DAEWOO

MEGA 300-III

MECHATROPIA™

D A E W O O W H E E L L O A D E R

Shop Manual

Printed in U.S.A.

Serial Number 0001 and Up

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To the Operator of a Daewoo Wheel Loader

⚠ DANGER!!!

Improper use of the Wheel Loader could cause serious injury or death. Before operating the wheel loader, or performing maintenance, the operator or technician must read and understand the entire Operation and Maintenance Manual.

Any Operation, Maintenance, Traveling or Shipping methods that do not follow the Safety guidelines printed in this Manual could cause serious injury or death.

Basic Wheel Loader Operating Safety

The safety information on the following pages is organized into the following topics.

I. **General Safety Essentials**
II. **Locations of Safety Labels**
III. **Summary of Safety Precautions for Lifting**
IV. **Operation**
V. **Equipment**
VI. **Maintenance**
VII. **Shipping and Transportation**

General Safety Essentials

Accessory Applications

The wheel loader has been designed primarily for moving earth with a bucket. For use as a grapple or for other object handling, contact Daewoo. Lifting-work applications are permitted in approved lift configuration, to rated capacity only, with no side-loading (unless prohibited by local regulation). DO NOT use the machine for activities for which it was not intended. DO NOT use the bucket for lifting work, unless lift slings are used in the approved configuration.

Working in rough terrain, use of an accessory hydraulic hammer (breaker), demolition applications, or other hazardous operation may require installation of additional protective structures to safeguard the operator.

Static Tipping Load

The machine can lift a maximum of 14,500 kg (31,967 lb) with the bucket in the Straight Ahead position, and a maximum of 12,000 kg (26,455 lb) with the bucket in the Fully Turned position. Hooks and slings must be attached to an eye that is in the center of the bucket. All lifts must be made with the machine standing on a firm and level surface. Loads must be balanced and supported evenly. Use taglines to keep the load steady if wind conditions and large surface area are a problem. Work crew hand signals, individual tasks and safe procedures should all be universally understood before the lift is made.

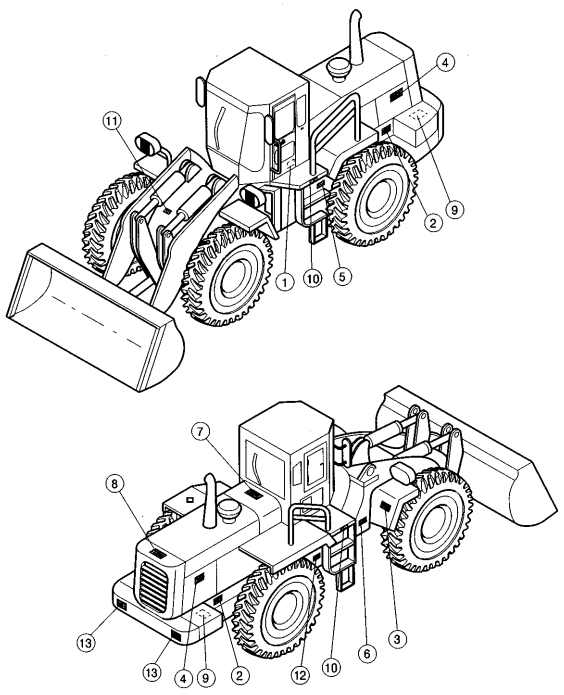
NOTE

Before using the wheel loader to make lifts, check the statutes at all levels of government that might have jurisdiction. Some governing bodies may require that all heavy lifting be done with a crane that is specifically designed for making lifts. When making lifts, always follow all instructions, guidelines, and restrictions for Safe Lifting in the Operation and Maintenance and Shop Manuals.

Locations of Safety Labels

Always keep these labels clean. If they are lost or damaged, attach them again or replace them with a new label. Make sure replacement parts have current labels.

There are other labels in addition to the safety labels that follow so handle them in the same way. Safety labels may be available in languages other than English. To find out what labels are available, contact your Daewoo distributor.



3192

1. Warning for operation, inspection and maintenance (2190 – 2530).

⚠ CAUTION

- Read manual and labels before operation and maintenance. Follow instructions and warnings in manual and on labels on the machine.
- Never get in under the machine while it is being jacked up with boom and arm.
- For transporting the machine, the swing lock must be hung on.
- Turn Auto-Idle switch OFF, when loading the machine.
- Sound the horn to alert the people nearby before operating, and make sure all persons are clear of area.
- Always make sure when leaving operator's seat to:
  - Lower bucket or other working tools to the ground.
  - Move SAFETY LOCK DEVICE (located near seat) to LOCK position.
  - Turn key switch OFF. Remove key from switch.
- If hydraulic components and units are ABNORMAL, consult nearest DAEWOO dealer or authorized service shop. Do not attempt to make an overhaul.

2. Warnings for high voltage.

⚠ DANGER

Serious injury or death can occur if machine or attachments contact with electric lines. Never move any part of unit or load closer to electric lines than 3 m (10') plus twice the line insulator length.

3. **Warning when opening front window (2190 – 2526).**

WARNING

When raising window, lock it in place with lock pins on both sides.

Falling window can cause injury.

4. **Warnings when opening engine hood (2190 – 2525).**

WARNING

Before opening bonnet, stop engine.

5. **Warning for handling accumulator (2190 – 2528).**

WARNING

- Keep away from flame.
- Do not weld or drill.

Explosion hazard

Accumulator

The wheel loader pilot control system is equipped with an accumulator. The accumulator will store a pressure charge that may enable the hydraulic controls to be activated for a brief period of time after the engine has been shut down. Activation of any of the controls may enable the selected function to operate under the force of gravity.

CAUTION!!!

Any raised attachment will lower to the ground if the accumulator holds a charge.

When shutting the machine down, lower the front attachment to the ground. After the engine has been shut down, move the joystick controls to release the pressure in the accumulator.

IMPORTANT

Refer to the Shop Manual for service procedures. Do not release any of the pilot lines until the pressure within the accumulator has been released.

6. **Keep off the steering turn area (4190 – 1992).**

DANGER

Keep out of the steering turn area.

7. **Warning for high temperature hydraulic oil (2190 – 2529).**

WARNING

HYDRAULIC OIL

To prevent hot oil from spurting out:

- Turn engine off.
- Allow oil to cool.
- Slowly loosen cap to relieve pressure before removing.

8. **Warning for high temperature coolant (2190 – 2531).**

WARNING

To prevent hot water from spurting out:

- Turn engine off.
- Allow water to cool.
- Slowly loosen cap to relieve pressure before removing.

9. Warning for battery maintenance (2190 – 2533).

DANGER

- Battery fumes can explode. Keep sparks and flames away from batteries.
- Always avoid storing metals like tools or inflammable materials around or on the batteries.
  Explosion or fire can be caused by short circuiting batteries.
- Sulfuric acid in battery is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed in eyes.

  If you spill acid on yourself:

  1. Flush your skin with water.
  2. Apply baking soda or lime to help neutralize the acid.
  3. Flush your eyes with water for 10-15 minutes.
     Get medical attention immediately.

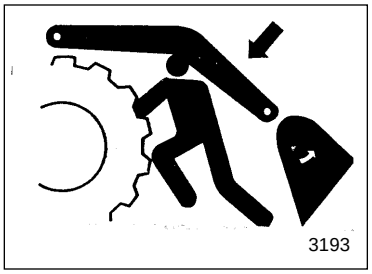
10. Warning for riding on machine (4190 – 1989).

WARNING

For your safety, do not stand on ladder when machine is in motion.

11. Warning for performing maintenance on front attachment (4190 – 2546).

DANGER



To avoid injury, securely brace lift arm before disassembly of valve or piping.

12. Warning to use safety lock (4190 – 1993).

WARNING

Safety lock must be in lock position when servicing pivot area or transporting machine.

13. Stay clear of working area caution (4190 – 1991).

CAUTION

Do not stay in the working area of the machine.

Summary of Safety Precautions for Lifting

⚠ DANGER!!!

Unsafe use of the wheel loader while making rated lifts could cause serious, potentially fatal injuries or extensive damage to the machine or nearby property. Do not let anyone operate the machine unless they've been properly trained and understand the information in the Operation and Maintenance Manual.

To make safe lifts, the following items must be evaluated by the operator and the work-site crew.

- Condition of ground support
- Wheel loader configuration and attachments
- Load weight
- Safe rigging of the load
- Proper handling of the suspended load

Taglines on opposite sides of the load can be very helpful in keeping a suspended load secure, if they are anchored safely to control points on the ground.

⚠ WARNING!!!

1. **NEVER wrap a tagline around your hands or body.**
2. **NEVER rely on taglines or use the wheel loader in lifting mode when wind gusts are in excess of 48.3 km/h (30 mi/h). Be prepared for any type of wind gust when working with loads that have a large surface area.**

Unauthorized Modifications

IMPORTANT

If you need more information or have any questions or concerns about safe operating procedures or working the wheel loader correctly in a particular application or in the specific conditions of your individual operating environment, please consult your local Daewoo representative.

Any modification made without authorization or written approval from Daewoo can create a safety hazard, for which the machine owner must be held responsible.

For safety's sake, replace all OEM parts with the correct authorized or genuine Daewoo part. For example, not taking the time to replace fasteners, bolts or nuts with the correct replacement parts could lead to a condition in which the safety of critical assemblies is dangerously compromised.

Attachment Precautions

Options kits are available through your dealer. Contact Daewoo for information on available one-way (single-acting) and two-way (double-acting) piping/valving/ auxiliary control kits. Because Daewoo cannot anticipate, identify or test all of the attachments that owners may wish to install on their machines, please contact Daewoo for authorization and approval of attachments, and their compatibility with options kits.

Avoid High-voltage Cables

Serious injury or death can result from contact or *proximity* to high-voltage electric lines. *The bucket does not have to make physical contact with power lines for current to be transmitted.*

Use a spotter and hand signals to stay away from power lines not clearly visible to the operator.

Depending upon the voltage in the line and atmospheric conditions, strong current shocks can occur with the boom or bucket as far away as 4 m – 6 m (13' 0" – 20' 0") from the power line. Very high voltage and rainy weather could further decrease that safety margin.

⚠ DANGER!!!

Before starting any type of operation near power lines *(either above ground or buried cable-type),* you should always contact the power utility directly and work out a safety plan with them.

Before Starting to Dig, Contact Authorities

Below ground hazards also include natural gas lines, water mains, tunnels and buried foundations. Know what's underneath the work-site before starting to dig.

Be Aware of Height Obstacles

Any type of object in the vicinity of the boom could represent a potential hazard, or cause the operator to react suddenly and cause an accident. Use a spotter or signal person working near bridges, phone lines, work-site scaffolds, or other obstructions.

Use Care on Loose Support

Working heavy loads over loose, soft ground or uneven, broken terrain can cause dangerous side load conditions and possible tipover and injury. Travel without a load or balanced load may also be hazardous.

If temperatures are changing, be cautious of dark and wet patches when working or traveling over frozen ground. Stay away from ditches, overhangs and all other weak support surfaces. Halt work and install support mats or blocking if work is required in an area of poor support.

Use Solid Support Blocking

Never rely on lift jacks or other inadequate supports when work is being done. Block wheels fore and aft to prevent any movement.

Digging Beneath Overhangs

Digging beneath an overhang is dangerous. The overhand could collapse on top of the operator and cause serious injury or death. Go on to another digging area before steep overhangs are formed. Know the height and reach limits of the wheel loader and plan ahead while working. Park wheel loader away from overhangs before work shutdown.

Digging Beneath the Wheel Loader

Digging beneath the wheel loader is dangerous. The earth beneath could collapse. This could cause the wheel loader to tip, which could cause serious injury or death to the operator. Working around deep pits, trenching or along high walls may require support blocks, especially after heavy rainfalls or during spring thaws.

Sloping Terrain Requires Caution

Dig evenly around the work-site whenever possible, trying to gradually level any existing slope. If it is not possible to level the area or avoid working on a slope, reducing the size and cycling rate of the workload is recommended.

On sloping surfaces, use caution when positioning the wheel loader prior to starting a work cycle. Stay alert for instability situations in order to avoid getting into them. For example, you should always avoid working the bucket over downhill side of the machine when parked perpendicular to the slope. Avoid full extensions of the bucket in a downhill direction. Lifting the bucket too high, too close to the machine, while the wheel loader is turned uphill can also be hazardous.

Stay Alert for People Moving through the Work Area

- When loading a truck you should always know where the driver is.
- Avoid loading over the cab of a truck even if the driver is in a safe spot. Someone else could have gone inside, for any number of reasons. Avoid working where unseen passersby might be.
- Slow down the work cycle and use slower travel speeds in congested or populated areas. Use a commonly understood signal so that other members of the work crew can warn the operator to slow or halt work in an impending hazardous situation.

Operation

Be Prepared – Get to Know All Operating and Safety Instructions

This is the Safety Alert Symbol. Wherever it appears – in this manual or on safety signs on the machine – you should be alert to the potential for personal injury or accidents. Always observe safety precautions and follow recommended procedures.

Operate While Seated at the Operator's Station ONLY

Never reach in through a window to work a control. Do not try to operate the wheel loader unless you are in the command position – seated at the controls. You should stay alert and focused on your work at all times but DO NOT twist out of the seat if job activity behind you (or to the side) requires your attention.

Use a spotter or signal person if you cannot see clearly and something is happening behind you.

Replace damaged safety labels and lost or damaged operator's manuals.

Do not let anyone operate the machine unless they have been fully and completely trained, in safety and in operation of the machine.

Learn the Signal Words Used with the Safety Alert Symbol

The words **"CAUTION," "WARNING,"** and **"DANGER"** used throughout this manual and on labels on the machine indicate hazards or unsafe practices. All three statements indicate that safety is involved. Observe the precautions indicated whenever you see the Safety Alert "Triangle," no matter which signal word appears next to the "Exclamation Point" symbol.

CAUTION!!!

Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury. It may also be used to alert against a generally unsafe practice.

WARNING!!!

Indicates a hazardous situation that, if not avoided, could result in serious injury or death. It may also be used to alert against a highly unsafe practice.

DANGER!!!

Indicates a hazardous situation that, if not avoided, is very likely to cause death or extremely serious injury. It may also be used to alert against equipment that may explode or detonate if handled or treated carelessly.

Before Starting the Engine

Do a "pre-start" safety check:

- Walk around your machine before getting in the operator's cab. Look for evidence of leaking fluid, loose fasteners, misaligned assemblies or any other indications of possible equipment hazard.
- All equipment covers and machinery safety guards must be in place, to protect against injury while the machine is being operated.
- Look around the work-site area for potential hazards, or people or property that could be at risk while operation is in progress.
- NEVER start the engine if there is any indication that maintenance or service work is in progress, or if a warning tag is attached to controls in the cab.
- A machine that has not been used recently, or is being operated in extremely cold temperatures, could require a warmup or maintenance service prior to start up.
- Check gauges and monitor displays for normal operation prior to starting the engine. Listen for unusual noises and remain alert for other potentially hazardous conditions at the start of the work cycle.
- Check tire inflation and check tires for damage or uneven wear. Perform maintenance before operation.

Never Use Ether Starting Aids

An electric-grid type manifold heater is used for cold starting. The glowing heater element can cause ether or other starting fluid to detonate, causing injury.

Mounting and Dismounting

- NEVER get on or off a moving machine. Do not jump on/off. The entry/egress path should be clear of mud, oil and spills and mounting hardware must be kept tight and secure.
- Always use handholds or steps and maintain at least 3-point contact of hands and feet. Never use controls as handholds.
- NEVER get up from the operator's seat or leave the operator's station and dismount the machine if the engine is running.

Observe General Safety Rules

Only trained and authorized personnel, with a good knowledge and awareness of safe procedures, may be allowed to operate or perform maintenance or service on the wheel loader.

All personnel at the work-site should be aware of assigned individual responsibilities and tasks. Communication and hand signals used should be understood by everyone.

Terrain and soil conditions at the job site, approaching traffic, weather-related hazards and any above or below ground obstacles or hazards should be observed and monitored by all work crew members.

Engine Ventilation

Engine exhaust gases can cause loss of judgment, loss of alertness, and loss of motor control. These gases can also cause unconsciousness, serious injury and fatal accidents.

Make sure of adequate ventilation before starting the engine in any enclosed area.

You should also be aware of open windows, doors or ductwork into which exhaust may be carried, or blown by the wind, exposing others to danger.

Take Time to Provide Good Visibility

Halt work if visibility is poor. Strong rains, snow, fog and extremely dusty conditions can all obscure visibility so badly that it is best to wait for weather to change or dust to settle before continuing operation.

Night work in areas of limited visibility should be halted if installation of extra work lights on the machine (or work area) is necessary.

Keep dirt and dust off of windows and off the lens surfaces of work lights. Stop working if lights, windows or mirrors need cleaning or adjustment.

Fuel, Oil and Hydraulic Fluid Fire Hazards

Add fuel, oil, antifreeze and hydraulic fluid to the machine only in a well ventilated area. The machine must be parked with controls, lights and switches turned off. The engine must be off and any flames, glowing embers, auxiliary heating units or spark-causing equipment must be doused, turned off and/or kept well clear of the machine.

Static electricity can produce dangerous sparks at the fuel filling nozzle. In very cold, dry weather or other conditions that could produce static discharge, keep the tip of the fuel nozzle in constant contact with the neck of the fuel filling nozzle, to provide a ground.

Keep fuel and other fluid reservoir caps tight and do not start the engine until caps have been secured.

Boost Starting or Charging Engine Batteries

Turn off all electrical equipment before connecting leads to the battery. This includes electrical switches on the battery charger or boost starting equipment.

When boost-starting from another machine or vehicle do not allow the two machines to touch. Wear safety glasses or goggles while required parallel battery connections – positive to positive and negative to negative – are made. (24 volt battery units consisting of two series-connected twelve volt batteries have a cable connecting one positive terminal on one of the 12 volt batteries to a negative terminal on the other battery. Booster or charger cable connections must be made between the non-series-connected positive terminals and between the negative terminal of the booster battery and the metal frame of the machine being boosted or charged.) Refer to the procedure and illustration in the Engine section of this book.

Connect positive cable first when installing cables and disconnect the negative cable first when removing them. The final cable connection, at the metal frame of the machine being charged or boost-started, should be as far away from the batteries as possible.

Keep “Pinch Point” Areas Clear – Use Caution in Reverse

Use a signal person in high traffic areas and whenever the operator’s view is not clear, such as when traveling in reverse.

Anyone standing near the wheels, or working assemblies of the attachment, is at risk of being caught between moving parts of the machine.

Never allow anyone to ride on any part of the machine or attachment, including any part of the operator’s cab.

Travel Precautions

Engage frame lock for long-distance travel. When traveling the wheel loader always keep lights on; make sure that you are in compliance with all state and local regulations concerning warning flags and signs.

Attachment control levers should not be operated while traveling.

Fold in work equipment so that the outer end of the boom is as close to the machine as possible, and is low – 203 mm – 304 mm (8" – 12") above ground.

Never travel over obstacles or slopes that will cause the machine to tilt severely. Travel around any slope or obstacle that causes 10 degrees tilt, or more.

Operate Carefully on Snow and Ice and in Very Cold Temperatures

In icy cold weather avoid sudden travel movements and stay away from even very slight slopes. The machine could skid off to one side very easily.

Snow accumulation could hide or obscure potential hazards. Use care while operating or while using the machine to clear snow.

Warming up the engine for a short period may be necessary, to avoid operating with sluggish or reduced working capacity. The jolting shocks and impact loads caused by bumping or bottoming the boom or attachment are more likely to cause severe stress in very cold temperatures. Reducing work cycle rate and work load may be necessary.

Parking the Machine

Avoid making sudden stops, or parking the machine wherever it happens to be at the end of the work day. Plan ahead so that the wheel loader will be on a firm, level surface away from traffic and away from high walls, cliff edges and any area of potential water accumulation or runoff. If parking on inclines is unavoidable, block the wheels to prevent movement. Lower the bucket or other working attachment completely to the ground, or to an overnight support saddle. There should be no possibility of unintended or accidental movement.

Shutdown Control Functions

After the bucket has been lowered to the overnight storage position, move all the switches and controls to the OFF position. Move the parking brake switch to the locked position. This will apply the parking brake. Move the pilot cut-off switch to the locked position. This will disable the bucket control lever. Move the key in the ignition switch to the OFF position, and remove the key from the switch.

Engage all lock-down security equipment that may have been installed on the machine.

IMPORTANT

When hydraulic system maintenance or service work must be performed, be aware that accumulators in the system store fluid under pressure after the system has been shut down. To release the hydraulic pressure in the accumulators, operate the control with the engine off until accumulator pressure is completely dissipated.

Equipment

Rough Operation May Require Use of Certified Safety Equipment

Work in mines, tunnels, deep pits or on loose or wet surfaces could produce danger of falling rock, roll over or hazardous flying objects. Additional protection for the operator's cab could be required in the form of a FOPS/ Falling Object Protective Structure, ROPS/Roll Over Protective Structure and/or OPS/Operator Protective Structure reinforcement system.

Any reinforcement system that is installed on the machine must pass safety and certification standards and carry appropriate labeling and rating information. For example, the most often added type of reinforcement system, FOPS, must meet or exceed Society of Automotive Engineers standard SAE J1356, "Performance Criteria for Falling Object Guards for Wheel loaders."

Never attempt to alter or modify any type of protective structure reinforcement system, by drilling holes, welding or remounting or relocating fasteners. Any serious impact or damage to the system requires a complete integrity reevaluation. Reinstallation, recertification and/or replacement of the system may be necessary.

Install Additional Safety Equipment if Conditions Require

When working with a breaker or in some shear work applications, a front guard over the windshield may be required. The windshield guard may or may not be OPS/certified, depending upon the specific application and working situation.

Laminate glass protection for the front, side or rear windows may also be recommended depending upon particular site conditions.

Contact your Daewoo distributor for available safety guards and/or recommendations if there is any danger of getting hit by objects that could strike the operator's cab. Make sure that all other work-site crew members are kept well away from the wheel loader and safe from potential hazards.

Movement Alarms

If the wheel loader is equipped with an audible travel movement alarm, test the alarm on a daily basis. The audible alarm should sound as soon as the travel system is engaged.

Seat Belts Should Be Used at All Times

Whenever the engine is running, the operator should be seated at the control station with the seat belt properly engaged.

Keep a Fire Extinguisher at Hand

It is recommended that an appropriately sized (2.27 kg [5 lb] or larger) multi-purpose "A/B/C" fire extinguisher be mounted in the cab. Check and service the fire extinguisher at regular intervals and make sure that all work-site crew members are adequately trained in its use.

Maintain Standard Safety Equipment in Good Condition

Machinery guards and body panel covers must be in place at all times. Keep well clear of rotating parts. Pinch point hazards such as cooling fan and alternator drive belts could catch hair, jewelry or oversize or very loose clothing.

Safety labels must be replaced if they are damaged or become unreadable. The information on labels gives work crew members an important safety reminder. Part numbers for each label and required mounting locations are shown on Pages 1-2 through 1-4 of this section.

Safety-critical Parts Must Be Replaced Periodically

Replace the following fire-related components as soon as they begin to show any sign of wear, or at regular periodic intervals, whether or not deterioration is visible:

- Fuel system flexible hoses, the tank overflow drain hose and the fuel filler cap.
- Hydraulic system hoses, especially the pump outlet lines and front and rear pump branch hoses.
- Keep mounting brackets and hose and cable routing straps tight. Hose routing should have gradual bends.

Hydraulic Cylinder Seals Require Periodic Replacement

Check cylinder drift rate at regular intervals. Maximum allowable rates are included at the end of the Hydraulic section in the Shop Manual. Overhaul seal kits are available through Daewoo.

High Pressure Hydraulic Lines Can Store a Great Deal of Energy

Exposed hydraulic hoses on the arm or boom could react with explosive force if struck by a falling rock, overhead obstacle or other job site hazard. Extra safety guards may be required. NEVER allow hoses to be hit, bent or interfered with during operation.

The Operator's Cab Should Be Kept Clean

Clean grease and dirt from pedals and controls. This contributes to safe operation.

Cleaning also provides an opportunity to inspect equipment. Minor damage can be repaired or corrected before major problems result.

Keep the cab floor and consoles free of tools and personal items.

Wear Eye Protection and Safety Clothing – Use Proper Tools

Contain long hair, and avoid wearing loose clothes or jewelry that could get caught in controls.

Full eye protection, a hard hat, safety shoes and gloves may be required at the job site.

While working on the machine, never use inadequate tools. They could break or slip, causing injury, or they may not adequately perform intended functions.

Breathing Masks, Ear Protection May Be Required

Do not forget that some risks to your health may not be immediately apparent. Exhaust gases and noise pollution may not be visible, but these hazards can cause disabling or permanent injuries.

NOTE

The sound level in the closed operator's cab is 75 dB(A). Additional information on the machine sound and vibration levels can be found in the Shop Manual.

Asbestos Fiber Hazard

Materials containing asbestos fiber can be present on the job site. Breathing air that contains asbestos fiber can ultimately cause serious or fatal lung damage. To prevent lung damage from asbestos fiber, observe the following precautions.

1. Use a respirator that is approved for use in an asbestos-laden atmosphere.
2. Use water for cleaning and for keeping dust down.
3. NEVER use compressed air for cleaning.

Battery Electrolyte and Explosive Gases Can Be Lethal

Flush eyes with water for 10 – 15 minutes if acid is splashed in the face. Anyone who swallows acid must have **immediate** medical aid. *Call the Poison Control listing in the front cover of the telephone directory.*

Explosive battery gas can be set off by sparks from incidental contact or static discharge. Turn off all switches and the engine when working on batteries. Keep battery terminals tight. Contact between a loose terminal and post can create an explosive spark.

Disconnect Batteries Before Electrical Service or Electrical Welding

Remove cable to negative terminal first when disconnecting cable. Connect positive terminal cables first when installing a battery.

Use Low Heat Portable Lighting

Hot surfaces on trouble lights or portable work lights can set off fuel or battery explosive gases.

Maintenance

Use Warning Tag During Service

Alert others that service or maintenance is being performed and tag operator's cab controls – and other machine areas if required – with a warning notice.

Warning tags for controls are available from Daewoo distributors; see Page 1-1 for more information.

Do Not Run the Engine if Repairs or Work Are Being Performed Alone

You should always have at least two people working together if the engine must be run during service. One person needs to remain in the operator's seat, ready to work the controls or stop the machine and shut off the engine.

Always Use Adequate Equipment Supports and Blocking

Do not allow weight or equipment loads to remain suspended. Lower everything to the ground before leaving the operator's seat. Do not use hollow, cracked or unsteady, wobbling weight supports. Do not work under any equipment supported solely by a lift jack.

Do Not Work on Hot Engines or Hot Cooling or Hydraulic Systems

Wait for the engine to cool off after normal operation. Park the wheel loader on a firm, level surface and lower all equipment before shutting down and switching off controls. When engine lube oil, gearbox lubricant or other fluids require change, wait for fluid temperatures to decrease to a moderate level before removing drain plugs.

NOTE

Oil will drain more quickly and completely if it is warm. Do not drain fluids at temperatures exceeding 95°C (203°F), however do not allow full cool-down.

Cool-down is Required Prior to Radiator or Reservoir Checks

Stop the engine and allow heat to dissipate before performing service on the engine radiator or hydraulic fluid reservoir. Both assemblies have air vent levers at or near the filler cap for venting built-up air pressure. Release the levers before trying to take off filler caps and LOOSEN CAPS SLOWLY, prior to removal.

Pressurized Hydraulic Oil Fluid Leaks Can Be Dangerous

Fluid leaks from hydraulic hoses or pressurized components can be difficult to see but pressurized oil has enough force to pierce the skin and cause serious injury.

Always use a piece of wood or cardboard to check for suspected hydraulic leaks. Never use your hands or expose your fingers.

Obtain immediate medical attention if pressurized oil pierces the skin.

⚠WARNING!!!

Failure to obtain prompt medical assistance could result in gangrene or other serious damage to tissue.

Use Correct Replacement Fasteners Tightened to Proper Torque

Refer to the General Maintenance section of the Shop Manual for information on tightening torques and recommended assembly compounds and always use the correct part.

Poor or incorrect fastener connections can dangerously weaken assemblies.

Dispose of All Petroleum-based Oils and Fluids Properly

Physical contact with used motor oil may pose a health risk. Wipe oil from your hands promptly and wash off any remaining residue.

Used motor oil is an environmental contaminant and may only be disposed of at approved collection facilities. Never drain any petroleum-based product on the ground or dispose of old oil in municipal waste collection containers, or in metropolitan sewer systems or rural landfills.

Check state and local regulations for other requirements.

Check Tire Pressure and Condition

Maintain tire pressure but do not over inflate. Inspect tires and wheels daily. When inflating tires, follow procedures in the Maintenance section, which include using an extension to allow you to avoid standing in front of or over a tire. Do not change a tire unless you have both experience and proper equipment.

Shipping and Transportation

Obey State and Local Over-the-Road Regulations

Check state and local restrictions regarding weight, width and length of a load prior to making any other preparation for transport.

The hauling vehicle, trailer and load must all be in compliance with local regulations governing the intended shipping route.

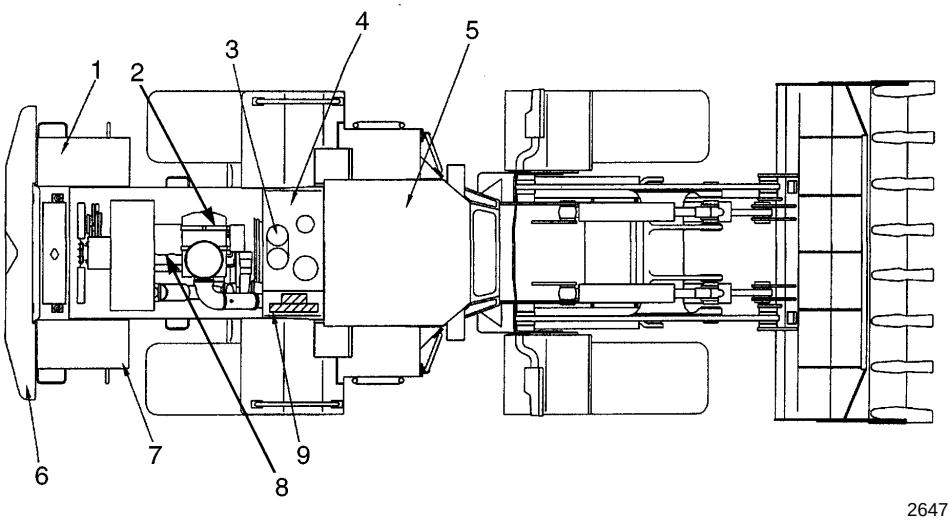
Partial disassembly or tear-down of the wheel loader may be necessary to meet travel restrictions or particular conditions at the job site.

Refer to the Transportation and Shipping section of the Operation and Maintenance Manual. Information on partial machine disassembly, loading and unloading, lifting and towing is included in the Operation and Maintenance Manual.

Component Locations

Figure 2-1 identifies the location of the major machine components.

1. Battery Box
2. Air Filter
3. Oil Filter
4. Oil Tank
5. Operator's Cab
6. Counterweight
7. Battery Box
8. Engine
9. Air Cond. Condenser
10. Fan
11. Radiator
12. Engine Oil Filler Cap
13. Engine Dipstick
14. Air Precleaner
15. Muffler
16. Rear Wheel Cover
17. Seat
18. Operator's Controls
19. Steering Wheel
20. Block
21. Front Wheel Cover
22. Control Valve
23. Tilt Cylinder
24. Lift Cylinder
25. Lever
26. Loader Arm
27. Bucket
28. Tooth
29. Link
30. Front Axle
31. Parking Brake
32. Drive Shaft
33. Center Pin
34. Transmission Filler Cap
35. Transmission
36. Transmission Oil Gauge
37. Rear Axle
38. Rear Axle Pivot
39. Fuel Filler Cap
40. Fuel Tank



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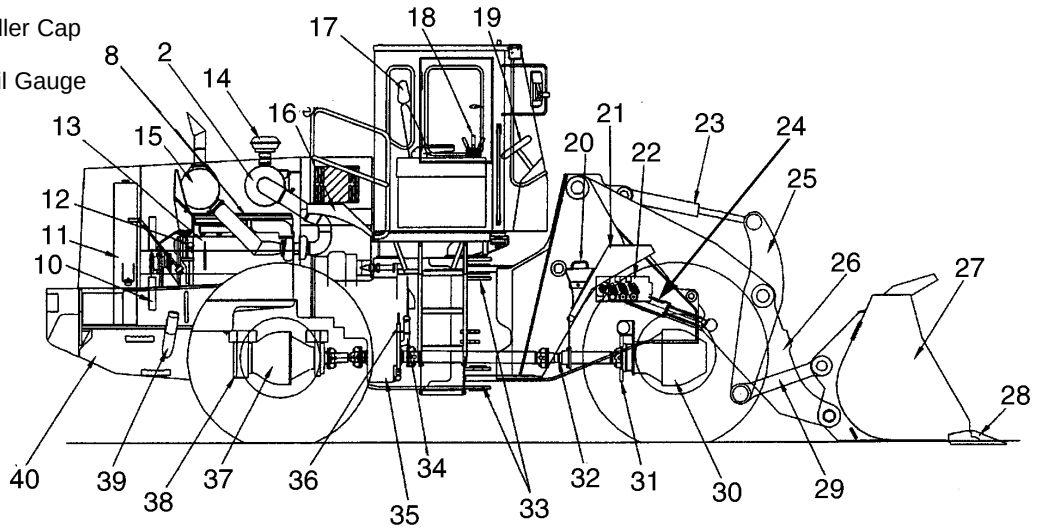


FIGURE 2-1

2648

General Specifications

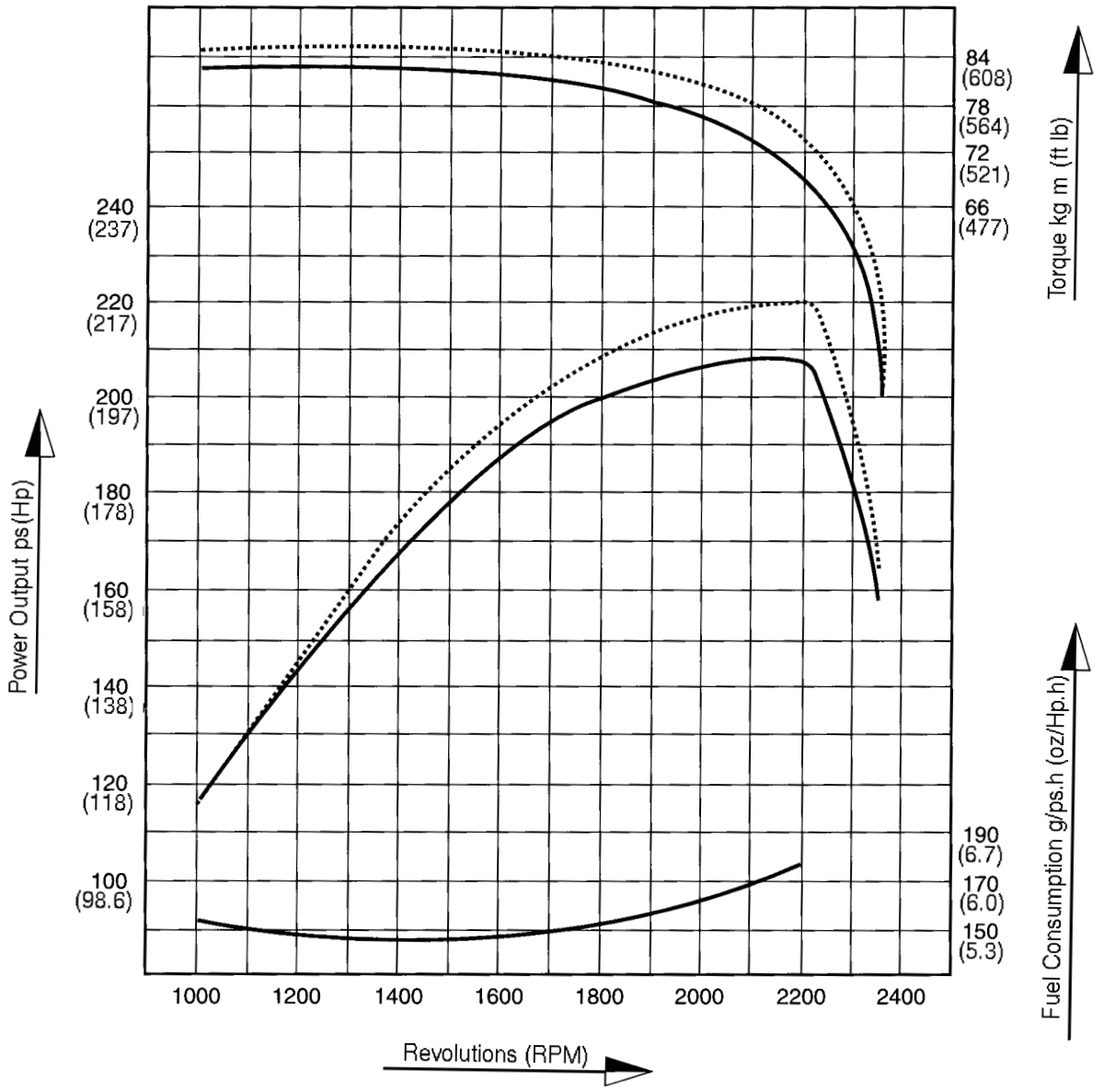
MEGA 300-III		
Item		**Specification**
Standard Bucket Capacity		2.4 m^3 (3.14 yd^3) Level 2.9 m^3 (3.79 yd^3) Heaped
Vehicle Weight		16,900 kg (37,258 lb)
Engine		
	Type	Daewoo D2366T
	Horsepower	208 ps (205 Hp) @ 2,200 RPM
	Max. Torque	83 kg m (600 ft lb) @ 1,300 RPM
Transmission		
	Type	Full Power Shift
	Speeds	4 Forward, 3 Reverse
Brake Systems		
	Travel Brakes	4 Wheel, Wet Disk
	Parking Brake	Drive Shaft Brake
Performance		
	Travel Speed	6 – 38 km/h (3.7 – 23.6 mph)
	Braking Distance	13.7 m @ 38 km/h (No Load) 45 ft @ 23.6 mph
	Steering Angle	± 40°
	Min. Tire Turning Radius	5,472 mm (17' 11")
	Service Load	5,220 kg (11,508 lb)
	Max. Excavation Performance	11,852 kg (26,129 lb)
	Bucket Rise Time	5.6 Seconds
	Bucket Dump Time	1.3 Seconds
	Bucket Descent Time	3.5 Seconds
	Max. Gradeability	58% (30°)
Static Tipping Load		
	Bucket Straight Ahead	12,415 kg (27,370 lb)
	Bucket Fully Turned	10,713 kg (23,618 lb)

Engine Specifications

Model	Daewoo D2366T
Type	4 Cycle In-line 6 Cylinder Diesel, Turbocharged, Water-cooled
Combustion Chamber	AVL Toroidal
Combustion System	Direct Injection
Cylinder Bore and Stroke	123 mm x 155 mm (4.84" x 6.10")
Engine Displacement	11,051 cm^3 (674 in^3)
Direction of Rotation	Counterclockwise (viewed facing flywheel)
Compression Ratio	16.5 : 1
Rated Flywheel Horsepower	208 Metric Hp (205 Hp) @ 2,200 RPM with Fan
Torque Output	83 kg m (684 ft lb) @ 1,300 RPM with Fan
Fuel Filter (Two-stage)	Felt Primary Element Paper Secondary Element
Cylinder Firing Order	1-5-3-6-2-4
Mass (Dry)	920 kg (2,028 lb)
Engine Oil	American Petroleum Institute/SAE Class CC/CD or better (Class CD-II, CE, CF-4, CG-4)
Injector Nozzle Type	NP-DLLA 150 SV 3117308
Fuel Injection Timing	5.6° BTDC
Valve Timing	Intake Open @ 18° BTDC Intake Close @ 34° ABDC Exhaust Open @ 46° BBDC Exhaust Close @ 14° ATDC
Fuel Injection Pump	NP-PE6P120/720 RS300
Governor	NP-EP/RSV 200-1300PO39C 311
Timer Type	NP-EP/SP 600-110025.5R
Supply Pump Type	NP-FP/KP
Batteries	2 x 12 V, 200 Ah
Charging System Regulator	IC Type (Integrated Circuit)
Alternator	60 amp, 24 V (IC Type)
Starter	6.6 Kw, 24 V (Magnet Type)
Engine Oil Capacity	21 l (22 qt) 25 l max./17 l min (26 qt max./18 qt min)
Engine Oil Pressure Ranges At Idle At Normal Speed	 0.8 – 1.4 kg/cm^2 (11.4 – 20 psi) 4.8 kg/cm^2 (68.3 psi)
Thermostat Temperatures	Opening begins @ 82°C (180°F), Fully open @ 95°C (203°F)
Coolant Capacity (Engine only)	19 l (20 qt)
Engine Coolant Thermostat	Wax-Pellet Type
Maximum Engine Tilt	35 degrees (Fore/Aft and Rt/Left)
Turbocharger Type	Exhaust Gas Driven
Lubrication Pressures At Idle At Max. Engine RPM	 Min. 0.8 bar (11.6 psi) Min. 2.0 bar (29 psi)
Rotor Shaft Axial Clearance	Max. 0.25 mm (0.0098")
Rotor Shaft Radial Clearance	Max. 0.5 mm (0.0197")

Engine Performance Curves

Figure 2-2 contains graphs that illustrate engine power, torque, and fuel consumption in relation to engine RPM.



- Power Output – Metric Hp (Hp)/RPM : 208 (205)/2,200
- Torque – Kg m (ft lb)/RPM : 83 (684)/1,300
- Fuel Consumption – g/ps.h (oz/Hp.h) : 175 (6.2)

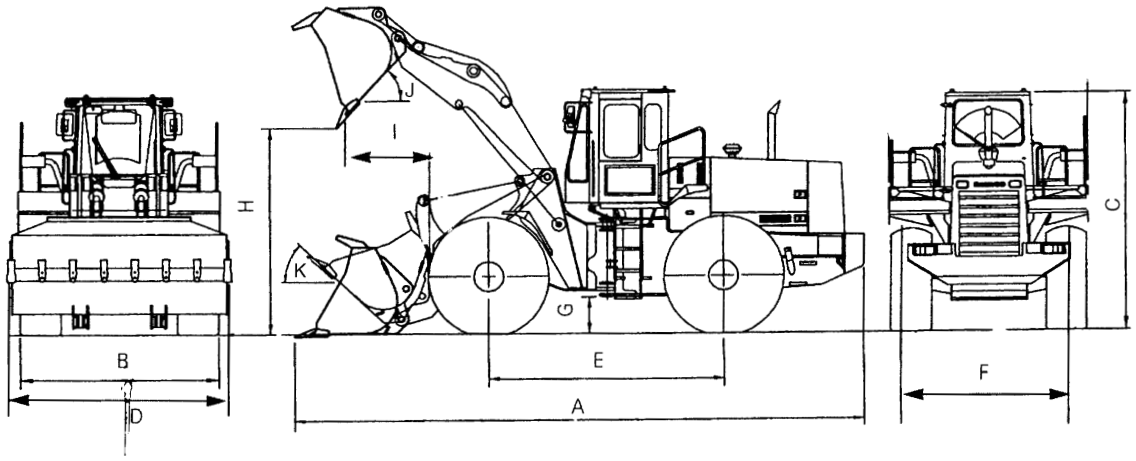
FIGURE 2-2

4430

Working Range and Dimensions

Figure 2-3 illustrates the exterior machine dimensions and the working range of the machine when it is equipped with a standard Bucket.

Figure 2-4 illustrates the working range when the machine is equipped with the optional Pallet Fork. Figure 2-5 illustrates the working range when the machine is equipped with the optional Log Fork.



Category	Dimension
Overall Length (A)	7,940 mm (26' 1")
Overall Width, without bucket (B)	2,760 mm (9' 1")
Overall Height (C)	3,470 mm (11' 5")
Bucket Width (D)	2,920 mm (9' 7")
Wheel Base (E)	3,200 mm (10' 6")
Tread (F)	2,150 mm (7' 1")
Ground Clearance (G)	470 mm (1' 7")
Dump Height, to tooth (H)	2,837 mm (9' 4")
Dump Distance, to bucket edge (I)	1,135 mm (3' 9")
Bucket Angle, Raised (J)	45°
Bucket Angle (K), Lowered	42°
Tire Size	23.5-25-16 PR

FIGURE 2-3

2883

Working Range with Pallet Fork (Option)

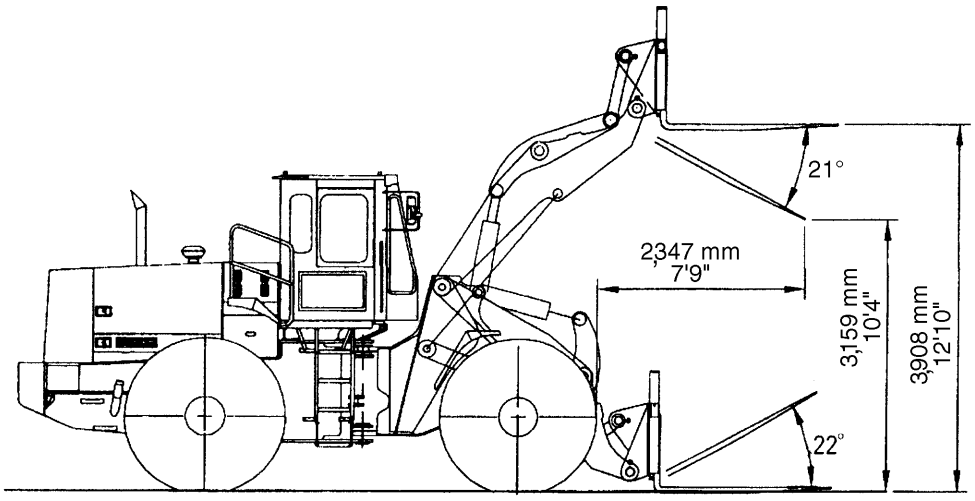


FIGURE 2-4

2884

Working Range with Log Fork (Option)

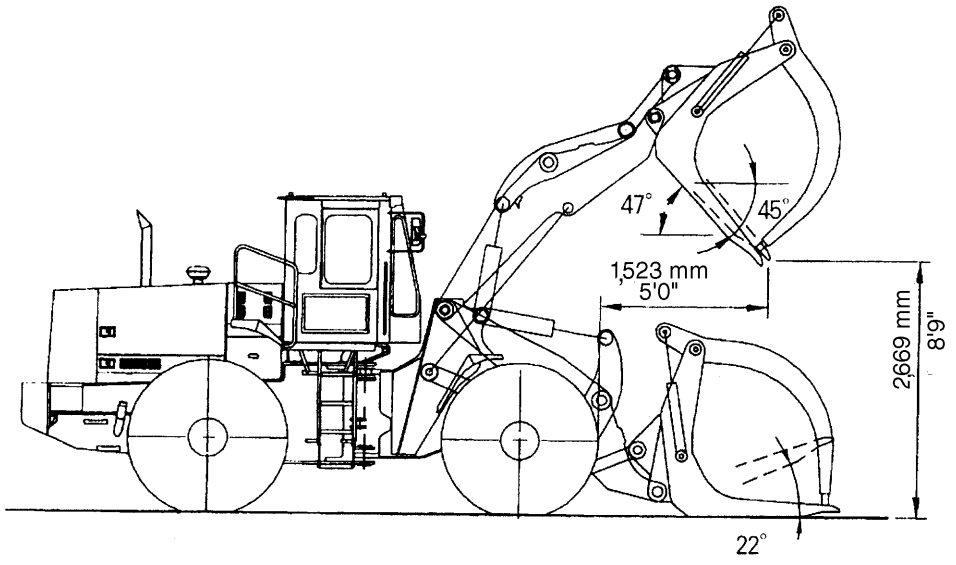


FIGURE 2-5

2885

Working Capacities

Bucket Capacity

The standard toothed bucket has a capacity of 2.9 m^3 (3.8 yd^3). An optional toothed bucket for heavy material has a capacity of 2.7 m^3 (3.5 yd^3). An optional bucket equipped with a cutting edge and no teeth has a capacity of 3.9 m^3 (5.1 yd^3).

Tipping Load

The Static Tipping Load with the bucket in the Over Front position is 12,415 kg (27,370 lb). With the bucket in the Fully Turned position, the Static Tipping Load is 10,713 kg (23,618 lb).

Material Weight

The data in Table 3-1 describes the weight of a cubic meter (cubic yard) of many types of workload materials.

Approximate Weight of Workload Materials

Material	Low Weight or Density, 1,100 kg/m³ (1,850 lb/yd³), or less	Medium Weight or Density, 1,600 kg/m³ (2,700 lb/yd³), or less	High Weight or Density, 2,000 kg/m³ (3,370 lb/yd³), or less
Charcoal	401 kg/m³ (695 lb/yd³)		
Coke, blast furnace size	433 kg/m³ (729 lb/yd³)		
Coke, foundry size	449 kg/m³ (756 lb/yd³)		
Coal, bituminous slack, piled	801 kg/m³ (1,350 lb/yd³)		
Coal, bituminous r. of m., piled	881 kg/m³ (1,485 lb/yd³)		
Coal, anthracite	897 kg/m³ (1,512 lb/yd³)		
Clay, DRY, in broken lumps	1,009 kg/m³ (1,701 lb/yd³)		
Clay, DAMP, natural bed		1,746 kg/m³ (2,943 lb/yd³)	
Cement, Portland, DRY granular		1,506 kg/m³ (2,583 lb/yd³)	
Cement, Portland, DRY clinkers		1,362 kg/m³ (2,295 lb/yd³)	
Dolomite, crushed		1,522 kg/m³ (2,565 lb/yd³)	
Earth, loamy, DRY, loose		1,202 kg/m³ (2,025 lb/yd³)	
Earth, DRY, packed		1,522 kg/m³ (2,565 lb/yd³)	
Earth, WET, muddy			1,762 kg/m³ (2,970 lb/yd³)
Gypsum, calcined, (heated, powder)	961 kg/m³ (1,620 lb/yd³)		
Gypsum, crushed to 3 inch size		1,522 kg/m³ (2,565 lb/yd³)	
Gravel, DRY, packed fragments			1,810 kg/m³ (3,051 lb/yd³)
Gravel, WET, packed fragments			1,922 kg/m³ (3,240 lb/yd³)
Limestone, graded above 2		1,282 kg/m³ (2,160 lb/yd³)	

Approximate Weight of Workload Materials (Continued)

Material	Low Weight or Density, 1,100 kg/m³ (1,850 lb/yd³), or less	Medium Weight or Density, 1,600 kg/m³ (2,700 lb/yd³), or less	High Weight or Density, 2,000 kg/m³ (3,370 lb/yd³), or less
Limestone, graded 1-1/2 or 2		1,362 kg/m³ (2,295 lb/yd³)	
Limestone, crushed		1,522 kg/m³ (2,565 lb/yd³)	
Limestone, fine			1,602 kg/m³ (2,705 lb/yd³)
Phosphate, rock		1,282 kg/m³ (2,160 lb/yd³)	
Salt	929 kg/m³ (1,566 lb/yd³)		
Snow, light density	529 kg/m³ (891 lb/yd³)		
Sand, DRY, loose		1,522 kg/m³ (2,565 lb/yd³)	
Sand, WET, packed			1,922 kg/m³ (3,240 lb/yd³)
Shale, broken		1,362 kg/m³ (2,295 lb/yd³)	
Sulphur, broken	529 kg/m³ (1,620 lb/yd³)		

IMPORTANT

Weights are approximations of estimated average volume and mass. Exposure to rain, snow or ground water; settling or compaction due to overhead weight and chemical or industrial processing or changes due to thermal or chemical transformations could all increase the value of weights listed in the table.

INSPECTION, MAINTENANCE AND ADJUSTMENT

Preventive Maintenance

Periodic checks and replacement of oil, grease, filters, etc. must be made at specific intervals, to keep the machine in good working condition. The following pages describe the items to be checked, the lubricants to be used, and the time interval between each check.

NOTE

The time interval between each service check may need to be shortened if the machine is operating in severe atmospheric conditions. Machines working in extremely hot or dusty conditions will require more frequent service checks. The total hours of machine operation are determined by the hour meter that is located on the front instrument panel.

Safety Precautions

1. Before performing any maintenance checks, move the pilot cutoff switch to the locked position. Place a warning tag on the controls so that no one begins to operate the machine while the maintenance checks are being performed.
2. Clean up all fuel spills. Fuel spills are hazardous, especially around the engine.
3. Inspect all fuel lines for leakage. Replace any lines, fittings, O-rings, or filters that show signs of wear or damage.
4. If a test procedure requires the engine to be running, keep all unnecessary personnel away from the machine.

Maintenance Intervals

Daily or Every 10 Operating Hours

- Grease Bucket Hinge Pins
- Grease Rod and Head Ends of Bucket Cylinders
- Grease Head Ends of Lift Cylinders
- Grease Loader Arm Feet
- Grease Arm-Lever Connecting Pins
- Grease Lift Cylinder Rods
- Check Engine Oil Level
- Check Transmission Oil Level
- Check Hydraulic System Oil Level
- Refill Fuel
- Drain Fuel Condensation
- Check Coolant Level
- Check Air Filter Indicator

Weekly or Every 50 Operating Hours

- Perform All Daily Service Checks
- Grease Rear Axle Pivot
- Grease Steering Cylinder Rods
- Steering Cylinder Head Ends
- Change Engine Oil and Filter*
- Replace Transmission Oil Filter*
- Hydraulic Full Flow Filter Replacement*
- Check Fan Belt Tension
- Clean Exterior of Radiator and Oil Cooler

*New Machine Break-in

Every 250 Operating Hours

- Perform All Daily and 50 Hour Service Checks
- Grease Upper and Lower Center Pins
- Grease Cooling Fan and Water Pump Pulley
- Replace Hydraulic System Pilot Filter
- Clean Air Cleaner
- Change Engine Oil and Filter
- Replace Transmission Oil Filter
- Hydraulic Full Flow Filter Replacement

Every 500 Operating Hours

- Perform All 10, 50 and 250 Hour Service Checks
- Grease Center Bearing of Front Drive Shaft
- Grease Both Universal Joints for Front Drive Shaft
- Grease Spline for Front Drive Shaft
- Grease Both Universal Joints for Rear Drive Shaft
- Grease Spline for Rear Drive Shaft
- Replace Fuel Filter Element

Every 1,000 Operating Hours

- Perform All 10, 50, 250, and 500 Hour Service Checks
- Center Axle and Axle End Oil Check
- Drain and Replace Hydraulic Oil
- Drain and Replace Transmission Fluid
- Clean Fuel Tank and Strainer
- Replace Air Cleaner Element
- Change Radiator Coolant

Every 1,500 Operating Hours

- Perform All 10, 50, 250, and 500 Hour Service Checks
- Center Axle and Axle End Oil Replacement

Annually or Every 2,000 Operating Hours

- Replace Wheel Brake Hoses, Steering Cylinder Hoses

Table of Recommended Lubricants

IMPORTANT

Do not use lubricants other than those recommended, without prior written approval from Daewoo.

Lubricant Manufacturer	Hydraulic Oil	Engine Oil	Grease	Axle Gear Oil	Transmission Gear Oil
Mobil	Mobil DTE 15M	Delvac 1330, 1340, Super 15W40, or Delvac 1	Mobilith AW1, or AW0 for cold weather	Mobilube HD 80W90	Multipurpose ATF
Shell	Tellus T46	Rotella T 15W40 or T30 (winter) or T40 (summer)	Alvania EP #2	Spirax HD 85W140	Donax TG
Chevron	EP ISO 46	Delo 300, 30 or 40 or 15W40	RPM EP 2	Delo 80W90	Chevron ATF

⚠ CAUTION!!!

Do not mix oils from different manufacturers. Daewoo does not endorse specific brands but does suggest that owners select quality oils whose suppliers provide assurance that required standards will always be met or exceeded.

IMPORTANT

Fluctuating daily or weekly extremes of temperature, or operation in sub-zero freezing weather may make it impractical to use straight weight lubricants. Use good judgement in selecting lubricant types that are appropriate for climate conditions.

Replacement of Lubricants and Filters

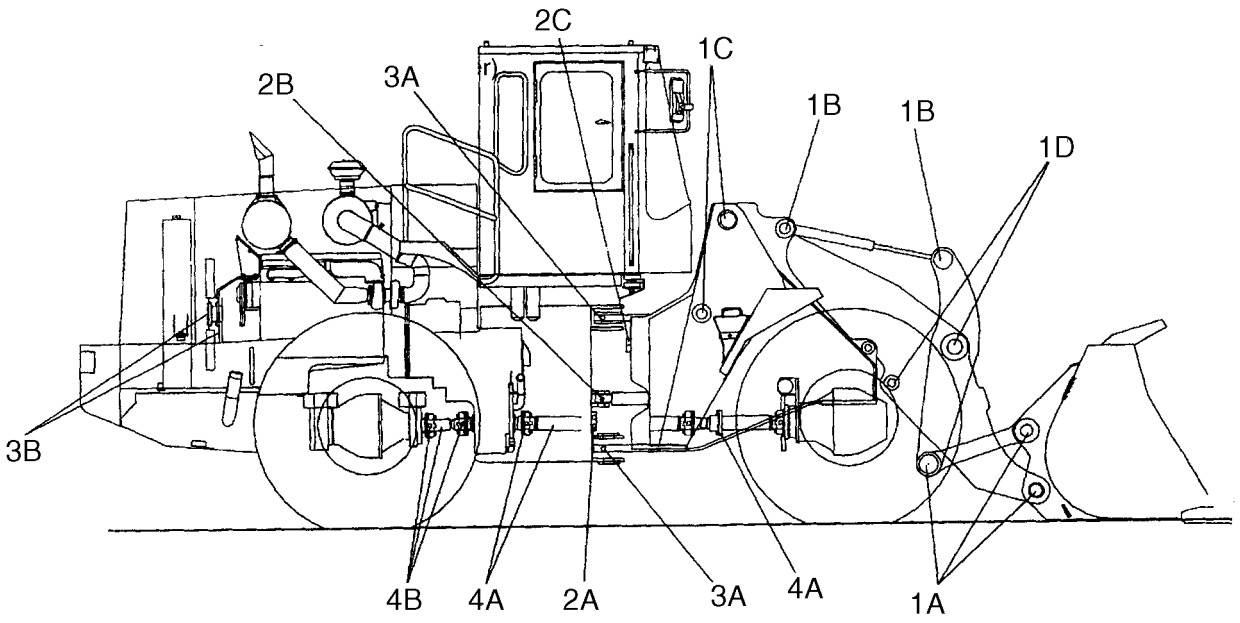


FIGURE 3-1 2822

Lubricating Grease Fittings

1. The following fittings are greased daily, or every 10 hours. If the bucket is being used in water, grease fittings 1A through 1D immediately after the machine is removed from the water. See Figure 3-1.

   A. Bucket hinge pins, 1 place on each side of bucket. See Figure 3-2. Bucket link pins,

FIGURE 3-2 2035

2 places on each side of bucket.

B. Bucket cylinder head ends. See Figure 3-3. Greased from two remote grease points (1, Figure 3-4).

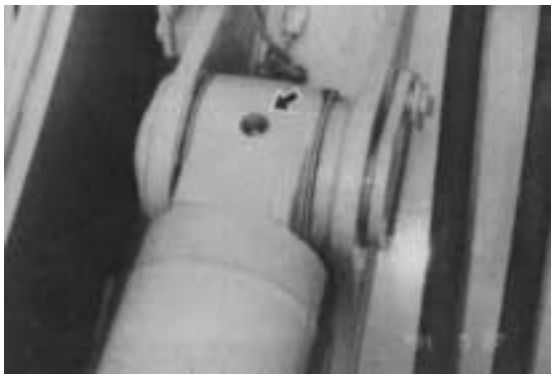


FIGURE 3-3 2036

Bucket cylinder rod ends, one place each side of bucket. See Figure 3-5.

1. Remote Fittings for Bucket Cylinder Heads
2. Remote Fittings for Lift Cylinder Heads
3. Remote Fitting for Drive Shaft Center Bearing

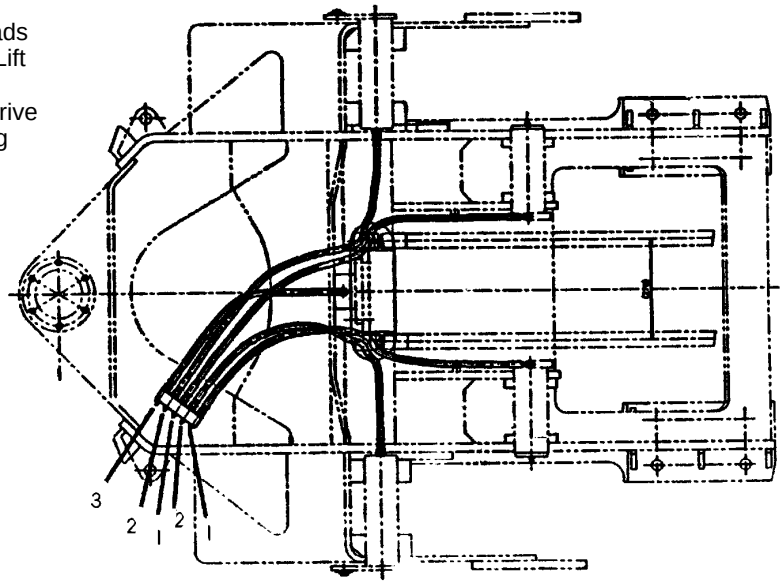


FIGURE 3-4

2861

FIGURE 3-5

2037

C. Lift cylinder heads. See Figure 3-6. Greased from two remote grease points (2, Figure 3-4).

   Loader arm cylinder foot end, 1 place on each side of the machine. See Figure 3-6.

D. Arm-lever connecting pins, 1 place on each side of machine. See Figure 3-7.

   Lift cylinder rods, 1 place on each side of machine. See Figure 3-7.

1. Lift Cylinder Head End
2. Loader Arm Cylinder Foot End

FIGURE 3-6

2041

FIGURE 3-7

2040

2. The following fittings are greased weekly, or every 50 hours. See Figure 3-1.

   A. Rear axle pivot, 1 place on each side of machine. See Figure 3-8.

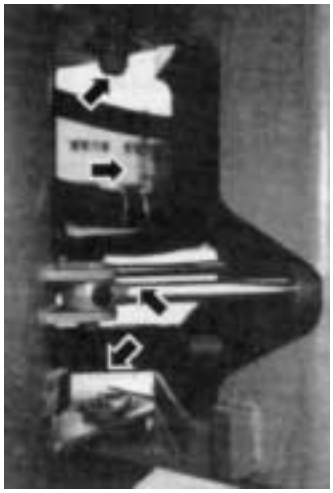


FIGURE 3-8 2823

   B. Steering cylinder rods, 1 place on each side of machine. See Figure 3-8.

   C. Steering cylinder head ends, remote greasing. One place on each side of machine. See Figure 3-8.

3. The following fittings are greased every 250 hours. See Figure 3-1.

   A. Center pins, upper and lower. Two places on each side of machine. See Figure 3-8.

4. The following fittings are greased every 500 hours. See Figure 3-1.

   A. Center bearing (1, Figure 3-9) of front drive shaft. Grease from a remote grease point (3, Figure 3-4).

1. Center Bearing

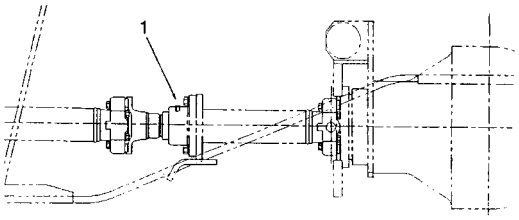


FIGURE 3-9 2865

   Two universal joints and one spline for front drive shaft. See Figure 3-10.

   B. Two universal joints and one spline for rear drive shaft. See Figure 3-10.

FIGURE 3-10 2824

Daily Or Every 10 Operating Hours

Check Engine Oil Level

Check the level of the engine oil every day before starting the engine. Remove the engine oil dipstick. See Figure 3-11. The oil level must be between the low and full marks. To add oil, remove the oil filler cap. See Figure 3-12.

FIGURE 3-11 2866

FIGURE 3-12 2826

Check Transmission Oil Level

Start the engine and move the machine to a level area. Place the transmission lever in neutral. Apply the parking brake. Allow the engine to idle until engine temperature is between 82°C (180°F) and 93°C (200°F). Remove the transmission dipstick (1, Figure 3-13). Wipe the dipstick clean and then insert it back into the transmission. Remove the dipstick and check the oil level mark. The oil level must be between the low and full marks. To add oil, remove the cap (2) from the transmission oil filler pipe.

1. Dipstick
2. Oil Filler Cap

FIGURE 3-13 4439

Check Hydraulic System Oil Level

Start the engine and move the machine to a level area. Apply the parking brake. Lower the bucket to the ground. Allow the engine to idle. Check the sight gauge that is attached to the hydraulic reservoir. See Figure 3-14. The oil level must be between the upper limit and the lower limit shown on the gauge. To add hydraulic oil, remove the reservoir breather-cap. See Figure 3-15.

1. Upper Limit
2. Lower Limit

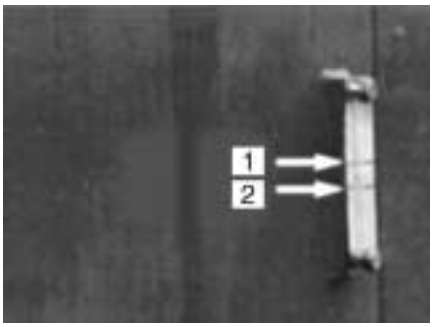


FIGURE 3-14 2828

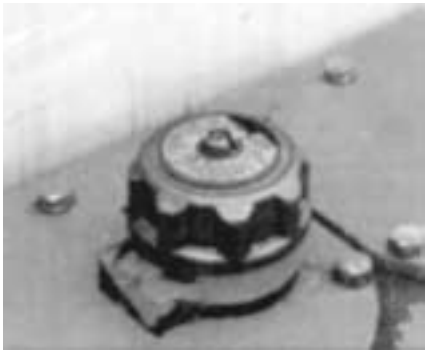


FIGURE 3-15 2829

Refill Fuel

At the end of each work day, fill the fuel tank. Fuel tank capacity is 300 liters (79.25 gal). Add fuel through the fuel filler pipe (1, Figure 3-16). When working at a temperature of 10°C (-12°F) or higher, use Korean Standard No. 1 S – Light Fuel or its equivalent. At temperatures below 10°C (-12°F), use Korean Standard No. 1 W – Light Fuel or its equivalent.

1. Fuel Filler Pipe

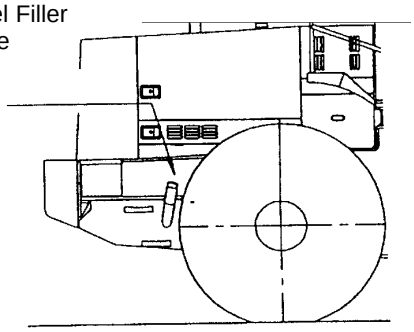


FIGURE 3-16 2831

Drain Fuel Condensation

Open the fuel tank drain valve. See Figure 3-17. Allow any condensed water or sediment to drain out of the tank. Also open the drains on the Primary and Secondary fuel filters and drain out any water or sediment. See Figure 3-18. Catch the drained material in a container. Properly dispose of the drained material.

FIGURE 3-17 2830

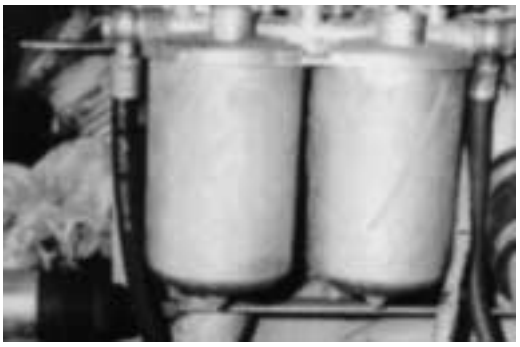


FIGURE 3-18 2832

Check Coolant Level

⚠WARNING!!!

Never open the radiator when it is hot. The scalding liquid inside a hot radiator is under pressure. Removing the cap from a hot radiator could cause a person to be sprayed and burned from the liquid inside. Wait for the radiator temperature to cool down before removing the cap.

Remove the fill cap from the radiator. See Figure 3-19. Check the level of the coolant inside the radiator. If low, add water to fill the radiator to a point that is 10 – 20 mm (1/2 – 3/4") below the top of the overflow pipe. If the temperature is below freezing, see Table 4-1 for antifreeze protection. Use the table to calculate a proper mixture of antifreeze and water to provide the level of protection necessary for the expected temperature.

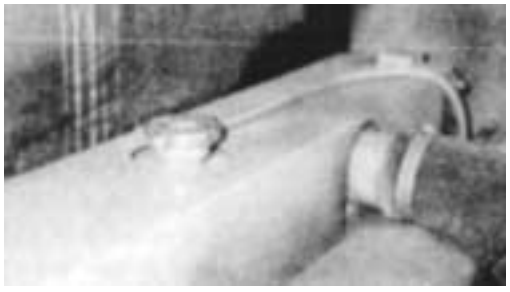


FIGURE 3-19 2833

Antifreeze Protection Levels

Table 4-1

Ethylene Glycol	Water	Maximum Freeze Protection
8.5 l (9.0 qt)	48.5 l (51.25 qt)	-6.1°C (21°F)
11.5 l (12.15 qt)	45.5 l (48.1 qt)	-8.9°C (15.98°F)
14.0 l (14.8 qt)	43.0 l (45.43 qt)	-12.1°C (10.22°F)
17.0 l (18.0 qt)	40.0 l (42.25 qt)	-16.0°C (3.2°F)
20.0 l (21.1 qt)	37.0 l (39.0 qt)	-20.0°C (-4.0°F)
23.0 l (24.3 qt)	34.0 l (36.0 qt)	-25.1°C (-13.2°F)
25.5 l (27.0 qt)	31.5 l (33.2 qt)	-30.0°C (-22°F)
28.5 l (30.1 qt)	28.5 l (30.1 qt)	-37.9°C (-36.2°F)
34.0 l (36.0 qt)	23.0 l (24.3 qt)	-55°C (-67°F)

Air Filter Indicator

The air filter system is equipped with a filter restriction indicator. See Figure 3-20. If air flow through the air filter element becomes restricted due to accumulation of dust and dirt, this indicator will light up. The engine must be running when the indicator is being checked. If the indicator lights, turn off the engine, and clean the air filter element.

FIGURE 3-20

2834

Weekly or Every 50 Operating Hours

Perform All Daily Service Checks

Change Engine Oil and Filter

Engine oil and filter must be changed after the first 50 hours of operation to comply with the new machine break-in requirements. After the first change, oil and filter should be changed every 250 hours.

⚠CAUTION!!!

Never attempt to change oil or filter on a hot engine. Hot oil could splash and cause burns. Allow the engine to cool down before changing oil or filter.

1. Position a container to catch the drain oil beneath the engine oil filter. See Figure 3-21.

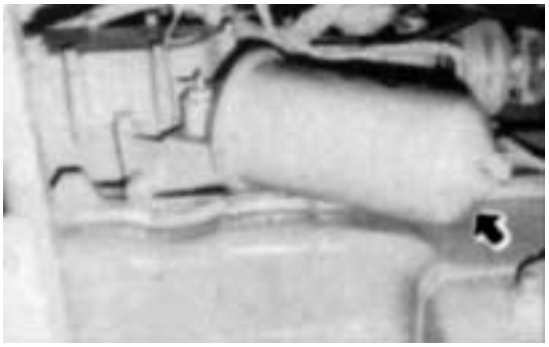


FIGURE 3-21 2835

2. Remove the drain plug from the bottom of the filter. Allow the oil to drain into the catch container.
3. Remove the bolt from the filter outer cover. Remove the cover, cover O-ring, and filter element.
4. Discard the filter element. Use a nonflammable, non-toxic solvent to clean the inside of the filter cover. Also clean the cover O-ring.
5. Insert a new filter element into the cover.
6. Insert the bolt through the center of the filter cover.
7. Install the O-ring on the cover.
8. Place the filter cover into position on the engine. Tighten the bolt to hold the filter cover to the engine. Tighten the drain plug in the filter cover.

NOTE

The engine oil capacity is 21 l (22 qt). The filter holds an additional 1 l (1 qt) of oil.

9. Position the catch container beneath the engine crankcase drain plug. See Figure 3-22. Remove the drain plug and allow all engine oil to drain out.

FIGURE 3-22 2836

10. Install the drain plug. Fill the engine with new oil of the type specified in the Table of Recommended Lubricants.

Replacing Transmission Oil Filters

The transmission oil filter must be changed after the first 50 hours of operation to comply with the new machine break-in requirements. After the first change, the filter must be changed every 500 hours.

1. Rotate the filter counterclockwise to remove it.
2. Clean the filter head.
3. Grease the filter gasket and the gasket mating surface on the filter head.
4. Thread the filter onto the filter head. Tighten the filter 1/2 turn after the filter gasket contacts the filter head. The filter should be torqued to 1.6 to 2.1 kg m (11.5 to 15 ft lb).
5. Start the engine and allow it to run until warmed up. Check the filter for leaks while the engine is running.

Hydraulic Full Flow Filter Replacement

The hydraulic full flow oil filters (2) must be changed after the first 50 hours of operation to comply with the new machine break-in requirements. After the first change, the filters must be changed every 250 hours.

1. Loosen the breather cap on the hydraulic reservoir. See Figure 3-15.
2. Clean the filter cover (2, Figure 3-23) and the reservoir around the cover.

1. Bolt
2. Cover
3. Spring
4. O-ring
5. Valve
6. Element
7. Strainer
8. Bolt
9. Cover

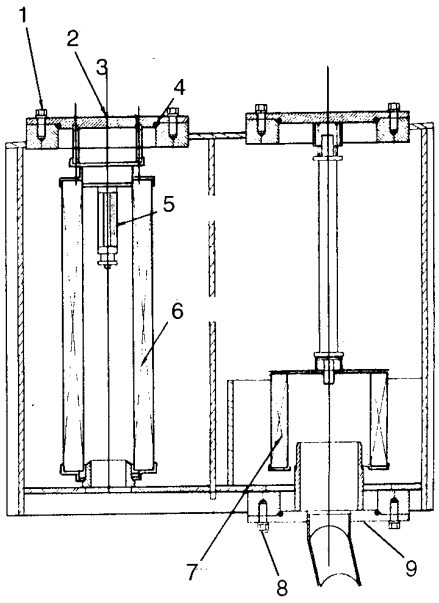


Figure 3-23 2045

3. Remove the bolts (1, Figure 3-23) from the cover (2).
4. Lift the cover (2) and O-ring (4) off the reservoir. Control the spring (3) that sits beneath the cover. Remove the spring (3).
5. Remove the valve (5) and the filter element (6) from the reservoir.
6. Clean the underside of the cover (2).
7. Set a new element (6) and valve (5) down into the reservoir. Press the element down onto its base until the top of the element is approximately 4 mm (0.157") below the edge of the reservoir.
8. Install a new O-ring (4) on the cover (2). Set the spring (3) into place on the element (6).
9. Set the cover (2, Figure 3-23) into place over the element (6). Install the bolts (1) through the cover (2) and tighten them.
10. Tighten the breather cap on the reservoir.

Check Fan Belt Tension

The fan belt tension must be checked after the first 50 hours of operation to comply with the new machine break-in requirements. After the first tension check, the belt must be checked every 150 hours. Apply 10 kg (22 lb) of force to the midpoint of the fan belt. See Figure 3-24. The fan belt should deflect 10 mm (0.4"). If the belt deflects more than this, loosen the control link and move the idler pulley (2) to tighten the belt tension until deflection is 10 mm. Inspect the fan belt for damage. If the belt is damaged, replace it.

1. Fan Pulley
2. Idler Pulley
3. Crank Pulley

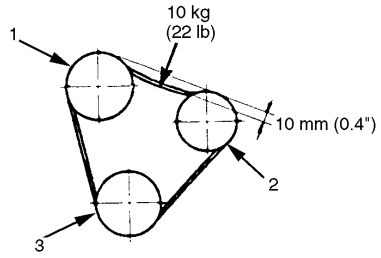


FIGURE 3-24 2838

Clean Exterior of Radiator and Oil Cooler

Dust and dirt accumulation on the fins of the radiator and oil cooler greatly reduce their cooling efficiency. Use water and steam to clean the fins on the radiator and oil cooler. On an especially dusty job site, clean the fins every 50 hours. On other job sites, clean the fins every 500 hours.

Every 250 Operating Hours

Perform All Daily and 50 Hour Service Checks

Hydraulic System Pilot Filter

Replace the filter element in the pilot filter. See Figure 3-25. Perform the following steps.

FIGURE 3-25 2047

1. Unthread the element cover (1, Figure 3-26). The cover is filled with oil. Dispose of the oil.

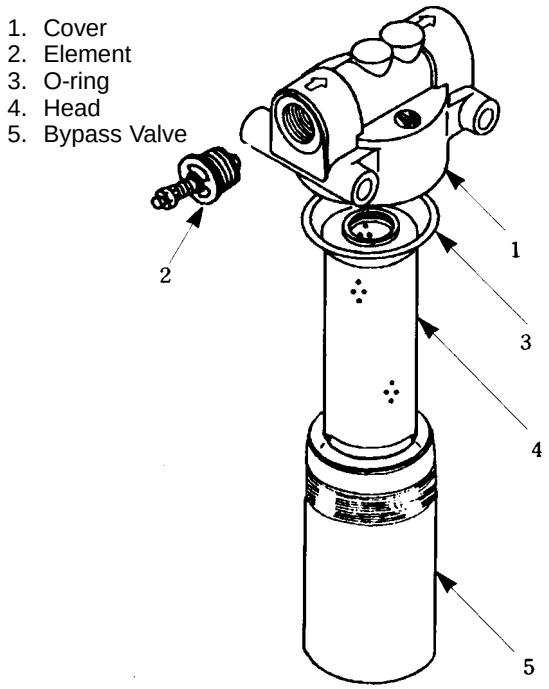


FIGURE 3-26 0099

2. Remove the O-ring (3, Figure 3-26) and the filter element (2).
3. Use a non flammable, non-toxic solvent to clean out the cover (1).
4. Insert a new filter element (2) into the cover (1). Install a new O-ring (3).
5. Thread the cover (1) onto the filter head (4).

Clean Air Cleaner

⚠CAUTION!!!

Never remove the air cleaner element while the engine is running. This will allow dirt to be sucked into the engine and cause serious engine damage. Always turn the engine off before servicing the air cleaner.

Remove the air cleaner element and clean it with compressed air. See Figure 3-27. Inspect the element. If any holes or damage are present, replace the element. If the element does not become damaged, it must be replaced every 1,500 hours.

FIGURE 3-27 2839

Inspect the tubes and clamps that are attached to the air cleaner. Be certain that the tubes have no holes, and that the clamps are tight.

The engine is equipped with a pre-cleaner. See Figure 3-28. Dust, insects, rainwater etc., can be present in the air. The pre-cleaner collects this material and discharges it. This prevents the material from being drawn into the air cleaner. The pre-cleaner does not need periodic cleaning or replacement.

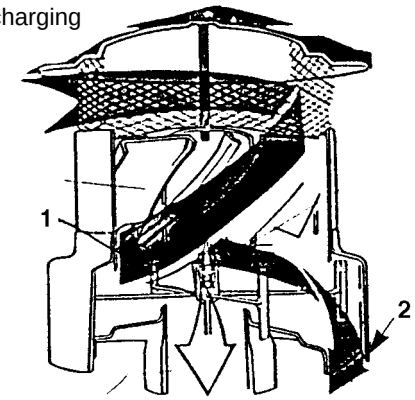


Figure 3-28 2840

Change Engine Oil and Filter

Follow procedure printed under 50 hour maintenance interval.

Replace Transmission Oil Filter

Follow procedure printed under 50 hour maintenance interval.

Hydraulic Full Flow Filter Replacement

Follow procedure printed under 50 hour maintenance interval.

Every 500 Operating Hours

Perform All 10, 50, and 250 Hour Service Checks

Fuel Filter Element Replacement

There are two fuel filters, a primary and a secondary. See Figure 3-18. Perform the following procedure on each filter.

1. Remove the bolt from the bottom of the element cover.
2. Remove the element, cover, and O-ring from the filter head.
3. Install a new element and O-ring.
4. Set the cover into place in the filter head.
5. Insert the bolt through the bottom of the element cover. Tighten the bolt.

Every 1,000 Operating Hours

Perform All 10, 50, 250, and 500 Hour Service Checks

Center Axle and Axle End Oil Check

The oil level in both the front and rear axle must be checked every 1,000 hours. The oil in both axles must be replaced every 1,500 hours.

Each axle contains a center differential, and a differential in each axle end. The same oil lubricates the center differential and the differentials in the axle ends, but the oil flows very slowly between these points. Therefore, the oil must be checked and refilled at all three places at the same time. To check the oil level, perform the following steps.

1. Drive the machine onto a level surface. Position the wheels on the axle being checked so that the axle end level plugs (1, Figure 3-29) are in the lowest position. Apply the parking brake.
   Block the wheels.

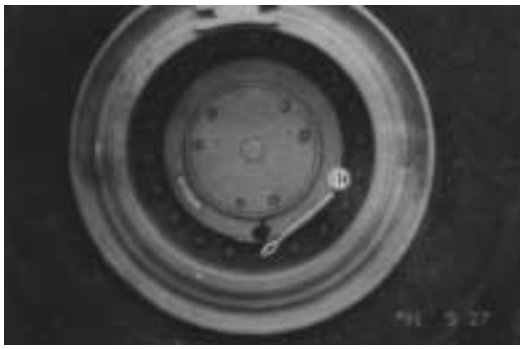


FIGURE 3-29

2. Clean the area around the level plugs on both ends of the axle. Remove the plugs.
3. Clean the area around the level plug (1, Figure 3-30) on the center differential. Remove the level plug (1).

1. Level Plug
2. Drain Plug

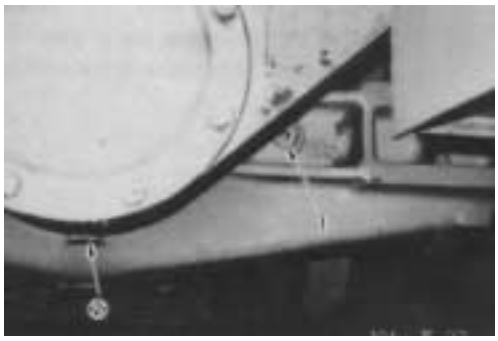


FIGURE 3-30

4. Check the oil level at the level plug hole on the center differential and the axle end differentials. The oil should be level with the bottom of the plug hole. Add oil as necessary.
5. Install the level plugs at all three locations.
6. Perform the previous five steps on the other axle.

Drain and Replace Hydraulic Oil

⚠CAUTION!!!

Be certain that the hydraulic oil has cooled before draining it. Hot oil could splash and cause burns.

1. Raise the boom to its highest position. Tilt the bucket back as far as possible, and turn off the engine. See Figure 3-31.

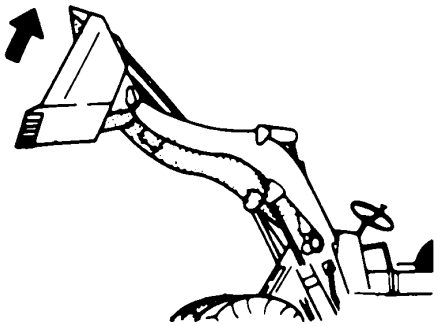


FIGURE 3-31 2052

NOTE

The hydraulic reservoir contains 250 l (264 qt) of oil.

2. Position a catch tank beneath the hydraulic reservoir drain plug. Open the reservoir breather cap. See Figure 3-15. Remove the drain plug from the bottom of the reservoir. See Figure 3-32. Allow all hydraulic oil to drain out.

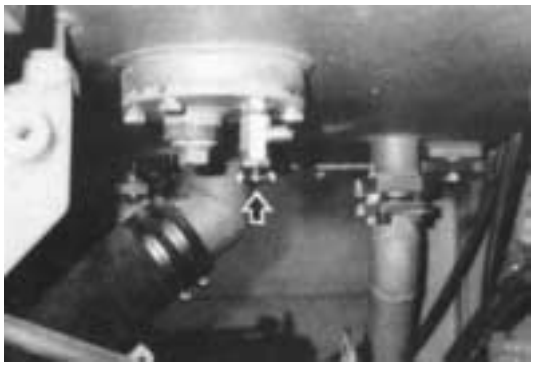


FIGURE 3-32 2053

Without starting the engine, operate the controls to dump the bucket. See Figure 3-33. Then operate the controls to lower the boom. See Figure 3-34. This will drain the oil out of the boom and bucket cylinders.

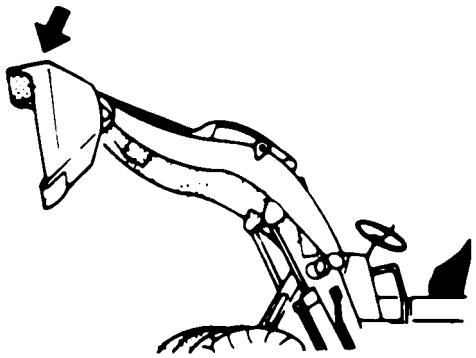


FIGURE 3-33 2054

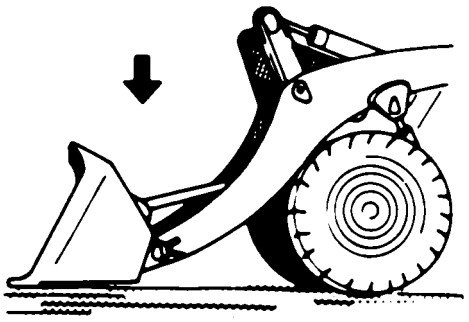


FIGURE 3-34 2055

3. Replace the full flow hydraulic filters, as described in the 50 hour (weekly) maintenance checks.
4. Remove and clean the pump inlet strainer (7) that is located inside the hydraulic reservoir. See Figure 3-23.
   A. Remove the bolts (8) that retain the strainer cover (9).
   B. Remove the strainer cover (9) and the strainer (7) from the reservoir.
   C. Remove the strainer (7) from the strainer cover.
   D. Clean the strainer (7) in a nonflammable, non toxic solvent.
   E. Mount the strainer (7) on the strainer cover (9).
   F. Insert the strainer (7), and cover (9), into the reservoir.
   G. Install and tighten the bolts (8) that retain the cover (9).
5. Install the reservoir drain plug. Refill the reservoir by pouring oil in through the breather cap opening. Install and tighten the breather cap.
6. Start the engine and operate the controls to raise and lower the bucket a few times. See Figure 3-35. Raise and lower the boom a few times. See Figure 3-36. Lower the bucket to the ground.

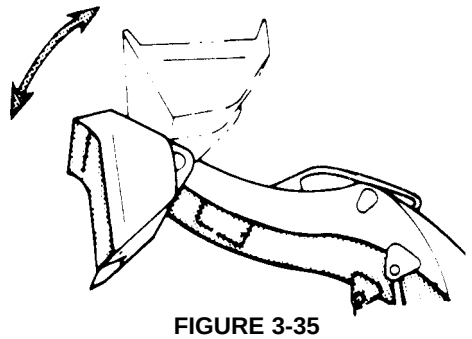


FIGURE 3-35 2057

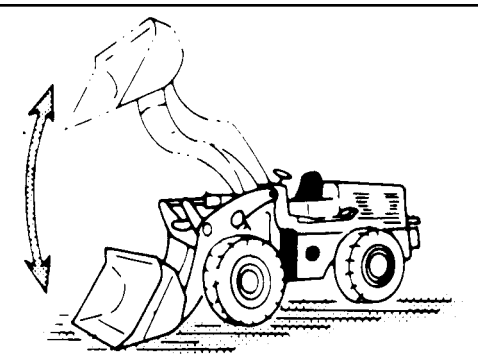


FIGURE 3-36 2058

7. Check the reservoir sight gauge. See Figure 3-14. The oil level must be between the upper limit and the lower limit on the sight gauge. Remove the breather cap and add oil if necessary.

Drain and Replace Transmission Fluid

1. Start the machine and drive it until the transmission fluid has warmed to 65 – 93°C (149 – 200°F). Park the machine on a level area.
2. Place the transmission lever in neutral. Apply the parking brake. Turn off the engine. Block the tires.

NOTE

The transmission contains 28 l (29.6 qt) of transmission fluid.

3. Remove the drain plug (1, Figure 3-37). Allow all transmission fluid to drain into a receptacle. Properly dispose of the drained fluid. Clean the drain plug (1).

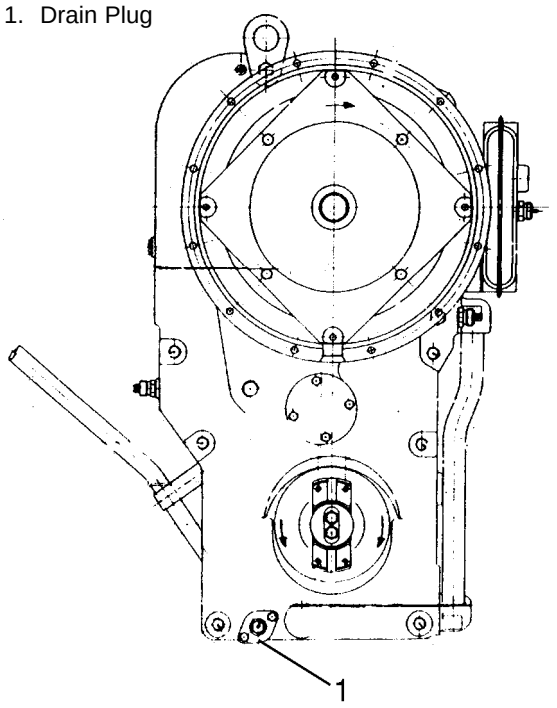


FIGURE 3-37 2868

4. Install the drain plug in the transmission.
5. Remove the inlet strainer. Use a nonflammable, non-toxic solvent to clean the strainer.
6. Inspect the gasket on the inlet strainer. Replace the gasket if it is damaged. Install the inlet strainer.
7. Remove the breather filter. Clean the breather filter and install it.
8. Fill the transmission with fluid through the fluid supply pipe. Add fluid until the fluid level reaches the low mark on the dipstick (1, Figure 3-38).

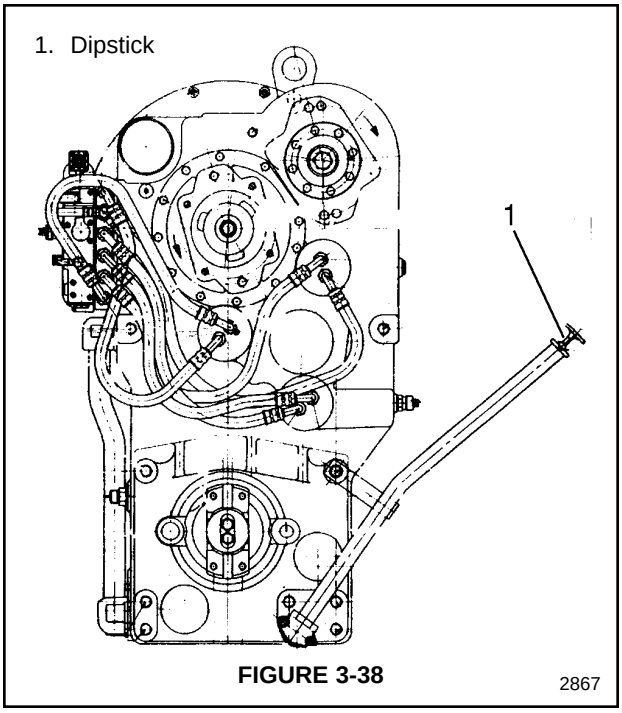


FIGURE 3-38 2867

9. Start the engine. Idle the engine for two minutes.
10. With the engine idling, check the transmission fluid level. Add fluid until the level reaches the high mark on the dipstick.
11. Idle the engine until the transmission fluid temperature reaches 82 – 93°C (180 – 200°F). Check the fluid level with the engine idling. The level must reach the high mark on the dipstick.

Clean Fuel Tank and Strainer

1. Drain the fuel tank.
2. Remove the cover and strainer located on the bottom of the tank.
3. Use a nonflammable, non-toxic, parts cleaner to clean the strainer and any sediment inside the tank.
4. Install the strainer and cover.

Replace Air Cleaner Element

⚠CAUTION!!!

Never remove the air cleaner element while the engine is running. This will allow dirt to be sucked into the engine and cause serious engine damage. Always turn the engine off before servicing the air cleaner.

1. Loosen the clamp that holds the cover on the air cleaner housing. See Figure 3-27.
2. Remove the element from the air cleaner housing.
3. Install a new filter element.
4. Install the cover on the air cleaner.

Change Radiator Coolant

⚠WARNING!!!

Never open the radiator when it is hot. The scalding liquid inside a hot radiator is under pressure. Removing the cap from a hot radiator could cause a person to be sprayed and burned from the liquid inside. Wait for the radiator temperature to cool down before removing the cap.

1. Remove the cap (1, Figure 3-39) from the radiator.
2. Open the drain (2) at the bottom of the radiator. Allow all coolant to drain out.
3. If the coolant being drained is especially rusty, or especially dirty, use a radiator flush additive. Follow the directions on the container for the additive.
4. Completely flush the additive out of the cooling system with clean water.
5. Fill the radiator with clean water. If temperatures below freezing are expected, add enough ethylene glycol antifreeze to prevent the water in the cooling system from freezing. See Table 4-1 for the amount of antifreeze to add.

1. Radiator Cap
2. Drain

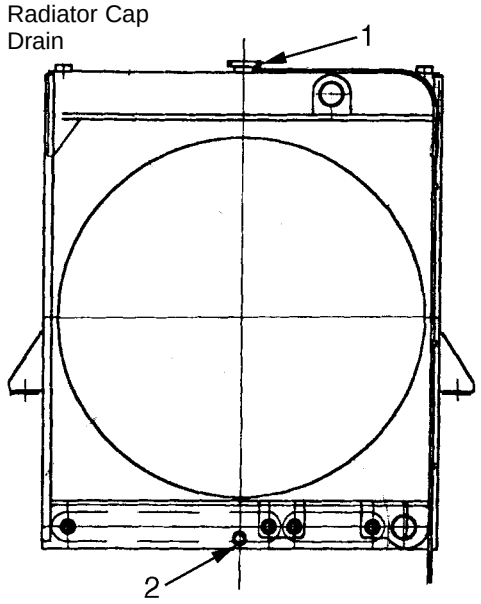


FIGURE 3-39

2843

6. Start the engine and allow it to run until it reaches normal operating temperature.
7. Allow the engine to cool. Check the coolant level in the radiator. Add additional coolant as needed. Fill the radiator to a point that is 10 – 20 mm (1/2 – 3/4") below the top of the overflow pipe.

Every 1,500 Operating Hours

Perform All 10, 50, 250, and 500 Hour Service Checks

Center Axle and Axle End Oil Replacement

Each axle contains a center differential, and a differential in each end. The same oil lubricates the center differential and the differentials in the axle ends, but the oil flows very slowly between these points. When checked, the oil must be checked and refilled at all three places at the same time. To drain and replace the oil in an axle, perform the following steps:

1. Drive the machine onto a level surface. Position the wheels on the axle being drained so that the axle end level plugs (1, Figure 3-29) are in the lowest position. Apply the parking brake.
   Block the wheels.
2. Clean the area around the level plugs on both ends of the axle. Remove the plugs.

NOTE

The center differential in the front axle contains 32 l (33.8 qt) of oil. Each axle end differential in the front axle contains 10 l of oil. The drain container must have a capacity of at least 52 l (55 qt).

The center differential in the rear axle contains 24 l of oil. Each axle end differential in the rear axle contains 9 l of oil (9.5 qt).

3. Clean the area around the level plug (1, Figure 3-30) and the drain plug (2) on the center differential. Remove the level plug (1) and the drain plug (2). Allow the oil to drain into a container.
4. Install the drain plug into the center differential, and tighten it.
5. Pump oil into the plug hole for the level plug on the center differential. Add oil until the oil level is even with the bottom of the plug hole. Go to the level plug holes on the axle ends. Add oil to these openings until the oil level is even with the bottom of the plug hole. Recheck the level on the center differential. Add oil if necessary. When the oil level is satisfactory at all three level plug holes, install and tighten the level plugs at all three locations.
6. Perform the previous five steps on the other axle.

Annually or Every 2,000 Operating Hours

Replace Hoses

Replace the hoses that carry brake fluid to the wheel brakes. Also replace the hoses that carry hydraulic fluid to the steering cylinders.

It is difficult to determine the condition of many hoses. The best way to ensure safe operation and to maintain maximum performance is to replace the hoses on a regular basis. If any of the brake or steering hoses become damaged or appear defective in any way, replace them immediately regardless of the time interval since their last replacement.

Bleeding Brakes

When brake hoses or brake tubes are replaced, air can be introduced into the brake hydraulic system. Air can cause the brakes to operate intermittently, which is a dangerous condition. Never operate the machine with air in the brake hydraulic system. A spongy feel when pressing the brake pedal is a sign that air is present in the brake hydraulic system.

To bleed air out of the brake hydraulic system, perform the following steps:

1 Start the engine and place the transmission in neutral.

2. Remove the rubber cap from the bleeder screw on the wheel. See Figure 3-40.

FIGURE 3-40 2062

3. Place one end of a plastic hose (1, Figure 3-41) over the bleeder screw (2). Place the other end of the hose in a container (3) filled with brake fluid.

1. Plastic Hose
2. Bleeder Screw
3. Container

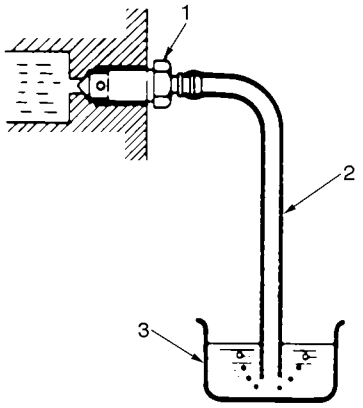


FIGURE 3-41

2063

4. Station one person in the operator's cab, and one person at the bleeder screw on the wheel being bled.
5. Open the bleeder screw (2, Figure 3-41). Then press down on the brake pedal until it rests on the floor of the cab. Hold the pedal down on the floor of the cab. Close the bleeder screw while the pedal is being held down. After the bleeder screw has been closed, allow the brake pedal to return to the upright position. Continue to open the bleeder screw and press down the pedal as described in this step, until the fluid expelled from the bleeder hose has no air bubbles present.
6. Securely close the bleeder screw (2). Install the rubber cap on the bleeder screw.
7. Perform the bleeding procedure on the other three wheels.

Severe Conditions Maintenance

Operating Condition	Required Maintenance
Mud, Water, Rain	1. Check for loose fittings, obvious damage to the machine, or any fluid leakage. 2. After completing operations, clean mud, rocks, or debris from the machine. Inspect for damage, cracked welds, or loosened parts. 3. Perform all daily lubrication and service. 4. If the machine was working in salt water or other corrosive materials, be sure to flush the equipment with fresh water.
Extremely Dusty or Hot Environment	1. Clean the engine air filter on a more frequent basis. 2. Clean the radiator and oil cooler fins to remove dirt and dust. 3. Clean the fuel system intake strainer and fuel filter more frequently. 4. Inspect the starter motor and alternator, and clean as often as necessary.
Rocky Terrain	1. Check the wheels, tires, rims, and valve stems for damage or excessive wear. 2. Inspect for loose or damaged fittings and bolts. 3. On a more frequent basis, inspect the bucket and boom for damage or excessive wear. 4. Install a top guard and front guard as necessary for protection against falling rock.
Extreme Cold	1. Use the proper grade of fuel for cold temperatures. 2. Use a gauge to check the antifreeze to be sure that it will provide protection for the coldest temperature expected. 3. Use a hydrometer to check the condition of the batteries. In extremely cold weather, remove the batteries at night and store them in a warm area.

General Maintenance

Fuel Transfer Pump

An optional fuel transfer pump (1, Figure 3-42) is available. This pump is mounted on top of the fuel tank (2). The switch that operates the pump is located to the inside of the left side battery box (when viewed from the counterweight (3) end of the machine). Place the pump inlet hose (4) into the refueling tank. Turn the pump switch on. Observe the fuel gauge inside the cab of the machine being fueled. When the tank is full, turn the pump switch off.

1. Transfer Pump
2. Fuel Tank
3. Counterweight
4. Inlet Hose
5. Radiator

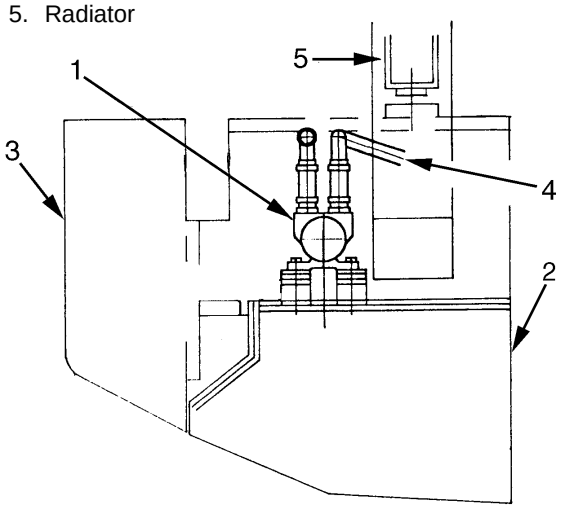


FIGURE 3-42 2844

The transfer pump contains a fuel filter. When changing the filter, always fill the new filter with fuel before installing it. If the pump is operated without fuel inside the pump casing, the pump will be damaged.

Parking Brake Adjustment

To adjust the parking brake, perform the following steps.

1. Jack up the machine enough to allow the tires to rotate freely.
2. Turn off engine and place transmission lever in neutral. Turn ignition switch to on position. Move the parking brake switch to the unlocked position.
3. Loosen the lock nut (1, Figure 3-43) on the adjusting rod.

1. Lock Nut
2. Brake Pad
3. Brake Disc

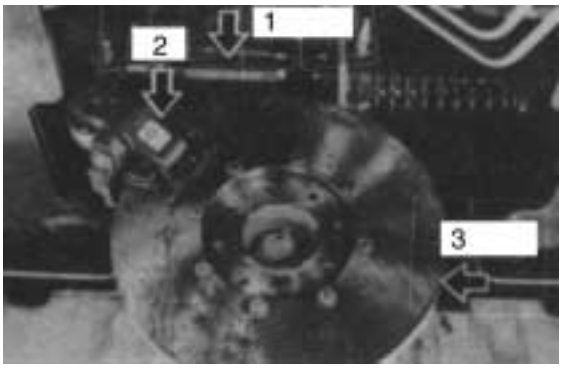


FIGURE 3-43 2061

4. Check the clearance between the brake pad (2, Figure 3-43) and the brake disc (3). Clearance should be 1 – 2 mm (0.040 – 0.080").
5. Rotate the adjusting rod to attain the specified clearance.
6. After the adjustment is complete, tighten the lock nut (1).

Check Battery Condition

⚠WARNING!!!

Exercise caution when working around a lead-acid battery. These batteries contain sulfuric acid and give off hydrogen gas when they are charging. Sulfuric acid will cause serious damage to skin and eyes. Always wear eye protection when working on batteries.

Hydrogen gas is explosive. Do not smoke, use open flame, or create sparks anywhere near the battery. The battery could explode. Do not wear a watch or rings when working on the battery. These items could cause sparks.

Do not allow a wrench to contact the positive terminal of the battery any any other metal part of the machine at the same time. If the negative cable is connected to the battery, the wrench will create sparks.

When removing the battery cables, always remove the negative (-) cable first. When attaching battery cables, always attach the positive cable first. See Figure 3-44.

FIGURE 3-44 2869

Be certain that the battery is held securely in its compartment. Clean the battery terminals and the battery cable connectors. A solution of baking soda and water will neutralize acid on the battery surface, terminals, and cable connectors. Grease can be applied to the connectors to prevent corrosion.

Check the level of the electrolyte in the battery. First clean the area around the battery caps. Open each cap. The fluid in each cell should be 10 – 15 mm
(0.40 – 0.60") higher than the battery plates. Add water to bring the fluid to the proper level.

Use a hydrometer to check the specific gravity of the electrolyte. At 6°C (43°F) a fully charged battery will give a reading of 1.290. The lower the reading, the lower the state of charge. At 1.150 the battery is completely discharged. The battery must be fully charged to provide the proper cranking speed during start-up. A fully charged battery will also prevent electrolyte freeze-up during cold temperatures. Charge the battery until it is fully charged.

If replacing a battery, it may be best to change both batteries at the same time. Using a new battery with an old battery can shorten the life of the new battery.

Check Hydraulic Pressures

Main Pump Pressure

1. Attach gauge to Port 1. See Figure 3-45.

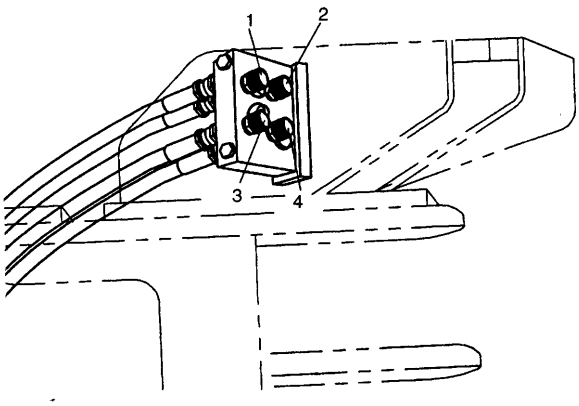


FIGURE 3-45 2846

2. The relief cartridge for the main pump must open at 195^{+5} kg/cm^2 ($2{,}845^{+70}$ psi).
3. Adjust the screw on the relief valve cartridge (1, Figure 3-46). Loosen the locknut and turn the screw clockwise to raise relief pressure. Turn the screw counterclockwise to lower the relief pressure.

1. Relief Valve Cartridge

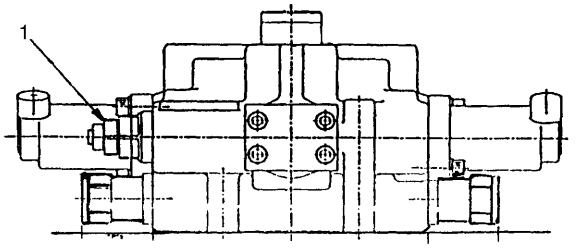


FIGURE 3-46 2847

4. Tighten the locknut after the pressure has been adjusted.

Steering Pump Pressure

1. Attach gauge to Port 2. See Figure 3-45.
2. Adjust the relief valve cartridge on the Steering Priority Valve. See Figure 3-47. The cartridge must be adjusted to open at 185^{+5} kg/cm^2 ($2{,}630^{+70}$ psi).

FIGURE 3-47 2870

3. Unscrew the plug and remove the plug and washer. Adjust the screw that is located beneath the plug. Turn the screw clockwise to raise relief pressure. Turn the screw counter-clockwise to lower the relief pressure.
4. Install the plug and washer after pressure has been adjusted.

Brake Charge Pressure

1. Attach gauge to Port 3. See Figure 3-45.
2. Adjust the C5 relief cartridge (1) on the brake pilot valve. See Figure 3-48. Relief pressure for unloading is 140 kg/cm^2 (1,991 psi). Relief pressure for loading is 120 kg/cm^2 (1,707 psi).
3. Loosen the locknut on the C5 adjusting screw. Rotating the adjusting screw clockwise will raise the relief pressure. Rotating the adjusting screw counterclockwise will lower the relief pressure.
4. Tighten the locknut after the adjustment has been made.

Control Lever Activation Pressure

1. Attach gauge to Port 4. See Figure 3-45.
2. Adjust the C7 decompression cartridge (2) on the brake pilot valve. See Figure 3-48. Relief pressure should be set at 32^{+3} kg/cm^2 (455^{+43} psi).

1. C5 Relief Cartridge
2. C7 Decompression Cartridge

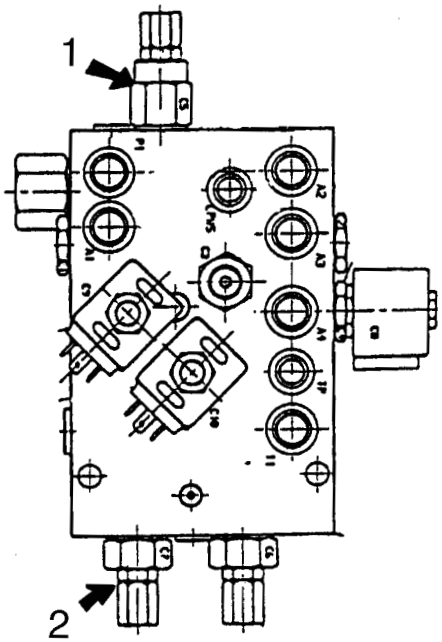


FIGURE 3-48 2849

3. Loosen the locknut on the C7 adjusting screw. Turn the adjusting screw clockwise to raise the relief pressure. Turn the adjusting screw counterclockwise to lower the relief pressure.
4. Tighten the locknut after the adjustment has been made.

Unloader Valve Pressure

1. Attach gauge to Port TPS on the unloader valve. See Figure 3-49.

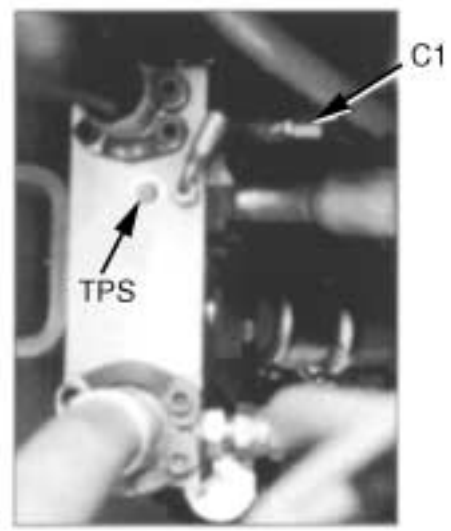


FIGURE 3-49 2850

2. Adjust pressure at cartridge C1. Pressure should be adjusted to 160 ± 5 kg/cm² (2,276 ± 70 psi).
3. Loosen the locknut at the C1 adjusting screw. Turn the adjusting screw clockwise to raise the relief pressure. Turn the adjusting screw counterclockwise to lower the relief pressure.
4. Tighten the locknut after the adjustment has been made.

Service Brake Outlet Pressure

1. Attach the gauge to the outlet port of the brake pedal valve. See Figure 3-50.
2. Outlet pressure should be 60 kg/cm² (853 psi).

FIGURE 3-50 2851

Transmission Clutch Pressure

1. Transmission pressure can be checked on the gauge in the operator's cab. If this gauge is inoperative, attach a pressure gauge to the clutch pressure gauge port (1, Figure 3-51) on the transmission.

1. Gauge Port

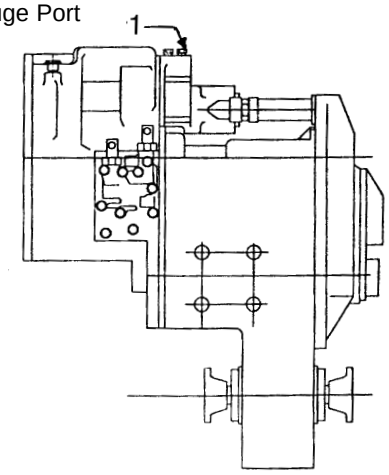


FIGURE 3-51 2852

2. With the transmission in neutral, and the engine at 2,000 – 2,530 RPM, the pressure should be 17 – 19 kg/cm² (272 – 270 psi).

Tires and Wheels

Proper tire pressure is an important factor in determining tire performance and tire life. A tire that is under-inflated does not properly support the machine, and will wear out quickly. Over-inflated tires have poor traction and puncture easily.

Use a pressure gauge to measure tire pressure. Always measure tire pressure before the machine has been working, when the tires are cold. Use Table 4-2 to determine the correct pressure for front or rear tires when driving the machine, or when working the machine.

Check the tires for damage and embedded objects. Check the valve stems for damage.

Wheel Nut Torque

Tighten the wheel nuts to 60 kg m (434 ft lb).

Table 4-2

Tire Dimension	Working Pressure		Driving Pressure	
	Front Tire	Rear Tire	Front Tire	Rear Tire
23.5-25-16PR(L-3) (Standard)	3.75 kg/cm^2 (53 psi)	3.0 kg/cm^2 (43 psi)	2.25 kg/cm^2 (32 psi)	2.25 kg/cm^2 (32 psi)
20.5-25-16PR(L-2) (Option)	4.25 kg/cm^2 (60 psi)	3.5 kg/cm^2 (50 psi)	2.5 kg/cm^2 (36 psi)	2.5 kg/cm^2 (36 psi)

⚠WARNING!!!

If a wheel and tire must be removed from the machine and replaced, or if a tire must be replaced on the wheel, allow this task to be performed only by experienced service personnel. A tire rim could be propelled off the wheel and cause serious bodily injury or death. See Figure 3-52.

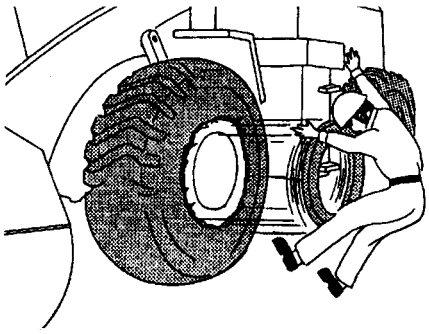


FIGURE 3-52

2853

Electrical System

The fuse box (1, Figure 3-53) is located beneath the operator's seat. The fuses are standard automotive type fuses. The description of which circuits each fuse protects, and the amperage rating of each fuse, is shown in Figure 3-54.

If an electrical circuit stops working, check the fuse that protects that circuit. If the fuse is blown, look for the cause of the blown fuse and correct the fault. Look for an electrical short in the circuit. When replacing a blown fuse, never insert a higher amperage fuse than the original fuse. This could cause damage to electrical components or cause a fire.

There are also two relay panels (2, Figure 3-53) and (3) located below the seat.

1. Fuse Box
2. Relay Panel
3. Relay Panel

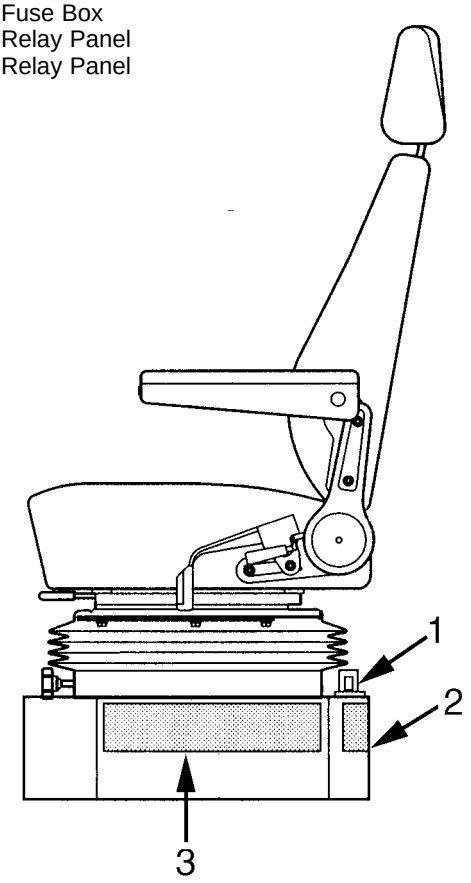


FIGURE 3-53

2854

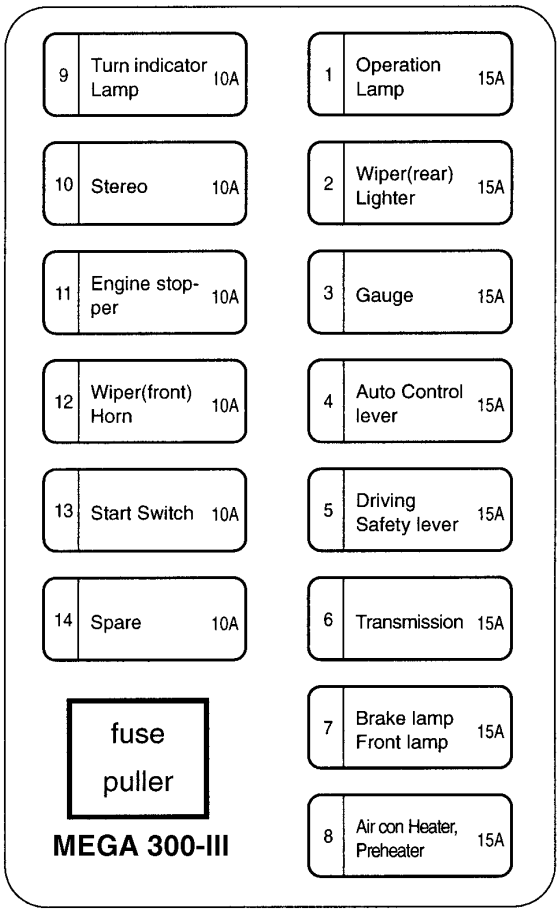


FIGURE 3-54

2855A

Bolt Torque Chart

Tightening Torque Specifications for Metric Bolts (For coated threads, pre-lubed assemblies)

Grade	Gr. 8.8		Gr. 10.9		Gr. 12.9	
Dia.	**Kg m**	**ft lb**	**Kg m**	**ft lb**	**Kg m**	**ft lb**
5 mm x std	0.59	4.3	0.79	5.7	1.0	7.2
6 mm x std	1.00	7.3	1.38	10	1.66	12
8 mm x std	2.49	18	3.46	25	4.15	30
8 mm x 1.0	2.76	20	3.87	28	4.56	33
10 mm x std	4.84	35	6.92	50	8.30	60
10 mm x 1.0	4.84	35	7.05	51	8.30	60
12 mm x std	8.57	62	11.89	86	14.52	105
12 mm x 1.5	9.00	65	12.59	91	14.94	108
14 mm x std	13.55	98	18.95	137	23.10	167
14 mm x 1.5	14.94	108	21.02	152	24.89	180
16 mm x std	20.88	151	29.46	213	35.54	257
16 mm x 1.5	22.54	163	31.53	228	38.03	275
18 mm x std	28.90	209	40.52	293	48.41	350
18 mm x 1.5	32.50	235	45.92	332	55.04	398
20 mm x std	40.94	296	57.95	419	69.01	499
20 mm x 1.5	46.05	333	64.03	463	77.03	557
22 mm x std	54.90	397	77.86	563	93.08	673
22 mm x 1.5	61.00	441	86.02	622	105.00	759
24 mm x std	71.00	513	100.00	723	120.00	868
24 mm x 2.0	78.00	564	109.95	795	130.00	940
27 mm x 2.0	115.06	832	160.00	1157	195.00	1410

Long Term Storage

Cleaning

Pressure wash the machine. Inspect the machine for any damage or missing parts. Drive the machine to check the steering linkage for damage.

Hydraulic System

Start the engine and allow it to idle for a few minutes. Drive the machine around for 2 – 3 minutes. Raise and lower the boom 2 – 3 times. Crowd and dump the bucket 2 – 3 times. This will circulate the hydraulic fluid through all hydraulic systems.

Lubrication

Perform all the daily maintenance procedures listed in this section (Section 3.) Grease all grease fittings in the steering linkage. Apply a coating of light oil to all exposed cylinder rods. Apply a coating of light oil to all control linkages and all control valve spools. Check the condition of the oil coating each month and add to the coating where necessary.

Battery

Disconnect the cables from the battery, or remove the battery from the machine. If the battery is removed, fully charge the battery and store it.

Cooling System Care

If the cooling system does not need antifreeze and is filled with water only, add an anti-rust additive. If temperatures below freezing are expected, add antifreeze to protect the system to the level of cold expected. See antifreeze protection Table 4-1. Use a hydrometer to check the level of the antifreeze protection once each month. If desired, the cooling system can be completely drained. If the system is drained, place a sign in the operator’s cab to warn the operator that there is no coolant in the engine.

Air Tank

Tap the brake pedal a few times to exhaust all of the air from the air tank.

TORQUE CONVERTER AND TRANSMISSION

Drive Train

The illustration shows the layout of the drive train assemblies. The engine (1, Figure 4-1) drives a torque converter (2), which drives a power shift transmission (3). Two output shafts extend out of the transmission. Each output shaft has a drive shaft attached to it. Front drive shaft (4) drives a final drive shaft (6) that drives the front differential (7).

A parking brake (8, Figure 4-1) is mounted on the front differential input shaft. The front differential is enclosed in the front axle housing (9). Each end of the front axle housing contains reduction gearing (10). Each end of the front axle housing also contains a service brake (11). Rear drive shaft (5) drives the rear differential (12). The rear differential is enclosed in the rear axle housing (13). Each end of the rear axle housing contains reduction gearing (10). Each end of the rear axle housing also contains a service brake (11).

1. Engine
2. Torque Converter
3. Transmission
4. Front Drive Shaft
5. Final Drive Shaft
6. Rear Drive Shaft
7. Front Differential
8. Parking Brake
9. Front Axle Housing
10. Reduction Gearing
11. Service Brake
12. Rear Differential
13. Rear Axle Housing

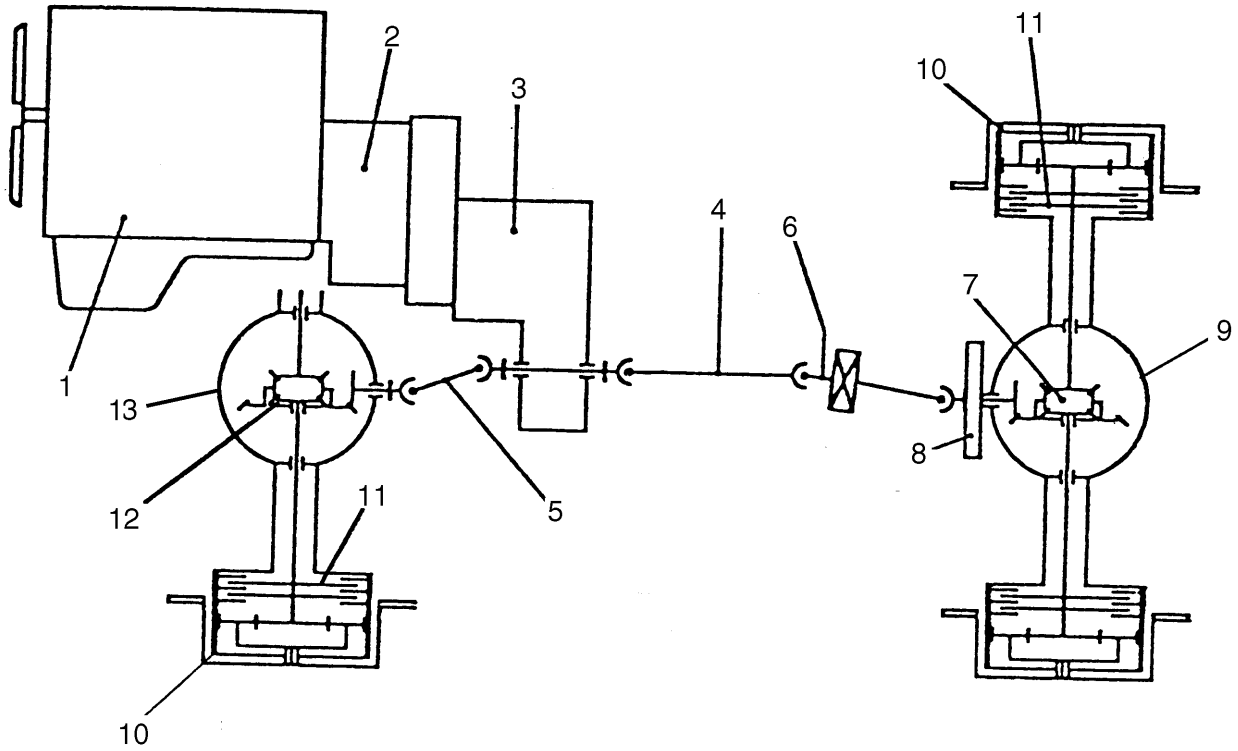


FIGURE 4-1

4922

Transmission

The machine contains a powershift transmission that has 4 forward speeds and 3 speeds in reverse. Gear changes are made by an electro-hydraulic control valve that is mounted on the transmission. Moving the gear select lever in the cab, generates an electrical signal that is transmitted to the control valve. The control valve contains solenoid valves that direct pressurized fluid to various clutches that control the forward and reverse gears.

The torque converter stall ratio is 2.879:1. Transmission fluid operating pressure is 5 kg/cm^2 (71.5 psi). Transmission fluid temperature should be kept below 90°C (194°F).

If the transmission cut-off switch (located in the cab) is in the OFF position, pressing the machine brake pedal will cut off the electrical signal to the transmission control valve. This stops the transmission from conducting engine torque to the axles. This makes it much easier to slow the machine.

External Assemblies

Figure 4-2 identifies external transmission assemblies.

1. Input Housing
2. Torque Converter
3. Speedometer Input Flange
4. Identification Plate
5. Oil Outlet Flange
6. Output Shaft
7. Transmission Mounting Points
8. Output Shafts
9. Dipstick
10. Oil Filter
11. Electrical Control Valve

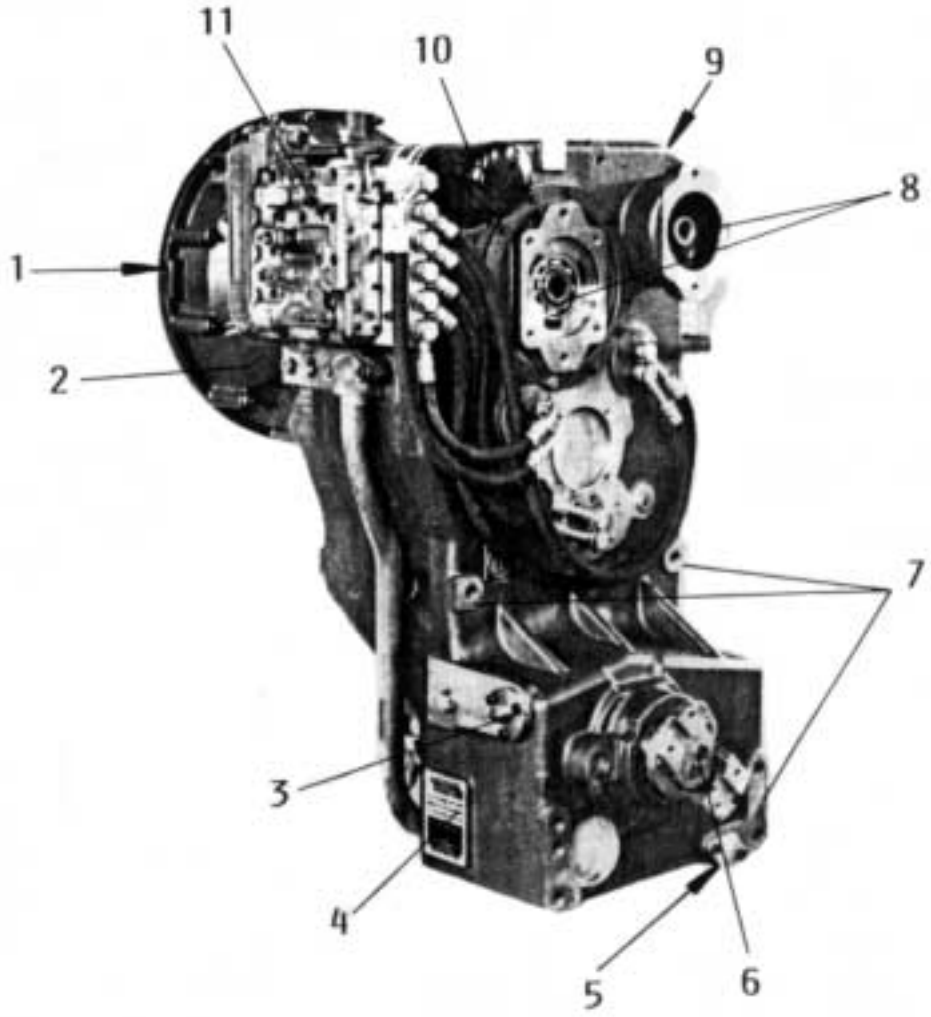


FIGURE 4-2

4441

Mechanical Layout

Figure 4-3 shows the location of many internal transmission assemblies.

1. Torque Converter
2. Pressure Filter
3. Transmission Oil Pump
4. Output Shaft
5. Reverse Clutch and Gear
6. Lubrication Oil Input
7. Pressure Oil Supply
8. Piston Carrier
9. Piston
10. Metal and Fiber Clutch Plates
11. Clutch Drum
12. Gear Shaft
13. Speedometer Drive Gear
14. Output Shaft
15. Transmission Housing

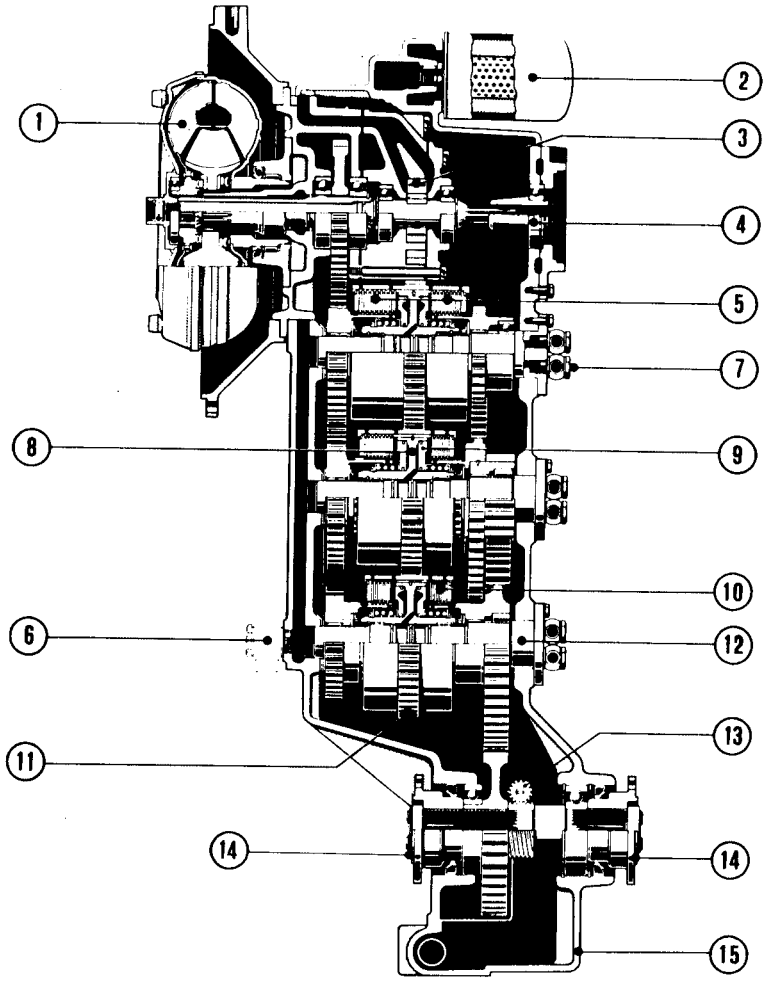


FIGURE 4-3

4442

Hydraulic Schematic

Figure 4-4 contains a hydraulic schematic for the torque converter and transmission.

1. Fourth Gear Clutch
2. Forward Clutch
3. Reverse Clutch
4. Third Gear Clutch
5. Second Gear Clutch
6. First Gear Clutch
7. Electrical Control Valve
8. Pressure Reduction Valve
9. Shift Relief Valve
10. Converter Relief Valve
11. Oil Sump
12. Lubrication Circuitry
13. Oil Cooler
14. Converter Regulator
15. Torque Converter
16. Pressure Control Valve

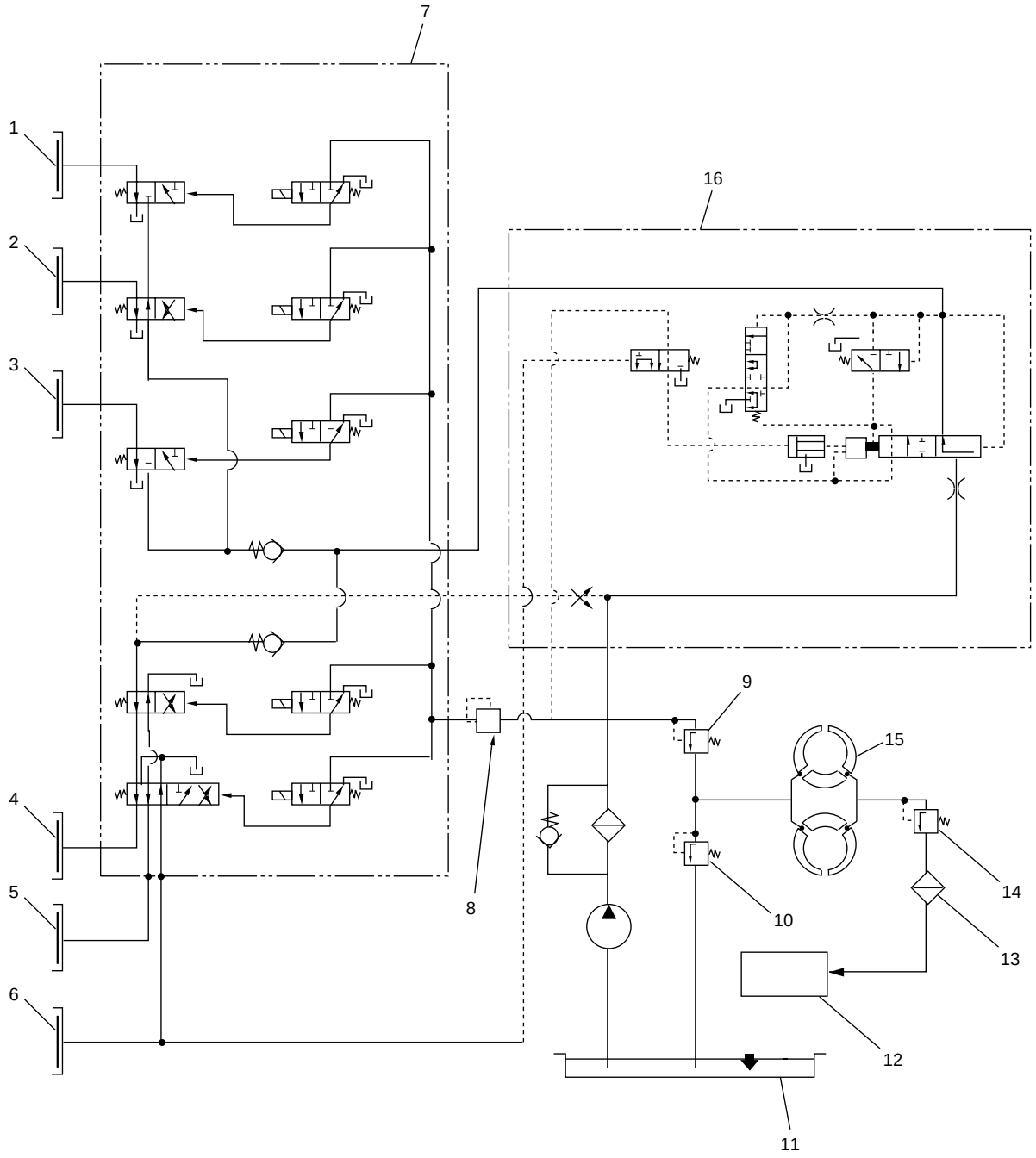


FIGURE 4-4

4443

Transmission Troubleshooting

Control Pressure Is Too Low at All Speeds As Indicated on the Gauge in the Operator's Cab

Test	Result	Action
1. Check control pressure.	Pressure too low.	If pressure is low, perform Step 2.
	Pressure good.	If pressure is OK, replace cab gauge.
2. Check lubrication pressure.	Pressure too low.	If pressure is low, perform Pump Test, Step 3.
	Pressure good.	If pressure is good, perform Control Time Test, Step 4.
3. Pump Test	Pressure too low.	Replace pump.
	Pressure good.	Replace gearbox.
4. Control Time Test	Test time too long.	Perform Pressure Control Valve Test, Step 5.
	Test time good.	Repair control valve.
5. Pressure Control Valve Test	Valve defective.	Replace pressure control valve.
	Valve good.	Replace control unit.

Control Pressure Too Low at a Specific Speed

Test	Result	Action
Check control pressure.	Pressure too low.	Replace gearbox.
	Pressure good.	Replace cab pressure gauge.

Transmission Fluid Temperature Too High

Test	Result	Action
1. Check fluid level.	Level low.	Fill to correct level.
	Level good.	Go to Step 2.
2. Check fluid temperature at oil cooler.	Cooler temp. same as transmission temp.	Cooler contains excessive dirt. Clean.
	Cooler temp. 8 – 10°C (46 – 50°F) lower than transmission temp.	Go to Step 3.
3. Check converter outlet pressure.	Pressure too high.	Repair transmission control valve.
	Correct pressure is 3.0 – 6.5 bar.	
	Pressure too low.	Go to Step 4.
4. Check converter relief valve.	Defective valve.	Repair or replace.
	Valve good.	Go to Step 5.
5. Check converter seal ring.	Good seal ring.	Speed of operation is too low. Operate machine at higher speed.
	Defective seal ring.	Replace seal ring.

No Transmission Function at Any Engine Speed

Test	Result	Action
1. Check transmission fluid level.	Level too low.	Add oil to correct level.
	Level good.	Go to Step 2.
2. Check mechanical connection between engine and torque converter.	Defective.	Repair.
	Connection good.	Go to Step 3.
3. Perform transmission control pressure test.	Pressure good.	Go to Step 4.
	No pressure.	Defective pump. Replace pump.
4. Test transmission controller current (use PR47). Test at switch outlet.	Current good.	Go to Step 5.
	No current.	Damaged wire harness. Replace. Controller defective. Replace controller.
5. Physically damaged gearbox.		Replace gearbox.

No Transmission Output in 1st and 2nd Gears

Test	Result	Action
1. Test solenoid current out of controller (use PR47). Test all gears.	No controller output current.	Go to Step 2.
	Controller output current good.	Go to Step 3.
2. Check current out of forward cut-off switch 1.	No response.	Defective cut-off switch or relay.
	Current from cut-off switch good.	Defective controller. Replace controller.
3. Check current out of solenoid valves.	No current output.	Damaged solenoids. Replace solenoids.

Control Valve

Disassembly

Figure 4-5 contains an exploded view of the transmission control valve. The index numbers in the figure correlate to the index numbers used in the disassembly and assembly steps that follow.

1. Remove the gasket (1, Figure 4-5), cover plate (2), and gasket (3).

1. Valve Gasket
2. Cover Plate
3. Valve Gasket
4. Check Ball
5. Check Ball
6. Check Ball
7. Spring
8. Spring
9. Spring
10. Threaded Plug
11. Threaded Plug
12. O-ring
13. O-ring
14. Spring
15. Spring
16. Check Ball
17. Check Ball
18. Bolt
19. Cover
20. Valve Body
21. Cover Gasket
22. Spring
23. Stop Washer
24. Spool
25. Spring
26. Piston
27. Spool
28. Washer
29. Washer
30. Shaft Seal
31. Snap Ring
32. Stop Plate
33. Detent Block
34. Spool
35. Washer
36. Washer
37. Shaft Seal
38. Snap Ring
39. Snap Ring
40. Piston
41. Stop Plate
42. Detent Block
43. Spool
44. O-ring
45. Set Screw
46. Plug
47. Valve Block
48. O-ring
49. Spring
50. Spool
51. Bolt
52. Bolt
53. Bolt
54. Bolt
55. Gasket
56. Spring
57. Check Ball
58. Set Screw
59. Threaded Plug
60. O-ring
61. Threaded Plug
62. O-ring
63. Threaded Plug
64. O-ring
65. Threaded Plug
66. O-ring
67. Threaded Plug
68. O-ring
69. Threaded Plug
70. O-ring

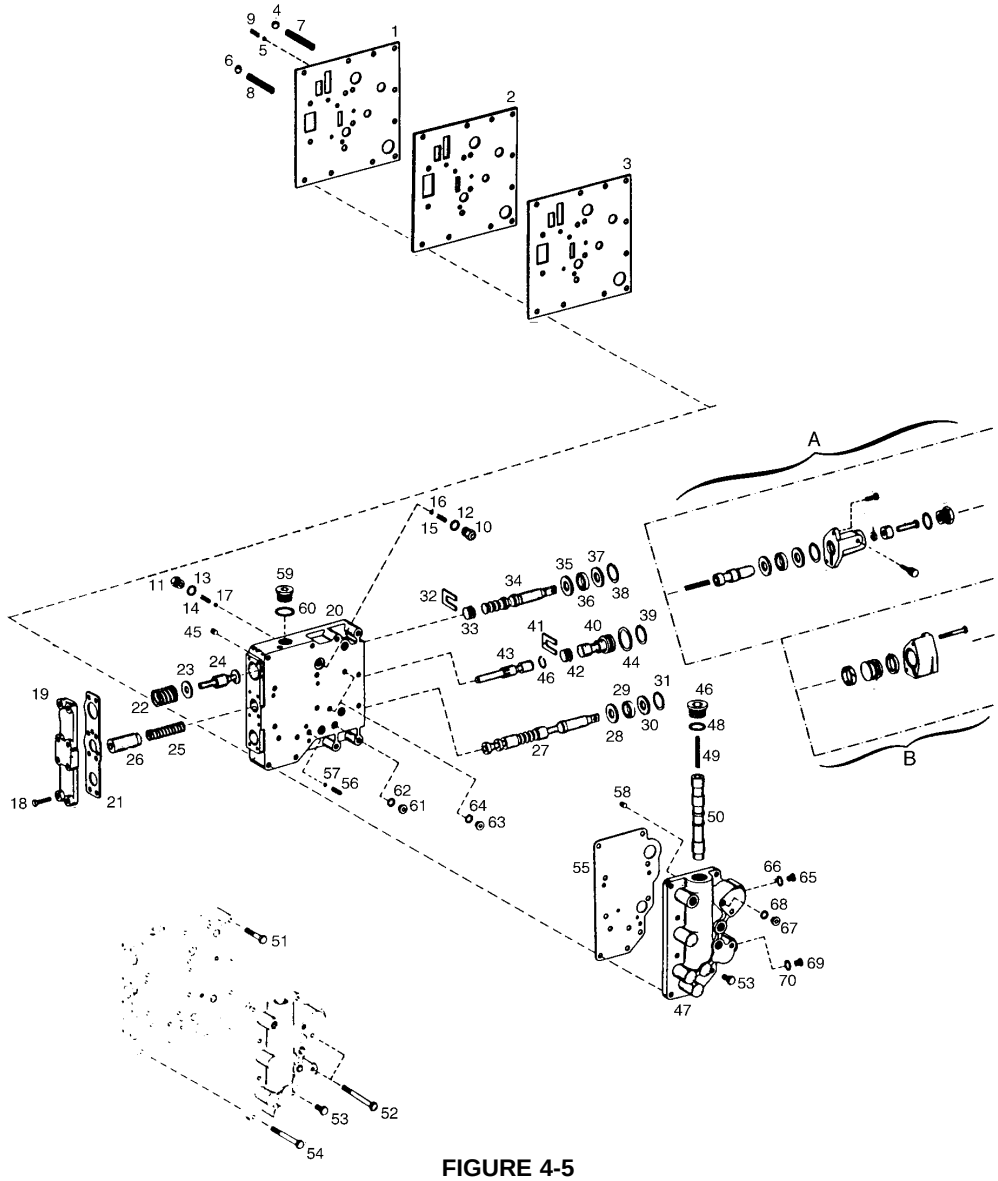


FIGURE 4-5

4444

2. Remove the check balls (4), (5), (6) and the compression springs (7), (8), and (9). See Figure 4-6.

FIGURE 4-6 4445

3. Remove the plugs (10) and (11), O-rings (12) and (13), springs (14) and (15), check balls (16) and (17). See Figure 4-7. Remove set screw (45).

FIGURE 4-7 4446

4. Remove the bolts (18) that hold cover (19) to the valve body (20). See Figure 4-8. Remove gasket (21).

FIGURE 4-8 4447

5. Remove the spring (22), stop washer (23), and spool (24) from valve bore “c.” See Figure 4-9. Remove the spring (25) and piston (26) from valve bore “b.” Remove the spool (27), from bore “a.”

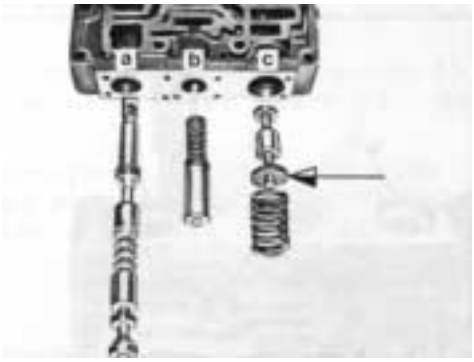


FIGURE 4-9 4448

6. Remove the stop plate (32) from bore “c.” See Figure 4-10. Then remove the detent block (33), and spool (34).

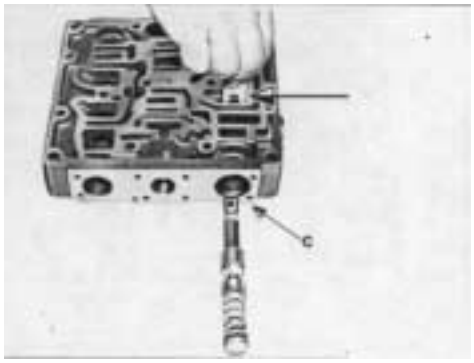


FIGURE 4-10 4449

7. Turn the valve over and work from the opposite side. See Figure 4-11. Remove the snap ring (39) from bore “d.” Use a slide hammer (special tool) to pull piston (40) out of bore “d.”

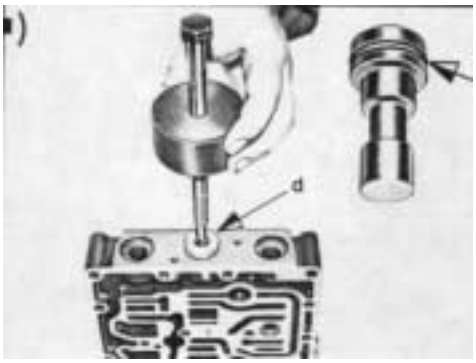


FIGURE 4-11 4450

8. Pull the stop plate (41) out of bore “d.” Remove the detent block (42), spool (43), and O-ring (44). See Figure 4-12.

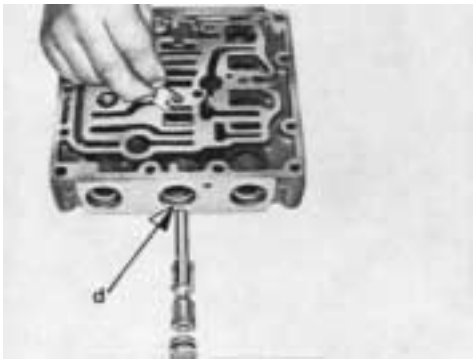


FIGURE 4-12 4451

9. Remove the snap ring (31) and (38) from bores “e” and “g.” See Figure 4-13. Remove washers (35 and 36) and (28 and 29). Remove spool shaft seals (30 and 37).

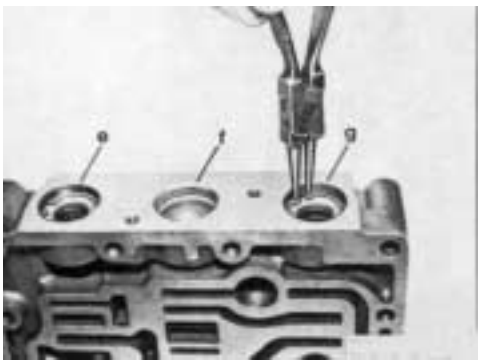


FIGURE 4-13 4452

10. Unscrew plug (46) from reverse gear valve block (47). Remove O-ring (48), spring (49), set screw (58) and spool (50).
11. Unscrew bolts (51, 52, 53, and 54) and remove valve block (47) and gasket (55).
12. Remove the spring (56) and check ball (57).

Assembly

NOTE

Before permanently installing any of the valve spools, first lubricate all spool seals and parts. Then check to be sure that the spool moves freely in its bore.

1. Apply Loctite to the set screw (45) and install it. See Figure 4-14.

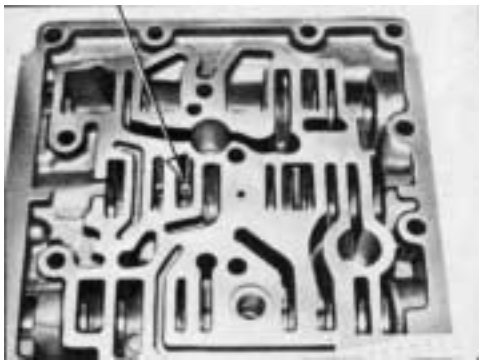


FIGURE 4-14 4453

2. Insert washer (35) into bore “e.” See Figure 4-15. Insert seal (36) into bore with seal lip facing into the valve. Insert washer (37) into bore. Install snap ring (38) into bore to hold parts in place.

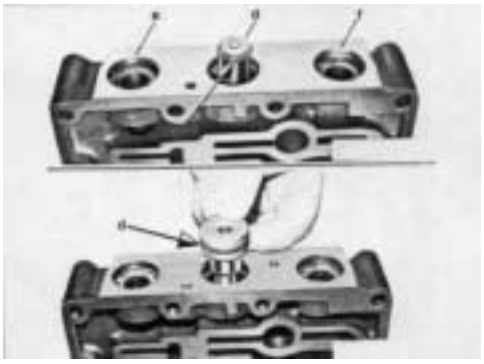


FIGURE 4-15 4454

3. Insert washer (28) into bore “f.” See Figure 4-15. Insert seal (29) into bore with seal lip facing into the valve. Insert washer (30) into bore. Install snap ring (31) into bore to hold parts in place.
4. Install ring (46) on spool (43). Insert spool (43) into bore “d.” Install detent block (42) and stop plate (41) into bore “d.”
5. Install ring (44) on piston (40). Install piston (40) into bore “d.” Install snap ring (39) into bore “d.”
6. Install spool (34) into bore “c.” See Figure 4-16. Install detent block (33) and stop plate (32).

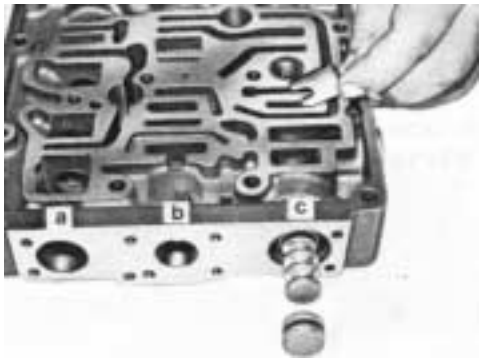


FIGURE 4-16 4455

7. Install check ball (17) into valve body (20). See Figure 4-17. Install spring (14) on top of check ball. Spring length is 20.1 mm (.79"). Install O-ring (13) and thread plug (11) into valve body.

FIGURE 4-17 4456

8. Install check ball (16) into valve body (20). See Figure 4-17. Install spring (15) on top of check ball. Spring length is 20.1 mm (.79"). Install O-ring (12) and thread plug (11) into valve body.
9. Insert spool (27) into bore “a.” See Figure 4-18.

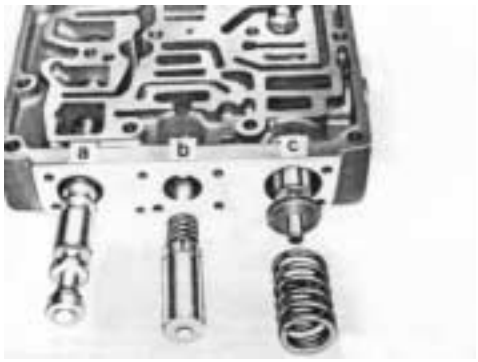


FIGURE 4-18 4457

10. Install spring (25) and piston (26) into bore “b.” Spring length is 73.8 mm (2.9"). See Figure 4-18.
11. Install the spool (24), stop washer (23), and spring (22) into valve bore “c.” See Figure 4-18. Spring length is 46.6 mm (1.83"). Washer thickness helps determine control pressure. Control pressure is marked on transmission identification plate.

    Washer ZF number 0730 103 356 has 2.0 mm (.078") thickness

    Washer ZF number 0730 103 835 has 3.0 mm (.118") thickness
12. Place gasket (21) and cover (19) on valve body (20). Install bolts and tighten to a torque of 6 Nm (4.4 ft lb).
13. Insert check ball (5) and spring (9) into valve body (20). Spring length is 20.1 mm (.79").

14. Insert spring (7) and check ball (4) into valve body (20). See Figure 4-19. Insert spring (8) and check ball (6) into valve body. Spring length is 54.4 mm (2.1").

FIGURE 4-19 4458

15. Insert check ball (57) and spring (56) into valve body (20). See Figure 4-20.

FIGURE 4-20 4459

16. Insert spool (50) and spring (49) into reverse valve block (47). Spring length is 107 mm (4.2"). Install O-ring (48) and then thread plug (46) into valve block (47).

17. Install gasket (55) and valve block (47) on valve body (20). Install bolts (51, 52, 53, and 54) and secure valve block (47) to valve body (20).

Second Gear Valve

Disassembly

Figure 4-21 contains an exploded view drawing of the parts contained in the second gear valve.

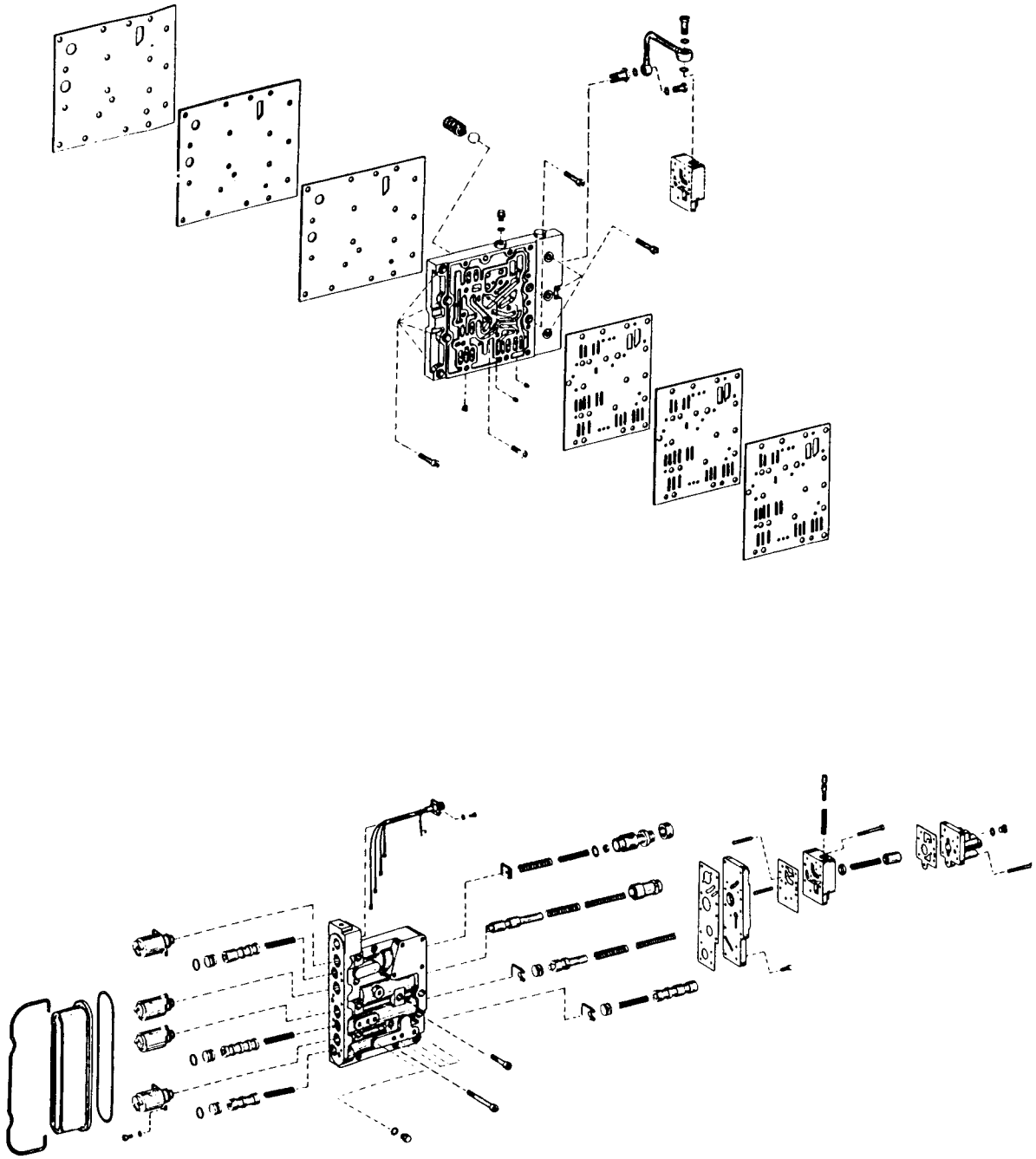


FIGURE 4-21

4460

1. Remove the hydraulic hose that is attached to the second gear valve. See Figure 4-22

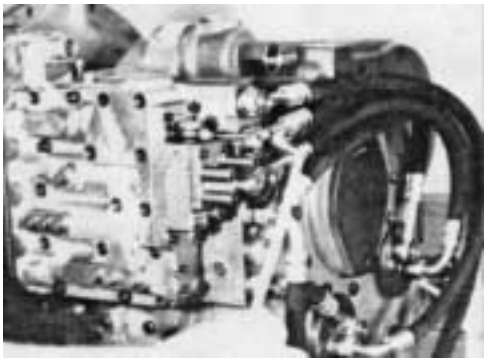


FIGURE 4-22 4461

2. Remove 2 bolts from the top of the second gear valve. See Figure 4-23 Install threaded studs that can be used to guide the valve for removal and installation.

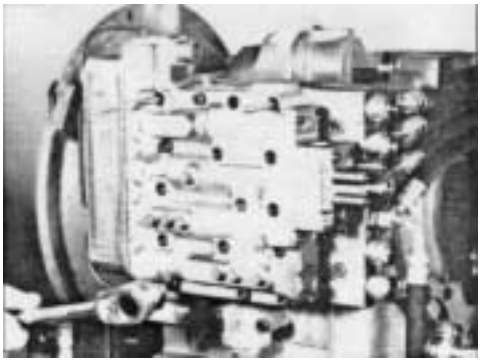


FIGURE 4-23 4462

3. Remove all attaching bolts from the second gear valve. See Figure 4-24. Slide the valve off the transmission.

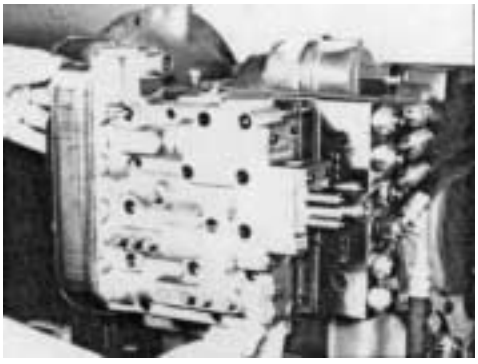


FIGURE 4-24 4463

4. Unlatch the wire clip that retains the solenoid cover. See Figure 4-25 Remove the solenoid cover.

FIGURE 4-25 4464

5. Unplug the wires from the solenoids. See Figure 4-26. Remove the bolts from the solenoid housings. Remove the solenoids.

FIGURE 4-26 4465

6. Remove the detent blocks from the valve bores. See Figure 4-27. Slide the spools and springs out of the valve bores.

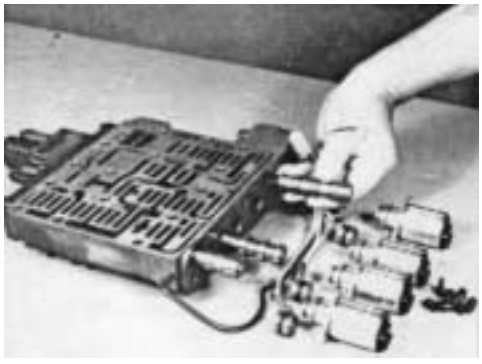


FIGURE 4-27 4466

7. Remove the bolts from the wire harness socket. See Figure 4-28. Pull the socket and wire harness out of the valve.

FIGURE 4-28 4467

8. Remove the bolts that hold the control valve housing to the second gear valve body. See Figure 4-29.

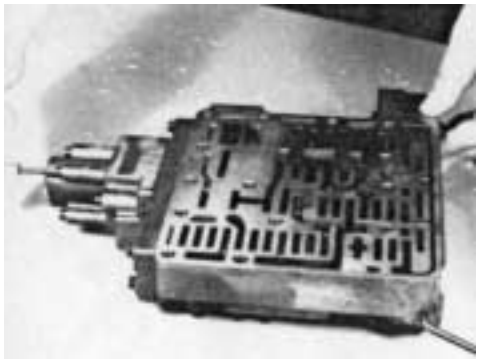


FIGURE 4-29 4468

9. Disassemble the control valve parts. See Figure 4-30.

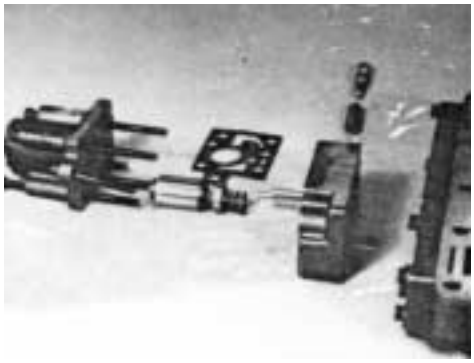


FIGURE 4-30 4469

10. Remove the bolts from the cover that retains the valve spools. See Figure 4-31. Use clamp bolts to remove the cover. Use caution because the cover is being acted on by spring pressure.

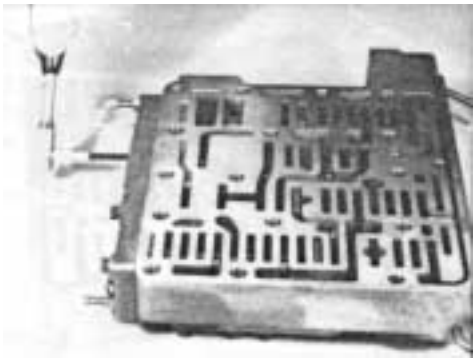


FIGURE 4-31 4470

11. Remove the spools and springs from their bores. See Figure 4-32.

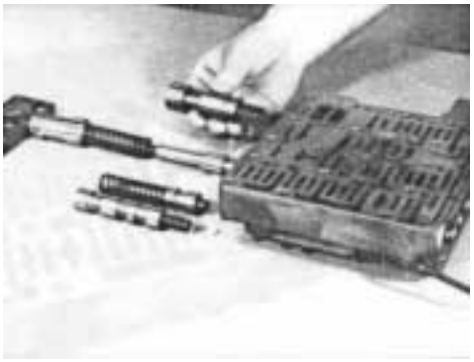


FIGURE 4-32 4471

12. Remove the stop plates and the detent blocks from the valve body. See Figure 4-33.

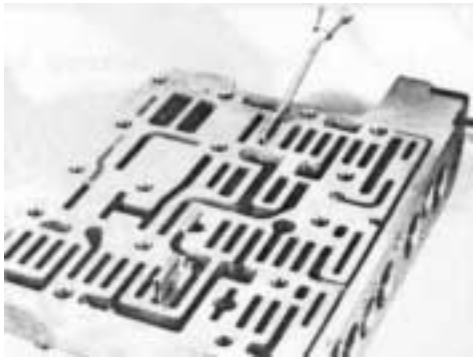


FIGURE 4-33 4472

Assembly

1. Install the detents and stop plates in the valve body. See Figure 4-34.

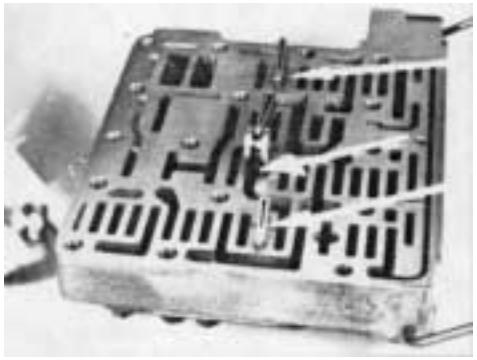


FIGURE 4-34 4474

2. Valve spools and springs are assembled into their bores as shown in Figure 4-35.

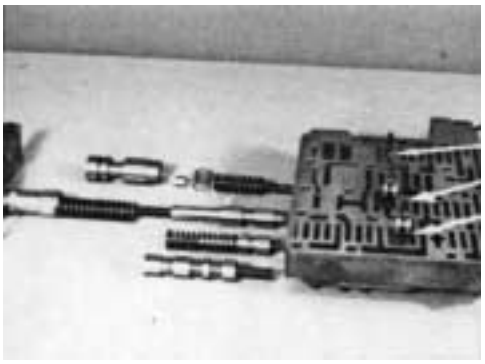


FIGURE 4-35 4473

3. Install the spring and spool as shown in Figure 4-36.

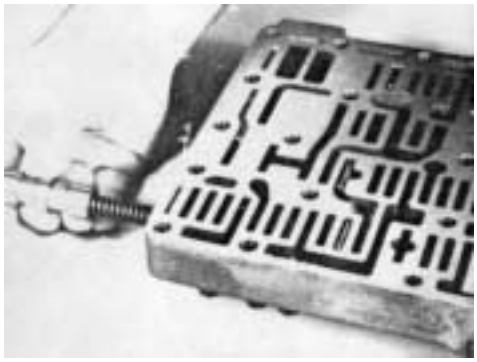


FIGURE 4-36 4475

4. Insert the reset spool and spring. See Figure 4-37.

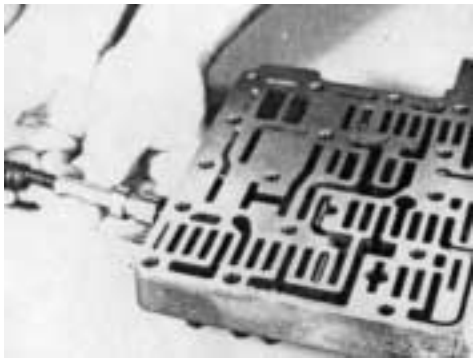


FIGURE 4-37 4476

5. Install the spool and springs for the pressure control spool. See Figure 4-38.

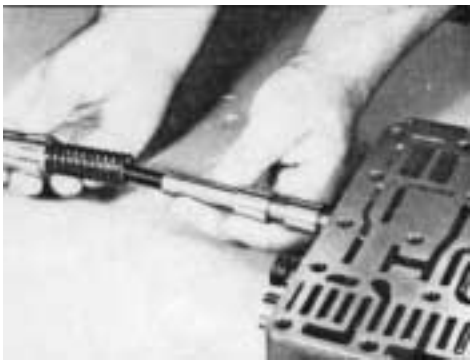


FIGURE 4-38 4477

6. Install the spool, springs, and piston in the last bore. See Figure 4-39.

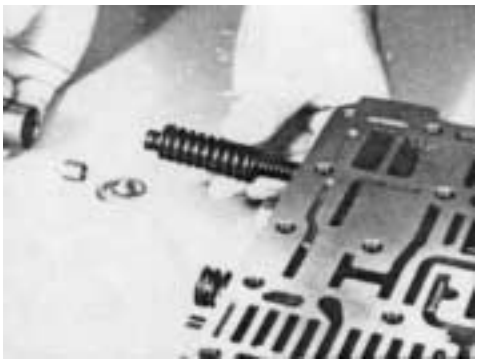


FIGURE 4-39 4478

7. Place the gasket on the cover. Use clamp bolts to install the cover on the valve body. See Figure 4-40.

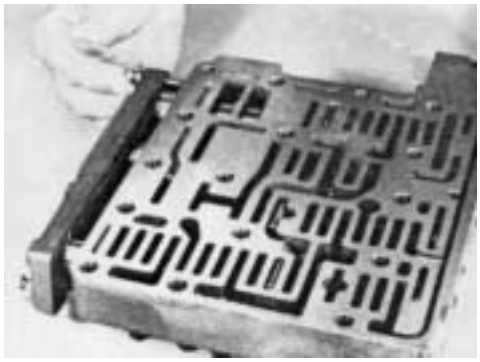


FIGURE 4-40 4479

8. Install the spool and spring as shown in Figure 4-41.

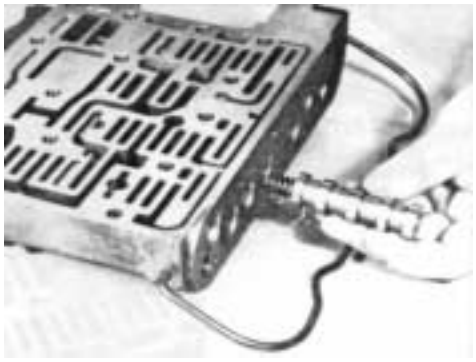


FIGURE 4-41 4480

9. Install the spool and spring as shown in Figure 4-42. Install all spools and springs on this side of the valve block.

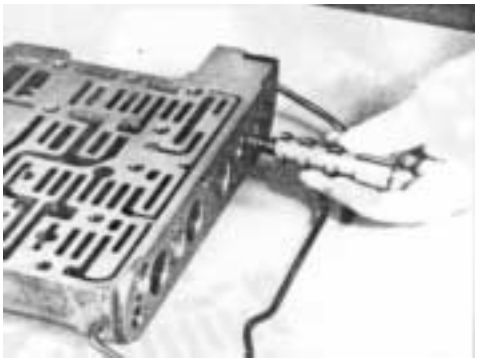


FIGURE 4-42 4481

10. Install all detent blocks on this side of the valve. See Figure 4-43. Insert the detent blocks so that their O-rings are inside the valve bore.

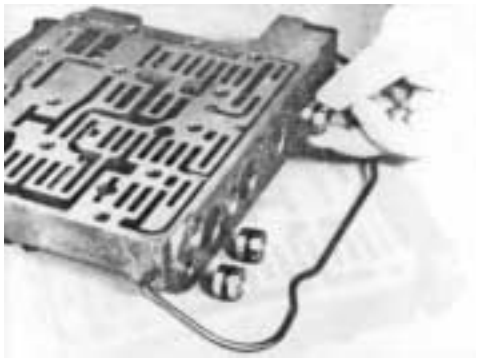


FIGURE 4-43 4482

11. Install all solenoids on this side of the valve. See Figure 4-44. Install the bolts that hold the solenoids in place. Tighten the bolts to 6 Nm (4.4 ft lb).

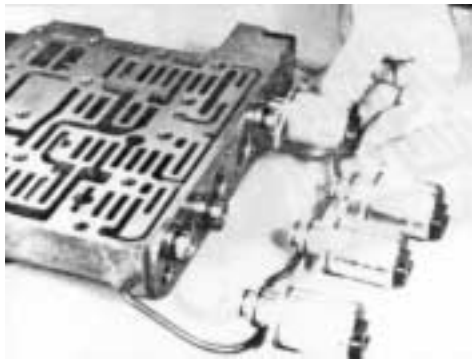


FIGURE 4-44 4483

12. Thread the wire harness through the opening in the valve body. Install the harness socket in the opening. See Figure 4-45. Bolt the socket in place.

FIGURE 4-45 4484

13. Install the wires on the solenoids. See Figure 4-46. Secure the ground wire in place.

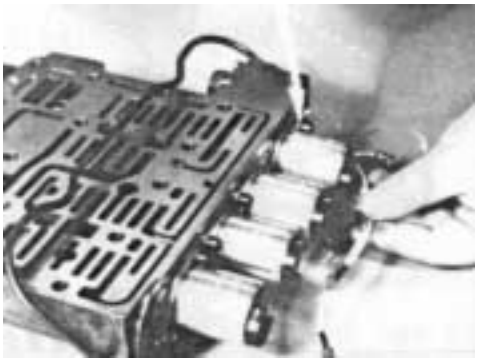


FIGURE 4-46 4485

14. Install the O-ring inside the solenoid cover. Install the cover on the valve body. See Figure 4-47. Use the spring clip to hold the cover in place.

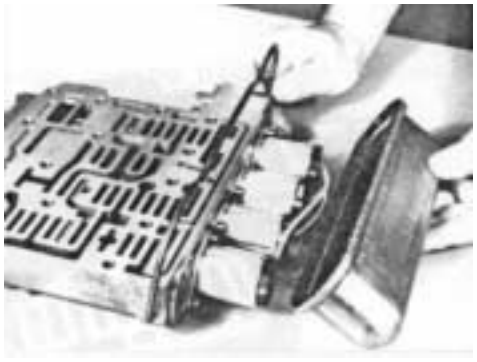


FIGURE 4-47 4486

15. Install the spool and spring in the side of the control valve block. See Figure 4-48. Install the pin to limit the movement of the spool.

FIGURE 4-48 4487

16. Place a gasket on the control valve block. Insert a second control pin into the control valve block. See Figure 4-49. Slide the control valve block up to the valve body by using the control pin.

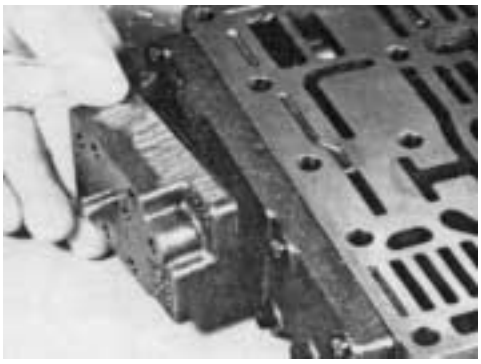


FIGURE 4-49 4488

17. Place a gasket on the control valve. Install the piston and spring into the control valve. See Figure 4-50. Install the control valve onto the valve block.

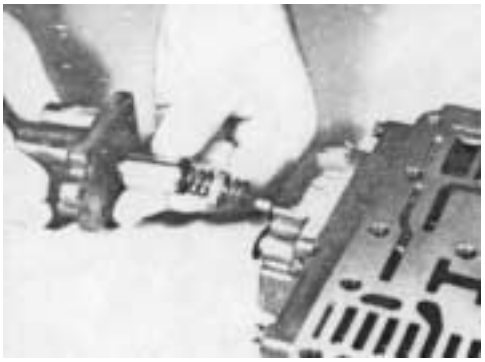


FIGURE 4-50 4489

18. Install the bolts into the control valve and tighten to 6 Nm (4.4 ft lb). See Figure 4-51.

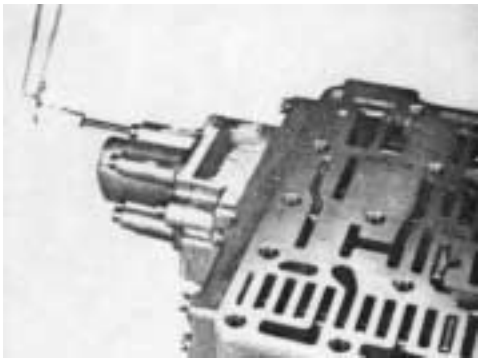


FIGURE 4-51 4490

Transmission WG-180 Control Valve

Disassembly

1. This procedure describes disassembly and assembly of the control valve on the WG-180 transmission. See Figure 4-52.

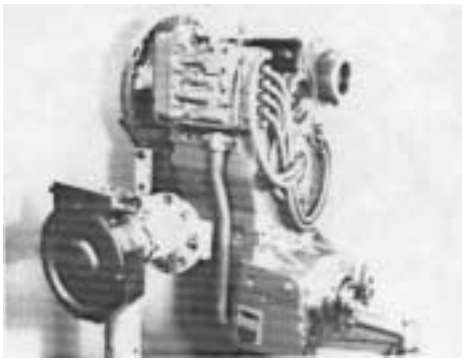


FIGURE 4-52 4491

2. Remove 2 bolts, one from each corner of the upper control valve. See Figure 4-53. Install a locating stud in place of each bolt. Remove all bolts that hold the control valve to the transmission. Remove the control valve from the transmission.

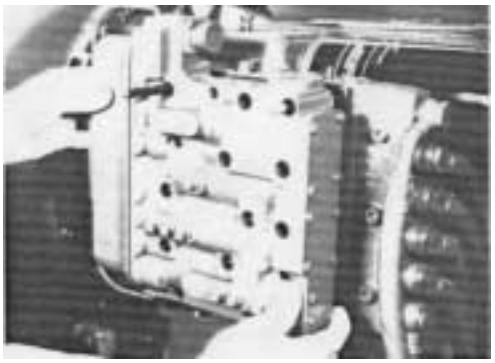


FIGURE 4-53 4492

3. Pry the spring clip loose from the solenoid cover. See Figure 4-54. Remove the cover and O-ring.

FIGURE 4-54 4493

4. Unplug the wires from the solenoids. See Figure 4-55. Remove the bolts from the solenoids. Remove the solenoids.

FIGURE 4-55 4494

5. Remove the detent blocks, springs, and spools from the valve bores. See Figure 4-56. Mark the spools, blocks, and bores so that the parts can be returned to the bores that they were removed from.

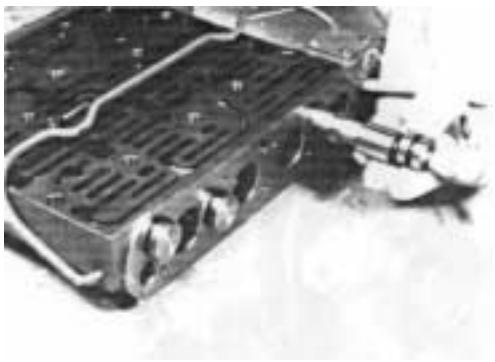


FIGURE 4-56 4495

6. On the opposite side of the valve, remove the bolts that hold the cover to the valve housing. See Figure 4-57. Exercise caution because the cover is being acted on by spring pressure.

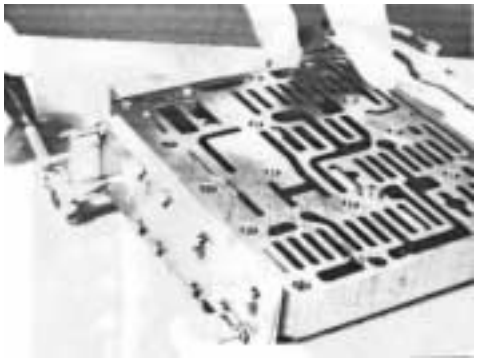


FIGURE 4-57 4496

7. Remove all spools and springs from their bores. See Figure 4-58. Mark the spools and bores so that the spools can be returned to the bores that they were removed from.

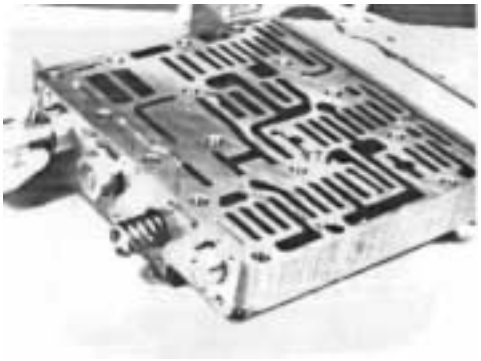


FIGURE 4-58 4497

8. Remove the stop plates and detent blocks from the valve body. See Figure 4-59.

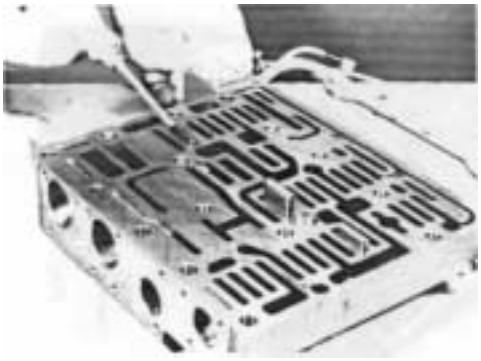


FIGURE 4-59 4498

Assembly

1. Figure 4-60 displays the spools, springs, detent blocks, and solenoids that are installed in the valve.

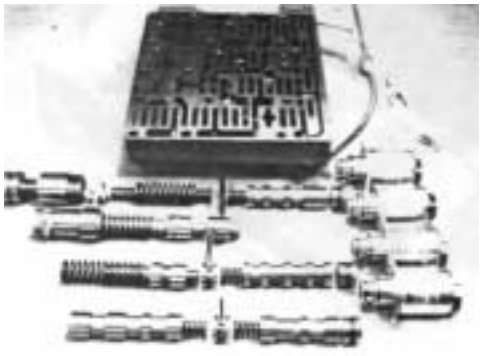


FIGURE 4-60 4499

2. Install the detent blocks and the stop plates into the valve body. See Figure 4-61. Install the springs and spools into the valve bores on the non solenoid side of the valve.

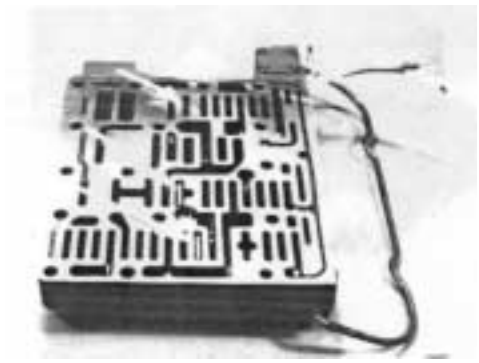


FIGURE 4-61 4500

3. Install a gasket on the cover. Install the bolts that hold the cover to the valve body. See Figure 4-62. Tighten the bolts to 6 Nm (4.4 ft lb).

FIGURE 4-62 4501

4. Install the springs, spools, stop blocks, and solenoids into the solenoid side of the control valve. See Figure 4-63. Bolt the solenoids to the valve body.

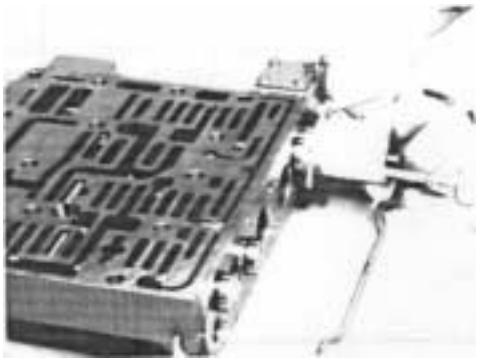


FIGURE 4-63 4502

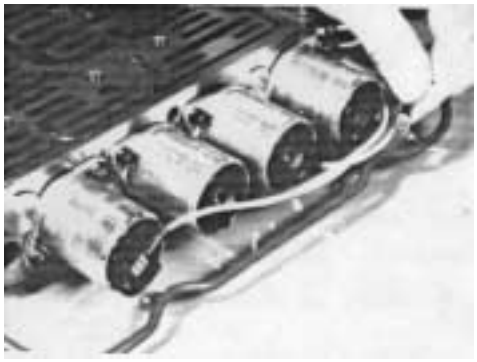


FIGURE 4-64 4503

5. Attach the wires to the solenoids. See Figure 4-64.
6. Install an O-ring into the solenoid cover.

FIGURE 4-65 4504

Transmission Disassembly

1. Remove the gasket and center plate from the valve manifold. See Figure 4-66.

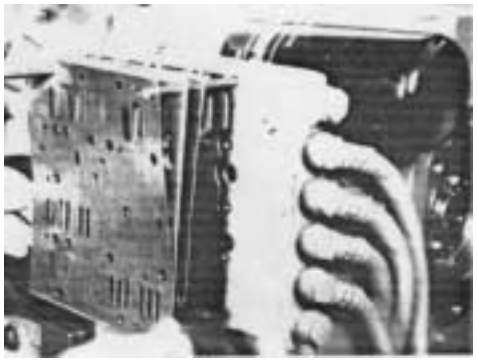


FIGURE 4-66 4505

2. Loosen and remove all hoses that are attached to the valve manifold. See Figure 4-67.

FIGURE 4-67 4506

3. Remove the bolts that hold the valve manifold to the valve base plate. See Figure 4-68. Remove the valve manifold. Remove the gaskets from the base plate.

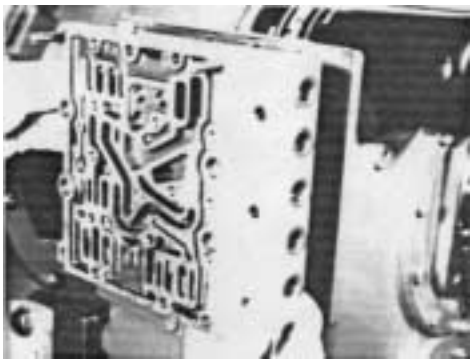


FIGURE 4-68 4507

4. In this step, 2 check balls and 2 springs are removed from bores in the valve manifold. Be sure to identify the bores that the balls and springs are released from, so that they can be returned to the correct bore when reassembled.

   Remove the 2 check valves, shown by the arrow. See Figure 4-69.

FIGURE 4-69 4508

5. Figure 4-70 shows an exploded view drawing of the torque converter, bell housing, and oil pump.

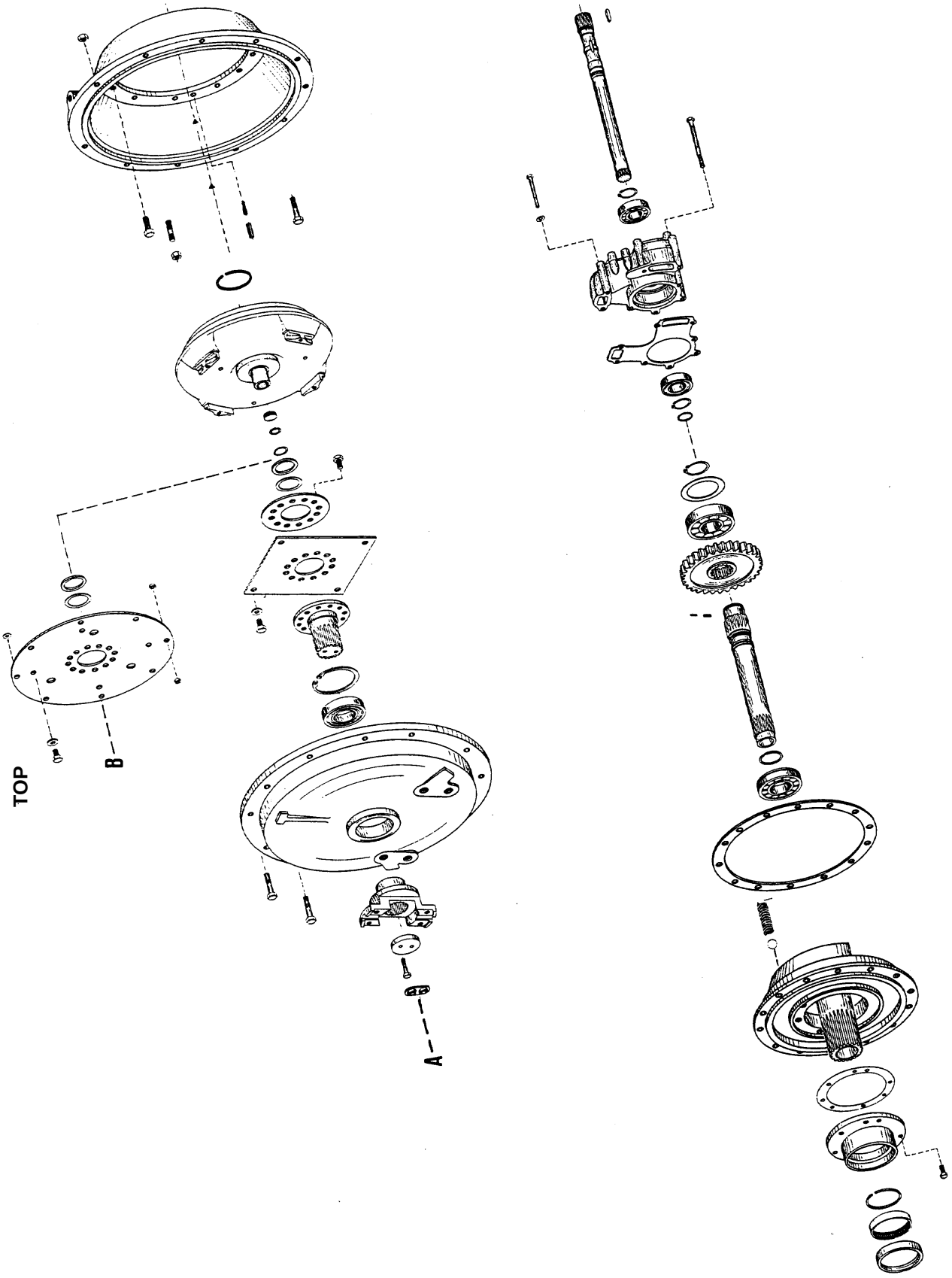


FIGURE 4-70

4509

6. Rotate the filter counterclockwise to unscrew it. See Figure 4-71. Remove the filter.

FIGURE 4-71 4510

7. Rotate the transmission until the bell housing cover is facing upward. Remove the bolts that hold the bell housing cover to the bell housing. See Figure 4-72. Carefully pry the cover upward while lifting the cover off the bell housing.

FIGURE 4-72 4511

8. Remove the lock from the 2 bolts that hold the drive flange to the torque converter shaft. See Figure 4-73. Remove the 2 bolts. Remove the disc from inside the drive flange.

FIGURE 4-73 4512

9. Carefully pry the drive flange off the torque converter shaft. See Figure 4-74.

FIGURE 4-74 4513

10. Use a large plastic hammer to drive the torque converter out of the bell housing cover. See Figure 4-75.

FIGURE 4-75 4514

11. At the back of the bell housing cover, remove the snap ring from the top of the bearing. See Figure 4-76. Remove the bearing.

FIGURE 4-76 4515

12. Remove the bolts that hold the drive plate to the torque converter. See Figure 4-77. Loctite was used on the bolts when they were installed. Separate the drive plate and input shaft from the torque converter.

FIGURE 4-77 4516

13. At the back side of the drive plate, remove the bolts that hold the drive plate to the drive shaft. See Figure 4-78. Loctite was used on the bolts when they were installed.

FIGURE 4-78 4517

14. Remove the bolts that hold the bell housing to the transmission. See Figure 4-79. Remove the bell housing.

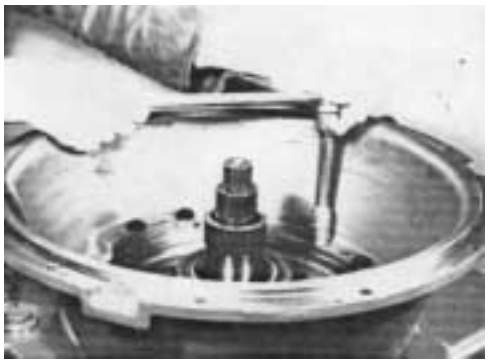


FIGURE 4-79 4518

15. Remove the hex head screws from the bearing cover. See Figure 4-80. Tap the bearing cover and remove it.

FIGURE 4-80 4519

16. Use a puller arrangement to pull the oil pump out of the transmission. See Figure 4-81. Loctite was used to install the oil pump.

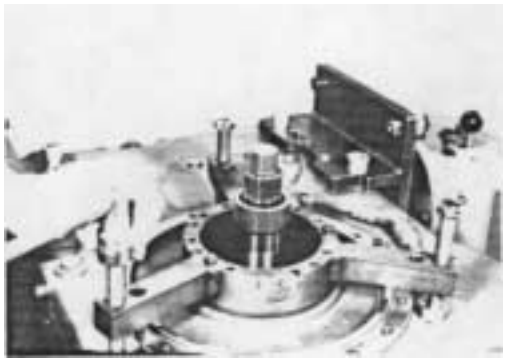


FIGURE 4-81 4520

17. Remove the bolts that hold the oil pump to the adapter housing. See Figure 4-82. Separate the pump from the adapter housing. The adapter housing contains a check ball and a spring. Be prepared to catch the ball and spring when the housing and pump are separated.

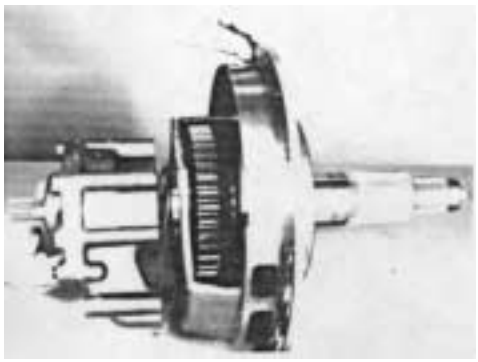


FIGURE 4-82 4521

18. Remove the spacer ring from the oil pump shaft. See Figure 4-83. Remove the snap ring from the oil pump shaft.

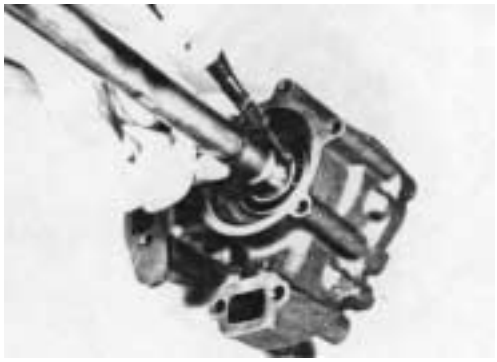


FIGURE 4-83 4522

19. Push the pump drive shaft out the back of the pump. See Figure 4-84.

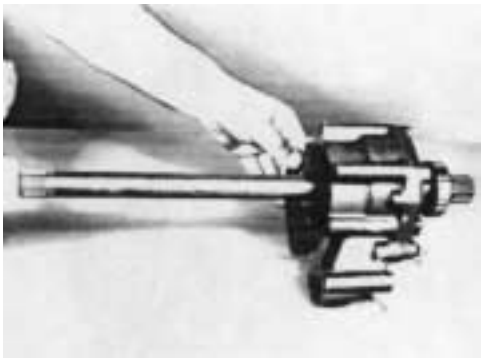


FIGURE 4-84 4523

20. Remove the snap ring from the shaft in the adapter housing. See Figure 4-85. The figure also shows the check ball and spring.

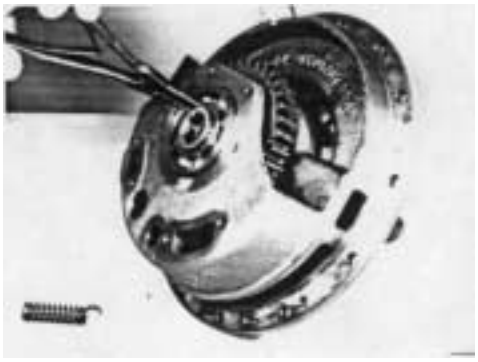


FIGURE 4-85 4524

21. Use a press to force the adapter shaft down until it is pressed past the gear. See Figure 4-86.

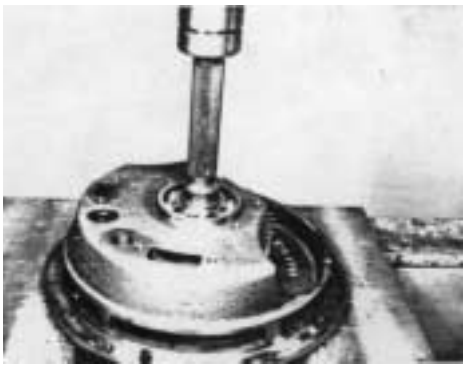


FIGURE 4-86 4525

22. Remove the gear from the adapter housing. See Figure 4-87.

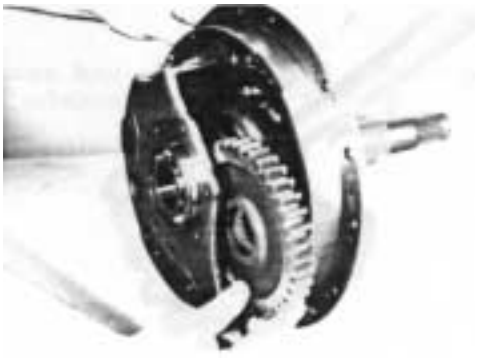


FIGURE 4-87 4527

23. Remove the ball bearing from the adapter housing. See Figure 4-88. Also remove the drive shaft and the roller bearing.

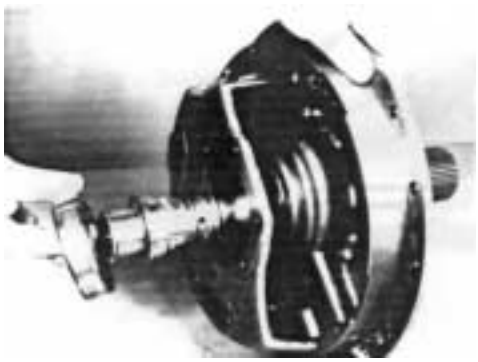


FIGURE 4-88 4528

24. Figure 4-89 contains an exploded view drawing of exterior transmission assemblies.

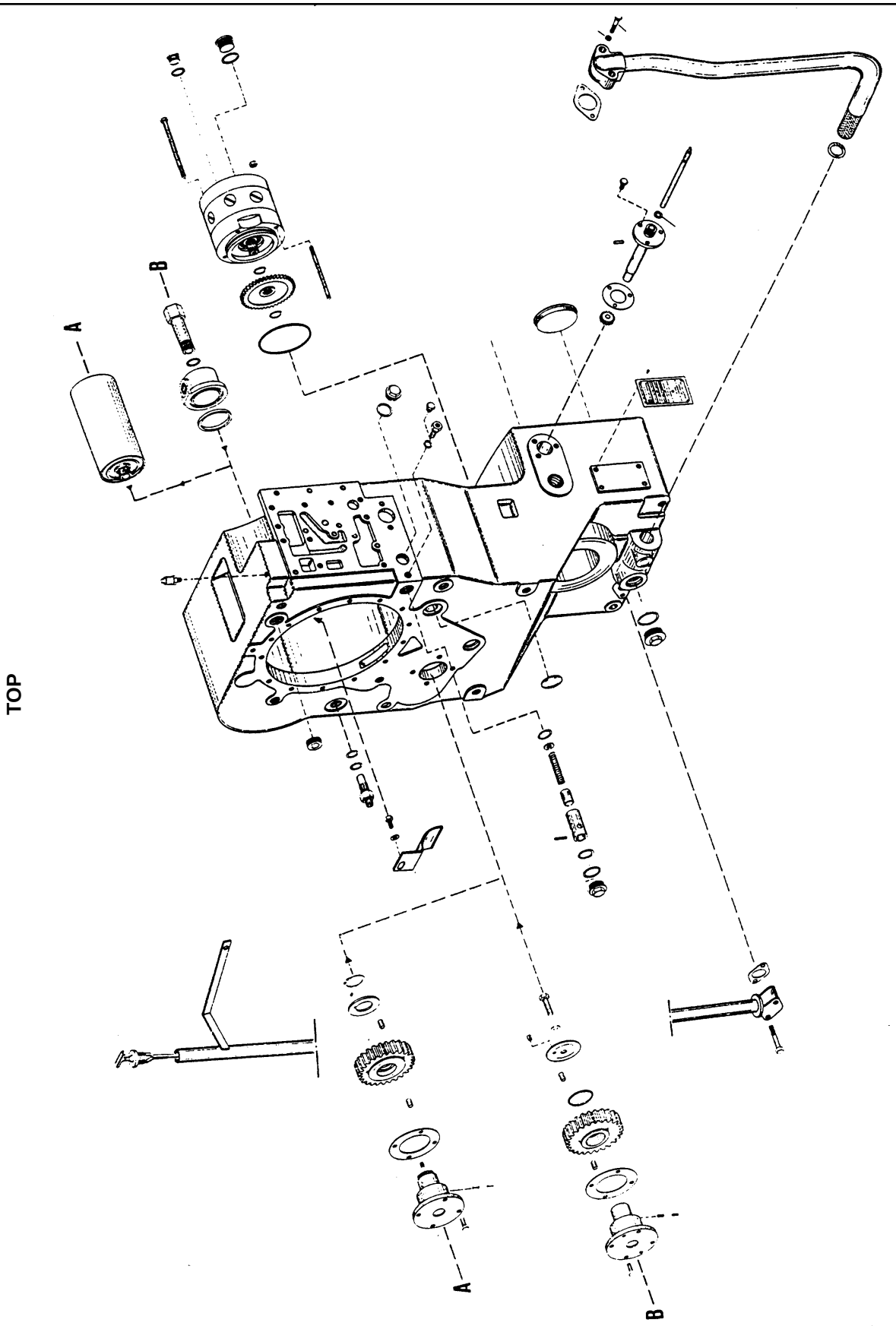


FIGURE 4-89

4526

25. Unthread and then remove the socket for the temperature sensor. See Figure 4-90.

FIGURE 4-90 4529

26. Unthread and remove the plug from the converter oil control valve. See Figure 4-91. Remove the spring clip and then remove the parts for the control valve.

FIGURE 4-91 4530

27. Position the transmission so that the input side is laying down on the work surface. This will position the Power Takeoff (PTO) assembly facing upward. An exploded view drawing that contains internal transmission components is shown in Figure 4-92.

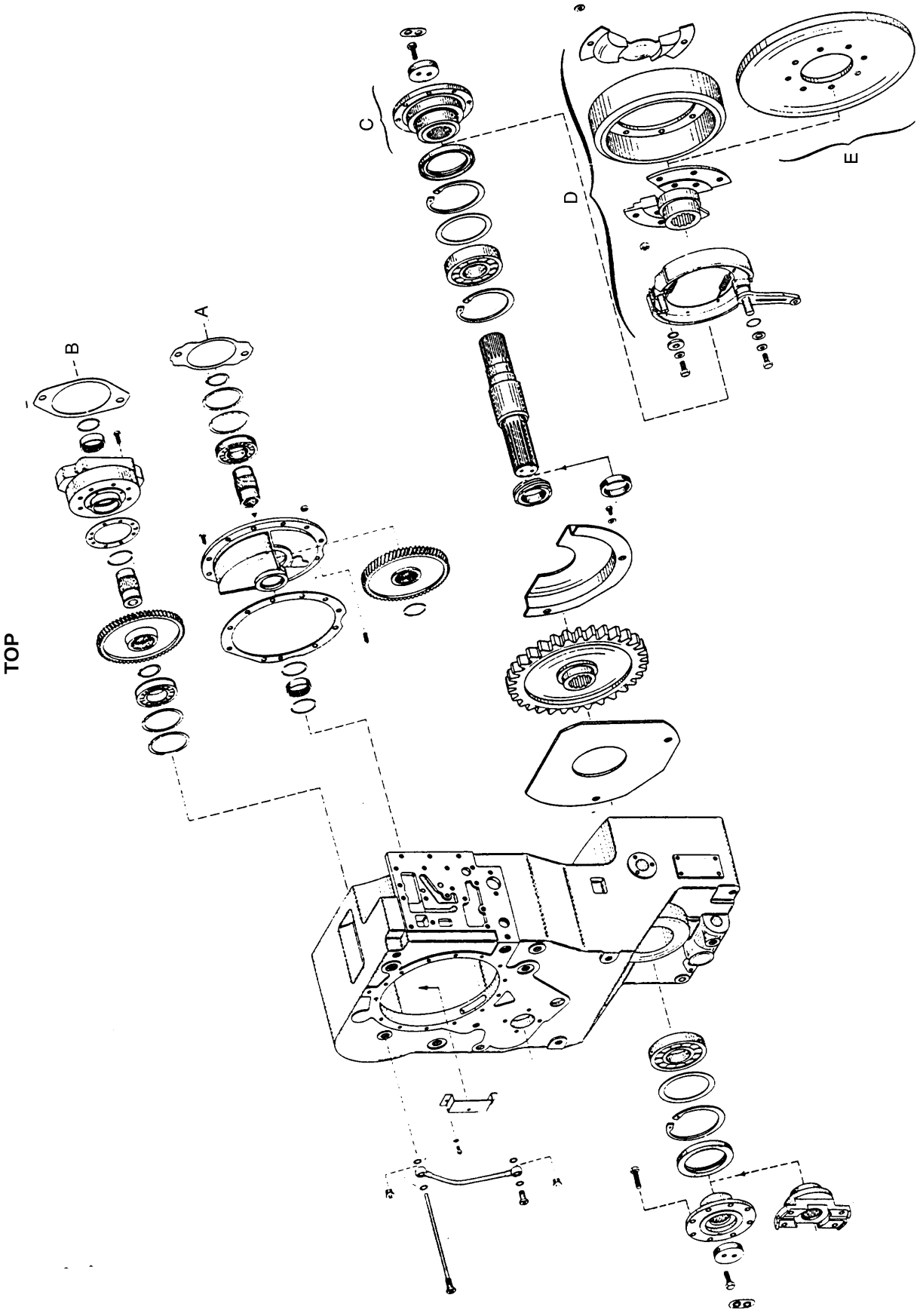


FIGURE 4-92

4531

28. Remove the bolts that hold the PTO housing to the transmission. See Figure 4-93. Lift the PTO housing out of the transmission.

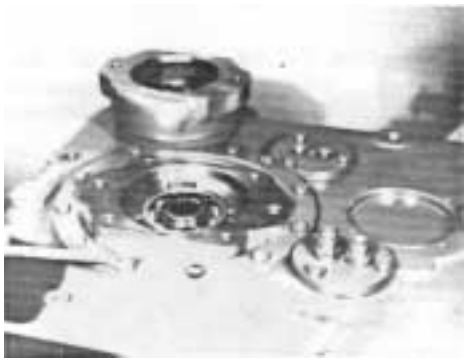


FIGURE 4-93 4532

29. Remove the snap ring that holds the bearing in place. See Figure 4-94. Remove the bearing.

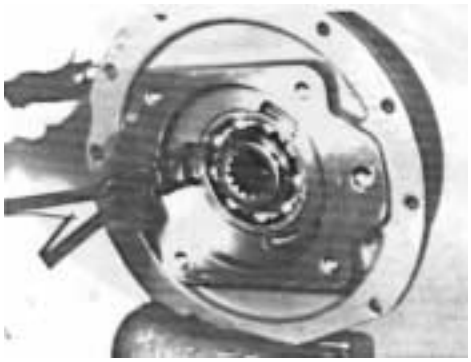


FIGURE 4-94 4533

30. Hold open the snap ring on the opposite side of the shaft. See Figure 4-95. Use a large plastic hammer to drive the hollow drive shaft out of the PTO housing.

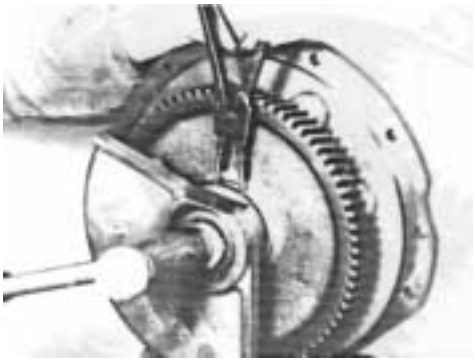


FIGURE 4-95 4534

31. Match mark the position of the pump mounting flange. See Figure 4-96. Remove the bolts that hold the flange in place. Remove the flange.

FIGURE 4-96 4535

32. Unbolt and remove the oil tubing. See Figure 4-97.

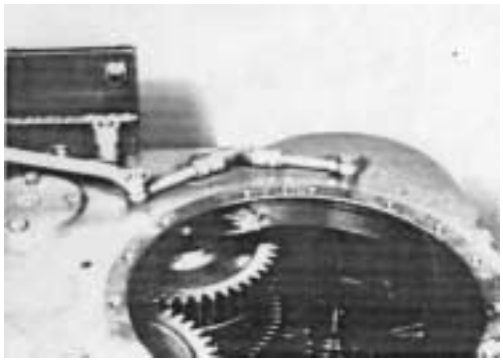


FIGURE 4-97 4536

33. Match mark the position of the bracket. See Figure 4-98. Remove the bolts that hold the bracket in place. Remove the bracket.

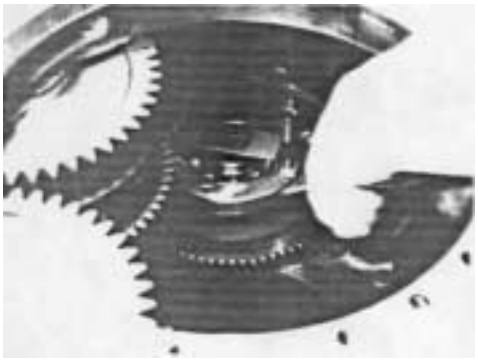


FIGURE 4-98 4537

34. Remove the snap ring. See Figure 4-99.

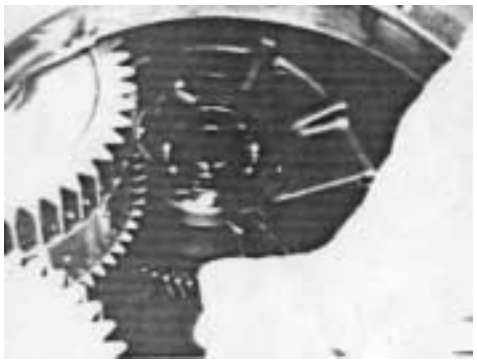


FIGURE 4-99 4538

35. Turn the transmission over and work from the other side. See Figure 4-100. Use an internal puller to pull the shaft out of the transmission.

FIGURE 4-100 4539

36. Match mark the anchor plate, shaft, and transmission. Remove the bolts that hold the gear shaft to the shaft anchor plate. See Figure 4-101. Remove the anchor plate. Remove the gear shaft from the transmission.

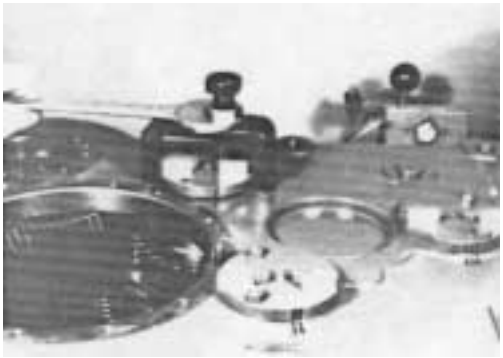


FIGURE 4-101 4540

37. Move clutch pack KV/K1 in the direction of the arrow. See Figure 4-102. This will create enough space to remove the large gear from the PTO shaft.

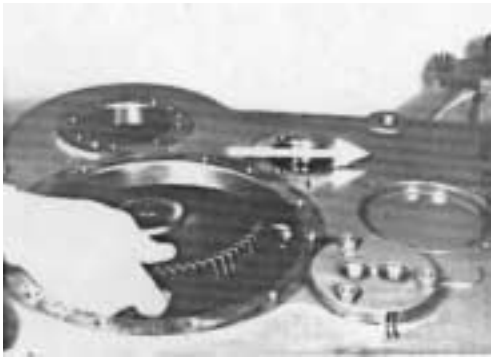


FIGURE 4-102 4541

38. Remove the snap rings from both sides of the bore in the transmission. See Figure 4-103. Remove the bearings.

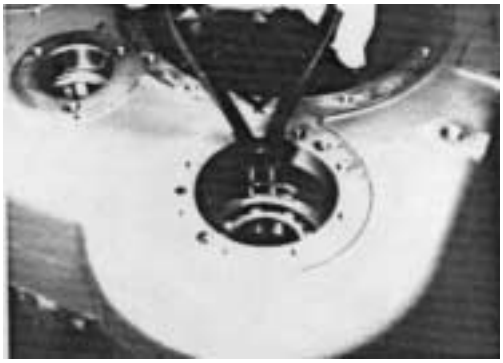


FIGURE 4-103 4542

39. Perform the same procedures described in Step 36 to the shaft and anchor plate marked with the arrow in Figure 4-104. Move clutch pack KV/K2 in the direction of the arrow, to remove the large gear from shaft KR/K2.

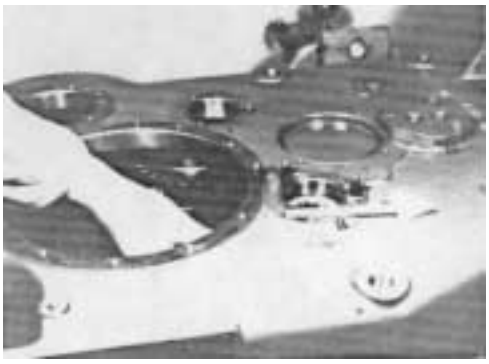


FIGURE 4-104 4543

40. Figure 4-105 contains an exploded view drawing of the KV/K1 clutch packs contained inside the transmission.

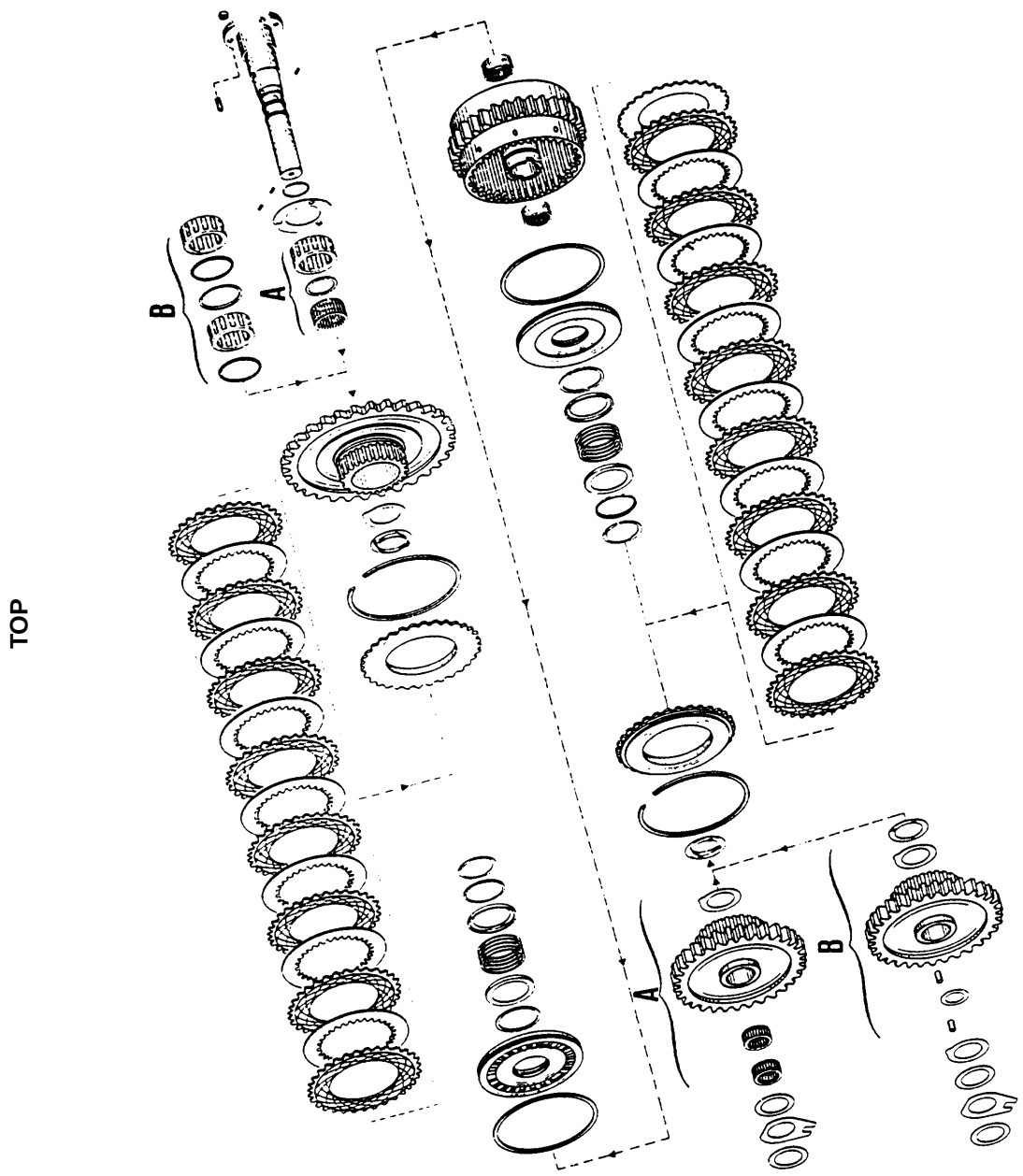


FIGURE 4-105

4544

41. Remove clutch pack KV/K1 from the transmission housing. See Figure 4-106. The clutch pack weighs approximately 20 kg (44 lb).

FIGURE 4-106 4545

KV/K1 Clutch Pack Disassembly

1. Remove the spur gear K1 from the plate pack. See Figure 4-107.

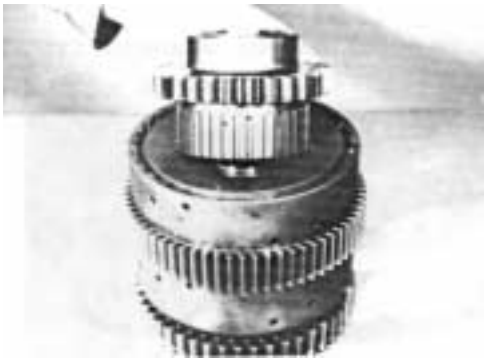


FIGURE 4-107 4546

2. Use a screwdriver to pry loose the snap ring. See Figure 4-108.

FIGURE 4-108 4547

3. Remove the metal and fiber plates from the first gear clutch pack. See Figure 4-109.

FIGURE 4-109 4548

4. Remove the KV spur gear from the clutch pack. See Figure 4-110.

FIGURE 4-110 4549

5. Remove the snap ring. Remove the KV clutch pack. See Figure 4-111.

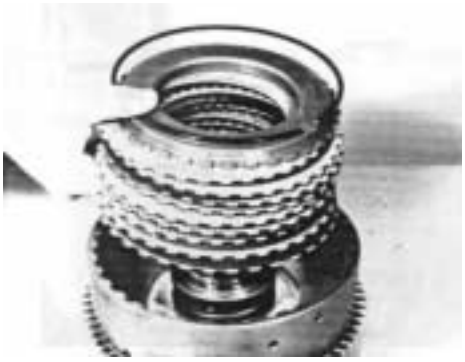


FIGURE 4-111 4550

6. Use a hydraulic press to press down on the piston. See Figure 4-112. This relieves pressure on the snap ring. Remove the snap ring.

FIGURE 4-112 4551

7. Use pliers to remove the piston from the piston carrier. See Figure 4-113. To make piston removal easier, rotate the piston while removing it.

FIGURE 4-113 4552

8. Pull the needle bearing from the piston carrier. See Figure 4-114. Remove the piston from the piston carrier on the opposite side.

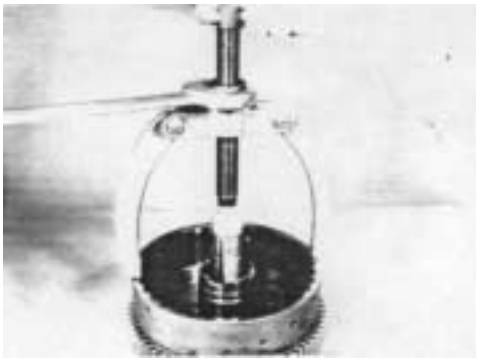


FIGURE 4-114 4553

KR/K2 Clutch Pack Disassembly

1. Remove the KR/K2 clutch pack from the transmission. See Figure 4-115.

FIGURE 4-115 4554

2. Figure 4-116 contains an exploded view drawing of the KR/K2 clutch packs.

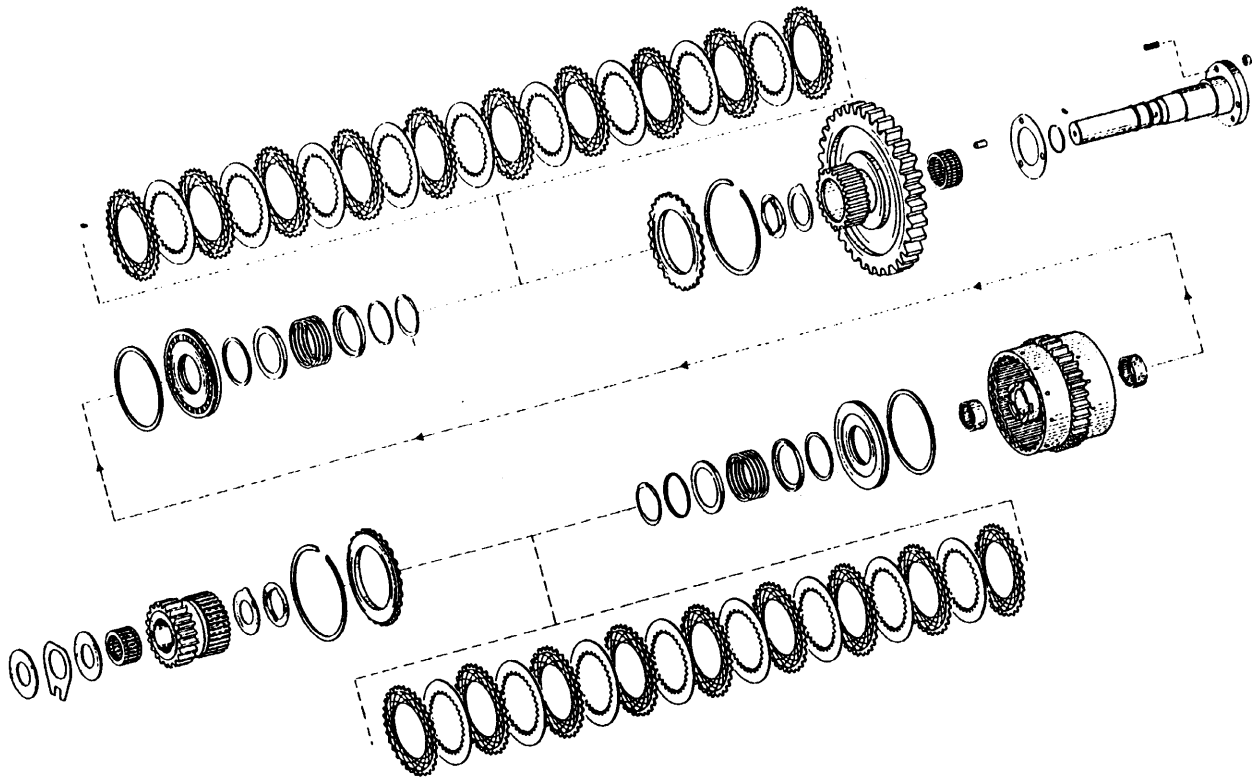


FIGURE 4-116 4555

3. Remove the spur gear and bearing from the clutch plate carrier. See Figure 4-117.

FIGURE 4-117 4556

4. Remove the snap ring and then remove the discs from the K2 clutch pack. See Figure 4-118.

FIGURE 4-118 4557

5. Remove the KR spur gear with the bearing and washer. See Figure 4-119.

FIGURE 4-119 4558

6. Remove the snap ring and then remove the discs from the clutch pack. See Figure 4-120.

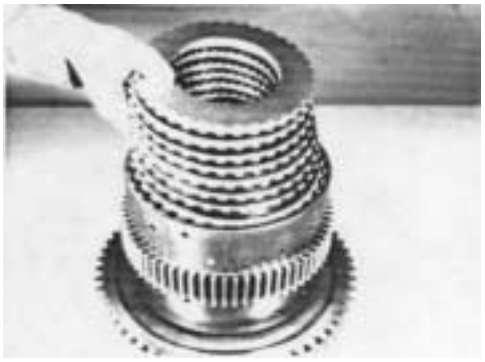


FIGURE 4-120 4559

7. Follow Steps 6, 7, and 8 in the KV/K1 disassembly procedure to remove the snap ring, piston, and needle bearing. See Figures 4-112, 4-113, and 4-114.
8. The type “A” reverse gear is held in place with a snap ring. Remove the snap ring that retains the reverse gear. See Figure 4-121. Remove the reverse gear.

FIGURE 4-121 4560

The type “B” reverse gear is held in place with a bolt. Remove the bolt that retains the reverse gear. See Figure 4-122. Remove the washer and reverse gear.

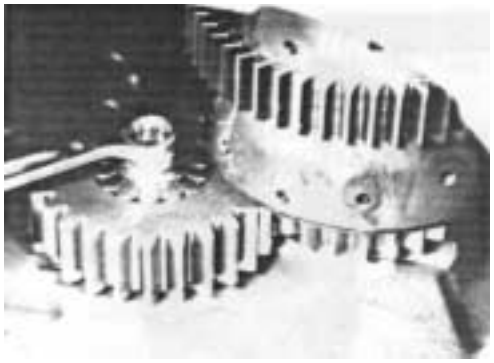


FIGURE 4-122 4561

9. Remove the bolts and then remove the shaft. See Figure 4-123. Remove the spur gear from the transmission.

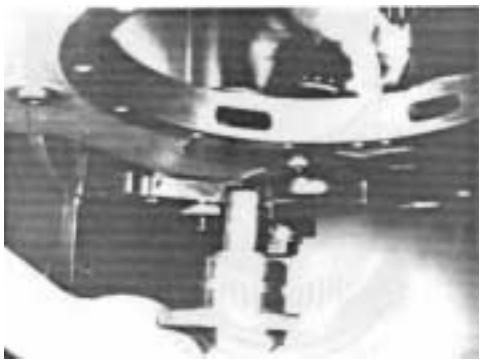


FIGURE 4-123 4562

10. Remove the bolts. Pull the K3/K4 shaft out of the transmission by using the special tool

FIGURE 4-124 4563

shown. See Figure 4-124.

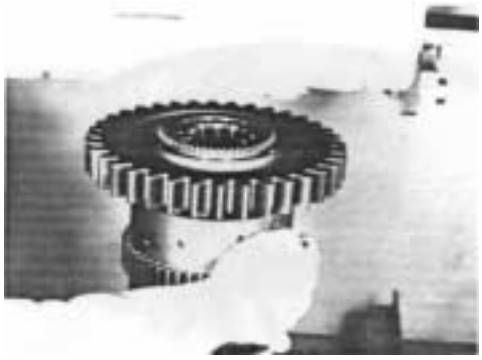


FIGURE 4-125 4564

11. Remove the K3/K4 clutch pack from the transmission. See Figure 4-125.

12. Remove the K3 spur gear from the clutch pack. See Figure 4-126. Make note of the bearing and washer sequence to ensure cor-

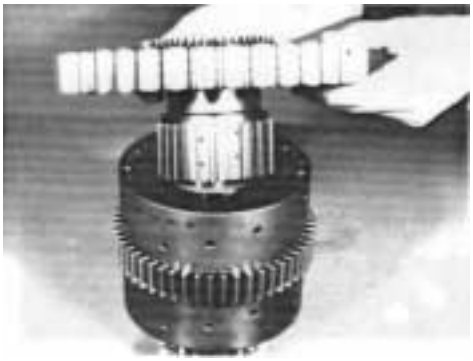


FIGURE 4-126 4565

rect order when assembled.

FIGURE 4-127 4566

13. Remove the snap ring. Then remove the fiber and metal discs. See Figure 4-127.

FIGURE 4-128 4567

14. Remove the gear from inside the clutch hous-

ing. See Figure 4-128. Make note of the bearing and washer sequence.

FIGURE 4-129 4927

15. Remove the snap ring. Then remove the fiber and metal discs for clutch pack K4. See Figure 4-129.
16. Follow Steps 6, 7, and 8 in the KV/K1 disassembly procedure to remove the snap ring, piston, and needle bearing. See

FIGURE 4-130 4568

Figures 4-112, 4-113, and 4-114.

17. Remove the bolts that hold the speedometer drive assembly to the transmission. See Figure 4-130. Remove the speedometer drive assembly.
18. Remove the speedometer drive gear. Drive the roll pin out of the cable housing.

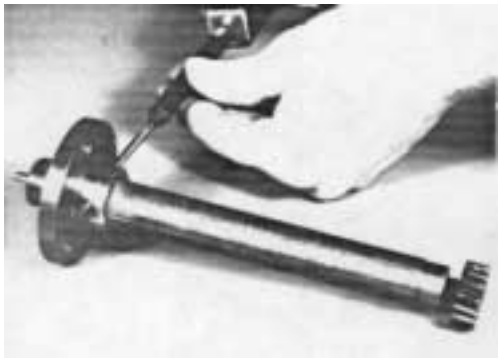


FIGURE 4-131 4569

See Figure 4-131.

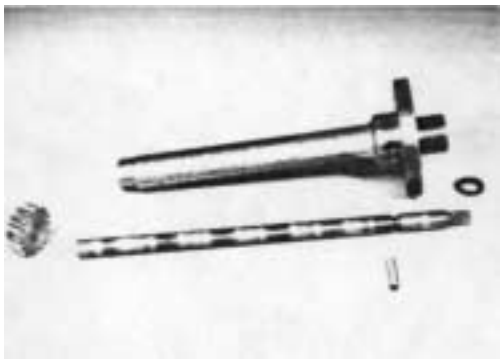


FIGURE 4-132 4570

19. Slide the cable out of the housing. See Figure 4-132. Remove the cable seal.

Final Drive Disassembly

NOTE

For units without a parking brake, perform Steps 1 and 2.

1. Remove the bolts from the lock plate. See Figure 4-133. Remove the lock plate.

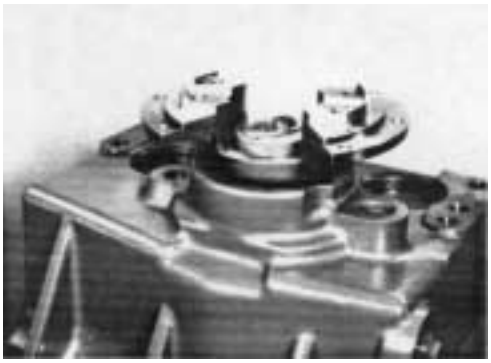


FIGURE 4-133 4571

FIGURE 4-134 4572

2. Remove the drive flange. See Figure 4-134.

NOTE

For units equipped with a parking brake disc, perform Steps 3 and 4.

3. Remove the bolts from the brake disc. See Figure 4-135. Use a large plastic hammer to lightly tap the brake disc. Remove the brake disc.

FIGURE 4-135 4573

4. Remove the bolts from the lock plate. Remove the lock plate. Remove the drive flange.

NOTE

For units equipped with a brake drum, perform Steps 5, 6, 7, and 8.

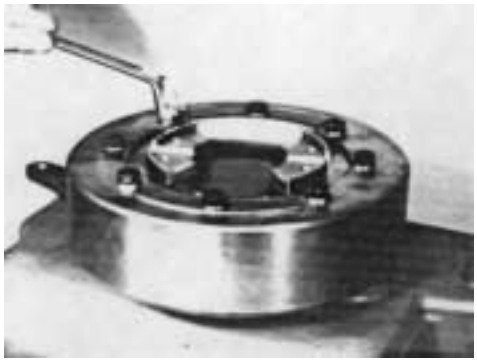


FIGURE 4-136 4574

5. Remove the bolts from the brake drum. See Figure 4-136.

6. Lift the brake drum off the transmission. See Figure 4-137.

FIGURE 4-137 4575

7. Remove the bolts that retain the lock plate. Remove the lock plate. Use a puller to pull the drive flange off the shaft. See Figure 4-138.

FIGURE 4-138 4576

8. Remove the brake shoes. See Figure 4-139.

FIGURE 4-139 4577

9. Remove the shaft seal. See Figure 4-140.

FIGURE 4-140 4578

10. Remove the snap ring. See Figure 4-141. Remove the washer.

FIGURE 4-141 4579

11. Remove the seal ring cover. See Figure 4-142.

FIGURE 4-142 4580

12. Remove the bolts that hold the oil baffle plate in place. See Figure 4-143. The bolts were assembled with Loctite. Remove the oil baffle plate.

FIGURE 4-143 4581

13. Turn the transmission 180° and work from the other side. Remove the bolts that hold the lock plate. See Figure 4-144. Use a puller to

FIGURE 4-144 4582

remove the drive flange.

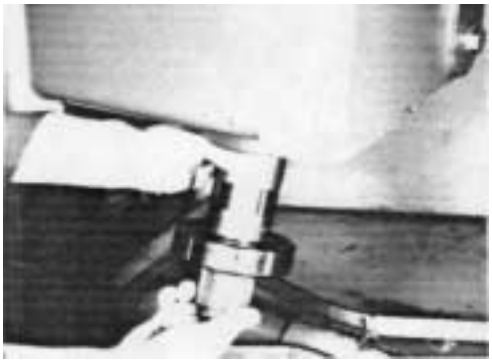


FIGURE 4-145 4583

14. Lightly tap the output shaft and remove the shaft from the transmission. See Figure 4-145.

FIGURE 4-146 4584

15. Remove the second oil baffle plate from the transmission. See Figure 4-146. Also remove

FIGURE 4-147 4585

the gear that is beneath the baffle plate.

16. Remove the shaft seal, snap ring, and spacer

FIGURE 4-148 4586

Transmission Assembly

Brake Drum

1. Steps 1 and 2 are only necessary for units equipped with a brake drum. Install an O-ring into the groove of the anchor pin. See Figure 4-149. Coat the O-ring with grease. Install the anchor pin into the bore in the transmission. Coat the installation bolts with Loctite. Install the bolts to hold the anchor pin in place.

FIGURE 4-149 4587

2. Assemble the brake cam onto the second anchor pin. See Figure 4-150. Install the O-ring into the groove on the anchor pin. Coat the O-ring with grease. Coat the installation bolts with Loctite. Install the bolts to hold the anchor pin in place.

FIGURE 4-150 4588

3. Install the snap ring into the bottom of the output shaft bore in the transmission housing. Install the shim washer on top of the snap ring. Shim washer thickness must equal 0.5 mm. Install the inner bearing on top of the spacer.
4. Place the oil baffle plate over the housing bore, on top of the bearing inner race.

FIGURE 4-151 4589

See Figure 4-151.

5. Set the gear on the inner bearing. See

FIGURE 4-152 4590

Figure 4-152. Align the marks on the bearing and the gear.

FIGURE 4-153 4591

6. Install the snap ring. See Figure 4-153.

End Plate Selection

1. Place the spacer and the speedometer worm

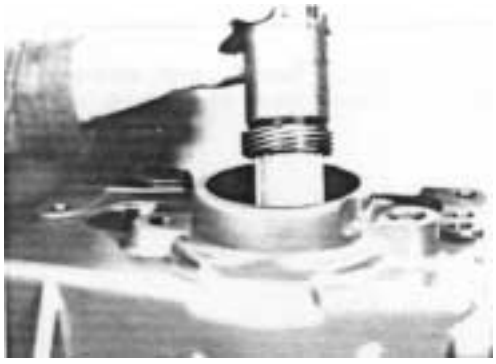


FIGURE 4-154 4592

gear on the output shaft. See Figure 4-154. Heat the parts if necessary. Set the output shaft into the transmission.

NOTE

The following steps describe taking measurements and using the measurements to calculate a shim thickness. The measurements shown in these steps are an example only. Be sure to take your own measurements and perform your own calculation to derive the correct shim thickness for your machine.

2. Use a depth micrometer to measure from the top of the bore, to the edge of the bearing on the output shaft. See Figure 4-155. In the example shown, the distance was measured

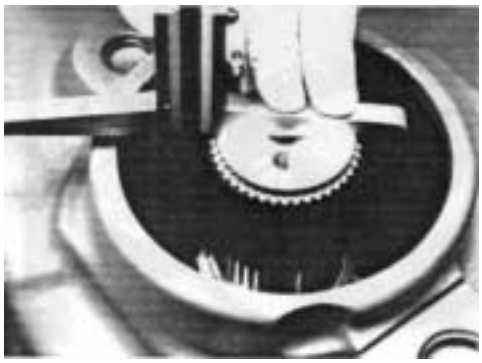


FIGURE 4-155 4593

at 79.55 mm (3.131"). This is measurement A.

3. Install a snap ring on top of the bearing. Use a depth micrometer to measure from the top of the bore to the edge of the snap ring. See Figure 4-156. In the example shown, the dis-

FIGURE 4-156 4594

tance was measured at 79.20 mm (3.118"). This is measurement B.

Subtract measurement B from measurement A.

79.55 mm
-79.20 mm
0.35 mm

The difference between the two measurements must be in the range of .30 – .50 mm (.0018 – .0196"). If the difference is not within this range, change the thickness of the shim washer beneath the inner bearing.

4. Install the outer bearing over the output shaft and into the bore. Install the snap ring into its groove above the bearing. Use a feeler gauge to measure the gap between the top of the bearing and the bottom of the snap ring. See Figure 4-157. The gap that was measured in

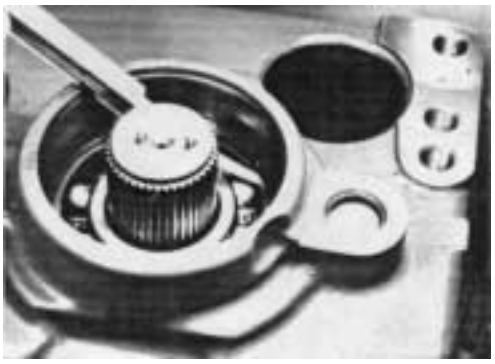


FIGURE 4-157 4595

this example was 1.80 mm (.0708").

5. Remove the snap ring. On top of the bearing, install a shim washer that is equal to the

FIGURE 4-158 4596

gap measured with the feeler gauge. See Figure 4-158. Install the snap ring.

6. Install the shaft seal into the output shaft bore. See Figure 4-159. Use a bearing driver to force the seal down until it bottoms on the

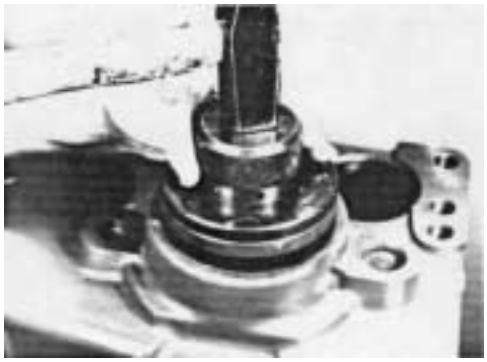


FIGURE 4-159 4597

snap ring.

7. Apply Loctite to the bolts that hold the semicircular oil baffle plate in place. Install the baffle plate and use the bolts to hold the plate in

FIGURE 4-160 4598

place. See Figure 4-160. Tighten the bolts to 49 Nm (36 ft lb).

FIGURE 4-161 4599

8. Apply Loctite to the bore plugs and install them. See Figure 4-161.

FIGURE 4-162 4600

9. Slide the output flange onto the splines of the output shaft. See Figure 4-162.

FIGURE 4-163 4601

FIGURE 4-164 4602

10. Apply a non hardening sealant to the flange disc. Install the bolts through the disc and tighten to 49 Nm (36 ft lb). See Figure 4-163.
11. Install the bolt lock plate. See Figure 4-164.

FIGURE 4-165 4603

FIGURE 4-166 4604

FIGURE 4-167 4605

12. For models equipped with a disc brake, install

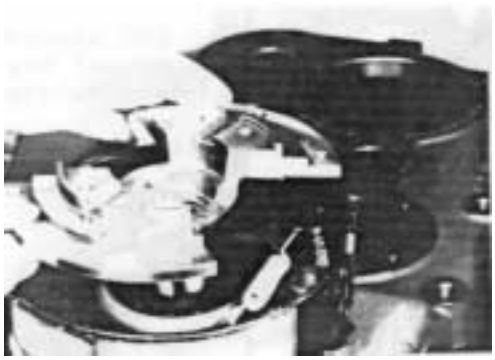


FIGURE 4-168 4606

the disc. Install the bolts into the disc and tighten to 69 Nm (50.8 ft lb). See Figure 4-165.

NOTE

FIGURE 4-169 4607

The following 7 steps are to be performed only on models that have a drum type brake.

FIGURE 4-170 4608

13. Apply Loctite to both bore covers and install them into the bores. See Figure 4-166.
14. Install the brake shoes. See Figure 4-167.
15. Slide the output flange onto the output shaft.

FIGURE 4-171 4609

See Figure 4-168.

16. Apply a non hardening sealant to the flange

FIGURE 4-172 4610

disc. Install the disc, then install the bolts to hold the disc in place. See Figure 4-169. Tighten the bolts to 49 Nm (36 ft lb).

FIGURE 4-173 4611

17. Install the bolt lock plate, to hold the bolts in

place. See Figure 4-170.

FIGURE 4-174 4612

FIGURE 4-175 4613

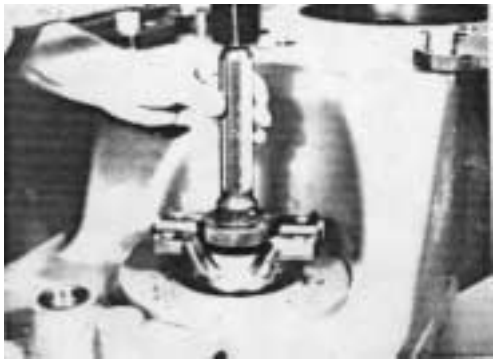


FIGURE 4-176 4614

18. Bolt the cover plate to the brake drum. See Figure 4-171. Tighten the bolts to 69 Nm (50.8 ft lb).

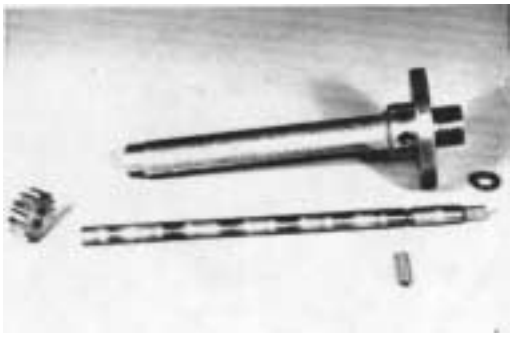


FIGURE 4-177 4615

19. Install the brake drum on the transmission. See Figure 4-172. Tighten the bolts to 69 Nm (50.8 ft lb).
20. Turn the transmission and work on the opposite end of the shaft. Install the shaft seal. See Figure 4-173.

FIGURE 4-178 4616

21. Slide the output flange onto the splined output shaft. See Figure 4-174.

FIGURE 4-179 4617

22. Apply a non hardening sealant to the retaining disc. Install the disc over the output flange. See Figure 4-175. Install the bolts through the disc and tighten them to 49 Nm (36 ft lb).

23. Install the bolt lock plate. See Figure 4-176.

FIGURE 4-180 4618

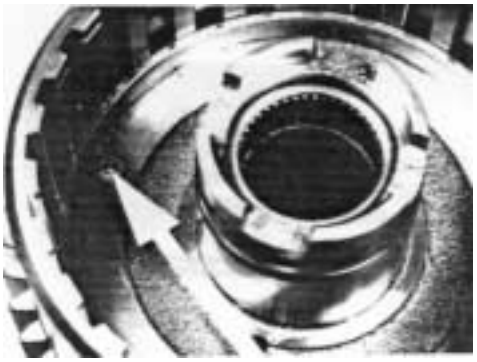


FIGURE 4-181 4619

24. Install the oil seal in the speedometer tube.

FIGURE 4-182 4620

Heat the speedometer gear and install it on the end of the drive shaft. See Figure 4-177. Assemble the drive shaft and tube.

FIGURE 4-183 4621

25. Place the speedometer gasket on the side of the transmission. Insert the speedometer tube into the transmission and install the bolts to

FIGURE 4-184 4622

hold it in place. See Figure 4-178. Tighten the

bolts to 25 Nm (18 ft lb).

FIGURE 4-185 4623

FIGURE 4-186 4624

26. If the machine is not equipped with a speedometer, install Loctite on a bore plug and tap it into the transmission. See Figure 4-179.

K3/K4 Clutch Pack Assembly

FIGURE 4-187 4625

1. Install a needle bearing into each side of the clutch carrier. See Figures 4-180 and 4-116. Exercise caution to prevent damage to the needles. Also exercise caution to prevent damage to the bleeder valves in the clutch carrier. See Figure 4-181.
2. Install seal rings into the inner and outer grooves on both pistons. See Figure 4-182.
3. Use an installation sleeve to install the piston on the shaft. This will help prevent damage to the inner seal. Install a piston on both sides of the clutch carrier. See Figure 4-183.
4. Install a lower spring guide, compression spring, and upper spring guide into the clutch carrier. See Figure 4-184.

5. Set the guide ring and then the snap ring on the spring guide. Use a press to force the spring down until the snap ring can be set into its groove. See Figure 4-185.

NOTE

The following steps describe taking measurements and using the measurements to make a calculation. The measurements shown in these steps are an example only. Be sure to take your own measure-

FIGURE 4-188 4626

ments on the transmission you are working on, and perform your own calculation.

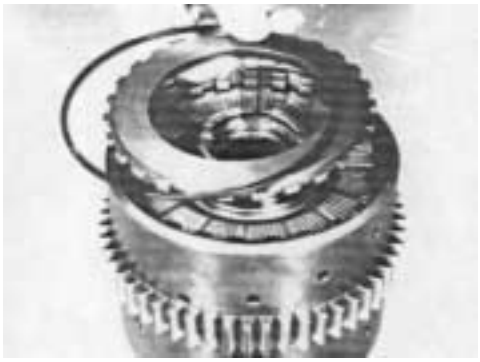


FIGURE 4-189 4627

6. The side of the clutch carrier that will have the plates installed first, has a smaller needle bearing than the other side of the clutch carrier. Insert into the clutch carrier, the first plate with external teeth. The thickness of this plate should equal 2.0 mm (.0787"). On top of this plate, place a plate with internal teeth. Place the backing plate on top of this plate. Use a depth micrometer to measure from the top of the clutch carrier hub to the surface of the backing plate. See Figure 4-186. In this example, the distance measured was 44.30 mm (1.744"). This is measurement A. After the measurement has been completed, remove the plates from the clutch carrier.

7. Insert the thrust washer into the inner plate carrier. Use a depth micrometer to measure

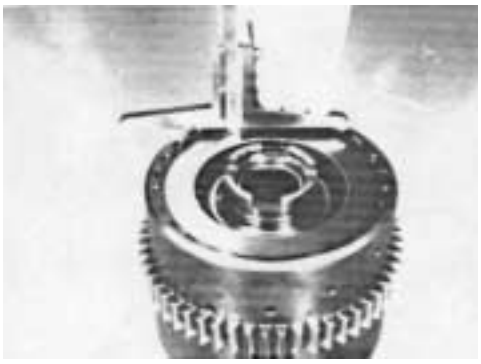


FIGURE 4-190 4628

the distance from the top of the carrier to the surface of the thrust washer. See Figure 4-187. In this example, the distance measured was 47.00 mm (1.850"). This is measurement B.

Subtract measurement B from measurement A.

47.00 mm (1.850") measurement A

FIGURE 4-191 4629

<u>-44.30 mm (1.744")</u> measurement B
2.70 mm (.106")

This calculation will derive the distance that the inner plate carrier will overlap the first inner plate. This distance must be a minimum of 2.50 mm (.0984"). If the distance is less than 2.50 mm, a second inner toothed plate should be installed on the piston side. Additional plates with external teeth can be installed beneath the backing plate.

8. Assemble the K4 clutch pack. See Figure 4-188. Insert the first plate with outer teeth into the clutch carrier. Plates

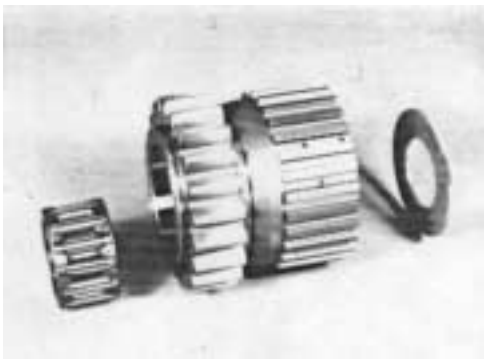


FIGURE 4-192 4630

with outer teeth have a 2.0 mm (.0787") thickness. Insert a plate with inner teeth on top of the first plate. Plates with inner teeth have a

FIGURE 4-193 4631

2.5 mm (.0984") thickness. Continue to alternate plates until 8 plates with external teeth and 7 plates with internal teeth have been installed.

9. Install the backing plate and then install the snap ring to hold the backing plate in place. See Figure 4-189.

10. Measure the distance from the top of the clutch carrier to the backing plate. See Figure 4-190. In the example shown, this measurement was 5.40 mm (.2125"). This is measurement A.

11. Pry upward on the backing plate until the plate is touching the snap ring. See Figure 4-191. Once again, measure the distance from the top of the clutch carrier to the backing plate. In the example shown, this

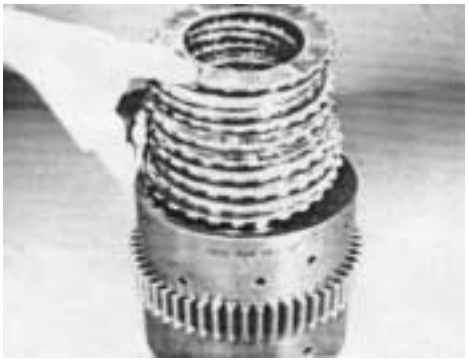


FIGURE 4-194 4632

measurement was 3.00 mm (.118"). This is measurement B.

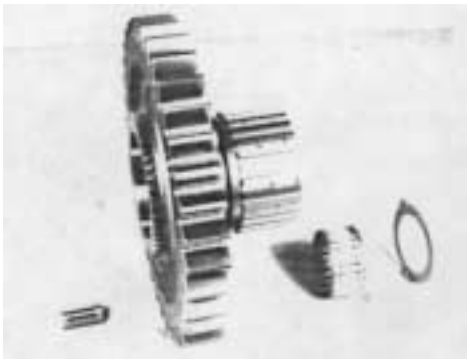


FIGURE 4-195 4633

Subtract measurement B from measurement A.

5.40 mm (.2125") measurement A
-3.00 mm (.118") measurement B
2.40 mm (.0944")

The difference between the two measurements must be 2.0 – 2.9 mm (.0787 – .114"). The correct difference between the two measurements can be achieved by installing an additional plate with internal teeth that has the correct thickness.

12. Apply grease to the needle bearing and thrust washer. Install both items into the inner plate carrier. See Figure 4-192.

FIGURE 4-196 4634

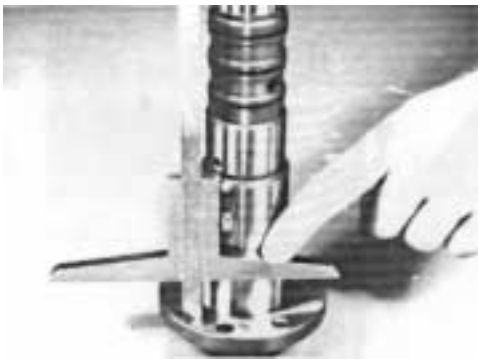


FIGURE 4-198 4636

13. Slide the backing plate down into the clutch carrier. See Figure 4-193. Slide the inner plate carrier down into the clutch carrier.

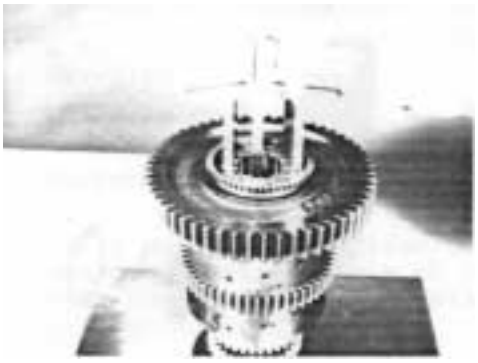


FIGURE 4-199 4637

FIGURE 4-197 4635

14. Install the clutch plate pack into the other side of the clutch carrier. This side of the clutch

FIGURE 4-200 4638

carrier has the larger diameter needle bearing. Insert a metal plate with external teeth into the clutch carrier. Then insert a fiber plate with external teeth into the clutch carrier. Now insert a plate with internal teeth into the clutch

FIGURE 4-201 4639

carrier. Continue to alternate externally toothed plates with internally toothed plates until all plates are in the clutch carrier.

FIGURE 4-202 4640

See Figure 4-194.

15. Apply grease to the backing plate and the needle bearing. See Figure 4-195. Install the needle bearing into the spur gear.

FIGURE 4-203 4641

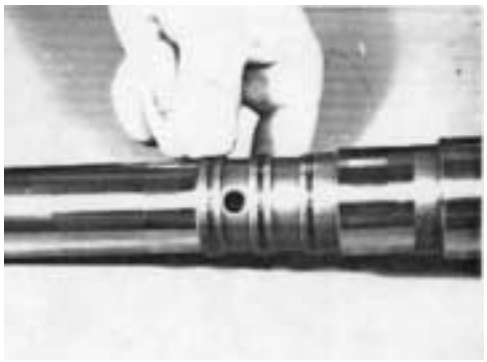


FIGURE 4-204 4642

16. Slide the backing plate down into the clutch carrier. See Figure 4-196. Set the spur gear down onto the clutch carrier. The splines on the spur gear must engage the inner teeth on the clutch plates.

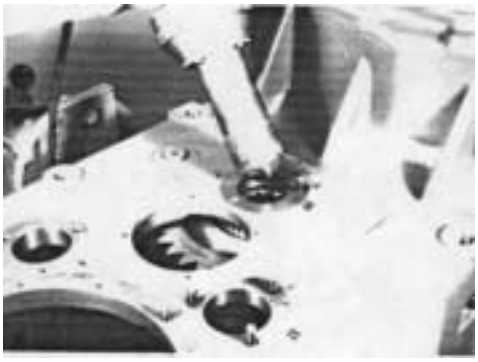


FIGURE 4-205 4643

FIGURE 4-207 4645

Determining Shim Washer Thickness

FIGURE 4-206 4644

FIGURE 4-208 4646

NOTE

The following steps describe taking measurements and using the measurements to make a calculation. The measurements shown in these steps are an example only. Be sure to take your own measurements on the transmission you are working on, and perform your own calculation.

1. Place the split tab washer and the grooved disc over the bore in the bottom of the transmission. See Figure 4-197. Lay the gasket in place on the bore on the top of the transmission. Use a depth micrometer to measure from the gasket on the top bore, to the surface of the grooved disc in the bottom bore. In this example, this distance is 248.5 mm (9.783"). This is measurement A.

2. Measure the distance from the edge of the bearing to the shaft flange. See Figure 4-198. In this example, this distance is 20.8 mm

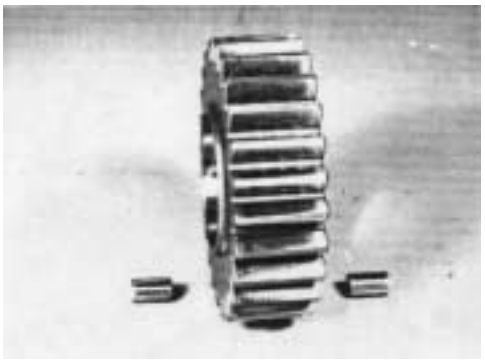


FIGURE 4-209 4647

(.818"). This is measurement B.

3. Measure the distance from the edge of the roller bearing to the top edge of the gear

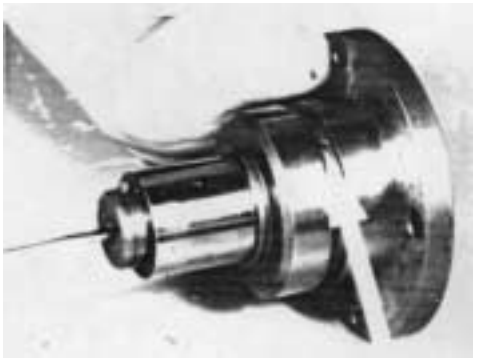


FIGURE 4-210 4648

teeth. See Figure 4-199. In this example, this distance is 224.7 mm (8.846"). This is mea-

FIGURE 4-211 4649

surement C.

To calculate the amount of end play that is present, perform the following calculation.

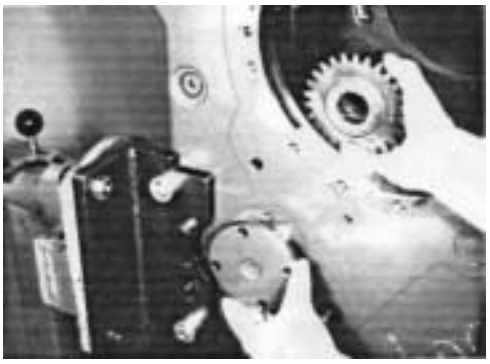


FIGURE 4-212 4650

248.50 mm (9.783") measurement A
- 20.80 mm (.818") measurement B

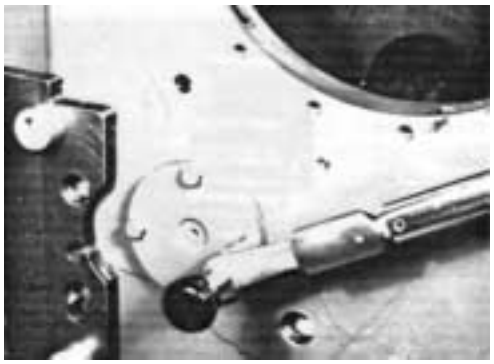


FIGURE 4-213 4651

227.70 mm (8.964")
-224.70 mm (8.846") measurement C
3.00 mm (.118")

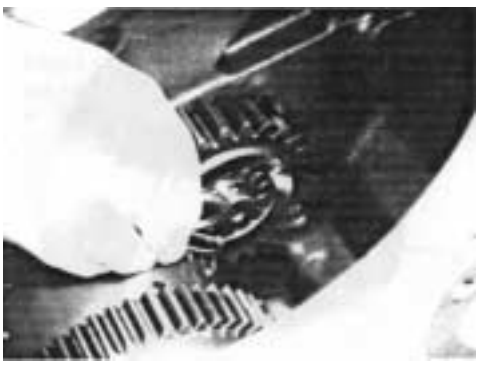


FIGURE 4-214 4652

The required amount of end play is .10 – .30 mm (.0039 – .0118"). To create

the required amount of end play for this example, use a shim that is 2.90 mm (.114") thick.

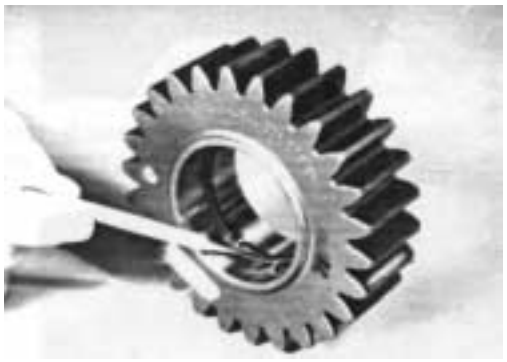


FIGURE 4-215 4653

3.00 mm (.118")
-2.90 mm (.114")

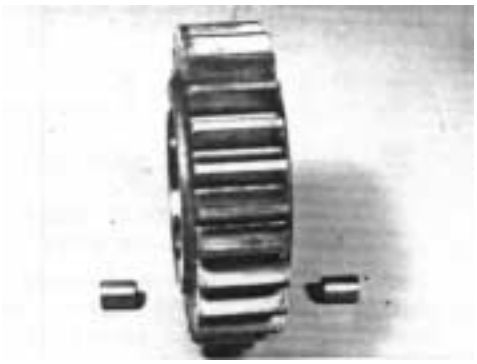


FIGURE 4-216 4654

.10 mm (.0039")

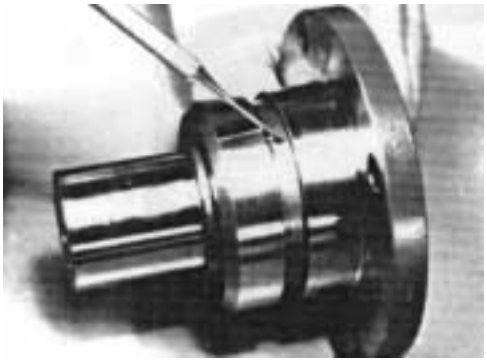


FIGURE 4-217 4655

4. Slide the clutch pack into the transmission housing. See Figure 4-200.

5. Install a dummy shaft into the transmission until it aligns the objects in the clutch pack. See Figure 4-201. Rotate the transmission 90° so that the clutch pack is now horizontal instead of vertical.

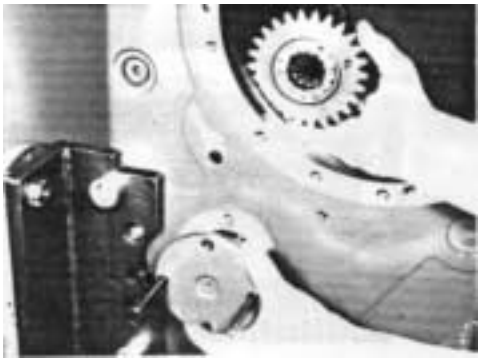


FIGURE 4-218 4656

6. Pull the dummy shaft back so that the washers and shims can be installed. See Figure 4-202.

7. Set the plastic washer, grooved disc, and the shim calculated in Step 45 onto the part of the dummy shaft that extends inside the transmission. The plastic washer must be against the housing. See Figure 4-203. Slide the clutch pack back onto the bearing driver. Rotate the transmission 180° to gain access to the other end of the clutch pack.

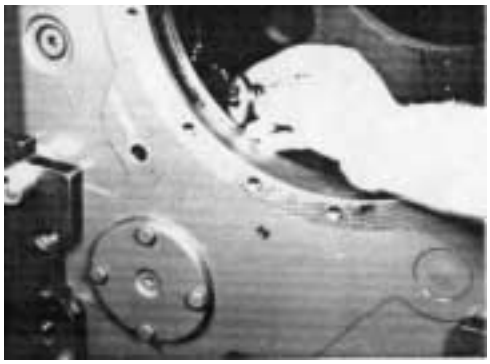


FIGURE 4-219 4657

8. Install the 3 rectangular seal rings on the K3/K4 shaft. See Figure 4-204. Be sure that the roll pin is installed in the shaft.

9. Before installing the shaft in the transmission, apply Loctite to the bolts. Heat the bore in the transmission housing before installing the shaft. See Figure 4-205.

10. Place the gasket in position on the shaft. Slide the shaft into the bore and the clutch pack. See Figure 4-206. Install the bolts to hold the shaft in place. Tighten the bolts to 25 Nm (19 ft lb). See Figure 4-206.

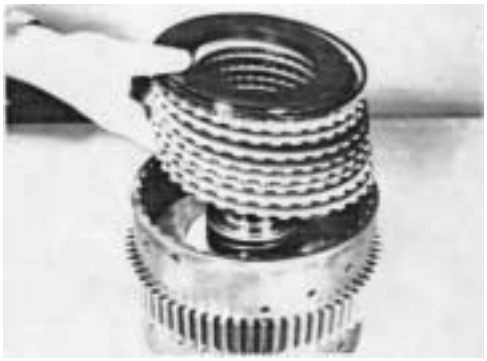


FIGURE 4-220 4658

11. Use compressed air to test both clutches to make sure that they are working. See Figure 4-207.

12. Use a dial indicator to check the end play of the shaft. See Figure 4-208. Allowable end play is .10 – .30 mm (.0039 – .0118"). Use shims to correct the end play, when necessary.

FIGURE 4-221 4659

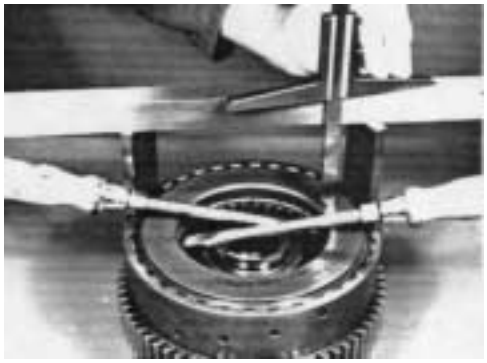


FIGURE 4-222 4660

Reverse Gear Type A – Assembly

1. Grease the rollers and install them into the gear. See Figures 4-209 and 4-89.

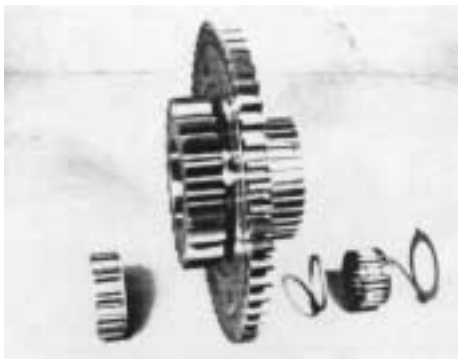


FIGURE 4-223 4661

2. Install the roll pin to hold the shaft to the flange. See Figure 4-210. Apply Loctite to the threads of the set screw and thread the set screw into the roll pin bore.

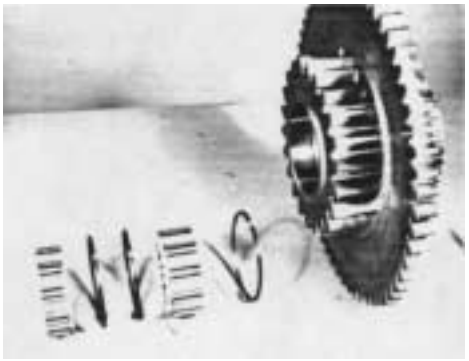


FIGURE 4-224 4662

3. Install the gasket on the flange. See Figure 4-211. Insert the spring into the shaft.
4. Position the gear inside the transmission. See Figure 4-212. Slide the gear shaft through the bore and through the gear.

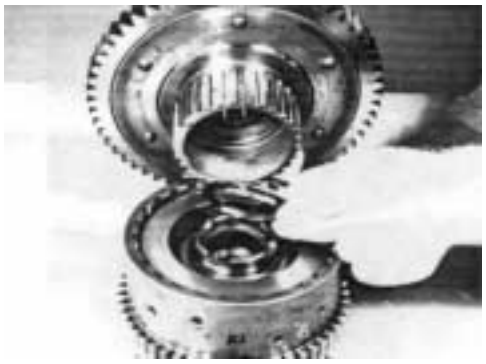


FIGURE 4-225 4663

5. Install the screws through the shaft flange and tighten them. See Figure 4-213.
6. Place a thrust washer on the gear shaft. See Figure 4-214. Install the snap ring to hold the washer in place.

FIGURE 4-226 4664

Reverse Gear Type B – Assembly

1. Insert the angle ring inside the gear. See Figure 4-215.

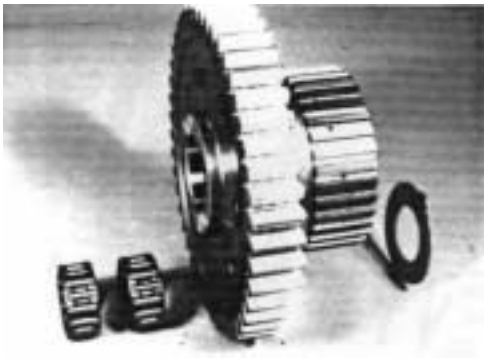


FIGURE 4-227 4665

2. Use grease to install the rollers inside the gear. See Figure 4-216.
3. Install the roll pin into the bore in the flange. See Figure 4-217.

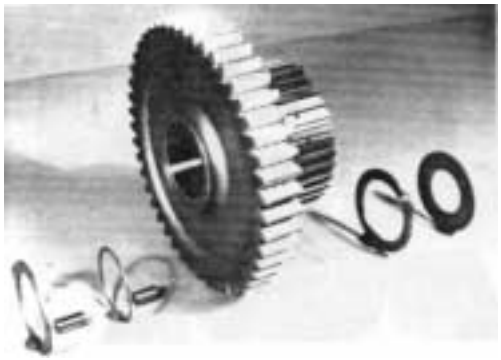


FIGURE 4-228 4666

4. Install the gasket on the flange. Position the gear inside the transmission. See Figure 4-218. Slide the shaft through the bore and through the gear. Install the bolts into the flange and tighten them.

FIGURE 4-229 4667

5. Install the roll pin into the thrust washer. See Figure 4-219. Use the bolt and washer to hold the thrust washer to the shaft. Tighten the bolt to 49 Nm (36 ft lb). Push the roll pin into the shaft.

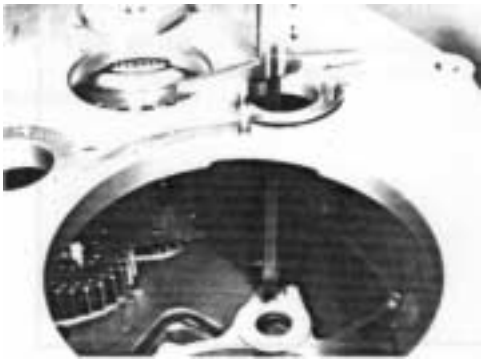


FIGURE 4-230 4668

KR/K2 Clutch Pack Assembly

1. To assemble the clutch pistons, perform Steps 1 – 7 under the heading K3/K4 Clutch Pack Assembly.

FIGURE 4-231 4669

2. Install the clutch plates on the side of the clutch carrier that has the larger bearing. See Figures 4-220 and 4-105. The first plate to be inserted must have teeth on the outer circumference. Outer toothed plates have a thickness of 2.0 mm (.0787"). The second plate to be inserted must have teeth on the inner circumference. This plate has a thickness of 2.5 mm (.0984"). Continue to alternate plates until all plates are installed.

FIGURE 4-232 4670

Install the backing plate on top of the clutch plates. Install the snap ring into the groove above the backing plate.

NOTE

The following steps describe taking measurements and using the measurements to make a calculation. The measurements shown in these steps are an example only. Be sure to take your own measurements on the transmission you are working on, and perform your own calculation.

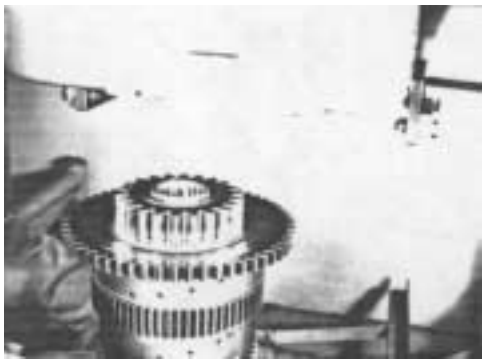


FIGURE 4-233 4671

FIGURE 4-234 4672

3. Measure the distance from the top of the clutch carrier to the backing plate. See Figure 4-221. In the example shown, this measurement was 5.40 mm (.2125"). This is measurement A.

4. Pry upward on the backing plate until the plate is touching the snap ring. See Figure 4-222. Once again, measure the distance from the top of the clutch carrier to the backing plate. In the example shown, this measurement was 3.20 mm (.1259"). This is measurement B.

   Subtract measurement B from measurement A.

   5.40 mm (.2125") measurement A
   -3.20 mm (.1259") measurement B
   2.20 mm (.0866")

   The difference between the two measurements must be 2.2 – 2.9 mm (.0866 – .114"). The correct difference between the two measurements can be achieved by installing an additional plate with internal teeth that has the correct thickness.

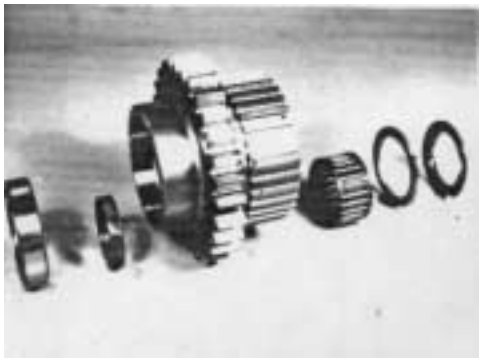


FIGURE 4-235 4673

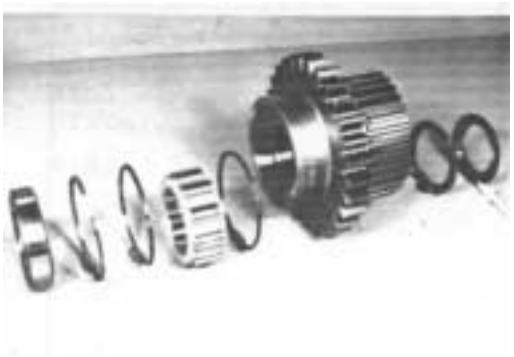


FIGURE 4-236 4674

FIGURE 4-237 4675

FIGURE 4-238 4676

2. Measure the distance from the top of the clutch carrier to the backing plate. See Figure 4-221. This is measurement A.
3. Pry upward on the backing plate until the plate is touching the snap ring. See Figure 4-222. Once again, measure the distance from the top of the clutch carrier to the backing plate. This is measurement B.
4. Subtract measurement B from measurement A. This difference must equal 2.0 – 2.9 mm (.0787 – .114"). The correct difference between the two measurements can be achieved by installing into the clutch carrier, an additional plate with internal teeth that has the correct thickness.

KV Spur Gear Assembly – Type A

5. Apply grease to the bearings and the washer. See Figure 4-239. Install these parts into the spur gear.

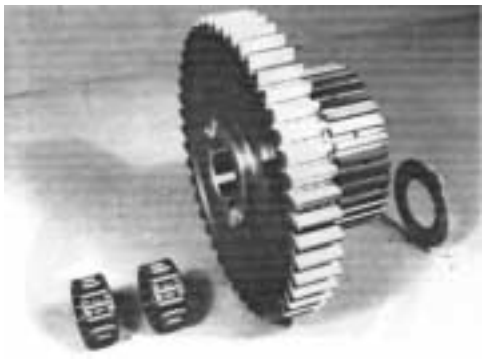


FIGURE 4-239 4677

KV Spur Gear Assembly – Type B

6. Apply grease to the bearing rollers and the washers. See Figure 4-240. Install these parts into the spur gear. The longest rollers must be assembled closest to the outside of the spur gear hub.

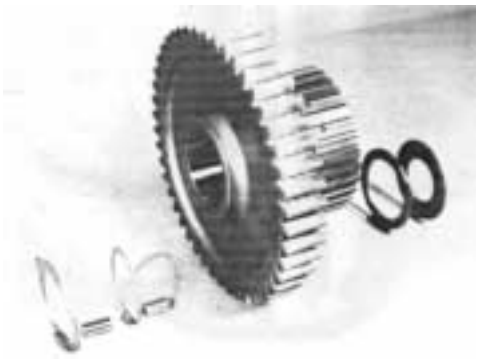


FIGURE 4-240 4678

KV Spur Gear Assembly – Type C

7. Apply grease to the parts. See Figure 4-241. Install the parts into the spur gear.

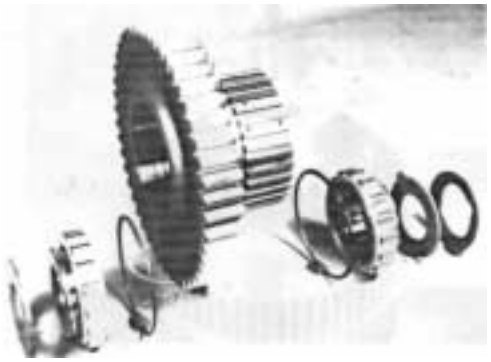


FIGURE 4-241 4679

8. Insert the thrust washer into the clutch carrier. See Figure 4-242. Insert the spur gear into the clutch carrier.

FIGURE 4-242 4680

Shim Selection

1. Place the split tab washer and the grooved disc over the bore in the bottom of the transmission. See Figure 4-243. Lay the gasket in place over the bore on the top of the transmission. Use a depth micrometer to measure from the gasket on the top of the bore, to the surface of the grooved disc in the bottom of the bore. In this example, this distance is

FIGURE 4-243 4681

252.0 mm (9.921"). This is measurement A.

2. Measure the distance from the first shoulder on the shaft to the shaft flange. See

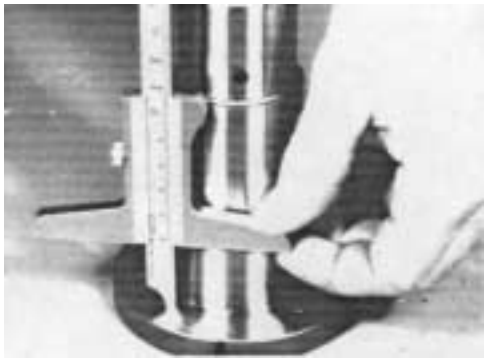


FIGURE 4-244 4682

Figure 4-244. In this example, this distance is 27.0 mm (1.0629"). This is measurement B.

3. Set the clutch carrier on a flat metal plate. See Figure 4-245. Measure the distance from the bottom of the clutch carrier to the top edge of the clutch carrier bore. In this example, this distance is 224.7 mm (8.846"). This is measurement C.

FIGURE 4-245 4683

The allowable amount of end play is between 0.10 and 0.30 mm (.0039 and .0118"). To calculate the end play, perform the following calculations.

252.00 mm (9.9210") measurement A
-27.00 mm (1.0629") measurement B
225.00 mm (8.8581")
-224.60 mm (8.8425") measurement C
.40 mm (.0156") end play

To bring the shaft within the allowable amount of end play, choose a .20 mm (.0078") shim.

.40 mm (.0156") end play
-.20 mm (.0078") shim
.20 mm (.0078") end play

4. Install the clutch pack into the transmission. See Figure 4-246. Do not install the shaft at this time.

FIGURE 4-246 4684

Power Take-off Shaft Assembly

1. Install both snap rings into the groove in the lower housing bore. See Figures 4-247 and 4-92.

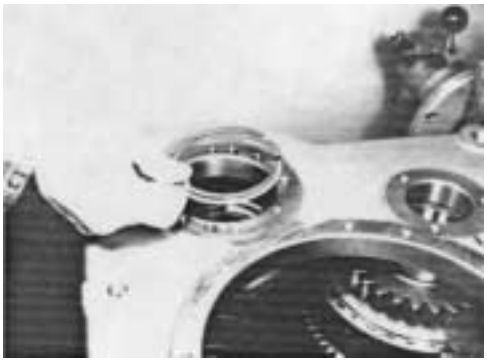


FIGURE 4-247 4686

2. Use a ring expander to install the ball bearing into the housing bore until the upper snap ring is engaged in the groove in the ball bearing. See Figures 4-248 and 4-249.

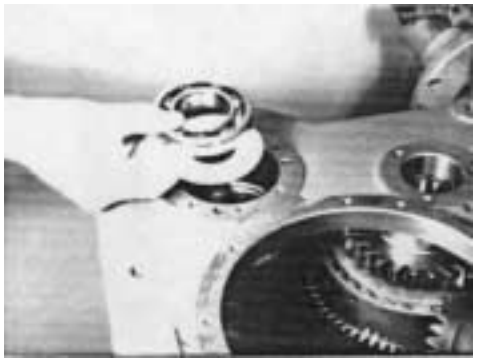


FIGURE 4-248 4687

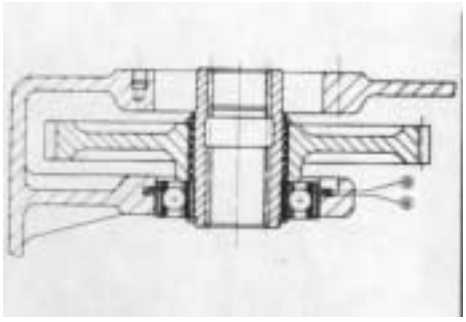


FIGURE 4-249 4685

FIGURE 4-250 4688

FIGURE 4-251 4689

FIGURE 4-252 4690

3. To create room for installing the power take-off gear, move the KV/K1 clutch pack in the direction of the arrow. See Figure 4-250.

FIGURE 4-253 4691

Install the gear so that the long collar faces down, toward the bearing.

4. Heat the ball bearing. Insert the PTO drive shaft through the gear and into the bearing. See Figure 4-251. Install the snap ring on the drive shaft.

FIGURE 4-254 4692

5. Install a dummy shaft into each of the clutch packs, KV/K1 and KR/K2. See Figure 4-252.

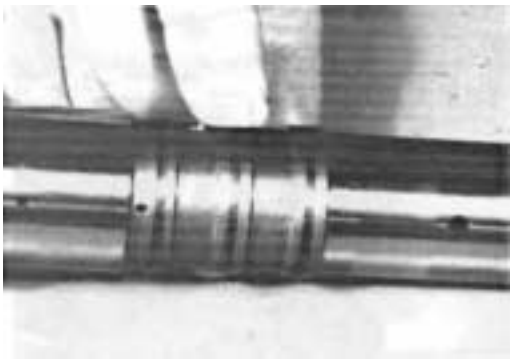


FIGURE 4-255 4693

FIGURE 4-256 4694

6. Turn the transmission 180°. See Figure 4-253. To prevent any parts from falling off the clutch packs, hold the clutch packs from the rear.

7. For each of the two clutch packs, install the split tab washer, grooved disc, and the shim washer that was calculated. See Figure 4-254. Remove the dummy shafts from the clutch pack bores and install them into the

FIGURE 4-257 4695

FIGURE 4-258 4696

bores from the side of the transmission that the shim washers were installed from.

8. Install the 3 seal rings on the KR/K2 shaft. See Figure 4-255.

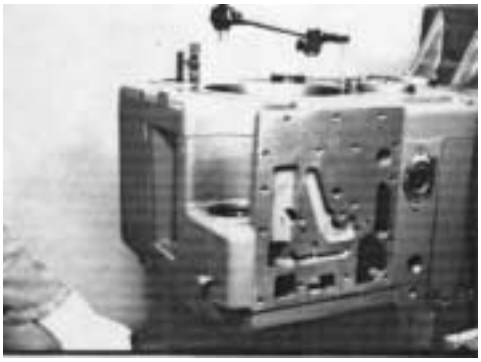


FIGURE 4-259 4697

9. Remove the dummy shaft from the KR/K2 bore. Heat the bore. See Figure 4-256.
10. Place the gasket over the KR/K2 bore. Insert the KR/K2 shaft into its bore. See Figure 4-257. Be sure to align the mark on the shaft flange with the mark on the bore shoulder.

FIGURE 4-260 4698

11. Install the bolts and nuts into the KR/K2 shaft flange and tighten to 25 Nm (18.4 ft lb). Use compressed air to check the operation of both clutch pistons. See Figure 4-258.
12. Install a dial indicator and check the end play on the KR/K2 shaft. See Figure 4-259. End play should be within the range of .10 – .30 mm (.0039 – .0118"). To keep end play within the range, use a shim.
13. Repeat Steps 8 through 12 to install the shaft into the other clutch bore.

FIGURE 4-261 4699

Emergency Steering Pump

1. Apply Loctite to the bolts and studs for the steering pump. Install the studs and tighten them. See Figure 4-260.
2. Apply grease to the O-ring for the steering pump. Install the O-ring into the groove in the pump. See Figure 4-261.

FIGURE 4-262 4700

FIGURE 4-263 4701

3. Insert the steering pump into the bore in the transmission. See Figure 4-262. Rotating the transmission output shaft will help the pump

FIGURE 4-264 4702

gear mesh with the gear inside the transmission. Install bolts from inside the transmission. Install and tighten nuts on the studs and the bolts.

4. For transmissions that are not equipped with an emergency steering pump, apply Loctite to the bore plug and use a bearing driver to install the plug into the bore. See Figure 4-263.
5. Coat set screws with Loctite and install them into the threaded holes around the bore plug. See Figure 4-264.

RPM Transmitter

NOTE

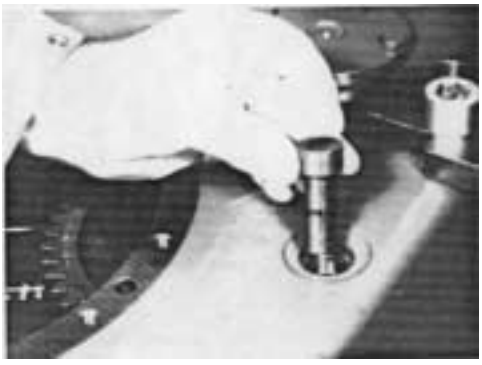


FIGURE 4-265 4703

The following steps describe taking measurements and using the measurements to calculate a shim thickness. The measurements shown in these steps are an example only. Be sure to take your own measurements on the transmission you are working on, and perform your own calculation to derive the correct shim thickness for your transmitter.

FIGURE 4-266 4704

1. The gap between the transmitter and the gear inside the transmission must be between .70 – 1.0 mm (.0275 – .0393"). Insert a gauge pin into the transmitter bore. See Figure 4-265. Mark with the snap ring, the distance to the surface of the transmission case.

FIGURE 4-267 4705

2. Measure the distance from the bottom of the gauge pin to the snap ring. See Figure 4-266. For this example, this distance measured 32.8 mm. This is measurement A.

FIGURE 4-268 4706

3. Measure the distance from the bottom of the transmitter to the seal ring on the transmitter. See Figure 4-267. For this example, this distance measured 33.8 mm. This is

FIGURE 4-269 4707

measurement B.

Calculate the shim thickness as follows.

32.8 mm (1.291") measurement A
.8 mm (.031") desired gap
32.0 mm (1.259")

33.8 mm (1.33") measurement B
32.0 mm (1.259")
1.8 mm (.070") necessary shim thickness

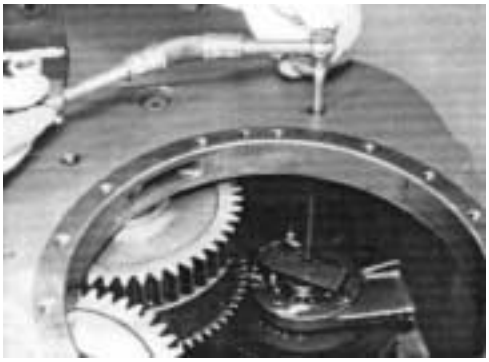


FIGURE 4-270 4708

4. Install the gasket and shim on the transmitter. See Figure 4-268. Apply seal ring compound

FIGURE 4-271 4709

to the transmitter threads. Install the transmitter and tighten it to 50 Nm (36.9 ft lb).

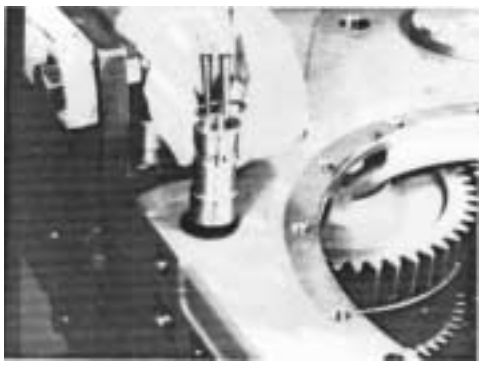


FIGURE 4-272 4710

5. If the transmission was not equipped with a transmitter, install a new seal ring on the threaded bore plug. Tighten the plug into the transmitter bore. See Figure 4-269.
6. Use socket head screws to tighten the bracket. See Figure 4-270. Apply Loctite to

FIGURE 4-273 4711

the socket head screws. Tighten the screws to 10 Nm (7.37 ft lb). Attach the oil supply hose as indicated. Install new hose seal rings.

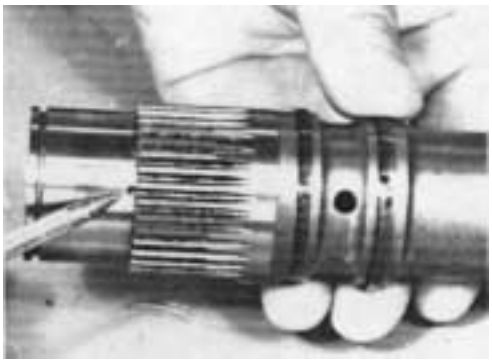


FIGURE 4-274 4712

FIGURE 4-275 4713

7. Assemble the converter control valve. See Figure 4-271.

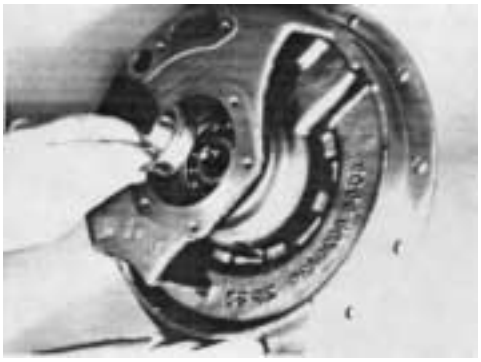


FIGURE 4-276 4714

8. Install the pressure control valve. See Figure 4-272. Hold it in place with a snap ring.
9. Install and tighten both the temperature sensor and the screw plug. See Figure 4-273.

FIGURE 4-277 4715

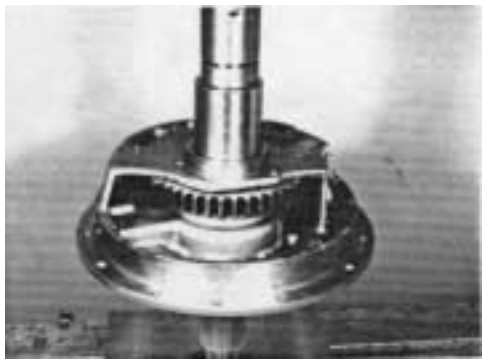


FIGURE 4-278 4716

Pump Installation

1. Install 2 square seal rings on the shaft

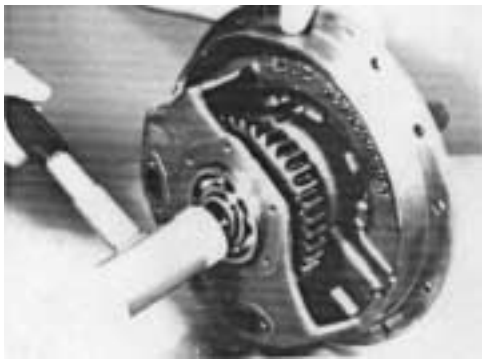


FIGURE 4-279 4717

(WK type). See Figure 4-274. Install 1 square ring on the shaft (non WK type). Install the roll pins, 2.5 x 5 mm (.098 x .196") and 1.5 x 5 mm (.059 x .196").

2. Install the bearing into the oil supply flange. Insert the shoulder side of the bearing first.

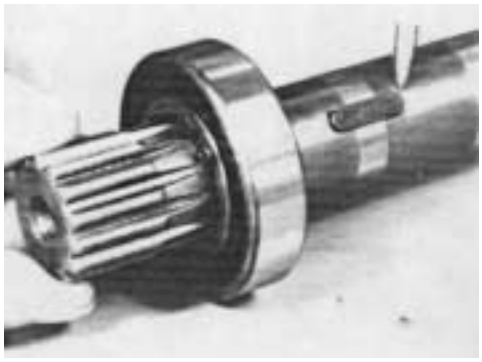


FIGURE 4-280 4718

Apply grease to the pump shaft and insert it into the oil supply flange. See Figure 4-275.

3. Install the bearing race into the oil supply flange. See Figure 4-276.
4. Set the spur gear into the oil supply flange. See Figure 4-277. Position the spur gear so that the longer hub of the gear will face the oil pump.
5. Slide the shaft through the spur gear and into the oil supply flange. See Figure 4-278. Be sure to engage the spline on the shaft with the spline inside the spur gear hub.
6. Install the ball bearing into the housing. Install the snap ring to hold the bearing in place.

FIGURE 4-281 4719

See Figure 4-279.

7. Install the snap ring on the pump drive shaft. See Figure 4-280. Heat the bearing (RS) and

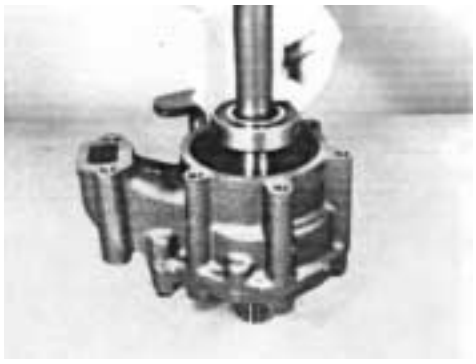


FIGURE 4-282 4720

slide it onto the shaft until it contacts the snap ring. The bearing must be positioned so that

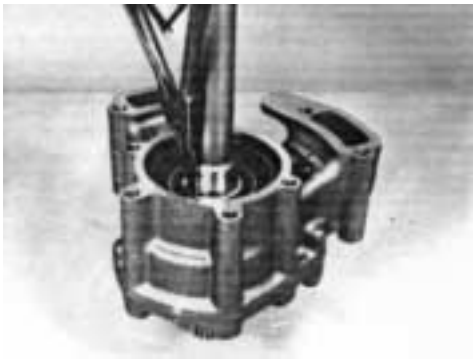


FIGURE 4-283 4721

the shielded side of the bearing contacts the snap ring. Install the key into the slot on the shaft.

8. Install the drive shaft into the pump. See

Figure 4-281. The shaft key must engage the

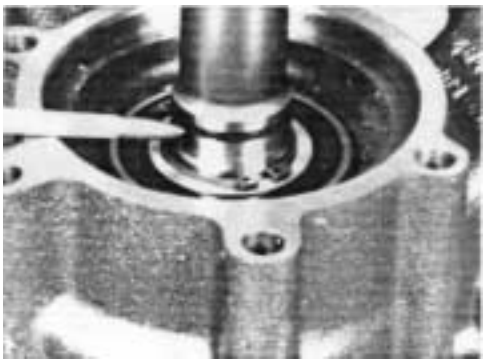


FIGURE 4-284 4722

inner roller.

FIGURE 4-285 4723

9. Heat the bearing and slide it down the shaft as far as possible. See Figure 4-282. The shielded side of the bearing must face upward.
10. Install the snap ring on the pump shaft.

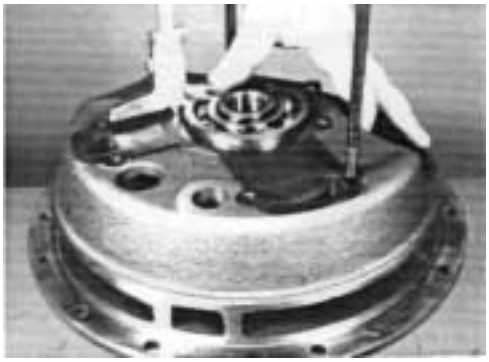


FIGURE 4-286 4724

See Figure 4-283.

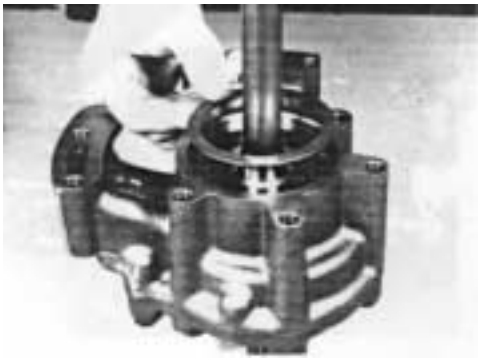


FIGURE 4-287 4725

11. Install the square seal ring on the pump shaft. See Figure 4-284.

FIGURE 4-288 4726

NOTE

The following steps describe taking measurements and using the measurements to calculate a shim thickness. The measurements shown in these steps are an example only. Be sure to take your

FIGURE 4-289 4727

own measurements on the transmission you are working on, and perform your own calculation to derive the correct shim thickness for your oil pump.

FIGURE 4-290 4728

12. Measure the distance from the top of the pump housing to the outer edge of the bearing. See Figure 4-285. In this example, this distance measured 7.15 mm (.281"). This is measurement A.

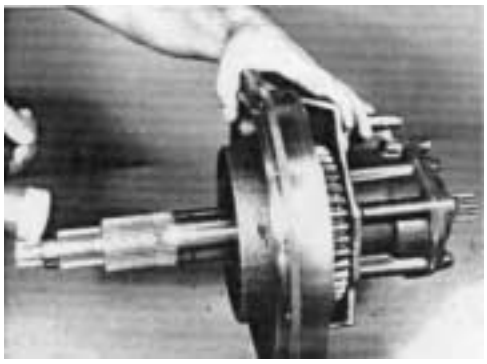


FIGURE 4-291 4729

FIGURE 4-292 4730

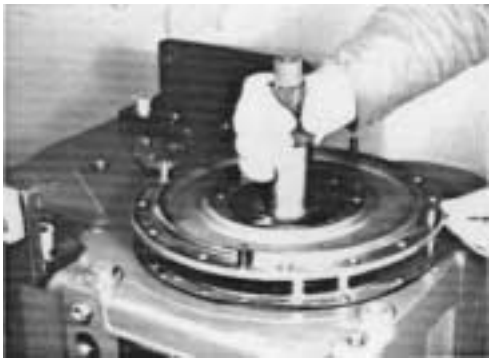


FIGURE 4-293 4731

13. Place the gasket on the flange surface. Measure the distance from the top outer edge of the bearing to the flange surface. See

FIGURE 4-294 4732

Figure 4-286. In this example, this distance measured 6.50 mm (.2559"). This is measurement B.

FIGURE 4-295 4733

The required endplay is .30 – .50 mm (.0118 – .0196").

To calculate the shim thickness needed to create the required endplay, perform the following calculations.

7.15 mm (.281") measurement A
-6.50 mm (.2559") measurement B
.65 mm (.02559") total endplay

FIGURE 4-296 4734

To bring the endplay within the required range, select a .30 mm (.0118") shim.

.65 mm (.02559") total end play
-.30 mm (.0118") shim

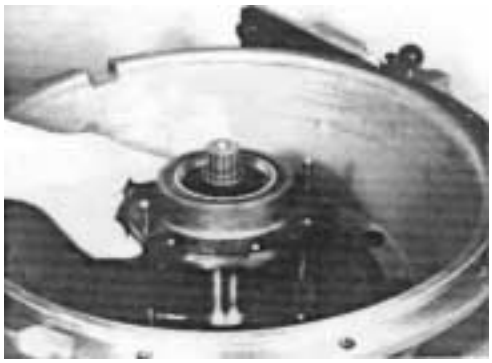


FIGURE 4-297 4735

.35 mm (.0137") endplay within required .30 – .50 mm range.

14. Apply grease to the .30 mm shim and install the shim in the pump housing. See Figure 4-287.
15. Install the parts for the converter relief valve into the oil supply flange. See Figure 4-288.

    Thread 2 assembly studs into the supply flange. Apply grease to the seal rings on the pump shaft.
16. Install the pump on the oil supply flange. See Figure 4-289.

17. Install the bolts that hold the pump to the oil supply flange. See Figure 4-290. Tighten the bolts to 25 Nm (18.4 ft lb).

18. Use a plastic hammer to lightly tap the pump drive shaft a few times to release tension. See Figure 4-291.

FIGURE 4-298 4736

19. Apply Loctite to the flange around the pressure intake pathway. A seal ring in good con-

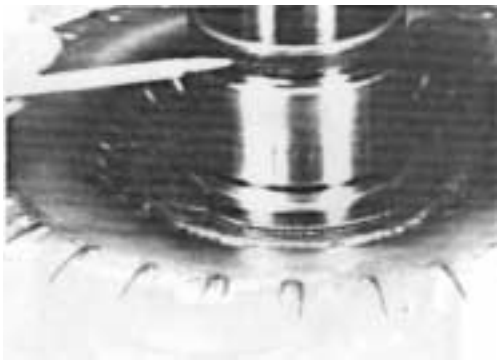


FIGURE 4-299 4737

dition is necessary for the pressure intake pathway. Install 2 assembly studs into the transmission to guide the installation of the oil supply flange and pump assembly.

20. Heat the housing bore that the oil supply flange will be installed into. See Figure 4-292.

21. Install the gasket on the bore of the oil supply flange. Set the oil supply flange and pump assembly into the bore in the transmission. See Figure 4-293.

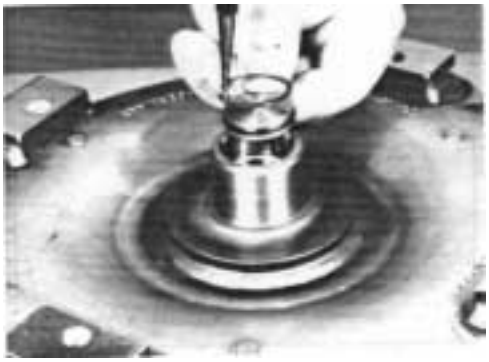


FIGURE 4-300 4738

22. Install the 2 roll pins. See Figure 4-294. Install 3 socket head screws to temporarily hold the oil supply flange.

FIGURE 4-301 4739

23. Set the adapter case into place on top of the oil supply flange. See Figure 4-295. Install the bolts into the adapter case and tighten to 69 Nm (51 ft lb).

FIGURE 4-302 4740

24. Use a bearing driver to install the bearing into the bearing cover. See Figure 4-296. The top edge of the bearing must be flush with the top edge of the bearing cover. Apply seal ring

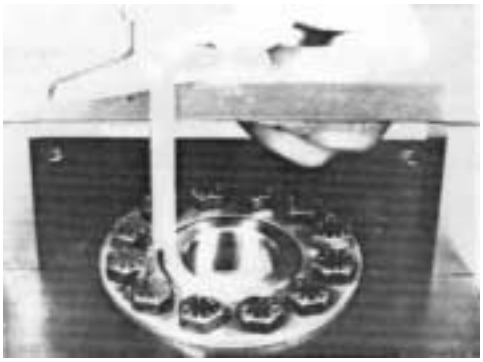


FIGURE 4-303 4741

compound to the shaft seal and install the seal in the bearing cover.

25. Thread 2 assembly studs into the adapter case. See Figure 4-297. Install the bearing cover gasket over the studs. Install the bolts to hold the bearing cover in place. Tighten the bolts to 25 Nm (18.4 ft lb).

FIGURE 4-304 4742

Type A Torque Converter Assembly

FIGURE 4-305 4743

(Torque Converter Type A is assembled separately from the engine. See Figure 4-70.)

1. Install the ball bearing (RS) into the torque

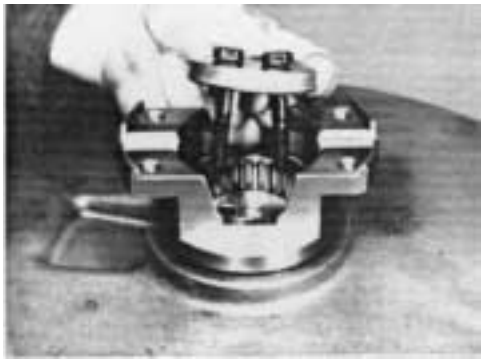


FIGURE 4-306 4744

converter cover. See Figure 4-298. Install the snap ring to hold the bearing in place.

2. Install the square ring in the top groove of the torque converter shaft. See Figure 4-299.

3. Coat the O-ring with grease. Install the

FIGURE 4-307 4745

O-ring in the groove in the shaft plug. See Figure 4-300. Install the shaft plug. Install the snap ring to hold the shaft plug in place.

FIGURE 4-308 4746

FIGURE 4-309 4747

4. Set the drive plate on the input shaft. See Figure 4-301. Set the drive collar on top of the drive plate. Coat the bolt threads with Loctite. Install the bolts and tighten to 69 Nm (51 ft lb).

Selecting the Spacer Washer

NOTE

The following steps describe taking measurements and using the measurements to calculate a shim thickness. The measurements shown in these steps are an example only. Be sure to take your own measurements on the transmission you are

FIGURE 4-310 4748

working on, and perform your own calculation to derive the correct shim thickness for your torque converter.

1. Slip the spacer ring over the torque converter

FIGURE 4-311 4749

input shaft. Measure the distance from the flat face of the flange to the top of the spacer ring. See Figure 4-302. In this example this distance measured 5.10 mm. This is measurement A.

FIGURE 4-312 4750

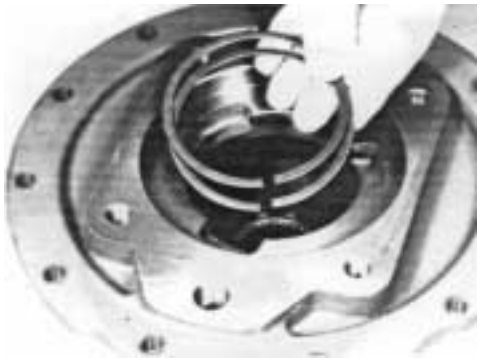


FIGURE 4-313 4751

FIGURE 4-314 4752

2. Measure the distance from the drive plate to the drive collar. See Figure 4-303. In this example this distance measured 4.60 mm. This is measurement B.

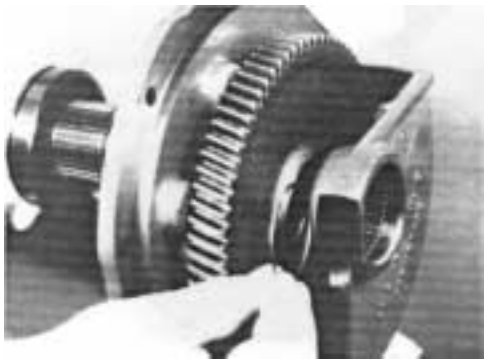


FIGURE 4-315 4753

3. The required drive plate gap is .10 – .30 mm (.0039 – .0118). To choose the shim washer of the proper thickness, first perform the following calculation.

FIGURE 4-316 4754

FIGURE 4-317 4755

5.10 mm (.200") measurement A
-4.60 mm (.181") measurement B
.50 mm

Choose a shim washer that exceeds .50 mm

FIGURE 4-318 4756

by .10 – .30 mm. A shim of .60 mm thickness will create a gap of .10 mm.

.60 mm – .50 mm = .10 mm.

FIGURE 4-319 4757

4. Install the shim washer of the thickness that was calculated in the previous step. See

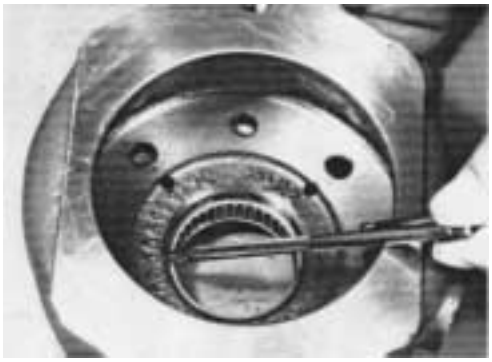


FIGURE 4-320 4758

Figure 4-304. Set the drive plate assembly on top of the diaphragm.

Apply Loctite to the 4 bolts. Install and tighten the 4 bolts and washers that hold the drive plate to the torque converter.

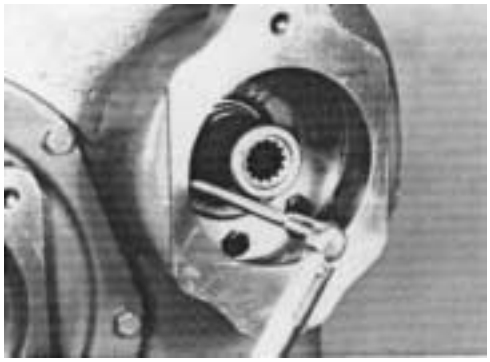


FIGURE 4-321 4759

FIGURE 4-322 4760

FIGURE 4-323 4761

5. Set the cover assembly on the torque converter. See Figure 4-305.
6. Slide the drive flange over the input shaft. See

FIGURE 4-324 4762

Figure 4-306. Install the disc inside the drive flange. Install 2 bolts into the disc and tighten

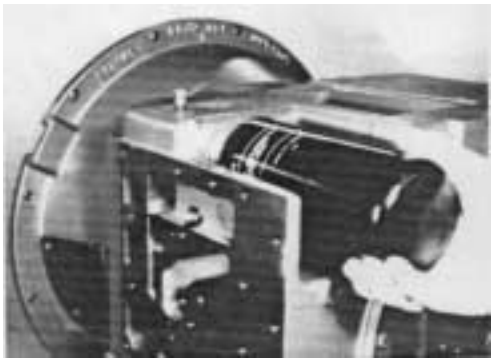


FIGURE 4-325 4763

them to 36 Nm (27 ft lb).

7. Install the bolt lock over the 2 bolts that retain the disc. See Figure 4-307.
8. Lift up the torque converter and cover assembly and set it on the bell housing. See

FIGURE 4-326 4764

Figure 4-308. Install the bolts through the cover and tighten the nuts to 49 Nm (36 ft lb).

FIGURE 4-327 4765

Type B Torque Converter Assembly

1. Slip the spacer ring over the torque converter

FIGURE 4-328 4766

shaft. See Figure 4-309. Measure from the flat

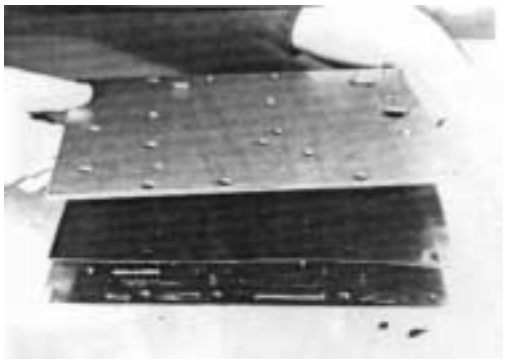


FIGURE 4-329 4767

surface of the torque converter flange to the top of the spacer ring. In this example this distance measured .30 mm (.0118").

The required torque converter gap is .10 – .30 mm (.0039 – .0118"). To create a

FIGURE 4-330 4768

gap that falls within the required span, select a .50 mm (.01968") thick shim washer.

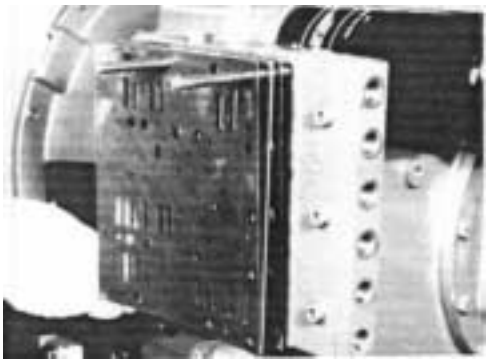


FIGURE 4-331 4769

2. Take the shim washer that was selected in the previous step, and place it on top of the spacer ring. Place the drive plate on the torque converter. Apply Loctite to the bolts. Install the bolts and washers that hold the

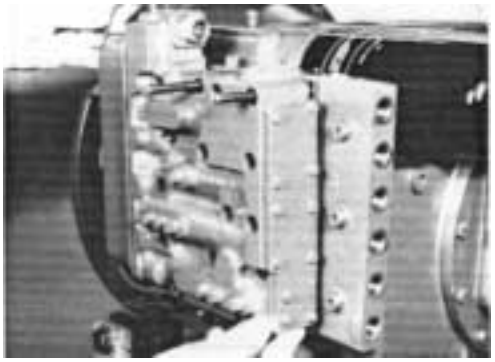


FIGURE 4-332 4770

drive plate to the torque converter.

3. Lift up the torque converter assembly

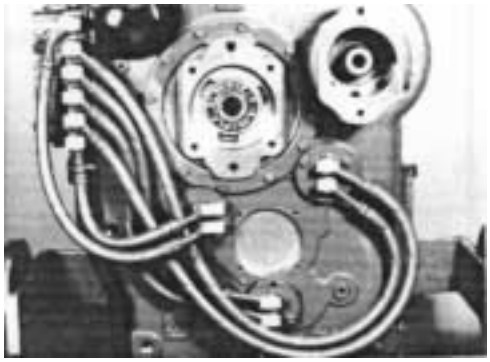


FIGURE 4-333 4771

and install it into the bell housing. See Figure 4-310.

Power Take-off Shaft

1. Install the lower snap ring into the housing bore. See Figures 4-311 and 4-92 (shaft A). Place the bearing down into the bore until it rests on the snap ring.

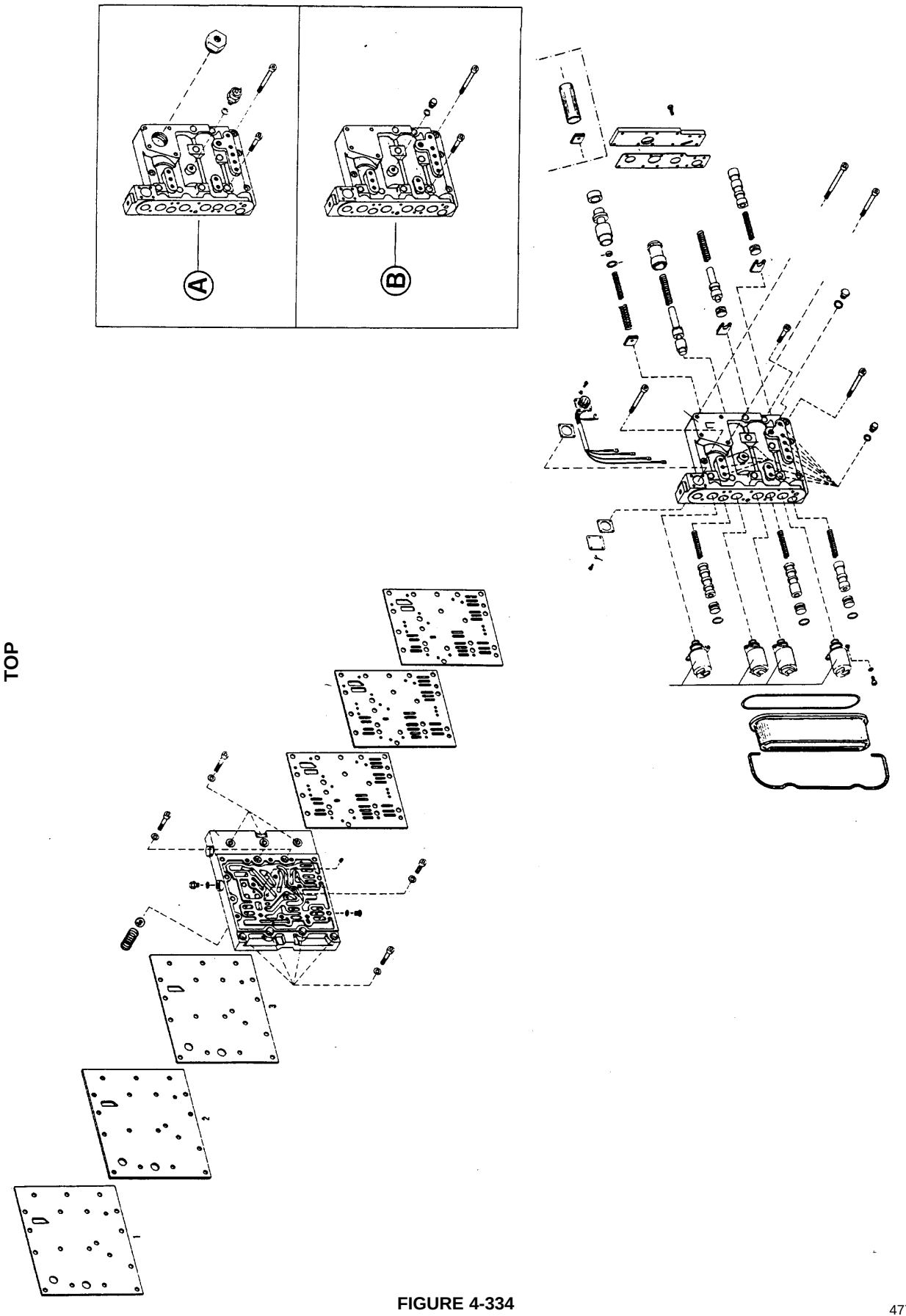


FIGURE 4-334

4772

Power Disengagement Gearbox

Disassembly

1. Remove the bolts that hold the disengagement gearbox to the transmission housing. See Figures 4-335 and 4-360.

FIGURE 4-335 4773

2. Remove the bolt lock plate. See Figure 4-336. Remove the bolts that hold the disc in place.

FIGURE 4-336 4774

3. Remove the disc. See Figure 4-337. Slide the output flange out of the housing.

FIGURE 4-337 4775

4. Working from the other end of the gearbox, remove the shaft from the housing. See Figure 4-338.

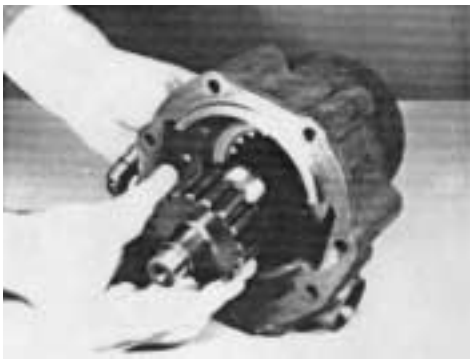


FIGURE 4-338 4776

5. Remove the synchromesh sleeve and its thrust washer. See Figure 4-339.

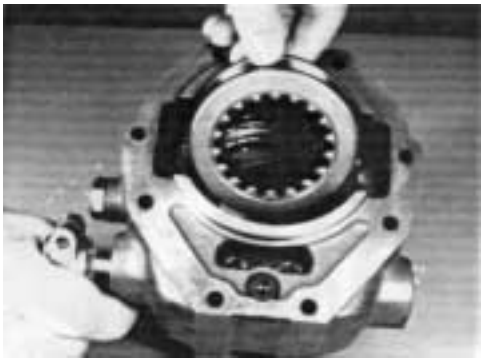


FIGURE 4-339 4777

6. Remove the lock bolt. See Figure 4-340.

FIGURE 4-340 4778

7. Remove the bolts that hold the shift fork to the shift rod. See Figure 4-341.

FIGURE 4-341 4779

8. Remove the shift fork and the shift rod. See Figure 4-342. Remove the fingers from the shift fork.

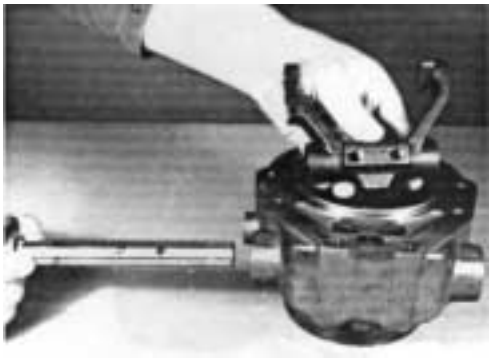


FIGURE 4-342 4780

9. Remove the seal, snap ring, and bearing from the housing. See Figure 4-343.

FIGURE 4-343 4781

Assembly

1. Install into the housing, the dowel and control washer for shift travel. See Figure 4-344.

FIGURE 4-344 4782

2. Install the shim washer and secure it with the lock screw. See Figure 4-345.

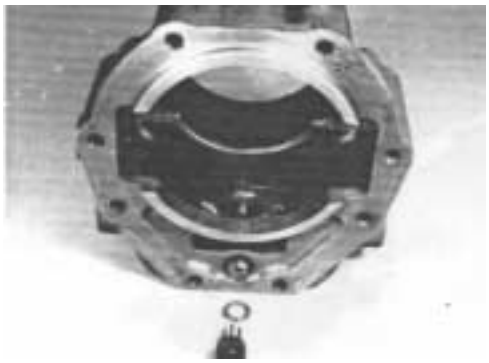


FIGURE 4-345 4783

3. Apply sealer to the outside of the rod seal. Install the seal in the end of the rod bore. See Figure 4-346.

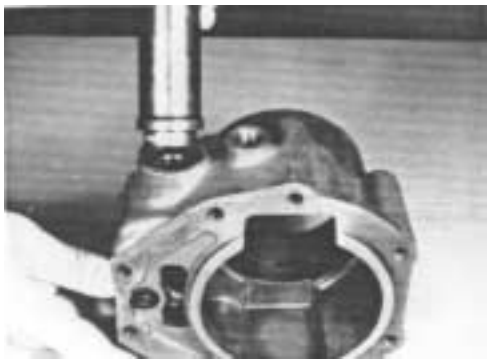


FIGURE 4-346 4784

4. Apply sealer and install the seal in the other end of the rod bore. See Figure 4-347.

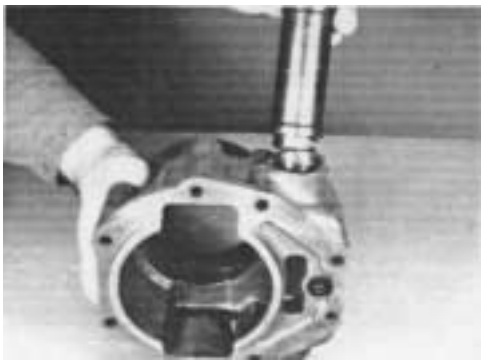


FIGURE 4-347 4785

5. Set the shift fork into the housing and slide the shift rod into the shift fork. See Figure 4-348. Align the bolt holes in the shift rod with the bolt holes in the shift fork.

FIGURE 4-348 4786

6. Apply Loctite to the shift fork bolts. Install the bolts and tighten to 35 Nm (26 ft lb). See Figure 4-349.

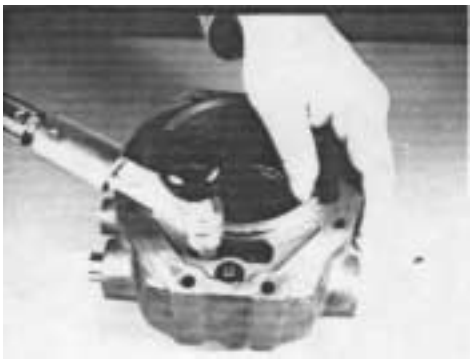


FIGURE 4-349 4787

7. Install the sleeve fingers into the shift fork. Install the synchromesh sleeve and thrust washer. See Figure 4-350.

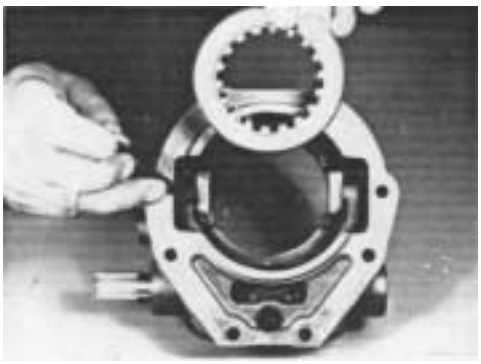


FIGURE 4-350 4788

8. Install the disc and then the ball bearing. See Figure 4-351.

FIGURE 4-351 4789

9. Install the snap ring. See Figure 4-352.

FIGURE 4-352 4790

10. Use a bearing driver to install the drive flange seal. See Figure 4-353. The top of the seal housing should be 12.0 mm (.472") from the top of the housing bore. Coat the inside lips of the seal with grease.

FIGURE 4-353 4791

11. Turn the housing over. Insert the shaft. See Figure 4-354.

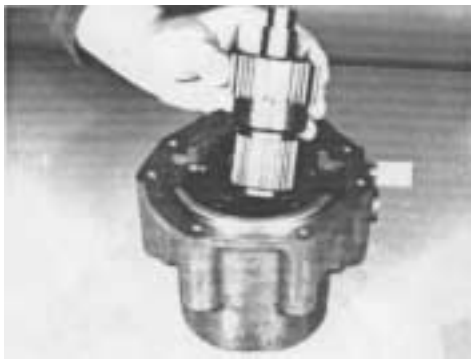


FIGURE 4-354 4792

12. Install the lock screw. See Figure 4-355.

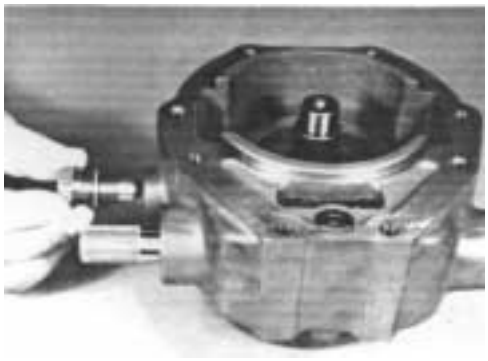


FIGURE 4-355 4793

13. The dowel and bolt that were installed in Steps 1 and 2 must be adjusted to create an over-shift travel of .10 – .20 mm (.0039 – .0078") during engagement or disengagement. See Figure 4-356. The shim between the bolt and dowel can also be changed if necessary. Install the shift lever.

FIGURE 4-356 4794

14. Install the drive flange on the shaft spline. See Figure 4-357.

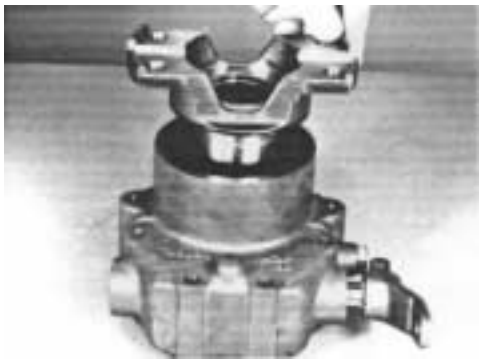


FIGURE 4-357 4795

15. Apply sealer to the disc. Install the disc. See Figure 4-358. Install the bolts through the disc. Tighten the bolts. Install the lock plate over the bolts.

FIGURE 4-358 4796

16. Thread 2 assembly studs into the transmission. See Figure 4-359. Slide the gasket over the studs. Slide the gearbox over the studs. Install the bolts into the gearbox. Tighten the bolts to 25 Nm (18 ft lb).

FIGURE 4-359 4797

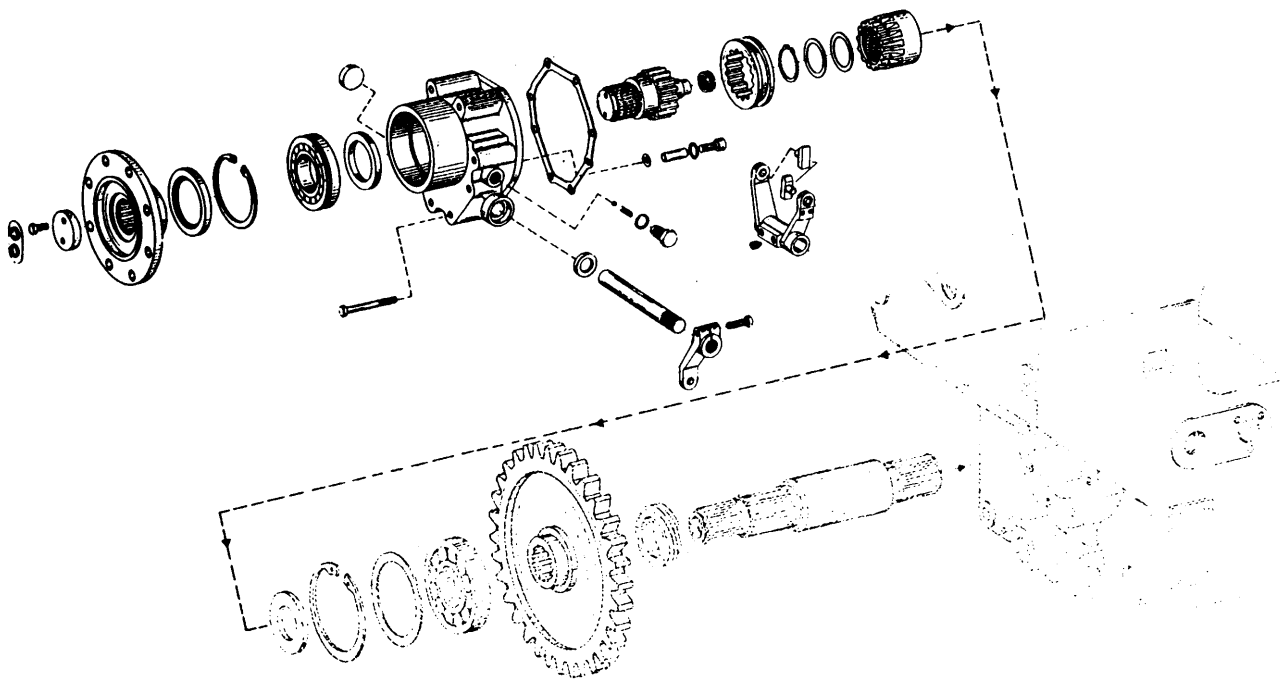


FIGURE 4-360 4798

Differential Type Output Gearing

Disassembly

1. On the disengagement gearbox, remove the lock from the two bolts that hold the output flange disc in place. Remove the bolts from the disc. Remove the disc from the output flange. Slide the output flange out of the gearbox.
2. Remove the bolts that hold the gearbox to the transmission. See Figures 4-361 and 4-413. Slide the gearbox off the transmission.

FIGURE 4-361 4799

3. Lift the hollow driveshaft out of the transmission. See Figure 4-362.

FIGURE 4-362 4800

4. Use a puller to remove the bearing from the transmission. See Figure 4-363.

FIGURE 4-363 4801

5. Working from the side of the transmission, remove the speedometer drive assembly. See Figure 4-364.

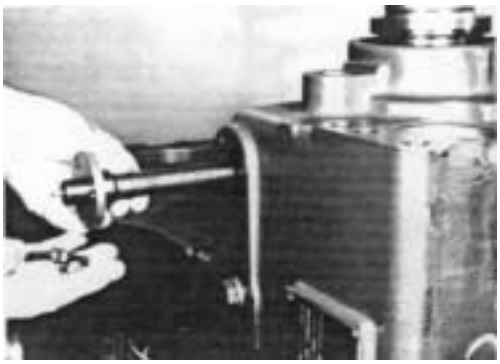


FIGURE 4-364 4802

6. Working on the output shaft of the transmission, remove the lock from the two bolts that hold the output flange disc in place. Remove the bolts from the disc. Remove the disc from the output flange. Slide the output flange out of the transmission. See Figure 4-365.

FIGURE 4-365 4803

7. Pry the oil seal out of the bore. See Figure 4-366.

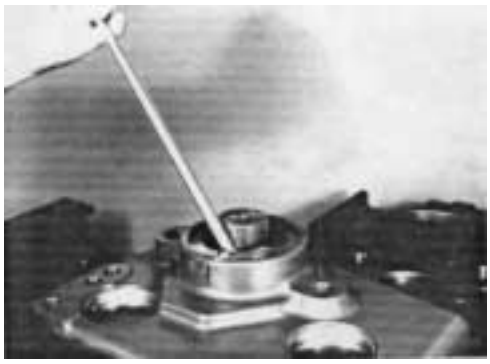


FIGURE 4-366 4804

8. Remove the snap ring and the spacer washer. See Figure 4-367.

FIGURE 4-367 4805

9. Use a slide hammer to pull the shaft and bearing out of the transmission. See Figure 4-368.

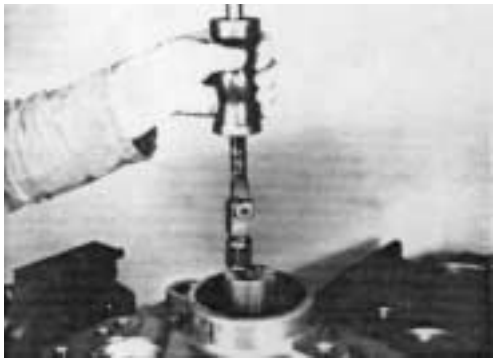


FIGURE 4-368 4806

10. Remove the snap ring and spacer washer. See Figure 4-369.

FIGURE 4-369 4807

11. Use a puller to remove the roller bearing. See Figure 4-370.

FIGURE 4-370 4808

12. Remove the cover from both bores near the output shaft bore. See Figure 4-371.

FIGURE 4-371 4809

13. Reach through the bores and remove the bolts from the oil baffle plate. See Figure 4-372.

FIGURE 4-372 4810

14. Remove the upper oil baffle plate. See Figure 4-373.

FIGURE 4-373 4811

15. Remove the bolts from the hollow shaft. The bolts were coated with Loctite for installation. See Figure 4-374. Remove the hollow shaft.

FIGURE 4-374 4812

16. Remove the second oil baffle plate. See Figure 4-375.

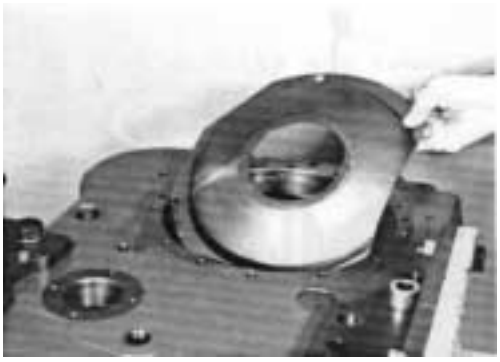


FIGURE 4-375 4813

17. Remove the bolts that hold the cover plate to the output gear. See Figure 4-376.

FIGURE 4-376 4814

18. Tap the cover plate to loosen it. See Figure 4-377.

FIGURE 4-377 4815

19. Remove the cover plate. See Figure 4-378.

FIGURE 4-378 4816

20. Tap the planetary carrier with a pin to loosen it. See Figure 4-379. Remove the planetary carrier from the transmission.

FIGURE 4-379 4817

21. Remove the output gear from the transmission. See Figure 4-380.

FIGURE 4-380 4818

22. Use a pin punch to drive the planetary gear roll pin into the planetary gear shaft. See Figure 4-381.

FIGURE 4-381 4819

23. Drive the planetary gear shaft out of the carrier. See Figure 4-382. Remove all the planetary gears from the planetary carrier.

FIGURE 4-382 4820

Assembly

1. Grease the bearing needles and install them in a planetary gear. Grease the thrust washers and install them into the planetary carrier. See Figure 4-383. Cool the planetary gear to shrink it. Insert the gear into the carrier. Slide the shaft through the carrier and the gear. Install the gear shaft carefully so that the pin hole in the shaft aligns with the pin hole in the carrier. Install 4 planetary gears on one side of the carrier.

FIGURE 4-383 4821

2. Install the sun gear and its thrust washers. See Figure 4-384. The washer with the smallest diameter hole must be at the bottom of the sun gear.

FIGURE 4-384 4822

3. Install the 2 remaining planetary gears. Install the roll pins into all the planetary gears. See Figure 4-385.

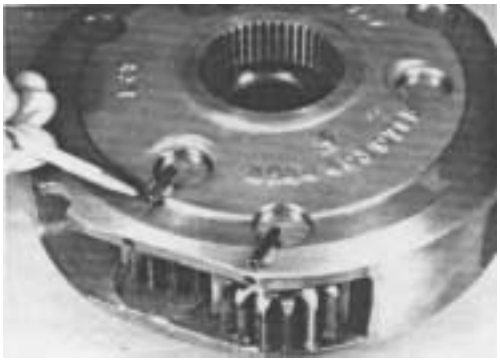


FIGURE 4-385 4823

4. Insert the output gear into the transmission housing. See Figure 4-386.

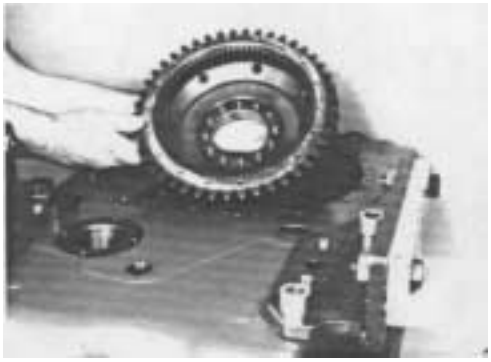


FIGURE 4-386 4824

5. Install the planetary carrier into the output gear. See Figure 4-387. The long hub of the planetary carrier must face down into the output gear.

FIGURE 4-387 4825

6. Insert the cover plate into the transmission and set it over the planetary carrier. See Figure 4-388.

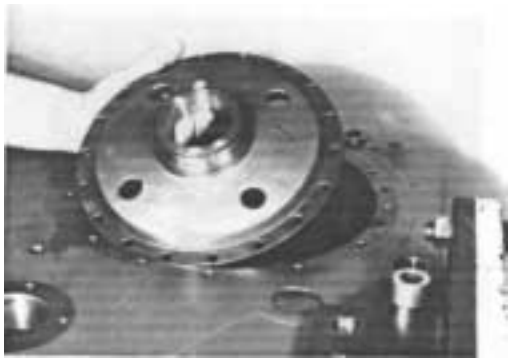


FIGURE 4-388 4826

7. Apply Loctite to the cover plate bolts. Bolt the cover plate to the output gear. See Figure 4-389.

FIGURE 4-389 4827

8. Insert the full circle oil baffle into the transmission. See Figure 4-390.

FIGURE 4-390 4828

9. Insert the lower snap ring into the hollow drive shaft. See Figure 4-391. Insert the needle bearing until it bottoms on the lower snap ring. Install the upper snap ring on top of the bearing.

FIGURE 4-391 4829

10. Insert the hollow drive shaft into the transmission. See Figure 4-392.

FIGURE 4-392 4830

11. Apply Loctite to the bolts for the hollow drive shaft. Bolt the hollow drive shaft to the output gear. See Figure 4-393.

FIGURE 4-393 4831

12. Install the semicircular oil baffle. See Figure 4-394. Apply Loctite to the bolts for the oil baffles. Bolt the oil baffles together. Tighten the bolts to 49 Nm (36 ft lb).

FIGURE 4-394 4832

13. Install the bearing over the hollow drive shaft. See Figure 4-395. Turn the transmission 180°.

FIGURE 4-395 4833

14. Install the roller bearing in the bore. See Figure 4-396.

FIGURE 4-396 4834

15. Install the hollow output shaft in the bore. See Figure 4-397.

FIGURE 4-397 4835

16. Install 2 assembly studs on the mounting plate for the power disengagement gearbox. See Figure 4-398. Slide the gasket over the assembly studs and into place on the mounting plate. Slide the power disengagement gearbox into place over the studs.

FIGURE 4-398 4836

17. On each end of the sun gear, align the thrust washer in preparation for installing the output shaft. Install the bolts that hold the disengagement gearbox to the transmission. See Figure 4-399. Tighten the bolts to 25 Nm (18 ft lb). Remove the assembly studs.

FIGURE 4-399 4837

18. Rotate the transmission 180°. Make sure that the roller bearing is bottomed in the bore. See Figure 4-400.

FIGURE 4-400 4838

NOTE

Some of the following steps describe taking a 1measurement and using the measurement to calculate a shim thickness. The measurements shown in these steps are an example only. Be sure to take your own measurements on the transmission you are working on, and perform your own calculation to derive the correct shim thickness for your transmission.

19. Install the snap ring into its groove. See Figure 4-401. Hold the snap ring down to the bottom of its groove. Then use a feeler gauge to measure the gap between the bottom of the snap ring and the top of the outer race of the bearing that is mounted below the snap ring. This gap must be .3 – .5 mm (.0118 – .0196"). In this example, the gap measured 1.5 mm (.059"). In this example the correct gap can be achieved by installing a shim washer of 1.2 mm thickness.

FIGURE 4-401 4839

1.5 mm (.059") total gap
-1.2 mm (.047") shim thickness
.3 mm (.0118") gap with shim installed

20. Insert the spacer washer of the thickness determined in the previous step. See Figure 4-402. Install the snap ring on top of the washer.

FIGURE 4-402 4840

21. Insert the ball bearing from the short end of the shaft until it bottoms on the flange. See Figure 4-403. Install the needle bearing in the other end of the shaft.

FIGURE 4-403 4841

22. Install the shaft into the transmission. See Figure 4-404. Be certain that the bearing bottoms on the snap ring inside the bore.

FIGURE 4-404 4842

23. Install a snap ring into the groove above the bearing. See Figure 4-405. Push the snap ring upward until it is forced against the upper part of its groove. Use a feeler gauge to measure the gap between the bottom side of the snap ring and the top side of the outer bearing race. Choose a shim thickness that is equal to the measured gap. In this example the gap measured 1.7 mm (.0669"). Therefore a shim was chosen that had a thickness of

FIGURE 4-405 4843

1.7 mm.

24. Remove the snap ring. See Figure 4-406. Install the shim washer that was chosen in the

FIGURE 4-406 4844

previous step. Install the snap ring into its groove.

25. Install the output flange seal. See Figure 4-407. Use a seal driver to move the seal down until it bottoms on the snap ring. Apply grease to the rubber lips of the seal.

FIGURE 4-407 4845

26. Insert the output flange into the transmission. See Figure 4-408.

FIGURE 4-408 4846

27. Apply sealing compound to the disc. Insert the bolts in the disc. See Figure 4-409. Install the disc in the flange and tighten the bolts.

FIGURE 4-409 4847

28. Install the lock plate on the bolts. See Figure 4-410.

FIGURE 4-410 4848

29. Apply Loctite to 2 bore plugs. Install the plugs into the bores on either side of the output flange. See Figure 4-411.

FIGURE 4-411 4849

30. Install a new gasket for the speedometer drive. Assemble the parts for the speedometer drive and bolt them to the transmission. See Figure 4-412.

FIGURE 4-412 4850

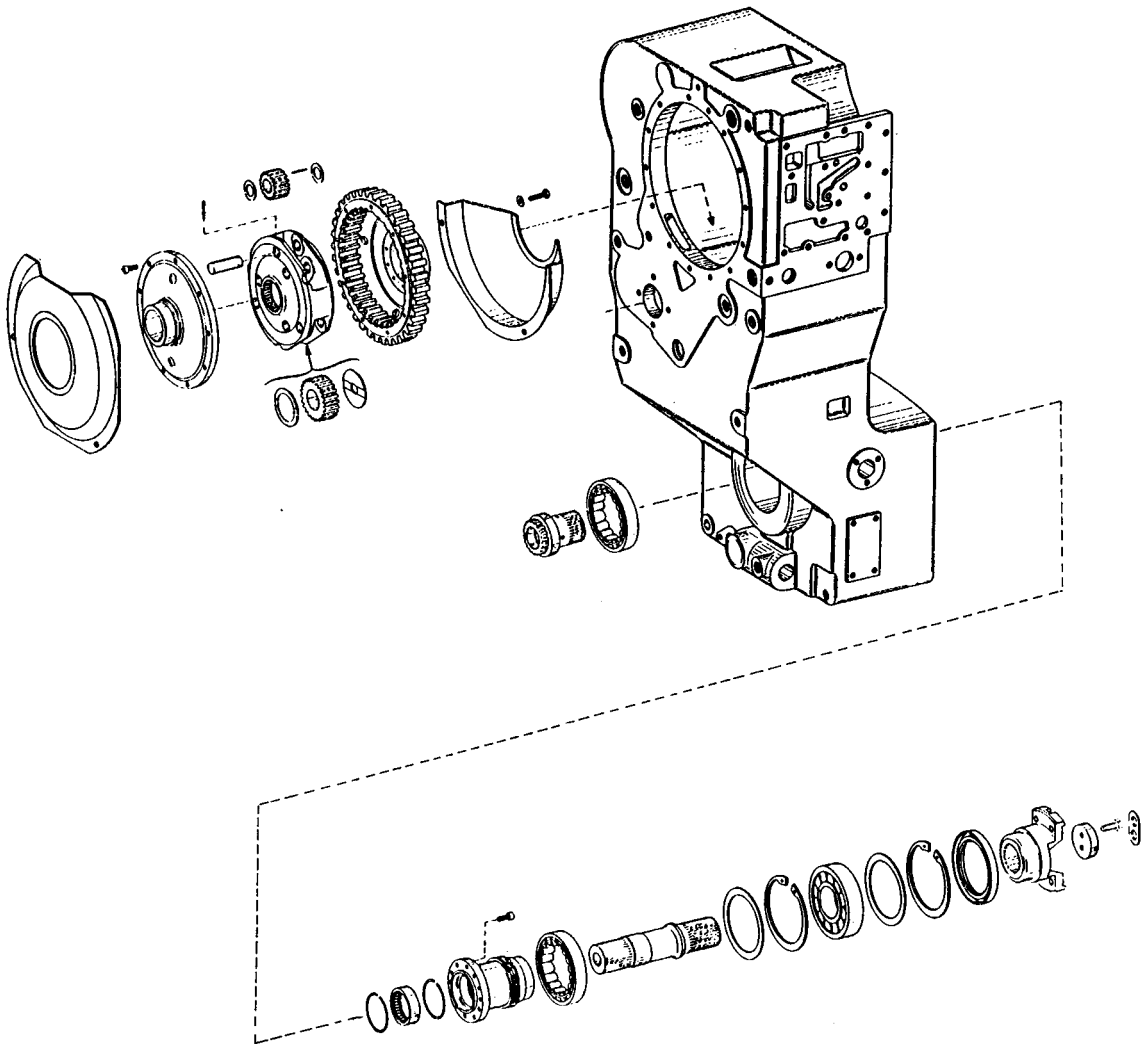


FIGURE 4-413

4851

WK Torque Converter

Disassembly

1. Figure 4-414 shows an assembled torque converter.

FIGURE 4-414 4852

2. Remove the lock plate from the bolts that hold the disc for the output flange. See Figure 4-415 and the exploded view in Figure 4-465. Remove the bolts and the disc.

FIGURE 4-415 4853

3. Prying carefully from both sides, remove the drive flange from the input shaft. See Figure 4-416.

FIGURE 4-416 4854

4. Suspend the assembly by its cover, and use a plastic hammer to lightly tap on the input shaft until the torque converter is separated from the cover. See Figure 4-417.

FIGURE 4-417 4855

5. Match mark the pump wheel and the impeller cover, so that they can be returned to their original positions when assembled. Remove the nuts and bolts from the impeller cover. See Figure 4-418.

FIGURE 4-418 4856

6. Use a plastic hammer to tap lightly on the impeller cover shaft. See Figure 4-419. This will separate the cover from the pump wheel.

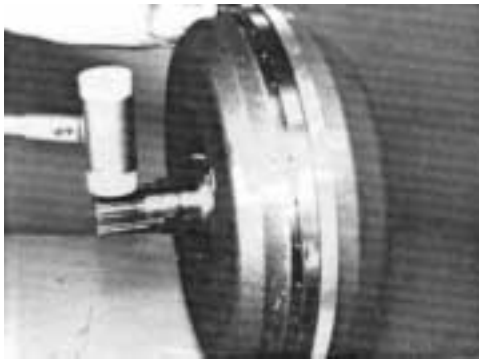


FIGURE 4-419 4857

7. Figure 4-420 shows the torque converter separated into 2 parts.

FIGURE 4-420 4858

8. Carefully pry from both sides to lift the turbine wheel out of the impeller cover. See Figure 4-421.

FIGURE 4-421 4859

9. Remove the O-ring, square ring, and ball bearing from the turbine wheel. See Figure 4-422.

FIGURE 4-422 4860

10. Remove the bolts that hold the hub to the turbine wheel. See Figure 4-423. Remove the hub.

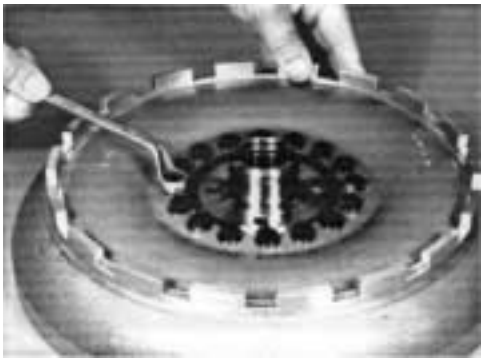


FIGURE 4-423 4861

11. Remove the bolts that hold the backing plate pack to the impeller cover. See Figure 4-424.

FIGURE 4-424 4862

12. Remove the plate pack and dowels. See Figure 4-425. There are 3 outer plates and 1 inner plate.

FIGURE 4-425 4863

13. Remove the snap ring. See Figure 4-426.

FIGURE 4-426 4864

14. Remove the shim and cup spring from the impeller cover. See Figure 4-427.

FIGURE 4-427 4865

15. Use compressed air to force the piston out of the impeller cover. See Figure 4-428.

FIGURE 4-428 4866

16. Working on the pump wheel, remove the stator. See Figure 4-429.

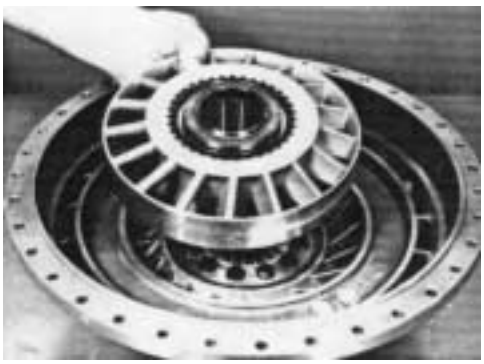


FIGURE 4-429 4867

17. Remove the thrust bearing and spacer washer from the stator. See Figure 4-430.

FIGURE 4-430 4868

18. Press the freewheeling inner race out of the stator. See Figure 4-431. Use caution to prevent damage to the bearing and spacer washer.

FIGURE 4-431 4869

19. Remove the snap ring. Press the freewheeling outer race out of the stator. See Figure 4-432.

FIGURE 4-432 4870

20. Remove the bolts that hold the pump flange to the pump wheel. See Figure 4-433. Remove the pump flange.

FIGURE 4-433 4871

Assembly

1. Thread 2 assembly studs into the pump wheel. Slide a new gasket for the pump flange over the assembly studs. See Figure 4-434. Set the pump flange into position on the pump wheel. Properly align the pump flange with the oil supply hole in the pump wheel.

FIGURE 4-434 4872

2. Insert the bolts into the pump flange. Tighten the bolts to 25 Nm (18 ft lb). See Figure 4-435.

FIGURE 4-435 4873

3. Heat the stator. Insert the freewheeling outer race into the stator. See Figure 4-436. Install the snap ring.

FIGURE 4-436 4874

4. Figure 4-437 shows the parts that will be installed into the stator.

FIGURE 4-437 4875

5. Apply grease to the cylindrical roller, compression spring, and the spring cap. See Figure 4-438. Insert these parts into the freewheeling outer bore.

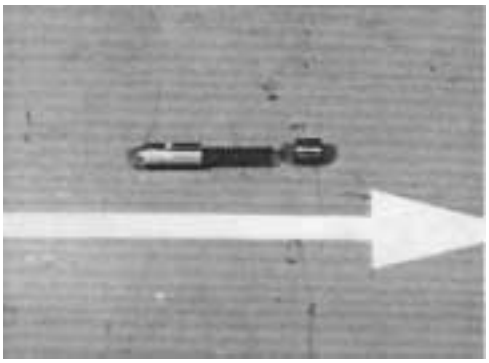


FIGURE 4-438 4876

6. Heat the ball bearing and slide it to the shoulder on the long end [24 mm (.944")] of the freewheeling inner race. See Figure 4-439.

FIGURE 4-439 4877

7. Install the spacer washer. See Figure 4-440. Install the freewheeling inner race into the stator. Use caution to prevent damage to parts.

FIGURE 4-440 4878

8. Turn the stator over and work from the other side. Use a tool to hold down the spring cap. Install two bearing rollers at two points, 180° apart. This will make it easier to install the remaining rollers. See Figure 4-441. Then install all the remaining rollers.

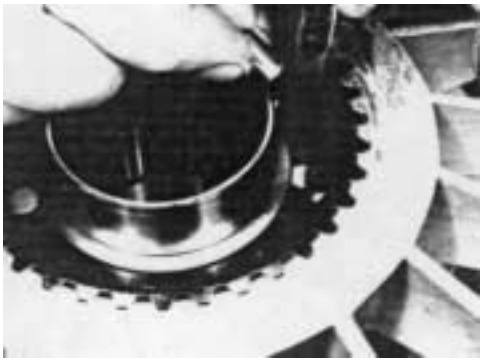


FIGURE 4-441 4879

9. Install the thrust washer. Then insert the bearing until it bottoms on the shoulder. See Figure 4-442.

FIGURE 4-442 4880

10. Turn the stator over and work from the other side. Install the shim washer. Install the thrust plate. See Figure 4-443.

FIGURE 4-443 4881

11. Insert the thrust washer into the pump wheel. Install the thrust bearing on top of the thrust washer. See Figure 4-444.

FIGURE 4-444 4882

12. Set the stator into the pump wheel. See Figure 4-445.

FIGURE 4-445 4883

13. Before installation, expand the square seal rings so that they make good contact with the sides of the grooves. Install the square seal rings into the grooves on both the inner and outer circumference of the piston. See Figure 4-446. Coat the rings with grease.

FIGURE 4-446 4884

14. Install the piston into the impeller cover. See Figure 4-447.

FIGURE 4-447 4885

15. Install the cylindrical rollers into the impeller cover as shown in Figure 4-448.

FIGURE 4-448 4886

16. Install the plate pack into the impeller cover. See Figure 4-449. Install the plates in the following order. Two plates with bolt holes on the outer circumference. One plate with tangs on the inner circumference. One plate with bolt holes on the outer circumference.

FIGURE 4-449 4887

17. Install the cup spring and the snap ring. The cup spring determines the gap setting for the plate pack. See Figure 4-450.

FIGURE 4-450 4888

18. Set the cover ring over the plate pack. See Figure 4-451. Install the bolts into the cover ring and plate pack. Tighten bolts to 35 Nm (26 ft lb).

FIGURE 4-451 4889

NOTE

The following steps describe taking measurements to calculate a shim thickness. The measurements shown in these steps are an example only. Be sure to take your own measurements to derive the correct shim thickness for your torque converter.

19. Use compressed air to move the piston. Then measure the gap between the snap ring and cup spring. See Figure 4-452. In this example, this gap measured 1.40 mm (.055").

FIGURE 4-452 4890

20. Remove the snap ring. See Figure 4-453. Install beneath the snap ring, a shim washer with the thickness measured in the previous step (1.40 mm). Install the snap ring.

FIGURE 4-453 4891

21. Install the hub in the turbine wheel. See Figure 4-454. Install the bolts and tighten to 25 Nm (18 ft lb).

FIGURE 4-454 4892

22. Heat the ball bearing and install it on the hub shaft. See Figure 4-455. Install the snap ring.

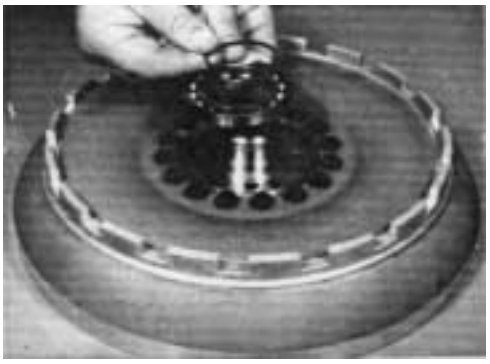


FIGURE 4-455 4893

23. Install the turbine wheel assembly into the impeller cover. See Figure 4-456.

FIGURE 4-456 4894

24. Install the collar shim, thrust bearing, and bearing washer into the turbine wheel. See Figure 4-457.

FIGURE 4-457 4895

NOTE

The following steps describe taking measurements and using the measurements to calculate a shim thickness. The measurements shown in these steps are an example only. Be sure to take your own measurements and perform your own calculation to derive the correct shim thickness for your torque converter.

25. Measure the distance from the flange face to the top of the bearing washer. See Figure 4-458. In this example, this distance measured 15.3 mm (.602"). This is measurement A.

FIGURE 4-458 4896

26. Measure the distance between the stator flange face and the top of the stator bearing inner race. See Figure 4-459. In this example, this distance measured 16.9 mm (.665"). This is measurement B. To calculate the total end play, and shim washer thickness necessary, perform the following calculations.

FIGURE 4-459 4897

16.9 mm (.665") measurement A
-15.3 mm (.602") measurement B
1.6 mm (.0629") total end play

The maximum allowable end play is .2 mm (.0078"). To create end play in the middle of the allowable range, choose a 1.5 mm (.059") shim.

1.6 mm (.0629") total end play
-0.1 mm (.0039") desired end play
1.5 mm (.059") shim thickness

27. Install the spacing and housing washers on the stator hub. See Figure 4-460. Install the gasket over the bolt holes on the outer circumference of the pump wheel.

FIGURE 4-460 4898

28. Install the assembled stator into the turbine wheel. See Figure 4-461.

FIGURE 4-461 4899

29. Apply grease to the gasket and housing washers in the pump wheel. Set the pump wheel on the impeller cover. See Figure 4-462. Align the match marks on the impeller cover and the pump wheel that were made during disassembly. Install two bolts 180° apart, and alternately tighten these bolts until the pump wheel and the impeller cover are flush at all points.

FIGURE 4-462 4900

30. Install all the bolts and washers. Cross tighten the bolts to a final torque of 25 Nm (18 ft lb). See Figure 4-463.

FIGURE 4-463 4901

31. Install the square sealing ring. See Figure 4-464.

FIGURE 4-464 4902

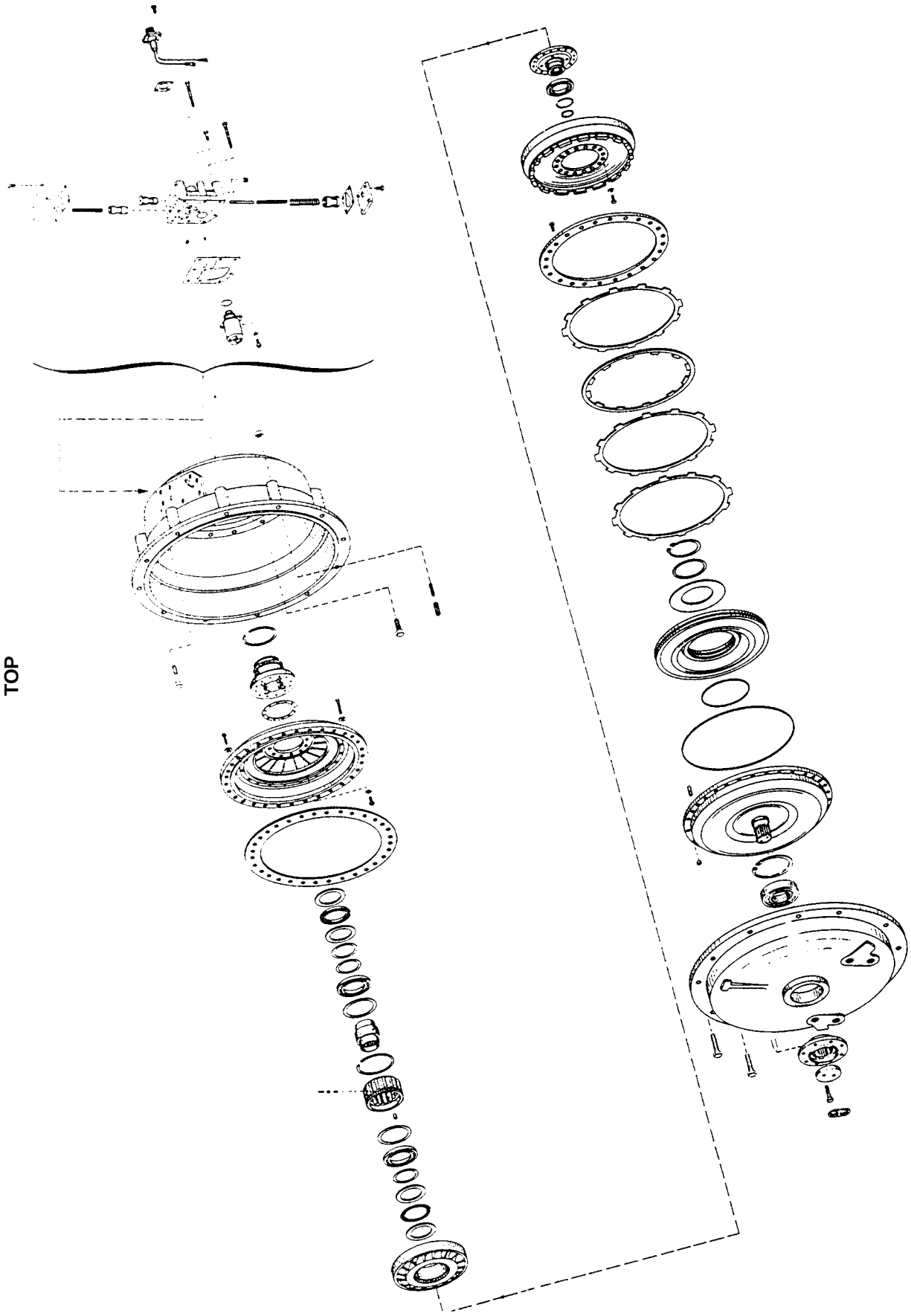


FIGURE 4-465

4903

WK Converter Clutch Valve

Disassembly

1. Remove the bolts that hold the valve assembly to the bell housing. See Figure 4-466. Remove the valve assembly.

FIGURE 4-466 4904

2. Unplug the cable for the solenoid. See Figure 4-467. Remove the bolts from the solenoid valve. Remove the solenoid valve.

FIGURE 4-467 4905

3. Remove the bolts that hold the cover plate to the valve body. See Figure 4-468. Remove the cover plate.

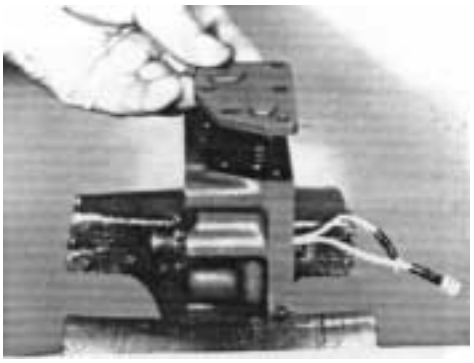


FIGURE 4-468 4906

4. Remove the sequence valve (spool and compression spring) from the valve body. See Figure 4-469.

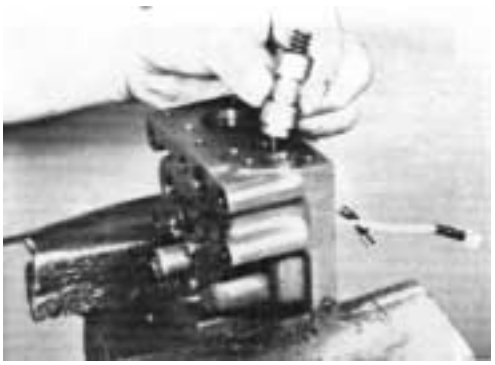


FIGURE 4-469 4907

5. Remove the spool, spring, and dowel from the adjacent bore. See Figure 4-470.

FIGURE 4-470 4908

6. Turn the valve 180°. Remove the bolts that hold the cover plate and gasket to the valve body. See Figure 4-471.

FIGURE 4-471 4909

7. Remove the pressure control spool. See Figure 4-472.

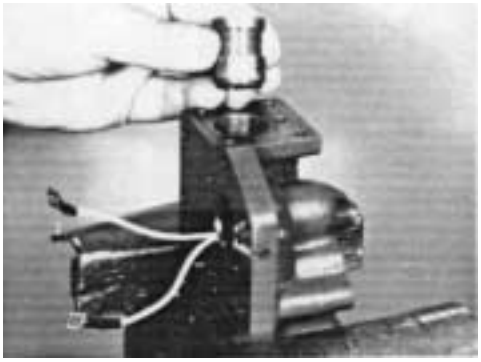


FIGURE 4-472 4910

8. Remove the screws that hold the wire socket to the valve body. Remove the socket and harness. See Figure 4-473.

FIGURE 4-473 4911

Assembly

1. Apply Loctite to both ends of the dowel pins. Install the dowel pins in the holes marked by the arrows and in the flange for the pressure control valve. See Figure 4-474.

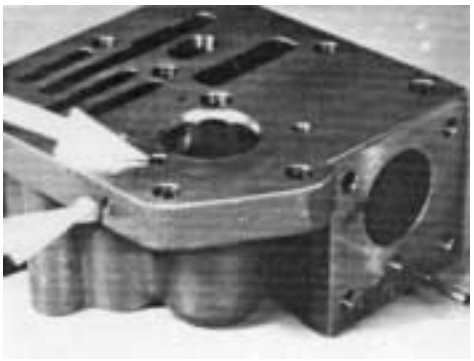


FIGURE 4-474 4912

2. Figure 4-475 shows the valve parts that will be installed into the valve body.

FIGURE 4-475 4913

3. Insert the pressure control spool into the bore. See Figure 4-476.

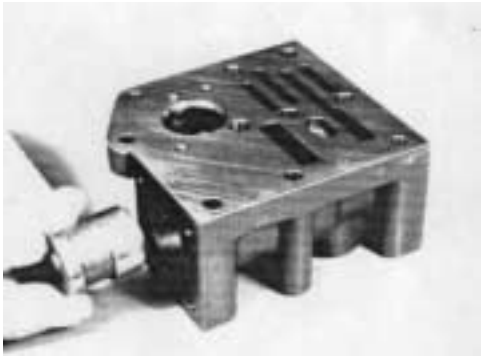


FIGURE 4-476 4914

4. Install the cover plate and gasket over the pressure control spool. See Figure 4-477. Install the bolts and tighten to 25 Nm (18 ft lb).

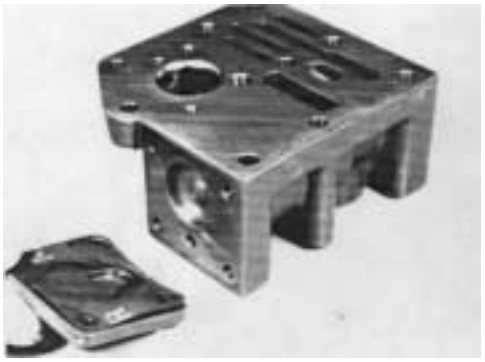


FIGURE 4-477 4915

5. Insert the dowel, springs, and pressure relief spool into the valve bore. See Figure 4-478.

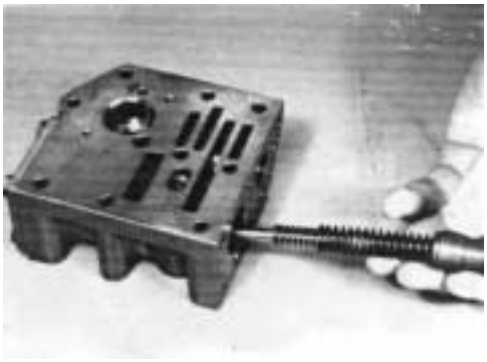


FIGURE 4-478 4916

6. Install the sequence valve into the valve bore. See Figure 4-479.

FIGURE 4-479 4917

7. Place the gasket and cover plate over the relief valve and sequence valve. See Figure 4-480. Install the screws and tighten to 10 Nm (8 ft lb).

FIGURE 4-480 4918

8. Install a new O-ring on the solenoid valve. See Figure 4-481. Insert the solenoid valve into its bore. Install the bolts into the solenoid valve and tighten to 10 Nm (8 ft lb).

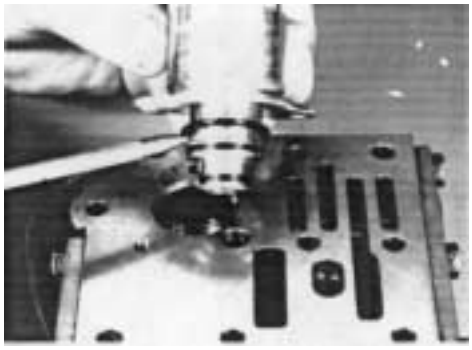


FIGURE 4-481 4919

9. Insert the cable harness and socket into the valve body. See Figure 4-482. Install the screws into the socket and tighten.

FIGURE 4-482 4920

10. Thread 2 assembly studs into the bell housing. See Figure 4-483. Slide the gasket for the clutch valve into position over the studs. Slide the valve into position over the studs. Insert the bolts into the valve and tighten to 10 Nm (8 ft lb). Remove the assembly studs.

FIGURE 4-483 4921

POWER STEERING

Power Steering System

Power Steering Unit

The machine contains a fully hydraulic steering unit. See Figure 5-1. Rotating the steering wheel controls hydraulic flow through the steering valve. See Figure 5-2. Figure 5-2 contains the hydraulic schematic for the steering system. The steering valve meters the volume of pump flow that is supplied to the steering cylinders.

1. Bearing
2. Centering Springs
3. Sleeve
4. Center Pin
5. Check Valve
6. Gerotor
7. End Cap
8. Spool
9. Drive Shaft
10. Housing

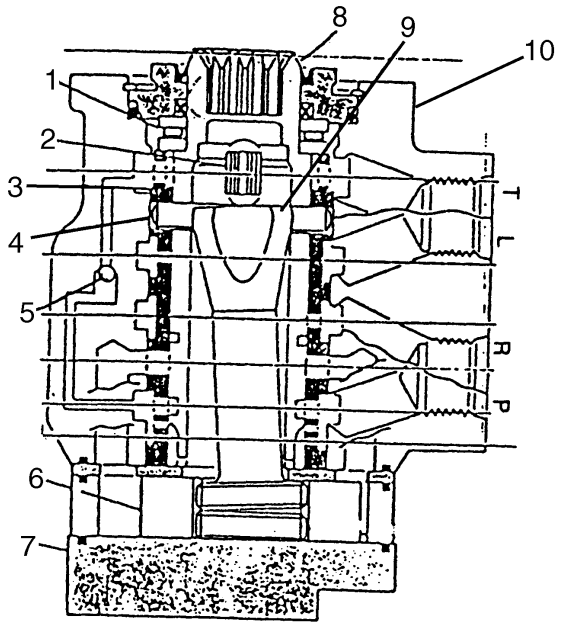


FIGURE 5-1

3772

The steering unit contains a gerotor. This allows the operator to steer the machine when the engine is not running or when the steering pump has failed. The gerotor functions as a manual hydraulic pump that is powered by the rotation of the steering wheel. Rotating the steering wheel will cause the gerotor to draw oil from the hydraulic tank and send this oil to the steering cylinders.

The shaft that is rotated by the steering wheel is attached to the spool (8, Figure 5-1) by the engagement of a spline. The spool is surrounded by a sleeve (3). The spool and sleeve are connected by the centering spring (2). At the steering wheel neutral position, the center pin does not contact the spool. A driveshaft (9) extends through the spool. The upper end of the driveshaft engages the center pin (4). The lower end of the driveshaft engages the spline in the gerotor (6).

1. Steering Unit
2. Cushion Unit
3. Relief Valve
4. Control Valve
5. Priority Valve
6. Oil Cooler
7. Accumulator
8. Steering Cylinder
9. Gerotor

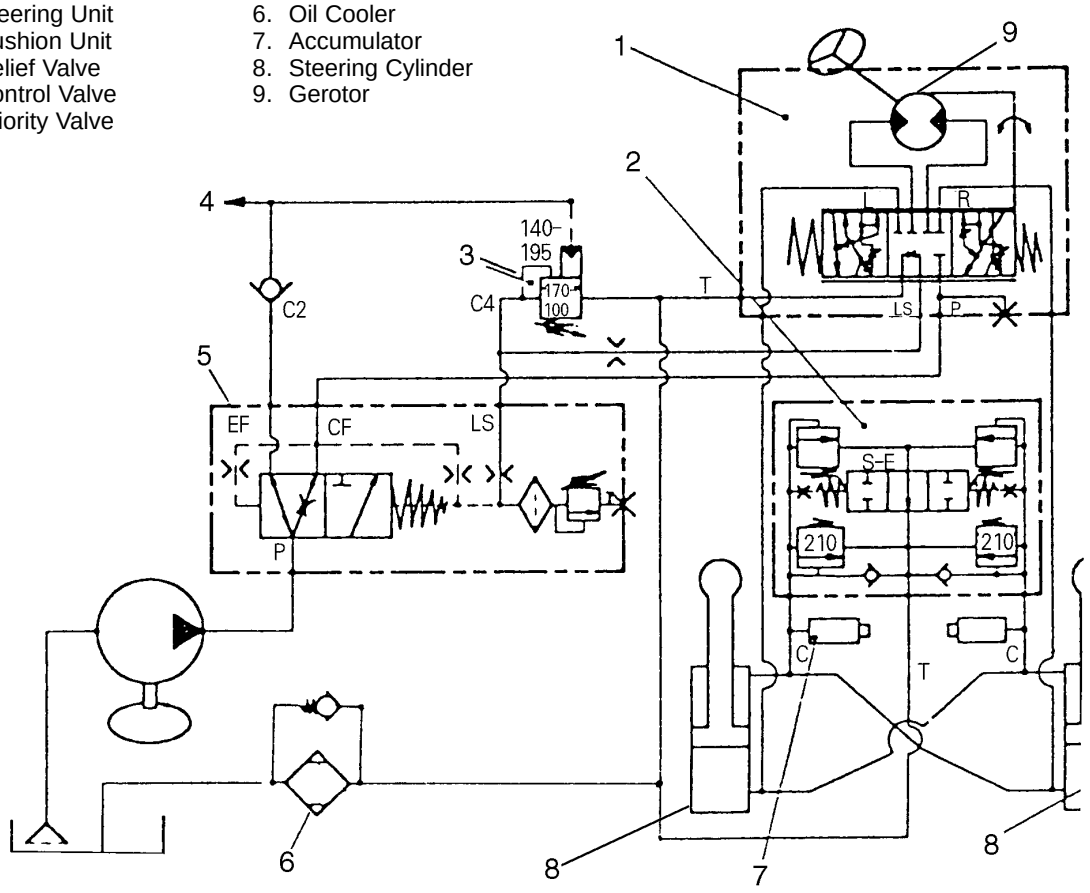


FIGURE 5-2

4932

Neutral Operation

With the steering wheel in the neutral position (wheels turned neither right nor left), the spool (2, Figure 5-3) and sleeve (1) are stationary at the position where the center pin (6) becomes centered in the spool space by the centering springs (3). Oil flow through the load sensing line (LS), port L, port R, and port T are bypassed to the tank line and the oil supply (P) is blocked by the directional spool in the steering unit (1, Figure 5-2). Even if an external force is applied to the steering cylinder, the steering unit is protected because the oil path is blocked by the directional spool.

Right Turn

The spool (2, Figure 5-3) is engaged with the spline of the steering shaft. When the steering wheel is turned to the right, the spool turns. The sleeve (1) is connected to the spool (2) by centering springs (3). When the spool turns, the sleeve turns. The sleeve turning angle is about 10° less than the spool turning angle. This allows the longitudinal slots in the spool to align with the ports in the sleeve. Oil from port P on the steering unit (1, Figure 5-2) travels through the control spool and is

1. Sleeve
2. Spool
3. Centering Spring
4. Spool
5. Sleeve
6. Center Pin
7. Drive Shaft

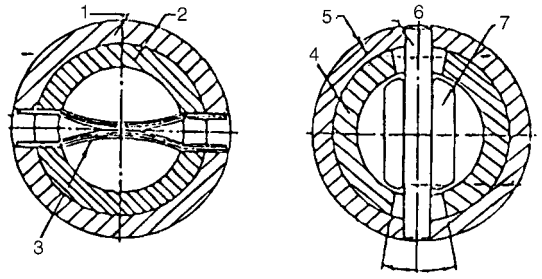


FIGURE 5-3

3773

directed to port R which directs the oil to the steering cylinders. The amount of oil flow metered to port R is controlled by the amount of steering wheel rotation. Excess oil flow through port P that is not metered to port R, is directed by the spool to port T and is then directed through the oil cooler and

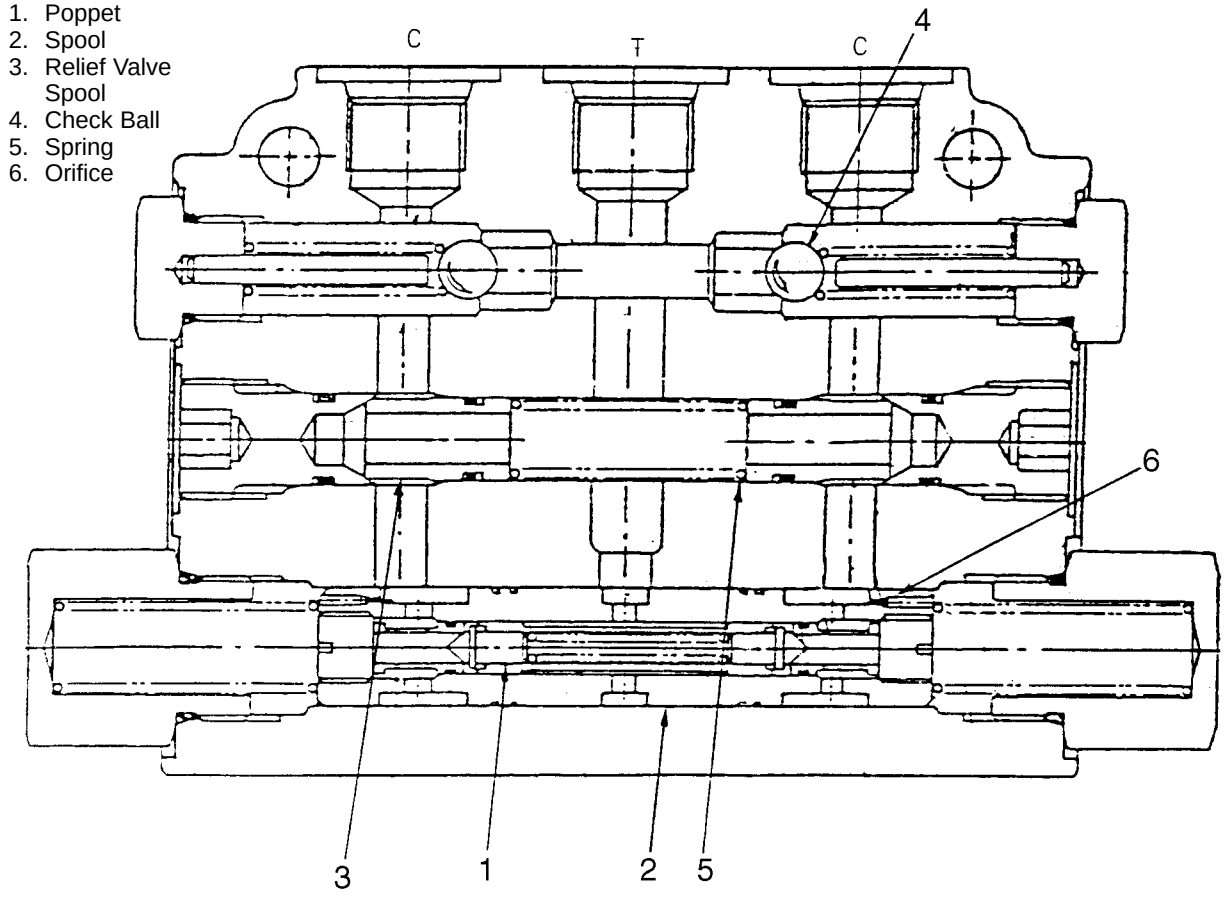


FIGURE 5-4

4933

into the tank.

Left Turn

The spool (2, Figure 5-3) is engaged with the spline of the steering shaft. When the steering wheel is turned to the left, the spool turns. The sleeve (1) is connected to the spool (2) by centering springs (3). When the spool turns, the sleeve turns. The sleeve turning angle is about 10° less than the spool turning angle. This allows the longitudinal slots in the spool to align with the ports in the sleeve. When the steering wheel is turned to the left, oil from
port P on the steering unit (1, Figure 5-2) is directed through the control spool in the steering unit, out port L and into the steering cylinders (8). The amount of oil flow metered to port L is controlled by the amount of steering wheel rotation. Excess oil flow through port P that is not metered to port L, is directed by the spool to port T and is then directed through the oil cooler and into the tank.

Gerotor

If the engine or pump is not operating, the gerotor (9, Figure 5-2) works as a manual pump when the steering wheel is turned. The gerotor will work when the input torque to the steering wheel is less than 12 kg m (87 ft lb). If the necessary input torque is greater than this, the gerotor will not function. When the steering wheel is turned, the gerotor creates a vacuum that draws oil from port T. See Figure 5-2. The gerotor pumps this oil through the control spool and into the steering cylinders. Return oil flows back to the spool and is used to lubricate the steering unit (1, Figure 5-2). The return oil then flows back into the tank line and is recirculated back to the gerotor and the steering cylinders.

Cushion Valve Operation

The cushion valve (2, Figure 5-2) absorbs any excessive peak pressure that may be generated during initial movement of the steering wheel or during a change in steering direction. The cushion valve also prevents excessive high pressure and cavitation that can result from steering load inertia.

The C ports in the cushion valve are connected in parallel to the steering cylinders. Port T in the cushion valve is connected to the tank line. See Figure 5-4. If a high pressure spike caused by

steering inertia is fed back to one of the C ports, the poppet (1, Figure 5-4) compresses its spring and directs the high pressure oil to the tank port T. Oil then pushes the spool (2) to close the passage to port T. This opens a path to the relief valve piston (3, Figure 5-4). Oil presses the piston (3) against its spring until a path is opened to the tank port T. This releases the pressure and protects the circuit components by keeping the maximum pressure below the desired level. If a vacuum is created in the opposite C port, oil will be drawn from the T passage, through the check ball (4). This will prevent cavitation.

Priority Valve Operation

Oil output from the steering pump flows through the priority valve to both the loader supply line and to the steering circuit. During operation of the steering wheel, the priority valve shifts and supplies pump flow only to the steering circuit. This results in smooth operation of the steering circuit.

At rest, the spool (1, Figure 5-5) maintains an open path between inlet port P and steering outlet port CF. Port EF is kept closed by the force from spring (2). The spool (1) contains a drilled passage. The passage is open to port CF and is also open to both ends of the spool. At the neutral position of the steering unit, oil from port P flows through port CF and into the drilled passage in the spool. At this time oil flowing out of CF is blocked at the control spool of the steering unit. This raises the pressure in port CF. At this time, port LS is open to the chamber on the far left side of the priority valve. Port LS is not open to the chamber on the far right side of the valve. As oil flows through the drilled passage in the spool, pressure builds on the right side of the spool but pressure is low on the left side of the spool because oil can drain into port LS. When oil pressure on the right side of the spool rises above the force of spring (2, Figure 5-5), the spool (1) shifts to the left. This allows pump flow at port P to flow out both ports CF and EF. Now both the loader supply line and the steering supply line are charged with flow from the steering pump. Whenever the steering wheel is turned, the spool in the steering unit directs some oil flow back to port LS. This equalizes the oil pressure on both ends of the spool (1). The spring now shifts the spool to the right. This closes off the passage from port P to port EF. This makes all steering pump flow now available only to the steering circuit from port CF.

1. Spool
2. Spring
P – Pressure Port
CF – Steering Supply Port
EF – Loader Supply Port
LS – Pilot Port

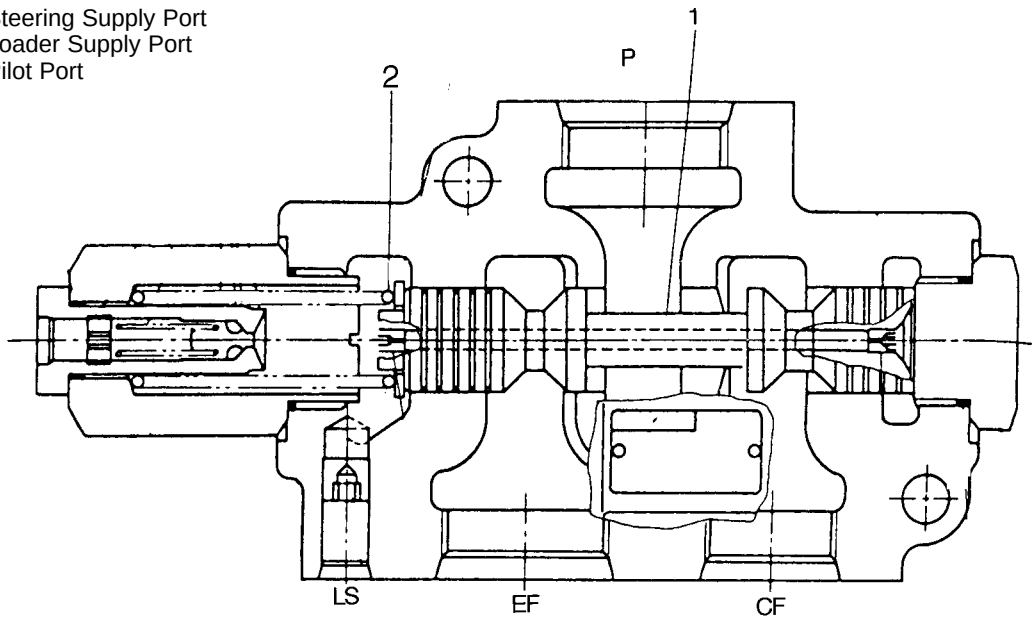


FIGURE 5-5

4934

Steering System Troubleshooting

Problem	Cause	Solution
Steering wheel does not operate smoothly	1. Broken or damaged oil pump	Replace pump
	2. Stuck or damaged relief valve	Repair or replace
	3. Stuck, damaged, or worn out steering valve	Clean, repair, or replace
	4. Restricted hose or pipe. Leaking or restricted hose, pipe, or connection	Clean, repair, or replace
	5. Mechanical defect in steering gear	Repair, replace
Steering wheel has a heavy feel	1. Oil level low in reservoir	Add oil
	2. Low oil pressure due to broken or damaged oil pump	Replace pump
	3. Steering valve stuck	Clean, repair, replace
	4. Low oil level in steering gearbox	Inspect oil level, fill to proper level
	5. Damaged bolt and nut in steering gearbox	Replace damaged parts
Difficult to drive in a straight line	1. Defective spool in steering valve	Tighten lock nut
	2. Stuck or damaged steering valve or damaged or defective spring	Repair, replace
	3. Improper fit of track link	Repair, replace
Noise during steering	1. Low oil level in reservoir	Add oil
	2. Restricted inlet pipe or filter	Clean, replace
Steering system leaking oil	1. Worn or damaged O-ring and oil seal of pipe and steering valve	Replace worn or damage parts

Steering Unit

1. Seal Ring
2. Housing
3. Spool
4. Sleeve
5. Ball
6. Threaded Bushing
7. O-ring
8. Backup Ring
9. Thrust Washers
10. Thrust Bearing
11. Spacer Ring
12. Cross Pin
13. Neutral Springs
14. Shaft
15. Spacer – 13.8 mm
16. Spacer – 25 mm
17. Spacer Bushing
18. O-ring – 80.5 x 1.5 mm
19. Middle Plate
20. Distributor Plate
21. Rotor
22. O-ring – 79.92 x 1.78 mm
23. Cylinder Gear
24. End Cover
25. Washer
26. Roll Pin 2.5 x 32 mm
27. Bolt

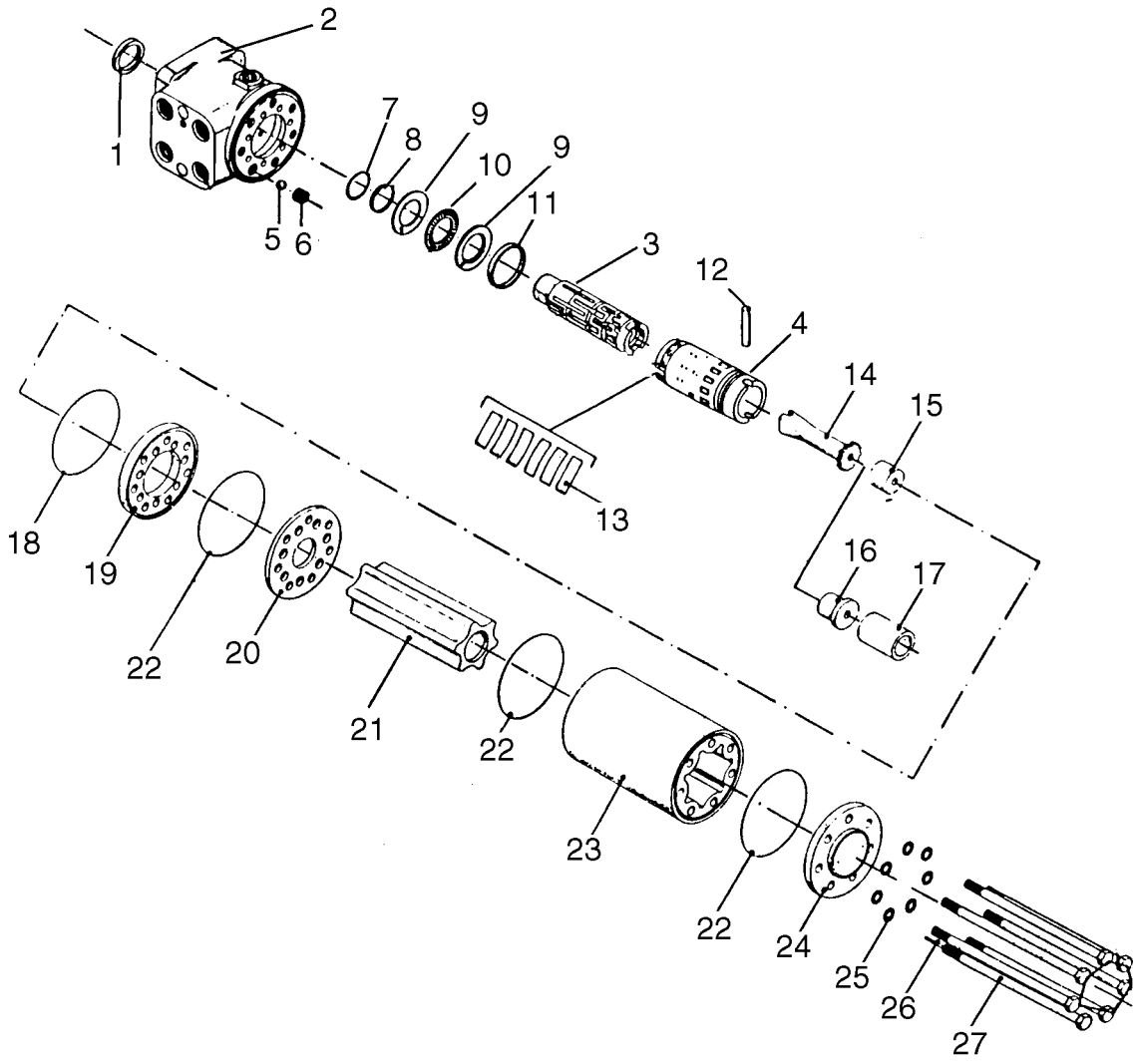


FIGURE 5-6

4935

An exploded view of the steering unit is shown in Figure 5-6.

Tools

The tools necessary for steering unit repair are illustrated below.

1. Stabilizing base. See Figure 5-7.

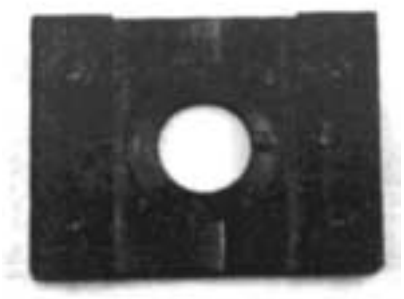


FIGURE 5-7 4936

2. O-ring assembly tool. See Figure 5-8.

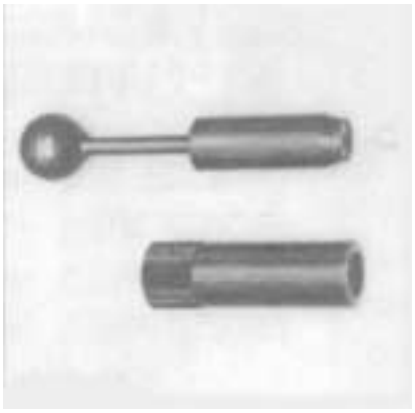


FIGURE 5-8 4937

3. Seal driver. See Figure 5-9.

FIGURE 5-9 4938

4. Torque wrench, 0 – 5 kg m (0 – 35 ft lb). See Figure 5-10. 13 mm socket. Ratchet handle. 12 mm screwdriver. 6 mm screwdriver. 2 mm screwdriver. Plastic hammer.

FIGURE 5-10 4939

Disassembly

It is very important to keep the inside of the steering unit clean. Make sure that the outside of the steering unit is clean before opening the unit. Use a wire brush and solvent to clean the entire unit.

1. Remove the steering column from the steering unit. Bolt the steering unit to the stabilizing base. Bolt the base to the work bench.
2. Remove the bolts from the steering unit end cover. See Figure 5-11.

FIGURE 5-11 4940

3. Remove the end cover from the unit. See Figure 5-12.

FIGURE 5-12 4941

4. Lift the cylinder gear off the unit. See Figure 5-13. Remove the 2 O-rings.

FIGURE 5-13 4942

5. Remove the spacer bushing and spacer from the cylinder gear. See Figure 5-14.

FIGURE 5-14 4943

6. Remove the shaft from the housing. See Figure 5-15.

FIGURE 5-15 4944

7. Remove the distributor plate from the housing. See Figure 5-16.

FIGURE 5-16 4945

8. Remove the O-ring from the top of the middle plate. See Figure 5-17.

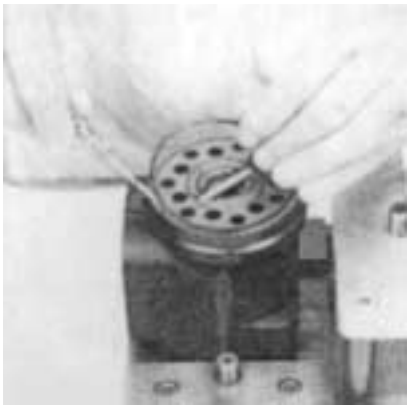


FIGURE 5-17 4946

9. Lift the middle plate off the housing. See Figure 5-18.

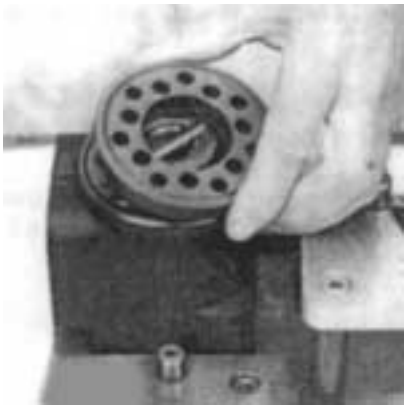


FIGURE 5-18 4947

10. Remove the O-ring from the housing. See Figure 5-19.

FIGURE 5-19 4948

11. Unscrew the threaded bushing and remove it. See Figure 5-20.

FIGURE 5-20 4949

12. Remove the cross pin. See Figure 5-21.

FIGURE 5-21 4950

13. Shake the ball out of the housing. See Figure 5-22.

FIGURE 5-22 4951

14. Pull the sleeve and spool out of the housing. See Figure 5-23.

FIGURE 5-23 4952

15. Remove the thrust bearing and thrust washers from the sleeve. See Figure 5-24. Remove the spacer ring. Be sure to remove the spacer ring. It can stick in the sleeve.

FIGURE 5-24 4953

16. Carefully slide the control spool out of the sleeve. See Figure 5-25.

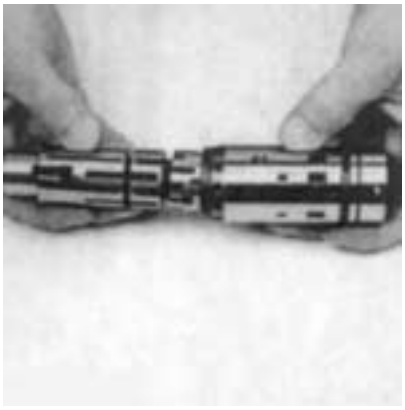


FIGURE 5-25 4954

17. Push the neutral position springs out of the groove in the spool. See Figure 5-26.

FIGURE 5-26 4955

18. Remove the dust seal from the housing. See Figure 5-27. Remove the O-ring and backup ring from inside the housing.

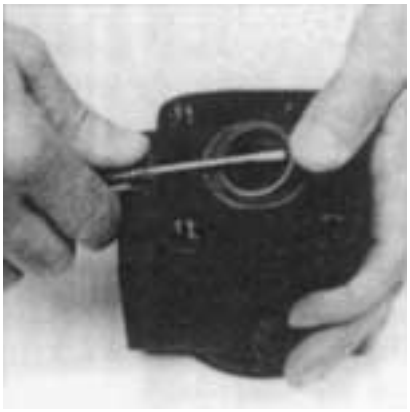


FIGURE 5-27 4956

19. Figure 5-28 shows all the parts removed from the steering unit. Clean all parts before assembly. Use only new O-rings and seals.

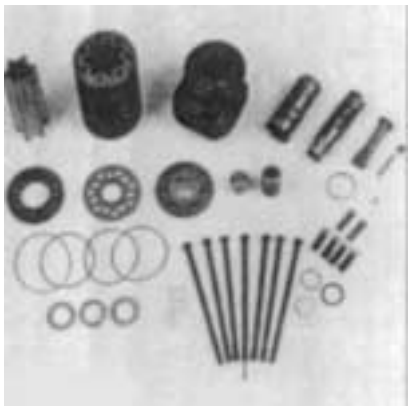


FIGURE 5-28 4957

Assembly

Use the bolt torque chart that follows to tighten the bolts as the steering unit is assembled.

Bolt Torque Chart	
Bolt Size	**Torque Value**
M10	4.8 kg m (35 ft lb)
3/8 – 16 NC	4.8 kg m (35 ft lb)

1. Install the springs in the spool slot. See Figure 5-29. The springs must be positioned as shown in Figure 5-30.

FIGURE 5-29 4958

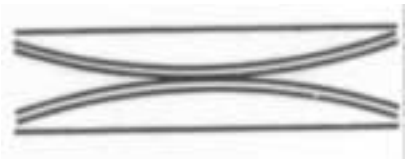


FIGURE 5-30 4959

2. Position the springs so that the amount of spring protruding out of the spool is equal on both sides. See Figure 5-31.

FIGURE 5-31 4961

3. Insert the spool into the sleeve. See Figure 5-32. Use care so that the sleeve and spool are correctly assembled. The spring slot in the sleeve must align with the spring slot in the spool. Also, one of the T shaped slots (A) in the spool must align with one of the small

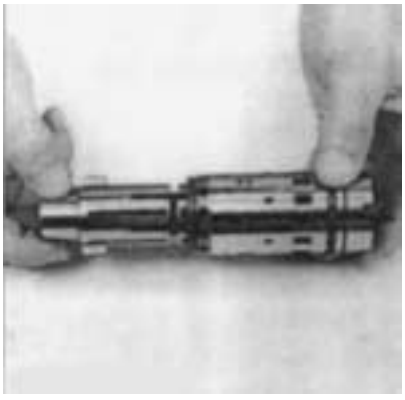


FIGURE 5-32 4962

holes (B) in the sleeve. See Figure 5-33.

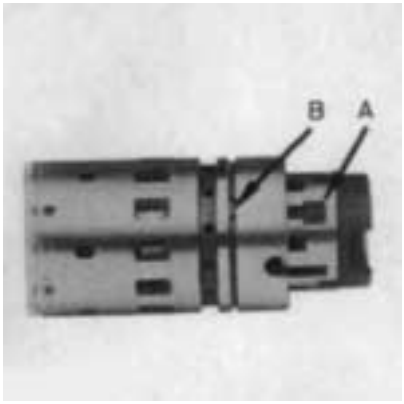


FIGURE 5-33 4960

4. Center the springs in the sleeve. See Figure 5-34.

FIGURE 5-34 4963

5. Install the seal ring on the sleeve. See Figure 5-35. Burnish the seal ring with a smooth object until the seal does not protrude past the diameter of the sleeve.

FIGURE 5-35 4964

6. Rotate the seal ring. See Figure 5-36. It must

FIGURE 5-36 4965

rotate freely without resistance.

FIGURE 5-37 4966

7. Turn the sleeve 180°. Install the cross pin into the sleeve and spool. See Figure 5-37.
8. Install the 2 thrust washers and the thrust bearing over the end of the spool. See Figure 5-38. The sequence of the parts installation is shown in Figure 5-39.

FIGURE 5-38 4967

1. Thrust Washer
2. Thrust Bearing
3. Thrust Washer
4. Spool
5. Sleeve

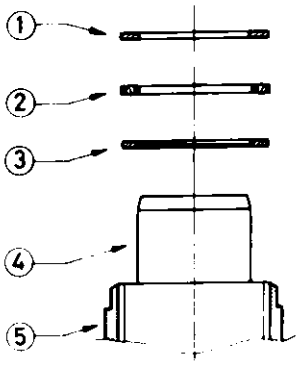


FIGURE 5-39 4968

9. Oil the O-ring and backup ring and then install them on an O-ring assembly tool. See Figure 5-40.

FIGURE 5-40 4969

10. Insert the assembly tool down into the bore of the steering unit. See Figure 5-41.

FIGURE 5-41 4970

11. Use the assembly tool to install the O-ring and the backup ring into the bore. See Figure 5-42.

FIGURE 5-42 4971

12. Unbolt the housing from the stabilizing base. Hold the housing in a horizontal position. See Figure 5-43. Insert the sleeve and spool into the bore.

FIGURE 5-43 4972

13. The sleeve will push the O-ring and backup ring into the correct position. See Figure 5-44.

FIGURE 5-44 4973

14. Bolt the housing back into the stabilizing base. See Figure 5-45.

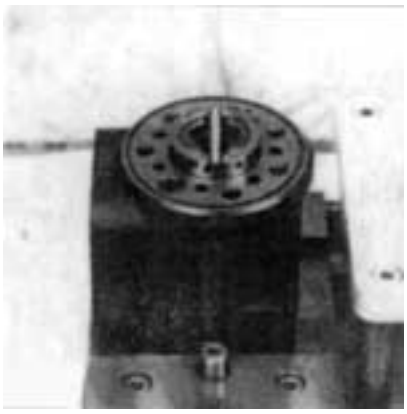


FIGURE 5-45 4974

15. Insert the ball into the hole. See Figure 5-46.

FIGURE 5-46 4975

16. Install the threaded bushing into the hole that the ball was placed into. See Figure 5-47. Lightly tighten the bushing. The top of the bushing must be lower than the surface of the housing.

FIGURE 5-47 4976

17. Lubricate the O-ring with 20 weight mineral oil and install it in the groove. See Figure 5-48.

FIGURE 5-48 4977

18. Install the middle plate onto the housing. See Figure 5-49. Be sure to properly align the plate holes with the holes in the housing.

FIGURE 5-49 4978

19. Lubricate the O-ring with 20 weight mineral oil and install it in the groove. See Figure 5-50.

FIGURE 5-50 4979

20. Install the distributor plate. See Figure 5-51. Be sure to properly align the plate holes with the holes in the middle plate.

FIGURE 5-51 4980

21. Install the shaft into the bore of the housing. See Figure 5-52. Position the slot in the shaft to engage the cross pin.

FIGURE 5-52 4981

22. Position the rotor so that the cross pin is located between 2 teeth as shown by the position of the screwdriver. See Figure 5-53.

FIGURE 5-53 4982

23. Lubricate 2 O-rings with 20 weight mineral oil and install them in the grooves of the cylinder gear. Slide the cylinder gear into position on the housing. See Figure 5-54.

FIGURE 5-54 4983

24. Use a bolt to align the bolt holes in the cylinder gear with the bolt holes in the housing. See Figure 5-55.

FIGURE 5-55 4984

25. Install the spacer bushing. See Figure 5-56. Remove the bolt that was installed in the previous step.

    OSPL 630 – 3.8 mm (11)

    OSPL 800 – (24)

    OSPL 1000 – (24)

FIGURE 5-56 4985

26. Use a screwdriver to install the OSPL 800 and 1000 spacers. See Figure 5-57.

FIGURE 5-57 4986

27. Install the end cover. See Figure 5-58.

FIGURE 5-58 4987

28. Install a washer and the roll pin into the hole shown in Figure 5-59.

FIGURE 5-59 4988

29. Install the 6 remaining bolts and tighten them. See Figure 5-60. Cross tighten the bolts and roll pin to 48.1 Nm (35 ft lb).

FIGURE 5-60 4989

30. Turn the steering unit over and work from the opposite side. Set the dust seal in position on the housing. See Figure 5-61.

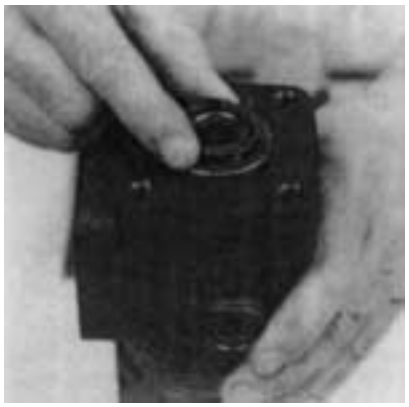


FIGURE 5-61 4990

31. Use a seal driver and a plastic hammer to install the dust seal. See Figure 5-62.

FIGURE 5-62 4991

32. Install plastic plugs to prevent dirt from entering the steering unit. See Figure 5-63.

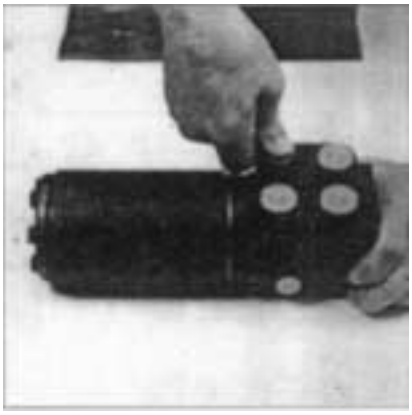


FIGURE 5-63 4992

33. Figure 5-64 shows the port identification for the steering unit.

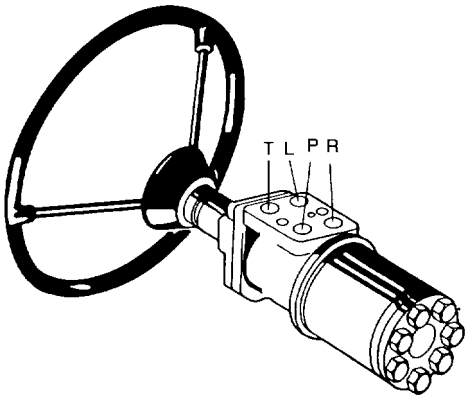


FIGURE 5-64 4993

L = Left pressure port
R = Right pressure port
T = Tank port
P = Pressure from pump

The following table shows the torque specifications for the hydraulic fittings used to install the steering unit.

Type of Screw Fitting	**Maximum Tightening Torque kg m (ft lb)**		
	1/4 RG 1/4 BSP.F R 1/4 G 1/4	1/2 RG 1/2 BSP.F R 1/2 G 1/2	7/16-20UNF
Cutting Edge	4 (29)	10 (72)	
Copper Washer	2 (15)	3 (22)	
Aluminum Washer	3 (22)	8 (58)	
O-ring			2 (15)

Priority Valve

Disassembly

1. The following tools are necessary to repair the priority valve. See Figure 5-65.

   Open end wrench – 27 mm
   Slip joint pliers
   Nylon rod
   Allen wrenches – 5 mm, 8 mm, 10 mm

FIGURE 5-65 4994

2. Use the open end wrench to loosen the PP plug. See Figure 5-66. Remove the O-ring.

FIGURE 5-66 4995

3. Use the open end wrench to loosen the LS plug. See Figure 5-67. Remove the O-ring.

FIGURE 5-67 4996

4. Remove the spring. See Figure 5-68.

FIGURE 5-68 4997

5. Use a nylon rod to push the spool out of the bore. See Figure 5-69.

FIGURE 5-69 4998

6. Use an 8 mm allen wrench to remove the plug from the pressure relief valve. See Figure 5-70.

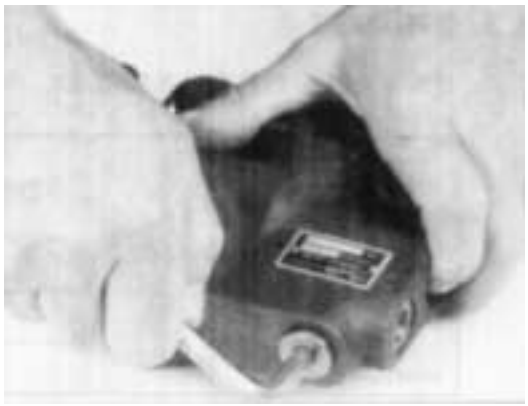


FIGURE 5-70 4999

7. Use a 10 mm allen wrench to unthread the pressure relief valve from its bore. See Figure 5-71.

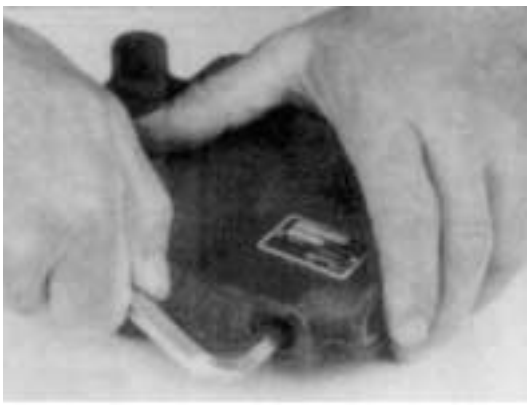


FIGURE 5-71 5000

8. Hold the pressure relief valve with a pliers and use a 5 mm allen wrench to remove the set screw. See Figure 5-72.

FIGURE 5-72 5001

9. The pressure relief valve is composed of a valve housing, valve needle, spring, and set screw. See Figure 5-73.

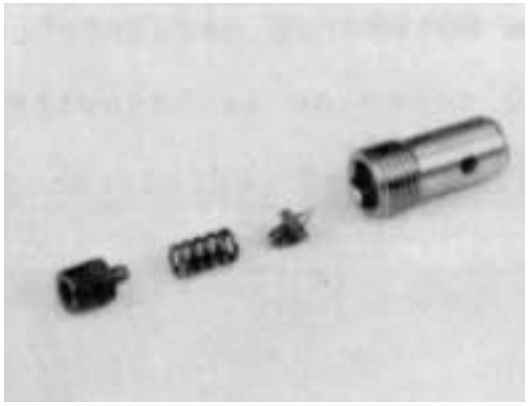


FIGURE 5-73 5002

10. Clean all parts with a nonflammable, nontoxic solvent.

    Carefully inspect all parts. Replace all worn or broken parts. Use only new O-rings to assemble the valve.

    Coat all parts with oil before assembling them.

Assembly

1. The relief valve pressure can be changed by changing springs. The following table displays the characteristics of the 3 springs available. See Figure 5-74.

Pressure in Bars	Wire Diameter (d)	Coil Inner Diameter (Di)	Spring Height (H)
4	2.5 mm (.0984")	12.5 mm (.492")	50
7	3.0 mm (.118")	12.5 mm (.492")	50
10	3.2 mm (.1259")	12.5 mm (.492")	50

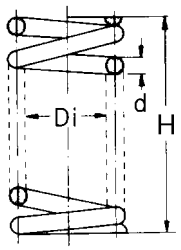


FIGURE 5-74 5003

2. Figure 5-75 shows the PP plug and the spool.

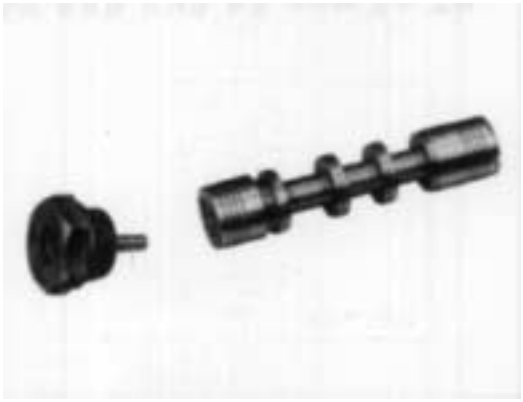


FIGURE 5-75 5004

3. Install the spool into the bore. See Figure 5-76. Use a nylon rod to position the spool in the neutral position.

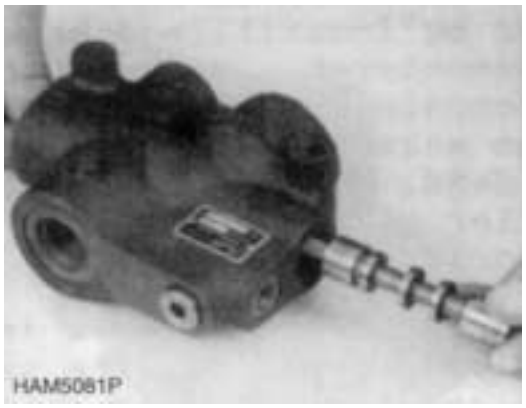


FIGURE 5-76 5005

4. Install the spring and the LS plug into the bore. See Figure 5-77. Use a new O-ring on the plug.

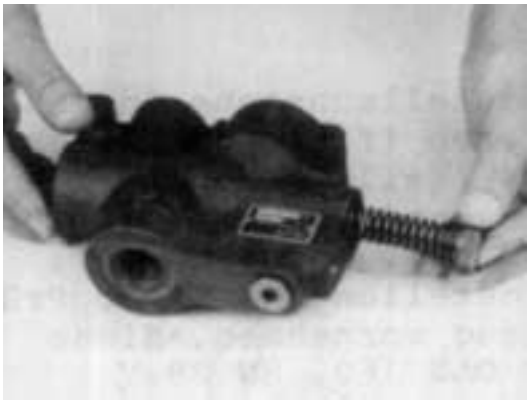


FIGURE 5-77 5006

5. Use the 27 mm wrench to tighten the PP plug and the LS plug to 6 kg m (44 ft lb). See Figure 5-78.

FIGURE 5-78 5007

6. Assemble the valve needle, spring, and set screw into the pressure relief valve housing. See Figure 5-73. Thread the pressure relief valve into the body of the priority valve and tighten it. See Figure 5-79.

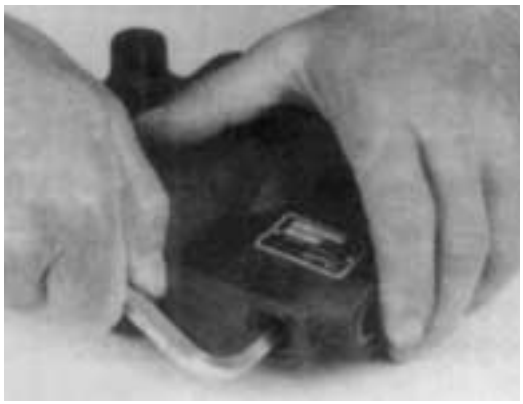


FIGURE 5-79 5008

7. Install the plug into the pressure relief valve bore. Tighten the plug to 5 kg m (36 ft lb). See Figure 5-80.

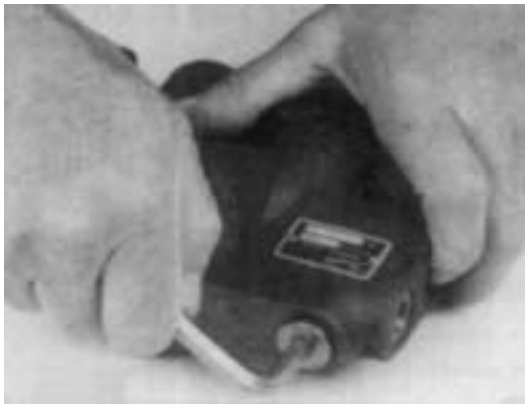


FIGURE 5-80 5009

Front and Rear Axles

Drive shafts transmit torque from the transmission to the front and rear axles. Figure 6-1 illustrates the major assemblies for the front axle. The front and rear axles each contain a self locking differential (2). Each end of each axle contains a planetary gear set (4) that further increases the torque that is delivered to the wheels. A multiple disc brake is installed in each axle end. The rear axle is connected to the axle support by a pin, and this allows a turning angle of 26 degrees. A disc-type parking brake (1) is mounted on the front axle.

1. Parking Brake
2. Differential
3. Axle Housing
4. Planetary Gear Set

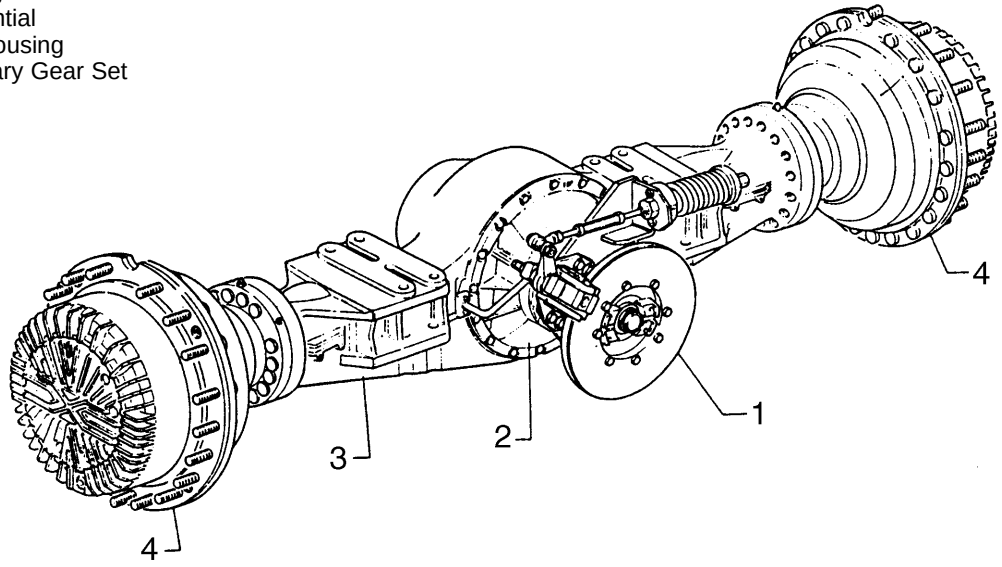


FIGURE 6-1

3741

Axle Troubleshooting

Problem	Possible Causes	Remedy
1. Leaking differential carrier	Damaged gasket or loose bolts on differential carrier	Replace gasket or tighten bolts
	Clogged breather vent	Clean breather or replace it
	Worn or damaged oil seal	Replace seal
2. Noise from differential gear	Worn or damaged gear	Replace gear
	Worn or damaged bearing	Replace bearing
	Backlash setting not correct	Reset backlash
	Damage to ring and pinion gear	Replace gears
	Gear oil level too low	Add oil to bring to proper level
3. Wheel hub oil leak	Loose bolts on planetary gear set housing	Tighten bolts
4. Noise from planetary gear case	Damaged wheel bearing	Replace damaged parts
	Worn or damaged ring and pinion gears	Replace damaged parts
	Worn or damaged differential needle bearing	Replace damaged parts
	Gear oil level too low	Add oil to bring to proper level
5. Wheel vibration	Loose lock nuts on inner gear flange	Tighten lock nuts
	Loose hub nuts	Tighten nuts
	Worn center pin bushing on frame	Replace worn parts
	Worn pin bushing on steering cylinder	Replace worn parts

Front Axle Housing

Figure 6-2 displays the front axle housing components.

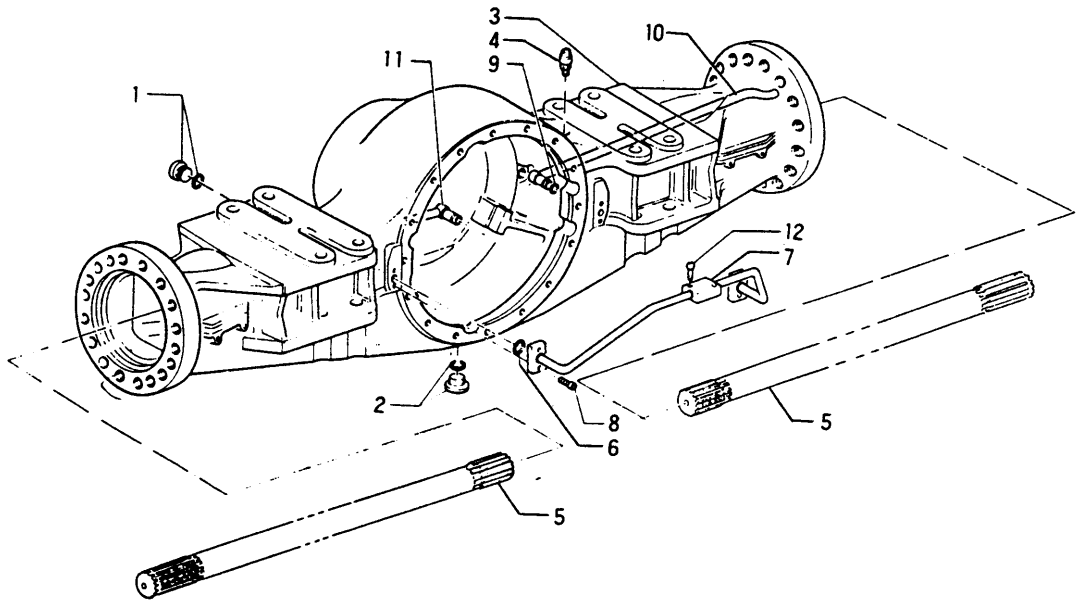


FIGURE 6-2

3742

Item No.	Description	Qty.
1	Oil Fill Plug	1
2	Oil Drain Plug	1
3	Front Axle Housing	1
4	Axle Vent	1
5	Axle Shaft	2
6	Tube Gasket	3
7	Oil Tube	1
8	Capscrew	4
9	Snap Ring	2
10	Oil Pipe, Right Side	1
11	Oil Pipe, Left Side	1
12	Capscrew	2

Axle Differential

Figure 6-3 contains an exploded view of the components that make up the front axle differential. The rear axle differential is the same.

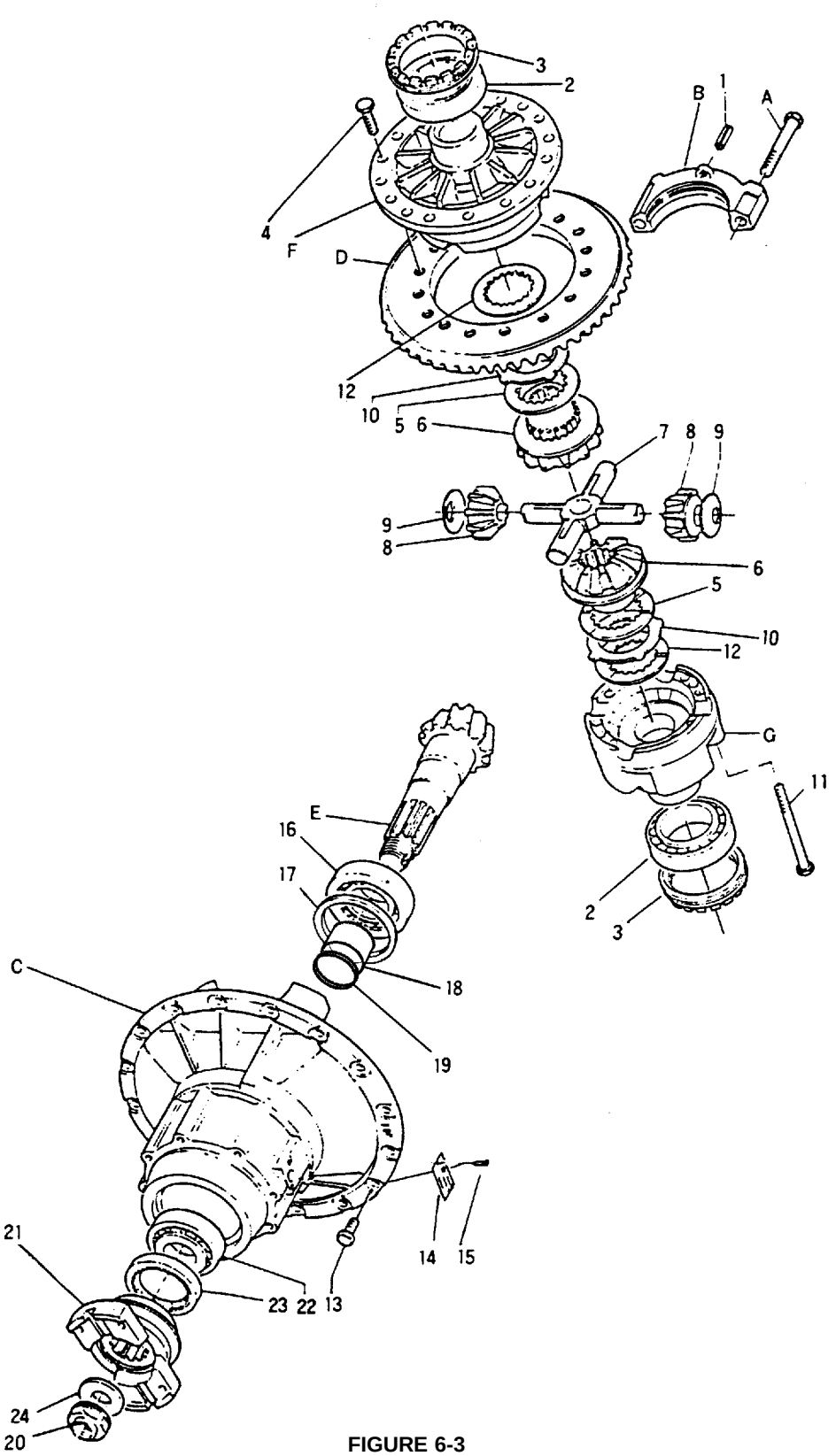


FIGURE 6-3

4923

Axle Differential (Continued)

Item No.	Description
1	Pin
2	Bearing
3	Bearing Adjusting Nut
4	Capscrew
5	Outer Clutch Disc
6	Sun Gear
7	Cross
8	Planetary Gear
9	Thrust Washer
10	Shim
11	Capscrew
12	Middle Clutch Disc
13	Capscrew
14	Plate

Item No.	Description
15	Rivet
16	Bearing
17	Shim
18	Spacer
19	Shim
20	Nut
21	Flange Assembly
22	Bearing
23	Seal
24	Washer
110	Differential Support Assembly
120	Ring and Pinion Gear Assembly
130	Differential Carrier Assembly
140	Spacer Assembly

Differential Cross Section

Figure 6-4 contains a cross-section view of the parts contained in the self-locking differential.

1. Ring Gear
2. Bevel Pinion
3. Cross
4. Upper Thrust Ring
5. Outer Disc
6. Inner Disc
7. Cover
8. Clutch Disc
9. Sun Gear
10. Lower Thrust Ring

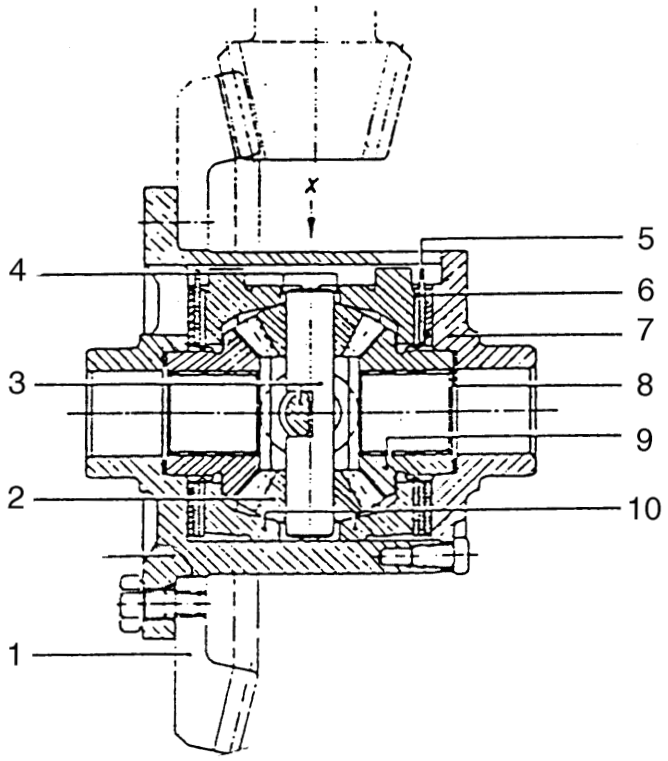


FIGURE 6-4

3744

Planetary Gear Set

Figure 6-5 contains an exploded view drawing of one front axle planetary gear set. The parts quantity shown is the number of parts present in two planetary gear sets (one front axle). The parts for the planetary gear sets in the rear axle are the same.

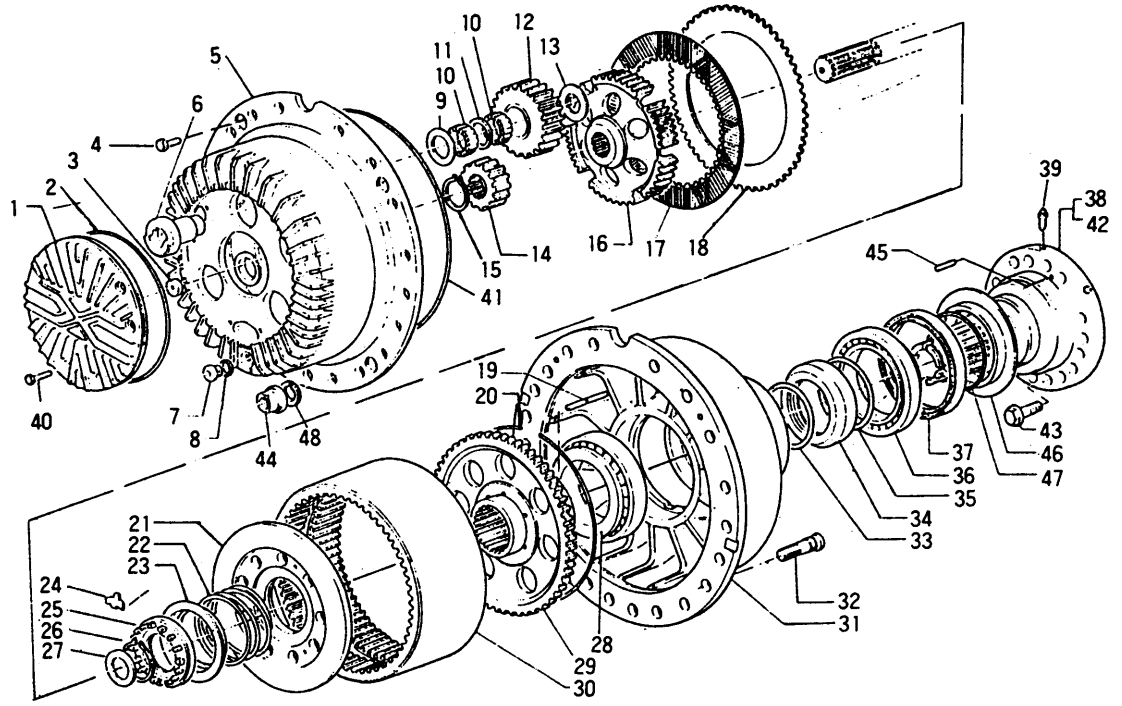


FIGURE 6-5

4924

Planetary Gear Set (Continued)

Item No.	Description	Qty.
1	Housing Cover	2
2	Cover Gasket	2
3	Shaft Thrust Plate	2
4	Capscrew	8
5	Planetary Housing	2
6	Pin	6
7	Plug	2
8	Plug Gasket	2
9	Thrust Washer	6
10	Bearing	6
11	Bearing Spacer	6
12	Differential Pinion Gear	6
13	Thrust Washer	6
14	Differential Side Gear	2
15	Snap Ring	2
16	Brake Disc Hub	2
17	Brake Disc	10
18	Steel Disc	10
19	Pin	12
20	Snap Ring	2
21	Pressure Plate	2
22	Spring	2
23	Spring Insert	2
24	Lockplate	4
25	Hub Nut	2
26	Snap Ring	2

Item No.	Description	Qty.
27	Thrust Washer	2
28	Bearing	2
29	Ring Gear Support	2
30	Ring Gear	2
31	Wheel Hub	2
32	Stud Bolt	38
33	Piston Seal	2
34	Piston	2
35	Piston Seal	2
36	Inner Bearing	2
37	Wheel Seal	2
38	Right Side Hub and Spindle Assy.	1
39	Bleeder Screw	2
40	Capscrew	12
41	Housing Seal Ring	2
42	Left Side Hub and Spindle Assy.	1
43	Capscrew	32
44	Nut	38
45	Pin	2
46	Ring	2
47	Seal Ring	2
48	Washer	38
110	Housing Assembly	2

Parking Brake

A disc type parking brake is attached to the input shaft on the front axle. See Figure 6-6. This brake is spring applied and hydraulically released. When the parking brake switch in the operator's cab is moved to the brake release position, the parking brake solenoid valve opens and directs fluid from the brake pump to the brake cylinder (18). Maximum parking brake hydraulic pressure is 100 bar. The brake cylinder retracts the brake set spring (22), and releases the brake.

If the electrical supply to the parking brake solenoid valve is interrupted, or if the engine is shut off, the parking brake is automatically applied.

As a safety feature, the transmission forward/ reverse gear selector must be in the neutral position and the parking brake switch must be in the ON position, in order to start the engine.

When the parking brake switch is on, a warning light glows. If either forward or reverse is selected on the transmission while the parking brake switch is on, a buzzer will sound.

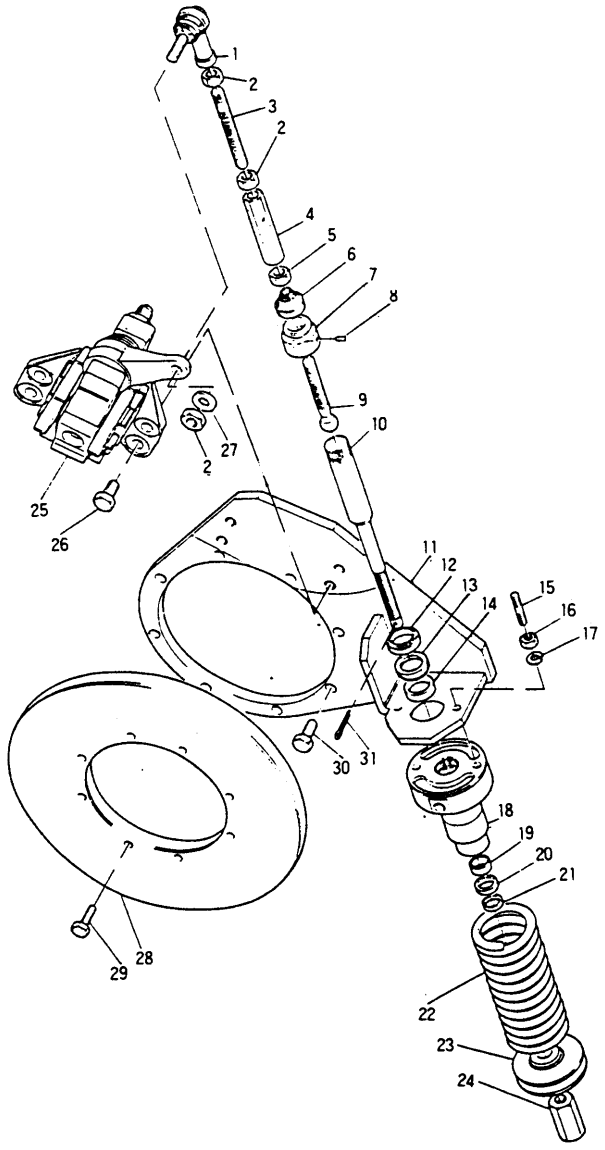


FIGURE 6-6

4926

Parking Brake (Continued)

Item No.	Description	Qty.
1	Ball Socket	1
2	Lock Nut	3
3	Adjusting Rod	1
4	Adjusting Sleeve	1
5	Lock Nut	1
6	Protective Cap	1
7	Joint Cover	1
8	Dowel Pin	1
9	Tension Rod	1
10	Stem	1
11	Mounting Plate Assy.	1
12	Seal	1
13	Gasket	1
14	Guide Ring	1
15	Threaded Stud	2
16	Nut	2

Item No.	Description	Qty.
17	Washer	2
18	Cylinder Body	1
19	Guide Ring	1
20	Gasket	1
21	Seal	1
22	Spring	1
23	Flange	1
24	Nut	1
25	Caliper Assy.	1
26	Capscrew	1
27	Washer	1
28	Brake Disc	1
29	Capscrew	8
30	Capscrew	8
31	Cotter Pin	1

Rear Axle

Figure 6-7 displays the major assemblies for the rear axle.

1. Differential
2. Axle Housing
3. Planetary Gear Sets

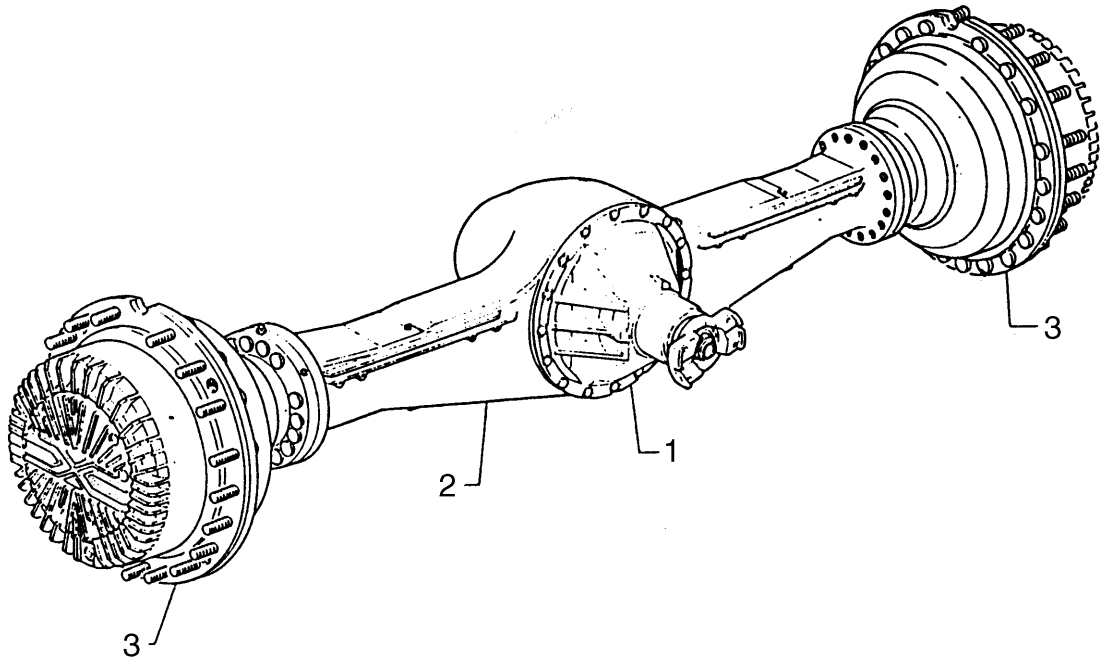


FIGURE 6-7

3747

Rear Axle Housing

Figure 6-8 displays the rear axle housing components.

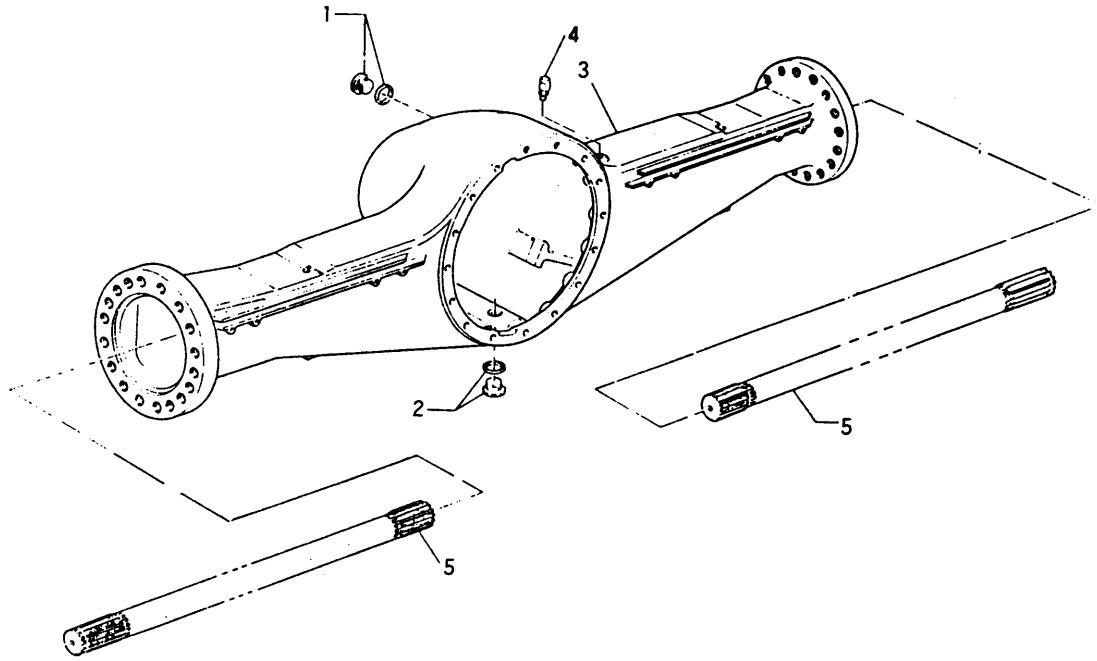


FIGURE 6-8

3748

Item No.	Description	Qty.
1	Oil Fill Plug	1
2	Oil Drain Plug	1
3	Rear Axle Housing	1
4	Axle Vent	1
5	Axle Shaft	2

Brake System

Wheel Brake Hydraulic Circuit

Multiple wet disc brakes for stopping vehicle movement are contained in the axle-end planetary gear sets. A brake pump supplies pressurized fluid to the brake hydraulic system. Force on the brake pedal moves 2 spools in the brake valve (5, Figure 6-9). The spools are proportional. The farther the brake pedal is pushed, the greater the amount of fluid that passes through each spool. One spool ports fluid to brake pistons in the front axle (3). The other spool ports fluid to brake pistons in the rear axle (1). Pressure on the brake pistons applies pressure to the brake discs, and this stops axle shaft and wheel rotation.

The brake hydraulic system also contains 5 accumulators (8, Figure 6-9). The accumulators hold a volume of pressurized fluid large enough to allow the brakes to be applied 9 times with full pressure, after the engine has been turned off.

The brake hydraulic system includes a pressure operated transmission cut-off switch (2). Pressing the brake pedal will open cut-off switch (2). When the transmission cut-off switch in the operator's cab is selected, this will cut off current to a solenoid operated hydraulic valve in the transmission. This prevents operation of the forward clutch in the transmission. This prevents the transmission from driving the wheels forward when the brake pedal is pressed.

1. Rear Axle
2. Transmission Cut-off Switch
3. Front Axle
4. Brake
5. Brake Pedal
6. Brake Pedal Switch
7. Parking Brake
8. Accumulators
9. Brake Valve
10. Pump
11. Pilot Cut-off Line
12. Safety Valve
13. Low Pressure Warning Switch
14. Parking Brake Valve

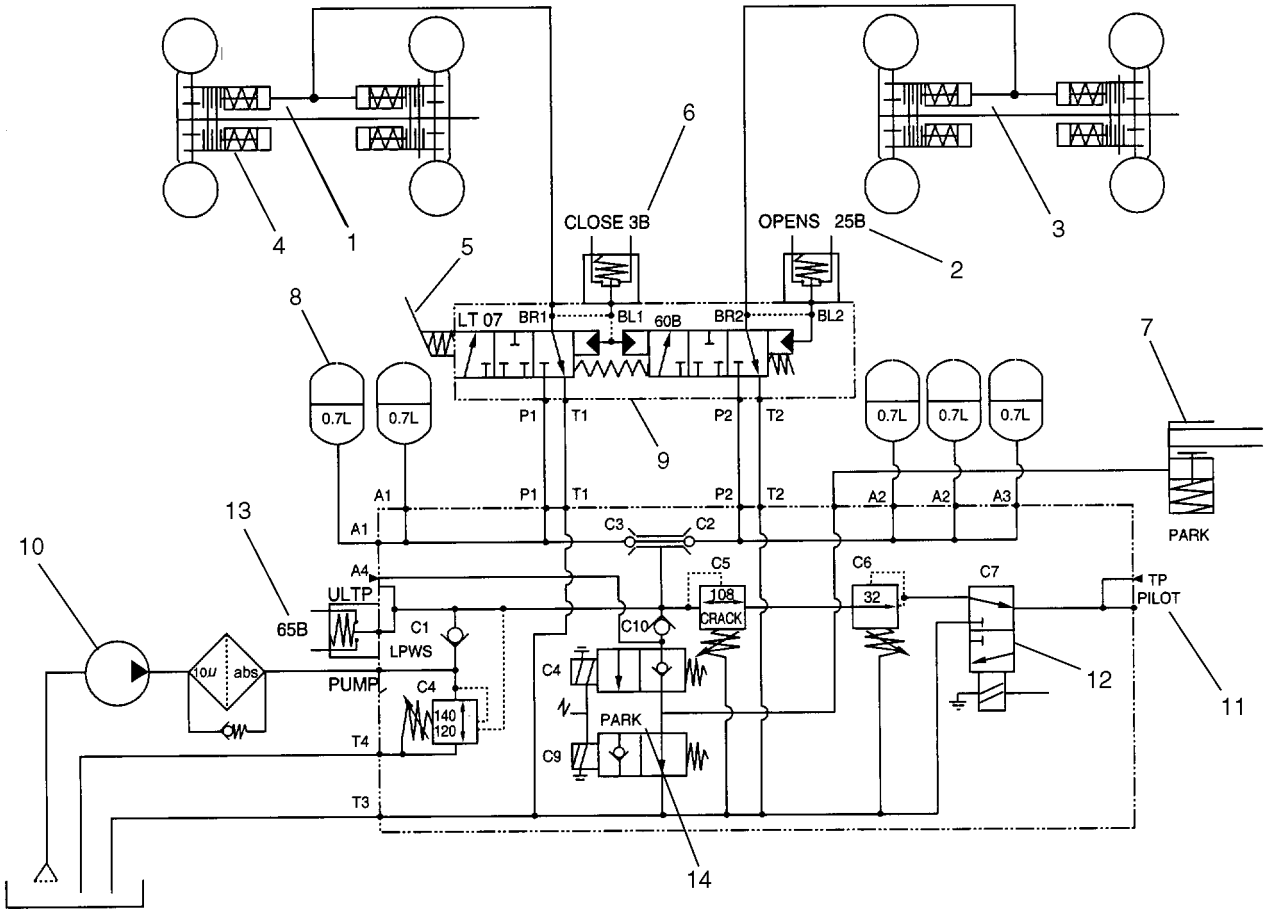


FIGURE 6-9

4925

Brake Pedal Valve

The brake pedal valve is attached to, and operated by, the brake pedal. See Figure 6-10. The valve contains two spools. See Figure 6-11. One spool ports fluid to the brake pistons in the front axle, and the other spool ports fluid to the brake pistons in the rear axle. Maximum system operating pressure is 60 ± 3 bars. If something in one of the circuits should fail, the other circuit will continue to operate.

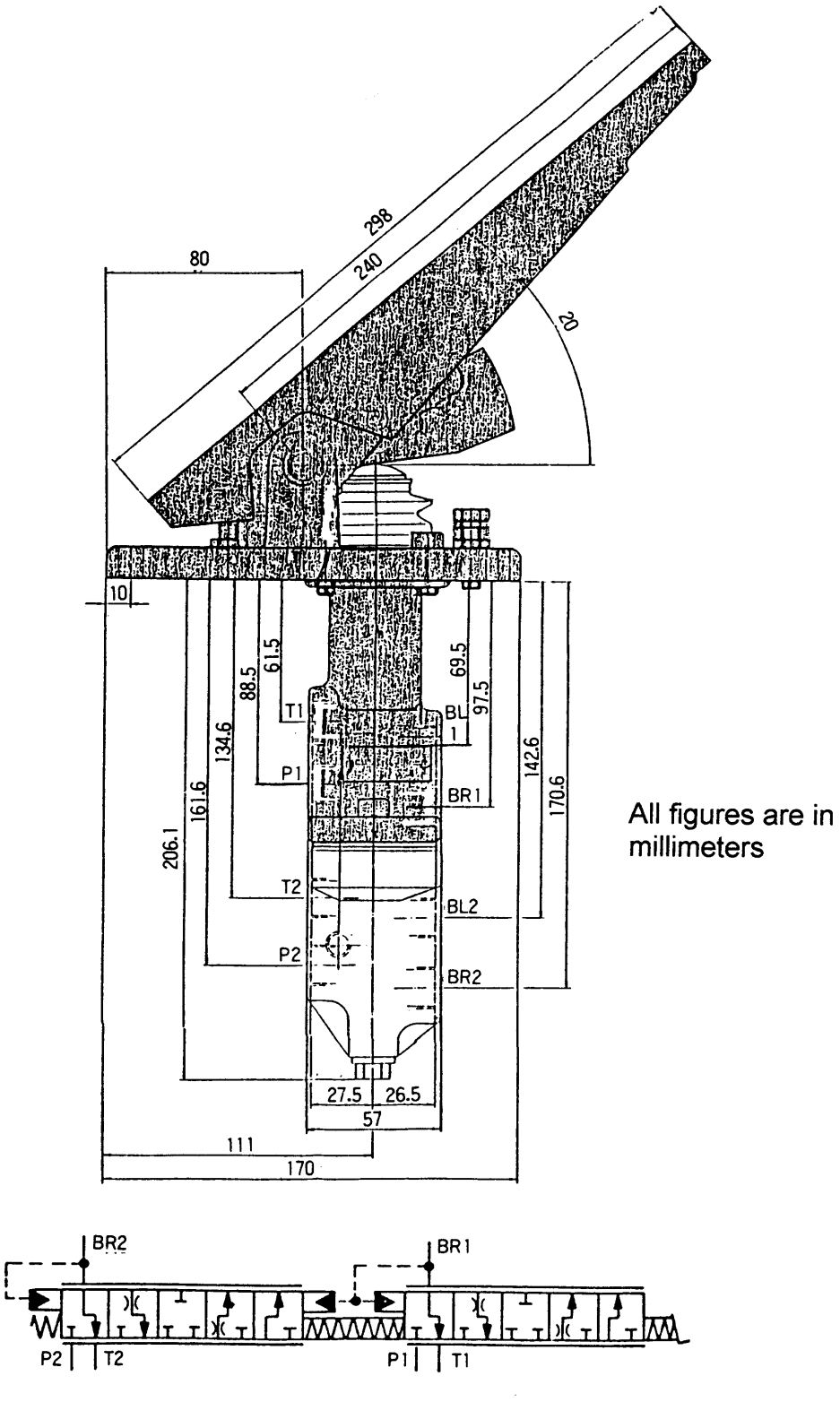


FIGURE 6-10

3752

When the brake pedal is depressed, force is applied to the working element (6, Figure 6-11). This force is transferred to the primary control spool (3) and the secondary control spool (4) by the main control spring (5). This causes the control spool lands to close the path from the supply ports (P1 and P2) to the tank ports (T1 and T2). Simultaneously, the spools then open a path from the brake circuit ports (Br1 and Br2) to the supply ports (P1 and P2). Drilled passages in the control spools (3 and 4) allow fluid pressure in ports P1 and P2 to act against the main control spring (5). This allows the brake pressure in both circuits to rise proportionally to the force applied to the brake pedal.

As the force applied to the brake pedal becomes constant, the control spools (3 and 4) move into a balanced position and hold the braking pressure constant.

When force is removed from the brake pedal, this removes force from the control spring. The return springs (7 and 8) now move the control spools (3 and 4) to the right. The spools open a path from the brake circuit ports (Br1 and Br2) to the tank ports (T1 and T2) and this releases the pressure from the brake circuits.

1. Primary Housing
2. Secondary Housing
3. Primary Control Spool
4. Secondary Control Spool
5. Main Control Spring
6. Working Element
7. Primary Return Spring
8. Secondary Return Spring
9. Pilot Passages

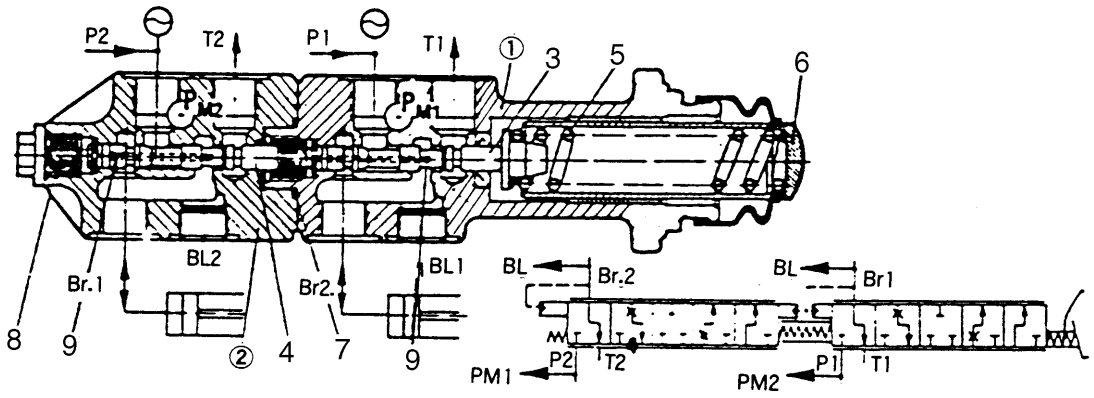


FIGURE 6-11

3753

Brake Disc and Piston Assembly

The brake discs and piston for the wheel brakes are contained in the housing for the axle end planetary gear sets. See Figure 6-12.

1. Axle Housing
2. Axle Shaft
3. Hub
4. Hub Bolt
5. Ring Gear
6. Brake Piston
7. Outer Brake Disc
8. Inner Brake Disc
9. Inner Brake Disc Carrier
10. Planet Gear Pin
11. Sun Gear
12. Planet Gear Carrier
13. Spring
14. Hub Bearing
15. Brake Piston Seal Ring
16. Brake Piston Seal Ring
17. Hub Bearing
18. Planet Gear

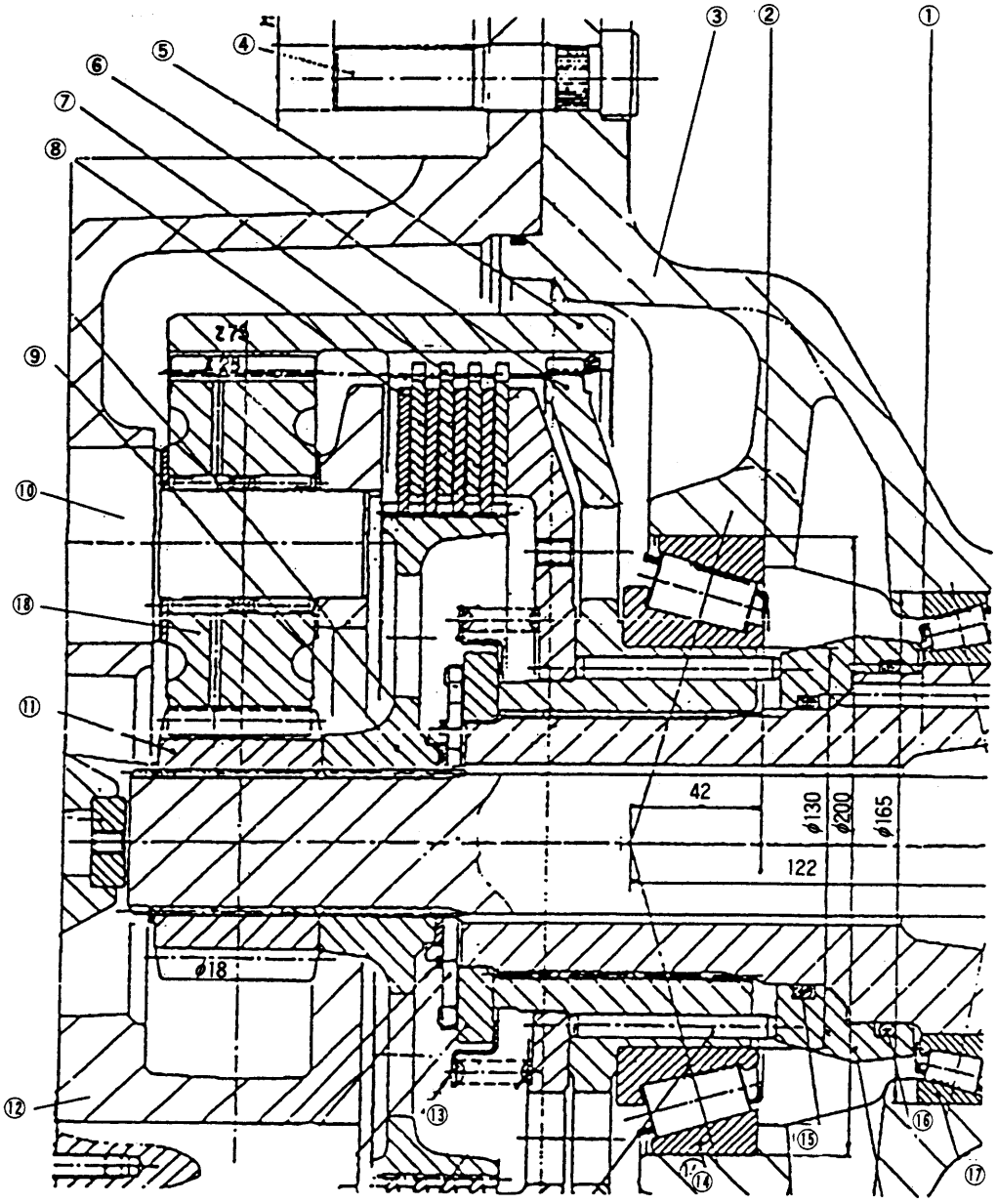


FIGURE 6-12

3754

Brake System Pressure Checks

1. Attach a gauge to the ULTP Port (2, Figure 6-13) (brake pump pressure check port) of the brake supply valve.
2. With the gauge installed, measure pressure as soon as the engine starts. This will ensure that the pressure is measured at maximum engine RPM. At maximum engine RPM, the pressure should rise to 140 bar until the unloading cartridge (C4) unloads pressure. Pressure should now fall to 0.
3. If no pressure is measured in Step 2, disassemble and clean C4, the unloading valve. If C4 operates normally, check valves C6, C7, C8, and C9.

Brake Disc Pressure Check

When the brake pedal is pressed down, maximum pressure applied to the brake discs in the axle is 60 bar. To check pressure output from the brake pedal valve, remove the pressure switch from the valve. Install a gauge in the switch port. Operate the brake pedal and check the pressure displayed on the gauge.

Pilot Line Pressure Check

The pump section that provides oil for the brake system also provides oil for the pilot valves. The pilot valves direct this oil to the bucket, boom, and option valves. The oil supply for the pilot valves passes through the brake supply valve. The brake supply valve controls the supply pressure of this oil. To check the pressure of the oil being supplied to the pilot valves, perform the following steps.

1. Install a pressure gauge into the TP Port (3, Figure 6-13) of the brake supply valve.
2. With the gauge installed, measure pressure as soon as the engine starts. This will ensure that the pressure is measured at maximum engine RPM. At maximum engine RPM, the pressure should be 30 bar.
3. If pressure is low or nonexistent, disassemble and clean valves C6 and C7.

Accumulator Check

Run the engine long enough to fill the brake system accumulators. Then turn off the engine. Apply the brakes with the engine turned off. There should be enough pressure in the accumulators to apply the brakes for both the front and rear axles. If the accumulators do not hold enough pressure to apply the brakes, the accumulators can be removed and inspected.

Before starting to work on accumulator removal, all pressure must be exhausted from the oil side of the accumulators. Maximum accumulator oil pressure is 140 bar.

⚠WARNING!!!

If oil fittings on an accumulator are loosened before accumulator pressure has been exhausted, hot pressurized oil could be sprayed into the eyes, face, or skin of the person working on the accumulator.

To exhaust the pressure, first turn the engine off. Then press the brake pedal at least 9 times. Or turn the parking brake switch on and off for at least 9 cycles. When all oil pressure has been exhausted, it is safe to start accumulator removal.

1. Pilot Port
2. ULTP Port
3. TP Port
4. Pump Port
5. Safety Valve

BRAKE SUPPLY VALVE

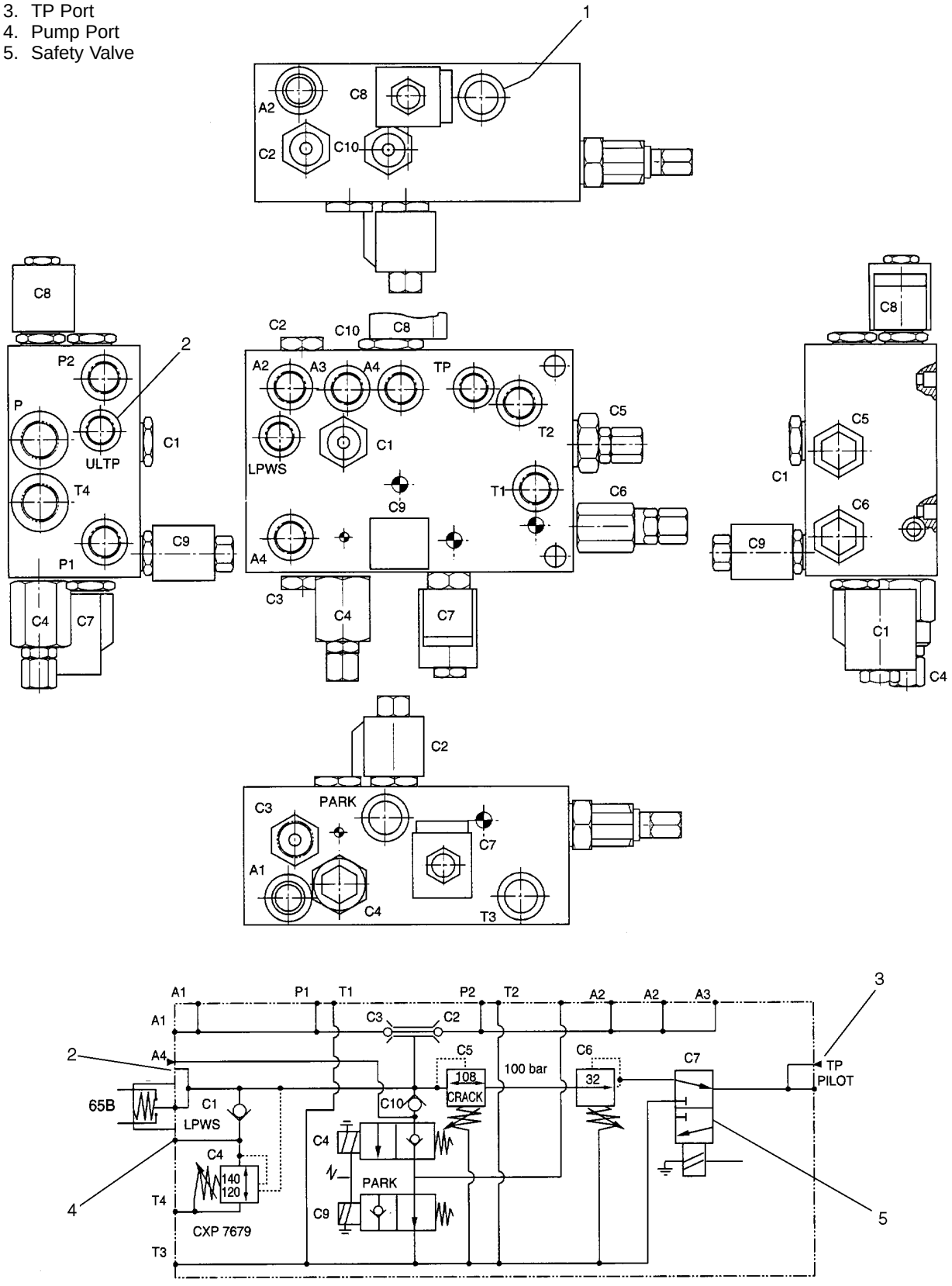


FIGURE 6-13

4928

HYDRAULIC SYSTEM

Hydraulic Circuits Description

The hydraulic system contains a pump that is made up of three vane type pumping sections. Pump section (1, Figure 7-1) supplies the boom and bucket cylinders, pump section (2) supplies the steering cylinders, and pump section (3) supplies pilot flow. Priority valve (4) and unloading valve (5) act together to form a two stage hydraulic circuit. When the steering system is not being used for steering, output from pump (2) is available to the boom and bucket circuit for faster cycle times with light loads. When pressure in the boom and bucket circuit is high, the unloading valve (5) directs any excess steering pump (2) output to tank (6). Fluid returning to tank passes through the oil cooler (7) or passes through the cooler bypass valve (8, Figure 7-1) if the cooler is clogged. Fluid returning to tank passes through a return filter (9) in the hydraulic tank.

The steering circuit contains a priority valve (4) that senses pressure in the steering cylinders and meters oil volume proportional to the load being sensed.

The pilot pump (3) supplies pump flow to the boom and bucket controls. Pilot pump flow passes through the pilot filter (10) and the pilot control valves (11,12,13 and 14).

Hydraulic Schematic

A schematic for the entire hydraulic system is included at the end of Section 7. See Figure 7-116.

1. Boom and Bucket Pump
2. Steering Pump
3. Pilot Pump
4. Priority Valve
5. Unloading Valve
6. Hydraulic Tank
7. Oil Cooler
8. Cooler Bypass Valve
9. Return Filter
10. Pilot Filter
11. Pilot Relief Valve
12. Regulator Valve
13. Pressure Relief Valve
14. Safety Cutoff Valve
15. Breather Cap
16. Filter Bypass Valve
17. Boom Cylinder
18. Bucket Cylinder
19. Boom Kick-out Proximity Switch
20. Bucket Dump-stop Switch
21. Control Valve
22. Main Relief Valve
23. Option Spool
24. Boom Spool
25. Bucket Spool
26. Cavitation Valve
27. Recycle Valve
28. Overload Relief Valve
29. Check Valve
30. Bucket Return-to-dig Proximity Switch
31. Boom Float Proximity Switch
32. Dump Stop Valve
33. Option Valve
34. Option Valve
35. Pilot Control Valve
36. Control Lever
37. Option Switch
38. Bucket Dump Valve
39. Bucket Crowd Valve
40. Boom Raise Valve
41. Slow Float Valve
42. Bucket Rollback Solenoid

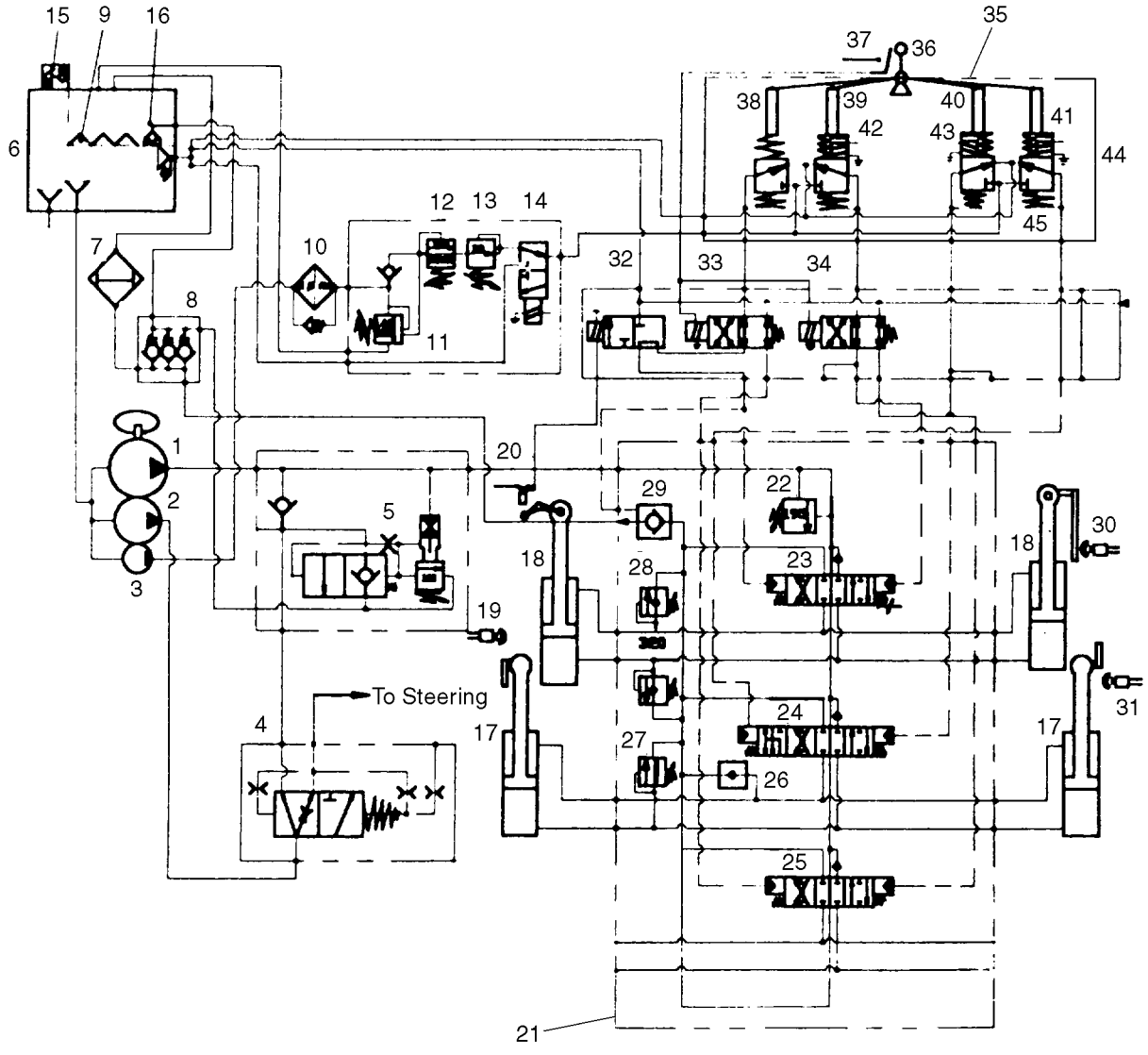


FIGURE 7-1

5010

Hydraulic Pump

The hydraulic pump contains three vane type pumping sections. See Figure 7-2. The first pumping section supplies fluid for the boom and bucket cylinders. Pumping volume for the first section is 81.5 cc per revolution. The second pumping section supplies fluid for the steering cylinders and has a pumping volume of 67.5 cc per revolution. The third pumping section supplies fluid for pilot flow and has a volume of 18 cc per revolution. The pump is driven by a shaft that is driven by the torque converter.

1. Boom/Bucket Pumping Section
2. Steering Pumping Section
3. Pilot/Brake Pumping Section

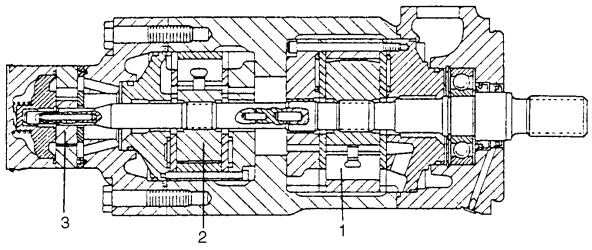


FIGURE 7-2

4034

The construction and operation of pumping sections one and two are the same. As the vane (4, Figure 7-3) rotates from position E to position A, the area between the vanes increases due to the shape of the cam ring. This creates a vacuum. The vacuum draws fluid from the tank, through the pump inlet (8) and into the space between the vanes. As the vanes rotate between position A and position B, the area between the vanes decreases due to the shape of the cam ring (1). This pressurizes the fluid between the vanes as it is forced out the pump discharge outlet (3). The pumping section has two inlets (5 and 8) and two outlets (3 and 10).

1. Cam Ring
2. Rotor
3. Outlet
4. Vane
5. Inlet
6. Slot
7. Passage
8. Inlet
9. Insert
10. Outlet

A-F Positions of Vanes

■ Pump Discharge Oil

□ Pump Inlet Oil

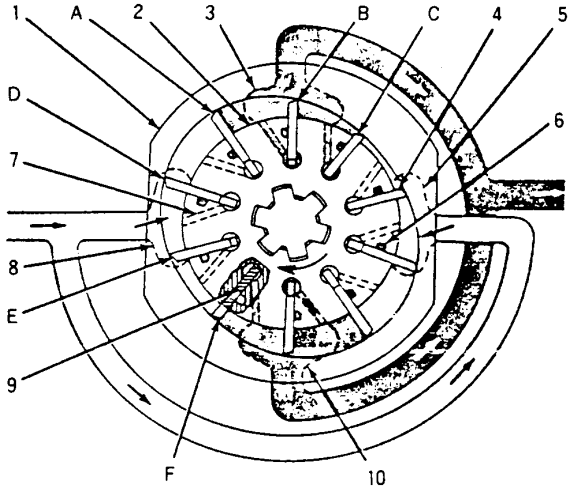


FIGURE 7-3

4035

Pressurized oil flows into the passages (7, Figure 7-3) on the rotor (2) and is directed into the slots (6) behind the vanes (4). This allows fluid to build up between the insert (9) and the vane (4). This forces the vanes (4) up against the cam ring (1) to create a tight seal between the cam ring and vane.

Pilot Pump

The construction of the pilot pump section is the same as pump sections one and two, except that there are no inserts (9, Figure 7-3) in the pilot pump. In the pilot pump, pressurized fluid is directed between the rotor (1, Figure 7-4) and the vane (8).

1. Rotor
2. Cam Ring
3. Outlet
4. Passage
5. Inlet
6. Inlet
7. Outlet
8. Vanes

A-G Positions of Vanes

■ Pump Discharge Oil

□ Pump Inlet Oil

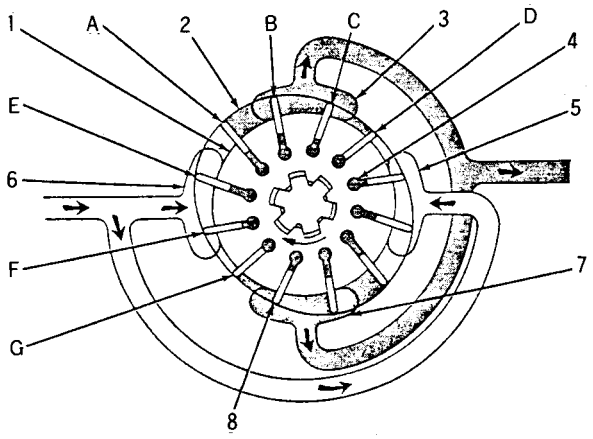


FIGURE 7-4 4036

Pump Removal

1. Match mark the hoses and lines so that they can be returned to their original positions at the time of assembly.
2. Disconnect hoses (1, Figure 7-5), (2), and (3) from the pump.

1. Inlet Hose
2. Outlet Hose
3. Hose

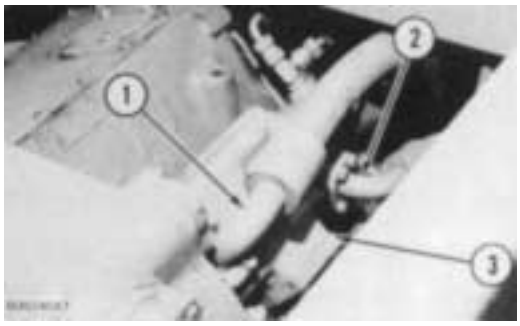


FIGURE 7-5 4037

3. Disconnect hose (4, Figure 7-6) from the pilot pump section.

4. Pilot Pump Hoses

FIGURE 7-6 4038

4. Support the pump (5, Figure 7-7) with a hoist. Remove the bolts (6) that hold the pump in place. Remove the pump.

5. Pump
6. Bolts

FIGURE 7-7 4039

Pump Disassembly

1. Remove the O-ring (1, Figure 7-8) from the pump body.

1. O-ring

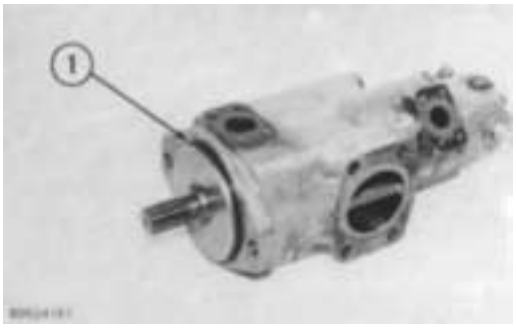


FIGURE 7-8 4040

2. Match mark the pilot pump body (3, Figure 7-9). Remove the bolts (2) that retain the pump body (3). Remove the pump body (3).

2. Bolts
3. Pump Body

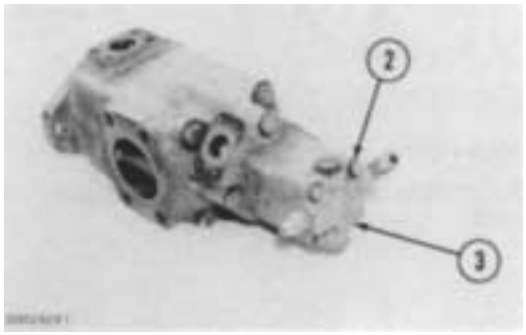


FIGURE 7-9 4041

3. Remove the plug, spring (5, Figure 7-10), and valve (4).

4. Valve
5. Spring

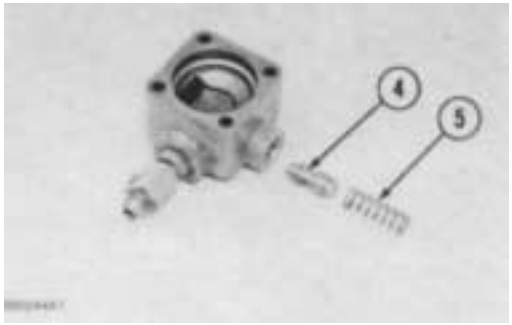


FIGURE 7-10 4042

4. Remove the rings (7, Figure 7-11), poppet (8), and spring (6).

6. Spring
7. Rings
8. Poppet

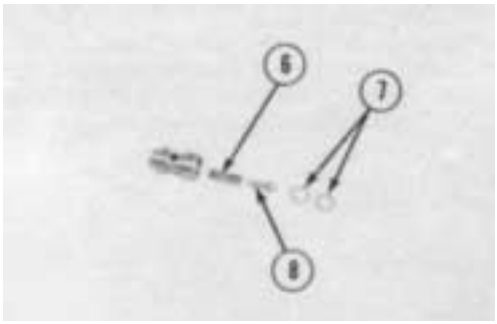


FIGURE 7-11 4043

5. Remove the spring (11, Figure 7-12), plate (10), and O-ring seal (9).

9. O-ring Seal
10. Plate
11. Spring

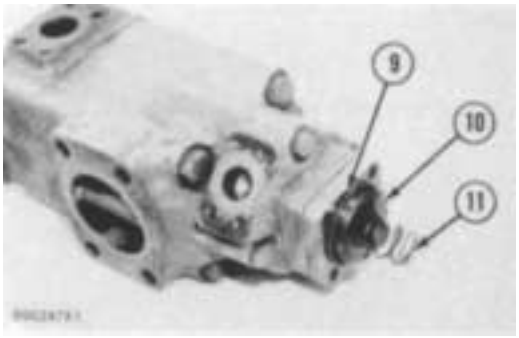


FIGURE 7-12 4044

6. Remove the cam ring (12, Figure 7-13).

12. Cam Ring

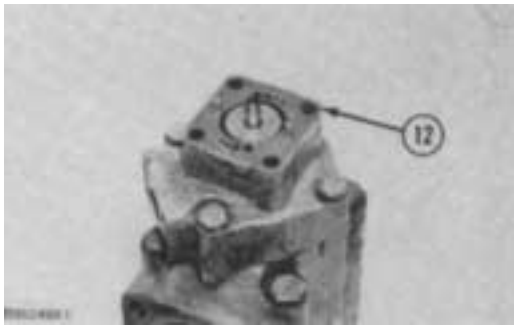


FIGURE 7-13 4045

7. To prevent the vanes from falling out of their slots, wind a rubber band around the rotor assembly (13, Figure 7-14). Remove the rotor assembly. Use a piece of paper to mark down the position of each vane before removing the vanes from the rotor. This will help return each vane to the slot that it was removed from. Remove the vanes from the rotor.

13. Rotor Assembly

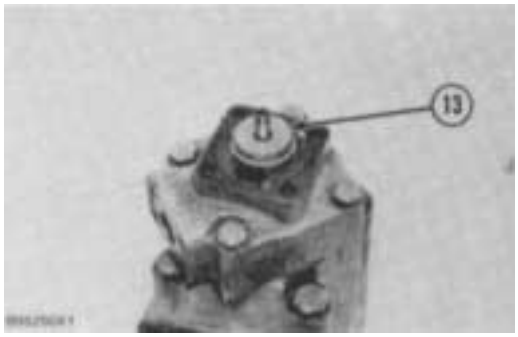


FIGURE 7-14 4046

8. Remove the O-ring seal (15, Figure 7-15) from the adapter (14). Remove the adapter (14).

14. Adapter
15. O-ring Seal

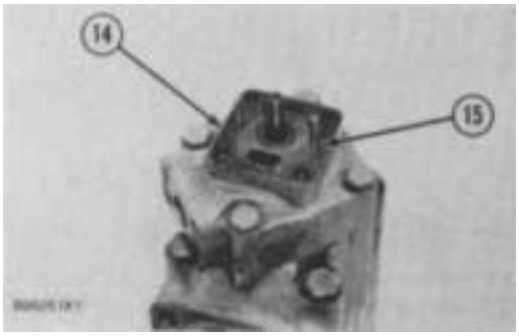


FIGURE 7-15

4047

9. Remove the O-ring seal (17, Figure 7-16) and pins (16).

16. Pin
17. O-ring Seal

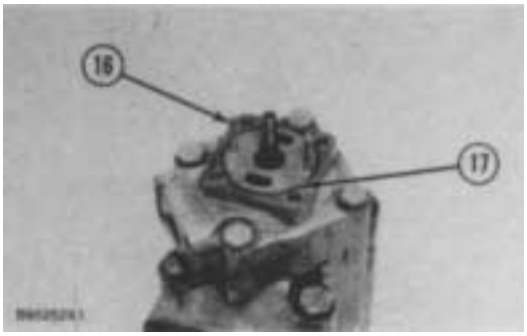


FIGURE 7-16

4048

10. Remove the bolts (19, Figure 7-17) and remove the pump cover (18).

18. Pump Cover
19. Bolts

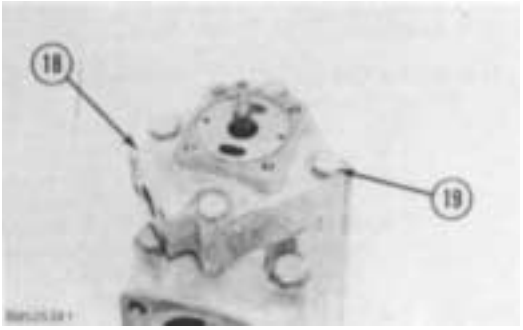


FIGURE 7-17

4049

11. Remove the O-ring seal (22, Figure 7-18) and seal rings (20) and (21).

20. Seal Ring
21. Seal Ring
22. O-ring Seal

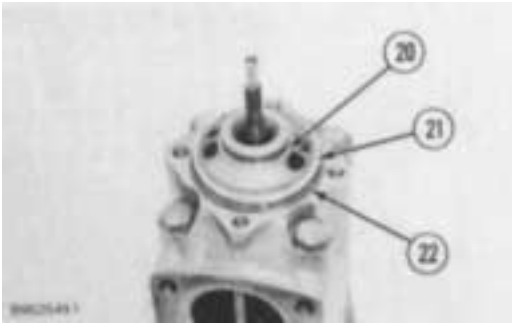


FIGURE 7-18

4050

12. Remove the pump cartridge. See Figure 7-19. Match mark the major cartridge assemblies so that they can be returned to their original positions during assembly.

    Remove the bolts (24, Figure 7-19) that retain the pressure plate (23). Remove the pressure plate.

23. Pressure Plate
24. Bolts

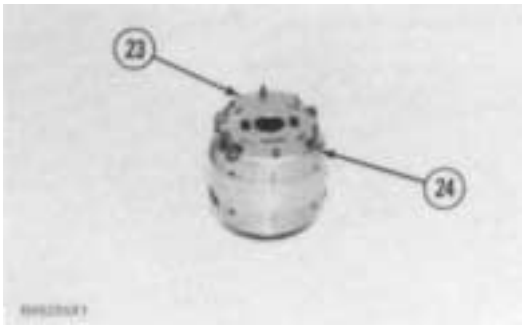


FIGURE 7-19 4051

13. Remove the seal (25, Figure 7-20) from the pressure plate.

25. Seal

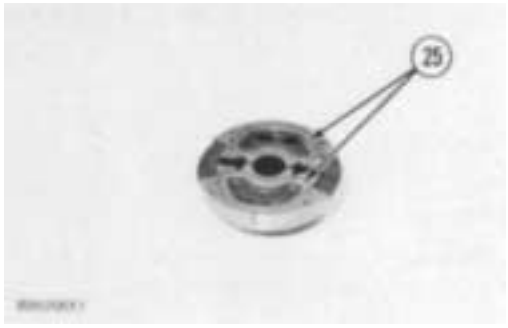


FIGURE 7-20 4052

14. Remove the wear plate (26, Figure 7-21). Remove the cam ring (28).

26. Wear Plate
28. Cam Ring

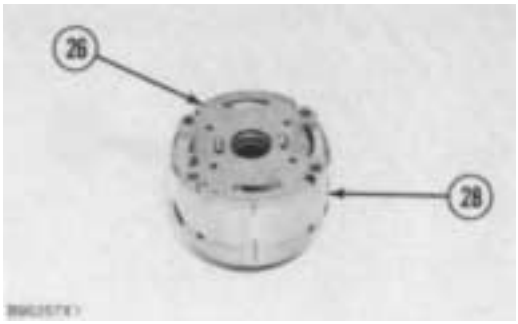


FIGURE 7-21 4053

15. Wind a rubber band around the rotor to prevent the vanes from falling out of their slots. Remove the rotor from the wear plate. Mark down the slot that each vane was removed from. During assembly, this will make it possible to return each vane to the slot that it was removed from. Remove the vanes from the rotor.
16. Remove the wear plate (29, Figure 7-22). Remove the seal from the pressure plate (30).

29. Wear Plate
30. Pressure Plate

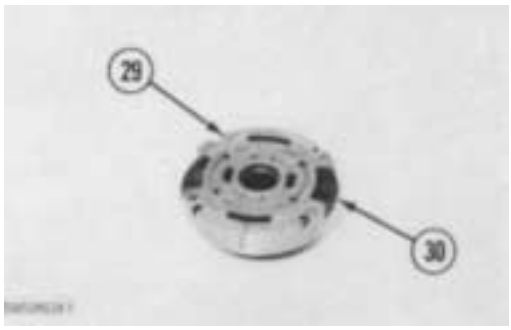


FIGURE 7-22 4054

17. Remove the bolts (31, Figure 7-23) that secure the second pump section to the third pump section.

31. Bolts

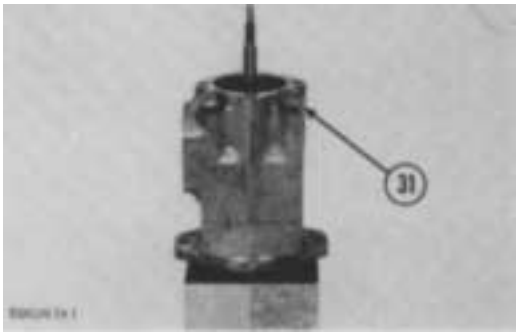


FIGURE 7-23 4055

18. Remove the body and shaft assembly (32, Figure 7-24).

32. Body and Shaft Assy.

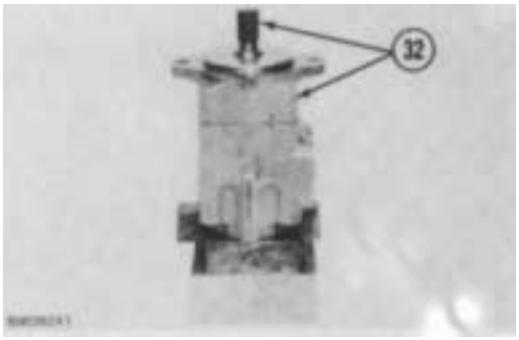


FIGURE 7-24 4056

19. Remove the O-ring seal (33, Figure 7-25) from the pump body.

33. O-ring Seal

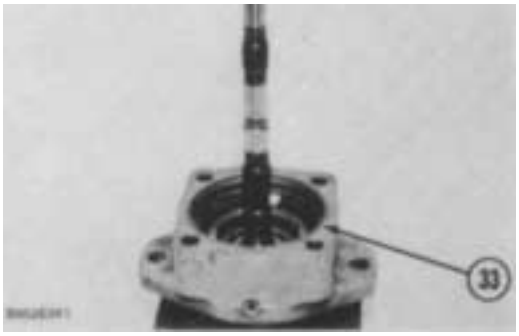


FIGURE 7-25 4057

20. Remove the spiral retainer ring (34, Figure 7-26) from the pump body. Remove the shaft and bearing assembly from the body.

34. Retainer Ring

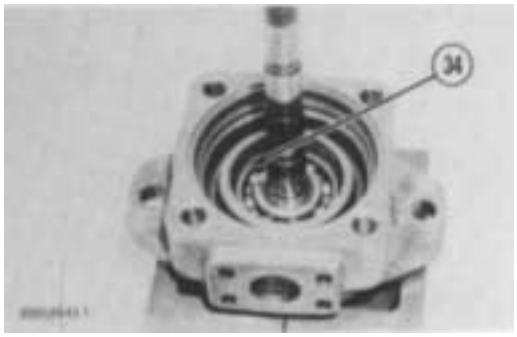


FIGURE 7-26 4058

21. Use a snap ring pliers to remove the bearing retainer ring (35, Figure 7-27) from the shaft.

35. Bearing Retainer Ring

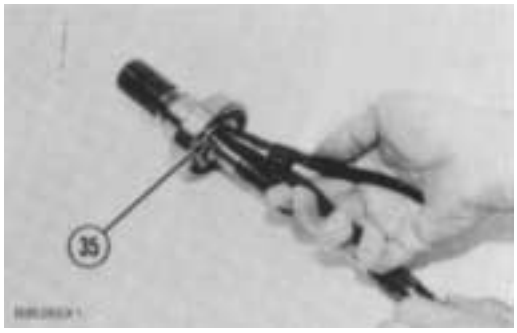


FIGURE 7-27 4059

22. Press the shaft out of the bearing. See Figure 7-28.

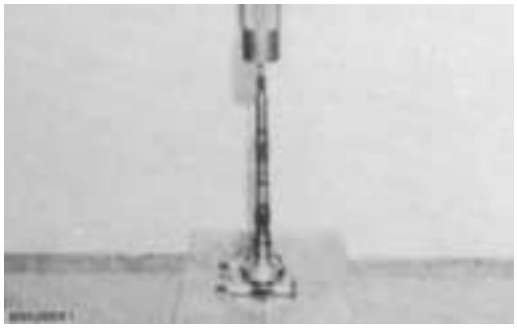


FIGURE 7-28 4060

23. Remove the spacer (36, Figure 7-29) from the pump body.

36. Spacer

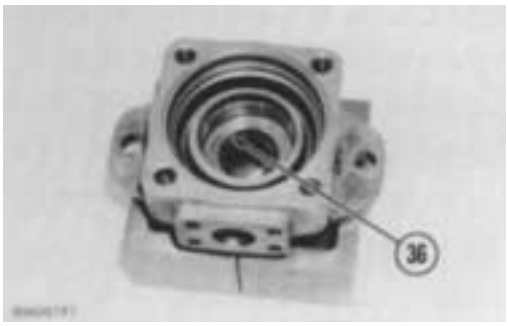


FIGURE 7-29 4061

24. Remove the shaft seal (37, Figure 7-30) from the pump body.

37. Shaft Seal

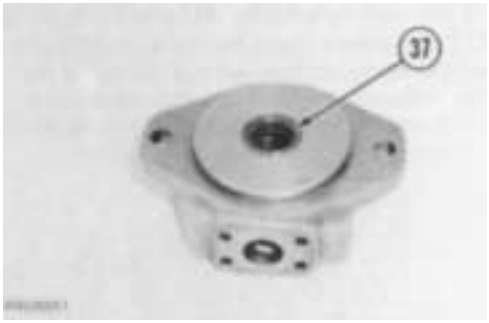


FIGURE 7-30 4062

25. Remove the seal rings (38, Figure 7-31) from the third pumping section.

38. Seal Rings

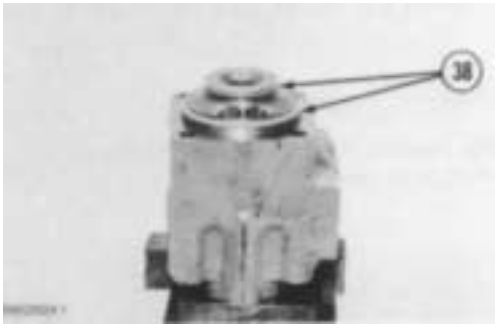


FIGURE 7-31 4063

26. Remove the cartridge (39, Figure 7-32) from the pump body.

39. Cartridge

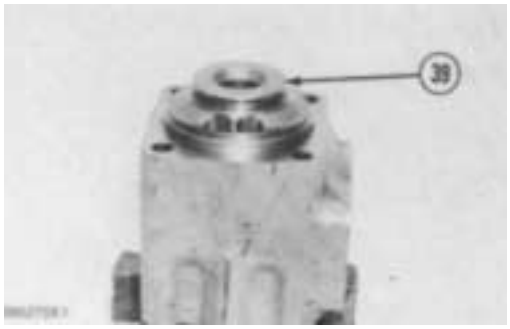


FIGURE 7-32 4064

27. Remove the bolts (40, Figure 7-33) that hold the pressure plate (41). Remove the pressure plate.

40. Bolts
41. Pressure Plate

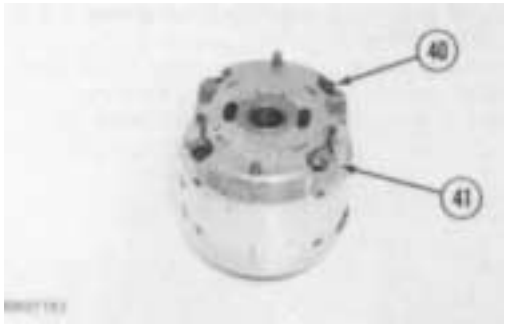


FIGURE 7-33 4065

28. Remove the wear plate (42, Figure 7-34) from the cam ring (44). Wind a rubber band around the rotor to prevent the vanes from falling out of their slots. Remove the rotor and vane assembly (43). Remove the vanes from the rotor. Mark down the slot that each vane was removed from. During assembly, this will make it possible to return each vane to the slot that it was removed from.

42. Wear Plate
43. Vane Assembly
44. Cam Ring

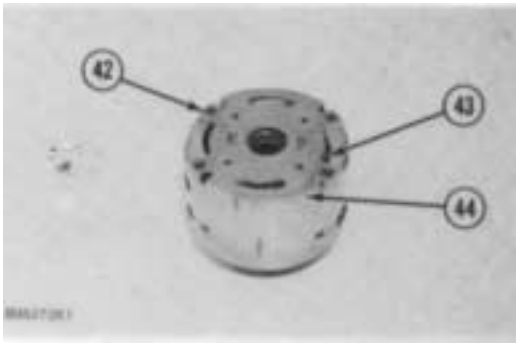


FIGURE 7-34 4066

29. Remove the wear plate (45, Figure 7-35) from

45. Wear Plate

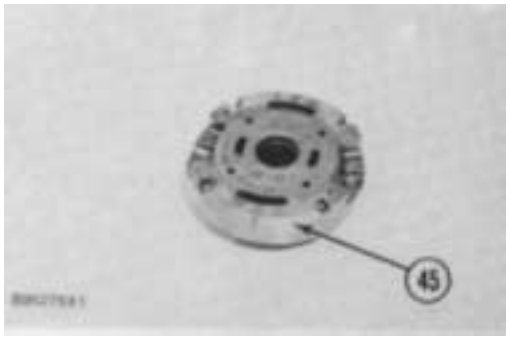


FIGURE 7-35 4067

the pressure plate.

30. Remove the seal (46, Figure 7-36) from the

46. Seal

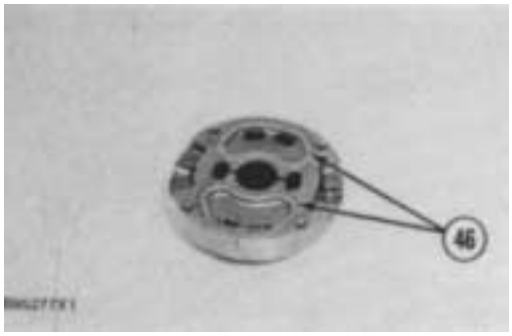


FIGURE 7-36 4068

pressure plate.

Pump Assembly

1. Seals

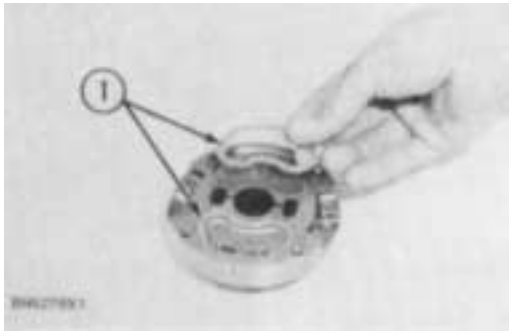


FIGURE 7-37 4069

1. Put the seals (1, Figure 7-37) into position on the pressure plate.

2. Install the wear plate (5, Figure 7-38) on the pressure plate. Insert the vanes into the rotor (4). The leading edge of each vane must be toward the direction of pump rotation. Hold the vanes in place by winding a rubber band around the rotor.

   Set the rotor (4) on the pressure plate (5).

   Set the cam ring (3) over the rotor (4). Set the wear plate (2) on top of the rotor and cam ring.

2. Wear Plate
3. Cam Ring
4. Rotor
5. Wear Plate

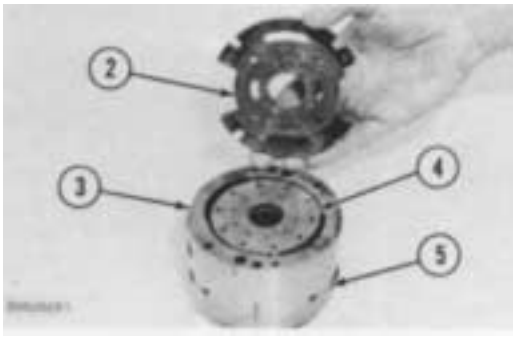


FIGURE 7-38 4070

3. Place the seals (7, Figure 7-39) on the pressure plate (6). Set the pressure plate on top of the wear plate (2). Install the bolts in the holes closest to the arrow that is in the same direction as the arrow on the cam ring (3). Tighten the bolts.

6. Pressure Plate
7. Seals

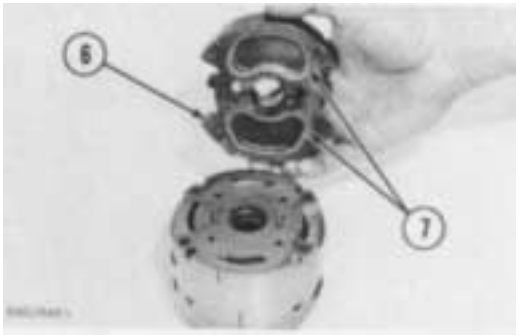


FIGURE 7-39 4071

4. Set the cartridge (8, Figure 7-40) into the pump housing.

8. Cartridge

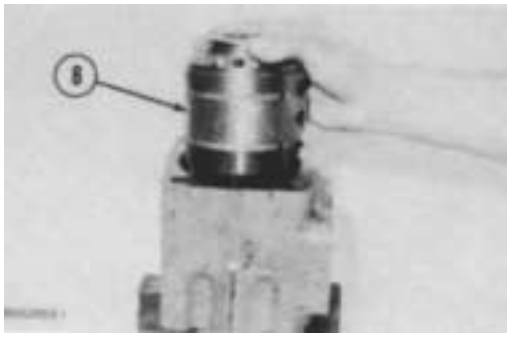


FIGURE 7-40 4072

5. Set the seal ring (9, Figure 7-41) on the cartridge.

9. Seal Ring

FIGURE 7-41 4073

6. Press the bearing (11, Figure 7-42) onto the shaft (10).

10. Shaft
11. Bearing

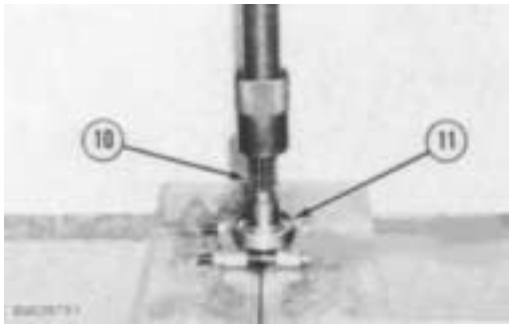


FIGURE 7-42 4074

7. Use a snap ring pliers to install the snap ring (12, Figure 7-43) on the shaft.

12. Snap Ring

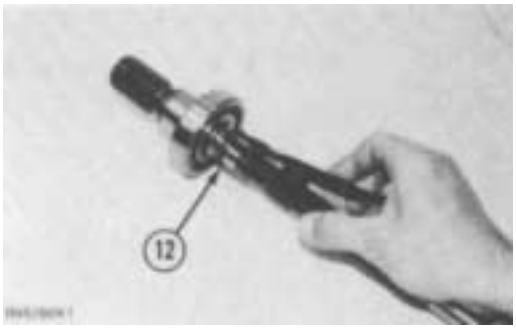


FIGURE 7-43 4075

8. Install the seal (13, Figure 7-44) into the body. The lip of the seal must face toward the bearing.

13. Seal

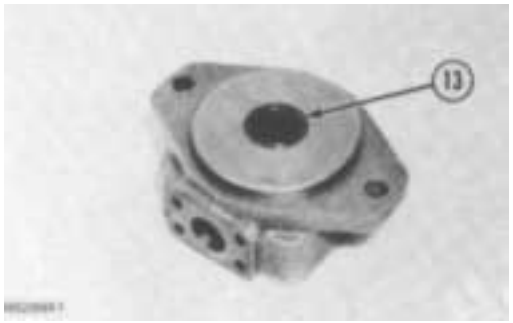


FIGURE 7-44 4076

9. Insert the ring (14, Figure 7-45) into the body.

14. Ring

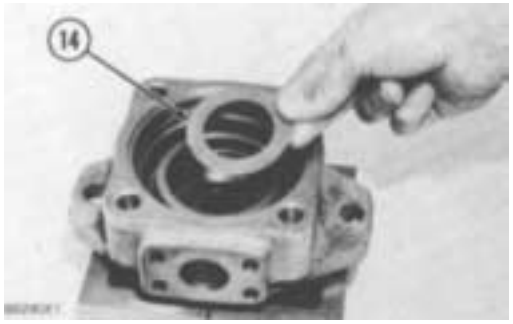


FIGURE 7-45 4077

10. Install the shaft and bearing assembly into the body. See Figure 7-46.

FIGURE 7-46 4078

11. Install the spiral retainer ring (15, Figure 7-47) over the shaft and onto the bearing.

15. Retainer Ring

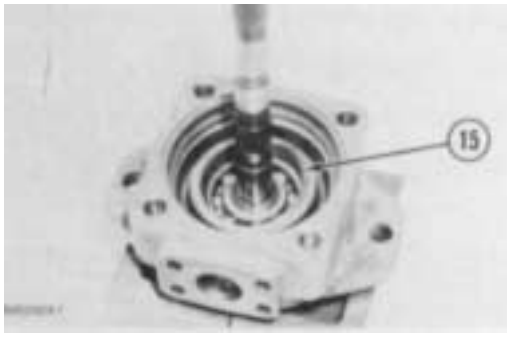


FIGURE 7-47 4079

12. Place the O-ring seal (16, Figure 7-48) into the body.

16. O-ring Seal

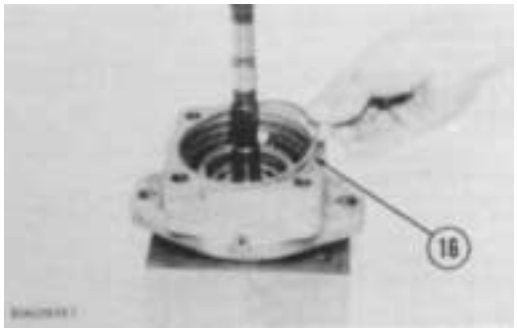


FIGURE 7-48 4080

13. Place the body assembly (17, Figure 7-49) onto the pump housing.

17. Body Assembly

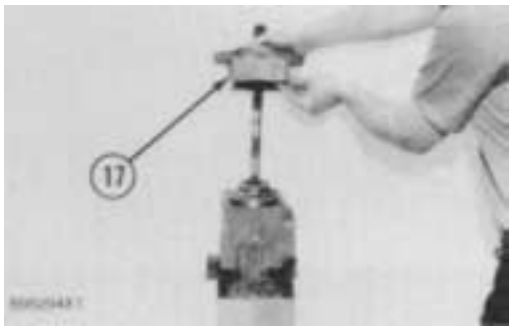


FIGURE 7-49 4081

14. Turn the pump upside down. Install and tighten the bolts (18, Figure 7-50).

18. Bolts

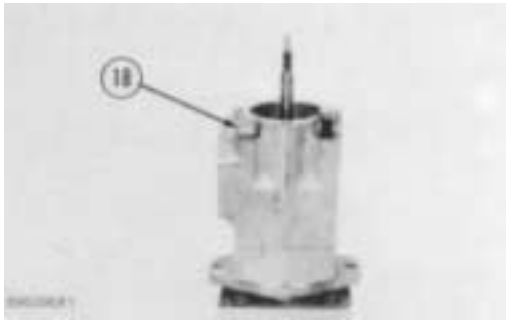


FIGURE 7-50 4082

15. Install the seals (19, Figure 7-51) on the pressure plate.

19. Seals

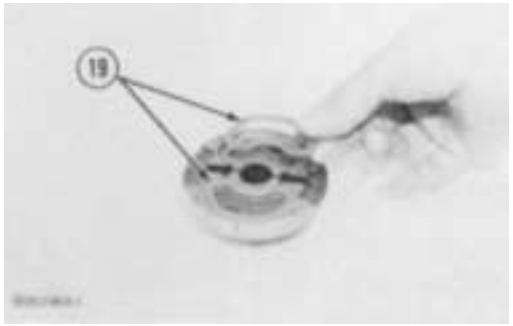


FIGURE 7-51 4083

16. Place the wear plate (24, Figure 7-52) over the pressure plate.

20. Pressure Plate
22. Seals
23. Cam Ring
24. Wear Plate
25. Pressure Plate

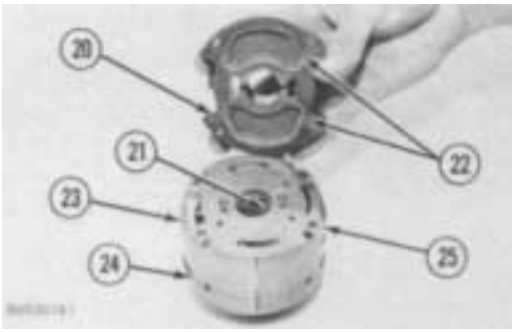


FIGURE 7-52 4084

Install the vanes into the rotor. The leading edge of each vane must be toward the direction of pump rotation. Hold the vanes in place by winding a rubber band around the rotor. Set the rotor on the wear plate (24, Figure 7-52). Remove the rubber band.

Set the cam ring (23) over the rotor. Set the wear plate (25) on top of the cam ring. Install the seals (22) on the pressure plate (25). Place the pressure plate (20) on top of the wear plate (25).

Insert the bolts into the pressure plate (20) and tighten the bolts.

17. Insert the assembled cartridge (26, Figure 7-53) into the pump housing.

26. Cartridge

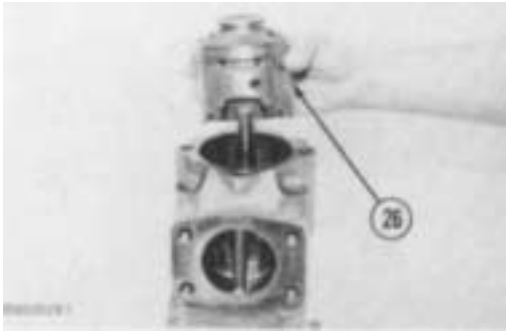


FIGURE 7-53 4085

18. Install the seal rings (27, Figure 7-54) onto the cartridge assembly.

27. Seal Rings

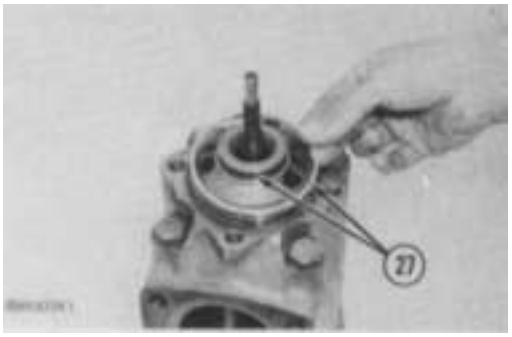


FIGURE 7-54 4086

19. Install the pump body (28, Figure 7-55) on the pump housing. Insert the bolts into the pump body and tighten them.

28. Pump Body

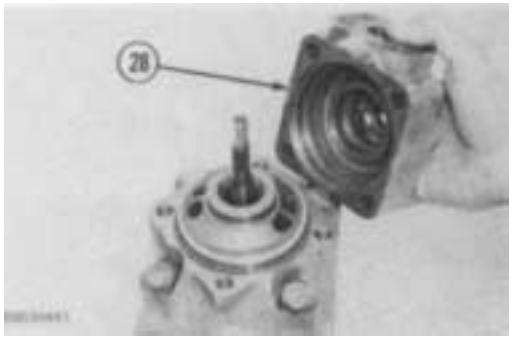


FIGURE 7-55 4087

20. Install the O-ring seal (30, Figure 7-56) and pins (29) on the pump body.

29. Pins
30. O-ring Seal

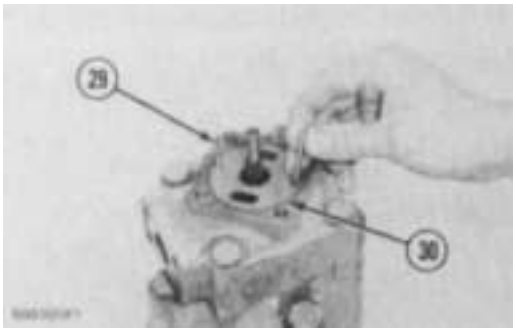


FIGURE 7-56 4088

21. Install the O-ring seal (32, Figure 7-57) on the adapter (31). Install the adapter (31) on the pump body.

31. Adapter
32. O-ring Seal

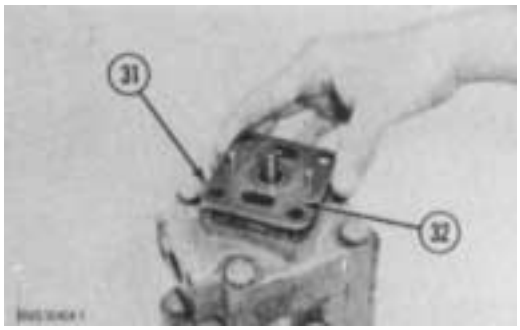


FIGURE 7-57 4089

22. Install the vanes into the same rotor slots that they were originally removed from. Wind a rubber band around the rotor to hold the vanes in place. Set the rotor (33, Figure 7-58) into place over the adapter (31). Remove the rubber band.

33. Rotor

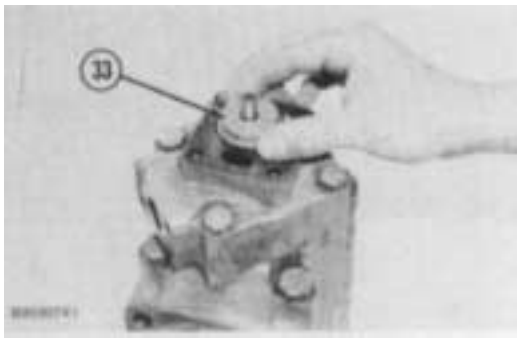


FIGURE 7-58 4090

23. Install the cam ring (34, Figure 7-59) on the adapter (31). The arrow (X) on the cam ring must point in the direction of pump rotation.

34. Cam Ring

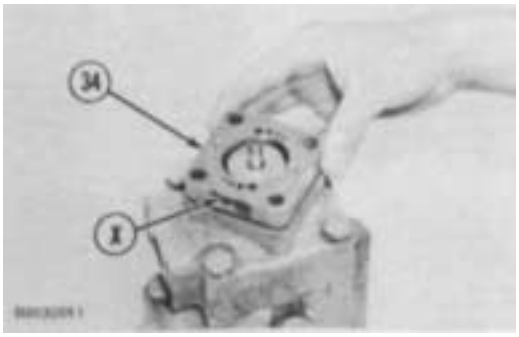


FIGURE 7-59 4091

24. Install the plate (35, Figure 7-60), O-ring seal (36), and spring (37) on the cam ring (34).

35. Plate
36. O-ring Seal
37. Spring

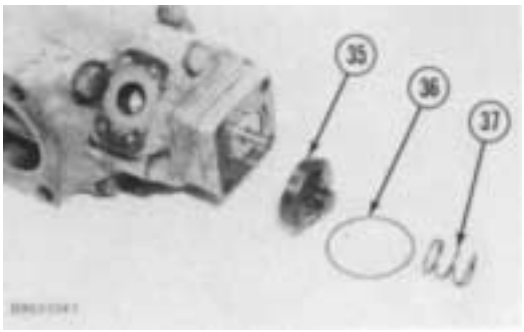


FIGURE 7-60 4092

25. Install the spring (38, Figure 7-61), poppet (41), rings (39), and plug (42) into the valve body (40).

38. Spring
39. Rings
40. Valve Body
41. Poppet
42. Plug

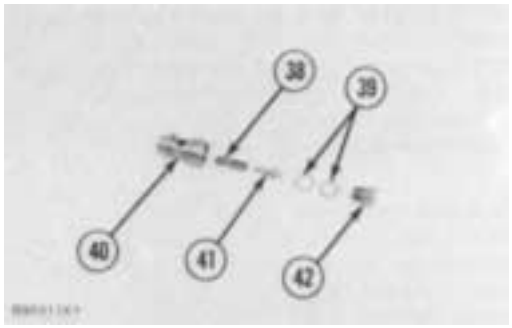


FIGURE 7-61 4093

26. Install the valve body (40), spring (43, Figure 7-62), and plug (44) into the cover.

43. Spring
44. Plug

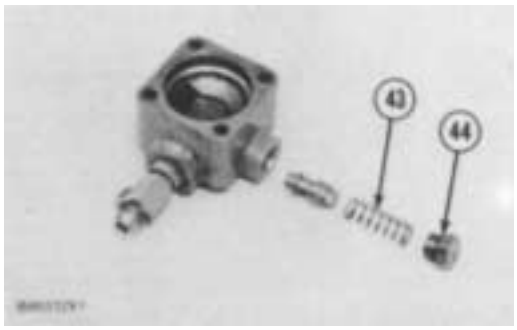


FIGURE 7-62 4094

27. Place the cover (45, Figure 7-63) on the pump. Install the bolts through the cover and tighten them.

45. Cover

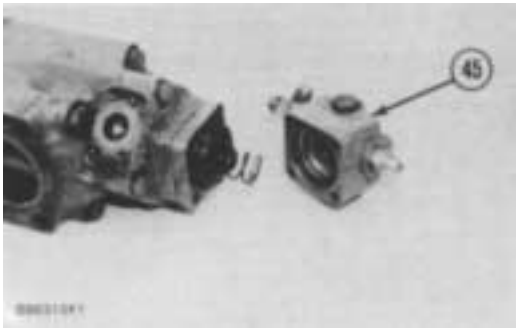


FIGURE 7-63 4095

28. Place the O-ring seal (46, Figure 7-64) on the pump body.

46. O-ring Seal

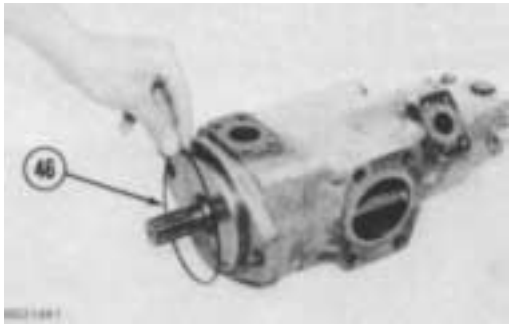


FIGURE 7-64 4096

Pump Installation

1. Support the pump (1, Figure 7-65) with a hoist. Move the pump into position and install and tighten the bolts.

1. Pump

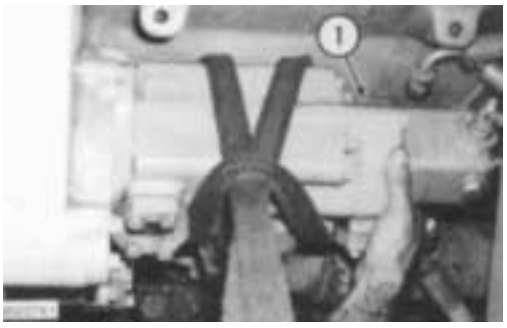


FIGURE 7-65 4097

2. Connect the hoses (2, Figure 7-66) to the pilot pump.

2. Pilot Pump Hoses

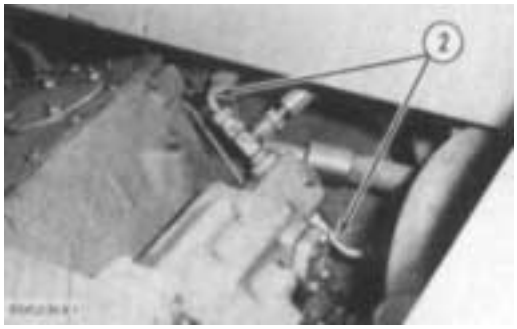


FIGURE 7-66 4098

3. Connect the hoses (3, Figure 7-67), (4), and (5) to the pump.

3. Inlet Hose
4. Outlet Hose
5. Hose

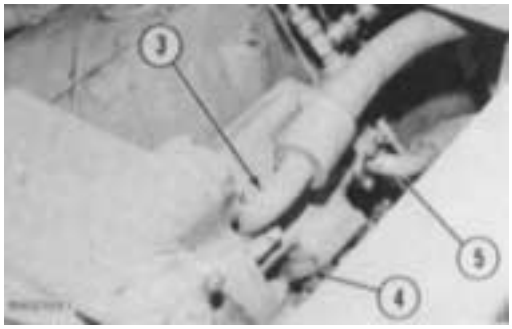


FIGURE 7-67 4099

Hydraulic Circuits and Components

Restriction Valve

The restriction valve is located at the tank port of the control valve. This valve creates a constant pressure in the return line when any of the control valves are being operated. If no control valve is being operated, the oil that flows through the open centers of the control valves passes through the restriction valve without being restricted.
See Figure 7-116.

Port A of the restriction valve is connected to the oil return line of the control valve. See Figure 7-68. Port B is connected to the center bypass line of the control valve. When all the control valves are in neutral, the oil returns through port B and is returned to tank without being restricted.

If any spool is being operated, the center bypass line is blocked. Return oil must now pass through the control valve oil return line and port A of the restriction valve. Oil passing through port A must overcome the spring force (1, Figure 7-68) of the poppet (2) to pass through the restriction valve. See Figure 7-69.This creates pressure in the return oil circuit all the way back to the cylinder that is being operated.

1. Poppet Spring
2. Poppet

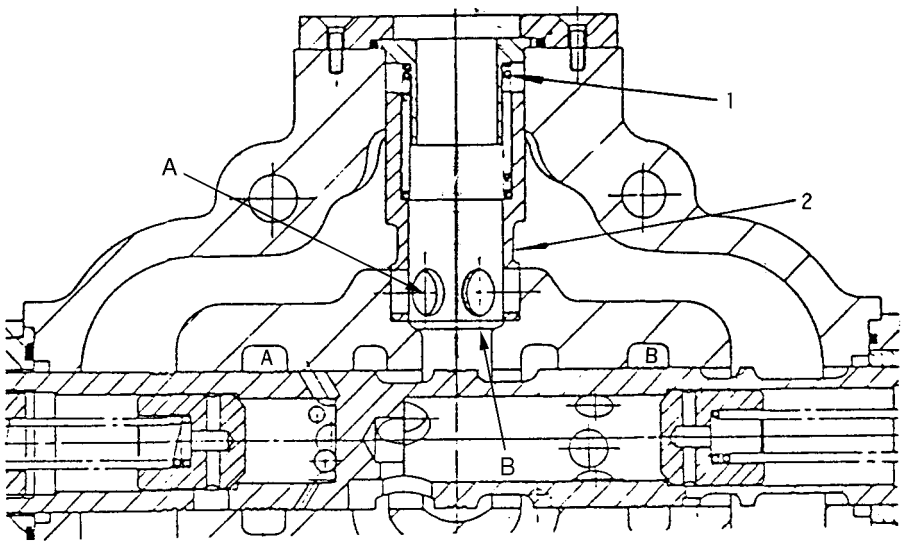


FIGURE 7-68

5011

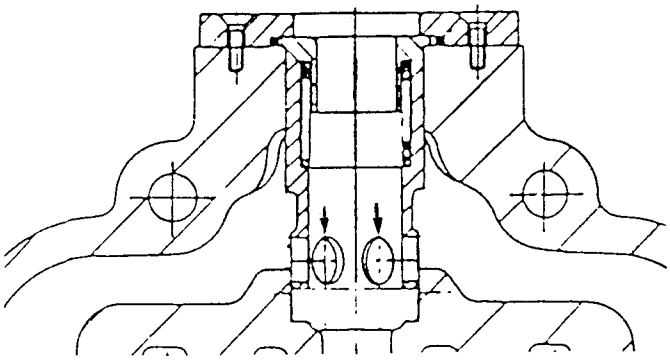


FIGURE 7-69

5012

Unloading Valve

The unloading valve is made up of three cartridges C1, C2, and C3. When pressure in the main pump output line is low, the unloading valve diverts output from the steering pump and directs it to the main pump output line. This line supplies the boom, bucket, and option control valves. This additional fluid creates faster cycle times. When pressure in the main pump output line is high, the unloading valve directs steering pump flow to tank.

Output from the steering pump passes through the priority valve. See the hydraulic schematic in Figure 7-116. This flow then passes out of the priority valve and enters the unloader valve at port EF. This flow is present at port A of C3 and present at port B of C2. See Figure 7-70. This flow raises the check spool (1) at C3 when the pressure in the output line from the main pump is below 160 kg/cm^2 (2,275 psi.) at port P2. This allows output from the steering pump to join flow from the main pump to supply the boom, bucket, and option control valves.

The pressure at port B of C2 is also present at port C of C2. When pressure in the main pump output line is above 160 kg/cm^2, this pressure forces spool (5) of C1 to move against the force of spring (6), which allows the oil in chamber C of C2 to flow through port D of C1 and back to tank. When oil in chamber C flows to tank through port D, the pressure in chamber C drops due to the venturi effect of the orifice (7) in check spool (4). This allows the pressure at B to lift check spool (4) off its seat. This allows the oil that is flowing into port B to flow past check spool (4) to tank. This is the output from the steering pump that is being directed back to tank. Figure 7-71 shows the cartridge and port location for the unloading valve.

1. C3 Spring
2. C3 Check Spool
3. C2 Spring
4. C4 Check Spool
5. C1 Check Spool
6. C1 Spring
7. Orifice

C. C2 Spool Chamber
C1. Valve Cartridge
C2. Valve Cartridge
C3. Valve Cartridge
D. C1 Port
E. C1 Port
EF. Unloader Valve Port
P1. C3 Port
P2. C3 Port
T. Tank

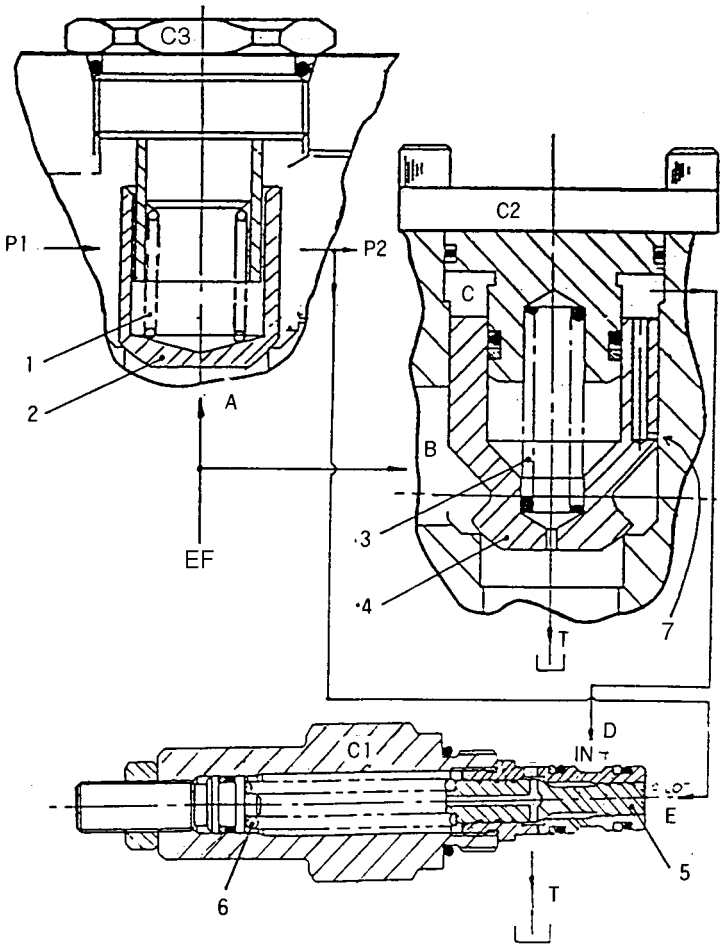


FIGURE 7-70

4107

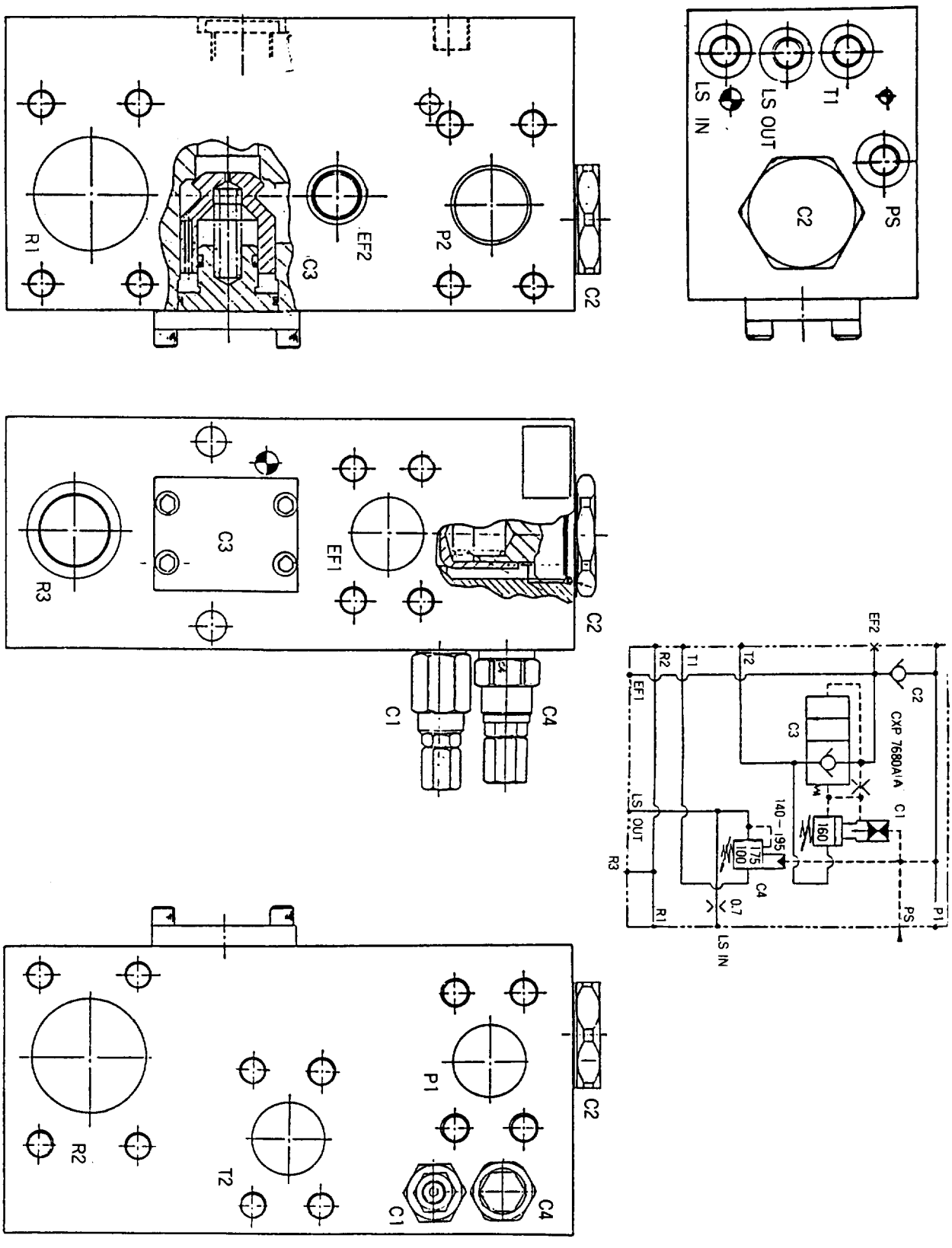


FIGURE 7-71

5013

Option Solenoid Valve

This is a pilot valve that controls oil flow to the control spool in the valve that controls the optional function (log fork, pallet fork operation). See Figure 7-72. The figure shows the valve cartridge identification and port location.

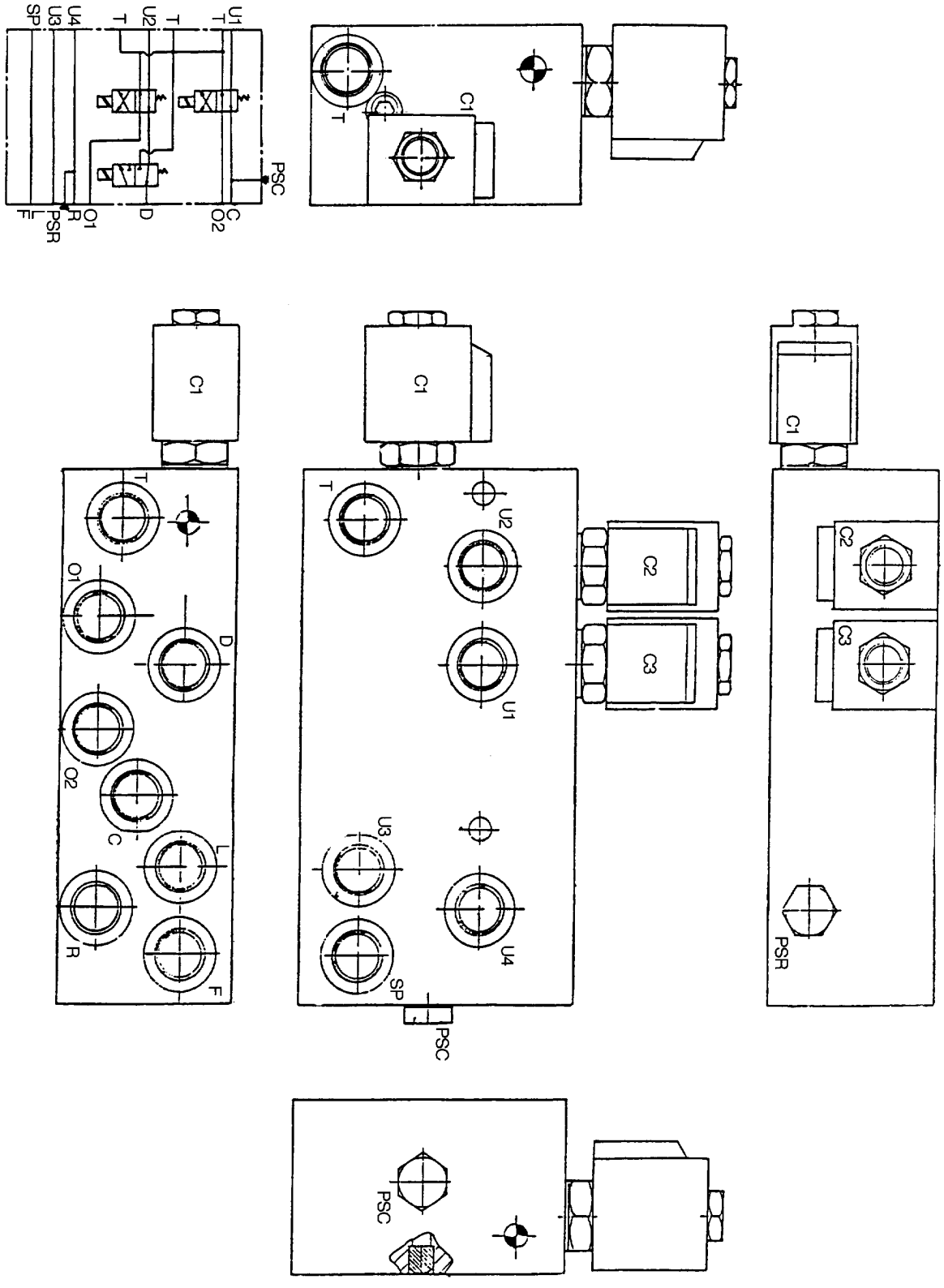


FIGURE 7-72

5015

Bypass Valve

This valve contains cartridges that allow return oil to bypass the oil cooler and return to tank if the oil cooler is restricted. See Figure 7-73.

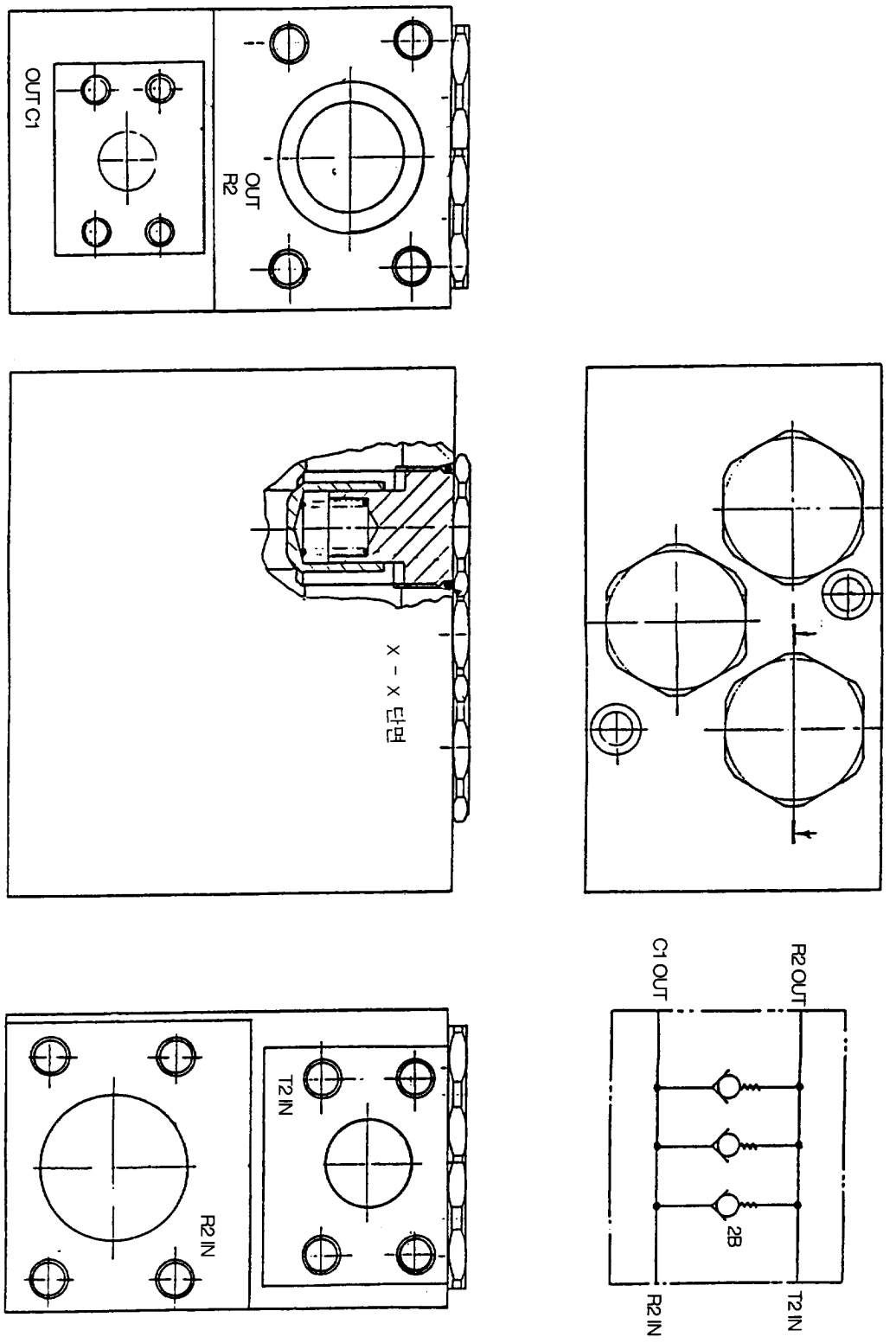


FIGURE 7-73

5016

Manually Controlled Pilot Valve

When no force is applied to the lever (1, Figure 7-74), the return spring (4) positions the lever at the neutral position. When the lever is moved, plunger (5) is moved, which pushes down the return spring (4). At the same time, spool (2) is moved by spring (3). When spool (2) moves down, a groove (6) in the spool opens the pilot pressure line to the line that the lever controls. This allows the pilot pressure to flow to the boom or bucket control valve, where the pilot pressure operates the control valve. When the lever is completely moved in one direction, the solenoid (7) energizes the electro-magnet (8) and holds the lever in the fully moved position.

Pilot Valve Operation

The lever handle is positioned on the right side of the operator's seat. This single lever controls the following machine functions; raise boom, lower boom, bucket crowd, and bucket dump. The lever positions are identified as follows:

F – Float
L – Lower
N – Neutral
R – Raise
H – Hold Position
C – Bucket Crowd
D – Bucket Dump
HR – Holds Lever in Raise Mode

1. Lever
2. Valve Spool
3. Regulating Spring
4. Return Spring
5. Plunger
6. Spool Groove
7. Solenoid
8. Electro-magnet

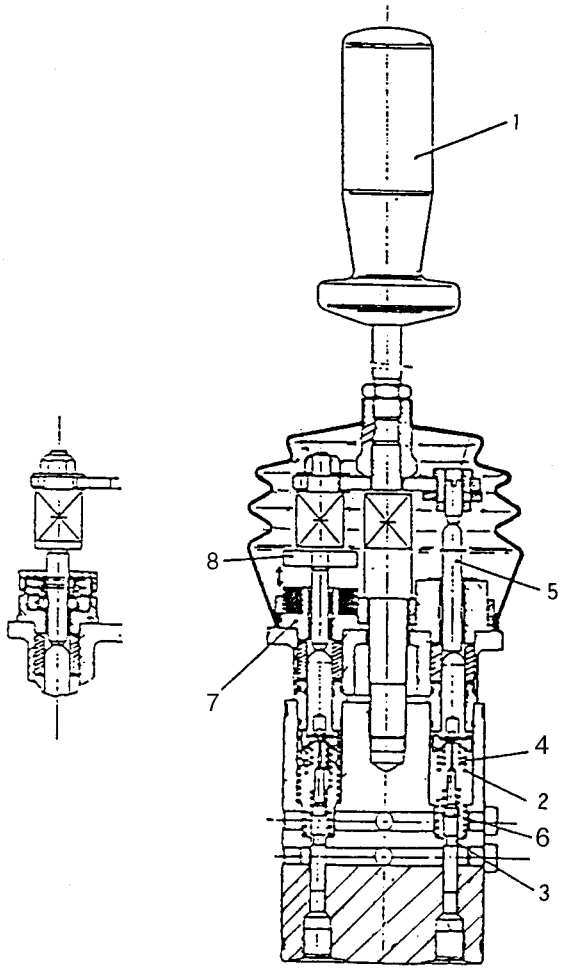


FIGURE 7-74

4108

Automatic Bucket Return-to-Dig System

This system automatically returns the bucket to a level position (the dig position), to reduce cycle time and to reduce operator effort.

When the bucket is on the ground, putting the lever in the RAISE position will raise the boom, and therefore the bucket. As the boom rises, the boom proximity switch is tripped ON. See Figure 7-75.

This powers a relay that activates the bucket return-to-dig function and also holds the pilot valve lever in the boom raise mode. As the boom continues to rise, and the bucket becomes parallel with the ground, the boom proximity switch is tripped OFF. This causes the pilot valve lever to return to the NEUTRAL position, and the bucket remains parallel with the ground. If the operator now moves the pilot valve lever to the boom lower position, the boom will lower to the ground and the bucket will already be in the dig position.

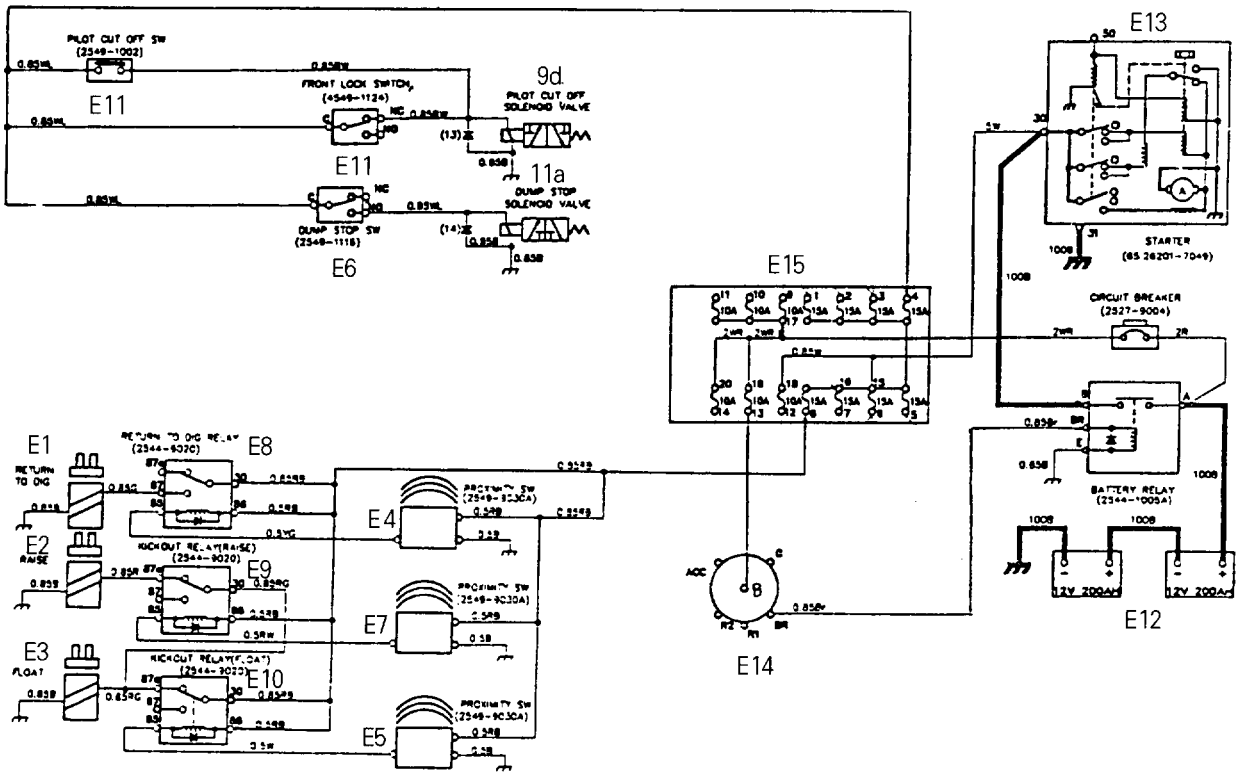


FIGURE 7-75

5014

Automatic Boom Kick-out System

When the pilot valve lever is in the HR position, this locks the boom into continuously raising. If the boom were allowed to rise to the maximum extension of the boom raising cylinders, there would be a certain amount of shock to the cylinders as they bottomed out, and the pump would then force oil over the relief valve. This would cause the oil temperature to rise. To prevent the shock and high temperature, the boom kick-out system stops the boom from rising before the point of maximum cylinder extension is reached.

When the pilot valve lever is operated to lift the boom off the ground, the raise kick-out proximity switch is tripped and reset to OFF. See Figure 7-75. This directs current through the float and raise kick-out relays and locks the pilot valve lever solenoid in the boom raise position. As the boom continues to rise it will reach a position where it trips the raise kick-out proximity switch to the ON position. This cuts off current to the pilot valve lever solenoid and this stops the boom from raising any farther.

Automatic Boom Float System

When the pilot valve lever is shifted to the float position, the lever is locked and oil from the pilot pump flows into the pilot valve and is directed to the boom spool. The float separation piston in the spool moves to the right and the boom spool moves to the float position. The contacts in the boom float proximity switch move to the OFF position and direct current through the float kick-out relay to lock the lever solenoid in the boom float position. If an attempt is made to float the boom when the boom is on the ground, the contacts in the boom float proximity switch are tripped to the ON position and this cuts off current to the lever solenoid.

If the pilot valve lever is operated when the bucket is being positioned by the return to dig system, loader pump output is directed to to the bucket cylinder and pressurized oil in the boom cylinder returns to tank.

Load Sensing Cartridge

In the hydraulic circuit that is supplied by the steering pump, maximum pressure is limited to $175^{+30\ -10}$ kg/cm^2 ($2489^{+427\ -142}$ psi). Pressure is limited by load sensing cartridge C4 in the unloading valve. See Figure 7-76. The load sensing cartridge can be adjusted to obtain the correct maximum pressure. Turning the load sensing adjusting screw clockwise will raise the relief pressure. Turning the screw counterclockwise will lower the relief pressure. Pressure can be monitored at the steering pump outlet.

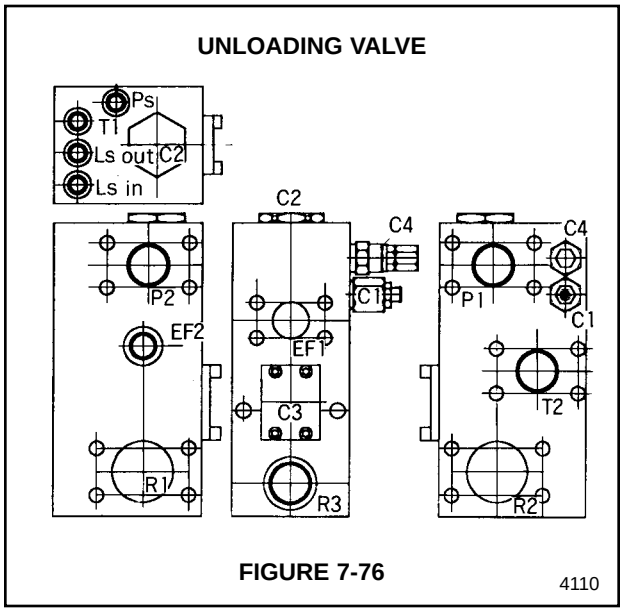


FIGURE 7-76

Unloading Valve

The unloading valve in the steering pump circuit is set to unload at $160^{\pm5}$ kg/cm^2 ($2275^{\pm71}$ psi). See Figure 7-70. The unloading valve cartridge C1 can be adjusted to obtain the correct unloading pressure. See Figure 7-76. Turning the C1 adjusting screw clockwise will raise the unloading pressure. Turning the screw counterclockwise will lower the unloading pressure. Pressure can be monitored at the steering pump outlet.

Brake Pressure Checks

The maximum loading and unloading pressure in the brake pilot valve is 120 – 140 kg/cm^2 (1,706 – 1,991 psi). This pressure can be checked at gauge port ULTP which is located at the upper part of the brake pilot valve. See the hydraulic schematic in Figure 7-116.

Service brake outlet pressure is 60 ± 5 kg/cm^2 (853 ± 71 psi). Pressure can be checked at the gauge port on the outlet side of the brake pedal valve.

Pressure to the lever controlled pilot valves should be 30 ± 5 kg/cm^2 (427 ± 71 psi). Pressure can be checked at the TP port on the brake pilot valve. See the hydraulic schematic in Figure 7-116.

Hydraulic Cylinders

The machine contains boom cylinders, bucket cylinders, blade cylinders, and steering cylinders. Each cylinder contains a cylinder tube, piston rod, piston, and cylinder head. See Figure 7-77.

The piston is held to the piston rod by a nut. A dust seal protects the U-ring and oil seal from dirt and also prevents oil from leaking out of the cylinder.

1. Retaining Ring
2. Dust Seal
3. U-ring
4. Seat O-ring
5. Port (A)
6. Cushion Plate
7. Wear Ring
8. Piston Nut
9. Port (B)
10. Seal O-ring
11. Piston
12. Spring
13. Cylinder Tube
14. O-ring, Backup Ring
15. Bushing
16. Cylinder Head
17. Bolt
18. Piston Rod

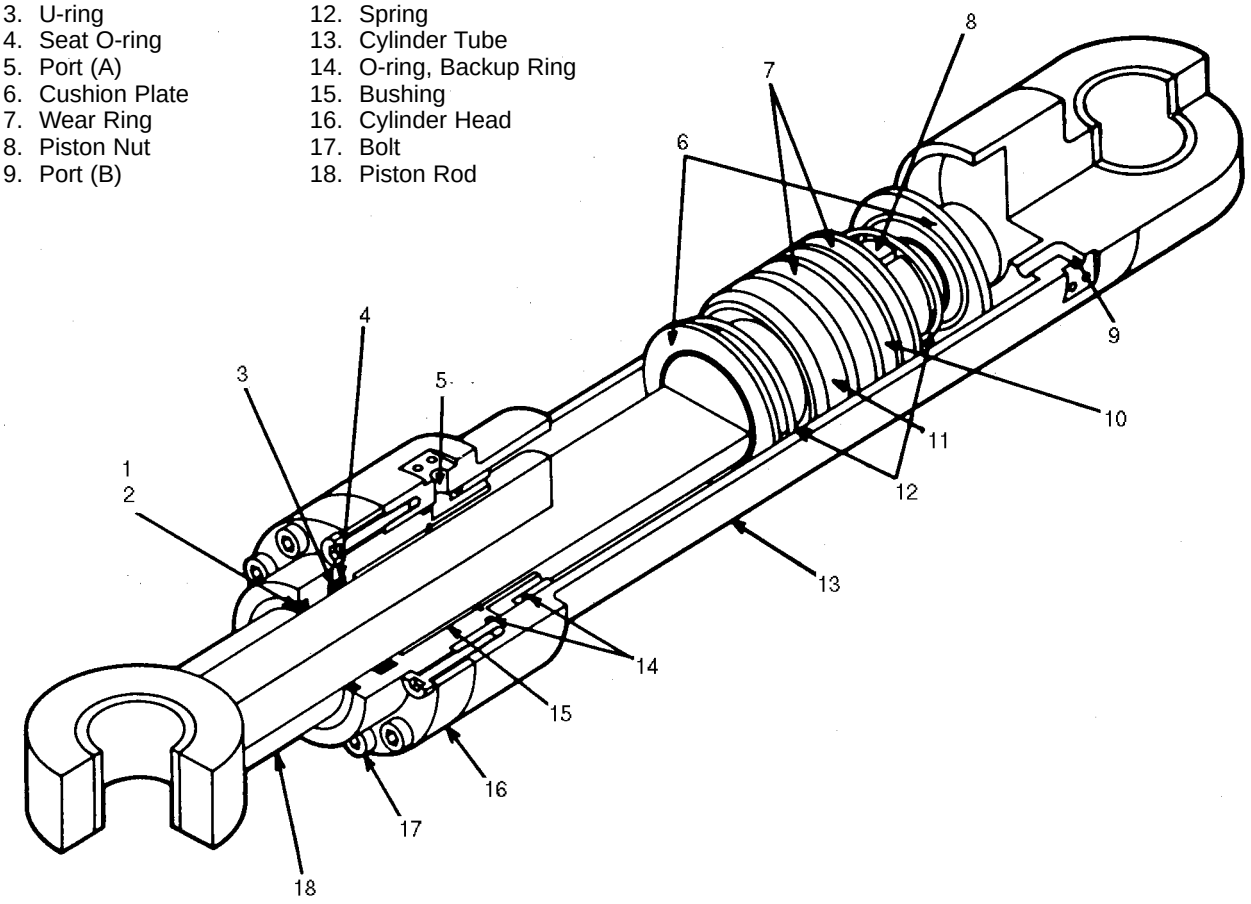


FIGURE 7-77

1548

Cylinder Operation

Oil flow from the pump (1, Figure 7-78) can enter cylinder port A or port B depending on the position selected at the control valve. When pump flow enters port A, the flow pushes the piston (2) down the tube. This extends the cylinder rod (3) out of the cylinder. Oil from the rod side of the cylinder flows out of port B and back to the reservoir (4). The force generated when the rod is extended, can be calculated as follows.

1. Pump
2. Piston
3. Cylinder Rod
4. Reservoir

A. Port A
B. Port B
D. Cylinder Inside Diameter
F_1. Cylinder Extend Force
R. Rod Diameter

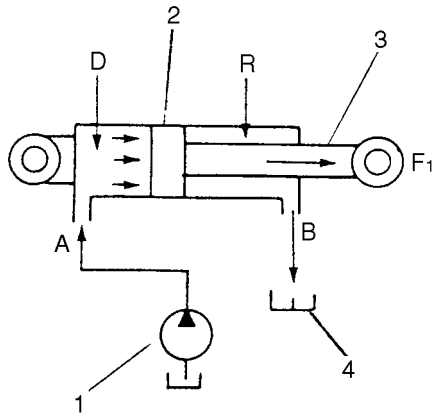


FIGURE 7-78 4112

$$F_1 = P \times \frac{\pi D^2}{4}$$

Where F_1 = Force, P = Pressure, π = 3.14, D = Cylinder Inside Diameter

When pump flow enters port B, the flow fills the rod (3, Figure 7-78) side of the cylinder and pushes the piston (2) down the tube. This retracts the cylinder rod (3). Oil from the other side of the piston (2) is forced out port A and back to the reservoir (4). The force generated when the rod is retracted, is less than the force generated when the rod is extended. This is true because the piston (2) area that is acted on by the oil pressure is smaller on the rod (3) side of the piston (2) than on the opposite side of the piston (2). The force generated when the rod (3) is retracted can be calculated as follows.

$$F_2 = P \times \frac{\pi(D^2 - R^2)}{4}$$

Where F_2 = Force, P = Pressure, π = 3.14, D = Cylinder Inside Diameter, R = Rod Diameter

Because the rod (3, Figure 7-78) takes up space inside the cylinder, the rod side of the cylinder fills faster than the opposite side of the cylinder. This causes the rod (3) to retract faster than it extends. The quantity of oil (Q1) needed to fully extend the cylinder, and the quantity (Q2) needed to fully retract the cylinder can be calculated as follows. See Figure 7-79.

S. Stroke Length

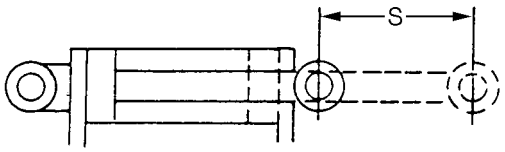


FIGURE 7-79 4113

$$Q_1 = S \times \frac{\pi D^2}{4}$$

$$Q_2 = S \times \frac{\pi(D^2 - R^2)}{4}$$

$$Q_1 > Q_2$$

Where Q_1 = Quantity of Oil needed to Fully Extend, Q_2 = Quantity of Oil needed to Fully Retract, π = 3.14, D = Cylinder Inside Diameter, R = Rod Diameter, S = Stroke Length

Hydraulic Cylinder Troubleshooting

Problem	Possible Cause	Remedy
Oil leaking between cylinder head (16) and piston rod (18). (Index nos. refer to Figure 7-77.)	1. Foreign material in U-ring (3).	Remove foreign material.
	2. Scratches in U-ring (3).	Replace U-ring (3).
	3. Damage to U-ring (3).	Replace U-ring (3).
	4. Foreign material in dust seal (2).	Remove foreign material.
	5. Scratches in dust seal (2).	Replace dust seal (2).
	6. Damage to dust seal (2).	Replace dust seal (2).
	7. Foreign material in seal O-ring (4).	Remove foreign material.
	8. Scratches in seal O-ring (4).	Replace O-ring (4).
	9. Damage to seal O-ring (4).	Replace O-ring (4).
	10. Scratches on sealing surface of piston rod (18).	If scratches are not deep, hone with an oil stone and lubricate. If scratches are deep, replace piston rod (18).
	11. Deep scratches on inner surface of bushing (15).	Replace bushing.
Oil leaking between cylinder head (16) and cylinder tube (13).	1. Damage to O-rings (14).	Replace O-rings (14).
Oil leaking from welded area of cylinder tube (13).	1. Damage to welded area.	Replace cylinder tube (13).
Cylinder drops from pull of gravity.	1. Light scratches on sealing surface of cylinder tube (13).	Hone out scratches with oil stone.
	2. Deep scratches on sealing surface of cylinder tube (13).	Replace cylinder tube (13).
	3. Deep scratches on sealing surface of piston O-rings (10).	Replace O-rings (10).
	4. Foreign material in U-ring (3).	Remove foreign material.
	5. Scratches in U-ring (3).	Replace U-ring (3).
	6. Damage to U-ring (3).	Replace U-ring (3).
	7. Nylon wear rings (7) twisted.	Replace nylon wear rings (7).
	8. Nylon wear rings (7) scratched.	Replace nylon wear rings (7).
	9. Nylon wear rings (7) have other damage.	Replace nylon wear rings (7).
Slow bucket and boom movements.	1. Reduced oil flow due to dirty filter or dirty intake line.	Disassemble and clean parts.
	2. Air drawn into circuit through loose connections.	Tighten the intake connections.
	3. Reservoir oil level too low.	Fill reservoir to specified level.
	4. Relief valve pressure setting incorrect.	Adjust relief valve pressure.
	5. Damaged pump shaft or pump drive sleeve.	Replace damaged parts.
	6. Pump worn or damaged internally.	Replace worn or damaged parts.

Hydraulic Cylinder Troubleshooting (Continued)

Problem	Possible Cause	Remedy
Slow bucket and boom movements (continued).	7. Relief valve sticking.	Disassemble and inspect cartridge. Clean or replace cartridge.
	8. Air in pressure line.	Perform cylinder bleeding procedure to remove air. Tighten or replace pressure line.
	9. Damaged pipe or hose.	Replace pipe or hose.
	10. Worn cylinder seals.	Replace worn parts.
Low pressure, shown by weak upward movement of boom and bucket.	1. Same cause and remedy (1, 3, 4, 6, 7, and 10) of previous problem.	
	2. Low pump output due to dirty discharge pipes.	Remove and clean pump discharge pipes.
	3. Relief valve spring is weak. Relief valve poppet worn.	Replace worn parts.
Cylinder drops when control valve is in neutral.	1. Worn plunger in control valve.	Replace plunger.
	2. Stuck overload relief valve due to worn seat surface.	Replace worn parts.
	3. Loose pipes or joints.	Tighten parts.
	4. Worn piston seal on hydraulic cylinder.	Replace seal.
Vibration or excessive noise.	1. Excessive resistance in pump intake line.	Inspect intake lines and clean or replace as necessary.
	2. Air being drawn into intake line.	Inspect pipe joints and tighten.
	3. Chattering relief valve.	Change oil, replace valve.
Air bubbles in oil.	1. Wrong type of operating oil.	Drain and fill with proper type of oil.
	2. Oil level too low.	Raise to proper level.
	3. Air trapped in system.	Perform cylinder bleeding procedure to remove air.
Frequent rubber hose damage.	1. System pressure too high.	Adjust relief valve pressure.
	2. Hoses breaking due to contact with other machine parts.	Restrain hoses to prevent contact.

Hydraulic Cylinder Disassembly

NOTE

Keep on hand a container large enough to hold all of the oil in the cylinder being repaired. When the cylinder rod and head are removed, the oil will run out of the cylinder.

1. Use an allen wrench to remove the bolts that hold the cylinder head to the cylinder tube. See Figure 7-80.

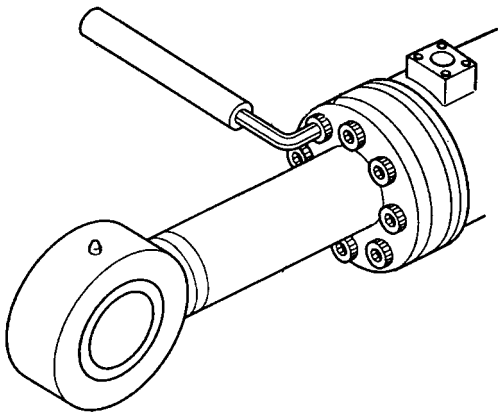


FIGURE 7-80 3826

2. Support the cylinder rod with a lifting sling. See Figure 7-81. Slide the cylinder rod out of the cylinder tube. Rotate the cylinder rod slightly as it is being pulled from the cylinder tube. This will make it easier to pull the rod out of the tube.

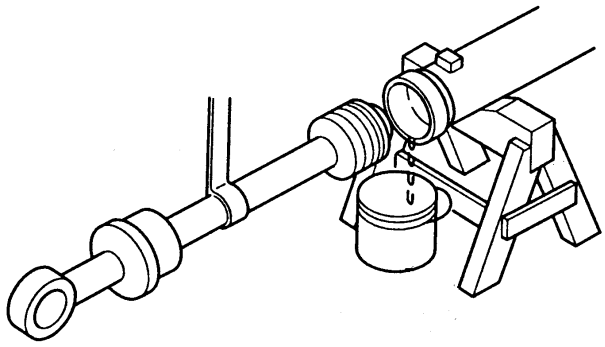


FIGURE 7-81 3827

3. Set the cylinder rod assembly into a repair fixture and secure the rod in place. See Figure 7-82. Use a power wrench and socket to remove the nut that holds the piston on the rod.

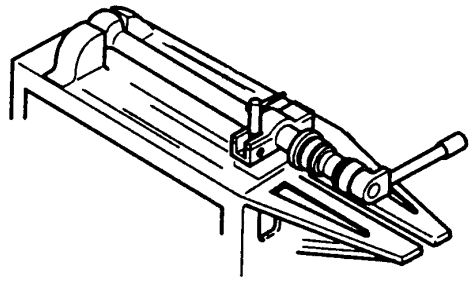


FIGURE 7-82 3828

4. Remove the piston nut (1, Figure 7-83), piston assembly (2), cushion flange (3), and cylinder head assembly (4).

1. Piston Nut
2. Piston Assembly
3. Cushion Flange
4. Cylinder Head Assembly

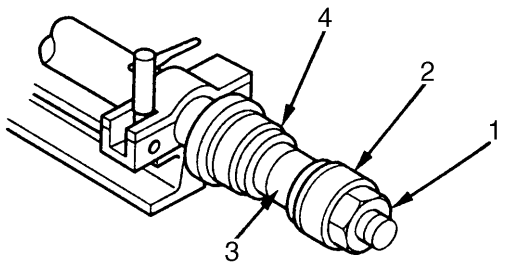


FIGURE 7-83 3829

5. Do not remove the slipper seal, backup ring, and back ring from the piston if these 3 items are not scratched or damaged. See Figure 7-84. Once these 3 items are removed from the piston, they must be replaced. They cannot be reused. Exercise caution when removing the slipper seal to prevent damage to the piston O-ring groove.

   Remove the wear rings from the piston.

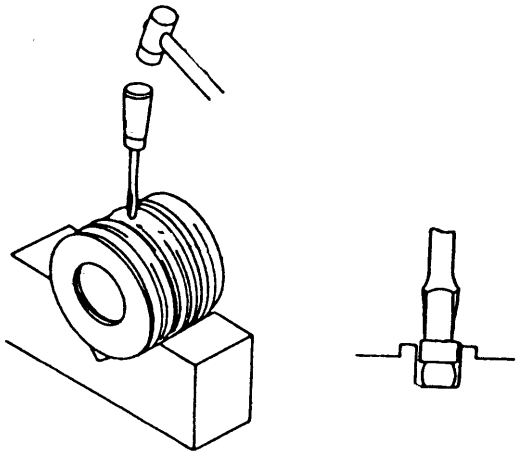


FIGURE 7-84 3830

6. When disassembling the cylinder head do not remove the slipper seal, backup ring, back ring, or dust seal unless the items are scratched or damaged. If the seals are removed from the head, they must be replaced. They cannot be reused.

   Remove the snap ring (1, Figure 7-85). Use a screwdriver to remove the dust seal (2) from the head.

1. Snap Ring
2. Dust Seal

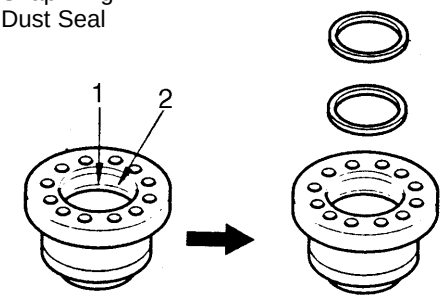


FIGURE 7-85 3831

7. Use caution to prevent damage to any parts other than the U-packing (1, Figure 7-86). Remove the U-packing (1). Remove the O-ring (2), and ring (3).

1. U-Packing
2. O-Ring
3. Ring

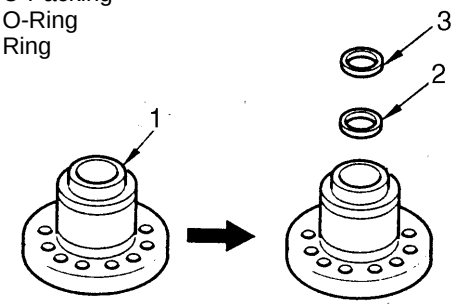


FIGURE 7-86 3832

Cylinder Assembly

NOTE

Check the cylinder head grooves for the U-packing and dust seal. If the edges of the grooves are sharp or have burrs, use an oil stone to smooth the surface. See Figure 7-87.

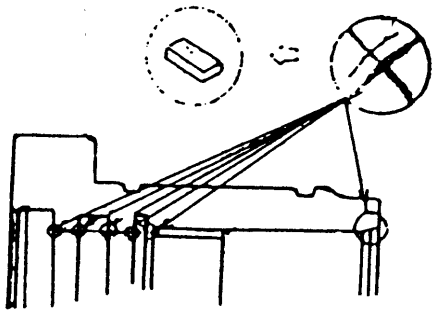


FIGURE 7-87 3833

1. Apply grease to the inner part of the cylinder head and to the U-packing groove. See Figure 7-88.

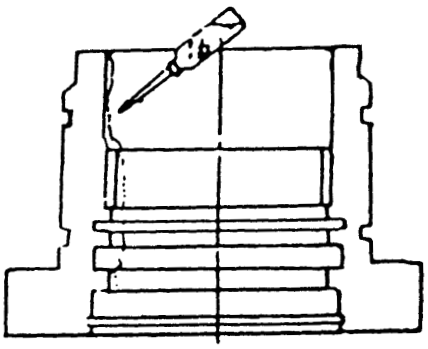


FIGURE 7-88 3834

2. Install the split backup ring into its groove by compressing the ring. See Figure 7-89. Make sure that the ends of the ring do not overlap.

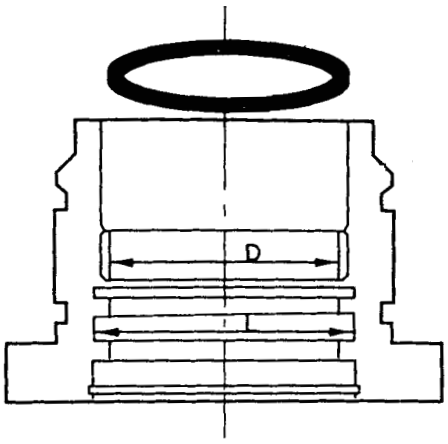


FIGURE 7-89 3835

NOTE

The U-packing can be installed by hand or by using a seal installing jig. The jig should be made of copper, aluminum, or plastic. If a jig is used, be sure that the jig does not have sharp edges that could damage the U-packing.

3. Insert one side of the U-packing in its groove. See Figure 7-90.

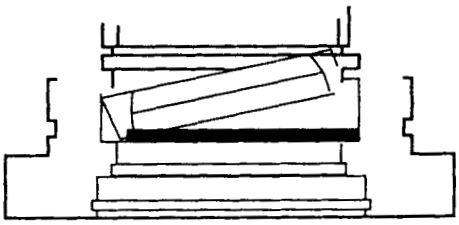


FIGURE 7-90 3836

4. Carefully push down on the other side of the U-packing until the entire U-packing is seated in its groove. See Figure 7-91.

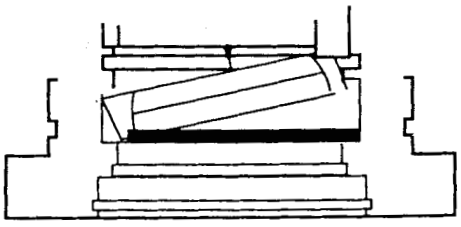


FIGURE 7-91 3837

5. Check to be sure that the U-packing and the backup ring are correctly installed by pushing with your hand on the inner diameter of the U-packing. See Figure 7-92.

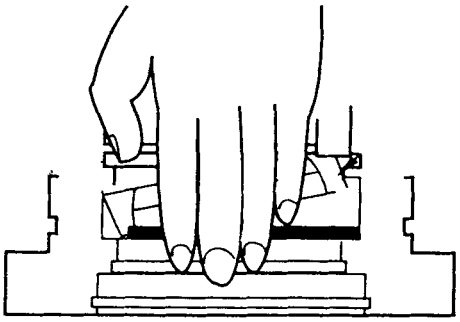


FIGURE 7-92 3838

NOTE

There are 2 backup rings used on the outside of the cylinder head. One backup ring is continuous. The other backup ring is open, split by an angled cut.

6. Use grease or an adhesive to hold the split backup ring (1, Figure 7-93) in place. Install the split backup ring (1) in the groove closest to the flange on the cylinder head.

1. Split Backup Ring
2. Continuous Backup Ring

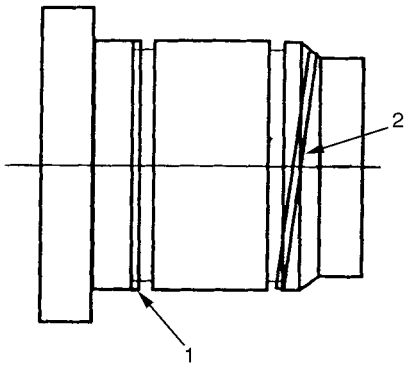


FIGURE 7-93 3840

7. Place the continuous backup ring in warm water. See Figure 7-94. The water temperature should be 30 – 50°C (86 – 122°F). Leave the ring in the water for 2 – 3 minutes. Slide the continuous backup ring (2, Figure 7-93) over the cylinder head and into its groove.

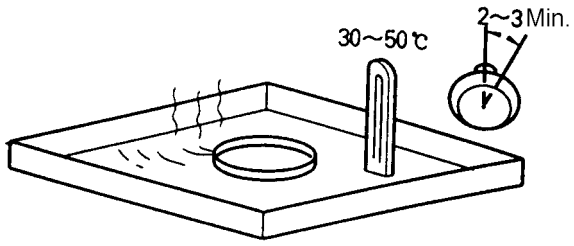


FIGURE 7-94 3839

8. Install an O-ring over each of the backup rings. See Figure 7-95.

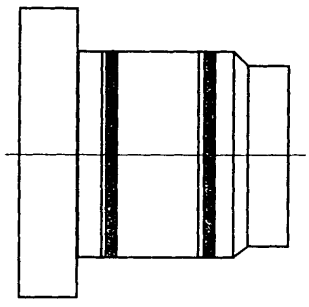


FIGURE 7-95 3841

9. Use a seal installing jig to install the dust seal into the cylinder head. See Figure 7-96. Install the snap ring.

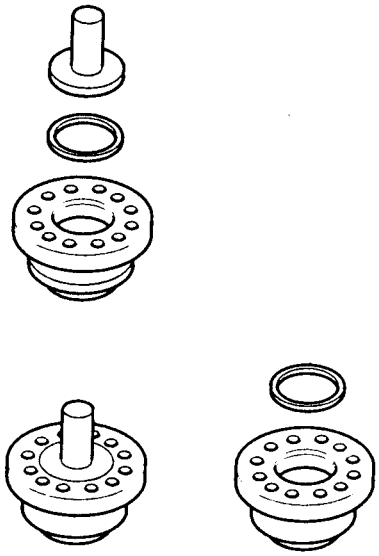


FIGURE 7-96 3842

10. On the piston, check the corners of the grooves that the piston rings will be mounted in. See Figure 7-97. If any burrs, roughness, or sharp edges (1) are present, use an oil stone to smooth the roughened areas and dull the sharp edges.

1. Burrs

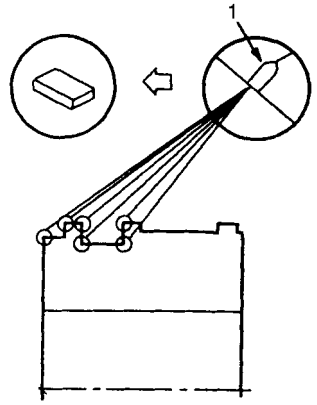


FIGURE 7-97 3843

11. Apply grease or hydraulic oil to the corner of the piston at position A. See Figure 7-98.

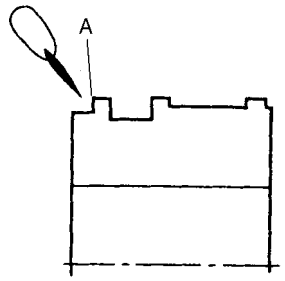


FIGURE 7-98 3844

12. Insert one end of the backup ring into its groove. See Figure 7-99. Use your hand to slide the other end of the ring into the groove.

1. Backup Ring

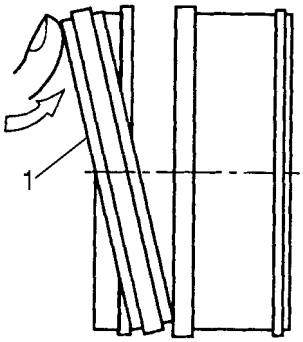


FIGURE 7-99 3845

13. Use warm water to expand the slipper seal. See Figure 7-100. This will make the seal easier to install. Set the slipper seal in 60 – 100°C (140 – 212°F) water for 5 minutes or longer.

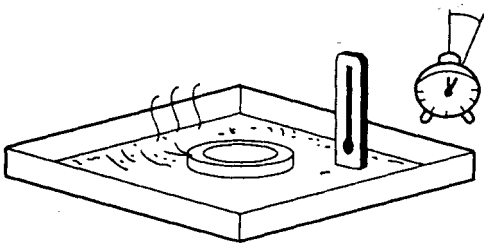


FIGURE 7-100 3846

14. Insert one end of the slipper seal (1, Figure 7-101) into its groove. Use your hand to slide the other end of the slipper seal into the groove.

1. Slipper Seal

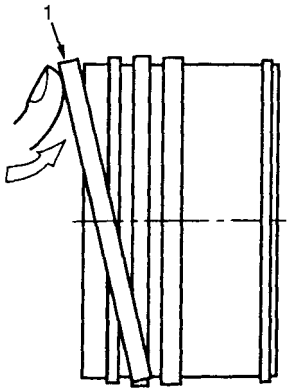


FIGURE 7-101 3847

IMPORTANT

Before the piston is inserted into the cylinder tube, make sure that the slipper seal is no longer expanded. If the seal is still expanded, it could catch on the threaded portion of the cylinder tube. An expanded seal could also jam inside the cylinder tube.

15. Install 2 backup rings (1, Figure 7-102). One ring fits on either side of the slipper seal (2).

1. Backup Ring
2. Slipper Seal

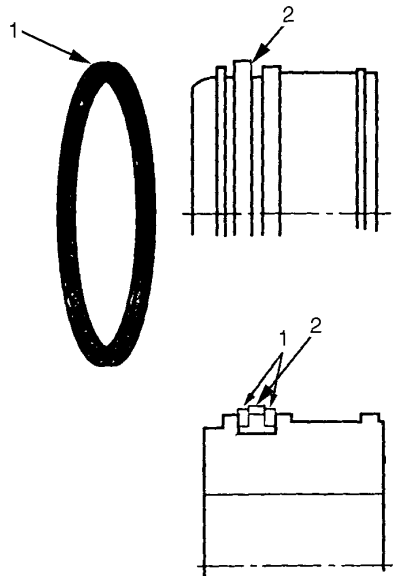


FIGURE 7-102 4031

16. Install the wear ring (1, Figure 7-103) on the piston.

1. Wear Ring

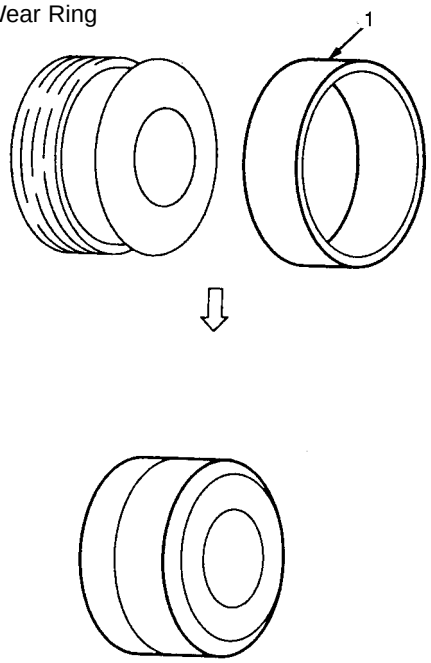


FIGURE 7-103 3849

17. Set the cylinder rod (1, Figure 7-104) into a repair fixture (2). Securely clamp the rod to the fixture. Exercise caution to prevent nicks or scratches to the chrome plated area of the rod. The chrome plated area is the oil sealing surface of the rod.

1. Cylinder Rod
2. Repair Fixture

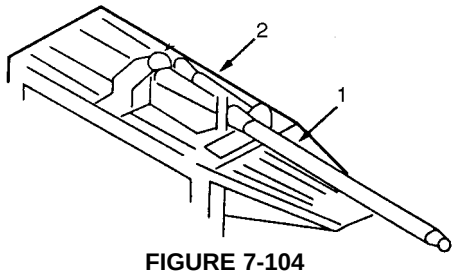


FIGURE 7-104 3850

18. Slide the cylinder head assembly (1, Figure 7-105) onto the cylinder rod (2). Use caution to prevent the threads on the rod from damaging the seals inside the cylinder head.

1. Cylinder Head
2. Cylinder Rod

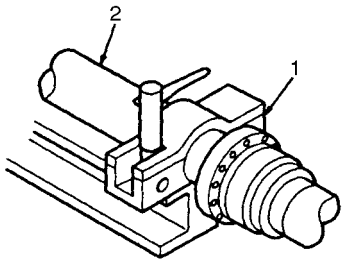


FIGURE 7-105 3851

19. Install the cushion flange (1, Figure 7-106) on the cylinder rod (2). Slide the piston assembly (3) onto the cylinder rod (2).

1. Cushion Flange
2. Cylinder Rod
3. Piston Assembly

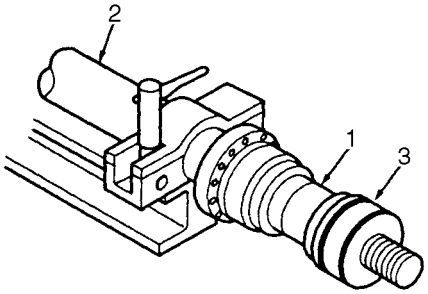


FIGURE 7-106 4030

20. Install the piston nut (1, Figure 7-107) and tighten it with an impact wrench. Then use a torque wrench to tighten the nut (1) to the specified torque. Use a pipe extension on the torque wrench handle if necessary, to achieve the specified torque.

1. Piston Nut

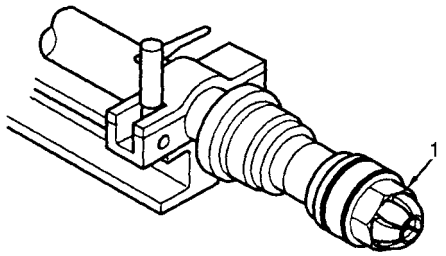


FIGURE 7-107 3853

It is also possible to rotate the handle of the torque wrench with a hoist and a lifting sling for a cushion. See Figure 7-108.

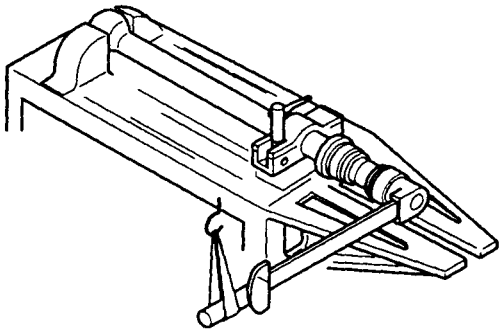


FIGURE 7-108 3854

After the nut has been tightened, check to see that the cushion flange moves.

21. Slide the rod assembly into the cylinder tube. Align the punch mark (1, Figure 7-109) with the port (2) in the cylinder tube. This will align the hole (3) in the cylinder head with the port (2).

1. Punch Mark
2. Port
3. Hole

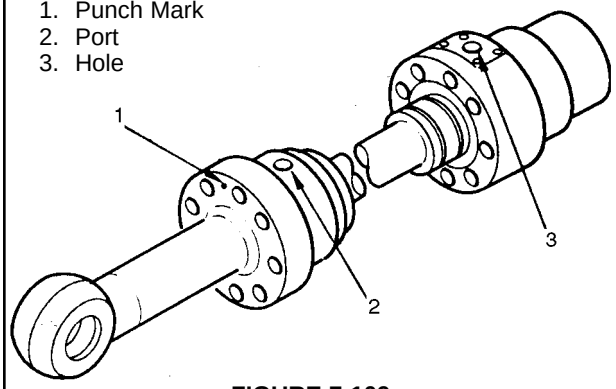


FIGURE 7-109 3855

22. Install the bolts in the cylinder head and tighten them to the torque specified in the bolt torque chart. See Figure 7-110. Double check to make sure that the hole in the cylinder head is aligned with the port in the cylinder tube.

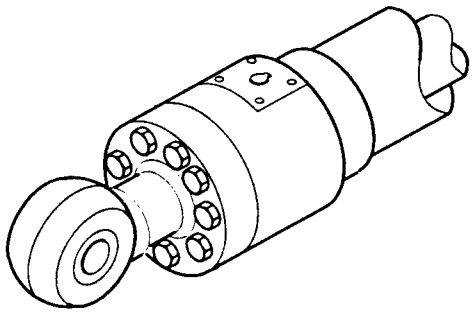


FIGURE 7-110 3856

NOTE

After rebuilding a cylinder, or after loosening a cylinder hydraulic line, air must be bled from the hydraulic system. To bleed air from the system, first extend and retract a cylinder (or pair of cylinders) about 5 times at low engine RPM. Stop the cylinder about 100 mm (4") short of full extension and full retraction. Then fully extend and retract the cylinder about 5 times, also at low engine RPM.

Boom Hydraulic Cylinder

The boom hydraulic cylinder has an inside diameter of 160 mm, a rod diameter of 85 mm, and a stroke length of 795 mm. Figure 7-111 contains an exploded view drawing of the parts contained in a boom cylinder.

1. Cylinder Tube
2. Cylinder Rod
3. Cylinder Head
4. Bushing
5. Snap Ring
6. Packing Header
7. U-ring
8. Wiper Ring
9. Snap Ring
10. Piston
11. Piston Ring
12. U-ring
13. U-ring Holder
14. Stopper
15. U-nut
16. Lock Washer
17. Pin Bushing
18. Pin Bushing
19. Grease Fitting
20. O-ring

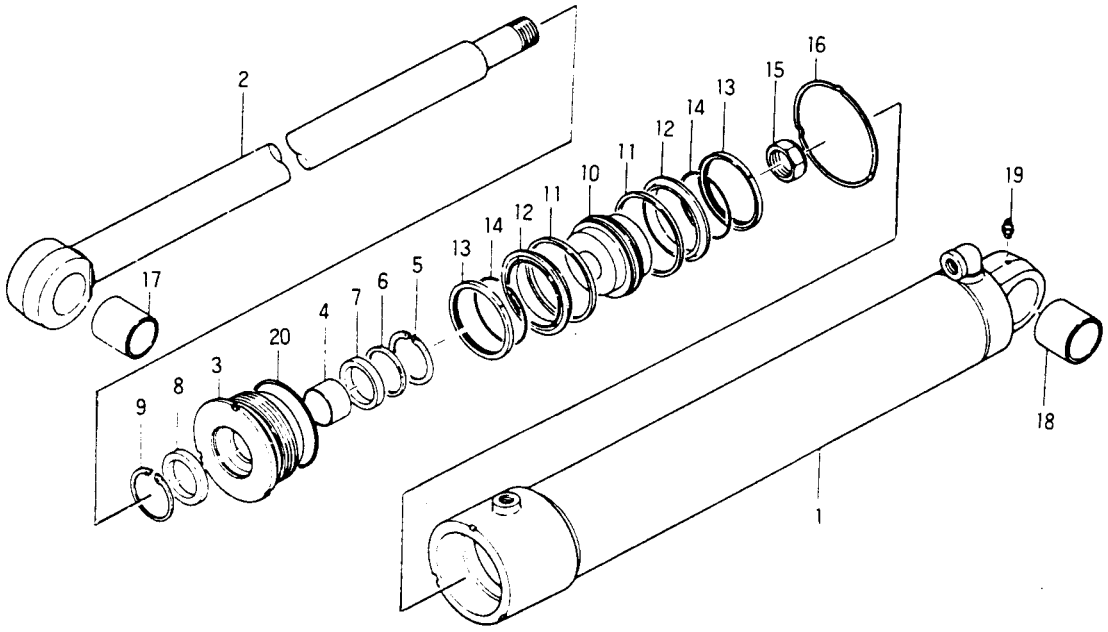


FIGURE 7-111

4114

Bucket Hydraulic Cylinder

The bucket hydraulic cylinder has an Inside diameter of 140 mm, a rod diameter of 75 mm, and a stroke length of 475 mm. Figure 7-112 contains an exploded view drawing of the parts contained in a bucket cylinder.

1. Cylinder Tube
2. Cylinder Rod
3. Cylinder Head
4. Bushing
5. Snap Ring
6. Packing Header
7. U-ring
8. Wiper Ring
9. Piston
10. Piston Ring
11. U-ring
12. U-ring Holder
13. U-ring Holder
14. Stopper
15. Castle Nut
16. Shim
17. Dividing Pin
18. Lock Washer
19. Pin Bushing
20. O-ring
21. O-ring
22. Plug

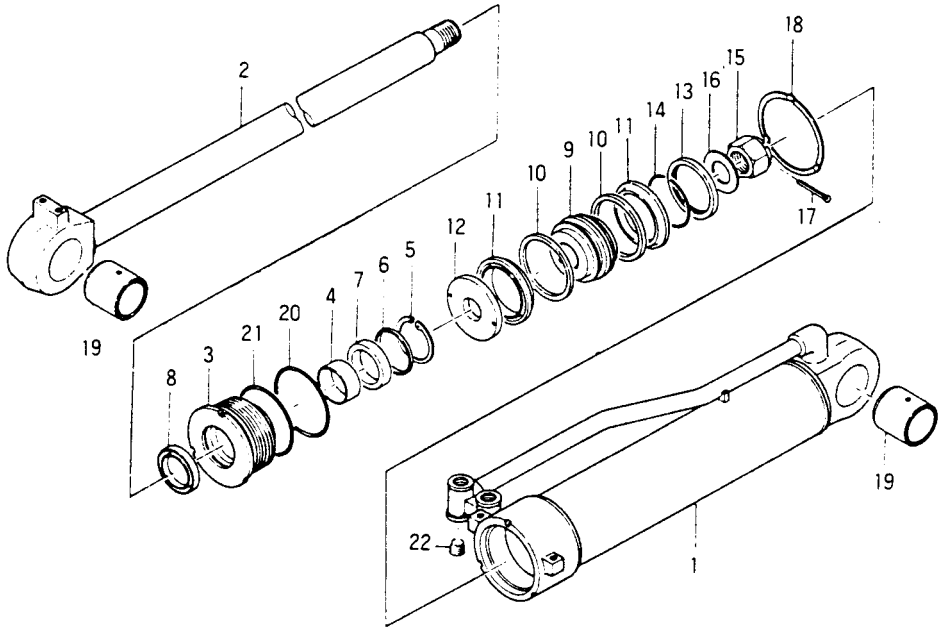


FIGURE 7-112

4115

Accumulator

The accumulator is a gas-charged storage device designed to hold a reserve quantity of hydraulic fluid under pressure. Accumulators are used in hydraulic circuits in much the same way that condensers (or capacitors) are used to collect, store and maintain electrical charge in a circuit.

In a hydraulic circuit, minor variations or lags in pump output that might otherwise cause unsteady or irregular operation are made up from the supply of pressurized oil in the accumulator.

Accumulators are solidly constructed to resist the high operating pressures of the fluids they contain. There are only three main moving parts: a valve assembly at the top allows adding or expelling gas from the compressible, precharged upper chamber; a valve assembly at the bottom of the accumulator for passing hydraulic fluid in and out, and an elastic diaphragm to separate the two chambers. See Figure 7-113. The flexible diaphragm changes shape to conform to the changing pressures and volumes of the two fluids in the upper and lower chambers.

DIAPHRAGM TYPE ACCUMULATOR (CROSS SECTION)

1. Screw Plug
2. Sealing Ring
3. Diaphragm
4. Fluid Valve
5. Steel Pressure Vessel
6. Valve Button

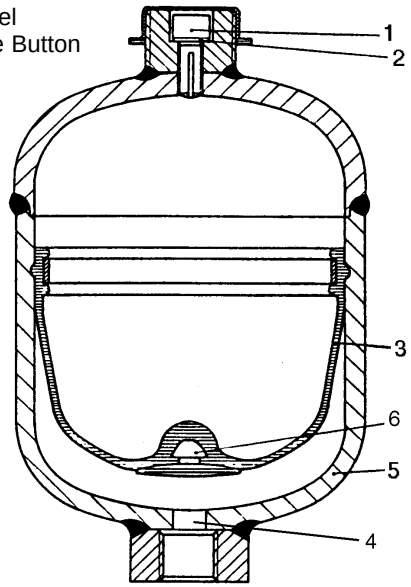


FIGURE 7-113

4032

The illustrations on this page show the position of the diaphragm in six possible positions. See Figure 7-114.

1. With no gas charge in the upper chamber (0 psi, empty) and no oil in the bottom (0 psi, dry) the elastic diaphragm hangs loosely.
2. When the pre-pressure charge of gas (usually nitrogen) is introduced through the valve at the top of the accumulator, the diaphragm expands to maximum size. The valve button in the center of the diaphragm pushes into the fluid opening in the bottom chamber, sealing off the lower valve. If the pressure of the gas charge exceeds system oil pressure, no fluid enters the accumulator. The button also keeps the diaphragm from protruding into the lower valve opening.

1. Without Nitrogen Fill
2. Pre-pressurized with Nitrogen to Pre-pressure P1
3. Storage of Pressure Fluid
4. Charged to Maximum Pressure P3
5. Discharge of Pressure Fluid
6. Discharged Down to Minimum Pressure P2

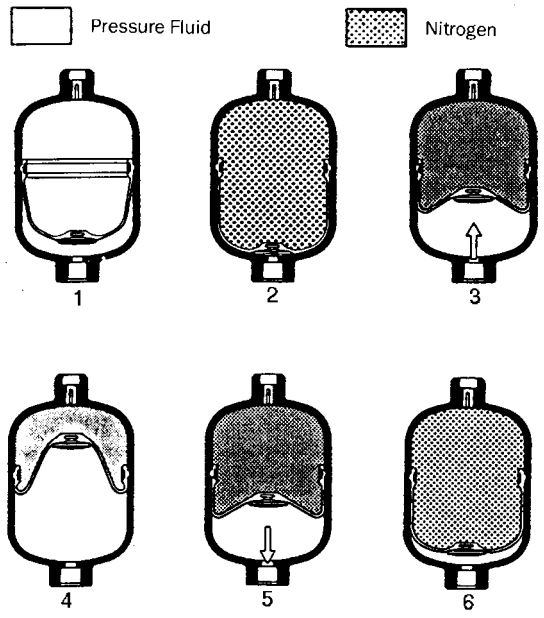


FIGURE 7-114

0361

NOTE

Precharge pressure is referred to as the "P1" pressure. The accumulator manufacturer's "P1" rated pressure should be stamped or marked on the accumulator's rating plate. Annual checks of actual precharge pressure should be made by tapping a hydraulic pressure gauge (and 3-way adapter coupling) into the valve on the bottom of the accumulator. When hydraulic fluid is pushed out of the lower valve opening by the pressure of the gas charge on the other side of the diaphragm – and there is no counter-pressure from system oil – the valve button on the bottom of the diaphragm eventually seals off the lower oil passage. Just after the needle on the gauge reaches its highest point (when there is 0 psi resistance from hydraulic system pressure) pressure on the gauge will drop sharply to zero, as the accumulator is completely emptied of oil and the diaphragm button closes.

Record the highest gauge reading and compare to the "P1" rated precharge pressure on the accumulator manufacturer's data label. Repeat this test at least once a year to verify proper functioning of the accumulator.

3. As hydraulic system pressure overcomes accumulator precharge pressure, the flexible diaphragm begins to retract upward.
4. When system oil is at highest working pressure and the accumulator fills to maximum reserve capacity, the flexible diaphragm is pushed up into the top of the upper chamber.

   The highest working pressure is sometimes referred to as the "P3" pressure and can be found on the manufacturer's data label on the exterior of the accumulator.
5. If system oil pressure begins to fall off or is momentarily checked or interrupted, the energy stored on the other side of the diaphragm, in the form of compressed gas, pushes oil back out of the lower chamber, maintaining oil pressure of the circuit.
6. With minimal system pressure, an equilibrium point may be reached in which accumulator precharge pressure and hydraulic system oil pressure achieve a rough balance. In this condition a minimal amount of oil is stored in the accumulator.

Charging the Accumulator with Nitrogen

1. Remove the protective cap (10, Figure 7-115) and the protective plug (11) from the accumulator (6).

1. Nitrogen Cylinder Fitting
2. Hose, 3 Meters Long
3. Check Valve
4. Pressure Gauge
5. Sealing Nut
6. Accumulator
7. Cylinder to Accumulator Adapter
8. Nitrogen Bleeder Valve
9. Nut O-ring
10. Protective Cap
11. Protective Plug
12. Sealing Ring

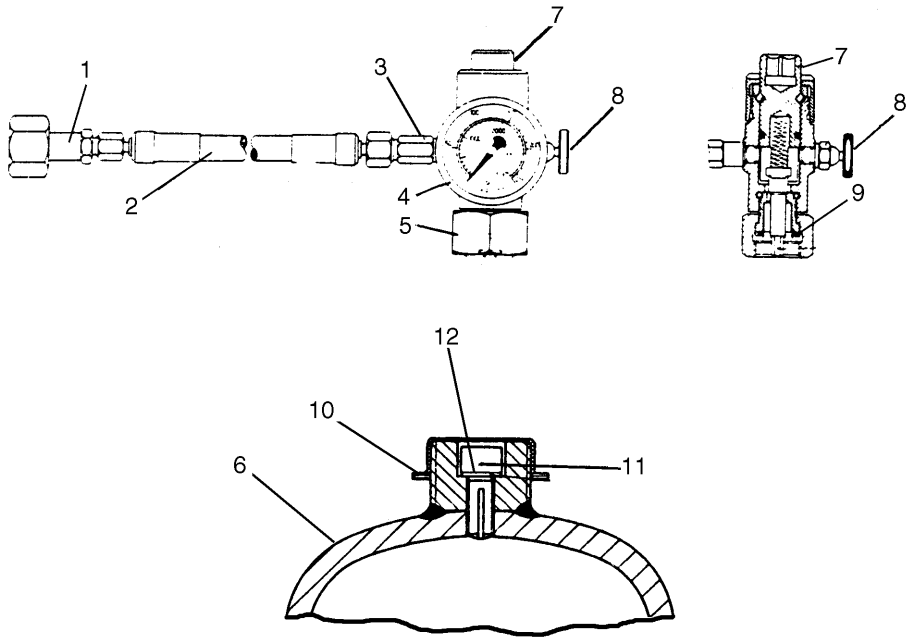


FIGURE 7-115

4116

2. Clean the area around the seal ring (12).
3. Thread the sealing nut (5) of the adapter (7) onto the accumulator. Tighten the adapter securely. Close the nitrogen bleeder valve (8).
4. Thread the nitrogen cylinder fitting (1) onto the nitrogen cylinder.
5. Open the valve on the nitrogen cylinder and charge the accumulator to a pressure that is higher than the primary pressure (P1) 30 kg/cm^2 (427 psi). Close the valve on the nitrogen cylinder.

   NOTE

   Wait 2 or 3 minutes for the nitrogen to warm to the ambient temperature. This will stabilize the pressure.
6. Slowly open the nitrogen bleeder valve (8). Open the valve (8) until the gauge (4) reading is equal to the primary pressure. Close the bleeder valve (8).
7. Unscrew the adapter (7) from the accumulator (6).
8. Thread the protective plug (11) into the accumulator. Tighten to 3 kg m (21.7 psi).
9. Check for nitrogen leaks around the protective plug (11). Coat the area around the protective plug (11) with soapy water. If soap bubbles form, retighten the protective plug (11).
10. Install the protective cap (10) on the accumulator.

⚠WARNING!!!

Accumulators store nitrogen under high pressure. Before replacing an accumulator, install an adapter (7) with a bleeder valve (8) on the accumulator. Slowly and carefully bleed off all nitrogen before removing the accumulator from the hydraulic system.

NOTE

After an accumulator has been installed, or after an accumulator has been recharged with nitrogen, check the nitrogen pressure (P1) after the first week of operation. Check for a pressure drop due to leaks. If no pressure drop is found after the first week, check again after 3 more weeks. If no pressure drop is found after 3 weeks, check after one year.

Hydraulic System Schematic

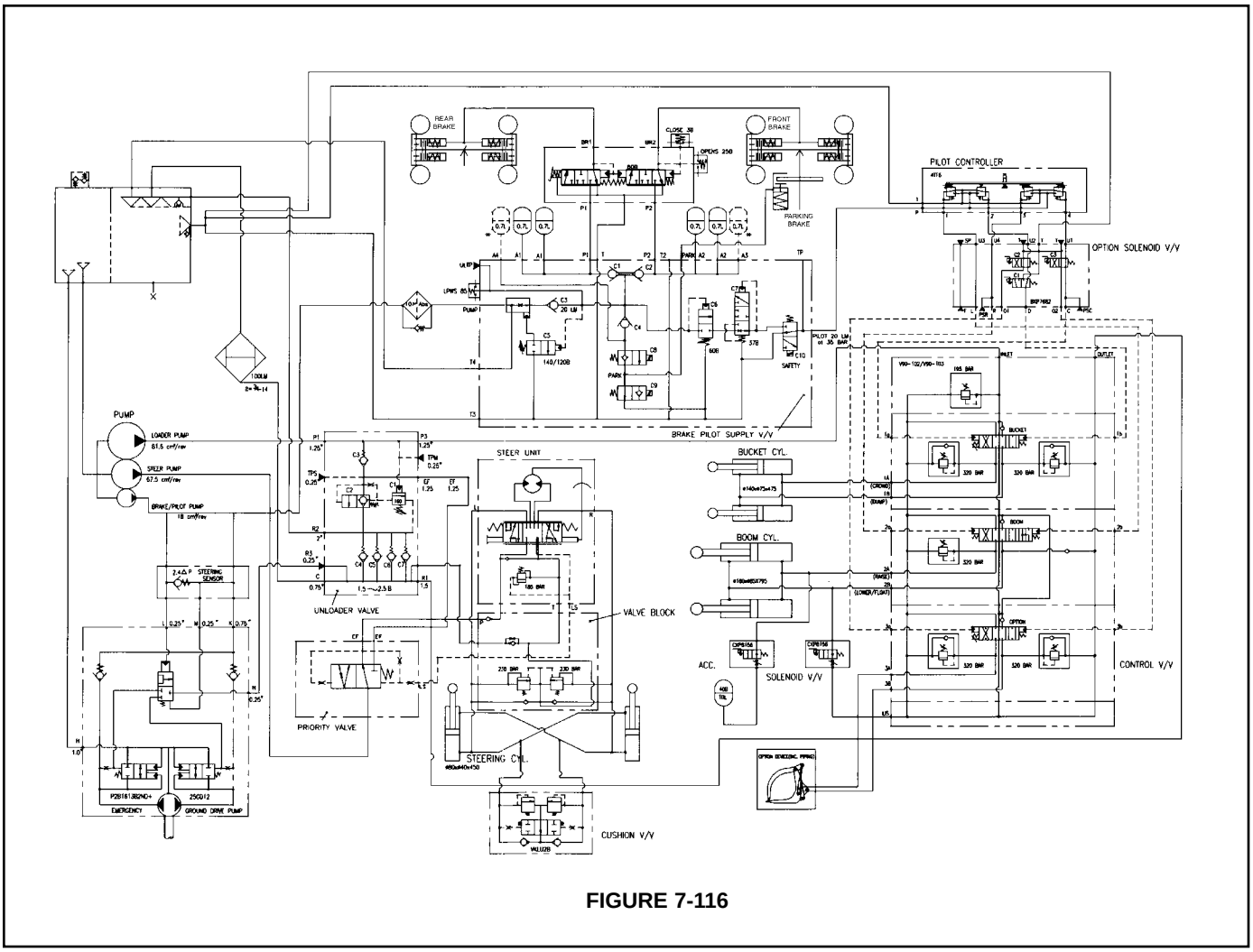


FIGURE 7-116

Engine Specifications (D2366T)

Item	D2366T	Item	D2366T
Engine type	Diesel in-line Vertical, Water-cooled 4-cycle, Turbocharged	Rated Power, Metric Hp (Hp) @ RPM	208 (205) @ 2,200
		Max. Torque Kg m (ft lb) @ RPM	83 (600) @ 1,300
Combustion system	DI, Toroidal		
No. of cylinders	6	Weight kg (lb)	920 (2,028)
Bore	123 mm (4.85")	Engine Dimensions	
Stroke	155 mm (6.10")	• Length mm (ft in)	1,294 (4' 3")
Total displacement	11,051 cm^3 (675 in^3)	• Width mm (ft in)	790 (2' 7")
Compression ratio	16.5 : 1	• Height mm (ft in)	1,070 (3' 6")
Firing order	1-5-3-6-2-4		

Detailed Specifications

Valve Clearance (cold engine)	
Intake valves	0.3 mm (0.012")
Exhaust valves	0.3 mm (0.012")
Cooling System	
Type	Forced circulation by impeller pump
Temperature control	Thermostat
Temperature range	92 – 95°C (180 – 203°F)
Lubrication System	
Type	Engine oil pressurized by gear pump
Filter	Full flow filter, replaceable paper element
Cooling system	Flat tube type oil cooler
Engine Lubrication Pressures	
At idle	0.8 – 1.4 bar (12 – 20 psi)
At max. engine RPM	3.0 – 4.8 bar (45 – 70 psi)
Fuel Filter	
Type	Double stage filtration, 1st stage – felt element 2nd stage – paper element
Fuel Injection Pump	
Type	Robert Bosch, P type pump
Governor	RSV style
Fan Belt (standard engine)	
Radiator fan belt	12.5 mm x 1,600 mm (2 – 0.5" x 63")
Electrical System	
Alternator	
Type	HC-60 (including IC regulator)
Capacity	24 V, 60 A
Starter	
Type	Reduction or magnetic style
Power draw	24 V, 6.6 Kw
Engine Oil Capacity	
System capacity	21 l (5.5 gal US)

Fuel Injection Timing and Valve Opening Timing

Item	D2366T
Fuel Injection (BTDC)	5.6 degree
Valve opening	
– Intake open (BTDC)	18 degree
– Intake close (ABDC)	34 degree
– Exhaust open (BBDC)	46 degree
– Exhaust close (ATDC)	14 degree

Turbocharger

Type	Exhaust Gas Driven
Lubrication Pressures	
At idle	Min. 0.8 bar (11.6 psi)
At max. engine RPM	Min. 2.0 bar (29 psi)
Rotor Shaft Axial Clearance	Max. 0.25 mm (0.0098")
Rotor Shaft Radial Clearance	Max. 0.5 mm (0.0197")

Valve Adjustment Sequence

The valve clearance on a cold engine is 0.3 mm (0.012") for both intake and exhaust valves.

Engine cylinder firing order is 1-5-3-6-2-4. When valves of cylinder 6 are completely opened, number one cylinder is at top dead center. When valves of cylinder 1 are completely opened, number six cylinder is at top dead center.

With No. 6 cylinder at TDC, adjust:

Exhaust valves for No. 2, 4 and 6 cylinders
Intake valves for No. 3, 5 and 6 cylinders

With No. 1 cylinder at TDC, adjust:

Exhaust valves for No. 1, 4 and 5 cylinders
Intake valves for No. 1, 2 and 4 cylinders

Engine Cylinder Compression Test

Start the engine and allow it to operate long enough for normal warm-up. Allow a brief cool down period (for cylinder head temperature surge) and remove fuel injection nozzles from the head. Install the compression gauge adapter in each threaded nozzle hole, in succession, and crank the engine with the starter (200 RPM) testing compression in each cylinder, in turn. Measured compression should be between 24 kg/cm^2 (340 psi) and 28 kg/cm^2 (398 psi), with a maximum difference between any two cylinders of 10 percent.

Wear Limits of Major Engine Components

Item	Standard Value	Limit (or NOTE)
Pistons/Cylinder		
Cylinder liners	123 mm – 123.025 mm (4.8425" – 4.8435")	123.225 mm (4.8514")
Projected height	0.03 mm – 0.08 mm (0.0012" – 0.0031")	
Block head face, maximum distortion	0.05 mm (0.0020")	Measured over 200 mm (7.9")
Cylinder head, height	114.9 mm – 115.0 mm (4.5236" – 4.5276")	113.9 mm (4.484")
Valve seat depression, intake valves exhaust valves	 0.35 mm – 0.50 mm (0.0138" – 0.0197") 0.55 mm – 0.70 mm (0.0217" – 0.0276")	 0.8 mm (0.031") 1.0 mm (0.039")
Piston diameter	122.791 mm – 122.949 mm (4.8343" – 4.8405")	Measured 18 mm (0.708") from bottom
Piston/liner clearance	0.051 mm – 0.234 mm (0.0020" – 0.0092")	0.3 mm (0.012")
Piston ring grooves, 1st ring 2nd ring Oil ring	 3.5 mm (0.1378") 3.060 mm – 3.080 mm (0.1205" – 0.1213") 4.040 mm – 4.060 mm (0.1591" – 0.1598")	 Replace if beyond limit Replace if beyond limit Replace if beyond limit
Piston height above block upper surface	0 mm – 0.12 mm (0" – 0.0047")	
Piston ring gap, 1st ring 2nd ring Oil ring	 0.4 mm – 0.65 mm (0.0157" – 0.0256") 0.4 mm – 0.65 mm (0.0157" – 0.0256") 0.3 mm – 0.60 mm (0.0118" – 0.0236")	 1.5 mm (0.0591") 1.5 mm (0.0591") 1.5 mm (0.0591")
Piston ring installation note	Stagger gaps 120° apart.	Ring gaps must not overlap. Space them as far apart as possible. (120° between each gap and the next.)

Wear Limits of Major Engine Components (Continued)

Item	Standard Value	Limit (or NOTE)
Crankshaft/Connecting Rods		
Outside diameter of journal	95.966 mm – 95.988 mm (3.7782" – 3.7791")	94.966 mm (3.7782")
Outside diameter of pin	82.966 mm – 82.988 mm (3.2664" – 3.2672")	81.966 mm (3.2270")
Axial runout of journal and pin	0.05 mm (0.0020")	0.1 mm (0.0039") (horizontal & vertical)
Out of round of journal and pin	0.008 mm (0.000315")	0.025 mm (0.000984")
Permanent radial runout of journal and pin	0.01 mm (0.000394")	0.03 mm (0.001181")
Permissible taper of journal and pin	0.01 mm (0.000394")	0.03 mm (0.001181")
Bearing clearance	0.072 mm – 0.142 mm (0.0028" – 0.0056")	0.25 mm (0.010") (in crown position)
Crankshaft end play	0.15 mm – 0.325 mm (0.0059" – 0.0128")	0.5 mm (0.020") (replace thrust bearing)
Crankshaft runout	0.05 mm (0.00197")	0.1 mm (0.0039") (use press to bend back)
Crankshaft balance	60 g/cm (5.334 oz/inch)	Measured @ 400 RPM
Journal bearing crush	0.15 mm – 0.25 mm (0.0059" – 0.010")	
Connecting rod bearing to crank pin clearance	0.032 mm – 0.102 mm (0.00126" – 0.00402")	0.20 mm (0.0079")
Connecting rod end play	0.22 mm – 0.319 mm (0.0087" – 0.0126")	0.5 mm (0.020")
Connecting rod small end bushing to piston pin clearance	0.05 mm – 0.08 mm (0.0020" – 0.0032")	0.12 mm (0.0047")
Connecting rod bearing crush	0.3 mm – 0.5 mm (0.012" – 0.020")	
Connecting rod permissible weight variation, rod to rod	56 g (1.9 oz)	
Connecting rod bearing Cap bolt torque	28 kg m (203 ft lb)	Oiled threads
Camshaft/Timing/Valve Train		
Camshaft, outside diameter	59.860 mm – 59.880 mm (2.3567" – 2.3574")	
Camshaft to cylinder block clearance	0.050 mm – 0.128 mm (0.0020" – 0.0050")	0.20 mm (0.0079")
Camshaft end play	0.13 mm – 0.27 mm (0.0051" – 0.0106")	0.30 mm (0.012") (replace thrust plate)
Timing gears (cam, idler, injection pump) back-lash between gears	0.16 mm – 0.28 mm (0.0063" – 0.0110")	0.35 mm (0.0138")

Wear Limits of Major Engine Components (Continued)

Item	Standard Value	Limit (or NOTE)
Idler gear, shaft end play	0.043 mm – 0.167 mm (0.0017" – 0.0066")	0.3 mm (0.012") (replace thrust collar)
Idler gear shaft to inserting hole clearance	0.025 mm – 0.091 mm (0.0010" – 0.0036")	0.15 mm (0.0059")
Valve timing Intake open (BTDC) Intake closed (ABDC) Exhaust open (BBDC) Exhaust closed (ATDC)	 18° 34° 46° 14°	
Valve stem, out. diameter, intake out. diameter, exhaust	 10.950 mm – 10.970 mm (0.43110" – 0.43189") 10.935 mm – 10.955 mm (0.43051" – 0.43130")	 10.87 mm (0.42795") 10.84 mm (0.42677")
Valve stem to valve guide clearance, intake valves exhaust valves	 0.030 mm – 0.065 mm (0.0012" – 0.0026") 0.045 mm – 0.080 mm (0.0018" – 0.0031")	 0.15 mm (0.006") (replace guide w/valve) 0.15 mm (0.006") (replace guide w/valve)
Valve thickness, intake Valve thickness, exhaust	1.5 mm (0.060") 1.5 mm (0.060")	1.0 mm (0.039") or less 0.9 mm (0.035") or less
Radial runout between valve stem and valve head		0.03 mm (0.0012")
Valve guide to cylinder head guide hole	0.01 mm – 0.39 mm (0.0039" – 0.0154")	Oil guides before installation
Valve guide clearance to valve spring seat	22 mm (0.866")	
Intake valve spring, free height spring tension, at 37 mm (1.46")	 75.5 mm (2.97") 61.8 kg – 68.3 kg (136.3 lb – 150.6 lb)	 72 mm (2.83") 61.8 kg (136.3 lb)
Exhaust valve inner spring, free height spring tension, at 34 mm (1.34")	 65 mm (2.56") 36.1 kg – 39.9 kg (79.6 lb – 88 lb)	 61.75 mm (2.43") 36.1 kg (79.616 lb)
Exhaust valve outer spring, free height spring tension, at 37 mm (1.46")	 75.5 mm (2.97") 61.8 kg – 68.3 kg (136.3 lb – 150.6 lb)	 72 mm (2.83") 61.8 kg (136.3 lb)
Valve clearance (cold)	0.3 mm (0.012")	
Rocker arm shaft, diameter	 23.978 mm – 23.959 mm (0.9440" – 0.9433")	 23.75 mm (0.9350")
Rocker arm shaft/rocker arm bushing clearance	0.020 – 0.093 mm (0.0007 – 0.0036")	0.2 mm (0.0078")
Push rod runout		0.3 mm (0.012")
Tappet to block, clearance	 0.035 mm – 0.077 mm (0.00138" – 0.00303")	 0.15 mm (0.006")
Outside diameter, tappet	19.944 mm – 19.965 mm (0.7852" – 0.7860")	

Wear Limits of Major Engine Components (Continued)

Item	Standard Value	Limit (or NOTE)
Lubrication System		
Oil pressure (rated speed)	4.8 kg/cm^2 (68 psi)	
Oil pressure (idling speed)	0.8 kg/cm^2 – 1.4 kg/cm^2 (11.4 psi – 20 psi)	0.6 kg/cm^2 (8.5 psi)
Oil temperature, maximum	90°C (194°F)	100°C (212°F) (briefly)
Oil capacity	21 l (22 qt)	
Oil Pump		
Axial play of gear(s)	0.025 mm – 0.089 mm (0.00098" – 0.00350")	(Replace gear or cover)
Gear shaft to cover clearance	0.032 mm – 0.077 mm (0.00126" – 0.00303")	
Drive gear to cover clearance	0.040 mm – 0.095 mm (0.00157" – 0.00374")	(Drive gear bushing)
Outside diameter, gear shaft	16.950 mm – 16.968 mm (0.66732" – 0.66803")	
Outside diameter, drive gear bushing	27.927 mm – 27.960 mm (1.09949" – 1.10079")	
Gear backlash, at input end *and* output end of drive gear	0.2 mm – 0.65 mm (0.008" – 0.026")	0.8 mm (0.031")
Oil pressure control valve	4 kg/cm^2 – 5 kg/cm^2 (57 psi – 71 psi)	
Filter element bypass	1.8 kg/cm^2 – 2.3 kg/cm^2 (25.6 psi – 32.7 psi)	
Filter cartridge bypass	4.0 kg/cm^2 – 4.8 kg/cm^2 (56.9 psi – 68.3 psi)	
Oil cooler bypass	5 kg/cm^2 – 6 kg/cm^2 (71.1 psi – 85.3 psi)	
Spray nozzle control valve	1.5 kg/cm^2 – 1.8 kg/cm^2 (21.3 psi – 25.6 psi)	
Oil pump relief valve	8.5 – 11.5 kg/cm^2 (120.8 – 163.5 psi)	
Cooling System		
Radiator leak test	Test with 1.0332 kg/cm^2 (14.7 psi) air pressure	
Pressure valve	0.5 kg/cm^2 (7 psi), opening pressure (on radiator cap)	
Negative pressure valve	20 kg/cm^2 (28.4 psi)	
Water pump, delivery volume	Approx 242 l/min (63.9 gal/min), 2,300 RPM, 85°C (185°F) coolant, 0.5 atm. back pressure	
Water pump main bearing	Less than 0.2 mm (0.008") play, inner to outer race	
Water pump, impeller to pump cover clearance	0.35 mm (0.014")	
Coolant operating temp.	80°C – 85°C (176°F – 185°F)	95°C (203°F)
Highest operating temp.	105°C (221°F) (briefly)	100°C (212°F) (briefly)
Thermostat opening temperature	71°C (160°F) (start)/83°C (181°F) (fully open)	(Stroke minimum is 9 mm) (0.3546")
Water pump drive belt	15 mm (0.5") deflection	

Wear Limits of Major Engine Components (Continued)

Item	Standard Value	Limit (or NOTE)
Fuel System		
Overflow valve, opening pressure	1 kg/cm^2 – 1.5 kg/cm^2 (14 psi – 19 psi)	
Projecting nozzle, height	4.2 mm (0.165")	
Fuel injection pump, tappet body to pump clearance	0.03 mm – 0.07 mm (0.001" – 0.003")	0.15 mm (0.006")
tappet wear limit	Less than 0.2 mm (0.008")	0.2 mm (0.008") or above
camshaft end play	0.02 mm – 0.06 mm (0.008" – 0.0024")	Adjust with shims
control rod, stroke distance	21 mm (0.827") (with calibrated pull test apparatus)	
sliding resistance	150 g (5.3 oz), maximum (pull scale test)	
Injection timing	5.6° BTDC	
Injection plunger, lift	4.7 mm (0.185")	
Pump timing interval, cylinder to cylinder	60° (± 30 s)	

Engine Oil Pump Overhaul and Rebuilding

IMPORTANT

Before removing or disassembling the pump, consider the following causes of low oil pressure and eliminate the possibility that a simpler procedure could provide a repair:

- **Wrong, worn or very low oil.**
- **Relief valve stuck open.**
- **Oil pump feed pipe cracked, broken or leaking.**
- **Oil pump strainer clogged.**
- **Oil pressure gauge inaccurate.**
- **Oil pump gears or other components worn or defective.**
- **Crankshaft or connecting rod bearings worn.**

1. Drain all oil from the oil pan and remove the pan to allow access to the oil pump.
2. Unbolt the two 10 mm x 50 mm fasteners holding the pump to the bottom of the engine block and remove the pump for service.
3. Remove the plug and locknut holding the oil relief valve to the lower part of the pump body. Before withdrawing the valve from the body of the pump,
   A. Undo the front lock ring and attaching nut on the pump drive gear and use a gear puller or two screwdrivers to remove the pump drive gear, which is held with a woodruff key. See Figure 8-2.

1. Lock Ring
2. Pump Cover
3. Woodruff Key
4. Dowel Pins
5. Relief Valve Plunger

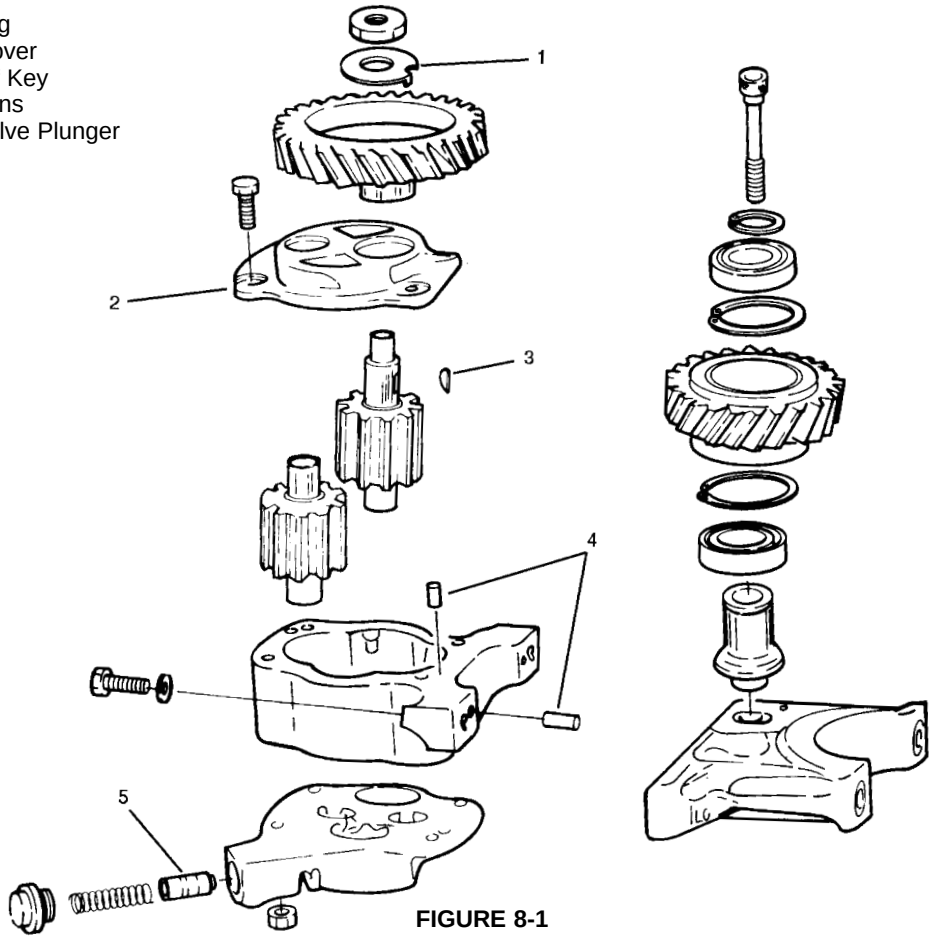


FIGURE 8-1

0259

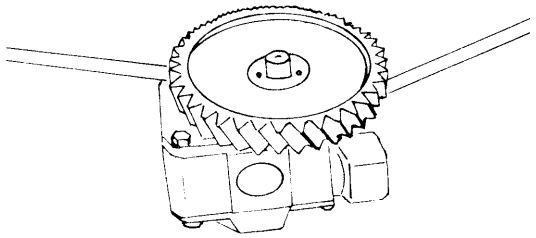


FIGURE 8-2 0260

B. Unbolt the oil pump cover and carefully pull it away from the body of the pump, taking care not to bend or otherwise damage the dowel pins maintaining alignment position of the cover.

4. With both gears still in the housing, use a straight edge and feeler gauge to measure the gap between the outer face of the gears and the pump cover. See Figure 8-3. Allowable clearance is between 0.025 mm (0.001") and 0.089 mm (0.0035"). Replace the cover or gear(s) if clearance is exceeded.

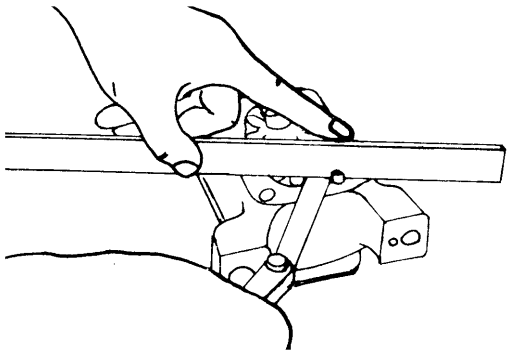


FIGURE 8-3 0261

5. Measure gear backlash as shown with a feeler gauge. See Figure 8-4. The allowable value is between 0.50 mm (0.020") and 0.65 mm (0.026").

6. Remove the gears from the pump body and check the diameter of both gear shafts with a micrometer. The standard tolerance is 16.968 mm (0.6680") to 16.950 mm (0.6673").

7. The final dimensional checks that need to be made are for the diameter and eccentricity of the shaft holes in the cover.

   Use a bore gauge to measure shaft hole diameter across several points, to make sure the hole is not out-of-round. Subtract measured shaft diameter from the measured bore dimension.

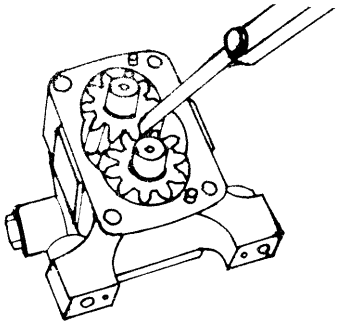


FIGURE 8-4 0262

Allowable clearance between the pump (output) drive shaft and pump cover hole is between 0.032 mm (0.0013") and 0.077 mm (0.0030").

Allowable clearance between the pump driven shaft (input) and the pump cover hole is between 0.040 mm (0.0016") and 0.094 mm (0.0037").

Replace the pump cover or one or both gears if values are beyond specified limits.

8. Pump reassembly consists of reversing the steps of the disassembly procedure.

IMPORTANT

Make sure that all parts have been thoroughly cleaned of all traces of grit, dust or sediment before reassembly. Always pre-lubricate friction surfaces of moving parts with engine assembly lube, to reduce any chance of causing damage upon initial start-up.

Fuel Injection Pump Installation, Alignment and Timing

If the fuel injection pump must be removed from the engine for overhaul, repair or replacement, it will be necessary to shim the pump mounting bracket as part of the installation procedure. See Figure 8-5. Precise, accurate positioning of the mounting bracket in relation to the cylinder block is required in order to set up and correctly align the pump and pump coupling drive shaft.

Smooth and efficient operation of the engine requires that a correctly metered volume of fuel is injected into the engine cylinder, at precisely the right instant, in response to variable load and speed requirements. Both the volume of fuel and the timing of fuel delivery, in relation to engine rotation, are adjustable. After the pump and mounting bracket have been correctly positioned check injection timing and delivery volume.

Injection Pump Installation

The bracket can be shimmed closer to or farther away from the engine block with four available sizes of flat shims, for shimming vertical clearance to the block:

- 0.1 mm (0.004")
- 0.15 mm (0.006")
- 0.2 mm (0.008")
- 0.5 mm (0.020")

There are three available sizes of washer shims, for adjusting pump height, to change the horizontal alignment of the pump:

- 0.1 mm (0.004")
- 0.2 mm (0.008")
- 0.3 mm (0.012")

1. Shims

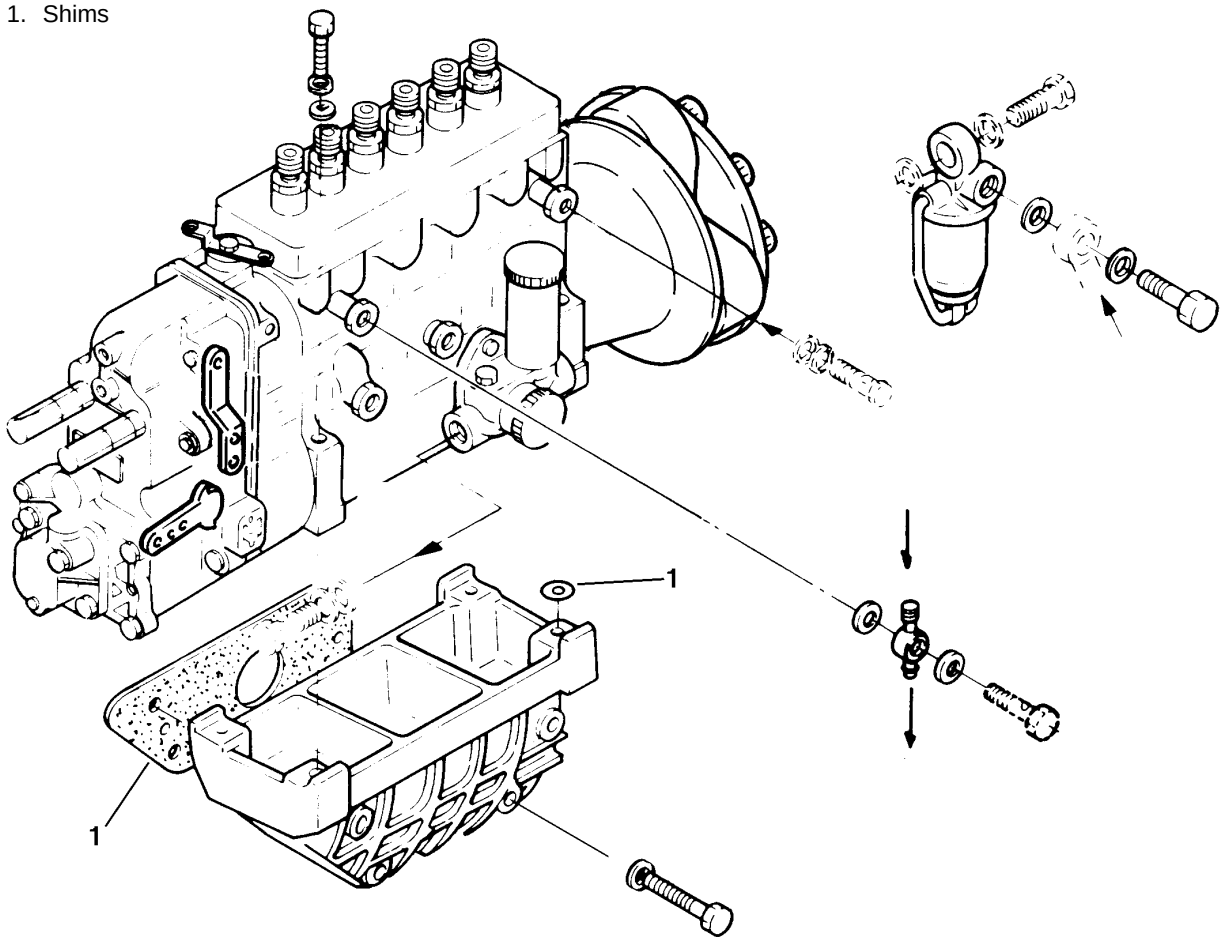


FIGURE 8-5

0263

IMPORTANT

Prior adjustment of engine timing gears (idler gear and injection pump drive gear) may be necessary for injection pump re-installation and alignment.

NOTE

Gear backlash between all timing gears should be between 0.16 mm (0.006") and 0.28 mm (0.011").

When pump mounting bracket shims have been installed in place, position the pump on the bracket and fully tighten installation bolts.

Rotate the engine until the mark on the vibration damper (at the front of the engine) is aligned with the pointer on the block. Remove the rectangular cover from the top of the flywheel housing in order to check alignment position.

Align the pointer on the injection pump with the line on the timer and assemble the injection pump and coupling drive shaft.

If alignment is incorrect, unbolt the injection pump mounting bracket, remove or add shims as required, and reinstall the pump. When alignment between the pump and coupling drive shaft is correct, use two open end wrenches to tighten the coupling joint bolts, simultaneously.

Injection Pump Timing Check

Turn the engine manually until the number 1 cylinder is at TDC.

Remove the delivery valve holder for number 1 cylinder from the top of the pump, along with the delivery valve spring, delivery valve and delivery valve gasket.

Install a tester (dial-type plunger stroke indicator or a glass tube volume level indicator) in the number 1 cylinder pump hole and observe tester manufacturer's set-up instructions.

For most types of injection pump testers, it's necessary to "zero" the tester by rotating the pump plunger to bottom dead center. Turn the pump manually and adjust the tester.

With number 1 cylinder at bottom dead center and the tester set up to measure plunger stroke (dial-type) or delivery volume (glass tube-type) turn the engine slowly by hand, bringing it up towards the number 1 cylinder top dead center position.

Injection delivery for the number 1 cylinder should be timed to 5.6° BTDC with the plunger in the pump stopping fuel flow as the plunger is lifted to:

3.0 mm (± 0.5 mm), or

0.118" (± 0.002").

If a change in the adjustment position is required, make the necessary correction by changing shim thickness between the flange sleeve and pump housing. See Figure 8-6.

Injection Pump Delivery Volume

Test injection volume using correct injection nozzles, nozzle holders and injection pipes. Tested fuel should be at a relatively warm temperature, between 40°C – 45°C (105°F –115°F).

Keep delivery pressure adjusted to 1.6 kg/cm^2 (23 psi).

To adjust injection volume, loosen the 2 nuts on the flange sleeve (12, Figure 8-6) and turn the flange sleeve (together with the plunger barrel) by using the long hole in the sleeve. Turn the flange sleeve clockwise to increase injection volume and counterclockwise to reduce volume.

1. Nut
2. Washer
3. O-ring
4. Deflector
5. O-ring
6. Camshaft
7. Cover
8. Delivery Valve Holder
9. Delivery Valve Gasket
10. Adjusting Shim
11. Delivery Valve
12. Flange Sleeve
13. Plunger Barrel
14. Plunger
15. Control Rod
16. Control Sleeve
17. Tappet

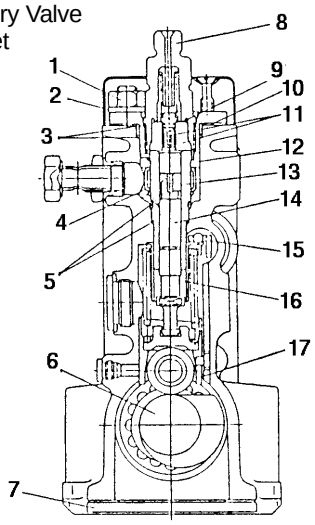


FIGURE 8-6

0264

Cylinder Head Bolt Torque Requirements

There are two separate sections of the cylinder head. Each half of the head is mated to three individual cylinders in the engine block.

During engine reassembly following an overhaul or repair, or at regular, periodic maintenance intervals (every 2,000 operating hours) checking head bolt fastener torque is a recommended service precaution.

Cylinder Head Surface Flatness

1. If the engine has been disassembled for service or repair, it is important to carefully clean carbon and deposits from the block and manifold mating surfaces of the cylinder head.
2. Check for distortion of the cylinder head prior to reassembly, using a straight edge and feeler gauge. Measure across six pairs of coordinates along the plane of each mating surface (block *and* manifold). See Figure 8-7.

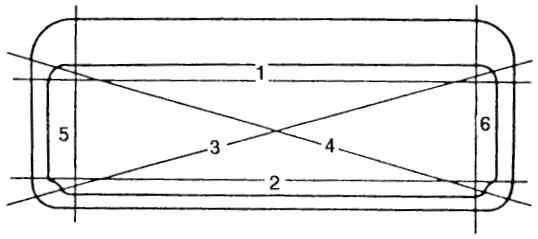


FIGURE 8-7 0265

3. If measured clearance between the straight edge and head exceeds 0.2 mm (0.008") at any point along the length of lines **1** through **6**, repair the damage with a surface grinder prior to reassembly. See Figure 8-7. If measured distortion exceeds 0.3 mm (0.012"), replacement of the cylinder head is required. (Required service value for the manifold surface is 0.4 mm (0.016"), and the service limit recommended replacement value is 1.0 mm (0.040").

NOTE

The standard value for cylinder head height is 114.9 mm – 115.0 mm (4.524" – 4.528"). Service limit replacement value is 113.9 mm (4.484"), or less.

Cylinder Head Tightening Procedure

One cylinder head section is shown in the illustration. See Figure 8-8. The tightening sequence for head bolt fasteners is indicated by the number next to each of the head bolts.

1. Clean each head bolt and the mating threads inside the engine block before reassembly.
2. The upper face of the cylinder block should be thoroughly cleaned and checked for distortion (maximum limit, 0.05 mm [0.002"]).
3. Use mating dowels to align the head gasket and cylinder head assembly to the engine block.
4. Pre-lubricate head bolts with clean engine oil and begin at head bolt number 1. Torque that bolt to 15 kg m (108 ft lb). Tighten each bolt in succession to the same value, then repeat the sequence, tightening to 20 kg m (145 ft lb). Repeat the procedure once again, tightening to the final head bolt torque value, 24.5 kg m (177 ft lb).

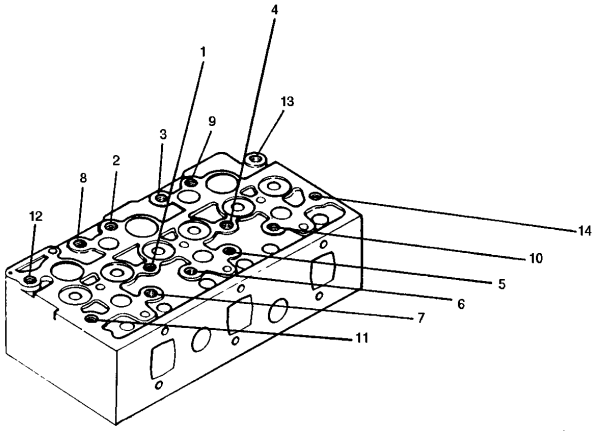


FIGURE 8-8 0266

ELECTRICAL SYSTEM

Electrical Schematic

A foldout schematic that displays the electrical circuits for the entire machine is printed at the end of this section. See Figure 9-7.

24 Volt Operation

The electrical system operates at 24 volts. The engine charging and starting system and electrical lights, controls and accessories (with the single exception of the cab radio/cassette player) all require 24 volt compatibility.

⚠WARNING!!!

1. **Do not attempt to replace 24 volt components with parts made for more widely available 12 volt systems. The cigarette lighter, for example, can overheat with a 12 volt element.**
2. **Disconnect the power source (the negative side of the battery, first) before performing any type of service or maintenance on the electrical system or accessories.**

Wiring Color Code for Electrical Schematic Diagrams

Color markings on the electrical schematic are abbreviated according to the following notation.

Letter	Color
W	White
B	Black
R	Red
Y	Yellow
G	Green

Letter	Color
L	Light blue
Gr	Grey
Br	Brown
Or	Orange
Lg	Light green
P	Pink
V	Violet

WR (White wire with red stripe)
Wire base color – 1st position
Wire stripe color – 2nd position

IMPORTANT

In the description for a wire that has a base color and a colored stripe, the base color is listed first. On the schematic, a wire marked WR is a White wire with a Red stripe.

On the schematic, the numbers printed on wire lengths represent the area of the wire cross section in millimeters. For example, a wire marked 0.85 means that the area of the wire cross section is 0.85 mm^2 (.0013 in^2). A wire marked 1.25 has a cross sectional area of 1.25 mm^2 (.0019 in^2).

Engine Start Circuit

When the ignition switch (1, Figure 9-1) is turned to START, terminal BR of (1) is energized and this conducts current to terminal BR of battery relay (2). This closes the contacts of (2) and this connects the batteries to terminal 30 of starter (3) and terminal B of start relay (4). When the ignition switch (1) is turned to the START position, current flows from terminal C of the starter switch to terminal C of the start relay (4). Current then flows through the start relay coil and out terminal D, on to the starter controller (5) terminal S and out terminal E to ground. This closes the contact in the start relay (4). This directs current flow from terminal PP of (4) to terminal 50 of the starter (3), and this causes the starter to rotate and crank the engine. The engine can be cranked only when the gear select switch (6) is in the NEUTRAL position. If the gear select switch (6) is in FORWARD or REVERSE, the current that flows from the switch (6) to the starter controller (5) opens the path to ground for the start relay (4). This prevents the start relay (4) from closing.

When the alternator is being driven, terminal R of the alternator (8, Figure 9-1) sends a square wave signal to terminal P of the starter controller (5). The size of the signal is directly related to the speed of the alternator. When the alternator reaches a speed of 500 RPM, the signal to the controller (5) causes it to create an open in the circuit between terminals S and E inside the controller (5). This causes an open in the ground path for current that powers the start relay (4). This opens the contact in the start relay (4) and prevents the starter (3) from cranking. The square wave signal prevents the engine from driving the starter motor if the key is held in the START position after the engine starts. The square wave signal also prevents the starter motor from being damaged if the start key is turned to start when the engine is running.

ENGINE START CIRCUIT

1. Ignition Switch
2. Battery Relay
3. Starter
4. Start Relay
5. Starter Controller
6. Gear Select Switch
7. Fuse Box
8. Alternator
9. Battery
10. Circuit Breaker

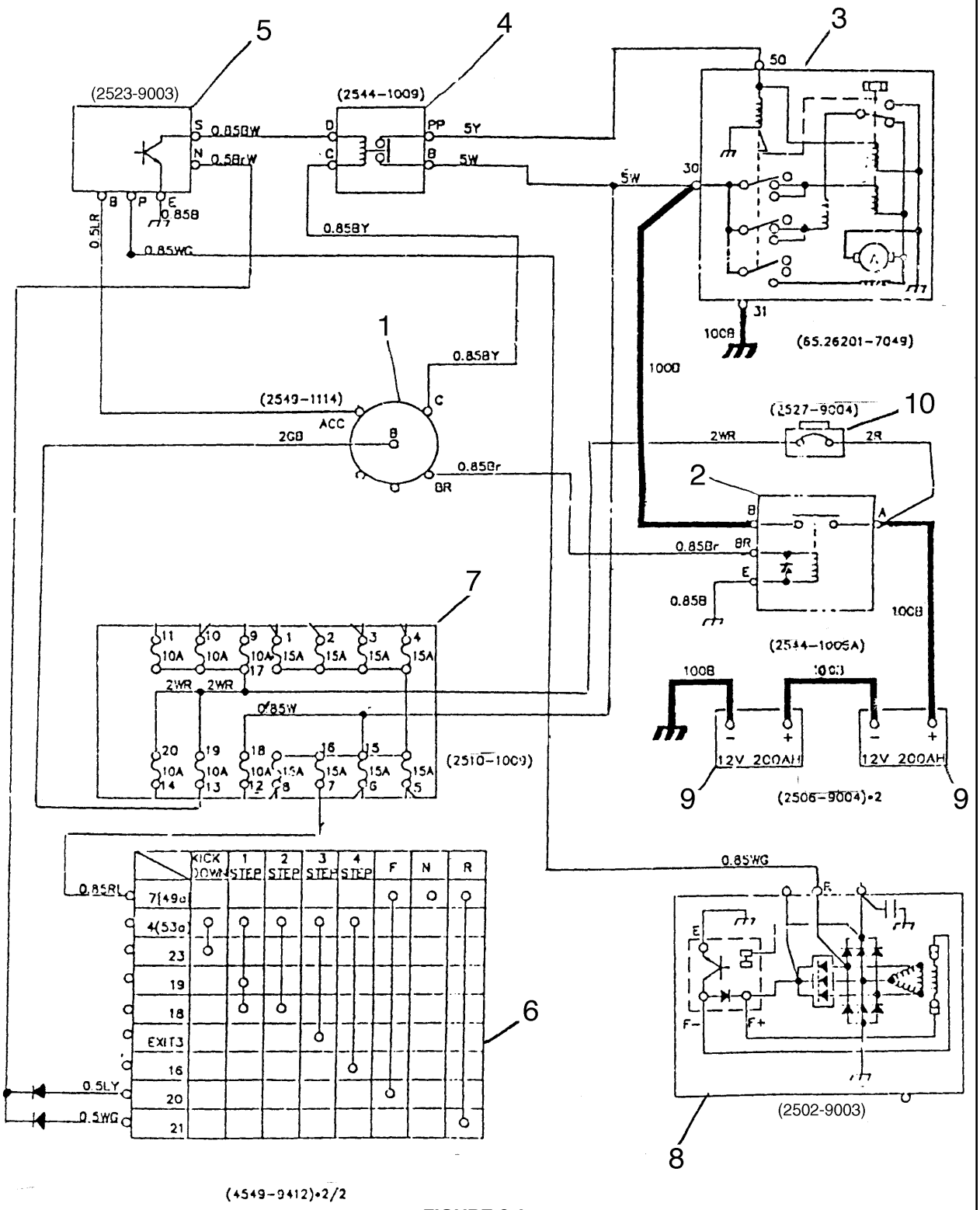


FIGURE 9-1

5018

Engine Stop Motor

When the ignition switch is in the OFF position, the engine stop motor closes the fuel cutoff lever on the injection pump to prevent fuel from reaching the engine. When the ignition switch is in the ON position, the engine stop motor opens the fuel cutoff lever on the injection pump to allow fuel to be pumped to the engine. The motion generated by the engine stop motor is sent through reduction gearing and is changed to a reciprocating motion to operate the fuel cutoff lever.

Current from the batteries (1, Figure 9-2) passes through the circuit breaker (2), and fuse box (3) and powers terminal B on the stop motor (4). This results in power at P2 of stop motor (4). Terminal B on the ignition switch (5) is also powered. With the ignition switch (5) in the ON position, terminal ACC is powered. ACC conducts power to terminal 86 on the stop relay (6). This energizes the solenoid in (6) and this connects terminal 87 with terminal 30 of stop relay (6, Figure 9-2). Current from B of (4) is present at P2 of (4). This powers terminal 87 of (6) and conducts power to 30 of (6). This powers terminal A of (4) and this powers the stop motor (4) to rotate clockwise from the 0° position to the 180° position. This moves open the cutoff lever on the injection pump and allows fuel to be pumped to the injectors.

With the ignition switch in the STOP position, power is removed from terminal ACC of the ignition switch (5). This allows terminals 30 and 87a to connect inside the stop relay (6). Battery power is present at B of (4), and is conducted to P1 of (4), and 87a of (6). This conducts power to terminal 30 of (6), A of (4), E of (4), and ground. This powers the stop motor (4) to rotate clockwise from the 180° position to the 360° position. This moves the cutoff lever on the injection pump to the closed position, and this prevents fuel from being pumped to the injectors.

1. Battery
2. Circuit Breaker
3. Fuse Box
4. Stop Motor
5. Ignition Switch
6. Stop Relay
7. Starter

ENGINE STOP MOTOR CIRCUIT

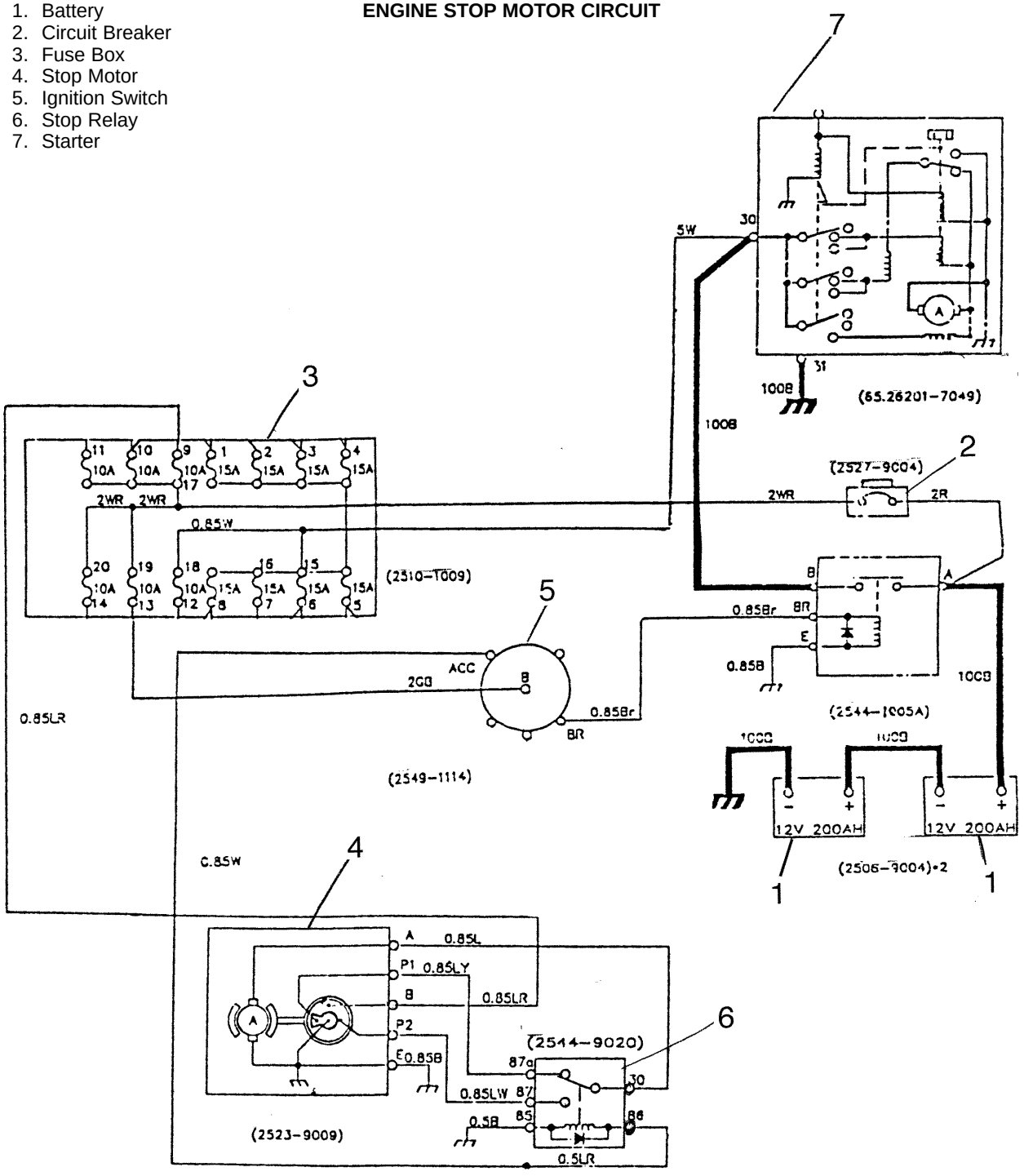


FIGURE 9-2

5019

Engine Intake Preheat Circuit

This circuit uses a thermal switch to monitor engine temperature. The thermal switch triggers an electronic preheat controller to operate only when the engine is cold. The preheat controller turns on a grid type resistance heater that is positioned between the engine air cleaner and the engine intake manifold. Warming incoming air before it enters the manifold and the cylinders greatly improves engine starting efficiency. See Figure 9-3.

The contacts inside the thermal switch (9) are normally open. When the temperature of the coolant drops below 10°C (50°F), the contacts close. When the ignition key (1) is turned to the PREHEAT position, the closed contacts allow the preheat controller (7) to begin current flow to the heating relay (10), which controls current flow (120 amps) to the heating element (4). The preheat controller (7) also turns on the preheat complete pilot light in the operator's cab (8) after the heating element has been heated for 19 seconds. The heating element (4) will heat for 19 seconds each time the ignition key is turned to the PREHEAT position.

The preheat controller (7) switches off current flow to the heater 15 seconds after the engine has started. The heater stays on for 15 seconds in order to achieve more complete cylinder combustion, shorten the time for engine warm-up, and reduce emissions generated during the engine start cycle.

A pulse signal is generated at alternator terminal R as soon as engine RPM exceeds 500 RPM. The signal goes to terminal 2 on the preheat controller (7, Figure 9-3) to start the timing of the 15 second shut-off sequence.

NOTE

As long as the ignition switch is in the PREHEAT position, current travels from the R1 terminal on the ignition switch to terminal 4 on the preheat controller (7). This causes the preheat controller to send current out of terminal (5) to the C terminal of the preheat relay (10). This causes the contacts in the relay (10) to close. This supplies power to heat the coils in the heating element (4).

When engine coolant temperature is above 10°C (50°F) due to ambient temperature or a warm engine, preheating engine intake air is not necessary. In this case, the contacts inside the thermal switch (9) are open. This prevents current flow to the preheat relay (10) which prevents the coils in the heating element (4) from receiving power. Open contacts in thermal switch (9) also trigger the preheat controller (7) to send current to the preheat complete light on the gauge panel in the operator's cab. The preheat complete light turns on immediately when the ignition key is turned.

ENGINE INTAKE PREHEAT CIRCUIT

1. Ignition Switch
2. Circuit Breaker
3. Battery
4. Heating Element
5. Battery Relay
6. Alternator
7. Preheat Controller
8. Preheat Complete Light
9. Thermal Switch
10. Preheat Relay
11. Electronic Control Unit
12. Starter
13. Fuse Box

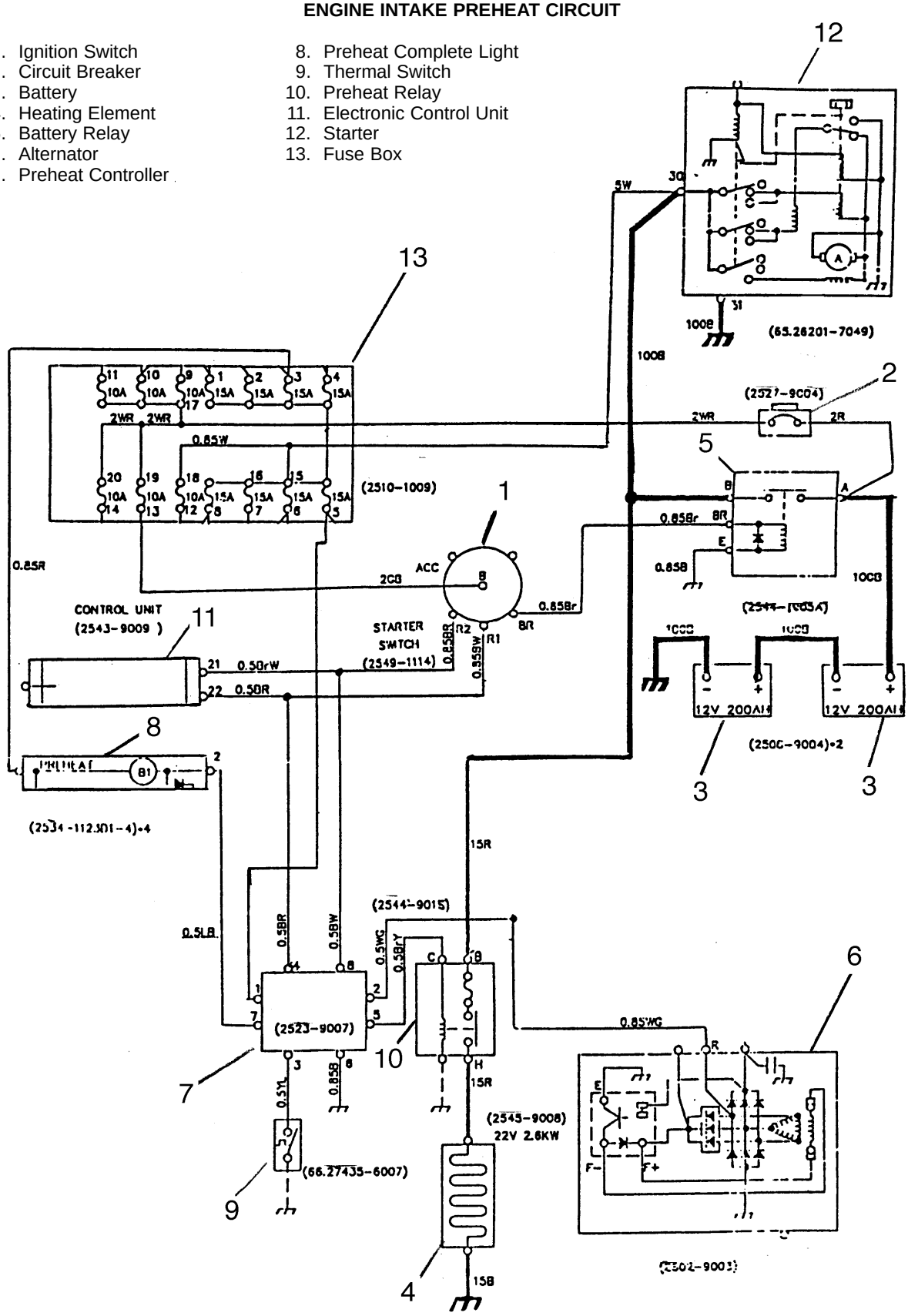


FIGURE 9-3

5020

NOTE

The preheat relay has a replaceable protective fuse. See Figure 9-4.

1. Terminal B
2. Fuse
3. Amperage Marked
4. Terminal H
5. Terminal C

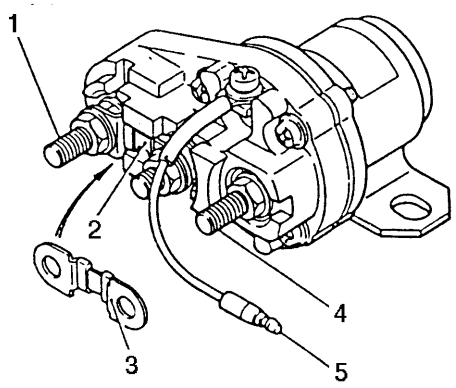


FIGURE 9-4

0275

Windshield Wiper Circuit

When the wiper switch (1, Figure 9-5) is in the I position, current is directed out of the switch at terminal 53. This current flows to terminal 53 on the wiper motor (2) and out to ground at terminal 31b. This powers the wiper at low speed.

When the wiper switch (1) is in the II position, current is directed out of the switch at terminal 53b. This current flows to terminal 53b on the wiper motor (2) and out to ground at terminal 31b. This powers the wiper at high speed.

When the wiper switch (1) is in the J position, current is directed out of the switch at terminal J. This current flows to terminals 1, 2, and 3 of the wiper timer (3). The wiper timer sends an intermittent output to terminal 86 of the timer relay (4). This energizes the coil in the relay, and connects terminal 30 to terminal 87 inside the relay. This allows current from the fused power line to flow from 87 to 30 through the timer relay, and into terminal 31b on the wiper switch (1). Current flows from 31b to terminal 53 on the switch, and out to 53 on the wiper motor (2). This powers the wiper motor in an intermittent cycle.

The cycle of current output from the wiper timer (3) can be shown on a graph. See Figure 9-6. The wiper motor (2) operates only when the current is at the high level (t1). The wiper motor is not powered during time t2. The time necessary to complete 1 cycle is 5.7 seconds.

1. Wiper Switch
2. Front Wiper Motor
3. Wiper Timer
4. Timer Relay
5. Fuse
6. Washer Motor

WINDSHIELD WIPER CIRCUIT

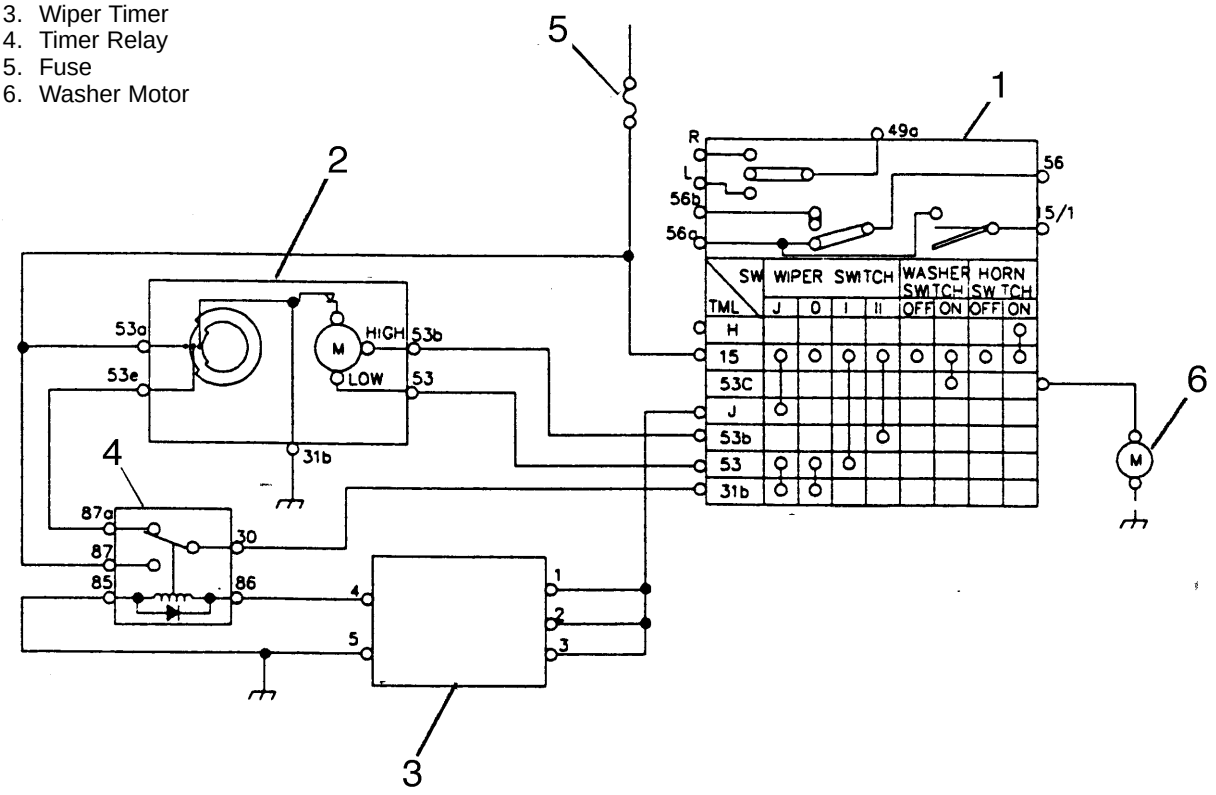


FIGURE 9-5

5021

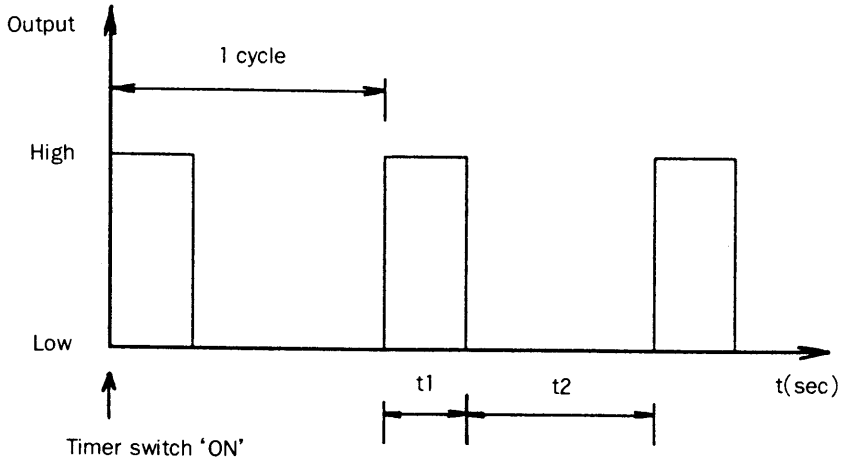


FIGURE 9-6

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Electrical System Schematic

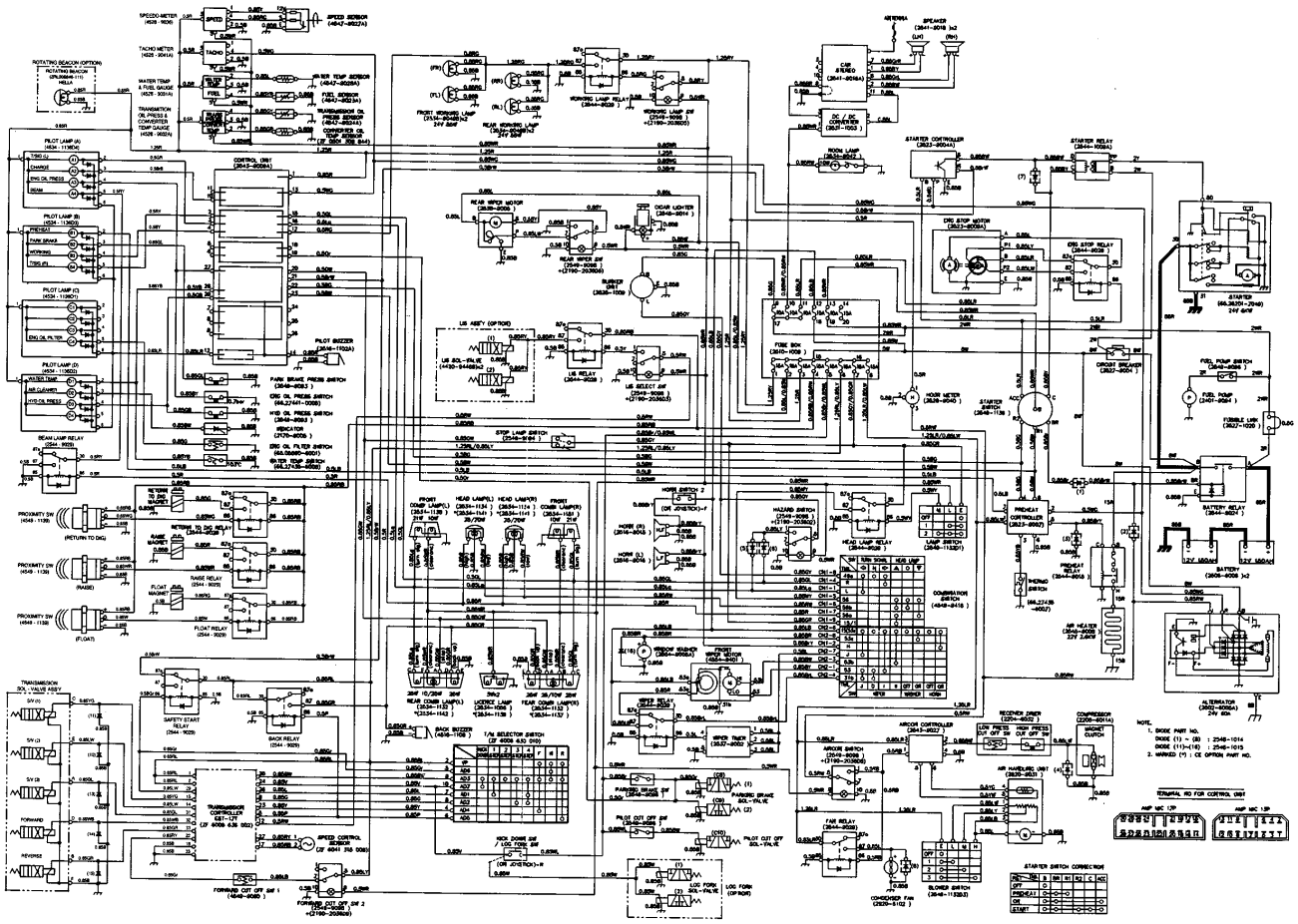

FIGURE 9-7

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