SB2025E01
Aug. 1999

Specifications
Systems Operation
Testing & Adjusting
Disassembly & Assembly

Lift Trucks Power Train

B20S-2, B25S-2, B30S-2

BC20S-2, BC25S-2, BC30S-2

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Read and understand all safety precautions and warnings before operating or performing lubrication, maintenance and repair on this product.

Basic safety precautions are listed in the “Safety” section of the Service or Technical Manual. Additional safety precautions are listed in the “Safety” section of the owner/operation/maintenance publication.
Specific safety warnings for all these publications are provided in the description of operations where hazards exist. WARNING labels have also been put on the product to provide instructions and to identify specific hazards. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons. Warnings in this publication and on the product labels are identified by the following symbol.

⚠ WARNING

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.
Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

DAEWOO cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by DAEWOO is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. DAEWOO dealers have the most current information available.

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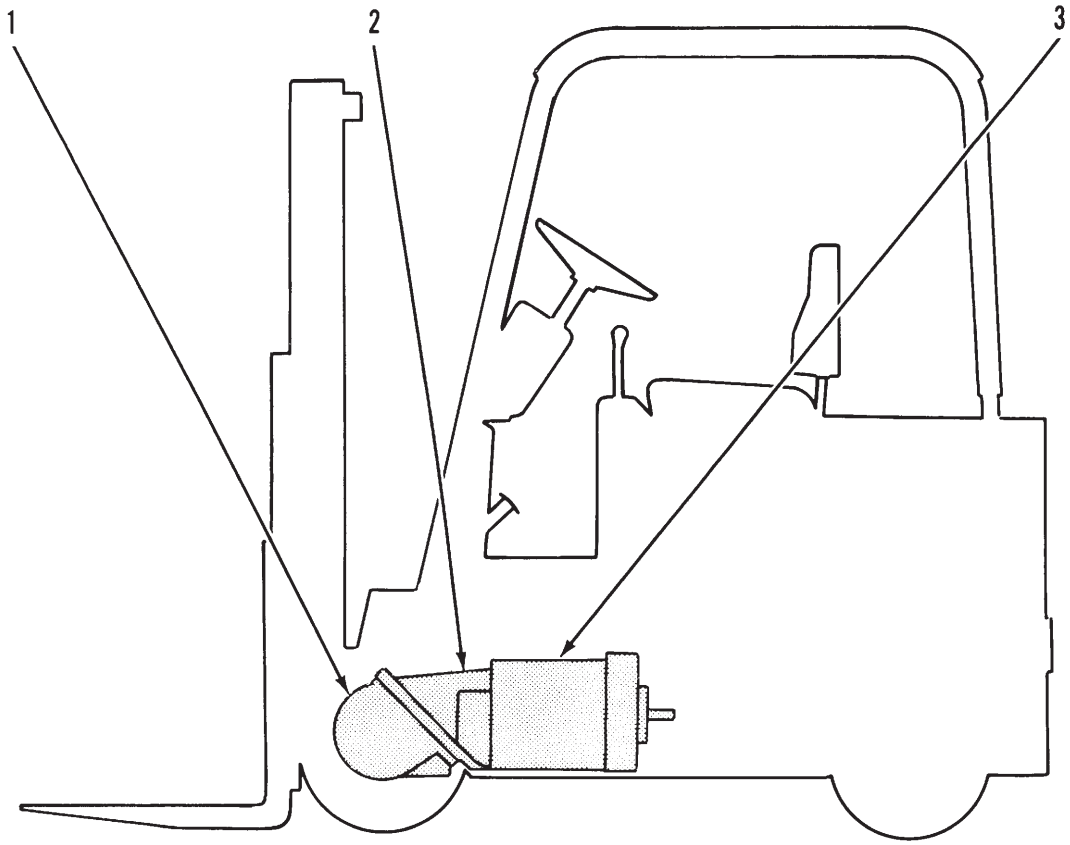
General Information

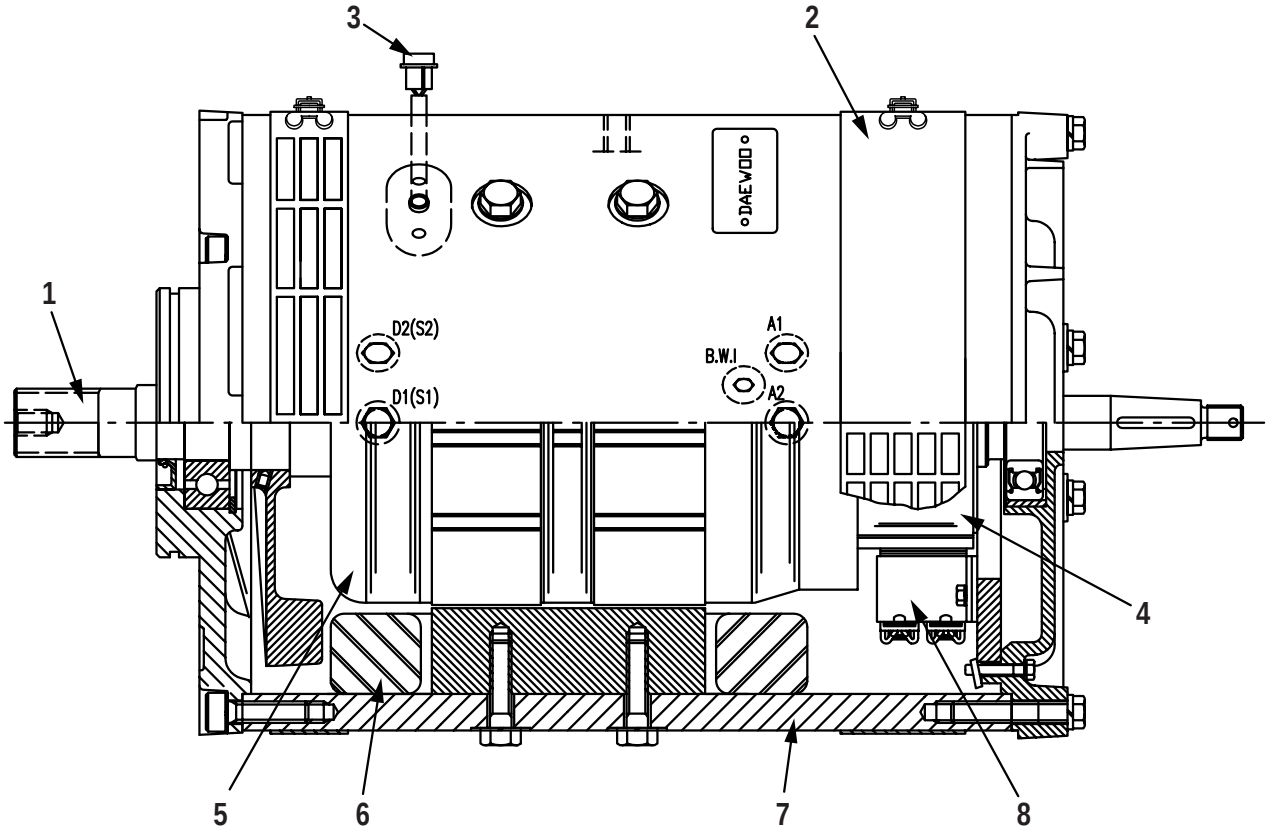


Power Flow
(1) Final drive (2) Power transfer group (3) Drive motor

The power train for the B, BC MODEL Lift Trucks consists of three main components: drive motor (3), power transfer group (2) and final drive (1).

Electric storage batteries are used as a power source for drive motor (3). The drive motor turns power transfer group (2). The power is sent through the power transfer group to the axles. The axle turns final drive (1), which is part of the drive wheels.

Drive Motor



Drive Motor
(1) Shaft. (2) Cover. (3) Thermal switch (thermostat). (4) Commutator. (5) Armature assembly. (6) Field coils. (7) Frame. (8) Brush holder.

The drive system is operated by a direct current (DC) motor. Electric storage batteries are the source of power for the DC motor.

The drive motor is a series wound motor and uses a high temperature insulation. A series wound motor is a commutator motor. The field and armature circuits are a series, which provides a single path for the current. Armature (5) is mounted with single row ball bearings at each end. The ball bearings are permanently lubricated with a high temperature lubricant.

The electrical connections to the motor are made at corrosion resistant terminals on motor frame (7). On the outside of the motor frame is cover (2) that can be removed for easy access to the brushes and the commutator. Field coils (6) are fastened to the inside of the motor frame.

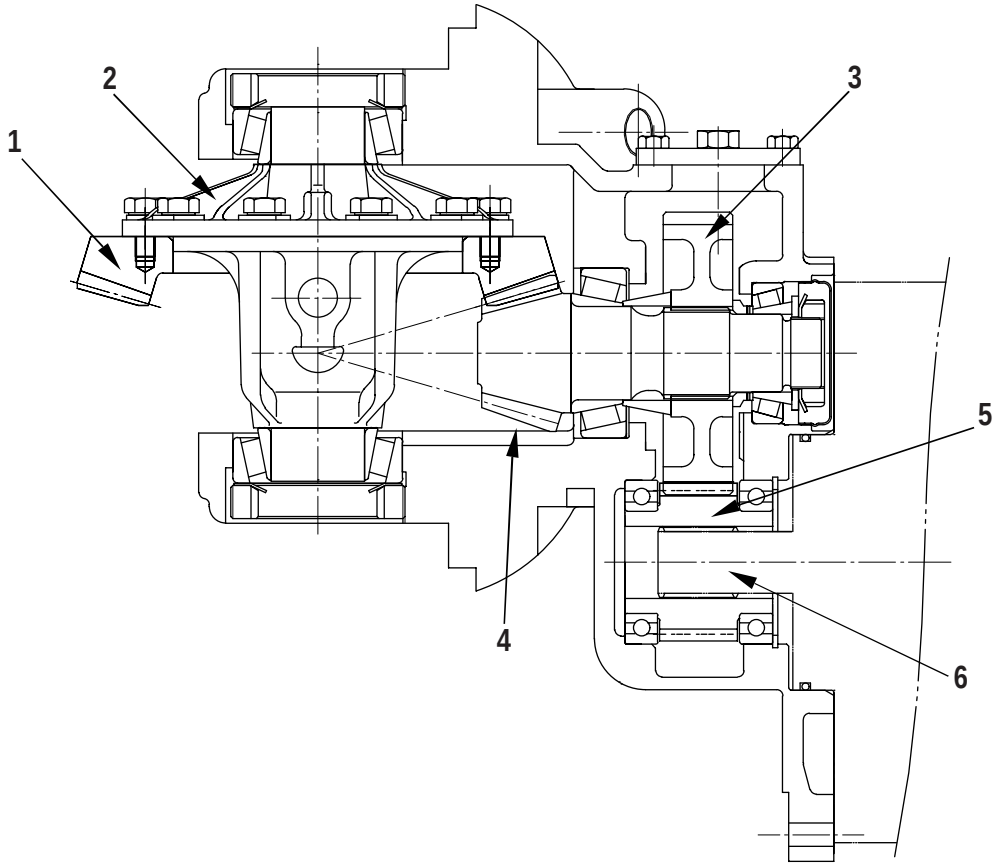
The four motor brushes are held in four brush holders (8). A spring holds each of the brushes against commutator (4) as the brushes wear.

The Optional Superior (S) function equipped lift truck's drive motor is protected from overheating by a thermal switch (thermostat) (3). The thermal switch opens at 150 $\pm$ 6°C (302 $\pm$ 11°F). It closes at 130 $\pm$ 7°C (266 $\pm$ 13°F). When the normally closed thermal switch is open, the amount of current through the motor is limited to allow the motor to cool. The motor has a fan for cooling.

The drive motor is activated when the parking brake is released, the key and seat switch are closed, a direction is selected and the accelerator pedal is depressed.

The drive motor powers the power transfer group through shaft (1).

Power Transfer Group



Power Transfer Group
(1) Bevel gear (2) Differential case (3) Helical gear (4) Spiral hypoid pinion (5) Input Gear (6) Drive Motor Shaft

The power transfer group is mounted under the frame in the front of the lift truck. It's a double reduction unit with the final reduction through spiral hypoid pinion (4) and bevel gear (1).

Power for the transfer group comes from the electric drive motor through the input gear connected with the Drive Motor Shaft (6) through the spline . The input gear (5) turns helical gear (3) that is mounted on the shaft of the hypoid pinion (4).
The hypoid pinion is engaged with bevel gear (1) which is mounted to differential case (2).

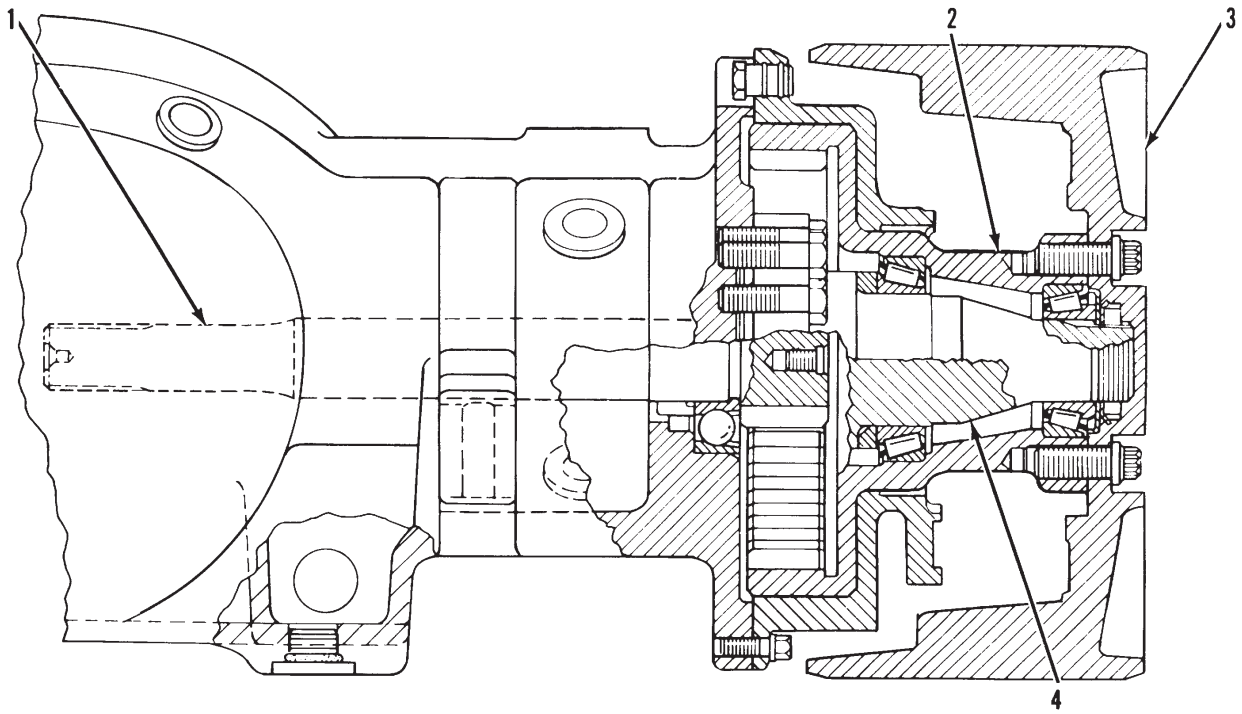
Differential case (2) has two pinion gears that are engaged with two side gears. The side gears turn the axle shafts.

The power transfer group is used to send the power from the electric drive motor to the wheels. When one wheel turns slower than the other, the power transfer group lets the inside wheel stop or turn slower in relation to the outside wheel.

When the truck is moving straight in a forward direction with the same traction under each wheel, there is equal torque on each axle. This holds (stops) differential pinion gears which give the same effect as if both wheels were on the same axle. During a turn, the force (traction) that is on the drive wheels is different. These different forces are also felt on opposite sides of the power transfer group and cause differential pinion gears to turn. The rotation of differential pinion gears stops or slows the inside wheel and lets the outside wheel go faster. This moves the machine through a turn under full power.

The power transfer group gets lubrication from oil thrown about inside the housing, by the rotating gears.

Final Drive



Final Drive
(1) Axle shaft (2) Hub (3) Drive wheel (4) spindle

The power transfer group turns axle shaft (1). The gear teeth on the end of axle shaft (1) engage the gear teeth of hub (2). The gear teeth of hub (2) are on the inside diameter of the hub, which causes the rotation of the hub to be the same as the axle shafts. The reduction in size between the axle shaft and the hub causes the hub to turn at a slower speed.
Spindle (4) is fastened to the truck frame and is used as a support for hub (2).
Drive wheel (3) is fastened to hub (2) and turns with the hub.

The final drive is a grease lubricated unit.

Troubleshooting

Visual Checks

Make a visual inspection of the truck to check for problems. Operate the truck in each direction.

Make a note of the noises that are not normal and find their source. If the operation is not correct, make reference to the Check List During Operation for “Problems” and “Probable Causes”.

Checks During Operation

Drive Motor

Before an analysis is made of any electric drive motor problem, always make reference to the Troubleshooting section of the MicroController System Operation module.

⚠ WARNING

The lift truck can move suddenly. Battery voltage and high amperage are present. Injury to personnel or damage to the lift truck is possible. Safely lift both drive wheels off the floor. Put wood blocks or jack stands of the correct capacity under the frame so the drive wheels are free to turn. During any test or operation check, keep away from the drive wheels. The head capacitor (HEAD CAP) will have to be discharged before any contact with the control panel is made. Disconnect the battery and discharge the HEAD CAP. Rings, watches and other metallic objects should be removed from hands and arms when troubleshooting the MicroController control system.

To prevent personal injury, never use air pressure that is more than 205 kPa (30 psi), and wear protective clothing and a face shield.

NOTICE

To prevent damage to electrical components, make sure the air line is equipped with a water filter when they are cleaned with air.

⚠ WARNING

If an electrical failure or an overload of the motor is present, personnel must not breathe the toxic fumes which are a product of the burnt insulation. All power must be disconnected from the motor before any inspection is made to find the failure. The area around the motor must be well ventilated (air flow) and the motor is to be cooled before any repair work is done. Water must not be used on any electric equipment because of the danger of electrical shock. If fire is present, disconnect the electrical power and use a carbon dioxide extinguisher to put the flame out.

Do not operate the drive motors without a load, as too much speed may cause damage to the motor and injury to personnel.

Problem 1: Drive Motor Will Not Operate.

Probable Cause:

1. Switch not closed (battery connector, key switch, seat switch, direction switch or parking brake switch):
Close the switch. If it still does not operate, test for power to the control panel and power flow through each switch with a voltmeter.

2. Bad connection. Fuse bad:
Check battery connections. Check connections at battery connector. Check fuses, drive and logics.
Replace fuse if bad.
Check the Drive motor and control panel for possible reasons for a bad fuse. Some causes are:
a. Operate during too heavy transistor load, too high current limit (C/L).
b. Operate in stall conditions.
c. Possible short circuit in drive motor, see Probable Causes 5, 6 and 7.

3. Low battery voltage:
Check battery terminal voltage. If too low, charge the battery.
Check all the cells for one or more that have defects.
Check the specific gravity of each cell. The maximum density difference from the highest to the lowest cell must not be more than. 020 SG (specific gravity).

4. Control panel operation not correct:
See the MicroController System Operation module.

5. Brushes are worn:
Inspect the drive motor commutator for burnt marks or scoring (scratches). Make corrections or make a repair of the armature commutator and replace the brushes as necessary. See Armature Commutator Inspection and Brush Inspection in Testing And Adjusting. Make reference to Problem: Sparks At The Commutator And/Or Rapid Brush Wear.

6. Check for opens in the field coils:
Test coils according to procedures in Testing And Adjusting. If there are opens, make a replacement of the field assembly.

7. Check for a short circuit in the armature windings:
Loose field winding pole pieces, make the necessary corrections.
Field armature bar insulation.
Repair or rebuild the insulation or make a replacement of the armature.

8. Static return to off circuit actuated:
If the static return to off is actuated, the control will not start again until the accelerator is released and the directional control lever is returned to neutral.

Problem 2: Traction will not operate through a normal work period, but hydraulic operation is normal.

Probable Cause:

1. Brakes have a defect, cause a resistance (lack of free movement). Heat increases, which causes the motor to stall:
Check the brake adjustment according to the procedures in Testing And Adjusting in the Vehicle Systems module.

2. Too much heat in MicroController control panel because:
a. Extra heavy traction loads.
Decrease the duty cycle load.
b. Faulty thermal switch.
See the MicroController System Operation module.
c. Too high current limit (C/L) setting.
Lower the setting on the C/L adjustments.

These can cause transistors to become defective, control panel failure or drive fuse to go bad.

Problem 3: Neither traction or hydraulic will last through a complete normal work period.

Probable Cause:

1. Too small a battery equipped in the lift truck:
Use a larger battery for the complete work cycle and normal work period.

2. Battery not being fully charged or equalized during the battery charging operation:
Check the battery cells for an equalization charge (a charge to make the specific gravity the same in all cells). Check the battery charger for defects.

3. Battery change interval is too long or changed battery cooling time is too short. This decreases the capacity and the ability of the battery:
Decrease the battery work duration before a change. Increase the battery cooling time after a charge before it is put to use.

4. Battery has one or more defective cells which results in less than the rated capacity and ability of the battery:
Replace the battery.

5. Traction system draws (make a consumption of) too much battery power because of traction system faults. Operation of the duty cycle (complete working cycle) condition is not correct:
Check the brake adjustment according to the procedures in Testing And Adjusting in the Vehicle Systems module, Check the mechanical components such as wheel bearings, axles, etc., for corrections to eliminate the faults. Change to a tire with less friction.

6. Hydraulic system draws too much battery power because of lifting and tilting arrangements, or hydraulic conditions are not correct for the duty cycle:
Decrease hydraulic relief valve setting to the capacity that only will be used.
Change to a smaller hydraulic pump.
Check the mast for restriction during operation.

7. Lift truck working more than the capacity of its design with no available power after one work shift:
Have available an extra (exchange) battery.
Decrease the speed and work load required to complete the work shift.

Problem 4: Sparks at the commutator and/or rapid brush wear.

Probable Cause:

1. Worn brushes:
Make a replacement of the brushes. See New Brush Installation And Brush Inspection in Testing And Adjusting.

2. Overheating (too much heat) of the traction motor:
Check for an overload motor or a motor with defects. See Armature Commutator Inspection in Testing And Adjusting.
Decrease the current limit (C/L) adjustments if set too high. See the MicroController System Operation module.
Test the plugging rate, if set too short it will cause arcing and wear at the brushes.
The duty cycle is too heavy, change the duty cycle.

3. Defective drive motor:
See Armature Commutator Inspection in Testing And Adjusting.

a. Commutator bars burnt in two or more positions at 180° apart because:

(1) Armature bars open.
Make a replacement of the armature.

(2) Motor was stalled against a heavy load while power discharged and caused the two bars, in contact with the brushes, to burn.

NOTICE

Too heavy a load can stall the motor, and result in a failure to the drive motor.

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(3) Short circuit in the armature.
See Armature Tests in Testing And Adjusting.

(4) Armature not in balance, out of round, off center or with high commutator bars. This causes the brushes to bounce (move up and down).
Make sure the diameter is the same all the way around and is in center line with the shaft. See Specifications.

b. Dirty motor that has a metallic or carbon dust. this dust is a conductor which causes electrical shorts, increase amp draw and decrease drive motor output:
Remove any dirt with air pressure.

c. Brush movement causes arcing and brush wear:
Check the brush springs for cracks, and overheat signs (blue).
Compare spring force with a new brush spring.
Check the brush holder for oversize (larger size than for brush).
Replace the brush spring if necessary.

d. Loose brush leads or motor bus bar connections.
Loose cable connections at motor terminals.
Results are:

(1) High resistance and heating.
(2) Faster brush wear.
Check brushes for tight-connections.
Replace the brushes if leads are loose in brush material. Check all cable and wire connections for tightness.

e. Wrong grade of brushes installed that are not adaptable to the motor:
Make sure all the brushes are of DAEWOO standards. Do not use other brands of brushes.

f. Possibly heavy working condition that causes too much motor heat and rapid brush wear:
Make a replacement of the brushes and make sure the brushes are seated. See New Brush Installation and Brush Inspection in Testing And Adjusting.
Check the brush springs for the correct installation and for the correct spring usage. Too strong a spring rate will increase amperage draw and brush wear rate.
Prevent operation in stall condition. Excessive (too much) duty cycle which increases motor temperatures and rapid brush wear.

4. Overload of the drive motor such as: towing loads, constant ramp operation, chiseling (hydraulic actions that are not practical) loads and dragging (pull or push loads on the ground) loads:
Operator training for better working practices.
Add an auxiliary cooling to the drive motors.

5. Current limit (C/L) set too high that causes too much current consumption through motors in the transistor range:
Decrease the current limit (C/L) adjustment to the correct setting, see the MicroController System Operation module.

6. Drive motor, armature or field windings have a defect that results in high current draw at low torque output:
See Armature Tests and Field Coil and Terminal Tests in Testing And Adjusting.

7. Restriction caused by components:
Correct and make adjustments to wheel brakes and parking brakes that drag.
Make changes to tires with less restriction.
Check and correct wheel bearing torques.

Problem 5: Low resistance to ground [battery polarity either positive (+) or negative (-) or a medium voltage is in direct contact with truck frame (body) or drive motor body].

Probable Cause:

1. Dirty battery, electrolyte on top of cells and is in contact with the frame. Current flows through battery box, which places a voltage on the truck frame:
Clean the battery with baking soda and water solution.

2. Battery or control panel wire connections in contact with truck frame:
Make a continuity test and move the wire from contact.
Remove wires in sequence until the fault is cleared.
The fault will be in the wire last disconnected.

3. Dirty motor:
Remove metallic or carbon dust with air pressure.

4. Wet motor:
To dry the motor, heat it to 90°C (194°F).

Problem: 6. Commutator surface has groove or extra wear.

Probable Cause:

1. Brushes are worn too low, brush wires caused arcing on the commutator:
Replace the brushes. See Brush Inspection in Testing And Adjusting and the method to make the Brush Lift Estimate in Testing And Adjusting.

2. Dirty motor; and possibly salt water got inside:
Disassemble motor, remove the debris with air pressure. If necessary, dry the motor with heat to 90°C (194°F)

3. Grades of brushes mixed:
Make sure all the brushes are of DAEWOO standards. Do not use other brands of brushes.

Problem 7: Lift truck moves faster in one direction than the other direction with the same amount of accelerator pedal movement in Bypass mode (speed).

Probable Cause:

1. Motor brushes not located in the correct electrical position (brush neutral settings):
If the holes in the brush holder are not extended, make them longer so that brush holder can have a little rotation. When the holder is in the correct position, lift truck speed will be the same in both directions.

2. One directional contactor worn more than the other or loose connection on one contactor:
Check contactor for wear and tighten any loose connections.

Problem 8: Lift truck will not get to top speed.

Probable Cause:

1. Battery not fully charged or battery has bad cells:
Charge the battery. Check for bad cells.
Replace battery if necessary.

2. A fault either in the drive motor, control panel or drive train:
Check lift truck speed in both directions. If the MicroController panel needs tuned up, make adjustments as shown in the respective MicroController System Operation module. If the drive motor is at fault, make the tests of the motor components in Testing And Adjusting.

Problem 9: Lift truck does not have enough power to position itself under a load. Lift truck does not have enough power on ramps or towing trailers.

Probable Cause:

1. Current limit (C/L) set too low:
Set current limit (C/L) to specification in the MicroController System Operation module.

2. Current limit (C/L) circuit has a defect:
Make test to the MicroController control panel as stated in the respective service module. Repair or replace components as necessary.

3. Unpolished or improperly positioned forks:
Install tapered and polished forks. Position forks correctly for load being lifted.

4. Lift truck equipped with tires that have poor traction:
Install tires that have good traction per recommendation from DAEWOO Inc.

5. Lift truck work load is too heavy or the duty cycle too long:
Decrease the work load and/or duty cycle.

Problem 10: Lift truck has slow acceleration:

Probable Cause:

1. Drive control overheated and the thermal switch opens:

NOTE: The lift truck will still go into the bypass mode, but current limit will be cut back in the transistor mode if the thermal switch opens. Allow the MicroController control panel to become cool so the thermal switch will close.

NOTE: The thermal switch will open circuit if the temperature is 150 $\pm$ 6°C (302 $\pm$ 11°F) and reclose (short circuit) at 130 $\pm$ 7°C (266 $\pm$ 13°F).

Power Transfer Group and Final Drive

Problem 1: Constant noise in drive axle housing.

Probable Cause:

1. Lubricant not to the specified level.

2. Wrong type of lubricant.

3. Wheel bearings out of adjustment or have a defect.

4. Bevel gear and pinion not in adjustment for correct tooth contact.

5. Teeth of bevel gear and pinion have damage or wear.

6. Too much or too little pinion to bevel gear clearance (backlash).

7. Loose or worn drive motor bearings.

8. Loose or worn side bearings.

9. Noise in the drive wheel reduction components.

Problem 2: Noise at different intervals.

Probable Cause:

1. Bevel gear does not run evenly.
a. Nut on drive gear not tightened correctly.
b. Drive gears have a defect (warped).

2. Loose or broken bearings.

3. Failure of or not enough lubricant on the drive wheel reduction components.

Problem 3: One drive wheel does not turn (motor operates).

Probable Cause:

1. Broken axle shaft.
a. Loose wheel bearings.
b. Loose flange studs or nuts.
c. Bent housing.

2. Pinion gear teeth have damage.

3. Bevel gear, pinion or gears broken.

Problem 4: Leakage of lubricant.

Probable Cause:

1. Loss through axle shafts.
a. Lubricant above specified level.
b. Wrong kind of lubricant.
c. Restriction of axle housing breather.
d. Axle shaft oil seal installed wrong or has damage.

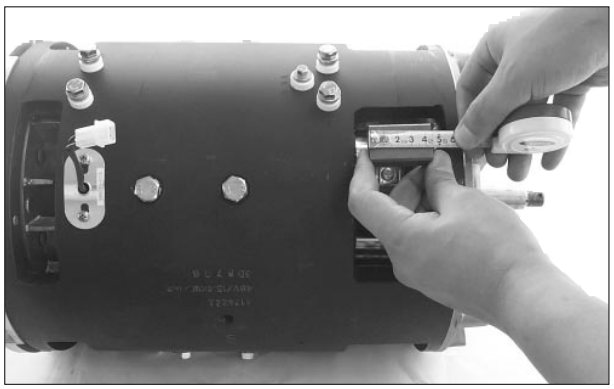
2. Loss at pinion.
a. Lubricant above specified level.
b. Wrong kind of lubricant.
c. Restriction of axle housing breather.
d. Drive motor seal worn or not installed correctly.

Drive Motor

Motor Brushes

Brush Inspection

1. Measure the brush material on the longest side.



Brush Measurement

2. If the brush length is less than 19 mm (.75 in) on the longest side, replace the brushes.

New Brush Installation

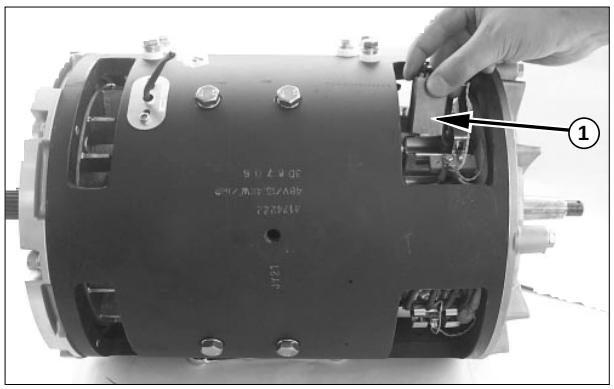
NOTE : Installation of new brushes is a two person operation.

1. Disconnect the batteries and remove them from the lift truck. Put the batteries close enough to the truck that the battery connector can be plugged in.

2. Lift the truck and put blocks under it so that the drive wheels are off the ground. Put blocks in front and in back of the steering wheels.

3. Discharge the head capacitor.

4. Remove the commutator screen cover remove old brushes.

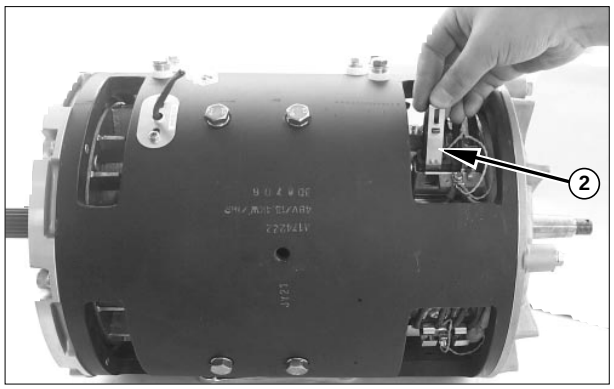


Install Brushes
(1) Brushes.

NOTICE

Installation of the wrong brushes can cause early motor failure. Always make sure the correct DAEWOO brushes are installed.

5. Install new brushes(1). Make sure the brushes move freely in the brush holders. Use a piece of plain bond paper to remove brush material if there is a restriction of brush movement.



Install Springs
(2) Spring.

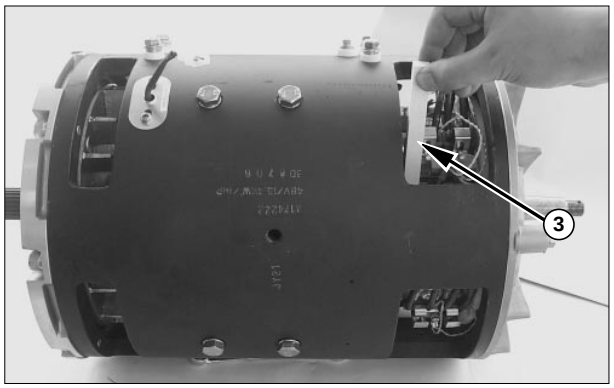
6. Place carefully the brush spring(2) on the top of brush and make sure they fasten into the brush holder box.

7. Pull up on the two wires of each brush until the contact end of the brush moves away from the commutator. Release the wires to see if the brush moves smoothly back into contact with the commutator. If it is too difficult to pull out, or it does not move smoothly in the brush holder box, remove the spring and brush. Make an inspection to find and correct the cause of the problem.

8. Connect the batteries to the battery connector.

⚠ WARNING

Wear eye protection when seating, polishing or cleaning the motor with air pressure. During the seating and polishing procedure, keep fingers away from components in rotation. For prevention of injury to fingers, do not use a commutator cleaner or brush seater stone that is shorter than 63.5 mm (2.50 in.).



Brush Seating
(3) ZLX –0036 Brush seater stone.

9. Put ZLX–0036 Brush Seater Stone (3) on the commutator and operate the motor at a slow speed.

NOTICE
Do not let stone (3) stay in contact with the commutator bar too long. This causes more wear than is necessary to the brushes and the commutator.

10. Move stone (3) across the commutator at the backe edge of the brushes for a short time. This will take the shiny finish off the commutator and seat the new brushes.

11. Turn the key switch to the OFF position and disconnect the batteries. Check the contact surface of each brush. At least 85% of the brush contact surface of each brush must show wear. If necessary, do Steps 8 through 11 again until the correct wear can be seen on the brush contact surface.

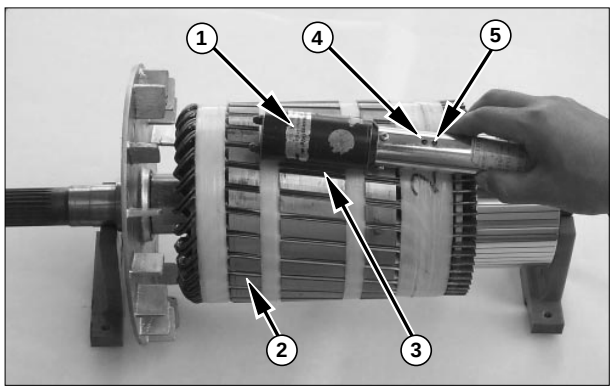
NOTICE
Never use air pressure that is more than 205 kPa (30 psi). Make sure the line is equipped with a water filter.

12. After the brushes have the correct seat contact surface, operate the motor at slow speed. Use compressed (pressure) air to remove all dust and abrasive grit.

Armature Tests

Tools Needed	
Digital Multimeter Or Equivalent	1
Growler Tester	1

Test For Short Circuit



Short Circuit Test
(1) Growler. (2) Armature. (3) Hacksaw blade.
(4) Green light. (5) Red light.

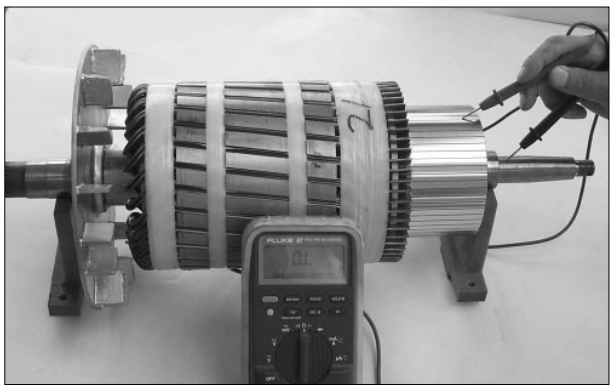
1. Put armature windings (2) in the jaws of growler. (3).

2. Turn the growler (1) on. Slowly turn the growler on the armature (2) while a hacksaw blade (3) is held over the windings.

3. If the windings are shorted, the green light (4) will be on. The red light (5) will be on if the windings do not have a short.

The odor of burned insulation from the drive motor while it is in operation is an indication of a short in the armature.

Ground Test



Ground Test.

A digital multimeter can also be used to test for grounds. Put the Function/Range Switch on the 2M resistance (Ω) scale. When the test probes are put on the commutator and the shaft, the meter must give an indication of over load (OL). This means that the resistance is more than 2 megohms.

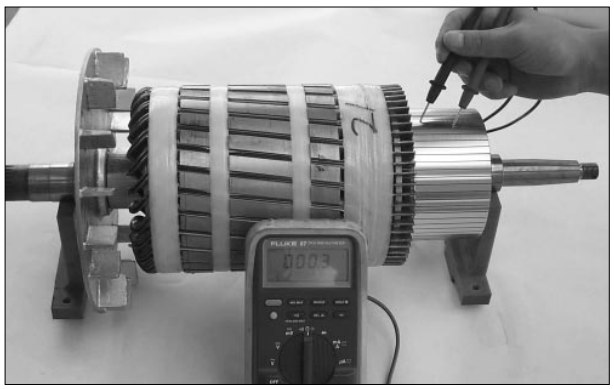
NOTICE

Never use air pressure that is more than 205 kPa (30 psi). Make sure the air line has a water filter.

If there is an indication of a ground in the above test, remove any dirt or debris form the armature with compressed (pressure) air.

Do the test for grounds again. If there is still an indication of a ground, make a replacement of the armature.

Open Circuit Test



Open Circuit Test

1. Put the digital multimeter Function / Range Switch on the 200 ohm resistance (Ω) scale.

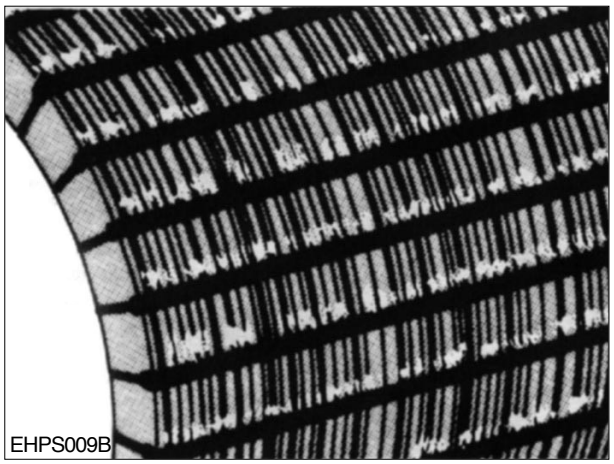
2. Put one test lead on one commutator bar. Put the other test lead on an adjacent (next to) bar and there must be less than one ohm resistance.

This test can also be done with an instrument, such as a Kelvin Double Bridge, that can make a measurement of very low resistance. Do the test the same as above and make a comparison of the resistance measurements.

Two burned areas on opposite sides of the commutator are indications of an open armature winding. These burned areas can cause very rapid brush wear.

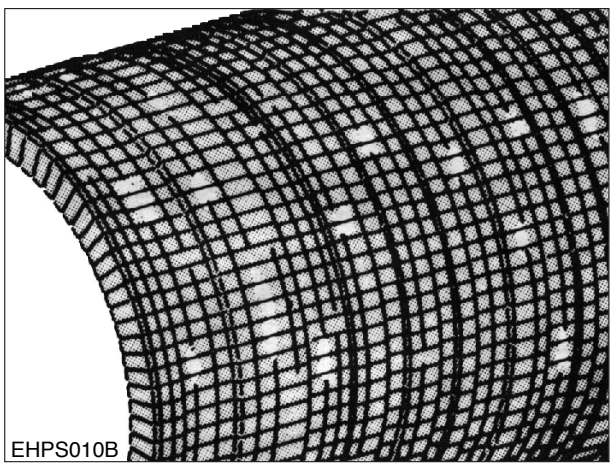
Commutator Inspection

Surfaces of Commutators that need Replacement



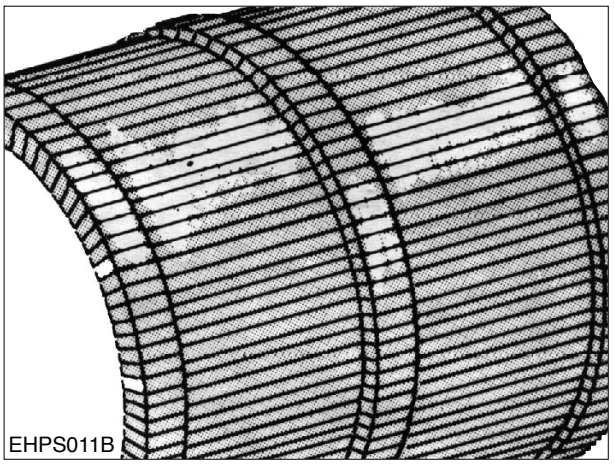
Marks on the Commutator Surface

Marks on the commutator surface are an indication that metal has moved from the commutator surface to the carbon brushes. Marks will cause fast brush wear.



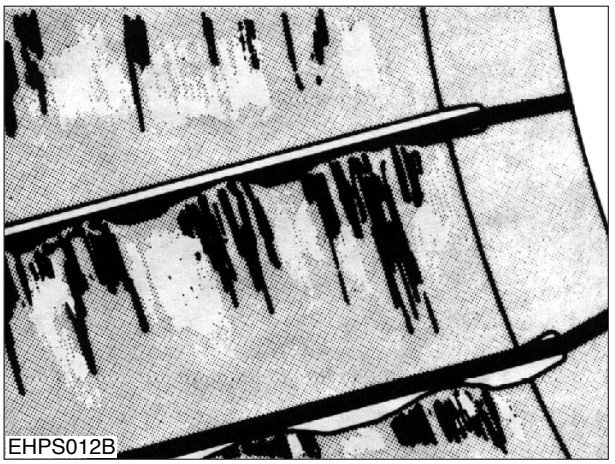
Threads on the Commutator Surface

Threads (grooves that look like threads) on the commutator surface, will also cause fast brush wear.



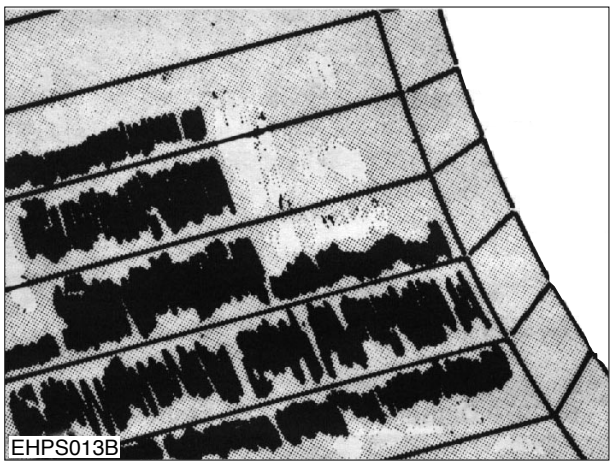
Grooves on the Commutator Surface

Grooves on the commutators surface are caused by a cutting material in the brush or atmosphere.



Copper Drag on the Commutator Surface

Copper drag is an extra amount of commutator material at the back edge of the commutator bars.



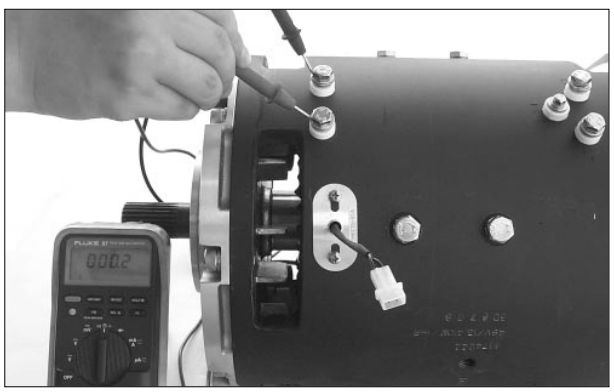
Pitch Bar–Marks on the Commutator Surface

Pitch bar–marks cause low or burnt marks on the commutator surface.

Field Coil and Terminal Tests

Tools Needed	
Digital Multimeter Or Equivalent	1

Open Circuit Test



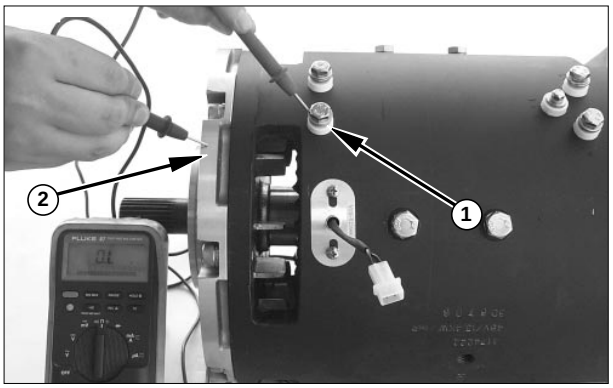
Open Circuit Test

1. Put the digital multimeter Function/Range Switch on the 200 ohm resistance (Ω) scale.

2. Put one test probe to each outer field terminal (S1,S2).

3. The resistance must be less than one ohm. If the resistance is too high, it is an indication of corrosion on the terminals or an open field coil.

Ground Test



Ground Test
(1) Field Terminal. (2) Motor housing.

1. Put the digital multimeter Function/Range Switch on the 20M resistance (Ω) scale.

2. Put one test lead to either outer field terminal (1) and the other test lead to the motor housing (2). There must be more than one megohm resistance.

3. If there is a measurement of less than one megohm, it can be caused by wet insulation on the field windings or excessive brush dust in housing. Heat the motor at 88°C (190°F) until the resistance goes above one megohm. If the resistance does not go above one megohm, the shell and field assembly must be replaced.

Armature Terminal Test

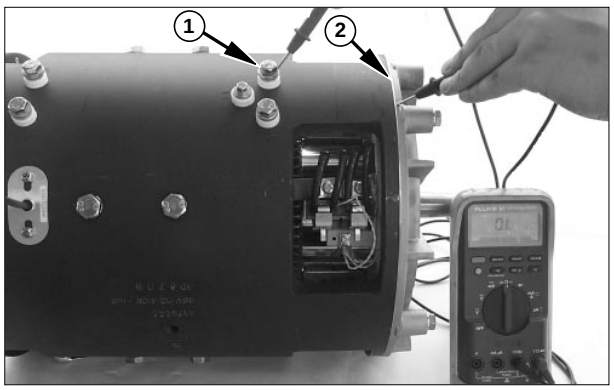
Tools Needed	
Digital Multimeter Or Equivalent	1

Test for Continuity

Brush Test

1. Put the digital multimeter Function/Range Switch on the 200 ohm resistance (Ω) scale.
2. Put one test lead to an outer armature terminal and the other test lead to each brush lead that connects to that terminal. There must be less than one ohm resistance.
3. Do Step 2 again with the other outer armature terminal and brush leads.
4. Too much resistance is an indication of corrosion at the connection to the terminal.

Ground Test

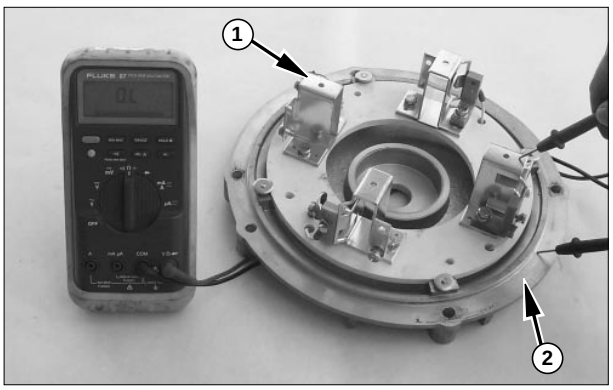


Ground Test
(1) Armature Terminal. (2) Motor Housing.

1. Put the digital multimeter Function/Range Switch on the 20M resistance (Ω) scale.
2. Put one test lead to an outer brush terminal (1) and the other test lead to the motor housing (2). There must be more than one megohm resistance.
3. Do the test again with one test lead on the other outer brush terminal.

Brush Holder Test

Tools Needed	
Digital Multimeter Or Equivalent	1



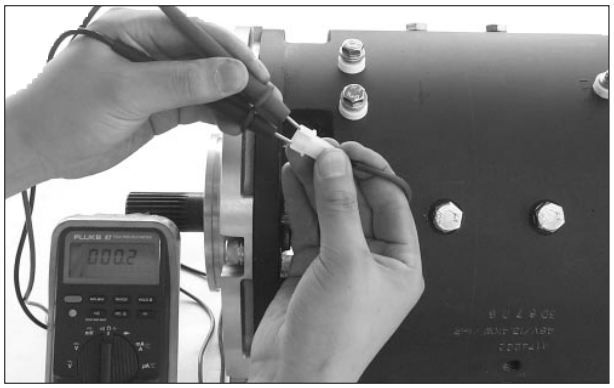
Brush Holder Test
(1) Brush Holder. (2) End Bell.

1. The brush holders are mounted on the rocker at the commutator end of the motor. Make a visual inspection of the brush holders and the rocker.
2. Put digital multimeter Function/Range Switch on the 200 ohm resistance (Ω) scale. Put one test lead to a brush holder (1) and the other test lead to the end bell (2). The meter must show overload (OL).
3. Check each brush holder. If meter reading is low, the brush holder is grounded. Replace the rocker.

Thermal Switch Tests

Tools Needed	
Digital Multimeter Or Equivalent	1

Open Circuits Test



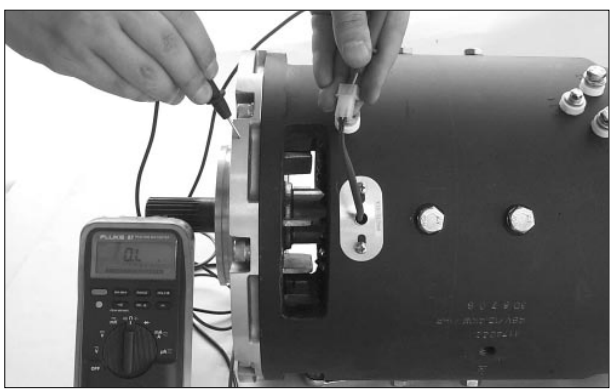
Open Circuit Test

1. Put the digital multimeter Function/Range Switch on the 200 ohm resistance (Ω) scale.

2. Put one test lead to each side of the thermal switch harness.

3. The resistance must be less than one ohm.

Ground Test



Ground Test

1. Put the digital multimeter Function/Range Switch on the 20M resistance (Ω) scale.

2. Put one test lead to either of the plug prongs. The other test lead must be grounded to the motor housing.
There must be more than one megohm resistance.

Brush Life Estimate

1. Before installation of new brushes, make an inspection of the armature commutator, see Armature Commutator Inspection in Testing and Adjusting.

2. Do the steps and procedures for New Brush Installation in Testing and Adjusting.

3. Make the initial (first) inspection of brush wear between 250 smh and 500 smh. The reason for this initial inspection is to see if the brush wear rate is normal and not too fast. The measurement will help make an estimate of the length of brush life to be expected.

NOTE : If there is an indication that brush wear is too fast, see Troubleshooting, Problem: Sparks at the commutator and/or rapid brush wear; for probable causes of this problem.

4. Inspect all brushes in the motors. Measure and record each brush length (see Specification for each new brush length and minimum brush length).

5. Estimate expected brush life (hours). Use the shortest measurement from Step 4 and the following Sample Procedure:

Length of new brush .....45.8 mm (1.803 in.)
Minimum length of brush.....19 mm (0.75 in.)
New brush length [45.8 mm (1.803 in.)] - Minimum brush length [19 mm(0.75 in.)] = Total amount of usable brush wear [26.8 mm(1.055 in.)].

Length of shortest brush at 500 smh is 43.3 mm (1.703 in.).

New brush length [45.8 mm (1.803 in.)] - Length of shortest brush at 500 smh [43.3 mm (1.703 in.)] = Amount of brush wear at 500 smh [2.5 mm (.10 in.)].

Amount of brush wear at 500 smh [2.5 mm (.10 in.)] ÷ Total amount of usable brush wear [26.8 mm (1.055 in.)] = Portion of brush used at 500 smh (.1).

Service Meter Hours (smh) at brush wear measurement (500 smh) ÷ Portion of brush used (.1) = Approximate total brush life of a new brush (5000 smh).

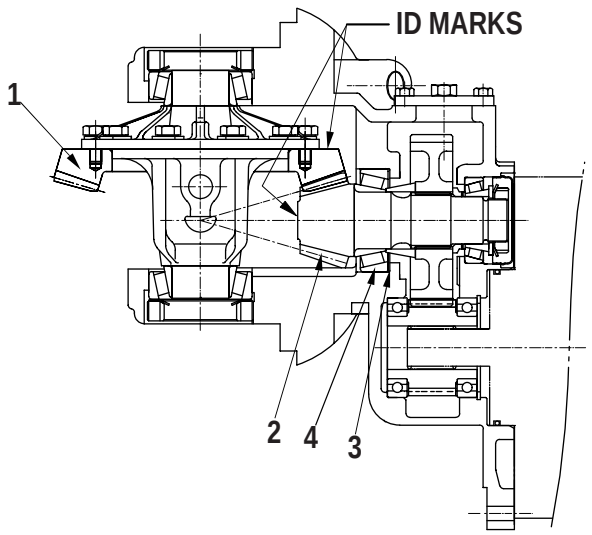
Approximate total brush life of a new brush (5000smh)–Amount of smh at brush life estimate (500 smh) = Remainder of usable brush life (4500 smh).

6. The smh estimate of brush life can be used if the machine is to work at the same rate (duty cycle), the battery is not discharged too much or the battery cells have not become damaged. If the machine is made to work harder, the battery is discharged too much, or the battery cells become damaged, the motor temperature will get hot very fast. This will cause rapid wear of the brush.

7. It is important to check brush length and brush condition at a specific time, such as during the preventive maintenance check. If an inspection shows that brush life will not extend to the next preventive maintenance check, install new brushes.

Power Transfer Group Adjustments

Power Transfer Group

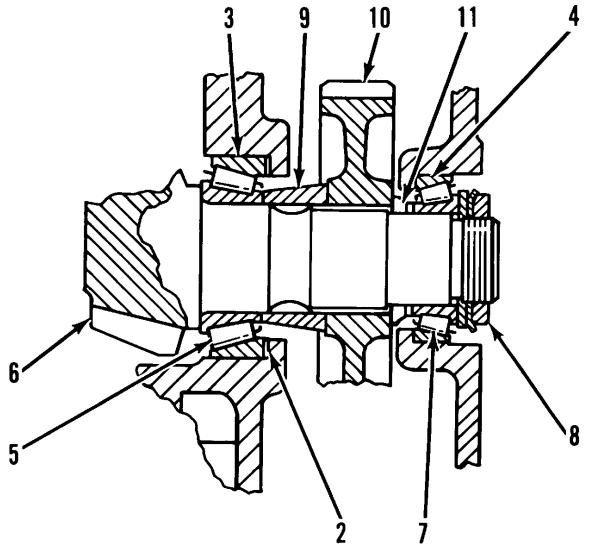


Power Transfer Group
(1) Bevel gear. (2) Pinion gear. (3) Shim pack. (4) Bearing cup.

Bevel gears and pinions are available in sets that are machined for each other and must never be installed separately. The same identification mark of letters and numbers is put on both the pinion and bevel gear. Make sure they have the same identification mark before going to the procedures that follow. The distance from the centerline of bevel gear (1) to the flat end of pinion (2) is 78.0 mm (3.071 in.). The end of each pinion has a mark of either a plus (+) number, a minus (-) number, or zero (0). These numbers indicate the position where each gear set runs best. The dimension is controlled by shim pack (3) behind inner bearing cup (4).

If a pinion has a mark of (+.10), it needs 0.10 mm (0.004 in.) less shims than a pinion with a mark of (0). This increases the distance from the centerline of the bevel gear to the end of the pinion to 78.1 mm (3.075 in.). This increase of 0.10 mm (0.004 in.) is the meaning of a (+.10) mark on the pinion. If the pinion has a mark of (-.10), it needs 0.10 mm (0.004 in.) more shims than a pinion with a (0) mark. This reduces the dimension from the centerline of the bevel gear to the end of the pinion to 77.9 mm (3.067 in.).

Pinion Installation



Pinion Configuration
(2) Shim pack. (3) Bearing cup. (4) Bearing cup.
(5) Bearing cone. (6) Pinion gear. (7) Bearing cone.
(8) Locknut. (9) Ring. (10) Gear. (11) Ring.

NOTE: The adjustment procedures that follow only cover the shim set configuration. Look for additional service publications to provide more detailed information on the change.

Old Pinion Marking	PINION SHIM CHART New Pinion Marking										
	+.10	+.08	+.06	+.04	+.02	0	-.02	-.04	-.06	-.08	-.10
+.10	0	+0.02mm (0.001 in.)	+0.04mm (0.002 in.)	+0.06mm (0.002 in.)	+0.08mm (0.003 in.)	+0.10mm (0.004 in.)	+0.12mm (0.005 in.)	+0.14mm (0.006 in.)	+0.16mm (0.006 in.)	+0.18mm (0.007 in.)	+0.20mm (0.008 in.)
+.08	-0.02mm (0.001 in.)	0	+0.02mm (0.001 in.)	+0.04mm (0.002 in.)	+0.06mm (0.002 in.)	+0.08mm (0.003 in.)	+0.10mm (0.004 in.)	+0.12mm (0.005 in.)	+0.14mm (0.006 in.)	+0.16mm (0.006 in.)	+0.18mm (0.007 in.)
+.06	-0.04mm (0.002 in.)	-0.02mm (0.001 in.)	0	+0.02mm (0.001 in.)	+0.04mm (0.002 in.)	+0.06mm (0.002 in.)	+0.08mm (0.003 in.)	+0.10mm (0.004 in.)	+0.12mm (0.005 in.)	+0.14mm (0.006 in.)	+0.16mm (0.006 in.)
+.04	-0.06mm (0.002 in.)	-0.04mm (0.002 in.)	-0.02mm (0.001 in.)	0	+0.02mm (0.001 in.)	+0.04mm (0.002 in.)	+0.06mm (0.002 in.)	+0.08mm (0.003 in.)	+0.10mm (0.004 in.)	+0.12mm (0.005 in.)	+0.14mm (0.006 in.)
+.02	-0.08mm (0.003 in.)	-0.06mm (0.002 in.)	-0.04mm (0.002 in.)	-0.02mm (0.001 in.)	0	+0.02mm (0.001 in.)	+0.04mm (0.002 in.)	+0.06mm (0.002 in.)	+0.08mm (0.003 in.)	+0.10mm (0.004 in.)	+0.12mm (0.005 in.)
0	-0.10mm (0.004 in.)	-0.08mm (0.003 in.)	-0.06mm (0.002 in.)	-0.04mm (0.002 in.)	-0.02mm (0.001 in.)	0	+0.02mm (0.001 in.)	+0.04mm (0.002 in.)	+0.06mm (0.002 in.)	+0.08mm (0.003 in.)	+0.10mm (0.004 in.)
-.02	-.0.12mm (0.005 in.)	-0.10mm (0.004 in.)	-0.08mm (0.003 in.)	-0.06mm (0.002 in.)	-0.04mm (0.002 in.)	-0.02mm (0.001 in.)	0	+0.02mm (0.001 in.)	+0.04mm (0.002 in.)	+0.06mm (0.002 in.)	+0.08mm (0.003 in.)
-.04	-0.14mm (0.006 in.)	-0.12mm (0.005 in.)	-0.10mm (0.004 in.)	-0.08mm (0.003 in.)	-0.06mm (0.002 in.)	-0.04mm (0.002 in.)	-0.02mm (0.001 in.)	0	+0.02mm (0.001 in.)	+0.04mm (0.002 in.)	+0.06mm (0.002 in.)
-.06	-0.16mm (0.006 in.)	-0.14mm (0.006 in.)	-0.12mm (0.005 in.)	-0.10mm (0.004 in.)	-0.08mm (0.003 in.)	-0.06mm (0.002 in.)	-0.04mm (0.002 in.)	-0.02mm (0.001 in.)	0	+0.02mm (0.001 in.)	+0.04mm (0.002 in.)
-.08	-0.18mm (0.007 in.)	-0.16mm (0.006 in.)	-0.14mm (0.006 in.)	-0.12mm (0.005 in.)	-0.10mm (0.004 in.)	-0.08mm (0.003 in.)	-0.06mm (0.002 in.)	-0.04mm (0.002 in.)	-0.02mm (0.001 in.)	0	+0.02mm (0.001 in.)
-.10	-0.20mm (0.008 in.)	-0.18mm (0.007 in.)	-0.16mm (0.006 in.)	-0.14mm (0.006 in.)	-0.12mm (0.005 in.)	-0.10mm (0.004 in.)	-0.08mm (0.003 in.)	-0.06mm (0.002 in.)	-0.04mm (0.002 in.)	-0.02mm (0.001 in.)	0

1. If the original bevel gear and pinion set is to be used again, measure old shim pack (2) and make a new shim pack the same thickness. If a new bevel gear and pinion set is used, refer to the Pinion Shim Chart for the amount that the original shim pack should be changed.
If three or more shims are used, the smaller shims are to be put in the center of the shim pack.

EXAMPLE: If the old pinion has a mark of (+.06) and the new pinion has a mark of (-.08) add 0.14 mm (0.006 in.) shims to the original shim thickness.

2. Install bearing cups (3) and (4) with new shim pack (2) behind bearing cup (3). Install bearing cone (5) on pinion shaft (6).

3. Put the pinion shaft assembly into the housing and install bearing cone (7) and nut (8). Tighten nut (8) to a torque of 15 to 34 N•m (11 to 25 lb•ft) while rotating the pinion.

4. Measure the distance from the centerline of the differential bearing bores to the end of the pinion and determine the amount of shims needed behind bearing cup (3). See Pinion Depth Check.

5. Remove bearing cup (3) and add or remove the required shims. Reinstall bearing cup (3).

6. Recheck pinion depth. The measured pinion depth must be within 0.03 mm (0.001 in.) of the required pinion depth.

7. After the pinion depth is correct, remove Pinion Depth Gauge and the pinion shaft. Put ring (9) on the pinion shaft and put gear (10) in position in the housing. [NOTE: Side of gear (10) with recessed hub must be installed next to ring (9)]. Put the pinion shaft in the housing and through gear (10). Install ring (11) on pinion shaft (6).

8. Set pinion bearing preload. See Pinion Bearing Adjustment.

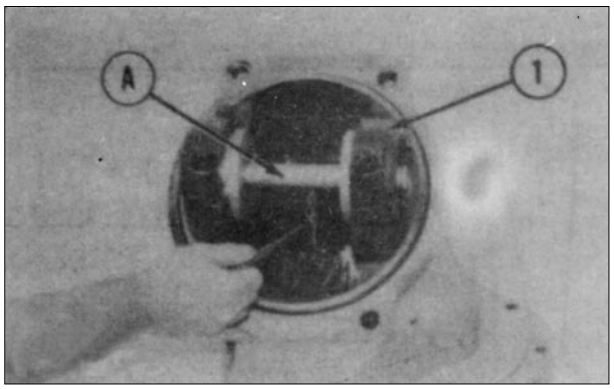
9. Recheck pinion depth.

10. After pinion bearing preload and pinion depth are correct, bend a tab on the lockwasher into a slot of nut (8) to lock it in position.

Pinion Depth Check

Tools Needed:

Pinion Depth Gauge (A).



Pinion Depth check
(1) Bearing cap (A) Pinion Depth Gauge

1. Put the bar and discs of tool (A) in the bearing bores of the housing assembly as shown. Install bearing caps (1) and tighten the bolts.

2. Measure the distance from the end of the pinion shaft to the bottom of the bar with an inside micrometer. Record this measurement.

3. Measure the outside diameter of the bar with an outside micrometer. Divide this measurement by 2 and add it to the recorded measurement from Step 2. Record this total measurement. This is the actual mounting distance.

4. Calculate the required shim thickness to add or remove as follows: the nominal mounting distance+deviation from nominal (as marked on the end of the pinion, either + or - number, in millimeters) = required mounting distance. The actual mounting distance (from Step 3) - the required mounting distance = required shim thickness to add or remove (added if difference is +, removed if difference is -).

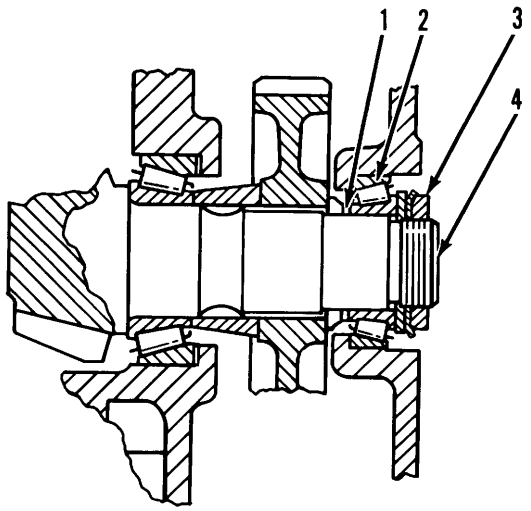
Example:

78.00 mm (3.071 in.)	- nominal mounting distance
- 0.08 mm (0.003 in.)	- deviation from nominal (marked on end of pinion)
77.92 mm (3.068 in.)	- required mounting distance
78.10 mm (3.075 in.)	- actual mounting distance from Step 3
-77.92 mm (3.068 in.)	- required mounting distance
0.18 mm (0.007 in.)	- thickness of shims to be added or removed

Pinion Bearing Adjustment

Tools Needed:

Pinion Bearing Preload Gauge (A)
Dial Indicator Group (B).



Pinion Bearing Preload Adjustment
(1) Shim pack (2) Bearing cone (3) Locknut (4) Pinion gear

Preload Shim Chart	
Part No.	**Thickness**
Part No.	Thickness
924760	0.04 mm (.002 in.)
924761	0.08 mm (.003 in.)
924762	0.12 mm (.005 in.)
924763	0.25 mm (.010 in.)
924764	0.8 mm (.03 in.)
924765	1.6 mm (.06 in.)

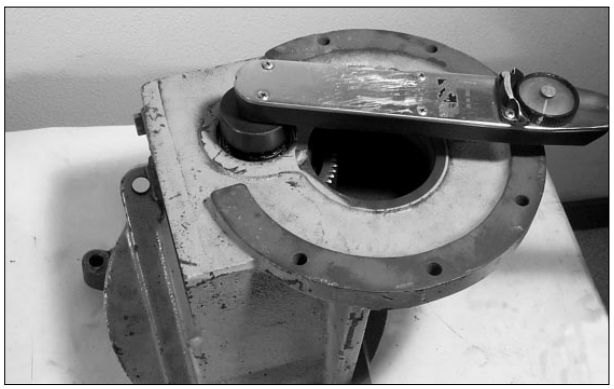
1. Install tool (A) [or 4.0 mm (.16 in.) of shims] in place of shim pack (1). Install bearing cone (2), the washer, lockwasher, and nut (3). Tighten nut (3) to a torque of 15 to 34 N•m (11 to 25 lb•ft.). (NOTE: See Preload Shim Chart for shim numbers.)

2. Use tooling (B) to measure the end play of pinion shaft (4). Record this measurement. Remove nut (3), the lockwasher, washer, and bearing cone (2).

3. Remove tool (A) (or shims). Measure the thickness of tool (A) with an outside micrometer (if shims were used, measure each shim individually and add the measurements together). subtract from this thickness the recorded end play from Step 2. This is the thickness of shims (1) that are needed with no bearing preload.

4. In order to get bearing preload, subtract 0.05 mm (.002 in.) from the shim pack thickness found in Step 3. This is the shim pack thickness that needs to be installed.

5. Install the correct thickness of shims (1), bearing cone (2), the washer, lockwasher, and nut (3). Tighten nut (3) to a torque of 180 ± 25 N•m (135 ± 18 lb•ft).

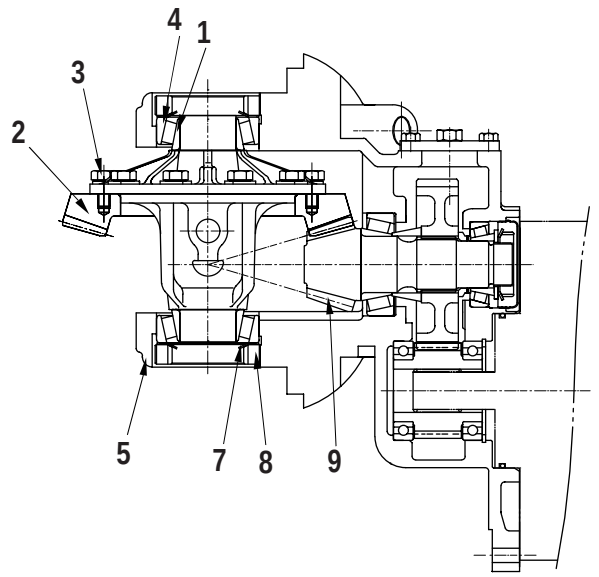


Rolling Torque Check

6. Check the rolling torque of the pinion as shown. It must be 0.85 to 1.70 N•m (7.5 to 15.0 lb•in). If the torque is not correct, add or remove shims (1) until it is correct. Removal of shims (1) increases the rolling torque. Adding shims (1) decreases the rolling torque. Record the actual rolling torque after the shims have been added or removed.

Power Transfer Group Bearing and Gear Clearance (Backlash) Adjustments

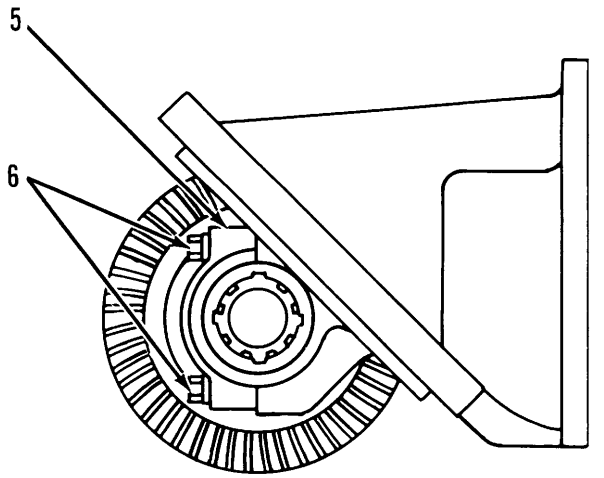
Tools Needed:
Dial Indicator Group (A)



Backlash Adjustment
(1) Bearing Cone. (2) Bevel Gear. (3) Bolt. (4) Bearing Cup.
(5) Bearing Cap. (7) Lockwasher. (8) Locknut.
(9) Pinion Gear.

1. Install bearing cones (1) on the differential case.

2. Put bevel gear (2) on the differential case and tighten ten bolts (3) to a torque of 70 ± 15 N•m (50 ± 11 lb•ft). Put bearing cups (4) on bearing cones (1).



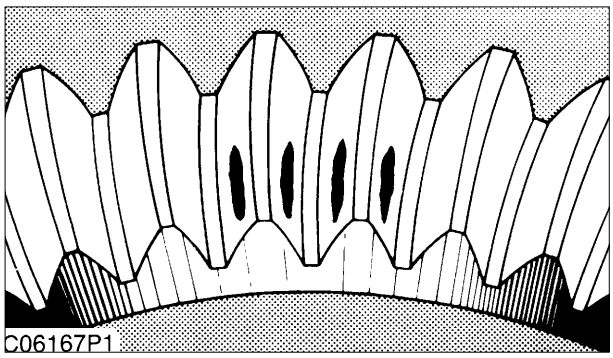
Install Carrier Assembly
(5) Bearing cap (6) Bolts

3. Put the carrier assembly in position in the housing assembly. Install bearing caps (5) and four bolts (6).
Tighten bolts (6) to a torque of 220 ± 25 N•m (160 ± 18 lb•ft).

4. Install lockwashers (7) and locknuts (8). Use tooling (A) to check gear clearance (backlash) between bevel gear (2) and pinion (9). Adjust locknuts (8) until the clearance is 0.15 to 0.20 mm (0.006 to 0.008 in.).
Adjust the clearance by turning one locknut (8) in and the other locknut out an equal amount.

5. Check the rolling torque again as shown in Pinion Bearing Adjustment, Step 6. Tighten locknuts (8) equally to preload the differential case bearings. Proper bearing preload will increase the rolling torque at the pinion (recorded in Pinion Bearing Adjustment, Step 6) by 0.63 to 0.88 N•m (5.6 to 7.8 lb•in).

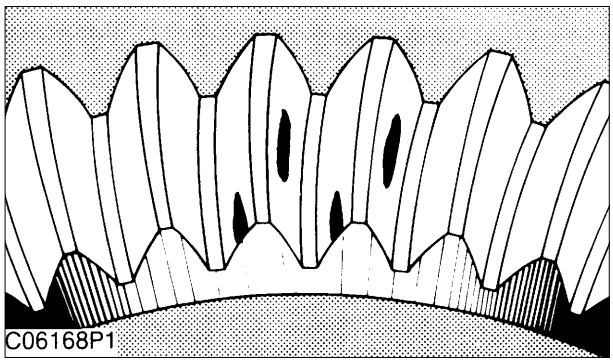
6. Measure backlash again. After backlash and preload are correct, bend a tab on each lockwasher (7) into a slot in locknuts (8) to hold them in position.



Correct Tooth Contact Setting

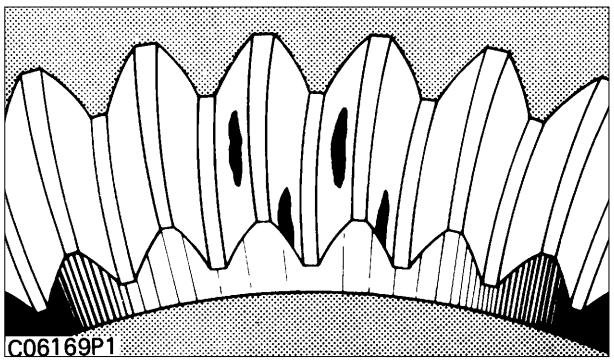
7. Check the tooth contact pattern as follows. Check the tooth contact setting between the bevel gear and pinion after the gear clearance (backlash) and bearing preload adjustments have been made as follows.

a. Put a small amount of Prussian blue, red lead or paint on the bevel gear teeth. Turn the pinion in both directions and check the marks made on the bevel gear teeth.



Short Toe Contact Setting

b. With no load, correct tooth contact setting will be as shown. The area of contact starts near the toe of the gear and goes 30 to 50% up the length of the tooth.
With this setting, when a load is put on the gear, the load will be over the correct area of the teeth.



Short Heel Contact Setting

c. If bevel pinion shaft is too far away from bevel gear, short toe contact will be the result as shown. The teeth of pinion will be in contact with toe ends of convex faces (part that makes a curve toward the outside), and top edge of heel end of concave faces (part that makes a curve toward the inside). To correct this, add shims under pinion bearing cup. After this is done, check gear clearance (backlash) and tooth contact again.

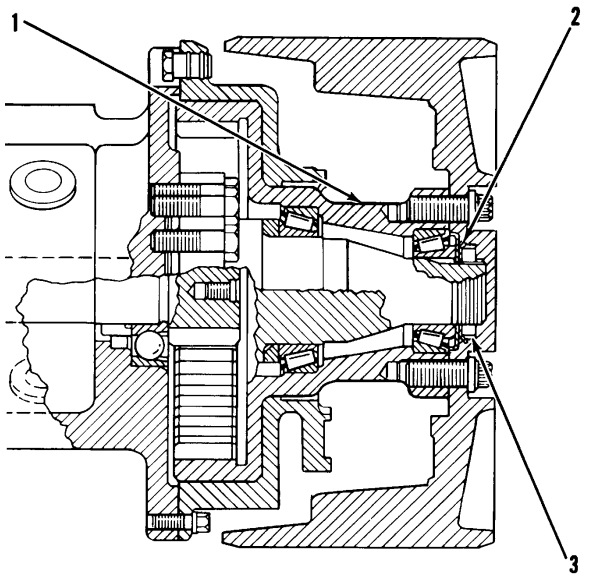
d. If bevel pinion shaft is too near to center of bevel gear, short heel contact will be the result as shown. The teeth of pinion will be in contact with the toe ends of concave faces (part that makes a curve toward the inside) and the heel ends of convex faces (part that makes a curve toward the outside). To correct this, remove shims from under pinion bearing cup. After this is done, check gear clearance (backlash)and tooth contact again.

NOTE: Several adjustments of both pinion and bevel gear can be needed before correct tooth contact and gear clearance (backlash) is made. Always remember that a change to gear clearance (backlash) will also change the tooth contact. Therefore, be sure gear clearance (backlash) is in correct adjustment before tooth contact is checked.

e. After gear clearance (backlash) and tooth contact are correct, remove extra Prussian blue, red lead or paint from bevel gear and pinion.

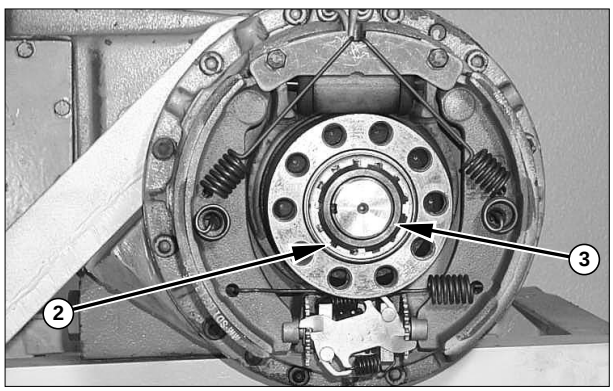
Final Drive

Wheel Bearing Adjustment



Wheel Bearing Adjustment
(1) Hub. (2) Washer. (3) Nut.

1. Tighten nut (3) slowly to 135 N•m (100 lb•ft) while hub (1) is turned to put the bearings in position.



Wheel Bearings
(2) Washer. (3) Nut.

2. Loosen nut (3) completely and tighten it again to 50 ± 5 N•m (37 ± 4 lb•ft).

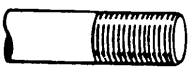
3. Bend washer (2) to hold the nut in position.

General tightening torque for bolts, nuts and taperlock studs

The following charts give the standard torque values for bolts, nuts and taperlock studs of SAE Grade 5 or better quality. Exceptions are given in other sections of the Service Manual where needed.

thread size	Standard torque	
inches	lb•ft	N•m*
1/4	9 ± 3	12 ± 4
5/16	18 ± 5	25 ± 7
3/8	32 ± 5	45 ± 7
7/16	50 ± 10	70 ± 15
1/2	75 ± 10	100 ± 15
9/16	110 ± 15	150 ± 20
5/8	150 ± 20	200 ± 25
3/4	265 ± 35	360 ± 50
7/8	420 ± 60	570 ± 80
1	640 ± 80	875 ± 100
1-1/8	800 ± 100	1100 ± 150
1-1/4	1000 ± 120	1350 ± 175
1-3/8	1200 ± 150	1600 ± 200
1-1/2	1500 ± 200	2000 ± 275

Use these torques for bolts and nuts with standard threads (conversions are approximate).



standard thread

Standard thread

5/16	13 ± 2	20 ± 3
3/8	24 ± 2	35 ± 3
7/16	39 ± 2	50 ± 3
1/2	60 ± 3	80 ± 4
5/8	118 ± 4	160 ± 6

Use these torque for bolts and nuts on hydraulic valve bodies.

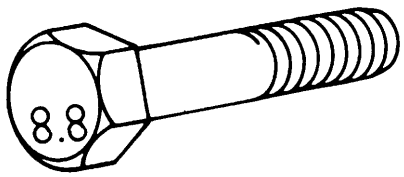
1/4	5 ± 2	7 ± 3
5/16	10 ± 3	15 ± 5
3/8	20 ± 3	30 ± 5
7/16	30 ± 5	40 ± 10
1/2	40 ± 5	55 ± 10
9/16	60 ± 10	80 ± 15
5/8	75 ± 10	100 ± 15
3/4	110 ± 15	150 ± 20
7/8	170 ± 20	230 ± 30
1	260 ± 30	350 ± 40
1-1/8	320 ± 30	400 ± 40
1-1/4	400 ± 40	550 ± 50
1-3/8	480 ± 40	650 ± 50
1-1/2	550 ± 50	750 ± 70

Use these torques for studs with taperlock threads.

taperlock Stud

*1 newton meter (N•m) is approximately the same as 0.1 kg•m.

Metric fasteners

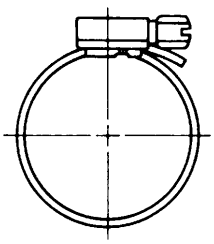


[Usually, material strength identification on bolt head is with numbers (i.e., 8.8, 10.9, etc.)] The chart on the right gives the torque for bolts and nuts with Grade 8.8.

NOTICE: Caution must be taken to avoid mixing metric and standard (customary) fasteners. Mismatched or incorrect fasteners can result in vehicle damage or malfunction, or possible personal injury.
Original fasteners removed from the vehicle should be saved for assembly when possible. If new ones are required, caution must be taken to replace with one that is of same part no. and grade or better.

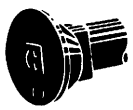
Metric ISO thread		
thread size (mm)	torque	
	(N•m)*	(lb•ft)
M6	12 ± 4	9 ± 3
M8	25 ± 7	18 ± 5
M10	55 ± 10	40 ± 7
M12	95 ± 15	70 ± 10
M14	150 ± 20	110 ± 15
M16	220 ± 30	160 ± 20
M18	325 ± 50	240 ± 35
M20	450 ± 70	330 ± 50
M22	600 ± 90	440 ± 65
M24	775 ± 100	570 ± 75
M27	1150 ± 150	840 ± 110
M30	1610 ± 200	1175 ± 150
M33	2000 ± 275	1450 ± 200
M36	2700 ± 400	200 ± 300
ISO – International Standard Organization		

Hose clamps - worm drive band type

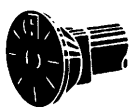


clamp width	initial assembly torque on new hose		reassembly or retightening torque	
	N•m*	lb•in	N•m*	lb•in
15.9 mm (.625 inch)	7.5 ± 0.5	65 ± 5	4.5 ± 0.5	40 ± 5
13.5 mm (.531 inch)	4.5 ± 0.5	40 ± 5	3.0 ± 0.5	25 ± 5
7.9 mm (.312 inch)	0.9 ± 0.2	8 ± 2	0.7 ± 0.2	6 ± 2

Ground engaging and cutting edge bolts and nuts



-Round dome shaped head-
Proof load - 120,00 psi min.
Tensile strength - 150,000 psi min.
Hardness - Rockwell C 33 to 39
Size - 5/8

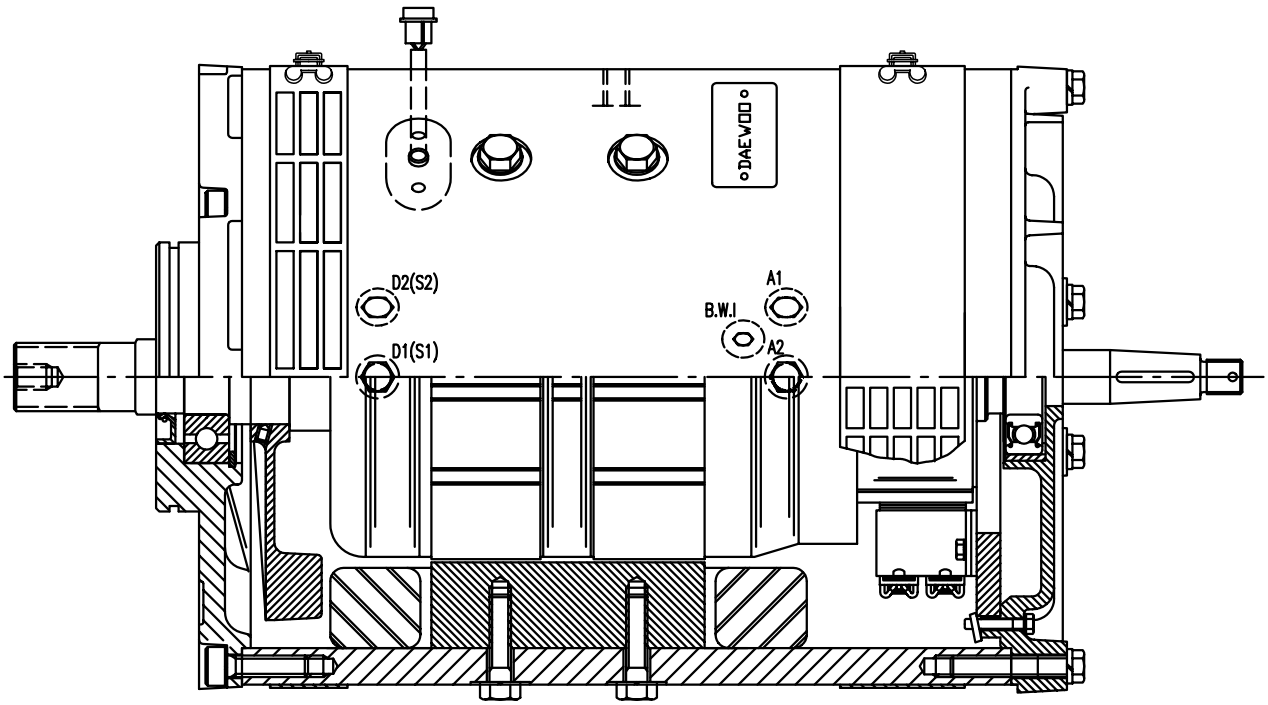


-Seven radial dashes-
Round dome shaped head
Proof load - 135,000 psi min.
Tensile strength - 160,000 psi min.
Hardness - Rockwell C 36 to 42
Sizes 3/4 thru 1-1/4

Torque requirements for plow bolts		
thread diam.	**standard torque**	
inches	**lb. ft.**	**N•m***
5/8	195 ± 20	265 ± 25
3/4	350 ± 50	475 ± 70
7/8	565 ± 85	765 ± 115
1	900 ± 110	1220 ± 150
1-1/4	1500 ± 185	2000 ± 250

*1 newton meter (N•m) is approximately the same as 0.1 kg•m.

Drive Motor



Drive Motors					
Model	**Voltage**	**[1]New Brush Size Thickness X width X length**	**Minimum Brush Length***	**[2]New Commutator Diameter**	**Minimum Commutator Diameter****
B20S-2, B25S-2 B30S-2	36/48	12.5 mm X 25.0 mm X 45.8 mm (.49 in. X 0.98 in. X 1.8 in.)	19.0 mm (.75 in.)	117.4 mm (4.62 in.)	111.0 mm (4.37 in.)
BC20S-2, BC25S-2, BC30S-2	36/48	16.0 mm X 28.0 mm X 45.8 mm (.63 in. X 1.10 in. X 1.80 in.)	19.0 mm (.75 in.)	119.0 mm (4.69 in.)	111.0 mm (4.37 in.)
B20S, B25S B30S, BC20S BC25S, BC30S	72/80	12.5 mm X 40.0 mm X 45.8 mm (.49 in. X 1.57 in. X 1.8 in.)	19.0 mm (.75 in.)	117.4 mm (4.62 in.)	111.0 mm (4.37 in.)

*As measured manually on standard trucks. As measured by the Brush Wear Indicator (BWI) on Superior (S) option trucks.
**All rough edges (burrs) must be removed after the commutator is machined.

Machine chamfer on the commutator bars ...0.40 mm (.016 in.)

Torque for the terminal bolts (not shown) that hold cable connections .....12 N•m (9 lb•ft)

Depth of the insulation below commutator bars .....1.0 mm (.04 in.)

Width of the insulation below commutator bars .....0.76 mm (.030 in.)

Maximum difference between commutator high and low point (out of round) .....0.03 mm (.001 in.) TIR

Maximum difference between bar to bar .....0.005 mm (.0002 in.) TIR

Thermal switch (not shown) [Superior (S) Option. only]:

Opening temperature .....150 ± 6°C (302 ± 11°F)

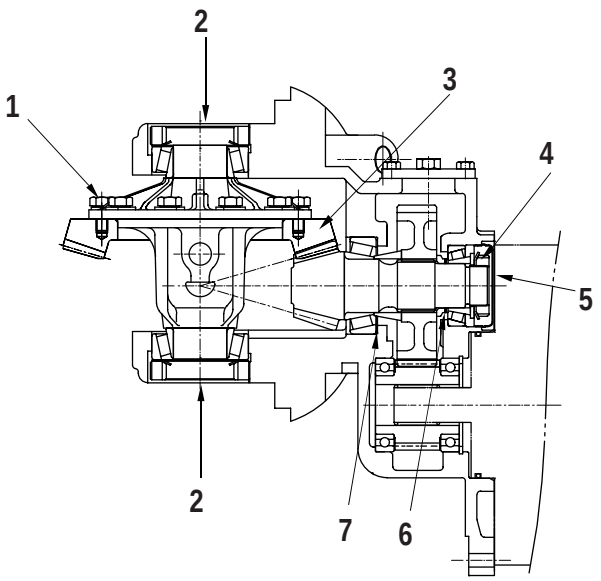
Closing temperature .....130 ± 7°C (266 ± 13°F)

Thermal switch (Not Shown)[Standard only]

Opening Temperature .....135 ± 4° (275 ± 10°F)

Closing Temperature .....118 ± 6° (244 ± 11°F)

Power Transfer Group



(1) Torque for bolts (1) that hold ring gear to differential case assembly .....70 ± 15 N•m (50 ± 11 lb•ft)

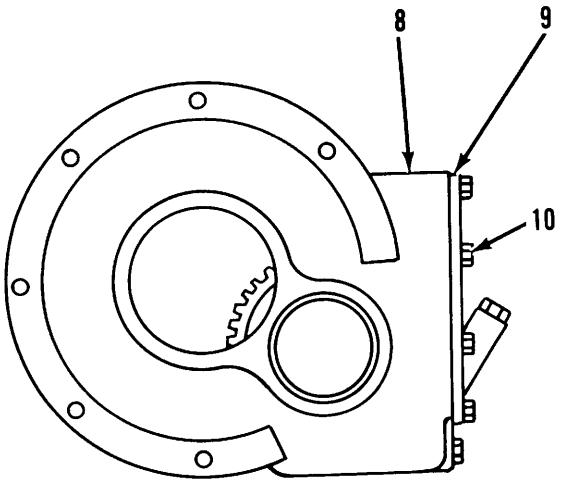
(2) Adjust differential bearings with locknut (2) to a rolling torque of .....2.12 to 2.97 N•m (19 to 27 lb•in)

(3) Amount of free play (backlash) between bevel gear and pinion (3) .....0.15 to 0.20 mm (.006 to .008 in.)

(4) Tighten nut (4) to 180 ± 25 N•m (135 ± 18 lb.ft.). Install shims (6) as needed to obtain rolling torque of 0.85 to 1.70 N•m (7.5 to 15.0 lb•in) at the pinion without the differential case assembly.

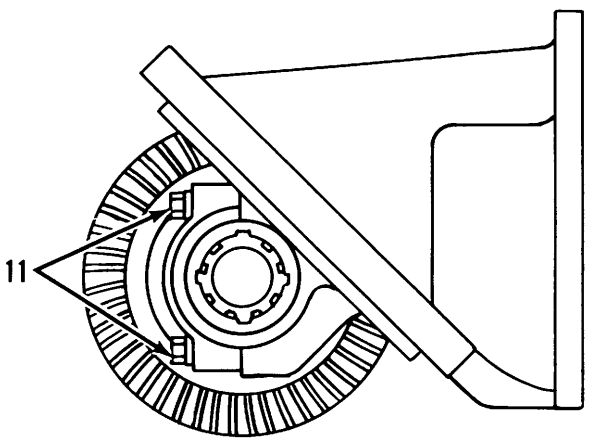
(5) Apply LOCTITE NO.609 Sealant to outside diameter of cap (5) prior to assembly.

(6) Install shims (7) as needed. See Power Transfer Group Adjustments in Testing and Adjusting.



(8) Apply Loctite No. 242 to six bolts (10).

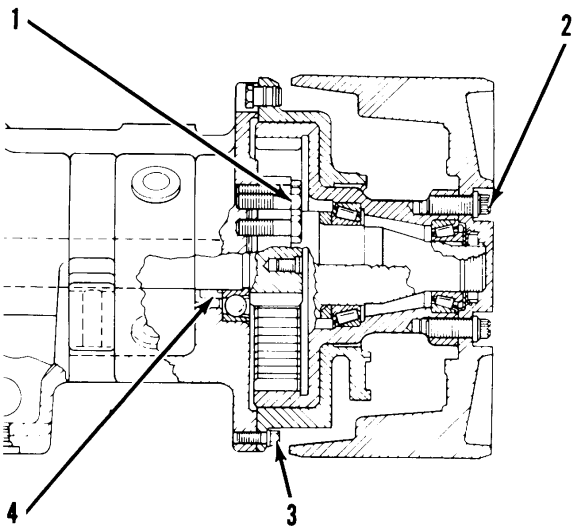
(9) Apply 6V1541 Primer and Loctite No. 17430 to cover (9) and housing assembly (8) prior to assembly.



(10) Torque for differential bearing cap bolts (11). .....220 ± 25 N•m (160 ± 18 lb•ft)

NOTE: The marks on the bearing caps and gear carrier must be in correct alignment.

Final Drive



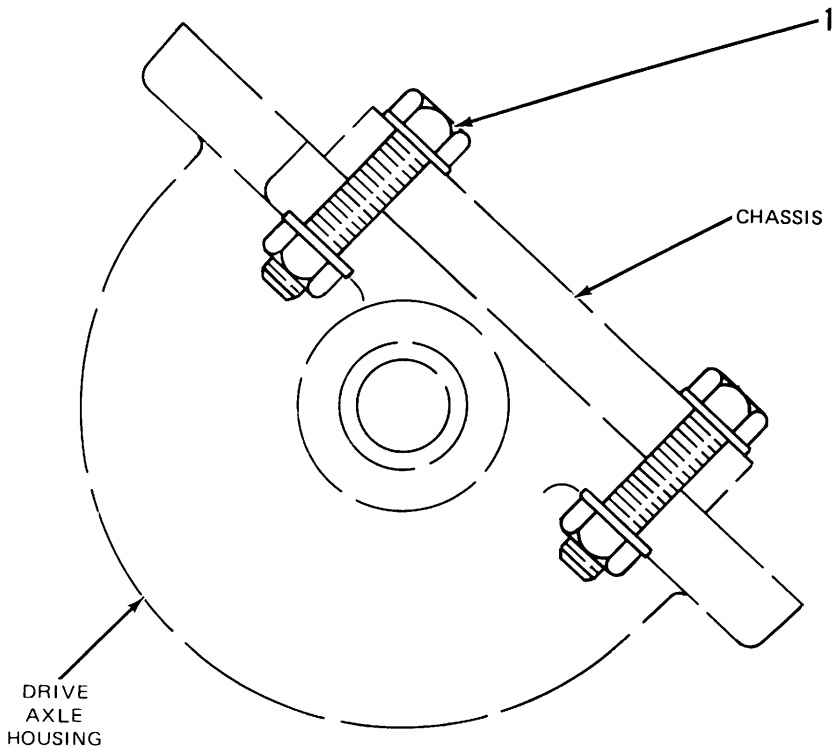
(1) Apply Loctite No.242 Thread Lock to thread of bolt (1) and tighten to a torque of .....115 ± 14 N•m

(2) Torque for wheel mounting bolts (2) .....270 ± 25 N•m (200 ± 18 lb•ft)

(3) Torque for bolts (3) holding service brake .....55 ± 10 N•m (41 ± 7 lb•ft)

(4) Heat retainer (4) to a temperature of 371 to 427°C (700 to 801°F) for no more than four hours and install on axle shaft.

Drive Axle Mounting Group



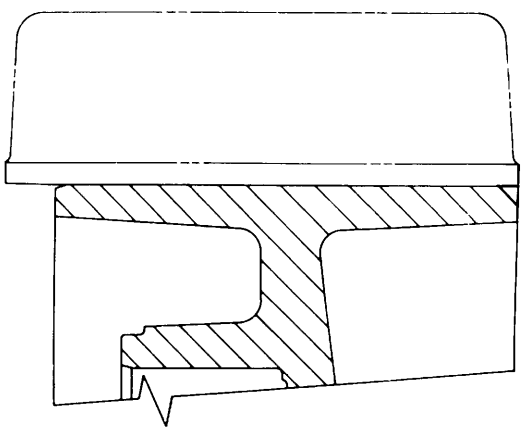
(1) Install four bolts (1) that fasten drive axle housing to the chassis frame. Tighten bolts (1) to a torque of .....488 ± 27 N•m (360 ± 20 lb•ft)

Drive Tire Installation

B Series

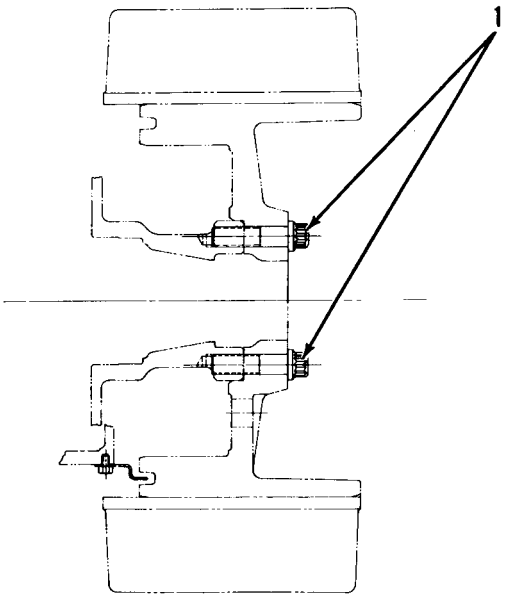
⚠ WARNING

The optional cushion drive tire must be installed as shown. failure to do so will decrease machine stability and cause possible personal injury.



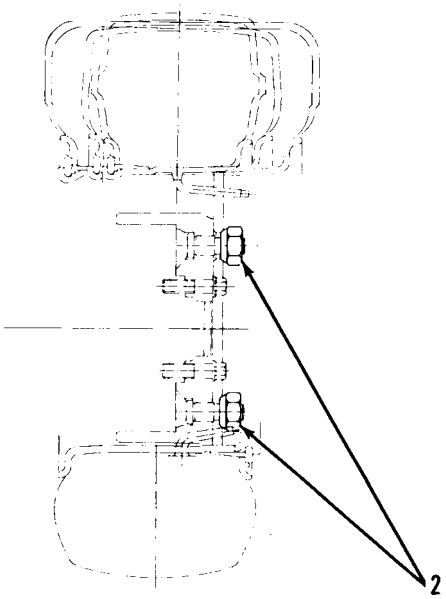
Cushion Tire

Install the cushion tire so that the edge of the tire is even with the outside edge of the wheel.



Cushion Tire Mounting

Tighten the cushion tire wheel mounting bolts (1) to a torque of .....270 ± 25 N•m (200 ± 18 lb•ft)



Pneumatic Tire Mounting

Tighten the pneumatic tire wheel nuts (2) to a torque of .....644 ± 34 N•m (475 ± 25 lb•ft)

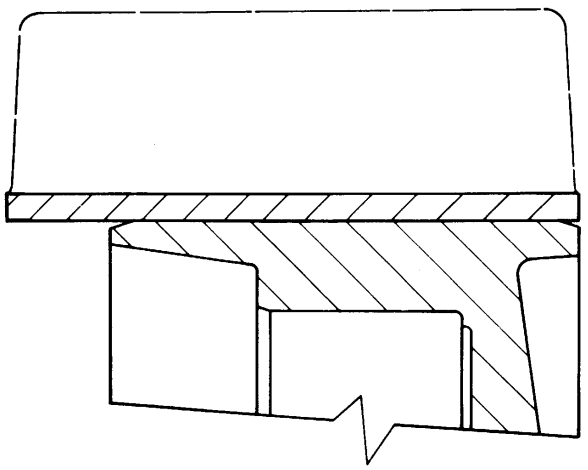
Use “crisscross” procedure to tighten the nuts.

BC Series

BC20S-2, BC25S-2

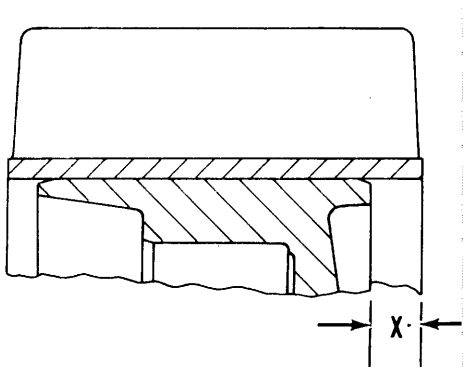
⚠ WARNING

The drive tire must be installed as shown below. Failure to do so will decrease the stability of the lift truck and can cause injury to the operator.



Install the tire so that the edge of the tire is even with the outside edge of the wheel.

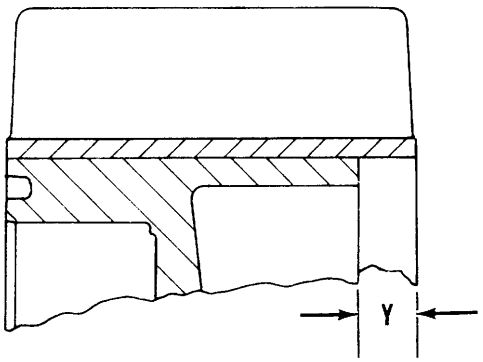
BC30S-2-Narrow Axle



BC30S Models-Narrow Axle

Install the tire so there is distance (X) between the edge of the tire and the outside edge of the wheel.
Distance (X) is .....21.4 ± 0.8 mm (.84 ± .03 in.)

BC30S-2 wide Axle



BC30S Models-Wide Axle

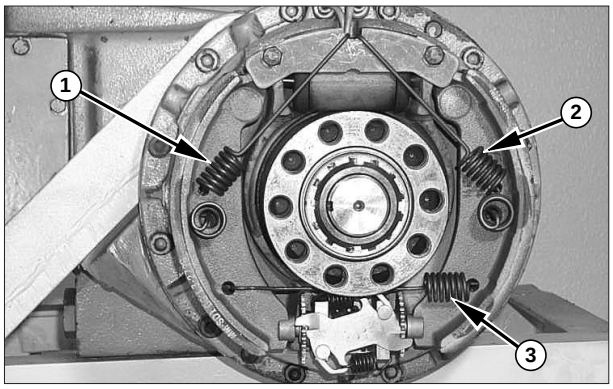
Install the tire so there is distance (Y) between the edge of the tire and the outside edge of the wheel.
Distance (Y) is.....25.4 ± 0.8 mm (1.00 ± .03 in.)

Disassembly & Assembly

Brakes, Brake Adjuster And Wheel Cylinder

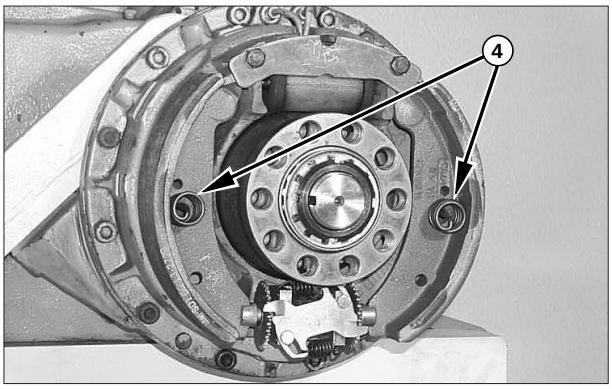
Remove Brakes, Brake Adjuster And Wheel Cylinder

Tools Needed	A
Jack Stand	1

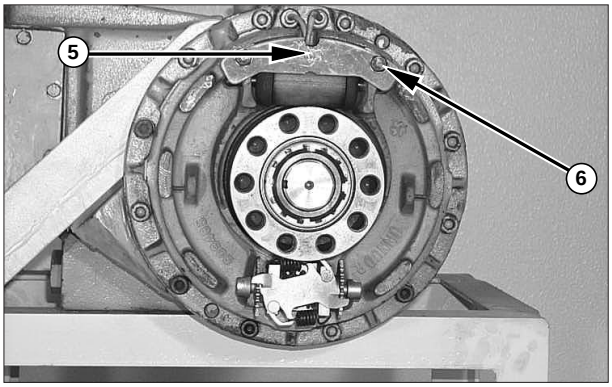


1. Put the lift truck in position on tooling (A), and remove the drive wheels. On B20/25/30S models, remove the brake drum also.

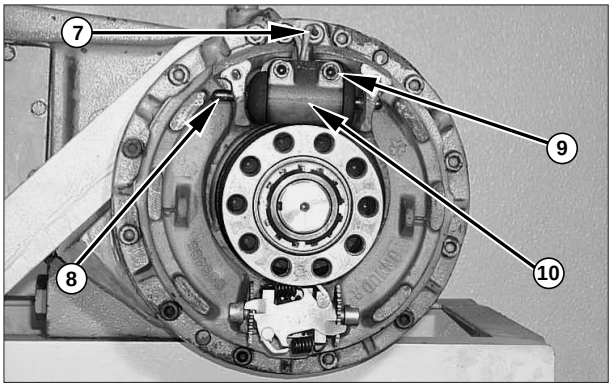
2. Remove brake return springs (1), (2) and (3) with a suitable brake shoe spring tool.



3. Remove brake retainer springs (4). Remove the brake shoes.

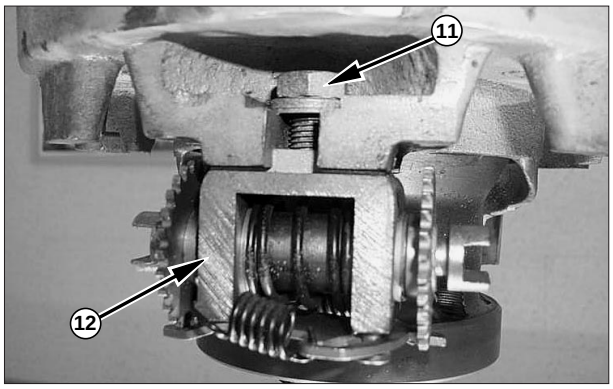


4. Remove bolts (6) to remove wheel cylinder cover (5).

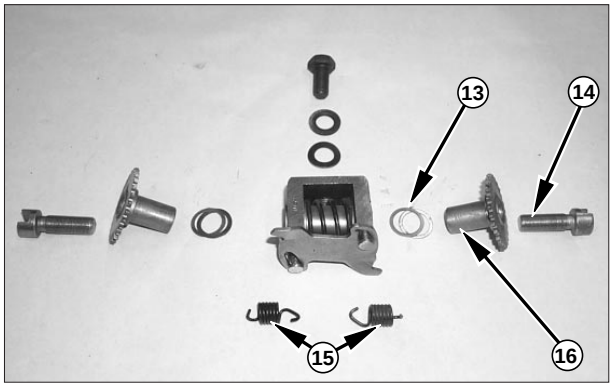


5. Disconnect brake lines (7). Remove plungers (8) from the wheel cylinder.

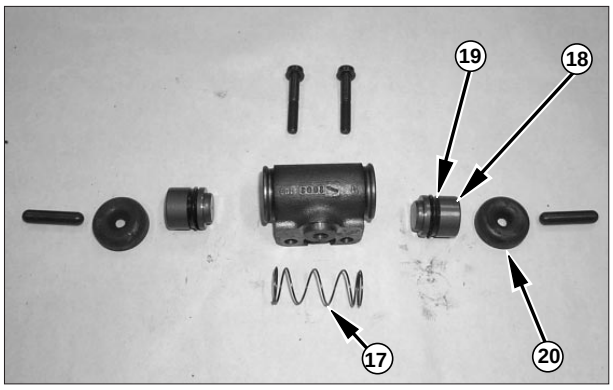
6. Remove bolts (9) to remove wheel cylinder (10).



7. Remove bolt (11) to remove brake adjuster (12).



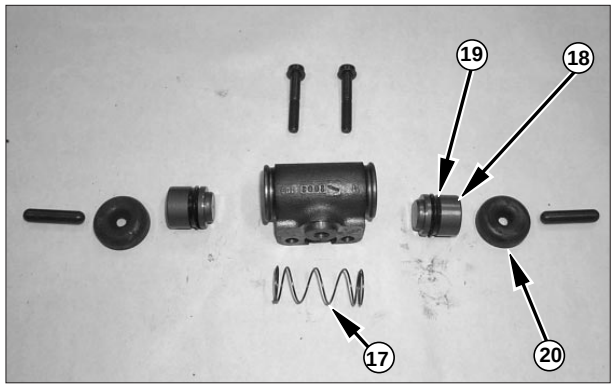
8. Disassemble the brake adjuster. Remove springs (15) from the adjuster. Remove bolt (14), wheel (16) and shims (13). Do the same for the other side of the brake adjuster.



9. Disassemble the wheel cylinder. Remove dust caps (20) from each end of the wheel cylinder.

10. Remove pistons (18) with seals (19) and spring (17) from the wheel cylinder.

Install Brakes, Brake Adjuster And Wheel Cylinder

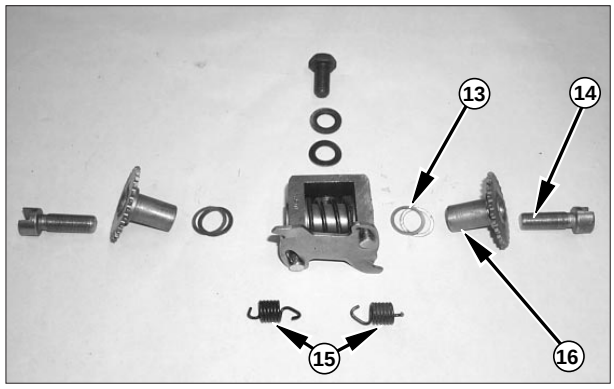


1. Install spring (17) in the wheel cylinder.

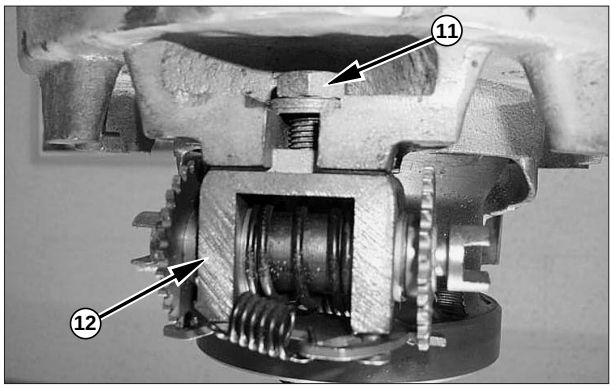
NOTE: Put clean brake fluid on the seals and inside of the wheel cylinder before assembly.

2. Install pistons (18) with seals (19) in the wheel cylinder.

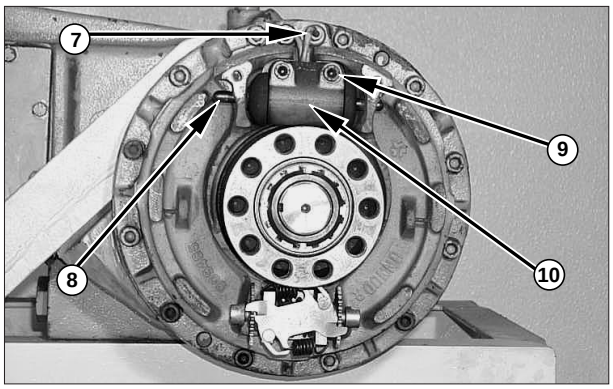
3. Install dust caps (20).



4. Install shims (13) on wheel (16). Install wheel (16) in the brake adjuster with bolt (14). Do the same for the other side of the brake adjuster. Install springs (15) on the arms of the brake adjuster.

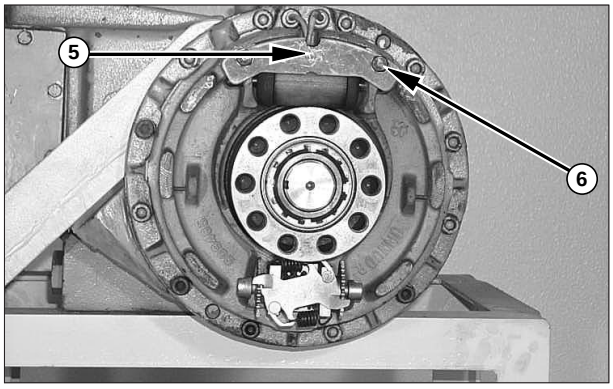


5. Install brake adjuster (12) and bolt (11) that holds it. Tighten the bolt to a torque of 72 ± 5 N•m (55 ± 4 lb•ft). See Brake Adjuster Installation in Testing And Adjusting for further adjustments.

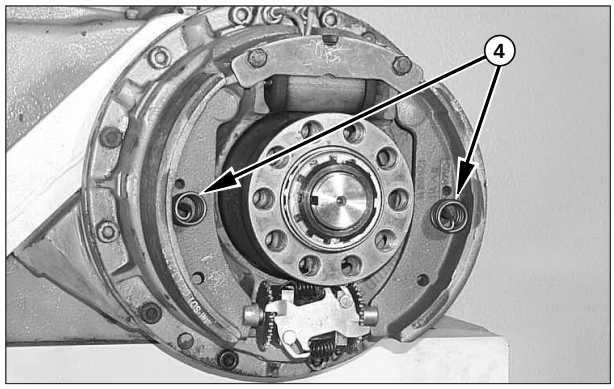


6. Install wheel cylinder (10) and bolts (9). Tighten the bolts to a torque of 15 ± 2 N•m (11 ± 1 lb•ft).

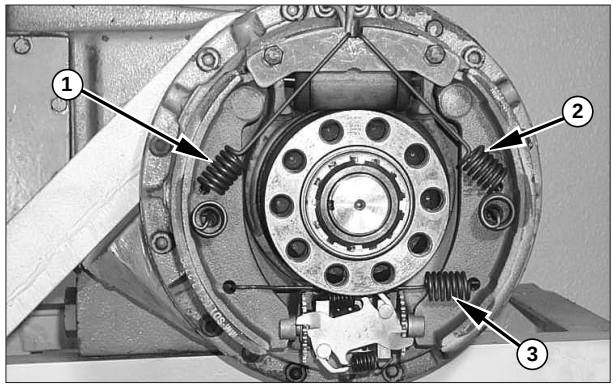
7. Install plungers (8). Connect brake lines (7), and tighten the nuts to a torque of 14 ± 2 N•m (10 ± 1 lb•ft).



8. Install wheel cylinder cover (5) and bolts (6).



9. Install the brake shoes and brake retainer springs (4).



10. Install brake return springs (1), (2) and (3) with a suitable brake spring tool.

11. Install the brake drums on B20/25/30S models. Install the drive wheels.

Power Transfer Group

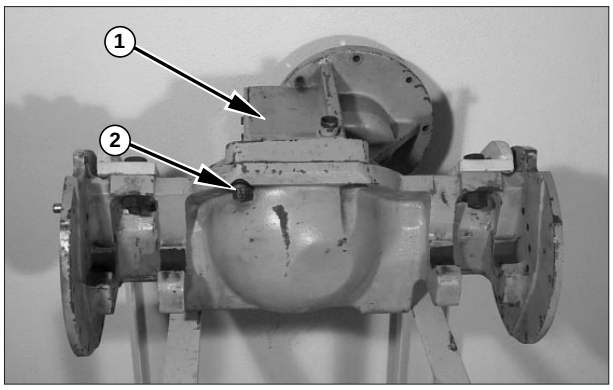
Remove And Install Power Transfer Group

Tools Needed	A
Link Bracket	1

Start By:

a. Remove transaxle

b. Remove final drives and hubs



1. The weight of power transfer group (1) is 50 kg (110 lb). Install tool (A) on the power transfer group, and attach a hoist.

2. Remove four bolts (2) and the power transfer group. Remove the O-ring seal if it is necessary.

NOTE: The following steps are for installation of the power transfer group.

3. Put the O-ring seal on the power transfer group if it was removed. Put clean SAE 10W oil on the seal.

4. Put the power transfer group in position on the drive axle housing. Install the four bolts.

End By:

a. Install final drives and hubs.

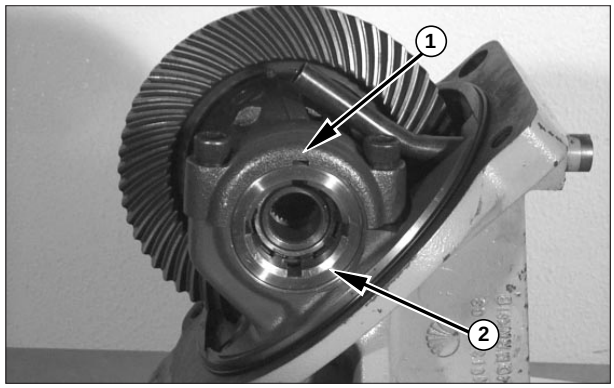
b. Install transaxle.

Disassemble Power Transfer Group

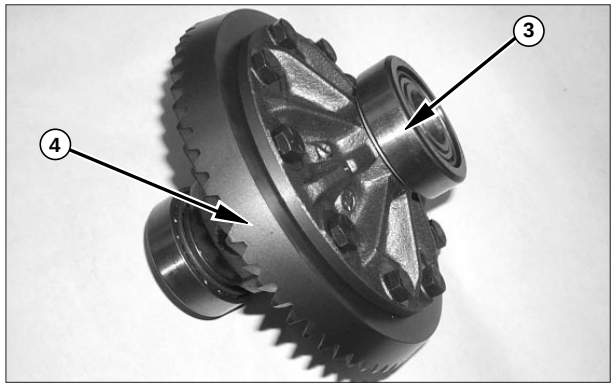
Tools Needed	A	B	C
Spanner Wrench	1		
Handle	1		
Bearing Puller		1	
Spanner Wrench			1

Start By:

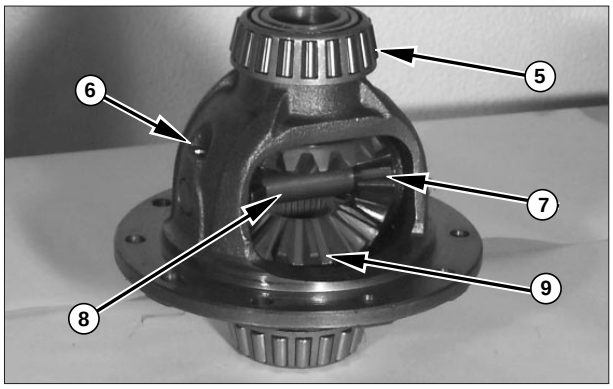
a. Remove power transfer group.



1. Mark the bearing caps and locknuts for proper installation. Bend the tab on the lockwasher back. Remove locknuts (2) with tooling (A) and the lockwashers. Remove bearing caps (1). The weight of the carrier assembly with the bevel gear is 50 kg (110 lb). Attach a hoist, and remove the carrier assembly.

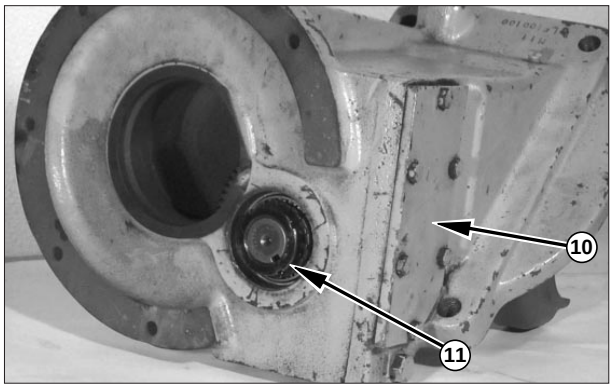


2. Remove two bearing cups (3). Remove the 10 bolts and bevel gear (4).

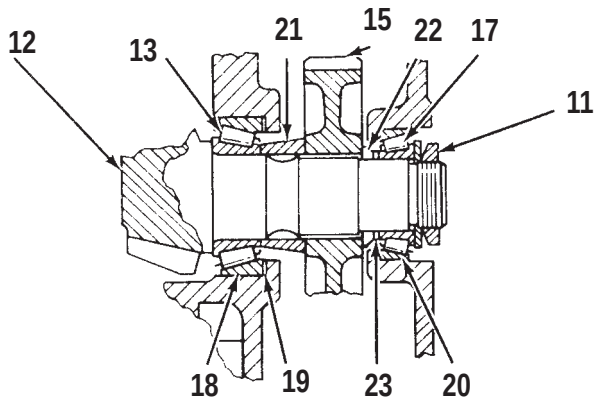


3. Use a hammer and punch to remove roll pin (6) from the carrier. Remove pin (8), side gears (7) and the thrust washers.

4. Remove axle gears (9) and the thrust washers. If bearing cones (5) need to be replaced, use tool (B) and a press to remove them from the carrier.



5. Remove cover (10) from the housing assembly. Remove the cap from over pinion nut (11). Bend the lockwasher away from nut (11). Remove nut (11) with tool (C). Remove the lockwasher and washer.



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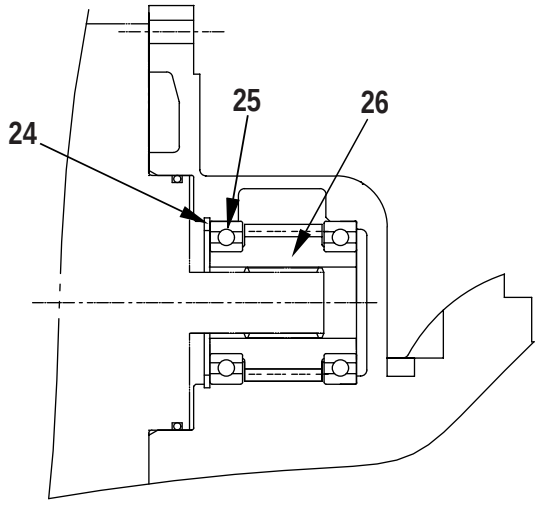
6. Remove outer bearing cone (17), shims (23) and ring (22) from the pinion shaft. Pull pinion shaft (12) out of gear (15) and the housing assembly. Remove ring (21) from the pinion shaft. Remove the gear from the side of the housing assembly that cover (10) was removed from.

7. If necessary, remove inner bearing cone (13) from the pinion shaft with a press.

8. If necessary, remove bearing cups (18) and (20) and shim (19) from the housing assembly.

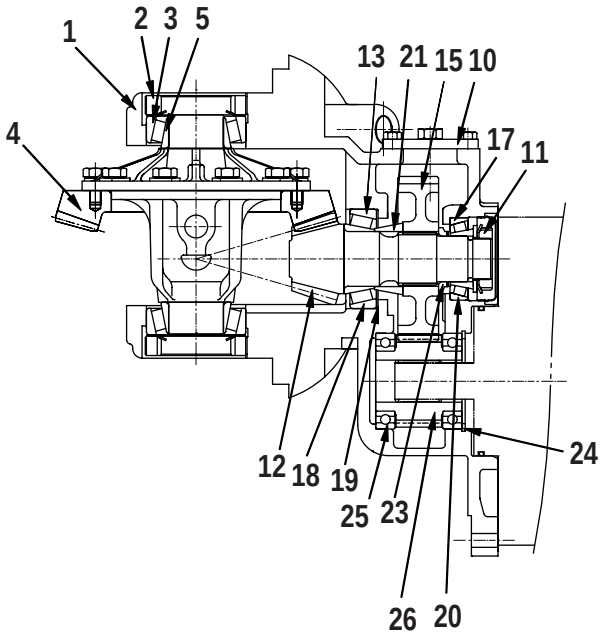


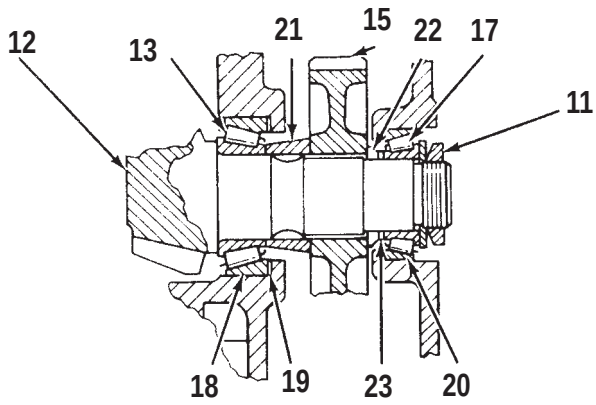
9. Remove the snap ring (24) from the gear shaft (26).

10. If necessary, remove the bearings (25) from the gear shaft (26) with a bearing puller.

Assemble Power Transfer Group

TOOLS NEEDED	A	C	D	E	F
Spanner Wrench	1				
Handle	1				
Spanner Wrench		1			
Pinion Depth Gauge			1		
Shim Pack, 4.0 mm (.16”)				1	
Dial Indicator Set					1





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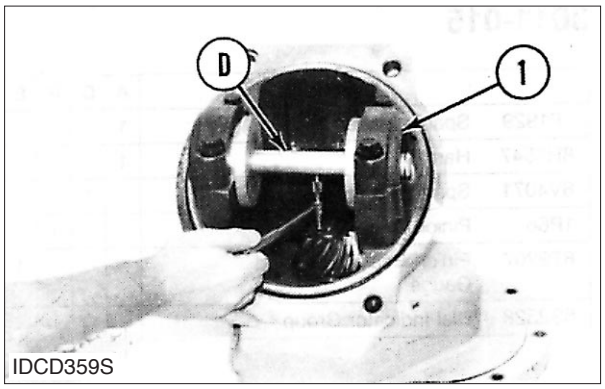
1. Install bearing cups (18) and (20) without shims (19) behind cup (18) in the housing assembly. Press bearing cone (13) on the pinion shaft.

2. Position pinion shaft (12) into the housing assembly. Install outer bearing (17) and nut (11) on the pinion shaft. Tighten the nut to a torque of 15 to 34 N•m (11 to 25 lb•ft) while rotating the pinion.



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3. Put the bar and discs of tool (D) in the bearing bores of the housing assembly as shown. Install bearing caps (1), and tighten the bolts.

4. Measure the distance from the end of the pinion shaft to the bottom of the bar with an inside micrometer. Record this measurement.

5. Measure the outside diameter of the bar with an outside micrometer. Divide this measurement by 2, and add it to the recorded measurement of Step 4. Record this total measurement.

6. Calculate the required shim thickness as follows: the nominal mounting distance ± deviation from nominal (as marked on the end of the pinion in millimeters, either + or - number) = required mounting distance. The measured distance (from Step 5) - the required mounting distance = required shim thickness. The measured distance must be within 0.03 mm (.001 in) of the required mounting distance. If it is, the correct thickness of shims have been installed. If the required mounting distance is greater than the measured distance, remove some shims (19). If the required mounting distance is less than the measured distance, add some shims (19).

EXAMPLE 1:

78.00 mm (3.071 in)	-	nominal mounting distance
- 0.09 mm (.004 in)	-	deviation from nominal (marked on end of pinion)
77.91 mm (3.067 in)	-	required mounting distance
78.10 mm (3.074 in)	-	actual mounting distance from Step 5
- 77.91 mm (3.067 in)	-	required mounting distance
0.19 mm (.007 in)	-	thickness of shims to be installed under cup (18)

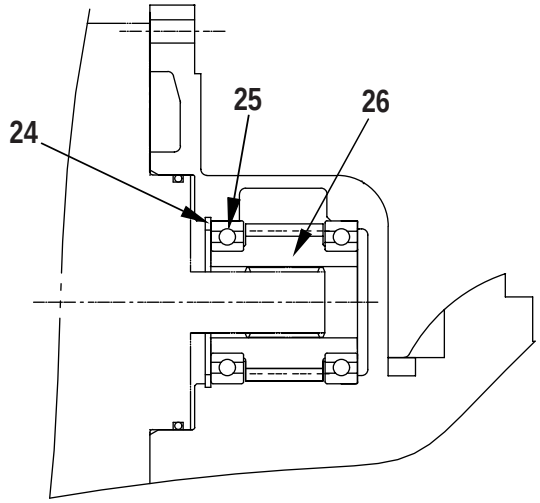
EXAMPLE 2:

78.00 mm (3.071 in)	-	nominal mounting distance
- 0.09 mm (.004 in)	-	deviation from nominal (marked on end of pinion)
77.91 mm (3.067 in)	-	required mounting distance
77.91 mm (3.067 in)	-	actual mounting distance
- 77.91 mm (3.067 in)	-	required mounting distance
0 mm (0 in)	-	thickness of shims that need to be added or removed from under cup (18)

7. If the original bearings and ring gear and pinion set are used, install bearing cups (18) and (20) with original amount of shims (19) behind bearing cup (18) in the housing assembly. Press bearing cone (13) on the pinion shaft.

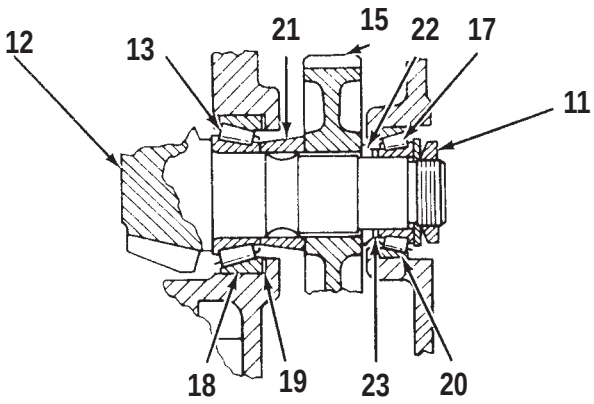
8. Do Steps 2-5. To calculate if the installed shims are the correct thickness, proceed as follows : the nominal mounting distance ± deviation from nominal (as marked on the end of the pinion, either + or - number) = required mounting distance. The measured distance must be within 0.03 mm (.001 in.) of the required mounting distance. If it is, the correct thickness of shims have been installed. If the required mounting distance is greater than the measured distance, remove some shims (19). If the required mounting distance is less than the measured distance, add some shims (19).

9. After the pinion depth is correct, remove tool (D) and pinion shaft (12) again.



10. Press bearings (25) on the gear shaft (26).

11. Install the gear shaft (26) in the housing. Install the snap ring (24) on the gear shaft (26).



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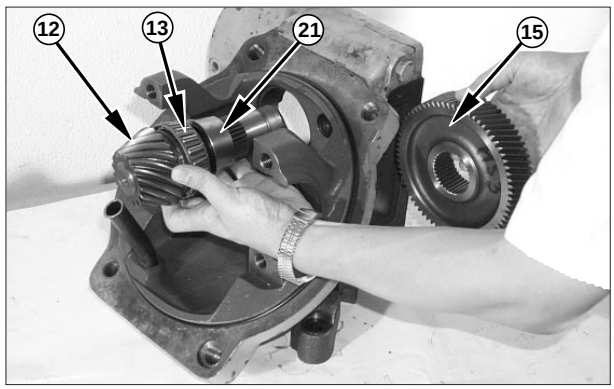
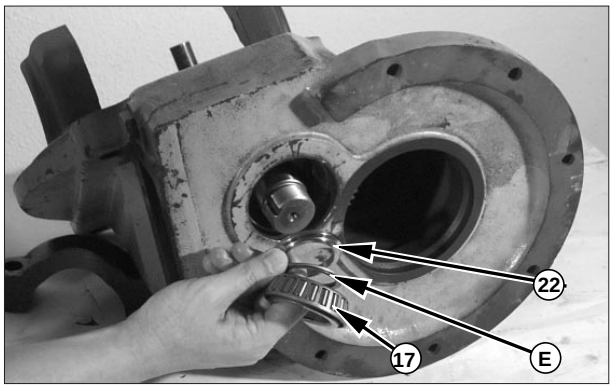
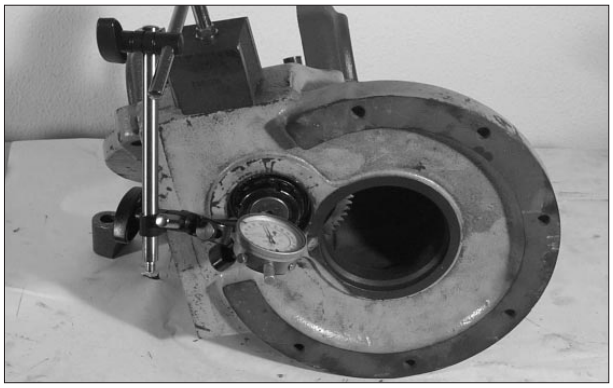




12. Put ring (21) in position on the pinion shaft. Put gear (15) in position in the housing assembly with the side that has a recessed hub next to ring (21). Put the pinion shaft in the housing assembly and through gear (15).

13. Install ring (22). Install tooling (E). Install bearing (17), the washer, lockwasher and nut (11). Tighten the nut to a torque of 15 to 34 N•m (11 to 25 lb•ft) while rotating the pinion.



14. Install tooling (F) as shown, and measure the end play of pinion shaft (12). Record the measurement. Remove nut (11), the lockwasher, washer and bearing cone (17).

NOTE: Be sure to measure each shim in shim pack (E) separately. The shims for setting rolling torque are not shown in the parts book. The part numbers are:

PART NO.	THICKNESS
924760	0.04 mm (.002 in)
924761	0.08 mm (.003 in)
924762	0.12 mm (.005 in)
924763	0.25 mm (.010 in)
924764	0.8 mm (.03 in)
924765	1.6 mm (.06 in)

15. Remove tooling (E). Measure the thickness of tooling (E). Subtract from this thickness the recorded end play from step (14). This is the thickness of shims (23) that are needed with no bearing preload (actual gauge thickness measured end play = clearance).

16. In order to get bearing preload, subtract from the shim pack found in Step 15, 0.05 mm (.002 in). This is thickness of shims that need to be installed.

17. Install the correct thickness of shims (23), bearing cone (17), the washer, lockwasher and nut (11). Tighten the nut to a torque of 180 $\pm$ 25 N•m (135 $\pm$ 18 lb•ft) with tool (C) and lock within this range.

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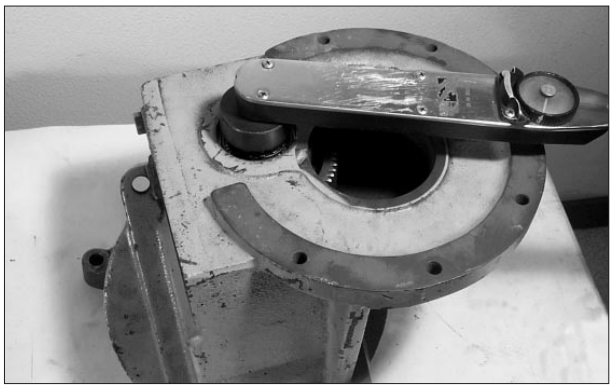
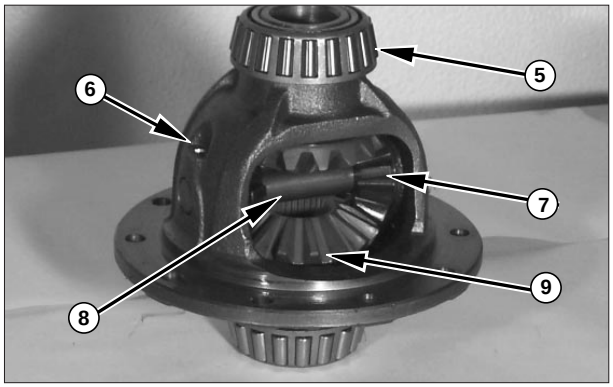
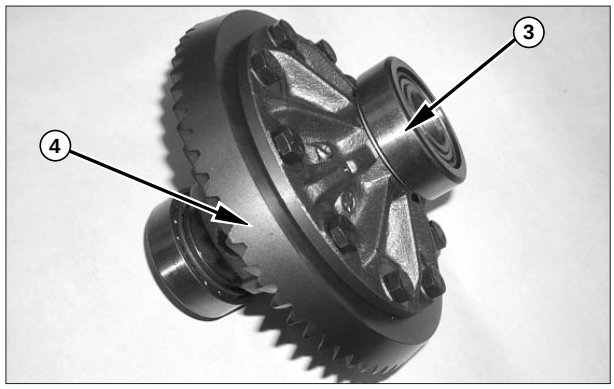


18. Check the rolling torque of the pinion as shown. It must be 0.85 to 1.70 N•m (7.5 to 15.0 lb•in). If the rolling torque is not correct, add or remove shims (23) until it is correct. Removal of shims (23) increases rolling torque. Adding shims (23) decreases the rolling torque. Record the actual rolling torque after the shims have been added or removed. Do not put the cap over the pinion nut yet.

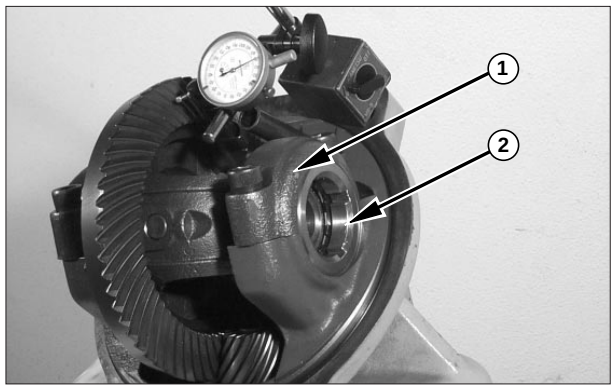


19. If bearing cones (5) were removed, heat them to 135°C (275°F), and install them on the carrier. Put the thrust washers and axle gears (9) in position in the carrier.

20. Install the thrust washers, side gears (7) and pin (8). Install roll pin (6) through the carrier and pin (8).



21. Put bevel gear (4) on the carrier and the ten bolts. Tighten the bolts to a torque of 70 ± 15 N•m (50 ± 11 lb•ft). Put bearing cups (3) on the bearing cones.

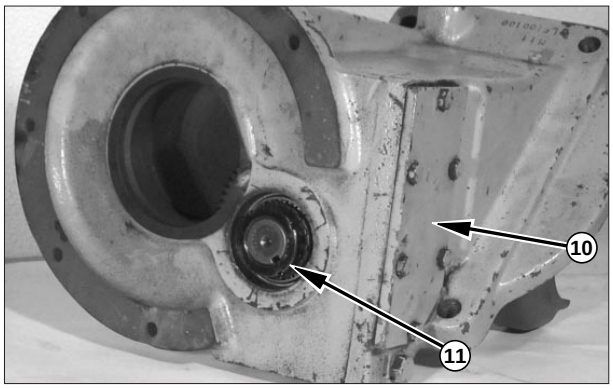


22. Put the carrier assembly in position in the housing assembly. Install bearing caps (1) and the four bolts. Tighten the bolts to a torque of 220 ± 25 N•m (160 ± 18 lb•ft).

23. Install the lockwasher and locknuts (2). Install tooling (F) as shown, and adjust locknuts (2) with tooling (A) until there is a backlash of 0.13 to 0.20 mm (.005 to .008 in). To adjust backlash, turn one locknut in and the other one out the same amount of turns.

24. Check the rolling torque again as shown in step 18. Tighten locknuts (2) with tooling (A) equally to preload the bearings. Proper bearing preload will increase the recorded preload in Step 18 by 0.63 to 0.88 N•m (5.6 ± 7.8 lb•in).

25. Measure backlash again. Bend a tab from each lockwasher into a slot of locknuts (2) to hold them in position.



26. After all the adjustments have been completed, put Bearing Mount Compound on the outside diameter of cap (11) and install it.

27. Put Gasket Maker on cover (10) and the housing assembly. Also, use Quick Cure Primer if the temperature is below 10 °C (50 °F).

End By:

a. Install power transfer group.

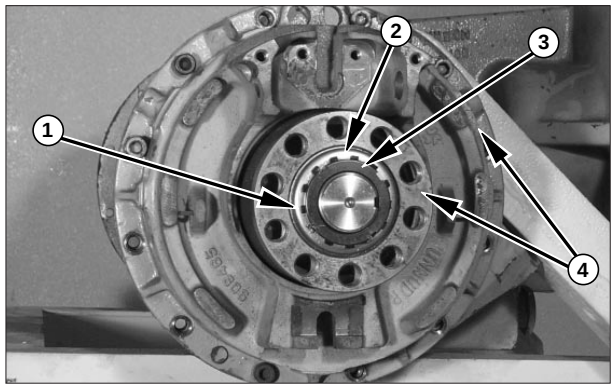
Final Drives And Hubs

Remove Final Drives And Hubs

Tools Needed	A
Spanner Wrench	1

Start By:

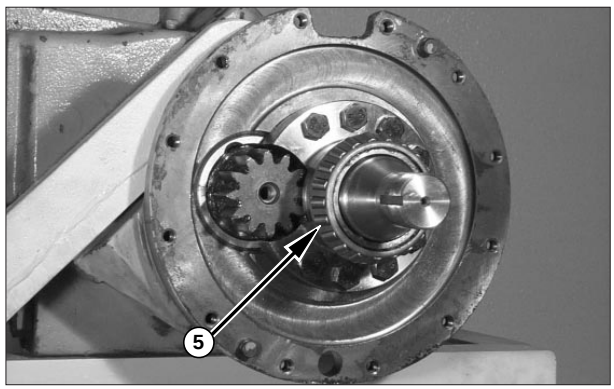
a. Remove brakes.



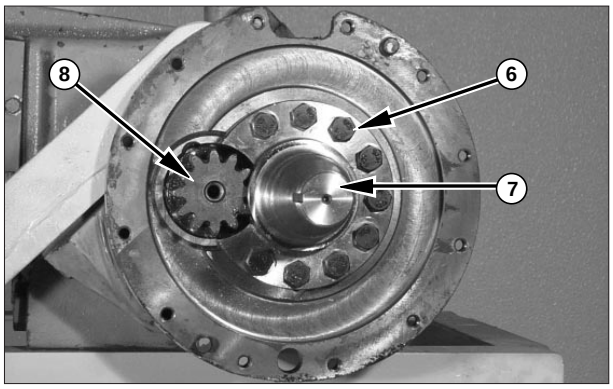
1. Bend back one of the tabs in locking washer (1).

2. Remove nut (3) with tool (A). Remove locking washer (1) and bearing (2).

3. Remove cover and hub assembly (4).

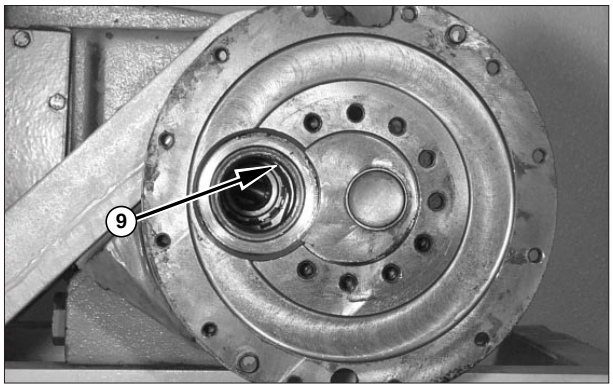


4. Remove bearing cone (5) from the spindle.

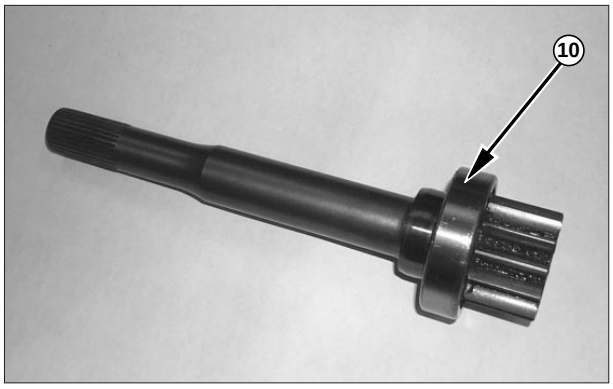


5. Remove bolts (6), and remove spindle (7).

6. Remove shaft assembly (8).



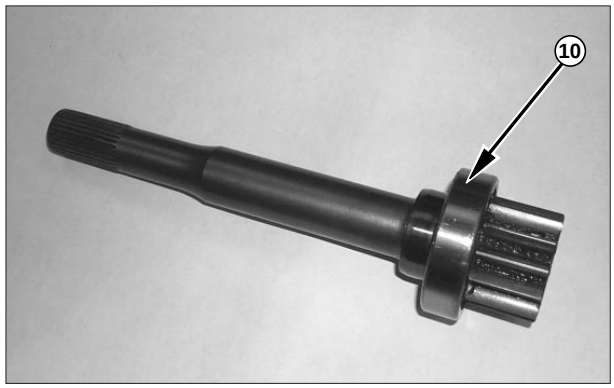
7. Remove lip seal (9) from the housing.



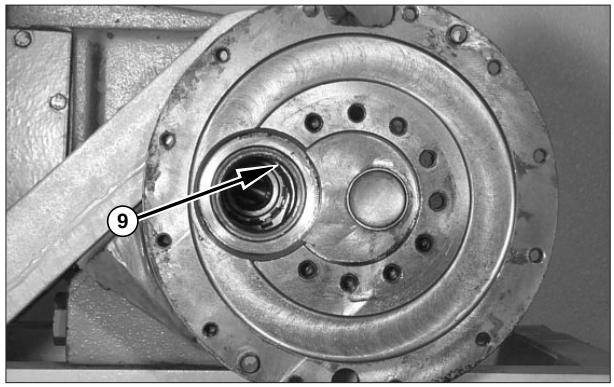
8. Remove the retainer and bearing (10) from the shaft.

Install Final Drives And Hubs

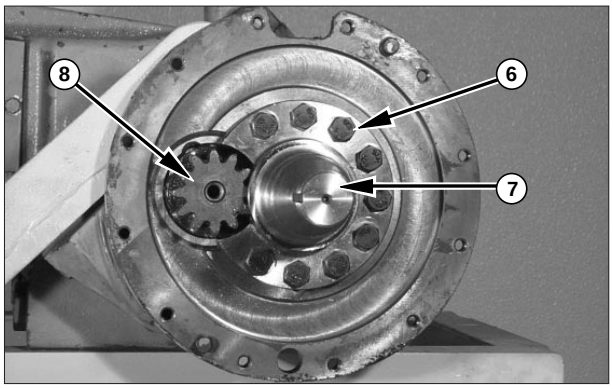
Tools Needed	A	B
Spanner Wrench	1	
Driver set		1



1. Install bearing (10) with a press. Heat the retainer to 317 to 427°C (700 to 801°F) and install it against bearing (10) with a press.



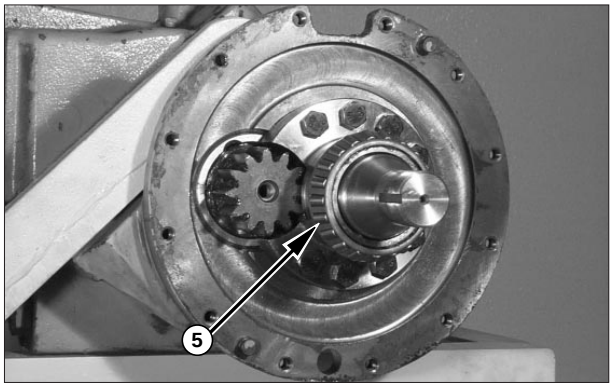
2. Install lip seal (9) in the housing with tool group (B) and a suitable press. Install the seal with the lip toward the inside.



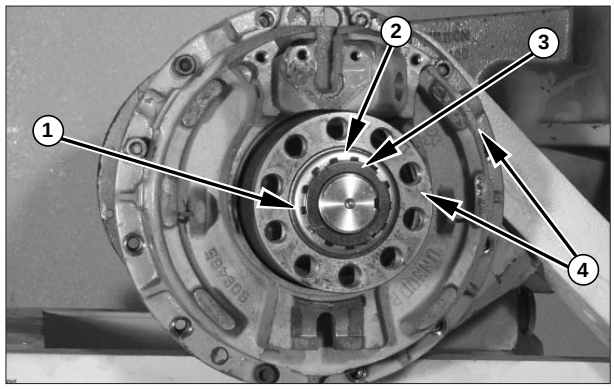
3. Install shaft assembly (8) in the housing.

4. Put Loctite No.242 Thread Sealant on th threads of the bolts that hold the spindle.

5. Put spindle (7) in position, and install bolts (6) that hold it. Tighten the bolts to a torque of 115 ± 14 N•m (85 ± 10 lb•ft).



6. Install bearing (5) on the spindle.



7. Put hub and cover assembly (4) in position on the housing, and install the bolts that hold it. Tighten the bolts to a torque of 55 ± 10 N•m (41 ± 7 lb•ft).

8. Install bearing (2) locking washer (1) and nut (3) on the spindle.

9. With tool (A), tighten nut (3) slowly to 135 N•m (100 lb•ft) while the hub is turned to put the bearings in position.

10. Loosen nut (3) completely, and tighten it again to a torque of 50 ± 5 N•m (37 ± 4 lb•ft).

11. Bend one of the tabs in washer (1) to hold the nut in position.

End By:

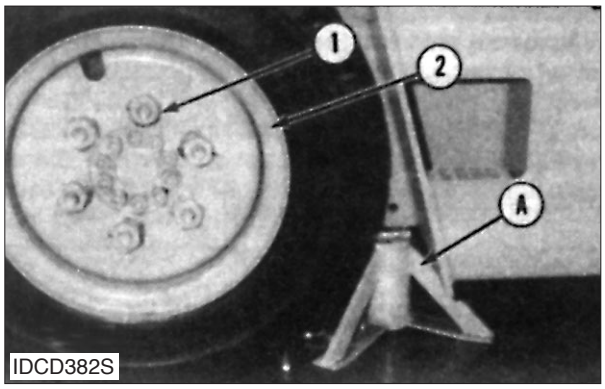
a. Install brakes.

Oil Cooled Disc Type Brake

Remove & Install Brakes (Oil Cooled Disc Type)

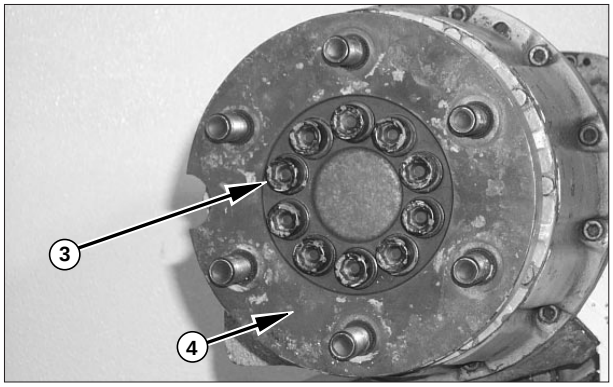
Tools Needed	A
Jack Stand	4

NOTE : The procedure to remove and install oil cooled disc type brakes is the same for both sides of the machine.

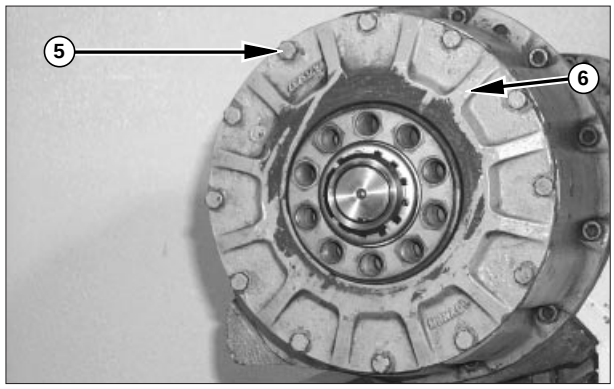


1. Put the lift truck in position on tooling (A).

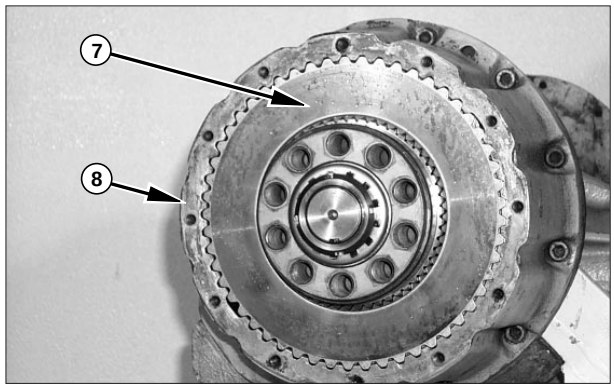
2. Remove the bolts (1) and wheel (2).



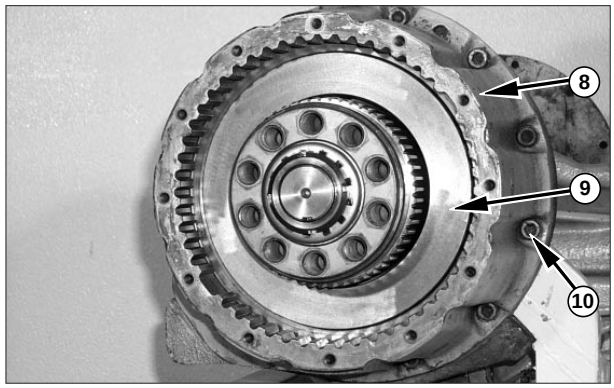
3. Remove bolts (3) and adapter (4).



4. Remove bolts (5) and cover (6).



5. remove the plates and discs (7) from hub (8).

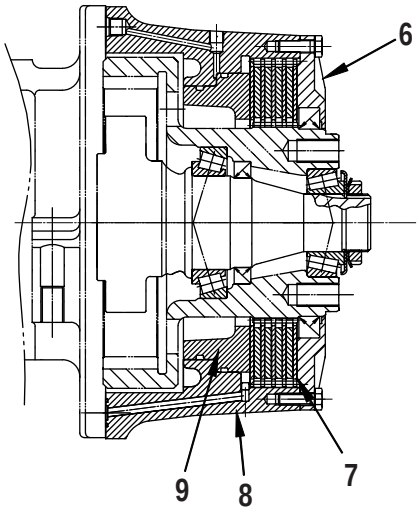


6. Remove piston (9) from hub (8).

7. Remove bolts (10) and hub (8).

NOTE : Check the condition of all O-ring seals and components. If any seals or components are worn or damaged use new parts for replacement.

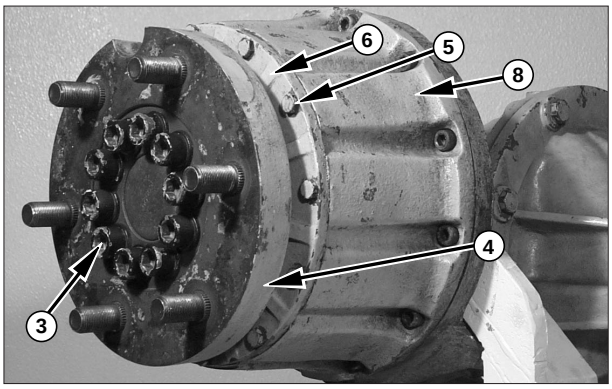
NOTE : Use the following steps to install the oil cooled disc type brakes. If new discs (7) are installed, soak the discs in transmission drive train oil for one hour prior to installation. Refer to the Operation and Maintenance Manual for further information.



8. Put **Loctite No. 17430** on the mating surfaces of hub (8) and the transaxle housing. Install hub (8) and bolts (10).

9. Install piston (9).

10. Install the plates and discs (7) into hub (8).



11. Put **Loctite No.17430** on the mating surfaces of hub (8) and cover (6). Install bolts (5) and cover (6).

12. Install adapter (4) and bolts (3).

13. Install bolts (1) and wheel (2).

14. Bleed the brake system. Refer to the Testing and Adjusting Manual for further information.

15. Remove tooling (A).