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SERVICE MANUAL

560C

SERIAL NUMBER
15001 AND UP



DRESSTA Co. Ltd.

A JOINT VENTURE OF KOMATSU AMERICA INTERNATIONAL CO. AND HUTA STALOWA WOLA S.A.

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FOREWORD

Welcome to the growing group of value-conscious people who operate DRESSTA machines.

This manual covers the instructions for safe operation, lubrications, adjustments and maintenance for normal daily care. These instructions are divided into six sections to simplify your reference to the information most important to you. Refer to the contents page at the beginning of the section for a complete list of the subjects covered except for Section 1, which should be read entirely.

This manual has been prepared to help you operate and maintain your machine with utmost efficiency and safety. Read this manual thoroughly and learn your machine before you attempt to operate it.

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.

Due to this continuous program of research and development, periodic revisions may be made to this publication. It is recommended that customers contact their distributor for information on the latest revision.

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DUE TO THIS CONTINUOUS PROGRAM OF RESEARCH AND DEVELOPMENT, PERIODIC REVISIONS MAY BE MADE TO THIS PUBLICATION. IT IS RECOMMEMENDED THAT CUSTOMERS CONTACT THEIR DISTRIBUTOR FOR INFORMATION ON LATEST REVISION.

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SAFETY PRECAUTIONS

1. GENERAL

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

Throughout this manual the use of the terms „left", „right", „front" and „rear" must be understood to avoid confusion when following instructions. These terms indicate the side of the vehicle when facing forward in the operator's seat.

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

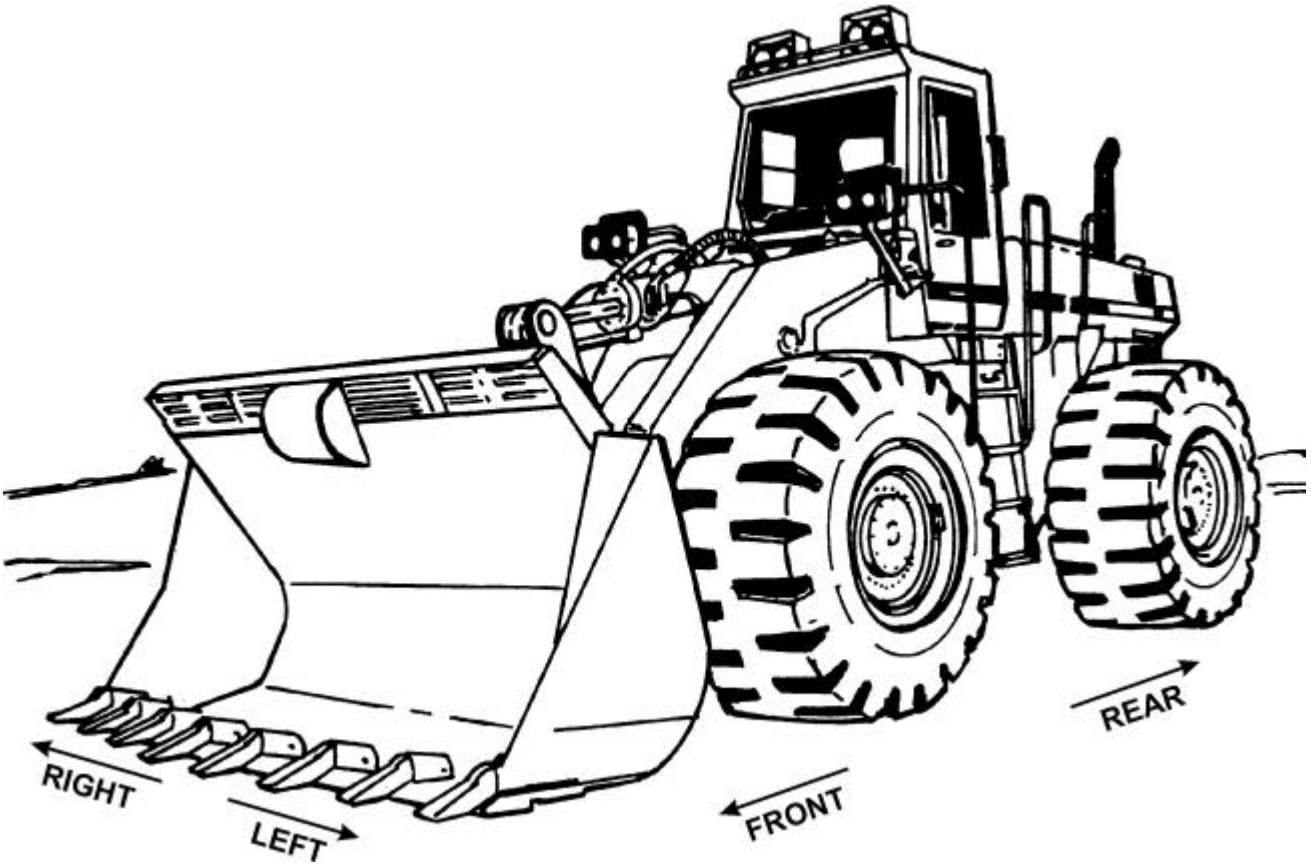


Fig. 1.1. 560 Series C Wheel Loader - Left Front View

WORK SAFELY - FOLLOW THESE RULES

This symbol is used throughout this manual to call your attention to warnings to instructions concerning personal safety. Carefully observe and follow these precautions. Be certain anyone operating or servicing this machine is aware of the safety rules. Failure to follow these precautions can result in serious injury or death.

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A. Personnel Precautions

1. Operating and servicing this machine can be hazardous if performed improperly. Personnel must have the necessary skills, information and equipment and use safe and proper procedures. Study the OPERATOR'S MANUAL before operating or servicing this machine. Consult your Construction Equipment Distributor for information and service.

2. Only trained and authorized personnel should be allowed to operate and service this machine.

3. Read all warning decals before starting, operating, maintaining or repairing this machine.

4. DO NOT wear jewelry or loose fitting or hanging clothing because they could catch on moving parts and cause injury or death. Wear proper safety equipment, such as a hard hat, rough-soled work shoes or safety shoes, ear protectors, reflective vests, respirators, safety glasses, goggles and heavy gloves. Consult your employer for specific requirements.

5. DO NOT jump on or off the machine. Keep two hands and one foot, or two feet and one hand, in contact with the steps and handholds at all times. Place objects on machine from ground level before climbing on. Always face the machine when climbing on or off to reduce the chances of slipping and injury.

6. Think before you act. Careful operators and service personnel are the best insurance against accidents.

7. Do not rush. Hurrying can lead to accidents. Haste, carelessness and lack of training are the primary causes of equipment-related injuries.

B. Machine Precautions

1. Carefully evaluate your application's particular safety needs. Each machine application can have unique requirements. You may need such attachments as: rear windshield wipers, windshield washers, heater, defroster fan, warning lights, air conditioning, ground driven steering, turn signals, Slow Moving Vehicle sign, FOPS, mirrors, backup alarm, fire extinguisher, spark arrestor, fire suppression system, cab screens, sound suppression, rotating beacon, additional lights, anti-vandalism attachments, guards, tow hook, Lexan windows, water glycol and communication radios. Consult your Construction Equipment Distributor for information.

2. Be sure the machine has the correct equipment required by local rules and regulations.

3. A rollover protective structure (ROPS) with a seat belt is required in almost all applications. DO NOT operate this machine without a ROPS.

4. It is recommended that the machine be equipped with a fully charged fire extinguisher. Personnel should be instructed in proper usage. Recharge immediately after use.

5. If the machine will be used for tree removal or site clearing, install approved operator protection Consult your Construction Equipment Distributor for information.

6. If the machine will be working under conditions of flying combustible material, install screens and guards to reduce the chance of fire.

7. If the machine will be driven on the roads, equip it with rear view mirror(s) and the necessary signal lights.

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8. If the machine is equipped with a suction fan (or a reversible fan in the suction position), check the engine exhaust system periodically for leaks. Exhaust gases are dangerous to the operator. On machines equipped with a cab, keep a vent open to outside air.

9. Keep shields and guard in place for your protection. Be sure to replace them after servicing the machine.

10. A first-aid kit should be available in case of an injury.

11. When transporting the machine, use caution when loading and unloading it. Load and unload the machine in a level area which fully supports the machine and transport vehicle. Block the transport vehicle so it cannot move. Use loading ramps of adequate strength, low angle and proper height. Keep the trailer bed and the machine's tires clean of clay, oil and other slippery materials. Lock the machine's frames together with the frame locking bar and pins. Apply the machine's parking brake. Block the tires and securely tie down the machine to the trailer bed.

2. OPERATION

A. Before Starting

1. Before entering the operator's compartment, walk completely around the machine and clear the area of personnel and obstructions.

2. Perform a visual check of the machine before starting the engine. Look for such things as missing protective devices, leaks, improper fluid levels, trash buildup and loose, damaged or missing parts. DO NOT start the engine until any unsafe conditions are corrected.

3. Before operating the machine, check that the frame locking bar and pins are in the storage position on the rear frame. A broken or lost frame locking bar or pins should be replaced immediately so that this device is always available for use.

4. Be sure all filler caps, dipsticks, plugs, latches, service doors, etc., are secure before starting.

5. BE SURE the operator's compartment, mounting steps and handholds are free of oil, grease, snow, ice, mud and foreign objects to reduce the possibility of slipping and injury. Repair any damaged steps or handholds. Remove or secure all maintenance and personal items which might interfere with the operator or jam the controls.

6. Do not use the machine's controls or hoses as handholds when climbing on or off the machine. Controls and hoses can move and do not provide solid support. Movement of the controls may cause unexpected machine movement and injury.

7. Understand all control functions before starting the engine.

8. Know the alternate exit routes from the operator's compartment for use in an emergency.

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

10. 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.

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B. Startup

1. Never start the engine indoors unless proper exhaust ventilation is provided to remove deadly exhaust gases. Open the building doors before startup. Once the engine is running, move the machine outdoors as soon as possible. Exhaust gases are hazardous and can cause unconsciousness and death.

2. Sit in the operator's seat before operating any controls. Keep hands and footwear free of grease, water and mud to insure positive control movement.

3. Before starting the engine, or when machine is standing with the engine running: lock the transmission shift lever in neutral (N), apply the parking brake and lower any raised equipment.

4. DO NOT SMOKE when using the ether injector. Do not use the ether injector when air temperature is above freezing. Follow the correct method for starting the engine. Refer to "Starting the Engine", in the OPERATOR'S MANUAL.

5. Before driving the machine, adjust the seatbelt. Adjust the seat for maximum comfort and control of the machine. Adjust the seat belt to fit snugly and low 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.

6. Use of the seat belt with the ROPS is strongly recommended. In the event of a rollover, stay with the machine. Experience has shown this will reduce the chance and seriousness of injury.

7. Before moving the machine, check the brakes, steering, attachment controls and safety devices. DO NOT operate the machine until any unsafe conditions have been corrected.

8. Do not shift the machine into gear unless air pressure gauge reads in the green "RUN" range. Low air pressure causes reduced braking.

9. Before moving the machine, sound the horn to warn nearby personnel.

10. Release the parking brake before moving the machine. The brake could burn or be damaged if the machine is driven with it applied.

11. Turn off the defroster fan before adjusting it to avoid injury.

12. NEVER HAUL PASSENGERS. Only the operator should be on the machine when it is moving. Be sure the cab door(s) is securely latched.

13. Use caution and follow the manufacturer's instructions when using external heaters to warm the power train in cold weather.

C. General Operating Precautions

1. Stay alert and aware of what you are doing. Use common sense. Do not operate when fatigued or ill. Know your machine and its capabilities. Use the machine only for its intended purpose. For your safety, read the OPERATOR'S MANUAL carefully and follow all instructions and precautions.

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2. Provide proper ventilation when operating in closed area to minimize the danger of exhaust gases. Exhaust gases are hazardous and can cause unconsciousness and death.

3. Maintain clear vision of all work and travel areas. Keep windows and mirror clean and repaired. Use a pole brush with clean water.

4. Look in the intended travel direction to be sure personnel and allied equipment do not interfere with the machine's work pattern. Do not operate if exposed personnel enter the immediate work area.

5. Turn on the machine's lights at night and times of poor visibility to see and be seen.

6. DO NOT adjust the seat while the machine is moving because a loss of control may result. Stop the machine, apply the parking brake and then adjust the seat.

7. Keep head, limbs and body inside the operator's compartment at all times because of the chance of being injured by hazards outside the operator's compartment.

8. NEVER allow anyone near the center articulation pivot. If the machine turned, they could be crushed.

9. NEVER allow anyone to stand on the ladder when the bucket is raised or the machine is moving or turning to prevent injury from falling, crushing or from falling material.

10. NEVER get on or off the machine while it is moving because serious injury or death could result.

11. After starting and while operating, observe instruments and warning lights frequently. Investigate any unusual indications or noises in the machine.

12. If the engine has a tendency to stall, investigate immediately. Do not operate the machine until the cause has been corrected.

13. If noise exposure exceeds 90 dBA for eight hours, wear ear protective equipment, per local regulations.

D. Driving the Machine

1. Carry the bucket low for maximum visibility and stability when traveling.

2. Before operating in areas with overhead obstructions, carefully check overhead clearance. Obstructions, such as guy wires, power lines, tree branches, bridges and building doors could cause a rollover accident.

3. Drive slow enough to insure complete control. Slow down when traveling in congested areas or on mud, ice or other slippery surfaces. Keep a safe distance away from other vehicles, according to the load and ground conditions.

4. Avoid crossing obstacles, such as ridges, curbs, logs and rocks. If you cannot avoid them, reduce speed and cross at an angle. Ease up to the breakover point, pass the balance point slowly and ease down on the other side.

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5. Cross ditches and gullies slowly and at an angle after checking that the ground will safely support the machine.

6. Avoid sidehill travel whenever possible. Drive straight up and down the hill. If the machine starts slipping sideways, turn downhill immediately.

7. Stop, look and listen before entering a highway. Stay on the right side of the road. Slow down and signal when turning off.

8. When roading the machine, engage the hydraulic lever locking plate to guard against accidental actuation of the levers. Personal injury could result if the bucket catches on a ledge in the road.

9. Do not use the transmission disconnect brake pedal when traveling fast or going downhill because this shifts the transmission into neutral. Loss of control or damage to the power train could result when the pedal is released and the transmission re-engages.

10. Never shift the transmission into neutral (N) when traveling downhill. The machine could go out of control or the power train could be damaged when the transmission is shifted into gear again.

11. Do not overspeed the engine. Excessive speeds can be hazardous and harmful to the power train. Select the proper gear before starting downhill. Control speed with the brakes, engine and transmission.

12. Never use the bucket as a brake except in an emergency. It might catch on the ground and result in personal injury.

13. DO NOT "pump" the brakes. Repeatedly pressing and releasing the brake pedal may reduce the oil pressure and result in reduced braking.

14. If the ground driven steering light comes on, IMMEDIATELY stop the machine in a safe place. Shut off the engine and apply the parking brake. Correct the cause be fore operating again.

15. If the brake system warning light or buzzer comes on during operation, IMMEDIATELY stop the machine in a safe place. Apply the parking brake. Correct the cause before operating again.

16. If the low pressure warning light or buzzer comes on, IMMEDIATELY stop the machine in a safe place. Apply the parking brake. The parking brake can be used to stop the machine in an emergency. Correct the cause before operating again.

17. Know the traffic flow pattern of the job site. Obey flagmen, signs and signals.

18. Give the right-of-way to loaded machines. On narrow or hilly roads, loaded machines should stay next to the high wall.

19. Keep the machine as close to the side of the road as safely possible to leave room for oncoming and passing vehicles.

20. Pass other vehicles only when the road is clear and the machine has enough distance and reserve power to pass.

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E. Operating the Attachments

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

2. Keep the work area free from obstructions and as smooth as possible.

3. Know the locations of underground cables, water mains, gas lines, etc. A broken gas line or electrical cable could cause personal injury or death.

4. Avoid operating too close to an overhang, deep ditch or excavation because the machine's weight and vibration may cause the edge to collapse and result in personal injury. If this cannot be avoided, use extra caution and face the machine toward the edge while operating.

5. Avoid undercutting high banks because the bank may cave in. Ramp up and remove the top layers first.

6. Trucks should be loaded from the driver's side whenever possible. When the truck is being loaded, be sure the driver either stays in the cab (on cab-protected trucks) or away from the truck and loader.

7. When loading trucks, be careful not to hit the truck with the loader or its bucket.

8. Use extra caution when moving with the bucket raised to minimize the chance of machine upset.

9. DO NOT swing a load over the heads of other workers or a truck cab.

10. If the loader begins in tip over because of an overload, IMMEDIATELY lower the bucket to regain stability.

11. There is no substitute for good judgement when working on a slope. Slope operation should be limited by ground and traction conditions, the load being carried and the speed of the machine.

12. NEVER operate sideways on a steep slope because a rollover and serious injury could result.

13. Using the loader to carry large objects that do not fit into the bucket is NOT recommended.

    Handling large objects can be extremely dangerous because the objects may roll or slide down the booms onto the operator. Never lift large objects higher than the operator unless the machine has a device which prevents the objects from falling back onto the operator.

14. When pushing over trees, the machine must have approved operator protection. Back away immediately when the tree starts to fall. Use extreme care when pushing over trees with dead branches which may fall. To reduce the chances of machine upset, never allow the machine to climb up the root structure.

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F. Pulling/Towing

1. For your safety, never push or tow a disabled machine farther than absolutely necessary to load it onto a truck.

2. When using a chain or cable, be sure it is strong enough for the expected load and properly secured to the drawbar pin.

3. Hitch only to the drawbar pin - NEVER HIGHER. Machine upset can result if pulling from the wrong location.

4. When pulling, position the machine so that the chain or cable aligns with the long axis of the machine.

5. Inspect chains and cable for flaws before using. Avoid kinking. Do not pull with a kinked chain or cable because the high stresses could cause a failure in the kinked area. Wear heavy gloves when handling chain or cable.

6. When pulling with a chain or cable, take up the slack slowly to avoid jerking. A chain or cable which fails under load can whip and cause serious injury. STAND CLEAR. DO NOT PULL OR TOW UNLESS THE OPERATOR'S COMPARTMENT IS GUARDED AGAINST OR OUT OF REACH OF A WHIPPING CHAIN OR CABLE.

G. Shutdown

1. Never leave the machine with the engine running or the bucket raised. When parking the machine, shut off the engine, lower the bucket to the ground, lock the transmission shift lever in neutral (N), apply the parking brake, turn off the electrical system master switch and remove the key.

2. Raised booms will drop whenever the control lever is moved to "LOWER" or "FLOAT", even with the engine off. ALWAYS lower the booms when parking the machine.

3. If the loader is equipped with a multi-purpose bucket, close the clam before dismounting.

4. Park the machine in a non-traffic area. If parking in 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.

5. Avoid parking on a slope because unexpected machine movement may occur. If necessary to park on a slope, park at a right angle to the slope and block the tires.

6. Always lock the machine, including any anti-vandalism attachments, when leaving it unattended.

3. MAINTENANCE

A. General Machine Precautions

1. Constantly be aware of dangers involved in working on the machine and take proper precautions. It is not possible to anticipate all conceivable ways or conditions under which this machine may be serviced or to provide precautions for all the possible hazards that may result. Safety is always the most important rule. Standard and accepted safety precautions and equipment should be used.

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2. Do not attempt repairs you do not understand. Consult your Construction Equipment Distributor for information and service.

3. NEVER run the engine when cleaning or lubricating the machine because serious injury could result from contacting moving parts.

4. Before servicing the machine, BE SURE the engine is off, the bucket is lowered, the transmission shift lever is locked in neutral (N), the parking brake is applied and the electrical system master switch is off and the key is removed. Tag the machine per local regulations.

5. Before working on the engine or electrical system, disconnect the negative (ground) battery cable. Tag the cable and controls to warn against starting.

6. Before working under the machine, block the tires to prevent machine movement.

7. ALWAYS lock the frames together before working near the center of the machine. If the frames move, serious injury or death could result.

8. NEVER stand near the bucket or tires while the engine is running.

9. During servicing, DO NOT allow anyone in the operator's compartment who is not trained and assisting in the servicing.

10. When it is necessary to make any checks or adjustments with the engine running, use two people. A trained operator must be at the controls to safeguard the mechanic making the checks or adjustments. BE SURE the transmission shift lever is locked in neutral (N), the parking brake is applied and the frames are locked together.

11. BE SURE the engine hood or access door(s) is secured in the open position during service work in the engine compartment. Unexpected closing could cause injury.

12. NEVER remove any guards or shields with the engine running because of the danger of contacting rotating parts.

13. When service requires access to areas that cannot be reached from the ground or a service platform on the machine, use a ladder or platform which meets proper requirements.

14. Use only approved parts for repairs and maintenance. Failure to do so could compromise personal safety, machine performance and reliability.

15. This machine is assembled using high strength fasteners. Replacement fasteners must be of the same size and strength as the originals. DO NOT SUBSTITUTE. Refer to the PARTS CATALOG for this machine. Tighten fasteners to the proper torque. Refer to STANDARD TORQUES in this Section.

16. Replace any missing or defaced decals. When parts which have decals on them are replaced, be sure to install new decals. New decals are available from your Construction Equipment Distributor.

17. NEVER adjust relief valves higher than the specified pressure because this may damage the machine and lead to an injury. When checking pressures, use the correct gauge for the expected pressure.

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B. General Work Precautions

1. Keep work area clean and dry. Remove water and oil spills immediately to reduce the chance of slipping and injury.

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

3. Use a non-toxic, non-flammable commercial solvent for cleaning parts, unless otherwise specified.

4. Avoid use of gasoline, diesel fuel, kerosene or other flammable solvents for cleaning parts. NEVER place these solvents in an o-pen pan.

5. Corrosion inhibitors are volatile and flammable. Use them only in a well ventilated area. Keep flames and sparks away. DO NOT SMOKE. Store container in a cool, well ventilated place.

6. Avoid prolonged exposure to volatile corrosion inhibitors because eye and skin irritation may occur.

7. 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.

8. Wear eye protection when using air or water under pressure to clean parts. Limit air pressure to 200 kPa and water pressure to 275 kPa.

9. When cutting, grinding, pounding, prying or whenever material could fly or fall, wear proper protective equipment such as goggles, hard hat, safety shoes and heavy gloves. Many of the machine's parts are hardened and can chip.

10. Wear hand and eye protection when draining hot fluids.

11. 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.

12. If necessary to do welding on the machine, attach the ground cable close to the weld area. Do not attach the ground cable where the current can flow through bearings or mounting pads because this will damage the parts.

13. Use extra caution when jacking up the machine. Jacking up the machine can be hazardous if performed improperly. Use jacking equipment of sufficient capacity. Be sure the jacking points are strong enough to support the machine. Be sure the jack is stable and well supported. Before jacking up the machine, block the tires which will not be lifted. Lock the frames together with the locking bar and pins. If the rear tires are being lifted, block the rear axle to prevent if from pivoting unexpectedly. DO NOT run the engine with the machine on jacks. For your safety, transfer the weight of the machine to approved blocks before servicing the machine.

14. Use the proper tool for the job. Be sure all tools are in good condition. Do not use tools which are worn, bent or have mushroomed heads because they can lead to injury.

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15. Never align holes with fingers or hands. Use the proper aligning tool to avoid injury.

16. Remove sharp edges and burrs from reworked parts.

17. Do not carry loose objects in pockets because they might catch on the machine and result in a fall or injury.

18. Use only properly grounded auxiliary power sources for chargers, heaters electric drills and similar equipment to reduce the chance of electrical shock.

19. Lift and handle all heavy parts with lifting devices of adequate capacity. Secure parts with proper slings and hooks. Use lifting eyes provided. Warn nearby personnel to stand clear.

20. DO NOT use the loader bucket or forks to lift personnel or as a work platform. Mechanical failure or human error could cause unexpected movement of the attachment and serious injury or death.

C. Attachments

1. For your protection, use EXTRA caution when adjusting the loader's bucket leveler or boom kick-out. Use two trained people and guard against accidental movement of the machine or loader linkage.

2. For your protection, keep head, body, hands and fingers away from the bucket and loader linkage when they are in a raised position, unless they are securely blocked.

3. When replacing cutting edges and teeth, securely block the bucket for your protection.

4. To install and remove bucket teeth, use a non-ferrous hammer. It is hazardous to hammer on the teeth. Wear safety glasses with side shields or goggles to reduce chances of injury.

D. Brakes

1. Block the tires to prevent machine movement before servicing the brakes.

2. Test the parking brake periodically. If the parking brake does not hold the machine, correct the cause as soon as possible. Until the cause is corrected, park the machine on level ground and block the tires to prevent it from moving.

3. When testing the parking brake, be sure the area near the machine is clear of personnel and obstructions because the machine may move during the test.

4. Air in the hydraulic brake lines reduces the brake's effectiveness. Whenever brake lines have been disturbed or if the brakes feel effective or spongy, bleed the brakes to remove entrapped air. Consult your Construction Equipment Distributor for information.

5. Wear goggles when adding brake fluid or bleeding the brakes. Brake fluid can cause serious eye injury. In case of eye contact, flush eyes thoroughly with water and get prompt medical attention

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E. Cab/ROPS

1. Do not attempt to repair a rollover protective structure (ROPS) after an accident. The ROPS is designed to bend during a rollover to protect the operator from sudden impact loads. Repair structures do not provide the original strength and protection. The regulations prohibit repair to damaged ROPS. Contact your Construction Equipment Distributor for information on ROPS replacement. Do not operate the machine again until the ROPS has been replaced.

2. Do not cut, grind, weld or drill holes in the ROPS because this could weaken the structure or affect its energy absorption capability.

3. Periodically inspect the ROPS for fatigue cracks. Cracks indicate a weakened structure which should be replaced for your protection.

4. Do not use bleach, dye or solvents on the seat belt because this may weaken the webbing and result in personal injury. Clean the seat belt with warm water and a mild detergent. Replace belts which have worn, frayed, torn, faded, stiff or rotted webbing.

5. Do not service the air conditioning system unless you are completely familiar with air conditioning and the safety precautions for handling liquid refrigerant which can cause sever frostbite. Contact your Construction Equipment Distributor.

F. Cooling

1. Hot, scalding coolant can spray out if the radiator cap is removed suddenly. Relieve system pressure by slowly turning cap to the first notch or lifting the safety lever (if equipped). Remove the cap ONLY after the pressure is relieved.

2. Use extreme caution when adding coolant to a hot radiator to avoid being burned. Wear gloves and goggles and keep face away from the filler neck.

G. Electrical

1. Batteries give off a highly flammable gas. DO NOT SMOKE or allow sparks or open flame near the batteries because a fire or explosion could result.

2 BE SURE the electrical system master switch is off when connecting or disconnecting batteries to minimize the chance of sparks and explosion.

3. DO NOT allow metal tools or a jumper cable clamp to contact the positive battery terminal and any other metal on the machine. The resulting sparks could cause an explosion.

4. When using a booster battery and jumper cables, connect the negative (ground) cable to the machine frame, 40 cm AWAY FROM THE BATTERY. ALWAYS connect the ground cable last and disconnect it first to avoid sparks near the battery. A spark could cause a battery explosion and injury.

5. Use only a booster battery with the same voltage as the battery in the machine. DO NOT jump a frozen battery because it might explode. Be sure the fluid levels are proper. For added safety, cover batteries with a damp cloth before attaching cables.

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6. NEVER check the battery charge by placing a metal object across the terminals. The sparks could cause a battery explosion. Use a voltmeter or hydrometer to measure charge.

7. Battery acid causes severe burns. Avoid contact with eyes, skin or clothing. Wear goggles, rubber gloves and apron. If skin contact occurs, flush with water. If eye contact occurs, flush with water for 15 minutes and get prompt medical attention.

8. The engine can be started with the transmission in gear if the neutral start switch is bypassed. Do not connect across the terminals on the starter motor. Attach booster batteries as directed in this manual.

9. DO NOT charge batteries in a closed area. Provide proper ventilation to guard against explosion of an accumulation of the gas given off in the charging process.

H. Engine

1. Do not rework or modify the engine flywheel because this could weaken it and lead to a failure.

2. Keep the engine exhaust manifold(s) and exhaust system clear of combustible material to reduce the chance of fire.

3. Be sure to retighten the fuel injection pump's priming pump plunger. If it is not tight, it will leak fuel and cause a fire hazard.

4. Ether starting fluid is highly flammable. Follow the precautions on the container. An explosion can result if sparks or flame contact the ether in the container or if the container is stored where the temperature exceeds the temperature listed on the container. Observe the following precautions:

a. Follow the correct method for starting the engine. Refer to "Starting the Engine", in the OPERATOR'S MANUAL.

b. Do not use the ether injector when the air temperature is above freezing.

c. DO NOT SMOKE when using ether starting fluid.

d. DO NOT store fluid containers in the operator's compartment or in direct sunlight. Store the containers in a cool, well ventilated place.

e. Keep the fluid containers out of the reach of children.

f. Do not breathe the hazardous ether vapor.

g. Do not let ether contact your skin because it can cause frostbite.

h. NEVER puncture the fluid container or put it into a fire. Dispose of empty containers properly.

i. For your safety, remove the ether container when welding, grinding or using a torch on the machine.

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INTRODUCTION

SAFETY PRECAUTIONS

I. Fuel System

1. NEVER remove the fuel filler cap or fill the fuel tank while the engine is running or when the machine is indoors. The fumes are hazardous and a spark or flame could cause a fire or explosion.
2. DO NOT SMOKE while filling the fuel tank or servicing the fuel system because a fire or explosion could result.

3. When filling the fuel tank, place the fuel nozzle against the side of the filler neck to reduce the chances of static electricity sparks.

4. NEVER mix gasoline, gasohol or alcohol with diesel fuel. This creates a fire or explosion hazard which could result in personal injury or death.

J. Hydraulics

1. For your safety, lower the bucket before servicing the machine. Be sure no one is standing near the bucket when it is being lowered.

2. NEVER work or walk under a raised bucket without proper blocking.

3. Before working on the hydraulic system, be sure the system pressure is relieved by moving the control levers in all directions with the engine off.

4. This machine has a pressurized hydraulic reservoir. Loosen the filler cap slowly to relieve the pressure before disassembly of any hydraulic system components. DO NOT OVERFILL.

5. DO NOT use hands to search for hydraulic leaks. Hydraulic oil escaping under pressure from a very small hole can be almost invisible, yet have sufficient force to penetrate the skin. Use a piece of card board or wood to search for suspected leaks. If injured by escaping oil, see a doctor immediately because of the possibility of serious infection or reaction to the oil.

K. Tires and Rims

1. Tire and rim repairs MUST be done by specially trained people using special safety tools. An improperly repaired tire or rim can separate suddenly and cause serious injury.

2. NEVER inflate a flat tire without inspecting the tire, rim and wheel for damage. Be sure all components are properly assembled. Unmounted tires being inflated or deflated should be placed in a tire safety cage. Inflate the tire to 35 kPa and check that all components are properly seated. NEVER stand directly in front of a tire and rim assembly while inflating. Use a clip-on air chuck with a hose long enough to allow the person inflating the tire to stand to the side. Serious injury could result if the tire and rim were to separate.

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SHIPPING SPECIFICATIONS

4. DIMENSIONS

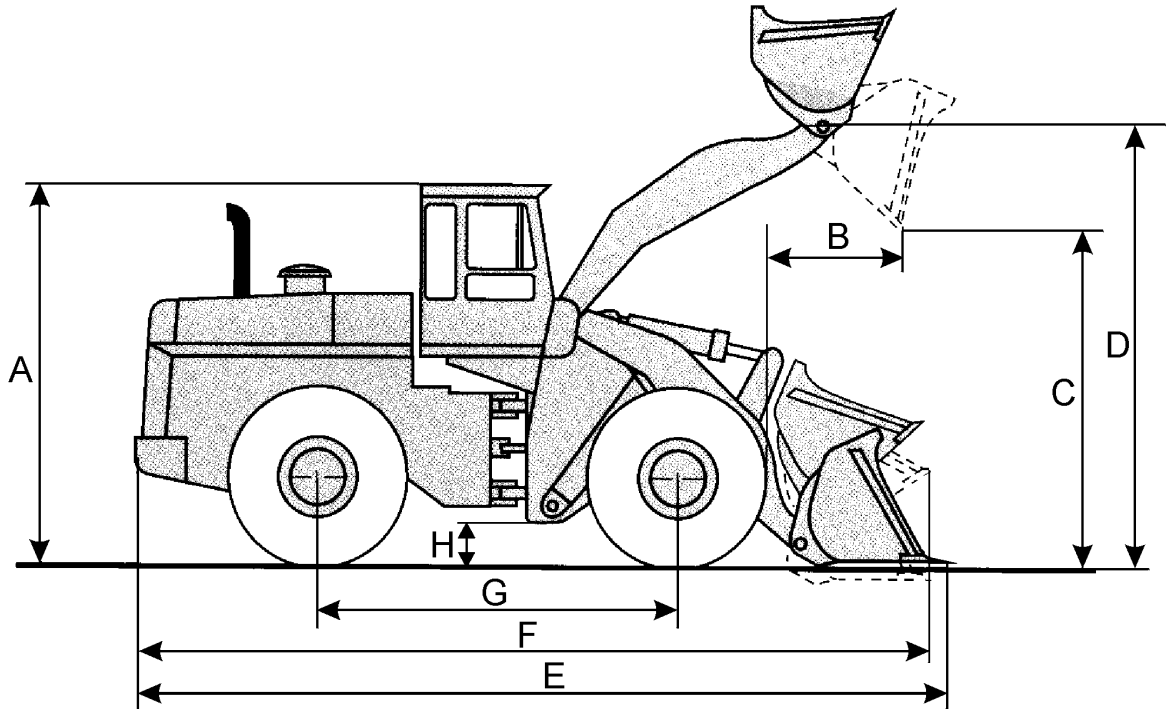


Fig. 1.2. General Dimension
(Machine Equipped with a 5,7 cu. m)

A. Height to top of cab	4110 mm
B. Reach at maximum height and 45° dump angle	1470 mm
C. Dump clearance at maximum height and 45° dump angle	3630 mm
D. Height to bucket pivot	5050 mm
E. Overall length with bucket on ground	9670 mm
F. Overall length with bucket at carry position	9570 mm
G. Wheel base	3940 mm
H. Ground clearance	500 mm
Width (over standard tires)	3380 mm
Width (bucket)	3600 mm
Operating weight	41 972 kg

5. SYSTEM REFILL CAPACITIES (APPROXIMATE)

Axle (each)	80 litres
Cooling System	86 litres
Crankcase w//Filters	43 litres
Fuel Tank	597 litres
Hydraulic System	382 litres
Transmission/Converter System	144 litres

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SERVICE INFORMATION

6. SERVICE PARTS

Always use genuine service parts. Service parts are available through your local distributor.

7. SERIAL NUMBERS

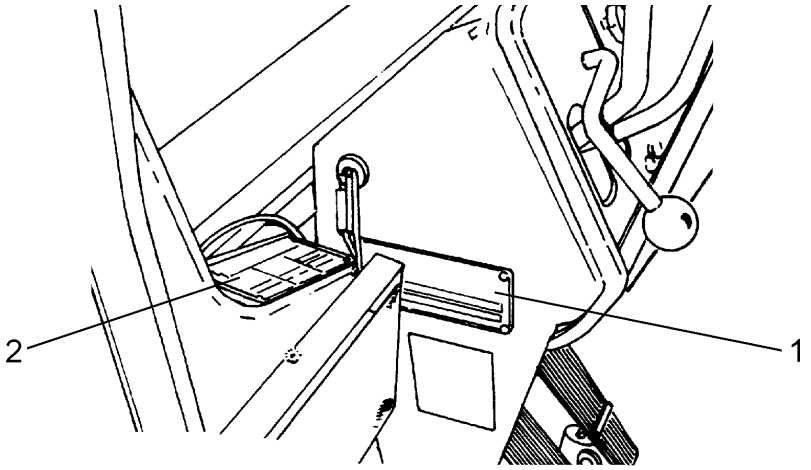


Fig. 1.3. Location of Chassis and ROPS Cab Serial Numbers Plates

1. Chassis Serial Number Plate
2. ROPS Cab Serial Number Plate

The chassis serial number is stamped on a number plate (1, Fig. 1.2), located on the left side of the instrument panel in the cab. It is also stamped on the left rear corner of the rear frame.

The engine serial number is stamped on the engine. For the serial number location, refer to your Cummins Diesel Engine OPERATOR'S MANUAL.

The torque converter serial number is stamped on a number plate (Fig. 1.3) located on the front side of the converter housing.

The transmission serial number is stamped on a number plate (Fig. 1.4) located on the upper left corner of the front side of the transmission housing.

The ROPS cab serial number is stamped on a number plate (2, Fig. 1.2), located on the left side of the instrument panel in the cab.

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

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SERVICE INFORMATION

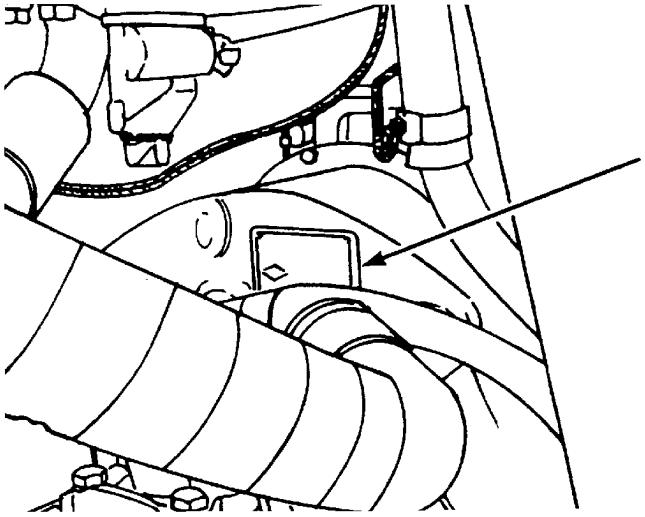


Fig. 1.4. Location of Torque Converter Serial Number Plate

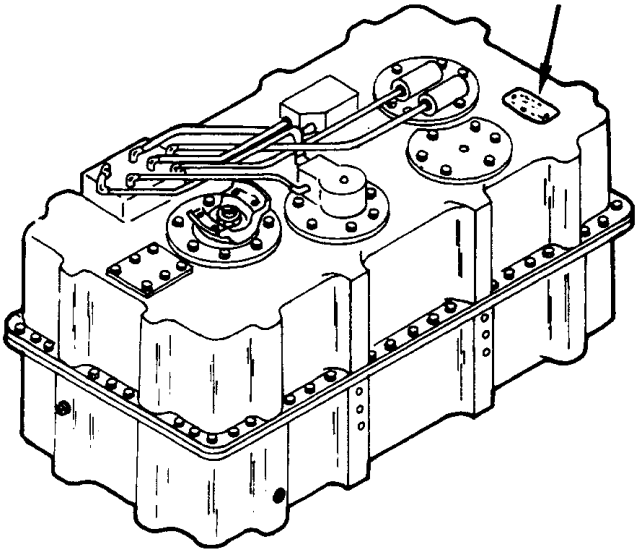


Fig. 1.5. Location of Transmission Serial Number Plate

8. INSPECTION AND REPAIR

The following notes should be used as a general guide to inspection and repair. Where a special procedure is necessary for a component or assembly, full details will be found in the relevant paragraph of the group.

Bearings

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

Pins and Bushings

Inspect for damage and check with mating parts for excessive wear.

Clevises and Pins

Check with mating parts for excessive wear.

Gaskets and Seals

Always use new seals and gaskets during assembly or 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 grease prior to installation. Felt dust seals must be soaked in light oil before assembly.

Do not "roll" an O-ring during installation. To correctly install the O-ring, position the ring at one point and, using a blunt narrow tool, stretch the O-ring into position. Do not stretch the O-ring any more than is required for proper installation.

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SERVICE INFORMATION

Gears and Splines

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 carborundum stone, but care must be taken so that only the burr is removed, and that the gear or spline profile is not changed.

Welds

Check all welded assemblies for cracks, twisting and misalignment.

Castings

Check castings for cracks and distortion.

Fuel Tanks and Reservoirs

Check for leaks and corrosion.

Pipes and Hoses

Check unions for leaks. Ensure that threads are undamaged. Check steel pipes for cracks and chafing. Check hoses for chafing, twisting or perishing, etc.

Lubricating Fittings

Ensure that these are undamaged and correctly installed. Check that grease galleries are clear.

Relief Valves

Before commencing work on the equipment hydraulic system, check that the relief valves are opening at their correct pressures. The pressures are listed, and information on how to check and adjust relief valve pressures is available in the "HYDRAULICS" section.

Lubrication

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

LOCTITE USAGE

9. SURFACE PREPARATION

Plain and Phosphate Coated Parts: Clean the surfaces where compounds are to be applied to remove heavy coating of oil, grease and dirt (rust or light oil film are not detrimental). Normal shop practice of cleaning or degreasing is adequate. Phosphate and oiled hardware is used in the "as received" condition provided it is dry to the touch.

Zinc or Cadmium Plated Parts or for Rapid Curing of the Compound: At least one of the mating surfaces should be degreased with a cleaning solution to which concentrated primer has been added (1 part primer concentrate to 30 parts trichlorethylene to 1-1-1 trichlorethene). Allow surfaces to dry for 3 to 5 minutes before applying compound.

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LOCTITE USAGE

Drawbar Studs or Special Stud Applications: Degrease parts with a cleaning solution to which concentrated primer has been added (1 part primer concentrate to BO parts trichlorethylene or 1-1-1 trichlorethene). Allow surfaces to dry for 3 to 5 minutes before applying compound. In blind holes, be sure to remove all chips and oil. Face Sealant: Mating parts must be cleaned as for plain and phosphate coated parts.

10. APPLICATION

Capscrews and Pipe Threads: Fill the first 2 to 3 leading threads in area of engagement with compound. For large quantities of capscrews, may also be applied by tumbling method (refer to manufacturer's instructions).

Studs: Fill full length of thread with one strip on diameters up to 25 mm, two strips 180 degrees apart on diameters up to 50 mm, and three strips 120 degrees apart on diameters over 50 mm. In all cases, apply one strip into tapped holes. Blind hole applications - apply enough compound to fill the bottom 2 to 3 threads of engagement, then insert stud. If engagement length exceeds one diameter, use proportionally more compound. For non-seated studs (studs that can go deeper in hole than required) turn stud one turn deeper than required. After bubbling stops, apply a ring of compound around at top of hole, then turn back to required height.

Primers: Apply primer to surface where sealant is to be applied. Allow primed solvent to evaporate 3 to 5 minutes before applying sealant. When sealant is applied to a primed surface, parts should be assembled within 3 minutes.

Face Sealant: For liquid sealant, spread an even coat (1 cc per 260 cm^2) on one of the mating surfaces. Assemble and tighten bolts. For gell sealant, apply as continuous bead (approximate 1 cc per 500 linear mm) to surface of one mating face.

NOTE: *When compound is used as a gasket, bolts which attach the parts should be coated with gear lubricant to prevent compound from sticking to bolts.*

11. SETTING TIME (BEFORE PLACING IN OPERATION)

Normal time for compound grades without use on any primer - 6 to 24 hours at room temperature with machined carbon steel parts. Higher temperatures will accelerate cure and lower temperatures will retard cure. Other base metals will provide more or less catalytic effect on cure.

Primed surfaces - 2 to 6 hours. This may be speeded by pretreating mating surfaces with special primers. Some metals (such as zinc and cadmium plate, anodized aluminum, and passivated stainless steel) are inactive an require heat or primer to cure the compound. A fast curing type primer will fix parts for normal handling in 10 to 15 minutes and will achieve 75 per cent of ultimate strength in 1 hour and full cure in 2 to 4 hours.

12. REMOVAL

Parts difficult to remove can be preheated to 200° C to 260° C prior to removal.

13. APPLICATION AT LOW TEMPERATURES

Without special precautions, these compounds can be applied and will cure at temperatures down to 10°C, and at that temperature, full strength will be obtained within 72 hours.

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LOCTITE USAGE

At temperatures from 10 to -18°C, the use of a primer is recommended.

If necessary, the compounds can be applied at temperatures below -18°C, only if heat is used to accelerate the cure as follows:

65°C for 60 minutes
95°C for 45 minutes
120°C for 30 minutes

STANDARD TORQUES

14. BOLT IDENTIFICATION CHART

Type	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.	

15. TORQUE VALUES FOR STANDARD FASTENERS

Recommended torque, Newton meters, for all Standard Application Nuts and Bolts, provided:
- All thread surfaces are clean and lubricated with engine oil.
- Joints are rigid, that is, no gaskets or compressible materials are used.
- When reusing nuts or bolts, use minimum torque values.
- The following torque values should be used in cases where „special torque values” are not given.

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LOCTITE USAGE

Modifying Factors

For various fasteners surface coating, multiply the standard torque by factors listed bellow:

- 0.65 - when finished jam nuts are used.
- 0.70 - when Molykote, white lead or similar mixtures are used as lubricants.
- 0.75 - when parkerized (phosphate coated) bolts or nuts are used.
- 0.85 - when cadmium plated bolts or nuts and zinc bolts w/waxed zinc nuts are used.
- 0.90 - when hardened surfaces are used under the nut or bolt head.

Torque values listed in this section are lubricated (wet) threads; values should be increased 1/3 for non - lubricated (dry) threads.

If a fine threaded fastener is used, multiply the appropriate torque value by 0.95 to obtain the clamping force shown for a coarse threaded fastener.

Torque Values For Standard Coarse Threaded (UNC or NC) Fasteners:

Thread Size in Inches	Heat Treated Material Grade 5 & Grade 8	
	Grade 5	Grade 8
	Newton Meter (Nm)	Newton Meter (Nm)
1/4	8	12
5/16	18	24
3/8	33	46
7/l6	52	73
1/2	79	110
9/l6	115	165
5/8	155	225
3/4	280	395
7/8	415	620
1	620	940
1 1/8	830	1340
1 1/4	1170	1900
1 3/8	1530	2480
1 1/2	2030	3300
1 3/4	3210	5170
2	4810	7810

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STANDARD TORQUES

Torque Values For Standard Coarse Thread Metric Fasteners:

Thread Size	Allowed Torque Value Newton Meters (Nm)		
	Class 5.8	Class 8.8	Class 10.9
M 6	7	10	15
M 8	16	25	35
M 10	32	50	70
M 12	55	85	120
M 14	85	130	185
M 16	115	180	255
M 18	175	275	390
M 20	220	355	500
M 22	275	440	620
M 24	385	610	860
M 27	500	800	1120
M 30	710	1140	1600
M 33	885	1410	1990
M 36	1190	1900	2670
M 39	1425	2280	3200

16. 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	Bolt Size	Bolt Torque Newton Meter (Nm)
1/2	5/16	20 to 24
3/4	3/8	30 to 37
1	3/8	37 to 47
1-1/4	7/16	47 to 61
1-1/2	1/2	62 to 79
2	1/2	75 to 88
2-1/2	1/2	110 to 125
3	5/8	190 to 200
3-1/2	5/8	160 to 180

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STANDARD TORQUES

17. 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. Figures are for tube nuts used with 37° flared fittings and JIC - 37°seat O-Ring boss plugs and swivel nuts.

Tube Nuts with 37° Flared Fittings and JIC - 37° Seat O-Ring Boss Plugs and Swivel Nuts				
Size	Tubing O.D.	Thread Size	Minimum Newton Meter (Nm)	Maximum Newton Meter (Nm)
4	1/4	7/16-20	12	16
5	5/16	1/2-20	16	20
6	3/8	9/16-18	29	33
8	1/2	3/4-16	47	54
10	5/8	7/8-14	72	79
12	3/4	1-1/16-12	105	110
14	7/8	1-3/16-12	120	135
16	1	1-5/16-12	150	165
20	1-1/4	1-5/8-12	190	205
24	1-1/2	2-1/2-12	220	235
32	2	2-1/2-12	305	325

18. 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	Radiator, Air Cleaner, Boots, Etc.	Hydraulic System
	Newton Meter (Nm)	Newton Meter (Nm)
"T" Bolt (Any Diameter)	6.2 to 7.3	—
Worm Drive - 1-3/4 inch Open Diameter and Under	2.2 to 3.3	4.5 to 5.6
Worm Drive - Over 1-3/4 inch Open Diameter	4.5 to 5.6	—
Worm Drive - All "Ultra-Tite"	11 to 12	4.5 to 5.5

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INTRODUCTION

SERVICE/SPECIAL TOOLS

19. SERVICE/SPECIAL TOOLS

All service (purchased) and special (fabricated) tools shown in this manual are included in the following list. Service tools, which have tool numbers, are available as described in the „SERVICE TOOL MANUAL" ISS-1531. Special tools are to be locally fabricated using the illustrations shown in this manual.

Section 4 - Brakes

Journal Bearing Driver	Fig. 1.6

Section 7 - Drive Train

Hydraulic Flow Meter	PLT-876 or PLT-877
Transmission Pressure Test Kit	PLT-309B

Section 7C - Transmission

Transmission Stand	Fig. 1.7
Snap Ring Groove Filler	Fig. 1.8
Rubber Plug Installer	PLT-825-1

Section 7D - Drive Axle and Differential

Axle Shaft Removal and Installation Tool	Fig. 1.9
Wheel Hub and Service Brake Clamping Tool	No. 51.877.0044 (three pcs)
Differential Holding Fixture Consists of:	Fig. 1.10
Swivel Weldment	Fig. 1.11
Stand Weldment (L.H.)	Fig. 1.12
Stand Weldment (R.H.)	Fig. 1.13
Clamp Assembly	Fig. 1.14
Tube	Fig. 1.15
Base	Fig. 1.16
Slide (Stand Weldment - L.H.)	Fig. 1.17
Slide (Stand Weldment - R.H.)	Fig. 1.18

Section 8 - Electrical

Instrument Tester	PLT-305
Volt/Ampere Tester	PLT-306

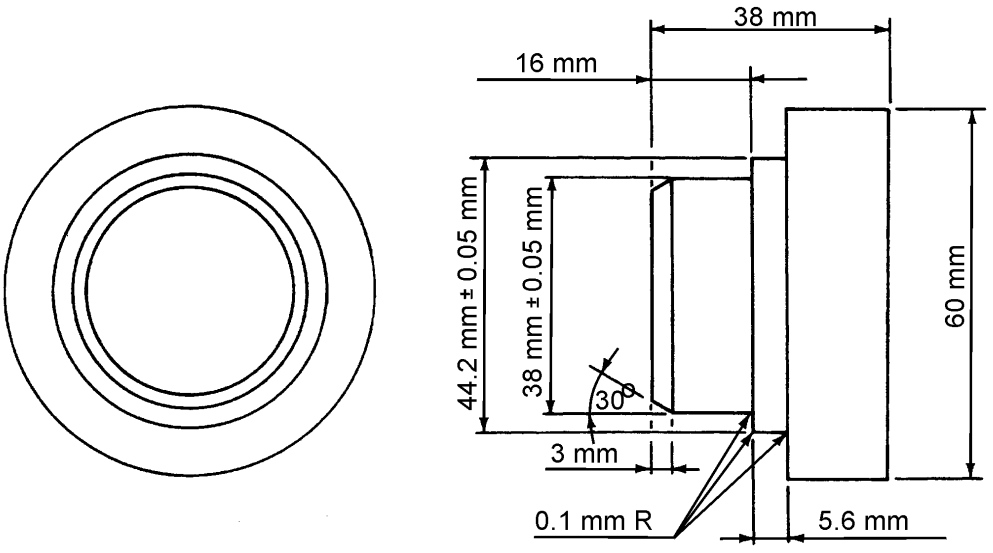


Fig. 1.6. Journal Bearing Driver

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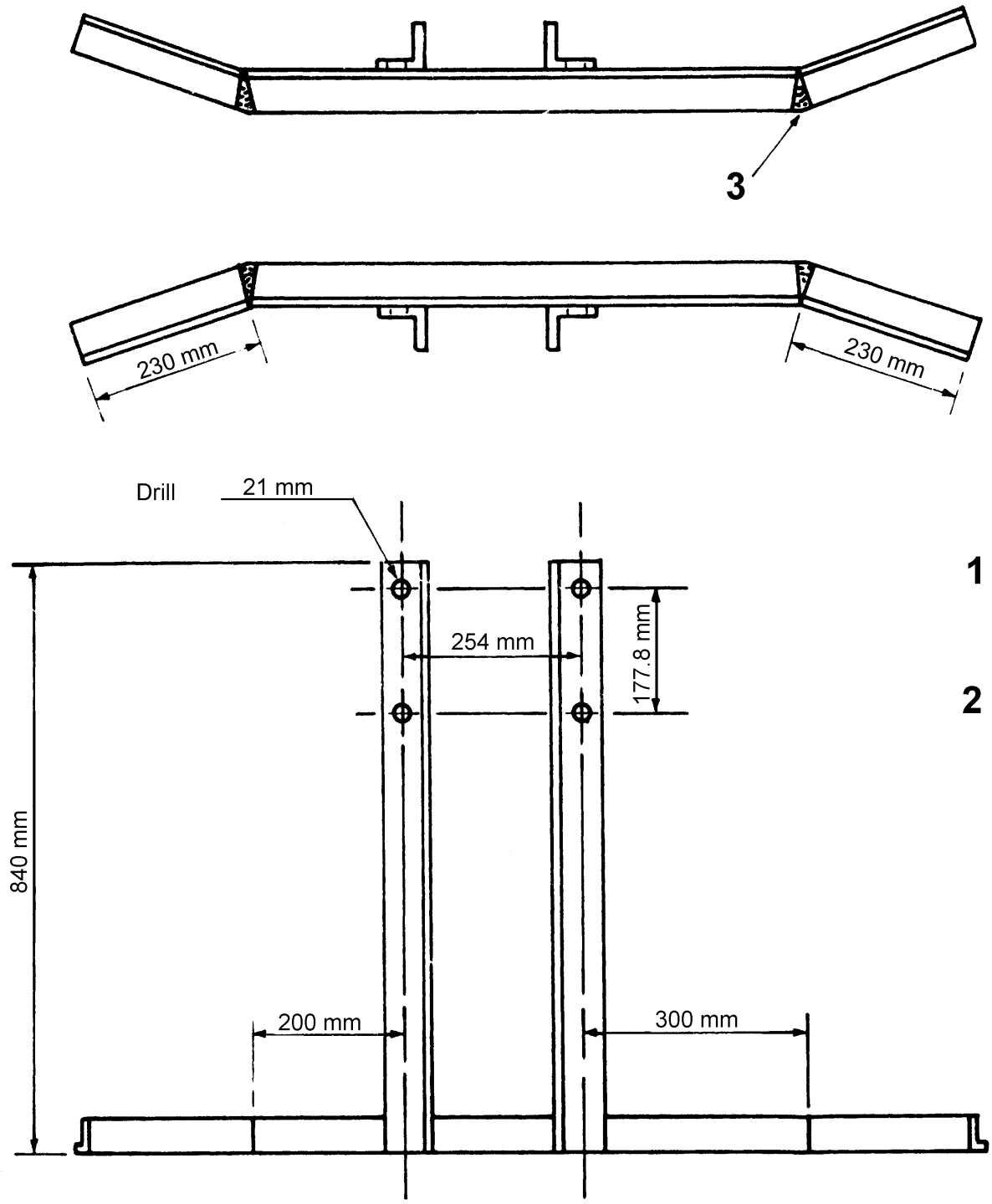


Fig. 1.7. Transmission Stand

1. Material - Angle Iron - 50x50 mm
2. Make 2 Stands - Right and Left Hand
3. Cut, Bend 20 mm and Weld

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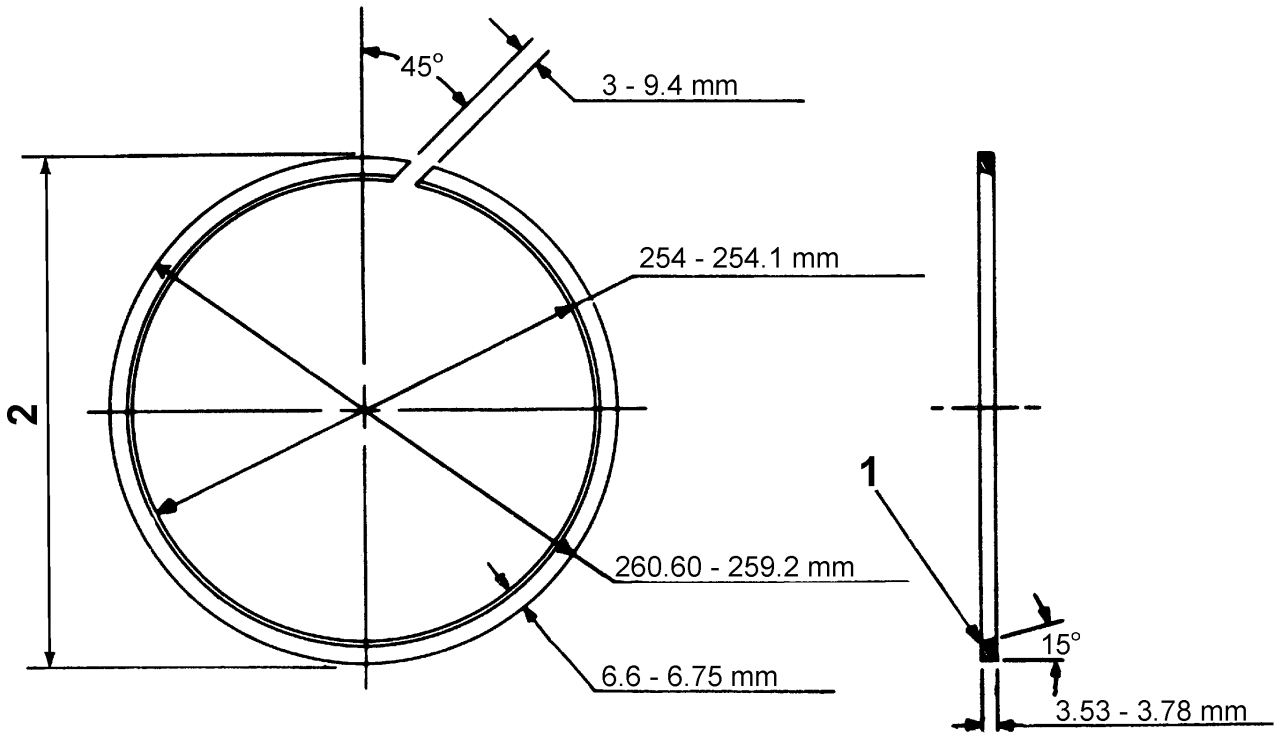


Fig. 1.8. Snap Ring Groove Filler

1. 0.25 mm radius max. - 4 corners 2. Ring must pass thru 254.0 - 254.10 mm diameter

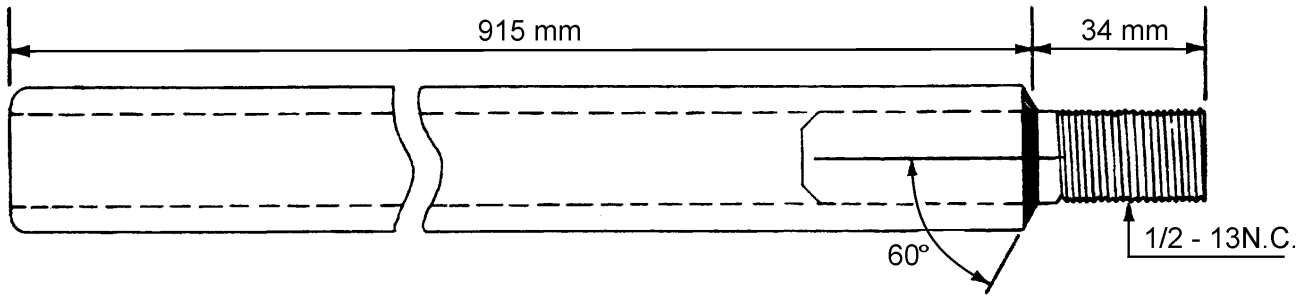


Fig. 1.9. Axle Shaft Removal and Installation Tool

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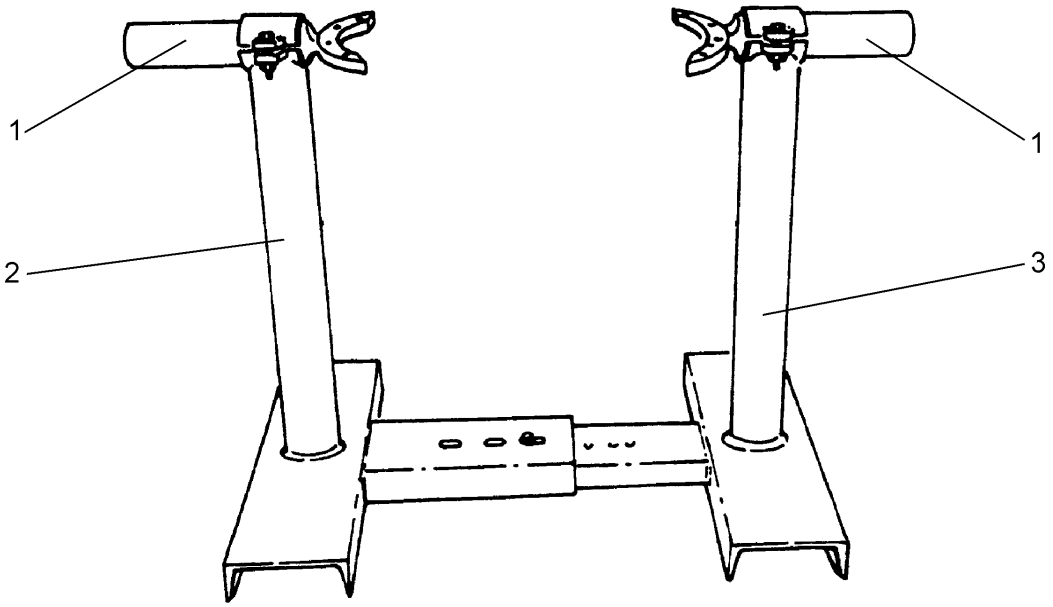


Fig. 1.10. Differential Holding Fixture

1. Swivel Weldment (Fig. 1.11) 2. Stand Weldment - Left Hand (Fig. 1.12)
3. Stand Weldment - Right Hand (Fig. 1.13)

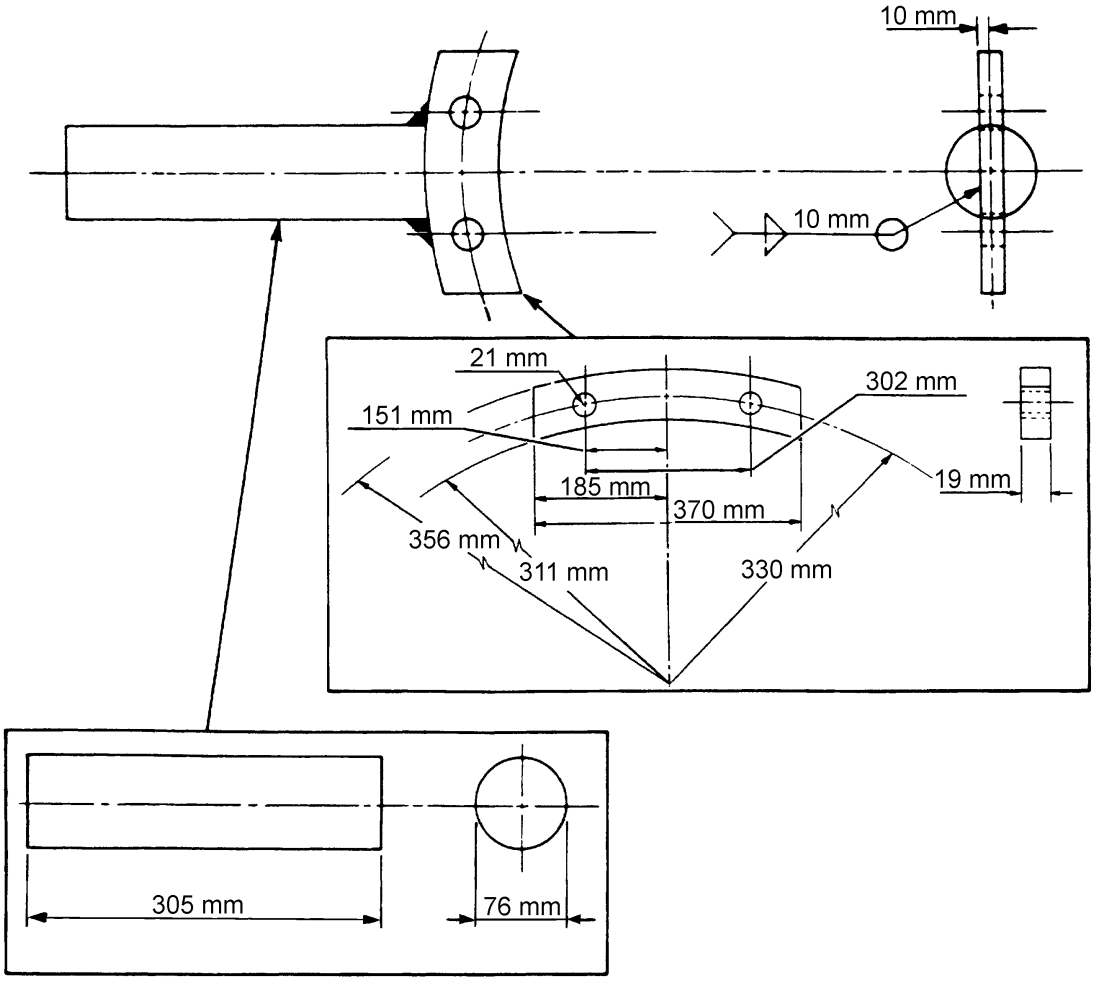


Fig. 1.11. Swivel Weldment

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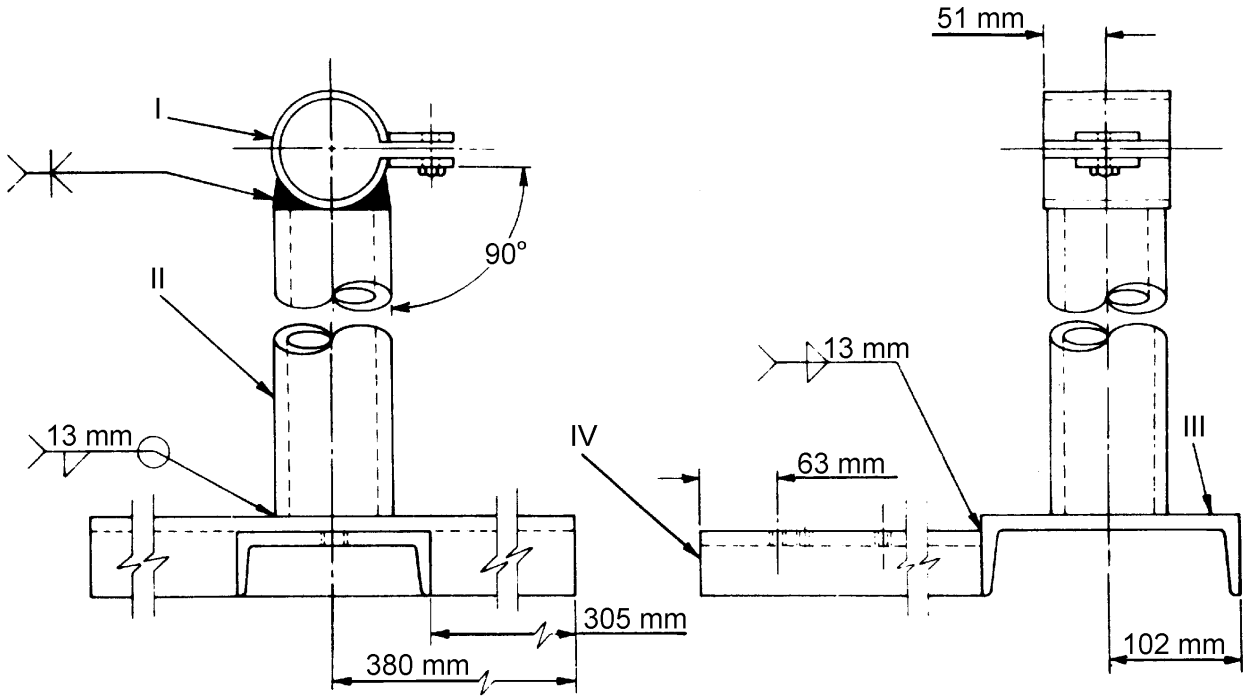


Fig. 1.12. Stand Weldment (L.H.)

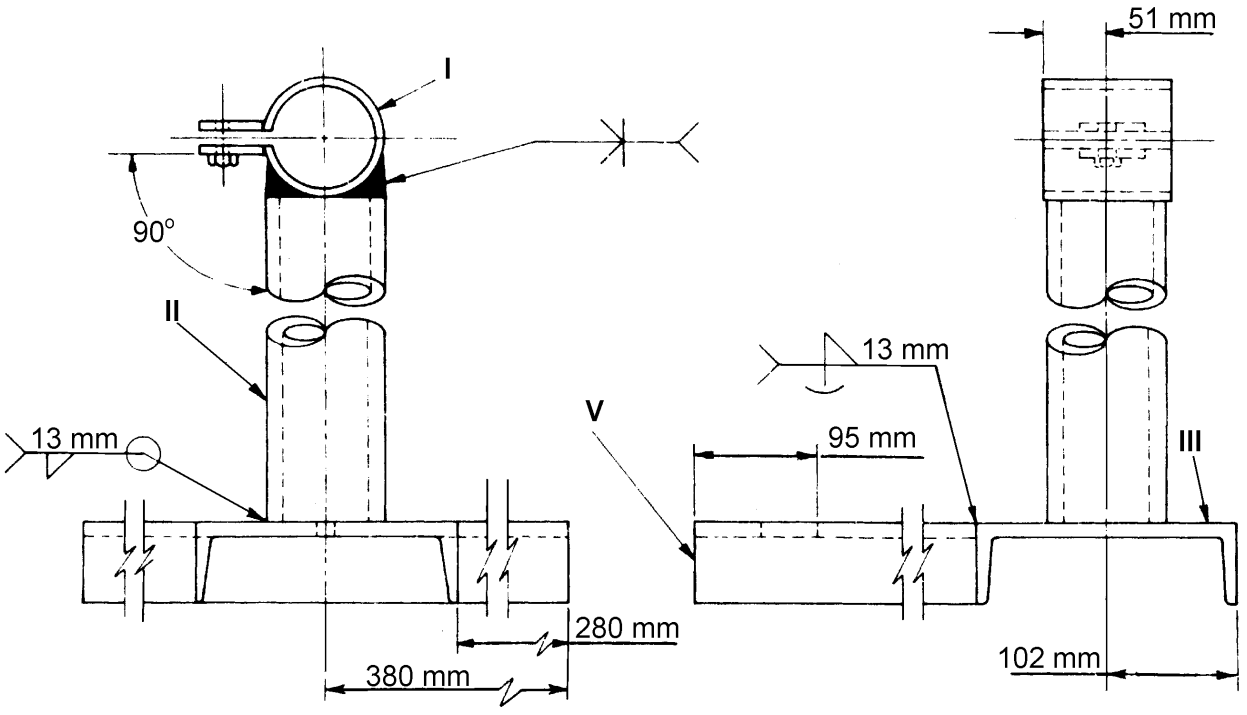


Fig. 1.13. Stand Weldment (R.H.)

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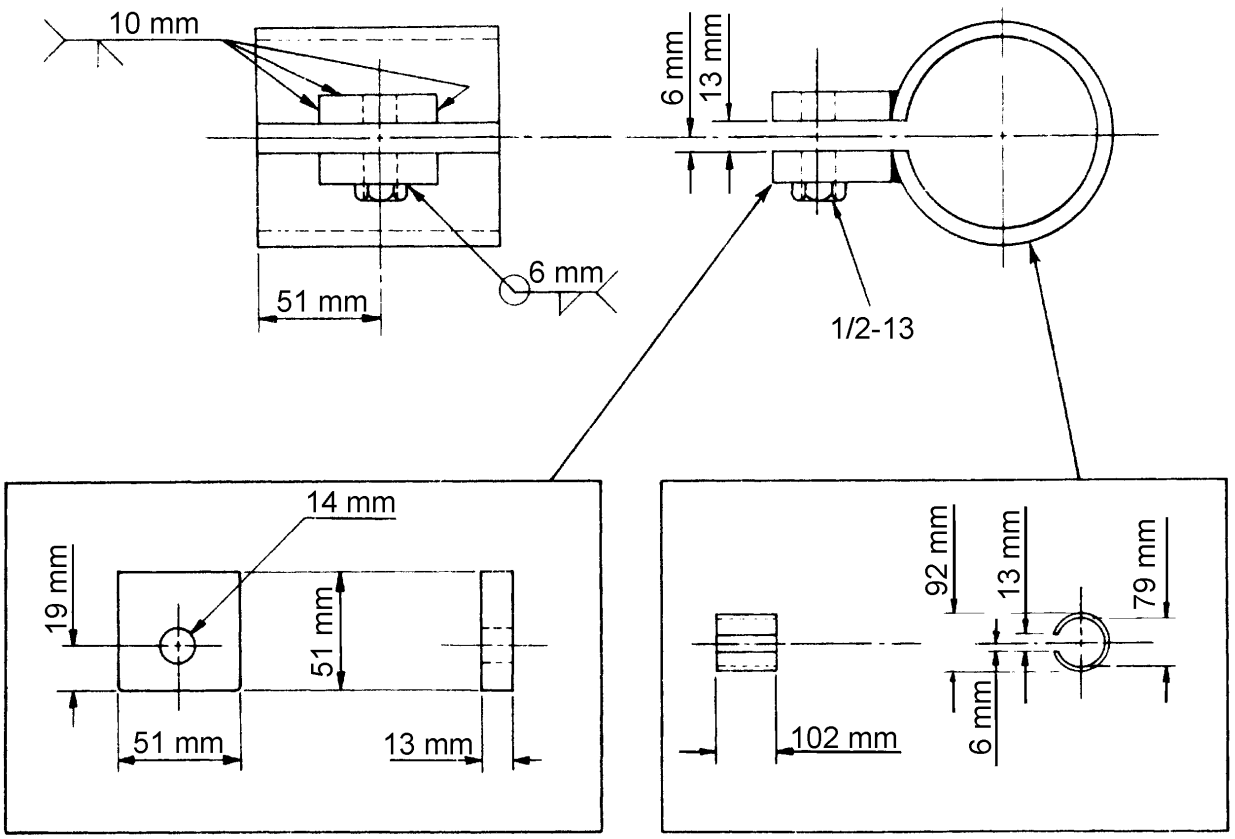


Fig. 1.14. Clamp Assembly

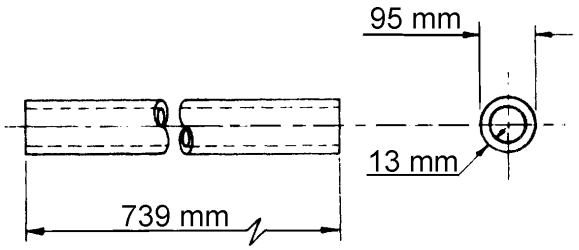


Fig. 1.15. Tube

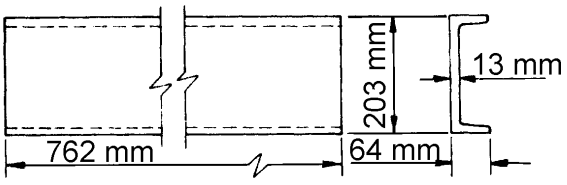


Fig. 1.16. Base

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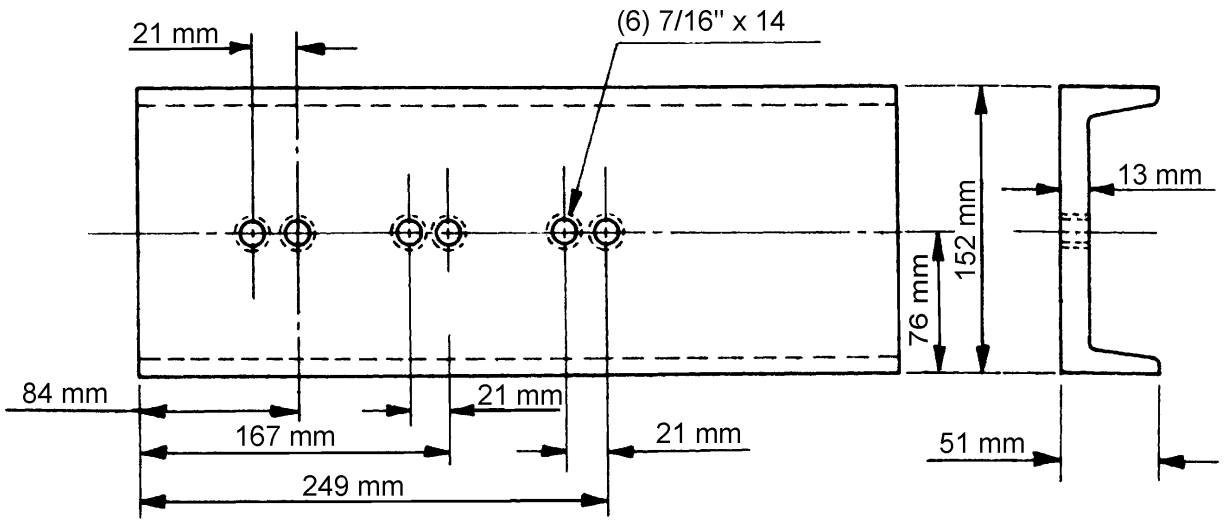


Fig. 1.17. Slide (Stand Weldment - L.H.)

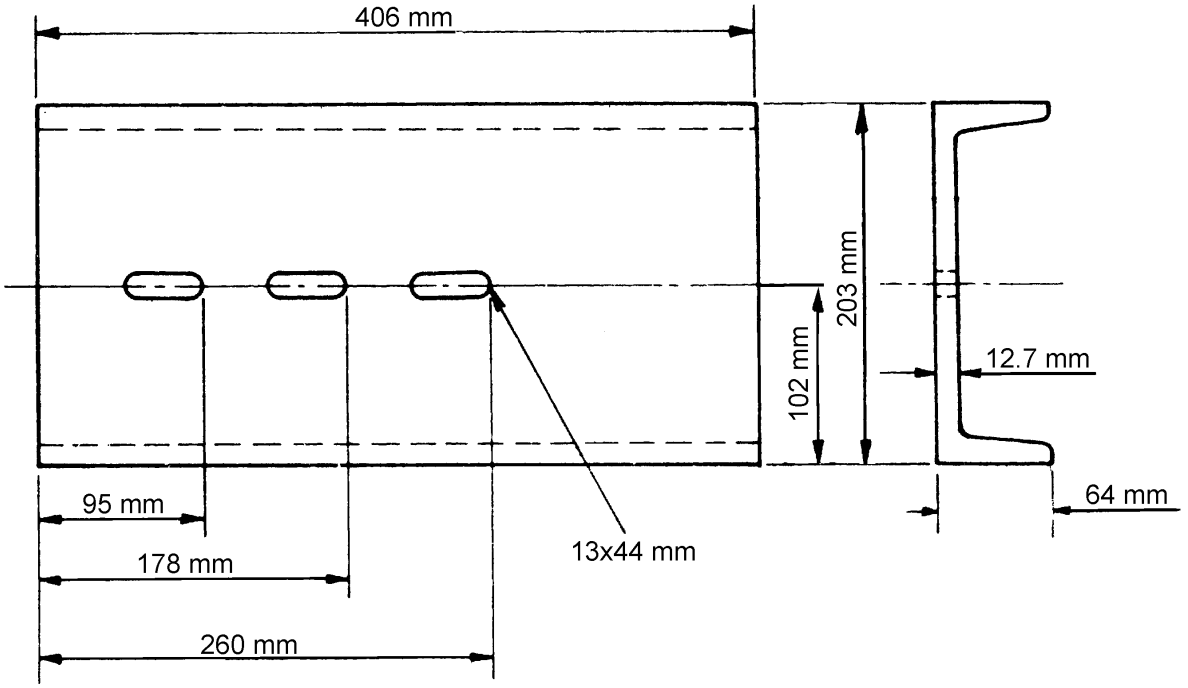


Fig. 1.18. Slide (Stand Weldment - R.H.)

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BRAKES

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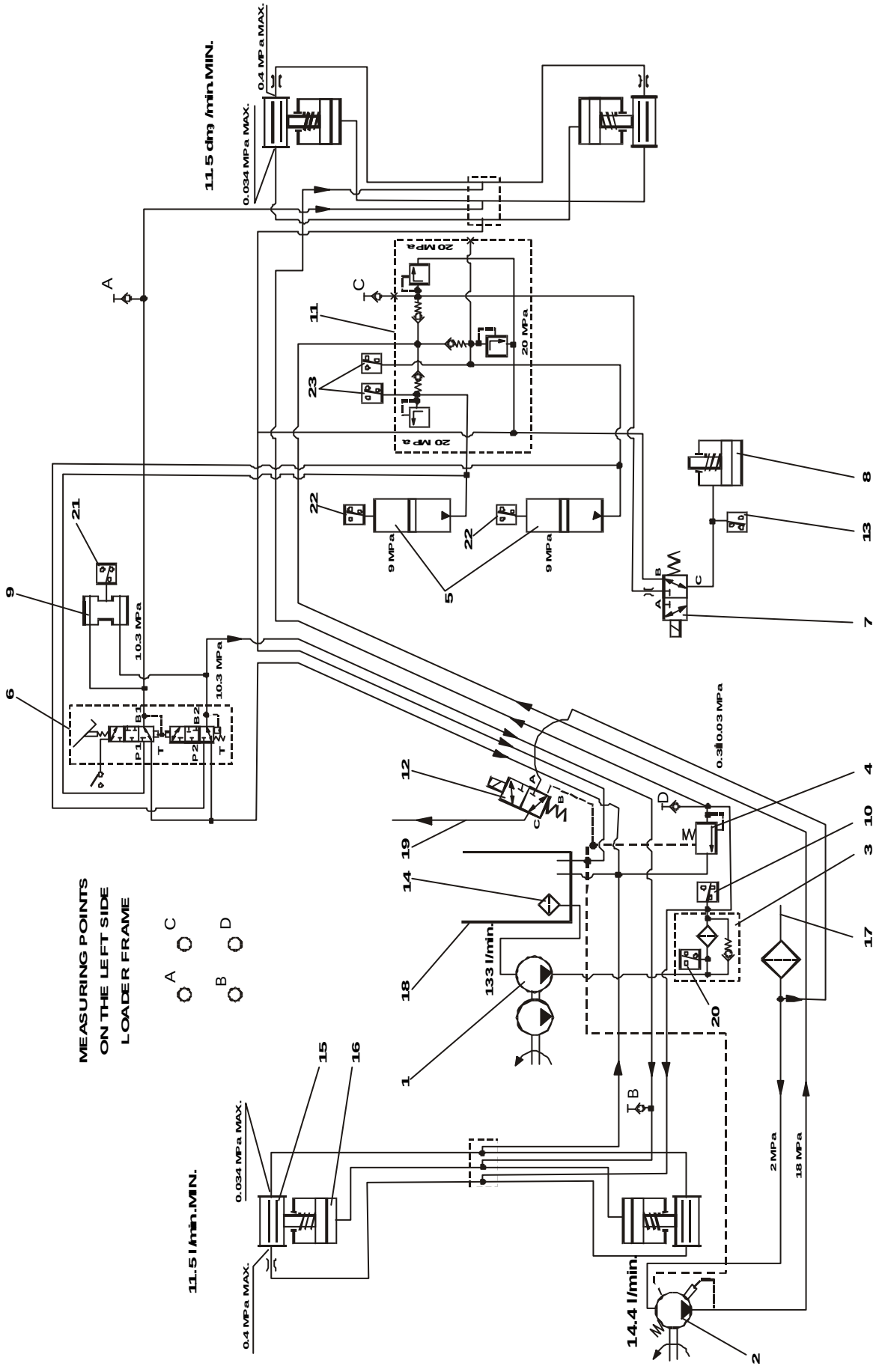


Fig. 4.1. Brake System

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BRAKES

WHEEL BRAKE

Legend for Fig. 4.1

1. Cooling Pump
2. Brake Pump
3. Cooling Filter
4. Regulator Valve
5. Gas Accumulators
6. Brake Valve
7. Parking Brake Valve
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10. Cooling Brake Low Pressure Switch
11. Valves Block
12. Electromagnetic Valve
13. Parking Brake Warning Light Switch
14. Strainer
15. Wheel Brake Assembly
16. Wheel Brake Apply Piston
17. Supply Line From Transmission System
18. Transmission Reservoir
19. Supply To Transmission Disconnect
20. Brake System Oil Filter Warning Light Switch
21. Brake System Differential Pressure Switch
22. Hydraulic Accumulators Gas Low Pressure Switch
23. Main Brake Oil Pressure Switch

1. DESCRIPTION (Refer to Diagram in Fig. 4.1)

The brake system is totally enclosed, hydraulically applied, and pressure lubricated. Each wheel has a brake (15) containing 8 friction discs which engage the wheel hub and 9 separator plates which are splined to the brake housing rigidly mounted to the spindle. The brake assemblies are mounted on the axles inboard of the final drive planetaries.
The engine drives double pump (Fig. 4.2) by torque converter. The rear section of pumps delivers oil from transmission (18) by cooling filter (3) to regulator valve (4). This valve regulates the flows to each brake assembly (15) at a constant rate, independent of engine or vehicle speed for cooling and lubricating purpose. The oil pressure measured in point D is 300 to 330 kPa. Each brake assembly receives approximately 23 l/min of filtered pressurized cooling oil from the brake cooling pump. This pump flow is regulated from 300 to 330 kPa by the brake regulator located at the right side of rear frame. Each of the four brake housing has a pipe plug orifice just inside the lubrication/cooling oil inlet. These orifices and the brake regulator maintain a constant cooling oil flow to the brakes. If oil pressure drops, the switch (10) switches the warning lamp on the panel. The warning lamp activated by switch (11) informs operator that filter (3) is clogged.

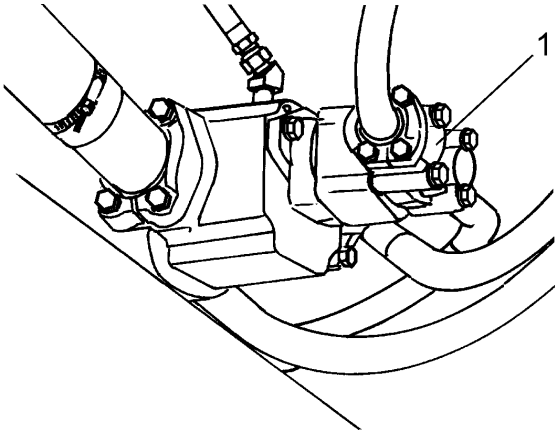


Fig. 4.2. Brake Cooling Pump

1. Brake Cooling Pump

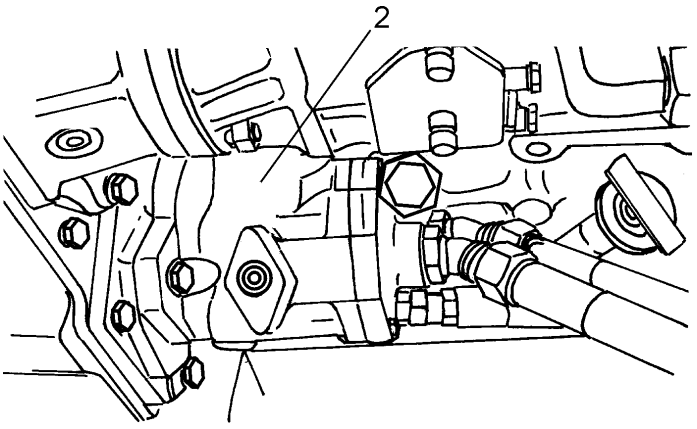


Fig. 4.3. Brake Piston Pump

2. Brake Piston Pump

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WHEEL BRAKE

The brake control system consists of an engine-mounted, variable-volume pump (2), valves block (11), two gas accumulators (5) located in the front frame, brake valve (6), differential valve (9) and brake pistons (16).

The engine-driven, pressure-compensated, variable-volume piston pump (Fig. 4.3).This pump draws oil from the transmission circuit (17) and pumps this oil through a valves block assembly (11) and into the two accumulators (Fig. 4.5). One accumulator supplied the rear axle and the other the front axle brakes. This pump maintains 18000 kPa at each accumulator. Each accumulator is connected to a separate inlet on the brake valve (Fig. 4.4). The brake apply pressure to each axle is controlled by the brake valve (6) from 0 to 10300 kPa, depending upon foot pedal position.

As the brake valve pedal is released from apply position, the brake piston return springs force apply oil from the apply-piston cavity through the brake valve out the return port to the transmission. If the panel switch is in ON position, after brake pedal pressing the transmission disconnect shifts by electromagnetic valve (12).

The gas accumulators perform two functions:

1. Provide for good brake response on fast apply.
2. Provide for multiple applications with a dead engine.

The valves block performs two functions:

1. Provide for front and rear axle independent braking and parking brake loosening by check valves.
2. Safe these three systems by relief valves.

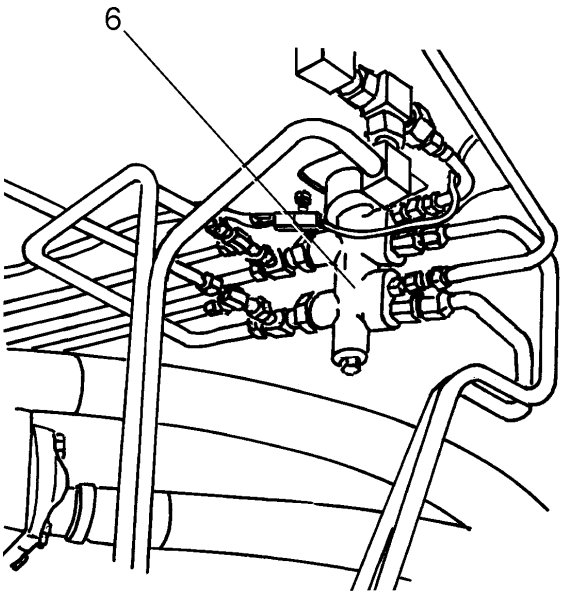


Fig. 4.4. Brake Valve

6. Brake Valve

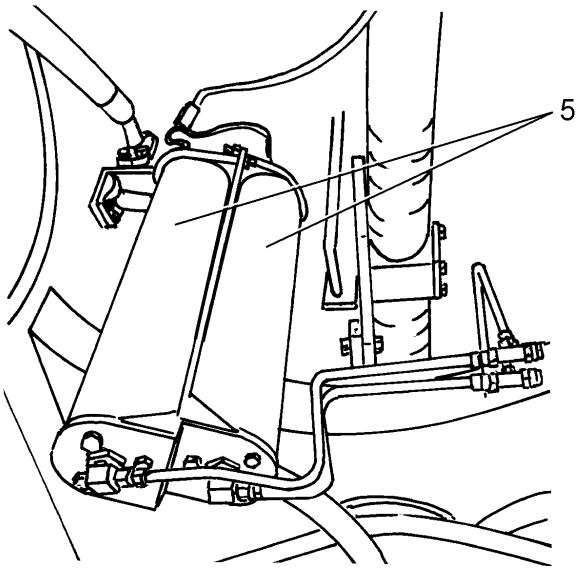


Fig. 4.5. Gas Accumulators

5. Gas Accumulators

The running clearance of the separator and friction discs affect brake response. External adjusting screws establish running clearance at the time of assembly. External adjusters are provided to compensate for friction material wear, but seldom require adjustment. The external adjusters also provide a means to determine average brake lining wear. Refer to SECTION 7D.

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2. OPERATIONAL TEST

WARNING! A change in vehicle braking characteristics or warning light and alarm signal coming on indicates malfunction in the brake system. Although the brakes may continue to function, the vehicle should not be operated until repairs have been made and both front and rear axle systems are operating normally. Always check the vehicle service and parking brakes after performing brake work and before returning the vehicle to service using the following procedure.

NOTE: *When checking brake operation the machine should be parked on level ground.*

1. Start the engine. The brake low pressure warning light and alarm signal should go out within 15 seconds. If the warning light and alarm signal remains on, the cooling pressure is below normal, the brake apply pump pressure is below normal, the on of accumulator gas pressure is dropping down or the pressure difference between the front and rear axle is excessive. Stop the engine.
2. After assurance that the brake hydraulic systems are satisfactory for a moment press on the brake alarm elimination switch which is under right panel to release the relay., fully depress and hold the brake pedal. Be sure the parking brake is released.

WARNING! Be sure the area in front of the machine is clear of personnel and obstructions as the vehicle may move forward during this test.

3. While depressing the brake pedal place the transmission control lever in forward, and into second gear, and depress the engine accelerator pedal until it is fully applied.

WARNING! If the machine starts to move forward, fully release the accelerator pedal. Do not hold the machine in this stall condition for more than ten seconds.

4. If the axle brakes do not hold the machine stationary during this test, stop the engine and refer to inadequate braking in the diagnostics section of this manual.
5. After correcting deficiencies of the service brake systems, recheck the system by repeating all steps.

3. SERVICE DIAGNOSIS

COMPLAINT	
PROBABLE CAUSE	REMARKS
Alarm Signal ON and Brake Warning Lamp Light (after Engine Stopping and Pressing the Brake Alarm Elimination Switch under R.H. Panel and Again Starting, Situation is Temporarily Changed)	
1. Air in main brake system	Perform venting of the system described in this section

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WHEEL BRAKE

COMPLAINT	
PROBABLE CAUSE	REMARKS
Alarm Signal ON and Brake Warning Lamp Light (after Engine Stopping and Pressing the Brake Alarm Elimination Switch under R.H. Panel Situation is Same)	
1. Problem in electrical system	Refer to SECTION 8.
2. Low cooling oil pressure in point D	a. Check regulator valve. b. Repair cooling pump section
3. Deference or low pressure in point A or B at engine operating and pedal pressing	a. One of system relief valve in valves block malfunction. b. Brake valve malfunction.
4. Deference or low pressure in point A or B at engine stopping and pedal pressing	a. One of system relief valve in valves block malfunction. b. One of accumulators malfunction. Refer to "ACCUMULATORS" in this section. c. Refer to SECTION 7D "DRIVE AXLE AND DIFERENTIAL".
5. Low pressure in point C at engine operating	a. Check brake pump section line. b. Brake pump malfunction. Refer to "BRAKE PUMP" in this Section.

For diagnostic, removal, service and installation of brakes refer to "WHEEL HUB AND SREVICE BRAKE" in SECTION 7D.

PARKING BRAKE

4. DESCRIPTION

The parking brake is mounted on the differential housing of the front drive axle assembly. It is a disc type brake that is spring actuated and hydraulically released. The complete assembly consists of a caliper brake that is mechanically connected to an hydraulic cylinder (8, Fig. 4.1) through a manual slack adjuster.

Hydraulic oil is pumped to the parking brake cylinder thru an electrical solenoid valve (7, Fig. 4.1) located on the left hand side of the front frame. Oil is supplied from the brake pump by valves block (11, Fig. 4.1), referred to earlier in this section. The solenoid valve is controlled by a push/pull switch located on the instrument control panel.

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PARKING BRAKE

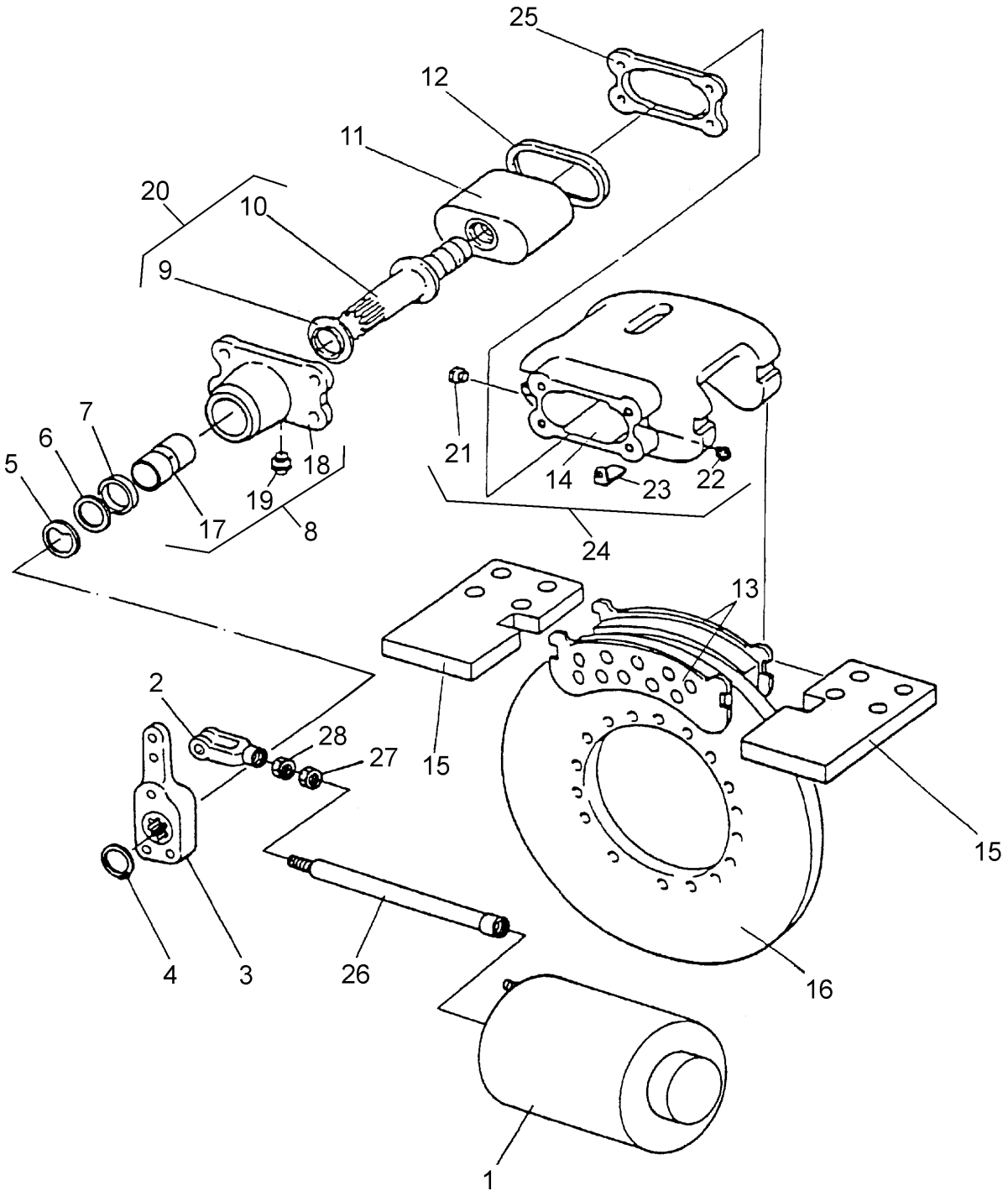


Fig. 4.6. Parking Brake Assembly

1. Cylinder	8. Cover Assembly	15. Mounting Bar	22. Grease Nipple
2. Rod End	9. Thrust Bearing	16. Brake Disc	23. Plate
3. Slack Adjuster	10. Shaft	17. Sleeve	24. Caliper Assembly
4. Retaining Ring	11. Piston	18. Cover	25. Gasket
5. Washer	12. Piston Seal	19. Grease Nipple	26. Pull Rod
6. Spring Washer	13. Linings	20. Shaft Assembly	27. Nut
7. Seal Ring	14. Caliper	21. Pressure Inlet Bolt	28. Nut

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PARKING BRAKE

When the knob of the brake release switch in the cab is pushed released position IN oil is allowed to enter the parking brake hydraulic cylinder (1, Fig. 4.6). This oil pressure compresses an internal spring that is mechanically connected to the manual slack adjuster to rotate away from the oil cylinder. This force is transmitted through the shaft (10) to move the piston (11) away from the lining assembly (13) releasing the pressure on the brake disc (16).

When the brake release switch knob is pulled applied piston OUT, the oil entering the parking brake oil cylinder is blocked and the oil pressure is relieved. This dumping of oil from the hydraulic cylinder releases the compressed internal spring which mechanically transmits force in the opposite manner discussed previously. This reverse action will continue until the piston (11, Fig. 4.6) forces the lining assembly against the brake disc (16). As the brake is applied, the parking brake warning light will come on and alarm signal will sound. If the transmission is placed in a direction mode with the brake applied, a starter motor is disconnected.



WARNING! Release the parking brake before moving the machine. The brake could burn or be damaged if the machine is driven with it applied.

5. SPECIFICATIONS

Brake Lining Minimum Allowable Thickness . . . . . 3.2 mm

Special Torques

Cap to Caliper Bolts . . . . . 170 to 180 Nm
Hydraulic Cylinder Mounting Bolts . . . . . 150 to 200 Nm
Caliper Mounting Bar Bolts (Loctite 262 applied) . . . . . 380 to 420 Nm

6. SERVICE DIAGNOSIS (Refer to Fig. 4.1)

COMPLAINT	
PROBABLE CAUSE	REMARKS
Brake Will Not Apply (Parking Warning Light is OFF)	
1. Electromagnetic valve (7) malfunction	Check spring and spool of valve.
2. Mechanical malfunction	Once it is determined that oil is not present at the hydraulic cylinder in the APPLIED position, place the brake release switch in the RELEASED position to allow oil to enter the hydraulic cylinder and continue as follows: a. Disconnect the slack adjuster at the hydraulic cylinder. b. Observe the hydraulic cylinder operation as the release valve is placed in the APPLIED position. If the actuator rod does not move IN replace the hydraulic cylinder. If the rod does move IN, look for damage or binding in the caliper brake assembly.

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BRAKES

PARKING BRAKE

COMPLAINT	
PROBABLE CAUSE	REMARKS
Brake Will Not Hold 2-nd Gear Stall	
1. Brake out of adjustment	Adjust the brake.
2. Brake linings glazed or coated with oil	Perform burnishing procedure.
3. Brake linings worn	Replace linings.
4. Mechanical problem	Refer to ”Brake Will Not Apply”
Brake Will Not Release	
1. Hydraulic circuit malfunction	Check for external oil leaks at spring cylinder, valves, tubes and fittings. Check pressure at valves block (point C).
2. Electromagnetic valve (7) malfunction	Check voltage, solenoid and spool.
3. Mechanical malfunction	Once it is determined that oil is present at the hydraulic cylinder in the ”RELEASED” position, continue as follows: a. Disconnect the slack adjuster at the hydraulic cylinder. b. Observe the hydraulic cylinder operation as the release valve is placed in the APPLIED position. If the actuator rod does not move IN replace the hydraulic cylinder. If the rod does move IN, look for damage or binding in the caliper brake assembly.

7. ADJUSTING AND OPERATIONAL TEST OF THE BRAKE

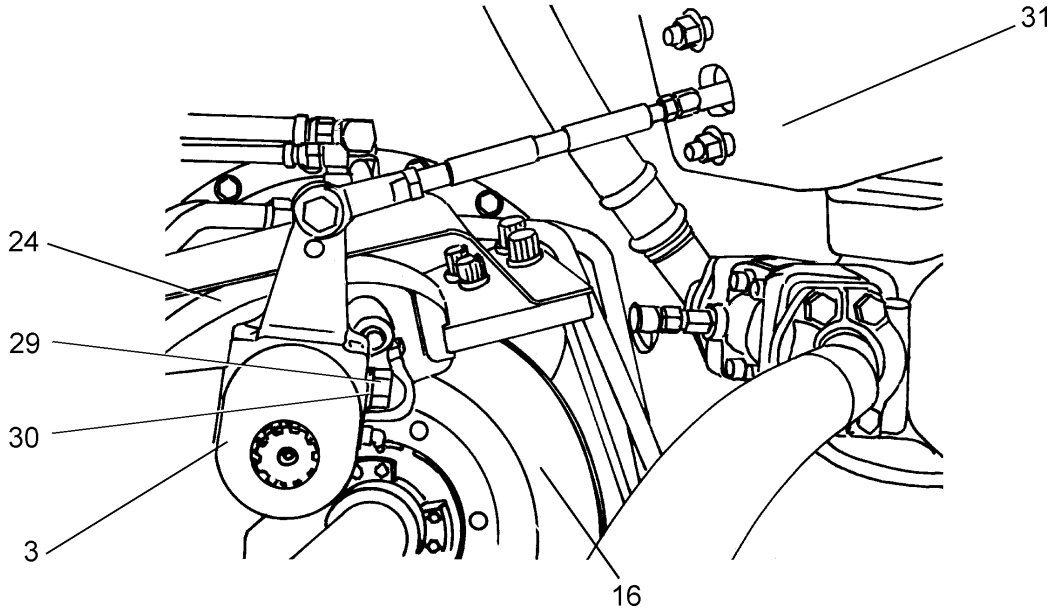


Fig. 4.7. Parking Brake

3. Slack Adjuster
16. Brake Disc
24. Brake Caliper
29. Bolt Retainer
30. Adjusting Bolt
31. Bracket

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PARKING BRAKE

WARNING! When performing the following step be sure someone is in the cab to prevent accidental brake application which would force the slack adjuster up and cause bodily injury to someone doing the adjustment.

1. With the parking brake release switch knob IN to release position, to adjust the lining, perform as follows:
   a. Use the wrench to depress the bolt retainer (29) while turning the bolt (30) clockwise until both linings are firmly against the brake disc.
   b. Apply hand pressure to the caliper (24) to keep the lining on the slack adjuster side of the disc firmly against the disc. Simultaneously, turn the bolt (30) counterclockwise until a measurement of 0.5 to 0.75 mm is obtained between the center of the opposite lining and the brake disc (16).
2. Perform as follow to test the brake operation:

WARNING! When testing the parking brake, be sure the area near the machine is clear of personnel and obstructions because the machine may move during the test.

   a. Start the engine a few minutes, build up hydraulic pressure and apply the service brake.
   b. Check that low hydraulic pressure warning light on the instrument panel is OFF. If the warning light remains ON, there is a loss of hydraulic pressure in the system. This must be corrected before further checking of the brake can be made.
   c. Apply the parking brake and raise the bucket.
   d. Shift the transmission to 2nd speed forward range, with the engine at low idle and the service brakes applied.
   e. Release the service brakes and slowly bring the engine to high idle (full throttle). The machine should not move.

WARNING! If the machine starts to move forward, fully release the accelerator pedal. Do not hold the machine in this stall condition for more than ten seconds.

3. If brake does not hold the machine, proceed as follows:
   a. Accelerate machine to maximum speed in first speed forward range. Place the transmission in neutral and apply the parking brake. Continue to drive for 3 to 5 m.
   b. Allow brake to cool down for 3 to 5 minutes.
   c. Repeat steps ”a” and ”b” for a total of brake applications.
   d. Perform point 2. If brake still does not hold the machine, repeat steps ”a” through ”c” in this point for burnishing linings and then test the brake operation once again.

WARNING! If parking brake does not hold machine, correct the cause as soon as possible. Until the cause is corrected, park the machine on level ground and block the tires to prevent it from moving.

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BRAKES

PARKING BRAKE

8. REMOVAL AND DISASSEMBLY (Refer to Fig. 4.6)

WARNING! The brake system has oil stored under high pressure. Before servicing brake system, park machine on a level surface, be sure the bucket is lowered and the engine is off.

1. Block the machine to prevent movement.
2. Push the parking brake release switch knob IN to the released position to remove tension in the slack adjuster (3).

WARNING! When performing the following step be sure someone is in the cab to prevent accidental brake application which would force the slack adjuster to spring up and could cause bodily injury to someone doing the adjustment.

3. Disconnect the rod end (2) from the slack adjuster (3).
4. Pull the brake release switch knob OUT to the applied position to relieve the oil pressure from the hydraulic cylinder (1) and allow the internal spring to expand.
5. Disconnect the oil line. Remove the hydraulic cylinder (1) from the bracket (31, Fig. 4.7).

WARNING! Hidden spring pressure. An internal spring is exerting force within the housing. If the hydraulic cylinder is malfunctioning, the assembly must be replaced.

6. Use the wrench to depress the bolt retainer (29, Fig. 4.7) while turning the adjusting bolt counterclockwise until it stops turning.
7. Remove the bolts securing the bar (15) to the support plate. Remove the brake assembly, mounting bar (15) and lining (13).
8. Remove the ring (4), slide the slack adjuster (3) and slide the washer (5) from the shaft (10).
9. Remove the spring washer (6) and seal ring (7) from the shaft (10).
10. Remove as a unit, the cover (8), shaft (10) and piston (11) from the caliper (14).
11. Slide the shaft and piston from the cover(18). Unscrew the piston from the shaft.
12. Remove and discard the thrust bearing (9), the piston seal (12) and gasket (25).
13. Remove and discard the sleeve (17) by collapsing, splitting or driving it from the bore of the cover (18).

IMPORTANT: *Use care not to damage the cover assembly bore while removing the sleeve.*

9. INSPECTION AND REPAIR

1. It is recommended that new seal ring and gasket be installed when the parking brake is disassembled.
2. Wash all parts in a solvent and air dry. Lubricate machined surface of usable parts to protect them.
3. Inspect the linings for damage, oil or grease saturation and wear. If linings are 3.2 mm or less they must be replaced.
4. Check the piston, slack adjuster and power screw shaft for cracks and excessive wear or damage at the threads and splines.

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10. REASSEMBLY AND INSTALLATION (Refer to Fig. 4.6)

IMPORTANT: *A special tool is required to aid in installed the sleeve properly. Refer to SECTION 1.*

1. Install the sleeve (17) in the cover (18) from the bracket side of the hub using the special tool. This driver will install the sleeve to the correct depth of 5.6 mm below the hub surface.
2. Install the piston seal (12) into the caliper (14).
3. Apply grease to the flat surface of the thrust bearing (9). Install the new thrust bearing, greased side first, over the splined end of the shaft (10) until it is against the shaft collar.
4. Screw the shaft (10) into the piston (11) after lubricating threads with grease.
5. Coat outside of piston with grease, then slide the shaft and piston assembly into the bracket side of the cover (8).
6. Secure the cover assembly (8) with new gasket (25) to the caliper (14) using 170 to 180 Nm of torque.
7. Install the seal ring (7), the spring washer (6) and then washer (5) over the power screw shaft.
8. Apply a coat of grease to the mounting splines of the slack adjuster (3). Slide the adjuster onto the shaft so that the adjuster bolt will face away from the hydraulic cylinder at installation.
9. Secure the adjuster to the shaft with the retaining ring (4).
10. Use the wrench to depress the adjusting bolt retainer while turning the adjusting bolt counterclockwise until it stops turning.
11. Mount the hydraulic cylinder (1) to the bracket (5, Fig. 4.7) but do not secure the rod end (2) to the adjuster at this time. Torque the cylinder mounting nuts to 150 to 200 Nm.
12. Assemble the brake assembly and the linings (13) to the mounting bars (15) so the lining pads are against each side of the disc (16). Secure the bars (15) to the support plate. Apply Loctite 262 and torque the bolts to 380 to 420 Nm.
13. Connect the hydraulic line to the hydraulic cylinder.
14. Observe that the hydraulic cylinder rod retract as the brake release valve knob is placed in the RELEASED position.

WARNING! When performing the following step be sure someone is in the cab to prevent accidental brake application which would force the slack adjuster up and could cause bodily injury to someone doing the adjustment.

15. Secure the adjuster (3) to the rod end (2) with the end pin and cotter.
16. Adjust the brakes and test as described in ADJUSTING AND OPERATIONAL TEST THE BRAKE.

SERVICE BRAKE WARNING LIGHT ”E” AND SWITCHES (Refer to SECTION 8)

11. DESCRIPTION

The service brake warning light ”E” located in the instrument panel is activated by seven switches monitoring four functions.

Two switches one on the top of each front and rear brake accumulator located in the front frame monitor the gas pressure in the each accumulator (Fig. 4.8).

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SERVICE BRAKE WARNING LIGHT ”E” AND SWITCHES (Refer to SECTION 8)

Two a main brake pressure supply switch located on the top of the valves block mounted in the front frame left hand side monitors brake system pressure (Fig. 4.9).

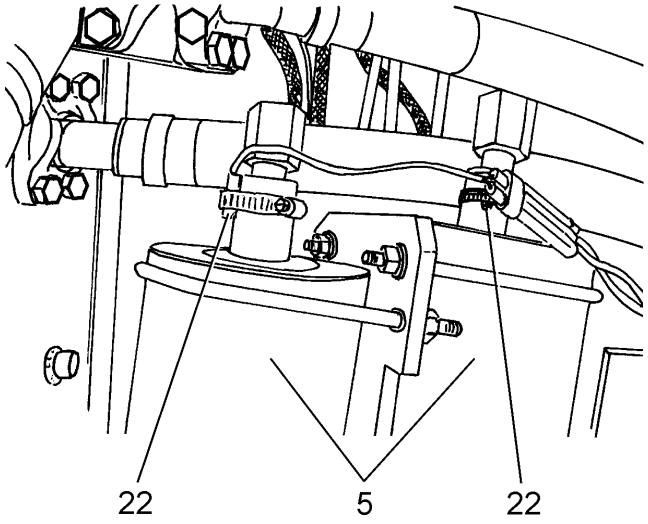


Fig. 4.8. Accumulator Switches

5. Gas Accumulator
22. Hydraulic Accumulators Gas Low Pressure Switch

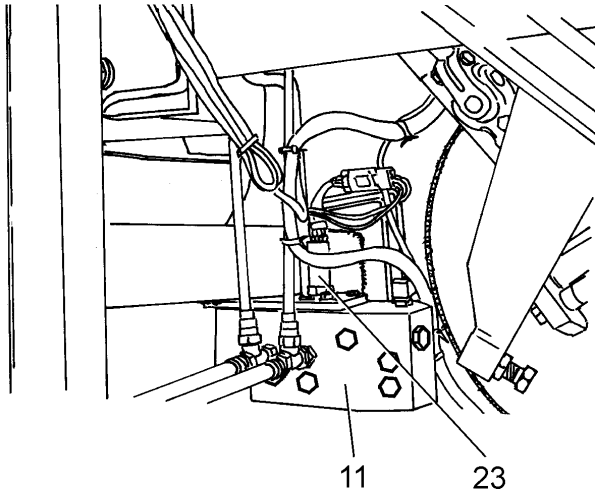
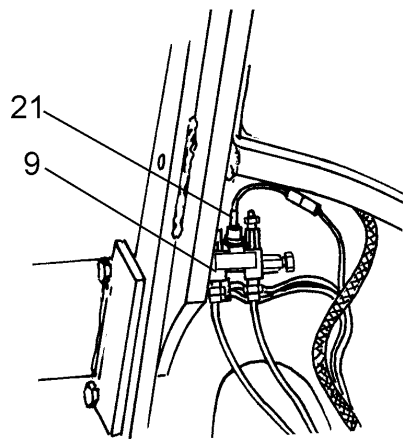


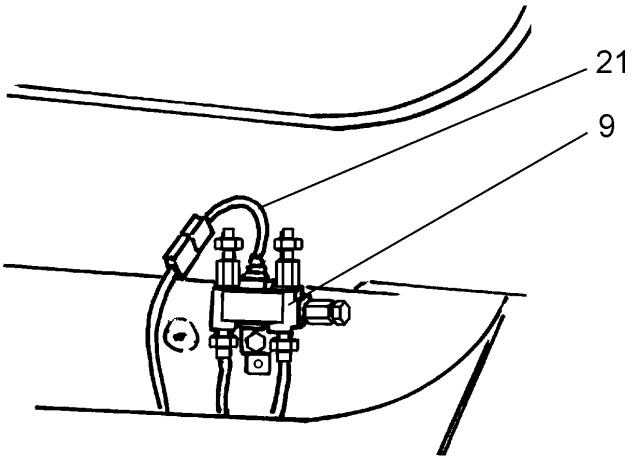
Fig. 4.9. Brake System Pump Pressure Supply

11. Valves Block
23. Main Brake Oil Pressure Switches

A differential pressure supply switch located in the front frame left of the brake pedal valve under the cab floor monitors brake system differential pressure between two axle when the brakes are applied (Fig. 4.10).



EARLT STYLE



LETER STYLE

Fig. 4.10. Brake System Differential Pressure Switch (View from Left Inspection Cover)

9. Differential Valve
21. Differential Pressure Switch

These four switches trigger the brake warning light thru a one second time delay. The light is held on by a latching relay located under the parking brake switch panel in the cab it can be reset by reaching with your fingers up along the right hand inside of the cowl and resetting the switch. A toggle type switch can be felt and a clicking sound will be heard.

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COOLING BRAKE LOW PRESSURE SWITCH AND BRAKE SYSTEM OIL FILTER WARNING LIGHT SWITCH

12. DESCRIPTION

Cooling brake low pressure switch is located at the cooling brake filter on the right side rear frame and monitors brake cooling pressure (Fig. 4.11).

The brake filter light in the instrument panel is activated by a switch located on the brake filter head mounted to the right hand topside of the rear frame (Fig. 4.11).

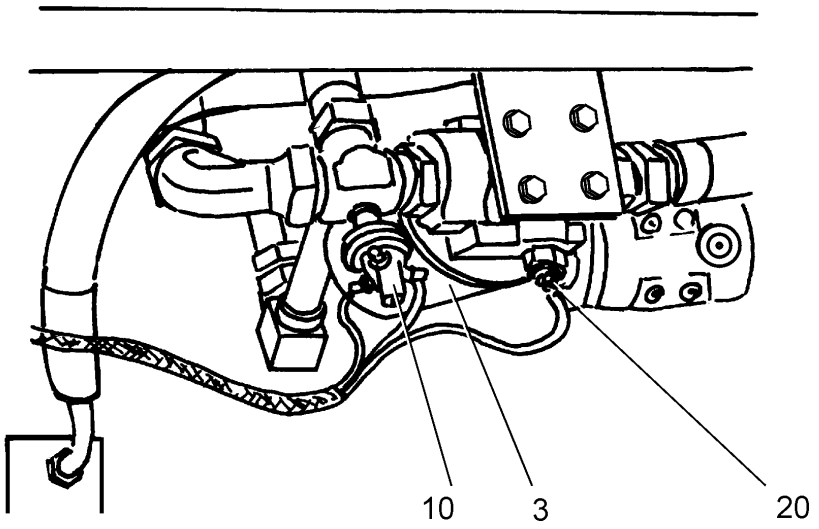


Fig. 4.11. Cooling Brake Low Pressure Switch and Brake System Warning Oil Light Switch

3. Cooling Filter
10. Cooling Brake Low Pressure Switch
20. Brake System Oil Filter Warning Light Switch

BRAKE PUMP

13. DESCRIPTION (Refer to Fig. 4.13)

The piston brake pump used in this system is designed for continuos operation. The pump is located below the injection pump on the right hand forward side of the engine and is driven off the engine drive train.

The major parts of the brake pump are: housing (43), a bearing supported drive shaft (53), a rotating group, a seal shaft (51) and valve plate (15) which contains the inlet and outlet ports and functions as a back cover.

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BRAKE PUMP

The rotating parts are: the cylinder block (31) and a spherical washer (34) which are splined to the drive shaft, a spring (29), nine pistons (36) and a shoe plate (35). The spring forces the cylinder block against the valve block and the washer against the shoe plate, thus holding the piston shoes against the swash plate (37). The swash plate (37) is seated in a pivoted yoke (42), the angle of which changes according to volume requirements. Rotation of the cylinder block imparts a reciprocating motion to the pistons due to the angle of the swash plate in relation to the drive axis. Each piston in turn completes one pumping cycle with each revolution of the cylinder block, intaking as it moves out of the cylinder bore and discharging as it moves in. Thus, nine pumping cycles take place with each revolution of the cylinder block. Pump intake and discharge is accomplished through a porting arrangement on the face of the valve plate and cylinder block. Pump displacement or volume depends on the piston stroke which is varied by the position of the yoke. When the yoke is perpendicular to the drive shaft there is no piston reciprocation, therfore no oil is pumped. Maximum displacement accurs when the yoke is at its greatest angle in relation to the drive shaft.

Inlet pressure to pump average 2000 kPa and outlet pressure average 18000 kPa.

14. REMOVAL

IMPORTANT: *Disconnected hydraulic 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 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.*

WARNING! Be sure the bucket is lowered to the ground, parking brake is ON and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

1. Remove the engine R.H. side sheet.
2. Disconnect the three hoses (1, 2 and 3, Fig. 4.12) from the rear of the pump (4). The hoses prevent from oil leakage.
3. Remove the bolts (5, Fig. 4.12) securing the pump to the engine. Remove the pump (4). Remove and discard the mounting gasket.

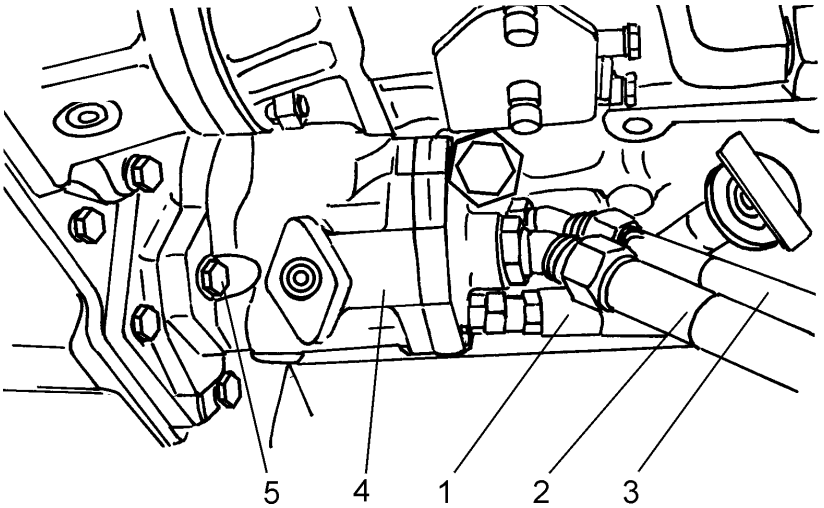


Fig. 4.12. Brake Pump Disconnecting Points

1. Hose 2. Hose 3. Hose 4. Brake Pump 5. Bolts

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BRAKE PUMP

15. DISASSEMBLY (Refer to Fig. 4.13)

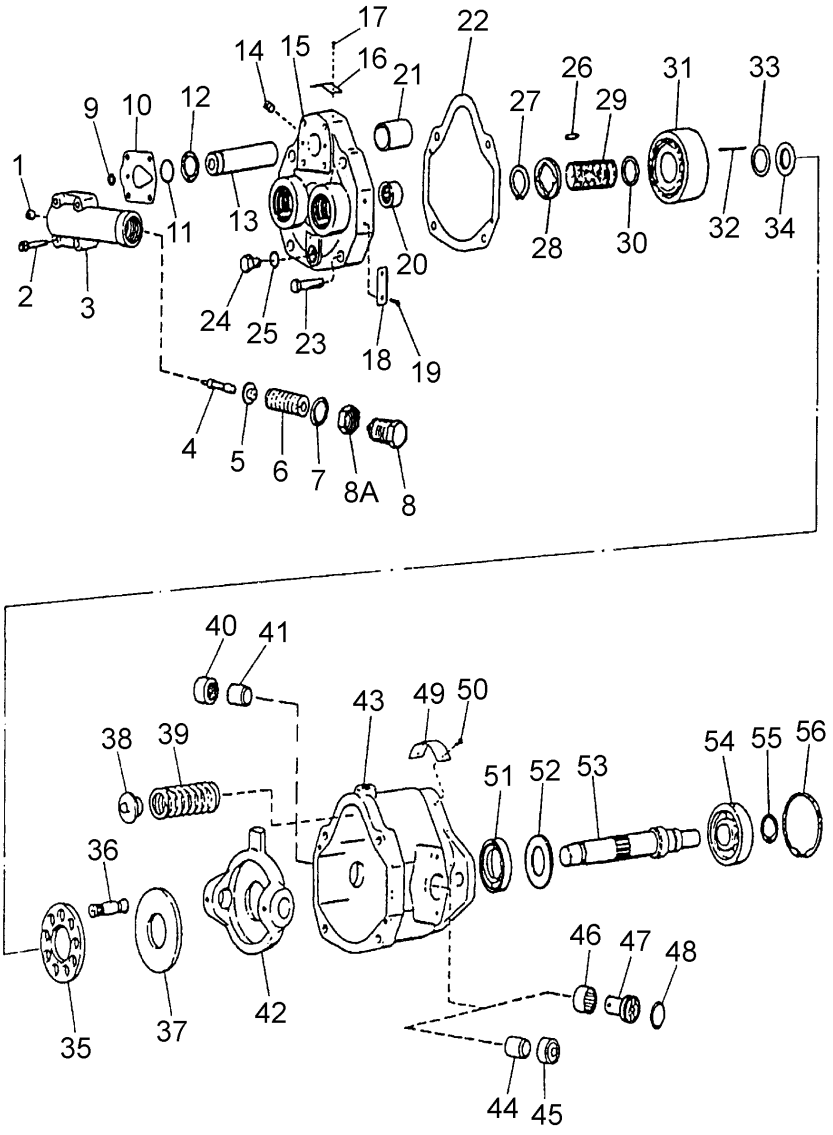


Fig. 4.13. Exploded View of Brake Pump

1. Plug
2. Bolts
3. Compensator Housing
4. Spool
5. Spring Seat
6. Spring
7. O-Ring
8. Adjusting Bolt
8A. Jam Nut
9. O-Ring
10. Gasket
11. O-Ring
12. Snap Ring
13. Piston Rod
14. Plug
15. Valve Plate
16. Plate
17. Screw
18. Plate
19. Screw
20. Bearing
21. Piston
22. Gasket
23. Bolts
24. Plug
25. O-Ring
26. Dowel Pins
27. Snap Ring
28. Limiter Washer
29. Spring
30. Thrust Washer
31. Cylinder Block
32. Dowel Pins
33. Washer
34. Spherical Washer
35. Shoe Plate
36. Pistons
37. Swash Plate
38. Spring Seat
39. Spring
40. Bearing
41. Inner Race
42. Yoke
43. Housing
44. Inner Race
45. Bearing
46. Bearing
47. Pin
48. Snap Ring
49. Plate
50. Screw
51. Shaft Seal
52. Washer
53. Drive Shaft
54. Bearing
55. Snap Ring
56. Snap Ring

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BRAKE PUMP

1. Remove the fittings from the back of the pump and thoroughly clean the outside. Clamp the pump assembly in a vise with the compensator housing (3) up. Remove the bolts (2) and lift the compensator housing (3). Discard O-rings (9 and 11) and mounting gasket (10).
2. Remove valve plate mounting bolts (23). Tap around valve plate (15) until thin blade screwdrivers can be used, as shown in Fig. 4.14, to pry the valve plate free of the dowels (26) in the housing (43).

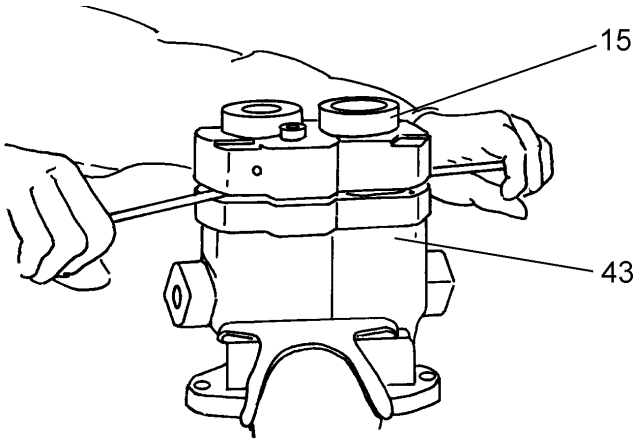


Fig. 4.14. Prying Valve Plate Free of Housing

15. Valve Plate
43. Housing

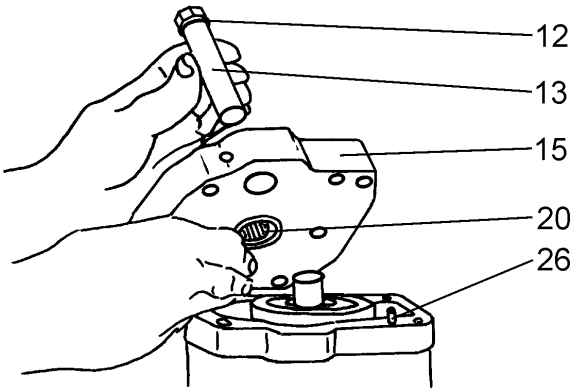


Fig. 4.15. Removing the Valve Plate and Piston Rod

12. Snap Ring
13. Piston Rod
15. Valve Plate
20. Bearing
26. Dowel Pin

3. Lift the valve plate (15), piston rod (13) and snap ring (12) from the housing, as shown in Fig. 4.15. The roller bearing (20) must not be removed from the valve plate unless replacement is necessary. Discard the valve plate gasket (22). Lift out the yoke actuating piston (21) from the housing bore.
4. Reposition the housing (43) in the vise at an angle as shown in Fig. 4.16. Lift the rotating unit out of the housing (43) as an assembly. As the rotating unit is lifted, grasp under the shoe plate (35) and pistons (36) to prevent the assembly from separating. Place the assembly on the side temporarily.
5. Lift the swash plate (37) from the housing bore. If difficulty is encountered in freeing the swash plate due to a possible oil lock, snap ring pliers can be used for leverage as shown in Fig. 4.17.
6. Turn the housing (43) in the vise as the bearing (54) is up. Remove the bearing internal snap ring (56) as shown in Fig. 4.18. Tap on the end of the shaft to free the shaft with bearing (54) and washer (52) from the housing (43) as shown in Fig. 4.19. Remove the washer (52) from the shaft (53). To replace the bearing (54), place the shaft in a press so it is supported by the bearing. Remove the snap ring (55) and press the shaft from the bearing.

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BRAKE PUMP

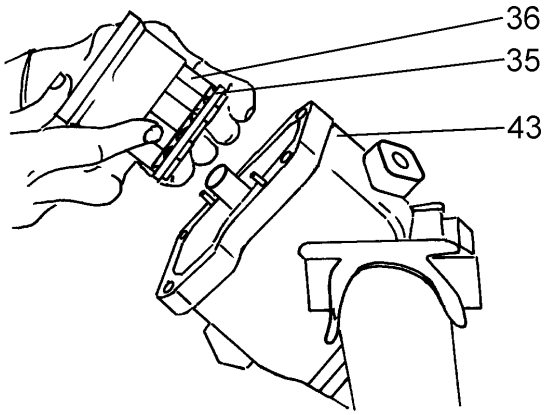


Fig. 4.16. Removing the Rotating Unit

35. Shoe Plate
36. Pistons
43. Housing

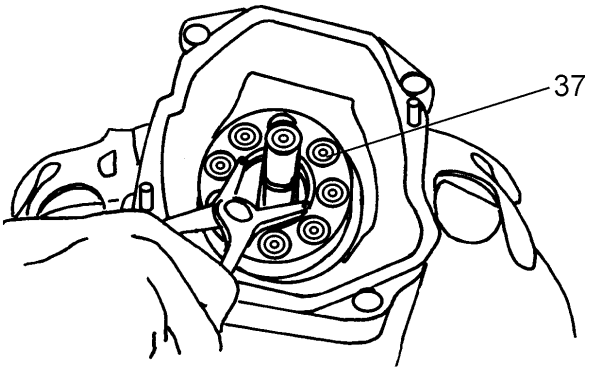


Fig. 4.17. Removing the Swash Plate

37. Swash Plate

7. Place the housing in the vise so the yoke is up. Remove the snap ring (48) securing the pin (47) to the housing (43). Remove the pin (47) from housing bore by pushing from the inside of the housing. Once the pin is removed, lift the yoke from the housing bore. The bearing must not be removed from the housing bores and yoke bore unless replacement is necessary.

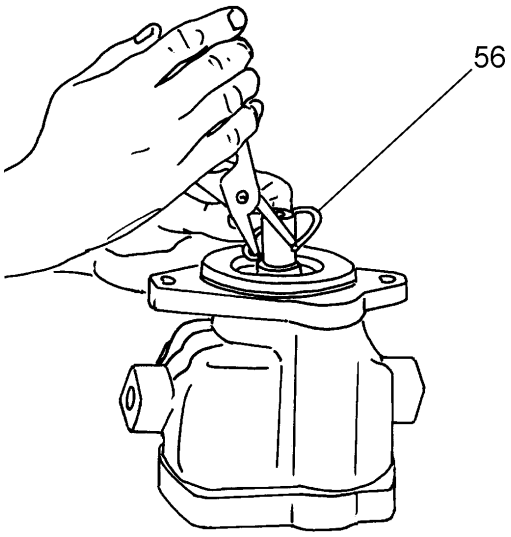


Fig. 4.18. Removing the Bearing Internal Snap Ring

56. Snap Ring

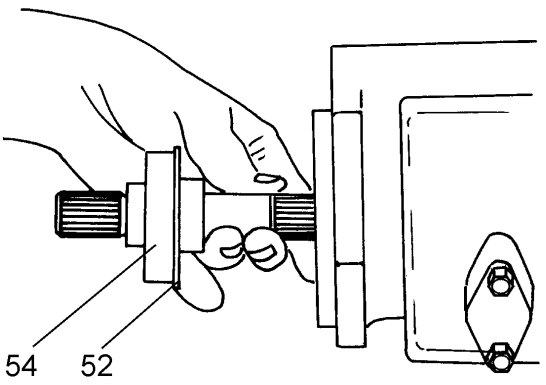


Fig. 4.19. Removing the Shaft and Bearing Assembly

52. Washer 54. Bearing

8. Remove the yoke return spring (39) and spring seat (38) from the housing. Remove and discard the shaft seal (51) located in the housing bore.

9. Before removing the adjusting bolts (8) and jam nut (8A), make jam nut relation to the adjusting bolts to maintain a close relief setting at reassembly. Remove the adjusting bolts (8) and jam nut (8A) from the compensator housing (3). Remove and discard O-ring (7).

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10. Tip the compensator housing down to free the adjustment spring (6), spring seat (5) and compensator spool (4) from the bore. If the spool does not come out, remove the plug (1) from the opposite end of the housing, and using an wrench spanner push the spool out.

11. Lay the rotating unit previously removed on a bench with the shoe plate (35) facing up as shown in Fig. 4.20. Lift the shoe plate with pistons (36) from cylinder block (31). Remove the pistons from the shoe plate being careful not to allow the pistons to strike one another.

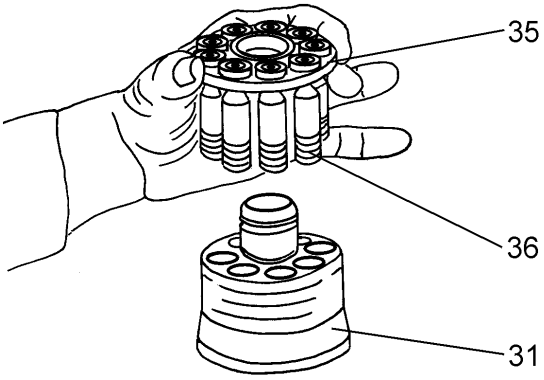


Fig. 4.20. Removing the Shoe Plate and Piston Assembly

31. Cylinder Block
35. Shoe Plate
36. Pistons

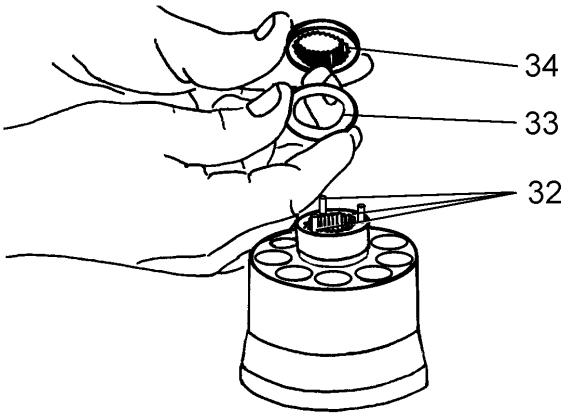


Fig. 4.21. Removing the Spherical and Flat Washer

32. Dowel Pins
33. Washer
34. Spherical Washer

12. Lift the spherical washer (34) and flat washer (33) from the dowel pins (32) as shown Fig. 4.21. Remove the dowel pins (32) from the cylinder block (31).

13. Remove the snap ring (27) and tip the cylinder block to free the limiter washer (28), spring (29) and thrust washer (30) from the bore.

16. INSPECTION AND REPAIR (Refer to Fig. 4.13)

1. It is recommended that new O-rings, shaft seal and gaskets be installed whenever the pump is disassembled for service.

2. Wash all parts thoroughly in a suitable solvent. Dry thoroughly with compressed air or a clean cloth.

3. Inspect pump housing for cracks and other damage. Be sure oil passages are clean and free of obstruction.

4. Inspect the flat surface of valve plate (15). The plate should be replaced if the surface which contacts cylinder block (31) is not smooth and free of grooves or metal buildup. Minor defects can be removed by lightly stoning the surface.

5. Inspect cylinder block (31). The cylinder block should be replaced if the surface which contacts valve plate (15) is not smooth and free of grooves or metal buildup. The pistons (36) should move freely in the cylinder block. If they are sticky in the bore, examine the bore for scoring or contamination

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6. Examine the O.D. of the pistons for finished condition, they should not show wear or deep scratches.
7. Examine shoe plate (35). It should be flat, without cracks or signs of wear in the pivot area.
8. Inspect the swash plate (37) for wear and scoring. If the defects are minor, stone the swash plate. If wear or damage is extensive replace the swash plate.
9. Inspect all bearings for roughness or excessive play and replace if necessary. Inspect the shaft seal area of the shaft for scoring or wear. Replace the drive shaft if bent or wear is excessive.
10. Inspect the all springs for breakage or weakness.
11. Inspect spool (4) for scoring.

17. REASSEMBLY (Refer to Fig. 4.13)

1. Install the compression spring (29) with a washer (28 and 30) on each side into the cylinder block (31). Be sure to install the washer (28) on top.
2. Install the tree dowel pins (32) in the cylinder block (31). Place the flat washer (33) on the dowels and position the spherical washer (34) as shown in Fig. 4.22, on the flat washer with the flat side down.
3. Place the shoe plate (35) (flange side up) onto the spherical washer (34). Be sure to align the piston openings in the shoe plate (35) and cylinder block (31). Install the pistons (36) into the shoe plate and cylinder block openings until the bottom as shown in Fig. 4.23. Place the rotating unit on the side until ready for installation.

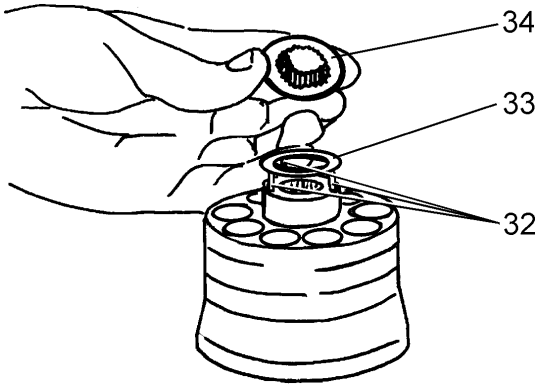


Fig. 4.22. Installing the Spherical Washer

32. Dowel Pins
33. Washer
34. Spherical Washer

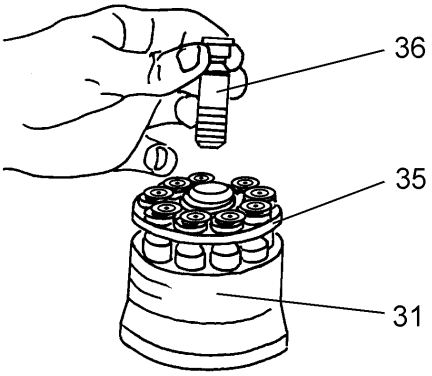


Fig. 4.23. Installing the Pistons

31. Cylinder Block
35. Shoe Plate
36. Pistons

4. Be sure the plug (1) is installed in the compensator housing (3). Install the spool (4) into the compensator housing and bottom it in its seat using a wooden dowel. Place the spring seat (5) on the end of the adjustment spring (6) and install both pieces into the compensator housing being sure not to cock the spring seat in the housing bore. Install the jam nut (8A) loosely on the adjusting bolt (8). Install a new O-ring (7) on the adjusting bolt and thread the adjusting bolt into the compensator housing (3) part way. Turn the adjusting bolt as necessary to align the assembly marks made in disassembly. Tighten the jam nut.

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BRAKE PUMP

IMPORTANT: *When installing new parts, alignment marks are not available for temporarily positioning the adjusting bolt. On these assemblies, the adjusting bolt must not be threaded "in" too far as excessive pressure will result in damage to the brake system.*

5. If the bearings (40 and 45) were removed from the pin bores in the pump housing (43), install new ones. Install the new shaft seal (51) into the pump housing until it bottoms.
6. Place the yoke return spring (39) and spring seat (38) in its bore of the housing (43).
7. Install the bearing (46) into the bore in the yoke (42). Install the yoke into the housing (43) being sure the spring seat engages the bore in the yoke. Install pin (47) and secure with snap ring (48).
8. If the shaft bearing (54) was removed, place the new bearing in a press and press the shaft (53) into the bearing until it bottoms. Secure with snap ring (55). The bearing must be installed so the shielded side is toward the splined end of the shaft. Install the bearing washer (52) into the housing (43). Install the shaft (53) and bearing assembly into the housing until the bearing bottoms. Use a suitable driver on the bearing as shown Fig. 4.24. Lubricate the bearing with suitable grease. Install the bearing internal snap ring (56) into the pump housing bore.

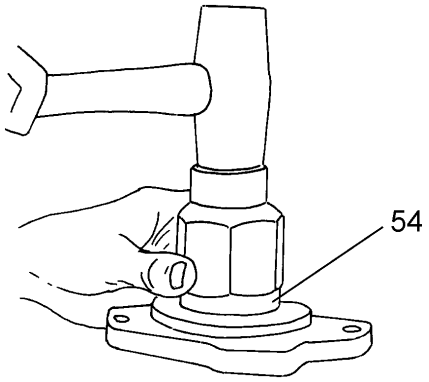


Fig. 4.24. Installing the Shaft and Bearing Assembly

54. Bearing

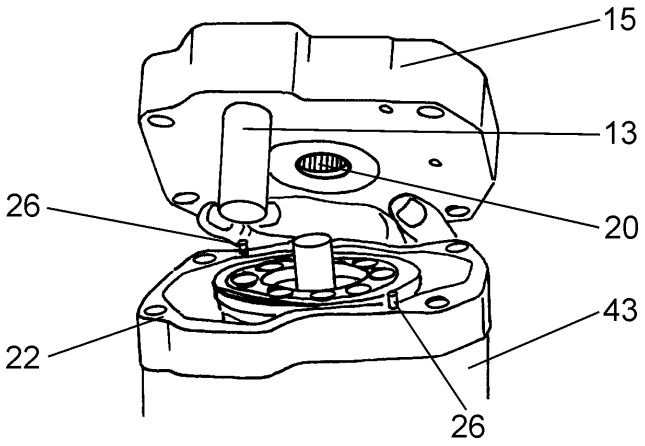


Fig. 4.25. Installing the Valve Plate

13. Piston Rod
15. Valve Plate
20. Bearing
22. Gasket
26. Dowel Pins
43. Housing

9. Install the swash plate (37) (finish side up) into the housing so it pilots in the yoke. Check that the swash plate is seated properly by rotating it by hand.
10. Position the pump housing (43) in the vise on an angle as shown in Fig. 4.16. Install the rotating unit into the housing, gripping the assembly as shown in Fig. 4.16, to prevent parts from separating.
11. If the bearing (20) was removed, install the new bearing into the valve plate (15) until it bottoms as shown in Fig. 4.25. Install dowel pins (26) into the pump housing (43) if they were removed, as shown in Fig. 4.25. Place a new mounting gasket (22) over the dowel pins (26) in the housing (43). Install the snap ring (12) on the piston rod (13) and insert the rod into the valve plate (15). Place the piston (21) over the piston rod (13) and carefully position the valve plate (15) on the dowels (26). Torque the mounting bolts (23) to 60 Nm.

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BRAKE PUMP

12. Install a new O-ring (11) and compensator housing mounting gasket (10) on the valve plate (15). Install a new O-ring (9) in its groove in the compensator housing (3). Secure the compensaror housing (3) to the valve plate (15) with the socket head bolts (2).
13. Install the fitting on the back of the pump.

18. INSTALLATION

1. Position the brake pump assembly with new mounting gasket, as shown in Fig. 4.12. Using mounting bolts (5) secure the pump to the engine.
2. Connect the tree pump hoses (1, 2 and 3, Fig. 4.12) to the brake pump.
3. Vent the brake system, refer in this section.
4. Start the engine and check the pressure in the brake system. The gauge reading should be about 30000 kPa. If the reading obtained is not within this specifications, adjust the pump compensator spool as below described:

   Loosen the jam nut (8A, Fig. 4.13). Turn the adjusting bolt (8) "IN" or "OUT" as necessary (1/2 turn at a time) until the pressure gauge reading is 20300 kPa. Secure with jam nut (8A). Stop the engine.

5. Install the engine R.H. side sheet.
6. Check the oil level and add if necessary.

BRAKE COOLING PUMP

For removal, service and installation refer to „HYDRAULIC AND BRAKE COOLING PUMP" in SECTION 10A.

BRAKE ACCUMULATOR

19. CHECK THE ACCUMULATOR CONDITION

1. With the engine on level ground and the parking brake applied, start the engine and low idle for 20 seconds.
2. Shut down the engine.
3. Apply the brake pedal repeatedly. The pedal must have hydraulic "feel" for at least seven (7) applies. If it does not, correct the problem by checking accumulator precharge, or the brake adjustment at each wheel end.

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BRAKES

BRAKE ACCUMULATOR

20. CHECKING NITROGEN CHARGE IN ACCUMULATOR (Refer to Fig. 4.26)

This can be done with the accumulator installed in the machine or with the accumulator removed and on a bench. If the accumulator is on a bench, read the warning preceding step 3 and being with step 4.

1. Park the machine on level ground, apply the parking brake, stop the engine and observe all other applications safety precautions.
2. Fully apply and release the service brake pedal repeatedly until the hydraulic resistance felt when the pedal is depressed has completely diminished. At this point, the only resistance felt will be a non diminishing spring force. This is dine to discharge the pressurized oil stored in the accumulators. This should require approximately 15 - 20 brake applications.

WARNING! Do not expose yourself to the discharge path of the accumulator oil fitting disconnected in step 3 below at any time.

3. Slightly loosen the fitting connecting the accumulator to the system oil and allow any remaining pressurized oil to escape. When no pressure remains, completely disconnect this fitting.
4. Remove the protective cover from the valve assembly on the gas side of the accumulator.
5. Use the checking / charging kit tool number DR09721 or equivalent (Fig. 4.26)

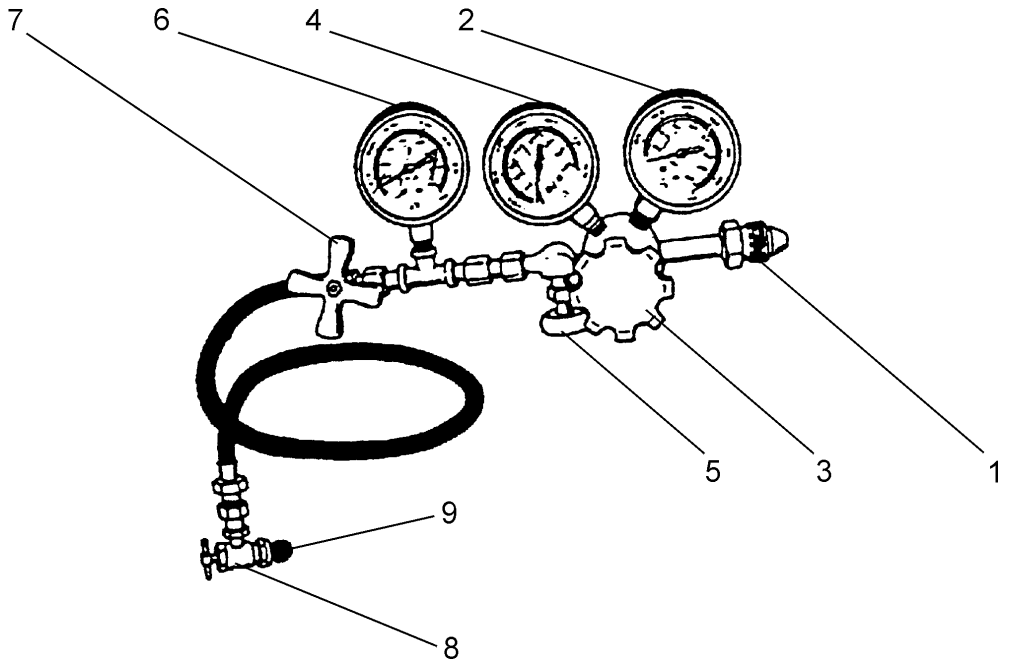


Fig. 4.26. Checking / Charging Kit Tool Number DR09721

1. Fitting	4. Gauge	7. Valve
2. Gauge	5. Valve	8. Valve
3. Regulator Valve	6. Gauge	9. Chuck

6. Use a source of dry pressurized nitrogen (tank) having a pressure of greater than 16000 kPa and the checking / charging kit tool number DR09721 assembly (1) through (9).
7. Verify that the source (tank) valve is closed.

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8. Set the pressure regulator valve (3) to the ”zero” pressure position (counter - clockwise)
9. Insure that the source fitting (tank) and fitting 1 are free of contaminants and then connect the two together and tighten with a wrench.
10. Slowly and slightly open the source (tank) valve while verifying that gauge (2) reads the tank pressure and gauge (4) reads ”zero”. If these conditions are not met, the procedure has not been followed correctly or some part of the equipment is faulty. Immediately close the source (tank) valve - trouble shoot and correct.
11. Close valve (7) (clockwise) close valve (8) (counter - clockwise) and close valve (5) (clockwise)
12. Install the chuck (9) on the valve of the accumulator which was exposed in step 4 above. Open the valve (7) (counter - clockwise)
13. Turn valve 8 ”ON” (clockwise). This step will cause gauge (6) to read the pressure in the accumulator while it contains only the nitrogen charge gas and no pressurized oil. Refer to the charge pressure charge (table) for the target reading in this step.

Ambient Temperature	Charge Pressure
$10^{O}C$	8.78 ± 0.175 MPa
$21^{O}C$	9.14 ± 0.175 MPa
$32^{O}C$	9.49 ± 0.175 MPa
$43^{O}C$	9.84 ± 0.175 MPa

14. If the gauge reading in step 13 is too high, slightly and momentarily open and close valve (5) to exhaust the excess to obtain the target pressure.
15. If the gauge reading in step 13 too low, refer to CHARGING ACCUMULATOR WITH NITROGEN.
16. When/if the pressure is satisfactory or for other reasons the test equipment P/N DR09721 may be removed as follows:
    a. Turn valve (8) and chuck (9) to the off position (completely counter - clockwise).
    b. Slightly loosen the chuck (9), and/or slightly open valve (3) to allow the pressure downstream of valve (3) as shown by gauge (4) to escape.
    c. When the gauge (4) reads ”zero” pressure remove the test equipment P/N DR09721.
    d. Connect and tighten the fitting removed in step 3 of CHECKING THE NITROGEN CHARGE IN THE ACCUMULATOR.

21. CHARGING ACCUMULATOR WITH NITROGEN (Refer to Fig. 4.26)

WARNING! Use only dry nitrogen to charge the accumulator. Never use any other gas, including oxygen or air, it could be extremely hazardous.

This can be done with the accumulator installed in the machine or with the accumulator removed and on a bench.

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BRAKES

BRAKE ACCUMULATOR

1. Refer to CHECKING THE NITROGEN CHARGE IN THE ACCUMULATOR AND accomplish steps 1 through 15 or if the accumulator is on a bench, read the warning preceding step 3 and accomplish step 4 through 15 as applicable. Leave the assembly 3 through 6 in the ending configuration, with valve (3) closed.
2. To ”set” the charging pressure in the hose leading to valve (7) to determine the target pressure and slowly increase the reading on gauge (4) by turning the regulator adjusting stem clockwise. Stop when the target pressure is reached. Turn the adjusting screw counterclockwise to decrease, if necessary. If the target pressure cannot be set, the procedure has not been followed correctly or part of the equipment is faulty trouble shoot and correct.
3. With the target pressure set as in step 2 above, slowly open valve (7) to charge the accumulator to the set target pressure.
4. When the target pressure has been reached as shown on gauges (4 and 6), close valve (5). The pressure shown on gauges (4 and 6)should remain stable. If they do not trouble shoot and correct.
5. Turn valve (8) on chuck (9) to the ”OFF” position (completely counter - clockwise).
6. Turn the source (tank) valve off.
7. Slightly loosen chuck (9) to allow the pressure downstream of valve (5) as shown by gauge (6) to escape.
8. Slightly open valve (5) to allow the remaining pressure downstream of the source (tank) valve to escape as shown by gauges (2 and 4).
9. When all three pressure gauges read ”zero” pressure, remove the test equipment P/N DR09721.
10. Connect and tighten the fitting removed in step 3 of CHECKING THE NITROGEN CHARGE IN THE ACCUMULATOR.

CHECK PERFORMANCE OF MAIN BRAKES

22. CHECK THE BRAKES EFFECTIVENESS

Whenever brake lines have been disturbed or if the brakes feel less effective or spongy, bleed the brakes to remove entrapped air as follows:

Venting of the system

For venting of the system refer to the OPERATOR’S MANUAL.

Venting procedure of transmission disconnecting circuit is as follows:

1. Put the machine in motion and leave it at slow RPM with neutral position of transmission direction lever locked, and the parking brake applied.
2. Set the transmission disconnect switch in braking position with transmission disconnecting, refer to Instruments and Controls OPERATOR’S MANUAL.
3. Loosen the connector of transmission disconnecting valve supply hose on the transmission by one turn.
4. Slightly depress the brake pedal. Watch outflow of the air and oil at the loosened connection of the hose.
5. Tighten the connection when the oil stream (deprived of air bubbles) starts flowing out.

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STEERING

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STEERING

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STEERING

GENERAL

1. SPECIFICATIONS

Frame stop clearance . . . . . 6 mm + 6 mm

Special Torques

Pitman arm mounting nut . . . . . 165-220 Nm
Bellcrank lever to bellcrank pivot nut . . . . . 300 Nm
Bellcrank lever to linkage rod nut . . . . . .110 Nm
Pitman arm to linkage rod nut . . . . . .110 Nm
Steering wheel nut . . . . . 48 Nm

2. SERVICE DIAGNOSIS

NOTE: *The following service diagnosis pertains to the mechanical portion of the steering system. For diagnosis of the hydraulic portion of the steering system, refer to Section 10, "HYDRAULICS".*

DIAGNOSTIC CHART

COMPLAINT	
PROBABLE CAUSE	REMARKS
Hard Steering	
1. Tires not inflated properly	Inflate to specification. Refer to Section 15, "WHEELS AND TRACKS"
2. Lack of lubricant in linkage	Lubricate linkage.
3. Steering gear adjustment tight	Check gear adjustment. Refer to "Adjustment Procedure" under "STEERING GEAR"
4. Steering column bearings worn	Repair steering column
5. Hinge pin bearings worn	Replace bearings. Refer to Section 9, FRAME
Steering Wheel Stops Before Frame Halves Reach Stop Clearance	
1. Steering gear not centered	Adjust. Refer to "LINKAGE ADJUSTMENT" in this section
Wheel Kickback Or Loose Steering	
1. Excessive lash in linkage	Adjust linkage. Refer to "LINKAGE ADJUSTMENT" in this section
2. Excessive lash between worm and shaft in steering gear	Adjust. Refer to "Adjustment Procedure" under "STEERING GEAR"
3. Worn gears in steering gear	Overhaul steering gear

3. LINKAGE ADJUSTMENT (Refer to Fig. 5.1)

1. Place the machine in a straight ahead position. Install the locking bar.

WARNING! Be sure the bucket is lowered to the ground, parking brake is ON and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

WARNING! Always lock the frames together before working near the center of the machine. If the frames move, serious injury or death could result.

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STEERING

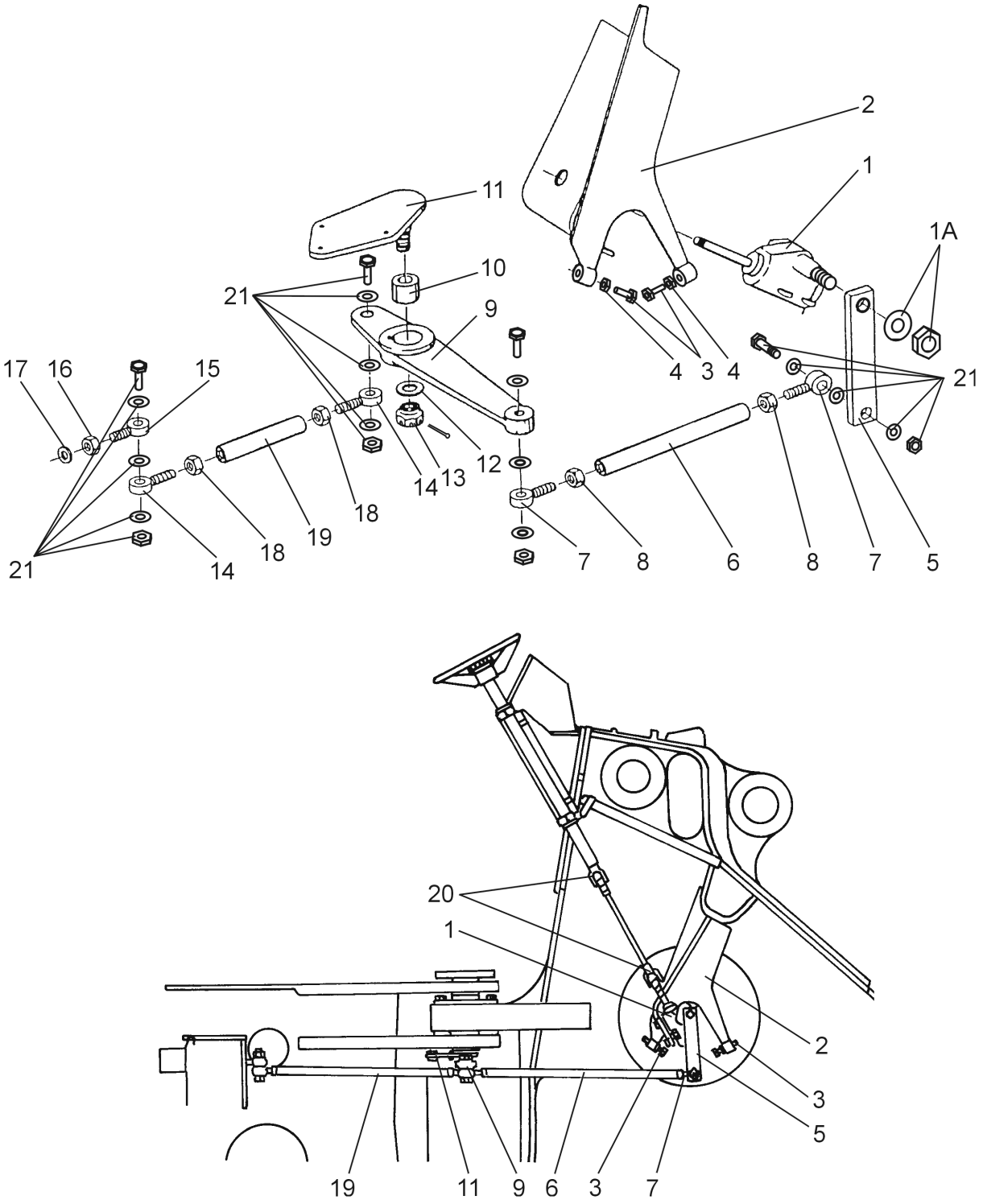


Fig. 5.1. Steering Linkage

1. Steering Gear
1A. Washer and Nut
2. Bracket (part of front frame)
3. Stop Bolt
4. Lock Nut
5. Pitman Arm
6. Rod
7. Rod End
8. Lock Nut
9. Bellcrank Lever
10. Bearing
11. Bellcrank Pivot
12. Washer
13. Nut and Pin
14. Rod End
15. Rod End
16. Lock Nut
17. Washer
18. Lock Nut
19. Rod
20. Yoke
21. Bolt, Washer, Nut

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2. Disconnect the pitman arm (5) at the steering gear (1). Disconnect the rod (19) at the bellcrank lever (9).
3. Center the steering gear. Turn the wheel as far as it will go in one direction. Counting the number of turns required, turn the wheel in the opposite direction as far as it will go. Now turn the wheel back half the number of turns to find center.
4. Install the pitman arm (5) so it is 5 degrees forward of a vertical or straight down position. Torque the mounting nut to 165-220 Nm.
5. Disconnect the rod (6) at the pitman arm. Check the free play in the steering gear by rotating the pitman arm back and forth by hand. Concentrate on the area where the pitman arm is in the 5 degrees to vertical position. If free play exists, adjust the steering gear as described under "STEERING GEAR".
6. Position the bellcrank assembly so the lever (9) is 90 degrees to the side of the frame.
7. Connect the rod (6) to the pitman arm. If necessary, the rod ends (7) must be adjusted so as not to disturb the bellcrank or pitman arm positions. Nuts for rod ends must be torqued to 110 Nm.
8. Adjust the rod end (15) at the hydraulic steering valve so the rod end (14) fits in place through the lever (9) without disturbing the lever position. Secure the rod end to the bellcrank lever using 110 Nm. Place the washer (17) into position to engage the slot in the steering valve spool and secure with the nut (16).
9. Remove the locking bar. Start the engine, loose the parking brake.
10. Operate the engine at approximately 1200 RPM. Turn the machine slowly to the right until the frame stop pads (bumpers) just make contact or are a maximum of 12mm apart. Stop the engine. Adjust and lock the pitman arm stop bolt (3) to prevent any further movement of the arm. Repeat this procedure by turning the machine to the left.
11. Remove the left side panel to allow access to steering/switch pump quick disconnect point (1, Fig. 5.2). Install a 30000 kPa gauge. The gauge hose must be long enough to place the gauge in the cab.
12. Operate the engine until the hydraulic system fluid is approximately 40-50°C.

NOTE: *Engine speed must not exceed 1200 RPM while performing the following pressure check.*

13. Turn the machine to a full left turn and observe the gauge reading. If the pressure does not drop below 2750 kPa, adjust the pitman arm stop (3) until it does.

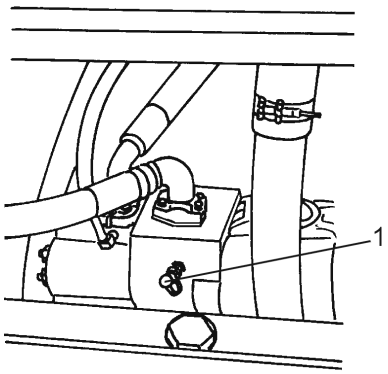


Fig. 5.2. Steering Linkage Hydraulic Pressure (Check Point)

1. Steering/Switch pump

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14. Release the steering wheel once the full turn is completed. The linkage might bind just enough to affect the pressure and a slight tap on the wheel would relieve the bind and give a more accurate reading. Sometimes this function can be helped by moving the machine forward and reverse at 1200 RPM to relieve tire squeeze which could affect the pressure reading.

15. Repeat steps 13 and 14 for the opposite direction.

16. Install the locking bar to prevent articulation.

17. With the hybraulic oil still at 40-50°C, check the pressure reading with the steering in neutral and the engine at high idle. Pressure should read 690 kPa maximum.

18. Turn the steering wheel fully in one direction with the engine at high idle. Let the wheel center itself, then recheck the pressure. Pressure should be plus or minus 170 kPa of the readíng obtained in step 17. Repeat for opposite steering wheel direction.

19. With the engine shut off, turn steering wheel fully in one direction and release. Wheel should center fully by itself. Repeat in opposite direction. If wheel fails to return to neutral position, check components for excessive drag and replace as required.

20. Disconnect the pressure gauge hose from the steering/switch pump (1, Fig. 5.2).

21. Install the side panel. Remove the frame locking bar.

STEERING COLUMN

4. DESCRIPTION AND OPERATION

The steering column provides the mechanical link between the steering wheel mounted at the upper end of the column and the steering gear. The steering gear is connected to the lower end of the column through an external shaft and universal joint. The steering column is enclosed in a cylindrical tube. Internal parts of the column rotate on bearings inside of the tube.

As the steering wheel is turned, the internal shaft of the steering column (through the external shaft and universal joint) moves the worm shaft in the steering gear assembly. Rotation of the worm shaft causes the pitman arm to rotate and move the steering linkage. The linkage manually moves the spool in the steering valve.

5. SPECIFICATIONS

Special Torques

Steering wheel nut	47 Nm

Spring Rates

Dust cup spring

No. of coils	3-3/4
Free length	25 mm
Test length	16 mm
Test load	112.3 N

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6. REMOVAL

WARNING! Be sure the bucket is lowered to the ground, parking brake is ON and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

WARNING! Always lock the frames together before working near the center of the machine. If the frames move, serious injury or death could result.

1. Loosen the hardware securing the yoke (4, Fig. 5.4) to the lower end of the steering wheel shaft (12). Mark yoke to shaft to maintain same relationship at installation.
2. Pry the cover from the steering wheel adjustment knob (4, Fig. 5.3) using a thin blade screwdriver under the notch in the cover. Remove the nut (26, Fig. 5.4), adjustment knob (25) and nut (24) from the wheel tube (23).
3. Using a suitable puller, remove the steering wheel (5, Fig. 5.3) from the wheel tube. Protect the exposed end of the wheel tube with a sleeve before using the puller as pressure must not be imposed upon the wheel tube.
4. Remove the side panel (1, Fig. 5.3). Remove the rubber caps (2). Working through the side panel opening, hold the nuts and loosen the bolts that were located under the rubber caps. Bolts should be loosened until the clamping affect is reduced, allowing the column assembly to be pulled out the top of the support assembly (3).

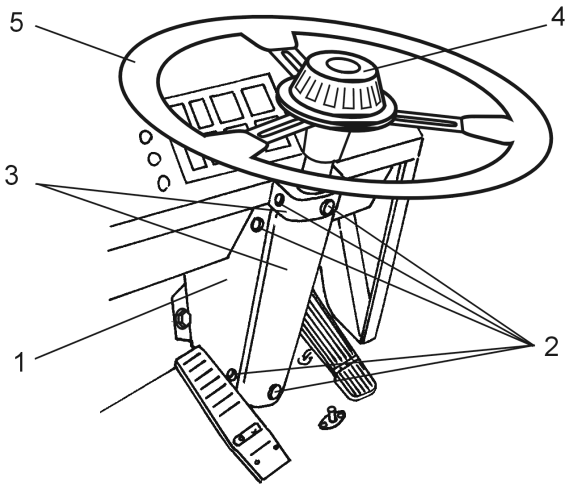


Fig. 5.3. Steering Column Disconnect Points

1. Side Panel
2. Rubber Cap
3. Support Assembly
4. Adjustment Knob
5. Steering Wheel

7. DISASSEMBLY (Refer to Fig. 5.4)

1. Remove the joint assembly (1), dust cap (8) and spring (9).
2. Push on the wheel tube (23) to force the spring seat (10) out of the jacket tube (14).
3. From the opposite end, push on the wheel shaft (12) to force out the dust seal (19).
4. Push on the shaft (12) until the snap ring (18) is protruding far enough out of the tube to be removed.

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5. Push on the wheel tube (23) to free the bearing (11) and the remaining internal components of the steering column from the tube.

6. To replace roller bearing (17), it must be pressed out the steering wheel end of the tube (14).

7. Remove the wheel tube (23) from the outer sleeve (16). Remove the dowel pin (21) securing the tube lock (20) to the outer sleeve and pull the locking rod (22) with tube lock from the outer sleeve. Unthread the locking rod from the tube lock.

8. Remove the retaining ring (15) from the OD of the outer sleeve (16).

9. Remove the dowel pin (13) to separate the wheel shaft (12) and the outer sleeve (16).

8. INSPECTION AND REPAIR

Check the dust cup spring for wear, damage or distortion. Refer to "SPECIFICATIONS" for test load data.
Check condition of bearings

9. REASSEMBLY

1. Assemble the wheel shaft (12) and the outer sleeve (16) and fix them with the dowel pin (13).

2. Install the retaining ring (15) on the OD of the sleeve (16).

3. Thread the locking rod (22) to the tube lock (20). Insert the locking rod (22) with tube lock to the outer sleeve (16), install the dowel pin (21) securing the tube lock to the outer sleeve. Install the wheel tube (23) in the outer sleeve (16).

NOTE: *Pin (21) must be pressed flush or 0.8 mm below the outer surface of the tube lock (20).*

4. If removed, press new roller bearing (17) into the tube (14).

5. Insert the mounting above internal components of the steering column to the tube (14).

6. Push on the shaft (12) to protruding far enough out of the tube (14). Install the snap ring (18) push back the shaft (12).

7. From the opposite end, press the dust seal (19) inside the tube (14).

8. Install the bearing (11) and spring seat (10) in the tube (14).

9. Install the spring (9) dust cap (8), and joint assembly (1).

Legend for Fig. 5.4

1. Joint Assembly
2. Yoke
3. Cross and Bearings
4. Yoke
5. Yoke Retaining Bolt
6. Lock Washer
7. Nut
8. Dust Cup
9. Spring
10. Spring Seat
11. Jacket Tube Bearing
12. Wheel Shaft
13. Dowel Pin
14. Jacket Tube
15. Retaining Ring
16. 0uter Sleeve
17. Roller Bearing
18. Snap Ring
19. Dust Seal
20. Tube Lock
21. Dowel Pin
22. Locking Rod
23. Wheel Tube
24. Nut
25. Adjustment Knob
26. Lock Nut

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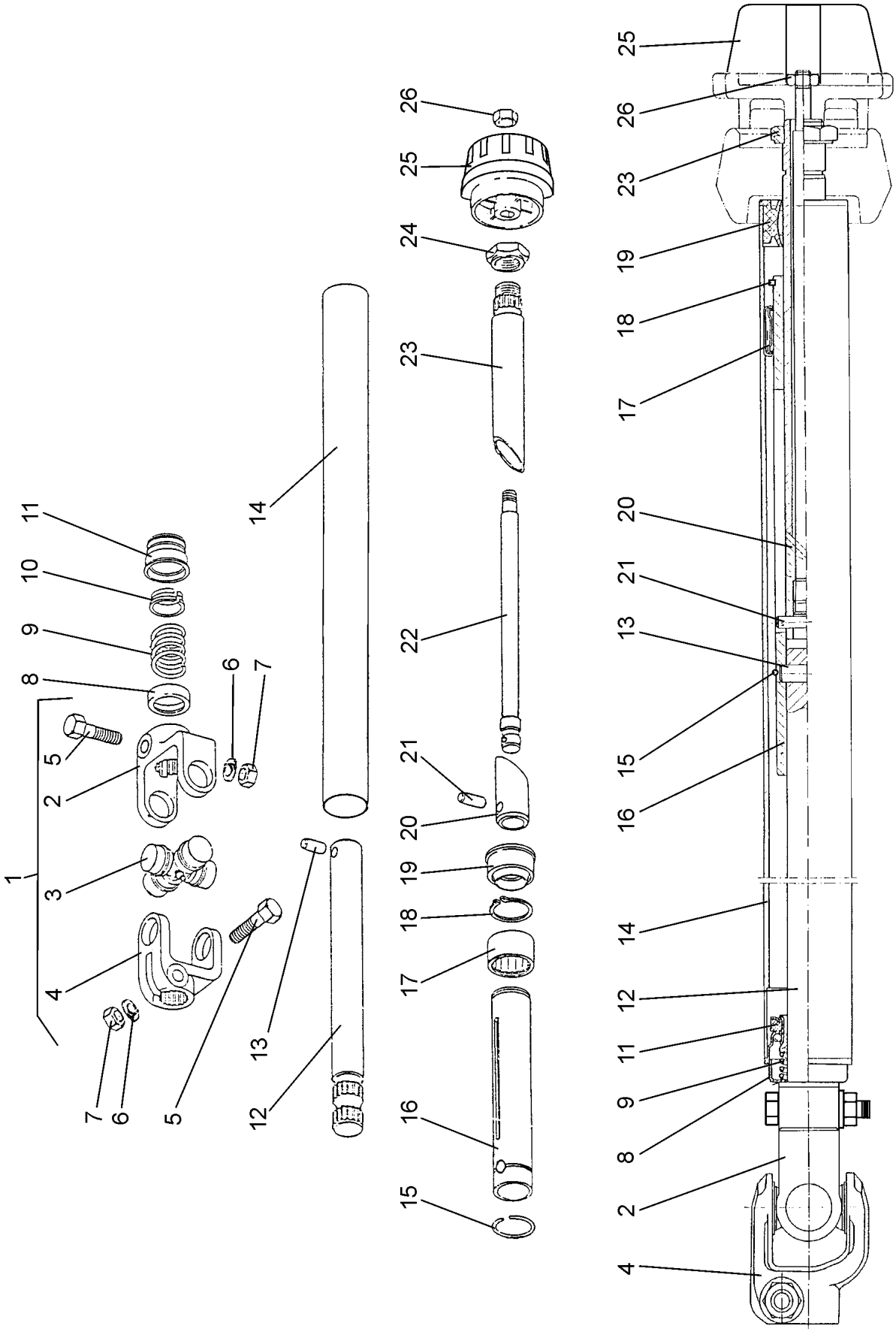


Fig. 5.4. Steering Column

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10. INSTALLATION

1. Insert the column assembly into the support assembly (3, Fig. 5.3). Working under cab, mount the yoke (2, Fig. 5.4) to the lower end of the steering wheel shaft (12) maintaining the same relationship as before disassembly.
2. Hold the nuts and tighten the bolts that securing the steering column clamp. Install the rubber caps (2, Fig. 5.3) in openings. Install the side panels (1) on each side of the steering column support.
3. Install the steering wheel (5, Fig. 5.3) on the wheel tube (23, Fig. 5.4). Torque the steering wheel nut (24, Fig. 5.4) to 47 Nm.
4. Turn the locking rod (22, Fig. 5.4) counter-clockwise to maximum, then turn back the locking rod two revolutions clockwise. Install the steering wheel adjustment knob (4, Fig. 5.3) and nut (26, Fig. 5.4).

STEERING GEAR

11. DESCRIPTION (Refer to Fig. 5.5)

The steering gear is mounted in the front frame and is connected to the shaft at the lower end of the steering column. The steering gear transfers the rotating effort of the steering wheel into movement of the mechanical linkage to operate the hydraulic steering valve mounted in the rear frame.

The mechanical linkage is connected to the pitman shaft gear (7) whose teeth mesh at a right angle with the teeth of the ball nut (16). The ball nut rides on the worm shaft (15) which is connected to the steering column by a shaft and universal joint. Helical grooves in the ball nut match helical grooves in the worm shaft. Balls riding in these grooves, mechanically connect the worm shaft to the ball nut.

There are ball bearings (14 and 24) at each end of the worm shaft. End play on the bearings is controlled by the bearing adjuster (25). A lash adjuster (8) controls the gear teeth lash between the pitman shaft gear and the ball nut.

12. THEORY OF OPERATION (Refer to Fig. 5. 5)

Movement of the steering wheel turns the worm shaft (15). The ball bearings which move between the helical grooves of the worm shaft and the ball nut (16), force the ball nut to move. This, in turn, moves the pitman shaft gear (7), whose teeth are meshed to the teeth of the ball nut.

There are two complete circuits of balls riding in the helical grooves. Tubular ball guides(19) deflect the balls away from their helical path at one end and guide them back to their path at the other end. This recirculating ball action acts as a rolling thread between the worm shaft and the ball nut.

The teeth on the pitman shaft gear (7) and the ball nut (16) are so designed that a tighter fit exists between the two when the front and rear frame are not articulated wheels are straight ahead. Proper engagement between the pitman shaft gear and the ball nut is obtained by an lash adjuster screw (8) which moves the pitman shaft endwise, permitting desired engagement of the tapered teeth of the ball nut and gear. The worm thrust bearing adjuster (25) can be turned to provide proper preloading of the upper and lower worm shaft thrust ball bearings (14 and 24).

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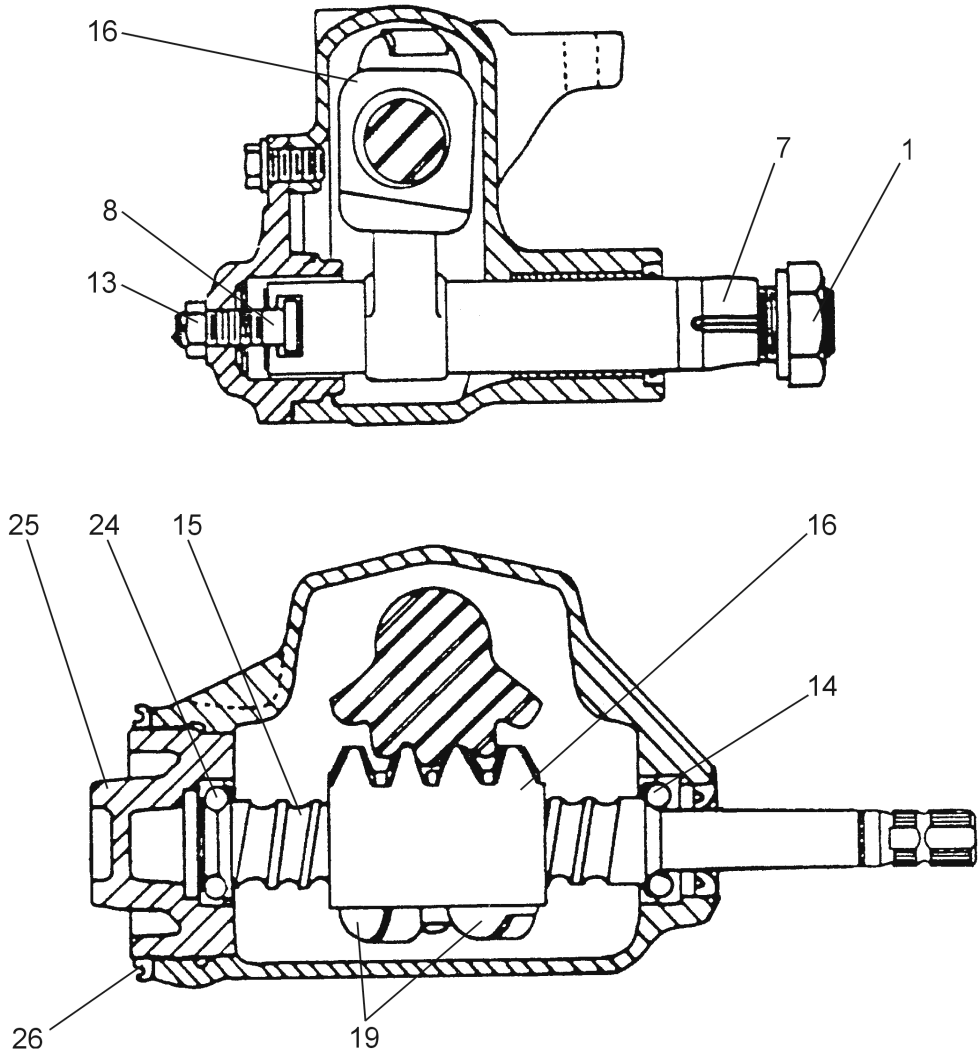


Fig. 5.5. Steering Gear (Cut view)

7. Pitman Shaft
8. Lash Adjuster Screw
13. Lash Adjuster Lock Nut
14. Bearing Ball
15. Worm Shaft
16. Ball Nut
19. Ball Return Guide
24. Bearing Ball
25. Bearing Adjuster
26. Bearing Adjuster Lock Nut

13. SPECIFICATIONS

Tolerances

Worm bearing preload	0.17-0.62 Nm
Pitman shaft preload (above worm bearing preload)	0.34-0.80 Nm
Maximum allowable pitman shaft preload	1.24 Nm
Pitman shaft to lash adjuster screw clearance	0.05 mm

Special Torques

Bearing adjuster lock nut	95-136 Nm
Lash adjuster screw lock nut	24-37 Nm
Pitman shaft side cover bolts	34-47 Nm
Pitman arm mounting nut	170-220 Nm

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14. WORM BEARING PRELOAD ADJUSTMENT

WARNING! Be sure the bucket is lowered to the ground, parking brake ON and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

WARNING! Always lock the frames together before working near the center of the machine. If the frames move, serious injury or death could result.

1. Disconnect the pitman arm (5, Fig. 5.1) from the steering gear (1).

NOTE: *Note the relative position of the bellcrank lever (9, Fig. 5.1) and pitman arm (5) so parts may be reassembled to the same relative position.*

2. Loosen the lock nut (13, Fig. 5.5) and turn the lash adjuster screw (8) a few turns counterclockwise to relieve the over center preload adjustment and provide clearance between the pitman shaft gear (7) and the worm ball nut (16).
3. Remove the cap from the steering wheel adjustment knob (4, Fig. 5.3) and remove it to gain access to the lock nut securing the wheel to the steering column shaft.
4. Turn steering wheel GENTLY in one direction to end of travel, then back one full turn.

IMPORTANT: *Do not turn steering wheel hard against "stops" when linkage is disconnected.*

5. Measure the worm bearing (14 and 24, Fig. 5.5) preload using a suitable socket and a torque wrench of not more than 5 Nm on the nut securing the steering wheel to the shaft. Rotate the torque wrench through a 90 degree arc. If the bearings are properly adjusted and the steering column bearings are free, the torque reading should be 0.17-0.62 Nm. Record the actual torque reading taken for later use when setting pitman shaft preload.
6. If the torque reading is within specification, the worm bearings do not require adjustment and the procedure for setting the pitman shaft preload should now be followed. If the torque reading is not within specification, continue as follows to obtain the correct worm bearing adjustment.

NOTE*: If "rough" or "lumpy" action was noted during the bearing check, the worm bearings are probably damaged and the steering gear should be removed, disassembled and examined.*

7. Loosen the adjuster lock nut (26, Fig. 5.5) and turn the worm bearing adjuster (25) clockwise until there is no perceptible end play in the worm.
8. Using a torque wrench of not more than 5 Nm and a suitable socket on the steering wheel nut, rotate the steering wheel through a 90 degree arc. At the same time, turn the bearing adjuster (25, Fig. 5.5) until a torque of 0.17-0.62 Nm is obtained at the steering wheel.
9. Tighten the adjuster lock nut (26, Fig. 5.5) to 95-136 Nm.
10. Recheck the worm bearing adjustment as described in step 8 to make sure it remained within specification after the lock nut is torqued. Record the actual torque reading taken for later use when setting the pitman shaft preload.

NOTE: *If the torque in step 8 is too high and cannot be adjusted downward, check the bearings in the steering column*.

11. After the worm bearing preload has been adjusted, proceed to "PITMAN SHAFT PRELOAD ADJUSTMENT".

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15. PITMAN SHAFT PRELOAD ADJUSTMENT

WARNING! Be sure the bucket is lowered to the ground,parking brake is ON and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

WARNING! Always lock the frames together before working near the center of the machine. If the frames move, serious injury or death could result.

NOTE: *Always check the worm bearing preload adjustment first, and adjust if necessary, before making the pitman shaft preload adjustment*.

IMPORTANT: *Do not turn steering wheel hard against "stops" when linkage is disconnected from pitman arm as damage to the gear may result.*

1. Center the steering gear by turning the steering wheel from extreme right to extreme left positions, counting the exact number of turns. Turn the wheel back exactly half way, to center position. Mark wheel at top or bottom center with a piece of tape.
2. Loosen the adjuster lock nut (13, Fig. 5.5) (it was done in step 13.2) and turn the adjuster screw (8) clockwise to remove all lash between the gear teeth. Torque the lock nut to 24-37 Nm.
3. Using a torque wrench of not more than 5 Nm and a suitable socket on the steering wheel nut, measure the greatest torque as the wheel is pulled through the center position. This torque should be 0.34-0.80 Nm greater than the worm bearing preload torque recorded under "WORM BEARING PRELOAD ADJUSTMENT" but not to exceed 1.24 Nm.
4. If torque is not within specified limits, loosen the lock nut (13, Fig. 5.5) and turn the adjuster screw (8) to obtain the proper adjustment. Torque the lock nut to 24-37 Nm.
5. After all adjustments have been completed, reconnect the pitman arm (5, Fig. 5.1) to the steering gear being sure the pitman arm and bellcrank lever (9) are in the same relative position they were in initially. Torque the nut (1, Fig. 5.5) to 165-220 Nm.
6. Install the steering wheel adjusting knob and cap.

16. REMOVAL (Refer to Fig. 5.6)

WARNING! Be sure the bucket is lowered to the ground, parking brake is ON and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

WARNING! Always lock the frames together before working near the center of the machine. If the frames move, serious injury or death could result.

1. Install the frame-locking bar.
2. Remove the cover from the side of the front frame to gain access to the steering gear (1).
3. Remove the nut and lock washer securing the pitman arm (4) to the steering gear (1).

NOTE: *Before removing the pitman arm, note the relative position of the pitman arm to the bellcrank lever (9, Fig. 5.1) so parts may be reassembled to the steering gear in the same position.*

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4. Remove the pitman arm from the steering gear and support it in the front frame to prevent damage to the linkage.

5. Loosen the hardware securing the steering gear shaft to the yoke (2).

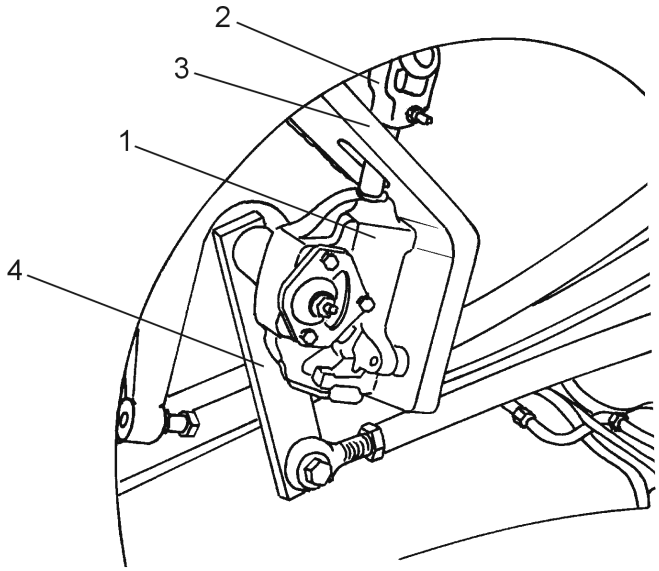


Fig. 5.6. Steering Gear Disconnect Points

1. Steering gear
2. Yoke
3. Mounting bracket
4. Pitman arm

6. Remove the hardware securing the steering gear to the mounting bracket (3). Using a soft hammer, tap on the steering gear until the shaft is free of the yoke (2). Remove the steering gear out the cover opening in the side of the front frame.

17. DISASSEMBLY (Refer to Fig. 5.7)

1. Place the steering gear in a vise, clampíng onto one of the mountíng pads. The wormshaft (15) should be in a horizontal position.

2. Rotate the wormshaft from stop to stop, counting the total number of turns. Then turn back exactly half way, placing the gear on center.

3. Remove the three bolts (12) attaching the side cover (11) to the housing (3). Drain oil from the steering gear.

4. Hit lightly on the threaded end of the pitman shaft (7) with a plastic hammer and lift the side cover and pitman shaft assembly from the gear housing.

NOTE: *If the pitman shaft gear does not clear the opening in the housing easily, turn the wormshaft by hand until the gear will pass through the opening in the housing.*

5. Loosen and remove the adjuster lock nut (26).

6. Remove the adjuster assembly (21) taking care not to drop the worm thrust bearing, if it comes out with the assembly.

7. Draw the wormshaft and ball nut assembly (15) from housing.

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MPORTANT: *Use care that the ball nut (16) does not run down to either end of the worm. Damage may be done to the ends of the ball guides (19) if the ball nut is allows to rotate until stopped at the end of the worm.*

8. Remove the remaining worm thrust bearing (14) from either the wormshaft or from inside the gear housing.
9. If necessary, use a suitable size screwdriver to pry the bearing retainer (22) from the bearing adjuster assembly (21) and remove the bearing (23).
10. Remove the locknut (13) from the lash adjuster screw (8) in the side cover (11). Remove the adjuster screw from the side cover by turning the screw clockwise. Slide the adjuster screw and the shim (9) out of the slot in the end of the pitman shaft (7).

NOTE: *The bushing inside the side cover (11) is not replaceable and should not be removed.*

11. Pry out and discard both the pitman shaft and wormshaft seals (5 and 6).
12. As a rule, disassembly of the wormshaft and ball nut assembly (15) will not be necessary if it is perfectly free with no indication of binding or tightness when rotated on the worm. However, if there is any indication of binding or tightness, the unit should be disassembled as follows:
    a. Remove the bolt (18) and the clamp (17) retaining the ball guides (19) in the ball nut (20). Draw the guides out of the ball nut.
    b. Turn the ball nut upside down and rotate the wormshaft back and forth until all the balls (20) have dropped out of the ball nut into a clean pan. With the balls removed, the ball nut can be pulled endwise off the worm.
13. Remove the bearing cup (4) from the housing (3) and the bearing cup (24) from the bearing adjuster (25).

18. INSPECTION AND REPAIR

1. Inspect the steel balls for flat spots, wear or other damage. Balls must be the same size within 0.003 mm. Inspect the holes and passages of the ball nut (16) for obstructions.
2. Examine the ball guides for distortion and bent fingers. Place both halves of each ball guide together and try the action of the balls.

19. REASSEMBLY

NOTE: *One of the most important phases of assembling the steering gear components is cleanliness. All parts must be kept clean. Any abrasive material remaining in the housing during assembly will quickly damage the mechanism. Grease and oil used during assembly must be free from dirt or other contaminants. Prelubricate all bearings and moving parts with "Lubriplate" or equivalent.*

1. Place the wormshaft (16, Fig. 5.7) horizontal on clean workbench. Place ball nut over worm with return guide holes in nut facing up. Align groove in worm and ball nut by sight (Fig. 5.8).
2. Count one-half of the total amount of balls (20, Fig. 5.7) into a clean container.

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STEERING

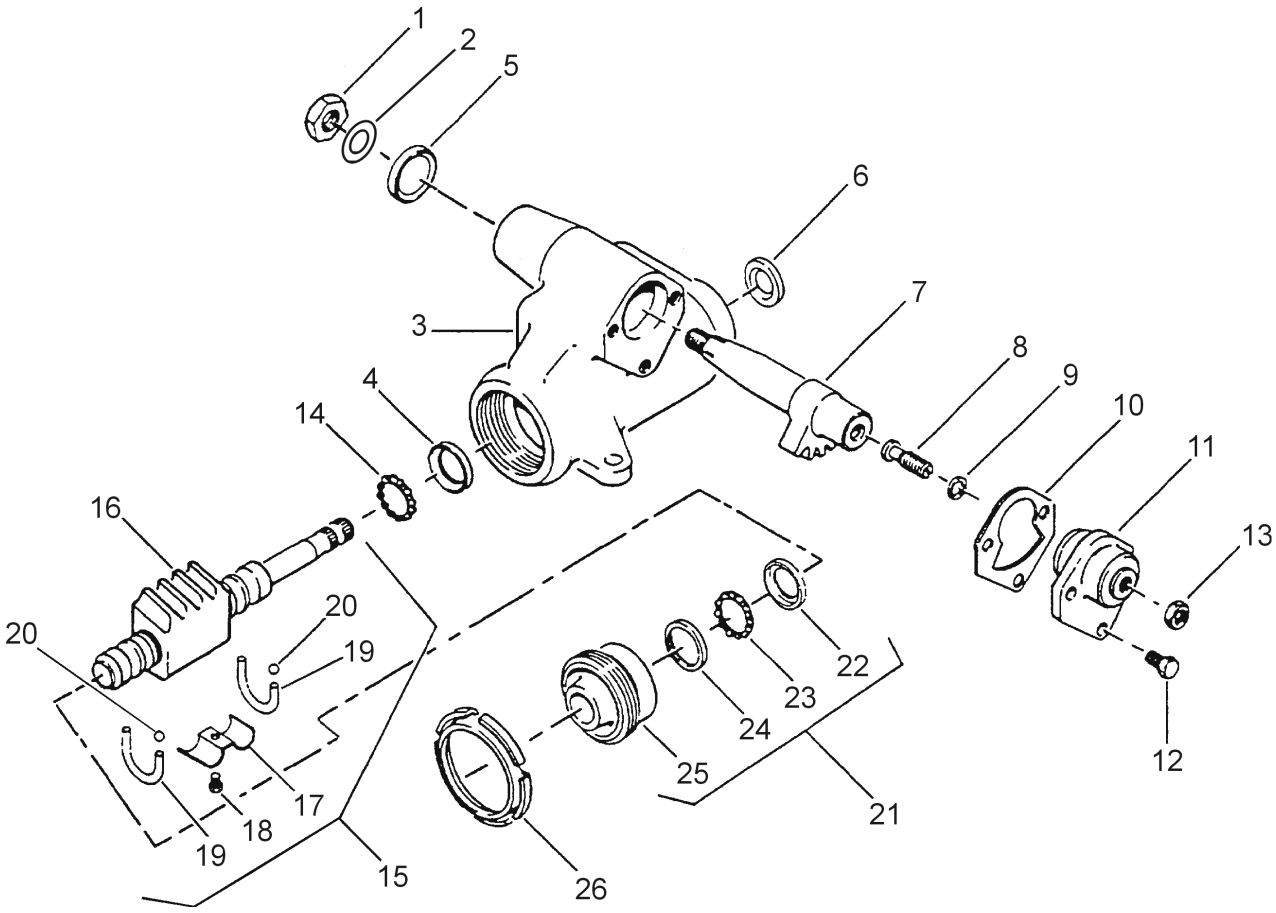


Fig. 5.7. Exploded View of Steering Gear

1. Nut
2. Lock Washer
3. Housing
4. Bearing Cup
5. Seal
6. Seal
7. Pitman Shaft Gear
8. Lash Adjuster Screw
9. Shim
10. Cover Gasket
11. Side Cover
12. Bolt
13. Lock Nut
14. Worm Thrust Bearing
15. Worm Shaft and Ball Nut Assy.
16. Ball Nut
17. Ball Return Guide Clamp
18. Bolt and Washer
19. Ball Return Guide
20. Steel Ball
21. Bearing Adjuster Assy
22. Bearing Retainer
23. Thrust Bearing
24. Worm Thrust Bearing Cup
25. Bearing Adjuster
26. Adjuster Lock Nut

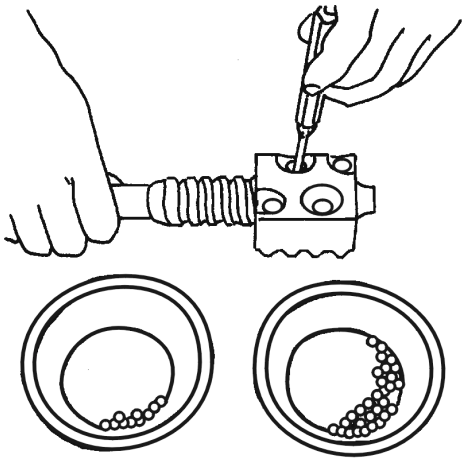


Fig. 5.8. Aligning Ball Nut to Worm Shaft

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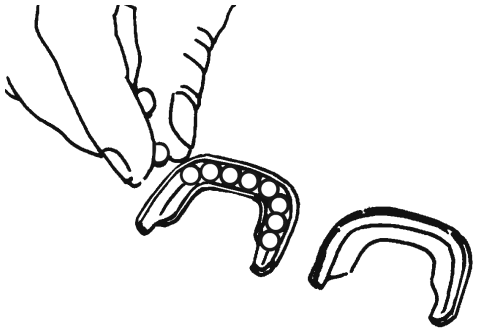


Fig. 5.9. Installing Balls in Guides

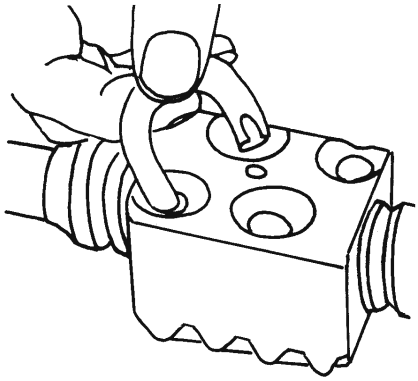


Fig. 5.10. Installing Ball Return Guides

3. Drop balls into one of the ball return guide holes. Slowly rotate worm away from that hole while inserting balls. Continue until circuit is filled from the bottom of one hole to the bottom of the other, or until stopped by reaching end of worm.

4. If balls are stopped by reaching end of worm hold down balls already installed with a rod or punch. Rotate shaft in a reverse direction a few turns. Filling of the circuit may then be continued. It may be necessary to work shaft back and forth holding balls down first in one hole and then in the other. This will close-up spaces between balls filling the circuit completely.

5. Lay one half of ball guide grove up, on bench. Place the remaining balls into the groove of the guide (19, Fig. 5.7). Cover assembly with opposite half of guide. Refer to (Fig. 5.9). Hold the two halves together and plug each end with vaseline to prevent balls from dropping out while installing guide.

6. Push ball return guide (19, Fig. 5.7) completely into holes in ball nut (Fig. 5.10). If guide does not push down all the way easily, hit it lightly into place with the wooden handle of a screw driver This completes one circuit of balls.

7. Fill remaining circuit with balls in same manner.

8. Install ball return guide clamp (17, Fig. 5.7) on ball nut with bolt and washer (18).

9. Be certain ball nut and balls are thoroughly lubricated. Test assembly by rotating ball nut on worm. Do not rotate ball nut to end of worm threads. Assembly must move freely. Temporarily tape shaft at both ends of ball nut until ready to install assembly in housing.

10. Install new seals (5 and 6, Fig. 5.7) into the housing (3). Seals should be pressed in flush with the housing face. Avoid damaging the outer lip of the seal. Lubricate the I.D. of both seals thoroughly.

11. If removed, install the bearing cup (4, Fig. 5.7)) into the housing (3) and the bearing cup (24) into the bearing adjuster (25).

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12. Remove the tape from the side of the ball nut nearest the splined end of the worm shaft. Install the worm thrust bearing (14, Fig. 5.7) onto the wormshaft.

13. Grasp the worm shaft on both sides of the ball nut to prevent the nut from running to the extreme ends of the shaft. Insert the worm shaft into the gear housing and guide the shaft carefully through the bearing cup (4, Fig. 5.7) and the seal (6).

14. Place the thrust bearing (23, Fig. 5.7) in the adjuster bearing cup (25) and press the retainer (22) into place with a suitable socket. Make sure that the bearing is free to rotate after assembling the retainer.

15. Apply a lithium base grease to the adjuster threads and install the adjuster (25, Fig. 5.7) and locknut (26) into the lower end of the housing (being careful to guide the end of the wormshaft into the bearing) until nearly all end play has been removed from the wormshaft.

16. Place the original shim (9, Fig. 5.7) on the lash adjuster (8). Insert the adjuster and shim into the slotted end of the pitman shaft (7).

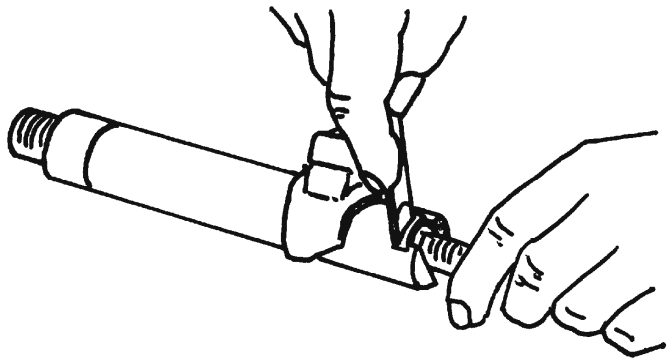


Fig. 5.11. Checking Clearance

17. Check the clearance between the screw head and the pitman shaft (Fig. 5.11). Clearance must not exceed 0.05 mm. If the clearance is greater, select the thicker shim. Four sizes are available.

18. Rotate the wormshaft until the ball nut (16, Fig. 5.7) is in the center of travel. This is to make sure that the pitman shaft gear (7) and the ball nut will engage properly, with the center tooth of the gear entering the center tooth space in the ball nut.

19. Tape the spline on the end of the pitman shaft to prevent seal damage, then insert the pitman shaft assembly, with preload adjuster screw and shim, into the housing so that the center tooth of the gear enters the center tooth space in the ball nut.

20. Place the side cover gasket (10, Fig. 5.7) on the housing.

21. Install the side cover (11, Fig. 5.7) onto the pitman shaft by reaching through the side cover lash adjuster hole with a screw driver and turning the adjuster screw counterclockwise until the screw bottoms; back the screw off one-half turn. Loosely install a new locknut (13) onto the adjuster screw.

22. Install and tighten the side cover bolts (12, Fig. 5.7) to 34-47 Nm.

23. Fill the steering gear with lubricant as specified in the OPERATOR'S MANUAL.

NOTE: *Bolt hole (12) is used for refilling the steering gear.*

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20. INSTALLATION (Refer to Fig. 5.6)

1. Align the splines of the steering gear shaft and yoke (2) as the assembly is positioned on the mounting bracket (3). Secure the assembly to the mounting bracket. Tighten the yoke mounting hardware.
2. Adjust the steering gear as described under "WORM BEARING PRELOAD ADJUSTMENT" and "PITMAN SHAFT PRELOAD ADJUSTMENT".
3. After all adjustments are completed, be sure that the pitman arm (5, Fig. 5.1) and bellcrank lever (9) are installed in their initial relative positions and that the pitman arm nut, lash adjuster screw lock nut and bearing adjuster lock nut are all properly torqued.
4. Install the cover to the side of the front frame.
5. Remove the frame-locking bar.
6. Check the steering system action.

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COOLING

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COOLING

SECTION 6

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GENERAL

1. DESCRIPTION

This machine has three cooling systems. First of them is a steering oil cooling system, the second is an engine cooling, the third is a transmission oil cooling system. Each system is equipped with separate radiator, which is mounted on rear part of the machine.

Steering Oil Cooling System

Mounted to the rear of the radiator (1) is an air-to-oil cooler type (28, Fig. 6.3) which provides cooling the steering hydraulic system. The oil is forced through the cooler by the hydraulic system of pumps. Air flow through the cooler is provided by the driven blower fan.

Engine Cooling System

The used cooling system is a pressure, closed-type system that permits to operate at extreme angles without loss of coolant through the overflow tube and also permits to operate at higher engine temperature without boiling. The radiator (core type) top tank (2, Fig. 6.6) is divided into two sections by a solid and sealed baffle plate. Connected to the top section are the aeration hose (20, Fig. 6.3) and make-up tube (7, Fig. 6.6). Connected to the lower section are circulation tubes (6,9, Fig. 6.3). The opposite end of the aeration hose and circulation tubes are connected to the thermostats housing. The opposite end of the make-up tube is connected to the radiator bottom tank (15, Fig. 6.6). The pressure / vacuum relief valve, which is an integral part of the radiator cap (1, Fig. 6.6), allows excess air and vapour to escape through an overflow tube at a pressure of 45 - 55 kPa. This valve also protects hoses from collapsing by permitting atmospheric air to enter the system if the pressure drops to 0 - 5,5 kPa. Air flow through the radiator is provided by the engine driven blower fan.

Detailed information of cooling system components, located on engine, can be found in Shop Manual K19 Series Engines, Bulletin No. 3810263-00 and Troubleshooting and Repair Manual K19 Engines, Bulletin 3810307-00.

Machines powered by the Q19 engines have an additional fuel cooler (2, Fig. 6.5) mounted to the front of radiator. The heated fuel from the return line of engine is directed to the cooler. Fuel temperature is reduced by flowing through the cooler core where the heat is dissipated by the core fins and the air flow from engine driven blower fan. Then fuel flows to the fuel tank.

Detailed information of cooling and system components located on engine can be found in Troubleshooting and Repair Manual QSK19 Series Engines, Bulletin 3666098-00.

Transmission Oil Cooling System

Mounted to the rear frame on the left side is the third oil cooler (26, Fig. 6.3) which provides cooling for the torque converter oil. The oil is forced through the cooler by the system charging pump and is cooled by the coolant being circulated by the engine coolant pump.

2. OPERATION

Steering Oil Cooling System

A double pump (hydraulic and steering) mounted on the torque converter is charging the oil to the steering system. Then oil used for loader / steering system is directed to oil cooler (28, Fig. 6.3). The heat is dissipated by air flow from engine driven fan. Oil is then directed to oil reservoir and again to loader / steering system.

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COOLING SYSTEM

GENERAL

Engine Cooling System

A gear drive centrifugal water pump, mounted on the right side of engine, circulates the coolant from radiator lower tank (15, Fig. 6.6) to the engine oil cooler which is build-in the engine. Past oil cooler coolant flows to engine crankcase, cylinder heads and to housing of thermostats.

When the coolant is cold, thermostats are closed, preventing circulation of low temperature coolant through radiator core. The coolant circulates only through the water pump, engine oil cooler and engine water passages.

When the coolant reaches the temperature of the thermostats lowest operating range, the thermostats begin to open and heated coolant is directed through thermostat housing to radiator top tank (2, Fig. 6.6). The heated coolant temperature is reduced by flowing down through the radiator core where the heat is dissipated by the radiator core fins and the air flow from engine driven blower fan. Coolant from the radiator bottom tank (15, Fig. 6.6) is taken back by water pump.

Transmission Oil Cooling System

Oil used for transmission, torque converter and lube of transmission and service brakes is directed to oil cooler (26, Fig. 6.3). The heat is dissipated by coolant flow from radiator to engine coolant pump.

3. SPECIFICATIONS

Steering Oil Cooler (Two types intermountable)

Tube type . . . . . round / oval
Tube material . . . . . steel / aluminum
Fin type . . . . . flat / serpentine ruffled
Oil flow at 2100 RPM . . . . . .180 l/min
Oil pressure . . . . . 515 - 655 kPa
Test pressure . . . . . .1370 kPa at 20°C

Engine Cooling System

Capacity . . . . . .102 l
Water pump type . . . . . Centrifugal
Flow at 2100 RPM . . . . . 757 l/min
Standard thermostat range . . . . . 80 to 90°C
Maximum allowable top tank temperature . . . . . 95°C
Minimum recommended top tank temperature . . . . . 70°C
Minimum coolant block pressure (at water manifold, with pressure cap removed) . . . . . 90 kPa
Maximum coolant block pressure (at water manifold, with pressure cap removed) . . . . . 241 kPa

Engine radiator:

Type . . . . . Fins and flat tubes
Core . . . . . Replaceable
Radiator cap opening pressures:
Pressure relief . . . . . 45 - 55 kPa
Vacuum relief . . . . . 0 - 5.5 kPa
Test pressure . . . . . 125 kPa

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GENERAL

Fuel cooler

Type . . . . . Fins and tubes

Transmission Oil Cooler

Oil flow. . . . . 136 l/min
Water flow . . . . . 757 l/min
Max entering water temperature . . . . . 90°C
Max entering oil temperature . . . . . 120°C
Max operation oil pressure . . . . . 1720 kPa
Flow directions . . . . . countrary

4. SERVICE DIAGNOSIS

Steering Oil Cooling System

COMPLAINT	
PROBABLE CAUSE	REMARKS
Overheating Due to Restricted Air Flow	
1. Clogged oil cooler.	Clean oil cooler.
2. Clogged engine radiator.	Clean radiator.
3. Internal clogged oil cooler.	Change oil cooler.

Engine cooling system

Overheating Due to Restricted Air Flow	
1. Bent fan blades.	Straighten and correct pitch of fan blades.
2. Trash between radiator fins.	Clean out thoroughly between radiator fins. Use compressed air.
3. Bent radiator fins.	Straighten bent fins.
4. Loose fan drive belt.	Check belt tension.
Overheating Due to Poor Circulation	
1. Low coolant level.	Fill cooling system to proper level.
2. Restriction in radiator core.	Drain system. Disconnect hoses and reverse flush the radiator. Disassemble the radiator and rod out the core tubes.
3. Radiator cap loose and coolant pressure escaping.	Tighten.
4. Faulty thermostat.	Check thermostats for operation. Replace if faulty. (Refer to Troubleshooting and Repair Manual K19 Engines).
5. Water pump defective.	Remove pump and recondition.(Refer to Troubleshooting and Repair Manual K19 Engines).
Overheating Due to Internal Leakage	
1. Warped cylinder head.	Replace cylinder head and gasket. Torque head bolts as specified in the Shop Manual K19 Series Engines.
2. Cylinder head bolts not properly torqued.	Torque head bolts. Refer to probable cause 1.

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COOLING SYSTEM

GENERAL

Overheating Due to External Leakage	
1. Defective hoses or connections	Replace defective hoses. Check clamps for fatigue and replace as required.
2. Radiator leaks	Remove the radiator. Repair or replace as necessary.
3. Radiator core seams broken	Remove radiator. Test for leaks and solder. Replace if necessary.
4. Damaged gaskets.	Check for leaks around water pump, water outlet header or outlet elbow and cylinder head. Replace defective gaskets.
5. Worn inner water pump parts.	Remove pump and inspect sealing parts. Replace where necessary, or replace pump. (Refer to Troubleshooting and Repair Manual K19 Engines).
6. Cracked or warped cylinder head.	Replace cylinder head and gasket. Torque head bolts as specified in Shop Manual K19 Series Engines.
7. Cracked crankcase.	Replace crankcase (refer to Shop Manual K19 Series Engines).
Engine Runs Cold	
1. Coolant temperature gauge or sensor faulty.	Replace sensor or temperature gauge.
2. Extremely cold weather.	Cover radiator.
3. Thermostat inoperative.	Replace.

Transmission Cooling System

Transmission Oil Overheating	
1. Operating too long in low efficiency ranges.	Review operating instructions in the Operator's Manual.
2. Clogged oil cooler.	Clean oil cooler.
3. Temperature gauge or sensors faulty.	Replace sensors or temperature gauge.
4. Torque converter problem	Refer to Section 7.
5. Transmission problem	Refer to Section 7B.

STEERING OIL COOLER

5. REMOVAL (Refer to Fig. 6.1 Fig 6.2)

WARNING! Turn master switch in "OFF" position and take key out to prevent accidental starting.

1. Drain the hydraulic reservoir as described in the Operator's Manual.

NOTE: *Depending on the work to be done, it may be desirable to remove the relief valve from the top of the hydraulic reservoir and attach a vacuum pump rather than drain the system. This pump must be in operation just prior to disconnecting the steering oil cooler tubes and until the tubes are plugged.*

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STEERING OIL COOLER

2. Remove the hardware securing the back up alarm (1) to the grille. Disconnect the wiring and remove the alarm.
3. Remove the grille (2).
4. Remove the hardware securing the light panel (3) to the rear shield (4). Disconnect the wiring at the lights and remove the light panel with lights from the machine.
5. Free the electrical harness tie strip from the oil cooler hydraulic tubes.
6. Remove the hardware securing the rear shield (4) to rear frame. Lift the rear shield off the machine.
7. Disconnect the hydraulic tubes (7) off the oil cooler (8).

***IMPORTANT**: Disconnected hydraulic 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 machine.*

8. Attach a hoist to the oil cooler lifting eye (5). Remove the hardware (6) securing the oil cooler to the radiator and frame. Lift the oil cooler (8) off the machine.

NOTE: *Steering oil cooler is an integral, indisassemble assy, and in case of damage or fault work, it shall be replaced by new one.*

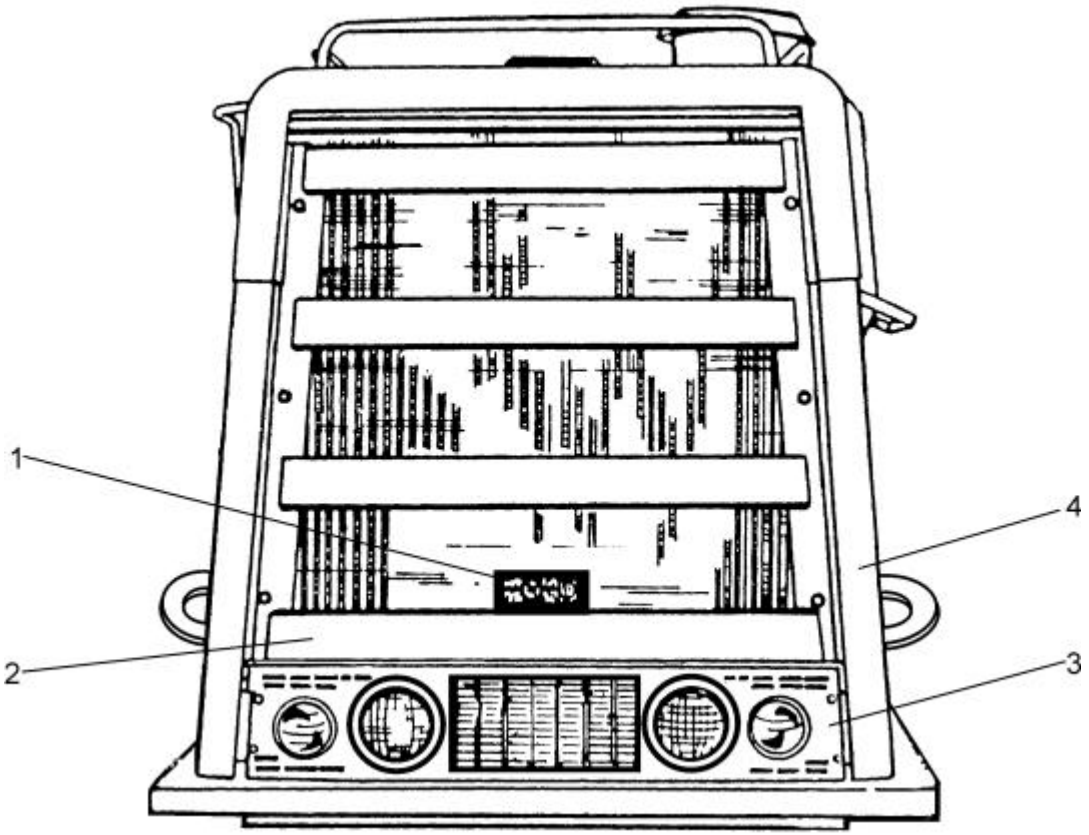


Fig. 6.1. Rear Covers Disassembly

1. Back-Up Alarm
2. Grille
3. Light Panel
4. Rear Shield

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COOLING SYSTEM

STEERING OIL COOLER

6. INSTALLATION

Special Torques:

Rear shield mounting bolts . . . . . 217 Nm

1. Reverse the procedure outlined under "REMOVAL".

NOTE: *Check that the insulator strips (3, Fig. 6.3) are in the place between the radiator and steering oil cooler and adhere properly. Replace on newone if necessary*

2. Fill the hydraulic reservoir (Refer to the Operator's Manual for the correct procedure).

3. Start engine and check steering oil cooler connections for leaks.

NOTE: *If a vacuum pump was used, it must be started before unplugging the hydraulic tubes. Disconnect the vacuum pump and install the relief valve once the tubes are connected to the oil cooler.*

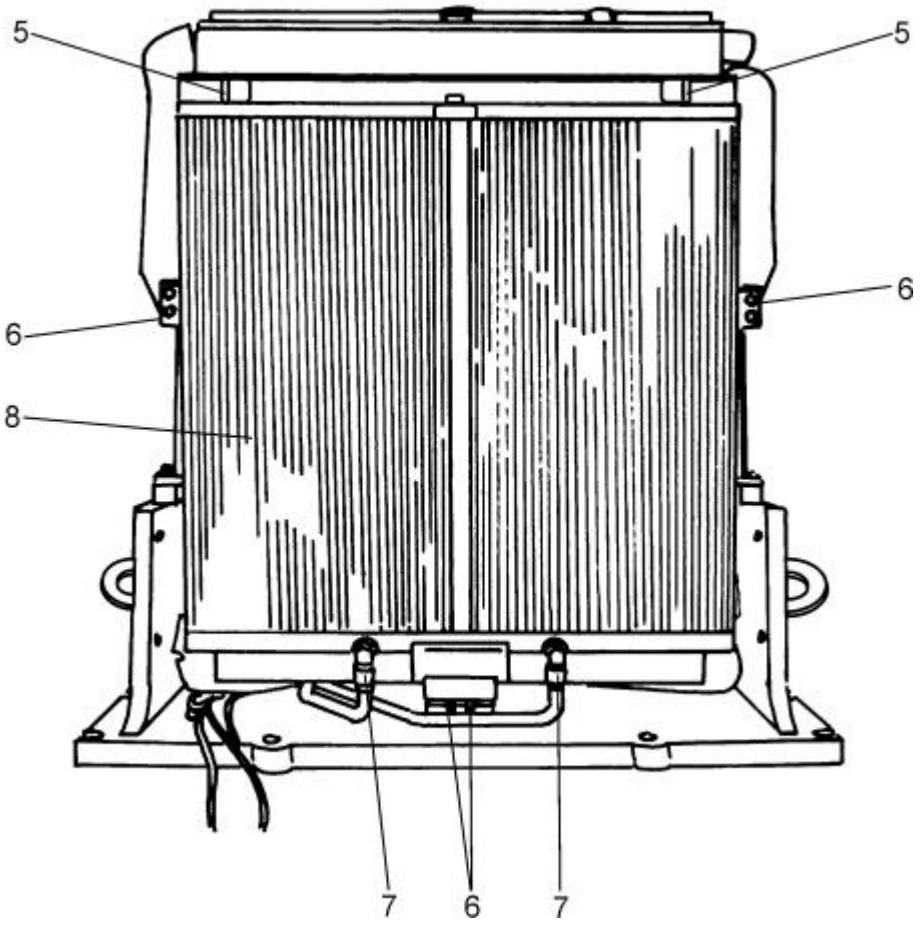


Fig. 6.2. Steering Oil Cooler Disconnecting Points

5. Lifting Eye.
6. Hardware Points
7. Hydraulic Tubes
8. Steering Oil Cooler

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RADIATOR

7. REMOVAL (Refer to Fig. 6.3 and 6.4)

WARNING! Turn master switch in "OFF" position and take key out to prevent accidental starting.

1. Drain the cooling system (Refer to the Operator's Manual for the correct procedure).
2. Remove the steering oil cooler as described under "STEERING OIL COOLER" in this section.
3. Loosen the clamp (8) and disassemble circulation tubes (6 and 9) .

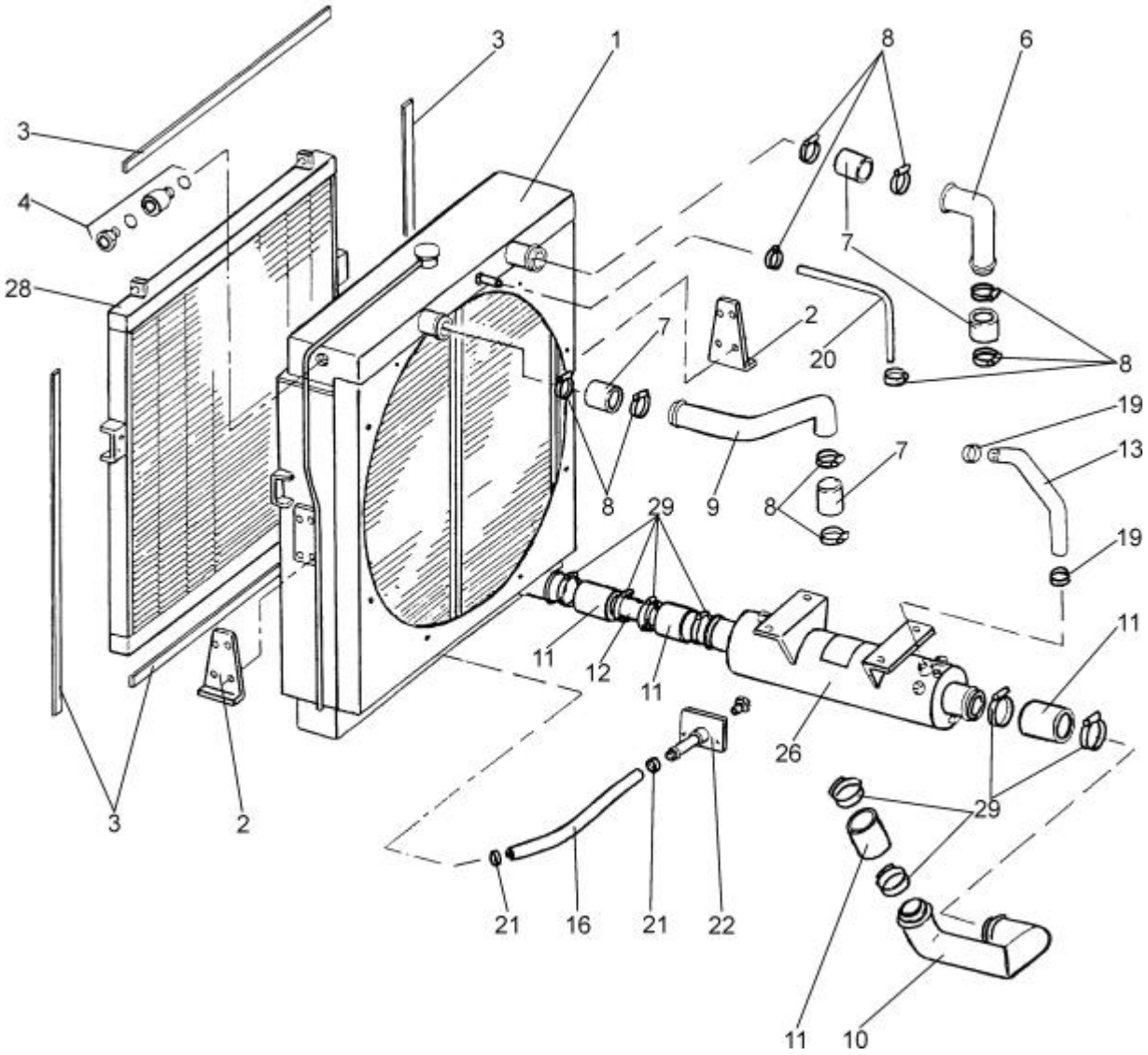


Fig. 6.3. Radiators Assy Connections

1. Radiator
2. Mounting Bracket
3. Insulator Strips
4. Gauge, Coolant Level
6. Circulation Tube
7. Hose
8. Clamp
9. Circulation Tube
10. Radiator Tube
11. Hose
12. Tube
13. Hose, Vent
16. Drain Hose
19. Clamp
20. Vent Hose
21. Clamp
22. Drain Pipe
26. Transmission Oil Cooler
28. Steering Oil Cooler
29. Clamp

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RADIATOR

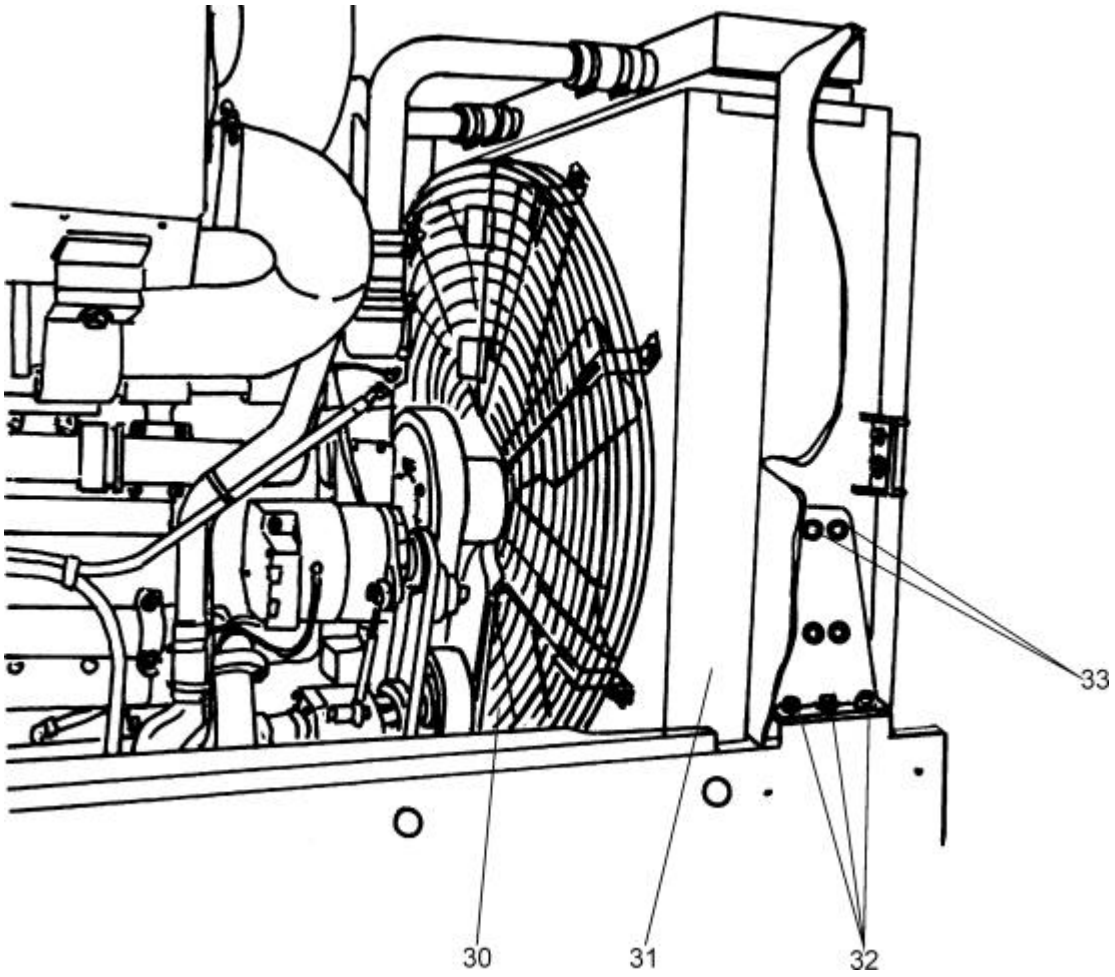


Fig. 6.4. Disassembly Points

30. Fan Guard
31. Radiator Shroud
32. Mounting Bolts
33. Mounting Bolts

4. Disconnect the aeration hose (20) at the radiator.
5. Loosen the hose clamps (29) securing the outlet tube (integral part of radiator bottom tank) to the connecting hoses (11) of the transmission oil cooler (26).
6. Loosen clamps (21), disconnect the drain hose (16) off the drain pipe (22) and free to drain hose to allow the hose to come off with the radiator (1).
7. MACHINES WITH Q19 ENGINES: Disconnect the fuel hoses off the tubes (5 and 6, Fig. 6.5). Remove tubes from the clips.

***IMPORTANT**: Disconnected fuel 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 engine fuel system.*

8. Remove the hardware securing the both halves of the fan guard (30) to the shroud (31). Secure the guard to the handles on the center hood.

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RADIATOR

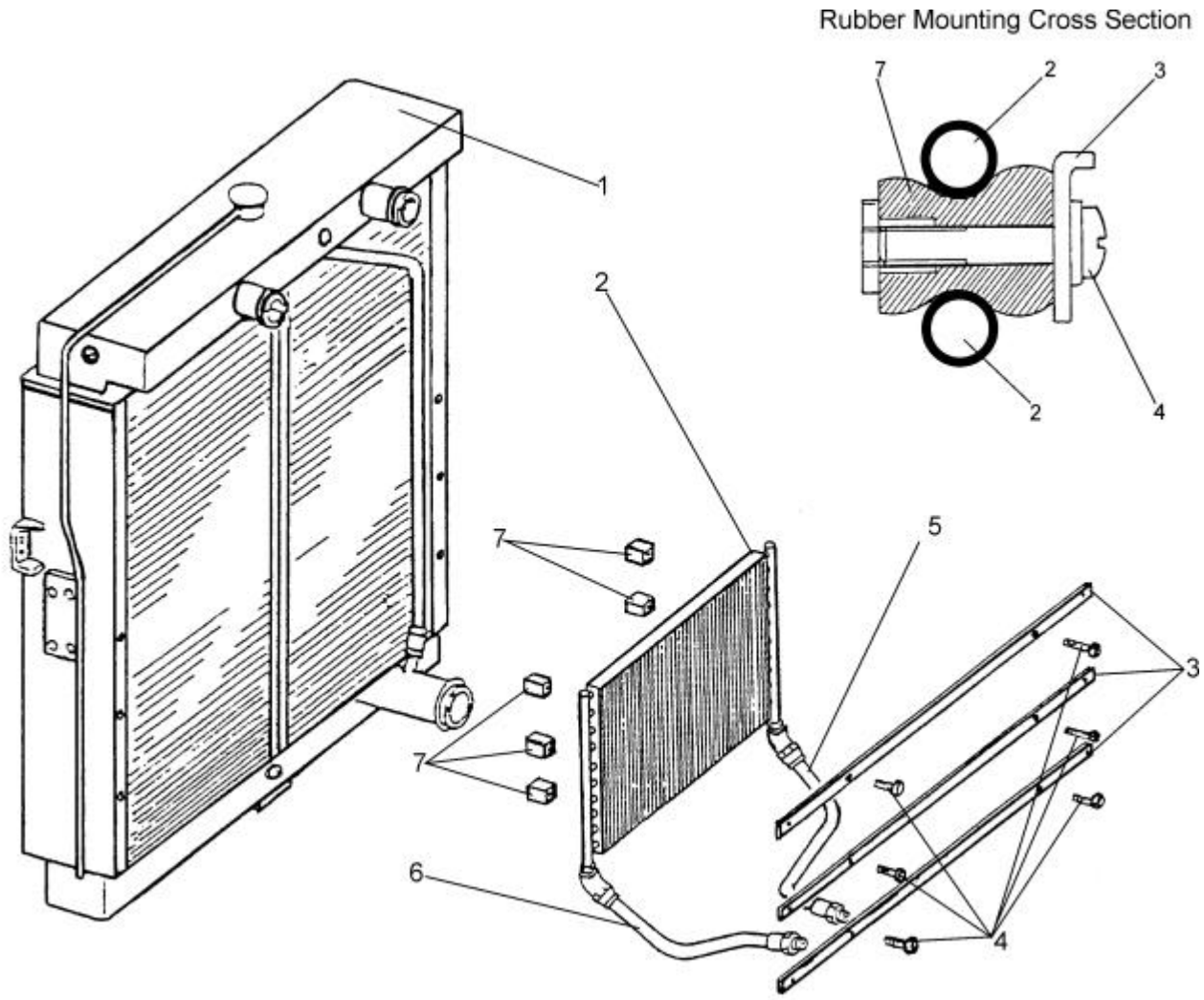


Fig. 6.5. Fuel Cooler Mounting

1. Radiator
2. Fuel Cooler
3. Mounting Bars
4. Bolts
5. Fuel Tube
6. Fuel Tube
7. Rubber Mounting

9. MACHINES EQUIPPED WITH LOW COOLANT LEVEL ATTACHMENT: Disconnect the electrical wiring from the two low coolant level probes in the radiator upper tank.
10. Remove two upper bolts (33) securing the bracket (2) to the radiator, and install two 1/2-13 eye bolts on each side.
11. Install the lifting attachment to eye bolts. Remove mounting bolts (32) securing bracket (2) to the rear frame.
12. Secure radiator (1) in vertical position and lift off the frame.

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COOLING SYSTEM

RADIATOR

8. DISASSEMBLY (Refer to Fig. 6.6)

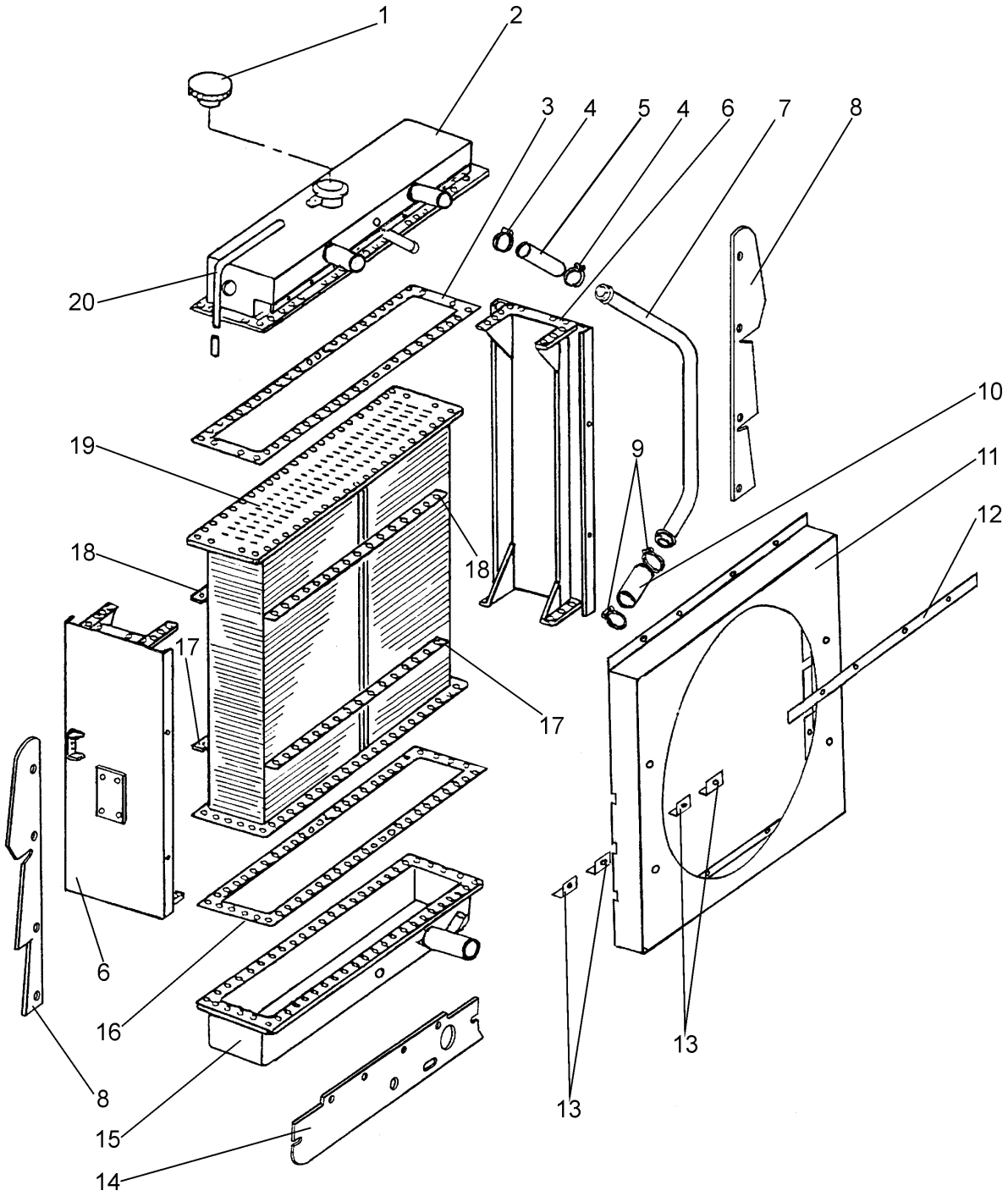


Fig. 6.6. Radiator Exploded View

1. Radiator cap
2. Top tank
3. Gasket
4. Clamp
5. Hose
6. Side Channel
7. Make-up Tube
8. Rubber Strip
9. Clamp
10. Hose
11. Shroud
12. Bar
13. Clip Shroud Mounting
14. Rubber Strip
15. Bottom Tank
16. Gasket
17. Core Bar
18. Core Bar
19. Radiator Core
20. Overflow Hose

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RADIATOR

1. Remove the bar (12) radiator shroud (11) and rubber strips (8 and 14).
2. MACHINES WITH Q19 ENGINES: Disassemble the fuel tubes (5 and 6) off the fuel cooler (2, Fig. 6.5). Disassemble bolts securing mounting bars (3) to the radiator (1, Fig. 6.5) and take fuel cooler off.

NOTE: *Fuel oil cooler is an integral, indisassemble assy, and in case of damage or faulty work, it shall be replaced by new one*.

3. Loosen clamps (4 and 9), remove hose (5 and 10)) and make-up tube (7).
4. Remove overflow hose (20)
5. Remove the top tank (2) and core bars (18). Discard the gasket (3).
5. Remove the bottom tank (15) clips shroud mounting (13) and core bars (17). Discard the gasket (16).
6. Remove the left and right side channels (6) .

9. INSPECTION AND REPAIR

1. Flush out the upper water tank thoroughly with water. Clean all radiator parts with steam cleaning equipment.

2. Flush out the core with water under pressure, both inside and outside. Inspect the core fins and tubes for damage. If possible, straighten bent fins to avoid air flow restrictions.

3. If the pressure relief valve is faulty or damaged, replace the radiator cap. Do not attempt to repair or replace any of the regulating valve parts. Be sure the overflow tube is not restricted.

4. Completely scrape all gasket flanges to remove used gasket.

10. REASSEMBLY AND INSTALLATION

1. Reverse the procedure outlined under "DISASSEMBLY" and "REMOVAL".

NOTE*: Check that the insulator strips (3, Fig. 6.3) are in the place between the radiator and oil cooler and adhere properly.*

NOTE*: Elongated holes are provided in the radiator shroud and fan guard shroud to establish equal clearance at all the fan blades.*

2. Refill cooling system as described in the Operator's Manual.
3. Start engine and check for leaks. After engine is up to operating temperatures, check coolant level.

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TRANSMISSION OIL COOLER

11. REMOVAL (Refer to Fig. 6. 7)

WARNING! Turn master switch in "OFF" position and take key out to prevent accidental starting.

1. Drain the cooling system (Refer to the Operator's Manual for the correct procedure).
2. Open and secure the left-hand access door.
3. Disconnect the wires from the oil temperature switch (1) and oil temperature sensor (2).
4. Disconnect the vent hose (3) at the oil cooler.
5. Disconnect the torque converter hose (4) (inlet) and transmission hose (5) (outlet) off the oil cooler. Tie these hoses up out of the way.

***IMPORTANT**: Disconnected hydraulic and cooling 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 machine.*

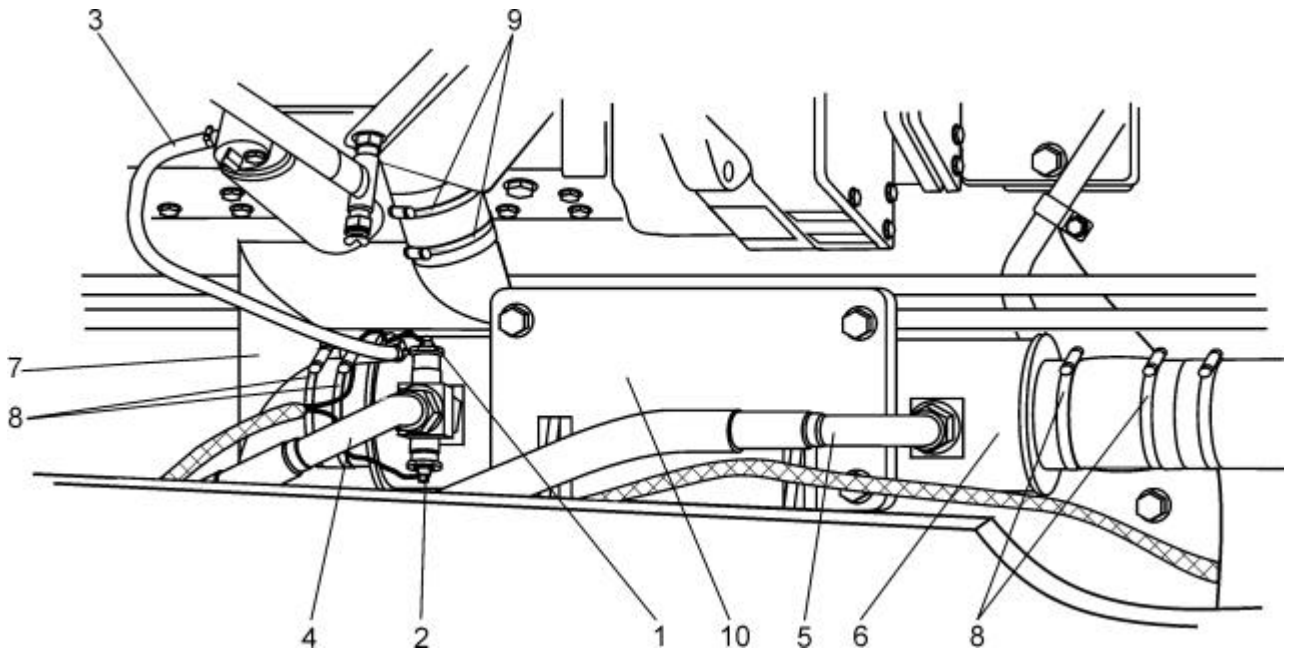


Fig. 6.7. Transmission Oil Cooler Disconnecting Points (Top View)

1. Oil Temperature Switch
2. Oil Temperature Sensor
3. Vent Hose
4. Inlet Hose
5. Outlet Hose
6. Oil Cooler
7. Outlet Elbow
8. Clamps
9. Clamps
10. Bracket

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TRANSMISSION OIL COOLER

6. Loosen the clamps hose (8).
7. Loosen the clamps (9) securing the outlet elbow (7) to the engine to provide movement of the outlet elbow (7).
8. Remove the hardware securing the oil cooler to the mounting bracket (10). Remove the hardware securing the mounting bracket to the rear frame and remove it.
9. Pry the outlet elbow (7) from the oil cooler. Free the oil cooler from the radiator and remove it from the machine.

NOTE: *Transmission oil cooler is an integral, indisassemble assy, and in case of damage or faulty work, it shall be replaced by new one*.

12. INSTALLATION

1. Reverse the procedure outlined under "REMOVAL".
2. Fill the cooling system (Refer to the Operator's Manual for the correct procedure).
3. Start engine and check all transmission oil cooler connections for leaks.
   Check transmission oil level (Refer to Operator's Manual)

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DRIVE TRAIN

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DRIVE TRAIN

SECTION 7

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1. DESCRIPTION

Power from the engine is transmitted through a flywheel to the torque converter and then is carried by a drive shaft to the transmission. The transmission transmit this power through two drive shafts to the front and rear axles.

This machine is equipped with a single stage, single phase torque converter and with a power shift transmission allowing the machine to operate in three speeds forward and three speeds in reverse.

2. HYDRAULIC OIL FLOW (Ref. to Fig. 7.1)

The hydraulic oil flow through the transmission and torque converter is managed by a cascading system of pressures. There is main oil which operates at 1240 - 1450 kPa, converter pressure oil operating at 415 - 550 kPa and lube pressure at 70 - 345 kPa. Priorities are established according to the pressure requirements of each component. When main pressure requirements are met, oil spills over-cascades-into the converter circuit. Excess from the converter cascades into the lube circuit.

The transmission sump is the source of supply for the oil in the transmission/torque converter system. A positive displacement, single element gear type hydraulic pump supplies the flow in the circuit. This charging pump is mounted on the torque converter and operating whenever the engine is running.

MAIN PRESSURE OIL: Oil in the transmission sump flows through filter (15) to the charging pump (5). The strainer has an integral by-pass valve which opens at a 17.5 kPa pressure differential. The check valve is used to keep the pump primed by preventing oil from draining back into the sump when the engine is not running.

Oil from the pump is directed through the pressure filters (6). Each of the filters is equipped with a by-pass valve which opens at 210 kPa pressure differential.

Oil from the filters is directed to the lover section of the transmission control valve. Some of the oil is directed through two internal passages to the range and directional spools in the upper section. The remainder of the oil flows through the main pressure relief cartridge (20) to the converter circuit.Oil to the direction section must first flow around the hydraulic operated transmission disconnect spool (22).

When the directional spool (27) is in the neutral position, the main oil pressure is blocked at this point. If the spool is in the forward or reverse position, main pressure oil is directed to engage the forward (9) or reverse (10) clutch pack. Oil at the range spool (26) is directed to engage the first (11), second (13) or third (12) clutch pack.

CONVERTER PRESSURE OIL: When the main pressure oil requirements are met, pressure will build to 1240 - 1450 kPa in the circuit and crack open the main pressure relief cartridge (20) to allow pump flow to enter the converter circuit. For oil flow through the torque converter (1), refer to Section 7B. Some oil will collect at the bottom of the flywheel housing where a gravity drain line (14) will return it to the sump. A breather line from the top of the torque converter connects to the breather (7) on the transmission housing.

Oil on the output side of the torque converter is directed to the oil cooler and then on to the lower section of the transmission control valve where it becomes part of the lubrication circuit.

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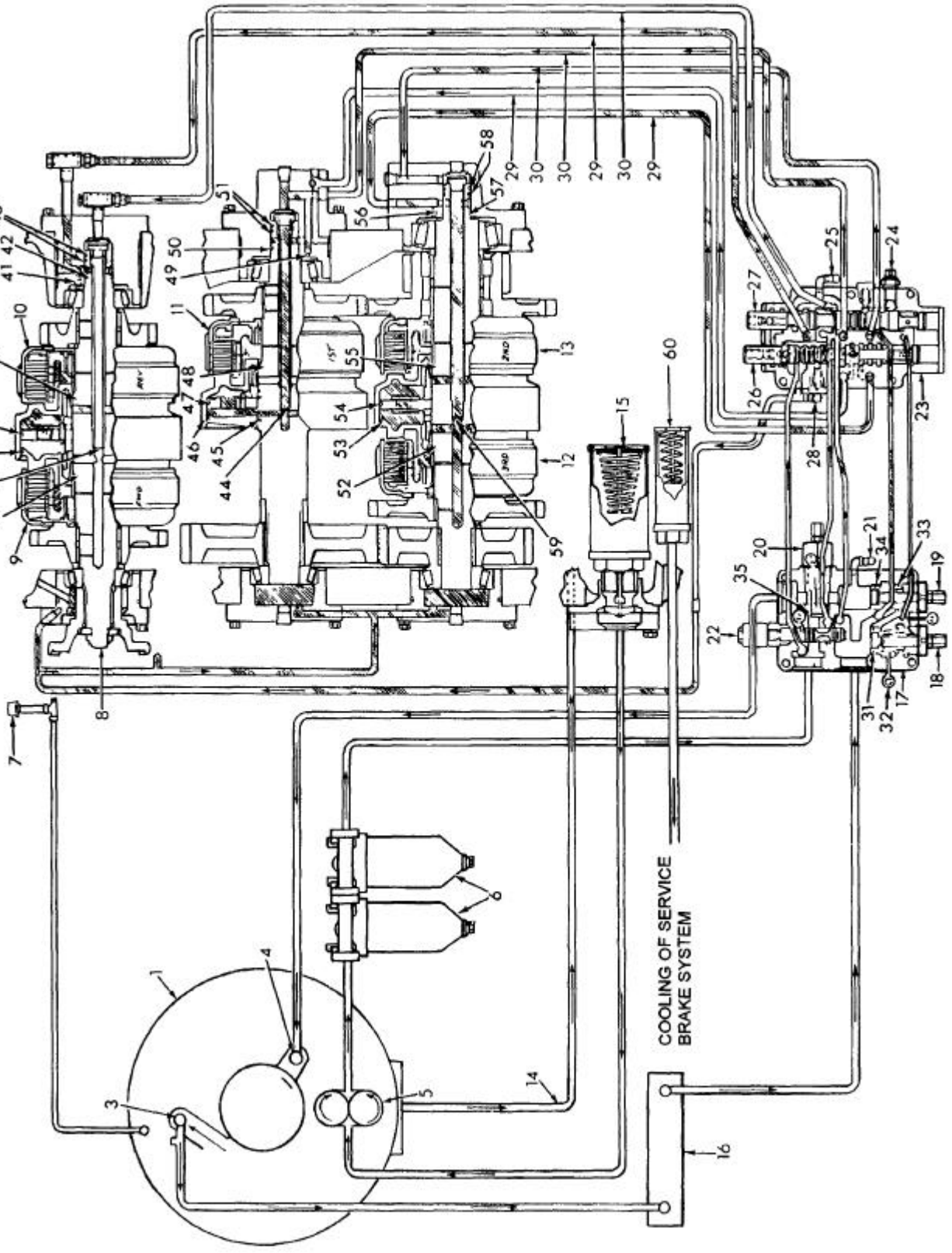


Fig. 7.1. Hydraulic Oil Flow

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Legend for Fig. 7.1.

1. Torque Converter.
3. Converter Out Port
4. Converter In Port
5. Charging Pump
6. Pressure Filters
7. Breather
8. Forward/Reverse Clutch
9. Forward Clutch Pack
10. Reverse Clutch Pack
11. First Clutch Pack
12. Third Clutch Pack
13. Second Clutch Pack
14. Drain Line
15. Transmission Sump Strainer
16. Oil Cooler
17. Control Valve
18. Lube Pressure Cartridge
19. Converter Pressure Cartridge
20. Main Pressure Cartridge
21. Converter Check Point
22. Transmission Disconnect Spool
23. Control Valve - Upper Portion
24. Neutral Safety Switch
25. Lube Check Point
26. Range Spool
27. Directional Spool
28. Main Check Point
29. Pressure Apply Oil
30. Lube Oil
31. O-Ring
32. Drain Port
33. O-Ring
34. O-Ring
35. O-Ring
36. O-Ring
37. Shaft Tube
38. O-Ring
39. O-Ring
40. O-Ring
41. Orifice Plug
42. O-Ring
43. O-Ring
44. Shaft Tube
45. O-Ring
46. O-Ring
47. O-Ring
48. O-Ring
49. Orifice Plug
50. O-Ring
51. Seal Ring
52. O-Ring
53. O-Ring
54. O-Ring
55. O-Ring
56. Orifice Plug
57. O-Ring
58. O-Ring
59. Shaft Tube
60. Service Brake Strainer

LUBE PRESSURE OIL: When the converter circuit pressures have been satisfied, pressure will build to 415 - 550 kPa in the circuit and crack open the converter pressure relief cartridge (19) to allow oil to enter the lubrication circuit, where it joins the flow from the oil cooler.

Lube pressure oil flows through internal passages to the upper section of the transmission control valve where it is directed to lubricate all disengaged clutch packs.

When the lube circuit is satisfied, pressure will build to 70 - 345 kPa and crack open the lube pressure relief cartridge (18), allowing excessive pressure oil return to the transmission sump.

3. SPECIFICATIONS

Transmission type . . . . . .Countershaft, constant mesh
Torque converter type . . . . . Single stage, single phase

Pressure oil filters:

Type . . . . . Two remote mounted, replaceable element
By-pass . . . . . Opens at 210 kPa pressure differential

Oil sump:

Type . . . . . Internal (in transmission)
By-pass . . . . . Opens at 17.5 kPa pressure differential
Oil cooler . . . . . .Remote mounted, oil-to-water type heat exchanger
Transmission, torque converter and oil cooler capacity . . . . . 68 litres
Charging pump capacity at 2100 RPM . . . . . 160 l/min
Toque converter drain rate . . . . . 4 - 8 l/min

Pressures

At transmission control valve:

Main . . . . . .1240 -1450 kPa
Converter . . . . . 415 - 550 kPa
Lube . . . . . 70 - 345 kPa

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DRIVE TRAIN

Special torques

Drive shaft mounting bolts (all) . . . . . 130 Nm

Transmission mounting:

Bracket to transmission mounting bolts . . . . . 390 Nm
Trunnion to frame . . . . . 940 Nm

4. SERVICE DIAGNOSIS

COMPLAINT	
PROBABLE CAUSE	**REMARKS**
Excessive Noise	
1. Low oil level	Correct oil level. Refer to Operator's Manual
2. Loose transmission mountings	Tighten all bolts. Refer to **Special Torques** in SPECIFICATIONS in this Section
3. Drive shafts need lubrication	Grease all shafts at lube fittings
4. Restriction in suction side of charging pump causing cavitation	Inspect supply hose and sump suction strainer. Inspect back flow check valve travel and spring return
5. Internal mechanical damage	Drain transmission oil sump and inspect oil for problem evidence (metal chips, charcoal, etc.). Analyse the evidence for cause (bearing failure, clutch plate facing, etc.). Repair. Flush oil cooler and all system hoses. Clean breather and sump strainer. Refill system with clean oil.
Severe Vibration	
1. Low oil level	Correct oil level. Refer to Operator's Manual
2. Loose or poorly aligned drive train components	Check and tighten all mounting bolts throughout entire drive train. Refer to **Special Torques** in SPECIFICATIONS. Check that all drive shaft yokes are installed in the same plane.
3. Drive shaft slip splines need lube	Coat shaft splines liberally with grease
4. Universal joints worn	Repair or replace. Refer to Section 7D
5. Excessive end play in transmission output shaft	Check and adjust endplay. Refer to Section 7C REASSEMBLY under TRANSMISSION
High Oil Temperature (Gauge and Light on Dash)	
1. Improper vehicle operation	Operate in proper gear range. Refer to Operator's Manual
2. Faulty gauge or light on dash; faulty sensor on converter	Check wiring; replace faulty components

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3. Foamed oil	A. Too much oil in sump. Drain to proper level. B. Check for air leak in pump suction line. C. Too much oil in converter housing. Check for low spots in converter breather line and/or high spots in converter drain line. Straighten lines. If problem persists, refer to CHECKING TORQUE CONVERTER LEAKAGE RATE in Section 7B
4. Faulty cooling circuit	A. Check air flow through cooler; check for clogged or damaged cooler hoses. B. Check for internal restrictions in cooler
5. Low system pressures	Refer to CHECKING TRANSMISSION AND TORQUE CONVERTER PRESSURES in this Section
6. Low oil flow through system	Refer to CHECK TORQUE CONVERTER CHARGING PUMP FLOW RATE in this Section
Slow or Erratic Clutch Engagement	
1. Control lever linkage malfunction	Check lever positions. Check cable for wear, restrictions, etc. Check all linkage connections, pins and bushings
2. Neutral knockdown valve spool not returning properly	Complaint will be for directional packs only. Disconnect hydraulic line at knockdown valve spool. Operate machine in forward and reverse. If problem remains, check knockdown valve spool, housing bore and return spring. If the problem has corrected itself, check hydraulic line and treadle valve.
3. Restriction in suction side of charging pump	Inspect supply hose and sump suction strainer. Inspect back flow check valve travel and spring return
4. Foamed oil	A. Too much oil in sump. Drain to proper level. B. Check for air leak in charging pump suction line C. Too much oil in converter housing. Check for low spots in converter breather line and/or high spots in converter drain line. Straighten lines. If problem persists, refer to CHECKING TORQUE CONVERTER DRAIN RATE in this Section
5. Leakage at control valves	Refer to CHECKING TRANSMISSION AND TORQUE CONVERTER PRESSURES in this Section
6. Charging pump malfunction	Refer to CHECKING THE CHARGING PUMP FLOW RATE in this Section
7. Internal leakage in the clutch pack and/or shaft	Refer to CHECKING TRANSMISSION AND TORQUE CONVERTER PRESSURES in this Section
Loss of Power	
1. Control lever linkage malfunction	Check lever position. Check cable for wear, restrictions, etc. Check all linkage connections, pins and bushings
2. Brakes dragging	Refer to SERVICE DIAGNOSIS in Section 4 BRAKES and Section 7D DRIVE AXLE
3. Low engine output	Refer to TEST AND ADJUSTMENTS in Section 12, POWER

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4. Neutral knockdown valve spool stuck in disconnect position	Disconnect hydraulic line at knockdown valve spool. Operate machine. If problem remains, check knockdown valve spool, housing bore and return spring. If the problem has corrected itself, check hydraulic line and treadle valve.
5. Main pressure spool of pressure regulator valve stuck open	Refer to CHECKING TRANSMISSION AND TORQUE CONVERTER PRESSURES in this Section
6. Internal leakage	Refer to CHECKING TRANSMISSION AND TORQUE CONVERTER PRESSURES in this Section
7. Charging pump malfunction	Refer to CHECKING THE CHARGING PUMP FLOW RATE in this Section
Loss of Drive in One Direction	
1. Directional control valve linkage malfunction	Check lever positions. Check cable for wear, restrictions, etc. Check all linkage connections, pins and bushings
2. Internal leakage in the clutch pack and/or shaft	Check directional pack pressures. Refer to CHECKING TRANSMISSION AND TORQUE CONVERTER PRESSURES in this Section
Loss of Drive in One Speed Range	
1. Range selector valve linkage malfunction	Check lever positions. Check cable for wear, restrictions, etc. Check all linkage connections, pins and bushings
2. Internal leakage in the clutch pack	Check range pack pressures. Refer to CHECKING TRANSMISSION AND TORQUE CONVERTER PRESSURES in this Section

5. CHECKING THE CHARGING PUMP FLOW RATE (Fig. 7.2)

1. Start the engine and bring the engine and torque converter to operating temperatures as indicated by the temperature gauges on the dash. Shut off the engine and apply the parking brake.

2. Place a hydraulic flow meter (PLT-876 or PLT-877 or equivalent with capacity of at least 250 lpm) on/at the machine.
3. Connect the flow meter into system at the inlet line (1) from the pressure filters to the transmission control valve (2) on the rear of the transmission. Use two hoses with 1-5/8 - 12x37º fittings and of suitable strength to accept pressure.

WARNING! Be sure the area in front and behind the machine is clear of personnel and obstructions. DO NOT allow anyone near the tires or on the access ladders during the test.

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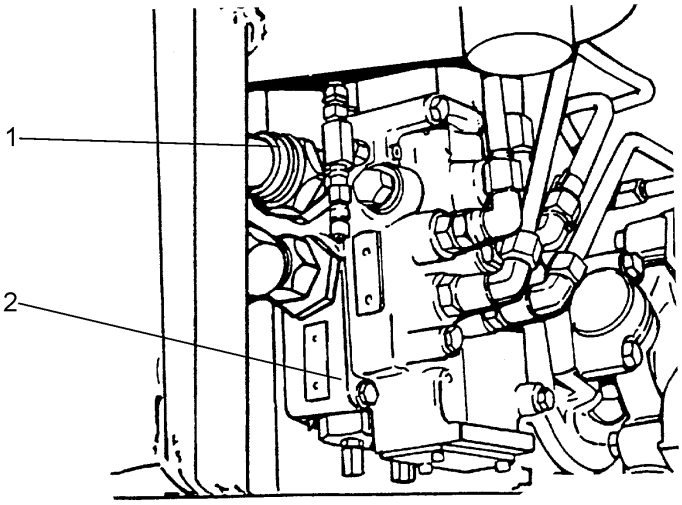


Fig. 7.2. Connection Points for Flow Meter

1. Inlet Line from Pressure Filters 2. Transmission Control Valve

***IMPORTANT**: The adjustable restrictor in the flow meter must be completely open during this entire test or the pump could be severely damaged.*

4. Start the engine . With the transmission in neutral, accelerate to full throttle and record the liters per minute flow meter reading.

5. Release the accelerator and record the flow meter reading at low idle.

6. Refer to **SPECIFICATIONS** for normal pump capacities. If the test result meet specifications, the pump is functioning properly.

7. If the results do not meet specifications, check for:

   a. RESTRICTION IN SUCTION SIDE OF CHARGING PUMP: Inspect supply hose and sump suction strainer. Inspect back flow check valve travel and spring return.

   b. CHARGIN PUMP MALFUNCTION: Overhaul pump.

8. Reconnect the inlet line from the pressure filters into the transmission control valve.

6. CHECKING TRANSMISSION AND TORQUE CONVERTER PRESSURES

1. Mount the Pressure Test Kit PLT-309B in a place easily visible to the operator.

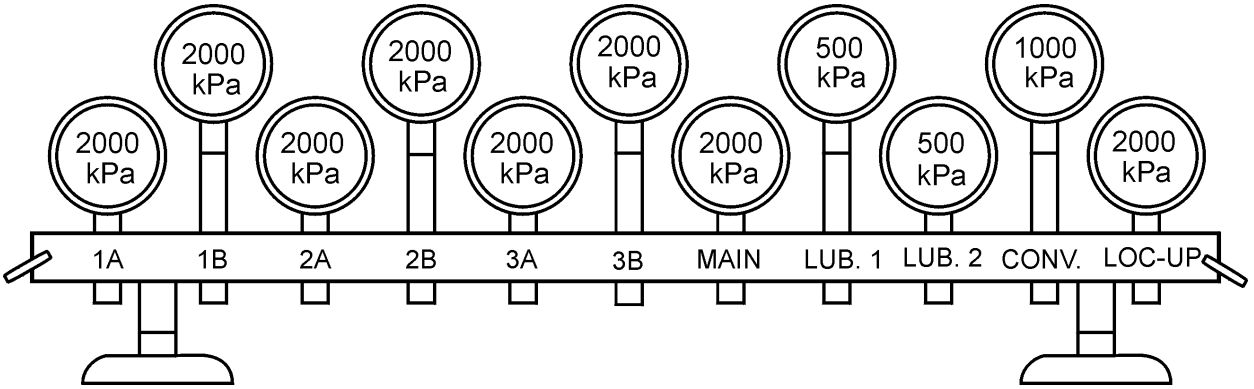


Fig. 7.3. Pressure Test Kit

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2. Connect the hoses from the gauges as follows:

   a. Gauge (1A, Fig. 7.3) to port (6, Fig. 7.4)
   b. Gauge (1B, Fig. 7.3) to port (7, Fig. 7.4)
   c. Gauge (2A, Fig. 7.3) to port (8, Fig. 7.4)
   d. Gauge (2B, Fig. 7.3) to port (4, Fig. 7.4)
   e. Gauge (3A, Fig. 7.3) to port (5, Fig. 7.4)
   f. Gauge (Main, Fig. 7.3) to plug (3, Fig. 7.4)
   g. Gauge (Lub 1, Fig. 7.3) to plug (1, Fig. 7.4)
   h. Gauge (Lub 2, Fig. 7.3) to port (9, Fig. 7.4)
   i. Gauge (Conv., Fig. 7.3) to plug (2, Fig. 7.4)

NOTE: *Gauges 3B and „Loc-up", if occur in the Test Kit, are not used during this procedure.*



WARNING! Be sure the area in front and behind the machine is clear of personnel and obstructions as the machine may move during this test. DO NOT allow anyone near the tires or on the access ladders during the test.

3. Start the engine and bring the engine and torque converter to operating temperatures as indicated by the temperature gauges on the dash. Apply parking brake.

4. Run the engine at full throttle with the transmission controls in the following positions and check the gauge readings in each position with those shown in the following chart.

GEAR RANGE	FIRST	SECOND	THIRD	FWD	REV	MAIN	LUBE 1	LUBE 2	CONV
Forward, Third	70-345 kPa	70-345 kPa	1240-1450 kPa	1240-1450 kPa	70-345 kPa	1240-1450 kPa	70-345 kPa	70-345 kPa	415-550 kPa
Reverse, Third	70-345 kPa	70-345 kPa	1240-1450 kPa	70-345 kPa	1240-1450 kPa	1240-1450 kPa	70-345 kPa	70-345 kPa	415-550 kPa
Neutral, First	900-1035 kPa	70-345 kPa	70-345 kPa	70-345 kPa	70-345 kPa	1240-1450 kPa	70-345 kPa	70-345 kPa	415-550 kPa
Neutral, Second	70-345 kPa	1240-1450 kPa	70-345 kPa	70-345 kPa	70-345 kPa	1240-1450 kPa	70-345 kPa	70-345 kPa	415-550 kPa

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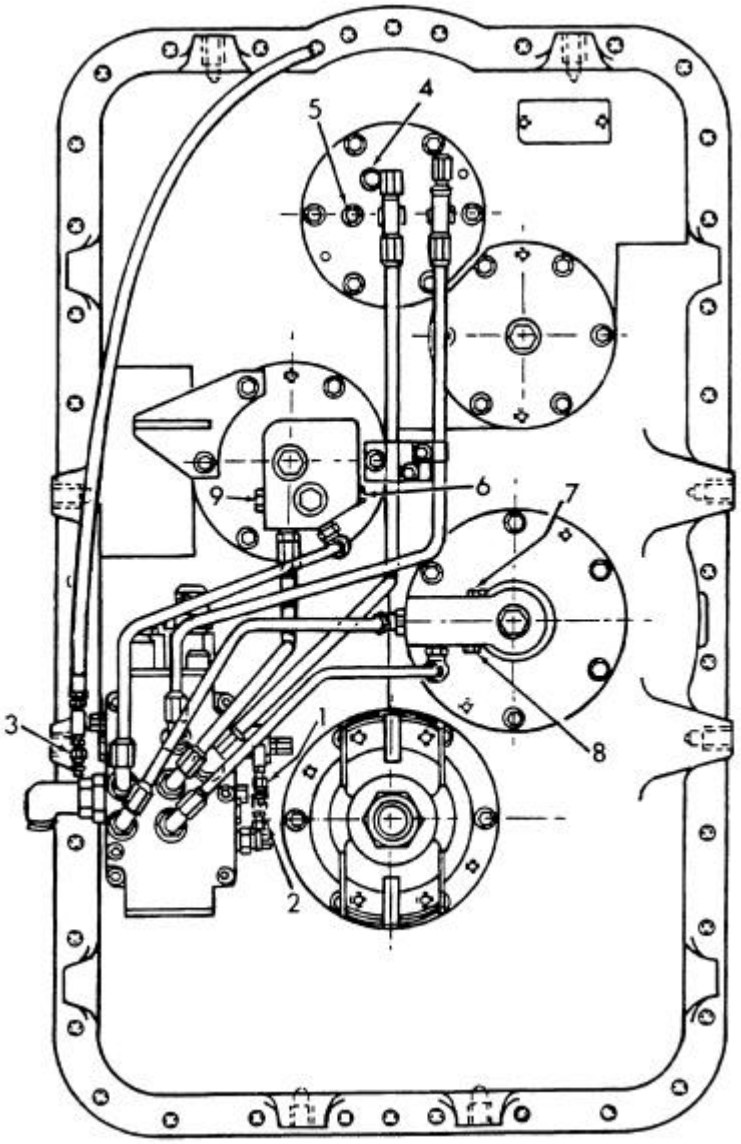


Fig. 7.4. Pressure Gauge Connect Points

1. Lube 1
2. Converter
3. Main
4. Forward (FWD)
5. Reverse (REV)
6. First
7. Second
8. Third
9. Lube 2

If pressures do not meet specifications, refer to the following **PRESSURE DIAGNOSTIC CHART**.

Pressure Diagnostic Chart

PROBLEM	PROBABLE CAUSE
1. Low lube/pressure	a. Low converter pressure (See Problem 3) b. O-ring (31 or 33, Fig. 7.1) leaking c. Lube pressure relief cartridge (18, Fig. 7.1) leaking d. Internal leak in transmission (See Problems 7, 8, 9, 10, 13 and 14)

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PROBLEM	PROBABLE CAUSE
2. High lube/pressure	a. Stuck lube pressure relief cartridge (18, Fig. 7.1) b. Drain port (32, Fig. 7.1) blocked c. Internal leak in transmission (See Problems 7, 11 and 12)
3. Low converter pressure	a. Low main pressure (See Problem 5) b. O-ring (34, Fig. 7.1) leaking c. Converter pressure relief cartridge (19, Fig. 7.1) leaking d. Internal leak in torque converter. Refer to CHECKING TORQUE CONVERTER LEAKAGE RATE in Section 7B e. Worn charging pump. Refer to CHECKING CHARGING PUMP FLOW RATE
4. High converter pressure	a. Stuck converter pressure relief cartridge (19, Fig. 7.1) b. Clogged oil cooler c. Restricted lines
5. Low main pressure	a. Low oil level b. Dirty pressure filters c. Dirty sump filter. d. Sump filter valve not opening. e. Leaking suction lines. Apply shave cream to all suction connections and tighten connections where cream disappears. f. Worn charging pump. Refer to CHECKING CHARGING PUMP FLOW RATE. g. O-ring (35, Fig. 7.1) leaking. h. Main pressure relief cartridge (20, Fig. 7.1) leaking i. Internal leak in transmission (See Problems 7, 8, 9, 11, 12, 13 and 14).
6. High main pressure	a. Stuck main pressure relief cartridge (20, Fig. 7.1).
7. Low forward and reverse engagement pressure	a. Low main pressure (See Problem 5). b. Hydraulically operated transmission disconnect spool not returning properly. Disconnect hydraulic line at spool. Operate machine. If problem remains, check the spool. If the problem has corrected itself, check hydraulic line and treadle valve. c. Directional spool linkage malfunction. Check lever positions. Check cable for wear or restrictions. Check all linkage connections. d. Oil leaking past tube (37, Fig. 7.1).
	e. O-rings (39 or 43, Fig. 7.1) leaking. Also accompanied with high lube pressure at disengaged forward or reverse.

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PROBLEM	PROBABLE CAUSE
8. Low forward engagement pressure only	a. Directional spool linkage malfunction. Check lever positions. Check cable for wear or restrictions. Check all linkage connections. b. O-rings (36 or 38, Fig. 7.1) leaking. Also indicated by low lube pressure at forward when engaged in reverse.
9. Low reverse engagement pressure only	a. Directional spool linkage malfunction. Check lever positions. Check cable for wear or restrictions. Check all linkage connections. b. Missing orifice plug (41, Fig. 7.1) or leaking O-rings (40 or 42). Also indicated by low lube pressure at forward when engaged in forward.
10. Low lube 2 pressure	a. Missing orifice plug (49, Fig. 7.1). b. O-ring (45 or 46, Fig. 7.1) leaking.
11. Low first engagement pressure only	a. Range spool linkage malfunction. Check lever positions. Check cable for wear or restrictions. Check all linkage connections. b. O-ring (48 or 50, Fig. 7.1) leaking. c. O-ring (47 or 52, Fig. 7.1) leaking. Also indicated by high lube 2 pressure when engaged in first. d. Oil leaking past tube (44, Fig. 7.1). Also indicated by high lube 2 pressure when engaged in first.
12. Low second and third engagement pressure	a. Range spool linkage malfunction. Check lever positions. Check cable for wear or restrictions. Check all linkage connections. b. Oil leaking past tube (59, Fig. 7.1). Also accompanied with high lube pressure at disengaged second or third. c. O-ring (54 or 58, Fig. 7.1) leaking. Also accompanied with high lube pressure at disengaged second or third.
13. Low second engagement pressure only	a. Range spool linkage malfunction. Check lever positions. Check cable for wear or restrictions. Check all linkage connections. b. Missing orifice plug (56, Fig. 7.1) or leaking O-rings (55 or 57). Also indicated by low lube pressure at second when engaged in third.
14. Low third engagement pressure only	a. Range spool linkage malfunction. Check lever positions. Check cable for wear or restrictions. Check all linkage connections. b. O-ring (52 or 53, Fig. 7.1) leaking. Also indicated by low lube pressure at third when engaged in second.

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TORQUE CONVERTER

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HYDRAULIC TORQUE CONVERTER SECTION 7B

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GENERAL

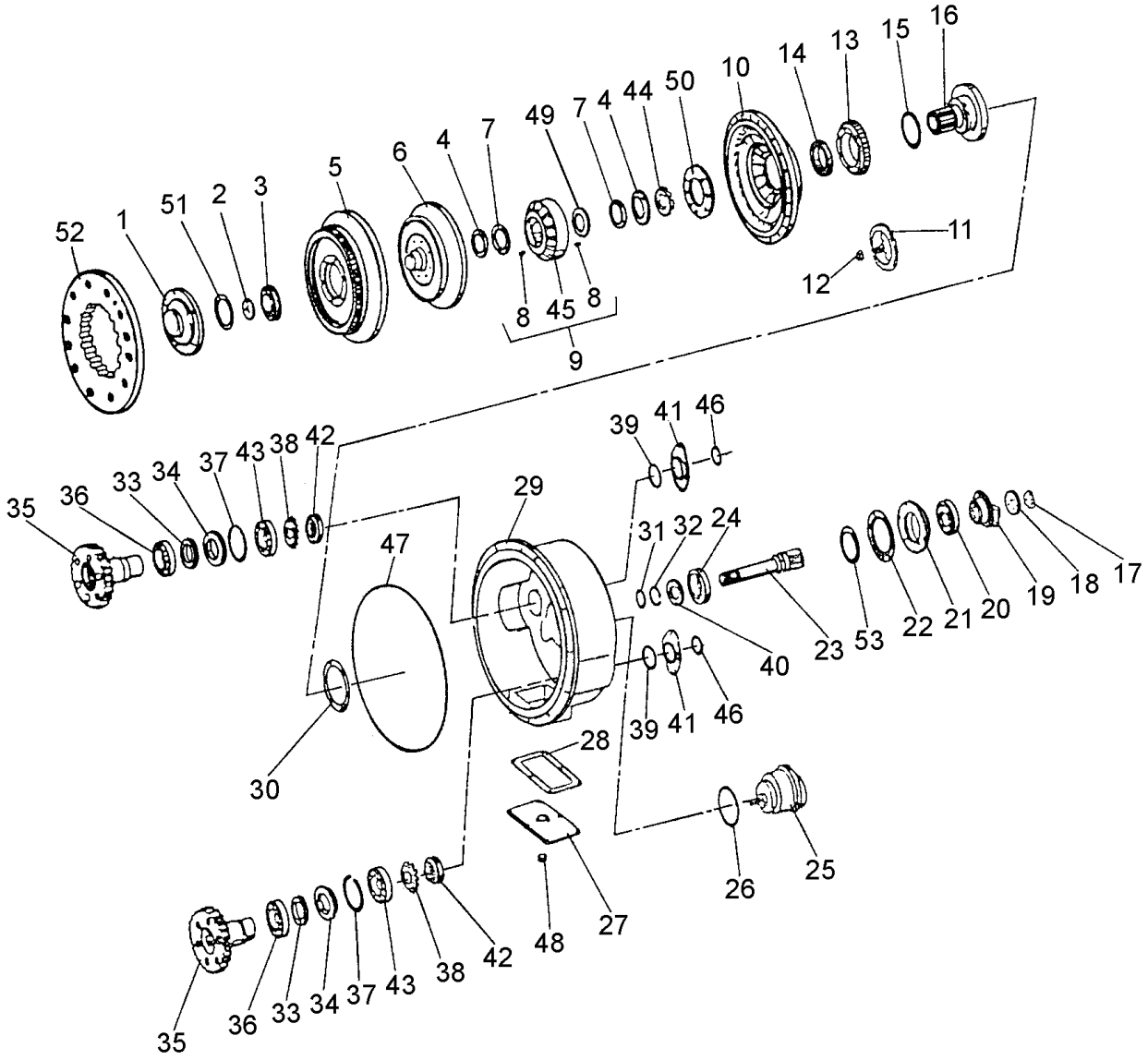


Fig. 7B.1. Exploded View of Torque Converter

1. Cover
2. Retainer Washer
3. Ball Bearing
4. Thrust Bearing
5. Drive Housing
6. Turbine
7. Thrust Washer
8. Spring Pin
9. Stator Assembly
10. Impeller
11. Spur Gear
12. Nut
13. Spur Gear
14. Ball Bearing
15. Seal Ring
16. Ground Sleeve Hub
17. Locking Plate
18. Retainer Washer
19. Output Flange
20. Oil Seal
21. Bearing Retainer
22. Gasket
23. Output Shaft
24. Ball Bearing
25. Charging Pump
26. O-Ring
27. Housing Cover
28. Cover Gasket
29. Converter Housing
30. Gasket
31. Seal Ring
32. Snap Ring
33. Cone Spacer
34. Cup Spacer
35. Spur Gear
36. Roller Bearing
37. Snap Ring
38. Lock Washer
39. O-Ring
40. Support Washer
41. Accessory Drive Adapter
42. Lock Nut
43. Roller Bearing
44. Converter Spacer
45. Stator
46. O-Ring
47. O-ring
48. Plug
49. Shims
50. Retainer Plate
51. Shims
52. Drive Ring
53. Shims

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HYDRAULIC TORQUE CONVERTER

GENERAL

1. DESCRIPTION (Refer to Fig. 7B.1)

This machine is equipped with a single stage, single phase torque converter, bolted directly to the engine flywheel housing.

A drive ring (52) is bolted to the engine flywheel and its teeth are meshed with the teeth on the drive housing (5). A bladed impeller (10) is bolted to this housing. All three pieces turn together at flywheel speed and are the input components of the converter.

At the output end is a output flange (19) which is splined to the output shaft (23). The output shaft rides on bearings (3 and 24) at both ends and carriers the turbine (6), which is splined to it. The turbine, shaft and flange turn at output speed.

Between the input and output is a stator (45) which is splined to the sleeve hub (16). The hub is bolted to the stationary converter housing (29). All of these components are fixed in position and do not turn.

One function of the torque converter is to act as a drive mechanism for auxiliary pumps. This torque converter drives three pumps: the hydraulic and cooling pump, the steering and switch pump and the torque converter charging pump. A spur gear (13) is bolted to the impeller (10) and is part of the input group, turning at flywheel speed. The spur gear teeth mesh with those of gear (11) and gears (35), which are arranged around the spur gear. Gear (11) is secured to pump (25) which is bolted in housing (29). Spur gears (35) ride on bearings (36 and 43) that are held in place by snap rings (37) and lock nuts (42). The hubs of gears (35) spline with the shafts of the hydraulic and cooling pump and the steering and switch pump, giving a driving force to each pump whenever the engine is running.

2. OPERATION (Refer to Fig. 7B.1)

Oil enters housing (29) and is directed through a passage in hub (16). The impeller (10) draws oil from the hub (16) and ejects it from its blades at high velocity. The turbine (6) is positioned opposite the impeller (10) and its blades receive the full impact of this velocity. Fluid exits, from the turbine in the opposite direction of rotation from that of the impeller. The curved blades of the stator (45) (positioned between the impeller and turbine) re-directs the flow back to the impeller in the same direction as the impeller is moving, completing the cycle.

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 (6) is rotating as fast as the impeller (10), 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.

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GENERAL

3. SPECIFICATIONS

Torque converter to transmission drive shaft bolts . . . . . 110 Nm
Impeller to drive housing bolts . . . . . 50 to 60 Nm
Spur drive gear mounting bolts . . . . . 95 to 110 Nm
Torque converter drive ring to flywheel . . . . . 80 Nm
Torque converter leakage rate (high idle neutral) . . . . . 4 to 8 lpm

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 as necessary
High Torque Converter Oil Temperature (Gauge on Dash)	
See SERVICE DIAGNOSIS in SECTION 7C	
Loss of Power	
See SERVICE DIAGNOSIS in SECTION 7C	
Grinding or Scraping Noise Inside Converter Housing	
Bearing failure allowing the turbine or impeller blades to strike the fixed stator	Replace bearings, turbine or impeller as necessary

Checking Torque Converter Leakage Rate

1. Start the engine and bring the engine and torque converter to operating temperatures as indicated by the temperature gauge on the dash. Shut off the engine and apply the parking brake.

WARNING! Be sure the area in front and behind the machine is clear of personnel and obstructions. DO NOT allow anyone near the tires or on the access ladders during the test. Lock the frames.

2. Drain the transmission below oil check level point (Fig. 7B.2). Refer to OPERATOR'S MANUAL.
3. Disconnect the leakage hose (1, Fig. 7B.3) from the transmission (2). Cap the hole in transmission at the correct size plactic cap.
4. Place the end of the hose in a large bucket. Start the engine. With the transmission in neutral, accelerate to full throttle.
5. When the leakage rate appears to have stabilized (approx. 1 minutes), switch the hose to another empty bucket and time the flow for one minute. After one minute, switch the hose back to the first bucket. Stop the engine.

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HYDRAULIC TORQUE CONVERTER

GENERAL

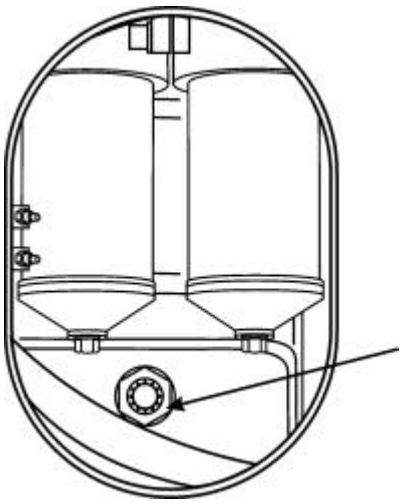


Fig. 7B.2. Oil Checking Level Point in Transmission

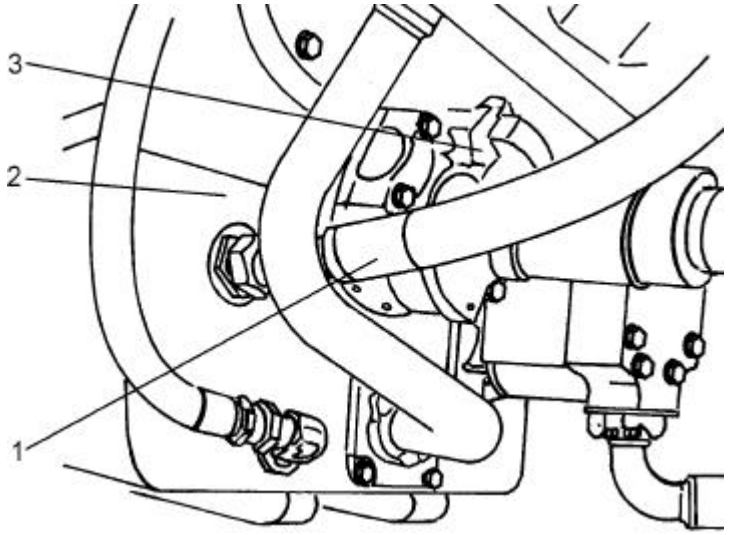


Fig. 7B.3. Transmission Disconnecting Point

1. Leakage Hose
2. Transmission
3. Drive Shaft

6. Measure the volume of oil in the second bucket. Refer to SPECIFICATIONS for normal leakage rate. If the test results meet specifications, the torque converter is not holding too much oil.
7. If the results do not meet specifications check for:
   A. Internal Leakage in Converter:
      Overhaul converter, replacing all seals and damaged parts.
   B. Check the charging pump seal.
8. Remove the plastic cap and reconnect the regular leakage hose (1, Fig. 7B.3) to transmission (2).
9. Fill the transmission. Refer to the OPERATOR'S MANUAL.

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5. REMOVAL

NOTE: *Before removing the torque converter perform SERVICE DIAGNOSIS according to the description in point 4 in this section, and check for Torque Converter Leakage Rate according to point 4 in this section, so as to be sure that the disassembly torque converter is advisable.*

IMPORTANT: *Disconnected hydraulic 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 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.*

WARNING! Be sure the bucket is lowered to the ground and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

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1. Remove the left and right fenders (1, Fig. 7B.4). Unlock and swing open the access door (2) and remove the access panel (3) on both sides of the engine. Remove mounting hardware securing the side hood (4) on each side of the engine. Swing the doors out of the way. Remove the exhaust pipe (5). Loosen the hose clamps securing the aspirator tube (6) to the muffler and to the precleaner (7). Remove the aspirator tube (6) and precleaner (7). Remove the center hood (8). Unscrew mounting hardware and remove the shields on each side of the bulkhead.

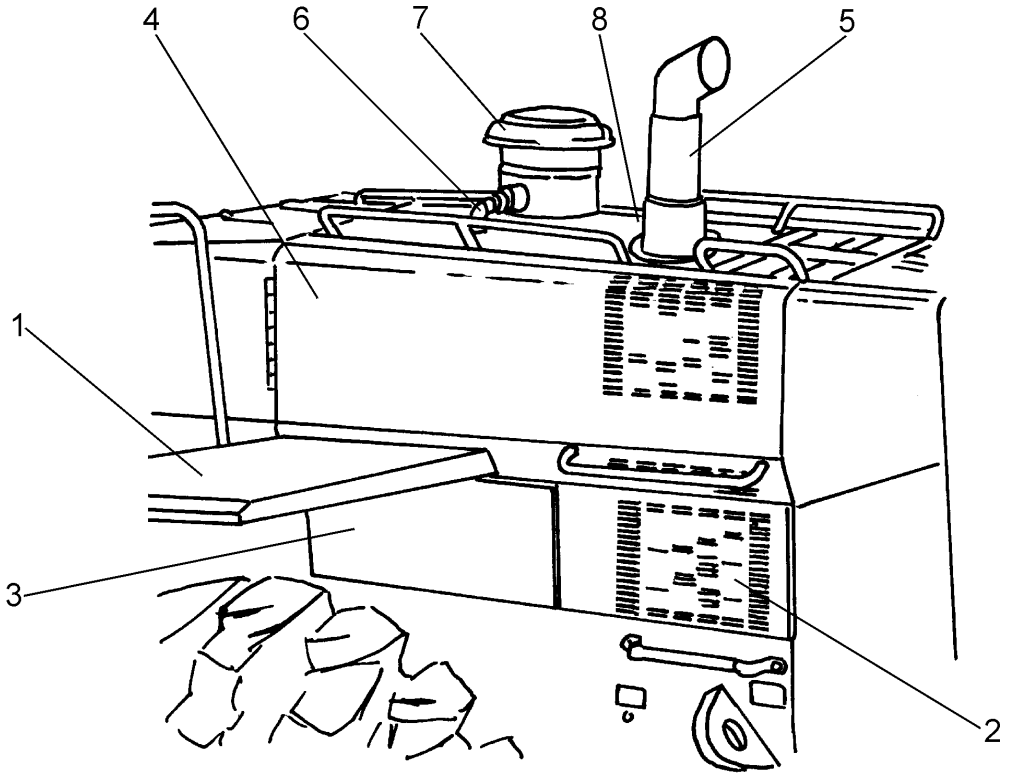


Fig. 7B.4. Hood and Side Panels

1. Fender
2. Access Door
3. Access Panel
4. Side Hood
5. Exhaust Pipe
6. Aspirator Tube
7. Precleaner
8. Center Hood

2. Drain the hydraulic reservoir. Refer to the OPERATOR'S MANUAL.
3. Disconnect the cables from the batteries so the batteries can be removed with the bulkhead.
4. Disconnect loader pump suction tube (3, Fig. 7B.5) and remove it, ground driven steering suction hose (2), ground driven steering return hose (5) and pilot valve return hose (1) from the bottom of the reservoir.
5. Disconnect steering switch pump section tube (8, Fig. 7B.5) and remove it, drain valve hose (10), hydraulic oil cooler supply hose in surge valve (9), steering valve return hose in surge valve (11), steering return surge valve (12), hydraulic oil cooler return hose (6) and loader control valve return hose (7) from the bottom of the reservoir.
6. Disconnect the electrical wire (4, Fig. 7B.5) from the hydraulic electrical differential pressure switch on the bottom of the reservoir.
7. Attach a hoist to the bulkhead and remove the bulkhead with reservoir and batteries.

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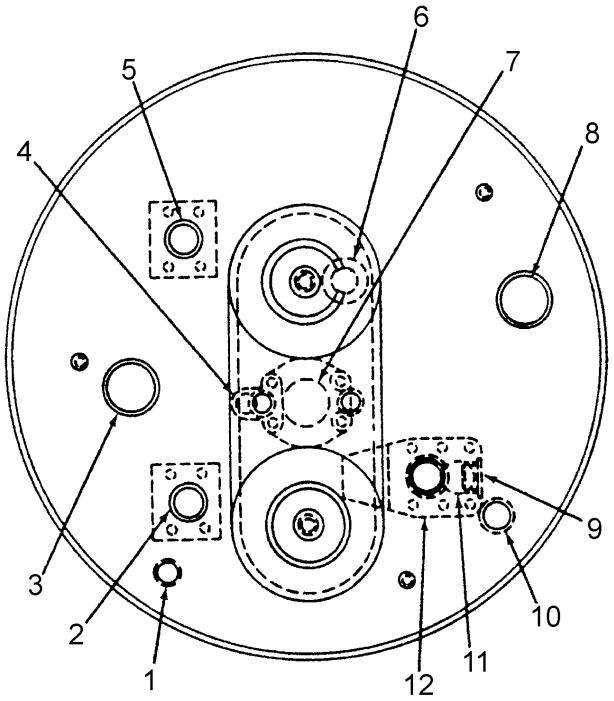


Fig. 7B.5. Hydraulic Reservoir Disconnecting Points (Bottom View)

1. Pilot Valve Return Port
2. Ground Driven Steering Suction Port
3. Loader Pump Suction Port
4. Electrical Differential Pressure Switch
5. Ground Driven Steering Return Port
6. Hydraulic Oil Cooler Return Port
7. Loader Control Valve Return Port
8. Steering Switch Pump Suction Port
9. Hydraulic Oil Cooler Supply Port in Surge Valve
10. Drain Valve Port
11. Steering Valve Return Port in Surge Valve
12. Steering Return Surge Valve

9. Disconnect the hose (3, Fig. 7B.6) from manifold (1). Disconnect the hoses (1, 3 and 4, Fig. 7B.7) from the hydraulic and cooling pump (22).

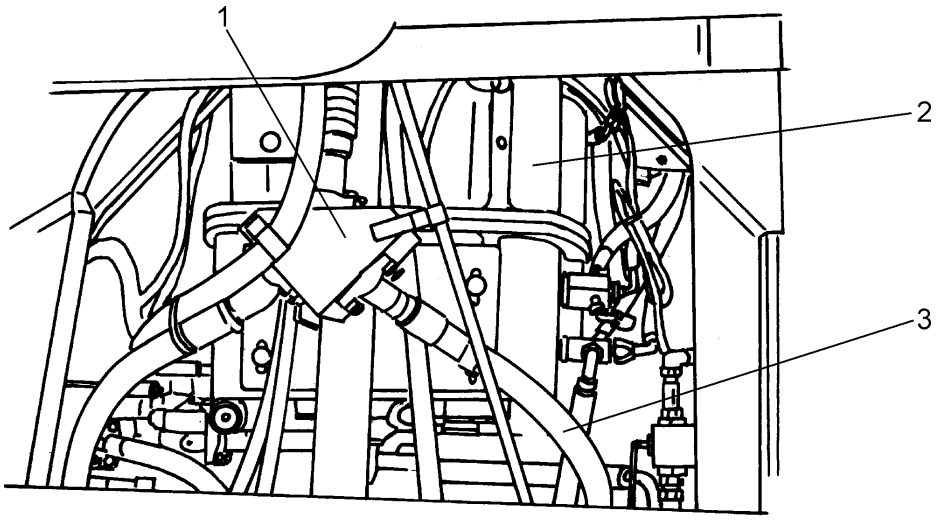


Fig. 7B.6. Disconnecting Point (Top View)

1. Manifold 2. Transmission 3. Hose

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10. Disconnect the hoses (16, 17 and 18, Fig. 7B.7) from the steering and switch pump (15).
11. Disconnect the hoses (9, 10 and 12, Fig. 7B.7) from the torque converter (8).
12. Remove the torque converter to transmission drive shaft (11, Fig. 7B.7).
13. Disconnect the hoses (19 and 20, Fig. 7B.7) from the torque converter charging pump (21).
14. Unscrew the steering and switch pump mounting bolts (13, Fig. 7B.7) and remove the pump (15) with tube (14).

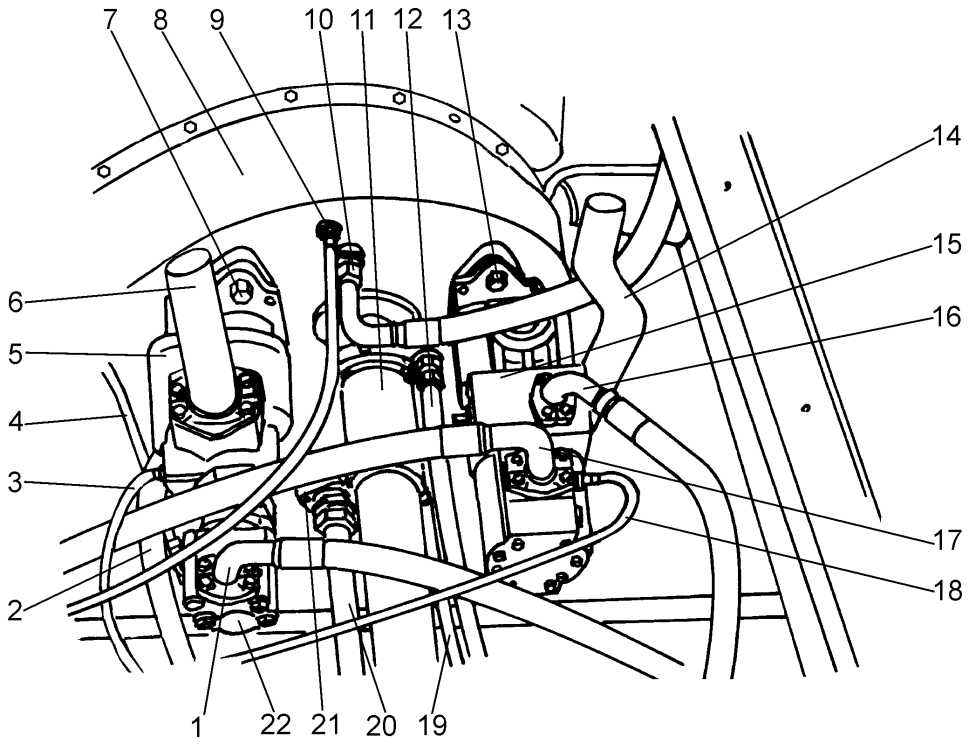


Fig. 7B.7. Torque Converter Disconnecting Points (Top View)

1. Hose
2. Hose
3. Hose
4. Hose
5. Hydraulic and Cooling Pump
6. Tube
7. Mounting Bolts
8. Torque Converter
9. Hose
10. Hose
11. Drive Shaft
12. Hose
13. Mounting Bolts
14. Tube
15. Steering and Switch Pump
16. Hose
17. Hose
18. Hose
19. Hose
20. Hose
21. Converter Charging Pump
22. Cooling Pump

15. Attach a suitable overhead hoist to the torque converter and the two remaining pumps.
16. Proceed as follows for removing torque converter lower mounting bolts:

    Unscrew the tube (1, Fig. 7B.8) from the manifold (3). Remove the pipes (2 and 4) from the manifold (3). If equipped sound absorbing lining (5), remove the snap fasteners (6) and pull back lining. Unscrew the lower mounting bolts.

17. Unscrew torque converter upper mounting bolts. Using a jack screw holes in the converter housing, pull the converter straight out from the flywheel housing.
18. Lift the converter wioth two pumps and hose (2, Fig. 7B.7) up and out of the machine.
19. Remove the hydraulic and cooling pump from the converter.

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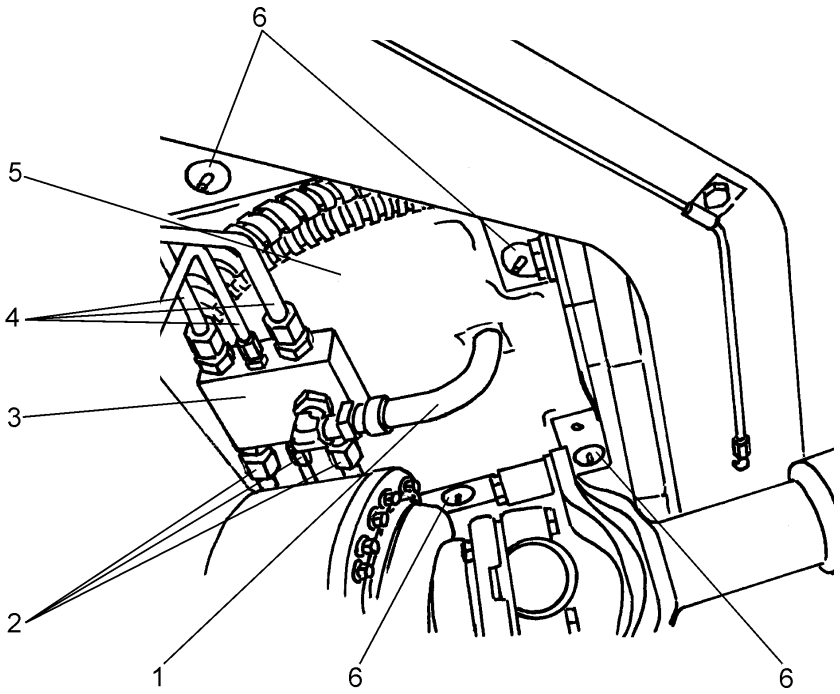


Fig. 7B.8. Disconnecting Points (Down View)

1. Tube
2. Pipes
3. Manifold
4. Pipes
5. Sound Absorbing Lining
6. Snap Fasteners

6. DISASSEMBLY (Refer to Fig. 7B.1)

1. Steam clean the torque converter to remove all external dirt, using plain steam.
2. Select a clean, dust free location and position the converter on a bench with the output shaft down. Place suitable blocks so the flange clears the bench.
3. Remove O-ring (47) from housing (29). Remove cover (27) and discard gasket (28).
4. Unscrew bolts with washers and remove cover (1) and shims (51), as shown in Fig. 7B.9. Tie the shims to the cover to facilitate reassembly. Remove the bolts securing retainer washer (2) to shaft (23) and remove the washer.
5. Insert a 3/8-16 NC eyebolts in two of the mounting holes in housing (5). Using a hoist, lift the rotating housing straight up from housing (29), as shown Fig. 7B.10. Place the assembly on a bench, remove the eyebolts and turn the assembly over so that drive housing (5) is down.
6. Remove the bolts and washer securing impeller (10) to drive housing (5), as shown in Fig. 7B.11, and lift off the impeller. Remove spacer (44), thrust bearing (4), thrust washer (7) and shims (49).
7. Remove stator assembly (9) from turbine (6). Spring pins (8) need not be removed from stator (45) unless replacement is necessary. Lift thrust washer (7) and thrust bearing (4) from turbine (6). Remove turbine (6) from bearing (3), as shown in Fig. 7B.12.
8. Place housing (5) up on blocks so that the gear teeth are down. Using a suitable driver, remove bearing (3) with its snap ring.

IMPORTANT: *The driver should be large enough to drive against the O.D. of the bearing. Do not drive against the bearing I.D. or damage to the bearing could result.*

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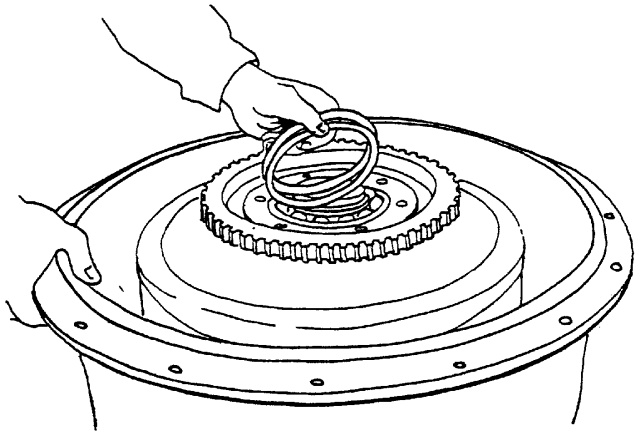


Fig. 7B.9. Removing of Shims

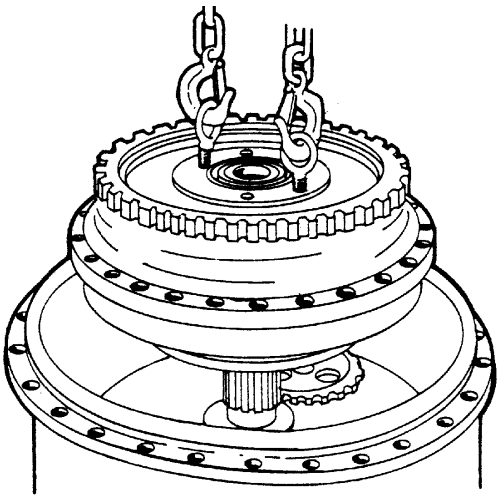


Fig. 7B.10. Lifting Drive Housing

9. Place the impeller (10) on blocks with gear (13) down. Remove the bolts securing the gear to the impeller and remove retaining plate (50). Tap the bearing and gear out of the impeller.
10. Press bearing (14) out of gear (13). Place housing (29) on its side on blocks.

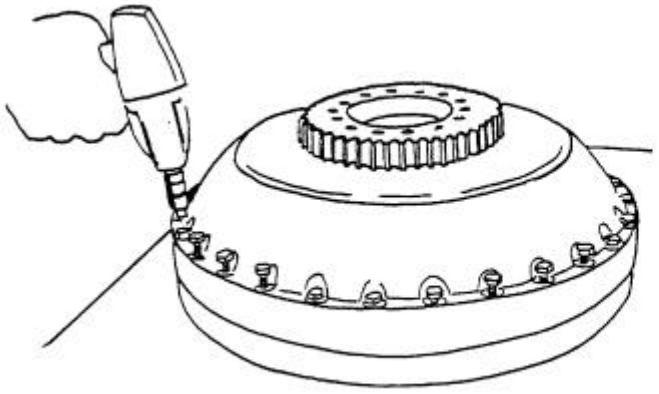


Fig. 7B.11. Removing of Bolts Securing Impeller to Housing

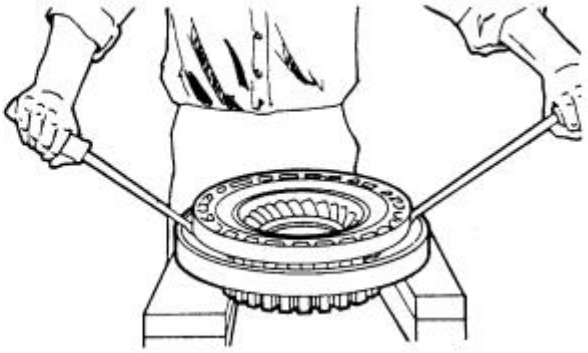


Fig. 7B.12. Removing Turbine

11. Bend back the tabs on lock plate (17) and remove the bolts, lock plate and washer (18). Slide the output flange (19) from the shaft. Remove the retainer (21) with seal (20). Remove the seal from the retainer. Discard gasket (22). Remove shims (53) and keep with retainer (21) to facilitate proper installation.
12. Working from inside housing (29), tap on the end of shaft (23) with mallet until bearing (24) is free (Fig. 7B.13). Remove shaft (23) with bearing (24), washer (40), snap ring (32) and seal ring (31). Remove seal ring (31) and if bearing or shaft replacement is necessary, remove snap ring (32), washer (40) and press bearing (24) from shaft (23) as shown in Fig. 7B.14.

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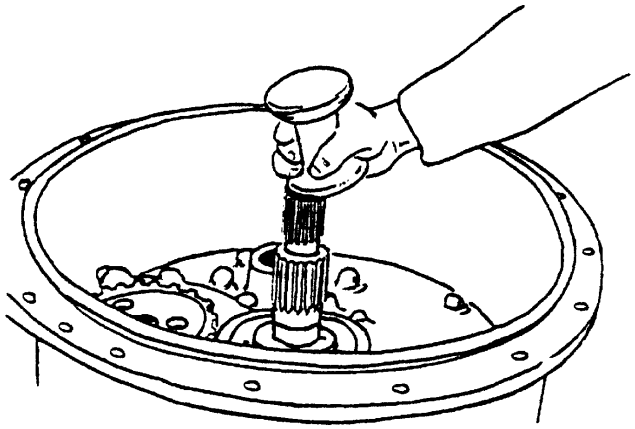


Fig. 7B.13. Removing of Shaft

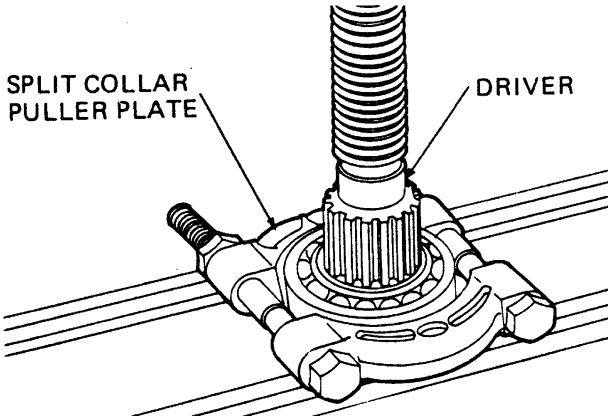


Fig. 7B.14. Output Shaft Bearing

13. Remove nut (42) and lock washer (38) from the hub of gear (35). Tap gear (35) with outer bearing cone (36) from housing (29) and bearing cone (43). Remove spacer (33). If bearing replacement is necessary, remove bearing cone (36) from gear (35) and remove the bearing cups, spacer (34) and snap ring (37) from housing (29).
14. Repeat step 13 for the other accessory gear.
15. Remove nut (12) and spur gear (11) off the shaft of pump (25). Unscrew the pump mounting bolts and remove the pump and discard O-ring (26).
16. Remove seal ring (15) from hub (16). If hub (16) needs to be replaced, place converter housing (29) in a press with the splined end of hub (16) facing down. Block up on the inside of housing (29) as close to the hub as possible without contacting the hub. Insert a steel plug on the rear of the hub and press out. Remove gasket (30).

7. INSPECTION AND REPAIR

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

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

3. Inspect and clean all hoses and piping removed when removing the converter.
4. Inspect sealing surfaces for wear or damage, especially in the hub (16) and gear (13) and condition of seal ring grooves.
5. Inspect all spleens and gears teeth for excessive wear, burrs or damage and replace if necessary. Slight burrs can be removed with a fine oil stone.
6. Replace all bearings that do not rotate freely.
7. Inspect the impeller, stator and turbine for signs of rubbing. If this condition exists, it is an indication that one or more of the bearings in the converter need replacement. If the blades are excessively worn or damaged, the entire assembly must be replaced.

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8. Inspect all threaded parts for damaged threads. Repair threads with a fine three-cornered file. Replace a threaded parts that can not be repaired.
9. Inspect the orifice in the cover (1). Use a small wire to be sure the orifice are clean and clear.

8. REASSEMBLY (Refer to Fig. 7B.1)

NOTE: *If the ground sleeve hub (16) was removed, pack it in dry ice or freeze to a temperature of -32°C for 30 minutes prior to assembly.*

1. If the ground sleeve hub (16) was removed, proceed as follows. Place the converter housing (29) in a press with its output side down. Position gasket (30) in the housing making sure the oil passages are not covered. Insert two guide bolts (3/8 x 3 inches with bolt heads cut off) into the frozen ground sleeve hub. Using the shoulder of ground sleeve hub, press the hub into converter housing. Remove the guide bolts when ground sleeve hub is properly seated in housing. Install seal ring (15) on the hub. Be sure to hook seal ring and coat lightly with grease.
2. Be sure snap ring (37) is properly seated in housing bore. Install the cup of outer bearing (43) in the bore until it bottoms on the snap ring. Install spacer (34) in the bore and install the cup of bearing (36) until it bottoms against the spacer. Install the cone spacer (33) and the cone of bearing (36) on gear (35) until it bottoms. Position the gear (35) in the housing and install the cone of bearing (43). Secure with the lock washer (38) and nut (42).
3. Repeat step 2 for the other accessory gear.
4. Install o-ring (26) on pump (25). Coat the bore of housing (29) with heavy grease. Start the pump in by hand, being sure to position the pump correctly as it is hard to turn the pump once it is started in the housing bore. Tap the pump into place using a soft hammer and secure with the lock washer and bolts.
5. Install gear (11) on the shaft of pump (25) and secure with nut (12). Install snap ring (32) and washer (40) on shaft (23). Press the output end of the shaft into bearing (24), until the bearing seats against washer (40) and snap ring (32).

NOTE: *The bearing must be held in the press so both races are supported.*

6. Install seal ring (31) in the groove of shaft (23). Coat the ring lightly with hydraulic oil. Insert shaft (23) into hub (16) from the output end of housing (29). Using a suitable driver against the outer race of bearing (24), seat the bearing against hub (16). Install a new seal (20) into retainer (21) until it is centered in the retainer. The seal lip should be facing out.
7. An output shaft end gap of 0 to 0.1 mm must be maintained in the converter assembly. Proceed as follows for checking and obtaining the proper end gap (Fig. 7B.15):

   Be sure bearing (24) is bottomed on hub (16). Install virgin lead (~ 2 mm thick) on outer bearing race. Install retainer (21) and gasket (22). DO NOT install the shims. Tighten the mounting bolts to standard torque. Remove retainer (21) and the compressed lead. Carefully measure thickness of compressed lead with a micrometer. This measurement, less 0 to 0.1 mm, is the amount of shims (53) to be installed between output shaft bearing and the retainer (21), as shown in Fig. 7B.16. Install shims (53) in the bore of bearing retainer (21). Install the retainer with gasket (22) and secure with hardware.

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NOTE: *Shim pack should never be the same or greater than thickness of the gap measurement (compressed lead).*

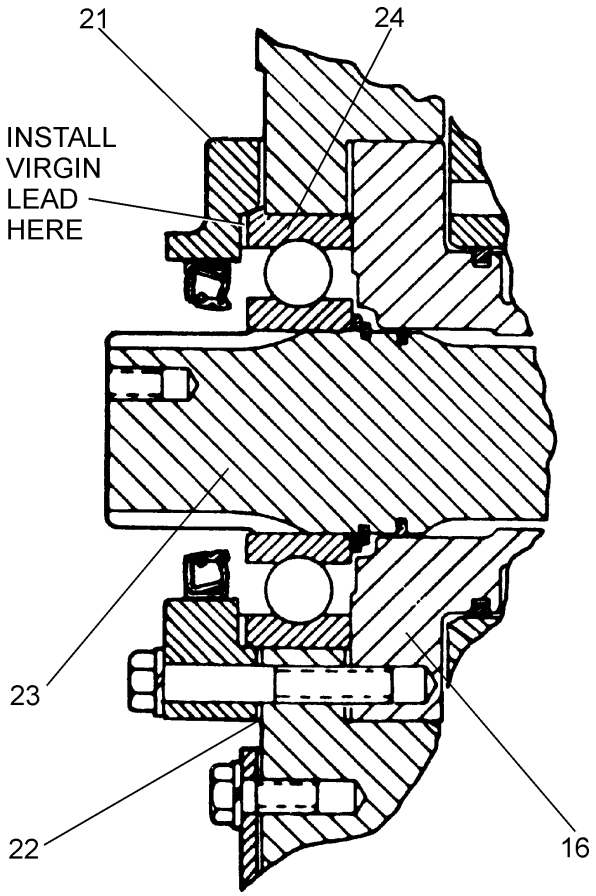


Fig. 7B.15. Cross Section of Output End of Torque Converter

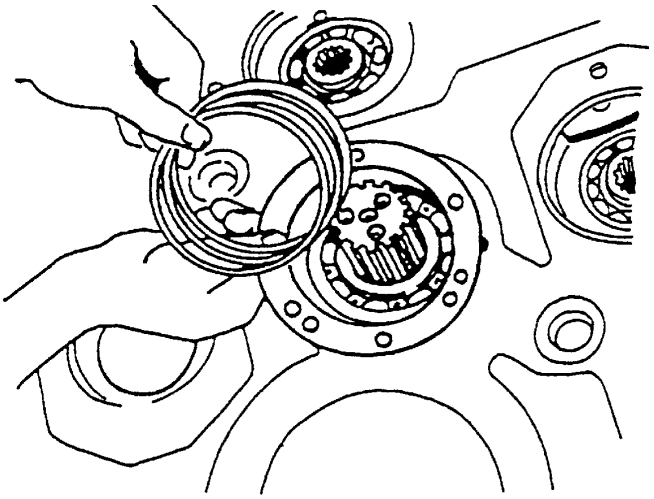


Fig. 7B.16. Installing Shims

16. Ground Sleeve Hub
21. Bearing Retainer
22. Gasket
23. Output Shaft
24. Ball Bearing

8. Install the output flange (19, Fig. 7B.17), retainer washer (18) and lock plate (17) and secure with bolts. Bend up tabs of lock plate (17). Press bearing (14) into gear (13) until it bottoms.
9. Apply Loctite ”Plastic Gasket” on the mating surfaces of gear (13) and impeller (10). Apply Loctite ”Plastic Gasket” on the mounting bolt threads and secure the gear (13), impeller (10) and plate (50) together. Torque the bolts to 95 - 110 Nm.
10. Position spacer (44), thrust bearing (4) and thrust washer (7) in impeller (10). Position stator (45) without shims (49) on thrust washer (7) being sure the spring pin (8) in the stator engages the hole in the thrust washer. Position thrust washer (7) on stator (45) being sure spring pin (8) in the stator engages the hole in the thrust washer. Position thrust bearing (4) and turbine (6) in the impeller. Install drive housing (5) without bearing (3) on impeller (10) and secure with four equally spaced drive housing to impeller bolts.

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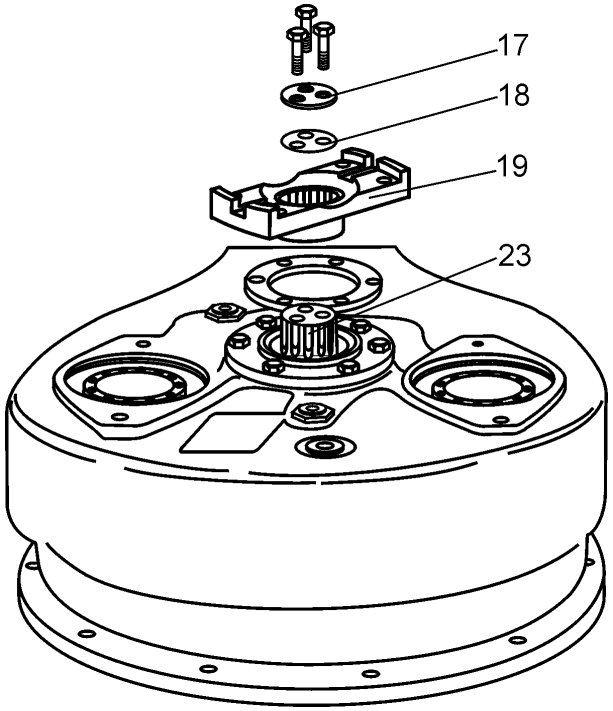


Fig. 7B.17. Installing Flange

17. Lock Plate
18. Retainer Washer
19. Output Flange
23. Shaft

11. To determine the amount of shims (49) needed to obtain the proper stator running clearance, proceed as follows:

    Position bearing (3) without its snap ring on the assembly. Position a bearing plate A, as shown in Fig. 7B.18 and tighten the bolts only enough to move the bearing into the housing bore to obtain a zero clearance of the standard components. Loosen the bolts to relieve possible component stress and retighten finger tight. Using a depth micrometer, measure the distance (B, Fig. 7B.18) from the top of the bearing to the machined surface of the drive housing. Remove the bearing bridge. Raise the bearing (3) and install the snap ring on the bearing. Reinstall the bearing bridge plate (A, Fig.7B. 18) and tighten the bolts only enough to seat the bearing. Loosen the bolts to relieve possible component stress and retighten finger tight. Measure the distance (C, Fig. 7B.18) from the top of the bearing to the machined surface of the drive housing. Subtract dimension B from dimension C and then subtract 0.15 to 0.25 mm. The result is amount required from shims (49).

12. Remove the four drive housing to impeller bolts and lift off drive housing (5) with turbine (6). Remove thrust bearing (4), thrust washer (7) and stator assembly (9). Install shims (49) and position stator (45) so that the spring pin (8) in the stator engages the hole in the thrust washer (7). Position thrust washer (7) on stator (49) being sure spring pin (8) in the stator engages the hole in the thrust washer. Install drive housing (5) with turbine (6) on impeller (10). Apply Loctite ”Thread Locker” on the bolt threads end torque the bolts to 50 - 60 Nm.

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13. Insert a 3/8-16 NC eyebolts in two of the cover mounting holes in housing (5). Using a hoist, lower the assembly into housing (29). As the assembly is lowered into housing (29), the splines of stator assembly (9) will engage with the splines of hub (16); then the splines of turbine (6) will engage the splines of shaft (23) and finally, gear (13) will mesh with gears (11 and 35). If at any point when contact is made, the hoist sling becomes slack, place a sling strain on the sling and rotate housing (50) to engage properly, then continue to lower the assembly into housing (29).

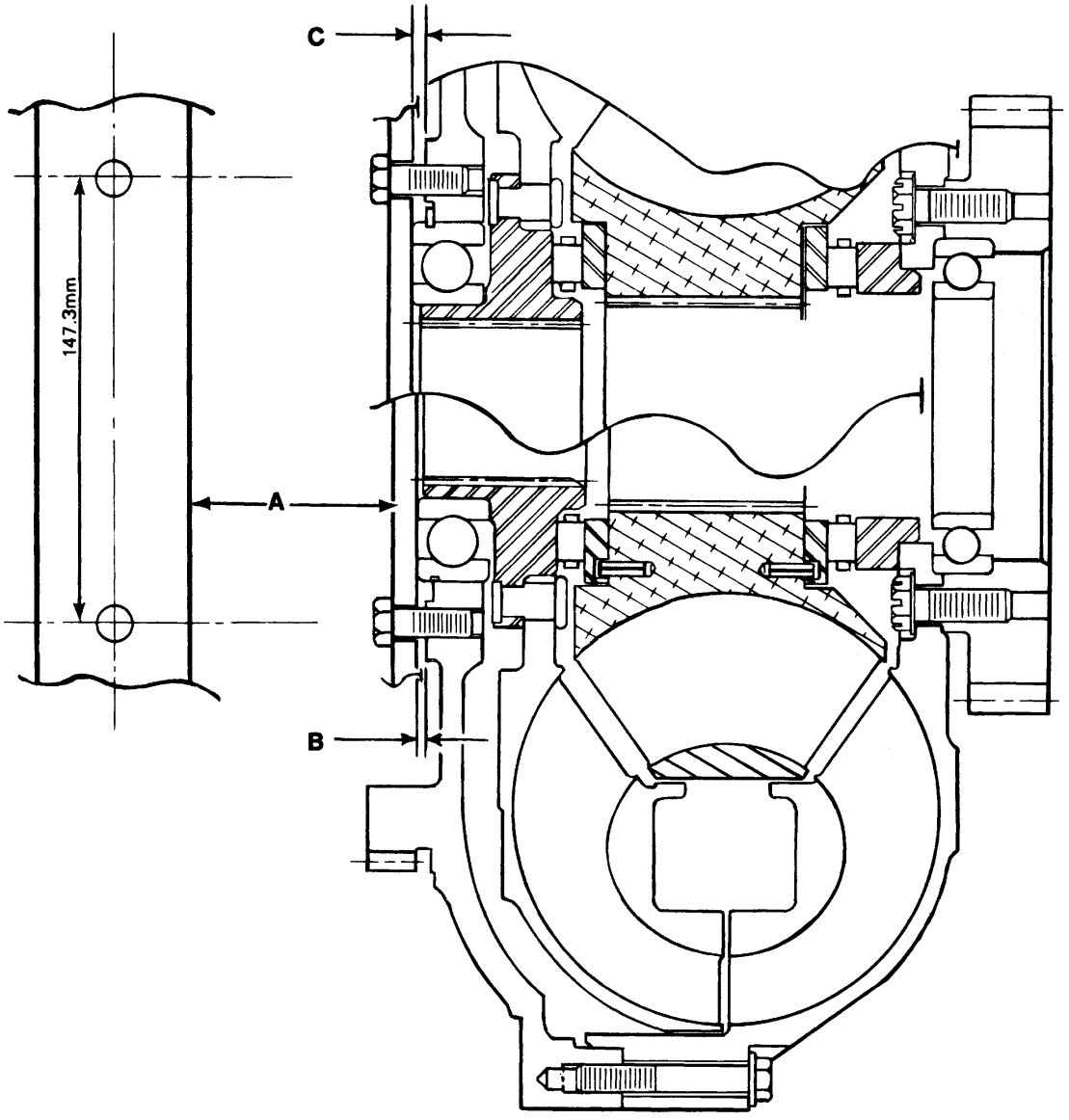


Fig. 7B.18. Determining Proper Stator Running Clearance

14. Install retaining washer (2) on the shaft (23) and secure with the bolts. Install the original amount of shims (51) and cover (1) and torque the mounting bolts to assure bottoming of bearing. Then loosen mounting bolts and tighten only finger tight. Check the clearance between cover (1) and housing (5) with a feeler gauge. There must be a clearance of 0.13-0.38 mm. If necessary, add shims (51) until clearance is obtained without having cover mounting bolts tightened. When correct gap is obtained, torque the bolts. Install O-ring (47) on housing flange. Install the cover (27) with gasket (28).

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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.*

1. Install the hydraulic and cooling pump on the torque converter.
2. Fasten the hoist and raise the torque converter into position on the aligning studs. Move the torque converter toward the engine until the drive housing gear meshes with the drive gear in the flywheel housing.

NOTE: *It may be necessary to rotate the engine flywheel to align the gear on the converter rotating housing with the flywheel ring gear.*

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

3. Install the upper mounting bolts and securing the torque converter to the flywheel housing.
4. Proceed as follows for installation torque converter lower mounting bolts:

   Install lower mounting bolts. If equipped sound absorbing lining (5, Fig. 7B.19): position the lining and install the snap fastener (6). Reconnect the pipes (2 and 4) to the manifold (3). Install tube (1) to the manifold (3).

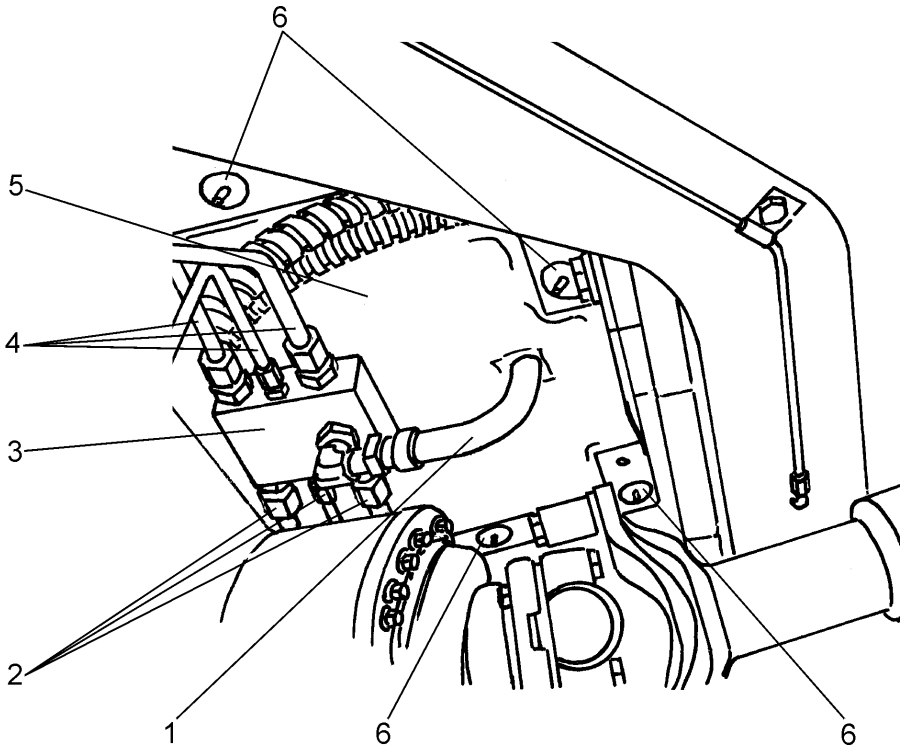


Fig. 7B.19. Reconnecting Points

1. Tube
2. Pipes
3. Manifold
4. Pipes
5. Sound Absorbing Lining
6. Snap Fastener

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5. Remove the hoist from the torque converter.
6. Install the steering and switch pump mounting bolts (13, Fig. 7B.20) and install the pump (15) with tube (14) to the torque converter (8).
7. Reconnect the hoses (19 and 20, Fig. 7B.20) to the converter charging pump (21).
8. Install the torque converter to transmission drive shaft (11, Fig. 7B.20) and torque the bolts to 130 Nm.
9. Reconnect the hoses (9, 10 and 12, Fig. 7B.20) to the torque converter (8).
10. Reconnect the hoses (16, 17 and 18, Fig. 7B.20) to the steering and switch pump (15).

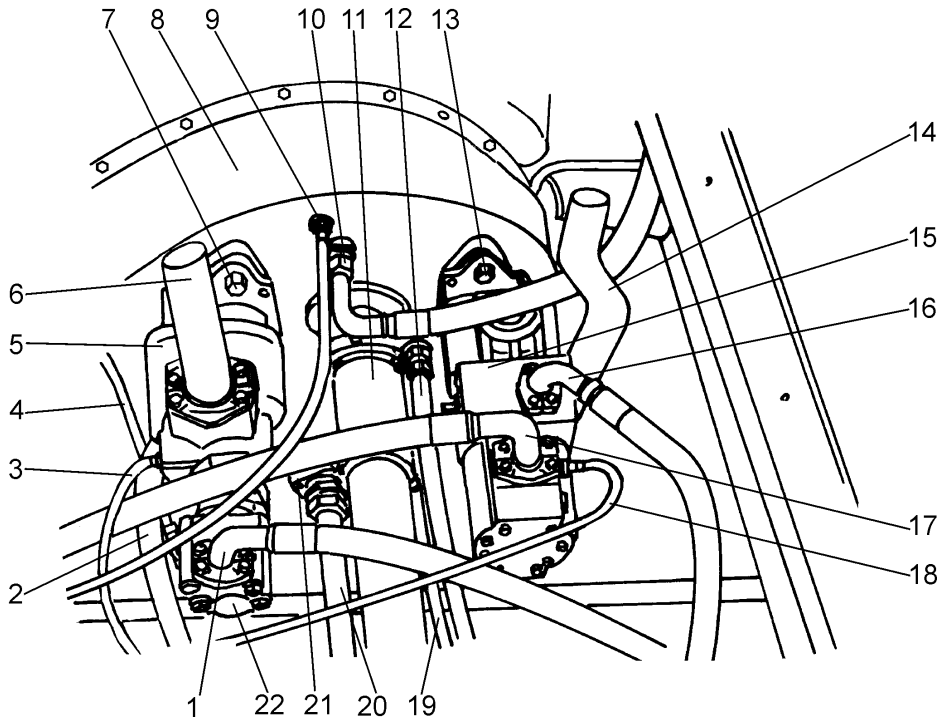


Fig. 7B.20. Torque Converter Reconnecting Points (Top View)

1. Hose
2. Hose
3. Hose
4. Hose
5. Hydraulic and Cooling Pump
6. Tube
7. Mounting Bolts
8. Torque Converter
9. Hose
10. Hose
11. Drive Shaft
12. Hose
13. Mounting Bolts
14. Tube
15. Steering and Switch Pump
16. Hose
17. Hose
18. Hose
19. Hose
20. Hose
21. Converter Charging Pump
22. Cooling Pump

11. Reconnect the hoses (1, 3 and 4, Fig. 7B.20) to the hydraulic and cooling pump (5). Reconnect the hose (3, Fig. 7B.21) to manifold (1).
12. Attach a hoist to the bulkhead and install the bulkhead with reservoir and batteries.
13. Reconnect the electrical wire (11, Fig. 7B.22) to the hydraulic filter switch on the bottom of the reservoir.

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TORQUE CONVERTER

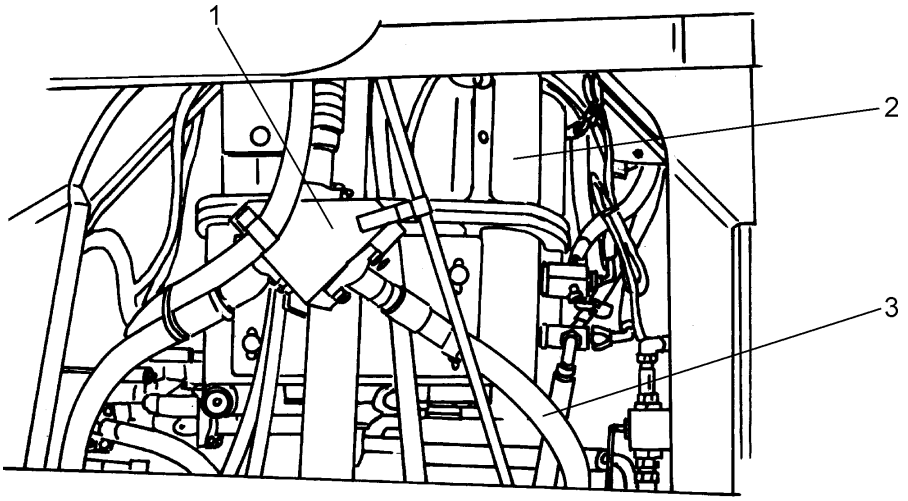


Fig. 7B.21. Reconecting Points (Top View)

1. Manifold 2. Transmission 3. Hose

14. Reconnect the loader control valve return hose (7, Fig. 7B.22), hydraulic oil cooler return hose (6), steering return surge valve (12), steering valve return hose in surge valve (11), hydraulic oil cooler supply hose in surge valve (9), drain valve hose (10), and steering switch pump section tube (8) to the bottom of the reservoir.
15. Reconnect the pilot valve return hose (1, Fig. 7B.22), ground driven steering return hose (5), ground driven steering suction hose (2) and loader pump suction tube (3) to the bottom of the reservoir.

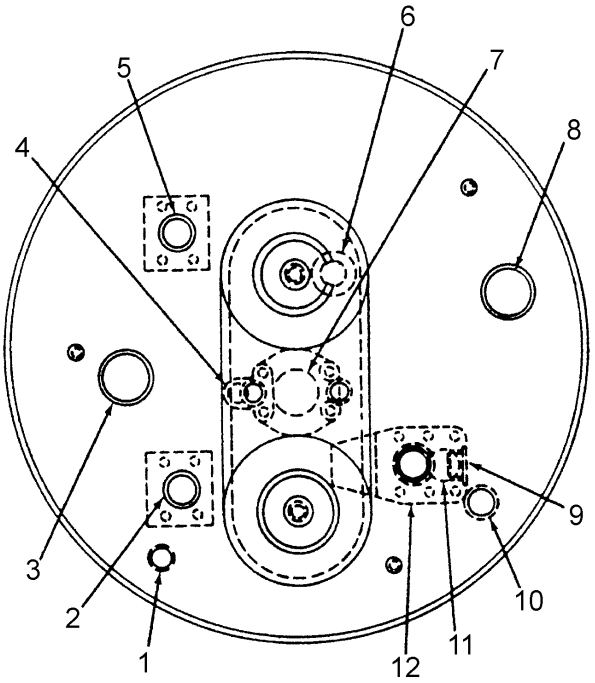


Fig. 7B.22. Hydraulic Reservoir Reconnecting Points

1. Pilot Valve Return Port
2. Ground Driven Steering Suction Port
3. Loader Pump Suction Port
4. Electrical Differential Pressure Switch
5. Ground Driven Steering Return Port
6. Hydraulic Oil Cooler Return Port
7. Loader Control Valve Return Port
8. Steering Switch Pump Suction Port
9. Hydraulic Oil Cooler Supply Port in Surge Valve
10. Drain Valve Port
11. Steering Valve Return Port in Surge Valve
12. Steering Return Surge Valve

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TORQUE CONVERTER

16. Reconnect the cables to the batteries.
17. Fill the reservoir. Refer to the OPERATOR'S MANUAL.
18. Install the center hood (8, Fig. 7B.23), precleaner (7), aspirator tube (6) and exhaust pipe (5). Install the side hood (4) on each side to the engine. Install the access panel (3) and access door (2) on both side to the engine. Install the shields on each side to the bulkhead. Install the left and right fender (1).

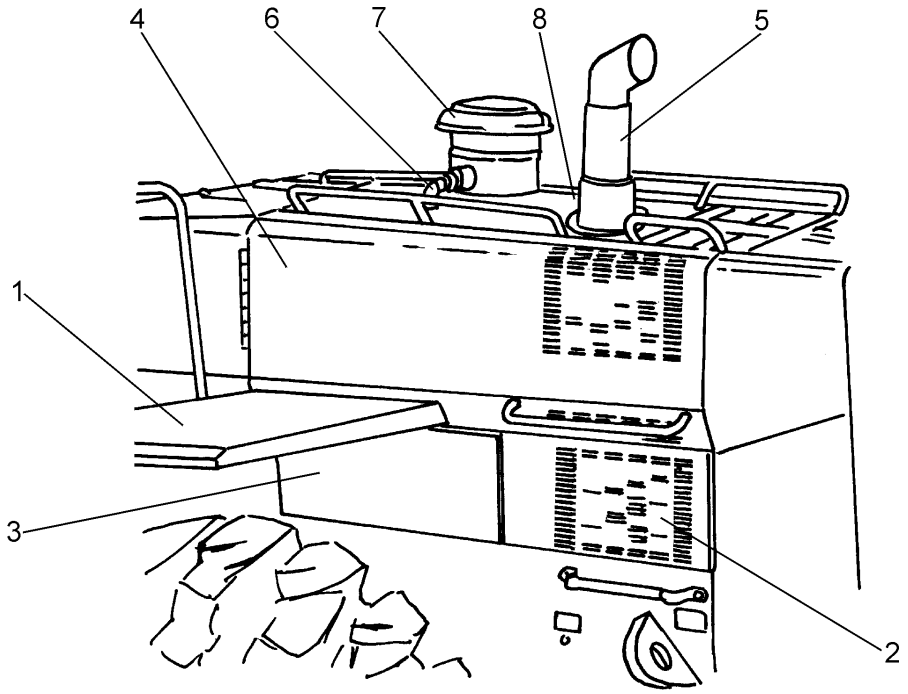


Fig. 7B.23. Hood and Side Panels

1. Fender
2. Access Door
3. Access Panel
4. Side Hood
5. Exhaust Pipe
6. Aspirator Tube
7. Precleaner
8. Center Hood

19. Simultaneously check all torque converter and transmission oil pressure as described in CHECKING TRANSMISSION AND TORQUE CONVERTER PRESSURES in SECTION 7C.

NOTE: *It is recommended that the transmission oil filters be serviced after the first 10 hours of operation and again at 50 hours of operation. Refer to the OPERATOR'S MANUAL for procedure. Thereafter, service the filter at the normal scheduled interval.*

CHARGING PUMP

10. DESCRIPTION AND OPERATION

The charging pump is a single element, positive displacement gear-type pump. It is bolted to the lower center front surface of the torque converter. Inside the torque converter, a drive gear is mounted on the pump shaft and is meshed with the accessory drive gear.

The pump draws oil through the strainer assembly in the transmission sump. Oil leaving the pump is directed to the pressure filters and to the transmission control valve.

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CHARGING PUMP

11. SPECIAL TORQUES

Pump Cover Bolts . . . . . 40 to 45 Nm

12. REMOVAL

IMPORTANT: *Disconnected hydraulic 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 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. Remove the charging pump inlet and outlet hoses.
2. Remove the access cover from the bottom of the torque converter and remove the nut and drive gear from the pump shaft.
3. Remove the pump mounting bolts and remove the pump. Discard the pump mounting O-ring.

13. DISASSEMBLY (Refer to Fig. 7B.24)

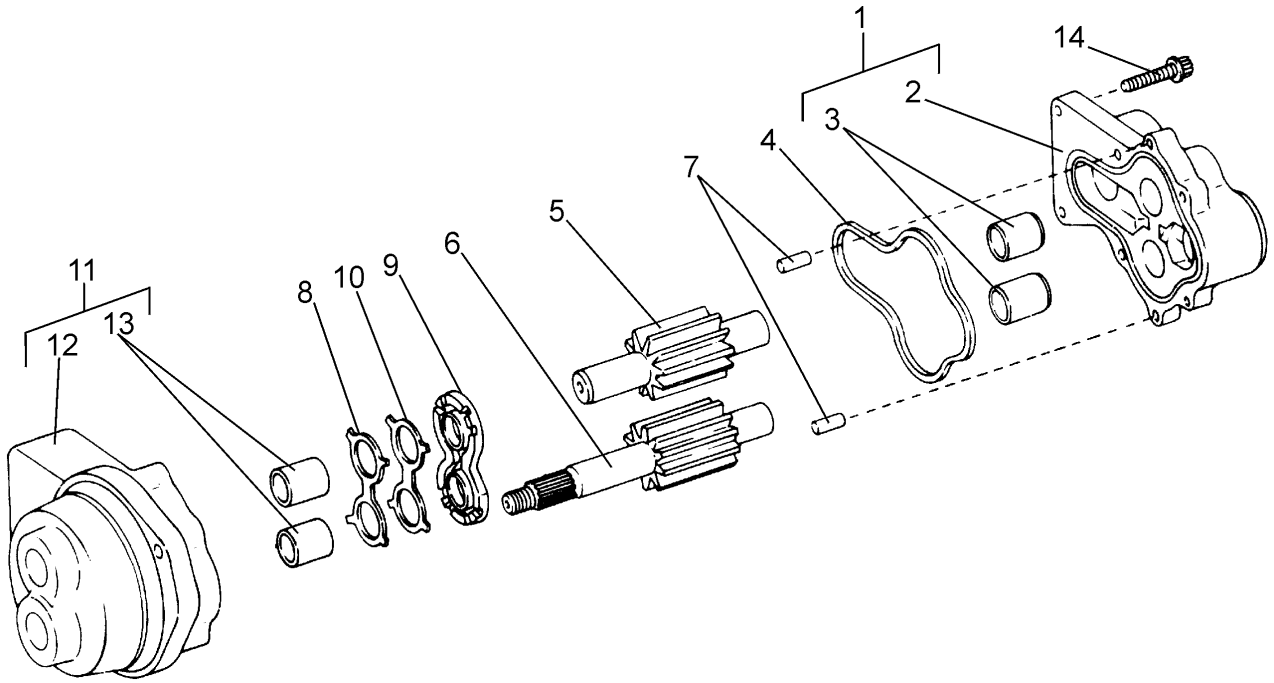


Fig. 7B.24. Exploded View of Charging Pump

1. Cover Assembly	5. Driven Gear	9. Wear Plate	13. Bushing
2. Cover	6. Drive Gear	10. Pressure Loading Seal	14. Bolt
3. Bushing	7. Dowel Pin	11. Body Assembly	
4. Gasket	8. Seal	12. Body	

1. Remove bolts (14). Tap around cover (2) with a soft mallet to free the cover from dowel pins (7). Lift cover (2) off body (12).
2. Remove and discard gasket (4) from the cover.

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HYDRAULIC TORQUE CONVERTER

CHARGING PUMP

NOTE: *The bushings (3) are not serviceable and should not removed from the cover.*

3. Index mark the teeth of gears (5 and 6) to retain the original mesh so that the same wear pattern will be re-established if the original gears are reinstalled.
4. Remove drive gear (6) and driven gear (5) from the pump body.
5. Remove wear plate (9), seal (10 and 8).

14. INSPECTION AND REPAIR

1. It is recommended that new O-ring, gasket and oil seals be installed when the pump is disassembled for service.
2. Wash all parts thoroughly in a suitable solvent. Dry thoroughly with compressed air.
3. Inspect bushing (3 and 13) for scoring or gouging.
4. Inspect the gears for signs of wear, chipped or broken teeth.
5. Inspect wear plate for excessive wear on the running surface.
6. Inspect the gear pockets in the pump body for signs of wear or scoring.

15. REASSEMBLY (Refer to Fig. 7B.24)

1. Install a new seal (8 and 10) in wear plate (9) and install the wear plate in the pump body (11).
2. Install drive gear (6) and driven gear (5) in the pump body. If the original gears are used, align the index marks on the teeth.
3. Install a new gasket (4) in the groove of cover (2) and secure the cover to the pump body. Torque the bolts to 40 - 45 Nm.

16. INSTALLATION

1. Install a new mounting O-ring on the pump. Coat the bore of the converter housing with heavy grease. Start the pump in by hand, being sure to position the pump correctly as it is hard to turn the pump once it is started in the housing bore. Tap the pump into place using a soft hammer and secure with the lock washers and bolts.
2. Working through the access hole in the bottom of the converter, install the drive gear on the pump shaft and secure with the nut.
3. Install the access cover with a new gasket to the bottom of the converter.
4. Reconnect the charging pump inlet and outlet hoses.

NOTE: *It is recommended that the transmission oil filters be serviced after the first 10 hours of operation and again at 50 hours of operation. Refer to the OPERATOR'S MANUAL for procedure. Thereafter, service the filters at the normal scheduled interval.*

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TRANSMISSION

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TRANSMISSION

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GENERAL

1. DESCRIPTION

General

This machine is equipped with a remote mounted power shift transmission of countershaft constant mesh gear type. It provides high speed shifting by the use of multiple disc, hydraulically actuated clutches which allow the machine to operate in three speeds forward and three speeds in reverse.

Power is transmitted from the torque converter output shaft through a drive shaft to the input yoke on the transmission rear cover. Output from the transmission is sent fore and aft through drive shafts to the front and rear differentials on the axles.

Transmission Housing

Mounted on the transmission housing are the transmission control valve and a breather for venting both the transmission and torque converter. The lower portion of the transmission housing serves as a common sump for the transmission/torque converter system.

The transmission contains five shafts: the directional shaft (2, Fig. 7C.1) carrying the forward clutch pack (3) and the reverse clutch pack (4); the reverse idler shaft (1); the first speed shaft (5) carrying the first speed clutch pack (6); the second and third speed shaft (7) carrying the second speed clutch pack (9) and the third speed clutch pack (8); and the output shaft (10). All the shafts are supported at both ends by bearings. Every gear is in constant mesh with at least one other gear on another shaft.

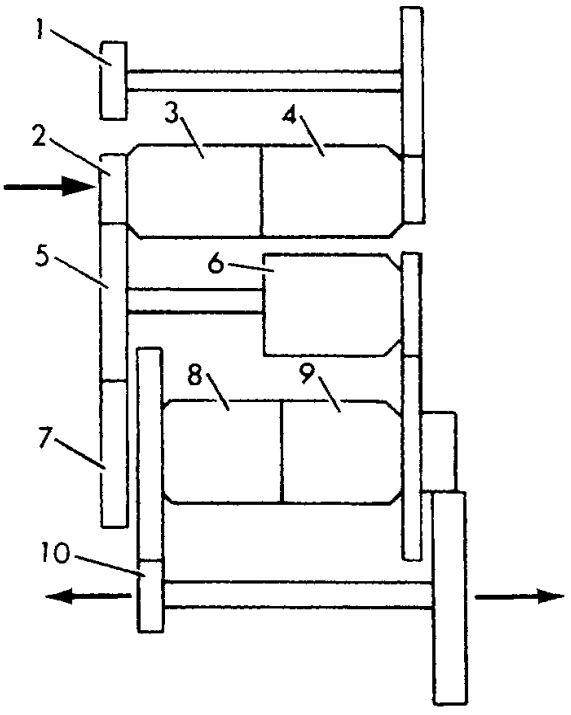


Fig. 7C.1. Transmission Shafts

1. Reverse Idler Shaft
2. Directional Shaft
3. Forward Clutch Pack
4. Reverse Clutch Pack
5. First Speed Shaft
6. First Speed Clutch Pack
7. Second and Third Speed Shaft
8. Third Speed Clutch Pack
9. Second Speed Clutch Pack
10. Output Shaft

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GENERAL

Transmission Control Valve

The transmission control valve is mounted on the lower front surface of the transmission and is composed of two parts. The outer half contains two spools which control the directional and the speed clutch packs. The second half contains three relief valves which control the main, converter and lube pressures in the system. Also contained in this section is a hydraulic operated spool which disconnects the transmission when the left hand brake pedal is actuated.

Power Flow Through the Transmission

Clutch pack gears (1 through 5, Fig. 7C.2) all ride on caged roller bearings which allow them to free-wheel on their shafts. However, if a particular clutch pack is engaged, its gear becomes locked to the shaft and is forced to turn with the shaft.

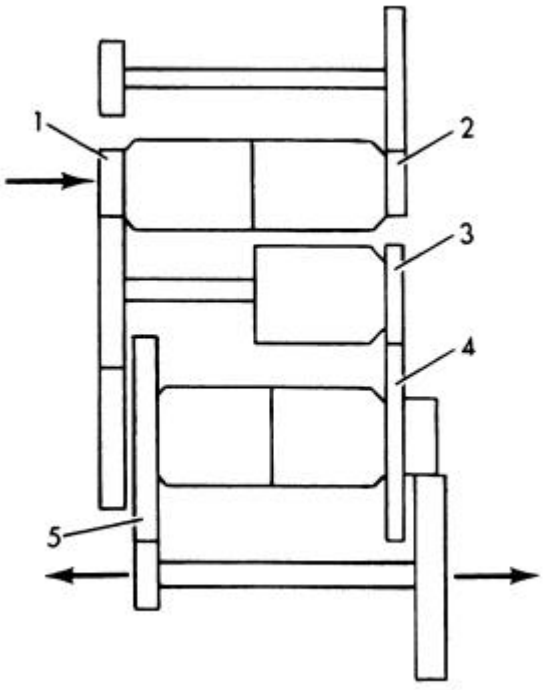


Fig. 7C.2. Clutch Pack Gears

1. Forward Clutch Pack Gear
2. Reverse Clutch Pack Gear
3. First Clutch Pack Gear
4. Second Clutch Pack Gear
5. Third Clutch Pack Gear

Fig. 7C.3 shows how power flow is a chain reaction from input to output through a series of interlocking gears. Every gear is in constant mesh with at least one other gear on another shaft.

For power to flow through the transmission it is necessary that one speed clutch pack and one directional clutch pack be engaged. The range spool in the transmission control valve has no “neutral” position, so one of the speed clutch packs is always engaged when the engine is running. The directional spool in the transmission has a “neutral” position, so with the spool in this position, both forward and reverse clutch packs are disengaged and their gears (1 and 2, Fig. 7C.2) are freewheeling on the directional shaft.

Power enters the transmission through the input yoke which is splined to the directional shaft. But when both directional gears (1 and 2, Fig. 7C.2) are freewheeling, there is no power to drive the adjacent gears and shafts, so power flow ends, the transmission is in “neutral” and the machine can not move.

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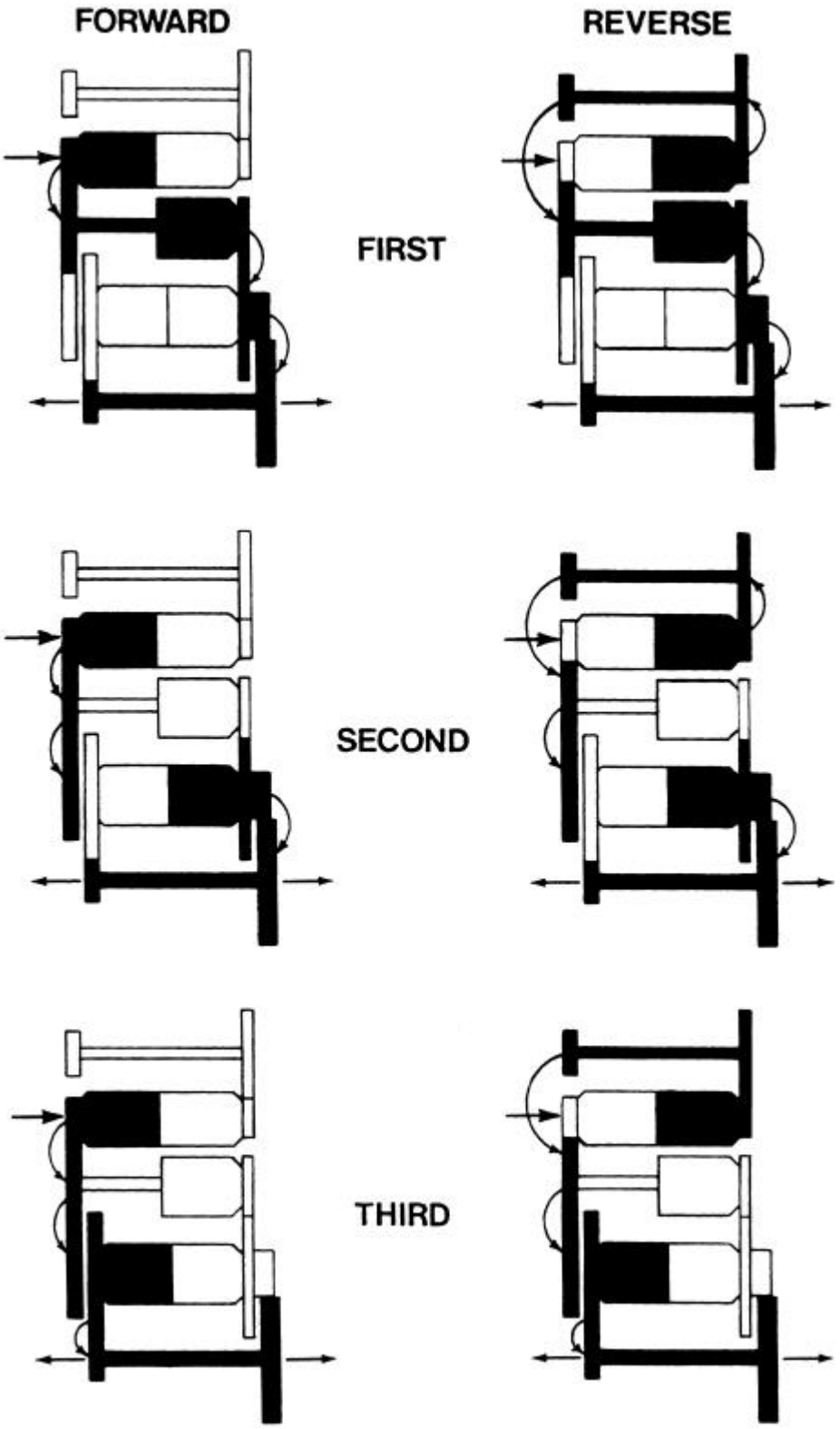


Fig. 7C.3. Power Flow Through the Transmission in All Gears

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The six diagrams in Fig. 7C.3 illustrate the six possible gearing combinations. In first forward, for example, an engaged forward clutch pack locks the forward gear into turning with the directional shaft. The rotating forward gear forces the first speed shaft to turn. The engaged first speed clutch pack locks the first speed gear into turning with the shaft. The rotating first speed gear forces the second gear to turn which forces the output shaft to turn. The power is then transmitted fore and aft to the axles.

In any forward gear, power is transmitted through the gears on four shafts, causing the input and output yokes to rotate in opposite directions. In any reverse gear, power is transmitted through the gears on five shafts, causing the input and output yokes to rotate in the same direction.

2. OPERATION

Hydraulic Oil Flow

The hydraulic oil flow through the transmission and torque converter is described in Section 7.

Hydraulic Clutch Packs

All the clutch packs and shafts in this transmission have nearly identical construction. The one difference is that the first speed shaft carries only the first speed clutch pack, while all the others are two clutches on a single shaft with a common apply force piston between them. However, the operation of all the packs is the same.

Fig. 7C.4 is a cross section of the directional shaft, with the forward clutch pack to the left and reverse to the right. The two packs are divided by a middle plate (6). On both sides of the middle plate is a reinforcing disc valve (16), and an accelerator piston (8). Inside the middle plate are guide pins (18), and compression springs (14 and 15). All of these parts are encased in the force piston assembly (7).

A drilled passage through the center of the shaft (13) delivers oil to the packs. A tube (12) is pressed into the right half of the drilled passage to separate the oil going to each pack.

The clutch hubs (1) are splined to the shaft and the bronze friction discs (5) are splined to the outer diameter of the clutch hubs. The drive gear and drum (3) are welded together, with separator plates (4) splined to the inside of the drum.

NEUTRAL (Fig. 7C.4): In neutral, all cavities are filled with oil at lube pressure. The large vertical passages supply oil to the accelerator piston cavities (A and D). The small vertical passages supply oil to cool and lubricate the clutch hubs, the friction discs and separator plates and the bearings (19) below the drive gears. Small orifices in the accelerator pistons feed oil to the force piston cavities (B and C). With equal pressure on both sides of the middle plate, the force piston assembly is centered mechanically by the centering springs (11). Neither clutch pack is engaged, but the shaft is turning. This means that everything which is splined to the shaft or held with snap rings is also turning, including the bronze friction plates on the clutch hubs. Freewheeling on the shaft are both drive gear and drum assemblies, including the separator plates splined to the drums.

INITIAL TRAVEL PHASE (Fig. 7C.5): When the directional lever in the cab is moved to “forward”, the mechanical linkage moves the direction spool in the transmission control valve to channel main pressure oil to the forward clutch pack.

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Main pressure fills accelerator piston cavity “A” and also lubricates the separator plates and the bearings underneath the forward drive gear. Since access to the force piston cavity “B” is through an orifice (1) in the accelerator piston (2), pressure in cavity “B” has not had time to reach main pressure and is still at lube pressure.

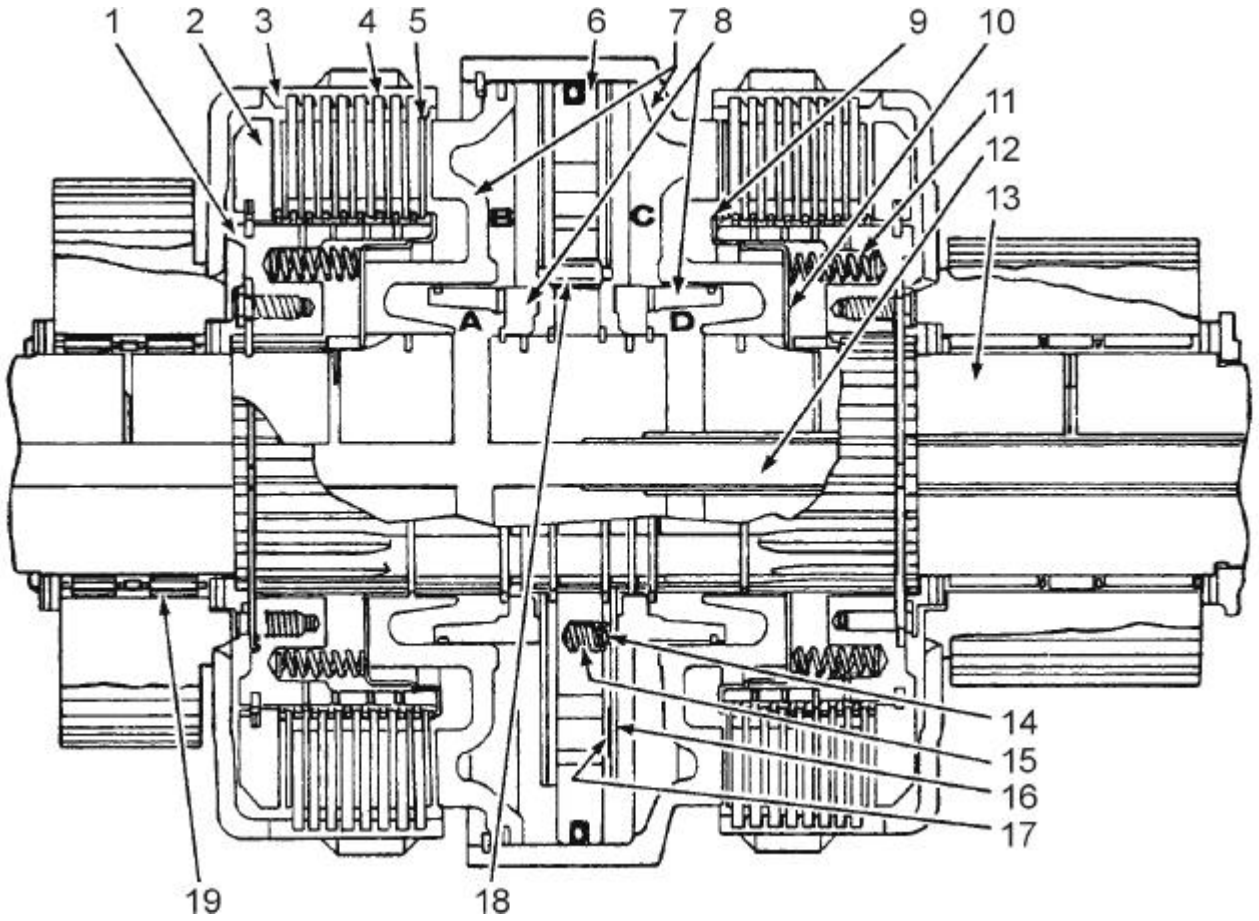


Fig. 7C.4. Clutch Pack in Neutral Position

1. Clutch Hub
2. Backing Plate
3. Drive Gear and Drum
4. Separator Plate
5. Friction Disc
6. Middle Plate
7. Force Piston Assembly
8. Accelerator Piston
9. Clutch Plate Retainer
10. Centering Spring Retainer
11. Centering Spring
12. Clutch Shaft Tube
13. Clutch Shaft
14. Inner Compression Spring
15. Outer Compression Spring
16. Disc Valve
17. Reinforcing Disc
18. Guide Pin
19. Bearings

Very little extra oil actually flows into the clutch pack to create main pressure for actuation. The pack is already filled with oil, so the shift form lube to main in only an increase in the pressure of the oil already there. Extra oil only fills in the gaps caused by the movements of the components under pressure. Because of this, a clutch can be actuated in about one second or less. No time is lost emptying and filling the cavities. But a lot happens in that short span of time.

SECONDARY TRAVEL PHASE (Fig. 7C.6): As main pressure fills cavity „A”, it acts first against the accelerator piston (1), pushing it to the right against the middle plate (2). This also forces the reinforcing disc and disc valve (3) in cavity „B” against the middle plate. At the same time, the guide pin (4) is pushing the other reinforcing disc and disc valve, in cavity „C”, away from the middle plate.

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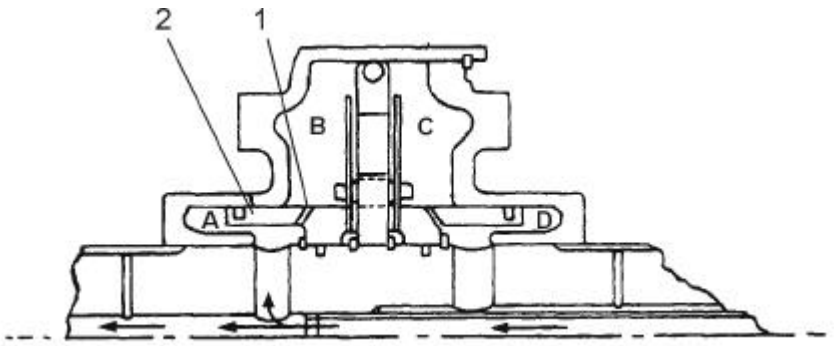


Fig. 7C.5. Clutch Pack Initial Travel Phase

1. Orifice
2. Accelerator Piston

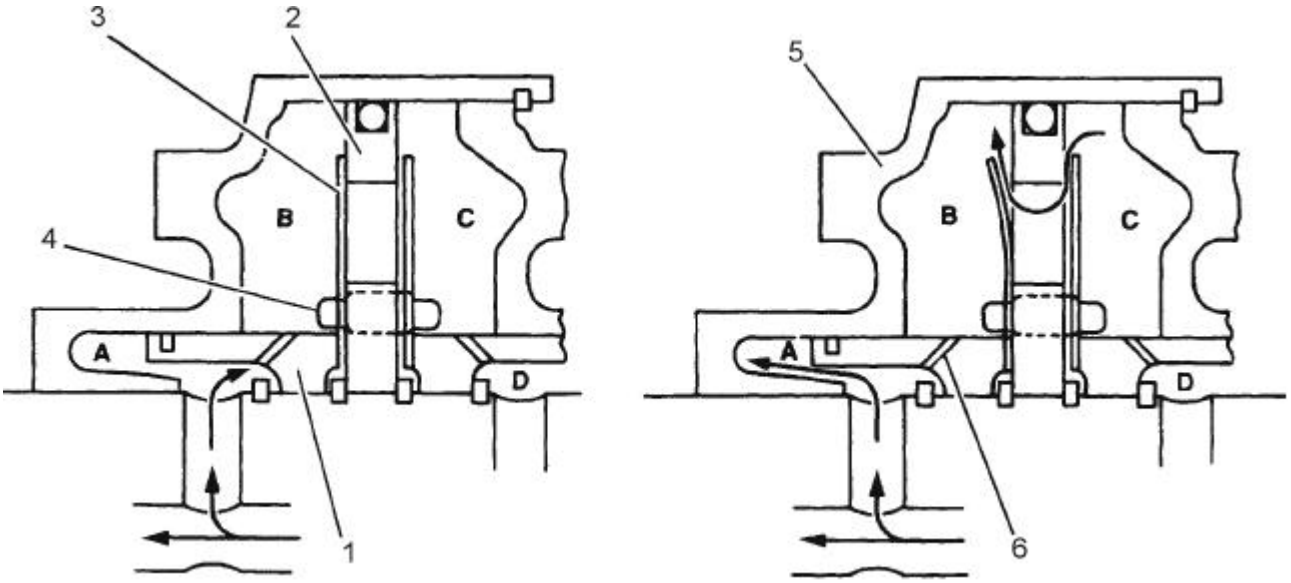


Fig. 7C.6. Clutch Pack Secondary Travel Phase

1. Accelerator Piston
2. Middle Plate
3. Reinforcing Disc and Disc Valve
4. Guide Pin
5. Force Piston
6. Orifice

Immediately after this, main pressure begins to act against the force piston (5), pushing it to the left. Cavity „B" is now expanding, while cavity „C" contracts by an equal amount.

With the guide pin (4) holding the disc open in cavity „C", oil is transferred through the hole in the middle plate into cavity „B". This oil transfer greatly accelerates the travel phase since little additional oil is needed to fill the expanding cavity „B", and the orifice (6) is just beginning to transmit main pressure into „B".

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APPLY PHASE (Fig. 7C.7): The apply phase starts when the force piston (1) begins to compress the clutch plates (2 and 3) together. At this point the pressure has increased in cavity „B" because of the flow through the orifice. Now main pressure is acting against all the surfaces inside the cavity and driving the force piston farther to the left.

The rotating friction discs (2) on the hub are pushed into the freewheeling separator plates (3) on the drum (4). The separator plates are forced to turn with the friction plates, so the drum and forward drive gear (5) must turn, too. The drive gear is now „engaged".

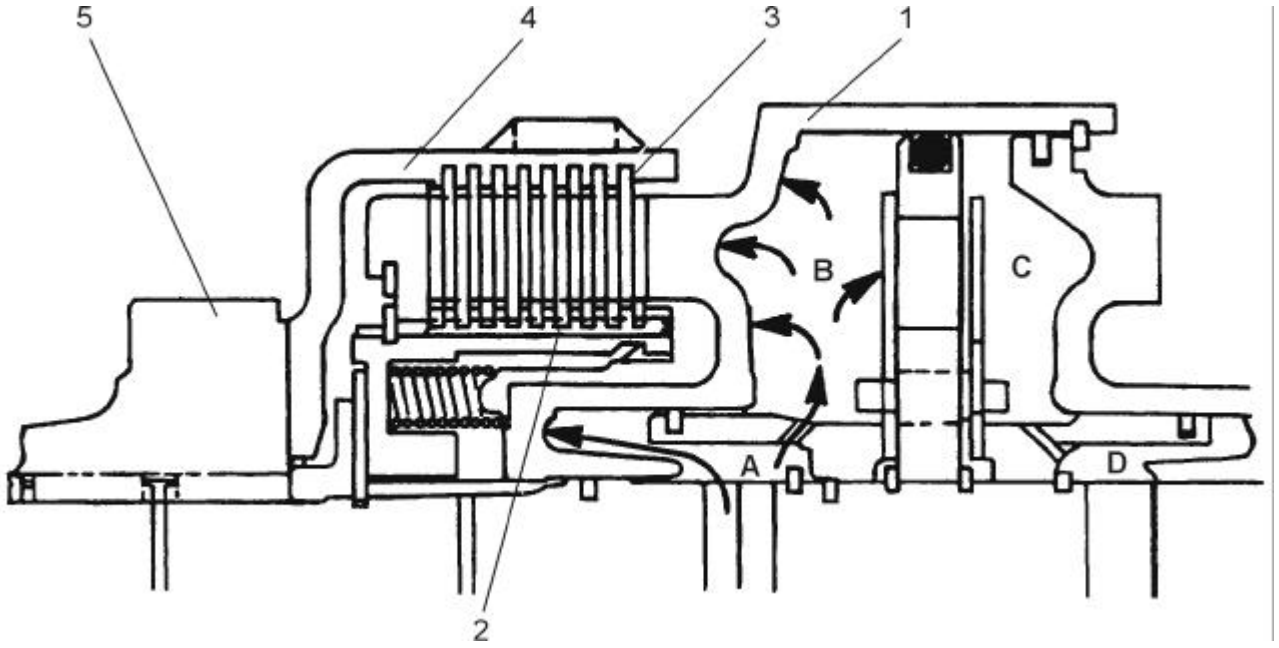


Fig. 7C.7. Clutch Pack Apply Phase

1. Force Piston
2. Friction Disc
3. Separator Plate
4. Drum
5. Forward Drive Gear

MODULATION: The engagement of the drive gear is the result of a gradual build-up of pressure. The initial movement of the force piston during the travel phase reduces the gap between the separator plates and the friction discs. The friction discs are still freewheeling, but the movement of the fluid inside the pack is already causing the discs to begin turning in the same direction as the separator plates.

The flow of main pressure through the orifices comes as a secondary action, applying force against the inside of cavity „B" and moving the force piston into full contact with the clutch plates.

This two step process is called „modulation" and is accomplished by the slower passage of main pressure through the orifices. This results in a more even, smoother transition into gear engagement because the drive gear is already beginning to rotate before the full force of main pressure brings the plates into contact.

RELEASE PHASE (Fig. 7C.4): When the directional lever in the cab is returned to „neutral", main pressure in the forward clutch pack is released and the oil in the pack is now regulated by the lube pressure system. An immediate pressure drop occurs in cavity „A". The compression springs (14 and 15) push against the reinforcing disc (17) and disc valve (16) and force the accelerator piston away from the middle plate (6). Simultaneously, the centering spring (11) which have been compressed under main pressure, act against the force piston (7) to return it to its neutral position.

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TRANSMISSION

GENERAL

3. SPECIFICATIONS

General

Transmission type . . . . . .Countershaft, constant mesh
Speeds . . . . . Three forward, three reverse
Clutches . . . . . Multiple disc, pressure balanced, oil cooled

Special Torques

Transmission housing mounting bolts . . . . . .70 Nm
Transmission shaft bearing retainer caps (all) . . . . . 70 Nm
Transmission sump strainer adapter mounting bolts . . . . . .80 Nm
Yoke retainer nuts:
Input . . . . . .270 - 410 Nm
Output . . . . . 815 - 1085 Nm

Dimensions

Forward / reverse shaft end play . . . . . 0.18 - 0.28 mm
Reverse idler shaft end play . . . . . 0.18 - 0.28 mm
First speed shaft end play . . . . . 0.18 - 0.28 mm
Second / third speed shaft end play . . . . . 0.18 - 0.28 mm
Output shaft end play . . . . . 0.25 - 0.36 mm
Clutch pack drum „run out” (max.) (all clutch packs). . . . . 1.78 mm
Forward / reverse clutch pack final clutch hub assembly:
aligned running clearance . . . . . 0.8 mm
Mis-aligned running clearance . . . . 3 - 5 mm

Spring Test Load Data

All clutch packs:
Reinforcing disc and valve:
Outer spring:
Free length . . . . . 13.3 mm
Test length . . . . . 7.6 mm
Test load . . . . . 58 + 6 N
Total number of coil 6
Inner spring:
Free length . . . . . 15 mm
Test length . . . . . 7.6 mm
Test load . . . . . 27 N
Total number of coil 9
Forward / reverse and second / third clutch packs:
Clutch hub spring:
Free length . . . . . 50 mm
Test length . . . . . 35.6 mm
Test load . . . . . 111 ± 11 N
Total number of coil 14
Transmission control valve:
Detent springs:
Free length . . . . . 27 ± 0.9 mm
Test length . . . . . 28.6 mm
Test load . . . . . 95 N
Total number of coil 16.5

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TRANSMISSION

4. REMOVAL

WARNING! Before servicing the machine be sure the bucket is lowered, the engine is off, the parking brake is applied, the transmission shift lever is locked in neutral (N), the electrical system master switch is off and the keys are removed from master switch and from starting switch.

WARNING! always lock the frames together before working near the center of the machine. If the frames move, serious injury or death could result.

IMPORTANT: *Before removing the transmission, simultaneously check all oil pressures as described under Par.7, CHECKING TRANSMISSION AND TORQUE CONVERTER PRESSURES in Section 7*

IMPORTANT: *Disconnected 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 as this could introduce foreign material into the system. Tag all disconnected lines for ease of correct installation.*

NOTE: *The transmission weighs approximately 1180 kg.*

1. Raise the machine up at least 500 mm off the ground. This is necessary to obtain clearance for the transmission to pass under the frame sides or the fuel tank. The front and rear of the machine must be kept on the same level so that the transmission will come straight down through the frame.

2. Remove the transmission guard from under machine. Also remove the top shield from above the transmission, if equipped.

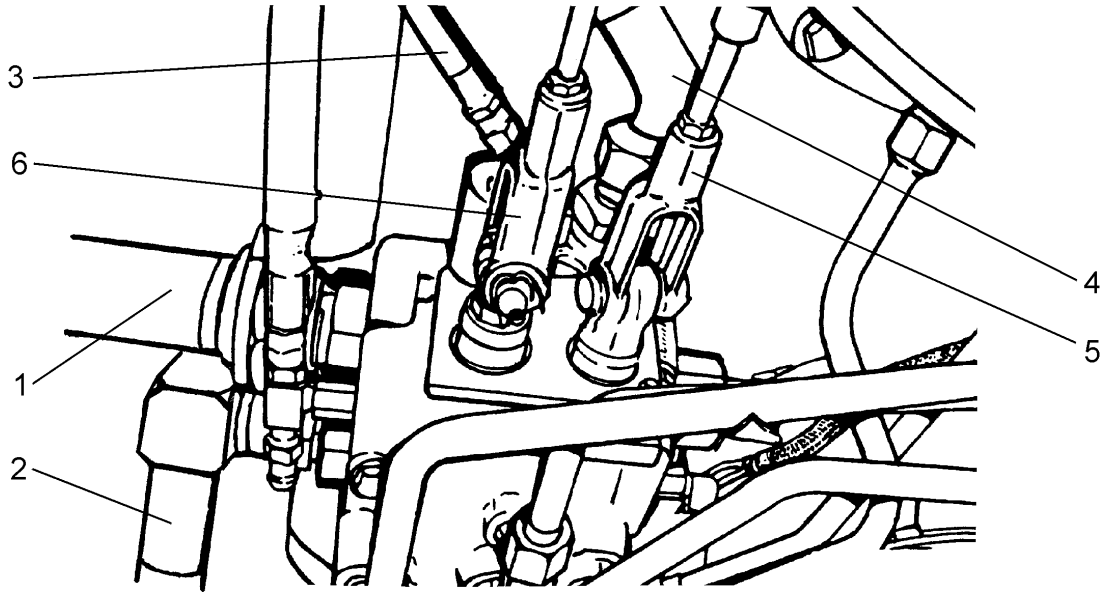


Fig. 7C.8. Control Valve Disconnects

1. Pump Pressure Hose
2. Oil Cooler Return Hose
3. Transmission Disconnect Hydraulic Hose
4. Torque Converter Supply Hose
5. Directional Control Cable
6. Range Control Cable

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TRANSMISSION

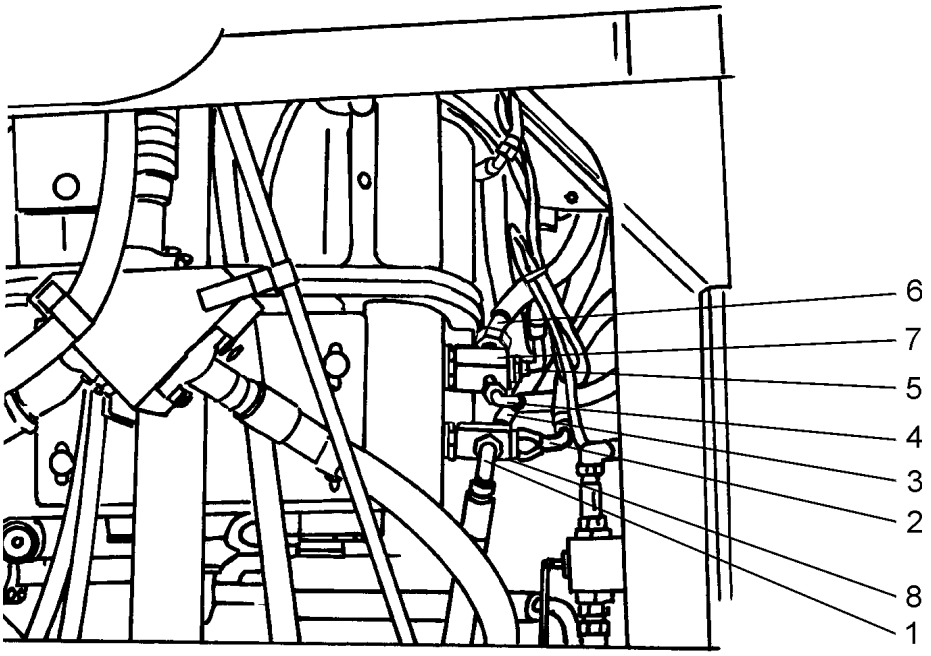


Fig. 7C.9. Upper Right Side of Transmission

1. Hydraulic Hose
2. Hydraulic Hose
3. Hydraulic Hose
4. Hydraulic Hose
5. Hydraulic Hose
6. Hydraulic Hose
7. Connector
8. Connector

3. Drain the oil from the hydraulic reservoir and the transmission. Refer to the OPERATOR'S MANUAL for this procedure.

4. Disconnect all hoses (1, 2, 3 and 4, Fig. 7C.8) from the transmission control valve. Remove the hose (3 and 4) from the bracket on the rear of the transmission.

5. Disconnect the control cables (5 and 6, Fig. 7C.8) on the transmission control valve and remove the cables from the bracket on the front of the transmission.

6. Disconnect the wires from the neutral start switch on the transmission control valve (19, Fig. 7C.15).

7. Disconnect the hydraulic hoses (1 through 6, Fig. 7C.9) from the two connectors (7 and 8) on upper right side of the transmission and remove the connectors.

8. MACHINES EQUIPPED WITH GROUND DRIVEN STEERING: Remove the ground driven steering pump from the rear of the transmission as described in Section 10A.

9. Remove the filler tube from the right side of the transmission (15, Fig. 7C15).

10. Disconnect three hoses (1, 2 and 3, Fig. 7C.10) from the lower rear of the transmission.

11. Disconnect hoses (1 and 3, Fig. 7C.11) and hose (5, Fig. 7C.13) from the manifold. Secure the hoses up out of the way.

12. Remove clamps (6 and 7, Fig. 7C.11) from the manifold and clamp (5) from holder (8)

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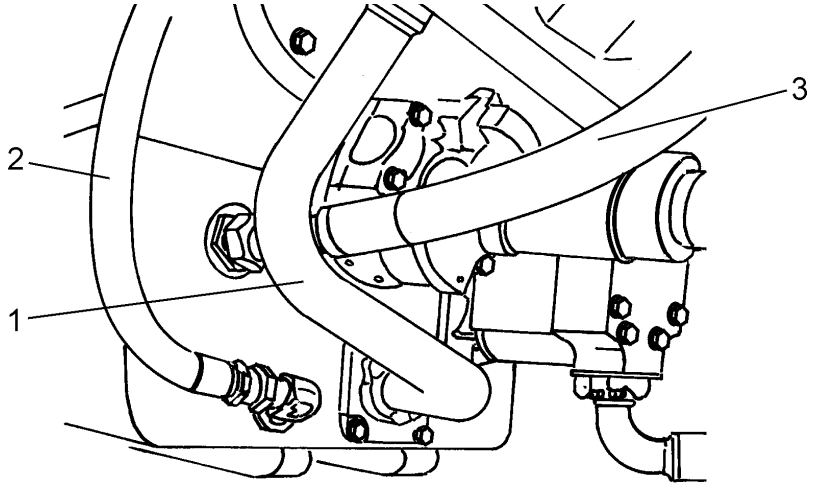


Fig. 7C.10. Lower Rear of Transmission
1. Transmission to Drive Pump Hose
2. Transmission to Brake Cooling Pump Hose
3. Torque Converter Drain Hose

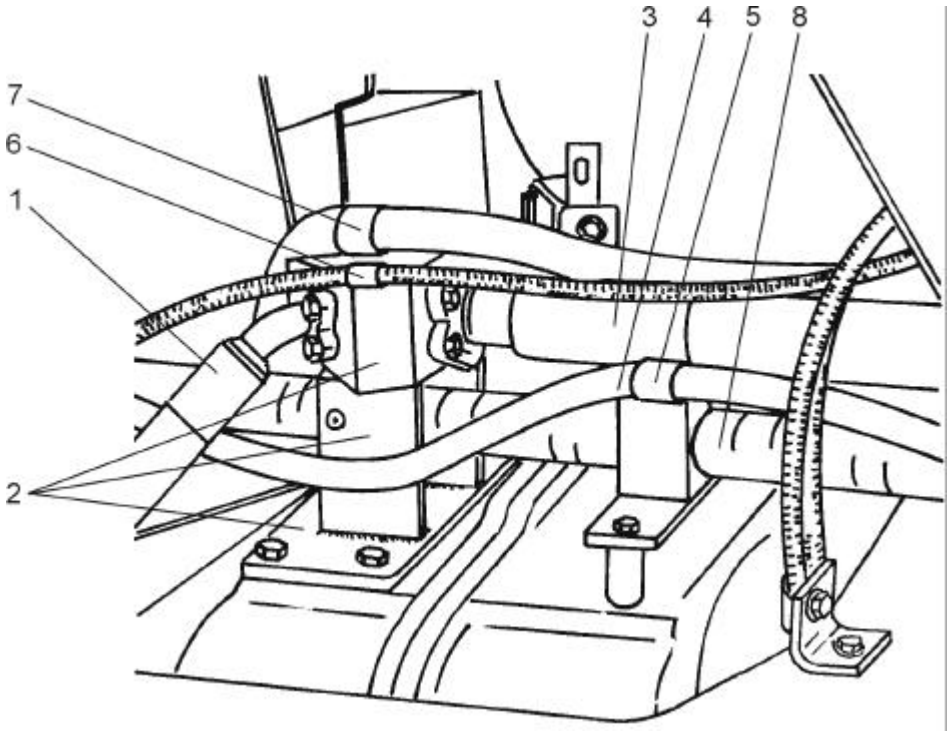


Fig. 7C.11. RH Disconnects

1. Loader Pump to Manifold Hose
2. Manifold with Bracket
3. Manifold to Loader Valve Hose
4. Hose
5. Clamp
6. Clamp
7. Clamp
8. Hose

13. Disconnect the drive shafts from the transmission and remove them out of the machine.

14. Disconnect hoses (4 and 8, Fig. 7C.11) from the bottom of the hydraulic reservoir.

15. Disconnect the manifold w/bracket (2, Fig. 7C.11) and plate (3, Fig. 7C.13) from the transmission.

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16. Remove any straps securing disconnected hoses and wires to the transmission or another hoses.

17. The disconnected hoses (4 and 8, Fig. 7C.11), together with manifold w/bracket (2) and holder w/plate (3 and 4, Fig. 7C.13), move to the left side in order to clear the space over the top of the transmission.

18. Block up under the transmission to keep it from tipping. Remove the sleeve and bracket (1 and 2, Fig. 7C.13).

19. Using two eye bolts with thread 3/4-10” attach a hoist to the top of the transmission and take up the slack.

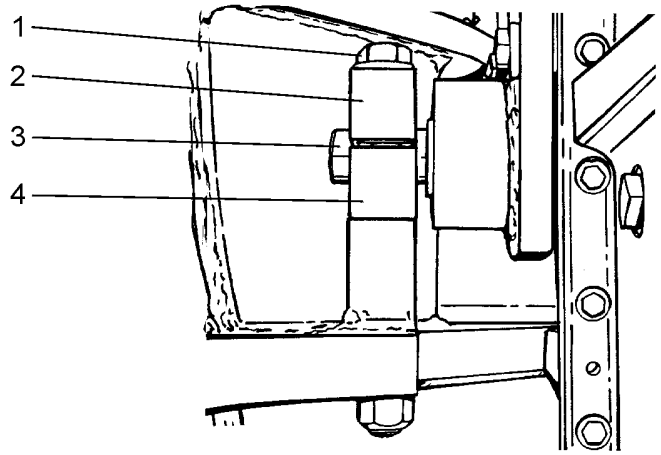


Fig. 7C.12. Lower Transmission Mount

1. Bolt
2. Upper Cap
3. Mounting Shaft
4. Lower Cap

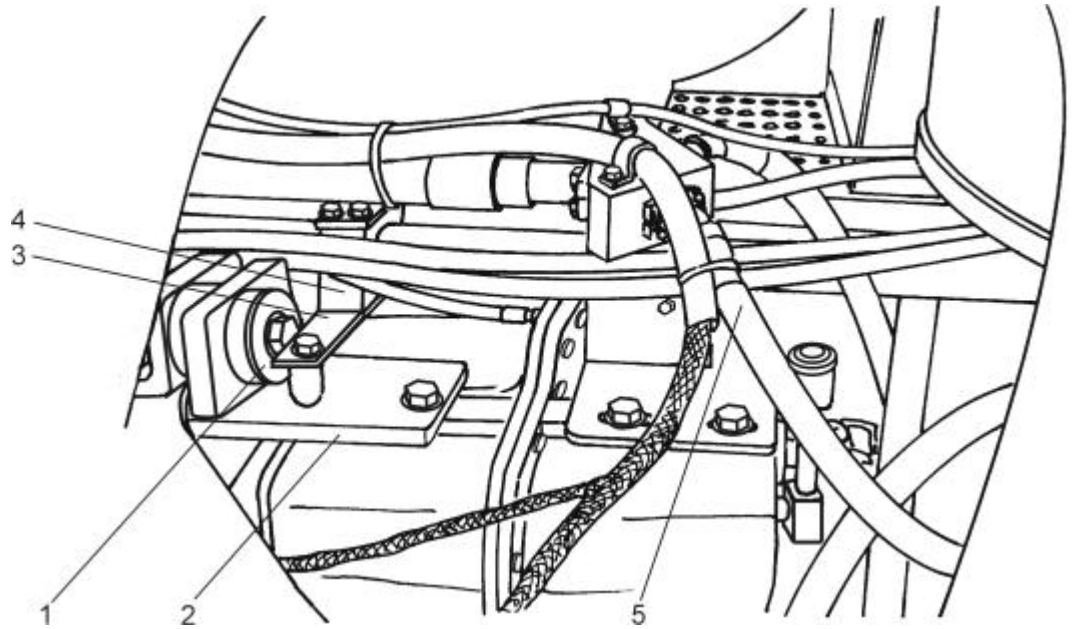


Fig. 7C.13. LH. Disconnects

1. Sleeve
2. Bracket
3. Plate
4. Holder
5. Steering/Switch Pump to Manifold Hose

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20. Remove bolts (1, Fig. 7C.12) and cap (2) from both sides of the transmission. Lift up on the transmission and remove shafts (3) and caps (4).

21. Remove the blocking and lower the transmission from the machine.

5. DISASSEMBLY

NOTE: *Special tools are required for disassembly. Refer to SERVICE / SPECIAL TOOLS in Section 1.*

Main Housing (Refer to Fig. 7C.14)

1. Clean the exterior of the transmission to remove all dirt and grease.

2. Place the transmission in a vertical position .

3. Remove and tag tubes (1 through 6, Fig. 7C.15) and hose (7). Remove the transmission control valve (8).

4. Remove lock nut (51), spacer (52), O-ring (53) and yoke (55) with deflector (56) from front side of transmission.

5. Mount the transmission in the stand so that the rear housing (3) is up.

6. Remove the lube hose (10, Fig. 7C.15) and lube tubes (11, 12 and 13).

Legend for Fig. 7C.14

1. Housing, Front
2. Gasket
3. Housing, Rear
4. Dowel Pin
5. Plug
6. Lock Nut
7. Spacer
8. O-Ring
9. Yoke
10. Oil Seal
11. Cap
12. Shims
13. O-Ring
14. Bearing Assembly
15. Bearing Cup
16. Bearing Cone
17. Clutch, F + R
18. Seal Ring
19. Cap, Oil Supply
20. Gasket
21. Orifice Plug
22. Dowel Pin
23. Plug
24. O-Ring
25. Cap, Bearing Retainer
26. Shims
27. Plug
28. O-Ring
29. Shaft, Reverse Idler
30. Cap, Bearing Retainer
31. Gasket
32. Gear, 52 T
33. Spacer
34. Clutch, 1st Gear
35. Roller Bearing
36. Bearing Cup
37. Bearing Cone
38. Cap, Oil Supply
39. Gasket
40. Plug
41. O-Ring
42. Cap, Bearing Retainer
43. Shims
44. O-Ring
45. Clutch, 2nd and 3rd
46. Roller Bearing
47. Bearing Cup
48. Bearing Cone
49. Cap, Oil Supply
50. Gasket
51. Lock Nut
52. Spacer
53. O-Ring
54. Output Yoke Assembly
55. Yoke Output
56. Deflector
57. Retainer Assembly
58. Output Shaft Retainer
59. Oil Seal
60. Roller Bearing
61. Bearing Cup
62. Bearing Cone
63. Shims
64. O-Ring
65. Shaft, Output
66. Flange
67. Oil Seal
68. Roller Bearing
69. Bearing Cup
70. Bearing Cone
71. Gasket
72. Baffle
73. Magnet
74. Strainer Valve Adapter
75. Gasket
76. Valve
77. Gasket
78. Transmission Sump Strainer
79. Support
80. Strainer (Brake Coolant)
81. O-Ring

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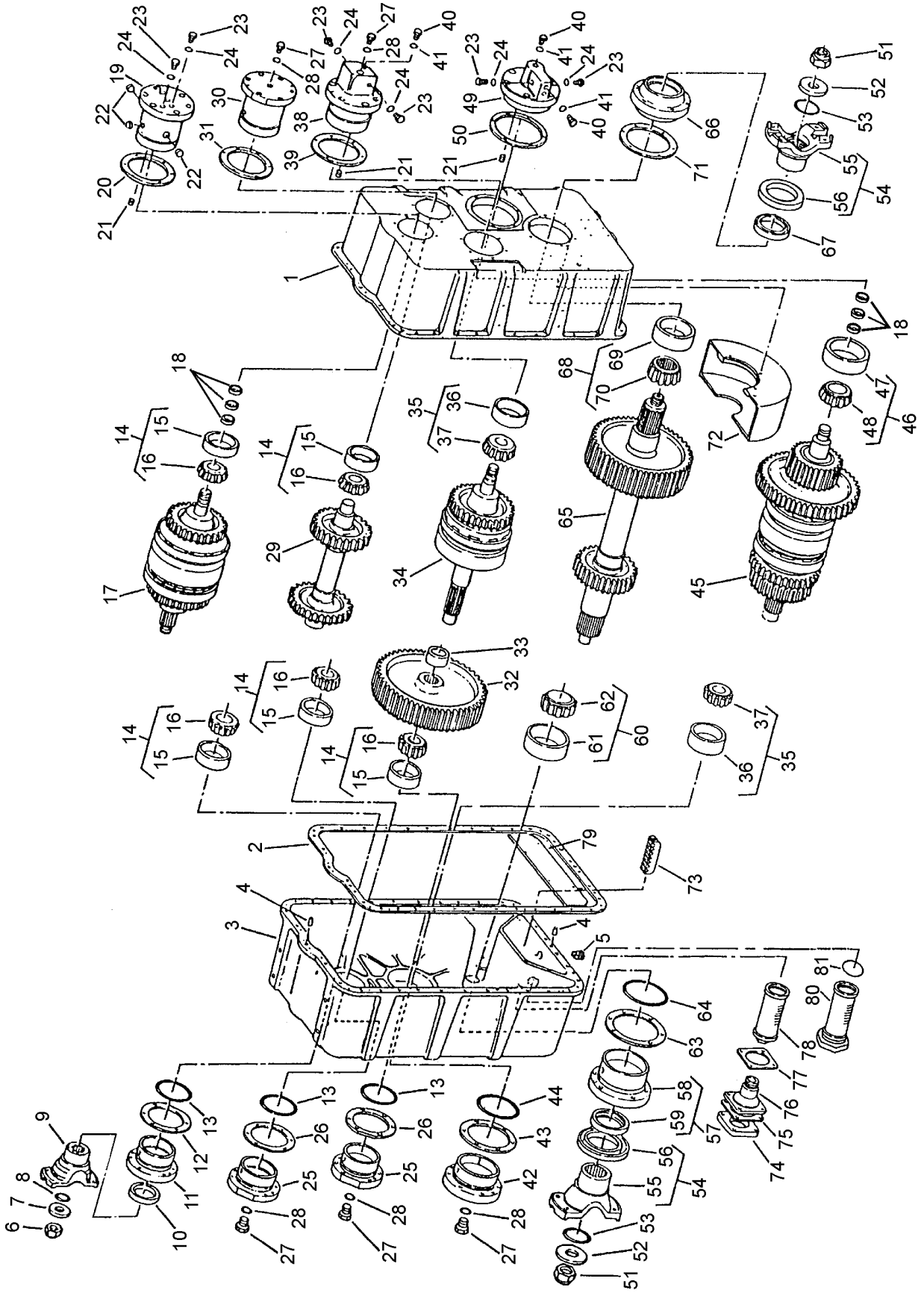


Fig. 7C.14. Transmission Housing and Internal Parts

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7. Remove the breather tube (14, Fig. 7C.15).
8. Remove nut (6), spacer (7), O-ring (8) and yoke (9).
9. Remove nut (51), spacer (52), O-ring (53) and yoke (55) with deflector (56).
10. Remove the mounting bolts for the caps (11, 25 and 42) and the output shaft retainer (58). Remove shims (12, 26, 43 and 63) and secure them together as sets.
11. Remove and discard O-rings (13, 44, and 64) and oil seals (10 and 59) from the caps. If needed, remove the bearing cups (15, 36 and 61) from the caps.
12. Remove adapter (74), valve (76) and strainer (78). Discard gaskets (77 and 75).
13. Remove strainer (80) and discard O-ring (81).
14. MACHINE EQUIPPED WITH GROUND DRIVEN STEERING: Insert a 3/4-10 x 9" bolt through the splined end and thread into the threaded end of steering sprocket (3, Fig. 7C.16). Remove retainer (6) and snap ring (4). Using the 9" bolt, push the steering sprocket assembly into the transmission. It will be removed when the housings are split.

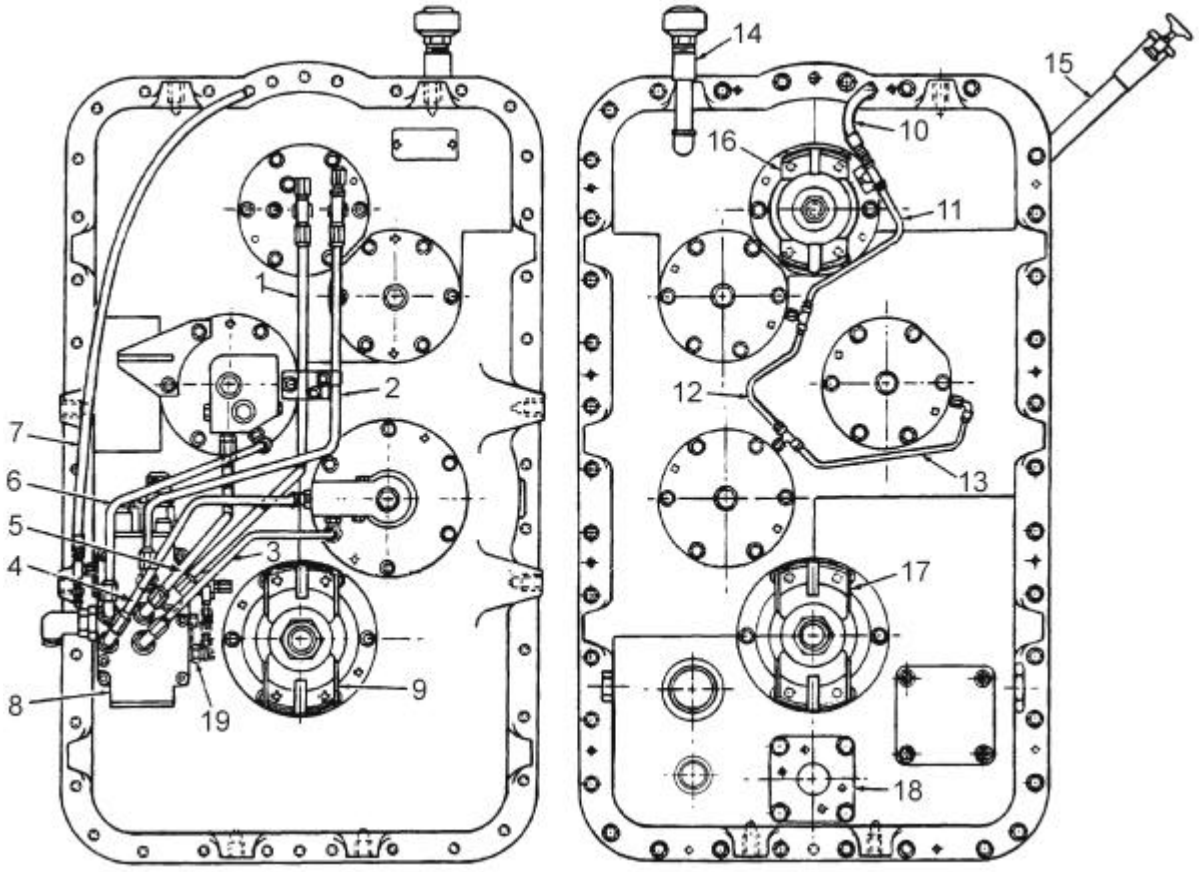


Fig. 7C.15. External Disconnects

1. Forward Tube
2. Reverse Tube
3. Third Tube
4. Second Tube
5. Lube Tube
6. First Tube
7. Lube Hose
8. Transmission Control Valve
9. Output Yoke
10. Lube Hose
11. Lube Tube
12. Lube Tube
13. Lube Tube
14. Breather Tube
15. Filler Tube
16. Input Yoke
17. Output Yoke
18. Strainer
19. Neutral Start Switch

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15. Remove the bolts and washers securing housing (1 and 3). Insert bolts in the jackscrew holes in housing (3). Turn the bolts evenly to free the housing from dowel pins (4).

16. Attach a hoist to housing (3) and lift it off housing (1). Remove and discard gasket (2).

17. MACHINES EQUIPPED WITH GROUND DRIVEN STEERING: Remove the steering sprocket assembly (3, Fig. 7C.16). Remove chain (2) from the output shaft. Remove shims (10) and secure them together as a set.

18. Attach a hoist to the forward/reverse clutch shaft (17). Remove the shaft while simultaneously lifting and removing the reverse idler shaft (29).

19. Remove the first gear shaft (34) and then the second/third gear shaft (45).

20. Remove the oil baffle (72) from around the output shaft (65) and remove the output shaft.

21. Remove the mounting bolts for the oil supply caps (19, 38 and 49), bearing retainer cap (30) and flange (66). Remove and discard oil sea (67) Use two bolts in the jackscrew holes, turning the bolts evenly, to pull the caps straight off. Discard the gaskets (20, 31, 39, 50 and 71). If needed, remove the bearing cups (15, 36, 47 and 69).

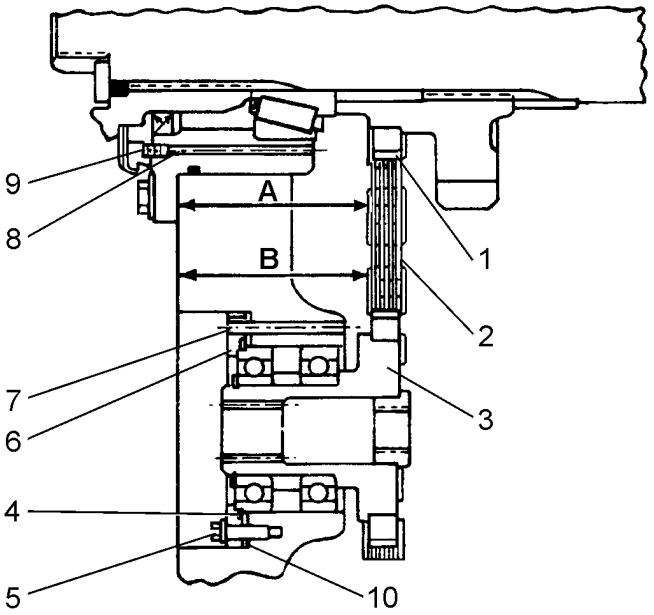


Fig. 7C.16. Ground Driven Steering Sprocket

1. Drive Sprocket
2. Chain
3. Steering Sprocket
4. Snap Ring
5. Bolt
6. Bearing Retainer
7. Access Hole
8. Access Hole
9. Plug
10. Shims

Reverse Idler Shaft (Refer to Fig. 7C.17)

1. Using a suitable puller, remove the reverse transfer drive gear (2) and the bearing cone (1) together.

2. Remove spacer (3) with pin (4) from the shaft.

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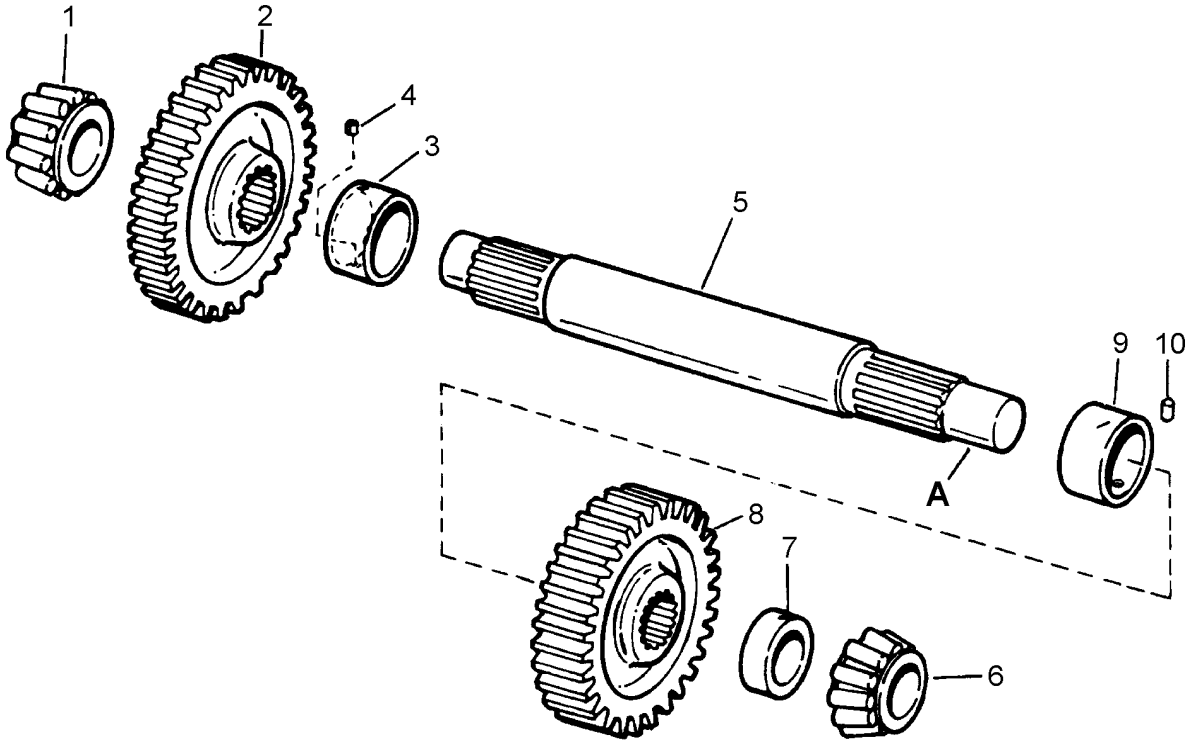


Fig. 7C.17. Reverse Idler Shaft

1. Bearing Cone
2. Reverse Transfer Drive Gear (36 tooth)
3. Spacer
4. Roll Pin
5. Reverse Idler Shaft
6. Bearing Cone
7. Spacer
8. Reverse Transfer Driven Gear (29 tooth)
9. Spacer
10. Roll Pin

3. Turn the shaft over. Using a suitable puller, remove the bearing cone (6).

4. Remove spacer (7), reverse transfer driven gear (8) and spacer (9) with pin (4).

Output Shaft (Refer to Fig. 7C.18)

1. Using a suitable puller, remove the first/second driven gear (6) and the bearing cone (5) together.

2. Remove spacer (7) from the shaft.

3. Turn the shaft over. Using a suitable puller, remove the third speed driven gear and sprocket (2) and the bearing cone (1) together.

4. Remove spacer (3) from the shaft.

Ground Driven Steering Sprocket (Refer to Fig. 7C.19)

1. If bearing replacement is necessary, remove snap ring (1). Using a suitable puller, remove bearing (2).

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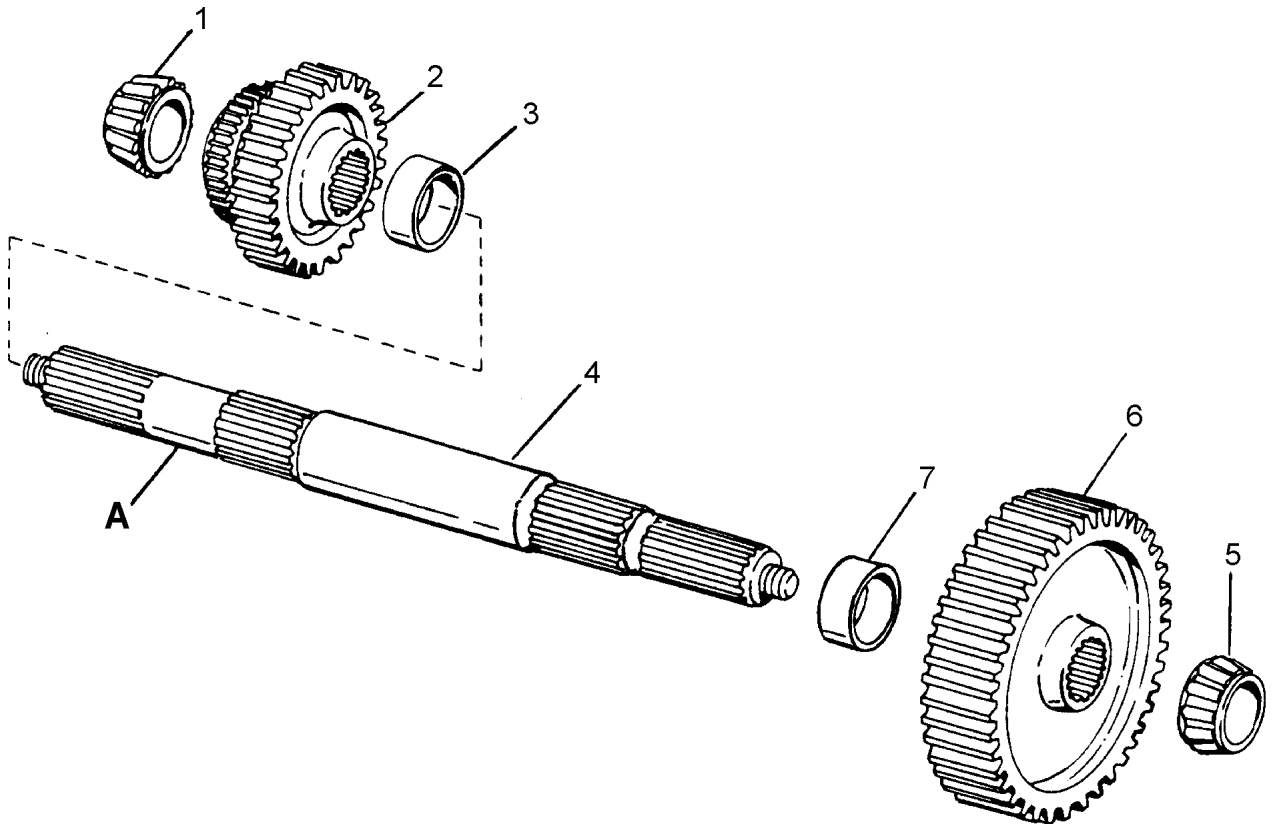


Fig. 7C.18. Output Shaft

1. Bearing Cone
2. Third Driven Gear (31 tooth)
3. Spacer
4. Output Shaft
5. Bearing Cone
6. First/Second Driven Gear (49 tooth)
7. Spacer

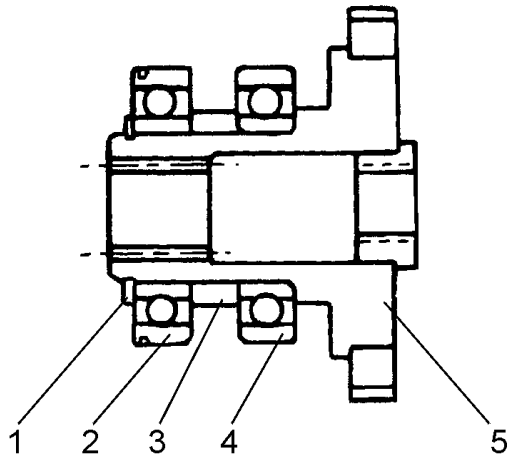


Fig. 7C.19. Ground Driven Steering Sprocket

1. Snap Ring
2. Outer Bearing
3. Spacer
4. Inner Bearing
5. Sprocket (33 tooth)

2. Remove spacer (3) from sprocket (5).

3. If bearing replacement is necessary, remove bearing (4).

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Clutch Packs

For disassembly, inspection and repair, and reassemble of the clutch packs, refer to CLUTCH PACKS in this section.

6. INSPECTION AND REPAIR

1. Discard all gaskets, oil seals, O-rings, snap rings, piston rings and seal rings, and replace with new.

2. Clean the metal parts in a suitable solvent. Never use a caustic solution. Dry the parts with compressed air. Be sure that oil passages and other openings are clean and not plugged.

IMPORTANT: *Do not spin the bearings before or during cleaning or until they are properly lubricated to prevent damaging them.*

IMPORTANT: *If bearing replacement is required, two-piece bearings must be replaced as a set. Refer to CLUTCH PACKS in this section for details concerning bearing inner races.*

3. Inspect the bearing for metal flaking, cracks, scoring, nicks or excessive wear. If the bearings appears to have been overheated, inspect for cause, such as dirt or lack of lubrication. Serviceable bearings should be adequately lubricated and enclosed in a lint-free wrapper until installed.

4. Inspect cast parts for cracks. Replace cracked parts. Inspect all bearing bores and mounting faces for wear, grooves and scratches. Remove burrs and scratches with a crocus cloth. Inspect tapped holes for damaged threads. Repair or replace as necessary.

5. Inspect all splines parts for worn, twisted, nicked or burred splines. If possible remove defects with a soft stone. Replace parts as necessary.

6. Inspect threaded parts for damaged threads. Repair threads by chasing or filling with a fine three cornered file. Replace when repair cannot be satisfactorily accomplished.

7. Inspect gear teeth for damage. Repair minor burrs or nicks with a fine file or emery cloth.

7. REASSEMBLY

NOTE: *Special tools are required for reassembly. Refer to SERVICE / SPECIAL TOOLS in Section 1.*

General

IMPORTANT: *Before reassembly, prelubricate all machined parts with transmission oil.*

All bearings should be installed as follows:

All bearing outer races must be seated in place using a press, not hammered in place. Outer races with caged bearings will chip off at the race shoulders if hammered into position. In deep case housings, a plate can be clamped across the machined surface and a portable hydraulic ram used

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to press the race into position. When installing races in through bore applications, the race should be pressed into position short of its final location. Use the retainer with or without spacer, where used, and torque the capscrews to pull the bearing race into its final location. If these instructions are not followed, excessive pre-loading of the bearings could result with ultimate failures.

All bearing inner races and cones should be installed on shafts using heat or the press method. Using an oven or oil bath, apply a maximum heat of 135-150º C uniformly to the entire bearing race or cone. When using the press method to install bearing cones always apply pressing force on the inner race only.

Clutch Packs

For reassembly; inspection of the clutch packs, refer to CLUTCH PACKS in this section.

Ground Driven Steering Sprocket (Refer to Fig. 7C. 19)

1. Install the inner bearing (4) on the sprocket until it bottoms against shoulder.
2. Install spacer (3) on the sprocket.
3. Install the outer bearing (2) on the sprocket until it bottoms against the spacer (3) and so that the snap ring groove in the bearing is away from the sprocket.
4. Install snap ring (1).

Output Shaft (Refer to Fig. 7C.18)

1. Place the output shaft (4) on end so that the end with the longer bearing surface (A) is up.
2. Install spacer (3) on the shaft until it is up against the shoulder. Install the third driven gear and sprocket (2) so that it is up against spacer (3) and the sprocket is up.
3. Press bearing cone (1) on the shaft until it bottoms against the gear.
4. Turn the shaft over and install spacer (7) on the shaft until it is up against the shoulder. Install the first/second driven gear (6) so that it is up against spacer (7).
5. Press bearing cone (5) on the shaft until it bottoms against gear (6).

Reverse Idler Shaft (Refer to Fig. 7C.17)

1. Place the reverse idler shaft (5) on end so that the end with the longer bearing surface (A) is up.
2. Install the longer spacer (9) on the shaft so that the pin (10) engages the spline and the spacer is up against the shoulder.
3. Install gear (8) on the shaft so that the side of the gear with the longer shoulder is up against spacer (9).

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4. Install spacer (7) on the shaft and press the bearing cone (6) on the shaft until it bottoms against the spacer.

5. Turn the shaft over and install spacer (3) on the shaft so that the pin (4) engages the shaft spline and the spacer is up against the shoulder.

6. Install gear (2) on the shaft so that the side of the gear with the longer shoulder is up against spacer (3).

7. Press bearing cone (1) on the shaft until it bottoms against spacer.

Main Housing (Refer to Fig. 7C.14)

1. If the bearing cups (15, 36, 47 or 69) were removed, press the new bearing cups into oil supply caps (19, 38 and 49), bearing retainer cap (30) and flange (66) until they bottom.

2. Be sure that orifice plugs (21) are installed in caps (19, 38 and 49).

3. Install seal (67) into cap (66), with the lip of the seal facing inward, until it is flush with the machined surface.

4. Install oil supply caps (19, 38 and 49), bearing retainer cap (30) and flange (66) on housing (1) using new gaskets (20, 31, 39, 50 and 71). Torque the cap mounting bolts to 70 Nm.

5. With the transmission housing (1) in the stand, lower the output shaft (65) into the housing and through the flange (66).

6. Install the oil baffle (72) below the output shaft.

7. Lower the second/third speed shaft (45) into the housing until it rests in cap (49).

8. Lower the first speed shaft (34) into the housing until it rests in cap (38).

9. Simultaneously lower the forward/reverse clutch shaft (17) and the reverse shaft (29) into the housing until they rest in caps (19 and 30).

10. MACHINES EQUIPPED WITH GROUND DRIVEN STEERING: Install steering sprocket assembly (3, Fig. 7C.16) in the rear transmission housing and install snap ring (4). Install retainer (6) without shims (10).

11. MACHINES EQUIPPED WITH GROUND DRIVEN STEERING: Place chain (2) over sprocket (1, Fig. 7C.16) on the output shaft.

12. Place a new gasket (2) on housing (1) and hold it in place with a little grease.

13. Support housing (3) on a hoist as level as possible. Gently lover the housing into place aligning the dowel pins (4). Install the mounting bolts to 70 Nm.

14. If the bearing cups (15, 36 or 61) were removed, press the new cups into caps (11, 25, 42 and 58) until they bottom.

15. To determine the appropriate size of the shims packs (12, 26, 43 and 63), when the shaft parts were changed, proceed as follows:

    a. Temporarily install the caps, without seals, shims or O-rings, with two bolts located 180º degrees apart. While rotating the shafts, alternately torque the bolts in 5 Nm increments to a maximum of 18 Nm.

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NOTE: *In order to turn shafts (29, 34 and 65), attach an air hose to port (2, Fig. 7C.20) to engage the reverse clutch pack and then turn the forward/reverse shaft.*

b. Use a feeler gauge to measure the gap between the housing (3) and the cap at each of the bolts. If the two readings are not the same, total the two readings and divide by two. To this result, add the following dimension and make up a shim pack equal to this thickness:

forward/reverse shaft	- 0.53 mm
reverse idler shaft	- 0.48 mm
first speed shaft	- 0.53 mm
second/ third shaft	- 0.53 mm
output shaft	- 0.69 mm

c. Remove the bolts and caps. Install the O-rings (13, 44 and 64) in the groove in the caps.

d. Install the seals (10 and 59), with the lip of the seals facing inward, until they are flush with machined surface of the caps.

e. Install the shim packs (12, 26, 43 and 63) on the caps and install the caps. Install all the bolts and washers. While rotating the shafts, torque the bolts to 70 Nm.

f. Mount a dial indicator on the housing, place the indicator pointer on the end of the shaft and set the indicator at zero.

g. In order to move the shafts, attach an air hose to the following ports:

forward/reverse shaft	- port (2, Fig. 7C.20)
reverse idler shaft	- port (3, Fig. 7C.20)
first speed shaft	- port (4, Fig. 7C.20)
second/ third shaft	- port (5, Fig. 7C.20)

The output shaft can be moved by lifting up on the opposite side of the shaft with a jack.

h. Raise the shaft and note the reading on the dial indicator. The reading should be 0.18 - 0.28 mm for all shafts except the output shaft which should be 0.25 - 0.36 mm.

i. If the end play is not within these limits, adjust the shim pack until a correct reading is obtained.

16. MACHINE EQUIPPED WITH GROUND DRIVEN STEERING: Shim the steering sprocket and engage the chain as follows (Refer to Fig. 7C.16):

a. Remove the plug (9) from the rear output shaft cap. Using a depth gauge through access holes (7 and 8), measure distance (A and B). The difference between this distances plus or minus 0.64 mm is the required size of shim pack (10).

b. Raise the transmission on end so that the output shaft is down.

c. Insert a 3/4-10 x 9” bolt through the splined end and threaded into the tread end of sprocket (3). Remove bearing retainer (6) and snap ring (4). Using the 9” bolt, push the sprocket back into the transmission and engage it with chain (2). Pull the sprocket back into place and install snap ring (4).

d. Install the correct size shim pack (10) and retainer (6).

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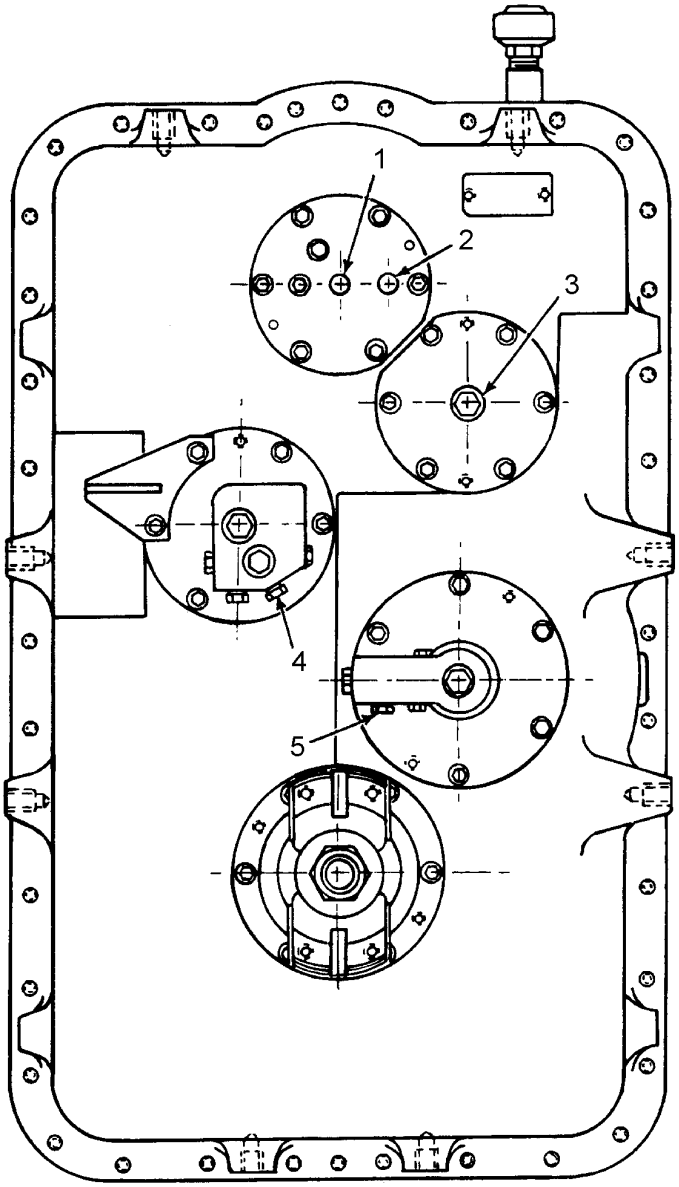


Fig. 7C.20. Air Connect Points

1. Forward Supply Port
2. Reverse Supply Port
3. Reverse Idler Port
4. First Supply Port
5. Third Supply Port

17. Apply grease to the outer machined surface of the output yokes (55). Install the yokes on the output shaft and through the seals, using care to avoid damage to the seals. Install new O-rings (53) on the ends of the shaft. Install washers (52) and nuts (51). Torque the nuts to 815-1085 Nm.

18. Apply grease to the outer machined surface of the input yoke (9). Install the yoke on the shaft and through the seal using care to avoid damage to the seal. Install a new O-ring (8) on the end of the shaft. Install washer (7) and nut (6). Torque the nut to 270-410 Nm.

19. Install strainer (78) on valve (76). Secure adapter (74) and valve (76) to housing (3) with new gaskets (75 and 77). Torque the bolts to 80 Nm.

20. Install strainer (80) with new O-ring (81) to housing (3).

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21. Install the breather tube (14, Fig 7C.15).

22. Install lube hose (10, Fig. 7C.15) and lube tubes (11, 12 and 13).

23. Secure the transmission control valve (8, Fig. 7C.15) to the transmission using new mounting O-rings

24. Install tubes (1 through 6, Fig. 7C.15) and hose (7).

8. INSTALLATION

1. Position the transmission under the machine and using two eyebolts with thread 3/4-10", attach the hoist to the top of the transmission. Raise the transmission up into the machine slightly higher then its installed position.

2. Install the transmission side mounting brackets to the mounting pads on each side of transmission. Torque the bolts to 390 Nm.

3. Install mounting shafts (3, Fig. 7C.12) in mounting brackets. Position the lower caps (4) on the frame and lower the transmission into place. Install upper caps (2) and bolts (1). Torque the bolts to 940 Nm.

4. Block up under the transmission to keep it from tipping and remove the hoist and two eye bolts.

5. Install the bracket and sleeve (1 and 2, Fig. 7C.13) to the transmission. Torque the bracket mounting bolts to 390 Nm. Remove the blocking from under the transmission

6. Reconnect three drive shafts to the transmission. Refer to Section 7D.

7. Position the two hoses (4 and 8, Fig. 7C.11) on their place and reconnect them to the bottom of the hydraulic reservoir. Secure the manifold w/bracket (2, Fig. 7C.11) and the plate with holder (3 and 4, 7C.13) to the top of the transmission.

8. Reconnect hoses (1 and 3, Fig. 7C.11) and hose (5, Fig. 7C.13) to the manifold.

9. Secure clamps (6 and 7, Fig. 7C. 11) to the manifold w/bracket and clamp (5) to the holder (4, Fig. 7C.13)

10. Reconnect the three hoses (1, 2 and 3, Fig. 7C.10) to the rear of the transmission.

11. Install the filler tube (15, Fig. 7C.15) to the right side of the transmission.

12. MACHINES EQUIPPED WITH GROUND DRIVEN STEERING: Install the ground driven steering pump to the rear of the transmission as described in Section 10A.

13. Reconnect the two connectors (7 and 8, Fig. 7C.9) to the transmission and reconnect the hoses (1 through 6).

14. Reconnect the wires to the neutral start switch (19, Fig. 7C.15).

15. Place the control cables (5 and 6, Fig. 7C.8) to the bracket on the front of the transmission and connect the cables to the transmission control valve.

16. Reconnect hydraulic hose (1, 2, 3 and 4, Fig. 7C.8) to the transmission control valve.

17. Reinstall the transmission guard under the machine. Reinstall the top shield covering the transmission and lower the machine to the ground.

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TRANSMISSION

18. Service the transmission oil filters and breather as outlined in the Operator's Manual.

19. Fill the transmission and the hydraulic reservoir with the type and quantity of oil as specified in the Operator's Manual.

20. Check all oil pressures as describes under CHECKING TRANSMISSION AND TORQUE CONVERTER PRESSURES in Section 7.

NOTE: *It is recommended that the transmission oil filters be serviced after the first 10 hours of operation and again at 50 hours of operation. Refer to the Operator's Manual for procedure. Thereafter, service the filter at the normal scheduled interval.*

CLUTCH PACKS

9. REMOVAL

Follow the necessary steps as outlined in Par. 5, DISASSEMBLY UNDER TRANSMISSION for removal of all the clutch packs.

10. DISASSEMBLY

NOTE: *Special tools are required for disassembly. Refer to SERVICE/SPECIAL TOOLS in Section 1.*

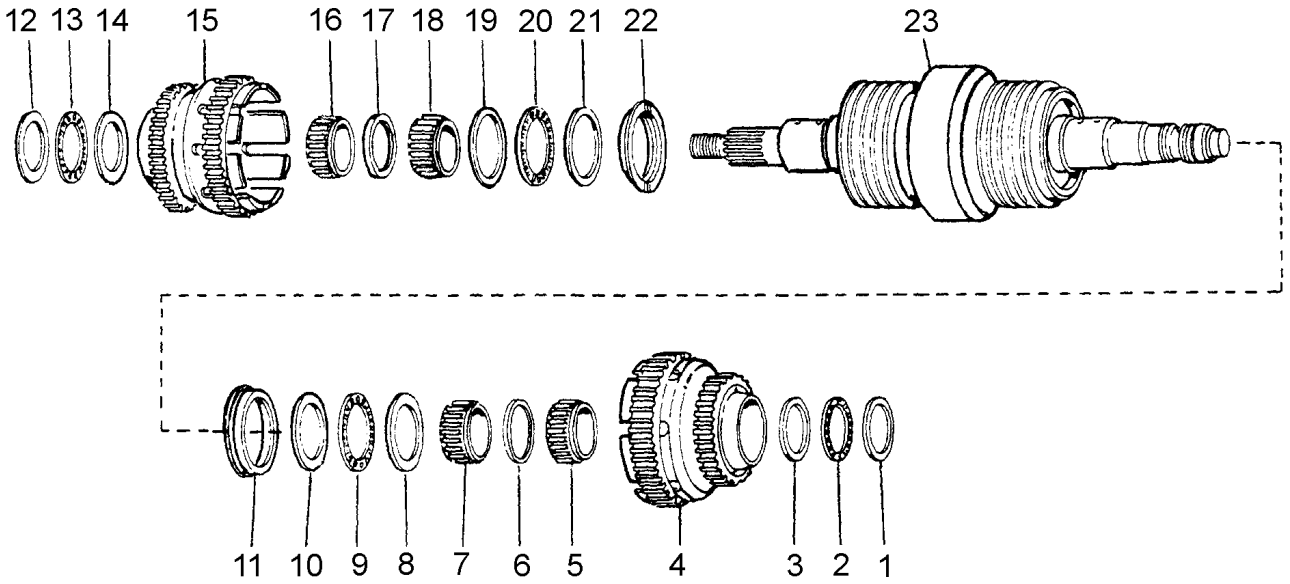


Fig. 7C.21. Exploded View of Forward/Reverse Clutch Pack Outer Components

1. Thrust Washer
2. Thrust Bearing
3. Thrust Washer
4. Reverse Gear and Drum
5. Needle Bearing
6. Bearing Spacer
7. Needle Bearing
8. Thrust Washer
9. Thrust Bearing
10. Thrust Washer
11. Clutch Spacer
12. Thrust Washer
13. Thrust Bearing
14. Thrust Washer
15. Forward Gear and Drum
16. Needle Bearing
17. Bearing Spacer
18. Needle Bearing
19. Thrust Washer
20. Thrust Bearing
21. Thrust Washer
22. Clutch Spacer
23. Basic Clutch Pack

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TRANSMISSION

CLUTCH PACKS

Forward/Reverse Clutch Packs (Fig. 7C.22)

1. Position the clutch pack in stand with the oil inlet end of the shaft facing up. Remove the hook-type seal rings (18, Fig. 7C.14) from the end of the shaft.

2. Using a suitable puller, remove the bearing cone (16, Fig. 7C.14) from the end of the shaft.

3. Remove parts (1 through 11, Fig. 7C.21) in the sequence indicated by the reference numbers.

4. Turn the clutch pack over in the stand. Using a suitable puller, remove the bearing cone (16, Fig. 7C.14) from the end of the shaft.

5. Remove parts (12 through 22, Fig. 7C.21) in the sequence indicated by the reference numbers.

6. Remove the bolts (8) which secure the split retainer rings (5) and remove the rings. Lift the final clutch hub assembly (4 through 9) from the shaft.

7. Remove the internal snap ring (30 and the external snap ring (4). Remove the backing plate (1) from the clutch hub (9).

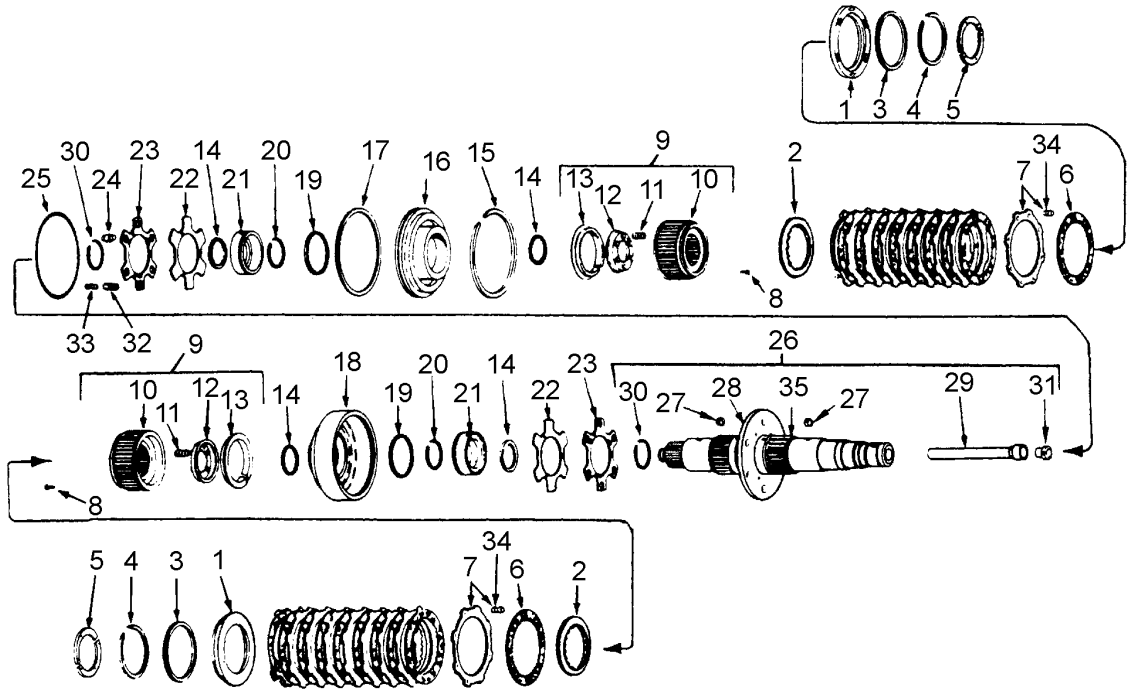


Fig. 22. Exploded View of Forward/Reverse and Second/Third Basic Clutch Pack

1. Backing Plate
2. Friction Disc (Forward/Reverse only)
3. Internal Snap Ring
4. External Snap Ring
5. Split Retainer Ring
6. Friction Disc
7. Separator Plate
8. Bolt
9. Clutch Hub Assembly
10. Clutch Hub
11. Spring
12. Spring Retainer
13. Retainer Ring
14. Seal Ring
15. Internal Snap Ring
16. Clutch Piston
17. Seal Ring
18. Piston Housing
19. Seal Ring
20. External Snap Ring
21. Accelerator Piston
22. Valve Disc
23. Reinforcement Disc
24. Dowel Pin
25. "0" Ring
26. Shaft Assembly
27. Guide Pin
28. Middle Plate
29. Tube
30. Snap Ring
31. Oil Inlet Cap
32. Inner Spring
33. Outer Spring
34. Rubber Plug (black - 9.8 mm)
34. Rubber Plug (silver - l0 mm)
35. Shaft

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8. Remove the stack of clutch plates, which include the friction discs (6), separator plates (7) and friction disc (2) with rubber plugs (34).

IMPORTANT: *Every time the clutch pack is over-hauled, the rubber plugs (34) must be discarded and new ones installed on every separator plate (7) which is being reused. Some of the plugs may be black and some may be silver. The quantity of black and/or silver plugs necessary for the reassembled pack will be determined during reassembly.*

9. Disassemble the clutch hub as follows (Fig. 7C.23).

   a. Using a bolt (36), two washers (37), a nut (38), and a plate (39), secure the clutch hub to a board (40) in order to contain the spring tension during disassembly.

   b. Using a snap ring pliers, remove the retainer ring (13).

   c. Slowly loosen the bolt (36) to release the tension on the springs (11).

   d. Remove the spring retainer (12) and the springs (11) from the hub (10).

10. Turn the clutch pack shaft over and follow steps 6 through 9 to remove and disassemble items (1 through 9) from the other end of the shaft.

11. Position the shaft so that the clutch piston (16) is up. Tap on the clutch piston with a soft hammer to make the snap ring (15) more accessible. Remove the snap ring.

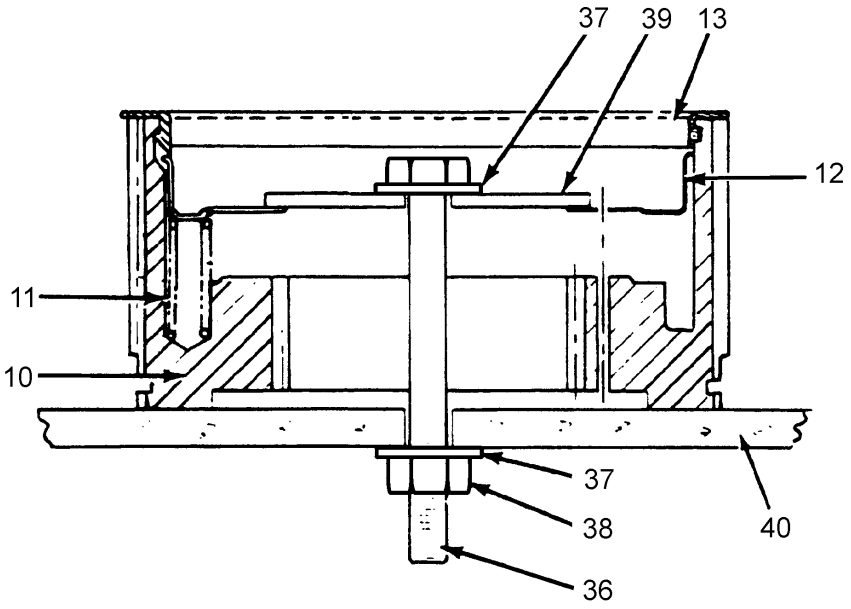


Fig. 7C.23. Clutch Hub Assembly

10. Clutch Hub	37. Washer
11. Spring	38. Nut
12. Spring Retainer	39. Plate
13. Retainer Ring	40. Board
36. Bolt	

12. Install the snap ring groove filler tool with the narrow face down in the snap ring groove of the piston housing (18). Using a soft hammer, tap around the edges of the piston housing until it slides free of the shaft.

IMPORTANT: *Do not allow the piston housing to fall from the shaft.*

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13. Remove the clutch piston (16). Remove the seal ring (17) from the piston.

14. Remove the two hook-type seal rings (14) from each side of the shaft.

15. Remove the snap ring (20) which holds the accelerator piston (21) to the shaft. Remove the accelerator piston, and remove the seal ring (19) from the piston. Remove the two hook-type seal rings (14) from the shaft.

16. Repeat step 15 to remove parts (14, 19, 20 and 21) from the other end of the shaft.

17. Remove the valve disc (22) and the reinforcing disc (23) from both sides of the middle plate (28).

18. Remove the dowel pins (24), inner compression springs (32), and outer compression springs (33) from the middle plate (28).

19. Remove the "O" ring (25) from the middle plate. Remove the two snap rings (30) which hold the middle plate (28) to the shaft, and remove the middle plate from the shaft and tube assembly (29).

Second/Third Speed Clutch Pack (Fig. 7C.22)

1. Position the clutch pack in a stand with the oil inlet end of the shaft facing up. Remove the hook-type seal rings from the end of the shaft.

2. Using a suitable puller, remove the bearing cone (1, Fig. 7C.24) from the end of the shaft.

3. Remove parts (2 through 7, Fig. 7C.24) in the sequence indicated by the reference numbers.

4. Turn the clutch pack over in the stand. Using a suitable puller, remove gear (9, Fig. 7C.24) and bearing cone (8).

5. Remove parts (10 through 18, Fig. 7C.24) in the sequence indicated by the reference numbers.

6. Remove the bolts (8) which secure the clutch hub retainers (5) and remove the retainers. Lift the final clutch hub assembly (4 through 9) from the shaft.

7. Remove the internal snap ring (3) and the. external snap ring (4). Remove the backing plate (1) from the clutch hub (9).

8. Remove the stack of clutch plates which include friction discs (6) and separator plates (7) with rubber plugs (34).

IMPORTANT: *Every time the clutch pack is over hauled, the rubber plugs (34) must be replaced on every separator plate (7) which is reused.*

9. Disassemble the clutch hub as follows (Fig. 7C.23):

   a. Using a bolt (36), two washers (37), a nut (38) and a plate (39), secure the clutch hub to a board (40) in order to contain the spring tension during disassembly.

   b. Using a snap ring pliers, remove the retainer ring (13).

   c. Slowly loosen the bolt (36) to release the tension on the springs (11).

   d. Remove the spring retainer (12) and the springs (11) from the hub (10).

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CLUTCH PACKS

10. Turn the clutch pack shaft over and follow steps 6 through 9 to remove and disassemble items (1 through 9) from the other end of the shaft.

11. Position the shaft so that the clutch piston(16) is up. Tap on the clutch piston with a soft hammer to make the snap ring (15) more accessible. Remove the snap ring.

12. Install the snap ring groove filler tool with the narrow face down in the snap ring groove o the piston housing (18). Using a soft hammer, tap around the edges of the piston housing until it slides free of the shaft.

IMPORTANT: *Do not allow the piston housing to fall from the shaft.*

13. Remove the clutch piston (16). Remove the seal ring (17) from the piston.

14. Remove the two hook-type seal rings (14) from each side of the shaft.

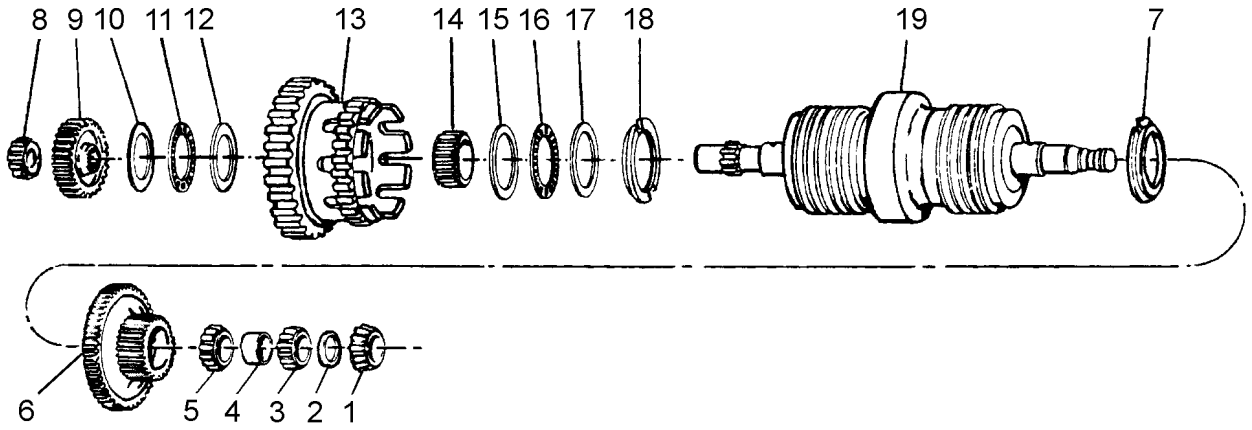


Fig. 7C.24. Exploded View of Second/Third Speed Clutch Pack Outer Components

1. Bearing Cone
2. Spacer
3. Needle Bearing
4. Bearing Spacer
5. Needle Bearing
6. Second Gear and Drum
7. Clutch Spacer
8. Bearing Cone
9. Gear (38 teeth)
10. Thrust Washer
11. Thrust Bearing
12. Thrust Washer
13. Third Gear and Drum
14. Needle Bearing
15. Thrust Washer
16. Thrust Bearing
17. Thrust Washer
18. Clutch Spacer
19. Basic Clutch Pack

15. Remove the snap ring (20) which holds the accelerator piston (21) to the shaft. Remove the accelerator piston, and remove the seal ring (19) from the piston. Remove the two hook-type seal rings (14) from the shaft.

16. Repeat step 15 to remove parts (14, 19, 20 and 21) from the other end of the shaft.

17. Remove the valve disc (22) and the reinforcing disc (23) from both sides of the middle plate (28).

18. Remove the dowel pins (24), inner compression spring (32), and outer compression spring (33) from the middle plate (28).

19. Remove the "O" ring (25) from the middle plate. Remove the two snap rings (30) which hold the middle plate (28) to the shaft, and remove the separator plate from the shaft and tube assembly (29).

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TRANSMISSION

CLUTCH PACKS

First Speed Clutch Pack Fig. 7C.26)

1. Position the clutch pack in a stand with the oil inlet end of the shaft facing up. Remove the hook-type seal rings from the end of the shaft.

2. Using a suitable puller, remove the bearing cone (37, Fig. 7C.14) from the end of the shaft.

3. Remove parts (1 through 9, Fig. 7C.25) in the sequence indicated by the reference numbers.

4. Remove the bolts (8) which secure the split retainer rings (5) and remove the rings. Lift the final clutch hub assembly (1 through 10) from the shaft.

5. Remove the internal snap ring (4) and the external snap ring (3). Remove the backing plate (1) from the clutch hub (10).

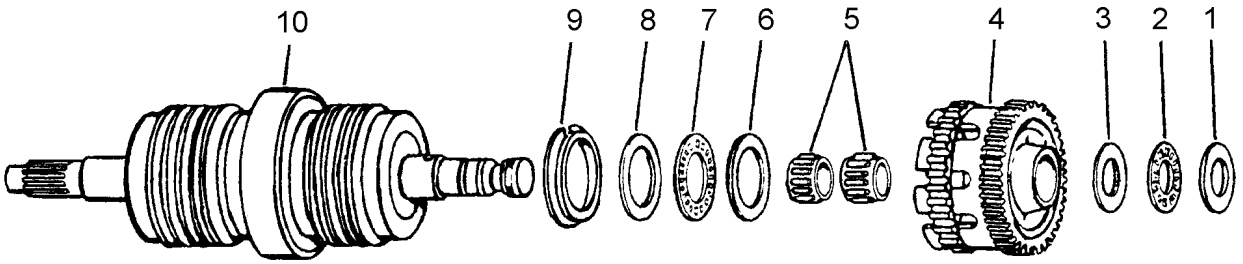


Fig. 7C.25. Exploded View of First Speed Clutch Pack Outer Components

1. Thrust Washer
2. Thrust Bearing
3. Thrust Washer
4. First Gear and Drum
5. Needle Bearing
6. Thrust Washer
7. Thrust Bearing
8. Thrust Washer
9. Clutch Spacer
10. Basic Clutch Pack

6. Remove the stack of plates which include friction discs (6) and separator plates (7) with rubber plugs (34).

***IMPORTANT**: Every time the clutch pack is overhauled, the rubber plugs (34) must be replaced on every separator plate (7) which is reused.*

7. Disassemble the clutch hub as follows (Fig. 7C.23):

   a. Using a bolt (36), two washers (37), a nut (38), and a plate (39), secure the clutch hub to a board (40) in order to contain the spring tension during disassembly.

   b. Using a snap ring pliers, remove the retainer ring (13).

   c. Slowly loosen the bolt (36) to release the tension on the springs (11).

   d. Remove the spring retainer (12) and the springs (11) from the hub (10).

8. Turn the clutch pack over. Using a suitable puller, remove bearing cone (16, Fig. 7C.14) and gear (32) together. Remove spacer (33).

9. Tap on the clutch piston (17) with a soft hammer to make the snap ring (16) more accessible. Remove the snap ring.

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CLUTCH PACKS

10. Install the snap ring groove filler tool with the narrow face down in the snap ring groove of the piston housing (19). Using a soft hammer, tap around the edges of the piston housing until it slides free of the shaft.

***IINPORTANT**: Do not allow the piston housing to fall from the shaft.*

11. Remove the clutch piston (17). Remove the seal ring (18) from the piston.

12. Remove the two hook-type seal rings (15) from each side of the shaft.

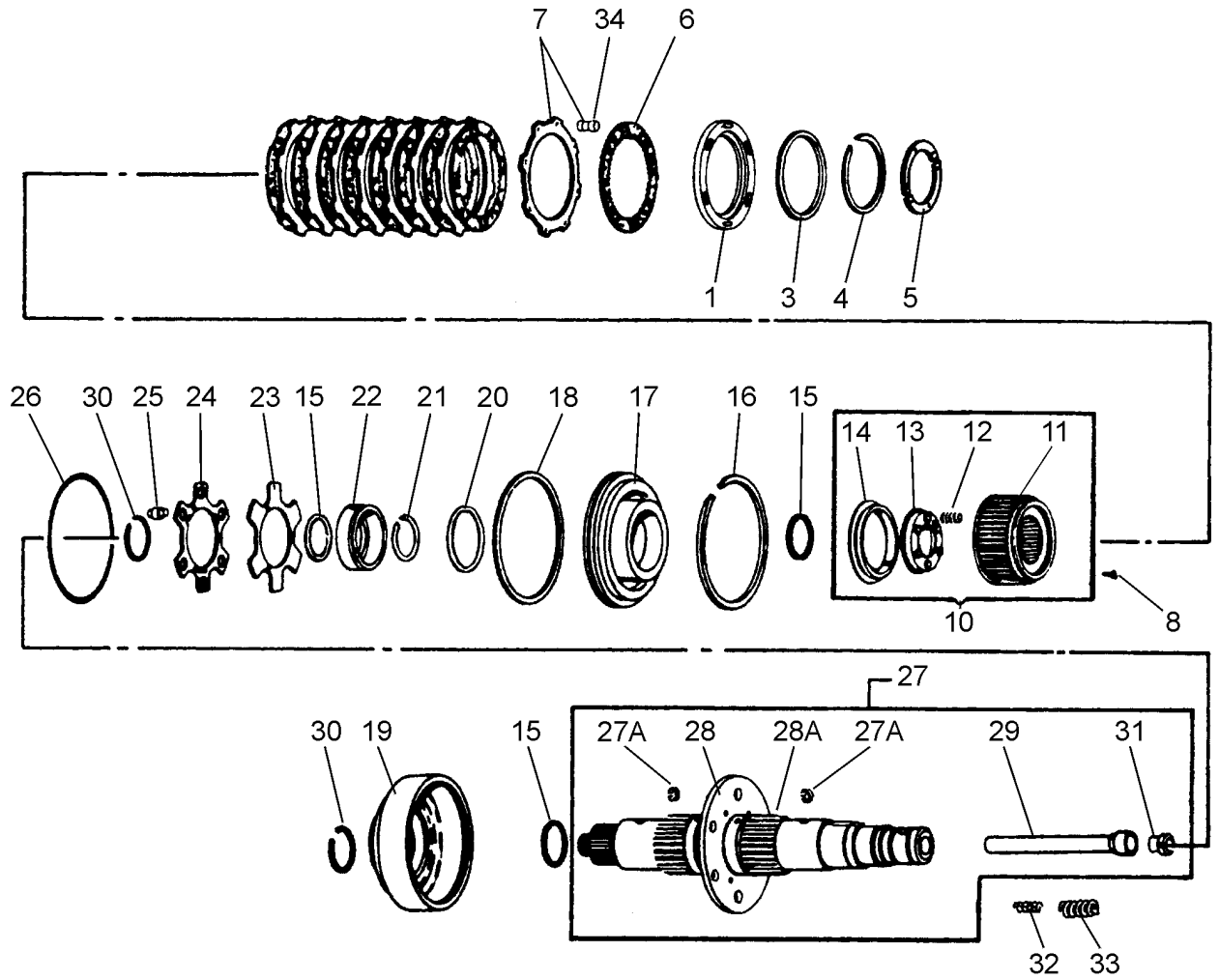


Fig. 7C.26. Exploded View of First Speed Basic Clutch Pack

1. Backing Plate
3. Snap Ring
4. Snap Ring
5. Split Retainer Ring
6. Friction Disc
7. Separator Plate
8. Bolt
10. Clutch Hub Assembly
11. Clutch Hub
12. Spring
13. Spring Retainer
14. Retainer Ring
15. Seal Ring
16. Snap Ring
17. Clutch Piston
18. Seal Ring
19. Piston Housing
20. Seal Ring
21. Snap Ring
22. Accelerator Piston
23. Valve Disc
24. Reinforcing Disc
25. Dowel Pin
26. O-Ring
27. Shaft Assembly
27A. Spring Pin
28. Middle Plate
28A. Shaft
29. Tube
30. Snap Ring
31. Oil Inlet Cap
32. Inner Spring
33. Outer Spring
34. Rubber Plug

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13. Remove the snap ring (21) which holds the accelerator piston (22) to the shaft. Remove the accelerator piston, and remove the seal ring (20) from the piston. Remove the hook-type seal ring (15) from the shaft.

14. Remove the valve disc (23) and the reinforcing disc (24). Remove the inner compression spring (32), and outer compression spring (33) from the middle plate (28). The dowel pin (25) is not removable and is part of the middle plate assembly.

15. Remove the O-ring (26) from the middle plate. Remove the two snap rings (30) which hold the middle plate to the shaft, and remove the middle plate from the shaft and tube assembly (29).

11. INSPECTION AND REPAIR

1. Discard all O-rings, lathe cut seal rings, hook-type seal rings, and snap rings. Replace with new.
2. Clean the metal parts in a suitable solvent. Never use a caustic solution: Dry the parts with compressed air. Be sure that oil passages and other openings are clean and not plugged. Be sure roll pins are in place in shaft lube ports.

IMPORTANT: *Do not spin the bearings before or during cleaning or until they are properly lubricated to prevent damaging them.*

IMPORTANT: *If bearing replacement is required, two piece bearings must be replaced as a set. Refer to Par. TRANSMISSION for details concerning bearing outer races.*

3. Inspect the bearings for metal flaking, cracks, scoring, nicks or excessive wear. If the bearing appears to have been overheated, inspect for cause such as dirt or lack of lubrication. Serviceable bearings should be adequately lubricated and enclosed in a lint-free wrapper until installed.

4. Inspect all splined parts for worn, twisted nicked or burred splines. If possible remove defects with a soft stone. Replace parts as necessary.

5. Inspect threaded parts for damaged threads. Repair threads by chasing or filing with a fine three cornered file. Replace when repair cannot be satisfactorily accomplished.

6. Inspect gear teeth for damage. Repair minor burrs or nicks with a fine file or emery cloth.

7. Carefully inspect the clutch plates for warping and wear. Allowable wear of the faced plates is governed by the grooves in the facing. These grooves permit oil to pass through the clutch plate stack in the engaged or released condition. The clutch plates must be replaced if excessive wear is evident on the faced plates.

IMPORTANT*: Reusable clutch plates or new clutch plates must be submerged in the same type oil used in the hydraulic system for a minimum of one hour prior to assembly. It is suggested that this be done in sufficient time to assure an uninterrupted assembly procedure. Covering the plates with oil from an oil can at assembly is not sufficient to prevent possible plate failure due to lack of lubrication at an initial start up after rebuild*

8. Check the compression springs for damage, distortion or weakness. Springs meeting the requirements shown in SPECIFICATIONS under GENERAL in this section, should function properly. Springs not meeting the requirements should be replaced.

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CLUTCH PACKS

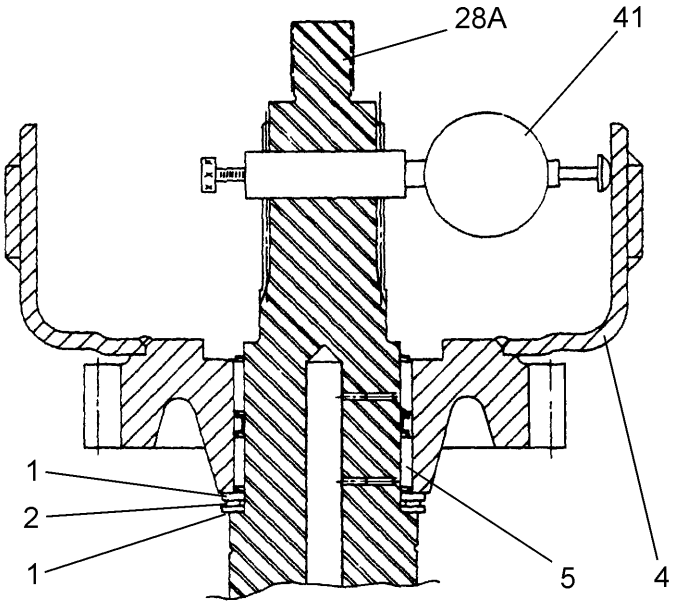


Fig. 7C.27 - Checking Each Drum Run-Out
(The Numbers are for First Speed Clutch)

1. Thrust Washer
2. Thrust Bearing
4. Drive Gear and Drum Assembly
5. Bearings
28A. Shaft
41. Dial Indicator

9. Check the "run-out" on each drum as follows (Fig. 7C.27):

a. Support the shaft (28A) in a vertical position.

b. Install the thrust washers (1) and thrust bearing (2) to seat on the shoulder of the shaft.

c. Place the drive gear and drum assembly (4) on the shaft, with the drum upward, as shown in the illustration.

d. Apply grease to the bearings (5) and slide the bearings down through the center of the drive gear and drum assembly.

e. Install a dial indicator (41) to the shaft. The end of the indicator should be fitted with a "shoe" to span the spaces in the drum.

IMPORTANT: *If the end of the shaft is splined, use some measure to protect the splines before installing the dial indicator.*

f. Rotate the drum completely around and take a reading on the dial indicator. Repeat at least once more for an accurate reading. The maximum "run-out" should not exceed 1.8 mm.

g. If the drum does not meet this specification, it should be replaced.

12. REASSEMBLY

NOTE: *Special tools are required for reassembly. Refer to "SERVICE/SPECIAL TOOLS" in Section 1.*

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TRANSMISSION

CLUTCH PACKS

First Speed Clutch Pack (Fig. 7C.26)

IMPORTANT: *All bearing inner races should be installed on shafts using heat. Using an oven or oil bath, apply a maximum heat of 135-150°C uniformly to the entire bearing race.*

IMPORTANT: *Before reassembly, pre-lubricate all machined parts with transmission oil.*

1. Install one snap ring (30) onto the shaft (27). Install the middle plate (28) with spring pins (27A) so that the extended portion of the spring pin is toward the oil inlet end of the shaft. Install the second snap ring (30) on the other side of the middle plate.

2. Install the three inner compression springs (32) and three outer compression springs (33) into the middle plate.

3. Install the reinforcing disc (24) over the guide pins, and install the valve disc (23) on top of the reinforcing disc.

4. Install one hook-type seal ring (15) onto the shaft on the oil inlet side of the middle plate.

IMPORTANT: *Use care when installing hook-type seal rings to avoid ring breakage.*

IMPORTANT: *Use care when installing the accelerator pistons to prevent breaking the hook-type seal ring on the shaft. Lubricate seal ring and inner bore of accelerating piston liberally with clean, new transmission fluid or grease before assembling.*

5. Install the seal ring (20) onto the accelerator piston (22). Install the accelerator piston onto the shaft and secure with the snap ring (21).

6. Install the two hook-type seal rings (15) onto the shaft on each side of the middle plate.

IMPORTANT: *Use care when installing hook-type seal rings to avoid ring breakage.*

IMPORTANT: *Use care when installing the piston housing (19) and the clutch piston (17) to prevent breaking the hook-type seal rings on the shaft. Lubricate the seal rings and inner bore of the housing and piston liberally with clean, new transmission fluid or grease before assembling.*

7. Install the seal ring (18) onto the clutch piston (17). Install the clutch piston onto the shaft, over the hook-type ring (15).

8. Install the O-ring (26) onto the separator plate (28). Liberally coat with grease the O-ring (26), seal ring (20), and seal ring (8).

NOTE: *The O-ring on the outer diameter of the separator plate is designed with a larger diameter than its groove hole. Once inside the piston housing however, this excess material is compressed into the groove, filling it completely.*

9. Install the snap ring groove filler tool with the narrow face up in the snap ring groove of the piston housing (19). Lubricate the groove area and the inside of the piston housing with heavy grease.

10. Install the piston housing (19) onto the shaft. Carefully feed the excess O-ring into the piston housing while applying pressure to the piston housing.

IMPORTANT: *Care must be taken during assembly to prevent cutting or otherwise damaging the seal rings and the O-ring.*

11. Depress the clutch piston (17) into the piston housing past the snap ring groove. Remove the snap ring groove filler and install the snap ring (16).

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CLUTCH PACKS

12. Apply air pressure to the oil inlet holes in the end of the shaft to check the operation of the clutch apply mechanism. The clutch piston and piston housing should move freely.

***IMPORTANT**: DO NOT exceed 700 kPa air pressure at the oil inlet ports.*

13. Reassemble the clutch hub assembly as follows (Fig. 7C.23):

a. Place the hub (10) on the board (40). Install the springs (11) into the hub.

b. Place the spring retainer (12) over the springs. Use a suitable tool to align the hole in the spring retainer with the corresponding hole in the hub. The upper end of each spring should be resting in one of the depressions in the spring retainer.

c. Install the bolt (36), washers (37), nut (38) and plate (39) as shown in the illustration. Compress the spring retainer to provide entry space for the retainer ring (13).

d. Install the retainer ring so that it is fully seated around the rim of the hub as shown in Fig. 7C.28.

IMPORTANT: When completed, the retainer ring must be tight and flat against the end of the hub splines as specified by the following maximum gap tolerances:

70% of circumference = zero clearance between hub and retainer ring

30% of circumference = 0.l8 mm maximum clearance

e. Remove the clutch hub assembly from the board.

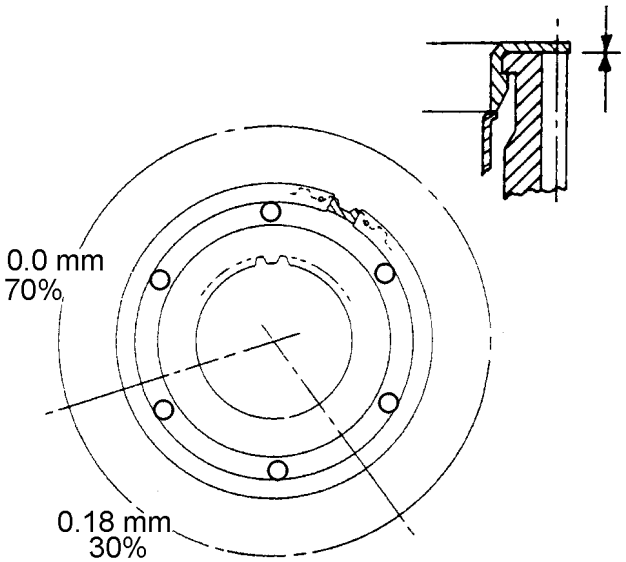


Fig. 7C.28. Seating the Clutch Plate Retainer Ring to Hub

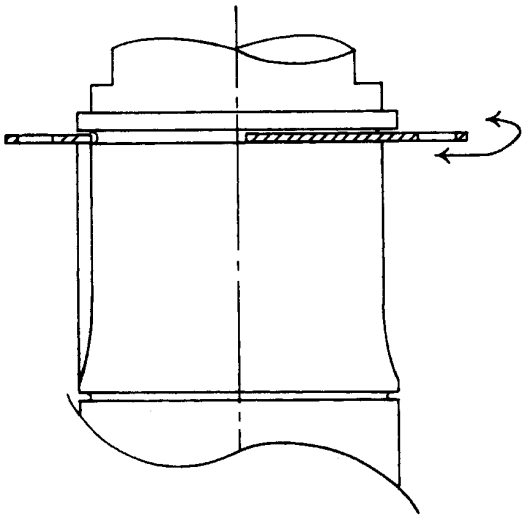


Fig. 7C.29. Checking Clutch Hub Retainers

14. Check the split retainer rings (5) for thickness, flatness, and binding, as follows (Fig. 29):

a. Insert each half all the way to the bottom of the groove in the shaft. With a light „bottoming" hand pressure, rotate the retainer halves around the shaft to check for a "no drag" condition.

b. If the retainers do not move freely in the groove, replace them with new. Also check new retainers, as in "a" above.

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15. Install the clutch hub assembly (10) on the shaft. Move the piston assembly (17 and 19) as far away from the hub as possible to prevent unnecessary compression of the hub internal springs.

16. Install both halves of the split retainer ring (5). Install and tighten the two retainer bolts (8). Align the retainer bolts as follows (Fig. 7C.30).

    a. Loosen, then retighten both bolts.

    b. Note the position of the "flats" on each bolt head. In their final position, the "flats" on the bolt heads must be in position A.

    c. Loosen each bolt head one "flat", but less than two "flats". Even a bolt head that was in position A must be loosened one "flat". Bolts which were retightened to positions B, C or D must be loosened (rotated counterclockwise) to the next "flat". DO NOT tighten these bolts to achieve the correct "flat" position.

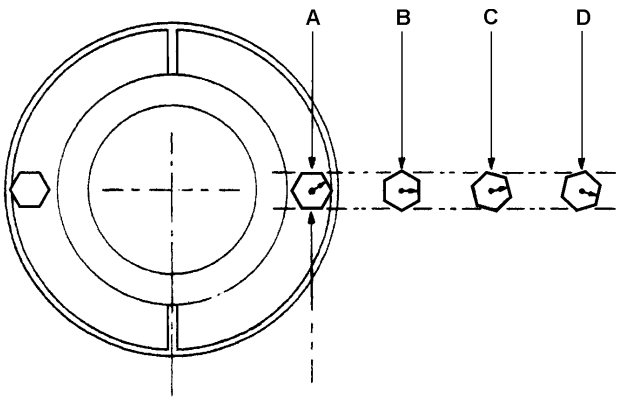


Fig. 7C.30. Aligning the Retainer Bolts

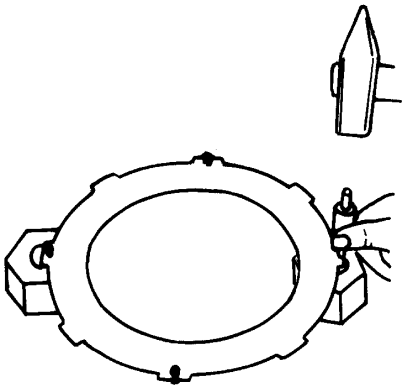


Fig. 7C.31. Installing Rubber Plug

17. Install rubber plugs (34) in the separator plates (7) as follows:

NOTE: *A special tool is available for installing the rubber plugs. Refer to SERVICE/SPECIAL TOOLS in Section 1.*

    a. Lubricate the plug with liquid soap and insert it into the large opening of the tool body (make sure the plug does not become wedged sideways).

    b. Insert the tool driver in the tool body.

    c. Position the tool flush and centered on the hole in the clutch plate as shown in Fig. 7C.31.

    d. Holding the tool tightly against the plate, strike the driver with a hammer so the plug enters the plate. The plug should be centered on the plate when finished.

18. Starting with a bronze friction disc (6), alternately stack the friction discs and the separator plates (7) onto the clutch hub assembly.

19. Install the backing plate (1) on top of the plates, and install the internal snap ring (4) and the external snap ring (3).

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20. Install spacer (9, Fig. 7C.25). thrust washer (8) thrust bearing (7) and thrust washer (6) on the shaft. The notches in spacer (9) must fit around the clutch hub retainer bolts (8, Fig. 7C.26).

21. Align the rubber plugs (34) of steel plates (7) so that each rubber plug is touching a plain drive lug on the steel plate above and below it.

22. Install the gear and drum (4, Fig. 7C.25) over the clutch plates so that the drive lugs on the steel plates fit into the spaces in the drum.

23. Apply grease to the two bearings (5, Fig. 7C.25) and slide the bearings down through the center of the drive gear and drum (4). Install thrust washer (3) thrust bearing (2) and thrust washer (1).

24. Install the heated bearing cone (37, Fig. 7C.14) on the end oft he shaft until it bottoms.

25. Turn the shaft over and install spacer (33, Fig. 7C.14)) until it is up against the shoulder. Install gear (32) so that it is up against spacer (33). Install the heated bearing cone (16) until it bottoms on gear (32),

Second/Third Speed Clutch Pack (Fig. 7C.22)

IMPORTANT: *All bearing inner races should be installed on shafts using heat. Using an oven or oil bath, apply a maximum heat of 135-150° C uniformly to the entire bearing race.*

IMPORTANT: *Before reassembly, pre-lubricate all machined parts with transmission oil.*

1. Install the middle plate (28) onto the shaft (35). Install the two snap rings (30) on each side of the separator plate. Position the shaft with the oil inlet holes up. Install the three guide pins (24) into the separator plate.

2. Install three inner compression springs (32) and three outer compression springs (33) into the separator plate. Install the reinforcing disc (23) and the valve disc (22) over guide pins (24).

3. Install a hook-type seal ring (14) onto the shaft.

IMPORTANT: *Use care when installing hook-type seal rings to avoid ring breakage.*

IMPORTANT: *Use care when installing the accelerator piston to prevent breaking the hook-type seal ring on the shaft. Lubricate the seal ring and inner bore of the accelerating piston liberally with clean, new transmission fluid or grease before assembling.*

4. Install a seal ring (19) onto the accelerator piston (21). Install the accelerator piston onto the shaft and secure it with the snap ring (20).

5. Turn the shaft over and repeat steps 2 through 4 for the other end of the shaft.

6. Install both hook-type seal rings (14) onto the shaft.

IMPORTANT*: Use care when installing hook-type seal rings to avoid ring breakage.*

IMPORTANT: *Use care when installing the piston housing (18) and the clutch piston (16) to prevent breaking the hook-type seal rings on the shaft. Lubricate the seal rings and inner bore of the housing and piston liberally with clean, new transmission fluid or grease before assembling.*

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7. Install the seal ring (17) onto the clutch piston (16). Install the clutch piston onto the opposite end of the shaft from the oil inlet holes, over the hook-type seal ring (14).

8. Install the "0" ring (25) onto the separator plate (28). Liberally coat with grease the O-ring (25), seal ring (19) and seal ring (17).

NOTE: *The O-ring on the outer diameter of the separator plate is designed with a larger diameter than its groove hole. Once inside the piston housing however, this excess material is compressed into the groove, filling it completely.*

9. Install the snap ring groove filler tool with the narrow face up in the snap ring groove of the piston housing (18). Lubricate the groove area and the inside of the piston housing with heavy grease.

10. Install the piston housing (18) onto the shaft. Carefully feed the excess O-ring into the piston housing while applying pressure to the piston housing.

IMPORTANT: *Care must be taken during assembly to prevent cutting or otherwise damaging the seal rings and the O-ring.*

11. Depress the clutch piston (16) into the piston housing past the snap ring groove. Remove the snap ring groove filler and install the snap ring (15).

12. Apply air pressure to the oil inlet holes in the end of the shaft to check the operation of the clutch apply mechanism. The clutch piston and piston housing should move freely.

IMPORTANT: *DO N0T exceed 700 kPa air pressure at the oil inlet ports.*

13. Reassemble both clutch hub assemblies as follows (Fig. 7C.23):

a. Place the hub (10) on the board (40). Install the springs (11) into the hub.

b. Place the spring retainer (12) over the springs. Use a suitable tool to align the hole in the spring retainer with the corresponding hole in the hub. The upper end of each spring should be resting in one of the depressions in the spring retainer.

c. Install the bolt (36), washers (37), nut (38) and plate (39) as shown in the illustration. Compress the spring retainer to provide entry space for the retainer ring (13).

d. Install the retainer ring so that it is fully seated around the rim of the hub as shown in Fig. 7C.28.

IMPORTANT: *When completed the retainer must be tight and flat against the end of the hub splines as specified by the following maximum gap tolerances:*

70% of circumference = zero clearance between hub and retainer ring

30% of circumference = 0.l8 mm maximum clearance

e. Remove the clutch hub assembly from the board.

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14. Check the split retainer rings (5) for thickness, flatness, and binding, as follows (Fig. 7C.29):

    a. Insert each half all the way to the bottom of the groove in the shaft. With a light "bottoming" hand pressure , rotate the retainer halves around the shaft to check for a "no drag" condition.
    b. If the retainers do not move freely in the groove, replace them with new. Also check new retainers, as in "a" above.

15. Install the clutch hub assembly (9) on the shaft. Move the piston assembly (16 and 18) as far away from the hub as possible to prevent unnecessary compression of the hub internal springs.

16. Install both halves of the split retainer rings (5). Install and tighten the two retainer bolts (8). Align the retainer bolts as follows (Fig. 7C.30):

    a. Loosen, then retighten both bolts.

    b. Note the position of the "flats" on each bolt head. In their final position, the "flats" on the bolt heads must be in position A.

    c. Loosen each bolt head one "flat", but less than two "flats". Even a bolt head that was in position A must be loosened one "flat". Bolts which were retightened to positions B, C or D must be loosened (rotated counterclockwise) to the next "flat". DO NOT tighten these bolts to achieve the correct "flat" position.

17. Install rubber plugs (34) in the separator plates (7) as follows:

NOTE: *A special tool is available for installing the rubber plugs. Refer to SERVICE/SPECIAL TOOLS in Section 1.*

    a. Lubricate the plug with liquid soap and insert it into the large opening of the tool body (make sure the plug does not become wedged sideways).

    b. Insert the tool driver in the tool body.

    c. Position the tool flush and centered on the hole in the separator plate as shown in Fig. 7C.31.

    d. Holding the tool tightly against the plate, strike the driver with a hammer so the plug enters the plate. The plug should be centered on the plate when finished.

18. Starting with a bronze friction disc (2), alternately stack the friction discs and the separator plates (7) onto the clutch hub assembly.

19. Install the backing plate (1) on top of the plates, and install the internal snap ring (3) and the external snap ring (4).

20. Turn the shaft over and repeat steps 14 through 19 for the other end of the shaft.

20. Install spacer (18, Fig. 7C.24), thrust washer (17), thrust bearing (16) and thrust washer (15) on the shaft. The notches in spacer (18) must fit around the clutch hub retainer bolts (8, Fig. 7C.22).

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22. Align the rubber plugs (34) of separator plates (7) so that each rubber plug is touching a plain drive lug on the separator plate above and below it.

23. Install the gear and drum (13, Fig. 7C.24) over the clutch plates so that the drive lugs on the separator plates fit into the spaces in the drum.

24. Apply grease to bearing (14, Fig. 7C.24) and slide the bearing down through the center of the drive gear and drum (13). Install thrust washer (12), thrust bearing (11) and thrust washer (10)

25. Install gear (9, Fig. 7C.24) on the shaft so that it is up against thrust washer (10). Install the heated bearing (8) on the shaft until it bottoms on gear (9).

26. Install spacer (7, Fig. 7C.24) on the shaft so the notches in the spacer fit around the clutch up retainer bolts (8, Fig. 7C.22).

27. Align the rubber plugs (34) of separator plates (7) so that each rubber plug is touching a plain drive lug on the steel plate above and below it.

28. Apply grease to bearings (3 and 5, Fig. 7C.24). Slide bearing (5), spacer (4) and bearing (3) down through the center of the drive gear and drum (6). Install spacer (2) and the heated bearing (1) on the shaft until it bottoms.

Forward/Reverse Clutch Pack (Fig. 7C.22)

IMPORTANT: *All bearing inner races should be installed on shafts using heat. Using an oven or oil bath, apply a maximum heat of 135-150° C uniformly to the entire bearing race.*

IMPORTANT: *Before reassembly, pre-lubricate all machined parts with transmission oil.*

1. Install the middle plate (28) onto the shaft (35). Install the two snap rings (30) on each side of the middle plate. Position the shaft with the oil inlet holes up. Install the three guide pins (27) into the middle plate (if removed).

2. Install three inner compression springs (32) and three outer compression springs (33) into the middle plate. Install the reinforcing disc (23) and the valve disc (22) over the guide pins (24).

3. Install a hook-type seal ring (14) onto the shaft.

IMPORTANT: *Use care when installing hook-type seal rings to avoid ring breakage.*

IMPORTANT: *Use care when installing the accelerator piston to prevent breaking the hook-type seal ring on the shaft. Lubricate the seal ring and inner bore of the accelerating piston liberally with clean, new transmission fluid or grease before assembling.*

4. Install a seal ring (19) onto the accelerator piston (21). Install the accelerator piston onto the shaft and secure it with the snap ring (20).

5. Turn the shaft over and repeat steps 2 through 4 for the other end of the shaft.

6. Install both hook-type seal rings (14) onto the shaft.

IMPORTANT: *Use care when installing hook-type seal rings to avoid ring breakage.*

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CLUTCH PACKS

IMPORTANT: *Use care when installing the piston housing (18) and the clutch piston (16) to prevent breaking the hook-type seal rings on the shaft. Lubricate the seal rings and inner bore of the housing and piston liberally with clean, new transmission fluid or grease before assembling.*

7. Install the seal ring (17) onto the clutch piston (16). Install the clutch piston onto the same end of the shaft as the oil inlet holes, over the hook-type seal ring (14).

8. Install the O-ring (25) onto the middle plate (28). Liberally coat with grease the O-ring (25), seal ring (19), and seal ring (17).

NOTE: *The O-ring on the outer diameter of the separator plate is designed with a larger diameter than its groove hole. Once inside the piston housing however, this excess material is compressed into the groove, filling it completely.*

9. Install the snap ring groove filler tool with the narrow face up in the snap ring groove of the piston housing (18). Lubricate the groove area and the inside of the piston housing with heavy grease.

10. Install the piston housing (18) onto the shaft. Carefully feed the excess O-ring into the piston housing while applying pressure to the piston housing.

IMPORTANT: *Care must be taken during assembly to prevent cutting or otherwise damaging the seal rings and the O-ring.*

11. Depress the clutch piston (16) into the piston housing past the snap ring groove. Remove the snap ring groove filler and install the snap ring (15).

12. Apply air pressure to the oil inlet holes in the end of the shaft to check the operation of the clutch apply mechanism. The clutch piston and piston housing should move freely.

IMPORTANT: *DO NOT exceed 700 kPa air pressure at the oil inlet ports.*

13. Reassemble both clutch hub assemblies as follows (Fig. 7C.23):

    a. Place the hub (10) on the board (40), Install the springs (11) into the hub.

    b. Place the spring retainer (12) over the springs. Use a suitable tool to align the hole in the spring retainer with the corresponding hole in the hub. The upper eñd of each spring should be resting in one of the depressions in the spring retainer.

    c. Install the bolt (36), washers (37), nut (38) and plate (39) as shown in the illustration. Compress the spring retainer to provide entry space for the retainer ring (13).

    d. Install the spring retainer so that it is fully seated around the rim of the hub as shown in Fig. 7C.28.

IMPORTANT: *When completed, the retainer must be tight and flat against the end of the hub splines as specified by the following maximum gap tolerances:*

70% of circumference = zero clearance between hub and retainer

30% of circumference = -0.l8 mm maximum clearance

    e. Remove the clutch hub assembly from the board.

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CLUTCH PACKS

IMPORTANT: *Whenever new external splined separator plates (7) are used and/or new drums (4 or 15, Fig. 7C.21) are used, run the separator plates up and down inside the drum. There must be free movement between the drive lugs on the separator plate and the spaces in the drum throughout the entire depth of the drum.*

14. Install black rubber plugs (34) in the separator plates (7) as follows:

    a. Lubricate the plug with liquid soap and insert it into the large opening of the tool body (make sure the plug does not become wedged sideways).

    b. Insert the tool driver in the tool body.

    c. Position the tool flush and centered on the hole in the separator plate as shown in Fig. 7C.31.

    d. Holding the tool tightly against the plate, strike the driver with a hammer so the plug enters the plate. The plug should be centered on the plate when finished.

15. Position the clutch hub assembly with the retainer ring (13, Fig. 7C.32) down. The assembly should be supported only on the retainer and elevated slightly above the work surface as shown in the illustration.

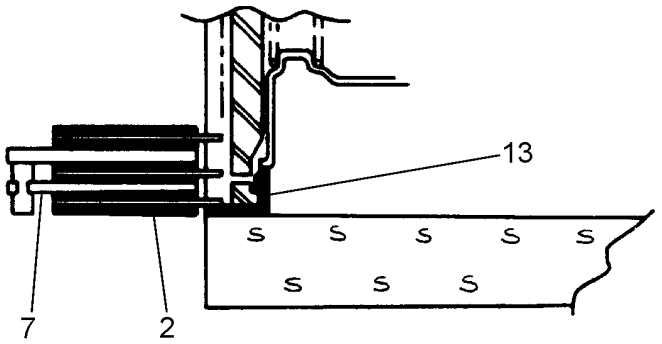


Fig. 7C.32. Stacking the Clutch Plates

2. Bronze Friction Disc
7. Separator Plate
13. Retainer Ring

16. Install the first friction disc (2) so that the organic side is facing down.

IMPORTANT: *Be sure that the organic facing material on friction disc (2) does not contact the edge of the retainer (13) at any point around the circumference.*

17. Install a separator plate (7) on top of the friction disc (2). Install a friction disc (6) on top of the separator plate (7). Continue alternately stacking separator plates (7) and friction discs (6) until all of them are installed.

18. Align the rubber plugs of the separator plates as shown in Fig. 7C.33. Each rubber plug (34) should be touching a plain drive lug (41) on the steel plate above and below it.

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19. Position backing plate (1, Fig. 7C.33) on top of the clutch plates. Check the aligned stack height of all the plates by noting the difference between the level of the backing plate (1) and the snap ring groove (42) in the clutch hub. If the backing (1) is above the snap ring groove (42), check for plate warpage. All rubber plugs (34) must be touching a plain tab (41) on adjacent separator plate.

IMPORTANT: *If the stack of plates must be compressed in order to install the snap ring into the groove (42, Fig. 7C.33), the assembly will be „pre-loaded" and could result in internal damage during operation.*

20. If the backing plate (1) is even or below retainer ring (5, Fig. 7C.22)), install the internal snap ring (3) and the external snap ring (4).

21. Check the aligned running clearance, or gap, between the backing plate and the adjacent friction disc, as shown in Fig. 7C.34. The running clearance should be zero to a maximum of 0.8 mm

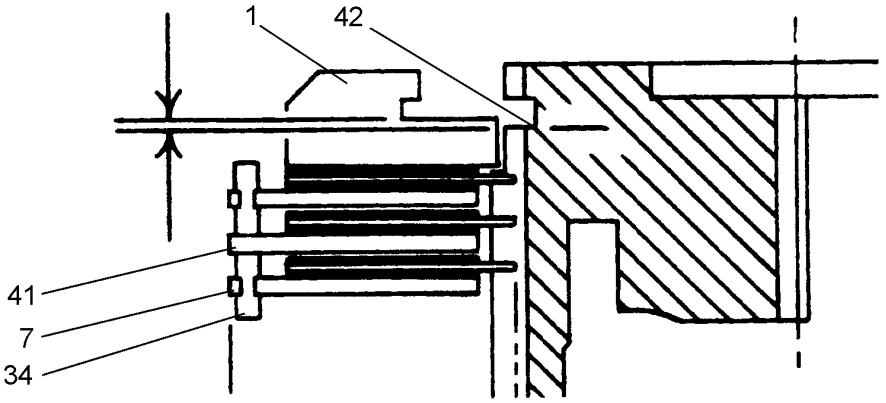


Fig. 7C.33. Checking the Aligned Stack Height

1. Backing Plate
7. Separator Plate
34. Rubber Plug
41. Plain Drive Lug on Separator Plate
42. Snap Ring Groove

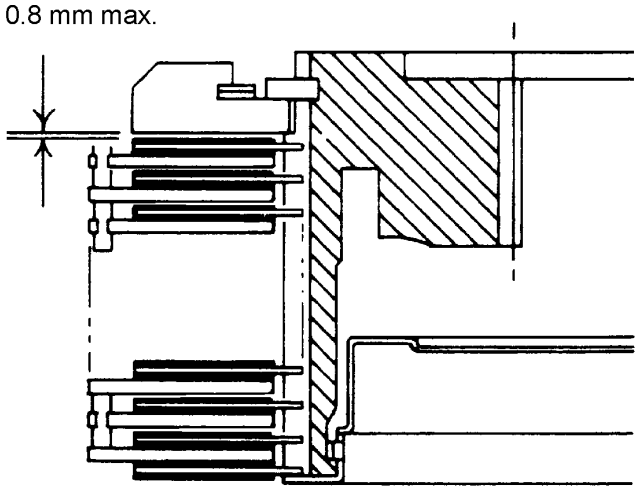


Fig. 7C.34. Checking the Aligned Running Clearance

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CLUTCH PACKS

22. If the aligned running clearance is not as specified in the previous step, correct as follows:

a. Check for warpage of the separator plates. All rubber plugs must be touching a plain tab on an adjacent separator plate.

b. The rubber plugs come in two different sizes:

Black - 9.8 mm
Silver - 10.0 mm

Adjust the running clearance by exchanging plates with silver plugs for plates with black plugs until the correct running clearance is obtained.

NOTE: *All plugs on one plate must be the same color*.

NOTE: *Be sure the plugs are installed correctly and protrude equally on each side of the plate.*

23. Misalign the separator clutch plates so that the rubber plugs fall between the drive lugs of the separator plate above and below it, as shown in Fig. 7C.35.

24. Check the misaligned running clearance, or gap, between the backing plate and the adjacent friction disc, as shown in Fig. 7C.36. The misaligned running clearance should be 3 - 5 mm.

25. If the misaligned running clearance is not as specified in the previous step, correct as follows:

a. Check for warpage of separator plates and of friction discs. Replace as necessary.

b. The thickness of the separator plates themselves may be on the high side (or low side) of the manufacturing tolerance. Individually measure and select these plates to obtain the correct misaligned running clearance.

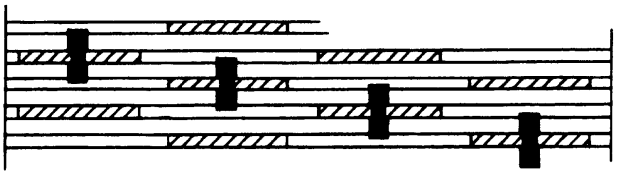


Fig. 7C.35. Misaligning the Separator Clutch Plates

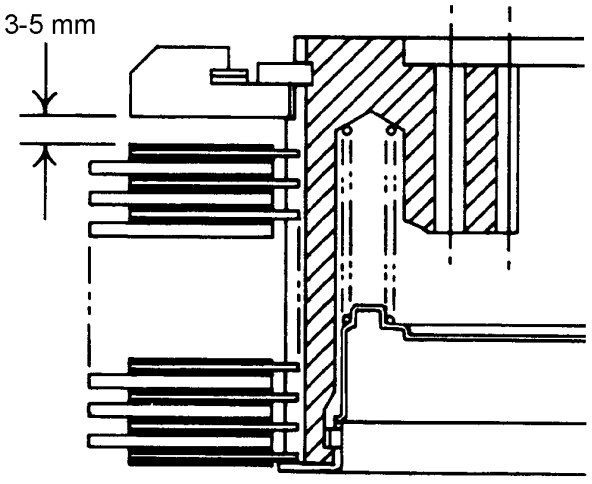


Fig. 7C.36. Checking the Misaligned Running Clearance

IMPORTANT: *If any plates are changed because of these measurements, be sure the rubber plugs on those plates remain the same. Recheck the aligned running clearance as well as the misaligned running clearance before proceeding.*

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CLUTCH PACKS

26. Check the split clutch hub retainers (5, Fig. 7C.22) for thickness, flatness, and binding, as follows:

    a. Insert each half all the way to the bottom of the groove in the shaft. With a light „bottoming" hand pressure, rotate the retainer halves around the shaft to check for a „no drag" condition.

    b. If the retainers do not move freely in the groove, replace them with new. Also check new retainers, as in „a" above.

27. Install the final clutch hub assembly (9) on the shaft. Move the piston assembly (16 and 18) as far away from the hub as possible to prevent unnecessary compression of the hub internal springs.

28. Install both halves of the clutch hub retainer (5). Install and tighten the two retainer bolts (8). Align the retainer bolts as follows (Fig. 7C.30):

    a. Loosen, then retighten both bolts.

    b. Note the position of the „flats" on each bolt head. In their final position, the „flats" on the bolt heads must be in position A.

    c. Loosen each bolt head one „flat", but less than two „flats". Even a bolt head that was in position A must be loosened one „flat". Bolts which were retightened to positions B, C or D must be loosened (rotated counterclockwise) to the next „flat". DO NOT tighten these bolts to achieve the correct „flat" position.

29. Turn the shaft over and repeat steps 26 through 28 for the other end of the shaft.

30. Position the shaft with the oil inlet holes up. Install spacer (11, Fig. 7C.21), thrust washer (10), thrust bearing (9) and thrust washer (8) on the shaft. The notches in spacer (11) must fit around the clutch hub retainer bolts (8, Fig. 7C.22).

31. Align the rubber plugs (34) of separator plates (7) so that each rubber plug is touching a plain drive lug on the separator plate above and below it.

32. Install the gear and drum (4, Fig. 7C.21) over the clutch plates so that the drive lugs on the separator plates fit into the spaces in the drum.

33. Apply grease to bearings (5 and 7, Fig. 7C.21). Slide bearing (7), spacer (6) and bearing (5) down through the center of the drive gear and drum (4).

34. Install thrust washer (3, Fig. 7C.21), thrust bearing (2) and thrust washer (1). Install the heated bearing cone on the shaft until it bottoms.

35. Repeat steps 22 through 26 on the opposite end of the shaft.

13. INSTALLATION

Follow the necessary steps as outlined in „REASSEMBLY" under „TRANSMISSION" for installation of all the clutch packs.

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TRANSMISSION

CONTROL VALVE

14. REMOVAL

1. Disconnect all hoses (1, 2, 3 and 4, Fig. 7C.37) from the transmission control valve. Remove the hose (3 and 4) from the bracket on the rear of the transmission.

2. Disconnect the control cables (5 and 6, Fig. 7C.37) on the transmission control valve and remove the cables from the bracket on the front of the transmission.

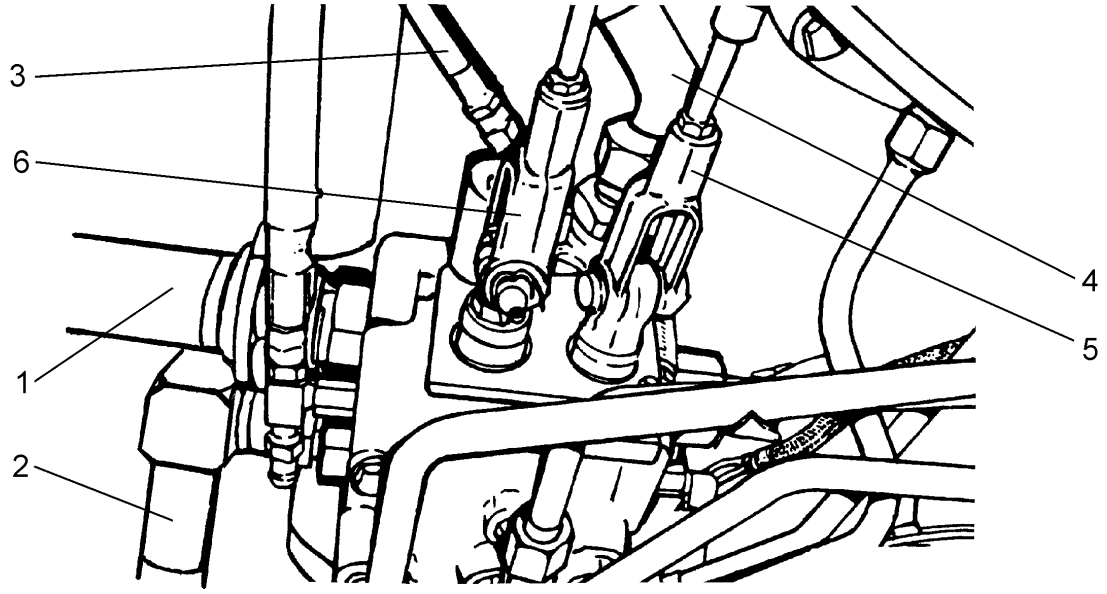


Fig. 7C.37. Control Valve Supply Hoses

1. Pump Pressure Hose
2. Oil Cooler Return Hose
3. Transmission Disconnect Hydraulic Hose
4. Torque Converter Supply Hose
5. Directional Control Cable
6. Range Control Cable

3. Remove tubes (1 through 6, Fig. 7C.38) and disconnect hose (7).

4. Disconnect the wires from the neutral start switch (9, Fig. 7C.38).

5. Remove the four bolts and lock washers securing the valve and remove the valve. Discard the O-rings (3 and 4, Fig. 7C.39).

15. DISASSEMBLY (Refer to Fig. 7C.39)

1. Remove the two bolts (34) with lock washers (35) securing the two valve halves (1 and 13) together. Separate the halves and discard O-rings (15 and 17).

2. Remove plug (18), spring (20), pin (21) and ball (22) from both sides of valve body (14). Remove and discard O-rings (19) from plugs (18).

3. Remove the neutral safety start switch (36) and ball (37) from upper valve body (14) and tap out slotted roll pins (16).

4. Remove the two plugs from valve body (14) and tap out slotted roll pins (16)

5. Remove end plate (31) and discard O-rings (28) and seals (27).

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CONTROL VALVE

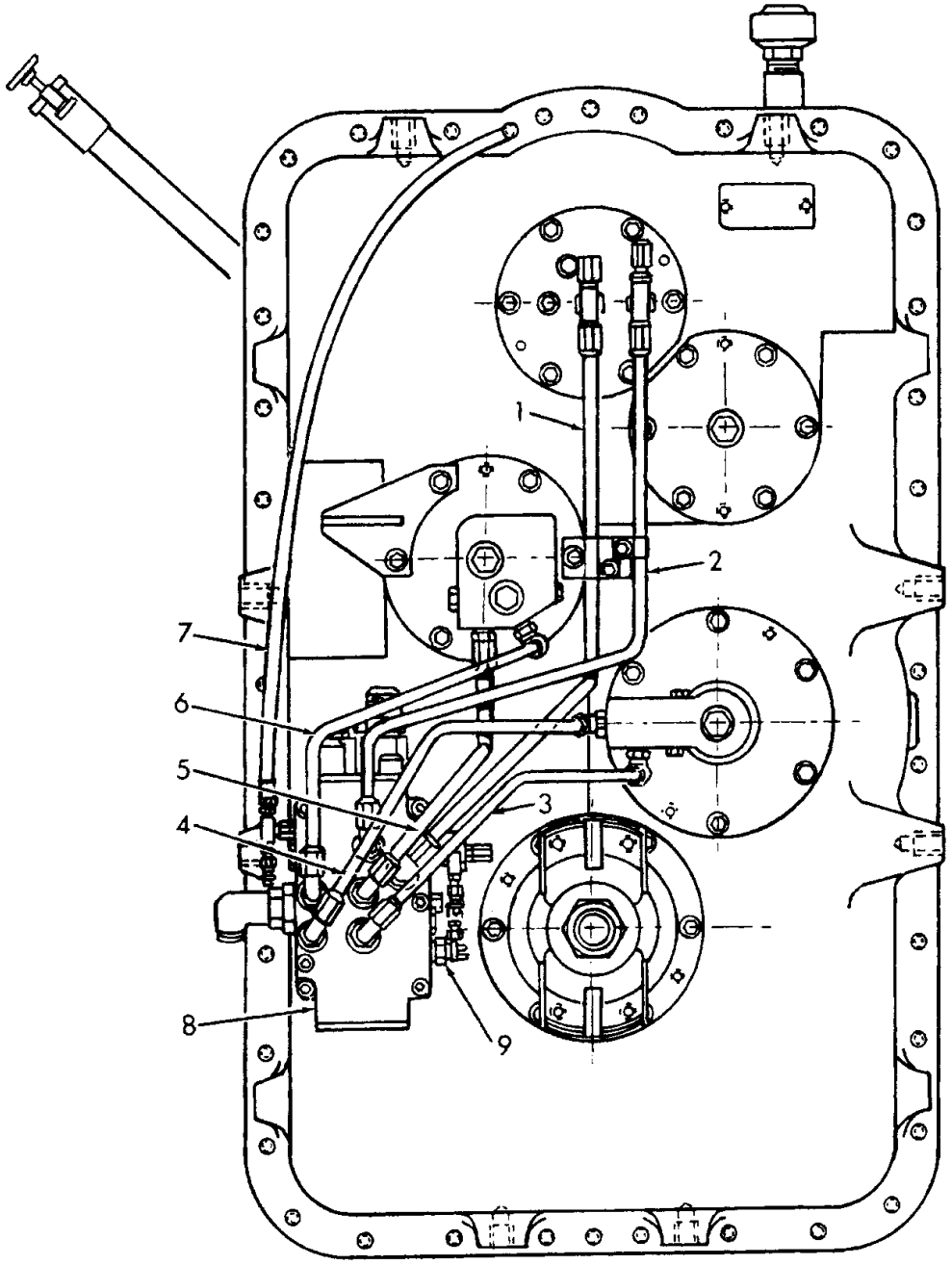


Fig. 7C.38. Transmission Front Tubes

1. Forward Tube
2. Reverse Tube
3. Third Tube
4. Second Tube
5. Lube Tube
6. First Tube
7. Lube Hose
8. Control Valve
9. Neutral Start Switch

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TRANSMISSION

CONTROL VALVE

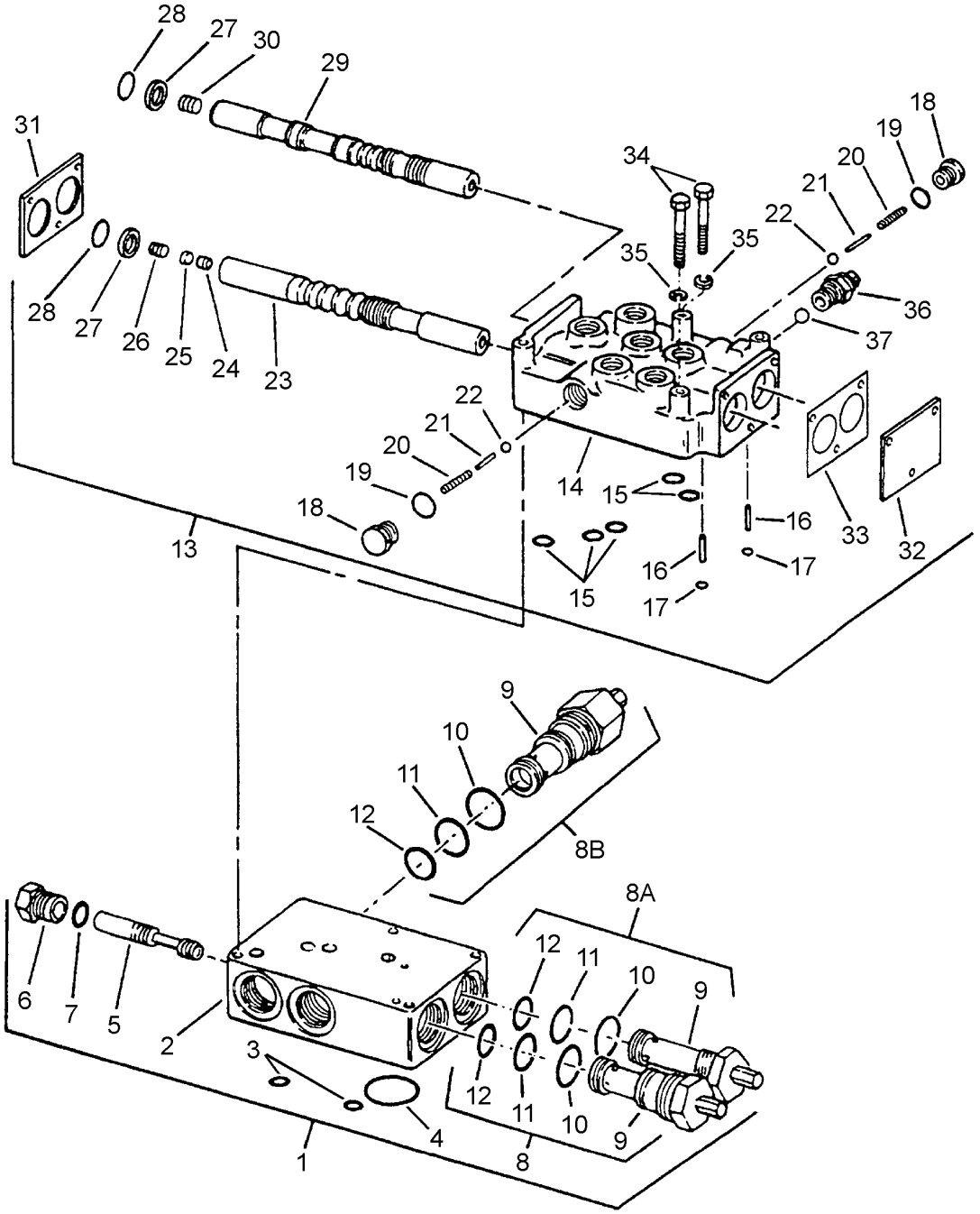


Fig. 7C.39. Exploded View of Transmission Control Valve

1. Lower Valve Assembly
2. Lower Valve Body
3. O-Ring
4. O-Ring
5. Neutralizer Spool
6. Plug
7. O-Ring
8. Lube Cartridge (10 PSI)
8A. Converter Cartridge (80 PSI)
8B. Main Cartridge (200 PSI)
9. Valve Body
10. O-Ring
11. O-Ring
12. O-Ring
13. Upper Valve Assembly
14. Upper Valve Body
15. O-Ring
16. Slotted Roll Pin
17. O-Ring
18. Plug
19. O-Ring
20. Spring
21. Detent Pin
22. Ball
23. Gear Range Spool
24. Lock Screw
25. Seal
26. Set Screw
27. Seal
28. O-Ring
29. Directional Spool
30. Plug
31. End Plate
32. End Plate
33. Plate Gasket
34. Bolt
35. Lock Washer
36. Neutral Safety Start Switch
37. Ball

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6. Remove spools (23 and 29) from the valve body.
7. Remove plug (30) from spool (29).
8. Remove set screw (26), seal (25) and lock screw (24) from spool (23).
9. Remove end plate (32) and discard gasket (33).
10. Remove cartridge valves (8, 8A and 8B) from valve body (2). Discard O-rings (10, 11 and 12).
11. Remove plug (6) and neutralizer spool (5). Discard O-ring (7).

16. INSPECTION AND REPAIR

1. Be sure all spool orifices and valve passages are open and clean.
2. Inspect all metal to metal surfaces for signs of burrs, nicks or other damage.
3. Check all springs for damage, distortion or weakness. Springs meeting the requirements shown in SPECIFICATIONS under GENERAL should function properly. Springs not meeting the requirements should be replaced.

17. REASSEMBLY (Refer to Fig. 7C.39)

1. Install neutralizer spool (5) and plug (6) with new O-ring (7) in valve body (2).
2. Install cartridge valves (8, 8A and 8B) with new O-rings (10, 11 and 12) in valve body (2).
3. Install lock screw (24), seal (25) and set screw (26) in spool (23).
4. Install plug (30) in spool (29).
5. Install seals (27) so that the lip of the seal faces in.
6. Install end plate (32) with a new gasket (33).
7. Insert spools (23 and 29) in valve body (14) and tap the slotted roll pins (16) into the valve body so that the slot in the pin faces away from the spools. Install the plugs in the pinholes.
8. Install end plate (31) with new O-rings (28).
9. Install ball (37) and the neutral safety start switch (36) in body (14).
10. Install ball (22) pin (21), spring (20) and plug (18) with new O-ring (19) in both sides of valve body (14).
11. Secure the two valve halves together using new O-rings (15 and 17).

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18. INSTALLATION

1. Secure the valve assembly to the transmission using new O-rings (3 and 4, Fig. 39).

2. Reconnect the wires to the neutral safety start switch (9, Fig. 7C.38).

3. Reinstall tubes (1 through 6, Fig. 7C.38) and connect hose (7) to the valve.

4. Reconnect the control cables (5 and 6, Fig. 7C.37) to the control valve spools.

5. Connect the hydraulic hoses (1, 2, 3 and 4, Fig. 7C.37) (2) to the control valve.

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DRIVE AXLE AND DIFFERENTIAL

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DRIVE AXLE AND DIFFERENTIAL SECTION 7D

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GENERAL

1. DESCRIPTION

This section covers the drive shafts, transfer drive, planetary gear, wheel hub and service brake. For a detailed description of these components refer to the pertinent heading in this section.

For servicing the disc type parking brake mounted to the differential of the front axle assembly, refer to Section 4, BRAKES.

2. THEORY OF OPERATION

The following covers the general flow of power through the driveline. For the detailed operation of a component in the driveline, refer to the pertinent heading in this section.

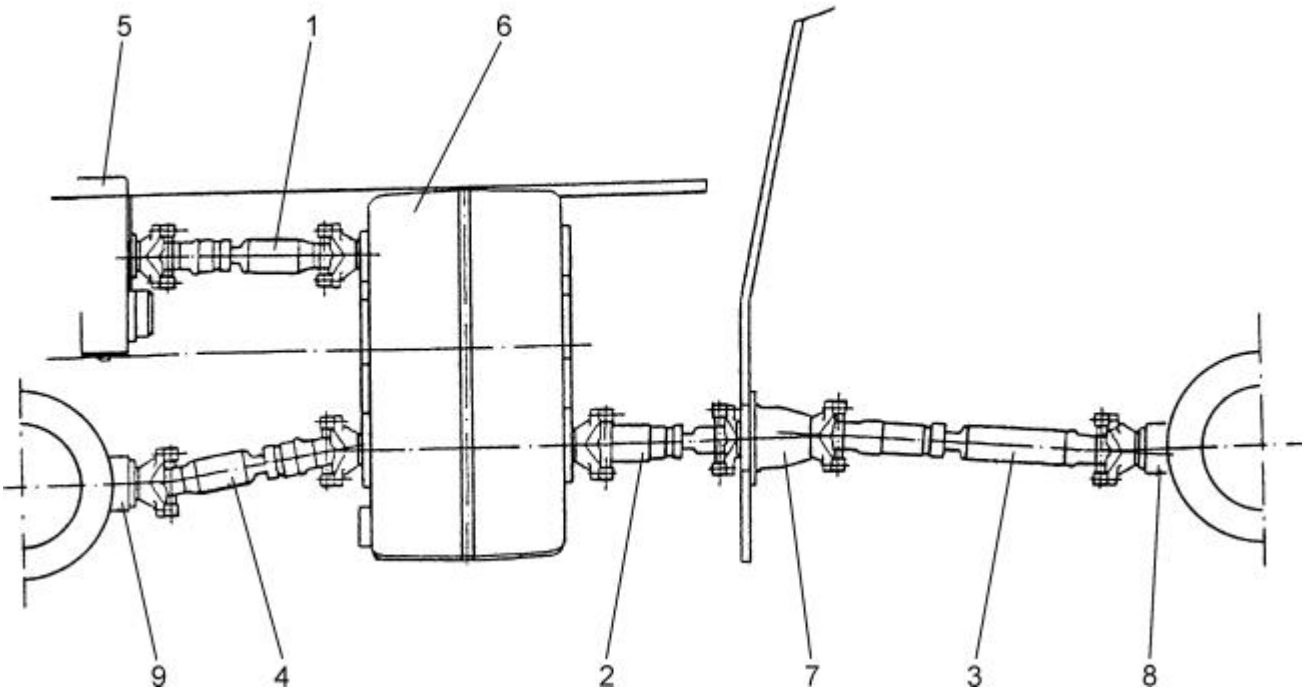


Fig. 7D.1. Drive Line

1. Torque Converter-to-Transmission Drive Shaft
2. Transmission-to-Transfer Drive Shaft
3. Transfer Drive-to-Front Differential Drive Shaft
4. Transmission-to-Rear Differential Drive Shaft
5. Torque Converter
6. Transmission
7. Transfer Drive Assembly
8. Front Drive Axle
9. Rear Drive Axle

Engine power transmitted through the torque converter is carried by a drive shaft (1, Fig. 7D.1) to the remotely mounted transmission. The transmission transmits this power through two drive shafts to the front and rear differentials. The rear drive shaft (4) connects directly to the rear differential. The front drive shaft (2) connects to a transfer drive (7), which in turn transmits the power to the front differential through a second drive shaft (3). The differentials distribute the incoming torque through the axle shafts to the planetary assemblies mounted directly to the wheel hubs.

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DRIVE SHAFTS

3. DESCRIPTION AND OPERATION

The purpose of the drive shafts is to transmit power. An articulated joint (2, Fig. 7D.2) located at each end of the shaft permits pivoting in all directions and adjusts for any misalignment between components.

A slip joint is provided to allow the shaft to telescope to compensate for changes in the distance between the connected components. For example, during normal operation the rear axle undergoes considerable movement due to surface irregularities and varying loads. Each time these conditions are encountered , a change in the overall length of the shafts occurs. The internal splines of the yoke (3, Fig. 7D.2) slip back and forth on the external splines of the shaft (8) to vary the length. The splines are lubricated by an external grease fitting (7) and the grease is kept within the slip yoke by either a cork or felt washer (5).

4. SPECIFICATIONS

Special torques:

Articulated joint mounting bolts . . . . . 130 Nm

5. SERVICE DIAGNOSIS

Drive line failures are usually indicated by noise or vibrations which may come and go as different ground speeds are reached. Transmission and tire problems are often attributed to the drive axle. Before deciding the cause of the problem is in the drive line, all sources of noise must be investigated. To aid in finding the cause of the problem, review the service diagnosis shown throughout this section.

Troubleshooting

COMPLAINT	
PROBABLE CAUSE	REMARKS
Noise	
1. Lack of lubricant	See Note A below
2. Backlash	See Note B below
3. Yokes loose	See Note B below
4. Yoke shaft splines worn	See Note B below
Vibration	
1. Drive shaft sprung or bent	Replace drive shaft
2. Yokes loose	Tighten mounting bolts
3. Articulated joint bearings not properly seated or worn	Disassemble and correct at fault or replace articulated joint
4. Excessive end play in transmission output shaft	Check and adjust end play. Refer to REASSEMBLY under TRANSMISSION in Section 7C

A. Inspect the undercarriage and notice if grease is being thrown at the slip joints and articulated joints. Tighten retainer cap and lubricate slip joint. If grease still extrudes, replace washers in the retainer cap assembly. If grease is being thrown out at the articulated joints, remove the drive shaft and replace the bearing seals or replace the articulated joints, if the bearings are worn.

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DRIVE SHAFTS

B. Use a small pry bar to check the articulated joints and yokes for looseness and for play. If able to move either or both flanges back and forth, tighten the mounting bolts at the articulated joints and yokes. Using two pry bars, insert a bar between the articulated joint and the shaft (one on each side), if backlash is present upon twisting the shaft in either direction, the splines are worn and the drive shaft must be replaced.

6. REMOVAL AND DISASSEMBLY

WARNING! Before servicing the machine be sure the bucket is lowered, the engine is off, the transmission shift lever is locked in neutral (N), the electrical system master switch is off and the keys are removed from master switch and from starting switch.

WARNING! Always lock the frames together before working near the center of the machine. If the frames move, serious injury or death could result.

1. Remove the mounting hardware securing the articulated joint to the connecting yoke at each end of the drive shaft assembly.

2. Pry the drive shaft assembly from the yokes. The bearing cups may stick in the grooves in the yoke and should be tapped at a slight angle using a soft hammer to unseat them.

NOTE: *A small pry bar can be used to apply leverage to telescope the slip yoke inward*.

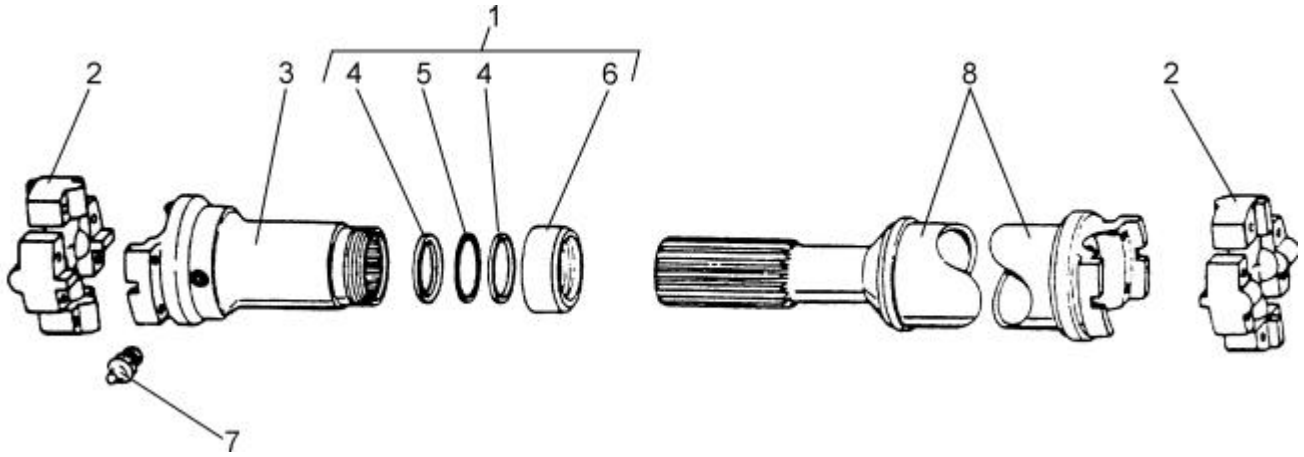


Fig. 7D.2. Drive Shaft Assembly

1. Retainer Cup Assembly
2. Articulated Joint
3. Yoke
4. Washer
5. Washer
6. Nut
7. Grease Fitting
8. Spline Shaft

3. Place the drive shaft on a clean work bench and remove the hardware securing the articulated joint (2, Fig. 7D.2) at each end of the shaft.

4. Remove the bearing caps from the articulated joint.

5. Punch mark the slip yoke (3) and splined shaft (8) so they will be reassembled in the same alignment. Unscrew the nut (6) and slide it back on the splined shaft. Remove the yoke and washers (4) and (5).

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DRIVE SHAFTS

7. INSPECTION AND REPAIR

1. Scrape and wipe contact surfaces of yokes and spider bearing cups, making sure all foreign material is removed. Clean grease, paint and solids out of threads, off the pilot diameters, and off the bolt head and mounting surfaces.

2. Remove all burrs and rough spots from the yoke flanges and from slip joint splines. Use a fine tooth file or a fine stone.

3. Inspect the drive shafts for signs of torsional fractures or other indications of impending failure.

4. Place the bearing assemblies on the spider and check for wear. If they are worn, replace the complete spider and bearing assembly.

8. REASSEMBLY AND INSTALLATION

1. Place the nut (6, Fig. 7D.2) and then the washer (5) with a metal or nylon washer (4) on each side over the spline shaft (8). Coat the shaft splines liberally with chassis grease.

2. Slide the yoke (3) onto the splined shaft aligning the punch marks made at disassembly. Screw the nut (6) onto the slip yoke and tighten securely.

3. Install a grease seal and bearing cap on opposite trunnions of the articulated joint. Install the articulated joint (2) to the drive shaft yoke being sure the lug on the bearing cap engages the yoke groove. Tap the opposite bearing cap at an angle to seat the articulated joint.

4. Secure the bearing caps to the drive shaft with the mounting hardware.

5. Repeat steps 3 and 4 to install the articulated joint on the opposite end of the drive shaft.

6. Install the other two grease seals and bearing caps on each of the articulated joint and wire them as shown in Fig. 7D.3 as a means of holding them in place as the shaft is installed.

7. Place the drive shaft in position between the mating yokes on the machine being sure the keys on the caps are piloted into the mating yoke grooves before tightening bolts. Bearing caps may be tapped lightly to seat assembly, but do not force bearing caps that do not seat properly.

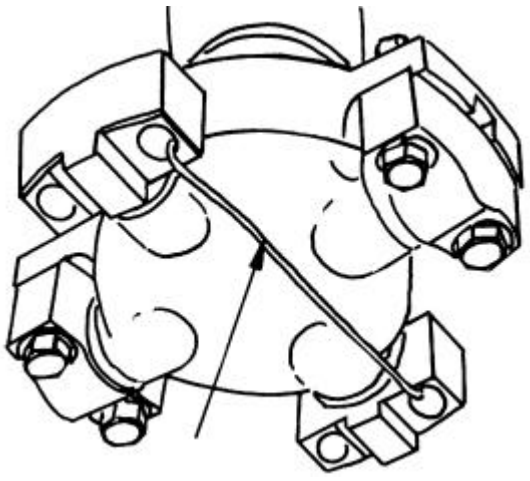


Fig. 7D.3. Bearing Caps Wired for Installation

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DRIVE SHAFTS

NOTE: *Install the mounting hardware in the bearing cap holes that are not wired and tighten only enough to hold the caps in place. Remove wire and install hardware in the remaining mounting holes.*

8. Torque all the mounting bolts to 130 Nm.

9. Drive shaft must be fully lubricated as described in the Operator's Manual before the machine is moved.

TRANSFER DRIVE

9. DESCRIPTION

The function of the transfer drive is to support the ends of the transmission to front axle drive shafts while transmitting the power between them. The transfer drive is basically a grease filled housing containing a short shaft (3, Fig. 7D.4) mounted by taper roller bearings. Oil seals (4) and (11) are used at each end of the assembly to contain the grease and prevent dirt from entering. The housing (9) is secured to the front frame of the machine near the hinge area. Lubrication is provided by the use of a tube (17) extending from the housing to a lubrication fitting (16) located in the front frame on the right of the machine.

10. SPECIFICATIONS

Special torques:

Yoke retainer mounting bolts . . . . . 80 Nm
Housing mounting bolts . . . . . 380 Nm

11. SERVICE DIAGNOSIS

Troubleshooting

COMPLAINT	
PROBABLE CAUSE	REMARKS
Excessive Noise	
1. Lack of lubricant	Refer to **Loss of Lubricant** complaint
2. Bearings damaged	Replace bearings
3. Vibration due to incorrect shaft end play	Adjust shaft shim pack as described in "REASSEMBLY"
Loss of Lubricant	
1. Worn or damaged oil seal	Replace oil seal
2. Foaming due to incorrect type or grade of lubricant	Fill with correct lubricant.

12. REMOVAL

WARNING! Before servicing the machine be sure the bucket is lowered, the engine is off, the transmission shift lever is locked in neutral (N), the electrical system master switch is off and the key is removed from master switch and starting switch.

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TRANSFER DRIVE

1. Disconnect the drive shaft at each end of the transfer drive and telescope the shaft inward. Refer to **DRIVE SHAFTS** in this section for procedure. Support the transfer drive-to-front differential drive shaft with a strap or chain so it is out of the way.

2. Disconnect and remove the lubrication line between the transfer drive housing and right hand side of front frame.

3. Turn the transfer drive shaft (end that attaches to the transmission drive shaft) so its yoke is in a vertical position to align with the cut out in the frame.

4. Remove the hardware securing the transfer drive to the front frame and remove the assembly from the machine.

13. DISASSEMBLY

1. Support the assembly in vise so the yoke (14, Fig. 7D.4) is in a horizontal position.

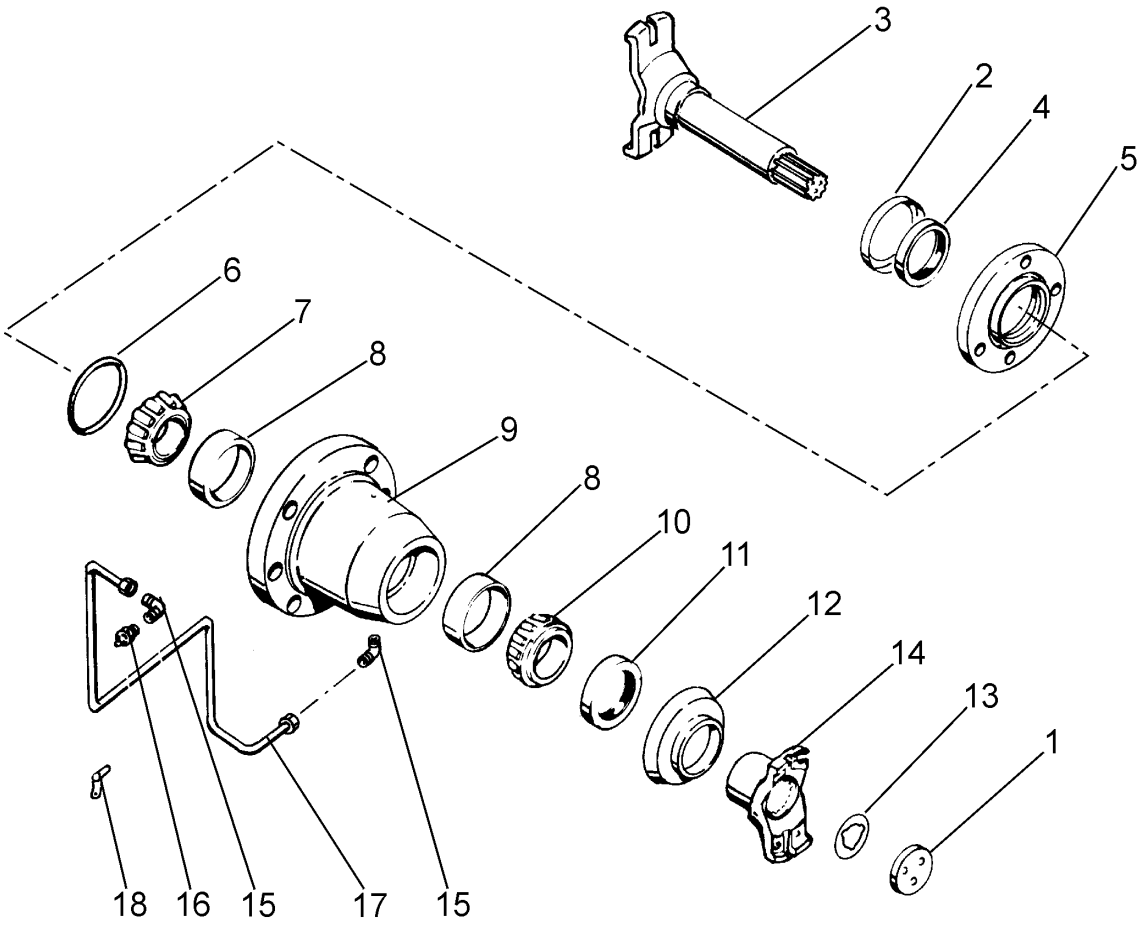


Fig. 7D.4. Transfer Drive Assembly

1. Yoke Retainer
2. Dirt Deflector
3. Shaft
4. Oil Seal
5. Retainer Flange
6. O-Ring
7. Bearing Cone
8. Bearing Cup
9. Housing
10. Bearing Cone
11. Oil Seal
12. Dirt Deflector
13. Shims
14. Yoke
15. Elbow
16. Lube Fitting
17. Lubrication Tube
18. Grip

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TRANSFER DRIVE

2. Keep the shaft (3) from turning and remove the hardware securing the yoke retainer (1) to the shaft. Remove the yoke retainer and shims (13).

3. Pull the yoke with dirt deflector (12) from the shaft.

4. Remove the hardware securing the retainer flange (5) to the housing (9). Tap on the splined end of the shaft to free the shaft and seal retainer from the housing.

5. Using a puller plate behind the seal retainer, push on the end of the shaft to free the bearing cone (7) from the shaft.

6. Remove the O-ring (6), dirt deflector (2) and oil seal (4) from the retainer flange.

7. Working from the flange end of the housing (9), push on the bearing cone (10) to free the oil seal (11).

14. REASSEMBLY

1. If removed, press the bearing cups (8, Fig. 7D.4) into the housing until they bottom.

2. Press a new oil seal (4) into the retainer flange (5) until it is flush with the outside face. The oil seal must be installed so the spring end is toward the mounting face of the retainer.

3. Install the dirt deflector (2) and O-ring (6) on the retainer flange.

4. Place the shaft (3) in a press with the spline end up. Install the retainer flange (5) in position being careful not to damage the oil seal as it contacts the riding surface on the yoke end of the shaft.

5. Install the bearing cone (7), small end of the taper up, until it bottoms on the shaft shoulder.

6. Install the housing (9) and secure the retainer flange to the housing.

7. Install the bearing cone (10) on the shaft until it seats in the bearing cup.

8. Install the oil seal (11), spring side down, until it is flush with the outside face of the housing,

9. Install the dirt deflector (12) on the yoke (14) and install the yoke until it bottoms against the bearing cone (10).

NOTE: *The yoke must be installed so it is in the same plane as the yoke of the shaft (3).*

10. Measure the thickness of the yoke retainer (1) with a micrometer. Record the reading.

11. Secure the yoke retainer to the shaft using a torque of 10 Nm. Do not install shims (13).

12. Measure the distance to the end of the shaft by inserting a depth micrometer into each of the three small openings in the retainer (1). Record each reading and average the results.

13. The amount of shims (13) to be installed is 0,10 to 0,15 mm greater than the difference between the yoke thickness (recorded in step 10) and the average measured gap recorded in step 12.

NOTE: *Measure shims individually with a micrometer when making up the shim pack.*

14. Install the shims and the yoke retainer. Torque the yoke retainer bolts to 80 Nm.

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TRANSFER DRIVE

15. INSTALLATION

1. Install the transfer drive assembly in the machine. Secure the housing to the front frame using a torque of 380 Nm.

2. Install the drive shaft to each end of the transfer drive (refer to DRIVE SHAFTS in this section for procedure).

3. Install the lubrication line between the front frame and transfer drive housing.

4. Lubricate the transfer drive as described in the Operator's Manual.

PLANETARY GEAR

16. DESCRIPTION

The planetary assemblies are located at each end of the axle assembly. Each planetary gear consists of a carrier, three planet gears and a ring gear. The three planet gears are mounted on shafts with tapered roller bearings supported in the carrier. The carrier is secured to the wheel hub. The ring gear is supported by the ring gear hub which is splined to the outer end of the axle spindle and cannot rotate.

17. THEORY OF OPERATION

Each planet gear (4) is meshed with the sun gear (3) and the ring gear (2). As the axle shaft rotates, the sun gear forces the planet gears not only to rotate on their shafts but also to travel around the inside of stationary ring gear. Since the planet gears are held in the carrier (1), it must rotate at the same rate as the planet gears travel around the ring gear. Rotation of the carrier (1) in direction **A** forces the wheel hub and wheel to which it is bolted to rotate, driving the machine in direction **B.**

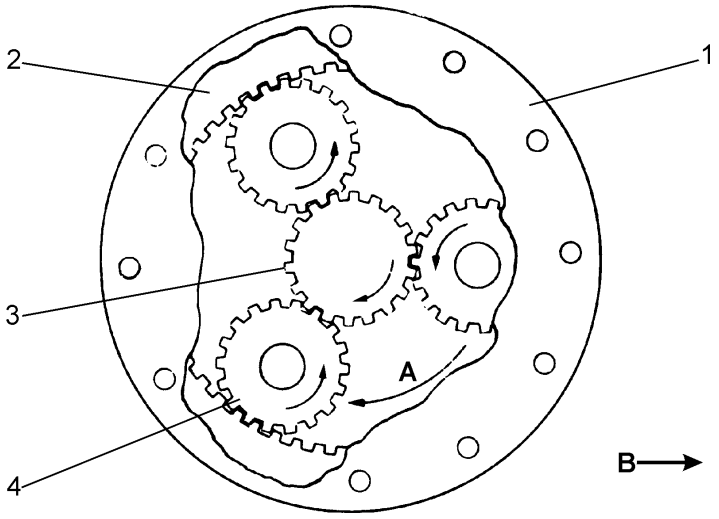


Fig. 7D.5. Wheel Planetary Drive

1. Carrier
2. Ring Gear
3. Sun Gear (integral part of axle shaft)
4. Planet Gear

A. Direction of Rotation
B. Direction of Machine Movement

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PLANETARY GEAR

18. SPECIFICATIONS

Special torques:

Wheel mounting bolts . . . . . 1250 - 1300 Nm
Planet cover mounting bolts . . . . . 135 - 150 Nm

19. REMOVAL (Fig. 7D.6)

WARNING! Before servicing the machine be sure the bucket is lowered, the parking brake is applied, the engine is off, the transmission shift lever is locked in neutral (N), the electrical system master switch is off and the key is removed from master switch and starting switch.

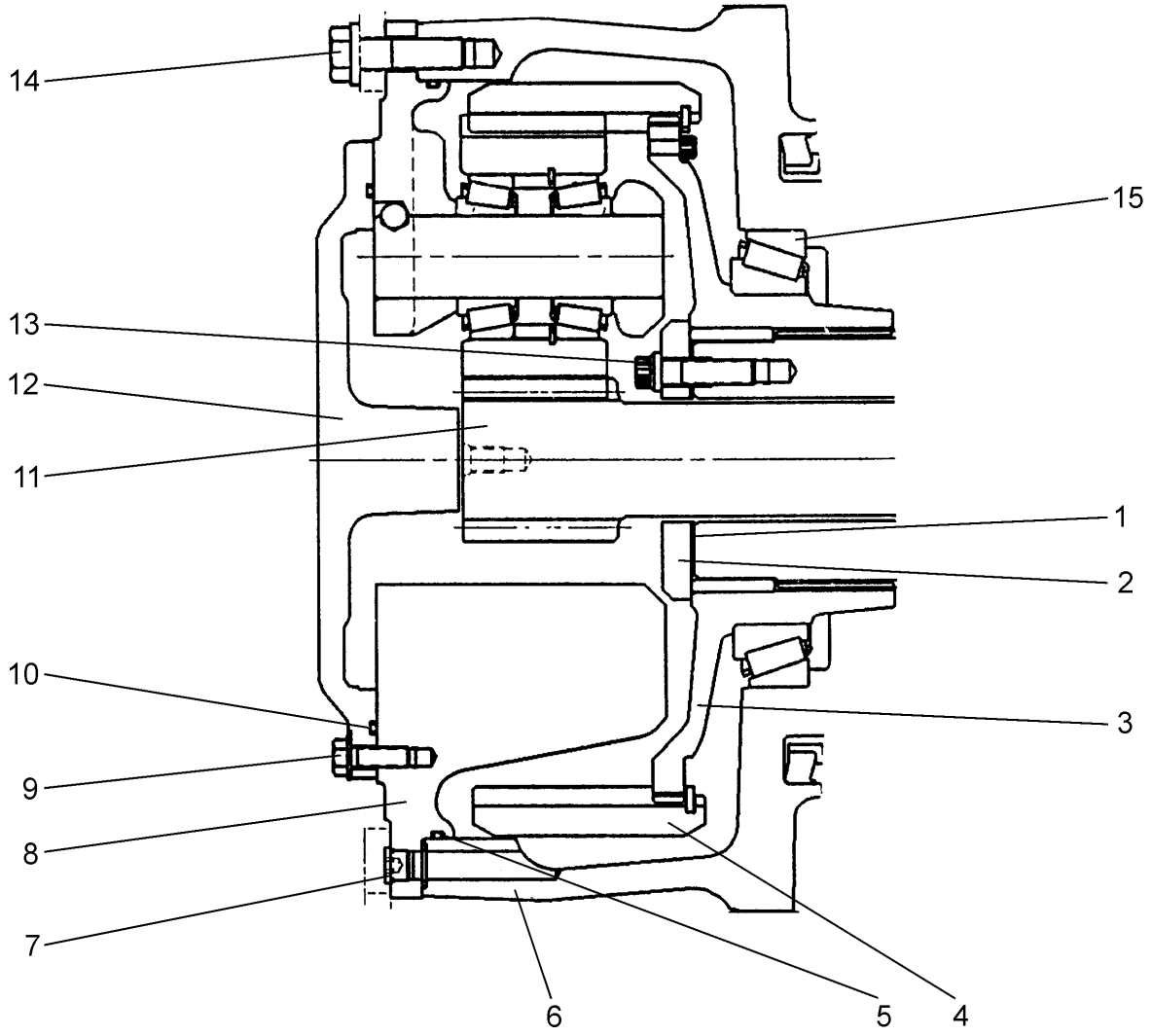


Fig. 7D.6. Planetary Gear

1. Shim Pack
2. Retainer
3. Ring Gear Hub
4. Ring Gear
5. O-Ring
6. Wheel Hub
7. Socket Head Cap Screw
8. Planetary Carrier
9. Bolt with Washer
10. O-Ring
11. Axle Shaft
12. Planetary Cover
13. Bolt
14. Bolt
15. Taper Bearing

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PLANETARY GEAR

1. Drain the planetary assembly as described in the Operator's Manual.

2. Securely block the tires at the axle that is not being serviced.

3. Loosen but do not remove the wheel mounting bolts at the wheel being serviced.

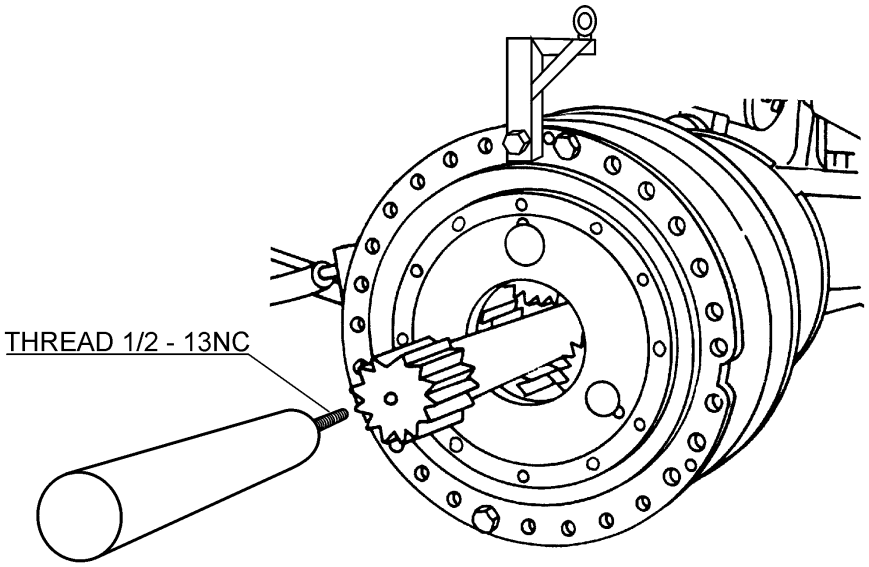


Fig. 7D.7. Axle Shaft Removing

4. Securely block up the machine under the frame so that the tires are just clear of the ground.

WARNING! Use extra caution when jacking up the machine. Jacking up the machine can be hazardous if performed improperly. Use jacking equipment of sufficient capacity. Be sure the jacking points are strong enough to support the machine. Be sure the jack is stable and well supported. Before jacking up the machine, block the tires which will not be lifted. Lock the frames together with the locking bar and pins. If the rear tires are being lifted, block the rear axle to prevent it from pivoting unexpectedly. DO NOT run the engine with the machine on jacks. For your safety, transfer the weight of the machine to approved blocks before servicing the machine.
Lift and handle all heavy parts with lifting devices of adequate capacity. Secure parts with proper slings and hooks. Use lifting eyes provided. Warn nearby personnel to stand clear. For your safety, whenever using blocking for support, use proper and approved blocks.

5. Attach a suitable hoist and sling to the tire and wheel assembly. Remove the mounting bolts and remove the tire and wheel assembly. For removing and repairing wheels see Section 15.

6. Remove the planetary cover (12) and discard the O-ring (10).

7. Using the special axle shaft removing tool (see Section 1) in the end of the axle shaft (11), pull the shaft straight out of the planetary and differential (Fig. 7D.7).

8. Rotate the wheel hub to position the drain plug hole at the top. Attach the special planetary lift bracket by screwing its attaching bolt into the drain plug hole.

9. Remove the three-socket head screw (7) securing the planetary carrier (8) to the wheel hub (6). Install four wheel mounting bolts (14) back into the wheel hub part way.

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PLANETARY GEAR

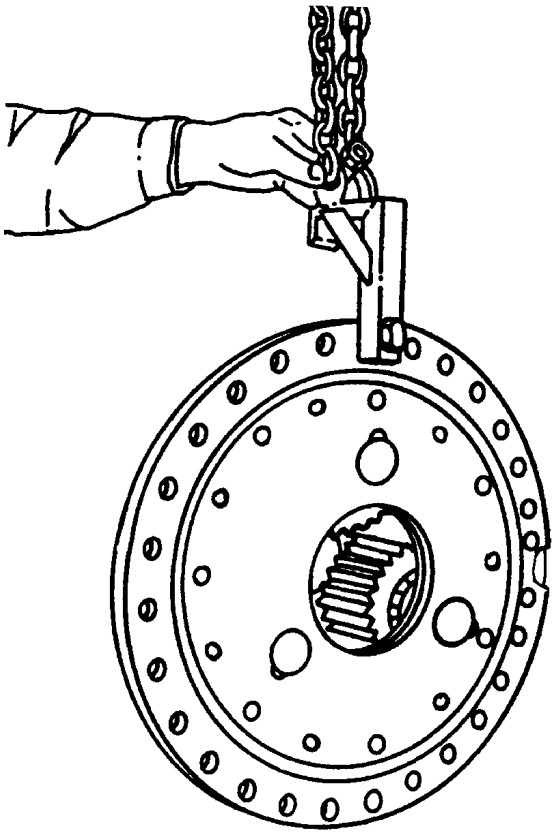


Fig. 7D.8. Lifting the Planetary Gear

10. Carefully loosen the planetary gear from the wheel hub and pull it out onto the wheel bolts until a hoist and sling can be attached to the lift bracket. Remove the four-wheel bolts and take the planetary gear away from the machine (Fig. 7D.8). Remove and discard the O-ring (5).

11. Remove and discard the O-ring (2, Fig. 7D.9) from the oil drain hole in the wheel hub.

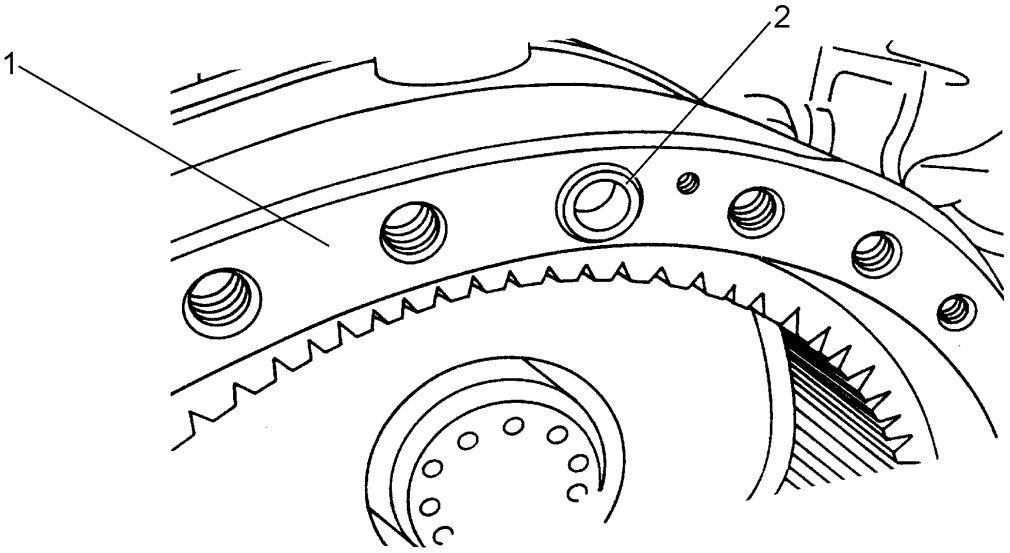


Fig. 7D.9. Oil Drain Hole

1. Wheel Hub 2. O-Ring

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PLANETARY GEAR

20. DISASSEMBLY (Fig. 7D.12)

1. Clean the planetary gear unit with solvent and blow dry.

2. Place the planetary unit in a large hydraulic press with the ball ends of the three gear pivot shafts down (Fig. 7D.10). Press the pivot shafts (3) out. Be sure to catch the retainer balls (9) as they loosen. Slide the planet gears (5) out and remove the bearings (4 and 7), spacer (6) and snap ring (8).

3. Thoroughly clean and inspect all parts. Replace all damaged or worn bearing cups or cones, shafts, planet gears, etc.

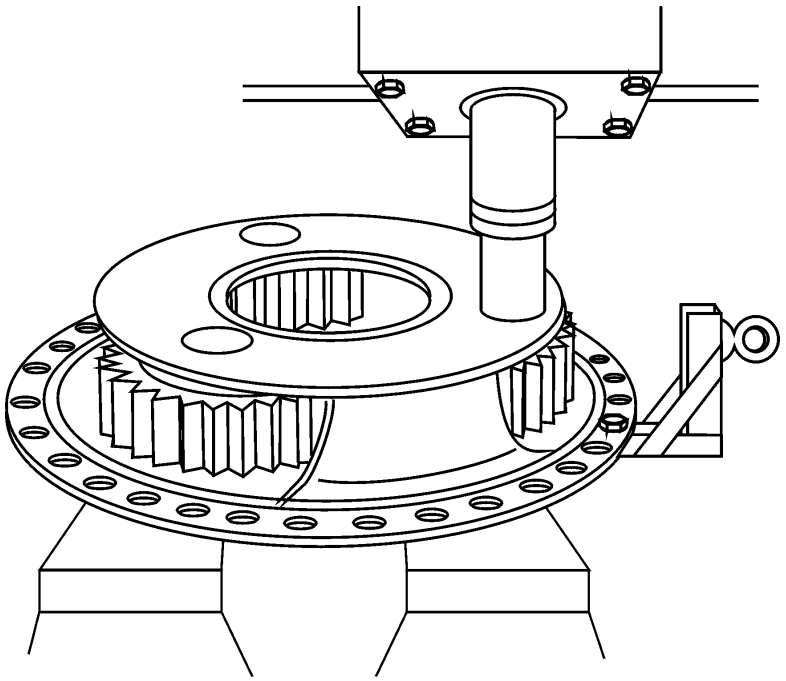


Fig. 7D.10. Removing Pivot Shafts

NOTE: *If the planet gear teeth are damaged, a close inspection of the sun gear teeth (axle end) and the ring gear teeth must be accomplished. Replace these components as required. Inspect the housing for cracks or other damage.*

21. REASSEMBLY (Fig. 7D.12)

NOTE: *The three planetary pinion shafts must be placed in a freezer for a minimum of one hour before installation.*

1. Position the planetary carrier (1) in a large hydraulic press, flanged side up, Fig. 7D.11.

2. Lubricate the bearings. Assemble snap ring (8), spacer (6), cups (7) and cones (4) into the planet gear (5).

NOTE: *Remove one pinion shaft from the freezer and completely install it before removing the next shaft from the freezer.*

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PLANETARY GEAR

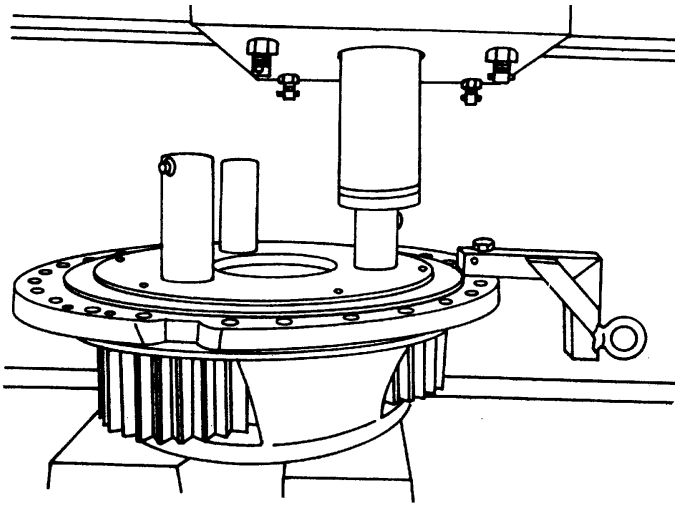


Fig. 7D.11. Installing the Shafts

3. Place the first shaft (3) in the planetary carrier with the retainer ball slot up. Be sure to align the shaft ball slot with slot in the housing. Place a liberal amount of grease on the retainer ball (9) and place it in the shaft slot.

NOTE: *When properly installed, the planet gears must be turnable by hand.*

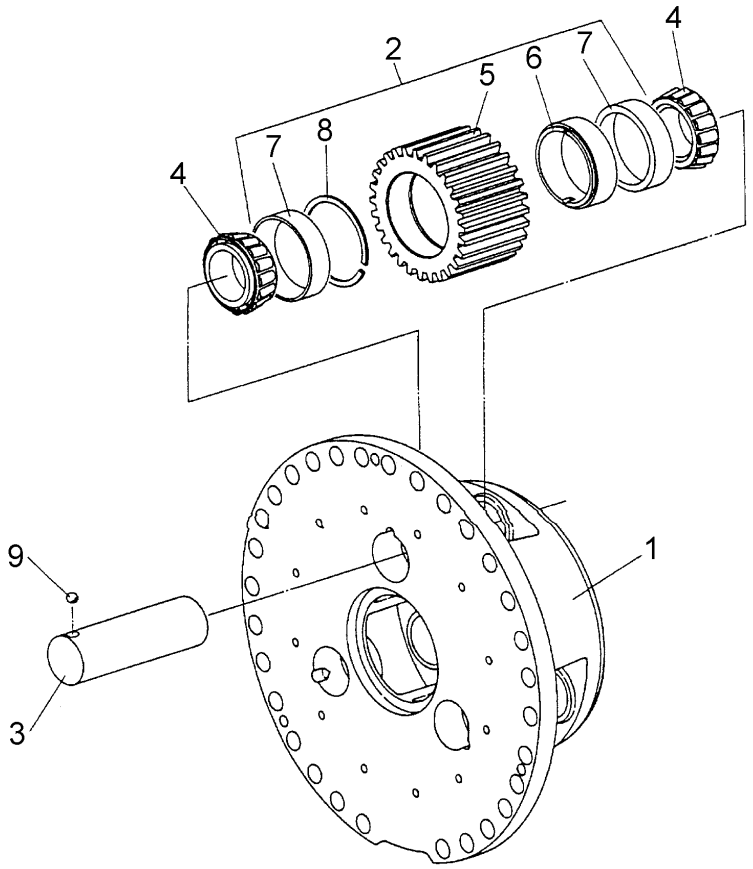


Fig. 7D.12. Exploded View of the Planetary Gear

1. Planetary Carrier
2. Planet Wheel Unit
3. Shaft
4. Bearing Cone
5. Planet Gear
6. Spacer
7. Bearing Cup
8. Snap Ring
9. Ball

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4. Repeat steps 2 and 3 to install the remaining two shafts.

5. Use the lifting bracket and an overhead hoist to remove the planetary unit from the hydraulic press.

22. INSTALLATION (Fig. 7D.6)

1. Lubricate the large O-ring (5) and place it in the groove around planetary unit.

2. Rotate the wheel hub to position the oil drain hole at the very top. Smear the new small O-ring with petroleum jelly and place it in the drain hole counterbore, Fig. 7D.13.

NOTE: *Check to assure that the ring gear and wheel hub have been properly shimmed and installed. Refer to Par. 32. INSTALLING WHEEL HUB AND BRAKE UNIT.*

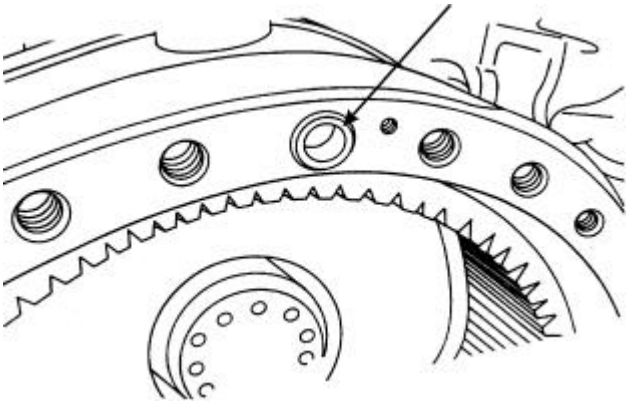


Fig. 7D.13. Small O-Ring Installing

3. Slide the planetary gear unit back into the wheel hub. Loosely install two wheel mounting bolts (14) to provide general alignment. Put in the axle shaft (11). Remove the lift bracket, Fig. 7D.14.

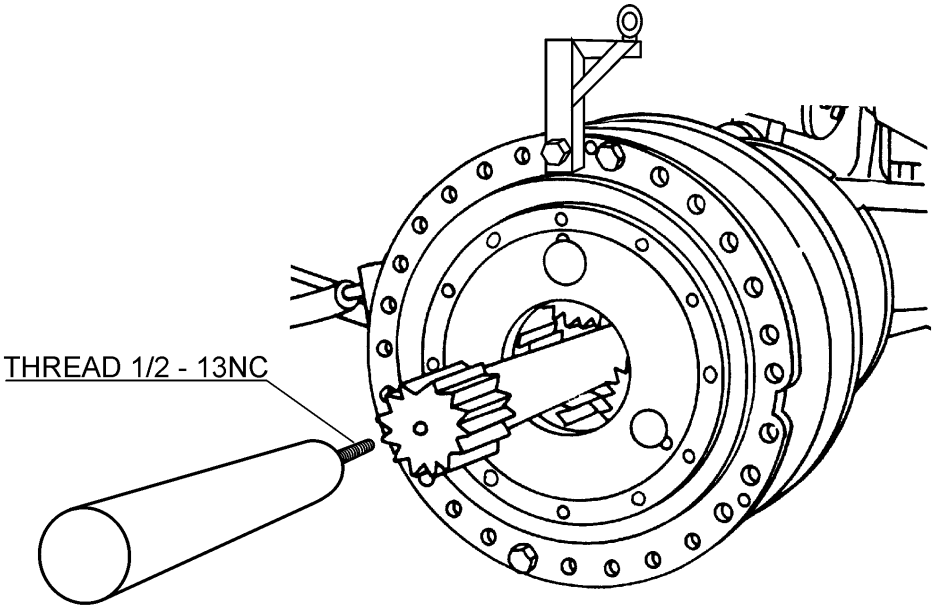


Fig. 7D.14. Planetary Gear and Axle Shaft Installing

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PLANETARY GEAR

4. Install the socket head cap screws (7, Fig. 7D.6) into the three small counterbored holes in the planetary carrier flange, Fig. 7D.15.

5. Lubricate and install the new large O-ring (10) in the groove on the inside of the planetary cover (12). Then install the planetary cover. Tighten the 12 bolts with washers (9) to 135-150 Nm.

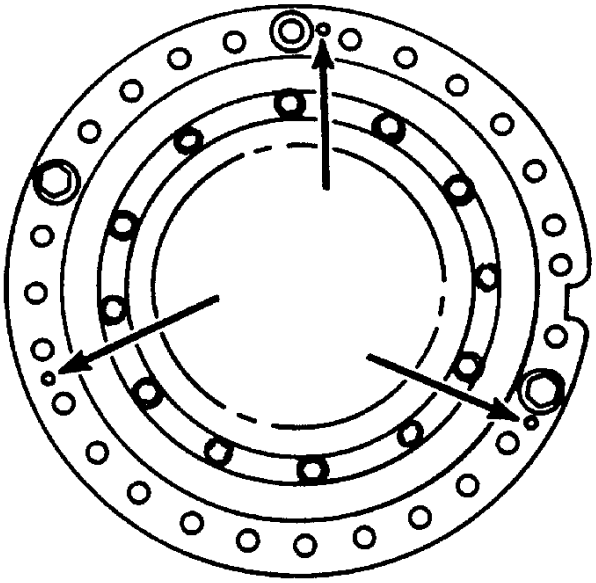


Fig. 7D.15. Three Socket Head Cap Screws

6. Fill the planetary to the proper level with oil. Also check and fill the axle housing as required. Refer to the Operator's Manual.

7. Reinstall the planetary unit oil drain plug.

8. Remove the temporarily installed bolts and washers. Install the tire and rim. Tighten all rim attaching bolts (14) to 1250-1300 Nm.

WHEEL HUB AND SERVICE BRAKE

23. DESCRIPTION

The wheel hub supports the tire and wheel assembly and rotates on two tapered roller bearings. The inboard bearing is mounted on the axle spindle and the outboard bearing is mounted on the planetary ring gear hub.

The service brake consists of four independent units located on all four wheels inside brake housings, which are bolted to the axle spindle flanges. Each brake consists of nine steel brake discs and eight friction discs. The steel brake discs are splined with ID of the brake housing, while the friction discs are splined to OD of the wheel hub spindle. The brakes are wet design and are hydraulically applied.

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WHEEL HUB AND SERVICE BRAKE

24. SPECIFICATIONS

Special torques:

Brake housing to axle flange bolts	520-550 Nm
Retainer plate to axle spindle end bolts	520-550 Nm
Number of friction brake discs	8
Number of separator plates (steel brake discs)	9
Thickness of friction disc:	
with linings	4.65 ± 0.2 mm
without linings	2.66 ± 0.2 mm
allowable, minimum thickness of lining (per side)	0.65 mm
Thickness of separator plate	3.42 ± 0.13 mm

25. REMOVAL (Fig. 7D.17)

WARNING! Before servicing the machine be sure the bucket is lowered, the engine is off, the parking brake is applied, the transmission shift lever is locked in neutral (N), the electrical system master switch is off and the key is removed from master switch and starting switch.

WARNING! If working out of the machine, use extra caution when hoisting or lifting all heavy parts. Secure parts with proper slings and hooks. Warn nearby personnel to stand clear.

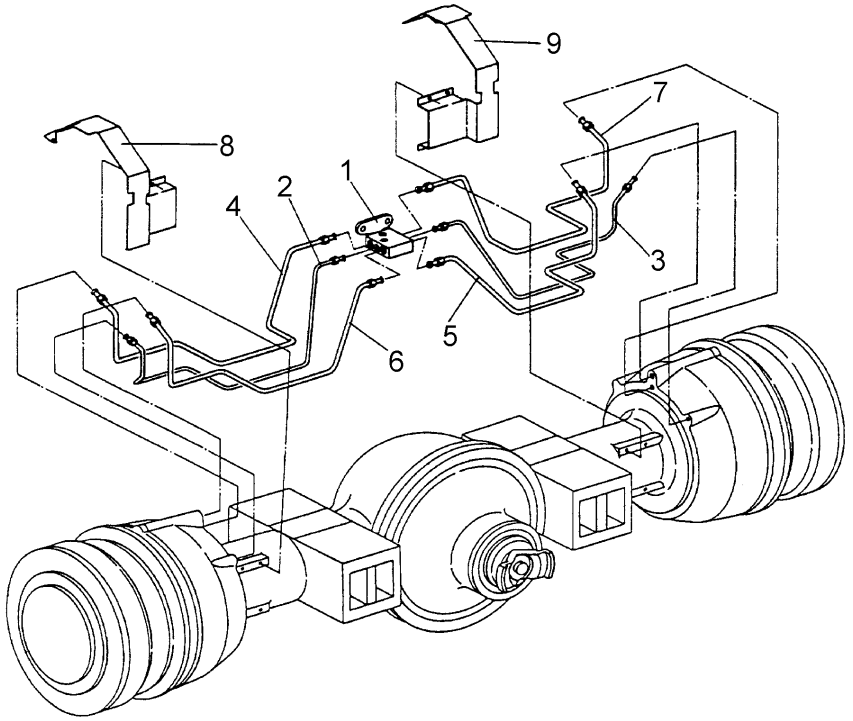


Fig. 7D.16. Front Axle Piping (Rear Axle Piping Similar)

1. Brake Line Manifold
2. Tube, Pressure (LH)
3. Tube, Pressure (RH)
4. Tube, Coolant In (LH)
5. Tube, Coolant In (RH)
6. Tube, Coolant Out (LH)
7. Tube, Coolant Out (RH)
8. Guard, Brake Line (LH)
9. Guard, Brake Line (RH)

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WHEEL HUB AND SERVICE BRAKE

1. Remove the two guards (8 and 9, Fig. 7D. 16) from the axle housing and disconnect the high pressure oil brake line tubes (2 and 3) and cooling tubes (4, 5, 6 and 7) from the brake housing.

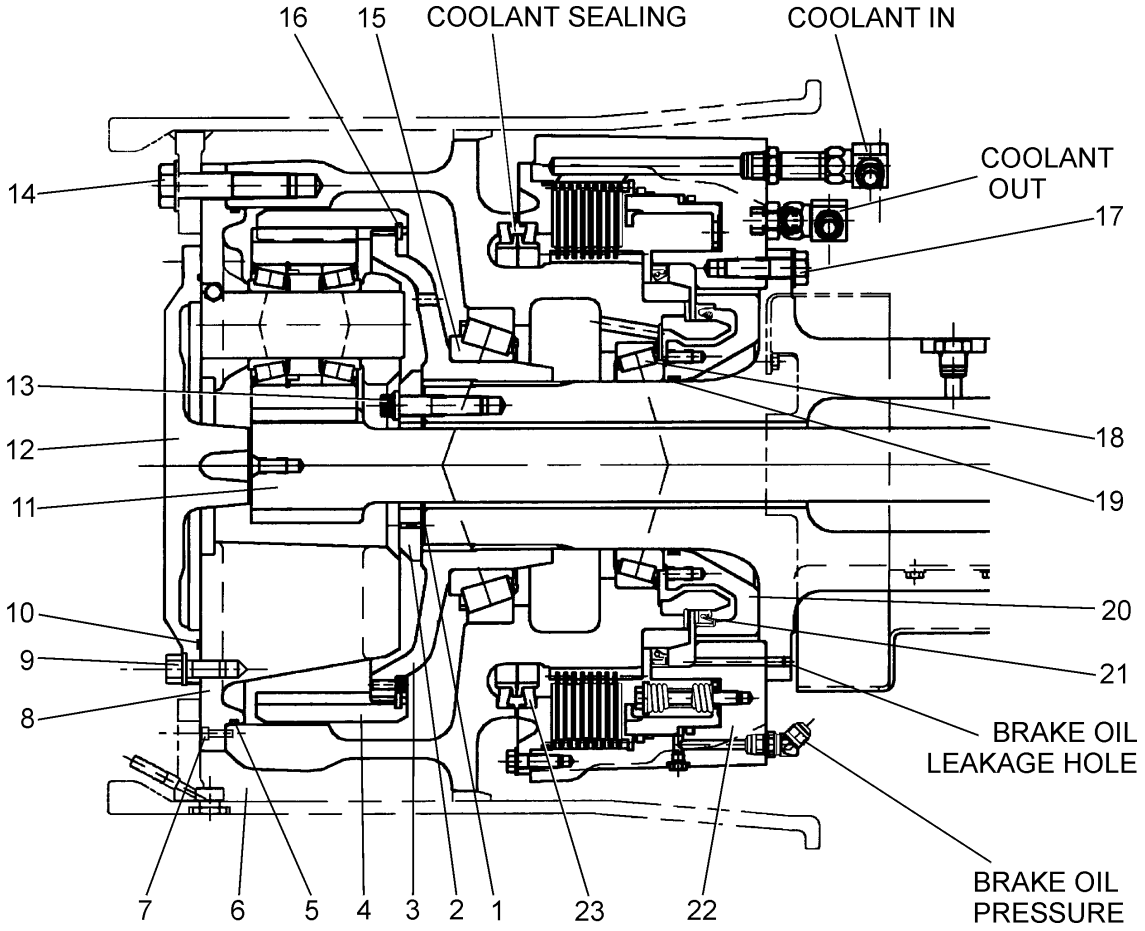


Fig. 7D.17. Wheel Hub and Service Brake

1. Shim Pack
2. Retainer Plate
3. Ring Gear Hub
4. Ring Gear
5. O-Ring
6. Wheel Hub
7. Socket Head Cap Screw
8. Planetary Carrier
9. Bolt with Washer
10. O-Ring
11. Axle Shaft
12. Planetary Cover
13. Bolt
14. Bolt
15. Taper Bearing
16. Ring and Bolts
17. Bolt
18. Taper Bearing
19. O-Ring
20. Ring
21. Oil Seal
22. Brake Assembly
23. Oil Seal

2. Remove the axle shaft and planetary gear unit (parts 5 to 12 and 14). Refer to Par. 19 in this Section.

3. Using a special set of tools No. 51.877.0044 (screw clamps - three pcs), clamp the wheel hub (6) and service brake assembly (22) together in three places, as shown on Fig. 7D.18. Screw the all clamps evenly, till the light resistance come out.

4. Attach a hoist and sling to the top clamp and take out the slack.

5. Punch mark the housing (at the top clamp) and axle spindle flange so they will be reassembled in the same alignment.

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6. Remove the bolts (13) securing the retainer (2) to the end of axle spindle. Remove the retainer and shims (1).

7. Remove the ring gear (4) and ring gear hub (3) as an assembly from the end of axle spindle. The bearing cone (15) will come off with the ring gear hub.

8. To separate the ring gear (4) and gear hub assembly, place the assembly on a bench with the hub up. Remove the bolts and securing ring (16) and lift the hub from the ring gear. If bearing cone (15) replacement is necessary, the cone should be removed from the ring gear hub with a suitable puller.

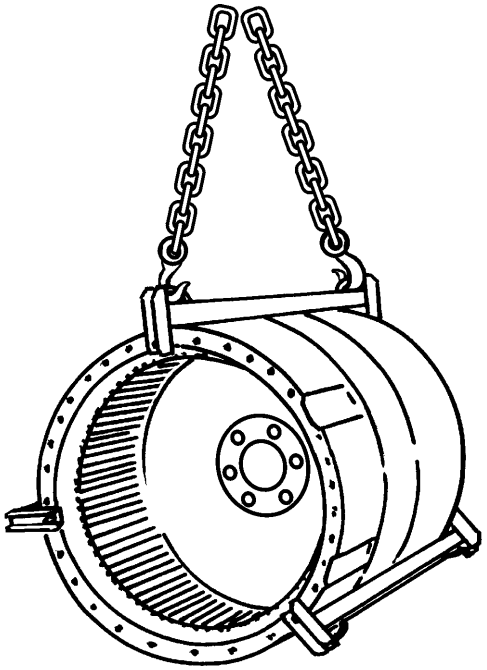


Fig. 7D.18. Removing the Wheel Hub and Service Brake



Fig. 7D.19. Positioning the Wheel Hub and Service Brake

8. Unscrew bolts (17) securing the brake housing to the flange of the axle housing flange.

9. Pull the wheel hub and brake assembly from the axle housing spindle being careful to avoid cocking the unit.

10. Place the unit down and attach the three-pieces sling to the eyebolts so the wheel hub is up. In such position place the unit on a sturdy bench, Fig. 7D.19.

11. Remove the three clamps from the wheel hub and service brake unit. Then pull up the wheel hub to separate it from the brake.

NOTE: *Pulling up the wheel hub be careful to avoid cocking the wheel hub and damaging the brake plates and the splines on relating parts.*

12. Remove the oil seal (23, Fig. 7D.17) from the wheel hub and the brake housing. Protect the metal rings until ready for inspection.

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WHEEL HUB AND SERVICE BRAKE

26. SERVICE BRAKE DISASSEMBLY (Fig. 7D.20)

1. Holding the brake on a sturdy bench, remove the three hydraulic fittings and the plugs from the seal end of the housing. Remove the ten thrust plate attaching bolts and washers (1) and remove the thrust plate (2) and O-ring (3) as shown on Fig. 7D. 21.

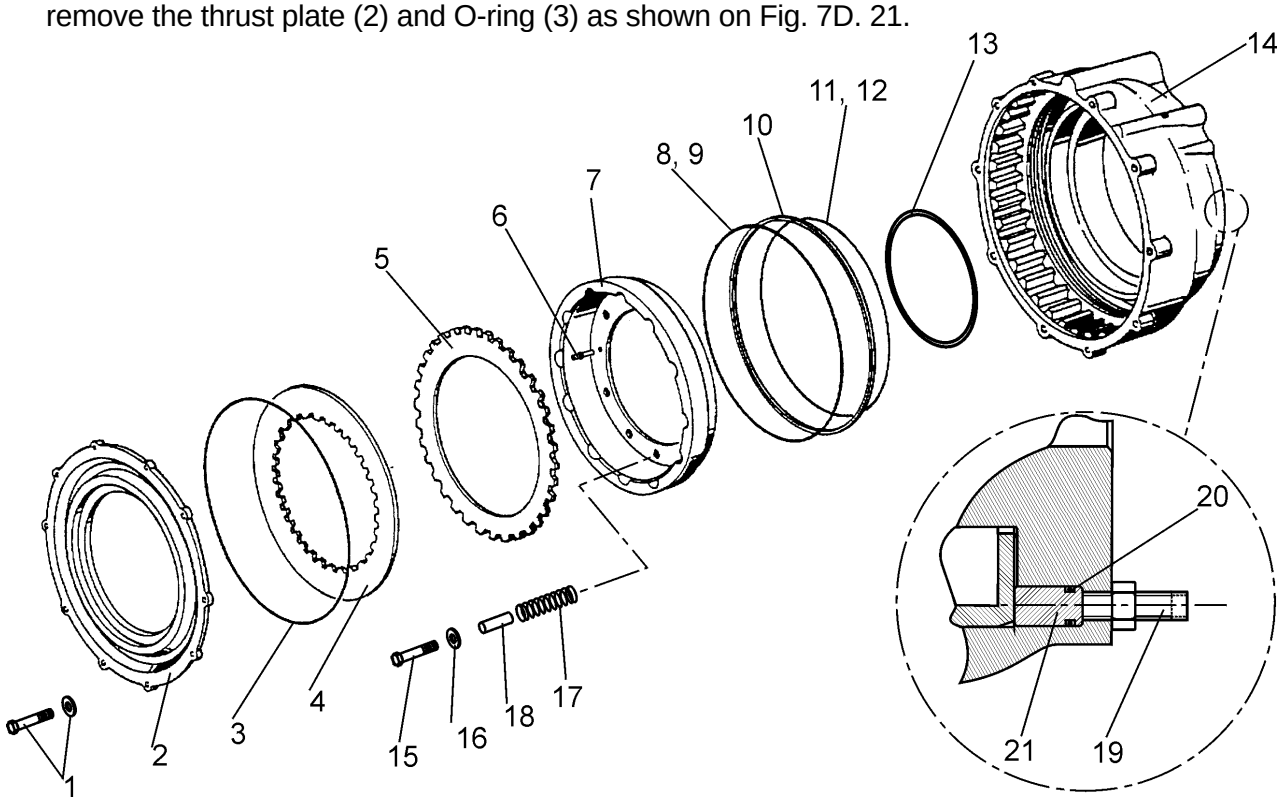


Fig. 7D.20. Exploded View of Brake Assembly

1. Bolt w/Washer
2. Thrust Plate
3. O-Ring
4. Friction Disc
5. Separator Plate (Steel)
6. Stop Screw and Nut
7. Brake Piston
8. Seal Ring
9. Rubber Ring
10. Wear Ring
11. Seal Ring
12. Rubber Ring
13. Oil Seal
14. Brake Housing
15. Bolt
16. Washer
17. Spring
18. Guide
19. Screw and Nut
20. O-Ring
21. Pin

2. Remove the all brake discs (4 and 5)

3. Remove six brake piston spring retainer bolts (15), washers (16), springs (17) and guides (18).

4. Slide the brake piston (7) up and lift it clear of the brake housing.

NOTE: *Check to assure that the brake piston stop screws are secure, Fig. 7D.22. Do not change the setting of these screws until readjusting the brake piston stroke.*

5. Remove two piston seal rings (8, and 11), wear ring (10) and two rubber rings (9 and 12) from seal rings grooves, and remove the large oil seal (13) from the brake housing.

6. Remove the cone of bearing (18, Fig. 7D.17) and ring (20, Fig. 7D.17) from the spindle of the axle housing.

7. Remove the O-ring and oil seal (19 and 21, Fig. 7D.17) from the ring (20).

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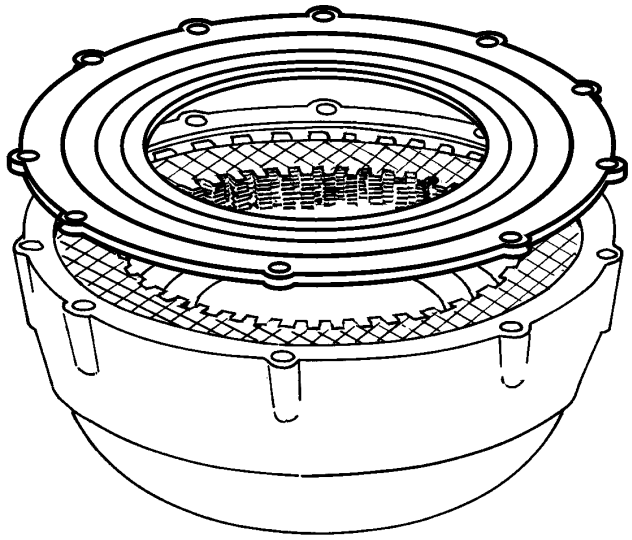


Fig. 7D.21. Thrust Plate Removing

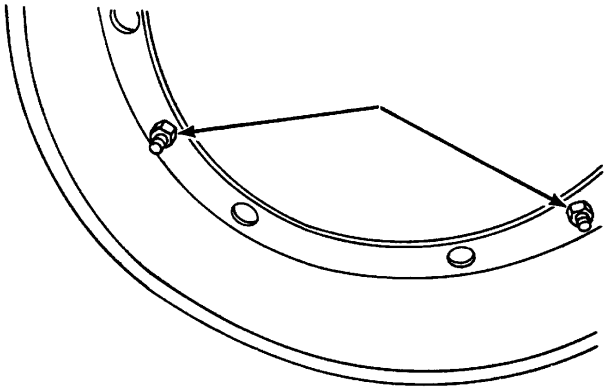


Fig. 7D.22. Stop Screw Setting

9. Remove three screws and nuts (19) and pull out three pins (21) from the brake housing. Discharge O-rings (20)

10. Thoroughly clean all components. Be sure to blow clear all oil passages within the brake housing

27. INSPECTION

1. Check the brake housing for external damage. Also check internally for spline wear and for gouging as well as piston ring land breakage.

2. Inspect the brake piston OD for scoring or nicks which might damage the brake seals. If nicks are small, smooth with crocus cloth.

3. Inspect the brake friction discs for excess wear. Allowable, minimum thickness of lining is 0.65 mm per side.

4. Inspect the steel separator plates for surface condition. Inspect all plates for bent or broken off teeth. Replace discs as required.

28. BRAKE REASSEMBLY (Fig. 7D.20 and Fig. 7D.23)

1. Before reassembling the brake unit, a test for leakage must be done. Provide the test as follow:

   a. Install three pins (21) with O-rings (20) and three screws and nuts (19) to the brake housing (14), so that the pins flush with bottom of the brake housing. For correct installation see Par. 33.

   b. Position the brake housing (14) on a sturdy bench, thrust plate end up.

   c. Install to the brake housing a new oil seal (13). Drive the seal in until flush with surface.

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d. With a liberal amount of petroleum jelly, install the lower rubber ring (11) and seal ring (12). Then install the rubber ring (9) and seal ring (8). Finally, install the wear ring (10).

IMPORTANT: *The remaining brake housing component installation must be accomplished with the seals installed. Extreme care must be taken so as not to damage the seals.*

NOTE: *Some brake piston seals and rings may have to be stretched to make them fit properly. Heating the piston seals in hot oil for several minutes before stretching will help. Do not overstretch them. When properly installed, these components should remain in their seal grooves evenly with approximately 1.5 mm of the seal rings evenly exposed.*

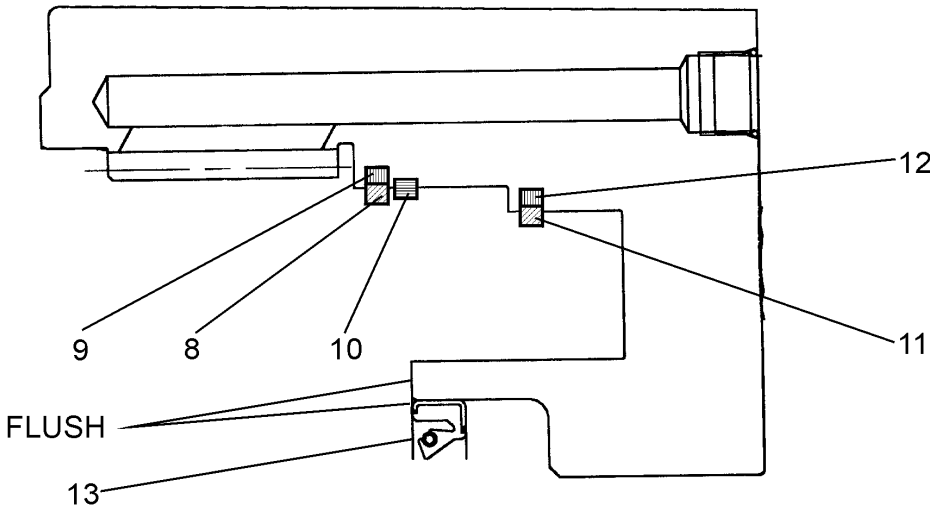


Fig. 7D.23. Oil Seals Installation

8. Sealing Ring
9. Rubber Ring
10. Wear Ring
11. Sealing Ring
12. Rubber Ring
13. Oil Seal

e. Install three stop screws with nuts (6) to the brake piston (7), as shown on Fig. 7D.22. Drive the screws in until their ends flush with surface of other side of the piston. Do not tight the nuts.

f. Lubricate the piston OD with petroleum jelly. Position it squarely in the brake housing bore against the top piston ring and apply downward pressure by hand. Do not use any tools to hammer or press the piston in. When contact is made, push the piston past the lower brake seal by hand until it bottoms.

g. Install the six piston return spring retaining bolts (15) with washers (16), springs (17) and spring guides (18). Tighten these bolts to 140-150 Nm.

h. Roll the brake housing onto its side. Rotate the housing to position the brake apply pressure port up (Fig. 7D.24). Fill the brake pressure passages with transmission oil allowing the air to bleed out.

i. When the pressure passages are full of oil, install the special gauge and shut off valve unit. Plug, with new O-rings, three holes in the rear surface at this time.

j. Reposition the brake housing with the seal end down, then connect the porta power hand pump unit, filled with transmission oil, to the gauge/shutoff valve. Before connecting do bleed the pump until clean oil flows from the hose end.

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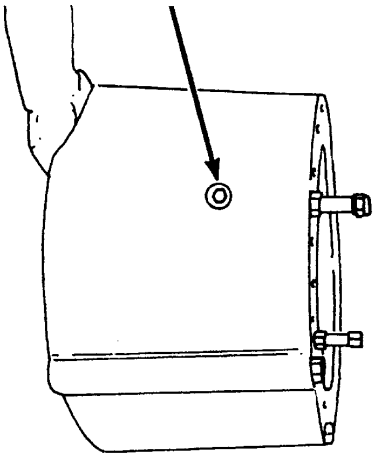


Fig. 7D.24. Brake Pressure Apply Port

k. Pump the porta power until the piston moves a small amount. Shut off the gauge valve unit and watch around the piston top and bottom for oil leakage. If leakage continues, remove the piston and replace the damaged brake seals.

NOTE: *A small amount of initial leakage will occur while the piston seals take a seat. This initial leakage should stop soon. No further leakage should be noted.*

l. After test, release hand valve and disconnect porta power hand pump. Leave gauge and shut of valve installed.

2. Lubricate all of the brake discs, (friction and steel), with transmission oil. Begin dropping the brake discs into the brake housing, first steel (5), then friction (4), etc. until all eight friction and nine steel discs have been installed. The top disc should be steel.

3. Using a piece of round straight steel bar (10 mm OD and 250 mm length), center and align inner teeth of all friction plates, Fig. 7D.25.

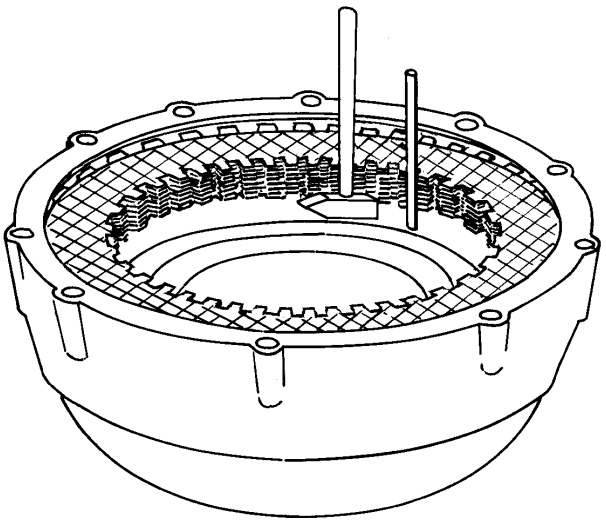


Fig. 7D.25. Teeth Aligning

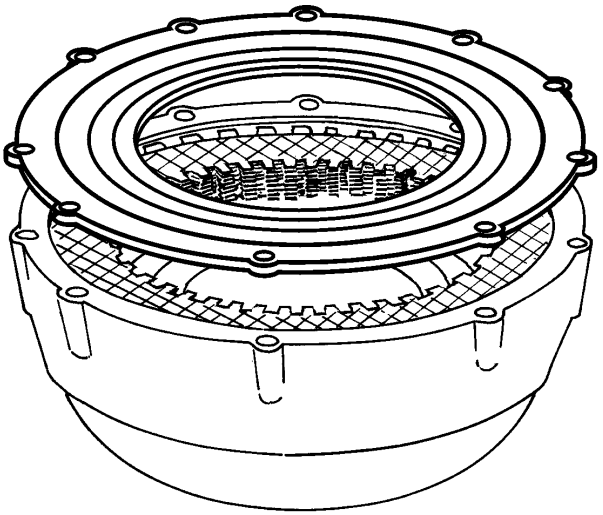


Fig. 7D.26. Thrust Plate Installing

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4. Lubricate a new O-ring (3) and install it in the thrust plate O-ring groove. Then install the thrust plate (2) into the brake housing (14), Fig. 7D.26. After the thrust plate is in position, install bolts and washers (1) in all holes and tighten them to 60 Nm.

5. Reattach the porta power hand pump to the gauge and shutoff valve. Pump up pressure to 2000 kPa and close the gauge unit valve. While timing for a period of one minute, gauge pressure should not drop more than 700 kPa. If the brake passes this test, open the hand valve and pump up to a pressure of 7000 kPa, then close the hand valve and time for one minute. Again, gauge pressure should not drop more than 700 kPa.

NOTE: *If the brake unit fails to hold the pressures as described above, repeat the test several times to be sure the brake piston seals are seated. If no improvement is seen, the complete brake must be disassembled to replace damaged brake piston seals. Refer to previous instructions to do this.*

6. Open the brake unit hand valve slightly to reduce gauge pressure to 3500 kPa. Then close and tighten the gauge unit hand valve. Disconnect the porta power hand pump.

7. While the brake piston presses on the brake discs, drive in the three stop screws (6) to the end, then unscrew back 1.5 turn and secure them with attached nuts.

NOTE: *The brake must remain in the pressurized condition from the assembly procedure while being assembled with the wheel hub.*

29. WHEEL HUB AND BRAKE UNIT ASSEMBLY

1. If the bearing cups (15 and 18, Fig. 7D.17) were removed from the wheel hub, install new bearing cups.

NOTE: *If a determining of wheel bearing shim pack is to provide, do not assembly the brake unit until the shim pack thickness is defined. See par. 31 in this Section.*

2. Clean the metal faced seal, its rubber retainers, the brake housing seal bore and wheel hub seal bore using non-petroleum solvent. Thoroughly dry all metal faced seal components and mounting bores before seal installation. Install the metal faced seals with the rubber retainers positioned as shown in the sectional view, Fig. 7D.27.

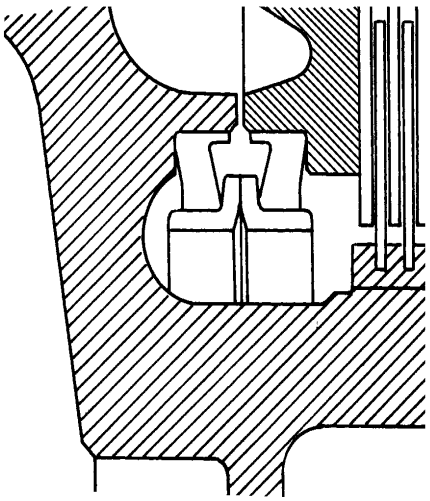


Fig. 7D.27. Sectional View of Metal Faced Seal



Fig. 7D.28. Hub Wheel and Brake Connecting

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3. Lubricate the bearing cups, the seal runners and seal lip with transmission oil. Wipe the metal-to-metal contact areas of the metal faced seal with a clean lint-free cloth, then coat them with transmission oil.

4. Place the ring gear (4, Fig. 7D.17) on a bench with the round inner groove up. Then put in the ring gear the ring gear hub (3) with splined spindle up. Secure them together using ring (16) and belonging bolts. Torque the bolts to 40 Nm.

5. Using a hoist and sling, lift the wheel hub up, with the splined spindle down. Slowly lower the hub, so the spindle enter into the brake unit smoothly. Fig. 7D.28.

6. Remove the sling from the wheel hub, then place the ring gear and ring gear hub unit into the wheel hub, with bearing cone down.

7. After the wheel hub is placed correctly with the brake assembly, clamp the unit together using the special clamps, as shown on Fig. 7D.29. Screw the bolts slightly, do not torque them. One of the clamps should be placed at the mark punched during removing the wheel hub and brake unit, Par. 25, Step 5.



Fig. 7D.29. Clamping the Hub Wheel and Brake Unit

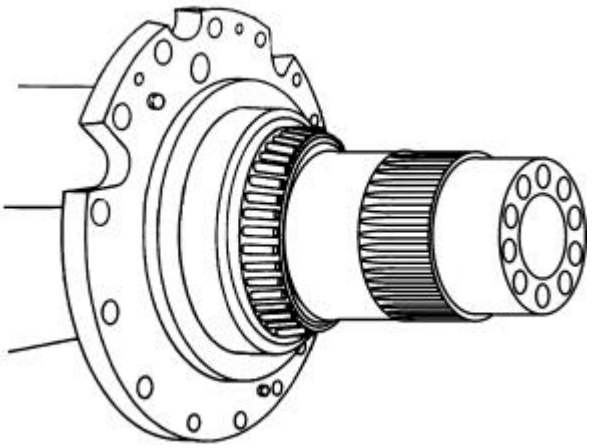


Fig. 7D.30. Axle Spindle

30. PREPARATION FOR THE BRAKE AND WHEEL HUB INSTALLATION

Before installing the wheel hub and brake assembly, the axle spindle and inner wheel bearings must be thoroughly cleaned and inspected. All rust and pits must be removed from the seal land with crocus cloth. The bearings must be replaced if any defects are found. Also inspect the spindle end spline to assure that no damage or excessive wear exists, (Fig. 7D.30).

Furthermore, if any of the following listed components have been changed, the wheel bearing end play and/or preload must be checked and a new shim pack must be installed:

a. Inner or outer bearing cups or cones (15 and 18, Fig. 7D.17).
b. Axle housing with spindle.
c. Ring (20, Fig. 7D.17) on spindle.
d. Planetary ring gear hub (3, Fig. 7D.17).
e. Wheel hub (6, Fig. 7D.17).

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31. PROCEDURE FOR DETERMINING WHEEL BEARING SHIM PACK

When determining the wheel bearing shim pack (Steps 1 through 12 below), no brake related parts are to be on axle, only the wheel hub, which must be fully seated, and the ring gear hub with the ring gear.

1. Bearing cups in wheel hub and bearing cone on ring gear hub must be fully seated. Check with a 0.05 mm feeler gauge Fig. 7D.31.

2. Install oil seal (21, Fig. 7D.17) into ring (20) flush with surface, then install the ring, with O-ring lubed (19), onto the axle spindle as far as possible by hand.

3. Install inner wheel bearing cone onto spindle (permissible to heat bearing cone to 150°C max.). as far as possible. Check with a 0.05 mm feeler gauge.

4. Lubricate both wheel bearing cones (on the ring gear hub and axle spindle).

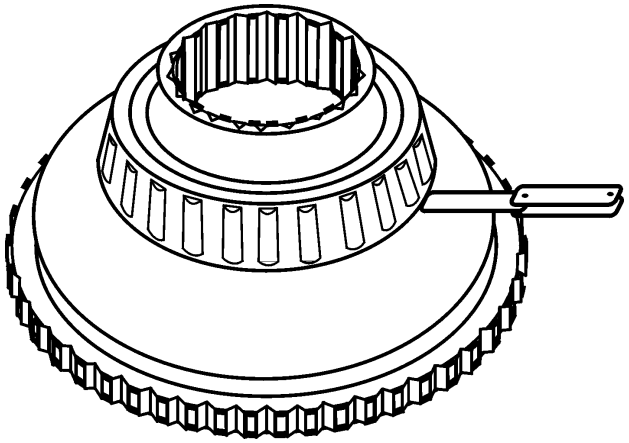


Fig. 7D.31. Bearing Cone on Ring Gear Hub

5. Place the ring gear hub with the ring gear into the wheel hub.

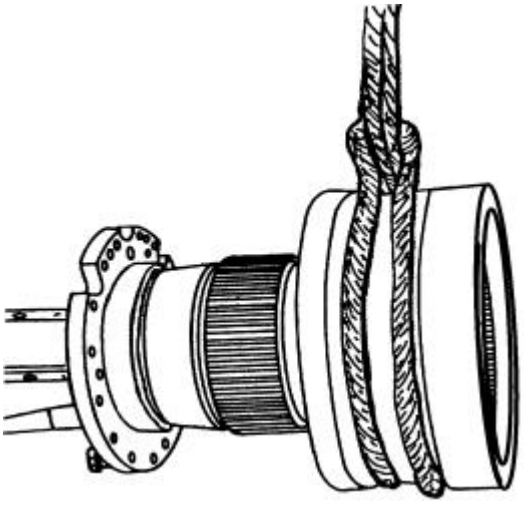


Fig. 7D. 32. Wheel Hub Installing

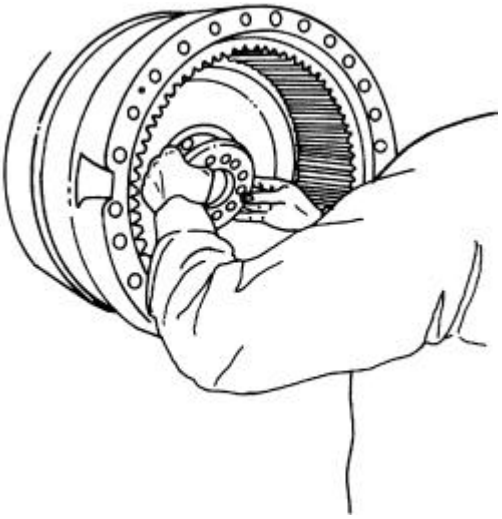


Fig. 7D. 33. Retainer Plate Installing

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WHEEL HUB AND SERVICE BRAKE

6. Install the wheel hub and ring gear hub onto the axle spindle, Fig. 7D.32.

7. Measure the thickness of the retainer plate (2, Fig. 7D.17) in two places and obtain an average reading. Install the retainer with four equally spaced bolts making sure that bolts turn easily by hand. Torque bolts to 55 Nm while turning wheel hub, Fig. 7D.33.

8. Loosen each bolt approximately 1/2 turn.

9. With a torque wrench tighten the four retainer bolts to 14 Nm while turning the wheel hub. Recheck all bolts. They must maintain 14 Nm while turning the wheel hub.

10. Measure from outside of retainer to end of axle spindle through small holes in two places and obtain average reading. Subtract retainer plate thickness obtained in Step 7 to determine shim pack thickness.

11. Measure shims individually to obtain final shim pack thickness determined in Step 10, with tolerance plus 0.00 minus 0.05 mm.

12. Remove the ring gear hub and wheel hub from the axle spindle.

32. INSTALLING WHEEL HUB AND BRAKE UNIT

1. Lubricate the brake housing oil seal lip (24, Fig. 7D.17) and ring oil seal lip (21). Attach an overhead hoist with two slings to the top clamp. Lift the unit and slide it over the axle spindle (seal end in) towards mounting axle flange (fig. 7D.34). Take care not to damage the seals and taper bearing. Install all mounting bolts (17, Fig. 7D.17) and tight them temporarily to 2 - 3 Nm. Place an adjustable stand under the wheel hub for support.

NOTE: *Do not tight the bolts (17) over 2 - 3 Nm while the three clamps are mounted on the unit.*

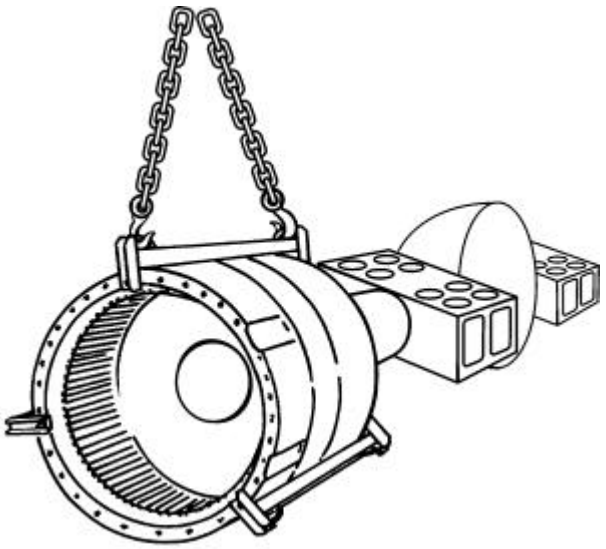


Fig. 7D.34. Wheel Hub and Brake Unit Installing

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2. Using a special lifting bracket, slide the ring gear and ring gear hub unit onto the axle spindle, see Fig. 7D.31.

3. Assemble the retainer plate (2, Fig. 7D.17) and premeasured shim pack (1) onto the spindle end. Install bolts (13) and torque them slightly, till light resistance come out.

4. Remove the three clamps, then tight the bolts (17, Fig. 7D.17) to 520-550 Nm. Remove the adjustable stand from under the wheel hub.

5. With a torque wrench tighten the ten retainer bolts (13, Fig. 7D.17) to 520-550 Nm.

6. Install the wheel planetary as described in Par. 22, INSTALLATION.

7. Reconnect the high pressure brake line tubes (2 and 3, Fig. 7D.16) and cooling tubes (4, 5, 6 and 7) to the brake housing.

8. Reinstall two guards (8 and 9, Fig 7D.16).

9. Fill the axle with oil as described in the Operator's Manual.

33. FRICTION DISCS CHECKING

To estimate the condition of the friction discs, following procedure is recommended:

1. With service brake released (not applied) loosen the locking nuts (19, Fig. 7D.20) and drive in the three screws (19) to move the pins (20) against the brake piston (7). Do not move the piston. Record number of screw turns.

2. With service brake applied, drive in the screws (19) again, until a resistance come out. Record the number of additional turns (T).

3. Drive back the screws with total number of turns from Steps 2 and 3, then secure them by locking nuts (19).

4. To estimate an abrasive wear of friction disc lining (for one side), calculate it as follows:

$$H = \frac{2(T-1)}{16} \text{ (mm)}$$

H - abrasive wear of one lining
T - number of screw turns in Step 2 (one turn makes about 2 mm)
16 - total number of friction linings

If the abrasive wear (H) of one lining is more than 0.35 mm, the friction discs must be replaced.

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DIFFERENTIAL

34. DESCRIPTION

The differential is bolted to the center of the axle housing. The front and rear axle differentials are the same except that the parking brake is mounted to the front differential housing. The differentials receive torque through an input yoke (1, Fig. 7D.35) connected to a drive shaft.

The three functions of the differential are: to change the direction of the input torque from the drive shaft, sending it 90 degrees to the right and left, to provide the first torque multiplication in the double reduction axle assembly, and to allow one drive wheel to rotate at a different speed than the opposite wheel.

Basically, the differential consists of a bevel ring gear (9), pinion shaft (12), pinion gear assembly (7 and 8) and side gears (11). The bevel ring gear, pinion gear assembly and side gears are held to the differential cases (6 and 10) which rotate on tapered roller bearings. The pinion shaft is supported in the differential carrier (4) by a straight roller bearing behind the pinion teeth to carry the radial load and two taper roller bearings, located in a retainer (2), in front of the pinion teeth to take the forward and reverse thrust. Shims (3 and 5) are used to set the proper pinion shaft mounting distance and pinion-to-ring gear backlash.

35. THEORY OF OPERATION (Ref. to Fig. 7D.35)

Drive line torque supplied to the input yoke (1) is transmitted to the pinion shaft (12). As the pinion shaft rotates it drives the mating ring gear (9) and its attached case (10). Due to ring gear configuration it rotates to 90 degrees to the direction of pinion shaft rotation. Also, because the pinion is considerably smaller than the ring gear, a gear reductions accomplished resulting in an increase in torque.

The rotating case (10) is bolted to the case (6) with the pinion gear assembly sandwiched in between. Each of the arms of the pinion pivot (8) supports a pinion gear (7). These four pinion gears are in mesh with two differential side gears (11) which in turn are splined to the axle shafts.

When both wheels are free to turn under equal resistant loads, the differential bevel ring gear and the four differential pinion gears act as one rigid unit, transmitting torque to both of the splined differential side gears. The side gears, being splined to the axle shafts, then drive both wheels with the same torque at identical speeds. In this instance, the pinion gears do not rotate on their axis therefore, the side gears rotate at the same rpm as the bevel ring gear.

When the resistance on one drive wheel exceeds the resistance on the other, or when the machine makes a turn, the ring gear continues to revolve but the pinion gears cease to act as a unit with the ring gear. The pinion gears now turn on their own axis and permit one drive wheel to rotate faster than the other. It follows that as one drive wheel slows down, the speed of the other drive wheel is proportionally increased. This permits the machine to make a sharp turn without dragging one drive wheel.

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DIFFERENTIAL

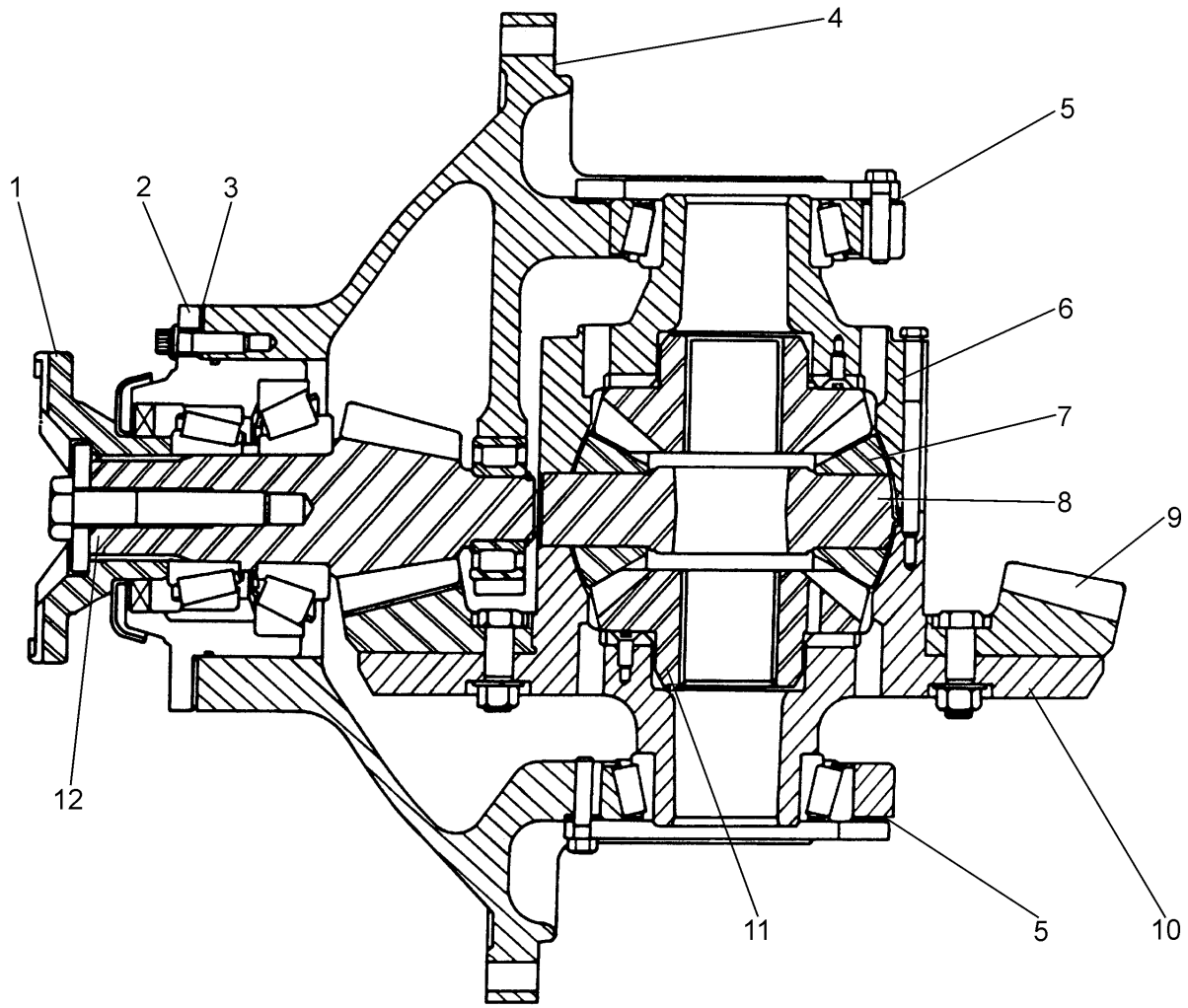


Fig. 7D.35. Differential Assembly Cross-Section

1. Input Yoke
2. Bearing Retainer
3. Shims
4. Differential Carrier
5. Shims
6. Differential Case (plain half)
7. Pinion Gear
8. Pinion Pivot
9. Ring Gear
10. Differential case (flanged case)
11. Side Gear
12. Pinion Shaft

36. SPECIFICATIONS

Tolerances:

Ring gear backlash . . . . . Etched on rim of ring gear

Special Torques:

Ring gear mounting bolts	540-610 Nm
Side gear thrust washer bolts (Loctite No. 277 applied)	40-50 Nm
Case half mounting bolts (Loctite No. 262 applied)	95-100 Nm
Carrier bearing retainer bolts	110-120 Nm
Carrier bearing cup bolts	920-1020 Nm
Pinion shaft bearing retainer bolts	220-240 Nm
Parking brake disc bolts (Loctite No. 262 applied)	220-240 Nm
Yoke retainer mounting bolts (Loctite No. 262 applied)	920-1020 Nm
Carrier housing -to-axle bowl bolts (Loctite No. 262 applied)	515-540 Nm

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DIFFERENTIAL

37. SERVICE DIAGNOSIS

NOTE: *To check for a damaged differential, jack up and block the machine so all wheels are clear of the ground and run the power train in first gear at moderate speed.*

NOTE: *If a failure should occur in the differential, the machine should not be operated under its own power. If the machine must be moved, disconnect the drive shaft at the transmission or remove the shaft completely. Drain both planetary assemble of the noisy axle, as described in Operator's MANUAL, remove the planetary covers and pull the axle shafts out to prevent further damage. After pulling out the axle shafts, install the planetary covers and fill the planetary reservoirs with lubricant before moving the machine. The machine may be driven a short distance with one axle if the drive shaft and axle shafts are removed from the noisy axle or differential.*

COMPLAINT	
PROBABLE CAUSE	REMARK
Loss of Lubricant	
1. Lubricant above specified level	1. Drain to correct level. Refer to the Operator's Manual
2. Foaming due to incorrect grade or type of lubricant	2. Fill with correct lubricant. Refer to the Operator's Manual
3. Leakage around input yoke	3. Replace oil seal
4. Leakage between bearing retainer and carrier housing	4. Replace O-ring
5. Axle leakage	5. Refer to SERVICE DIAGNOSIS under DRIVE AXLE in this Section
Continual Noise	
1. Incorrect lubricant or level too low	1. Refer to **Loss of Lubricant** complaint
2. Pinion or carrier bearings worn or loose	2. Replace bearings
3. Gear teeth excessively worn or damaged	3. Replace gears
4. Unmatched pinion and ring gear	4. Replace with new matched pinion and ring gear
5. Pinion and ring gear adjustment too tight (not enough backlash)	5. Readjust pinion and ring gear backlash
Intermittent Noise	
1. Incorrect lubricant or level too low	1. Refer to **Loss of Lubricant** complaint
2. Loose or broken differential bearings	2. Check all bearings. Replace pinion and/or carrier bearings
Noise on Coast	
1. Pinion or carrier bearing damaged	1. Replace bearings
2. Pinion and ring gear adjustment too loose	2. Readjust pinion and ring gear backlash
3. Excessive pinion shaft end play	3. Replace parts as necessary

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DIFFERENTIAL

Noise on Turns	
1. Differential side gears defective	1. Check drive axle for alignment. Check pinion gears, roller bearings and thrust washers. Replace if necessary
2. Thrust washers worn or damaged	2. Replace pinion gear and side gear thrust washers
3. Excessive backlash between side gears	3. Replace side and pinion gear thrust washers and bearings
4. Worn pinion gears or side gears	4. Replace pinion and side gears, thrust washers and bearings
Differential Overheats	
1. Incorrect lubricant or level too low	1. Refer to **Loss of Lubricant** complaint
2. Carrier bearings adjusted too tight	2. Readjust bearings to the proper preload
3. Pinion and ring gear adjustment too tight	3. Readjust backlash
4. Excessive wear in gears	4. Check gears for excessive wear or scoring. Replace as necessary

38. REMOVAL

WARNING! Before servicing the machine be sure the bucket is lowered, the parking brake is applied, the engine is off, the transmission shift lever is locked in neutral (N), the electrical system master switch is off and the keys are removed from master switch and from starting switch.

NOTE: *It is possible to remove the differential assembly from the axle housing bowl provided a means of supporting the differential on a hydraulic jack is available. If not available, it is recommended that the complete axle assembly first be removed. Refer to* ***REMOVAL*** *under* ***DRIVE AXLE.***

1. Remove the axle shaft from each side of the axle assembly. Refer to **REMOVAL** under **WHEEL PLANETARY**.

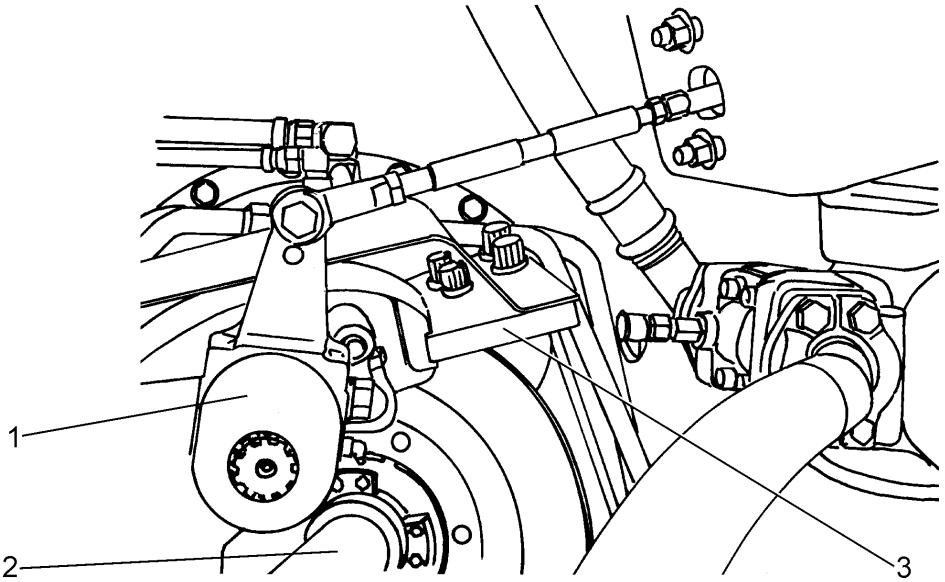


Fig. 7D.36. Parking Brake

1. Parking Brake Assembly 2. Drive shaft 3. Mounting Bars

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2. Remove the drive shaft as described in **REMOVAL AND DISASSEMBLY** under **DRIVE SHAFTS**.

3. FRONT DIFFERENTIAL ONLY: Remove the parking brake assembly (1, Fig. 7D.36) and mounting bars (3). Refer to **PARKING BRAKE** in Section 4, **BRAKES**.

4. Remove the hardware securing the differential assembly to the axle housing bowl. Using puller bolts in the three 3/4" NC holes provided in the differential carrier housing, start the assembly out from the axle bowl. Remove the puller bolts.

5. Support the differential using a hydraulic jack and support plates secured to the puller holes in the carrier housing flange. Carefully pull the assembly from position.

6. Remove the O-ring from behind the flange of the carrier housing.

39. DISASSEMBLY (Refer to Fig. 7D.37)

1. Place the differential in the holding fixture or in a stand with the ring gear up.

2. Inspect the ring gear and pinion. If they are not damaged and a good wear pattern is indicated, measure and record the backlash (Fig. 7D.38). This measurement will be used at reassembly.

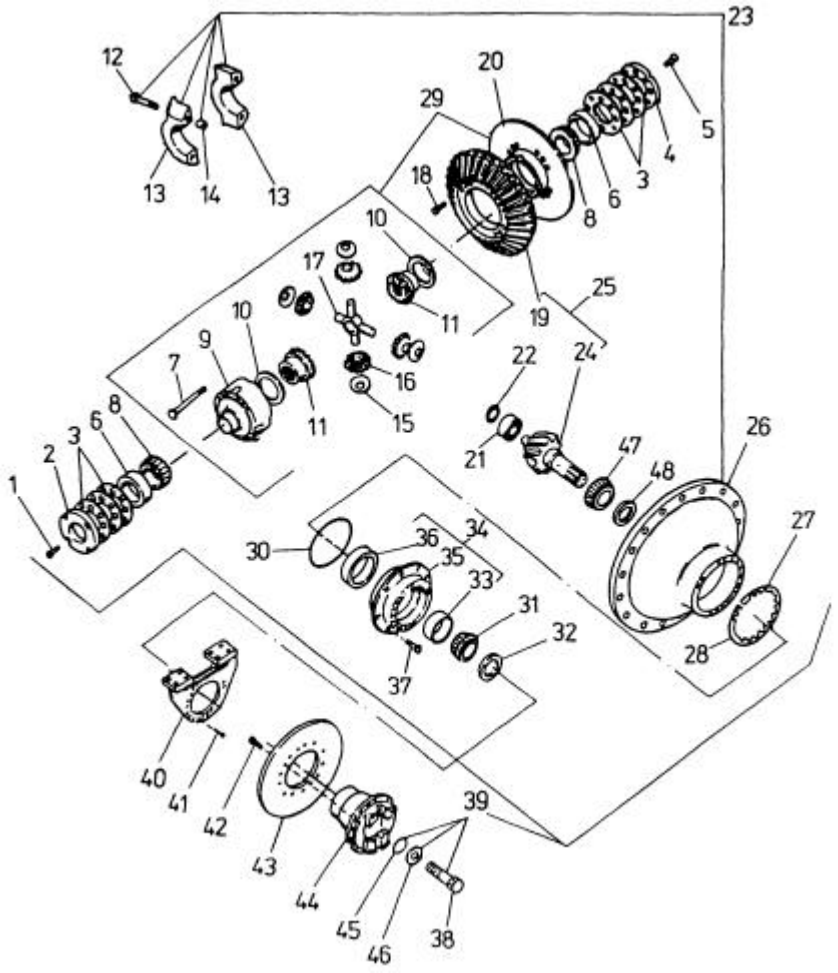


Fig. 7D.37. Front Axle Differential Exploded View

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DIFFERENTIAL

Legend for Fig. 7D.37. Front Axle Differential Exploded View

1. Bolt
2. Bearing Retainer
3. Shims
4. Bearing Retainer
5. Bolt
6. Bearing Cup
7. Bolt
8. Bearing Cone
9. Case Half, Plane
10. Thrust Washer
11. Side Gear
12. Cup Bolt
13. Carrier Cap
14. Cap Sleeve
15. Thrust Washer
16. Pinion Gear Seat
17. Pinion Pivot Arm
18. Bolt
19. Ring Gear
20. Flanged Case Half
21. Roller Bearing
22. Retaining Ring
23. Carrier Housing Unit
24. Pinion Shaft
25. Matched Gear Set
26. Differential Carrier Housing
27. Shim
28. Shim
29. Differential Gear
30. O-Ring
31. Outer Bearing Cone
32. Oil Seal
33. Outer Bearing Cup
34. Bearing Retainer Assembly
35. Bearing Retainer
36. Inner Bearing Cup
37. Bolt
38. Bolt
40. Parking Brake Mounting Plate *
41. Bolt *
42. Bolt *
43. Parking Brake Disc *
44. Input Yoke
45. O-Ring
46. Yoke Retainer
47. Inner Bearing Cone
48. Bearing Spacer

***** - Used on front differential only

NOTE: *Two teeth on the ring gear and one tooth on the pinion are marked with "X"s. These teeth must be in mesh and the backlash must be checked at this point.*

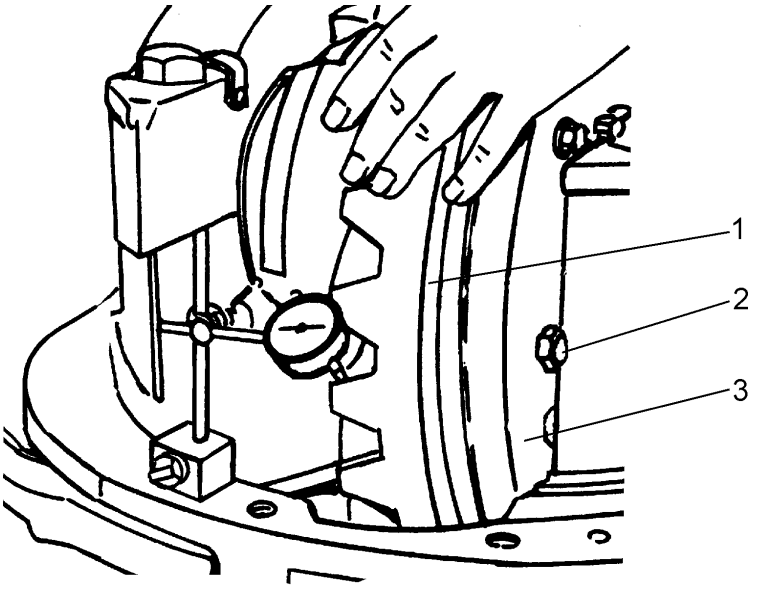


Fig. 7D.38. Checking Backlash

1. Ring Gear 2. Nut 3. Case Half, Flanged

NOTE*: If the ring gear (1, Fig. 7D.38) is to be replaced, it will be easier to loosen the nuts (2) holding the gear to the flanged case half (3) before removing the assembly. Hold the pinion shaft yoke with a bar to keep the ring from turning.*

3. Rotate the differential assembly 180 degrees in the holding fixture so the input yoke is up.

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4. Remove the bolt (38) securing the yoke retainer (46) to the pinion shaft (24) and lift the input yoke (44) with retainer and O-ring (45) from the pinion shaft. On front differentials, the parking brake disc (43) will come off with the input yoke and can easily be separated if replacement is necessary.

5. Remove the bolts securing the bearing retainer (35) to the carrier housing (26). On front differential, these bolts also secure the parking brake mounting plate (40).

6. FRONT DIFFERENTIAL ONLY: Lift the parking brake mounting plate (40) from the bearing retainer.

7. Install 5/8" NC bolts in the three puller holes provided in the bearing retainer until the bearing retainer is free of the carrier housing bore. Replace the puller bolts with eyebolts and, using a hoist, lift the retainer and pinion shaft assembly from the carrier housing.

8. Remove the shims (27 and 28). Tag and keep them separate for proper reassembly. Remove the O-ring (30) from the bearing retainer.

9. Support the bearing retainer in a press with the oil seal end up. Press the pinion shaft from the retainer. Remove the spacer (48) from the pinion shaft. If replacement of the pilot bearing (21) is necessary, it must be pressed from the shaft after removal of the retaining ring (22). The inner bearing cone (47) must also be pressed from the shaft if bearing replacement is necessary.

10. The outer bearing cone (31) will be left loose in the retainer (35) once the shaft is removed. To free this bearing cone from the retainer, the oil seal (32) must first be removed. If bearing replacement is necessary, the retainer can be supported in a press with the oil seal down and the bearing cone used to press the oil seal from the retainer.

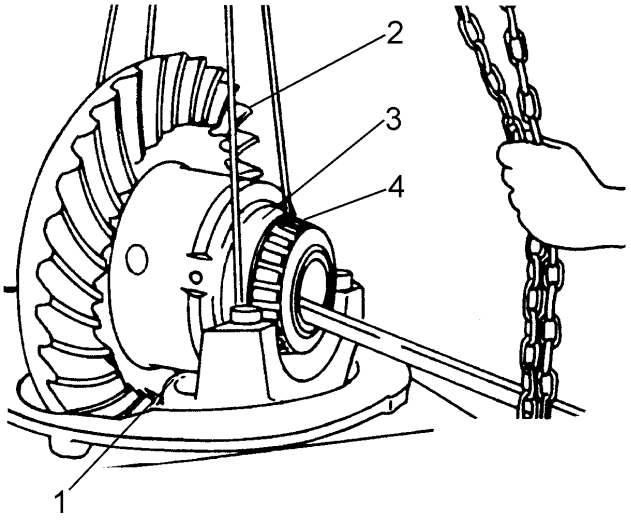


Fig. 7D.39. Lifting Differential from Carrier Housing

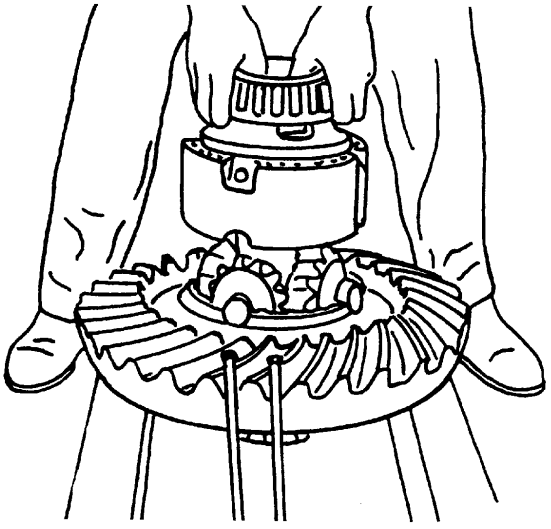


Fig. 7D.40. Removing Differential Cases (Plain Half)

1. Pinion Shaft Bearing Boss
2. Ring Gear
3. Differential Assembly
4. Carrier Bearing Cone

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11. Rotate the differential assembly 180 degrees in the holding fixture so the ring gear is up.

12. Remove the bolts (1 and 5), retainer (2 and 4) and shims (3) from both sides of the carrier housing.

13. Punch mark one cap (13) to the carrier housing to assure reassembly on the same side. Remove the bolts (12) and washers securing the caps to the carrier housing and, using a fiber hammer, loosen the caps from the sleeve (14) and carrier bearings.

14. Sling a cable around the differential assembly as shown in Fig. 7D.39. Lift the assembly just high enough to remove the two carrier bearing caps. Tag the caps for assembly in the same location. Insert a bar through the center of the ring gear and differential assembly to keep it balanced as it is lifted from the carrier housing. As the assembly is lifted out, tip it slightly so that the ring gear clears the pinion shaft bearing boss.

15. Rest the assembly on the flanged case (20) on blocking high enough to prevent damage to the carrier bearing cone (Fig. 7D.40). Using a punch or chisel match mark the cases (9 and 20) for correct alignment during reassembly.

16. Remove the bolts (7) and washers and lift the plain half case from the flanged half (Fig. 7D.40). One of the side gears (11) may come off with the plain half case and care must be taken not to let it fall and damage the gears (16) or flanged case half.

17. Remove the screws securing the thrust washer (10) to the case half. If replacement of the carrier bearing cone (8) is required, a standard bearing puller can be used.

18. Grasp the pinion pivot (17) and lift it with the gears (16) and thrust washers (15) from the flanged case half.

19. Remove the remaining side gear (11) and thrust washer (10) from the flanged case half. The thrust washer has screws retaining it to the case half.

20. If necessary to remove the ring gear (19) from the case half, match mark the case to the gear before disassembly. Remove the mounting nuts and washers and drive out the dowel bolts (18). Separate the ring gear and case half.

40. INSPECTION AND REPAIR

1. Four magnets located inside the axle housing are accessible through the differential opening in the axle bowl. These magnets should be removed, cleaned and reinstalled.

2. If a thrust washer (10, Fig. 7D.37) or (15) cannot be reused it is recommended that they be replaced in sets.

3. If the flanged case half needs to be replaced, the new case half must be line reamed to the ring gear as follows:

   a. Support the flanged case half with the counterbored side of the mounting holes down.

   b. Position the ring gear on the case half so the mounting holes are aligned and the larger ring gear holes are concentric with the smaller case half holes.

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c. Using the holes in the ring gear as a template, ream the holes through the case half to 20,650- 20,675 mm.

d. Match mark the case half to the ring gear to assure assembly in the same position.

41. REASSEMBLY (Refer to Fig. 7D.37)

1. Lubricate all parts of the differential assembly with the type lubricant specified in the Operator's Manual.

2. If removed, press new bearing cones (8) on the two differential case halves (9 and 20) until they are fully seated.

3. If removed, seat the ring gear on the flanged case half aligning the match marks. Drive the dowel bolts (18) in from the ring gear side and secure with the nuts and washers. Torque bolts to 540 - 610 Nm.

4. Apply Loctite No. 277 to the mounting surface of each of the thrust washers (10) and position in the case halves. Apply Loctite No. 277 to the mounting bolts and secure the thrust washers using a torque of 40 - 50 Nm.

5. Position the flanged case half on blocking high enough to protect the bearing cone. Install the side gear (11) in the case half.

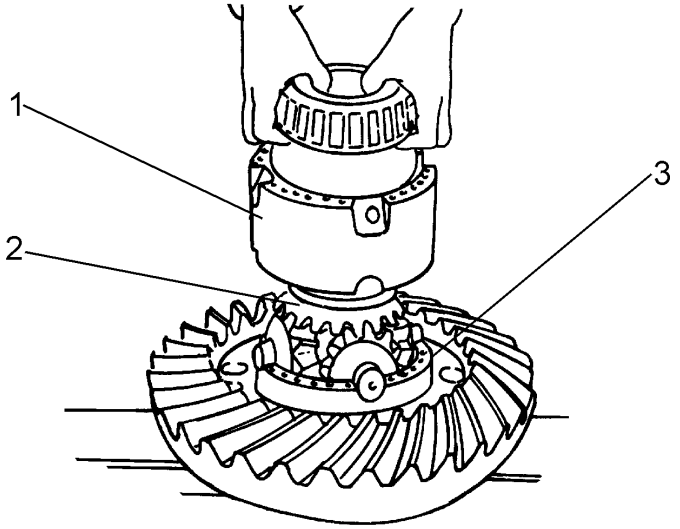


Fig. 7D.41. Installing Differential Case (Plain Half)
1. Differential Case 2. Side Gear 3. Flanged Case

6. Place the four pinion gears (16) with thrust washers (15) on the pinion pivot (17). Position the thrust washers so that the tabs are below the centerline of the pinion pivot. There is a shoulder on the inner bore of the flanged case which these tabs contact to prevent the thrust washers from turning. When the thrust washers are correctly positioned, place the pinion pivot assembly in the flanged case being sure that all four pinion gears mesh with the side gear and that the pinion pivot is seated in the flanged case.

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7. Install the other side gear (2, Fig. 7D.41). Install the plain differential case (1) with thrust washer on the flanged case (3) so that previous identification marks are aligned. Apply Loctite No. 262 to the case half mounting bolts and install the bolts and washers. Torque to 95-100Nm.

8. Lift the differential assembly (3, Fig. 7D.39) and tip it slightly when installing it in the carrier housing so the ring gear teeth will clear the pinion shaft rear bearing boss (1). When the assembly clears the bearing boss, place the carrier bearing cups on the cones (4) and lower the assembly into position.

9. Install the caps (13) over the sleeves (14) on the carrier housing so the aligning marks coincide. Install the mounting hardware. Draw the cap bolts down, but do not torque them.

10. Install the retainer (2) on each side of the carrier housing. Do not install shims. Torque the retainer bolts on the plain case side to 110 - 120 Nm and the bolts on the flanged case side to 7 Nm while rotating the differential assembly.

11. On the flanged case side, measure the distance to the carrier housing face by inserting a depth micrometer into each of the three small openings in the retainer (2). Record each reading and average the results.

12. Measure the thickness of the retainer at the three small openings with a micrometer. Record each reading and average the results.

13. Subtract the figure obtained in step 12 from the one in step 11 and divide the remainder in half. The result is the amount of shims to be installed under the retainer on each side of the carrier housing.

NOTE: *Measure shims individually with a micrometer when making up the shim packs.*

14. Remove the retainers (2). Install the proper amount of shims (3) and reinstall the retainers. Torque the retainer bolts to 110 - 120 Nm while rotating the differential assembly. Next torque the cap bolts (12) to 920 - 1020 Nm.

15. If the bearing (21) was removed, press a new bearing on the pinion shaft (24) until it bottoms and secure with the retaining ring (22).

16. If the pinion shaft bearings were removed, press new bearing cups (33 and 36) into the retainer (35) until they bottom. Press a new inner bearing cone (47) on the pinion shaft until it bottoms.

17. Support the pinion shaft in a press on end so the spline is up. Install the bearing spacer (48) over the shaft until it rests on the inner bearing cone. Position the retainer (35) over the shaft so it rest on the inner bearing, then press the outer bearing cone ((31) on the shaft until it bottoms on the bearing spacer.

18. Coat the OD of a new oil seal (32) with “MARSEAL” or equivalent sealant. Using a suitable driver, install the oil seal with the spring down until it is flush with the outside face of the retainer (35). Lubricate the oil seal lip and the surface it contacts on the input yoke with a lithium base grease or equivalent.

19. Record the mounting distance dimensions etched on the end of the pinion shaft. These “A” and ”B” dimensions can either be a “Plus or a “Minus” figure and must be recorded as such to be used in a calculation later in reassembly.

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DIFFERENTIAL

20. Install the “O” ring (30) in the groove of the retainer (35).

21. Locate the mating teeth of the pinion shaft and ring gear and place the retainer with the original shims (27 and 28) removed in disassembly on the carrier housing. Use a drift pin to align the mounting holes and shims. Be sure the mating gear teeth are in mesh.

22. FRONT DIFFERENTIAL ONLY: Install the parking brake mounting plate (40) on the bearing retainer.

23. Secure the bearing retainer (35) to the housing (26). Torque the mounting bolts to 220 - 240 Nm. On front differential, these bolts also secure the parking brake mounting plate.

24. FRONT DIFFERENTIAL ONLY: If the brake disc (43) was removed, install the disc so it pilots on the input yoke. Apply Loctite No. 262 and torque the mounting bolts to 220 - 240 Nm.

25. Install the input yoke (44) on the pinion shaft.

26. Place the O-ring (45) on the yoke and secure the yoke retainer (46) to the pinion shaft. Apply Loctite No. 262 to the retainer bolt and torque to 920 - 1020 Nm.

27. Arriving at the proper pinion shaft mounting distance is determined by checking the distance between the end of the pinion shaft and the outside of the differential case. This distance (shown as “C” in Fig. 7D.42) will vary with each pinion shaft due to manufacturing tolerances. Set the proper mounting distance as follows:

a. Locate and record the dimension stamped or etched on the flanged half-differential case. If this dimension is not legible, it can be determined as follows:

1. Measure the diameter of the differential case to the nearest hundreds of millimeters, as shown in Fig. 7D.43.

2. Divide this measurement in half to obtain the radius of the case, and record the radius dimension to be used in a later calculation.

b. If the “A” dimension recorded in step 19 was a “Plus” figure, it should be added to 287 mm If it was a “Minus” figure , subtract it from 287 mm. Record the results.

c. Add or subtract the “B” dimension recorded in step 19 dependent upon whether it was a “Plus” or “Minus” figure from 145,80 mm. Record the result.

d. Subtract the result arrived at in step “c” from the one arrived at in step “b” and record the result again.

e. Subtract the recorded figure obtained in step “a” from the recorded figure obtained in step “d” to arrive at the proper mounting distance (“C”, Fig. 7D.42).

f. Measure the distance between the end of the pinion shaft and the outside of the differential case with a feeler gauge (Fig. 7D.44). If the dimension is not the same as the one previously calculated in step “e” (“C”, Fig. 7D.42), add or remove shims from under the bearing retainer until correct setting is obtained. Adding shims will decrease the dimension.

28. To measure the backlash (amount of “play” between the teeth of the ring gear and pinion shaft) rotate the gears until the match market teeth are meshing. Check the backlash dial indicator at this point with a dial indicator positioned as shown in Fig. 7D.45.

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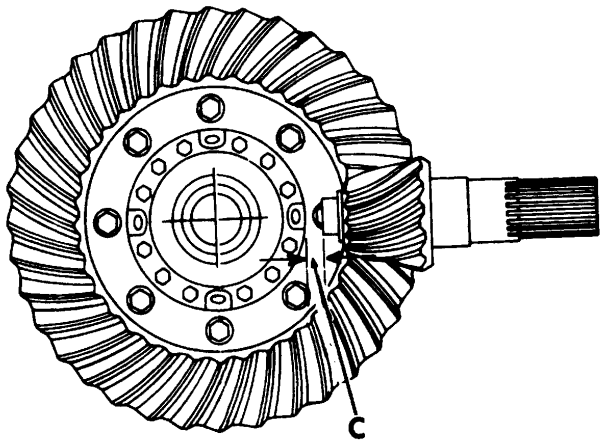


Fig. 7D.42. Point of Measurement Between Pinion Shaft and Differential Case

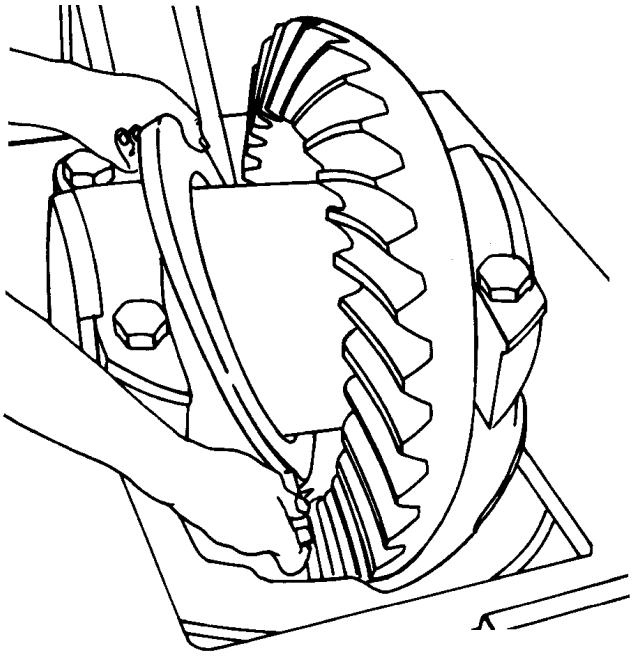


Fig. 7D.43. Measuring the Diameter of the Flanged Half Differential Case

NOTE: *Position the dial indicator at 90 degrees tooth surface for maximum accuracy.*

29. Rotate the ring gear so that one ring gear tooth contacts the side of one pinion shaft tooth. Hold the pinion shaft stationary and move the ring gear in the opposite direction until the same ring gear tooth contacts the next pinion shaft tooth. Record the reading.

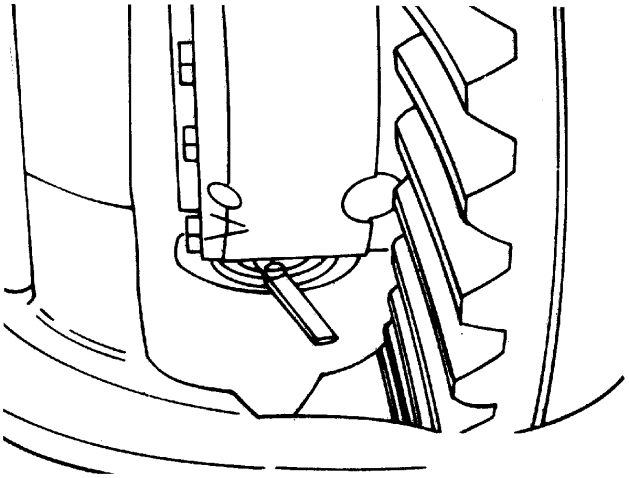


Fig. 7D.44. Using a Feeler Gauge Between Pinion Shaft and Differential Case

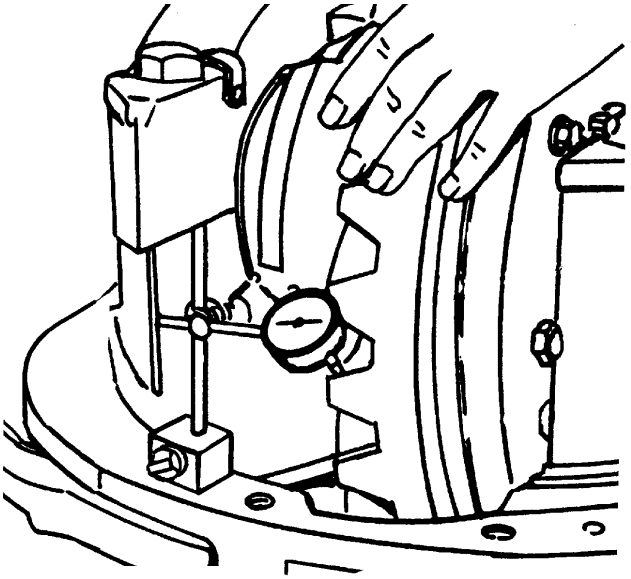


Fig. 7D.45. Checking Backlash

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30. WHEN NEW RING GEAR AND PINION SET IS USED: The correct backlash for each gear set is etched on the rim of the ring gear. Compare this reading with the measured reading recorded in step 29. These readings should agree.

    WHEN ORIGINAL RING GEAR AND PINION SET IS USED: Gears that have been in service for long periods form running contacts which must not be greatly changed and the gear teeth wear pattern must be considered in the backlash adjustment. The backlash reading taken during disassembly should be used to maintain the original wear pattern rather than the initial backlash etched on the rim of the ring gear. Compare that reading with the measured reading recorded in step 29. These readings should agree.

31. If the backlash readings taken do not agree, transfer shims from under one of the bearing retainers (2) to the other. DO NOT change the total number of shims, or the bearing preload will be changed. With every change of shims, loosen the bearing cap bolts (12). Always torque the bearing retainer bolts (1) before torquing the cap bolts. Recheck the backlash.

32. After the correct pinion shaft mounting distance and backlash have been established, check for correct tooth contact (new gear set) or original wear pattern (used gear set). Apply a coat of oiled red lead to the ring gear teeth. While applying resistance to the ring gear, rotate the pinion shaft to obtain a tooth pattern. Observe the size, shape and location of the bare area caused by the tooth contact.

NOTE: *When tooth marks are obtained by hand, they are apt to be rather small and favor the toe of the gear. However, under an actual operating load, the contact area will spread out and move toward the rear of the tooth; the higher the load, the greater becomes the contact area.*

33. Correct tooth contact will result as shown in Fig. 7D.46. Figures 7D.47 through 7D.50 show improper or incorrect tooth contact. To correct such conditions, readjust the ring gear and pinion as follows:

NOTE: *Beside obtaining the correct tooth contact for new gear sets, the following ring gear and pinion adjustments can be made to bring the tooth contact back to the original wear pattern for used gear sets.*

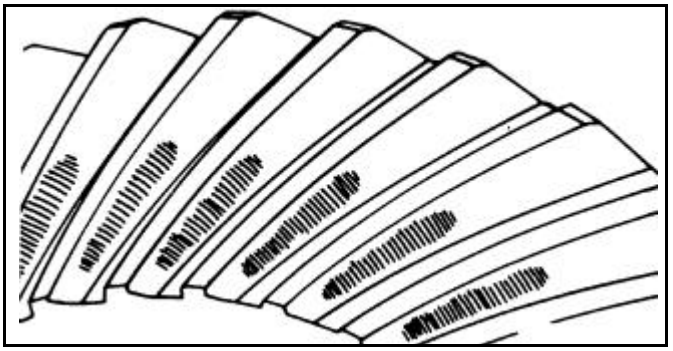
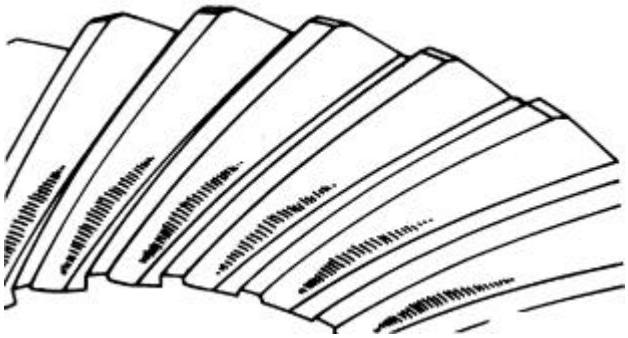
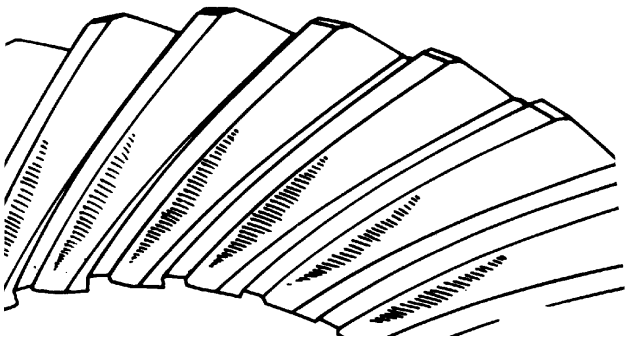
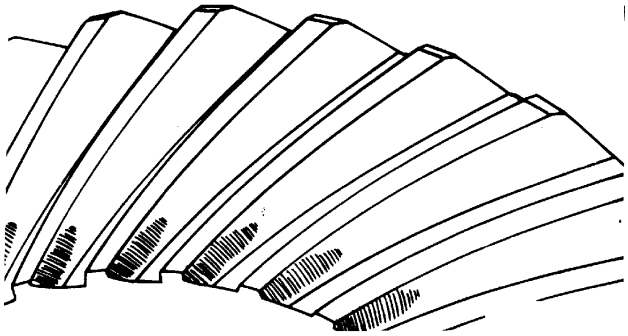
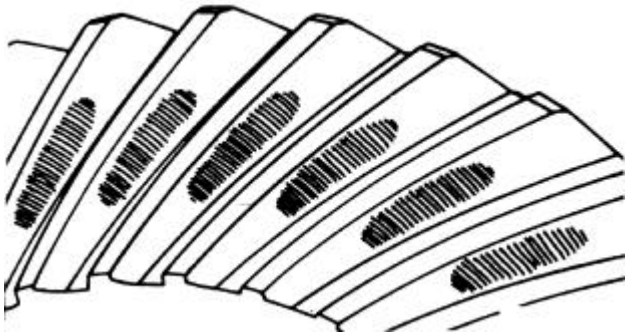


Fig. 7D.46. Correct Gear Tooth Contact

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DIFFERENTIAL

 Fig. 7D.47. Low Narrow Contact	If the tooth marking is across the length of the tooth, but narrow and low on the flank the teeth will gall or score. This type of contact causes excessive wear and noise. CORRECTING LOW NARROW CONTACT: Move the pinion away from the center of the ring gear by adding shims under the pinion shaft bearing retainer. Readjust the backlash
 Fig. 7D.48. High Narrow Contact	If the tooth marking is across the length of the tooth, narrow and high on the tooth face, the teeth will roll over or gall. This type of contact causes excessive wear and noise. CORRECTING HIGH NARROW CONTACT: Move the pinion in toward the center of the ring gear by removing shims from under the pinion shaft bearing retainer. Readjust the backlash.
 Fig. 7D.49. Short Toe Contact	If the tooth marking is too heavy on the toe of the tooth, the tooth edges might chip and damage, or excessive wear will result. CORRECTING SHORT TOE CONTACT: Move the ring gear away from the pinion. However, this adjustment might increase the backlash beyond acceptable limits. If such is the case, it will be necessary to move the pinion in toward the gear by removing shims from under the pinion shaft bearing retainer.
 Fig. 7D.50. Short Heel Contact	If the tooth marking is too heavy on the hell of the tooth, the tooth edges might chip and damage, or excessive wear will result. CORRECTING SHORT HEEL CONTACT: Move the ring gear in toward the pinion. However, this adjustment may decrease the backlash. If such is the case, it will be necessary to move pinion away from the center of the ring gear by adding shims under the pinion shaft bearing retainer

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DIFFERENTIAL

42. INSTALLATION

1. reverse the procedure described in **REMOVAL**.

NOTES:

(*1). Torque the carrier housing mounting bolts to 520 - 550 Nm after applying Loctite No. 262.*

(2). If the front differential assembly was removed, adjust the parking brake. Refer to PARKING BRAKE in Section 4, BRAKES.

DRIVE AXLE

43. DESCRIPTION

The front axle is bolted to the front frame, and the rear axle is bolted to an oscillating cradle called a bolster which is pinned to the rear frame. All components of both axles are similar with the exception of a parking brake mounted to the front axle differential. Both axles consist of a three-piece assembly with a spindle welded to each side of the bowl housing, a differential assembly, two planetary assemblies and two multi plate, wet design service brakes flanged of each axle spindle.

The axle assemblies accomplish three main functions: they change the direction of the input torque from the drive shaft, sending it 90 degrees to the right and left; they increase the input torque through reduction gearing, and they provide a means of securing the wheels and supporting the machine.

Both axles are full floating, double reduction axle axles. Full floating means that none of the weight is supported by, or transmitted to the axle shafts. All weight on the axles is supported by the wheels, the bearings and the axle housing. The first reduction occurs in the differential between the pinion gear and ring gear. The second gear reduction takes place in the planetary housing where the planet gear multiply the input torque from the axle shaft.

44. SPECIFICATIONS

Weights:

Machine weight (approximate)	39 230 Kg

Special torques:

Axle housing mounting bolts	3100 Nm
Wheel mounting bolts	1250 - 1300 Nm

45. SERVICE DIAGNOSIS

NOTE: *Axle noise may be isolated within the axle by jacking up the machine so the tires clear the ground. If the noise is in one axle, disconnect the drive shaft of the opposite axle at the transmission. Now the noise may be isolated with only the noisy axle turning. Run the engine at a moderate speed with the transmission in first gear. Both wheels must be off the ground to prevent damage to the differential*.

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DRIVE AXLE

COMPLAINT	
PROBABLE CAUSE	REMARK
Excessive Noise	
1. Lubricant level low	1. Refer to **Loss of Lubricant** complaint
2. Wheel bearings not adjusted correctly	2. Check for proper shim pack thickness as described in PROCEDURE FOR DETERMINE WHEEL BEARING SHIM PACK, Par. 30
3. Wheel bearings damaged	3. Replace bearings
4. Sun gear teeth worn or damaged	4. Replace axle shaft. Check planet gears for damage
5. Planetary gears or ring gear worn or damaged	5. Replace planet and/or ring gear. Check sun gear teeth for damage
6. Planetary bearings damaged	6. Replace bearings
Loss of Lubricant	
1. Lubricant level to high	1. Drain to correct level
2. Lubricant foams due to incorrect type or grade	2. Drain and fill with correct type and viscosity of oil
3. Lubricant leaks at planetary cover	3. Tighten bolts or apply a new sealer
4. Lubricant leaks from inside of service brake housing (between wheel hub and brake housing)	4. Check rubber/metal rings for damage. Replace if necessary. Refer to WHEEL HUB AND BRAKE UNIT ASSEMBLY, Par. 29
5. Oil leaks from inside of service brake, behind the wheel, through a small hole in the brake housing and axle mounting flange: a. Transmission oil leaks, b. Multi-Purpose Gear Lubricant leaks	5. Replace oil seals. Refer to BRAKE REASSEMBLY, Par. 28 under WHEEL HUB AND SERVICE BRAKE: a. Replace oil seal (13, Fig. 7D.23), b. Replace oil seal (21, Fig. 7D.17)
6. Lubricant leaks between wheel hub and planet carrier	6. Replace O-ring on carrier flange
7. Lubricant leaks at differential housing	7. Remove differential and replace O-ring
8. Differential leakage	8. Refer to SERVICE DIAGNOSIS under DIFFERENTIAL
Wheel Drags	
1. Wheel bearings too tight	1. Check for proper shim pack thickness as described in PROCEDURE FOR DETERMINE WHEEL BEARING SHIM PACK, Par. 30
2. Service brake problem	2. Check for proper condition of service brake parts as described in INSPECTION, Par 27 under WHEEL HUB AND SERVICE BRAKE
Brake does not work properly	
1. Air in hydraulic system	1. Bleed the system. Refer to Section 4
2. Brake friction discs worn	2. Check and adjust the brake as described in FRICTION DISCS CHECKING, Par. 33.
3.Brake piston seals worn	3. Replace seals as necessary. Refer to BRAKE REASSEMBLY, Par 28

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DRIVE AXLE

46. REMOVAL AND DISASSEMBLY

WARNING! Before servicing the machine be sure the bucket is lowered, the parking brake is applied, the engine is off, the transmission shift lever is locked in neutral (N), the electrical system master switch is off and the keys are removed from master switch and from starting switch.

NOTE: *Before removing the axle assembly refer to* ***SERVICE/SPECIAL TOOLS*** *in Section 1* ***MACHINE SPECIFICATIONS*** *for the tools required to properly service the different components of the axle assembly.*

WARNING: The machine weighs over 39,000 kg. Adequate lifting and blocking equipment must be available before beginning axle removal.

WARNING! Use extra caution when jacking up the machine. Jacking up the machine can be hazardous if performed improperly. Use jacking equipment of sufficient capacity. Be sure the jacking points are strong enough to support the machine. Be sure the jack is stable and well supported. Before jacking up the machine, block the tires which will not be lifted. Lock the frames together with the locking bar and pins. If the rear tires are being lifted, block the rear axle to prevent it from pivoting unexpectedly. DO NOT run the engine with the machine on jacks. For your safety, transfer the weight of the machine to approved blocks before servicing the machine.
Lift and handle all heavy parts with lifting devices of adequate capacity. Secure parts with proper slings and hooks. Use lifting eyes provided. Warn nearby personnel to stand clear. For your safety, whenever using blocking for support, use proper and approved blocks.

1. Park the machine on a level surface. Install the frame-locking bar so that frame halves are in a straight ahead position.

2. Drain the axle assembly as described in the Operator's Manual.

3. Securely block the tires at the axle not being removed.

4. Disconnect the hydraulic brake lines (pressure and lube) from the brake line manifold on the axle.

5. Remove the drive shaft. Refer to **DRIVE SHAFTS** in this section.

6. FRONT AXLE ONLY: disconnect the parking brake linkage from the brake cylinder. This will allow the brake assembly to come off with the axle.

7. Loosen, but do not remove the wheel mounting bolts.

8. Securely block up the machine under the frame so that the tires are just clear of the ground.

9. Attach a suitable hoist and sling to the wheel and tire assembly. Remove the mounting bolts and remove the wheel and tire assembly from both ends of the axle.

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10. With the axle assembly adequately supported, remove the axle mounting hardware and remove the axle from the machine. Place the axle assembly in a suitable work stand with the differential positioned upward.

11. To remove all or any of the components from the axle assembly, refer to the pertinent heading in this section for the desired component.

NOTE: *If removing the differential assembly, use a hoist and a chain wrapped around the input yoke to pull the assembly straight out of the axle bowl.*

47. REASSEMBLY AND INSTALLATION

1. To install the components removed from the axle assembly, refer to the instructions under the pertinent heading in this section.

NOTE: *If the differential was removed, be sure the axle housing is positioned in the work stand with the bowl opening up to allow the differential to be lowered into position with a hoist and chain*.

2. Position the axle under the machine. Install the mounting hardware and torque the bolts to 3100 Nm.

3. Install the tire and wheel assembly to both sides of the axle. Install and tighten the mounting bolts, then lower the tires to the ground and torque bolts to 1250-1300 Nm.

4. Connect the hydraulic brake lines (pressure and lube) to the brake line manifold on the axle.

5. Install the drive shaft. Refer to DRIVE SHAFTS in this section.

6. FRONT AXLE ONLY: Connect the parking brake linkage and install the hydraulic line to the brake cylinder.

7. Fill the axle assembly with oil as described in the Operator's Manual.

8. Adjust the parking brake as described in Section 4, **BRAKES**.

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SECTION 8

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CRANKING MOTOR

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GENERAL

1. DESCRIPTION

A 24V negatively grounded electrical system is used, consisting of a loader system, cab system, and air conditioner.

Four (eight for arctic) 12V batteries connected in series-parallel supply the 24V.

A master switch located on the positive side of the electrical circuit is used to cut out the electrical power.

The lights are sealed boom type and are controlled by the light switches on the panel.

The circuits are protected by an 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 quide 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 to prevent accidental starting.

WIRING DIAGRAM

2. ELECTRICAL LOADER SYSTEM

Electrical loader system consists of starting circuit, charging circuit and accessories circuit.

a. Starting Circuit

The starting circuit contains the batteries, master switch, breaker, starting switch, neutral safety relay (switched by neutral safety switch), magnetic switch, starter solenoid, cranking motor. The master switch is located on the positive side of the batteries and must be in the "ON" position to complete the battery circuit for starting power. Power is available at the magnetic switch whenever the master switch is in the "ON" position, the neutral safety switch is closed allowing the power to flow on an actuate the starter. When the starting key is turned, power flows to the neutral safety relay. When the transmission directional lever is in neutral position, the neutral safety switch is closed and neutral safety relay is in position „ON” allowing the power to flow on and actuate the magnetic switch. When actuated, the coil of the switch draws the spool down, connecting the larger power line from the battery to the starter solenoid. When the solenoid is actuated, it draws its spool in, engaging the drive gear for the starter and connecting the battery cable to the starter motor for cranking. Both the magnetic switch and starter solenoid are spring tensioned to remain in the "disengaged" position. When the starting switch is released, both units release their spools, breaking the circuit.

b. Charging Circuit

The charging circuit contains the alternator and the batteries. 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.

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WIRING DIAGRAM

c. Accessories Circuit

This circuit supplies power to the lights, fuel solenoid valve, ether start, alarm and warning lights, instruments limit switch and any accessory on the machine. Automatic reset circuit breakers are used to protect them.

Legend for Fig. 8.1

1. Battery
2. Master Switch
3. Cranking Motor
4. Alternator
5. Horn
6. Back-up Alarm
7. Horn
8. Alarm (Emergency Steering, Main and Parking Brake)
9. Hydraulic Accumulators Gas Pressure Switches
10. Cooling Brake Low Pressure Switch
11. Brake System Oil Filter Warning Light Switch
12. Directional Neutral Safety Switch
13. Transmission Oil Filter Warning Light Switch
14. Air Conditioner Low Pressure Switch
15. Hydraulic Oil Filter Warning Light Switch
16. Brake System Differential Pressure Switch
17. Coolant Temperature Warning Light Switch
18. Hourmeter Switch
19. Air Conditioner High Pressure Switch
20. Transmission Oil Temperature Warning Light Switch
21. Ground Drive Steering Alarm and Lamp Switch
22. Main Brake Low Pressure Switch
23. Back-up Alarm
24. Stop Light Switch
25. Parking Brake Warning Light Switch
26. Magnetic Switch
27. Rear Left Directional Lamp
28. Left Stop Lamp
29. Rear Left Work Lamp
30. Rear Right Work Lamp
31. Rear Right Directional Lamp
32. Right Stop Lamp
33. Brake Cooling Filter Warning Lamp
34. Hydraulic Oil Filter Warning Lamp
35. Transmission Oil Filter Warning Lamp
36. Coolant Level Low Warning Lamp
37. Coolant Temperature Sensor
38. Coolant Level Low Sensor
39. Fuel Level Sensor
40. Engine Oil Pressure Sensor
41. Torque Converter Temperature Sensor
42. Tachometer Sensor
43. Boom Raise Limit Magnetic Switch
44. Bucket Dump Limit Magnetic Switch
45. Brake Parking Switch
46. Circuit Breakers
47. Bulbs Check and Drive Disconnection Switch
48. Ether Start and Rear Work Lamps Switch
49. Low Level Lamps Switch
50. Front Work Lamps Switch
51. Front Auxiliary Lamps Switch
52. Key Start Switch
53. Cooling Low Level Relay
54. Parking Brake Relay
55. Brake Differential Pressure Delay Relay
56. Brake Alarm Relay
57. Neutral Safety Switch Relay
58. Stop Light Relay
59. Bucket Dump Limit Magnetic Switch Relay
60. Boom Rise Limit Magnetic Switch Relay
61. Brake Alarm Elimination Switch
62. Horn Button
63. Start Ether Solenoid Valve
64. Drive Disconnection Solenoid Valve
65. Parking Brake Solenoid Valve
66. Boom Raise Limit Electromagnet
67. Bucket Dump Limit Electromagnet
68. Engine Stop Fuel Pump Solenoid Valve
69. Air Conditioner Clutch
70. Front Left Work Lamp
71. Front Right Work Lamp
72. Low Level Work Lamp
73. Warning Lights Diodes
74. Alarm Diodes
75. Auxiliary Power Supply
76. Cab Work Lamp Connector
77. Instruments Panel

A. Fuel Reserve Warning Lamp
B. Ground Drive Steering Warning Lamp
C. Parking Brake Warning Lamp
D. Coolant Temperature Warning Lamp
E. Brake Warning Lamp
F. Transmission Oil Temperature Warning Lamp
G. Coolant Temperature Gauge
H. Coolant Temperature Gauge
J. Transmission Temperature Gauge
K. Engine Oil Pressure Gauge
L. Gauge Cluster Lamps
M. Voltmeter

78. Tachometer
79. Hourmeter
80. Cab connectors

Wires Colors:

R. Red	B. Black	P. Pink	LB. Light Blue
T. Tan	BR. Dark Gray	V. Violet	DG. Dark Green
W. White	G. Gray	DB. Dark Blue	LG. Light Green
Y. Yellow	O. Orange		

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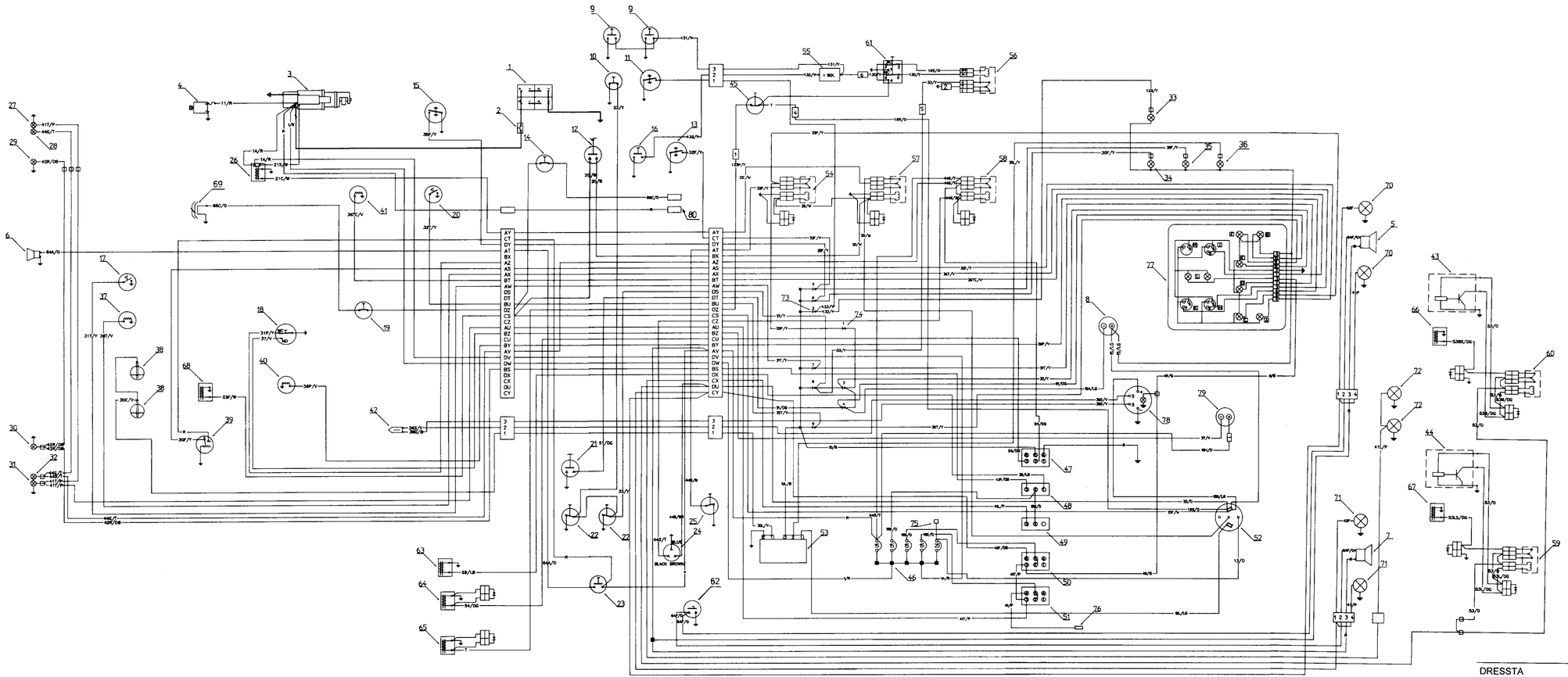
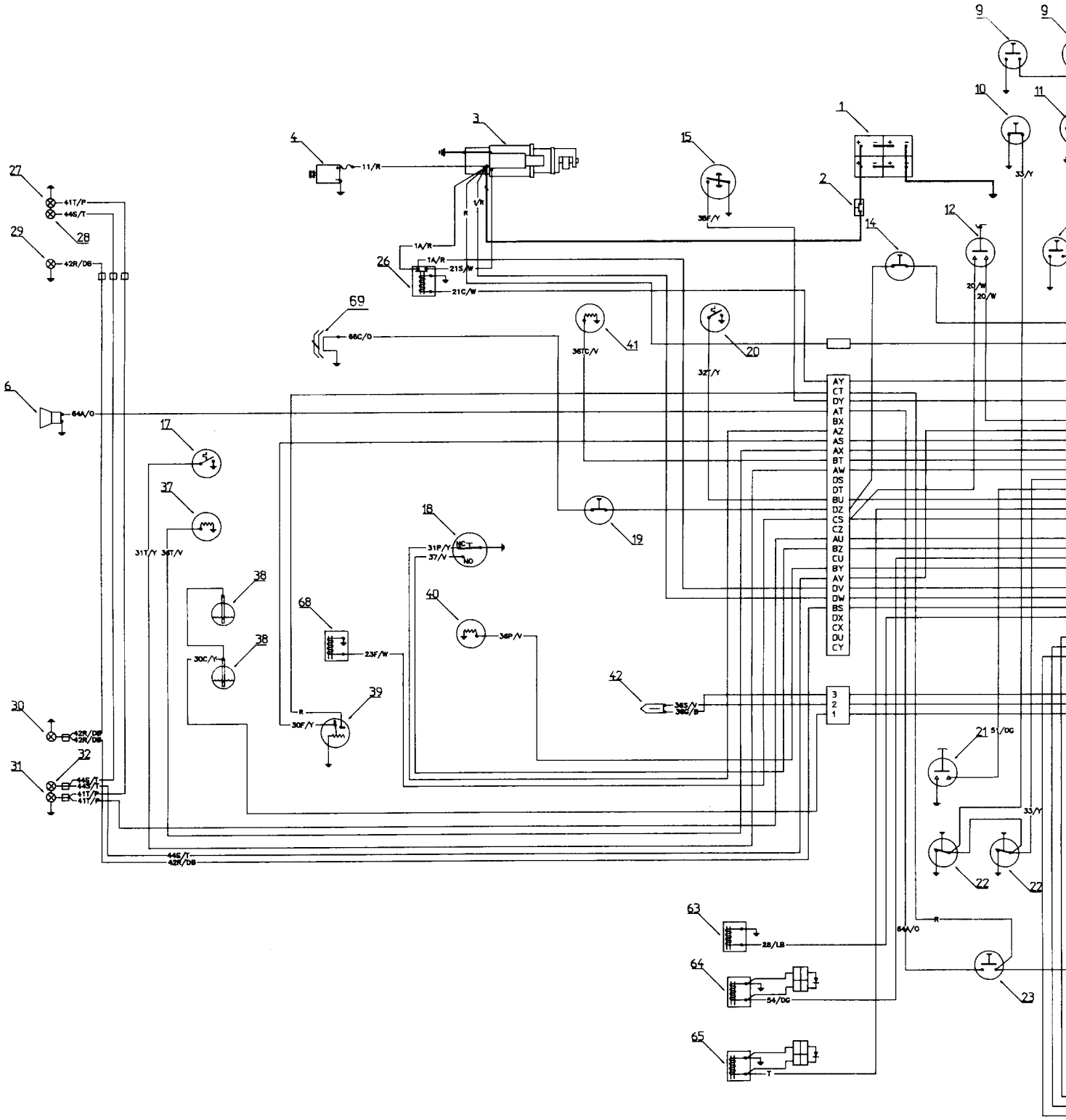
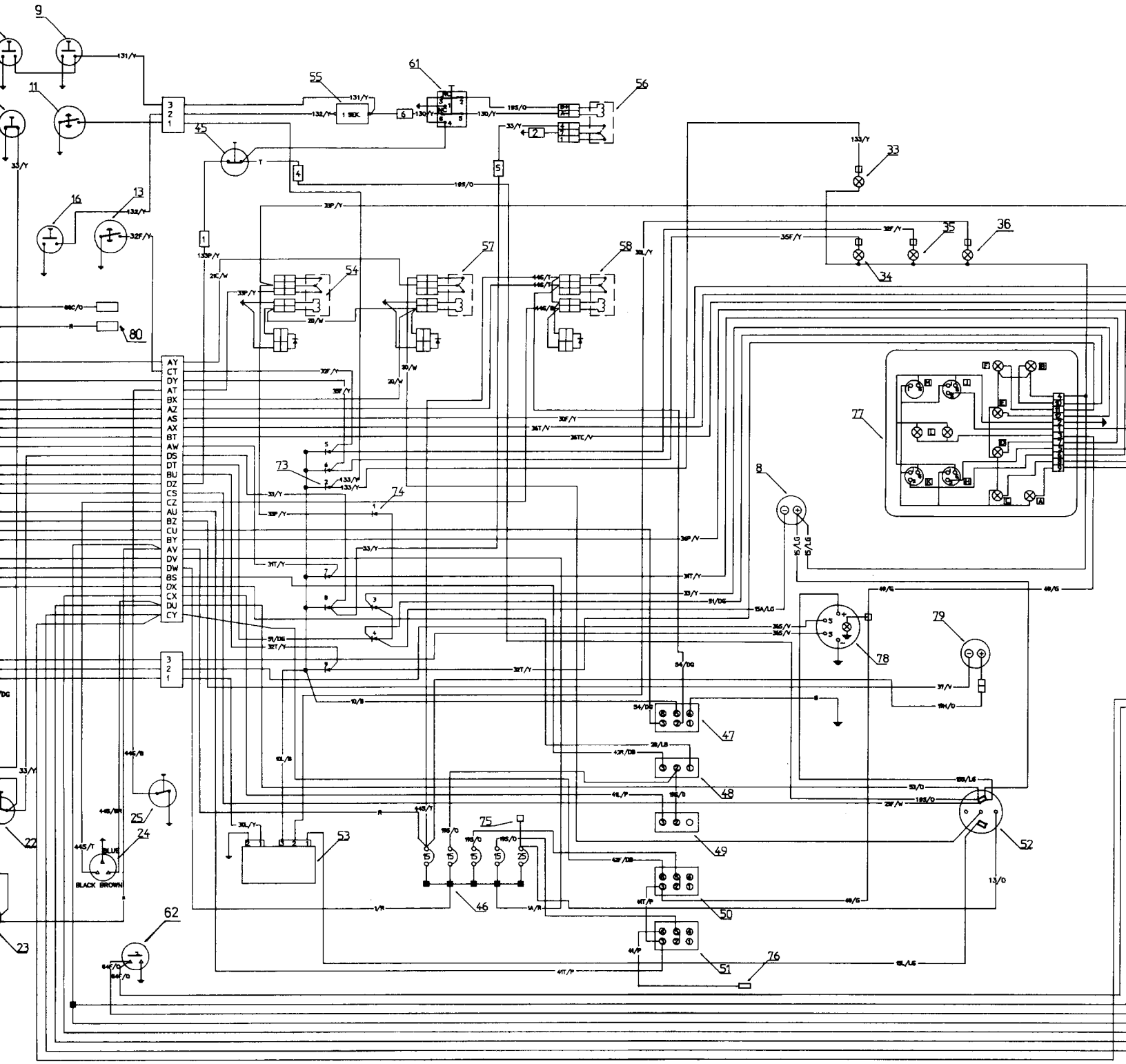


Fig. 8.1. Electrical Machine System

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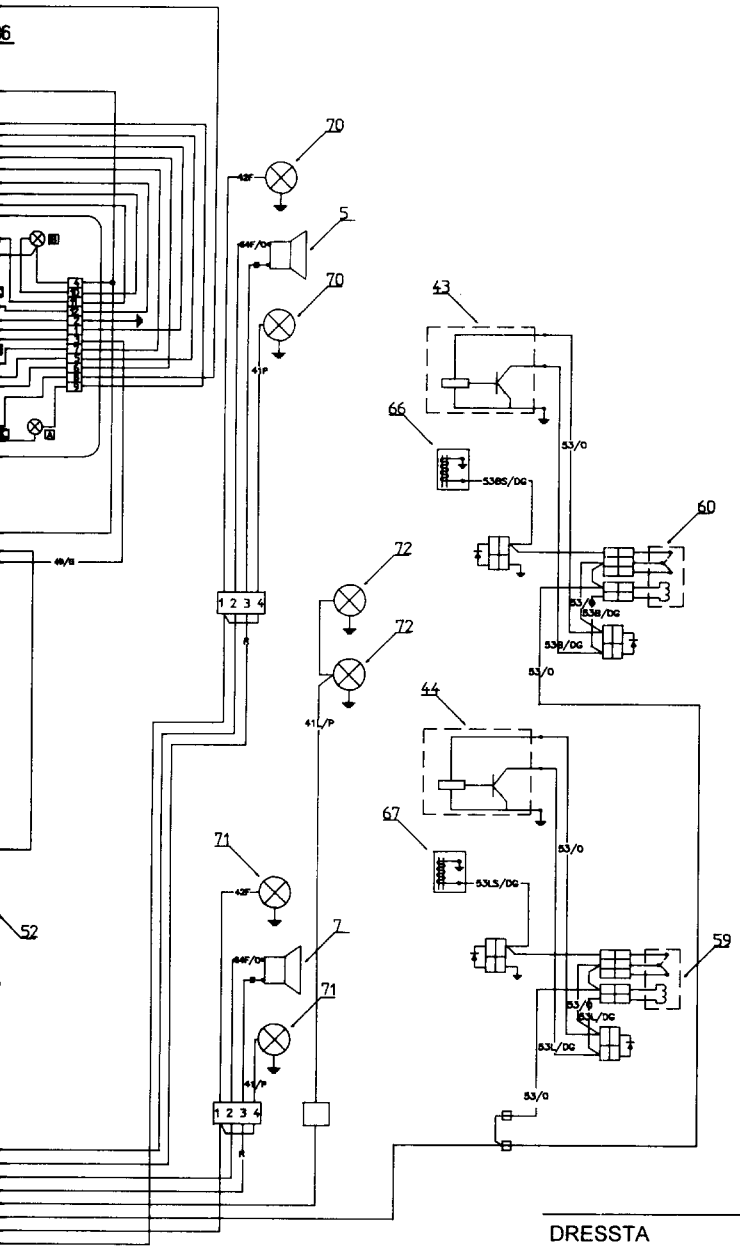


Fig. 8.1. Electrical Machine System

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WIRING DIAGRAMS

Legend for Fig. 8.1A (only for CE version)

1. Rear Parking Lamp
2. Left Stop Lamp
3. Rear Left Work Lamp
4. Back-up Alarm
5. Right Work Lamp
6. Rear Right Parking Lamp
7. Right Stop Lamp
8. Auxiliary Cooler Fan Assy (*)
9. Coolant Temperature Warning Light Switch
10. Coolant Temperature Sensor
11. Coolant Level Low Sensor
12. Alternator
13. Magnetic Switch
14. Fuel Level Sensor
15. Cranking Motor
16. Hourmeter Switch
17. Engine Oil Pressure Sensor
18. Torque Converter Temperature Sensor
19. Air Conditioner High Pressure Switch (*)
20. Tachometer Sensor (*)
21. Hydraulic Oil Filter Warning Light Switch
22. Main Brake Low Pressure Switch
23. Drive Disconnection Solenoid Valve
24. Parking Brake Solenoid Valve
25. Start Ether Solenoid Valve (*)
26. Master Switch
27. Battery
28. Air Conditioner Low Pressure Switch (*)
29. Hydraulic Accumulators Gas Pressure Switches
30. Cooling Brake Low Pressure Switch
31. Directional Neutral Safety Switch
32. Brake System Differential Pressure Switch
33. Brake System Oil Filter Warning Light Switch
34. Ground Drive Steering Alarm and Lamp Switch
35. Main Brake Low Pressure Switch
36. Back-up Alarm
37. Parking Brake Warning Light Switch
38. Stop Light Switch
39. Horn Button
40. Brake Differential Pressure Delay Relay
41. Brake Parking Switch
42. Brake Alarm Elimination Switch
43. Brake Alarm Relay
44. Parking Brake Relay
45. Neutral Safety Switch Relay
46. Stop Light Relay
47. Warning Lights Diodes
48. Alarm Diodes
49. Turn Signal Lamp Switch (*)
50. Cooling Low Level Relay(*)
51. Circuit Breakers
52. Auxiliary Power Supply
53. Bulbs Check and Drive Disconnection Switch
54. Ether Start and Rear Work Lamps Switch
55. Low Level Lamps Switch (*)
56. Front Work Lamps Switch
57. Front Auxiliary Lamps Switch (*)
58. Cab Work Lamp Connector
59. Alarm (Emergency Steering, Main and Parking Brake)
60. Brake Cooling Filter Warning Lamp
61. Hydraulic Oil Filter Warning Lamp
62. Transmission Oil Filter Warning Lamp
63. Coolant Level Low Warning Lamp (*)
64. Instruments Panel

A. Fuel Reserve Warning Lamp
B. Ground Drive Steering Warning Lamp
C. Parking Brake Warning Lamp
D. Coolant Temperature Warning Lamp
E. Brake Warning Lamp
F. Transmission Oil Temperature Warning Lamp
G. Coolant Temperature Gauge
H. Coolant Temperature Gauge
J. Transmission Temperature Gauge
K. Engine Oil Pressure Gauge
L. Gauge Cluster Lamps
M. Voltmeter

65. Tachometer (*)
66. Hourmeter
67. Key Start Switch
68. Front Left Turn Signal Lamp (*)
69. Front Left Work Lamp
70. Horn
71. Low Level Work Lamp (*)
72. Front Right Turn Signal Lamp (*)
73. Front Right Work Lamp
74. Horn
75. Boom Raise Limit Magnetic Switch
76. Boom Raise Limit Electromagnet
77. Boom Rise Limit Magnetic Switch Relay
78. Bucket Dump Limit Magnetic Switch
79. Bucket Dump Limit Electromagnet
80. Bucket Dump Limit Magnetic Switch Relay
81. Engine Stop Fuel Pump Solenoid Valve
82. Air Conditioner Clutch (*)
83. Cab connectors
84. Front Parking Lamps 560C -CE
85. Passing Lamps 560C -CE
86. Turn Signal and Emergency Light Switch 560C -CE
87. Rear Left Directional Lamp 560C -CE
88. Back-up Lamp 560C -CE
89. Rear Right Turn Signal Lamp 560C -CE
90. Transmission Oil Filter Warning Light Switch

(*) - if equipped

Wires Colors:

R. Red	Y. Yellow	G. Gray	V. Violet	DG. Dark Green
T. Tan	B. Black	O. Orange	DB. Dark Blue	LG. Light Green
W. White	BR. Dark Gray	P. Pink	LB. Light Blue	

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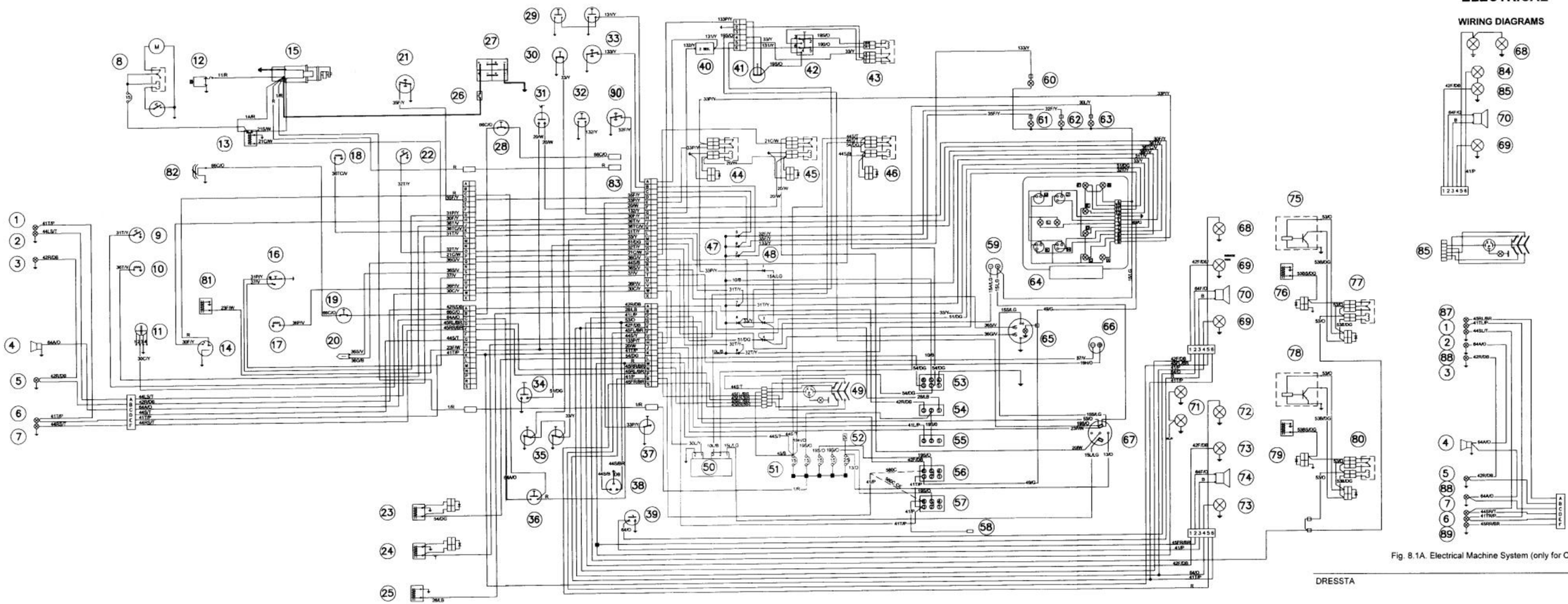
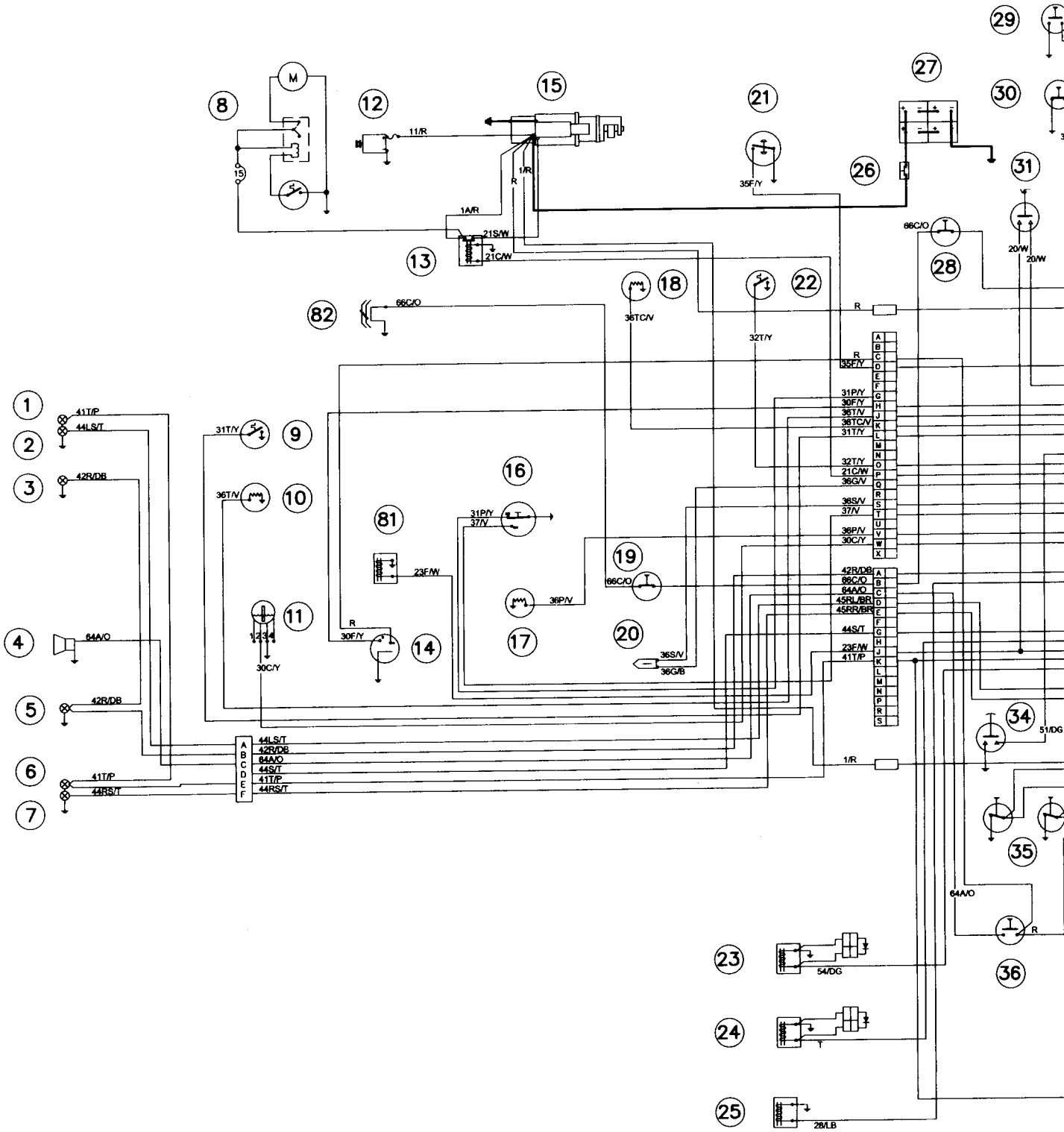
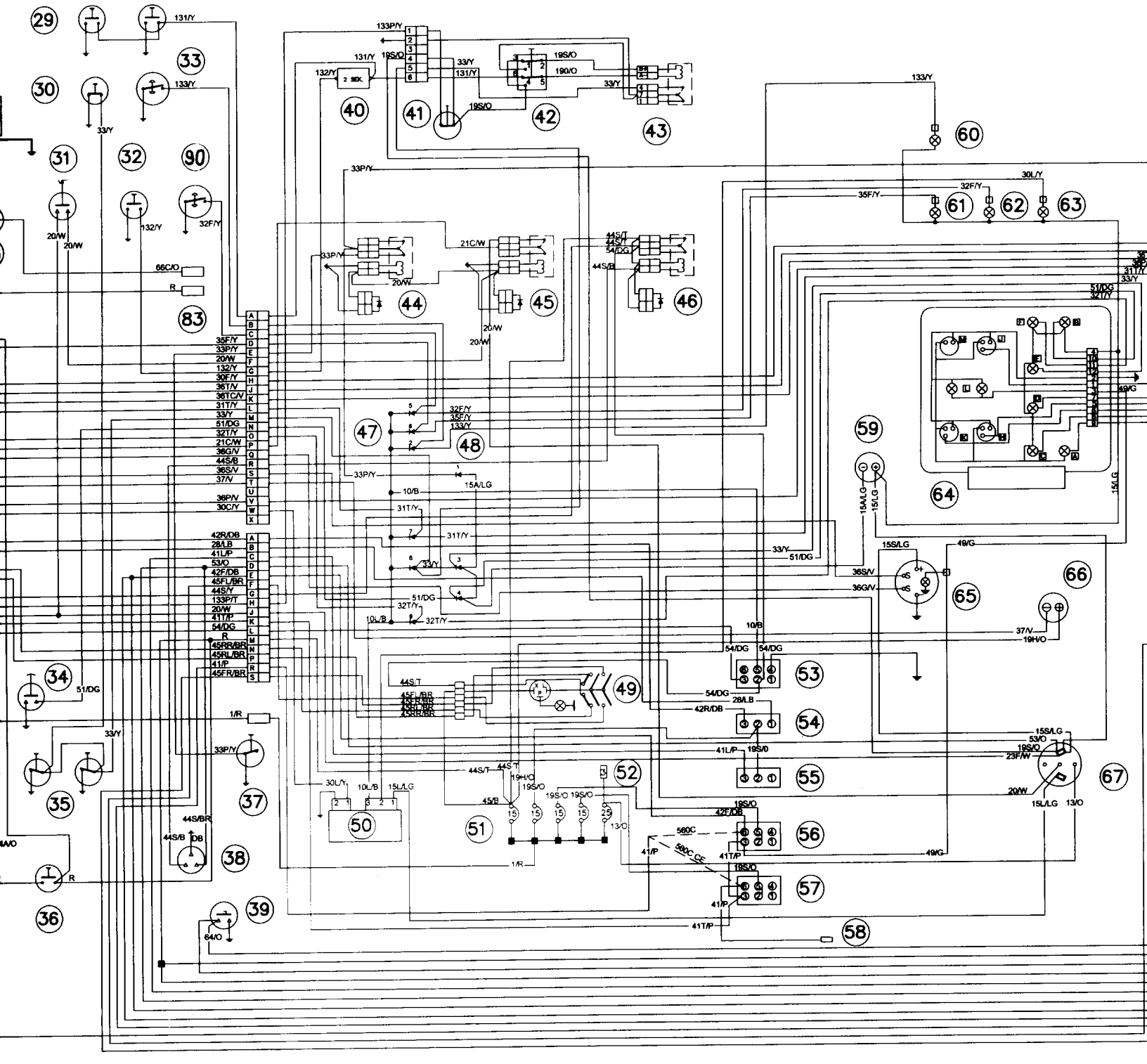


Fig. 8.1A. Electrical Machine System (only for CE version)

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WIRING DIAGRAMS

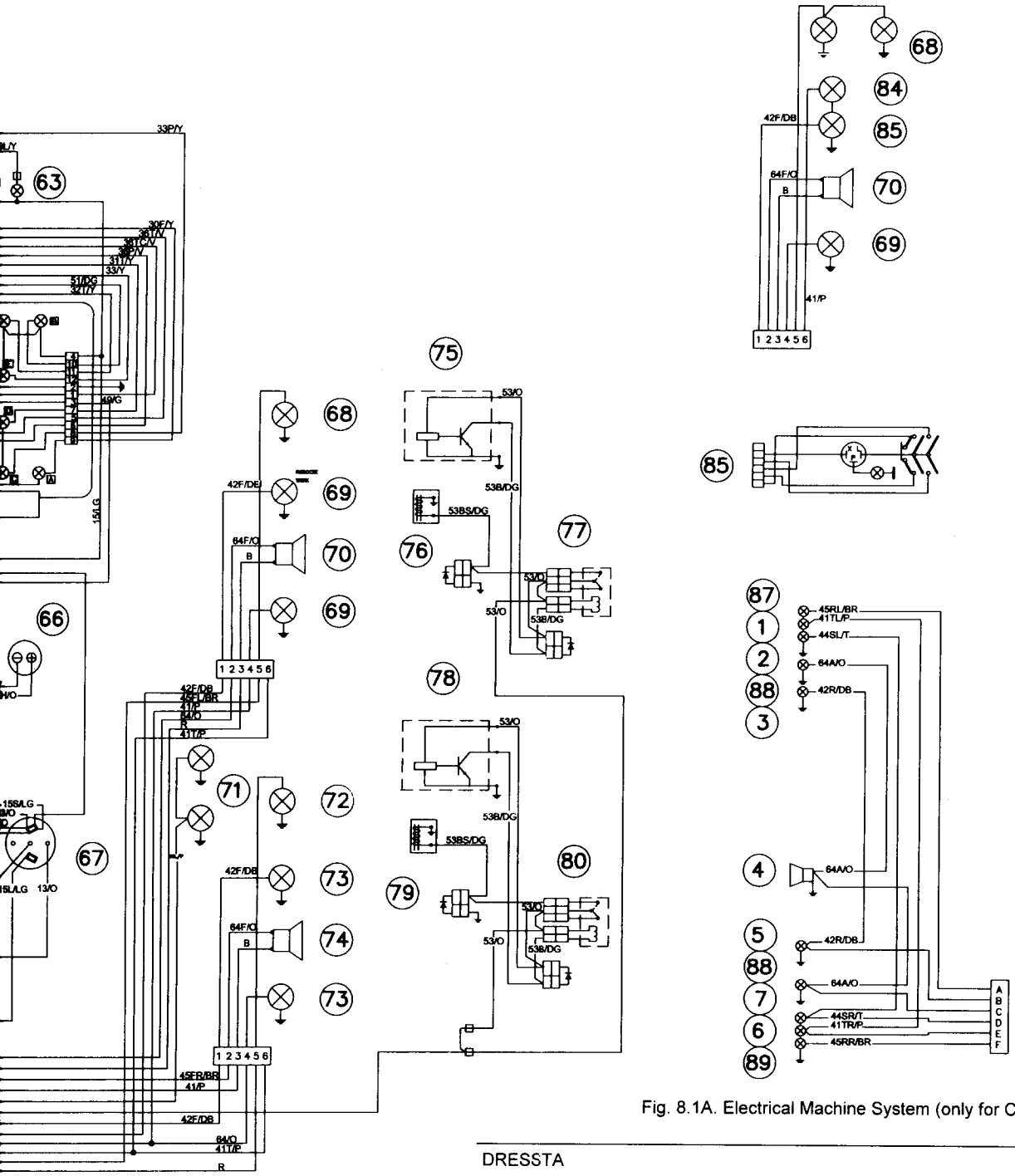


Fig. 8.1A. Electrical Machine System (only for CE version)

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WIRING DIAGRAMS

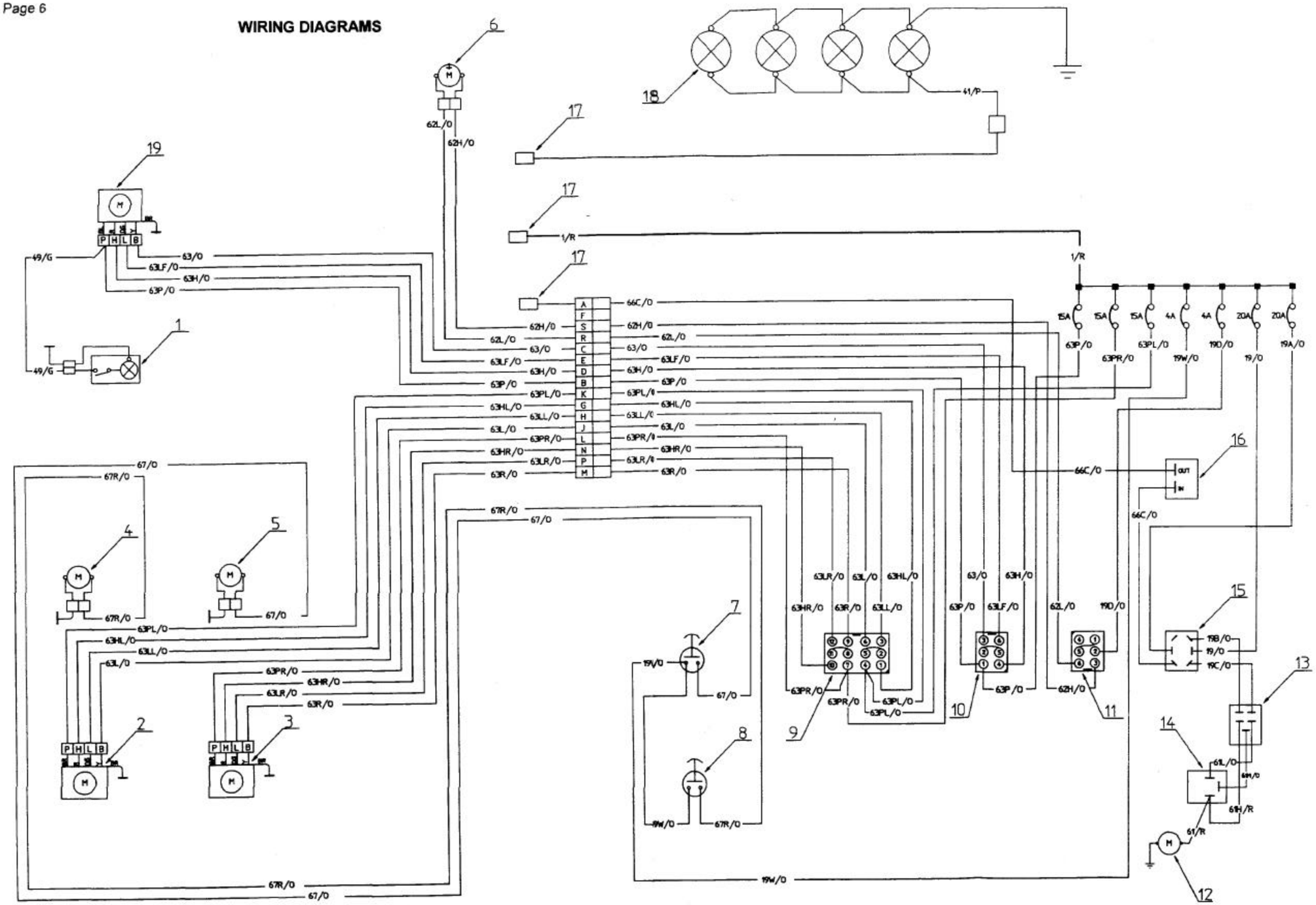


Fig. 8.2. Electrical Cab System

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ELECTRICAL

WIRING DIAGRAMS

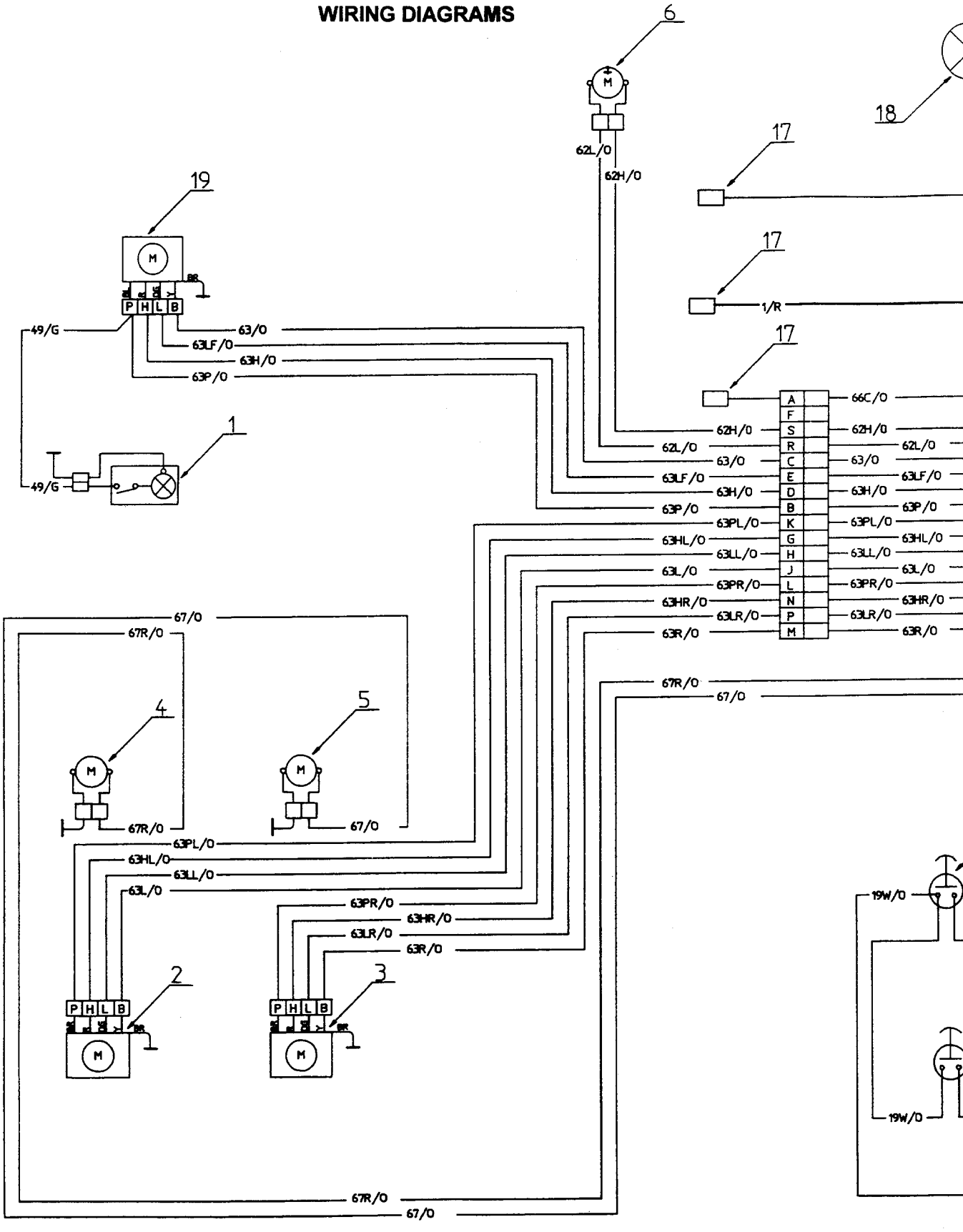
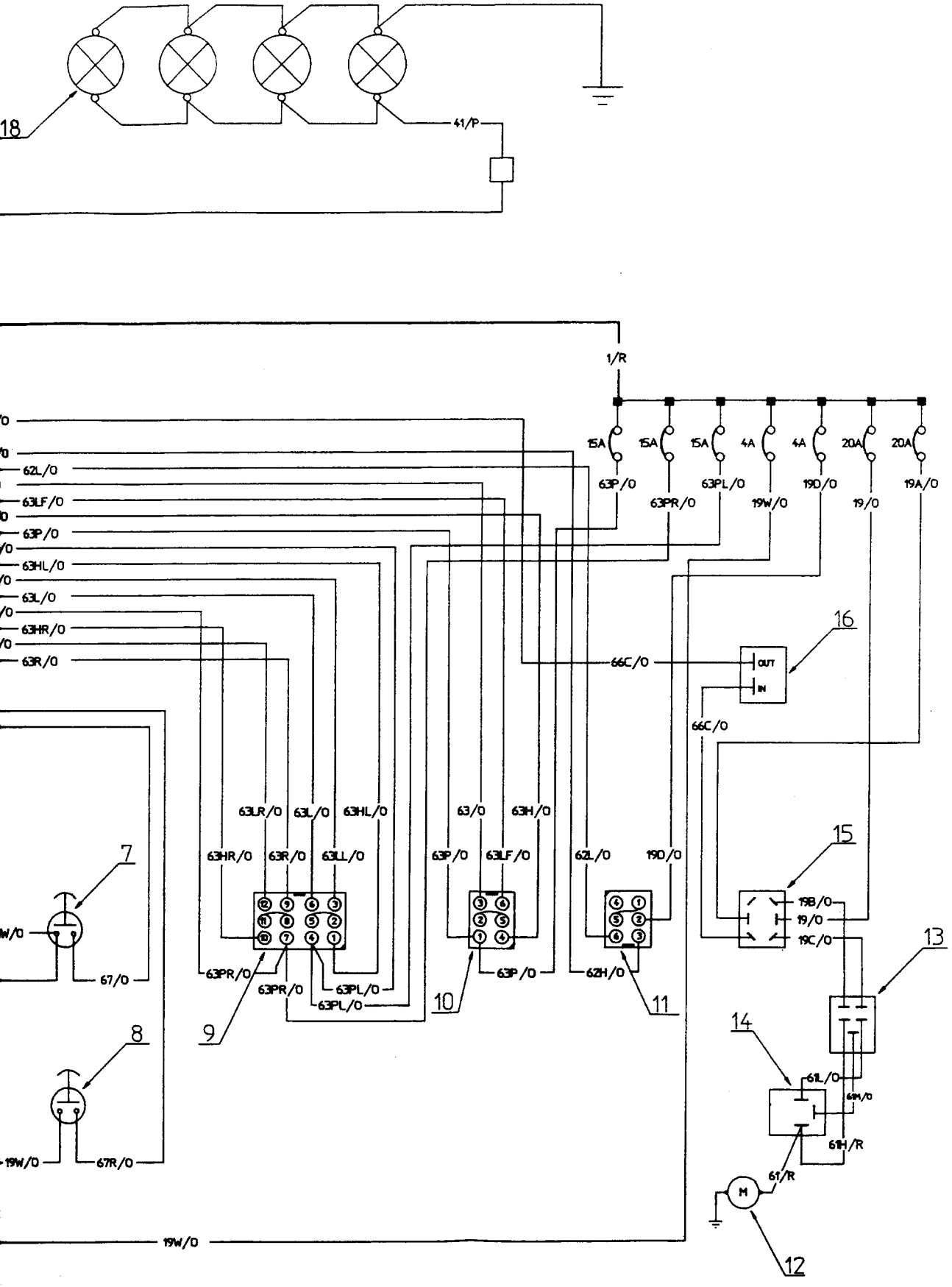


Fig. 8.2. Electrical Cab System

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WIRING DIAGRAMS

Legend for Fig. 8.2

1. Cab Light
2. Rear Left Wiper Motor
3. Rear Right Wiper Motor
4. Rear Window Washer Pump
5. Front Window Washer Pump
6. Front Window Defroster Fan Motor
7. Front Window Washer Pump Button
8. Rear Window Washer Pump Button
9. Rear Wipers Motor Switch
10. Front Wiper Motor Switch
11. Defroster Fan Motor Switch
12. Heater Fan Motor
13. Heater Fan Motor Switch
14. Resistor
15. Heater Switch
16. Thermostat
17. Supply Connector
18. Top Work Lamp
19. Front Wiper Motor

Wires Colors:

R. Red
T. Tan
W. White
Y. Yellow
B. Black
BR. Dark Gray
G. Gray
O. Orange
P. Pink
V. Violet
DB. Dark Blue
LB. Light Blue
DG. Dark Green
LG. Light Green

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ELECTRICAL

WIRING DIAGRAMS

3. SERVICE DIAGNOSIS

When performing any service diagnosis on the electrical system, refer to the wiring diagrams 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 steering wheel to alert other personnel that work is being performed on the machine with the master switch in position „ON".

COMPLAINT	
PROBABLE CAUSE	REMARKS
Engine will not Crank or Crank Slowly	
1. Weak batteries	Check the condition of each battery. Refer to "Testing and Maintenance the Battery"
2. Dirty or loose power cable connections	Clean all connections and tighten
3. Defective 25A breaker, key starter switch, directional neutral safety switch, neutral safety switch relay, magnetic switch, starter solenoid, starter 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
Boom Positioner or Bucket Positioner not Functioning Properly	
1. Proximity switch gap out of adjustment	Refer to OPERATOR'S MANUAL for adjustment procedure
2. Faulty limit magnetic switch or relay, limit electromagnet, wiring	Using a voltmeter or lamp check for voltage beginning at the voltage source
3. Mechanical problem in pilot control valve	Refer to SECTION 10B"VALVES"
Alarm Signal On and Brake Warning Lamp Light (after Engine Stopping and Pressing the Brake Alarm Elimination Switch under R.H. Panel Situation is Same)	
1. Faulty cooling brake low pressure switch	Check for voltage using a voltmeter or check lamp
2. Problem in cooling brake system	Refer to SECTION 4 „BRAKES"
3. Faulty one of two main brake oil pressure switch	Check for voltage using a voltmeter or check lamp
4. Problem in main brake system	Refer to SECTION 4 „BRAKES"
5. Faulty one of hydraulic accumulator gas pressure switch	Check for voltage using a voltmeter or check lamp
6. Problem in one of two accumulator	Refer to SECTION 4 „BRAKES"
7. Faulty one of two brake system or differential pressure switch	Check for voltage using a voltmeter or check lamp and Refer to SECTION 4 „BRAKES"
8. Faulty brake alarm relay	Check for voltage solenoid and contacts

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WIRING DIAGRAMS

COMPLAINT	
PROBABLE CAUSE	REMARKS
Alarm Signal On and Brake Warning Lamp Light (after Engine Stopping and Pressing the Brake Alarm Elimination Switch under R.H. Panel and Starting the Engine Signal and Light are Temporarily Off)	
Air or other problem in brake system	Refer to SECTION 4 „BRAKES”
Alarm Signal and Parking Brake Warning Lamp Light	
Faulty parking brake warning lamp switch, parking brake relay or parking brake solenoid valve	Check for voltage switch, relay and valve
Alarm Signal and Ground Drive Steering Warning Lamp Light (Engine is O.K.)	
1. Faulty ground drive steering alarm and lamp switch	Check for voltage using a voltmeter or check lamp
2. Problem in steering system	Refer to SECTION 10 „HYDRAULICS”

NOTE: *For electrical switches location on the machine refer to their system*

ALTERNATOR

4. SPECIFICATIONS

Manufacturer type . . . . . Delco Remy 30SI 24V/80A
Adjusted voltage at external temp. 26°C . . . . . 28 ± 0.4 V
Adjusted load parallel to the battery . . . . . 2 kW
Permissible voltage spread at 10A 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] . . . . . 36/2000 A/RPM
54/3000 A/RPM
66/4000 A/RPM
73/5000 A/RPM
76/6000 A/RPM

Voltage setting at 10A 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

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ALTERNATOR

5. INTRODUCTION

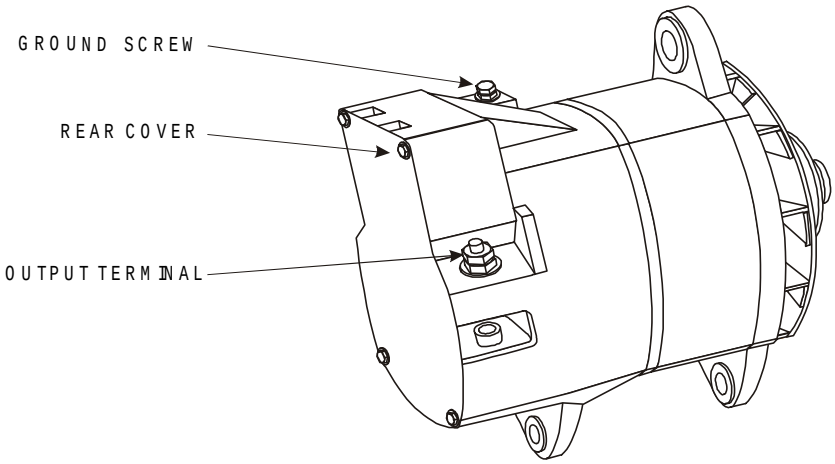


Fig. 8.3. View Of Alternator

The Integral Charging System shown in Fig. 8.3 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.

6. OPERATING PRINCIPLES

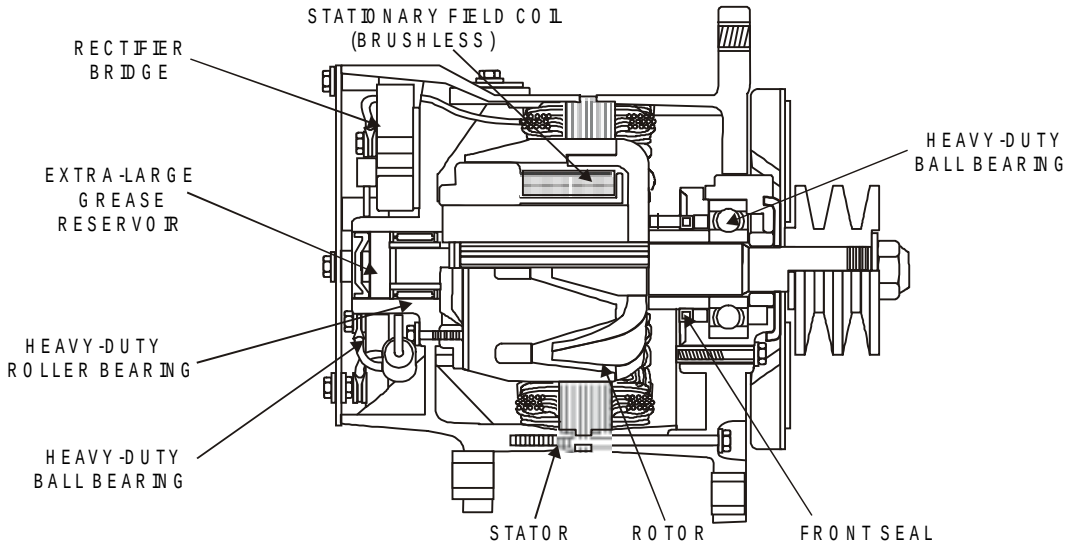


Fig. 8.4. Cross Sectional View Typical 30-SI

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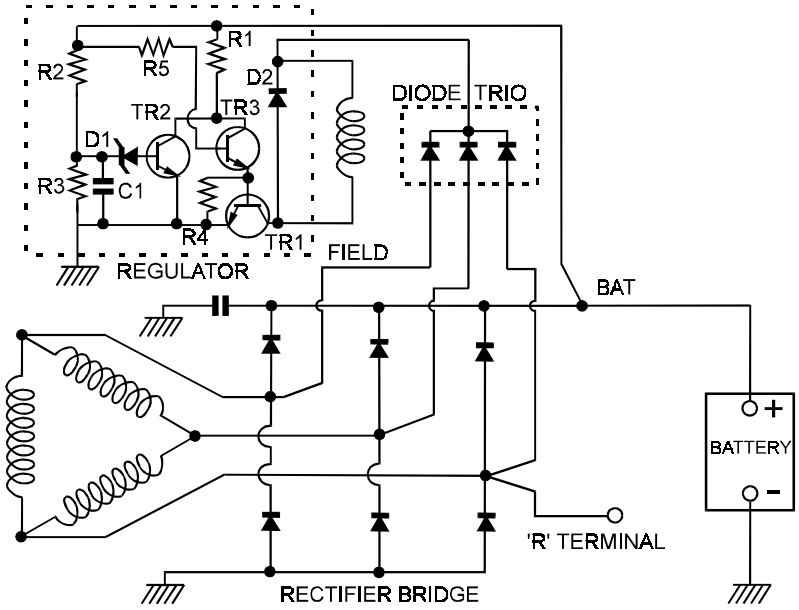


Fig. 8.5. Alternator Wiring Diagram

A wiring diagram is shown in Fig. 8.5. The basic operating principles are explained as follows:

The base-emitter 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 "BAT" 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 "BAT" 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.

7. 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.

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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. 8.7. 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 studs.
5. Connect a voltmeter from "BAT" 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 under heading of "INTEGRAL CHARGING SYSTEM REPAIR".
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 output 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.

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ALTERNATOR

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".

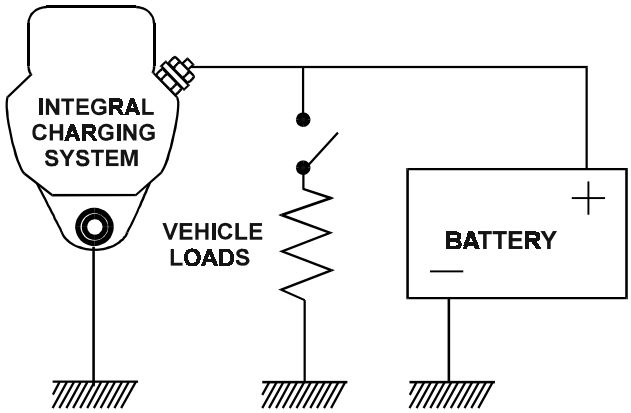


Fig. 8.6. Basic Wiring Diagram

8. INTEGRAL CHARGING SYSTEM REPAIR

Component parts and connections are shown in Fig. 8.7.

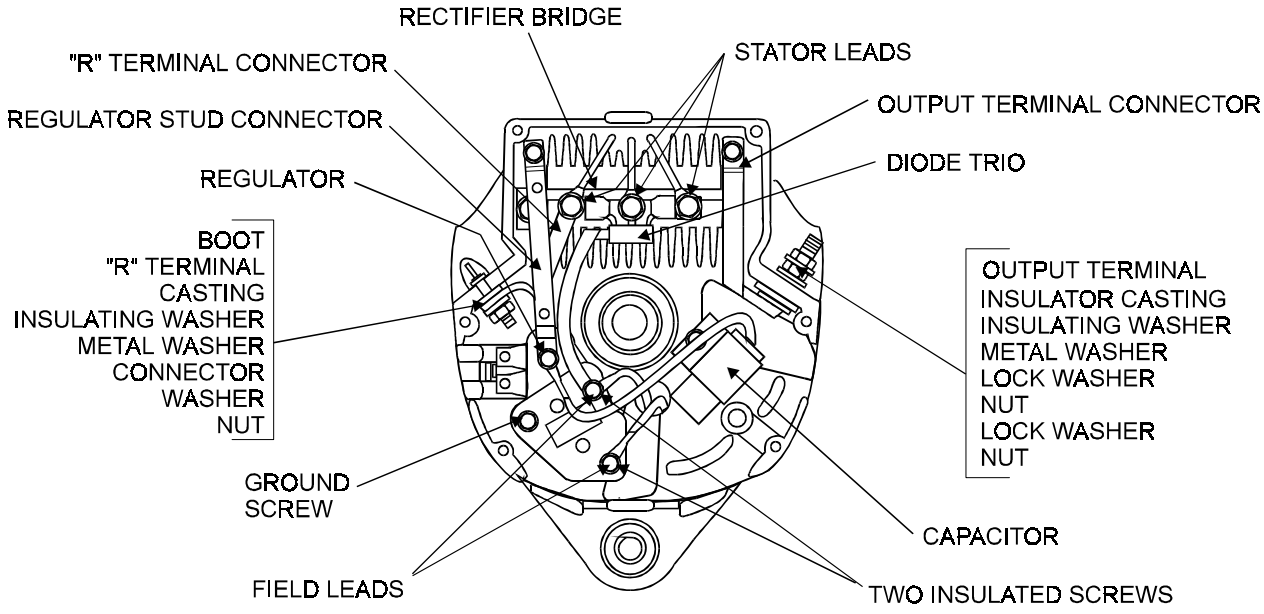


Fig. 8.7. Typical 30-SI Negative Ground

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NOTE: *The diode trio has been removed in Fig. 8.9. along with the end plate. Also that the rectifier end frame has been dipped in clear electric grade varnish.*

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

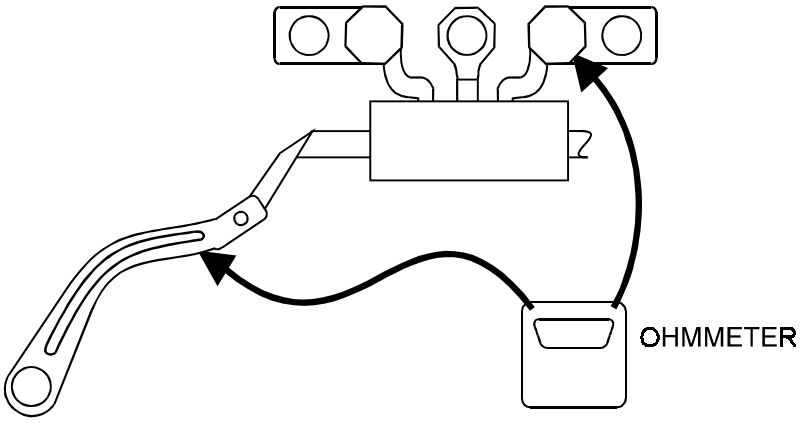


Fig. 8.8. Checking Diode Trio

To check the diode trio, remove it from the end frame assembly by detaching the nuts and attaching screw.

NOTE: *That 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, and using the lowest range scale, to the single connector and to one of the three connectors, (Fig. 8.8). 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

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. 8.8). 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 on each rectifier bridge.

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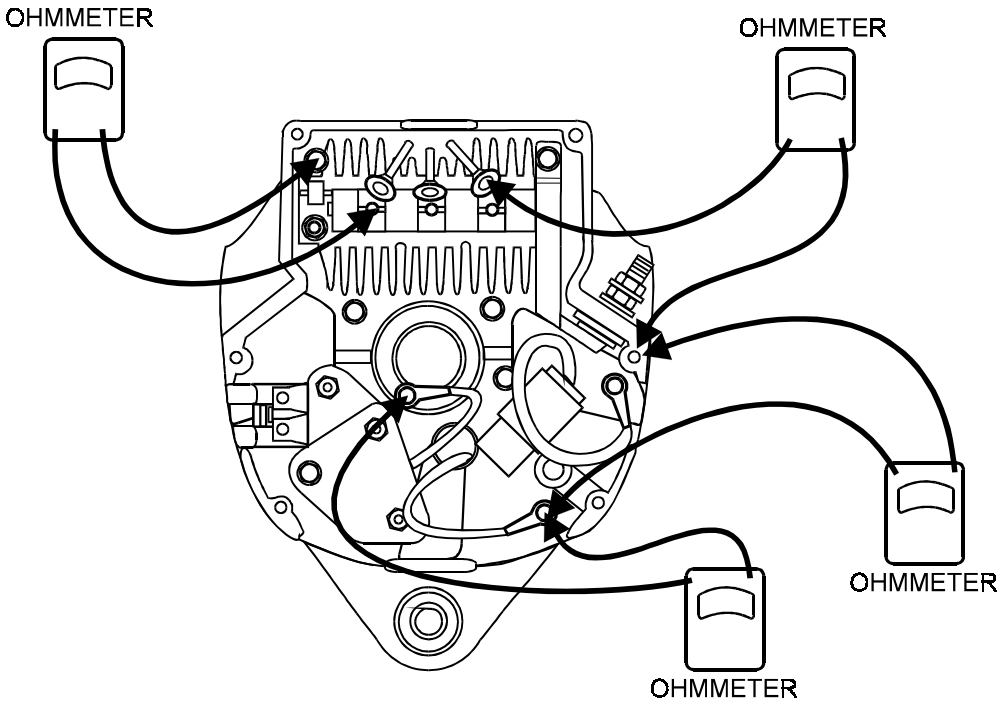


Fig. 8.9. Checking Components

IMPORTANT: *If rectifier bridge is constructed with flat metal clips at the three studs, press down firmly onto flat metal clips and not onto threaded stud.*

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.

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 (2,5-2,8)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. If the resistance reading is below the specified value, the winding is shorted. The specified resistance value is in range (8,5-9,5) Ohms. To replace the field coil, see the section entitled "Disassembly”.

e. Stator checks

Omit for overcharged battery. Most stators are delta wound and only a check for grounds can be mode with an ohmmeter. Connect from either lead to the frame (Step 4, Fig. 8.9). The reading should be infinite. If not, replace the stator. Refer to Par. ”Disassembly”. If the regulator checks good and if the alternator fails to supply rated output, replace the stator if it is badly discolored.

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f. Disassembly (Fig. 8.10)

1. Remove screws (2) and rear cover (1).
2. Remove fan (39) and pulley.
3. Remove 4 thru-bolts (36).
4. Separate Drive End frame (34) and rotor (30) from Housing rectifier (7) and stator (23).
5. Press rotor (30) from end frame (34).
6. Remove collar (32) from rotor shaft (30).
7. To replace Drive End frame bearing (33):
   a. Remove four screws (35) attaching bearing retainer (31).
   b. Remove bearing retainer (31).
   c. Push on inner race to remove bearing (33).
   d. Press in new bearing (33) against outer race.
   e. Assemble bearing retainer (31) with screws (35).
   f. Assemble inside collar (32) over shaft.
   g. Press rotor (30) into drive end frame (34).
8. To replace Rectifier End Frame (7) bearing:
   a. Pull bearing cone (8) from shaft and bearing cup (4) from housing rectifier (7)
   b. Assemble new bearing cone (8) and bearing cup as shown in Fig. 8.4. with bearing seal away from grease reservoir.
   c. Use Delco Remy Lubricant Part No. 1948791 and fill reservoir half full. Arrange lubricant so a portion will touch bearing when assembled.
9. To replace field coil (26):
   a. Remove attaching bolts.
   b. Install new field coil (26) and torque bolts to 6 Nm.

Legend for Fig. 8.10

1. Rear Cover
2. Screw & Lock Washer
3. Cap
4. Bearing Cup
5. Bushing
6. Plug
7. Hsg. Rectifier
8. Bearing Cone
9. Rect. Bridge
10. Screw
11. Washer
12. Diode Trio
13. Relay Terminal Pkg.
13A. Connector
14. Connector
15. Connector
16. Screw
17. Nut
18. Output Terminal Pkg.
19. Voltage Regulator
20. Screw & Washer
22. Capacitor & Bracket
23. Stator
25. Grommet
26. Field Coil Asm.
27. Screw
28. Ground Screw Terminal
29. Lock Washer
30. Rotor Asm.
31. Bearing Retainer
32. Collar
33. Bearing
34. Frame
35. Screw
36. Bolt
37. Nut
38. Washer
39. Fan

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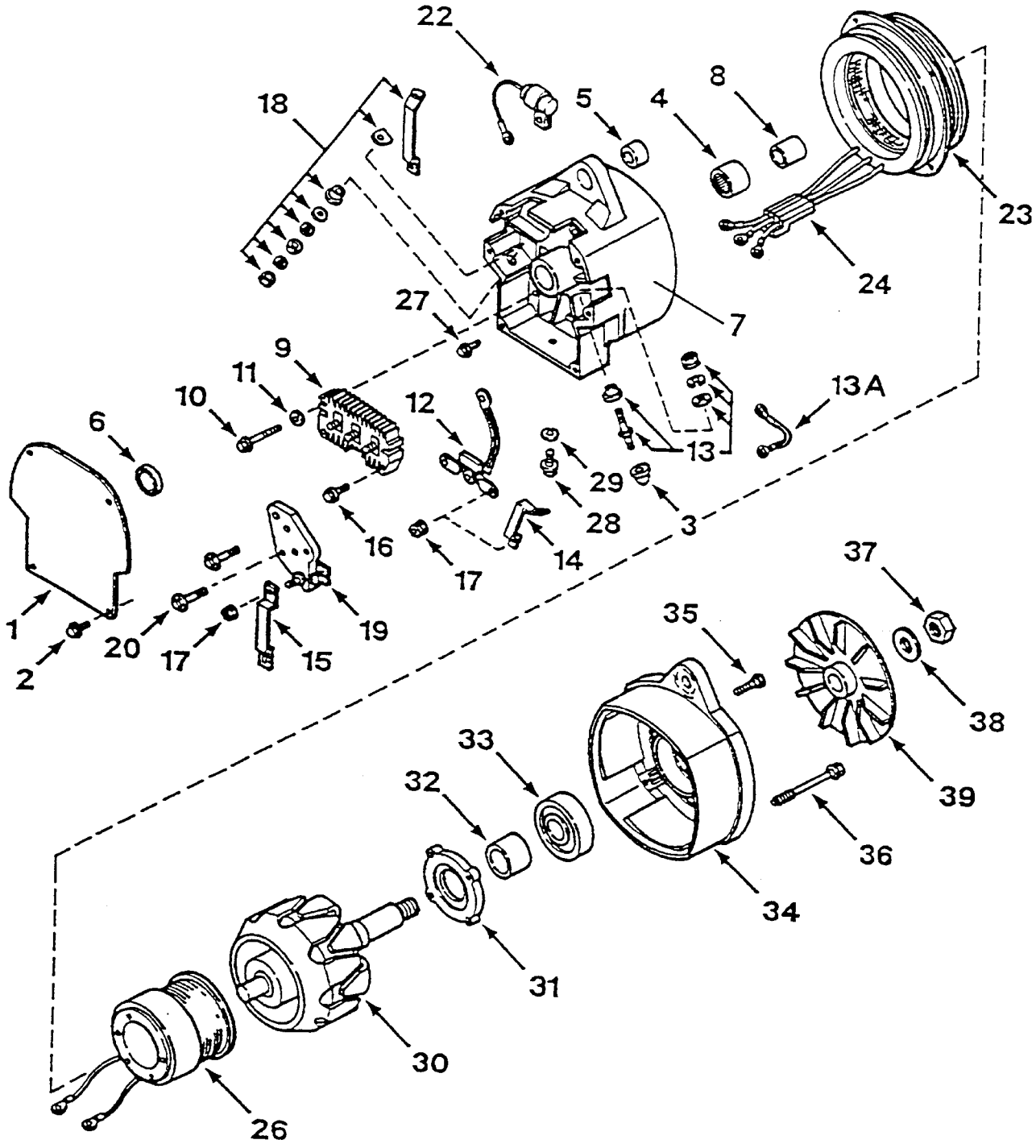


Fig. 8.10. Exploded View of Alternator

g. Reassembly

After reassembly, before attaching rear cover, dip housing rectifier about 25 mm deep into clear electric grade varnish, or use spray can, to restore assembly to new condition.

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ELECTRICAL

BATTERY

9. 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.

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.

10. 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.

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BATTERY

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).

11. 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.

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

b. 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.

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

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ELECTRICAL

BATTERY

12. 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.

1. If the stabilized open circuit voltage is below 12.2 volts, charge the battery as described under BATTERY CHARGING until an open circuit voltage of at least 12.4V 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. f 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 load test leads to the terminals and applying a load 475A equal to 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 Step c.
4. If the stabilized voltage of the battery was 12.4 or above when it was first examined, proceed to Step c.

c. Load procedure

IMPORTANT*: This procedure is valid only if the battery is at or above the state of charge specified in Step b.*

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 equal 475A to 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".

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BATTERY

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 receiver 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.

13. BATTERY CHARGING GUIDE

Recommended Rate and Time for Fully Discharged Condition

Rated Battery Capacity	Charge	
Above 170 to 250 Minutes	3.5 hrs. @ 30 Amperes	4 hrs. @ 25 Amperes
	5 hrs @ 20 Amperes	6.5 hrs. @ 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.

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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.

14. 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.

Batteries in stock should be recharged when the stabilized voltage falls to 12.2 volts 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 it should be recharged before installation.

15. BATTERY PRIMARY RATINGS

Batteries are rated to perform in accordance with the COLD CRANKING PERFORMANCE and RESERVE CAPACITY ratings.

a. Cold cranking performance
   The Cold Cranking Performance is designated as the discharge load in amperes which a battery at -18°C can deliver for 30 seconds and maintain a voltage of 1.2 volts per cell or higher.
b. Reserve capacity
   The Reserve Capacity Rating is the number of minutes a new fully charged battery at 26.7°C can be discharged at 25 amperes to an out point of 10.5 volts.

16. COLD ENGINE CRANKING PERFORMANCE

Effect of temperature and oil viscosity on ENGINE CRANKING PERFORMANCE

a. 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%.
b. 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.

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17. DRY CHARGE ACTIVATION

a. Before attempting to activate a battery, read and understand the Safety Precautions in this chapter.
b. Battery and acid must be at a temperature of 15°C to 38°C at time of filling.
c. Remove the plugs and fill each cell to level 21-27 mm above the top edge plates. Electrolyte gravity should be 1.265 ± 0.005 at temperature 27°C.
d. 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.
e. Charge battery no more than 7A for 30 minutes. Battery is ready if specific gravity is 1.250 or more at temperature 15.5°C
f. Check electrolyte level and add destillated water if need.
g. 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 volts this indicates a reverse cell, an "open" circuit or a shorted cell, and the battery should be replaced.

18. TYPICAL CAUSE OF BATTERY FAILURE

a. Is the battery being used in the application for which it was designed.
b. Does the hold-down hardware fit the battery properly.
c. 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.
d. 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.
e. 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.
f. 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.

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19. 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.

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.

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CRANKING MOTOR

20. SPECIFICATIONS

Manufacturer type . . . . . Delco Remy 50 MT
Maximum power . . . . . 13 KM
Supply voltage . . . . . 24 V
Noise housing bolts torque . . . . . .190-250 Nm

21. INTRODUCTION

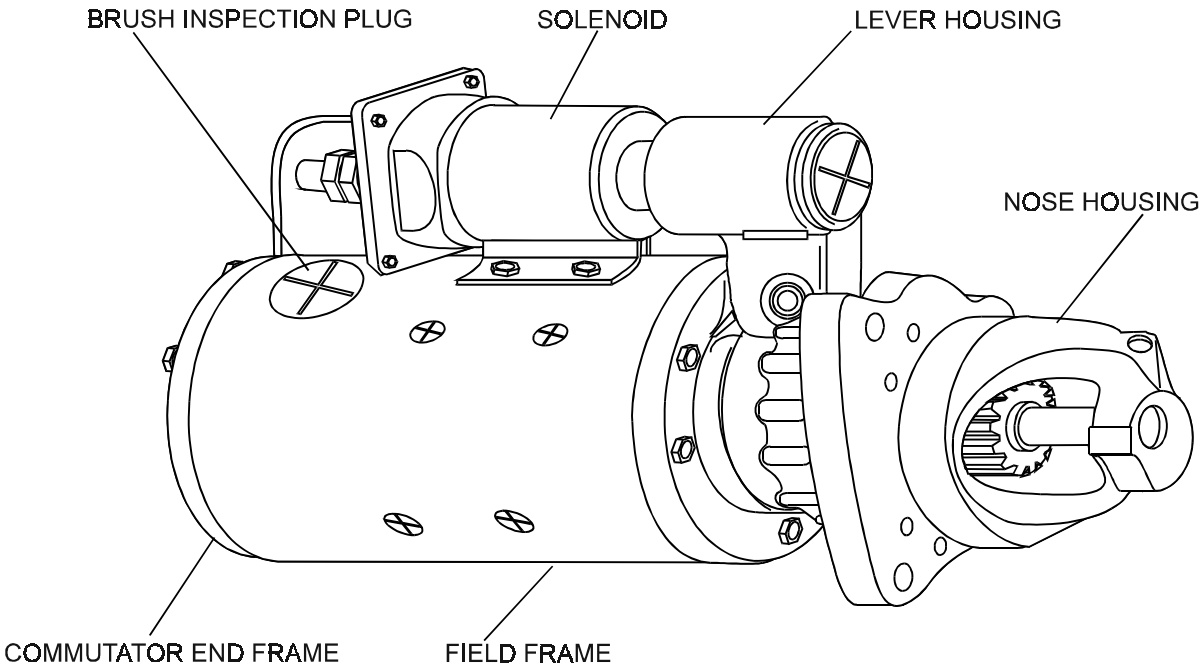


Fig. 8.11. View of Cranking Motor

Heavy duty cranking motors have a shift lever and solenoid plunger that are totally enclosed to protect them from exposure to dirt, icing conditions and splash. The nose housing can be rotated to obtain a number of different solenoid positions with respect to the mounting flange.

Lubrication is provided to the sintered bronze bushings by an oil saturated wick. Oil can be added to each wick by removing an oil reservoir cup which is accessible on the outside of the motor.

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. 8.12, 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 frame are attached to the field frame independently by bolts entering threaded holes in the field frame.

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22. OPERATION

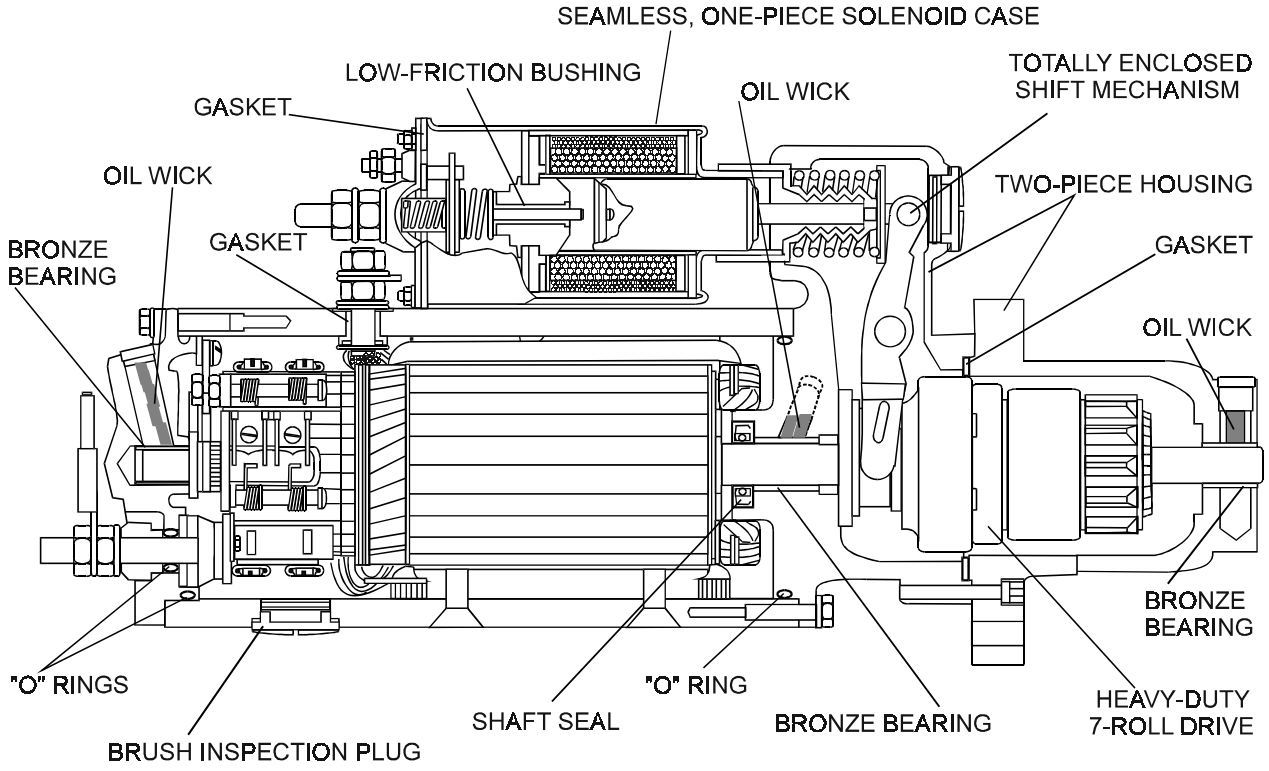


Fig. 8.12. Cross-Sectional View

NOTE: *the starting circuit was explained in WIRING DIAGRAMS par 2 "Electrical Leader System"*

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.

23. 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 Par. "BATTERY". Insure that the battery is fully charged. The wiring, switches, and cranking motor cannot be checked if the battery is defective or discharged.

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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.

b. Magnetic Switch, Solenoid and Control Switches:

Inspect all switches to determine their condition. From the "Electrical Loader Diagram" determine which circuits should be energized with the starting switches closed. Use a voltmeter to detect any open circuits.

c. 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.

d. No-Load Test (Fig. 8.13)

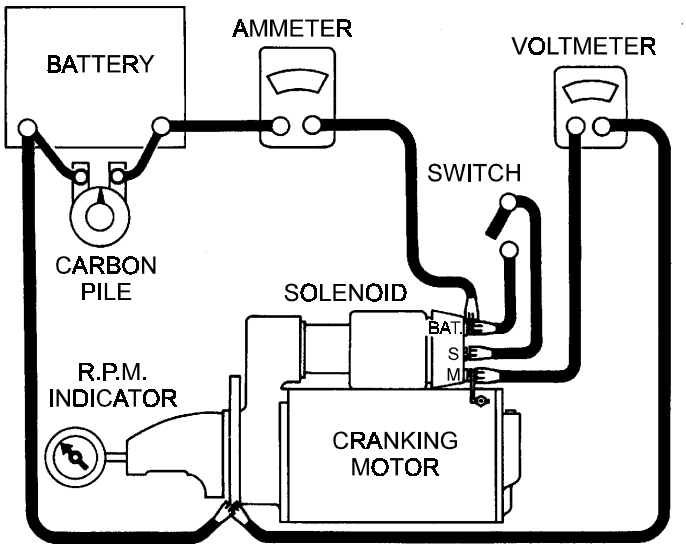


Fig. 8.13. No-load Test Circuit

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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 Service Bulletins 1M-188. It is not necessary to obtain the exact voltage specified in these bulletins, 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:

e. 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).
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 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.

f. 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.

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2. Disconnect field coil connector from solenoid motor terminal, and lead from solenoid ground terminal.
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.

g. 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.

h. 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.

k. 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. The insulation should then be undercut 0.8 mm (1/32 of an inch) wide and 0.8 mm (1/32 of an inch) deep, and the slots cleaned out to remove any trace of dirt or copper dust. As a final step in this procedure, the commutator should be sanded lightly with No. 00 sandpaper to remove any burrs left as a result of the undercutting procedure.

The armature should be checked for opens, short circuits and grounds as follows:

l. 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. The insulation should then be undercut except as noted above.

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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.

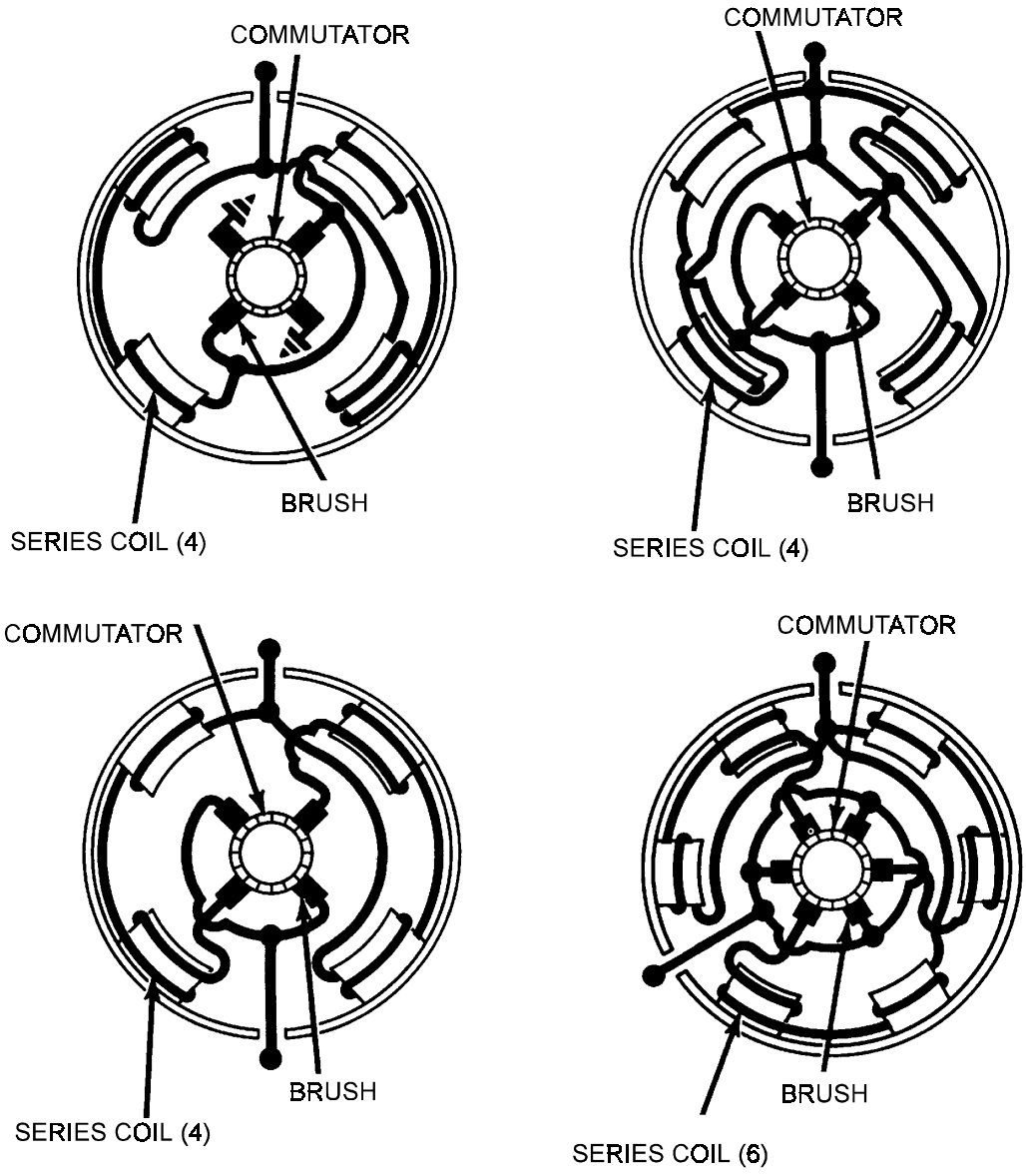


Fig. 8.14. Internal Motor Circuits

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.

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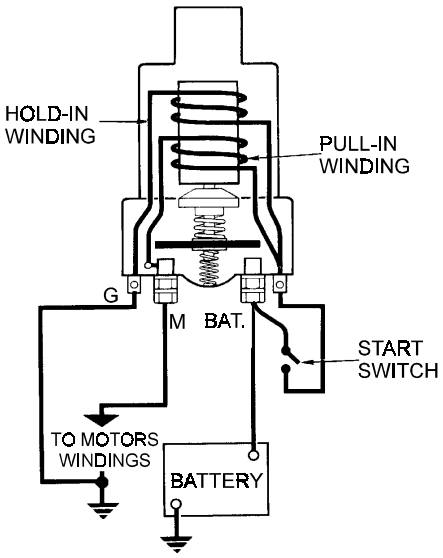


Fig. 8.15. Internal Solenoid Circuit ("G" and "S" Terminals Moved to Clarify Illustration)

m. Field Coil Checks

The various types of circuits used are shown in the wiring diagrams of Fig. 8.14. 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.

n. 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.

o. Solenoid Checks

A basic solenoid circuit is shown in Fig. 8.15. Solenoids may differ in appearance but can be checked electrically by connecting a battery of 24 V a switch, and an ammeter to the two solenoid windings. With all leads disconnected from the solenoid, make test connections as shown to the solenoid switch terminal and to the second switch terminal, (G), to check the hold-in winding (Fig. 8.16). Use the carbon pile to decrease the battery voltage to the value specified in Service Bulletin IS-188 and compare the ammeter reading with specifications. A high reading indicates a shorted hold-in winding, and a low reading excessive resistance. To check the pull-in winding connect from the solenoid switch terminal (S) to the solenoid motor (M or MTR) terminal (Fig. 8.17).

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To check for grounds, move battery lead from "G" (Fig. 8.16) and from "MTR"(Fig. 8.17) to solenoid case, (not shown). Ammeter should read zero. If not, winding is grounded.

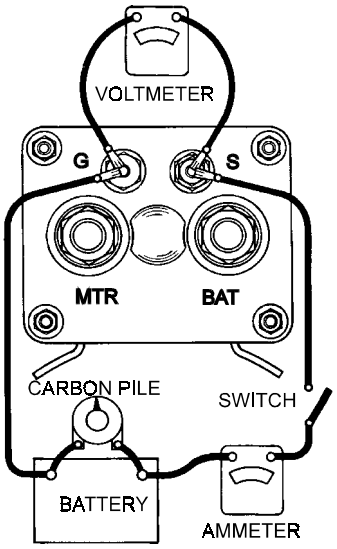


Fig. 8.16. Checking Solenoid Hold-in Winding

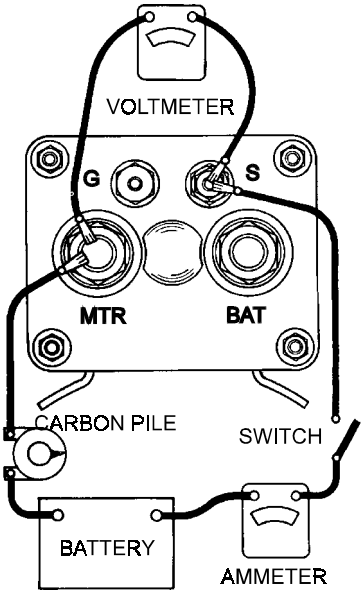


Fig. 8.17. Checking Solenoid Pull-in Winding

NOTE: *If needed to reduce the voltage to the specified valve, connect the carbon pile between the battery and the "MTR" terminal as shown. If the carbon pile is not needed, connect a jumper directly from the battery to the "MTR" terminal.*

WARNING! To prevent overheating, do not leave the pull-in winding energized more than 15 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.

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p. Reassembly

To reassemble the end frame with brushes onto the field frame, pull the armature out of the field frame just far enough to permit the brushes to be placed over the commutator. Then push the commutator end frame and the armature back against the field frame.

r. Lubrication

All bearings, wicks and oil reservoirs should be saturated with SAE No. 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.

Before pressing the bearing into place, dip it in SAE No. 20 oil. Also, tangent wicks (if present) 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.

s. Pinion Clearance

To check pinion or drive clearance follow the steps listed below.

1. Make connections as shown in Fig. 8.18.
2. Momentarily flash a jumper lead from terminal G to terminal MTR. Fig. 8.18. 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. 8.19).
5. Adjust clearance by removing plug and turning shaft nut (Fig. 8.19).

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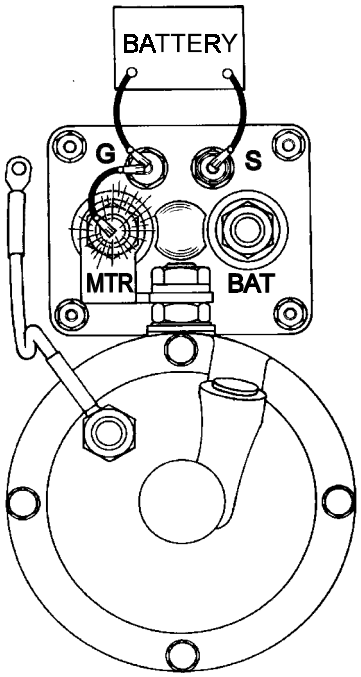


Fig. 8.18. Checking Pinion Clearance Circuit

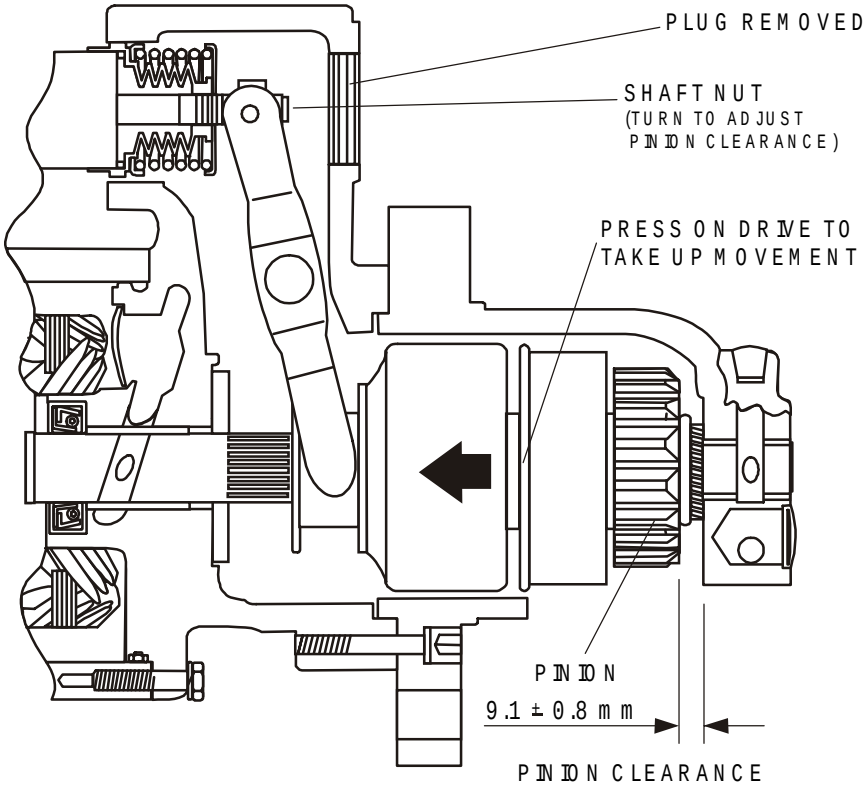


Fig. 8.19. Measuring Pinion Clearance

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FRAME

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FRAME

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1. DESCRIPTION AND OPERATION

The chassis of the machine is basically two frames witch articulate at their center connection. The front frame provides the mount for the operator's cab, controls and front axle. The rear frame provides the mounting for the engine, radiator, torque converter, transmission, rear axle and hydraulic system reservoir.

The front and rear frames are each composed of many smaller items welded together to form a single rigid assembly. The two frame sections are connected at their hinge points by a pin and bearing assembly.

In addition to their center hinge pins, the outside edges of the frame sections are linked together by a pair of steering cylinders. As one cylinder extends, the opposite contracts, pivoting the frame sections on the hinge pins and steering the machine. This type of articulated steering has definite advantages, it eliminates the need of a steering axle with its additional parts, eliminates the drag link and tie rod, and allows the rear wheels to track in the path of the front wheels. This latter item insures a much shorter turning radius than that afforded by the more conventional rigid frame and steering axle type.

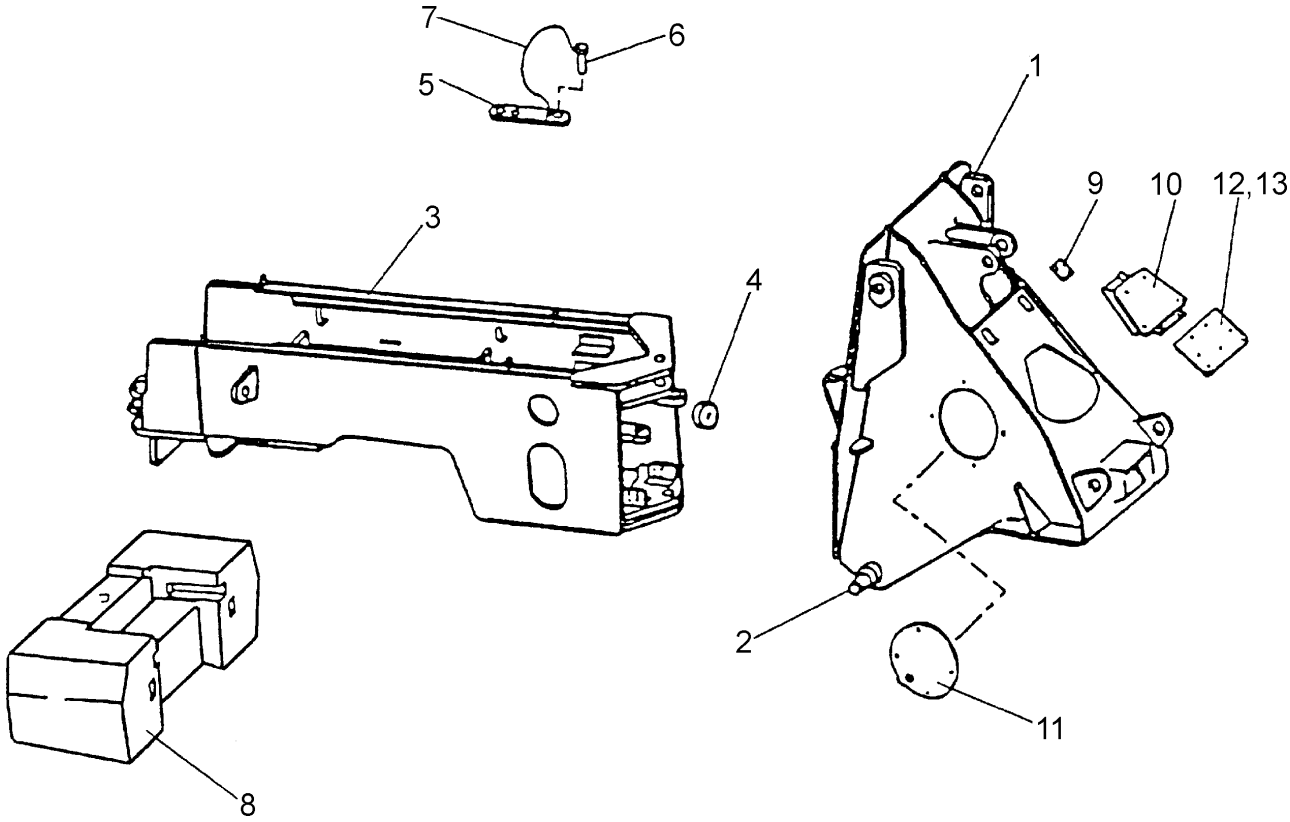


Fig. 9.1. View of Frames

1. Front Frame
2. Shaft
3. Rear Frame
4. Bumper
5. Frame Locking Bar
6. Pin
7. Cable
8. Counter Weight
9. Cover
10. Support
11. Cover
12. Cover
13. Cover

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2. SPECIFICATIONS

Special Torques

Upper Hinge:
- Bearing Retainer Plate Bolts:
  - Initial and Intermediate . . . . . 30 Nm
  - Final (Loctite 262 applied) . . . . . 220 Nm
- Retainer Plate to Frame Bolts (Loctite 262 applied) . . . . . 220 Nm
- Retainer Plate to Hinge Pin Bolts (Loctite 262 applied) . . . . . 380 Nm

Lower Hinge:
- Bearing Retainer Plate Bolts:
  - Initial . . . . . 70 Nm
  - Intermediate . . . . . 30 Nm
  - Final (Loctite 262 applied) . . . . . 220 Nm
- Retainer Plate to Frame Bolts (Loctite 262 applied) . . . . . 220 Nm
- Retainer Plate to Hinge Pin Bolts:
  - Initial . . . . . 380 Nm
  - Intermediate . . . . . 135 Nm
  - Final (Loctite 262 applied) . . . . . 380 Nm

Steering Linkage Bellcrank Lever to Linkage Rod . . . . . 110 Nm
Steering Cylinder Pin Mounting Bolts . . . . . 270 Nm

Tolerances:

Maximum Permissible Vertical Movement:
- Between Front and Rear Frames . . . . . 0.13 mm

3. 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 hinge pin assemblies being sure they are properly centered and seals and bearings are in good condition.
To keep rust and corrosion to a minimum, periodic painting of abrasions and bare metal is recommended.

4. 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.

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Any repair welding performed on the front and rear frames must be classified as a critical weld. Special attention must be given to the size, strength and surface quality of the repair. For the technique required to produce successful repairs it is recommended that the manual entitled ”WELDING MAINTENANCE” from SM-WELD-1 be obtained.

5. CHECKING HINGE VERTICAL MOVEMENT

1. Position the machine on a fairly level piece of ground.
2. Place the boom control lever in ”Float” so that the bucket rests squarely on the ground. If the machine is not equipped with a bucket, rest the lower boom ends on blocks.
3. Install the locking bar between frame halves with the frames in a straight ahead position.
4. Position a dial indicator with its base on the front frame and the indicator on the rear frame, as near to the centerline of the machine as possible. Set the dial indicator at zero.
5. Start the engine and power the booms down until the front tires are raised off the ground. Read the dial indicator and record the reading.
6. Raise the boom to a height of about 1 m off the ground. Read the dial indicator and record reading. Lower the boom to the rest [position and turn off the engine.
7. The total vertical movement as shown by the dial indicator readings should not exceed 0.13 mm.
8. If the total vertical movement exceeds 0.13 mm, remove the retainer plate (10, Fig. 9.6) from the lower hinge, remove shims (9) between the retainer plate and frame and reinstall the retainer plate. Apply Loctite 262 and torque the retainer plate to frame bolts (11) to 220 Nm and retainer plate to hinge pin bolts (12) to 380 Nm.
9. Recheck the vertical movement and, if necessary, remove additional shims (9, Fig. 9.6) until vertical movement is within specifications. If vertical movement still exceeds 0.13 mm with all shims removed, separate the machine halves and check the shims in the lower hinge bearing assembly as described in this section. If vertical movement cannot be brought within specification, contact your Local Authorized Distributor.

6. DISASSEMBLY



WARNING! Before servicing the machine, be sure the engine is off, the bucket is lowered, the transmission shift lever is locked in neutral (N), the parking brake is on and the key is removed from master switch and starting switch. To hoist the warning plate in cab.

IMPORTANT: *The machine weights over 39230 kg. Adequate lifting and blocking equipment must be available before beginning this procedure.*

1. Position the machine in the straight ahead position on level ground under a hoist capable of supporting the rear portion of the rear frame when separated from the front frame. If a floor support is used for the rear frame, it must be such that the rear frame can be moved from the front frame at least a couple of feet. Clearance between frames is needed to remove the bearings from the frame. Block the front frame up so it will drop once unpinned from the rear frame.

NOTE: *Both sides of the rear frame must be supported to prevent the frame from pivoting on the bolster and axle.*

2. Drain the hydraulic reservoir. Refer to the OPERATOR’S MANUAL for this procedure.

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3. Remove the transfer drive to transmission drive shaft which passes directly over the lower hinge. Refer to SECTION 7D, for procedure.
4. Disconnect the steering cylinder hoses (4, Fig 9.2) from the bracket (3) so the cylinders can remain with the front frame.
5. Disconnect the transmission control cables (2, Fig. 9.2) at the control valve on the transmission. Free these cables from the bracket (1). Next, free these cables from the clamp (7, Fig. 9.4). Pull both cables from the rear frame and bring them forward to come off with the front frame.

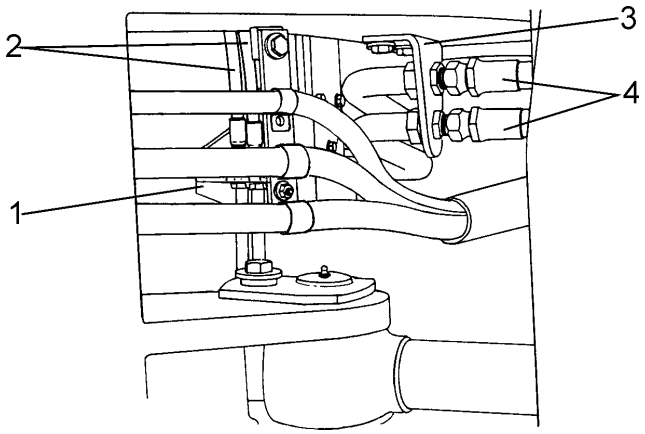


Fig. 9.2. Frame Disconnect Points
(R.H. side of hinge area shown)

1. Cable Support Bracket
2. Transmissions Control Cables
3. Hose Support Bracket
4. Steering Cylinder Hoses

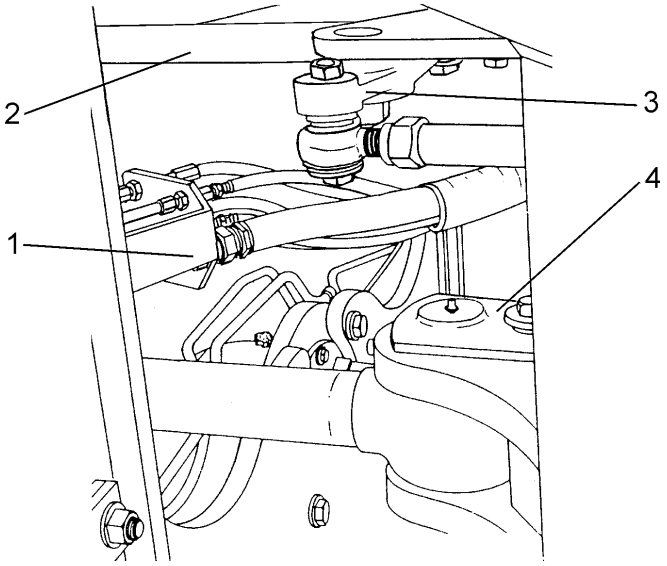


Fig. 9.3. Frame Disconnect Points
(L.H. side of hinge area shown)

1. Hose Support Bracket
2. Steering Linkage Rod
3. Steering Linkage Bellcrank
4. Cylinder Locking Pin

6. Remove the mounting hardware and locking pin (4, Fig. 9.3) securing each steering cylinder to the rear frame and free the cylinder rod from the frame.

NOTE: *Install a sling around each steering cylinder and secure it to the front frame to provide support.*

7. Disconnect the hoses at the support bracket (1, Fig.9.3) to allow them to come off with the rear frame.
8. Disconnect the steering linkage rod (2, Fig.9.3) at the bellcrank lever (3). Support the rod in the front frame to prevent damage.
9. Remove the accelerator pedal cable clamp (3, Fig. 9.4) from the hoses manifold (5) and from the bottom of the hydraulic reservoir. The cable (1) is strapped at few points, but there should be enough flexibility so they do not have to be disconnected if the frames are only to be separated enough to service the hinge assembly.

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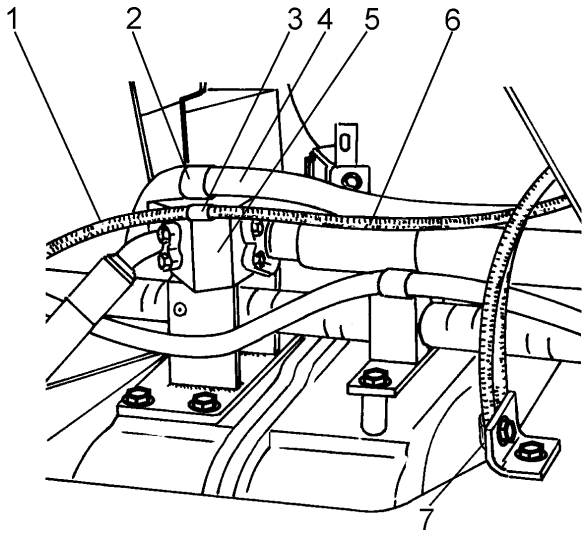


Fig. 9.4. Frame Disconnect Points

1. Accelerator Pedal Cable
2. Electrical Harness Clamp
3. Cable Clamp
4. Electrical Harness
5. Manifold
6. Loader Pilot Valve Return Hose
7. Cable Clamp

10. Disconnect the hose (6, Fig. 9.4) from the bracket on the hose support mounted to the front frame to allow the hose to stay with the rear frame.
11. Disconnect the hose (1, Fig. 9.5) at the manifold (4). Disconnect the hose (2) at the hydraulic reservoir and remove the clamp (3) securing the hose to the manifold (4). Both hoses will remain with the front frame. To provide clearance for removal of the top hinge pin, free the hoses from the clamps (8) and chain the hoses up put of the way to the front frame.
12. Close the two shut off valves for the heater hoses (5, Fig. 9.5) located on the left hand side of the machine. Free the heater hoses from the hose clamps (7 and 6). Disconnect the hoses from the heater and position them so they will not ”hang up” as the frames are separated.

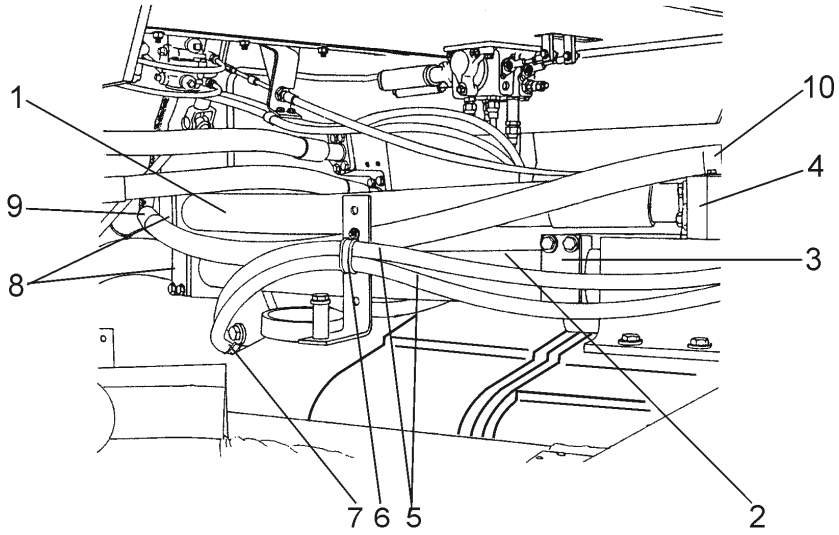


Fig. 9.5. Frame Disconnect Points (Left Side)

1. Loader Control Valve to Manifold Hose
2. Loader Control Valve to Reservoir Hose
3. Hose Clamp
4. Manifold
5. Heater Hoses
6. Hose Clamp
7. Hose Clamp
8. Hose Clamps
9. Electrical Harness Clamp
10. Electrical Harness Clamp

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13. If the frames are only to be separated enough to service the hinge assembly, the electrical harness crossing the articulation point should not have to be disconnected. To provide sufficient flexibility for movement, free the harness clamps (9 and 10, Fig 9.5) and the clamp behind the steering valve on inside of L.H. frame.
14. Remove the hardware securing the lower hinge pin retainer plate (10, Fig. 9.6) to the rear frame and pin. Remove the retainer plate (10) and shims (9). Remove the spacer (4) from the frame if it does not come loose when the retainer plate is removed.
15. Remove the hardware securing the retainer plate (10, Fig. 9.7) to the pin (1). Remove the retainer plate (10). Remove the hardware securing the upper hinge pin retainer plate (6) to the rear frame and pin. Remove the upper pin (1, Fig. 9.7) with retainer plate and lower pin (1, Fig.9.6). Move the rear frame away from the front frame being careful that the spacer (2, Fig. 9.6) in the front frame lower hinge clears the rear frame.

NOTE: *As the frames are separated, observe the electrical harness and the accelerator pedal cable for tension.*

16. Remove the spacers (7 and 9, Fig. 9.7) from the rear frame.

Lower Hinge Bearing (Refer to Fig. 9.6)

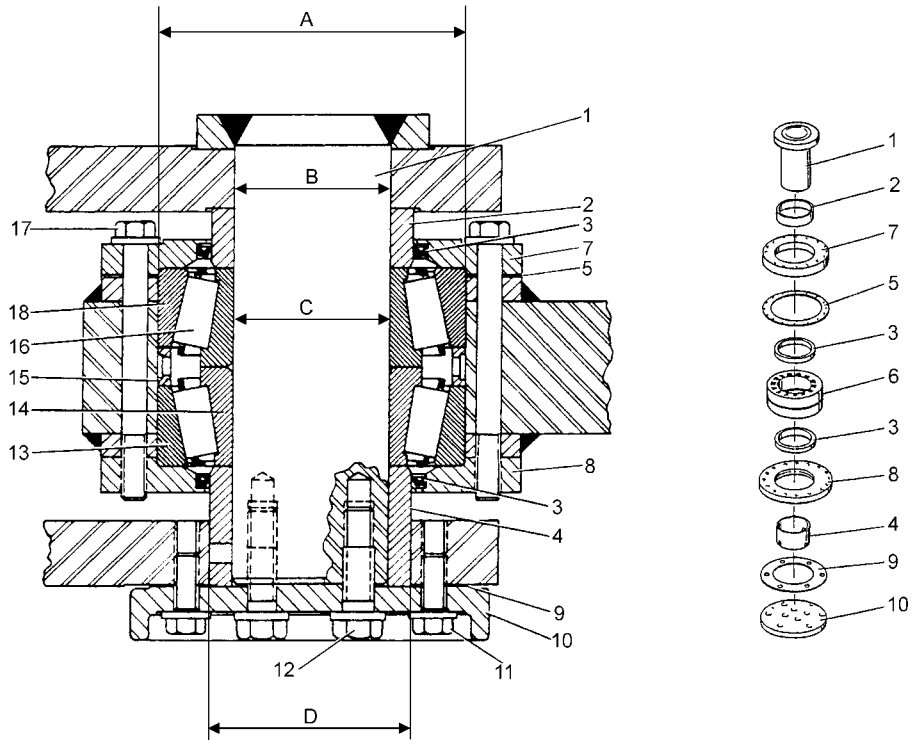


Fig. 9.6. Lower Hinge Assembly

1. Pin	7. Retainer Plate	13. Bearing Cup
2. Spacer	8. Retainer Plate	14. Bearing Cone
3. Oil Seal	9. Shims	15. Bearing Spacer
4. Spacer	10. Retainer Plate	16. Bearing Cone
5. Shims	11. Bolts	17. Bolts
6. Bearing Assembly	12. Bolts	18. Bearing Cup

A Front Frame Bearing Bore Diameter . . . . . ∅ 212.62 + 0.05
B Rear Frame Pin Bore Diameter . . . . ∅ 107.95 + 0.05
C Pin Diameter . . . . . ∅ 107.90 – 0.05
D Rear Frame Spacer Bore Diameter . . . . . ∅ 139.80 + 0.05

17. Remove the spacer (2, Fig. 9.6). Remove the bolts (17) and washers securing the retainer plates (7 and 8) together. Remove the retainer plates with oil seals (3) and the shims (5) from

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the front frame. Remove and discard the oil seals. Press the complete bearing assembly from the front frame.

IMPORTANT: *To prevent damage to the bearing assembly, press only on the bearing cup using a suitable driver.*

Upper Hinge Bearing (Refer to Fig. 9.7)

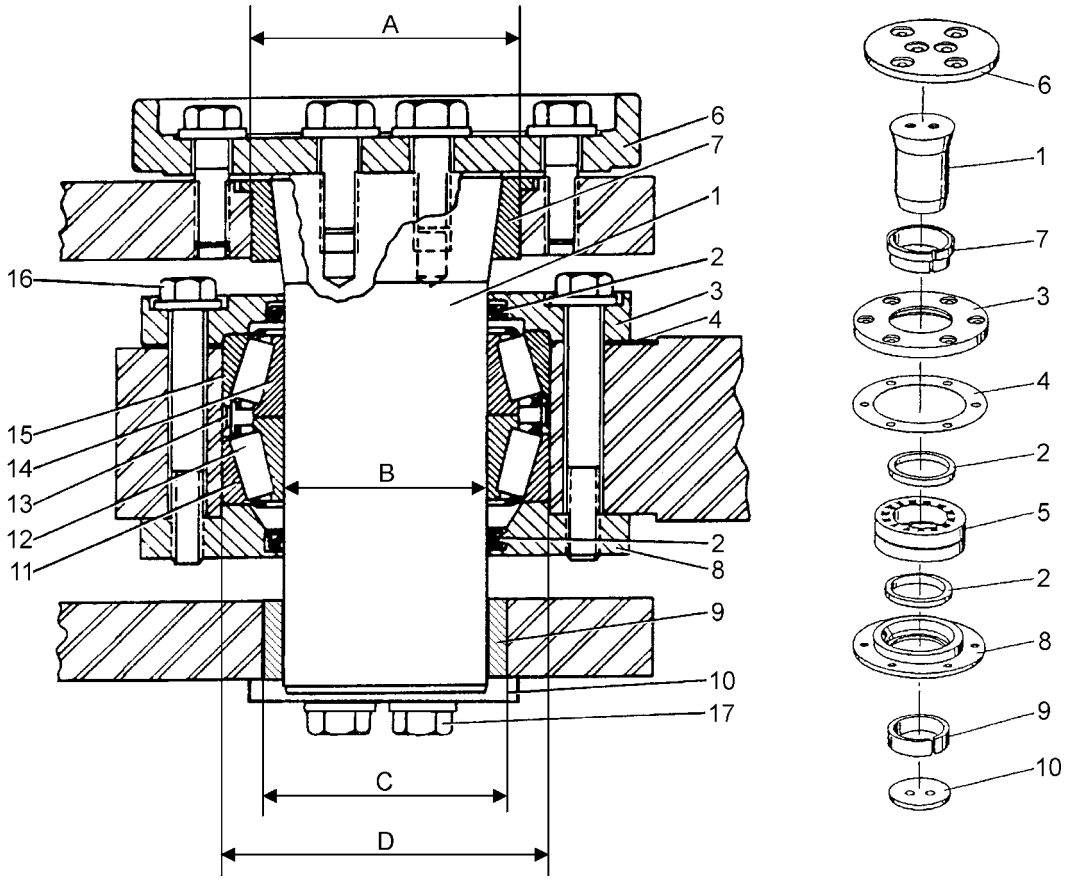


Fig. 9.7. Upper Hinge Assembly

1. Pin
2. Oil Seal
3. Retainer Plate
4. Shims
5. Bearing Assembly
6. Retainer Plate
7. Spacer
8. Retainer Plate
9. Spacer
10. Retainer Plate
11. Bearing Cup
12. Bearing Cone
13. Bearing Spacer
14. Bearing Cone
15. Bearing Cup
16. Bolts
17. Bolts

A Rear Frame Spacer Bore Diameter . . . . . ∅ 132.10 ± 0.05
B Pin Diameter . . . . . ∅ 99.920 – 0.05C
Rear Frame Spacer Bore Diameter . . . . . ∅ 110.08 – 0.05
D Front Frame Bearing Bore Diameter . . . . . ∅ 159.87 + 0.05

18. Remove the bolts (16, Fig. 9.7) and washers securing the retainer plates (3 and 8) together. Remove the retainer plates with oil seals (2) and the shims (4) from the front frame. Remove and discard the oil seals. Press the complete bearing assembly from the front frame.

IMPORTANT: *To prevent damage to the bearing assembly, press only on the bearing cup using a suitable driver.*

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7. INSPECTION AND REPAIR

1. It is recommended that all new seals and bearings be installed when the frames are disassembled.
2. Wash all parts in a suitable solvent and air dry. Lubricate machined surfaces of usable parts to protect them.
3. Inspect the spacer for wear and replace if necessary.
4. Check all parts 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 or other damage.
6. Inspect tapped holes for damaged threads.
7. Check dimension of bores in lower and upper hinge frames.
8. Check dimension of the lower and upper pin.

8. REASSEMBLY

Lower Hinge Bearing (Refer to Fig. 9.6)

1. Install new seals (3) into the retainer plates (7 and 8) so that when the retainers are in position on the front frame, the seals lips will be facing up.
2. Seat the bearing cup (13) into the retainer plate (8) until it bottoms.
3. Install the retainer plate with bearing cup into the front frame bore until the retainer plate is finally seated against the frame.
4. Install the lower bearing cone (14), bearing spacer (15) and upper bearing cone (16) in position in the frame.
5. Prevent the retainer plate (8) from moving and press the upper bearing cup (18) into the frame bore. No gap must exist between the bearing cones.
6. Position the top retainer plate (7) in the bore and install bolts (17). Torque the bolts to 70 Nm to seat the bearings. Release the torque and retorque to 30 Nm.
7. Using a feeler gauge, measure the gap between the frame and the top retainer plate (7) in four places. Average the results. Make up a shims (5) to the average measured gap minus 0.075 to 0.18 mm. The size of the shims should not exceed any one measured reading. Measure the shims individually when making up the shim pack.
8. Remove the top retainer plate (7) and install the shims (5). Reinstall the retainer plate and secure with the bolts (17) and washer. Apply Loctite 262 to the bolts (17) and torque to 220 Nm.

Upper Hinge Bearing (Refer to Fig. 9.7)

9. Install new seals (2) into the retainer plates (3 and 8) so that when the retainers are in position on the front frame, the seals lips will be facing up.
10. Position the lower bearing cup (11) on the retainer plate (8) and press the retainer and cup into the frame bore until the retainer is fully seated against the frame.
11. Install the lower bearing cone (12), bearing spacer (13) and upper bearing cone (14) in position in the frame.

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12. Prevent the retainer plate (8) from moving and press the upper bearing cup (15) into the frame bore. No gap must exist between the bearing cones.
13. Position the top retainer plate (3) in the bore and install bolts (16). Torque the bolts to 30 Nm to seat the bearings. Release the torque and retorque to 30 Nm once again.
14. Using a feeler gauge, measure the gap between the frame and the top retainer plate (3) in four places. Average the results. Make up a shims (4) to the average measured gap minus 0.075 to 0.18 mm. The size of the shims should not exceed any one measured reading. Measure the shims individually when making up the shim pack.
15. Remove the top retainer plate (3) and install the shims (4). Reinstall the retainer plate and secure with the bolts (16) and washer. Apply Loctite 262 to the bolts (16) and torque to 220 Nm.
16. Install the upper hinge spacer (7) into the rear frame bore until it bottoms.
17. Secure the retainer plate (6) to the upper hinge pin (1). Apply Loctite 262 to the mounting bolts and torque to 380 Nm.

Joining the Frames

18. Position the spacer (2, Fig. 9.6) in the upper retainer of the lower hinge assembly until it bottoms on the bearing cone.
19. Move the rear frame into position with the front frame until alignment for hinge pin installation is achieved. Be careful not to allow rear frame to contact the upper spacer (2, Fig. 9.6) in the lower hinge assembly as frames come together.
20. Install the upper hinge pin with retainer plate attached being sure to align the mounting holes in the retainer plate and frame.
21. Install the lower hinge pin (1, Fig. 9.6). Position the spacer (4, Fig. 9.6) through the frame and lower retainer plate (8). Place the retainer plate (10, Fig. 9.6) in position and install washer and bolts (12) through retainer plate into the pin. Torque bolts to 380 Nm.
22. The spacer (2, Fig. 9.6) must be tight against the rear frame. Using a feeler gauge, check that there is no clearance between the spacer and frame. Loosen the bolts (12, Fig. 9.6) and retorque to 135 Nm being sure the front frame does not move. This can be accomplished by placing a jack under the bottom of the front frame ear.
23. Measure the gap between the retainer plate (10, Fig. 9.6) and the rear frame in three places. Average the results. Make up a shims to the average measured gap less 0.075 to 0.18 mm. The size of the shims should not exceed any one measured reading. Measure the shims individually when making up the shim pack.
24. Remove the retainer plate (10, Fig. 9.6) and install the shims (9). Apply Loctite 262 on the bolts (12) and torque the bolts to 380 Nm. Apply Loctite 262 on the bolts (11) and torque the bolts to 220 Nm. Recheck clearance between the top spacer (2) and the rear frame ear as described in Step 22.
25. Install the bolts which secure the upper hinge pin retainer plate (6, Fig. 9.7) to the frame. Apply Loctite 262 and torque the bolts to 220 Nm. Install the bolts (17) which secure the lower retainer plate (10) to the frame. Apply Loctite 262 and torque the bolts to 220 Nm.
26. Remove the hoist and blocking from the front and rear frames. Secure the electrical harness with the clamps (9 and 10, Fig. 9.5) and also clamp harness to the inside of the L.H. frame behind the steering valve.
27. Route the heater hoses (5, Fig. 9.5) back into position and connect to the heater. Secure the heater hoses with clamps. Secure the hoses at the hinge area with the clamps (6 and 7). Open the two shut off valves on the left hand side of the machine.

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28. Free the loader control valve hoses (1 and 2, Fig. 9.5) from the chain or strap securing them to the front frame. Connect the hose (2) to the hydraulic reservoir and the hose (1) to the manifold (4). Secure the hoses with the clamps (3 and 8).
29. Connect the loader pilot valve return hose (6, Fig. 9.4) to the bracket on the hose support mounted to the front frame. Secure the accelerator pedal cable (1) with the clamp (3) to the manifold (5) and with the clamp to the bottom of the hydraulic reservoir.
30. Connect the steering linkage rod (2, Fig. 9.3) to the bellcrank lever (3). Remove any support that may have been used to prevent the rod from bending while disconnected. Torque the rod nut to 110 Nm. Connect the hoses to the support bracket (1). Secure the steering cylinder on each side of the rear frame with the locking pin (4) and pin mounting hardware. Torque bolts to 270 Nm. Remove the sling used to support the cylinders in the front frame at disassembly.
31. Bring the transmission control cables (2, Fig. 9.2) into position at the control valve on the transmission but do not connect to the valve spool. Secure the cables to the bracket (1) and clamp (7, Fig. 9.4). Connect each cable to the valve spool after moving the spool through the detent positions to determine its final position and placing the control lever in the corresponding position.
32. Connect the steering cylinder hoses (4, Fig. 9.2) to the bracket (3). Install the transfer drive to transmission drive shaft. Refer to SECTION 7D, for procedure. Lubricate the upper and lower hinge bearings. Fill the hydraulic reservoir as described in the OPERATOR'S MANUAL. If the accelerator pedal cable to be disconnected for frame separated refer to SECTION 12, for proper adjustment. Unblock the front frame and take off rear frame support.
33. Start the engine and build up pressure in the hydraulic system. Check the following: machine articulation, hydraulic leakage at the disconnect points performed for frame separation, proper hinge assembly installation (refer to CHECKING HINGE VERTICAL MOVEMENT in this section).

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HYDRAULIC

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HYDRAULICS

SECTION 10

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GENERAL

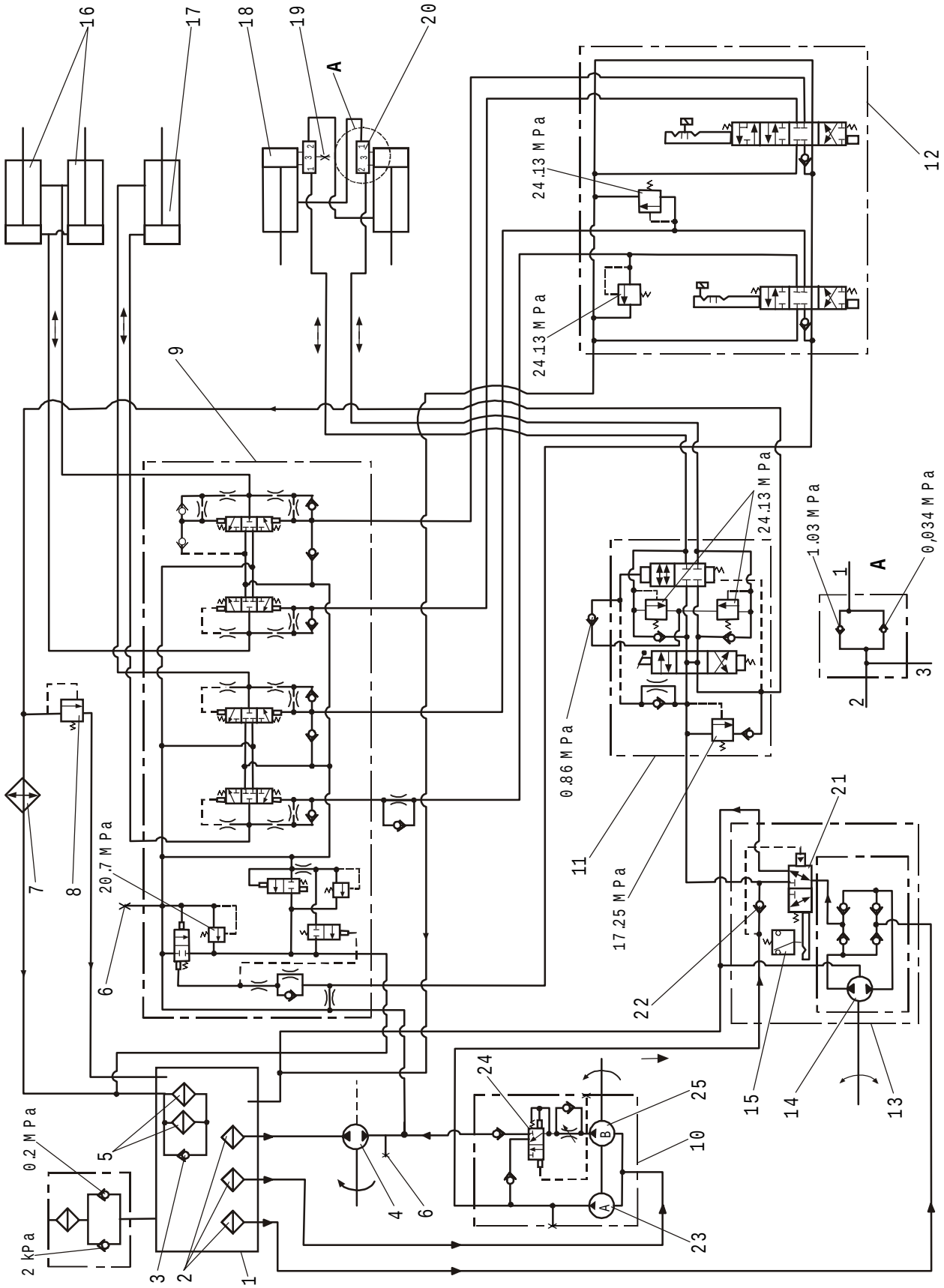


Fig. 10.1. Hydraulic System

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HYDRAULICS

GENERAL

Legend for Fig. 10.1

1. Hydraulic Reservoir
2. Strainers
3. Bypass Valve
4. Hydraulic Pump
5. Return Filters
6. Quick Disconnect
7. Oil Cooler
8. Surge Valve
9. Hydraulic Control Valve
10. Steering / Switch Pump
11. Steering Valve
12. Pilot Control Valve
13. Ground Driven Steering System (If equipped)
14. Ground Driven Steering Pump (If equipped)
15. Warning Light Switch
16. Boom Cylinders
17. Bucket Cylinder
18. Steering Cylinders
19. Quick Disconnect
20. Steering Cylinder Check Valve
21. Ground Driven Steering Diverter Valve (If equipped)
22. Check Valve for Ground Driven Steering System (If equipped)
23. Steering Element of Steering / Switch Pump
24. Diverter Valve Element of Steering / Switch Pump
25. Switch element of Steering / Switch Pump

1. DESCRIPTION

The system consists of the steering and hydraulic components, which are interconnected to share a common hydraulic reservoir for efficient operation. The reservoir is a gravity and pressurized type, which provides oil flow to the inlet ports of the hydraulic pumps.

Following, is a general description of the hydraulic and steering system components. For a detailed description of each of these components, refer to the pertinent sub-section in this section.

Steering System (Standard)

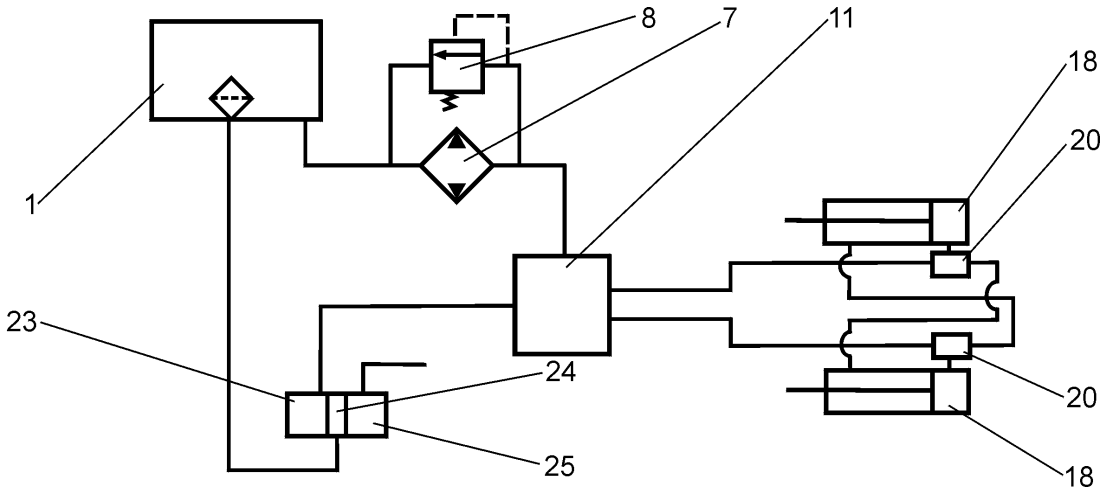


Fig. 10.2. Steering System Standard Line Diagram

1. Hydraulic Reservoir
7. Oil Cooler
8. Surge Valve
9. Hydraulic Control Valve
11. Steering Valve
18. Steering Cylinders
20. Steering Cylinder Check Valve
23. Steering Element of Steering / Switch Pump
24. Diverter Valve Element of Steering / Switch Pump
25. Switch element of Steering / Switch Pump

The steering system is a mechanically controlled hydraulic system. The mechanical linkage consists of the steering wheel, steering column, steering gear and the linkage connected to the control spool of the steering valve. This mechanical linkage is explained in more detail in SECTION 5.

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GENERAL

The hydraulic portion of the steering system consists of the common hydraulic reservoir (1, Fig. 10.2) the steering element (23) of the steering / switch pump mounted on the left hand side of the torque converter, a steering valve (11), two steering cylinders (18) and a hydraulic oil cooler (7).

The hydraulic oil from the reservoir enters the steering element (23) of the steering / switch pump through a common intake line with the switch element (25). Oil on the outlet of the steering element is forced through its own outlet port to the steering valve (11) and returns to the oil cooler (7) and reservoir (1) until the steering linkage is moved for a turn. When the steering wheel is turned, the mechanical linkage moves the valve spool, permitting pressurized oil to flow to the end of one steering cylinder (18) and to the opposite end of the other steering cylinder through a steering cylinder check valve (20) and a connecting line. The oil being displaced in each cylinder is forced back into the steering valve, through the oil cooler and the reservoir to begin the cycle again.

Hydraulic System

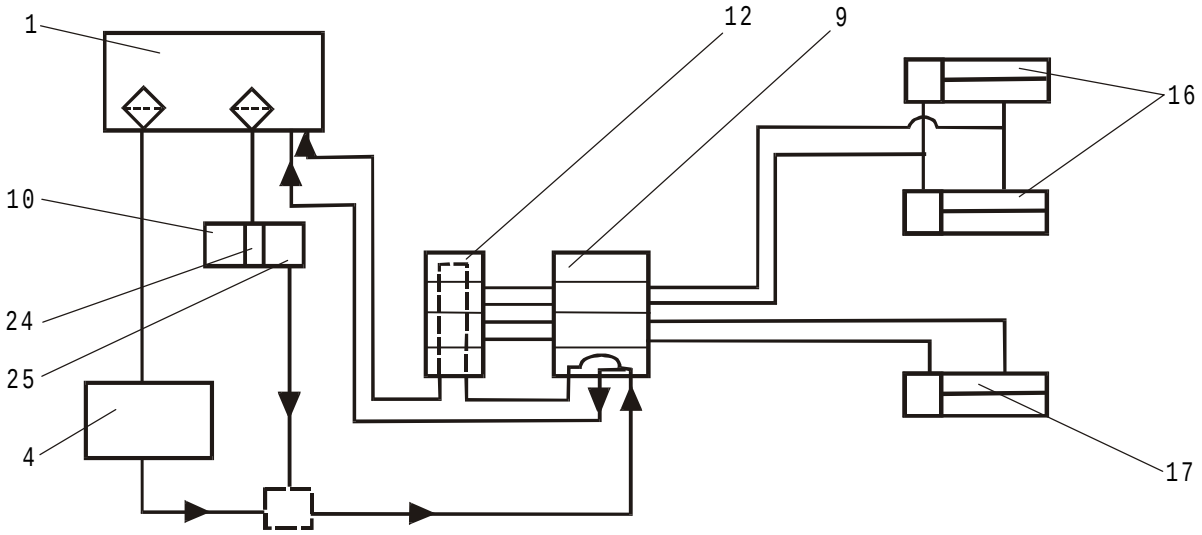


Fig. 10.3. Hydraulic System Line Diagram

1. Hydraulic Reservoir
4. Hydraulic Pump
9. Hydraulic Control Valve
10. Steering / Switch Pump
12. Pilot Control Valve
16. Boom Cylinders
17. Bucket Cylinder
24. Diverter Valve Element of Steering / Switch Pump
25. Switch element of Steering / Switch Pump

The hydraulic system consists of the common hydraulic reservoir (1, Fig. 10.3), the hydraulic pump (4) mounted on the right hand side of the torque converter, the switch element (25) of the steering / switch pump, a pilot control valve (12), a hydraulic control valve (9), two boom cylinders (16) and one bucket cylinder (17).

The pilot control valve (12), which is connected mechanically to the boom and bucket control levers in the cab, hydraulically controls the movement of the spool in the hydraulic control valve. The hydraulic oil flow from the pump (14) is controlled by the spool in the hydraulic control valve (9), which direct the flow to extend or retract the boom cylinders (16) or the bucket cylinder (17).

The boom control lever has four positions: raise, hold, lower and float. The bucket control lever has three positions: roll back, hold and dump.

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The boom and bucket cylinders are double acting in that oil is directed into the cylinder end or the rod end to move the piston rod in the direction desired. The displaced oil on the opposite side of the piston is directed back into the return circuit and to the reservoir.

The boom has an electrically actuated boom stop positioner valve which will stop the boom's rise at any preset height.

The bucket has an electrically actuated positioner valve which will position the bucket at a preset loading angle automatically.

Ground Driven Steering System (If equipped)

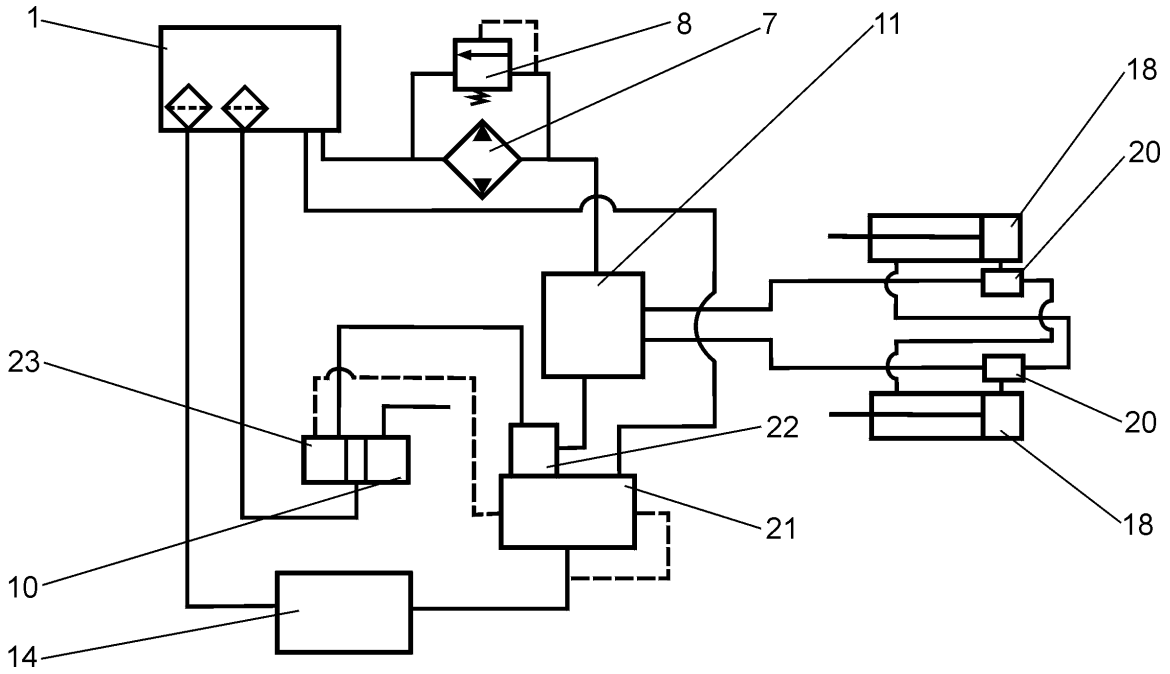


Fig. 10.4. Ground Driven Steering System hydraulic Line Diagram (If equipped)

1. Hydraulic Reservoir
7. Oil Cooler
8. Surge Valve
10. Steering / Switch Pump
11. Steering Valve
14. Ground Driven Steering Pump (If equipped)
18. Steering Cylinders
20. Steering Cylinder Check Valve
21. Ground Driven Steering Diverter Valve (If equipped)
22. Check Valve for Ground Driven Steering System (If equipped)
23. Steering Element of Steering / Switch Pump

Ground driven steering is provided as an optional attachment to be used in the event of engine failure or at other times when the torque converter driven steering element of the steering / switch pump is inoperative.

This auxiliary system consists of the common hydraulic reservoir (1, Fig. 10.4), a ground driven steering pump (14) mounted on the rear of the transmission, a diverter valve (21) to direct the flow from this pump, a check valve (22) mounted on the diverter valve, and a pressure switch which electrically activates a warning light in the cab when this system is operative.

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2. THEORY OF OPERATION

The following covers the general flow of oil through the hydraulic system. To trace the flow of oil through a component refer to the pertinent sub-section in this section.

The reservoir located behind the operator's cab on the bulkhead is the source of supply for the steering and hydraulics loader equipment. Two combination vacuum / pressure relief valves mounted in the top of the reservoir are used to maintain a head of pressure in the reservoir.

Oil flowing from the hydraulic reservoir passes through wire mesh strainers, located within the reservoir and into a dual element gear type pump called the steering / switch pump, a single element hydraulic pump and, if equipped, ground driven steering pump. Each pump draws oil from the reservoir through its own intake line.

Detailed Steering System (Refer to Fig. 10.1)

The steering element (23) provides oil only to the steering valve (11). The switch element (25) provides oil flow to the steering valve or to the hydraulic control valve, depending upon the engine speed. At low engine speeds, the output from the switch element by left check valve combines with the output from the steering element to supply the steering valve. When the engine speed is increased, the flow from the switch element (25) is directed by right check valve to the hydraulic control valve. This shifting of oil is accomplished by the diverter valve element (24), which is located between the steering and switch elements in the steering / switch pump and now is shifted to the right.

When the steering wheel is turned, the left spool inside the steering valve (11) is positioned to direct incoming pump flow to the steering cylinders by right spool shifted down. Oil from the steering valve is directed to the steering cylinder check valve (20), which redirect the oil flow to the piston side of one steering cylinder and to the rod side of the other steering cylinder. This causes one cylinder to extend while the other retracts. Since the steering cylinders are mounted between the front and rear frames, this action causes the frames to pivot on the center hinge assembly, drawing the frames together on one side and pushing them apart on the other. When a machine is moving through a turn, this opposing action of the steering cylinders causes the front and rear wheels to track each other.

Oil which is being displaced by the steering cylinders is returned to the steering valve. From here, oil from the steering valve is divided to flow to the reservoir after cooling through the oil cooler (7). A surge valve (8) is located at the bottom of the hydraulic reservoir (1). Should the return flow exceed the capacity of the oil cooler, the surge valve will open and allow excess flow to bypass the oil cooler and return directly to the reservoir. Two shack valves in steering valve (11)

The steering system pressure is limited to 17.25 MPa by the system relief valve located in the steering valve (11).

Detailed Loader Hydraulic System (Refer to Fig. 10.1)

At lower engine speed only the hydraulic pump (4) supplies the oil to the hydraulic control valve (9) for operation of the equipment hydraulics. As the engine speed increases, the flow from the switch element (25) of the steering / switch pump (10) is shifted by the diverter valve element (24) and right check valve to combine with the flow from the hydraulic pump.

A small volume of oil entering the hydraulic control valve (9) is sent to the pilot control valve (12). When the boom or bucket levers in the cab are in the "hold" position, this oil flows through the pilot control valve and is returned back to the reservoir.

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As the operator moves the boom or bucket lever, the corresponding spool in the pilot control valve is repositioned to direct this small volume of oil back to the matching plunger section of the hydraulic control valve where it is used to move both plungers within the section. One plunger will now allow the main volume of oil entering the valve to flow to the appropriate cylinder - the bucket cylinder (17) or both boom cylinders (16). Oil returning from the cylinders flows around the other plunger, which redirects it to return passages within the valve. From here the oil is returned directly to the hydraulic reservoir.

The hydraulic system pressure is limited to 20.7 MPa by the system relief valve located in the loader control valve (9).

Detailed Ground Driven Steering System (If equipped) (Refer to Fig. 10.1)

This auxiliary system is called a ground driven steering system because, in the event of a power failure while the machine is rolling, the rotation of the tires sends a driving force back through the wheel, axle shafts, differential and drive shafts to set the output shaft in the transmission in motion. With the ground driven steering pump (14) being driven by the output shaft through a set of gears, enough rotation is produced for the pump to deliver a small quantity of oil for limited steering.

GROUND DRIVEN STEERING ”OFF”

When the ground driven steering system is not operable, oil flows through the steering system in the same way as described under "Steering System” except that the output from the steering / switch pump (10) goes through a check valve (22). The check valve, which is mounted on top of the ground driven steering diverter valve (21), allows free flow from the steering / switch pump into the steering valve.

At the same time, pressure is sensed through a pilot line from the steering element (23) to the diverter valve. The pressure moves a spool inside the valve to the left to allow return oil from the ground driven steering pump (14) to return to the reservoir. This pressure is present whenever the steering element is producing enough flow to operate the steering system.

GROUND DRIVEN STEERING ”ON”

When, for any reason, the steering element (23) fails to produce enough flow for the steering system, the pressure in the pilot line to the diverter valve (21) will drop. This lack of pressure allows a spring inside the diverter valve to shift the valve spool to the right. Now the shifted spool allows oil coming from the ground driven steering pump to be directed to the steering valve (11), where it is redirected to the steering cylinders (18). The volume of oil produced by the ground driven steering pump is sufficient for limited steering of the machine in the event of power failure. The check valve (22) prevents flowing the oil from the diverter valve (21) to steering / switch pump (10).

3. SPECIFICATIONS

Operating Pressures

Steering System Pressure	17.25 MPa
Hydraulic System Pressure	20.7 MPa

Operating Time - Maximum (At full throttle with bucket empty)

Steering Response Time (lock to lock)	3.0 seconds
Boom Raise	9.1 seconds
Boom Lower	6.3 seconds
Bucket Rollback	3.8 seconds
Bucket Dump	2.8 seconds

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4. SERVICE DIAGNOSIS

The first step to proper service diagnosis is to verify the operator's complaint. If possible, the machine should be operated by service person to determine if the problem is a system or a circuit problem.

By performing the "HYDRAULIC SYSTEM PERFORMANCE TEST" and the "STEERING SYSTEM PERFORMANCE TEST" in this section, a component be eliminated as a cause of the problem being encountered.

NOTE: *Before performing any tests, check all hydraulic connections and lines for external leakage or damage. Also check the hydraulic reservoir oil level and the type of oil being used. Refer to the OPERATOR'S MANUAL for the correct specifications.*

Steering System

NOTE: *The following service diagnosis pertains to the hydraulic portion of the steering system. For diagnosis of the mechanical portion of the steering system, refer to SECTION 5*.

COMPLAINT	
PROBABLE CAUSE	REMARKS
Noisy Operation	
1. Low or high oil level	Fill with correct oil to proper oil level. Refer to OPERATOR'S MANUAL.
2. Improper oil viscosity	Change oil to proper viscosity. Refer to OPERATOR'S MANUAL.
3. Reservoir pressure / vacuum relief valve defective	Repair or replace.
4. Air leak between the reservoir and pump	Check lines and connections.
5. Partially restricted pump inlet	Check reservoir strainers for restriction
No Steering Response (Low Pressure)	
1. Steering linkage damaged	Repair or replace.
2. Steering / switch pump not rotating	Pump shaft broken. This would also cause slow loader hydraulics. Refer to "HYDRAULIC SYSTEM PERFORMANCE TEST".
3. Steering relief valve malfunction	Repair or replace. Refer to "STEERING VALVE" in SECTION 10 B.
Weak Steering in Both Directions (Low Pressure)	
1. Air leak between the reservoir and pump	Check line and connections.
2. Steering valve malfunction	System relief valve malfunctioning. Refer to "STEERING SYSTEM PRESSURE TEST"
3. Steering cylinder malfunction	Check for cylinder leakage as described under "STEERING CYLINDER LEAKAGE TEST" in SECTION 10C.
Hard Steering in Both Direction (Pressure is O.K.)	
1. Steering valve malfunctions	Control spool binding
2. Steering cylinder malfunction	Check for cylinder seizured. Disconnect one cylinder from the frame and check the other.

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COMPLAINT	
PROBABLE CAUSE	REMARKS
Slow Steering in Both Directions	
1. Steering / switch pump malfunction	a. Switch element inefficient. This would also cause slow loader hydraulics. Refer to ”LOADER SYSTEM PERFORMANCE TEST”. b. Steering element inefficient. Perform ”PUMP FLOW TEST” as described in SECTION 10A. c. Diverter valve malfunction. Check its operation as described under ”DIVERTER VALVE SWITCH POINT TEST AND ADJUSTMENT” in SECTION 10A.
Slow Steering in One Direction	
1. One of shock valve in steering valve malfunction	Refer to ”STEERING SHOCK VALVE PRESSURE TEST” under ”STEERING VALVE” in SECTION 10B.
2. Steering cylinder check valve malfunction	Repair or replace. Refer to SECTION 10B.
Machine Drifts to One Side	
1. Steering linkage out of adjustment	Adjust linkage as described in SECTION 5.
2. Steering shock valve leaking (machine has slow steering in opposite direction)	Refer to ”STEERING SHOCK VALVE PRESSURE TEST” under ”STEERING VALVE” in SECTION 10B.
Erratic Steering (Nose Wander)	
1. Air in system	Locate and eliminate the cause.
2. Diverter valve malfunction	Check switching operation. Refer to ”DIVERTER VALVE SWITCH POINT TEST AND ADJUSTMENT” in SECTION 10A.
3. Steering cylinder check valve faulty	Repair or replace. Refer to SECTION 10B.

Additional Service diagnosis for loader equipped with ground driven steering

No Steering Response	
1. Steering / switch pump not rotating	Pump shaft broken steering system operates while engine is shut-down and machine is rolling
Ground Driven Steering System Lamp does not light While Engine is Shut-Down and Machine is Rolling	
1. Ground driven steering system operates	Burnt-out bulb Electric wire problem. Warning Lamp switch defected.
2. Ground driven steering system does not operates	Ground driven steering diverted. Ground driven steering diverter valve spool or spring problem. Ground driven steering pump problem.

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Hydraulic System (Refer also to hydraulic control valve diagnosis in SECTION 10B)

COMPLAINT	
PROBABLE CAUSE	REMARKS
Noisy Operation	
1. Low or high oil level	Fill with correct oil to proper oil level. Refer to OPERATOR'S MANUAL.
2. Improper oil viscosity	Change oil to proper viscosity. Refer to OPERATOR'S MANUAL.
3. Reservoir pressure / vacuum relief valve defective	Repair or replace.
4. Air leak between the reservoir and pump	Check lines and connections.
5. Partially restricted pump inlet	Check reservoir strainers for restriction.
No Response or Slow Motion to Hydraulic Controls in One Circuit	
1. Pilot control valve linkage binding or damaged	Lubricate linkage or repair broken linkage.
2. Pilot control valve spools binding	Clean all foreign material until spool moves freely. Refer to "PILOT CONTROL VALVE" in SECTION 10B.
3. Bucket or boom cylinders malfunction	a. Check the cylinders for leakage. Refer to "CYLINDER LEAKAGE TEST" in SECTION 10C. b. Remove the cylinder from the machine and inspect for internal damage. Replace worn parts.
4. Hydraulic control valve spools binding	Clean all foreign material until spool moves freely. Refer to "HYDRAULIC CONTROL VALVE" in SECTION 10B.
Slow Motion in Both Circuits (Pressure is O.K.)	
1. Engine problem. Low stall speed	Contact you nearest certified Authorized Service for a full engine diagnostic check.
2. Restricted suction line	Clean suction filter or check line
3. Hydraulic pump or steering / switch pump malfunction	Perform "HYDRAULIC SYSTEM PERFORMANCE TEST" as described in this section.
4. Hydraulic control valve low pressure relief valve malfunction	Refer to "HYDRAULIC CONTROL VALVE" in SECTION 10B.
Slow or No Motion in Both Circuit (Low Pressure)	
1. Air leak between the reservoir and pump	Check lines and connections.
2. Hydraulic control valve main pressure relief valve malfunction	Refer to "HYDRAULIC CONTROL VALVE" in SECTION 10B.
3. Hydraulic pump malfunction	Refer to "HYDRAULIC PUMP" in SECTION 10C.
Bucket Cylinder Drifts	
1. Bucket shock valve malfunction	Refer to "BUCKET SHOCK VALVE PRESSURE TEST AND ADJUSTMENT" under "PILOT CONTROL VALVE" in SECTION 10B.
2. Cylinder leakage	Refer to appropriate cylinder "LEAKAGE TEST" in SECTION 10C.
3. Pilot control valve section leakage	Overhaul pilot control valve. Refer to SECTION 10B.

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HYDRAULICS

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COMPLAINT	
PROBABLE CAUSE	REMARKS
Boom Cylinders Drifts	
1. One of boom cylinder leakage	Refer to ”BOOM CYLINDER LEAKAGE TEST” in SECTION 10C.
2. Pilot control valve boom section leakage	Overhaul pilot control valve. Refer to SECTION 10B.
Control Lever Doesn’t Hold in the ”DETENT’ Position	
1. Malfunction in detent mechanism in pilot control valve	Refer to ”PILOT CONTROL VALVE” in SECTION 10B.
2. Malfunction in electrically actuated positioners	Refer to ”SERVICE DIAGNOSIS” in SECTION 8.
Slow or Loss of ”FLOAT”	
1. Pilot control valve boom section malfunction	Refer to ”PILOT CONTROL VALVE” in SECTION 10B.
2. Hydraulic control valve boom section malfunction	Refer to ”HYDRAULIC CONTROL VALVE” in SECTION 10B.

TEST AND ADJUSTMENT

5. STEERING 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 tires or on the access ladders 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. Check the steering stop pads. Be sure the steering wheel stops turning before the frame halves hit the stop pads. If the machine halves hit the stop pads, the steering linkage must be adjusted. Refer to ”LINKAGE ADJUSTMENT” in SECTION 5.
2. Operate the machine to warm up the hydraulic oil.
3. Raise the bucket slightly off the ground and turn the steering wheel to the left until the machine stops articulating.
4. Accelerate the engine to full throttle. The test will consist of three full articulations. The observer should record the time it takes to articulate the machine from left to right, back to left and back to right again.
5. Decelerate to low idle and position the machine in the straight ahead position. Lower the bucket to the ground and stop the engine.
6. To arrive at the steering response time, divide the results obtained in Step five by three.
7. The steering response time should be a maximum of 3.0 seconds. If the machine articulates to this specifications, it is working properly.
8. If the test results indicate that the response time is longer than the specification:
   a. The area in which the test is being conducted is prohibiting the steering from functioning correctly. As the machine articulates, the axles and tires may wind up, thus changing the reading from the specification. Move the machine and retake the test.

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b. The steering system relief valve, steering cylinders, cylinder check valve or the steering element of the steering / switch pump is malfunctioning or air leak in suction line. Refer to the ”STEERING SYSTEM PRESSURE TEST” in this section to help identify the cause of the problem. If after performing the steering system pressure test, the results indicate the problem must be an inefficient steering element, the element output can be checked using a flow meter. Refer to ”PUMP FLOW TEST” under ”STEERING / SWITCH PUMP” in SECTION 10A.

9. If the test results indicate that the response time is shorter than the specification, the diverter valve element of the steering / switch pump may be malfunctioning. Refer to ”DIVERTER VALVE SWITCH POINT TEST AND ADJUSTMENT” under ”STEERING / SWITCH PUMP” in SECTION 10A.

6. HYDRAULIC 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 tires or on the access ladders 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. Operate the machine to warm up the hydraulic oil.
2. With the bucket empty, slowly depress the accelerator until the engine reaches full throttle. Raise the boom from the ground to its full height and record the time. Lower the bucket to the ground and record the time. Decelerate the engine to low idle.
3. Raise the bucket off the ground and place the bucket in the ”DUMP” position. Slowly depress the accelerator until the engine reaches full throttle. Shift the bucket control lever to the ”ROLLBACK” position and roll back the bucket. Record the time it takes for the bucket to roll back. Now shift the bucket control level to the ”DUMP” position and dump the bucket. Record the time. Slowly decelerate the engine until it is operating a low idle. Position the bucket so it is parallel to the ground and lower the bucket to the ground.
4. The test results should be as follows:
   a. The boom raise time should be 9.1 seconds.
   b. The boom lower time should be 6.3 seconds.
   c. The bucket roller time should be 3.8 seconds.
   d. The bucket dump time should be 2.8 seconds.
5. If the recorded data corresponds with the preceding specifications, the hydraulic pumps on the machine are functioning properly.
6. If the test results do not correspond to these specifications, follow the instruction in Steps 7 or 8.
7. If both the boom and bucket circuits are slow:
   a. The diverter valve element of the steering / switch pump may be malfunctioning. This would cause a faster than normal steering response and can be verified following the ”STEERING SYSTEM PERFORMANCE TEST” in this section.
   b. The switch element of the steering / switch pump may be inefficient. To verify that the output of the switch element is inefficient, refer to the ”DIVERTER VALVE SWITCH POINT TEST AND ADJUSTMENT” under ”STEERING / SWITCH PUMP” in SECTION 10A.

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c. The system relief valve is malfunctioning. Refer to the ”LOADER SYSTEM PRESSURE TEST” in this section.

d. The loader pump is inefficient. Check pump output using a flow meter. Refer to ”PUMP FLOW TEST” under ”HYDRAULIC AND COOLING PUMP” in SECTION 10A.

8. If only one circuit is slow, it is probably due to leakage in the cylinder. Refer to the appropriate cylinder ”LEAKAGE TEST” in SECTION 10C.

7. STEERING SYSTEM PRESSURE TEST

WARNING! Be sure the area in front and behind the machine is clear of personnel and obstructions. DO NOT allow anyone near the tires or on the access ladders during this test.

1. Operate the machine to warm up the hydraulic oil. Install the frame locking bar and stop the engine.
2. Connect a 30000 kPa pressure gauge to the quick disconnect (3, Fig. 10.5) on the L.H. steering cylinder check valve (2). The gauge hose should be long enough to allow the gauge to reach into the cab.
3. Operate the engine at low idle and turn the steering wheel into a full right hand turn. Check the pressure gauge and record the reading. Return the steering wheel to the straight ahead position.

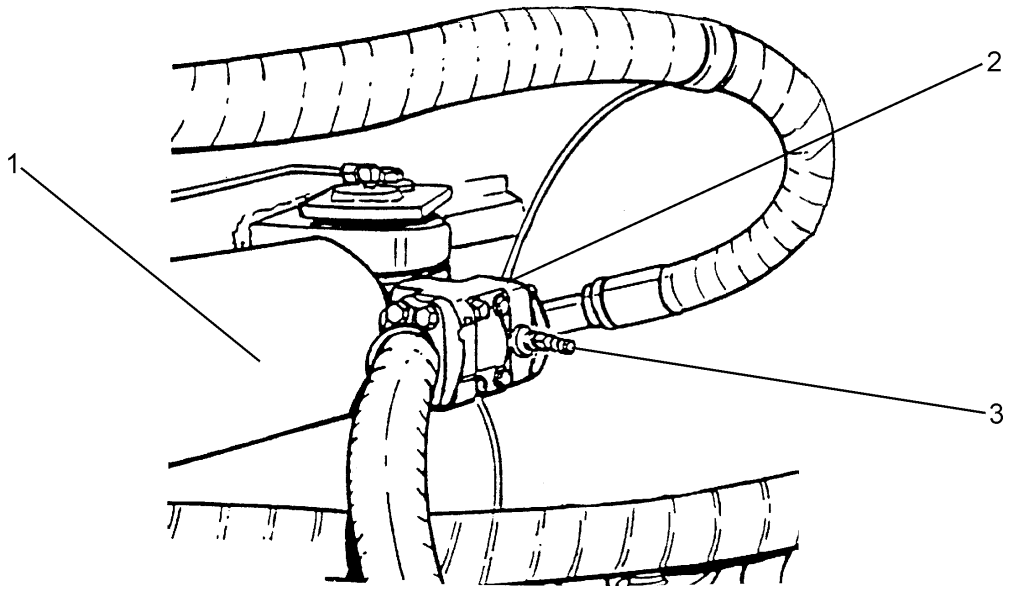


Fig. 10.5. Steering System Test Point

1. L.H. Steering Cylinder 2. Check Valve 3. Quick Disconnect

4. Slowly depress the accelerator until the engine is operating at high idle. Turn the steering wheel into a full turn position (same direction). Check the pressure gauge and record the reading. Return the wheel to the straight ahead position. Stop the engine.
5. Connect the 30000 kPa pressure gauge to the R.H. steering cylinder check valve. Repeat Steps 3 and 4 for the opposite direction.

IMPORTANT: *The R.H. cylinder check valve has a provision for a quick disconnect but none is installed.*

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6. The steering system relief valve should open at 17.25 MPa in both directions.
7. If the readings do not match the specifications at either high or low idle refer to ”Weak Steering in Both Directions (Low Pressure) under ”SERVICE DIAGNOSIS” in this section.
8. If the readings do not match the specifications at either high or low idle one direction only:
   a. Steering shock valve is malfunctioning. Refer to ”STEERING SHOCK VALVE PRESSURE TEST” under ”STEERING VALVE” in SECTION 10B.
   b. ONE DIRECTION ONLY: Steering cylinder check valve (2, Fig. 10.5) malfunction. Repair or replace. Refer to SECTION 10B.
9. If the test results meet the specifications only at high idle, check for internal leakage at the cylinders. Refer to ”STEERING CYLINDER LEAKAGE TEST” in SECTION 10C.

8. HYDRAULIC SYSTEM PRESSURE TEST

WARNING! Be sure the area in front and behind the machine is clear of personnel and obstructions. DO NOT allow anyone near the tires or on the access ladders during this test.

1. Operate the machine to warm up the hydraulic oil. Stop the engine.
2. Connect a 30000 kPa pressure gauge to the quick disconnect at the top of the hydraulic control valve. The gauge hose should be long enough to allow the gauge to reach into the cab.
3. Operate the engine at low idle. Raise the boom to its full height. Keep the boom lever in the ”RAISE” position and hold it there. Record the highest pressure reading achieved on the gauge. Lower the boom until the bucket is approximately 1 m. off the ground. Roll the bucket all the way back. Keep the bucket lever in the ”ROLLBACK” position and hold it there. Record the highest pressure reading achieved on the gauge. Lower the bucket to the ground.
4. Accelerate the engine to full throttle. Perform and record the same tests as described in Step 3.

IMPORTANT: *Do not continue these pressure conditions for more than a few seconds.*

5. The hydraulic system relief valve should open at 20.7 MPa.
6. If the test results do not meet this specification at either high or low idle, refer to ”Slow or No Motion in Both Circuit (Low Pressure)” under ”SERVICE DIAGNOSIS” in this section.
7. If the test results only meet this specification in one circuit, there could be internal leakage at the cylinder for the other circuit. Refer to the appropriate cylinder ”LEAKAGE TEST” in SECTION 10C.

NOTE: *Depending on the severity of the leak, it may or may not show up in the results taken at full throttle and only indicate a lower pressure reading at low idle.*

9. SUCTION LINE LEAKAGE TEST

1. Apply shaving cream to all the suction lines and fittings.
2. Operate the system and observe the shaving cream.
3. If a leak is present, a crater will from in the shaving cream at the location of the leak.

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TEST AND ADJUSTMENT

10. HYDRAULIC CONTROL LEVER LEAKAGE ADJUSTMENT

WARNING! Be sure the area in front and behind the machine is clear of personnel and obstructions. DO NOT allow anyone near the tires or on the access ladders during this test. Install the frame locking bar.

1. Check the linkage (Fig.'s 10.6 and 10.7) to insure that all hardware items are secure.
2. Start the engine and operate at low idle.
3. Operate the boom control lever. The boom should raise when the boom lever is pulled back and should automatically return to the hold position when released. Shift the lever forward one position and the boom will lower under pressure. Shift the lever to the full forward position and the boom should float down. Once the bucket is resting on the ground, shift the control lever into the hold position.

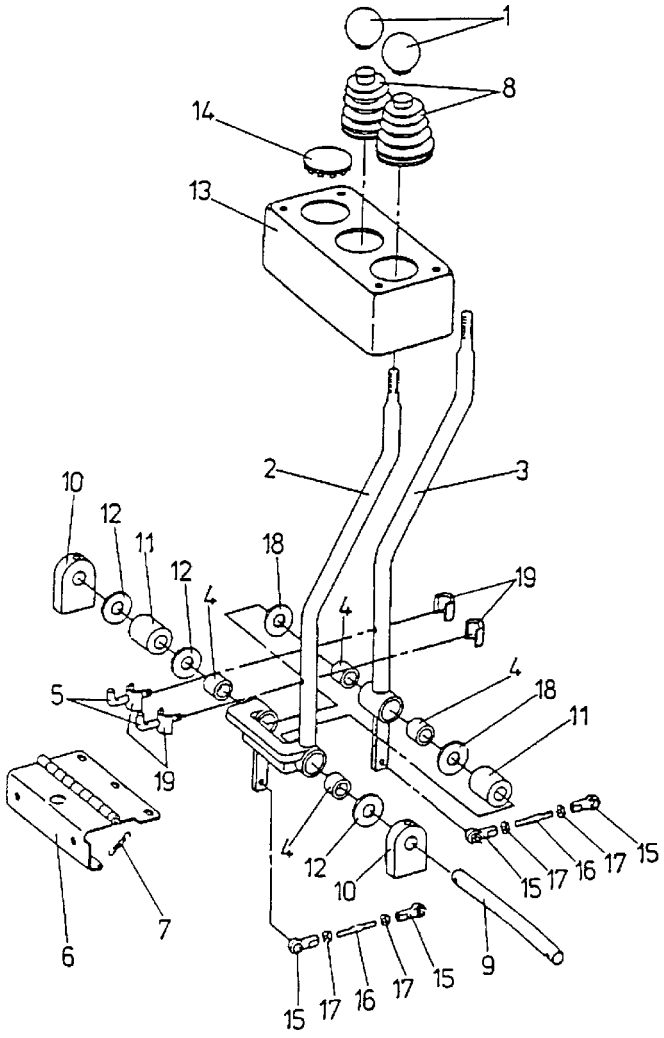


Fig. 10.6. Hydraulic Control Linkage 2-Spool

1. Knob	6. Hinge	11. Spacer	16. Control Rod
2. Bucket Control Lever	7. Spring	12. Washer	17. Nut
3. Boom Control Lever	8. Boot	13. Cover	18. Spring Washer
4. Needle Bearing	9. Control Levers Shaft	14. Plug	19. Clamp
5. Rod	10. Bar	15. Rod End	

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TEST AND ADJUSTMENT

4. Raise the bucket a few feet off the ground. The bucket will roll back when the bucket control lever is shifted back and automatically return to the hold position when released. Shift the lever all the way forward and the bucket will dump. Shift the control lever back to the position and lower the bucket to the ground. Shut off the engine.
5. HYDRAULIC CONTROL LINKAGE 2-SPOOL: Adjustments can be made to the linkage by loosening nut (17, Fig. 10.6). Turn control rod (16) into or out of rod end (15). Tighten nut (17) when all adjustments are completed.
6. HYDRAULIC CONTROL LINKAGE 3-SPOOL: Adjustments can be made to the linkage by loosening nut (15, Fig. 10.7). Turn control rod (14) into or out of rod end (13). Tighten nut (15) when all adjustments are completed.

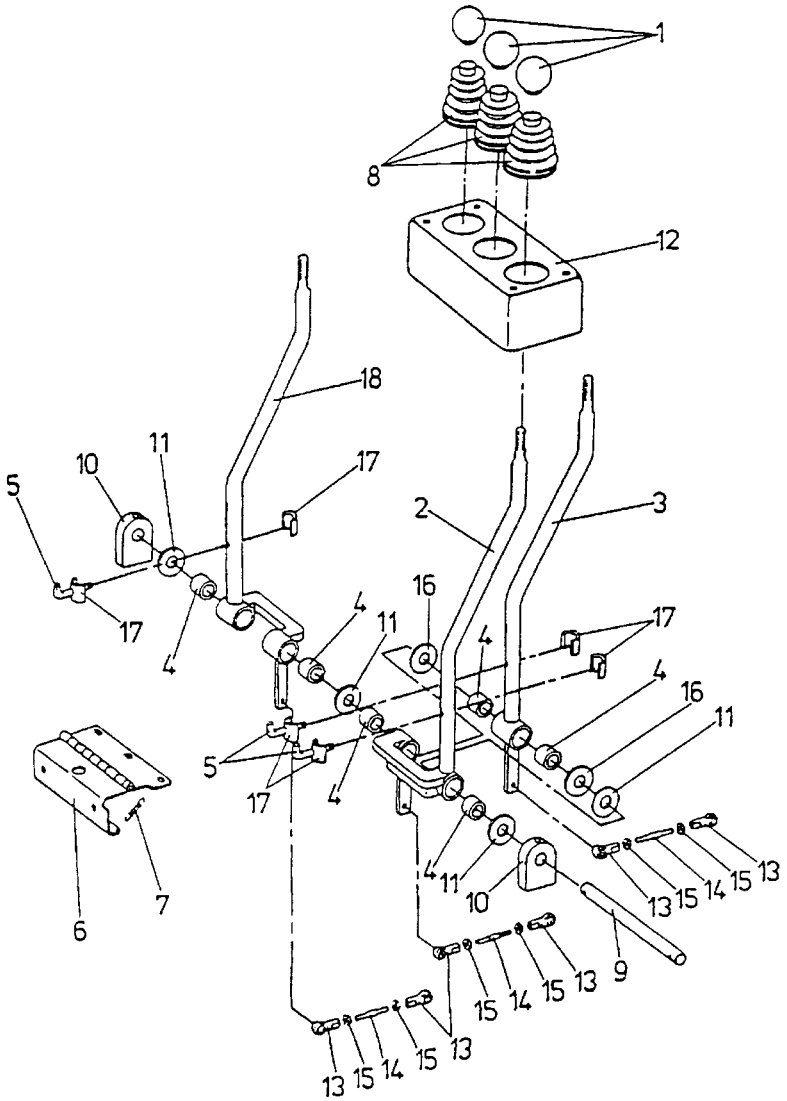


Fig. 10.7. Hydraulic Control Linkage 3-Spool

1. Knob
2. Bucket Control Lever
3. Boom Control Lever
4. Needle Bearing
5. Rod
6. Hinge
7. Spring
8. Boot
9. Control Levers Shaft
10. Bar
11. Spacer
12. Cover
13. Rod End
14. Control Rod
15. Nut
16. Spring Washer
17. Clamp
18. Auxiliary Control Lever

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PUMPS

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PUMPS

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STEERING / SWITCH PUMP

1. DESCRIPTION

The steering/switch pump is a dual element (tandem) gear type pump. The pump is mounted on the left hand side of the torque converter. A power take off gear inside the torque converter is driven by engine torque through a series of gears. This power take off gear drives the steering/switch pump through a spline connection.

Oil from the hydraulic reservoir enters the inlet port at the bottom of the pump and exits through two outlet ports at the top. The pump components are contained in three sections. The section containing the steering element (1, Fig. 10A.1) only supplies the flow for the steering system. The section containing the switch element (3) supplements the flow for the steering system at low engine RPM and supplements the hydraulic circuit at higher engine RPM. The middle section of the pump contains the diverter valve (2) which is used to shift the flow of the switch element.

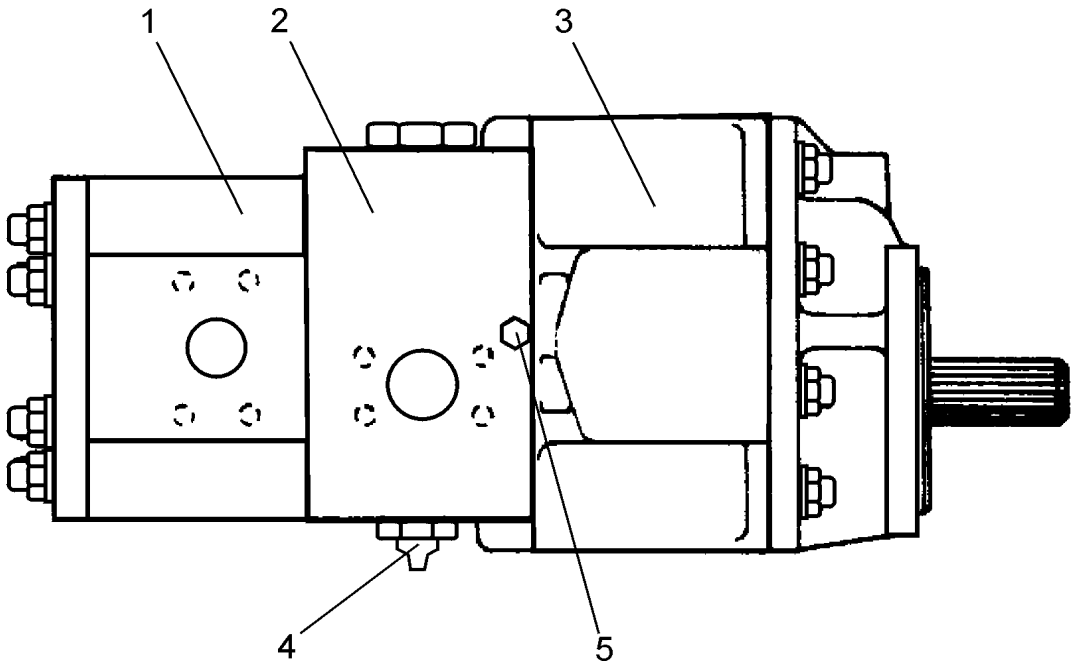


Fig. 10A.1. Steering/Switch Pump Outline

1. Steering Element
2. Diverter Valve
3. Switch Element
4. Quick Disconnect Plug
5. Adjustment Screw Plug

2. THEORY OF OPERATION

Steering Element Flow

All the flow of the steering element is supplied directly to the steering valve at all times and does not pass through the diverter valve.

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Switch Element Flow at Low RPM (Fig. 10A.2)

The diverter valve is sensitive to the flow entering from the switch element. The flow from the switch element enters from an internal passage in the housing. The flow passes through a series of holes in the orifice assembly (1), around the spool (2) and opens the check valve (3) to combine with the flow (7) from the steering element.

Simultaneously, flow from the switch element is directed to the left and right sides of the spool through the internal passages (5) and (6). A check valve located in port (8) will seat and prevent hydraulic system oil from entering the diverter valve whenever the spool (2) is shifted to the left allowing switch element flow to enter the steering system.

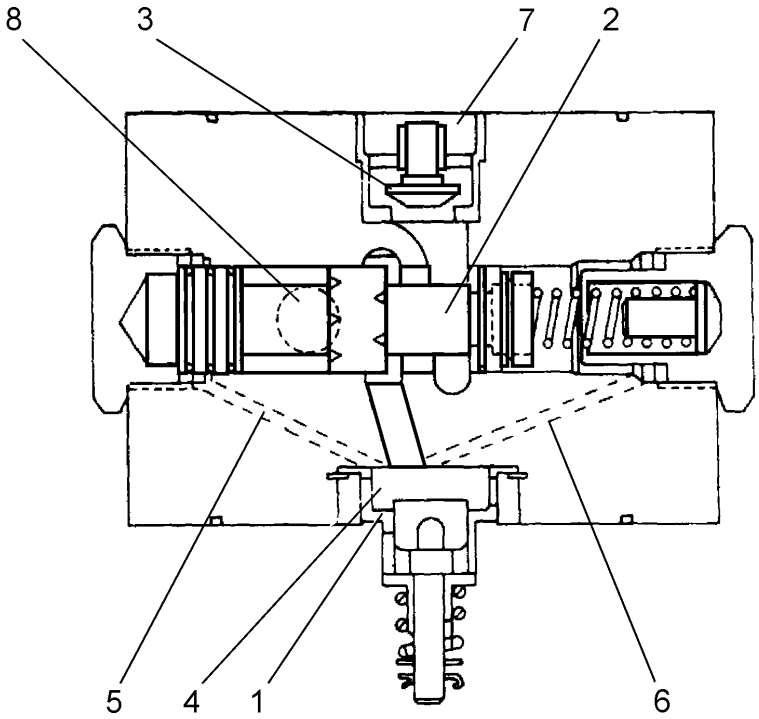


Fig. 10A.2. Diverter Valve Position at Low RPM

1. Orifice Assembly
2. Spool
3. Check Valve
4. Inlet Side from Switch Element
5. Internal Passage
6. Internal Passage
7. To Steering Element
8. Port to Hydraulic System

When engine speed is increased, the pump flow from the switch element to the diverter valve is increased. When this flow increases to the point where it can no longer pass easily through the orifice (1), a pressure build up on the inlet side (4) of the orifice will occur. This pressure, which is steering pressure plus the pressure building up behind the orifice, is felt in the internal passage (5) on the left side of the spool. Because the internal passage (6) is located on the opposite side of the orifice, only steering pressure is felt on the right hand side of the spool.

Since the spool (2) has equal area, it can only shift when the pressure builds enough to over come the spring and steering pressure at the right side of the spool. The pressure should occur between 1400 to 1600 engine RPM.

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STEERING / SWITCH PUMP

Switch Element Flow at High RPM (Fig. 10A.3)

When the spool shifts to the right, oil from the switch element will be redirected to the hydraulic system through port (8). At the same time, the check valve (3) will seat and prevent steering system oil from entering the diverter valve.

The orifice assembly (1) always maintains the pressure differential across the spool. As the engine speed is increased past the switch point, excess heat will be generated if all the switch pump element flow is forced through the holes in the orifice assembly.

To prevent this from occurring, a piston (9) is incorporated into the orifice assembly. At a predetermined oil flow rate, the piston will shift upward and allow the additional flow to by-pass the holes in the orifice assembly.

An adjusting screw is incorporated in the diverter valve section to change the point at which the spool shifts. The adjusting screw has a point which fits into one of the holes in the orifice assembly. Turning the screw in reduces the total area of the orifice causing the spool to shift at a lower engine speed. Turning the screw out increases the total area of the orifice causing the spool to shift at a higher engine speed. Refer to "DIVERTER VALVE SWITCH POINT TEST AND ADJUSTMENT" in this section for the proper procedure.

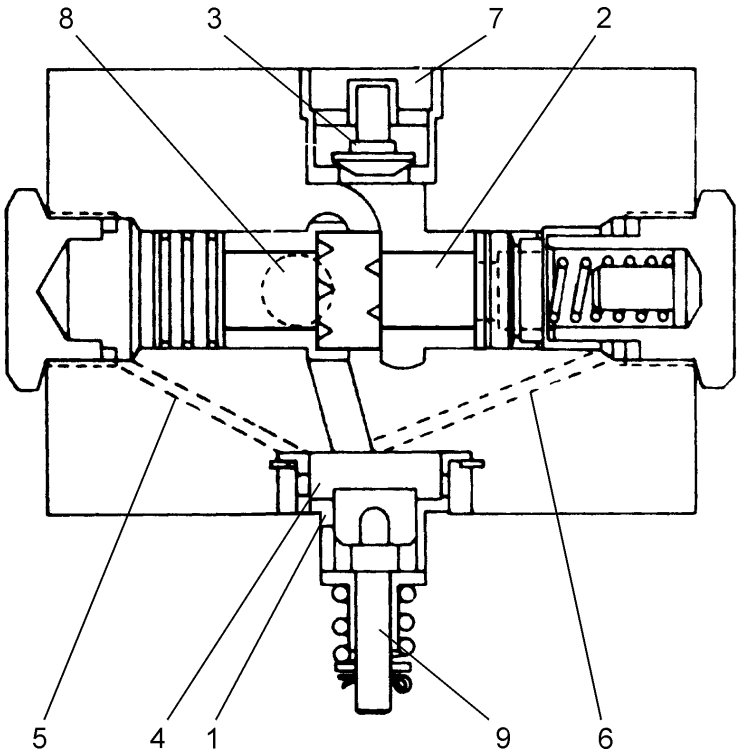


Fig. 10B.3. Diverter Valve Position at High RPM

1. Orifice Assembly
2. Spool
3. Check Valve
4. Inlet Side from Switch Element
5. Internal Passage
6. Internal Passage
7. to Steering Element
8. Port to Hydraulic System
9. Piston

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PUMPS

STEERING / SWITCH PUMP

When the engine speed falls below 1400 RPM, the spring and steering pressure on the right side of the spool (2) will overcome the pressure on the inlet side (4) of the orifice assembly. The drop in pressure on the left of the spool will shift the spool back to the left, opening the way for the oil to again flow through port (7).

3. SPECIFICATIONS

Type . . . . . Dual Element Gear

Pump Output at 2100 Engine RPM and Free Flow:

Switch Element . . . . . 244 lpm
Steering Element . . . . . 208 lpm

Diverter Valve Switch Point . . . . . 1400 -1600 RPM

Spring Rates

DESCRIPTION	FREE LENGTH	TEST LENGTH	TEST LOAD
Valve spool spring	65.0 mm	50.8 mm	490 N
Orifice piston spring	25.4 mm	12.7 mm	290 N

Special Torques

Pump body stud nuts:

Front Section (SAE-10W Oil Applied) . . . . . 220 - 240 Nm
Rear Section (SAE-10W Oil Applied) . . . . . 110 - 120 Nm

4. PUMP FLOW TEST

NOTE: *Before flow rating this pump, check to see that the diverter valve section of this pump is functioning properly. Refer to "DIVERTER VALVE SWITCH POINT TEST AND ADJUSTMENT" in this section.*

Pump failure is most easily discovered by sign such as noise or leakage at the pump housing. If no external signs are present, a flow meter should be used to check pump output.

STEERING ELEMENT CHECK: When checking the steering element flow, the flow meter must be installed between the steering element and the steering valve.

SWITCH ELEMENT CHECK: When checking the switch element flow, the flow meter must be installed between the switch element and the hose manifold (mounted above the transmission) which joins the flow from the switch element with the flow from the hydraulic pump.

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STEERING / SWITCH PUMP

1. Start the engine and warm the hydraulic oil to operating temperature.

IMPORTANT: *If the flow meter has been installed before the oil warm-up procedure, be sure the adjustable restrictor in the meter is completely open during warm-up, or the pump could be severely damaged.*

2. Accelerate the engine to full throttle. Set the adjustable restrictor to 3450 kPa and record the flow rate of the pump.
3. With the engine still at full throttle, increase the adjustable restrictor setting to 10350 kPa. Record the flow rate at this pressure.
4. Decelerate to low idle and completely open the adjustable restrictor to free flow.
5. The switch element output is rated at 244 lpm at 2100 RPM at 0 kPa. The steering element output is rated at 208 lpm at 2100 RPM at 0 kPa. However, the pump is considered acceptable if the flow rate did not drop more than 10 percent between Steps 2 and 3.

5. DIVERTER VALVE SWITCH POINT TEST AND ADJUSTMENT

WARNING! Be sure the area in front and behind the machine is clear of personnel and obstructions. DO NOT allow anyone near the tires or on the access ladders during this test.

1. Place the machine in a straight ahead position and install the frame locking bar.
2. If the machine does not have a tachometer, install one for this test.
3. Connect a 30000 kPa pressure gauge to the quick disconnect (3, Fig. 10A.6) on the side of the diverter valve section of the pump. The gauge hose should be long enough to place the gauge inside the cab.
4. Start the engine and operate at low idle.
5. Turn the steering into a full turn in either direction. The test gauge should be reading approximately 17240 kPa.
6. Slowly depress the accelerator, increasing the engine speed. The pressure gauge reading will suddenly drop, indicating that the diverter valve has shifted the flow to the hydraulic system. At this point, read the tachometer. Record the reading.
7. Slowly decrease the engine speed. When the pressure gauge jumps back up, read the tachometer and record the reading. Continue to decrease the engine speed to low idle.
8. The diverter valve should shift the flow to the hydraulic system when the engine speed reaches between 1400 to 1600 RPM. The diverter valve will shift back to the steering system when the engine speed drops below 1400 RPM.
9. If the diverter valve has shifted at these specified readings, the valve is working properly.
10. If the diverter valve has not shifted at these specified readings, it may be out of adjustment. The adjustment is made at the adjustment screw plug (5, Fig. 10A.1) near the switch element outlet hose.

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11. Adjust the diverter valve switch point as follows (Fig. 10A.4):
    a. Remove the plug (1). Remove the set screw (2).

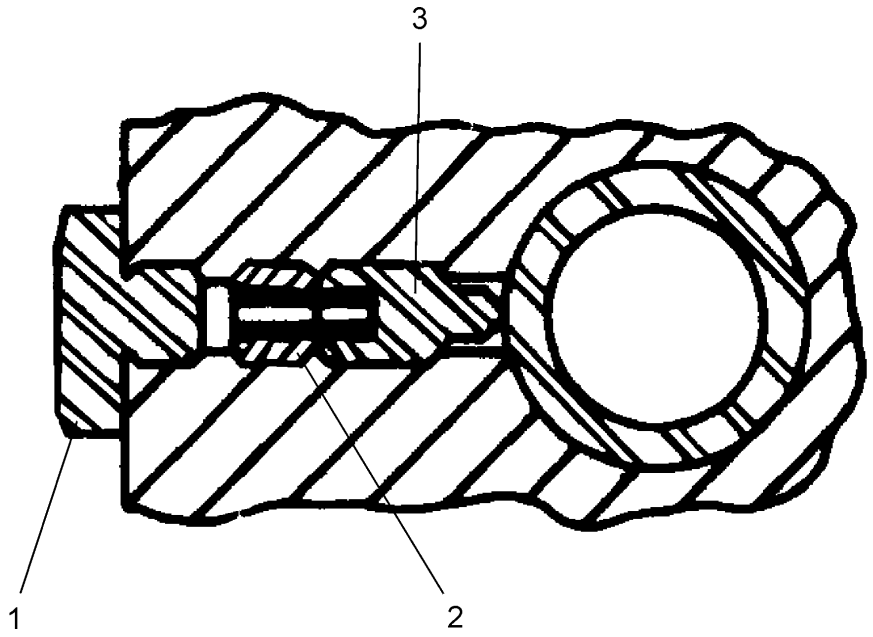


Fig. 10A.4. Pump Diverter Valve Adjustment Point

1. Plug
2. Set Screw
3. Adjustment Screw

    b. Turn the adjustment screw (3) clockwise to shift the switch point to a lower RPM. Turn the adjustment screw counterclockwise to shift the switch point to a higher RPM.
    c. The adjustment screw should only be turned a small amount at a time. Install and tighten the set screw (2) and repeat Steps 5 through 8. Continue to adjust and recheck the switch point in small increments until the correct setting is achieved.
    d. Install and tighten the set screw (2). Install the plug (1).

12. If the switch point is higher than the correct specification and can not be brought into specification through adjustment, the switch element (3, Fig. 10A.1) is probably inefficient. This could cause the hydraulic system to be slow, which can be verified as described under "HYDRAULIC SYSTEM PERFORMANCE TEST" in SECTION 10. Also, the switch element output can be checked using a flow meter as described under "PUMP FLOW TEST" in this section.
13. If the switch point is lower than the correct specification and can not be brought into specification through adjustment, the diverter valve is probably malfunctioning. This could cause the steering system to respond faster than normal, which can be verified as described under "STEERING SYSTEM PERFORMANCE TEST" in SECTION 10.

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STEERING / SWITCH PUMP

6. REMOVAL

IMPORTANT: *Disconnected hydraulic 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 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.*

WARNING! Be sure the bucket is lowered to the ground, the parking brake is ON and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

1. Remove the left fenders (1, Fig. 10A.5), left cover (2) from the bulkhead and cover (3) (if equipped).
2. Drain the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
3. Disconnect the inlet tube (1, Fig. 10A.6) from the hydraulic reservoir and the hoses (4, 5 and 6) from the pump (2).

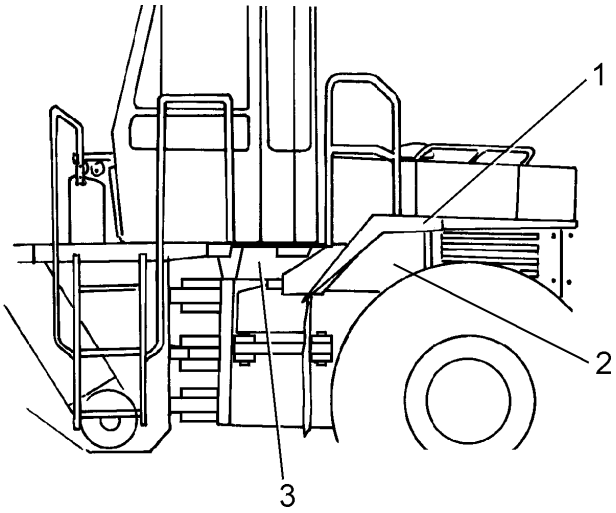


Fig. 10A.5. Covers Removing

1. Left Fenders
2. Left Cover
3. Cover (if equipped)

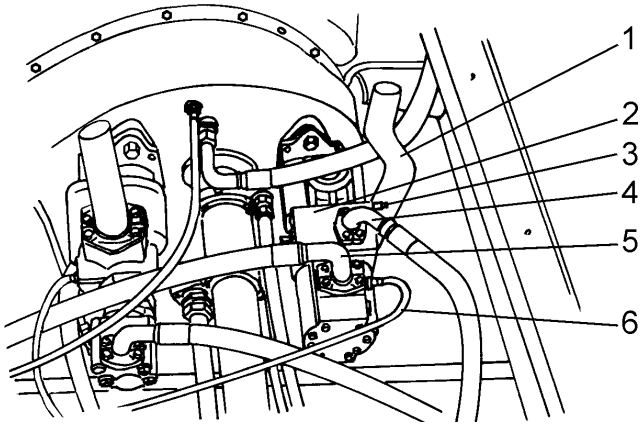


Fig. 10A.6. Steering/Switch Pump Disconnecting Points (Top View)

1. Inlet Tube
2. Steering/Switch Pump
3. Quick Disconnect
4. Hose
5. Hose
6. Hose

4. Remove the hardware securing the pump (2, Fig. 10A.6) to the torque converter.
5. Remove the steering/switch pump (2) with inlet tube (1) from the machine.
6. Remove the inlet tube (1) from the pump (2).
7. Remove and discard mounting O-ring.

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STEERING / SWITCH PUMP

7. DISASSEMBLY (Refer to Fig. 10A.7)

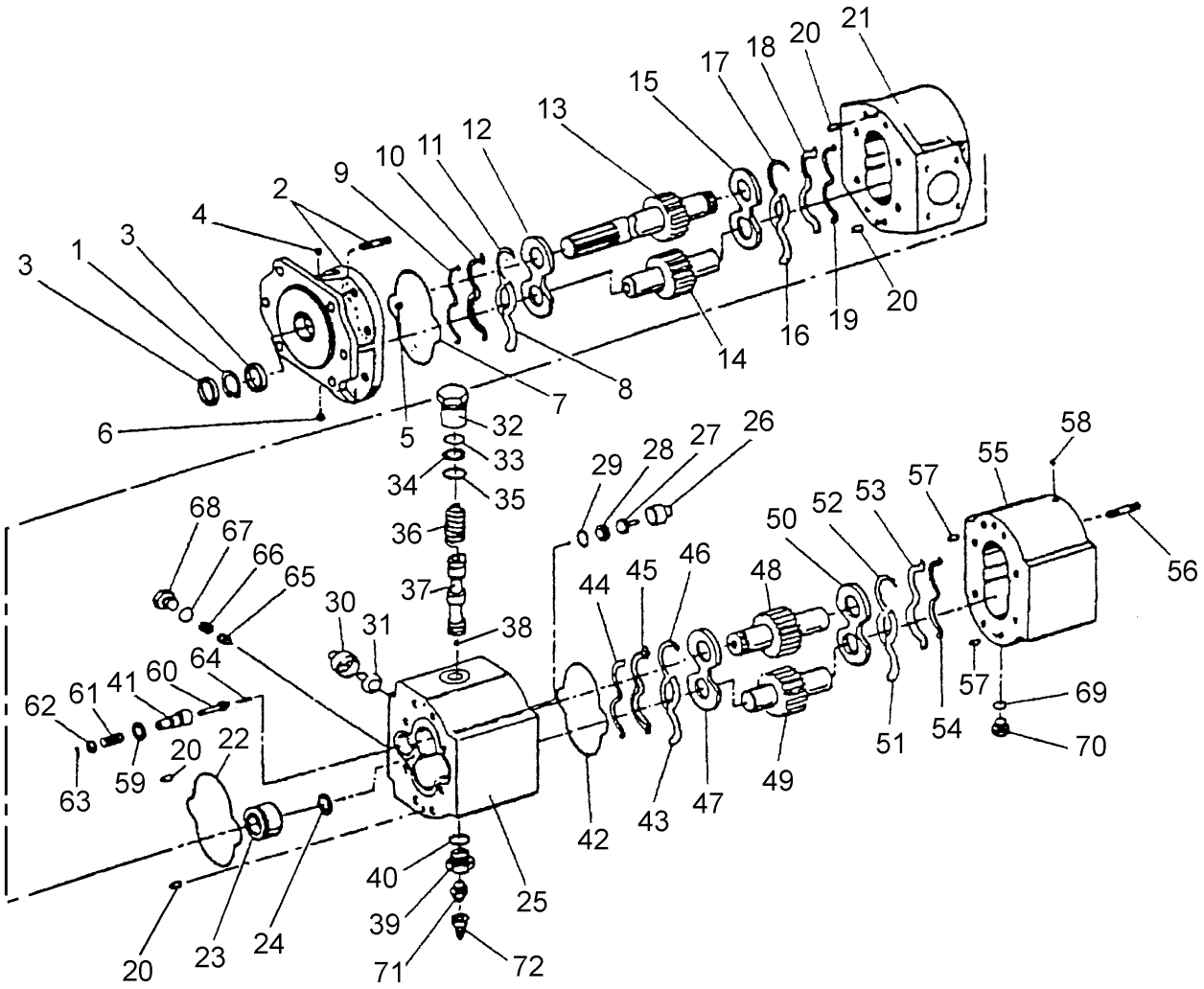


Fig. 10A.7. Exploded View of Steering / Switch Pump

1. Spacer Ring
2. Flange and Stud
3. Seals
4. Steel Ball
5. Flange Plug
6. Plug
7. O-Ring
8. Isolation Plate
9. O-Ring
10. Backup Ring
11. Retainer Ring
12. Pressure Plate
13. Drive Gear Shaft
14. Idler Gear Shaft
15. Pressure Plate
16. Isolation Plate
17. Backup Ring
18. Retainer Ring
19. O-Ring
20. Dowel Pins
21. Body
22. O-Ring
23. Splined Coupling
24. Snap Ring
25. Valve Block
26. Retainer
27. Piston
28. Seat
29. O-Ring
30. Retainer
31. Piston
32. Plug
33. O-Ring
34. Backup Ring
35. O-Ring
36. Spring
37. Valve Spool
38. Set Screw
39. Adapter
40. O-Ring
41. Orifice
42. O-Ring
43. Isolation Plate
44. O-Ring
45. Retainer Ring
46. Backup Ring
47. Pressure Plate
48. Drive Gear Shaft
49. Idler Gear Shaft
50. Pressure Plate
51. Isolation Plate
52. Backup Ring
53. Retainer Ring
54. O-Ring
55. Body
56. Stud
57. Dowel Pins
58. Steel Ball
59. Snap Ring
60. Piston
61. Spring
62. Washer
63. Cotter Pin
64. Roll Pin
65. Adjusting Screw
66. Set Screw
67. O-Ring
68. Plug
69. O-Ring
70. Plug
71. Connector
72. Quick Disconnect

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STEERING / SWITCH PUMP

1. Thoroughly clean the exterior of the pump with a suitable solvent to remove accumulated grime. Dry with compressed air.
2. To disassemble the pump, secure it, drive shaft up, in a vise having protective jaws. Index mark pump sections with a center punch, scribe or indelible marker.
3. Remove the nuts and washers which secure the mounting flange (2). A tap with a soft mallet may be necessary to free the flange from the dowel pins (20).
4. Remove the O-ring (7) from the mounting flange. Remove the two seals (3) and the spacer ring (1). Do not remove the ball (4), relief valve (6) or flange plug (5) as they are not individually replaceable.
5. Using two nuts, "double nut" the pump studs (2) and unthread them from the body (21).
6. Remove isolation plate (8), backup ring (10), O-ring (9) and retainer ring (11) from pressure plate (12).
7. Lift up on the pump drive gear shaft (13) to dislodge the pressure plate (12) from the front body (21). Remove the pressure plate. Match mark the gear shafts (13 and 14) to each other for ease of reassembly. Remove both gear shafts from the body (21).

IMPORTANT: *Be careful in removing the inner pressure plate (15) as it will bind in the body if it is not straight during removal.*

8. Remove inner pressure plate (15), isolation plate (16), retaining ring (18), backup ring (17) and O-ring (19).
9. Remove the front body (21) with dowel pins (20). A tap with a soft mallet may be necessary to free the body from the dowel pins (20) in the valve block (25).

NOTE: *Keep all the components removed from the body (21). Separate from those to be removed from the body (55) later in disassembly.*

10. Remove the splined coupling (23) from the end of the drive gear shaft (48). Remove the snap ring (24) from the coupling only if replacement is necessary. Remove the O-ring (22) from the valve block (25).
11. Turn the pump over and remove the nuts and washers from the rear studs (56). Remove the rear studs in a manner described in Step 5. Carefully turn the pump front side up again and remove the valve block (25). A tap with a soft mallet may be necessary to free the valve block from the dowel pins (57). Remove the O-ring (42) from the valve block. Set the valve block aside for later disassembly.
12. Remove isolation plate (43), backup ring (46), O-ring (44) and retainer ring (45) from the pressure plate (47).
13. Lift up on the drive gear shaft (48) to dislodge the pressure plate (47). Remove the pressure plate. Match mark the gear shafts (48 and 49) to each other for ease of reassembly. Remove both gear shafts from the body.

IMPORTANT: *Be careful in removing the inner pressure plate (50) as it will bind in the body if it is not straight during removal.*

14. Remove inner pressure plate (50), isolation plate (51), backup ring (52), O-ring (54) and retainer ring (53) from the rear body (55).
15. Scribe or mark the plug (70) to the rear body for easy rematching during assembly. Remove the plug (70) and O-ring (69).

NOTE: *Do not remove the steel ball (58) as it is not individually replaceable.*

16. Scribe or mark the plug (32) to the valve block for easy rematching during assembly. Remove the plug. Remove the O-ring (33), O-ring (35) and backup ring (35) from the plug (32).

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17. Remove the spring (36). Slide the valve spool (37) out of the valve block. Do not force it. If the spool hangs up, work it back and forth until it freely slides out. Do not remove the set screw (38) from the spool unless necessary.
18. To remove the internal check valve parts (26 thru 29), tap two opposite holes in the retainer (26) with 3/8" x 16 tap. Use a 3/8" capscrew in each hole as a jack to remove the retainer from the bore. Apply force evenly to both capscrews to avoid damage to the bore.
19. Remove the piston (27). Use external snap ring pliers to remove the seat (28) with O-ring (29).
20. To remove the orifice piston assembly (41 and 59 thru 63), remove the cotter pin (63), washer (62) and spring (61). Remove the snap ring (59) to remove the orifice (41) and the piston (60).
21. To remove the piston (31), tap two opposite holes in the retainer (30) with a 3/8" x 16 tap. Use a 3/8" capscrew in each hole as a jack to remove the retainer from the bore. Apply force evenly to both capscrews to avoid damage to the bore.
22. Do not disturb the diverter valve switch point assembly (65 through 68) unless replacement is necessary. If so, remove the plug (68) and O-ring (67). Remove the set screw (66). Remove the adjustment screw (65).
23. To finish disassembly of the valve block, loosen the adapter (39) and remove it with O-ring (40), connector (71) and quick disconnect (72).

8. INSPECTION AND REPAIR

1. Clean all metal parts in solvent and dry with compressed air.
2. It is recommended that all new: O-rings, seals, scraper rings, retaining rings and backup rings be installed when the steering / switch pump is disassembled.
3. Measure the gear track inside the body (21, Fig. 10A.7) and body (55). The nominal depth of this cut is 0.2 mm and should not exceed 0.4 mm if the body is to be reused.
4. Inspect all pump castings for cracks or other damage. Check bushing areas of pump shafts for grooves or scoring. Inspect the sides or face of the gears for excessive wear. If gear teeth edges are sharp, break edges with emery cloth.
5. Check for damage, distortion or weakness of springs (36 and 61, Fig. 10A.7). Refer to "SPECIFICATIONS" in this section.

9. REASSEMBLY (Refer to Fig. 10A.7)

NOTE: *Lubricate all parts with clean hydraulic oil before reassembly.*

IMPORTANT: *Be sure to assemble the pump castings correctly by aligning the index marks made at disassembly. The valve block (25) and bodies (21 and 55) have a wide and narrow cored passage. The side with the wide cored passage is the suction (inlet) side of the pump.*

1. Install the plug (70) with O-ring (69) to the body (55). Install plug until tightened securely and index marks made at disassembly are aligned.
2. Position the body (55) on a bench with the gear bore up. Install the dowel pins (57) in the body.
3. A close examination of the isolation plates (43 and 51) will reveal that one of them has beveled edges and the other square edges. Refer to Fig. 10A.8.

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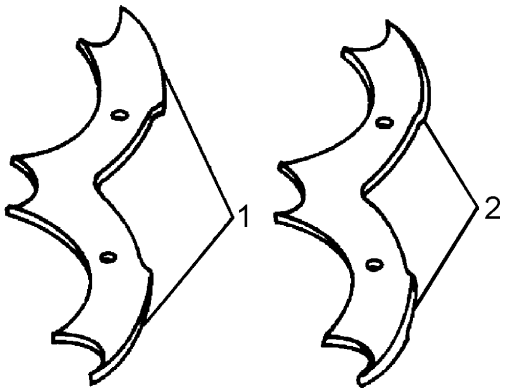


Fig. 10A.8. Isolation Plates

1. Plates with Square Edges
2. Plates with Beveled Edges

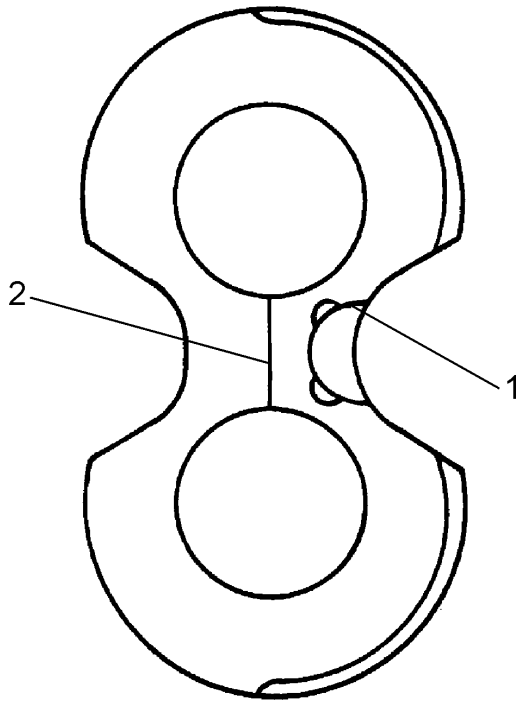


Fig. 10A.9. Pressure Plate

1. Rounded Trap Slots
2. Lube Channel

4. Select the isolation plate (51) with the beveled edge. Install this plate, beveled edge down, into the rear body on the suction (inlet) side of the pump body.
5. Place the backup ring (52) into the body opposite the isolation plate (51). Fit the O-ring (54) into the backup ring and install the retainer ring (53), rounded side down, into body.
6. The pressure plate has rounded trap slots on one side only (Fig. 10A.9). These slots, when plate is installed, must be on discharge side of pump.

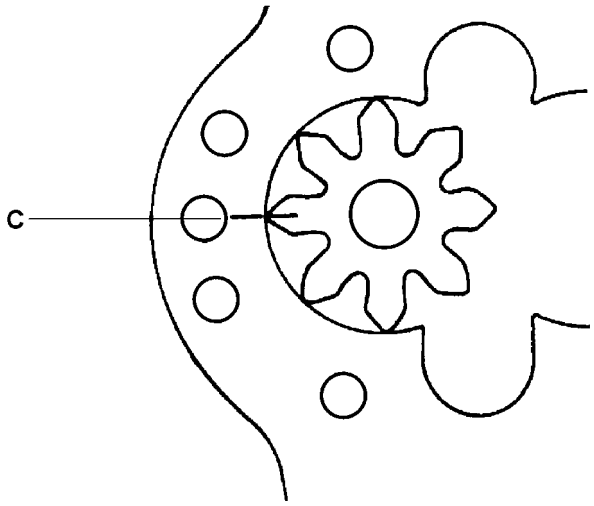


Fig. 10A.10. Gear Timing (Typical Housing Shown)

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7. Install the pressure plate (50) so the rounded trap slots are on the discharge side of the body and the counterbore on the ID of the pressure plate fits over the protruding bushings. If the plate binds on the way down, work it back and forth gently until it slides into position.
8. Coat the gear shafts (48 and 49) with clean hydraulic oil. Install the idler gear and then the drive gear to mesh with the idler gear. When installed properly, the drive gear will be in the right hand bore when viewed from the suction side of the body (55).
9. Before continuing to assemble the pump, this set of gear shafts will have to be positioned in the body for proper timing with the front set of gears. Rotate the gears until the point of a tooth on drive gear is lined up with the center (C, Fig. 10A.10) of the dowel nearest the drive gear. Do not rotate the gears from this position until the front set of gears has been assembled.
10. Install the pressure plate (47), counterbored side up and with the trap slots toward the discharge side into the body (55) until it bottoms on the gears.
11. Install square edged isolation plate (43) into position on the pressure plate on the inlet side of the pump. Place the backup ring (46) onto plate opposite the isolation plate. Fit the O-ring (44) into the backup ring and install the retainer ring (45), rounded side down into the body.
12. Install the adjustment screw (65) into the valve body (25) so that it almost, but not quite, enters the bore for the orifice (41). Maintain this position and install the set screw (66). Install the O-ring (67) onto the plug (68) and loosely install the plug into the valve body. Final adjustment will be made after the pump is installed on the machine.
13. Install O-ring (29) onto the check valve seat (28). Install the seat in the internal check valve bore, with the chamfered edge of the seat entering the bore first.
14. Install the piston (27) in the retainer (26). Place the valve block (25) in a press or a vise. Center the retainer with piston in the check valve bore. Place a bushing or wrench socket over the retainer to act as a protective sleeve and slowly press the retainer into position. When properly positioned, the entire retainer will be flush to 0.5 mm below the surface or the valve block.
15. Press the external check valve retainer (30) with piston (31) into the valve block in a similar manner. When properly positioned, the large diameter of the retainer (the surface with the tapped holes) will be flush to 0.5 mm below the surface of the valve block.
16. Slide the valve spool (37) into the valve block so the set screw (38) enters first. The spool should slide freely in the bore.
17. Slide the spring (36) into the bore. The inner end of the spring should seat inside the valve spool.
18. Install new O-rings (33 and 35) and backup ring (34) onto the plug (32). Install the plug into the valve block and tighten the plug until the scribe marks made during disassembly are aligned.
19. Install the adapter (39) with O-ring (40), connector (71) and quick disconnect (72) in the bore opposite the plug (32).
20. To install the orifice piston assembly (41 and 59 thru 63), install the piston (60) through the orifice (41). Place the valve block (25) in a press or vise. Be sure the roll pin (64) is in position in the block. Center the orifice and piston in the bore in line with the roll pin. Place a bushing or wrench socket over the orifice to act as a protective sleeve and slowly press the orifice into position. Secure it with the snap ring (59).
21. Install the spring (61) and washer (62) over the end of the piston (60) and secure in place with the cotter pin (63).
22. Install the O-ring (42) in its groove on the side of the valve block (25) with the protruding bushings. Use clean heavy grease to hold the O-ring in the groove when the valve block is installed on the body (55).

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23. Slide the valve block (25) down on the gear shafts until the valve block makes contact with the dowel pins in the body (55). Seat the valve block on the body using caution to keep the valve block level. If the surfaces are not parallel when the bushing enters the backup ring in the body, the bushing will pinch and damage the backup ring.
24. Hold the valve block and the rear body together and slide the partially assembled unit to the edge of the work bench. Install the rear studs (56) up through the bottom of the rear body. Lubricate stud threads with SAE-10W oil. Install the washers and nuts. Tighten the nuts enough to hold the unit together.
25. Install the coupling (23) with snap ring (24) on the drive gear shaft (48) being careful not to rotate the drive gear shaft and upset the timing position performed earlier in reassembly.
26. Install the O-ring (22) in the groove of the valve block (25). Use heavy grease to keep the O-ring in the groove. Install the dowel pins (20) in the valve block.
27. Install the dowel pins (20) in the body (21) on the side with the open gear bore. Install the body, gear bore side up, on the valve block.
28. From the two remaining isolation plates, select the one with the beveled edge (Fig. 10A.8). Install this plate (16), beveled edge down, into the body cavity over the protruding bushings so it is on the suction side.
29. Place the backup ring (17) over the protruding bushings in the body cavity, opposite the isolation plate. Fit the O-ring (19) into the backup ring and install the retainer ring (18), rounded side down, into the body.
30. Install the pressure plate (15) so the rounded trap slots are on the discharge side of the body and the counterbore on the ID of the pressure plate fits over the protruding bushings. If the plate binds on the way down, work it back and forth gently until it slides into position.
31. Coat the front drive gear shaft journals with clean hydraulic oil. With the extension end up, slide the gear (13) down the bore until the splines contact the spline coupling. Do not engage the spline of the shaft in the coupling yet. To time the front set of gears with the rear set, rotate the shaft so that the center of the valley between two teeth is lined up with the center of the dowel nearest the gear. If the spline on the shaft will not enter the coupling, lift the shaft slightly and rotate it to the next valley. Continue to do this until the combination is found that will allow the valley between two gear teeth to line up with the center of the dowel. Do not turn the rear shafts while trying for the correct combination.
32. Coat the journals of the front idler gear (14) with clean hydraulic oil. Slide the gear down into position. Do not drop gear into position. Dropping will damage the bronze surface on pressure plate (15).
33. Repeat Steps 10 and 11 for installing items (8 thru 12) into the body (21).
34. Double nut four body studs (2) and using the nuts, install and tighten the studs. Remove the nuts and use them to install the remaining studs.
35. Press a new seal (3), lip end first, into the flange (2) until the groove for the spacer ring (1) is exposed. The maximum allowable depth, the seal should be pressed into the flange, is 21.4 mm below the surface of the flange. Install the spacer ring (1). Press the other new seal, lip end out, into the flange until the outer edge of the seal is a minimum of 7.2 mm below the surface of the flange. Liberally coat the ID of both seals with clean grease.

IMPORTANT: *Press only on the metal surfaces of the oil seals.*

36. Coat the splines of the drive gear shaft (13) with clean, heavy grease to protect the seals (3) during installation of the mounting flange.
37. Install the O-ring (7) into the groove of the mounting flange, using heavy grease to hold it in position during flange installation.

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38. Carefully slide the flange down on the gear shafts and the studs until contact is made with the dowel pins in the body (21). The flange must be started squarely on the dowels to prevent damage to the backup ring in the body as the gear bushings enter it.
39. Lubricate the stud threads with SAE-10W oil and install the washers and nuts.
40. Torque the front section stud nuts to 220 - 240 Nm. Torque the rear section stud nuts to 110 - 120 Nm.
41. Check to see if the pump shaft can be turned by hand using a wrench approximately 250 mm long.

NOTE: *If the shaft will not turn, disassemble the pump and examine for burrs, foreign material or incorrect assembly causing build-up or interference in the parts. Correct cause and reassemble the pump.*

10. INSTALLATION

1. Install the inlet tube (1, Fig. 10A.6) and mounting O-ring to the steering / switch pump (2).
2. Position the pump assembly into machine and install into torque converter aligning pump shaft splines with torque converter drive gear. Using mounting hardware secure the pump ti the torque converter.
3. Connect the inlet tube (1, Fig. 10A.6) to the hydraulic reservoir.
4. Connect the hoses (4, 5 and 6, Fig. 10A.6) to the pump (2).
5. Fill the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
6. Start the engine and check for leakage at the pump sections and hoses connections.
7. Check the oil level and add if necessary.
8. Install the left cover (2, Fig. 10A.5) to the bulkhead, left fender (1) and cover (3) (if equipped).
9. Adjust the switch point setting. Refer to "DIVERTER VALVE SWITCH POINT TEST AND ADJUSTMENT" in this section.

HYDRAULIC AND BRAKE COOLING PUMP

11. DESCRIPTION

The large section of the tandem pump, mounted to the torque converter housing on the right side of the machine provide the oil flow for the hydraulic and brake cooling system.

The Fig. 10A.11 shows the separate pump oil inlet ports and the pump drain port that is marked by an asterisk. The two pump outlet ports (not visible) are on the direct opposite side from the inlet ports.

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HYDRAULIC AND BRAKE COOLING PUMP

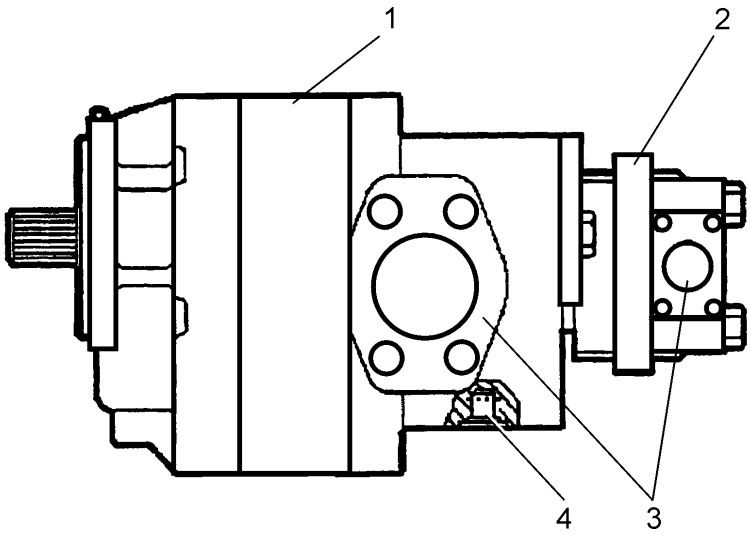


Fig. 10A.11. Hydraulic and Brake Cooling Pumps

1. Hydraulic Pump
2. Brake Cooling Pump
3. Pump Inlet Ports
4. Pump Drain Port

12. THEORY OF OPERATION

The subject pumps are conventional type gear pumps that receive oil from the pressurized reservoir (directly above) and discharge directly to their respective hydraulic systems. No pressure relief or switching devices are incorporated in these pumps.

The pump drain port shown at the bottom of the pump is used to protect the pump under abnormal (or undesirable) operating conditions. Under the conditions of a high (or relief) pressure demand from the hydraulic or brake cooling system when the engine is at low idle, the first thing that happens is that the engine RPM is reduced further by the hydraulic pump load. In this circumstance, most of the oil being pumped stays within the pump to satisfy its internal lubrication needs. The problem is that a good portion of the lube system oil flow would stay within the pump and become hotter and hotter with each successive cycle through the lube system, (with age and loss of pump efficiency, the problem is magnified). The pump drain line provides the means to constantly the pump lube oil back to the reservoir while it is being replaced with fresh oil from the inlet port.

13. SPECIFICATIONS

Type:

Hydraulic Pump	Single Element Gear
Brake Cooling Pump	Single Element Gear

Pump Output at 2100 Engine RPM and Free Flow:

Hydraulic Pump	370 lpm
Brake Cooling Pump	133 lpm

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PUMPS

HYDRAULIC AND BRAKE COOLING PUMP

14. HYDRAULIC PUMP FLOW TEST

Pump failure is most easily discovered by signs such as noise or leakage at the pump housing. If no external signs are present, a flow meter should be used to check pump output.

1. Start the engine and warm the hydraulic oil to operating temperature.

IMPORTANT: *If the flow meter has been installed before the oil warm-up procedure, be sure the adjustable restrictor in the meter is completely open during warm-up, or the pump could be severely damaged.*

2. Accelerate the engine to full throttle. Set the adjustable restrictor to 3450 kPa and record the flow rate of the pump.
3. With the engine still at full throttle, increase the adjustable restrictor setting to 10350 kPa. Record the flow rate at this pressure.
4. Decelerate to low idle and completely open the adjustable restrictor to free flow.
5. The pump output is rated at 370 lpm at 2100 RPM at 0 kPa. However, the pump is considered acceptable if the flow rate did not drop more than 10 percent between Steps 2 and 3.

15. REMOVAL

IMPORTANT: *Disconnected hydraulic 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 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.*



WARNING! Be sure the bucket is lowered to the ground, the parking brake is ON and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

Hydraulic Pump

1. Remove the right fenders (1, Fig. 10A.12), right cover (2) from the bulkhead and cover (3) (if equipped).
2. Drain the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
3. Remove the inlet tube (7, Fig. 10A.13) from the hydraulic pump.
4. Unscrew bolts securing the brake cooling pump (2, Fig. 10A.13) to the hydraulic pump (6) and remove the brake cooling pump from the hydraulic pump.
5. Disconnect the houses (3 and 4, Fig. 10A.13) from the hydraulic pump (6).
6. Unscrew bolts (8, Fig. 10A.13) securing the hydraulic pump to the torque converter and remove the pump from the machine.
7. Remove the manifold from the bottom of hydraulic pump.
8. Remove and discard mounting O-ring.

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HYDRAULIC AND BRAKE COOLING PUMP

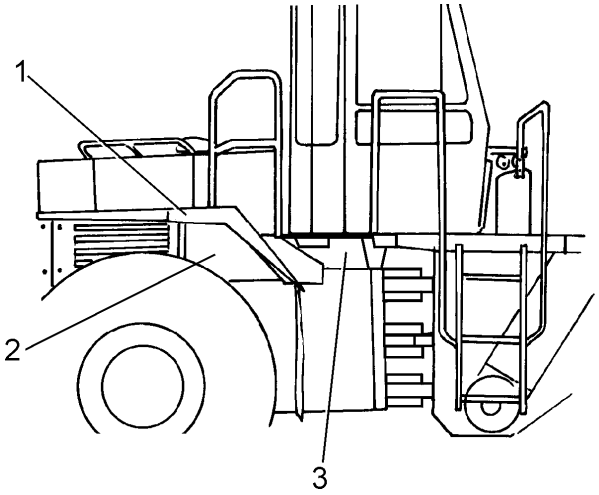


Fig. 10A.12. Covers Removing

1. Right Fenders
2. Right Cover
3. Cover (if equipped)

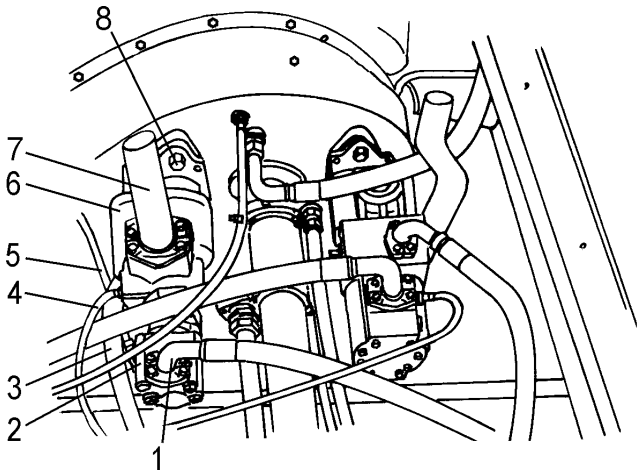


Fig. 10A.13. Hydraulic and Brake Cooling Pump Disconnecting Points (Top View)

1. Hose
2. Brake Cooling Pump
3. Hose
4. Hose
5. Hose
6. Hydraulic Pump
7. Inlet Tube
8. Mounting Bolts

Brake Cooling Pump

1. Remove the right fenders (1, Fig. 10A.12), right cover (2) from the bulkhead and cover (3) (if equipped).
2. Drain the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
3. Disconnect the houses (1 and 5, Fig. 10A.13) from the brake cooling pump (2).
4. Unscrew bolts securing the brake cooling pump (2) to the hydraulic pump (6) and remove the brake cooling pump from the hydraulic pump. Remove the brake cooling pump from the machine
5. Remove and discard mounting O-ring.

16. DISASSEMBLY (Refer to Fig. 10A.14)

Legend for Fig. 10A.14

1. Bolts
2. Washers
3. Body
4. Dowel Pins
5. O-Ring
6. Bearing
7. O-Ring
8. Backup Ring
9. O-Ring
10. Pressure Plate
11. Gear Body
12. Idler Gear Shaft
13. Drive Gear Shaft
14. Bolts
15. Mounting Flange
15A. Plug
16. Seals
17. Spacer Ring
18. O-Ring
19. Coupling
20. Body
21. Dowel Pins
22. O-Ring
23. Bearing
24. O-Ring
25. Backup Ring
26. Pressure Plate
27. Gear Body
28. Idler Gear Shaft
29. Drive Gear Shaft
30. Mounting Flange
31. Seals
32. Spacer Ring
33. Plug
34. Studs
35. Nuts

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PUMPS

HYDRAULIC AND BRAKE COOLING PUMP

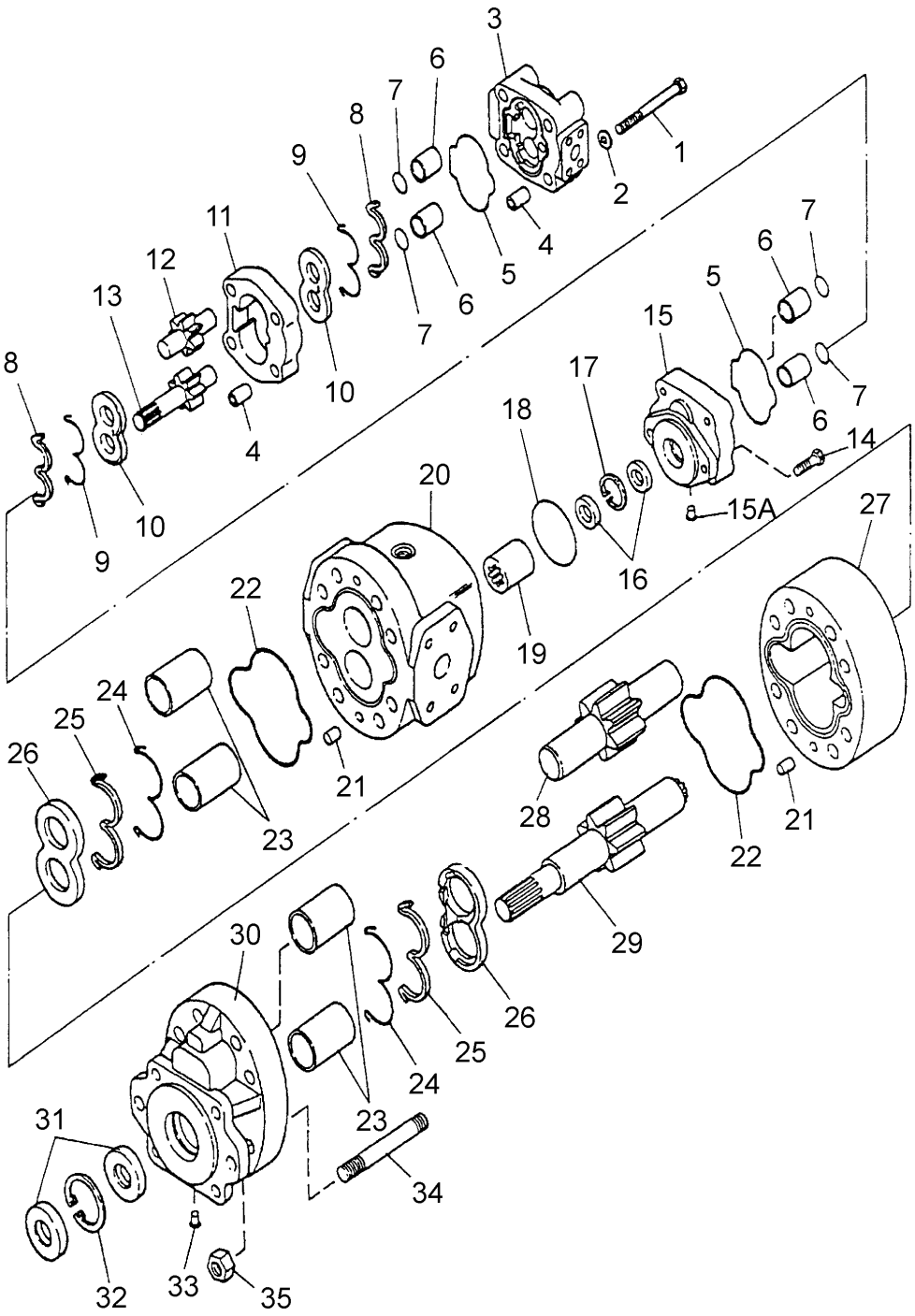


Fig. 10A.14. Exploded View of Hydraulic and Brake Cooling Pumps

Hydraulic Pump

1. Thoroughly clean the exterior of the pump with a suitable solvent to remove accumulated grime. Dry with compressed air.
2. Position the pump on a bench having a clean work area so the drive shaft is pointing up. Index mark the pump bodies and mounting flange to retain correct relationship during reassembly.
3. Remove the nuts (35) securing the pump section.

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HYDRAULIC AND BRAKE COOLING PUMP

IMPORTANT: *Do not pry the pump bodies and mounting flange apart with a screwdriver or other similar tool, as such action can damage machined sealing surfaces.*

4. Using a soft mallet, tap around the mounting flange (30) to free it from the dowel pins (21) in the gear body (27). Remove the mounting flange.
5. Remove the oil seals (31) and spacer ring (32) from the mounting flange (30). Do not remove the plug (33) as it is not individually replaceable.
6. Remove the pressure plate (26), backup ring (25) and O-rings (22 and 24).
7. Lift up slightly on the pump gear shafts to dislodge the pressure plate (26) from the bore. Match mark the teeth of the drive gear shaft (29) and idler gear shaft (28) for correct reassembly and remove them from the gear body (27).
8. Tap around the gear body (27) with a soft mallet to free it from the dowel pins (21) in the body (20). Remove the gear body.
9. Remove the pressure plate (26), backup ring (25) and O-rings (22 and 24).
10. If necessary remove the bearings (23) and coupling (19).

Brake Cooling Pump

1. Thoroughly clean the exterior of the pump with a suitable solvent to remove accumulated grime. Dry with compressed air.
2. Position the pump on a bench having a clean work area so the drive shaft is pointing up. Index mark the pump bodies and mounting flange to retain correct relationship during reassembly.
3. Remove the bolts (1) with washer (2) securing the pump section.

IMPORTANT: *Do not pry the pump bodies and mounting flange apart with a screwdriver or other similar tool, as such action can damage machined sealing surfaces.*

4. Using a soft mallet, tap around the mounting flange (15) to free it from the dowel pins (4) in the gear body (11). Remove the mounting flange.
5. Remove the oil seals (16) and spacer ring (17) from the mounting flange (15). Do not remove the plug (15A) as it is not individually replaceable.
6. Remove the pressure plate (10), backup ring (8) and O-rings (5, 7 and 9).
7. Lift up slightly on the pump gear shafts to dislodge the pressure plate (10) from the bore. Match mark the teeth of the drive gear shaft (13) and idler gear shaft (12) for correct reassembly and remove them from the gear body (11).
8. Tap around the gear body (11) with a soft mallet to free it from the dowel pins (4) in the body (3). Remove the gear body.
9. Remove the pressure plate (10), backup ring (8) and O-rings (5, 7 and 9).
10. If necessary remove the bearings (6).

17. INSPECTION AND REPAIR

1. It is recommended that all new O-rings, backup rings, pressure plates and seals be installed when the hydraulic pump or brake cooling pump is disassembled.
2. Clean all metal parts in a suitable solvent and dry with compressed air.

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3. Measure the gear track inside the gear body (27, Fig. 10A.14). The nominal depth of this cut is 0.2 mm and should not exceed 0.38 mm if the gear body is to be reused.
4. Inspect all pump castings for cracks or other damage. Check bushing areas of pump shafts for grooves or scoring. Inspect the sides or face of the gears for excessive wear. If gear teeth edges are sharp, break edges with emery cloth. If any of these parts are found to be unacceptable, a new pump must be installed.

18. REASSEMBLY (Refer to Fig. 10A.14)

Hydraulic Pump

1. If necessary, install bearings (23) using an arbor press or bearing driver. Install the bearings flush with the face of the mounting flange (30) and body (20). Install the coupling (19) in the body (20).
2. Install a new O-ring (24) and backup ring (25) in the groove in pressure plate (26).
3. Install the pressure plate (26), O-ring (22) and dowel pins (21) in the body (20).
4. Install the gear body (27) in the body (20) and seat using a soft hammer. The gear body must be installed with the index marks aligned.
5. Install the drive gear shaft (29) and idler gear shaft (28) in the gear body aligning the index marks on the gear teeth.
6. Install the O-ring (22) and dowel pins (21) in the gear body (27).
7. Install a new O-ring (24) and backup ring (25) in the groove in pressure plate (26).
8. Press a new oil seal (31), lip end first, into the mounting flange (30) until it bottoms. Position the spacer ring (32) on top of the seal. Press another new seal (31), lip end out, into the mounting flange. The other edge of the outer seal must be pressed in a minimum of 0.76 mm below the pilot surface of the flange. Liberally coast the I.D. of both seals with clean greases.

IMPORTANT: *Press only on the metal surfaces of the oil seals.*

9. Install the pressure plate (26) in mounting flange (30).
10. Install the mounting flange (30) in the gear body (27) and seat using a soft hammer. The mounting flange must be installed with the index marks aligned.
11. Lubricate the studs (34) threads with oil and install the nuts (35). Torque the nuts to 325 - 340 Nm.

Brake Cooling Pump

1. If necessary, install bearings (6) using an arbor press or bearing driver. Install the bearings flush with the face of the mounting flange (15) and body (3).
2. Install a new O-ring (9) and backup ring (8) in the groove in pressure plate (10).
3. Install the pressure plate (10), O-rings (5 and 7) and dowel pins (4) in the body (3).
4. Install the gear body (11) in the body (3) and seat using a soft hammer. The gear body must be installed with the index marks aligned.
5. Install the drive gear shaft (13) and idler gear shaft (12) in the gear body aligning the index marks on the gear teeth.

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6. Install the O-ring (5) and dowel pins (4) in the gear body (11).
7. Install a new O-ring (9) and backup ring (8) in the groove in pressure plate (10).
8. Press a new oil seal (16), lip end first, into the mounting flange (15) until it bottoms. Position the spacer ring (17) on top of the seal. Press another new seal (16), lip end out, into the mounting flange. The other edge of the outer seal must be pressed in a minimum of 0.76 mm below the pilot surface of the flange. Liberally coast the I.D. of both seals with clean greases.

IMPORTANT: *Press only on the metal surfaces of the oil seals.*

9. Install the O-ring (7) and the pressure plate (10) in mounting flange (15).
10. Install the mounting flange (15) in the gear body (11) and seat using a soft hammer. The mounting flange must be installed with the index marks aligned.
11. Lubricate the bolts (1) threads with oil and install the bolts with washers (2).

19. INSTALLATION

Hydraulic Pump

1. Position the new mounting O-ring on the front of the hydraulic pump (6, Fig. 10A.13)). Install the manifold to the bottom of hydraulic pump.
2. Position the hydraulic pump as shown in Fig. 10A.13 and install into torque converter aligning pump shaft splines with converter drive gear. Install the bolts (8) and secure the hydraulic pump (6) to the torque converter.
3. Connect the hoses (3 and 4) to the hydraulic pump (6).
4. Install the inlet tube (7) to the hydraulic pump.
5. Install the brake cooling pump (2) to the hydraulic pump (6).
6. Fill the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
7. Start the engine and check for leakage at the pump sections and hoses connections.
8. Check the oil level and add if necessary.
9. Install the right cover (2, Fig. 10A.12) to the bulkhead, right fender (1) and cover (3) (if equipped).

Brake Cooling Pump

1. Position the new mounting O-ring (18, Fig. 10A.14) on the front of the brake cooling pump (2, Fig. 10A.13).
2. Position the brake cooling pump as shown in Fig. 10A.13 and install into hydraulic pump (6). Install the bolts (14) and secure the brake cooling pump to the hydraulic pump.
3. Connect the hoses (1 and 5) to the brake cooling pump (2).
4. Fill the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
5. Start the engine and check for leakage at the pump sections and hoses connections.
6. Check the oil level and add if necessary.
7. Install the right cover (2, Fig. 10A.12) to the bulkhead, right fender (1) and cover (3) (if equipped).

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PUMPS

GROUND DRIVEN STEERING PUMP (IF EQUIPPED)

20. DESCRIPTION AND OPERATION (Refer to Fig. 10A.15)

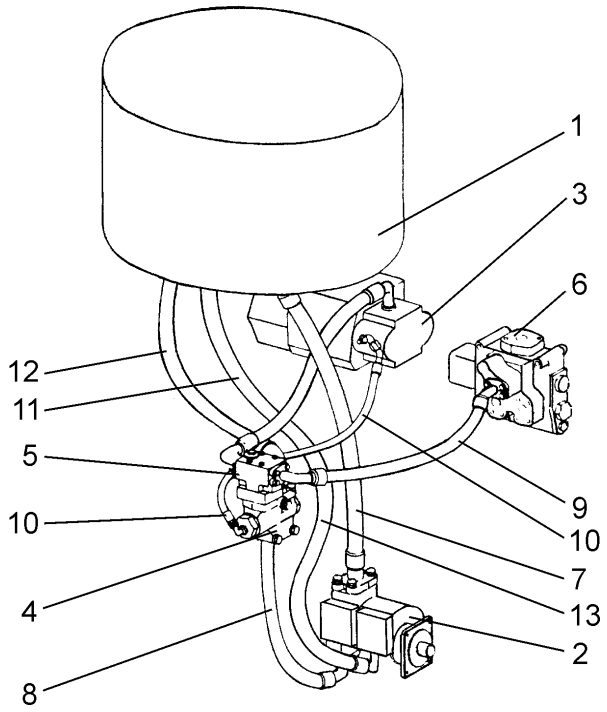


Fig. 10A.15. Ground Driven Steering System

1. Hydraulic Reservoir
2. Ground Driven Steering Pump
3. Steering/Switch Pump
4. Ground Driven Steering Diverter Valve
5. Ground Driven Steering Check Valve
6. Steering Control Valve
7. Pump Inlet Hose
8. Pump Outlet Hose
9. Steering Control Valve Inlet Hose
10. Diverter Valve Pilot Hose
11. Pump Outlet Hose
12. Check Valve Return Hose
13. Drain Hose

The ground driven steering pump (2) is a single element gear type pump. The output of this pump is used to supply a limited volume of hydraulic oil for the steering control valve (6) when the steering element of the steering/switch pump (3) does not supply sufficient oil for steering control.

The ground driven steering pump draws oil from the hydraulic reservoir (1). This oil enters the inlet port on the top of the pump and exits through the outlet port on the bottom from where it is sent to the ground driven steering diverter valve (4).

The ground driven steering pump is mounted to the rear of the transmission housing on the lower, right hand side. The pump drive gear is splined to the emergency steering gear inside the transmission, which is chain driven by the rear gear on the output shaft. The direction of pump rotation changes when the direction of the output shaft rotation changes. Inlet oil is directed by check poppets inside the pump gear body and pump valve body to whichever side of the gear set is functioning as the suction side (according to the direction of rotation). A second set of check poppets direct discharge side oil to the outlet port of the pump.

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GROUND DRIVEN STEERING PUMP (IF EQUIPPED)

21. SPECIFICATIONS

General

Type	Single Element Gear
Rated Capacity	8 lpm at 100 RPM at 0 kPa
Maximum Operating Pressure	17240 kPa
Drive Shaft Turning Torque	Maximum of 35 Nm

Special Torques

Pump Section Stud Bolts (with oil applied)	110 - 120 Nm

22. REMOVAL (Refer to Fig. 10A.16)

IMPORTANT: *Disconnected hydraulic 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 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.*

WARNING! Be sure the bucket is lowered to the ground, the parking brake is ON and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

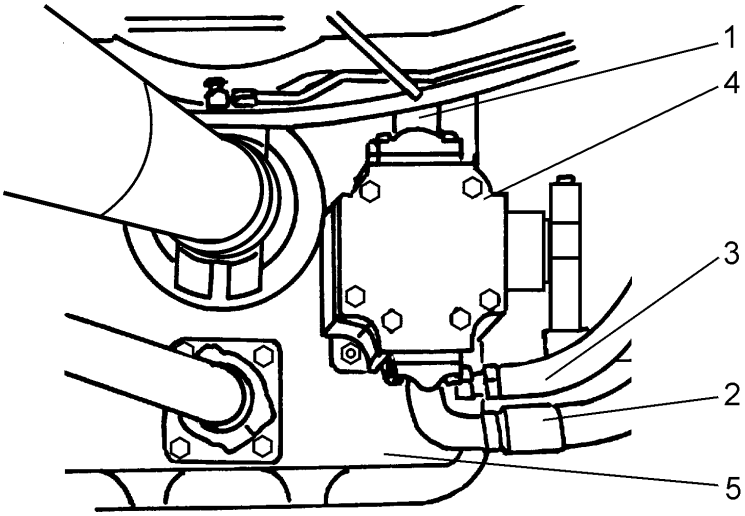


Fig. 10A.16. Ground Driven Steering Pump Disconnecting Points

1. Inlet Hose
2. Outlet Hose
3. Drain Hose
4. Ground Driven Steering Pump
5. Transmission

1. Remove the upper cover (if equipped) and lower cover.
2. Drain the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
3. Drain the transmission. Refer to the OPERATOR'S MANUAL for this procedure.

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GROUND DRIVEN STEERING PUMP (IF EQUIPPED)

4. Disconnect the pump inlet hose (1), outlet hose (2) and drain hose (3) at the ground driven steering pump (4).
5. Remove the pump mounting hardware and remove the pump (4) and mounting O-ring from the transmission (5).

23. DISASSEMBLY (Refer to Fig. 10A.17)

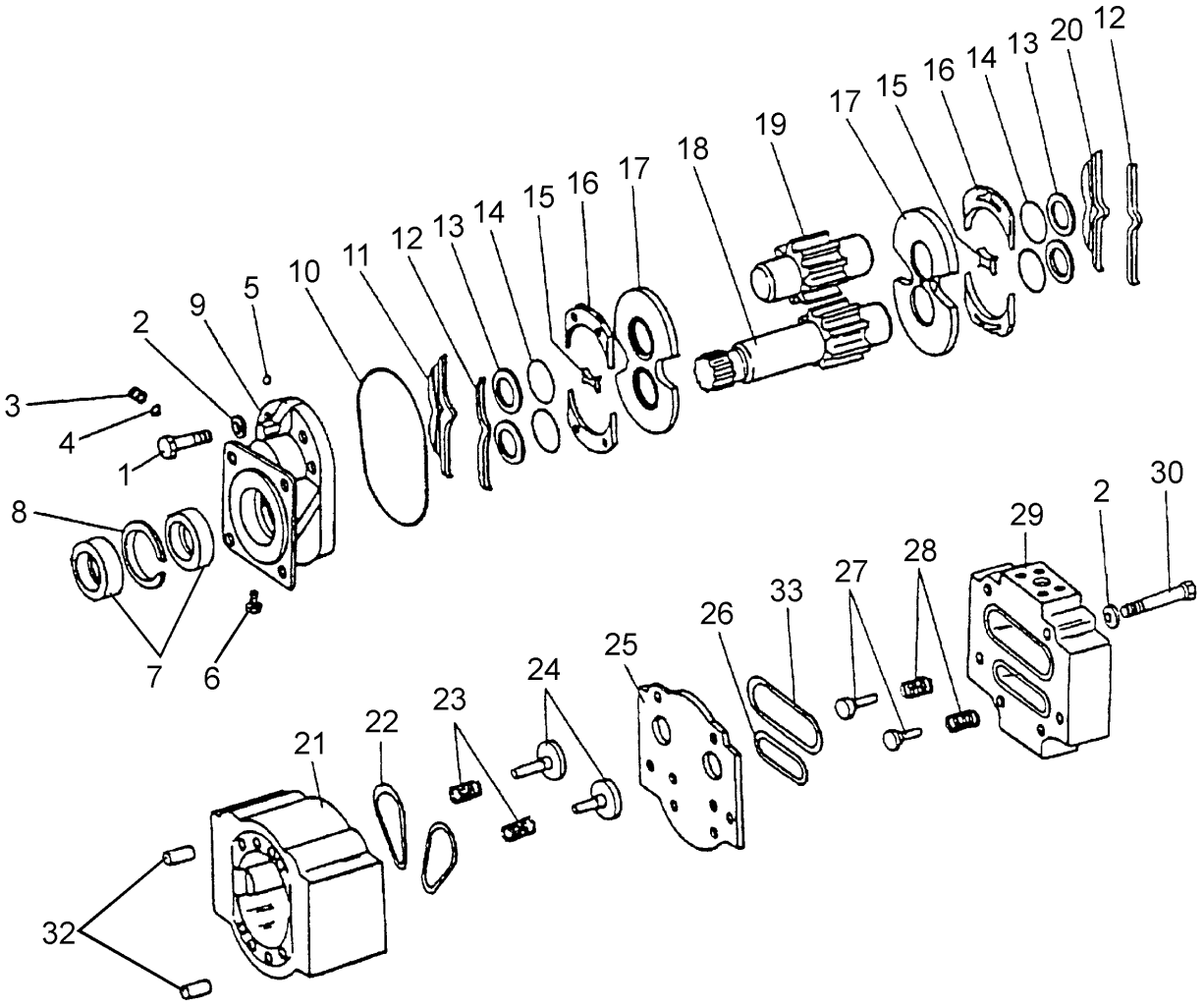


Fig. 10A.17. Exploded View of Ground Driven Steering Pump

1. Bolts
2. Washer
3. Plug
4. Check Ball
5. Steel Ball
6. Relief Plug
7. Seals
8. Spacer Ring
9. Mounting Flange
10. O-Ring
11. Top Isolation Plate
12. Strip Seal
13. Backup Ring
14. O-Ring
15. Center Separator
16. End Separator
17. Pressure Plate
18. Drive Gear
19. Idler Gear
20. Bottom Isolation Plate
21. Gear Body
22. O-Ring
23. Return Spring
24. Gear Body Piston
25. Spacer Plate
26. O-Ring
27. Valve Body Piston
28. Return Spring
29. Valve Body
30. Bolts
32. Dowel Pins
33. O-Ring

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GROUND DRIVEN STEERING PUMP (IF EQUIPPED)

1. Thoroughly clean the exterior of the pump with a suitable solvent to remove accumulated grime. Dry with compressed air.
2. Position the ground driven steering pump on a bench having a clean work area so the drive shaft is pointing up. Index mark the tree pump sections to retain correct relationship during reassembly.
3. Remove the mounting bolts (1) and washers (2). A tap with a soft mallet may be necessary to free the flange from the dowel pins (32).

IMPORTANT: *Do not pry the pump bodys and mounting flange apart with a screwdriver or other similar tool, as such action can damage machined sealing surfaces.*

4. Remove the mounting flange (9). Remove the shaft seals (7) and spacer ring (8) from the flange.
5. Remove the O-ring (10), pressure plate (17), center separator (15), end separators (16), O-rings (14), backup rings (13), strip seal (12) and top isolation plate (11).
6. Lift up slightly on the pump gear shafts to dislodge the pressure plate (17) from the bore. Match mark the teeth of the drive gear shaft and idler gear shaft for correct reassembly and remove them from the gear body (21).
7. Remove the pressure plate (17), center separator (15), end separators (16), O-rings (14), backup rings (13), strip seal (12) and bottom isolation plate (20). Dowel pins (32) need not be removed.
8. Remove the return spring (23) and gear body piston (24) from the gear body (21).
9. Turn the pump over and remove the bolts (30) with washer (2) from the valve body (29).
10. Tap around the valve body (29) with a soft mallet to free it from the gear body (21). Remove the valve body.
11. Remove the return spring (28) and valve body piston (27), O-rings (26 and 33) from the valve body (29).
12. Remove the spacer plate (25) and O-Rings (22) from the gear body (21).

24. INSPECTION AND REPAIR

1. Clean all metal parts in solvent and dry with compressed air.
2. Discard all O-rings, backup ring, isolation plates, spacer plate and the shafts oil seals. These parts should be replaced with new whenever the pump is service.
3. Inspect the pressure plates for grooves or wear. If grooved or if the bronze plating is worn thru, replace the pressure plate.
4. Inspect the pump sections for cracks and replace as necessary.
5. Check the return springs for damage, distortion or weakness.

25. REASSEMBLY (Refer to Fig. 10A.17)

NOTE: *When reassembling the pump, lubricate the component parts with the same oil as used in the hydraulic system.*

1. Install the valve body piston (27), return spring (28) and O-rings (26 and 33) to the valve body (29).

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2. Install the O-Rings (22) and spacer plate (25) to the gear body (21).
3. Install the bolts (30) with the washers (2) and secure the valve body (29) to the gear body (21).
4. Turn the pump over and install the gear body piston (24) and return spring (23) to the gear body (21).
5. Install the center separator (15), end separators (16), O-rings (14), backup rings (13), bottom isolation plate (20) and strip seal (12) in the groove in pressure plate (17).
6. Install pressure plate (17), bronze face up, in gear body (21).
7. Install the drive gear (18) and idler gear (19) in the gear plate aligning the index marks on the gear teeth.
8. Install the center separator (15), end separators (16), O-rings (14), backup rings (13), top isolation plate (11) and strip seal (12) in the groove in pressure plate (17).
9. Install the O-ring (10) and pressure plate (17), bronze face up, in mounting flange (9).
10. Press a new oil seal (7), lip end first, into the mounting flange (9) until it bottoms. Position the spacer ring (8) on top of the seal. Press another new seal (7), lip end out, into the mounting flange. The other edge of the outer seal must be pressed in a minimum of 0.76 mm below the pilot surface of the flange. Liberally coast the I.D. of both seals with clean greases.
11. Install the mounting flange (9) in the gear plate (21) and seat using a soft hammer. The mounting flange must be installed with the index marks aligned.
11. Lubricate the bolts (1) threads with oil and install with washers (2).

26. INSTALLATION (Refer to Fig. 10A.16)

1. Install the pump mounting hardware and install the ground driven steering pump (4) with mounting O-ring to the transmission (5).
2. Connect the pump inlet hose (1), outlet hose (2) and drain hose (3) to the pump (4).
3. Fill the transmission. Refer to the OPERATOR'S MANUAL. for this procedure.
4. Fill the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
5. Start the engine and check for leakage at the pump sections and hose connections.
6. Install the upper cover (if equipped) and lower cover.

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VALVES

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VALVES

SECTION 10B

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STEERING VALVE

1. DESCRIPTION (Refer to Fig. 10B.1)

The steering valve is located on the forward left side of the rear frame. Its function is to direct oil to and from the steering cylinders when the steering wheel is turned.

Although the valve is mounted to the rear frame a mechanical linkage joins the control spool (1) to the steering gear, which is mounted on the front frame. The control spool has three positions: neutral (or straight ahead), left turn and right turn. When the steering wheel is moved for a right hand turn, the control spool is pulled out of the valve. When the frames reach the degree of turn that was indexed by the steering wheel, the linkage will push the spool back into the neutral position. A left hand turn is just the opposite, with the control spool being pushed into the valve.

An adjustable system relief valve assembly (2, Fig. 10B.7) is bolted to the steering valve housing, directly above the inlet port (7, Fig. 10B.1). The relief valve limits system pressure to 17240 kPa.

Located above the main control spool is the locking spool (2), which contains a check valve (9). Above the locking spool are two circuit relief valves (3). These valves are not adjustable and are set to open at 24130 kPa.

Attached to the outside of the valve is a check valve (4). This check valve connects to a crossover hose (10) which leads back to the locking spool.

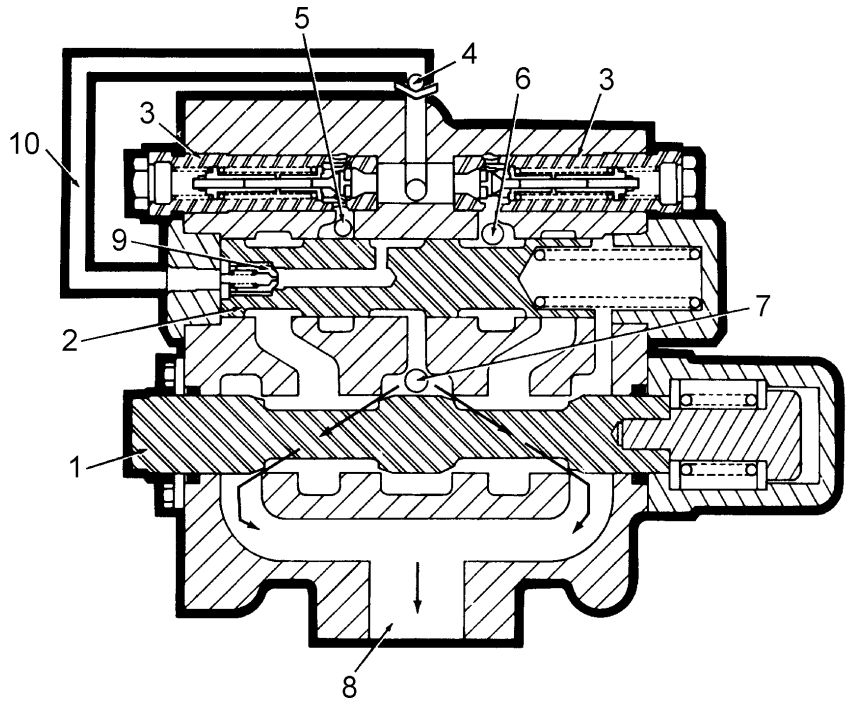


Fig. 10B.1. Sectional View of Steering Valve in Neutral

1. Main Control Spool
2. Locking Spool
3. Circuit Shock Valve Assembly
4. External Check Valve
5. Port for L.H. Steering Cylinder Piston Side and R.H. Steering Cylinder Rod Side
6. Port for R.H. Steering Cylinder Piston Side and L.H. Steering Cylinder Rod Side
7. Inlet Port
8. Return to Reservoir Port
9. Locking Spool Check Valve
10. Crossover Hose

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2. OPERATION

Steering Valve in Neutral (Refer to Fig. 10B.1)

Oil enters the steering valve at the inlet port (7), flows around the main control spool (1) and through passages in the valve housing to the return to reservoir port (8). The locking spool (2) blocks the oil from flowing to the outlet ports (5 and 6). But the outlet ports are open to the circuit shock valves (3) in case outside forces exert excess pressure on the steering circuits.

Steering Valve in Turn (Refer to Fig. 10B.2)

Fig. 10B.2 shows the main control spool (1) shifted into the valve body for a right hand turn. With the spool in this position, oil from the inlet port (7) is blocked from the return to reservoir port (8). Oil flows up the center passage to the locking spool (2) and through the center core in the spool.

The oil pressure unseats the locking spool check valve (9) and the oil passes through the crossover hose (10) until it is stopped by the external check valve (4). Pressure then begins to build on the left side of the locking spool. This pressure will overcome the spring tension on the right side and the locking spool will shift to the right. Pump flow from the inlet port (7) is now open to the cylinder port (6) is open to return to reservoir.

When the turn is complete and the linkage has again centered the main control spool (1), the inlet port (7) is open to the return to reservoir port (8) and the inlet pressure is reduced. This reduces the pressure against the face of the locking spool check valve (9) and the check valve spring will reseat the valve. An orificed passage in the check valve restricts the return of oil from the left side of the locking spool (2) to control the rate at which the locking spool returns to its "NEUTRAL" position.

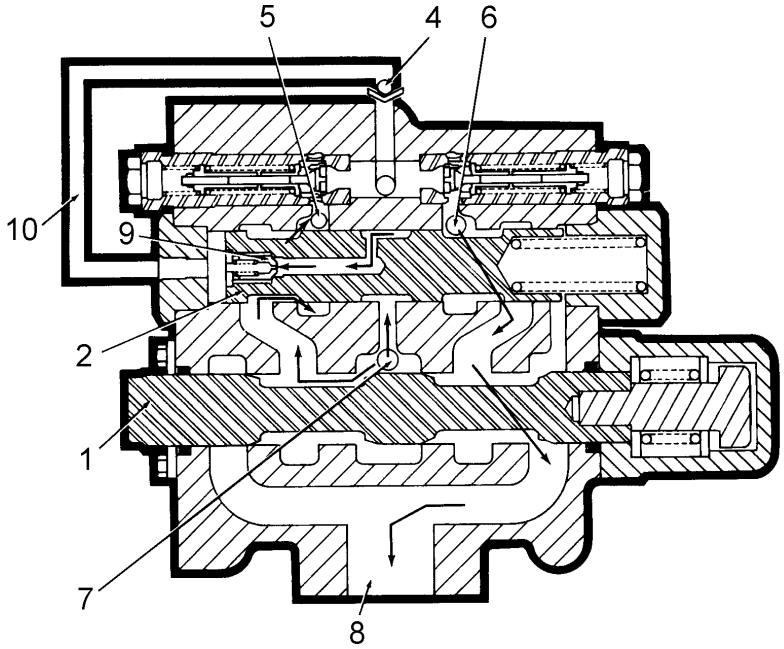


Fig. 10B.2. Sectional View of Steering Valve in Turn

1. Main Control Spool
2. Locking Spool
4. External Check Valve
5. Port for L.H. Steering Cylinder Piston Side and R.H. Steering Cylinder Rod Side
6. Port for R.H. Steering Cylinder Piston Side and L.H. Steering Cylinder Rod Side
7. Inlet Port
8. Return to Reservoir Port
9. Locking Spool Check Valve
10. Crossover Hose

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STEERING VALVE

Steering Circuit Shock Valves (Refer to Fig. 10B.3)

The two circuit shock valves in the steering valve are used to protect the steering cylinders against excessive pressure and cavitation when the main control spool is in the neutral position.

The condition illustrated in Fig. 10B.3 is one in which an external force on the frames is retracting the L.H. steering cylinder and extending the R.H. steering cylinder. The resulting pressure spike is quickly felt back through the cylinder port (1). When the pressure rises above 24130 kPa at the left relief valve (2), the pressure acting against the tapered face of the valve stem (3) will compress the large spring (4) and the stem will move to the right. The pressurized oil now flows to the center shock passage (5) between the circuit relief valves and acts against the face of the right shock valve (6). The light spring (7) behind the right relief valve is easily compressed, moving the entire assembly to the right. Oil can now flow from the port (1) of the retracting cylinder to the port (8) of the extending cylinder.

At the same time, the pressurized oil in the center passage (5) will unseat the external check valve (9) and flow through the crossover hose (10) to the locking spool (11). This oil will seat the locking spool check valve (12) and shift the locking spool to the right. The shifted locking spool allows the excess flow from the left cylinder port (1) to flow to the right cylinder port (8) to avoid cylinder cavitation.

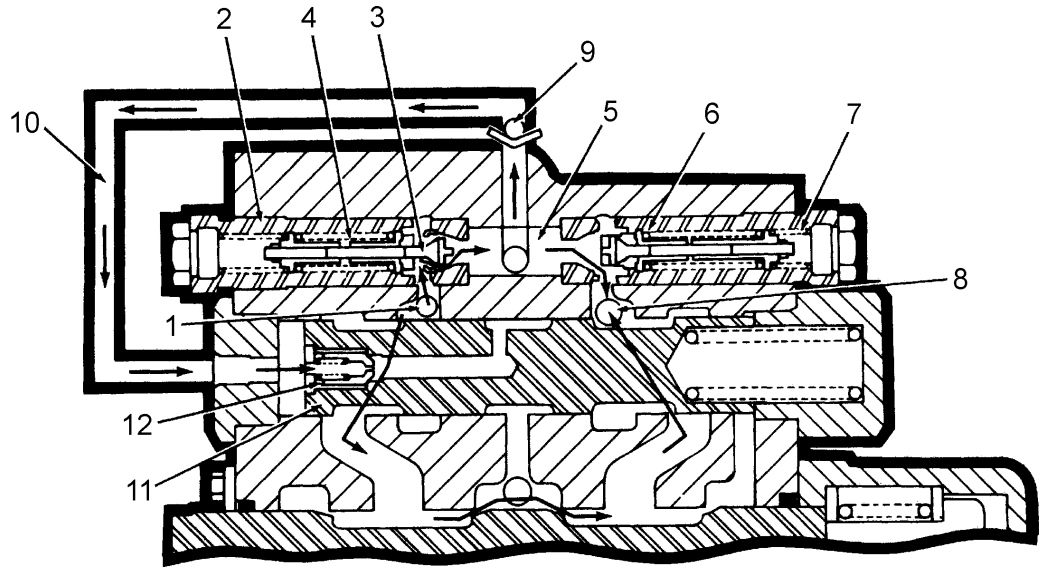


Fig. 10B.3. Sectional View of Steering Circuit Relief Valves

1. Port for L.H. Steering Cylinder Piston Side and R.H. Steering Cylinder Rod Side
2. Left Shock Valve
3. Valve Stem
4. Large Stem
5. Center Passage
6. Right Shock Valve
7. Light Spring
8. Port for R.H. Steering Cylinder Piston Side and L.H. Steering Cylinder Rod Side
9. External Check Valve
10. Crossover Hose
11. Locking Spool
12. Locking Spool Check Valve

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VALVES

STEERING VALVE

Steering System Relief Valve (Refer to Fig. 10B.4)

Incoming oil for the steering valve passes through the system relief valve inlet port (1). Some of this oil flows around the check poppet (2) and through the orifice (3) to the passage (4) above the pilot poppet (5). When the pressure of this oil reaches the relief setting of 17240 kPa, the pilot poppet is forced off its seat allowing the oil in the passage (4) to drain out through the return to reservoir passage (6). The oil drains to the reservoir faster than it can flow through the orifice (3) and this creates a pressure differential across the check poppet (2).

The higher system pressure acting against the outside surfaces of the check poppet forces the check poppet off of its seat (7). Excess flow can now drain directly to the reservoir passage (6) to reduce system pressure.

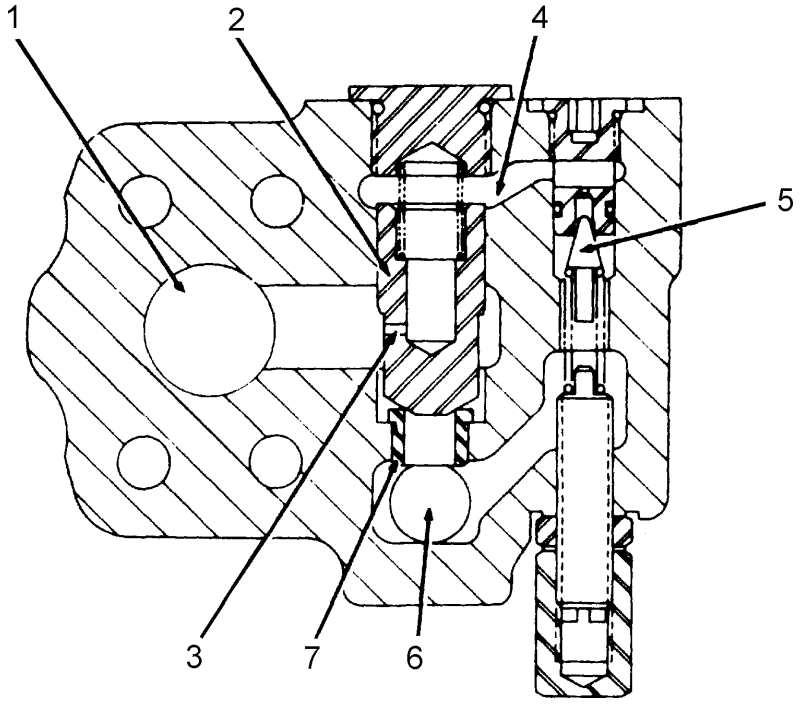


Fig. 10B.4. Sectional View of Steering System Relief Valve

1. Inlet Port
2. Check Poppet
3. Orifice
4. Passage
5. Pilot Poppet
6. Return to Reservoir Passage
7. Check Poppet Seat

3. SPECIFICATIONS

Operating Pressures

Main Relief Valve	17240 kPa
Circuit Relief Valves	24130 kPa

Special Torques

Main Spool Shoulder Bolt	70 - 80 Nm
Main Relief Valve Assembly:	
Jam Nut	60 Nm
Acorn Nut	60 Nm

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Spring Test Load Data

DESCRIPTION	NO.0F COILS	FREE LENGTH	TEST LENGTH	TEST LOAD PRESSURE
Circuit Relief Valve Return Spring	8	38.1 mm	20.6 mm	7.6 N
Check Valve Poppet Spring	8	15.5 mm	9.5 mm	494 N
Check Valve Plunger Spring	12	97.5 mm	88.9 mm	534 N
Main Plunger Centering Spring	5	45 mm	41.1 mm	267 N

4. SERVICE DIAGNOSIS

COMPLAINT	
PROBABLE CAUSE	REMEDY
Sticking Control Valve Spool	
1. Steering linkage too tight or out of adjustment	Repair and adjust as described in SECTION 5.
2. Distorted valve housing caused by, improperly tightened mounting bolts	Loosen and retighten to proper torque.
3. Distorted valve housing caused by non-level mounting face	Correct.
4. Dirt or foreign matter	Clean valve.
5. Centering spring damaged	Replace.
6. Scored or burred lands in spool bore	Repair or replace if necessary.

5. STEERING SYSTEM RELIEF VALVE TEST AND ADJUSTMENT

NOTE: *Before checking the relief valve pressure, be sure the hydraulic reservoir is filled to the correct level and with the proper hydraulic oil as described in the OPERATOR'S MANUAL.*



WARNING! Be sure the area in front and behind the machine is clear of personnel and obstructions. DO NOT allow anyone near the tires or on the access ladders during this test.

1. Install the frame locking bar with the machine in the straight ahead position.
2. Connect a pressure gauge capable of measuring 30000 kPa to the quick disconnect in the right hand steering cylinder check valve. Use a hose long enough to read the gauge from the operator's seat.
3. Start the engine and operate the machine until the hydraulic oil is at normal operating temperature.
4. Turn the steering wheel to a full turn position (either direction). Slowly, increase the engine speed to high idle. Record the reading of the pressure gauge when the relief valve opens. Stop the engine.

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5. The steering system relief valve should open at 17240 kPa. If the test results meet this specification, the steering system relief valve is functioning properly.

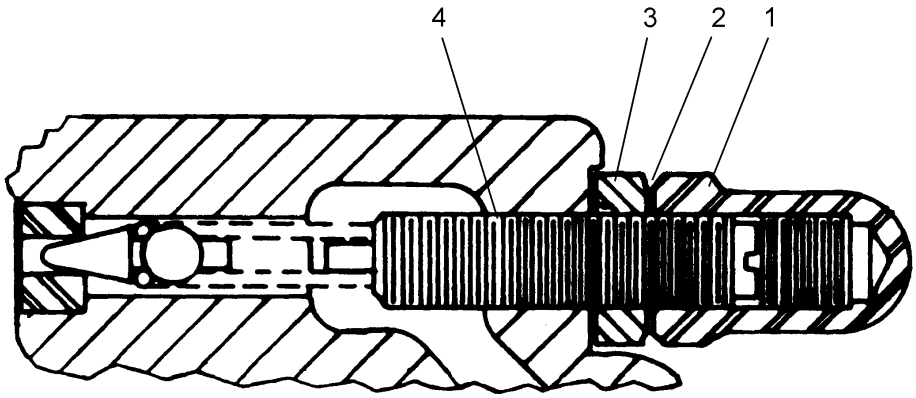


Fig. 10B.5. Steering System Relief Valve

1. Acorn nut 2. Washer 3. Jam Nut 4. Adjusting Screw

6. If the test results do not meet the specification, adjust the system relief pressure at the main relief assembly on the steering valve as follows:
   a. Hold the jam nut (3, Fig. 10B.5) and unscrew the acorn nut (1). Remove the washer (2).
   b. Hold the adjusting screw (4) and loosen the jam nut (3).
   c. Rotate the adjusting screw 1/8 of a turn. Turn the screw clockwise to increase the pressure and counterclockwise to decrease the pressure. Hold the adjusting screw in this position and tighten the jam nut.
   d. Start the engine and repeat Step 4. Turn the adjusting screw as required to obtain the correct relief pressure. Tighten the jam nut between each adjustment.
   e. When the correct relief setting has been obtained, torque the jam nut to 60 Nm.
   f. Be sure the washer (2) is in good condition. Install the washer and the acorn nut (1). Torque the acorn nut to 60 Nm.
   g. Repeat Step 4 once more to be sure the position of the adjusting screw has not changed.

6. STEERING CIRCUIT SHOCK VALVE PRESSURE TEST

The steering circuit shock valves are factory preset at 24130 kPa and are not adjustable. The only pressure test which can be performed on these valves is a test to determine that they are not opening below steering system pressure of 17240 kPa. Refer to "STEERING SYSTEM PRESSURE TEST" in SECTION 10.

If the results of the steering system pressure test indicates the problem may be a faulty circuit shock valve, a new one should be installed. If one is not available, swap the circuit shock valves within the steering valve and repeat the test. The problem should now appear in the opposite direction.

NOTE: *One indication of a faulty circuit shock valve is to have slow steering in one direction only. Also, the machine would drift in the opposite direction of slow steering when the steering wheel is not being turned.*

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7. REMOVAL (Refer to Fig. 10B.6)

IMPORTANT: *Disconnected hydraulic 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 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.*

WARNING! Be sure the bucket is lowered to the ground, the parking brake is ON and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

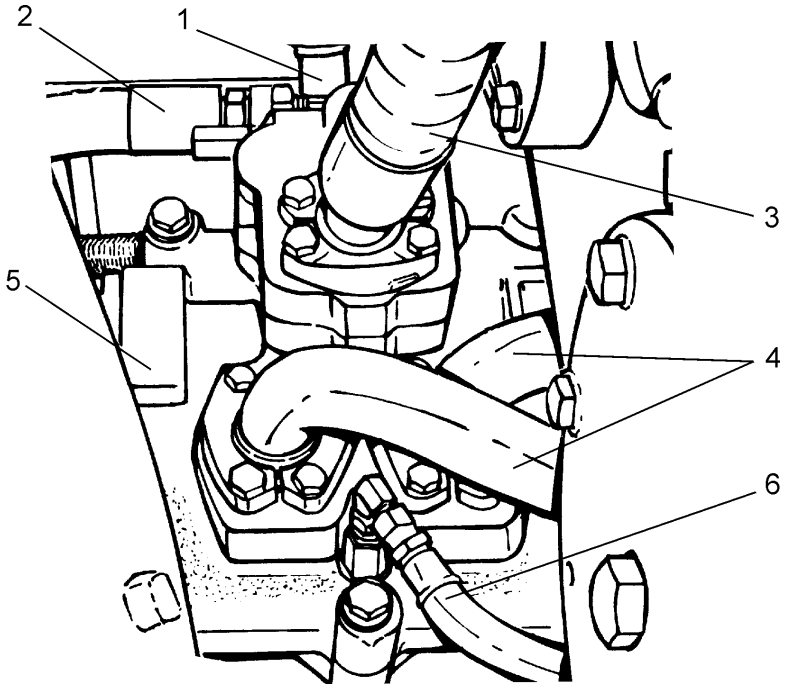


Fig. 10.6. Steering Valve Disconnect Points

1. Valve to Reservoir Hose
2. Valve to Oil Cooler Hose
3. Valve Inlet Hose
4. Steering Cylinder Tubes
5. Steering Valve
6. Check Valve and Locking Spool Cap Hose

1. Drain the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
2. Remove the cover from the bottom of the machine. Remove the upper cover (if equipped).
3. Support the linkage rod between the bellcrank and steering valve. Disconnect the rod at the valve (5).
4. Disconnect the two steering cylinder tubes (4) and the inlet hose (3) at the steering valve.
5. Disconnect the reservoir hose (1) and the cooler hose (2) at the steering valve.
6. Remove the hardware securing the steering valve to the bracket on the left hand frame and remove the valve out the bottom of the machine.

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8. DISASSEMBLY (Fig. 10B.7)

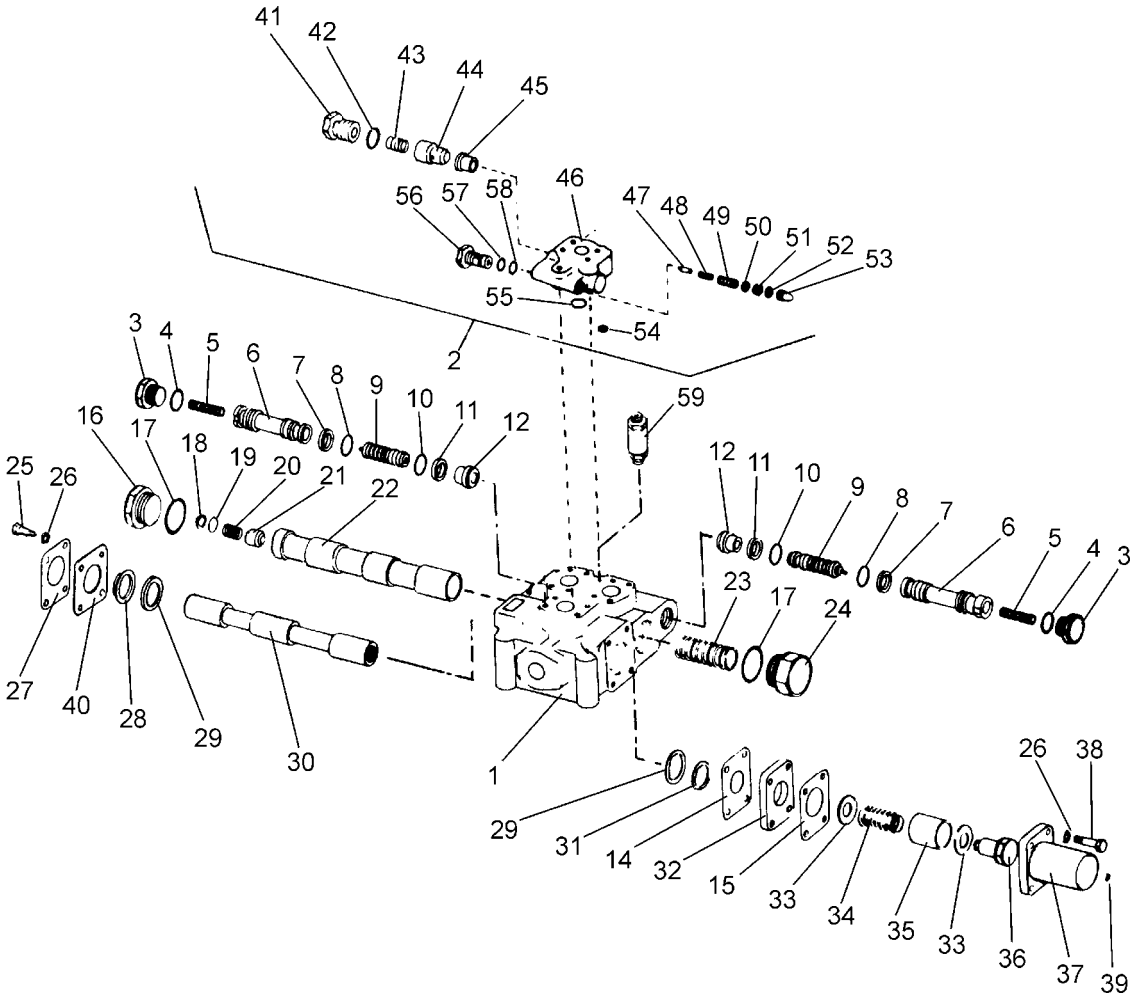


Fig. 10B.7. Exploded View of Steering Valve

1. Housing
2. Main Relief Valve Assembly
3. Plug
4. O-Ring
5. Return Spring
6. Sleeve
7. Backup Ring
8. O-Ring
9. Circuit Shock Valve Assembly
10. O-Ring
11. Backup Ring
12. Guide Seat
14. Shim
15. Shim
16. Cap
17. O-Ring
18. Retaining Ring
19. Washer
20. Spring
21. Locking Spool Poppet
22. Locking Spool
23. Centering Spring
24. Cap
25. Bolt
26. Washer
27. Retainer Plate
28. Wiper
29. Seal
30. Main Control Spool
31. Backup Ring
32. Retainer Plate
33. Washer
34. Centering Spring
35. Spacer
36. Shoulder Bolt
37. Cover
38. Bolt
39. Bleeder Plug
40. Retainer Plate
41. Cap
42. O-Ring
43. Spring
44. Check Valve
45. Valve Seat
46. Housing
47. Poppet
48. Spring
49. Adjusting Screw
50. Washer
51. Jam Nut
52. Washer
53. Acorn Nut
54. O-Ring
55. O-Ring
56. Check Valve Seat
57. O-Ring
58. O-Ring
59. Check Valve

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STEERING VALVE

1. Remove the hose (6, Fig. 10B.6) which connects the check valve (59) and the locking spool cap (16). Remove the check valve from the housing (1).
2. Remove the main relief valve assembly (2) from the housing (1). Remove O-rings (54 and 55). If necessary, disassemble the main relief valve as follows:
   a. Remove the acorn nut (53), washer (52), jam nut (51) and washer (50).
   b. Unthread the adjusting screw (49) from the housing (46).
   c. Slide out the spring (48) and poppet (47).
   d. Remove the check valve seat (56). Remove the O-rings (57 and 58) from the seat.
   e. Remove the cap (41), spring (43) and check valve (44). Remove the O-ring (42) from the cap (41). Remove the seat (45) from the housing.
3. Remove the bolts (25) and washers (26) to remove the retainer plates (27 and 40). Remove the wiper (28) and seal (29) from the housing (1).
4. Remove the bolts (38) and washers (26). Remove the cover (37). Pull the entire main control spool assembly from the housing.
5. Remove the backup ring (31) and seal (29). Remove the shims (14 and 15) and retainer plate (32).

IMPORTANT: *The main spool is adjusted with shims at the factory. Measure the thickness of the shims (13 and 15). The same thickness of shims must be used during assembly of the valve. If shims are in good condition, tie the pack together and reuse.*

6. Being careful not to damage the control spool (30), remove the shoulder bolt (36). Remove the washer (33), spacer (35) and centering spring (34).
7. Remove the cap (16) and cap (24) from the housing. Remove both O-rings (17). Remove the spring (23) and slide the locking spool (22) from the housing.
8. To disassemble the check valve, remove the retaining ring (18), washer (19), spring (20) and locking spool poppet (21).
9. To disassemble either circuit shock valve assembly:
   a. Unscrew the sleeve assembly (6) from the housing.
   b. Remove the plug (3), O-ring (4) and return spring (5) from the sleeve.
   c. Slide the circuit shock valve (9) from the sleeve.

NOTE: *Do not attempt further disassembly of the circuit relief valve (9).*

   d. Remove the O-ring (8) and backup ring (7) from the sleeve.
   e. Remove the guide seat (12) from the housing. Remove the O-ring (10) and backup ring (11) from the guide seat.

9. INSPECTION AND REPAIR

1. Clean all parts in clean solvent and dry with compressed air.
2. Check all springs for damage, distortion or weakness. Springs meeting the requirements shown in "SPECIFICATIONS" should function properly. Springs not meeting the requirements should be replaced.
3. All bores and surfaces of sliding parts must be free of nicks, scores or excessive wear. All poppets, spools, pistons and sleeves must fit snugly, without binding through a complete revolution. Spools must be free of longitudinal score marks.
4. Inspect all flow passages. These passages must be clean and free of foreign particles.
5. Discard all O-rings, wipers and seals. Replace with new.
6. Inspect poppet seating surfaces and poppet faces for nicks or excessive wear.

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10. REASSEMBLY (Refer to Fig. 10B.7)

NOTE: *Lubricate all parts including housing bores with clean hydraulic oil before assembly.*

1. Install a new O-ring (10) and backup ring (11) onto the guide seat (12). Install the guide seat into the housing (1).
2. Install a new O-ring (8) and backup ring (7) onto the sleeve (6). Install the sleeve into the housing.
3. Slide the circuit shock valve (9) into the sleeve. The nut on the end of the relief valve should be toward the outside. Seat the spring (5) against the shock valve. Install the plug (3) with O-ring (4) into the sleeve. Repeat this procedure for second shock valve.
4. Install the cap (16) with O-ring (17) into the housing.
5. Slide the locking spool poppet (21) into the locking spool (22). Position the spring (20) inside the poppet. Install the washer (19). Install the retaining ring (18) in the groove.
6. Be sure the locking spool (22) is well lubricated and slide it into the housing bore. The end of the spool with the locking spool poppet (21) should be toward the cap (16). Install the spring (23) into the plunger. Install the cap (24) with O-ring (17).
7. Press the seals (29) into each side of the housing. The lips of the seals should be toward the inside.
8. Slide one washer (33), spacer (35), spring (34) and other washer (33) onto the shoulder bolt (36). Install the shoulder bolt into the end of the spool (30) and torque the bolt 70 to 80 Nm.
9. Position the backup ring (31) against the seal (29). Liberally coat the spool and the ID of both seals (29) and the backup ring (31) with clean grease. Position the shims (14), retainer plate (32) and shims (15) against the valve housing and hold them loosely in place with two bolts (38).

IMPORTANT: *Be sure to install the same size shim pack as was removed during disassembly.*

10. Install the spool assembly through the shims (14 and 15) and retainer plate (32) through the backup ring (31) and into the valve housing. Ease the spool past the seals (29) being careful not to damage the lips of the seals. Remove the two bolts (38).
11. Slide the cover (37) over the end of the spool. Install the washers (26) and bolts (38) through the cover, shims and retainer plate and into the housing.
12. Liberally coat the ID of the wiper (28) with clean grease. Install the wiper over the end of the spool with the metal face toward the inside and seated against the seal (29).
13. Carefully install the retainer plates (40 and 27), being careful not to damage the lips of the wiper (28). Install the washers (26) and bolts (25).
14. Reassemble the main relief valve (2) as follows:
    a. Install the seat (45) into the housing (46).
    b. Position the check valve (44) in the housing with the spring (43) in the valve counter bore.
    c. Install the O-ring (42) on the cap (41). Install the cap in the housing so that the spring (43) seats in the cap counter bore.
    d. Install O-rings (57 and 58) onto the check valve seat (56). Install the check valve seat into the housing.
    e. Slide the poppet (47) and spring (48) into the housing. Install the adjusting screw (49), threading it down just until spring tension is felt. Hold the screw in this position and install one washer (50) and the jam nut (51). Tighten the jam nut.
    f. Install washer (52) over the screw. Install, but do not tighten, the acorn nut (53). The relief valve adjustment must be set after installation of the valve on the machine.

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STEERING VALVE

15. Using new O-ring (54 and 55), install the main relief valve assembly (2) onto the valve housing (1). Install the check valve (59). Install the hose (6, Fig. 10B.6) between the check valve and the locking spool cap (16).

11. INSTALLATION (Refer to Fig. 10B.6)

1. Install and secure the steering valve (5) to the left hand frame.
2. Install the reservoir hose (1) and the cooler hose (2) to the steering valve (5).
3. Install the two steering cylinder tubes (4) and the inlet hose (3) to the steering valve (5). Install the rod to the valve.
4. Fill the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for oil specifications and procedure.
5. Start the engine and turn the steering wheel completely to the right and to the left several times to expel all air and to make sure that the valve is functioning properly.
6. Check the oil level and add if necessary. Install the bottom cover and upper cover (if equipped)
7. Check the steering stop pads. Be sure the steering wheel stops turning before the frame halves hit the stop pads. If the machine halves hit the stop pads or are more than 12.7 mm apart, the steering linkage must be adjusted. Refer to "LINKAGE ADJUSTMENT" in SECTION 5.
8. Check the steering system relief valve pressure setting by following the procedure outlined under "STEERING SYSTEM RELIEF VALVE TEST AND ADJUSTMENT" in this section.
9. Check the steering circuit relief valve pressure by following the procedure outlined under "STEERING CIRCUIT RELIEF VALVE PRESSURE TEST" in this section.

PILOT CONTROL VALVE

12. DESCRIPTION (Refer to Fig. 10B.8)

The pilot control valve is mounted to the underside of the cab floor. It is made up of four sections which are bolted together to make one unit: the inlet section (1), the bucket section (2), the boom section (3) and the end section (4). There is also a spacer block located between the bucket and boom sections.

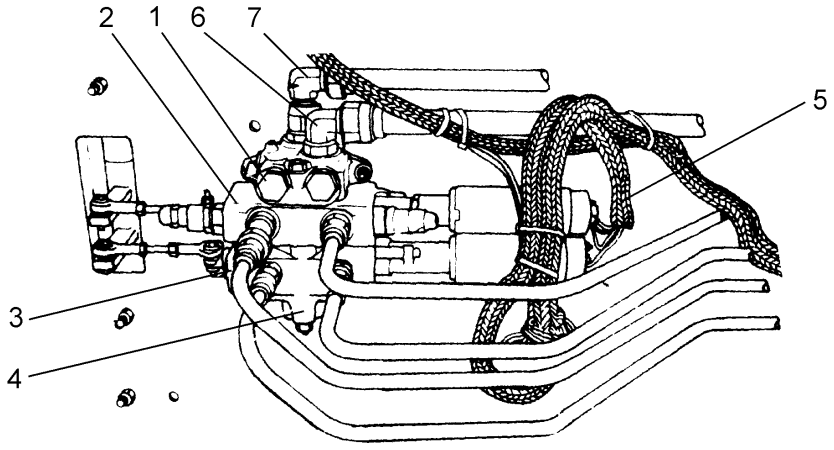


Fig. 10B.8. Pilot Control Valve Assembly

1. Inlet Section
2. Bucket Section
3. Boom Section
4. End Section
5. Electrical Cable for Boom Positioner and Bucket Positioner
6. Inlet Line
7. Return to Reservoir Line

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PILOT CONTROL VALVE

The valve is a two-spool, open center, priority valve. The spools are shifted through mechanical linkage by the boom and bucket control levers in the cab. The interconnecting passages of this open center valve are in series; meaning that the bucket section has priority for flow over the boom section.

The bucket section (2) controls the flow of oil through the bucket section of the loader control valve, to and from the bucket cylinder. Two circuit relief valves for the bucket circuit are in the pilot valve bucket section and are set to open at 22750 kPa. The three positions of the spool are "DUMP", "HOLD" and "ROLLBACK". There is a magnetic solenoid assembly in the end of the spool which provides an electric detent for the spool in the "ROLLBACK" position. An electric cable (5) joins the solenoid assembly to a proximity switch near the bucket cylinder which activates the solenoid to hold the spool in the "ROLLBACK" position until the bucket reaches its proper digging position after dumping.

The boom section (3) controls the flow of oil through the boom section of the loader control valve, to and from the boom cylinders. The four positions of the spool are "RAISE", "HOLD", "LOWER" and "FLOAT". There is a magnetic solenoid assembly in the end of the boom spool just like the one in the bucket section which detents the spool in the "RAISE" position. A proximity switch on the front frame activates the solenoid to hold the spool in "RAISE". When the boom arms approach the switch, the switch opens the circuit, releasing the spool and stopping the upward movement of the boom arms at a predetermined height.

13. OPERATION

General

The pilot control valve and the hydraulic control valve work together to activate the boom and bucket cylinders. A small portion of the pump flow which enters the inlet section of the hydraulic control valve is set through an external line (6, Fig. 10B.8) to the pilot control valve. When both spools are in the "hold" position, the oil can flow directly through the open center of the valve to the end section where it is redirected back thru the return passages to the return to reservoir line (7).

When one of the spools is moved out of the "HOLD" position, the inlet flow is blocked from return and is redirected back into the hydraulic control valve to one of the pilot ports of the corresponding hydraulic valve section. Here it is used to shift a plunger, opening a passage for pump flow oil to activate a cylinder. At the same time, the opposite pilot port in the hydraulic valve section is returning oil to the pilot valve, where it flows through the return passages and back to the reservoir.

Bucket Section

NEUTRAL (Fig. 10B.9):

Oil from the inlet section enters the bucket section in three places: at the upper cavity (1) next to the load check poppet (4) and at the two lower cavities (2) on either side of the center spool port (3). The center spool port is the open center passage to the boom section, where as the upper cavity (1) is blocked from the boom section. When the bucket lever is in the "HOLD" position, oil will flow around the spool and out the center passage to the boom section.

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PILOT CONTROL VALVE

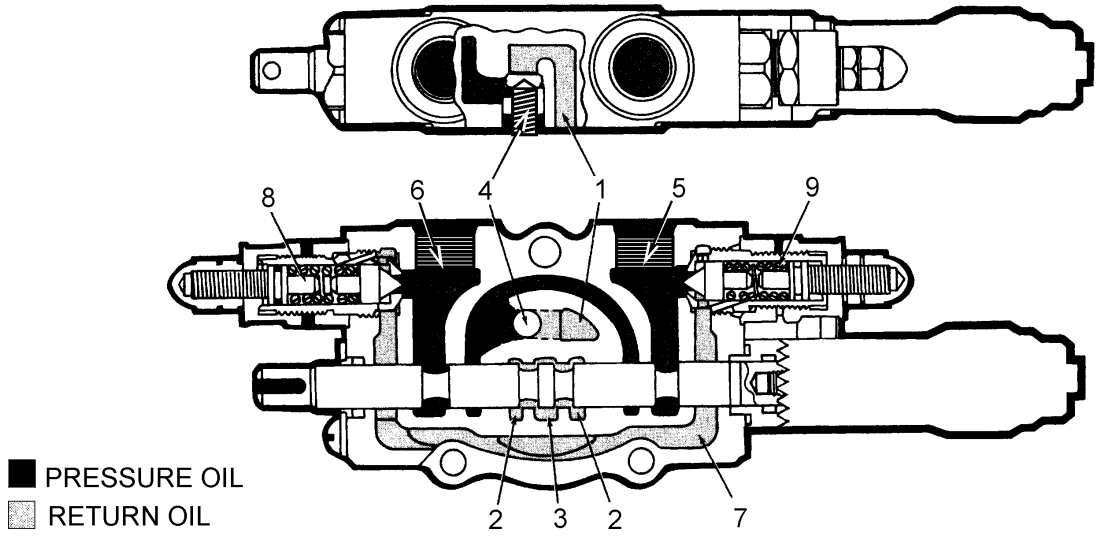


Fig. 10B.9. Bucket Section in "NEUTRAL"

1. Upper Inlet Cavity
2. Lower Inlet Cavity
3. Center Spool Port
4. Load Check Poppet
5. Rod Side Port
6. Piston Side Port
7. Return to Reservoir Passage
8. Piston Side Circuit Shock Valve
9. Rod Side Circuit Shock Valve

Circuit shock valves (8 and 9) are used on both sides of this circuit to protect against structural damage to the bucket cylinder or linkage, which could happen if an external force is exerted on the bucket when the spool is in the neutral position. Pressure spikes which are felt at the hydraulic control valve plunger are felt back to the corresponding pilot valve port. For example, a pressure spike at the bucket rod side plunger would be sensed at the pilot valve rod side port (5). If this pressure should build above the relief setting, the rod side shock valve (9) will open, allowing oil to enter the return passage (7) back to the reservoir. The pressure in the open side of the circuit will then drop, which allows the plungers in the hydraulic control valve of shift and relieve the excess pressure.

BUCKET DUMP (Fig. 10B.10):

When the bucket lever is placed in the "DUMP" position, the spool is shifted to the left. Incoming pump flow is now trapped in the lower inlet cavities (2) and is blocked from entering the center spool port (3) which is open to return. Because of this restriction, pressure builds in the upper inlet cavity (1) and acts against the face of the load check poppet (4). When this pressure increases above the combined pressure of the oil behind the load check poppet and the tension of the poppet spring, the poppet is forced off its seat. Incoming pump flow now passes around the right side of the spool and out the rod side port (5) to the rod side pilot port of the hydraulic control valve bucket section (refer to "Bucket Dump" under "HYDRAULIC CONTROL VALVE").

Oil returning from the piston side pilot port of the loader control valve bucket section enters the piston side port (6) and passes around the left side of the spool to the return to reservoir passage (7).

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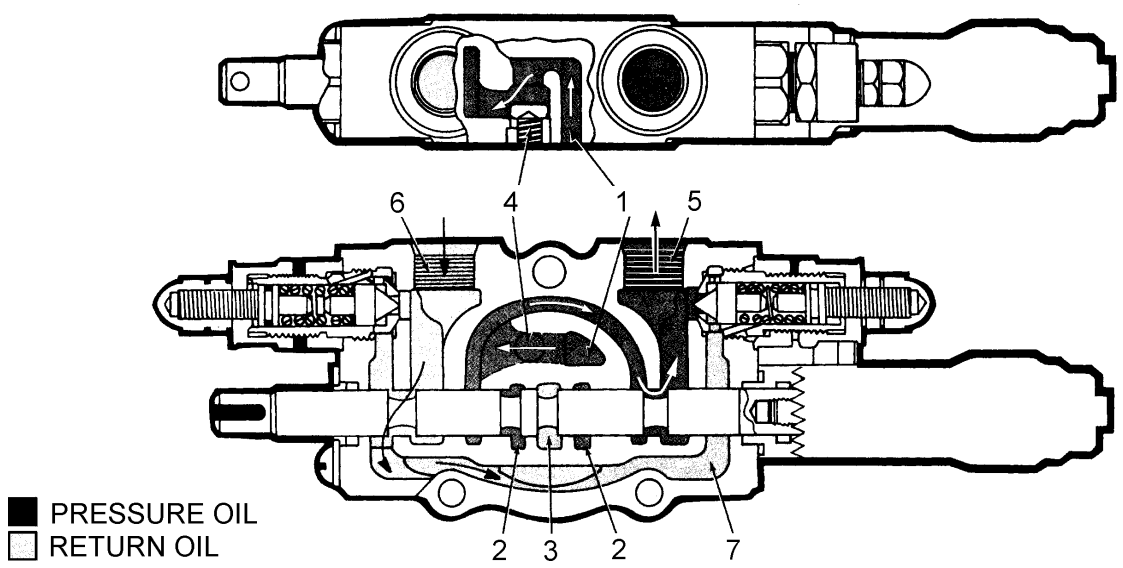


Fig. 10B.10. Bucket Section in "DUMP"

1. Upper Inlet Cavity
2. Lower Inlet Cavity
3. Center Spool Port
4. Load Check Poppet
5. Rod Side Port
6. Piston Side Port
7. Return to Reservoir Passage

When the bucket lever is returned to "HOLD", incoming pump flow is again able to pass from the lower inlet cavities (2) into the center spool port (3). This decreases the pressure acting against the load check poppet (4) and the force of the spring returns the poppet to its seat.

BUCKET ROLLBACK:

When the bucket lever is placed in the "ROLLBACK" position, the spool is shifted to the right. The pressure of the incoming pump flow unseats the load check poppet (4, Fig. 10B.10) in the same way as outlined under ”Bucket Dump". But now the flow passes around the left side of the spool and out the piston side port (6) to the piston side pilot port of the hydraulic control valve bucket section (refer to "Bucket Rollback" under ”HYDRAULIC CONTROL VALVE”). Oil returning through the rod side port (5) passes around the right side of the spool and enters the return to reservoir passage (7).

Boom Section

NEUTRAL (Fig. 10B.11):

Oil flow from the open center port of the bucket section (see "Bucket Section in Neutral") is split as it enters the boom section so that it flows around the spool at the two lower inlet cavities (2). The upper inlet cavity (1), next to the load check poppet (4) is connected to pump flow through a passage from the right hand lower cavity. The center spool port (3) is the open center passage to the end section. When both the boom and the bucket levers are in "hold", oil will flow directly through the valve to the end section where it is directed into the return to reservoir passage (7). Oil at the rod side port (5) and the piston side port (6) is trapped by the spool.

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PILOT CONTROL VALVE

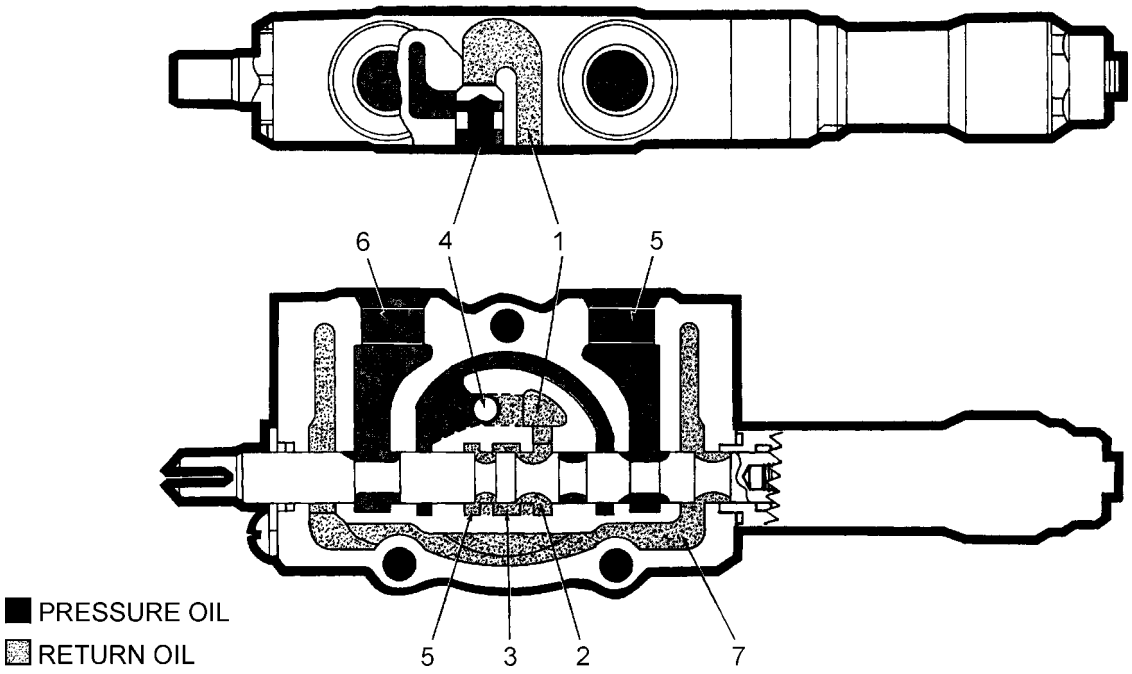


Fig. 10B.11. Boom Section in "NEUTRAL"

1. Upper Inlet Cavity
2. Lower Inlet Cavity
3. Center Spool Port
4. Load Check Poppet
5. Rod Side Port
6. Piston Side Port
7. Return to Reservoir Passage

BOOM LOWER (Fig. 10B.12):

When the boom lever is placed in the "LOWER" position, the spool is shifted to the left. Incoming pump flow is now blocked from entering the center spool port (3) which is open to return. Because of this restriction, pressure builds in the upper inlet cavity (1) and acts against the face of the load check poppet (4). When this pressure increases above the combined pressure of the oil behind the load check poppet and the tension of the poppet spring, the poppet is forced off its seat. Incoming pump flow now passes around the right side of the spool and out the rod side port (5) to the rod side pilot port of the loader control valve boom section (refer to "Boom Lower" under "HYDRAULIC CONTROL VALVE").

Oil returning from the piston side pilot port of the loader control valve boom section enters the piston side port (6) and passes around the left side of the spool to the return to reservoir passage (7).

When the boom lever is returned to "HOLD", incoming pump flow is again able to pass from the lower inlet cavities (2) into the center spool port (3). This decreases the pressure acting against the load check poppet (4) and the force of the spring returns the poppet to its seat.

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PILOT CONTROL VALVE

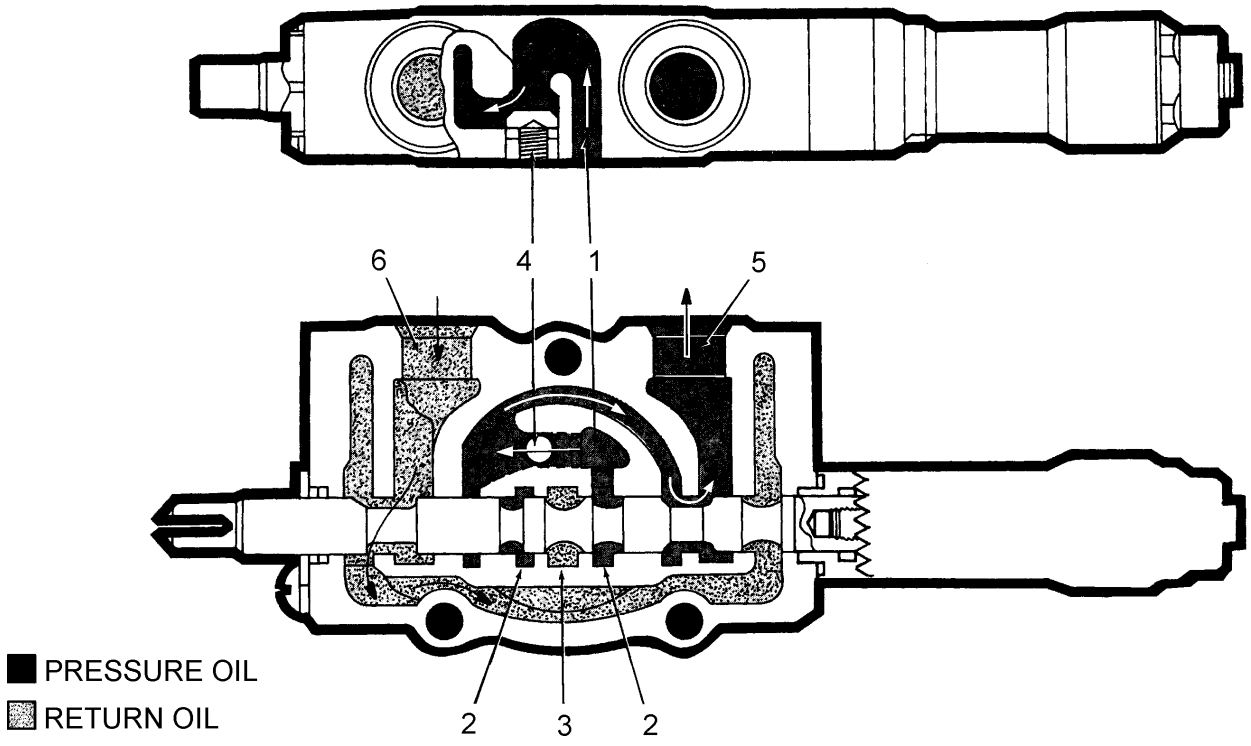


Fig. 10B.12. Boom Section in "LOWER"

1. Upper Inlet Cavity
2. Lower Inlet Cavity
3. Center Spool Port
4. Load Check Poppet
5. Rod Side Port
6. Piston Side Port
7. Return to Reservoir Passage

BOOM RAISE:

When the boom lever is placed in the "RAISE" position, the spool is shifted to the right of the neutral position. The pressure of the incoming pump flow unseats the load check poppet (4, Fig. 10B.12) in the same way as outlined under "Boom Lower". But now the flow passes around the left side of the spool and out the piston side port (6) to the piston side pilot port of the loader control valve boom section (refer to "Boom Raise" under "HYDRAULIC CONTROL VALVE"). Oil returning through the rod side port (5) passes around the right side of the spool and enters the return to reservoir passage (7).

BOOM FLOAT (Fig. 10B.13):

Whenever the boom lever is placed in the "FLOAT" position, the spool is shifted to its farthest left position. Pump flow is directed from the upper inlet cavity (1) and both lower inlet cavities (2) out through the center spool port (3) back to the reservoir. The rod side port (5) and the piston side port (6) are now both open to the return to reservoir passage (7) and also open to each other through this passage. The load check poppet (4) has returned to its seat, trapping the oil in the passage behind it.

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PILOT CONTROL VALVE

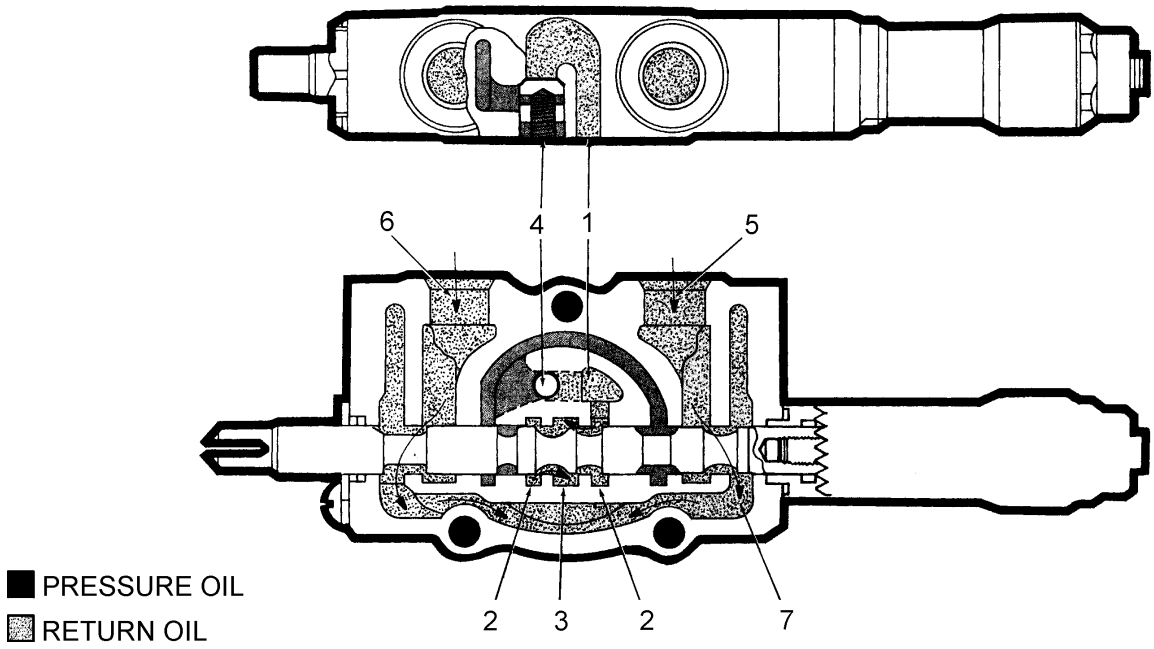


Fig. 10B.13. Boom Section in "FLOAT"

1. Upper Inlet Cavity
2. Lower Inlet Cavity
3. Center Spool Port
4. Load Check Poppet
5. Rod Side Port
6. Piston Side Port
7. Return to Reservoir Passage

14. SPECIFICATIONS

Special Torques

Section Mounting Tie Rod Nuts:

- 5/16 -18 NC Lower Nuts . . . . . 20 Nm
- 3/8 - 24 NC Upper Nuts . . . . . 45 Nm

Bucket Section:

- Circuit Shock Valves:
  - Shock Valve Assembly to Housing . . . . . 40 - 70 Nm
  - Assembly Lock Nut to Housing . . . . . 15 Nm
  - Jam Nut . . . . . 14 ± 2 Nm
  - Acorn Nut . . . . . 14 ± 2 Nm
- Detent Pin to Spool (w/Loctite 271) . . . . . 100 - 115 Nm
- Magnetic Solenoid Assembly to Cap Jam Nut . . . . . 60 Nm
- Cap and Spacer Mounting Cap Screws . . . . . 7 ± 1 Nm
- Detent Pin Lock Nut . . . . . 14 ± 2 Nm

Boom Section:

- Detent Pin to Spool (w/Loctite 271) . . . . . 100 - 115 Nm
- Solenoid Pin to Detent Pin (w/Loctite 271) . . . . . 100 - 115 Nm
- Magnetic Solenoid Assembly to Cap Jam Nut . . . . . 60 Nm
- Cap and Spacer Mounting Bolts . . . . . 7 ± 1 Nm
- Detent Pin Lock Nut . . . . . 14 ± 2 Nm

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PILOT CONTROL VALVE

Spring Test Load Data

DESCRIPTION	NO. OF COILS	FREE LENGTH	TEST LENGTH	TEST LOAD PRESSURE
Bucket Section Spool Centering Spring	7.5	43.3 mm	27.8 mm	69 N
Boom Section Spool Centering Spring	7.5	57.7 mm	34.1 mm	105 N
Boom Section Detent Pin Spring	16	26.2 mm	17.5 mm	76 N
Load Check Poppet Spring	10.5	25.4 mm	10.3 mm	1.3 N
Bucket Circuit Shock Valve Poppet Spring	7	24.2 mm	22.2 mm	340 N

Pressures

Bucket Circuit Shock Valve Opening Pressure . . . . . 22750 ± 700 kPa at 1.9 l/min.

15. SERVICE DIAGNOSIS

NOTE: The pilot control valve and the hydraulic control valve work together to operate the loader hydraulic system. Refer to "SERVICE DIAGNOSIS" under "HYDRAULIC CONTROL VALVE" in this section and in SECTION 10 for additional information.

COMPLAINT	
PROBABLE CAUSE	REMEDY
Loss of Power or Delay In Reaction Time	
1. Pilot valve spool not positioned properly	Free and clean binding linkage. Check spool. Check detent balls (boom section only). Replace valve if spool or bore is scored or damaged.
Bucket or Boom Will Not Move or Moves Slowly	
1. Pilot valve spool not positioned properly	Free and clean binding linkage. Check spool. Check detent balls (boom section only).
2. BUCKET SECTION ONLY: Overload shock valves set for low or stuck open	Perform "BUCKET CIRCUIT SHOCK VALVE PRESSURE TEST AND ADJUSTMENT". If necessary, replace or service overload shock valves.

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PILOT CONTROL VALVE

COMPLAINT	
PROBABLE CAUSE	REMEDY
Bucket Dumps or Boom Drifts When Pilot Valve Control Lever is Centered	
1. BUCKET SECTION ONLY: Malfunctioning overload shock valves	Perform "BUCKET CIRCUIT SHOCK VALVE PRESSURE TEST AND ADJUSTMENT". If necessary, replace or service overload shock valves.
2. Excessive leakage in pilot valve	Check spool and bore for excessive wear or scoring. Replace valve if necessary.
3. Pilot valve spool not centering properly	Free up spool in pilot valve by making sure end mechanism is free.
Load Drops With Handle In Raise Position and Working Bucket	
1. Pilot valve load check poppet stuck open or damaged because of contamination	Inspect load check poppet. Replace if necessary.
Slow or Loss of Float In Boom	
1. Pilot valve spool not positioned properly	Free and clean binding linkage. Check spool. Check detent balls (boom section only). Check detent pin. Screw securely into pilot valve spool. Replace if necessary.
Pilot Valve Spool Sticking	
1. Scored spool or bore	Check spool and bore for excessive wear or scoring. Replace valve if necessary.
2. End mechanism binding	Check end mechanism for wear and dirt. Clean and reposition for free operation.
3. Control lever linkage binding	Check control lever linkage. Clean and grease parts before reassembly.
External Leakage	
1. Spool seals damaged	Replace seals.
2. O-ring between sections damaged	Inspect and replace O-rings.
Boom Positioner or Bucket Positioner Not Working Properly	
1. Electrical problem in positioner proximity switch, electrical relay or pilot valve magnetic solenoid	Check Wiring Diagram and refer to "SERVICE DIAGNOSIS" in SECTION 8.
2. Mechanical problem with boom or bucket section spool components	Check control lever operation in all positions. Inspect and clean spool. Repair as necessary.

16. BUCKET CIRCUIT SHOCK VALVE PRESSURE TEST AND ADJUSTMENT



WARNING! Be sure the area in front and behind the machine is clear of personnel and obstructions. DO NOT allow anyone near the tires or on the access ladders during this test.

NOTE: *Before checking the shock valve pressure, be sure the hydraulic reservoir is filled to the correct level and with the proper hydraulic oil as described in the OPERATOR'S MANUAL.*

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1. Operate the machine to warm up the hydraulic oil. Install the frame locking bar and stop the engine.
2. Remove the rod side pilot tube (4, Fig. 10B.14) and the connector at the pilot control valve. Install a tee into the 3/4 -16 NF valve port and install the connector and oil to tube to the tee.
3. Connect a 30000 kPa pressure gauge to the open tee port. The gauge hose should be long enough to allow the gauge to reach into the cab.
4. Start the engine and raise the boom a few feet off the ground. Shift the bucket lever to detented "ROLLBACK" so the bucket positioner sets the bucket in its digging position.
5. Slowly move the machine forward, allowing the underside of the bucket cutting edge to contact an immovable vertical object along its entire length.

IMPORTANT: *Failure to make contact along the entire length of the cutting edge could cause damage to the bucket.*

6. Slowly depress the accelerator, increasing the pressure on the cutting edge. Observe the gauge and record the pressure at which the valve opens.

IMPORTANT: *Do not continued this pressure condition on the bucket for more than a few seconds.*

7. Release the accelerator, lower the bucket to the ground and shut off the engine.
8. The shock valve should open at 22750 ± 700 kPa. If the shock valve meets this specification, switch the positions of the two shock valves in the valve body and repeat Steps 4 thru 8 to test the other relief valve.
9. If the relief valve does not meet the specification, it should be adjusted as follows (Fig. 10B.18):
   a. Hold the jam nut (3) and remove the acorn nut (1).
   b. Hold the adjusting screw (12) to prevent its movement and loosen the jam nut (3).
   c. Rotate the adjusting screw (12) in a clockwise direction to increase the pressure or in a counterclockwise direction to decrease the pressure. A 1/4 turn of the adjusting screw will change the pressure setting approximately 1700 kPa.
   d. Repeat Steps 4 through 8 until the correct pressure is obtained.
   e. Inspect the two O-rings (2) and replace if necessary. Hold the adjusting screw in its correct position and tighten the jam nut. Torque the nut to 14 ± 2 Nm.
   f. Install and torque the acorn nut (1) to 14 ± 2 Nm.

17. REMOVAL (Refer to Fig. 10B.14)

IMPORTANT: *Disconnected hydraulic 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 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.*



WARNING! Be sure the bucket is lowered to the ground the parking brake is ”ON” and turn the master switch to the ”OFF” position and take out the key from the master switch and starting switch to prevent accidental starting.

1. Park the machine on a level surface with the bucket flat on the ground.
2. Drain the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.

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3. Disconnect the tubes (3 thru 6) from the bucket and boom sections of the valve.
4. Disconnect the inlet line (1) and the return to reservoir line (2).
5. Disconnect the electrical harness (7) from the ends of the bucket and boom sections.

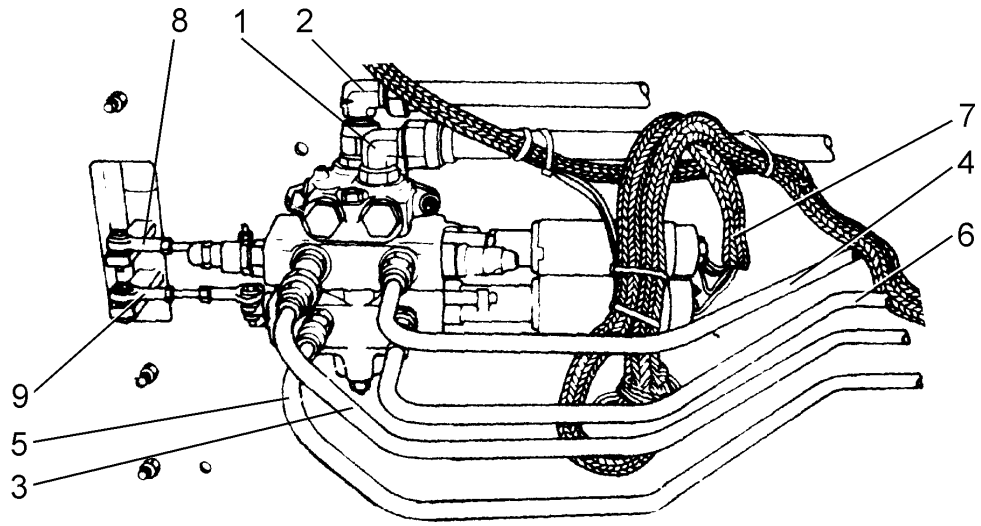


Fig. 10B.14. Pilot Control Valve Disconnect Point

1. Inlet Line
2. Return to Reservoir Line
3. Bucket Cylinder Piston End Pilot Port Tube (Rollback)
4. Bucket Cylinder Rod End Pilot Port Tube (Dump)
5. Boom Cylinder Piston End Pilot Port Tube (Raise)
6. Boom Cylinder Rod End Pilot Port Tube (Lower)
7. Electrical Harness for Boom Positioner and Bucket Positioner
8. Bucket Control Linkage
9. Boom Control Linkage

6. Disconnect the bucket linkage (8) and the boom linkage (9).
7. Remove the valve mounting hardware and remove the valve from the machine.

18. DISASSEMBLY

Separating the Valve Sections (Refer to Fig. 10B.15)

IMPORTANT: *Although the bucket section and the boom section contain many of the same items, the parts are NOT INTERCHANGEABLE between sections. Do not mix parts from both assemblies together.*

1. Scribe the valve sections to each other for correct reassembly.
2. Remove the tie rod nuts (3 and 6) from one side of the valve. Remove the tie rods (4 and 7).

IMPORTANT: *Load check poppets and springs are located between the sections. Exercise care when separating the sections.*

3. Separate the sections. Remove the O-rings (10 and 22) from between the sections. Remove the load check poppet and springs. Tag the poppets with respect to their plunger section. Remove the spacer (21) from between the sections.

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PILOT CONTROL VALVE

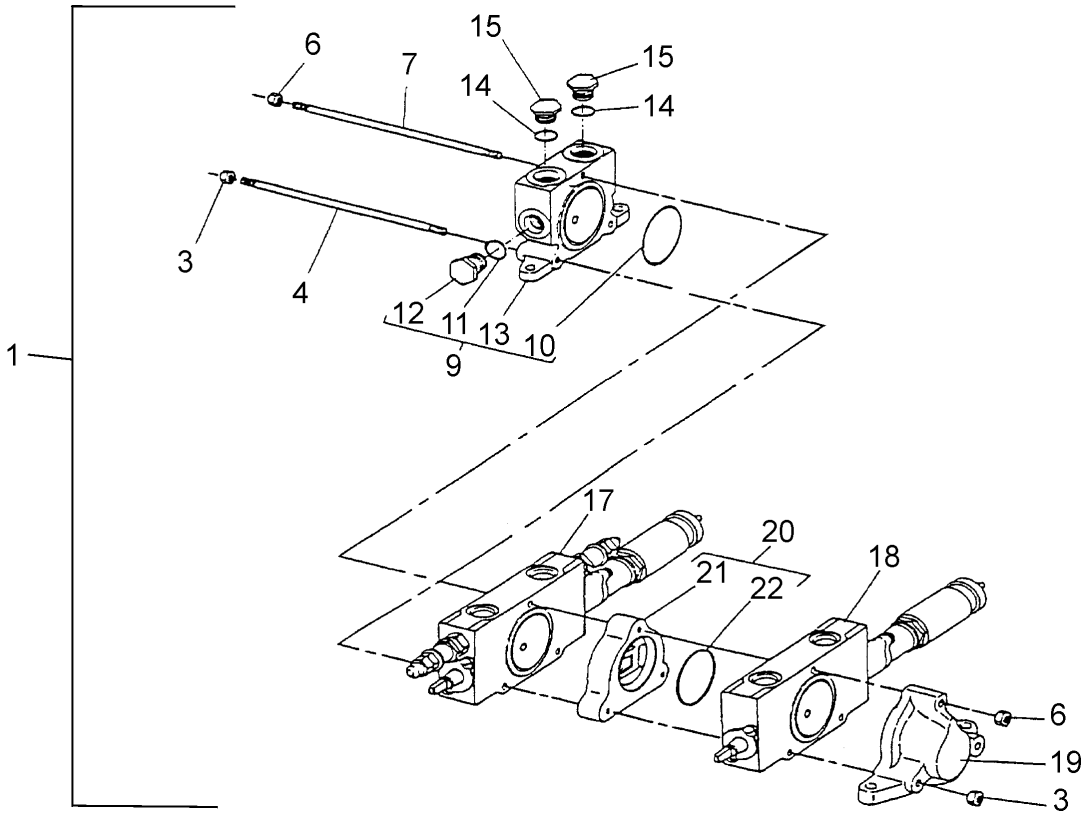


Fig. 10B.15. Separating the Valve Sections

1. Pilot Control Valve
3. Nut
4. Tie Rod
6. Nut
7. Tie Rod
9. Inlet Assembly
10. O-Ring
11. O-Ring
12. Plug
13. Inlet Body
14. O-Ring
15. Plug
17. Bucket Section
18. Boom Section
19. Cover
20. Spacer Assembly
21. Spacer
22. O-Ring

Boom Section (Refer to Fig. 10B. 16)

4. Remove the seal plate (4). Remove the wiper (5) and the seal (6). Remove the bolts (19) securing the cap (20) and the spacer (23). Slide the entire spool assembly from the boom section housing (1).
5. Clamp the eye end of the spool (2) in a vise having protective jaws.
6. Unscrew the nut (12) and slide it up onto the cap (20). Count the number of exposed threads on the cap, up to the edge of the magnetic solenoid assembly (13). Record this number for correct reassembly.
7. Unscrew the magnetic solenoid assembly (13) from the cap and pull it straight back to free the block (10). Remove the nut (9) and bolt (11) and remove the block (10). Remove the solenoid pin (8).

NOTE: *Do not attempt further disassembly of the magnetic solenoid assembly (13).*

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PILOT CONTROL VALVE

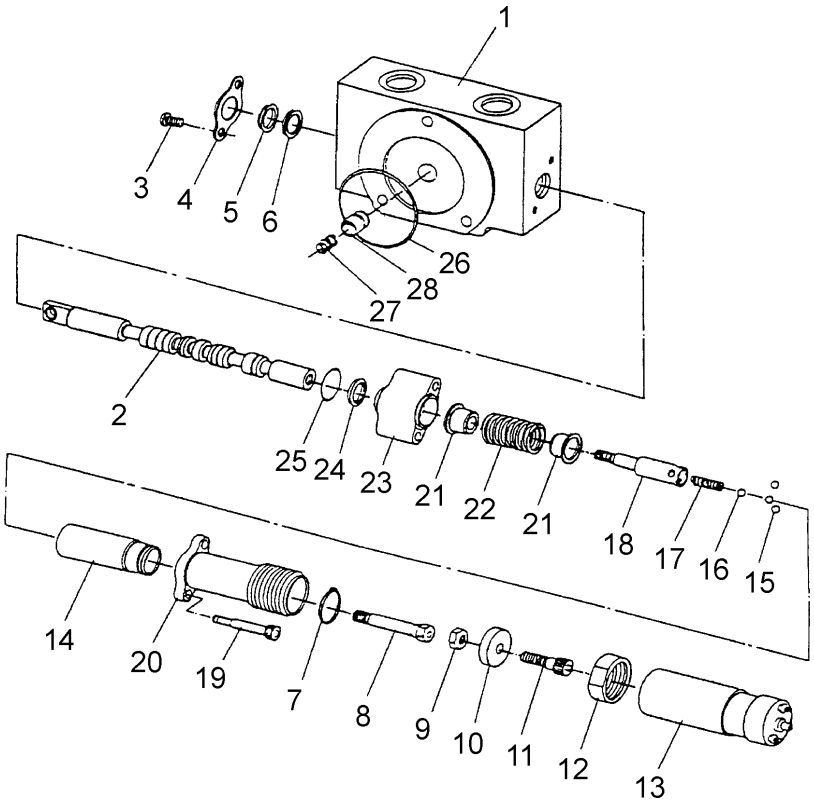


Fig. 10B.16. Exploded View of Pilot Control Valve - Boom Section

1. Housing	8. Solenoid Pin	15. Ball	22. Spring
2. Boom Spool	9. Lock Nut	16. Ball	23. Boom Spacer
3. Bolt	10. Block	17. Detent Spring	24. Seal Spool
4. Seal Plate	11. Bolt	18. Detent Pin	25. O-Ring
5. Wiper	12. Jam Nut	19. Bolt	26. O-Ring
6. Seal	13. Magnetic Solenoid Assembly	20. Cap	27. Spring
7. Snap Ring	14. Sleeve	21. Spring Seat	28. Poppet

8. Remove the snap ring (7). To avoid losing the detent balls (15 and 16), wrap a cloth around the cap (20) and with a rapid motion, pull the cap and the sleeve (14) off the spool assembly. Remove the balls and the detent spring (17).
9. Insert a rod into one of the detent holes in the detent pin (18) and gently exert a slight pressure against the pin to unscrew it from the spool (2).
10. Remove the centering spring (22) and the two spring seats (21). Remove the seal (24) and the O-ring (25) from the spacer (23).

Bucket Section (Refer to Fig. 10B.17)

11. Remove the seal plate (4). Remove the wiper (5) and the seal (6). Remove the bolts (15) securing the cap (16) and the spacer (19). Slide the entire spool assembly from the bucket section housing (1).
12. Clamp the eye end of the spool (2) in a vise having protective jaws.
13. Unscrew the nut (11) and slide it up onto the cap (16). Count the number of exposed threads on the cap, up to the edge of the magnetic solenoid assembly (12). Record this number for correct reassembly.

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PILOT CONTROL VALVE

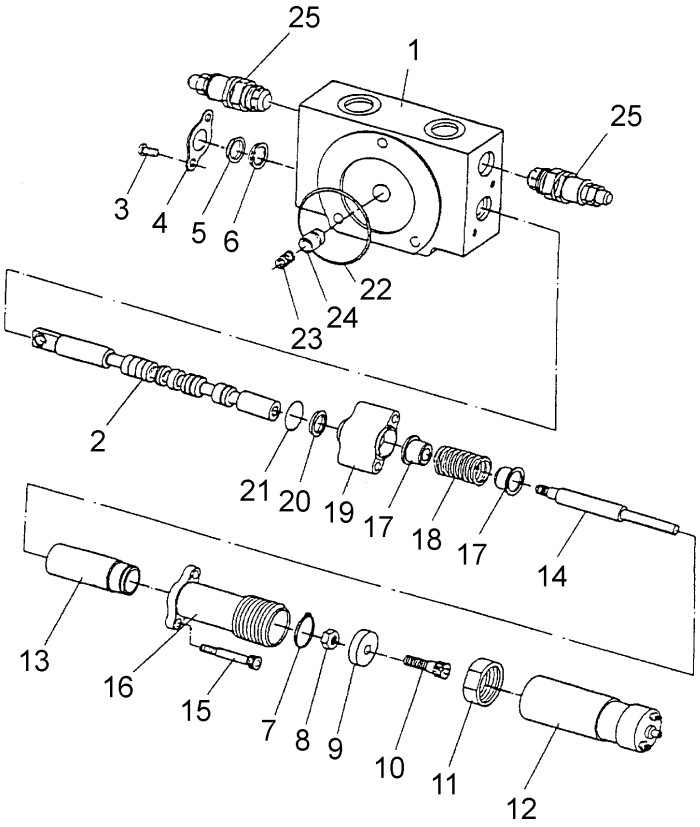


Fig. 10B.17. Exploded View of Pilot Control Valve - Bucket Section

1. Housing
2. Bucket Spool
3. Bolt
4. Seal Plate
5. Wiper
6. Seal
7. Snap Ring
8. Lock Nut
9. Block
10. Bolt
11. Jam Nut
12. Magnetic Solenoid Assembly
13. Sleeve
14. Detent Pin
15. Bolt
16. Cap
17. Spring Seat
18. Spring
19. Bucket Spacer
20. Seal Spool
21. O-Ring
22. O-Ring
23. Spring
24. Poppet
25. Shock Valve

14. Unscrew the magnetic solenoid assembly (12) from the cap and pull it straight back to free the block (9). Remove the nut (8) and bolt (10) and remove the block (9).

NOTE: *DO NOT attempt further disassembly of the magnetic solenoid assembly (12).*

15. Remove the snap ring (7). Pull the cap (16) and the sleeve (13) off the spool assembly.
16. Insert a rod through the cross hole in the detent pin (14) and gently exert a slight pressure against the pin to unscrew it from the spool (2).
17. Remove the centering spring (18) and the two spring seats (17). Remove the seal (20) and the O-ring (21) from the spacer (19).
18. Unscrew the entire shock valve assembly (25) from both sides of the bucket section (1).

Disassemble the shock valve as follows (refer to Fig. 10B.18):

IMPORTANT: *To preserve the original pressure setting, do not disassemble items 1, 2, 3, 4 and 12 unless replacement is necessary.*

a. Separate the cap (4) with associated parts (1, 2, 3 and 12) intact from the sleeve (11).
b. Remove the spring guide (5), O-ring (7), spring (6), poppet (8), lock nut (9) and O-ring (10) from the sleeve (11).

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PILOT CONTROL VALVE

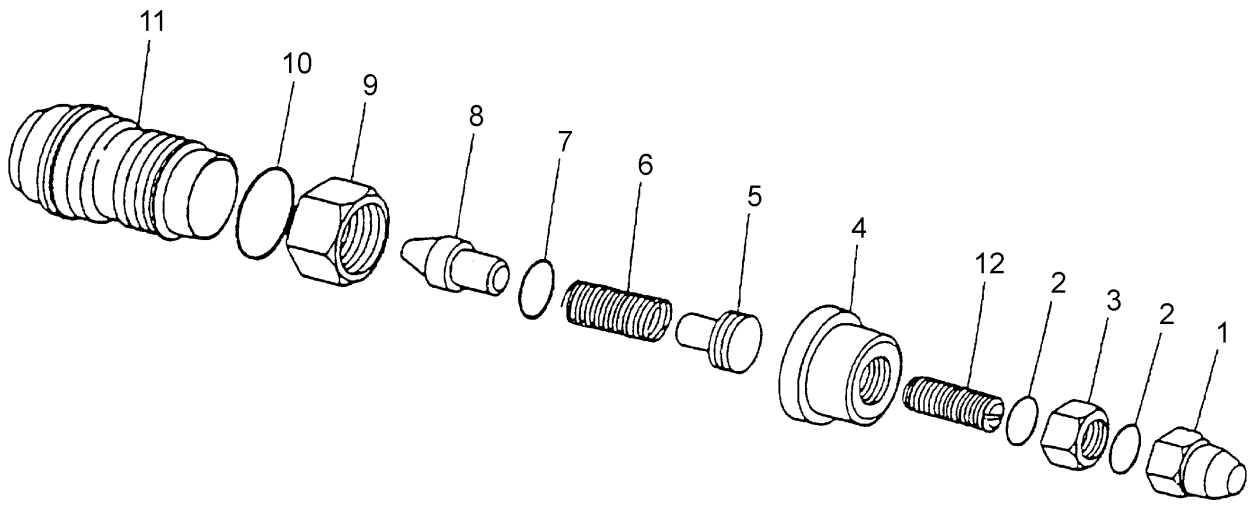


Fig. 10B.18. Exploded View of Bucket Section Relief Valve

1. Acorn Nut	4. Cap	7. O-Ring	10. O-Ring
2. O-Ring	5. Spring Guide	8. Poppet	11. Sleeve
3. Jam Nut	6. Spring	9. Lock Nut	12. Adjusting Screw

19. INSPECTION AND REPAIR

1. Clean all parts in clean solvent and dry with compressed air.
2. Check all springs for damage, distortion or weakness. Springs meeting the requirements shown in "SPECIFICATION" should function properly. Springs not meeting the requirements should be replaced.
3. All bores and surfaces of sliding parts must be free of nicks, scores or excessive wear. All poppets, spools, pistons and sleeves must fit snugly, without binding through a complete revolution. Spools must be free of longitudinal score marks.
4. Inspect all flow passages. These passages must be clean and free of foreign particles.
5. Discard all O-rings, wipers and seals and replace with new.
6. Inspect poppet seating surfaces and poppet faces for nicks or excessive wear.

20. REASSEMBLY

Bucket Section (Refer to Fig. 10B.17)

NOTE: *Lubricate all parts, including bores, with clean hydraulic oil before reassembly.*

1. Reassemble the circuit shock valve assembly as follows (refer to Fig.10B.18):
   a. Install a new O-ring (10) onto the sleeve (11) and a new O-ring (7) onto the spring guide (5).
   b. Insert the poppet (8), spring (6) and spring guide (5) into the sleeve (11).
   c. Items 1, 2, 3 and 12 should have remained assembled to the cap (4). However, if any of these parts has needed replacement, assemble them as shown in the illustration. Torque the jam nut (3) to 14 ± 2 Nm. Torque the acorn nut (1) to 14 ± 2 Nm.

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d. Install the shock valve assembly into the bucket section housing. Back off the lock nut (9) to torque the assembly to 40 - 70 Nm. Tighten the lock nut against the housing and torque the lock nut to 14 ± 2 Nm.

2. Install the seal (20) and the O-ring (21) into the spacer (19). The lips of the seal (20) should be toward the O-ring groove.
3. Clamp the eye end of the spool (2) in a vise with protective jaws.
4. Slide the spacer (19) over the spool. Place one spring seat (17) over the end of the spool. Assemble the centering spring (18) and the other spring seat (17) onto the detent pin (14).
5. Apply a small amount of Loctite 271 to the threads inside the spool. Install the detent pin (14) into the spool. The centering spring should ride between the two spring seats. Torque the detent pin to 100 - 115 Nm.
6. Slide the sleeve (13) over the detent pin (14). Slide the cap (16) over the sleeve. Install the snap ring (7) into the end of the sleeve to secure the cap.
7. Remove the spool from the vise and carefully install the spool into the bucket section housing (1). Install the bolts (15) through the cap (16) and spacer (19) and into the housing. Torque the bolts to 7 ± 1 Nm.
8. Install the seal (6) over the spool and into the housing, with the lips of the seal facing inward. Install the wiper (5) over the spool and against the seal (6) with the lip of the wiper facing outward. Install the seal plate (4) to the housing.
9. Apply a small amount of Loctite 271 to the threads of the detent pin (14). Install the detent pin through the center of the sleeve (13).
10. Place the bolt (10) through the hole in the block (9). Thread the lock nut (8) onto the bolts until the nut is snug against the block.
11. Apply a small amount of Loctite 271 to the threads of the bolt (10). Install the bolt into the end of the detent pin (14) until the lock nut (8) is seated against the detent pin.
12. Back the bolt out of the detent pin approximately 1/2 of a turn. Hold the bolt in this position and thread the lock nut down the bolt until it is against the detent pin. Refer to Fig. 10B.19. Torque the lock nut to 14 ± 2 Nm.

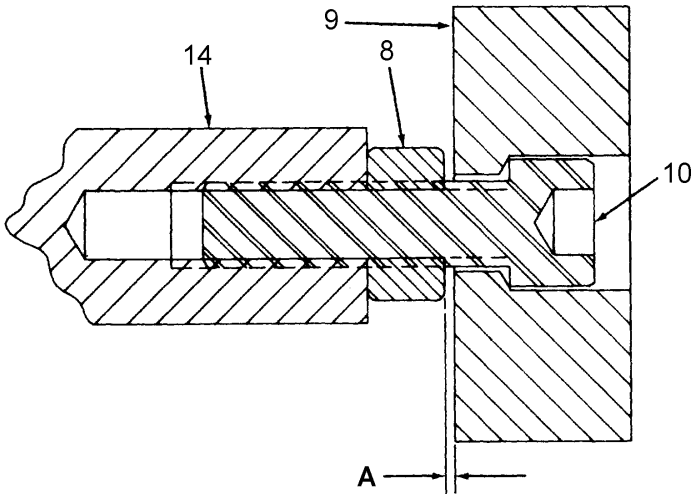


Fig. 10B.19. Detent Pin and Block Adjustment

8. Lock nut 9. Block 10. Bolt 14. Detent Pin

A . . . . . 0.46 - 0.64 mm

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13. Referring to Fig. 10B.19 measure dimension A between the lock nut and the block. The clearance should be 0.46 - 0.64 mm. Adjust the bolt and the lock nut until the correct dimension is achieved. Retorque the lock nut to 14 ± 2 Nm.
14. Screw the nut (11) onto the cap (16) and slide it up toward the valve housing.
15. Install the magnetic solenoid assembly (12) over the block (9) and screw it onto the cap until the number of exposed threads on the cap is the same as recorded during disassembly.
16. Hold the magnetic solenoid assembly in this position and rethread the jam nut (11) onto the cap until the nut is seated against the solenoid assembly housing. Torque the jam nut to 60 Nm.

Boom Section (Refer to Fig. 10B.16)

NOTE: *Lubricate all parts, including bores, with clean hydraulic oil before reassembly.*

17. Install the seal (24) and the O-ring (25) into the spacer (23). The lips of the seal (24) should be toward the O-ring groove.
18. Clamp the eye end of the spool (2) in a vise with protective jaws.
19. Slide the spacer (23) over the spool. Place one spring seat (21) over the end of the spool. Assemble the centering spring (22) and the other spring seat (21) onto the detent pin (18).
20. Apply a small amount of Loctite 271 to the threads inside the spool. Install the detent pin (18) into the spool. The centering spring should ride between the two spring seats. Torque the detent pin to 100 - 115 Nm.
21. Reposition the spool (2) in the vise so that the detent pin (18) is upward. Install the detent spring (17) into the detent pin. Position the larger ball (16) on the end of the detent spring.
22. Slide a small punch through the center of the detent pin and use the punch to depress the spring (17) and ball (16) below the level of the three holes in the side of the detent pin.
23. Install the three smaller balls (15) into the three holes around the detent pin and hold them in place with clean grease. Slide the sleeve (14) over the detent pin being sure the balls remain in position inside the pin.
24. Apply a small amount of Loctite 271 to the threads of the solenoid pin (8). Install the solenoid pin through the center of the sleeve (14) and into the detent pin (18). Torque the solenoid pin to 100 - 115 Nm.
25. Slide the cap (20) over the sleeve (14). Install the snap ring (7) into the end of the sleeve to secure the cap.
26. Remove the spool from the vise and carefully install the spool into the boom section housing (1). Install the bolts (19) through the cap and spacer (23) and into the housing. Torque the bolts to 7 ± 1 Nm.
27. Install the seal (6) over the spool and into the housing with the lips of the seal facing inward. Install the wiper (5) over the spool and against the seal (6), with the lip of the wiper facing outward. Install the seal plate (4) to the housing.
28. Place the bolt (11) through the hole in the block (10). Thread the lock nut (9) onto the bolt until the nut is snug against the block.
29. Apply a small amount of Loctite 271 to the threads of the bolt (11). Install the bolt into the end of the solenoid pin (8) until the lock nut (9) is seated against the solenoid pin.
30. Back the bolt out of the solenoid pin approximately 1/2 of a turn. Hold the bolt in this position and thread the jam nut down the bolt until it is against the solenoid pin. Refer to Fig. 10B.19. Torque the lock nut to 14 ± 2 Nm.

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31. Referring to Fig. 10B.19 measure dimension A between the lock nut and the block. The clearance should be 0.46 - 0.64 mm. Adjust the bolt and the lock nut until the correct dimension is achieved. Retorque the lock nut to 14 ± 2 Nm.
32. Screw the nut (12) onto the cap (20) and slide it up toward the valve housing.
33. Install the magnetic solenoid assembly (13) over the block (10) and bolt it onto the cap until the number of exposed threads on the cap is the same as recorded during disassembly.
34. Hold the magnetic solenoid assembly in this position and rethread the jam nut (12) onto the cap until the nut is seated against the solenoid assembly housing. Torque the jam nut to 60 Nm.

Joining the Valve Sections (Refer to Fig. 10B.15)

NOTE: Lubricate all parts, including bores, with clean hydraulic oil before reassembly.

35. Lightly coat the O-rings (10 and 22) with grease to hold them in the grooves between the sections. Install the O-rings. Position the spacer (21) between the boom section (18) and the bucket section (17).
36. Install the load check poppets and the springs into the boom section (18) and the bucket section (17).
37. Stack the inlet section (9), bucket section (17), boom section (18) and cover (19) together in that order. Be certain the poppets, springs and O-rings remain in place.
38. Install the tie rod (7) in the upper single hole through all sections. Install the tie rods (4) through the lower two holes. Install the nuts (3 and 6) and tighten all the nuts down evenly in steps. When all the nuts are tight, torque upper nuts to 45 Nm and torque the lower nuts to 20 Nm.

21. INSTALLATION (Refer to Fig. 10B.14)

1. Position the valve on the machine and install the mounting hardware.
2. Connect the bucket linkage to the bucket spool and connect the boom linkage to the boom spool.
3. Connect the bucket cylinder piston side pilot tube (3) and the rod side pilot tube (4) to the bucket section.
4. Connect the boom cylinder piston side pilot tube (5) and the rod side pilot tube (6) to the boom section.
5. Connect the inlet line (1) and the return to reservoir line (2) to the inlet section.
6. Connect the electrical harness (7) to the ends of the boom and bucket sections.
7. Start the machine and operate both the boom and the bucket control levers several times thru all positions to expel all air and to make sure that all functions are operating properly. Check the operation of the boom positioner and the bucket positioner.
8. Check the fluid level in the hydraulic reservoir and fill as necessary. Refer to the OPERATOR'S MANUAL for oil specifications and procedure.
9. Check the bucket circuit shock valve pressure setting by following the procedure outlined under "BUCKET CIRCUIT SHOCK VALVE PRESSURE TEST AND ADJUSTMENT" in this section.

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22. DESCRIPTION (Refer to Fig.10B.20)

The hydraulic control valve is mounted to the inside front wall of the front frame. It is made up of four sections which are bolted together to make one unit. The four sections are: the inlet section (1), the bucket section (2), the boom section (3) and the end section (4).

At low engine speeds, the valve operates on the oil output of the hydraulic pump. At high engine speeds, this oil is supplemented by oil from the switch pump section of the steering/switch pump. The two oil flows are joined at a manifold, mounted on the transmission and a single hose brings oil to the inlet port (5) in the inlet section of the valve. Oil which circulates through the hydraulic control valve is returned to the reservoir through the outlet port (6).

The hydraulic control valve is a pilot operated valve, meaning that oil from the pilot control valve is used to shift the spools in the hydraulic control valve. A small portion of oil entering the inlet section passes through an external pilot feed tube (7) to a cover plate (8) where it is sent on, through another external tube, to the pilot control valve.

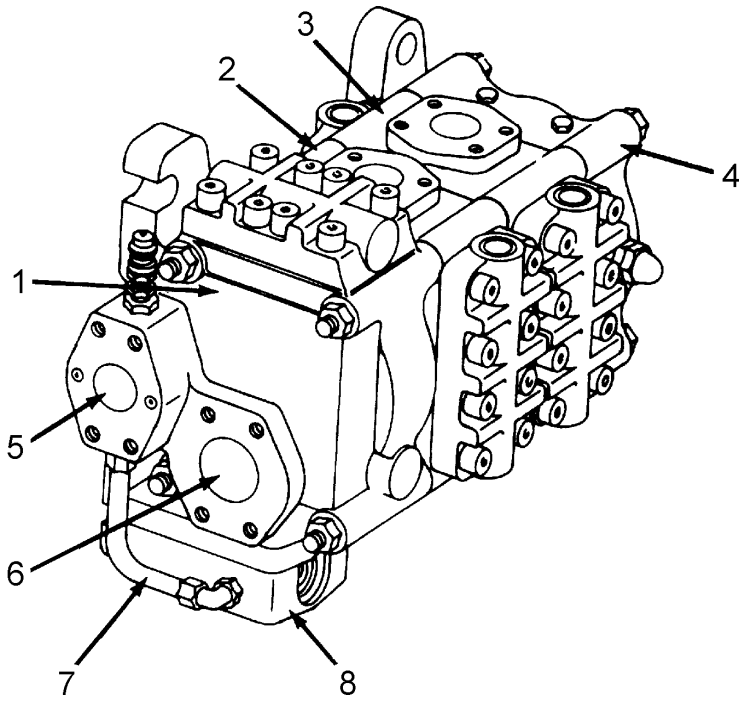


Fig. 10B.20. Hydraulic Control Valve Assembly

1. Inlet Section	3. Boom Section	5. Inlet Port	7. Pilot Feed Tube
2. Bucket Section	4. End Section	6. Outlet Port	8. Cover Plate

The largest portion of the oil flow entering the inlet section is circulated through the bucket section and boom section of the valve, to be ready for actuation of the bucket or boom cylinders. When the pilot control valve spools are in the "hold" position, this oil passes through the hy7draulic valve and returns to the reservoir.

Two external tubes connect the inlet section to the end section. These tubes control the unloading valve located in the end section.

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VALVES

HYDRAULIC CONTROL VALVE

23. OPERATION

Inlet Section (Refer to Fig.10B. 21)

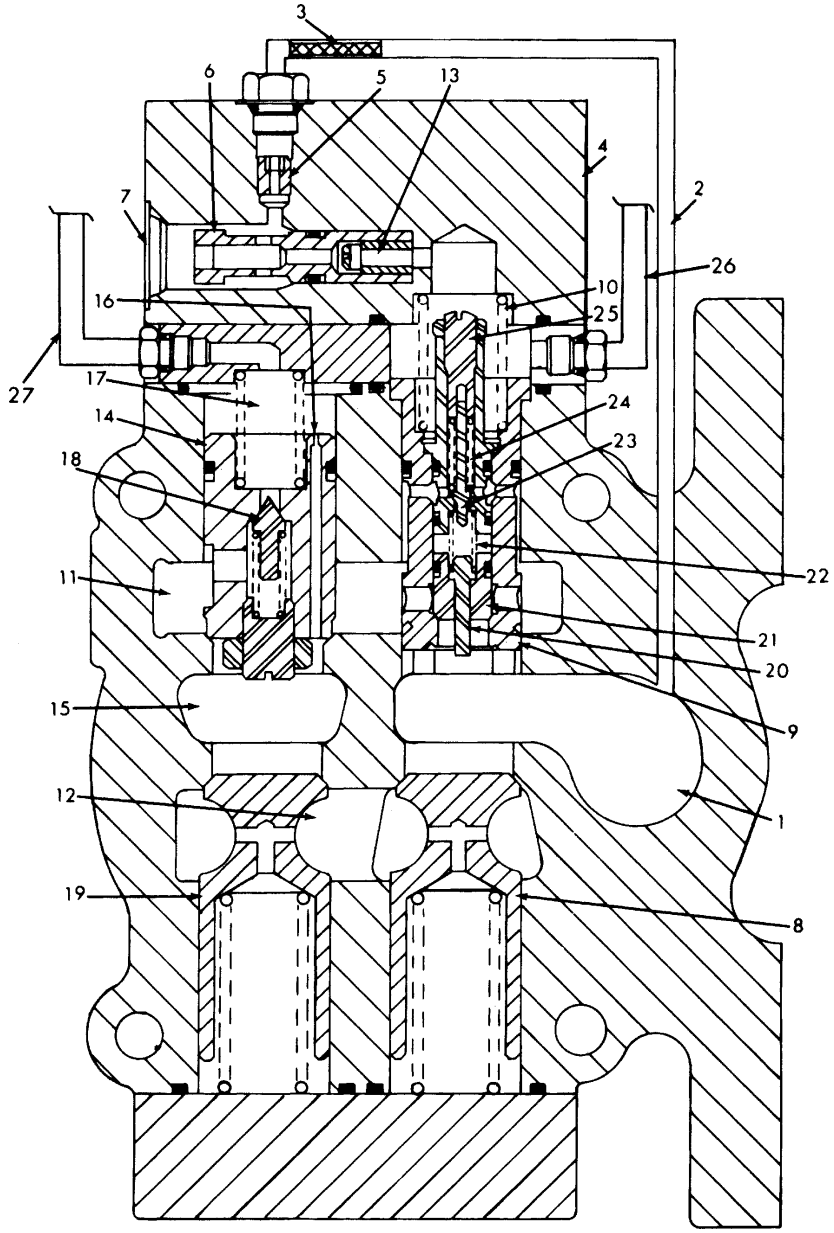


Fig. 10B. 21. Cross Section of Inlet Section

1. Supply Port
2. Pilot Feed Tube
3. Filter Screen
4. Cover Plate
5. Orifice
6. Dampening Sleeve
7. Port to Pilot Control Valve
8. Load Check Poppet
9. Flow Control and Main Relief Valve
10. Spring
11. Outlet Port
12. Supply Core
13. Dampening Poppet
14. Low Pressure Relief Valve
15. Return Core
16. Orifice
17. Spring Cavity
18. Pilot Poppet
19. Anti-void Poppet
20. Piston
21. Relief Poppet
22. Spring Cavity
23. Pilot Poppet
24. Spring
25. Adjusting Screw
26. Tube from Flow Control Valve Spring Cavity to End Section
27. Tube from Low Pressure Relief Valve Spring Cavity to End Section

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HYDRAULIC CONTROL VALVE

Oil from the pump enters the supply port (1). A small portion of oil goes through the pilot feed tube (2) and through a filter screen (3) in this tube to the cover plate (4). The flow then passes through an orifice (5) around the dampening sleeve (6) and leaves the valve at the port (7) to the pilot control valve. With the pilot control valve spools in "HOLD", this oil flow is returned to the reservoir, creating only reservoir return pressure on the downstream side of the orifice.

The larger portion of the oil entering at the supply port is blocked by the load check poppet (8) and the flow control valve (9). This incoming pump pressure oil will overcome the force of the spring (10) and the return pressure oil at the cover plate (4) moving the flow control valve upward. This opens a passage for the pump pressure oil to flow out the outlet port (11) and return to the reservoir.

NOTE: *The flow control valve has within it a main relief valve. The entire assembly is considered the flow control valve and it is this entire assembly which moves during the action described in the preceding paragraph.*

When a pilot control valve spool is shifted out of the "HOLD" position, the flow from port (7) to the pilot valve no longer returns to the reservoir, but is redirected back into the loader valve to shift the boom or bucket spools. This creates a restriction which is felt back through the line to port (7) and to the area around the spring (10). The combined efforts of the increased pressure and the spring action will force the flow control valve back on its seat, closing off the passage to the outlet port (11).

With no place else for the pump flow oil to go, the load check poppet (8) is forced off its seat and the pump flow oil enters the supply core (12) to the boom and bucket valve sections.

The dampening sleeve (6) acts as a shock absorber to smooth out the reaction of the flow control valve (9). When low pressure is sensed at port (7) and the flow control valve begins to move off its seat, the pressure in the cavity around the spring (10) temporarily rises, forcing the dampening poppet (13) to the left onto its seat. All oil escaping from the spring cavity must now pass thru a small orifice in the end of the dampening poppet. This action tends to slow the movement of the flow control valve upward off of its seat. When the pressure at port (7) increases, the dampening poppet (13) moves to the right, allowing the higher pressure oil to enter the spring cavity through the somewhat larger orifice in the side of the dampening poppet.

The low pressure relief (14) keeps a small amount of back pressure on the oil returning from the bucket and boom sections through the return core (15). The pressure of this returning oil acts against the bottom of the valve and passes thru the orifice (16) to gradually increase the pressure in the spring cavity (17). When the pressure in the spring cavity reaches 1035 -1380 kPa, the pilot poppet (18) is forced off its seat allowing oil in the spring cavity to dump to the outlet port (11). This rapidly decreases the pressure of the oil in the spring cavity. Now the pressure of the oil in the return core can overcome the force of the spring and the whole valve moves upward, off of its seat, to dump return oil directly to the outlet port. Simultaneously, in reaction to the decreased pressure in the spring cavity, the spring behind the pilot poppet (18) reseats the poppet. Oil from the return core (15) is still entering the spring cavity through the orifice (16). When the pressure on both sides of the valve is equalized, the force of the spring in the spring cavity reseats the valve completing the cycle.

Located beside the load check poppet (8) is the anti-void poppet (19). If pump flow can not keep up with cylinder movement, such as when lowering the boom from a raised position, the anti-void poppet opens to supplement pump flow. The pressure of the oil going to the cylinders through the supply core (12) is sensed on both sides of the anti-void poppet through the small orifices to the spring side of the poppet. When supply oil is being used at a greater rate than the pumps can deliver, supply pressure drops below the pressure of the oil returning through the return core (15).

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The return oil can now overcome the force of the spring behind the anti-void poppet moving the poppet off its seat. This opens a passage for return flow to recirculate back to the boom and bucket sections through the supply core (12).

Contained within the flow control valve (9) is the main relief valve. During normal operation when the system pressure is the same on both sides of the valve, the valve is kept on its seat by the spring (10). Pressure is acting against the end of the piston (20) and the relief poppet (21). The same pressure is acting on the spring cavity (22) between the piston and the pilot poppet (23) because of the leakage of oil between the piston and the relief poppet. As pressure increases, the piston will be forced farther into the spring cavity increasing the pressure on the pilot poppet. When the pressure reaches the point that it can overcome the force of the spring (24), the pilot poppet is forced off its seat allowing the oil in the spring cavity to flow out to the outlet port (11) through the small openings around the pilot poppet. This quickly decreases the pressure in the spring cavity and the pressure acting against the end of the relief poppet (21) pushes the relief poppet off its seat allowing the main volume of oil to exit through the valve body to the outlet port.

The relief setting on the main relief valve can be adjusted by turning the adjusting screw (25). Turning the screw inward increases the tension on the spring (24) requiring a higher pressure to unseat the pilot poppet (23). Turning the screw outward has the opposite effect of lowering the relief setting.

The function of the two tubes (26 and 27) which connect the inlet section to the end section is explained under "End Section".

End Section (Refer to Fig. 10B.22)

The end section (1) contains an unloading valve assembly which consists of a spring seated poppet (2) and a piston (3). There are two externally mounted tubes which connect the end section to the inlet section (4). One tube (5) communicates the pressure from the spring side of the flow control valve (6) to the bottom of the unloading valve piston (3). The other tube (7) provides for oil flow between the spring side of the low pressure relief valve (8) and the top of the unloading valve poppet (2). An internal cored passage (9) which passes through all the section of the loader valve connects the center chamber (10) of the unloading valve with the outlet-to-reservoir port (11) in the inlet section.

The function of the low pressure relief valve (8) in the inlet section is to keep 1035 - 1380 kPa backpressure on the return oil from the cylinders. The function of the unloading valve assembly in the end section is to eliminate this backpressure when system pressure reaches 6900 kPa.

The low pressure relief valve (8) maintains the backpressure through the operation of its internal pilot poppet (13). As oil enters the return core pressure builds. The pressure acts on the face of the low pressure relief valve and on the spring side of the pilot poppet. The pressure is felt on the spring side through the drilled passage (14) in the valve. When the pressure reaches approximately 1035 kPa, the pilot poppet is moved off of its seat. This opens the spring side of the valve to the outlet port (11) which lowers the pressure on the spring side. The pressure on the face of the valve at the return core (12) can now overcome the force of the spring allowing return core oil to enter the outlet port (11). With the spring side drained to the outlet port, the pilot poppet (13) will reseat. Pressure continues to be felt through the drilled passage (14) until the spring side pressure will reseat the entire valve. This action maintains the backpressure on the return oil from the cylinders.

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HYDRAULIC CONTROL VALVE

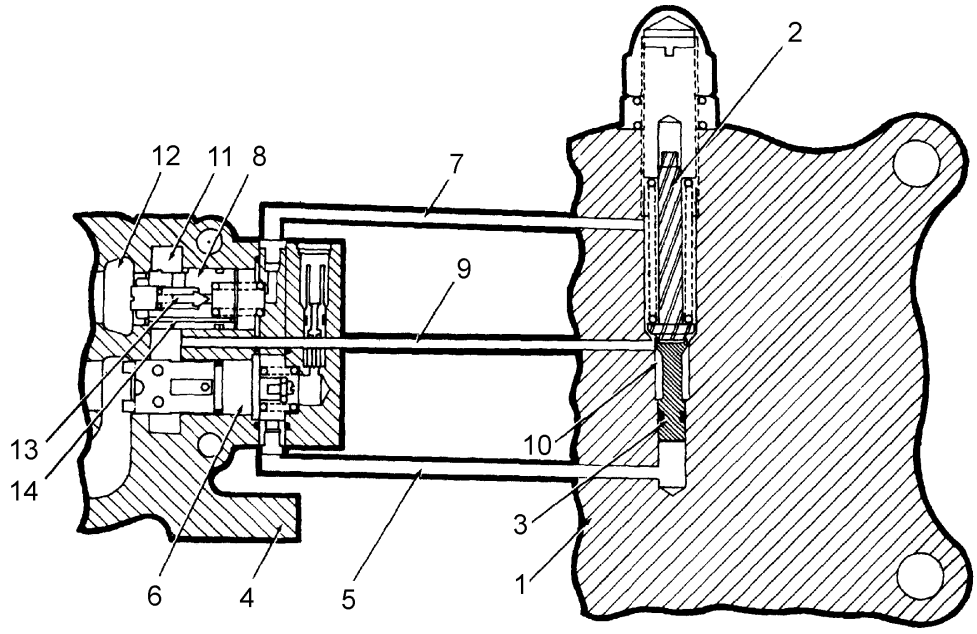


Fig. 10B.22. Sectional View of End Section, Unloading Valve and Connections to the Inlet Section

1. End Section
2. Unloading Poppet
3. Unloading Piston
4. Inlet Section
5. External Tube
6. Flow Control Valve
7. External Tube
8. Low Pressure Relief Valve
9. Internal Cored Passage
10. Center Chamber
11. Outlet to Reservoir Port
12. Return Core
13. Pilot Poppet
14. Drilled Passage

The low pressure relief valve spring side pressure is also sensed back through the external tube (7) to the area around the unloading valve poppet (2) but the oil is trapped in this area as long as both poppets (2 and 13) remain on their seats. When the loader system operating pressure at the spring side of the flow control valve (6) reaches approximately 6900 kPa this pressure will be sensed through the other external tube (5) to the bottom of the unloading piston (3). This pressure is sufficient to move the piston upward and force the poppet (2) off its seat. Oil from the external passage (7) now drains off around the poppet and through the internal cored passage (9) to the outlet port (11). The pressure at the return core (12) can now move the entire low pressure relief valve assembly (8) against its spring dumping off return core pressure to the reservoir without first having to move the pilot poppet (13).

Any time the loader hydraulic system is being operated under no load conditions, the low pressure relief valve is governing its own operation since the pressure through the external tube (5) is insufficient to move the unloading piston (3).

Bucket Section

NEUTRAL (Refer to Fig. 10B.23):

The bucket section of the loader control valve directs oil to and from the bucket cylinder. This section contains two plungers (2 and 9) which are spring centered. Each of the plungers contains a restrictor poppet (3 and 10). A check poppet (5) is located in the pilot cover (12). Main pressure oil flows through the supply core (7) from the inlet section and returns to the inlet section through the return core (6). The pilot cover contains two ports which are connected to the pilot control valve. At the left is the rod side pilot port (8). The other port is the is the piston side pilot port (1). The large port to the left is the rod side cylinder port (11) and the other port is the piston side cylinder port (4).

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VALVES

HYDRAULIC CONTROL VALVE

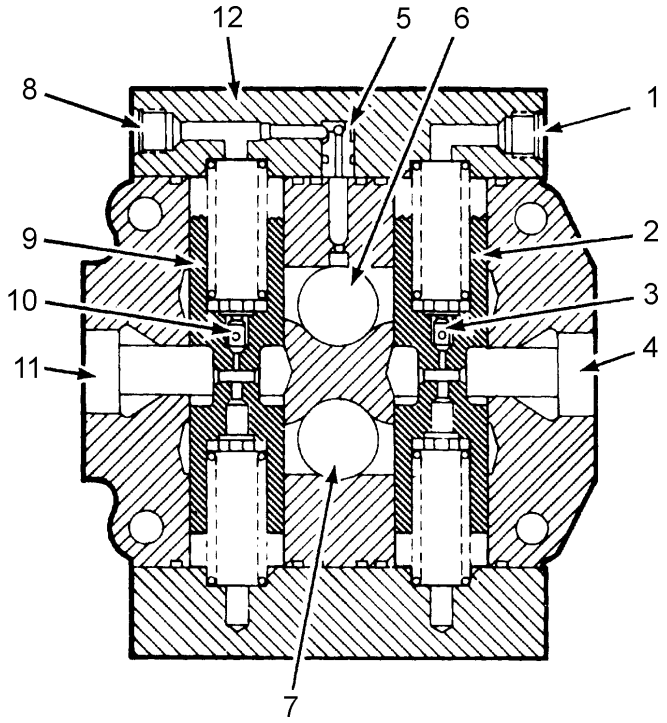


Fig. 10B.23. Bucket Section in "NEUTRAL"

1. Piston Side Pilot Port
2. Piston Side Plunger
3. Restrictor Poppet
4. Piston Side Cylinder Port
5. Check Poppet
6. Return Core
7. Supply Core
8. Rod Side Pilot Port
9. Rod Side Plunger
10. Restrictor Poppet
11. Rod Side Cylinder Port
12. Pilot Cover

When the bucket lever in the cab is in the "HOLD" position, both of the plungers (2 and 9) in the loader valve are centered by their springs. When in this position, the plungers are blocking both the supply core (7) and the return core (6) from the cylinder ports (4 and 11). No oil can flow to or from the bucket cylinder so the cylinder is not moving.

BUCKET ROLLBACK (Refer to Fig. 10B.24):

When the bucket lever in the cab is placed in the "ROLLBACK" position, oil from the pilot control valve flows into the piston side pilot port (1). Oil pushes against the top of the piston side plunger (2). A small amount of oil can pass through the restrictor poppet (3) but the orifice in the poppet shows the oil flow. This allows enough pressure to build up on the pilot port side of the plunger to force the plunger down opening the supply core (7) to the piston side cylinder port (4). Since main pressure oil entering from the supply core now passes through a horizontal passage in the plunger, this pressure is also sensed in the lower spring chamber of the plunger. In order to keep the plunger down against this main pressure, the orifice in the restrictor poppet maintains a higher pressure in the upper spring chamber by continuing to restrict the pilot port flow.

At the same time, return flow from the cylinder enters the rod side cylinder port (11) and is sensed through internal passages in the plunger (9). Since the rod side pilot port (8) is open to return, meaning lower pressure, a pressure differential is created between the top and bottom of the plunger. The plunger moves upward opening the rod side cylinder port (11) to the return core (6). The rod side plunger is kept up by the continuing pressure differential between the top and bottom of the spool. A small amount of return oil will exit through the check poppet (5) but does not affect the plunger operation.

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HYDRAULIC CONTROL VALVE

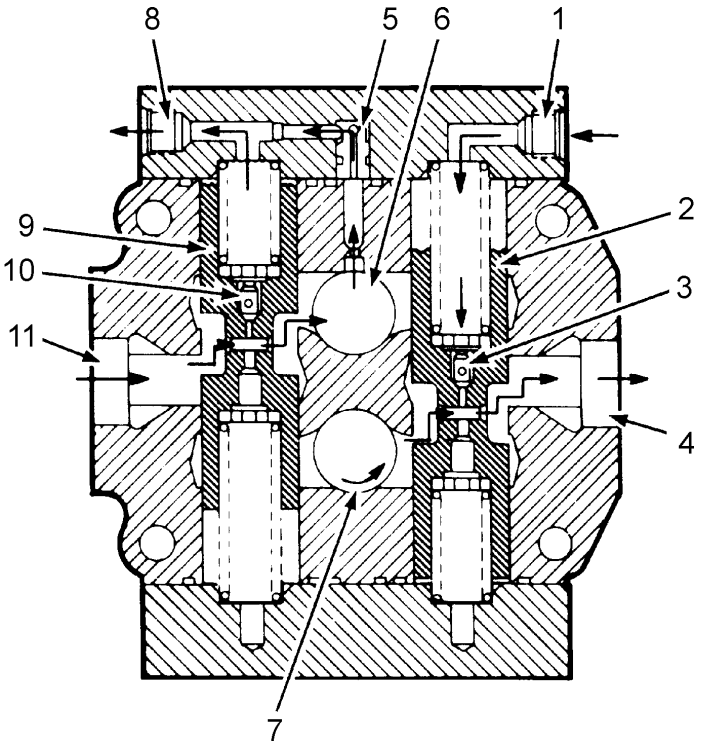


Fig. 10B.24. Bucket Section in "ROLLBACK"

1. Piston Side Pilot Port
2. Piston Side Plunger
3. Restrictor Poppet
4. Piston Side Cylinder Port
5. Check Poppet
6. Return Core
7. Supply Core
8. Rod Side Pilot Port
9. Rod Side Plunger
10. Restrictor Poppet
11. Rod Side Cylinder Port

The restrictor poppet (3) provides feathering action of the bucket. If the operator wants a slow rollback, he moves the lever only part way and only a partial flow of oil acts on the top of the plunger. The restrictor poppet orifice allows a portion of that flow to go out to the system. The result is a slower build-up of pressure on the plunger because of the flow through the orifice. The plunger will move down a small amount and allow a smaller main flow to the cylinder resulting in slower bucket movement.

BUCKET DUMP (Refer to Fig. 10B.25):

When the operator places the bucket lever in "DUMP", the plungers react in the opposite manner. Oil enters the rod side pilot port (8) to push the rod side plunger (9) down, allowing main pressure flow to the rod side cylinder port (11). At the same time, the piston side pilot port (1) is open to return, the piston side plunger (2) moves up and oil from the piston side cylinder port (4) flows to the return core. The pressure of the oil entering the rod side pilot port keeps the ball in the check poppet (5) on its seat and no oil flows through the check poppet.

An external one-way restrictor check valve in the line from the piston side pilot port (1) keeps a small amount of backpressure in the upper spring chamber of the piston side plunger (2). This prevents the plunger from moving to the full open position, providing a control for the speed of bucket dump.

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HYDRAULIC CONTROL VALVE

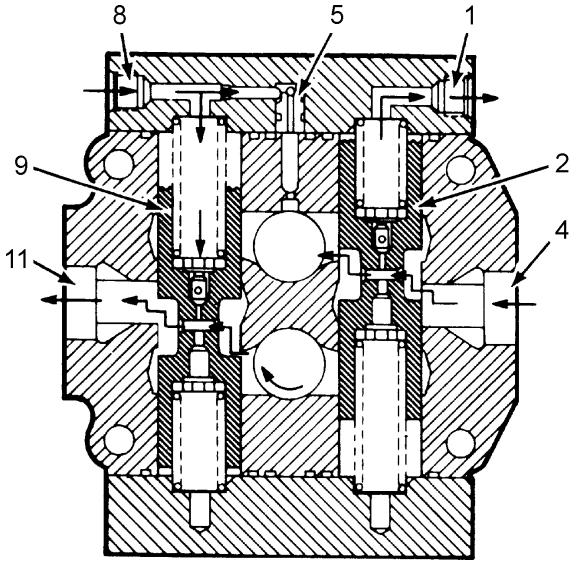


Fig. 10B.25. Bucket Section in "DUMP"

1. Piston Side Pilot Port
2. Piston Side Plunger
4. Piston Side Cylinder Port
5. Check Poppet
8. Rod Side Pilot Port
9. Rod Side Plunger
11. Rod Side Cylinder Port

BUCKET DUMP OVER CENTER (Refer to Fig. 10B.26):

When dumping the bucket, there is a point in its rotation when the weight of the load and the bucket will force the motion of the bucket to be faster than the motion of the cylinder. When this condition of dumping over the center of gravity occurs, the motion of the cylinder will force oil out of the piston side of the cylinder faster than the pump flow can fill the rod side. Due to this drawing effect, system pressure and pilot pressure will drop.

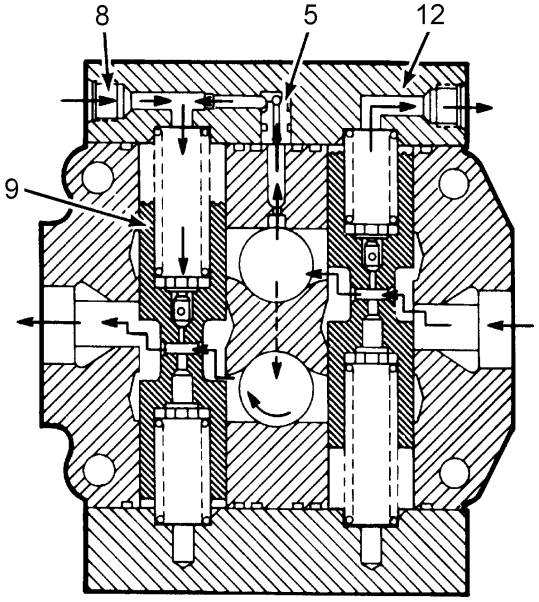


Fig. 10B.26. Bucket Section in "DUMP OVER CENTER"

5. Check Poppet
8. Rod Side Pilot Port
9. Rod Side Plunger
12. Pilot Cover

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HYDRAULIC CONTROL VALVE

When pilot pressure at the rod side pilot port (8) drops, the spring-centered rod side plunger (9) will want to return to the "NEUTRAL" position. This is prevented as the pressure on the top of the check poppet (5) is lower than the return pressure acting on its bottom. The poppet will open directing return oil through the passage in the pilot cover (12) to the rod side plunger. This maintains a pressure differential which holds the rod side plunger down.

In addition, the pressure of the oil returning thru the inlet section is greater than supply pressure, due to the drawing effect of the cylinder. The pressure through the return core is maintained at 1035 - 1380 kPa by the low pressure relief valve in the inlet section. When the pump flow can not keep up with the cylinder movement to the point where supply pressure drops below 1035 -1380 kPa, the return flow will unseat the anti-void poppet (19, Fig. 10B.21) in the inlet section allowing the return flow to supplement the pump flow. This will prevent the rod side of the cylinder from cavitating.

Boom Section

NEUTRAL (Refer to Fig. 10B.27):

The boom section of the loader control valve directs oil to and from the boom cylinder in a similar manner to the operation of the bucket section. The boom section also contains two plungers, but here the piston side plunger (2) contains one restrictor poppet (3) while the rod side plunger (12) contains two restrictor poppets (13 and 15). A check poppet (5) is located in the pilot cover (16). A float poppet (6) is located between the return core (8) and the upper check poppet (5). This float poppet is connected through an internal passage (7) to a lower check poppet (10) which in turn is connected to the lower side of the rod side plunger (12). When the boom lever in the cab is in the "hold" position, both of the plungers are centered by their springs blocking supply and return oil from flowing to the boom cylinder.

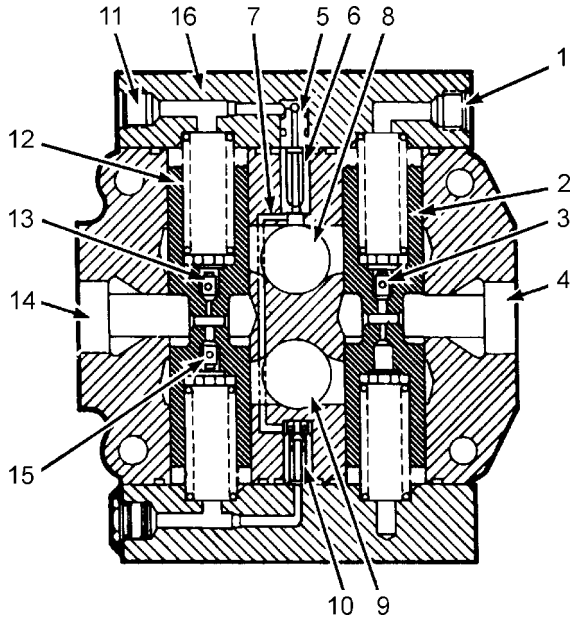


Fig. 10B.27. Boom Section in "NEUTRAL"

1. Piston Side Pilot Port
2. Piston Side Plunger
3. Restrictor Poppet
4. Piston Side Cylinder Port
5. Upper Check Poppet
6. Float Poppet
7. Passage
8. Return Core
9. Supply core
10. Lower Check Poppet
11. Rod Side Pilot Port
12. Rod Side Plunger
13. Upper Restrictor Poppet
14. Rod Side Cylinder Port
15. Lower Restrictor Poppet
16. Pilot Cover

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HYDRAULIC CONTROL VALVE

BOOM RAISE (Refer to Fig. 10B.28):

The operation of the boom section when the boom lever in the cab is placed in the "RAISE" position is almost the same as that described for "BUCKET ROLLBACK" except for the addition of the lower restrictor poppet (15) in the rod side plunger (12). The pressure differential between the cylinder port (14) and the pilot port (11) causes the plunger to move upward which opens the port (14) to the return core (8). A small amount of oil from the return core is directed through a passage (7) to the lower check poppet (10). The check poppet moves down and oil passes through its orifice to the lower spring chamber. The orifice in the lower restrictor poppet (15) helps to maintain the pressure in the lower spring chamber to keep the plunger up.

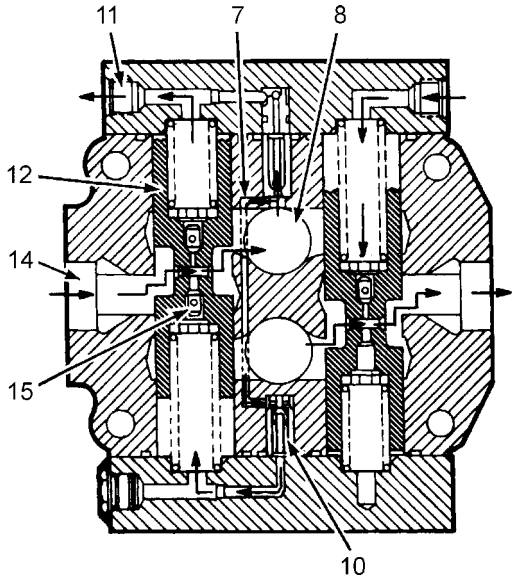


Fig. 10B.28. Boom Section in "RAISE"

7. Passage	10. Lower Check Poppet	12. Rod Side Plunger
8. Return Core	11. Rod Side Pilot Port	14. Rod Side Cylinder Port
		15. Lower Restrictor Poppet

BOOM LOWER (Refer to Fig. 10B.29):

The operation of the boom section in "LOWER" is almost the opposite of "RAISE". However, in the "LOWER" position, the lower restrictor poppet (15) controls the speed at which the rod side plunger (12) moves down. Oil enters the rod side pilot port (11) and pressure builds in the upper spring chamber. Although a small amount passes through the upper restrictor poppet (13), the pressure in the spring chamber is enough to begin the downward movement of the plunger (12). As the plunger moves down, the only exit for the oil in the lower spring chamber is the orifice in the lower restrictor poppet (15) since the pressure in this chamber has seated the lower check poppet (10).

The retarded action of the rod side plunger gives the piston side plunger (2) time to shift upward opening the piston side cylinder port (4) to the return core. However, the weight of the bucket and boom arms will try to force oil out of the piston side of the cylinder at a faster rate than pump flow can deliver oil to the rod side. This will have the effect of increasing return pressure above supply pressure. The pressure through the return core is maintained at 1035 - 1380 kPa by the low pressure relief valve in the inlet section. When the supply pressure drops below 1035 - 1380 kPa, the return flow will unseat the anti-void poppet (19, Fig. 10B.21) in the inlet section allowing return flow to supplement pump flow. This will prevent the rod side of the cylinder from cavitating.

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HYDRAULIC CONTROL VALVE

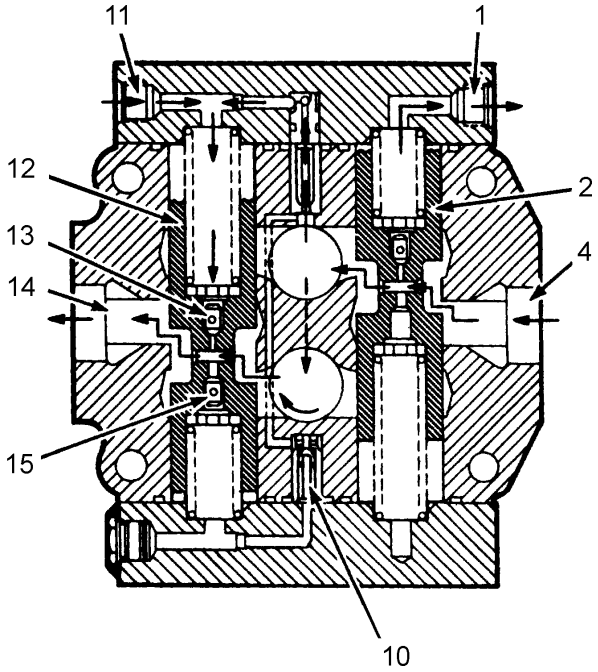


Fig. 10B.29. Boom Section in "LOWER"

1. Piston Side Pilot Port
2. Piston Side Plunger
4. Piston Side Cylinder Port
10. Lower Check Poppet
11. Rod Side Pilot Port
12. Rod Side Plunger
13. Upper Restrictor Poppet
14. Rod Side Cylinder Port
15. Lower Restrictive Poppet

BOOM IN FLOAT WITH THE BUCKET RAISED (Refer to Fig. 10B.30) :

When the control lever in the cab is placed in the "Float" position both the piston side pilot port (1) and the rod side pilot port (11) are open to return, meaning there is lower pressure at the upper spring chambers of both plungers.

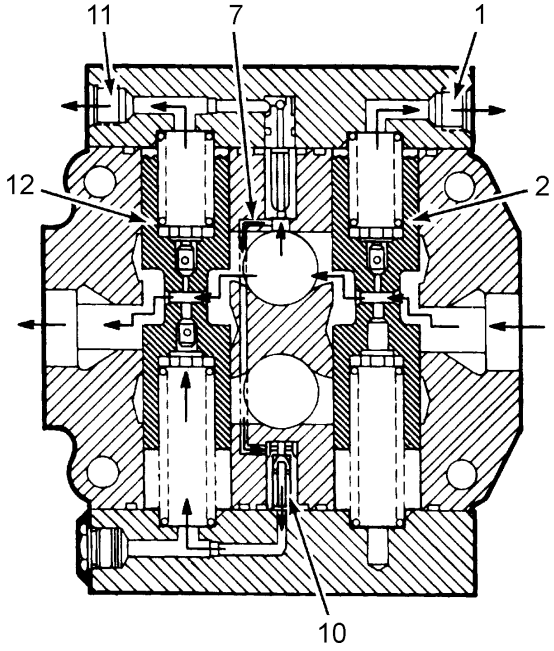


Fig. 10B.30. Boom Section in ”FLOAT” with the Bucket Raised

1. Piston Side Pilot Port
2. Piston Side Plunger
7. Passage
10. Lower Check Poppet
11. Rod Side Pilot Port
12. Rod Side Plunger

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The weight of the boom will create a high pressure on the piston side and the piston side plunger (2) will move upward and open a passage to the return core.

The return pressure oil will be felt through the passage (7) through the lower check poppet (10) and to the lower spring chamber of the rod side plunger (12). This pressure forces the rod side plunger up. Now the rod side cylinder port is also open to the return core. With both plungers up, the returning oil from the piston side feeds directly into the rod side of the cylinder.

With both pilot ports open to reservoir, the flow control poppet (9, Fig. 10B.21) in the inlet section is forced off its seat by the incoming pump flow, returning this flow directly to the reservoir. The load check poppet (8) in the inlet section is seated so no pressure is created at the boom section supply core.

BOOM IN FLOAT WITH THE BUCKET ON THE GROUND (Refer to Fig. 10B.31):

In "FLOAT" both pilot ports (1 and 11) are open to return, creating low pressure on the upper spring chambers of both plungers (2 and 12). As explained in the preceding paragraph, pump flow entering the inlet section is returning to the reservoir through the flow control poppet and the load check poppet is seated. If the bucket should hit a rock, the boom arms will be forced upward, creating a pressure spike on the rod side of the boom cylinder and a void on the piston side. The pressure spike at the rod side cylinder port (14) easily moves the rod side plunger (12) upward opening the port to the return core. This pressure is sensed through the passage (7) and in the lower spring chamber keeping the plunger up.

At the same time, the void at the piston side cylinder port (4) creates a pressure differential between the cylinder port and the upper spring chamber of the piston side plunger (2). Even though this chamber is open to return to reservoir, it is still subject to the 200 kPa working pressure of the reservoir which is greater than the void at the cylinder port (4). Since the void has quickly drained any pressure from the lower spring chamber, the piston side plunger is moved downward opening the port to the supply core. But with the load check poppet seated, no pump flow is coming through the supply core. In the inlet section, the pressure of the returning oil unseats the anti-void poppet (19, Fig. 10B.21) allowing return oil to flow into the supply passage and back to the boom section where it is used to fill the void on the piston side of the boom cylinder.

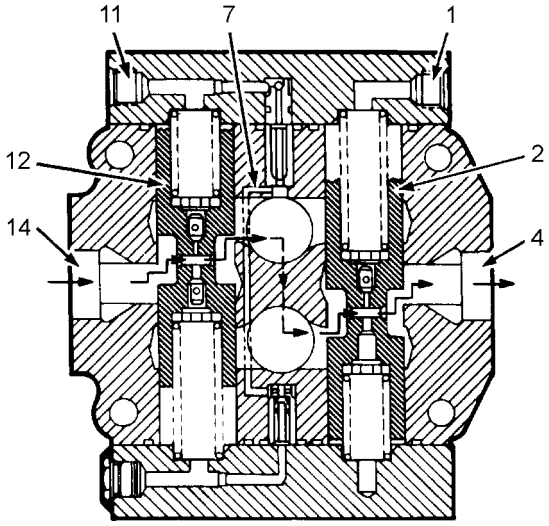


Fig. 10B.31. Boom Section in "FLOAT" with The Bucket on The Ground

1. Piston Side Pilot Port
2. Piston Side Plunger
4. Piston Side Cylinder Port
7. Passage
11. Rod Side Pilot Port
12. Rod Side Plunger
14. Rod Side Cylinder Port

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24. SPECIFICATIONS

Special Torques:

Boom Section:

End Cover Plug	70 Nm
End Cover Socket Head Screws	80 Nm
Pilot Cover Socket Head Screws	80 Nm

Bucket Section:

End Cover Socket Head Screws	80 Nm
Pilot Cover Socket Head Screws	80 Nm

End Section:

Pipe Plugs	20 Nm
Unloading Tube Fitting Nuts	20 Nm
Unloading Valve Jam Nut	60 Nm
Unloading Valve Acorn Nut	60 Nm

Inlet Section:

Main Relief Valve Adjusting Screw Lock Nut	30 ± 5 Nm
Poppet Cover Socket Head Screw	80 Nm
Cover Block Socket Head Screws	80 Nm
Inlet Cover Orifaced Set Screw (with Loctite 271 applied)	7 ± 1 Nm
Inlet Cover Elbow Nut	40 ± 5 Nm
Inlet Cover Socket Head Screw	80 Nm
Spacer Socket Head Screw	7 ± 5 Nm
Connector Fitting at Spacer	40 ± 5 Nm
Spacer to Inlet Cover Tube Nuts	35 Nm
Low Pressure Relief Valve Adjusting Screw Lock Nut	60 Nm

Valve Assembly Tie Rod Nuts:

Initial Torque	30 Nm
Intermediate Torque	70 Nm
Final Torque	140 Nm.

Bucket Cylinder Mounting Pin Locking Bolt	650 Nm

Pressures

Main relief valve	20700 kPa
Low pressure relief valve	1035 - 1380 kPa
Unloading valve	6200 - 6900 kPa

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HYDRAULIC CONTROL VALVE

Spring Test Load Data

DESCRIPTION	NO. OF COILS	FREE LENGTH	TEST LENGTH	TEST LOAD PRESSURE
Inlet Section:				
Poppet Cover Spring	9	77.8 mm	34.9 mm	170 N
Main Relief, Valve to Cover Spring	9	77.8 mm	34.9 mm	170 N
Low Pressure Relief Valve to Cover Spring		43.3 mm	20.6 mm	101 ± 8 N
Low Pressure Relief Valve Spring (internal)	11	27.0 mm	21.8 mm	55.6 N
Main Relief Valve:				
Poppet to Valve Spring	8	21.6 mm	9.1 mm	6 ± 0.6 N
Adjusting Screw Spring	11	29.2 mm	26.1 mm	516 N
Bucket Section:				
Plunger Spring	12	79.4 mm	57.2 mm	205 N
Boom Section:				
Plunger Spring	12	79.4 mm	57.2 mm	205 N
End Section:				
Unloading Valve Spring	10	47.7 mm	41.4 mm	445 ± 44 N

25. SERVICE DIAGNOSIS

NOTE: *The hydraulic control valve and the pilot control valve work together to operate the loader hydraulic system. Refer to "SERVICE DIAGNOSIS" under "PILOT CONTROL VALVE" in this section and in SECTION 10 "HYDRAULICS" for additional information.*

Inlet Section

NOTE: *A malfunction in the inlet section will affect both the boom and bucket operation. If either of these operate correctly, the problem is probably not in the inlet section.*

COMPLAINT	
PROBABLE CAUSE	REMEDY
Excessive Neutral Flow Pressure	
1. Restriction in hydraulic valve pilot control flow	a. Clogged filter screen in pilot feed tube. Clean screen. Flush out pilot feed tube. b. Malfunctioning in orifice or dampening sleeve in pilot supply cover plate. Check.
2. Restriction in pilot control valve return to reservoir line	Flush out line. Replace if necessary.
3. Restriction in hydraulic valve return to reservoir line	Flush out line. Replace if necessary.
4. Main relief valve stuck in closed position	Disassemble inlet section. Inspect and repair main relief valve.

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HYDRAULIC CONTROL VALVE

COMPLAINT	
PROBABLE CAUSE	REMEDY
High Operating Pressures	
1. Main relief valve set too high or is malfunctioning	Perform MAIN RELIEF VALVE PRESSURE TEST. Adjust, repair or replace as necessary.
High Operating Temperatures	
1. Faulty main relief valve	Perform MAIN RELIEF VALVE PRESSURE TEST. Adjust, repair or replace as necessary.
2. Clogged hydraulic valve return line	Check and remove the obstruction.
Delay In Reaction Time	
1. Pilot valve spool not positioned properly	Refer to PILOT CONTROL VALVE SERVICE DIAGNOSIS
2. Excessive leakage in hydraulic valve or pilot valve	Check spools and bores for excessive wear or scoring. Replace damaged parts.
3. Anti-void poppet stuck open	Remove foreign material from poppet, poppet seat and bore. Make sure poppet seats properly and moves freely. Replace return spring if fatigued or distorted.
Loss of Power (Low Pressure)	
1. Defective pilot valve	Check, repair or replace.
2. Malfunctioning main relief valve	Check, repair or replace.
Loss of Power (Low Relief Valve Pressure Higher)	
1. Malfunctioning low pressure relief valve	Check, repair or replace
Noticeable Voids In Bucket Rollback When Boom Is Lowered In Float	
1. Defective unloading valve	Repair and/or adjust. Refer to „UNLOADING VALVE TEST AND ADJUSTMENT”.
Noticeable Void In Bucket And Boom When Lowering	
1. Main flow control relief valve poppet stuck open	Replace or repair relief valve.
2. Low pressure relief valve stuck open or out of adjustment	Remove foreign material from poppet, poppet seat and bore. Make sure poppet seats properly and moves freely. Replace return spring if fatigued or distorted. Adjust.
3. Anti-void poppet stuck closed	Remove foreign material from poppet, poppet seat and bore. Make sure poppet seats properly and moves freely. Replace return spring if fatigued or distorted.

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VALVES

HYDRAULIC CONTROL VALVE

Bucket Section

COMPLAINT	
PROBABLE CAUSE	REMEDY
Bucket Does Not Move Or Moves Slowly	
1. Plungers binding in bucket section	Clean all foreign material until plunger moves freely. Replace damaged or worn parts.
2. Broken springs in either plunger	Replace springs in pairs.
3. Restrictor poppet incorrect or out of place	Check assembly for correct poppet location.
Bucket Cylinder Drift	
1. Plunger binding in bucket section	Clean all foreign material until plunger moves freely. Replace damaged or worn parts.
2. Broken or weak plunger return spring in hydraulic control valve	Replace springs in pairs.
3. Holes in either plunger or restrictor poppets plugged	Free holes of foreign material. Replace worn or damaged parts.
Noticeable Void Or Chattering When Rolling Bucket Back	
1. Void in boom	Lower check poppet in boom section not seating correctly or out of place. Reseat poppet or replace poppet in bore.
Bucket Drifts With Engine Shut Off	
1. Plunger binding in bucket section	Clean all foreign material until plunger moves freely. Replace damaged or worn parts.
Noticeable Void Or Chattering When Dumping Bucket	
See Probable Cause and Remedy under "Inlet Section"	
1. Restriction in pilot pressure line	Flush out line or replace as required. Clean filter screen in pilot feed tube. Refer to OPERATOR'S MANUAL.
2. Holes in plunger plunged	Free holes of foreign material. Replace worn or damaged parts.
3. Restrictor poppet in plungers not seating properly	Lap to mating seat or replace.

Boom Section

COMPLAINT	
PROBABLE CAUSE	REMEDY
Boom Does Not Raise Or Moves Slowly	
1. Plungers binding in boom section	Clean all foreign material until plunger moves freely. Replace damaged or worn parts. Clean filter screen in pilot feed tube. Refer to OPERATOR'S MANUAL.
2. Broken springs in either plunger	Replace springs in pairs.
3. Void in boom	Check restrictor poppet in boom rod side plunger and seats in plunger or float poppet.
4. Restrictor poppet incorrect or out of place	Check assembly for correct poppet location.

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HYDRAULIC CONTROL VALVE

COMPLAINT	
PROBABLE CAUSE	REMEDY
Load Drops With Control Lever In Hold Position	
1. Broken or weak plunger return spring in boom section	Replace springs in pairs.
2. Holes in either plunger or restrictor poppets plugged	Free holes of foreign material. Replace worn or damaged parts
Load Drops With Control Lever In Raise Position And Working Bucket	
1. Holes in boom piston side plunger or restrictor poppet plugged	Free holes in foreign material. Replace worn or damaged parts.
2. Broken springs in plunger	Replace broken springs in pairs.
3. Plunger binding	Clean all foreign material until plunger moves freely. Replace damaged or worn parts. Check Probable Causes and Remedies listed under "Boom Does Not Raise Or Moves Slowly" and "Load Drops With Control Lever In Hold Position".
Slow Or Loss Of Float	
1. Boom section plungers binding	Clean out all foreign material until plunger moves freely. Replace damaged or worn parts.
2. Lower check poppet stuck closed	Flush out foreign material until lower check poppet operates freely.
3. Restriction in hole of plunger	Remove foreign material from hole of plunger. Replace damaged or worn parts.
4. Restriction in restrictor poppet	Remove foreign material or install new parts as required.
5. Low pressure relief valve in inlet section stuck closed	Remove foreign material until valve operates freely. Replace worn or damaged parts.
6. Restrictor poppet in plungers not seating properly	Lap to mating seat or replace.
Boom Drifts With Engine Shut Off	
1. Plungers binding in boom section	Clean all foreign material until plunger moves freely. Replace damaged or worn parts.
2. Excessive leakage in valves	Check plungers and bores for excessive wear or scoring.
Noticeable Void Or Chattering When Lowering Boom	
1. Broken plunger springs	Replace springs in pairs.
2. Hole in restrictor poppet plugged	Free hole in foreign material.
3. Chatter - malfunction in external restrictor type check valve	Check external restrictor type check valve for dirt and correct poppet seating. Replace if necessary.
See Probable Cause and Remedy under "Dumping Bucket" in Bucket Section	

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VALVES

HYDRAULIC CONTROL VALVE

26. MAIN RELIEF VALVE TEST AND ADJUSTMENT

WARNING! Be sure the area in front and behind the machine is clear of personnel and obstructions. DO NOT allow anyone near the tires or on the access ladders during this test.

NOTE: *Before checking the relief valve pressure, be sure the hydraulic reservoir is filled to the correct level and with the proper hydraulic oil as described in the OPERATOR'S MANUAL.*

1. Remove the front cover.
2. Connect a 30000 kPa pressure gauge to the quick disconnect fitting (1, Fig. 10B.32) at the inlet port of the loader control valve. The gauge hose should be long enough to allow the gauge to reach into the cab.

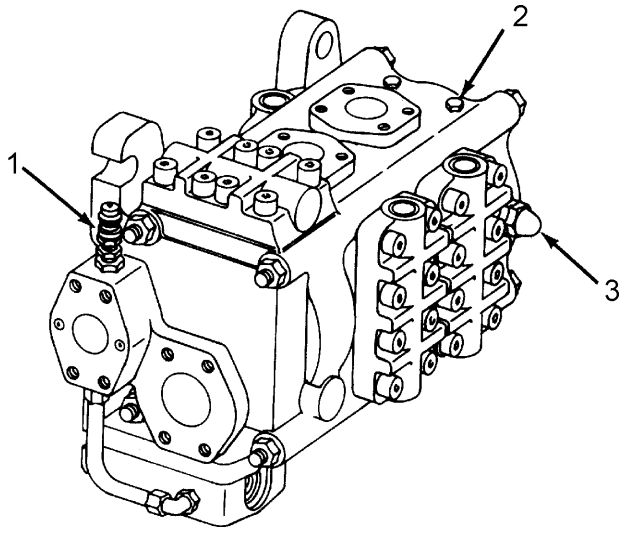


Fig. 10B.32. Main Pressure Relief, Low Pressure Relief and Unloading Valve Test Points

1. Quick Disconnect Fitting for Main Pressure Relief Valve Pressure Test
2. Port Plug for Low Pressure Relief Valve Pressure Test
3. Acorn Nut on Unloading Valve

2. Operate the machine to warm up the hydraulic oil. Install the frame locking bar.
3. To perform the test, raise the boom slightly, roll the bucket all the way back and hold the bucket lever in this position. Accelerate to full throttle and record the reading on the pressure gauge when the relief valve opens.

IMPORTANT: *Do not continue this pressure condition for more than a few seconds.*

4. Release the accelerator, lower the bucket to the ground and shut off the engine.
5. The relief valve should open at 20000 - 21400 kPa. If the relief valve meets this specification, it is functioning properly. If the relief valve does not meet this specification it should be adjusted as outlined in the following steps.
6. Remove the two vacuum pressure relief valves from the top of the hydraulic reservoir. Install a 3/4 - 14 NPT plug in one of the ports. Install a vacuum pump at the other port and turn on the pump.

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7. At the cover plate (8, Fig. 10B.20) on the hydraulic control valve, disconnect the tube which goes to the pilot control valve.
8. Remove the pilot feed tube (7, Fig. 10B.20) between the inlet port and the cover plate (8). Use a 9/16 -18 cap to plug the fitting at the inlet port.
9. Remove the cover plate from the valve. The main relief valve spring will come off with the cover plate.



WARNING! Do not pull the relief valve all the way out of the inlet body because the vacuum pump may not completely hold the inlet line hydraulic oil in the inlet hose.

10. Hold the relief valve and, without turning the adjusting screw, loosen the jam nut. Turn the adjusting screw clockwise to increase the pressure or counterclockwise to decrease the pressure. A 1/4 turn of the adjusting screw will change the pressure setting approximately 2750 kPa. When going from a lower to a higher setting, turn the adjusting screw the desired amount. When going from a higher setting to a lower setting, turn the adjusting screw 1/2 turn beyond the desired final position and then turn it back to the final position.
11. When the adjusting screw is positioned correctly, hold the screw in this position and torque the jam nut to 30 ± 5 Nm.
12. Insert the relief valve and the spring in the inlet section. Reinstall the cover plate (8, Fig.10B.20) and torque the mounting bolts to 80 Nm.

IMPORTANT: *Tighten the mounting bolts evenly to prevent distortion of the cover plate and valve body.*

13. Install the pilot feed tube (7, Fig. 10B.20) and torque the tube nuts to 35 Nm.
14. Recheck the relief pressure by repeating Steps 2 thru 5.

27. LOW PRESSURE RELIEF VALVE TEST AND ADJUSTMENT



WARNING! Be sure the area in front and behind the machine is clear of personnel and obstructions. DO NOT allow anyone near the tires or on the access ladders during this test.

NOTE: *Before checking the relief valve pressure, be sure the hydraulic reservoir is filled to the correct level and with the proper hydraulic oil as described in the OPERATOR'S MANUAL.*

1. Remove the port plug (2, Fig. 10B.32) in the side of the end section and nearest the unloading valve acorn nut (3). Connect a pressure gauge capable of measuring 4000 kPa to the 7/16 - 20 straight thread port. Use a gauge hose long enough to allow the gauge to reach into the cab.
2. Operate the machine to warm up the hydraulic oil. Install the frame locking bar.
3. With an empty bucket resting on the ground, accelerate to full throttle and move the boom control lever to the "RAISE" position. As the boom is going up, observe and record the reading on the gauge.
4. Release the accelerator, lower the bucket to the ground and shut off the engine.
5. The low pressure relief valve should open at 1035 - 1380 kPa. If the relief valve meets this specification, it is functioning properly. If the relief valve does not meet this specification, it should be adjusted as outlined in the following steps.

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VALVES

HYDRAULIC CONTROL VALVE

WARNING! Do not try to adjust the low pressure relief valve without draining the hydraulic reservoir. Adjustment requires complete removal of the valve from the inlet section and a vacuum pump is insufficient for this procedure.

6. Drain the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
7. At the cover plate (8, Fig. 10B.20) on the loader control valve, disconnect the tube which goes to the pilot control valve.
8. Remove the pilot feed tube (7, Fig. 10B.20) between the inlet port and the cover plate (8). Remove the cover plate. The main relief valve spring will come off with the cover plate.
9. Disconnect the two external tubes from the cover block (14, Fig. 10B.35) which is under the cover plate. Remove the cover block. The low pressure relief valve spring will come off with the cover block. Remove the low pressure relief valve from the inlet section.
10. Loosen the lock nut (22, Fig. 10B.35). Turn the adjusting screw (23) clockwise to increase pressure and counterclockwise to decrease pressure. One full turn changes the pressure setting by 485 kPa.
11. When the correct pressure setting is obtained, hold the adjusting screw in this position and torque the lock nut to 60 Nm.
12. Insert the relief valve and the spring in the inlet section. Install the cover block and torque the mounting bolts to 80 Nm.

IMPORTANT: *Tighten the mounting bolts evenly to prevent distortion of the cover block and valve body.*

13. Connect the two external tubes to the fittings on the cover block.
14. Insert the main relief valve spring and install the cover plate (8, Fig. 10B.20). Torque the mounting bolts to 80 Nm.

IMPORTANT: *Tighten the mounting bolts evenly to prevent distortion of the cover plate and valve body.*

15. Connect the pilot feed tube (7, Fig. 10B.20) and torque the tube nuts to 35 Nm.
16. Fill the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
17. Recheck the relief pressure by repeating Steps 2 thru 5.
18. After the gauges are disconnected, torque the port plug (2, Fig. 10B.32) to 20 Nm.

28. UNLOADING VALVE TEST AND ADJUSTMENT

WARNING! Be sure the area in front and behind the machine is clear of personnel and obstructions. DO NOT allow anyone near the tires or on the access ladders during this test.

NOTE: *Before checking the relief valve pressure, be sure the hydraulic reservoir is filled to the correct level and with the proper hydraulic oil as described in the OPERATOR'S MANUAL.*

1. Connect pressure gauges with hoses long enough to reach into the cab to the following locations:
   a. A 30000 kPa gauge to the quick disconnect fitting (1, Fig. 10B.32) at the inlet section.
   b. A 5000 kPa gauge to the port (2, Fig. 10B.32) in the side of the end section and nearest the unloading valve acorn nut (3). Remove the 7/16 - 20 port plug to install the gauge.

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HYDRAULIC CONTROL VALVE

2. Operate the machine to warm up the hydraulic oil. Install the frame locking bar.

IMPORTANT: *The low pressure relief valve must be operating properly before performing the unloading valve test. Refer to "LOW PRESSURE RELIEF VALVE TEST ANO ADJUSTMENT" in this section.*

3. With an empty bucket resting on the ground, accelerate to full throttle and move the boom control lever to the "RAISE" position. Observe the readings on the pressure gauges as the boom cylinders approach their full stroke position. The reading of the first gauge connected at the inlet section should be 6200 - 6900 kPa just before the reading on the second gauge connected at the end section drops off to somewhere below 690 kPa.
4. The reading of the first gauge when the second gauge drops off is the unloading valve opening pressure. If this pressure is 6200 - 6900 kPa, the unloading valve is functioning properly. If the pressure does not meet this specification, the unloading valve should be adjusted as outlined in the following steps.
5. Remove the acorn nut (3, Fig. 10B.32) and loosen the jam nut. Turn the adjusting screw clockwise to increase pressure and counterclockwise to decrease pressure. One full turn changes the pressure setting by 1550 kPa.
6. When the correct pressure setting is obtained, hold the adjusting screw in this position and torque the jam nut to 60 Nm. Install the acorn nut and torque the acorn nut to 60 Nm.
7. Recheck the unloading valve opening pressure by repeating Steps 3 and 4.
8. After the gauges are disconnected, torque the port plug (2, Fig. 10B.32) to 20 Nm.

29. REMOVAL

IMPORTANT: *Disconnected hydraulic 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 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.*



WARNING! Be sure the bucket is lowered to the ground, the parking brake is ON and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

1. Park the machine on a level surface with the bucket flat on the ground. Place the loader controls in neutral, "HOLD". Drain the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
2. Attach a suitable hoist and sling around the bucket cylinder rod. Remove the cylinder rod mounting pin locking bolt and remove the mounting pin. A one inch threaded hole is provided in the pin to aid in pin removal.
3. Start the engine and place the bucket control lever in the "DUMP" position to retract the cylinder enough for the rod eye to clear the bellcrank. Shut off the engine.
4. Attach a hoist and sling through the cylinder rod eye and lift the cylinder up toward a vertical position. Lift the cylinder just enough so the hydraulic valve support plate (1, Fig. 10B.33) can be raised straight up from the front frame with the hydraulic valve (2). Take care not to damage the cylinder hoses. Secure the cylinder in this position.
5. Disconnect the hydraulic hoses and tubes from the hydraulic control valve.

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VALVES

HYDRAULIC CONTROL VALVE

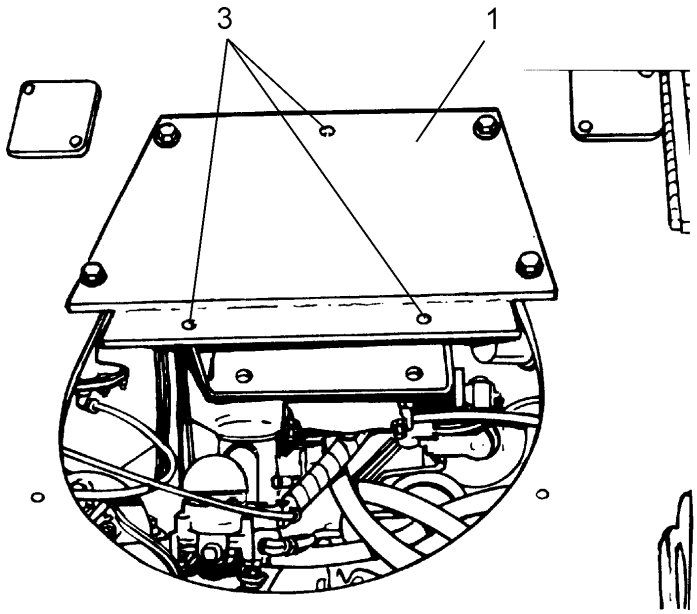


Fig. 10B.33. Front Frame With Cover Plate Removal

1. Loader Control Valve Support Plate
2. Loader Control Valve
3. Eyebolt Locations

6. Remove the cover plate located below the hydraulic valve support plate (1, Fig. 10B.33) from the front frame.
7. Install eyebolts in the support plate at the three tapped holes (3, Fig. 10B.33). Attach a suitable hoist and sling to the eyebolts.
8. Remove the support plate mounting hardware and lift the support plate with control valve from the frame.
9. Carefully set the assembly down on a flat surface. Remove the hardware securing the support plate to the valve and lift the plate off the valve.
10. Carefully turn the valve assembly over so that it rests on its mounting pads.

NOTE: *If it is not necessary to separate the valve body sections to service the valve, remove the eye bolts from the support plate, leave the plate and valve attached and turn the assembly over so that it rests on the plate.*

30. DISASSEMBLY

Separating the Valve Sections (Refer to Fig. 10B.34)

1. Scribe the valve sections to each other for correct reassembly.
2. Remove the external tubes (12 and 15) which connect the end section (7) to the inlet section (3).
3. Remove the nuts (11) and washers (10). Remove the rods (8) which connect the inlet section (3), the bucket section (4), the boom section (5), the auxiliary section (6) (if equipped) and the end section (7). Separate the sections.

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HYDRAULIC CONTROL VALVE

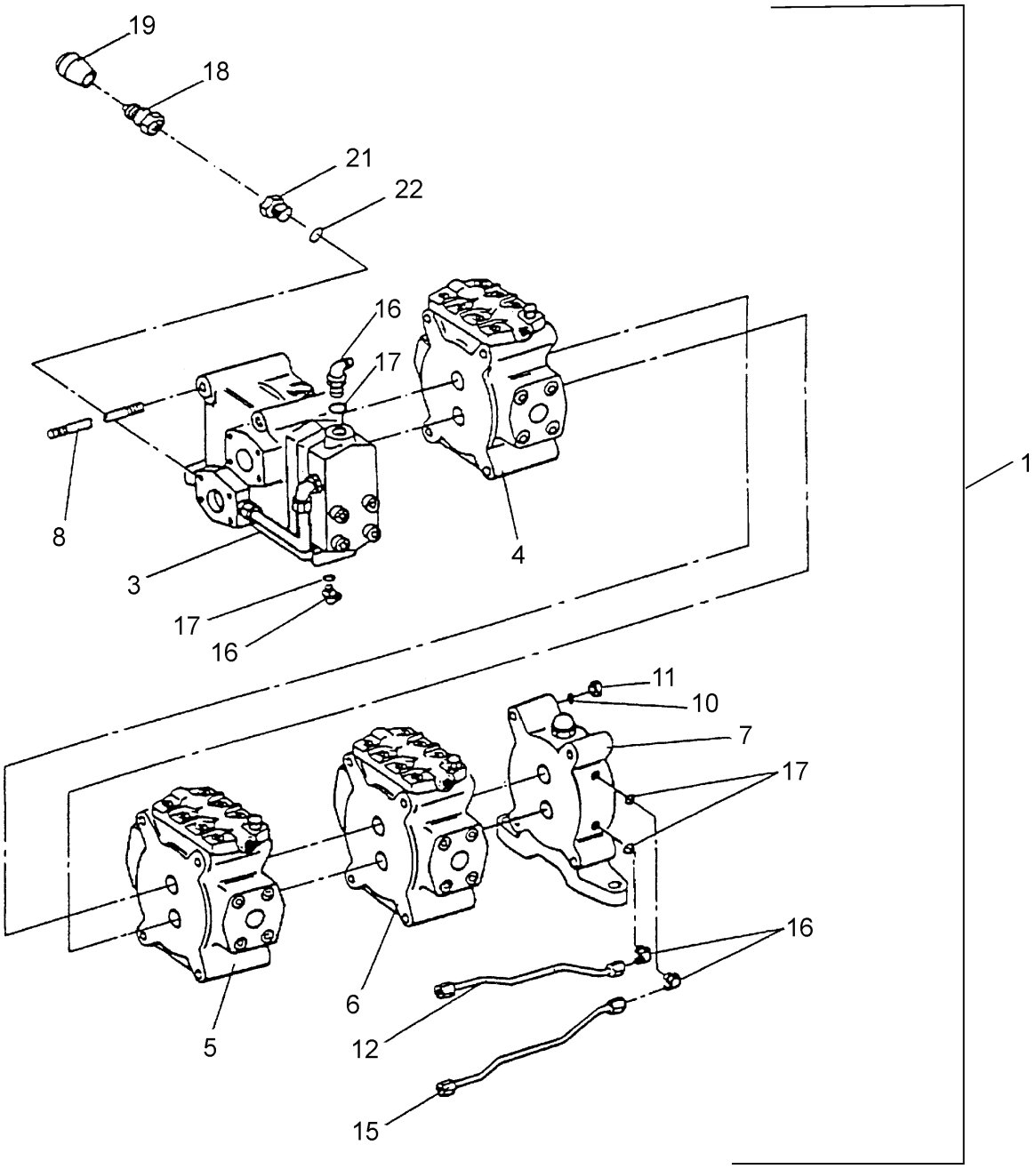


Fig. 10B.34. Exploded View Of Valve Assembly

1. Loader Control Valve
3. Inlet Section
4. Bucket Section
5. Boom Section
6. Auxiliary Section #
7. End Section
8. Tie Rod
10. Washer
11. Nut
12. External Tube
15. External Tube
16. Elbow
17. O-Ring
18. Quick Disconnect Plug
19. Quick Disconnect Cover
21. Adapter
22. O-Ring

- Part of five section valve assembly only. Refer to "BUCKET SECTION" for disassembly, reassembly and specifications.

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Inlet Section (Refer to Fig. 10B.35)

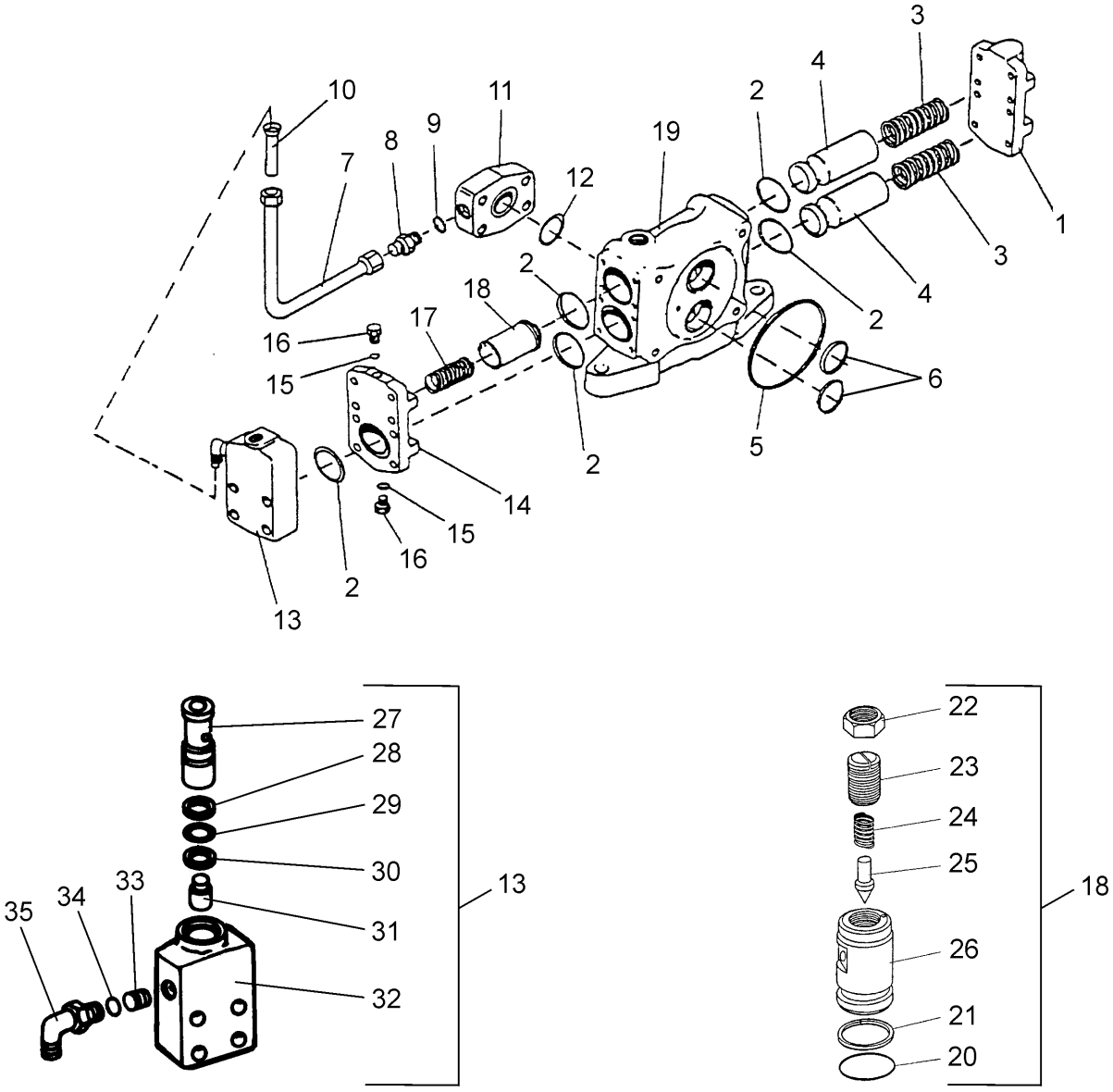


Fig. 10B.35. Exploded View of Inlet Section

1. Poppet cover
2. O-Ring
3. Spring
4. Poppet
5. O-Ring
6. O-Ring
7. Pilot Feed Tube
8. Connector
9. O-Ring
10. Filter
11. Spacer
12. O-Ring
13. Pilot Supply Cover Plate
14. Cover Block
15. O-Ring
16. Plug
17. Spring
18. Low Pressure Relief Valve
19. Inlet Body
20. O-Ring
21. Backup Ring
22. Lock Nut
23. Adjusting Screw
24. Spring
25. Poppet Valve
26. Valve
27. Dampening Sleeve
28. Backup Ring
29. O-Ring
30. Backup Ring
31. Dampening Poppet
32. Inlet cover
33. Set Screw
34. O-Ring
35. Elbow

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4. Remove the body O-rings (5 and 6). Scribe the covers (1, 14 and 13) and the spacer (11) to the inlet body (19) for reference at reassembly.



WARNING! All valve covers are spring loaded. Use care in removing them.

5. Remove the screws and remove the poppet cover (1). Remove the O-rings (2), springs (3) and poppets (4). Tag the springs and poppets so that they may be installed in the correct body bore at reassembly.
6. Disconnect the pilot feed tube (7) from the elbow (35) and the connector (8). Remove the filter (10) from the tube.
7. Remove the spacer (11) from the body. Remove the O-ring (12). Remove the connector (8) and O-ring (9).
8. Remove the screws and remove the pilot supply cover plate (13). The outer O-ring (2) will come off with the pilot supply cover plate (13).
9. Remove the sleeve (27) and dampening poppet (31) from the cover (32). Remove the two backup rings (28 and 30) and O-ring (29) from the sleeve. Remove the elbow (35), O-ring (34) and set screw (33) from the cover.
10. Remove the screws to remove the cover block (14). Remove the plug (16) and O-rings (15) from the cover block.
11. Remove the inner O-rings (2) and the spring (17).
12. Remove the low pressure relief valve (18) from the inlet body. Disassemble the component parts (20 thru 26) of this valve in the sequence indicated by the reference numbers in the exploded view.

Bucket Section (Refer to Fig. 10B.36)

13. Remove the body O-rings (14 and 15).
14. Scribe the covers (1 and 6) to the body (16) for reference at reassembly.



WARNING! All valve covers are spring loaded. Use care in removing them.

15. Remove the screws to remove the cover assembly (1). Remove the poppet valve (3) and ball (5) from the pilot cover (2). Remove the O-ring (4) from the poppet valve.

IMPORTANT: *The plungers (12) are a select fit. Mark each plunger with its proper bore and position (top and bottom) before removing them. Reversing the plungers at reassembly will result in a valve malfunction.*

16. Remove the O-ring (8), O-rings (7), springs (9) and plungers (12) from the body (16). Remove the washers (10) from the top and bottom of each plunger. Remove the poppets (13) from the top of the plungers. Remove the O-rings (11) from the washers (10).
17. Remove the screws to remove the end cover (6). Remove the O-ring (8), O-rings (7) and springs (9) from the body (16).

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HYDRAULIC CONTROL VALVE

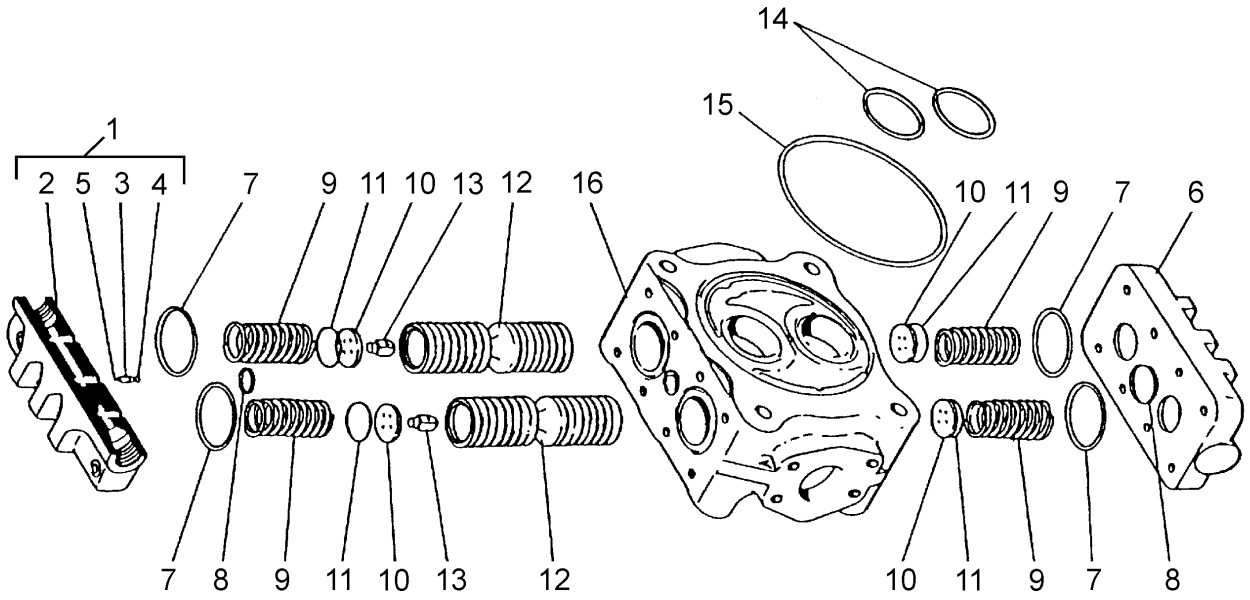


Fig. 10B.36. Exploded View of Bucket Section

1. Cover assembly	5. Ball	9. Spring	13. Restrictor Poppet
2. Pilot cover	6. End cover	10. Washer	14. O-Ring
3. Poppet valve	7. O-Ring	11. O-Ring	15. O-Ring
4. O-Ring	8. O-Ring	12. Plunger	16. Body

Boom Section (Refer to Fig. 10B.37)

18. Remove the body O-rings (22 and 23).
19. Scribe the covers (1 and 6) to the body (24) for reference at reassembly.

WARNING! All valve covers are spring loaded. Use care in removing them.

20. Remove the screws to remove the cover assembly (1). Remove the poppet valve (3) and ball (5) from the pilot cover (2). Remove the O-ring (4) from the poppet valve.
21. Remove the O-ring (10) and valve (11) from the body (24). Remove the O-ring (12) and backup ring (13) from the valve (11).

IMPORTANT: *The plungers (18) are a select fit. Mark each plunger with its proper bore and position (top and bottom) before removing them. Reversing the plungers at reassembly will result in a valve malfunction.*

IMPORTANT: *The identification of each poppets (19, 20 and 21) with its plunger (18) and position within the plunger (top or bottom) is mandatory.*

22. Remove the O-rings (9), springs (15) and plungers (18) from the body (24). Remove the washers (16) from the top and bottom of each plunger. Remove the poppets (19, 20 and 21) from the plungers. Remove the O-rings (17) from the washers (16).

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HYDRAULIC CONTROL VALVE

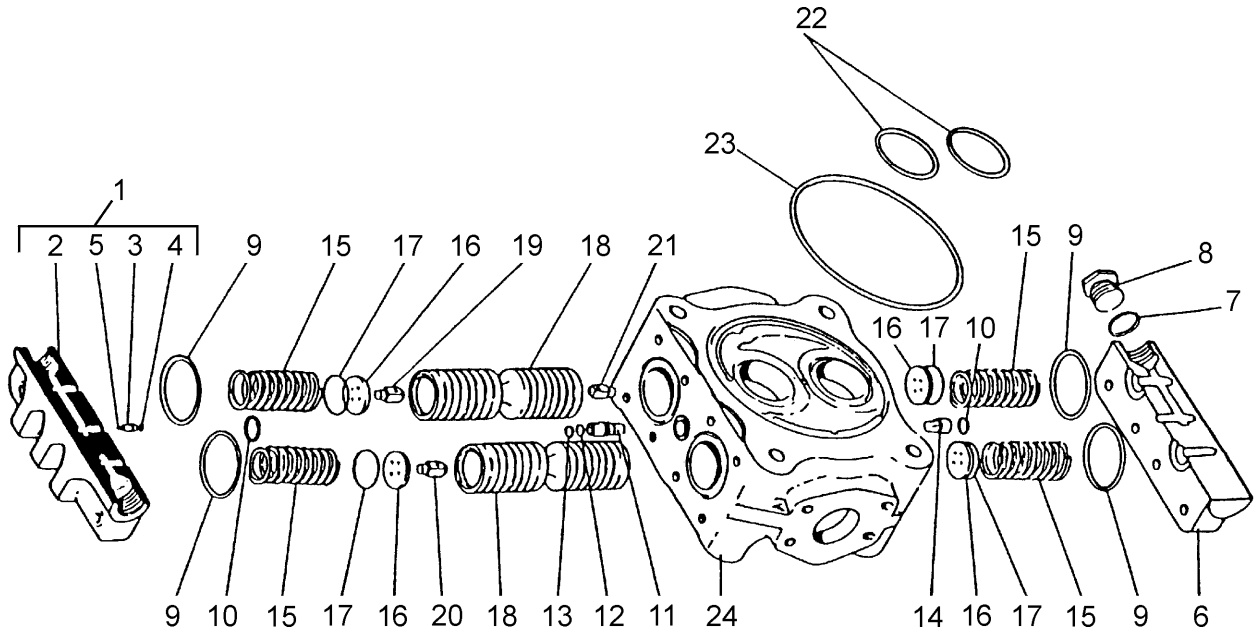


Fig. 10B.37. Exploded View of Boom Section

1. Cover Assembly
2. Pilot Cover
3. Poppet Valve
4. O-Ring
5. Ball
6. End cover
7. O-Ring
8. Plug
9. O-ring
10. O-Ring
11. Valve
12. O-Ring
13. Backup Ring
14. Poppet
15. Spring
16. Washer
17. O-Ring
18. Plunger
19. Restrictor Poppet
20. Restrictor Poppet
21. Restrictor Poppet
22. O-Ring
23. O-Ring
24. Body

23. Remove the screws to remove the cover (6). Remove the plug (8) and O-ring (7) from the cover.
24. Remove the O-ring (10), O-rings (9), spring (15) and poppet (14) from the body.

End Section (Refer to Fig. 10B. 38)

25. Remove the acorn nut (1) and the jam nut (3). Remove the two O-rings (2) from both sides of the jam nut.
26. Unscrew the adjustment screw (4) from the valve body (13). Remove the spring (5) and the poppet (6).
27. Remove the piston (7) from the valve body. Air pressure applied to the lower elbow (12) may help to remove the piston. Remove the backup ring (8) and O-ring (9) from the piston.
28. If necessary, remove the two plugs (11) and two elbows (12). Remove the O-rings (10).

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VALVES

HYDRAULIC CONTROL VALVE

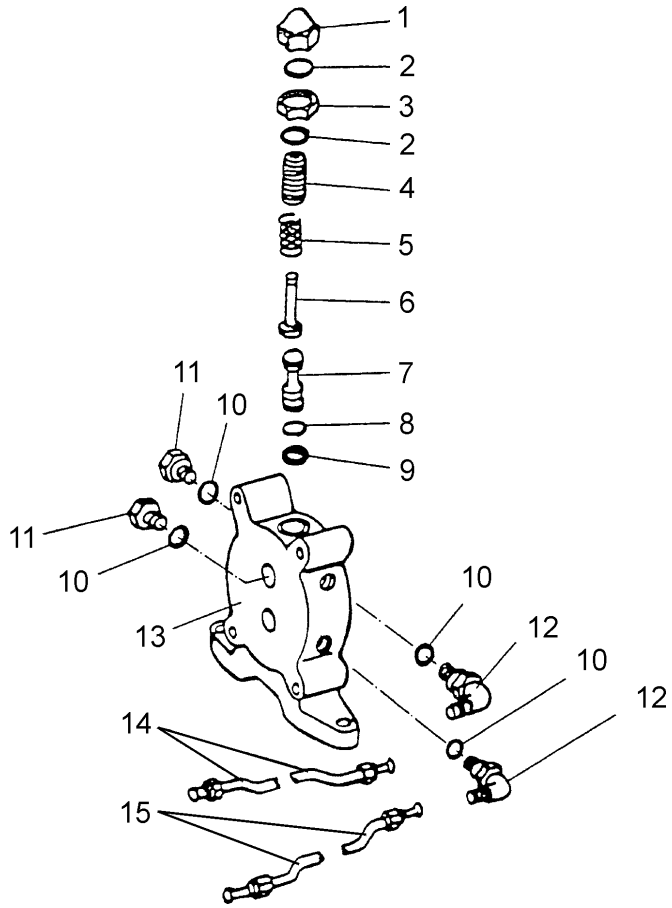


Fig. 10B.38. Exploded View of End Section

1. Acorn Nut	6. Unloading Poppet	11. Plug
2. O-Ring	7. Unloading Piston	12. Elbow
3. Jam Nut	8. Backup Ring	13. Valve Body
4. Adjusting Screw	9. O-Ring	14. External Tube
5. Spring	10. O-Ring	15. External Tube

31. INSPECTION AND REPAIR

1. Clean all parts in clean solvent and dry with compressed air.
2. Check all springs for damage, distortion or weakness. Springs meeting the requirements shown in "SPECIFICATIONS" should function properly. Springs not meeting the requirements should be replaced.
3. Inspect all poppet seating surfaces and poppet faces for nicks or excessive wear.
4. All bores and surfaces of sliding parts must be free of nicks, scores or excessive wear. All poppets, plungers, pistons and sleeves must fit snugly without binding through a complete revolution.
5. Inspect all flow passages. These passages must be clean and free of foreign particles.
6. Discard all O-rings and replace with new. Inspect back-up rings for damage or deterioration. Replace defective parts.
7. Inspect inlet section filter element. Replace with new if any damage is evident.

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32. REASSEMBLY

End Section (Refer to Fig. 10B.38)

NOTE: *Lubricate all parts, including bores, with clean hydraulic oil before reassembly.*

1. Install new O-rings (10) on the two plugs (11) and the two elbows (12). Install the plugs and elbows into the valve body (13) as shown in the illustration.
2. Install the backup ring (8) and O-ring (9) onto the piston (7). The O-ring should be toward the short end of the piston. Install the piston, O-ring groove end first, into the valve body bore.
3. Install the poppet (6) and spring (5). Be sure the piston (7) is far enough into the bore to allow the poppet to seat properly against its seating surface in the bore.
4. Install the adjusting screw (4) into the valve body until resistance is felt by the spring. After this point, one complete turn of the adjusting screw changes the pressure setting by 1550 kPa. Refer to "SPECIFICATIONS" for correct unloading valve relief pressure setting. An approximation of the pressure setting can be made at this time by turning in the adjusting screw 3-1/2 to 4 complete turns.

NOTE: *Final adjustment of the unloading valve pressure setting is made after the valve is installed on the machine.*

5. Hold the adjusting screw in position at the approximate pressure setting. Use new O-rings (2) on both sides on the jam nut (3) and install the jam nut over the adjusting nut. Torque the jam nut to 60 Nm. Install the acorn nut (1) against the jam nut but do not torque it at this time.

Boom Section (Refer to Fig. 10B.37)

NOTE: *Lubricate all parts, including bores, with clean hydraulic oil before reassembly.*

6. Install new O-rings (17) onto all four washers (16).
7. Install the poppet (20) into the top of its correct plunger (18). Install a washer (16) into each end of the plunger.

NOTE: *The top of every plunger can be identified by a "V" groove cut around the upper surface of the plunger.*

8. Install the poppet (21) into the bottom of its plunger (18) and the poppet (19) into the top. Install a washer (16) into each end of the plunger.

IMPORTANT: *Plungers must be positioned correctly within the valve body. The top of the plungers should always be nearest the pilot cover (2).*

9. Install both plungers (18) into the valve body. Install all four springs (15) into the plungers.
10. Install a new O-ring (7) onto the plug (8). Install the plug into the end cover (6) and torque the plug to 70 Nm.
11. Install the poppet (14) into the valve body.
12. Lightly coat the three end cover O-rings (9 and 10) with clean grease and install the O-rings in their valve body grooves. Place the end cover (6) in position and install the screws. Tighten the screws evenly and torque them to 80 Nm in a cross corner sequence.

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13. Install the backup ring (13) into the groove of the valve (11) toward the smaller O.D. end of the poppet. Install the O-ring (12) in the groove toward the larger O.D. end of the poppet. Install the float poppet, smaller O.D. end first, into the valve body.
14. Install an O-ring (4) onto the poppet valve (3). Place the ball (5) into the bore of the poppet valve and install the valve, ball end first, into the pilot cover (2).
15. Lightly coat the three pilot cover O-rings (9 and 10) with clean grease and install the O-rings into their valve body grooves. Place the pilot cover in position and install the socket head screws evenly and torque them to 80 Nm in a cross corner sequence.

NOTE: *The body O-rings (22 and 23) are installed when all the valve sections are reassembled.*

Bucket Section (Refer to Fig. 10B.36)

NOTE: *Lubricate all parts, including bores, with clean hydraulic oil before reassembly.*

16. Install new O-rings (11) onto all four washers (10).
17. Install the poppet (13) into the top of its correct plunger (12). Install a washer (10) into each end of the plunger.

NOTE: *The top of every plunger can be identified by a "V" groove cut around the upper surface of the plunger.*

18. Install the poppet (13) into the top of its correct plunger (12). Install a washer (10) into each end of the plunger.

IMPORTANT: *Plungers must be positioned correctly within the valve body. The top of the plungers should always be nearest the pilot cover (2).*

19. Install both plungers (12) into the valve body. Install all four springs (9) into the plungers.
20. Lightly coat the three end cover O-rings (7 and 8) with clean grease and install the O-rings in their valve body grooves. Place the end cover (6) in position and install the screws. Tighten the screws evenly and torque them to 80 Nm in a cross corner sequence.
21. Install an O-ring (4) onto the poppet valve (3). Place the ball (5) into the bore of the poppet valve and install the valve, ball end first, into the pilot cover (2).
22. Lightly coat the three pilot cover O-rings (7 and 8) with clean grease and install the O-rings into their valve body grooves. Place the pilot cover (2) in position and install the screws. Tighten the screws evenly and torque them to 80 Nm in a cross corner sequence.

NOTE: *The body O-rings (14 and 15) are installed when all the valve sections are reassembled.*

Inlet Section (Refer to Fig. 10B.35)

NOTE: Lubricate all parts, including bores, with clean hydraulic oil before reassembly.

23. Install the poppets (4) and springs (3) into their correct body bores.
24. Lightly coat the two poppet cover O-rings (2) with clean grease and install the O rings in their valve body grooves. Place the poppet cover (1) in position and install the screws. Tighten the screws evenly and torque them to 80 Nm in a cross corner sequence.

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25. To reassemble the low pressure relief valve (18):
    a. Install the backup ring (21) and O-ring (20) into the groove of the valve body (26), with the O-ring closest to the end of the body.
    b. Install the poppet (25) and spring (24).
    c. Install the adjusting screw (23) into the valve body until resistance is felt by the spring. After this point, one complete turn of the adjusting screw changes the pressure setting by 485 kPa. Refer to "SPECIFICATIONS" for correct low pressure relief valve setting. An approximation of the pressure setting can be made at this time by turning in the adjusting screw 2 to 2-1/2 complete turns.
    d. Hold the adjusting screw in position at the approximate pressure setting and install the lock nut (22) over the screw. Torque the lock nut to 61 Nm.
26. Install the low pressure relief valve (18), lock nut end first, into the valve body (19).
27. Install O-rings (15) onto both plugs (16). Install the plugs into the cover block (14) and torque the plugs to 20 Nm.
28. Lightly coat the two cover block O-rings (2) with clean grease and install the O-rings in their valve body grooves. Place the cover block (14) in position, with the spring (17) placed between the low pressure relief assembly (18) and the counter bore of the cover block. Install the screws and torque the screws to 80 Nm in a cross corner sequence.
29. Install an O-ring (29) with a backup ring (28 and 30) on either side, in the groove of the sleeve (27). Install the dampening poppet (31) into the sleeve, with the small end of the poppet (31) inward in the sleeve.
30. Install the dampening poppet and sleeve assembly into the inlet cover (32) with the dampening poppet end inward in the cover.
31. Apply Loctite 271 to the threads of the set screw. Install the set screw into the inlet cover (32) and torque to 7 ± 1 Nm.
32. Install an O-ring (34) onto the elbow (35). Install the elbow into the inlet cover (32). Position the open end of the elbow parallel with the cover face and torque the elbow nut to 40 ± 5 Nm.
33. Lightly coat the inlet cover O-ring (2) with clean grease and install the O-ring in the groove of the cover. Place the pilot supply cover plate (13) in position. Install the screws and torque the screws to 80 Nm in a cross corner sequence.
34. Lightly coat the spacer O-ring (12) with clean grease and install the O-ring in the groove of the spacer (11). Install the screws which mount the spacer and torque the screws to 7 ± 1 Nm.
35. Install an O-ring (9) onto the connector (8) and torque the connector to 40 ± 5 Nm.
36. Install the filter (10) in the end of the pilot feed tube (7) which attaches to the elbow (35). Install the tube between the elbow and the connector (8). Torque the tube nuts to 35 Nm.

NOTE: *The body O-rings (5 and 6) are installed when all the valve sections are reassembled.*

Joining the Valve Sections (Refer to Fig. 10B.34)

37. Lightly coat all the body O-rings (inlet section - 5 and 6, Fig. 10B.35) (bucket section - 14 and 15, Fig. 10B.36) (boom section - 23 and 22, Fig. 10B.37) with clean grease and install all the O-rings in the appropriate grooves of the valve bodies.

IMPORTANT: *When putting the valve sections together be sure the O-rings are properly positioned in their grooves so that they are not damaged.*

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38. Install the tie rods (8). Install the washers (10) with the dished side of the washers toward the valve. Install the nuts (11).
39. Torque the tie rod nuts in three stages, using a cross corner sequence in each stage as follows:
    Initial torque : 30 Nm
    Intermediate torque : 70 Nm
    Final torque : 140 Nm
40. Install the two external tubes (12 and 15) which connect the inlet section and the end section.

33. INSTALLATION

1. If removed, install the support plate (1, Fig. 10B.33) to the hydraulic control valve. Tighten the mounting bolts evenly to prevent distortion of the valve bodies.
2. Install eyebolts in the three tapped holes (3, Fig. 10B.33) of the support plate and lower the valve into the frame. Install the plate mounting hardware.
3. Connect all the hydraulic hoses and tubes to the loader control valve.
4. Lower the bucket cylinder so that the rod eye is level with the linkage bellcrank. Take care not to damage the bucket cylinder hoses or bucket positioner electrical wiring.
5. Start the engine. Use the bucket control lever to slowly extend the cylinder until the rod eye is aligned with the mounting hole in the bellcrank.
6. Coat the bucket cylinder mounting pin with chassis grease and install the mounting pin, aligning the locking bolt hole in the pin and bellcrank. Install and torque the locking bolt to 650 Nm.
7. Lubricate the cylinder rod bushings through the lube fitting using Multi-Purpose Grease until grease appears.
8. Operate the boom and bucket through several maneuvers to expel all air and to check the operation of the loader control valve.
9. Fill the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
10. Check the pressure settings of the main pressure relief valve, low pressure relief valve and the unloading valve as outlined in this section.

STEERING CYLINDER CHECK VALVES

34. DESCRIPTION

Two steering cylinder check valves are incorporated into the system to maintain a back pressure on the return flow from the steering cylinders. This pressure helps to ease off the torsional forces created in the axle when making a tight turn at low ground speeds. The check valves also act as a manifold to connect the piston side of one cylinder with the rod side of the opposite cylinder. The check valve which is mounted to the L.H. steering cylinder is equipped with a quick disconnect to check steering pressures.

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STEERING CYLINDER CHECK VALVES

35. OPERATION (Refer to Fig. 10B.39)

Oil from the steering valve is directed through a line to the valve port (4) on the check valve. The spring tension of the outer poppet (2) is much less than the spring tension of the inner poppet (3). Therefore, the outer spool will shift very easily allowing oil to flow out the adjacent cylinder piston side port (5) and out the opposite cylinder rod side port (1).

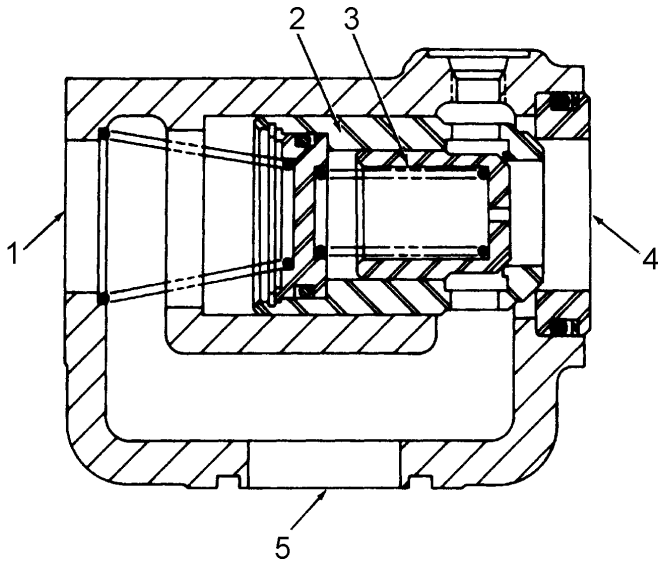


Fig. 10B.39. Sectional View Of Steering Cylinder Check Valve

1. Opposite Cylinder Rod Side Port
2. Outer Poppet
3. Inner Poppet
4. Valve Port
5. Adjacent Cylinder Piston Side Port

In reverse, when oil is forced out of the cylinders pressure begins to increase because the two cylinder ports (1 and 5) are blocked from the valve port (4) by the two poppets (2 and 3). This cylinder return pressure can affect only the outer circumference of the inner poppet (3) and that the area inside the inner poppet is open to the low pressure of the valve port through the orifice in the face of the inner poppet. When the cylinder return pressure builds to 1035 kPa, the inner poppet will be forced to the left against the spring tension and the return oil can flow back to the steering valve.

36. SPECIFICATIONS

General

Opening Pressure . . . . . 1035 kPa
Rated Flow at 20684 kPa . . . . . 397 l/min

Spring Test Load Data

DESCRIPTION	NO.0F COILS	FREE LENGTH	TEST LENGTH	TEST LOAD PRESSURE
Outer Poppet Spring	5	52.3 mm	30.5 mm	40 N
Inner Poppet Spring	11.5	45.7 mm	35.6 mm	125 N

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VALVES

STEERING CYLINDER CHECK VALVES

37. REMOVAL (Refer to Fig. 10B.40)

IMPORTANT: *Disconnected hydraulic 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 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.*

WARNING! Be sure the bucket is lowered to the ground, parking brake is ON and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

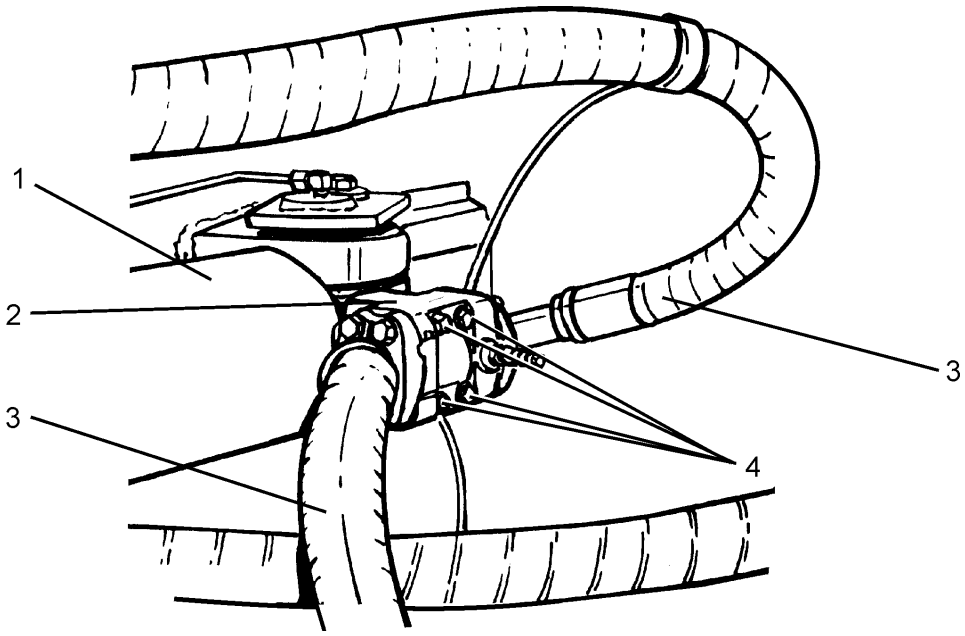


Fig. 10B.40. Steering Cylinder Check Valve Disconnecting Points

1. Steering Cylinder
2. Check Valve
3. Hoses
4. Bolts

1. Remove the hoses (3) from the both sides steering cylinder check valve (2).
2. Remove the bolts (4) securing the valve and remove the valve from the steering cylinder (1).
3. Remove and discard the O-Ring.

38. DISASSEMBLY (Refer to Fig. 10B.41)

1. Remove the seat (11) from the valve body (1). Remove the backup ring (10) and O-ring (9) from the seat.
2. Remove the outer poppet (8) with inner poppet (7), spring (6), seat (5), O-ring (4) and retaining ring (3).
3. Remove the spring (2) from the valve body.
4. Remove the retaining ring (3) and remove seat (5) from the outer poppet (8). Remove the O-ring (4) from the seat.

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5. Remove the spring (6) and inner poppet (7) from the outer poppet (8).
6. If equipped: unscrew the plug (16) and remove O-ring (17) from the valve body (1).
7. If equipped: remove cover (13), disconnect plug (12), connector (14) and O-ring (15) from the valve body (1).

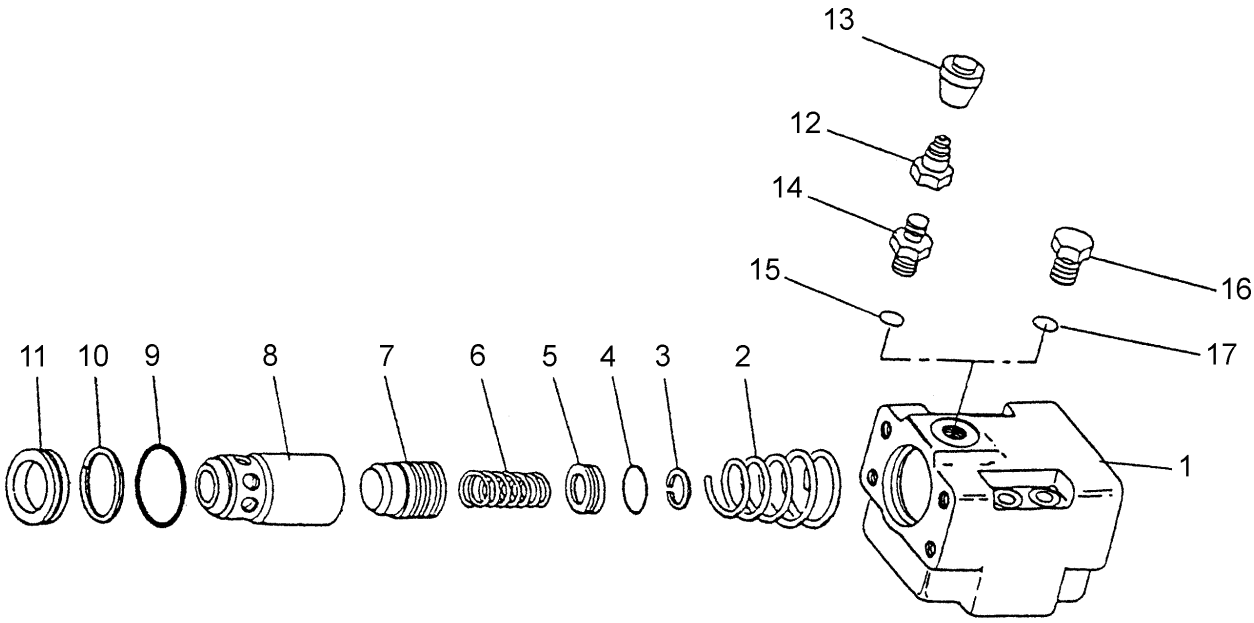


Fig. 10B.41. Exploded View of Steering Cylinder Check Valve

1. Valve Body
2. Spring
3. Retaining Ring
4. O-Ring
5. Seat
6. Spring
7. Inner Poppet
8. Outer Poppet
9. O-Ring
10. Backup Ring
11. Seat
12. Quick Disconnect Plug
13. Quick Disconnect Cover
14. Connector
15. O-Ring
16. Plug
17. O-Ring

39. INSPECTION AND REPAIR

1. Clean all parts thoroughly.
2. Inspect parts for signs of cracking, scoring, deterioration or excessive wear. Refer to "SPECIFICATIONS" for Spring Test Data.
3. Replace all O-rings.

40. REASSEMBLY (Refer to Fig. 10B.41)

1. Coat all parts with oil before assembling.
2. If equipped: install the O-ring (17) and plug (16) to the valve body (1).
3. If equipped: install the O-ring (15), connector (14), disconnect plug (12) and cover (13) to the valve body (1).
4. Install the spring (2) to the valve body (1).

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STEERING CYLINDER CHECK VALVES

5. Install the O-ring (4) on the seat (5). Install the inner poppet (7), spring (6), seat (5) with O-ring (4) and retaining ring (3) to the outer poppet (8). Install the outer poppet to the valve body (1).
6. Install the backup ring (10) and O-ring (9) on the seat (11) and install the seat to the valve body (1).

41. INSTALLATION (Refer to Fig. 10B.40)

IMPORTANT: *The valve must be positioned so that the arrow cast into the side of the body points toward the line which services the opposite steering cylinder.*

1. Position the O-ring, check valve (2) on the steering cylinder (1) and install the mounting bolts (4).

IMPORTANT: *Tighten the mounting bolts evenly to prevent distortion of the valve body.*

2. Install the hydraulic hoses (3) to the steering cylinder check valve.
3. Start the machine and turn the steering wheel completely to the right and to the left several times to expel all air and to make sure the valve is functioning properly.
4. Check the oil level and fill if necessary.

GROUND DRIVEN STEERING DIVERTER VALVE (IF EQUIPPED)

42. DESCRIPTION

The ground driven steering diverter valve is located on the right side of the rear frame near the transmission. It is a pilot operated single spool valve, with a spring return. Return oil from the ground driven steering pump is directed by the spool to either the hydraulic reservoir or the steering valve. An adapter block and the ground driven steering check valve are mounted on the outlet port to the steering valve. An electrical switch is mounted into the end of the valve. This switch activates a warning light in the cab when the ground driven steering system is in operation.

43. OPERATION (Refer to Fig. 10B.42)

When the ground driven steering system is "OFF", oil pressure from the steering element of the steering / switch pump is sensed through a pilot line from the pump to the pilot port (1) on the diverter valve. Pressure builds to the left of the spool (2) and shifts the spool to the right. Oil from the ground driven steering pump enters the diverter valve at the inlet port (3), flows around the spool and exits at the return to reservoir port (4). With the spool shifted to the right, oil is blocked from the outlet port (5) to the adapter block and check valve. In this position the pin (6) contacts the end of the normally closed switch located in the switch port (7). The pin opens the switch to break contact with the warning light in the cab.

If, for any reason, the steering element of the steering / switch pump becomes inoperative, no pressure will be sensed at the pilot port (1). The loss of pressure will allow the spring (8) to return the spool (2) to the left. This opens the passage for oil, which is entering the inlet port (3) from the ground driven steering pump to exit through the outlet port (5) to the adapter block and check valve and to the steering valve. With the spool moved to the left, the pin (6) no longer contacts the end of the electrical switch, so the switch returns to its normally closed position and the warning light in the cab goes on.

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GROUND DRIVEN STEERING DIVERTER VALVE (IF EQUIPPED)

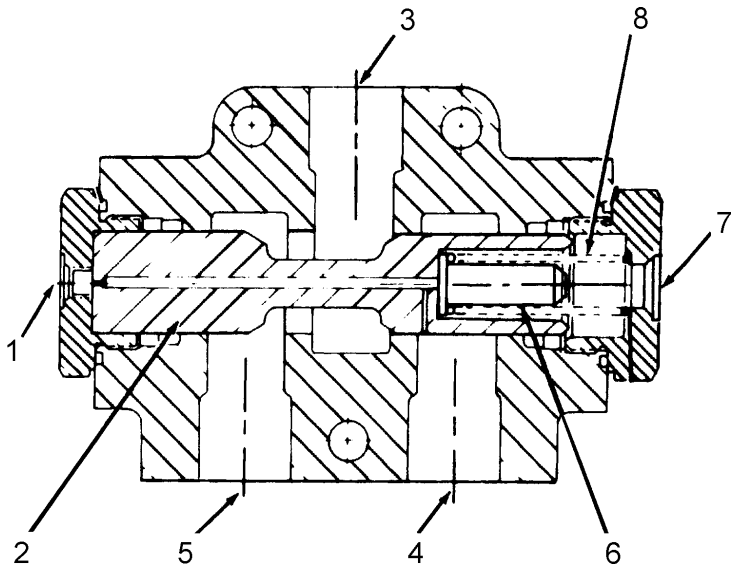


Fig. 10B.42. Sectional View Of Diverter Valve

1. Pilot Port
2. Spool
3. Inlet Port from Ground Driven Steering Pump
4. Return to Reservoir Port
5. Outlet Port to Adapter Block and Check Valve
6. Pin
7. Electrical Switch Port
8. Return Spring

44. SPECIFICATIONS

Pilot line pressure necessary to shift spool . . . . . 310 ± 70 kPa

Return spring test load data

No. of coils 14
Free length . . . . . 98 mm
Test length . . . . . 51 mm
Test load pressure . . . . . 267 ± 18 N

45. REMOVAL (Refer to Fig. 10B.43)

IMPORTANT: *Disconnected hydraulic 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 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.*

WARNING! Be sure the bucket is lowered to the ground, the parking brake is ON and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

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GROUND DRIVEN STEERING DIVERTER VALVE (IF EQUIPPED)

1. Drain the hydraulic reservoir. Refer to the OPRETOR'S MANUAL for this procedure.
2. Disconnect the ground driven steering pump return to reservoir line (1) from the top of the diverter valve.
3. Disconnect the inlet line (2) and the outlet line (3) from the check valve (6).
4. Disconnect the pilot line (4) from the end of the diverter valve.
5. Disconnect the ground driven steering pump inlet line (5) from the bottom of the diverter valve.
6. Disconnect the wiring from the electrical switch.
7. Remove the hardware which secures the diverter valve to the machine and remove the diverter valve (8) with check valve (6) and adapter block (7) from the machine.

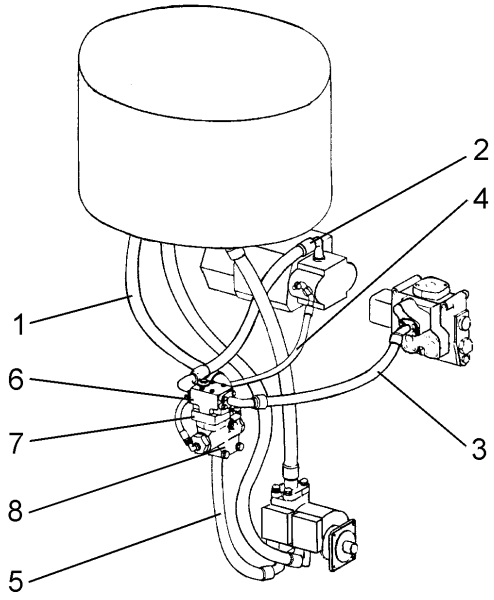


Fig. 10B.43. Diverter Valve Disconnect Points

1. Ground Driven Steering Pump Return to Reservoir Line
2. Check Valve Inlet Line
3. Check Valve Outlet Line
4. Steering / Switch Pump to Diverter Valve Pilot Line
5. Inlet Line from Ground Driven Steering Pump
6. Check Valve
7. Adapter Block
8. Diverter Valve

46. DISASSEMBLY (Refer to Fig. 10B.44)

1. If necessary, remove the check valve (6, Fig. 10B.43) and the adapter block (7) from the diverter valve.
2. If necessary, remove the electrical switch from the valve end plug (1).
3. Remove the end plug (1) with O-ring (2), the spring (3), pin (4) and spool (7) from the valve body (8). Remove the pilot plug (5) with O-ring (6) from the valve body.

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GROUND DRIVEN STEERING DIVERTER VALVE (IF EQUIPPED)

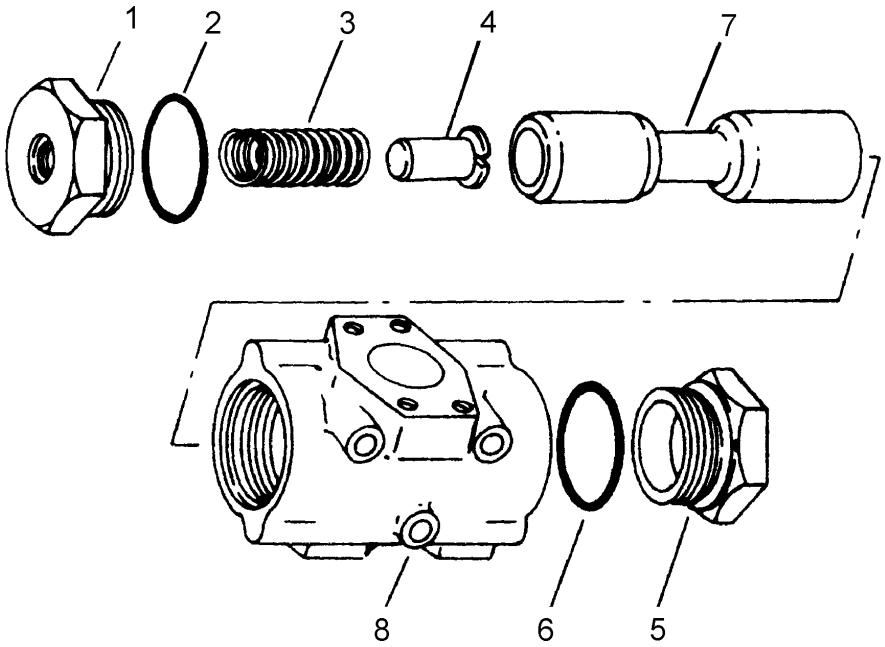


Fig. 10B.44. Exploded View of Diverter Valve

1. End Plug	3. Return Spring	5. Pilot Plug	7. Spool
2. O-Ring	4. Pin	6. O-Ring	8. Valve Body

47. INSPECTION AND REPAIR

1. Clean all parts thoroughly. Discard the O-rings and replace with new.
2. Inspect parts for signs of cracking, scoring, deterioration and excessive wear. Refer to "SPECIFICATIONS" for Spring Test Data.

48. REASSEMBLY

1. Coat all parts with oil before assembly.
2. Assemble the component parts of the diverter valve in the reverse order of disassembly. Refer to Fig. 10B.44.
3. Install the electrical switch into the end plug (1).
4. If removed, install the adapter block (7, Fig. 10B.43) to the valve body. The adapter block should sit over the outlet port closest to the pilot port plug (5, Fig. 10B.44).

IMPORTANT: *Tighten the mounting bolts evenly to prevent distortion of the valve body.*

5. If removed, install the check valve (6, Fig. 10B.43) on top of the adapter block.

IMPORTANT: *The check valve must be positioned so that the arrow cast into the valve body points toward the front of the machine when the diverter valve is installed on the rear frame.*

IMPORTANT: *Tighten the mounting bolts evenly to prevent distortion of the valve body.*

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GROUND DRIVEN STEERING DIVERTER VALVE (IF EQUIPPED)

49. INSTALLATION (Refer to Fig. 10B.43)

1. Install the diverter valve into the machine. The check valve and adapter on top of the diverter valve should be toward the outside of the machine with the arrow cast into the check valve pointing toward the front frame.

IMPORTANT: *Tighten the mounting bolts evenly to prevent distortion of the valve body.*

2. Connect all the hydraulic lines (1 thru 5) as shown in the illustration.
3. Connect the wiring to the electrical switch.
4. Fill the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
5. Start the machine. Drive forward for a short distance, turning the steering wheel to the right and left to expel all air and to be sure the diverter valve is operating.
6. Check the oil level and add if necessary.

GROUND DRIVEN STEERING CHECK VALVE (IF EQUIPPED)

50. DESCRIPTION AND OPERATION (Refer to Fig. 10B.45)

The ground driven steering check valve sits on top of the ground driven steering diverter valve and is used to direct the flow of oil to the steering valve from either the steering section of the steering / switch pump (normal steering system) or the ground driven steering pump (auxiliary steering system).

During normal steering, oil enters the check valve at the steering/switch pump inlet port (1), unseats the check poppet (2) and flows out the outlet port (3) to the steering valve. No oil enters the check valve from the diverter valve inlet port (4) because the diverter valve is in the "OFF" position during normal operation.

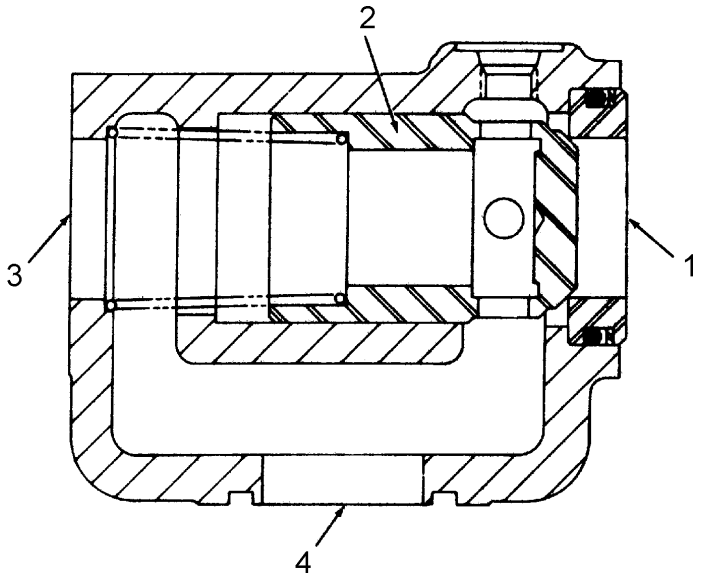


Fig. 10B.45. Sectional View Of Ground Driven Steering Check Valve

1. Steering / Switch Pump Inlet Port
2. Check Poppet
3. Outlet Port
4. Diverter Valve Inlet Port

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GROUND DRIVEN STEERING CHECK VALVE (IF EQUIPPED)

When the auxiliary system becomes operational, oil flow at the steering/switch pump inlet port (1) is not sufficient to unseat the check poppet. Additionally, this condition has moved the diverter valve to the "ON" position. Oil from the ground driven steering pump now enters the check valve at the diverter valve inlet port (4) and out the outlet port (3). The pressure of this oil keeps the poppet (2) on its seat which prevents the back flow of ground driven steering oil into the normal steering supply.

51. SPECIFICATIONS

Spring Test Load Data:

No. of coils	14
Free length	89 mm
Test length	48.3 mm
Test load pressure	28 N

52. REMOVAL

IMPORTANT: *Disconnected hydraulic 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 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.*

WARNING! Be sure the bucket is lowered to the ground, the parking brake is ON and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

1. Drain the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
2. Remove the outlet line to the steering valve. Remove the inlet line from the steering / switch pump.
3. Remove the hardware securing the valve and remove the valve from the diverter valve.

53. DISASSEMBLY (Refer to Fig. 10B.46)

1. Remove the seat (5) from the valve body (3). Remove the backup ring (6) and O-ring (4) from the seat.
2. Slide the check poppet (2) and spring (1) from the valve body.

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GROUND DRIVEN STEERING CHECK VALVE (IF EQUIPPED)

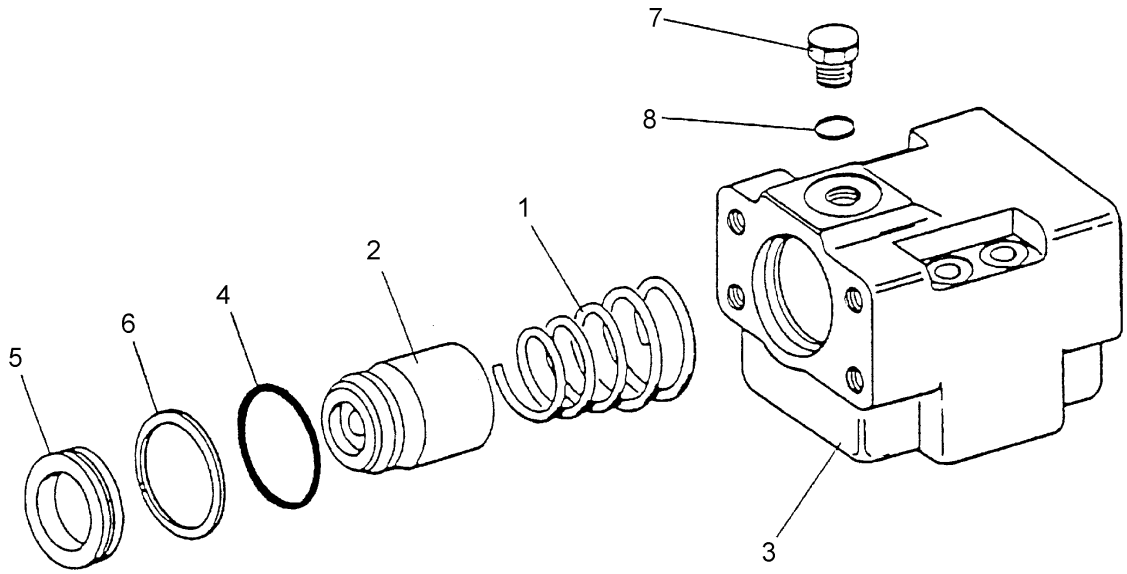


Fig. 10B.46. Exploded View of Ground Driven Steering Check Valve

1. Spring	3. Valve Body	5. Seat	7. Plug
2. Check Poppet	4. O-Ring	6. Backup Ring	8. O-Ring

54. INSPECTION AND REPAIR

1. Clean all parts thoroughly. Discard the O-ring and replace with new.
2. Inspect parts for signs of cracking, scoring, deterioration or excessive wear. Refer to "SPECIFICATIONS" for Spring Test Data.

55. REASSEMBLY (Refer to Fig. 10B.46)

1. Coat all parts with oil before assembling.
2. Assemble the component parts in the reverse order of disassembly.

56. INSTALLATION

IMPORTANT: *The valve must be positioned so that the arrow cast into the side of the body points toward the steering valve.*

1. Position the valve on the diverter valve and install the mounting hardware.

IMPORTANT: *Tighten the mounting bolts evenly to prevent distortion of the valve body.*

2. Install the inlet line from the steering / switch pump. Install the outlet line to the steering valve.
3. Fill the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
4. Start the machine and turn the steering wheel completely to the right and to the left several times to expel all air and to make sure the valve is functioning properly.
5. Check the oil level and add if necessary.

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STEERING RETURN SURGE VALVE

57. DESCRIPTION AND OPERATION (Refer to Fig. 10B.47)

The steering return surge valve is bolted to the bottom of the hydraulic reservoir. Return oil from the steering control valve flows into port (A), passes through the valve body and is sent to the hydraulic oil cooler through port (B). When the pressure of the oil reaches 620 kPa, the pressure overcomes the force of the spring (1) and moves the poppet (2) off its seat. This allows the excess pressure oil to by-pass the cooler and return directly to the reservoir through port (C). When the pressure is reduced, the spring reseats the poppet and all returning oil is again sent to the oil cooler.

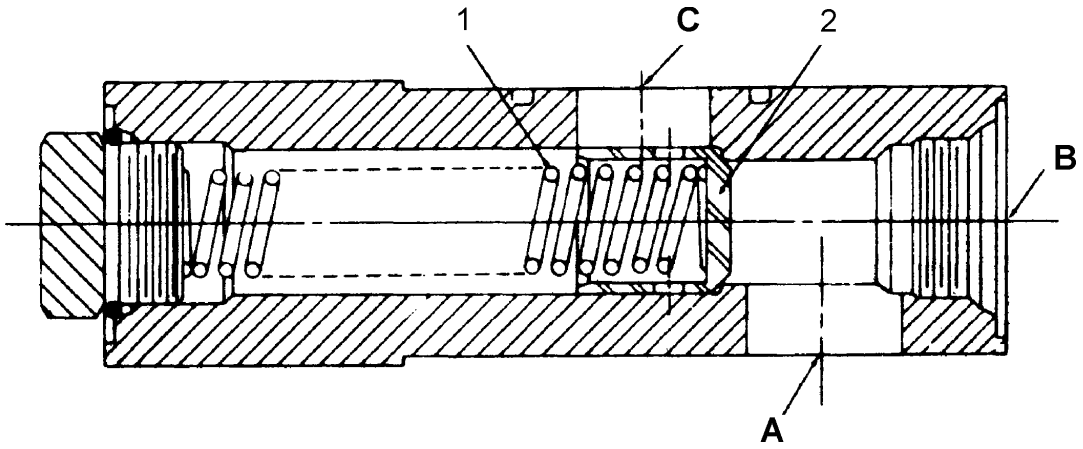


Fig. 10B.47. Sectional View Of Steering Return Surge Valve

A. Return From Steering Control Valve
B. Supply To Oil Cooler
C. To Hydraulic Reservoir
1. Spring
2. Poppet

58. SPECIFICATIONS

Valve opening pressure	620 kPa

Spring Test Load Data:

No. of coils	22
Free length	135.4 mm
Test length	96.6 mm
Test load pressure	400 N

59. REMOVAL (Refer to Fig. 10B.47)

IMPORTANT: *Disconnected hydraulic 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 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.*

WARNING! Be sure the bucket is lowered to the ground, the parking brake is ON and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

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VALVES

STEERING RETURN SURGE VALVE

1. Drain the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
2. Disconnect the return line from the steering control valve (A) and the supply line (B) to the oil cooler.
3. Remove the surge valve from the reservoir.

60. DISASSEMBLY

Disassemble the component parts in the sequence indicated by the reference numbers in Fig. 10B.48.

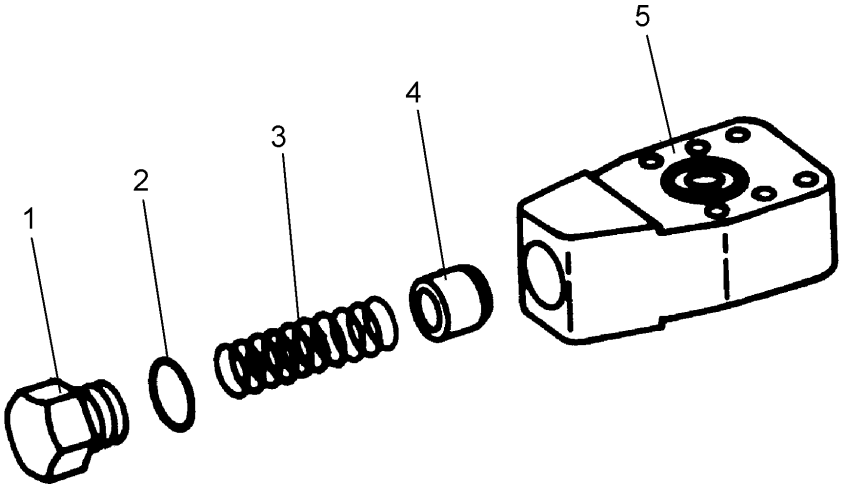


Fig. 10B.48. Exploded View Of Steering Return Surge Valve

1. Plug 2. O-Ring 3. Spring 4. Poppet 5. Valve Body

61. INSPECTION AND REPAIR

1. Clean all parts in clean solvent. Dry with compressed air.
2. Discard the O-ring and replace with new.
3. Check the spring for damage, distortion or weakness. Refer to "SPECIFICATIONS".

62. REASSEMBLY

Reassemble the component parts in the reverse order of disassembly.

63. INSTALLATION (Refer to Fig. 10B.47)

1. Using a new O-ring between the valve and the reservoir, install the valve to the bottom of the reservoir. The supply port (B) for the oil cooler should be toward the left hand side of the machine.
2. Install the return line from the steering control valve to port (A) and the supply line to the oil cooler to port B.
3. Fill the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
4. Start the machine and test the operation of the hydraulic system.

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CYLINDERS

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CYLINDERS

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BUCKET CYLINDER

1. DESCRIPTION AND OPERATION (Refer to Fig.'s 10C.3 and 10C.4)

The bucket cylinder is located in the center of the front frame, with the base end mounted to the frame and the rod end mounted to the bellcrank.

The cylinder has a two-piece piston (6 and 9) and is held in place on the piston rod (25) by two retainer halves (8), which fit into a groove of the rod and by bolts (5) which hold the retainers and piston halves together.

Each piston half has a piston seal (10) consisting of a seal with a backing ring underneath. Wear rings (7) on each piston half protect the piston seal from contaminants. O-rings (11) under the wear rings provide a continuous positive fit at the leading edge of the wear rings. O-rings (23) and buffer rings (22) prevent leakage from either direction between the rod and the piston.

The gland (15) is held in place at the end of the cylinder housing (1) by a three-piece lock ring (16). A cord ring (12) fits between the lock ring and the cylinder cover (19). Another O-ring (24) fits in a groove on the front face of the gland. Shims (27, 28, 29) are used in the bucket cylinder to maintain the correct spacing between the cover (19) and the gland (15).

Located in the internal bore of the gland is a wiper ring (18) which prevents entry of dirt and oil loss, a backup ring (32) and O-ring (31) to improve sealability and a wear ring (30) to prevent metal pick up between the gland (15) and the piston rod (25). A wiper ring (17) in the cover cleans dirt from the rod as it retracts.

Cylinder rod movement within the housing is accomplished by applying pressurized oil flow on either side of the piston and allowing oil on the opposite side of the piston to return to reservoir.

2. SPECIFICATIONS

Dimensions

Cylinder Bore	254 mm
Cylinder Stroke	750 mm
Rod End Mounting Pin O.D.	126.92 to 127 mm
Rod End Bushing I.D.:	
Before Installation	127.37 to 127.42 mm
After Installation	127.25 to 127.36 mm
Base End Mounting Pin O.D.	126.92 to 127 mm
Base End Bushing I.D.:	
Before Installation	127.37 to 127.42 mm
After Installation	127.25 to 127.36 mm
Cylinder Cover Shim Thickness	0.08 mm
	0.18 mm
	0.25 mm

Special Torques

Piston Half Bolts (apply Loctite 262)	360 Nm
Cylinder Cover Bolts (apply Loctite 262)	110 Nm
Mounting Pin Locking Bolt	650 Nm

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CYLINDERS

BUCKET CYLINDER

3. BUCKET CYLINDER LEAKAGE TEST

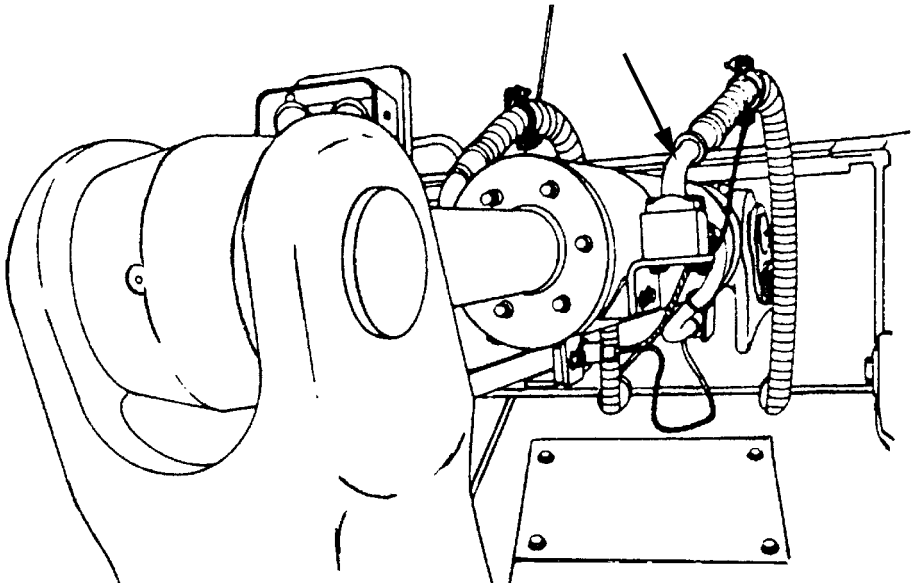


Fig. 10C.1. Bucket Cylinder Base End Hydraulic Hose

1. Operate the machine to warm up the hydraulic oil.
2. Place the bucket on the ground in the ”ROLL BACK” position.
3. Disconnect the hydraulic hose (Fig. 10C.1) which feeds the base end of the bucket cylinder. Plug this hose to prevent return oil from flowing out during the test.
4. Place the bucket control lever in the ”ROLL BACK” position and have a second person watch for oil leakage at the open port on the cylinder.

WARNING! High pressure oil. Be sure to place the bucket control lever in the ”ROLL BACK” position. If placed in the ”DUMP” position, high pressure hydraulic oil will be directed out the plugged hydraulic hose and eject the plug.

5. Shut off the engine. Remove the plug from the hydraulic hose and reconnect the hose to the base end tube.
6. No oil should have flowed out of the open port of the cylinder. If any oil was seen coming from the open port repair the cylinder by replacing the piston seals as outlined in this section.

4. REMOVAL (Refer to Fig. 10C.2)

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.*

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BUCKET CYLINDER

1. Rest the bucket with the skid plates flat on the ground.
2. Attach a suitable hoist and sling to the cylinder. The hoist must be installed to give the best possible balance. Place tension on the hoist.

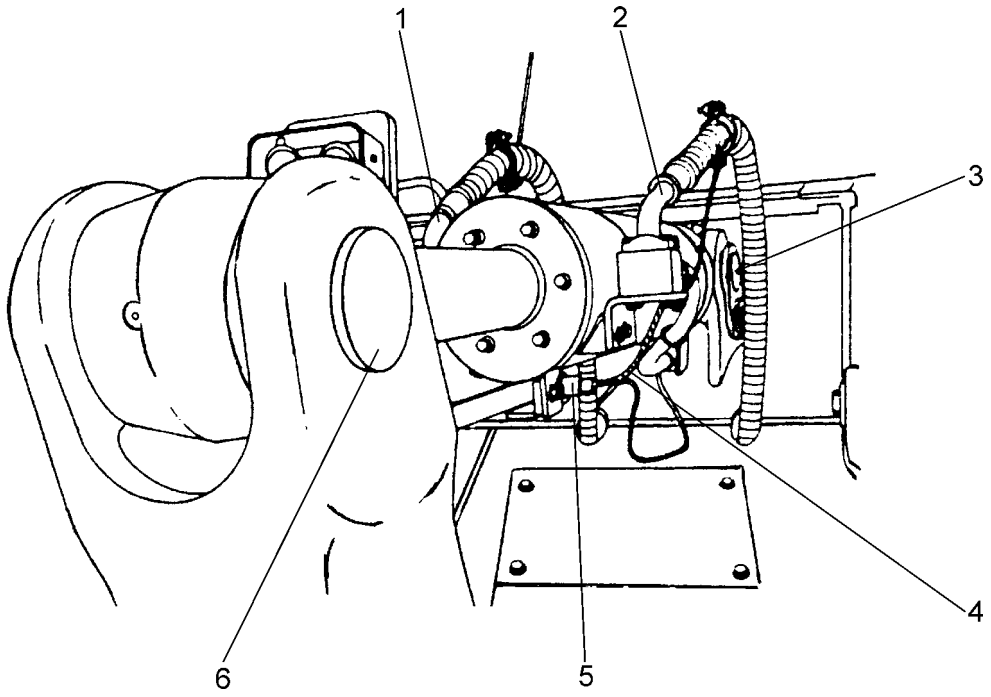


Fig. 10C.2. Bucket Cylinder Disconnect Points

1. Rod End Hydraulic Hose
2. Base End Hydraulic Hose
3. Base End Mounting Pin
4. Electrical Cable
5. Bucket Positioner Proximity Switch
6. Rod End Mounting Pin

3. Disconnect the electrical cable (4, Fig. 10C.2) from the proximity switch (5) of the bucket positioner. Remove all the cable clamps which secure the electrical cable.
4. Remove the rod end pin lock bolts and remove the rod end mounting pin (6).
5. Place the bucket control lever in the ”DUMP” position to retract the cylinder. Return the control lever to ”HOLD” and shut off the engine.
6. Disconnect the hose restraint cables from the inlet and return manifolds on the cylinder housing. Disconnect the base end hydraulic hose (2) and the rod end hydraulic hose (1).
7. Disconnect the lubrication tube at the base end of the cylinder.
8. Remove the base end pin lock bolt and remove the base end mounting pin (3). Remove the cylinder from the machine.
9. Remove and discard the seal ring which are on either side of the bushings at both the base end and the rod end of the cylinder.

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BUCKET CYLINDER

5. DISASSEMBLY (Refer to Fig.'s 10C.3 and 10C.4)

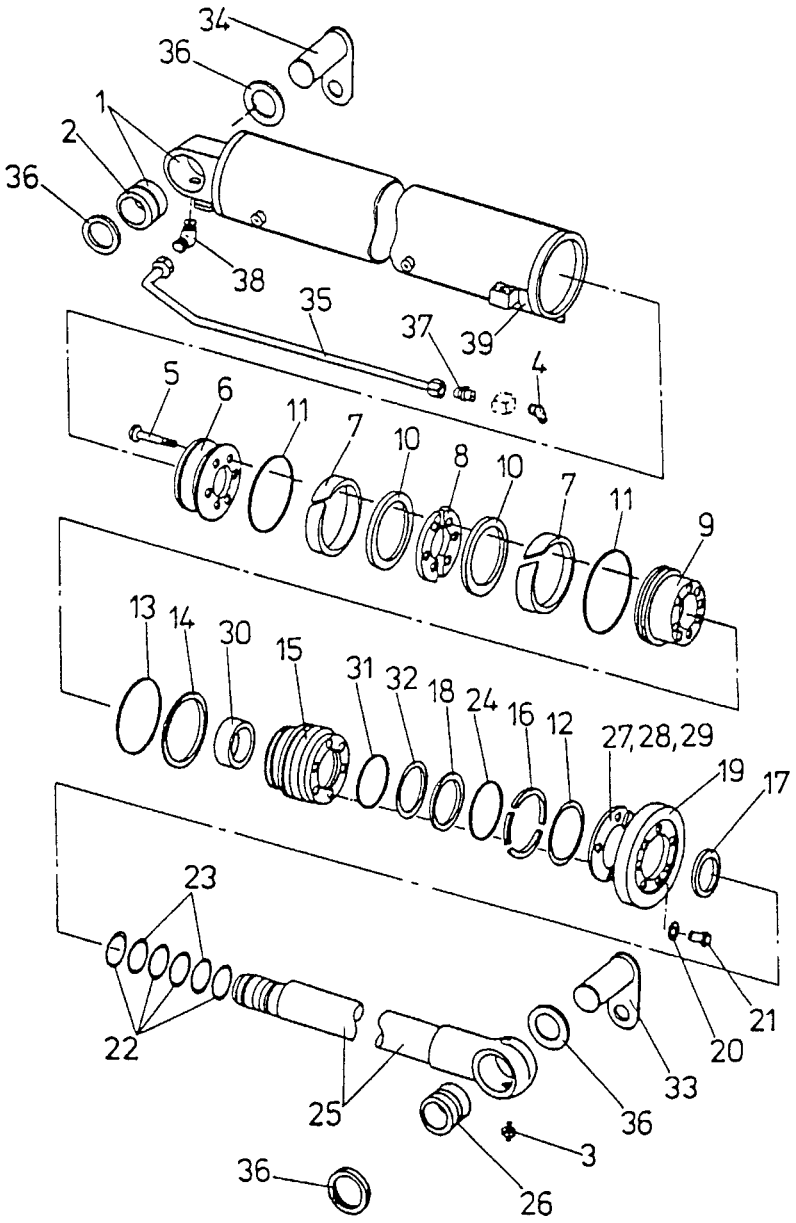


Fig. 10C.3. Exploded View of Bucket Cylinder

Legend for Fig.'s 10C.3 and 10C.4

1. Cylinder Housing Assembly
2. Bushing
3. Lubrication Fitting
4. Lubrication Fitting
5. Bolts and Washers
6. Piston Half
7. Wear Ring
8. Retainer Halves
9. Piston Half
10. Piston Seal
11. O-Ring
12. Cord Ring
13. O-Ring
14. Buffer Ring
15. Gland
16. Lock Ring
17. Wiper Ring
18. Wiper Ring
19. Cover
20. Washers
21. Bolts
22. Buffer Ring
23. O-Ring
24. O-Ring
25. Piston Rod
26. Bushing
27. Shim
28. Shim
29. Shim
30. Wear Ring
31. O-Ring
32. Backup Ring
33. Pin
34. Pin
35. Pipe
36. Seal Ring
37. Connector
38. Connector

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BUCKET CYLINDER

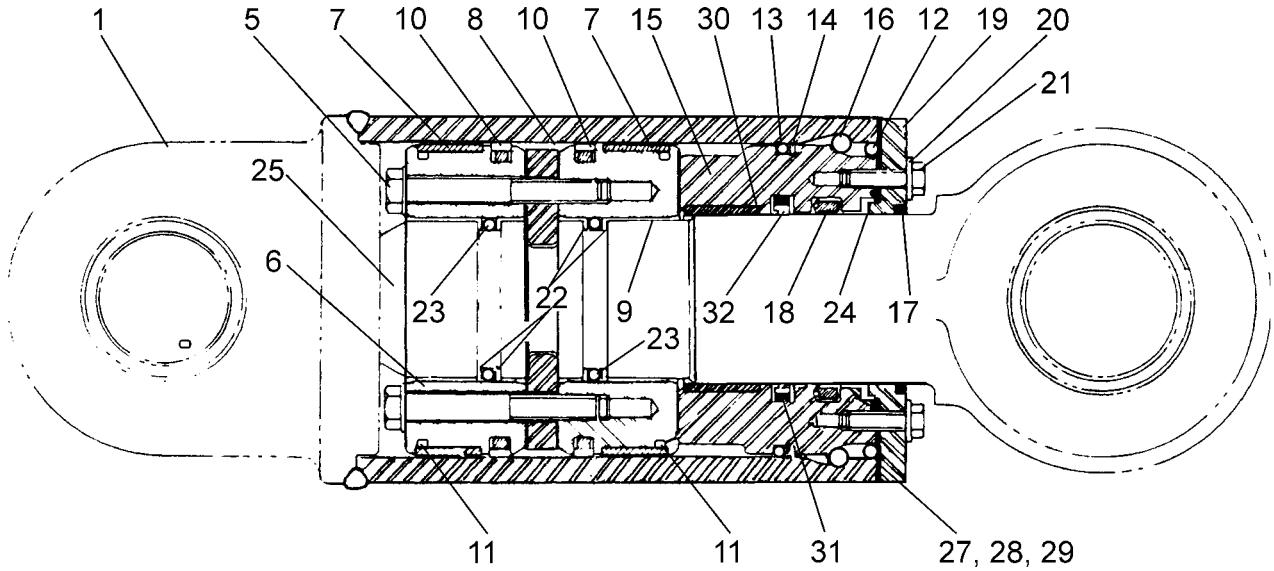


Fig. 10C.4. Cross Section View of Bucket Cylinder

NOTE: *Do not remove the external hydraulic tube from the cylinder housing unless replacement is necessary.*

1. Steam clean or wash the cylinder with solvent before disassembly.
2. Attach a hoist to the cylinder rod eye as shown in Fig. 10C.5, using a strap to protect the bearing in the eye. Raise the cylinder up and secure it to the hoist frame.

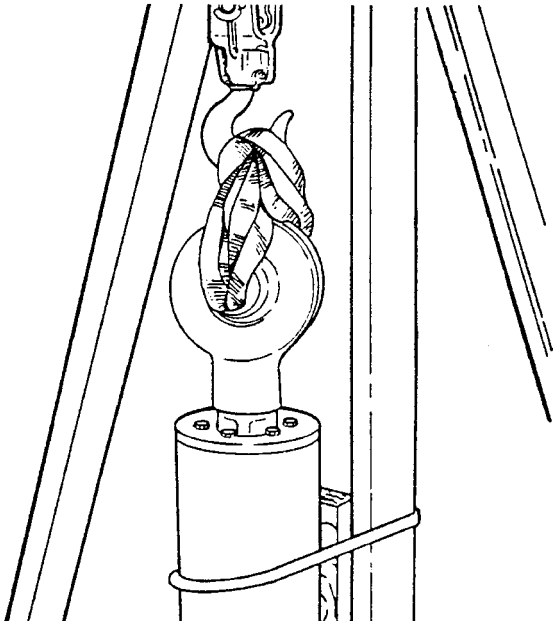


Fig. 10C.5. Securing the Cylinder to the Hoist

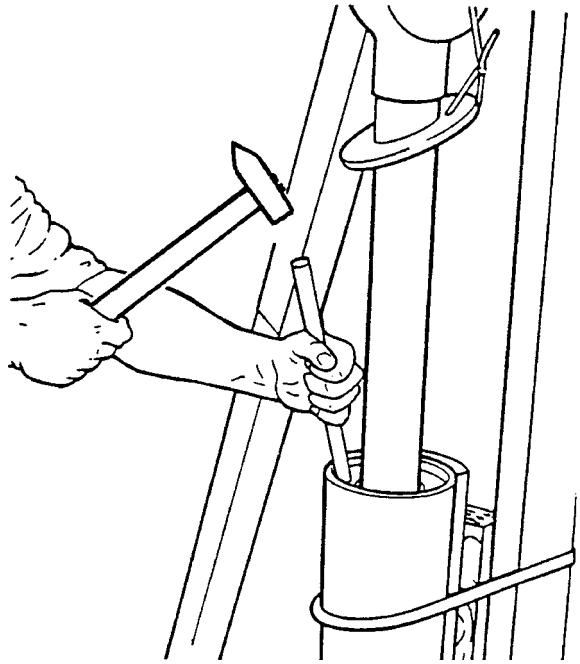


Fig. 10C.6. Relieving the Tension on the Lock Ring

3. Using the hoist, pull the cylinder rod out to approximately 1/2 stroke.
4. Remove the bolts (21, Fig. 10C.3 and 10C.4) and washers (20) which secure the cylinder cover (19) and move the cover toward the piston rod eye as shown in Fig. 10C.6, to provide working clearance.

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5. Remove the shims (27,28,29) from behind the cylinder cover. Secure each shim pack half together for use at reassembly.
6. Install the bolts (21) removed from the cylinder cover into the gland (15). Place a protective covering over the piston rod. Using a soft mallet as shown in Fig. 10C.6, drive the bolts to move the gland into the housing and to free the lock ring (16). Slide the cord ring (12) from the gland (15) and remove the lock ring.
7. Pull the entire piston rod assembly from the cylinder housing (1).
8. Remove the bolts (5) with washers. Remove the piston half (6), the retainer halves (8) and the piston half (9) from the piston rod (25).
9. Remove the wear rings (7), O-rings (11) and piston seals (10) from both piston halves.
10. Remove the O-rings (23) and buffer rings (22) from the piston rod.
11. Slide the gland (15) from the piston rod (25). Remove the O-ring (13) and buffer ring (14) from the outside of the gland. Remove the O-ring (24) from the front of the gland. Remove the wear ring (30), backup ring (32), O-ring (31) and wiper ring (18) from the inside of the gland.
12. Slide the cord ring (12) and the cylinder cover (19) from the piston rod (25). Remove the wiper ring (17) from the cylinder cover.

6. INSPECTION AND REPAIR (Refer to Fig.'s 10C.3 and 10C.4)

1. It is recommended that all new O-rings, backup rings, wear rings and seals be installed when the 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 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 part as necessary.
6. Inspect tapped holes for damaged threads.
7. Inspect all piston bolts (5) for possible signs of fatigue. Replace all the bolts if any one is considered to be questionable.
8. The washers (5) are hardened washer which must be completely flat and undamaged on both sides.
9. Carefully inspect the area of the piston half (6) which contacts the hardened washers (5). This area must be free of any damage.

IMPORTANT: *The bolts (5), washers (5) and the mating surface of the piston half (6) must function as an "Oil-Tight" connection. Leakage thru the drilled bolt holes can cancel the sealing functions of the piston half seals and cause high stress loads on the bolts (5).*

10. Inspect the inner surfaces of both piston halves (6 and 9) which mate against the retainers (8). The parts must be free of nicks and handling damage and must made completely flat against each other.
11. Inspect the I.D. of both piston halves (6 and 9) for possible damage at contact point with O-rings (23) and buffer rings (22).

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BUCKET CYLINDER

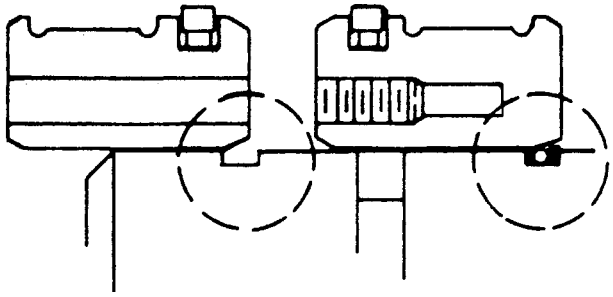


Fig. 10C.7. Inspecting Chamfer on Piston Half I.D.

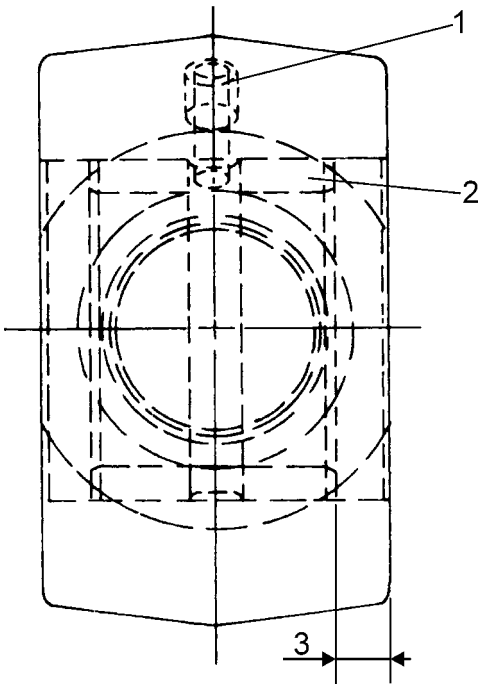


Fig. 10C.8. Bushing Replacement

1. Bushing
2. Tapped Hole for Lubrication Fitting
3. Bucket Cylinder (both ends): flush

12. Inspect the leading I.D. chamfer of both piston halves (6 and 9) as shown in Fig. 10C.7. A sharp corner here makes installation difficult and is likely to damage the O-rings (23) and buffer rings (22) during assembly.
13. Carefully inspect the I.D. of the gland (15) for sharp corners and burrs. Inspect the machined counterbore for the wiper ring (18) to make sure the area is free of scratches. The rod seal must mate against a smooth, ground surface.
14. Check bushings and mounting pins. Replace damaged, excessively worn or out-of-round bushings. Replace cracked or excessively scored or scratched pins. Refer to ”SPECIFICATIONS” in this section for dimension of new parts.
15. If bushing replacement is necessary, press in the new bushing see position 3, Fig. 10C.8. If the bushing (1) has a lubrication groove, the groove should line up with the tapped hole (2) for the lubrication fitting.

7. REASSEMBLY (Refer to Fig.’s 10C.3 and 10C.4)

NOTE: *All parts should be coated with hydraulic oil before assembly EXCEPT the tapped holes in the gland (15) and the piston half (6 and 9) and all bolts (5 and 21). Coat all O-rings, wear rings, wipers and seals with grease.*

1. Install the wiper ring (17) into the cylinder cover (19) with the lip facing the outside of the cover as shown in Fig. 10C.9. Press only on the metal portion of the seal during installation.
2. Slide the cylinder cover (19) and the cord ring (12) onto the piston rod (25).

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CYLINDERS

BUCKET CYLINDER

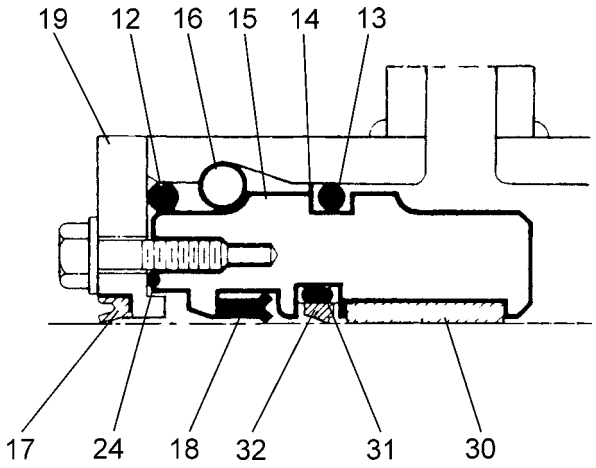


Fig. 10C.9. Installing the Gland Seals

12. O-Ring
13. O-Ring
14. Buffer Ring
15. Gland
16. Lock Ring
17. Wiper Ring
18. Wiper Ring
19. Cylinder Cover
24. O-Ring
30. Wear Ring
31. O-Ring
32. Backup Ring

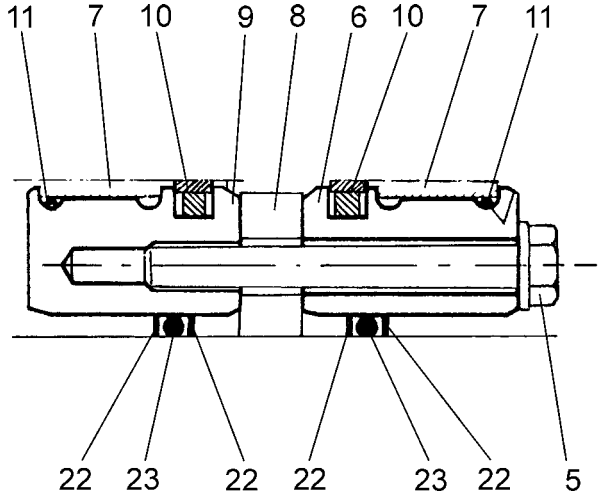


Fig. 10C.10. Installing the Piston Half Seals

5. Bolts and Washers
6. Piston Half
7. Wear Ring
8. Retainer Halves
9. Piston Half
10. Piston Seal
11. O-Rings
22. Buffer Ring
23. O-Ring

3. Sub-assemble the gland (15) by installing the buffer ring (14), O-ring (13), wear ring (30), O-ring (31), backup ring (32), wiper ring (18) and O-ring (24) as shown in Fig. 10C.9. Be sure the lips of the backup ring and wiper ring point toward the wear ring.
4. Install the gland (15) onto the piston rod with the tapped hole end of the gland toward the cylinder cover (19).
5. Into both piston halves (6 and 9) install the piston seal (10).
6. Install the O-rings (11) at the outer ends of the wear ring grooves in both piston halves as shown in Fig. 10C.10. Install the wear rings (7) over the O-rings.
7. Install the inner set of two buffer rings (22) and an O-ring (23). Install the tapped piston half (9) onto the rod. As the I.D. chamfer of the piston half contacts the inner set of rings (refer to Fig. 10C.7), the rings must be completely compressed in their groove. Do not allow the rings to become distorted or to extrude out between the piston half and the rod. Once the piston half (6) can be used as a slide hammer, if necessary, to help position the inner piston half.
8. Install the outer set of two buffer rings (22) and an O-ring (23). Install the other piston half (6) as shown in Fig. 10C.10. Again, be careful to completely compress the inner set of rings as they pass under the piston half. Be sure the drilled holes in the piston half (6) line up with the tapped holes in the other piston half (9).
9. Install the retainer halves (8) between the piston halves (6 and 9) with all bolt holes aligned. Apply Loctite 262 to the threads of the bolts (5). Install the bolts (5) with washers and tighten them down evenly. Torque the bolts to 380 Nm.
10. Install a hoist sling through the piston rod eye. Place a rag or wiper around the sling where it passes through the eye to prevent damage to the bushing. Coat the gland with hydraulic oil.
11. Temporarily fasten the cylinder cover (19) to the gland (15) with three bolts (21). Leave approximately 5 mm of space between the gland and the cover.
12. Stand and block the cylinder housing (1) in a vertical position. With the hoist, lower the piston rod assembly into the housing.
13. Rap on the three bolts in the cylinder cover to position the gland (15) into the cylinder housing.

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14. Remove the three bolts. Pull the piston rod (25) out of the housing to within 300 mm of its fully extended length. Pull the cylinder cover and cord ring (12) away from the housing.
15. Install the lock ring (16) by placing them, equally spaced, in the cylinder housing internal groove.
16. Allowing adequate space for the cylinder to extend, apply shop line air pressure to the base end of the cylinder. This will drive the piston end against the gland to fully seat the segments lock ring. Repeat this procedure twice more.
17. Position the cord ring (12) on the end of the gland. Be sure the O-ring (24) is in its groove in the end of the gland.
18. Install the shims (27, 28, 29) as follows:

STEP A. Install a shim pack between the cylinder cover and the gland that is approximately 1 mm thick. Measure these shims individually before installation and record the exact total thickness.

NOTE: *The shims are furnished in halves for ease of installation. Be sure each half of the shims pack contains the same number of shims of the same size.*

STEP B. Install the bolts (21) with washer (20) and torque the bolts evenly to 110 Nm.

STEP C. Measure the gap (3, Fig. 10C.11) which occurs between the cylinder cover (19) and the housing (1) with the shims pack (27, 28, 29) installed.

STEP D. Subtract this result from the exact size of the shims pack as recorded in STEP A.

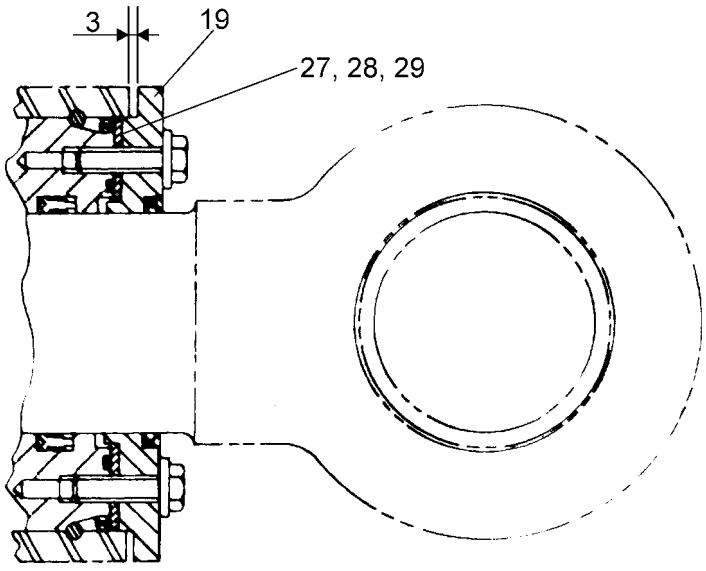


Fig. 10C.11. Cylinder Cover Shimming Procedure

3. Gap Between Cover and Housing
19. Cylinder Cover
27, 28, 29. Shims Pack

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STEP E. Remove the bolts (21, Fig.10C.3 and 10C.4) and washers (20) and remove the shims pack.

STEP F. Make up a final shim pack to equal the result obtained in STEP D minus 0.15 - 0.25 mm. Measure the shims individually to obtain the correct final shims pack thickness.

STEP G. Install the final shim pack. Apply Loctite 262 to the threads of the bolts (21) and install the bolts, with washers (20). Tighten them evenly and torque to 110 Nm.

19. Again apply shop line air pressure to the base end of the cylinder with the piston rod positioned no more than 300 mm from full stroke. Recheck the torque on the cylinder cover bolts (21).
20. If removed, install the external hydraulic tube to the cylinder housing.
21. Install new seal ring into the groove of the bushings at both the rod end eye and the base end eye. The lips of the seal should be facing outward.

8. INSTALLATION

1. Using a suitable hoist and sling, place the bucket cylinder in position on the machine with the rod end toward the bellcrank and the external hydraulic tube to the base end of the cylinder on the L.H. side.
2. Coat the base end mounting pin with chassis grease and install the pin from the left side of the cylinder toward the right side. Install and tighten the pin locking hardware to 650 Nm.
3. Connect the base end hydraulic hose (2, Fig. 10C.2) and the rod end hydraulic hose (1). Install the hose restraint cables to the inlet and return manifolds on the cylinder housing.
4. Start the engine. Use the bucket control lever to slowly extend or retract the cylinder until the rod eye lines up with mounting hole in the bellcrank.
5. Coat the rod end mounting pin (6, Fig. 10C.2) with chassis grease and install the pin from the right side of the cylinder toward the left side. Install and tighten the pin locking hardware to 650 Nm. Remove the hoist and sling.
6. Install the lubrication pipe to the base end of the cylinder. Lubricate the rod end and the base end bushings through the lube fitting.
7. Connect the electrical cable (4, Fig. 10C.2) to the proximity switch (5) of the bucket positioner.
8. Operate the bucket through several ”DUMP” and ”Roll Back” maneuvers to expel all air and to check the operation of the cylinder.
9. Check the oil level in the hydraulic reservoir and fill as necessary, Refer to the OPERATOR’S MANUAL for oil specifications and procedure.
10. Test the bucket positioner to be sure it is returning the bucket to its digging position after ”ROLL BACK”. If adjustment is necessary, refer to the OPERATOR’S MANUAL.

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9. DESCRIPTION AND OPERATION (Refer to Fig.'s 10C.14 and 10C.15)

The two boom cylinders are located on each side of the front frame, with the base end mounted to the frame and the rod end mounted to the underside of the boom arms.

The cylinder has a two-piece piston (6 and 9) and is held in place on the piston rod (25) by two retainer halves (8), which fit into a groove of the rod and by bolts (5) which hold the retainers and piston halves together.

Each piston half has a piston seal (10) consisting of a seal with a backing ring underneath. Wear rings (7) on each piston half protect the piston seal from contaminants. O-rings (11) under the wear rings provide a continuous positive fit at the leading edge of the wear rings. O-rings (23) and buffer rings (22) prevent leakage from either direction between the rod and the piston.

The gland (15) is held in place at the end of the cylinder housing (1) by a three-piece lock ring (16). A cord ring (12) fits between the lock ring and the cylinder cover (19). Another O-ring (24) fits in a groove on the front face of the gland.

Located in the internal bore of the gland is a wiper ring (17) which prevents entry of dirt and oil loss, a backup ring (29) and O-ring (28) to improve sealability and a wear ring (27) to prevent metal pick up between the gland (15) and the piston rod (25). A wiper ring (18) in the cover cleans dirt from the rod as it retracts.

Cylinder rod movement within the housing is accomplished by applying pressurized oil flow on either side of the piston and allowing oil on the opposite side of the piston to return to reservoir.

BOOM CYLINDERS

10. SPECIFICATIONS

Dimensions

Cylinder Bore	216 mm
Cylinder Stroke	1220 mm
Rod End Mounting Pin O.D.	114.22 to 114.3 mm
Rod End Bushing I.D.:	
Before Installation	114.67 to 114.72 mm
After Installation	114.55 to 114.66 mm
Base End Mounting Pin O.D.	139.6 to 139.67 mm
Base End Bushing I.D.:	
Before Installation	140.07 to 140.12 mm
After Installation	139.95 to 140.06 mm

Special Torques

Piston Half Bolts (apply Loctite 262)	360 Nm
Cylinder Cover Bolts (apply Loctite 262)	110 Nm
Mounting Pin Locking Bolt	650 Nm

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11. BOOM CYLINDER LEAKAGE TEST

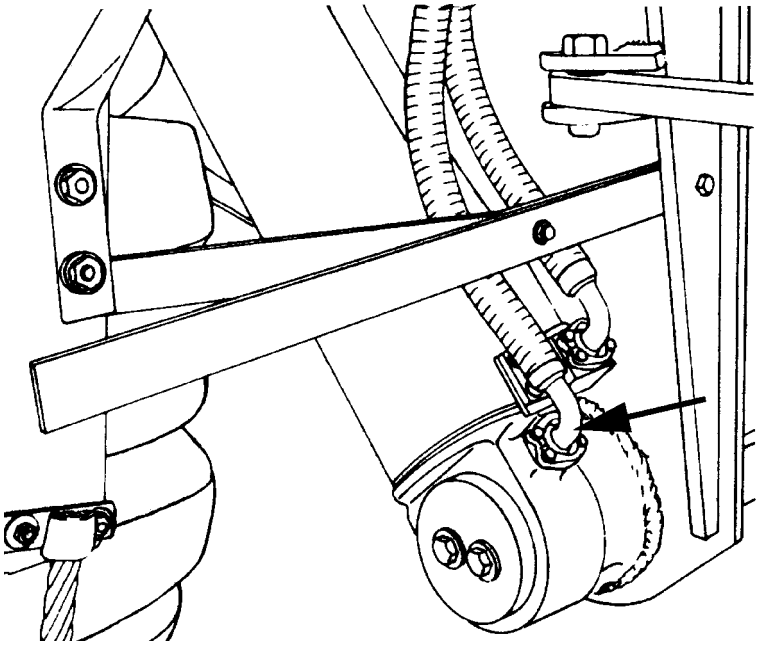


Fig. 10C.12. Boom Cylinder Base End Hydraulic Hose

1. Operate the machine to warm up the hydraulic oil. Install the frame locking bar and block the rear tires to prevent machine movement.
2. Place the empty bucket in the ”DUMP” position and lower it to the ground.
3. Place the boom control lever in the ”LOWER” position to raise the front of the machine off the ground 300 - 400 mm. Place timbers under each front tire and lower the machine onto the timbers.
4. Raise the boom slightly and place the bucket in the ”ROLL BACK” position. Lower the boom until the cylinders are completely retracted.
5. Disconnect the hydraulic hose (Fig. 10C.12) at the base end of one of the cylinders. Plug this hose to prevent return oil from flowing out during the test.
6. Place the boom control lever in the ”LOWER” position and have a second person watch for oil leakage at the open port on the cylinder.

WARNING! High pressure oil. Be sure to place the boom control lever in the ”LOWER” position. If placed in the ”RAISE” position, high pressure hydraulic oil will be directed out the plugged hydraulic hose and eject the plug.

7. Shut off the engine. Remove the plug from the hydraulic hose and reconnect the hose to the base end of the cylinder.
8. Repeat Steps 5 through 7 to test the opposite boom cylinder.
9. No oil should have flowed out of the open port of the cylinder. If any oil was seen coming from the open port repair the cylinder by replacing the piston seals as outlined in this section.

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12. REMOVAL (Refer to Fig. 10C.13)

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. Raise the boom and bucket about 300 mm off the ground, keeping the bottom of the bucket horizontal. Place blocking under the bucket and lower the bucket onto the blocking. This will keep the boom cylinder rod ends slightly extended so that when the rod end pins are removed, the cylinder can be retracted enough to clear the boom arms.
2. Attach a suitable hoist and sling to the cylinder. The hoist must be installed to give the best possible balance. Place tension on the hoist. Remove the rod end pin locking bolt on the inside of the boom arm. Remove the rod end mounting pin.
3. Place the boom control lever in the ”LOWER” position to retract the cylinder. Return the control lever to ”HOLD” and shut off the engine.
4. Disconnect the rod end hydraulic line (1, Fig.10C.13) and the base end hydraulic line (2).
5. Remove the cylinder pin retainer pin (3, Fig. 10C.13).
6. Remove the bolt and lock nut inside the frame which secures the base end pin to the front frame.
7. Remove the base end pin and remove the cylinder from the machine. Remove and discard the wiper seals which are on either side of the bushings on both the base end and the rod end of the cylinder.

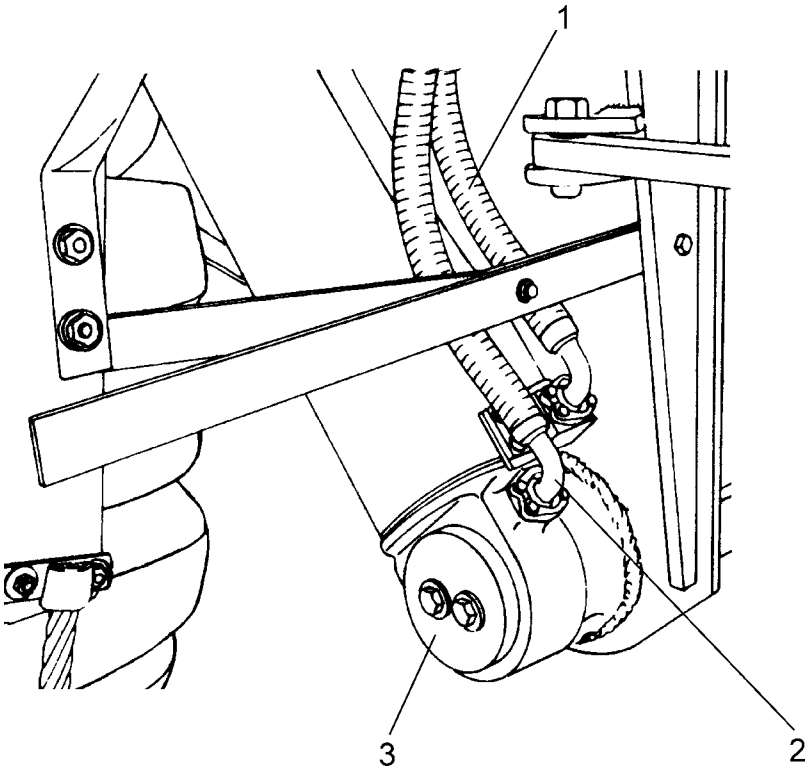


Fig. 10C.13. Boom Cylinder Disconnect Points

1. Rod End Hydraulic Hose
2. Base End Hydraulic Hose
3. Base End Pin Retainer

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13. DISASSEMBLY (Refer to Fig.'s 10C.14 and 10C.15)

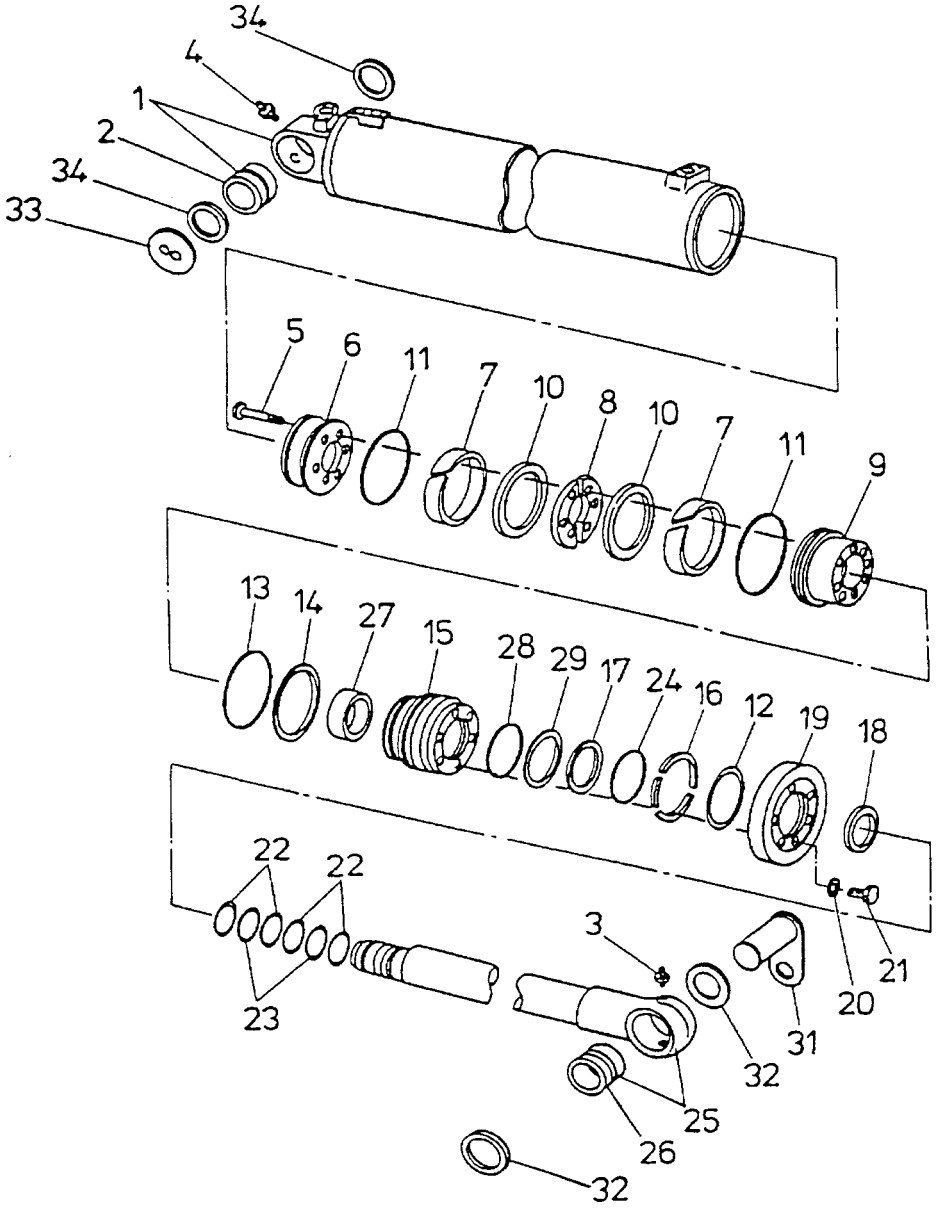


Fig. 10C.14. Exploded View of Boom Cylinder

Legend for Fig.'s 10C.14 and 10C.15

1. Cylinder Housing Assembly
2. Bushing
3. Lubrication Fitting
4. Lubrication Fitting
5. Bolts and Washers
6. Piston Half
7. Wear Ring
8. Retainer Halves
9. Piston Half
10. Piston Seal
11. O-Ring
12. Cord Ring
13. O-Ring
14. Buffer Ring
15. Gland
16. Lock Ring
17. Wiper Ring
18. Wiper Ring
19. Cover
20. Washers
21. Bolts
22. Buffer Ring
23. O-Ring
24. O-Ring
25. Piston Rod
26. Bushing
27. Wear Ring
28. O-Ring
29. Backup Ring
31. Pin
32. Seal Ring
33. Plate
34. Seal Ring

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BOOM CYLINDER

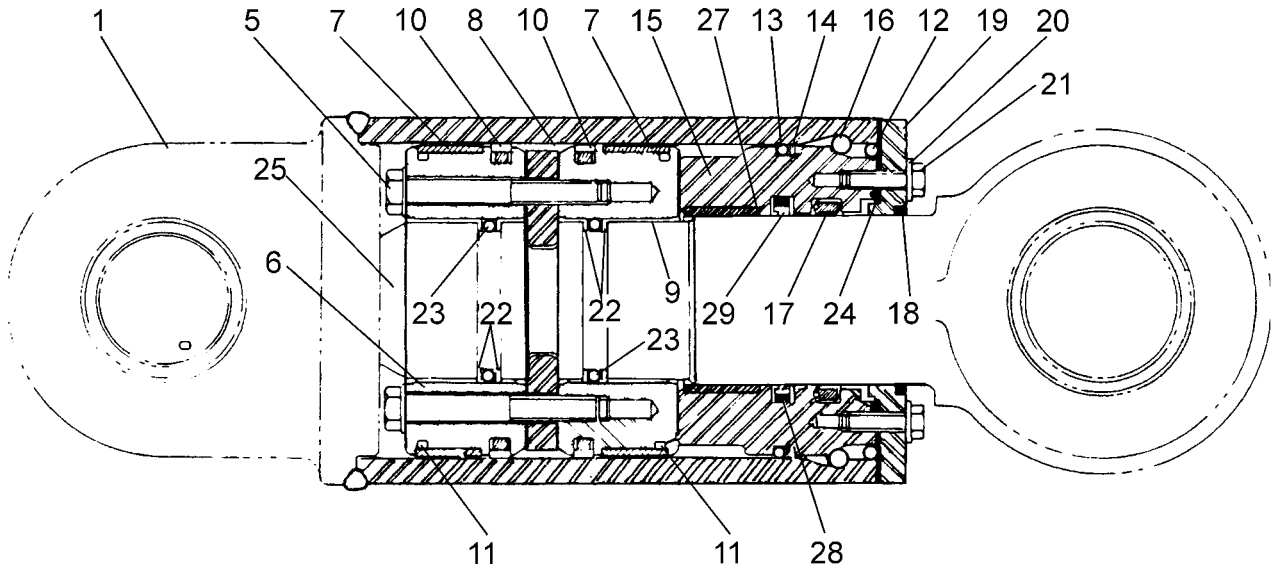


Fig. 10C.15. Cross Section View of Boom Cylinder

1. Steam clean or wash the cylinder with solvent before disassembly.
2. Attach a hoist to the cylinder rod eye as shown in Fig. 10C.16, using a strap to protect the bearing in the eye. Raise the cylinder up and secure it to the hoist frame.

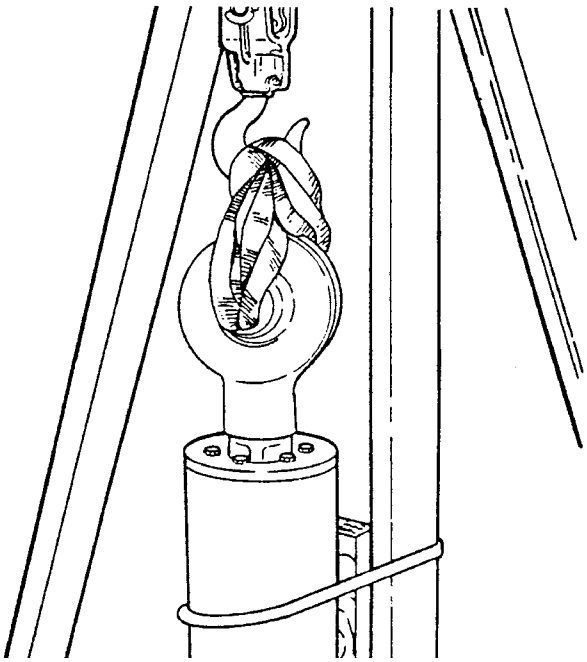


Fig. 10C.16. Securing the Cylinder to the Hoist

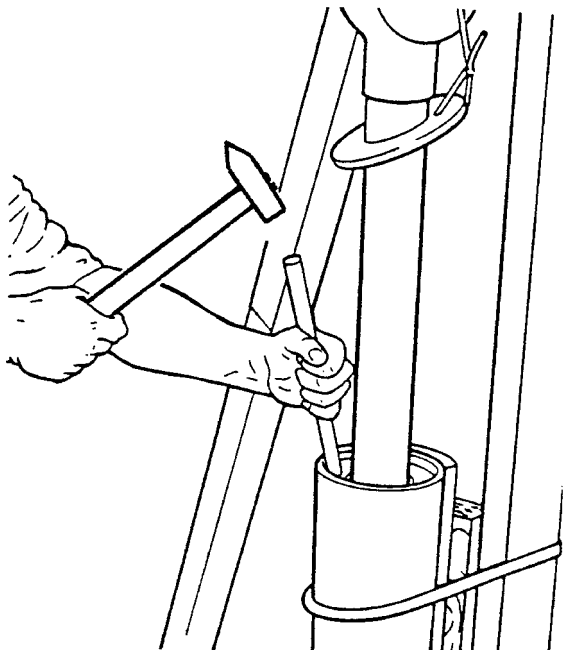


Fig. 10C.17. Relieving the Tension on the Lock Ring

3. Using the hoist, pull the cylinder rod out to approximately 1/2 stroke.
4. Remove the bolts (21, Fig. 10C.14 and 10C.15) and washers (20) which secure the cylinder cover (19) and move the cover toward the piston rod eye as shown in Fig. 10C.17, to provide working clearance.

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5. Install the bolts (21) removed from the cylinder cover into the gland (15). Place a protective covering over the piston rod. Using a soft mallet as shown in Fig. 10C.6, drive the bolts to move the gland into the housing and to free the lock ring (16). Slide the cord ring (12) from the gland (15) and remove the lock ring.
6. Pull the entire piston rod assembly from the cylinder housing (1).
7. Remove the bolts (5) with washers. Remove the piston half (6), the retainer halves (8) and the piston half (9) from the piston rod (25).
8. Remove the wear rings (7), O-rings (11) and piston seals (10) from both piston halves.
9. Remove the O-rings (23) and buffer rings (22) from the piston rod.
10. Slide the gland (15) from the piston rod (25). Remove the O-ring (13) and buffer ring (14) from the outside of the gland. Remove the O-ring (24) from the front of the gland. Remove the wear ring (27), backup ring (29), O-ring (28) and wiper ring (17) from the inside of the gland.
12. Slide the cord ring (12) and the cylinder cover (19) from the piston rod (25). Remove the wiper ring (18) from the cylinder cover.

14. INSPECTION AND REPAIR (Refer to Fig.'s 10C.14 and 10C.15)

1. It is recommended that all new O-rings, backup rings, wear rings and seals be installed when the 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 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 part as necessary.
6. Inspect tapped holes for damaged threads.
7. Inspect all piston bolts (5) for possible signs of fatigue. Replace all the bolts if any one is considered to be questionable.
8. The washers (5) are hardened washer which must be completely flat and undamaged on both sides.
9. Carefully inspect the area of the piston half (6) which contacts the hardened washers (5). This area must be free of any damage.

IMPORTANT: *The bolts (5), washers (5) and the mating surface of the piston half (6) must function as an "Oil-Tight" connection. Leakage thru the drilled bolt holes can cancel the sealing functions of the piston half seals and cause high stress loads on the bolts (5).*

10. Inspect the inner surfaces of both piston halves (6 and 9) which mate against the retainers (8). The parts must be free of nicks and handling damage and must made completely flat against each other.
11. Inspect the I.D. of both piston halves (6 and 9) for possible damage at contact point with O-rings (23) and buffer rings (22).

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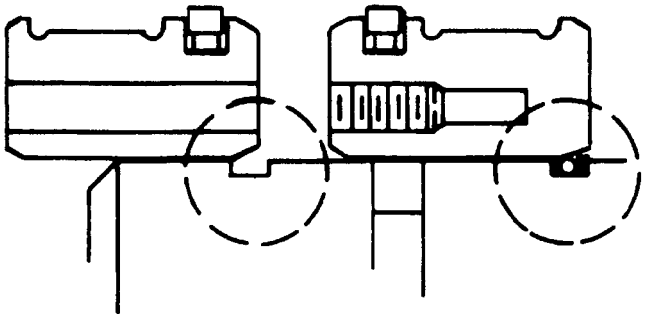


Fig. 10C.18. Inspecting Chamfer on Piston Half I.D.

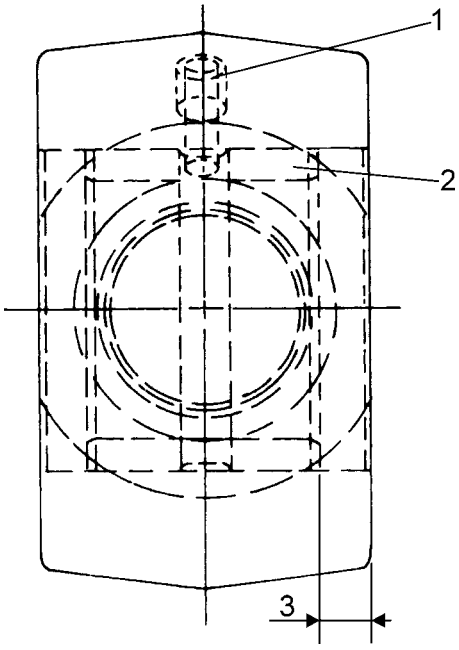


Fig. 10C.19. Bushing Replacement

1. Bushing
2. Tapped Hole for Lubrication Fitting
3. Boom Cylinder (both ends): 11.4 mm

12. Inspect the leading I.D. chamfer of both piston halves (6 and 9) as shown in Fig. 10C.18. A sharp corner here makes installation difficult and is likely to damage the O-rings (23) and buffer rings (22) during assembly.
13. Carefully inspect the I.D. of the gland (15) for sharp corners and burrs. Inspect the machined counterbore for the wiper ring (17) to make sure the area is free of scratches. The rod seal must mate against a smooth, ground surface.
14. Check bushings and mounting pins. Replace damaged, excessively worn or out-of-round bushings. Replace cracked or excessively scored or scratched pins. Refer to ”SPECIFICATIONS” in this section for dimension of new parts.
15. If bushing replacement is necessary, press in the new bushing see position 3, Fig. 10C.19. If the bushing (1) has a lubrication groove, the groove should line up with the tapped hole (2) for the lubrication fitting.

15. REASSEMBLY (Refer to Fig.’s 10C.14 and 10C.15)

NOTE: *All parts should be coated with hydraulic oil before assembly EXCEPT the tapped holes in the gland (15) and the piston half (9) and all bolts (5 and 21). Coat all O-rings, wear rings, wipers and seals with grease.*

1. Install the wiper ring (18) into the cylinder cover (19) with the lip facing the outside of the cover as shown in Fig. 10C.20. Press only on the metal portion of the seal during installation.
2. Slide the cylinder cover (19) and the cord ring (12) onto the piston rod (25).

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CYLINDERS

BOOM CYLINDER

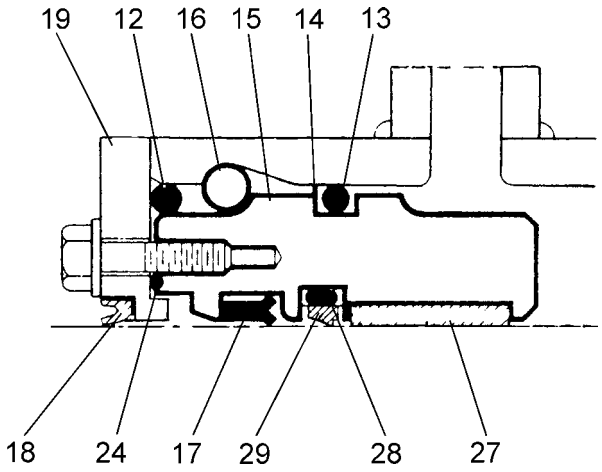


Fig. 10C.20. Installing the Gland Seals

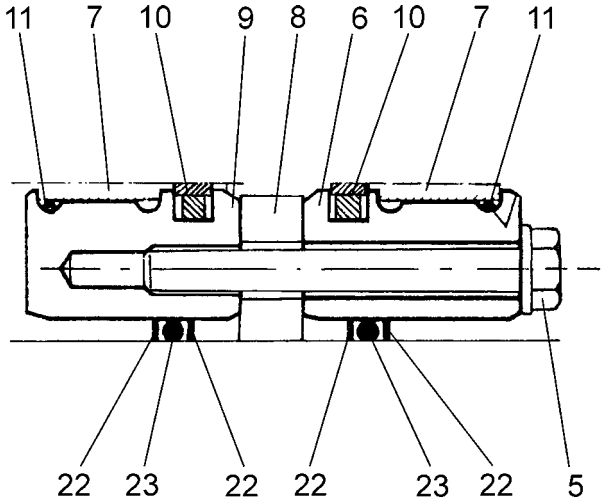


Fig. 10C.21. Installing the Piston Half Seals

12. O-Ring
13. O-Ring
14. Buffer Ring
15. Gland
16. Lock Ring
17. Wiper Ring
18. Wiper Ring
19. Cylinder Cover
24. O-Ring
27. Wear Ring
28. O-Ring
29. Backup Ring

5. Bolts and Washers
6. Piston Half
7. Wear Ring
8. Retainer Halves
9. Piston Half
10. Piston Seal
11. O-Rings
23. Buffer Ring
22. O-Ring

3. Sub-assemble the gland (15) by installing the buffer ring (14), O-ring (13), wear ring (27), O-ring (28), backup ring (29), wiper ring (17) and O-ring (24) as shown in Fig. 10C.20. Be sure the lips of the backup ring and wiper ring point toward the wear ring.
4. Install the gland (15) onto the piston rod with the tapped hole end of the gland toward the cylinder cover (19).
5. Into both piston halves (6 and 9) install the piston seal (10).
6. Install the O-rings (11) at the outer ends of the wear ring grooves in both piston halves as shown in Fig. 10C.21. Install the wear rings (7) over the O-rings.
7. Install the inner set of two buffer rings (22) and an O-ring (23). Install the tapped piston half (9) onto the rod. As the I.D. chamfer of the piston half contacts the inner set of rings (refer to Fig. 10C.18), the rings must be completely compressed in their groove. Do not allow the rings to become distorted or to extrude out between the piston half and the rod. Once the piston half (6) can be used as a slide hammer, if necessary, to help position the inner piston half.
8. Install the outer set of two buffer rings (22) and an O-ring (23). Install the other piston half (6) as shown in Fig. 10C.21. Again, be careful to completely compress the inner set of rings as they pass under the piston half. Be sure the drilled holes in the piston half (6) line up with the tapped holes in the other piston half (9).
9. Install the retainer halves (8) between the piston halves (6 and 9) with all bolt holes aligned. Apply Loctite 262 to the threads of the bolts (5). Install the bolts (5) with washers and tighten them down evenly. Torque the bolts to 380 Nm.
10. Install a hoist sling through the piston rod eye. Place a rag or wiper around the sling where it passes through the eye to prevent damage to the bushing. Coat the gland with hydraulic oil.
11. Temporarily fasten the cylinder cover (19) to the gland (15) with three bolts (21). Leave approximately 5 mm of space between the gland and the cover.

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12. Stand and block the cylinder housing (1) in a vertical position. With the hoist, lower the piston rod assembly into the housing.
13. Rap on the three bolts in the cylinder cover to position the gland (15) into the cylinder housing.
14. Remove the three bolts. Pull the piston rod (25) out of the housing to within 300 mm of its fully extended length. Pull the cylinder cover and cord ring (12) away from the housing.
15. Install the lock ring (16) by placing them, equally spaced, in the cylinder housing internal groove.
16. Allowing adequate space for the cylinder to extend, apply shop line air pressure to the base end of the cylinder. This will drive the piston end against the gland to fully seat the segments lock ring. Repeat this procedure twice more.
17. Position the cord ring (12) on the end of the gland. Be sure the O-ring (24) is in its groove in the end of the gland.
18. Apply Loctite 262 to the threads of the bolts (21) and install the bolts with washer (20). Tighten evenly and torque to 110 Nm.
19. Again apply shop line air pressure to the base end of the cylinder with the piston rod positioned no more than 300 mm from full stroke. Recheck the torque on the cylinder cover bolts (21).
20. Install new wiper ring on each side of the bushing at both the rod end eye and base end eye. The lips of the seal should be facing outward.

16. INSTALLATION

1. Using a suitable hoist and sling, place the boom cylinder in position on the machine with the hydraulic ports upward.
2. Coat the base end pin with chassis grease and install the pin through the cylinder and into the frame until the hole through the pin lines up with the hole through the frame. Install the bolt down through the frame and pin. Install and tighten the lock nut.
3. Install the cylinder pin retainer (3, Fig 10C.13)
4. Connect the rod end hydraulic line (1, Fig. 10C.13) and the base end hydraulic line (2) to the cylinder.
5. Start the engine. Use the boom control lever in ”RAISE” to slowly extend the cylinder rod until the rod eye lines up with the mounting hole in the boom arm. The lubrication fitting should point toward the rear of the machine.
6. Coat the rod end pin with chassis grease and install the pin from the inside of the boom arm toward the outside. Install and tighten the pin locking hardware to 650 Nm. Remove the hoist and sling.
7. Lubricate the rod end and the base end bushings through the lube fitting.
8. Operate the boom up and down several times to expel all air and to check the operation of the cylinder.
9. Check the oil level in the hydraulic reservoir and fill as necessary, Refer to the OPERATOR’S MANUAL for oil specifications and procedure.

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CYLINDERS

STEERING CYLINDERS

17. DESCRIPTION AND OPERATION (Refer to Fig.'s 10C.23. and 10C.24)

The steering cylinders are mounted between the front and rear frames on each side of the machine with the base end mounted to the front frame and the rod end mounted to the rear frame. The steering cylinders are the double acting, single stage type.

The one piece piston (8) is secured to the rod (14) with a lock nut (4). The piston seal (7) consists of an inner ring and an outer ring. On either side of the piston seal are wear rings (5) which provide sealing between the two sides of the piston O-rings (6) under the wear rings provide a continuous positive fit at the leading edges of the wear rings.

The gland (13) is held in place at the outer end of the cylinder housing (16) by a three-piece lock ring (3). A cord ring (2) fits between the lock ring and the cylinder cover (1). An O-ring (9) and buffer ring (10) help prevent leakage between the gland and the cylinder housing.

Located in the internal bore of the gland is a wiper ring (12) which prevents entry of dirt and oil loss, a backup ring (21) and O-ring (20) to improve sealability and a wear ring (19) to prevent metal pick up between the gland (13) and the piston rod (14). A wiper ring (11) in the cylinder cover cleans dirt from the rod as it retracts. An O-ring (18) helps to seal the cover to the gland.

Cylinder rod movement within the housing is accomplished by applying pressurized oil flow on either side of the piston and allowing the oil on the opposite side of the piston to return through the steering valve to the reservoir.

18. SPECIFICATIONS

Dimensions

Cylinder Bore	127 mm
Cylinder Stroke	489 mm
Rod End Mounting Pin O.D.	63.42 to 63.50 mm

Rod End Bushing I.D.:

Before Installation	63.81 to 63.86 mm
After Installation	63.72 to 63.82 mm

Special Torques

Cylinder Cover Bolts (apply Loctite 262)	45 Nm
Lock Nut	1625 ± 135 Nm
Mounting Pin Locking Bolt	270 Nm

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STEERING CYLINDERS

19. STEERING CYLINDER LEAKAGE TEST

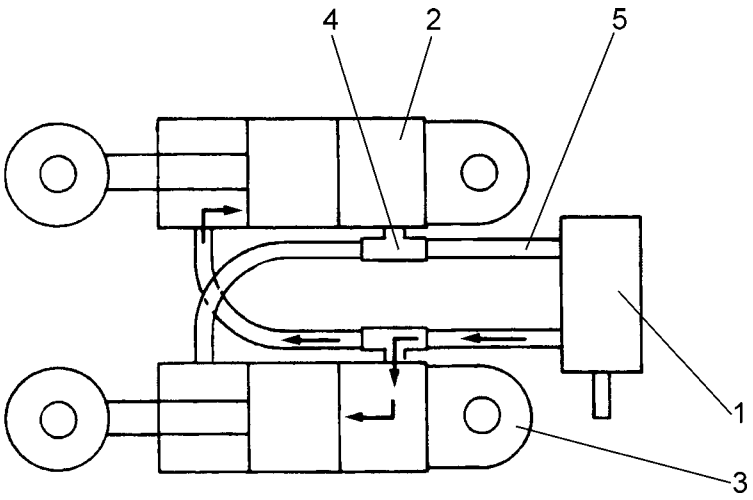


Fig. 10C.22. Steering Cylinder Leakage Test

1. Steering Control Valve
2. L.H. Steering Cylinder
3. R.H. Steering Cylinder
4. Steering Cylinder Check Valve
5. Hydraulic Hose from Steering Control Valve

1. Place the machine in a straight ahead position and install the frame locking bar.
2. At the steering cylinder check valve (4, Fig. 10C.22) on the L.H. steering cylinder (2), disconnect the hose from the rod side of the R.H. cylinder (3).
3. Let the oil drain from this hydraulic line into a container. Allow the hose to rest in the container during this test.
4. Place a second container under check valve (4).
5. Also at the check valve (4), disconnect the hydraulic hose (5) from the steering valve (1). Install a plug in the hose to prevent return oil from coming out when the steering wheel is turned.
6. With a second person observing the two containers, run the engine at low idle and turn the steering wheel to the LEFT ONLY.

WARNING! High pressure oil. Be sure to turn the steering wheel to the LEFT ONLY. Do not put the machine into a right hand turn or permit the valve spool to go past center when returning from the left hand turn. This would permit high pressure oil to be directed out the plugged hose (5) from the steering valve and eject the plug.

7. The observer should note if any oil has flowed out of the disconnect hose from the rod side of the R.H. cylinder (3) or out of the check valve (4) on the L.H. cylinder.
8. No oil should have flowed out of either the disconnected hose from the R.H. cylinder or from the check valve.
9. If oil flows out of the disconnected hose from the R.H. cylinder, the R.H. cylinder piston seal are leaking.
10. If oil flows out of the check valve, the L.H. cylinder piston seals are leaking.
11. Shut off the engine. Remove the plug from the hydraulic hose (5). Reconnect both hoses to the check valve (4).
12. If any oil was observed, repair the appropriate cylinder by replacing the piston seals as outlined in this section.

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CYLINDERS

STEERING CYLINDERS

20. REMOVAL

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. Place the machine on a level surface and install the frame locking bar.
2. Attach a suitable support equipment to the cylinder being removed.
3. Remove the rod end mounting pin which secures the cylinder to the rear frame. Remove the upper shims and keep the shims with the pin.
4. Start the engine. Turn the steering wheel to retract the appropriate cylinder rod. A turn to the left will retract the L.H. cylinder and a turn to the right will retract the R.H. cylinder. Shut off the engine.
5. Remove the hardware which secure the steering cylinder check valve (4, Fig. 10C.22) to the steering cylinder housing. Remove the check valve, with the hydraulic hose still attached, from the steering cylinder.
6. Remove the base end mounting pin and remove the upper shims. Keep the shims with the pin.
7. Remove the cylinder from the machine.
8. Remove the lower shims. Keep the shims with the pins.

21. DISASSEMBLY (Refer to Fig. 10C.23 and Fig. 10C.24)

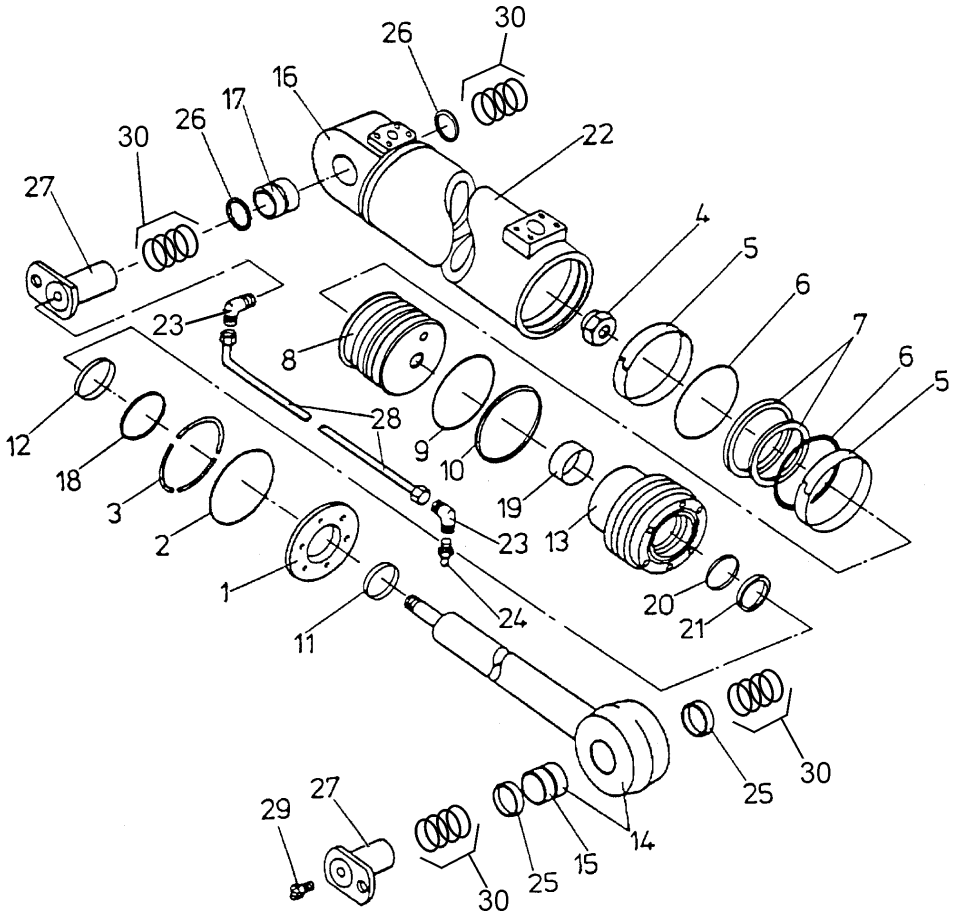


Fig. 10C.23. Exploded View of Boom Cylinder

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STEERING CYLINDERS

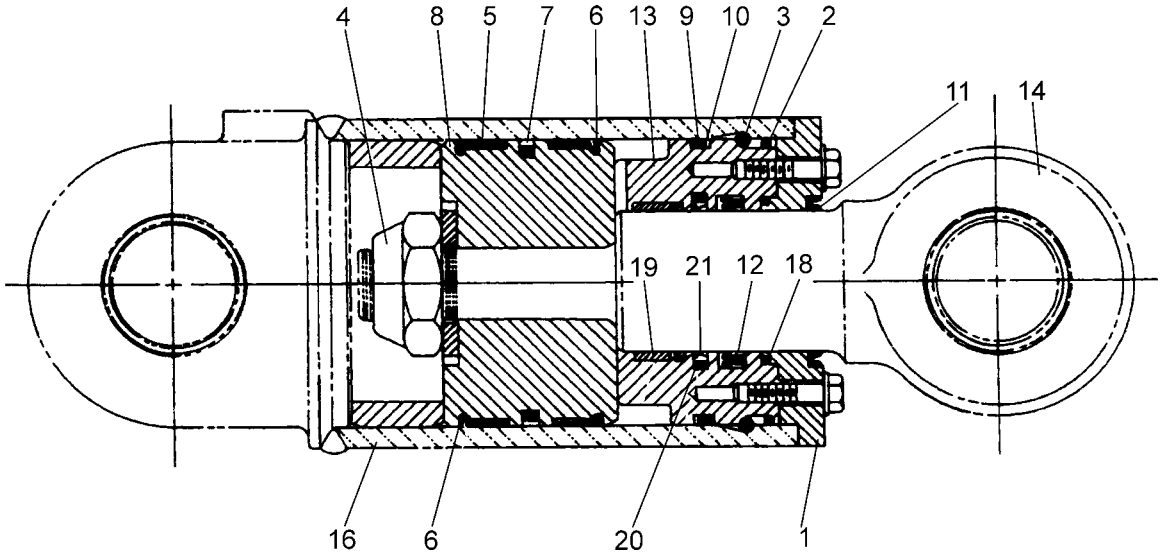


Fig. 10C.24. Cross Section View of Steering Cylinder

Legend for Fig. 10C.23 and Fig. 10C.24

1. Cylinder Cover
2. Cord Ring
3. Lock Ring
4. Nut
5. Wear Ring
6. O-Ring
7. Piston Seal
8. Piston
9. O-Ring
10. Buffer Ring
11. Wiper Ring
12. Wiper Ring
13. Gland
14. Piston Rod
15. Bushing
16. Cylinder Housing Assembly
17. Bushing
18. O-Ring
19. Wear Ring
20. O-Ring
21. Backup Ring
23. Elbow
24. Lubrication Fitting
25. Seal Ring
26. Seal Ring
27. Pin
28. Pipe
29. Lubrication Fitting
30. Shims

1. Steam clean or wash the cylinder with solvent before disassembly.
2. Remove and discard the wiper seals (25 and 26) from both ends of the cylinder.
3. Attach a hoist to the cylinder rod eye as shown in Fig. 10C.25, using a strap to protect the bearing in the eye. Raise the cylinder up and secure it to the hoist frame.

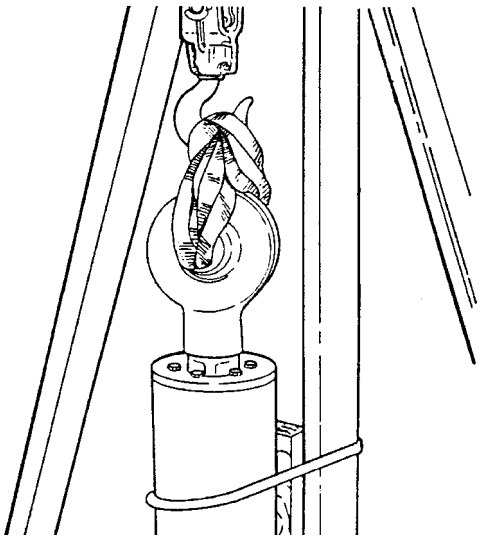


Fig. 10C.25. Securing the Cylinder to the Hoist

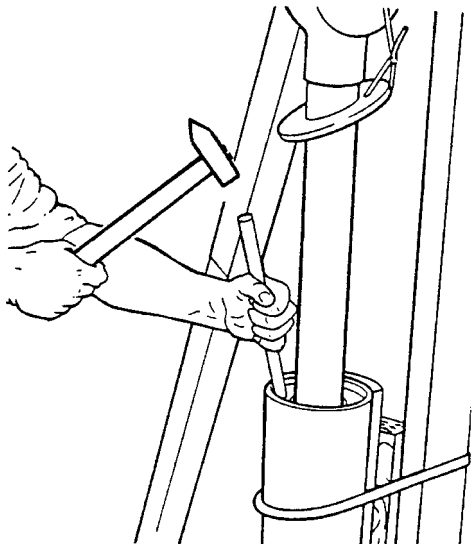


Fig. 10C.26. Relieving the Tension on the Lock Ring

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4. Using the hoist, pull the cylinder rod out to approximately 1/2 stroke.
5. Remove the bolts and washer which secure the cylinder cover (1, Fig. 10C.23 and 10C.24) and move the cover toward the piston rod eye as shown in Fig. 10C.26, to provide working clearance.
6. Install the bolts removed from the cylinder cover into the gland (13). Place a protective covering over the piston rod. Using a soft mallet as shown in Fig. 10C.26, drive the bolts to move the gland into the housing and to free the lock ring (3). Slide the cord ring (2) from the gland and remove the lock ring.
7. Pull the entire piston rod assembly from the cylinder housing (16).
8. Clamp the piston rod eye in a press or vise. Remove piston rod nut (4) from the piston rod. To reduce the breaking effort, an X-4 geared head wrench will reduce the breaking effort to 1/4 of that required by using the breaker bar alone (Fig. 10C. 27).

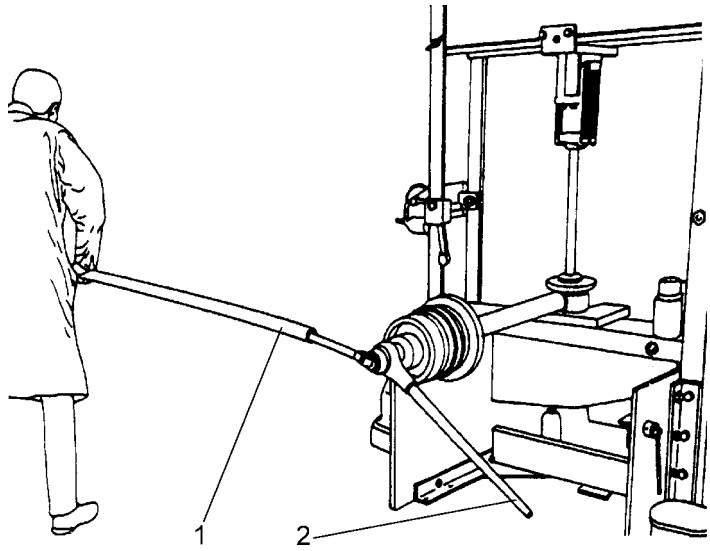


Fig. 10C.27. Removing the Piston Rod Nut

1. Breaker Bar 2. X-4 Geared Head Wrench

9. Remove the piston (8) from the rod. Remove the two wear rings (5), the two O-rings (6) and the piston seal (7).
10. Slide the gland (13) from the piston rod. Remove the O-ring (9) and buffer ring (10) from the outside of the gland. Remove the wear ring (19), backup ring (21), O-ring (20) and wiper ring (12) from the inside of the gland.
11. Slide the cord ring (2) and the cylinder cover (1) from the piston rod. Remove the O-ring (18) and the wiper ring (11) from the cylinder cover.

22. INSPECTION AND REPAIR

1. It is recommended that all new O-rings, backup rings, wear rings and seals be installed when the 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.

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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 wear rings.
5. Clean the piston rod threads with solvent and a stiff brush. Repair threads if necessary with a thread chaser or three cornered file.
6. Inspect tapped holes for damaged threads.
7. Carefully inspect the I.D. of the gland (13) for sharp corners and burrs. Inspect the machined counterbore for the wiper ring (12) to make sure the area is free of scratches. The wiper ring must mate against a smooth, ground surface.
8. Check bushing (15 and 17) and mounting pins (27). Replace damaged, excessively worn or out-of-round bushings. Replace cracked or excessively scored or scratched pins. Refer to ”SPECIFICATIONS” in this section for dimension of new parts.
9. If bushing replacement in necessary, press in the new bushing see position 3, Fig. 10C.28 and so that the lubrication groove in the bushing (1) lines up with the lube fitting tapped hole (2).

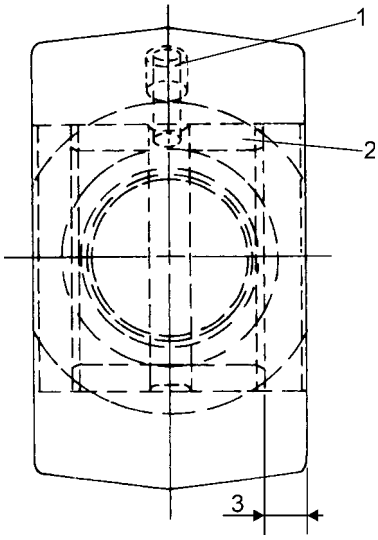


Fig. 10C.28. Bushing Replacement

1. Bushing
2. Tapped Hole
3. Dimension: 8.6 mm

23. REASSEMBLY (Refer to Fig.’s 10C.23 and 10C.24)

NOTE: *All parts should be coated with hydraulic oil before assembly EXCEPT the tapped holes in the gland (13) and the gland to cylinder cover bolts. Coat all O-rings, wear rings, wipers and seals with grease.*

1. Install the wiper ring (11) into the cylinder cover (1) with the lip facing the outside of the cover as shown in Fig. 10C.29. Press only on the metal portion of the seal during installation. Install the O-ring (18) onto the cylinder cover.
2. Slide the cylinder cover and the cord ring (2) onto the piston rod.
3. Sub-assemble the gland (13) by installing the O-ring (9), buffer ring (10), wear ring (19), O-ring (20), backup ring (21) and wiper ring (12) as shown in Fig. 10C.29. Be sure the lips of the backup ring and wiper ring point toward the wear ring.

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CYLINDERS

STEERING CYLINDERS

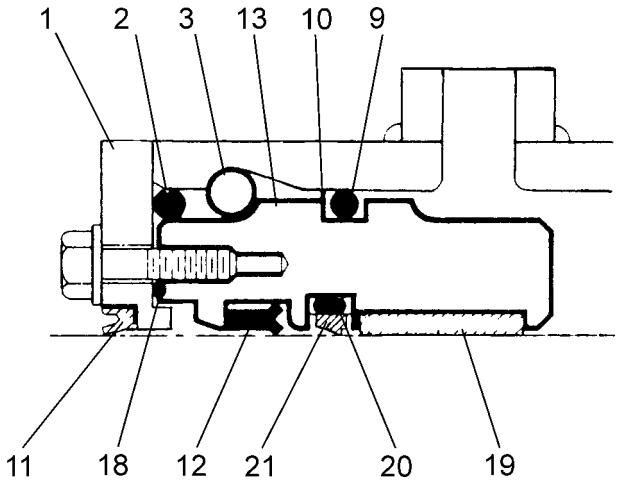


Fig. 10C.29. Installing the Gland Seals

1. Cylinder Cover
2. Cord Ring
3. Lock Ring
9. O-Ring
10. Buffer Ring
11. Wiper Ring
12. Wiper Ring
13. Gland
18. O-Ring
19. Wear Ring
20. O-Ring
21. Backup Ring

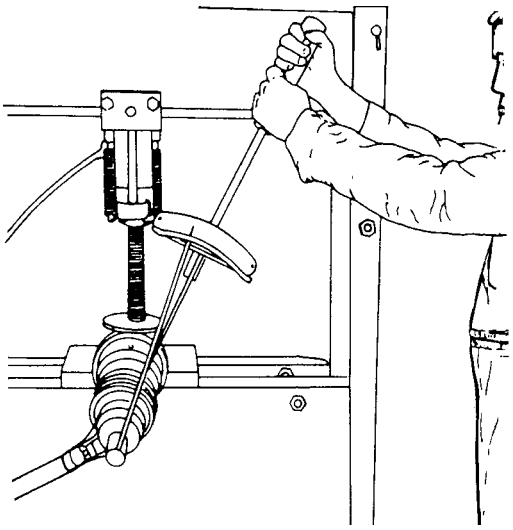


Fig. 10C.30. Torquing the Lock Nut

4. Install the gland (13) onto the piston rod with the tapped hole end of the gland toward the cylinder cover (1). Be sure the O-ring (18) is in place on the cover.
5. Install the piston seal (7) into the center groove of the piston (8).
6. Install the O-rings (6) at the outer ends of the wear ring grooves in both piston halves as shown in Fig. 10C.24. Install the wear rings (5) over the O-rings.
7. Install the piston onto the rod until it bottoms against the shoulder of the rod.
8. Install the lock nut (4), running it on the piston rod until the piston is snugly held. A suggested method of torquing this nut is with the aid of an X-4 geared head wrench to reduce the torquing effort (Fig. 10C.30). Torque the nut to 1625 ± 135 Nm.
9. Remove the piston rod assembly from the press or vise. Install a hoist sling through the piston rod eye. Place a rag or wiper around the sling where it passes through the eye to prevent damage to the bushing. Coat the piston and gland with hydraulic oil.

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STEERING CYLINDERS

10. Temporarily fasten the cylinder cover (1) to the gland (13) with three cover mounting bolts. Leave approximately 5 mm of space between the gland and the cover.
11. Stand and block the cylinder housing (16) in a vertical position. With the hoist, lower the piston rod assembly into the housing.
12. Rap on the three bolts in the cylinder cover to position the gland (13) into the cylinder housing.
13. Remove the three bolts. Pull the piston rod out of the housing to within 300 mm of its fully extended length. Pull the cylinder cover and cord ring (2) away from the housing.
14. Install the lock ring (3) by placing them, equally spaced, in the cylinder housing internal groove.
15. Allowing adequate space for the cylinder to extend, apply shop line air pressure to the base end of the cylinder. This will drive the piston end against the gland to fully seat the lock ring. Repeat this procedure twice more.
16. Position the cord ring (2) on the end of the gland (13). Be sure the O-ring (18) is in position on the cylinder cover.
17. Apply Loctite 262 to the threads of the cylinder cover bolts and install the bolts with washer. Tighten them evenly and torque to 45 Nm.
18. Again apply shop line air pressure to the base end of the cylinder with the piston rod positioned no more than 300 mm from full stroke. Recheck the torque on the cylinder cover bolts.
20. Install new wiper ring (25 and 26) on each side of the bushings (15 and 17) at both the rod end eye. The lips of the seal should be facing outward.

24. INSTALLATION

1. Using a suitable hoist and sling, place the steering cylinder in position on the machine, with the base end toward the front frame and the steering cylinder check valve port facing toward the inside of the machine.
2. Measure the distance between the top surfaces of the cylinder end and mounting bracket on the front frame. If the distance exceedes 1.5 mm add the same number of shims on both sides of the cylinder end.
3. Coat the base end mounting pin with chassis grease and install the pin the top downward. Install and tighten the pin lock bolt to 270 Nm.
4. Install the steering cylinder check valve to the steering cylinder housing.
5. Start the engine. Be sure the frame locking bar is installed. Turn the steering wheel to extend the cylinder until the rod eye line up with the mounting hole in the rear frame. A turn to the left will extend the R.H. cylinder and turn to the right will extend the L.H. cylinder.
6. Measure the distance between the top surfaces of the rod end and mounting bracket on the rear frame. If the distance exceedes 1.5 mm add the same number of shims on both sides of the rod end.
7. Coat the rod end mounting pin with chassis grease and install the pin from the top downward. Install and tighten the pin lock bolt to 270 Nm.
8. Connect the cylinder base end lubrication pipe.
9. Lubricate the rod end and the base end bushings through the lube fittings.
10. Remove the frame locking bar and articulate the machine several times to expel all air and to check the operation of the steering cylinders.
11. Check the oil level in the hydraulic reservoir and fill as necessary. Refer to the OPERATOR'S MANUAL for oil specifications and procedure.

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RESERVOIRS AND FILTERS

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RESERVOIR AND FILTERS

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1. DESCRIPTION (Refer to Fig. 10E.2)

The hydraulic reservoir is in the center of the bulkhead on the rear frame. It is a one piece welded assembly (13) with two return filter elements (7), two loader return surge valves (16), two vacuum/pressure relief valves (22), a drain valve (27), a sight gauge (14) and various ports on the bottom for suction and return lines.

2. OPERATION (Refer to Fig. 10E.2)

The reservoir acts as a storage tank for the majority of the steering and loader equipment hydraulic system oil. The remainder of oil fills the lines and system components.

The combination vacuum/pressure relief valve (22) is used to maintain a head of pressure in the reservoir. If the pressure in the reservoir rises above 200 kPa, the excess pressure will be bled off to the atmosphere. If the pressure falls below 2 kPa, the valve will function to allow air at atmospheric pressure to enter the reservoir.

Return oil from steering control valve flows to a steering return surge valve (4, Fig. 10E.5) at the bottom of the reservoir. The oil passes through the oil cooler, return filter elements (7) on the way to the reservoir. When the pressure of the return oil reaches a predetermined setting. The surge valve opens allowing steering return oil to flow directly into the reservoir. A hydraulic oil filter warming light switch located outside the reservoir at the loader control valve return port, senses restrictions in the return filter element and triggers a warning light on the cab instrument panel.

3. SPECIFICATIONS

Operating Pressures

Vacuum/pressure relief valves:
- Pressure (cracking) . . . . . 200 kPa
- Vacuum (cracking) . . . . . 0 - 2 kPa

Loader Return Surge Valves (cracking) . . . . . 125 ± 14 kPa
Steering Return Surge Valve . . . . . Refer to SECTION 10B

Spring Test Load Data

Loader Return Surge Valve Spring:
- No. Of Coils 7.5
- Free Length . . . . . 57.7 mm
- Test Length . . . . . 34.1 mm
- Test Load Pressure . . . . . 105 N

Steering Return Surge Valve Spring. . . . . Refer to SECTION 10B

Special Torques

Loader Return Surge Valve . . . . . 130 - 155 Nm
Return Filter Rod Retainer Nut. . . . . 14 - 16 Nm

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4. LOADER RETURN SURGE VALVE TEST (Refer to Fig. 10E.1)

1. With the valve out of the reservoir, connect an air pressure source equipped with a 500 kPa gauge to the inlet side of the valve.
2. Charge the valve and observe at what pressure the valve opens.
3. The valve should open at 125 ± 14 kPa. If the test result does not meet this specification, add or subtract shims (20) as necessary and retest the valve.

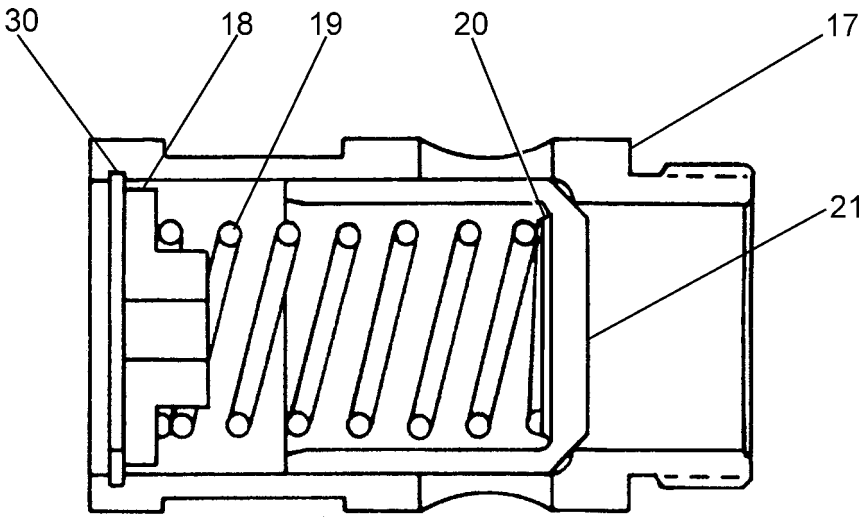


Fig. 10E.1. Sectional View of Loader Return Surge Valve

17. Housing
18. Spacer
19. Spring
20. Shim
21. Poppet
30. Retaining Ring

5. REMOVAL

WARNING! Refer to „Safety Precautions" in SECTION 10.

***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 reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
2. Disconnect the hydraulic lines from the bottom of the reservoir. Cap the reservoir ports to prevent entry of dirt.
3. Remove the electrical switch from the bottom of the reservoir.
4. Remove the reservoir cover panel from the bulkhead.
5. Remove the bolts securing the reservoir to the bulkhead. Remove the reservoir from the bulkhead.

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6. DISASSEMBLY (Refer to Fig. 10E.2)

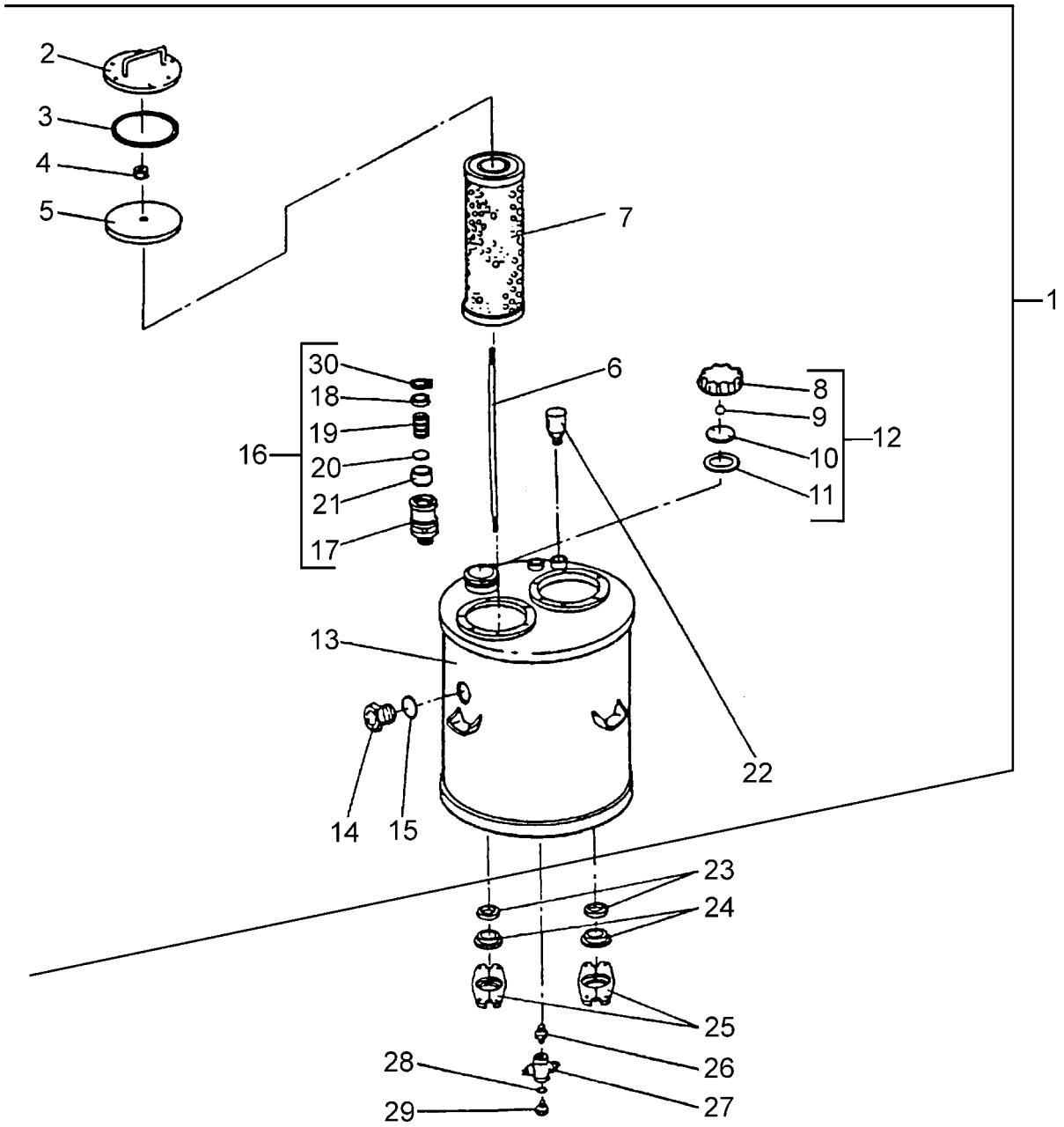


Fig. 10E.2. Exploded View of Hydraulic Reservoir

1. Reservoir
2. Cover
3. O-Ring
4. Retainer Nut
5. Filter Retainer
6. Filter Rod
7. Return Filter Element
8. Filler Cover
9. Ball
10. Plate
11. Gasket
12. Filler Cover Assembly
13. Reservoir Tank
14. Sight Gauge
15. O-Ring
16. Loader Return Surge Valve Assembly
17. Valve Housing
18. Spacer
19. Spring
20. Shim
21. Poppet Valve
22. Vacuum Pressure Relief Valve
23. Seal Ring
24. Plug (for machines without ground driven steering)
25. Split Flange
26. Connector
27. Drain Valve Assembly
28. O-Ring
29. Plug
30. Retaining Ring

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1. Remove both covers (2). Remove O-ring (3) from the covers.
2. Remove the retainer nut (4) and the filter retainer (5) from the top of both return filter elements (7). Remove the filter elements.
3. Remove the loader return surge valves (16). If necessary, disassembly the valve by removing the retainer ring (30), spacer (18), spring (19), shim (20) and poppet (21) from the housing (17).
4. Remove the vacuum pressure relief valves (22).
5. Vacuum Pressure Relief Valve (Bruning Co.):

   If necessary, disassemble the component parts of the vacuum pressure relief valve in the sequence indicated by the reference numbers in Fig. 10E.3.
6. Vacuum Pressure Relief Valve (Bendix Corp.):

   If necessary, disassemble the component parts of the vacuum pressure relief valve in the sequence indicated by the reference numbers in Fig. 10E.4.

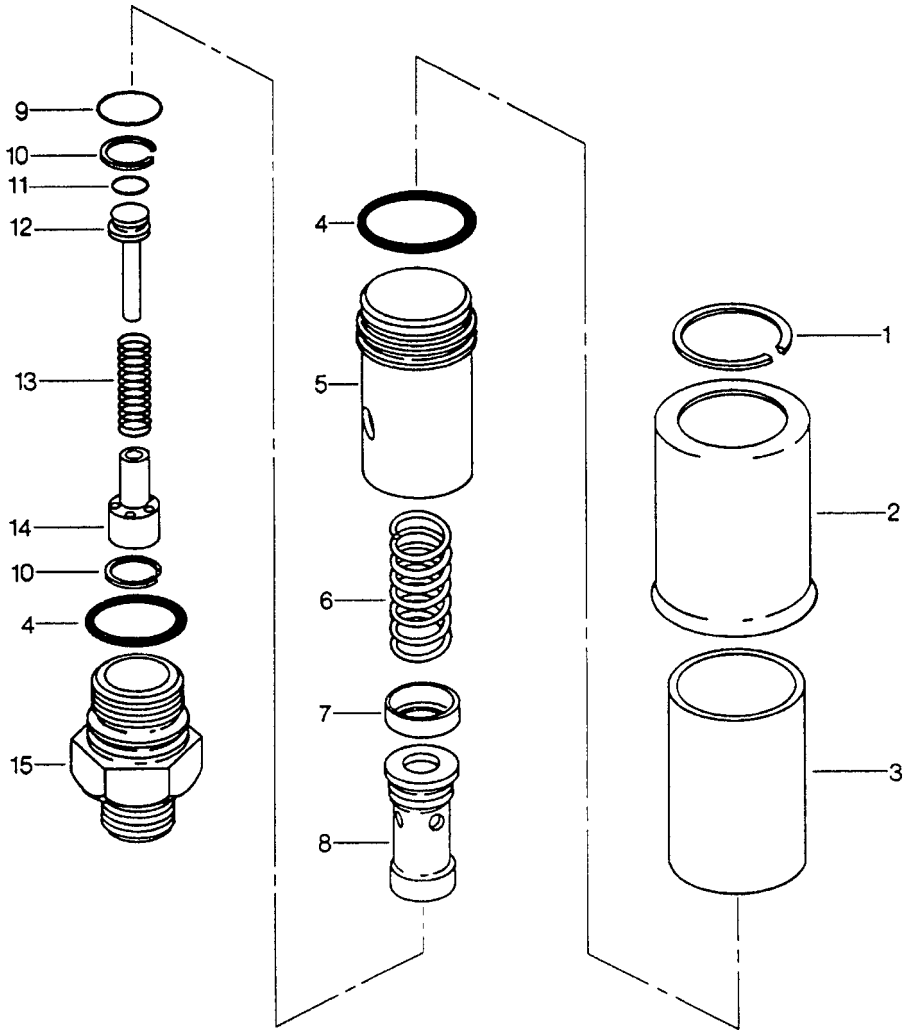


Fig. 10E.3. Sectional View of Vacuum Pressure Relief Valve (Bruning Co.)

1. Lock Ring	6. Spring	11. Poppet Seal
2. Cover	7. Retainer Ring	12. Poppet
3. Filter	8. Sleeve	13. Poppet Spring
4. Seal Ring	9. Sleeve Seal	14. Guide
5. Cap	10. Lock Ring	15. Housing

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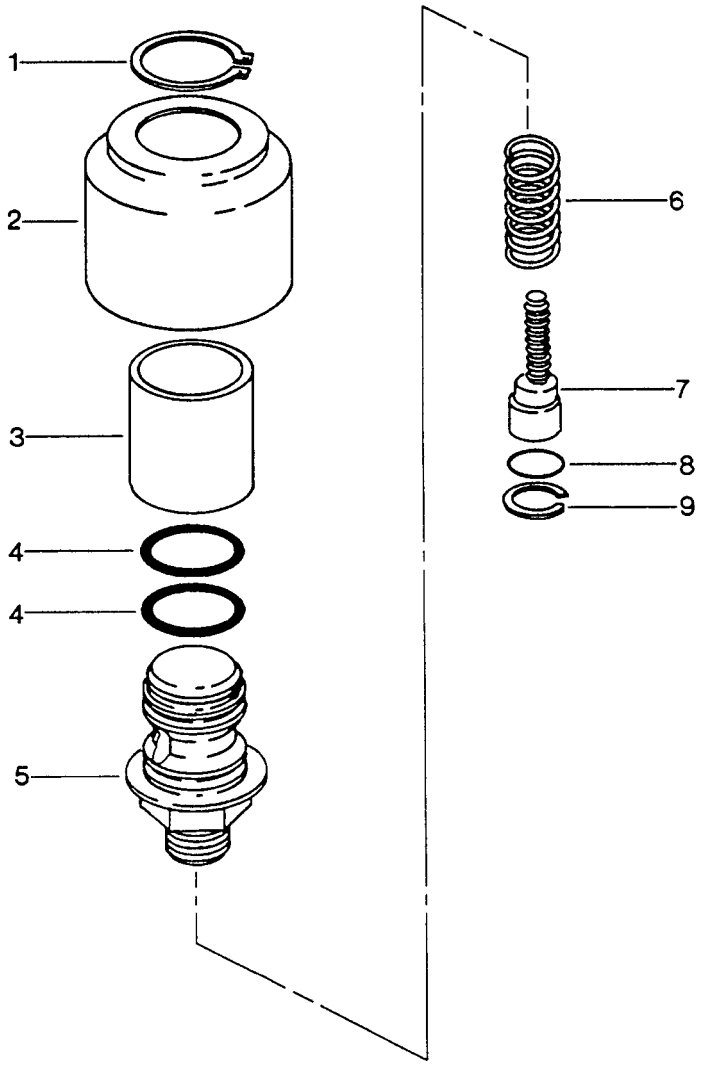


Fig. 10E.4. Sectional View of Vacuum Pressure Relief Valve (Bendix Corp.)

1. Retaining Ring
2. Cover
3. Filter
4. O-Ring
5. Valve Housing
6. Spring
7. Valve
8. O-Ring
9. Retaining Ring

7. INSPECTION AND REPAIR

1. Before cleaning the reservoir, inspect the residue left in the tank. Check for deposition of foreign particles that could indicate a component failure in the system.
2. Discard the return filter elements and replace with new.
3. Clean and dry all parts thoroughly. Clean the suction screens inside the reservoir by flushing with a commercial solvent and drying with compressed air.
4. Inspect the tank and all fittings for signs of wear or damage.
5. Be sure all parts move freely in the surge valves and the vacuum pressure relief valves. Clean or replace the relief valve filter element.
6. Check the spring for damage, distortion or weakness. Refer to ”SPECIFICATIONS”.

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8. REASSEMBLY (Refer to Fig. 10E.2)

1. Reassemble the component parts of the hydraulic reservoir in the reverse of disassembly.
2. After installing the loader return surge valves (16), apply a torque 130 - 155 Nm to the valve housing.
3. If the filter rod (6) was removed, apply Loctite to the threads only at the bottom end of the rod before installing.
4. Torque the filter rod retainer nut (4) to 14 - 16 Nm.

9. INSTALLATION

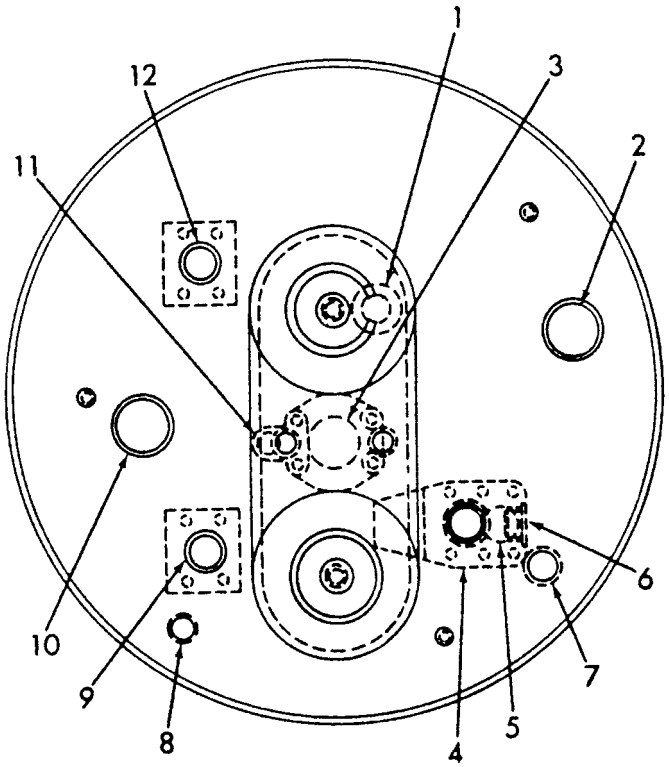


Fig. 10E.5. Hydraulic Reservoir Port Connections

1. Hydraulic Oil Cooler Return Port
2. Steering Switch Pump Suction Port
3. Loader Control Valve Return Port
4. Steering Return Surge Valve (If equipped)
5. Steering Valve Return Port in Surge Valve
6. Hydraulic Oil Cooler Supply Port in Surge Valve
7. Drain Valve Port
8. Pilot Valve Return Port
9. Ground Driven Steering Suction Port (If equipped)
10. Loader Pump Suction Port
11. Hydraulic Oil Filter Warming Light Switch
12. Ground Driven Steering Return Port (If equipped)

1. Position the hydraulic reservoir into the bulkhead with the sight gauge toward the front of the machine and visible through the cutout in the bulkhead.
2. Install and tighten the reservoir mounting hardware. Install the reservoir cover panel to the bulkhead
3. Connect all the hydraulic lines and the electrical switch to the bottom of the reservoir as shown in Fig. 10E.5.
4. Fill the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for this procedure.
5. Start the machine and test the operation of all the hydraulic components.

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POWER

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POWER

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1. DESCRIPTION

The machine 560C is powered by one of two type of Cummins engine.

First type KT-19 is a heavy duty, turbocharged diesel engine. This engine is a high speed, four cycle, four valve in head type, using a 24V direct starting system. The engine has PT type direct injection fuel system. For further information subject the engine refer to the Operation and Maintenance Manual KT19, KTA19, and KTTA19 Engine Series, Bulletin No. 3666013-02; Shop Manual K19 Engines Series, Bulletin No. 3810258 and Troubleshooting K19 Series Engines, Bulletin No. 3810307-00

Second type QSK 19 is a heavy duty, turbocharged, aftercooled diesel engine. This engine is a high speed, four cycle, four valve in head type, using a 24V direct starting system. The engine is equipped with electronic control QUANTUM^{TM} direct injection fuel system, designed to optimize engine control and reduce exhaust emissions. QUANTUM^{TM} fuel system monitors critical engine temperature, fluid level, intake manifold pressure, oil pressure, fuel rail pressure, and will log diagnostic faults when an over or under normal operating range condition occurs, For further information subject the engine refer to the Operation and Maintenance Manual QUANTUM^{TM}, QSK19 Series Engines, Bulletin No. 3666120-01, and Troubleshooting and Repair Manual QSK 19 Series Engines, Bulletin No. 3666098-00

2. SPECIFICATIONS

Special Bolt and Nut Torque Data

Air cleaner hose clamps . . . . . 11 Nm

Air precleaner mounting clamp . . . . . 14 - 20 Nm

Alternator terminals (1/4-28 UNF-2A) . . . . . 6 - 8 Nm

Battery terminals . . . . . 28 - 34 Nm

Cranking motor:

- No. 10-32 terminal . . . . . 1.8 - 3.4 Nm
- 1/2-13 terminal . . . . . 27 - 34 Nm

Rear mounting support bolts to mounting plate . . . . . 270 - 330 Nm

Mounting plate to frame . . . . . 200 - 240 Nm

Front support mounting bolts to flywheel housing . . . . . 200 - 240 Nm

Front rear mounting support bolts to frame . . . . . 850 - 1030 Nm

Gear ring to flywheel . . . . . 75 - 90 Nm

Exhaust muffler clamps . . . . . 32 Nm

Torque converter to flywheel housing bolts . . . . . 100 - 120 Nm

Conditioner compressor to bracket . . . . . 50 - 60 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. SERVICE DIAGNOSIS

NOTE: *When an operator complaint is made that the machine is slow, verify if the problem is in just one area or is in overall performance problem. If the engine is at fault, system will be affected. If the machine digs and loads but has no power for travel or if all systems work except for poor bucket operation, it is more likely that a hydraulic problem exists instead of an engine problem. It is recommended that the service diagnosis in Section 7B „TORQUE CONVERTER" be reviewed to aid in isolation the cause of the problem.*

K19 engine diagnosis.

COMPLAINT	
PROBABLE CAUSE	REMARKS
Engine Will Not Crank or Crank Slowly	
1. Incorrect oil for operating in low temperature condition.	Change oil and filters. Use type recommended. (Refer to Operator's Manual).
2. Oil temperature too low.	Install oil panel heater or drain oil and refill with heated oil. (Contact with Machine Manufacturer).
3. Battery or ground connections broken, corroded or loose.	Check for damage. Clean and tighten if necessary.
4. Battery charge low.	Check electrolyte level and specific gravity. Recharge or replace batteries. (Refer to Operator's Manual).
5. Starter pinion or ring gear damage.	Remove starter. Check for damage. (Refer to Troubleshooting and Repair Manual K19 Engines).
6. Hydraulic lock in cylinder.	Check intake or exhaust valve operation. (Refer to Troubleshooting and Repair Manual K19 Engines).
7. Internal engine damage.	Use oil analysis and inspect filters to locate area of probable damage. (Refer to Troubleshooting and Repair Manual K19 Engines).
Engine Will not Start (No smoke from exhaust)	
1. No fuel in tank.	Fill the fuel tank.
2. Shut-off valve closed.	Use manual override. Replace or repair electrical problem. (Refer to Troubleshooting and Repair Manual K19 Engines).
3. Fuel connection loose or suction side of pump.	Tighten all fuel fittings and connections from fuel tank to fuel pump.
4. Fuel filter or suction line plugged.	Replace fuel filters. Check restriction in suction line. (Refer to Troubleshooting and Repair Manual K19 Engines).
5. Fuel pump malfunction.	Replace fuel pump .(Refer to Troubleshooting and Repair Manual K19 Engines).
Loss of Power	
1. Machine brakes dragging.	Check the operation of the parking and service brakes. Refer to SECTION 4, BRAKES .
2. Engine malfunction.	Contact you nearest Cummins Authorized Service for a full engine diagnostic check.

NOTE: *Loss of power in only one direction or speed range indicates a transmission problem.*

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QSK19 engine diagnostics.

Operation of the engine and his subsystems parameters (temperatures, pressures, coolant and oil levels) are monitored by a system of sensors. If value of any parameter is exceeded, a signal of malfunction will be recorded in memory of Electronic Control Module (ECM) and shown on operator's panel. There are three lamps on the panel which can light in certain combinations. They are codes of malfunction specified in Operation and Maintenance Manual QSK 19 Series Engines. To follow diagnosis of engine electronic control system, and remove recorded fault codes (after the engine is repaired) from the memory, use electronic tools is required. They could be Laptop or Desk Computer and data link adapter. That is maintained by a Cummins Authorized Service.

Each failure of the engine electronic control system that occurs must be repaired by a Cummins Authorized Service only.

4. AIR INTAKE SYSTEM TEST

WARNING! Be sure the bucket is lowered on the ground and turn master switch in "OFF" position and take key out from master switch and starting switch to prevent accidental starting.

1. Remove the end cover from the air cleaner.
2. Remove both filter elements from the air cleaner. Using duct tape, mask the entire perforated metal outside diameter of the safety (small) element. Sealing must be air tight. Reinstall the tapped element only and cover.
3. Tee in a 0 to 100 kPa pressure gauge to the air cleaner restriction indicator tube (1, Fig. 12.1) at the air cleaner.
4. Remove plug (2, Fig. 12.1) or nozzle of ether injector (if equipped) from the intake manifold. Connect a manually regulated compressed air supply.
5. Adjust the air regulator until the pressure gauge reads 20 kPa. If pressure cannot be achieved, it may be necessary to turn the engine crankshaft over slightly until a minimal leakage occurs past the engine valves.
6. Using a soap solution and a paint brush, coat the following areas and check for leaks (see Fig. 12.1):
   a. Air cleaner body surfaces around the outlet pipe connections.
   b. Air cleaner restriction indicator tube connection (1, Fig 12.1) to air cleaner.
   c. All clamped hose (3, Fig. 12.1) connections between air cleaner outlet, intake manifold (aftercooler QSK 19) including connections at turbocharger.
   d. Surface of all air induction piping between the air cleaner, the air intake manifold (aftercooler QSK 19) including manifold gasket area.
7. No leakage is permitted between the air cleaner and suction side of the turbocharger. If leakage at the joints is detected, tighten hose clamps. If leakage still persists, remove the parts to determine cause. Replace parts as necessary and retest.
8. Remove the filter elements and remove the duct tape. Inspect the seals for damage. Reinstall both elements and the end cover.

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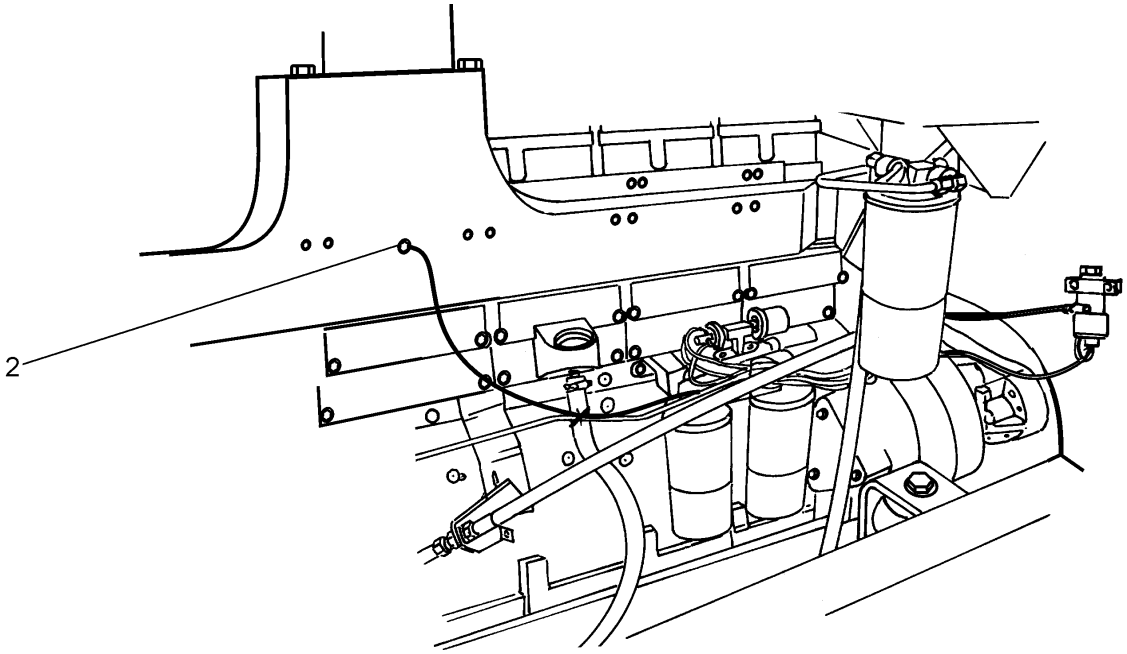


Fig. 12.1. Air Pressure Connecting Point (K 19 Engine)

2. Nozzle Ether Injector

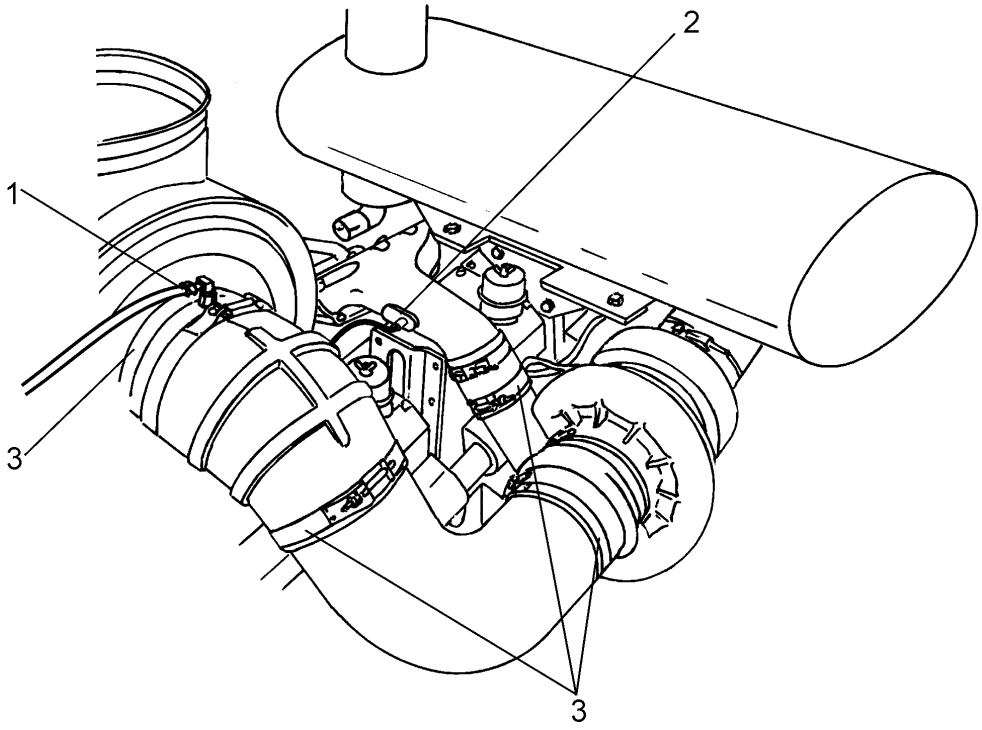


Fig. 12.1. Air Intake System Check Points (QSK 19 Engine)

1. Restriction Indicator Tube
2. Nozzle Ether Injector
3. Clamped Hose

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5. ENGINE 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 bucket is lowered, transmission shift lever is locked in neutral (N) position, the parking brake applied and the frames are locked together.

Accelerator Pedal Linkage Adjustment (KT19 engine)

NOTE: *Engine accelerator pedal must be adjusted correctly before checking operation of other systems.*

Before performing the adjustments, remove all dirt accumulated from the control linkage.
After adjustment has been performed, machine must be checked out in actual operation for proper functioning.

WARNING! For you personal protection never perform any adjustments with engine running. Always have another trained operator helping in the operator's compartment when adjustments must be done with the engine running.

WARNING! When removing or installing the measuring equipment, or measuring engine speed, be careful not to touch any high temperature parts or rotating parts.

1. Open the right access door.
2. Check that fuel pump lever (7, Fig. 12.3), overriding spring (1) and linkage return spring (2) are in position and are functional. Check the return spring for damage, distortion or weakness.

Engine Not Running (Refer to Fig. 12.3)

1. Adjust the pedal (8) height so that the position at low idle is 37 degrees above floorboard (9), (measured from the top of the pedal). This is accomplished by disconnecting the rod end (10) at the pedal and turning it in or out on the rod (12) until it can be reconnected to the pedal at the prescribed height.

NOTE: *If necessary, additional adjustment can be obtained by using the same procedure at the other end of the rod (11) by working from under the floorboard. Once the correct height is obtained, be sure jam nuts (11 and 13) are tightened.*

2. Adjust the pedal stop (14) so that the pedal travels a total of 25 degrees from the low idle position (measured from the top of the pedal) before contacting the stop. Loosen the stop jam nut on either side of the pedal stop (14) to allow the stop to be adjusted to rest against the pedal in this position, then tighten the jam nut against the floor board.

3. Remove the return spring (2).

4. Disconnect the cable rod (4) at the fuel pump lever (7).

5. Check the fuel pump lever position is adjusted properly (Refer to Fig. 12.3)

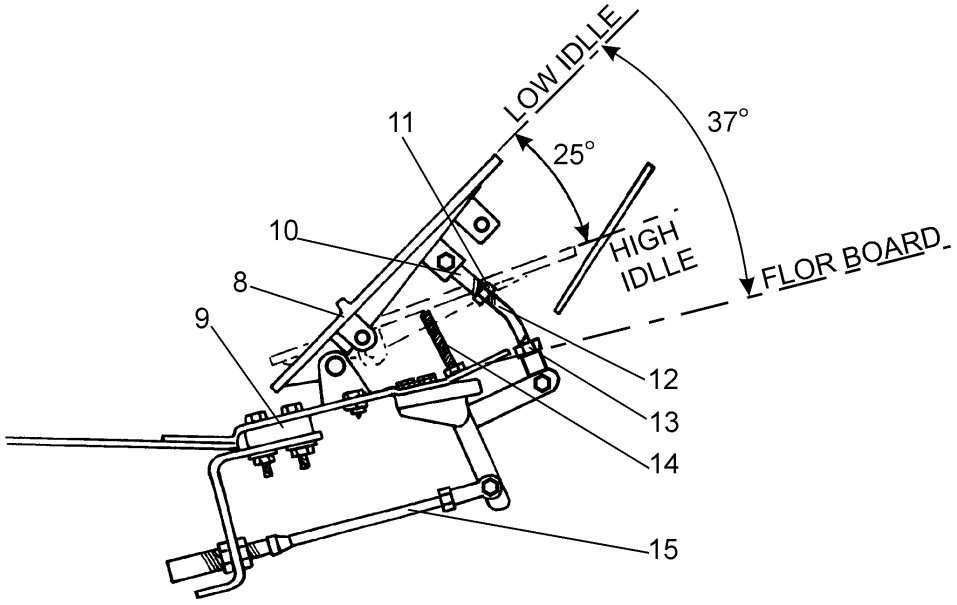
6. With accelerator pedal fully released adjust the linkage rod end (5) to aligned with fuel pump lever hole. Install bolt.

7. Connect the linkage return spring (2).

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NOTE: *If necessary, additional adjustment can be obtained by using the same procedure at the bellcrank end of the cable rod located under the floorboard.*

8. With accelerator pedal fully depressed against the pedal stop, check the so the fuel pump lever (7) is to travel its full stroke of 23.5 degrees.



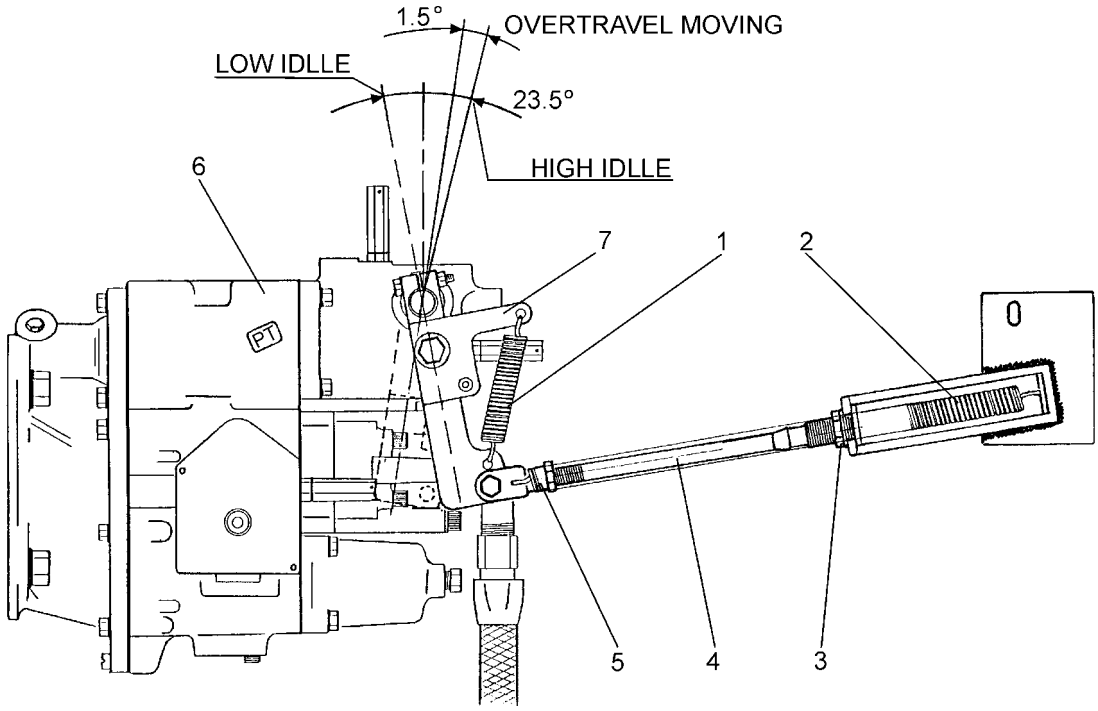


Fig. 12.3 Engine Linkage Adjustment Points

1. Override spring
2. Linkage return spring
3. Jam nut
4. Cable rod
5. Rod end
6. Fuel pump
7. Fuel pump lever
8. Accelerator pedal
9. Floorboard
10. Rod end
11. Jam nut
12. Rod
13. Jam nut
14. Pedal stop
15. Linkage

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Engine Running

1. With accelerator pedal fully released check to make sure engine is running at designated low idle speed (675 - 775 RPM).
2. With accelerator pedal fully depressed position, check to make sure engine is running at designated high idle speed (2200 - 2350 RPM).
3. If designated speed are not within specification, readjust the linkage as necessary.

Accelerator Pedal (QSK19 engine)

General

The QSK 19 engine is controlled by the APS (Accelerator Position Sensor) mounted in the accelerator pedal, connected by wire harness to the ECM (Electronic Control Module).
The APS sends a signal determines the desired engine speed to the engine control system, when the operator pushes on the accelerator pedal.
The accelerator pedal not required any mechanical adjusting. In case malfunction the fault code (431 or 432) will be recorded in ECM memory (see Operators Manual fault codes reading).

Accelerator Position Sensor (APS) Resistance Check (Refer Fig. 12.4)

NOTE: *When making engine test connection, the starting switch MUST be in „OFF" position and all test points MUST be teed into, leaving all engine sensors properly installed in their respective ports and electronically connected to the ECM. If any sensors are disconnected during engine operation, a fault code will result. This fault code will derate the engine AND will require resetting the ECM by a Cummins Authorized Service.*

1. Disconnect 3-pin connectors from harness under operator's cab: Throttle Position Sensor (TPS) (1), and Idle Validation Switch (IVS) (2).

2. Inspect if the harness connectors are not damaged.

3. Use the typical ohmmeter to measure the resistance between wires :

TPS connector:

A and C - pedal depressed or released	2000 - 3000 Ω
B and C - pedal released	1500 - 3000 Ω
B and C - pedal depressed	200 - 1500 Ω
A to the metal part of pedal assembly	100 kΩ or more
B to the metal part of pedal assembly	100 kΩ or more
C to the metal part of pedal assembly	100 kΩ or more

IVS connector:

C and A - pedal depressed	125 Ω or less
B and A - pedal released	125 Ω or less
B and C - pedal depressed or released	100 kΩ or more
A and B - pedal depressed	100 kΩ or more
A and C pedal released	100 kΩ or more
Foot pedal operating range (standard value)	released 45 degree depressed 17 degree

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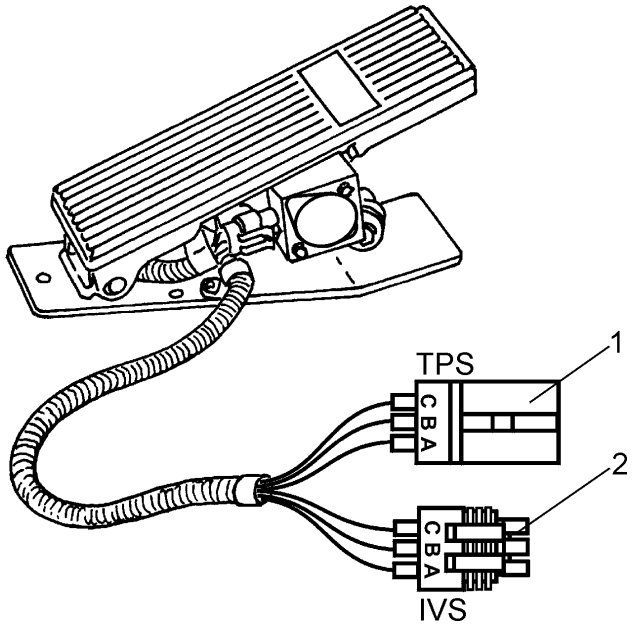


Fig. 12.3. Accelerator Pedal

1.TPS Connector	2. IVS Connector
A. Throttle Position Return Wire (white)	A. Idle Validation Switch Return Wire (orange)
B. Throttle Position Signal Wire (black)	B. IVS OFF Idle Signal Wire (blue)
C. Throttle Position Supply Wire (red)	C. IVS OFF Idle Signal Wire (green)

4. If the resistance values are not within the specification the throttle position sensor has failed. Replace the throttle position sensor.

IMPORTANT: *Use only Cummins recommended lubricant DS-ES. Other lubricants, such as lubricating oil or grease, in the connectors can cause Electronic Control Module (ECM) damage, poor engine performance, or premature connector pin wear.*

5. Before reconnect connectors (1 and 2, Fig. 12.3), use quick-dry electrical connectors cleaner to remove all dirt and moisture from the connectors ports and the harness connectors. Apply a small amount of lubricant (DS-ES) to the connector terminals. Do not fill the entire connector cavity with lubricant.

NOTE: *If the throttle or throttle position sensor is changed or after calibration download cycle the throttle pedal (key switch in „ON" position) through its complete travel 3 times. This procedure calibrates the new throttle with the ECM.*

6. If designated speed (see Engine Running, par 1 and 2 above) are not within specification contact with nearest Cummins Authorized Service.

6. REMOVAL

NOTE: *The dismounting and mounting procedures described below are the same for both version of the machines i. e. equipped with KT 19 or QSK19 engines. However, there are some additional notes referring to QSK 19 engines only. They are noted* „MACHINE POWERED BY QSK 19 ENGINE".

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

1. Position the machine in a place which makes it possible to use a crane for lifting of disassembled assemblies. Lock the frames.
2. Turn the electrical master switch to the "OFF" position.

WARNING! Be sure the bucket is lowered on the ground and turn master switch in "OFF" position and take key out from master switch and starting switch to prevent accidental starting.

NOTE: *Special tools are required to remove the engine. Refer to „SERVICE /SPECIAL TOOLS" in Section 1 INTRODUCTION.*

3. Drain the oil from the crankcase. The drain point is located on the right side of the rear frame. Refer to operator‘s Manual.
4. Drain the coolant from the cooling system. The drain point is located on the left side of the rear frame (1, Fig. 12.4). Refer to OPERATOR'S MANUAL.
5. Remove the left and right fenders (2, Fig. 12.4) top elements.
6. Unlock and swing open the access door (3, Fig. 12.4) and remove the access panel (4) on both sides of the engine.
7. Remove mounting hardware securing the side hood (5, Fig. 12.4) on each side of the engine. Swing the doors out of the way.

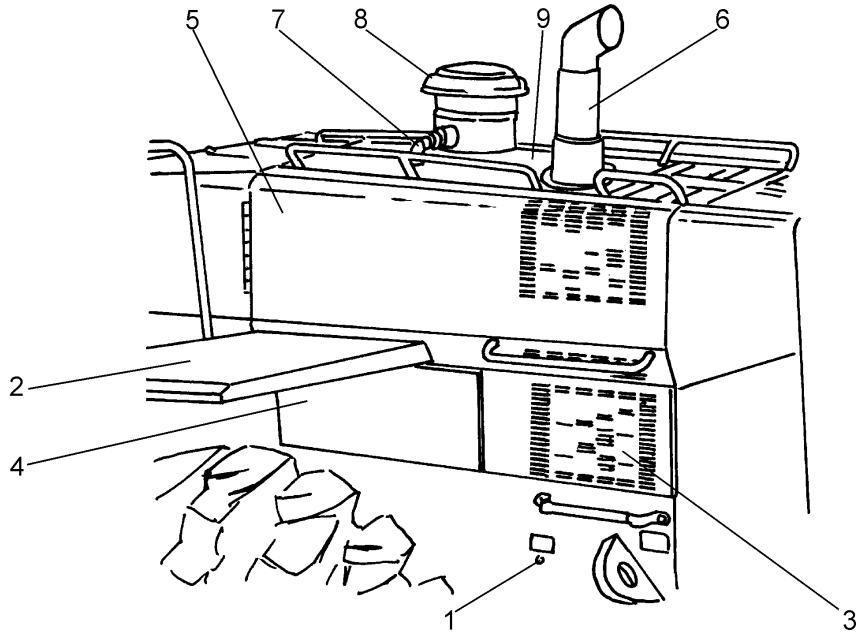


Fig. 12.4. Hood and Side Panels

1. Coolant Drain Point
2. Fender Top Element
3. Access Door
4. Access Panel
5. Side Hood
6. Exhaust Pipe
7. Aspirator Tube
8. Pre-cleaner
9. Center Hood

8. Remove the exhaust pipe (6, Fig. 12.4).
9. Loosen the hose clamps securing the aspirator tube (7, Fig. 12.4) to the muffler and to the precleaner (8). Remove the aspirator tube.

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10. Remove the air pre-cleaner (8, Fig. 12.4).
11. Remove the center hood (9, Fig. 12.4).
12. Disconnect the air cleaner filter indicator tube (1, Fig 12.5) at the air cleaner.
13. Loosen the clamp (2, Fig. 12.5) securing the air cleaner tube to the turbocharger. Remove the mounting hardware securing the air cleaner (3) to the mounting bracket. Remove the air cleaner wit tube (4) attached.
14. Loosen the clamp securing the tube (5, Fig. 12.5) to the turbocharger. Remove the mounting hardware securing the muffler to support brackets (6) each sides. Remove the muffler (7).

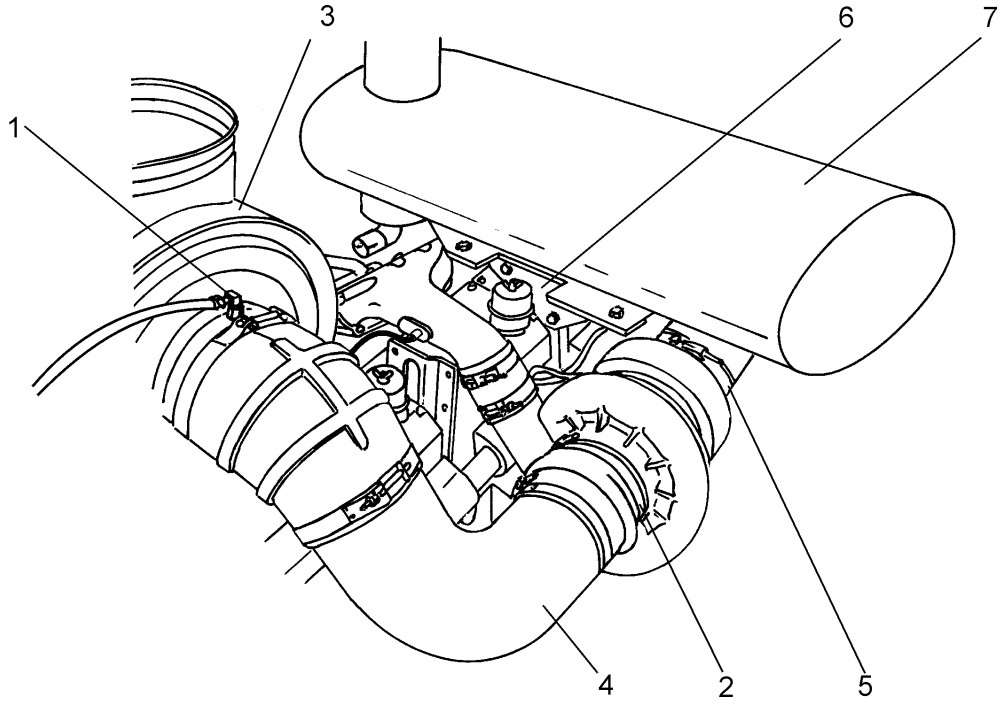


Fig. 12.5. Air Cleaner and Muffler Disassembly Points

1. Indicator Tube
2. Clamp
3. Air Cleaner
4. Tube
5. Clamp
6. Support Bracket
7. Muffler

15. MACHINE POWERED BY QSK 19 ENGINE: Remove the mounting hardware securing muffler brackets (6, Fig.12.5). Remove the muffler brackets.
16. Remove the steering oil cooler and the radiator as described in Section 6, „COOLING" with the following exceptions:

    a. Disconnect the aeriation hose at the engine instead of the radiator upper tank.

    b. Free both halves of the fan shroud from the guard shroud and remove them out the top. The steering oil cooler can remain attached to the radiator for removal.

    c. If the proper lifting equipment is available, the steering oil cooler can remain attached to the radiator for removal

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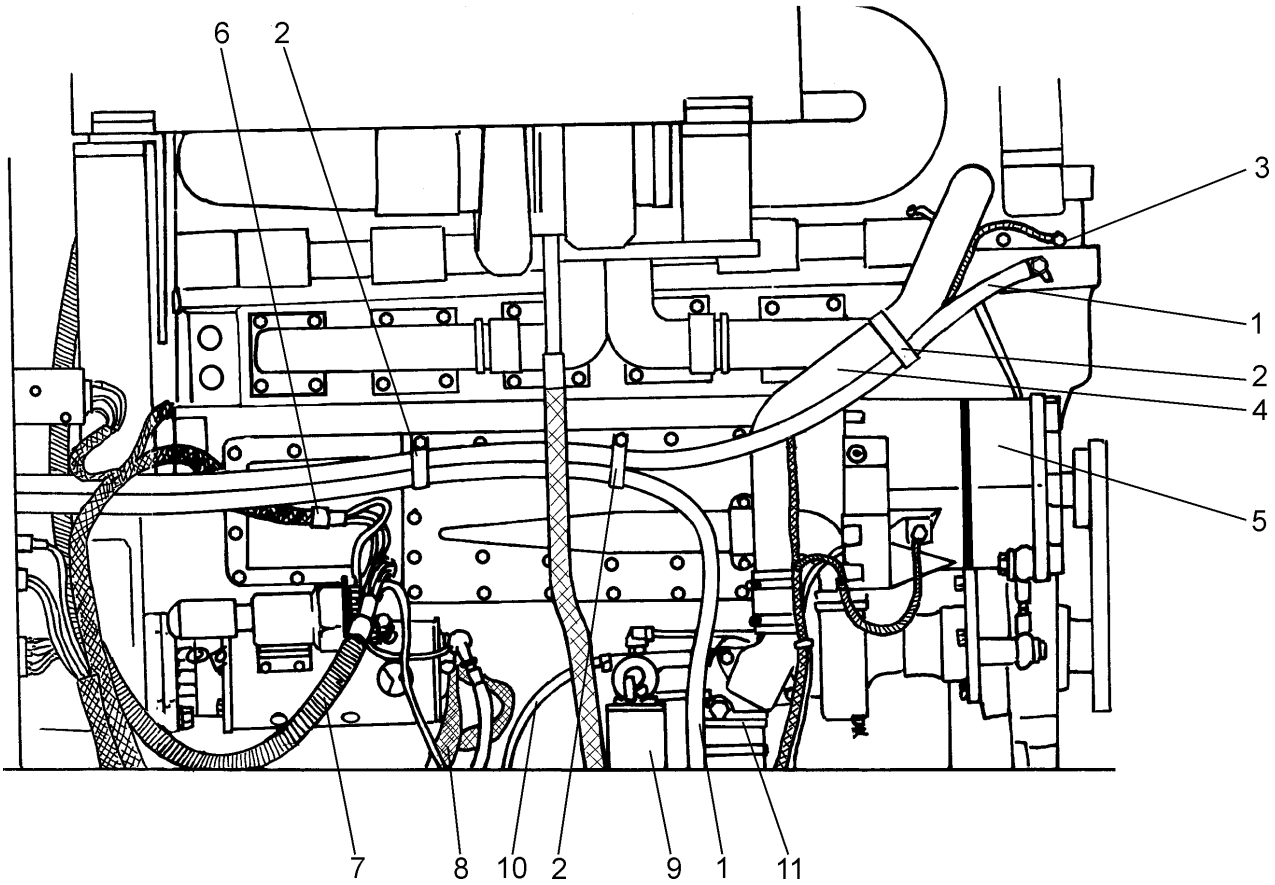


Fig. 12.6. Engine Disconnecting Points

1. Heater hoses
2. Hose Clamps
3. Coolant Temperature Sensor
4. Coolant Tube
5. Alternator
6. Wiring
7. Battery Cable
8. Ground Strap
9. Coolant Filter
10. Oil Cooler Vent Hose
11. Coolant Elbow

17. MACHINE EQUIPPED WITH CAB HEATER: Disconnect the heater hoses (1, Fig. 12.6) from the shut-off valves. Free the hoses from the hose clamps (2) on the engine and move the hoses to the front of the machine out of the way.

18. Disconnect the electrical harness and move the harness into the left side of the machine so it is out of the way at the following engine locations:

    a. Disconnect the wires at the engine coolant temperature sensor (3, Fig. 12.6) and switch at the thermostat housing.

    b. Remove the tie straps securing the harness to the coolant tube (4, Fig. 12.6).

    c. Disconnect the wiring at the alternator (5, Fig. 12.6).

    d. Disconnect the wiring (6, Fig. 12.6) at the cranking motor solenoid.

    e. Disconnect the battery cable (7, Fig. 12.6) at the cranking motor solenoid. Disconnect the ground strap (8) at the cranking motor.

    f. MACHINE WITH TACHOMETER: Disconnect wire at the tachometer pick-up (1, Fig. 12.7).

    g. Disconnect the wire (1, Fig. 12.8) at the ether start valve coil (2).

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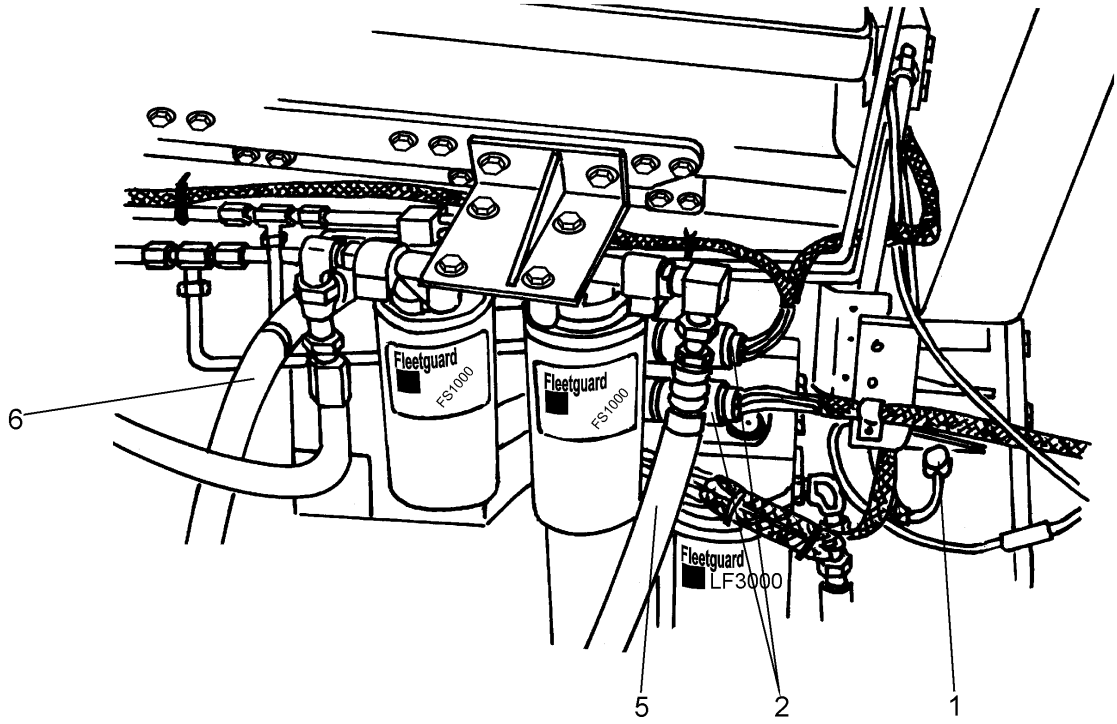


Fig. 12.7. Engine Disconnecting Point

1. Tachometer Wire
2. Interface Connectors
5. Fuel Supply Hose
6. Fuel Return Hose

h. Disconnect the wiring at the engine oil pressure switch (3, Fig. 12.8) and sensor (4) at the oil filter head.

i. Disconnect the wire at the fuel pump solenoid valve (1, Fig. 12.9).

j. MACHINE WITH AIR CONDITIONER: Disconnect the conditioner compressor clutch wiring. Remove the conditioner compressor with attached hoses from the engine and secure it out of the way.

k. MACHINE POWERED BY QSK 19 ENGINE: Disconnect two interface connectors (2, Fig. 12.7)

NOTE: *Disconnected interface connectors must bee protected from dirt and water.*

19. Unscrew the coolant filter (9, Fig. 12.6). Loosen the clamp and free oil cooler vent hose (10) from the engine coolant pump housing.
20. Remove the hardware securing the coolant pump elbow (11, Fig. 12.6) (engine component) to the bottom of the water pump. This will allow the transmission oil cooler to remain mounted to the frame.
21. Remove the accelerator pedal linkage return spring (2, Fig. 12.9). Free the accelerator cable (3) from the bracket (4) and disconnect the cable from the fuel pump lever (5). Free the clamps securing the cable to the bracket at the engine and pull the cable forward out of the way.
22. Disconnect the ether start valve tube at the ether start valve (2, Fig. 12.8) and at the engine.
23. Disconnect the fuel supply hose (6, Fig. 12.9) (5, Fig. 12.7 QSK 19 engine) from the fuel pump.
24. Disassemble the hardware securing the oil filler tube (9, Fig. 12.9) to the frame.

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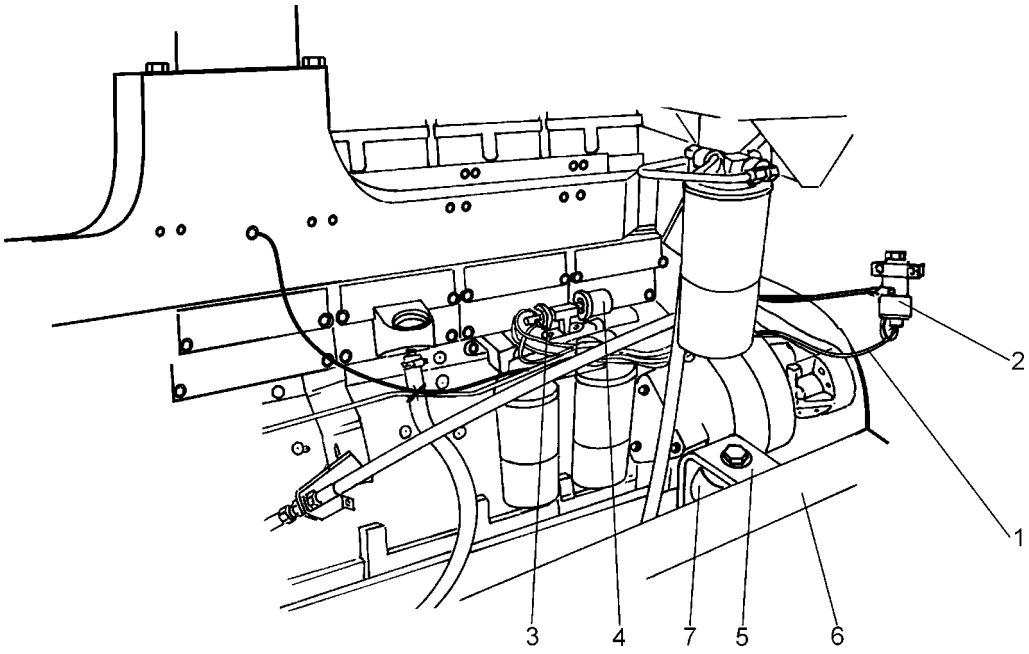


Fig. 12.8. Engine Disconnecting Points

1. Ether Valve Solenoid Wire
2. Ether Start Valve
3. Engine Oil Pressure Switch
4. Engine Oil Pressure Sensor
5. Engine Front Support
6. Frame
7. Rubber Shock Mounts

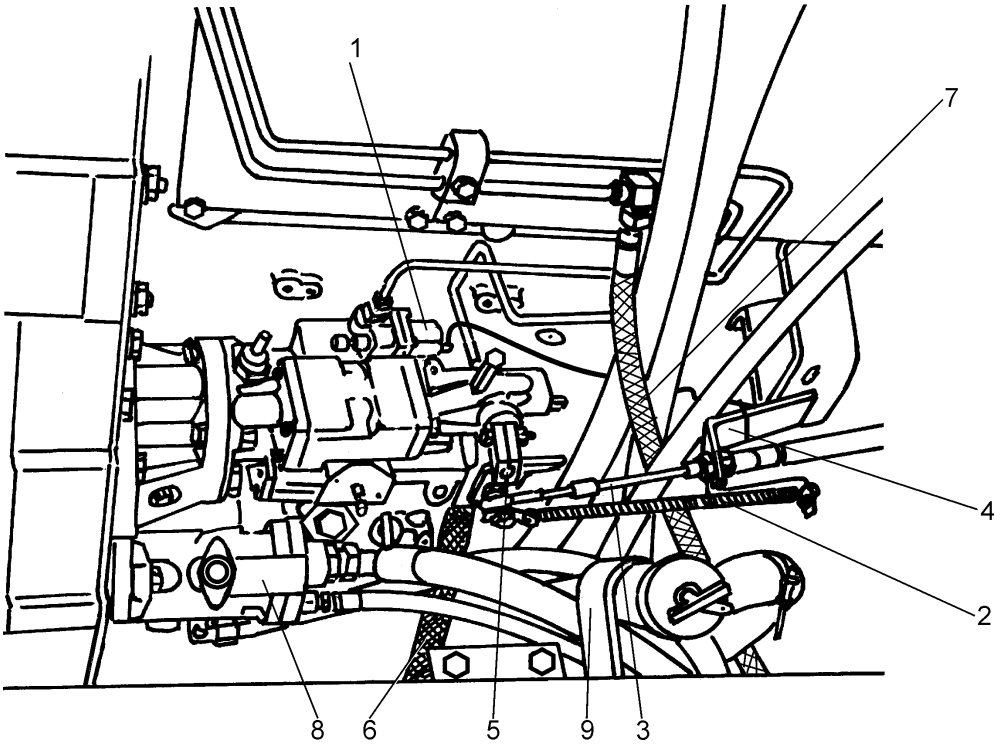


Fig. 12.9. Engine Disconnecting Points

1. Solenoid Valve
2. Pedal Linkage Spring
3. Accelerator Cable
4. Bracket
5. Fuel Pump Lever
6. Supply Hose
7. Fuel Return Hose
8. Brake Charge Pump
9. Oil Filler Tube Hardware

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25. Disconnect the fuel tank return hose (7, Fig. 12.9) (6, Fig. 12.7 QSK 19 engine) from the engine.
26. Remove the fuel tank pipe and breather to provide clearance for engine removal.
27. Unscrew the bolt securing the brake charge pump (8, Fig. 12. 9) to the engine. Remove the pump with attached hoses, and take it out of frame.
28. Loosen the clamp securing the engine oil drain hose (1, Fig.12.12) to the engine and pull the hose free.

IMPORTANT: *To prevent the loss of an excess amount of transmission oil, have a 1-7/8 inch cap ready to install on the hose connection on the transmission housing.*

29. Drain the transmission below oil check level point, refer to OPPERATOR'S MANUAL. Disconnect the engine flywheel housing drain hose (1, Fig. 12.10) at the transmission (2) and cap the fitting. Free this hose from the clamp securing it to the rear frame near the drive shaft (3) to allow the hose to come off with the engine.

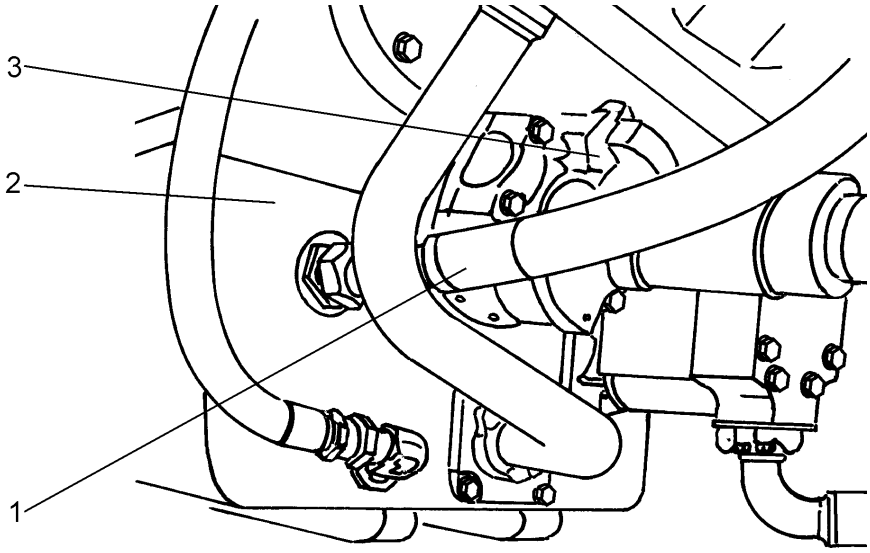


Fig. 12.10. Transmission Disconnecting Point

1. Drain Hose 2.Transmission 3. Drive Shaft

30. Drain the hydraulic reservoir. Refer to the OPERATOR'S MANUAL.
31. Proceed as follows for removing torque converter lower mounting bolts:

    Unscrew the tube (1, Fig 12.11) from the manifold (3). Remove the pipes (2 and 4) from the manifold (3). If equipped sound absorbing lining (5), remove the snap fasteners (6) and pull back lining. Unscrew the lower mounting bolts.

32. Support the torque converter assembly in the rear frame by wooden elements. Remove the hardware securing the torque converter housing to the flywheel housing.
33. Remove the hardware securing the engine front support (5, Fig. 12.8) to the rear frame (6) on both sides of the engine. After the engine is removed from the rear frame, the front supports will have to be removed from the engine flywheel housing.
34. Remove the bolts (3, Fig. 12.13) securing the engine support (1) to the mounting plate (2). The rear mounting plate is secured to the rear frame (5) and does not have to be removed.

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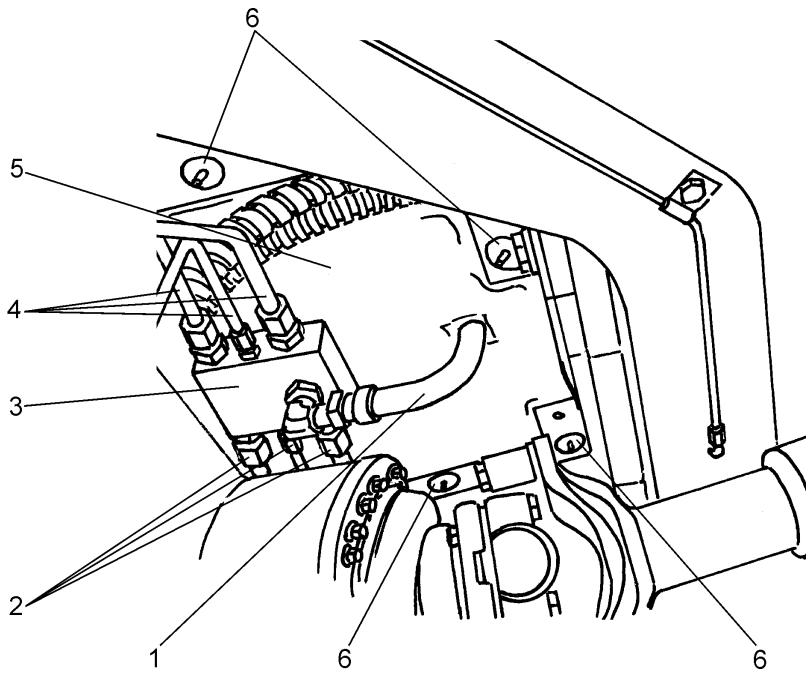


Fig. 12.11 Disconnecting Points (Bottom View)

1. Tube
2. Pipes
3. Manifold
4. Pipes
5. Sound Absorbing Lining
6. Snap Fasteners

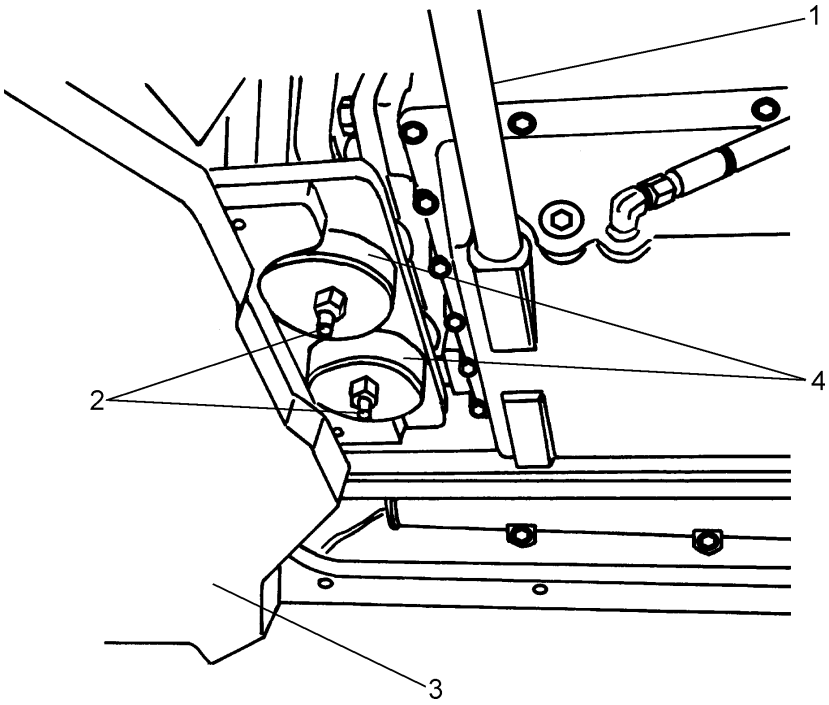


Fig. 12.12. Engine Rear Support (Bottom View)

1. Oil Drain Hose
2. Mounting Bolts
3. Rear Frame
4. Rubber Shock Mounts

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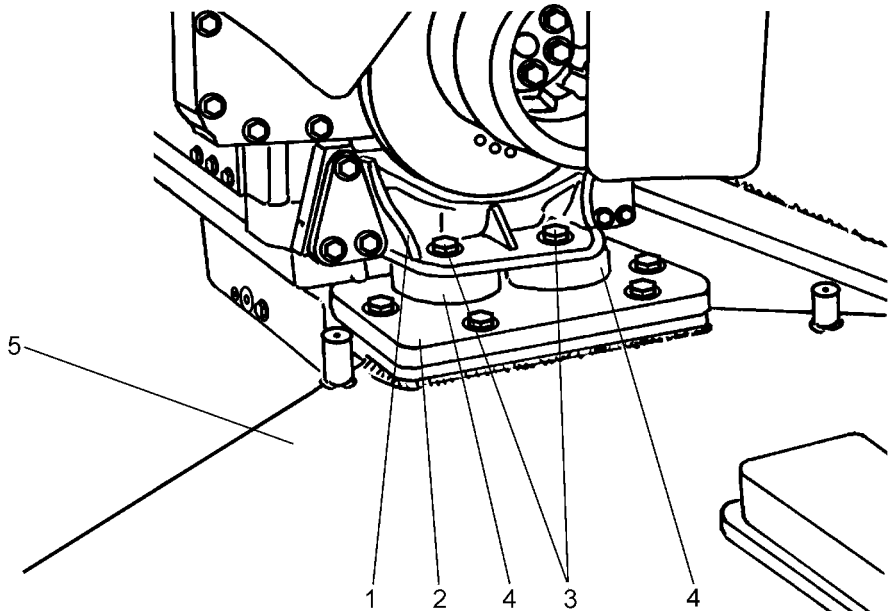


Fig. 12.13. Engine Rear Support (Top View)

1. Engine Front Support
2. Mounting Plate
3. Mounting Bolts
4. Rubber Shock Mounts
5. Rear Frame

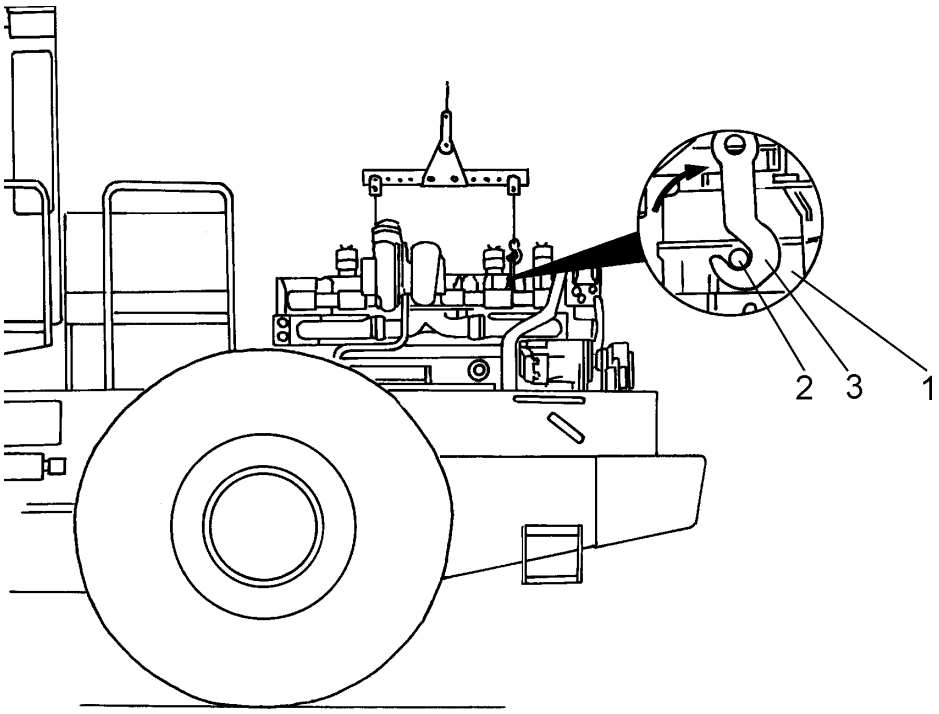


Fig. 12.14. Engine Removal (Lifting Method)

1. Rocker Lever Housing
2. Cast Boss
3. Hook

35. Attach the lifting hooks (3, Fig. 12.14) (refer to „SERVICE /SPECIAL TOOLS" in Section 1 INTRODUCTION) to the engine lifting cast boss (2) of the rocker lever housing (1).

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The engine KT 19 weight is approximately 1735 kg. In addition to hoist capable of supporting a minimum of 2500 kg must be used to left the engine.

36. MACHINE POWERED BY QSK 19 ENGINE: Attach the lifting hooks to the engine lifting eyes (engine component). The engine weight is approximately 2045 kg. Hoist capable of supporting a minimum of 2500 kg must be used to lift the engine.
37. Make a visual inspection around the engine to be sure all disconnects have been made that would obstruct its removal. Raise and guide engine backward until separate off the torque converter. Carefully hoist the engine from the frame and place it in a suitable stand or support.

7. ENGINE REPAIR

For detailed information pertaining to maintenance or engine repair, refer to the Engine Operation and Maintenance Manual KT19, KTA19, and KTTA19 Engine Series Bulletin No. 3666013-02, and Shop Manual and Specification Manual K19 Engine Series Kit No. 3810258-00 also Troubleshooting K19 Series Engines, Bulletin No. 3810307-00

MACHINE POWERED BY QSK 19 ENGINE: For detailed information pertaining to maintenance or engine repair, refer to the Operation and Maintenance Manual QUANTUM™, QSK19 Series Engines, Bulletin No. 3666120-01, and Troubleshooting and Repair Manual QSK 19 Series Engines, Bulletin No. 3666098-00 (Base engine), Troubleshooting and Repair Manual QSK Fuel System QSK 19 Engines Series, Bulletin No. 3666113.

IMPORTANT: *Welding on the engine or engine mounted components is not recommended. Disconnect both positive (+) and negative (-) battery cables from the battery before welding on the machine. Attach the welder ground cable no more than 0.6 meters from the part being welder. Do not connect the ground cable of the welder to the Electronic Control Module (ECM) cooling plate or ECM.*

8. ENGINE INSTALLATION

1. Secure the front support (5, Fig. 12.8) to each side of the engine flywheel housing using a torque of 200 - 240 Nm.
2. Install a new O-ring in the groove of the torque converter housing.

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

3. Position the engine on the mounting pads of the rear frame using the lifting equipment used for removal (Fig. 12.14). If the teeth of the torque converter drive housing and the drive ring (mounted to engine flywheel) do not engage, the shaft (1, Fig. 12.15) can be used to turn the flywheel. This shaft is held in the disengaged position by a spring. To turn the flywheel, apply pressure inward with the ratchet and turn the shaft until it locks. To disengage the shaft, back off on the shaft to allow the spring to return it to the disengaged position.

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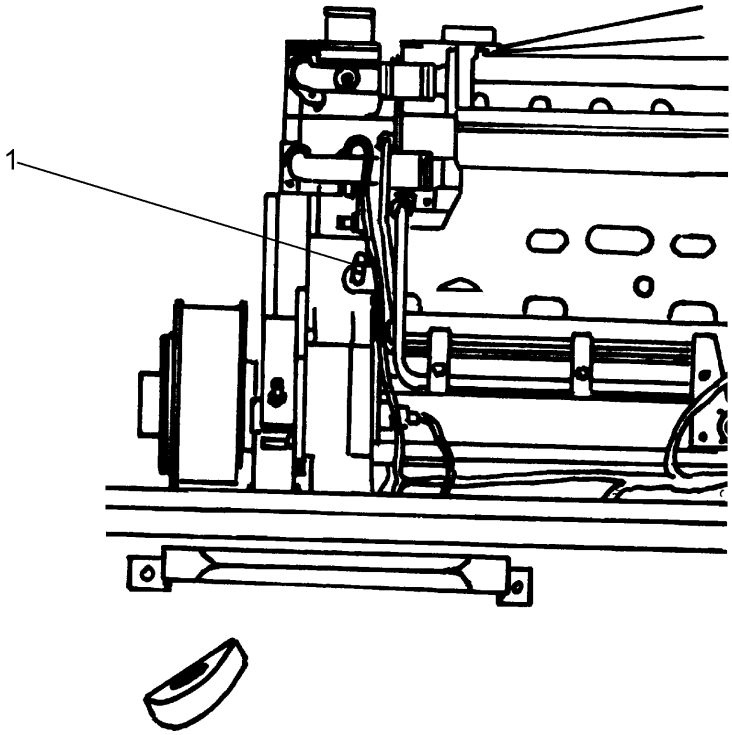


Fig. 12.14. Shaft Used to Mechanically Turn Engine Flywheel

1. Barring Device Shaft

4. If the rubber shock mounts have to be replaced due to cracking or deterioration, they must be assembled so that the piece with the shoulder is on top and the large flat washer against the bottom of the mating piece. At the front mounting, position the rubber mount on each side of the frame. Torque the bolts to 850 - 1030 Nm. At the rear mounting, position the rubber mount (4, Fig. 12.12 and Fig. 12.13) on each side of the mounting plate (2, Fig. 12.13). Insert the spacer through the rubber mount and torque the bolts to 270 - 330 Nm.
5. Install the bolts securing the torque converter housing to the flywheel housing. Remove the support elements from under the torque converter.
6. Proceed as follows for installing torque converter lower mounting bolts:

   Install the lower mounting bolts. If equipped sound absorbing lining (5, Fig 12.11), position the lining and install the snap fasteners (6). Reconnect the pipes (2 and 4) to the manifold (3). Install the tube (1) to the manifold (3).
7. Reconnect the engine flywheel housing drain hose (1, Fig. 12.10) to the transmission (2). Secure the hose with the clamp to the rear frame near the drive shaft (3).
8. Connect the engine oil drain hose (1, Fig.12.12) to the engine.
9. Install the brake charge pump (8, Fig. 12. 9) with a new gasket to the engine.
10. Install the fuel tank pipe and breather to the fuel tank.
11. Reconnect the fuel tank return hose (7, Fig. 12.9) (6, Fig. 12.7 QSK 19 engine) to the engine.
12. Install the oil filler tube (9, Fig. 12.9) to the frame.
13. Connect the fuel supply hose (6, Fig. 12.9) (5, Fig. 12.7 QSK 19 engine) to the fuel pump.
14. Reconnect the ether start valve tube to the ether start valve (2, Fig. 12.8) and to the engine.
15. Install the accelerator cable (3, Fig. 12.9) to the bracket (4) and reconnect the cable to the fuel pump lever (5). Install the accelerator pedal linkage return spring (2). Secure the cable to the bracket.

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16. Install a new gasket (refer to the Cummins Parts Catalog) and connect the water pump elbow (11, Fig. 12.6).
17. Install a new coolant filter (9, Fig. 12.6) (refer to the OPERATOR'S MANUAL and Cummins Parts Catalog). Install oil cooler vent hose (10) to the engine coolant pump housing.
18. Route the main harness and secure it in the clips along the left and right side of engine. Reconnect the electrical harness at the following engine locations:

    a. Reconnect the wires at the engine coolant temperature sensor (3, Fig. 12.6) and switch at the thermostat housing.

    b. Secure the harness to the coolant tube (4, Fig. 12.6) with the straps.

    c. Reconnect the wiring at the alternator (5, Fig. 12.6).

    d. Reconnect the wiring (6, Fig. 12.6) at the cranking motor solenoid.

    e. Reconnect the battery cable (7, Fig. 12.6) at the cranking motor solenoid. Reconnect the ground strap (8) at the cranking motor.

    f. MACHINE WITH TACHOMETER: Reconnect wire at the tachometer pick-up (1, Fig. 12.7).

    g. Reconnect the wire (1) at the ether start valve coil (2, Fig. 12.8).

    h. Reconnect the wiring at the engine oil pressure switch (3, Fig. 12.8) and sensor (4) at the oil filter head.

    i. Reconnect the wire at the fuel pump solenoid valve (1, Fig. 12.9).

    j. MACHINE WITH AIR CONDITIONER: Reinstall the conditioner compressor to the engine. Reconnect the conditioner compressor clutch wiring.

    k. MACHINE POWERED BY QSK 19 ENGINE: Reconnect two interface connectors (2, Fig. 12.7).

NOTE *Before reconnect interface connectors, use quick-dry electrical connectors cleaner to remove all dirt and moisture from the connectors ports and the harness connectors. Apply a small amount of lubricant (DS-ES) to the connector terminals. Do not fill the entire connector cavity with lubricant.*

NOTE: *Do not use compressed air into the connectors. Compressed air can moisture due to condensation.*

IMPORTANT: *Use only Cummins recommended lubricant DS-ES. Other lubricants, such as lubricating oil or grease, in the connectors can cause Electronic Control Module (ECM) damage, poor engine performance, or premature connector pin wear.*

19. MACHINE EQUIPPED WITH CAB HEATER: Reconnect the heater hoses (1, Fig. 12.6) to the shut-off valves. Secure the hoses with clamps (2) on the engine.

20. Install the steering oil cooler and the radiator as described in Section 6 „COOLING"

    a. Reconnect the aeriation hose to the engine thermostat housing.

    b. Install both halves of the fan shroud to the guard shroud.

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21. MACHINE POWERED BY QSK 19 ENGINE: Install the muffler brackets (6, Fig.12.5).
22. Lubricate all exhaust system hardware with "Never-Seez" compound. Install the muffler (7, Fig. 12.5) to support brackets (6). Install the clamp securing the tube (5) to the turbocharger.
23. Install the air cleaner (3, Fig. 12.5) with tube (4) to the mounting bracket. Install the clamp (2) securing the air cleaner tube to the turbocharger.

NOTE: *If the air inlet system was disassembled (air cleaner, inlet tube), install the air cleaner lines so that hoses and tubes do not touch or rub other parts of the machine. Apply liquid gasket to the hose connection ends of the air cleaner and turbocharger tubes.*

24. Reconnect the air cleaner filter indicator tube (1, Fig 12.5) to the air cleaner.
25. Install the center hood (9, Fig. 12.4).
26. Install the air pre-cleaner (8, Fig. 12.4).
27. Install the aspirator tube (7, Fig. 12.4). Install the hose clamps securing the aspirator tube to the muffler and to the precleaner (8).
28. Install the exhaust pipe (6, Fig. 12.4).
29. Install the side hood (5, Fig. 12.4) on each side of the engine.
30. Fill the engine with oil. Refer to the Engine Operation and Maintenance Manual KT19, KTA19, and KTTA19 Engine Series Bulletin No 3666013-02 for procedure to fill and prime engine before start up.
31. MACHINE POWERED BY QSK 19 ENGINE: Fill the engine with oil. Refer to the Operation and Maintenance Manual QUANTUM™, QSK19 Series Engines, Bulletin No 3666120-01, for procedure to fill and prime engine before start up.
32. Fill the cooling system. Refer to the OPERATOR'S MANUAL for coolant specifications and procedure.
33. Fill the hydraulic reservoir. Refer to the OPERATOR'S MANUAL for lubricant specifications and procedure
34. Check the transmission oil and add oil if necessary. Refer to the OPERATOR'S MANUAL for the lubricant specifications and procedure.
35. Check the air induction system for leaks as described under "AIR INTAKE SYSTEM, TEST".
36. Adjust the accelerator linkage as described under "ACCELERATOR PEDAL LINKAGE ADJUSTMENT".
37. Start and operate the engine to bring all systems to operating temperature and check for coolant or oil leaks at the disconnected points during engine removal.
38. Install the left and right fenders (2, Fig. 12.4) top elements.
39. Install the access panel (4, Fig. 12.4) on both sides of the engine. Shut the access door (3) and lock.
40. Before moving the machine unlock the frames and check operating of the brake system.

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SUPERSTRUCTURE

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SUPERSTRUCTURE

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R.O.P.S. CAB

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GENERAL

1. SPECIFICATIONS

Special Torques

Floorboard Mounting Bolts	35 Nm
Ladder Mounting Bolts	110 Nm
Cab-to-frame Mounting Bolts	920 Nm
Counterweight Mounting Bolts	1760 Nm
Fuel Tank Mounting Bolts	380 Nm
Grille Mounting Bolts	220 Nm
Bulkhead-to-frame Bolts	380 Nm
Battery Box-to-frame Bolts	380 Nm

CAB WINDOW GLASS

2. REPLACEMENT (Refer to Fig. 13.1)

WARNING! Before servicing the machine, be sure the engine is off, the bucket is lowered, the transmission shift lever is locked in neutral (N), the parking brake is off and the key is removed.

1. Starting at the seam of the weather stripping, pull out the edge of seal lip (B) with a window molding tool. Pull the molding tool around the window through groove (A) to release the seal.

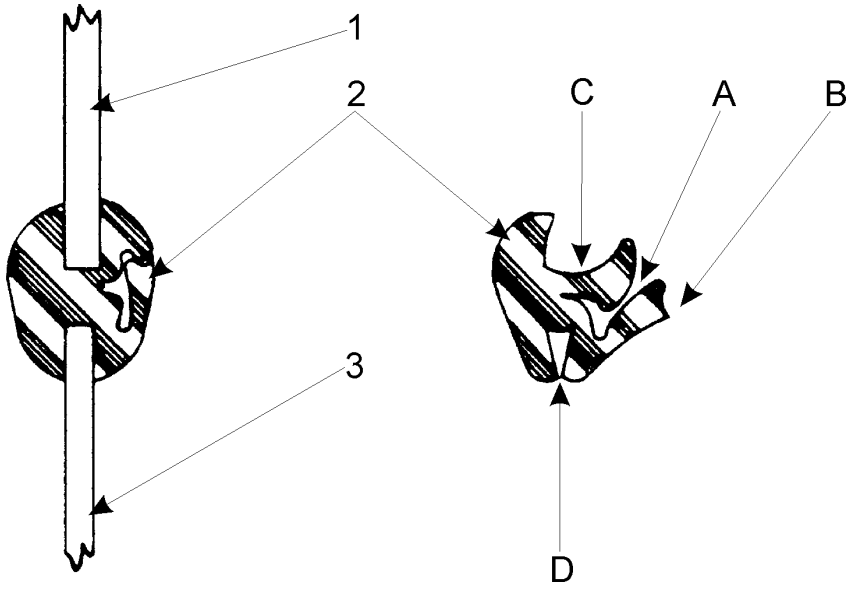


Fig. 13.1. Section View of Glass Or Window and Weather Stripping

A. Seal Lip Groove
B. Seal Lip
C. Glass Groove
D. Sheet Metal Groove

1. Glass or Window
2. Weather Stripping
3. Cab Sheet Metal

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CAB WINDOW GLASS

2. Carefully push the top of the glass or window towards the seal lip of the weather stripping until the top edge is free from the stripping. Remove the glass or window.
3. Remove the weather stripping from the window frame and clean thoroughly.
4. If necessary, replace the weather stripping as follows:
   A. Starting at the bottom and center of the window frame, press groove (D) of the weather stripping around the sheet metal.
   B. After the stripping is installed, tap against the sheet metal, especially in the corners, to insure a snug fit.
   C. Cut off excess stripping leaving approximately 9.5 mm past the starting point to avoid a gap in the seam after the glass or window is installed.
   D. Force the overlapped stripping down to from an even seam. If an even seam cannot be obtained, cut off more stripping from one end.
5. Liberally coat groove (C) of the weather stripping with a mild soap and water solution.
6. Place the bottom edge of the glass or window in groove (C). While applying a downward and inward pressure on the glass or window, pry the outer lip of groove (C) around the edge of the glass or window.

IMPORTANT: *Work carefully, do not exert excessive pressure on the edge of the glass.*

7. Liberally coat groove (A) with a mild soap and water solution. Using the window molding tool, force seal lip (B) into through the groove forcing the seal lip inward.

R.O.P.S. CAB

3. REMOVAL

WARNING! Do not attempt to repair a rollover protective structure R.O.P.S. after an accident. Repaired structure do not provide the original strength and protection. Contact your Construction Equipment Distributor for information on R.O.P.S. replacement. Do not operate the machine again until the R.O.P.S. has been replaced.

WARNING! Do not cut, grind, weld or drill holes in the R.O.P.S. because this could weaken the structure or affect its energy absorbing capability. Periodically inspect the R.O.P.S. for fatigue cracks. Cracks indicate a weakened structure which should be replaced for your protection.

1. Close the two water supply valves on the engine. Disconnect the heater fan motor electrical wiring (1 and 2, Fig. 13.2) at the heater connection. Disconnect the two heater hoses (3, Fig. 13.2) at the heater and remove the hose clips necessary to allow the hoses to be pulled out of the way for cab removal.
2. Disconnect the defroster fan and cab light electrical wiring.
3. Disconnect the windshield washer pump electric wiring.

WARNING! Drain valve ejection. Do not open the drain valves more than two turns. If ejection did occur, contact could result in injury.

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R.O.P.S. CAB

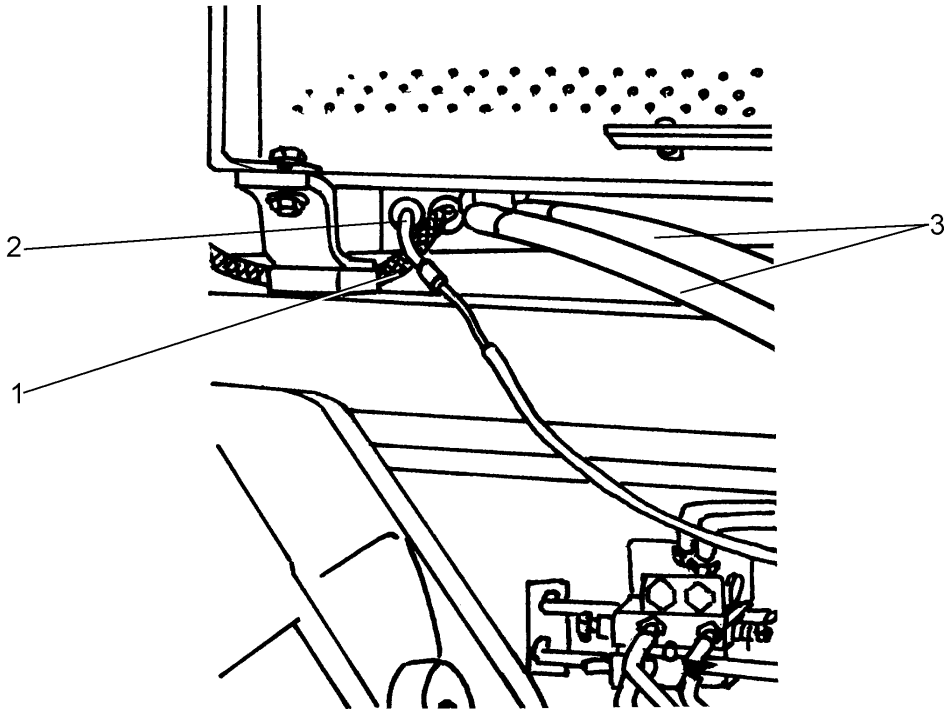


Fig. 13.2. Heater Disconnecting Points

1. Electrical Wiring 2. Electrical Wiring 3. Heater Hoses

4. Attach the cab to a suitable overhead hoist.
5. Remove the mounting hardware securing the cab to the front frame and to the floorboard. Lift the cab from the machine.

4. INSTALLATION

1. Fasten the hoist and lift the cab.
2. Position the cab on the floorboard and front frame.
3. Torque the cab to the front frame bolts to 920 Nm and the floorboard bolts to 35 Nm.
4. Install the windshield washer pump electrical wiring.
5. Install the defroster fan and dome light electrical wiring.
6. Install the hose clips and connect two heater hoses (3, Fig. 13.2) to the heater. Connect the heater fan motor electrical wiring (1 and 2, Fig. 13.2) to the heater connection.
6. Before moving the machine check the operation of the windshield wipers, washers, defroster fan, heater fan and the dome light.

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SUSPENSION

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SUSPENSION

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1. DESCRIPTION

The bolster (1, Fig. 14.4) is a box type frame located below the torque converter in the rear frame. The bolster is joined to the channels by the two pins (8) and (13) which are mounted at the front and rear of the bolster on the machine centerline. The bolster swivels on this pins and allows the rear axle, which is rigidly bolted to the bolster, to oscillate a total 24 degrees up and down. This arrangement provides machine stability by keeping all four tires on the ground even in rough terrain.

2. SPECIFICATION

Bolster front pin nut (initial only)	415 - 550 Nm
Front and rear pin retainer bolts	275 Nm
Counter weight mounting bolts	1790 Nm

3. REMOVAL

WARNING! Be sure the bucket is lowered to the ground and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

WARNING! Always lock the frames together before working near the center of the machine. If the frames move, serious injury or death could result.

1. Remove the counterweight from the rear of the machine. The counterweight weight is approximately 2000 kg (5600 kg logger version). Hoist capable of supporting a minimum of 2500 kg (6000 kg logger version) must be used to remove the counterweight.
2. Drain the tank. Plugs are located at both corners at the front of the tank.
3. Remove the hardware securing the radiator drain tube bracket to the left hand side of the fuel tank.
4. Remove the hardware securing the engine oil drain hose bracket to the right hand side of the fuel tank.
5. Disconnect the fuel tank return hose (1, Fig. 14.1) at the engine fuel line tee (2). Remove the tee strap securing the hose to the engine oil filler tube (3).
6. MACHINE POWERED BY QSK 19 ENGINE: Disconnect the fuel tank return hose (1, Fig. 14.2) from the fuel cooler return tube (2). Remove the hose from the clip (3).

IMPORTANT: *Disconnected 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. Openings must never be plugged with rags. This practice could introduce dirt or lint into critical components. Also tag all disconnected lines and wires for easier installation.*

7. Working under machine, remove the plate from the front of the fuel tank (1, Fig. 14.3). Disconnect the filter supply hose (2). Disconnect and tag the electrical wiring at the fuel level sensor (3).
8. Support the fuel tank. Remove the mounting hardware and remove the tank from the machine. Remove the fuel tank from the machine with fuel drain hose, to gain access to the bolster rear pin.

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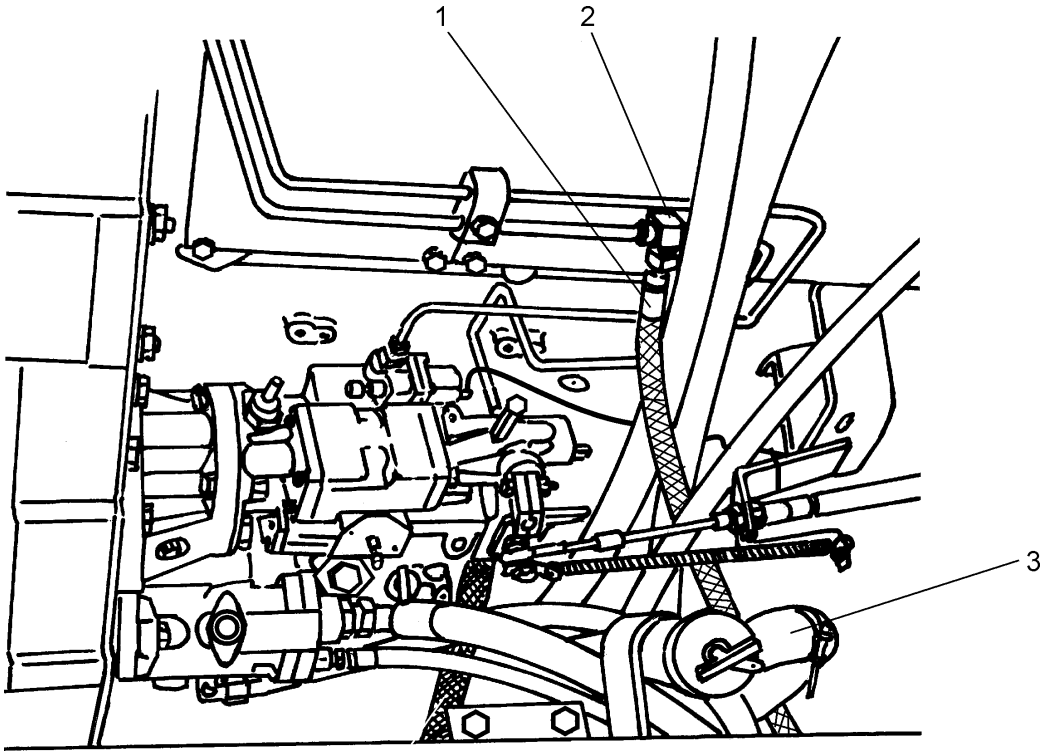


Fig. 14.1. Engine Disconnecting Points (KT19)

1. Fuel Return Hose
2. Fuel Line Tee
3. Oil Filler Tube

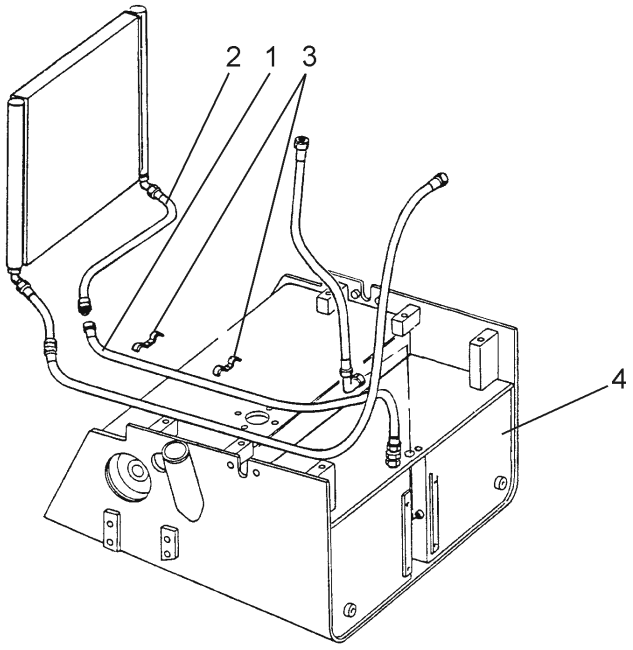


Fig. 14.2. Engine Disconnecting Points (QSK19)

1. Fuel Return Hose
2. Fuel Cooler Return Tube
3. Clip
4. Fuel Tank

9. Remove the rear axle from the machines as described in SECTION 7D, "DRIVE AXLE AND DIFFERENTIAL". It is not necessary to drain the oil from the axle housing and planetary unless axle disassembly is also to be performed.

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10. Disconnect two lubricating hoses (20, Fig. 14.4) from the elbows (19).

11. To prevent damage to the pins lubrication system; elbows (16 and 19 Fig. 14,5) tubes (2) and (3) during bolster (1) removal, they should be removed at this time. Once the bolster is removed, it should be blocked to prevent its weight from damaging the fittings spot welded to the underside of the casting.

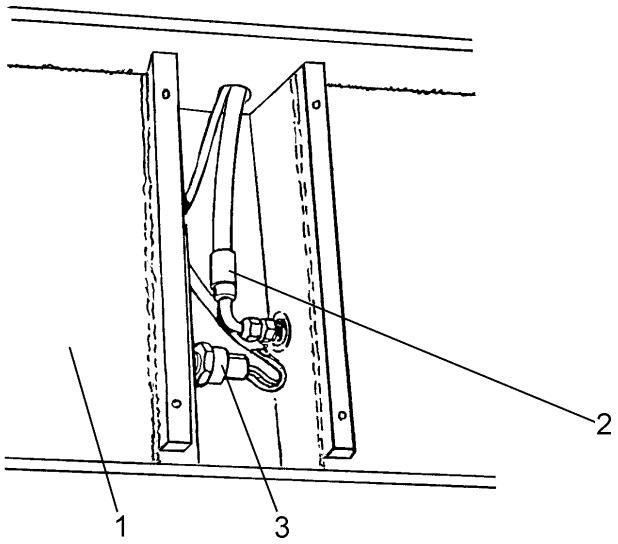


Fig. 14.3. Disconnect Points at Front of Fuel Tank

1. Fuel Tank 2. Fuel Supply Hose 3. Fuel Level Sensor

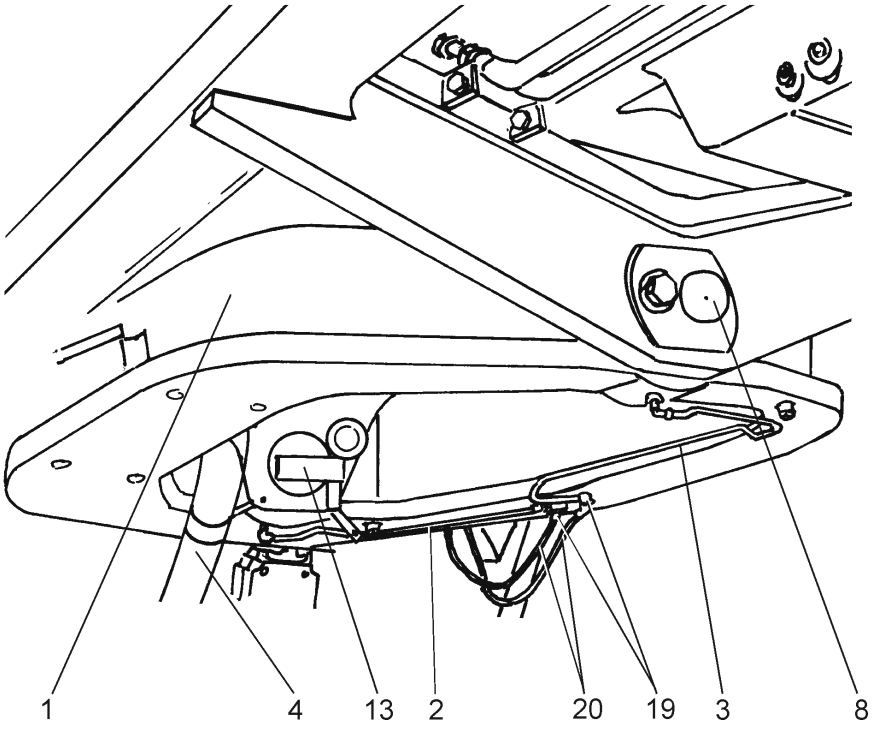


Fig. 14.4. Bolster in the Frame

1. Bolster
2. Lubrication Tube
3. Lubrication Tube
4. Oil Drain Hose
8. Front Pin
13. Rear Pin
19. Elbows
20. Lubricating Hoses

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12. Disconnect the engine flywheel housing drain hose (4, Fig. 14.4) at the flywheel housing. Free this hose from the clamp securing it to the bolster (1). Secure the hose in upward position.

13. Remove the hardware securing the front pin retainer (10, Fig. 14.5) to the frame and remove the retainer.

14. Remove the front pin nut (9, Fig. 14.5) and washer (3).

15. Loosen the hardware securing the front pin cam (11, Fig. 14.5) to the frame and rotate the cam until it no longer is in contact with the pin.

16. Remove the hardware securing the rear pin (13, Fig. 14.5) to the frame.

17. Adequately support the bolster with the removal equipment to be used.

18. Drive the front and rear mounting pins (8 and 13, Fig. 14.5), from position and remove the bolster from the machine.

4. BOLSTER REPAIR (Refer to Fig. 14.5)

1. At the rear of the bolster, remove and discard one of the wiper seals (12). From this end of the bore, drive out the bushing (2) and remaining wiper seal (12).

2. At the front of the bolster, remove the gland (6) with O-ring (7) from the outer end of the bore. Next remove the wiper seal (5) and thrust washer (4) from each end of the bore and drive out the bushing (2).

3. Install new bushing (2) in the front bore of the bolster until it is flush with the inner face of the counterbore. Use a soft mandrel to install the bushing. Check ID ($89.12^{+0.1}$) after installation.

4. Install the bushing (2) in the rear bore of the bolster until it is 9.5 mm below the face of the bore. Use a soft mandrel to install the bushing. Check ID ($89.12^{+0.1}$) after installation.

NOTE: *Lubricate all thrust washers, wiper seals and O-ring with lithium base grease before assembly.*

5. Install a thrust washer (4) into each side of the bolster front bore so the chamfer on the inside diameter is facing out. Press new wiper seals (5) into the bolster bore, seal lips facing out until they bottom against the thrust washers.

6. Install a new O-ring (7) into the groove of the gland (6). Install the gland into the counter bore of the bolster front bore until it bottoms against the thrust washer (4).

7. Install new wiper seals (12) in the bolster rear bore, seal lips facing out, until they bottom against the bushing (2).

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5. INSTALLATION (Refer to Fig. 14.5)

1. Position the bolster in the rear frame so the mounting pin holes are aligned.
2. Install both pins (8, Fig. 14.3) and (13) by driving them in from the rear of the machine. Be careful not to damage the wiper seals or O-ring during pin installation.
3. Rotate the front pin so the flat of the pin head is in contact with the boss on the rear frame.

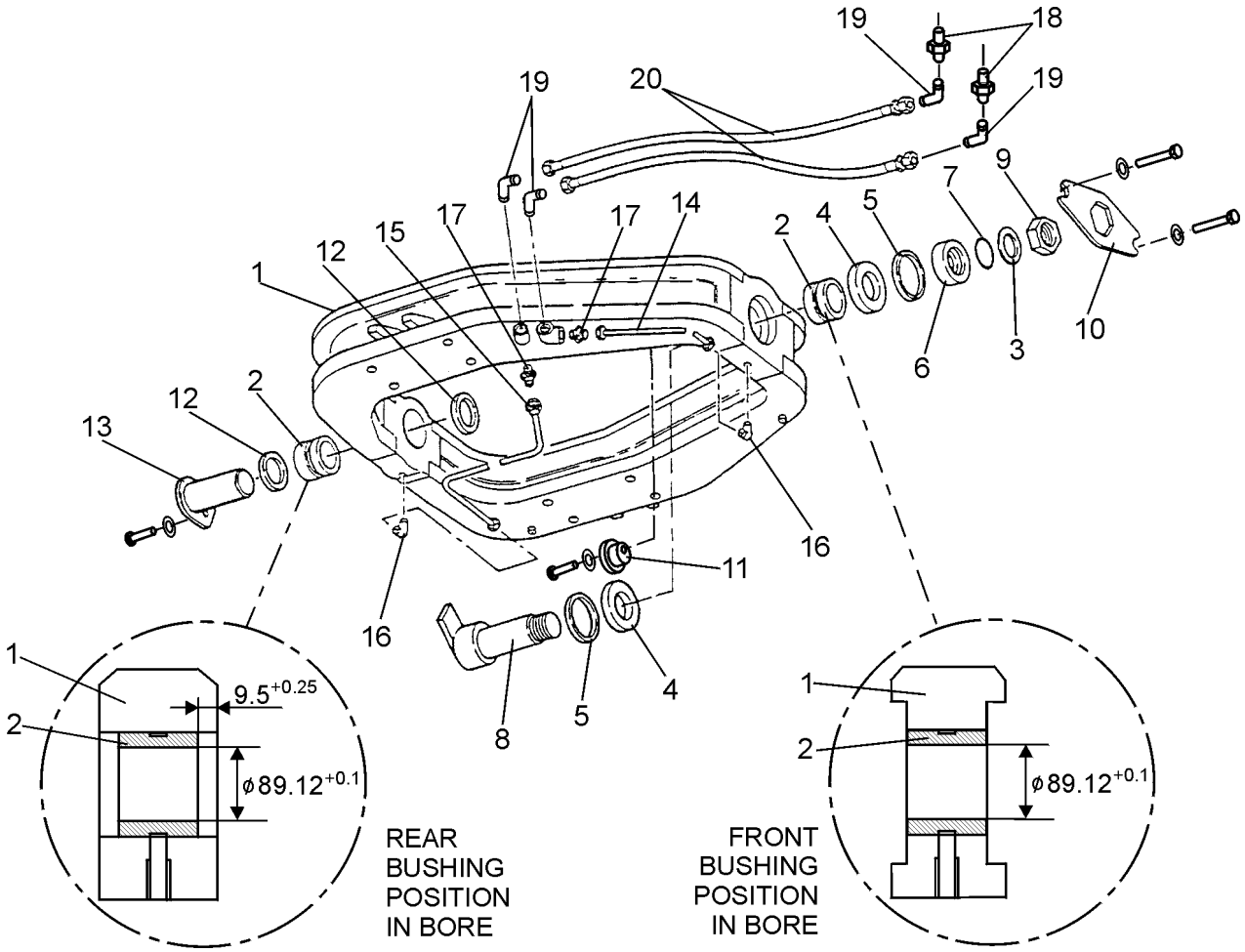


Fig. 14.5. Exploded View of Bolster and Related Parts

1. Bolster
2. Bushings
3. Washer
4. Thrust Washers
5. Wiper Seals
6. Gland
7. O-Ring
8. Front pin
9. Nut
10. Retainer
11. Cam
12. Wiper Seals
13. Rear Pin
14. Lubrication Tube
15. Lubrication Tube
16. Tube Elbows
17. Tube Connectors
18. Lubrication Fittings
19. Elbows
20. Lubricating Tube

4. Install the washer (3) and nut (9). Torque the nut to 415 - 550 Nm to seat the component parts in the bolster bore then loosen the nut.
5. Retighten nut, using the retainer (10) as a wrench, until the pin is just snug. Do not over tighten. Install the retainer.

NOTE: *Because of the position of the hex-shaped cutout in the retainer, two installation positions for the retainer are available by turning the plate over.*

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6. If the retainer mounting holes do not line up with the tapped holes in the rear frame (either plate position) loosen the nut until holes are aligned, but not more than 30 degrees. Torque the retainer mounting bolts to 275 Nm.

NOTE: *Because of the two retainer positions that are available, the amount of nut loosening required will always be less than 30 degrees provided both positions are checked during this process.*

7. Rotate the cam (11) to contact the pin and secure with the mounting hardware. Secure the rear pin (13) to the frame with the mounting hardware.

8. Install the pins lubrication system elbows (16 and 19) and tubes (14 and 15). Secure these tubes with clamps to the underside of the bolster.

9. Reconnect two lubricating hoses (20, Fig. 14.4) to the elbows (19).

10. Lubricate the two bolster pivots through the lube fittings using Multi-Purpose Grease until grease appears at the pivots.

11. Reconnect the engine flywheel housing drain hose (4, Fig. 14.4) to the flywheel housing. Secure the hose to the bolster (1) with the clamp.

12. Install the rear axle on the machine as described in SECTION 7D, "DRIVE AXLE AND DIFFERENTIAL" following only the pertinent instructions.

13. Install the fuel tank.

14. Working under machine, reconnect the filter supply hose (2, Fig. 14.3). Reconnect the electrical wiring at the fuel level sensor (3). Install the plate to the front of the fuel tank (1).

15. Install the hardware securing the radiator drain tube bracket to the left hand side of the fuel tank.

16. Install the hardware securing the engine oil drain hose bracket to the right hand side of the fuel tank.

17. Reconnect the fuel tank return hose (1, Fig. 14.1) to the engine fuel line tee (2). Install the strap securing the hose to the engine oil filler tube (3).

18. MACHINE POWERED BY QSK 19 ENGINE: Reconnect the fuel tank return hose (1, Fig. 14.2) to the fuel cooler return tube (2). Fasten the hose with the clip (3).

19. Install the counterweight. The counterweight weight is approximately 2000 kg (5600 kg logger version). Hoist capable of supporting a minimum of 2500 kg (6000 kg logger version) must be used to installing the counterweight. Torque the mounting bolts to 1760 Nm.

20. Fill the fuel tank following the procedures described in the OPERATOR'S MANUAL.

21. Start the engine and check fuel connections for leaks.

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WHEELS AND TRACKS

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WHEELS AND TRACKS

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4. Wheel Disassembly and Assembly 2
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1. DESCRIPTION

The tires are mounted onto wheels which ride on tapered roller bearings on the end of the axle spindles. The wheel can be removed with the tire mounted or dismounted, however, the preferred procedure is to allow the tire to remain mounted on the drive wheel if suitable lifting equipment is available. If replacement of the tire is necessary, remove the tire from the wheel. Consult your tire manufacturer for the correct procedure. The recommended tire and inflation pressures are listed under SPECIFICATIONS. For proper tire maintenance, refer to OPERATOR'S MANUAL.

2. SPECIFICATIONS

Special Torques

Wheel Mounting Bolts . . . . . 1250 - 1300 Nm

Tire Operating Pressure

All Type of Tires and Wheel Assemblies 29" and 33"

Front Wheel . . . . . 350 kPa
Rear Wheel . . . . . 350 kPa

For proper working inflation on optional tires, consult your local tire distributor.

3. WHEEL REMOVAL

1. Position the machine in a place which makes it possible to use a crane for lifting of disassembled wheel. Install the frame locking bar so that frame halves are in a straight ahead position.



WARNING! Always lock the frames together before working near the center of the machine. If the frames move, serious injury or death could result.

2. Turn the electrical master switch to the "OFF" position.



WARNING! Be sure the bucket is lowered to the ground and turn the master switch to the OFF position and take out the key from the master switch and starting switch to prevent accidental starting.

3. Securely block the tires at the wheel not bean removed.

4. Loose, but do not remove the wheel mounting bolts.

4. Remove the fender.

5. Securely block up the machine under the frame so the tire is just clear of the ground.



WARNING! Use extra caution when jacking up the machine. Jacking up the machine can be hazardous if performed improperly. Use jacking equipment of sufficient capacity. Be sure the jacking points are strong enough to support the machine. Be sure the jack is stable and well supported. Do not run the engine with the machine on jacks.



WARNING! The machine weights over 38000 kg. Adequate jacking lifting and blocking equipment must be available beginning wheel removal.

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WHEEL AND TRACKS

6. Attach a suitable hoist and sling to the wheel and tire assembly. Remove the mounting bolts and remove the wheel assembly from the axle.

4. WHEEL DISASSEMBLY AND ASSEMBLY (Refer Fig. 15.1 or Fig. 15.2)

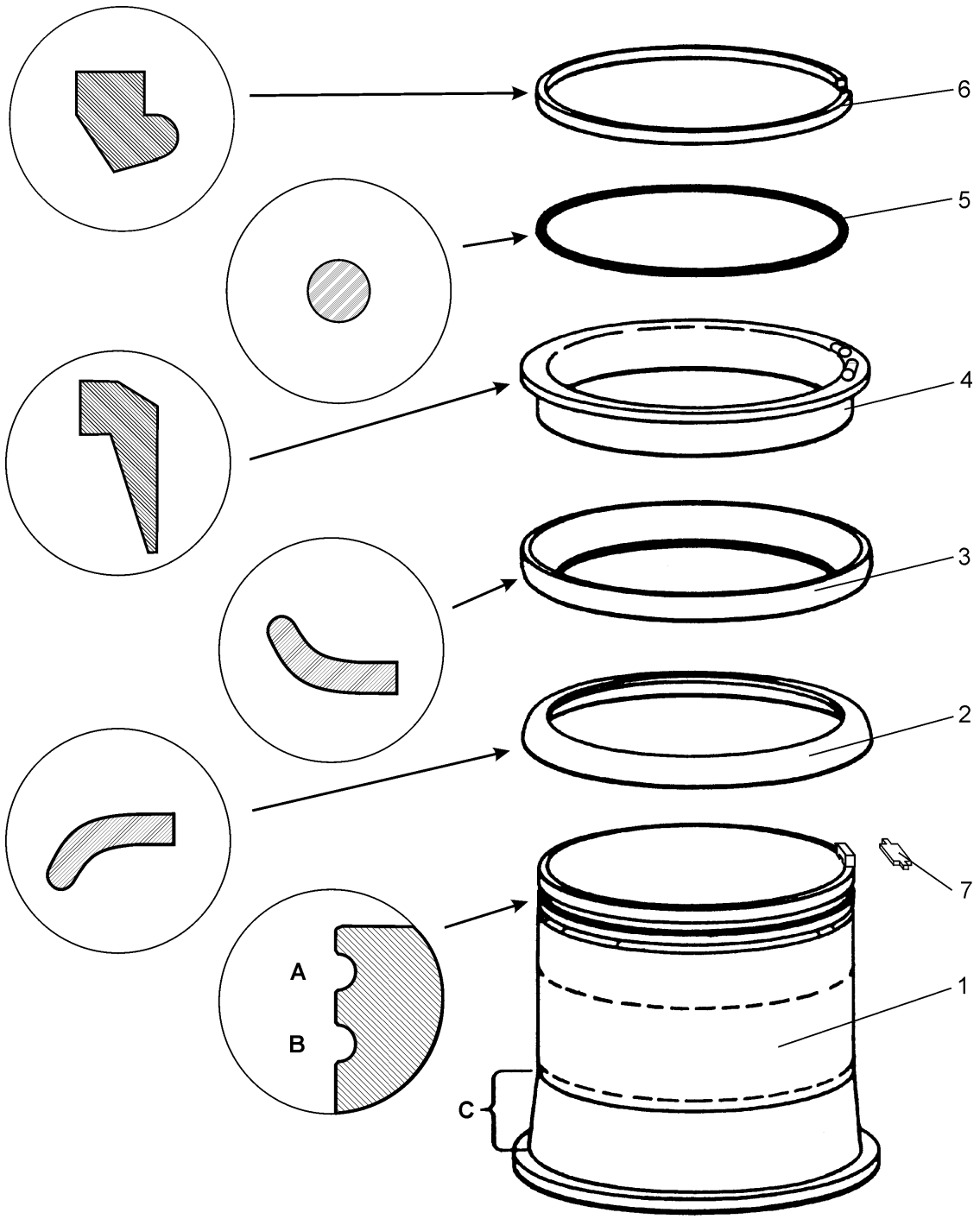


Fig. 15.1. Wheel Assembly Exploded View

1. Wheel Rim
2. Side Ring
3. Side Ring
4. Bead Seat Band
5. O-Ring
6. Lock Ring
7. Protective Block

A. Lock Ring Grove
B. O-Ring Grove
C. Tire Seat

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WARNING! Do not try to remove tire from wheel before completely deflating.

WARNING! Do not let anyone disassemble and assemble tires without proper training.

1. Complete deflate wheel.

NOTE: *Disassembling of a wheel should be made on a press for dismantling of heavy wheel machine tires.*

2. Press the bead seat band (4) to remove protective block (7) and take the block off.

3. Press the beat seat to release lock ring (6) and take the ring off.

4. Remove the O-ring (5).

5. Take off the tire (8) with bead seat band (4) from the wheel rim (1).

NOTE: *Do not insert forks inside tire hole. Lift with rope sling or round fork or padded forks having six inch minimum, or lift a tire on the outside circumference only.*

6. Remove the bead seat band (4).

7. Remove the side rings (2 and 3).

8. Remove the valve (4, Fig. 15.3 or 5, Fig. 15.4) .

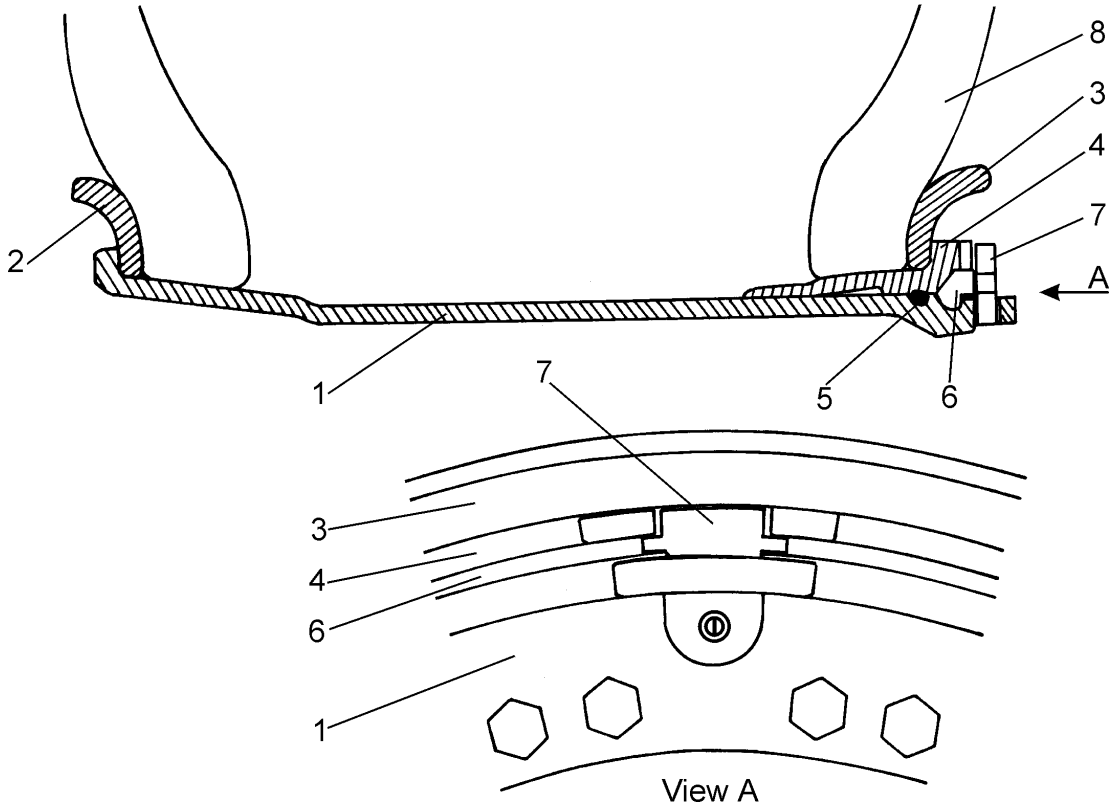


Fig. 15.2. Wheel Assembly Cross Section

1. Wheel Rim
2. Side Ring
3. Side Ring
4. Beat Seat Band
5. O-Ring
6. Lock Ring
7. Protective Block
8. Tire

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Wheel - Mounting Maintenance (Refer Fig. 15.1)

Check the rings and wheel in the following way:

1. Lock ring (6) - clean, inspect. Use wire brush or sand blast to free of corrosion and rust.

2. Rubber O-ring (5) - and change if necessary.

3. Bead seat band (4) - clean, tire seat inspect. Use wire brush or sand blast to free of corrosion.

4. Side rings (3 and 2) - clean, inspect. Use wire brush or sand blast to free of corrosion and rust

5. Wheel rim (1) - clean, inspect for fractures and repaint. Use wire brush or sand blast to free of corrosion and rust.

   a. Lock ring grove (A) - **give a special attention to lock ring grove**, clean, inspect for fractures and repaint.
   b. O-ring grove (B) - clean, inspect for fractures and repaint.
   c. Tire seat (C) - clean, inspect for fractures and repaint..

Wheel mounting (Refer Fig. 15.1 and Fig. 15.2)

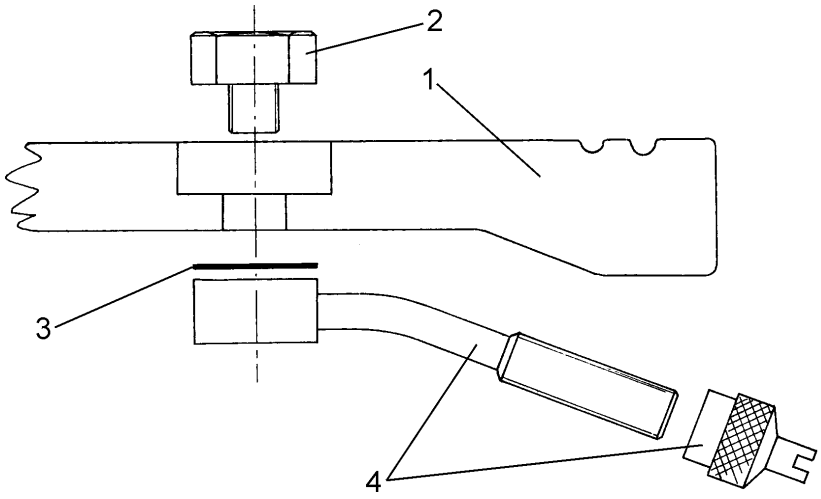


Fig. 15.3. (29” Wheel Valve)

1. Wheel
2. Bolt
3. Rubber Gasket
4. Valve with Cap

1. Install the valve (4, Fig. 15.3 or 5, Fig. 15.4).

2. Install the side ring (2) on the wheel rim (1).

3. Lubricate wheel surface (C), use approved lubricant for tire mounting. Install the tire (8).

NOTE: *Do not insert forks inside wheel hole. Lift with rope sling or round fork or padded forks having six inch minimum, or lift a tire on the outside circumference only.*

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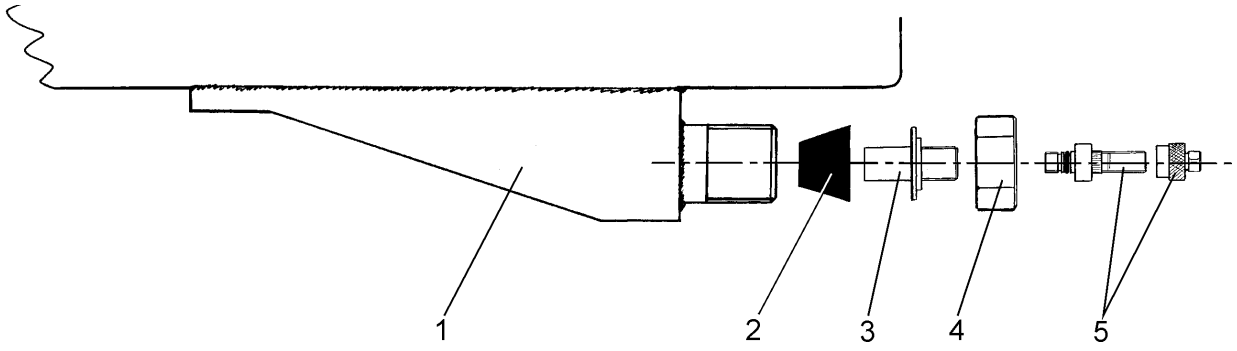


Fig. 15.4. (33” Wheel Valve)

1. Wheel Element
2. Rubber Element
3. Link
4. Flange Nut
5. Valve with Cap

4. Position the side ring (3) on the tire.

5. Lubricate outside surface and install the bead seat band (4) on the wheel.

6. Press the beat seat. Lubricate O-ring (5) and install in the grove (B).

7. Install the lock ring (6) on the grove (A). The cut point must be under the protective block (7).

8. Install protective block (7) .

9. Again, make sure the lock ring is in its proper grove completely around the wheel before inflating the tire to desired pressure.

10. Inflate the tire initially to 500 kPa. Check all side and lock rings are in the place.

WARNING! Do not seat rings by hammering while tire is inflated.

11. Inflate the tire up to desired pressure.

WARNING! Never inflate a flat tire without inspecting the tire, and wheel for damage. Be sure all components are properly assembled. Unmounted tires being inflated or deflated should be placed in tire safety cage. Inflate the tire to 50 kPa and check that all components are properly seated. Never stand directly in front of a tire and rim assembly while inflating. Use clip-on air chuck whit a hose long enough to allow person inflating the tire to stand to the side. Serious injury can result if the tire or rim where to separate.

IMPORTANT: *Operation of the machine with incorrect pressure in tires (depending work place) may cause damage of tires or increased fuel consumption.*

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5. WHEEL INSTALLING

1. Attach a suitable hoist and sling to the wheel and tire assembly. Install the wheel on the axle. Install the mounting bolts.

2. Install the fender.

3. Remove securely block from under machine. Disconnect the frame locking bar.

NOTE: *It is recommended, after few machine working hours with the repaired wheel, to tighten the mounting nuts with torque 1250 - 1300 Nm.*

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MOUNTED EQUIPMENT

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MOUNTED EQUIPMENT

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GENERAL

1. SAFETY PRECAUTIONS

This symbol is used throughout this manual to call your attention to warnings to instructions concerning personal safety. Carefully observe and follow these precautions. Be certain anyone operating or servicing this machine is aware of the safety rules. Failure to follow these precautions can result in serious injury or death.

Before servicing the machine, BE SURE the engine is off, the bucket is lowered, the transmission shift lever is locked in neutral (N), the parking brake is applied and the electrical system master switch is off and the key is removed. Tag the machine per OSHA regulations.

Before working under the machine, block the tires to prevent machine movement.

ALWAYS lock the frames together before working near the center of the machine. If the frames move, serious injury or death could result.

NEVER stand near the bucket or tires while the engine is running.

Lift and handle all heavy parts with lifting devices of adequate capacity. Secure parts with proper slings and hooks. Use lifting eyes provided. Warn nearby personnel to stand clear.

For your safety, whenever using blocking for support, use approved blocks per OSHA regulations before servicing the machine.

For your protection, keep head, body, hands and fingers away from the bucket and loader linkage when they are in a raised position, unless they are securely blocked per OSHA regulations. When replacing cutting edges and teeth, securely block the bucket for your protection.

For your safety, remove the ether container when welding, grinding or using a torch on the machine.

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.**

To install and remove bucket teeth, use a nonferrous hammer. It is hazardous to hammer on the teeth. Wear safety glasses with side shields or goggles to reduce chances of injury.

For your protection, use EXTRA caution when adjusting the loader's bucket leveler or boom kick-out. Use two trained people and guard against accidental movement of the machine or loader linkage.

2. DESCRIPTION AND OPERATION

Boom, Bucket and Linkage (Refer to Fig 17.1)

The boom consists of two arms (1) and (2) connecting the loader with the bucket. The upper and lower pivot pins (8) which connect the boom to the loader frame and bucket, ride on bushings (4) in the boom arms. Wiper rings (3) are used to prevent dirt from entering the boom pivots and damaging the bushings. Cord rings (26) are also used for protection at the bucket connection. Two boom cylinders connected by the pins (10) raise and lower the boom arms.

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GENERAL

The bellcrank (12) is pinned between the boom arms with the pivot shaft (14). A wiper ring (5) is used at each pivot point on the inboard side to prevent grease from filling the bellcrank housing. A wiper ring (13) is used on the outboard side to prevent dirt from damaging the bushings. The upper end of the bellcrank is pinned to the rod end of the bucket cylinder by the pin (16). The bushing and wiper rings at this location are in the cylinder rod eye. The lower end of the bellcrank is pinned to the link (18) which also connects to the bucket. Bushings (19) and wiper rings (15) are used at each end of the link. These components form a "Z" bar linkage for bucket operation.

Several buckets are available for service. They are all of welded construction with a replaceable cutting edge and, if equipped, bucket teeth.

LOADER LINKAGE PIVOTS

3. SPECIFICATIONS

Special Torques:

Pivot pin locking bolts (All) . . . . . 651 Nm

4. REMOVAL AND DISASSEMBLY

WARNING! Refer to "Safety Precautions" in this section.

Bellcrank Link: Block under the link (18, Fig. 17.1). Remove the pin (20) at the bucket. A one inch threaded hole is provided in the pin to aid in pin removal. Attach a hoist to the open end of the link. Remove the pin (20) securing the link to the bellcrank (12) in the same manner and lift the link from position. Place the link in a press to remove the bushings (19) with wiper rings (15).

Bellcrank: Raise the boom until the pivot shaft (1, Fig. 17.2) can clear the tires. Block under the bucket. Support the bucket cylinder, remove the pin (2) and retract the cylinder. A one inch threaded hole is provided in the pin to aid in pin removal. Attach a hoist to the bellcrank (3) and remove the pin (4) securing the bellcrank to the link (5) in the same manner as the upper pin (2). Remove the bolt (6) and nut securing the pivot shaft (1) to each end of the bellcrank and drive the pivot shaft from position. Be careful not to loose the shims (24, Fig. 17.1) (if equipped) located between the bellcrank and boom arm. To replace the bushing (23) and inboard wiper ring (5) used on each end of the bellcrank, a portable hydraulic ram and suitable puller must be used.

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LOADER LINKAGE PIVOTS

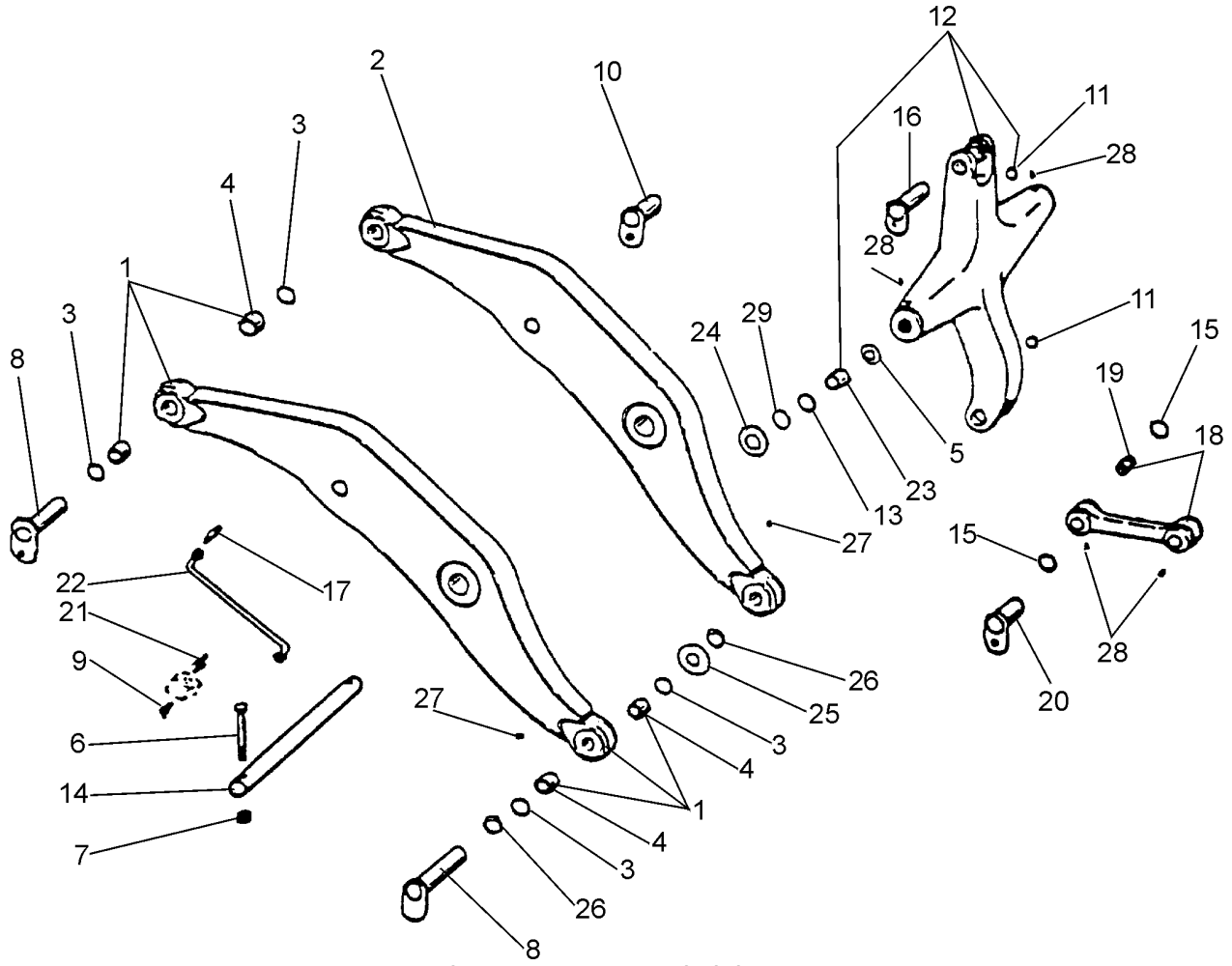


Fig. 17.1. Boom and Linkage

1. R.H. Boom Arm
2. L.H. Boom Arm
3. Wiper Ring
4. Bushings
5. Wiper Ring
6. Bolt
7. Nut
8. Pivot Pins
9. Grease Nipple
10. Boom Cylinder Pin
11. Sleeve
12. Bellcrank
13. Wiper Ring
14. Bellcrank Pivot Shaft
15. Wiper Ring
16. Bucket Cylinder Pin
17. Elbow
18. Bellcrank Link
19. Bushing
20. Pivot Pin
21. Connector
22. Lubricating Tube
23. Bushing
24. Shim
25. Shim
26. Cord Ring
27. Grease Nipple
28. Grease Nipple
29. Seal Ring

Boom Arm: To remove the lower pivot bushings (4, Fig. 17.1), separate the bucket from the linkage as described in "REMOVAL" under "BUCKET". Raise the boom to the desired position and block securely. The two bushings in each boom arm can then be pressed from position using a suitable driver and portable hydraulic ram. To remove the upper pivot bushings (4), remove the pivot pin mounting hardware and pull the pivot pins (8) from position. A 1-1/4 inch threaded hole is provided in the pivot pin for removal. A puller and portable hydraulic ram can be used or, if desired, an eyebolt can be installed and another machine using a chain can be used. Once the pins are removed, use the boom cylinders to raise the boom arms from the frame and block securely. The two bushings with wiper rings (3) in each boom arm can then be pressed from position.

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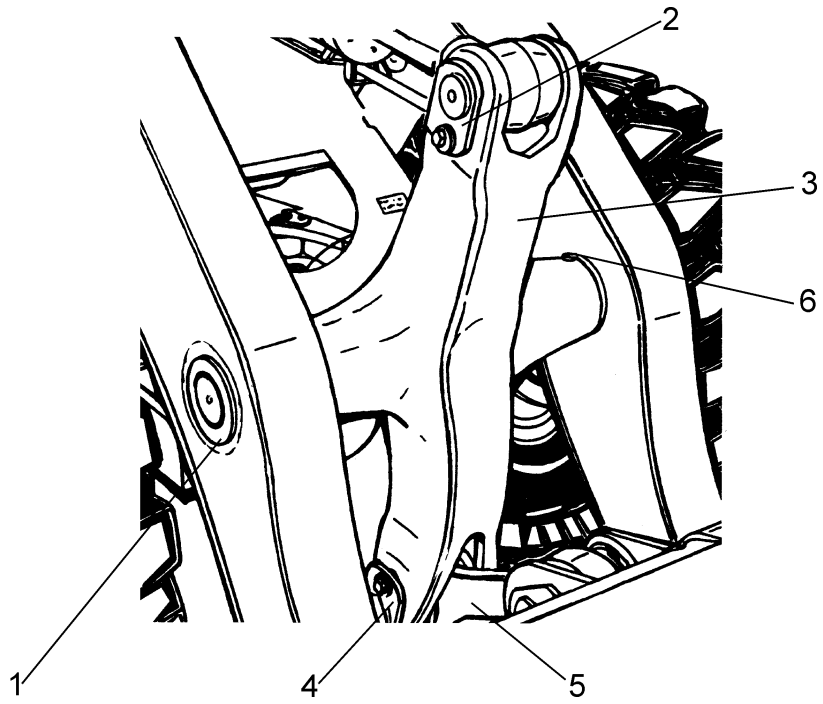


Fig. 17.2. Bellcrank Disconnect Points

1. Bellcrank pivot shaft	3. Bellcrank	5. Bellcrank link
2. Bucket cylinder pin	4. Pivot pin	6. Pivot shaft bolt

5. REASSEMBLY AND INSTALLATION

NOTE: *For ease of assembly, lubricate pivot pins generously with chassis grease prior to installation. Once installation is completed, lubricate linkage pivot points through the lube fittings using Multi Purpose Grease until grease appears.*

Boom Arm: The upper and lower pivot bushings (4, Fig. 17.1) must be pressed into each end of the bore so the seal groove is facing out and is flush with the outside face of the bore. The wiper rings (3) are all installed into the bushings so the lip is facing out. To assemble the boom arm pivots to the frame or bucket, reverse the procedure used for removal. If necessary, the boom cylinder can be used to align components for pivot pin installation. The mounting bolts for the pivot pins (8) must be torqued to 650 Nm.

Bellcrank Link: Press a new bushing (19, Fig. 17.1) in each bore until it is flush with the outside face of the bore. Install wiper rings (15) in each bushing so the lips are facing out. Position the link between the bucket and bellcrank (12) so the front grease fitting is pointing up. Install the pivot pins (20) and secure using a torque of 650 Nm.

Bellcrank: Install the inboard seal (5, Fig. 17.1) in the small groove of each bushing (23) so the seal lip enters first. Press the bushing into each bore of the bellcrank (12) until it bottoms in the bore. Install the outboard wiper rings (13) in each bushing so that it seats in the bushing groove with the seal lip facing out. Hoist the bellcrank into position so that the curved portion of the bellcrank is down and the convex side is down and forward. Apply pressure to the bellcrank so that it is over against one of the boom arms. Measure the gap on the opposite side of the bellcrank and, if necessary, add shims (24) so that no more than 3.2 mm gap exists. Install the pivot shaft (1, Fig. 17.2) aligning the holes for the mounting bolts (6). Install the two mounting bolts and nuts. Secure the bucket cylinder and the bellcrank link to the bellcrank with the pivot pins and torque the pivot pin mounting hardware to 650 Nm.

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6. SPECIFICATIONS

Special Torques:

Pivot pin locking bolt . . . . . 650 Nm

7. REMOVAL (Refer to Fig. 17.3)

WARNING! Refer to "Safety Precautions" in this section.

1. Place the bucket on the ground, bottom sheet parallel to the ground. Place the loader controls in neutral "HOLD".

2. If available, support the bucket with a suitable chain hoist during removal operation. If a hoist is not available, securely block the rear of the bucket to prevent it from rolling back when it is separated from the linkage.

3. Block under the, link (1) to prevent it from dropping when the pivot pin (2) is removed.

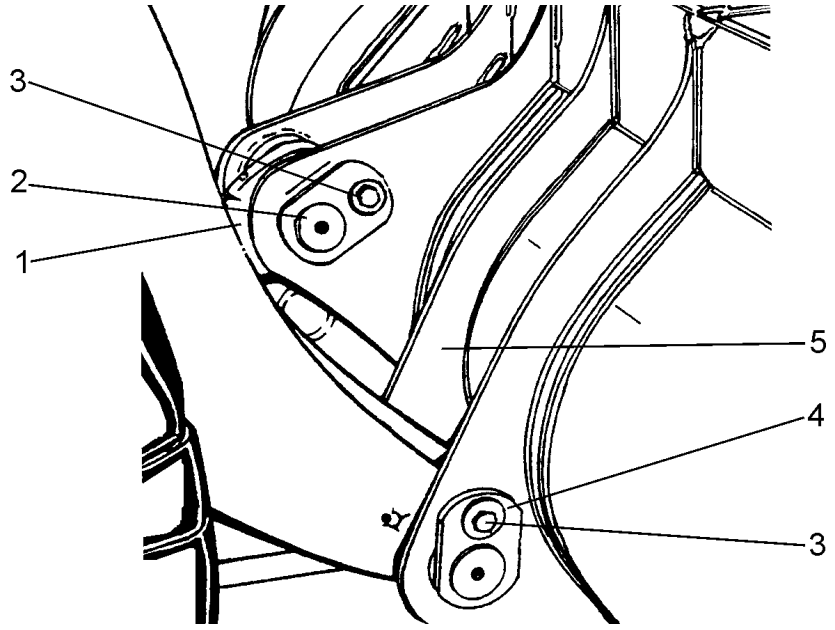


Fig. 17.3. Bucket Disconnect Points

1. Bellcrank link
2. Link pivot pin
3. Pin locking bolts
4. Boom pivot pin
5. Bucket

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BUCKET

4. Remove the bolt (3) and washer securing the pin to the bucket and remove the pin. A one inch threaded hole is provided in the pin for removal. Using heavy gauge wire, secure the link (1) (loose end) up to the bellcrank to keep it out of the way.

5. Remove the bolt (3) and washer securing each boom arm pivot pin (4) at the bucket and remove the pins. A 1-1/4 inch threaded hole is provided in the pivot pin for removal. A puller and portable hydraulic ram an be used or, if desired, an eyebolt can be installed and another machine using a chain can be used. Retain the cord rings (26, Fig. 17.1).

6. Place the boom control lever in the "FLOAT" position allowing the boom arms to drop away from the bucket. Be careful not to loose the shims (25, Fig. 17.1) (if equipped) located between the boom arm and bucket. Back the loader away from the bucket.

8. INSTALLATION

1. Slowly move the machine to the bucket until the boom arms are in position. The mounting holes can be aligned by lowering and raising the boom arms. If necessary, a hoist can be used on the bucket to align the link and boom arm mounting holes.

2. Measure the gap between the bucket and each side of the boom arm on both sides of the machine. Add the total of the figures obtained. If the result is more than 3.2 mm shims (25, Fig. 17.1) must be installed between the bucket and the boom arm.

NOTE: *If more than one shim is required, all the shims can be installed at one location to keep the total clearance below 3.2 mm.*

3. Complete installation of the bucket by reversing the order described in "REMOVAL". For ease of assembly, lubricate the pivot pins generously before installation. Torque the pin locking bolts (3, Fig. 17.3) to 650 Nm.

NOTE: *Be sure to install the cord rings (26, Fig. 17.1) between the bucket and each side of the boom arms.*

4. Lubricate the loader linkage pivots through the lube fittings using Multi-Purpose Grease until grease appears.

9. CUTTING EDGE REPLACEMENT

WARNING! Refer to "Safety Precautions" in this section.

NOTE: *Replace the cutting edge before it wears back to the weld joining it to the backing plate.*

1. Prior to removing worn cutting edge, straighten any low that may be in the backing plate.

2. Tack weld a brace in the center of the bucket hold straightened backing plate (Fig. 17.4).

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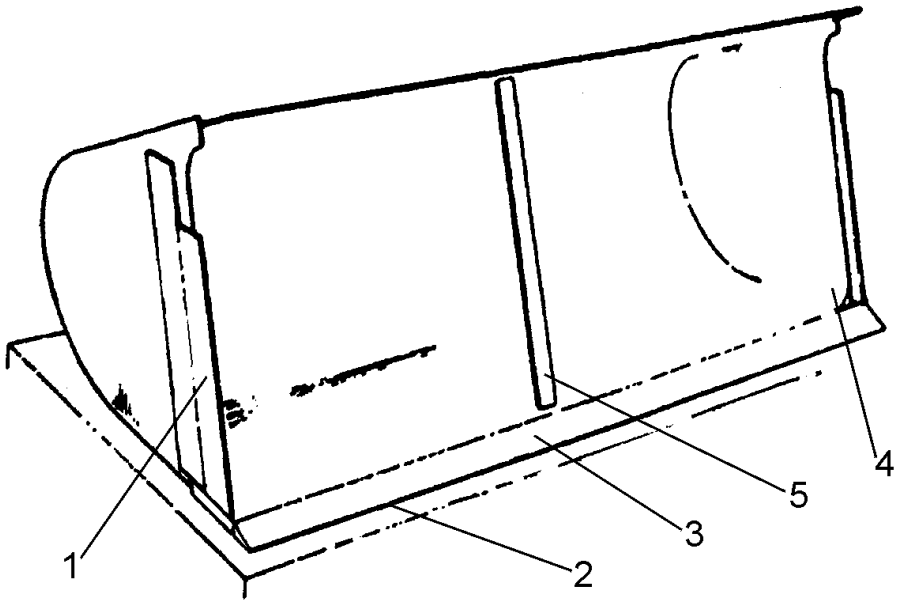


Fig. 17.4. Bracing Bucket

1. Side cutting edge
2. Cutting edge
3. Backing plate
4. Corner stiffner
5. Brace

3. Clamp a stout piece of stock, having a straight edge, along the weld, joining the cutting edge and backing plate. Cut off front of cutting edge at upper weld with cutting torch. Use clamped straight edge as guide for torch (Fig. 17.5).

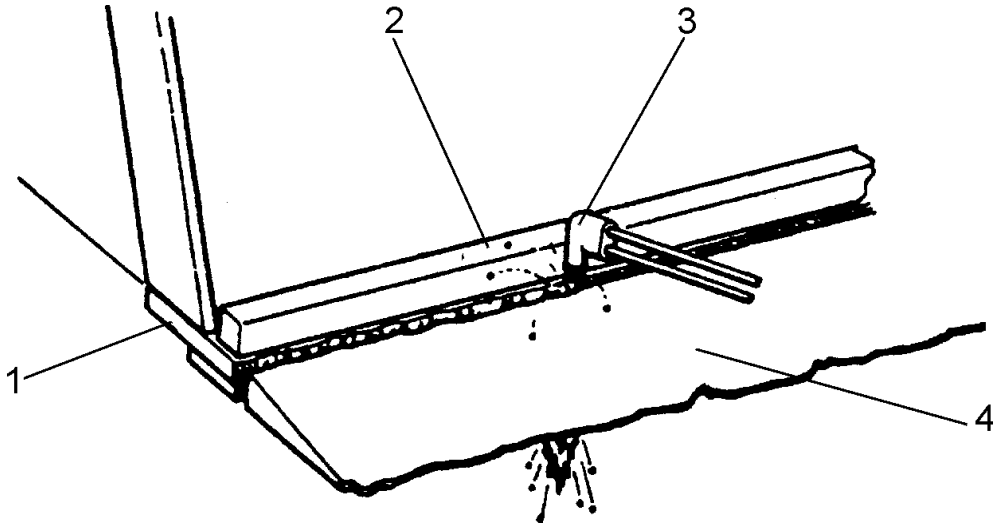


Fig. 17.5. Removing Cutting Edge

1. Backing plate
2. Guide bar
3. Torch
4. Cutting edge

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4. Remove weld at rear of cutting edge and on bottom of backing plate (Fig. 17.6). Use air carbon arc process. Keep heat penetration (heat build-up) in backing plate to a minimum to control plate warpage.

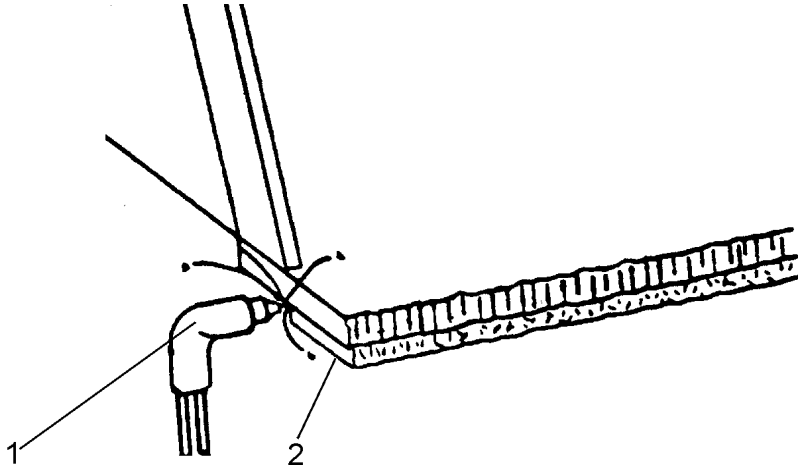


Fig. 17.6. Removing Edge

1. Torch 2. Smooth surface

5. Dress backing plate along forward face and lower surface to receive replacement cutting edge (Fig. 17.7).

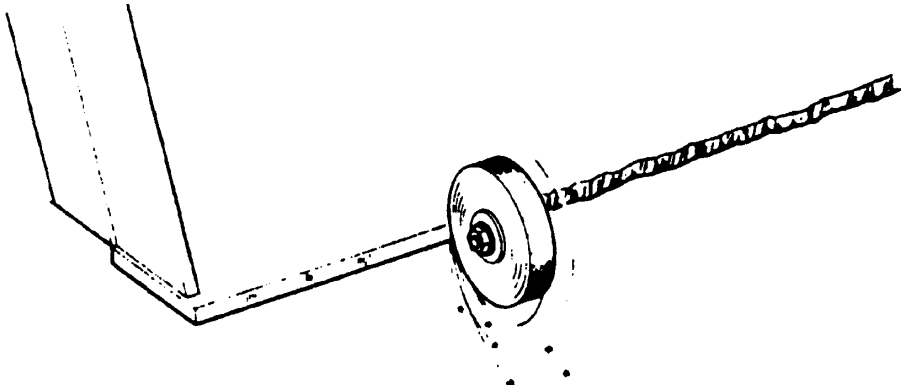


Fig. 17.7. Dressing Backing Plate

6. Position new cutting edge on backing plate. Tack weld edge to backing plate at front of plate and along back of edge (Fig. 17.8). Start tacks at center of edge and work alternately between front edge of plate and rear of edge toward both ends. Fix edge with firm welds.

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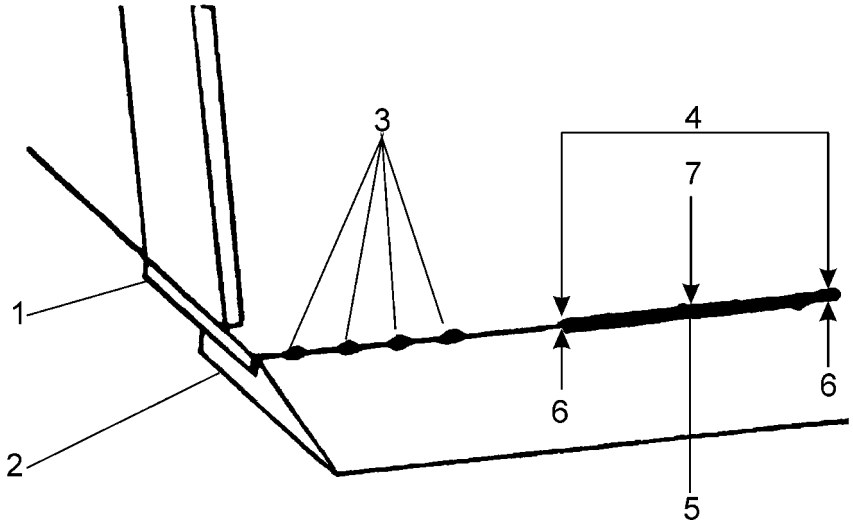


Fig. 17.8. Welding Edge to Bucket

1. Backing plate
2. Cutting edge
3. Small tack welds
4. 9 mm fillet weld
5. Centerline of bucket
6. Start of weld pass
7. Finish of weld pass

7. Best results will be obtained by preheating the edge and backing plate to 90°C to 150°C. Use a 9 mm fillet weld to join the rear of edge to bottom ob backing plate (Fig. 17.9).

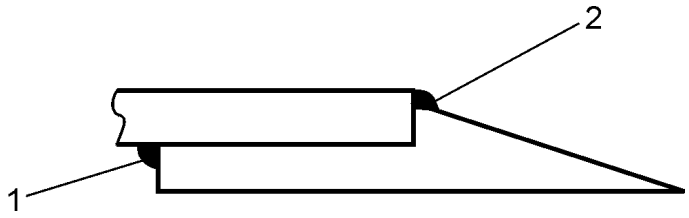


Fig. 17.9. Fillet Welds

1. 9 mm fillet weld
2. Fillet weld

8. Start a weld 150 mm on either side of cutting edge center and work alternately toward the center.

9. Skip 150 mm from previous welds and work back. Continue to backstep welds alternately on either side of cutting edge center until weld is completed at bucket side plates.

10. Join front of cutting edge to front of backing plate in same manner. Remove tack welded brace (5, Fig. 17.4).

10. TOOTH AND ADAPTER INSTALLATION

WARNING! Refer to "Safety Precautions" in this section.

NOTE: *Be sure surfaces are dry, clean and free of rust. Welding should be done with a dry E 7018 rod (either from an oven or fresh from the can). A maximum size rod of 5 mm should be used with a current no stronger than 250 amp*.

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1. Space the adapters on the cutting edge to the dimensions (A, B and C, Fig. 17.10). Spacing is the same for straight edge or spade nose buckets.

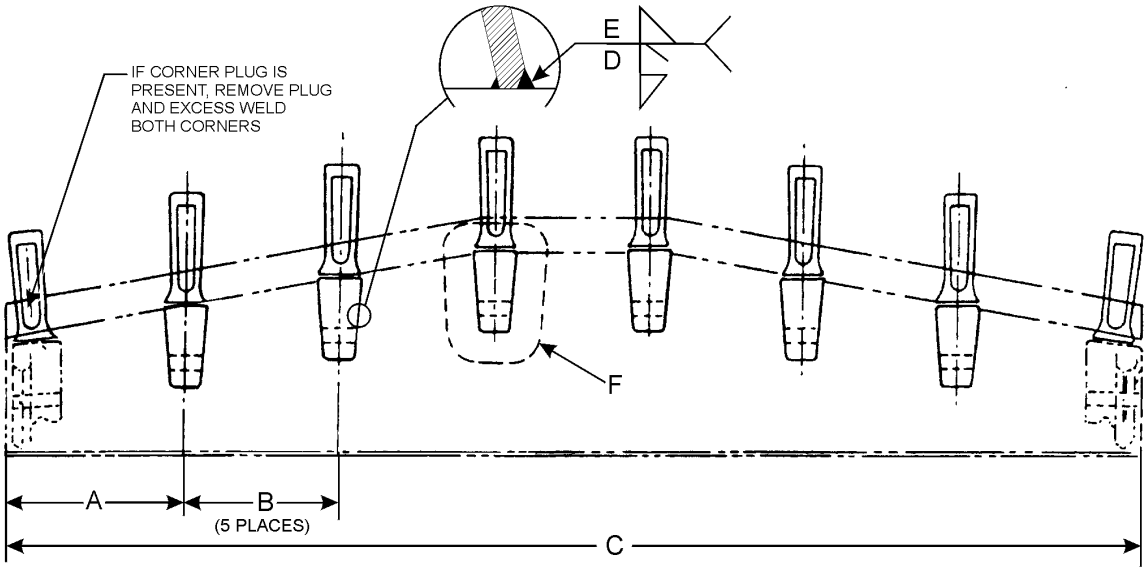


Fig. 17.10. Tooth Adapter Spacing

A. 589.3 mm	D. Outside weld of 19 x 19.6 mm
B. 492.8 mm	E. Inside weld of 3.0 mm
C. 3645 mm	F. Area to be preheated (typical)

2. Place a 0.5 -1 mm shim on the shank of the tooth (G, Fig.17.11) and, while holding the adapter, slide the tooth with shim in the adapter. The tooth should fit up tight against the adapter. Also, there must be a minimum clearance of 2 - 3 mm between the bottom of the tooth and the cutting edge (H, Fig. 17.11). It is permissible to grind on the adapter, but never on the tooth itself. Each adapter must be positioned and fit up (Fig. 17.12) with the same tooth that will be installed in that adapter.

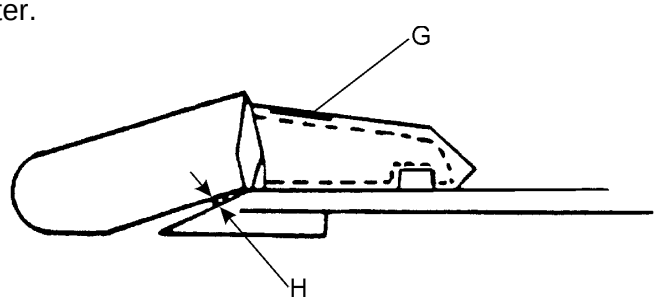


Fig. 17.11. Tooth Fit-Up

G. Shim location H. Tooth-to-cutting edge clearance

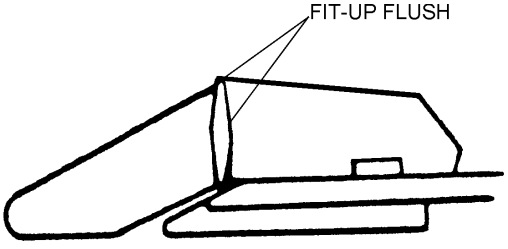


Fig. 17.12. Adapter Fit-Up

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3. Tack weld adapter in position in the sequence shown in Fig. 17.13. Remove tooth after adapter is tacked.

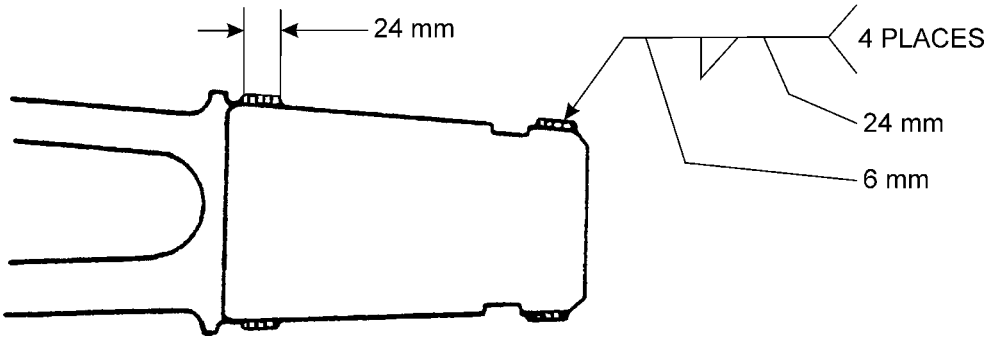


Fig. 17.13. Adapter Tacking Sequence

4. Starting at one of the center adapters, preheat the bucket cutting edge by applying heat to the bottom side of the cutting edge (F, Fig. 17.10). Continue heating until the temperature on the top side of the cutting edge reaches 200°C for a distance of 100 mm all around the adapter. Use of a Tempil Stik is recommended. When the cutting edge temperature reaches 200°C, start heating the adapter both inside and out to 200°C.

5. Follow the welding sequence shown in Fig. 17.14 starting at 15mm on the inside of the adapter (J, Fig. 17.14). The size of these welds is shown as (D and E, Fig. 17.10). The bead on the insides of the adapter must be sized so that it will not prevent insertion of the tooth. Continue until the adapter is welded halfway, then proceed to the next adapter. Weld this one halfway, then finish the first adapter.

NOTE: *Keep locking key recesses free from weld material*.

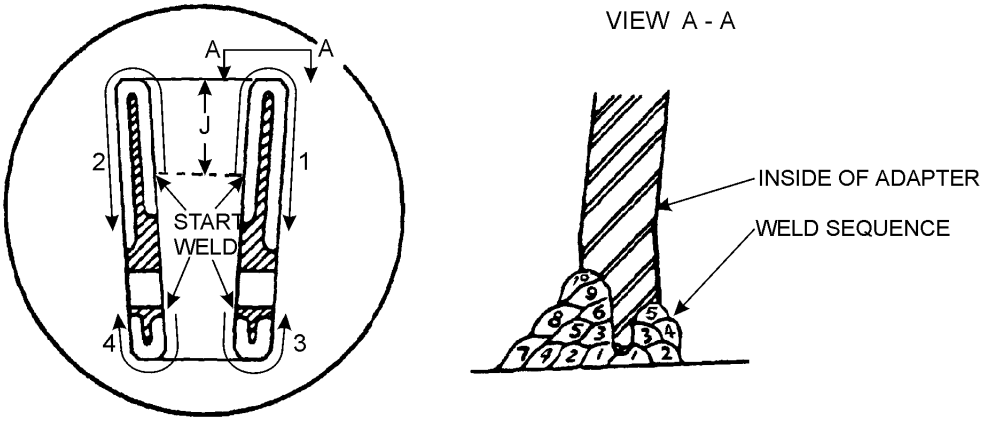


Fig. 17.14. Welding Sequence

J. Starting point of weld sequence

6. Continue alternating welding on adapters from the center out until all adapters are welded. During all welding or if the welding is stopped for any reason, the adapters and the bucket must be maintained at 200°C. Reheat if required.

7. No undercut or notches of any kind will be tolerated from the adapter to the bucket. Toe of weld must be blended into adapter either by welding or grinding.

8. After everything is cooled, insert each tooth into its respective adapter. Should the tooth not sit flush against the adapter, remove the tooth and grind the inside edges of the adapter to allow a tight fit up (Fig. 17.12).

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9. Install the locking key. Refer to the steps shown in Fig. 17.15. Insert the locking key (1) angled slightly toward the front of the bucket as shown in Step A. Drive the locking key in, using a suitable bar being certain to drive on both steel parts of the lock at the same time (Step B). Locking key should straighten as it is driven in. Even if locking is flush with side of adapter, it may not be correctly located as indicated by the circle in Step B. To be sure key is correctly located, it should be driven in until it snaps in place and then checked that it is centered in the adapter (dimension A is equal on both sides as shown in Step C). If not centered, tap on key to center it.

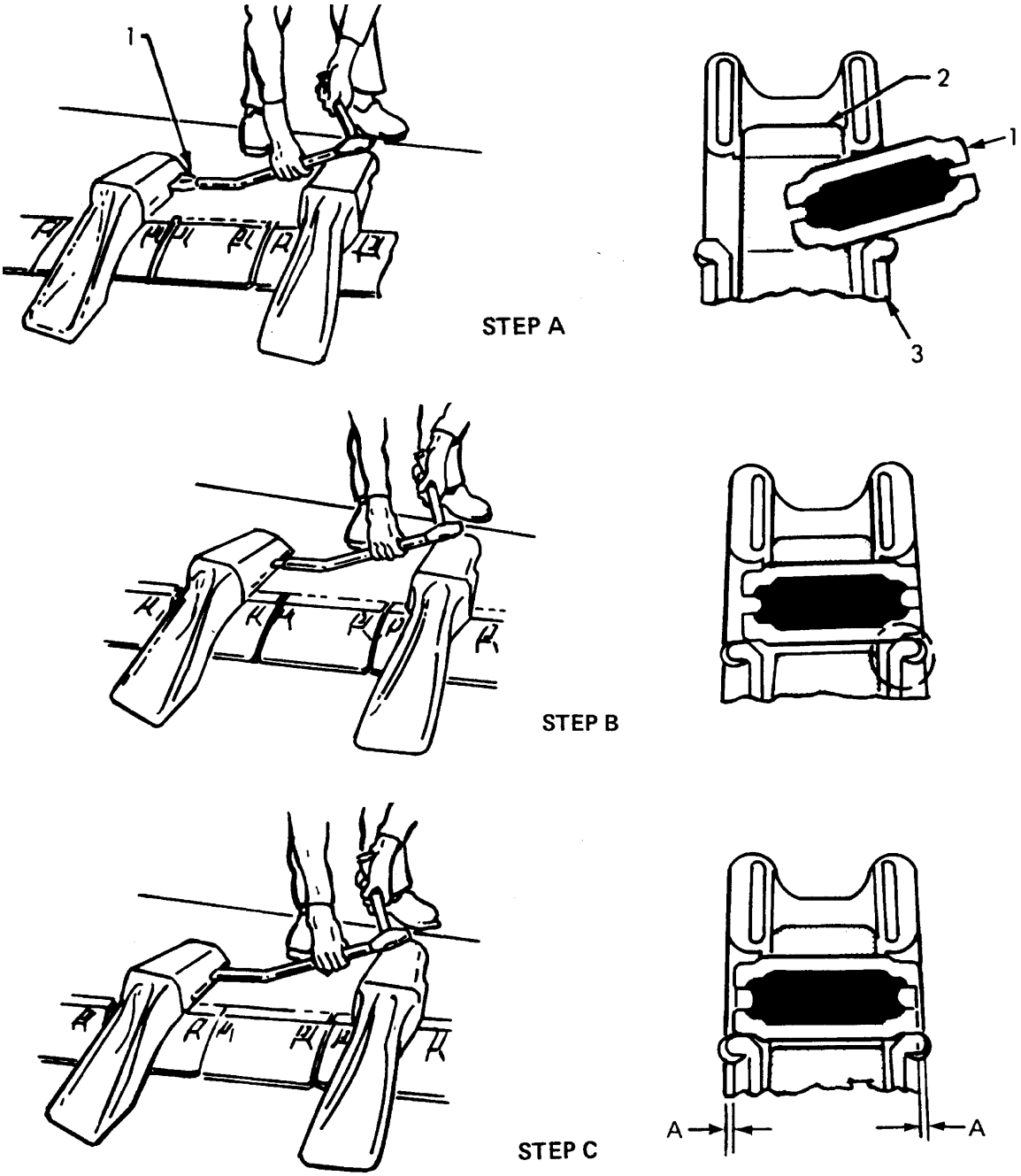


Fig. 17.15. Tooth Locking Key Installation

1. Locking key 2. Shank of tooth 3. Adapter