CATERPILLAR®

# Service Manual

# Models
# TH336, TH337, TH406, TH407, TH414, TH514, TH417

S/N TDE00100 & After
S/N TDF00100 & After
S/N TBX00100 & After
S/N TBY00100 & After
S/N TBZ00100 & After
S/N TBW00100 & After
S/N TBT00100 & After

***31200370***

*Revised*
*March 12, 2013*

## 1.7 SAFETY INSTRUCTIONS

Following are general safety statements to consider ***before*** performing maintenance procedures on the telehandler. Additional statements related to specific tasks and procedures are located throughout this manual and are listed prior to any work instructions to provide safety information before the potential of a hazard occurs.

For all safety messages, carefully read, understand and follow the instructions ***before*** proceeding.

### 1.7.1 Personal Hazards

PERSONAL SAFETY GEAR: Wear all the protective clothing and personal safety gear necessary to perform the job safely. This might include heavy gloves, safety glasses or goggles, filter mask or respirator, safety shoes or a hard hat.

LIFTING: **NEVER** lift a heavy object without the help of at least one assistant or a suitable sling and hoist.

### 1.7.2 Equipment Hazards

LIFTING OF EQUIPMENT: Before using any lifting equipment (chains, slings, brackets, hooks, etc.), verify that it is ofthe proper capacity, in good working order, and is properly attached.

**NEVER** stand or otherwise become positioned under a suspended load or under raised equipment. The load or equipment could fall or tip.

**DO NOT** use a hoist, jack or jack stands only to support equipment. Always support equipment with the proper capacity blocks or stands properly rated for the load.

HAND TOOLS: Always use the proper tool for the job; keep tools clean and in good working order, and use special service tools only as recommended.

### 1.7.3 General Hazards

SOLVENTS: Only use approved solvents that are known to be safe for use.

HOUSEKEEPING: Keep the work area and operator cab clean, and remove all hazards (debris, oil, tools, etc.).

FIRST AID: Immediately clean, dress and report all injuries (cuts, abrasions, burns, etc.), no matter how minor the injury may seem. Know the location of a First Aid Kit, and know how to use it.

CLEANLINESS: Wear eye protection, and clean all components with a high pressure or steam cleaner before attempting service.

When removing hydraulic components, plug hose ends and connections to prevent excess leakage and contamination. Place a suitable catch basin beneath the machine to capture fluid run off.

It is good practice to avoid pressure-washing electrical/ electronic components. In the event pressure-washing the machine is needed, ensure the machine is shut down before pressure-washing. Should pressure-washing be utilized to wash areas containing electrical/electronic components, JLG recommends a maximum pressure of 52 bar (750 psi) at a minimum distance of 30,5 cm (12 in) away from these components. If electrical/electronic components are sprayed, spraying must not be direct and for brief time periods to avoid heavy saturation,

Check and obey all Federal, State and/or Local regulations regarding waste storage, disposal and recycling.

## 2.2.2 Metric Fastener Torque Chart (Continued)

| | | | Magni Coating (Ref 4150701)* | | | |
|---|---|---|---|---|---|---|
| | | | CLASS 12.9 SOCKET HEAD CAP SCREWS M6 AND ABOVE* | | | |
| SizePITCH | | Tensile Stress Area | Clamp Load See Note 4 | Torque (Dry or Loctite® 263™) K = .17 | Torque (Lub OR Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K = .16 | Torque (Loctite® 262™ OR Vibra-TITE™ 131) K = .15 |
| | | Sq mm | kN | [N.m] | [N.m] | [N.m] |
| 3 | 0.5 | 5.03 | | | | |
| 3.5 | 0.6 | 6.78 | | | | |
| 4 | 0.7 | 8.78 | | | | |
| 5 | 0.8 | 14.20 | | | | |
| 6 | 1 | 20.10 | 12.5 | 13 | 12 | 11 |
| 7 | 1 | 28.90 | 18.0 | 21 | 20 | 19 |
| 8 | 1.25 | 36.60 | 22.8 | 31 | 29 | 27 |
| 10 | 1.5 | 58.00 | 36.1 | 61 | 58 | 54 |
| 12 | 1.75 | 84.30 | 52.5 | 105 | 100 | 95 |
| 14 | 2 | 115 | 71.6 | 170 | 160 | 150 |
| 16 | 2 | 157 | 97.8 | 265 | 250 | 235 |
| 18 | 2.5 | 192 | 119.5 | 365 | 345 | 325 |
| 20 | 2.5 | 245 | 152.5 | 520 | 490 | 460 |
| 22 | 2.5 | 303 | 189.0 | 705 | 665 | 625 |
| 24 | 3 | 353 | 220.0 | 900 | 845 | 790 |
| 27 | 3 | 459 | 286.0 | 1315 | 1235 | 1160 |
| 30 | 3.5 | 561 | 349.5 | 1780 | 1680 | 1575 |
| 33 | 3.5 | 694 | 432.5 | 2425 | 2285 | 2140 |
| 36 | 4 | 817 | 509.0 | 3115 | 2930 | 2750 |
| 42 | 4.5 | 1120 | 698.0 | 4985 | 4690 | 4395 |

**NO. 5000059 REV. J**

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS
2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%
*3. ASSEMBLY USES HARDENED WASHER OR FASTENER IS PLACED AGAINST PLATED STEEL OR RAW ALUMINUM
4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

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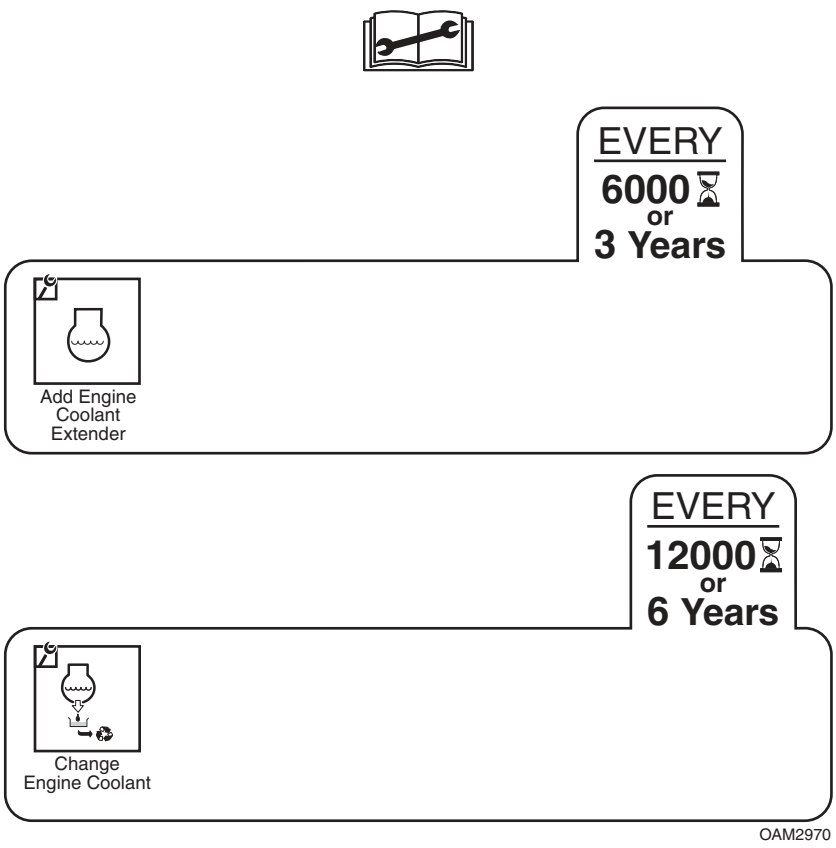
## 2.5.4 6000 & 12000 Hour




***Note:*** *If hour and year intervals are listed, use the interval that occurs first. Refer to Engine Operation & Maintenance Manual for additional information.*

### 3.6.1 Boom Removal

While the boom sections can be separated from each other on the machine, it is much safer, more efficient and more cost- effective to remove the complete boom assembly from the machine and place it on suitable supports for separation. Work can then progress at a normal working height.

***Note:*** *When removing a complete boom assembly use a hoist or crane with a minimum lift capacity of 6000 lbs.*

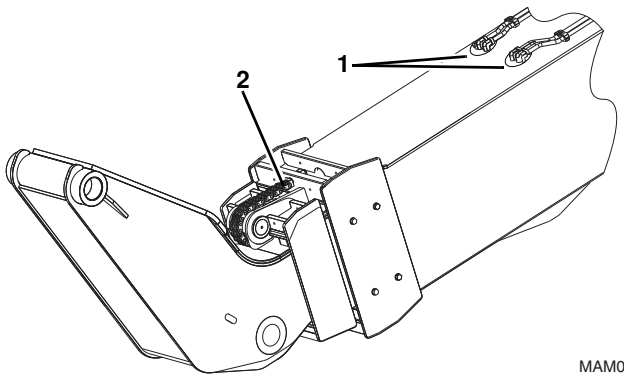
1. Remove any attachment from the quick coupler assembly. Refer to Operation & Maintenance Manual.
2. Park the machine on a hard, level surface, fully retract the boom, raise the boom assembly to access lift/lower cylinder pin, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
3. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
4. Open the engine cover. Allow the system fluids to cool.
5. Remove boom angle sensor arm. Refer to Section 9.12.8, “Boom Angle Sensor.”
6. Properly disconnect the battery.
7. Place a sling around the first boom section at the balance point.
8. Take the weight off the boom assembly.
9. Label, disconnect and cap all hydraulic hoses attached to the tubes on the bottom of the boom. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
10. Label, disconnect and cap any electrical cables if equipped.
11. Remove the pin from the rod end of each compensation cylinder being careful not to drop the cylinder. Lower each cylinder to a secure position.
12. Remove the pin from the rod end of the lift/lower cylinder being careful not to drop the cylinder. Lower the cylinder to a secure position.
13. Confirm that the boom assembly is balanced with the sling and remove the boom assembly pivot pin.
14. Lift the boom assembly from the machine and lower onto suitable supports

### 3.6.2 Second and Third Boom Section Removal

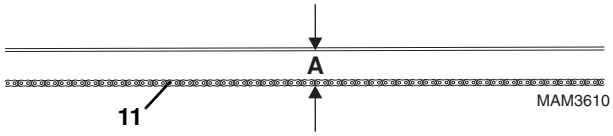
1. Set the complete boom on level ground and by repositioning the slings turn boom over on to the top side. Set the complete boom on suitable stands to begin tear down.

***Note:*** *With the complete boom setting upside down, the removal and replacing of each boom section, tilt cylinder, hoses, extend and retract chains and extend/retract cylinder are made much easier.*

2. Label, disconnect and cap the tilt circuit hoses from the tilt cylinder at the front of the third boom section. Label, disconnect and cap the auxiliary circuit hoses from the quick disconnect fittings at the front of the third boom section. Cap all fittings and openings to prevent dirt and debris from entering the hydraulic system.
3. Place a sling around the tilt cylinder and remove the retaining rings and pin at the barrel end of the tilt cylinder. Remove tilt cylinder.
4. Remove all wear pads, shims and backing plates from the front inside of the first boom section. Label and tag each set of wear pads being removed.




5. Disconnect both tilt hoses and (if equipped) both auxiliary hoses (**1**) at the bottom of the first boom section.Plug the hose ends and cap the tube ends to prevent dirt and debris from entering the hydraulic system. Pull the disconnected hoses from the rear of the boom.
6. Loosen and remove the lock nut and jam nut (**2**) on the retract chain at the front of the first boom section.



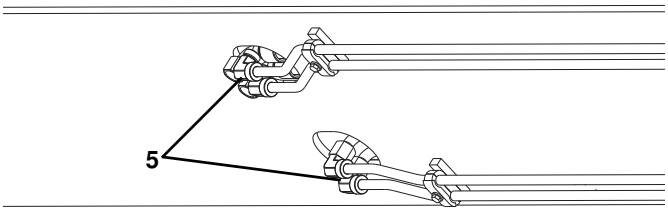

8. Tighten both front top extend chain adjusting nuts (**10**) evenly to increase tension in the retract chain (**11**) until the distance between the bottom of the bottom of the second boom section and the bottom of the retract chain is 115 - 117 mm (4.5 - 4.6 in)(**A**).
9. Start the machine and retract the boom approximately 0,5 m (197.0 in). Fully retract and extend the boom several times.
10. Extend the boom fully. Turn OFF engine
11. Measure dimension (**A**), if adjustment is required, repeat step eight thru eleven.
12. Tighten both extend chain lock nuts (**9**) to 120 Nm (86 lb-ft) against the adjusting nut (**10**).

***Note:*** *Ensure that there is a minimum of one full thread of the clevis showing beyond the lock nut.*

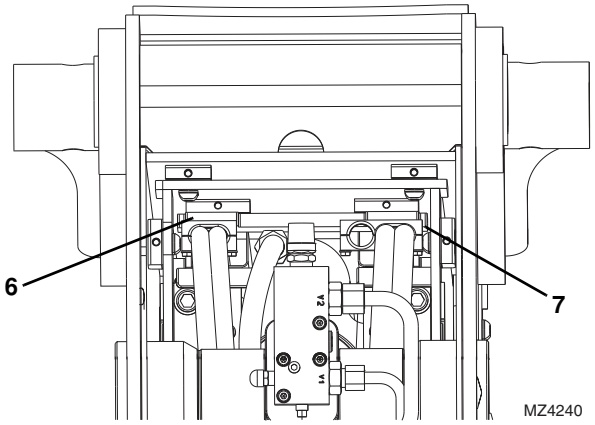
13. Remove the boom safety prop.

### 3.14.3 Tilt-Electrical/Auxiliary Hose Removal

1. Label, disconnect and cap both hoses from the tilt cylinder or auxiliary fittings at the front of the boom. Disconnect the electrical plug connection from the boom head. Label and remove the electrical plug from the end of the electrical cable. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
2. Cut nylon ties securing the electrical cable (if equipped) from the tilt hoses.




3. Label, disconnect and cap both hoses attached to the tubes on the bottom of the boom (**5**). Plug the hose ends with plastic plugs (use plastic plugs for the needed clearance when removing the hoses from between the sections) and cap the tube ends to prevent dirt and debris from entering the hydraulic system.

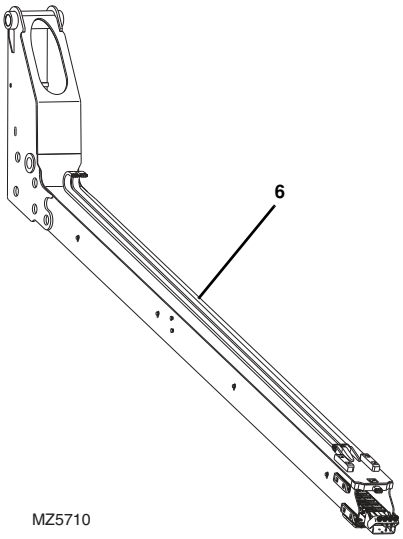



4. Loosen the clamps holding the tilt (**6**) or auxiliary hoses (**7**) at the rear of the second boom section.
5. From the rear of the boom, pull the tilt (**6**) or auxiliary hoses (**7**) from between the first and second boom sections.
6. Pull the tilt (**6**) or auxiliary hoses (**7**) from the third boom section.

### 3.14.4 Tilt-Electrical/Auxiliary Hose Installation

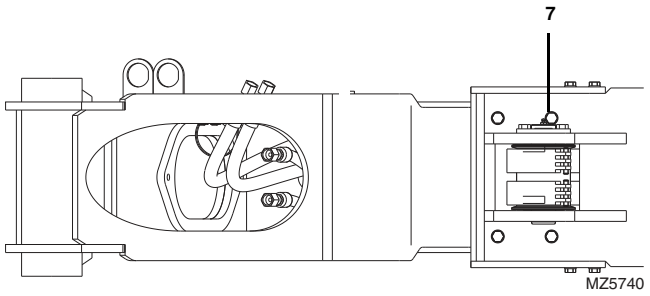
1. Slowly push the new hoses between the first and second boom sections until the hose ends are visible at the tube fitting connections under the first boom section.
2. Uncap and connect the previously remove hoses to the proper fittings and tighten.
3. Feed the remaining tilt cylinder hoses or auxiliary hoses through the top left (tilt) and top right (auxiliary) third boom section.
4. Uncap and connect the tilt hoses or auxiliary hoses to the proper fitting at the boom head.
5. Connect the electrical plug to the previously labeled electrical cable.
6. Install the electrical plug on the side of the boom head.
7. Refer to Section 2.2.3, “Hydraulic Hose Torque Chart,” for proper hose torque.
8. Tighten the clamp holding the tilt hoses or auxiliary hoses at the rear of the second boom section.

### 3.18.7 Fourth Boom Section Installation




1. Apply Loctite® 242™ to the wear pad mounting bolts. Install the bottom, left right and top wear pads. Do not shim or tighten the side and top wear pad bolts at this time. Install both extend chains (**6**) on bottom rear of fourth boom section. Lay extend chains the length of fourth boom section.
2. Grease the inside third boom section on area's where the fourth boom section wear pads will slide.
3. Using a suitable sling, balance the fourth boom section and carefully slide 914 mm to 1219 mm (3 ft to 4 ft) into the front of the third boom section. Set the fourth boom section head onto suitable support and reset sling under the boom head of the fourth boom section. Carefully slide the fourth boom section into the third boom section. Leave 1829 mm to 2438 mm (6 ft to 8 ft) of the fourth boom section out to be able to install wear pads in front of the third boom section.
4. With the sling still under boom head install the top wear pads. Lower the fourth boom section and install the bottom, left and right side wear pads. Do not shim or tighten bolts at this time.

***Note:*** *Grease wear pads, inside sheaves, bores and pins during assembly.*




5. Apply Loctite® 242™ to the sheave mounting bolts, Install the sheave (**7**), pin, lock plate and bolts at the bottom front of the third boom section. Torque bolts to 90 Nm (66 lb-ft). Grease the sheave using the grease fitting in the pin. Spin the sheave by hand to ensure the sheave spins freely on the pin and to distribute grease evenly. Pull both extend chains from the fourth boom section around the front and over the sheave. Install both chain clevises, pins and clips.
6. Retract the fourth boom section the remainder of the way into the third boom section and install the wear pads at the rear of third and fourth boom sections.
7. Apply Loctite® 242™ to the wear pad mounting bolts and install the bottom left and right side wear pads, backing plates, shims and bolts. Shim the top wear pads on the rear of the fourth boom section. Shim the top left and right wear pads on the rear of the fourth boom section. Torque bolts to 90 Nm (66 lb-ft). Torque grease fitting bolts to 45 Nm (33 lb-ft).

### 3.18.8 Third and Fourth Boom Section Installation

1. At the rear of the third boom section apply Loctite® 242™ to the wear pad mounting bolts and install the bottom rear wear pads, washers and bolts. Torque to 90 Nm (66 lb-ft). Install the bottom rear left and right side wear pads, backing plate and bolts (do not shim or tighten bolts). Install the top rear wear pads, backing plates and bolts (front bolts are drilled and tapped for grease fittings. do not shim or tighten bolts). Install both extend chains on the bottom rear of the third boom section. Lay extend chains the length of third boom section.
2. Grease the inside second boom section on areas where the third boom section wear pads will slide.
3. Install retract chain, pin and clip to bottom front inside of the second boom section.

***Note:*** *Keep the retract chain centered on bottom of the third boom section while installing the third boom section into the second boom section.*

### 3.21.4 Expose Chains for Inspection

**c. Retract Chain**

1. Park the machine on a firm, level surface. Place the transmission control lever in (N) NEUTRAL, engage the park brake switch and raise the boom to a horizontal (level) position.
2. Fully extend the boom until the retract chain is taut. Shut the engine OFF.

The retract chain will be visible for inspection with the machine in this state.

While doing the chain inspection, check all chain clevis ends for distortion or cracking and sheaves for bearing wear or grooving from the chain.

If during the inspection, if any chain is found to be damaged or stretched, the chain must be replaced. It is recommended that when any chain is replaced, that all the chains and clevises be replaced at the same time.

**d. Extend Chains**

The extend chains are only partially visible through the rear of the boom with all the sections retracted. It is possible to see a section of the extend chain as the boom is slowly extended. If there is ANY question that one or both extend chains are damaged, the extend chains should be removed, inspected and replaced if necessary.

Refer to Section 3.21, "Boom Extend and Retract Chains - TH414 & TH417."

***Note: DO NOT** attempt to repair a chain. Replace a stretched or damaged chain with a new part. Always replace both the chain and the clevis. It is recommended that when any chain is replaced, that all chains and clevis' be replaced at the same time.*

### 3.21.5 Chain Lubrication

After inspection and before being returned to service, chains must be lubricated with Cat Multipurpose Grease-NLGI Grade 2.

The lubricant must penetrate the chain joint to prevent wear. Applying lubricant to the external surfaces will prevent rust, but the chains should be articulated to make sure the lubricant penetrates to the working surfaces between the pins and links.

To prepare the chain for lubrication, the chain plates should be brushed with a stiff brush or wire brush to clear the space between the plates so that lubricant can penetrate to the working surfaces.

Lubricant may be applied with a narrow paint brush or directly poured on, but the chain should be well flooded with lubricant and the boom should be extended and retracted to be sure that the lubricant penetrates to the working surfaces. All surplus lubricant should be wiped away from the external surfaces. DO NOT use a solvent for this wiping operation.

Regular application of lubricant is necessary to make sure that all working surfaces are adequately lubricated. In extremely dusty conditions, it may be necessary to lubricate the chains more often. Refer to Section 2.5, "Service and Maintenance Schedules," and Section 2.6, "Lubrication Schedules," for detailed information.

Lubrication of chains on vehicles working consistently in extreme hot or cold conditions requires special consideration. Contact the Caterpillar dealer for guidance.

# Section 4
# Cab and Covers

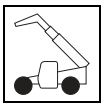
## Contents

## 4.5 CAB INSTALLATION

1. Block all four wheels to help prevent the machine from moving. Assure that there is sufficient overhead and side clearance for cab installation.
2. Attach a sling with a minimum lifting capacity of 363 kg (800 lb) through the lifting eyes of the cab.
3. Use a hoist or overhead crane and sling attached to the cab. Carefully begin to align the cab with the mounting holes in the frame. Stop and check that wiring, hydraulic hoses, cables, etc., will not be pinched or damaged as the cab is positioned. Readjust the position of the sling as needed to help balance the cab during installation.
4. Install the four cab to frame mount bolts, washers and nuts to 150 Nm (111 lb-ft).
5. Connect the previously labeled cab harness connectors to their appropriate locations.
6. Install the fuel tank. Refer to Section 7.6.2, “Fuel Tank.”
7. Install the hydraulic oil reservoir. Refer to Section 8.7.3, “Hydraulic Oil Reservoir Removal/Installation.”
8. If machine is equipped with a mechanical throttle, route throttle cable into cab and connect to the throttle assembly. Refer to Section 4.3.4, “Mechanical Throttle Pedal.”
9. Reconnect the cab ground strap.
10. Uncap and reconnect the previously labeled hydraulic hoses to their appropriate locations.
11. Reconnect any remaining electrical connections to their appropriate locations.
12. Reconnect the heater hoses to the cab heater. Refer to Section 4.3.8, “Heater/Air Conditioning System (if Equipped).”
13. Fill the cooling system completely with coolant, allowing time for the coolant to fill the engine block.The cooling system capacity is listed in Section 2.4, “Fluids and Lubricant Capacities.”
14. Properly connect the battery.
15. Carefully examine all cab components, fasteners, etc., one last time before engine start-up. Rectify any faulty conditions.
16. Start the engine and check the operation of all controls. Check for hydraulic fluid leaks. Check the hydraulic fluid level in the tank and add fluid as required.

***Note:*** *When the engine is initially started, run it briefly at low idle and check the machine for any visual sign of fluid leakage. STOP the engine immediately if any leakage is noted, and make any necessary repairs before continuing.*

17. Wait for the engine to cool and check the coolant level. Add coolant to the overflow bottle as required to bring the coolant to the proper level.
18. Install the protective cover to the front of the cab.
19. Install the mirrors and all other cab components as needed, if removed.
20. Unblock the wheels.
21. Close and secure the engine cover.
22. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.



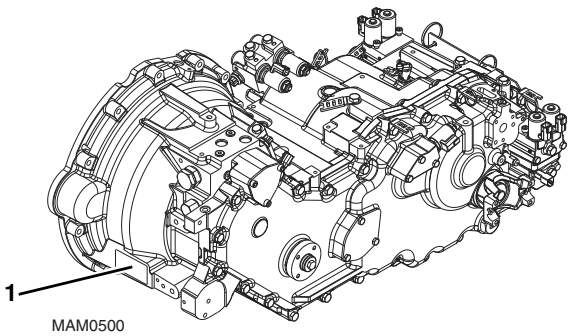
## 5.7 AXLE ASSEMBLY AND DRIVE SHAFT TROUBLESHOOTING

| Problem | Possible Causes | Remedy |
|---|---|---|
| **1. Excessive axle noise while driving.** | 1. Oil level too low. | 1. Fill oil to correct level. Refer to Section 2.4, “Fluids and Lubricant Capacities.” |
| | 2. Axle and/or wheel end housings filled with incorrect oil or oil level low. | 2. Drain axle and/or wheel end housings and fill to correct level. Refer to Section 2.4, “Fluids and Lubricant Capacities.” |
| | 3. Incorrect alignment of ring and pinion gears. | 3. Correct alignment by adding or removing shims as needed. |
| | 4. Incorrect pinion (input) shaft bearing preload. | 4. Correct bearing preload by adding or removing shims as needed. |
| | 5. Worn or damaged bearings. | 5. Replace bearings as needed. |
| | 6. Worn or broken gear teeth. | 6. Replace gears as needed. |
| | 7. Contamination in the axle. | 7. Drain axle and/or wheel end housings and fill to correct level. Refer to Section 2.4, “Fluids and Lubricant Capacities.” |
| | 8. Axle housing damaged. | 8. Replace damaged parts. |
| **2. Intermittent noise when traveling.** | 1. Universal joint(s) worn or damaged. | 1. Repair or replace universal joints as needed. |
| | 2. Differential ring and/or pinion gears damaged. | 2. Determine cause and repair as needed. |
| **3. Vibration or intermittent noise when traveling.** | 1. Drive shaft universal joint assembly(ies) incorrectly tightened. | 1. Tighten capscrews to correct torque. |
| | 2. Drive shaft universal joint(s) worn or damaged. | 2. Repair or replace universal joints as needed. |
| | 3. Drive shaft(s) damaged/ unbalanced. | 3. Replace drive shaft(s) as needed. |

**WARNING**

**DO NOT** service the machine without following all safety precautions as outlined in Section 1, "Safety Practices," of this manual.

## 6.2 TRANSMISSION SERIAL NUMBER




The transmission serial number plate (**1**) is located on the front of the transmission case behind the oil dipstick. Information contained in the serial number is required in correspondence with the transmission manufacturer.

## 6.3 SPECIFICATIONS AND MAINTENANCE INFORMATION

For transmission, oil specifications and maintenance information, refer to Section 2, "General Information and Specifications."

Detailed transmission service instructions are provided in the following publications:

- Service Manual (P/N 31200562)
- Parts Manual (P/N 31200563)

## 6.4 TRANSMISSION REPLACEMENT

***Note:*** *Contact the local Caterpillar dealer if internal transmission repair is required during the warranty period.*

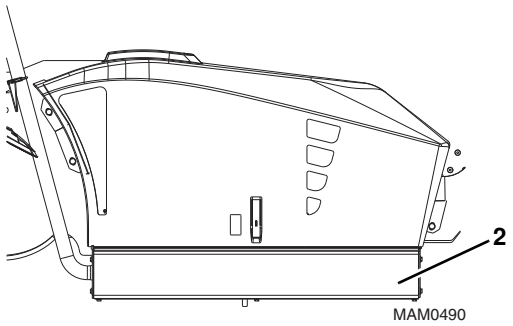
Cleanliness is of extreme importance. Before attempting to remove the transmission, thoroughly clean the exterior of the transmission to help prevent dirt from entering during the replacement process. Avoid spraying water or cleaning solution onto or near the transmission shift solenoids and other electrical components.

### 6.4.1 Transmission Removal

**WARNING**

**NEVER** lift a transmission alone; enlist the help of at least one assistant or use a suitable hoist or overhead crane and sling.

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Remove engine cover to allow easier access to the transmission.
5. Drain the hydraulic oil reservoir. Refer to Section 8.7.1, "Hydraulic Oil Reservoir Draining."
6. Properly disconnect the battery.

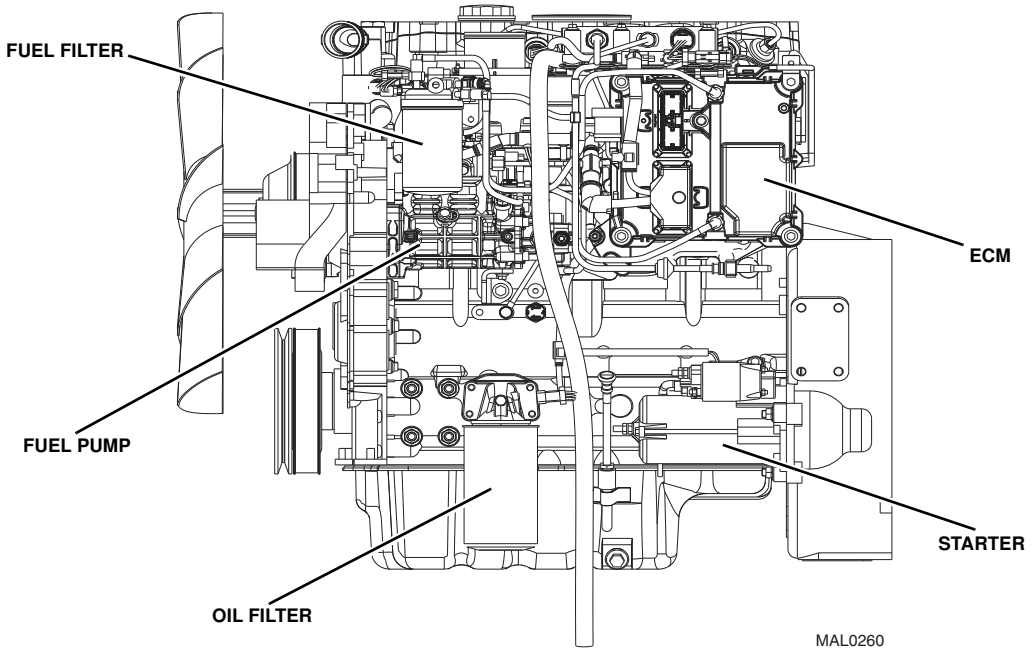



7. Remove the bottom and side shell (**2**) of the engine compartment.
8. Thoroughly clean the transmission and surrounding area, including all hoses and fittings, before proceeding.

## 7.1.2 Component Terminology

To understand the safety, operation and maintenance information presented in this section, it is necessary that the operator/mechanic be familiar with the names and locations of the engine components. The following illustration identifies the components that are referred to throughout this section.

**ELECTRONIC ENGINE SHOWN**

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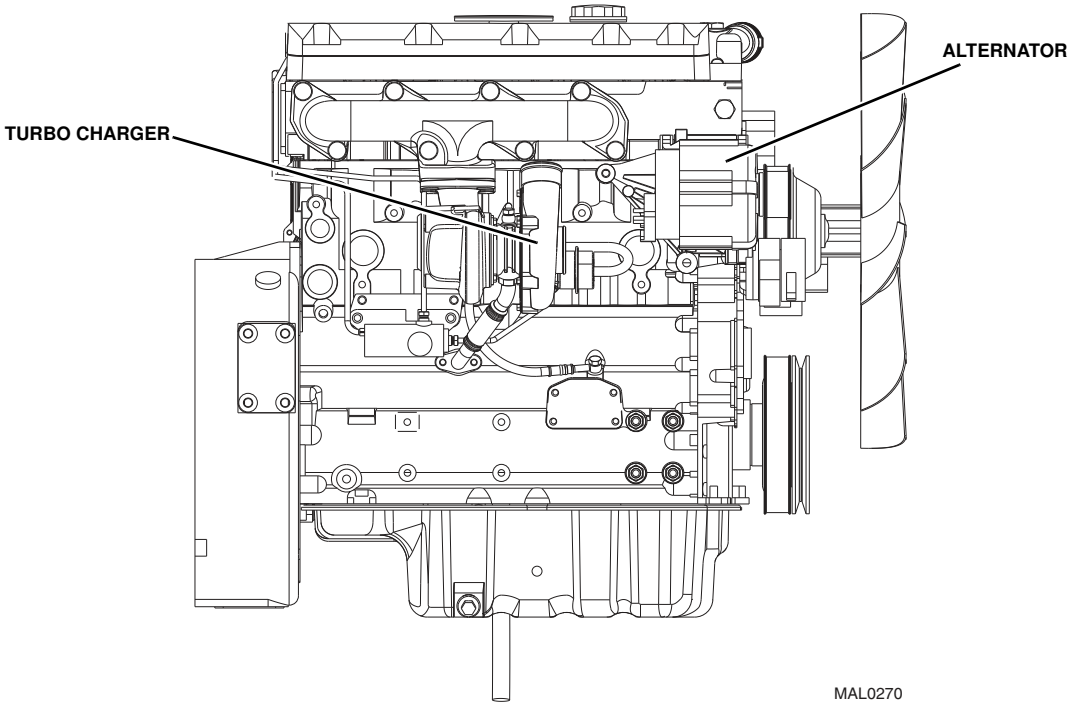


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# Section 8
# Hydraulic System

## Contents

## 8.9 AUXILIARY PUMP (PLATFORM EQUIPPED MODELS ONLY)

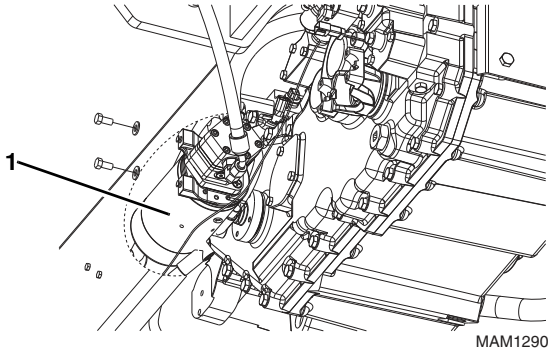
### 8.9.1 Auxiliary Pump Description

The auxiliary pump works as a safety back up for the platform in case of engine stalling. The pump will allow the platform to lower without the engine running.

### 8.9.2 Auxiliary Pump Replacement

**a. Auxiliary Pump Removal**

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. .Properly disconnect the battery.




5. Thoroughly clean the auxiliary pump (**1**) and surrounding area, including all hoses and fittings, before proceeding.
6. Place a suitable container to catch hydraulic fluid drainage beneath the frame.
7. Label, disconnect and cap the hydraulic hoses attached to the auxiliary pump. Slowly turn hose fittings to allow any trapped pressure in the hydraulic system to escape. Call all fittings to prevent dirt and debris from entering the hydraulic system.
8. Wipe up any hydraulic fluid spillage in, on, near and around the machine and work area.
9. Label and disconnect the electrical connections to the auxiliary pump.
10. Support the valve and remove the bolts securing the pump to the engine pod.
11. Remove the pump.

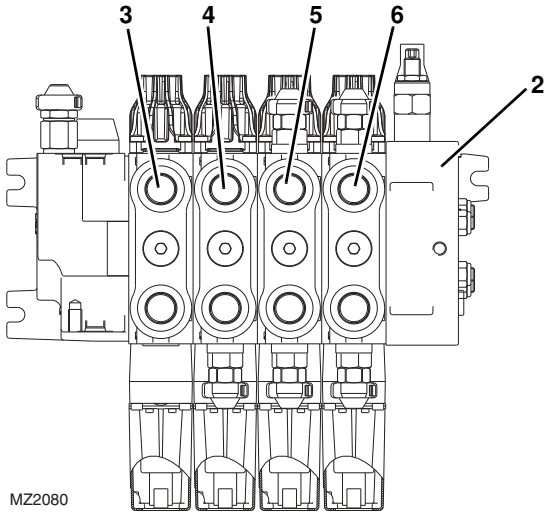
**b. Auxiliary Pump Installation**

1. Install the pump to its original orientation and secure in place with the previously used hardware.
2. Connect the previously labeled electrical connections to the pump.
3. Uncap and connect the previously labeled hydraulic hoses to the auxiliary pump.
4. Properly connect the battery.
5. Test the pump functions.
6. Close and secure the engine cover.
7. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

## 8.10 CONTROL VALVES

### 8.10.1 Main Control Valve

The main control valve is mounted at the rear of the machine inside the frame.

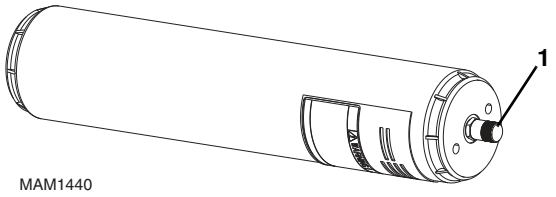



The main control valve assembly (**2**) consists of working sections with their own valve assemblies, each providing a specific hydraulic function. Those functions are: lift/lower (**3**), extend/retract (**4**), tilt (**5**) and auxiliary (**5**).

## 8.12 BOOM RIDE CONTROL (TH336, TH337, TH406, TH407 - IF EQUIPPED)

### 8.12.1 General Accumulator Information

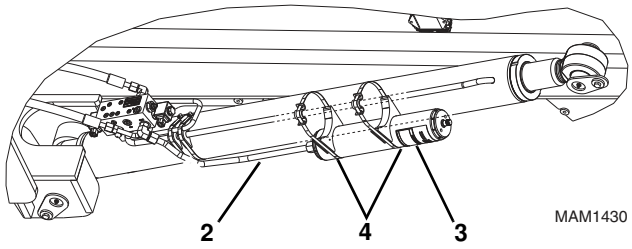
The accumulator is a 275 bar (3988 psi) piston type accumulator.
The pneumatic accumulator is operated by compressed gas. Gas and hydraulic oil occupy the same container. When oil pressure rises, incoming oil compresses the gas. When oil pressure drops, the gas expands, forcing the oil out into the lift side of the lift/lower cylinder.
The gas is separated from the oil by a piston. This prevents the mixing of gas and oil and keeps gas out of the hydraulic system.




The accumulator must be “pre-charged” with gas before use in the hydraulic system. This is done by filling the gas chamber with dry nitrogen to a pressure of 35 bar (507 psi). The schrader valve is located under the protective cap (**1**) at the top of the accumulator. The schrader valve is used for pre-charging and testing the accumulator.

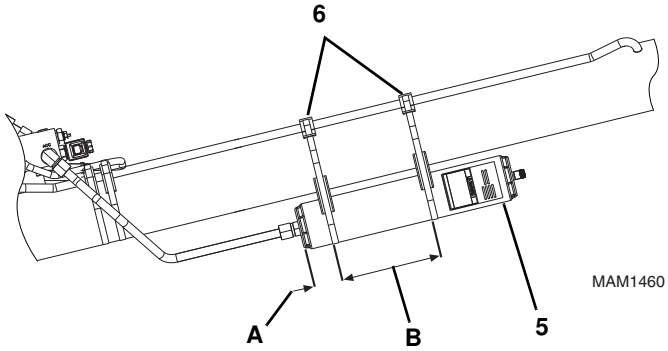
#### a. Accumulator Removal

1. Remove any attachment from the machine. Park the machine on a firm level surface and fully retract the boom. Raise the boom to allow sufficient work space around the lift/lower cylinder to allow the accumulator to be removed. Support the boom. Place the travel select lever in (N) NEUTRAL, engage the park brake, shut the engine OFF and chock wheels.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery.




5. Disconnect and cap or plug the hydraulic tube (**2**) at the accumulator (**3**).
6. Remove the two straps (**4**) securing the accumulator to the lift/lower cylinder.
7. Remove the accumulator.
8. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.

#### b. Accumulator Installation




1. Secure the accumulator (**5**) to the lift/lower cylinder with the two straps (**6**) to the proper dimensions:
   **A.** 57,0 ± 0,10mm (2.25 ± 0.375 in)
   **B.** 200,0 ± 0,10mm (7.875 ± 0.375 in)
2. Uncap and connect the hydraulic tube to the accumulator.
3. Remove the boom support.
4. Properly connect the battery.
5. Close and secure the engine cover.
6. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.
7. Refer to Section 8.12.3, “Pre-Charging Accumulator,” for Accumulator pre-charging instructions.

2. Press the "C" and "OK" buttons on the dash simultaneously to enter the analyzer mode.
3. Scroll to "Access Level Code". Enter the code "33271" to go into access level 2.
4. Scroll to and select the "Operator Tools" screen.
5. Scroll to and select the "Review Service History" screen.
6. Scroll through the screens to view the last 15 times the machine was serviced.

### 9.6.5 Set Service Interval

To set the machine recommended service interval:

1. Turn the engine to the ON position.
2. Press the "C" and "OK" buttons on the dash simultaneously to enter the analyzer mode.
3. Scroll to "Access Level Code". Enter the code "33271" to go into access level 2.
4. Scroll to and select the "Operator Tools" screen.
5. Scroll to and select the "Set Service Interval" screen.
6. Enter a new service interval.

### 9.6.6 Cabin Joystick Telescope: X-Axis/ Roller

To change the joystick telescope function on the joystick:

1. Turn the engine to the ON position.
2. Press the "C" and "OK" buttons on the dash simultaneously to enter the analyzer mode.
3. Scroll to "Access Level Code". Enter the code "33271" to go into access level 2.
4. Scroll to and select the "Operator Tools" screen.
5. Scroll to and select the "Cabin Joystick Telescope" screen.
6. Select either X-AXIS or ROLLER.

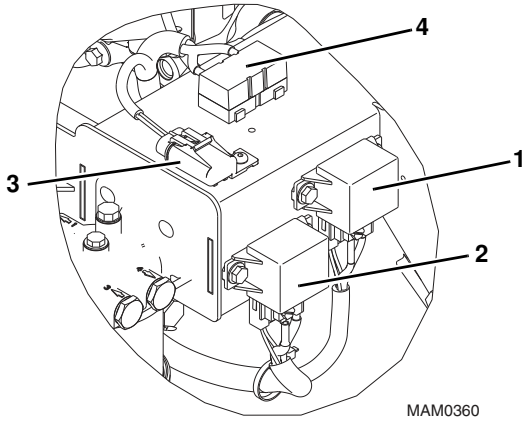
*When changing the joystick function, ensure the correct joystick operation decal is installed. Contact the local Caterpillar dealer.*

## 9.7 FUSES AND RELAYS

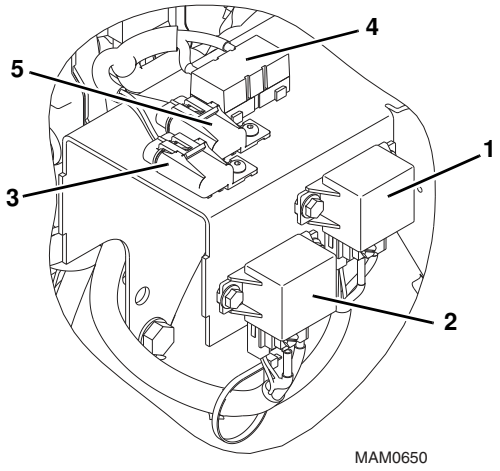
### 9.7.1 Engine Compartment

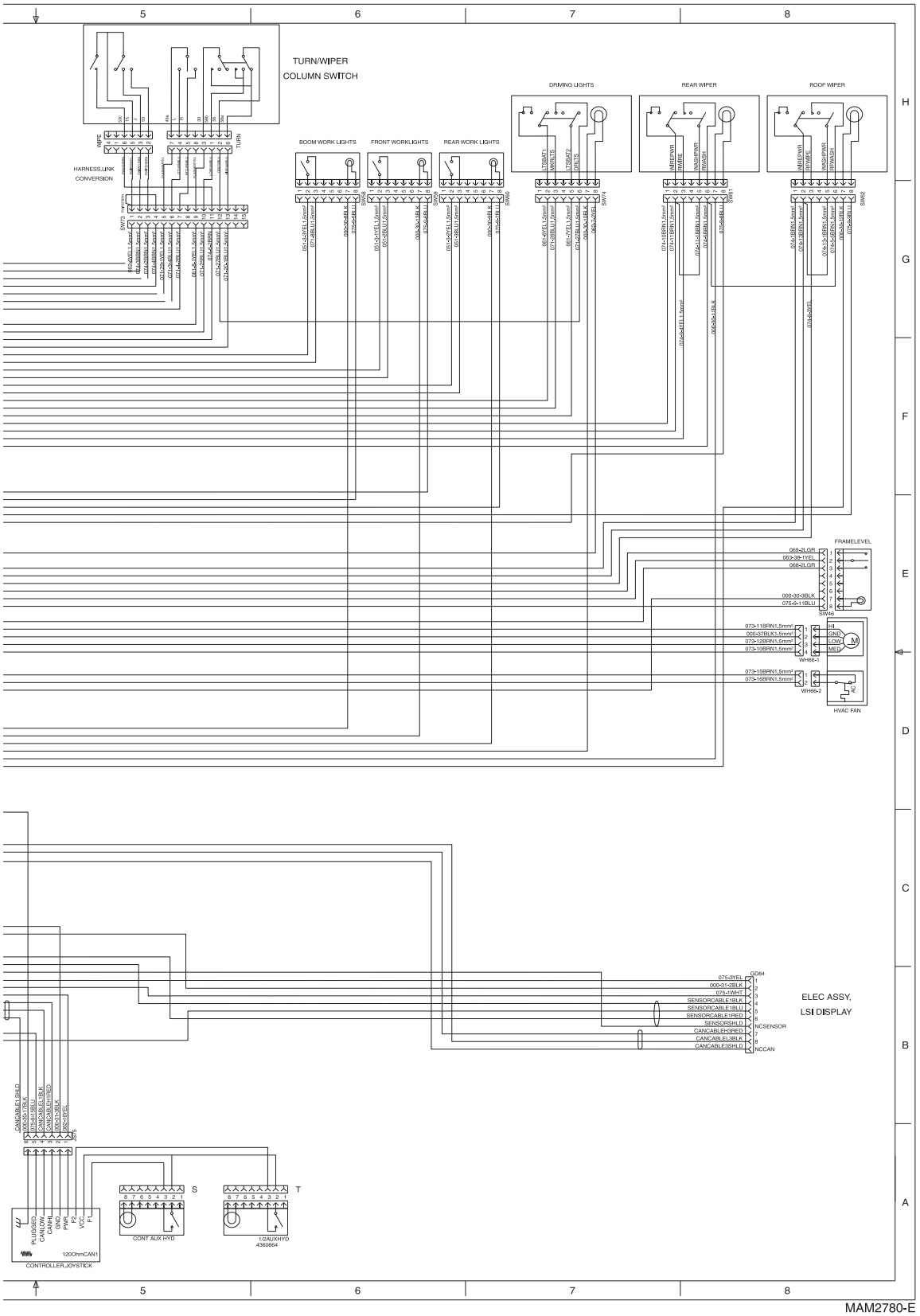
The starter relay (**1**), glow plug relay (**2**), transmission fuse (**3**) and glow plug fuse (**4**) are located on the air filter bracket in the engine compartment. In electronic engine equipped machines and additional engine fuse (**5**) is located on the air filter bracket.

**MECHANICAL ENGINE**



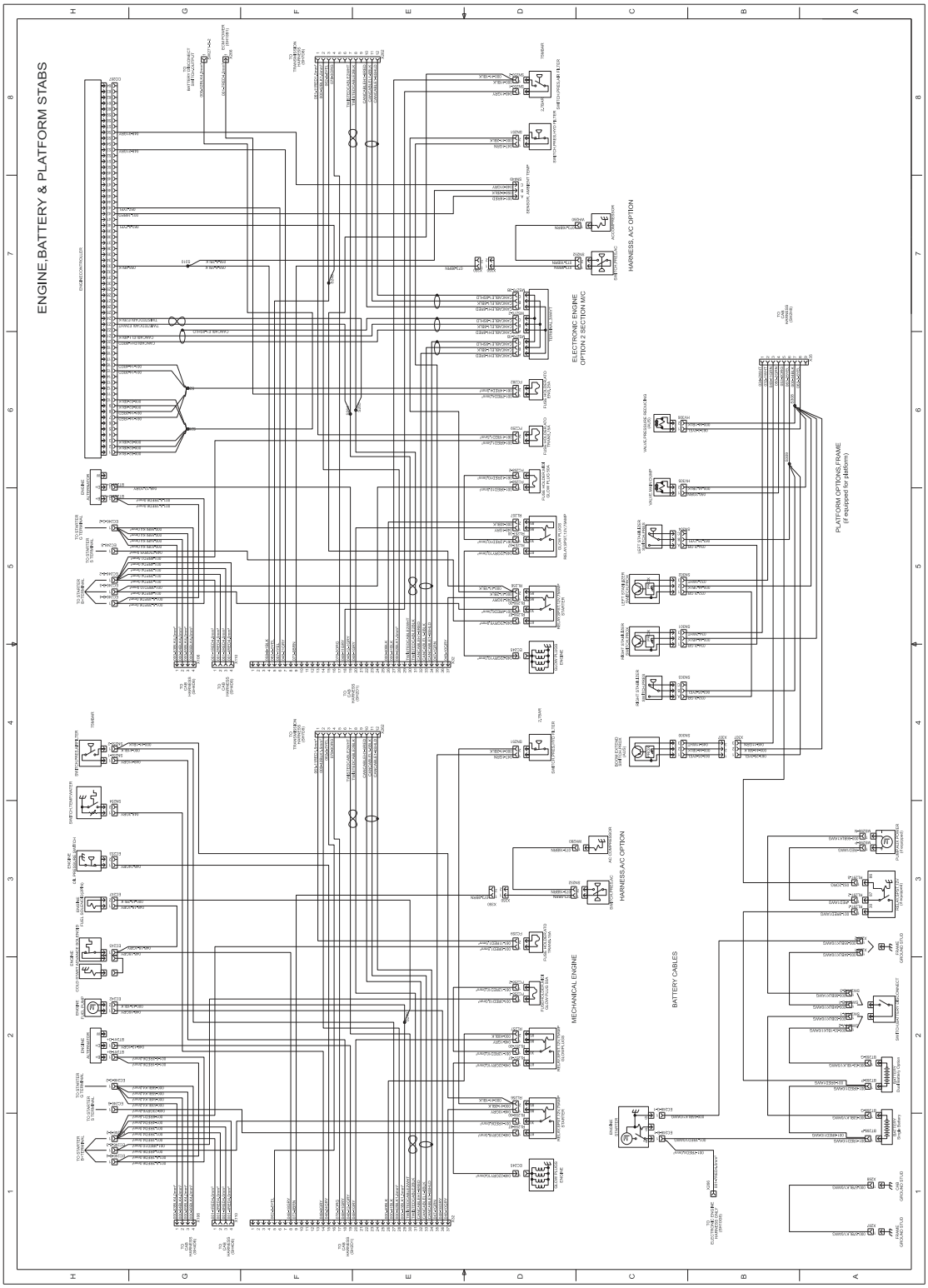

**ELECTRONIC ENGINE**




TURN/WIPER
COLUMN SWITCH
DRIVING LIGHTS
REAR WIPER
ROOF WIPER
BOOM WORK LIGHTS
FRONT WORKLIGHTS
REAR WORK LIGHTS
WIPE
TURN
HARNESS LINK
CONVERSION
FRAMELEVEL
SW46
HVAC FAN
WH66-1
WH66-2
ELEC ASSY,
LSI DISPLAY
GD84
CONTROLLER JOYSTICK
CONT AUX HYD
1/2AUXHYD
4360664
120OhmCAN1
MAM2780-E

## 9.8.9 Engine, Battery and Platform Outriggers Harness (if equipped)

**(Sheet 10 of 12)**




MAM1184-E

**b. Disassembly**

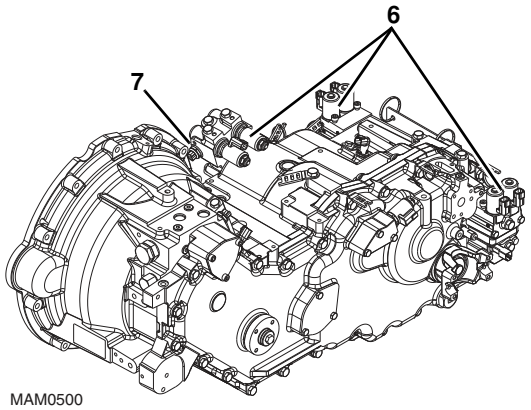
**DO NOT** disassemble the pump. The pump is not serviceable. Replace pump if found to be defective.

**c. Installation and Testing**

1. Install the reservoir into the mounting bracket. Secure with the previously used hardware.
2. Connect the windshield washer hoses to the reservoir.
3. Connect the cab wiring harness connectors to the reservoir connectors.
4. Fill the washer fluid reservoir with washer fluid.
5. Install the fuel tank. Refer to Section 7.6.2, “Fuel Tank.”
6. Install the hydraulic oil reservoir. Refer to Section 8.7.3, “Hydraulic Oil Reservoir Removal/Installation.”
7. Properly connect the battery.
8. Turn the ignition key switch to the RUN position and press the washer switch. Verify that fluid is sprayed on the windshield, roof and rear glass.
9. Close and secure the engine cover.
10. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

## 9.12 SOLENOIDS, SENSORS AND SENDERS

### 9.12.1 Transmission Solenoid Valves




**Note:** If the transmission is not shifting properly, the transmission shift control switch (travel select lever), wiring harness or transmission shift solenoids (**6**) should be checked in order to determine which component is defective. Specific information to determine which travel position and corresponding component is not responding can be found in the detailed transmission service instructions (covering repair, disassembly, reassembly and adjustment information) are provided in the following publications:

- System Operation Testing and Adjusting (P/N RENR5195-05)
- Troubleshooting (P/N RENR5185-04)

The transmission should be checked, serviced and repaired only by experienced service technicians who are aware of all safety instructions and particular component features.

***Note:*** *Contact the local Caterpillar dealer if internal transmission repair is required during the warranty period.*

### 9.12.2 Transmission Oil Temperature Switch

**a. Transmission Oil Temperature Switch Removal**

The transmission oil temperature switch (**7**) is located at the left side of the forward/reverse solenoid housing.

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery.
5. Unplug the transmission oil temperature switch connector from the wiring harness connector.
6. The switch is threaded into the transmission housing. Remove the switch.

**b. Transmission Oil Temperature Switch Inspection and Replacement**

Inspect the switch and the wiring harness connector terminals for continuity. Replace a defective or faulty switch with a new part.

**c. Transmission Oil Temperature Switch Installation and Testing**

1. Thread the transmission oil temperature switch into the transmission housing snugly, then connect the switch connector to the wiring harness connector.
2. Properly connect the battery.
3. Check for proper fluid level.

## 9.16.3 LSI System Calibration

### a. Standard Calibration

To calibrate the LSI, certain conditions must be met:

- The sensor must be installed according to Section 9.16.2, “LSI Sensor.”.
- The machine control system must be powered on for at least 10 minutes before calibration.
- The calibration shall be conducted with the standard carriage and forks attached and weights as necessary.
- If the machine is equipped with outriggers, they shall remain up for the calibration procedure.
- The machine must be on a level surface with the wheels steered straight and park brake OFF, with straight driving over a distance of at least 2 m (6.5 ft) being the last movement before entering a calibration point.
- The calibration must be completed within 30 minutes after starting procedure.

| Model | Market | Test Weight on Forks | Weight on Rear Axle | |
|---|---|---|---|---|
| | | | Acceptable Range | Nominal Value |
| TH336 | CE | 3000 kg (6614 lb) | 950 - 1050 kg (2094 - 2315 lb) | 1000 kg (2204 lb) |
| TH337 | CE | 1900 kg (4189 lb) | 950 - 1050 kg (2094 - 2315 lb) | 1000 kg (2204 lb |
| TH406 | CE | 3000 kg (6614 lb) | 850 - 950 kg (1874 - 2094 lb) | 900 kg (1984 lb) |
| | AUS | | 1472 - 1572 kg (3245 - 3466 lb) | 1522 kg (3355 lb) |
| TH407 | CE | 3000 kg (6614 lb) | 700 - 800 kg (1543 - 1764 lb) | 750 kg (1654 lb) |
| | AUS | | 1725 - 1825 kg (3803 - 4023 lb) | 1775 kg (3913 lb) |
| TH414 | CE | 640 kg (1411 lb) | 1450 - 1550 kg (3197 - 3417 lb) | 1500 kg (3307 lb) |
| | AUS | 1000 kg (2205 lb) | 1545 - 1645 kg (3406 - 3627 lb) | 1595 kg (3516 lb) |
| TH514 | CE | 1000 kg (2205 lb) | 1250 - 1350 kg (2756 - 2976 lb) | 1300 kg (2866 lb) |
| | AUS | 1000 kg (2205 lb) | 2389 - 2489 kg (5267 - 5487 lb) | 2439 kg (5377 lb) |
| TH417 | CE | 1000 kg (2205 lb) | 1450 - 1550 kg (3197 - 3417 lb) | 1500 kg (3307 lb) |
| | AUS | 1000 kg (2205 lb) | 1575 - 1675 kg (3472 - 3692 lb) | 1625 kg (3582 lb) |

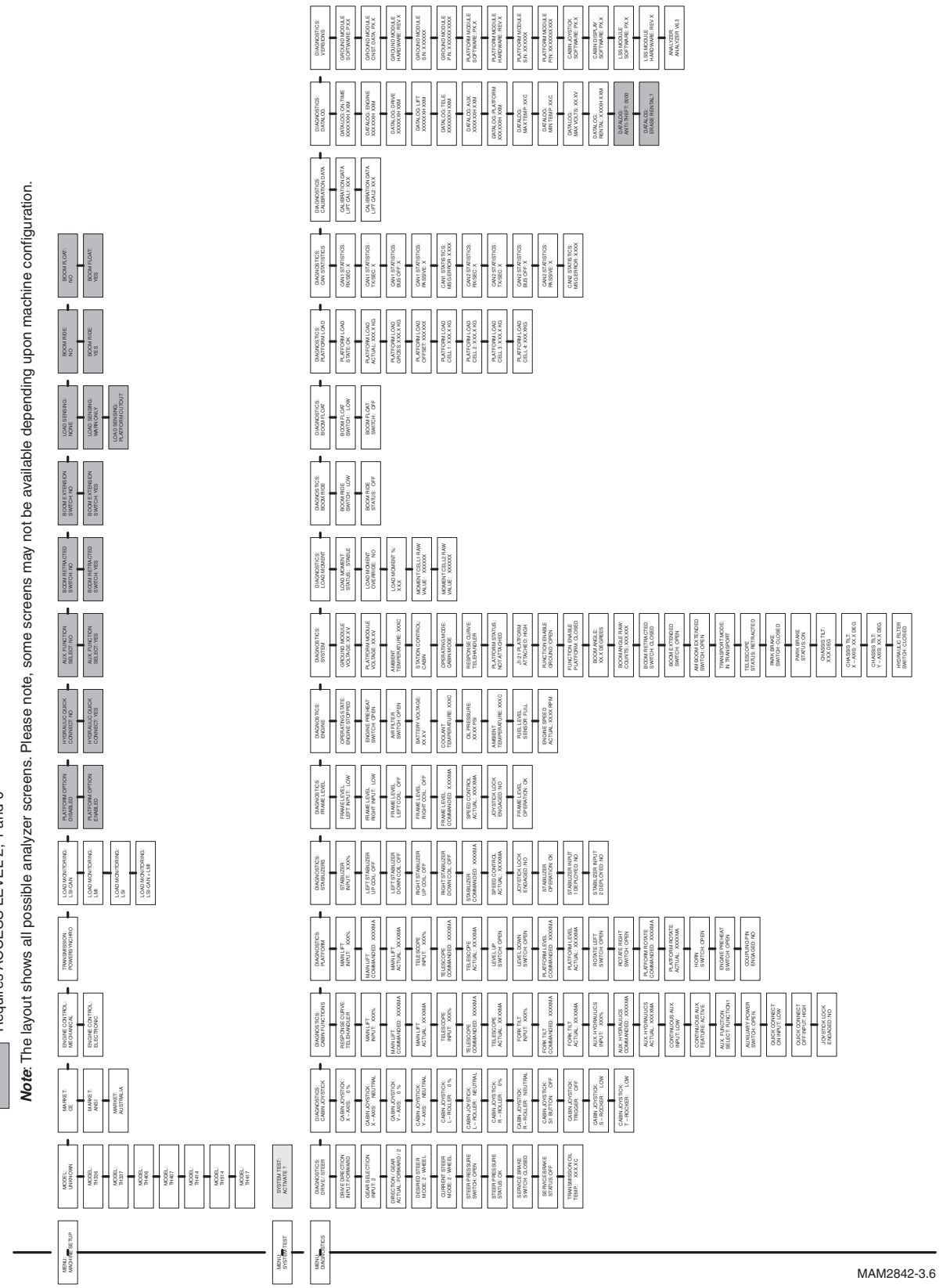
Calibration Procedure:

1. Place the appropriate additional test weight, listed in the above table, within the machine’s reach, in front of, but not contacting the scale.
2. Position the machine so that the only the rear wheels are on the load-bearing surface of the scale, the boom level and fully retracted with the attachment with forks level (not contacting ground). Shut engine OFF.
3. With ignition key in OFF position, press and hold TEST button on LSI display and turn ignition key to engine START position. Release the ignition key when engine start is achieved, but continue to hold TEST button on LSI display until the LED power indicator on LSI display begins to flash (approximately 2 seconds). Release TEST key within 2 seconds of power LED flashing.
4. The lower green LED of the scale should be on constant.
5. Press the TEST button on the LSI display and release. The lower green LED should flash for approximately 8 seconds while the calibration point is read. Following a successful calibration of the first point, the buzzer will sound for 2 seconds, the green LED will be turned off, and the top red LED will be on constant.
6. Without driving the machine, extend the boom to reach the appropriate additional test weight (step 1), listed in the above table. Lift the additional weight until the boom is horizontal. Fully retract the boom.
7. Slowly extend the boom until the rear axle weight in the above table is achieved.
8. Press the TEST button on the LSI display and release. The top red LED should flash for approximately 8 seconds while the calibration point is read. Following a successful calibration of the second point, the buzzer will be on constant, the red LED will be turned off, and the green power LED will be on constant.

## (Sheet 2 of 2)

- Not ACCESSABLE
- Requires ACCESS LEVEL 3, 2, 1 and 0
- Requires ACCESS LEVEL 2, 1 and 0

***Note***: The layout shows all possible analyzer screens. Please note, some screens may not be available depending upon machine configuration.



| Message | Fault Code | Indicators | Other Actions Taken | Trigger for Fault | Latch Until |
|---|---|---|---|---|---|
| OPERATING MODE INTERLOCK - PARK BRAKE NOT SET | 2320 | 1 | J2-26 Engage Starter output will be deactivated and engine start will not be permitted if the PLATFORM STATION is active and CABIN MODE was the last valid operating mode.<br>Changeover to PLATFORM MODE will not be permitted.<br>Changeover to CABIN MODE will not be permitted.<br>All hydraulic function requests from the platform station will be ignored. | The PLATFORM STATION or CABIN STATION is active and the UGM has detected J4-5 Park Brake is LOW (not set) during a MODE changeover situation or during PLATFORM MODE. | J4-5 Park Brake is HIGH (set). |
| ERRATIC PLATFORM ATTACHED SIGNAL | 2321 | 1 | The platform will be considered attached.<br>Display the platform attached screen on the cabin's LCD. | The UGM detects three signal transitions on J1-21 within a 5 second period. | Power cycled. |
| CONFLICTING FRAME LEVEL SIGNALS | 2322 | 1 | Deactivate and inhibit J2-5 Frame Level Right Valve.<br>Deactivate and inhibit J2-7 Frame Level Left Valve.<br>Deactivate and inhibit J1-3 Stabilizer and Frame Level Speed Valve (if applicable) as it relates to frame leveling functions only. | J4-17 Frame Leveling Right and J4-9 Frame Leveling Left inputs are both HIGH simultaneously. | Power cycled. |
| CABIN JOYSTICK – X AXIS FAULT | 2323 | 1 | X-axis function requests will be ignored by the UGM. | The cabin joystick detects a fault on the X-axis of the joystick. | Power cycled. |
| CABIN JOYSTICK – Y AXIS FAULT | 2324 | 1 | Y-axis function requests will be ignored by the UGM. | The cabin joystick detects a fault on the Y-axis of the joystick. | Power cycled. |
| CABIN JOYSTICK – ROLLER FAULT | 2325 | 1 | Roller function requests will be ignored by the UGM. | The JLG cabin joystick detects a fault with the roller on the joystick. | Power cycled. |
| CABIN JOYSTICK – S1 BUTTON FAULT | 2326 | 1 | S1 button function requests will be ignored by the UGM. | The cabin joystick detects a fault with the S1 button on the joystick. | Power cycled. |
| CABIN JOYSTICK – S2 BUTTON FAULT | 2327 | 1 | S2 button function requests will be ignored by the UGM. | The JLG cabin joystick detects a fault with the S2 button on the joystick. | Power cycled. |
| CABIN JOYSTICK – S3 BUTTON FAULT | 2328 | 1 | S3 button function requests will be ignored by the UGM. | The JLG cabin joystick detects a fault with the S3 button on the joystick. | Power cycled. |
| CABIN JOYSTICK – S4 BUTTON FAULT | 2329 | 1 | S4 button function requests will be ignored by the UGM. | The JLG cabin joystick detects a fault with the S4 button on the joystick. | Power cycled. |
| CABIN JOYSTICK – S SWITCH FAULT | 2330 | 1 | S switch function requests will be ignored by the UGM. | The cabin joystick detects a fault with the S switch. | Power cycled. |
| CABIN JOYSTICK – T SWITCH FAULT | 2331 | 1 | T switch function requests will be ignored by the UGM. | The cabin joystick detects a fault with the T switch. | Power cycled. |

| Message | Fault Code | Indicators | Other Actions Taken | Trigger for Fault | Latch Until |
|---|---|---|---|---|---|
| MAIN TELESCOPE IN VALVE – OPEN CIRCUIT | 33189 | 1 | Deactivate output J2-34 Main Telescope In Valve. | The UGM detects an open circuit at this output or the UGM detects a CURRENT FEEDBACK LOST condition and sets an internal flag to determine if this fault condition is the reason for the fault. | Power cycled. |
| MAIN TELESCOPE IN VALVE – SHORT TO GROUND | 33190 | 1 | Deactivate output J2-34 Main Telescope In Valve. Decouple/disable current feedback input J3-4 Telescope Return (Disables Telescope Out and In). | The UGM detects a short to ground at this output or the UGM detects a CURRENT FEEDBACK LOST condition and sets an internal flag to determine if this fault condition is the reason for the fault. | Power cycled. |
| FORK TILT UP VALVE – OPEN CIRCUIT | 33191 | 1 | Deactivate output J2-8 Fork Tilt Up Valve. | The UGM detects an open circuit at this output or the UGM detects a CURRENT FEEDBACK LOST condition and sets an internal flag to determine if this fault condition is the reason for the fault. | Power cycled. |
| FORK TILT VALVES – SHORT TO BATTERY | 33192 | 1 | Deactivate output J2-8 Fork Tilt Up Valve. Deactivate output J2-19 Fork Tilt Down Valve. Decouple/disable current feedback input J3-6 Tilt Return (Disables Fork Tilt Up and Down). | The UGM detects a short to battery at this output. | Power cycled. |
| FORK TILT UP VALVE – SHORT TO GROUND | 33193 | 1 | Deactivate output J2-8 Fork Tilt Up Valve. Decouple/disable current feedback input J3-6 Tilt Return (Disables Fork Tilt Up and Down). | The UGM detects a short to ground at this output or the UGM detects a CURRENT FEEDBACK LOST condition and sets an internal flag to determine if this fault condition is the reason for the fault. | Power cycled. |
| FORK TILT DOWN VALVE – OPEN CIRCUIT | 33194 | 1 | Deactivate output J2-19 Fork Tilt Down Valve. | The UGM detects an open circuit at this output or the UGM detects a CURRENT FEEDBACK LOST condition and sets an internal flag to determine if this fault condition is the reason for the fault. | Power cycled. |
| FORK TILT DOWN VALVE – SHORT TO GROUND | 33195 | 1 | Deactivate output J2-19 Fork Tilt Down Valve. Decouple/disable current feedback input J3-6 Tilt Return (Disables Fork Tilt Up and Down). | The UGM detects a short to ground at this output or the UGM detects a CURRENT FEEDBACK LOST condition and sets an internal flag to determine if this fault condition is the reason for the fault. | Power cycled. |
| AUXILIARY FUNC-TION-A VALVE – OPEN CIRCUIT | 33196 | 1 | Deactivate output J2-9 Auxiliary Function-A Valve. Deactivate and inhibit the Continuous Auxiliary Hydraulics feature. Turn OFF the Continuous Auxiliary Hydraulics indicator. | The UGM detects an open circuit at this output or the UGM detects a CURRENT FEEDBACK LOST condition and sets an internal flag to determine if this fault condition is the reason for the fault. | Power cycled. |

| Message | Fault Code | Indicators | Other Actions Taken | Trigger for Fault | Latch Until |
|---|---|---|---|---|---|
| ENGINE FUEL RELAY – SHORT TO BATTERY | 33268 | 1 | Deactivate output J2-31 Engine Fuel Relay. Deactivate and inhibit output J2-26 Engage Starter. | The UGM detects a short to battery at this output. | Power cycled. |
| ENGINE FUEL RELAY – SHORT TO GROUND | 33269 | 1 | Deactivate output J2-31 Engine Fuel Relay. Deactivate and inhibit output J2-26 Engage Starter. | The UGM detects a short to ground at this output. | Power cycled. |
| CRAB STEER VALVE – OPEN CIRCUIT | 33270 | 1 | Deactivate output J2-16 Crab Steer Valve. Try to complete any pending steer mode changes. Display the “Steer Valve Failure” screen on the LCD of the cabin’s display. | The UGM detects an open circuit at this output. | Power cycled. |
| CRAB STEER VALVE – SHORT TO BATTERY | 33271 | 1 | Deactivate output J2-16 Crab Steer Valve. Try to complete any pending steer mode changes and prohibit any new steer mode requests. Display the “Steer Valve Failure” screen on the LCD of the cabin’s display. | The UGM detects a short to battery at this output. | Power cycled. |
| CRAB STEER VALVE – SHORT TO GROUND | 33272 | 1 | Deactivate output J2-16 Crab Steer Valve. Try to complete any pending steer mode changes. Display the “Steer Valve Failure” screen on the LCD of the cabin’s display. | The UGM detects a short to ground at this output. | Power cycled. |
| ALL WHEEL STEER VALVE – OPEN CIRCUIT | 33273 | 1 | Deactivate output J2-4 All Wheel Steer Valve. Try to complete any pending steer mode changes. Display the “Steer Valve Failure” screen on the LCD of the cabin’s display. | The UGM detects an open circuit at this output. | Power cycled. |
| ALL WHEEL STEER VALVE – SHORT TO BATTERY | 33274 | 1 | Deactivate output J2-4 All Wheel Steer Valve. Try to complete any pending steer mode changes and prohibit any new steer mode requests. Display the “Steer Valve Failure” screen on the LCD of the cabin’s display. | The UGM detects a short to battery at this output. | Power cycled. |

| Message | Fault Code | Indicators | Other Actions Taken | Trigger for Fault | Latch Until |
|---|---|---|---|---|---|
| CANBUS FAILURE – CABIN JOYSTICK | 6617 | 1 | Disregard any CAN messages with the cabin joystick source addresses. Deactivate and inhibit all hydraulic functions. | The UGM does not detect the cabin's joystick on the CAN bus for a period of 250msec and an ENGINE STOPPED or ENGINE RUNNING state exists for a period of one second. | Valid CAN bus communication is re-established with the joystick. |
| CANBUS FAILURE – CABIN DISPLAY | 6618 | 1 | | The UGM does not detect the cabin's display on the CAN bus. | Power cycled. |
| CANBUS FAILURE – UNKNOWN TROUBLE CODE: (SPN):(FMI) | 6619 | 1 | N/A | The UGM has detected an unknown module reporting a DM1 or transfer protocol message. | Power cycled. |
| CANBUS FAILURE – BOOM ANGLE SENSOR | 6621 | 1 | Display the fixed boom angle value of '99' on the operator's cabin display. Temporarily assign a fixed boom angle value of 99×. Disallow boom angle sensor calibration ("BOOM ANGLE: CALIBRATION FAIL"). Ignore any hydraulic function requests from the platform station. Deactivate and inhibit the Lift Up output if the platform is detected as attached or PLATFORM MODE is the current active mode; otherwise, derate the MAX LIFT UP in the PERSONALITIES menu screen by the LIFT UP DERATE value in the Constant Data tables. | The UGM or platform module has lost communications with the Boom Angle Sensor. | Power cycled. |
| CANBUS FAILURE - TCU MODULE | 6622 | 1 | | CAN Communications has been lost with the TCU module for 30 seconds or more. Only reported if the telematics machine configuration digit is enabled. | Valid CAN bus communications is re-established with the telematics module |
| CANBUS FAILURE - GATEWAY MODULE | 6623 | 1 | | CAN Communications has been lost with the gateway module for 30 seconds or more. Only reported if the telematics machine configuration digit is enabled. | Valid CAN bus communications is re-established with the gateway module |
| CANBUS FAILURE - TELEMATICS CAN-BUS LOADING TOO HIGH | 6629 | 1 | If this fault has been detected, the CANBUS FAILURE TCU COMUNICATIONS LOST fault will be suppressed. | | Power cycled. |

| SPN | SPN Description | FMI | FMI Description | Warning Level |
|---|---|---|---|---|
| 738 | Transmission Range Clutch Solenoid #5 | 5 | Current Below Normal | 2 |
| 738 | Transmission Range Clutch Solenoid #5 | 6 | Current Above Normal | 2 |
| 2827 | Power Up Without Neutral | 31 | Not Available or Condition Exists | 3 |
| 4217 | Transmission Shift Modulation Solenoid Valve | 3 | Voltage Above Normal | 3 |
| 4217 | Transmission Shift Modulation Solenoid Valve | 5 | Current Below Normal | 2 |
| 4217 | Transmission Shift Modulation Solenoid Valve | 6 | Current Above Normal | 2 |
| 4218 | Transmission Shift Rail 1 Position | 3 | Voltage Above Normal | 2 |
| 4218 | Transmission Shift Rail 1 Position | 4 | Voltage Below Normal | 2 |
| 4218 | Transmission Shift Rail 1 Position | 8 | Abnormal Frequency, Pulse Width or Period | 2 |
| 4219 | Transmission Shift Rail 2 Position | 3 | Voltage Above Normal | 2 |
| 4219 | Transmission Shift Rail 2 Position | 4 | Voltage Below Normal | 2 |
| 4219 | Transmission Shift Rail 2 Position | 8 | Abnormal Frequency, Pulse Width or Period | 2 |
| 4220 | Transmission Shift Rail 3 Position | 3 | Voltage Above Normal | 2 |
| 4220 | Transmission Shift Rail 3 Position | 4 | Voltage Below Normal | 2 |
| 4220 | Transmission Shift Rail 3 Position | 8 | Abnormal Frequency, Pulse Width or Period | 2 |
| 4221 | Transmission Directional Shift at High Speed | 14 | Special Instruction | 3 |

# EN15000 – LSI-System Explanation

- Introduction:
  - European (CE) telehandlers will be expected to comply with new regulations pertaining to the machine's load moment or rear axle's moment sensing system. The intention of the new regulation is to prevent longitudinal (forward) instability from occurring by reducing the machine's function speeds before the 100% axle unloaded cutout point is reached.
  - These new regulations are part of the European Standard EN15000:2008.

- Effective:
  - All machines produced after August 31st 2010 shall comply with the requirements of EN15000:2008.

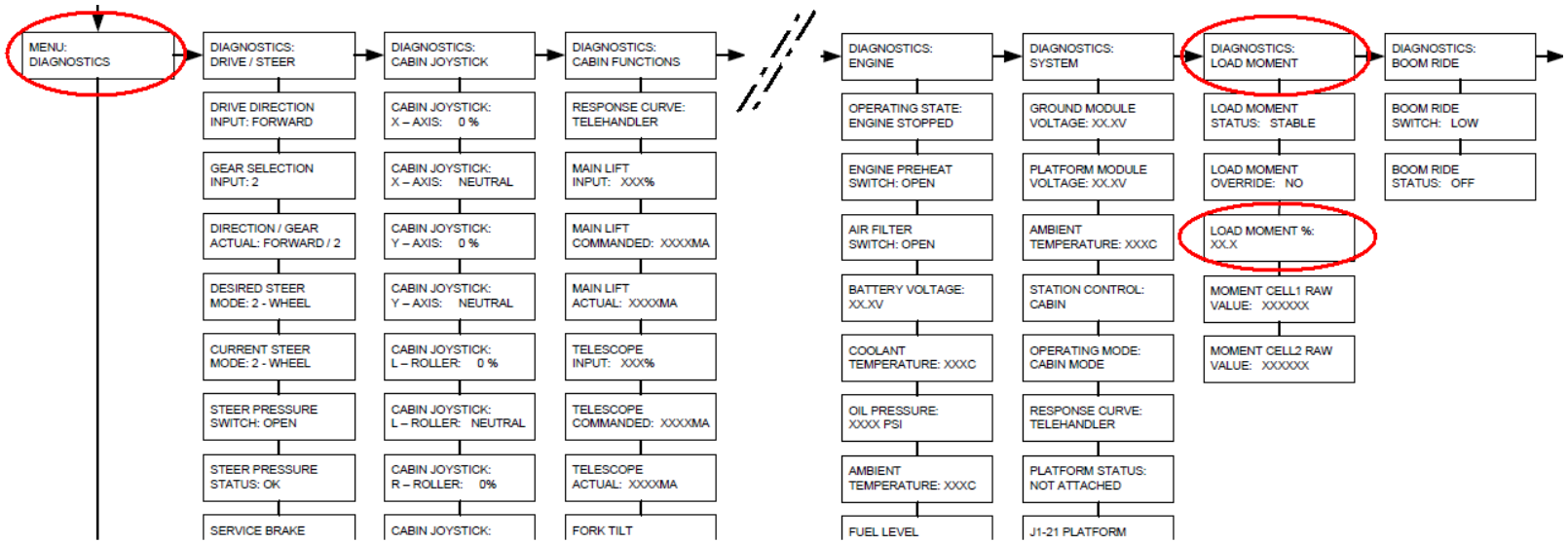
# EN15000 – Settings Explanation

- LSI High Speed Current: Max. mA setting for boom down movement
- LSI Low Speed Current: Max. mA setting for boom down movement when axle load percentage meets or exceeds 70% after evaluation period
- LSI Creep Speed Current: Max. mA setting for boom down movement when axle load percentage meets or exceeds 70% during evaluation period
- Ramp to High Speed Time: Required time to ramp up from LSI LOW Speed Current to LSI High Speed Current for boom down after the evaluation period
- Rear Axle Evaluation Time: Period that rear axle load percentage will be monitored after each initial boom down request greater than LSI LOW SPEED CURRENT.
- Reset Point Percentage: Rear axle load percentage point to reset overload condition
- Reset Point Debounce Time: Period that joystick must be in neutral position after Reset Point Percentage is passed to get max. allowed speed back (LOW or Creep Speed) in stable condition.
- LMI-CAN Trip Point Percentage of Load: Trigger point for mA output (LOW or Creep).
- LSI Low Speed Current (TELE): Max. mA setting for TELE OUT movement when axle load percentage exceeds 70% after evaluation period
- Ramp to High Speed Time (TELE): Required time to ramp up from LSI LOW Speed Current to LSI High Speed Current for TELE OUT movement after the evaluation period
- High Speed Current (EN15000 passive): Max. mA setting for boom down movement when the boom is fully retracted and so the EN15000 LSI system is passive.

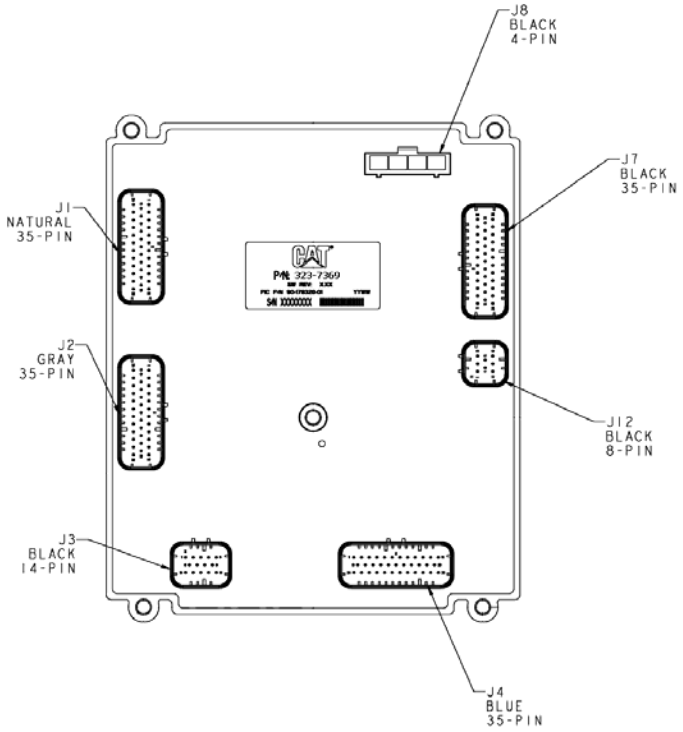
# EN15000 - Components

- Rear Axle Unloaded Moment Percentage

**Push C + OK for 2 seconds to enter analyzer menu**

# EN15000 – Error Code 8519




- **8519 -> LSI OUT OF CALIBRATION**
- The LSI-CAN Check Points have not been calibrated or failed a check with the UGM.
- The UGM is reporting the LSI-CAN Check Points either have not been entered after a LSI System calibration or during the LSI check the actual load cell raw counts are not within +/- 10 counts of the logged calibrated counts. The most likely event is the machine is either not on level ground or the machine is not in the proper configuration for running the test.Also, if the UGM were to be replaced in the field, the UGM logged LSI-CAN check points will need to be re-entered in the CALIBRATIONS menu. Once this has been completed, the LSI-CAN check point test in the OPERATOR TOOLS menu will need to be performed.
- **The LSI System does not need to be calibrated. The UGM just needs the information from the LSI System so the UGM can perform the a system integrity check.**

# Table of Contents

## Disassembly and Assembly Section



**WARNING**

**Accidental machine starting can cause injury or death to personnel working on the machine.**

**To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.**

**Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.**

**35.** Repeat Step 39 for the other tube assembly.

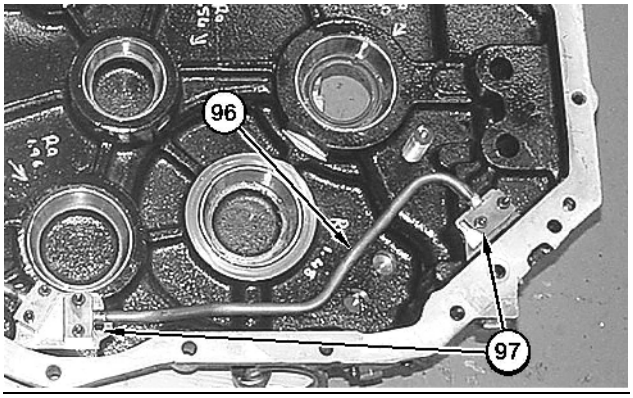



Illustration 40 g01033960

Cover of a transmission with four speeds

**a.** Remove screws (97) in order to remove tube assembly (96).

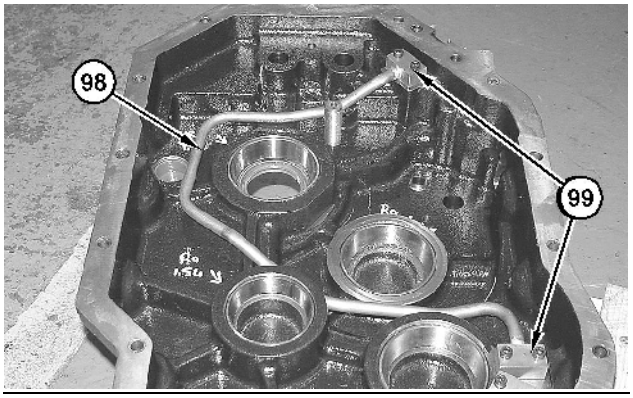



Illustration 41 g01033964

Cover of a transmission with five speeds

**b.** Remove screws (99). Remove tube assembly (98) and the O-ring seals.

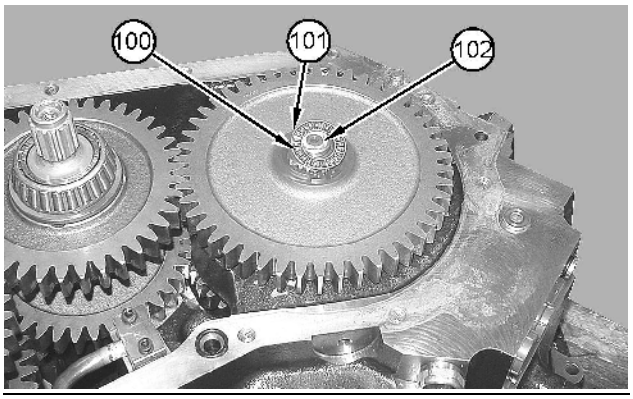



Illustration 42 g01042376

**36.** Remove thrust bearing (100) and sleeve (101) from input shaft (102).

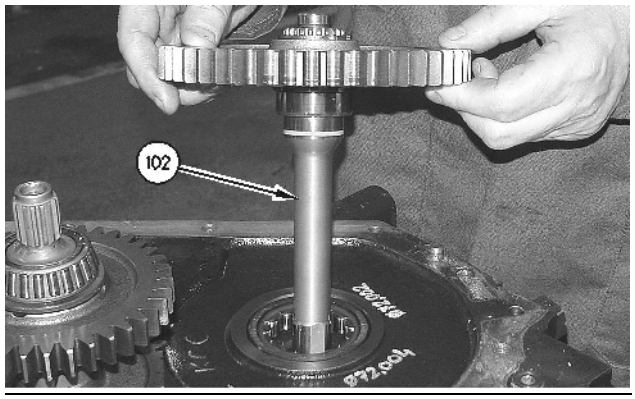



Illustration 43 g00893604

**37.** Remove input shaft (102).

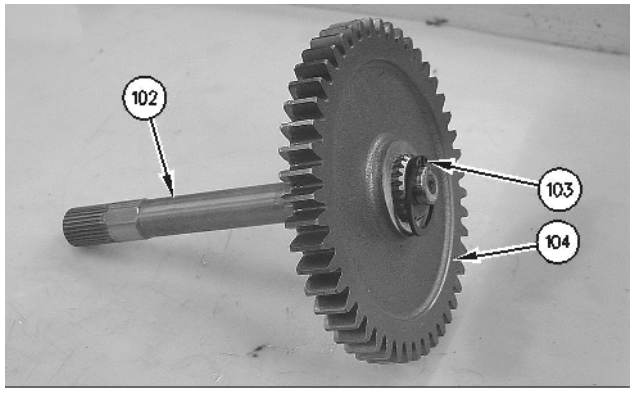



Illustration 44 g00893605

**38.** Use Tooling (K) in order to remove retaining ring (103). Remove gear (104) from input shaft (102).

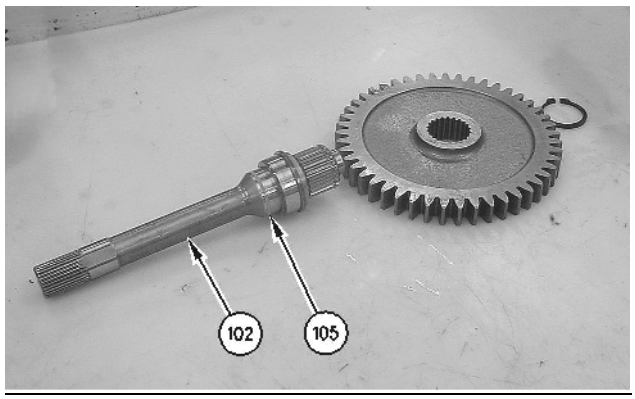



Illustration 45 g00893606

**39.** Remove ring seal (105) from input shaft (102).

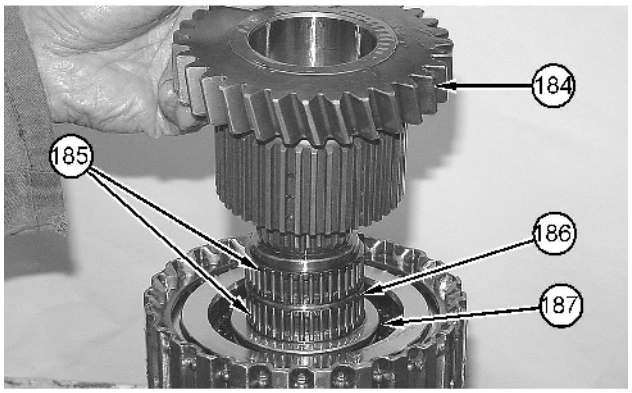



Illustration 97 g01035603

**93.** Remove forward primary gear (184), needle bearings (185), spacer (186), and thrust washer (187).

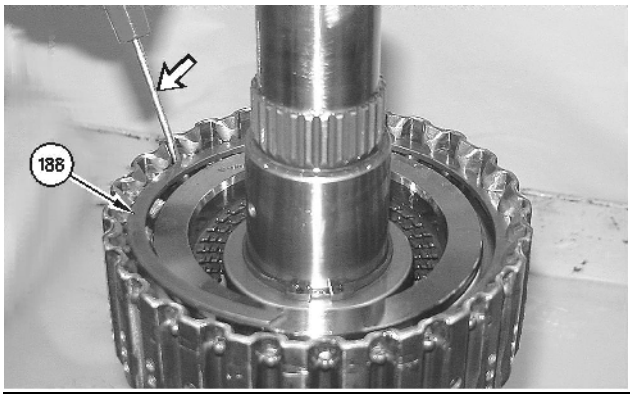



Illustration 98 g00894711

**94.** Remove retaining ring (188).

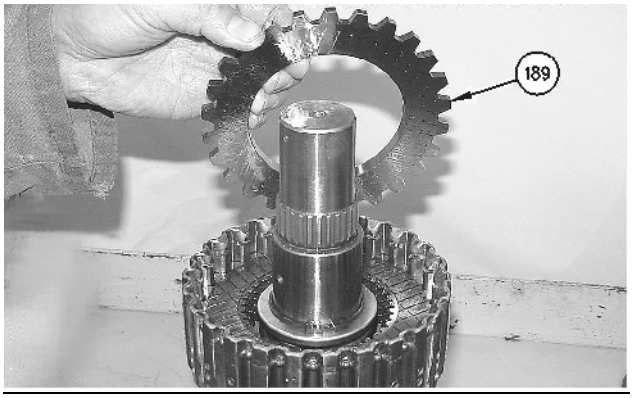



Illustration 99 g00894719

**95.** Remove top plate (189).

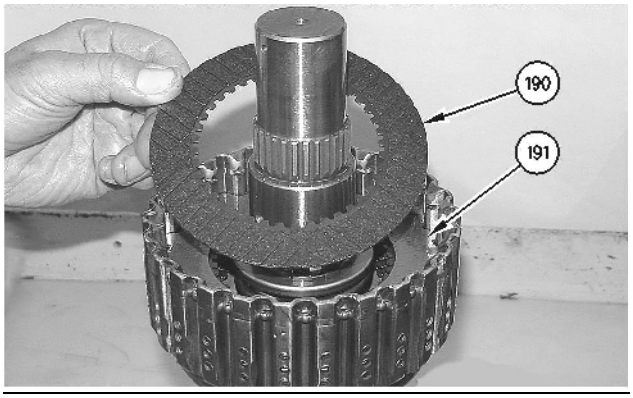



Illustration 100 g00894726

**96 .** Remove friction plate (190) and clutch plate (191).

**97 .** Repeat Step 101 until the six friction plates and the six clutch plates are removed.

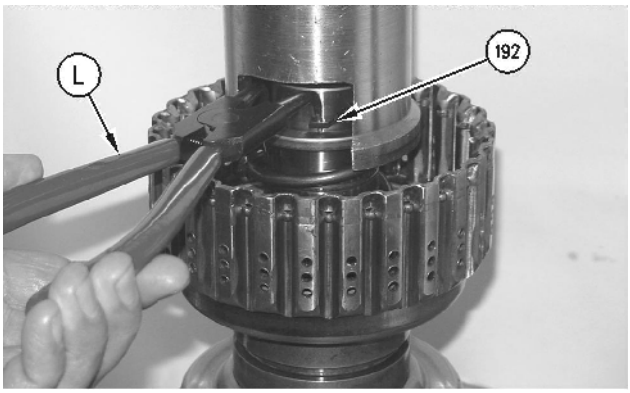



Illustration 101 g00894934

Typical Example of Tooling (L)

**⚠ WARNING**

**Personal injury can result from being struck by parts propelled by a released spring force.**

**Make sure to wear all necessary protective equipment.**

**Follow the recommended procedure and use all recommended tooling to release the spring force.**

**98 .** Use a suitable press in order to take the load off retaining ring (192) and remove the retaining ring with Tooling (K).

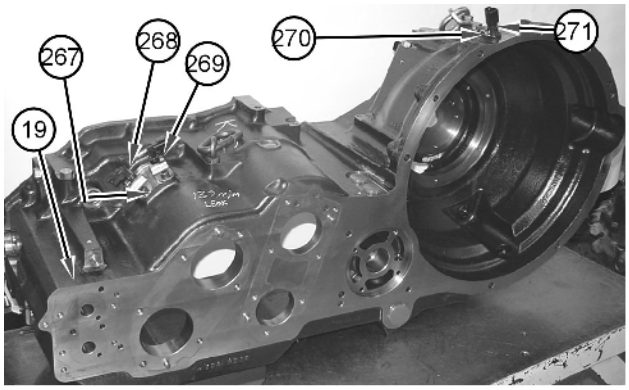



Illustration 154 g01116625

**151.** Remove bolts (267) that secure speed sensors (268) and (269) to transmission housing (19). Remove bolt (270) that secures speed sensor (271) and remove the three sensors from the transmission housing.

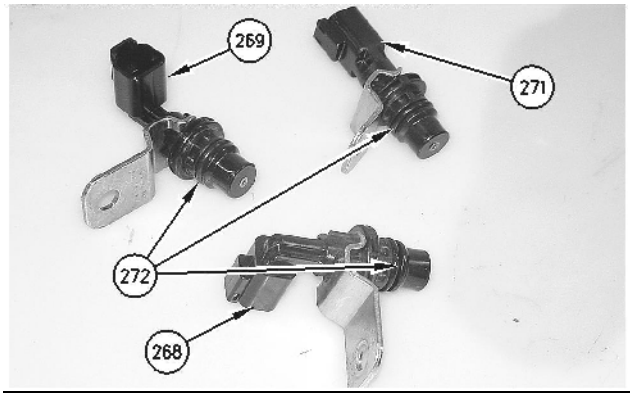



Illustration 155 g00896542

**152.** Remove O-ring seals (272) from speed sensors (268), (269), and (271).

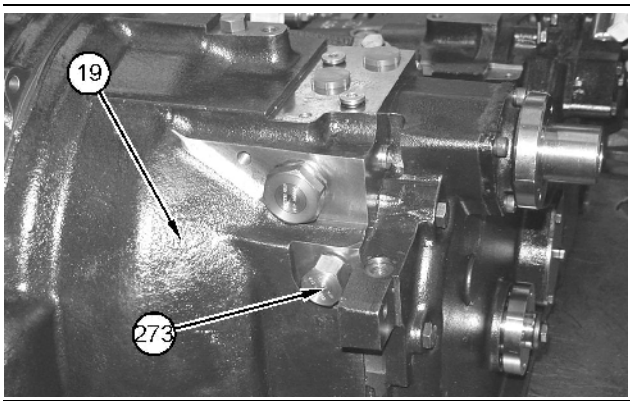



Illustration 156 g01042705

**153.** Remove torque converter relief valve (273) from transmission housing (19).

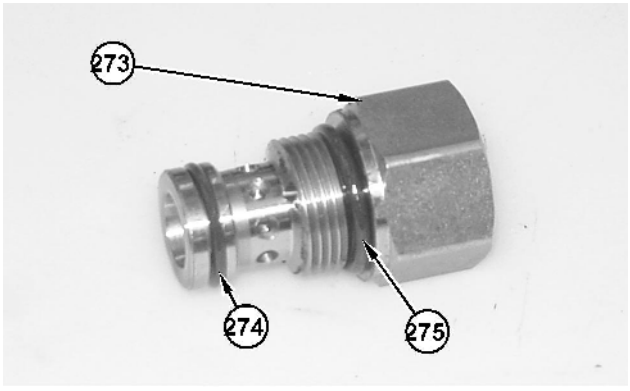



Illustration 157 g01036140

**154.** Remove O-ring seals (274) and (275) from torque converter relief valve (273).

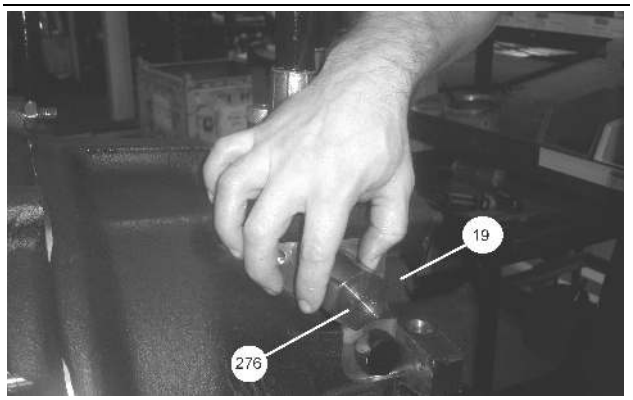



Illustration 158

**155 .** Remove pressure regulator valve (276) from transmission housing (19).

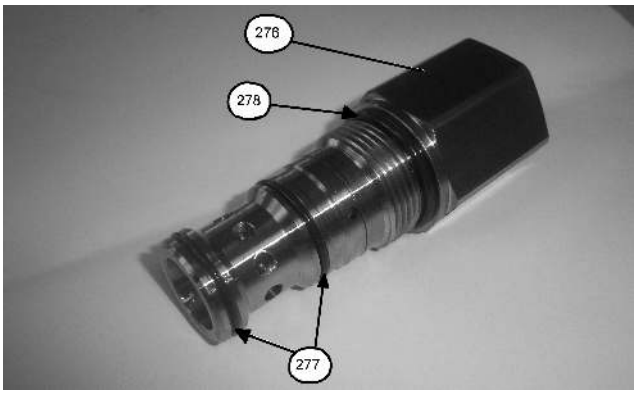



Illustration 159

**156** Remove O-ring seals (277) and (278) from pressure regulator valve (276).

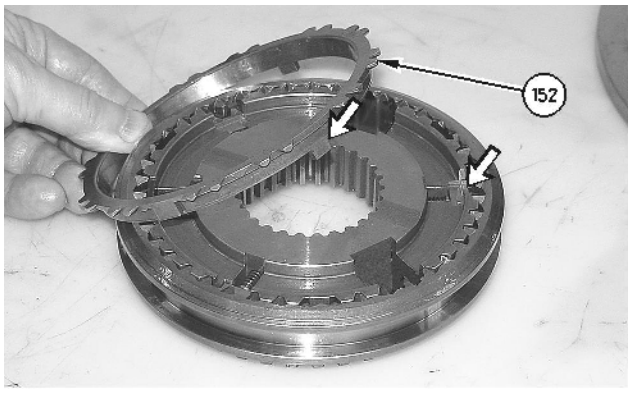



Illustration 208 g00900546

**50.** Install outer cone (152) so that the lugs on the outer cone are aligned with the three energizers.

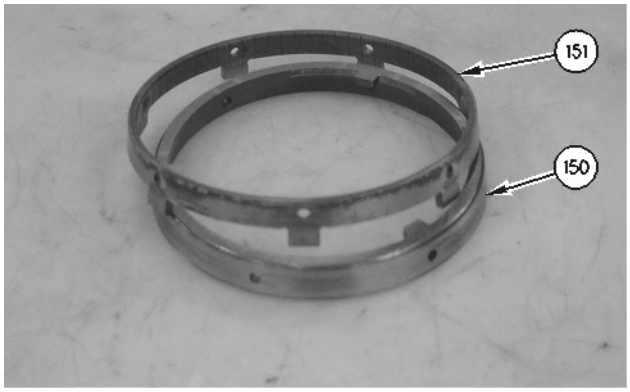



Illustration 209 g00900554

Example of Damaged Inner Cone (150) and Damaged Friction Ring (151)

**51.** Check the surfaces of inner cone (150) and friction ring (151). Replace the inner cone of the friction ring with a new part if any of the following damage is found:

- Scuffing
- Burn marks.

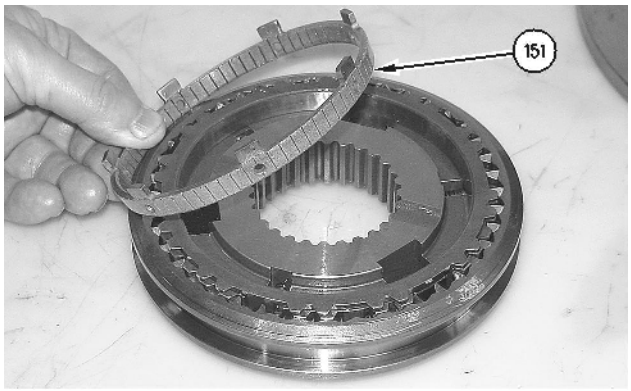



Illustration 210 g00900589

**52.** Install friction ring (151) for the synchronizer.

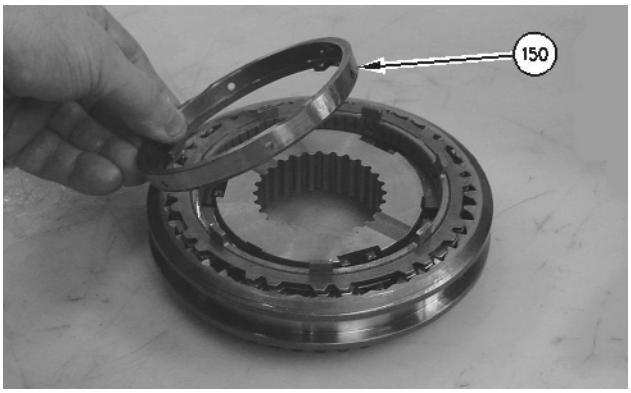



Illustration 211 g00900595

**53.** Install inner cone (150) for the synchronizer.

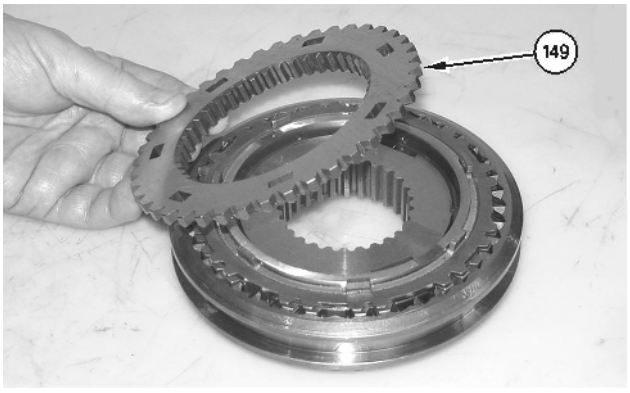



Illustration 212 g00900596

**54.** Install dog tooth plate (149) for the synchronizer.

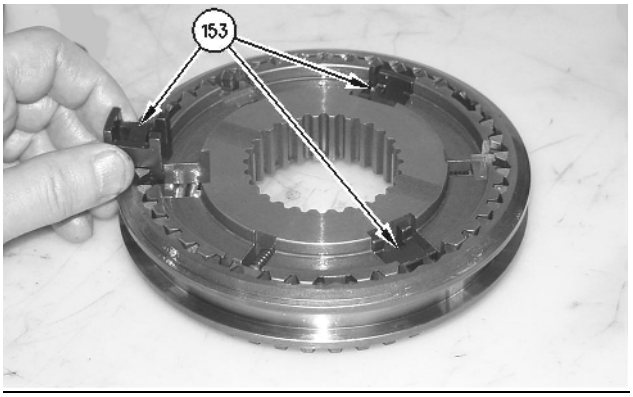



Illustration 213 g00900544

**55.** Turn the synchronizer onto the other side and install connecting blocks (153).

**56.** Repeat Step 52 to Step 56 for the other side of the synchronizer.

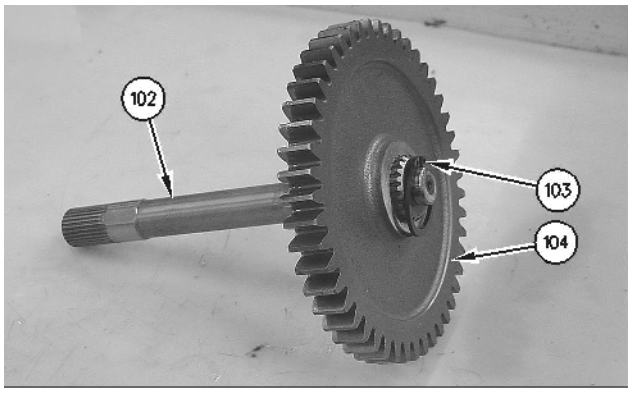



Illustration 262 g00901266

**108 .** Install gear (104) onto input shaft (102) and use Tooling (K) in order to install retaining ring (103).

**Note:** Ensure that the boss of gear (104) is at the same side as retaining ring (103).

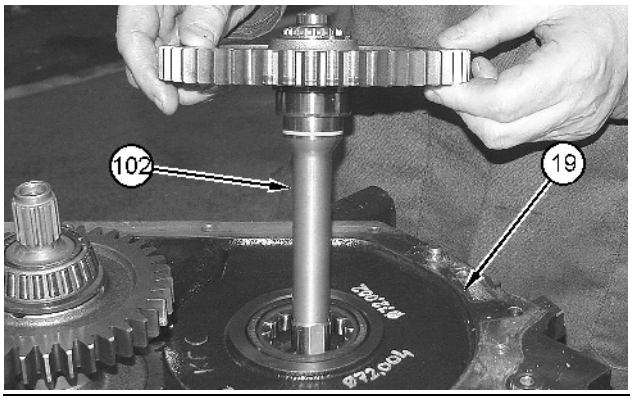



Illustration 263 g01048518

**109 .** Install input shaft (102) into transmission housing (19).

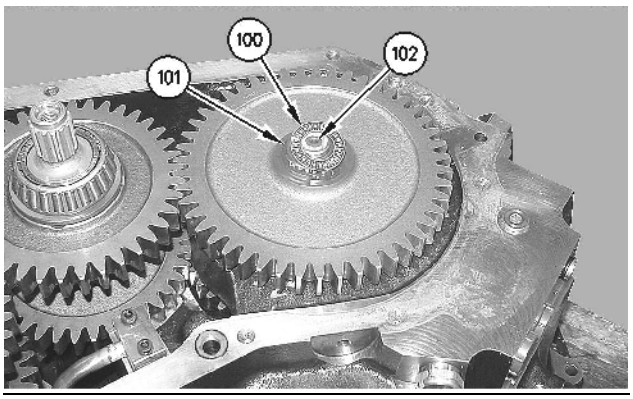



Illustration 264 g00901268

**110.** Install sleeve (101) and thrust bearing (100) onto the end of input shaft (102).

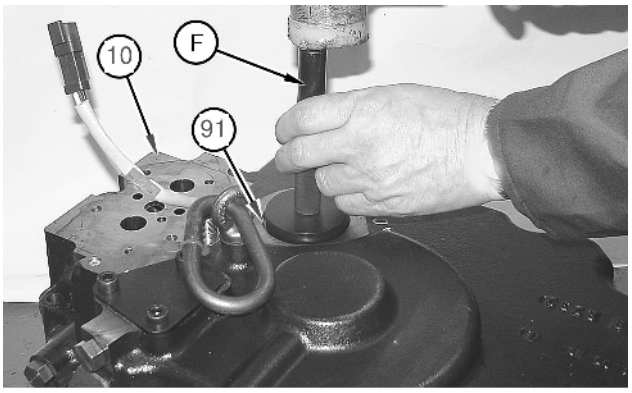



Illustration 265 g01117449

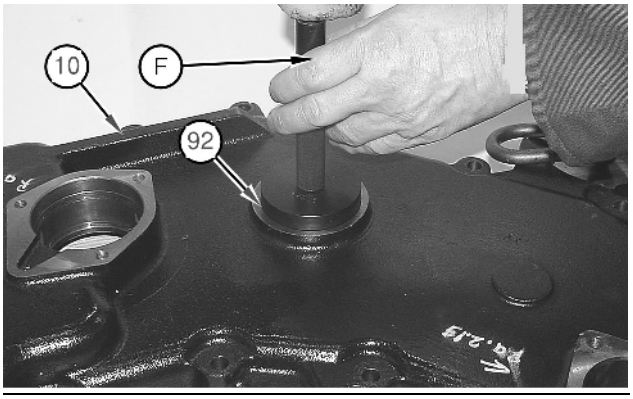



Illustration 266 g01117454

**111.** Use Tooling (F) in order to install seals (91) and (92) into transmission cover (10).

**112.** Position transmission cover (10) onto the other side and install the tube assembly into the transmission cover. The position of the tube assembly in a transmission with five speeds is different to the position of the tube assembly in a transmission with four speeds.

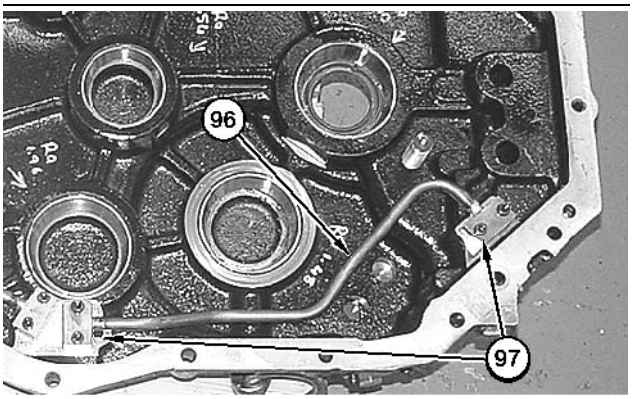



Illustration 267 g01033960

Cover of a Transmission with Four Speeds

**a.** Install tube assembly (96) and the O-ring seals into the transmission cover. Install screws (97).

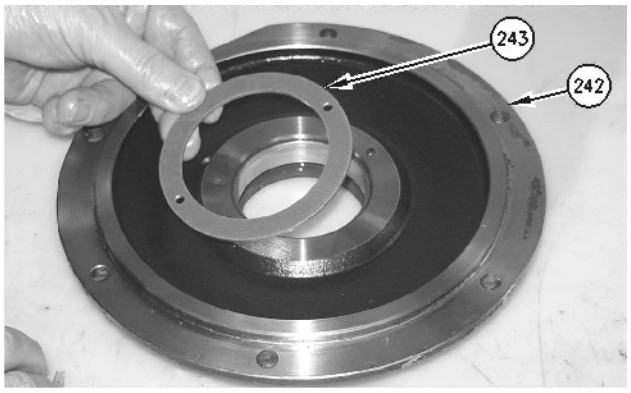



Illustration 312 g00900216

**154.** Install thrust bearing (243) onto the rear of cover (242) for the pump drive gear. Ensure that the two small pins on the cover engage with the holes in the thrust bearing.

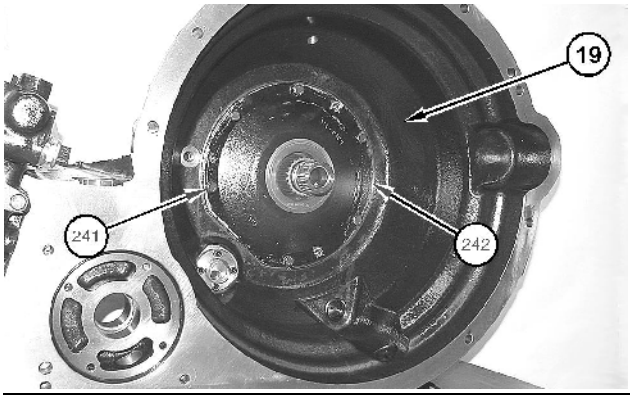



Illustration 313 g01049413

**155.** Install cover (242) for the pump drive gear onto transmission housing (19) with bolts (241). Tighten bolts (241) in a diagonal pattern.

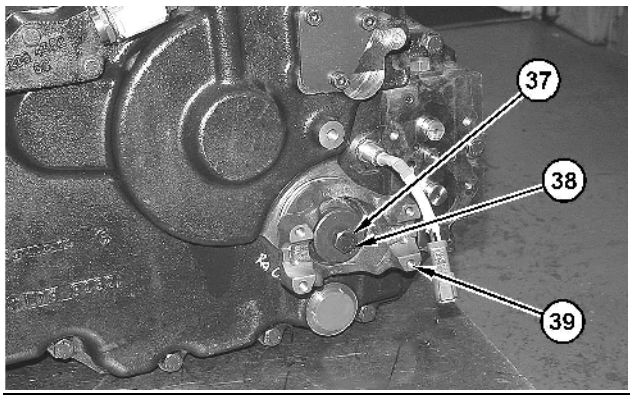



Illustration 314 g01033899

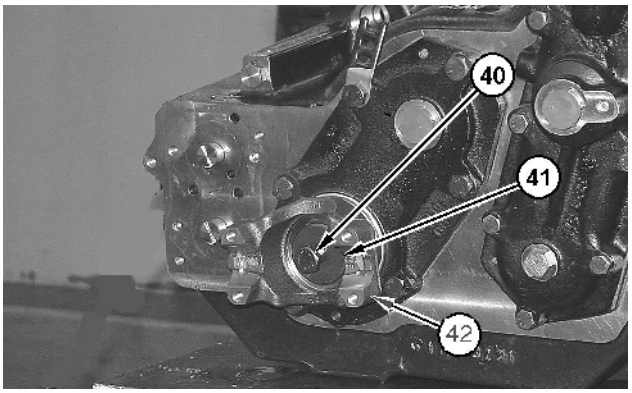



Illustration 315 g01033901

**156** Install drive yokes (39) and (42), washers (38) and (41) and bolts (37) and (40) onto both ends of the output shaft.

**Note:** Ensure that the yokes are installed with the same phase angle.

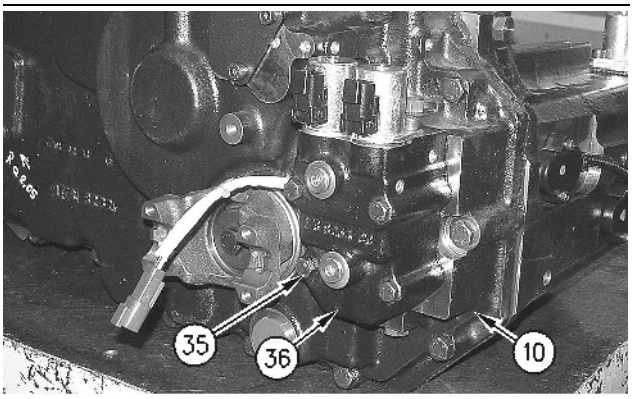



Illustration 316 g00901664

**157** Install actuator (36) and bolts (35) onto transmission cover (10).

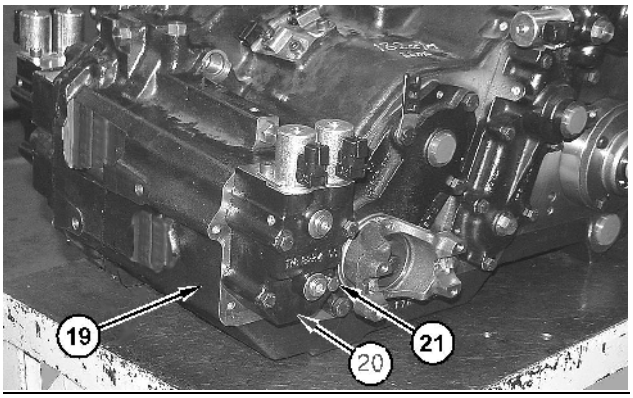
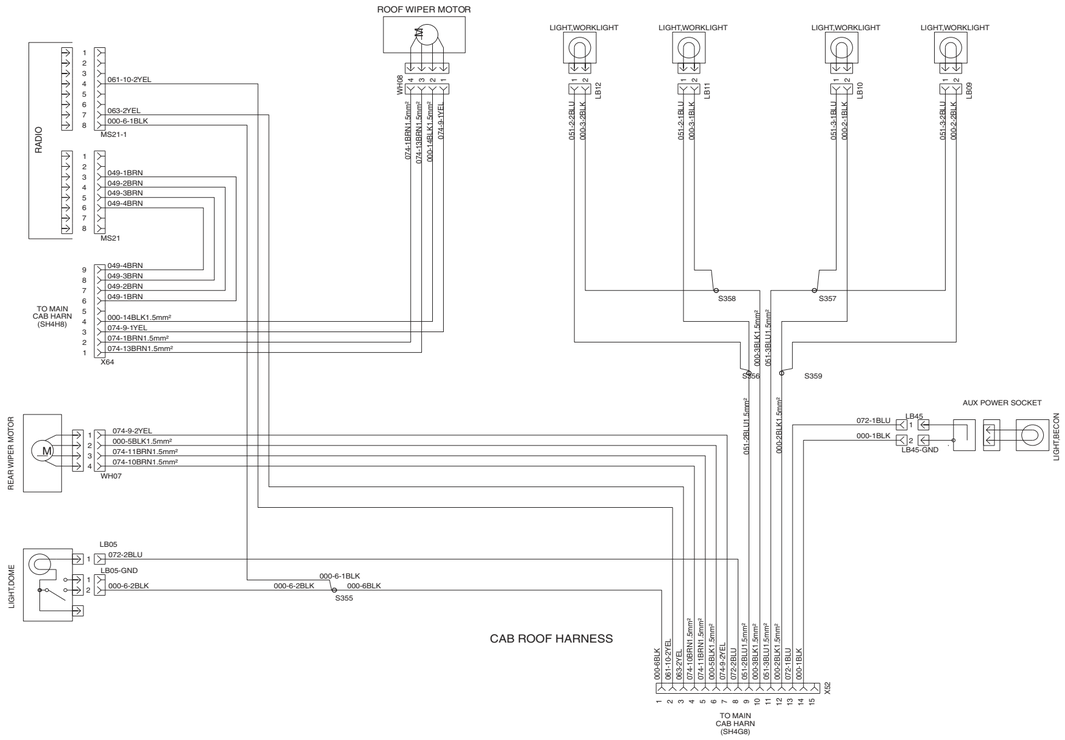
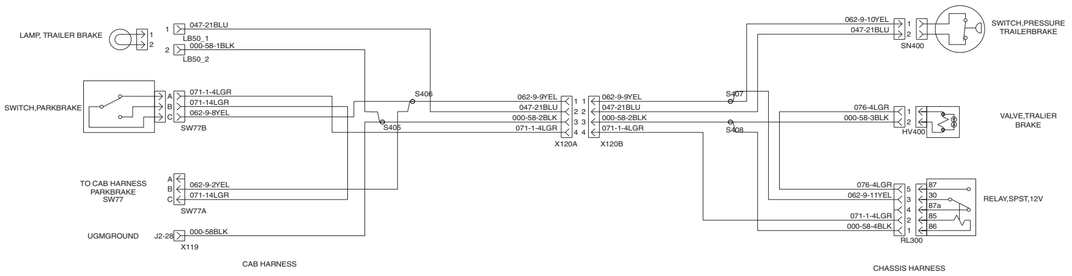



Illustration 317 g01033886

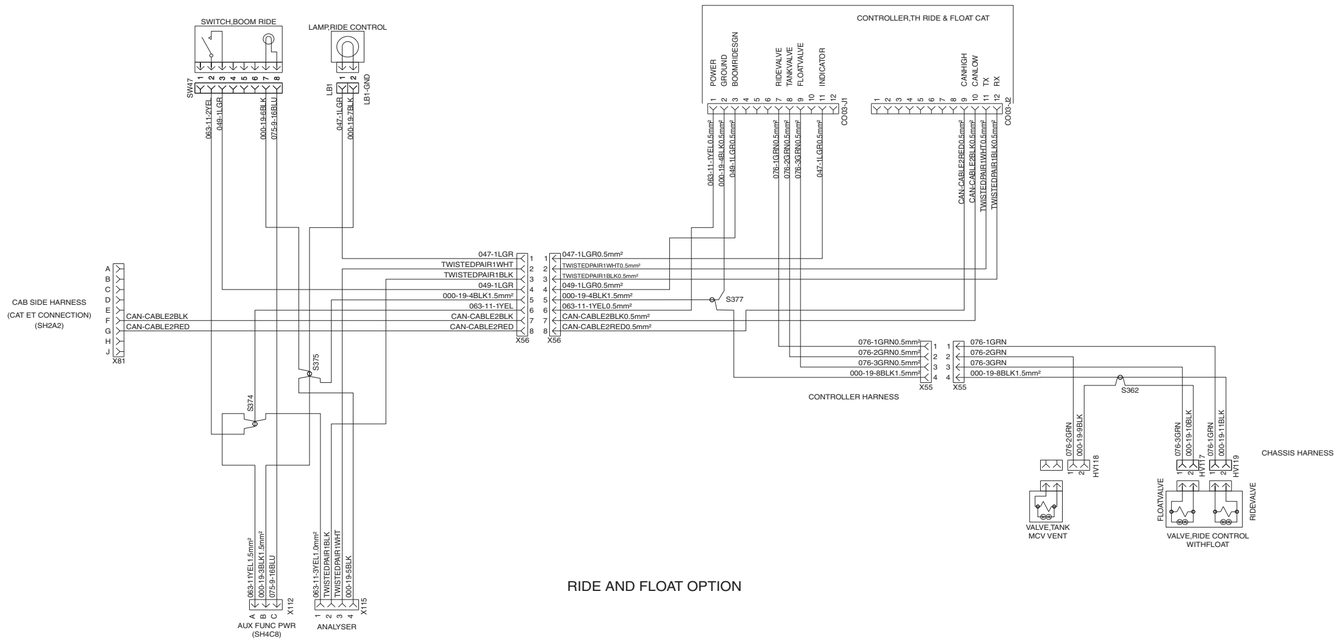
**158 .** Install actuator (20) and bolts (19) onto transmission housing (19).

# CABROOF,RIDE AND FLOAT & BOOM EXT LIMIT

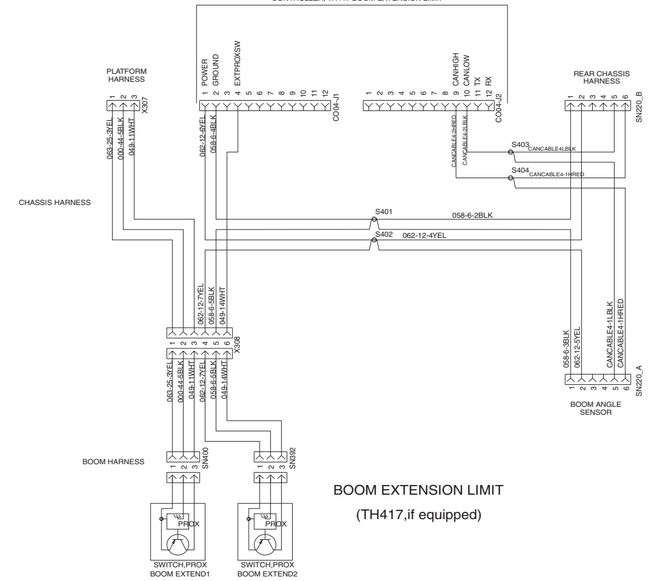



## ITALIAN TRAILER BRAKE




## RIDE AND FLOAT OPTION




## BOOM EXTENSION LIMIT

(TH417,if equipped)

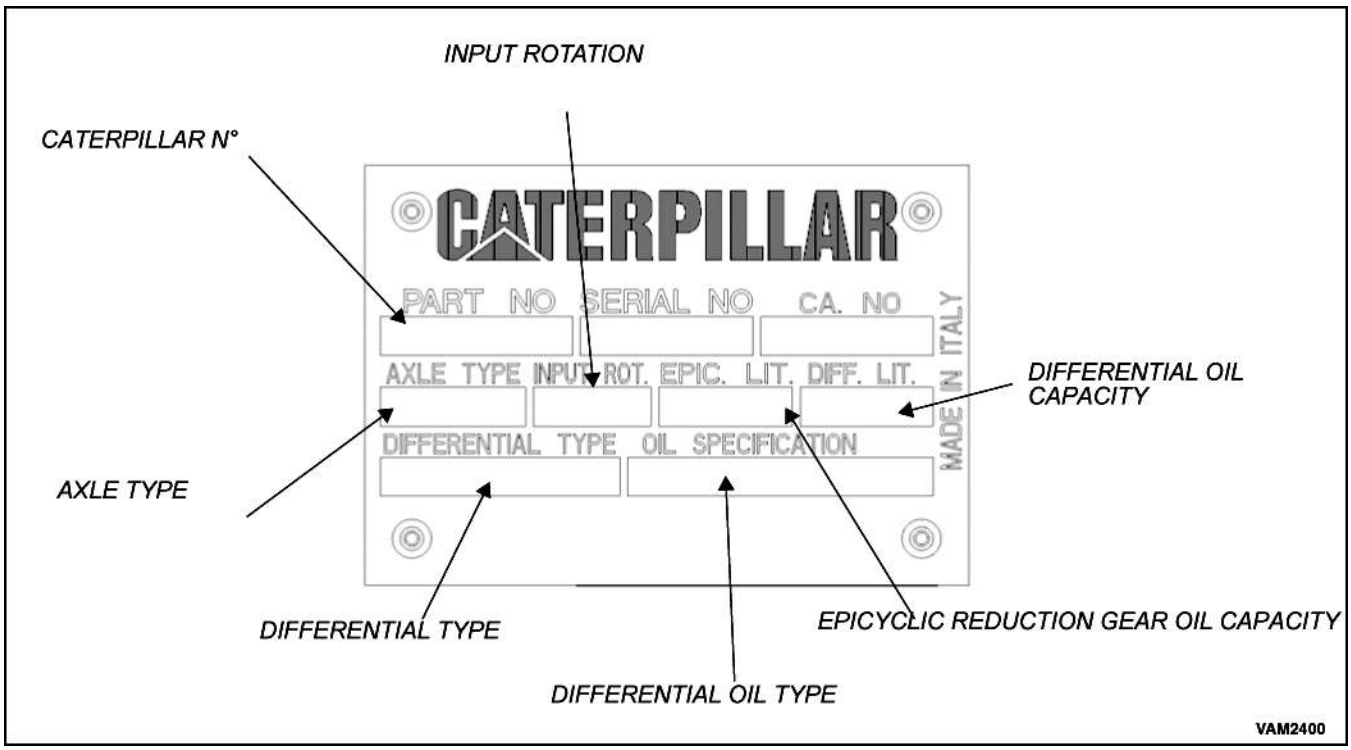
# EFFECTIVITY PAGE

August 8, 2008 - A - Original Issue Of Manual

January 22, 2014 - B - Update Front Cover to Include TH336C, TH337C, TH406C, TH407C, TH414C

July 15, 2014 - C - Revised Front Cover.

## 2.3 PRODUCT IDENTIFICATION

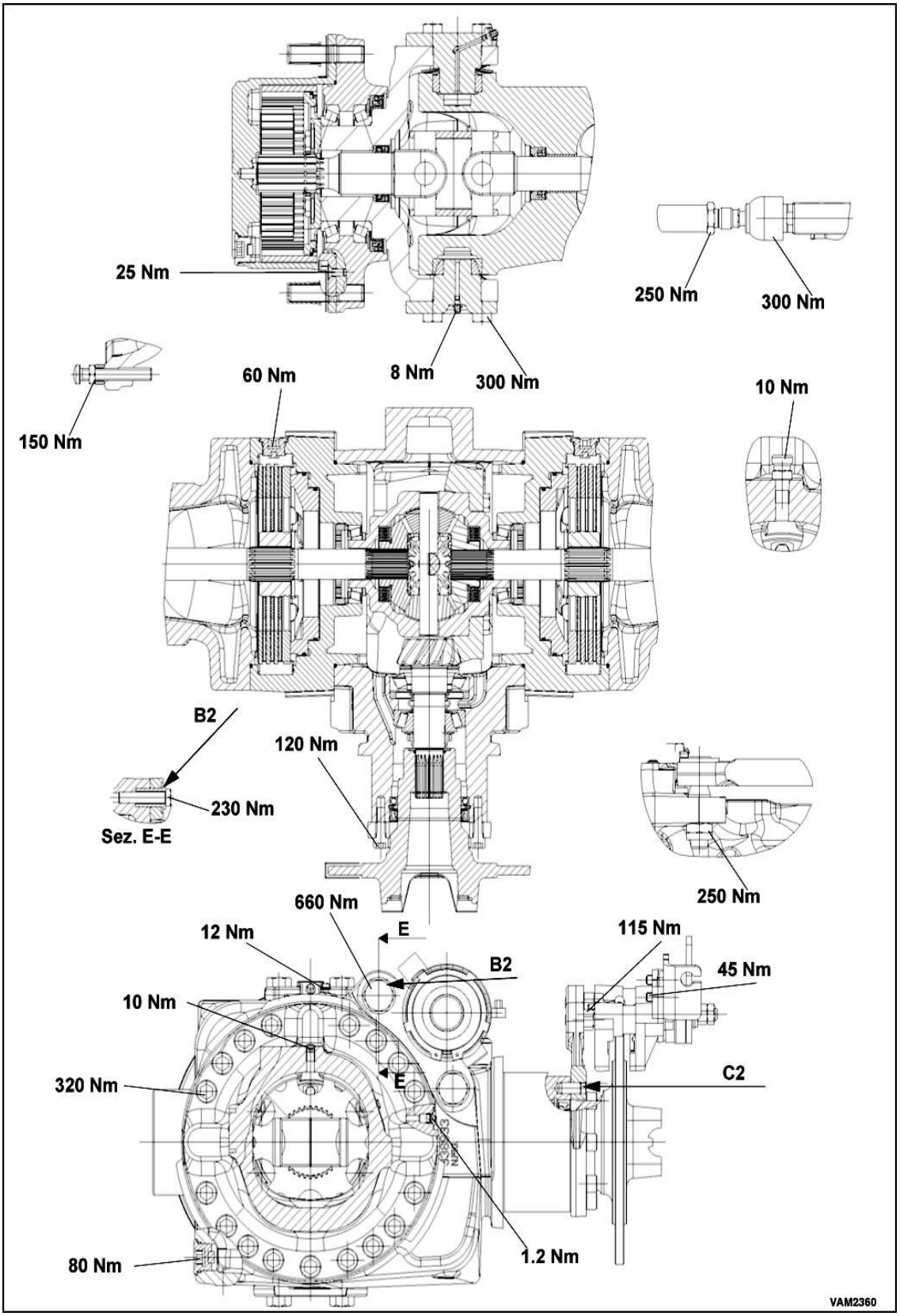


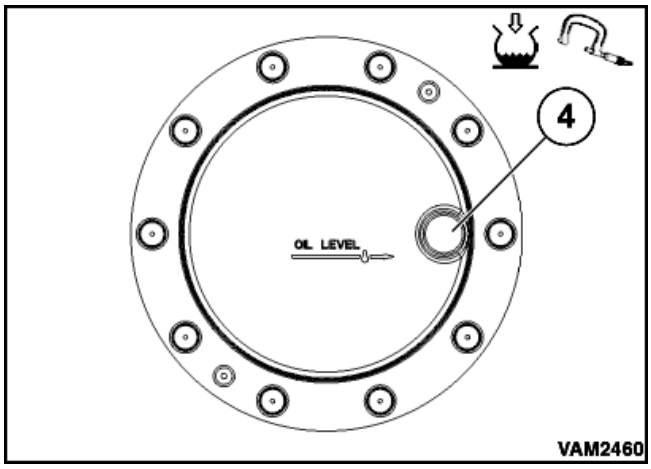

## 2.4 MEASUREMENTS

This manual indicates all measurements in the International System (SI). Use the conversion table shown below to convert Imperial Measurement.

| S.I. | | GB/USA SYSTEM | |
|---|---|---|---|
| 1 | (mm) | 0.03937 | (in) |
| 10 | (mm) | 0.3937 | (in) |
| 25.4 | (mm) | 1 | (in) |
| 6.4516 | (cm²) | 1 | (sq. in) |
| 1 | (m²) | 1550 | (sq. in) |
| 16.378 | (cm²) | 1 | (cu. in) |
| 0.473 | (dm²) | 1 | (U.S. pint) |
| 1 | (l) | 61.02 | (cu. in) |
| 1 | (l) | 0.2642 | (U.S. gal) |
| 1.772 | (g) | 1 | (oz) |
| 0.4536 | (kg) | 1 | (lb) |
| 0.00070308 | (kg/mm²) | 1 | (lb/sq. in) |
| 1 | (bar) | 14.51 | (psi) |
| 1 | (kg.m) | 7.246 | (lb. ft) |
| 1(daN)= 10 (N)= 1,02 (kg.f) | | 2.24 | (lb. f) |

VAM2510

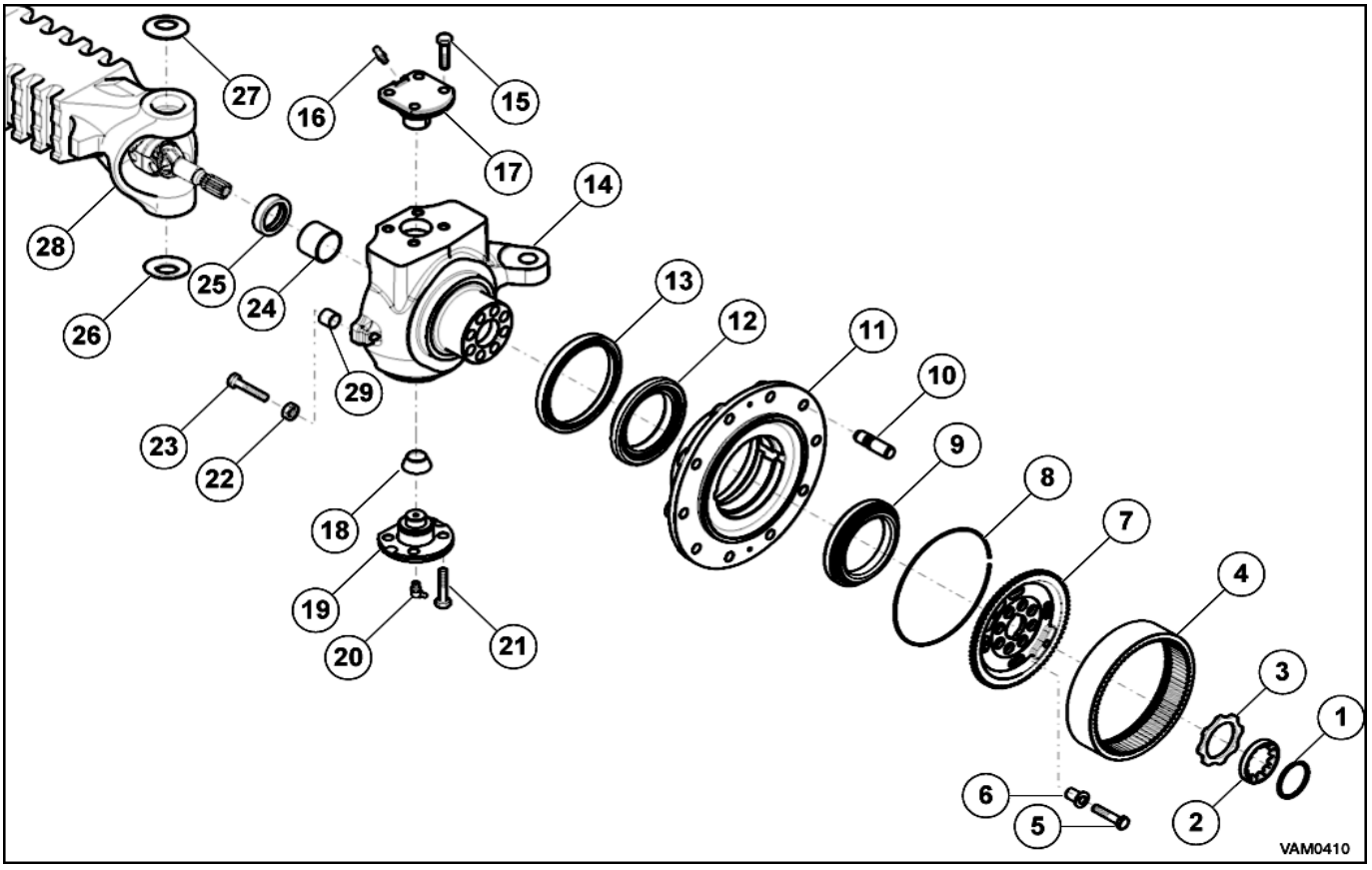

25 Nm
250 Nm
300 Nm
150 Nm
60 Nm
8 Nm
300 Nm
10 Nm
B2
120 Nm
230 Nm
Sez. E-E
250 Nm
660 Nm
12 Nm
E
115 Nm
B2
45 Nm
10 Nm
C2
320 Nm
E
1.2 Nm
80 Nm
VAM2360




6. Rotate the wheel end so the hole (**4**) is in the position shown in the graphic above. Fill to the bottom, of the fill plug hole with specified oil. See “Technical Features” on page 2.4. Tighten plug to the prescribed torque. See “Tightening Torques and Sealants” on page 2.12.

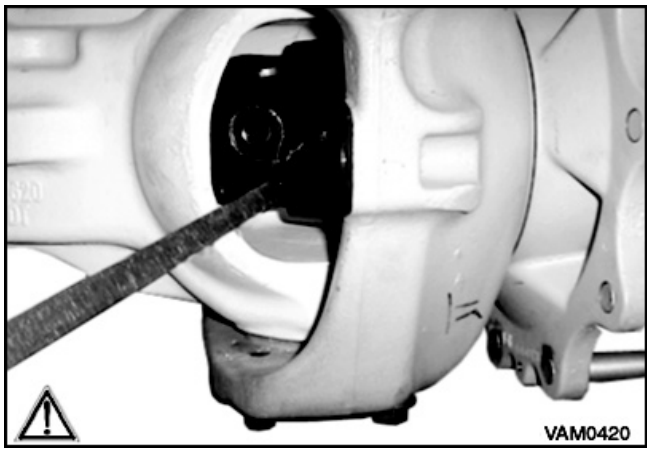
## 4.3 WHEEL HUB GROUP

### 4.3.1 General Drawing



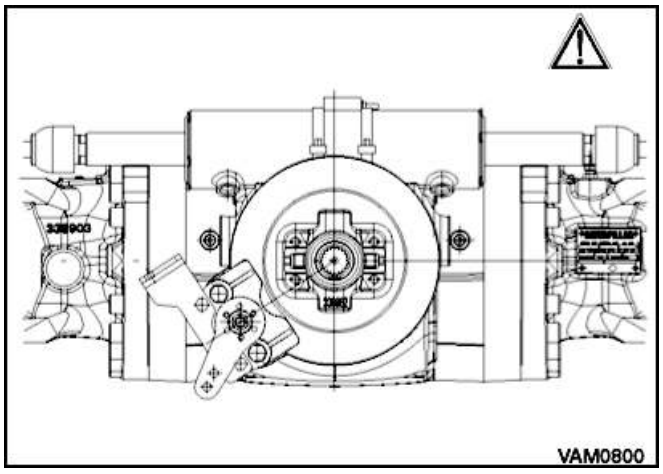

### 4.3.2 Disassembly

***Note:*** *Remove the epicyclic reduction gear group before disassembling wheel hub group.*

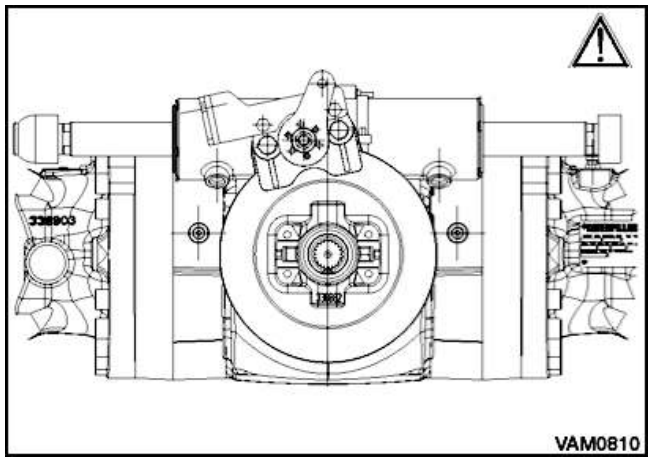



**Important:** Do not damage the double U-Joint while completing the following procedure.

1. Insert a lever between the swivel housing (**14**) and the axle beam and fit it into the double U-Joint. With the lever, push the double U-Joint in the direction of the wheel hub to allow lock ring (**1**) removal.



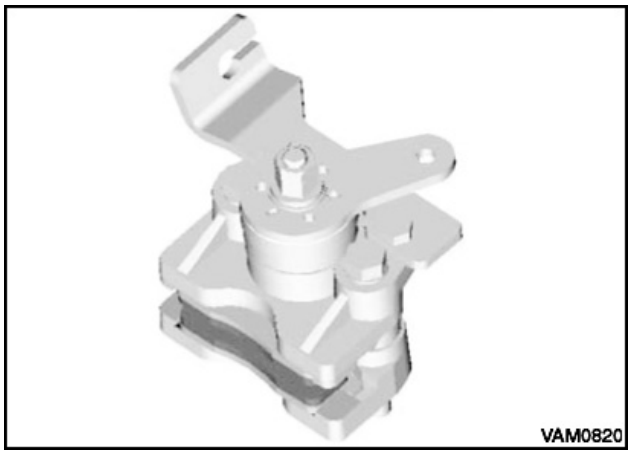

6. Note in the illustration above that the brake caliper of the 314-8934 axle is positioned downward.

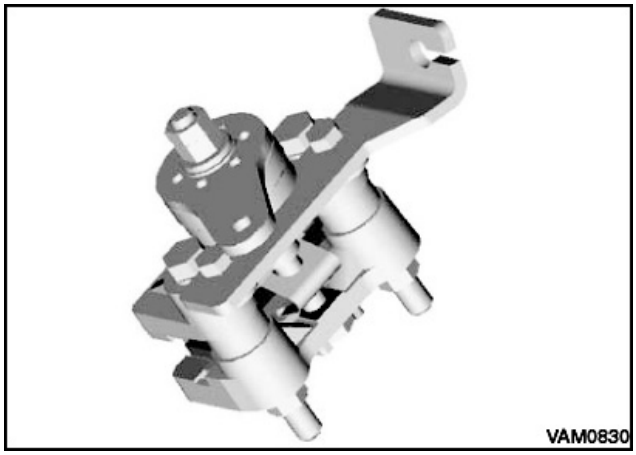



7. The brake caliper of the 314-8932 axle, shown above) is positioned upward.

### 4.4.4 Parking Brake Caliper

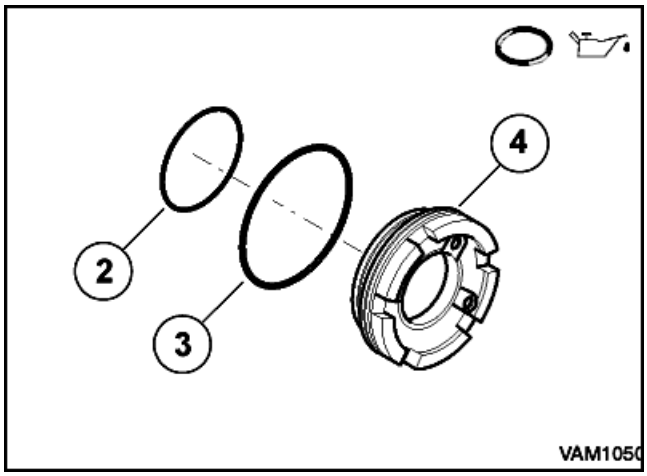
Some of the following graphics may not show your axle, but indicated procedures are correct.



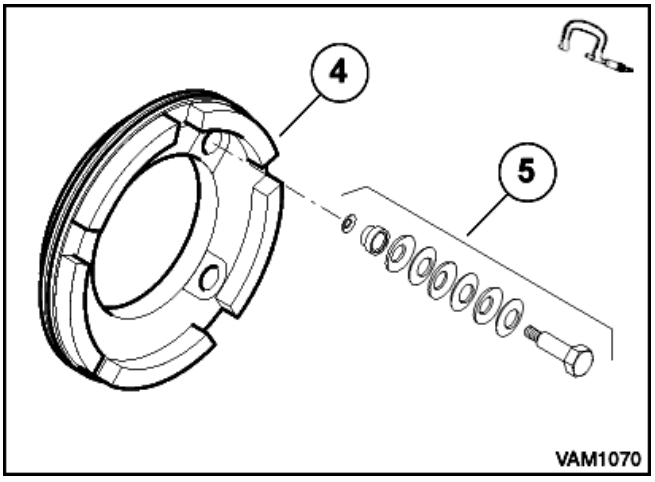




1. The parking brake assembly is a ball and cam, sliding caliper brake **designed for use primarily as a parking brake,** with some service brake capability. The brake (shown in the photos above and the exploded graphic on the following page) has an open caliper design to facilitate changing linings, along with a retraction spring to reduce drag from the brake pads and the disc.

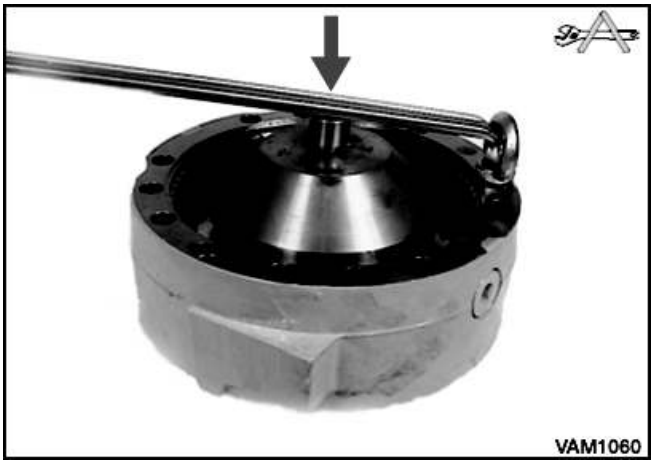
***Note:*** *The brake assembly should not be subject to high pressure wash.*




3. Assemble new O-Rings (**2)** and **(3**) to the brake piston (**4**). Lubricate the O-Rings.



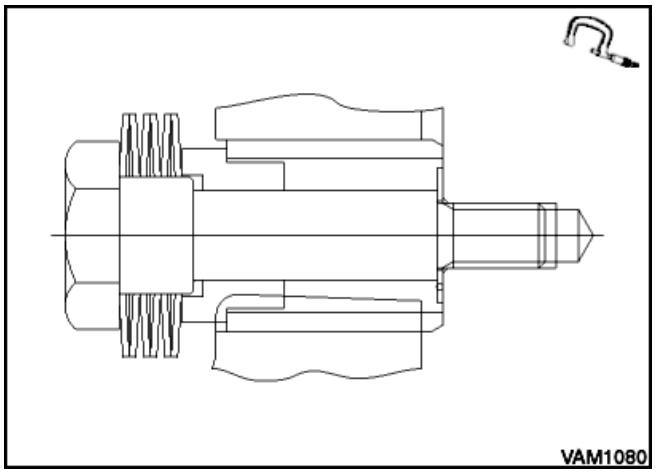

6. Assemble the self-adjust kit (**5**) and tighten the screws to the prescribed torque (see 2.8).




4. Insert the piston (**4**) into the brake cylinder (**1**) and position the special tool (Sec. 5) on the piston.

***Note:*** *Position the positive brake piston (**4**) with a slot aligned with the hydraulic connection or with the inspection hole on the brake cylinder (**1**).*

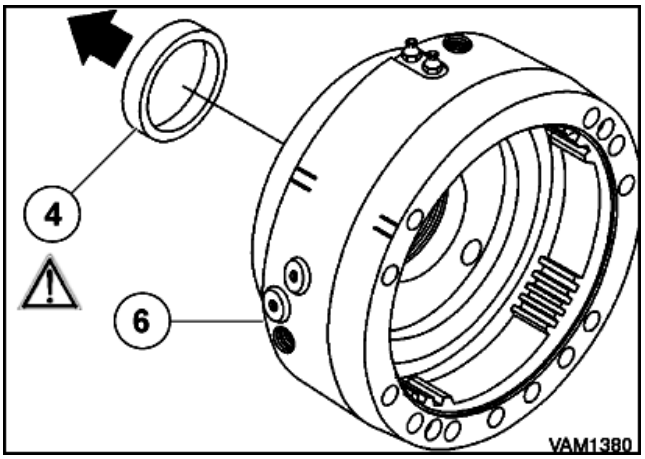
5. With a lever anchored to an eyebolt, apply just enough pressure to insert the piston into the brake flange.




***Note:*** *Assembly of the self-adjust kit (**5**).*

7. Check that the brake plate (**7)** and (**10**) and the brake drive plate (**6)** and (**9**) do not show any sign of burning. If they do, replace them.
   Furthermore, check brake plate wear and if necessary, replace it.

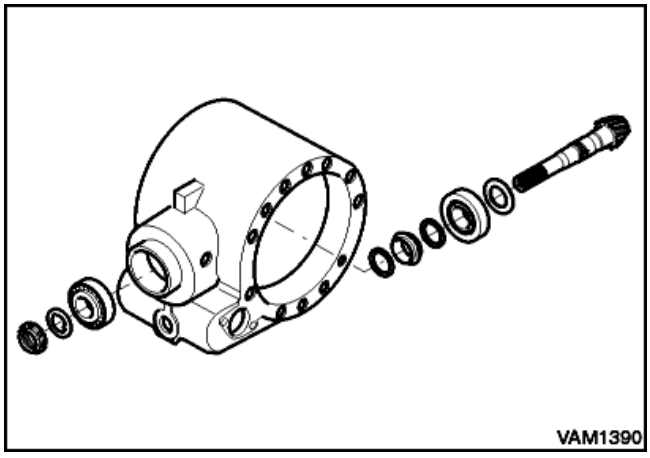
***Note:*** *See the following section 4.7.4, Brake disks replacement.*



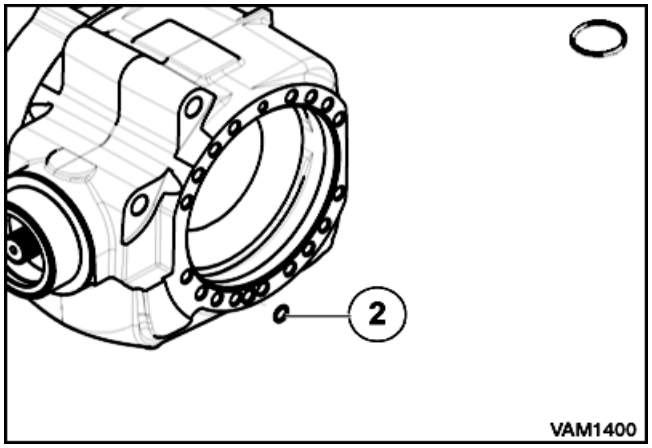

9. Use a driver and a hammer to remove the bearing cup (**4**) from the brake cylinder (**6**).

**Important:** Do not invert the bearing cups if the bearings are not replaced

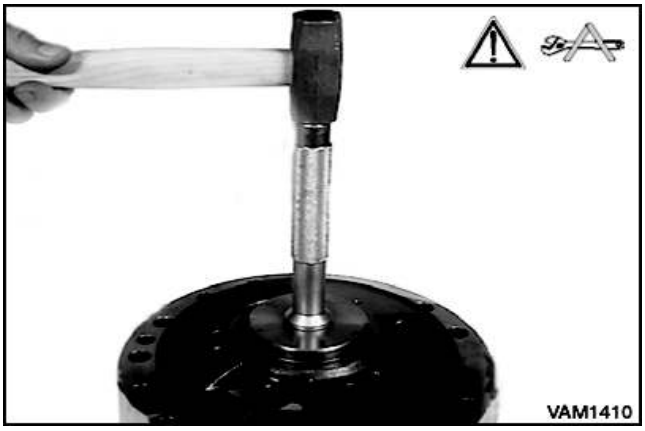
### 4.9.3 Assembly




1. Assemble the pinion group before assembling the differential support group.
   **See:** section 4.12.3, assembly

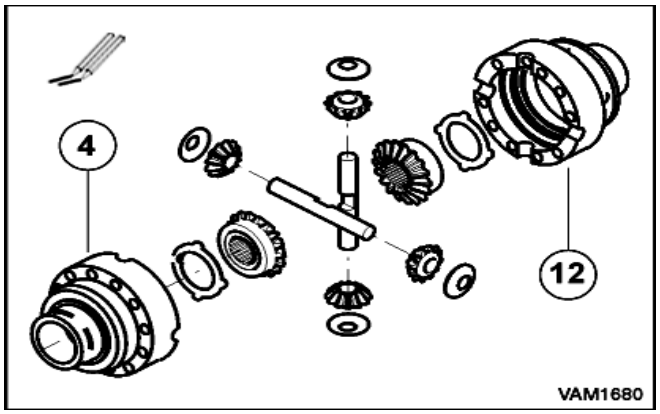



2. Lubricate and assemble new O-Ring (**2**) on every side of the central body (**1**).

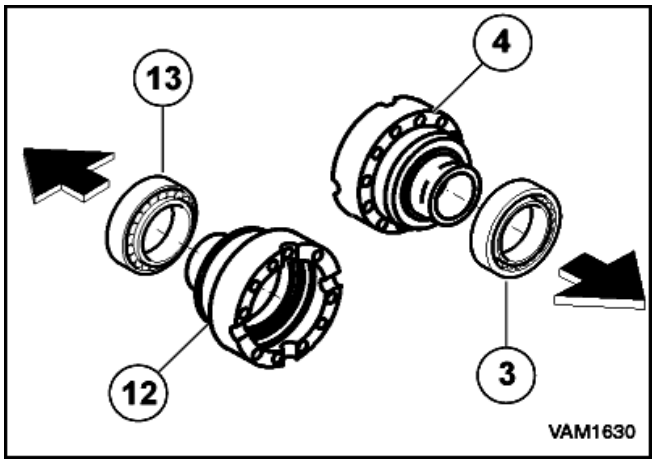



3. Position the brake cylinder (**6**) on a flat surface and force the bearing cup (**4**) using the special tool (Sec. 5).

**Important:** Do not invert bearing cups if the bearings are not replaced.\

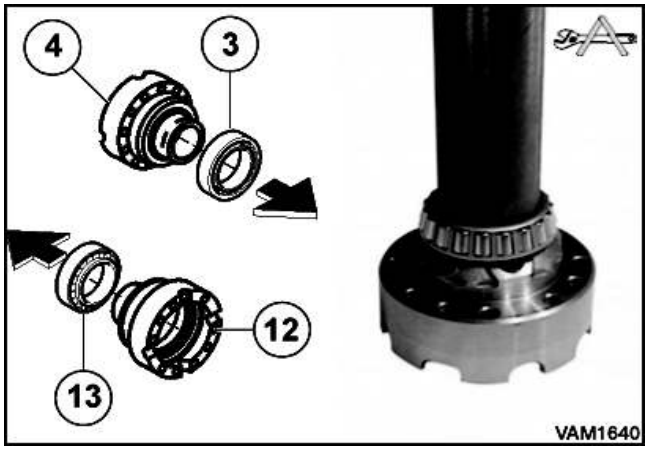



2. Make alignment marks on the two half boxes before splitting them.
   Disassemble the differential box into two half boxes (**4)** and (**12**) complete with relative components.
   Disassemble all the components.
   Check the operating and wear condition of the components.

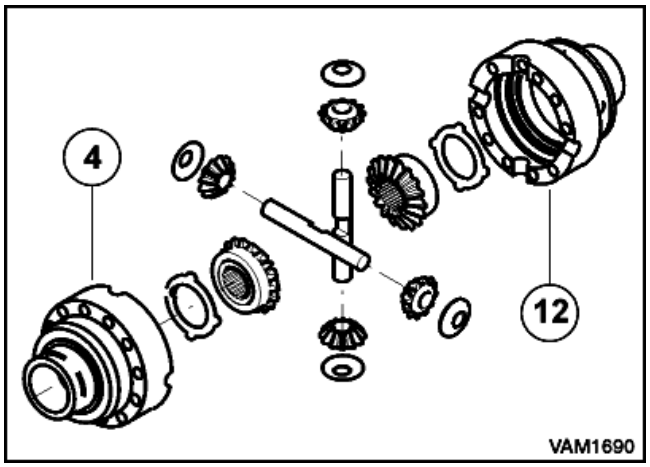



3. Remove the bearing cones (**3)** and (1**3)** of the half boxes (**4)** and (**12**) using two levers or a three-hold extractor.

### 4.11.3 Assembly



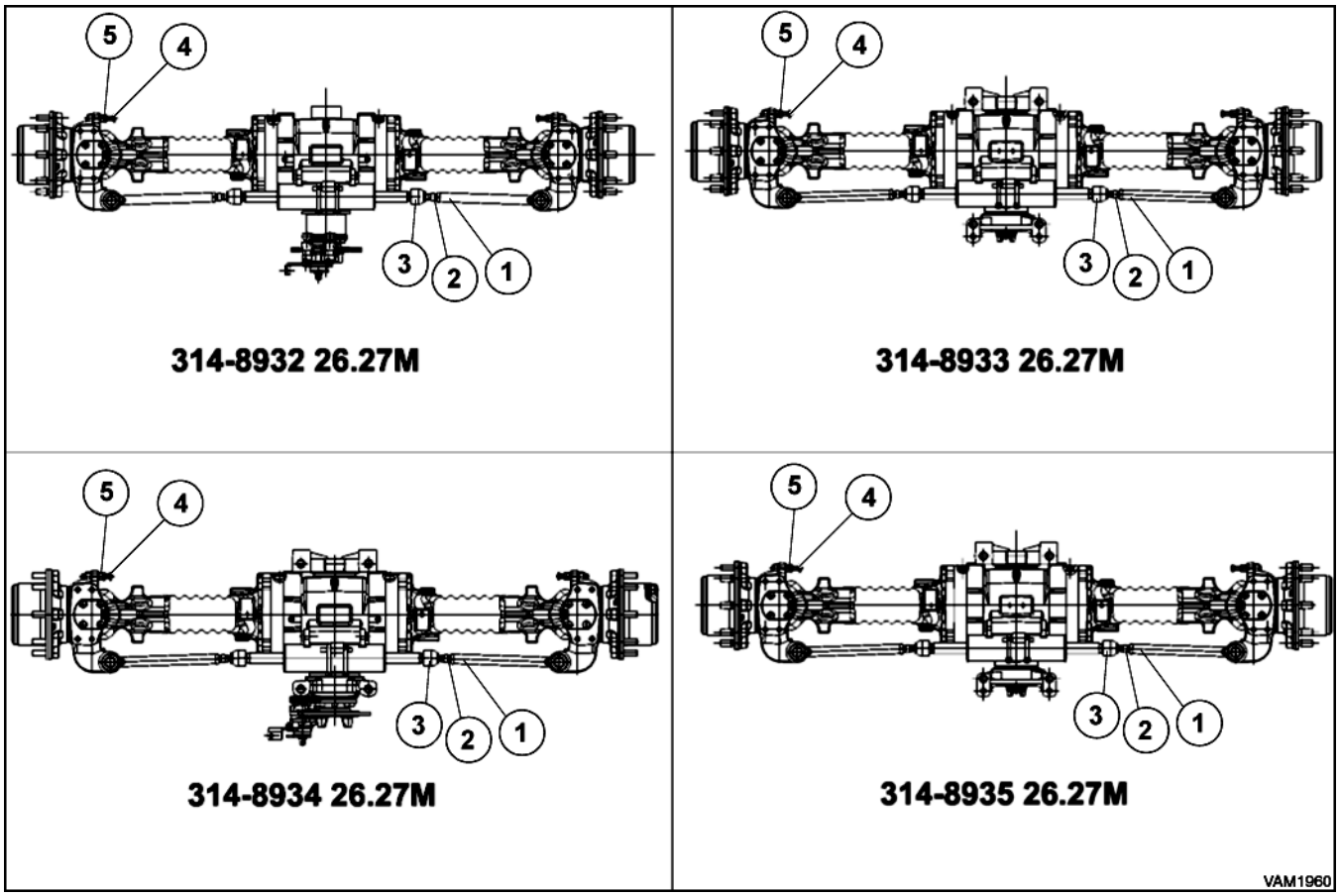

1. Assemble the bearing cones (**3)** and (**13**) on the half housings (**4)** and (**12**) using the special tool (Sec. 5) and a hammer.



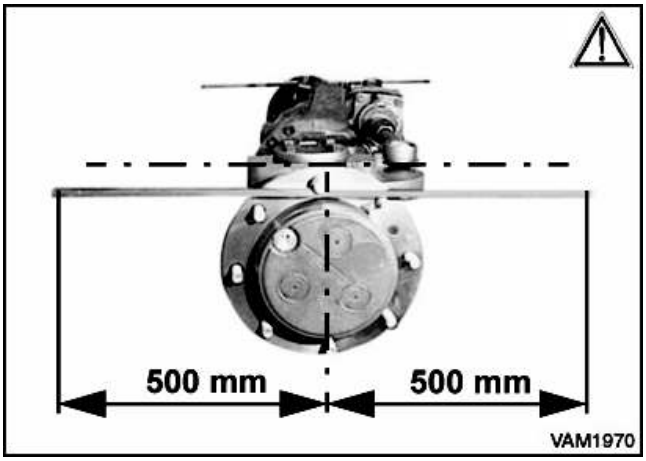

2. Position a half housing (**4)** or (**12**) on a workbench and assemble all inner components: thrust washers (**5)** and (**11**), sun gears (**6)** and (**10**), spider gears (**8**), and thrust washers as shown in the graphic above

## 4.13 TOE-IN/STEERING ANGLE

### 4.13.1 General Drawing




### 4.13.2 Toe-in adjustment




1. Put two equal one-meter-long linear bars on the wheel sides and lock them with two nuts on the wheel hub stud bolt.

**Important**: The two bars must be fixed on their middle so they are perpendicular to the supporting surface and parallel to the pinion shaft axis; align the two bars.

## Service Brake Pressure Switch

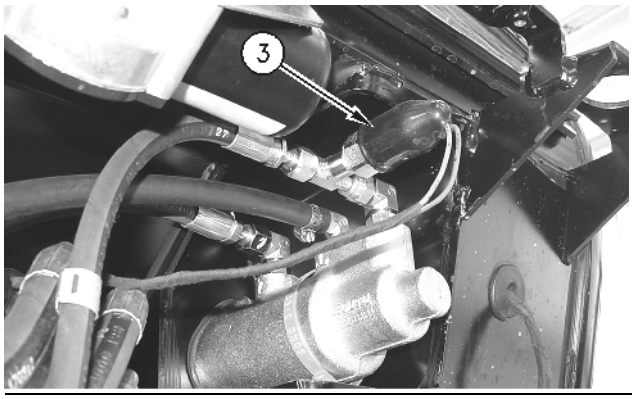



Illustration 9 g00903938

Service brake pressure switch (3) is located on the end of the brake cylinder. Remove the cover from the front of the cab in order to gain access to the service brake pressure switch. The service brake pressure switch sends a signal to the ECM in order to neutralize the transmission when the brakes are applied.

## Transmission Speed Selector (Powersynchro Transmission)


Illustration 10

Lever (5) for the transmission speed selector is located on the left side of the steering column. The transmission speed selector sends a signal to the ECM in order to control the speed and direction of the machine.

## Transmission Oil Temperature Sensor

Transmission oil temperature sensor (7) is located on the transmission housing next to the forward and reverse solenoids. Refer to Illustration 5. The transmission oil temperature sensor sends a signal to the ECM regarding the temperature of the transmission oil.

## Engine Speed Sensor

Engine speed sensor (9) is located at the interface of the torque converter housing and the engine. Refer to Illustration 5. The engine speed sensor sends a signal to the ECM regarding the speed of the engine.

## Torque Converter Output Speed Sensor

Torque converter output speed sensor (10) is located on the transmission housing in front of the torque converter. Refer to Illustration 5. The torque converter output speed sensor sends a signal to the ECM regarding the speed of the torque converter.

## Transmission Intermediate Speed Sensors

The transmission intermediate speed sensors (11) are located on the transmission housing. Refer to Illustration 5. The transmission intermediate speed sensors send signals to the ECM regarding the speed of the transmission shafts.

## Transmission Output Speed Sensor

Transmission output speed sensor (12) is located on the transmission housing above the yoke for the drive shaft to the front axle. Refer to Illustration 5. The transmission output speed sensor sends a signal to the ECM regarding the output speed of the transmission.

Table 2

| Solenoid | Function |
|---|---|
| Transmission Solenoid 1 | This solenoid controls the reverse direction clutch. |
| Transmission Solenoid 2 | This solenoid controls the forward direction clutch. |
| Transmission Solenoid 3 | This solenoid engages the first synchronizer. |
| Transmission Solenoid 4 | This solenoid engages the second synchronizer. |
| Transmission Solenoid 5 | This solenoid engages the third synchronizer. |
| Transmission Solenoid 6 | This solenoid engages the fourth synchronizer. |
| Transmission Solenoid 7 | This solenoid engages the fifth synchronizer. |

The transmission solenoids use a combination of proportional solenoids and on/off solenoids.

The directional solenoids are proportional solenoids. The proportional solenoids allow better shift modulation.

The speed or synchronizer solenoids will be on/off solenoids.

The synchronizer modulation valve aids in the shifting of the transmission.

## Synchronizer Solenoids

- Solenoid Valve 3 (Synchronizer 1)
- Solenoid Valve 4 (Synchronizer 2)
- Solenoid Valve 5 (Synchronizer 3)
- Solenoid Valve 6 (Synchronizer 4)
- Solenoid Valve 7 (Synchronizer 5)

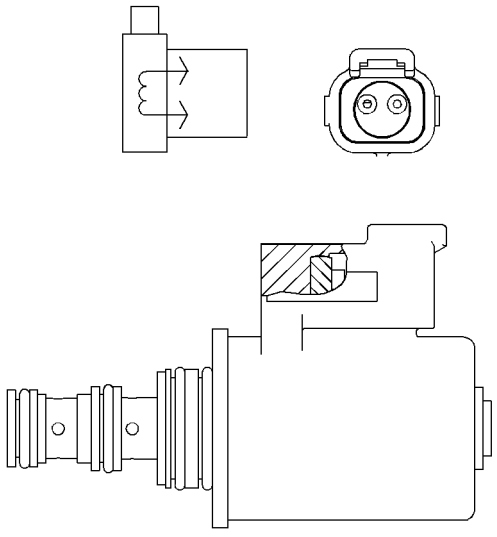


Illustration 28 g01009007

## Directional Solenoids

- Solenoid Valve 1 (Reverse)
- Solenoid Valve 2 (Forward)
- Modulation Valve (Synchronizer)

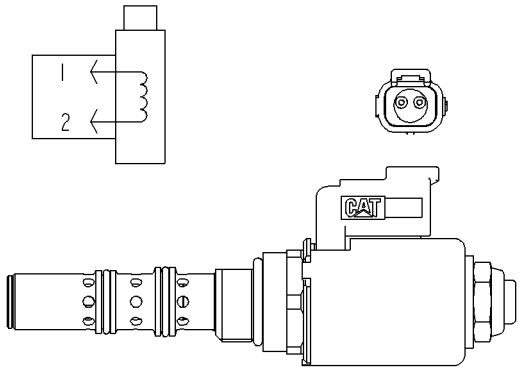



Illustration 29 g00899201

# Data Link

## CAN Data Link

The CAN Data Link is used in order to aid the transmission ECM with the control of the transmission.

i01904226

# Electrical Schematic

**SMCS Code:** 7566-PWT

This is a simplified schematic of the power train system for the machine ECM. This schematic does not show all possible harness connectors. Always see the Electrical System Schematic in the Service Manual for the machine for an accurate schematic of a particular machine.

# Clutch Operation

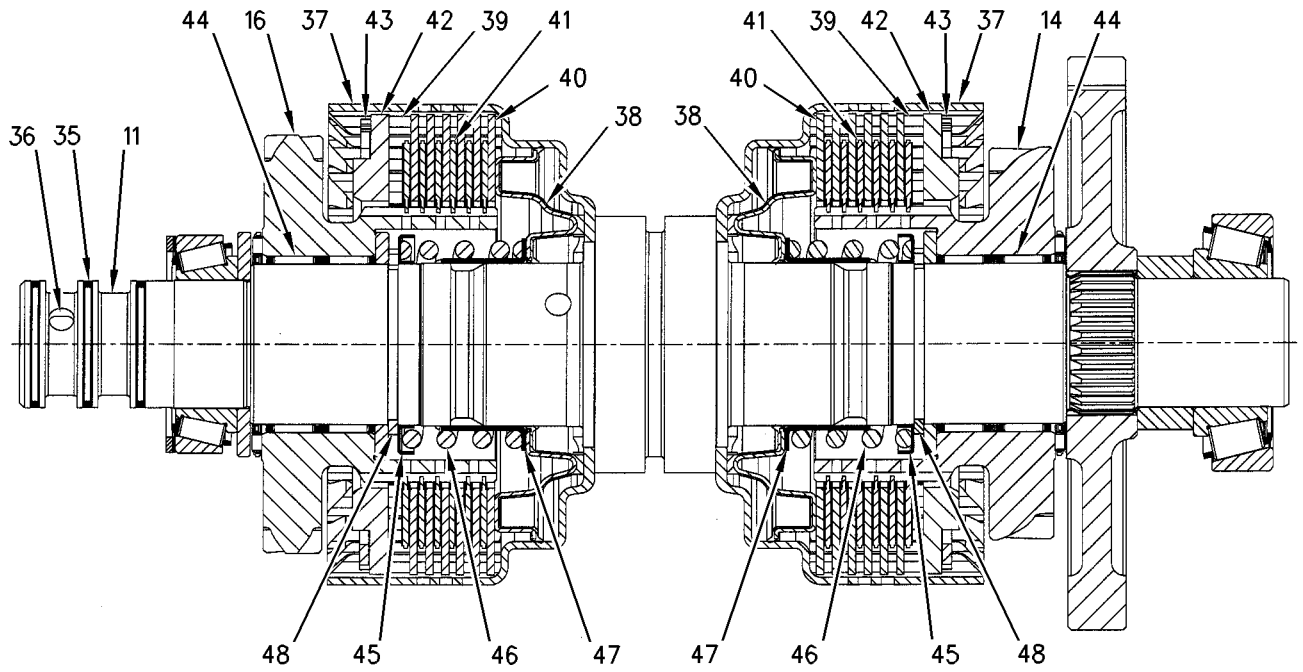



Illustration 35 g00886075

(11) Forward/reverse shaft
(14) Forward primary gear
(16) Reverse primary gear
(35) Seal rings
(36) Control oil passage
(37) Drum shaft assembly
(38) Clutch piston
(39) Clutch pack
(40) Outer discs
(41) Inner discs
(42) Backing plate
(43) Snap ring
(44) Needle bearings
(45) Spring
(46) Needle bearings
(47) Spring retainer
(48) Circlip

The two clutches on the forward/reverse shaft operate in an identical manner. **The forward clutch and the reverse clutch have the following main components:**

**Seal rings (35) –** Three seal rings are located on the end of forward/reverse shaft (11). Control oil is connected to each clutch through a series of passages which are formed in the housings of the torque converter and the transmission. Control oil is connected to a control oil passage (36) in the forward/reverse shaft. The control oil is prevented from leaking by seal rings (35).

**Drum shaft assembly (37) –** Each clutch pack is installed in a drum shaft assembly which has internal splines. A section of the bore of drum shaft assembly is smooth in order to allow operation of clutch piston (38).

**Clutch pack (39) –** The clutch packs consist of outer discs (40) with external splines on the outer diameter and inner discs (41) with internal splines on the inner diameter. The outer discs are made from steel and the inner discs (friction) are made from steel and a paper based material. An outer disc is installed first against clutch piston (38), and an inner disc is then installed. The external splines on the outer disc engage with corresponding splines in drum shaft assembly (37). The discs are stacked alternately until six inner discs and six outer discs are installed. The discs are held in position by backing plate (42) and snap ring (43).

The hub of forward primary gear (14) and the hub of reverse primary gear (16) have external splines which engage with the internal splines of inner discs (41). The inner discs and the primary gears which run on needle bearings (44) are free to increase in speed and free to rotate in the opposite direction to the outer discs provided that there is no oil pressure in that specific clutch.

Table 3

| FORWARD DIRECTION | |
|---|---|
| **Selected Speed** | **Engaged Clutches and Synchronizers** |
| Neutral | None |
| First Speed Forward | Forward clutch (F) and synchronizer (X) with first gear (20) |
| Second Speed Forward | Forward clutch (F) and synchronizer (X) with second gear (21) |
| Third Speed Forward | Forward clutch (F) and synchronizer (Y) with third gear (22) |
| Fourth Speed Forward (1) | Forward clutch (F) and synchronizer (Y) with fourth gear (23) |
| Fifth Speed Forward (if equipped) (1) | Forward clutch (F) and synchronizer (Z) with fifth gear (19) |

(1) Forward direction only

Table 4

| REVERSE DIRECTION | |
|---|---|
| **Selected Speed** | **Engaged Clutches and Synchronizers** |
| Neutral | None |
| First Speed Reverse | Reverse clutch (R) and synchronizer (X) with first gear (20) |
| Second Speed Reverse | Reverse clutch (R) and synchronizer (X) with second gear (21) |
| Third Speed Reverse | Reverse clutch (R) and synchronizer (Y) with third gear (22) |
| Fourth Speed Reverse (Power Shuttle Transmission ) | Reverse clutch (R) and synchronizer (Y) with third gear (23) |

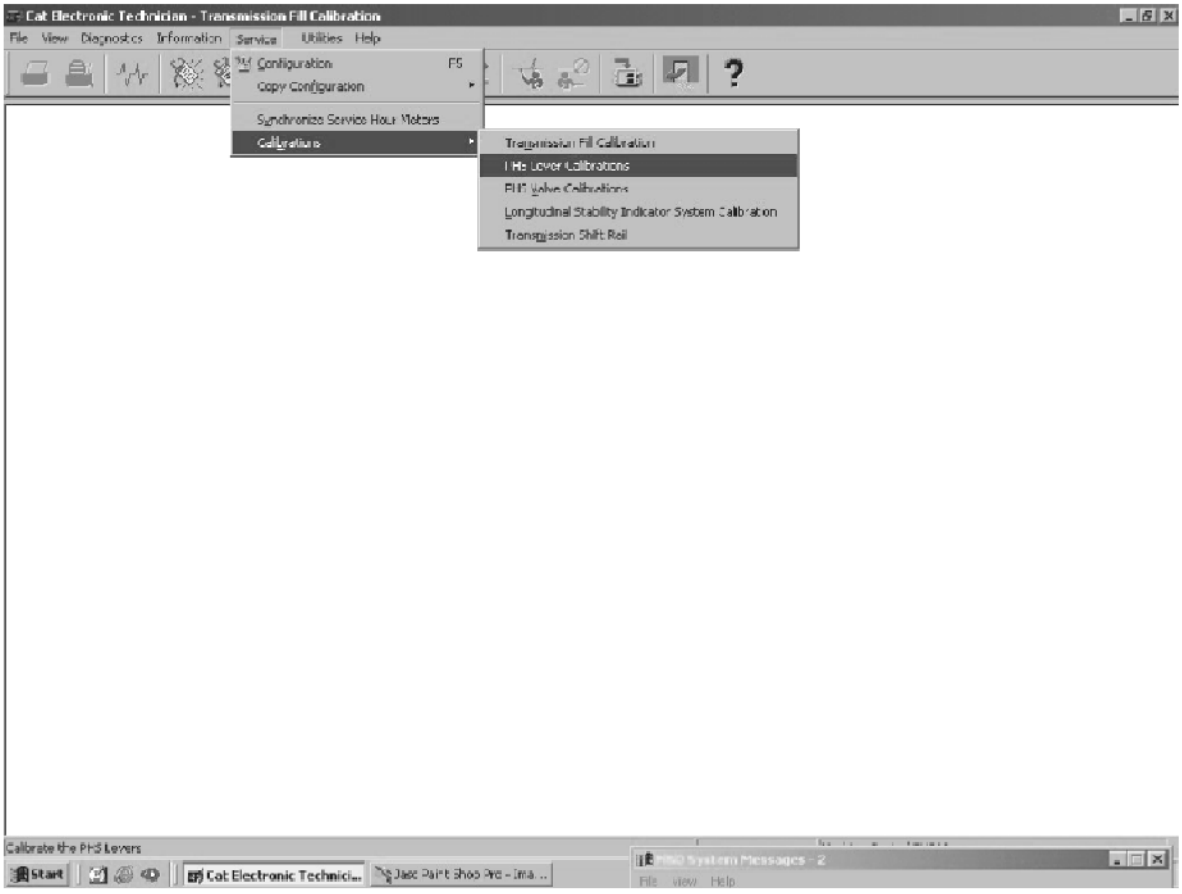



Illustration 55 g00931831

**Note:** Calibrate the position sensors for the transmission shift rail first if the machine is equipped with the powersynchro transmission.

To get to the calibration procedures for the transmission, you click on the “Service” menu. Click on “Calibration”. Click on the “Transmission Shift Rail”. The “Transmission Shift Rail” is the last item on the list. Next, the first calibration screen will appear.

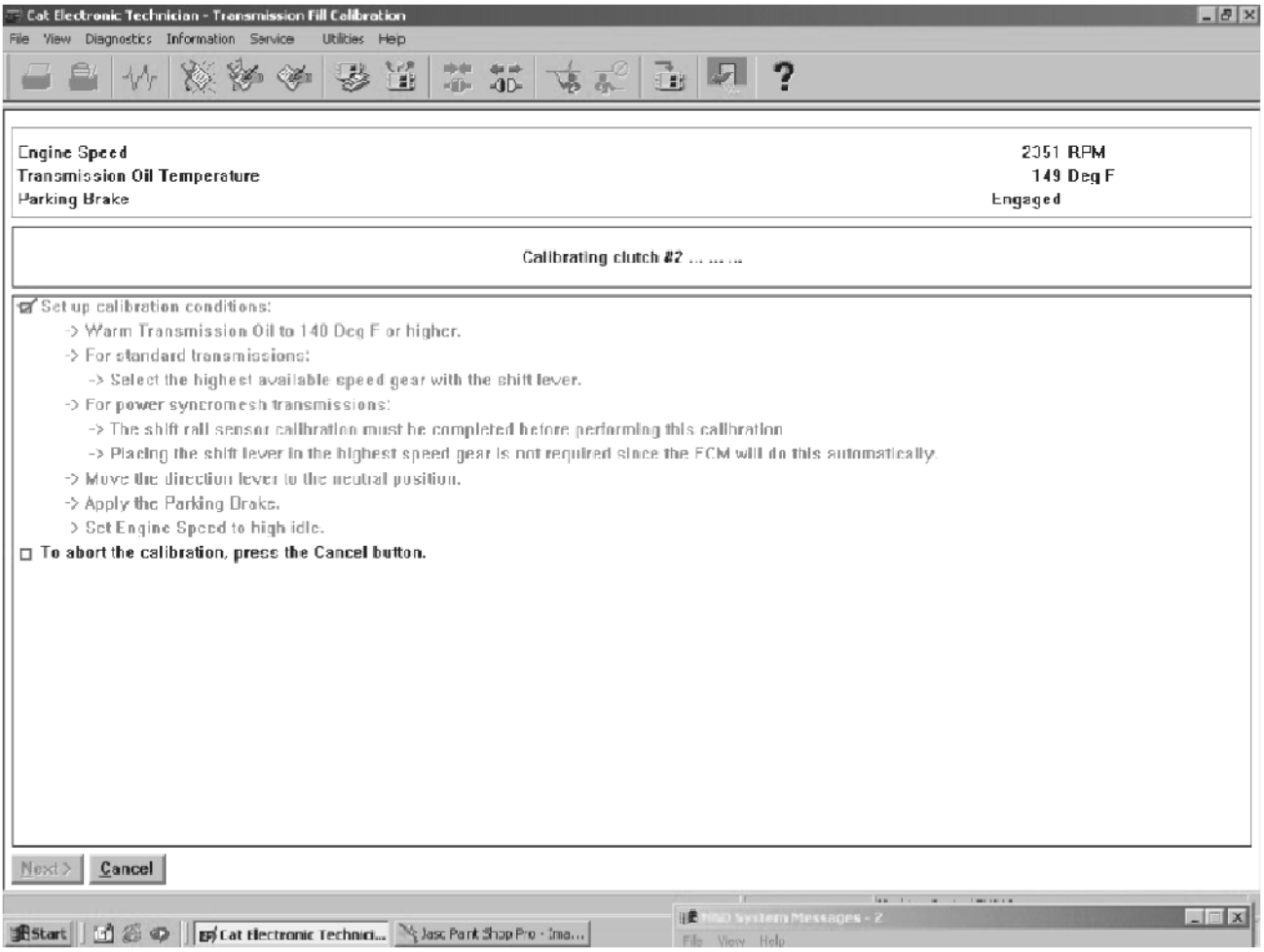



Illustration 65 g00932439

The number two clutch is the forward clutch.

The second clutch is calibrated automatically after the first clutch is calibrated.

# Index