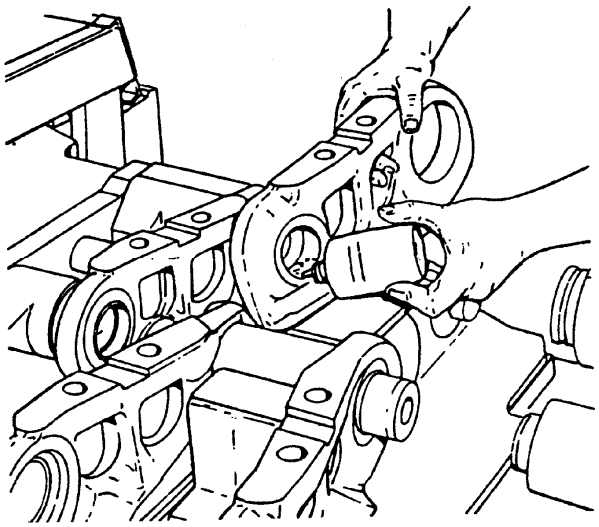

Fig. 15.9. LOCTITE #680 to Pin Bore

SINGLE CHAIN JOINT REBUILD

Disassembly

NOTE: *Track must be on floor and be blocked up on each side of pin to be removed.*

Assemble Ram (Fig. 15.10) as follows:

Install hoses from pump to ram. Thread connecting rods (3) into cylinder (1). Install bolster (2) on connecting rods (3). Thread nuts (6) on connecting rods (3).

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TRACKS OR WHEELS

TRACK CHAIN

NOTE: *Be sure connecting rods are fully threaded into cylinder. Position chain between rods. Be sure nuts are fully threaded on connecting rods.*

Pin Removal (Fig. 15.11)

1. Using a slow speed drill and a 12 [mm] drill bit, remove rubber plug from leaking joint pin. Thread forcing pin (8) on cylinder rod (5).

NOTE: *Be sure forcing pin is fully threaded on rod.*

2. Install pin receiver (9) to bolster (2). Align forcing pin on track pin and press track pin out. Remove oil seals and spacers from track links. Inspect parts for wear or damage.

NOTE: *If bushing removal is not required, proceed with Step 1 under pin installation. If bushing removal is required, refer to bushing removal.*

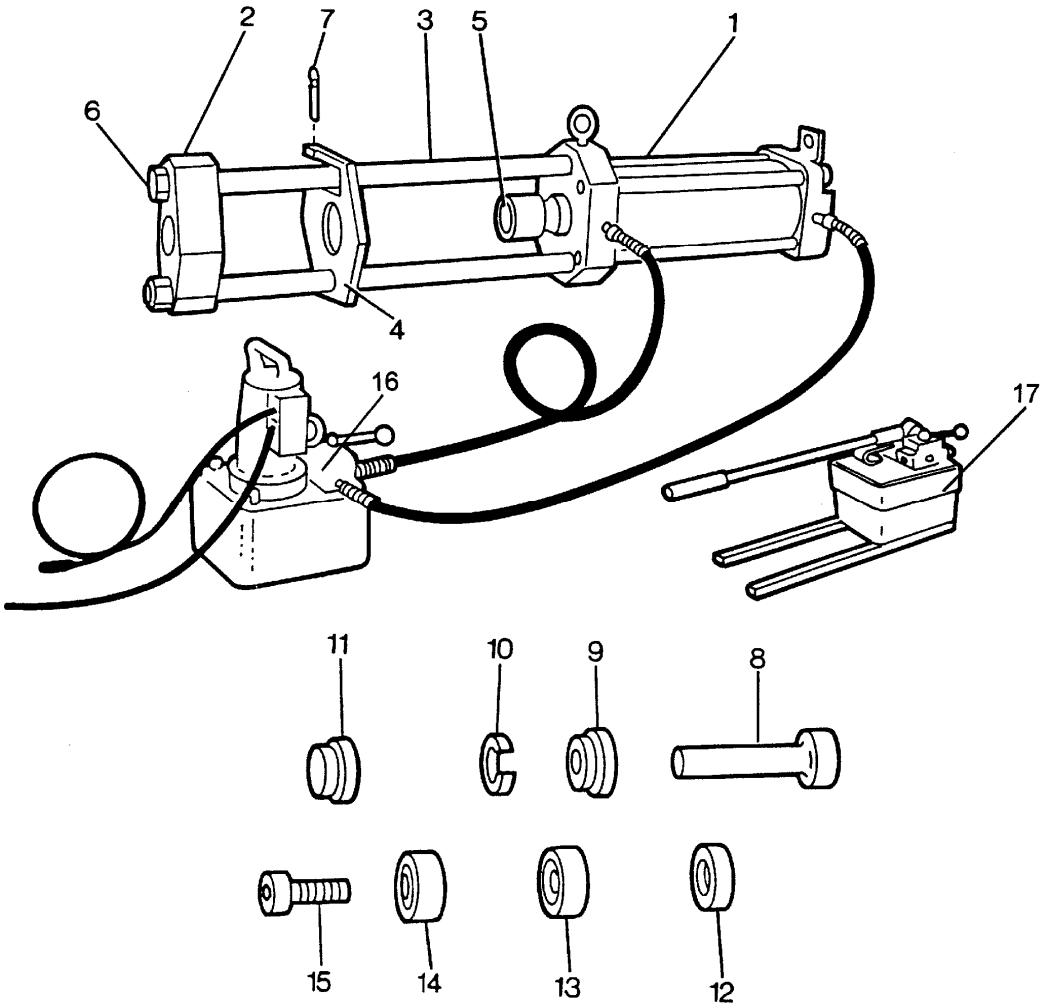

Fig. 15.10. 150 Ton Ram - DR11-809

1. Cylinder Assembly
2. Bolster
3. Connecting Rods
4. Guide Plate
5. Cylinder Rod
6. Connecting Rod Nut
7. Hitch Pin
8. Forcing Pin
9. Pin Receiver
10. Bushing Adapter
11. Pin Adapter
12. Bushing Receiver
13. Ram Cap
14. Adapter Plug
15. Cap Screw
16. Electric Pump
17. Hand Pump

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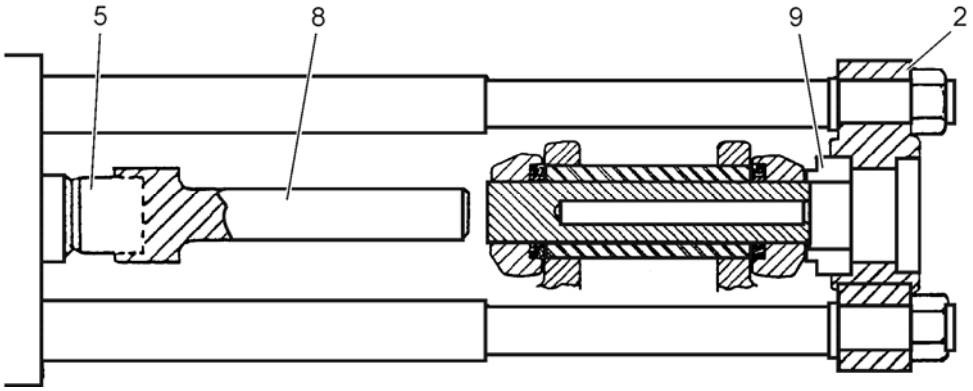

Fig. 15.11. Pin Removal

2. Bolster
5. Cylinder Rod
8. Forcing pin
9. Pin Receiver

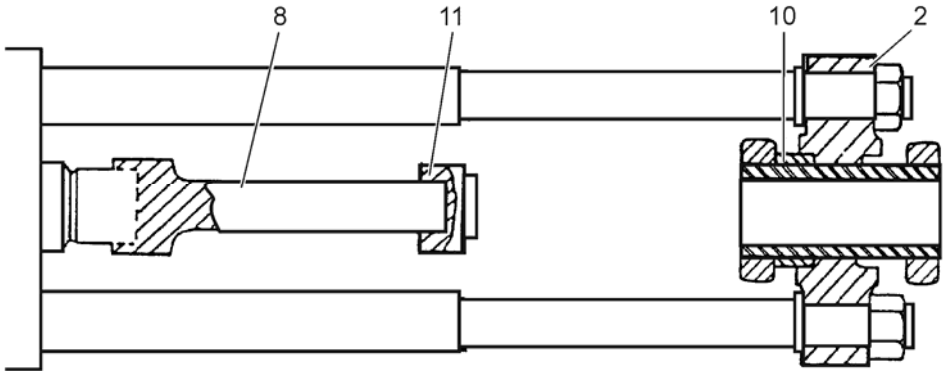

Fig. 15.12. Bushing Removal

2. Bolster
8. Forcing Pin
10. Bushing Adapter
11. Pin Adapter

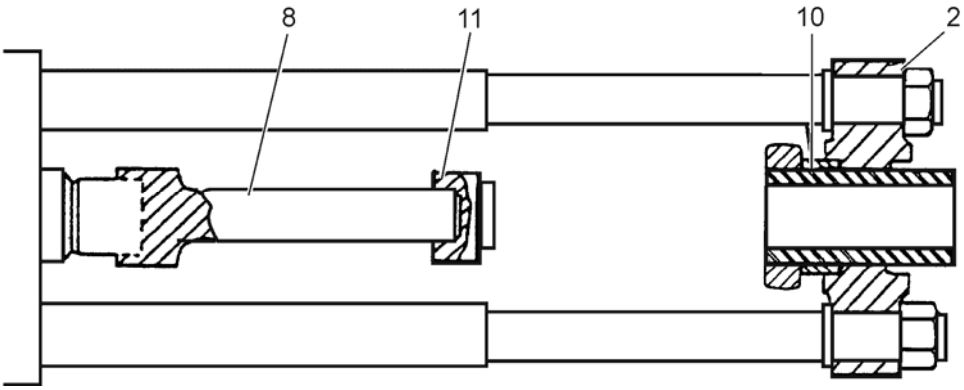

Fig. 15.13. Bushing Removal

2. Bolster
8. Forcing Pin
10. Bushing Adapter
11. Pin Adapter

Bushing Removal (Fig.'s 15.12 and 15.13)

1. Using a slow speed drill and a 12 [mm] drill bit, remove rubber stopper from pin next to previously removed pin. Align forcing pin (8) on track pin and press track pin out. Remove pin receiver (9) from bolster (2). Install bushing adapter (10) in bolster (2). Install pin adapter (11) on forcing pin (8). Press bushing off link. Reposition ram and press bushing off other link.

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Reassembly

Bushing Installation (Fig.'s 15.14 and 15.15)

1. Clean up parts with emery cloth as required. Remove bushing adapter from bolster (2). Install bushing receiver (12) in bolster (2). Align ram and press bushing into link until it bottoms against bushing receiver (12). Reposition ram and press bushing into other link. Install new seals (Fig. 15.15) and spacers in links.

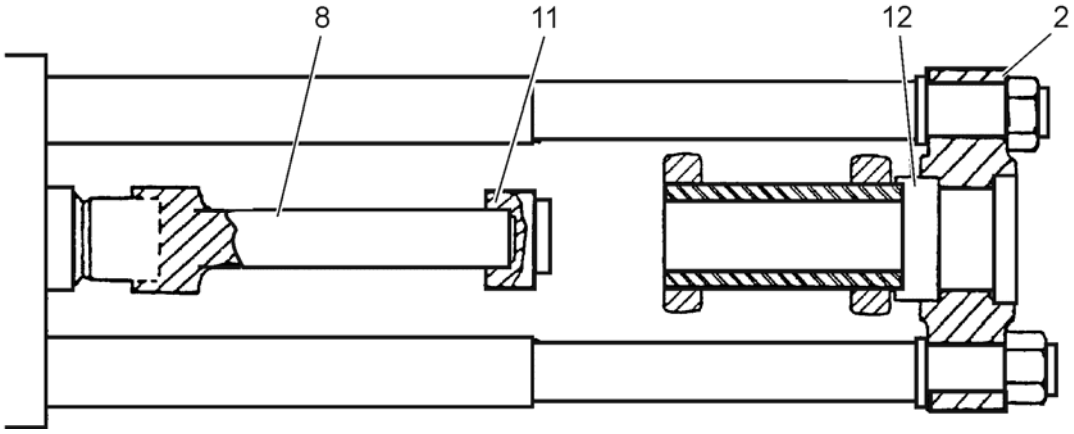

Fig. 15.14. Bushing Installation

2. Bolster 8. Forcing Pin 11. Pin Adapter 12. Bushing Receiver

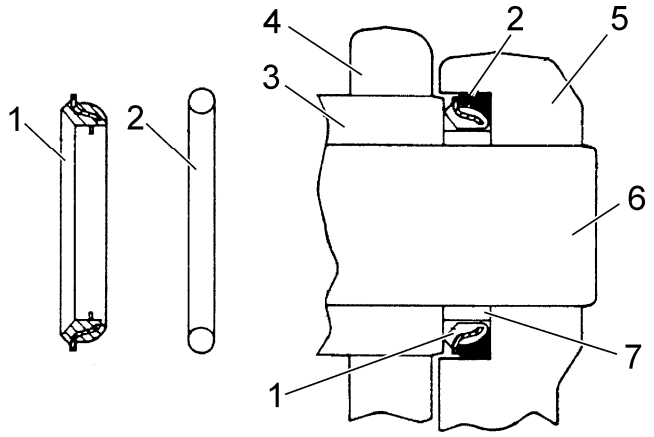

Fig. 15.15. Seal Installation

1. Track Seal
2. O-Ring
3. Bushing
4. Track Link
5. Track Link
6. Pin
7. Thrust Ring

Pin Installation (Fig. 15.16)

1. On new or reused pin, make an index mark (1, Fig. 15.6) on lube hole end of pin opposite cross-drilled hole (3, Fig. 15.6). Remove nuts (6) and bolster (2) from connecting rods. Install guide plate (4) with hitch pin (7). Reinstall bolster (2) and connecting rod nuts (6).

NOTE: *Be sure nuts are fully threaded on connecting rods.*

2. Remove forcing pin and pin adapter (11, Fig. 15.14) from ram. Install ram cap (13) on ram. Install adapter plug (14).

NOTE: *Be sure ram cap is fully threaded on ram. Be sure ram cap bolt is fully threaded into ram cap.*

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TRACK CHAIN

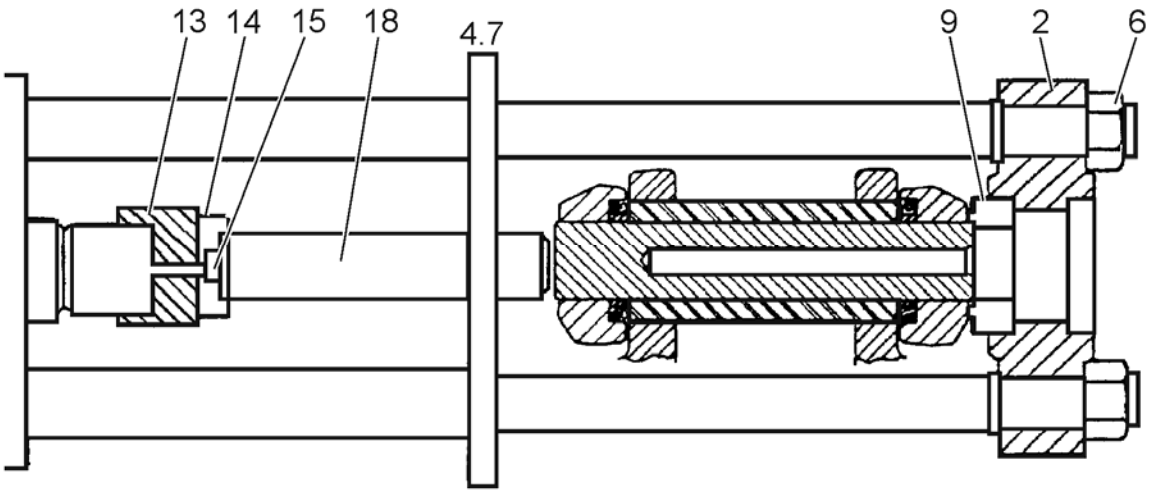

Fig. 15.16. Pin Installation

2. Bolster	7. Hitch Pin	14. Adapter Plug
4. Guide Plate	9. Pin Receiver	15. Ram Cap Bolt
6. Connecting Rod Nut	13. Ram Cap	18. Pilot Pin

3. Remove bushing receiver (12, Fig. 15.14) from bolster. Install pin receiver (9) to bolster (2).
4. Position pilot pin (18) in track assembly so that pilot pin fits freely. Position new track pin in guide plate (4) with index mark (1, Fig. 15.6) facing toward track shoe mounting surface cross-drilled hole (3, Fig. 15.6) will be facing away from track shoe mounting. Apply LOCTITE #680 in bore of link and on OD of track pin. Align track pin on adapter plug (14), guide plate (4) and pilot pin (18) and press track pin in until it bottoms.
5. Repeat Steps 1 through 4 for other track pin.
6. For initial check of the seal pressurize joint with 350 [kPa] of air pressure. After pressure holds for 10 [sec], place a special purpose rubber plug in end of pin of assembled joint using mounting tool (refer to SERVICE/SPECIAL TOOLS).Tap it in until it is flush or slightly below chamber of pin hole.
7. For final check of the seal use seal tester or vacuum pump (refer to SERVICE/ SPECIAL TOOLS). Insert lubricator nozzle of tool through plug. Pull a vacuum of 70 ± 5 [kPa] and hold for 10 [sec]. In event that vacuum cannot by held, either seal to bushing face or chain pin to link bore mating surfaces are leaking. To determine which side is leaking, pressurize joint with 350 [kPa] of air pressure, apply soap solution to both seal areas and check for soap bubbles. After finding which side is leaking, joint must be rebuilt. If vacuum holds for 10 [sec], fill evacuated pin with oil under 100 to 170 [kPa] to obtain required oil level 54 to 74 [mm] below the end face of the pin. Use oil recommended in OPERATOR'S MANUAL with 0.02% red dye. Remove lubricator. Remove special purpose plug and install proper plug (10, Fig. 15.5) using mounting tool (refer to SERVICE /SPECIAL TOOLS). Tap it in until it is 3 [mm] below chamfer edge of pin hole. After installing plug punch the pin hole around its chamfer edge using header (refer to SERVICE /SPECIAL TOOLS) to prevent plug from escaping.

NOTE: *Once joint is lubricated, there is no way of checking for leaks.*

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TRACKS OR WHEELS

TRACK CHAIN

DRY SEALED TRACK SYSTEM

Disassembly

1. Position chain on press so that bushing end (non-threaded end) of split link is toward rams. Remove track shoes. Install disassembly adapters on ram heads. Advance chain and lower table so split link drops into saddle. Press pin out of right link then press pin out of left link. Remove loose split links from press. Advance track chain so next link drops into saddle. Press pin and bushing out of right link, then press pin and bushing out of left link. Remove loose links, bushing and pin from press. Repeat this step with remaining sections of chain. Remove spring seal washers from chain links.

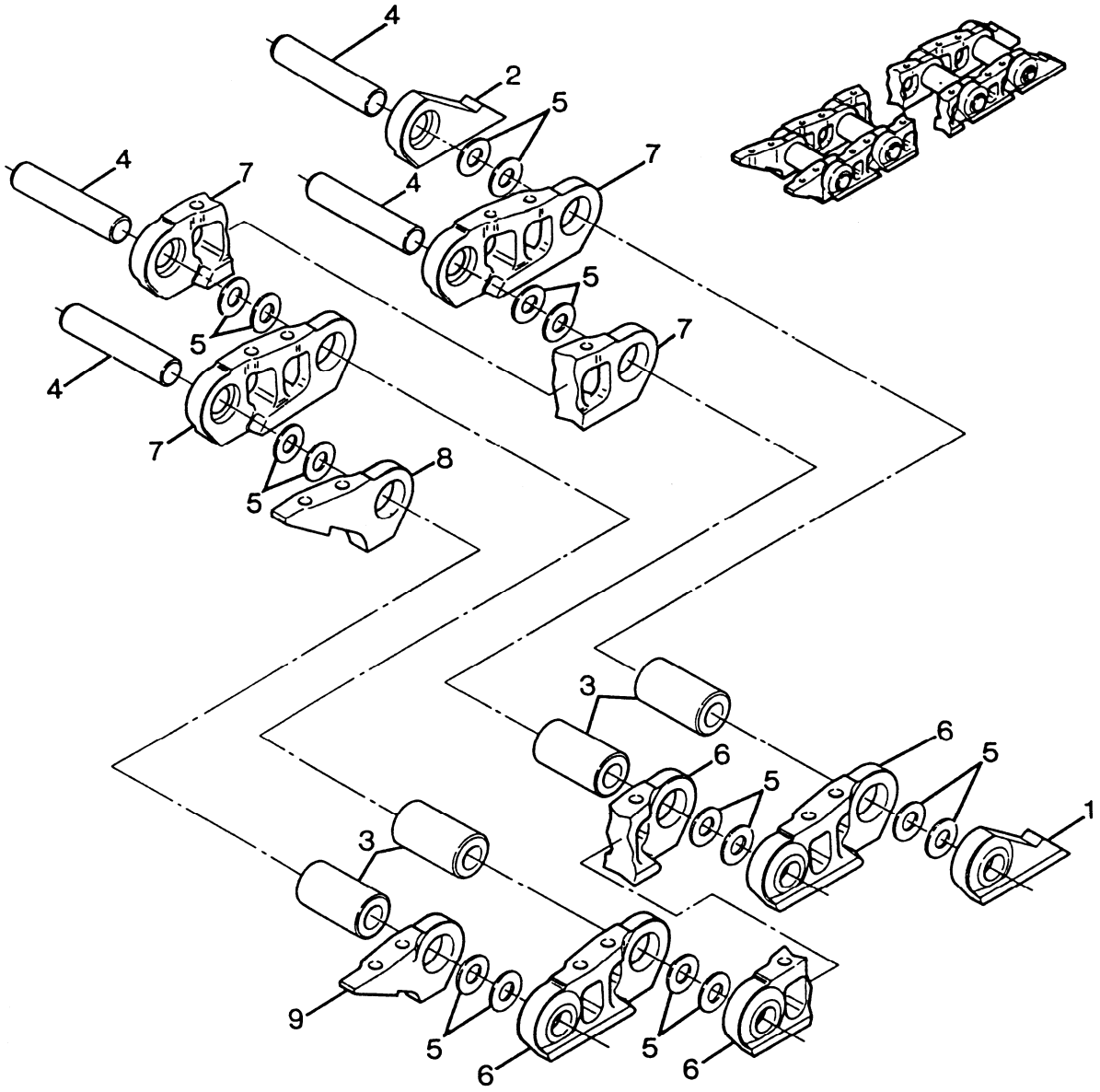

Fig. 15.17. Exploded View of Dry Sealed Track System

1. Master Split Link - Pin R.H. Down
2. Master Split Link - Pin L.H. Down
3. Track Link Bushing
4. Track Link Pin
5. Spring Seal Washer
6. Right Track Link
7. Left Track Link
8. Master-Split Link - Bushing L.H. Upper
9. Master-Split Link - Bushing R.H. Upper

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2. To replace a damaged section of track, remove the track shoes, and cut out the damaged section with a cutting torch. Remove the end links as outlined in the following Step 3. Rebuild the section onto the track by pressing individual links, link pins and bushings together with a hydraulic track press using the installing tool with necessary adapters listed in Fig. 15.10.
3. To replace an individual link that is damaged, remove the track from the machine. After the track is free and extended flat, remove three or four of the track shoes adjacent to the damaged part. Cut the pins and bushings of the damaged link with a torch. The cuts should be made as close to the inside faces of the inner links as possible (Fig. 15.18) to provide sufficient clearance between the links for the removal of the remaining pin and bushing sections.

IMPORTANT: *Be careful not to damage the inner faces of the links when cutting the bushings and pins.*

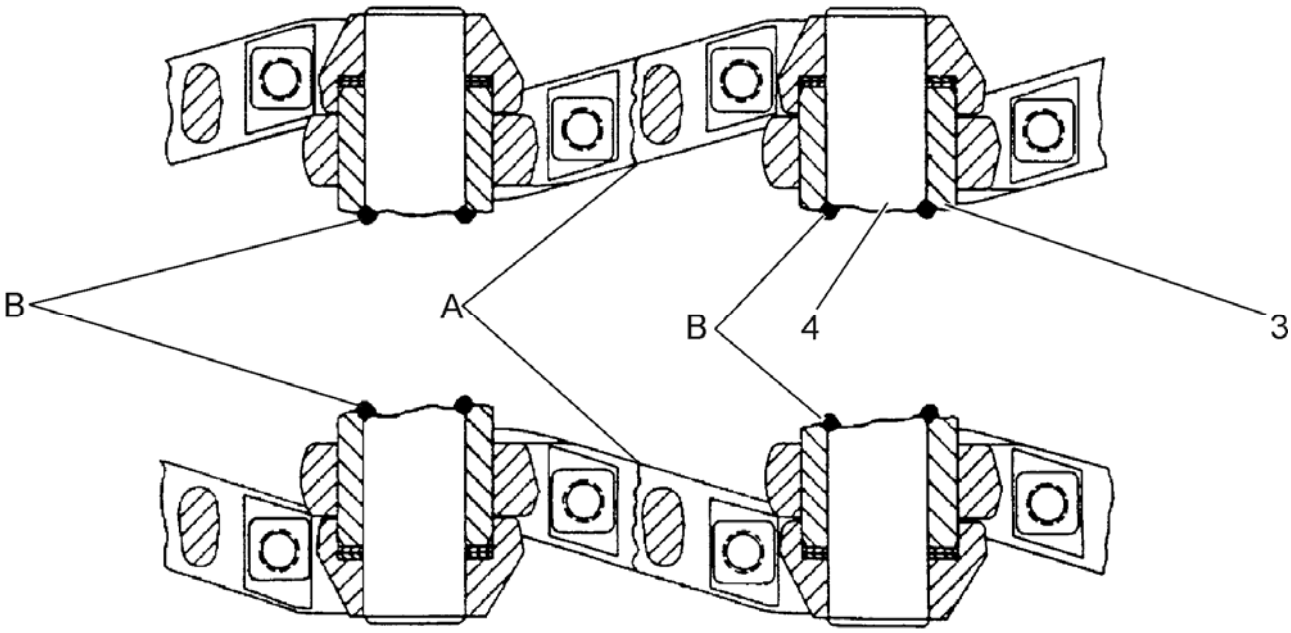

Fig. 15.18. Removal of Damaged Links

3. Bushing	A. Broken Link or Links to be Replaced
4. Pin	B. Torch Cut and Weld Pins and Bushings at Each End of Broken Links

4. The pieces of the pins and bushings remaining in the links must now be securely welded together at the cuts (Fig. 15.18). It is important that the welds be strong enough to carry the bushing out with the pin. Press each of the pin and bushing assemblies (welded) out of the links. Remove the sealing washers from the link counterbore.
5. Remove and replace the damaged link or links. Assemble the two loose, right and left, track links using a bushing (Fig. 15.19). Assemble a bushing also into the links attached to the track (Fig. 15.19). Place the spring seal washers and bushing spacers into the link counterbore (Fig. 15.19). Place the bushing and links assembly onto the track and insert the aligning pin to hold the track link alignment while the new pin is pressed in position (Fig. 15.19). Use the aligning pin again when joining the two sections of track.

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Rotating the Track Pins and Bushings

As internal and external wear on track pins and bushings develop, the tracks actually get longer and the separations between the parting edges of the links become greater. This gradual wear, in time, produces excessive stretch in the track assembly and requires that the idler be adjusted forward to maintain the proper track tension. Improperly adjusted tracks, either too tight or too loose, affect the rates of wear on all track parts such as pins, bushings, links, etc.

Since wear occurs on one side of the link pins and bushing (Fig. 15.20), the track pins and bushings can be reversed to obtain additional service from the track. To do this, press out all the track pins and bushings. Rebuild the track chain, pressing the pins and bushings in so that they are turned 180 degrees (1/2 turn). Follow the instructions furnished with the track pin press and installing tool.

The unworn surface of each pin is operating against the unworn surface in its bushing and the unworn outside surface of the bushing which contacts the sprocket.

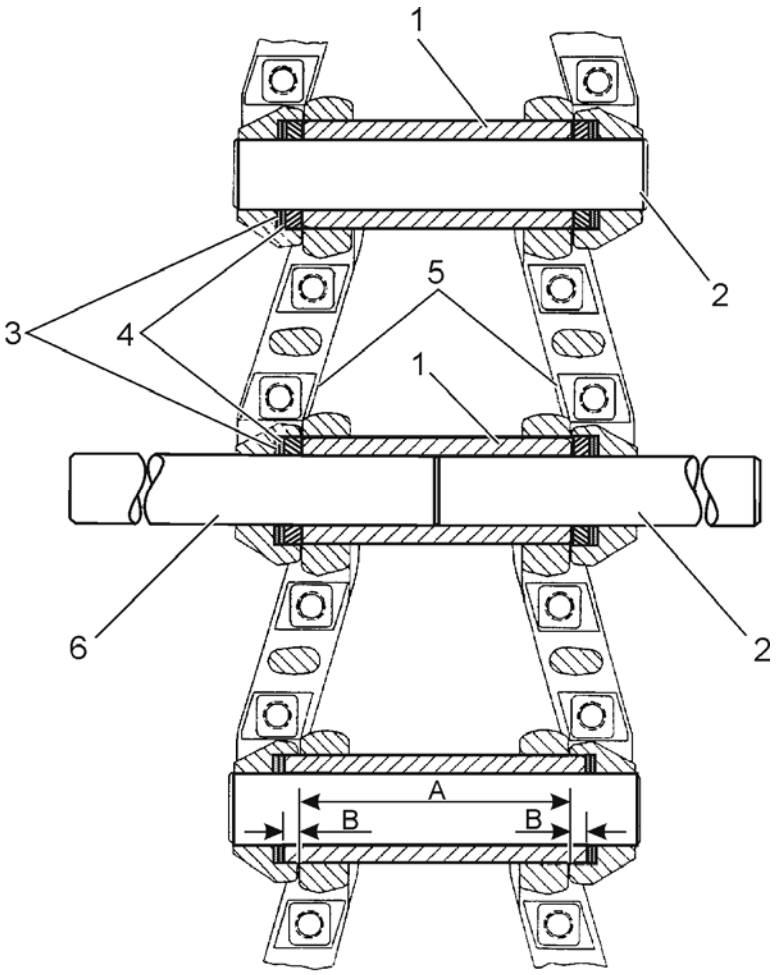

Fig. 15.19. Assembly of New Links

1. Master Bushing
2. Standard Pin
3. Spring Seal Washers
4. Spacer
5. New Link or Links
6. Aligning Pin

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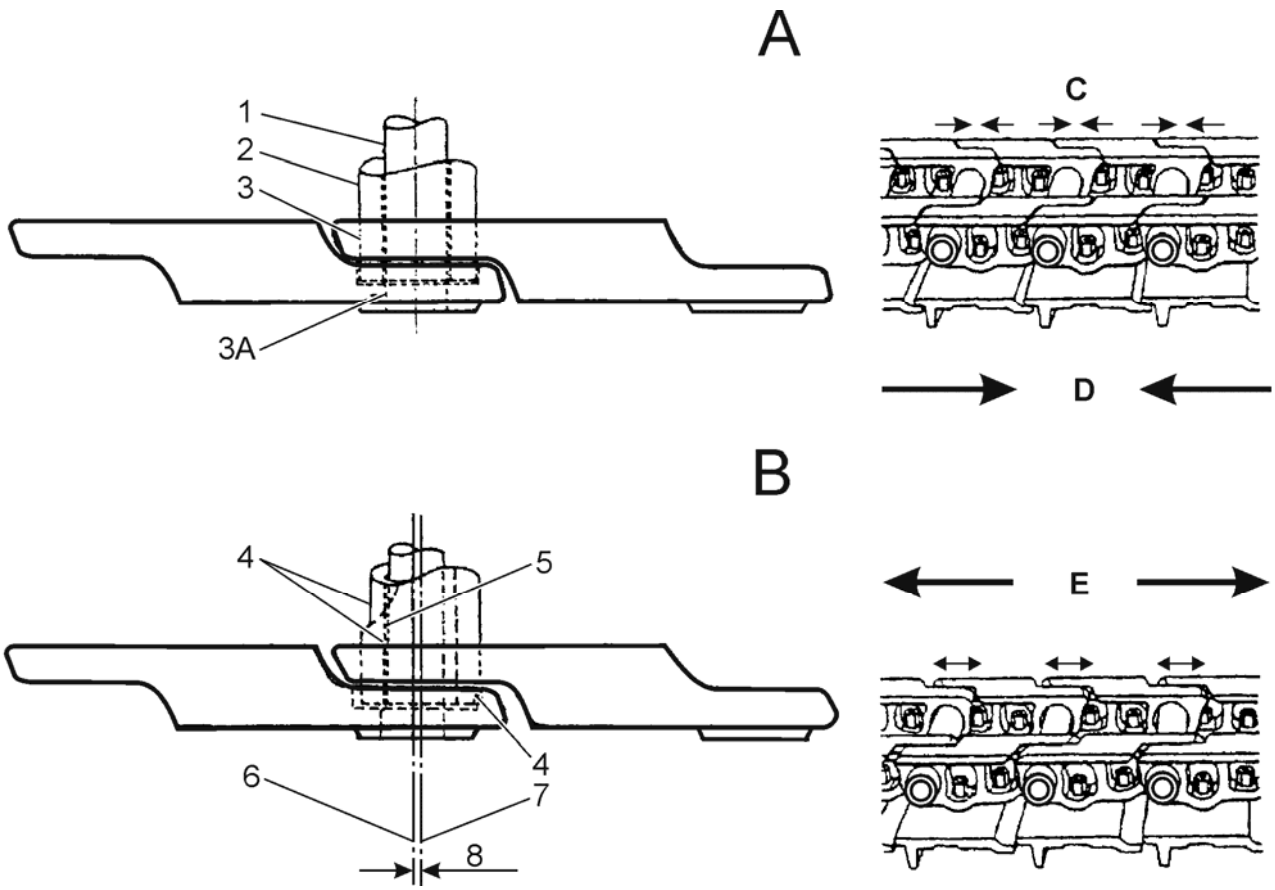

Fig. 15.20. Showing Effects of Track Pin and Bushing Wear

1. Pin
2. Bushing
3. Press Fit (No Movement Between Link and Bushings)
3A. Press Fit (No Movement Between Link and Pins)
4. Bushing Wear
5. Pin Wear
6. Centerline of Pin
7. Centerline of Bushing
8. Amount of Track Length Increase per Link
A. New Link Assembly Joint
B. Worn Link Assembly Joint
C. Turn Pins and Bushings
D. Track Shortens
E. Track Stretches

Reconditioning Track Shoe Grousers by Manual Arc Welding

When the wear of the track shoe grousers reaches a point called the "permissible wear limit" it should then be decided whether a set of new shoes is to be installed, or whether the old ones are in good enough condition to be rebuilt by welding a millrolled, specially shaped grouser bar to the worn grousers.

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8. INSTALLATION

Installing Chain when Removed from Under Machine

1. Raise machine with suitable lifting equipment. Properly place suitable capacity stands under machine frame and remove lifting equipment. With suitable lifting equipment, arrange track chain under sprocket, rollers and front idler. Split link half with wearing surface toward next regular link should be positioned before front idler. Align track chain on ground with sprocket.
2. With suitable lifting equipment, start to engage sprocket teeth with split link half which has track shoe surface. Start machine and slowly turn the sprocket. Make sure track chain is pulled up and onto sprocket. Continue to guide track chain over top idlers and over front idler.
3. Block track chain on front idler as shown in Fig. 15.3. Be sure mating surfaces of split link are clean. Interlock split link halves in front of front idler with the hammer. Install split link bolts checking visually and by hand tightening to insure alignment. Care should be exercised not to strip tapped holes. Remove master link bolts and install track shoe. Coat split link bolt threads with engine oil and torque to 650 ± 70 [Nm] + 120 [°] of turn. Refer to MAINTENANCE in this Section.
4. Adjust track tension, refer to SPECIFICATIONS in this Section and OPERATOR'S MANUAL.

Installing Chain when Not Removed from Under Machine

1. Position split link half with wearing surface and next link just past front idler. Block track chain on front idler as shown in Fig. 15.3. Align track on ground with sprocket. With suitable lifting equipment, start to engage sprocket teeth with split link half which has track shoe surface.
2. Make sure track chain is pulled up and onto sprocket. Continue to guide track chain over top idlers and over front idler. Be sure mating surfaces of split link are clear. Interlock split link halves in front of front idler with the hammer. Install split link bolts checking visually and by hand, tightening to insure alignment. Care should be exercised not to strip tapped holes. Remove split link bolt and install track shoe. Coat split link bolt threads with engine oil and torque to 650 ± 70 [Nm] + 120 [°] of turn. If only leaking joints were rebuilt, install track shoes on both sides of repaired joints.
3. Adjust track tension, refer to SPECIFICATIONS in this Section and OPERATOR'S MANUAL.

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SECTION 17

MOUNTED EQUIPMENT

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MOUNTED EQUIPMENT

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GENERAL

1. SPECIFICATIONS

Special Bolts Torque Data

Bulldozer cutting edge nuts	1050 [Nm]
Bulldozer end bit nuts	1050 [Nm]
Bullgrader cutting edge nuts	1050 [Nm]
Bullgrader end bit nuts	1050 [Nm]
Bulldozer lift cylinder yoke bolts	450 [Nm]
Bullgrader lift cylinder yoke bolts	450 [Nm]
Push arm trunnion cap bolts	2100 [Nm]
C frame trunnion cap bolts	2100 [Nm]
Pivot trunnion bolts	845 [Nm]
Upper strut and blade tilt/pitch cylinder cap bolts	845 [Nm]
Diagonal strut cap bolts	1050 [Nm]
Ripper mounting frame bolts	3100 ± 5% [Nm]
Counterweight and drawbar stud nuts	3100 ± 5% [Nm]
Drawbar mounting bolts	3100 ± 5% [Nm]

Weights

Blade U-2	3900 [kg]
Blade D-2	3450 [kg]
Blade G-2	2480 [kg]
Coal Blade	4850 [kg]
Bulldozer blade tilt cylinder (without blade pitch)	200 [kg]
Bulldozer blade tilt cylinder (with blade pitch)	200 [kg]
Bulldozer blade pitch cylinder	178 [kg]
Bullgrader blade tilt cylinder	180 [kg]
Bulldozer diagonal strut	85 [kg]
Bulldozer upper strut	103 [kg]
Bullgrader lower strut	170 [kg]
Bullgrader upper strut	87 [kg]
Push arm assy	705 [kg]
C frame	2125 [kg]
Ripper lift cylinder	152 [kg]
Ripper pitch cylinder	152 [kg]
Pin puller cylinder	22 [kg]
Ripper mounting frame	325 [kg]
Ripper draft frame	1155 [kg]
Ripper tool beam (single shank ripper)	1983 [kg]
Ripper tool beam (multi shank ripper)	1690 [kg]
Ripper shank STD (single shank ripper)	543 [kg]
Ripper shank STD (multi shank ripper)	340 [kg]

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2. REMOVAL

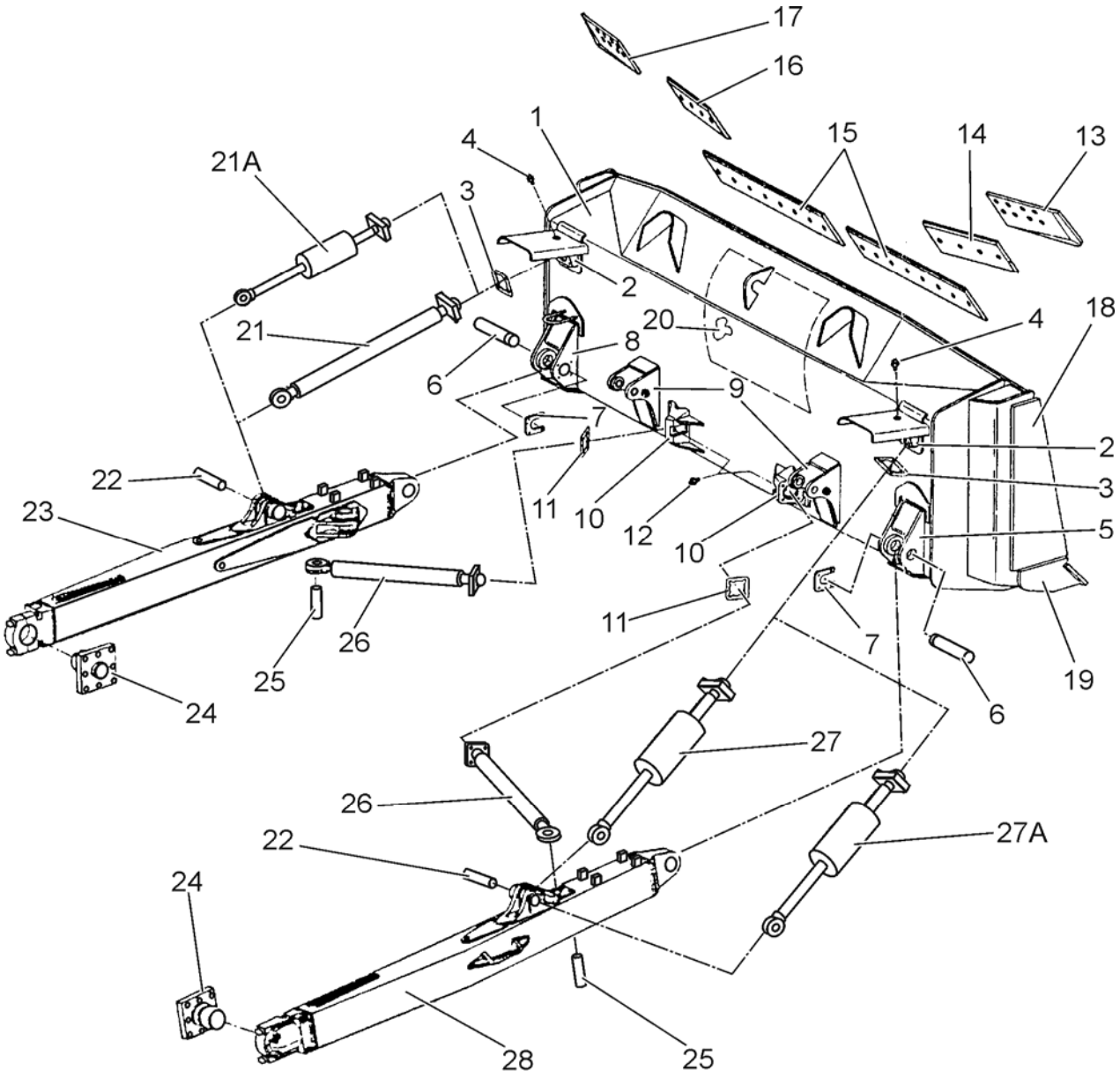

Fig. 17.1. Exploded View of Blade, Push Arms and Struts

1. Bulldozer Blade
2. Upper Strut or Tilt/pitch Socket
3. Upper Strut Shim
4. Lube Fitting
5. Right Push Arm Bracket
6. Pin
7. Pin Retainer
8. Left Push Arm Bracket
9. Lift Cylinder Brackets
10. Diagonal Strut Socket
11. Diagonal Strut Shim
12. Lube Fitting
13. Right Cutting Edge End Bit
14. Right Cutting Edge
15. Center Cutting Edges
16. Left Cutting Edge
17. Left Cutting Edge End Bit
18. Side Cutter Plate
19. Lower Wear Plate
20. Pusher Plate
21. Upper Strut
21A. Blade Tilt/pitch Cylinder (with Blade Pitch)
22. Pin
23. Left Push Arm Assy
24. Trunnion Assy
25. Pin
26. Diagonal Strut
27. Blade Tilt Cylinder (without Blade Pitch)
27A. Blade Tilt Cylinder (with Blade Pitch)
28. Right Push Arm Assy

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BULLDOZER BLADE

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train neutral lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

WARNING! Due to the considerable weight and bulk of each bulldozer component, a suitable hoist or lifting device MUST be used. Remove each component separately using suitable blocking on the remaining components.

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate proper installation.*

Blade Only

1. Lower the blade (7, Fig. 17.2) to the ground and install a block under the front portion of push arms (10). Attach a hoist to the blade lifting eye and take up the slack.
2. Disconnect the lift cylinders at the blade (7) by removing the pin locking hardware and drive out the mounting pins from lift cylinder brackets (10). Hydraulically retract the rods and secure the cylinders to the radiator guard with the cylinder hangers.
3. Install blocks under diagonal struts (26, Fig. 17.1) and remove the bolts securing the strut cap to blade socket. Remove shims (11) from blade socket (10). Keep shims (11) with diagonal strut (26) for proper installation.
4. Machine with Blade Tilt:

   Attach a hoist to the tilt cylinder (1, Fig. 17.2) on the right side. Place tension on the hoist. Remove the bolts securing tilt cylinder cap (5) to blade socket (4). Move the piston rod ball (6) of the tilt cylinder (1) back from the blade socket (4). Install block on the push arm (12) under tilt cylinder (1) and slowly lower the tilt cylinder (1) until rest on the block. Remove the shims (3) from blade socket (4). Keep shims (3) with tilt cylinder (1) for proper installation. Repeat this procedure for the upper strut on the left side.

5. Machine with Blade Tilt/pitch:

   Attach a hoist to the tilt/pitch cylinder (1, Fig. 17.3) on the left side. Place tension on the hoist. Remove the bolts securing tilt/pitch cylinder cap (5) to blade socket (4). Move the piston rod ball (6) of the tilt/pitch cylinder (1) back from the blade socket (4). Install block on the push arm (12) under tilt/pitch cylinder (1) and slowly lower the tilt/pitch cylinder (1) until rest on the push arm (12). Remove the shims (3) from blade socket (4). Keep shims (3) with tilt/pitch cylinder (1) for proper installation. Repeat this procedure for the tilt cylinder on the right side as described above.

6. Disconnect the push arm (11, Fig. 17.2) from the push arm bracket (9) by removing the pin retainer and drive out pin (8). Repeat this step on the opposite side of the machine.
7. Remove the blade (7).

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BULLDOZER BLADE

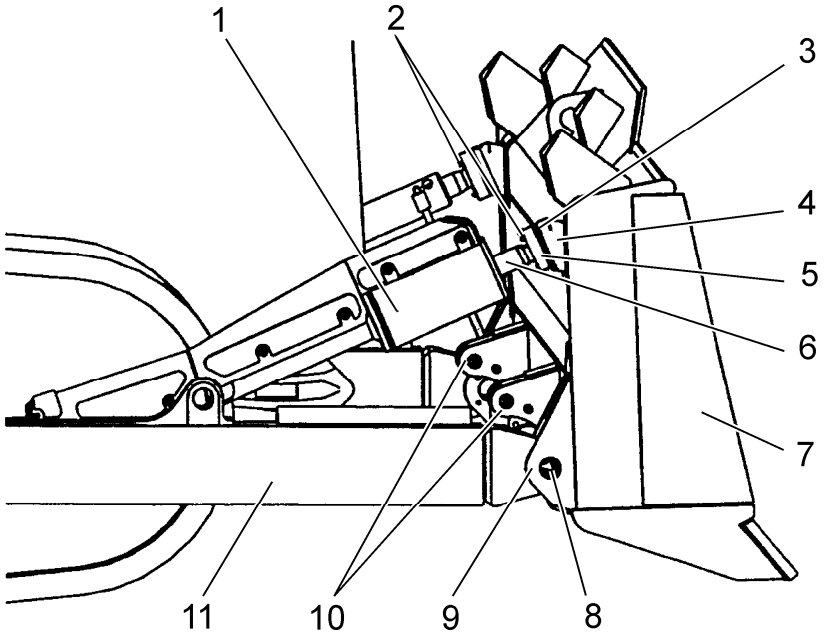

Fig. 17.2. Blade Disconnecting Point (without Blade Pitch)

1. Blade Tilt Cylinder
2. Cap Bolts
3. Shims
4. Blade Socket
5. Tilt Cylinder Cap
6. Cylinder Rod Ball
7. Blade
8. Pin
9. Push Arm Bracket
10. Lift Cylinder Brackets
11. Push Arm

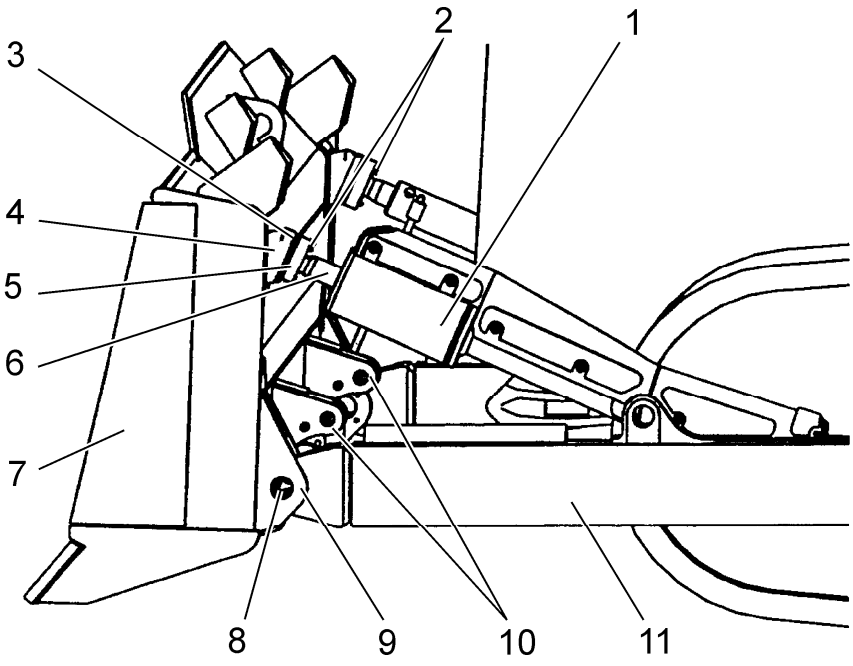

Fig. 17.3. Blade Disconnecting Point (with Blade Pitch)

1. Blade Tilt/Pitch Cylinder
2. Cap Bolts
3. Shims
4. Blade Socket
5. Tilt/Pitch Cylinder Cap
6. Cylinder Rod Ball
7. Blade
8. Pin
9. Push Arm Bracket
10. Lift Cylinder Bracket
11. Push Arm

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Blade w/Push Arms

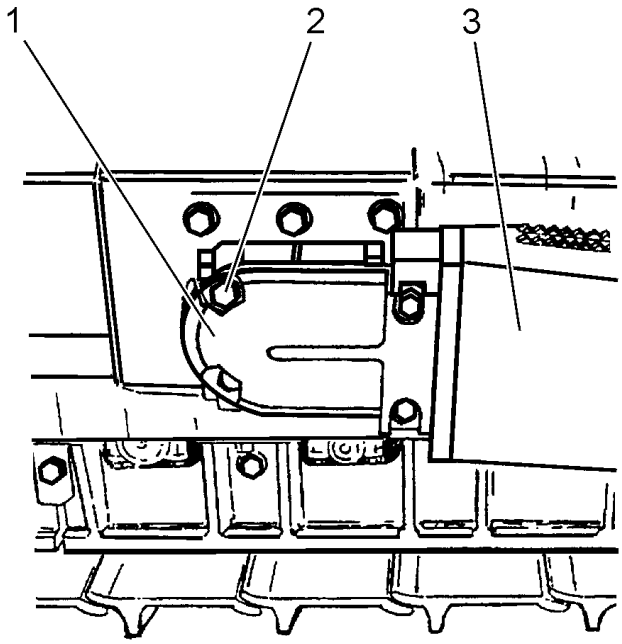

Fig. 17.4. Blade Hoses Connection Cover

1. Blade Hoses Connection Cover
2. Cover Bolts
3. Push Arm

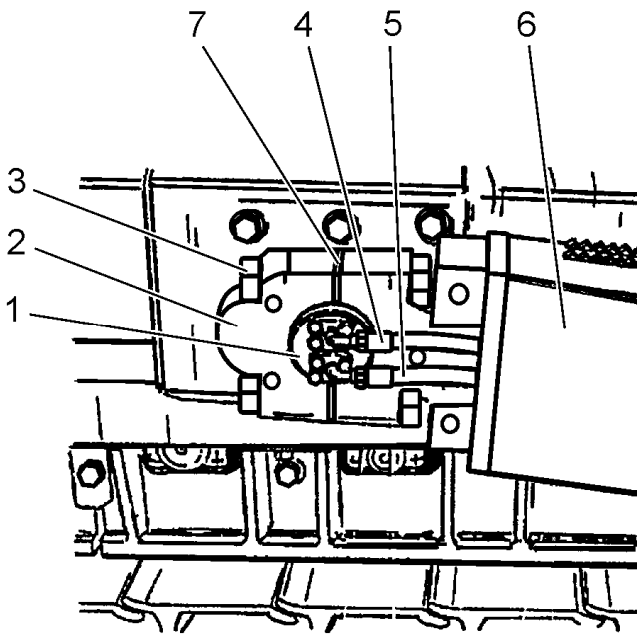

Fig. 17.5. Push Arm Disconnecting Points

1. Trunnion
2. Trunnion Cap
3. Bolts
4. Hose
5. Hose
6. Push Arm
7. Shims

1. Lower the blade (1, Fig. 17.1) to the ground and install blocks under the rear end of the push arms (23 and 28).
2. Disconnect the lift cylinders at the blade (7, Fig. 17.2) by removing the pin locking hardware and drive out the mounting pins from lift cylinder brackets (10). Hydraulically retract the rods and secure the cylinders to the radiator guard with the cylinder hangers.
3. Unscrew bolts (2, Fig. 17.4) and remove blade hoses connection cover (1) from push arm (3). Repeat this step on the opposite side of the machine.
4. Machine with Blade Tilt: Disconnect hoses (4 and 5, Fig. 17.5) from right trunnion (1).
5. Machine with Blade Tilt/Pitch: Disconnect hoses (4 and 5, Fig. 17.5) from right and left trunnions (1).
6. Unscrew two trunnion cap bolts (3, Fig. 17.5) and remove cap (2) with shims (7) from push arm (6). Repeat this step on the opposite side of the machine.
7. Back the machine out from between the push arms.
8. Reassemble shims (7, Fig. 17.5) and caps (2) to the push arms (6) and secure with bolts (3) to prevent their damage or being lost.

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3. INSTALLATION

Blade Only

1. Attach a hoist to the blade lifting eye and lower it into position.
2. Align the pinhole in the pivot of push arm (11, Fig. 17.2) with the hole in push arm bracket (9). Insert pin (8) through the bracket, aligning the lock holes. Secure the pin with the pin retainer. Repeat this step on the opposite side of the machine.
3. Machine with Blade Tilt:

   Attach a hoist to the tilt cylinder (1, Fig. 17.2) on the right side. Place tension on the hoist. Slowly raise the tilt cylinder (1) and insert the piston rod ball (6) of tilt cylinder (1) in blade socket (4) and secure the tilt cylinder cap (5) to the blade socket with the bolts (2) and washers. Be sure to tighten the bolts with washers evenly to 270 [Nm]. Determine the number of shims (3) needed to fill the gap between tilt cylinder cap (5) and blade socket (4), then add one additional shim to provide clearance. Each shim is 0.75 [mm] thick. Remove the bolts (2) with washers, add the amount of shims (3) required and install and torque the bolts with washers to 845 [Nm]. Remove the block from under tilt cylinder. Repeat this procedure for the upper strut on the left side.
4. Machine with Blade Tilt/Pitch:

   Attach a hoist to the tilt/pitch cylinder (1, Fig. 17.3) on the left side. Place tension on the hoist. Slowly raise the cylinder (1) and insert the piston rod ball (6) of tilt/pitch cylinder (1) in blade socket (4) and secure the tilt/pitch cylinder cap (5) to the blade socket with the bolts (2) and washers. Be sure to tighten the bolts with washers evenly to 270 [Nm]. Determine the number of shims (3) needed to fill the gap between tilt/pitch cylinder cap (5) and blade socket (4), then add one additional shim to provide clearance. Each shim is 0.75 [mm] thick. Remove the bolts (2) with washer, add the amount of shims (3) required and install and torque the bolts with washers to 845 [Nm]. Remove the block from under tilt/pitch cylinder. Repeat this procedure for the tilt cylinder on the right side as described above.

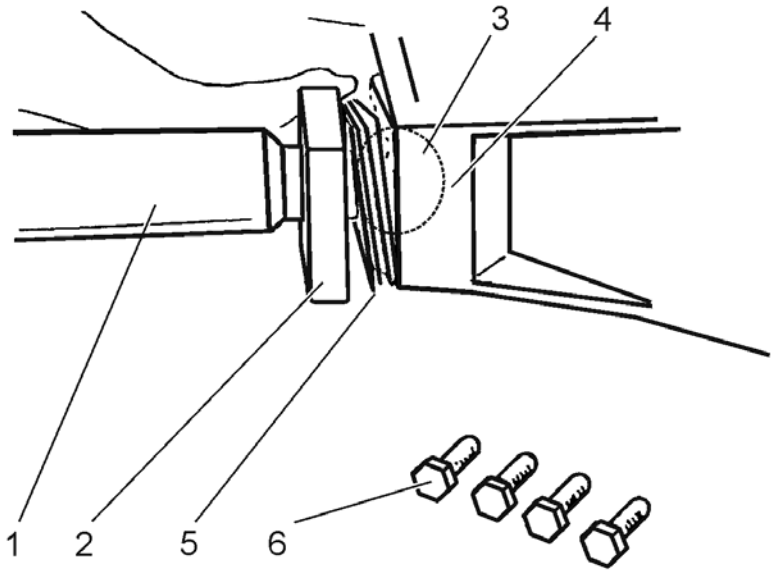

Fig. 17.6. Installing Diagonal Strut to Blade Socket

1. Diagonal Strut	3. Strut Ball	5. Shims
2. Strut Cap	4. Blade Socket	6. Bolts

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5. Insert the ball of diagonal strut (1, Fig. 17.6) to blade socket (4) and connect the diagonal strut cap (2) to the socket with the bolts (6) and washers. Be sure to tighten the bolts (6) with washers evenly. Determine the number of shims (5) needed to fill the gap between cap (2) and socket (4), then add one additional shim to provide clearance. Each shim is 0.75 [mm] thick. Remove the bolts (6) with washers and add the amount of shims required. Install the bolts (6) with washers and torque to 1050 [Nm]. Repeat this procedure on the opposite diagonal strut.
6. Disconnect the lift cylinder hangers from the radiator guard and hydraulically extend the cylinder rods until the eyes line up with the lift cylinder brackets (10, Fig. 17.2) on the rear of the blade (7). Insert the lift cylinder mounting pins through the brackets (10), aligning the lock hole in the pins with the lock holes brackets. Secure the pins with the locking hardware.
7. Remove the blocks from under diagonal struts.

Blade w/Push Arms

1. Drive the machine between the push arms (23 and 28, Fig. 17.1).
2. Position trunnion cap (2, Fig. 17.5) over the trunnion and connect it to push arm (6) with the two bolts and nuts. Be sure to tighten the bolts evenly. Determine the number of shims (7) needed to fill the gap between cap (2) and push arm (6), than add one additional shim to provide clearance. Remove the bolts, add the number of shims (7) required and install and torque the bolts to 2100 [Nm]. Repeat this procedure on the opposite side of machine. It may be necessary to adjust the diagonal struts to move the push arms either in or out before attaching them to the trunnions.
3. Machine with Blade Tilt: Connect the hoses (4 and 5, Fig. 17.5) to right trunnion (1).
4. Machine with Blade Tilt/pitch: Connect hoses (4 and 5, Fig. 17.5) to right and left trunnions (1).
5. Install the cover (1, Fig. 17.4) to the push arm (3) and secure with bolts (2). Repeat this step on the opposite side of the machine.
6. Disconnect the lift cylinder hangers from the radiator guard and hydraulically extend the cylinder rods until the eyes line up with the lift cylinder brackets (10, Fig. 17.2) on the rear of the blade (7). Insert the lift cylinder mounting pins through the brackets (10), aligning the lock hole in the pins with the lock holes in the bracket. Secure the pins with the locking hardware.
7. Remove the blocks from under push arms.

BULLDOZER PUSH ARMS

4. REMOVAL

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train neutral lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

WARNING! Due to the considerable weight and bulk of each bulldozer component, a suitable hoist or lifting device MUST be used. Remove each component separately using suitable blocking on the remaining components.

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BULLDOZER PUSH ARMS

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate proper installation.*

Right Push Arm

1. Lower the blade (1, Fig. 17.1) to the ground and install blocks under the front and rear push arm (28) being removed.
2. Machine with Blade Tilt: Remove the blade tilt cylinder (27, Fig. 17.1) from the machine as described in SECTION 10C, Paragraph 8, REMOVAL.
3. Machine with Blade Tilt/Pitch: Remove the blade tilt cylinder (27A, Fig. 17.1) from the machine as described in SECTION 10C, Paragraph 16, REMOVAL.
4. Install blocks under the diagonal strut (26, Fig. 17.1). Disconnect diagonal strut (26) from the push arm (28) by removing the pin locking hardware and drive out the mounting pin (25).
5. Unscrew bolts (2, Fig. 17.4) and remove blade hoses connection cover (1) from push arm (3).
6. Disconnect two hoses (4 and 5, Fig. 17.5) from trunnion (1). Unscrew two trunnion cap bolts (3) and remove cap (2) with shims (7) from push arm (6).
7. Disconnect the push arm (28, Fig. 17.1) from the blade (1) by removing the pin retainer (7) and drive out pin (6). Remove the push arm (28) from the machine.
8. If necessary, remove two hoses (4 and 5, Fig. 17.5) from the push arm (6).

Left Push Arm

1. Lower the blade (1, Fig. 17.1) to the ground and install blocks under the front and rear push arm (23) being removed.
2. Machine with Blade Tilt: Remove the upper strut (21, Fig. 17.1) from the push arm (23) by removing the pin locking hardware and drive out mounting pin (22). Tie the upper strut (21) up out of the way.
3. Machine with Blade Tilt/pitch: Remove the blade tilt/pitch cylinder (21A, Fig. 17.1) from the machine as described in SECTION 10C, Paragraph 11, REMOVAL.
4. Install blocks under the diagonal strut (26, Fig. 17.1). Disconnect diagonal strut (26) from the push arm (23) by removing the pin locking hardware and drive out the mounting pin (25).
5. Unscrew bolts (2, Fig. 17.4) and remove blade hoses connection cover (1) from push arm (3).
6. Machine with Blade Tilt/pitch: Disconnect two hoses (4 and 5, Fig. 17.5) from trunnion (1).
7. Unscrew two trunnion cap bolts (3, Fig. 17.5) and remove cap (2) with shims (7) from push arm (6).
8. Disconnect the push arm (23, Fig. 17.1) from the blade by removing the pin retainer (7) and drive out pin (6). Remove the push arm (23) from the machine.
9. If necessary, remove two hoses (4 and 5, Fig. 17.5) from the push arm (6).

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5. INSTALLATION

Right Push Arm

1. Position the push arm (28, Fig. 17.1) so that the bracket (5) and the rear of the push arm is up against the trunnion (24).
2. Position trunnion cap (2, Fig. 17.5) over the trunnion and connect it to push arm (6) with the two bolts and nuts. Be sure to tighten the bolts evenly. Determine the number of shims (7) needed to fill the gap between cap (2) and push arm (6), then add one additional shim to provide clearance. Remove the bolts, add the number of shims (7) required, install the bolts and torque to 2100 [Nm].
3. Align the pin hole in push arm (28, Fig. 17.1) with the holes in blade bracket (5). Insert the push arm mounting pin (6) so that the groove in the pin is on the side of blade bracket (5) with the tapped holes. Secure the pin (6) with the pin retainer (7).
4. If removed, install two hoses (4 and 5, Fig. 17.5) in the push arm (6).
5. Connect two hoses (4 and 5, Fig. 17.5) to the trunnion (1).
6. Install the cover (1, Fig. 17.4) to the push arm (3) and secure with bolts (2).
7. Position the eye of the diagonal strut (26, Fig. 17.1) in the bracket on the side of the push arm (28) so that the pin holes are aligned. Insert the mounting pin (25) through the bracket, aligning the lock holes. Secure the pin (25) with the locking hardware.
8. Machine with Blade Tilt: Install the blade tilt cylinder (27, Fig. 17.1) to the machine as described in SECTION 10C, Paragraph 10, INSTALLATION.
9. Machine with Blade Tilt/pitch: Install the blade tilt cylinder (27A, Fig. 17.1) to the machine as described in SECTION 10C, Paragraph 20, INSTALLATION.
10. Remove the blocks from under push arm (28).

Left Push Arm

1. Position the push arm (23, Fig. 17.1) so that the bracket (8) and the rear of the push arm is up against the trunnion (24).
2. Position trunnion cap (2, Fig. 17.5) over the trunnion and connect it to push arm (6) with the two bolts and nuts. Be sure to tighten the bolts evenly. Determine the number of shims (7) needed to fill the gap between cap (2) and push arm (6), then add one additional shim to provide clearance. Remove the bolts, add the number of shims (7) required, install the bolts and torque to 2100 [Nm].
3. Align the pin hole in push arm (23, Fig. 17.1) with the holes in blade bracket (8). Insert the push arm mounting pin (6) so that the groove in the pin is on the side of blade bracket (8) with the tapped holes. Secure the pin (6) with the pin retainer (7).
4. Machine with Blade Tilt/pitch: If removed, install two hoses (4 and 5, Fig. 17.5) in the push arm (6). Connect hoses (4 and 5, Fig. 17.5) to the trunnion (1).
5. Install the cover (1, Fig. 17.4) to the push arm (3) and secure with bolts (2).
6. Position the eye of the diagonal strut (26, Fig. 17.1) in the bracket on the side of the push arm (23) so that the pin holes are aligned. Insert the mounting pin (25) through the bracket, aligning the lock holes. Secure the pin (25) with the locking hardware.
7. Machine with Blade Tilt: Position the eye of the upper strut (21, Fig. 17.1) in the bracket on top of the push arm (23) so that the pin holes are aligned. Insert pin (22) through the bracket, aligning the lock holes. Secure the pin (22) with locking hardware.
8. Machine with Blade Tilt/pitch: Install the blade tilt/pitch cylinder (21A, Fig. 17.1) to the machine as described in SECTION 10C, Paragraph 15, INSTALLATION.
9. Remove the blocks from under push arm (23).

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6. REMOVAL AND DISASSEMBLY

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train neutral lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

WARNING! Due to the considerable weight and bulk of each bulldozer component, a suitable hoist or lifting device MUST be used. Remove each component separately using suitable blocking on the remaining components.

1. Attach a hoist to the upper strut. Place tension on the hoist.
2. Disconnect upper strut (21, Fig. 17.1) from the push arm (23) by removing the pin locking hardware and drive out pin (22).
3. Remove the bolts securing upper strut cap to blade socket (2, Fig. 17.1) and remove the upper strut (21) and shims (3).
4. If necessary, remove the eyebolt (1, Fig. 17.7) from upper strut housing (2).

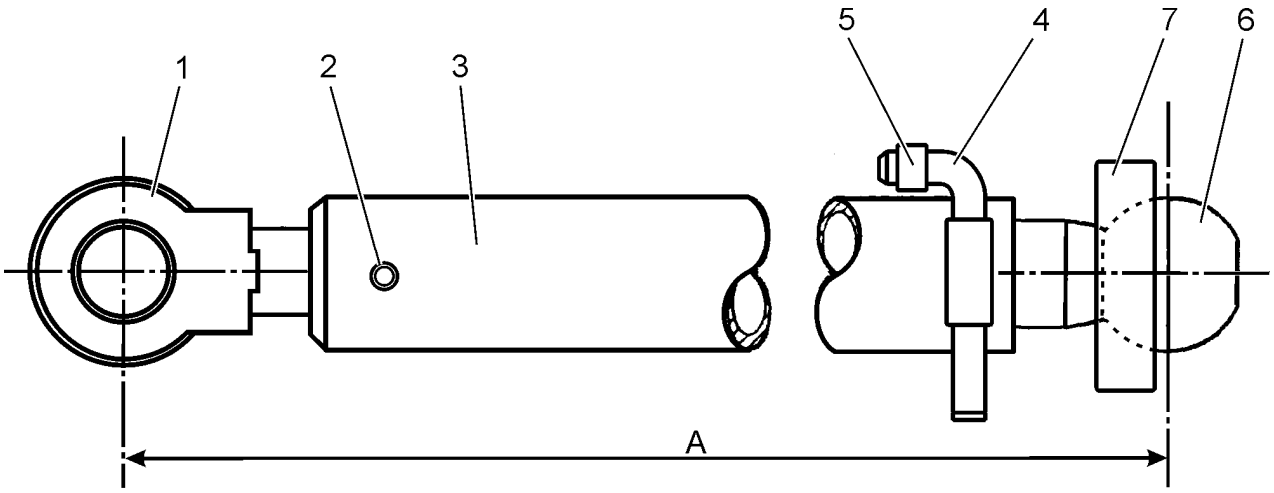

Fig. 17.7. Upper Strut

1. Eyebolt
2. Lube Fitting
3. Upper Strut Housing
4. Lock Pin
5. Lock Pin Collar
6. Strut Ball
7. Strut Ball Cap

A. Nominal Strut Mounting Length . . . . . 1356 [mm]

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BULLDOZER UPPER STRUT

7. REASSEMBLY AND INSTALLATION

1. Install the eyebolt (1, Fig. 17.7) on upper strut housing (3).
2. Adjust the upper strut to nominal mounting length 1356 [mm] (Fig. 17.7).
3. Position the upper strut (21, Fig. 17.1) so that the eye is inside the bracket on top of the push arm (23) and the strut ball is in blade socket (2). Connect upper strut cap to socket (2) with the four bolts and washers. Be sure to tighten the bolts with washers evenly to 270 [Nm]. Determine the number of shims (3) needed to fill the gap between upper strut cap and socket (2), then add one additional shim (3) to provide clearance. Each shim (3) is 0.75 [mm] thick. Remove bolts, add the amount of shims required and install and torque the bolts with washers to 845 [Nm].
4. Position the eye of the upper strut (21, Fig. 17.1) in the bracket on top of the push arm (23) so that the pin holes are aligned. Insert pin (22) through the bracket, aligning the lock holes. Secure the pin (22) with the locking hardware.

BULLDOZER DIAGONAL STRUTS

8. REMOVAL AND DISASSEMBLY

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train neutral lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

WARNING! Due to the considerable weight and bulk of each bulldozer component, a suitable hoist or lifting device MUST be used. Remove each component separately using suitable blocking on the remaining components.

1. Attach a hoist to the diagonal strut. Place tension on the hoist.
2. Disconnect the diagonal strut (26, Fig. 17.1) from the push arm (23 or 28) by removing the pin locking hardware and drive out the mounting pin (25).
3. Remove the bolts (6, Fig. 17.6) securing cap (2) to socket (4) and remove the strut (1) and shims (5).
4. If necessary, remove the eyebolt (7, Fig. 17.8) from diagonal strut housing (4).

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BULLDOZER DIAGONAL STRUTS

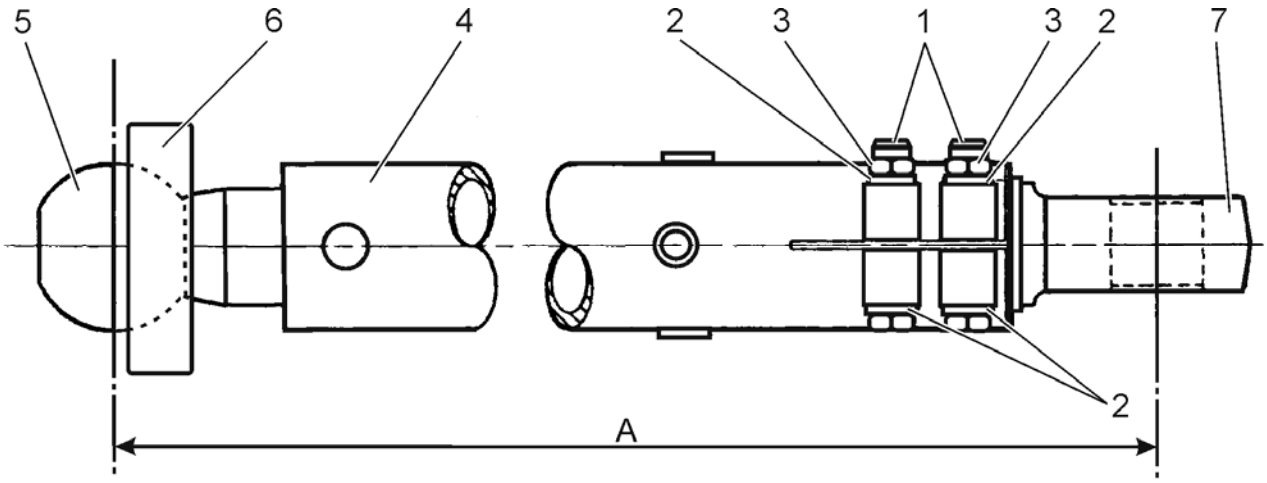

Fig. 17.8. Diagonal Strut

1. Bolt
2. Washer
3. Nut
4. Diagonal Strut Housing
5. Strut Ball
6. Strut Ball Cap
7. Eyebolt

A. Nominal Strut Mounting Length . . . . . 1200 [mm]

9. REASSEMBLY AND INSTALLATION

1. Install the eyebolt (7, Fig. 17.8) on diagonal strut housing (4).
2. Adjust the diagonal strut to nominal mounting length 1200 [mm] (Fig. 17.8).
3. Position the diagonal strut (26, Fig. 17.1) so that the eye is inside the bracket on the side of the push arm (23 or 28) and the strut ball in blade socket (10). Connect the strut socket cap to the blade socket (10) with the four bolts (6) and washers. Be sure to tighten the bolts evenly. Determine the number of shims (11) needed to fill the gap between strut socket cap and socket (10) then add one additional shim (11) to provide clearance. Each shim (11) is 0.75 [mm] thick. Remove the bolts, add the amount of shims (11) required and install and torque the bolts with washers to 1050 [Nm].
4. Position the eye of the diagonal strut (26) in the bracket on the side of the push arm (23 and 28) so that the pin holes are aligned. Insert the mounting pin (25) through the bracket, aligning the lock holes. Secure the pin (25) with the locking hardware.

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BULLGRADER BLADE

10. REMOVAL

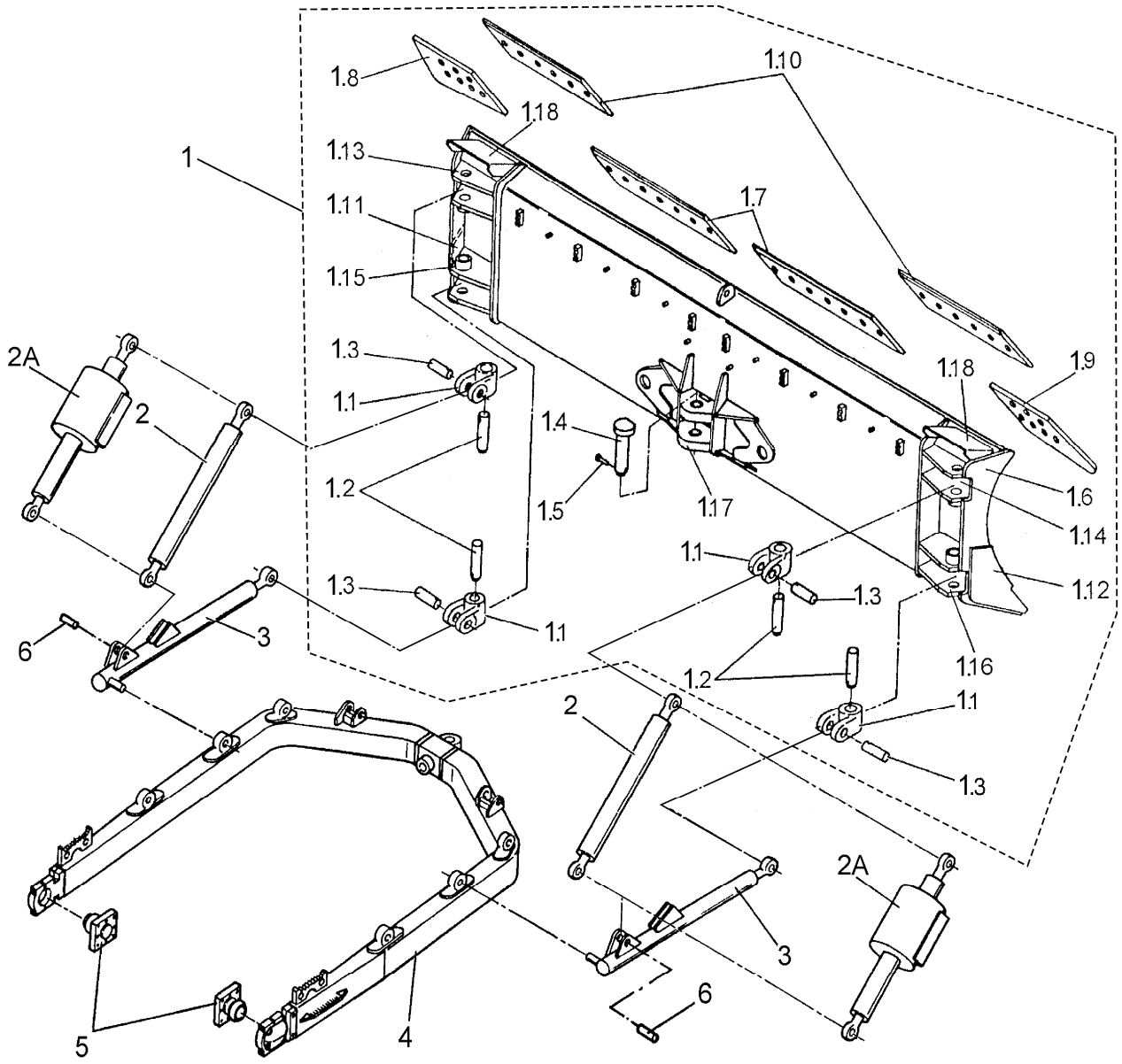

Fig. 17.9. Exploded View of Bullgrader Blade and “C” Frame

1. Blade Assy

1.1. Swivel Bar	1.7. Center Cutting Edges	1.13. L.H. Upper Strut Bracket
1.2. Swivel Bar Pins	1.8. L.H. Cutting Edge End Bit	1.14. R.H. Upper Strut Bracket
1.3. Mounting Pin	1.9. R.H. Cutting Edge End Bit	1.15. L.H. Lower Strut Bracket
1.4. Center Pin	1.10. Cutting Edges	1.16. R.H. Lower Strut Bracket
1.5. Mounting Pin	1.11. L.H. Side Plate	1.17. “C” Frame Bracket
1.6. Bullgrader Blade	1.12. R.H. Side Plate	1.18. Guard

“C” Frame Assy

2. Upper Strut
2A. Blade Tilt Cylinder
3. Lower Left & Right Strut Assy
4. “C” Frame Assy
5. Frame Trunnion Assys
6. Lower Strut Pin

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BULLGRADER BLADE

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train neutral lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

CAUTION! Due to the considerable weight and bulk of each bullgrader component, a suitable hoist or lifting device MUST be used. Remove each component separately using suitable blocking on the remaining components.

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate proper installation.*

Blade Only

1. Lower the blade (1, Fig. 17.9) to the ground and install blocks under the front portion of the C frame (4). Attach a hoist to the blade lifting eye and take up the slack.
2. Machine without hydraulic tilt: Disconnect upper strut (2) from the swivel bar (1.1) by removing the pin (1.3) locking hardware and drive out pin (1.3). Flip the upper strut (2) back away from the blade (1). Repeat this procedure on the opposite side of the machine.
3. Machine with hydraulic tilt: Remove the hose guard (17, Fig. 17.10) and disconnect frame to blade hoses (7 and 23) from the tubes (6) at the rear of the blade (15). Disconnect hoses (4 and 5) from the tubes (6 and 18) at the right side of the machine and disconnect hoses (4 and 5) from the tubes (6 and 22) at the left side of the machine.
4. Disconnect the tilt cylinder (2A, Fig. 17.9) from the swivel bar (1.1) by removing the pin (1.3) locking hardware and drive out pin (1.3). Flip the tilt cylinder (2A) back away from the blade (15). Repeat this procedure at the opposite side of the machine.
5. Install blocks under lower struts (3). Disconnect lower strut (3) from the swivel bar (1.1) by removing the pin (1.3) locking hardware and drive out pin (1.3). Flip the lower strut (3) back away from the blade (1). Repeat this procedure at the opposite side of the machine.
6. Disconnect the blade (1) from the “C” frame (4) by removing the cotter pin, mounting pin (1.5) and drive out blade center pin (1.4).
7. Lift off the blade.

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BULLGRADER BLADE

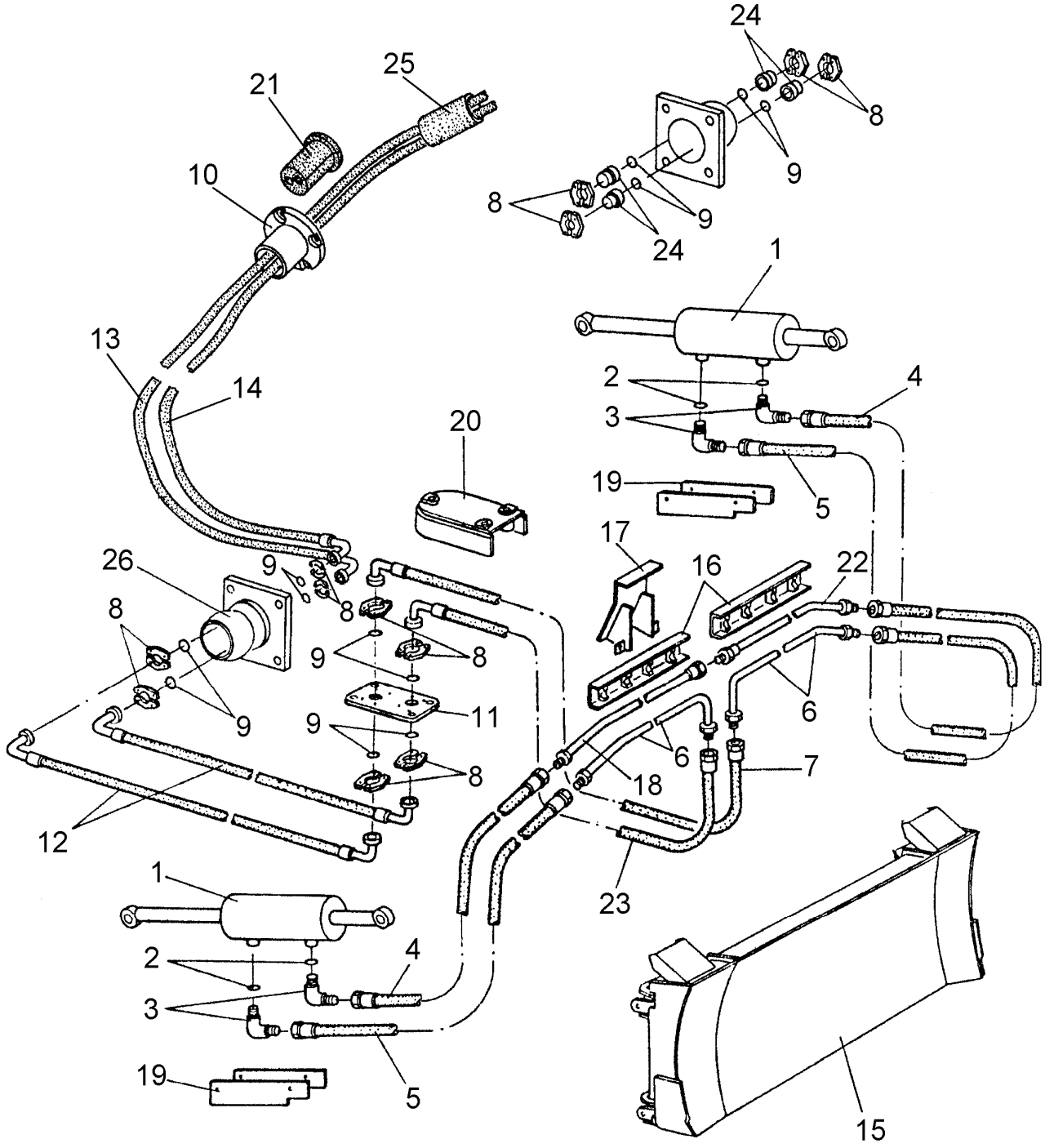

Fig. 17.10. Bullgrader Blade Tilt Piping

1. Blade Tilt Cylinder
2. O-Rings
3. Elbows
4. Hose
5. Hose
6. Tube Assy
7. Frame to Blade Hose
8. Split Flange
9. O-Rings
10. Flange Guard
11. Plate
12. Trunnion to Frame Hoses
13. Valve to Trunnion Hose
14. Valve to Trunnion Hose
15. G-2 Blade Assy
16. Hose Guards
17. Hose Center Guard
18. Tube Assy
19. Hose Guard (on Cylinder)
20. Hose Guard (on “C” Frame)
21. Hose Guard
22. Tube Assy
23. Frame to Blade Hose
24. Plugs
25. Hose Guard
26. R.H. Trunnion

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Blade w/C Frame

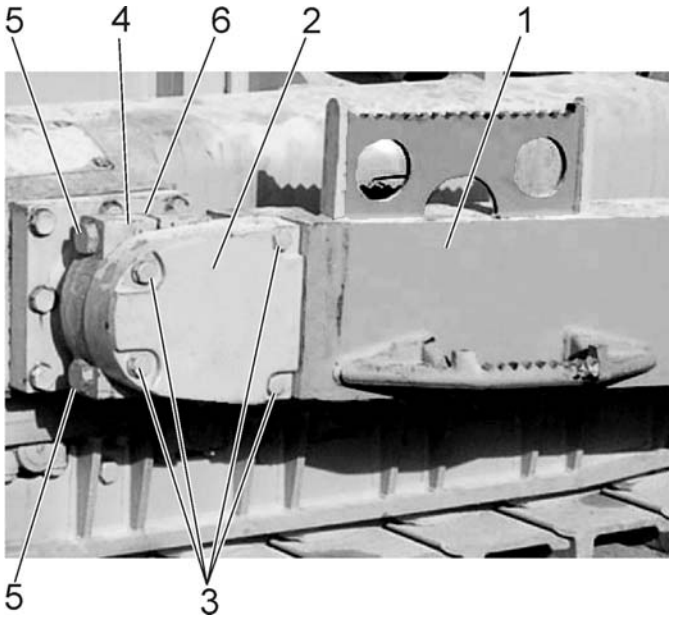

Fig. 17.11. Removing the Trunnion Caps

1. “C” Frame
2. Blade Hoses Connection Guard
3. Cover Bolts
4. Trunnion Cap
5. Bolts
6. Shims

1. Lower the blade (1, Fig. 17.9) to the ground and install blocks under the rear portions of the ”C” frame (4).
2. Disconnect the lift cylinder from the “C” frame (4) by removing the pin locking hardware and drive out the mounting pins. Hydraulically retract the rods and secure the cylinders to the frame radiator guard with the cylinder hanger and wire.
3. Unscrew bolts (3, Fig. 17.11) and remove blade hoses connection guard (2) from “C” frame (1). Repeat this step on the opposite side of the machine.
4. Machine with hydraulic tilt: Disconnect hoses (12, Fig. 17.10) from right trunnion (26).
5. Unscrew two trunnion cap bolts (5, Fig.17.11) and remove cap (4) with shims (6) from “C” frame (1). Repeat this step on the opposite side of the machine.
6. Back the machine out from between the “C” frame.
7. Reassemble shims (6) and caps (4) to the “C” frame (1) and secure with bolts (5) to prevent their damage or being lost.

11. INSTALLATION

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train neutral lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

CAUTION! Due to the considerable weight and bulk of each bullgrader component, a suitable hoist or lifting device MUST be used. Remove each component separately using suitable blocking on the remaining components.

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BULLGRADER BLADE

Blade Only

1. Attach a hoist to the blade lifting eye and lower it into position.
2. Position the blade (1, Fig. 17.9) to align the pinhole in the pivot of “C” frame (4) with the hole in blade bracket (1.17). Insert the blade center pin (1.4) through the bracket, aligning the lock holes. Secure the center pin (1.4) with the mounting pin (1.5) and cotter pin.
3. Position the eye of the lower strut (3) in the swivel bar (1.1) on the blade (1) so that the pin holes are aligned. Insert the mounting pin (1.3) through the swivel bar (1.1), aligning the lock holes. Secure the pin (1.3) with the locking hardware. Repeat this procedure on the opposite side of the machine.
4. Machine without hydraulic tilt: Position the eye of the upper strut (2) in the swivel bar (1.1) on the blade (1) so that the pin holes are aligned. Insert the mounting pin (1.3) through the swivel bar (1.1), aligning the lock holes. Secure the pin (1.3) with the locking hardware. Repeat this procedure on the opposite side of the machine.
5. Machine with hydraulic tilt: Position the eye of the tilt cylinder (2A) in the swivel bar (1.1) on the blade (1) so that the pin holes are aligned. Insert the mounting pin (1.3) through the swivel bar (1.1), aligning the lock holes. Secure the pin (1.3) with the locking hardware. Repeat this procedure on the opposite side of the machine.
6. Reconnect hoses (4 and 5) to the tubes (6 and 22) at the left side of the machine and reconnect hoses (4 and 5) to the tubes (6 and 18) at the right side of the machine. Reconnect frame to blade hoses (7 and 23) to the tubes (6) at the rear of the blade (15). Install the hose guard (17) to the rear of the blade (15). Adjust and vent the blade tilt hydraulic system with “C” frame according to OPERATOR’S MANUAL.
7. Remove the blocks from under diagonal struts and “C” frame.

Blade w/C Frame

1. Drive the machine between the “C” frame (4, Fig. 17.9).
2. Position trunnion caps (4, Fig.17.11) over the trunnions and connect them to the “C” frame (1) with the bolts (5) and nuts. Be sure to tighten the bolts evenly. Determine the number of shims (6) needed to fill the gap between trunnion caps (4) and the “C” frame (1), then add one additional shim to provide clearance. Remove the bolts, add the number of shims (6) required and install and torque the bolts (5) to 2100 [Nm].
3. Disconnect the lift cylinder hanger and wire from the frame radiator guard and hydraulically extend the cylinder rods until the eyes line up with the bracket on the “C” frame (4, Fig. 17.9). Insert the mounting pins through the brackets, aligning the lock holes. Secure the pins with the locking hardware.
4. Machine with hydraulic tilt: Connect the hoses (12, Fig. 17.10) to the right trunnion (26). Adjust and vent the blade tilt hydraulic system with “C” frame according to OPERATOR’S MANUAL. Operate the tilt cylinders and check for leaks.
5. Install blade hoses connection cover (2, Fig.17.11) to the “C” frame (1) and secure with bolts (3). Repeat this step on the opposite side of the machine.

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12. REMOVAL

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train neutral lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

CAUTION! Due to the considerable weight and bulk of each bullgrader component, a suitable hoist or lifting device MUST be used. Remove each component separately using suitable blocking on the remaining components.

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate proper installation.*

1. Lower the blade (1, Fig.17.9) to the ground and install blocks under the front of the “C” frame (4).
2. Disconnect the lift cylinders from the “C” frame (4) by removing the pin locking hardware and drive out the mounting pins. Hydraulically retract the rods and secure the cylinders to the main frame radiator guard with the cylinder hanger and wire.
3. Disconnect left lower strut (3) from the “C” frame bracket by removing the lock pin and free the strut trunnion from the “C” frame bracket. Flip the lower left strut (3) back away from the “C” frame (4) and install blocks under the lower left strut (3). Repeat this procedure on the opposite side of the machine.
4. Unscrew bolts (3, Fig. 17.11) and remove blade hoses connection cover (2) from “C” frame (1). Repeat this step on the opposite side of the machine.
5. Machine with hydraulic tilt: Disconnect hoses (12, Fig. 17.10) from the right trunnion (26). Remove hose guard (20) from the “C” frame and disconnect hoses (7 and 23) from the “C” frame plate (11).
6. Disconnect the “C” frame (4, Fig. 17.9) from blade (1) by removing the cotter pin, mounting pin (1.5) and drive out blade center pin (1.4). Using the hoist, remove the blade (1) with lower struts (3) and upper struts (2) or tilt cylinders (2A).
7. Install blocks under the rear of the “C” frame (4) on each side of the machine. Unscrew two trunnion cap bolts (5, Fig.17.11) and remove cap (4) with shims (6) from “C” frame (1). Repeat this step on the opposite side of the machine.
8. Back the machine out from between the “C” frame (1).
9. Reassemble shims (6, Fig.17.11) and caps (4) to the “C” frame (1) and secure with bolts (5) to prevent their damage or being lost.

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BULLGRADER „C“ FRAME

13. INSTALLATION

1. Drive the machine between the “C” frame (1, Fig. 17.9).
2. Position trunnion caps (4, Fig. 17.11) over the trunnions and connect them to the “C” frame (1) with the bolts (5) and nuts. Be sure to tighten the bolts evenly. Determine the number of shims (6) needed to fill the gap between caps (4) and the “C” frame (1), then add one additional shim to provide clearance. Remove the bolts, add the number of shims (6) required. Reinstall the bolts (5) and torque to 2100 [Nm].
3. Disconnect the lift cylinder hanger and wire from the main frame radiator guard and hydraulically extend the cylinder rods until the eyes line up with the bracket on the “C” frame (4, Fig. 17.9). Insert the mounting pins through the brackets, aligning the lock holes. Secure the pins with the locking hardware.
4. Attach a hoist to the blade lifting eye and lower the blade (1, Fig.17.9) with lower struts (3) and upper struts (2) or tilt cylinders (2A) into position. Align the pinhole in the swivel pin of “C” frame (4) with the hole in blade bracket (1.17). Insert the blade center pin (1.4) through the bracket, aligning the lock holes. Secure the center pin (1.4) with the mounting pin (1.5) and cotter pin.
5. Position the lower strut (3) in the “C” frame bracket. Insert the strut trunnion in the brackets on the top of “C” frame and secure with the trunnion locking pin. Repeat this procedure on the opposite side of the machine. Remove the blocks from the both lower struts (3).
6. Machine with hydraulic tilt: Reconnect the hoses (12, Fig. 17.10) to the right trunnion (26). Reconnect frame to blade hoses (7 and 23) to the “C” frame plate (11). Install the hose guard (20) to the “C” frame. Adjust and vent the blade tilt hydraulic system with “C” frame according to OPERATOR’S MANUAL. Operate the tilt cylinders and check for leaks.
6. Install blade hoses connection cover (2, Fig.17.11) to the “C” frame (1) and secure with bolts (3). Repeat this step on the opposite side of the machine.

BULLGRADER STRUTS

14. REMOVAL AND DISASSEMBLY

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train neutral lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

CAUTION! Due to the considerable weight and bulk of each bullgrader component, a suitable hoist or lifting device MUST be used. Remove each component separately using suitable blocking on the remaining components.

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BULLGRADER STRUTS

Upper Strut

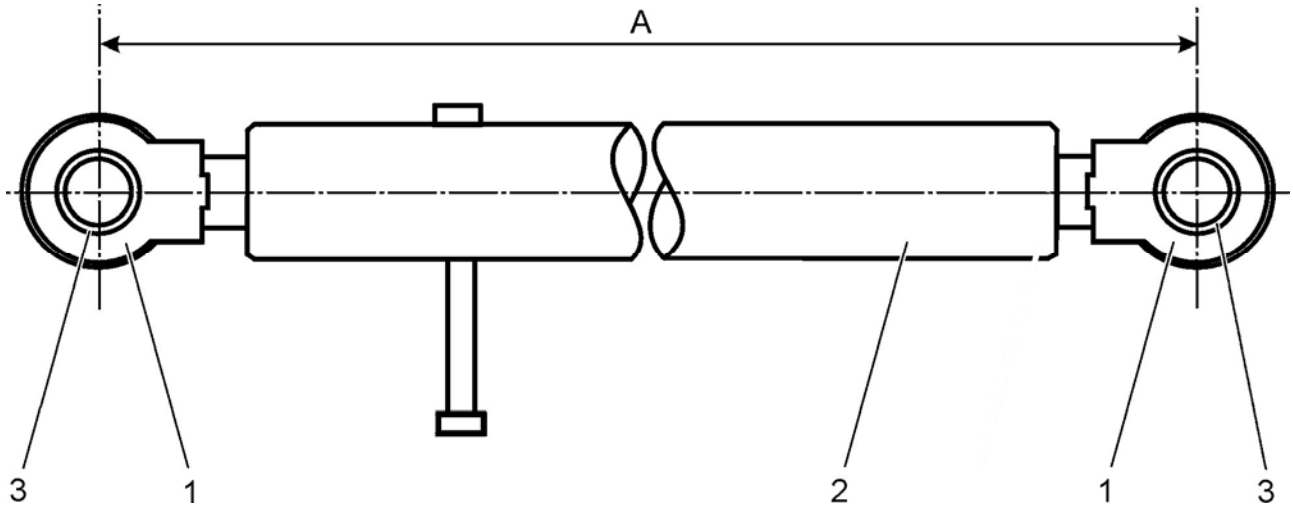

Fig. 17.12. Upper Strut Adjustment

1. Eyebolt 2. Upper Strut Body 3. Bushing

A. Nominal Strut Mounting Length . . . . . 1368.5 [mm]

1. Disconnect upper strut (2, Fig. 17.9) from the lower strut (3) by removing the pin locking hardware and drive out pin (6).
2. Disconnect upper strut (2) from the blade swivel bar (1.1) by removing the pin locking hardware and drive out pin (1.3). Remove the upper strut (2) from the machine.
3. Remove the eyebolt (1, Fig. 17.12) from the strut body (2). Remove bushing (3) from the eyebolt (1), if necessary. Repeat this step on the opposite side of the strut.

Lower Strut

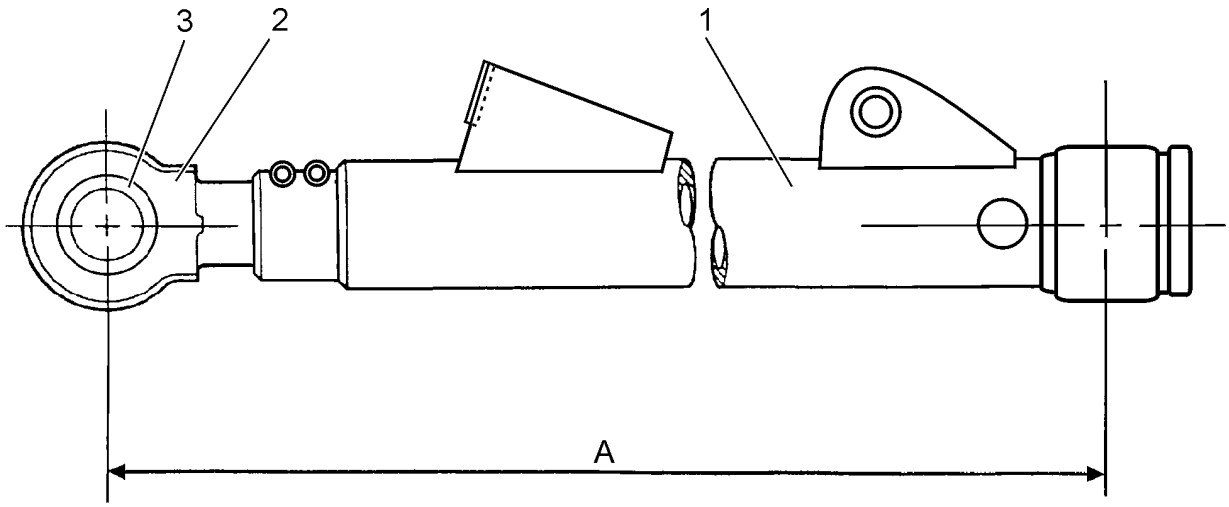

Fig. 17.13. Lower Strut Adjustment

1. Lower Strut Body 2. Eyebolt 3. Bushing

A. Nominal Strut Mounting Length . . . . . 1694 [mm]

1. Disconnect upper strut (2, Fig. 17.9) or tilt cylinder (2A) from lower strut (3) by removing the lock pin and drive out pin (6). Tie upper strut (2) or tilt cylinder (2A) up out of the way.

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BULLGRADER STRUTS

2. Disconnect the lower strut (3) from blade swivel bar (1.1) by removing the pin locking hardware and drive out pin (1.3).
3. Remove the cotter pin securing the “C” frame lower strut trunnion and free the trunnion from the “C” frame (4) bracket. Remove the lower strut (3) from the machine
4. Remove the eyebolt (2, Fig. 17.12) with bushing from lower strut body (1). Remove the bushing (3) from the eyebolt (2), if needed.
5. If necessary, remove strut trunnion and trunnion pin.

15. REASSEMBLY AND INSTALLATION

Upper Strut

1. Install new bushings (3, Fig. 17.12) to the eyebolts (1), if removed. Install the eyebolts (1) on the upper strut body (2).
2. Adjust the upper strut to nominal mounting length 1368.5 [mm].
3. Position the eye of the upper strut (2, Fig. 17.9) in the bracket on top of the lower strut (3) so that the pin holes are aligned. Insert pin (6) through the bracket, aligning the lock holes. Secure the pin with the locking hardware.
4. Position the eye of the upper strut (2) in the blade swivel bar (1.1) so that the pin holes are aligned. Insert pin (1.3) through the swivel bar (1.1), aligning the lock holes. Secure the pin (1.3) with the locking hardware.
5. If necessary, adjust the upper strut (2) as described in the OPERATOR’S MANUAL.

Lower Strut

1. If removed, install strut trunnion and trunnion pin. If removed, install new bushing (3, Fig. 17.13) in the eyebolt (2). Install the eyebolt (2) on lower strut body (1).
2. Adjust the lower strut to nominal mounting length 1694 [mm].
3. Position the eye of the lower strut (3, Fig. 17.9) in the blade swivel bar (1.1) so that the pin holes are aligned. Insert pin (1.3) through the swivel bar (1.1), aligning the lock holes. Secure the pin (1.3) with the locking hardware. Position the lower strut trunnion close to the “C” frame bracket. Insert the strut trunnion in the bracket on top of the “C” frame (4). Secure the trunnion with the locking pin.
4. Position upper strut (2) or tilt cylinder (2A) so that eyebolt is in the bracket on the lower strut (3). Install pin (6), aligning the lock holes and secure with the pin lock pin.
5. If necessary, adjust the upper strut as described in the OPERATOR’S MANUAL.

TRUNNIONS

16. TRUNNION REPLACEMENT

1. Remove the blade with push arm (3, Fig. 17.4) or “C” frame (1, Fig. 17.11) as described in this Section.
2. Remove the bolts securing trunnion (24, Fig. 17.1) to the track frame and remove the trunnion.
3. Remove any paint or dirt from the trunnion pad on the track frame.
4. Mount the trunnion to the track frame. Secure the trunnion with eight bolts. Tighten the bolts to 845 [Nm].
5. Install the blade with push arm (3, Fig. 17.4) or “C” frame (1, Fig. 17.11) as described in this Section.

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17. LIFT CYLINDER YOKE REPLACEMENT (Refer to Fig. 17.14)

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train neutral lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

WARNING! Due to the considerable weight and bulk of each bulldozer component, a suitable hoist or lifting device MUST be used. Remove each component separately using suitable blocking on the remaining components.

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate proper installation.*

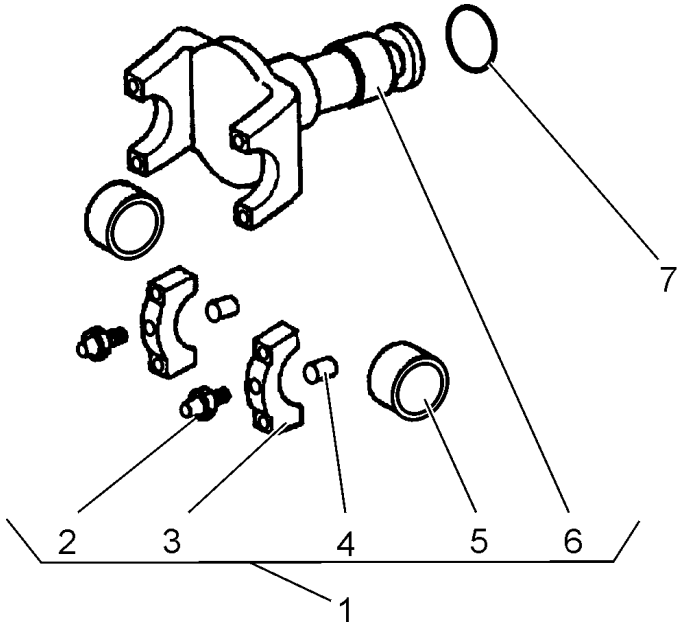

Fig. 17.14. Lift Cylinder Yoke

1. Lift Yoke Assembly
2. Lube Fitting
3. Yoke Cap
4. Spring Pin
5. Yoke Bushing
6. Lift Cylinder Yoke
7. Wiper Ring

1. Remove the hydraulic lift cylinder. Refer to SECTION 10C for removal procedure.
2. Rotate the yoke (6) 90 degrees toward the front of the machine and remove the yoke from the crosstube. The ring (7) will come out with the yoke.
3. Install the new yoke as follows:
   a). Install the new ring (7) over the shaft of the yoke (6).
   b). If necessary, install new bushings in the ends of the cylinder crosstube (refer to SECTION 9, FRAME).
   c). Align the tang of the eccentric yoke (6) with the slot in the crosstube. Insert and turn the yoke 90 degrees to the rear of the machine. The turning action will lock the yoke into position.
4. Install the hydraulic lift cylinder. Refer to SECTION 10C for installation procedure.

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18. REMOVAL (Refer to Fig. 17.15)

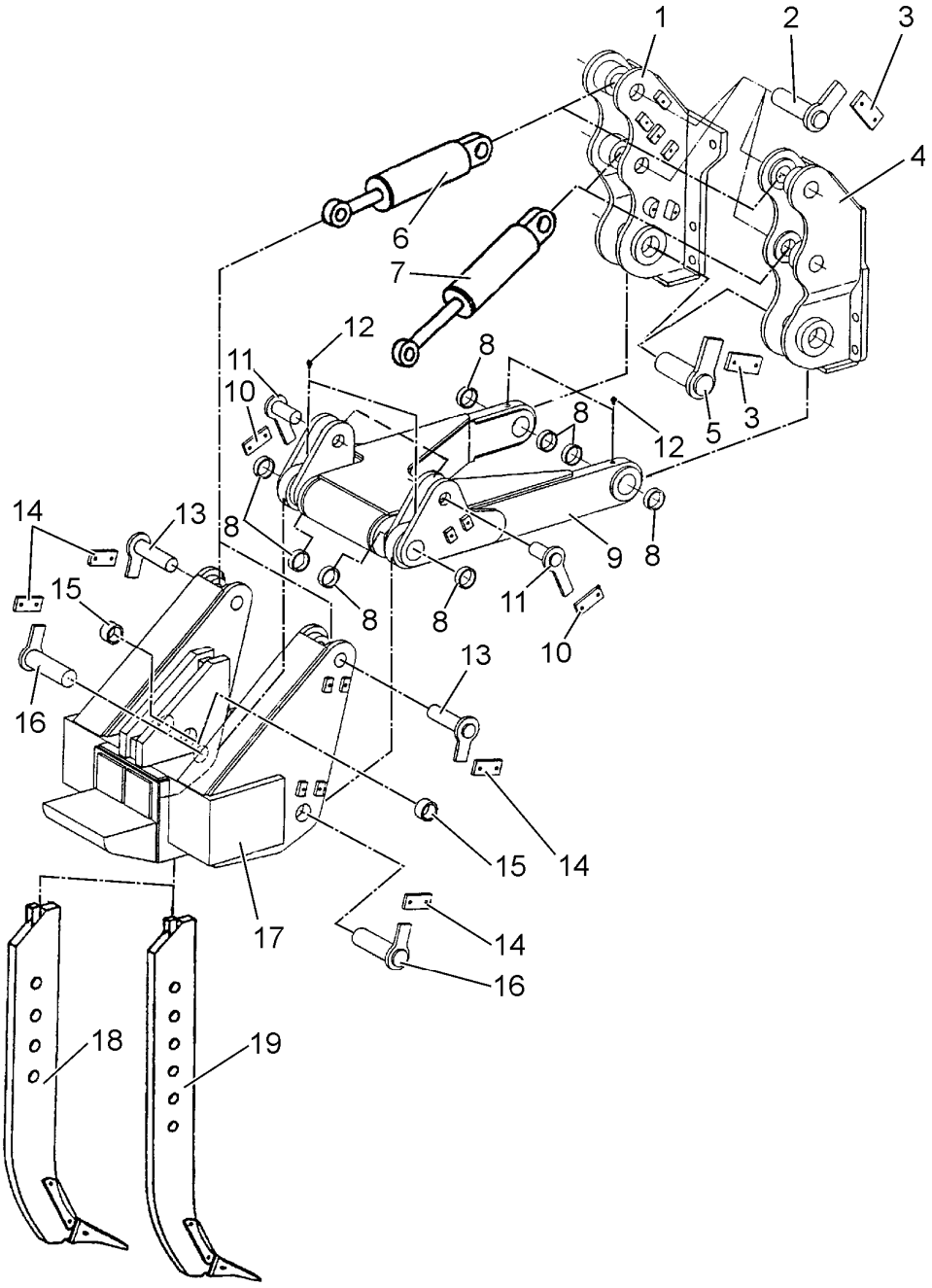

Fig. 17.15. Single Shank Ripper

1. Left Mounting Frame
2. Cylinder Pin
3. Stop Plate
4. Right Mounting Frame
5. Draft Frame Pin
6. Ripper Pitch Cylinder
7. Ripper Lift Cylinder
8. Bushing
9. Draft Frame
10. Stop Plate
11. Cylinder Pin
12. Lube Fitting
13. Cylinder Pin
14. Stop Plate
15. Ripper Shank Pin Bushing
16. Draft Frame Pin
17. Tool Beam
18. Ripper Shank Assy (STD)
19. Ripper Shank Assy (DEEP DIG)

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WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train neutral lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

WARNING! Due to the considerable weight and bulk of each bulldozer component, a suitable hoist or lifting device MUST be used. Remove each component separately using suitable blocking on the remaining components.

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate proper installation.*

1. Position suitable blocking under draft frame (9) and tool beam (17). Remove pitch cylinders (6), refer to SECTION 10C. Reinstall mounting pins (2 and 13) in mounting frame (1 and 4) and tool beam (17).
2. Remove ripper lift cylinders (7), refer to SECTION 10C. Reinstall mounting pins (2 and 11) in mounting frame (1 and 4) and draft frame (9).
3. Attach hoist to cylinder mounting pins (13) at tool beam (17) and take out slack in hoist. Remove draft frame pins (16) and lift tool beam (17) from ripper. If necessary, remove shank (18 or 19) from tool beam (17).
4. Attach hoist to draft frame (9) and take out slack in hoist. Remove draft frame pins (5) and lift draft frame (9) from ripper.
5. Attach hoist to cylinder mounting pins (2) at left mounting frame (1) and take out slack in hoist. Remove mounting hardware and lift left frame from machine.
6. Attach hoist to cylinder mounting pins (2) at right mounting frame (4) and take out slack in hoist. Remove mounting hardware and lift right frame from machine.

19. DRAFT FRAME (Refer to Fig. 17.15)

1. Position draft frame assembly (9) on a stand. Using a hydraulic press, remove the old draft frame bushings (8) from draft frame (9).
2. Place new bushing (8) in draft frame (9). Using the hydraulic press, press bushing (8) into draft frame (9). Repeat for other bushings (8). Coat inner surfaces of bushings (8) with fresh grease. Remove draft frame (9) from the stand.

20. TOOL BEAM (Refer to Fig. 17.15)

1. Position tool beam assembly (17) on a stand. Using a hydraulic press, remove the old ripper shank pin bushings (15) from tool beam (17).
2. Place new bushing (15) in tool beam (9). Using the hydraulic press, press bushing (15) into tool beam (17). Repeat for other bushing (15). Coat inner surfaces of bushings (15) with fresh grease. Remove tool beam (17) from the stand.

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SINGLE SHANK RIPPER

21. INSTALLATION (Refer to Fig. 17.15)

1. Clean mating surfaces of mounting frames (1 and 4) to rear main frame.
2. Using hoist on cylinder pin (2) place mounting frame (1) into position. Install hardware and torque the bolts to 3100 ± 5 [%] [Nm]. Remove pin (2) from mounting frame (1).
3. Using hoist on cylinder pin (2) place mounting frame (4) into position. Install hardware and torque the bolts to 3100 ± 5 [%] [Nm]. Remove pin (2) from mounting frame (4).
4. Attach hoist to draft frame (9) and place in position in mounting frames (1 and 4). Install mounting pins (5), being careful not to damage bushings (8), and secure with plate and hardware. Hoist draft frame (9) and support with blocking.
5. Attach hoist to cylinder pins (13) on tool beam (17) and place in position. Secure tool beam (17) to draft frame (9) with pins (16), plates and hardware. Position suitable blocking under tool beam (17).
6. Install ripper lift cylinders (7), refer to SECTION 10C.
7. Install ripper pitch cylinders (6), refer to SECTION 10C.
8. If removed, install shank (18 or 19) to tool beam (17).

MULTI SHANK RIPPER

22. REMOVAL (Refer to Fig. 17.16)

WARNING! Before working at the machine, be sure that the blade and ripper have been lowered to the ground, engine is OFF, the drive train neutral lock lever is in locked (ON) position and parking brake is set. The starting switch and the electrical system master switch are turned OFF, keys are removed and the controls are tagged to prevent inadvertent engine starting.

WARNING! Due to the considerable weight and bulk of each bulldozer component, a suitable hoist or lifting device MUST be used. Remove each component separately using suitable blocking on the remaining components.

IMPORTANT: *Disconnected hydraulic lines must be capped with the correct size plastic cap. If caps are not available, use tape or rubber stoppers. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical hydraulic components. Tag all disconnected lines to facilitate proper installation.*

1. Position suitable blocking under draft frame (9) and tool beam (16). Remove pitch cylinders (6), refer to SECTION 10C. Reinstall mounting pins (2 and 13) in mounting frame (1 and 4) and tool beam (16).
2. Remove ripper lift cylinders (7), refer to SECTION 10C. Reinstall mounting pins (2 and 11) in mounting frame (1 and 4) and draft frame (9).
3. Attach hoist to cylinder mounting pins (13) at tool beam (16) and take out slack in hoist. Remove draft frame pins (15) and lift tool beam (16) from ripper. If necessary, remove shanks (17) from tool beam (16)

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MULTI SHANK RIPPER

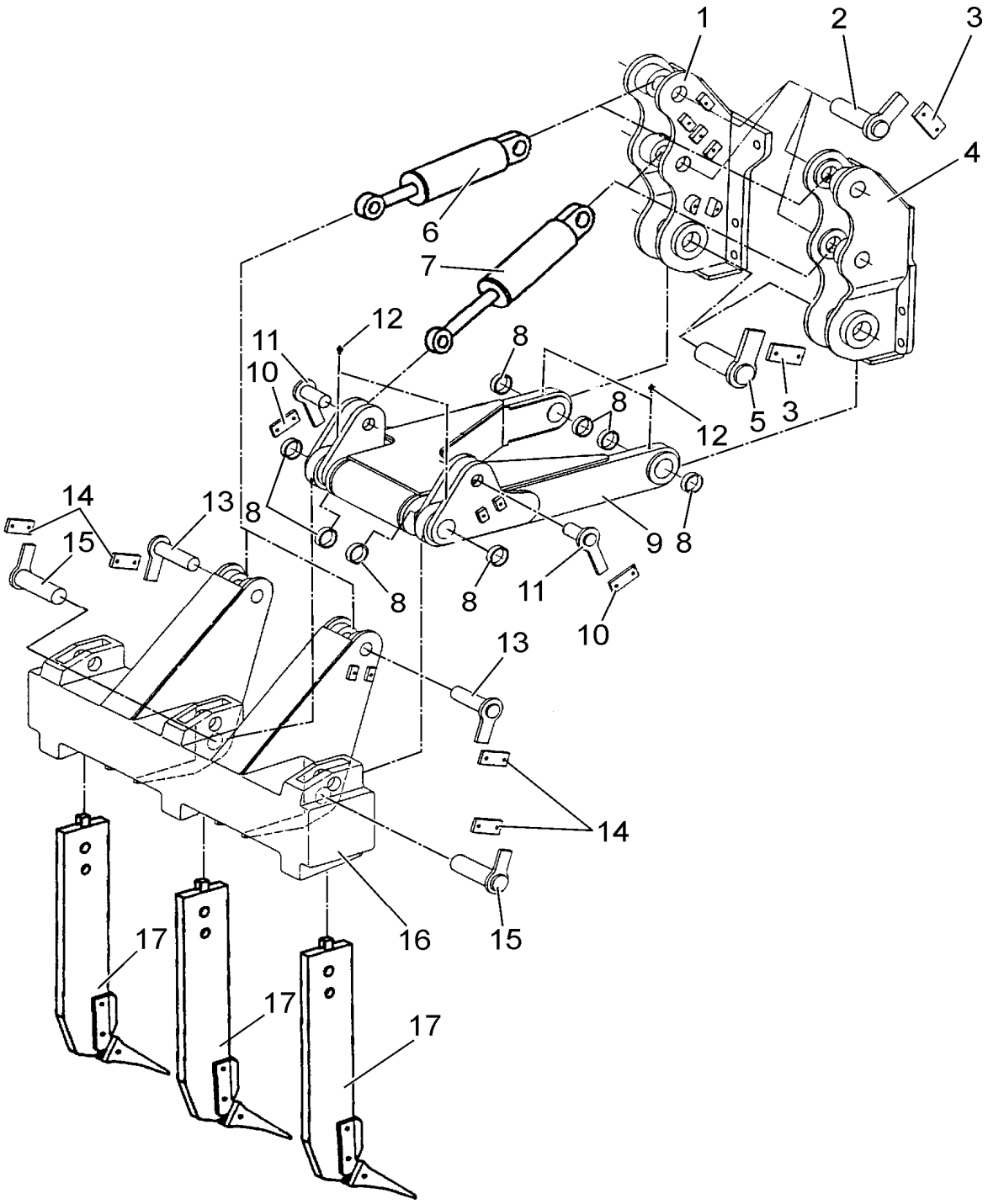

Fig. 17.16. Multi Shank Ripper

1. Left Mounting Frame
2. Cylinder Pin
3. Stop Plate
4. Right Mounting Frame
5. Draft Frame Pin
6. Ripper Pitch Cylinder
7. Ripper Lift Cylinder
8. Bushing
9. Draft Frame
10. Stop Plate
11. Cylinder Pin
12. Lube Fitting
13. Cylinder Pin
14. Stop Plate
15. Draft Frame Pin
16. Tool Beam
17. Ripper Shank Assy

4. Attach hoist to draft frame (9) and take out slack in hoist. Remove draft frame pins (5) and lift draft frame (9) from ripper.
5. Attach hoist to cylinder mounting pins (2) at left mounting frame (1) and take out slack in hoist. Remove mounting hardware and lift left frame from machine.
6. Attach hoist to cylinder mounting pins (2) at right mounting frame (4) and take out slack in hoist. Remove mounting hardware and lift right frame from machine.

23. DRAFT FRAME (Refer to Fig. 17.16)

1. Position draft frame assembly (9) on a stand. Using a hydraulic press, remove the old draft frame bushings (8) from draft frame (9).
2. Place new bushing (8) in draft frame (9). Using the hydraulic press, press bushing (8) into draft frame (9). Repeat for other bushings (8). Coat inner surfaces of bushings (8) with fresh grease. Remove draft frame (9) from the stand.

24. INSTALLATION (Refer to Fig. 17.16)

1. Clean mating surfaces of mounting frames (1 and 4) to rear main frame.
2. Using hoist on cylinder pin (2) place mounting frame (1) into position. Install hardware and torque the bolts to 3100 $\pm$ 5 [%] [Nm]. Remove pin (2) from mounting frame (1).
3. Using hoist on cylinder pin (2) place mounting frame (4) into position. Install hardware and torque the bolts to 3100 $\pm$ 5 [%] [Nm]. Remove pin (2) from mounting frame (4).
4. Attach hoist to draft frame (9) and place in position in mounting frames (1 and 4). Install mounting pins (5), being careful not to damage bushings (8), and secure with plate and hardware. Hoist draft frame (9) and support with blocking.
5. Attach hoist to cylinder pins (13) on tool beam (16) and place in position. Secure tool beam (16) to draft frame (9) with pins (15), plates and hardware. Position suitable blocking under tool beam (16).
6. Install ripper lift cylinders (7), refer to SECTION 10C.
7. Install ripper pitch cylinders (6), refer to SECTION 10C.
8. If removed, install shanks (17) to toll beam (16).