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B35D & B40D 6 X 6

ARTICULATED DUMP TRUCK

REPAIR MANUAL

Document Part Number 872092

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TO THE SERVICE PERSONEL

⚠ WARNING

Do not operate the machine unless you have read the Operator's Manual and fully understand how to operate the machine properly.

This manual is written for an experienced technician and are on-the-job guides containing only the vital information needed for diagnosis, analyses, testing and repair. Essential tools required in performing certain service works are identified and in this manual and are recommended for use.

The safe operation of your ***BELL EQUIPMENT*** machines very important to prevent any personal injury and/ or damage. This manual must be read and fully understood before carrying out any tests on your ***BELL EQUIPMENT*** machine.

Right and left hand sides are determined by facing in the direction of forward travel.

This manual is divided into chapters. The information contained in the manual is in logical sequence, with the instructions written in step by step format.

Effective maintenance on your ***BELL EQUIPMENT*** machine is achieved when personnel fully understand the information contained in this manual.

Every effort has been made to ensure that the information contained in this manual was correct at the time of publication. ***BELL EQUIPMENT Co.*** has a policy of continuous product development, improvement, and design. ***BELL EQUIPMENT Co.*** reserves the right to change, amend and update the design of its product at any time without prior notice. With this policy, changes may have occurred that are not included in this manual.

Whilst every endeavour has been made to provide accurate and reliable information, ***BELL EQUIPMENT Co.*** specifically disclaims any actual or implied warranty and under no circumstances shall be liable for any loss, damage or injury to person or property suffered, whether direct, indirect or consequential, arising from the use of this manual. In particular and without detracting from above, the disclaimer also applies in the event of any specification, warning, or representation contained in this manual being inadequate, inaccurate, or unintentionally misleading.

The user is urged to strictly comply with the instructions and warnings that are given in the interests of general safety. Please do not hesitate to contact your ***BELL EQUIPMENT*** Product Support Representative whenever you have a query on your ***BELL EQUIPMENT*** product or this manual.

BELL EQUIPMENT

SAFETY SYMBOL

The following safety symbol is used for all safety messages. When you see the safety symbol, follow the safety message to avoid personal injury or death.

WARNINGS and **CAUTIONS** must be read, fully understood and followed, before carrying out the action or maintenance procedure concerned.

WARNINGS and **CAUTIONS** are always placed before any action or maintenance procedure where personal injury and/or damage to the machine could occur if that action, test or maintenance procedure is not carried out correctly.



WARNING AND CAUTION SYMBOL

Throughout this manual the word **WARNING** is used to alert the operator and others of the risk of personal injury during the operation of the equipment. **CAUTION** indicates the possible damage to the machine. **NOTE** highlights information of special interest.

⚠ CALIFORNIA PROPOSITION 65 WARNING

Diesel engine exhaust and some of its constituents are known to the state of California to cause Cancer, birth Defects and other Reproductive Harm.

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B35D and B40D 6X6 ARTICULATED DUMP TRUCK REPAIR MANUAL

THIS MANUAL IS APPLICABLE TO

B35D 6X6 (E359835)
B40D 6X6 (E409840)

Document Part Number 872092

Issue:0
(Revised:)

Technical Documentation
BELL EQUIPMENT COMPANY
Richards Bay

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IMPORTANT

Due to ***BELL EQUIPMENT'S*** policy of continuous product improvement, the information contained in this manual was correct up to the time of printing (Revised date of manual). Any changes after this date will only be included in the next update of this manual.

The illustrations in this manual are pictorial and not necessarily true representations of components. Photographs and illustrations may show optional equipment.

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ABBREVIATION LIST

The table below lists the abbreviations used in this manual:

Abbreviation	Meaning
ºC	degrees Celsius
ºF	degrees Fahrenheit
A	ampere
ADT	Articulated Dump Truck
Ah	ampere hours
CB	circuit breaker
d	diagnostic
D	drive
DNS	Do Not Shift
ECU	Electronic Control Unit
FOPS	Falling Objects Protective Structure
ft	foot (feet)
ft lb	foot pound
HP	Horsepower
ISO	International Standards Organisation
kg	kilogram
km	kilometre
km/h	kilometres per hour
kPa	kilo pascal
kW	kilowatt
lb	pound
LCD	Liquid Crystal Display
LED	Light Emitting Diode

Abbreviation	Meaning
m	metre
m^3	cubic metre
N	Neutral
m.p.h.	miles per hour
MSDS	Material Safety Data Sheet
Nm	Newton metre
psi	pounds per square inch
PTO	Power Take-Off
R	Reverse
r.p.m.	revolutions per minute
ROPS	Roll Over Protective Structure
SMR	Service Meter Reading
USGAL	United States Gallon
V	Volt
yd^3	cubic yard

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BULLETINS

Record the relevant information from the Technical Documentation Bulletins, Service Bulletins and Parts Bulletins into this manual as follows:

- Ensure the manual number (87--------) reflected in the bulletin is the same as the 87------ number at the top of the main content pages.
- Carry out the instructions as detailed in the bulletin.
- Record the required information below.
- File the bulletins in numerical order in a suitable 3 or 4 ring binder.

TECHNICAL DOCUMENTATION BULLETIN RECORD				
BULLETIN NO.	SUBJECT	INSERTED BY		
		NAME	SIGNATURE	DATE

TECHNICAL DOCUMENTATION BULLETIN RECORD

BULLETIN NO.	SUBJECT	INSERTED BY		
		NAME	SIGNATURE	DATE

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USER'S INFORMATINON FEEDBACK FORM

Should you, as user of this manual, have any suggestion for improving the manual, or you find any errors or omissions, then we would like to know.

Please complete a facsimile of this form and hand it in to your nearest ***BELL EQUIPMENT*** Product Support Representative or post it directly to your nearest ***BELL EQUIPMENT*** Branch. Addresses are given in the Operator Maintenance Manual.

Ideas, Comments (Please State Page Number):_____

_____

_____

_____

_____

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_____

Machine Model: _____

Serial Number:_____

VIN: _____

Page Number: _____

OVERALL, how would you rate the quality of this publication? (Check one)

Poor		Fair		Good		Very Good		Excellent	
1	2	3	4	5	6	7	8	9	10

Company Name: _____

Technician Name: _____

Address:_____

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Phone Number: _____

Fax Number: _____

Thank you for your co-operation.

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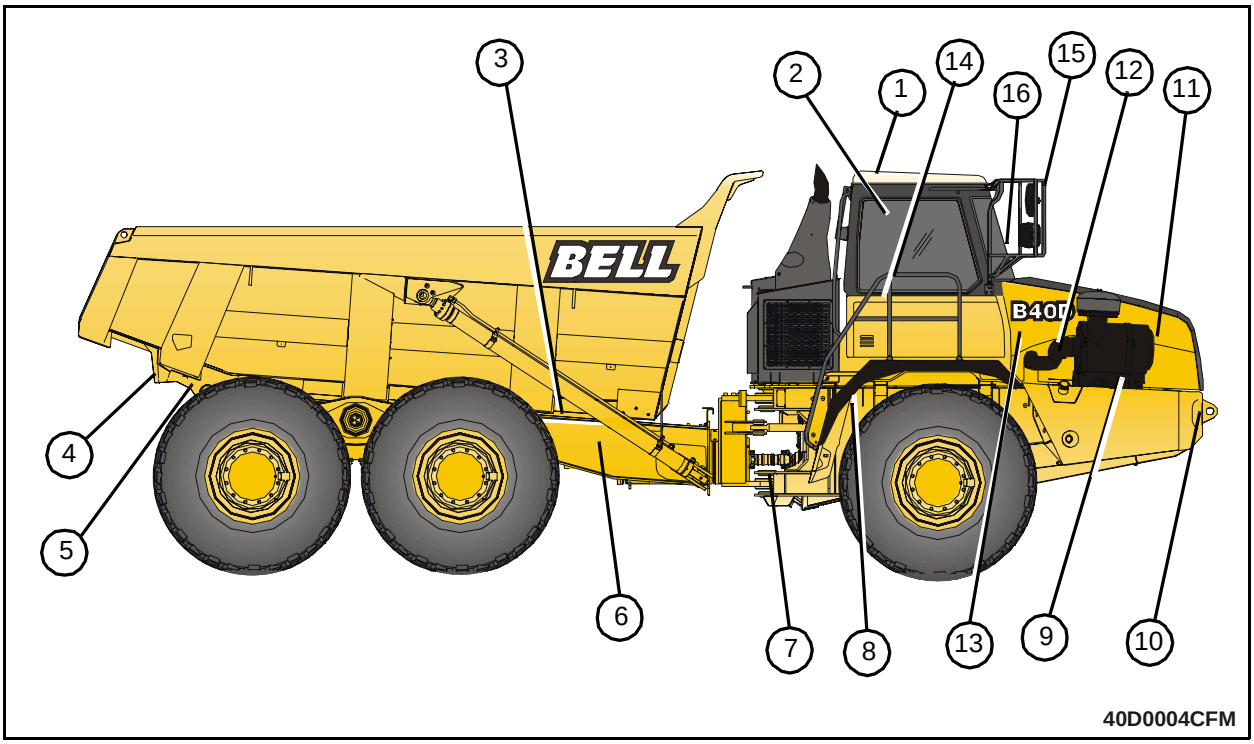
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SAFETY

Specification

This machine complies to the CE Specification.

Safety Features



1. **ROPS/FOPS Cab Protection**. The Roll Over Protective Structure has been certified to meet specified test requirements according to SAE J1040 and ISO 3471. The Falling Objects Structure has been certified to meet specified test requirements according to SAE J/ISO 3449 and ISO 3449.

2. **Cab with Heater/Defroster**. Positive pressure ventilation system circulates both outside and inside air through filters for a clean working environment. Built in defroster vents direct air flow for effective window de-fogging/de-icing.

3. **Bin Service Lock.**

4. **Stop/Back lights**. Highly visible lights.

5. **Backup Alarm.**

6. **Independent Parking Brake**.

7. **Articulation locking Bar.**

8. **Secondary Steering**. Ground driven, continuously in operation. Secondary steering indicator light will light when activated.

9. **Horn**.

10. **Halogen Lights and Turn Signals.**

11. **Engine Fan Guard.**

12. **Bypass Start Protection.**

13. **Exhaust Brake and Transmission Retarder (If Equipped).**

14. **Safety Belt Retractors.**

15. **Mirrors.**

16. **Large Windshield Wiper With Washer.**

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Material Safety Data Sheets (MSDS)

The Federal Occupational, Safety and Health Administration (OSHA) Standard 29 CFR 1910.1200 and in some cases, State and Local Right-to-Know laws, may require that specific **MSDS** be available to the employees prior to operating this equipment. This may include information on substances contained in this equipment such as antifreeze, engine oil, battery acid, hydraulic fluid and freon (if equipped with an air conditioner).

To ensure a prompt response, please be sure to include your return address and ZIP (postal) code, along with the model, serial number and/or **VIN** number of your machine.

Unauthorised Modifications of the Roll Over Protective Structure (ROPS) and the Falling Objects Protective Structure (FOPS)

Do not make unauthorised modifications or alterations to the ROPS and FOPS such as: welding on extinguisher brackets, CB aerial brackets, fire suppression systems etc. Unauthorised modifications will affect the structural limits of the ROPS and FOPS and will void the certification.

The Roll Over Protective Structure has been certified to meet specified test requirements according to SAE J1040 and ISO 3471. The Falling Objects Protective Structure has been certified to meet specified test requirements according to SAE J/ISO 3449 and ISO 3449.

Any planned modification or change must be reviewed in advance by the ***BELL EQUIPMENT*** **Engineering Department** to determine if the modification or change can be made within the limits of the certifying tests. It is important that each person in your organisation, including management, be made fully aware of these rules involving **ROPS** and **FOPS**. Whenever anyone sees unauthorised modifications or changes to a machine's **ROPS** or **FOPS** both the customer and manufacturer must be notified in writing.

Make sure that all parts are installed correctly if the **ROPS** or **FOPS** is loosened or removed for any reason. Tighten mounting bolts to the correct torque. The protection offered by **ROPS** or **FOPS** will be impaired if they are subjected to structural damage, is involved in an overturn incident, or is altered in any way. A damaged **ROPS** or **FOPS** must be replaced, not reused.

Noise Emission Levels

The sound pressure was tested according to ISO 6394 (SAE J/ISO 6394) and the sound power was tested according to ISO 6393 (SAE J 2102).\plain \par

General Safety

Be sure all operators of this machine understand every safety message. Replace operator's manual and safety decals immediately if missing or damaged.

Safety Regulation

Every country (State) has its own safety regulations. It is the obligation of the operator to know and follow these. This also applies to local regulations covering different types of work. Should the recommendations in this manual deviate from those of your country, your local safety regulations should be followed.

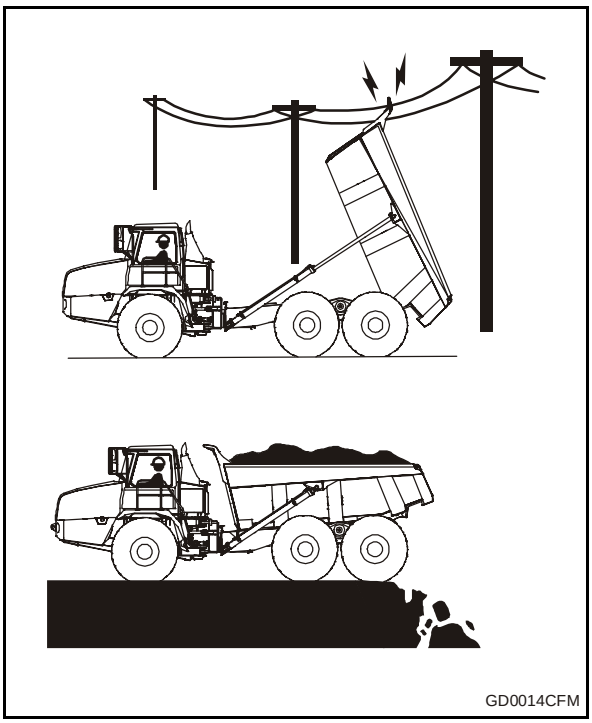
Mounting and Dismounting the Machine

Always use the handrails and steps provided to get on and off the machine. Use both hands and face the machine. Never get on or off a moving machine. Never jump off the machine. Use a hand line to pull equipment up onto the platform, do not climb on or off the machine carrying tools or supplies.

Use extra care when mud, snow, or moisture present slippery conditions. Keep steps clean and free of grease, oil and foreign objects.

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Avoid Work Site Hazards



Avoid Overhead Power Lines

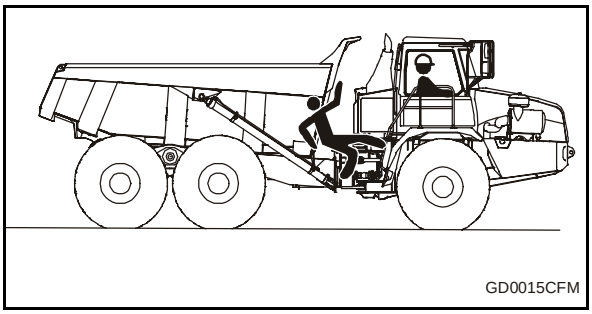
Never move any part of the machine within 3 m (10 ft) plus twice the line insulator length, as serious injury or death may result.

Operate Only On Solid Footing

Operate only on solid footing with strength sufficient to support machine. Be alert working near embankments, excavations and with bin raised. Avoid working on surfaces that could collapse under machine.

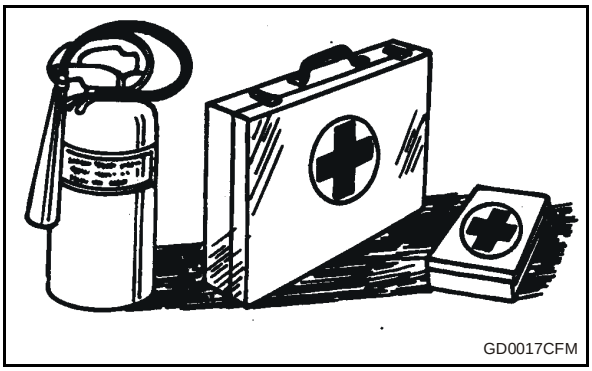
Use caution when backing up to berms before dumping load.

Keep Riders Off the Machine



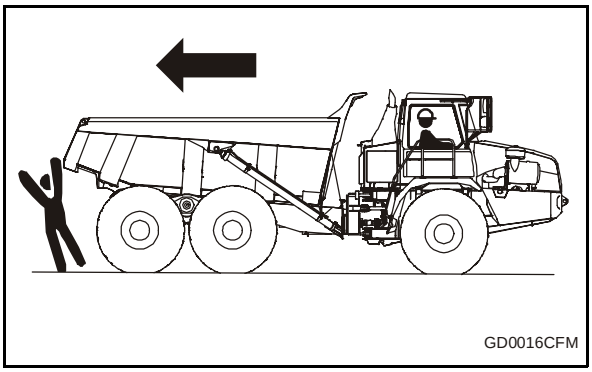
Do not allow unauthorised personnel on the machine.

Prepare for Emergencies



Keep a first aid kit and fire extinguishers handy and know how to use them. Inspect and have your extinguisher serviced as recommended on its instruction plate. Keep emergency numbers for doctors, ambulance service, hospital and fire department near your telephone.

Avoid Backing Over Accidents



Make sure all persons are clear of machine path before moving the machine. Where conditions permit, raise bin for better visibility to the rear. Use mirrors to assist in checking all round machine.

Keep windows, mirrors and backup alarm clean and in good condition.

Use a signal person when backing if view is obstructed and/or in close quarters. Keep signal person in view at all times.

Use prearranged hand signals to communicate.

Handle Chemical Products And Flammable Fluids Safety

Exposure to hazardous chemicals can cause serious injury. Under certain conditions, lubricants, coolants, paints and adhesives used with this machine may be hazardous.

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If uncertain about safe handling or use of these chemical products, contact your authorized dealer for a Material Safety Data Sheet (MSDS).



Handle fuel with care, as it is highly flammable. Do not smoke or go near an open flame or sparks while refuelling. Always stop the engine before refuelling the machine and fill the fuel tank outdoors.

Keep all fuels and lubricants in properly marked containers and away from all unauthorised persons. Do not smoke in the storage areas.

Store oily rags and other flammable material in a protective container, in a safe place.

Do not weld or flame cut pipes or tubes that have contained flammable fluids. Clean them thoroughly with nonflammable solvent before welding or flame cutting them.

Starting fluid is highly flammable. Keep all sparks and flames away when using it. To prevent accidental discharge when storing the pressurised can, keep the cap on the can and store it in a cool protected place. Do not burn or puncture a starting fluid container.

Clean the Machine Regularly

Wait until the engine has cooled before removing trash from areas such as the engine, radiator, batteries, hydraulic lines, fuel tank and operators cab. Remove any grease, oil or debris build-up. Keep the machine, especially the walkways and steps, free of foreign material, such as debris, oil, tools and other items which are not part of the machine.

Prevent Battery Explosions and Acid Burns



The standard battery supplied with the machine is a sealed type that does not need maintenance. keep sparks and flames away from the batteries.

If a non-sealed battery is subsequently installed, keep sparks and flames away from the batteries. Use a flashlight to check the battery electrolyte level. Use a voltmeter or hydrometer to check battery charge. Never place a metal object across the posts. Always remove the grounded (Negative -) battery clamp first and replace it last.

Do not smoke in areas where batteries are being charged.

Sulphuric acid in battery electrolyte is poisonous and is strong enough to burn skin, eat holes in clothing and cause blindness if splashed into the eyes.

Avoid the hazard by:

- Filling the batteries in a well ventilated area.
- Wearing eye protection and rubber gloves.
- Avoid breathing fumes when electrolyte is added.
- Avoid spilling or dripping electrolyte.

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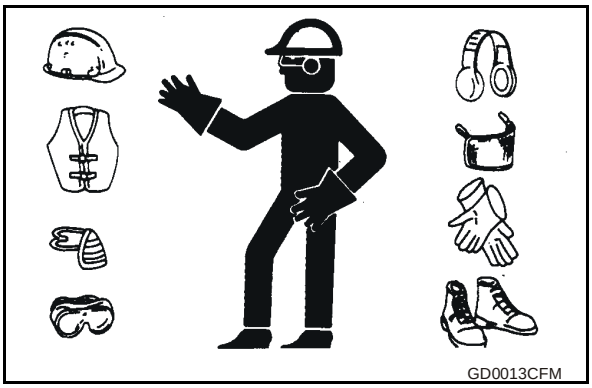
If you spill acid on yourself:

- Flush your skin with water.
- Apply baking soda or lime to help neutralise the acid.
- Flush your eyes with water for 10 - 15 minutes and get medical attention immediately.

If acid is swallowed:

- Drink large amounts of water or milk.
- Then drink milk of magnesia, beaten eggs, or vegetable oil.
- Get medical attention immediately.

Wear Protective Equipment



Wear a hard hat, protective glasses and other protective equipment as required by the job conditions. Do not wear loose clothing or jewellery that can catch on controls or other parts of the machine.

When you drive connecting pins in or out, guard against injury from flying pieces of debris by wearing goggles or protective glasses. Prolonged exposure to loud noise can cause impairment or loss of hearing. Wear a suitable hearing protective device such as earmuffs or earplugs. Wear gloves when handling wire rope cable.

Use the Seat Belt

Use a seat belt at all times to minimise the chance of injury in an accident.

The seat belt must not be altered or modified in any way. Such changes can render the belt ineffective and unsafe.

The seat belt is designed and intended for the seat's occupant to be of adult build and for one occupant of the seat only.

Avoid High Pressure Fluids

Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve the pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks.

If any fluid is injected into the skin it must be surgically removed within a few hours by a doctor who is familiar with this type of injury or gangrene may result.

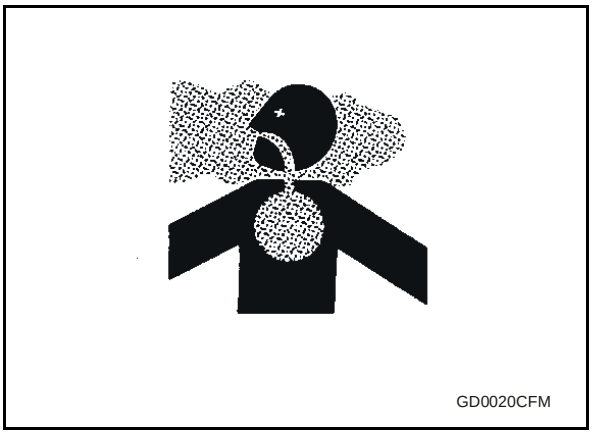
Stay Clear Of Moving Parts

Entanglements in moving parts can cause serious injury.

Stop engine before examining, adjusting or maintaining any part of the machine with moving parts.

Keep guards and shields in place. Replace any guard or shield that has been removed for access as soon as service or repair is complete.

Beware of Toxic Fumes



Prevent asphyxiation. Engine exhaust fumes can cause sickness or death.

Operate only in well ventilated indoor areas. Avoid hazardous fumes by first removing paint on painted surfaces before welding.

Wear an approved respirator when sanding or grinding painted surfaces.

If a solvent or paint stripper is used, wash surface with soap and water. Remove solvent or paint containers before welding and allow at least 15 minutes before welding or heating.

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Dispose of Waste Properly

Improper disposal of waste can threaten the environment. Fuel, oils, coolants, filters and batteries used with this machine may be harmful if not disposed of properly.

Never pour waste onto the ground, down a drain or into any water source.

Air conditioning refrigerants can damage the atmosphere. Government regulations may require using a certified service centre to recover and recycle used refrigerants.

If uncertain about the safe disposal of waste, contact your local environmental centre or your dealer for more information.

Start Only From Operator's Seat


GD0022CFM

Avoid unexpected machine movement. Start engine only while sitting in operator's seat. Ensure all controls and working tools are in proper position for a parked machine.

Never attempt to start engine from the ground. Do not attempt to start engine by shorting across the starter solenoid terminals.

Lower bin during work interruptions, apply park brake and be careful not to accidentally actuate controls when co-workers are present.

Operating The Machine

Avoid Tip Over

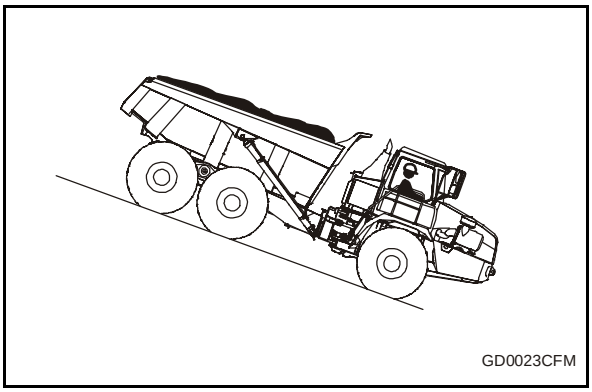
Use safety belt at all times. Do not jump from machine if it tips.

Use extra care when bin is raised. Machine stability is greatly reduced when bin is raised. Drive slowly, avoid sharp turns and uneven ground.

Do not over load the machine.

Before operating machine after it has tipped, carefully inspect all hydraulic and electrical lines.

Operating on Slopes


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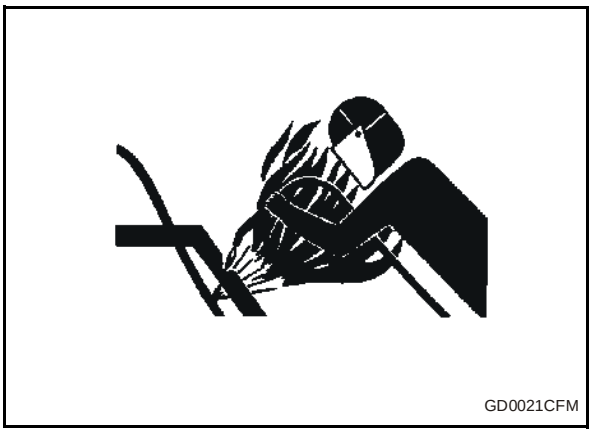
Avoid side slope travel whenever possible.

Check service brakes frequently when operating on slopes

The maximum slope will be limited by the ground conditions.

Welding Repairs

NOTE:Disable electrical power before welding. Turn off main battery switch or disconnect positive battery cable. Separate harness connectors to engine, alternator and vehicle microprocessors.


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Avoid welding near fluid lines. Do not let heat go beyond work area near fluid lines.

Remove paint properly. Wear eye protection and protective equipment when welding.

Do not inhale dust or fumes.

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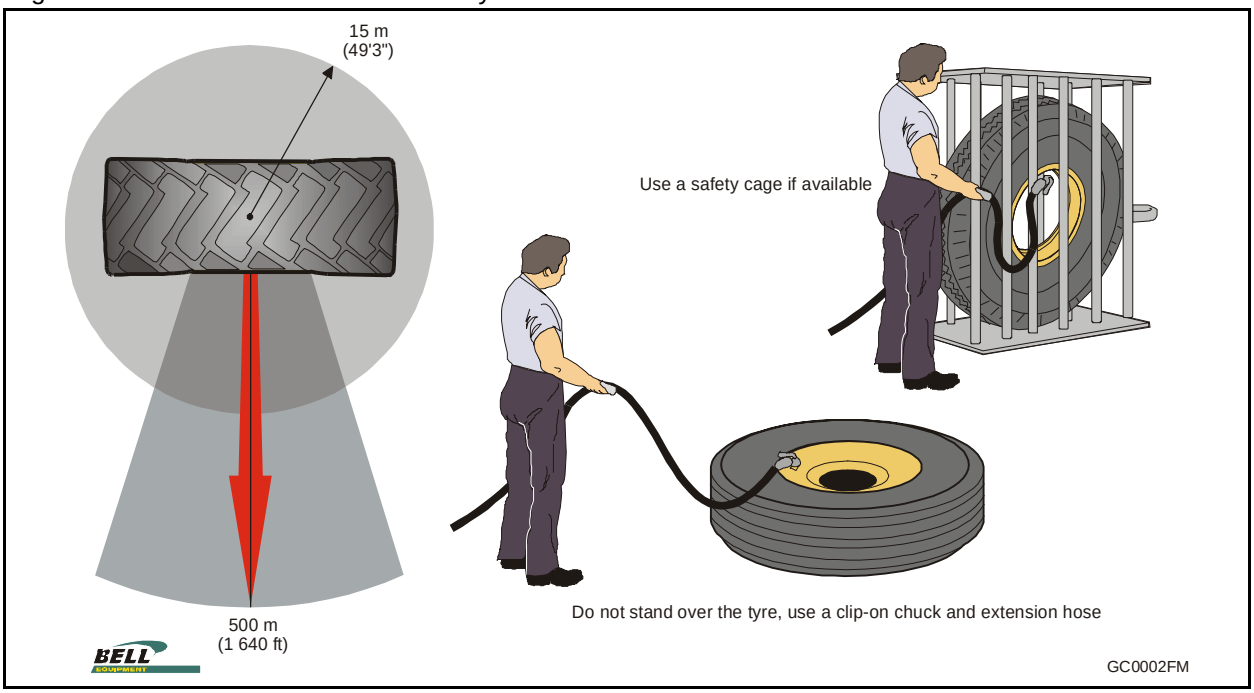
Tyre Information

Welding or heating of the rim components, external fire or excessive use of brakes can cause overheating of the tyres, which could cause a tyre explosion.

This explosion can propel the tyre, rim and final drive components approximately 500 metres (1 640ft) from the machine, which may cause personal injury or death and/or property damage.

If the tyre is overheating and could explode, do not approach it within the area represented by the shaded area in the drawing, until it has cooled.

Stand behind the tread and use a self attaching chuck with extension hose to inflate the tyres. Use a safety cage if available. Do not stand over the tyre.



NOTE:It is recommended that only trained personnel service and change tyres and rims.

Inspect and Maintain ROPS

A damages roll-over protective structure (ROPS) should be replaced, not reused.

If the ROPS was loosened or removed for any reason, inspect it carefully before operating the machine again.

To Maintain the ROPS:

- Replace missing hardware using correct grade hardware.
- Check hardware torque.
- Check isolation mounts for damage, loose-ness or wear; Replace if necessary.
- Check ROPS for cracks or physical damaged.

Drive Metal Pins

Always wear protective goggles or safety glasses and other safety equipment.

Use soft hammer or a brass bar between hammer and object to prevent chipping.

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CHAPTER 1. WHEELS

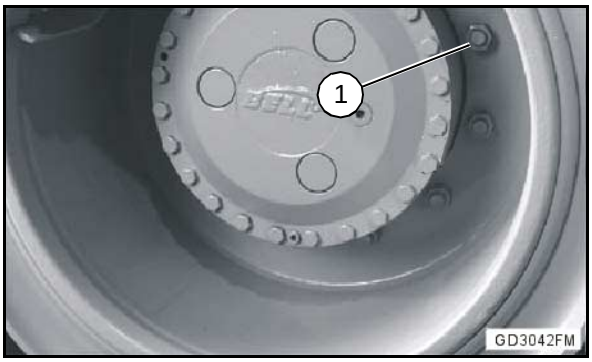
REMOVAL AND INSTALLATION

Removal

⚠ CAUTION

Always chock at least one other wheel when raising a wheel off the ground.

Park the machine on firm level ground. Chock wheels.



Loosen flange nuts (1) one full turn.

⚠ CAUTION

Components are heavy. Use lifting devices.

Truck - Specification

B35D Articulated Dump Truck - Weight - - - 26 725 kg (58,919 lb.)

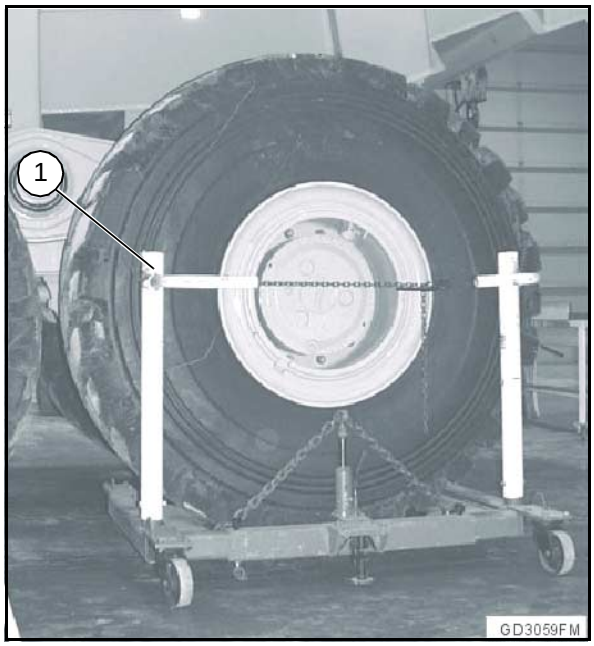
B40D Articulated Dump Truck - Weight - - - - 28 850 kg (63,603 lb.)

Wheel - Specification

Tyre and Rim - Weight approximate - - - - - - - - - 771kg. (1700 lb.)

Wheel Nut Torque - - - - - - - - - - - - - 650 Nm (480 lb-ft)

Raise wheel. Support axle housing with an 18 to 20 ton floor stand.



Attach wheel lift (1) to wheel. Secure tyre with safety chain.

Remove flange nuts and washers. Remove wheel.

Clean threads of wheel bolts and flange nuts.

Clean mating surfaces of flange nuts, washers, rim, and hub.

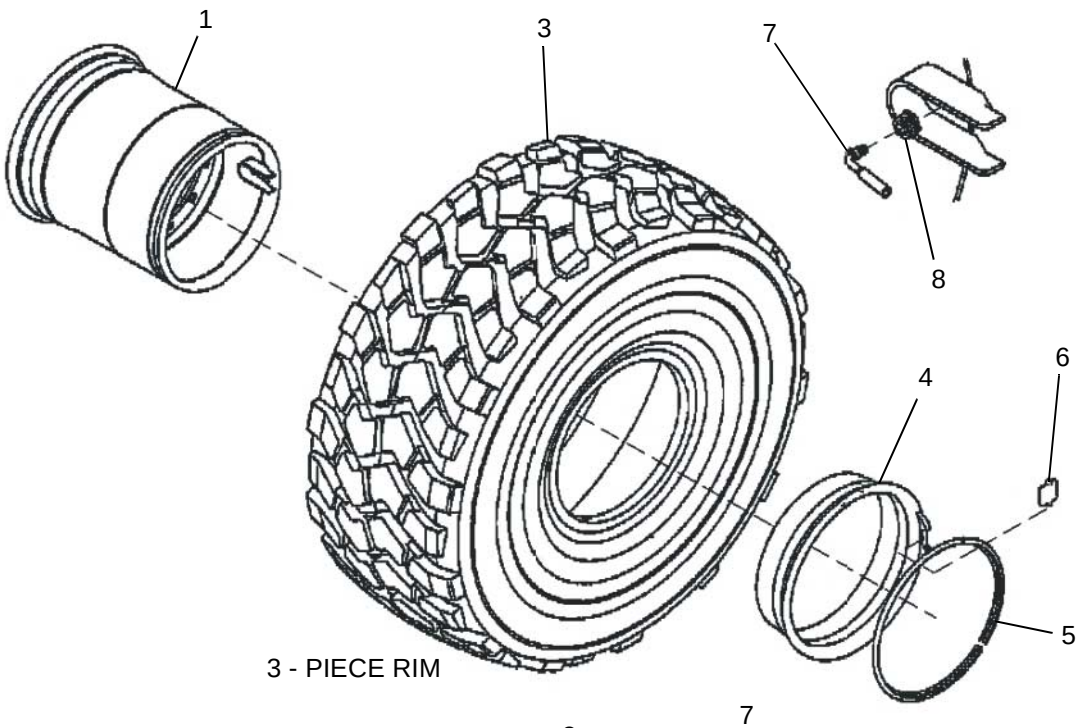
⚠ WARNING

Re-check torque on flange nuts after five hours. Tighten as necessary. Re-check torque every 50 hours thereafter.

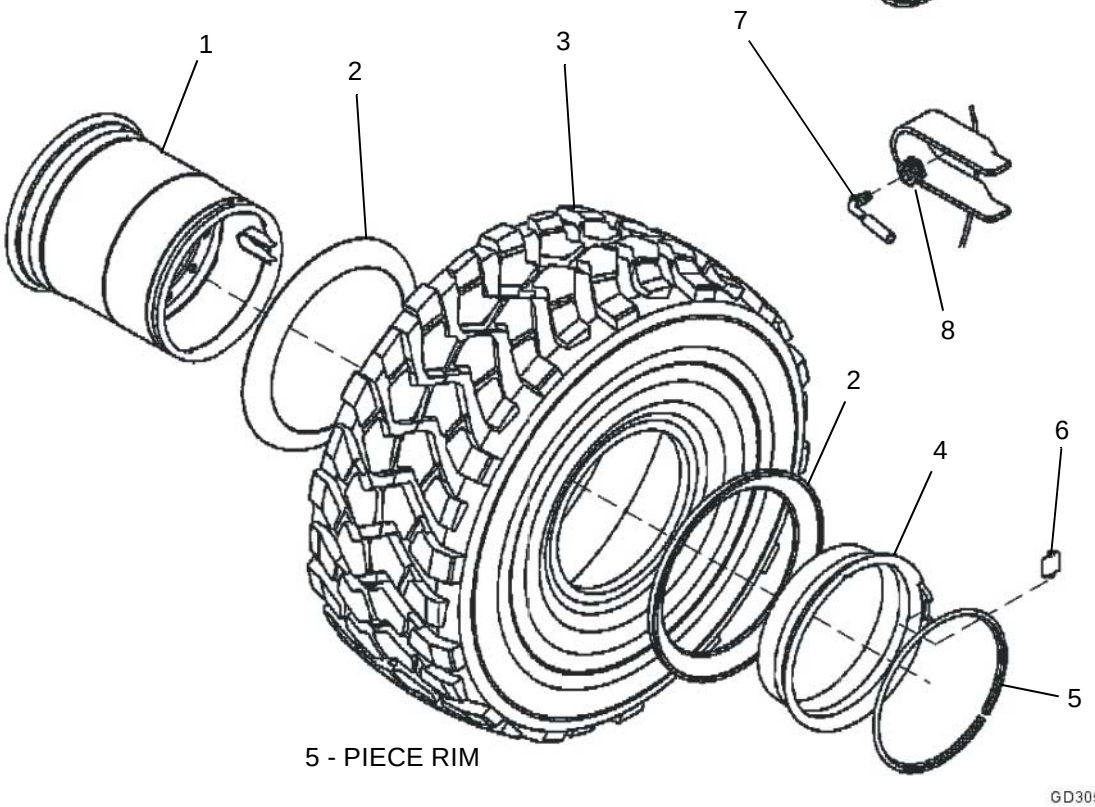
Install wheel. Install washers and flange nuts.

Tighten flange nuts to specification in a crisscross pattern.

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3 - PIECE RIM



5 - PIECE RIM

GD3058FM

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1. Rim.
2. Side Ring (2 used - 5-Piece Rims Only).
3. Tyre.
4. Bead Seat Ring.
5. Lock Ring.
6. Driver Block.
7. Valve Stem.
8. Seal Nut.

⚠ CAUTION

Service Tyres Safely. (See CHAPTER "SAFETY").

NOTE: Tyre can be removed without removing wheel from machine. See John Deere Off-The-Road tyre Maintenance Manual to remove tyre from rim.

Remove valve core from valve stem (7) to deflate tyre (3). Check valve stem for plugging by inserting a probe.

Inspect and replace parts as necessary.

⚠ WARNING

To prevent slippage between tyre and rim during machine operation, clean all contact surfaces thoroughly before assembly.

Thoroughly clean all parts before assembly.

Apply soap lubricant to beads of tyre (3). Assemble wheel set (1 - 6). Ensure that all components are properly aligned and seated.

Install valve stem (7). Hand-tighten seal nut (8).

Install pressure-regulating valve, clip-on chuck, and extension hose on valve stem.

⚠ CAUTION

Clear area of all persons. Stand aside while inflating tyre. DO NOT stand in front of tyre. Use only recommended air pressure. Pressure over this limit can cause explosion.

Add air until tyre beads slide out against seats.

Re-check proper alignment of wheel set components around entire circumference before fully inflating tyre.

Inflate tyre to specification. Check air pressure in tyre using an accurate gauge with 7 kPa (0.07 bar) (1 psi) graduations. (**See CHAPTER "SAFETY", in Operator's Manual for correct tyre pressures).**

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CHAPTER 2. AXLES AND SUSPENSION SYSTEMS

SECTION 1. REMOVAL AND INSTALLATION

AXLES

Remove and Install Front Axle

Support machine front frame with 20-ton shop stands.

Chock middle and rear wheels securely.

⚠ CAUTION

Component is heavy. Use lifting device.

Axles - Specification

Front Axle - Weight approximate - - - 2019 kg (4450 lb)

Attach a lifting device to axle.

Remove wheels. **See "REMOVAL AND INSTALLATION" on page 1.**

Remove drive shaft. **(See "DRIVE SHAFTS" on page 21).**

Relieve brake accumulator pressure. Pump service brake pedal at least 100 strokes.

Disconnect brake line(s) at top of differential housing.

Plug or cap open line(s).

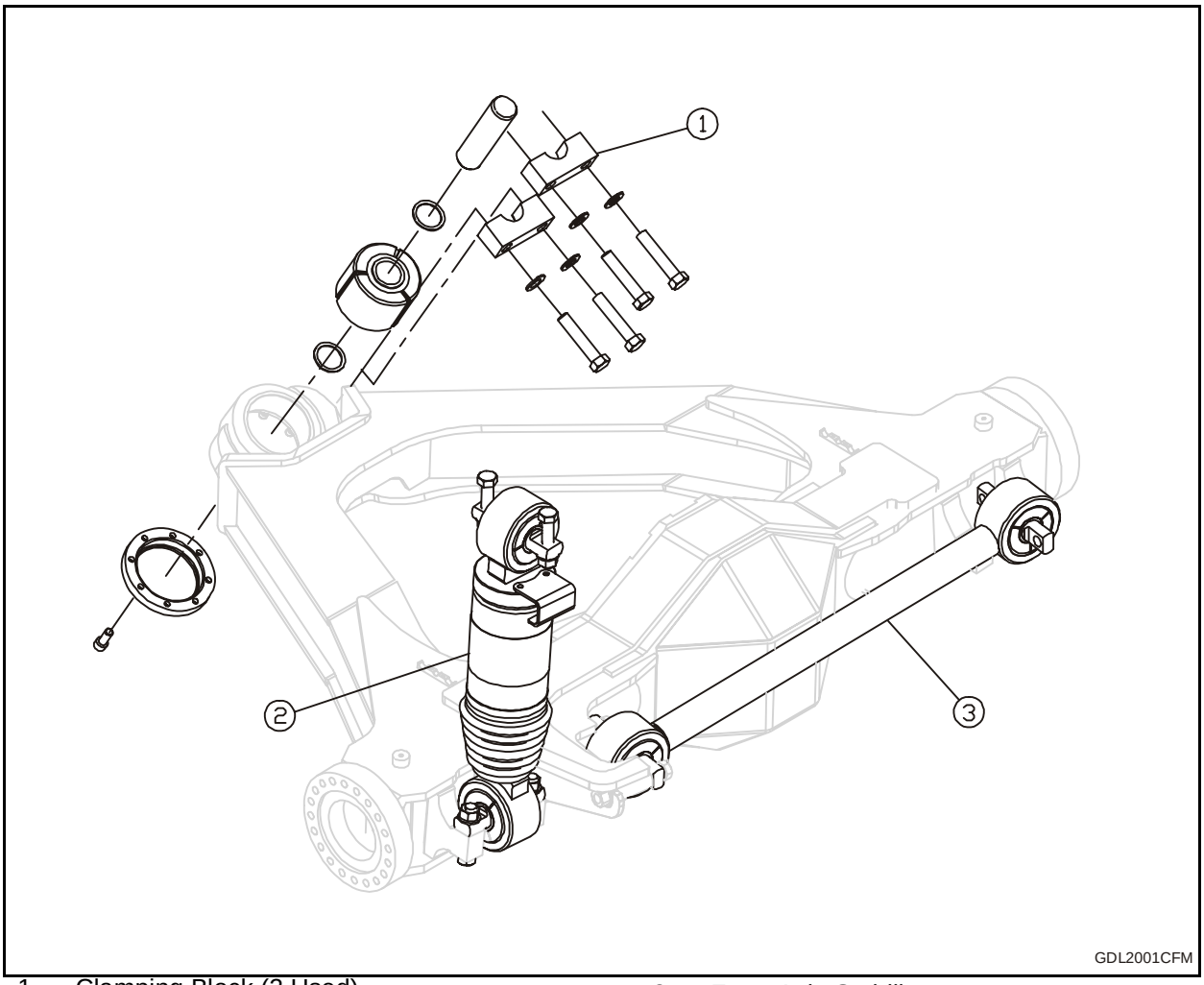
Dry caliper service brakes:

- Disconnect brake pressure line.

Wet disk brakes:

- Disconnect brake pressure line, brake cooling oil delivery line, and brake cooling oil return line.
- Close all openings with caps and plugs.

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1. Clamping Block (2 Used).
2. Suspension Strut (2 Used).
3. Front Axle Stabilizer.

Remove stabilizer (3) and struts (2). **(See "AXLE LINKS, STABILIZERS AND STRUTS" on page 25).**

Remove clamping blocks (1). Remove spacers from both sides of pivot pin.

Lower axle with lifting device.

Inspect parts and replace or repair as necessary. **(See "Front Axle Pivot" on page 34).**

Raise axle with lifting device.

Install spacers on pivot pin. Install clamping blocks.

Install struts and stabilizer.

Connect brake line(s) at top of differential housing.

Install drive shaft. **(See "DRIVE SHAFTS" on page 21).**

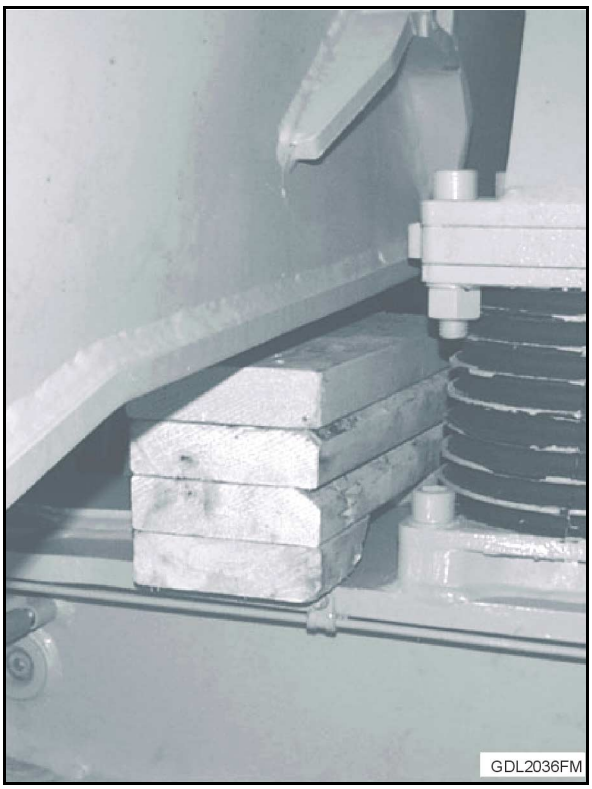
Install wheels. **(See "REMOVAL AND INSTALLATION" on page 1).**

Bleed Service Brake Hydraulic System. **(See "BLEED SERVICE BRAKE HYDRAULIC SYSTEM" on page 249).**

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Remove and Install Middle or Rear Axle

Support machine rear frame with 20-ton shop stands. Chock front wheels securely.

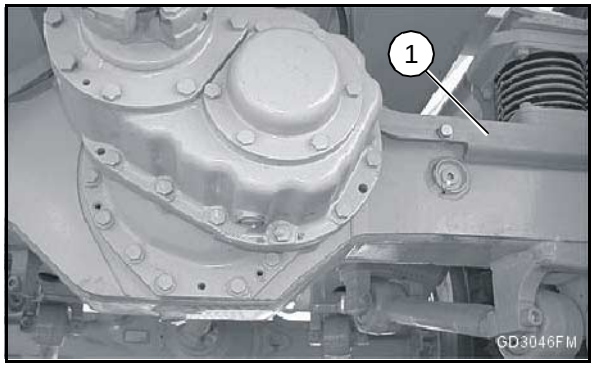


On axle not removed, put wood blocks between axle housing and frame on both sides to support walking beams when wheels are removed from other axle.

Remove wheels. **See "REMOVAL AND INSTALLATION" on page 1.**

Remove drive shaft(s). **(See "DRIVE SHAFTS" on page 21).**

Relieve brake accumulator pressure. Pump service brake pedal at least 100 strokes.



Loosen bolts on brake line covers (1) and remove the covers.

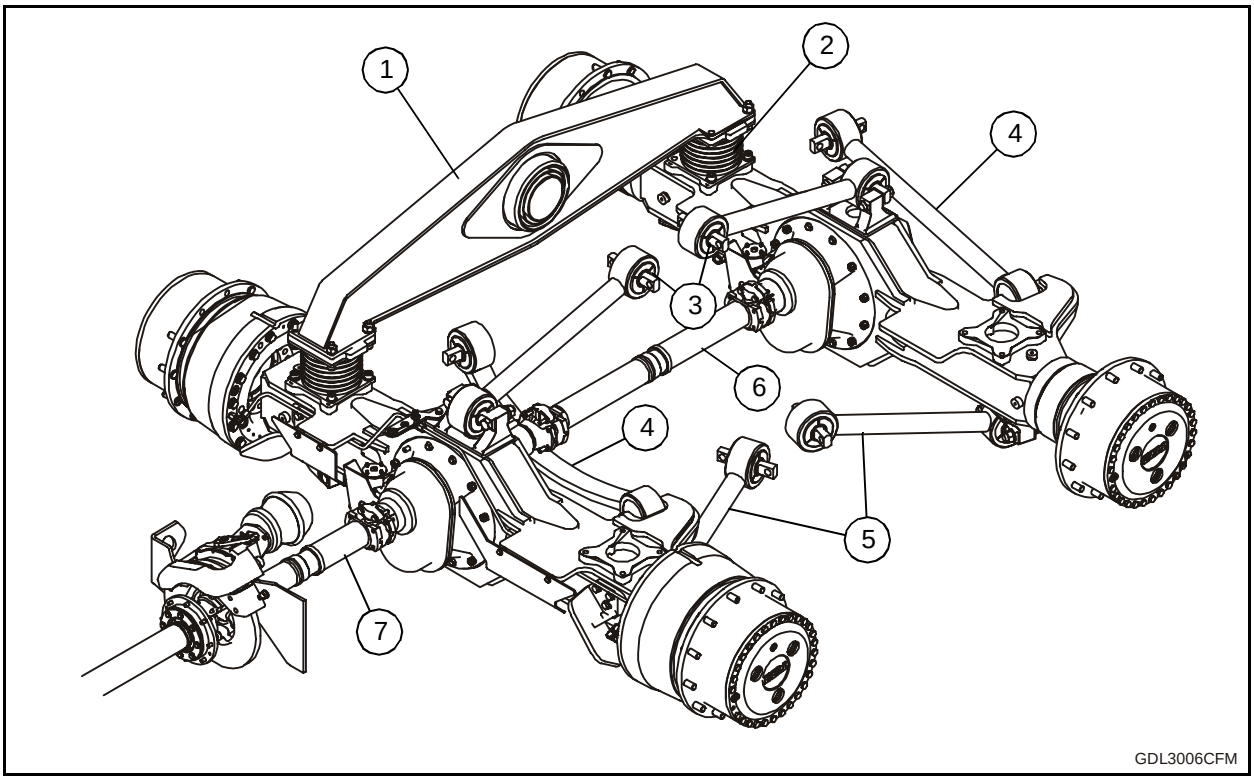
Loosen brake line(s) on axle(s) to be removed.

Disconnect brake line(s) at calipers.

Close open line(s) using caps or plugs.

- Dry caliper service brakes: Disconnect brake pressure line.
- Wet disk brakes: Disconnect brake pressure line, brake cooling oil delivery line, and brake cooling oil return line.

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1. Walking Beam (2 used).
2. Rubber Mount (2 used per axle).
3. Upper Link (1 used per axle).
4. Stabilizer (1 used per axle).
5. Drag Link (2 used per axle).
6. Middle Axle-to-Rear Axle Drive Shaft.
7. Park Brake-to-Middle Axle Drive Shaft.

Remove upper link (3), stabilizer (4), and drag links (5). See Axle Links, Stabilizers, and Struts (Group 0242).

⚠ CAUTION

Component is heavy. Use lifting device.

Axles - Specification

Middle Axle - Weight - - 1565 kg (3450 lb) approximate

Rear Axle - Weight - - - 1474 kg (3250 lb) approximate

Attach a lifting device to axle.

Remove socket head cap screws from rubber mounts (2).

Lower axle from walking beams with lifting device.

Inspect and replace parts as necessary.

Raise axle to walking beams with lifting device.

Install socket head cap screws in rubber mounts.

Install drag links (5), stabilizer (4), and upper link (3). **(See "AXLE LINKS, STABILIZERS AND STRUTS" on page 25).**

Connect brake line(s).

Install drive shaft(s). **(See "DRIVE SHAFTS" on page 21).**

Install wheels. **(See "REMOVAL AND INSTALLATION" on page 1.**

Bleed Service Brake Hydraulic System. **(See "BLEED SERVICE BRAKE HYDRAULIC SYSTEM" on page 249).**

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CHAPTER 2. AXLES AND SUSPENSION SYSTEMS

SECTION 2. DIFFERENTIAL OR BEVEL DRIVE

AXLE DIFFERENTIAL

Remove and Install

Relieve pneumatic pressure. **See Relieve Pneumatic Pressure (Operator's Manual, CHAPTER 8, SECTION 1).**

Remove wheels. **See "REMOVAL AND INSTALLATION" on page 1.**

Remove drive shaft(s) from axle. **(See "DRIVE SHAFTS" on page 21).**

Drain axle housing. **See Change Axle Oil (Operator's Manual, CHAPTER 15, SECTION 2).**

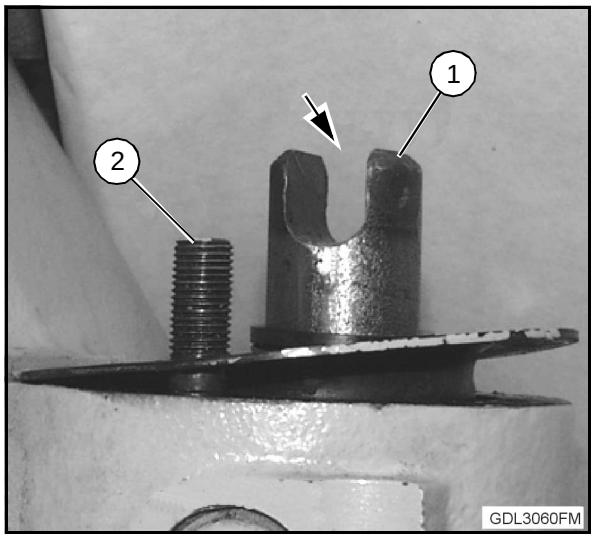
Drain planetaries. **See Change Final Drive Oil (Operator's Manual, CHAPTER 15, SECTION 2).**

NOTE: Leave axle shafts installed until differential lock has been manually engaged.

Remove planetary covers. **(See "AXLE OUTBOARD PLANETARIES" on page 39).**

Remove Differential Lock Actuator **(See "Remove and Install Differential Lock Actuator" on page 331).**

NOTE: Differential lock must be fully engaged to remove differential from axle housing.



Manually engage differential lock.

- Note alignment of differential lock actuator mounting stud (2) and shifting fork arm (1). When arm is parallel to stud, differential lock is fully engaged.
- Hold one axle shaft and turn the other while pushing shifting fork arm outward. Differential lock will engage and arm will be parallel with stud.

Remove axle shafts. **(See "Axle Shafts" on page 41).**

⚠ CAUTION

Component is heavy. Use lifting device.

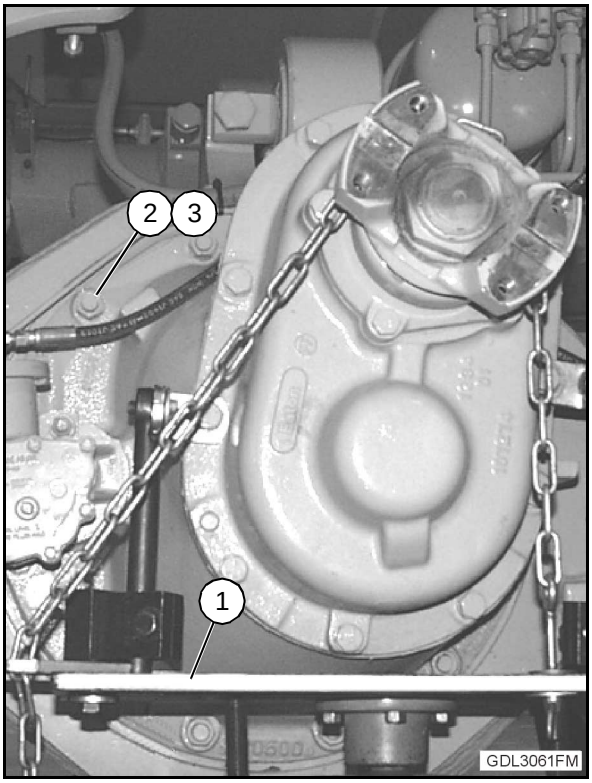
Axle Differential - Specification

Front Axle Differential
Weight - - - - - - - - - - - - - - 284 kg (625 lb) approximate

Middle Axle Differential
Weight - - - - - - - - - - - - - - 284 kg (625 lb) approximate

Rear Axle Differential
Weight - - - - - - - - - - - - - - 227 kg (500 lb) approximate

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Connect a lifting device like JT01642A Low Lift Transmission Jack (1) to differential.

Differential cover has rigid form-in-place gasket on it. Tap cover with lead hammer to break it loose.

For front and rear axles, remove differential assembly from axle housing. For middle axle, press through-shaft from output-side bearing and remove differential assembly from axle housing.

- Remove middle axle output yoke.



- Install DFT1194 Bearing Puller and D01290AA Puller Bar from D01173AA Puller Set across middle axle output shaft. Tighten nuts on DFT1194 to press shaft and differential out of middle axle housing.

Inspect parts and replace or repair as necessary.

Manually engage differential lock.

Apply rigid form-in-place gasket to differential housing flange and studs.

Install differential in axle housing. For middle axle, ensure output shaft is firmly seated in bearing.

Install yoke(s). Apply rigid form-in-place gasket to yoke retaining nut(s) and tighten to specification.

Axle Differential—Specification

Yoke Retaining Nut - Torque - - - - 1100 N•m (811 lb-ft)

Install Differential Lock Actuator. **(See “Remove and Install Differential Lock Actuator” on page 331).**

Install axle shafts. **(See Axle Shafts “Axle Shafts” on page 41).**

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Install planetary covers. **(See "AXLE OUTBOARD PLANETARIES" on page 39).**

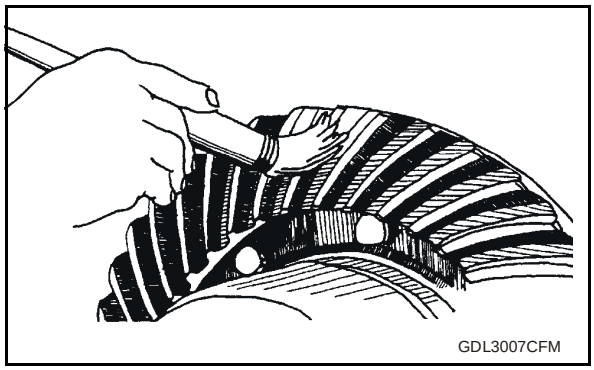
Refill planetaries. **(See Change Final Drive Oil Operator's Manual, CHAPTER 15, SECTION 2).**

Refill axle housing. **(See Change Axle Oil Operator's Manual, CHAPTR 15, SECTION 2)**.

Install drive shaft(s) on axle. **(See "DRIVE SHAFTS" on page 21).**

Install wheels. **(See "REMOVAL AND INSTALLATION" on page 1).**

Check Gear Tooth Contact Pattern



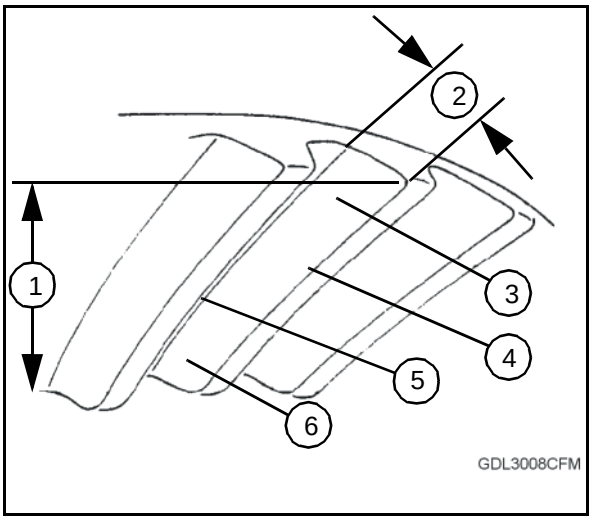
Coat several ring gear teeth with marking compound.

Turn ring gear so pinion gear leaves a wear pattern through marking compound.

Inspect wear pattern.

The length and shape of contact pattern varies, especially for used gears.

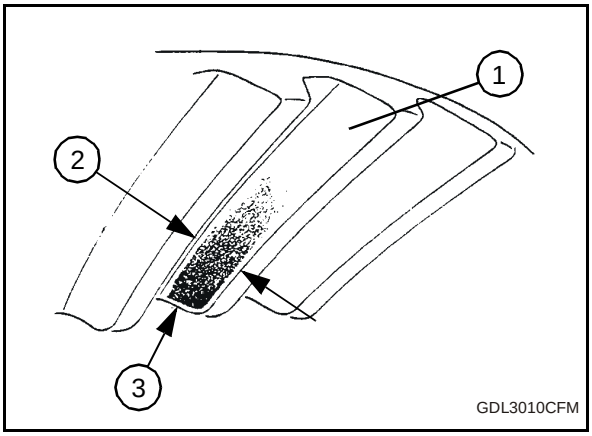
The position of contact pattern is important for all gears.



1. Face Width.
2. Tooth Depth.

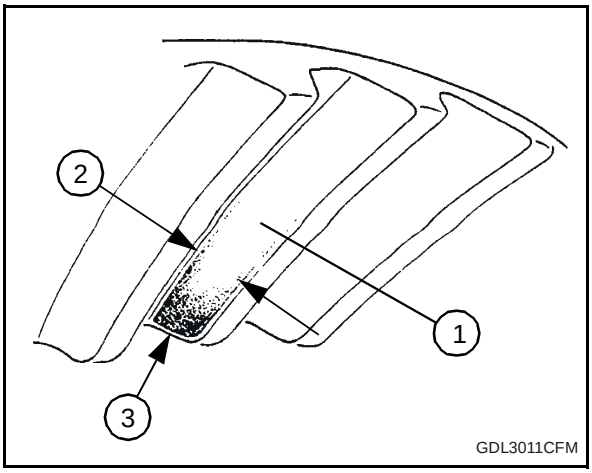
Wear pattern must not be too much toward tooth heel (3), and must not run off of toe (6). Pattern should be centered between top land (4) and root (5).

Compare wear pattern to examples.



- A correct pattern is up slightly from the toe (3) and centers evenly (2) along the face width.

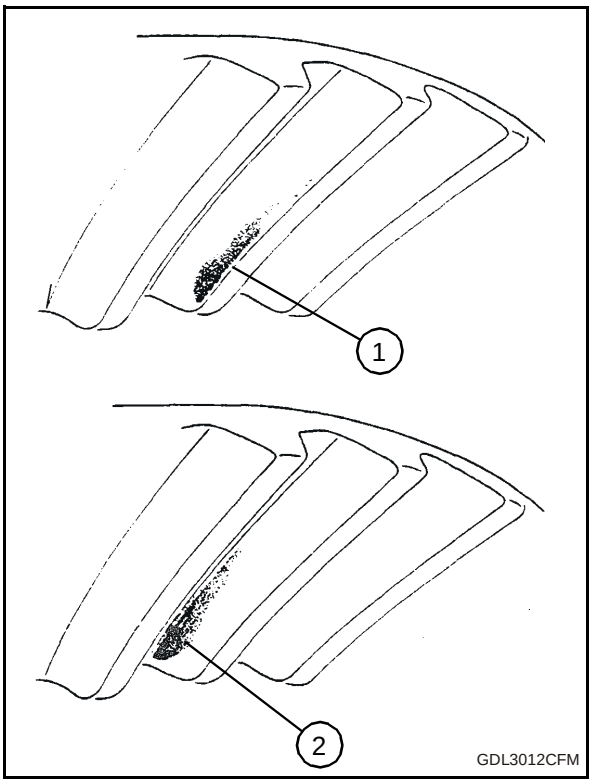
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- Wear patterns for used gears typically vary in shape and length. Wear patterns should not run off of toe, and should not be too close to root or land of tooth.
- When reassembling used gear sets, adjust as necessary to produce the same gear tooth contact pattern as before disassembly.

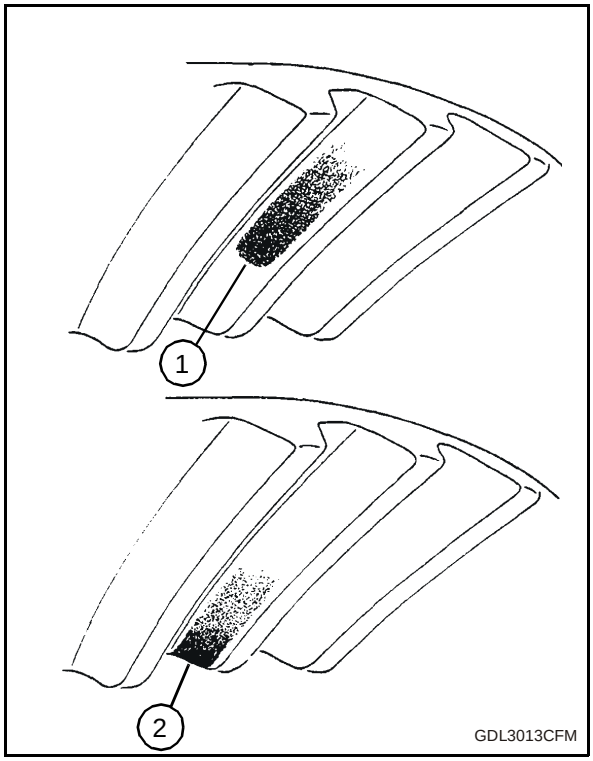
To adjust the tooth contact pattern, the positions of the ring gear and pinion gear are adjusted.

Shims between the pinion bearing housing and carrier control where the wear pattern is between the top land and root.



- If wear pattern is too close to top land (1), use thinner shim(s) between pinion bearing housing and carrier to move pinion toward ring gear.
- If wear pattern is too close to root (2), use thicker shim(s) between pinion bearing housing and carrier to move pinion away from ring gear.

Adjusters on the ring gear bearings control where the wear pattern is between tooth heel and toe.

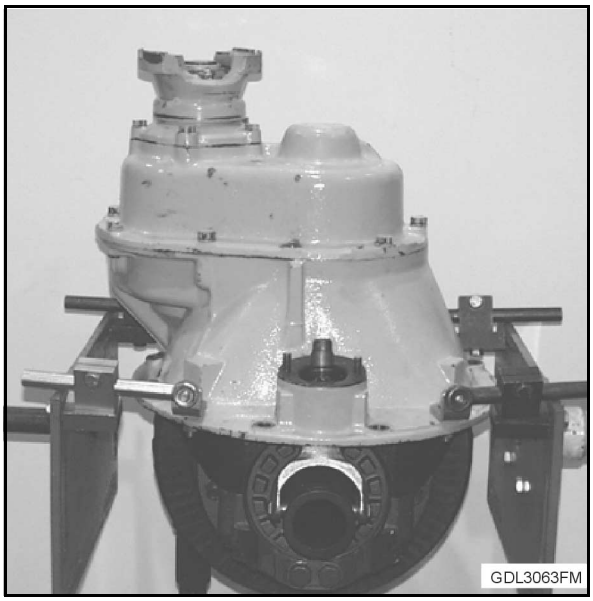


- If wear pattern is too close to tooth heel (1), adjust ring gear position toward teeth side to move ring gear toward pinion.
- If wear pattern is too close to tooth toe (2), adjust ring gear position toward back side to move ring gear away from pinion.

Adjust backlash to specifications after any adjustment or shim change.

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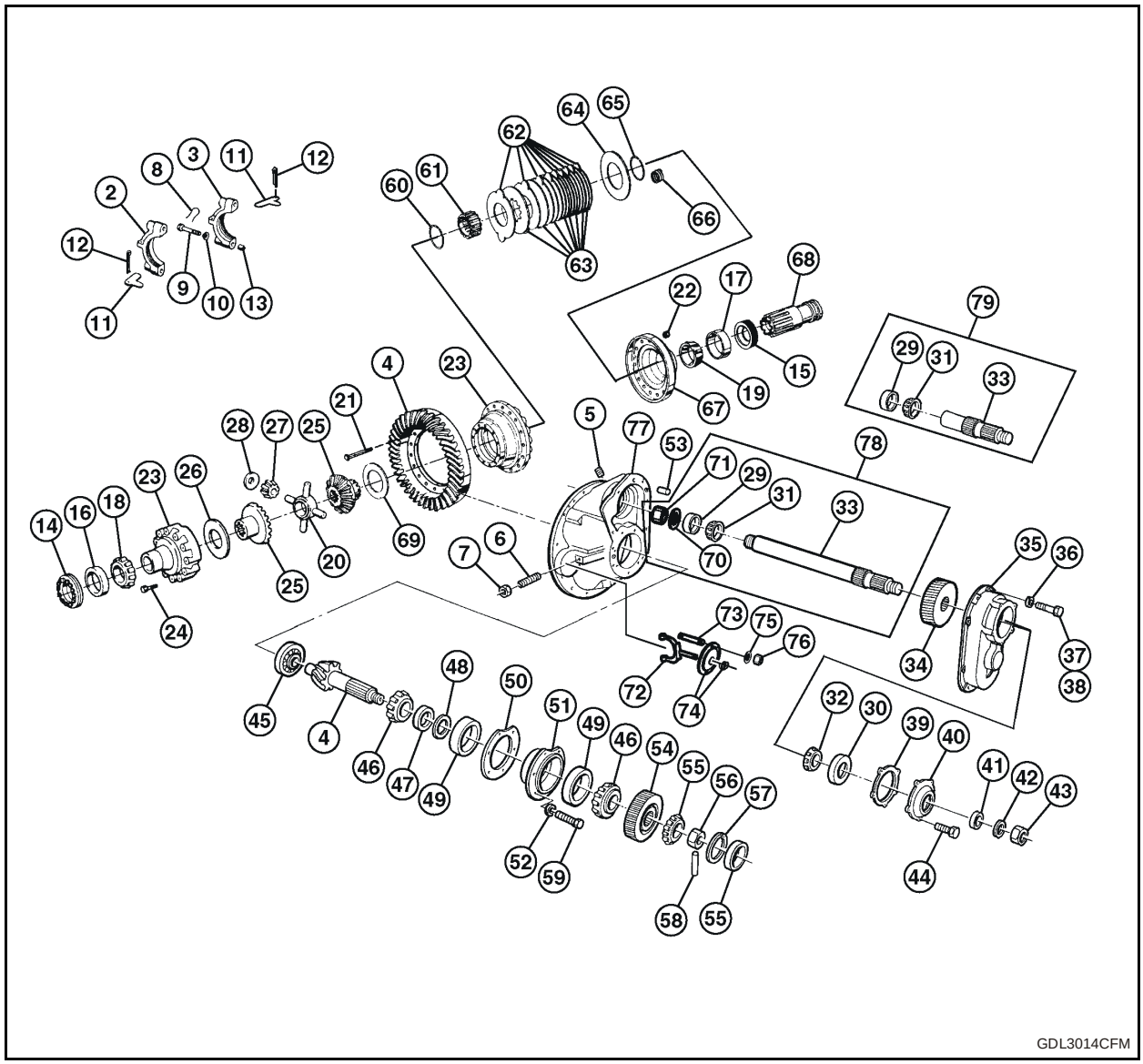
Disassemble



Install differential in a repair stand like D01003AA Repair Stand. Differential must be able to rotate 360 degrees.

Check gear tooth contact pattern. If the wear pattern runs off the teeth and/or heavy wear is evident, the gear set must be replaced.

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2. Ring Gear Bearing Cap - Teeth Side.
3. Ring Gear Bearing Cap - Back Side.
4. Ring Gear and Pinion.
5. Plug.
6. Screw.
7. Nut.
8. Retainer (4 used).
9. Bearing Cap Cap Screw (4 used).
10. Washer (4 used).
11. Lock Plate (2 used).
12. Cotter Pin (2 used).
13. Bushing (2 used).
14. Adjuster - Teeth Side.
15. Adjuster - Back Side.
16. Ring Gear Bearing Cup - Teeth Side.
17. Ring Gear Bearing Cup - Back Side.
18. Ring Gear Bearing Cone - Teeth Side.
19. Ring Gear Bearing Cone - Back Side.
20. Spider.
21. Ring Gear Cap Screw (16 used).
22. Nut (16 used).
23. Spider Housing.
24. Spider Housing Cap Screw (12 used).
25. Bevel Gear (2 used).
26. Thrust Washer.
27. Bevel Gear (4 used).
28. Thrust Washer (4 used).
29. Input Shaft Inner Bearing Cup.
30. Input Shaft Outer Bearing Cup.
31. Input Shaft Inner Bearing Cone.
32. Input Shaft Outer Bearing Cone.
33. Input Shaft - Front and Rear Axles Only.
33. Through Shaft - Middle Axles Only.
34. Power Divider Upper Gear.
35. Power Divider Housing.
36. Lock Washer (10 used).
37. Power Divider Housing Cap Screw.
38. Power Divider Housing Cap Screw (9 used).
39. Shim (as required).
40. Input Shaft Outer Bearing Housing.
41. Input Shaft Seal.
42. Washer.
43. Input Yoke Retaining Nut.
44. Input Shaft Outer Bearing Housing Cap Screw (5 used).
45. Pinion Pilot Bearing.
46. Pinion Shaft Bearing Cone (2 used).
47. Spacer.
48. Shim (as required).
49. Pinion Shaft Bearing Cup (2 used).
50. Shim (as required).
51. Pinion Shaft Bearing Housing.
52. Washer (6 used).
53. Dowel Pin (2 used).
54. Power Divider Lower Gear.
55. Power Divider Lower Gear Roller Bearing.
56. Nut.
57. Snap Ring.
58. Dowel Pin.
59. Pinion Shaft Bearing Housing Cap Screw (6 used).
60. Snap Ring.
61. Gear.
62. Differential Lock Outside-Splined Disk (7 used).
63. Differential Lock Inside-Splined Disk (7 used).
64. Pressure Plate.
65. Snap Ring.
66. Compression Spring (12 used).
67. Differential Lock Housing Half.
68. Differential Lock Shaft.
69. Thrust Washer.
70. Washer (2 used) - Middle Axles Only.
71. Output Yoke Retaining Nut (2 used) - Middle Axles Only.
72. Differential Lock Actuator Fork.
73. Stud.
74. Fork and Spring Kit.
75. Washer (2 used).
76. Nut (2 used).
77. Carrier.
78. Through Shaft Assembly - Middle Axle Only.
79. Input Shaft Assembly - Front and Rear Axle Only.

If ring gear and pinion will be reused, record backlash. Differential must be returned to identical backlash when reassembled.

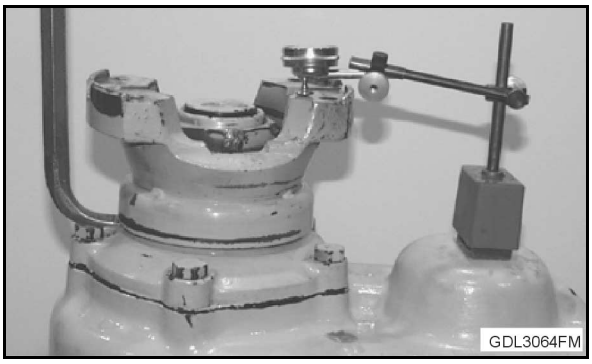
- Install a magnetic base with dial indicator on carrier. Position dial indicator at extreme heel of a ring gear tooth, perpendicular to tooth surface.
- Hold pinion shaft to prevent it from turning. Rotate ring gear. Measure distance tooth heel is free to travel. Compare distance to backlash specification.

Axle Differential - Specification

Ring Gear Backlash with No Pinion Movement - Distance - - - - - - -0.203 - 0.457 mm (0.008—0.018 in.)

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Record input shaft end play. Install a dial indicator on the input shaft. Lift yoke with a pry bar and record end play.



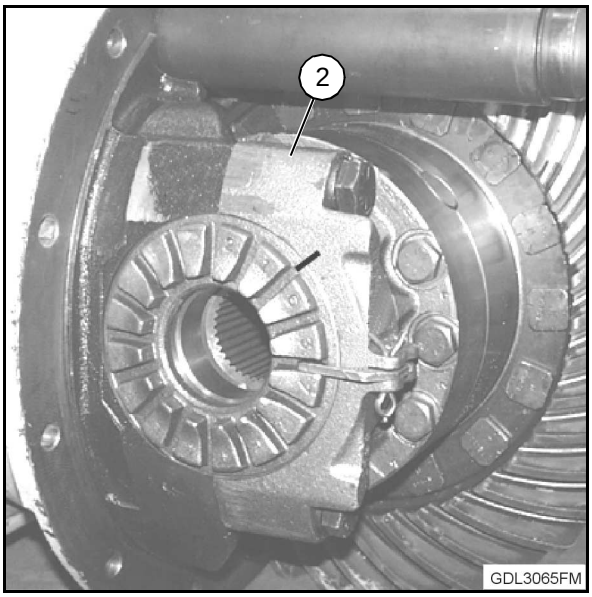
Compare input shaft end play to specifications.

Axle Differential - Specification

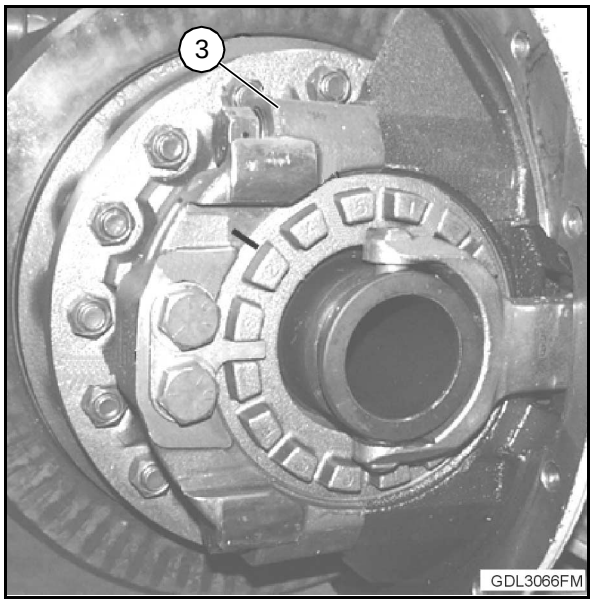
Input Shaft - End Play with new parts
- - - - - - - - - - - - - -0.076 - 0.178 mm (0.003 - 0.007in.)

Input Shaft - End Play with used parts
- - - - - - - - - - - - - -0.33—0.43 mm (0.013—0.014 in.)

Mark bearing adjuster positions for reference during reassembly.



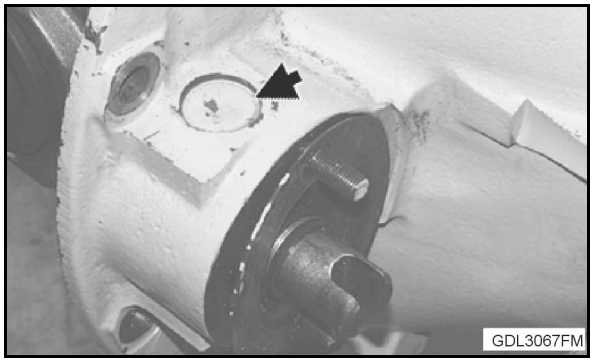
Mark bearing cap (2) for installation on the same bearing.



Mark bearing cap (3) for installation on the same bearing.

Remove input yoke.

Remove input shaft outer bearing housing (40), power divider housing (35), and shaft (33). Note thickness of shim(s) (39) for input yoke end-play adjustment during reassembly.

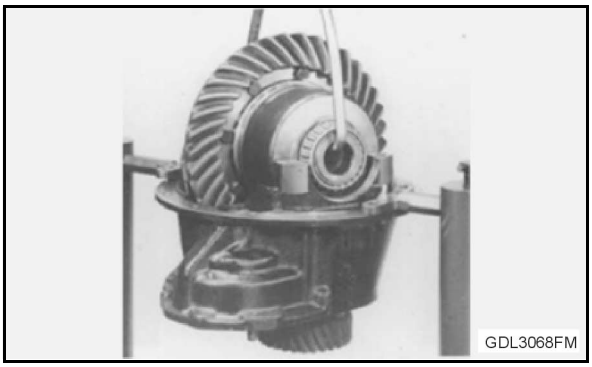


Remove expansion plugs. Remove shift fork pivot shaft.

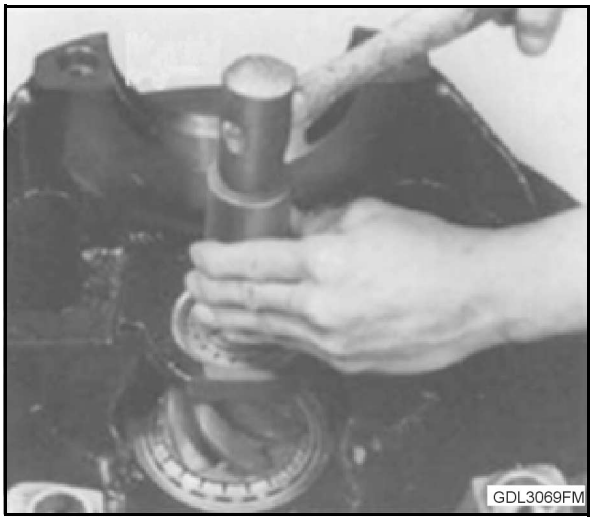
Rotate differential on stand so carrier (77) is at bottom. Remove actuator fork (72), seal and spring (74). Remove differential lock shaft (68).

Remove lock plates (11). Remove bearing caps (2 and 3) and adjusters (14 and 15).

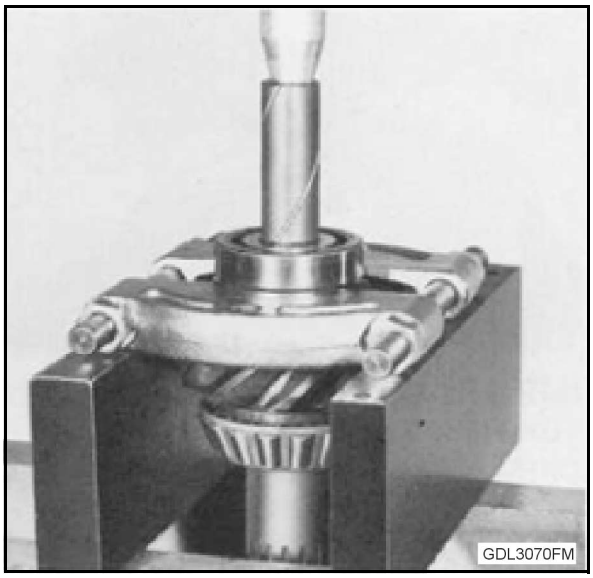
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Lift differential assembly from carrier with a nylon sling.



Remove pinion shaft (4) and bearing housing (51). Drive pinion shaft and pilot bearing (45) out of carrier.



Remove pinion pilot bearing (45) using a press and a knife-edged bearing puller like D01274AA Bearing Puller.

Disassemble differential lock clutch pack.

⚠ CAUTION

Springs inside differential lock housing are under load.

- Remove two nuts (22) and cap screws (21). Install longer cap screws on nuts. Remove remaining cap screws (21). Loosen longer cap screws evenly to relieve spring pressure. Remove ring gear (4) from spider housing (23).
- Separate differential lock housing half (67) from spider housing (23). Remove springs (66). Note arrangement of inside-splined disks (63), outside-splined disks (62), and pressure plate (64). Remove disks from housing.
- Remove ring gear bearing cone (19) from differential lock housing half (67) with a bearing puller such as D01267AA Bearing Puller.

Disassemble spider housing.

- Mark spider housing halves (23) to ensure same alignment for reassembly.
- Remove cap screws (24). Separate spider housing halves.
- Disassemble thrust washers (26, 28, and 69), bevel gears (25 and 27), and spider (20).
- Remove ring gear bearing cone (18) from spider housing half (23).

Inspect parts and replace as necessary.

Assemble

Assemble spider housing.

- Install ring gear bearing cone (18) on spider housing half (23).
- Assemble spider (20), bevel gears (25 and 27), and thrust washers (26, 28, and 69).
- Install spider assembly in spider housing half. Align housing halves. Install cap screws (24). Tighten to specification.

Axle Differential - Specification

Spider Housing Cap Screw - Torque
- - - - - - - - - - - - - - - - - - -149 - 176 Nm (110 - 130 lb-ft)

Assemble differential lock and ring gear.

- Install bearing cone (19) on differential lock housing half (67).
- Install ring gear (4) on housing (23).
- Install snap ring (60) and gear (61).

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NOTE:Apply SAE 80W90 gear oil to each clutch disk during assembly.

- Install one outside-splined disk (62) into housing (23), then alternate inside-splined disks (63) and outside-splined disks (62) until seven of each are installed. Install pressure plate (64).
- Using a press, push against pressure plate (64) and install snap ring (65).
- Install compression springs (66) on pressure plate (64). Position springs inward as far as possible to allow easier installation of housing half (67).
- Install differential lock housing half (67) over springs.
- Install shaft (68) through housing half (67) and inside-splined disks.
- Compress housing half (67) against spider housing (23) with a press. Install cap screws (21) with heads on ring gear side. Install nuts (22).

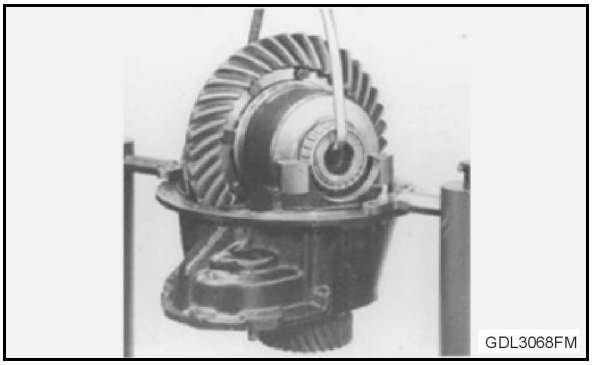
Axle Differential - Specification

Ring Gear Cap Screw - Torque
- - - - - - - - - - - - - - - - - - 264 - 332 Nm (195 - 245 lb-ft)

Lubricate ring gear bearing cones (18 and 19) with axle oil.

Lower differential into carrier with hoist.

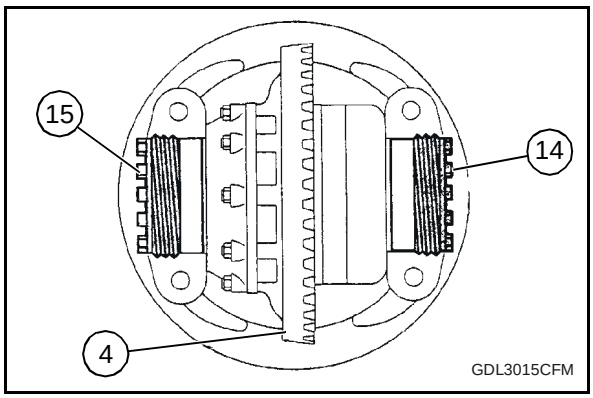
NOTE:1. When installing ring gear bearing caps, it may be necessary to tap them with a hammer to fully seat them.
2. Hand-tighten cap screws in bearing caps for bearing preload adjustment, then final-tighten.



Install ring gear bearing caps (2 and 3). Install washers (10) and cap screws (9). Hand-tighten only.

Install bearing adjusters (14 and 15). If the ring gear and pinion are being reused, tighten adjusters to same positions as when removed. Install locks (11).

If a new ring gear and pinion set are being used, adjust bearing pre-load.



- Turn teeth-side adjuster (14) until one thread shows.
- Tighten back-side adjuster (15) until back-side bearing cup firmly contacts back-side bearing cone.
- Facing teeth-side of ring gear, push against ring gear assembly to check bearing-to-bearing movement of ring gear.
  There should be no free movement. Tighten back-side adjuster (15) and recheck free movement, if necessary.
  Bearing cones and cups should be firmly seated on both sides of ring gear.
- Tighten teeth-side adjuster (14) another two or three more notches to preload ring gear bearings.
- Install locks (11).

Tighten cap screws (9) to specification.

Axle Differential - Specification

Ring Gear Bearing Cap Cap

Screw - Torque - - - - - - 475 - 580 Nm (350 - 428 lb-ft)

Assemble pinion bearings in housing. Use rolling drag test in a hydraulic press to determine correct shim thickness.

- Press bearing cups (49) into bearing housing (51) using a correct-sized disk from D01045AA Bushing/Bearing Seal Driver Set. Press cups to bottom of bores.

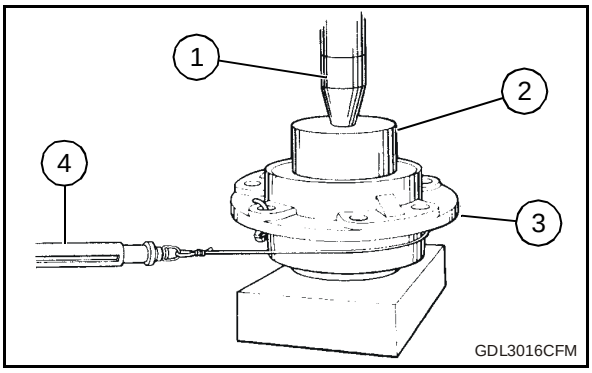
NOTE:Use a shim 4.7 mm (0.185 in.) thick for initial setup. Adjust shim thickness as necessary for correct rolling drag.

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- Lubricate bearing cones (46) with axle oil. Assemble shim(s) (48) as required, spacer (47), and pinion shaft bearings (46) into bearing housing (51).

Axle Differential - Specification

Pinion Shaft Bearing Initial Shim - Thickness
- -4.7 mm (0.185 in).



- Install pinion shaft bearing housing with bearings in a press.
- Put disks from D01045AA Bushing/Bearing Seal Driver Set over bearing races. DO NOT push on bearing cages.
- Attach a spring scale such as JDG94 Spring Scale to bearing housing by wrapping a soft wire around the housing at least once.
- Press on disk with ram to preload bearings to specification.

Axle Differential - Specification

Input Shaft Bearing Preload - Pressure
- - - - - - - - - - - - - - - - - - 16.8 - 17.7 t (18.5 - 19.5 tons)

- Pull the spring scale to turn the housing. Write down force indicated on the spring scale. Compare to specification.

Axle Differential - Specification

Input Pinion Shaft Bearing Rolling Drag - Force
- 2 - 3 kg (2 - 7 lb)

- Install a different shim, if necessary, and repeat rolling drag test. A thicker shim will decrease preload.

NOTE: Bearings may “grow” when pressed onto input shaft. Use a slightly thicker shim for final assembly than was used for rolling drag test.

- When spring scale force is within specification, write down shim thickness. Add 0.025 mm (0.001 in.) to shim thickness for final assembly.

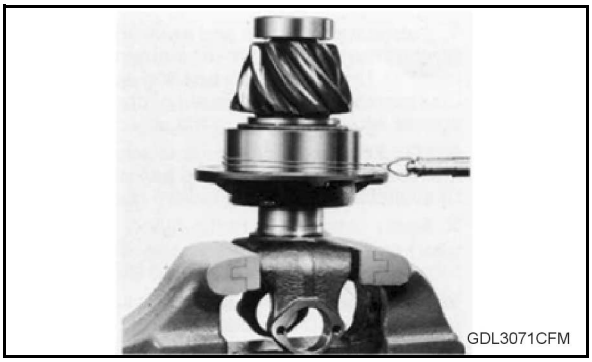
Assemble pinion shaft assembly (4, 45 - 49, 51).

Check rolling drag for final pinion shaft assembly.

- Install pilot bearing (45) on pinion shaft (4).
- Press bearing cone (46) on pinion shaft.
- Install spacer (47), shim (48), and cup (49) on shaft.
- Install shaft into housing (51).
- Press bearing cone (46) onto shaft.
- To check bearing preload of pinion shaft final assembly, install a driveline yoke on pinion shaft instead of helical gear. Tighten nut to specification.

Axle Differential - Specification

Input Pinion Nut - Torque - - - - - - - 1100 Nm (811 lb-ft)



- Install the input shaft assembly in a vise. Tighten vise on driveline yoke.
- Attach a spring scale to the housing by wrapping a soft wire around the housing at least once.
- Pull the spring scale to turn the housing. Record force indicated on the spring scale. Compare to specification.

Axle Differential - Specification

Input Pinion Shaft Bearing - Rolling Drag Torque
- 2 - 5 kg (5 - 12 lb)

- If bearing preload is not within specifications, disassemble input shaft assembly and install a different shim (48). A thicker shim will reduce preload.
- When preload is correct, remove driveline yoke and install power divider lower gear (54), bearing (55), nut (56), and pin (58) on pinion shaft.
- Install bearing cup (55) and snap ring (57) in power divider housing (35).

Install pinion shaft assembly into carrier. If ring gear and pinion shaft are being reused, use same shim(s) (50).

If new ring gear and pinion shaft are used, install shim(s) (50) as necessary to obtain correct backlash and gear tooth wear pattern.

Axle Differential - Specification

Ring Gear - Backlash
- - - - - - - - - - - - - 0.203 - 0.457 mm (0.008 - 0.018in.)

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Check backlash and gear tooth contact pattern. Adjust pinion with shims (50), if necessary. Adjust ring gear with adjusters (14 and 15), if necessary.

- If backlash is less than specification or contact pattern is too close to tooth root, move ring gear one notch away from pinion and re-check.
- If backlash is greater than specification or contact pattern is too close to tooth top land, move ring gear one notch toward pinion and recheck.
- If contact pattern runs off of tooth toe, move pinion outward with thicker shim(s).
- If contact pattern is too far from tooth toe, move pinion inward with thinner shim(s).

Assemble differential lock actuator fork and spring kit (72 - 76).

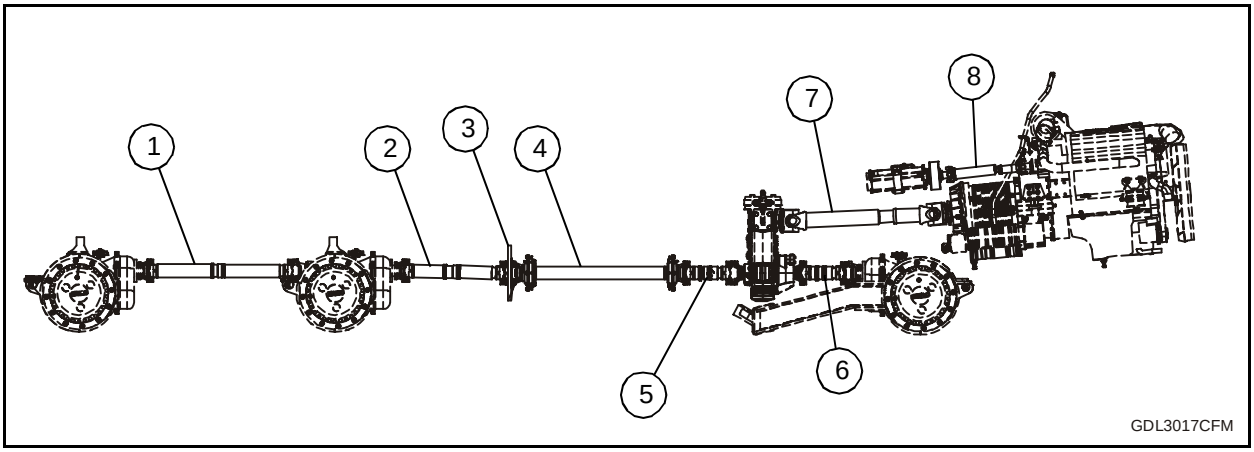
Install shaft (33), power divider housing (35), and input shaft outer bearing housing (40). Adjust thickness of shim(s) (39) for correct input yoke end play.

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CHAPTER 2. AXLES AND SUSPENSION SYSTEMS

SECTION 3. INPUT DRIVE SHAFTS AND U-JOINTS

DRIVE SHAFTS



1. Middle Axle-to-Rear Axle Drive Shaft.
2. Park Brake-to-Middle Axle Drive Shaft.
3. Park Brake Disk.
4. Oscillation Joint-to-Park Brake Drive Shaft.
5. Transfer Case-to-Oscillation Joint Drive Shaft.
6. Transfer Case-to-Front Axle Drive Shaft.
7. Transmission-to-Transfer Case Drive Shaft.
8. Engine-to-Main Hydraulic Pump Drive Shaft.

Remove and Install Transfer Case-to-Front Axle Drive Shaft or Transfer Case-to-Oscillation Joint Drive Shaft

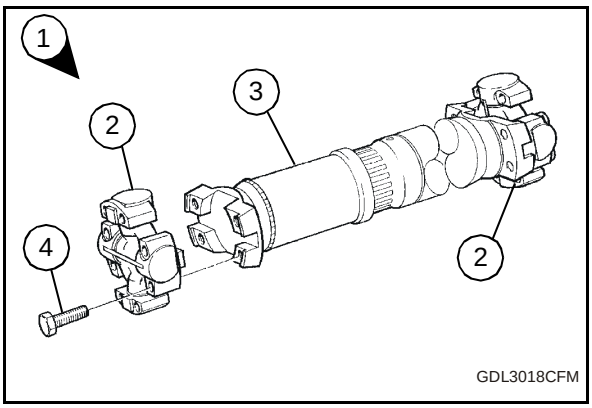
⚠ CAUTION

Component is heavy.

Specification

Transfer Case-to-Front Axle Drive Shaft Weight - 25 kg (55 lb) approximate

Transfer Case-to-Oscillation Joint Drive Shaft Weight - 25 kg (55 lb) approximate



Remove cap screws (4) and drive shaft assembly (1).

Remove cross and bearing assemblies (2) from drive shaft (3).

Inspect and replace parts as necessary.

NOTE: Assemble drive shaft so yokes on ends of the shaft are aligned. If yokes are not aligned, severe vibration and machine damage may result.

Assemble drive shaft so yokes are aligned.

Install cross and bearing assembles on drive shaft.

Install drive shaft assembly.

Apply rigid form-in-place gasket to cap screws. Install cap screws and tighten to specification.

Remove and Install Transfer Case-to-Front Axle Drive Shaft or Transfer Case-to-Oscillation Joint Drive Shaft - Specification

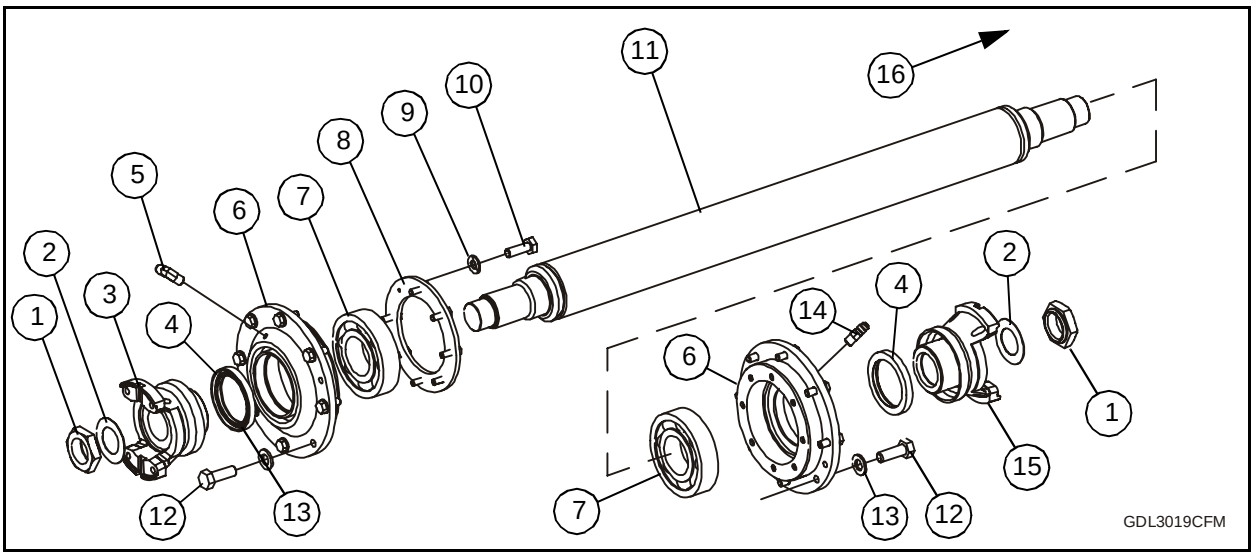
Cross and Bearing Torque - - - - - - 142 Nm (104 lb-ft)

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Remove and Install Oscillation Joint-to-Park Brake Drive Shaft

Remove transfer case-to-oscillation joint drive shaft.

Remove park brake-to-middle axle drive shaft.



1. Nut (2 used).
2. Washer (2 used).
3. Output Yoke.
4. Seal (2 used).
5. Grease Elbow.
6. Bearing Cover (2 used).
7. Bearing (2 used).
8. Bearing Retainer Ring.
9. Washer (8 used).
10. Cap Screw (8 used).
11. Drive Shaft.
12. Cap Screw (16 used).
13. Washer (16 used).
14. Grease Elbow.
15. Input Yoke.
16. Front of Machine.

Disconnect grease lines from grease elbows (14 and 5).

Remove nut (2), washer (1), and input yoke (15) from front of drive shaft (11).

Remove cap screws (12) and washers (13) from rear bearing cover (6).

⚠ CAUTION

Component is heavy. Use hoist.

Specification

Oscillation Joint-to-Park Brake Drive Shaft and Rear Bearing Assembly Weight;
- 68 kg (150 lb) approximate

Install two cap screws into threaded holes in rear bearing cover, to push rear bearing assembly away from oscillation tube. Remove drive shaft and rear bearing assembly from oscillation tube.

Remove cap screws (12) and washers (13) from front bearing cover.

Install two cap screws into threaded holes in front bearing cover, to push front bearing cover away from oscillation tube. Remove front bearing cover from oscillation tube.

Remove nut (2), washer (1), and output yoke (3) from drive shaft.

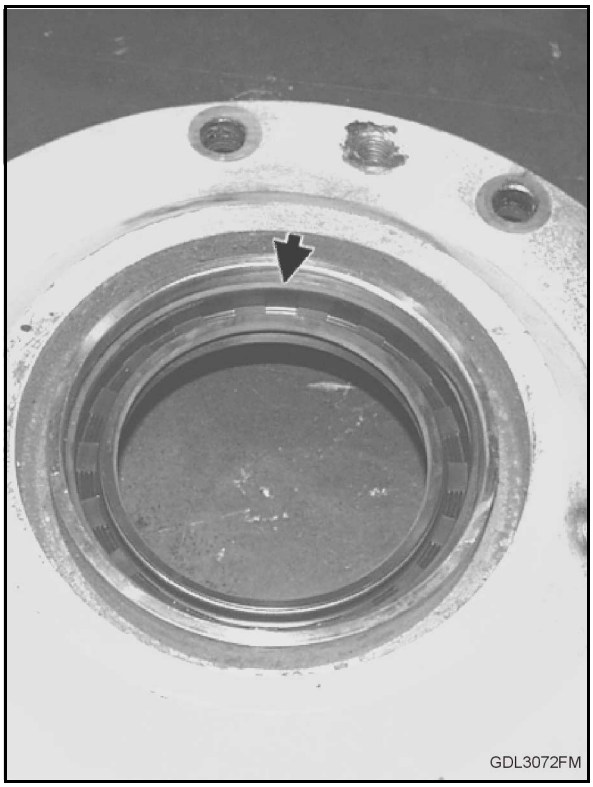
Remove cap screws (10) and washers (9) from bearing retainer ring (8). Remove rear bearing cover from drive shaft.

Remove seals (4) from front and rear bearing covers.

Clean bearing covers and cap screws.

Inspect parts and replace as necessary.

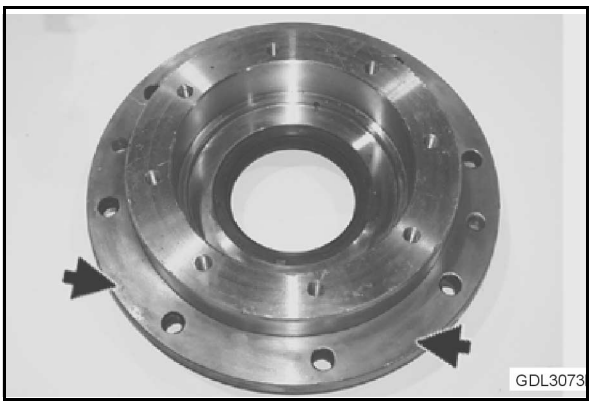
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Using a 109 mm (4.312 in.) diameter seal driver, install seals in front and rear bearing covers. Drive each seal to bottom of bore, with open side of seal facing outward (See arrow).

Remove front and rear bearings (7) from drive shaft.

Using DFT1187 Bearing Driver, install bearings on drive shaft. Drive bearings onto drive shaft until they are against shoulder.



Apply rigid form-in-place gasket to flange of rear bearing cover (See arrows).

Install rear bearing cover on drive shaft. Apply rigid form-in-place gasket to cap screws (10). Install washers (9) and cap screws through bearing retainer ring and into rear bearing cover.

Apply rigid form-in-place gasket to nut. Install output yoke, washer, and nut on drive shaft. Tighten nut to specification.

Specification

Yoke Retaining Nut Torque - - - - - -1100 N•m (811 lb-ft)

Install drive shaft and rear bearing assembly into oscillation tube. Apply rigid form-in-place gasket to rear bearing cover cap screws. Install washers and cap screws.

Apply rigid form-in-place gasket to flange of front bearing cover.

Install front bearing cover on drive shaft and oscillation tube. Apply rigid form-in-place gasket to cap screws (12). Install washers (13) and cap screws in front bearing cover.

⚠ CAUTION

Input and output yokes must be aligned to ensure smooth operation. If yokes are not aligned, severe vibration may occur in driveline during operation.

Apply rigid form-in-place gasket to nut. Install input yoke, washer, and nut on drive shaft. Ensure that input yoke and output yoke are aligned with each other. Tighten nut to specification.

Specification

Yoke Retaining Nut Torque - - - - - 1100 N•m (811 lb-ft)

Connect grease lines on grease elbows (5 and 14).

Install park brake-to-middle axle drive shaft.

Install transfer case-to-oscillation joint drive shaft.

Remove and Install Park Brake-to-Middle Axle Drive Shaft

⚠ CAUTION

Component is heavy. Use lifting device.

Support park brake disk with a lifting device.

⚠ CAUTION

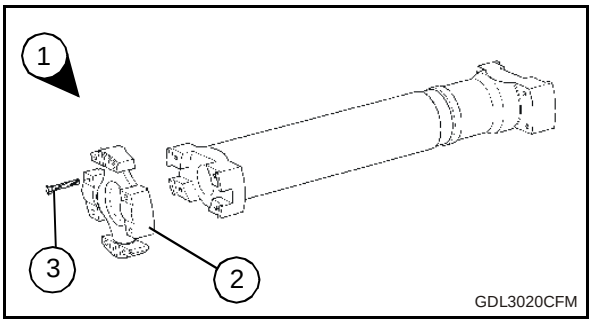
Component is heavy. Use hoist.

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Specification

Park Brake-to-Middle Axle Drive Shaft Weight:
- 40 kg (87 lb) approximate

NOTE: Removing front cross and bearing assembly from machine also disconnects park brake disk.



Remove cap screws (3) and drive shaft assembly (1).

If park brake is not engaged, remove disk from machine. **(See "PARK BRAKE" on page 257).**

Remove cross and bearing assemblies (2) from drive shaft.

Inspect and replace parts as necessary.

⚠ CAUTION

Assemble drive shaft so yokes on ends of the shaft are aligned. If yokes are not aligned, severe vibration and machine damage may result.

Assemble drive shaft so yokes are aligned.

Install cross and bearing assembles on drive shaft.

Apply rigid form-in-place gasket to cap screws. Install cap screws and tighten to specification.

Remove and Install Park Brake-to-Middle Axle Drive Shaft Specification

Cross and Bearing Torque - - - - - - - 142 N•m (104 lb-ft)

Install drive shaft assembly. Install park brake disk, if removed. **(See "PARK BRAKE" on page 257).**

Apply rigid form-in-place gasket to cap screws. Install cap screws.

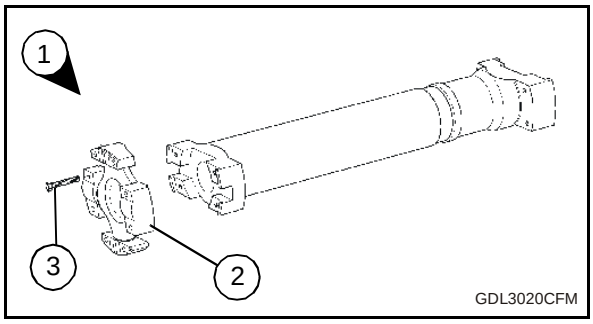
Remove and Install Middle Axle-to-Rear Axle Drive Shaft

⚠ CAUTION

Component is heavy. Use hoist.

Specification

Middle Axle-to-Rear Axle Drive Shaft Weight:
- 68 kg (150 lb) approximate



Remove cap screws (3) and drive shaft assembly (1).

Remove cross and bearing assemblies (2) from drive shaft.

Inspect and replace parts as necessary.

⚠ CAUTION

Assemble drive shaft so yokes on ends of the shaft are aligned. If yokes are not aligned, severe vibration and machine damage may result.

Assemble drive shaft so yokes are aligned.

Install cross and bearing assembles on drive shaft.

Install drive shaft assembly.

Apply rigid form-in-place gasket to cap screws. Install cap screws and tighten to specification.

Remove and Install Middle Axle-to-Rear Axle Drive Shaft Specification

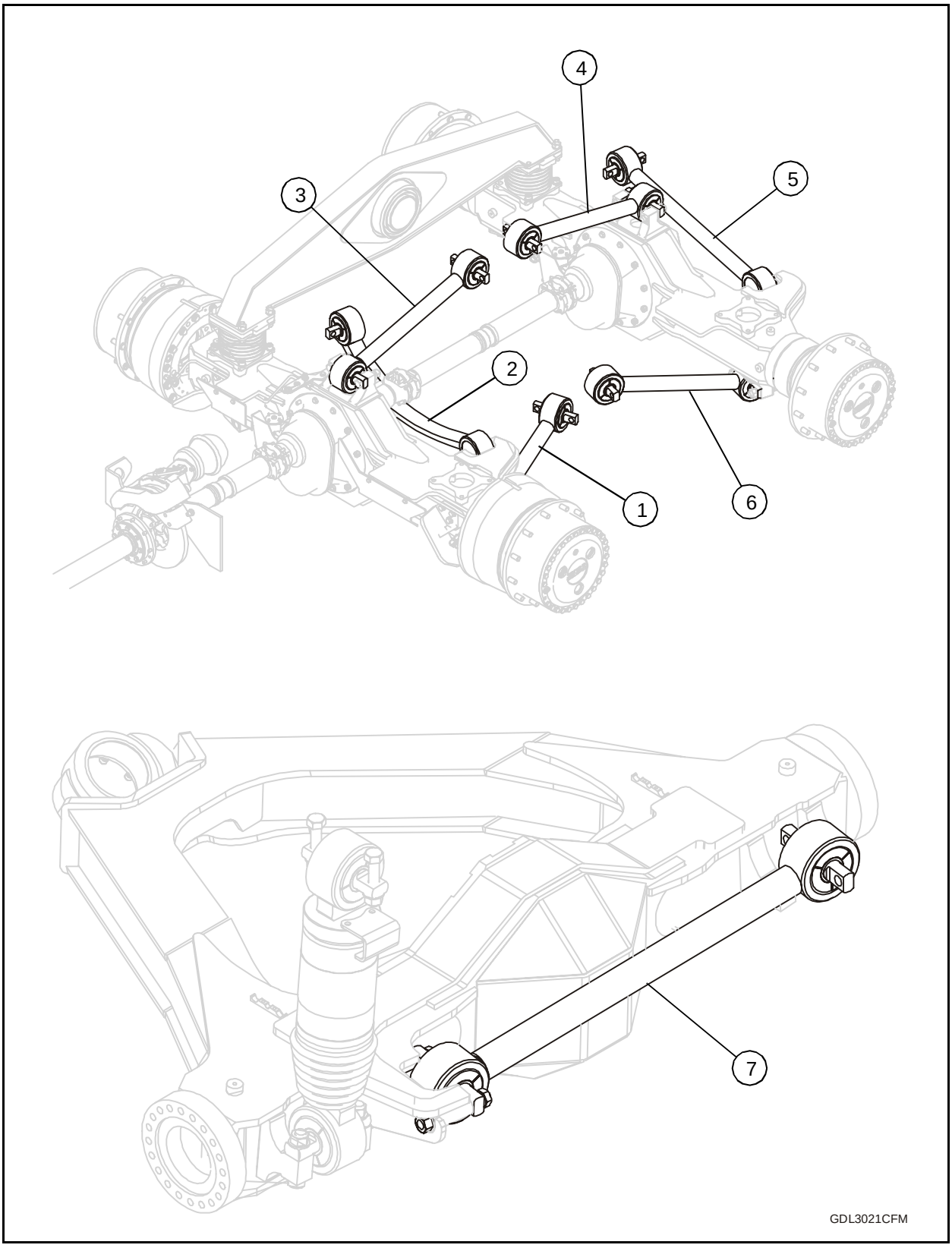
Cross and Bearing Torque - - - - - - - 142 Nm (104 lb-ft)

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CHAPTER 2. AXLES AND SUSPENSION SYSTEMS

SECTION 4. AXLE MOUNTING PARTS

AXLE LINKS, STABILIZERS AND STRUTS



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1. Middle Axle Drag Link (2 used).
2. Middle Axle Stabilizer.
3. Middle Axle Upper Link.
4. Rear Axle Upper Link.
5. Rear Axle Stabilizer.
6. Rear Axle Drag Link (2 used).
7. Front Axle Stabilizer.

Remove and Install Links and Stabilizers

⚠ CAUTION

Components are heavy. Use hoist.

Axle Links, Stabilizers, and Struts Specification

Link or Stabilizer Weight:
- - - - - - - - - - - - - - - - - - 45.5 kg (100 lb) approximate

Remove mounting hardware and component.

Inspect parts and replace as necessary.

Replace bushings, if necessary.

Clean cap screw threads.

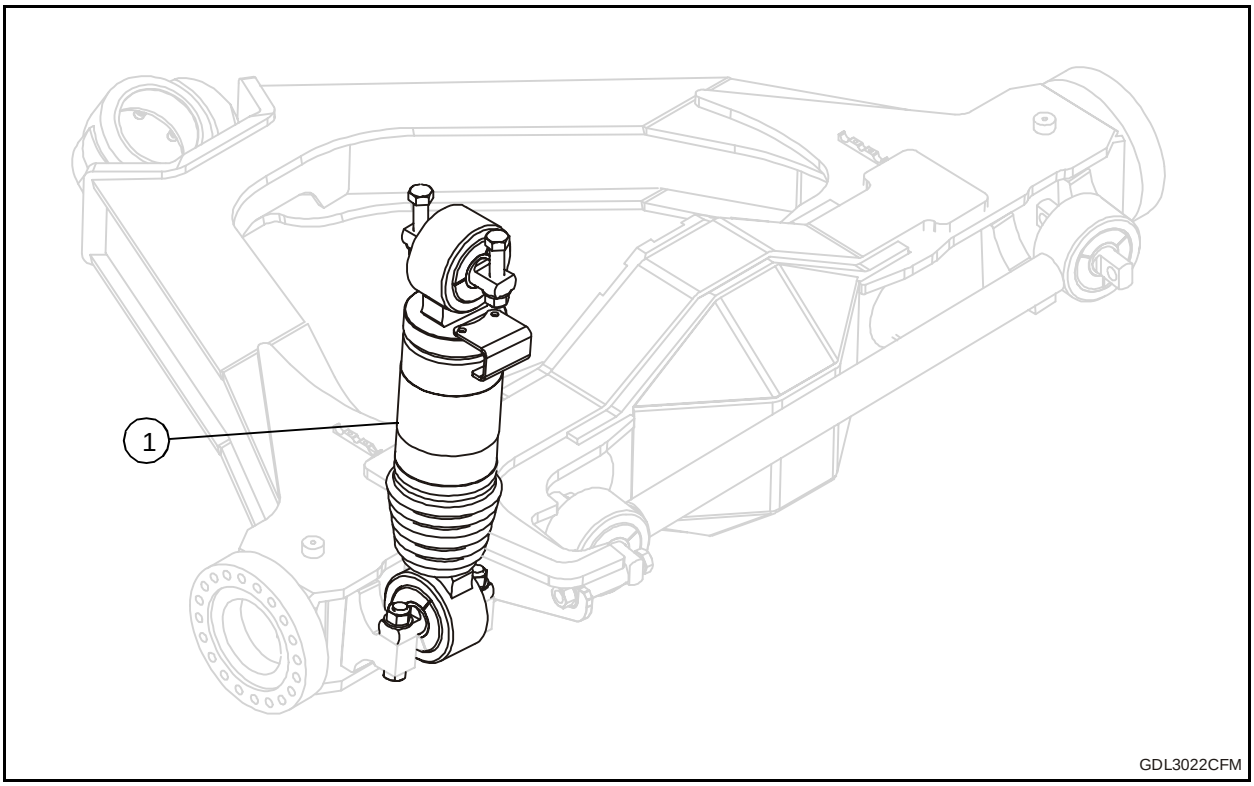
Apply rigid form-in-place gasket to cap screw threads.

Install component and mounting hardware.

Tighten mounting hardware to specification.

Axle Links, Stabilizers, and Struts Specification

Link or Stabilizer Cap Screw and Nut Torque:
- 1295 Nm (955 lb-ft)



Remove and Install Front Suspension Strut

Inspect suspension struts (1).

- Inspect suspension struts for damage.
- Inspect suspension struts for oil leakage. **(See Front Suspension Strut Leakage Check CHAPTER 4, SECTION 3 on the Operation and Test Manual)**.
- Inspect suspension struts for correct ride height. **(See Check Front Axle Suspension Struts Operator's Manual, CHAPTER 13, Section 1).**

Support machine front frame with 20-ton shop stands. Chock middle and rear wheels securely.

⚠ CAUTION

Component is heavy. Use lifting device.

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Axle Links, Stabilizers, and Struts Specification

Front Axle Weight- - - - 2019 kg (4450 lb) approximate

Attach a lifting device to axle.

Remove wheel. **(See "REMOVAL AND INSTALLATION" on page 1).**

Lower axle to relieve tension on strut.

⚠ CAUTION

Strut will be under compression. Use care when removing mounting hardware.

Remove mounting hardware and strut.

Inspect, repair, or replace strut, as necessary.

Clean cap screw threads.

Apply rigid form-in-place gasket to cap screw threads.

Install suspension strut and mounting hardware.

Tighten mounting hardware to specification.

Axle Links, Stabilizers, and Struts Specification

Suspension Strut Cap Screw and Nut Torque:
- 1295 N•m (955 lb-ft)

Install wheel. **(See "REMOVAL AND INSTALLATION" on page 1).**

Remove lifting device and shop stands.

Recharge suspension struts, if necessary.

Recharge Front Suspension Strut

⚠ CAUTION

DO NOT recharge a suspension strut that leaks or appears damaged. Repair or replace strut.

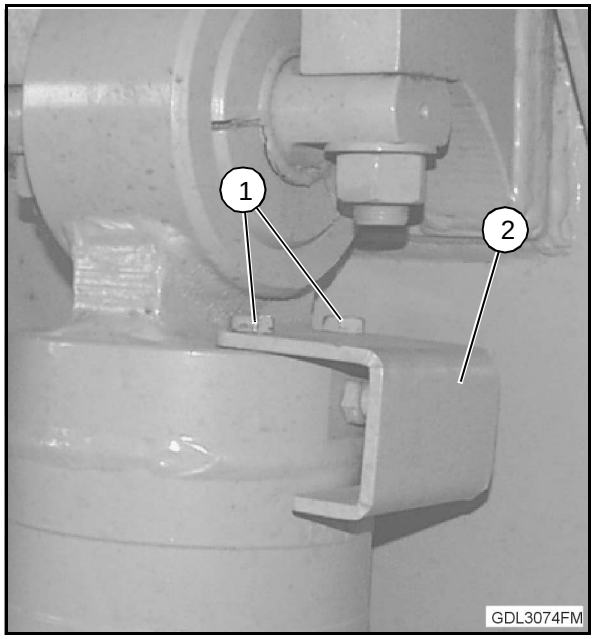
NOTE: To obtain correct pressure and ride height, struts must be recharged while installed on machine.

Inspect strut for damage and leakage. Remove, repair or replace, and install, if necessary.

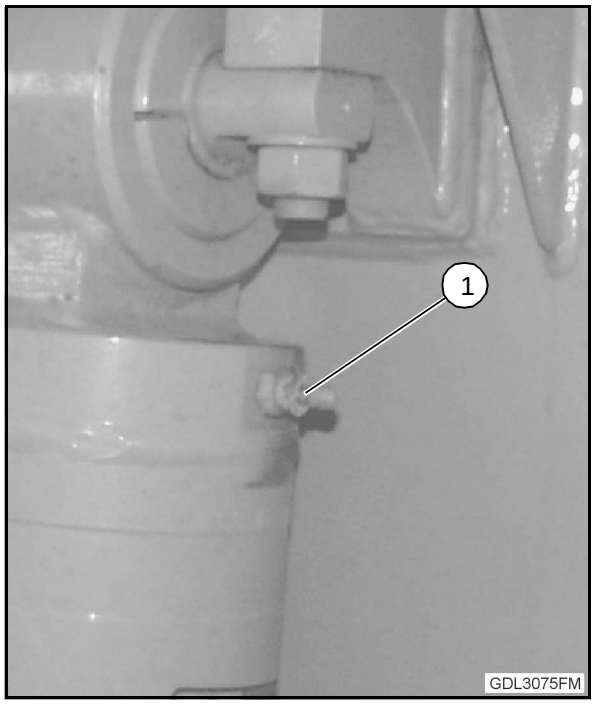
Check ride height. **(See Check Front Axle Suspension Struts Operator's Manual CHAPTER 13, SECTION 1)**.

⚠ CAUTION

Avoid personal injury or death from pressurized gas and fluids.



Remove cap screws (1) and guard (2).

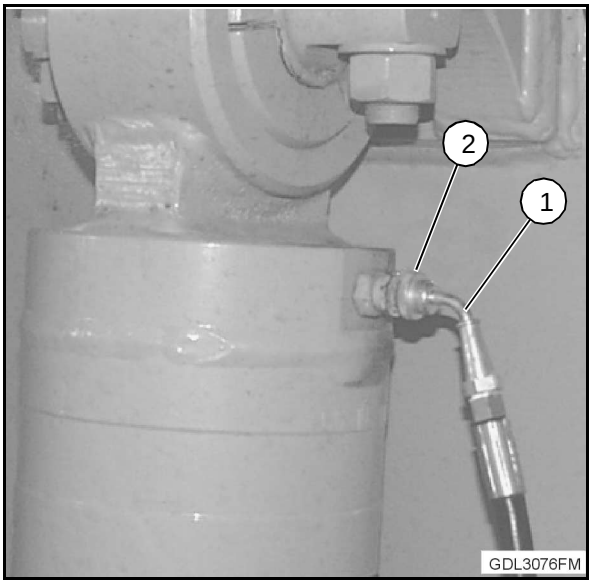


Remove fitting cap (1).

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⚠ CAUTION

Use ONLY dry nitrogen to charge strut. Other gases can cause oxidation or condensation.



Connect JT03522 Adapter and Hose (1) to recharge fitting on strut.

⚠ CAUTION

DO NOT loosen inner nut on recharge fitting. Personal injury will result. Loosen ONLY outer nut.

Turn outside nut (2) on recharge fitting counterclockwise to open. DO NOT loosen inner nut.

Pressure gauge on regulator will read pressure in strut.

Pressurize the strut with dry nitrogen.

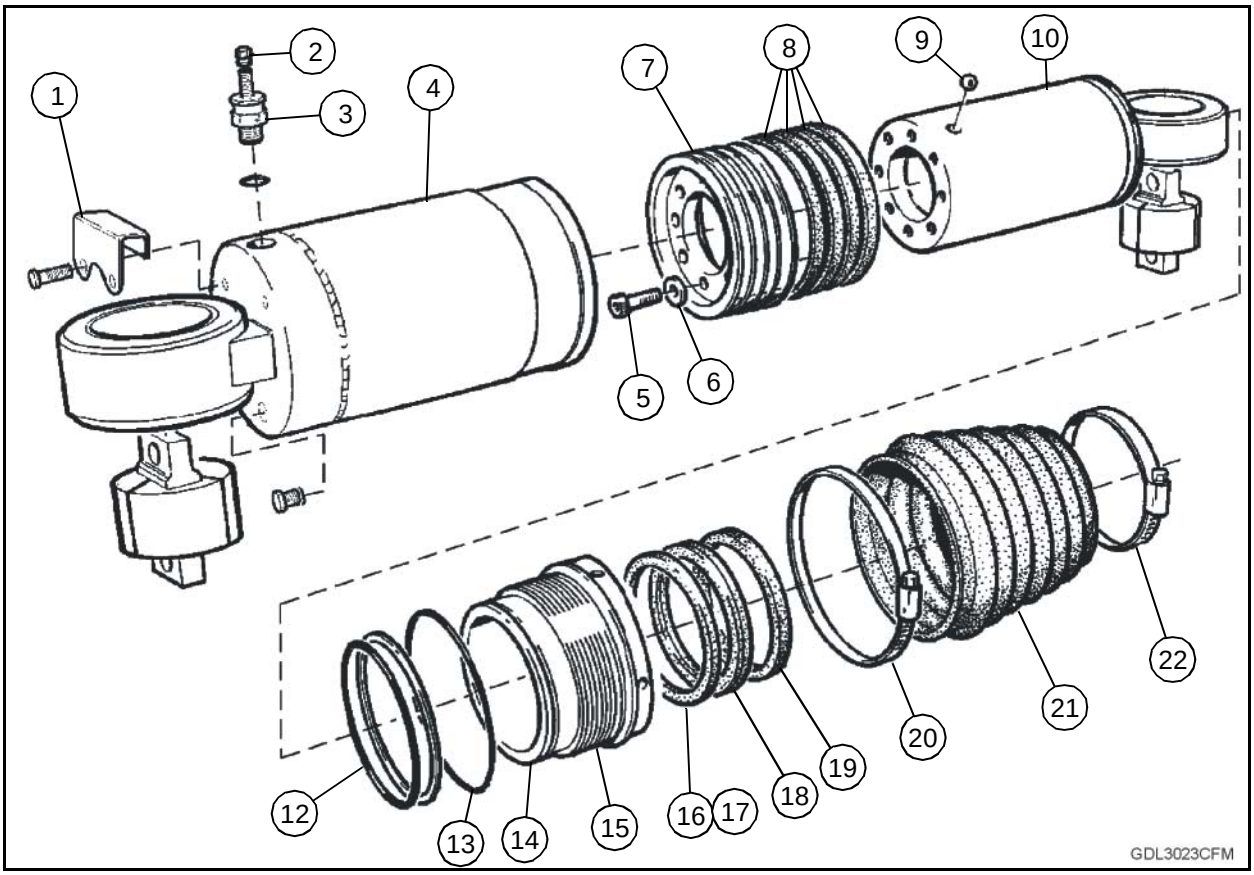
Axle Links, Stabilizers, and Struts Specification

Front Suspension Strut Pressure:
- -3500 kPa (35 bar) (500 psi)

Tighten outer nut on recharge fitting. Remove adapter and hose.

Operate machine and apply brakes a few times to cycle the suspension strut rods. Recheck ride height. **(See Check Front Axle Suspension Struts Operator's Manual, CHAPTER 13, SECTION 1).**

Install clamps, fitting cap, and guard.



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1. Valve Guard.
2. Valve Cap.
3. Charging Valve.
4. Barrel.
5. Screw (8 used).
6. Lock Washer (8 used).
7. Piston.
8. Piston Seal (4 used).
9. Ball.
10. Rod.
11. Oil Plug.
12. O-Ring.
13. Backup Ring.
14. O-Ring.
15. Rod Guide.
16. Composite Seal.
17. Composite Seal O-Ring.
18. U-Seal.
19. Wiper Seal.
20. Clamp.
21. Boot.
22. Clamp.

Disassemble and Assemble Front Suspension Strut

Discharge nitrogen pressure from strut.

- Remove valve guard (1) and valve cap (2).

⚠ CAUTION

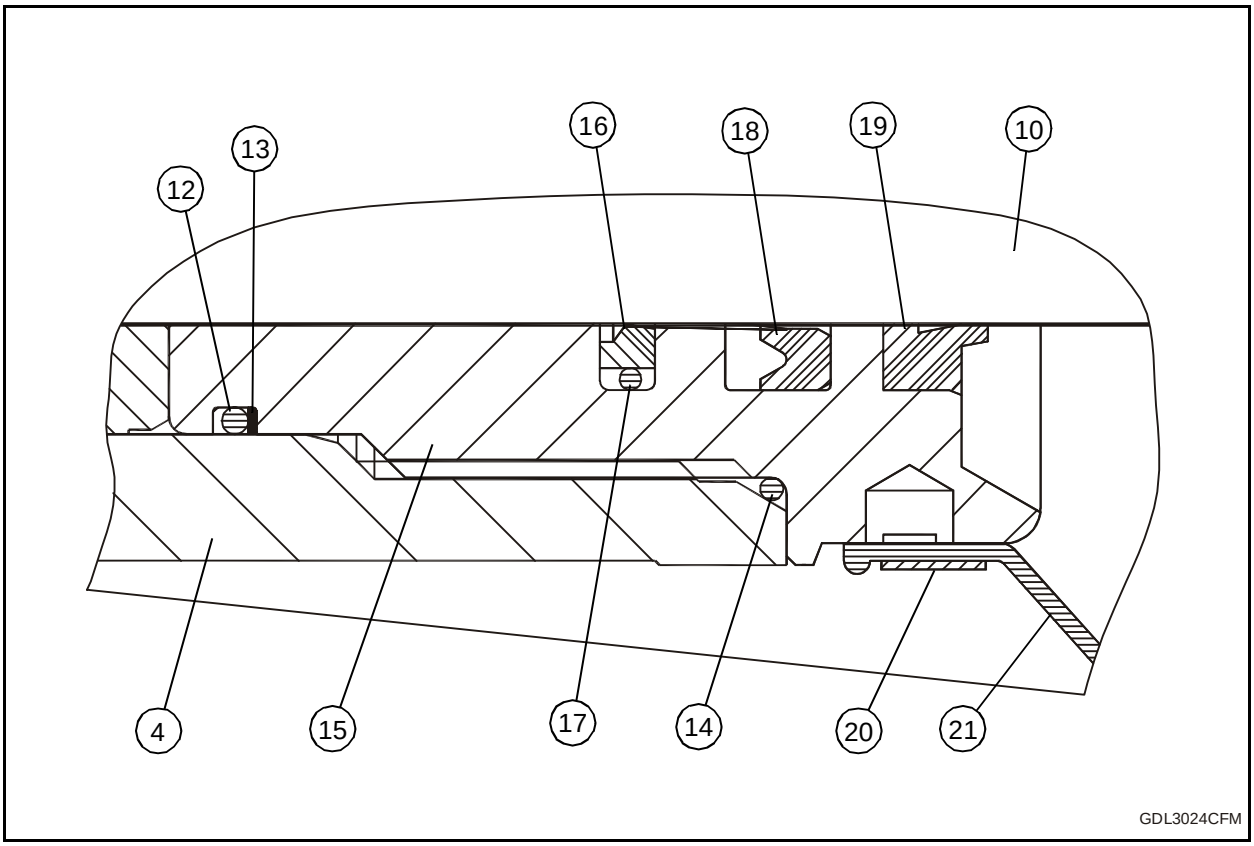
Avoid personal injury or death from pressurized gas and fluids.

- Slowly loosen outer nut on charging valve (3) to discharge nitrogen pressure. Remove valve after pressure is released.

Disassemble strut.

- Remove oil plug (11) and drain oil.
- Remove clamps (20 and 22) from boot (21). Disconnect boot from rod guide (15).
- Remove rod guide assembly (12 - 19), rod (10), and piston assembly (5 - 8) from barrel (4).
- Remove seals (8) from piston (7). Remove screws (5) and lock washers (6). Remove piston from rod.
- Remove ball (9) from rod.
- Remove rod guide assembly, boots, and clamps from rod.
- Remove rings and seals (12 - 14, 16 - 19) from rod guide (15).
- 3. Clean, inspect, and replace parts as necessary.

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4. Barrel.
10. Rod.
12. O-Ring.
13. Backup Ring.
14. O-Ring.
15. Rod Guide.
16. Composite Seal.
17. Composite Seal O-Ring.
18. U-Seal.
19. Wiper Seal.
20. Clamp.
21. Boot.

Assemble strut.

NOTE: Apply a thin layer of petroleum jelly to all internal components during assembly.

- Separate O-ring (17) from composite seal (16). Install O-ring in rod guide.
- Bend composite seal into “kidney” shape. Install composite seal in rod guide.
- Install U-seal (18) in rod guide.
- Install wiper seal (19) in rod guide.
- Install backup ring (13) on rod guide.
- Install O-ring (12) on rod guide.
- Install O-ring (14) on rod guide.
- Install boot on rod.
- Install rod guide assembly on rod.
- Install ball in rod.
- Install seals on piston.
- Install piston assembly on rod.

Apply rigid form-in-place gasket to screws. Install screws and lock washers. Tighten screws to specification.

Axle Links, Stabilizers, and Struts Specification

Suspension Strut Piston Retaining Screw Torque: - 135 Nm (100 lb-ft)

- Install piston assembly, rod, and rod guide assembly in barrel. Tighten rod guide in barrel.
- Fill strut with oil.

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- Install strut in 12 ton hydraulic press with oil plug at top. Compress strut until rod extends 100 mm (3.9 in.) from rod guide.
- Install charging valve in barrel. Ensure charging valve is fully open.
- Fill strut until overflowing with 15W40 engine oil. Allow time for oil to settle.
- Compress strut until rod extends 30 mm (1.2 in.) from rod guide. Ensure O-ring is seated firmly on oil plug. Install oil plug.
- Remove strut from hydraulic press.

⚠ WARNING

Use ONLY dry nitrogen to charge strut. Other gases can cause oxidation or condensation.

Charge strut with dry nitrogen.

- Connect nitrogen source to charging valve. Charge strut to specification. Close charging valve.

Axle Links, Stabilizers, and Struts Specification

Suspension Strut Nitrogen Charging Pressure: - 3585 kPa (35.9 bar) (520 psi)

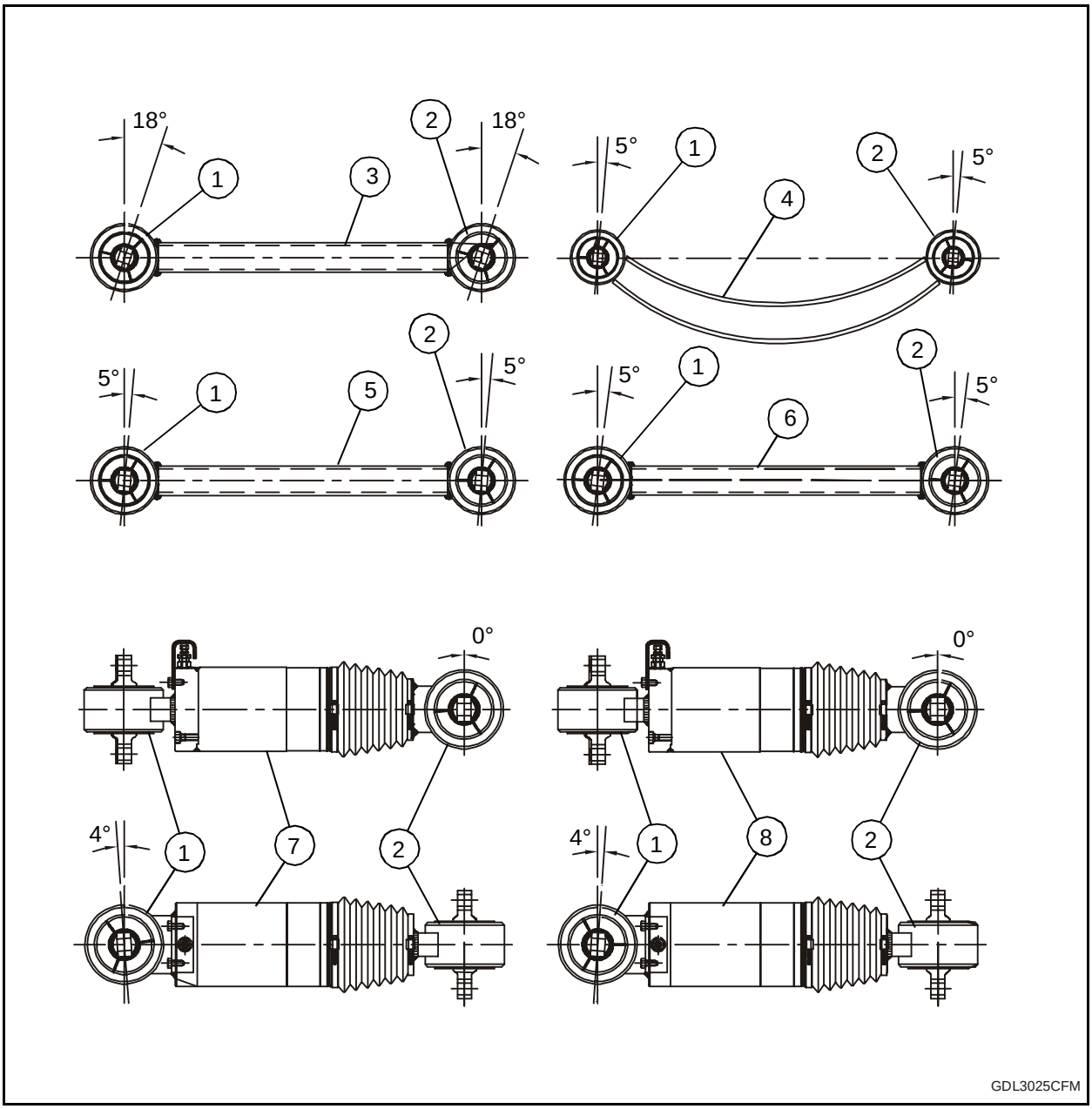
- Disconnect nitrogen source. Install valve cap. Install valve guard.
- Install strut in 12 ton hydraulic press. Mark rod at rod guide and 50 mm (2.0 in.) from rod guide. Compress strut to mark. Decompress. Ensure strut expands to original mark. Repeat this step once.
- Remove strut from hydraulic press.

Install clamps on boot.

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Replace Bushings

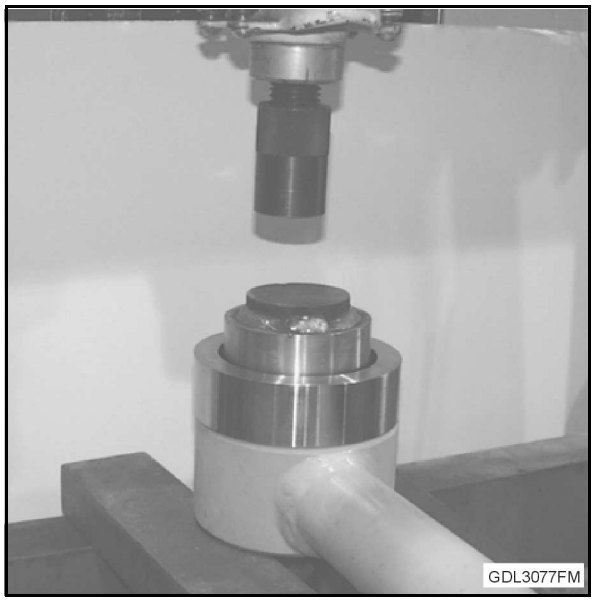
Cut old bushing out with a torch. Bushings cannot be pressed out of bores.



1. Axle End.
2. Frame End.
3. Middle or Rear Axle Upper Link or Drag Link (6 used).
4. Middle Axle Stabilizer.
5. Rear Axle Stabilizer.
6. Front Axle Stabilizer.
7. Front Axle Left Strut.
8. Front Axle Right Strut.

Align new bushing on bore at proper angle, as shown.

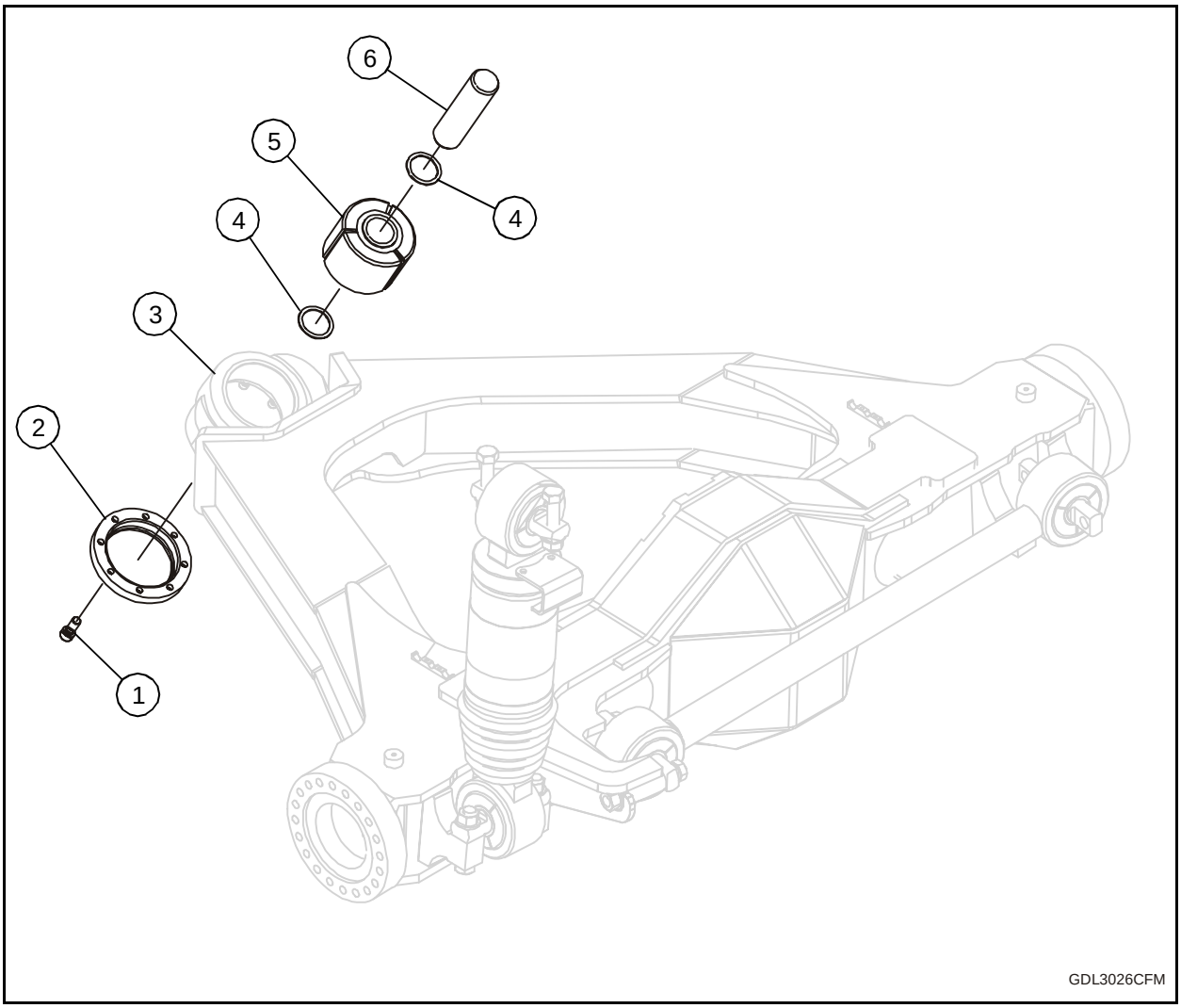
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Install bushing using DFT1196 Bushing Driver. Press bushing into bore until centered.

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Front Axle Pivot



1. Socket Head Cap Screw (8 used).
2. Housing Cover.
3. Bore.
4. Spacer (2 used).
5. Bushing.
6. Pin.

Disassemble and Assemble

Remove front axle. Remove spacers (4) when clamping blocks are removed from pin. (**See "AXLES" on page 5).**

Remove socket head cap screws (1) and housing cover (2).

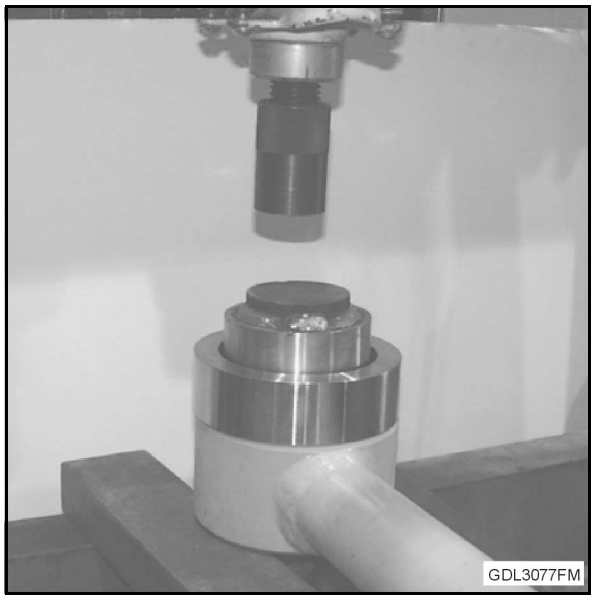
Press pin (6) from bushing (5).

Cut old bushing out with a torch. Bushings cannot be pressed out of bores.

Press pin into new bushing.

Align new bushing on bore.

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Install bushing using DFT1196 Bushing Driver. Press bushing into bore until centered.

Install housing cover and socket head cap screws.

Middle and Rear Axle Walking Beams

Remove and Install Beam

Support machine rear frame with 20-ton shop stands. Chock front wheels securely.

⚠ CAUTION

Components are heavy. Use lifting device.

Middle and Rear Axle Walking Beams Specification

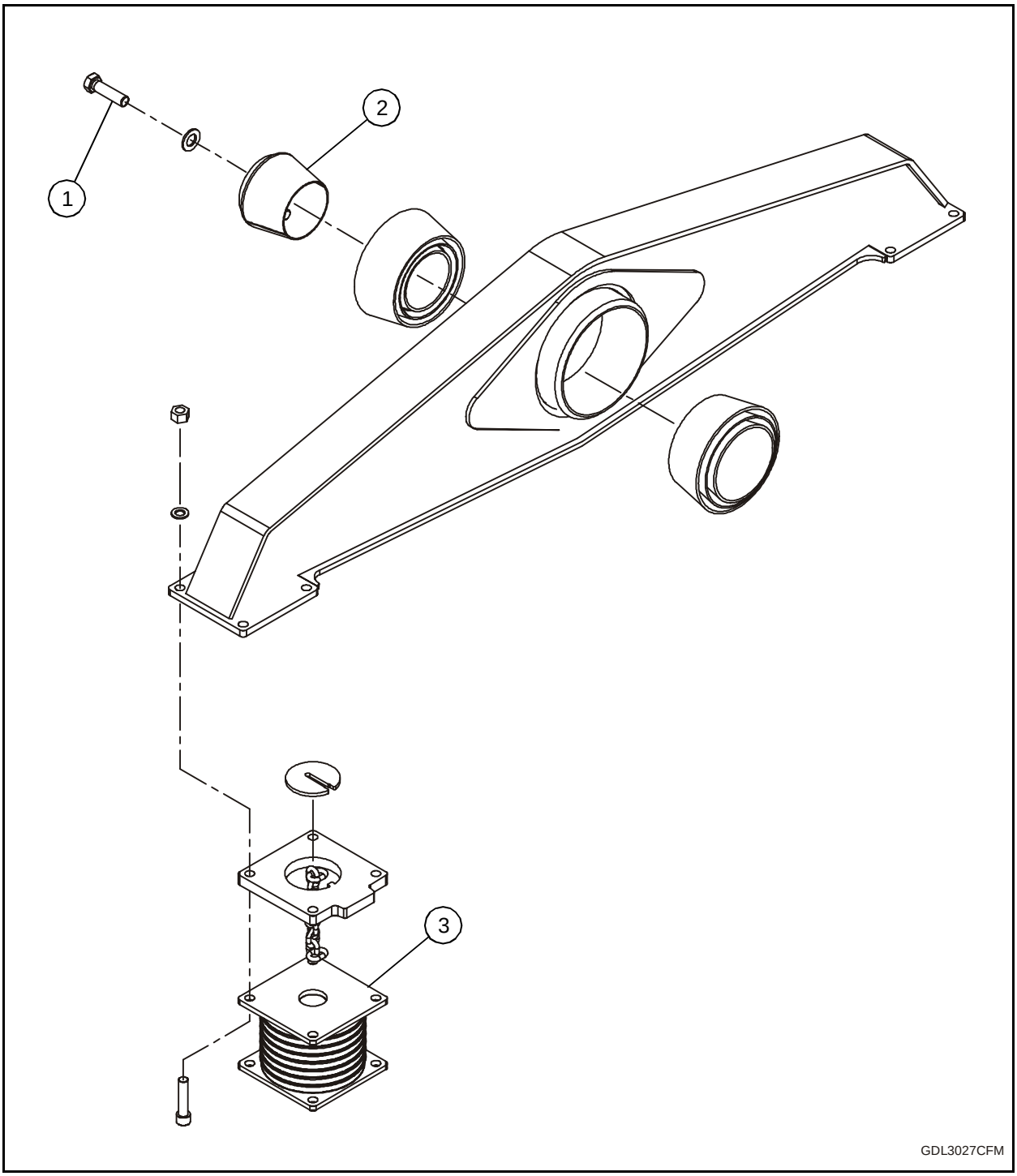
Middle Axle Weight - - 1565 kg (3450 lb) approximate

Rear Axle Weight- - - - 1474 kg (3250 lb) approximate

Attach lifting devices to middle and rear axles.

Remove wheels. **(See “REMOVAL AND INSTALLATION” on page 1).**

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1. Cap Screw (3 used).
2. Taper Plug.
3. Rubber Mount (2 used).

Disconnect walking beam from rubber mounts (3).

5. Lower middle and rear axles approximately 2.5 cm (1 in.) from walking beam with lifting devices. Support middle and rear axles with 20-ton shop stands.

⚠ CAUTION

Component is heavy. Use lifting device.

Middle and Rear Axle Walking Beams Specification

Walking Beam Weight :
- - - - - - - - - - - - - - - - - - - 263 kg (580 lb) approximate

Attach a lifting device to walking beam.

Remove cap screws (1) and washers from taper plug (2).

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Insert DFT1199 Bushing Pusher in threaded holes in taper plug. Turn pushers clockwise evenly until walking beam comes off.

Replace parts as necessary.

Install bearings and taper plug on walking beam.

Install walking beam on machine. Install washers and cap screws.

Attach lifting devices to middle and rear axles. Raise axles to walking beam.

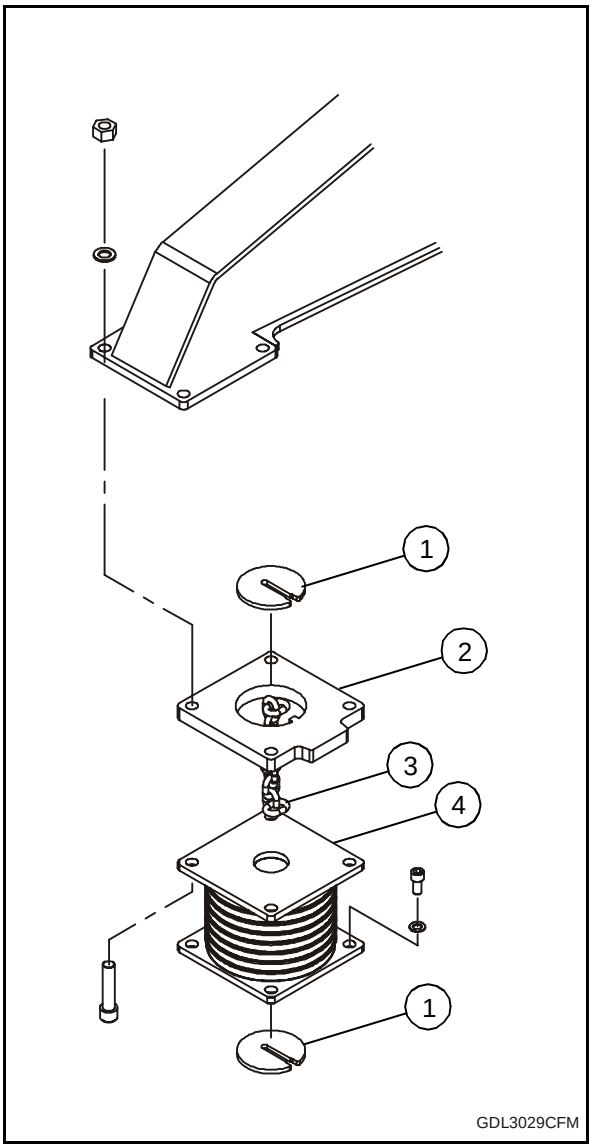
Connect walking beam to rubber mounts.

Install wheels. **(See "REMOVAL AND INSTALLATION" on page 1).**

Remove and Install Rubber Mount

Support axle with lifting device and remove wheel. **(See "REMOVAL AND INSTALLATION" on page 1).**

Support walking beam with shop stand.



1. Retainer (2 used).
2. Spacer.
3. Chain.
4. Rubber Mount.

Disconnect rubber mount (4) from walking beam and axle. Lower axle with lifting device. Remove rubber mount.

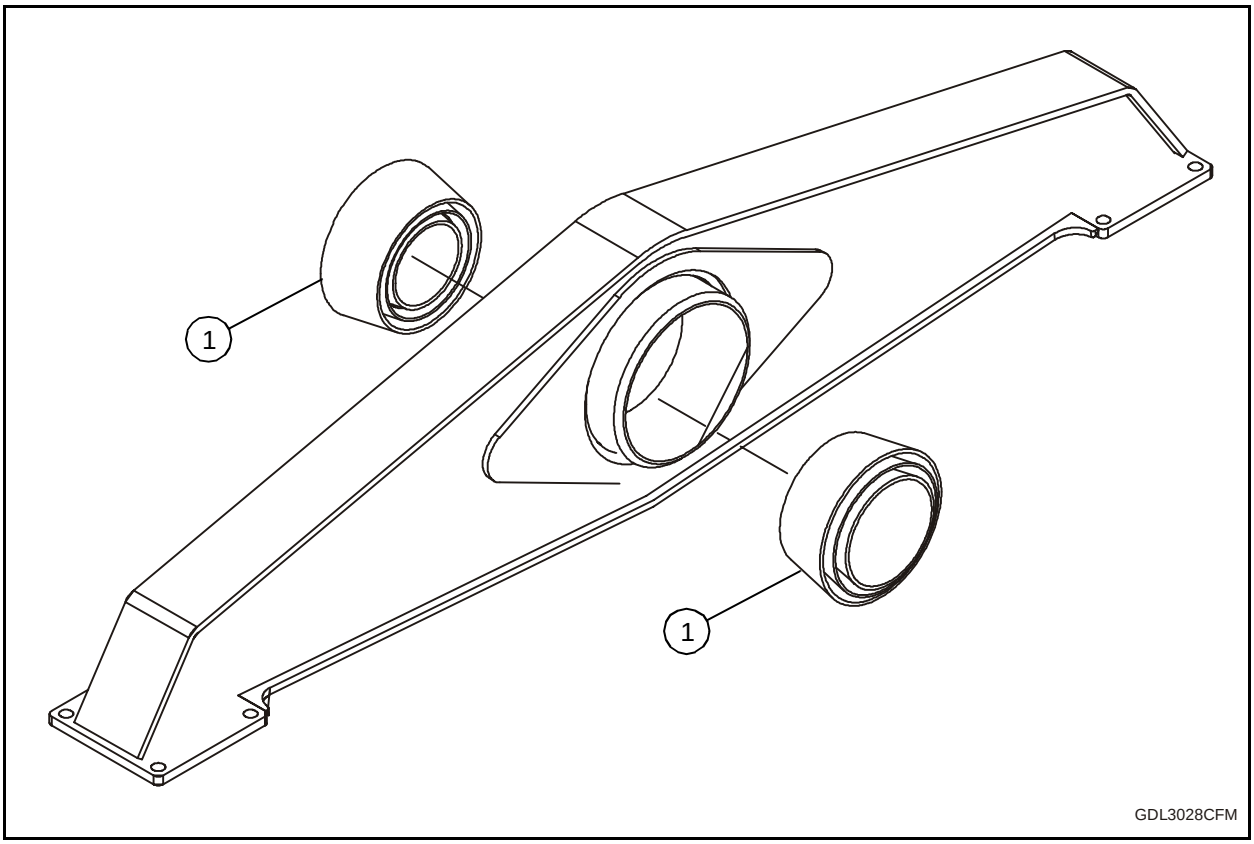
Inspect parts and replace as necessary.

Install rubber mount on axle. Raise axle with lifting device. Install rubber mount on walking beam.

Install wheel. **(See "REMOVAL AND INSTALLATION" on page 1).**

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Remove and Install Bushing



1. Bushing (2 Used).

Remove bushings (1) by cutting with a hand-held grinder or cutting torch.

Press new bushings into bores using DFT1200 Bushing Driver. Press bushings below edge of bore per specifications.

Middle and Rear Axle Walking Beams Specification

Bushing Installation Distance:- 3.175 mm (0.125 in.) Below Bushing Bore

Apply Anti-Seize Lubricant to walking beam pivot shaft and bushing.

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CHAPTER 2. AXLES AND SUSPENSION SYSTEMS

SECTION 5. AXLE SHAFTS, BEARINGS AND REDUCTION GEARS

AXLE OUTBOARD PLANETARIES

Remove and Install

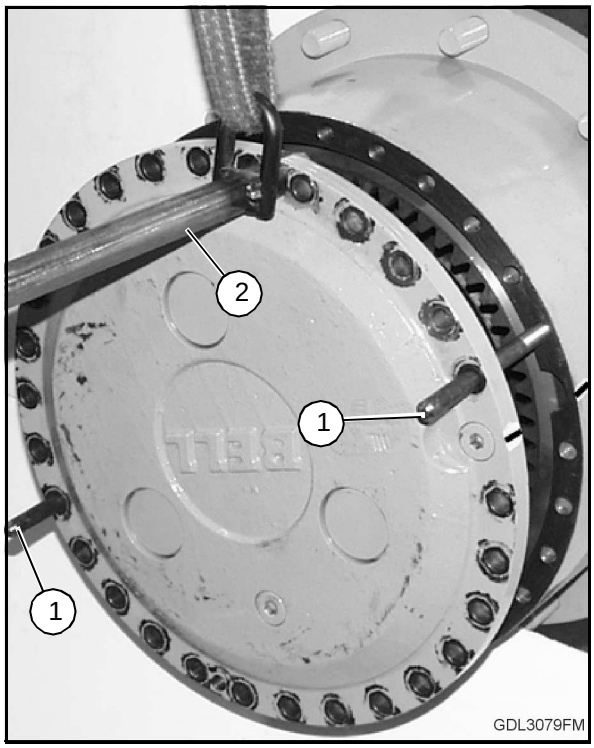
Remove wheels. **(See "REMOVAL AND INSTALLATION" on page 1).**

Drain planetary. **(See Change Final Drive Oil Operator's Manual, CHAPTR 15, SECTION 2).**

Drain axle oil. **(See Change Axle Oil Operator's Manual, CHAPTER 15, SECTION 2)**.

NOTE: Drain plug must be aligned with cutout in axle housing, or oil will not drain properly.

Mark planetary cover and axle housing to ensure correct assembly.



Remove two cap screws from planetary cover and install DFT1195 Planetary Alignment Studs (1). Remove remaining cap screws from planetary cover.

⚠ CAUTION

Component is heavy. Use hoist.

Axle Outboard Planetaries Specification

Planetary Cover Weight:
- - - - - - - - - - - - - - - - - - -93 kg (205 lb) approximate

Install two cap screws into threaded jack screw holes. Tighten cap screws to separate planetary cover from hub.

Remove cap screws from jack screw holes and install DFT1178 Lifting Tool (2). Rotate planetary until lifting tool is at top. Attach lifting tool to a hoist.

Remove planetary cover.

Inspect parts and repair as necessary. Clean cap screws and mating surfaces.

Apply rigid form-in-place gasket to mating surfaces of axle housing and planetary cover.

Use DFT1178 Lifting Tool and hoist to align planetary cover on planetary housing. Ensure sun gear and planetary gears are properly aligned. Push planetary cover into housing until ring gear is partially engaged.

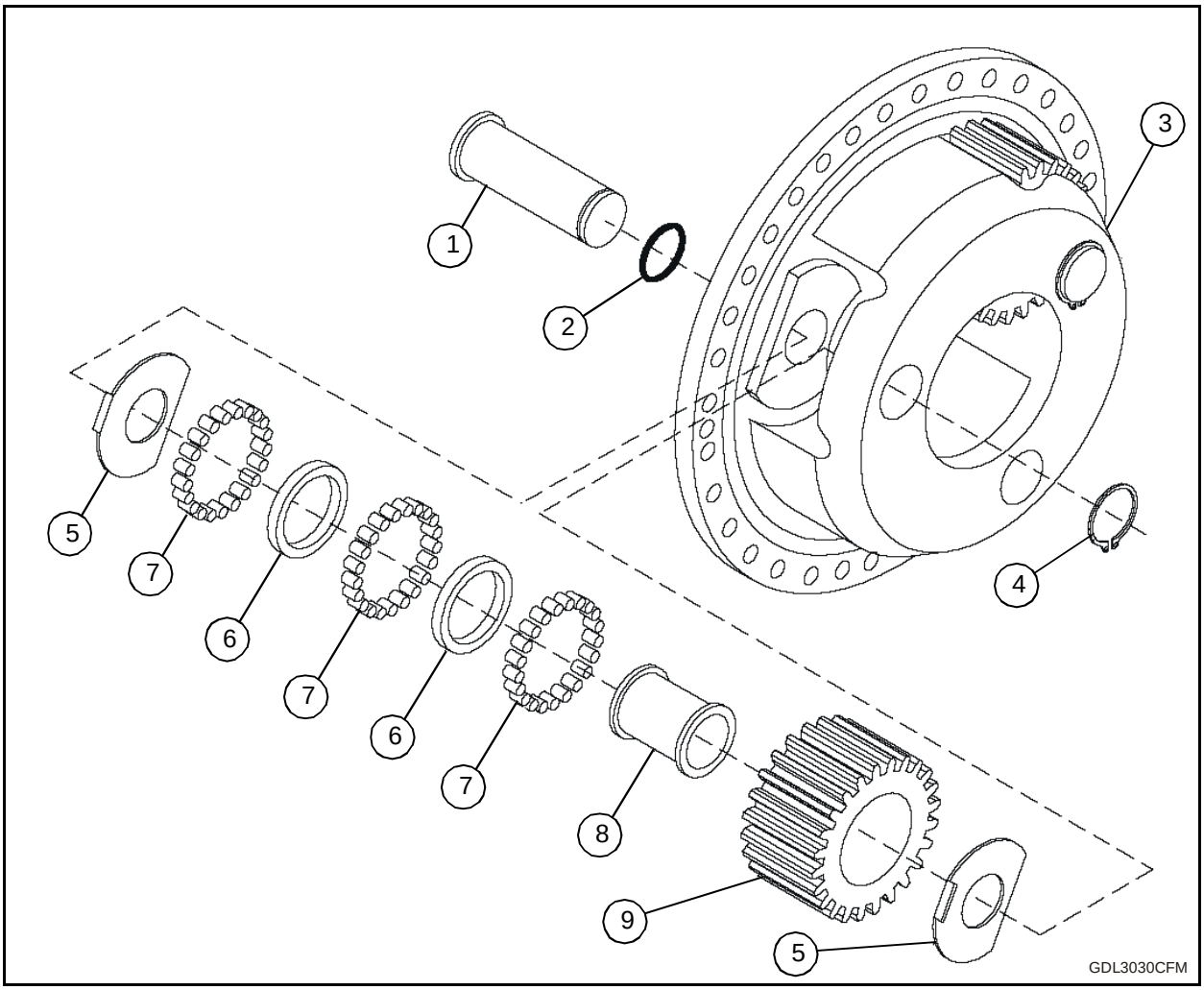
Remove DFT1195 Planetary Alignment Studs. If axle shaft splines are not engaged in differential, use lifting tool and planetary cover as leverage on axle shaft, to align splines. Turn opposite wheel hub to assist spline alignment.

Ensure drain plug in planetary cover and cutout in axle housing are aligned. Push planetary inward by hand until cover is fully seated.

Apply rigid form-in-place gasket to cap screws. Install cap screws.

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Disassemble and Assemble



1. Pin.
2. O-Ring.
3. Carrier Cover.
4. Snap Ring.
5. Thrust Washers (2 used).
6. Spacers (2 used).
7. Bearing Rollers (63 used).
8. Inner Bearing Race.
9. Gear.

Remove snap ring (4) and press out pin (1). Remove O-ring (2) from pin.

⚠ CAUTION

Bearing rollers will fall off sleeve when pulled out of gear.

Remove gear (9) and thrust washers (5).

Disassemble parts (6 - 8) as shown.

Clean and inspect parts for wear or damage.

Assemble parts (6—8) as shown.

Install gear and thrust washers.

Install O-ring on pin and press pin into carrier cover.

Install snap ring.

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Axle Shafts

Remove and Install

Remove planetary cover. See Axle Outboard Planetaries.

Remove axle shaft.

Inspect parts and repair as necessary.

Install axle shaft part way into housing.

Install planetary cover. Use planetary cover and lifting tool as leverage to align axle shaft splines in differential. **(See "AXLE OUTBOARD PLANETARIES" on page 39).**

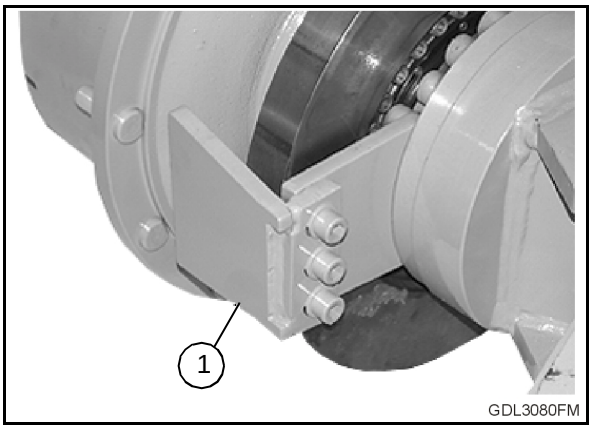
Axle Hubs

Remove and Install B35D

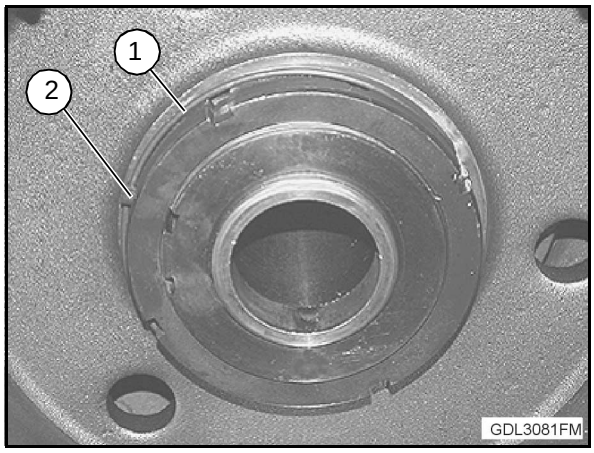
Remove brake caliper. **(See "SERVICE BRAKES B35D" on page 237).**

Remove outboard planetary. **(See "AXLE OUTBOARD PLANETARIES" on page 39).**

Remove axle shaft. **(See "Axle Shafts" on page 41).**



Remove rotor shield (1).



Remove retaining ring (1) and pin (2) from spanner nut. Remove spanner nut using JDG1351 Spanner Wrench.

⚠ CAUTION

Component is heavy. Use hoist.

Axle Hubs Specification

Ring Gear Weight: - - - - - - -45 kg (100 lb) approximate

Remove ring gear.

⚠ CAUTION

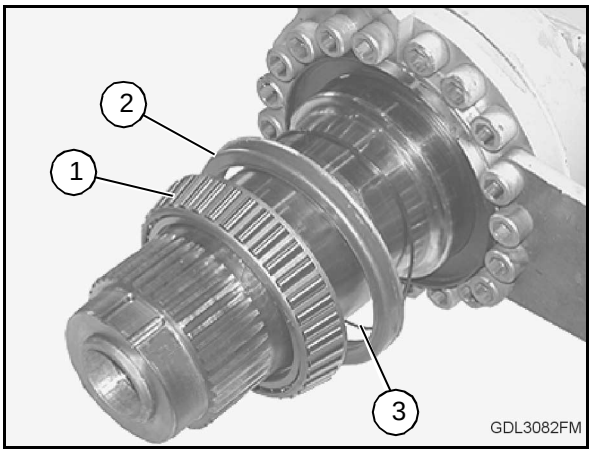
Component is heavy. Use hoist.

Axle Hubs Specification

Hub and Rotor Weight: - - 181 kg (400 lb) approximate

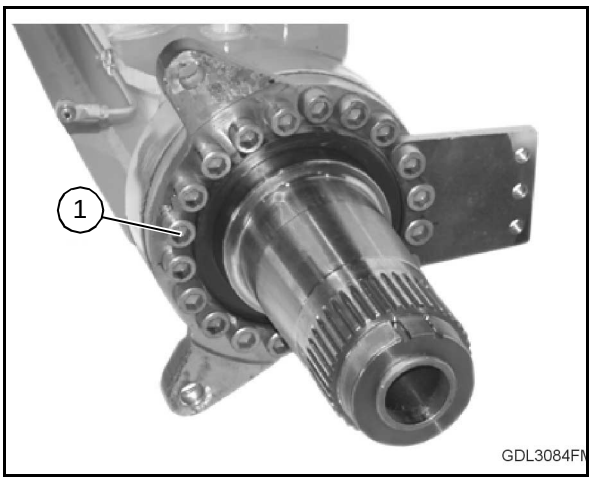
Attach sling and hoist to hub. Pry on back side of rotor to aid in removing hub from spindle.

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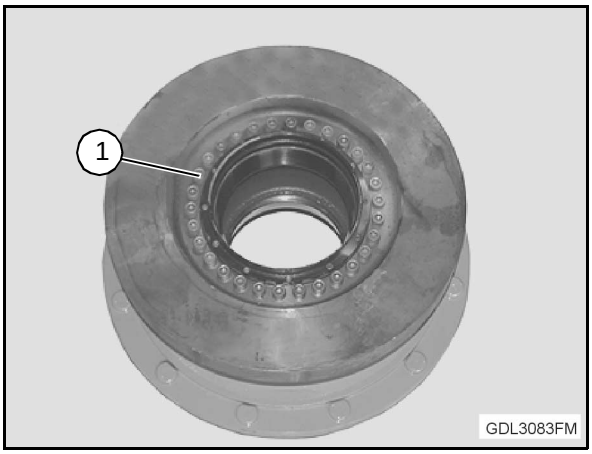


Remove inner bearing (1) from spindle using a knife-edge bearing puller.

Remove seal (2) and O-ring (3).

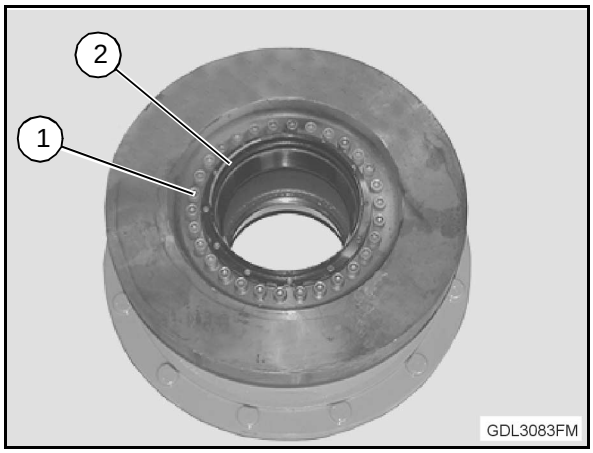


Remove and install socket head cap screws (1) and remove spindle, if necessary.



Remove and install socket head cap screws (1) and brake rotor, if necessary.

Replace bearing cups, if necessary.



Remove and install socket head cap screws (1) and seal carrier (2), if necessary.

Clean and inspect bearings, bearing cups, and seal surface area on spindle for damage or wear.

Install O-ring and seal on spindle.

Install inner hub bearing. Use heat to ensure bearing is fully seated.

Attach sling and hoist to hub and install hub.

Install outer bearing. Use heat to ensure bearing is fully seated.

Install ring gear.

Install spanner nut and tighten until nut contacts ring gear.

Install DF1002 Rolling Drag Torque Bar in hub. Check rolling drag using a beam torque wrench. Tighten spanner nut to specification.

Axle Hubs Specification

Ring Gear Hub Bearings (Dry) Rolling Drag Torque: -40 - 50 Nm (29 - 33 lb-ft)

Ring Gear Hub Bearings (Lubricated) Rolling Drag Torque:- - - - - - - - - - - - - - - - - 18 - 20 Nm (13 - 15 lb-ft)

Align hole in spanner nut to slot in spindle. Install pin in spanner nut hole and install retaining ring in groove on spanner nut.

Install rotor shield and socket head cap screws.

Install axle shaft. **(See “Axle Shafts” on page 41).**

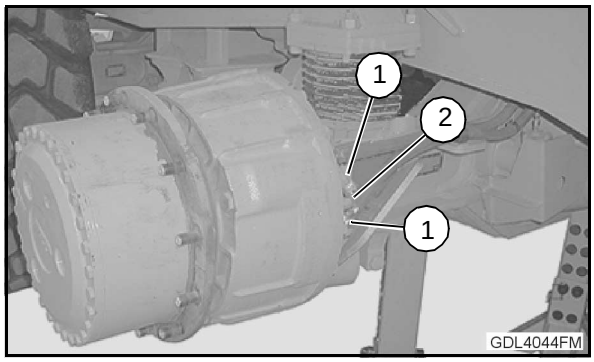
Install outboard planetary. **(See “AXLE OUTBOARD PLANETARIES” on page 39).**

Install brake caliper. **(See “SERVICE BRAKES B35D” on page 237).**

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Remove And Install - B40D

Remove wheel. **(See "REMOVAL AND INSTALLATION" on page 1).**

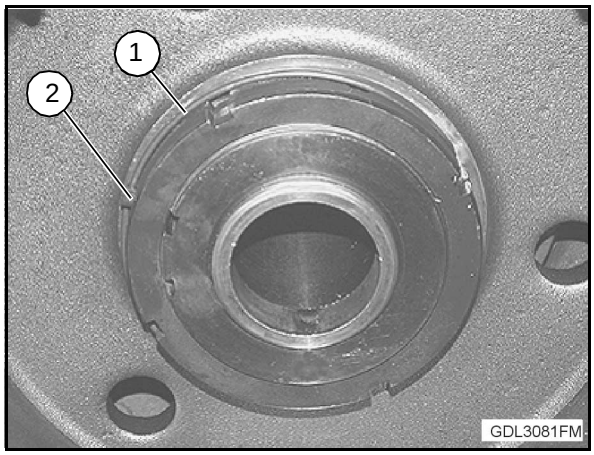


Disconnect brake cooling oil lines (1) and hydraulic line (2). Close all openings with caps and plugs.

Drain wet disk brake housing. **(See Change Wet Disk Brake Cooling Oil - B40D Operator's Manual, CHAPTER 15, SECTION 2).**

Remove planetary cover. **(See "AXLE OUTBOARD PLANETARIES" on page 39).**

Remove axle shaft. **(See "Axle Shafts" on page 41).**



Remove retaining ring (1) and pin (2) from spanner nut. Remove spanner nut using JDG1351 Spanner Wrench.

⚠ CAUTION

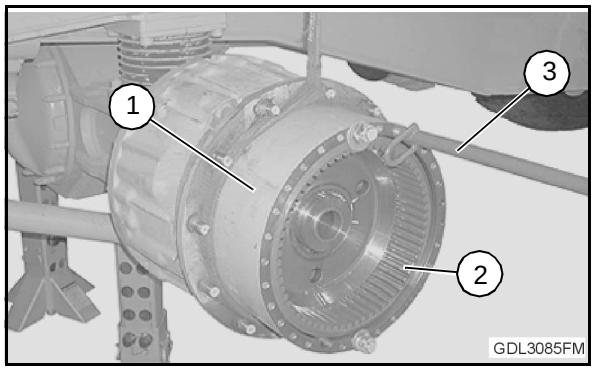
Component is heavy. Use hoist.

Axle Hubs - Specification

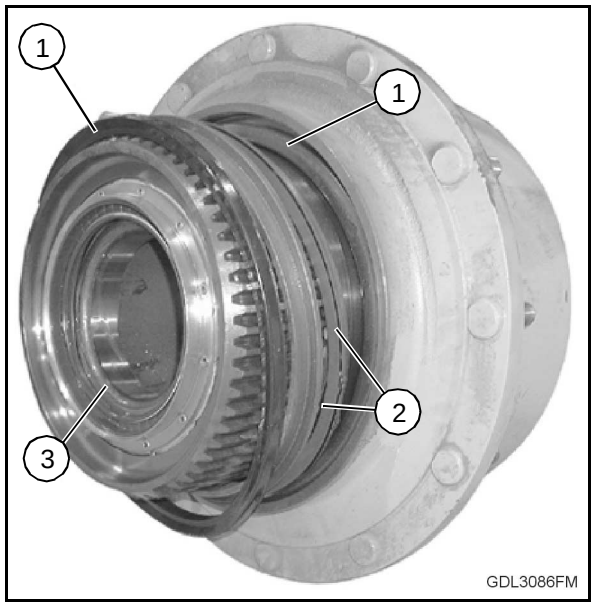
Ring Gear and Axle Hub Weight:
- - - - - - - - - - - - - - - - - - -170 kg (370 lb) approximate

⚠ CAUTION

Face seal rings and lip seal are fragile. Use care when removing axle hub from spindle.



Install hardware as necessary to retain ring gear (2) in axle hub (1). Attach sling and hoist to axle hub. Install DFT1178 Lifting Tool (3) on axle hub. Use pry bar between axle hub and brake housing. Remove axle hub from spindle.

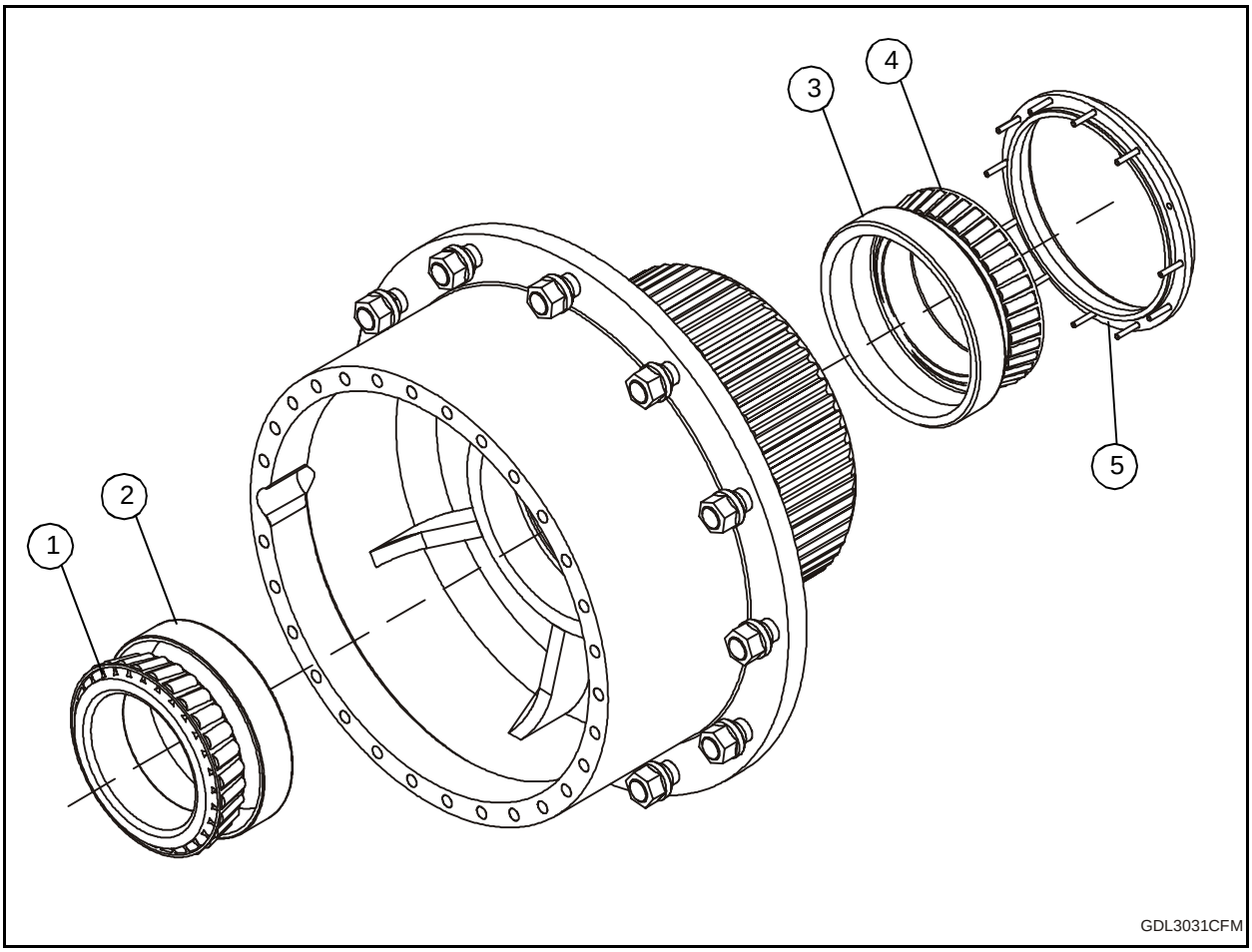


Remove face seal metal rings (2) and face seal rubber rings (1). Remove lip seal (3), if necessary.

Remove ring gear from axle hub.

Remove bearing cones and cups, if necessary.

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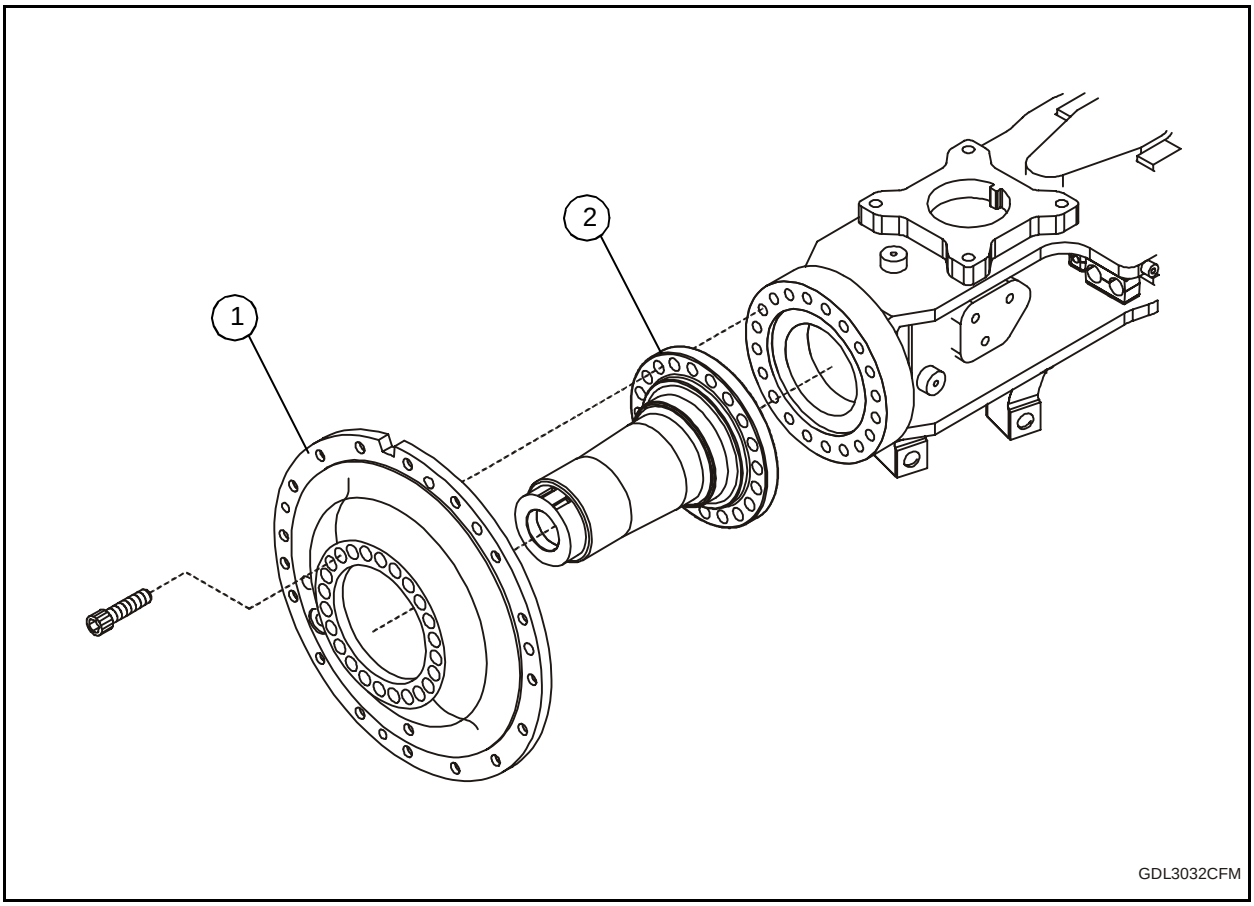
1. Outer Bearing Cone.
2. Outer Bearing Cup.
3. Inner Bearing Cup.
4. Inner Bearing Cone.
5. Lip Seal Retainer.

- Remove outer bearing cone (1).
- Remove lip seal retainer (5) and inner bearing cone (4).
- Remove bearing cups (2 and 3).
- Clean, inspect, and replace parts as necessary.
- Install bearing cups.
- Apply cure primer and flexible form-in-place gasket to lip seal retainer mating surface. Install lip seal retainer flush with hub surface.

Remove and install spindle, if necessary.

- a. Remove brake housing. **(See “Service Brakes B40D” on page 242).**

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1. Brake Housing Cover Plate.
2. Spindle.

⚠ CAUTION

Components are heavy. Use hoist.

- Remove two socket head cap screws and install guide pins.
- Attach hoist to brake housing cover plate (1) and spindle (2).
- Remove remaining socket head cap screws.
- Remove cover plate and spindle.
- Clean, inspect, and replace parts as necessary.
- Install spindle and cover plate.
- Install socket head cap screws.
- Remove guide pins and install remaining socket head cap screws.
- Install brake housing. **(See "Service Brakes B40D" on page 242).**

Clean, inspect, and replace parts as necessary.

Install lip seal, if removed.

Ensure lip seal is clean. Apply a thin coating of axle oil to seal inner edge.

With isopropyl alcohol, thoroughly clean and dry face seal rubber rings, face seal metal rings, face seal seat on brake housing, and face seal seat on axle hub.

Install metal rings into rubber rings. Install face seal ring assemblies into seats.

Apply a thin coating of brake cooling oil to wear surfaces of face seal metal rings.

Align axle hub and brake disk splines. Install axle hub. Install outer bearing. Install ring gear.

Install spanner nut and tighten until nut contacts ring gear.

Install DF1002 Rolling Drag Torque Bar in hub.

Check rolling drag using a beam torque wrench. Tighten spanner nut to specification.

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Axle Hubs Specification

Ring Gear Hub Bearings (Dry) Rolling Drag Torque:
- 40 - 50 Nm (29 - 33 lb-ft)

Ring Gear Hub Bearings (Lubricated) Rolling Drag:
- - - - - - - - - - - - - - - - Torque 18 - 20 Nm (13 - 15 lb-ft)

Align hole in spanner nut to slot in spindle. Install pin in spanner nut hole and install retaining ring in groove on spanner nut.

Perform wet disk brake cooling oil leakage check. **(See "Service Brakes B40D" on page 242).**

Install axle shaft. **(See "Axle Shafts" on page 41).**

2Install planetary cover. **(See "AXLE OUTBOARD PLANETARIES" on page 39).**

Connect wet disk brake cooling lines and hydraulic line.

Fill axle hub. **(See Change Final Drive Oil Operator's Manual, CHAPTE 15, SECTION2).**

Fill axle. **(See Change Axle Oil Operator's Manual, CHAPTER 15, SECTION 2).**

Fill wet disk brake housing. **(See Change Wet Disk Brake Cooling Oil - B40D Operator's Manual, CHAPTER 15, SECTION 2).**

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CHAPTER 3. TRANSMISSION

SECTION 1.REMOVAL AND INSTALLATION

REMOVE AND INSTALL TRANSMISSION

Engine and transmission are removed together. Remove engine and transmission, then remove transmission from engine. **(See “ENGINE” on page 105).**

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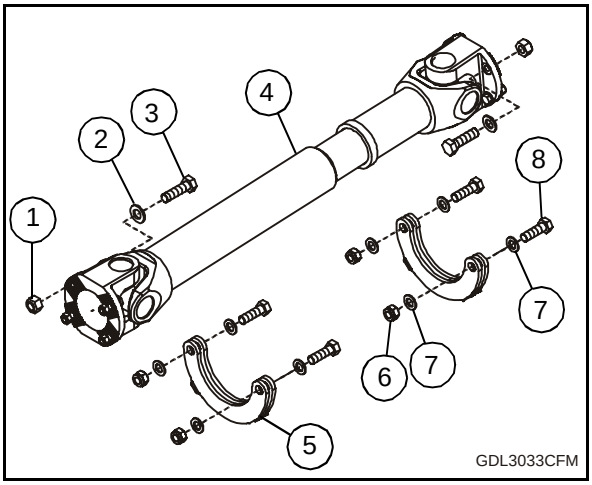
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SECTION 2. INPUT DRIVE SHAFTS AND U-JOINTS

REMOVE AND INSTALL TRANSMISSION-TO-TRANSFER CASE DRIVE SHAFT

Tilt cab. **(See Tilt Cab Operator's Manual CHAPTER 7, SECTION1).**



1. Nut (8 used).
2. Washer (8 used).
3. Cap Screw (8 used).
4. Drive Shaft Assembly.
5. Guard (2 used).
6. Nut (4 used).
7. Washer (8 used).
8. Cap Screw (4 used).

Remove nuts (6), washers (7), cap screws (8), and guards (5).

Remove cap screws (3), washers (2), and nuts (1) from flanges of drive shaft assembly (4).

⚠ CAUTION

Component is heavy. Use hoist.

Specification

Transmission-to-Transfer Case Drive Shaft Weight:
- -91 kg (200 lb) approximate

Remove drive shaft assembly.

Inspect and replace parts as necessary.

⚠ WARNING

Assemble drive shaft so yokes on ends of the shaft are aligned. If yokes are not aligned, severe vibration and machine damage may result.

Assemble drive shaft so yokes are aligned.

Apply rigid form-in-place gasket to cap screws (3). Install nuts (1), washers (2), and cap screws. Tighten to specification.

Specification

Drive Shaft Universal Joint Cap Screw Torque:
- 210 Nm (154 lb-ft)

Install guards, washers, cap screws, and nuts.

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CHAPTER 3. TRANSMISSION

SECTION 3. GEAR, SHAFT AND POWER SHIFT CLUTCHES

DISASSEMBLE TRANSMISSION

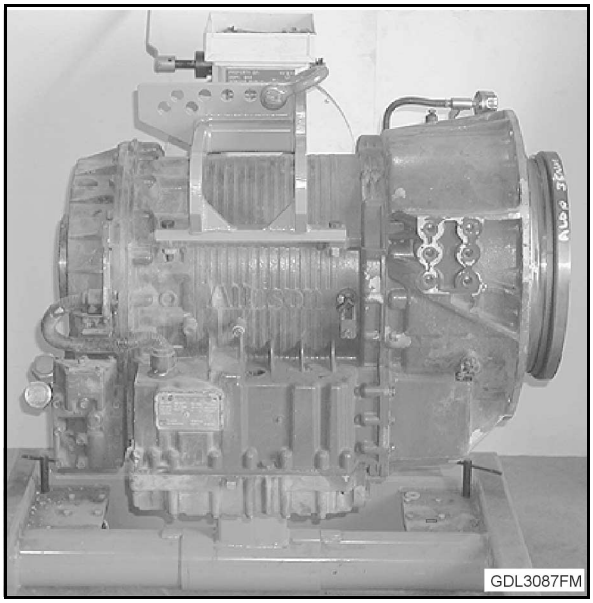
Clean and drain transmission to prevent contamination of parts.

⚠ CAUTION

The approximate weight of transmission is 499 kg (1100 lb).

Transmission Specification

Transmission Weight:
- - - - - - - - - - - - - - - - - - - -499 kg (1100 lb) approximate



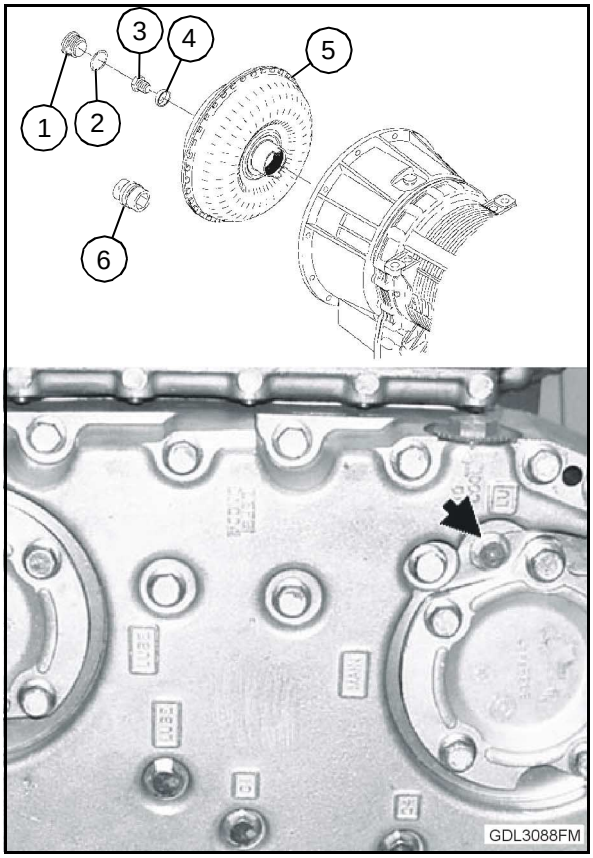
Install JDG1501-6 Main Case Holding Fixture on main housing so dipstick side is away from mounting plate.

Fasten holding fixture to repair stand D05223ST Engine Repair Stand.

Remove all sensors and output flange.

Position transmission with torque converter up.

Remove any brackets on torque converter that restrict movement of converter.



1. Plug.
2. O-Ring.
3. Cap Screw.
4. Shim.
5. Torque Converter.
6. Cap Screw Removal Tool.

Remove threaded plug (1) and O-ring (2).

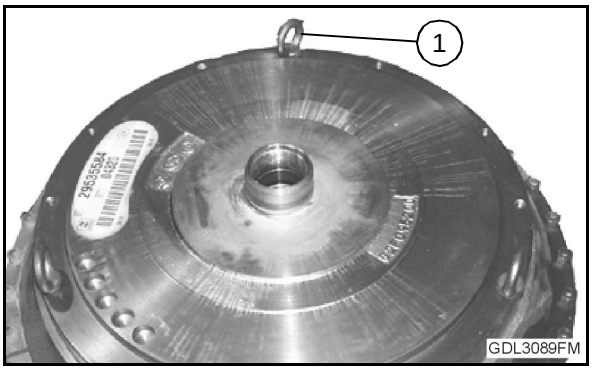
Apply air pressure to lock up test port to hold converter and turbine shaft stationary.

Use JDG1501-12 Spanner Nut Tool (6) to remove cap screw (3) and shim (4).

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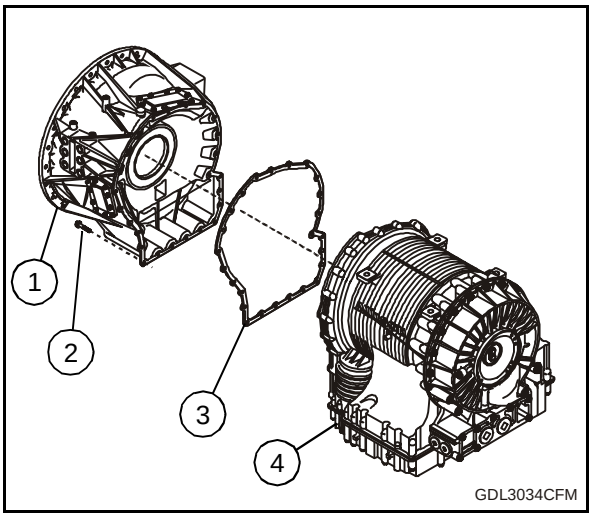
⚠ CAUTION

Heavy componet use hoist.



Install three eye bolts (1) equally spaced in torque converter cover and lift with hoist.

Store torque converter on wooden blocks tall enough to keep converter hub from contacting work bench.

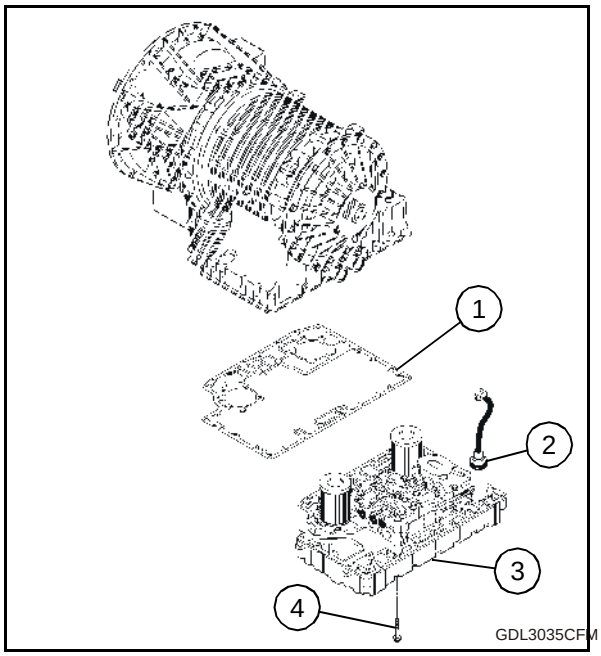


1. Torque Converter Housing.
2. Cap Screw (25 used).
3. Gasket.
4. Main Housing.

Remove cap screw (2) to remove torque converter housing (1).

Remove the seven cap screws from inside the converter housing using mechanical fingers.

Position transmission with control valve up.



1. Gasket.
2. Standoff and Harness Connector.
3. Control Valve.
4. Cap Screw (43 used).

Remove cap screws (4) holding control valve.

Remove harness connector, snap ring, and bracket.

⚠ CAUTION

The approximate weight of control valve is 25 kg (56 lb).

Transmission Specification

Control Valve Weight - - - - - 25 kg (56 lb) approximate

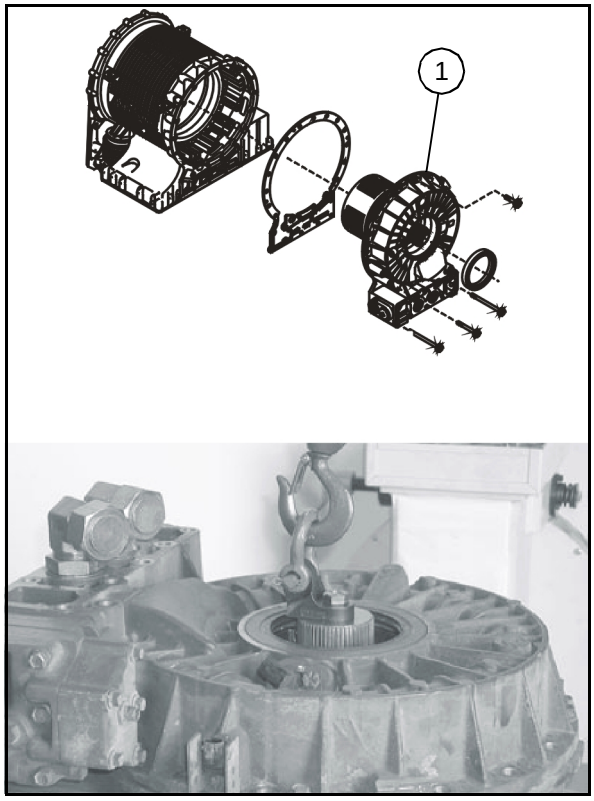
Remove control valve (3) and gasket (1) by either prying up on reinforced tabs or using jack bolts.

Position transmission with output shaft up.

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⚠ CAUTION

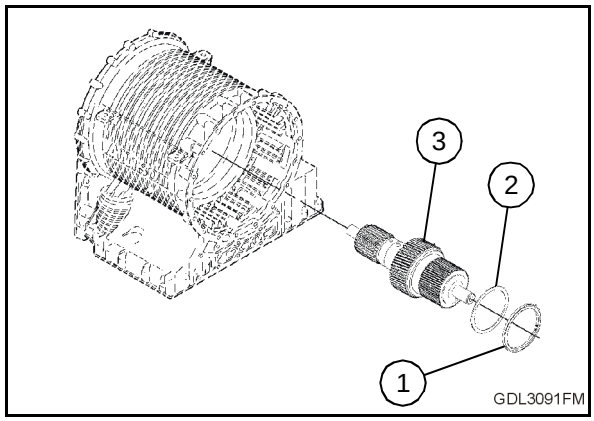
The approximate weight of Retarder is 34 kg (75 lb).



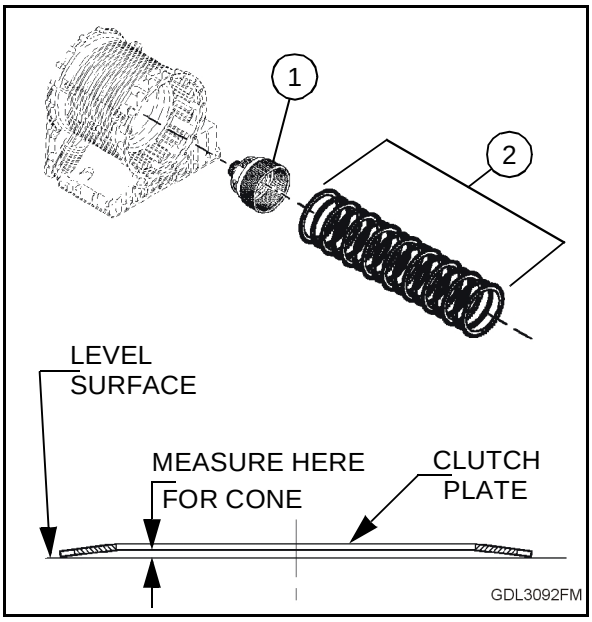
Transmission Specification

Retarder Weight - - - - - - - - - 34 kg (75 lb) approximate

Remove retarder (1) using M10 lifting eye bolt and hoist. Retarder includes P3 planetary and C5 piston.



Remove thrust bearing (1), shim (2), and main shaft (3).



Remove P2 planetary (1) from housing

Remove C5 clutch pack (2) from housing. Inspect plates for wear.

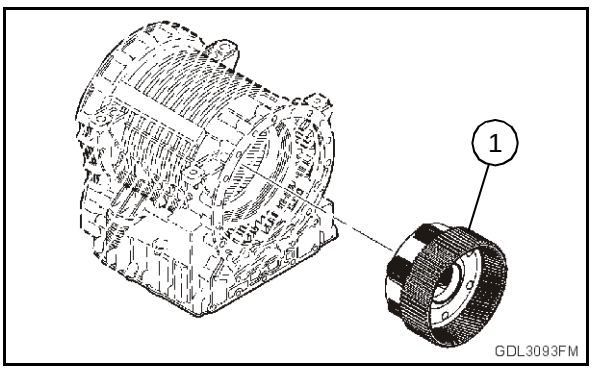
Transmission Specification

C5 Friction Plate Minimum Thickness
- 3.48 mm (0.137 in.)

C5 Friction Plate Oil Groove Minimum Depth
- 0.20 mm (0.008 in.)

C5 Reaction Plate Minimum Thickness
- 2.41 mm (0.095 in.)

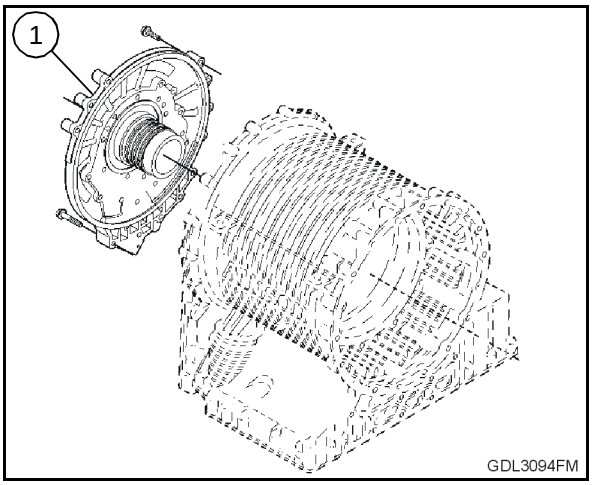
C5 Plate Cone Maximum Cone
- 0.25 mm (0.010 in.)



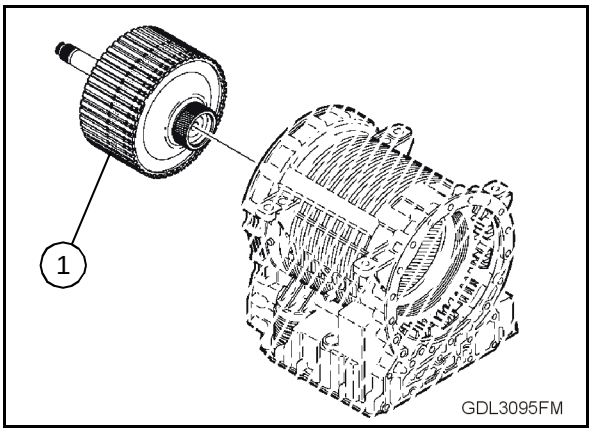
Remove P1 planetary (1) from main housing.

Position transmission with input shaft up.

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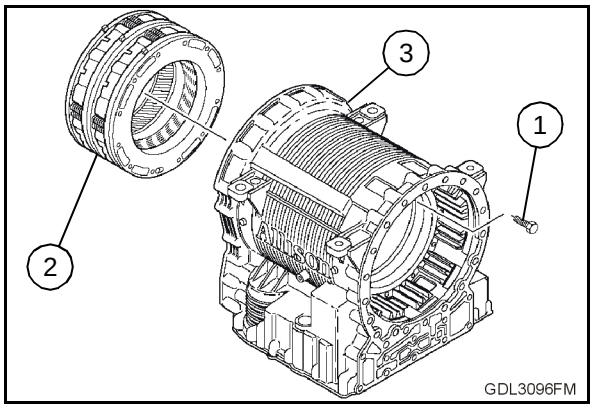
Loosen cap screws and remove front support (1).



Remove turbine shaft and C1/C2 clutch module (1) from main housing using M16 eye bolt and hoist.

Store C1/C2 clutch module so that it will not roll and be damaged.

Position main housing horizontally.



Remove cap screws (1) and C3/C4 clutch (2) by sliding it out input end of main housing (3).

Remove main housing from stand for cleaning and inspection.

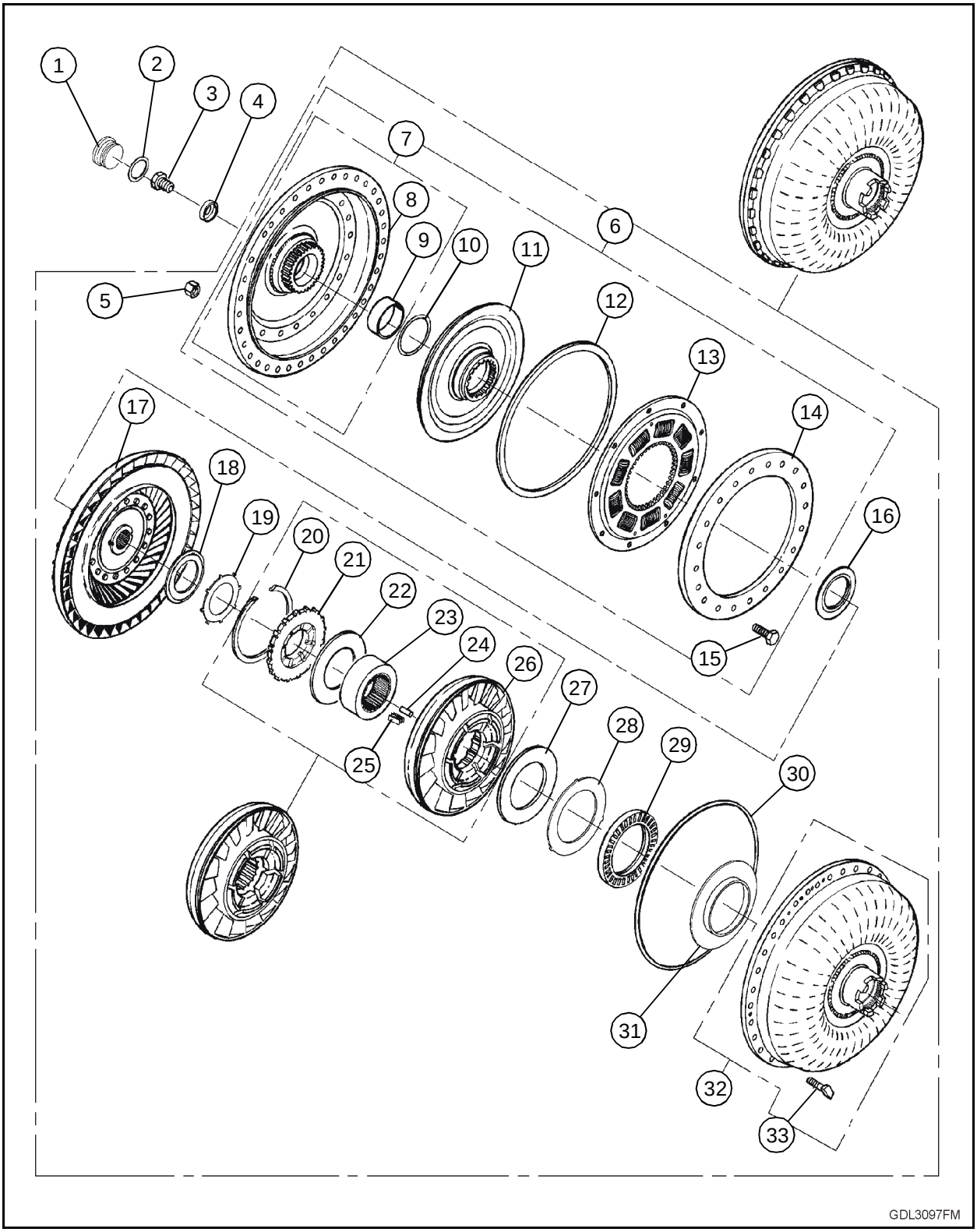
Inspect main housing clutch plate splines.

Transmission Specification

Clutch Plate Splines Maximum Wear:
- 1.15 mm (0.045 in.)

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DISASSEMBLE AND ASSEMBLE TORQUE CONVERTER



1. Converter End Plug.
2. O-Ring.
3. Cap Screw.
4. Shim.
5. Nut (36 used).
6. Torque Converter Cover (complete).
7. Converter Cover.
8. Converter Cover.
9. Bushing.
10. Lockup Piston Seal Ring.
11. Lockup Clutch Piston.
12. Lockup Piston Seal Ring.

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13. Dampener.
14. Lockup Clutch Backplate.
15. Cap Screw (44 used).
16. Thrust Bearing.
17. Turbine.
18. Thrust Bearing.
19. Star Washer.
20. Snap Ring.
21. Stator Thrust Plate.
22. LH Stator Thrust Washer.
23. Stator Race.
24. Stator Roller (13 used).
25. Stator Spring (13 used).
26. Stator Cam.
27. Shim.
28. Pump Thrust Bearing Race.
29. Pump Thrust Bearing.
30. O-Ring.
31. Thrust Bearing Race.
32. Torque Converter Pump.
33. T-Head Cap Screw (36 used).

Place torque converter on flat surface with oil pump tangs downward. Support on wooden blocks that keep oil pump tangs from contacting workbench.

Scribe a line on converter cover (7) and torque converter pump (32) to maintain converter balance and aid in assembly.

Disassemble torque converter.

Measure stator thrust plate (21) thickness.

Torque Converter Specification

Stator Thrust Plate Minimum Thickness
- 9.45 mm (0.372 in.)

Measure thickness of lockup clutch backplate (14) wear surface.

Torque Converter Specification

Lockup Clutch Backplate Minimum Thickness
- 11.79 mm (0.464 in.)

Lockup Clutch Backplate Maximum Distortion
- 0.15 mm (0.006 in.)

Remove dampener (13) from converter cover (7).

Measure thickness across lockup clutch friction surfaces.

Torque Converter Specification

Lockup Clutch Friction Surface Minimum Thickness
- 8.51 mm (0.335 in.)

Maximum Distortion
- 0.51 mm (0.020 in.)

Measure spline wear between turbine (17) and dampener (13).

Torque Converter Specification

Turbine and Dampener Spline Wear Maximum Play
- 0.38 mm (0.015 in.)

Remove lockup clutch piston (11).

Remove seal rings (10 and 12) from lockup clutch piston.

Measure thickness of lockup clutch piston.

Torque Converter Specification

Lockup Clutch Piston Minimum Thickness
- 6.53 mm (0.257 in.)

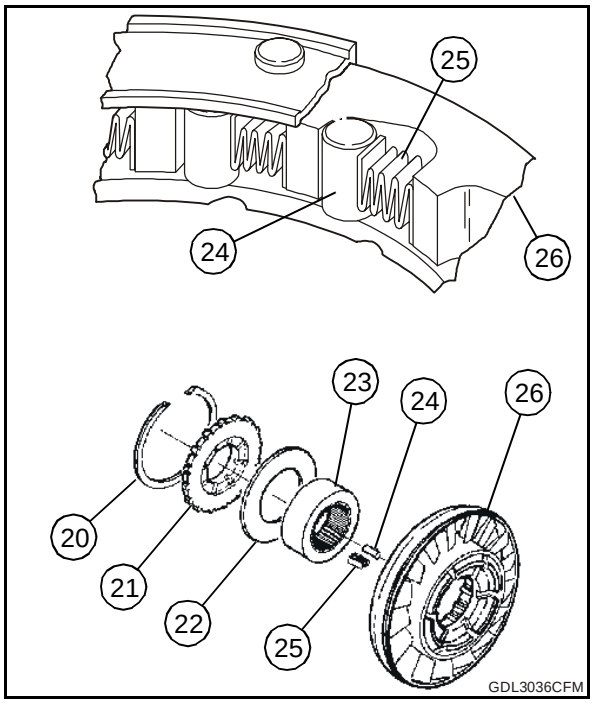
Torque Converter Cover

Bushing Maximum Inside Diameter
- 66.91 mm (2.634 in.)

Remove thrust bearing (16).

Inspect all parts for wear or damage. Replace as necessary.

Install stator race (23) into stator cam (26).



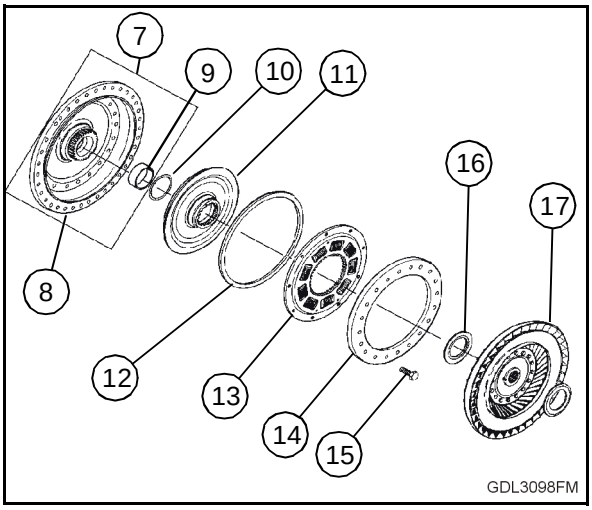
Lubricate and install stator rollers (24) and stator springs (25) into stator cam (26).

Install roller into small end of stator cam pocket.

Install stator thrust washer (22) and stator thrust plate (21) onto stator cam (26).

Install snap ring (20).

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If removed, install bushing (9) into bore of cover (8) using bushing installer.

If new bushing is installed, position turbine (17) into new bushing and check for freedom of movement.

Remove turbine after checking for movement.

Install lockup clutch piston seal rings (10 and 12).

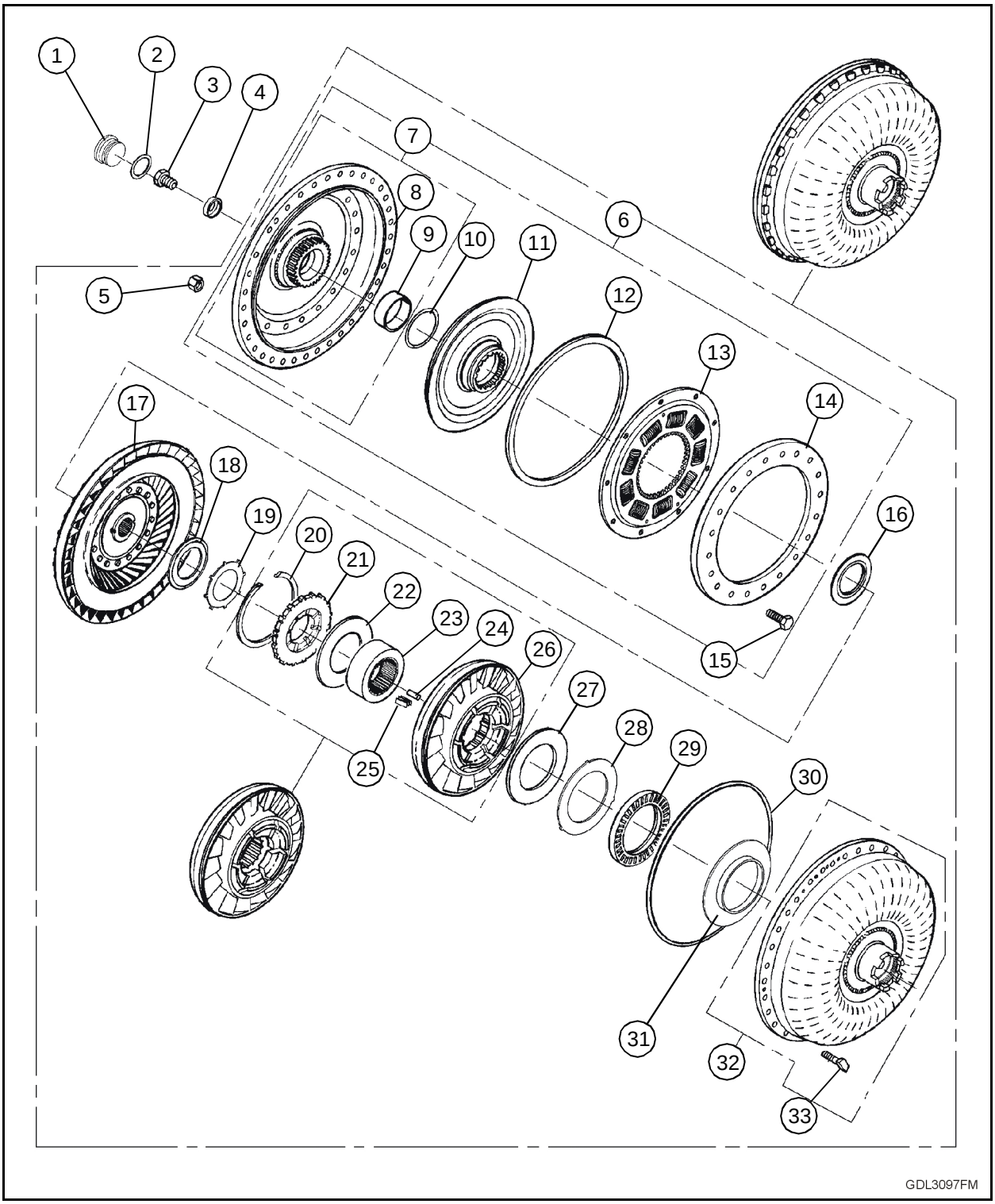
Install lockup clutch piston (11), dampener (13) and lockup clutch backplate (14) in cover (8) with cap screws (15).

Torque Converter Specification

Clutch Backplate Cap Screw Torque
- -30 Nm (22 lb-ft)

Install thrust bearing (16) and turbine (17).

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1. Converter End Plug.
2. O-Ring.
3. Cap Screw.
4. Shim.
5. Nut (36 used).
6. Torque Converter Cover (complete).
7. Converter Cover.
8. Converter Cover.
9. Bushing.
10. Lockup Piston Seal Ring.
11. Lockup Clutch Piston.
12. Lockup Piston Seal Ring.
13. Dampener.
14. Lockup Clutch Backplate.
15. Cap Screw (44 used).
16. Thrust Bearing.
17. Turbine.
18. Thrust Bearing.
19. Star Washer.
20. Snap Ring.
21. Stator Thrust Plate.
22. LH Stator Thrust Washer.
23. Stator Race.
24. Stator Roller (13 used).
25. Stator Spring (13 used).
26. Stator Cam.
27. Shim.
28. Pump Thrust Bearing Race.
29. Pump Thrust Bearing.
30. O-Ring.
31. Thrust Bearing Race.
32. Torque Converter Pump.
33. T-Head Cap Screw (36 used).

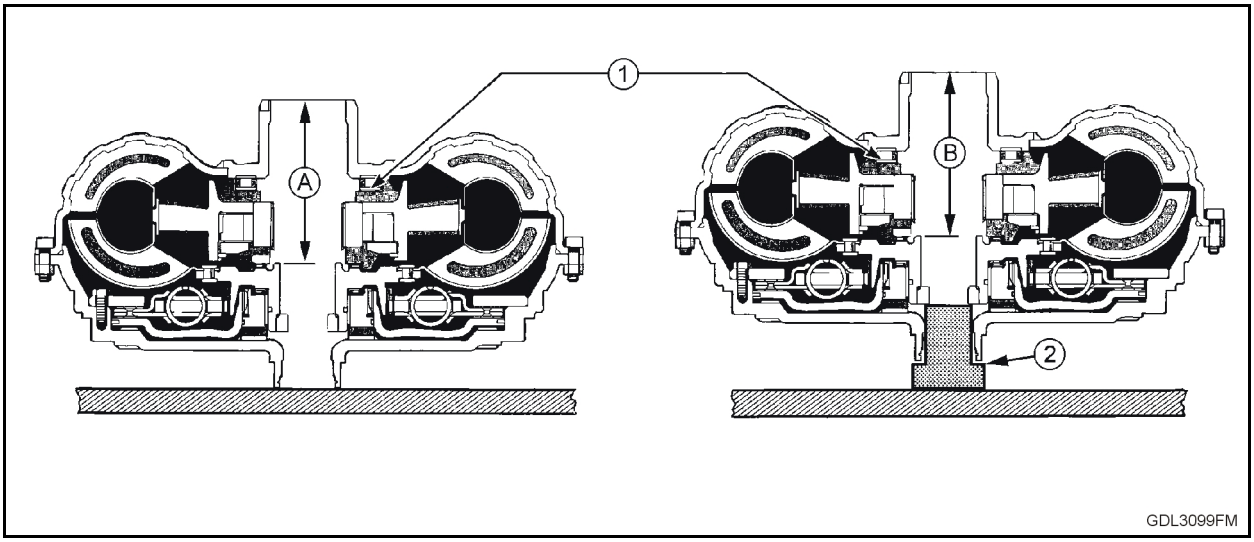
Install parts (27 - 31).

Align scribe marks on converter cover and pump.

Install four nuts (5) and cap screws (33) evenly spaced on torque converter.

Torque Converter Specification

Torque Converter Cover Cap Screw Torque
- 33 Nm (24 lb-ft)



A. Measurement Without End Play Gauge.
1. Shim Location.
B. Measurement With End Play Gauge.
2. End Play Gauge.

With converter on flat surface, measure distance from top of torque converter cover to thrust surface of turbine assembly with depth micrometer. Record as dimension A.

Place JDG1501-13 End Play Gauge into converter cover and measure again. This is dimension B.

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Subtract dimension B from dimension A to get dimension C.

Use table to determine proper shim to be used.

NOTE: If new shim is required, torque converter must be disassembled and proper shim installed.

Torque Converter Turbine Hub Shims

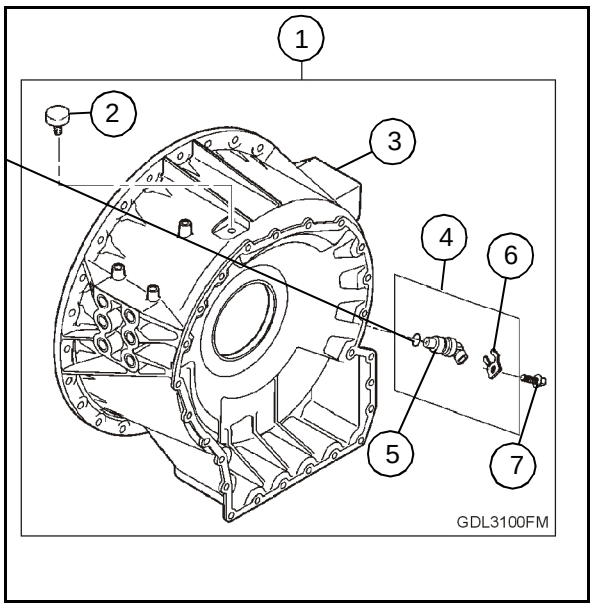
Dimension C	Part Number	Shim Thickness
0.153 - 0.35 mm (0.006—0.014 in.)	–	0.000
0.36 - 0.58 mm (0.014—0.023 in.)	AT256597	0.27 mm (0.011 in.)
0.59 - 0.81 mm (0.023—0.032 in.)	AT256596	0.48 mm (0.019 in.)
0.81 - 1.00 mm (0.032—0.040 in.)	AT256595	0.711 mm (0.028 in.)

Install remaining nuts (5) and cap screws (33).

Torque Converter Specification

Torque Converter Cover Cap Screw Torque
- 33 Nm (24 lb-ft)

Disassemble and Assemble Torque Converter Housing



1. Torque Converter Housing.
2. Breather.
3. Converter Housing.
4. Transmission Input Speed Sensor.
5. O-Ring.
6. Transmission Input Speed Sensor Retainer.
7. Cap Screw.

Remove breather (2) and transmission input speed sensor (4).

Transmission Specification

Transmission Input Speed Sensor Resistance
- 300 ± 30 ohms

Inspect all components for wear or damage. Replace if necessary.

Install breather (2) and transmission input speed sensor (4).

Transmission Specification

Breather Vent Torque- - - - - - - - - - - 14 Nm (124 lb-in.)

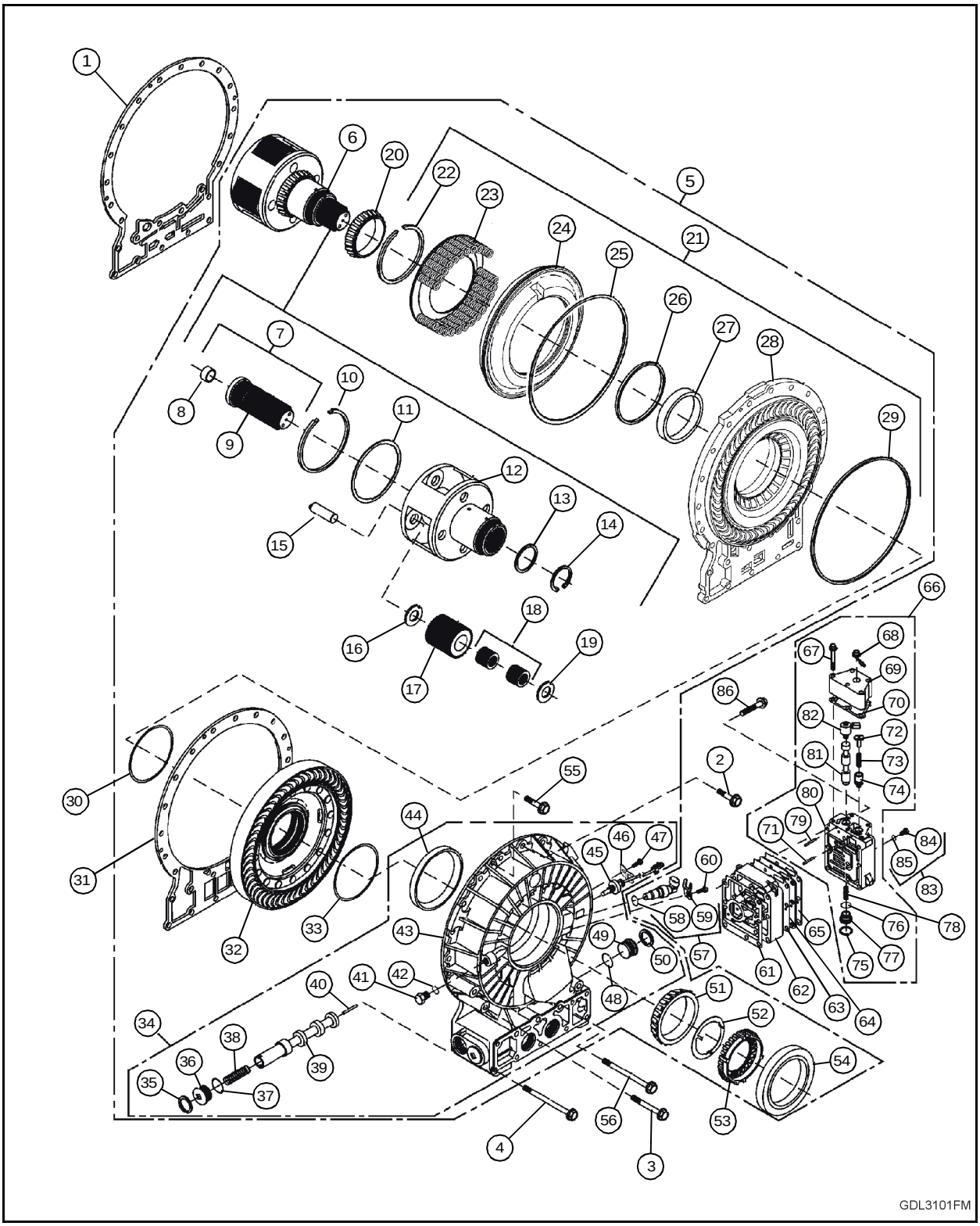
Transmission Input Speed Sensor Cap Screw Torque
- 27 Nm (20 lb-ft)

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Disassemble and Assemble Retarder and P3 Planetary



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1. Retarder Housing Gasket.
2. Cap Screw (12 used).
3. Cap Screw (2 used).
4. Cap Screw (7 used).
5. Retarder and P3 Planetary Module.
6. P3 Planetary Carrier.
7. Output Shaft Assembly.
8. Bushing.
9. Output Shaft.
10. Internal Retaining Ring.
11. P3 Indexing Ring.
12. P3 Planetary Carrier.
13. Thrust Washer.
14. External Retaining Ring.
15. P3 Planetary Spindle (4 used).
16. P3 Thrust Washer (4 used).
17. P3 Pinion Gear (4 used).
18. Roller Bearing (8 used).
19. P3 Thrust Washer (4 used).
20. Roller Bearing Assembly.
21. Retarder Stator Assembly.
22. External Retaining Ring.
23. Spring and Retainer Assembly.
24. C5 Clutch Piston.
25. C5 Piston Seal Ring.
26. C5 Piston Seal Ring.
27. Roller Bearing Cup.
28. Retarder Stator.
29. O-Ring.
30. Retarder Seal Ring.
31. Retarder Housing Gasket.
32. Rotor Assembly.
33. Retarder Seal Ring.
34. Retarder Housing Assembly.
35. Retaining Ring.
36. Valve Plug.
37. O-Ring.
38. Valve Spring.
39. Retarder Valve.
40. Spring Pin.
41. Tachograph Plug.
42. Tachograph Plug Washer.
43. Retarder Housing.
44. Roller Bearing Cup.
45. Temperature Sensor Assembly.
46. Retainer.
47. Cap Screw.
48. O-Ring.
49. Valve Plug.
50. Retaining Ring.
51. Roller Bearing Assembly.
52. Lock Nut Retainer.
53. Bearing Lock Nut.
54. Oil Seal.
55. Cap Screw (3 used).
56. Cap Screw (4 used).
57. Speed Sensor.
58. O-Ring.
59. Speed Sensor Retainer.
60. Cap Screw.
61. Channel Plate Gasket.
62. Channel Plate.
63. Separator Plate Gasket.
64. Solenoid Separator Plate.
65. Separator Plate Gasket.
66. Retarder Control Body Assembly.
67. Cap Screw (5 used).
68. Solenoid Connector.
69. Solenoid Cover.
70. Solenoid Cover Gasket.
71. Retaining Pin.
72. Valve Stop.
73. Spring.
74. Exhaust Back-Fill Valve.
75. Retaining Ring.
76. O-Ring.
77. Plug.
78. Spring.
79. Retaining Pin.
80. Retarder Control Body.
81. Retarder Control Valve.
82. Solenoid.
83. Pressure Tap Plug Assembly.
84. Pressure Tap Plug.
85. O-Ring.
86. Cap Screw (9 used).

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Remove retarder control body (66).

Remove channel plate (62), solenoid separator plate (64) and gaskets.

Remove solenoid cover (69) and gaskets.

Remove retaining pin (79) and solenoid (82) from retarder control body (80).

Check resistance of retarder solenoid.

Retarder Specification

Control Solenoid Resistance- - - - - - - - - - - 2 - 5 ohms

Remove retarder control valve (81). Inspect for wear or damage.

Remove pin (71), parts (72—78).

Remove temperature sensor (45).

Remove output speed sensor (57) and check resistance.

Retarder Specification

Output Speed Sensor Maximum Resistance
- 300 ±30 ohms

Remove tachograph plug (41) and washer.

Remove plug (49).

Remove parts (35—39). Remove spring pin (40) only if damaged.

Remove seal (54).

Bend tab on lock nut retainer (52) and remove lock nut (53) using Spanner Nut Torque Tool JDG1501-12.

Support retarder housing to allow P3 carrier removal using JDG1501-12 and press.

Remove cap screws (55) and retarder gasket (31).

Remove rotor assembly (32) and inspect splines.

Retarder Specification

Rotor Assembly Splines Maximum Wear
- 0.38 mm (0.015 in.)

If replacement is needed remove bearing assembly (51).

Remove retaining ring (14) and thrust washer (13) to remove output shaft (7).

Inspect splines.

Retarder Specification

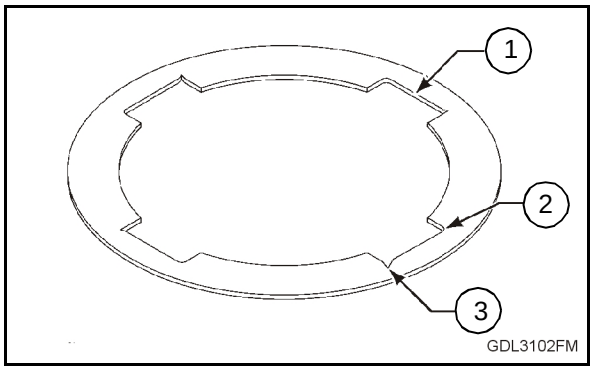
Output Shaft and P3 Carrier Splines Maximum Wear
- 0.38 mm (0.015 in.)

If replacement is needed remove bearing assembly (20).

Measure P3 pinion gear end play with feeler gauge.

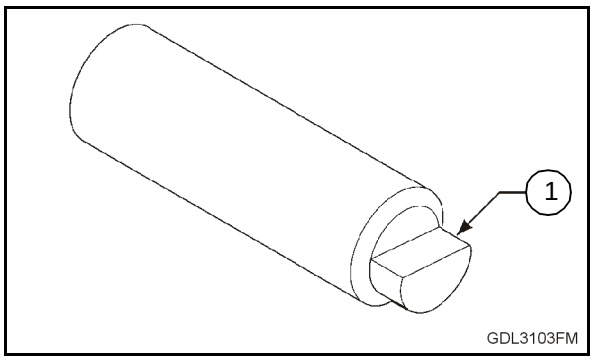
P3 Planetary Specification

Pinion Gear End Play
- - - - - - - - - - - - - - - - - - - 0.94 mm (0.037 in.) Maximum



1. Indexing Flat.
2. No Wear.
3. Abnormal Wear.

Remove retaining ring (10) and inspect indexing ring (11). Check spindles (15) for abnormal wear where the spindles contact indexing ring.

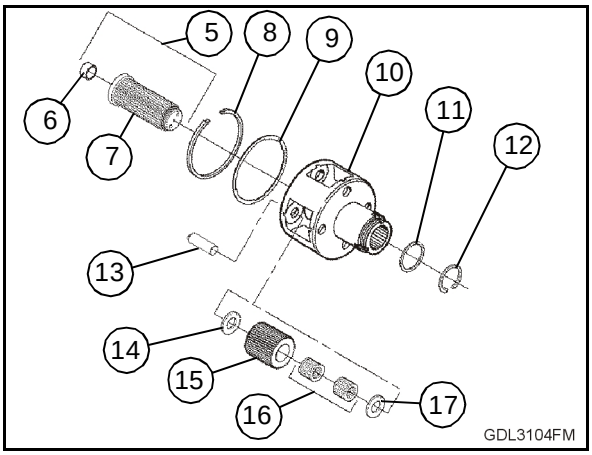


Inspect planetary spindles. If the planetary spindles have a sharp edge (1) instead of a radius edge, replace spindles.

P3 Planetary Specification

Planetary Spindle Edge Wear Wear Added Radius
- - - - - - - - - - - - - - - - - - - 0.25 - 1.50 mm (0.01 - 0.059)

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1. Spindle Edge.
5. Output Shaft (Complete).
6. Bushing.
7. Output Shaft.
8. Retaining Ring.
9. Indexing Ring.
10. P3 Planetary Carrier.
11. Thrust Washer.
12. Retaining Ring.
13. P3 Planetary Spindle (4 used).
14. Thrust Washer (4 used).
15. P3 Pinion Gear (4 used).
16. Roller Bearing (8 used).
17. Thrust Washer (4 used).

Measure thickness of thrust washers (14 and 17).

P3 Planetary Specification

Thrust Washers Minimum Thickness
- 1.40 mm (0.055 in.)

Thrust Washer Step Wear Maximum Depth
- 0.12 mm (0.005 in.)

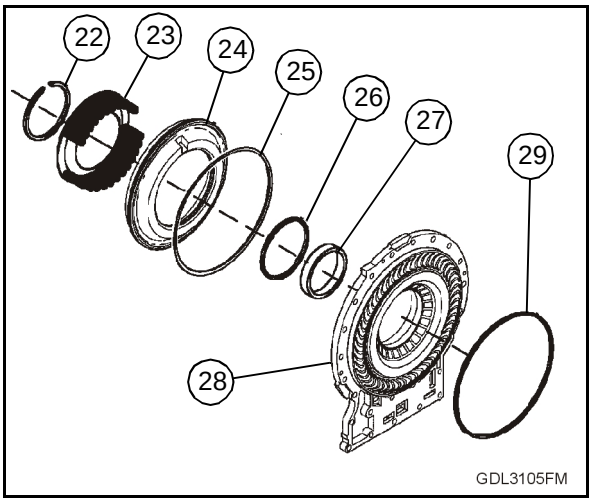
Inspect bushing (6) inside the end of output shaft (7) for wear or damage.

Retarder Specification

Output Shaft Bushing Maximum Inside Diameter
- 36.14 mm (1.423 in.)

⚠ CAUTION

C5 piston springs are highly compressed. A spring compressor must be used to control the release of spring force. Personal injury can occur if spring force is not controlled.



22. Snap Ring.
23. Spring and Retainer.
24. C5 Clutch Piston.
25. C5 Piston Seal Ring.
26. Seal Ring.
27. Roller Bearing Cup.
28. Retarder Stator.
29. O-Ring.

Compress spring (23) and remove snap ring (22) using JDG1501-8 C1-C2-C5 Spring Compressor Tool and C5 Spring Compressor from JDG1501-7 C1 Spring Compressor.

NOTE: The JDG1501-7 C1 Spring Compressor includes the C1, C2, and C5 Spring Compressors.

Remove C5 clutch piston (24) from retarder stator (28).

Remove bearing cup (27) only if replacing bearing (20). Cup is a press fit.

Inspect all parts for wear or damage. Replace as necessary.

Install bearing cup (27) if removed.

Install inner seal rings (25 and 26) onto C5 clutch piston (24).

Align tab on back of C5 clutch piston (24) with notch for the piston tab in retarder stator (28) and install.

Align tab on spring retainer with notch in retarder stator.

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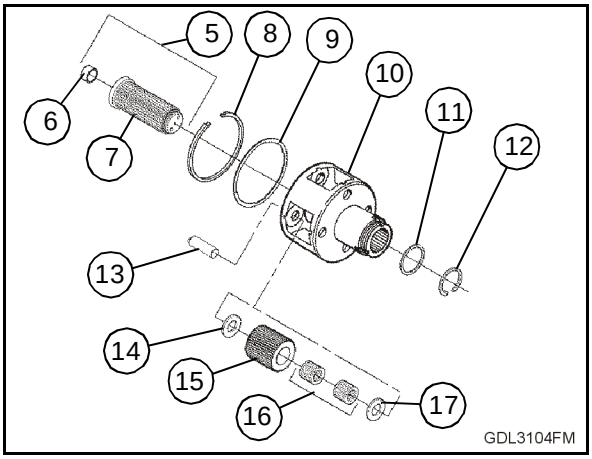
⚠ CAUTION

C5 piston springs are highly compressed. A spring compressor must be used to control the release of spring force. Personal injury can occur if spring force is not controlled.

Compress spring and retainer using the JDG1501-8 C1-C2-C5 Spring Compressor Tool and the C5 Spring Compressor from JDG1501-7 C1 Spring Compressor.

Install snap ring (22) so ends clear tab in spring retainer.

Assemble P3 planetary.



5. Output Shaft (Complete).
6. Bushing.
7. Output Shaft.
8. Retaining Ring.
9. Indexing Ring.
10. P3 Planetary Carrier.
11. Thrust Washer.
12. Retaining Ring.
13. P3 Planetary Spindle (4 used).
14. Thrust Washer (4 used).
15. P3 Pinion Gear (4 used).
16. Roller Bearing (8 used).
17. Thrust Washer (4 used).

Planetary spindles must not rotate after indexing rings have been installed or lubrication flow may be blocked.

When indexing ring slots are worn on one corner (normal wear condition), flip indexing ring over to obtain new, unworn contact surface. If both surfaces are worn, replace indexing ring.

If components were replaced check pinion end play with feeler gauge.

P3 Planetary Specification

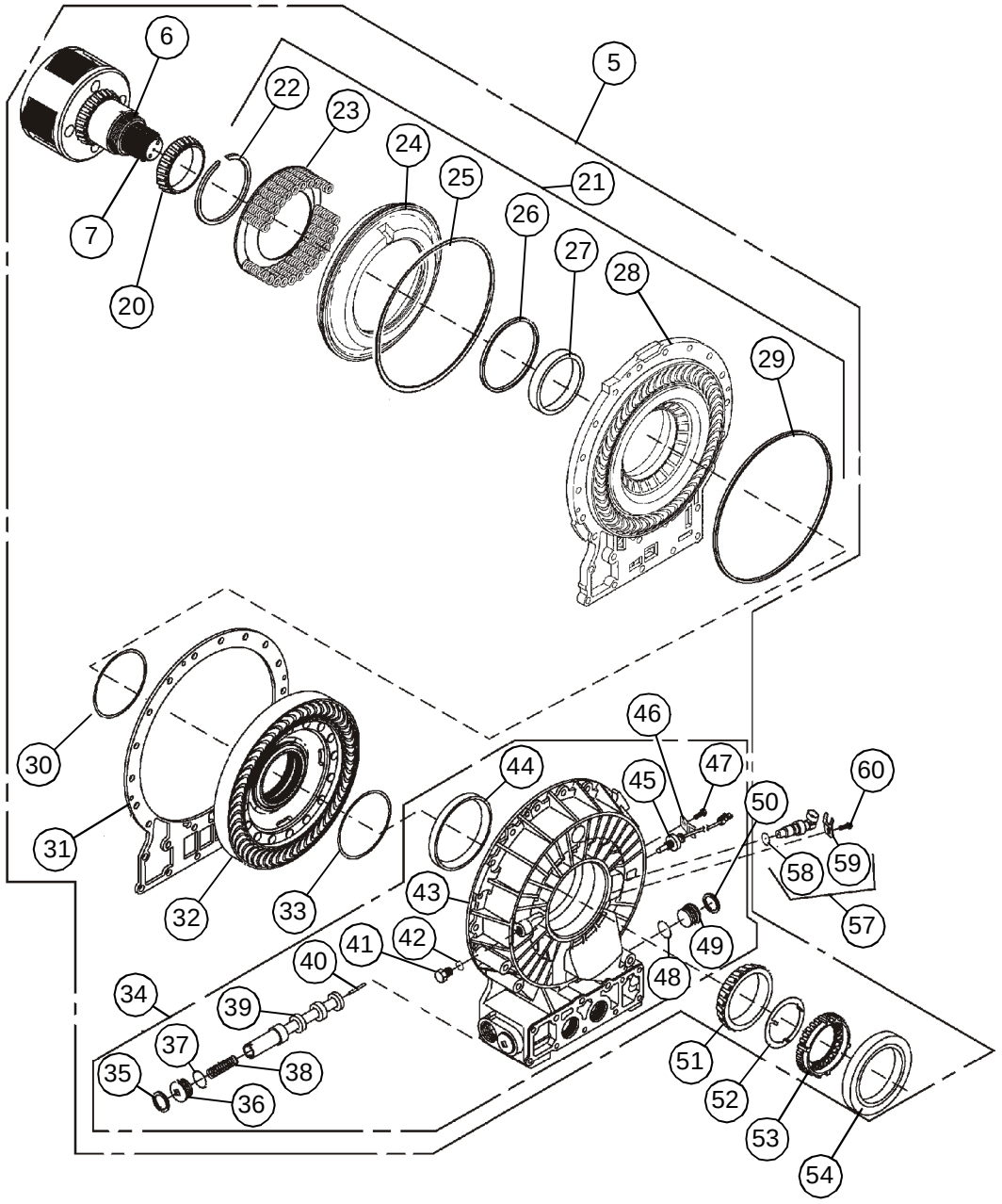
Pinion Gear End Play
- - - - - - - - - - - - - - - - - - 0.94 mm (0.037 in.) Maximum

Thrust Washer Step Wear Maximum Depth
- 0.12 mm (0.005 in.)

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5. Retarder and P3 Planetary Assembly.
6. P3 Planetary Carrier.
7. Output Shaft Assembly.
20. Roller Bearing.
21. Retarder Stator Assembly.
22. Retaining Ring.
23. Spring and Retainer.
24. C5 Clutch Piston.
25. Piston Seal Ring.
26. Seal Ring.
27. Roller Bearing Cup.
28. Retarder Stator.
29. O-Ring.
30. Retarder Seal Ring.
31. Retarder Housing Gasket.
32. Rotor Assembly.
33. Retarder Seal Ring.
34. Retarder Housing Assembly.
35. Retaining Ring.
36. Valve Plug.
37. O-Ring.
38. Valve Spring.
39. Retarder Valve.
40. Spring Pin.
41. Tachograph Plug.
42. Tachograph Plug Washer.
43. Retarder Housing.
44. Roller Bearing Cup.
45. Temperature Sensor Assembly.
46. Retainer.
47. Cap Screw.
48. O-Ring.
49. Valve Plug.
50. Retaining Ring.
51. Roller Bearing Assembly.
52. Lock Nut Retainer.
53. Bearing Locknut.
54. Oil Seal.
57. Speed Sensor.
58. O-Ring.
59. Speed Sensor Retainer.
60. Cap Screw.

Install O-Ring (29).

Install output shaft assembly (7) in P3 planetary carrier.

Install thrust washer (13) and retaining ring (14).

Install bearing (20) if removed.

Install bearing cup (44) if removed.

Place P3 planetary carrier (6) on work table with output shaft up.

Install retarder stator assembly (21) on output shaft.

Install seal rings (30 and 33) on rotor (32) and place rotor on output shaft.

Install two M8 guide pins in retarder housing (43) and place gasket (31) and retarder housing over stator aligning holes.

Remove guide pins and install cap screws (55) and tighten to specification.

Retarder Specification

Retarder Housing Cap Screw Torque
- 14 Nm (124 lb-in.)

Install output speed sensor (57) and O-ring with bracket and cap screw.

Retarder Specification

Output Speed Sensor Cap Screw Torque
- -27 Nm (20 lb-ft)

Install plug (49) and O-ring (48) with retaining ring (50).

Install plug and washer (41 and 42).

Retarder Specification

Tachograph Plug Torque- - - - - - - - - - 62 Nm (46 lb-ft)

Install parts (35 - 40).

Install temperature sensor parts (45 - 47).

Retarder Specification

Temperature Sensor Cap Screw Torque
- -27 Nm (20 lb-ft)

⚠ WARNING

Press force should not exceed 10 230 N (2300 lb-force). Do not over tighten bearing lock nut (53) 200 Nm (148 lb-ft). Damage to bearings could occur. Rotate cover assembly while pressing bearing to position.

Support P3 planetary and install roller bearing (51) into retarder housing with press.

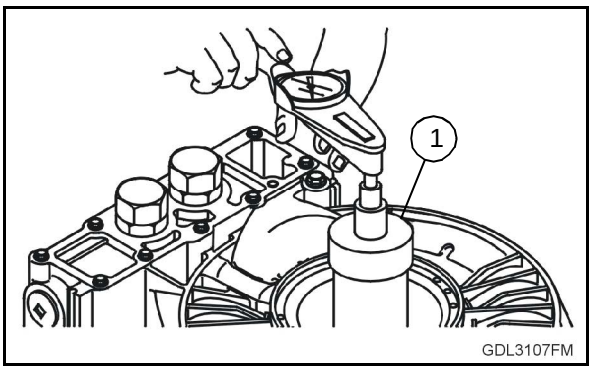
Install new lock nut retainer (52). Do not use lock nut retainer tabs more than once.

Install and tighten bearing lock nut (53) with JDG1501-12 Spanner Nut Torque Tool. Tighten lock nut to initial torque setting. Do not bend tab or install seal at this time.

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Retarder Specification

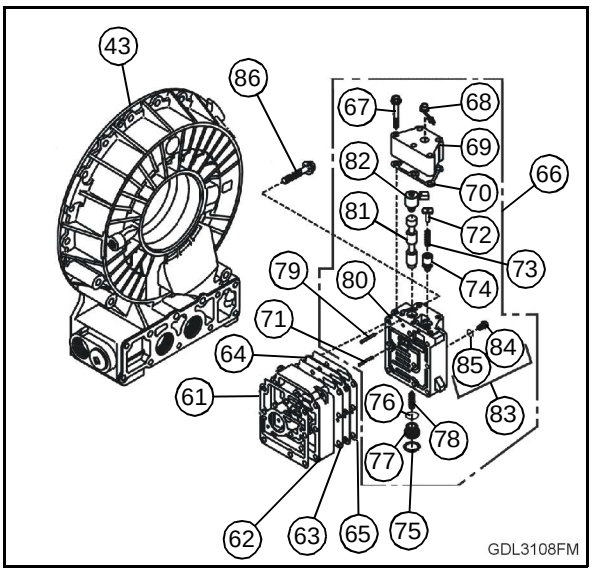
Bearing Lock Nut Initial Torque
- 200 Nm (148 lb-ft)



Check rolling drag torque of P3 carrier.

Retarder Specification

P3 Carrier Output Bearing Rolling Drag Torque
- 3 Nm (27 lb-ft) maximum



43. Retarder Housing.
61. Channel Plate Gasket.
62. Channel Plate.
63. Separator Plate Gasket.
64. Solenoid Separator Plate.
65. Separator Plate Gasket.
66. Retarder Control Body Assembly.
67. Cap Screw (5 used).
68. Solenoid Connector.
69. Solenoid Cover.
70. Solenoid Cover Gasket.
71. Retaining Pin.
72. Valve Stop.
73. Spring.
74. Exhaust Back-Fill Valve.
75. Retaining Ring.
76. O-Ring.
77. Plug.
78. Spring.
79. Retaining Pin.
80. Retarder Control Body.
81. Retarder Control Valve.
82. Solenoid.
83. Pressure Tap Plug Assembly.
84. Pressure Tap Plug.
85. O-Ring.
86. Cap Screw (9 used).

Install pressure tap plug (84) and O-ring (85).

Retarder Control Valve Specification

Pressure Tap Plug Torque - - - - - - - 12 Nm (106 lb-in.)

Install retarder control valve (81) and parts (75 - 78) into control valve body (80).

Install exhaust valve backfill valve parts (72 - 74).

⚠ CAUTION

Install solenoid retaining pin (79) in off-center hole in control valve body bore. Installing retaining pin in centerline bore will destroy solenoid.

Install solenoid (82) and retaining pin (79) smooth end first in off-center hole in control valve body.

Install parts (67 - 71) control valve body.

Retarder Control Valve Specification

Solenoid Cover Cap Screw Torque - - - 27 Nm (20 lb-ft)

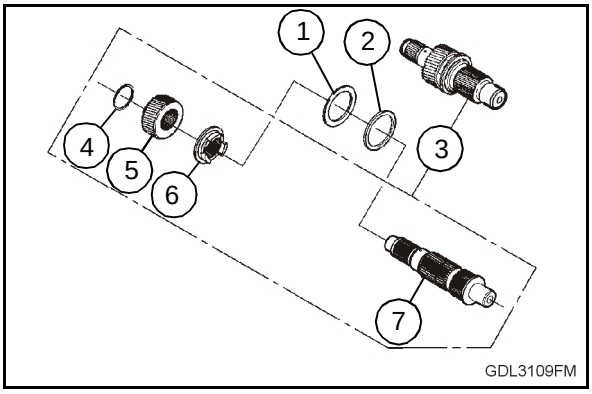
Install channel plate and solenoid plate parts (61 - 66) to retarder housing.

Retarder Control Valve Specification

Retarder Control Body Torque - - - - - - 27 Nm (20 lb-ft)

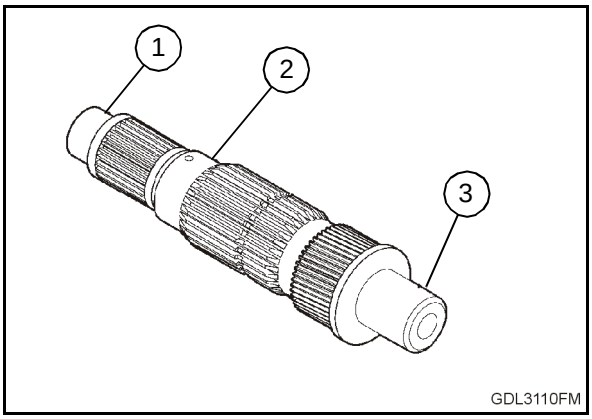
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Disassemble and Assemble Main Shaft



1. Shim.
2. Thrust Bearing.
3. Main Shaft.
4. Snap Ring.
5. P2 Sun Gear.
6. Spacer.
7. Main Shaft.

Remove snap ring (4), P2 sun gear (5), thrust bearing (2) and spacer (6).



Measure main shaft journals. Inspect all parts for wear or damage. Replace parts as necessary.

Main Shaft Journal Specification

Journal 1 - Minimum Diameter:
- 35.92 mm (1.414 in.)

Journal 2 - Minimum Diameter:
- 52.98 mm (2.086 in.)

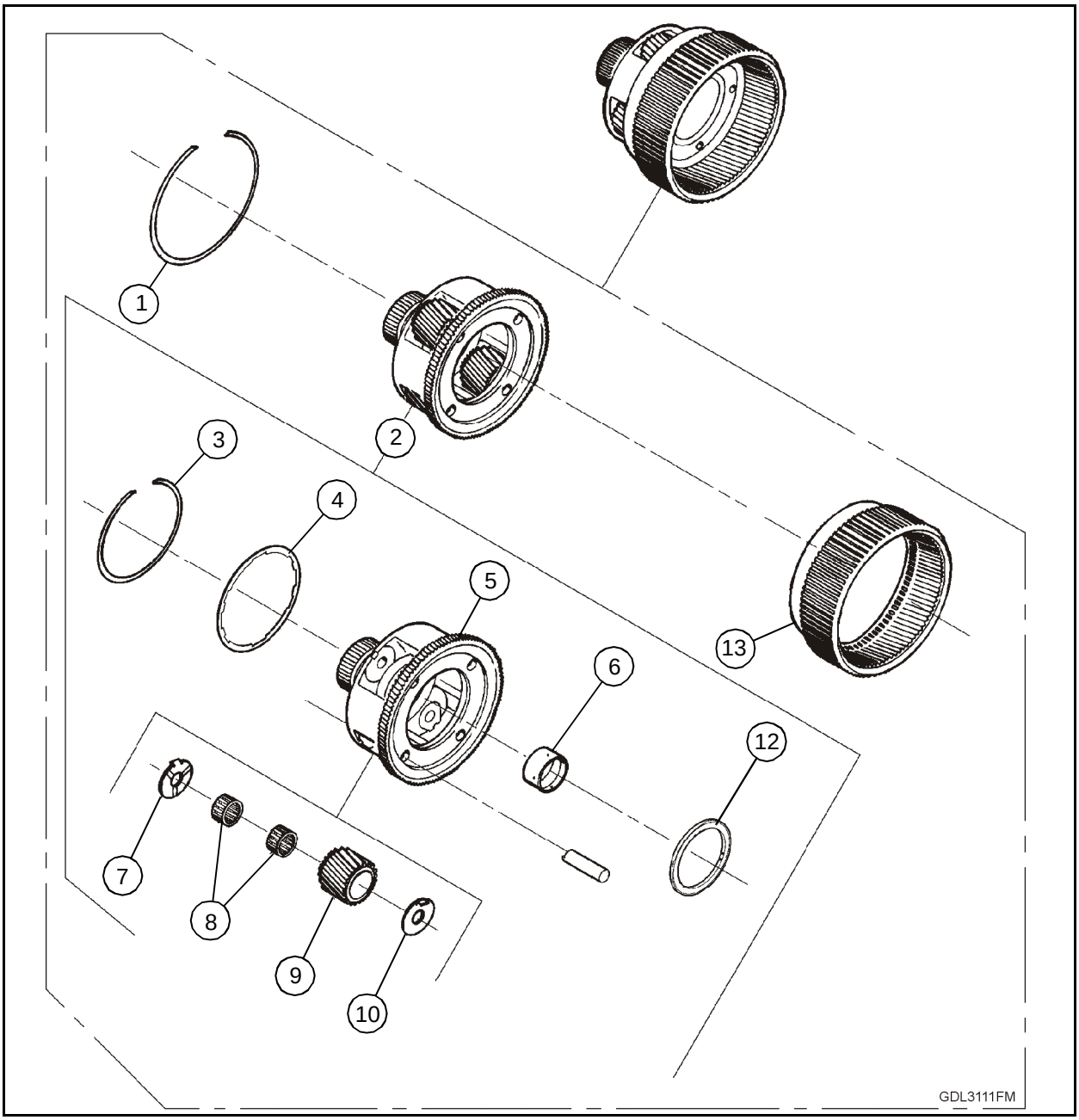
Journal 3 - Minimum Diameter:
- 35.92 mm (1.414 in.)

NOTE: Measurement for selective shim and thrust bearing is performed during final assembly.

Install spacer, thrust bearing, P2 sun gear and snap ring. Snap ring must lock in position.

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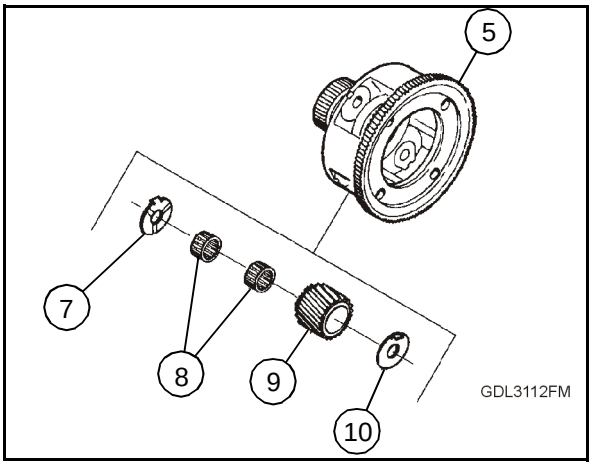
Disassemble and Assemble P2 Planetary



1. Snap Ring.
2. P2 Planetary Carrier.
3. Snap Ring.
4. P2 Indexing Ring.
5. P2 Planetary Carrier.
6. Bushing.
7. Thrust Washer (4 used).
8. Roller Bearing (8 used).
9. P2 Pinion Gear (4 used).
10. Thrust Washer (4 used).
11. P2 Planetary Spindle (4 used).
12. Thrust Bearing.
13. P3 Planetary Ring Gear.

Remove P3 planetary ring gear (13).

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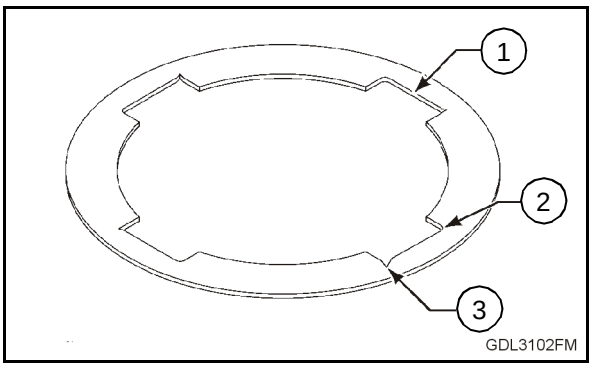
5. P2 Planetary Carrier.
7. Thrust Washer (4 used).
8. Roller Bearing (8 used).
9. P2 Pinion Gear (4 used).
10. Thrust Washer (4 used).

Check P2 pinion gear (9) end play in P2 carrier (5) with feeler gauge.

P2 Planetary Specification

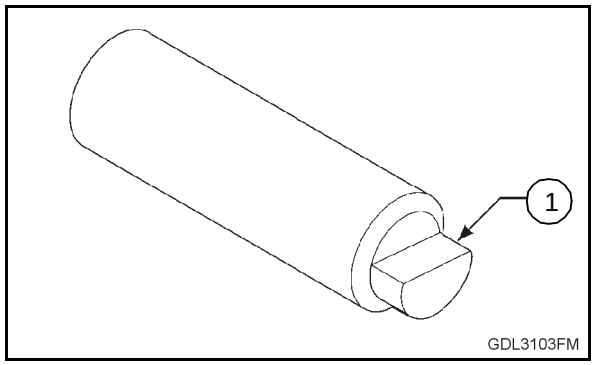
Pinion Gear End Play
- - - - - - - - - - - - - - - - - - 0.94 mm (0.037 in.) Maximum

Disassemble P2 planetary.



Inspect indexing ring and spindles for abnormal wear where spindles (11) contact indexing ring.

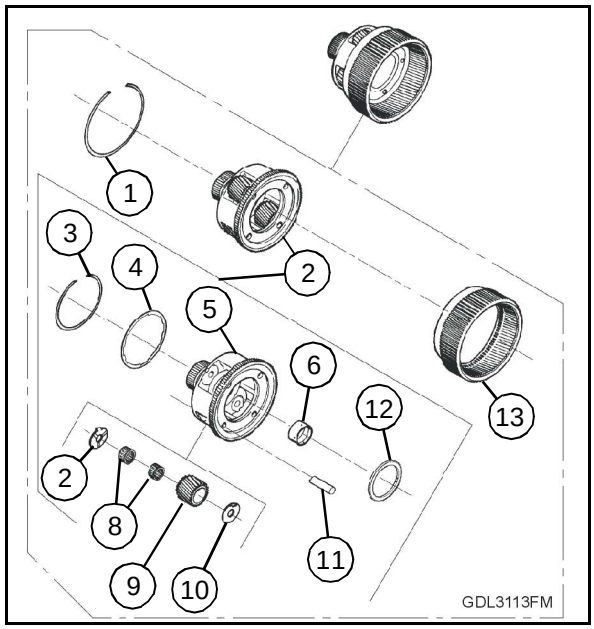
1. Indexing Flat.
2. No Wear.
3. Abnormal Wear.



Inspect planetary spindle. If the planetary spindle has a sharp edge instead of a radius edge, replace spindles.

P2 Planetary Specification

Planetary Spindle Edge Wear Wear Added Radius:
- - - - - - - - - - - - - - - - -0.25 - 1.50 mm (0.01 - 0.059 in.)



Measure thickness of thrust washers (7 and 10).

P2 Planetary Specification

Thrust Washers Minimum Thickness
- 1.40 mm (0.055 in.)

Thrust Washer Step Wear Maximum Depth
- 0.12 mm (0.005 in.)

Measure inside diameter of bushing (6) inside P2 planetary carrier (5) for wear or damage.

P2 Planetary Specification

Bushing Maximum Inside Diameter
- 53.23 mm (2.096 in.)

Check spline wear of P2 carrier (2) and P3 planetary ring gear (13).

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P2 Planetary Specification

Carrier Spline Wear Maximum Wear
- 0.38 mm (0.015 in.)

Inspect all parts for wear or damage. Replace as necessary.

Assemble planetary.

Planetary spindles must not rotate after indexing ring has been installed or lubrication flow may be blocked.

When indexing ring slots are worn on one corner (normal wear condition), flip indexing ring over to obtain new, unworn contact surface. If both surfaces are worn, replace indexing ring.

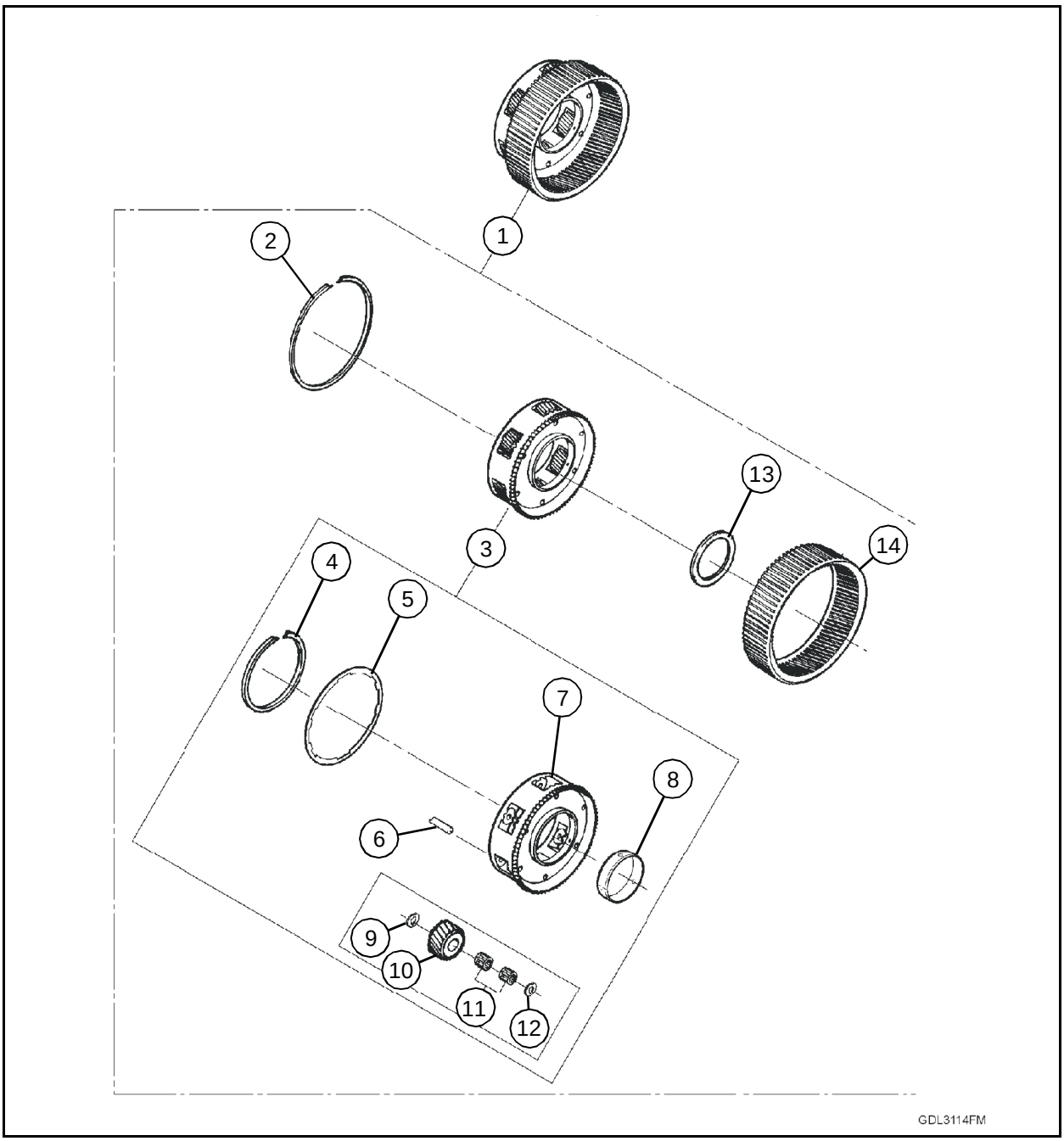
If any components are replaced measure all pinions for end play with feeler gauge.

P1 Planetary Specification

Pinion Gear End Play
- 0.94 mm (0.037 in.) Maximum

Install thrust bearing (12) and ring gear (13).

Disassemble and Assemble P1 Planetary



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1. P1 Planetary (Complete).
2. Snap Ring.
3. P1 Planetary Carrier.
4. Retaining Ring.
5. P1 Indexing Ring.
6. P1 Pinion Spindle (6 used).
7. P1 Planetary Carrier.
8. P1 Carrier Bushing.
9. P1 Thrust Washer (6 used).
10. P1 Pinion Gear.
11. Roller Bearing (12 used).
12. P1 Thrust Washer (6 used).
13. Thrust Bearing.
14. P2 Ring Gear.

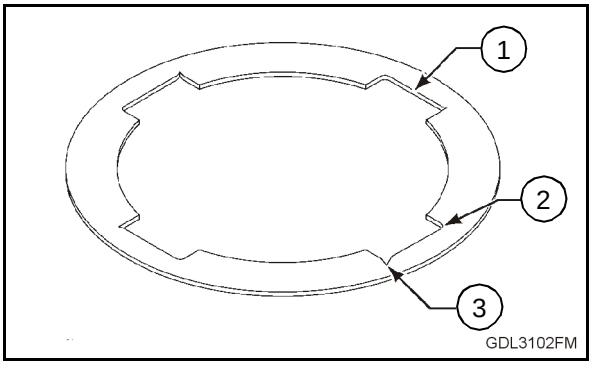
Remove P2 ring gear.

Check P1 planetary pinions for end play with feeler gauge.

P1 Planetary Specification

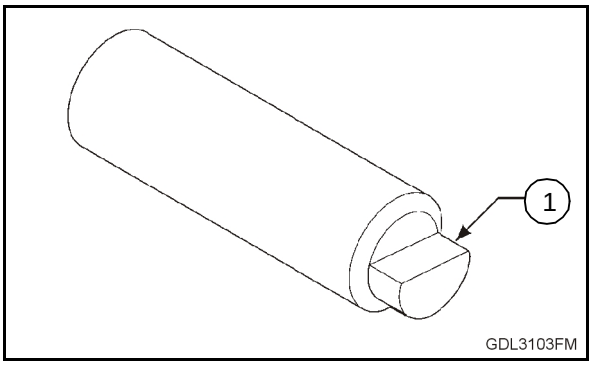
Pinion Gear End Play
- - - - - - - - - - - - - - - - - - 0.94 mm (0.037 in.) Maximum

Disassemble P1 planetary.



Inspect indexing ring and spindles for abnormal wear where spindles (6) contact indexing ring.

1. Indexing Flat.
2. No Wear.
3. Abnormal Wear.



Inspect planetary spindle. If the planetary spindle has a sharp edge instead of a radius edge, replace spindles.

P1 Planetary Specification

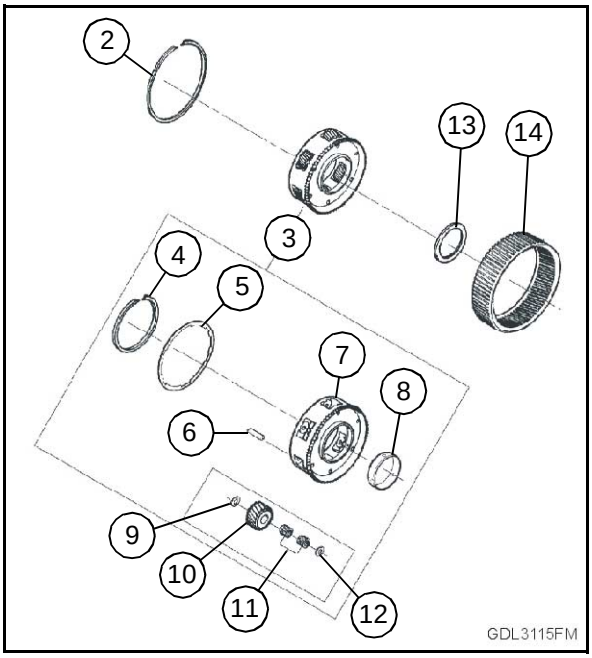
Planetary Spindle Edge Wear Wear Added Radius:
- - - - - - - - - - - - - - - - -0.25 - 1.50 mm (0.01 - 0.059 in.)

Measure thickness of thrust washers (9).

P1 Planetary Specification

Thrust Washers Minimum Thickness
- 1.40 mm (0.055 in.)

Thrust Washer Step Wear Maximum Depth
- 0.12 mm (0.005 in.)



1. Sharp Flat Edge (Radius Added on Edge 0.25 - 1.50 mm).
2. Snap Ring.
3. P1 Planetary Carrier.
4. Retaining Ring.
5. P1 Indexing Ring.
6. P1 Pinion Spindle (6 used).
7. P1 Planetary Carrier.
8. P1 Carrier Bushing.
9. P1 Thrust Washer (6 used).

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10. P1 Pinion Gear.
11. Roller Bearing (12 used).
12. P1 Thrust Washer (6 used).
13. Thrust Bearing.
14. P2 Ring Gear.

Inspect bushing (8) inside P1 planetary for wear or damage.

P1 Planetary Specification

Planetary Bushing Maximum Inside Diameter
- 89.32 mm (3.516 in.)

If replacement is required press new bushing to correct distance below carrier surface.

P1 Planetary Specification

Planetary Bushing Depth Distance
- 0.40 mm (0.16 in.)

Check spline wear of P1 carrier (7) and P2 planetary ring gear (14).

P1 Planetary Specification

Carrier Splines Maximum Wear
- 0.38 mm (0.015 in.)

Inspect all parts for wear or damage. Replace as necessary.

Assemble P1 planetary.

Planetary spindles must not rotate after indexing rings have been installed or lubrication flow may be blocked.

When indexing ring slots are worn on one corner (normal wear condition), flip indexing ring over to obtain new, unworn contact surface. If both surfaces are worn, replace indexing ring.

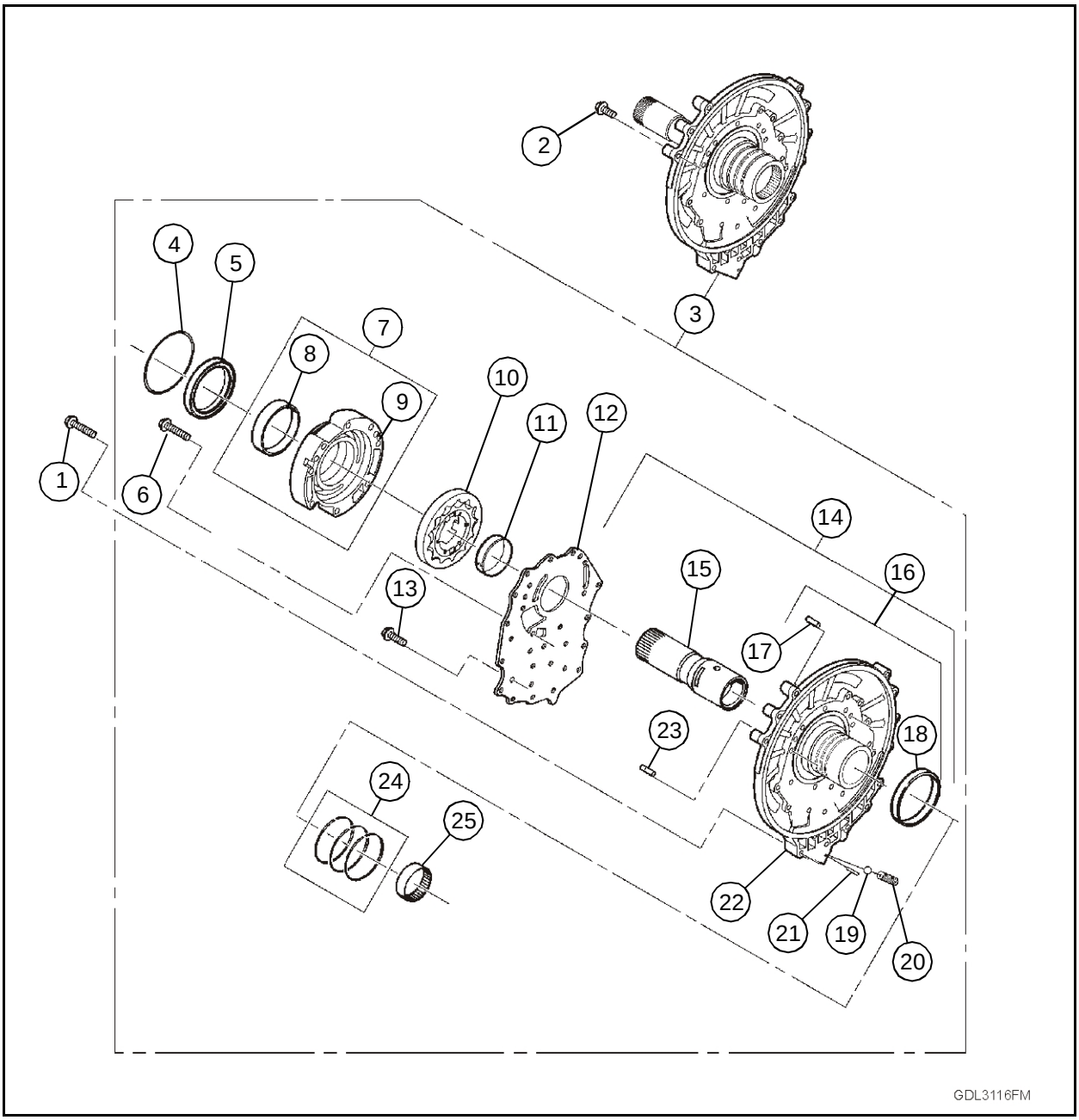
If any components are replaced measure all pinions for end play with feeler gauge.

P1 Planetary Specification

Pinion Gear End Play Maximum
- 0.94 mm (0.037 in.)

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Disassemble and Assemble Front Support and Charging Oil Pump



1. Cap Screw (7 used).
2. Cap Screw (7 used).
3. Front Support.
4. O-Ring.
5. Seal.
6. Cap Screw (8 used).
7. Pump Housing.
8. Bushing.
9. Pump Housing.
10. Pump Gear Set.
11. Bushing.
12. Wear Plate.
13. Cap Screw (14 used).
14. Front Support (complete).
15. Ground Sleeve.
16. Front Support.
17. Dowel Pin.
18. Front Support Sleeve.
19. Ball.
20. Spring.
21. Dowel Pin.
22. Front Support.
23. Dowel Pin.
24. Seal Ring (3 used).
25. Roller Bearing.

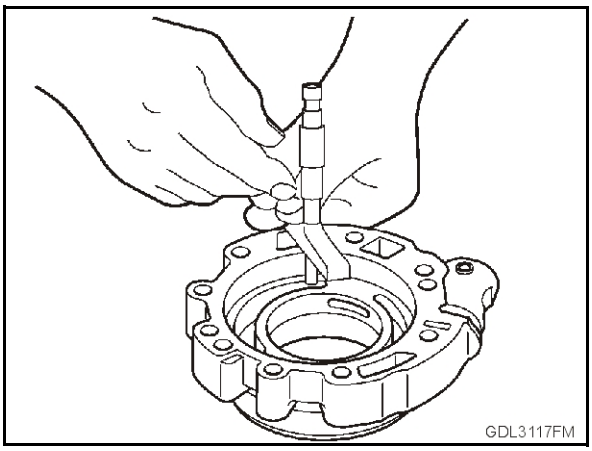
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Remove seal rings (24) from front support hub.

Remove pump housing (7).

Use JDG1501-11 Main Pressure Relief Spring Compressor to remove pin (21).

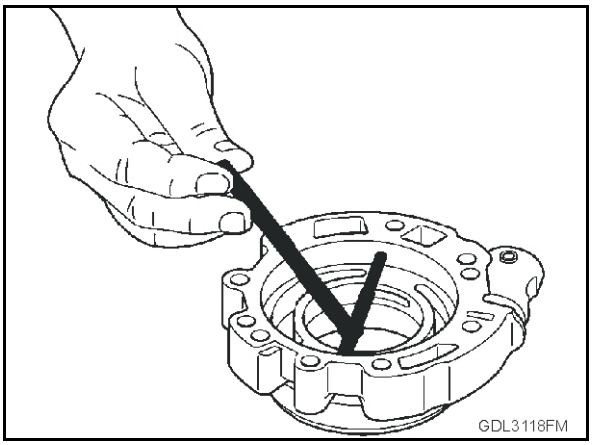
Remove spring (20) and ball (19).



Measure gear cavity depth in pump housing.

Front Support and Charging Oil Pump Specification

Pump Housing Gear Cavity Maximum Depth
- 19.04 mm (0.750 in.)



Measure gear cavity diameter in pump housing.

Front Support and Charging Oil Pump Specification

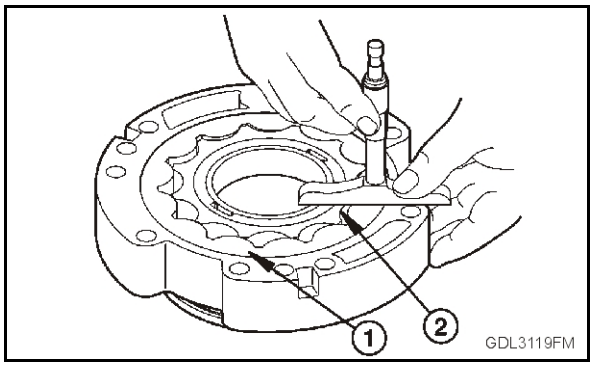
Pump Housing Gear Cavity Maximum Inside Diameter
- 150.25 mm (5.915 in.)

Inspect bushing (8) inside pump housing for wear or damage. Replace if necessary.

Front Support and Charging Oil Pump Specification

Pump Housing Bushing Maximum Inside Diameter
- 89.19 mm (3.511 in.)

Install gear set (10) into pump housing (7).

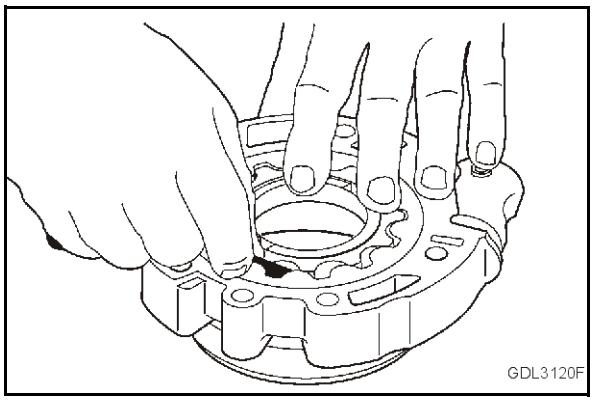


Measure pump gear side clearance.

1. Gear Set. 2. Pump Gear.

Front Support and Charging Oil Pump Specification

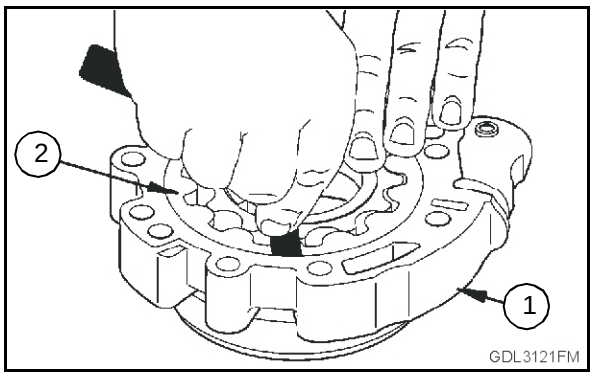
Pump Gear Side Clearance Maximum Clearance
- 0.10 mm (0.004 in.)



Measure gear tooth tip clearance.

Front Support and Charging Oil Pump Specification

Gear Tooth Tip Maximum Clearance
- 0.15 mm (0.006 in.)



1. Pump Housing. 2. Driven Gear.

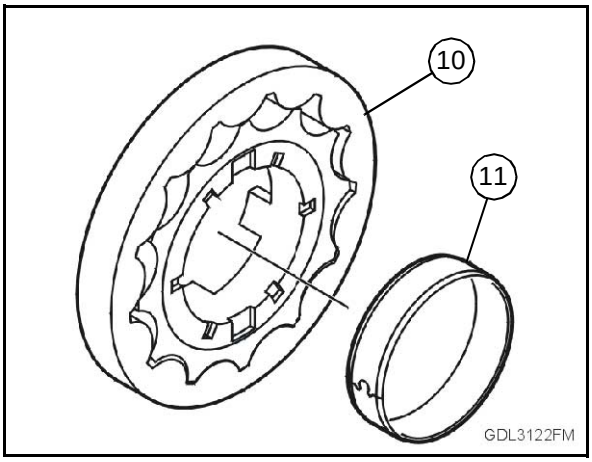
Measure driven gear-to-pump housing clearance.

Front Support and Charging Oil Pump Specification

Driven Gear-to-Pump Clearance Maximum Clearance
- 0.30 mm (0.012 in.)

Replace pump housing and gear set if any measurement is out of specification.

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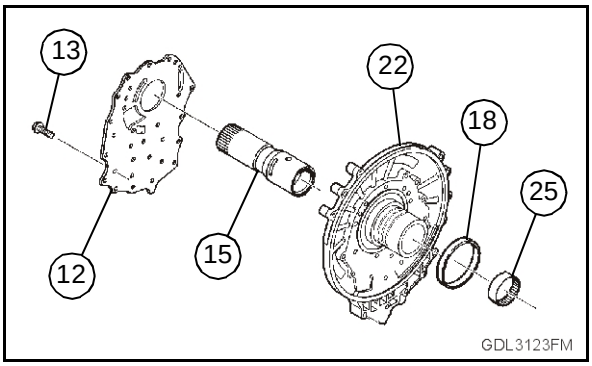
10. Gear Set. 11. Bushing.

Measure inside diameter of bushing (11) inside gear set (10).

Front Support and Charging Oil Pump Specification

Pump Bushing Maximum Inside Diameter
- 66.93 mm (2.635 in.)

Replace bushing if damaged or worn.



12. Wear Plate.
13. Cap Screw (14 used).
15. Ground Sleeve.
18. Front Support Sleeve.
22. Front Support.
25. Bearing.

Inspect wear plate (12) for wear or damage. Remove and replace if necessary.

Inspect bearing (25) for wear or damage. Remove and replace if necessary. Bearing is a press fit.

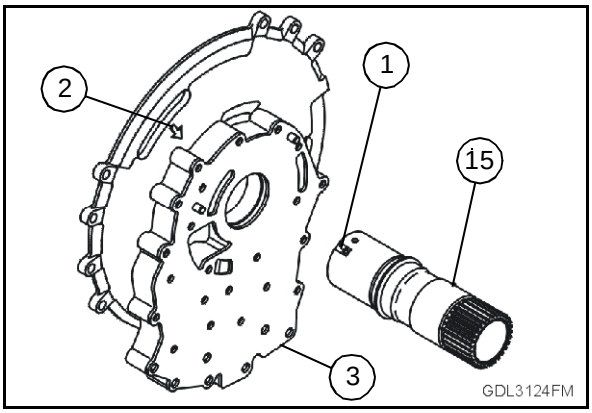
Measure front support sleeve (18) diameter. Remove and replace if necessary. Support sleeve is a press fit.

Front Support and Charging Oil Pump Specification

Front Support Sleeve Minimum Outside Diameter
- 119.81 mm (4.717 in.)

Replace ground sleeve (15) if worn or damaged by pressing ground sleeve from front support (22).

Inspect all parts for wear or damage. Replace if necessary.



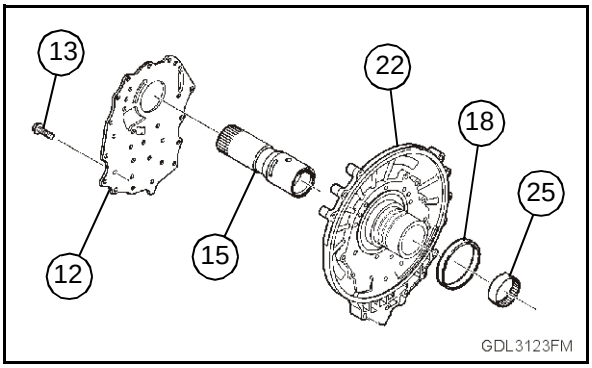
If removed, install ground sleeve (15) in front support with press.

Machined flat at base of ground sleeve (1) must align with cast arrow (2) on front support (3).

Transmission Specification

Ground Sleeve Maximum Radial Runout
- 0.13 mm (0.005 in.)

NOTE: Lubrication hole in support sleeve (18) must be positioned with relief valve bore in bottom of front support.



Install support sleeve (18) with press. Position lubrication hole in support sleeve with relief valve bore in bottom of front support.

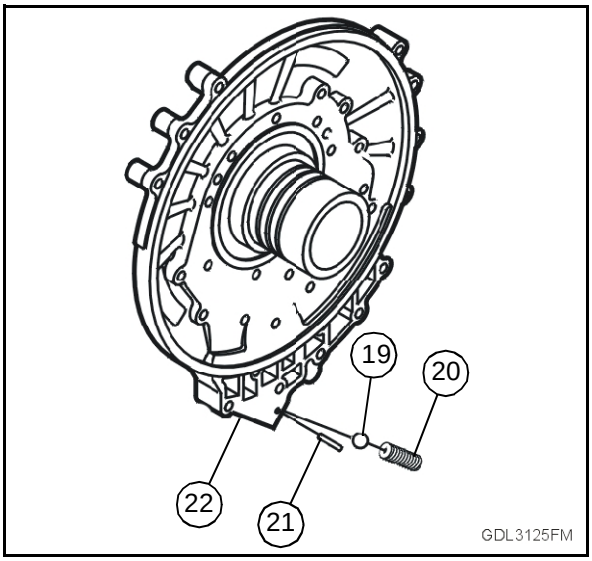
Install wear plate (12).

Front Support and Charging Oil Pump Specification

Wear Plate Cap Screw Torque
- 56 Nm (42 lb-ft)

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Install bearing (25) using press. Press bearing flush to 0.25 mm (0.010 in.) below surface.

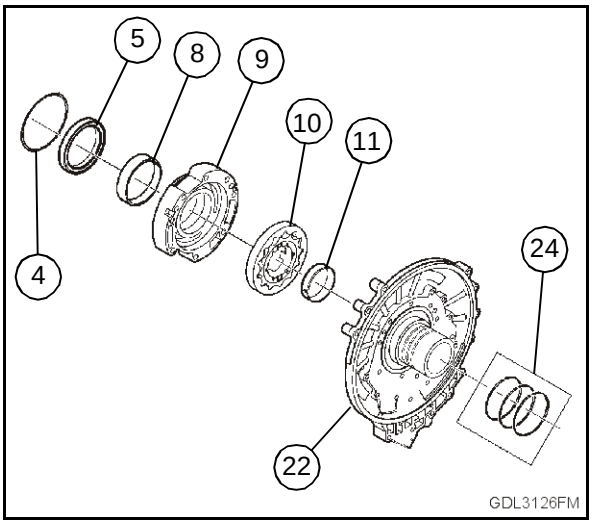


19. Ball.
20. Spring.
21. Dowel Pin.
22. Front Support.

Install pressure relief ball (19) and pressure relief spring (20).

Use JDG1501-11 Main Pressure Relief Spring Compressor to compress pressure relief spring (20).

Install pin (21).



4. O-Ring.
5. Seal.
8. Bushing.
9. Pump Housing.
10. Pump Gear Set.
11. Bushing.
22. Front Support.
24. Seal Ring (3 used).

Install bushing (8) into pump housing.

Install seal (5) and O-ring (4).

Install bushing (11) into pump gear. Align staking in bushing with slots in inside gear of gear set.

Lubricate and install pump gear set (10) into pump housing (9).

Install pump housing (9) onto front support (22).

Front Support and Charging Oil Pump Specification

Pump Housing Cap Screw Torque
- 56 Nm (42 lb-ft)

Place three seal rings (24) into sealing bore of C1/C2 clutch.

Measure end gap with feeler gauges.

Front Support and Charging Oil Pump Specification

Sealring End Gap Maximum Gap
- 1.44 mm (0.057 in.)

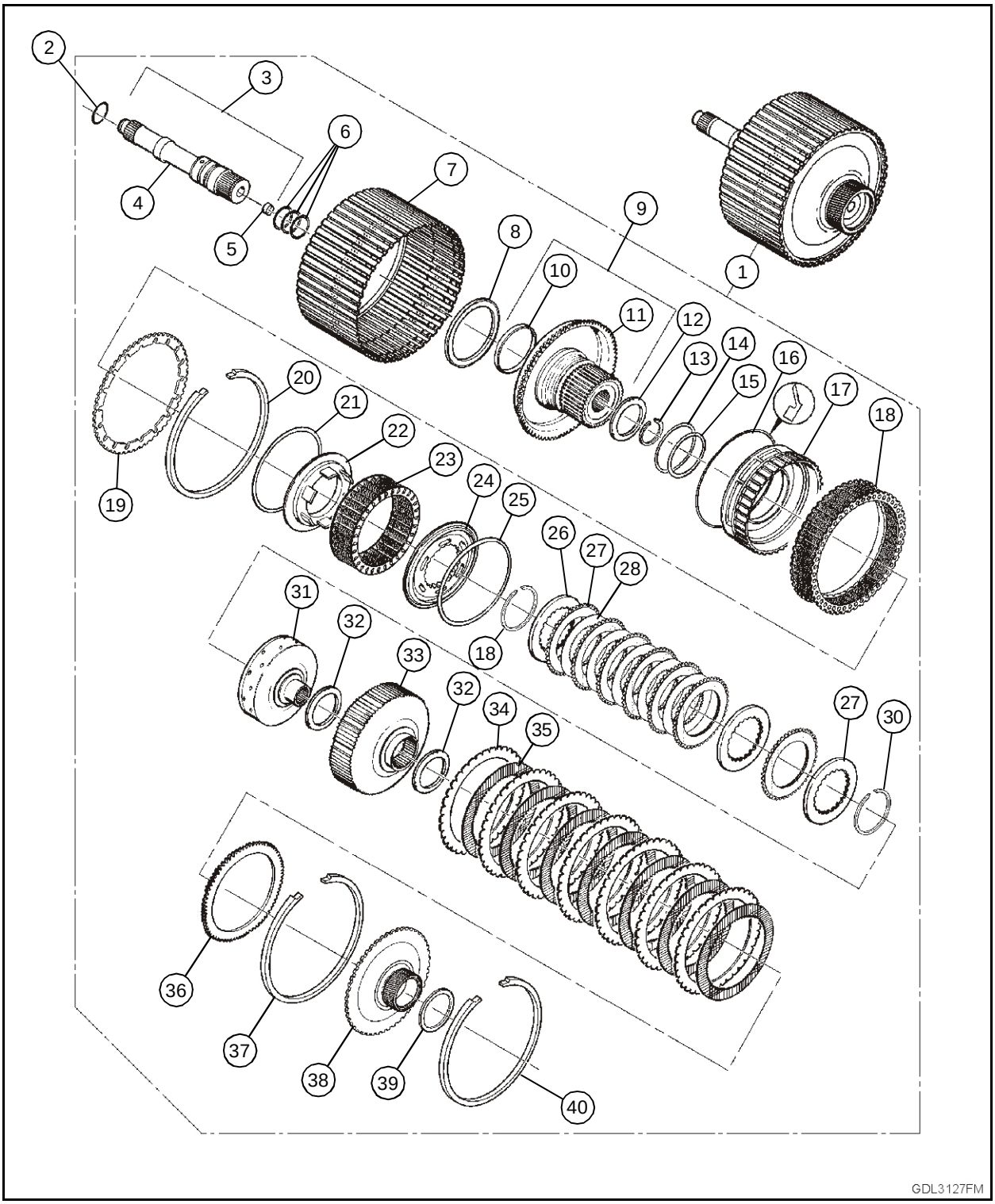
Remove three seal rings from C1/C2 clutch and install onto front support hub.

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Disassemble and Assemble C1/C2 Clutch



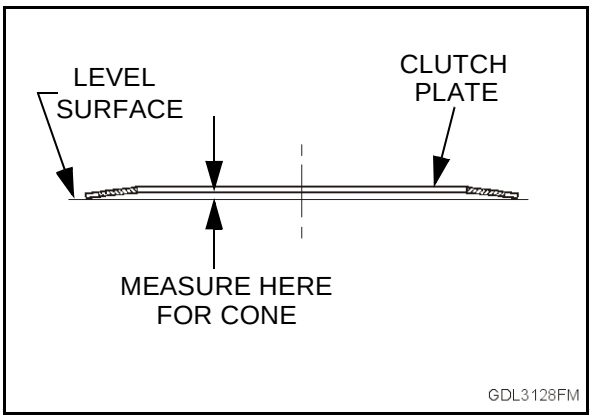
1. C1/C2 Clutch Module (Complete).
2. O-Ring.
3. Turbine Shaft.
4. Turbine Shaft.
5. Turbine Shaft Bushing.
6. Seal Ring (3 used).
7. Rotating Drum.
8. Thrust Bearing.
9. C1/C2 Clutch Hub and Bushing.
10. C1/C2 Clutch Hub Bushing.
11. C1/C2 Clutch Hub.
12. Thrust Bearing.
13. Snap Ring.
14. C2 Piston Seal Ring.

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15. C1 Piston Seal Ring.
16. External Seal Ring.
17. C2 Piston.
18. C2 Spring.
19. C2 Spring Plate.
20. Retaining Ring.
21. C1 Seal Ring.
22. C1 Piston.
23. C1 Spring.
24. Balance Piston.
25. Seal Ring.
26. Snap Ring.
27. C1 Clutch Backplate (2 used).
28. C1 Friction Plate (7 used).
29. C1 Reaction Plate (6 used).
30. Snap Ring.
31. C1 Drive Hub.
32. Thrust Bearing (2 used).
33. C2 Drive Hub.
34. C2 Reaction Plate (7 used).
35. C2 Friction Plate (7 used).
36. C2 Clutch Backplate.
37. Internal Snap Ring.
38. Sun Gear (complete).
39. Thrust Bearing.
40. Snap Ring.

Disassemble C1/C2 clutch.

Inspect thrust bearing (39) for wear. Replace if necessary.



Inspect C1/C2 plates for wear.

C1/C2 Clutch Plates Specification

C1/C2 Backplate Minimum Thickness
- 7.90 mm (0.31 in.)

Maximum Distortion - - - - - - - - - - - 0.15 mm (0.006 in.)

C1/C2 Friction Plate Minimum Thickness
- 2.92 mm (0.115 in.)

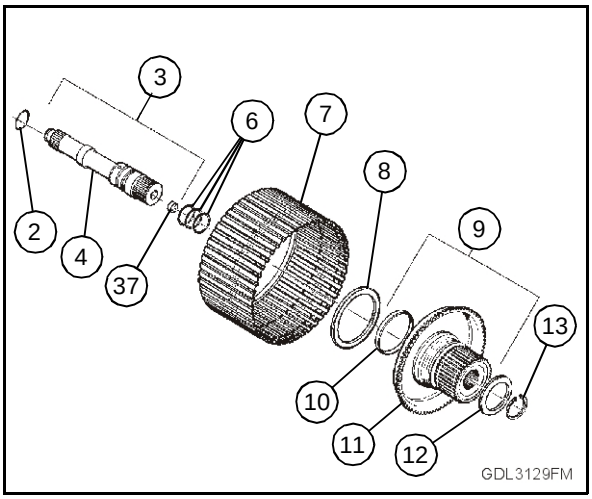
C1/C2 Friction Plate Oil Groove Minimum Depth
- 0.20 mm (0.008 in.)

C1/C2 Friction Plate Cone Maximum Height
- 0.25 mm (0.010 in.)

C1/C2 Reaction Plate Minimum Thickness
- 2.41 mm (0.095 in.)

C1/C2 Reaction Plate Cone Maximum Height
- 0.25 mm (0.010 in.)

C1/C2 Drive Hub Spline Maximum Wear
- 0.38 mm (0.015in).



2. O-Ring.
3. Turbine Shaft.
4. Turbine Shaft.
5. Turbine Shaft Bushing.
6. Seal Ring (3 used).
7. Rotating Drum.
8. Thrust Bearing.
9. C1/C2 Clutch Hub and Bushing.
10. C1/C2 Clutch Hub Bushing.
11. C1/C2 Clutch Hub.
12. Thrust Bearing.
13. Snap Ring.

Remove snap ring (13) and turbine shaft (4).

Inspect bushing (5) inside end of turbine shaft (4). Replace if necessary.

C1/C2 Clutch Specification

Turbine Shaft Bushing Maximum Inside Diameter
- 36.14 mm (1.423 in.)

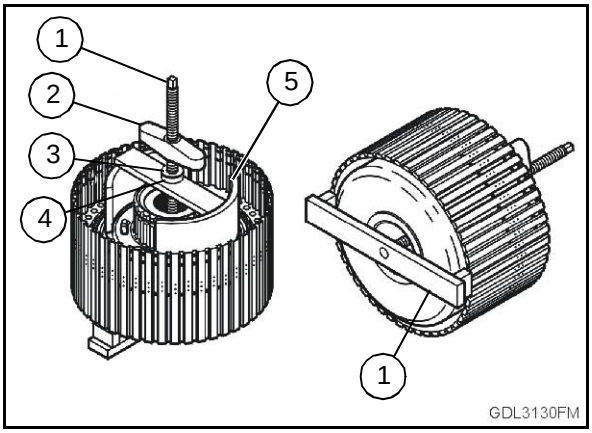
Remove seal rings (6).

Remove O-ring (2) from turbine shaft (4).

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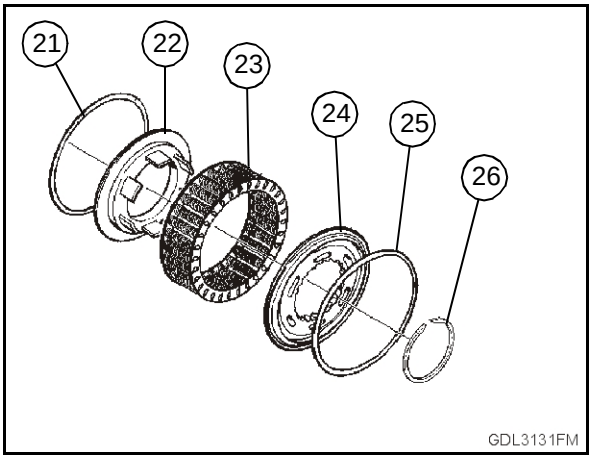
⚠ CAUTION

C1 springs are highly compressed. A spring compressor must be used to control the release of spring force. Personal injury can occur if spring force is not controlled.



Compress C1 spring (23) using JDG1501-8 C1-C2-C5 Spring Compressor Tool (1 - 4) and JDG1501-7 C1 Spring Compressor (5).

NOTE:The JDG1501-7 C1 Spring Compressor includes the C1, C2, and C5 Spring Compressors.



21. C1 Seal Ring.
22. C1 Piston.
23. C1 Spring.
24. Balance Piston.
25. Seal Ring.
26. Snap Ring.

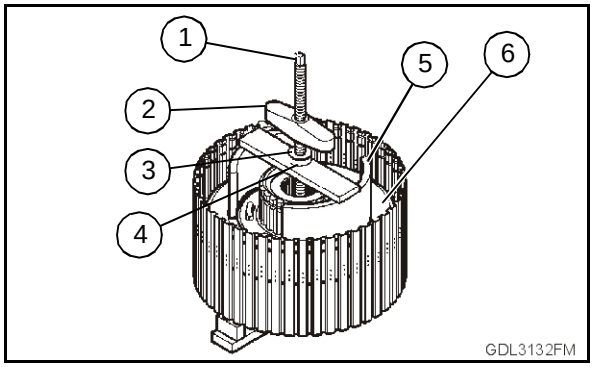
Remove snap ring (26).

Loosen handle (2) to release the C1 spring force.

Remove balance piston (24), seal ring (25) and C1 spring (23).

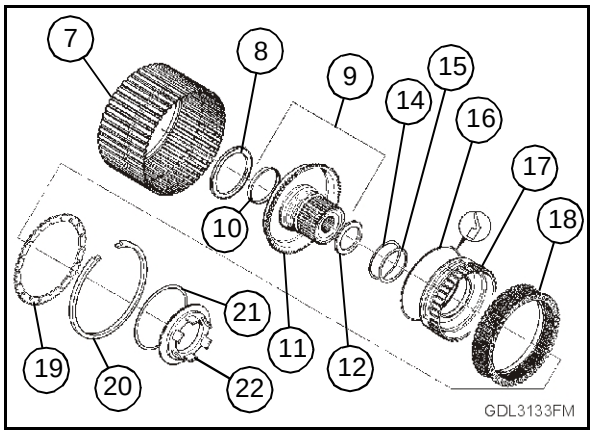
⚠ CAUTION

C2 springs are highly compressed. A spring compressor must be used to control the release of spring force. Personal injury can occur if spring force is not controlled.



Compress C2 spring (18) using JDG1501-8 C1-C2-C5 Spring Compressor Tool (1 - 4), C2 Spring Compressor (6), and JDG1501-7 C1 Spring Compressor (5).

NOTE:The JDG1501-7 C1 Spring Compressor includes the C1, C2, and C5 Spring Compressors.



7. Rotating Drum.
8. Thrust Bearing.
9. C1/C2 Clutch Hub and Bushing.
10. C1/C2 Clutch Hub Bushing.
11. C1/C2 Clutch Hub.
12. Thrust Bearing.
14. C2 Piston Seal Ring.
15. C1 Piston Seal Ring.
16. External Seal Ring.
17. C2 Piston.
18. C2 Spring.
19. C2 Spring Plate.

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20. Retaining Ring.
21. C1 Seal Ring.
22. C1 Piston.

Remove retaining ring (20).

Loosen handle (2) to release the C2 spring force.

Remove C2 spring and spring plate (18 and 19).

Remove rotating drum (7) from hub assembly (11) and C1 piston (22) and C2 piston (17).

Inspect clutch splines of rotating drum.

C1/C2 Clutch Specification

Rotating Drum Spline Maximum Wear
- 0.38 mm (0.015 in.)

Remove C1 piston (22) and C2 piston (17) from hub (9) by rocking side to side.

Inspect inside diameter of rotating clutch hub bushing (10). Replace as necessary.

C1/C2 Clutch Specification

Rotating Clutch Hub Bushing Maximum Inside Diameter - - - - - - - - - - - - - - - - - 120.27 mm (4.735 in.)

Remove seal rings (14 and 15) from hub.

Remove C1 piston (22) and seal ring (21) from C2 piston (17) and seal ring (16) by tapping lightly on C1 piston.

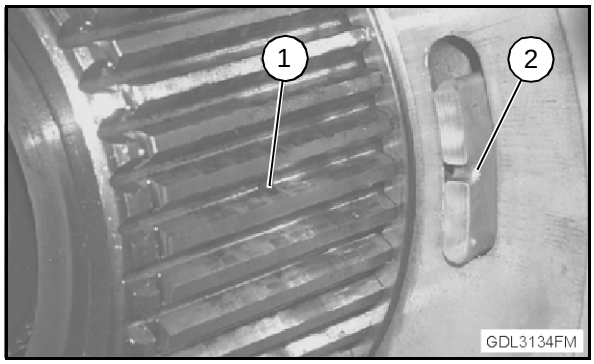
Remove seals from pistons.

Inspect all parts for wear or damage. Replace if necessary.

Apply clean transmission oil to all parts.

Install C1 piston (22) into center of C2 piston (17).

Tap C1 piston lightly until fully seated.



Notch (2) on C1 piston must align with one of four lube ports (1) in C1/C2 clutch hub (11).

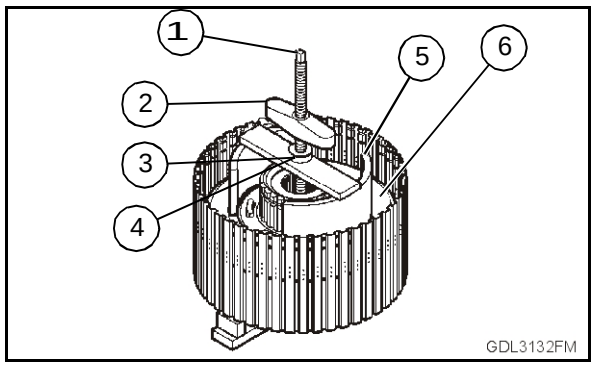
Install rotating drum (7) over C1/C2 hub (9) and C1 and C2 pistons (22 and 17).

Install C2 spring (18). Index the spring with the drive hub tangs and the splines on the C2 piston (17).

Be sure that C2 spring has made contact with C2 piston.

If contact has not been made, remove C2 spring and re-index it in next spline on rotating drum.

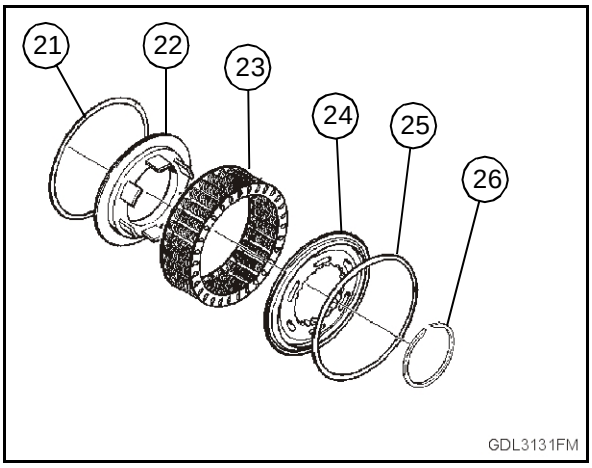
Install C2 spring plate (19). Index spring plate with drive hub tangs and splines on C2 piston.



Compress C2 spring (18) using JDG1501-8 C1-C2-C5 Spring Compressor Tool (1 - 4), C2 Spring Compressor (6), and JDG1501-7 C1 Spring Compressor (5).

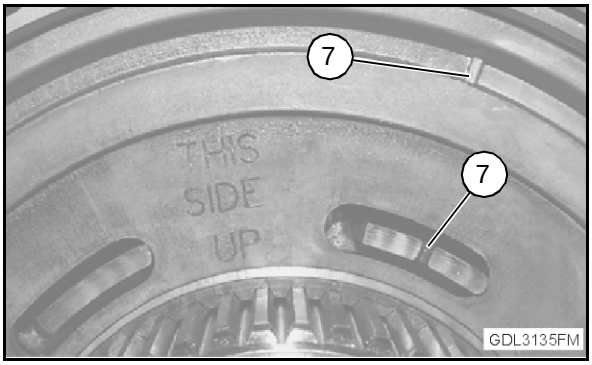
Install snap ring.

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Install C1 spring (23).

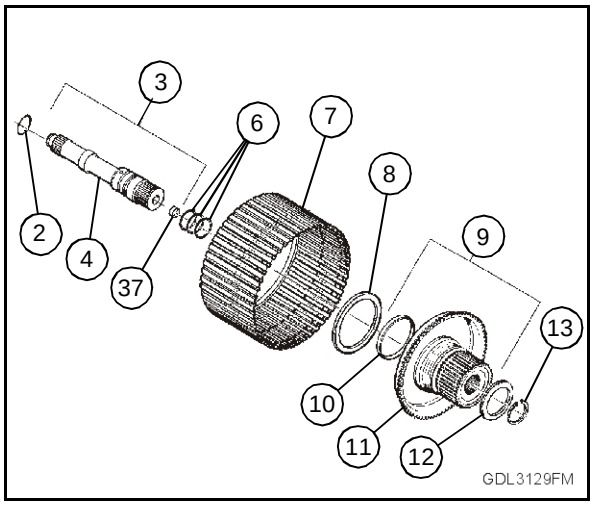
Apply clean transmission oil to seal ring (25). Install seal ring on balance piston (24).



Install balance piston with THIS SIDE UP and alignment mark (7) aligned with alignment mark (notch) in C1 piston.

Compress C1 spring (23) using JDG1501-8 C1-C2-C5 Spring Compressor Tool (1 - 4) and JDG1501-7 C1 Spring Compressor (5).

Install snap ring (26).



2. O-Ring.
3. Turbine Shaft.
4. Turbine Shaft.
5. Turbine Shaft Bushing.
6. Seal Ring (3 used).
7. Rotating Drum.
8. Thrust Bearing.
9. C1/C2 Clutch Hub and Bushing.
10. C1/C2 Clutch Hub Bushing.
11. C1/C2 Clutch Hub.
12. Thrust Bearing.
13. Snap Ring.

Install C1/C2 clutch pistons into rotating clutch drum (7).

Install bushing (5) into turbine shaft (4).

Install O-ring (2) onto forward end of turbine shaft.

Install three butt-joint seal rings (6) into the sealing bore of ground sleeve in C1/C2 clutch hub (11).

Measure end gap with feeler gauges.

C1/C2 Clutch Specification

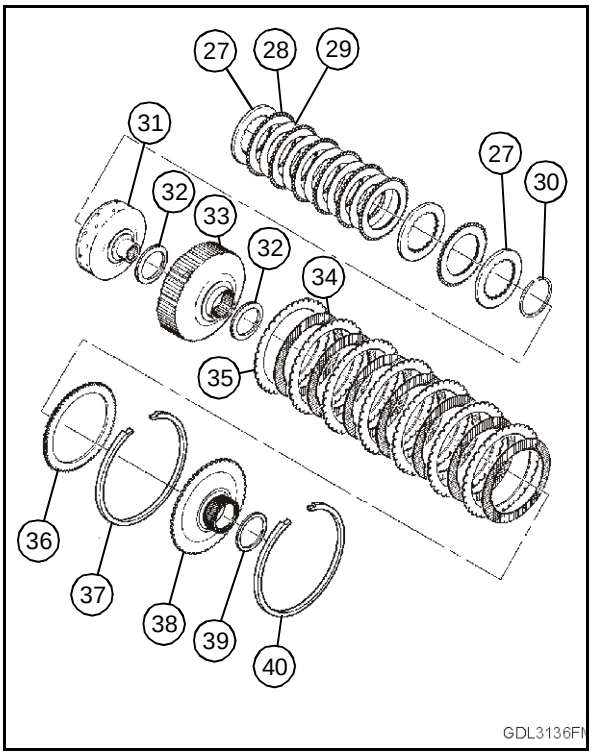
Ground Sleeve Seal Ring Butt-Joint Maximum End Gap - - - - - - - - - - - - - - - - 0.65 - 1.01 mm (0.026 - 0.040 in.)

Remove seal rings from ground sleeve bore and install on turbine shaft (4).

Install turbine shaft (4), snap ring (13) and thrust bearing (12).

Position C1/C2 clutch with turbine shaft down.

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27. C1 Clutch Backplate (2 used).
28. C1 Friction Plate (7 used).
29. C1 Reaction Plate (6 used).
30. Snap Ring.
31. C1 Drive Hub.
32. Thrust Bearing (2 used).
33. C2 Drive Hub.
34. C2 Reaction Plate (7 used).
35. C2 Friction Plate (7 used).
36. C2 Clutch Backplate.
37. Internal Snap Ring.
38. Sun Gear (complete).
39. Thrust Bearing.
40. Snap Ring.

Install C1 clutch pack. Backplates (27) are installed on both ends of clutch pack. Install clutch plates alternately, starting with a friction plate (28).

Install C1 snap ring (30).

Install thrust bearing (32) on each side of C2 drive hub (33).

Install C2 drive hub (33) over C1 drive hub (31).

Install C2 clutch plates (34 and 35). Install clutch plates alternately, starting with steel reaction plate (34).

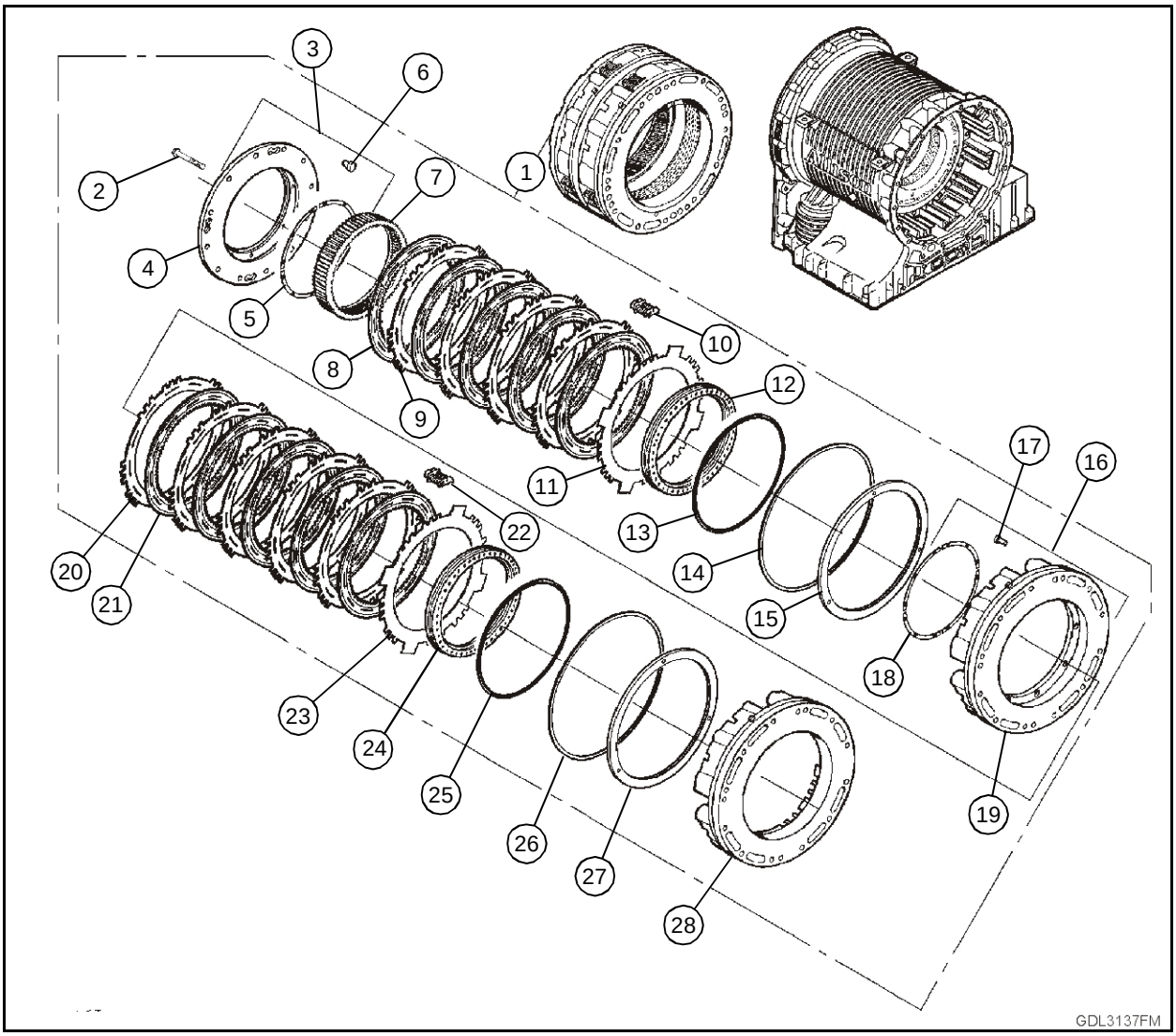
Install C2 backplate (36) and C2 snap ring (37).

Install thrust bearing (39).

Install P1 sun gear (38) and snap ring (40).

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Disassemble and Assemble C3/C4 Clutch and Main Housing



1. C3/C4 Clutch (complete).
2. Cap Screw (14 used).
3. C3 Backplate (complete).
4. Backplate.
5. P1 Ring Thrust Plate (4 used).
6. Rivet (12 used).
7. P1 Ring Gear.
8. C3 Friction Plate (5 used).
9. C3 Reaction Plate (4 used).
10. Return Spring (4 used).
11. Return Plate.
12. Spring Retainer.
13. Seal Ring.
14. Seal Ring.
15. C3 Clutch Piston.
16. C3 Clutch Housing.
17. Rivet.
18. P1 Ring Thrust Plate (4 used).
19. C3 Clutch Housing.
20. C4 Reaction Plate (5 used).
21. C4 Friction Plate (5 used).
22. Return Spring.
23. Return Plate.
24. Spring Retainer.
25. Seal Ring.
26. Seal Ring.
27. C4 Clutch Piston.
28. C4 Clutch Housing.

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Inspect clutch splines in interior of main housing.

C3/C4 Clutch and Main Housing Specification

Main Housing Clutch Splines Maximum Wear
- 1.15 mm (0.045 in.)

Remove cap screws (2).

C3 and C4 clutch diassembly is similar.

Remove C3 backplate (3).

Inspect thrust plates (5 and 18) and rivets (6 and 17) on clutch backplate (4 and 19).

C3/C4 Clutch and Main Housing Specification

C3/C4 Thrust Plate Contact Surface Minimum Thickness - - - - - - - - - - - - - - - - - 2.81 mm (0.111 in.)

C3/C4 Thrust Plate Distortion Maximum Distortion
- 0.15 mm (0.006 in.)

C3/C4 Thrust Plate Step Wear Maximum Wear Depth
- 0.13 mm (0.005 in.)

If replacement of backplate is necessary, remove by drilling out rivets.

Remove P1 ring gear (7) and inspect clutch splines.

C3/C4 Clutch and Main Housing Specification

P1 Ring Gear Clutch Splines Maximum Wear
- 0.38 mm (0.015 in.)

Remove C3 clutch pack (8 and 9).

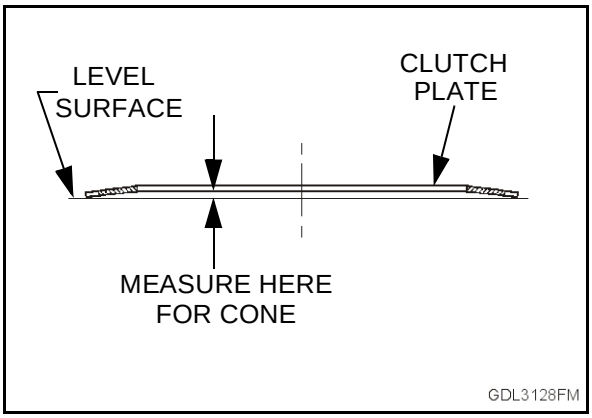
Inspect return plates (11 and 23) for wear or damage. Replace as necessary.

C3/C4 Clutch Specification

Piston Return Plate Minimum Thickness
- 4.91 mm (0.193 in.)

Remove return spring (10 and 22) assemblies only if damaged and replacement is necessary.

Remove C3 housing (16).



Inspect C3/C4 plates for wear.

C3/C4 Clutch Specification

C3/C4 Friction Plate Minimum Thickness
- 3.485 mm (0.137 in.)

C3/C4 Friction Plate Oil Groove Minimum Depth
- 0.20 mm (0.008 in.)

C3/C4 Friction Plate Cone Maximum Cone
- 0.25 mm (0.010 in.)

C3/C4 Reaction Plate Minimum Thickness
- 2.41 mm (0.095 in.)

C3 Reaction Plate Cone Maximum Cone
- 0.40 mm (0.016 in.)

C4 Reaction Plate Cone Maximum Cone
- 0.25 mm (0.010 in.)

Inspect splines in C3/C4 clutch housings.

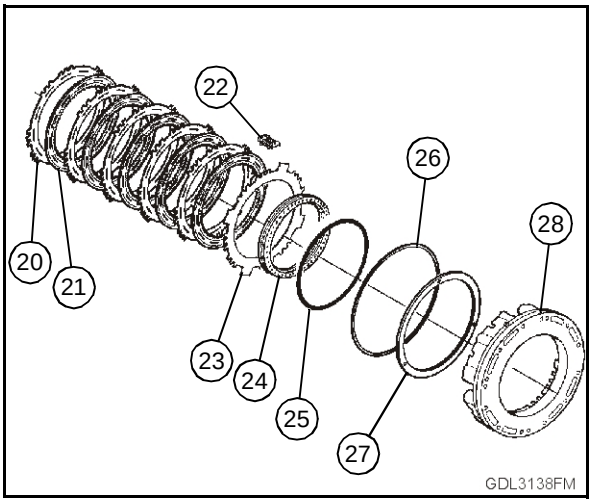
C3/C4 Clutch Housing Specification

C3/C4 Clutch Housing Spline Wear Maximum wear
- 1.15 mm (0.045 in)

Remove all seal rings.

Remove spring retainer (24) and piston (27) from C4 housing.

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20. C4 Reaction Plate (5 used).
21. C4 Friction Plate (5 used).
22. Return Spring.
23. Return Plate.
24. Spring Retainer.
25. Seal Ring.
26. Seal Ring.
27. C4 Clutch Piston.
28. C4 Clutch Housing.

Install and lubricate seal rings (25 and 26) and piston (27) into C4 housing (28).

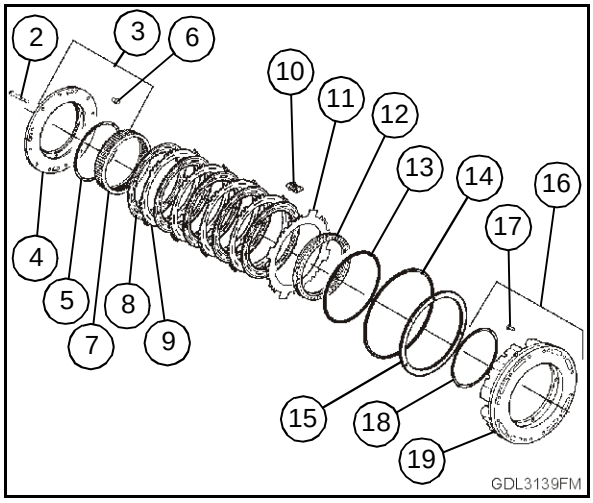
Install return springs (22) if removed.

Install piston return plate (23) with return springs (22).

Install C4 clutch pack (20 and 21). Clutch plates are installed alternately, starting with a friction plate (21).

If removed, install thrust plates (5 and 18). Thrust plates must not move on housing.

NOTE: A correctly formed rivet upset will be 4.00 mm (0.157 in.) in diameter and no more than 1.00 mm (0.039 in.) above the clutch housing surface.



2. Cap Screw.
3. C3 Backplate (complete).
4. Backplate.
5. P1 Ring Thrust Plate (4 used).
6. Rivet (12 used).
7. P1 Ring Gear.
8. C3 Friction Plate (5 used).
9. C3 Reaction Plate (4 used).
10. Return Spring (4 used).
11. Return Plate.
12. Spring Retainer.
13. Seal Ring.
14. Seal Ring.
15. C3 Clutch Piston.
16. C3 Clutch Housing.
17. Rivet.
18. P1 Ring Thrust Plate (4 used).
19. C3 Clutch Housing.

Install seal rings (13 and 14).

Lubricate and install C3 clutch piston (15) into C3 clutch housing.

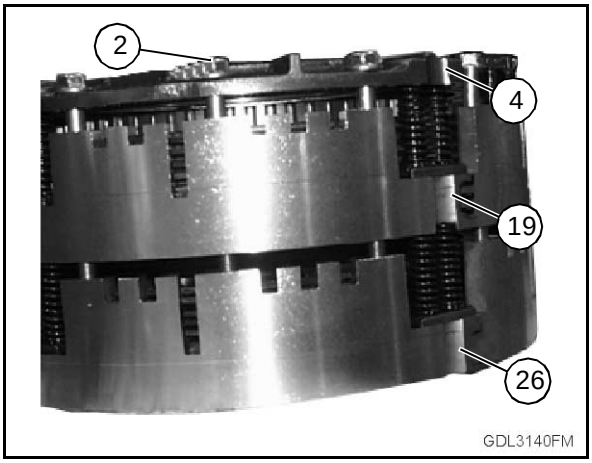
Install C3 clutch housing (19) with clutch piston (15) on top of assembled C4 clutch housing. Ensure that index tangs are aligned.

Install spring retainer (12).

Install piston return plate (11), return springs and P1 ring gear (7).

Install C3 clutch pack. Clutch plates are installed alternately, starting with a friction plate (8).

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2. Cap Screw.
4. Backplate.
19. C3 Clutch Housing.
28. C4 Clutch Housing.

Install C3 backplate (4). Backplate (4) must be indexed with C3 (19) and C4 (28) housings in order to insert into main housing correctly.

Install cap screws (2).

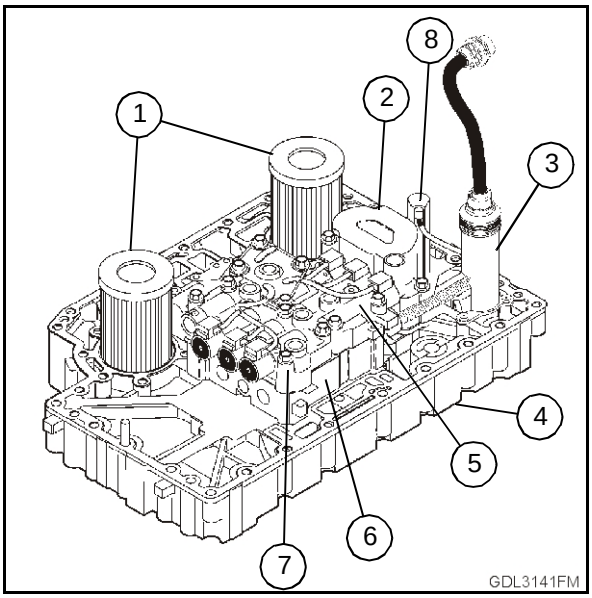
C3/C4 Clutch Specification

C3/C4 Cap Screw Torque - - - - - - - - - -56 Nm (42 lb-ft)

Disassemble and Assemble Control Valve

⚠ WARNING

1. Control valve assembly springs and other parts can be mistakenly interchanged. Make identification tags for each part removed as to its location.
2. Control valve parts fit together closely and have specific clearances. These parts depend upon smooth sealing surfaces and may leak if the sealing surface is scratched. Valves, when dry, must move freely by their own weight in their bores. Carefully handle all such parts. Keep them in clean containers until they are installed.

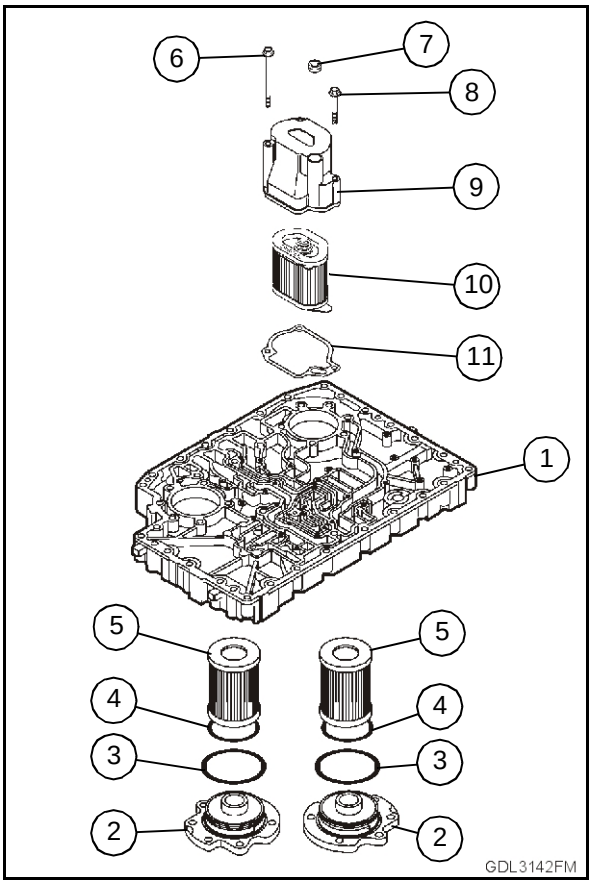


1. Filters.
2. Suction Filter.
3. Wiring Harness.
4. Channel Housing.
5. Rotating Clutch Solenoid.
6. Stationary Clutch Solenoid.
7. Main Valve Body.
8. Transmission Oil Level Sensor.

Remove control valve from transmission. **(See "DISASSEMBLE TRANSMISSION" on page 51).**

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Remove Filters



1. Channel Housing.
2. Filter Cover (2 used).
3. O-Ring (2 used).
4. O-Ring (2 used).
5. Filter (2 used).
6. Cap Screw.
7. Face Seal.
8. Cap Screw.
9. Suction Filter Housing.
10. Suction Filter.
11. Gasket.

Remove two filter covers (2) if not previously removed, four O-rings (3 and 4), and two filters (5).

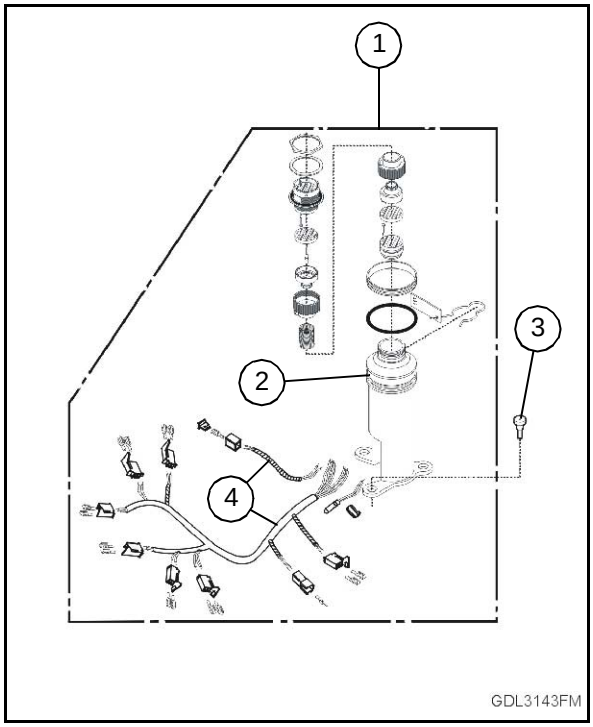
Remove cap screws (6 and 8).

Remove suction filter housing (9), seal (7), suction filter assembly (10), and gasket (11).

Clean and inspect suction filter. Replace as necessary.

Inspect inside diameter of rotating clutch hub bushing (10). Replace as necessary.

Remove Electrical Components and Sensors



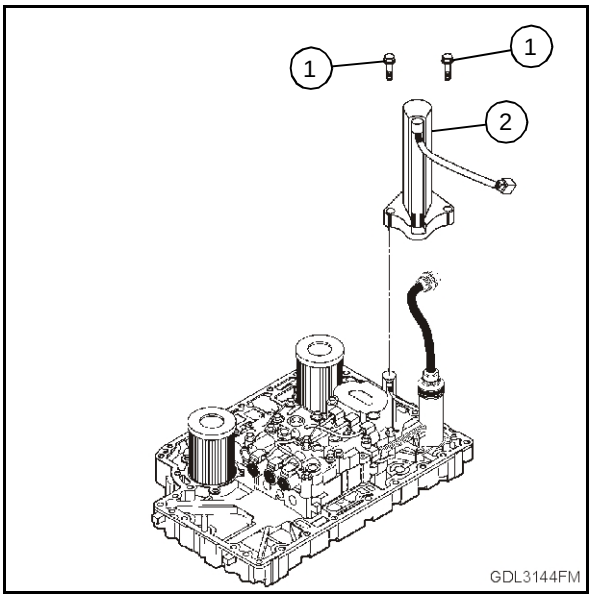
1. Harness (Complete).
2. Standoff.
3. Cap Screw (3 used).
4. Wire Harness.

Remove wire harness cover plate.

Disconnect all connectors. Do not remove wires from wiring harness.

Remove cap screws (3) and harness (1).

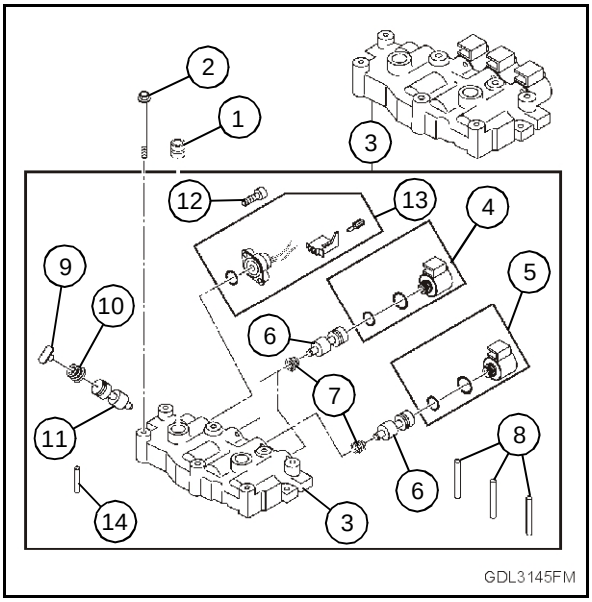
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1. Cap Screw (2 used).
2. Oil Level Sensor.

Unscrew cap screws (1) and remove oil level sensor (2).

Disassemble and Assemble C1/C2 Clutch Solenoid Body



1. Seal.
2. Cap Screw (3 used).
3. C1/C2 Clutch Solenoid Body.
4. Solenoid Normally Open (2 used).
5. Solenoid Normally Closed.
6. Valve (3 used).
7. Spring (3 used).
8. Solenoid Retention Pins (3 used).
9. Valve Stop.
10. Spring.
11. Valve.
12. Cap Screw (2 used).
13. C3 Pressure Switch.
14. Retention Pin.

Remove C1/C2 clutch solenoid body (3) from main valve body.

Disassemble C1/C2 clutch solenoid body.

Check C3 pressure switch (13).

C1/C2 Clutch Solenoid Body Specification

C3 Pressure Switch Resistance (Closed) Resistance
- 2 ohms maximum

C3 Pressure Switch Resistance (Open) Resistance
- 20,000 ohms minimum

C3 Pressure Switch Open/Close Pressure
- - - - - - - - - - - - - - - - - - 159—255 kPa (23—37 psi)

NOTE: Solenoids normally open can be identified by a flat rear face. Normally closed solenoids have a recess at rear face.

Check resistance of C1/C2 solenoids (4 - 5).

C1/C2 Clutch Solenoid Body Specification

C1/C2 Clutch Solenoids Resistance- - - - - - 2 - 5 ohms

Inspect all parts for wear or damage. Replace as necessary.

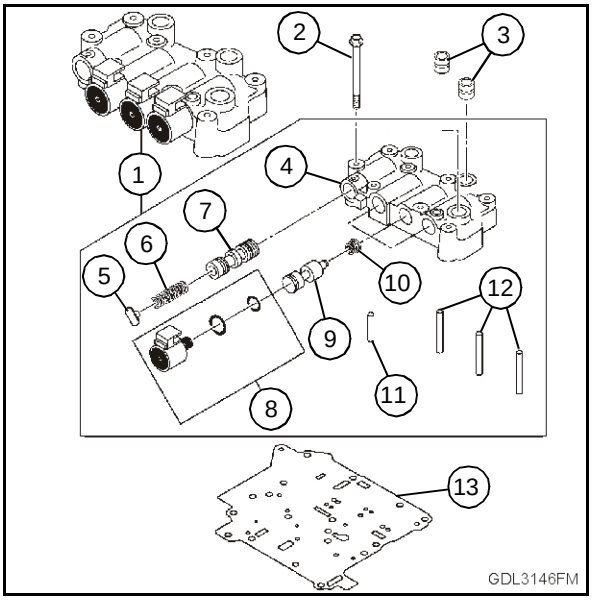
Assemble C1/C2 solenoid body.

C1/C2 Clutch Solenoid Body Specification

C3 Pressure Switch Cap Screw Torque
- 5 - 8 Nm (62 lb-in.)

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Disassemble and Assemble C3/C4 Clutch Solenoid Body



1. C3/C4 Clutch Solenoid Body Assembly.
2. Cap Screw (8 used).
3. Seal (2 used).
4. Stationary Clutch Solenoid Body.
5. Valve Stop.
6. Valve Spring.
7. Overdrive Valve.
8. Solenoid Normally Closed (3 used).
9. Solenoid Valve (3 used).
10. Spring (3 used).
11. Retention Pin.
12. Retaining Pin (3 used).
13. Solenoid Separator Plate.

Remove C3/C4 clutch solenoid (1) from main solenoid valve.

Disassemble C3/C4 clutch solenoid body.

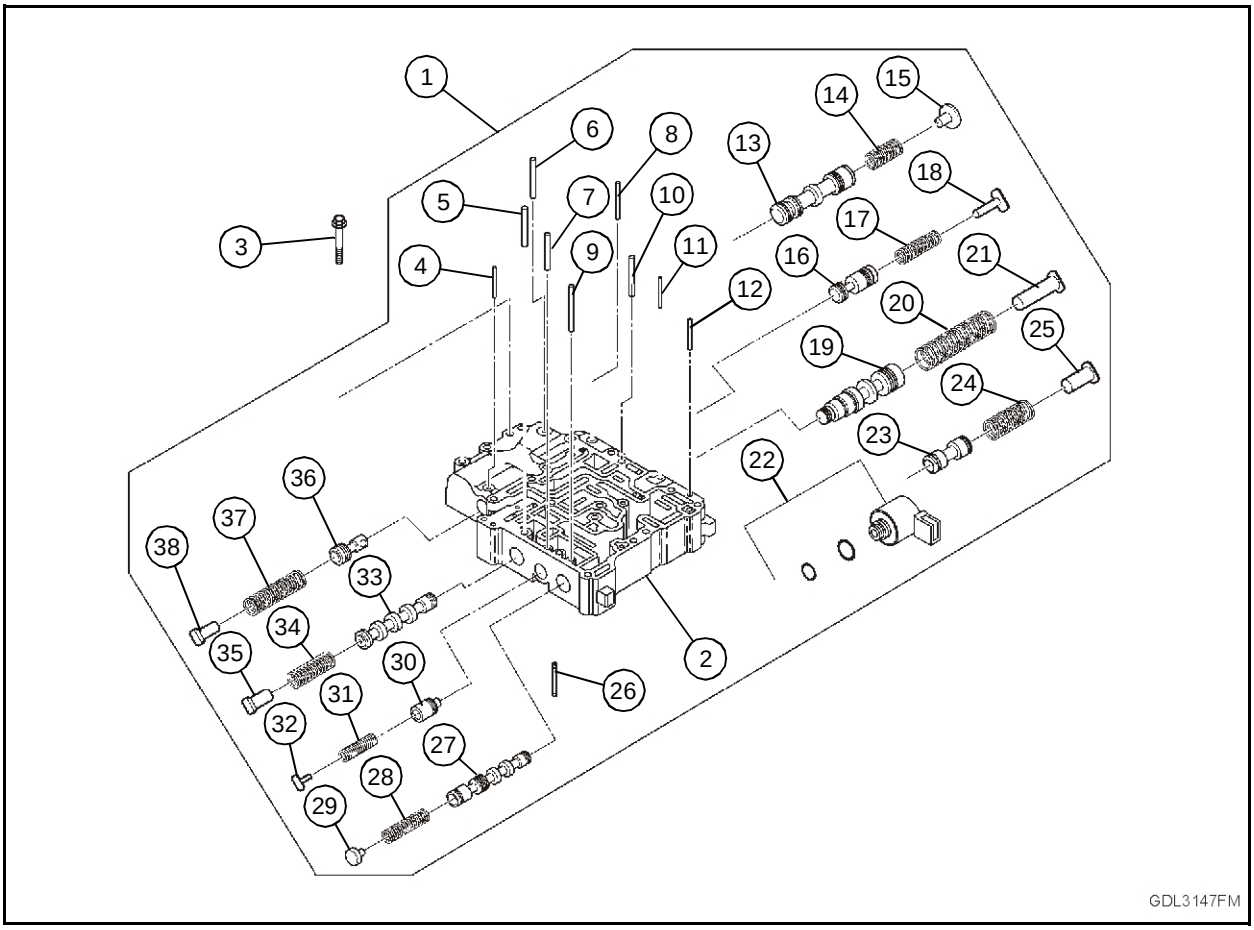
Check resistance of solenoids (8).

C3/C4 Clutch Specification

C3/C4 Clutch Solenoid Resistance - - - - - - 2 - 5 ohms

Inspect all parts for wear or damage.

Assemble C3/C4 clutch solenoid body.



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1. C3/C4 Clutch (complete).
2. Cap Screw (14 used).
3. C3 Backplate (complete).
4. Backplate.
5. P1 Ring Thrust Plate (4 used).
6. Rivet (12 used).
7. P1 Ring Gear.
8. C3 Friction Plate (5 used).
9. C3 Reaction Plate (4 used).
10. Return Spring (4 used).
11. Return Plate.
12. Spring Retainer.
13. Seal Ring.
14. Seal Ring.
15. C3 Clutch Piston.
16. C3 Clutch Housing.
17. Rivet.
18. P1 Ring Thrust Plate (4 used).
19. C3 Clutch Housing.
20. C4 Reaction Plate (5 used).
21. C4 Friction Plate (5 used).
22. Return Spring.
23. Return Plate.
24. Spring Retainer.
25. Seal Ring.
26. Seal Ring.
27. C4 Clutch Piston.
28. C4 Clutch Housing.

Disassemble and Assemble Main Valve Body

Remove main control valve body (1) from oil transfer channel plate.

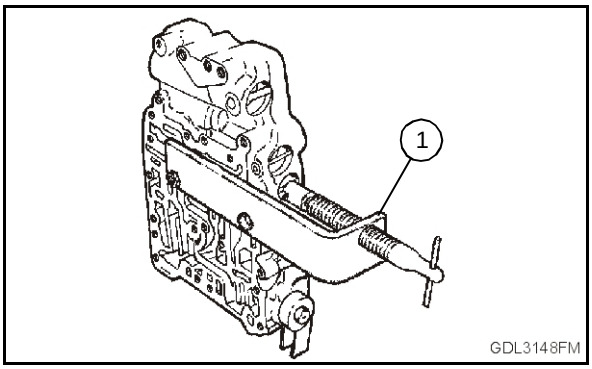
Disassemble main control valve body. Check resistance of solenoid (22).

Main Control Valve Specification

Solenoid Resistance - - - - - - - - - - - - - - - - 2 - 5 ohms

⚠ CAUTION

Main regulator spring (20) and control main spring (24) are highly compressed. Personal injury can occur if spring force is not controlled.

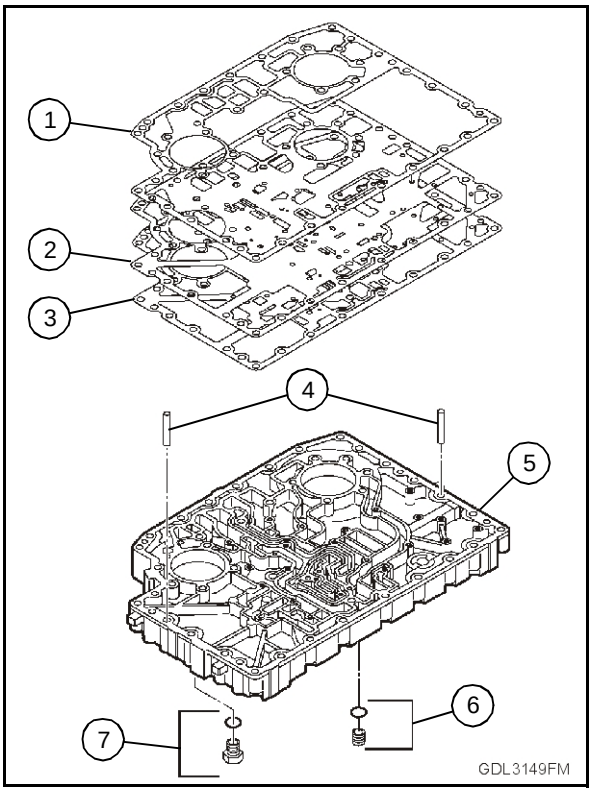


Use JDG1501-4 Main Pressure Spring Remover/ Installer to compress main regulator spring (20) and control main spring (24).

Clean and inspect all parts for wear or damage. Replace as necessary.

Assemble main control valve body.

Disassemble and Assemble Channel Housing



1. Gasket.
2. Separator Plate.
3. Gasket.
4. Dowel Pin.
5. Channel Housing.
6. Drain Plug.
7. Pressure Tap Plug (8 used).

Disassemble channel housing.

Clean and inspect all parts for wear or damage.

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Replace parts as necessary.

Install new O-rings on all plugs.

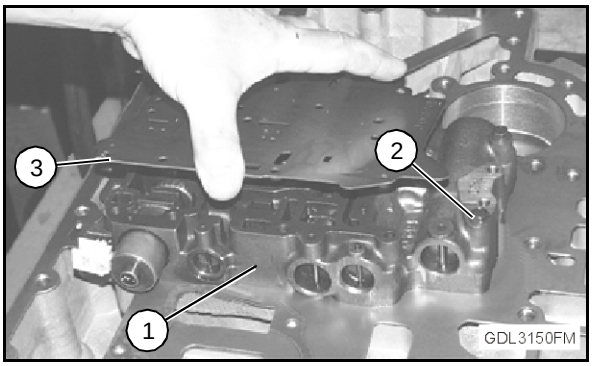
Install parts in plate.

Channel Housing Specification

Pressure Tap Plug Torque - - - - - - - 12 Nm (106 lb-in.)

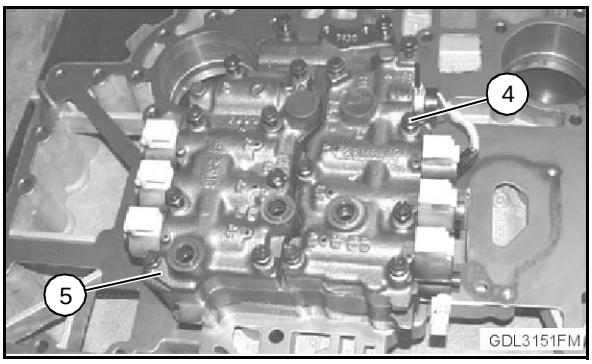
Drain Plug Torque - - - - - - - - - - - - - - - 27 Nm (20 lb-ft)

Assemble Control Valve



1. Main Control Valve Body.
2. Cap Screw (2 used).
3. Solenoid Separator Plate.

Install main control valve body (1) and solenoid separator plate (3) with gaskets. Tighten cap screws (2) until finger tight.



4. C1/C2 Clutch Solenoid Body.
5. C3/C4 Clutch Solenoid Body.

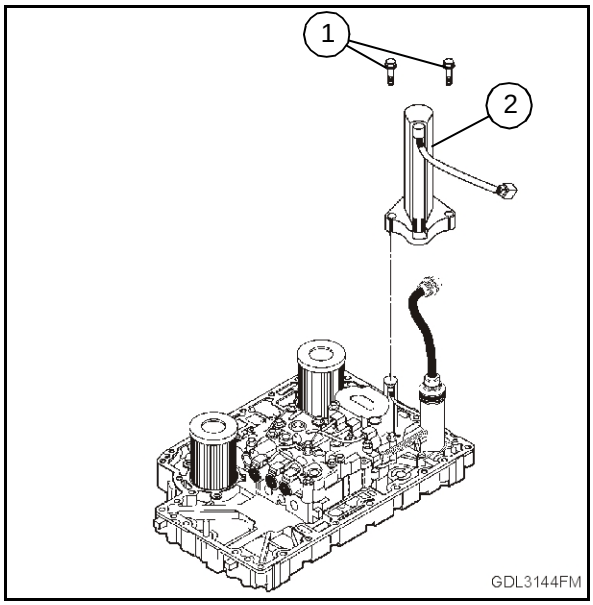
Install C1/C2 clutch solenoid body (4) and C3/C4 clutch solenoid body (5).

Control Valve Specification

Main Valve Body Cap Screw Torque
- 12 Nm (106 lb-in.)

C1/C2 Clutch Solenoid Body Cap Screw Torque
- 12 Nm (106 lb-in.)

C3/C4 Clutch Solenoid Body Cap Screw Torque
- 12 Nm (106 lb-in.)

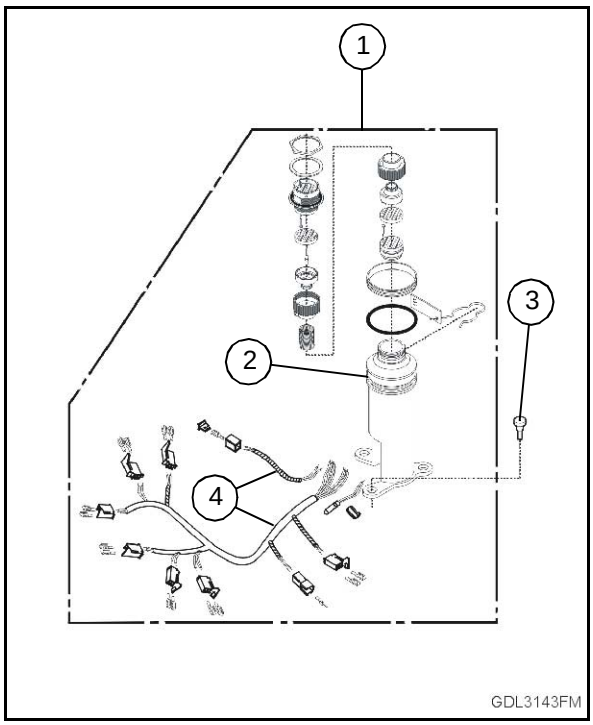


1. Cap Screw. 2. Oil Level Sensor.

Install oil level sensor (2).

Control Valve Specification

Oil Level Sensor Cap Screw Torque
- 12 Nm (106 lb-in.)



1. Harness. 2. Standoff.
3. Cap Screw. 4. Wire Harness.

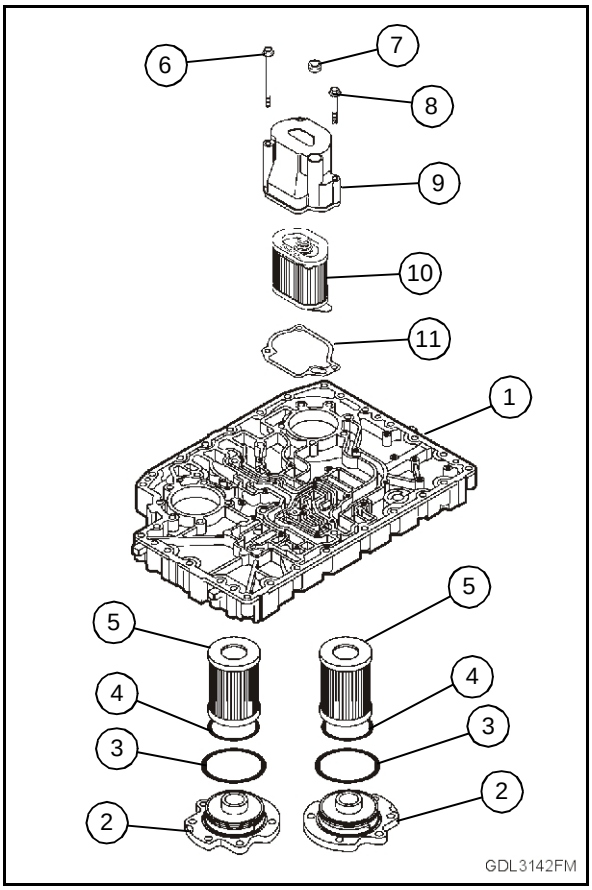
Install harness (1).

Control Valve Specification

Harness Cap Screw Torque - - 2 - 3 Nm (18 - 27 lb-in.)

Reconnect all connectors and install standoff.

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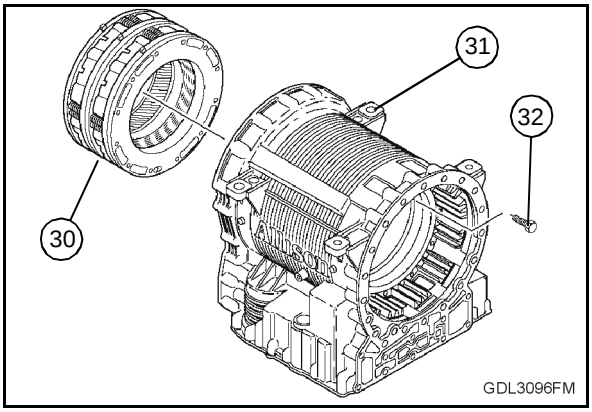
1. Channel Housing.
2. Filter Cover (2 used).
3. O-Ring (2 used).
4. O-Ring (2 used).
5. Filter (2 used).
6. Cap Screw.
7. Face Seal.
8. Cap Screw.
9. Suction Filter Housing.
10. Suction Filter.
11. Gasket.

Install gasket (11), seal (7), filter (10) and suction filter housing (9). Do not install lube and main filters at this time.

Control Module Specification

Suction Filter Cap Screw Torque - - 12 Nm (106 lb-in.)

Assemble Transmission



30. C3/C4 Clutch.
31. Housing.
32. Cap Screw (12 used).

Position transmission housing horizontally on stand.

Install C3/C4 clutch (1) through input end of housing (2).

NOTE: Align tabs on clutch assembly with the slot in main housing.

Install two cap screws (3) 180 degrees from each other to hold clutch in place.

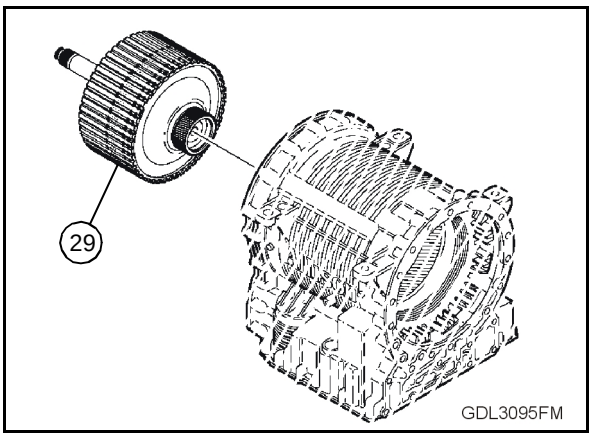
Position transmission housing with output end up.

Install remaining cap screws (3).

Transmission Housing Specification

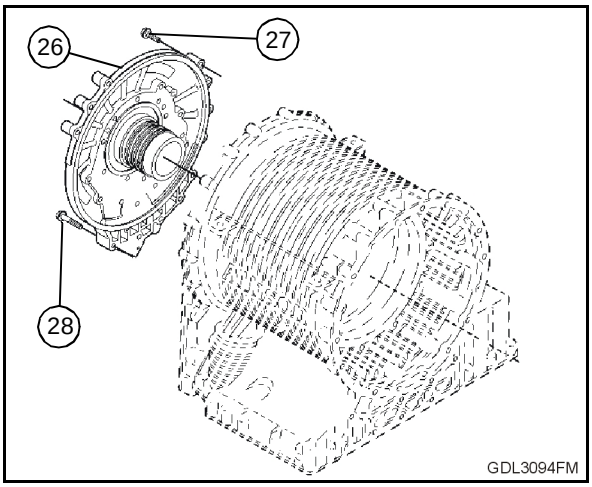
C3/C4 Clutch Cap Screw Torque - - - - 56 NM (42 lb-ft)

Position transmission housing with input end up.



Install C1/C2 clutch (4) using M16 eye bolt and hoist.

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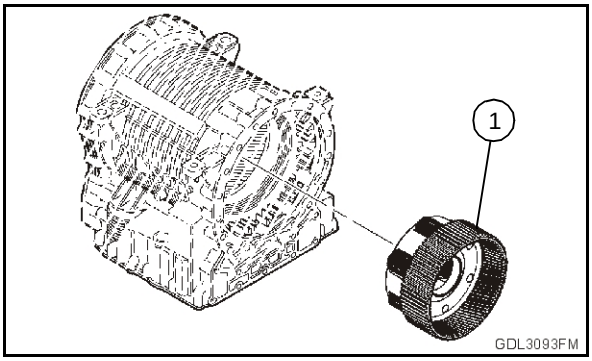


Install front support and charging pump (7) over top of the turbine shaft.

Transmission Housing Specification

Front Support Cap Screw Torque - - - - 56 Nm (42 lb-ft)

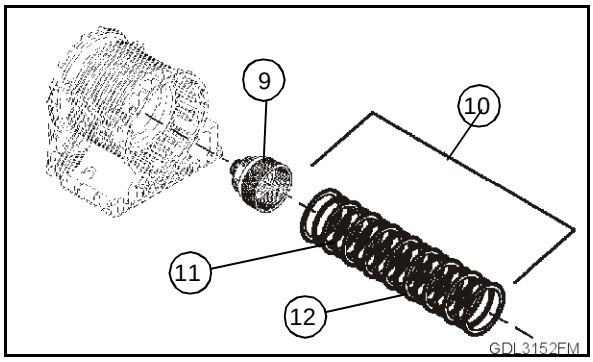
Position transmission housing with output end up.



Install P1 planetary (1).

NOTE:P1 planetary consists of P1 carrier and P2 ring gear.

Mesh P1 pinion gears with P1 ring gear inside C3/ C4 clutch.



9. P2 Planetary.
10. C5 Clutch Pack (Complete).
11. Reaction Plate (9 used).

Install P2 planetary (9).

NOTE:P2 planetary consists of P2 carrier and P3 ring gear.

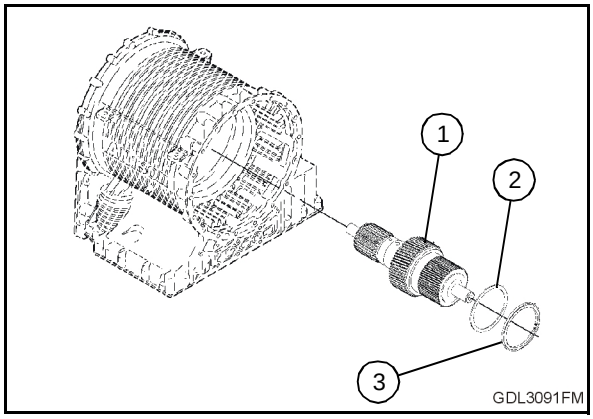
Mesh P2 pinion gears with P2 ring gear during assembly.

Install C5 clutch pack (10) in main housing.

Stack all plates with cone facing same direction.

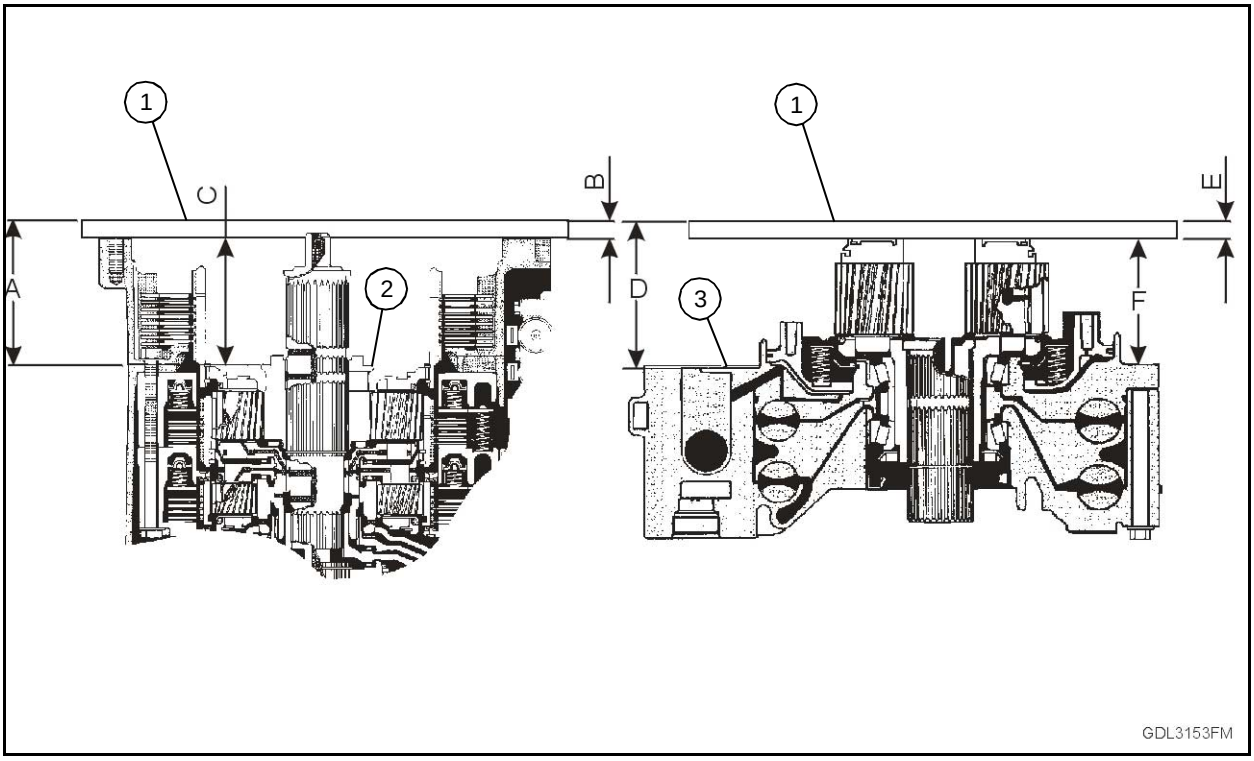
Start with steel reaction plate (11) and alternate with, friction plates (12).

Steel reaction plates mesh with main housing and reaction plates mesh with P3 ring gear.



Install main shaft (1) without shim (2) and thrust bearing (3).

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1. Straightedge.
2. Bearing and Shim Removed.
3. Gasket Installed.

A. Top of Straightedge to Shim Dimension.
B. Thickness of Straightedge.
C. A Minus B Dimension.
D. P3 to Retarder Gasket Dimension.
E. Thickness of Straightedge Dimension.
F. D Minus E Dimension.

Place a straightedge (1) across retarder housing mounting surface of main housing.

Measure dimension (A), from top of straightedge (1) to shim thrust surface on main shaft bearing spacer (2).

Measure dimension (B), thickness of straightedge.

Subtract dimension (B) from dimension (A) - this is dimension (C).

Place retarder housing on bench, output end down.

Install new gasket on mounting surface (3).

Place a straightedge (1) across P3 planetary carrier.

Measure dimension (D).

Measure dimension (E).

Subtract dimension (E) from dimension (D) - this is dimension (F).

Subtract dimension (C) from dimension (F) - this is dimension (G).

Use dimension (G) and table for correct shim thrust bearing.

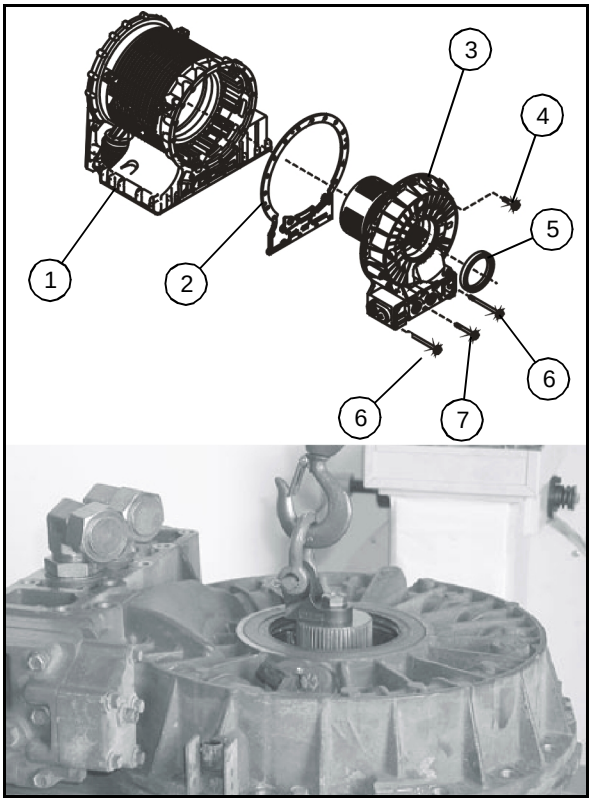
https://truckmanualshub.com/

Shim Thickness Dimension (G)	Part Number	Shim Thickness
4.770 - 4.843 mm (0.180 - 0.190 in.)	AT256516	0.27 mm (0.01 in.)
4.844—5.113 mm (0.191—0.201 in.)	AT256517	0.54 mm (0.02 in.)
5.114—5.383 mm (0.202—0.212 in.)	AT256518	0.81 mm (0.03 in.)
5.384—5.653 mm (0.213—0.223 in.)	AT256519	1.08 mm (0.04 in.)
5.654—5.923 mm (0.224—0.233 in.)	AT256520	1.35 mm (0.05 in.)
5.924—6.193 mm (0.234—0.244 in.)	AT256521	1.62 mm (0.06 in.)
6.194—6.380 mm (0.245—0.251 in.)	AT256522	1.89 mm (0.07 in.)

Install proper shim and thrust bearing.

⚠ CAUTION

The approximate weight of retarder is 34 kg (75 lb).



Install new retarder gasket (2) on main housing (1).

Retarder Specification

Retarder and P3 Planetary Weight - - - - - 34 kg (75 lb)

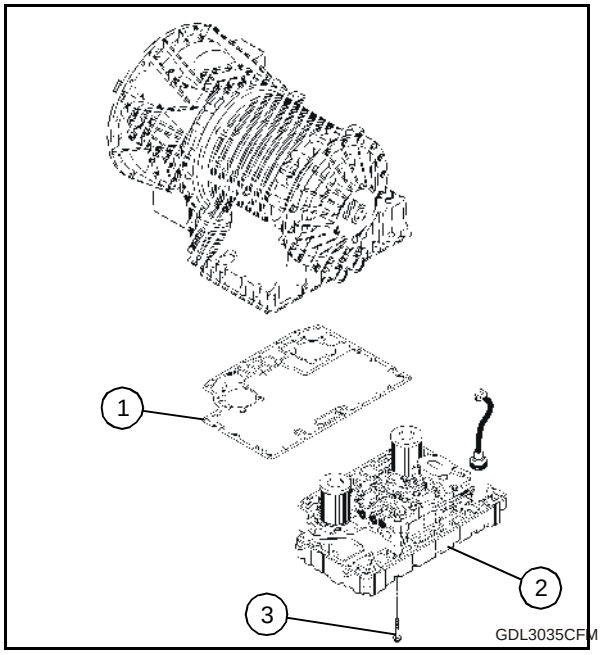
Install retarder housing (15) on main housing (13) using hoist and M10 eye bolt or lifting bracket JT01748. Use guide pins to help with retarder housing installation.

Transmission Housing Specification

M12 Rear Housing Cap Screw Torque
- 100 Nm (75 lb-ft)

M10 Rear Housing Cap Screw Torque
- 57 Nm (42 lb-ft)

Position transmission vertically.



Install new control valve gasket (1) on control valve (2).

⚠ CAUTION

The approximate weight of control valve is 25 kg (56 lb).

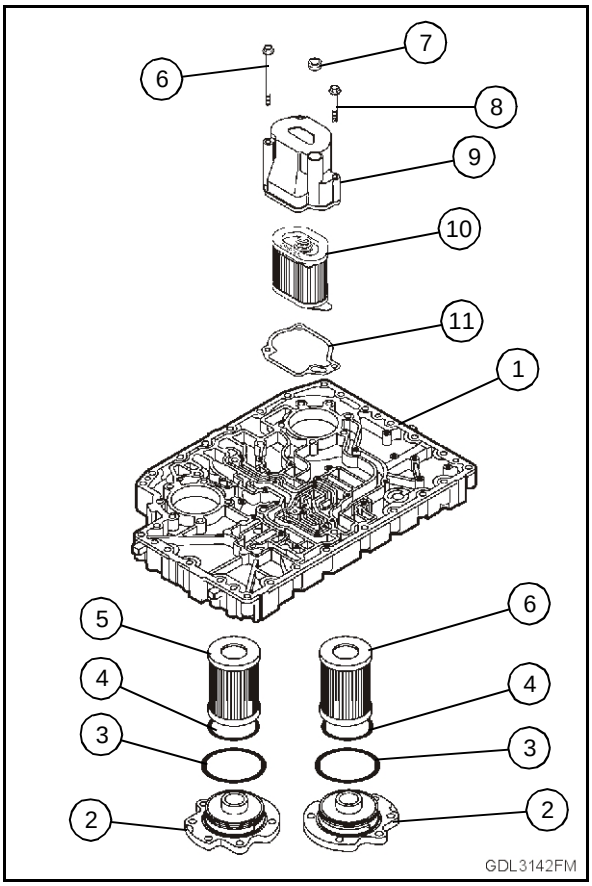
Transmission Specification

Control Valve Weight - - - - - - - - - - - - - - - 25 kg (56 lb)

Install control valve onto main housing using guide pins.

Install one cap screw (3) in top center hole.

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Install O-rings (3 and 4), filters (5), and filter covers (2).

Transmission Specification

Filter Cover Cap Screw Torque - - - - - 55 Nm (40 lb-ft)

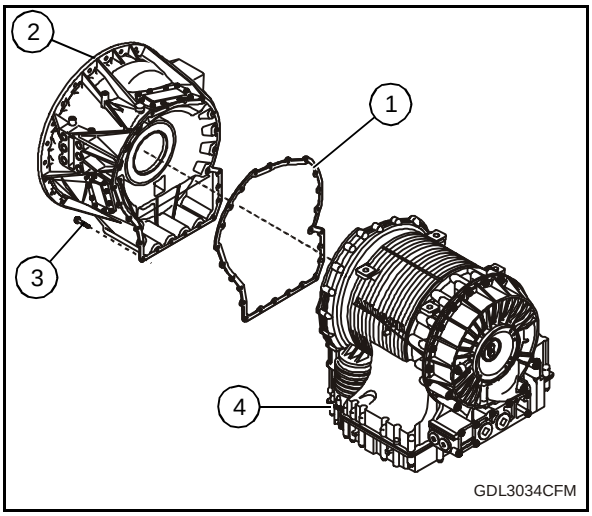
NOTE: Main and lube filters are interchangeable.

Remove guide pins and install remaining thirty-one cap screws into control valve.

Transmission Specification

Control Valve Cap Screw Torque - - - - -55 Nm (40 lb-ft)

Position transmission housing with input end up.



Install new torque converter housing gasket (1) on main housing (2).

Install guide bolts to aid torque converter housing (2) installation and keep gasket (3) in place.

Install seven cap screws (3) into inside of torque converter housing (2) with mechanical fingers.

Install remaining cap screws (3).

Transmission Housing Specification

Torque Converter Housing Cap Screw Torque -56 Nm (42 lb-ft)

Install torque converter into torque converter housing using eyebolts and hoist.

Install torque converter.

NOTE: Torque converter must be in proper location to engage charge pump prior to measuring for C1/C2 turbine shaft selective shim.

Install JDG1501-13 Converter End Play Gauge.

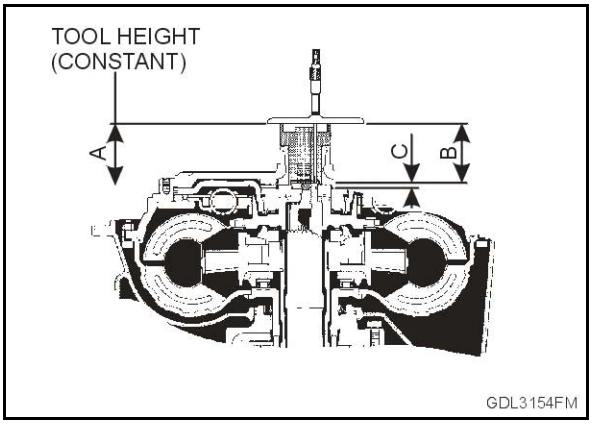
NOTE: Dimension (C) includes correction due to deflection caused by torque. Accurate torque value is critical to selection of the proper shim.

Tighten torque converter end play gauge attaching cap screw.

Transmission Housing Specification

Torque Converter End Play Gauge Attaching Cap Screw Torque - - - - - - - - - - - - - - - - - 30 Nm (23 lb-ft).

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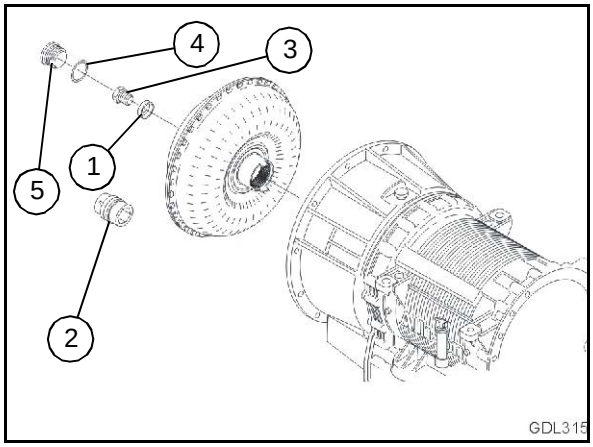
Measure from top of torque converter end play gauge to face of turbine shaft. Record as dimension (B).

Subtract height of tool (A) {100 mm (3.937 in.)} from dimension (B). This is dimension (C).

Remove tool and torque converter.

Select proper shim from table.

C1/C2 turbine Shaft Shim Thickness Dimension (C)	Part Number	Shim Thickness
0.4129 - 0.6597 mm (0.016 - 0.026 in.)	AT256495	4.000 mm (0.157 in.)
0.6598 - 0.8378 mm (0.0261 - 0.033 in.)	AT256496	4.203 mm (0.165 in.)
0.8379 - 1.0158 mm (0.0331 - 0.400 in.)	AT256497	4.381 mm (0.172 in.)
1.0159 - 1.1938 mm (0.401 - 0.0470 in.)	AT256498	4.559 mm (0.179 in.)
1.1939 - 1.3708 mm (0.0471 - 0.054 in.)	AT256499	4.736 mm (0.186 in.)
1.3709 - 1.5488 mm (0.0541 - 0.061 in.)	AT256500	4.914 mm (0.193 in.)
1.5489 - 1.7268 mm (0.061v0.068 in.)	AT256501	5.092 mm (0.200 in.)
1.7269—1.9048 mm (0.068—0.075 in.)	AT256502	5.270 mm (0.207 in.)
1.9049—1.9733 mm (0.075—0.078 in.)	AT256503	5.448 mm (0.214 in.)



Install shim (1) with shim step side toward turbine shaft (cupped end down).

Use JDG1501-12 Torque Converter Nut Torque Tool (2) to install cap screw (3).

Transmission Converter Specification

Torque Converter Retaining Cap Screw Torque - 110 Nm (80 lb-ft)

Install O-ring (4) on converter end plug (5).

Transmission Converter Specification

Torque Converter Plug Torque - - - - - - 55 Nm (40 lb-ft)

Install torque converter retaining brackets.

Transmission Converter Specification

Retaining Bracket Cap Screw Torque - 55 Nm (40 lb-ft)

Install external components.

Transmission Housing Specification

Yoke Retainer Plug Cap Screw Torque - 55 Nm (40 lb-ft)

Fill Tube Cap Screw Torque - - - - - - - - 27 Nm (20 lb-ft)

Breather Torque - - - - - - - - - - - - - - 14 Nm (124 lb-in.)

Input Speed Sensor Torque - - - - - - - - 27 Nm (20 lb-ft)

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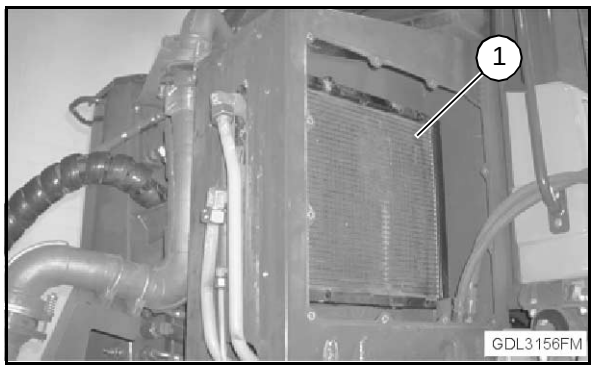
CHAPTER 3. TRANSMISSION

SECTION 4. HYDRAULIC SYSTEM

REMOVE AND INSTALL TRANSMISSION OIL COOLER

Remove top and rear covers, right side grille and front access panel from transmission oil cooler housing.

Remove brake oil cooler (400D only). **(See "Wet Disk Brake Cooling Oil Cooler" on page 255).**



Disconnect lines from transmission oil cooler (1). Cap and plug all openings.

Remove 90° fitting from front end of transmission oil cooler. Plug opening.

Remove cap screws and transmission oil cooler.

Install transmission oil cooler.

Install 90° fitting to front end of transmission oil cooler.

Connect lines to transmission oil cooler.

Install brake oil cooler (400D only). **(See "Wet Disk Brake Cooling Oil Cooler" on page 255).**

Install top and rear covers, right grille and front access panel to transmission oil cooler housing.

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CHAPTER 4. ENGINE

SECTION 1. REMOVAL AND INSTALLATION

ENGINE

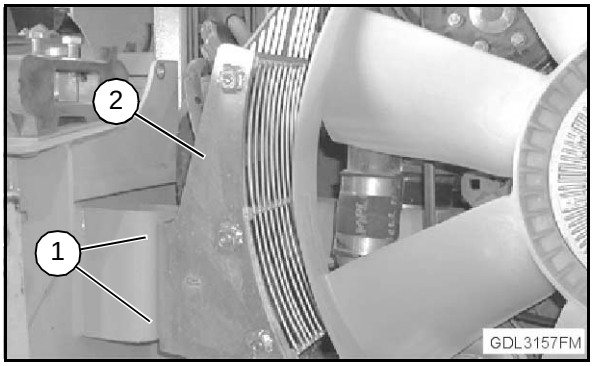
Remove and Install

Turn battery disconnect switch to OFF.

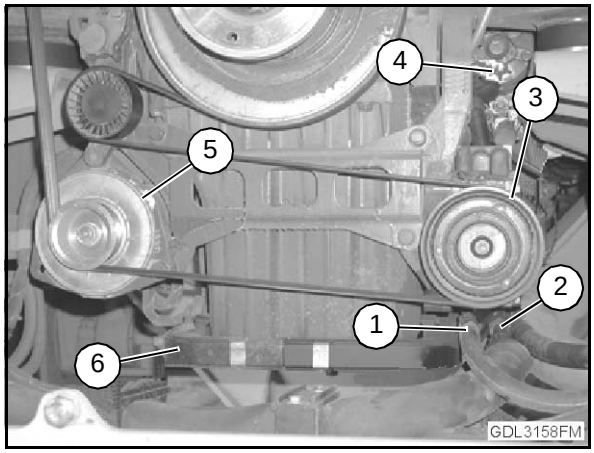
Remove hood. (See Hood in Group 1910.)

Lower frame bottom guards.

Remove charge air aftercooler and radiator. **(See “REMOVE AND INSTALL CHARGE AIR AFTERCOOLER” on page 183).**



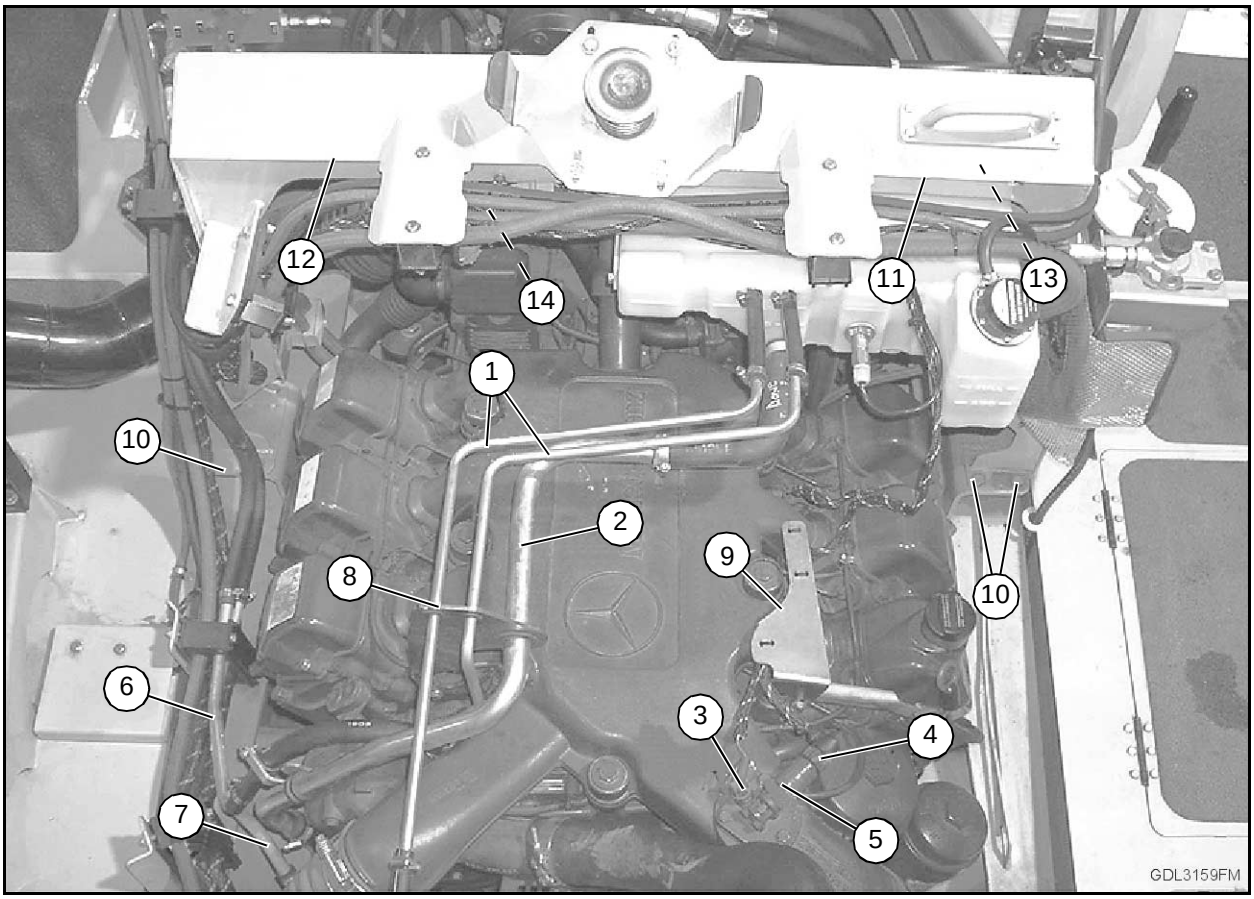
Remove cap screws (1) and fan guard (2) from left and right side.



Disconnect wire’s from starting motor (4) and alternator (5). Pull wires from starter through harness tube (6).

Disconnect high pressure line (1) and low pressure line (2) from A/C compressor (3).

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1. Bleed Lines.
2. Fill Tube.
3. Cold Start Glow Plug Wire Connector.
4. Cold Start Solenoid Wire Connector.
5. Cold Start Fuel Line.
6. Heater Hose.
7. Heater Hose.
8. Support Bracket.
9. Support Bracket.
10. Cap Screw and Nuts (8 used).
11. Cross Member.
12. Air Intake Boot.
13. Exhaust Clamp.
14. Air Compressor Output Line.

Disconnect lines (1 and 2) from expansion tank.

Disconnect heater hoses (6 and 7). Remove cap screws for bracket (8) and remove with lines (1 and 2).

Disconnect start aid glow plug wire connector (3), solenoid wire connector (4), and fuel line (5).

Remove bracket (9) and move harness away from engine. Cut wires ties as necessary.

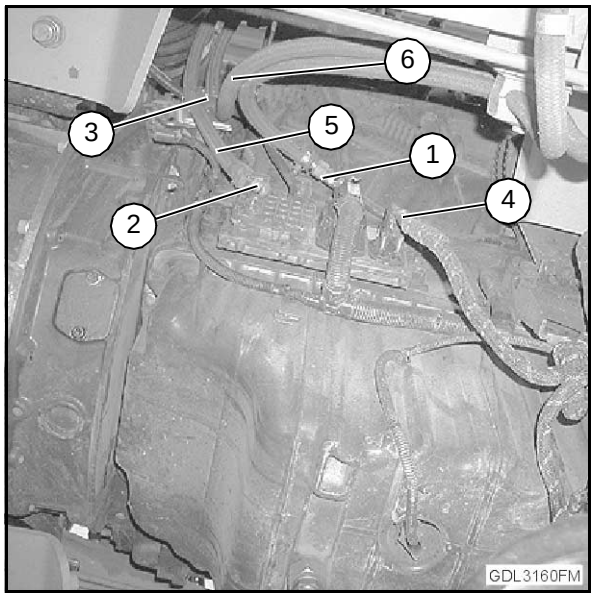
Remove cap screws (10) that holds cross member (11). Lift up cross member and swing over to right side fender. Install one cap screw to hold cross member in place.

Disconnect intake boot (12).

Remove clamp (13) and disconnect exhaust pipe from exhaust plenum.

Disconnect steel braided output line (14) from compressor.

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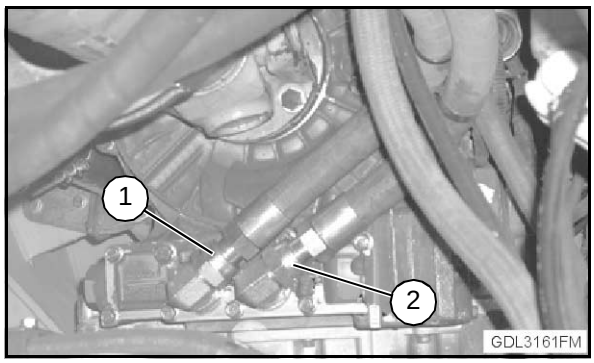


Drain fuel tank. Disconnect fuel lines (1 and 5).

Remove clamp (3) and move lines (1, 5, and 6) towards right frame rail.

Disconnect wire connector (4).

Disconnect output speed sensor, retarder temperature sensor, turbine speed sensor, input speed sensor, retarder sensor, and transmission control module wire connectors. **(See Transmission Harness Component Location in Operation and Test Manual CHAPTER 3, SECTION 1).**



Disconnect line (2) and drain fluid from cooler into suitable container. Disconnect line (1). Close all openings using caps and plugs.

Disconnect transmission drive shaft. **(See "REMOVE AND INSTALL TRANSMISSION-TO-TRANSFER CASE DRIVE SHAFT" on page 49).**

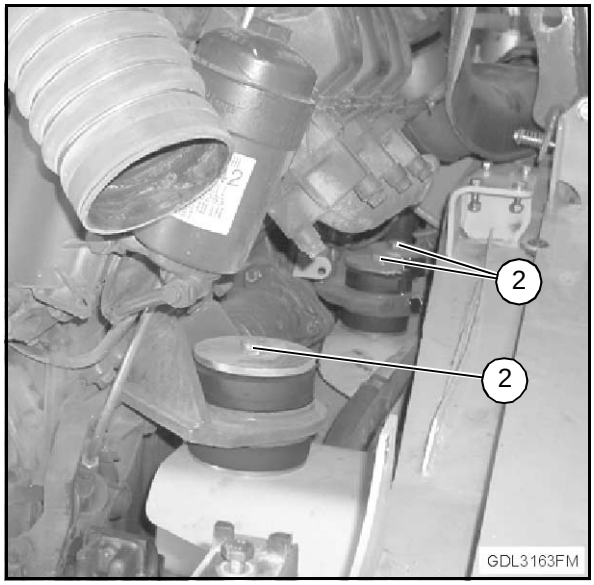


⚠ CAUTION

Approximate weight of engine and transmission is 907 kg (2400 lb).

Remove and Install Engine Specification

Engine and Transmissionm Weight
- 907 kg (2400 lb)

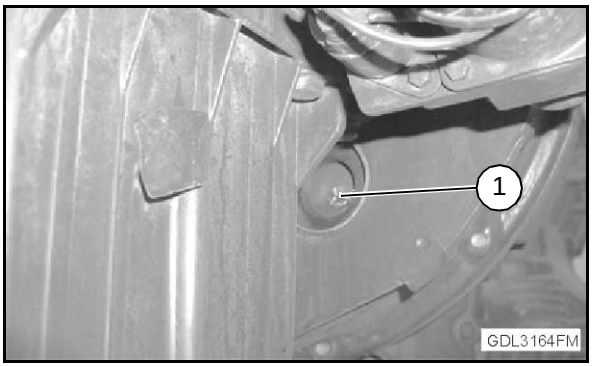


Attach JDG23 Lifting Beam to suitable hoist and hook to three engine hookup points.

Remove cap screws for front engine mounts (1) and transmission mounts (2). Note location of washers between rubber mounts and frame.

Remove engine. Use shop stands or wooden blocks to support the engine and transmission.

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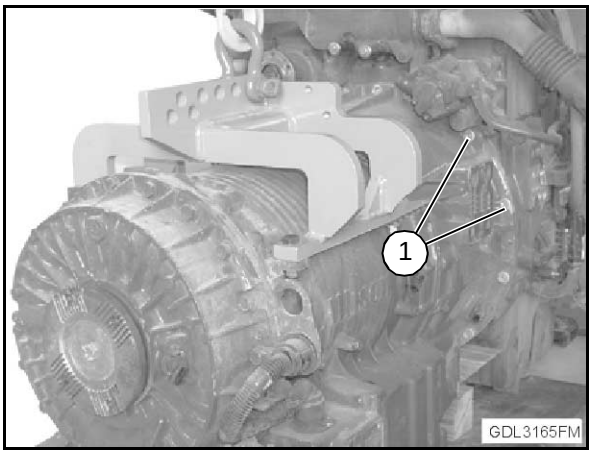
Using JDG1500-16 turning tool rotate engine until flex plate cap screws (1) appear in access hole.

Rotate engine and remove cap screws.

⚠ CAUTION

Approximate weight of transmission is 544 kg (1200 lb)

Attach JDG1501-6 main case holding fixture tool to transmission. Attach a suitable hoist to tool.



Remove cap screws (1) and remove transmission from engine. Remove cap screws holding flexplate adapter to flywheel.

Repair or replace as necessary.

Install flexplate adapter to flywheel. Tighten cap screws to specification.

Remove and Install Engine Specification

Flexplate Adapter-to-Flywheel Cap Screws Torque
- 110 N•m (81 lb-ft)

Before installing the transmission, align one of the cap screw holes in the flex plate discs and one of the tapped holes in torque converter adapter with hole in flywheel housing.

Install transmission to flywheel housing.

Appy rigid form in place gasket to threads of transmission-to-flywheel housing cap screws.

Tighten to specification.

Remove and Install Engine Specification

Transmission-to-Flywheel Housing Cap Screws Torque
- 83 Nm (61 lb-ft)

Appy medium strength thread lock and sealer to threads of cap screws.

Rotate engine and install flexplate-to-converter adapter cap screws.

Tighten to specification.

Remove and Install Engine Specification

Flexplate-to-Converter Adapter Cap Screws Torque
- 34 Nm (25 lb-ft)

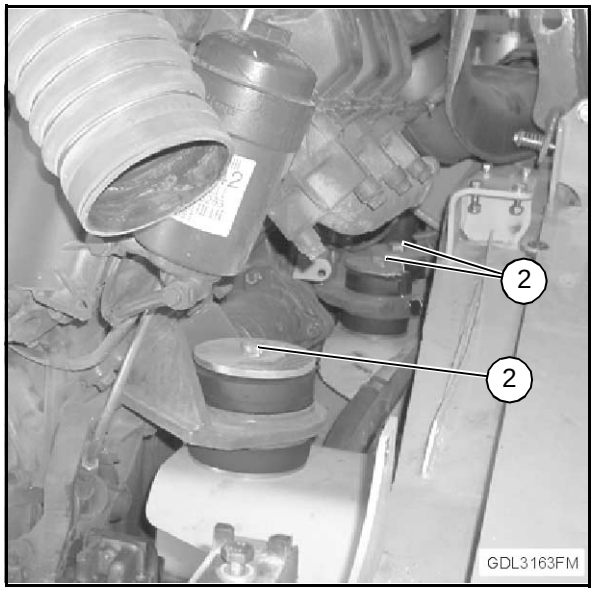
⚠ CAUTION

Approximate weight of engine and transmission is 1542 kg (3400 lb)



Using a suitable hoist, attach JDG23 lifting beam to three lifting points on engine. Install engine into frame.

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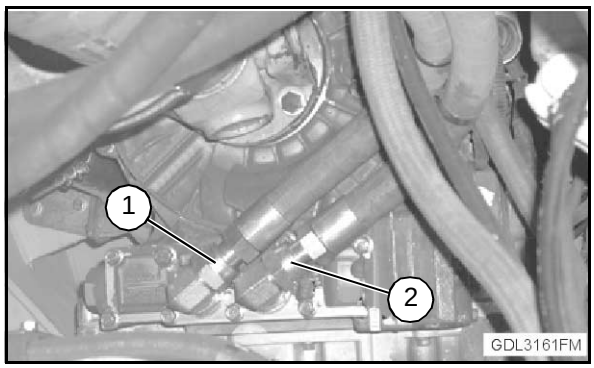
Note location of rubber mounts and washers and install cap screws through mounts and frame.

Tighten to specification.

Remove and Install Engine Specification

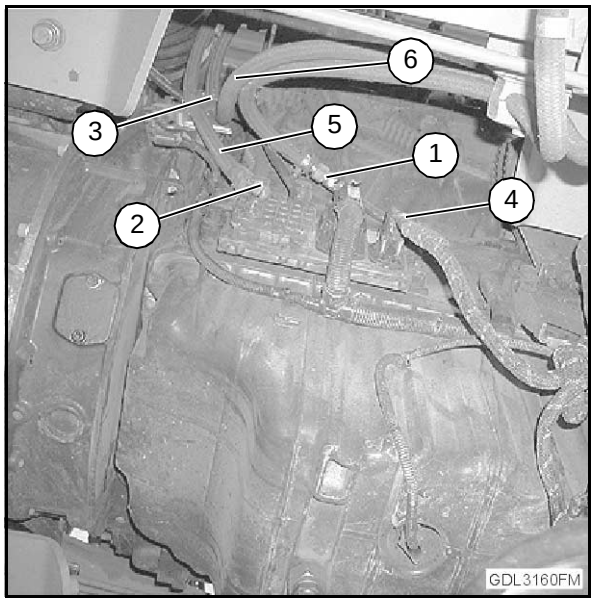
Engine and Transmission Mounts-to-Frame Cap Screws Torque - - - - - - - - - - - - - - - 410 Nm (300 lb-ft)

Connect transmission drive shaft. **(See "REMOVE AND INSTALL TRANSMISSION-TO-TRANSFER CASE DRIVE SHAFT" on page 49).**



Connect transmission lines (1 and 2).

Connect transmission drive shaft. **(See "REMOVE AND INSTALL TRANSMISSION-TO-TRANSFER CASE DRIVE SHAFT" on page 49).**



Connect output speed sensor, retarder temperature sensor, turbine speed sensor, input speed sensor, retarder sensor, and transmission control module wire connectors. **(See Transmission Harness Component Location in Operation and Test Manual CHAPTER 3, SECTION 1)**

Connect wire connector (4).

Connect fuel lines (1 and 5). Use new sealing washers and tighten banjo bolt (2) to specification.

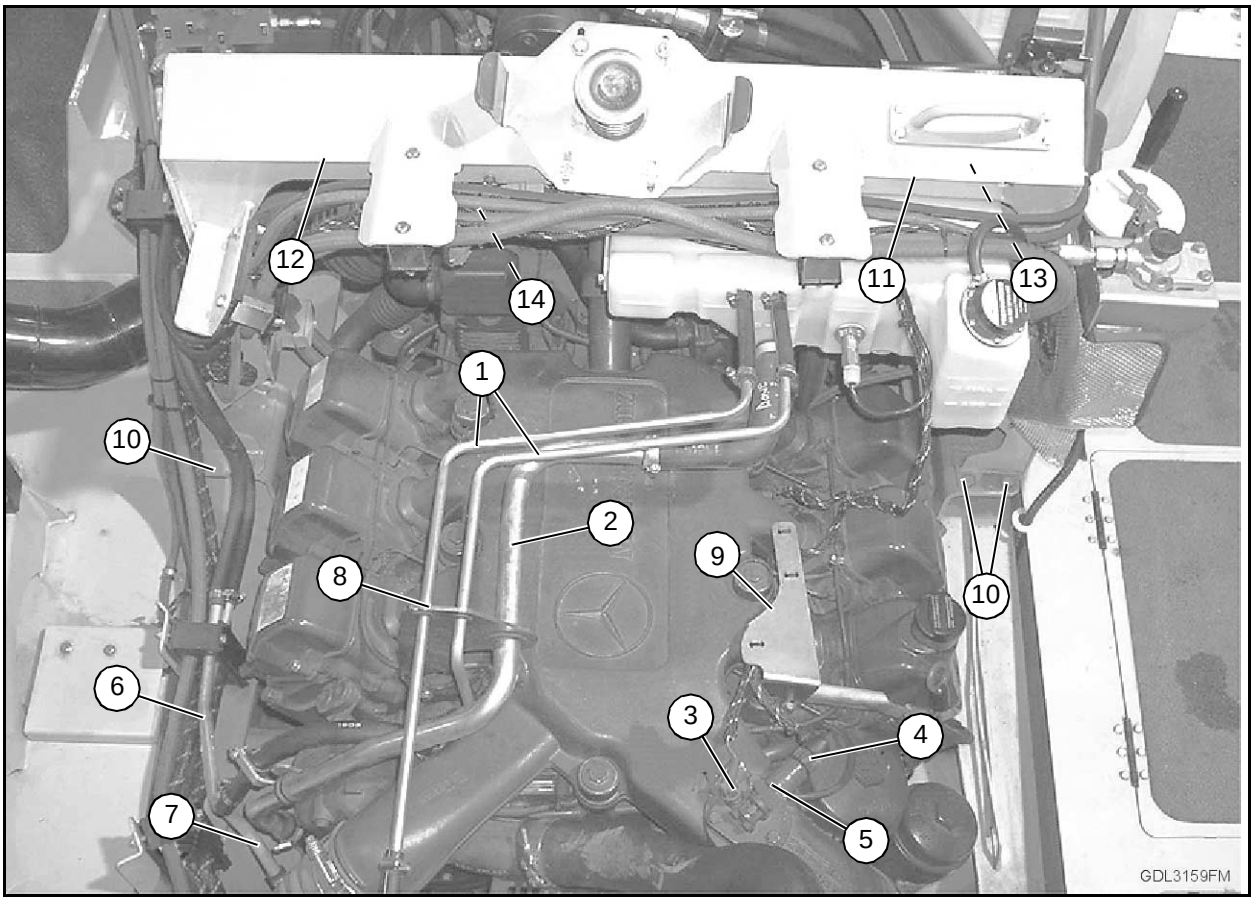
Remove and Install Engine Specification

Fuel Line-to- Fuel Controller Banjo Bolt Torque - 40 Nm (30 lb-ft)

Install fuel lines (5 and 6) into clamp (3).

Tighten cap screw for clamp.

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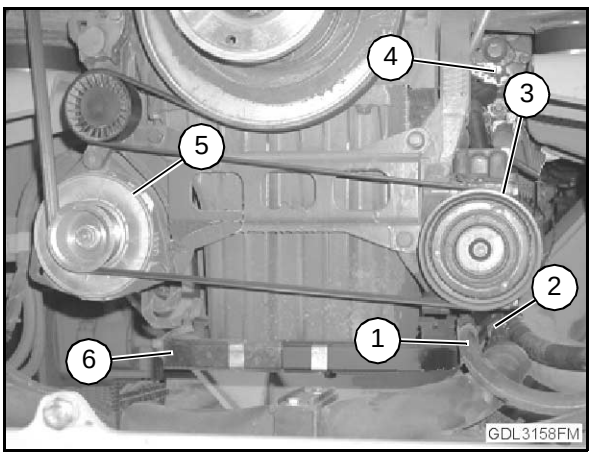
Connect compressor output line (14) and intake boot (12).

Connect exhaust pipe and install clamp (13).

Swing cross member (11) over engine and install cap screws and nuts (10).

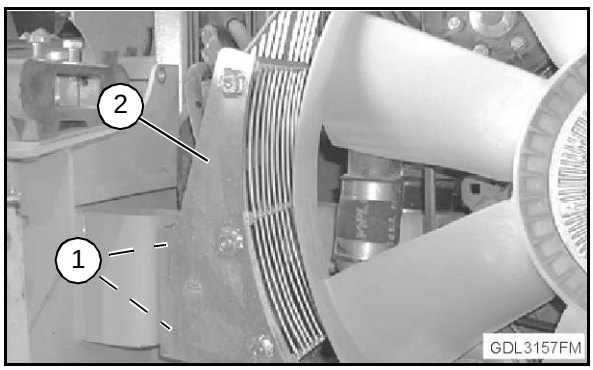
Connect start aid glow plug wire connector (3), solenoid wire connector (4), and fuel line (5).

Install bracket (9) and wire tie harness as required. Connect lines (1 and 2) to expansion tank. Connect heater hoses (6 and 7) and install support bracket (8).



Connect low and high pressure lines (1 and 2).

Pull wires through harness tube (6) and connect wires to starting motor and alternator.



Install fan Guards (2) using cap screws and nuts (1).

Install charge air aftercooler and radiator. **(See "REMOVE AND INSTALL CHARGE AIR AFTERCOOLER" on page 183).**

Raise frame bottom guards. Install bonnet. **(See "BONNET" on page 293).**

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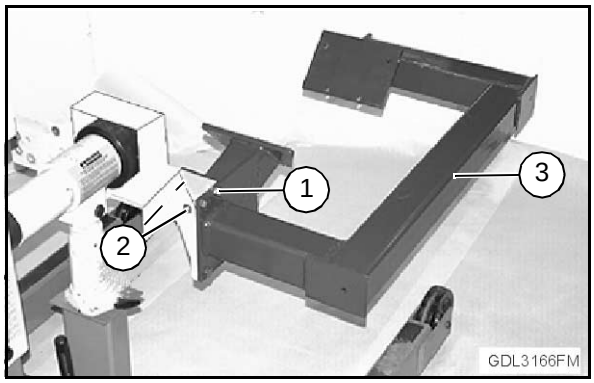
CHAPTER 4. ENGINE

SECTION 2. CRANKSHAFT, MAIN BEARINGS AND FLYWHEEL

INSTALL ENGINE ON REPAIR STAND

Remove belt, engine fan, fan hub, and crankshaft pulley.

Remove mounts from engine block.



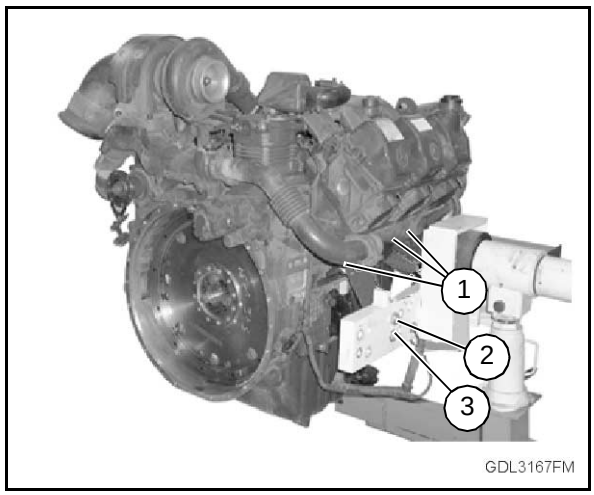
Fasten DFT1224 Engine Mounting Adapter (3) to D055223ST engine repair stand using cap screws (1 and 2). **(See "CHAPTER 17. DEALER FABRICATED TOOLS" on page 351.)**

⚠ CAUTION

The approximate weight of engine is 1087 kg (2400 lb)

Install Engine on Repair Stand Specification

Engine Weight - - - - - - - - - - - - - - - - 1087 kg (2400 lb)



Lower engine on repair stand and install cap screws (1) where original engine mounts were.

Install bracket using cap screws and nuts (2 and 3).

Install cap screw (1) into engine .

Tighten all cap screws and remove hoist.

CRANKSHAFT AND MAIN BEARING FAILURE ANALYSIS

Scored Main Bearing

(Diagnosis also applies to connecting rod bearing.)

- Oil starvation.
- Contaminated oil.
- Engine parts failure.
- Excessive heat.
- Poor periodic service.

Galled or "Wiped" Bearings

- Fuel in lubricating oil (incomplete combustion).
- Coolant in lubrication system (cracked block, liner seal failure, or leaking water pump seal with plugged hole).
- Insufficient bearing oil clearance.
- Parts not lubricated prior to engine operation.
- Wrong bearing size.

Inconsistent Wear Pattern

- Misaligned or bent connecting rod.
- Warped or bowed crankshaft.
- Distorted cylinder block.

Broken Main Bearing Caps

- Improper installation.
- Dirt between bearing and crankshaft journal.
- Low oil pressure.
- Oil pump failure.

Cracked, Chipped or Broken Bearings

- Overspeeding.
- Excessive idling.
- Lugging.
- Excessive oil clearance.
- Improper installation.

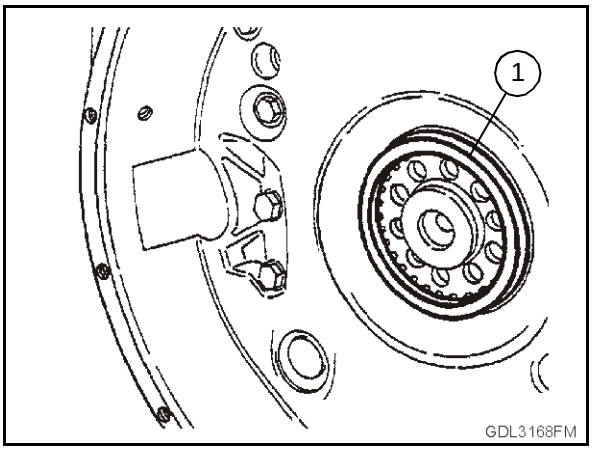
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CRANKSHAFT OIL SEALS

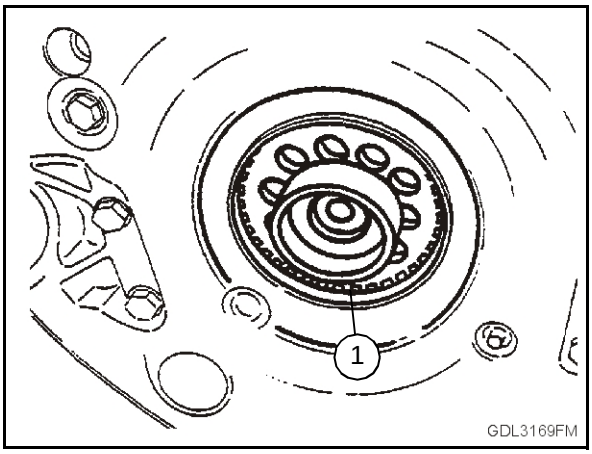
Remove and Install Rear Oil Seal

Remove the engine. **(See "Remove and Install" on page 105).**

Remove flywheel. **(See "FLYWHEEL" on page 114).**



Carefully remove rear oil seal (1) from timing case.



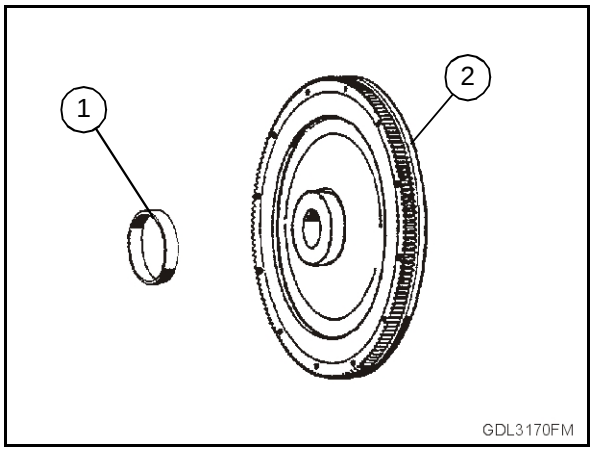
Install spacer (1) from JDG1500-32 Rear Oil Seal Installation Tool on crankshaft.

Apply engine oil to lip of rear oil seal.

Install rear oil seal on installation tool. Install seal into housing, over spacer.

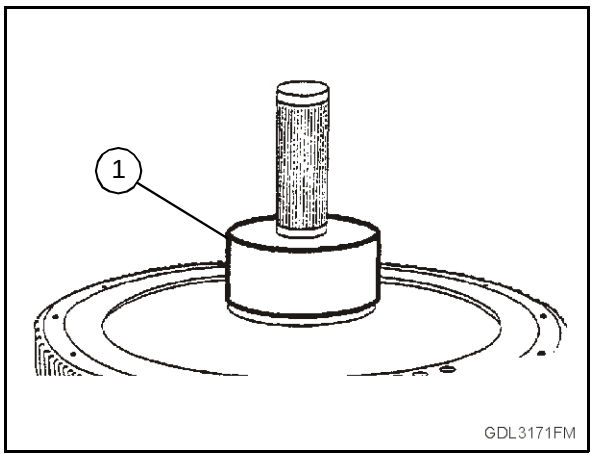
Remove and Install Rear Wear Sleeve

Remove flywheel. **(See "FLYWHEEL" on page 114).**



Remove wear sleeve (1) from flywheel (2) using a puller. Discard wear sleeve.

Heat new wear sleeve to 200°C (392°F).



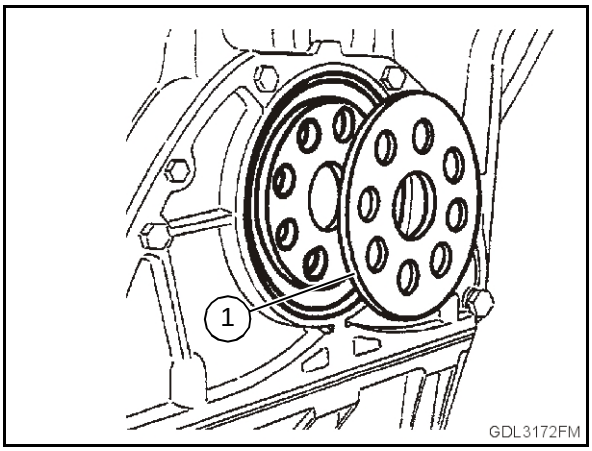
With rounded edge of new wear sleeve to JDG1500-33 Crankshaft Race Seal Ring Installation Tool (1), use tool to install wear sleeve onto flywheel.

Install flywheel. **(See "FLYWHEEL" on page 114.)**

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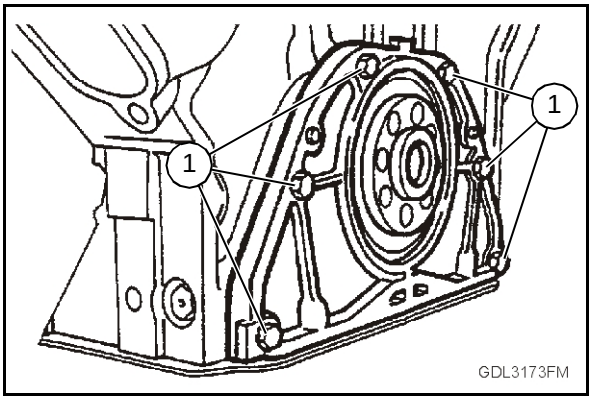
Remove and Install Front Oil Seal and Wear Sleeve

Remove damper.



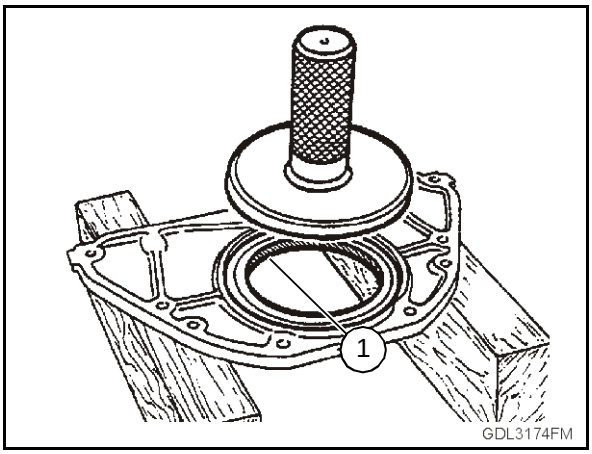
Remove oil splash ring (1).

Remove oil pan. **(See "REMOVE AND INSTALL OIL PAN" on page 146).**



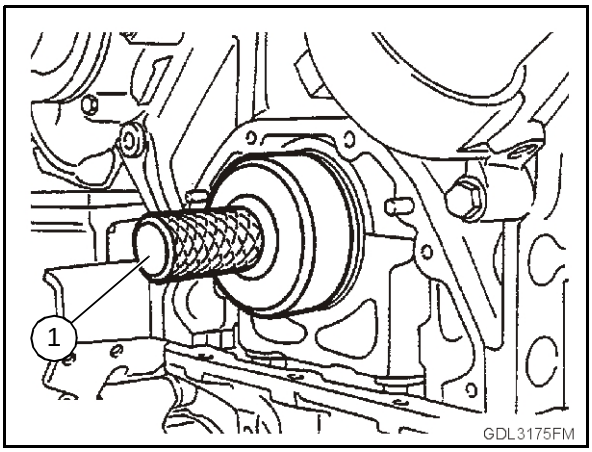
Remove bolts (1) to remove front housing and front oil seal.

Remove gasket from front housing and discard.



Support front housing when removing front oil seal (1).

Remove front oil seal from front housing using JDG1591 Front Crankshaft Seal Installation Tool.



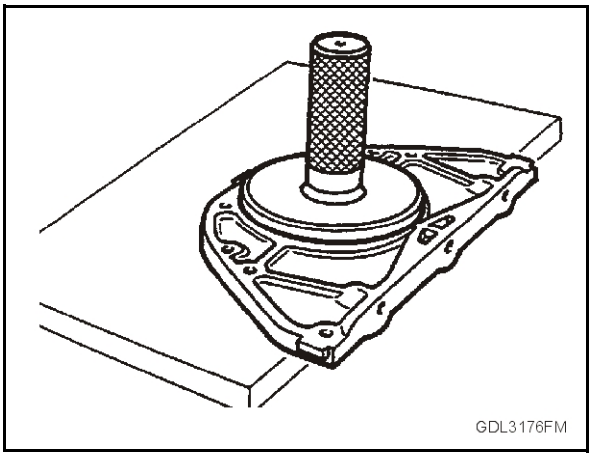
Remove front wear sleeve using JDG1500-34 Front Crankshaft Seal Race Puller.

Clean seal race surface on crankshaft.

Heat seal race to approximately 200°C (392°F).

Install front seal race on crankshaft using JDG1500-33 Front Crankshaft Seal Race Installation Tool (1).

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With front housing flat on an even support install front oil seal flush to the support using JDG1591 Front Crankshaft Seal Installation Tool.

Lubricate front wear sleeve and front oil seal running surfaces with clean engine oil.

Install new front housing gasket over the dowel pins on crankcase.

Install front housing cap screws and front housing to crankcase. Tighten front housing cap screws to specification.

Front Housing Specification

Cap Screw Torque - - - - - - - - - - - - - 25 Nm (221 lb-in.)

Install oil pan. **(See "REMOVE AND INSTALL OIL PAN" on page 146).**

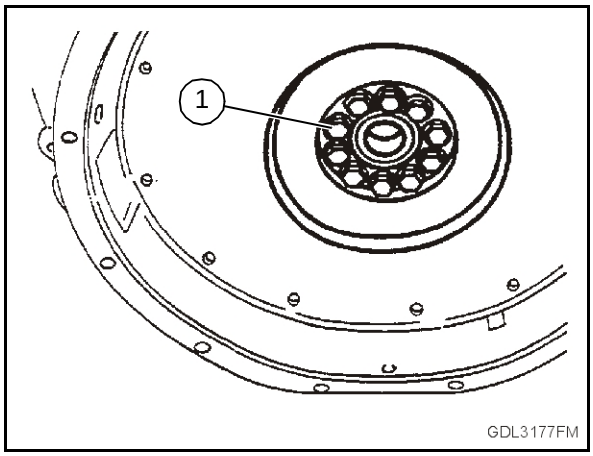
Install splash ring.

Install damper.

FLYWHEEL

Remove and Install

Pull crankshaft position sensor out from timing case approximately 8 mm (0.3 in.).



Remove flywheel cap screws (1).

Install JDG1500-36 Pilot Bolts (2) evenly spaced into flywheel cap screw holes.

Remove flywheel over pilot bolts.

Install flywheel over pilot bolts.

Remove pilot bolts.

Measure the shank length of flywheel cap screws from the end of cap screw to the bottom of cap screw head.

Replace all cap screws if any are longer than specified length.

Flywheel Specification

Cap Screw Shank Length
- 75 mm (2.95 in.) Maximum

Install flywheel cap screws and tighten to specification.

Flywheel Specification

Cap Screw Torque - - - - - - - - - - - - 210 Nm (155 lb-ft)

Torque Turn - 90°

Push crankshaft position sensor to its stops.

Inspect Flywheel and Ring Gear

Examine flywheel for signs of cracking and scoring.

Examine ring gear for damaged or worn teeth. Replace flywheel ring gear, if necessary. **(See "Remove and Install Ring Gear" on page 115).**

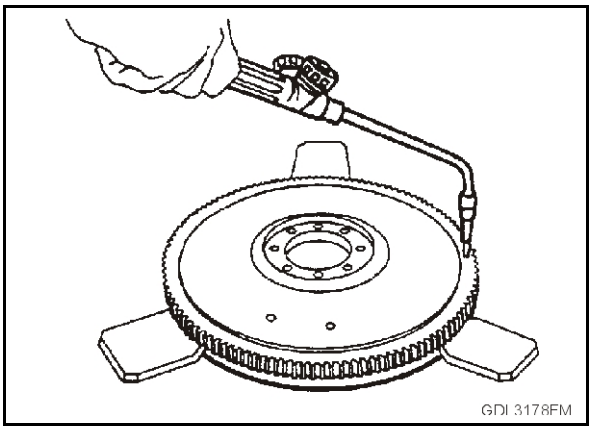
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Remove and Install Ring Gear

⚠ CAUTION

DO NOT use heated oil to heat ring gear. Oil fumes or oil can ignite above 193°C (380°F). Use an oven or flame heat. Plan a safe handling procedure to avoid burns.

If ring gear is damaged, place the flywheel on a solid flat surface.



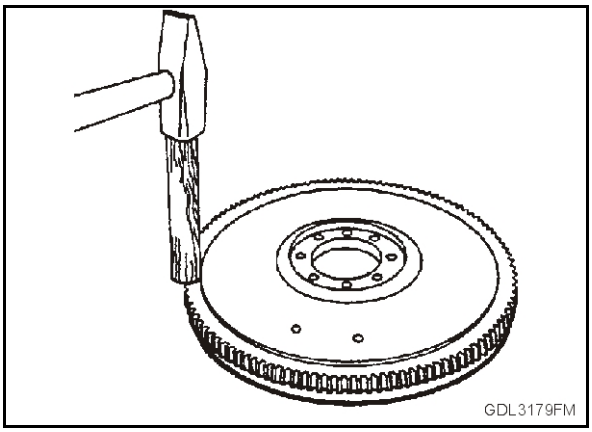
Heat ring gear rapidly to 250 - 280°C (482 - 536°F).

Remove ring gear using a press or with a brass drift and hammer.

⚠ WARNING

If flame heat is used, be sure gear is heated uniformly around circumference. DO NOT OVERHEAT. Overheating may destroy original heat treatment of gear.

Heat new ring gear to 250 - 280°C (482 - 536°F) using either oven heat or flame heat.

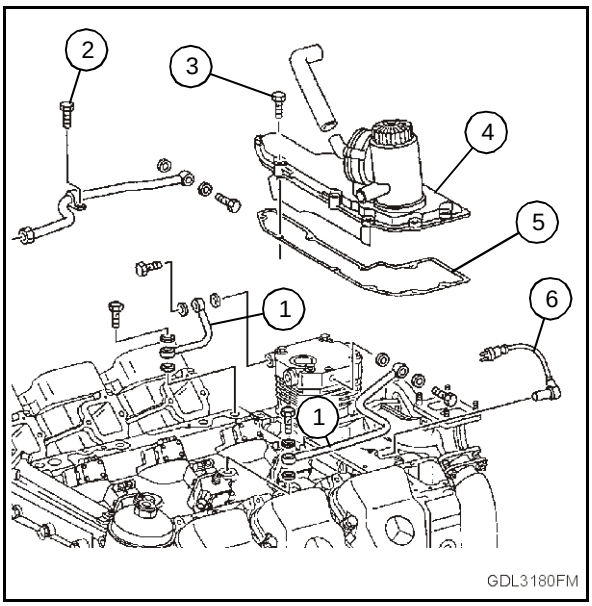


Install ring gear flush with face of flywheel using wood block and hammer.

Remove and Install Timing Case Cover

Remove turbocharger. **(See "TURBOCHARGER" on page 167).**

Remove intake manifold. **(See "REMOVE AND INSTALL AIR INTAKE MANIFOLD" on page 165).**



Remove compressor coolant lines (1).

Remove fuel line (2) connected to outlet side of fuel pump.

Disconnect camshaft position sensor (6) at sensor.

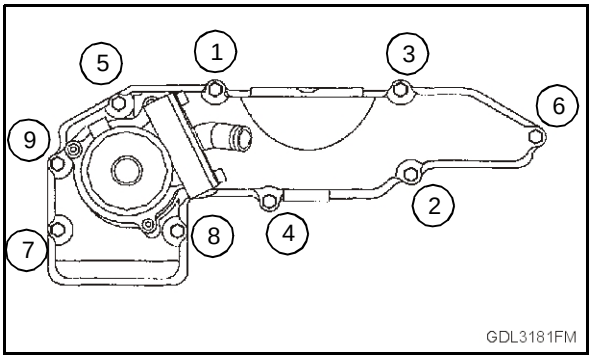
Disconnect crankcase breather hose at crankcase.

Remove cap screws (3) and timing case cover (4).

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Clean sealing surfaces of timing case cover, timing case and crankcase.

Seal joints between timing case and crankcase with clear RTV silicone adhesive sealant.



Install new gasket (5), timing case cover and cap screws. Tighten cap screws to specification in the sequence shown.

Timing Case Cover Specification

Cap Screw Torque - - - - - - - - - - - - 25 Nm (221 lb-in.)

Connect crankcase breather hose at crankcase .

Install coolant lines to crankcase and compressor.

Tighten banjo fittings to specification.

Coolant Line Specification

Banjo Fitting at Compressor Torque

- 30 Nm (22 lb-ft)

Banjo Fitting at Crankcase Torque

- 35 Nm (26 lb-ft)

Install fuel line. Tighten fittings to specification.

Fuel Line Specification

Banjo Fitting at Fuel Pump Torque

- 40 Nm (30 lb-ft)

Connection Between Fuel Lines Torque

- 45 Nm (33 lb-ft)

Connect camshaft position sensor at sensor.

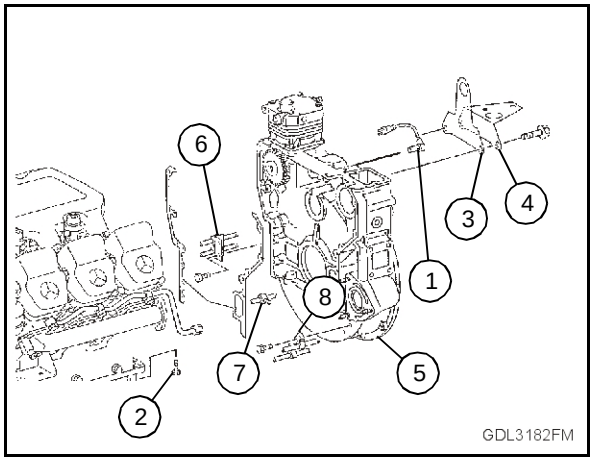
Install intake manifold. **(See "REMOVE AND INSTALL AIR INTAKE MANIFOLD" on page 165).**

Install turbocharger. **(See "TURBOCHARGER" on page 167).**

Remove and Install Timing Case

Remove engine. **(See "ENGINE" on page 105).**

Remove timing case cover. **(See "Remove and Install Timing Case Cover" on page 115).**



Remove camshaft position sensor (1).

Remove lifting eye (3) and bracket (4) from timing case (5).

Disconnect oil line bracket from timing case (6).

Remove fuel line bracket (7) from timing case.

Remove engine harness bracket (8) from timing case.

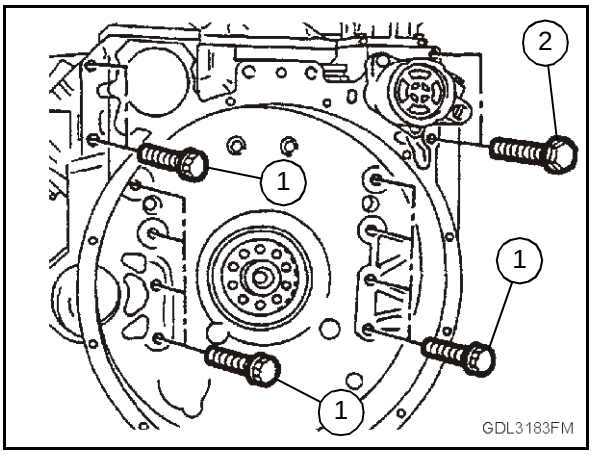
Remove starting motor.

Remove flywheel. **(See "FLYWHEEL" on page 114).**

NOTE: Be careful not to damage oil pan gasket. If gasket is damaged, replace oil pan gasket. (See "REMOVE AND INSTALL OIL PAN" on page 146).

Remove cap screws (2) mounting oil pan to timing case. Loosen all other oil pan cap screws.

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Remove timing case cap screws (1 and 2) and timing case.

Clean timing case and crankcase sealing surfaces.

Tighten oil pan cap screws to specification.

Install new gasket over dowel pins on crankcase and adjust for length.

Seal joint faces between timing case gasket and oil pan gasket with clear RTV silicone adhesive sealant.

Install timing case to crankcase with timing case cap screws (1 and 2). Tighten to specification.

Timing Case Specification

M12 x 57 Cap Screw Torque - - - - - -100 Nm (74 lb-ft)

M12 x 167 Cap Screw Torque - - - - - - 80 Nm (59 lb-ft)

Install flywheel. **(See "FLYWHEEL" on page 114).**

Install camshaft position sensor.

Install turbocharger oil return lines.

Install engine lifting eye and bracket to timing case.

Tighten cap screw to specification.

Engine Lifting Eye Specification

Cap Screw Torque - - - - - - - - - - - - - 150 Nm (111 lb-ft)

Install oil line bracket to timing case.

Install fuel line bracket to timing case. Tighten cap screw to specification.

Fuel Line Bracket Specification

Cap Screw Torque - - - - - - - - - - - - 25 Nm (221 lb-in.)

Install engine harness bracket to timing case. Tighten cap screw to specification.

Wiring Harness Bracket Specification

Cap Screw Torque - - - - - - - - - - - - 25 Nm (221 lb-in.)

Install timing case cover. **(See "Remove and Install Timing Case Cover" on page 115).**

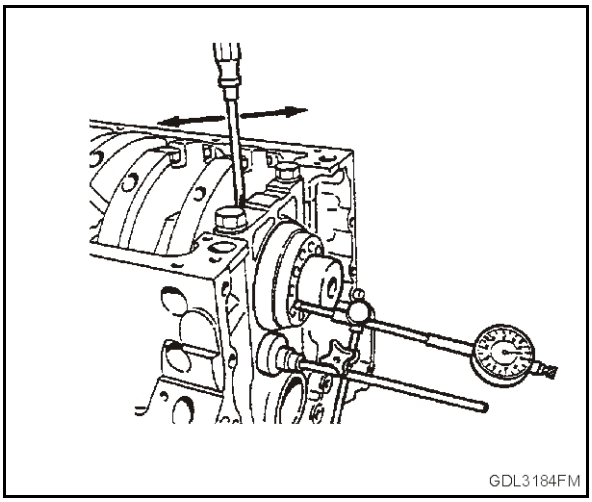
Install starting motor.

Install engine. **(See "ENGINE" on page 105).**

CRANKSHAFT

Check Crankshaft End Play

NOTE: Measure crankshaft end play prior to removing crankshaft to determine condition of thrust bearings.



Attach a magnetic base and dial indicator to crankcase.

NOTE: DO NOT apply too much pressure on pry bar. Bearings can be damaged.

Gently pry crankshaft as far to rear of engine as possible using a pry bar.

Turn the dial indicator zero.

Gently pry crankshaft as far forward as possible and note dial indicator reading. If end play is not within specifications, replace crankshaft thrust bearing.

Crankshaft Specification

Axial End Play

- - - - - - - - - - - 0.150 - 0.351 mm (0.0059 - 0.0138 in.)

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Remove Crankshaft

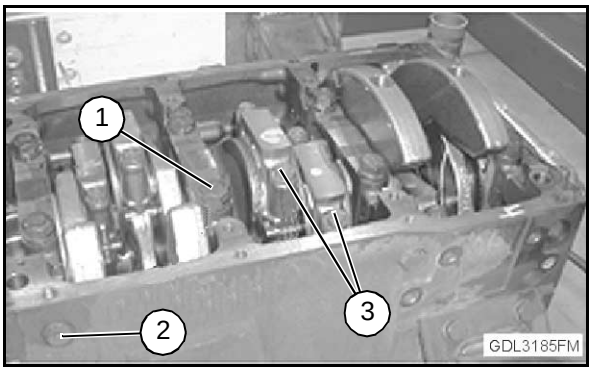
Remove timing case. **(See "Remove and Install Timing Case" on page 116).**

Remove oil pump. **(See "REMOVE AND INSTALL ENGINE OIL PUMP" on page 147).**

Remove front housing. **(See "CRANKSHAFT OIL SEALS" on page 112).**

Remove pistons and connecting rods. **(See "Pistons and Connecting Rods" on page 132).**

NOTE:1. Mark main bearing caps and bearings and rod caps and bearings for ease in assembly.
2. If cylinder head is removed from engine, ensure that pistons do not fall to floor when connecting rod caps are removed. Put a suitable container with padding under engine.



Rotate crankshaft as required to remove connecting rod cap screws (3) and caps.

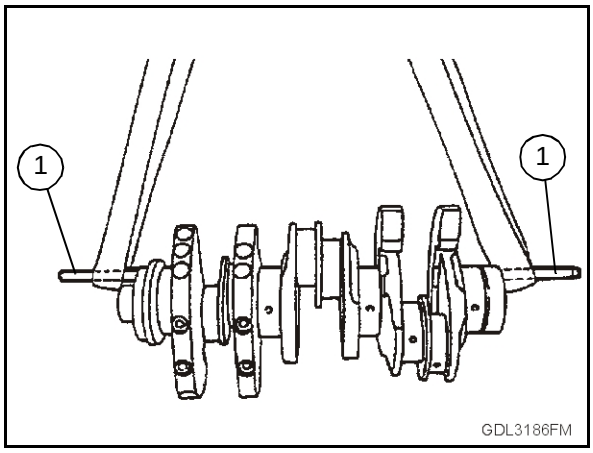
Remove main bearing lateral cap screws (2).

Remove main bearing vertical cap screws (1).

Remove main bearing caps using a soft-face (plastic) hammer, if necessary. Tap gently, using the minimum force necessary.

⚠ CAUTION

Use a lifting device for heavy components.



Install JDG1500-36 Pilot Bolts (1) in ends of crankshaft. Attach a lifting strap.

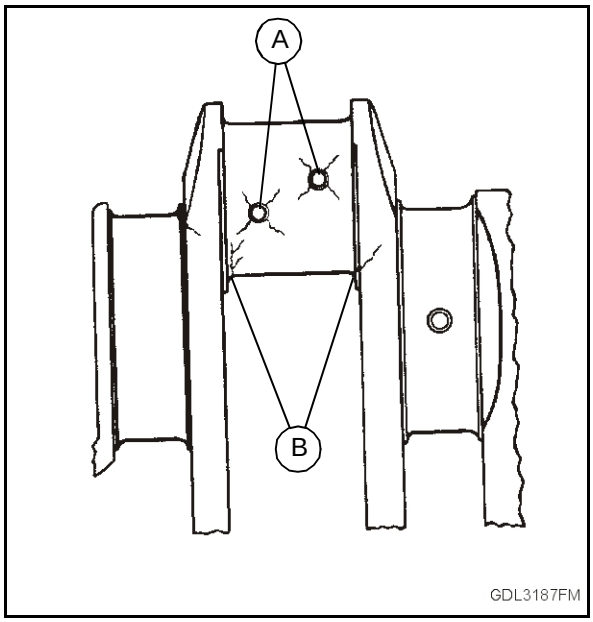
Carefully remove crankshaft from block with a hoist.

Clean crankshaft, especially oil passages. Dry thoroughly.

Place crankshaft on clean V-blocks.

Inspect Crankshaft

Thoroughly clean crankshaft. Clear restrictions from all oil passages.



Inspect crankshaft for signs of load stress, cracks, or scratches on journals.

Also check each journal for evidence of excessive overheating or discoloration.

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If either condition exists, replace crankshaft, since heat treatment has probably been destroyed.

Inspect front crankshaft gear for cracks, chipped teeth, or excessive wear. Replace gear as required.

Inspect the keyway for evidence of cracks or wear. Replace crankshaft as necessary.

Carefully check the crankshaft for cracks in the area of rod journal oil holes (A) and at journal fillets (B).

Replace crankshaft if any cracks are found.

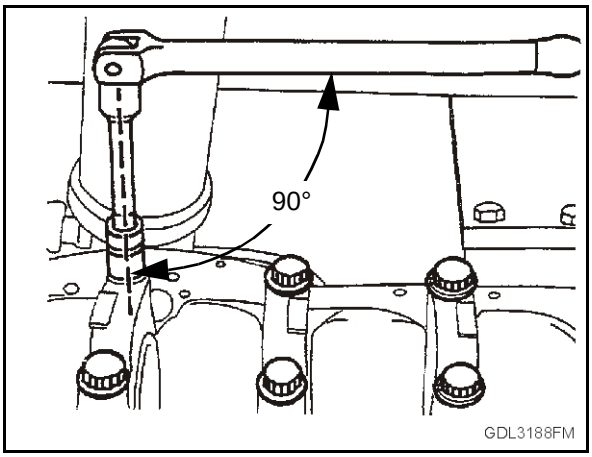
⚠ CAUTION

Small cracks may not be visible to the eye. Use a method such as the Fluorescent Magnetic Particle method. This method magnetizes the crack, using magnetic particles which are fluorescent and glow under 'black light'. The crankshaft must be demagnetized after inspection.

Measure Crankshaft Bearings and Journals

With crankshaft removed from engine, install main bearing caps with bearing (if previously removed).

Ensure bearings are installed correctly.



Tighten main bearing cap screws to specification.

Tighten main bearing cap screws to their final torque by placing ratchet handle centerline to crankshaft, then turn clockwise an additional 90°, as shown. Handle should then be perpendicular to crankshaft centerline.

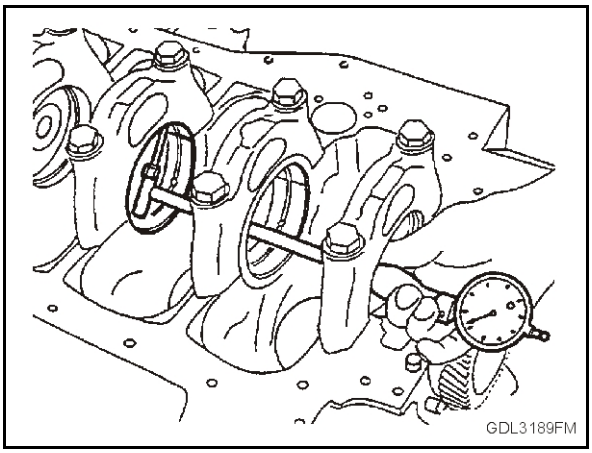
Crankshaft Specification

Main Bearing Vertical Cap Screw Torque
- 320 Nm (236 lb-ft)

Main Bearing Vertical Cap Screw Final Torque Turn
- 90°

Main Bearing Lateral Cap Screw Torque
- 125 Nm (92 lb-ft)

NOTE: If engine has previously had a major overhaul and undersized bearings were used, ID and OD dimensions may not be the same as those recorded. However, oil clearance must be as specified in this procedure. See Crankshaft Grinding Specifications in this procedure for undersize bearing and crankshaft journal specifications.



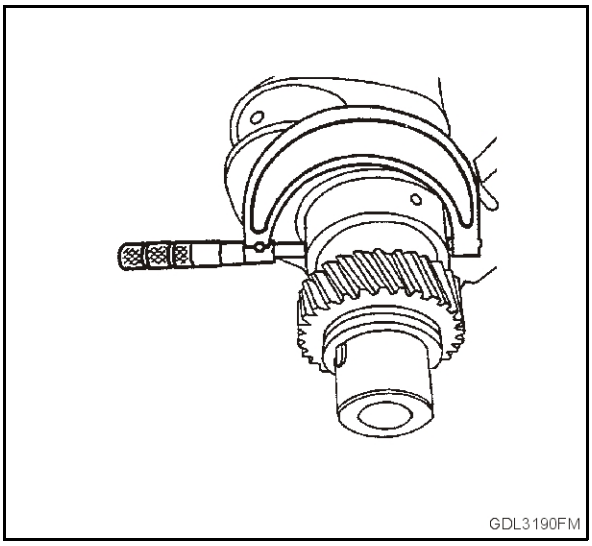
Measure ID of all assembled bearings with an inside micrometer in three locations: vertical and 30° above and 30° below joint face.

Compare measurements with the following specifications:

Crankshaft Specification

Main Bearing ID
- - - - - - - - 108.056 - 108.102 mm (4.2542 - 4.2560 in.)

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Measure OD of all respective crankshaft journals in four locations 90° apart. Compare measurements with the following specifications.

Crankshaft Specification

Main Journal OD
- - - - - - - - - 107.98 - 108.00 mm (4.2512—4.2520 in.)

Main Journal Radial Runout
- - - - - - - - - - - - - - - - -0.020 mm (0.0008 in.) Maximum

Main Journal Width
- - - - - - - - - 42.000 - 42.016 mm (1.6535 - 1.6542 in.)

Main Journal and Thrust Bearing Width
- - - - - - - - - 42.000 - 42.062 mm (1.6535 - 1.6559 in.)

NOTE: If engine has previously had a major overhaul and undersized bearings were used, ID and OD dimensions may not be the same as those recorded. However, oil clearance must be as specified below. See Crankshaft Grinding Specifications in this procedure for undersize bearing and crankshaft journal specifications.

Determine crankshaft-to-main bearing oil clearance based on bearing ID and journal OD measurements above, and compare to the following specifications.

Crankshaft Specification

Crankshaft-to-Main Bearing Oil Clearance
- - - - - - - - - - - 0.056 - 0.122 mm (0.0022 - 0.0048 in.)

Measure connecting rod journal OD and width. Compare to the following specifications.

Crankshaft Specification

Connecting Rod Journal OD
- - - - - - - - - - - 93.98 - 94.00 mm (3.7000 - 3.7008 in.)

Connecting Rod Journal Width
- - - - - - - - - -37.000 - 37.010 mm (1.4567 - 1.4571 in.)

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GRINDING GUIDELINES

NOTE: Crankshaft grinding should be done ONLY by experienced personnel on equipment capable of maintaining crankshaft size and finish specifications.

In addition to the standard size bearings, undersize bearings are available for main bearing and rod bearing journals. **(See Crankshaft Grinding Specifications in this procedure for journal and bearing sizes.)**

If journals are tapered, out-of-round, scored, or damaged, grind the crankshaft and install the proper undersize bearings.

NOTE: If undersize bearings are used, check bearing clearance after bearing caps have been tightened to specified torque.
If undersize bearings are too tight and clearance is not within specifications, the journal and bearing will be wiped clean of all oil.
This would result in premature wear of parts.

If the crankshaft is to be reground, use the following recommended guidelines:

Compare the crankshaft journal measurements taken during inspection and determine the size to which the journals are to be reground.

Grind all main journals or all connecting rod journals to the specified size. **(See "GRINDING SPECIFICATIONS" on page 122).**

NOTE: Care must be taken to avoid localized heating which often produces grinding cracks.
Cool the crankshaft while grinding by using coolant generously. DO NOT crowd the grinding wheel into the work.
Grind crankshaft with journals turning counterclockwise, as viewed from the front end of the crankshaft. Lap or polish journals in opposite direction of grinding.

Polish or lap the ground surfaces to prevent excessive wear of the journals.

NOTE: Production crankshafts are induction hardened and shotpeened at the factory.
Field shotpeening is not recommended due to the equipment required and part geometry.
When thrust surfaces are reground and an oversized bearing is used, crankshaft end play specification must be maintained. (See "Check Crankshaft End Play" on page 117).

Stone the edge of all oil holes in the journal surfaces smooth.

When finished grinding, inspect the crankshaft for cracks with the Fluorescent Magnetic Particle method, or similar method. Demagnetize crankshaft after inspection.

Thoroughly clean the crankshaft and oil passages using a volatile, non-petroleum base solvent. Dry the crankshaft.

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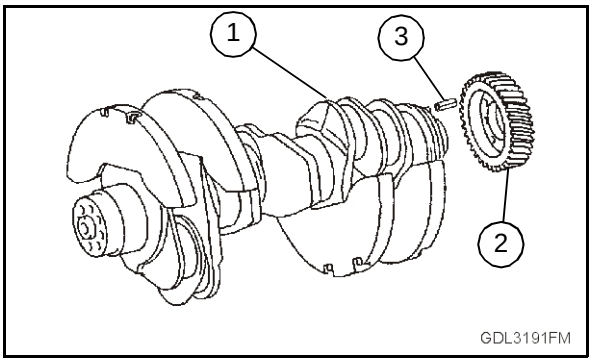
GRINDING SPECIFICATIONS

ITEM	MEASUREMENT	SPECIFICATION
Main Journal		
0.100 mm Undersize	OD	107.88 - 107.90 mm (4.2472 - 4.2480in.)
0.250 mm Undersize	OD	107.73 - 107.75 mm (4.2413 - 4.2421 in.)
0.500 mm Undersize	OD	107.48 - 107.50 mm (4.2315 - 4.2323 in.)
0.750 mm Undersize	OD	107.23 - 107.25 mm (4.2216 - 4.2224 in.)
1.00 mm Undersize	OD	106.98 - 107.00 mm (4.2118 - 4.2126 in.)
Main Bearing		
0.100 mm Undersize	ID	107.956 - 108.002 mm (4.2502 - 4.2520 in.)
0.250 mm Undersize	ID	107.806 - 107.852 mm (4.2443 - 4.2461 in.)
0.500 mm Undersize	ID	107.556 - 107.602 mm (4.2345 - 4.2363 in.)
0.750 mm Undersize	ID	107.306 - 107.352 mm (4.2246 - 4.2264 in.)
1.00 mm Undersize	ID	107.056 - 107.102 mm (4.2148 - 4.2166 in.)
Connecting Rod Bearing Journal		
0.100 mm Undersize	OD	93.88 - 93.90 mm (3.6961 - 3.6968in.)
0.250 mm Undersize	OD	93.73 - 93.75 mm (3.6901 - 3.6909in.)
0.500 mm Undersize	OD	93.48 - 93.50 mm (3.6803 - 3.6811in.)
0.750 mm Undersize	OD	93.23 - 93.25 mm (3.6705 - 3.6712in.)
1.00 mm Undersize	OD	92.98 - 93.00 mm (3.6606 - 3.6614in.)
Connecting Rod Bearing		
0.100 mm Undersize	ID	93.954 - 93.996 mm (3.6990 - 3.7006 in.)
0.250 mm Undersize	ID	93.804 - 93.846 mm (3.6931 - 3.6947 in.)
0.500 mm Undersize	ID	93.554 - 93.596 mm (3.6832 - 3.6849 in.)
0.750 mm Undersize	ID	93.304 - 93.346 mm (3.6734 - 3.6750 in.)
1.00 mm Undersize	ID	93.054 - 93.096 mm (3.6635 - 3.6652 in.)
Thrust Bearing and Main Bearing Journal		
0.500 mm Oversize	Width	42.500 - 42.562 mm (1.6732 - 1.6757 in.)
1.00 mm Oversize	Width	43.000 - 43.062 mm (1.6929 - 1.6953in.)
Engine		
Engine Stroke	Length	150 mm (5.91 in.)

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Remove and Install Crankshaft Gear

NOTE:Remove crankshaft gear only if replacement is necessary.



Remove crankshaft gear (2) from crankshaft (1) using a suitable puller.

⚠ CAUTION

1. Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer and do not exceed 182°C (360°F). Do not allow a heating element to be in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.
2. If flame heat is used, be sure gear is heated uniformly around circumference. DO NOT OVERHEAT. Overheating may also destroy original heat treatment of gear.

Heat crankshaft gear to 80°C (176°F), using either heated oil or oven heat.

If removed, install dowel pin (3) in crankshaft.

Install gear on crankshaft.

⚠ CAUTION

When installing gear, do not gouge or nick crankshaft flange. Use only enough force as necessary. Excessive striking force may damage thrust bearings.

Firmly seat gear against crankshaft flange using a driver. Ensure crankshaft gear locates properly on dowel pin.

Once gear cools, reseat gear.

Install Main Bearing and Crankshaft

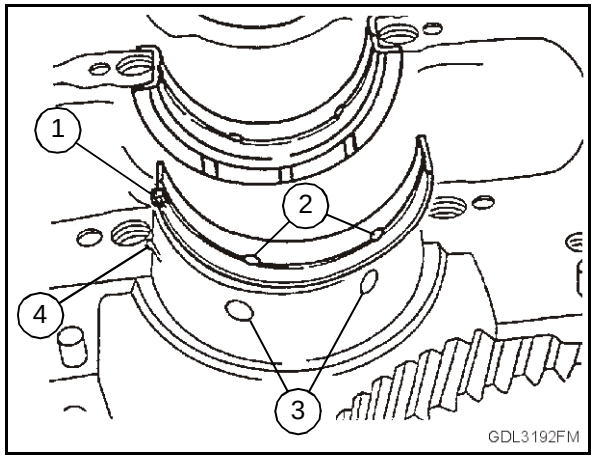
⚠ CAUTION

If new main or thrust bearings are installed, they must be installed as a matched set.

NOTE:If crankshaft gear was removed from crankshaft, install gear before installing crankshaft. (See “Remove and Install Crankshaft Gear” on page 123).

During assembly, apply a liberal coating of clean engine oil to:

- All main bearing webs in block.
- Both sides of main bearing inserts and thrust bearing.
- Entire OD of crankshaft main bearing journal.



Install main and thrust bearings in block. Be sure locating tabs (1) on inserts are properly positioned with slot (4) in block web.

Check to make sure that oil holes in main bearing web (3) are properly aligned with oil holes in bearing (2).

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⚠ CAUTION

Use a lifting device for heavy components.

Carefully position crankshaft onto main bearings using a hoist and JDG1500-36 Pilot Bolt.

⚠ CAUTION

Main bearing vertical cap screws are stretched when tightened to specification. Cap screws are usable up to a maximum shank length of 156 mm (6.14 in.) measured from the end of cap screw to the bottom of cap screw head. If any cap screw is at or longer than the specification, replace both cap screws for the that bearing cap.

Measure the shank length of main bearing vertical cap screws from the end of cap screw to the bottom of cap screw head. Replace both cap screws for that bearing cap if either cap screw is at or longer than the specification.

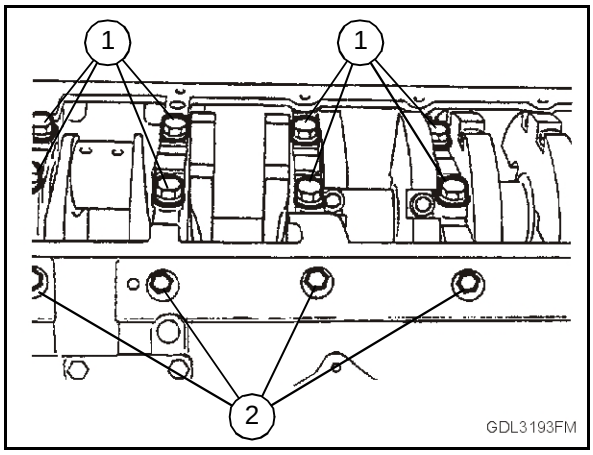
Crankshaft Specification

Main Bearing Vertical Cap Screw Shank Length
- - - - - - - - - - - - - - - - - - - 156 mm (6.14 in.) Maximum

Dip main bearing cap screws completely in clean engine oil and install them in main bearing caps.

Apply a liberal amount of oil to bearing inserts in caps.

NOTE: Install bearing caps in the same position as removed. If caps were not marked during removal, there are stamped numbers on the top of main bearing caps. Although caps are not numbered 1 - 4, the numbers are in ascending order starting at the front of the engine and proceeding toward rear of engine. The side of cap with stamped number must face front of engine.



Install each main bearing cap, main bearing, and main bearing vertical cap screw and washer (1), with the recesses and tabs aligned, in matching order.

Make sure bearing tabs also match up before tightening cap screws.

⚠ WARNING

Do not use a pneumatic wrench to install main bearing cap screws, as damage to threads can occur.

Tighten main bearing cap screws to specification.

Tighten main bearing cap screws to their final torque by placing ratchet handle centerline to crankshaft, then turn clockwise an additional 90°. Handle should then be perpendicular to crankshaft centerline.

Crankshaft Specification

Main Bearing Vertical Cap Screw Torque
- 320 Nm (236 lb-ft)

Main Bearing Vertical Cap Screw

Final Torque Turn - 90°

Main Bearing Lateral Cap Screw Torque
- 125 Nm (92 lb-ft)

Install lateral main bearing cap screw (2) and tighten to specification.

Crankshaft Specification

Main Bearing Lateral Cap Screw Torque
- 125 Nm (92 lb-ft)

Turn crankshaft by hand. If it does not turn easily, disassemble parts and determine the cause.

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Install connecting rod bearings and connecting rod caps. **(See "Assemble Piston and Connecting Rod" on page 136).**

Check crankshaft for specified end play. **(See "Check Crankshaft End Play" on page 117).**

Install oil pump. **(See "REMOVE AND INSTALL ENGINE OIL PUMP" on page 147).**

Install timing case. **(See "Remove and Install Timing Case" on page 116).**

Install timing case cover. **(See "Remove and Install Timing Case Cover" on page 115).**

Install flywheel. **(See "FLYWHEEL" on page 114).**

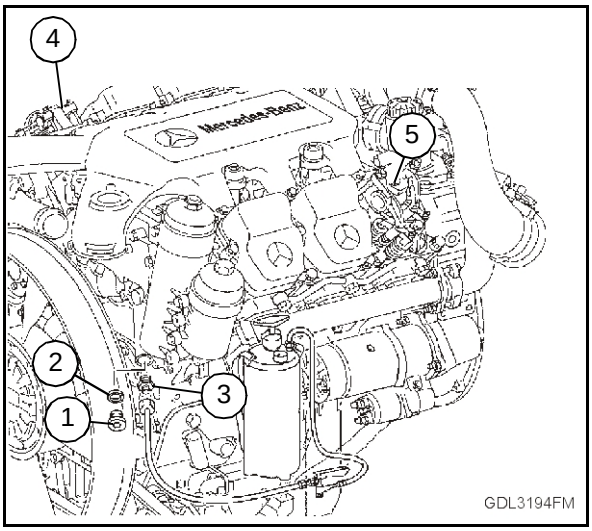
Install engine. **(See "ENGINE" on page 105).**

BLEED ENGINE OIL CIRCUIT AFTER MAJOR OVERHAUL

⚠ CAUTION

After major overhaul of the engine, the oil circuit must be bled to ensure proper lubrication when the engine is first started.

Fill a container, that can be pressurized using a hand pump, with clean engine oil.



Remove valve covers from number 1 (4) and number 6 (5) cylinders. **(See "REMOVE AND INSTALL VALVE COVER" on page 150).**

Remove plug (1) and seal (2) from oil filter base.

Install fitting (3). Adapt pump to fitting.

Pressurize container to approximately 300 kPa (3 bar) (43 psi). Open shut-off valve on container and observe rocker arms. Allow oil to flow until oil from rocker arms is free of bubbles. Maintain at least 150 kPa (1.5 bar) (22 psi) in container during bleed procedure.

Disconnect line from oil filter base, remove adapter and install seal and plug. Tighten to specification.

Oil Filter Base Specification

Plug Torque - - - - - - - - - - - - - - - - - - - 65 Nm (48 lb-in.)

Install valve covers. **(See "REMOVE AND INSTALL VALVE COVER" on page 150).**

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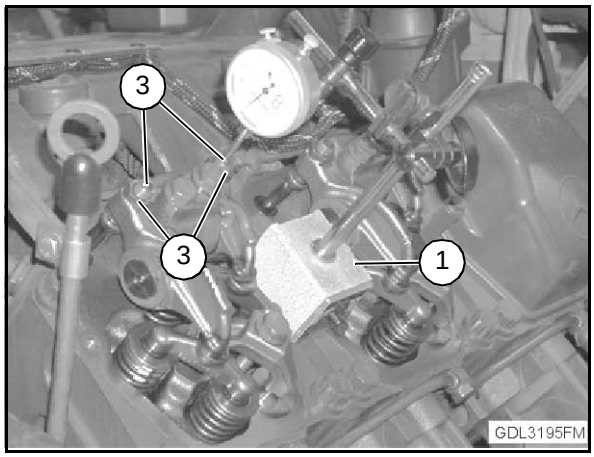
CHAPTER 4. ENGINE

SECTION 3. CAMSHAFT AND TIMING GEAR TRAIN

CAMSHAFT

Check Valve Lift

NOTE:1. For a more accurate measurement, it recommended that valve lift be measured at 0.00 mm (in.) valve clearance and with engine COLD.
2. Measuring valve lift can give an indication of wear on camshaft lobes and cam followers or bent push rods.



Remove rocker arm cover. Loosen lock nut (2) on rocker arm. Set valve clearance at 0.00 mm (0.0 in.) on valve being checked. Tighten lock nut.

Put dial indicator tip on adjusting screw as shown. Be sure that valve is fully closed.

Check pre-set on dial indicator. Set dial indicator pointer at zero.

Manually turn engine in the direction of rotation.

Observe dial indicator reading as valve is moved to fully open position. Record reading and valve number.

Specification

Intake Valve Lift - - - - - - 8.0 - 8.3 mm (0.314 - 0.326in.)

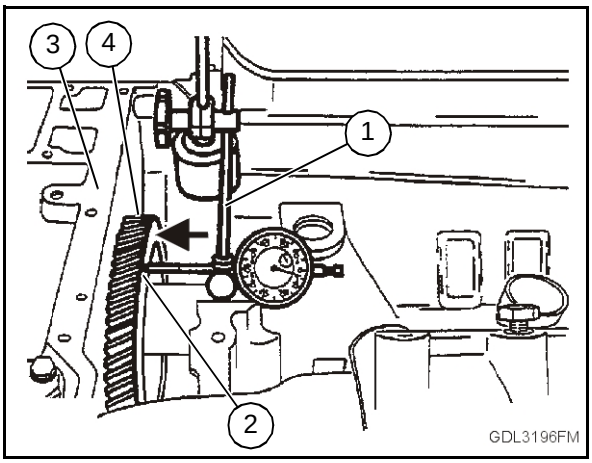
Exhaust Valve Lift - - - - 8.3 - 8.5 mm (0.326 - 0.334in.)

Repeat procedure on all remaining valves.

Reset valve clearance to specification after measuring lift. Go to Valve Clearance Adjustment. **(See procedure in CHAPTER 2, SECTION 3 in Operation and Test Manual).**

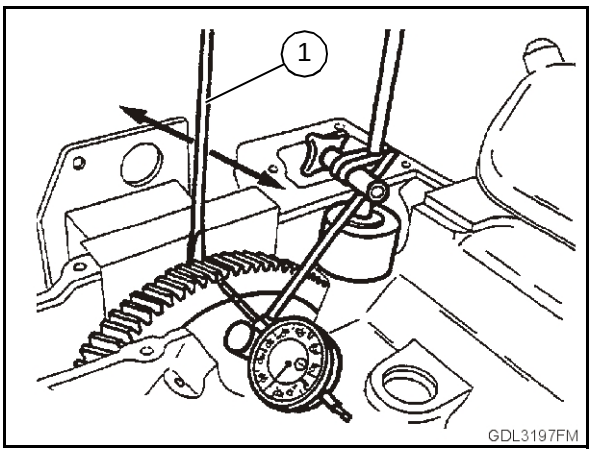
Check and Measure Camshaft End Play and Gear Backlash

Remove timing case cover. **(See "Remove and Install Timing Case Cover" on page 115).**



Push on camshaft drive gear (4) in the direction of timing case (3).

Install magnetic base dial indicator (1) and position tip (2) on front of camshaft drive gear. Set dial indicator to zero.



Using a pry bar (1) move camshaft back and forth and observe end play reading.

Specification

Camshaft End Play Distance
- - - - - - - - - - - - - - - - 0.2 - 0.9 mm (0.008 - 0.035 in.)

Measure backlash between camshaft drive gear and crankshaft gear in three different positions around the camshaft gear.

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Specification

Camshaft Drive Gear-to-Crankshaft Gear Backlash
- - - - - - - - - - - 0.070 - 0.180 mm (0.0028 - 0.0071 in.)

Install timing case cover. **(See "Remove and Install Timing Case Cover" on page 115).**

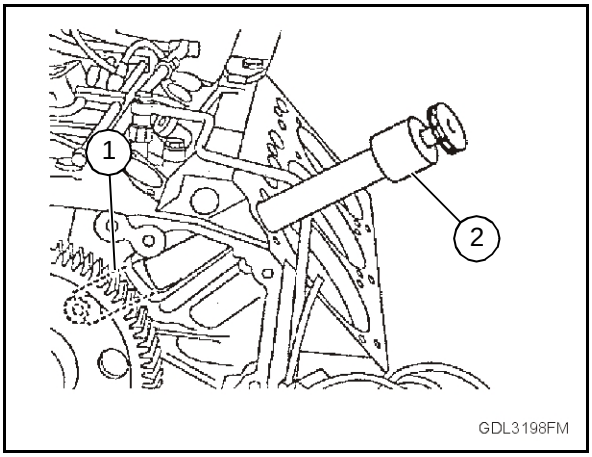
Remove Camshaft

Remove timing case. **(See "Remove and Install Timing Case" on page 116)**

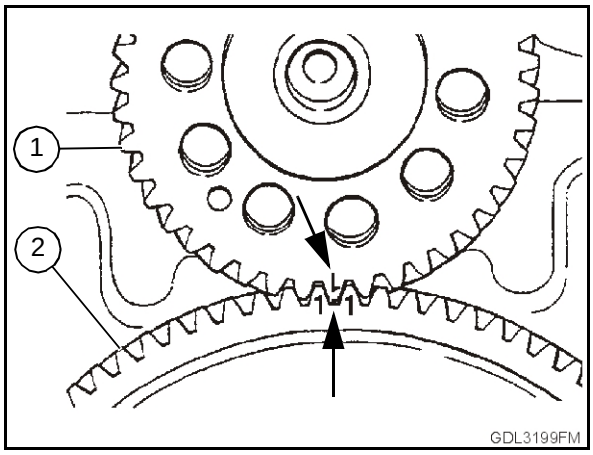
Remove cylinder heads. **(See "Remove Cylinder Head" on page 151)**

Remove oil filter housing. **(See "REMOVE AND INSTALL OIL FILTER HOUSING" on page 145).**

NOTE: Mark or identify lifters when removing. Lifters should be installed in the same bore they were removed from.

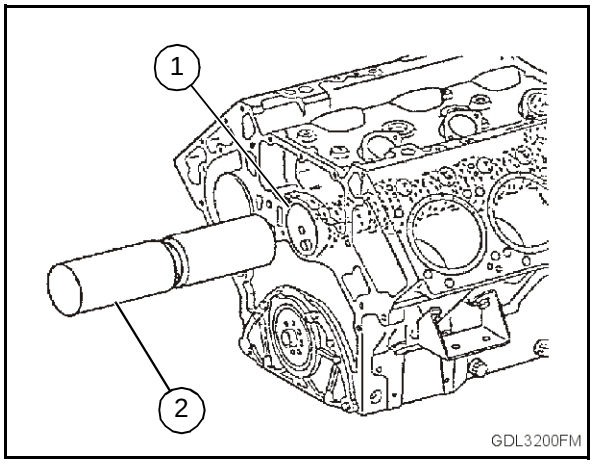


Remove valve lifters (1) using JDG1596 removal tool (2).



Turn engine in the direction of rotation until the timing marks on the crankshaft gear (1) align with the timing marks on camshaft drive gear (2).

NOTE: When removing camshaft, pull straight out and hold as level as possible to avoid bearing damage.



Install JDG1593 guide sleeve (2) on to camshaft (1) at the fan side of engine.

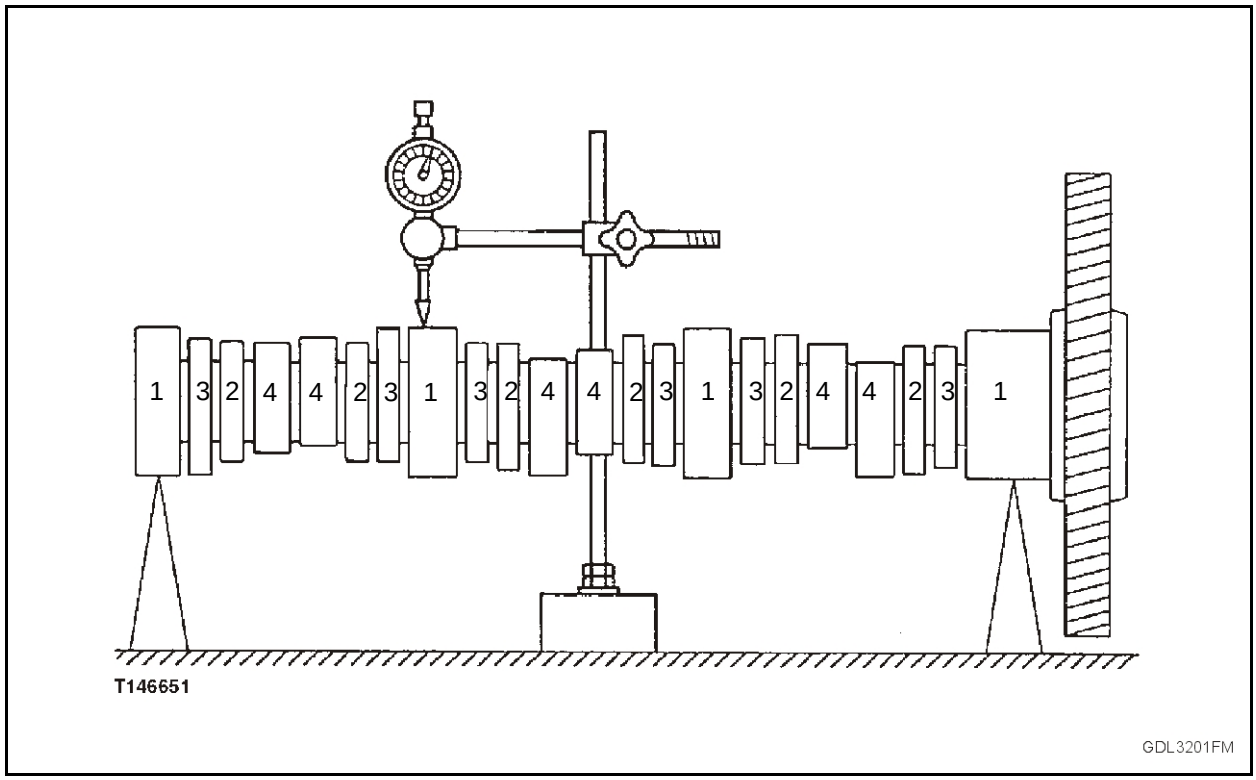
⚠ CAUTION

Camshaft lobe edges are sharp. Wear protective gloves when handling camshaft to prevent injury to hands.

Remove camshaft out of flywheel side, guiding wear sleeve through bearings to prevent damage.

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Inspect and Measure Camshaft



1. Camshaft Bearing Journals (4 off).
2. Intake Valve Lobe (6 off).
3. Exhaust valve Lobe (6 off).
4. Electronic Unit Injector Lobe (6 off).

Support camshaft on v-blocks. Using a magnetic base dial indicator and measure camshaft.

Check radial runout of camshaft bearing journals.

Measurements must not exceed specification.

Inspect and Measure Camshaft Specification

Camshaft Bearing Journals Radial Runout
- 0.050 mm (0.002 in)

Measure camshaft lobe height for intake lobes (2) and exhaust lobes (3).

Inspect and Measure Camshaft Specification

Camshaft Intake Lobe Height
- - - - - - - - - - - - - - - - - - - 8.0 - 8.3 mm (0.314 - 0.326 in)

Specification

Camshaft Exhaust Lobe Height
- - - - - - - - - - - - - - - - - - 8.3 - 8.5 mm (0.326 - 0.334 in)

Measure camshaft lobe height for electronic unit injector lobes (4).

Inspect and Measure Camshaft Specification

Camshaft Electronic Unit Injectors Lobe Height
- - - - - - - - - - - - - - - - - -17.7 - 18.0 mm (0.697 - 0.709in)

Compare measurements with specifications.

Replace camshaft and bushings as needed.

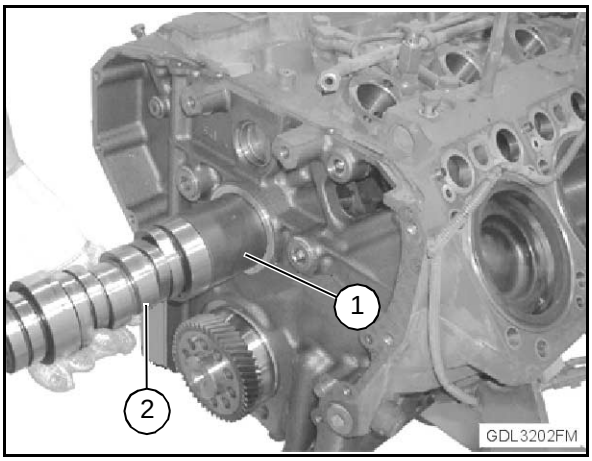
Install Camshaft

Turn engine in the direction of rotation until the No. 1 cylinder is at TDC on the compression stroke so timing marks on crankshaft gear and camshaft gear can be aligned.

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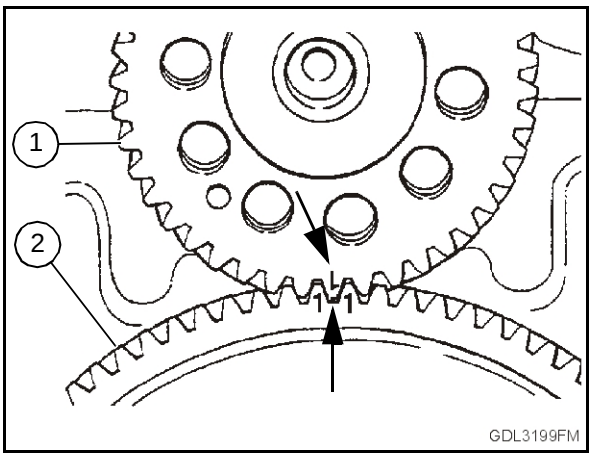
⚠ CAUTION

1. When installing camshaft, hold as level as possible and slowly slide through bores to avoid bearing damage.
2. Camshaft lobe edges are sharp. Wear protective gloves when handling camshaft to prevent injury to hands.



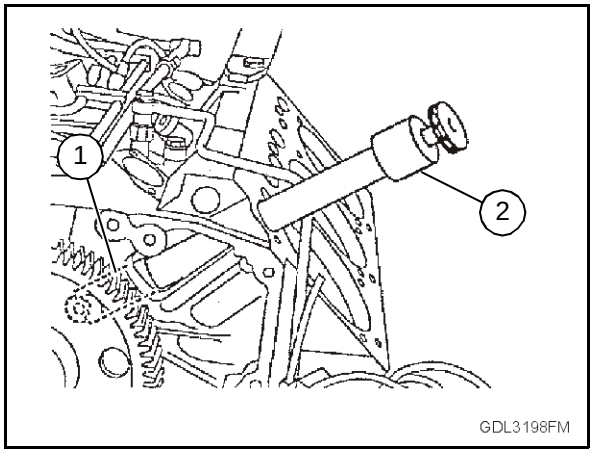
Install JDG1593 guide sleeve (1) onto camshaft (2).

Slide sleeve and camshaft into bearings from the flywheel side of the engine.



Align timing marks on camshaft drive gear (2) and crankshaft gear (1).

Install oil filter housing. **(See "REMOVE AND INSTALL OIL FILTER HOUSING" on page 145).**



Install lifters in the correct bores using JDG1596 lifter tool

Install cylinder heads. **(See "Install Cylinder Head" on page 152).**

Install timing case. **(See "Remove and Install Timing Case" on page 116).**

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CHAPTER 4. ENGINE

SECTION 4. CYLINDER BLOCK, LINERS, PISTONS AND RODS

LINER, PISTON AND ROD ANALYSIS

Scuffed or Scored Pistons

- Overheating.
- Overfueling.
- Insufficient lubrication.
- Insufficient cooling.
- Improper piston-to-liner clearance.
- Coolant leakage into crankcase.
- Misaligned or bent connecting rod.
- Improperly installed piston.
- Low oil level.
- Improper operation.
- Incorrect connecting rod bearing clearance.
- Carbon build-up in ring groove.
- Improper engine break-in.
- Worn piston.
- Contaminated oil.
- Distorted cylinder liner.
- Plugged piston cooling orifice.
- Ingestion of dust through air intake.

Worn or Broken Compression Rings

- Insufficient lubrication.
- Insufficient cooling.
- Improper ring installation.
- Improper timing.
- Abrasives in combustion chamber.

Clogged Oil Control Ring

- Improper oil.
- Excessive blow-by.
- Contaminated oil.
- Improper periodic service.
- Low operating temperature.

Stuck Rings

- Improper oil classification.
- Improper periodic service.
- Poor operating conditions.
- Coolant leakage into crankcase.
- Excessive cylinder liner taper.

Mottled, Grayish or Pitted Compression Rings

- Internal coolant leaks.

Dull Satin Finish and Fine Vertical Scratches on Rings

- Dirt and abrasives in air intake system.

Piston Pin and Snap Ring Failure

- Misaligned connecting rod.
- Excessive crankshaft end play.
- Incorrect snap rings.

Broken Connecting Rod

- Inadequate piston-to-liner clearance.
- Worn connecting rod bearing.
- Distorted cylinder line.
- Piston pin failure.

Cylinder Liner Wear and Distortion

- Incorrectly installed compression rings.
- Insufficient lubrication.
- Uneven cooling around liner.
- Inadequate piston-to-liner clearance.
- Liner bore damage.

Warped Cylinder Block

- Insufficient cooling.

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Pistons and Connecting Rods

Remove Pistons and Connecting Rods

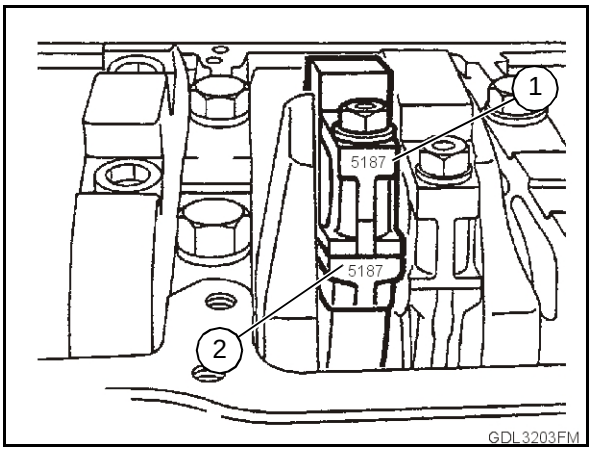
Remove engine oil pump. **(See "REMOVE AND INSTALL ENGINE OIL PUMP" on page 147).**

Remove cylinder head. **(See "Cylinder Head" on page 151).**

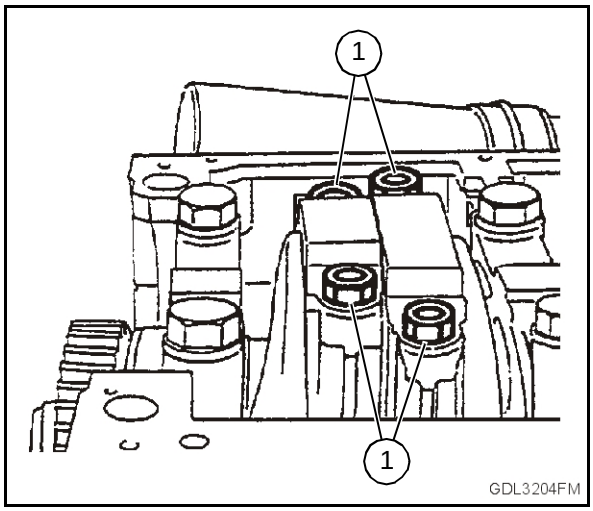
Remove any ridges from top of liner bores with a scraper or ridge reamer before removing pistons.

⚠ CAUTION

Make sure connecting rods and caps are marked before removing caps.

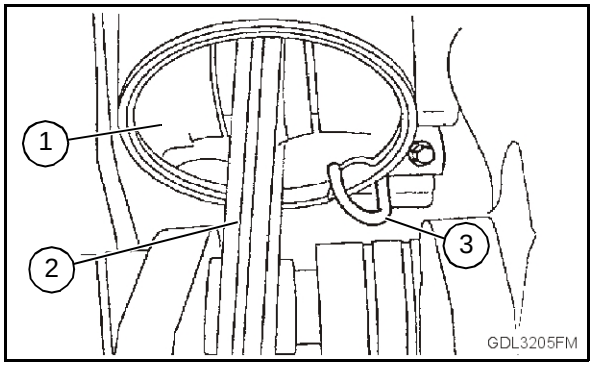


Note stamped numbers of connecting rod cap (1) and connecting rod (2).



Remove cap screws (1) from connecting rod and cap.

Remove connecting rod caps and cap bearings from crankshaft. Keep bearings with their respective caps.



Mark piston (1) and rod (2) to ensure they are installed in the same location as removed.

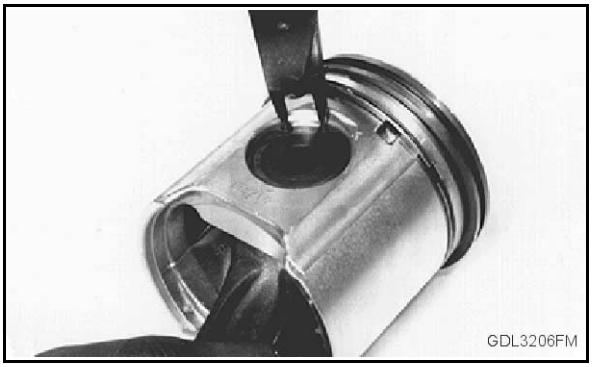
⚠ CAUTION

When removing piston and rod, be careful not to damage piston cooling nozzles (3).

Rotating engine as required, gently tap piston and rod through top of cylinder block, holding rod to avoid scratching liner.

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Disassemble Pistons and Connecting Rods



Remove piston snap rings. Remove piston pin and connecting rod from piston.

Discard snap rings, DO NOT reuse.

If checking rings to determine cause of engine trouble, ring end gap should be as follows:

Pistons and Connecting Rods Specification

No. 1 Piston Compression Ring End Gap
- - - - - - - - - - - - 0.60 - 0.75 mm (0.024 - 0.030 in.) new

No. 1 Piston Compression Ring End Gap
- - - - - - - - - - - - - - - - - - -1.0 mm (0.039 in.) repair limit

No. 2 Piston Compression Ring End Gap
- - - - - - - - - - - - 0.40 - 0.55 mm (0.016 - 0.022 in.)new

No. 2 Piston Compression Ring End Gap
- - - - - - - - - - - - - - - - - - -1.0 mm (0.039 in.) repair limit

No. 3 Piston Oil Ring End Gap
- - - - - - - - - - - - 0.30 - 0.45 mm (0.012 - 0.018 in.)new

No. 3 Piston Oil Ring End Gap
- - - - - - - - - - - - - - - - - - -0.8 mm (0.031 in.) repair limit

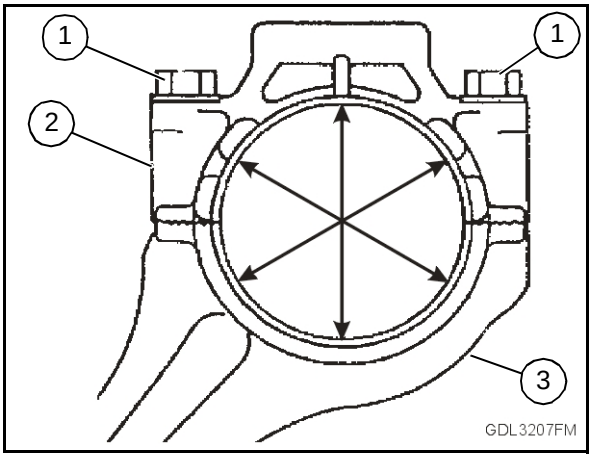
Remove piston rings using the JDG1500-31 Piston Ring Pliers.Discard all rings.

Measure and Inspect Connecting Rod

Inspect rod and bearings for damage or wear. If any blueing or discoloration is present rod should be discarded.

⚠ CAUTION

Never use new connecting rod cap screws when checking rod bearing ID. Use new cap screws only for final assembly of connecting rods.



Install connecting rod cap (2) on to connecting rod (3) with bearings in correct position using cap screws (1).

Tighten cap screws.

Using an inside micrometer measure rod ID at three places as shown. Compare measurements to specifications.

Pistons and Connecting Rods Specification

Connecting Rod-Standard Bearings ID
- - - - - - - - - - - - - - 94.05 - 94.09 mm (3.702 - 3.704 in.)

Connecting Rod-0.10 mm Undersize ID
- - - - - - - - - - - - - - 93.95 - 93.99 mm (3.698 - 3.700 in.)

Connecting Rod-0.25 mm Undersize ID
- - - - - - - - - - - - - - 93.80 - 93.84 mm (3.692 - 3.694 in.)

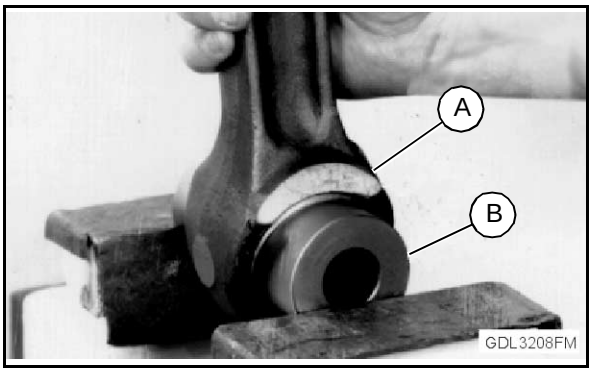
Connecting Rod-0.50 mm Undersize ID
- - - - - - - - - - - - - - 93.55 - 93.59 mm (3.683—3.685 in.)

Connecting Rod-0.75 mm Undersize ID
- - - - - - - - - - - - - - 93.30 - 93.34 mm (3.673—3.675 in.)

Connecting Rod-1.0 mm Undersize ID
- - - - - - - - - - - - - - 93.05 - 93.09 mm (3.663—3.665 in.)

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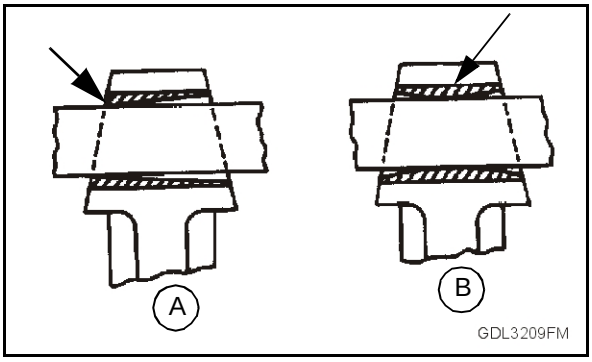
Inspect Piston Pins and Bushings



Insert piston pin (B) through piston pin bushing and carefully clamp in a soft-jawed vise.

Rotate connecting rod (A) back and forth several times to make sure connecting rod moves freely on piston pin.

Remove piston pin from connecting rod.



Insert piston pin from either side of rod bushing. If pin is free on one end, but tight on the other, the bore could be tapered (A). If pin enters freely from both sides, but is tight in the center, bore is bell-mouthed (B).

Measure rod pin bushings and compare measurements with specifications given below:

Pistons and Connecting Rods Specification

Installed Connecting Rod Pin Bushing (After Boring) ID 52.05 - 52.06 mm (2.049 - 2.050in.)

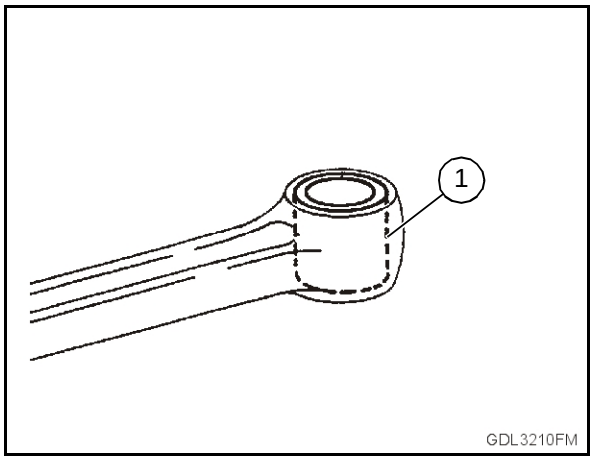
Connecting Rod Pin-to-Bushing Oil Clearance 0.055 - 0.070 mm (0.002 - 0.003in.)

Replace bushing if required. **(See "Replace Piston Pin Bushing in Connecting Rod" on page 134)**

Replace Piston Pin Bushing in Connecting Rod

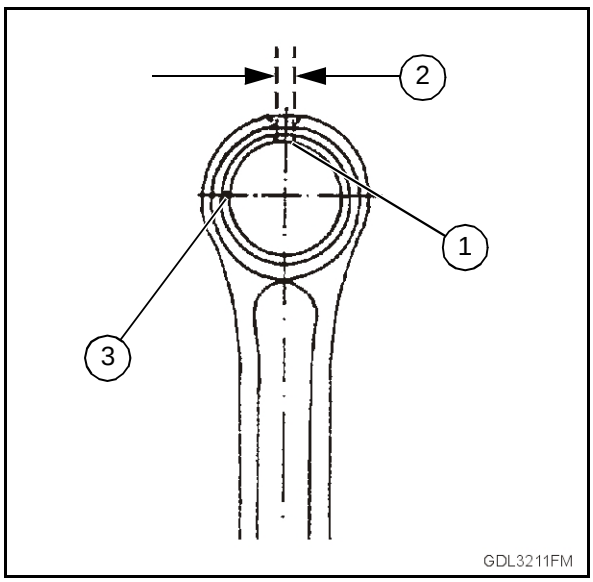
⚠ WARNING

Installed connecting rod bushings must be line-bored to specification. This should be done ONLY by experienced personnel on equipment capable of maintaining specifications. Replacement of bushings and line-boring of bushing bores should be accomplished by a qualified machine shop.



Press bushing (1) out of connecting rod.

Cool new bushing by placing in freezer.



Press new bushing into rod with joint (3) positioned as shown. Be careful not to damage bore.

Drill a 6 mm(0.236 in.) oil passage (2) through bushing.

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Countersink oil bore (1) with 15 mm (0.590) spherical cutter to a depth of 1 mm (0.39 in.)

Line bore bushing to specification.

Pistons and Connecting Rods Specification

Installed Connecting Rod Pin Bushing (After Boring) ID - - - - - - - - - - - - - - 52.05 - 52.06 mm (2.049 - 2.050in.)

Ream bushing to provide proper oil clearance for pin.

Pistons and Connecting Rods Specification

Connecting Rod Pin-to-Bushing Oil Clearance - - - - - - - - - - - - - - 0.055 - 0.070 mm (0.002—0.003in)

Clean Piston

⚠ CAUTION

Always follow manufacturer's instructions and safety steps exactly.



Clean piston ring grooves using a piston ring groove cleaning tool.

⚠ CAUTION

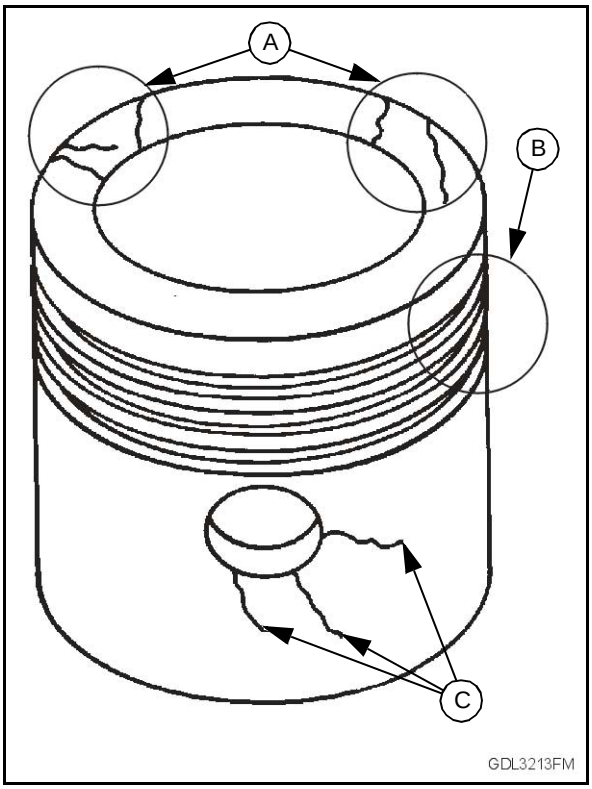
When washing pistons, always use a stiff bristle brush - NOT A WIRE BRUSH - to loosen carbon residue. DO NOT bead blast ring groove areas.

Clean pistons by any of the following methods:

- Chemical soaking following the manufacturer's instructions.
- Glass bead cleaning following the manufacturer's instructions.
- Hot water with liquid detergent soap.

If cleaning with hot water and liquid detergent, soak pistons in a 50 percent solution of liquid household detergent and hot water for 30 to 60 minutes. Use a stiff bristle brush - NOT A WIRE BRUSH - to loosen carbon residue. Thoroughly dry the pistons.

Visually Inspect Piston



Carefully inspect pistons under magnification. Check for:

- Signs of fatigue.
- Fine cracks in the piston head (A).
- Bent or broken ring lands (B).
- Cracks in the skirt (C) at inner and outer ends of piston pin bore.
- Excessive piston skirt wear. (Original machining marks must be visible.)

If any imperfections are found, replace the piston and liner as a set.

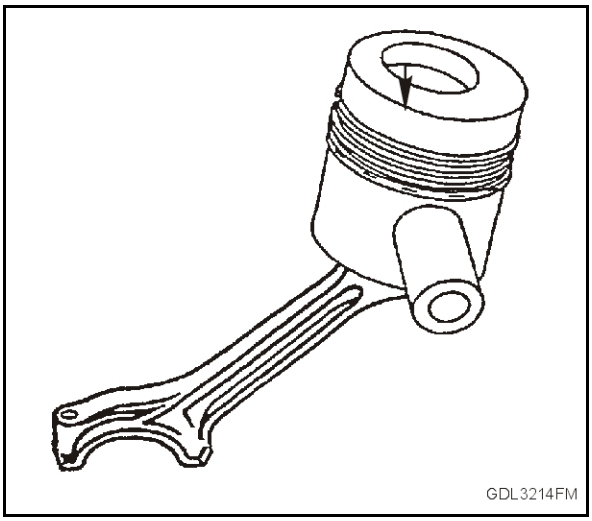
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Assemble Piston and Connecting Rod

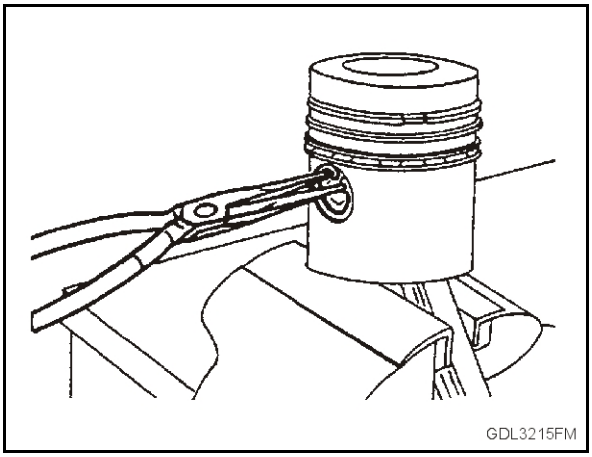
⚠ CAUTION

1. Pistons must be installed on same connecting rods from which they were removed.
2. New piston pin snap rings must be used.

Apply clean engine oil to piston pins.

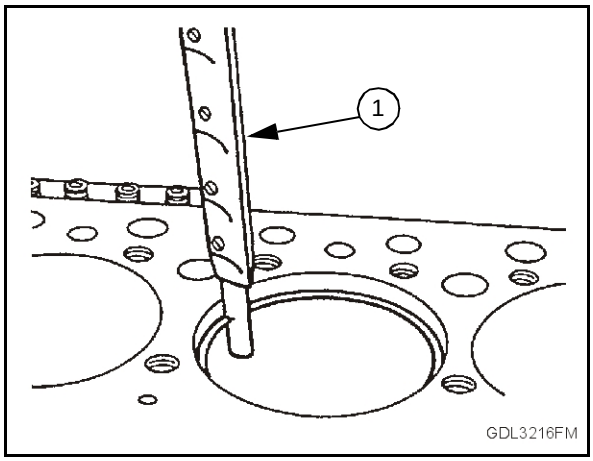


Install pistons on connecting rods. Arrow or triangle should point to the flywheel.



Install piston pins using new retaining rings.

NOTE: If old rings were not removed, ensure rings are clean before reinstalling piston, especially center piston ring.



Install new rings into cylinder and check ring end gap using a feeler gauge.

Pistons and Connecting Rods Specification

No. 1 Piston Compression Ring End Gap
- - - - - - - - - - - -0.60 - 0.75 mm (0.024 - 0.030 in.) new

No. 1 Piston Compression Ring End Gap
- - - - - - - - - - - - - - - - - - 1.0 mm (0.039 in.) repair limit

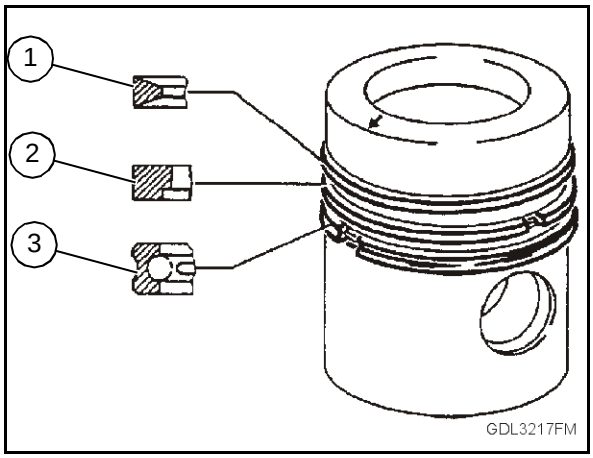
No. 2 Piston Compression Ring End Gap
- - - - - - - - - - - - 0.40 - 0.55 mm (0.016 - 0.022 in.)new

No. 2 Piston Compression Ring End Gap
- - - - - - - - - - - - - - - - - - 1.0 mm (0.039 in.) repair limit

No. 3 Piston Oil Ring End Gap
- - - - - - - - - - - - 0.30 - 0.45 mm (0.012 - 0.018 in.)new

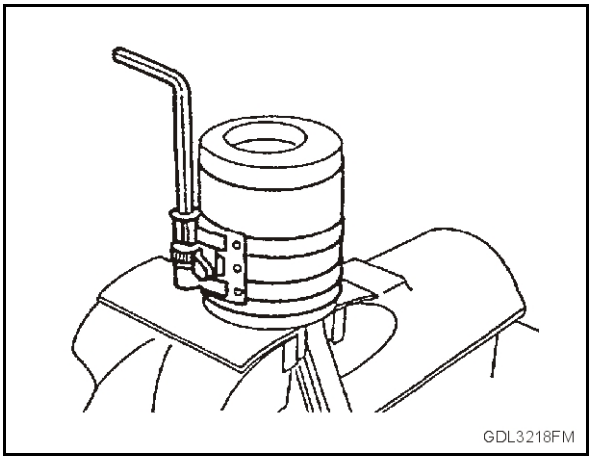
No. 3 Piston Oil Ring End Gap
- - - - - - - - - - - - - - - - - - 0.8 mm (0.031 in.) repair limit

Apply clean engine oil to rings and install piston rings on piston using JDG1500-31 Piston Ring Pliers.

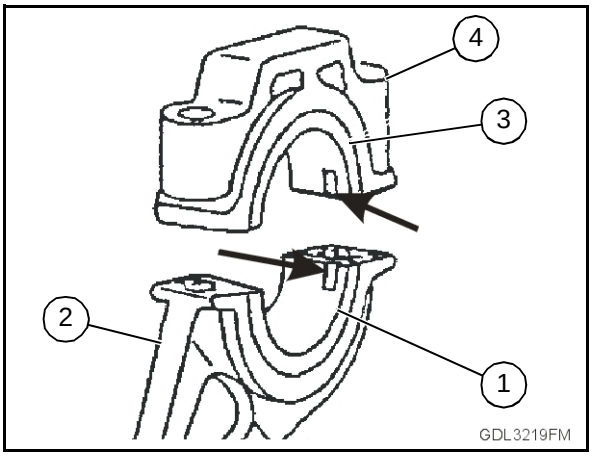


Install piston rings in proper grooves as called out in figure. Stagger ring gaps 120°.

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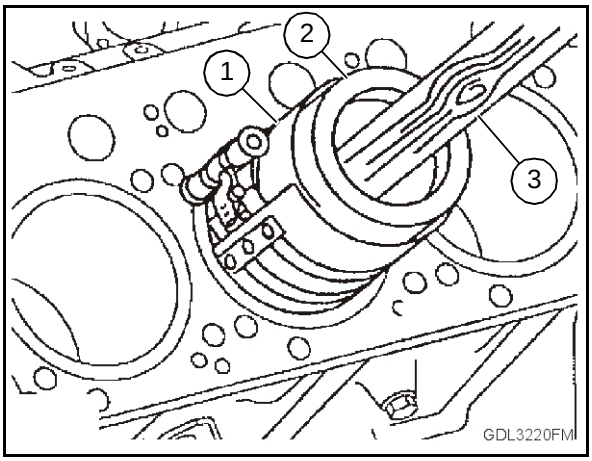
Apply clean engine oil to piston, ID of liner and piston ring compressor. Install ring compressor on piston tight enough to where ring compressor can just be shifted on piston.



Install bearings (1 and 3) in connecting rod (2) and cap (4). Make sure that tabs (arrows) on bearings are properly seated in rod and cap recess.

⚠ CAUTION

Piston and liners have code letters stamped on them. All pistons will not fit all liners. Check code stampings before installing pistons in liners. (See “Measure Cylinder Liner” on page 141).



Apply clean engine oil to piston rings and inside of ring compressor (1). Use a piston ring compressor to compress rings into ring grooves.

Install piston and rod into liner with the arrow or triangle pointing towards the flywheel. Do not let rod drag on liner or hit piston cooling nozzles when being installed.

Tap piston (2) into liner using a wooden dowel (3), rotating crankshaft as required until connecting rod bearing is resting on journal of crankshaft. Remove piston ring compressor.

⚠ WARNING

Connecting rod cap screws are stretched when tightened to specification. Cap screws are usable up to a maximum shank length of 68.5 mm (2.69 in.) measured from the end of cap screw to the bottom of cap screw head. If any cap screw is at or longer than the specification, replace both cap screws for the that bearing cap.

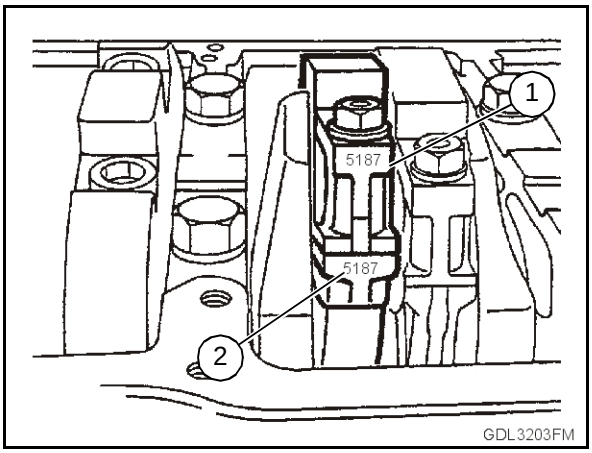
Measure the shank length of connecting rod cap screws from the end of cap screw to the bottom of cap screw head. Replace both cap screws for that bearing cap if either cap screw is at or longer than the specification.

Pistons and Connecting Rods Specification

Connecting Rod Cap Screw Shank Maximum Usable Length - 74.5 mm (2.93 in.)
- - - - - - - - - - - - replace both cap screws at or longer.

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Oil the running surface of bearing and install bearing into rod cap, ensuring tab on bearing is properly seated in recess of rod.



Install cap on connecting rod ensuring stamped number on connecting rod cap (1) and stamped number on connecting rod (2) are towards the same side as shown.

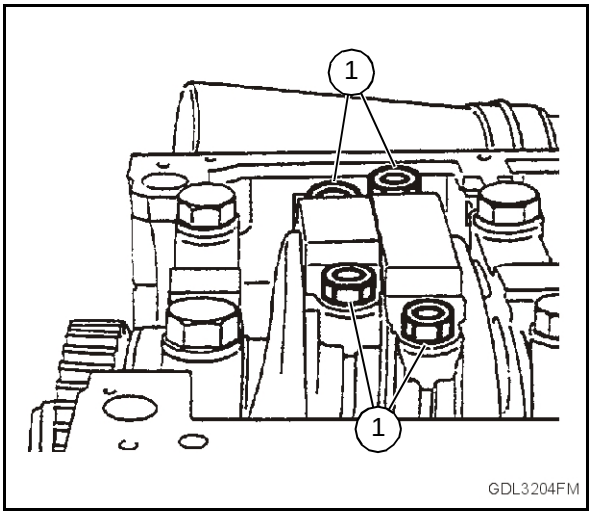
Dip cap screws (3) into clean engine oil fully coating threads.

Install cap screws (3) and tighten to specification.

Pistons and Connecting Rods Specification

Connecting Rod Cap Screw First Stage Torque - 110 Nm (81 lb-ft)

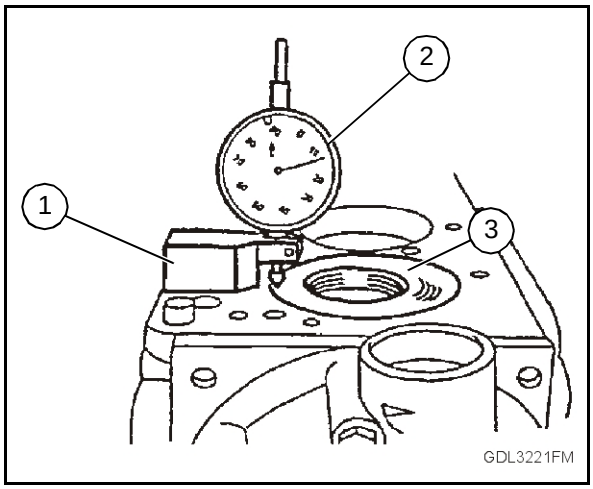
Connecting Rod Cap Screw Final Stage Torque - Turn 90°



Rotate each piston to TDC and check protrusion above block surface. **(See "Check Piston Protrusion" on page 138.)**

Check Piston Protrusion

NOTE:Piston protrusion is measured with head gasket removed and block surface clean.



Rotate crankshaft until piston is at TDC.

Using a magnetic base dial indicator, measure piston protrusion above surface of block. Compare measurement to the following specifications.

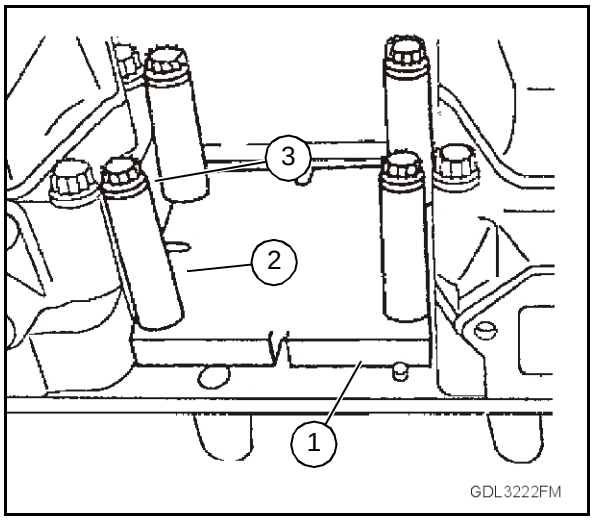
Specification

Piston Height Above Block Protrusion - - - - - - - - - - - - - - - 0.27 - 0.61 mm (0.011 - 0.024 in.)

Cylinder Liners

Measure Cylinder Liner Protrusion

Remove cylinder head. **(See "Remove Cylinder Head" on page 151).**



Clean area around top of cylinder liner and block.

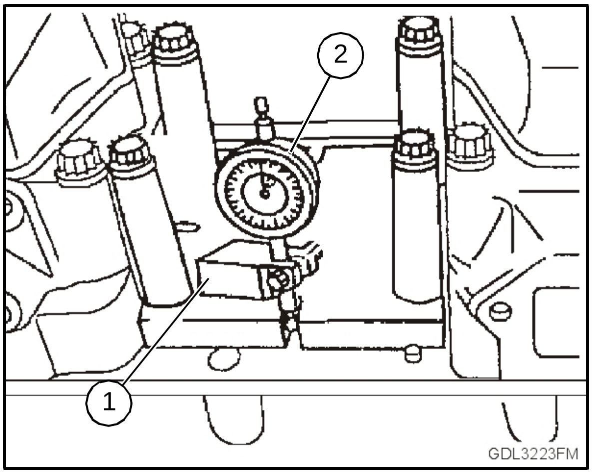
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Install JDG150094 Liner Preload and Measuring Tool (1) on top of cylinder liner using spacers (2) and cylinder head cap screws (3).

Tighten cap screws to specification.

Cylinder Liners Specification

Liner Preload Plate Cap Screws Torque -50 Nm (37 lb-ft)



Place JDG1500-35 Dial Indicator Holder (1) on plate.

Install dial indicator (2) into holder so that probe is under preload on the engine block when holder is held tight to plate. Set dial indicator to zero.

Slide dial indicator in slot of liner preload and measuring tool and over the top of liner. Observe measurement and compare to specification.

Cylinder Liners Specification

Cylinder Liner Protrusion Distance - - - - - - - - - - - - - -0.245 - 0.315 mm (0.010 - 0.012 in.)

Measure at all four slots in liner preload and measuring tool. Maximum difference between the four measuring points must not be above specification.

Cylinder Liners Specification

Difference between Four Measuring Spots of Cylinder Liner Protrusion - Distance - - - - - - - - - - - - - - - - - - 0.02 mm (0.001 in.) Maximum

If difference exceeds specification, liner must be removed and inspected.

If measurement is above specification, liner must be machined by a qualified machine shop.

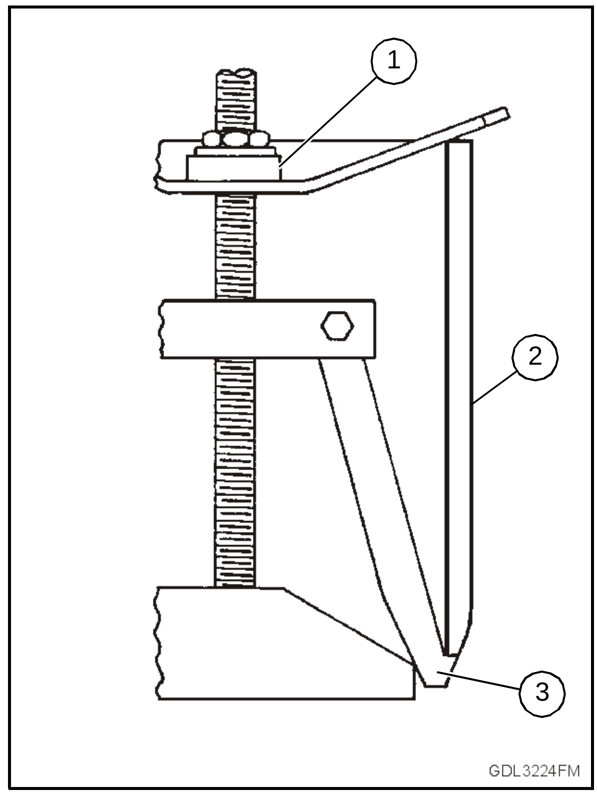
If measurement is below specification liner shims must be installed. **(See "Install Cylinder Liner Shims If Required" on page 143).**

Remove liner preload and measuring tool.

Install cylinder head. **(See "Install Cylinder Head" on page 152).**

Remove Liner

Make a mark on the liner and the engine block.



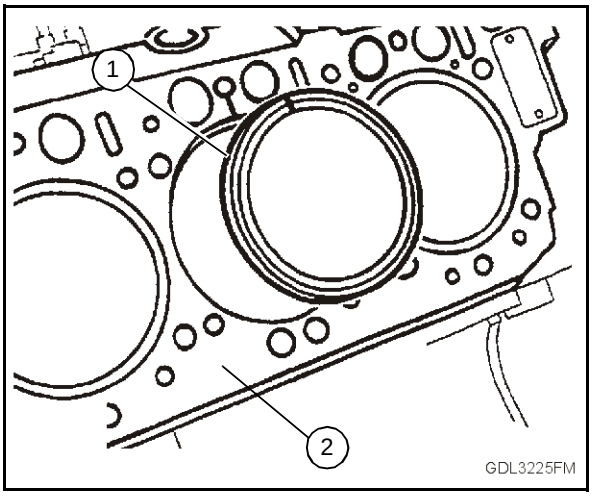
Install D01062AA Cylinder Liner Remover (1) into cylinder bore and hook the jaws (2) on the bottom of the liner (2).

Tighten jaw adjusting nut to tension jaws on the bottom of the liner.

Using slide hammer knock liner loose from block.

Loosen jaw adjusting nut and remove D01062AA Cylinder Liner Remover from liner.

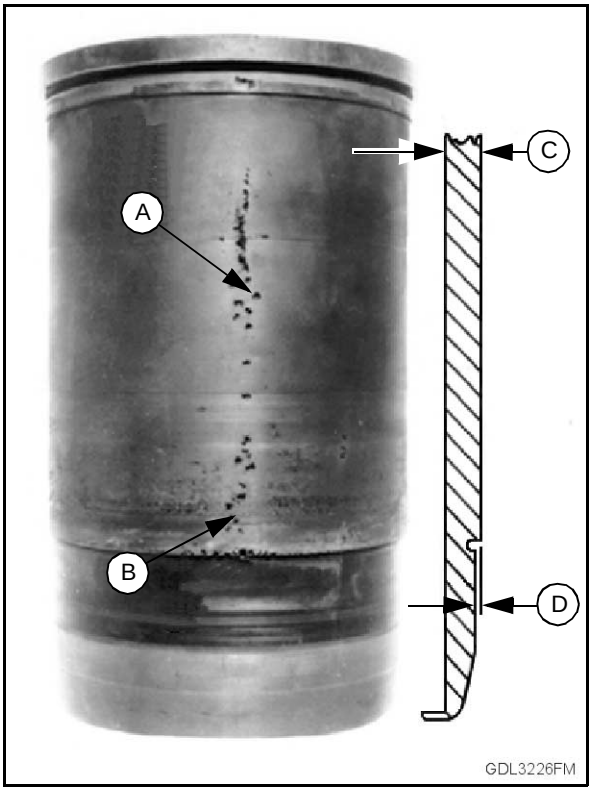
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Remove liner (1) from engine block (2).

Visually Inspect

NOTE:If liner pitting has occurred, check condition of coolant.



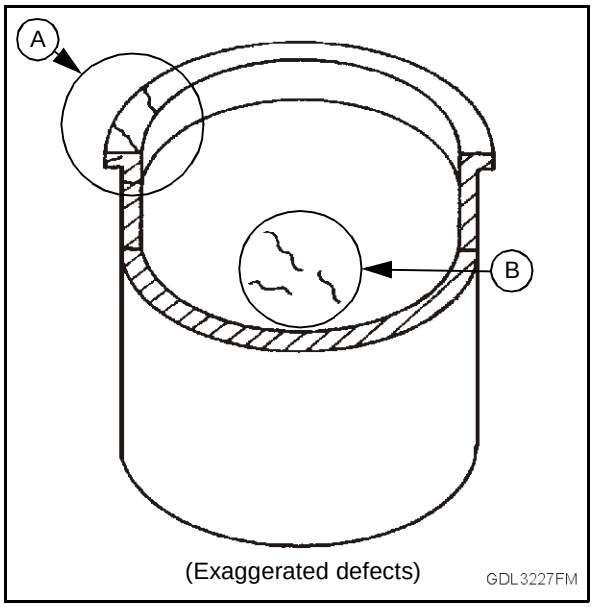
Inspect exterior length of liner for pitting (A).

Check packing step for erosion (B).

If pitting or erosion is observed, measure depth of pits with a fine wire or needle.

Replace piston and liner if depth of any pit (A) is one-half or more of liner thickness (C).

NOTE:Liners are reusable if the depth of pits or erosion is less than one-half the amount specified. When installing reusable liners, rotate 90° from original position. The liners should be also deglazed and new ring sets installed in pistons.



Visually examine liner ID. Replace piston and liner if:

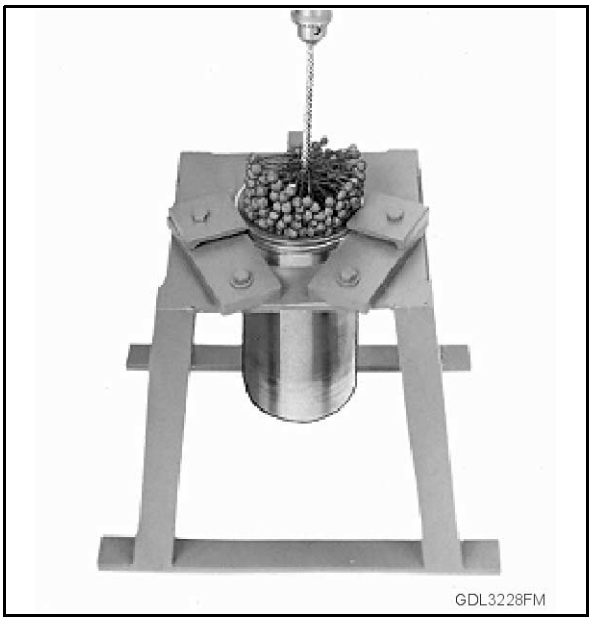
- The crosshatch honing pattern is not visible immediately below the top ring turn-around area.
- Liners are pitted or contain deep vertical scratches that can be detected by the fingernail.

Carefully examine liner for signs of fatigue, such as fine cracks in the flange area (A) and cracks in the ring travel area (B).

Inspect block for cracks or erosion in the O-ring packing areas.

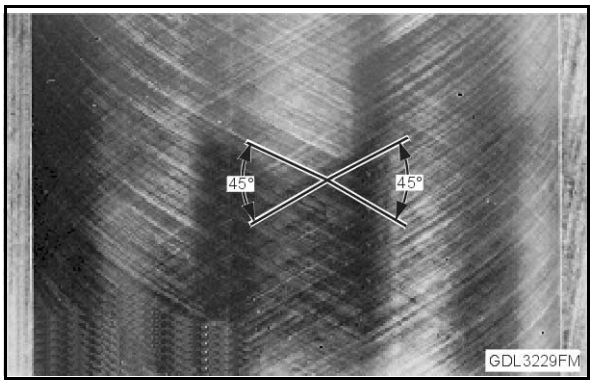
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Deglaze Cylinder Liner



Secure cylinder liner in a holding fixture.

Use D17005BR Flexible Cylinder Hone to deglaze cylinder liner. Use honing oil along with flex hone when deglazing liners.



Use D17006BR Flexible Cylinder Hone according to instructions supplied with tool to obtain a 45 ° cross-hatch pattern.

Thoroughly clean liners after deglazing.

Clean Cylinder Liner

Use a stiff bristle brush to remove all debris, rust, and scale from OD of liners, under liner flange, and in O-ring packing areas. Make certain there are no nicks or burrs in areas where packings will seat.

⚠ WARNING

Do not use gasoline, kerosene, or commercial solvent to clean liners. Solvents will not remove all the abrasives from liner walls.

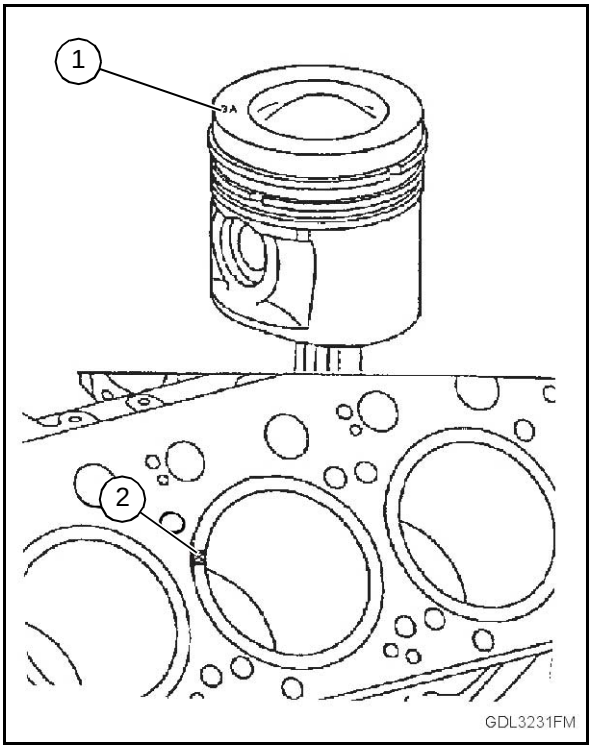
Thoroughly clean liner ID with a 50 percent solution of hot water and liquid detergent.

Rinse thoroughly and wipe dry with a clean rag.

Swab out liner as many times as necessary with clean 10W engine oil.

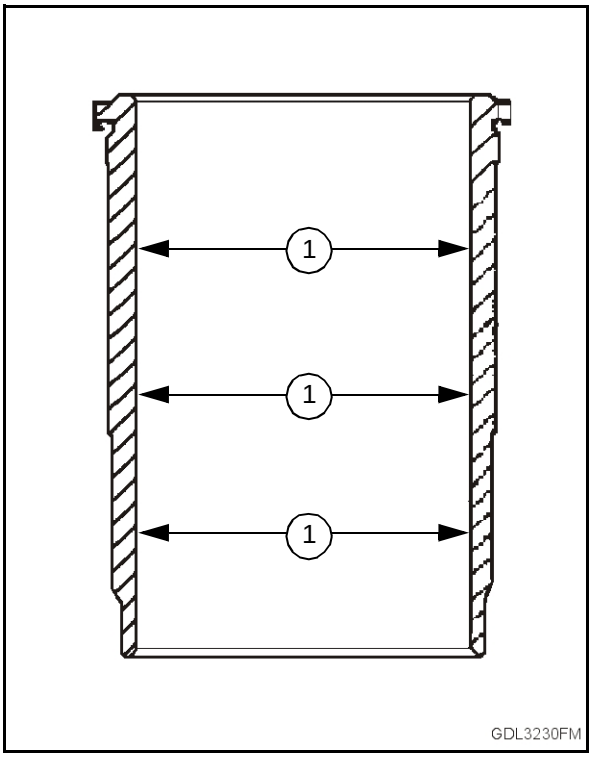
Clean liner until a white rag shows no discoloration.

Measure Cylinder Liner



Identify code letter mark on piston (1) and code letter mark cylinder liner (2).

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Take cylinder liner ID measurements (3) at three different places, 90° from each other.

Compare measurements with specifications.

Cylinder Liners Specification

Cylinder Liner Code Letter “A” ID
- - - - - - - - 129.990 - 129.995 mm (5.1177 - 5.1179 in.)

Cylinder Liner Code Letter “B” ID
- - - - - - - - 129.995 - 130.005 mm (5.1179 - 5.1182 in.)

Cylinder Liner Code Letter “C” ID
- - - - - - - - 130.005 - 130.010 mm (5.1182 - 5.1184 in.)

⚠ CAUTION

Not all pistons fit in all cylinder liners. Refer to Piston and Cylinder Liner Selection Table for proper piston and cylinder liner matches.

Piston and Cylinder Selection Table	
Stamped Piston Code Letter	**Stamped Cylinder Liner Code Letter**
BA Will Fit	A or B Liner
BC Will Fit	B or C Liner

Inspect and Clean Cylinder Block

NOTE: All components (including piston cooling orifices), water gallery plugs and oil gallery plugs must be removed from the cylinder block for inspection and cleaning. Refer to the proper Chapter for removal of all external and internal mounted components.

Remove cylinder head locating dowels, if not previously removed. Clean out all threaded holes for cylinder head mounting cap screws in top deck of cylinder block using a 14.0 x 2.0 mm tap.

Use compressed air to remove any debris or fluid which may be present in the cap screw hole.

⚠ CAUTION

If cylinder block is cleaned in a hot tank, be sure to remove any aluminum parts. Aluminum parts can be damaged or destroyed by hot tank solutions. Remove all serial number plates.

Clean block thoroughly, using cleaning solvent, pressure steam, or a hot tank.

Inspect liner support flanges for burrs. If burrs are present, use a small half-moon file and **LIGHTLY** file (in a circular motion) burr off. **DO NOT** let file hit top deck of cylinder block while filing.

Carefully inspect block for cracks or any other physical damage. If a cracked block is suspected, pressure test the block.

A procedure for pressure testing is outlined in FOS (Fundamentals of Service) Manual - ENGINES.

Replace block if there is evidence of a crack or physical damage.

Check cylinder block flatness using D05012ST-A **“Beveled Edge”** Straightedge and feeler gauge. Check lengthwise, crosswise, and diagonally in several places.

If any measurement exceeds specification, the cylinder block must be either resurfaced or replaced.

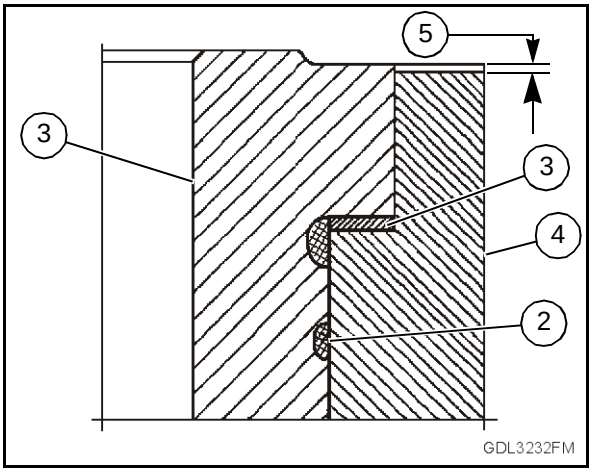
Specification

Cylinder Block Top Surface Wave Depth
- - - - - - - - - -8 - 16 micrometer (0.00031 - 0.00063 in).

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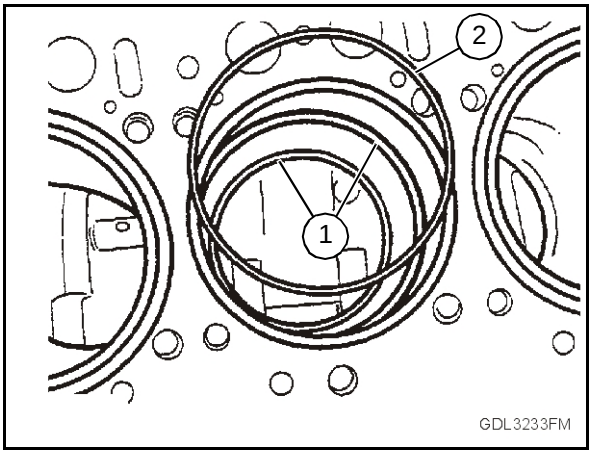
Install Cylinder Liner Shims If Required

Measure cylinder liner protrusion. **(See "Measure Cylinder Liner Protrusion" on page 138).**



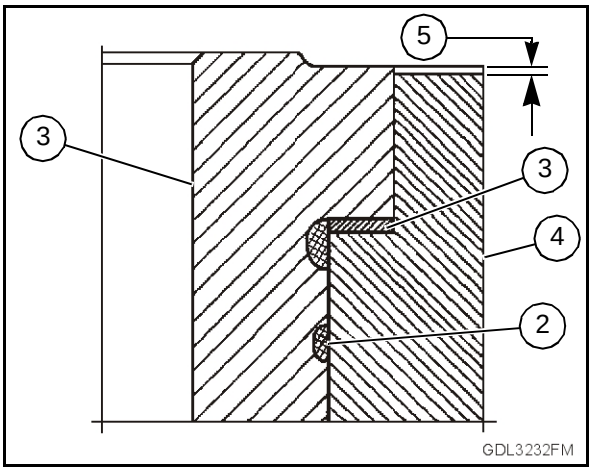
Install shims as required between seal (1) and cylinder block (4) to achieve correct cylinder liner protrusion (5).

Install O-Rings In Seal Grooves



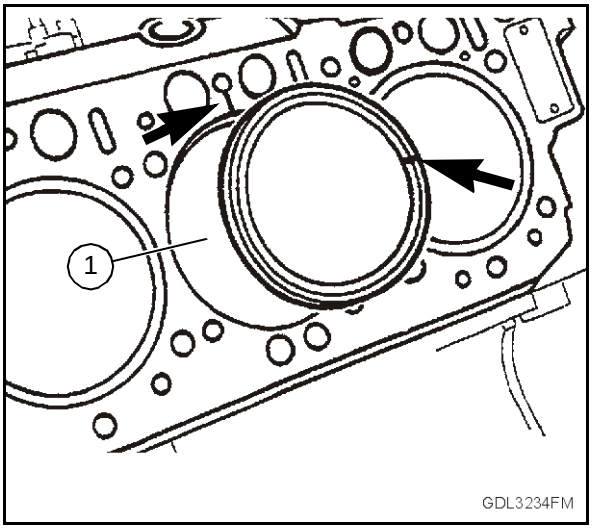
Check seal grooves in cylinder block (1) so that they are clean and free of any nicks or burrs.

Install new O-rings (2) in seal grooves. Do not lubricate O-rings.



Install seal (1) against collar of cylinder liner (3).

Install O-ring (2) into upper seal groove of liner.

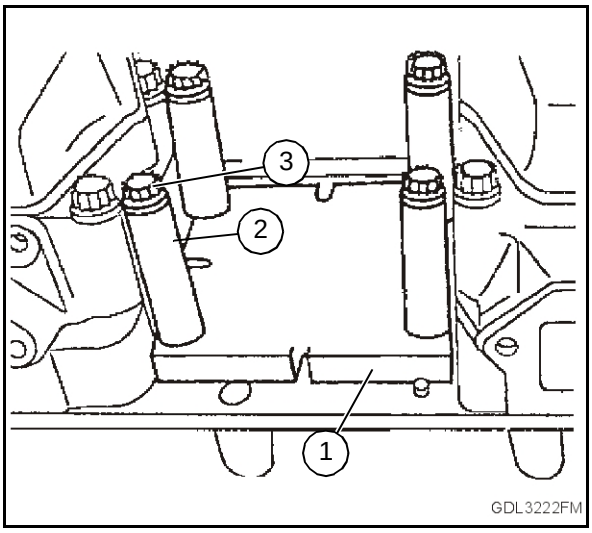


Apply liquid soap to cylinder liner lower pilot surface and bevel to aid in liner installation.

If installing same liner as removed, install liner (1) 90° from marks (arrows) made when removed.

Slide liner into engine block.

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Install plate (1) over liner using spacers (2) and cap screws (3).

Evenly tighten cap screws to specification.

Cylinder Liners Specification

Liner Preload Plate Cap Screws Torque
- 50 Nm (37 lb-ft)

Measure cylinder liner protrusion. **(See “Measure Cylinder Liner Protrusion” on page 138).**

Check Engine Rotation for Excessive Tightness

Rotate crankshaft several revolutions to be sure engine rotates without excessive tightness.

Check liners for deep scratches caused by an improperly installed or broken piston ring.

Check side clearance of rods. Must have slight side-to-side movement.

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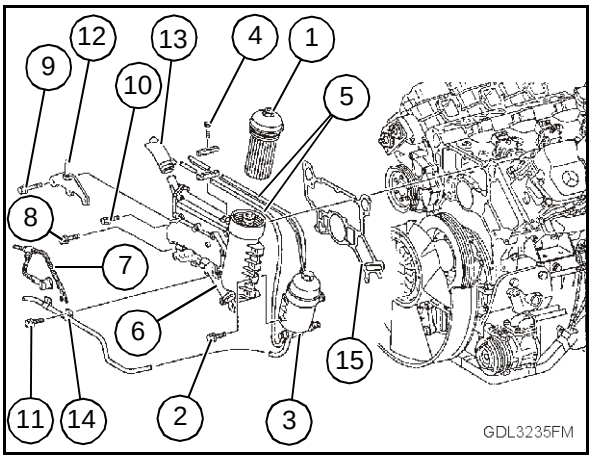
CHAPTER 4. ENGINE

SECTION 5. LUBRICATION SYSTEM

REMOVE AND INSTALL OIL FILTER HOUSING

Remove air intake manifold. **(See "REMOVE AND INSTALL AIR INTAKE MANIFOLD" on page 165).**

Remove thermostat housing. **(See "THERMOSTATS AND HOUSING" on page 179).**



Disconnect coolant line (13) from engine oil filter housing.

Remove oil filter cap and element (1).

Remove cap screw (2) and disconnect fuel filter (3) from engine oil filter housing (6).

Remove clamp (4) holding fuel line (5) to engine oil filter housing.

Disconnect engine wiring harness (7) from oil pressure sensor, oil temperature sensor and coolant temperature sensor.

Remove cap screws (8 - 11), air intake manifold mounting bracket (12), fuel line clamps (14) and engine oil filter housing.

Clean sealing surfaces. Install engine oil filter housing (6), new gasket (15), air intake mounting bracket (12), fuel line clamps (14) and cap screws (8 - 11). Tighten cap screws to specification.

Engine Oil Filter Housing Specification

Cap Screw Torque - - - - - - - - - - - - - - 50 Nm (37 lb-ft)

Connect engine wiring harness (7) to oil pressure sensor, oil temperature sensor and coolant temperature sensor.

Install clamp (4) holding fuel line (5) to engine oil filter housing (6).

Fuel Line Clamp Specification

Cap Screw Torque - - - - - - - - - - - - - - 25 Nm (221 lb-in.)

Install fuel filter (3) and cap screw (2) to engine oil filter housing.

Install oil filter cap and element (1). Tighten to specification.

Engine Oil Filter Specification

Cap Torque - - - - - - - - - - - - - - - - - - - 40 Nm (30 lb-ft)

Connect coolant line (13) to engine oil filter housing.

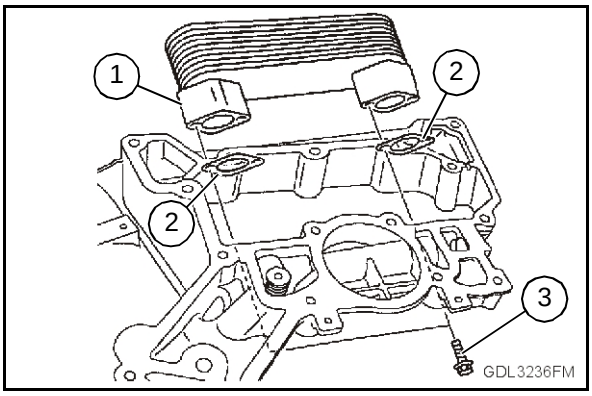
Install thermostat housing. **(See "THERMOSTATS AND HOUSING" on page 179).**

Install air intake manifold. **(See "REMOVE AND INSTALL AIR INTAKE MANIFOLD" on page 165).**

REMOVE, INSPECT, AND INSTALL ENGINE OIL COOLER

Remove engine oil filter housing. **(See "REMOVE AND INSTALL OIL FILTER HOUSING" on page 145).**

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Remove cap screws (3) and oil cooler (1) from oil cooler housing.

Inspect engine oil cooler and replace, if necessary. Clean sealing surfaces.

Install engine oil cooler, gaskets (2) and cap screws.

Tighten cap screws to specification.

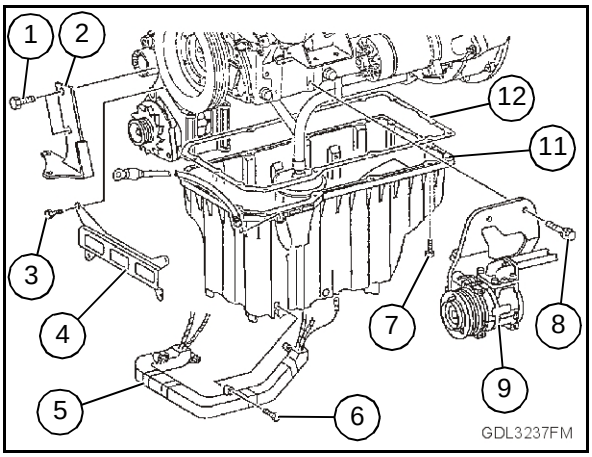
Engine Oil Cooler Specification

Cap Screw Torque - - - - - - - - - - - - - 25 Nm (221 lb-in.)

Install engine oil filter housing. **(See "REMOVE AND INSTALL OIL FILTER HOUSING" on page 145).**

REMOVE AND INSTALL OIL PAN

Loosen tension on serpentine belt and remove belt from A/C compressor.



Remove dipstick and guide (10).

Remove cap screws (3) and brace (4).

Remove cap screws (8) and move A/C compressor (9) aside.

Remove cap screws (1) and brace (2).

Remove cap screws (6) and move engine harness ducting (5) aside.

Remove cap screws (7) and oil pan (11).

Clean and inspect oil pan. Clean all sealing surfaces.

Install new gasket, oil pan and cap screws. Tighten to specification.

Oil Pan Specification

Cap Screw Torque- - - - - - - - - - - - - - - 55 Nm (40 lb-ft)

Install engine harness ducting and cap screws.

Install brace (2) and cap screws.

Install A/C compressor and cap screws.

Install brace (4) and cap screws.

Install dipstick and guide. Tighten to specification.

Oil Pan Specification

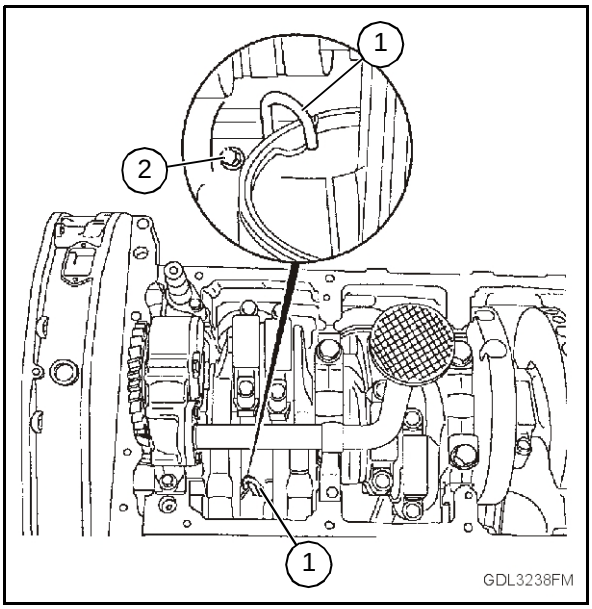
Dipstick Guide Torque - - - - - - - - - - - - 50 Nm (37 lb-ft)

Install belt on A/C compressor.

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REMOVE, INSPECT AND INSTALL PISTON COOLING ORIFICES

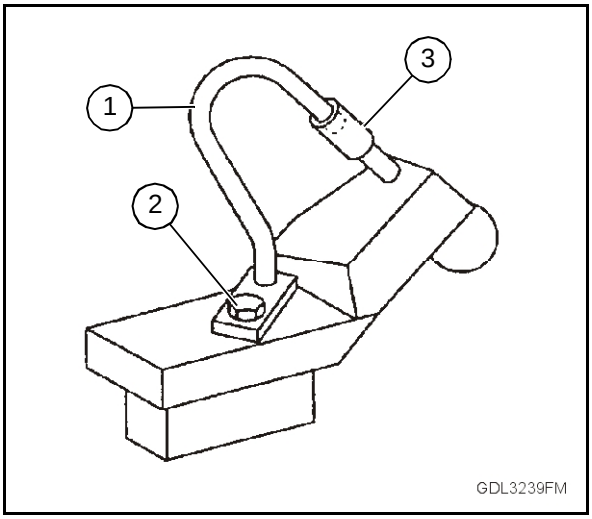
Remove oil pan. **(See "REMOVE AND INSTALL OIL PAN" on page 146).**



Remove valve lifters (1) using JDG1596 removal tool (2).

Remove cap screws (2) and oil spray nozzles (1) from crankcase.

Clean oil spray nozzles with solvent. Dry thoroughly.



Install oil spray nozzle (1) and cap screw (2) on JDG1595 Piston Cooling Oil Spray Nozzle Gauge.

Adjust nozzle as necessary to fit nozzle tip into nozzle adjustment guide (3).

Adjustment will ensure that nozzle is lubricating piston correctly.

Repeat check for each spray nozzle.

Install oil spray nozzles and cap screw. Ensure locating pins on nozzles align with locating holes on crankcase.

Tighten to specification.

Oil Spray Nozzle Specification

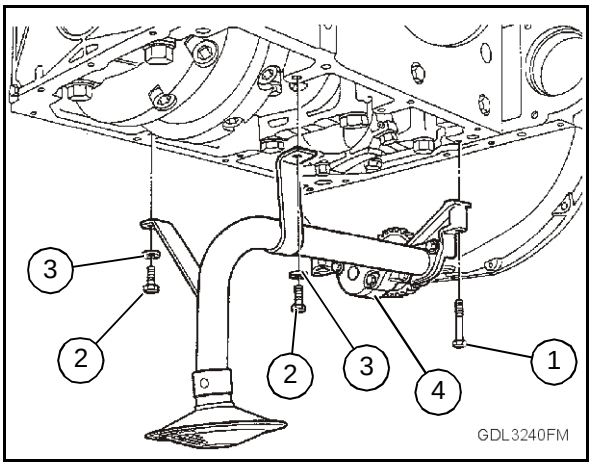
Cap Screw Torque - - - - - - - - - - - - - 25 Nm (221 lb-in.)

Install oil pan. **(See "REMOVE AND INSTALL OIL PAN" on page 146).**

REMOVE AND INSTALL ENGINE OIL PUMP

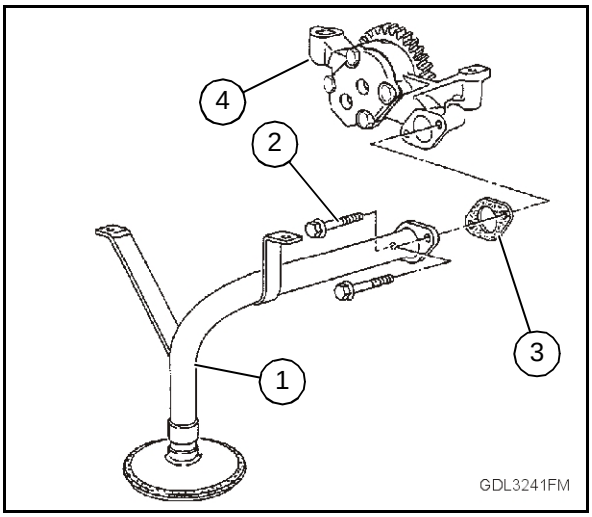
Remove oil pan. **(See "REMOVE AND INSTALL OIL PAN" on page 146).**

Remove oil pressure relief valve. **(See "REMOVE AND INSTALL OIL PRESSURE RELIEF VALVE" on page 148).**



Remove oil pump mounting cap screw (1), oil intake pipe mounting cap screws (2), washers (3) and remove oil pump and intake pipe assembly (4).

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Remove oil intake pipe cap screws (2) and oil intake pipe (1) from oil pump (4).

Remove oil intake pipe gasket (3) and discard.

Clean oil intake pipe with suitable solvent and dry thoroughly.

Install new oil intake pipe gasket and install intake pipe to oil pump with oil intake pipe cap screws.

Tighten cap screws to specification.

Oil Pump Specification

Intake Pipe Cap Screws Torque - - - - - 35 Nm (26 lb-ft)

Install oil pump and intake pipe assembly to crankcase with oil intake pipe and oil pump mounting cap screws.

Tighten cap screws to specification.

Oil Pump Specification

Mounting Cap Screw Torque- - - - - - - - 35 Nm (26 lb-ft)

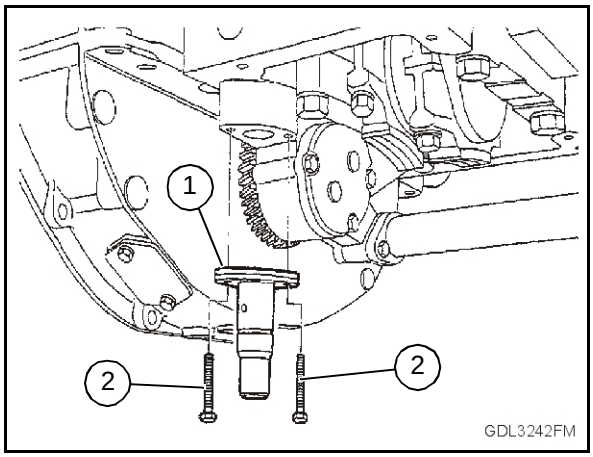
Oil Intake Pipe Mounting Cap Screw Torque
- 35 Nm (26 lb-ft)

Install oil pressure relief valve. **(See "REMOVE AND INSTALL OIL PRESSURE RELIEF VALVE" on page 148).**

Install oil pan. **(See "REMOVE AND INSTALL OIL PAN" on page 146).**

REMOVE AND INSTALL OIL PRESSURE RELIEF VALVE

Remove oil pan. (**See "REMOVE AND INSTALL OIL PAN" on page 146).**



Remove oil pressure relief valve cap screws (2) and oil pressure relief valve (1).

Install oil pressure relief valve cap screws and oil pressure relief valve. Tighten oil pressure relief valve cap screws to specification.

Oil Pressure Relief Valve Specification

Cap Screw Torque- - - - - - - - - - - - - 25 Nm (221 lb-in.)

Install oil pan. **(See "REMOVE AND INSTALL OIL PAN" on page 146).**

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CHAPTER 4. ENGINE

SECTION 6. CYLINDER HEAD AND VALVES

CYLINDER HEAD AND VALVES FAILURE ANALYSIS

Make preliminary inspection of cylinder head and valve assembly during disassembly.

Look for the following conditions:

Sticking Valves

- Carbon deposits on valve stem.
- Worn valve guides.
- Scored valve stems.
- Warped valve stems.
- Misaligned or broken valve springs.
- Worn or distorted valve seats.
- Insufficient lubrication.

Warped, Worn, or Distorted Valve Guides

- Lack of lubrication.
- Cylinder head distortion.
- Excessive heat.
- Unevenly tightened cylinder head cap screws.

Distorted Cylinder Head and Gasket Leakage

- Loss of cylinder head cap screw torque.
- Broken cylinder head cap screw.
- Overheating from low coolant level operation.
- Insufficient liner standout.
- Coolant leakage into cylinder causing hydraulic failure of gasket.
- Cracked cylinder head.
- Cracked cylinder liner.
- Damaged or incorrect gasket.
- Overpowering or overfueling.
- Damaged cylinder head or block surfaces.
- Improper surface finish on cylinder head.
- Improperly tightened cylinder head cap screws.
- Faulty gasket installation (misaligned).

Worn or Broken Valve Seats

- Misaligned valves.
- Distorted cylinder head.
- Carbon deposits on seats due to incomplete combustion.
- Valve spring tension too weak.
- Excessive heat.
- Improper valve clearance.
- Improper valve timing.
- Incorrect valve or seat installed.

Burned, Pitted, Worn, or Broken Valves

- Worn or distorted valve seats.
- Loose valve seats.
- Worn valve guides.
- Insufficient cooling.
- Cocked or broken valve springs.
- Improper engine operation.
- Improper valve train timing.
- Faulty valve rotators.
- Warped or distorted valve stems.
- “Stretched” valves due to excessive spring tension.
- Warped cylinder head.
- Bent push rods.
- Carbon build-up on valve seats.
- Rocker arm failure.
- Incorrect valve or seat installed.
- Incorrect piston-to-valve clearance.

Improper Valve Clearance

- Inefficient use of fuel.
- Engine starts harder.
- Maximum engine power will not be achieved.
- Shorter service life of valve train.
- Greater chance for engine to overheat.

Excessive Valve Recession

- Worn valve guides.
- Bent valves.
- Debris passed through valve train.

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REMOVE AND INSTALL VALVE COVER

Loosen valve cover cap screws and remove valve cover.

Install new gasket.

Install valve cover. Tighten valve cover cap screws to specification.

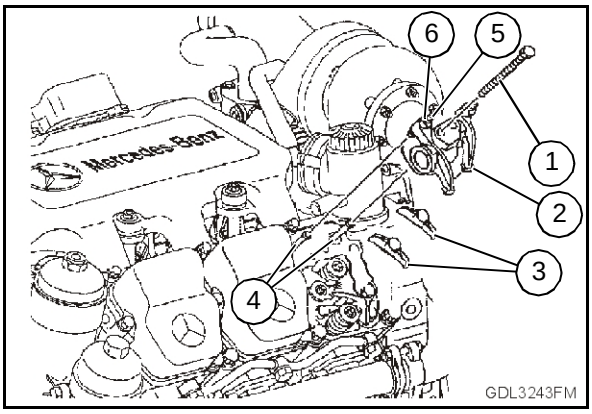
Valve Cover Specification

Cap Screws Torque - - - - - - - - - - - - 20 Nm (177 lb-in.)

Rocker Arms and Shaft

Remove, Disassemble and Inspect

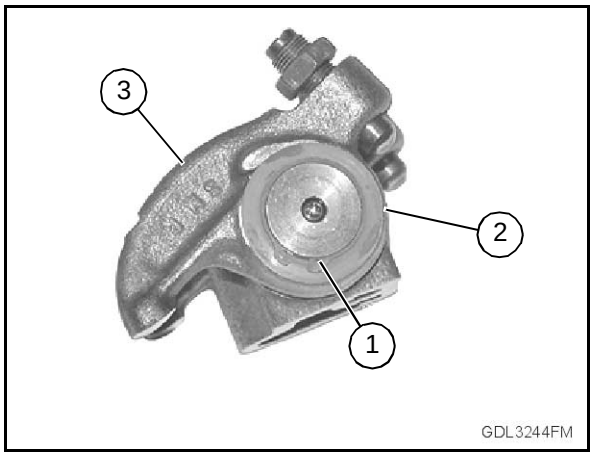
Remove valve cover from cylinder head(s). **(See "REMOVE AND INSTALL VALVE COVER" on page 150).**



Loosen lock nuts (6) and back off adjusting screws (5).

Remove push rods (4).

Remove cap screws (1) and lift off rocker shaft assembly (2) and valve cradles (3).



Remove snap rings (1) and washers (2).

Remove rocker arms (3) from rocker shaft.

Disassemble and inspect parts.

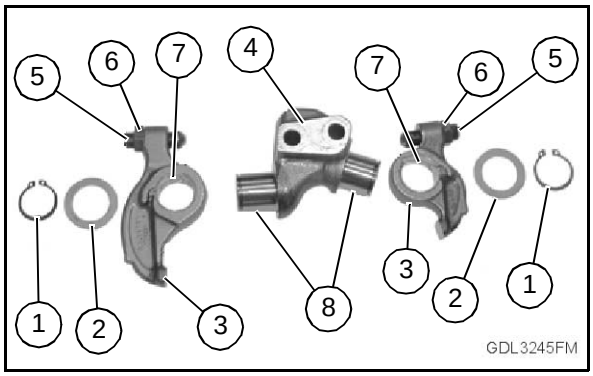
Measure ID of rocker arm bushing (7) and OD of shaft bushing surface (8). Compare measurements to specification.

Rocker Arm Specification

Shaft OD - - - - - - - - - - - - - - - - 24.980 mm (0.983 in.)

Bushings ID

- - - - - - - - - - - 25.005 - 25.021 mm (0.984 - 0.985 in.)

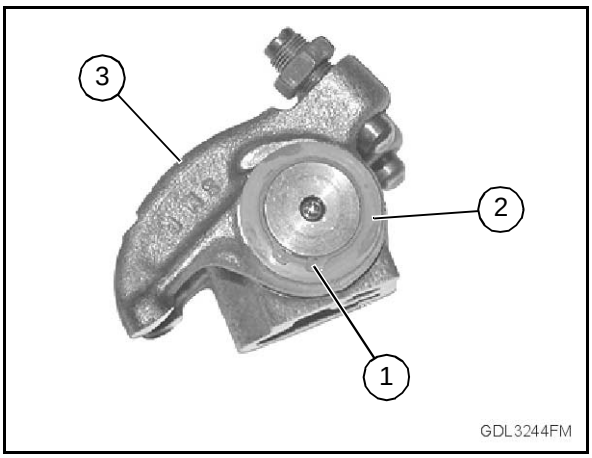


If rocker arm bushings are worn, press out old bushings from rocker arm. Supercool new bushings and press into rocker arm, ensuring that lube hole in rocker arm (9) is lined up with hole in bushing (7).

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Assemble and Install Rocker Arms and Shaft

Apply engine oil to rocker arm bushings and rocker shafts.



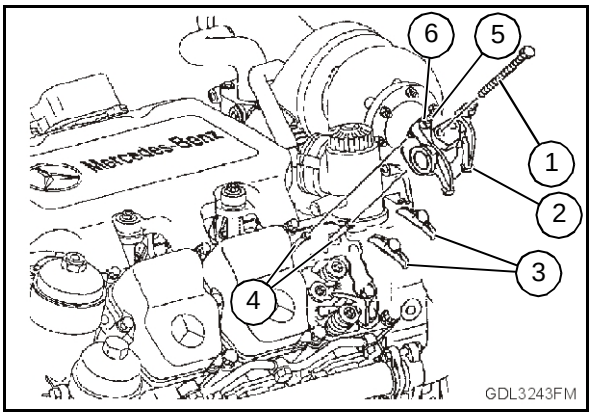
Install rocker arm (3) onto shaft.

Install washer (2) and snap ring (1).

Measure the shank length of rocker shaft cap screws from the end of cap screw to the bottom of cap screw head. Replace both cap screws for that cylinder head if longer than the specification.

Rocker Shaft Assembly Specification

Cap Screw Shank Length
- 91 mm (3.58 in.) Maximum.



Install valve cradles (3), rocker shaft assembly (2) and cap screws (1). Tighten cap screws to specification.

Rocker Shaft Assembly Specification

Cap Screw Torque - - - - - - - - - - - - - - -60 Nm (44 lb-ft)

Torque Turn - 90°

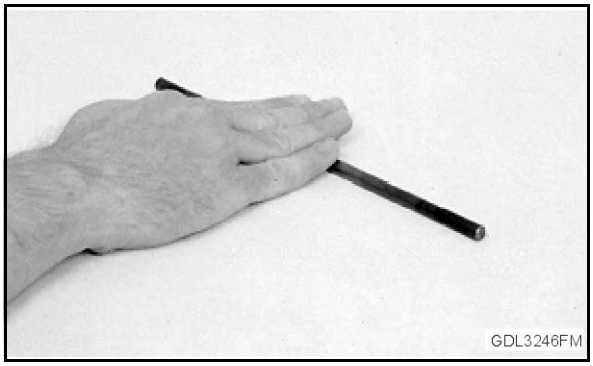
Install push rods (4), making sure push rods are properly seated in cam followers.

Turn adjusting screws (5) until they just make contact with push rods.

Adjust valve clearance. **(See Valve Clearance Adjustment in CHAPTER 2, SECTION 3 in the Opeeration and Test Manual).**

Clean and Inspect Push Rods

Clean push rods with suitable solvent and dry thoroughly.



Check push rods for straightness by rolling on a flat surface.

Inspect contact ends for wear and damage.

Replace damaged or worn push rods.

Cylinder Head

Remove Cylinder Head

⚠ CAUTION

1. Explosive release of fluids from pressurized cooling system can cause serious burns.
2. Shut off engine.
3. Remove filler cap only when cool enough to touch with bare hands.
4. Slowly loosen cap to first stop to relieve pressure before removing completely.

Drain engine coolant.

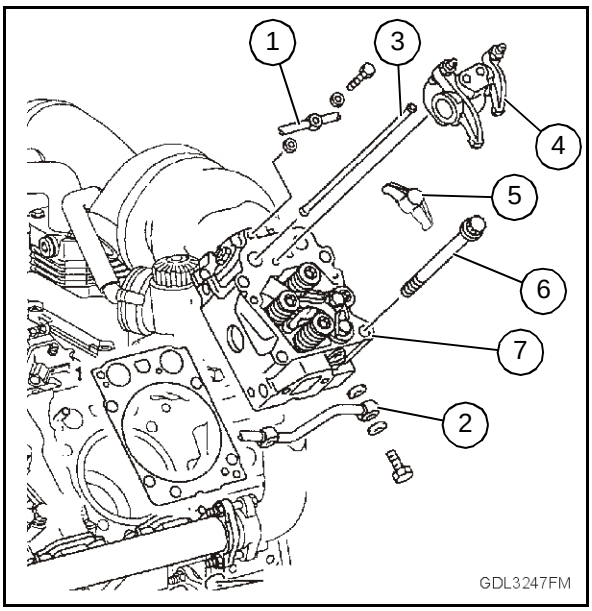
Remove exhaust manifold. **(See “REMOVE AND INSTALL EXHAUST MANIFOLD” on page 161).**

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Remove intake manifold. **(See "REMOVE AND INSTALL AIR INTAKE MANIFOLD" on page 165).**

Remove valve cover from cylinder head(s). **(See "REMOVE AND INSTALL VALVE COVER" on page 150).**

Remove fuel delivery nozzle(s) from cylinder head(s). **(See "REMOVE AND INSTALL FUEL DELIVERY NOZZLE" on page 164).**



Remove rocker arm assembly (4) and valve cradle (5) from cylinder head(s). **(See "Rocker Arms and Shaft" on page 150).**

Remove push rods (3) from cylinder head.

Disconnect leak-off lines (1).

Remove exhaust brake line (2).

Remove cylinder head cap screws (6) and cylinder head (7).

Install Cylinder Head

Use JDG1500-46 Tap and Die for Head Bolt Holes and Bolts to clean up threads in cylinder block and cap screws.

Install centering sleeves into cylinder block.

Install new head gasket over centering sleeves.

Install cylinder head (7) onto cylinder block.

⚠ WARNING

Cylinder head cap screws are stretched when tightened to specification. Cap screws are usable up to the maximum shank length specification measured from the end of cap screw to the bottom of cap screw head. If any cap screw is longer than the specification, replace all cap screws for that cylinder head.

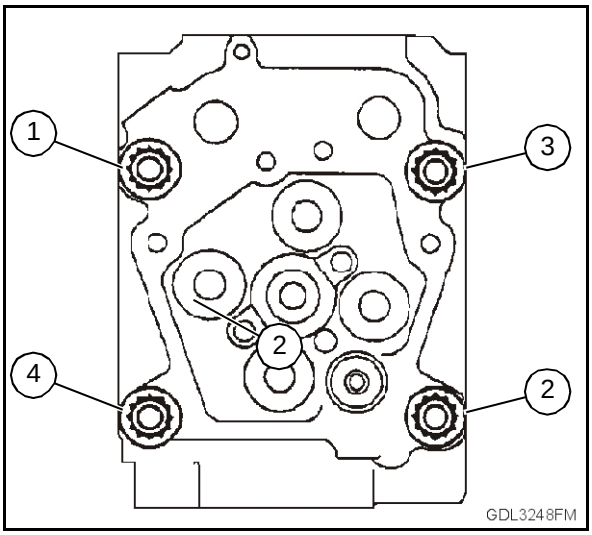
Measure the shank length of cylinder head cap screws from the end of cap screw to the bottom of cap screw head. Replace all cap screws for that cylinder head if longer than the specification.

Cylinder Head Specification

Cap Screw Shank Length
- - - - - - - - - - - - - - - - - 212.0 mm (8.346 in.) Maximum

Oil threads of cap screws with clean engine oil and install cylinder head cap screws (6).

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Tighten cap screws in sequence, 1 - 4, in six stages to specification.

Cylinder Head Specification

Cap Screws 1st Stage Torque - - - - - - 10 Nm (89 lb-in.)

Cap Screws 2nd Stage Torque - - - - - - 50 Nm (37 lb-ft)

Cap Screws 3rd Stage Torque - - - - - - 100 Nm (74 lb-ft)

Cap Screws 4th Stage Torque - - - - - 200 Nm (148 lb-ft)

Cap Screws 5th Stage Torque - - - - Turn 90° Clockwise

Cap Screws 6th Stage Torque - - - - Turn 90° Clockwise

Install push rods.

Install exhaust brake line.

Connect leak-off line.

Install rocker arm assembly (4) and valve cradle (5) to cylinder head(s). **(See "Rocker Arms and Shaft" on page 150).**

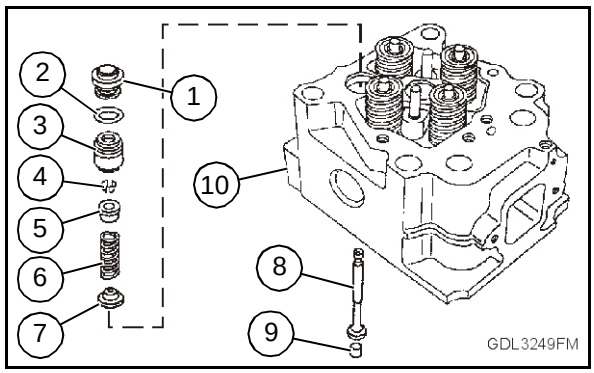
Install fuel delivery nozzle(s) to cylinder head(s). **(See "REMOVE AND INSTALL FUEL DELIVERY NOZZLE" on page 164).**

Install valve cover to cylinder head(s). **(See "REMOVE AND INSTALL VALVE COVER" on page 150).**

Install intake manifold. **(See "REMOVE AND INSTALL AIR INTAKE MANIFOLD" on page 165).**

Install exhaust manifold. **(See "REMOVE AND INSTALL EXHAUST MANIFOLD" on page 161).**

Remove and Install Engine Exhaust Valve Brake



Remove cylinder head. (10). **(See "Cylinder Head" on page 151).**

Remove plug (1) and piston (3).

Use a spacer (9) to keep valve in closed position.

Remove retainer locks (4) using JDG1592 Spring Retainer Depressor.

Remove spring retainer (5), spring (6), spring guide (7), and valve (8). Inspect parts and replace as necessary.

Install valve, spring guide, spring and spring retainer.

Install retainers ensuring they are seated in the valve stem groove.

Install piston into cylinder head.

Install plug.

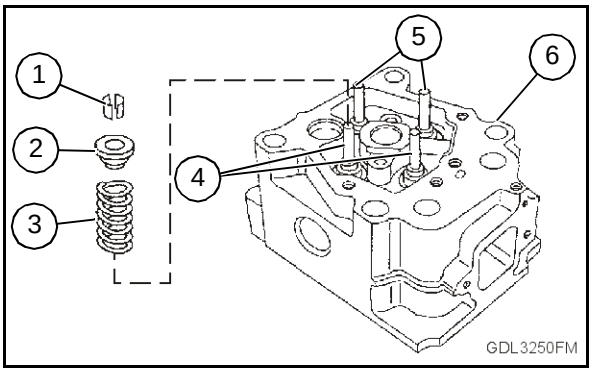
Install cylinder head. **(See "Cylinder Head" on page 151).**

Intake and Exhaust Valves

Remove Intake and Exhaust Valves

Remove cylinder head. **(See "Cylinder Head" on page 151)**.

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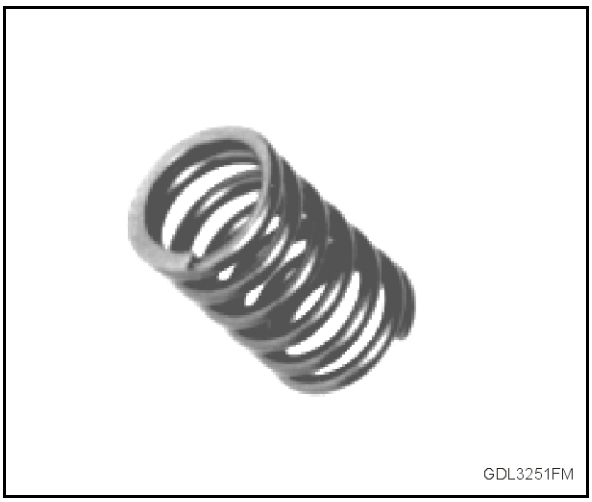


Compress valve springs and remove retainer locks (1).

Relieve tension and remove retainers (2) and valve springs (3).

Remove intake valves (4) and exhaust valve (5) from cylinder head (6).

Inspect Valve Springs



Inspect valve springs for alignment, wear, and damage.

Put springs on a flat surface to see that they are square and parallel.

Inspect Valve Spring Retainers and Retainer Locks

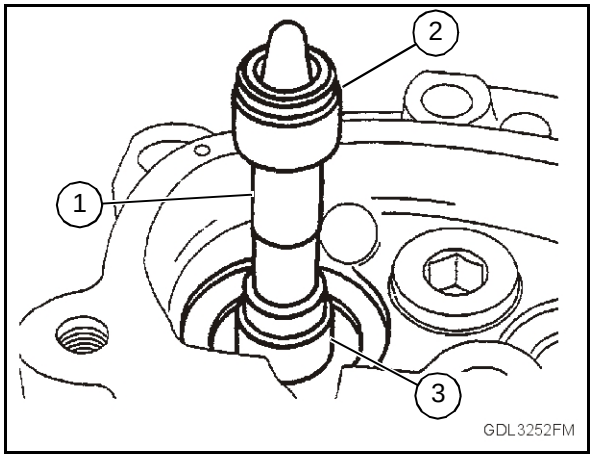
Inspect valve spring retainers for excessive wear in area where valve springs and retaining locks seat.

Replace as needed.

Inspect retainer locks for excessive wear. Replace as needed.

Install Intake and Exhaust Valves

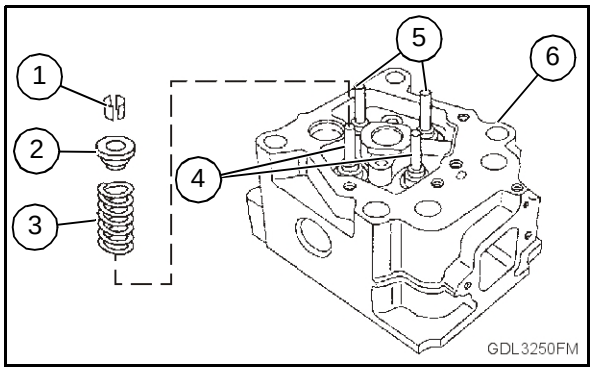
Install Valve Seal



Use Valve Seal Installation Tool (1) to install valve seal.

Apply a light film of multi-purpose grease to sleeve of valve seal (2).

Slide valve seal down sleeve and push firmly onto valve guide (3).



Apply a light film of multi-purpose grease to the stems of intake valve (4) and exhaust valve (5).

Install valves into head (6) and through valve seals.

Install valve springs (3) and retainers (2).

Compress valve spring.

Apply grease to the insides of retainer locks (1) to hold them in place when being installed.

Install retainer locks onto valves and release spring tension. Make sure retainer locks stay in the groove on the valve when spring tension is released.

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Install cylinder head. **(See "Cylinder Head" on page 151).**

Valves

Clean

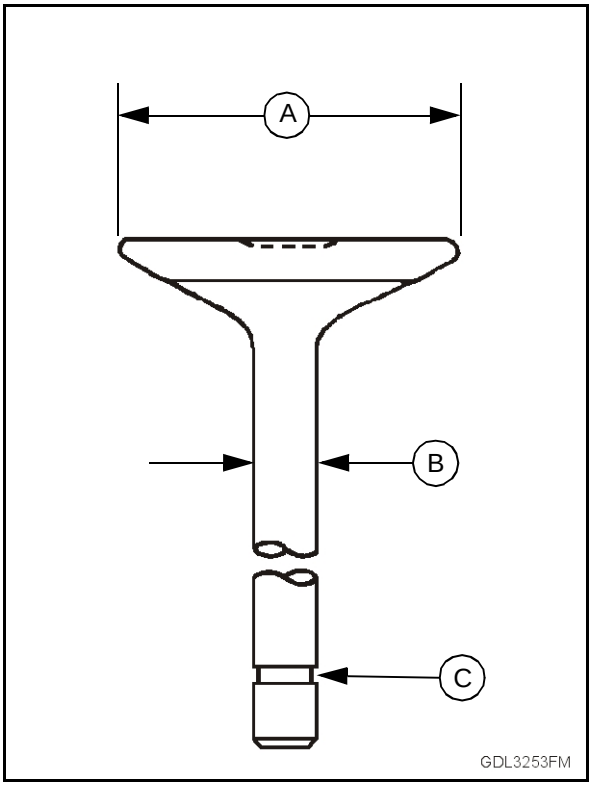
Hold each valve firmly against a soft wire wheel on a bench grinder.

Make sure all carbon is removed from valve head, face and stem. Polish valve stem with steel wool or crocus cloth to remove scratch marks left by wire brush.

NOTE: Any carbon left on valve stem will affect alignment in refacer if valves need to be refaced.

Inspect and Measure

Thoroughly clean and inspect valves to help determine if they can be restored to a serviceable condition. Replace valves that are burned, cracked, eroded, or chipped.



A. Valve Head OD.
B. Valve Stem OD.
C. Valve Retainer Lock Groove.

Inspect valve retainer lock groove (C) on valve stem for damage.

Also inspect stems for signs of scuffing, which may indicate insufficient valve guide-to-valve stem clearance. Replace if damage is found.

Measure valve head OD (A). Compare valve stem OD (B) with guide ID to determine clearance, as outlined later in this group.

Intake and Exhaust Valve Specification

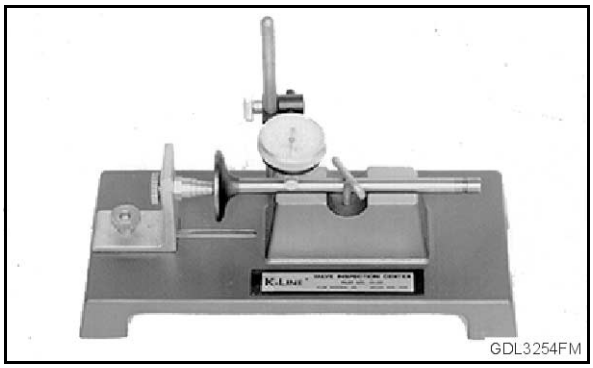
Intake Valve Stem OD
- - - - - - - - - - - 8.935 - 8.950 mm (0.3518 - 0.3524 in.)

Exhaust Valve Stem OD
- - - - - - - - - - - 8.925 - 8.940 mm (0.3514 - 0.3520 in.)

Intake Valve Head OD
- - - - - - - - - - - - - - - -45.4 - 45.6 mm (1.787 - 1.795 in.)

Exhaust Valve Head OD
- - - - - - - - - - - - - - - -40.9 - 41.1 mm (1.610 - 1.618 in.)

Intake and Exhaust Valve Length
- - - - - - - - - - - - - - - - - - -145 mm (5.708 in.) Maximum



Use a valve inspection center to determine if valves are out of round, bent or warped.

Intake and Exhaust Valve Specification

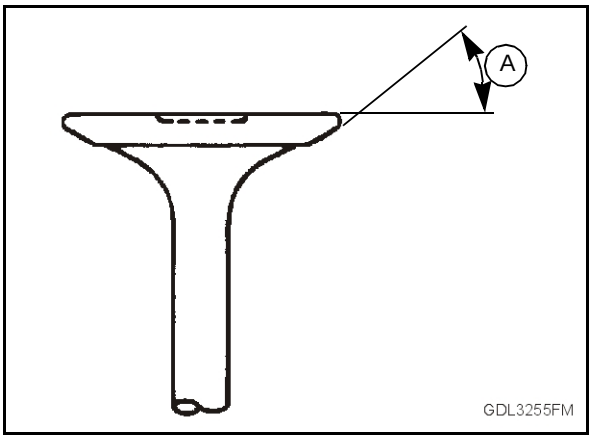
Valve Seat-to-Stem Runout - - - - 0.03 mm (0.0012 in.)
Valve Head-to-Stem Runout - - - 0.20 mm (0.0079 in.)
Valve Seat Out-of-Round - - - - - 0.01 mm (0.0004 in.)

Grind (Reface)

⚠ WARNING

Valve grinding should only be done by experienced personnel familiar with equipment and capable of maintaining required specifications.

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A. Valve Face Angle.

If necessary to reface valve, grind valve face angle (A) to following specification.

Intake and Exhaust Valve Specification

Intake Valve Face Angle- 30°

Exhaust Valve Face Angle - - - - - - - - - - - - - - - - - - 45°

Intake Valve Face Width
- - - - - - - - - - - - - 3.5 - 3.6 mm (0.138 - 0.142 in.) new

Exhaust Valve Face Width
- - - - - - - - - - - - - 3.5 - 3.6 mm (0.138 - 0.142 in.) new

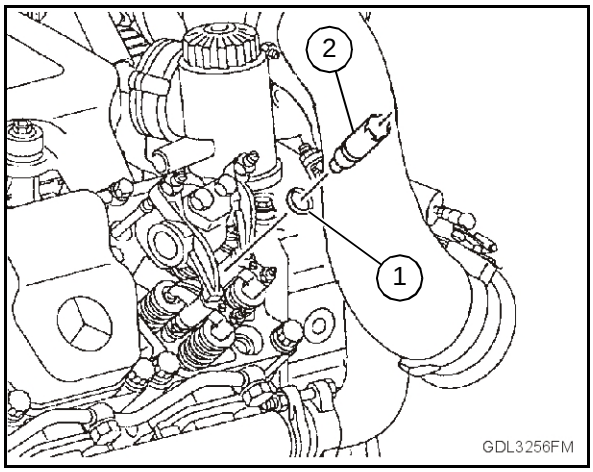
⚠ WARNING

When valve faces are ground, DO NOT nick valve head-to-stem radius with facing stone. A nick could cause the valve to break. Grind all sharp edges to a radius after grinding valves.

Cylinder Head

Remove, Inspect and Install Protective Sleeve

NOTE: Protective sleeve can be removed with cylinder head installed. If removed with cylinder head installed, drain coolant and remove fuel delivery nozzle (See "REMOVE AND INSTALL FUEL DELIVERY NOZZLE" on page 164) before removing protective sleeve.



Remove protective sleeve (2) and o-ring (1) using JDG1597 Spanner Socket.

Inspect protective sleeve and o-ring. Replace as necessary.

Install protective sleeve and o-ring using JDG1597 Spanner Socket.

Inspect and Clean

Inspect combustion face for evidence of physical damage, oil or coolant leakage, or gasket failure prior to cleaning the cylinder head.

Repair or replace cylinder head if there is evidence of physical damage, such as cracking, abrasion, distortion, or valve seat "torching." Inspect all cylinder head passages for restrictions.

Scrape gasket material, oil, carbon, and rust from head. Use a powered brass or copper wire brush to clean sealing surfaces.

⚠ CAUTION

Be sure to remove all plugs before cleaning head, as parts can be damaged or destroyed by hot tank solutions.

Clean cylinder head in a chemical hot tank, or with solvent and a brush.

Dry with compressed air and blow out all passages.

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Check Cylinder Head Combustion Face Flatness

Check cylinder head flatness using D05012ST-A “Bevelled Edge” Straightedge and feeler gauge. Check lengthwise, crosswise, and diagonally.

If any measurement exceeds specification, the cylinder head must be either resurfaced or replaced.

Cylinder Head Specification

Cylinder Head Out-of-Flat -0.015 mm (0.0006 in.) per any 150 mm (5.9 in.) length

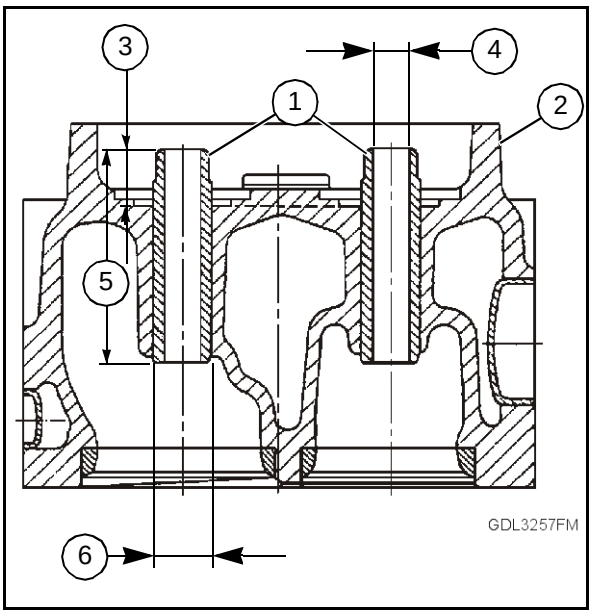
Cylinder Head Height - 113.85 - 114.15 mm (4.482 - 4.494 in.) New Condition

Cylinder Head Height - - - - - - - - - - - - - - - - - - - 113.5 mm (4.468 in.) Minimum

Clean, Inspect and Repalce Valve Guides

Use an appropriate valve guide end brush to clean valve guides before inspection or repair.

A few drops of light oil or kerosene will help to fully clean the guide.



1. Valve Guide (16 used).
2. Cylinder Head (8 used).
3. Projection of Valve Guide from Cylinder Head.
4. Valve Guide ID.
5. Valve Guide Length.
6. Valve Guide OD.

Measure valve guides and compare to specifications. For valve guide ID measurement (4) use a telescoping gauge and micrometer and take measurement half-way into the valve guide.

Valve Guide Specification

Valve Guides ID - - - - - - - - - - - 9.000 - 9.022 mm (0.3543 - 0.3552 in.)

Standard OD - - - - - - - - - - 15.028 - 15.046 mm (0.5917 - 0.5924 in.)

0.20 mm Oversize OD - - - - - - - - - 15.228 - 15.246 mm (0.5924 - 0.6000 in.)

0.40 mm Oversize OD - - - - - - - - - 15.428 - 15.446 mm (0.6074 - 0.6081 in.)

Cylinder Head Specification

Standard Guide Bore ID - - - - - - - - - 15.000 - 15.018 mm (0.5905 - 0.5913 in.)

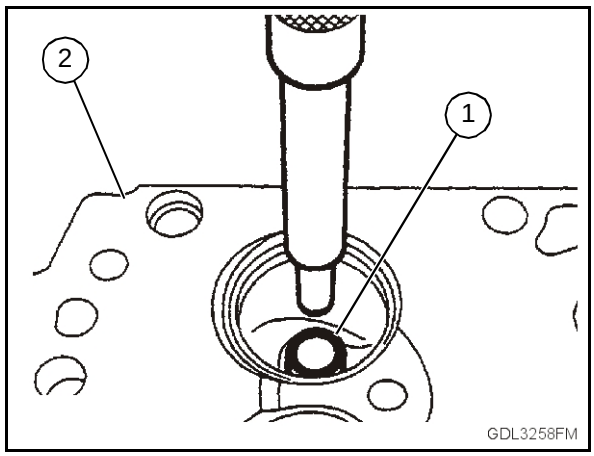
0.20 mm Oversize Guide Bore ID - - - - - - - - - 15.200 - 15.218 mm (0.5984 - 0.5991 in.)

0.80 mm Oversize Guide Bore ID - - - - - - - - - 15.400 - 15.418 mm (0.6063 - 0.6070 in.)

Projection of Valve Guide Distance - - - - - - - - - - - - - - - -21.1 - 21.5 mm (0.831 - 0.846 in.)

Intake and Exhaust Valve Specification

Valves Length - - - - 61.7 - 62.3 mm (2.429 - 2.453 in.)



If valve guide(s) (1) need to be replaced, knock out old valve guide from combustion side of head (2) towards top of cylinder head.

Bore out cylinder head valve guide bore to specification for guide size being replaced.

Press in new valve guide until projection of valve guide from cylinder head specification is achieved.

Ream out valve guide for proper valve stem-to-guide clearance.

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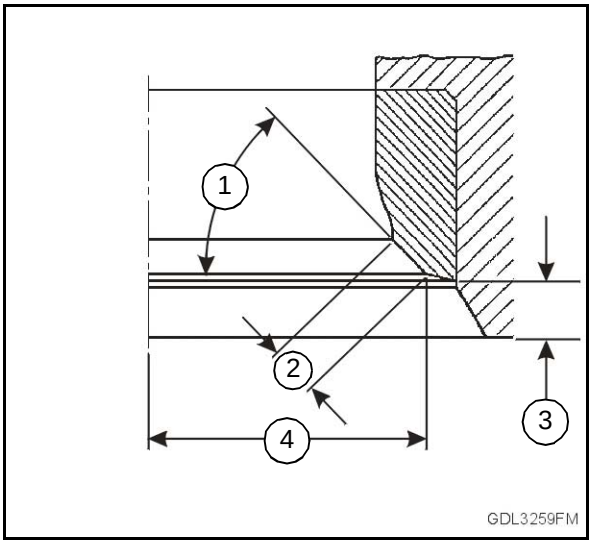
Clean and Inspect Valve Seats

Use an electric hand drill with D17024BR End Brush or equivalent brush to remove all carbon on valve seats.

Check seats for cracks, pits, or excessive wear.

Check entire combustion face for rust, scoring, pitting, or cracks.

Measure Valve Seats



1. Valve Seat Angle.
2. Valve Seat Width.
3. Valve Seat Recess in Cylinder Head.
4. Valve Seat Diameter.

Measure valve seats for proper specifications listed below.

Intake and Exhaust Valve Specification

Intake Valve Seat Angle - - - - - - - - - - - - - - - - - - - 30°

Exhaust Valve Seat Angle - - - - - - - - - - - - - - - - - - 45°

Intake Valve Seat Width - - - - - - - - 4.50 mm (0.177 in.)

Exhaust Valve Seat Width - - - - - - 4.50 mm (0.177 in.)

Intake Valve Seat-to-Cylinder Head Recess
- - - - - - - - - - - - - 3.60 - 3.80 mm (0.1417 - 0.1496 in.)

Exhaust Valve Seat-to-Cylinder Head Recess
- - - - - - - - - - - - - 2.80 - 3.00 mm (0.1102 - 0.1181 in.)

New/Finished Intake Valve Seat Diameter
- - - - - - - - - - - 56.99 - 57.01 mm (2.2436 - 2.2444 in.)

New/Finished Exhaust Valve Seat Diameter
- - - - - - - - - - - 48.99 - 49.01 mm (1.9287 - 1.9295 in.)

If valve seat is not within specification, recondition valve seat by grinding, or replace valve seat inserts if reconditioning is not possible. **(See "Grind Valve Seats" on page 158).**

Grind Valve Seats

⚠ WARNING

Valve seat grinding should only be done by experienced personnel familiar with equipment and capable of maintaining required specifications. ALWAYS keep work area clean when grinding valve seats. Be sure valve guide bores are clean before grinding valve seats.

If valve seats need grinding, only a few seconds are required to recondition the average valve seat.

Avoid the tendency to grind off too much. Do not use excessive pressure on the grinding stone.

Check the seat width and contact pattern between the seat and valve with bluing.

Seat width **MUST BE** maintained within specification.

Use a vernier caliper or scale to measure seat width.

Thoroughly clean seat area after grinding and replace valves and valve seat inserts as necessary.

NOTE: Valve seat width can be reduced with a narrowing stone. This will change the angle at the top of the seat and increase the diameter. If valve seat width is too narrow, valve may burn or erode. Varying the width changes the fine contact between valve face and seat.

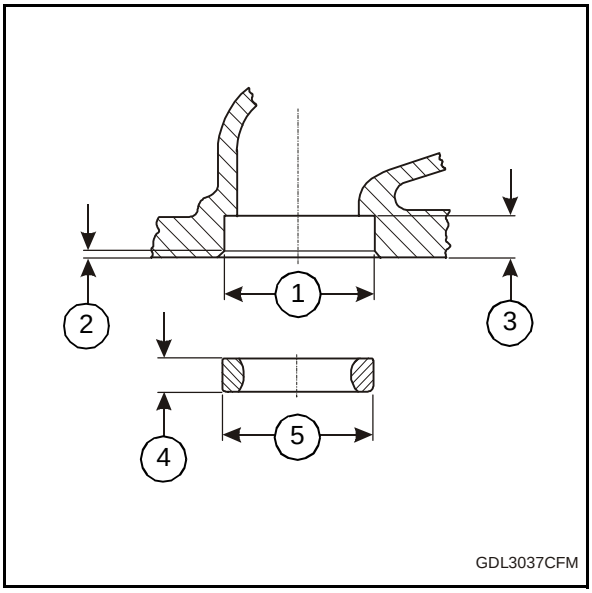
Grind valve seats to specification. **(See "Measure Valve Seats" on page 158).**

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Replace Valve Seat Inserts

⚠ CAUTION

The lower edge of valve seat must not contact bottom of bore in cylinder head or premature valve and valve seat failure will occur. Removal and installation of valve seats and valve seat grinding should only be done by experienced personnel familiar with equipment and capable of maintaining required specifications.



1. ID of Cylinder Head Bore for Valve Seat Insert.
2. Distance from Cylinder Head Surface-to-Valve Seat.
3. Depth of Valve Seat Bore in Cylinder Head.
4. Height of Valve Seat Insert.
5. Valve Seat Insert OD.

Install valve seat inserts using the following specifications:

Valve Seat Specification

Mating Surface of Head-to-Valve Seat Intake Valve Seat Insert Distance
- - - - - - - - - - - - - 3.10 - 3.40 mm (0.1220 - 0.1339 in.)

Mating Surface of Head-to-Valve Seat Exhaust Valve Seat Insert Distance
- - - - - - - - - - - - - 2.80 - 3.10 mm (0.1102 - 0.1220 in.)

Bore in Cylinder Head Intake and Exhaust Valve Seat Insert Standard Depth
- - - - - - - - - - - - 10.90 - 11.10 mm (0.4291 - 0.4370 in.)

Bore in Cylinder Head Intake and Exhaust Valve Seat Insert 0.20 mm (0.007 in.) Oversize Depth
- - - - - - - - - - - - 11.10 - 11.30 mm (0.4370 - 0.4449 in.)

Bore in Cylinder Head Intake and Exhaust Valve Seat Insert 0.40 mm (0.015 in.) Oversize Depth
- - - - - - - - - - - - 11.30 - 11.50 mm (0.4449 - 0.4526 in.)

Valve Seat Insert Intake Valve Seat Insert Standard Height- - - - - - - - - 7.70 - 7.80 mm (0.3031 - 0.3071 in.)

Valve Seat Insert Intake Valve Seat Insert 0.20 mm (0.007 in.) Oversize Height
- - - - - - - - - - - - - 7.90 - 8.00 mm (0.3110 - 0.3150 in.)

Valve Seat Insert Intake Valve Seat Insert 0.40 mm (0.015 in.) Oversize Height
- - - - - - - - - - - - - 8.10 - 8.20 mm (0.3189 - 0.3228 in.)

Valve Seat Insert Exhaust Valve Seat Insert Standard Height- - - - - - - - 8.00 - 8.10 mm (0.3150 - 0.3189 in.)

Valve Seat Insert Exhaust Valve Seat Insert 0.20 mm (0.007 in.) Oversize Height
- - - - - - - - - - - - - 8.20 - 8.30 mm (0.3228 - 0.3268 in.)

Valve Seat Insert Exhaust Valve Seat Insert 0.40 mm (0.015 in.) Oversize Height
- - - - - - - - - - - - - 8.40 - 8.50 mm (0.3307 - 0.3346 in.)

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Valve seat insert OD and cylinder head bore ID specifications are as follows:

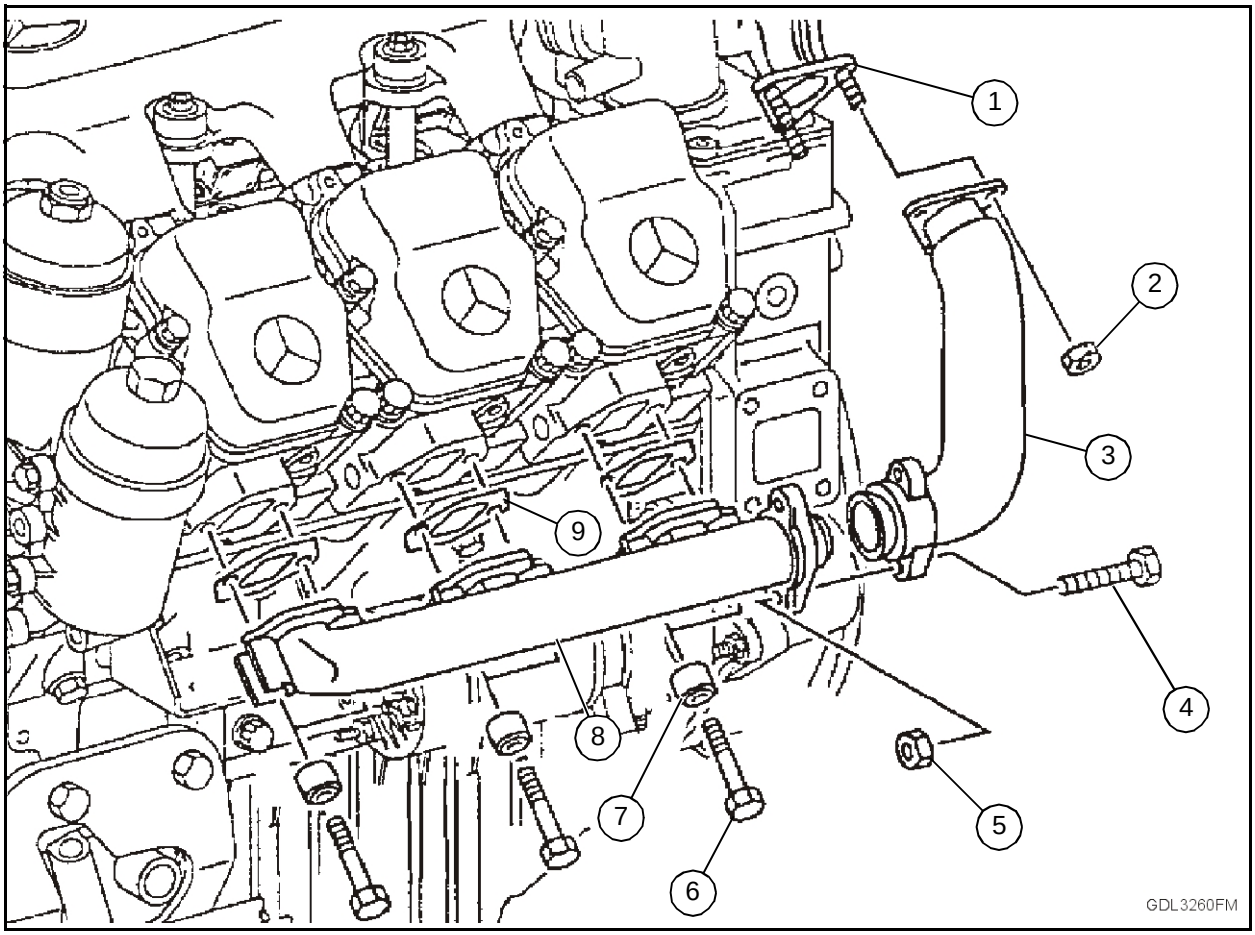
Valve Seat Specification	
Intake Valve Seat Insert Standard OD	47.38 - 47.39 mm (1.8653—1.8657 in.)
Intake Valve Seat Insert 0.2 mm (0.007 in.) OD	47.58 - 47.59 mm (1.8732 - 1.8736 in.)
Intake Valve Seat Insert 0.4 mm (0.015 in.) Oversize OD	47.78 - 47.79 mm (1.8811 - 1.8815 in.)
Exhaust Valve Seat Insert Standard OD	43.08 - 43.09 mm (1.6961 - 1.6965 in.)
Exhaust Valve Seat Insert 0.2 mm (0.007 in.) Oversize OD	43.28 - 43.29 mm (1.7039 - 1.7043 in.)
Exhaust Valve Seat Insert 0.4 mm (0.015 in.) Oversize OD	43.48 - 43.49 mm (1.7118 - 1.7122 in.)
Head Intake Valve Seat Bore Standard ID	47.300 - 47.325 mm (1.8622 - 1.8631 in.)
Head Intake Valve Seat Bore 0.2 mm (0.007 in.) Oversize ID	47.500 - 47.525 mm (1.8701 - 1.8711 in.)
Head Intake Valve Seat Bore 0.4 mm (0.015 in.) Oversize ID	47.700 - 47.725 mm (1.8780 - 1.8789 in.)
Head Exhaust Valve Seat Bore Standard ID	43.000 - 43.025 mm (1.6929 - 1.6939 in.)
Head Exhaust Valve Seat Bore 0.2 mm (0.007 in.) Oversize ID	43.200 - 43.225 mm (1.7008 - 1.7018 in.)
Head Exhaust Valve Seat Bore 0.4 mm (0.015 in.) Oversize ID	43.400 - 43.425 mm (1.7087 - 1.7096 in.)

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CHAPTER 4. ENGINE

SECTION 7. EXHAUST SYSTEM

REMOVE AND INSTALL EXHAUST MANIFOLD



1. Exhaust Plenum.
2. Nut (3 used).
3. Exhaust Elbow.
4. Cap Screw (2 used).
5. Nut (2 used).
6. Cap Screw (6 used).
7. Spacer (6 used).
8. Exhaust Manifold.
9. Gasket (3 used).

⚠ CAUTION

Prevent possible injury from hot exhaust pipes. Exhaust pipes can be hot enough to cause burns. Wait for exhaust pipes to cool before working on the machine.

NOTE:Right side shown. Procedure for the left side is the same.

Remove nuts (2) from exhaust plenum (1).

Remove cap screws (6) and spacers (7).

Remove exhaust manifold (8) and elbow (3) from engine.

Remove cap screws (7) and nuts (5) to remove elbow from manifold.

Install elbow to manifold and tighten Cap screws and nuts to specification.

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Remove and Install Exhaust Manifold Specification

Exhaust Manifold-to-Elbow Cap Screws and Nuts Torque - 50 Nm (37 lb-ft)

Install manifold to cylinder haeds and exhaust plenum using new gaskets (9). Tighten cap screws and nuts to specification.

Remove and Install Exhaust Manifold Specification

Exhaust Manifold-to-Cylinder Head Cap Screws Torque 50 Nm (37 lb-ft)

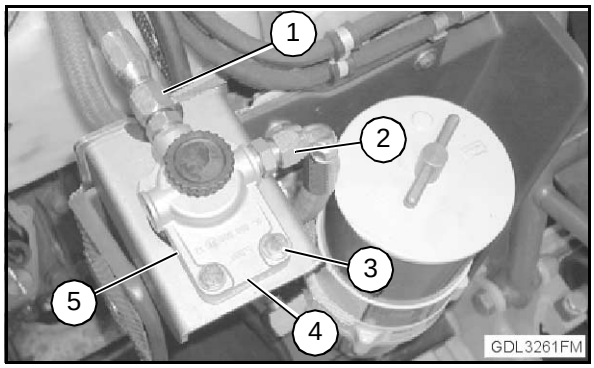
Exhaust Elbow-to-Exhaust Plenum Nuts Torque - 50 Nm (37 lb-ft)

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CHAPTER 4. ENGINE

SECTION 8. FUEL INJECTION SYSTEM

REMOVE AND INSTALL HAND PRIMER PUMP



Disconnect inlet line (1) and outlet line (2).

Remove cap screws, washers, and nuts (3).

Remove primer (5) and spacer (4).

Clean, repair, or replace parts as necessary. See Clean Fuel Screen. **(See Operator's Manual, CHAPTER 17, SECTION 1)**.

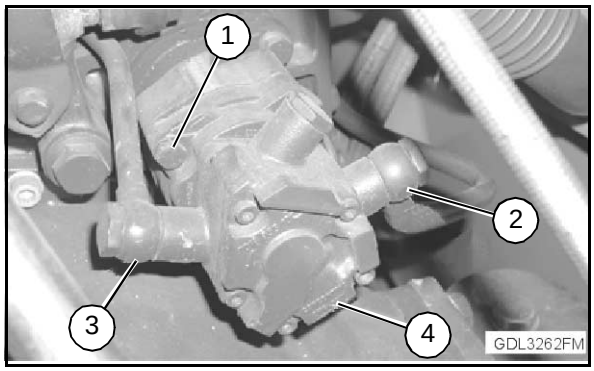
Install spacer, primer, cap screws, washers, and nuts.

Connect inlet line and outlet line.

Prime fuel system. See Prime Fuel System. **(See Operator's Manual, CHAPTER 17, SECTION 1)**.

REMOVE AND INSTALL FUEL SUPPLY PUMP

Raise cab. See Tilt Cab. **(See Operator's Manual CHAPTER 7, SECTION 1).**



Disconnect fuel inlet line (2) and fuel outlet line (3).

Remove cap screws (1) and fuel supply pump (4).

Install fuel supply pump and cap screws. Tighten cap screws to specification.

Fuel Supply Pump Specification

Mounting Cap Screw Torque - - - - - - - 60 Nm (44 lb-ft)

Connect fuel inlet line and fuel outlet line. Tighten banjo fittings to specification.

Fuel Supply Pump Specification

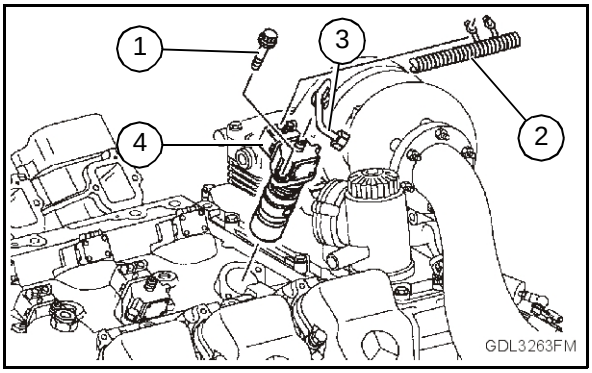
Banjo Fittings Torque - - - - - - - - - - - - 40 Nm (30 lb-ft)

Lower cab. See Tilt Cab. **(See Operator's Manual CHAPTER 7, SECTION 1).**

REMOVE AND INSTALL ELECTRONIC UNIT INJECTOR (EUI)

Turn battery disconnect switch to OFF.

Remove air intake manifold. **(See "REMOVE AND INSTALL AIR INTAKE MANIFOLD" on page 165).**



Disconnect engine harness from electronic unit injector (EUI).

Remove fuel line (3) from EUI and cylinder head.

NOTE: If EUI is difficult to remove, rotate engine in direction of rotation to press EUI out of crankcase.

Remove cap screws (1) and EUI (4).

Inspect EUI. Replace o-rings, if necessary.

Install EUI and cap screws.

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Electronic Unit Injector (EUI) Specification

Cap Screw Torque - - - - - - - - - - - - - - - 65 Nm (48 lb-ft)

Install fuel line to cylinder head and EUI.

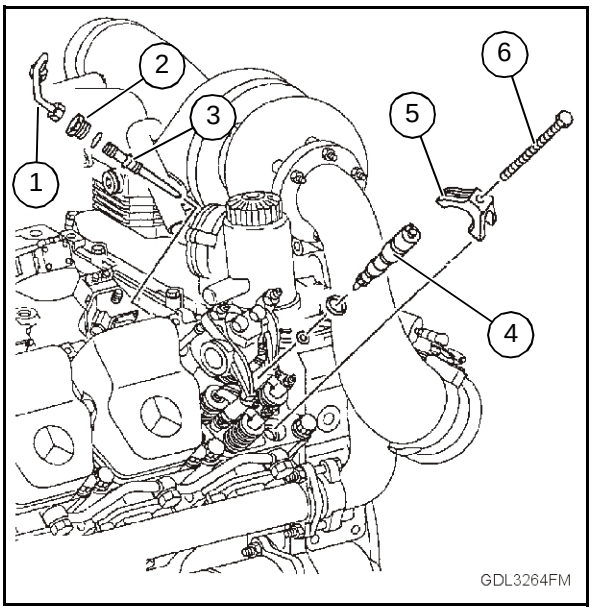
Connect engine harness to EUI.

Install air intake manifold. **(See "REMOVE AND INSTALL AIR INTAKE MANIFOLD" on page 165).**

REMOVE AND INSTALL FUEL DELIVERY NOZZLE

Remove valve cover. **(See "REMOVE AND INSTALL VALVE COVER" on page 150).**

Remove air intake manifold. **(See "REMOVE AND INSTALL AIR INTAKE MANIFOLD" on page 165).**



1. High Pressure Fuel Line.
2. Thrust Screw.
3. High Pressure Pipe.
4. Fuel Delivery Nozzle Retainer.
6. Cap Screw.

Disconnect high pressure fuel injection line (1) at high pressure pipe (3).

Loosen thrust screw (2) and remove high pressure pipe.

Remove cap screw (6) and fuel delivery nozzle retainer (5).

Connect injection nozzle puller to fuel delivery nozzle (4) with adapter.

Remove fuel delivery nozzle.

Install new O-ring on fuel delivery nozzle and high pressure pipe.

NOTE: Install fuel delivery nozzle, aligning tab with high pressure pipe installation location.

Install high pressure pipe loosely to ensure proper alignment of fuel delivery nozzle.

Install fuel delivery nozzle retainer and cap screw.

Tighten cap screw to specification

Fuel Delivery Nozzle Specification

Retainer Cap Screw Torque - - - - - - - - 50 Nm (37 lb-ft)

Retainer Cap Screw Shank Length
- - - - - - - - - - - - - - - - - - - -91.0 mm (3.58 in.) maximum

Tighten high pressure pipe thrust screw to specification.

High Pressure Pipe Specification

Thrust Screw 2Torque - - - - - - - - - - - - 40 Nm (30 lb-ft)

Connect high pressure fuel injection line. Tighten connector to specification.

High Pressure Fuel Injection Line Specification

Connector Torque - - - - - - - - - - - - - 25 Nm (221 lb-in.)

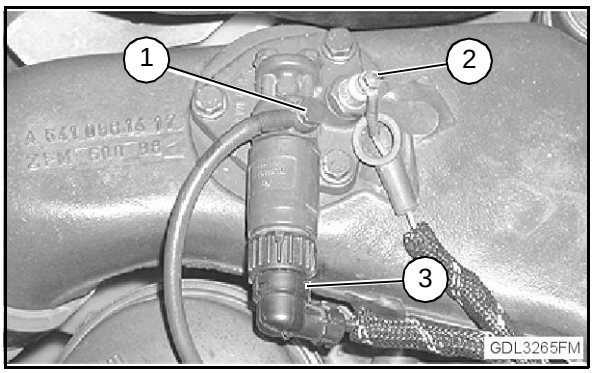
Install valve cover. **(See "REMOVE AND INSTALL VALVE COVER" on page 150).**

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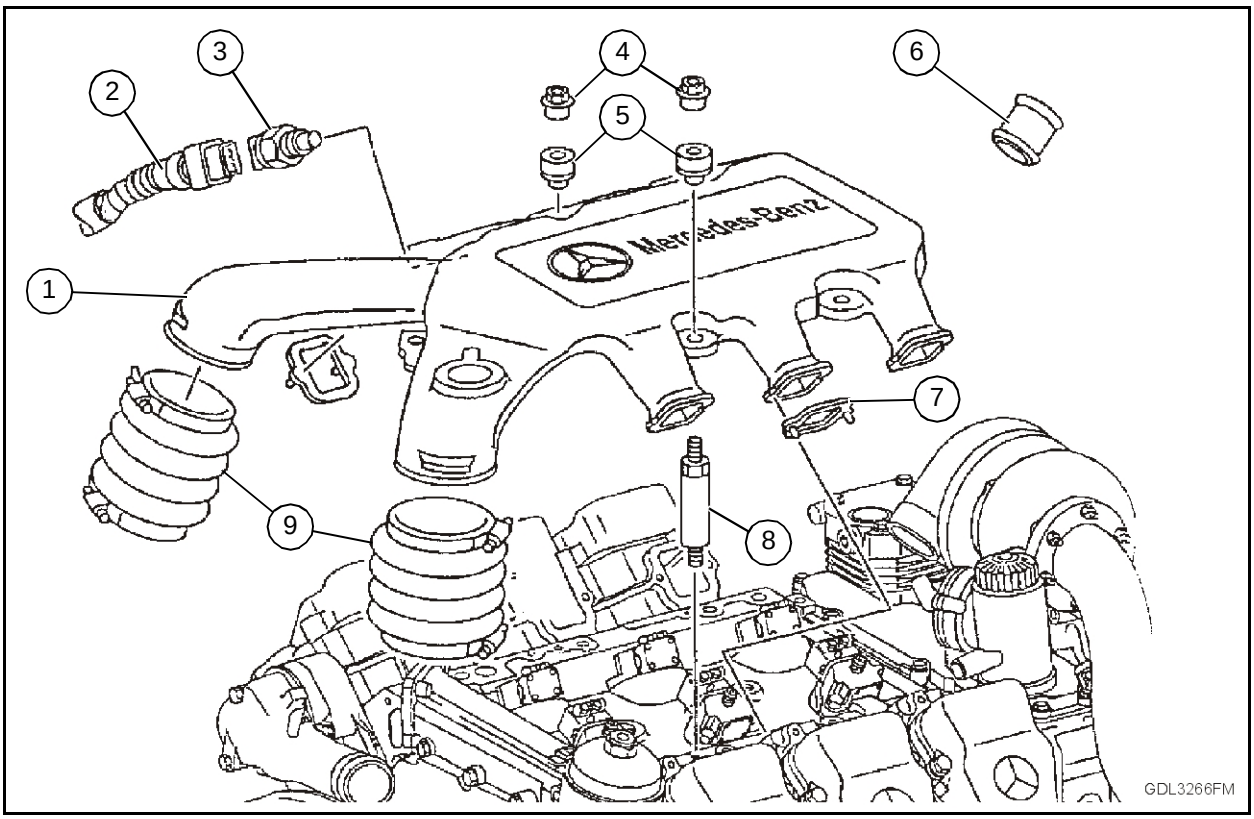
CHAPTER 4. ENGINE

SECTION 9. AIR INTAKE MANIFOLD SYSTEM

REMOVE AND INSTALL AIR INTAKE MANIFOLD



Disconnect fuel line (1) and wire connectors (2 and 3).



1. Intake Manifold.
2. Wire Connector.
3. Intake Manifold Air Pressure/Temperature Sensor.
4. Nut (5 used).
5. Isolator (5 used).
6. Adapter Tube.
7. Gasket (6 used).
8. Stud (5 used).
9. Charge Air Hoses.

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Disconnect wire connector (2) from intake manifold air pressure/temperature sensor (3).

Disconnect charge air hoses (9) from intake manifold (1).

Remove nuts (4) and isolators (5).

Remove studs (8) from engine block.

Lift off manifold and disconnect tube (6) from turbocharger.

Install new gaskets (7) onto cylinder heads.

Lower manifold into place, inserting tube (6) into turbocharger and making sure gaskets remain on cylinder heads.

Install studs (8) into block and tighten to specification.

Remove and Install Air Intake Manifold Specification

Intake Manifold Studs Torque - - - - - - - 40 Nm (30 lb-ft)

Install isolators (5), and nuts (4).

Tighten nuts to specification.

Remove and Install Air Intake Manifold Specification

Manifold Retaining Nuts Torque - - - - - 40 Nm (30 lb-ft)

Connect boots (9) and wire connector (2).

Connect fuel line and wire connector to start aid solenoid.

Connect wire to glow plug.

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CHAPTER 4. ENGINE

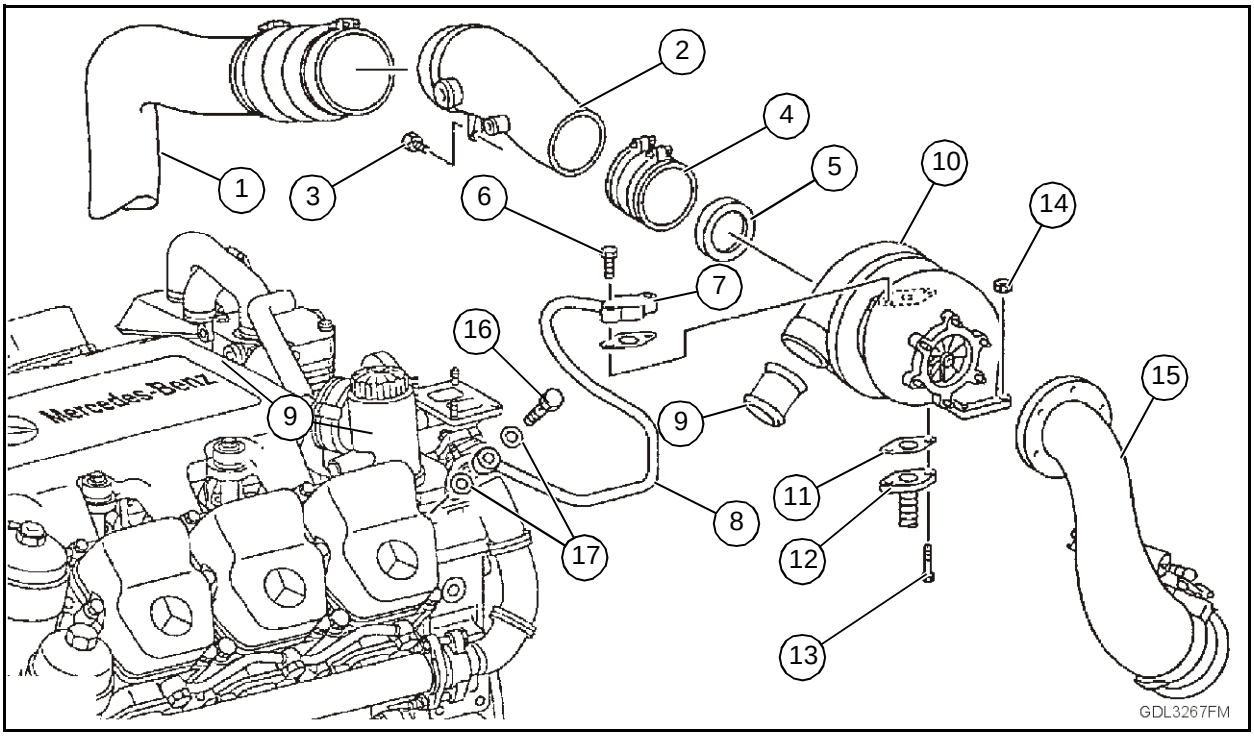
SECTION 10. TURBOCHARGER

TURBOCHARGER

Remove and Install Turbocharger

⚠ CAUTION

Prevent possible injury from hot exhaust pipes and turbocharger. Exhaust pipes and turbocharger can be hot enough to cause burns. Wait for exhaust pipes and turbocharger to cool before working on the machine.



1. Intake Pipe.
2. Adapter Pipe.
3. Cap Screw.
4. Boot.
5. Compensating Ring.
6. Cap Screw (2 used).
7. Gasket.
8. Oil Delivery Pipe.
9. Adapter Tube.
10. Turbocharger.
11. Gasket.
12. Oil Return Pipe.
13. Cap Screw (2 used).
14. Nut (4 used).
15. Exhaust Flap Connector Pipe.
16. Banjo Bolt.
17. Sealing Washer (2 used).

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Disconnect boot (4) and connector pipe (15) from turbocharger (10).

Disconnect oil return line (12).

Remove oil delivery pipe (8).

Remove nuts (14) and remove turbocharger.

Install turbocharger on exhaust plenum and secure with nuts (14).

Tighten to specification.

Remove and Install Turbocharger Specification

Turbocharger Mounting Nuts Torque
- 50 Nm (37 lb-ft)

Using new gaskets (7 and 11) and sealing washers (17) install oil delivery and return pipes.

Tighten hardware to specification.

Remove and Install Turbocharger Specification

Oil Delivery and Return Lines Cap Screws Torque
- 25 Nm (221 lb-in.)

Oil Delivery Line Banjo Bolt Torque
- 35 Nm (26 lb-ft)

Connect boot (4) and pipe (15).

Turbocharger Lubrication

⚠ CAUTION

Never spin the turbocharger turbine and compressor with compressed air. Damage to the turbine shaft and bearings can occur because there is no lubrication to the bearings.



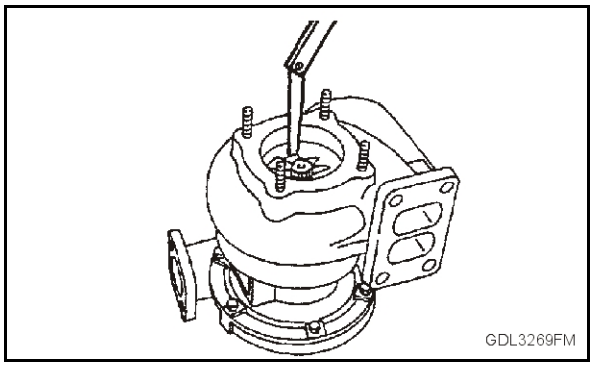
Fill oil return (drain) port with clean engine oil.

Turn the compressor and turbine by hand to properly lubricate turbine shaft and bearings.

If turbocharger is to be stored for an extended period of time, lubricate internally and install protective covers on all openings.

Radial Bearing Clearance Check

NOTE:1. This test will give an indication of the condition of the radial bearings within the center housing and rotating assembly.
2. Radial clearance is determined only at the turbine end of turbocharger.



Press turbine wheel to the side. Measure the gap between the turbine wheel and housing using a feeler gauge.

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Press wheel in the opposite direction and measure gap again.

The difference between the first and second measurement is the radial clearance.

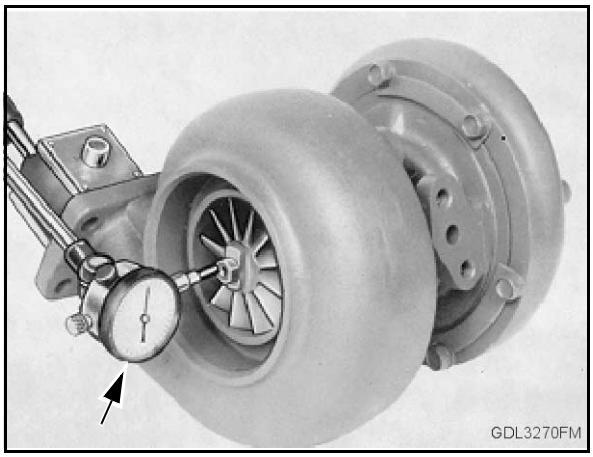
Specification

KKK Turbocharger Shaft Radial Bearing Clearance
- 0.45 mm (0.018 in.)

Perform measurements in at least two places. If clearance is not within specification, install a new turbocharger.

Axial Bearing End Play Check

This test will give an indication of the condition of the thrust bearing within the center housing and rotating assembly.



Mount magnetic base dial indicator (arrow) so that indicator tip rests on flat surface on turbine end of shaft. Preload indicator tip and zero dial on indicator.

Move shaft axially back and forth by hand.

Observe and record total dial indicator movement.

Specification

KKK Turbocharger Shaft Axial Bearing End Play
- 0.16 mm (0.006 in.)

T45 Turbocharger Shaft Axial Bearing End Play
- - - - - - - - - - - - - - - 0.025 - 0.090 mm (0.001 - 0.004 in.)

If axial bearing end play is not within specification, install a replacement turbocharger.

Turbocharger Seven-Step Inspection

The following inspection procedure is recommended for systematic failure analysis of a suspected failed turbocharger. This procedure will help to identify when a turbocharger has failed, and why it has failed so the primary cause of the failure can be corrected.

Proper diagnosis of a non-failed turbocharger is important for two reasons. First, identification of a non-failed turbocharger will lead to further investigation and repair of the cause of a performance complaint.

Second, proper diagnosis eliminates the unnecessary expense incurred when a non-failed turbocharger is replaced.

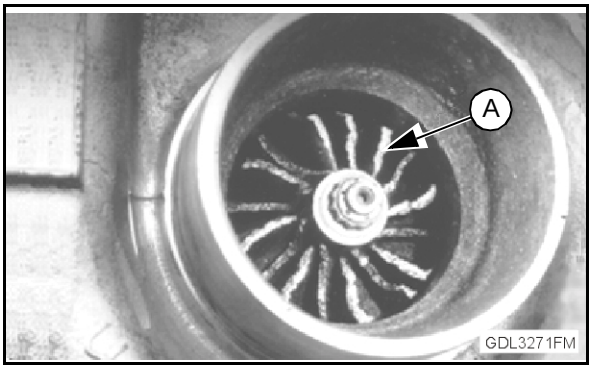
The seven recommended inspection steps, which are explained in detail on following pages, are:

- Compressor Housing Inlet and Compressor Wheel.
- Compressor Housing Outlet.
- Turbine Housing Inlet.
- Turbine Housing Outlet and Turbine Wheel.
- External Center Housing and Joints.
- Internal Center Housing.
- Turbocharger Bench Test.

NOTE: 1. To enhance the turbocharger inspection, an inspection sheet (Form No. DF-2280 available from Distribution Service Center - English only) can be used that lists the inspection steps in the proper order and shows potential failure modes for each step.
2. Check off each step as you complete the inspection and record any details or problems obtained during inspection.
3. Retain this with the work order for future reference.

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Compressor Housing Inlet and Compressor Wheel

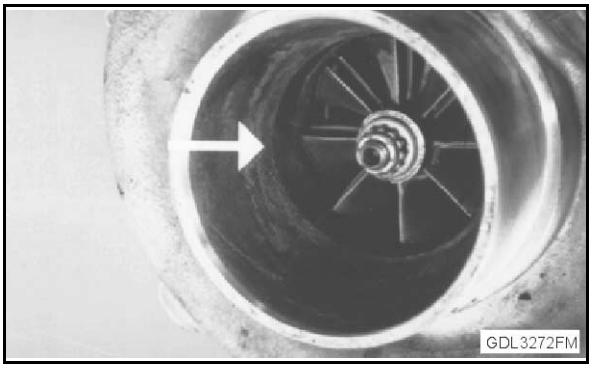


Check compressor inlet and compressor wheel (A) for foreign object damage.

NOTE: Foreign object damage may be extensive or minor. In either case, the source of the foreign object must be found and corrected to eliminate further damage.

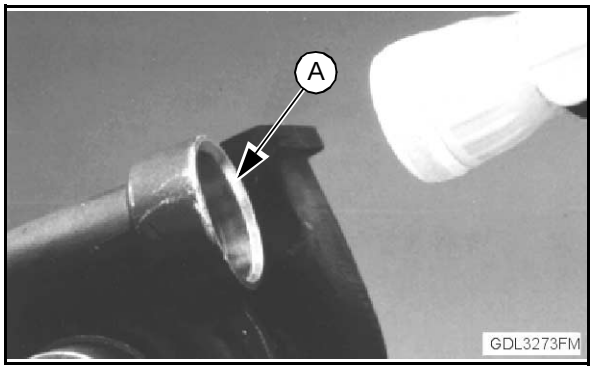
Mark findings on your checklist and continue the inspection.

NOTE: You will need a good light source for this check.



Check compressor inlet for wheel rub on the housing (arrow). Look very closely for any score marks on the housing itself and check the tips of the compressor wheel blades for damage.

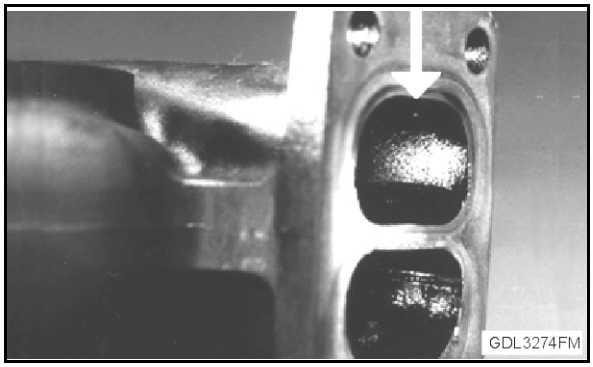
Compressor Housing Outlet



Check compressor housing outlet (A). The outlet should be clean and free of dirt or oil.

Mark it on your checklist if dirt or oil is found and continue the inspection.

Turbine Housing Inlet

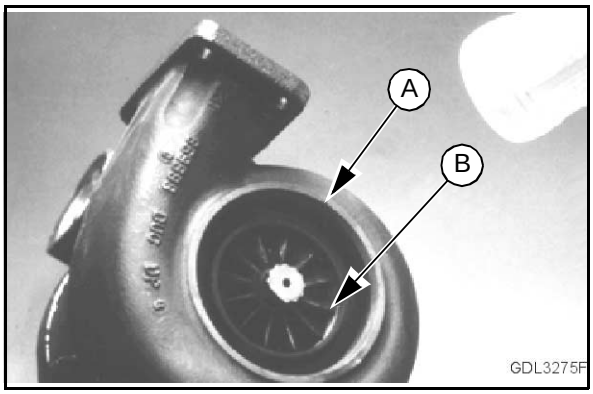


Check the turbine housing inlet ports (arrow) for oil in housing, excessive carbon deposit or erosion of center walls.

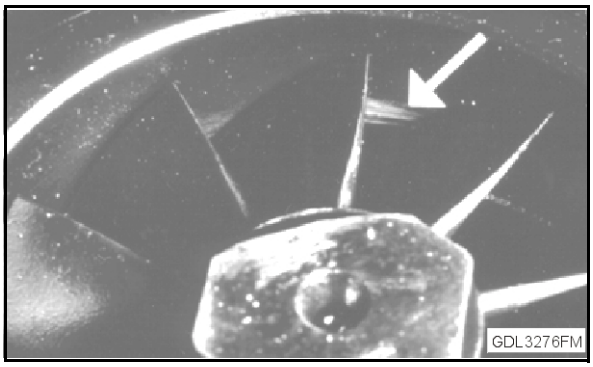
NOTE: If the inlet is wet with oil, or has excessive carbon deposits, an engine problem is likely. Center wall erosion (cracking or missing pieces), indicate excessive exhaust temperature.

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Turbine Housing Outlet and Turbine Wheel

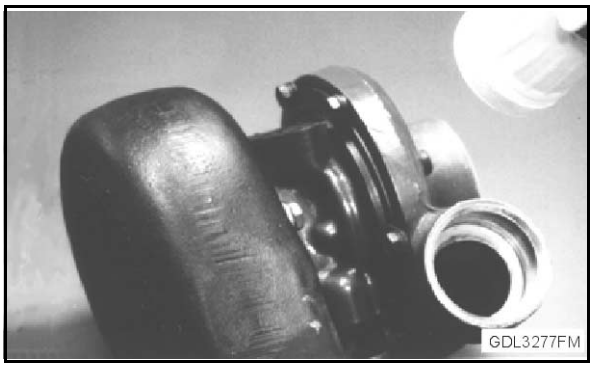


Use a flashlight to look up inside the turbine housing outlet (A) and check blades (B) for foreign object damage.



Inspect the wheel blades and housing for evidence of wheel rub (arrow). Wheel rub can bend the tips of the blades with the housing showing wear or damage.

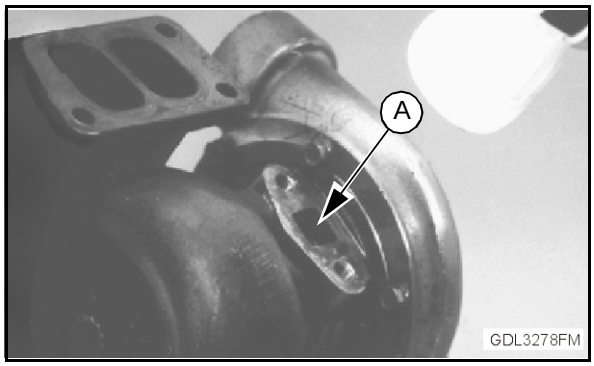
External Center Housing and Joints



Visually check the outside of the center housing, all connections to the compressor, and turbine housing for oil.

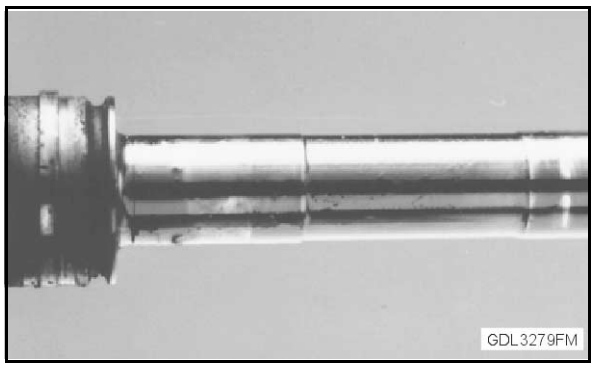
NOTE: If oil is present, make sure it is not coming from a leak at the oil supply or return line.

Internal Center Housing



Using a flashlight, look through the oil return hole (A), to check the condition of the shaft and/or bearings.

There should not be excess carbon deposits on the shaft or in the housing.

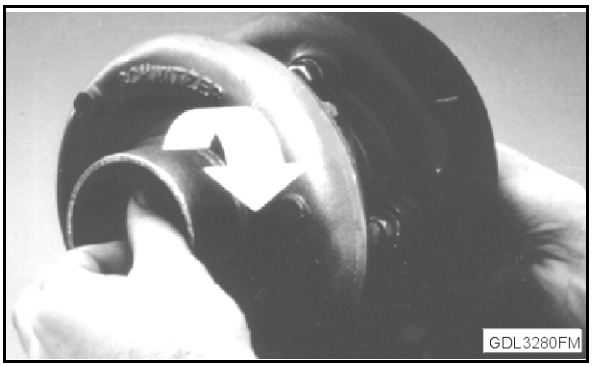


Excessive “**blueing**” or “**coking**” of oil along the complete length of the shaft indicates a possible lack of lubrication caused by an engine failure, or improper operation, such as hot shutdowns.

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Turbocharger Bench Test

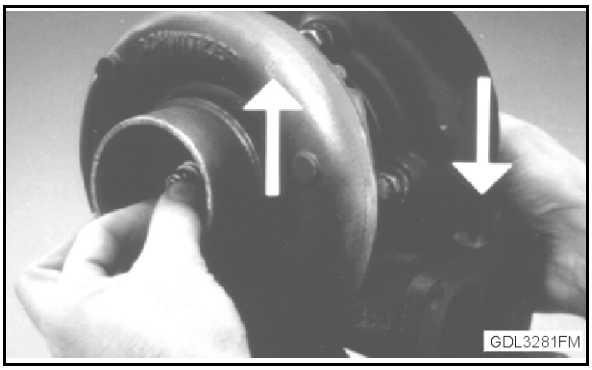
Mount the turbocharger in a vise.



Rotate the shaft, using both hands, to check rotation and clearance. The shaft should turn freely, however, there may be a slight amount of drag.

⚠ CAUTION

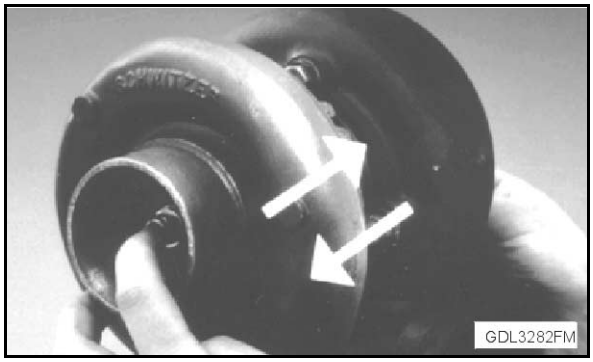
Use only moderate hand force of 0.7 - 0.9 N (3 - 4 lb-force) on each end of shaft.



Next, pull up on the compressor end of the shaft and press down on the turbine end while rotating shaft.

Neither the compressor wheel nor the turbine wheel should contact the housing at any point.

NOTE: There will be some “play” because the bearings inside the center housing are free floating.



Next, check shaft endplay by moving the shaft back and forth while rotating. There will be some endplay but not to the extent that the wheels contact the housings.

NOTE: These diagnostic procedures will allow you to determine the condition of the turbocharger. If the turbocharger has failed, analysis of your inspection notes should direct you to the specific areas of the engine to correct the problems causing the turbocharger failure. It is not unusual to find that a turbocharger has not failed. If your turbocharger passes all the inspections, the problem lies somewhere else.

⚠ WARNING

Before you finalize your conclusion that the turbocharger has not failed, it is strongly recommended that the following procedures of checking radial bearing clearance and axial bearing endplay with a dial indicator be performed. These procedures are not required if a failure mode has already been identified.

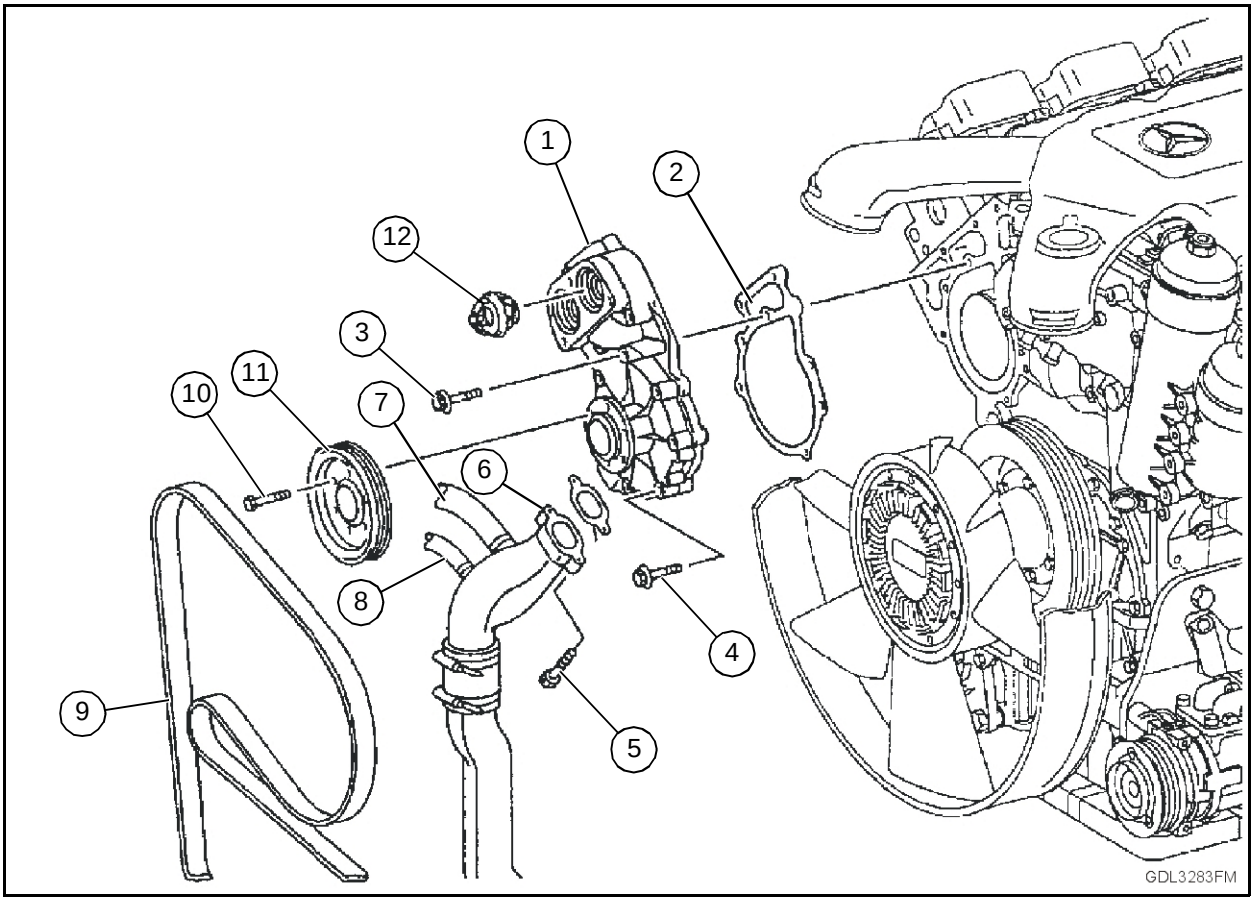
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CHAPTER 4. ENGINE

SECTION 11. COOLING SYSTEM

WATER PUMP

Remove and Install Water Pump



1. Water Pump.
2. Gasket.
3. Cap Screw (9 Used).
4. Gasket.
5. Cap Screw (2 used).
6. Adapter Pipe.
7. Fill Hose.
8. Heater Hose.
9. Belt.
10. Cap Screw (6 used).
11. Pulley.
12. Thermostat (2 used).

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Remove and Install Thermostats and Housing **(See "THERMOSTATS AND HOUSING" on page 179).**

Loosen belt (9) and remove from pulley (11).

Remove cap screws (5) and disconnect adapter pipe (6) from water pump (1).

Remove pulley (11).

Remove cap screws (3) and remove water pump.

Repair or replace as required.

Install water pump using a new gasket (2) and cap screws (3).

Tighten to specification.

Remove and Install Water Pump Specification

Water Pump Cap Screws Torque
- 25 Nm (221 lb-in.)

Install pulley (11).

Tighten cap screws to specification.

Remove and Install Water Pump Specification

Water Pump Pulley Cap Screws Torque
- 25 Nm (221 lb-in.)

Connect adapter pipe (6) with cap screws (5).

Tighten to specification.

Remove and Install Water Pump Specification

Adapter Pipe-to-Water Pump Cap Screws Torque
- 50 Nm (37 lb-ft)

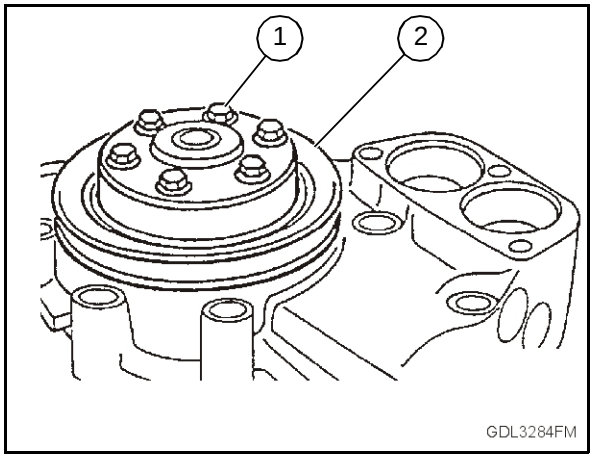
Install belt.

Install thermostat housing. **(See "Remove And Install Thermostats And Housing" on page 179)**

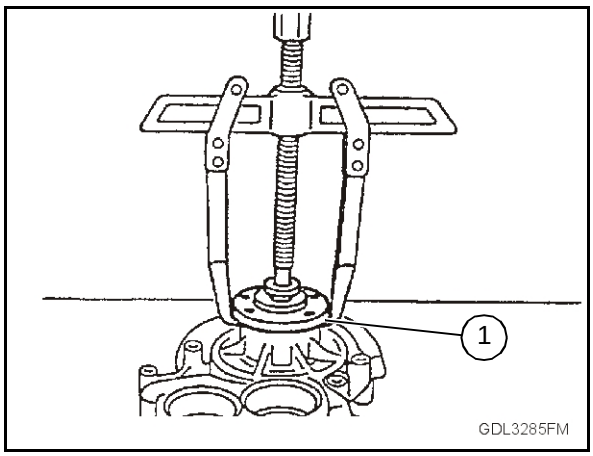
Disassemble and Assemble

Remove water pump from engine. **(See "WATER PUMP" on page 173).**

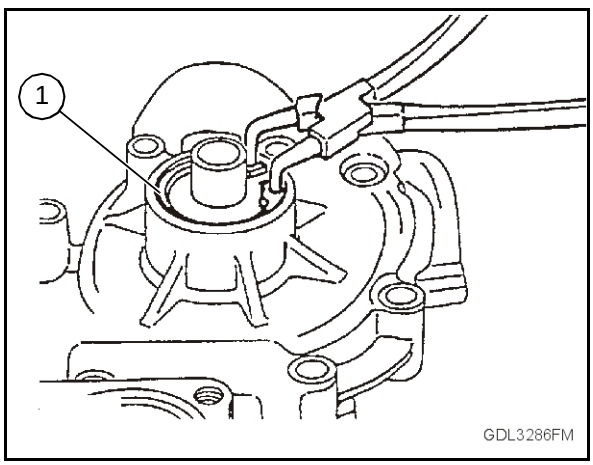
Remove thermostats and housing. **(See "Remove And Install Thermostats And Housing" on page 179).**



Remove cap screws (1) to remove water pump pulley (2).

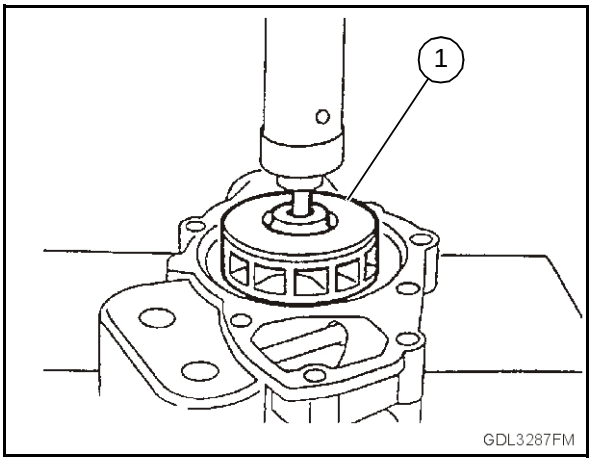


Remove water pump pulley hub (1) with a gear puller.

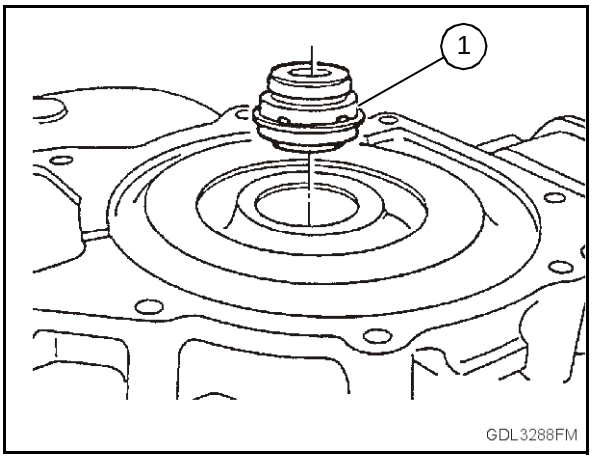


Remove snap ring (1) from front bore of water pump housing with snap ring pliers.

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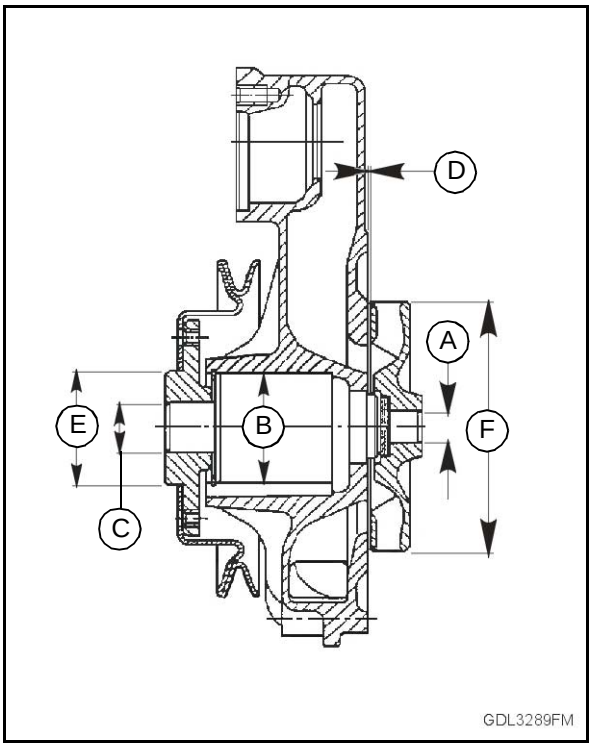
Support water pump housing and press water pump shaft through water pump impeller (1) until shaft and bearing are removed from impeller. Discard impeller, shaft and bearing.



Remove and discard ceramic seal (1).

Inspect water pump housing for cracks or damage. Inspect parts for wear or damage.

Measure water pump housing and parts. Measurements must be within specification.



A. Impeller Shaft OD and Impeller ID.
B. Bearing OD and Housing ID.
C. Hub Shaft OD and Hub ID.
D. Impeller-to-Housing Clearance.
E. Hub OD.
F. Impeller OD.

Water Pump Specification

Water Pump Impeller Shaft OD
- - - - - - - - - 15.045 - 15.056 mm (0.5923 - 0.5928 in.)

Water Pump Impeller ID
- - - - - - - - - 15.000 - 15.018 mm (0.5905 - 0.5913 in.)

Water Pump Bearing OD
- - - - - - - - - 54.981 - 54.994 mm (2.1646—2.1651 in.)

Water Pump Housing ID
- - - - - - - - - 54.940 - 54.970 mm (2.1630 - 2.1642 in.)

Water Pump Hub Shaft OD
- - - - - - - - - 25.048 - 25.061 mm (0.9861 - 0.9867 in.)

Water Pump Hub ID
- - - - - - - - - 25.000 - 25.021 mm (0.9842 - 0.9851 in.)

Water Pump Impeller-to-Housing Clearance
- - - - - - - - - - - - - - - - 0.6 - 1.0 mm (0.023 - 0.039 in.)

Water Pump Hub OD
- - - - - - - - - 55.940 - 55.970 mm (2.2024 - 2.2035 in.)

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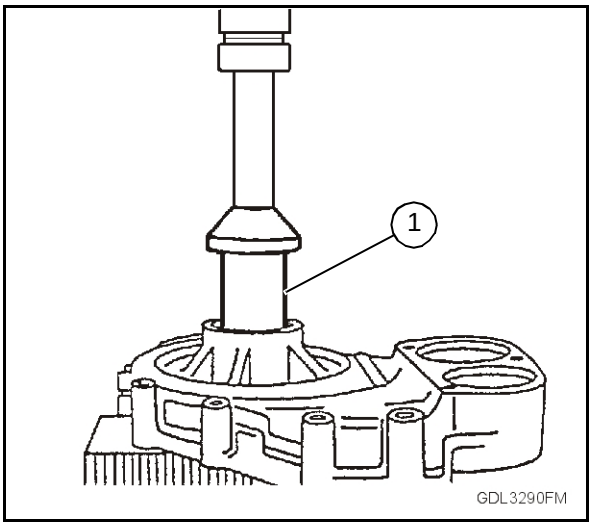
NOTE:Oil leakage indicates a damaged sealed bearing. Coolant leakage indicates a damaged housing seal.

Inspect weep holes for oil or coolant leakage.

Remove gasket material from housing and clean with suitable solvent. Dry thoroughly.

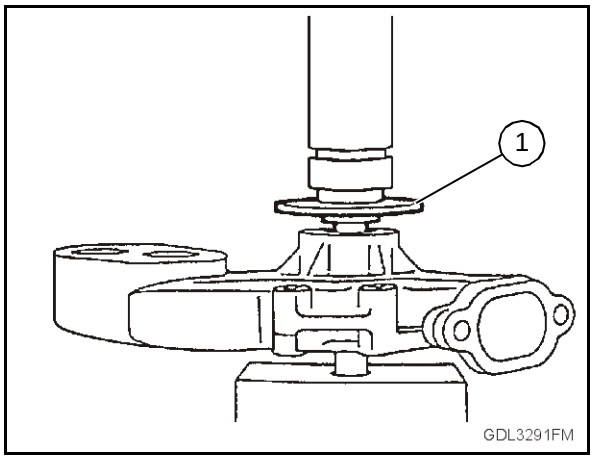
⚠ WARNING

DO NOT press against end of bearing shaft. Only press against outer race when installing bearing and shaft into housing.

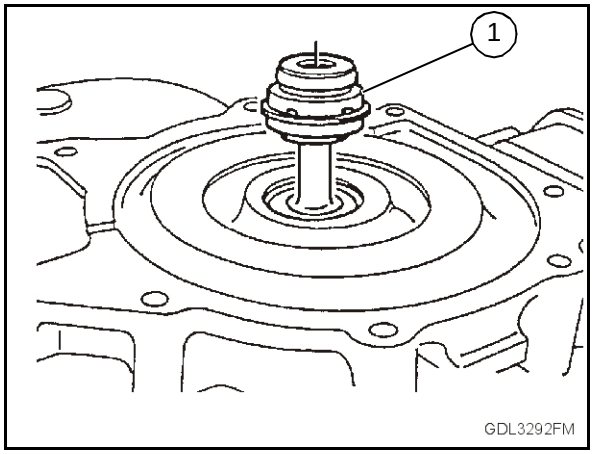


Install water pump shaft and bearing (1) into water pump housing using a bearing driver.

Install internal snap ring with snap ring pliers.

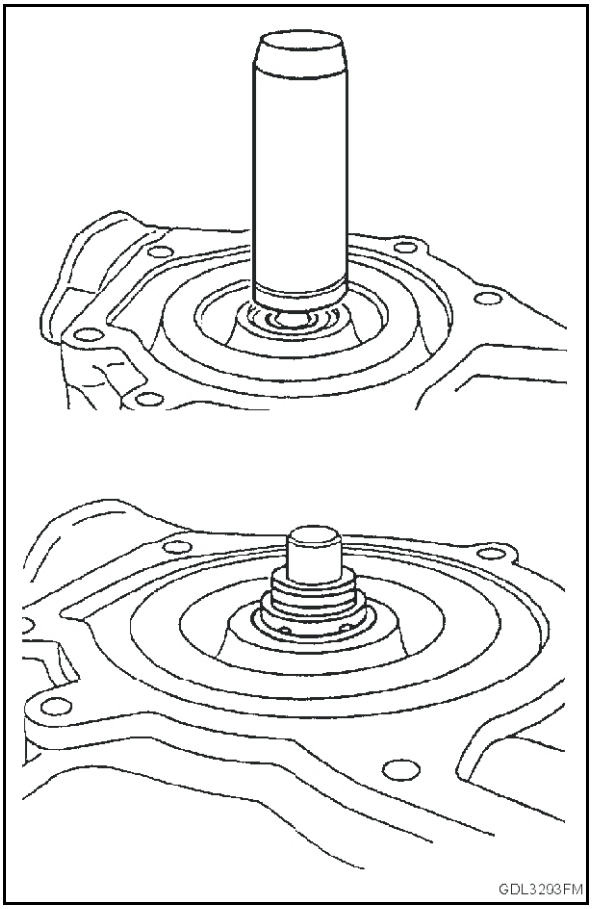


Heat water pump pulley hub (1) and install on shaft flush with the bearing.

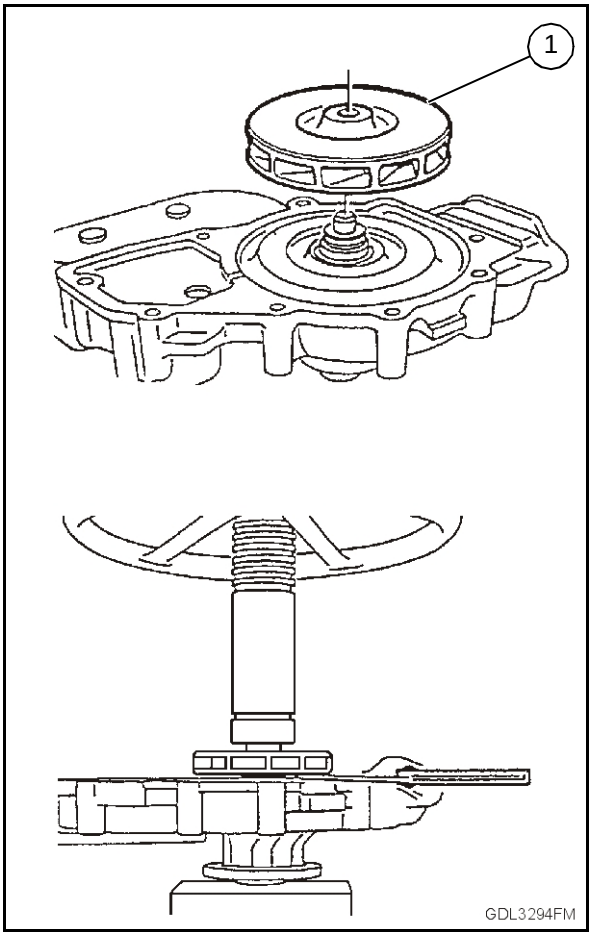


Put new ceramic seal (1) over the water pump shaft.

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Install dry ceramic seal onto water pump shaft and into water pump housing until firmly seated using a seal driver.



Support front of water pump housing and shaft.

Install water pump impeller (1) on shaft using a driver.

Push impeller on the shaft to the specify clearance.

Measure clearance using feeler gauge.

Water Pump Specification

Water Pump Impeller-to-Housing Clearance
- - - - - - - - - - - - - - - - - 0.6 - 1.0 mm (0.023 - 0.039 in.)

Turn water pump shaft to check that it turn freely with minimal resistance.

Install water pump pulley. Tighten cap screws to specification.

Specification

Water Pump Pulley Cap Screw Torque
- 25 Nm (221 lb-in.)

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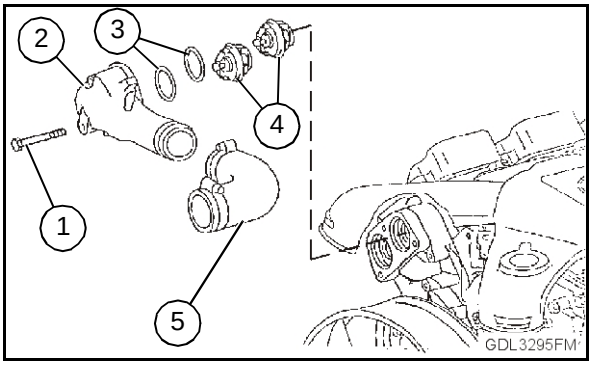
CHAPTER 4. ENGINE

SECTION 12. THERMOSTATS, HOUSING AND WATER PIPING

THERMOSTATS AND HOUSING

Remove And Install Thermostats And Housing

Drain coolant from engine. (**See Change Engine Coolant In Operator's Manual, CHAPTER 11, SECTION 2).**



Disconnect upper radiator hose (5) from thermostat housing (2).

Remove cap screws (1).

Remove thermostat housing, O-rings (3) and thermostats (4).

⚠ CAUTION

Bleed hole in thermostats must be to the top for cooling system to properly purge itself of all trapped air.

Install thermostats in thermostat housing so bleed hole is to the top.

Install new O-rings (4).

Install thermostat housing and cap screws. Tighten cap screws to specification.

Thermostat Housing Specification

Cap Screws Torque - - - - - - - - - - - - 25 Nm (221 lb-in).

Fill engine coolant. **(See Change Engine Coolant. in Operator's Manual, CHAPTER 11, SECTION 2).**

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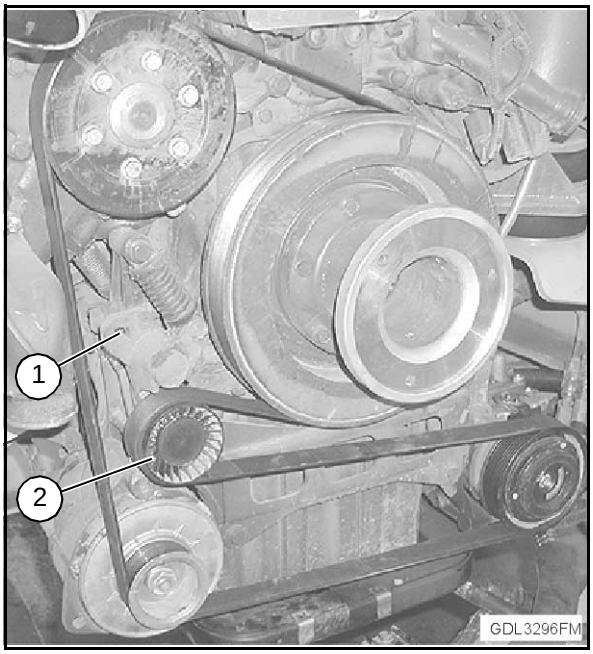
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CHAPTER 5. ENGINE AUXILIARY SYSTEM

SECTION 1. COOLING SYSTEM

FAN BELT

Remove and Install



Pry tensioner lever (1) counterclockwise. Remove belt from tensioner pulley (2). Remove belt from other pulleys.

NOTE: Belt must be moved between fan and fan shroud for removal and installation.

Remove belt from machine.

Install belt on machine. Ensure belt is correctly seated on all pulleys.

Pry tensioner lever counterclockwise and install belt tensioner pulley.

RADIATOR

Remove and Install Radiator

See "REMOVE AND INSTALL CHARGE AIR AFTERCOOLER" on page 183).

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CHAPTER 5. ENGINE AUXILIARY SYSTEM

SECTION 2. INTAKE SYSTEM

AIR INTAKE SYSTEM

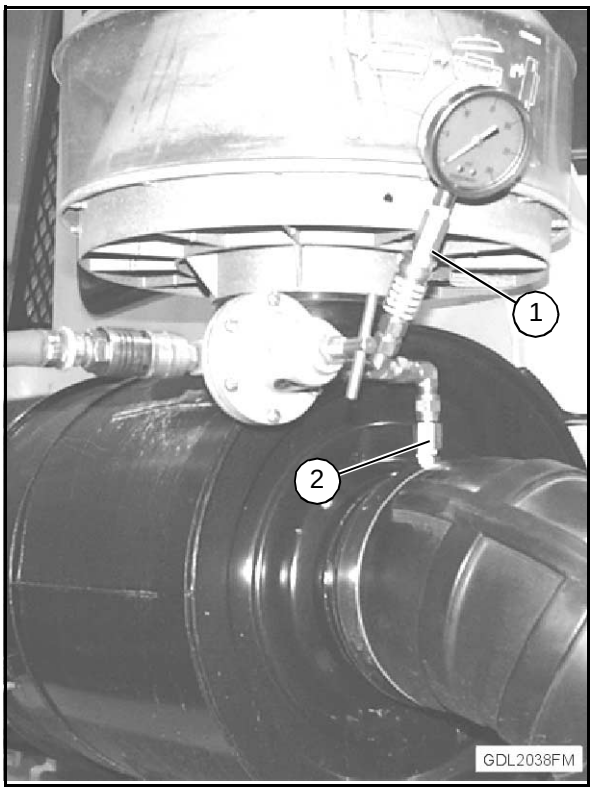
Leakage Check



Remove air cleaner cover. Remove primary air filter element.

Install large plastic bag on primary air filter element as shown.

Install primary air filter element. Install air cleaner cover.



Remove air restriction indicator. Connect air pressure regulator (1) to air cleaner using hose and fitting (2) from JDE147 Manifold Pressure Tester.

Pressurize air intake system to specifications. Turn engine slightly to close valves, if necessary.

Air Intake System Specification

Leakage Test Pressure 14 - 34.5 kPa (0.14 - 0.345 bar) (2 - 5 psi)

Spray a soap solution over all connections from the air cleaner to turbochargers. Check for air leaks.

Tighten clamps or replace parts as needed.

Remove test assembly. Install air restriction indicator.

Remove plastic bag from primary air filter element. Assemble air cleaner.

REMOVE AND INSTALL CHARGE AIR AFTERCOOLER

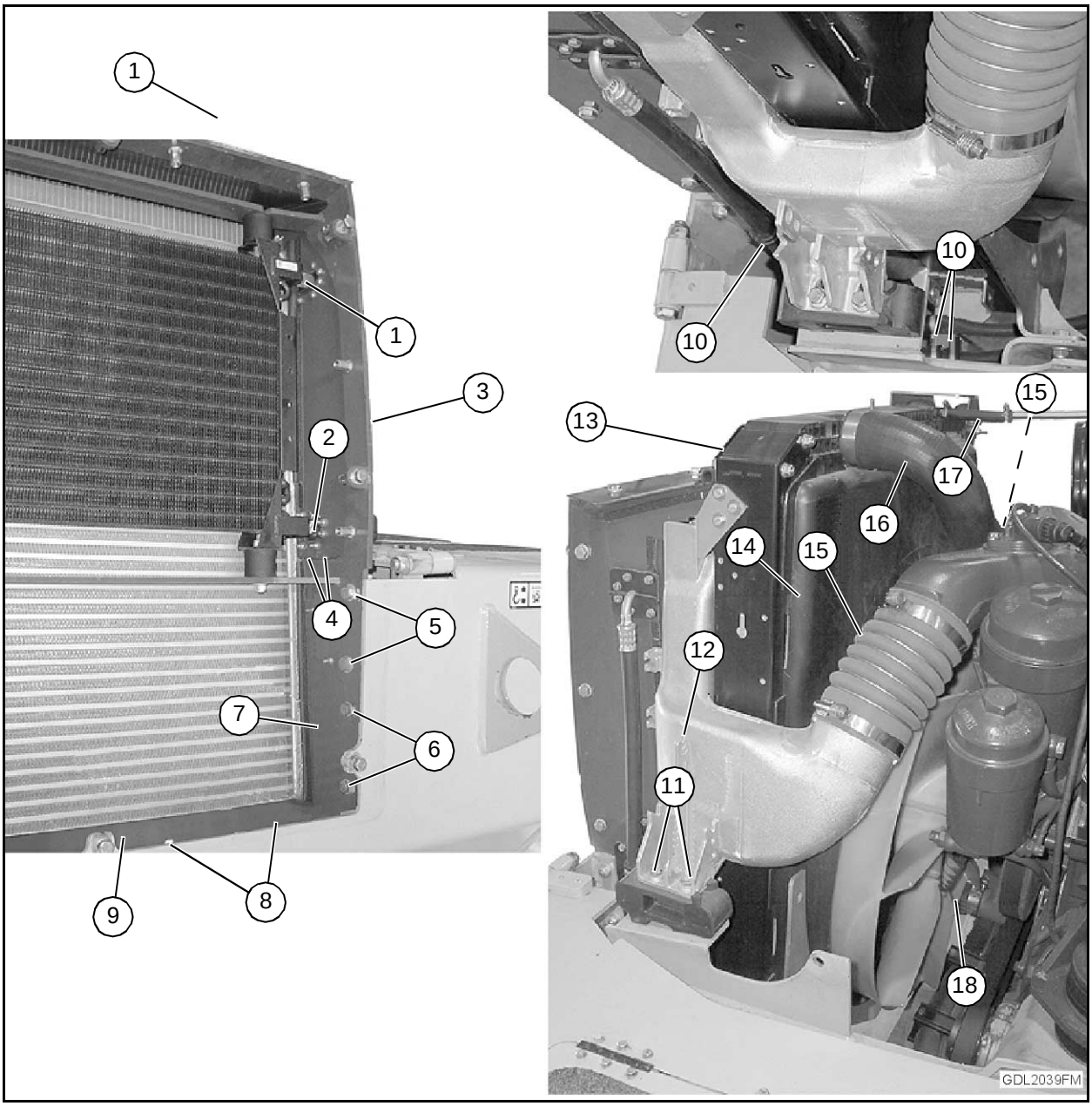
Remove bonnet **(See “Remove and Install Bonnet” on page 293).**

Remove grille.

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⚠ CAUTION

Component is heavy. Use hoist.



1. Condenser Inlet Line.
2. Condenser Outlet Line.
3. Condenser with Mounting Frame and Seal Plates.
4. Cap Screw and Nut (4 used).
5. Cap Screw (4 used).
6. Cap Screw (4 used).
7. Lower Seal Plate (2 used).
8. Cap Screw and Nut (4 used).
9. Bottom Seal Plate.
10. Condenser Line Bracket (5 used).
11. Cap Screw (4 used).
12. Aftercooler Lifting Flange (2 used).
13. Radiator.
14. Fan Shroud.
15. Charge Air Flexible Hose (2 used).
16. Radiator Upper Hose.
17. Radiator Overflow Hose.
18. Radiator Lower Hose.

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Disconnect condenser inlet line (1) and outlet line (2).

(See "Remove and Install Condenser" on page 287).

Remove and Install Charge Air Aftercooler Specification

Air Conditioning Condenser with Mounting Frame and Upper Seal Plates Weight - - - - - - - - - - - 18 kg (40 lb)

Remove cap screws and nuts (4). Remove cap screws (5).

Remove condenser with mounting frame and seal plates (3).

Remove cap screws (6 and 8). Remove bottom seal plate (9) and lower seal plates (7).

Remove brackets (10) and move inlet line and outlet line aside.

Drain radiator (13). See Change Engine Coolant (Operator's Manual, Section 3-9).

Disconnect charge air flexible hoses (15), radiator overflow hose (17), radiator upper hose (16), and radiator lower hose (18).

⚠ CAUTION

Component is heavy. Use hoist.

Remove and Install Charge Air Aftercooler Specification

Charge Air Aftercooler and Radiator Weight - 45 kg (100 lb)

Attach a hoist to aftercooler lifting flanges (12).

Remove cap screws (11). Remove aftercooler and radiator from machine.

Remove radiator from aftercooler. Remove fan shroud (14) from radiator.

Clean, inspect, repair, or replace parts as necessary.

Install fan shroud on radiator. Install radiator on aftercooler.

Install radiator and aftercooler in machine. Install cap screws.

Connect radiator lower hose, radiator upper hose, radiator overflow hose, and charge air flexible hoses.

Fill radiator. **(See Change Engine Coolant Operator's Manual, CHAPTER 11, SECTION 2).**

Install lower and bottom seal plates. Install cap screws.

Install condenser with mounting frame and seal plates. Install cap screws. Install cap screws and nuts.

Install brackets on inlet and outlet lines. Connect lines. **(See "Remove and Install Condenser" on page 287).**

Install grille.

Install hood. **(See "Remove and Install Bonnet" on page 293).**

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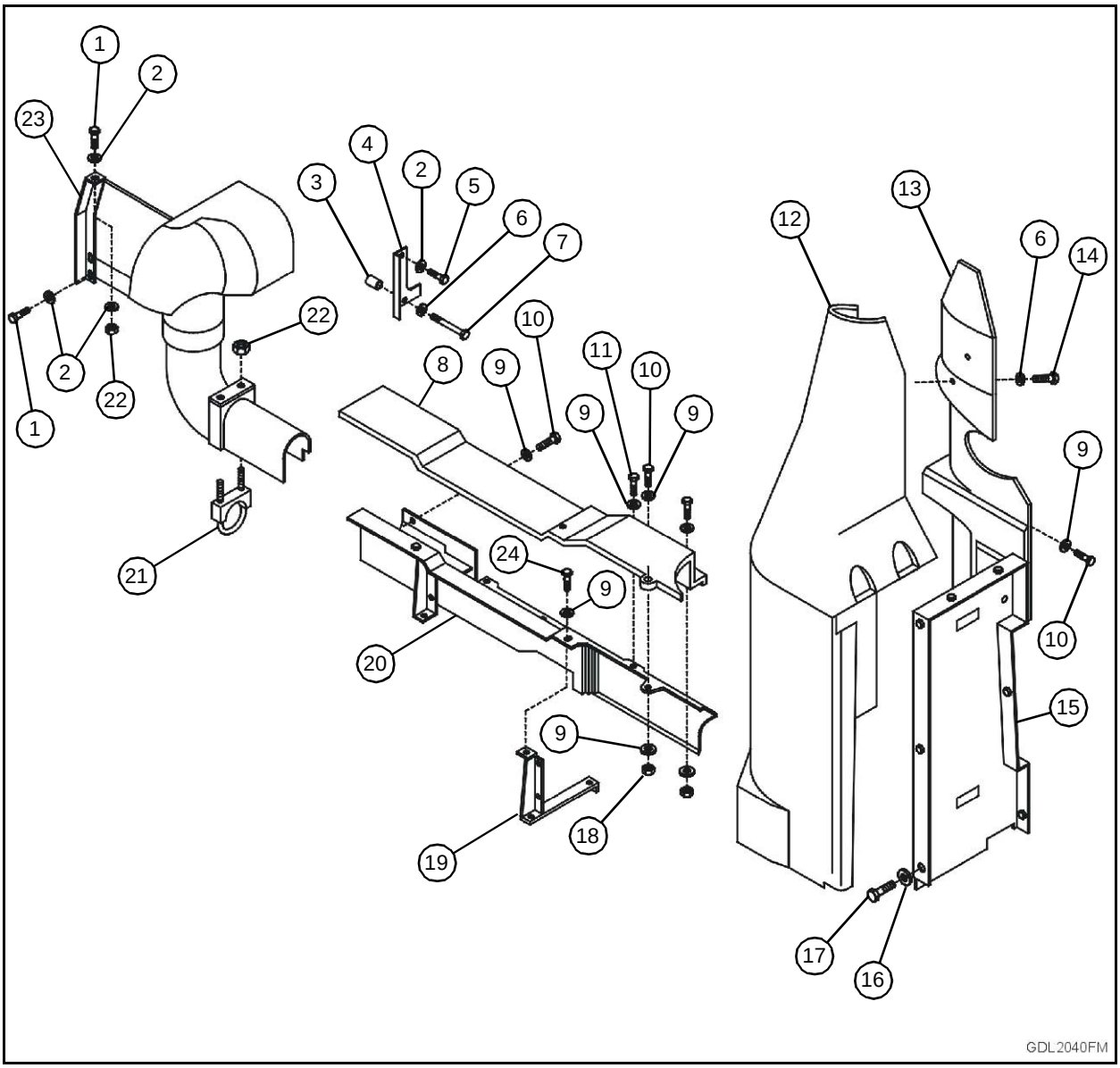
CHAPTER 5. ENGINE AUXILIARY SYSTEM

SECTION 3. EXTERNAL EXHAUST SYSTEM

SILENCER AND EXHAUST PIPES

Remove and Install Silencer and Exhaust Pipes

Tilt Cab **(See Operator's Manual, CHAPTER 7, SECTION 1).**

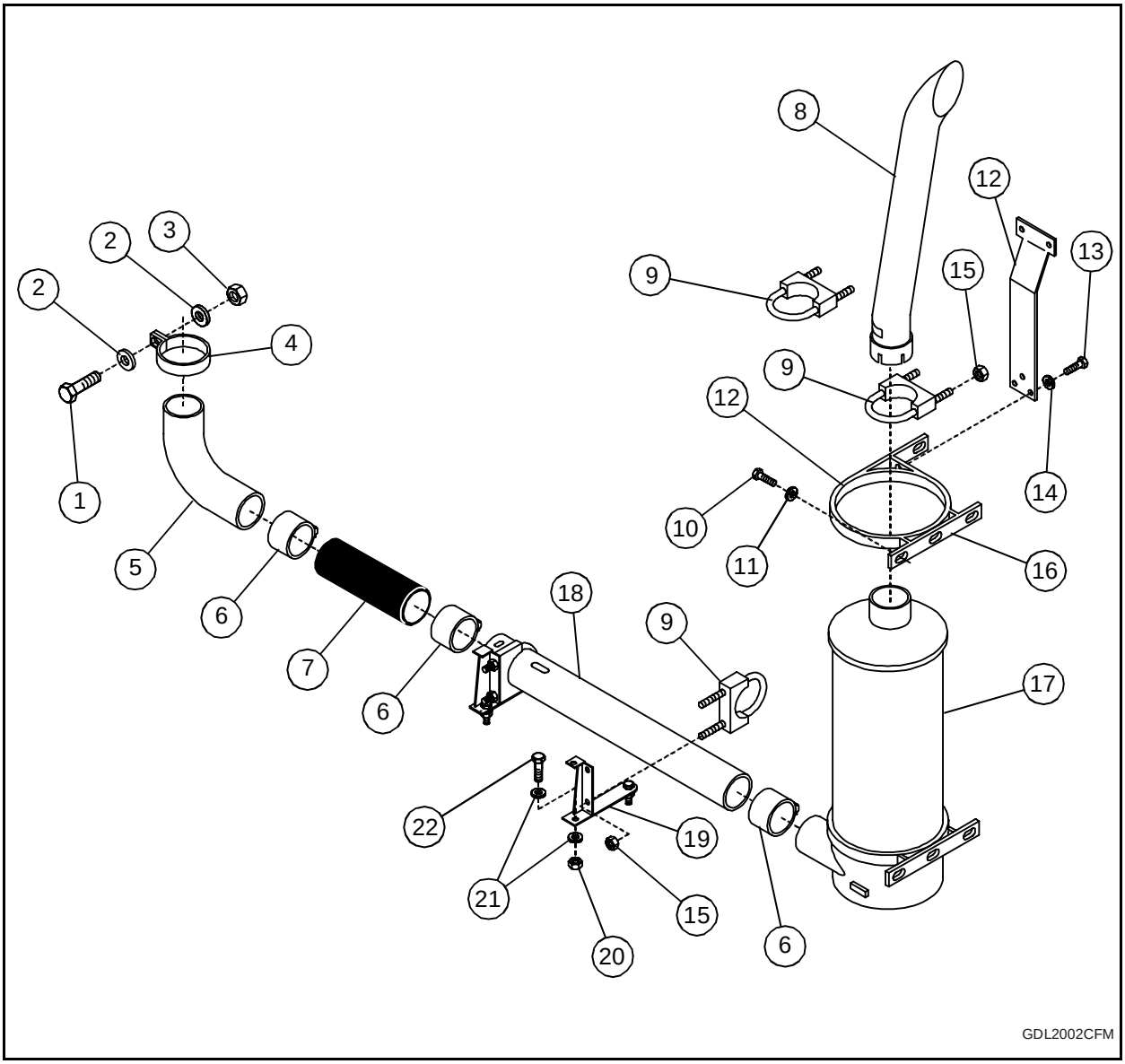


1. Cap Screw (7 used).
2. Washer (9 used).
3. Bushing (2 used).
4. Bracket.
5. Cap Screw.
6. Washer (5 used).
7. Cap Screw (2 used).
8. Shield.
9. Washer (19 used).
10. Cap Screw (7 used).
11. Cap Screw (4 used).
12. Shield.
13. Shield.
14. Cap Screw.
15. Shield.
16. Washer (8 used).
17. Cap Screw (8 used).
18. Nut (2 used).
19. Bracket (2 used).
20. Shield.

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21. Clamp.
22. Nut (11 used).
23. Bracket.
24. Cap Screw (2 used).

Remove parts (1 - 24) as necessary to access muffler and exhaust pipes.



1. Cap Screw.
2. Washer (5 used).
3. Nut.
4. Clamp.
5. Exhaust Manifold.
6. Clamp.
7. Flex Pipe.
8. Exhaust Stack.
9. Clamp (5 used).
10. Cap Screw (7 used).
11. Washer (2 used).
12. Bracket.
13. Cap Screw (2 used).
14. Washer (2 used).
15. Nut (11 used).
16. Mounting Band (2 used).
17. Muffler.
18. Pipe.
19. Bracket (2 used).
20. Nut (4 used).
21. Washer (4 used).
22. Cap Screw (4 used).

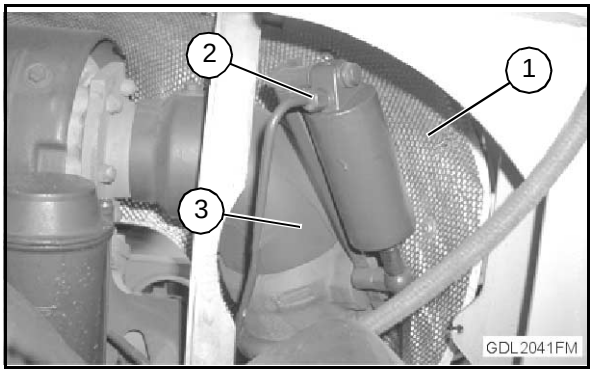
Repair or replace parts (1 - 22) as necessary.

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Remove and Install Exhaust Brake Valve Flapper

Relieve Pneumatic Pressure **(See Operator's Manual, CHAPTER 7, SECTION 1).**

Tilt Cab **(See Operator's Manual, CHAPTER 7, SECTION 1).**



Remove exhaust shield (1).

Disconnect air line (2).

Remove valve assembly (3) from machine. Cover turbocharger exhaust port.

Inspect and replace parts as necessary.

Install valve assembly on machine.

Connect air line.

Install exhaust shield.

Perform Exhaust Brake Adjustment **(See CHAPTER 2, SECTION 3 in Operation and Test Manual).**

Body Heater Pipes

Remove and Install

⚠ CAUTION

Prevent personal injury from unexpected machine movement. Always install the dump body prop and articulation safety lock bar before working with the body raised and in the articulation joint area.

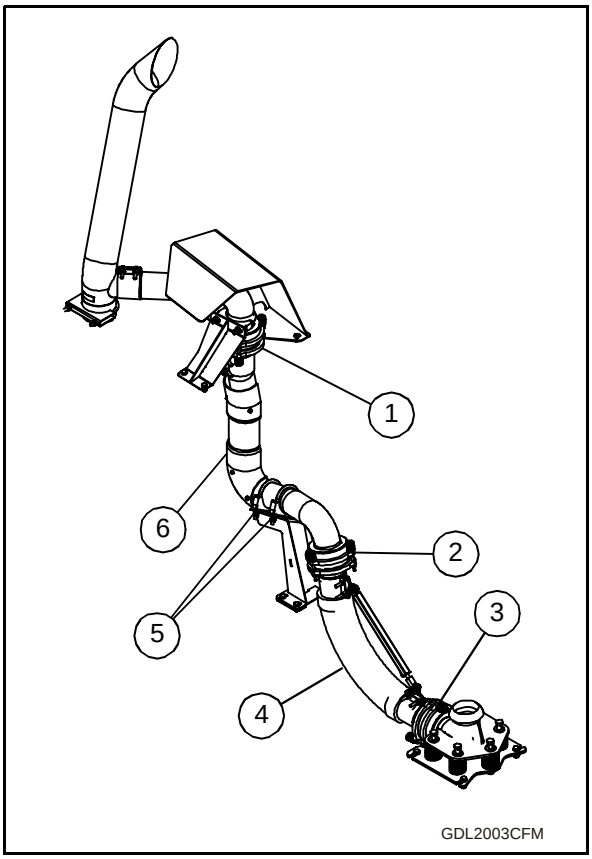
Install Articulation Safety Lock Bar **(Operator's Manual, CHAPTER 7, SECTION 1)**.

Install Dump Body Prop **(Operator's Manual, CHAPTER 7, SECTION 1)**.

⚠ WARNING

Exhaust pipes and muffler can be hot.

Allow the exhaust parts to cool before servicing.

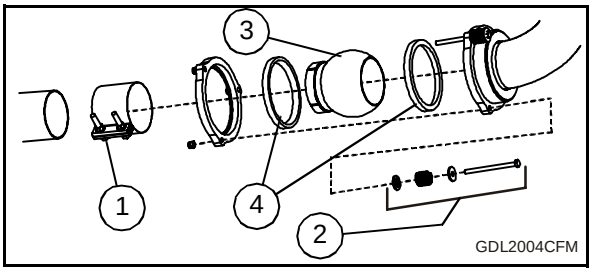


Remove swivel ball spring assembles (10) from swivel joints (2 and 3). Remove flexible exhaust tube (4).

Remove swivel ball spring assemblies from swivel joint (1). Remove U-bolts (5). Remove mid-section exhaust pipe (6).

Repair or replace parts as necessary.

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Tighten cap screws and nuts in all seal clamps (1).

Compress springs to specification.

Body Heater Pipes Specification

Swivel Joint Spring Compressing Length
- 43 mm (1.7 in.)

Adjust body heater exhaust collar, if necessary.

Install mid-section exhaust pipe. Install U-bolts. Install swivel ball spring assemblies (2).

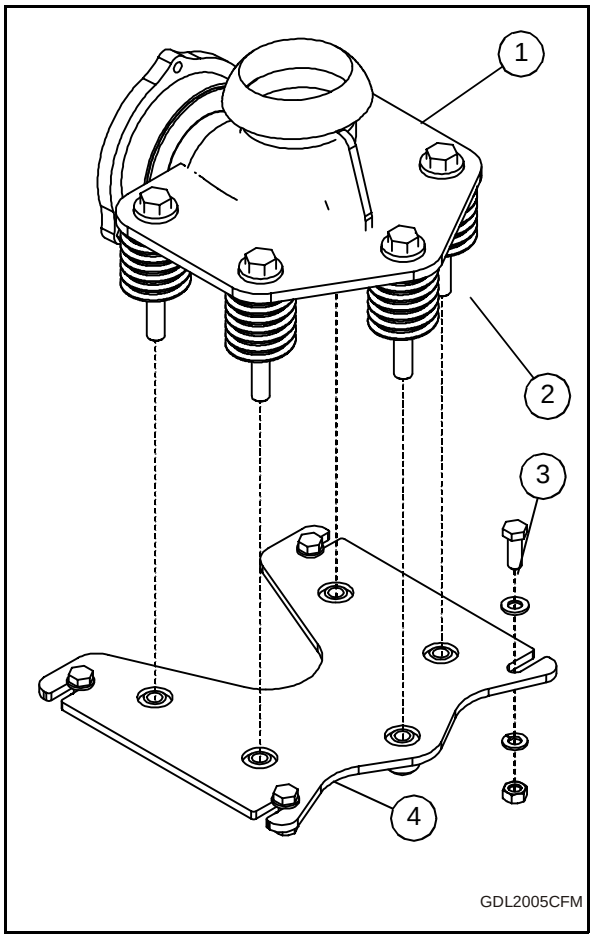
Install flexible exhaust tube.

Install swivel ball spring assemblies (2).

Tighten all swivel ball spring assemblies. Tighten only enough to compress springs. Ensure that swivel balls (3) turn freely against seal rings (4) when machine frames articulate and oscillate.

Adjust Body Heater Exhaust Collar

Remove flexible exhaust tube.



Tighten spring retaining cap screws (2).

Loosen mounting cap screws (3). Move exhaust collar so mounting plate (4) is centered on frame bracket holes.

Put hardwood blocks approximately 40 mm (1.6 in.) thick on each side of rear frame under front rubber dump body pads. Lower dump body onto blocks.

Check alignment and adjust position of exhaust collar, if necessary.

Remove hardwood blocks and float dump body down until at rest. Raise dump body and install dump body prop.

Tighten mounting cap screws.

Install flexible exhaust tube.

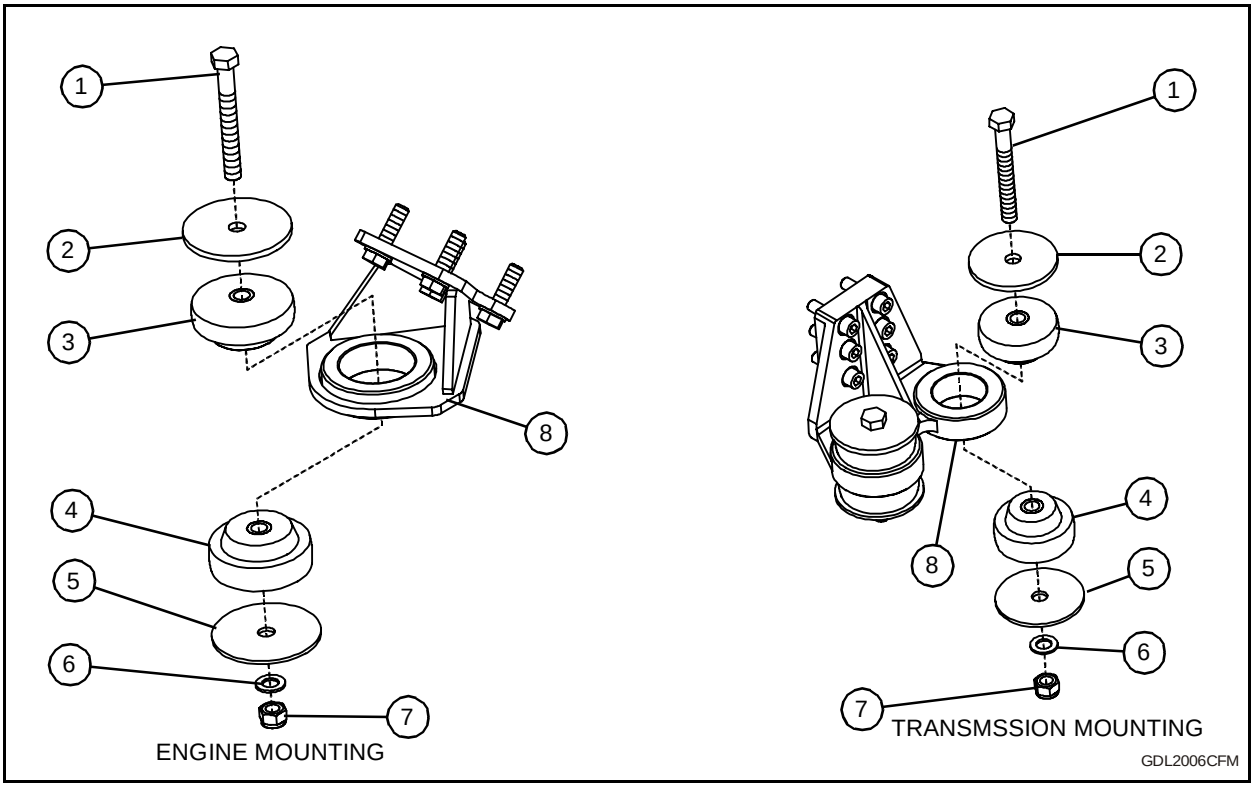
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CHAPTER 5. ENGINE AUXILIARY SYSTEM

SECTION 4. ENGINE MOUNTING

RUBBER MOUNTINGS

Remove and Install Engine and Transmission Rubber Mountings



Remove nuts (7), washers (6), cap screws (1), upper spacers, (2), and upper rubber mounts (3).

Write down the number of lower spacers (5) used for each mount.

⚠ CAUTION

The approximate weight of engine and transmission is 1475 kg (3250 lb).

Remove and Install Engine and Transmission Rubber Mounts Specification

Engine and Transmission Weight
- 1475 kg (3250 lb)

⚠ CAUTION

The recommended method for lifting the engine is using the JDG23 Lifting Sling or JT07336 6000-lb Load Rotor. The lifting force must be at 90° at the lifting points.

Lift the engine and transmission just enough to relieve pressure on lower mounts (4), using the JDG23 Lifting Sling or JT07336 6000-lb Load Rotor and a hoist.

Connect to the lifting brackets at the front and rear of engine.

Remove brackets (8) if necessary.

Replace lower mounts (4) and lower spacers (5) as necessary.

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Install brackets, if removed. Apply rigid form-in-place gasket to cap screw threads. Tighten hardware to specifications.

Remove and Install Engine and Transmission Rubber Mounts Specification

Bracket-to-Engine Cap Screw Torque
- -120 Nm (90 lb-ft

Bracket-to-Transmission Cap Screw Torque
- 196 Nm (145 lb-ft)

Install upper mounts, upper spacers, cap screws, washers, and nuts.

Lower engine and transmission so full weight rests on rubber mounts.

Tighten cap screws and nuts to specification.

Remove and Install Engine and Transmission Rubber Mounts Specification

Rubber Mount Cap Screw and Nut Torque
- 410 Nm (300 lb-ft)

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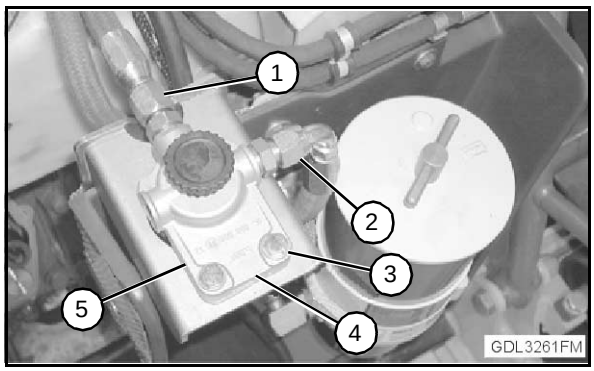
CHAPTER 5. ENGINE AUXILIARY SYSTEM

SECTION 5. EXTERNAL FUEL SUPPLY SYSTEM

HAND PRIMER PUMP

Remove And Install Hand Primer Pump

Relieve pressure in fuel system.



Disconnect inlet line (1) and outlet line (2).

Remove cap screws, washers, and nuts (3).

Remove primer (5) and spacer (4).

Clean, repair, or replace parts as necessary. **(See Clean Fuel Screen Operator's Manual, CHAPTER 17, SECTION 1).**

Install spacer, primer, cap screws, washers, and nuts.

Connect inlet line and outlet line.

Prime Fuel System **(See Clean Fuel Screen Operator's Manual, CHAPTER 17, SECTION 1).**

PRIMARY FUEL FILTER (WATER SEPARATOR)

Remove and Install Primary Fuel Filter

Drain Primary Fuel Filter (Water Separator) until empty. Close drain screw. **(See Operator's Manual, CHAPTER 11, SECTION 1).**

Disconnect heater wire (3), if equipped.

Disconnect inlet line (4) and outlet line (1).

Remove cap screws, nuts (2), and filter assembly.

Repair or replace parts as necessary. See Replace Primary Fuel Filter **(See Water Separator Operator's Manual, CHAPTER 14, SECTION 1).**

Install filter assembly, nuts, and cap screws.

Connect outlet line and inlet line.

Connect heater wire, if equipped.

Fill filter housing with clean fuel.

Prime Fuel System **(See Operator's Manual, CHAPTER 18, SECTION 1).**

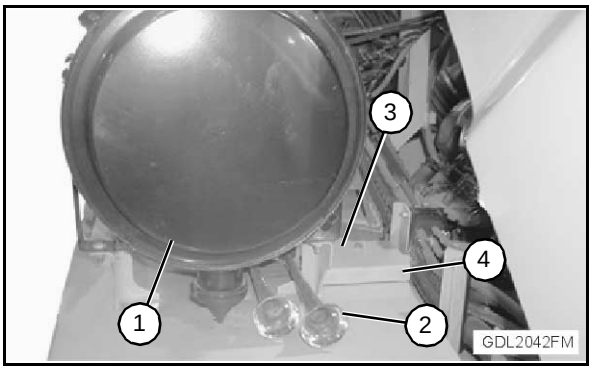
FUEL TANK

Remove and Install Fuel Tank

Drain fuel from fuel tank.

Remove and Install Fuel Tank Specification

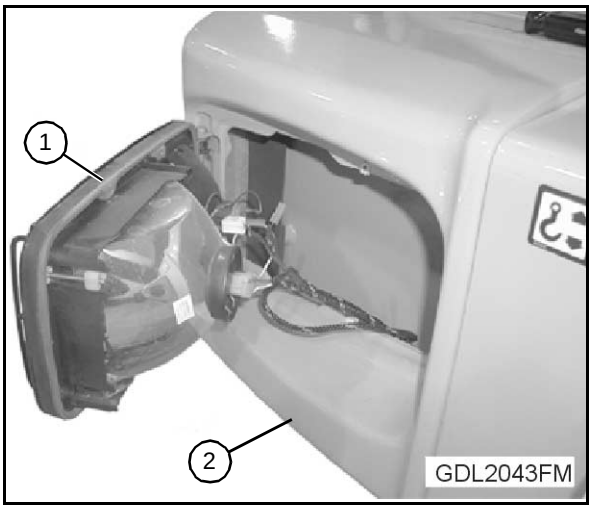
Fuel Tank Capacity - - - - - - - - - - - - - - - 400 L (106 gal)



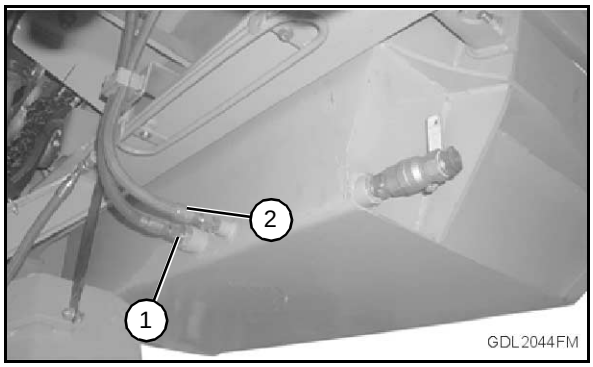
Remove air cleaner (1). Remove pneumatic line from air horn (2). Disconnect pneumatic lines from fuel tank.

Remove plate (3) and disconnect wiring harness from fuel level sender (4).

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Remove headlight (1) and headlight housing (2).



Disconnect fuel suction line (1) and return line (2) from fuel tank. Close openings using caps and plugs.

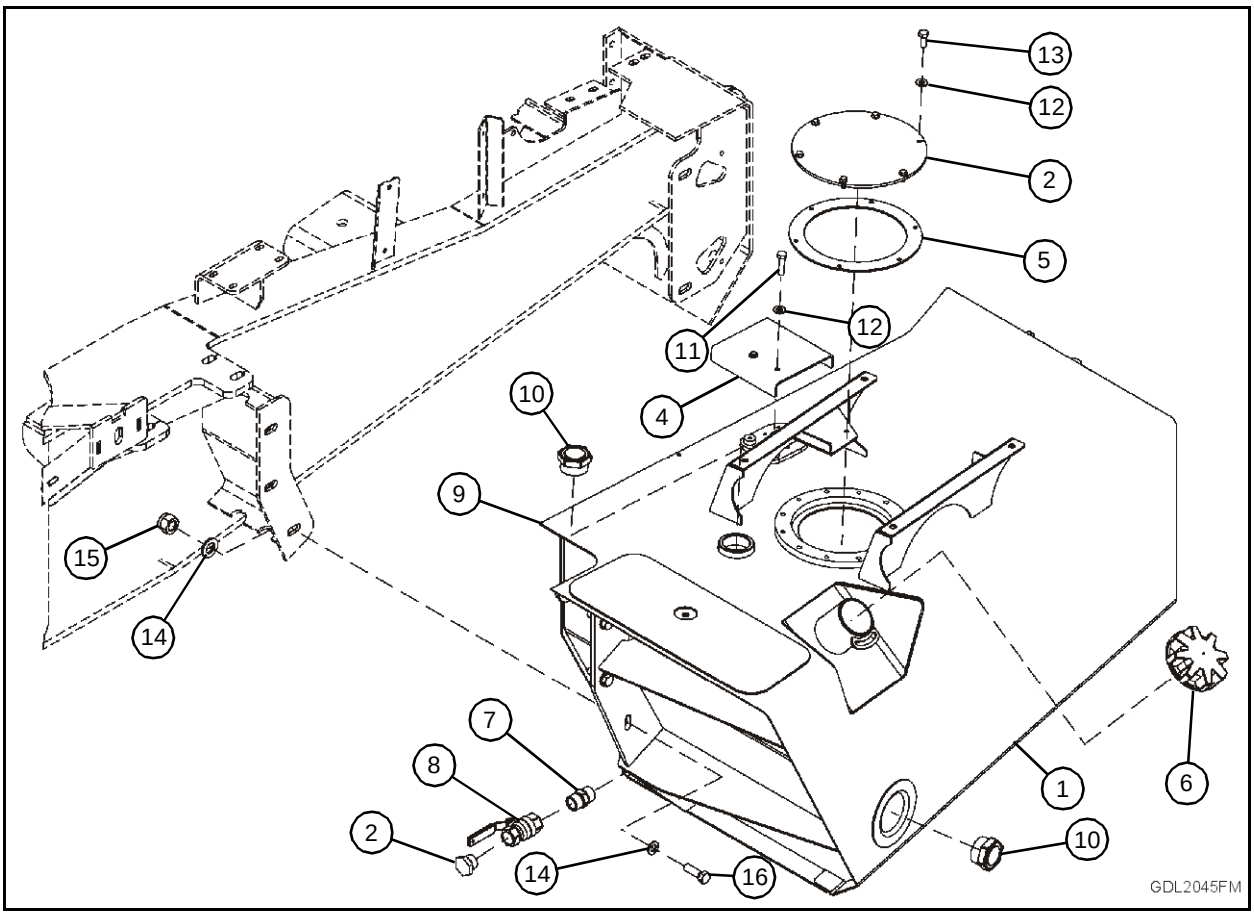
⚠ CAUTION

Component is heavy. Use hoist.

Remove and Install Fuel Tank Specification

Fuel Tank Weight - - - - - - 290 kg (640 lb) approximate

Support fuel tank with hoist.



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1. Fuel Tank.
2. Plug.
3. Lid.
4. Plate.
5. Gasket.
6. Fill Cap.
7. Nipple.
8. Drain Valve.
9. Tread Pad.
10. Plug (2 used).
11. Cap Screw (2 used).
12. Washer (8 used).
13. Cap Screw (6 used).
14. Washer (10 used).
15. Nut (5 used).
16. Cap Screw (5 used).

Remove cap screws (16), washers (14) and nuts (15). Remove fuel tank.

Repair or replace parts as necessary.

Install fuel tank. Install cap screws, washers, and nuts.

Connect suction and return lines.

Install headlight housing and headlight.

Connect wiring harness to fuel level sender and install plate. Connect pneumatic lines to fuel tank.

Install pneumatic line on air horn. Install air cleaner.

Fill tank with fuel.

Prime Fuel System **(See Operator's Manual, CHAPTER 18, SECTION 1).**

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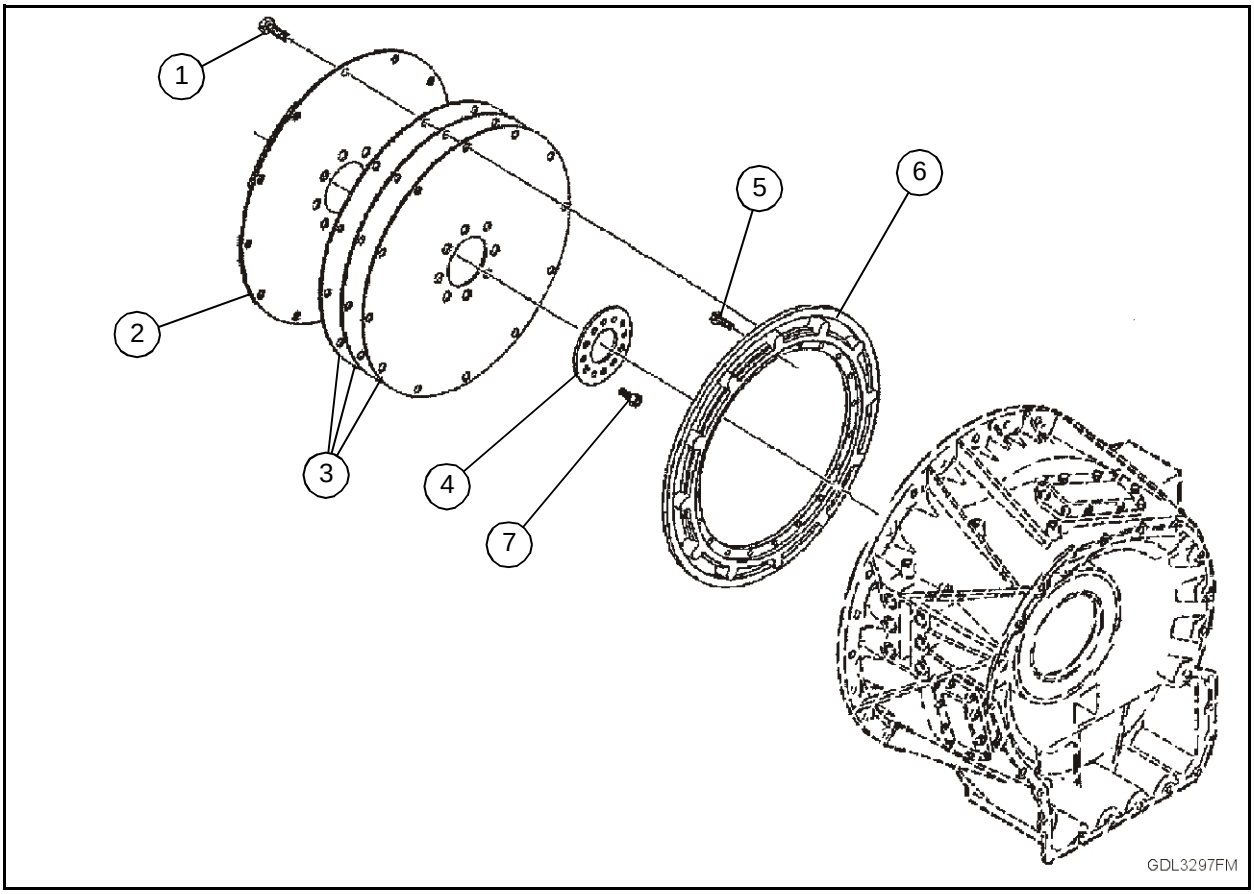
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CHAPTER 6. CONNECTOR DRIVE (FLEXPLATE)

SECTION 1. ELEMENTS

REMOVE AND INSTALL CONNECTOR DRIVE (FLEXPLATE)



1. Disks-to-Adapter Cap Screw (12 used).
2. Disk.
3. Disk (3 used).
4. Plate.
5. Adapter-to-Torque Converter Cap Screw (12 used).
6. Adapter.
7. Plate and Disks-to-Flywheel Cap Screw (12 used).

Check crankshaft end play. **(See "Check Crankshaft End Play" on page 117).**

Remove the engine and transmission. **(See "ENGINE" on page 105).**

Remove cap screws (5 and 7) to remove parts (2, 3, 4, and 6).

Repair or replace parts as necessary.

Install adapter (6).

Apply medium strength thread lock and sealer to threads of cap screws (5). Tighten cap screws to specification.

Connector Drive (Flexplate) Specification

Adapter-to-Torque Converter Cap Screw Torque
- 35 Nm (25 lb-ft)

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Apply rigid form-in-place gasket to threads of cap screws (7) and fasten disks (2 and 3) and plate (4) to the flywheel.

Tighten the cap screws to specification.

Connector Drive (Flexplate) Specification

Flexplate Disks-to-Flywheel Cap Screw Torque
- 110 Nm (81 lb-ft)

Apply anti-seize to center hub of torque converter.

After transmission is installed to flywheel housing, apply rigid form-in-place gasket to threads of cap screws (1).
Install cap screws through opening in flywheel housing to fasten the disks to adapter.
Tighten cap screws to specification.

Connector Drive (Flexplate) Specification

Flexplate Disks-to-Adapter Cap Screw Torque
- 35 Nm (25 lb-ft)

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CHAPTER 7. TRANSFER DRIVE

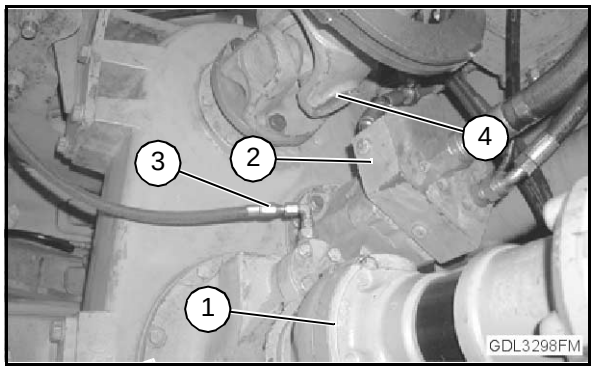
SECTION 1. REMOVAL AND INSTALLATION

REMOVE AND INSTALL TRANSFER CASE

Install articulation lock bar. Chock wheels. Relieve hydraulic pressure. Relieve brake accumulator pressure. **(See Prepare Machine for Maintenance Operator's Manual, CHAPTER 7, SECTION 1).**

Relieve Pneumatic Pressure. **(See Operator's Manual, CHAPTER 7, SECTION 1).**

Tilt Cab **(See Operator's Manual, CHAPTER 7, SECTION 1).**



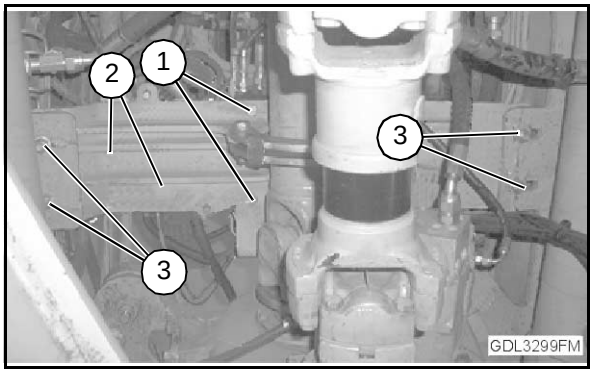
Disconnect transfer case-to-oscillation joint drive shaft.

Remove transfer case-to-front axle drive shaft (1). **(See "DRIVE SHAFTS" on page 21).**

Disconnect transmission-to-transfer case drive shaft (4). **(See "REMOVE AND INSTALL TRANSMISSION-TO-TRANSFER CASE DRIVE SHAFT" on page 49).**

Disconnect air line (3). Remove fitting and install a plug.

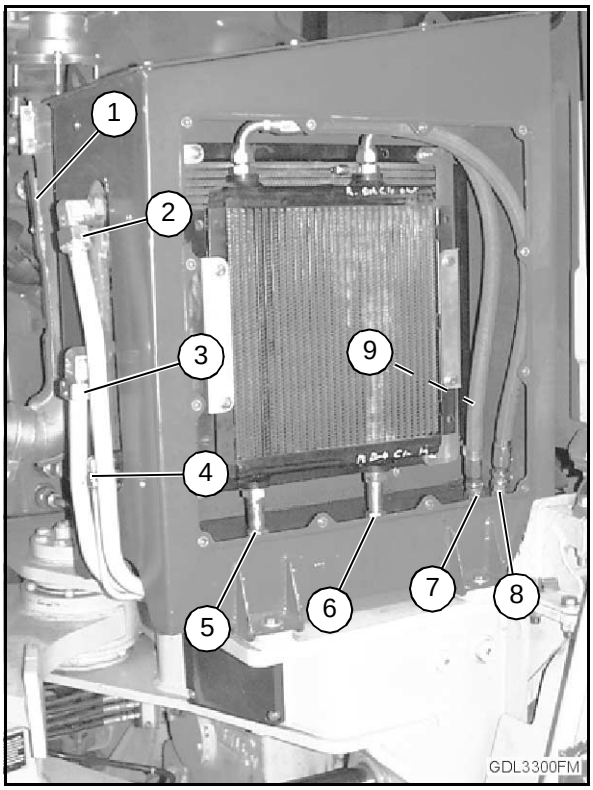
Remove Secondary Steering Pump (2) **(See "SECONDARY STEERING PUMP" on page 227).**



Remove mounting cap screws (1 and 2) from hydraulic fan motor controller and hydraulic system manifold.

Remove cross frame cap screws (3).

Drain wet brake reservoir (B40D only). **(See Change Wet Disk Brake Cooling Oil - B40D Operator's Manual, CHAPTER 15, SECTION 2).**



Disconnect hoses (2 - 9). Close all openings with caps and plugs.

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Disconnect hydraulic fan motor hoses.

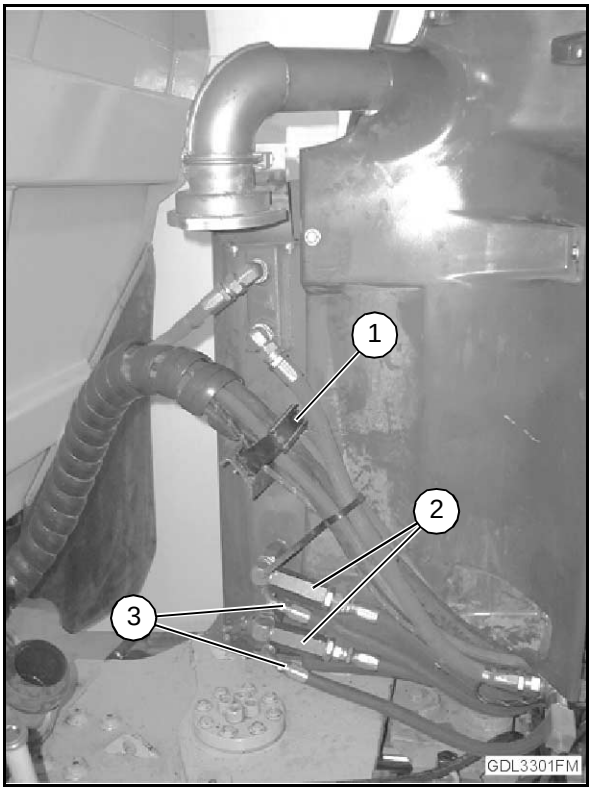
Disconnect transmission cooling hose support on cooler housing.

⚠ CAUTION

Heavy component. Use hoist.

Remove cooler assembly from machine with hoist.

Remove body heater pipe, if equipped. **(See "Body Heater Pipes" on page 189).**



Disconnect hose pack clamps (1) from reservoir.

Label and disconnect wet brake reservoir hoses and check valves (2).

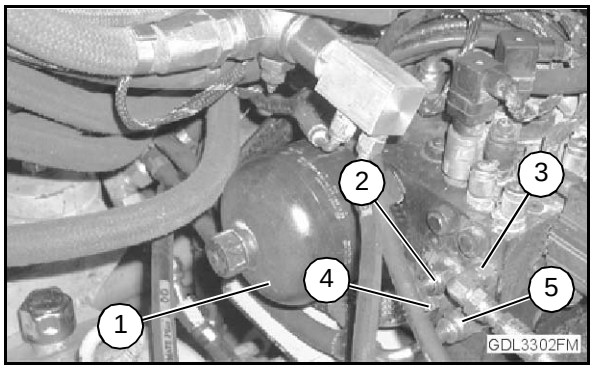
⚠ CAUTION

Heavy component. Use hoist.

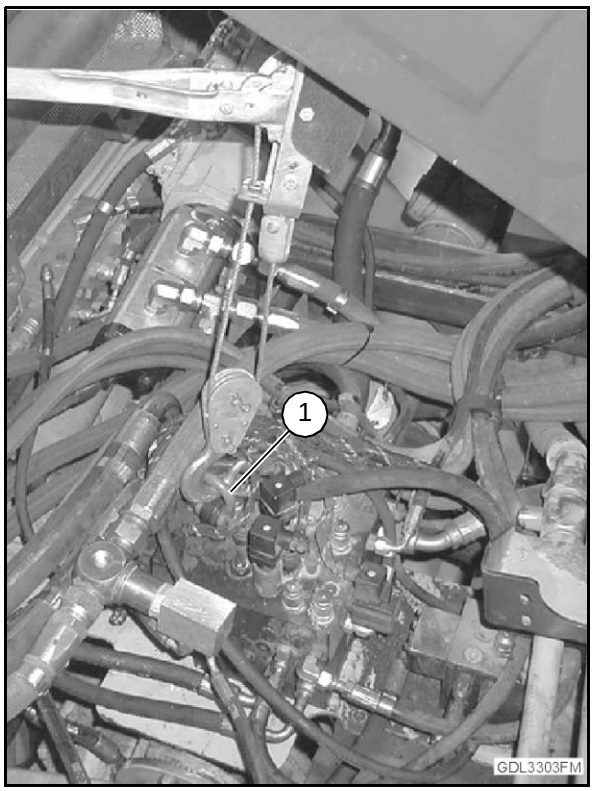
Remove and Install Transfer Case Specification

Wet Disk Brake Cooling Oil Reservoir and Muffler Assembly Weight- - - - - - 143 kg (315 lb) approximate

Remove muffler shield (3) and disconnect muffler.



Remove brake accumulator (1) and disconnect hoses (2 - 5) from hydraulic system manifold.



Attach JT01748 lifting bracket (1) to hydraulic system manifold.

Attach cable winch at bottom of cab and lifting bracket. Lift and support hydraulic system manifold assembly.

Move cross frame aside.

⚠ CAUTION

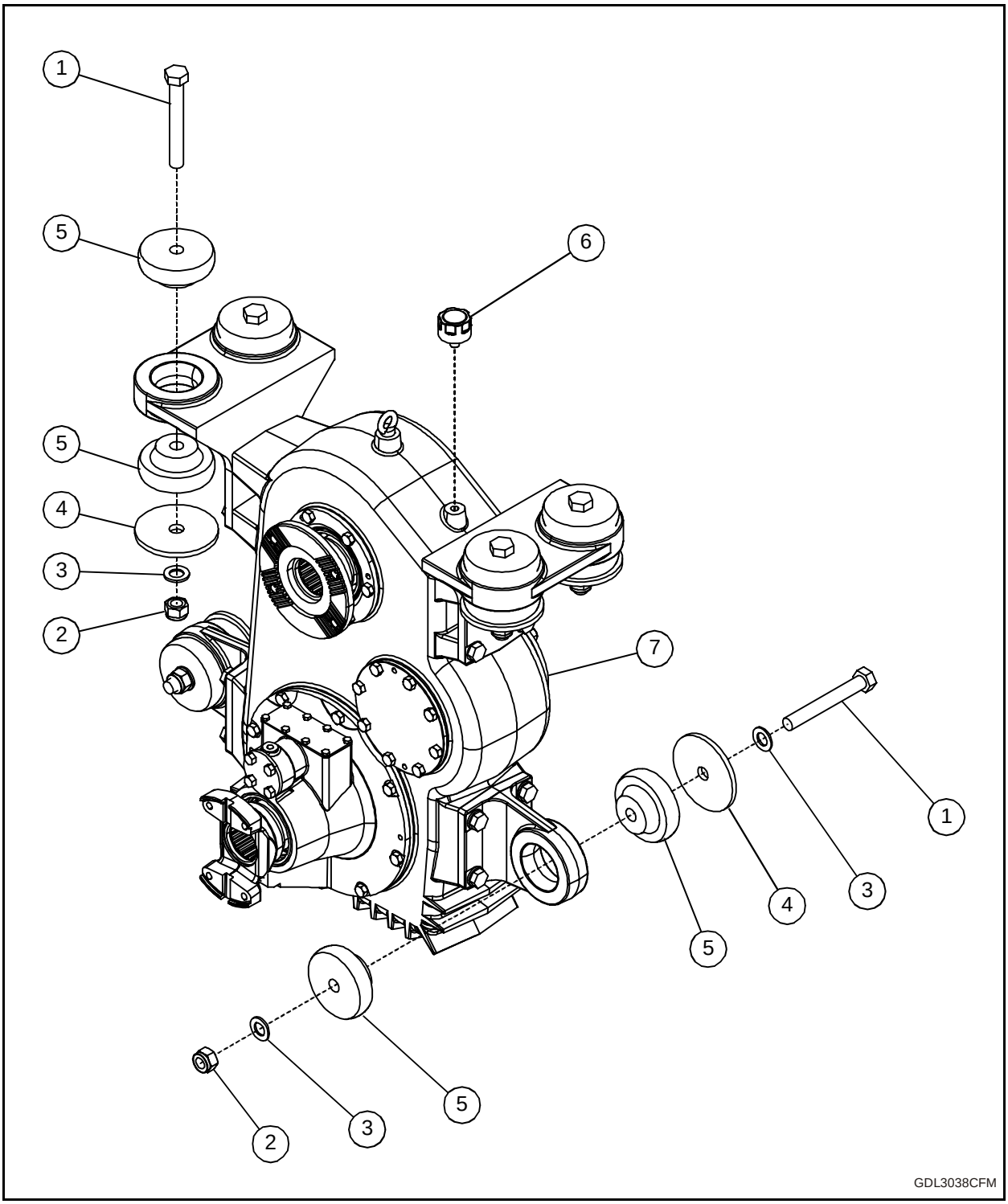
Heavy component. Use hoist.

Remove and Install Transfer Case Specification

Transfer Case Weight approximate
- -218 kg (480 lb)

Support transfer case with hoist.

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1. Cap Screw (6 used).
2. Nut (6 used).
3. Washer (8 used).
4. Spacer (6 used).
5. Rubber Mount Pads (12 used).
6. Breather.
7. Transfer Case.

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Remove parts (1 - 5).

Remove supports from transfer case.

Lift transfer case from frame.

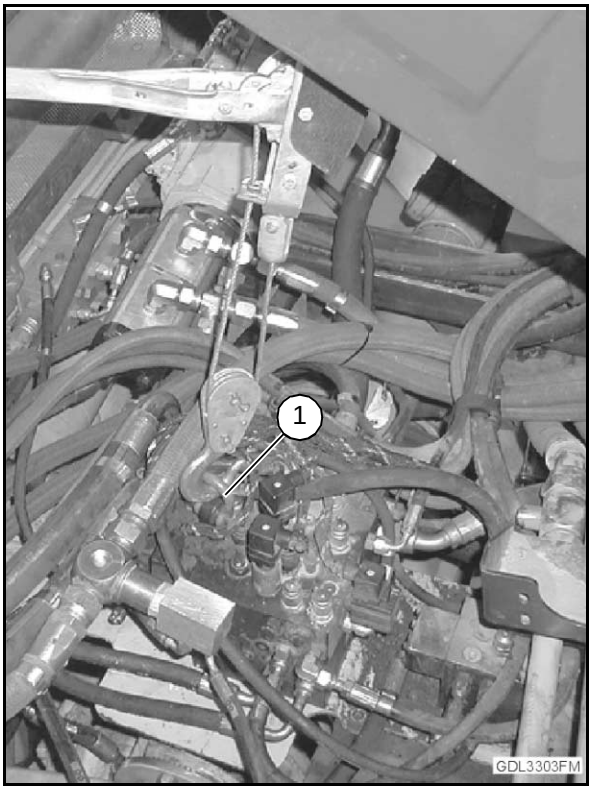
Inspect, repair, and replace parts as necessary. **(See “TRANSFER CASE” on page 205).**

Lower transfer case into frame.

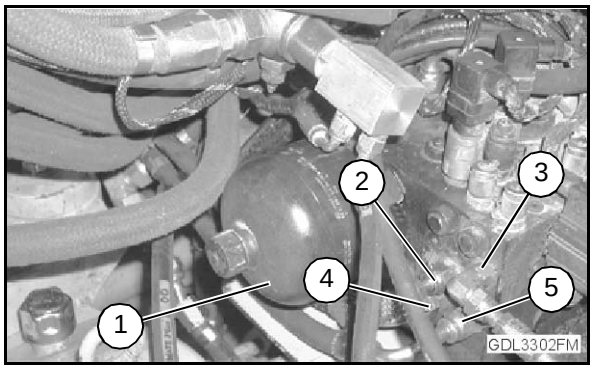
Apply cure primer and rigid form-in-place gasket to support cap screws. Install supports.

Install transfer case rubber mount pads (5) and cap screws (1).

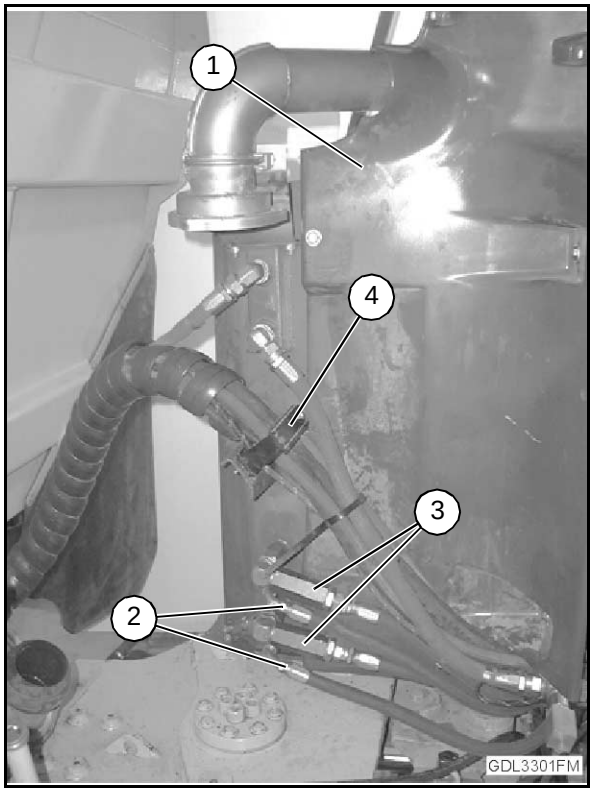
Install cross frame.



Lower hydraulic system manifold assembly to position. Remove JT01748 Lifting Bracket (1).



Install brake accumulator (1) and connect hoses (2 - 5) to hydraulic system manifold.



Install wet disk brake cooling oil reservoir and muffler assembly.

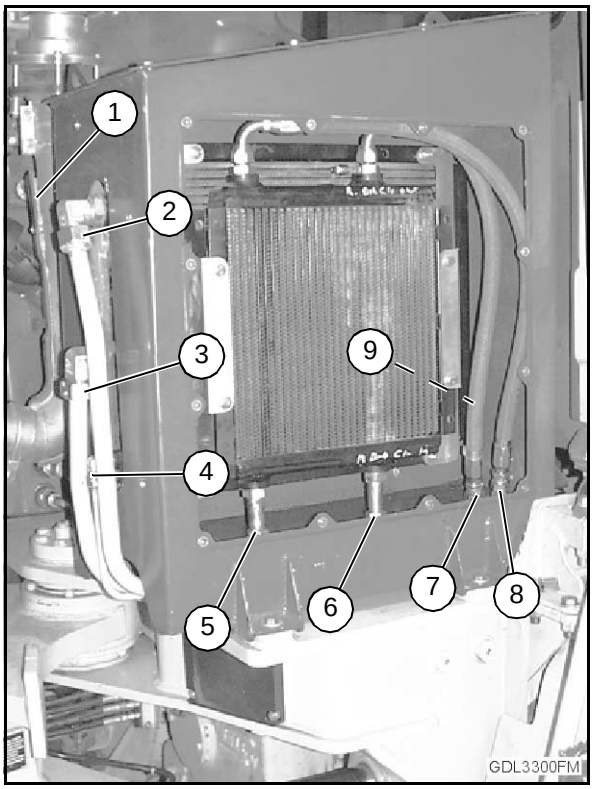
Connect muffler and install muffler shield (1).

Connect hoses (2) and bypass check valves (3).

Connect hose pack clamps (4) to reservoir.

Install body heater pipes, if equipped. **(See “Body Heater Pipes” on page 189).**

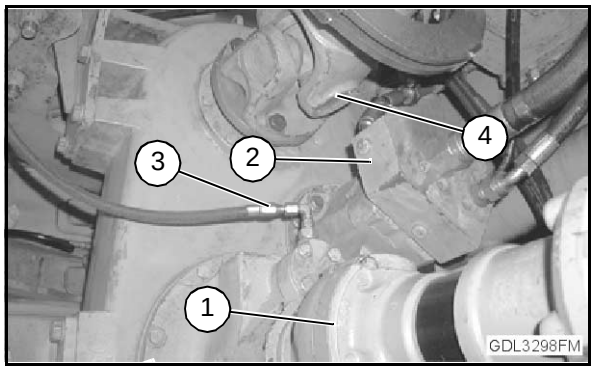
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Install cooler assembly on machine and insert hydraulic fan motor hoses.

Connect fan motor hoses. Connect hoses (2 - 9).

Attach transmission cooling hose mounting bracket to cooler assembly.



Install cross frame mounting cap screws (7), hydraulic system manifold cap screws (5), and hydraulic fan motor controller cap screws (6).

Install secondary steering pump. **(See "SECONDARY STEERING PUMP" on page 227).**

Install fitting and interaxle lock actuator air line (3).

Connect transmission-to-transfer case drive shaft. **(See "REMOVE AND INSTALL TRANSMISSION-TO-TRANSFER CASE DRIVE SHAFT" on page 49).**

Install transfer case-to-front axle drive shaft. Connect transfer case-to-oscillation joint drive shaft. **(See "DRIVE SHAFTS" on page 21).**

Fill wet brake reservoir (B40D only). **(See Change Wet Disk Brake Cooling Oil - B40D. Operator's Manual, CHAPTER 15, SECTION 2).**

Lower cab. **(See Tilt Cab in Operator's Manual, CHAPTER 7, SECTION 1).**

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CHAPTER 7. TRANSFER DRIVE

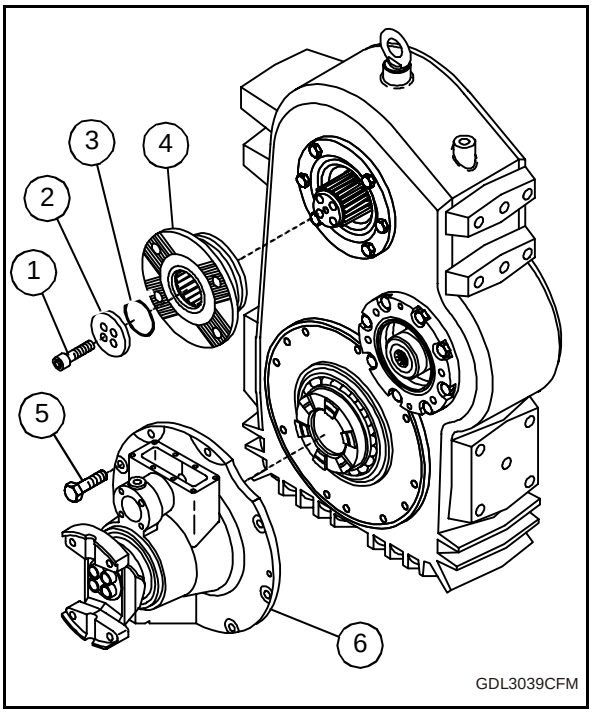
SECTION 2. GEAR SHAFTS AND BEARINGS

TRANSFER CASE

Disassemble Transfer Case

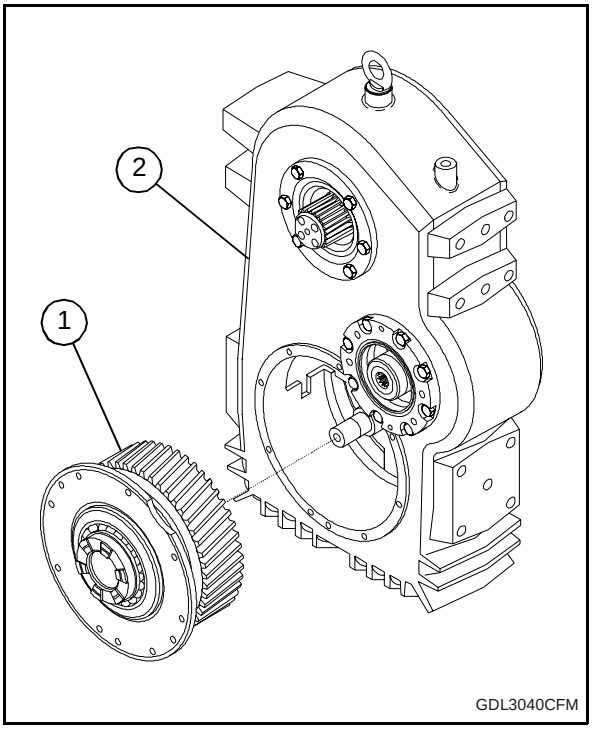
Clean outside of transfer case.

Mount transfer case in D05223ST Engine Repair Stand with DFT1223 Transfer Case Mounting Bracket.

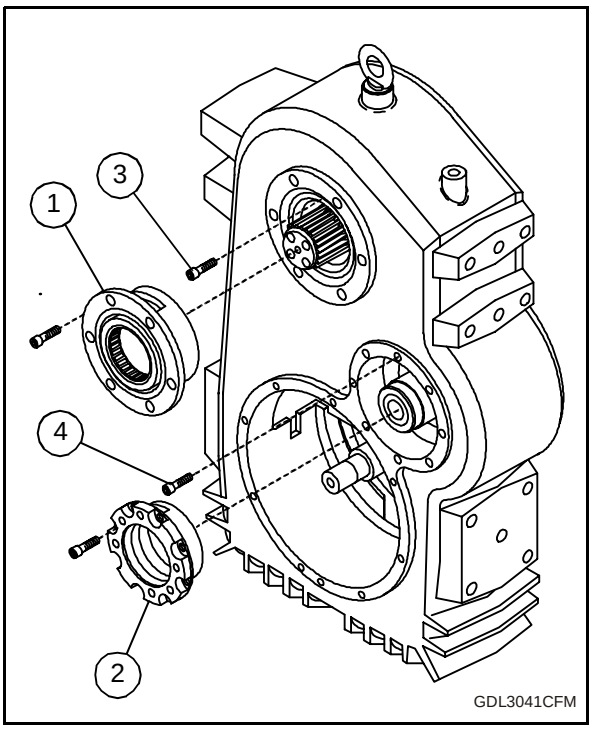


Unscrew cap screw (1) (4 off) and remove retainer (2), O-ring (3) and input yoke (4).

Remove cap screws (5) and separate front output housing assembly (6) from transfer case housing with jack screws.



Use Remove planetary and output gear assembly (1) with jack screws from transfer case housing (2).



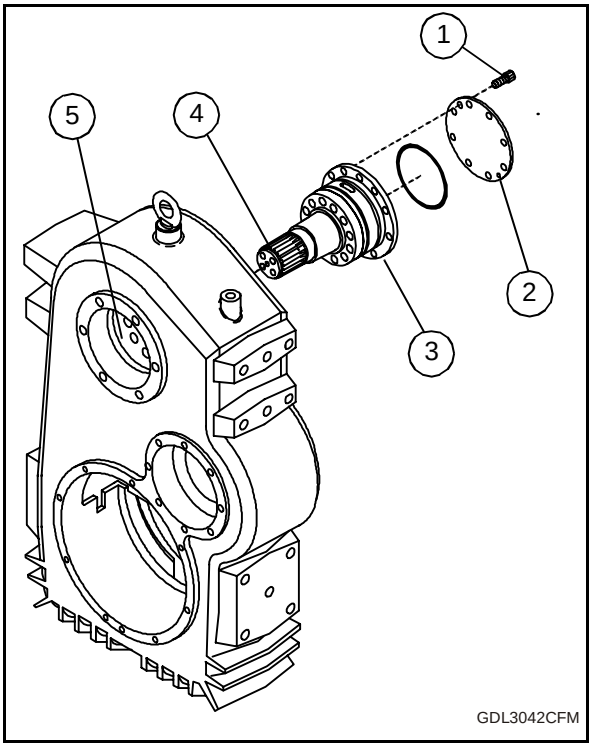
Remove input shaft bearing housing (1) with jack screws.

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Remove idler shaft bearing housing (2) with jack screws.

Remove cap screws (3 and 4) securing input and idler gears.

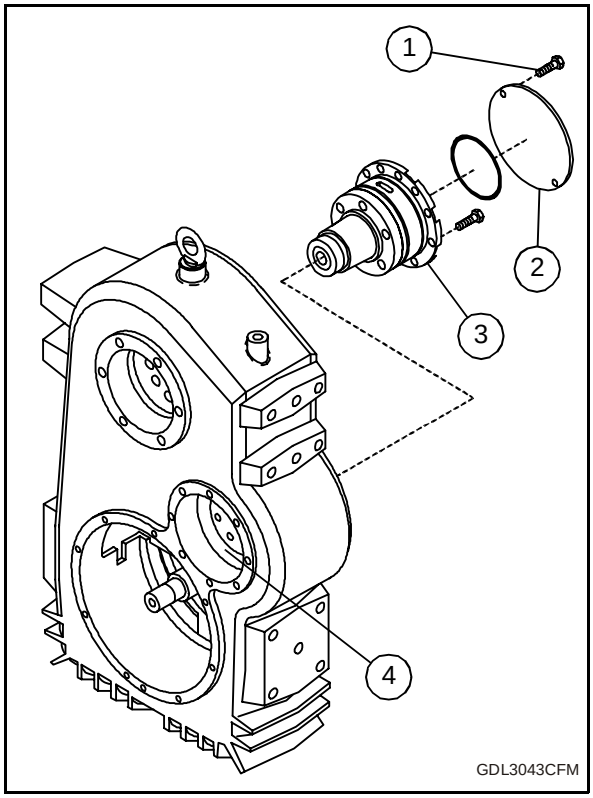
Rotate transfer case so rear of case is face-up.



Unscrew cap screw (1) and remove cover (2) and O-ring.

Remove input shaft bearing housing (3) with jack screws.

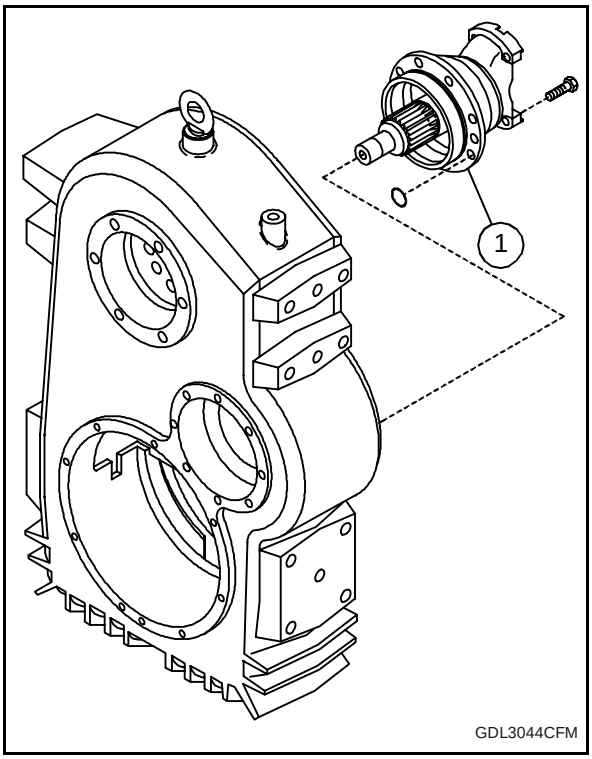
Tap input shaft with (4) soft faced hammer to remove shaft from input gear (5).



Unscrew cap screw (1) and remove cover (2) and O-ring. Remove idler shaft bearing housing (3) with jack screws.

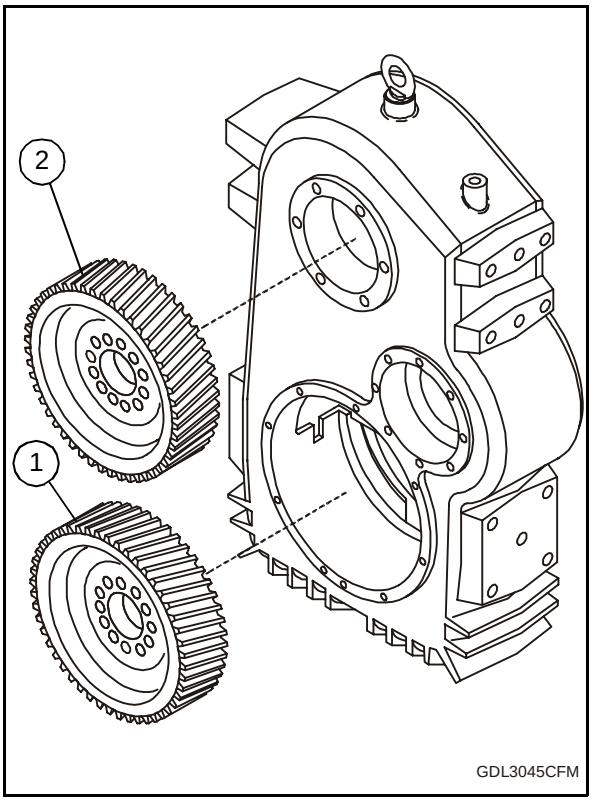
Tap idler shaft with soft faced hammer to remove idler shaft from gear (4).

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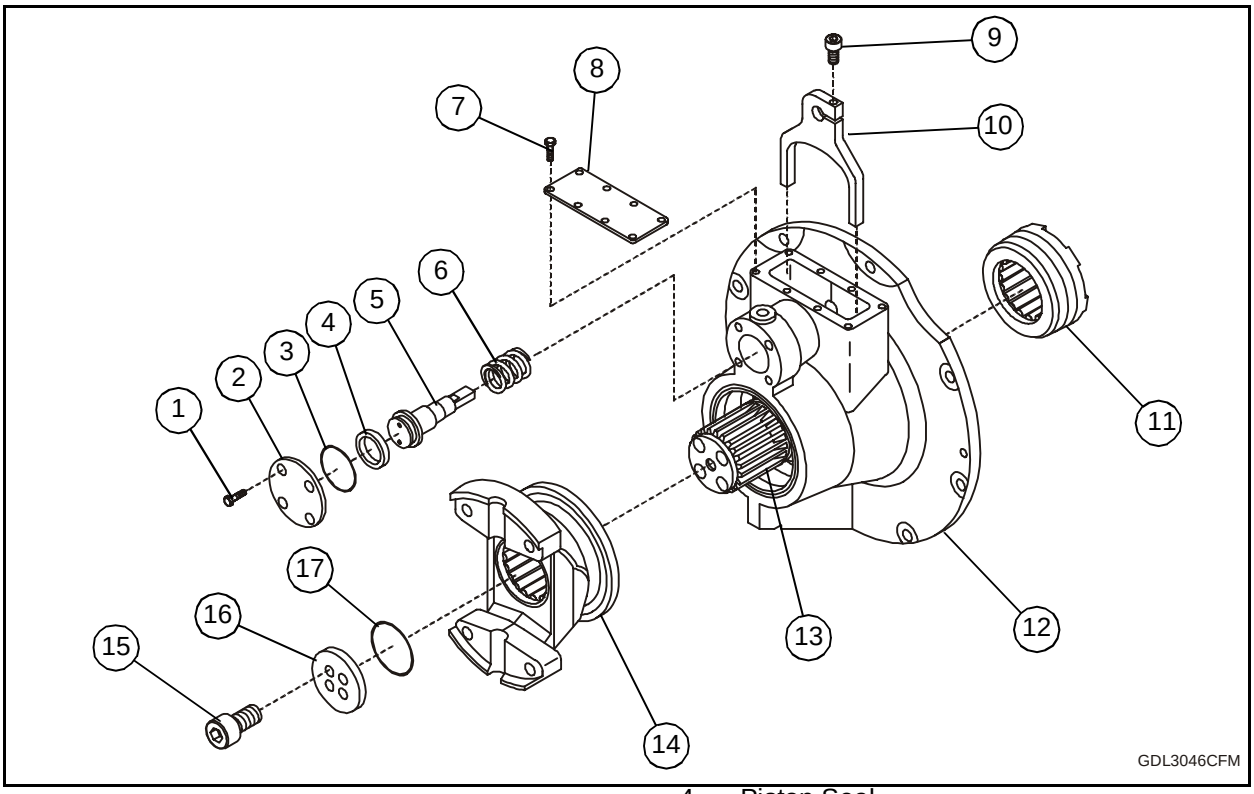


Remove rear output housing (1) with jack screws.

Rotate transfer case 180°, making sure top of case moves down. Ensure gears do not fall from case.



Remove idler gear (1) and input gear (2).



1. Cap Screw (4 used).
2. Cover.
3. O-Ring.
4. Piston Seal.
5. Piston.
6. Spring.

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7. Cap Screw (8 used).
8. Cover.
9. Cap Screw.
10. Fork.
11. Coupler Slide Collar.
12. Front Output Housing.
13. Front Output Shaft.
14. Yoke.
15. Cap Screw (4 used).
16. Retainer.
17. O-Ring.

Disassemble and Assemble Front Output Shaft

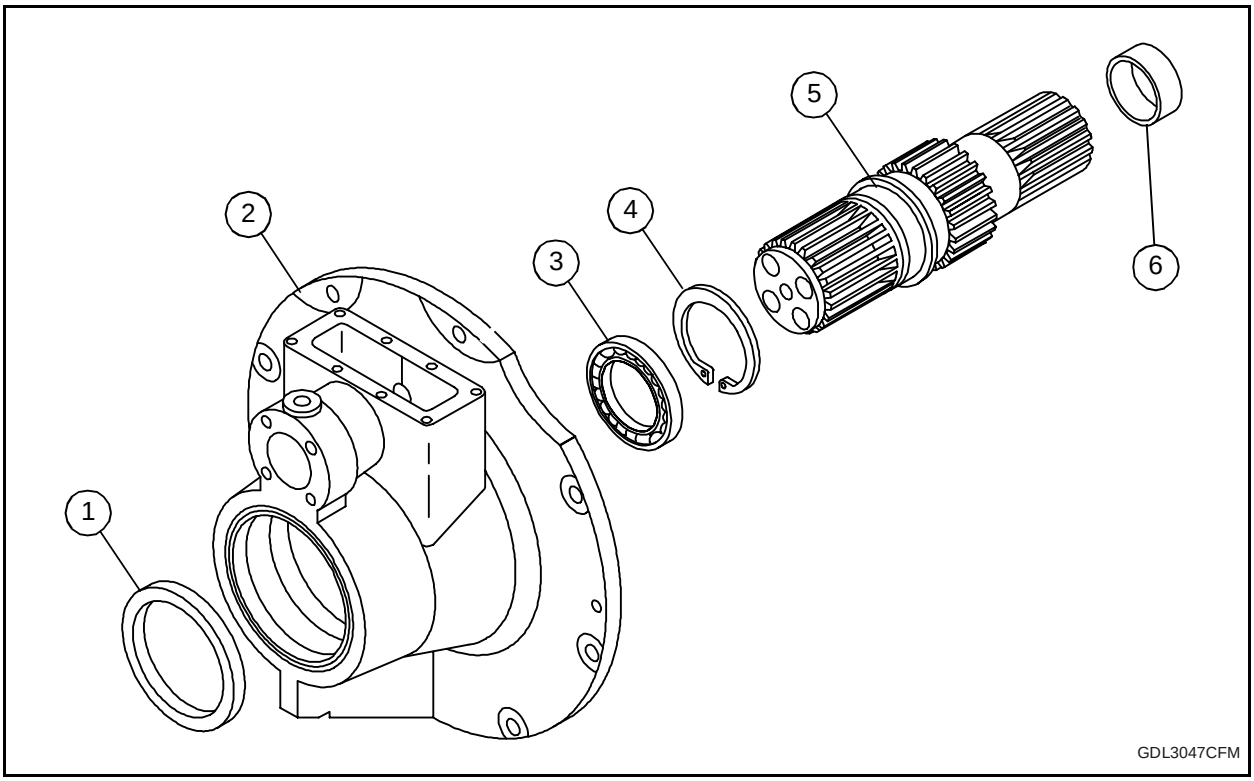
Assembly and Interaxle Lock

Remove covers (2 and 8) and O-ring (3).

Loosen cap screw (9). Using an adjustable two-pin spanner wrench or similar tool, remove piston (5).

Remove seal (4), spring (6), and fork (10).

Remove parts (14 - 17).



1. Seal.
2. Front Output Housing.
3. Bearing.
4. Snap Ring.
5. Front Output Shaft.
6. Bushing.

Remove seal (1).

Press shaft (5) from housing (2), using an appropriate driver from D01045AA Bushing, Bearing and Seal Driver Set.

Remove snap ring (4) from housing.

Press bearing (3) from housing.

Clean, inspect, and replace parts as necessary.

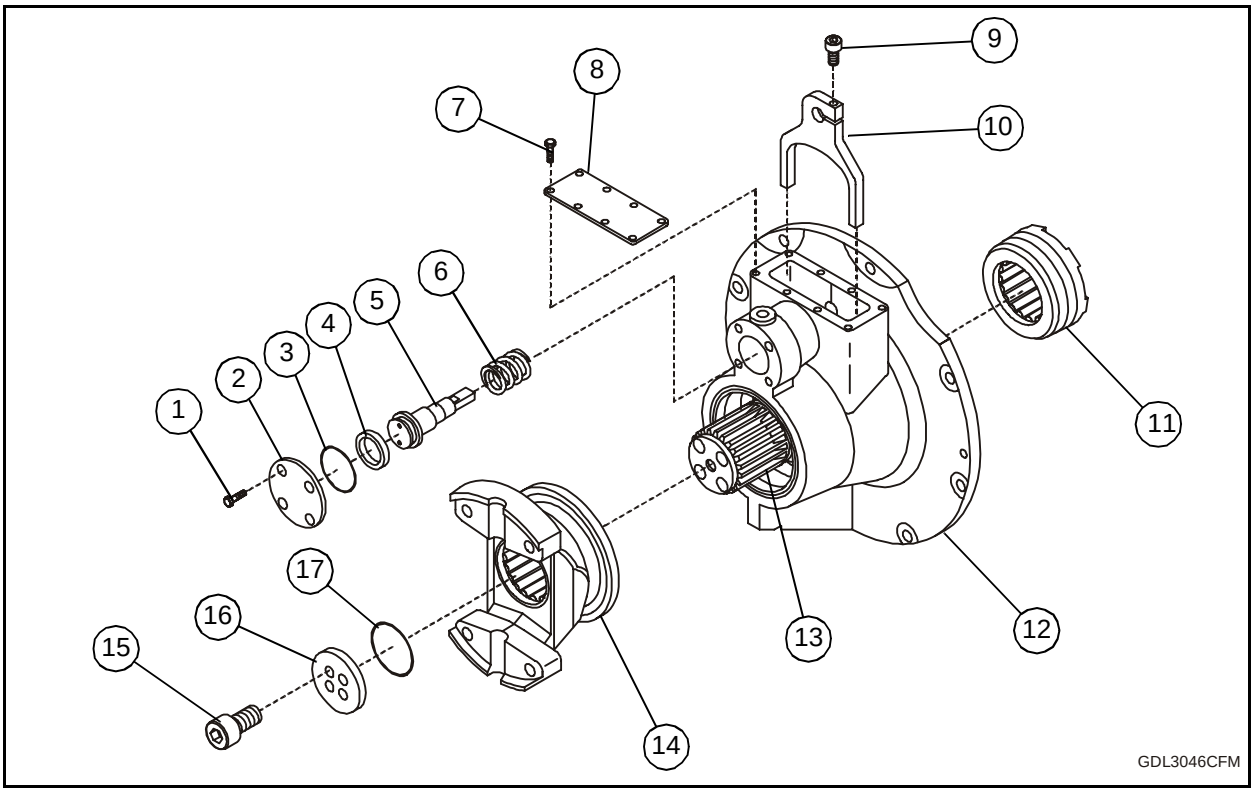
Replace bushing (6) if worn or damaged.

Heat housing (2) to 85°C (185°F), and install bearing (3) and snap ring (4).

Heat bearing (3) and housing (2) to 85°C (185°F), and install shaft (5). Allow assembly to cool.

Apply a thin layer of petroleum jelly to lip of seal (1). Apply flexible form-in-place gasket to outer diameter of seal. Install seal.

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1. Cap Screw (4 used).
2. Cover.
3. O-Ring.
4. Piston Seal.
5. Piston.
6. Spring.
7. Cap Screw (8 used).
8. Cover.
9. Cap Screw.
10. Fork.
11. Coupler Slide Collar.
12. Front Output Housing.
13. Front Output Shaft.
14. Yoke.
15. Cap Screw (4 used).
16. Retainer.
17. O-Ring.

Install coupler slide collar (11) over shaft (13).

Collar must move freely over splined area of shaft.

Install cap screw (9) and piston (5) in fork (10).

Tighten cap screw until clearance is removed, but piston rotation is still possible. Maintain setting and remove fork from piston.

Install fork (10) in housing (12) and on collar (11).

Apply a thin layer of petroleum jelly to lip of seal (4). Lip must face away from piston.

Apply a thin layer of petroleum jelly to piston bore and piston journals.

NOTE: Adjustment to fork must be done after front output housing assembly is installed.

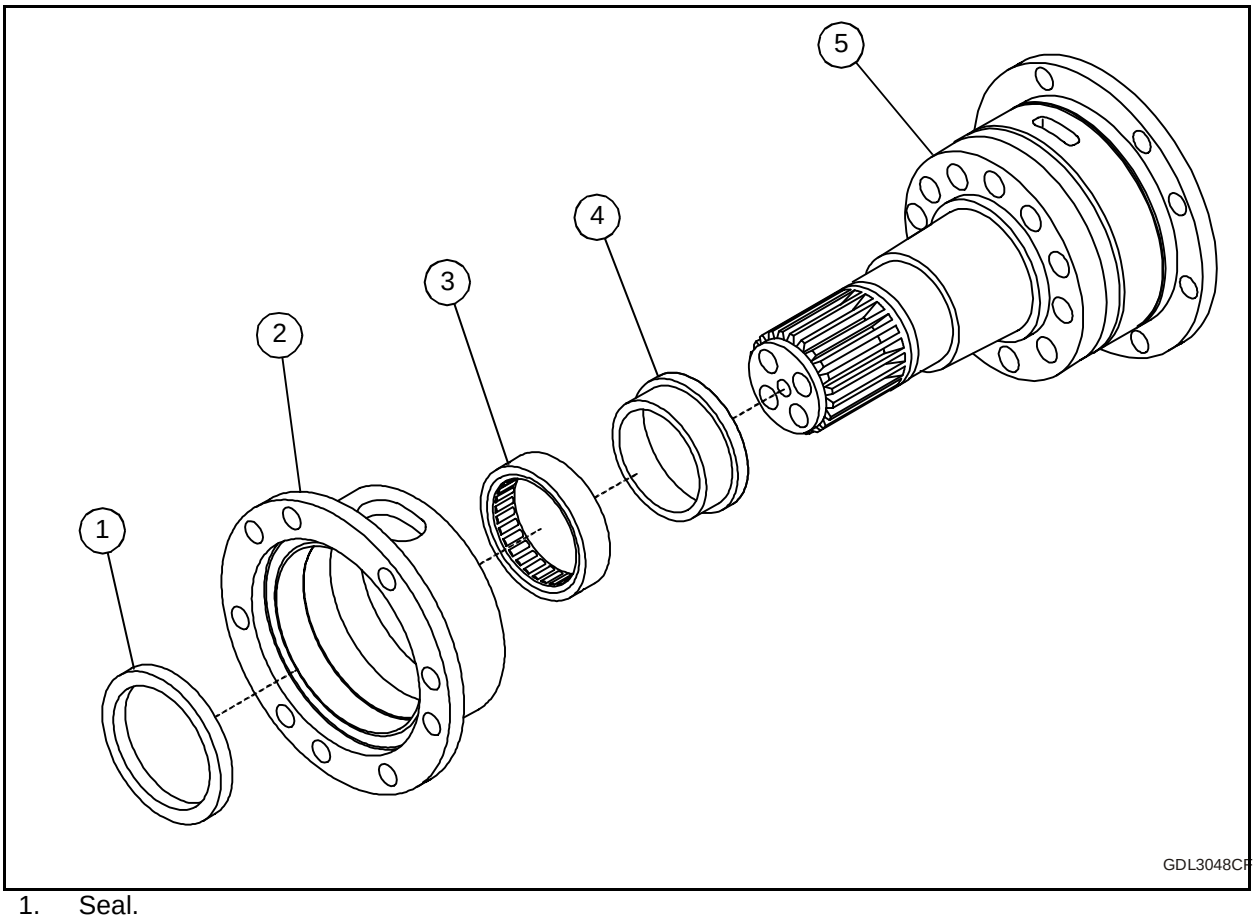
Using an adjustable two-pin spanner wrench, install piston (5) spring (6). Do not tighten cap screw at this time.

Apply anti-seize lubricant to splines of shaft. Install yoke (14), O-ring (17), and retainer (16). Tighten cap screws (15) to specification.

Transfer Case Specification

Front Output Yoke Cap Screw Torque
- 156 Nm (115 lb-ft)

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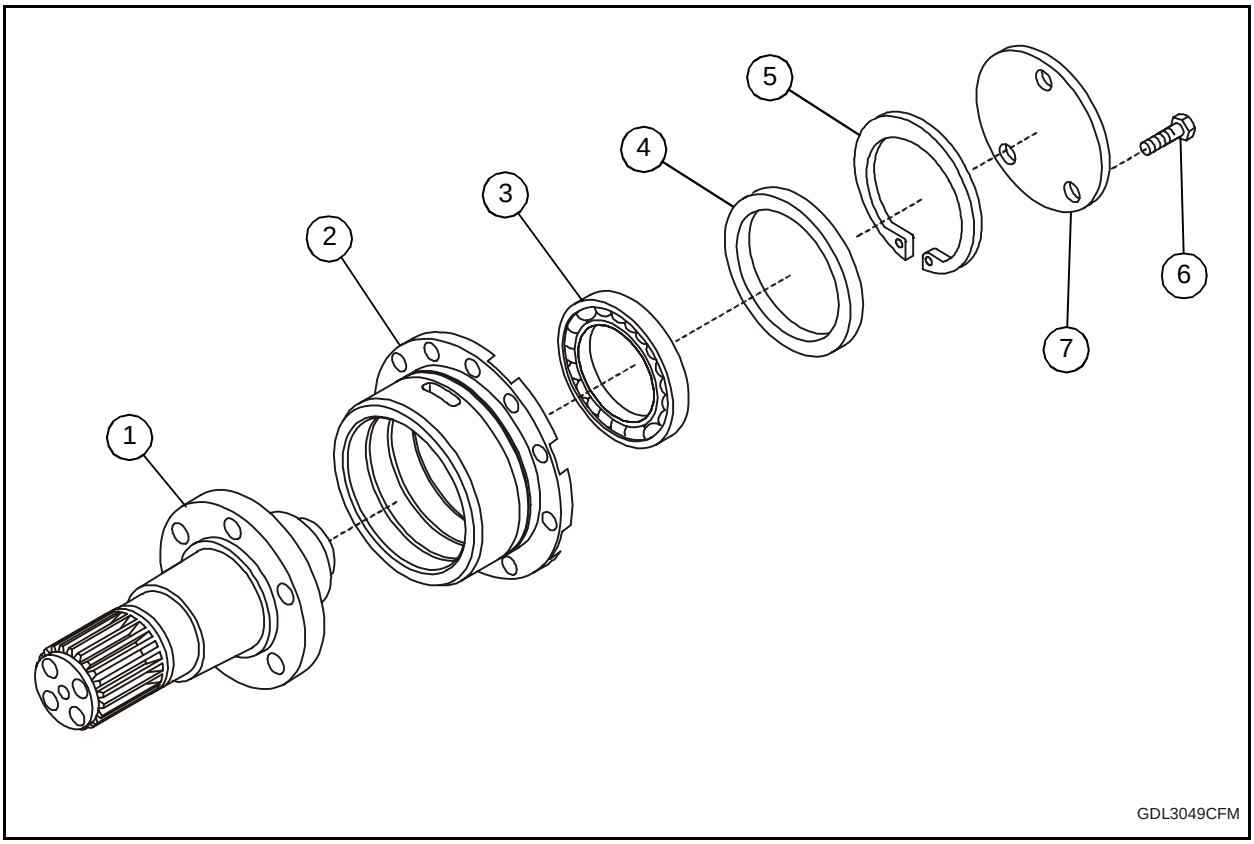
1. Seal.
2. Front Bearing Housing.
3. Bearing.
4. Inner Race.
5. Input Shaft and Rear Bearing Housing.

Disassemble and Assemble Input Shaft Assembly

Using a puller, remove inner race (4) from input shaft (5).

Remove seal (1) and use press to remove bearing (3).

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1. Input Shaft.
2. Input Shaft Rear Bearing Housing.
3. Bearing.
4. Spacer.
5. Snap Ring.
6. Cap Screw (3 used).
7. Retainer.

Remove retainer (7) and snap ring (5).

Support housing (2), remove shaft (1) using a press.

Remove spacer (4) and bearing (3).

Inspect and replace parts as necessary.

Heat housing (2) to 85°C (185°F). Install bearing (3) and spacer (4).

Install snap ring in housing with open end aligned with oil hole.

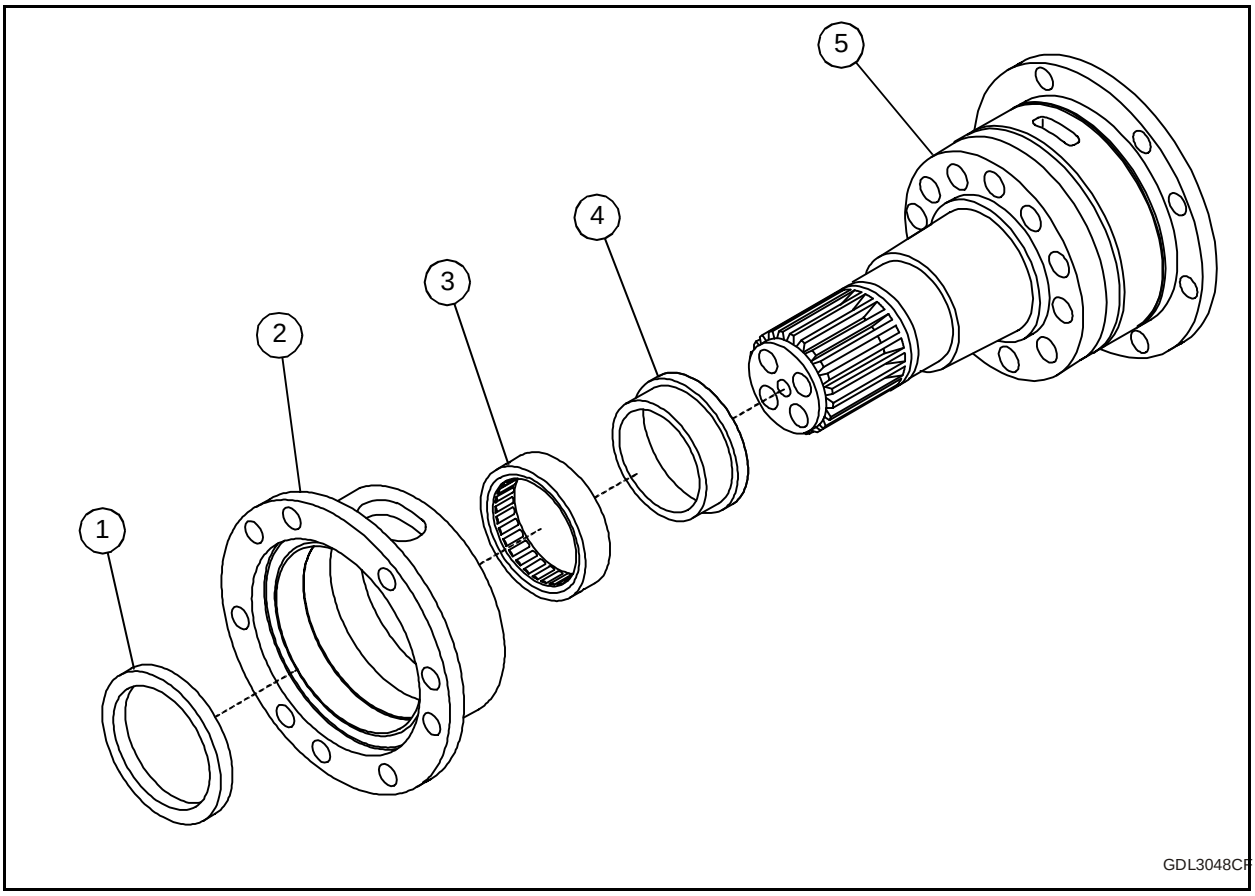
Heat inner race of bearing (3) to 85°C (185°F). Install input shaft (1).

Install retainer (7). Tighten cap screws (6) to specification.

Transfer Case Specification

Input Shaft Rear Bearing Retainer Cap Screw Torque
- 88 Nm (65 lb-ft)

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1. Seal.
2. Front Bearing Housing.
3. Bearing.
4. Race.
5. Input Shaft.

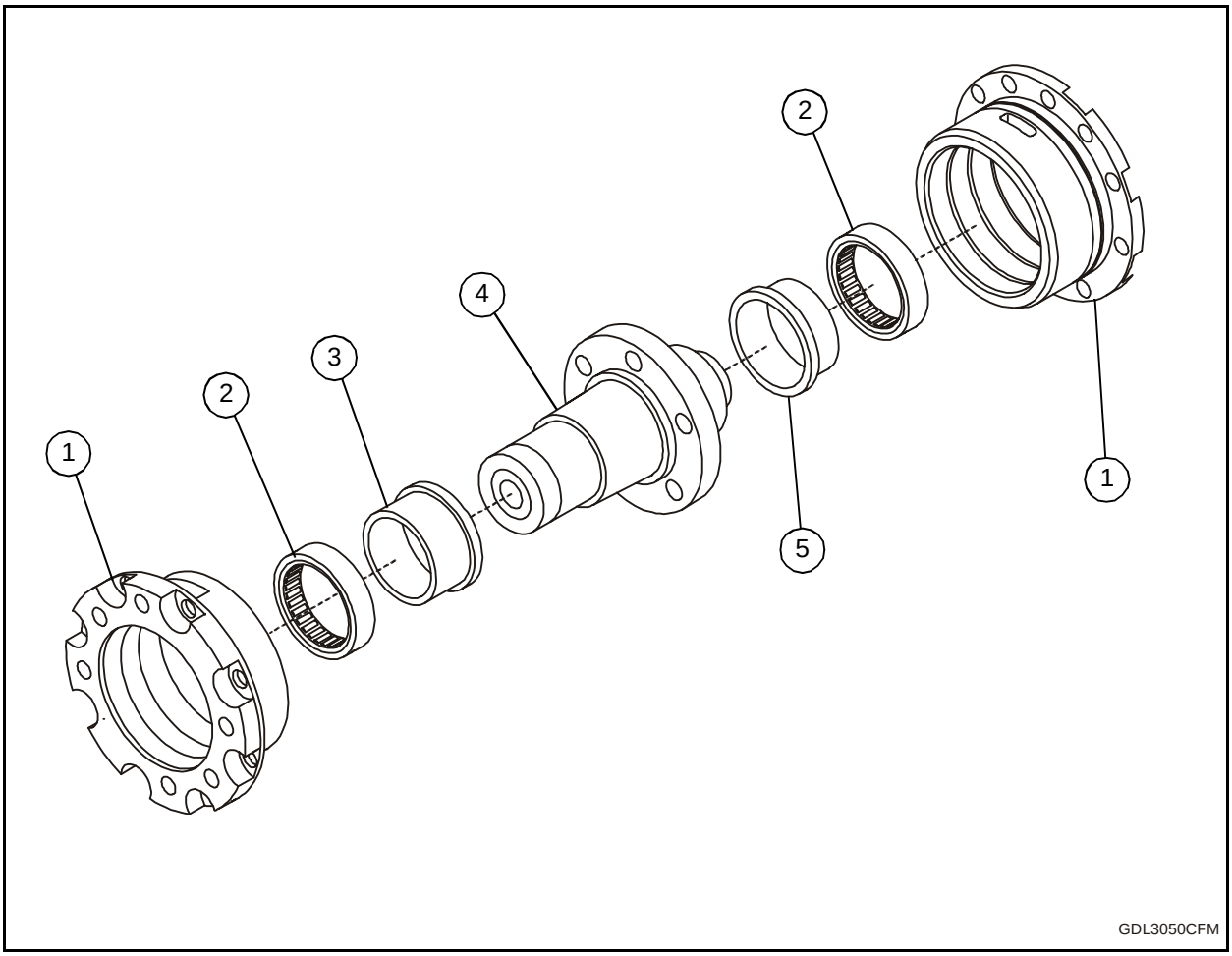
Heat housing (2) to 85° C (185° F) and install bearing (3).

NOTE: Allow housing to cool before proceeding.

Apply a thin layer of petroleum jelly to lip of seal (1) and Flexible Form-In-Place Gasket to outer edge of seal and install.

Heat bearing race (4) to 85° C (185° F) and install on shaft (5).

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1. Housing (2 used).
2. Bearing (2 used).
3. Inner Race.
4. Shaft.
5. Inner Race.

Disassemble and Assemble Idler Shaft Assembly

Use a puller to remove inner bearing races (3 and 5) from shaft (4).

Use a puller to remove bearings (2) from housings (1).

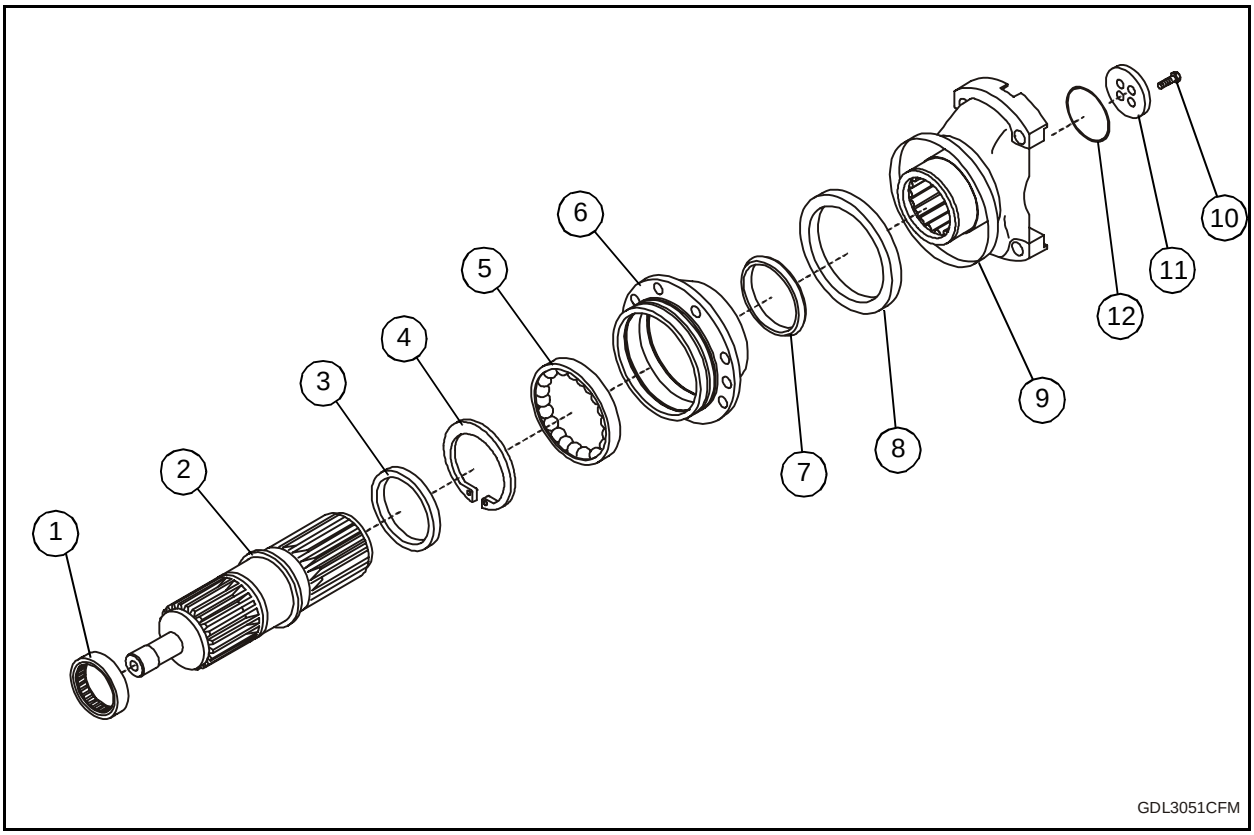
Clean, inspect, and replace parts as necessary.

Heat housings (1) to 85°C (185°F). Install bearings (2).

Heat inner bearing races (3 and 5) to 85°C (185°F).

Install bearing races on shaft (4).

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1. Bearing.
2. Shaft.
3. Inner Race.
4. Snap Ring.
5. Bearing.
6. Rear Bearing Housing.
7. Inner Race.
8. Seal.
9. Yoke.
10. Cap Screw (4 used).
11. Retainer.
12. O-Ring.

Disassemble and Assemble Rear Output Shaft Assembly

Remove yoke (9) and seal (8).

Support rear bearing housing (6) with yoke-side up and tap shaft (2) with soft-faced hammer to remove race (7) and shaft (2).

Remove snap ring (4) and remove bearing (5) with press.

Clean, inspect, and replace parts as needed.

Heat housing (6) to 85°C (185°F). Install bearings (1 and 5) and snap ring (4).

Heat inner race (3) to 85°C (185°F). Use press to push inner race (3) on shaft (2) tight to shoulder.

Install shaft (2) in housing (6).

Heat inner race (7) to 85°C (185°F). Install inner race.

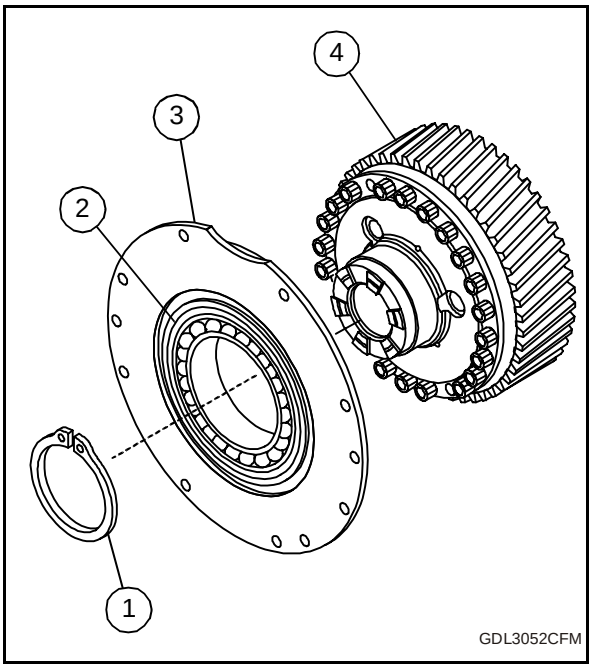
NOTE: Allow parts to cool before proceeding.

Apply a thin layer of petroleum jelly to lip of seal (8). Apply flexible form-in-place gasket to outside diameter of seal (8).

Install seal.

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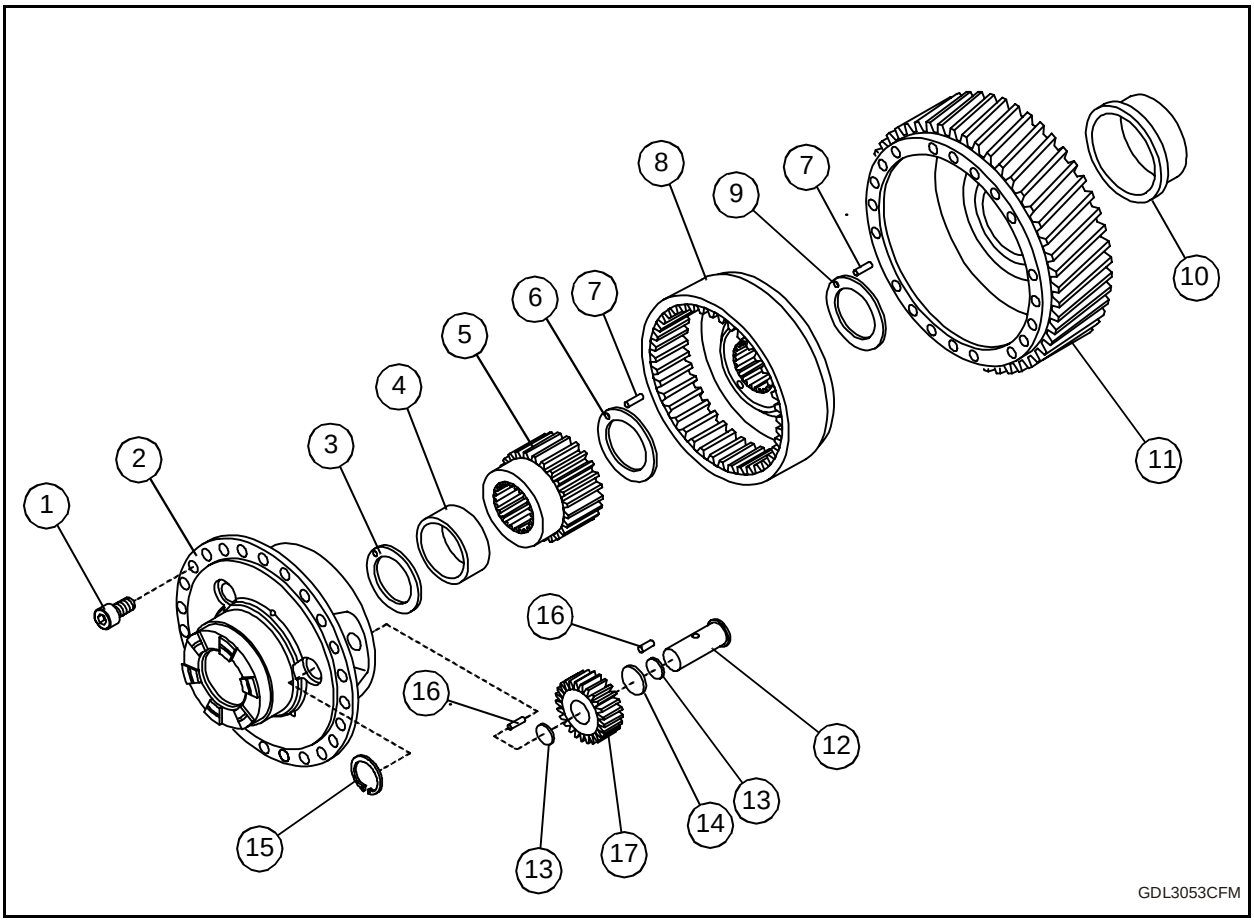
Disassemble and Assemble Planetary Gear Assembly



Remove snap ring (1). Press output gear (4) from cover (3).

Press bearing (2) from cover.

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1. Cap Screw (20 used).
2. Carrier.
3. Thrust Washer.
4. Bushing.
5. Sun Gear.
6. Thrust Washer.
7. Spring Pin (3 used).
8. Ring Gear.
9. Thrust Washer.
10. Inner Race.
11. Output Gear.
12. Shaft (3 used).
13. Wear Washer (6 used).
14. Spacer (3 used).
15. Snap Ring (3 used).
16. Needle Roller (144 used).
17. Planetary Gear (3 used).

Remove cap screws (1) and output gear (11).

Remove and inspect parts (3 - 10).

Remove snap rings (15). Using a press, remove shafts (12).

Remove planetary gears (17), needle rollers (16), spacers (14) and wear washers (13).

Inspect and replace parts as necessary.

⚠ CAUTION

Planetary Gears (17) are a matched set, replace all gears when replacing damaged gears.

Apply petroleum jelly to planetary gears (17). Install needle rollers (16), spacer (14) and wear washer (13).

Heat carrier (2) to 75°C (167°F). Put shafts (12) in freezer.

Position planetary gear and roller assembly with guide pin.

Press shaft (12) into position with oil hole toward outer edge of planetary housing (2).

Install snap rings (15) with open end toward outer edge of planetary housing.

Check to ensure planetary gears rotate freely.

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Apply low air pressure to oil hole in pins to remove petroleum jelly from oil passage.

Replace bushing (4) if worn or damaged. Install new bushing flush with inner face of carrier.

Check height of spring pins (7).

Transfer Case Specification

Planetary Thrust Washer Locating Spring Pin Height
- - - - - - - - - 1.3 ± 0.2 mm (0.051 ± 0.008 in.) Maximum

NOTE: Metal face of thrust washer (3) must face planetary carrier (2). Metal face of thrust washer (6) must face ring gear (8). Metal face of thrust washer (9) must face output gear (11).

Apply a thin layer of petroleum jelly to thrust washer (3, 6, and 9) and install with metal face towards planetary carrier, ring gear, and output gear.

Install sun gear (5) in carrier (2).

Transfer Case Specification

Sun Gear-to-Planetary Gear Backlash
- - - - - - - - - - - - - - -0.154 - 0.234 mm (0.006 - 0.009 in.)

Install ring gear (8) on planetary carrier (2). Check for free rotation of planetary gear set.

Transfer Case Specification

Planetary Gear-to-Ring Gear Backlash
- - - - - - - - - - - - - - -0.199 - 0.328 mm (0.008 - 0.013 in.)

Install output gear (11) on carrier assembly with two equally spaced cap screws without thread lock.

Tighten cap screws to initial torque.

Transfer Case Specification

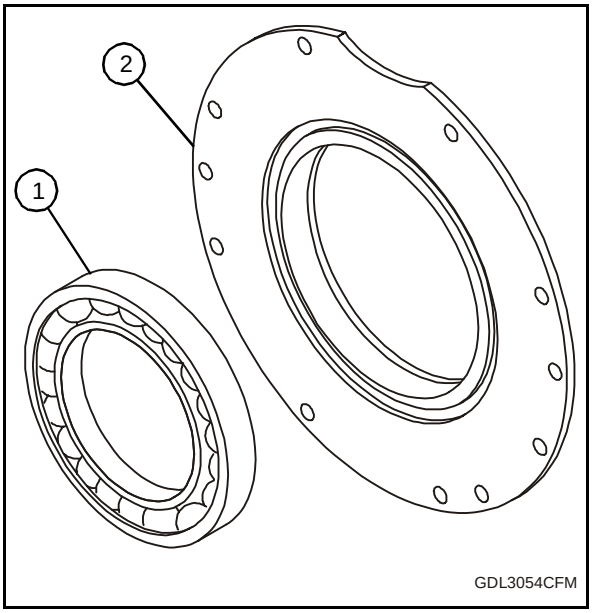
Output Gear Cap Screw Initial Torque
- -80 Nm (59 lb-ft)

Check to ensure planetary gear set rotates freely.

Apply medium strength threadlock and sealer to cap screws. Torque to specification.

Transfer Case Specification

Output Gear Cap Screw Torque- - - - 156 Nm (115 lb-ft)



Heat bearing cover (2) to 85°C (185°F). Install bearing to specified height.

Transfer Case Specification

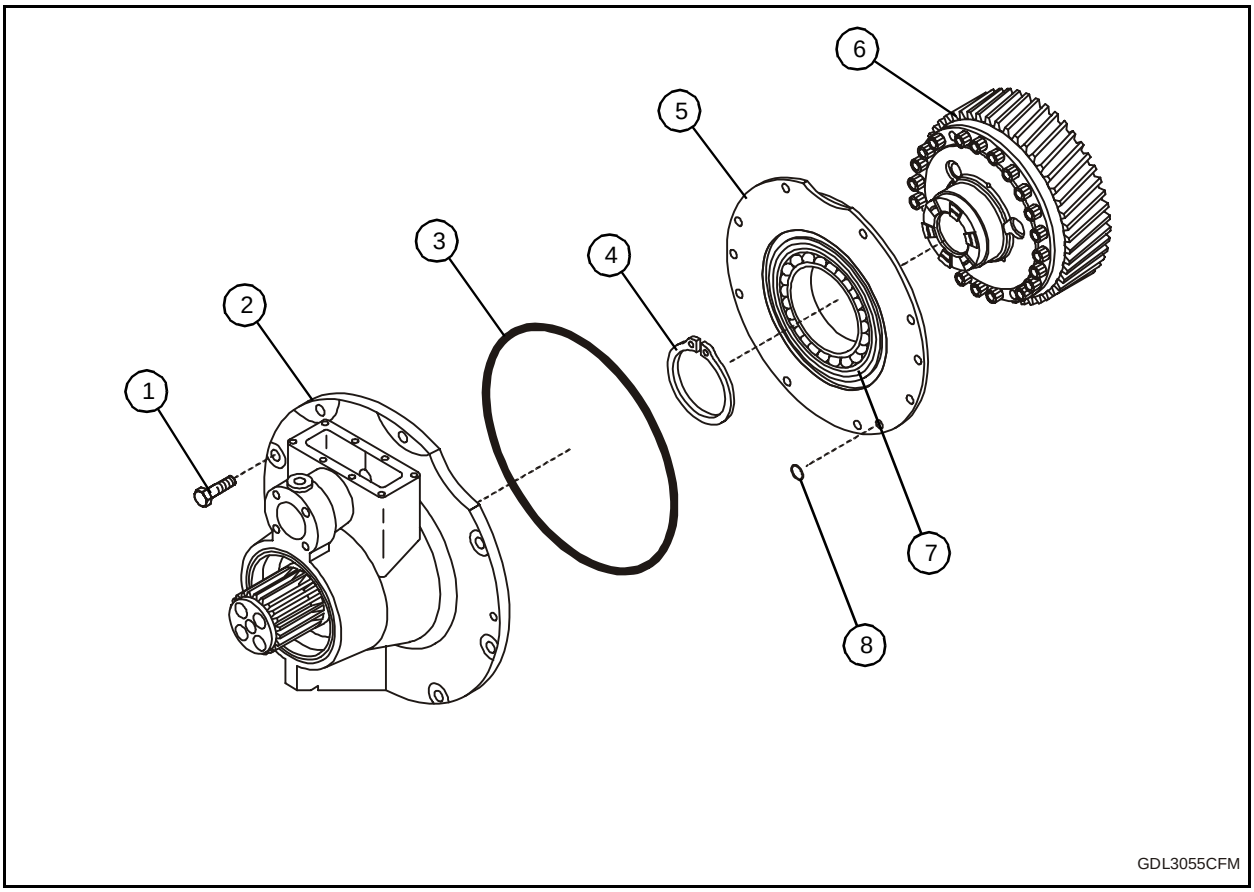
Front Output Gear Bearing Height
- - - - - - - - - - - - - 13.85 ± 0.15 mm (0.55 in. ± 0.006 in.)

Measure bearing (1) height from rear of cover (2) at three locations 120° apart.

Transfer Case Specification

Front Output Gear Bearing Height
- - - - - - - - - - -0.055 mm (0.002 in.) maximum variation

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1. Cap Screw (8 used).
2. Front Output Housing.
3. O-Ring.
4. Snap Ring.
5. Cover.
6. Planetary Housing and Output Gear.
7. Bearing.
8. O-Ring.

Heat inner race of bearing (7) to 85°C (185°F).

Install bearing and cover on planetary assembly (6).

Allow to cool. Install snap ring (4).

Install O-rings (3 and 8) in front output housing (2).

Assemble Transfer Case

NOTE: It is critical to keep housing and components dry and clean from any contaminants during the assembly procedure. Do not allow any sealants, grease, or any other contaminants on component mounting surfaces.

Clean transfer case housing thoroughly.

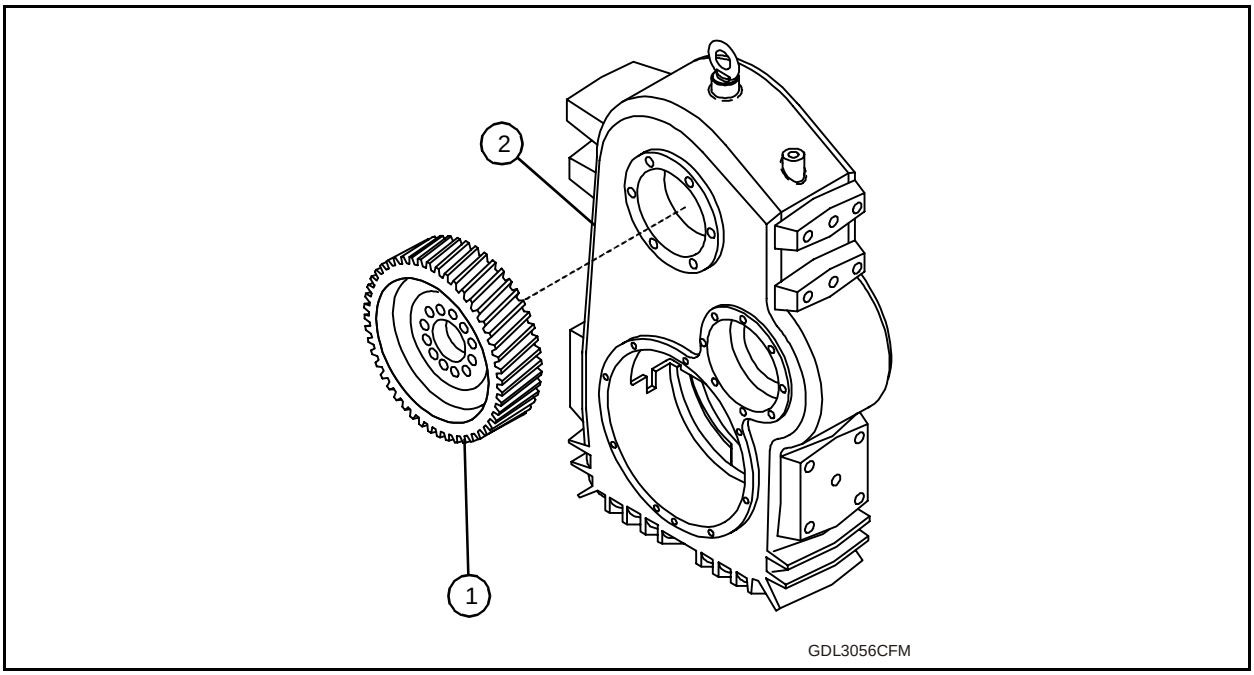
Inspect transfer case mounting surfaces for flatness and cracks at bolt holes. Remove any nicks or sharp edges using an oil stone.

Install plugs with new copper washers and tighten to specification.

Assemble Transfer Case Specification

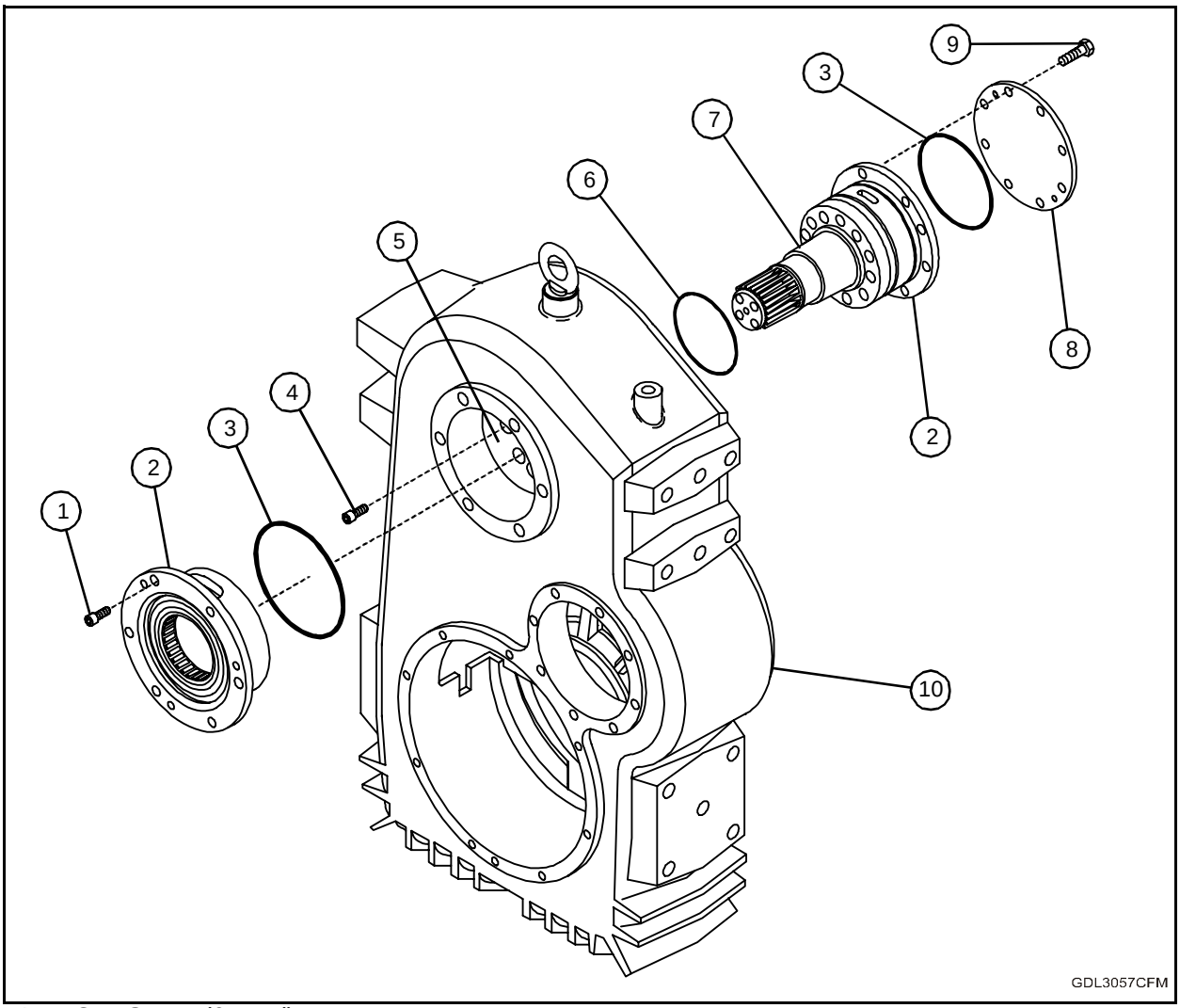
Transfer Case Filler Plugs Torque	25 Nm (221 lb-in.)

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Install input gear (1) through bottom of housing (2), with ground face towards housing. Secure gear and rotate housing 180°.

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1. Cap Screw (6 used).
2. Input Shaft Housing.
3. O-Ring (3 used).
4. Cap Screw (12 used).
5. Input Gear.
6. O-Ring.
7. Input Shaft.
8. Cover.
9. Cap Screw (8 used).

10—Transfer Case Housing

⚠ CAUTION

Input shaft (7) and input gear (5) must be keep clean during assembly.

Apply a thin layer of petroleum jelly to O-rings (3 and 6) and install.

Position input gear (5).

Install two guide pins in input shaft (7) and two guide pins in housing (10).

NOTE:Mating surfaces of housing and input shaft must remain dry and clean.

Heat transfer case housing (10) at input shaft opening to 85°C (185°F).

⚠ CAUTION

Openings in transfer case (10) and idler shaft bearing housings (2) must match for proper oil flow to bearings.

Install input shaft (7) and rear housing (2) matching openings in transfer case (1) and rear housing (2).

Install cover (8). Tighten cap screws (9) to specification.

Transfer Case Specification

Input Shaft Housing and Cover Cap Screw Torque
- 54 Nm (40 lb-ft)

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Rotate housing in stand 180° so front of housing is up.

Hold input shaft and gear secure.

Apply cure primer and medium strength thread lock on two equally spaced cap screws (4).

Tighten alternately in equal increments.

Apply medium strength thread lock and install remaining cap screws.

Transfer Case Specification

Input Gear Cap Screw Torque
- 156 Nm (115 lb-ft)

Measure axial clearance of bearing at input shaft (4).

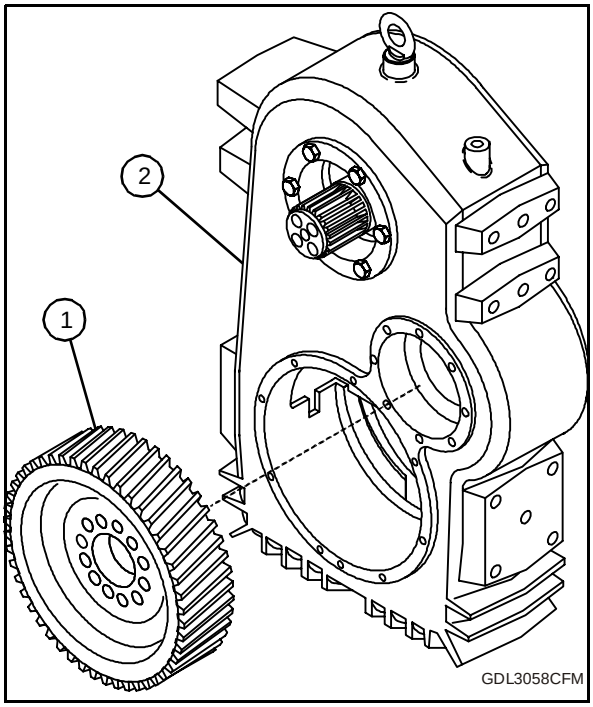
Transfer Case Specification

Input Shaft Bearing Axial Runout (Wobble)
- - - - - - - - - - - - - - - - - - 0.4-1.2 mm (0.016-0.047 in.)

Install two guide pins in housing (10). Install front bearing housing (2) matching openings in housing and transfer case.

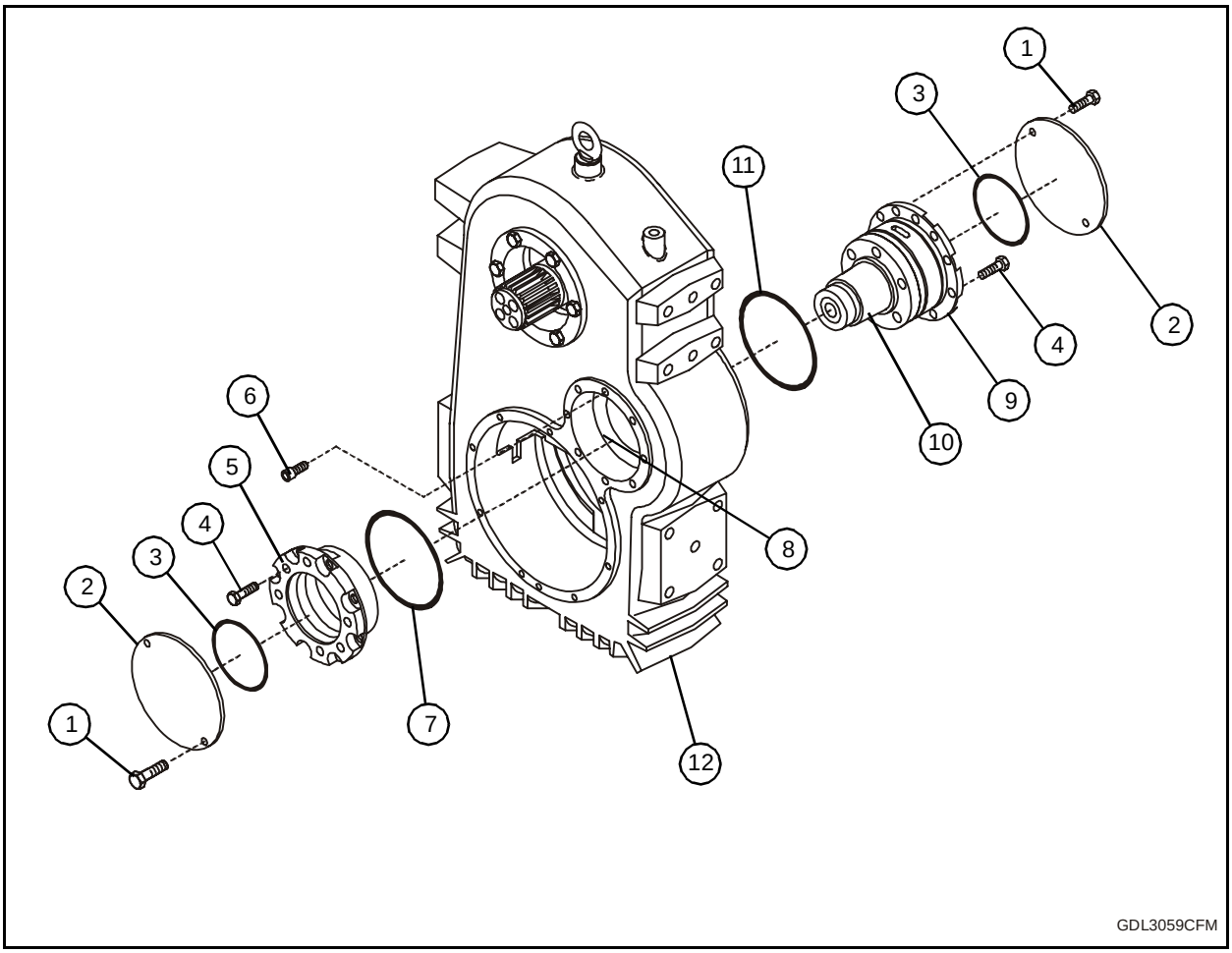
Transfer Case Specification

Input Shaft Housing and Cover Torque
- 54 Nm (40 lb-ft)



Install idler gear (1), with machined surface of gear towards housing through bottom of housing (2). Slide gear to position and secure.

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1. Cap Screw (2 used).
2. Cover.
3. O-Ring (2 used).
4. Cap Screw (16 used).
5. Front Housing.
6. Cap Screw (12 used).
7. O-Ring.
8. Idler Gear.
9. Rear Idler Shaft Bearing Housing.
10. Idler Shaft.
11. O-Ring.
12. Transfer Case Housing.

⚠ CAUTION

Housing (12) and idler shaft bearing housing (5 and 9) mounting surfaces must be kept clean.

⚠ WARNING

Openings in transfer case (12) and idler shaft bearing housings (9) must match for proper oil flow to bearings.

Apply a thin layer of petroleum jelly to O-ring (11) and install on idler housing (9).

Install guide pins to idler shaft (10) and to housing (12).

Install idler shaft (10) and bearing housing (9) matching openings in transfer case (12) and housing (9).

Remove guide pins and install cap screws (4) hand tight at this time.

Rotate housing 180° in stand so front of housing is up.

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NOTE:Tighten cap screws (6) incrementally and diagonally across making sure idler gear is square.

Apply primer and thread lock and sealer to cap screws. Install and tighten two cap screws (6) diagonally and evenly tighten, making sure idler gear is positioned properly on shaft.

Transfer Case Specification

Idler Shaft-to-Idler Gear Cap Screw Torque
- 156 Nm (115 lb-ft)

Measure axial clearance of bearing at idler shaft (10).

Transfer Case Specification

Idler Shaft Bearing Axial Runout (Wobble)
- - - - - - - - - - - - - - - - - 0.4 - 1.2 mm (0.016 - 0.047 in.)

Apply a thin layer of petroleum jelly to O-ring (7) and install on idler housing (5).

⚠ WARNING

Openings in transfer case (12) and idler shaft bearing housings (5) must match for proper oil flow to bearings.

Use guide pins to install idler shaft bearing housing (5). Make sure to match openings in transfer case (12) and housing (5).

Transfer Case Specification

Idler Shaft Housing Cap Screw Torque
- -54 Nm (40 lb-ft)

Rotate housing 180° in stand so back of housing is up.

Tighten cap screws (4) and install cover (2).

Transfer Case Specification

Idler Shaft Housing Cap Screw Torque
- -54 Nm (40 lb-ft)

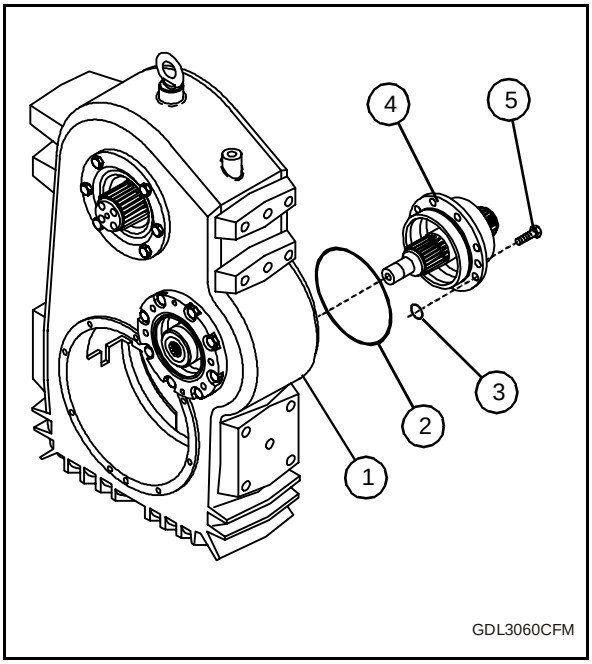
Transfer Case Specification

Idler Shaft Housing Cover Cap Screw Torque
- -88 Nm (65 lb-ft)

Check backlash between input gear and idler gear.

Transfer Case Specification

Input Gear to Idler Gear Backlash
- - - - - - - - - - - - - - - -0.25 - 0.42 mm (0.010 - 0.017 in.)



Apply a thin layer of petroleum jelly to O-rings (2 and 3).

Position O-ring (2) on rear output housing (4) and O-ring (3) on transfer case housing (1).

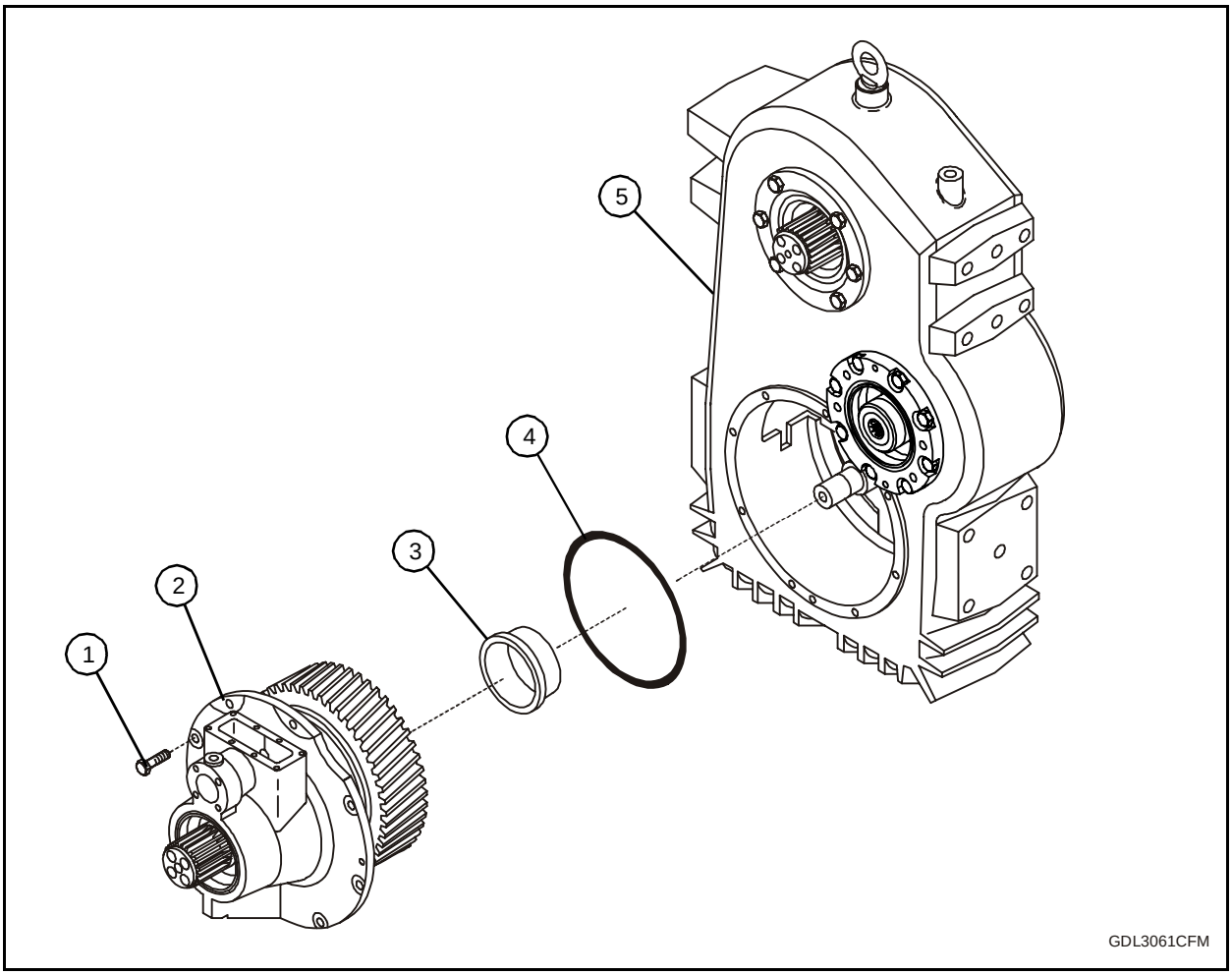
Using two guide pins install rear output housing (1).

Transfer Case Specification

Rear Output Housing Cap Screw Torque
- -54 Nm (40 lb-ft)

Rotate housing 180° in stand so front of housing is up.

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1. Cap Screw (8 used).
2. Front Output Assembly.
3. Inner Race.
4. O-Ring.
5. Transfer Case Housing.

If not previously installed heat inner race (3) to 85°C (185°F). Install inner race on front output assembly (2).

NOTE:Keep mating surfaces dry and clean.

Apply a thin layer of petroleum jelly to O-ring (4) and install.

Using guide pins, install front output assembly.

Transfer Case Specification

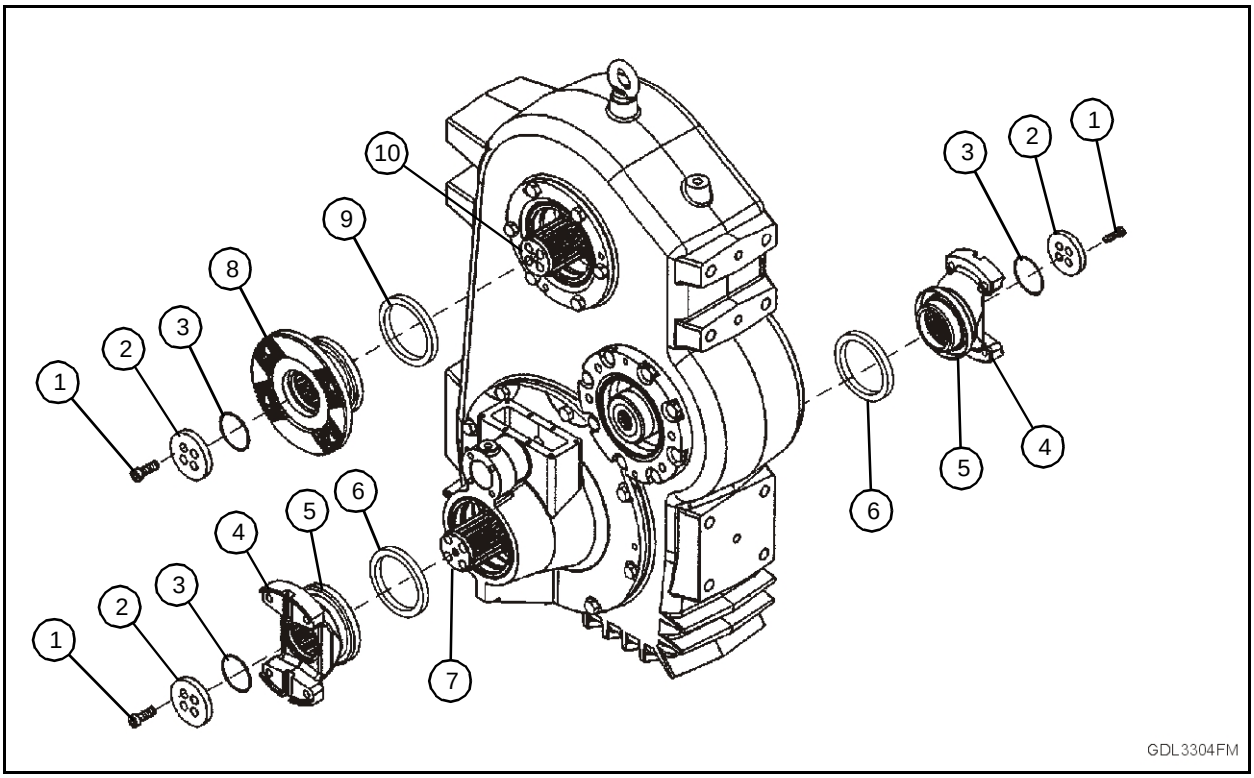
Front Output Assembly Cap Screw Torque
- 54 Nm (40 lb-ft)

Check backlash between idler gear and output gear.

Transfer Case Specification

Input Gear-to-Idler Gear Backlash 0.25 - 0.42 mm (0.010 - 0.017 in.)

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1. Cap Screw (12 used).
2. Retainer Plate (3 used).
3. O-Ring (3 used).
4. Yoke (2 used).
5. Mud Shield (2 used).
6. Seal (2 used).
7. Front Output Shaft.
8. Input Shaft Flange.
9. Seal.
10. Input Shaft.

If removed press mud shield (5) onto yoke (4).

If not previously installed, apply flexible form-in-place gasket to outer surface of seals (6 and 9) and press into housing.

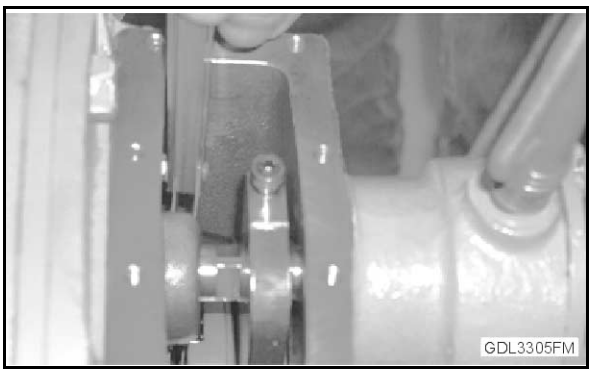
Apply anti-seize compound to O-rings (3), splines of yokes (4), and flange (8).

Apply cure primer and medium thread lock to cap screws and install yokes (4) and input flange (8).

Transfer Case Specification

Yoke and Input Flange Cap Screw Torque
- 156 Nm (115 lb-ft)

Interaxle Lock Coupler Adjustment



Rotate output yoke until teeth of slide coupler and teeth on planetary carrier are positioned to engage.

Apply air pressure to engage coupler. Coupler teeth must fully engage when air pressure is applied.

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Transfer Case Specification

Interaxle Lock Actuator Air Pressure
- - - - - - - - - - - 6 - 9.1 bar 600 - 910 kPa (87 - 132 psi)

NOTE:With coupler released, fork must clear housing.

Apply air pressure several times to engage teeth.

Check clearances and function of fork. Check for air leaks.

With coupler teeth engaged, clearance between fork rear face and coupler must be at specification. Adjust by rotating piston with adjustable two-pin spanner wrench.

Transfer Case Specification

Interaxle Lock Fork-to-Coupler Clearance 0.20 - 0.40 mm (0.008 - 0.016 in.)

With coupler disengaged, check clearance between raised tip of sliding coupler teeth and teeth on planetary carrier.

Transfer Case Specification

Interaxle Lock Coupler Teeth Clearance
- - - - - - - - - - - - - - - - - - 1.0 mm (0.039 in.) minimum

After adjustment has been completed, remove shift fork cap screw and apply medium strength thread lock and sealer. Tighten to specification.

Transfer Case Specification

Shift Fork Cap Screw Torque - - - - - 18 Nm (159 lb-in.)

NOTE:Check to be sure cover O-ring is in place.

Position O-ring install actuator cover.

Transfer Case Specification

Clutch Piston Actuating Cover Cap Screw Torque
- -54 Nm (40 lb-ft).

Apply flexible form-in-place gasket and install shift fork cover.

Transfer Case Specification

Coupler Shift Fork Cover Torque
- 12 Nm (106 lb-in.)

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CHAPTER 8. STEERING SYSTEM

SECTION 1. SECONDARY STEERING

SECONDARY STEERING PUMP

Remove And Install Secondary Steering Pump

⚠ CAUTION

Prevent personal injury from unexpected machine movement. Always install articulation locking bar before working in the articulation joint area.

Install articulation locking bar.

Mark and disconnect lines.

Remove pump. Repair or replace as necessary.

Install pump. Connect lines as marked.

⚠ CAUTION

Secondary steering pump will be damaged if housing is not filled with oil before moving machine.

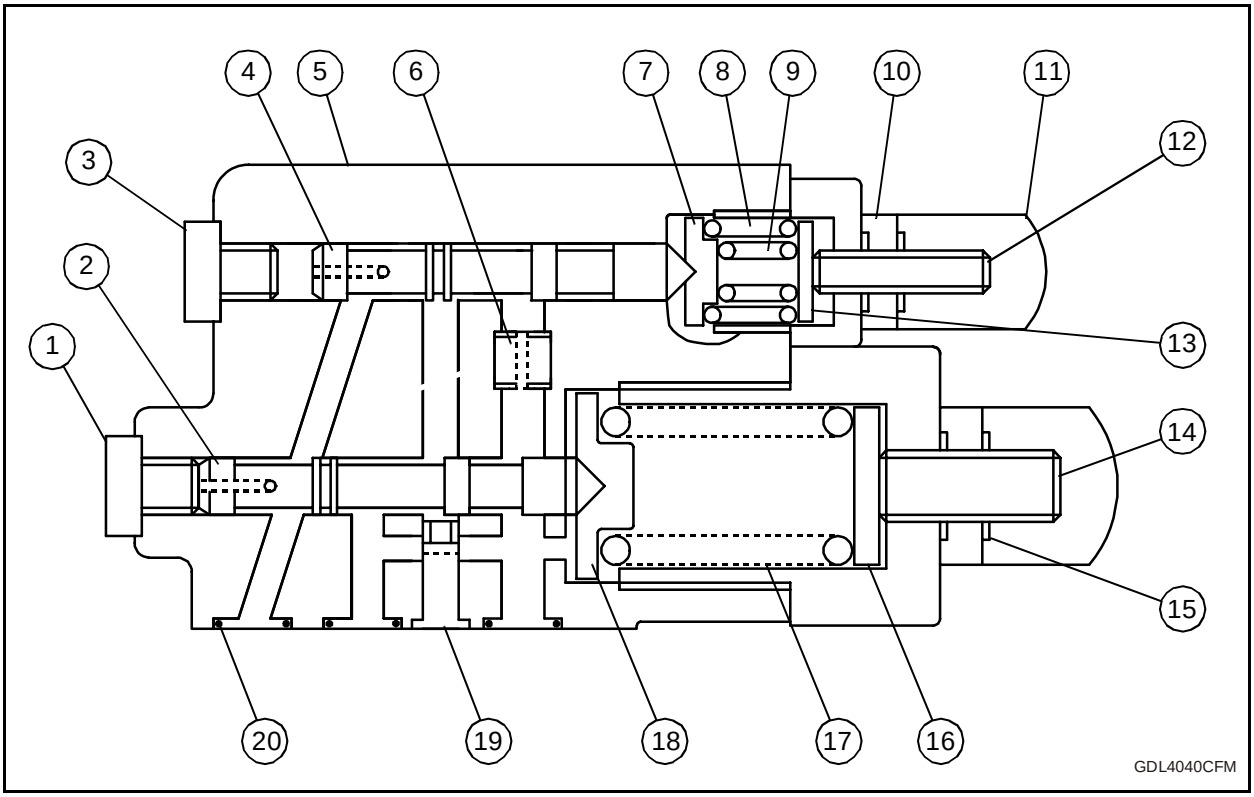
Fill pump housing with oil through drain port.

Adjust residual and compensator valves. Do Secondary Steering Pump Residual and Compensator Valves Test and Adjustment. **(See CHAPTER 6, SECTION 3 in Operation and Test Manual).**

Disassemble and Assemble

Clean and drain pump.

Remove anti-cavitation valve.

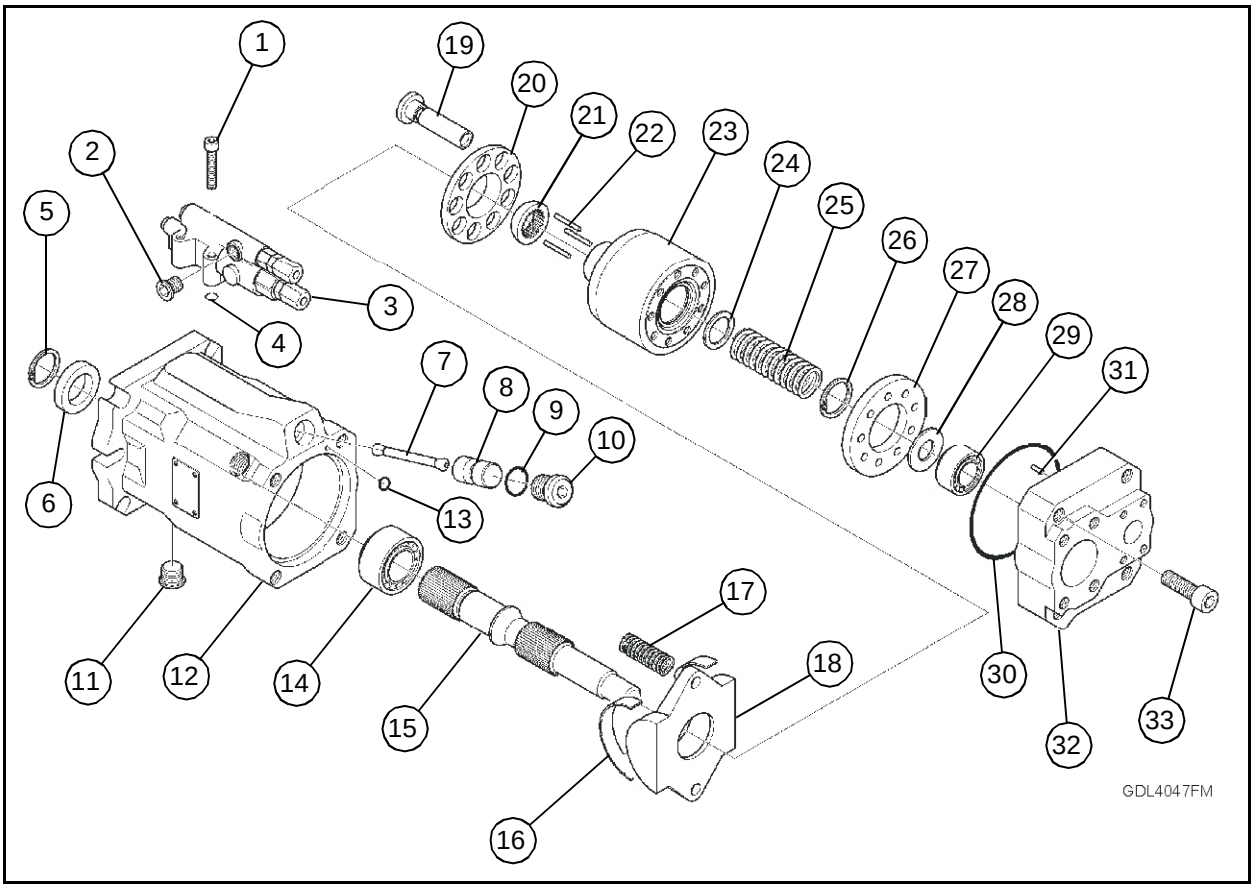


1. Plug.
2. Compensator Valve Spool.
3. Plug.
4. Residual Valve Spool.
5. Pump Regulator Valve.
6. Orifice.
7. Spring Guide.
8. Outer Spring.
9. Inner Spring.
10. Nut (2 used).
11. Cap (2 used).
12. Adjusting Screw.
13. Plate.
14. Adjusting Screw.

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15. Sealing Washer (4 used).
16. Plate.
17. Spring.
18. Spring Guide.
19. Orifice.
20. O-Ring (3 used).

Remove regulator valve. Disassemble as necessary.



1. Cap Screw (4 used).
2. Plug.
3. Pump Regulator Valve.
4. O-Ring (3 used).
5. Snap Ring.
6. Oil Seal.
7. Control Rod.
8. Control Piston.
9. O-Ring.
10. Plug.
11. Plug.
12. Pump Housing.
13. O-Ring.
14. Tapered Roller Bearing Cone and Cup.
15. Drive Shaft.
16. Swash Plate Bearing (2 used).
17. Spring.
18. Swash Plate.
19. Piston (9 used).
20. Retainer Plate.
21. Guide Ball.
22. Pin (3 used).
23. Cylinder Block.
24. Washer.
25. Spring.
26. Snap Ring.
27. Distributor Plate.
28. Spacer.
29. Tapered Roller Bearing Cone and Cup.
30. O-Ring.
31. Dowel Pin.
32. Port Plate.
33. Cap Screw (4 used).

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⚠ CAUTION

The distributor plate may stick to the port plate when removed. The highly machined surface on port plate, distributor plate, and cylinder block must not be damaged. Lay parts on clean, lint-free towels to protect the machine surfaces.

Remove port plate (32) and distributor plate (27).

Remove tapered roller bearing cone (29) and spacer (28).

Remove the rotary group (19 - 26) as an assembly.

⚠ CAUTION

Spring (25) is under compression. A press must be used to compress spring to remove snap ring (26).

Inspect cylinder block. Remove spring (25) only if replacement is necessary.

Remove control piston assembly (7 - 10).

Remove swash plate (18), drive shaft (15), spring (17), and bearings (16).

Remove tapered roller bearing cone (14) using a press. Remove bearing only if replacement is necessary.

Remove snap ring (5) and oil seal (6).

Clean and inspect all parts for wear and damage.

Replace parts as necessary.

⚠ CAUTION

Replace all oil seals and O-rings. Old seals and O-rings will leak.

Install oil seal (6) with lip facing inside of housing.

Press seal into housing just far enough to install snap ring.

Apply petroleum jelly to sealing lip.

Put pump housing in vise with large opening up, at approximately a 30° angle with control piston port at bottom.

NOTE: Apply clean oil to all internal parts as they are assembled.

Install swash plate bearings and spring.

Install tapered roller bearing cone on drive shaft tight against shoulder. Bearing cone is a press fit.

Install drive shaft and swash plate. Position spring (17) on swash plate using a screwdriver.

Install control rod (7) by pushing the swash plate to one side and moving end of control rod in the opposite direction.

Install control piston, O-ring, and plug.

Move pump housing to a horizontal position.

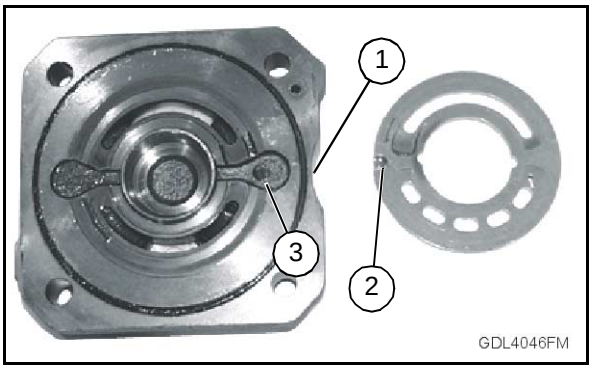
Assemble rotary group (19 - 26). A press must be used to install spring (25).

Pins (22) are installed in cylinder block between washer (24) and guide ball (21).

Install assembled rotary group into pump housing.

Install spacer (28) and bearing cone (29).

Install O-rings (13 and 30).



1. Port Plate.
2. Notch.
3. Dowel Pin.

Apply a small amount of petroleum jelly on the mating surface of distributor plate and port plate (1).

Install the distributor plate on port plate so notch (2) engages the dowel pin (3).

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Install port plate.

Tighten cap screws to specification using a crisscross pattern.

Secondary Steering Pump Specification

Port Plate-to-Pump Housing Cap Screw Torque
- 47 Nm (35 lb-ft)

Install pump regulator valve.

Install anti-cavitation valve.

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CHAPTER 8. STEERING SYSTEM

SECTION 2. HYDRAULIC SYSTEM

STEERING VALVE

Remove And Install Steering Valve

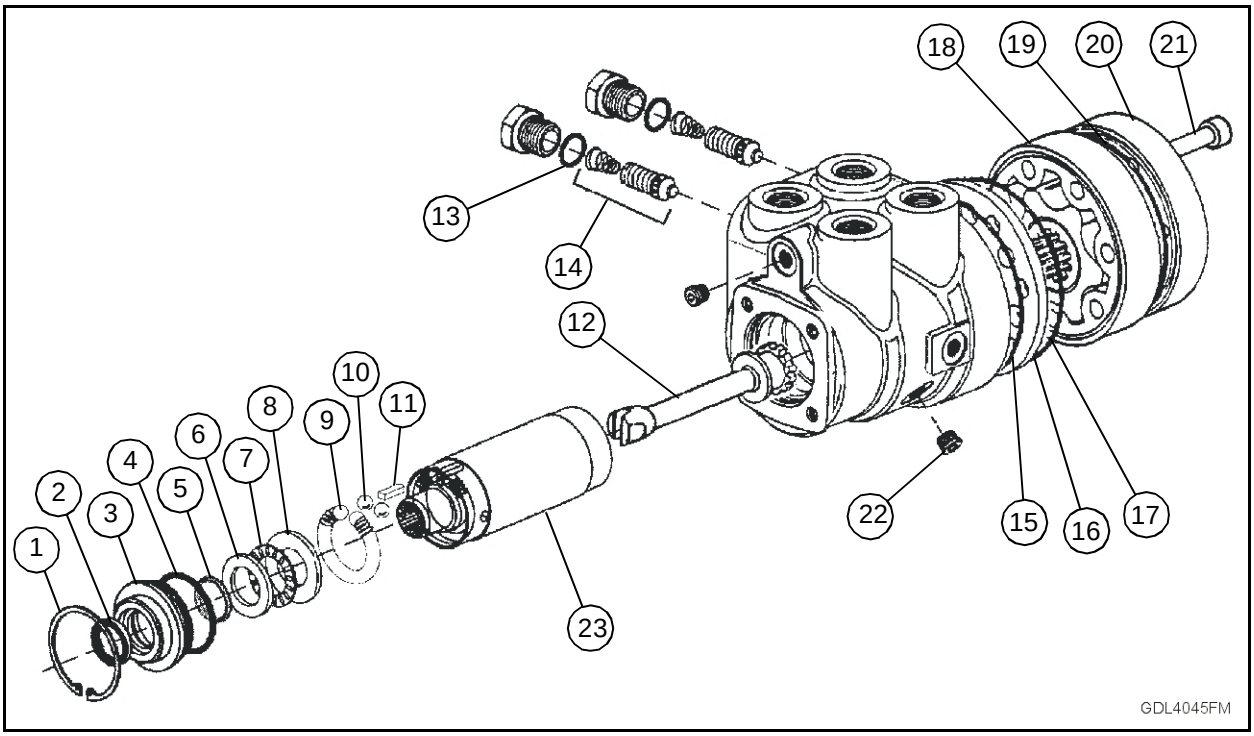
Mark and disconnect lines from steering valve. Close all openings using caps and plugs.

Remove cap screws and steering valve.

Disassemble and assemble steering valve as necessary.

Install steering valve.

Connect lines as marked.



1. Snap Ring.
2. Seal.
3. Retainer.
4. O-Ring.
5. Seal (three piece).
6. Bearing Race.
7. Thrust Bearing.
8. Bearing Race.
9. Spring.
10. Ball (2 used).
11. Key.
12. Drive Shaft.
13. O-Ring (2 used).
14. Relief Valve (2 used).
15. O-Ring.
16. Wear Plate.
17. O-Ring.
18. Gerotor Assembly.
19. O-Ring.
20. End Cap.
21. Cap Screw (7 used).
22. Plug.
23. Spool.

Disassemble and Assemble

Clean steering valve housing.

Drain oil from housing.

Remove relief valves (14) and plug (22).

Put pump in vise with gerotor end up. Scribe a line across housing to aid in assembling.

Remove gerotor assembly parts (15 - 21).

Remove drive shaft (12).

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Remove snap ring (1), spool (23), and parts (2 - 11).

⚠ WARNING

Spool must be replaced as an assembly.

Clean and inspect parts for wear or damage.

Replace as necessary.

⚠ CAUTION

Replace all seals and O-rings with new. Apply petroleum jelly to all seals and O-rings. Apply clean hydraulic oil to all internal parts while assembling.

Install parts (1 - 5) into housing.

Install bearing race (6), thrust bearing (7), and bearing race (8).

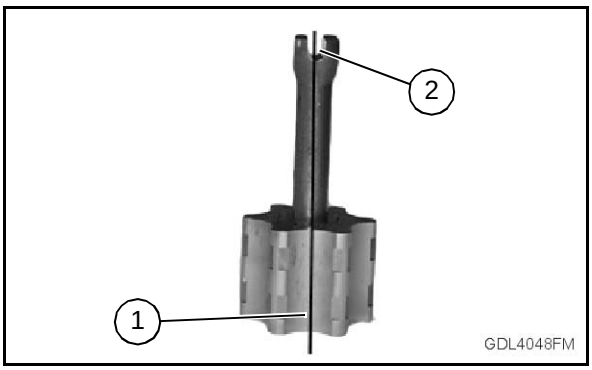
Install spool (23).

Mark splined end of drive shaft (12) to indicate position of slot on opposite end.

Install drive shaft, O-ring (15), and wear plate (16).

⚠ WARNING

Strong steering wheel oscillation can occur if gerotor is not timed. For correct operation, the gerotor must be installed with two opposing star roots (1) in alignment with slot (2) at opposite end of drive shaft.



Install O-ring (17) and gerotor assembly (18). Gerotor star must be installed on drive shaft with two opposing star roots aligned with indicator mark on drive shaft.

Install O-ring (19), end cap, and cap screws. Tighten cap screws in a crisscross pattern to specification.

Steering Valve Specification

End Cap-to-Housing Cap Screws Torque
---------- 165 Nm (120 lb-ft)

Install plug (22) and relief valves.

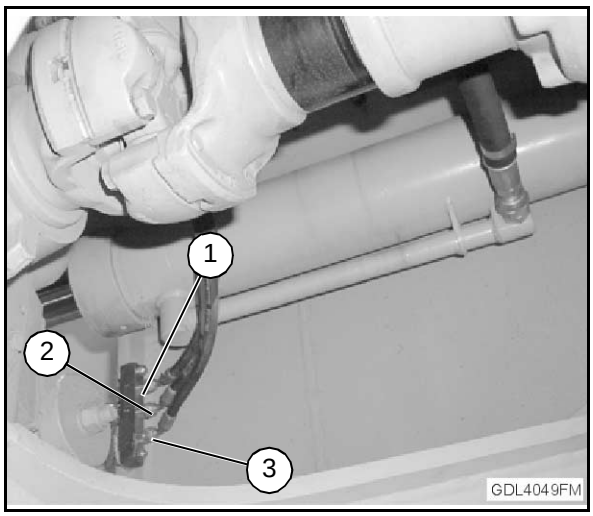
Steering Cylinder

Remove and Install Steering Cylinder

Install articulation safety lock bar. **(See Install Articulation Safety Lock Bar Operator's Manual CHAPTER 7, SECTION 1).**

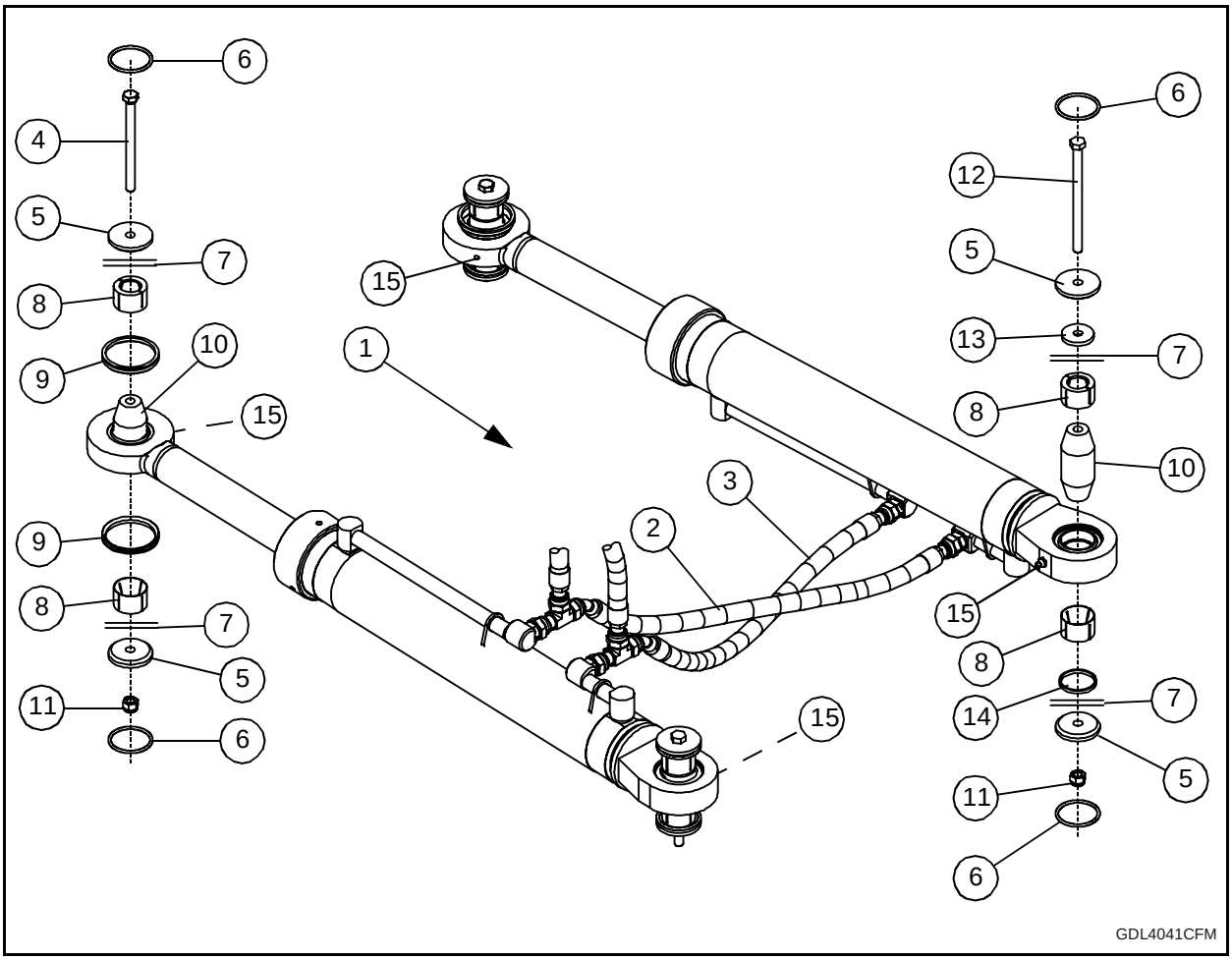
Relieve hydraulic pressure. **(See Pre-Service instructions in Operator's Manual CHAPTER 7, SECTION 1).**

Drain hydraulic reservoir. **(See Change Hydraulic Oil in Operator's Manual CHAPTER 16).**



For left-side steering cylinder removal, label and disconnect hydraulic control valve test lines (1 - 3).

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1. Front of Machine.
2. Hydraulic Line - Right Turn Pressure.
3. Hydraulic Line - Left Turn Pressure.
4. Cap Screw (2 used).
5. End Plate (8 used).
6. O-Ring (8 used).
7. Cylinder-to-Frame Mount (8 used).
8. Expanding Cone (8 used).
9. V-Ring (4 used).
10. Pin (4 used).
11. Nut (4 used).
12. Cap Screw (2 used).
13. Washer (2 used).
14. Spacer Ring (2 used).
15. Grease Fitting (4 used).

Label grease lines and disconnect from fittings (15).

Label and disconnect hydraulic lines (2 and 3).

⚠ CAUTION

Component is heavy. Use lifting device.

Steering Cylinder Specification

Steering Cylinder Weight- - - - - - - - - - - 95 kg (210 lb)

Attach a lifting device to cylinder.

Disassemble cylinder pivot assemblies (4 - 14). Lower cylinder from machine.

Clean, inspect, repair, or replace parts as necessary.

Raise cylinder to machine. Assemble pivot assemblies. Pack pivot assemblies with fresh grease.

Connect hydraulic lines.

Connect grease lines.

For left-side steering cylinder removal, connect hydraulic test lines.

Fill hydraulic reservoir. **(See Change Hydraulic Oil in Operator's Manual CHAPTER 16).**

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Disassemble and Assemble

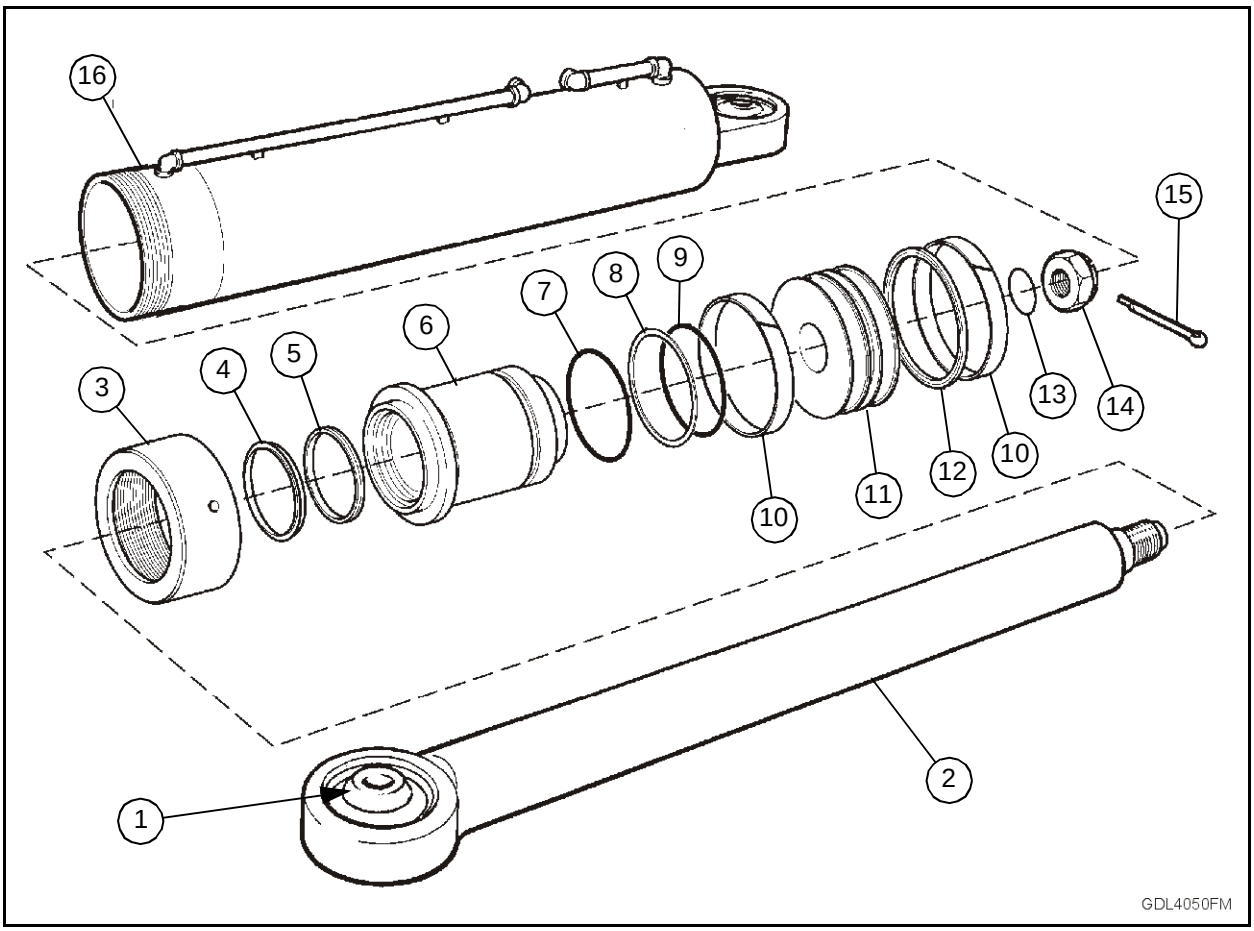
⚠ CAUTION

Component is heavy. Use hoist.

Steering Cylinder Specification

Steering Cylinder Weight - - - - - - - - - - - 95 kg (210 lb)

Install cylinder on a cylinder service stand such as JT30043 Cylinder Service Stand.



1. Bushing.
2. Rod.
3. Barrel Nut.
4. Wiper Seal.
5. U-Seal.
6. Rod Guide.
7. O-Ring, Rod Guide Outside.
8. Backup Ring.
9. O-Ring, Rod Guide Inside.
10. Wear Ring (2 used).
11. Piston.
12. Seal.
13. O-Ring, Piston Inside.
14. Nut.
15. Cotter Pin.
16. Barrel.

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Unscrew barrel nut (3) from barrel (16) with spanner wrench. Remove barrel nut, rod (2), rod guide assembly (4 - 9), and piston assembly (10 - 15) from barrel.

Remove and disassemble piston assembly.

Remove and disassemble rod guide assembly.

Remove barrel nut.

Clean, inspect, or replace parts as necessary.

NOTE: Apply clean hydraulic oil to all rod guide and piston components during assembly.

Assemble rod guide assembly.

- Install U-seal (5) and wiper seal (4) in rod guide (6). U-seal lip must face rod end.
- Install outside O-ring (7) and backup ring (8) on rod guide.
- Install inside O-ring (9) in rod guide.

Install barrel nut on rod.

Install rod guide assembly on rod.

Install seal (12) and wear rings (10) on piston (11).

Install piston on rod.

Install O-ring (13) on rod. Ensure O-ring is firmly seated on piston.

Apply rigid form-in-place gasket to threads of nut (3). Tighten nut to specification. Install cotter pin (15).

Steering Cylinder Specification

Piston Retaining Nut Torque - - - - - 400 N•m (295 lb-ft)

Install rod in barrel.

Apply an anti-seize lubricant to threads of barrel nut. Tighten barrel nut.

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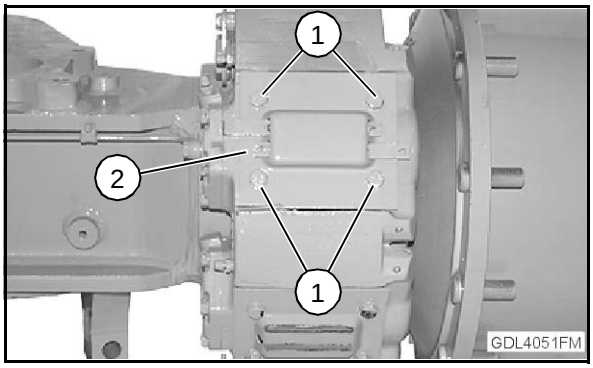
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CHAPTER 9. SERVICE BRAKES

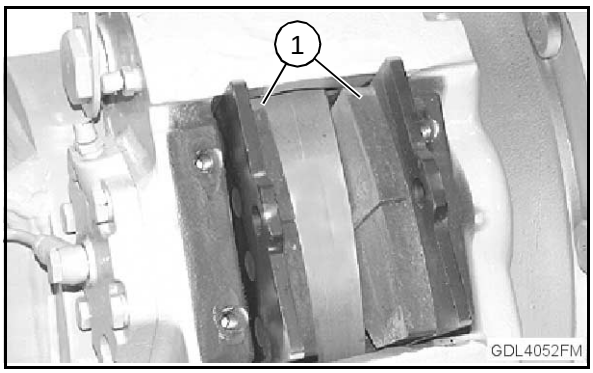
SECTION 1. ACTIVE ELEMENTS

SERVICE BRAKES B35D



Remove wheel. **(See Wheels “REMOVAL AND INSTALLATION” on page 1).**

Remove four cap screws (1) and retaining plate (2).



Remove brake pads (1).

Repeat steps 1 - 3 for two lower remaining brake pads.

Retract caliper pistons.

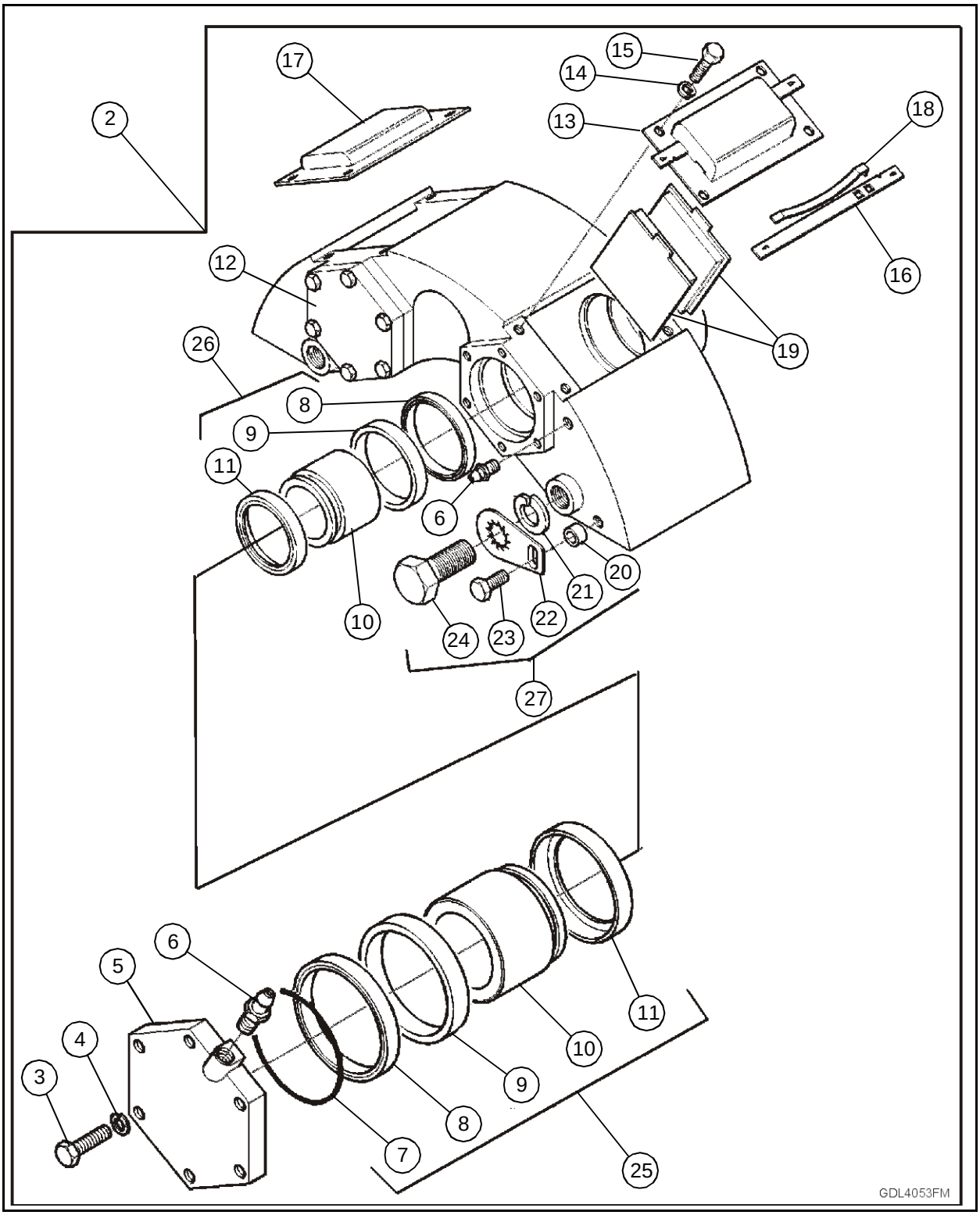
Install brake pads.

NOTE: Wear indicator plate is for upper pads only.

Install retaining plate with indicator tabs positioned over brake pads.

Repeat steps 5 - 7 for two lower remaining brake pads.

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1. Not Used.
2. Brake Caliper.
3. Cap Screw (12 used).
4. Thrust Washer (12 used).
5. Cover (2 used).
6. Bleed Screw (6 used).
7. O-Ring (2 used).
8. Scraper Ring (4 used).
9. Seal (4 used).
10. Piston (4 used).
11. Boot (4 used).
12. Cover.
13. Cover.
14. Thrust Washer (8 used).
15. Cap Screw.
16. Rail (2 used).

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17. Cover.
18. Leaf Spring (2 used).
19. Brake Actuating Disk (4 used).
20. Washer (4 used).
21. Spring Washer (4 used).
22. Lock Plate (4 used).
23. Cap Screw (4 used).
24. Cap Screw (4 used).
25. Seal Kit.
26. Kit, Piston.
27. Kit, Caliper.

Remove and Install Caliper

Remove brake pads.

Disconnect brake line from caliper.

Remove cap screws (23) and lock plates (22).

Remove bolts (24).

⚠ CAUTION

Component is heavy. Use hoist.

Service Brakes 350D Specification

Service Brake Caliper Weight
- - - - - - - - - - - - - - - - - - - -46 kg (100 lbs) approximate

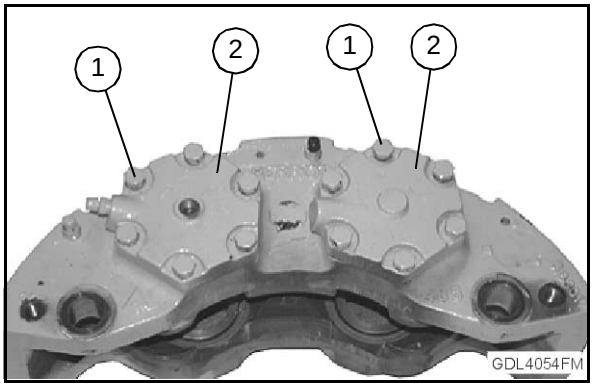
Remove brake caliper.

Apply an anti-seize lubricant to bolts (24) and install.

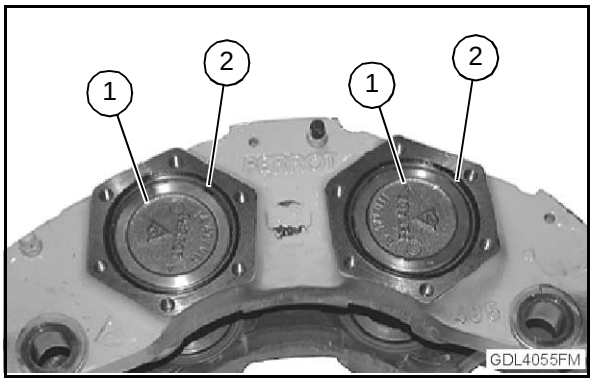
Install brake pads.

Disassemble and Assemble Caliper

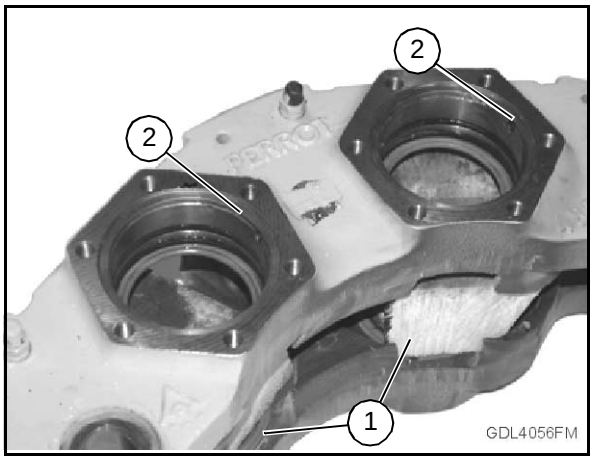
Remove brake caliper.



Remove cap screws (1) and covers (2).



Remove O-rings (2) and push pistons (1) out of bores using hand pressure.

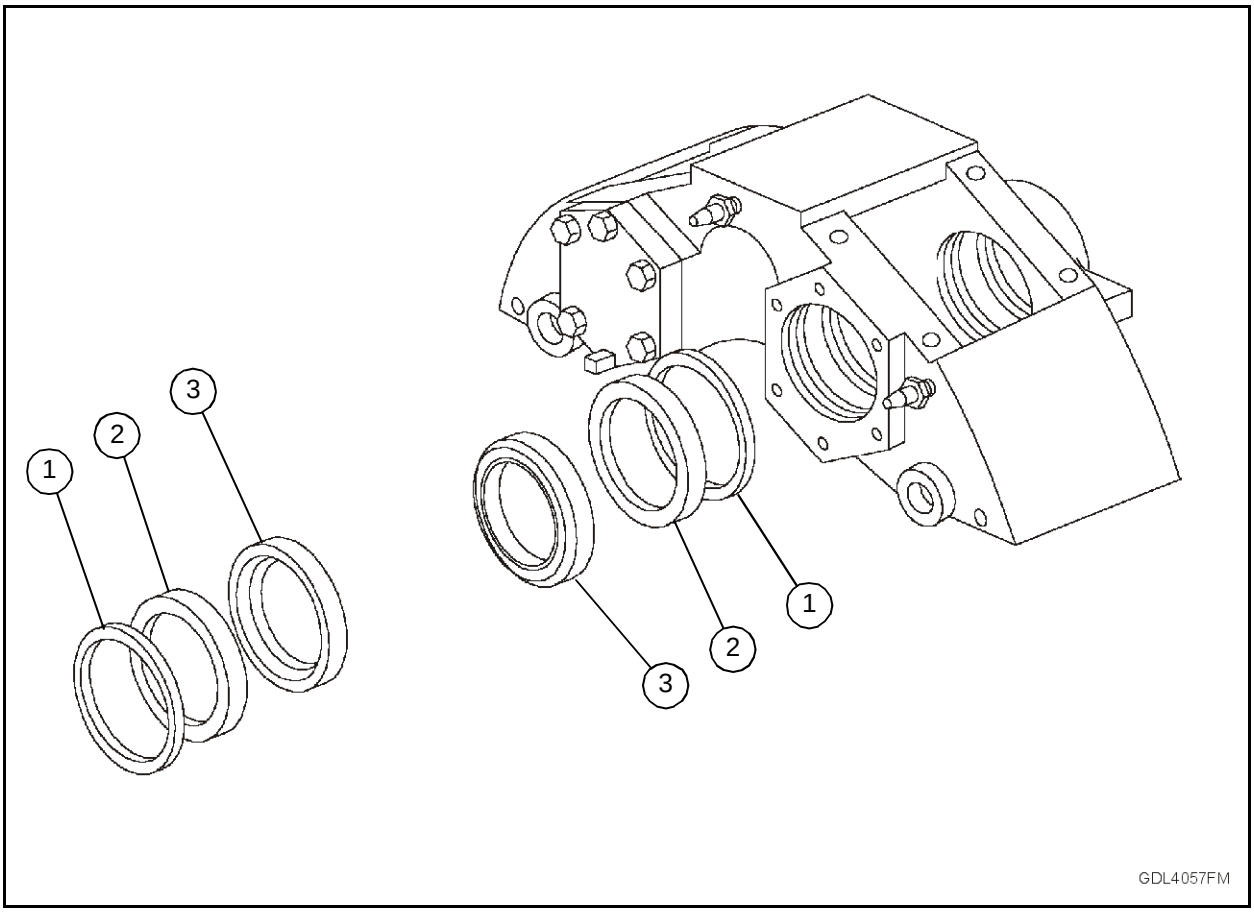


Put wood blocks (1) as shown and apply air pressure to ports (2) to remove two remaining pistons.

Service Brakes B35D Specification

Wood Block Thickness - - - - - - - - - - - - - 51 mm (2 in.)

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Remove lip seal (1), square cut seal (2), and dust boot seal (3) from each piston bore.

Inspect, repair, and replace parts as necessary.

⚠ CAUTION

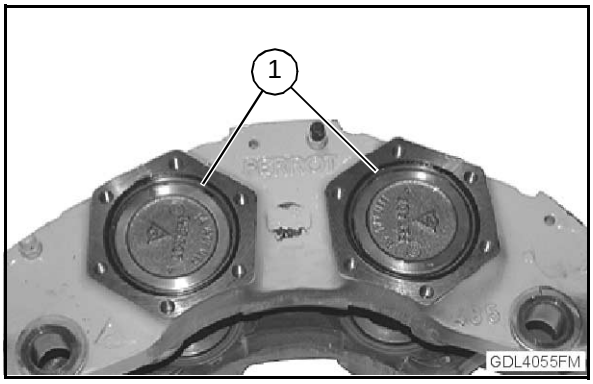
Install lip seal with lip side of seal facing pressure side of bore.

Apply a thin layer of petroleum jelly to seals (1 and 2). Install seals into piston bore.

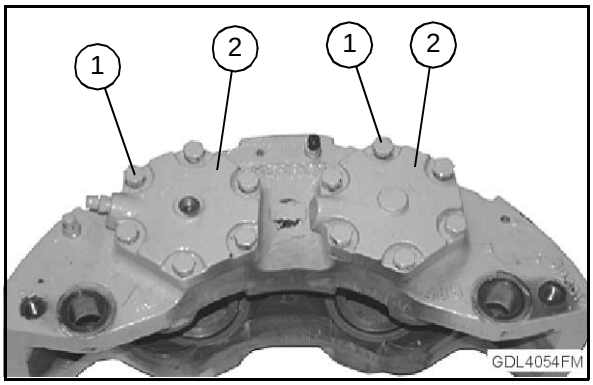
Apply a thin layer of petroleum jelly to piston. Install piston in bore.

Install dust boot seal (3).

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Install O-rings (1).



Install covers (2) and cap screws (1).

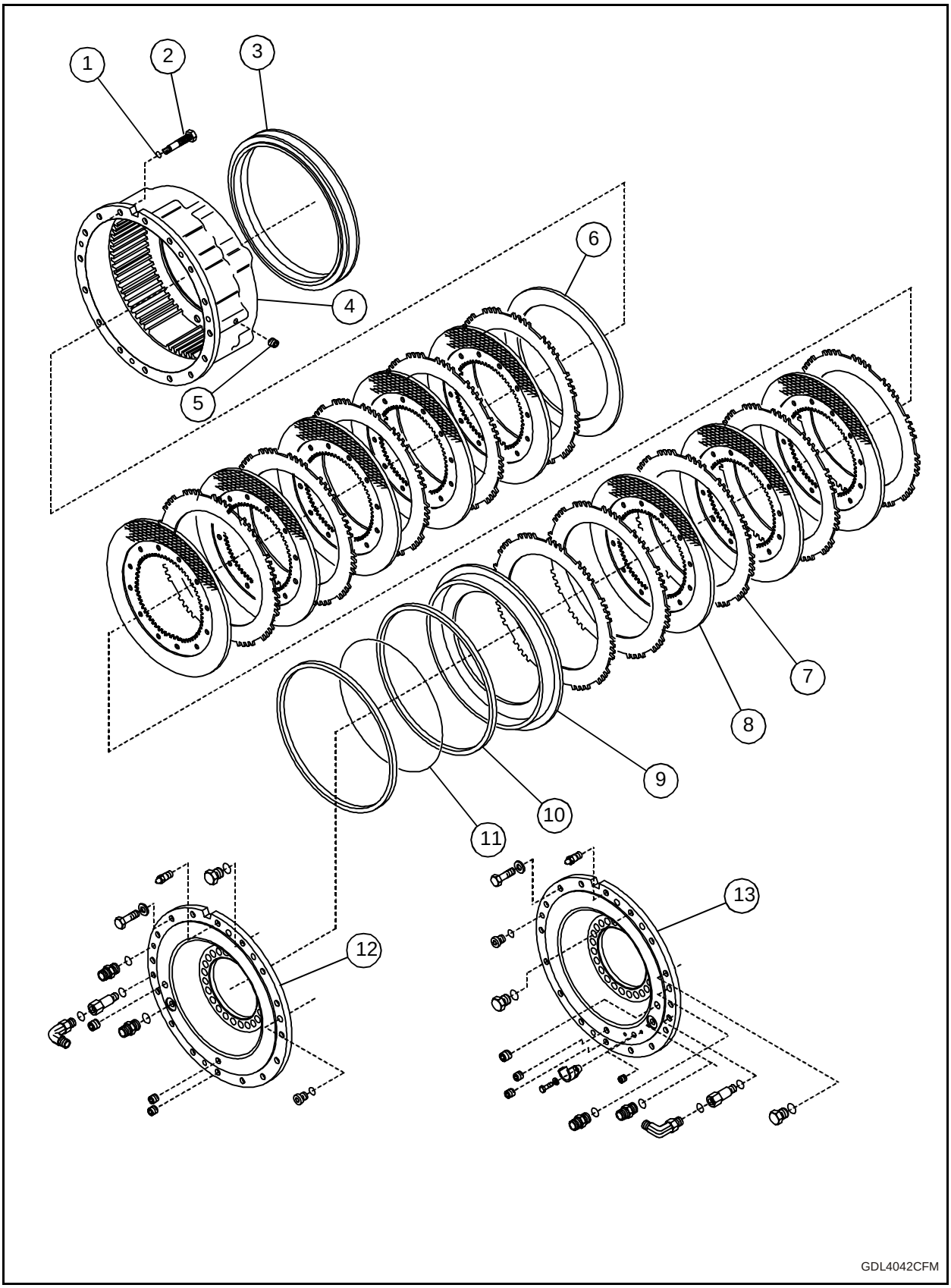
Install brake caliper.

Remove and Install Brake Disk

Remove axle hub. **(See "Axle Hubs" on page 41).**

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Service Brakes B40D



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1. Washer (16 used).
2. Cap Screw (16 used).
3. Face Seal.
4. Brake Housing.
5. Plug.
6. Spacer.
7. Separator Plate (10 used).
8. Friction Disk (8 used).
9. Piston.
10. Seal (2 used).
11. Seal Spacer.
12. Cover Plate (Left Front and Right Middle Axle).
13. Cover Plate (Right Front and Left Middle Axle).

Remove and Install Service Brakes B40D

Remove wheel. **(See "REMOVAL AND INSTALLATION" on page 1).**

Drain cooling oil from wet disk brake housing.

⚠ WARNING

DO NOT let metal face seals fall to the floor during removal of outboard planetary housing. Damage to metal face seals will occur.

Remove outboard planetary and housing. **(See "AXLE OUTBOARD PLANETARIES" on page 39).**

⚠ CAUTION

Store face seal set with metal sealing surfaces together. If surfaces are damaged, face seal must be replaced as a matched set.

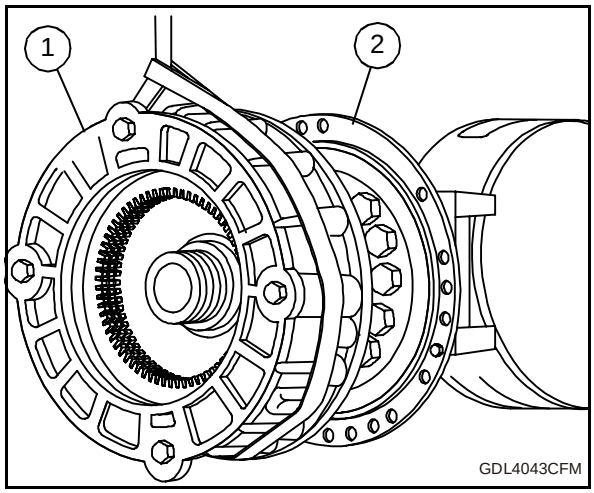
Remove face seal assemblies from outboard planetary and wet disk brake housings.

⚠ CAUTION

Component is heavy. Use hoist.

Service Brakes B40D Specification

Wet Disk Brake Housing Weight - - - - - 116 kg (255 lb)



Attach lifting sling and hoist to brake housing.

Remove cap screws and washers. Move brake housing (1) away from cover plate (2).

Clean and inspect all brake housing parts. Replace parts as necessary. **(See "Disassemble and Assemble Planetary Housing" on page 245).**

⚠ CAUTION

Silicone gasket must not enter brake housing port holes. If port holes are blocked by gasket, damage to wet brakes will occur.

Apply a 3.0 mm (0.125 in.) bead of RTV silicone form-in-place gasket on mounting surface of brake housing.

Gasket must go completely around every cap screw hole and port hole.

Evenly spread bead around mounting surface making sure gasket does not enter port holes.

Attach lifting sling and hoist to brake housing making sure inlet and bleeder screw ports will line up with correct holes in cover plate.

Install two guide studs opposite one another on brake housing.

Install brake housing onto cover plate making sure port holes are correctly aligned.

Apply high strength thread lock compound to cap screws.

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Install cap screws and washers.

Replace guide studs with cap screws and washers.

Tighten to specification.

Service Brakes B40D Specification

Cover Plate-to-Brake Housing Cap Screw Torque
- 870 Nm (640 lb-ft)

⚠ CAUTION

Install "Matched Set" face seals only. DO NOT mix new and used face seals.

Clean metal and rubber rings of face seal with isopropyl alcohol.

If wear or damage is found, replace face seal as a matched set.

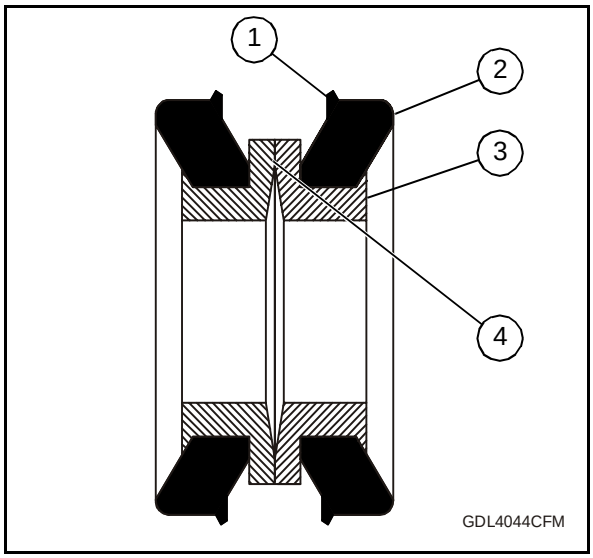
A matched set is two new rings or two used rings that have been run together.

Clean face seal bores of planetary housing and brake housing with isopropyl alcohol. Inspect bores.

Remove small marks or scratches with fine emery cloth or a fine abrasive stone. If marks or scratches cannot be removed, replace housing.

⚠ WARNING

Face seal rubber ring and all surfaces that contact the rubber ring must be clean and dry before installation. If these surfaces are not clean and dry, face seal will leak.



Install rubber ring (2) of face seal onto metal ring (3) with lip (1) facing metal ring.

⚠ CAUTION

Rubber and metal seal rings must be assembled before installing into bore.

Install assembled face seals in planetary housing and brake housing bores until rubber seal contacts bottom of bore. Apply a light film of brake cooling oil on contact area (4) of the two metal rings.

Install outboard planetary housing. **(See "AXLE OUTBOARD PLANETARIES" on page 39).**

Check face seal and hub seal for leakage. **(See "Face Seal and Hub Seal Leakage Check" on page 245.)**

Install axle shaft and outboard planetary. **(See "AXLE OUTBOARD PLANETARIES" on page 39).**

Fill brake housing and check wet disk brake cooling oil level. **(See Check Wet Disk Brake Cooling Oil Level - B40D Operator's Manual, CHAPTER 12, SECTION 4).**

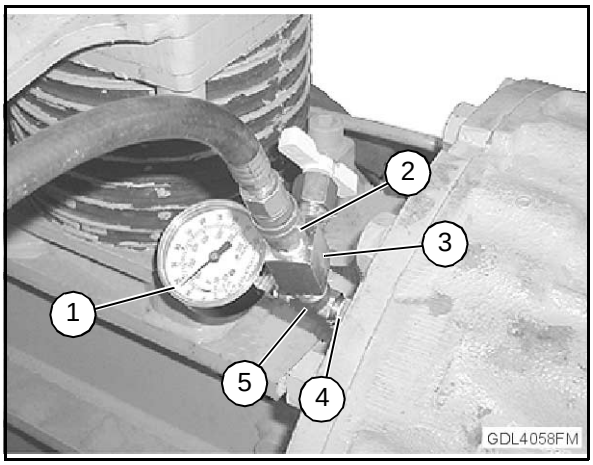
Bleed wet disk brake cooling system. **(See Change Wet Disk Brake Cooling Oil - B40D Operator's Manual, CHAPTER 15, SECTION 2).**

Bleed Service Brake Hydraulic System. **(See "BLEED SERVICE BRAKE HYDRAULIC SYSTEM" on page 249).**

Install wheel. **(See "REMOVAL AND INSTALLATION" on page 1).**

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Face Seal and Hub Seal Leakage Check



1. Gauge.
2. Male Quick Coupler.
3. Shut-Off Valve.
4. Adapter.
5. Tee.

Remove brake cooling inlet and outlet lines. Close open fittings using a JT03035 7/8-14F Cap and JT03163 7/8-14M Plug.

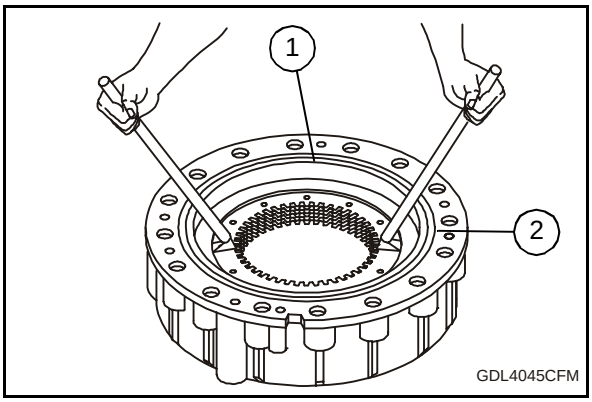
Remove top brake housing plug. Install a 0 - 200 kPa (0 - 2 bar) (0 - 30 psi) gauge (1), shut-off valve (3), and air supply male quick coupler (2) using a tee (5) and Parker No. 10-1/4F50G Adapter (4).

Close shut-off valve. Connect a regulated air supply of 100 kPa (1 bar) (15 psi) to male quick coupler.

NOTE: Rotate planetary housing a few times before doing check to ensure seals are properly seated.

Open shut-off valve to pressurize brake housing. Close shut-off valve and observe gauge for 5 minutes. If pressure drops below 100 kPa (1 bar) (15 psi), inspect and replace face seal and hub seal as necessary.

Disassemble and Assemble Planetary Housing

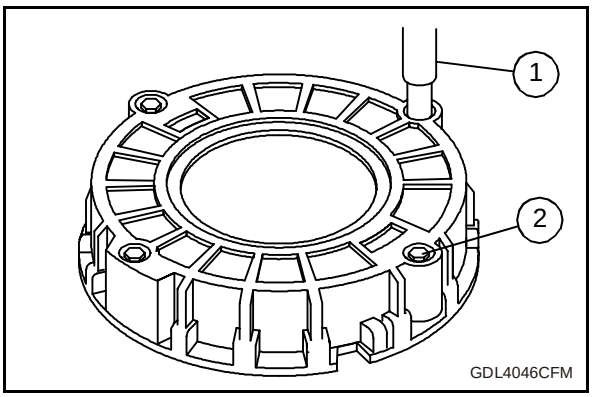


Remove piston (1) and seals (2) by prying under piston as shown.

Remove separator plates, friction disks, and spacer, maintaining stack order.

⚠ CAUTION

Spring force behind return spring plug. A press must be used to retain plug while removing until spring pressure is relieved.



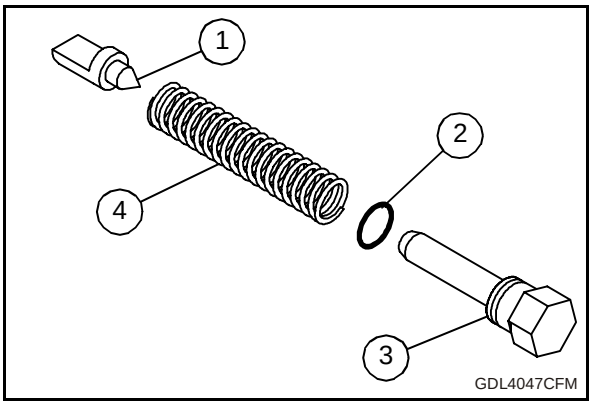
Remove piston return spring assemblies (2). Use a press (1) to retain assembly until plug threads are completely disengaged and spring pressure is relieved.

⚠ CAUTION

DO NOT use a cleaning solvent or solution to clean friction disks. Wipe with a lint-free shop rag and clean brake cooling oil. Replace all O-rings. Used O-rings will leak.

Clean and inspect all parts and replace as necessary.

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Install piston return spring assemblies. Using a press apply and keep pressure on spring assembly while turning plug (3). Tighten plug to specification.

Service Brakes B40D Specification

Piston Return Spring Assembly Torque
- 1-102 Nm (60-75 lb-ft)

NOTE:If friction disks and separator plates are reusable, maintain original stack order.

Inspect friction disks for wear, damage, or warpage. If any of these are found the complete stack (friction disks and separator plates) must be replaced.

Service Brakes B40D Specification

Friction Disk Thickness
- 4.87 mm (0.192 in.) minimum

Inspect separator plates for wear, damage, or warpage. If any of these are found the complete stack (friction disks and separator plates) must be replaced.

Service Brakes B40D Specification

Separator Plates Thickness
- 3.07 mm (0.121 in.) minimum

Install spacer plate in bottom of housing.

NOTE:Apply brake cooling oil on all separator plates and friction disks before installing.

Install a separator plate against spacer plate. Make sure splines on separator plate engage splines in housing and spaces are over return springs.

Install a friction disk against separator plate.

Continue alternating separator plates and friction disks until stack is complete. The end of the stack will be two separator plates.

⚠ CAUTION

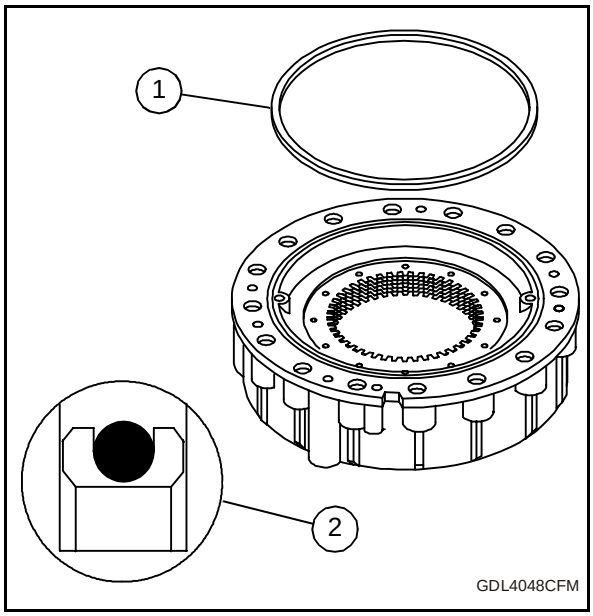
Apply hydraulic oil to the outside diameter of the piston, housing bore and seals.

Install piston until seated on guides of return springs.

⚠ CAUTION

To prevent housing or piston damage, use DFT1222 Wet Disk Brake Piston Seal Installer to install seals and spacer.

NOTE:The sealing arrangement between the piston and the housing consists of one spacer and two seals.



Install inner piston seal (1) between piston and housing until contact with piston shoulder is made.

Use DFT1222 Wet Disk Brake Piston Seal Installer for correct installation (2). **(See "CHAPTER 17. DEALER FABRICATED TOOLS" on page 351).**

Install spacer making sure it is seated against seal.

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Install outer piston seal with rubber part of seal facing spacer. Press seal down until rubber part of seal contacts spacer.

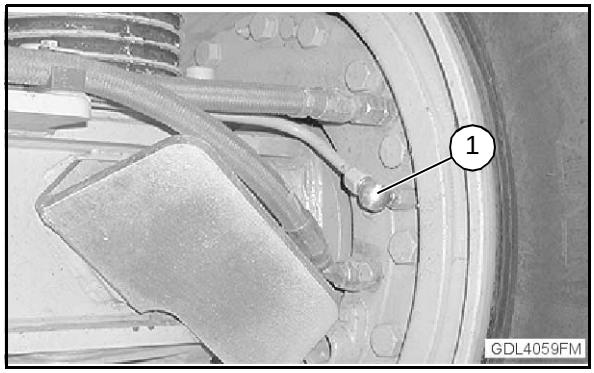
Install brake housing. **(See "Service Brakes B40D" on page 242.)**

Perform piston seal leakage check. **(See procedure Below.)**

Piston Seal Leakage Check

⚠ CAUTION

Hand pump must be filled with the same oil used in hydraulic system.



Install a JT05845 Hand Pump, 0 - 13 800 kpa (0 - 138 bar) (0 - 2000 psi) pressure gauge, and shut-off valve rated for 13 800 kpa (138 bar) (2000 psi) at the brake apply inlet (1) using Parker No. 6-1/ 4F5OG Adaptor Fitting.

Bleed air from brake piston using hand pump.

Apply 10 000 kPa (100 bar) (1450 psi) pressure to piston and close shut-off valve.

Observe pressure gauge for two minutes, If pressure drops inspect and replace piston seal as necessary. If pressure does not drop, continue with check.

Slowly open shut-off valve and allow pressure to drop to 690 kPa (6.9 bar) (100 psi). Close shut-off valve.

Observe pressure gauge for two minutes. If pressure drops, inspect and replace piston seal as necessary.

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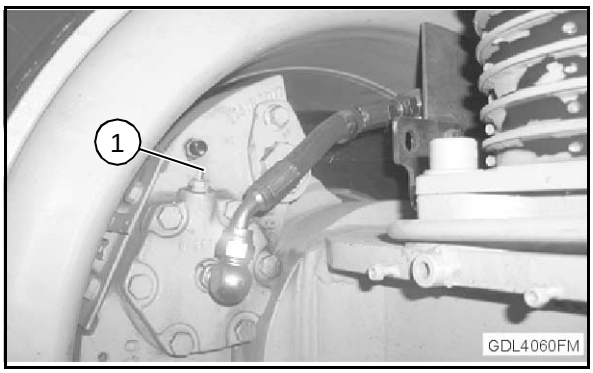
CHAPTER 9. SERVICE BRAKES

SECTION 2. HYDRAULIC SYSTEM

BLEED SERVICE BRAKE HYDRAULIC SYSTEM

Calipers

Check hydraulic reservoir oil level. Add oil, if necessary.



Attach clear plastic hose to bleed screw (1). Put other end of hose in clear container of hydraulic oil.

Run engine at slow idle. Apply service brake.

Loosen bleed screw slowly. Allow air to bleed. Tighten bleed screw to specification when no air bubbles emerge.

Specification

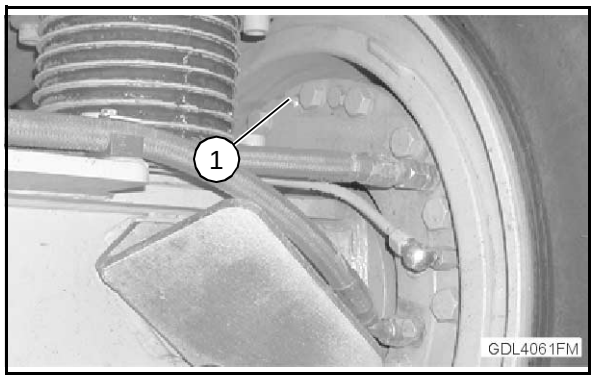
Bleed Screw Torque 20 - 27 Nm (15 - 20 lb - ft)

Release service brake. Stop engine.

Repeat bleed procedure for all brake calipers.

Wet Disk

Check hydraulic reservoir oil level. Add oil, if necessary.



Attach clear plastic hose to bleed screw (1). Put other end of hose in clear container of hydraulic oil.

Run engine at slow idle. Apply service brake.

Loosen bleed screw slowly. Allow air to bleed. Tighten bleed screw to specification when no air bubbles emerge.

Specification

Bleed Screw Torque 20-27 Nm (15-20 lb-ft)

Release service brake. Stop engine.

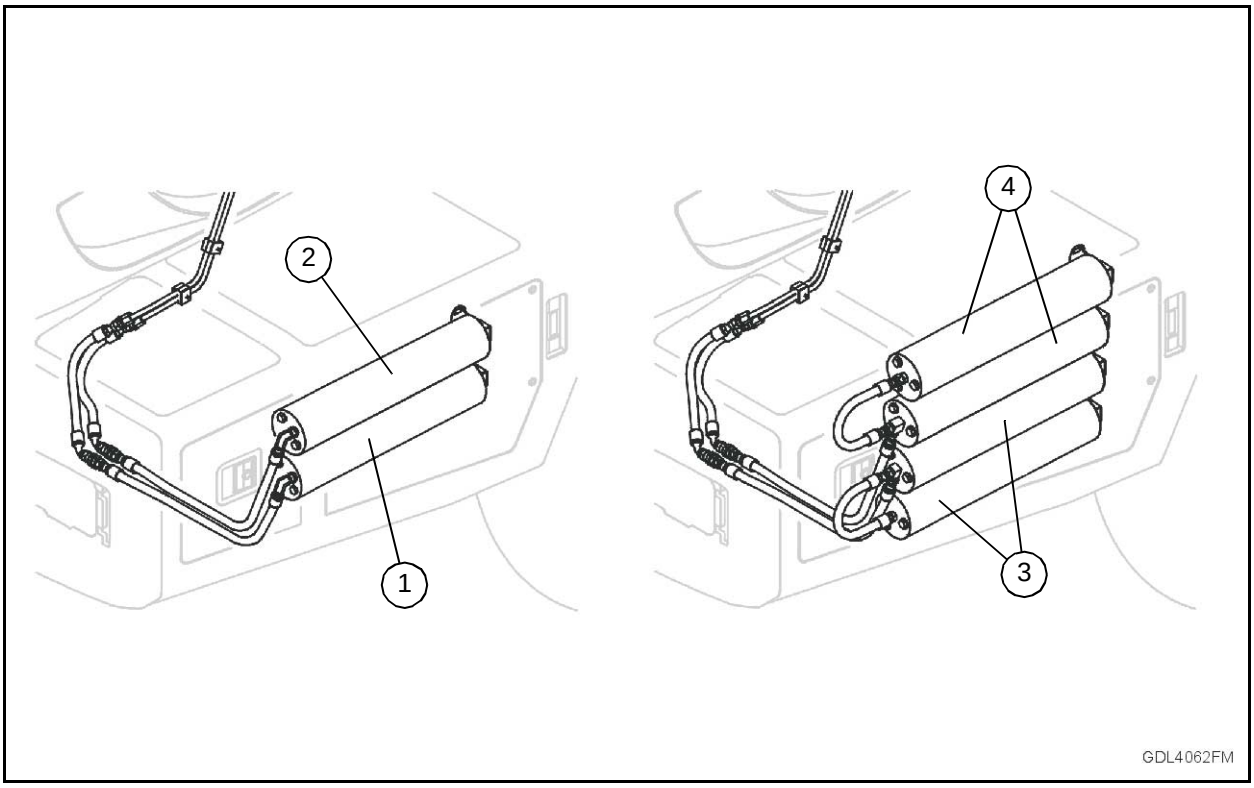
Repeat bleed procedure for all brake housings.

Brake Accumulators

Remove and Install Brake Accumulators

Relieve brake accumulator pressure. Pump service brake pedal repeatedly until no oil “hiss” is heard from accumulators.

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1. Front Brake Accumulator - B35D.
2. Rear Brake Accumulator - B35D.
3. Front Brake Accumulators - B40D.
4. Rear Brake Accumulators - B40D.

Disconnect hydraulic lines from accumulators (1 - 4). Close all openings with caps and plugs.

Remove accumulators from machine.

Inspect and replace parts as necessary.

Install accumulators in machine.

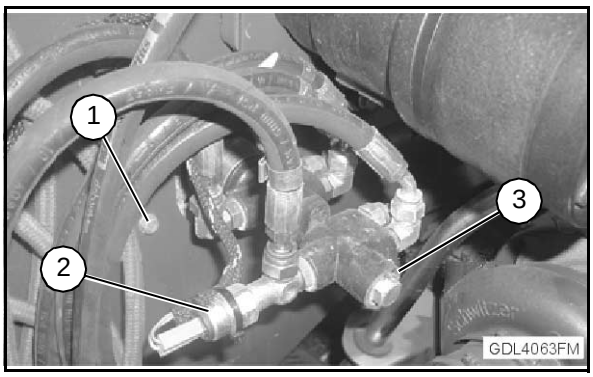
Connect hydraulic lines.

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Brake Valve

Remove and Install Brake Valve

Relieve brake accumulator pressure. Pump service brake pedal repeatedly until no oil "**hiss**" is heard from accumulators.



1. Cap Screw (4 used).
2. Sensor.
3. Brake Valve.

Disconnect wire leads from sensor (2).

Disconnect hydraulic lines. Close all openings with caps and plugs.

Remove cap screws (1).

Remove brake valve (3).

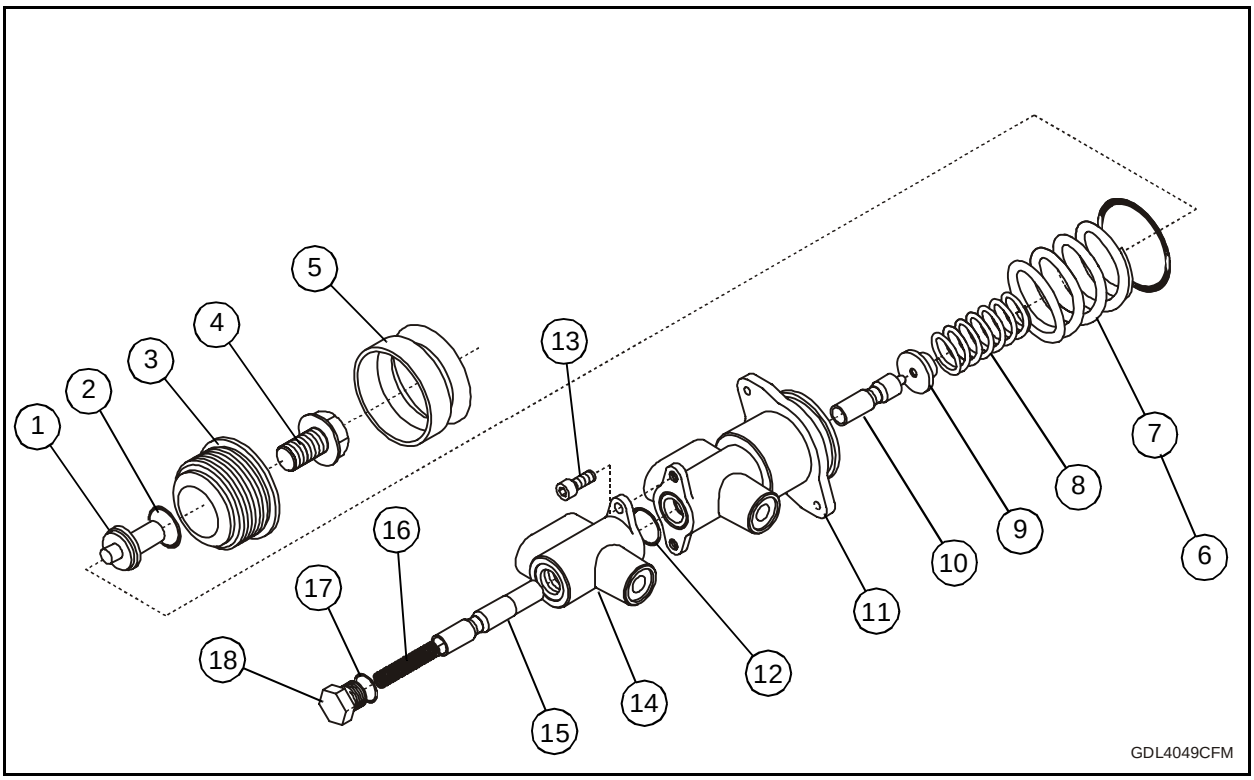
Inspect, repair, or replace parts as necessary.

Install brake valve.

Install cap screws.

Install hydraulic lines.

Install wire leads on sensor.



1. Piston.
2. O-Ring.
3. Rear Cap.
4. Cap Screw.
5. Dust Cover.
6. O-Ring.
7. Spring.
8. Spring.
9. Spring Retainer.
10. Piston.
11. Rear Housing.
12. O-Ring.
13. Screw (2 used).
14. Front Housing.
15. Piston.
16. Spring.
17. O-Ring.
18. Front Plug.

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Disassemble and Assemble Brake Valve

Clean brake valve housing before disassembling.

Remove parts (1 - 18).

Inspect all parts for wear or damage. Replace parts as necessary.

⚠ CAUTION

Replace all O-rings. Used O-rings leak. Apply clean hydraulic oil to all internal parts before assembling.

NOTE: To ease assembly, tighten rear cap and front plug after all valve parts are installed.

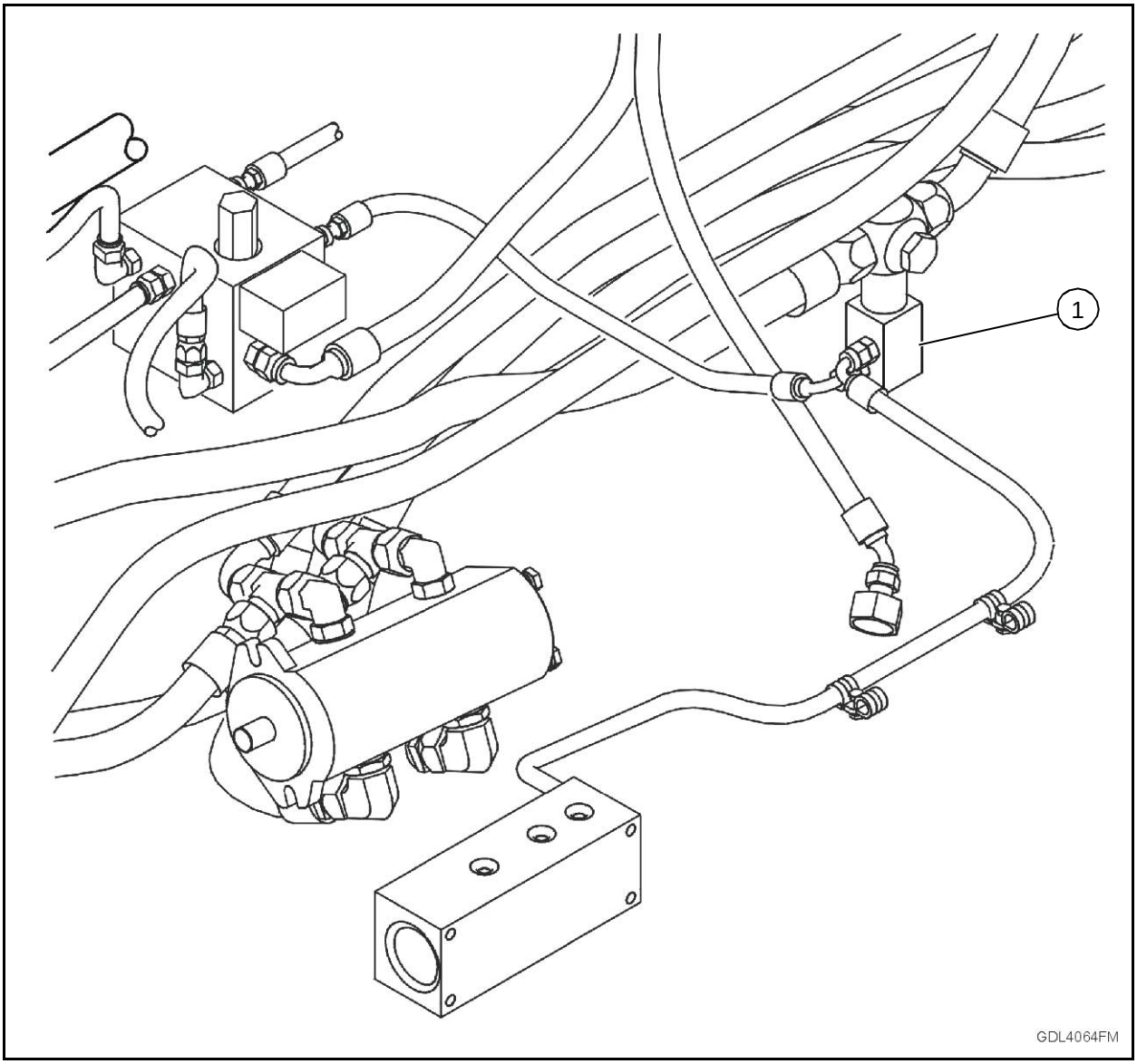
Assemble parts (1 - 18).

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WET DISK BRAKE THERMAL VALVE

Remove and Install Thermal Valve

Relieve hydraulic pressure. **(See Prepare Machine for Maintenance Operator's Manual, CHAPTER 7, SECTION 1).**



Disconnect brake cooling oil lines and hydraulic lines from thermal valve (1). Close all openings with caps and plugs.

Remove thermal valve.

Inspect and replace parts as necessary.

Install thermal valve.

Connect hydraulic lines and brake cooling oil lines.

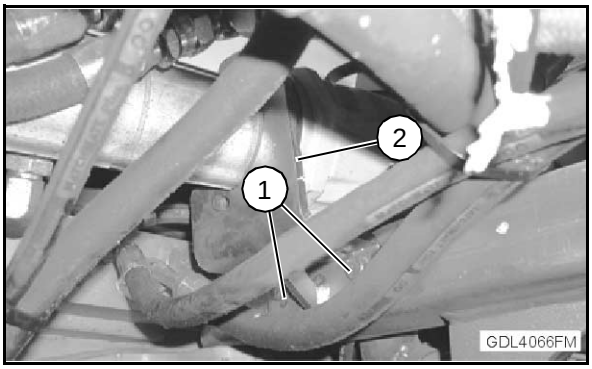
Wet Disk Brake Cooling Oil Pumps

Remove and Install Cooling Oil Pumps

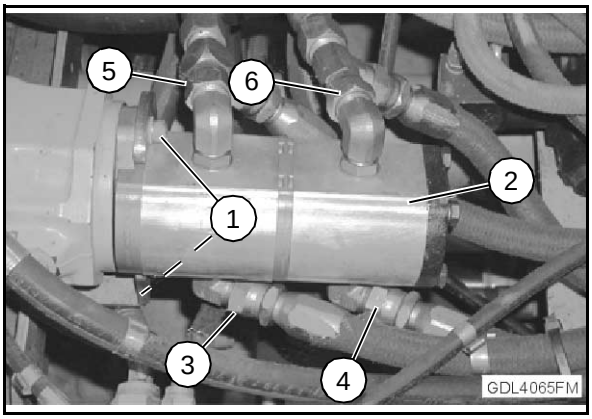
Drain wet disk brake cooling oil reservoir. **(See Change Wet Disk Brake Cooling Oil - B40D Operator's Manual, CHAPTER 15, SECTION 2).**

Tilt Cab **(Operator's Manual, CHAPTER 7, SECTION 1).**

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Remove cap screws (1) from bracket (2).



Label and disconnect inlet lines (3 and 4) and outlet lines (5 and 6). Close all openings with caps and plugs.

Remove socket head cap screws (1), bracket, and pumps (2).

Clean, repair, or replace parts as necessary.

Install pumps, bracket, and socket head cap screws.

Connect inlet lines and outlet lines.

Install cap screws in bracket.

Fill wet disk brake cooling oil reservoir. **(See Change Wet Disk Brake Cooling Oil - B40D Operator's Manual, CHAPTER 15, SECTION 2).**

Wet Disk Brake Cooling Oil Reservoir

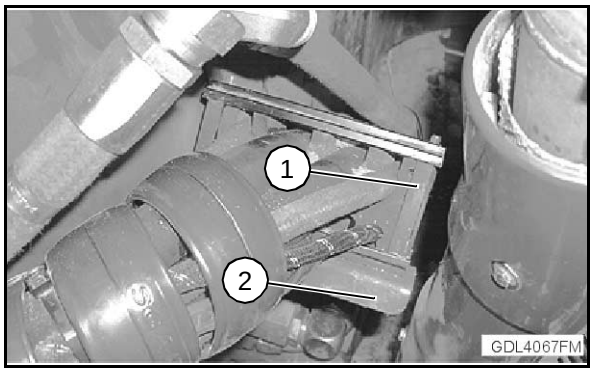
Remove and Install Cooling Oil Reservoir

Drain brake cooling oil reservoir. **(See Change Wet Disk Brake Cooling Oil - B40D Operator's Manual, CHAPTER 15, SECTION 2).**

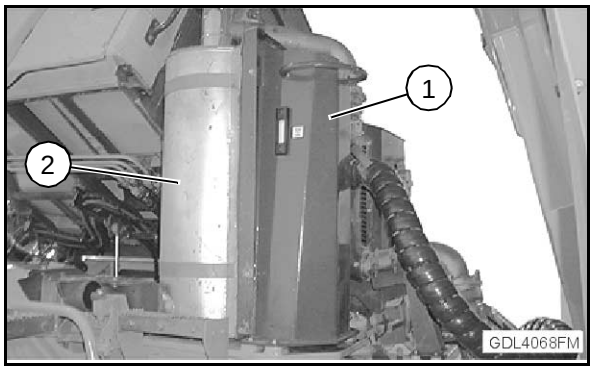


Remove outer exhaust shield (1).

Disconnect hydraulic lines from brake cooling oil reservoir. Close all openings with caps and plugs.



Remove cap screws, lock nuts, and dump body hydraulic lines clamp (1) from support bracket (2).



Remove cap screws securing brake cooling oil reservoir (1) to muffler (2), machine frame and dump body heater pipe, if equipped.

Remove brake cooling oil reservoir, using a proper lifting device.

Install brake cooling oil reservoir to muffler, machine frame and dump body heater pipe, if equipped.

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Install dump body hydraulic lines clamp, cap screws, and lock nuts to support bracket.

Connect hydraulic lines to brake cooling oil reservoir.

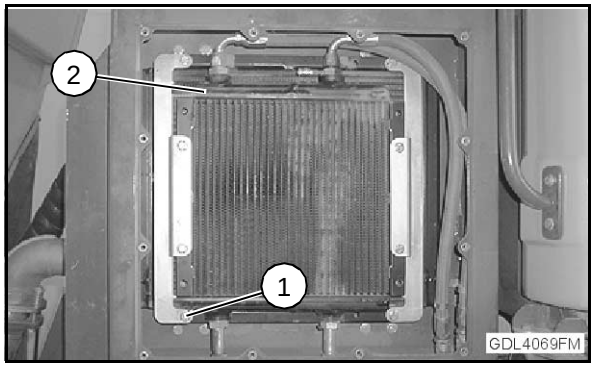
Install outer exhaust shield.

Fill brake cooling oil reservoir. **(See Change Wet Disk Brake Cooling Oil - B40D Operator's Manual, CHAPTER 15, SECTION 2).**

Wet Disk Brake Cooling Oil Cooler

Remove and Install Cooling Oil Cooler

Remove top cover and right side grille from transmission oil cooler housing.



Remove brake cooling oil reservoir, using a proper lifting device.

Install brake cooling oil reservoir to muffler, machine frame and dump body heater pipe, if equipped.

Install dump body hydraulic lines clamp, cap screws, and lock nuts to support bracket.

Connect hydraulic lines to brake cooling oil reservoir.

Install outer exhaust shield.

Fill brake cooling oil reservoir. **(See Change Wet Disk Brake Cooling Oil - B40D Operator's Manual, CHAPTER 15, SECTION 2).**

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CHAPTER 10. PARK BRAKE

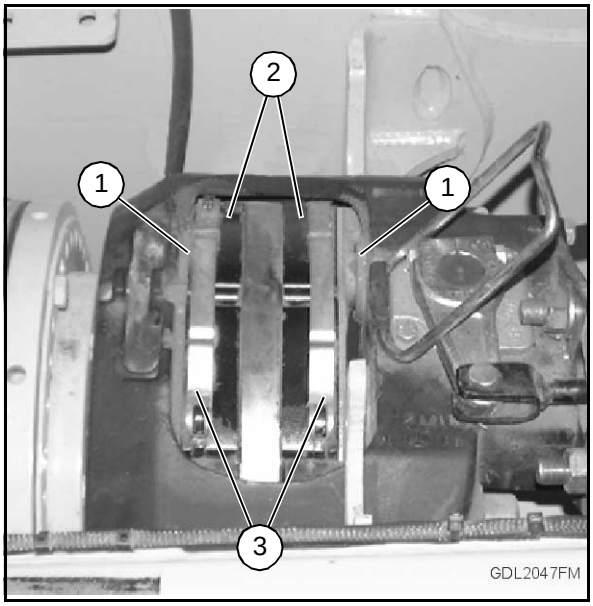
SECTION 1. ACTIVE ELEMENTS

PARK BRAKE

Remove And Install Park Brake Pads

Install dump body prop. Install wheel chocks. Relieve pneumatic pressure. **(See Prepare Prepare Machine For Maintenance in Operator's Manual, CHAPTER 7).**

Release the park brake. **(See Mechanically Releasing Park Brake Operator's Manual CHAPTER 6, SECTION 1).**

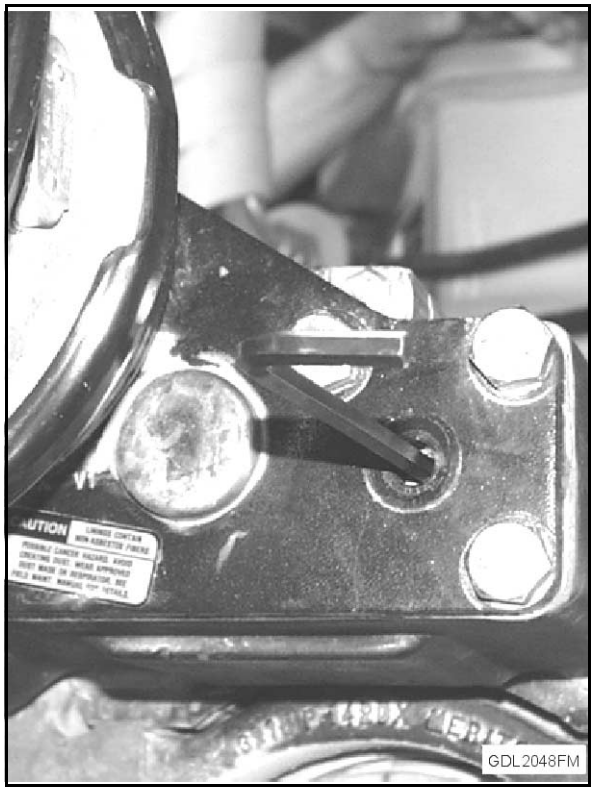


Move retaining bar aside. Remove brake pads (2).

Remove backing plates (1) from calipers.

Remove retaining clips (3) from pads.

Clean and inspect parts for wear or damage.



Remove plug and washer from socket head adjustment screw.

Turn socket head adjustment screw counterclockwise until resistance is felt.

A "clicking" sound is heard as adjusting screw is turned.

Install retaining clips on pads. Install backing plates.

Install pads. Install retaining bar.

Apply park brake. **(See Mechanically Releasing Park Brake in Operator's Manual CHAPTER 6, SECTION 1).**

Turn socket head adjustment screw clockwise until resistance is felt.

Turn counterclockwise to specification. Install washer and plug over socket head adjustment screw.

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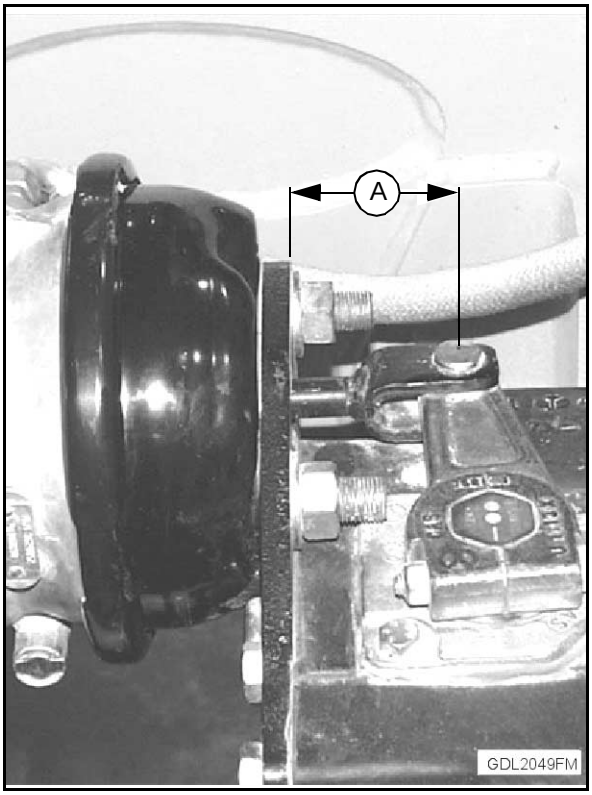
Specification

Adjusting Screw Initial Rotation
- - - - - - - - - - - - - - - - Clockwise until resistance is felt.

Final Rotation - - - - - - - - - - Counterclockwise 7 clicks.

Measure actuator rod travel.

- Start engine. Allow air system to increase to normal operating pressure.
- Release park brake. Measure from bottom of park brake actuator to center of clevis on actuator rod. Record measurement.
- Apply park brake. Measure from bottom of park brake actuator to center of clevis on actuator rod. Record measurement.
- Subtract smallest measurement from largest measurement to get actuator rod travel.



- Compare actuator rod travel to specification.

Specification

Actuator Rod Travel Distance
- - - - - - - - - - - - - - - - - - - 50.8 mm (2.0 in.) maximum

If actuator rod travel is greater than specification, pneumatically release and apply park brake 20 times to help seat parts.

Repeat actuator rod travel measurements. If travel is still greater than specification, actuator has failed and must be replaced.

Remove and Install Caliper

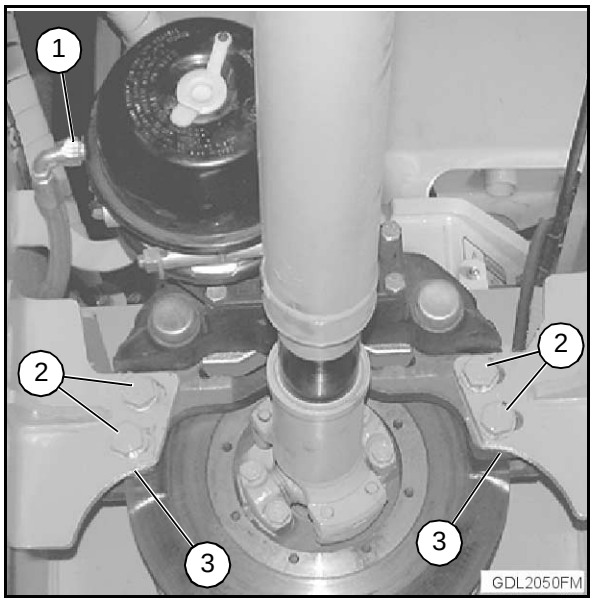
Install dump body prop. Install wheel chocks. Relieve pneumatic pressure. **(See Prepare Machine for Maintenance Operator's Manual CHAPTER 7, SECTION 1).**

Remove park brake pads.

⚠ CAUTION

Component is heavy. Use hoist.

NOTE: Write down the number of shims (3) removed from each side of caliper mount.



Disconnect air line (1) from actuator.

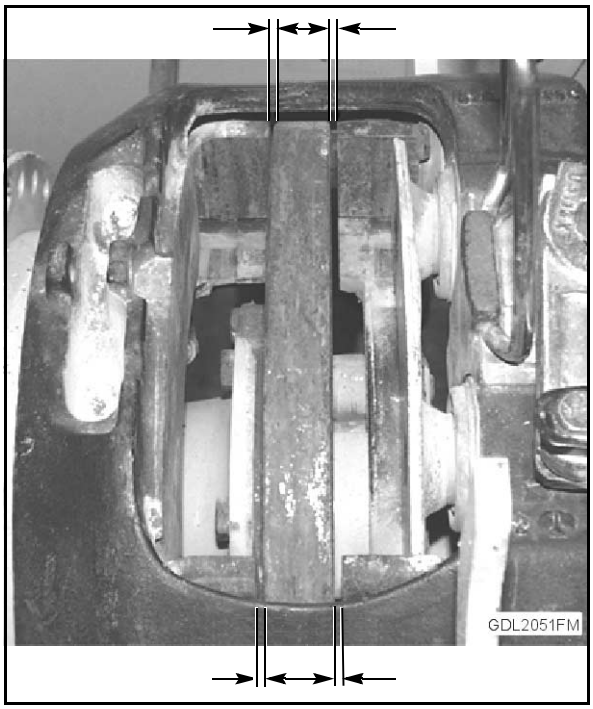
Remove cap screws and washers (2) and shims.

Remove caliper from machine.

Repair or replace parts as necessary.

Install caliper in machine.

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Install shims as needed. Park brake disk should be centred in calliper. Install cap screws and washers.

Attach air line.

Remove and Install Disk

Install dump body prop. Install wheel chocks. Relieve pneumatic pressure. **(See Prepare Machine for Maintenance Operator's Manual CHAPTER 7, SECTION 1).**

Remove park brake pads.

⚠ CAUTION

Components are heavy. Use lifting devices.

Support park brake disk with lifting device. Support oscillation tube-to-middle axle drive shaft with hoist.

Disconnect front cross and bearing assembly from park brake disk and yoke. **(See "DRIVE SHAFTS" on page 21).**

Remove park brake disk from machine.

Install park brake disk in machine.

Connect cross and bearing assembly. **(See "DRIVE SHAFTS" on page 21).**

Install park brake pads.

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CHAPTER 11. FRAME AND SUPPORTING STRUCTURE

SECTION 1. FRAME INSTALLATION

WELDING ON MACHINE

Use caution when Welding on Machine **(See Operator's Manual, Safety Section)**.

SEPARATE FRONT AND REAR FRAMES

Raise dump body and Install Dump Body Prop **(See Operator's Manual, CHAPTER 7, SECTION 1).**

Relieve hydraulic pressure. Install wheel chocks at front and rear of front wheels. **(See Prepare Machine for Maintenance Operator's Manual, CHAPTER 7, SECTION 1).**

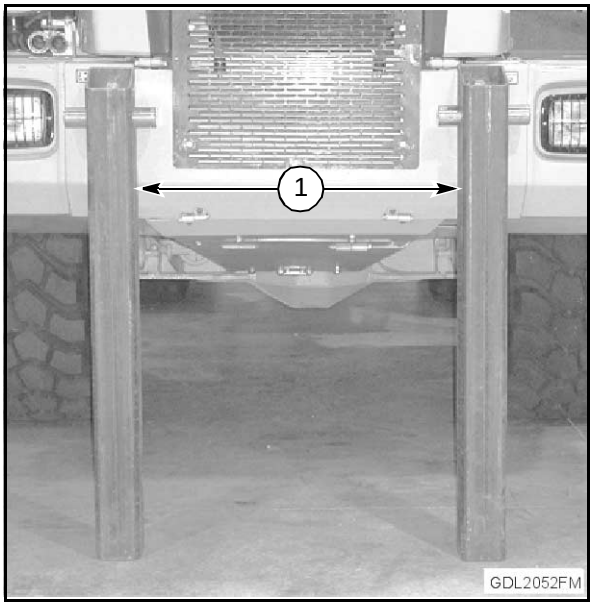
Relieve Pneumatic Pressure **(See Operator's Manual, CHAPTER 7, SECTION 1).**

Disconnect electrical harness at articulation joint.

Label and disconnect air and hydraulic hoses at articulation joint.

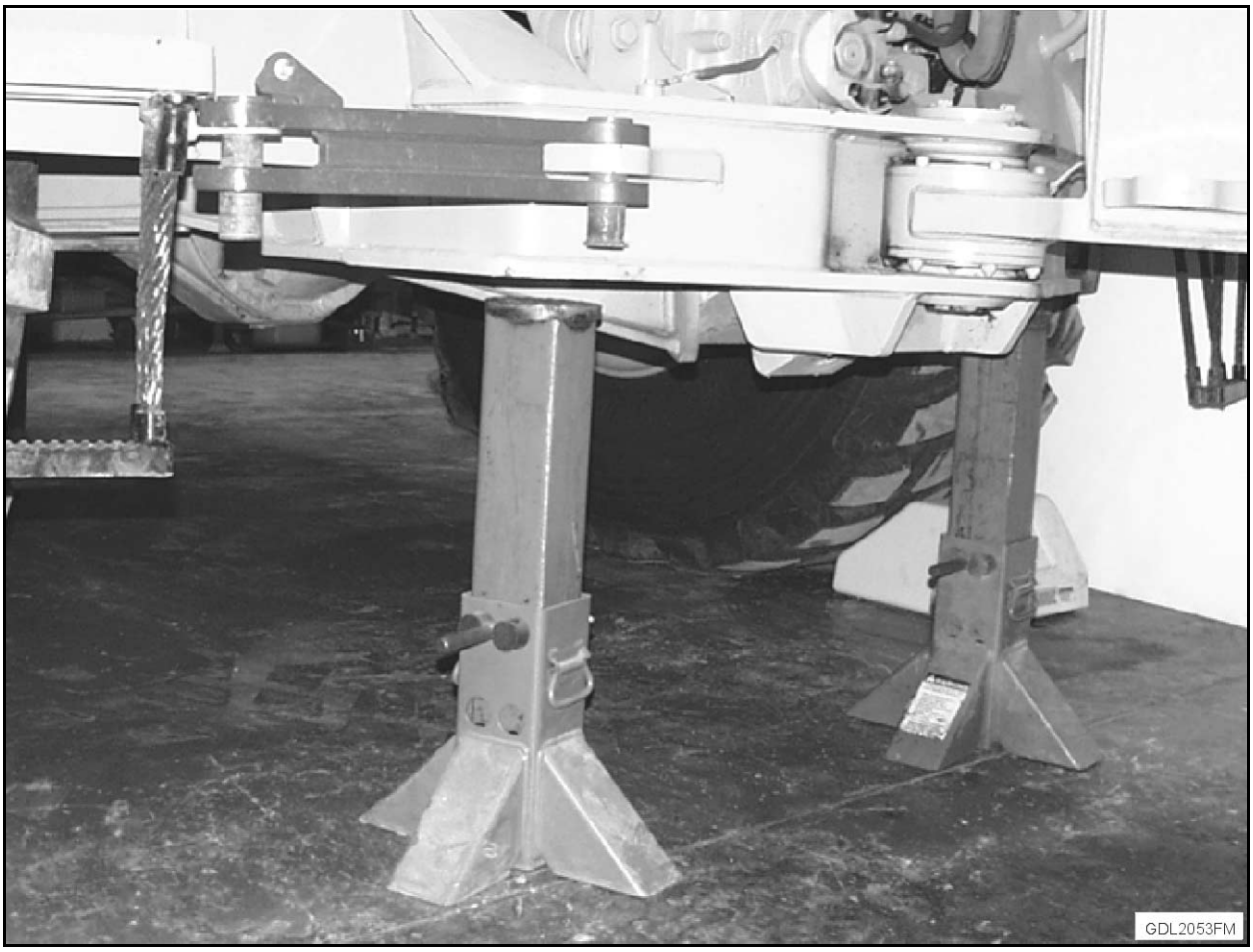
Remove park brake-to-middle axle drive shaft. **(See "DRIVE SHAFTS" on page 21).**

Remove park brake pads, caliper, and disk. **(See "PARK BRAKE" on page 257).**



Support front of machine, using DFT1185 Supports (1).

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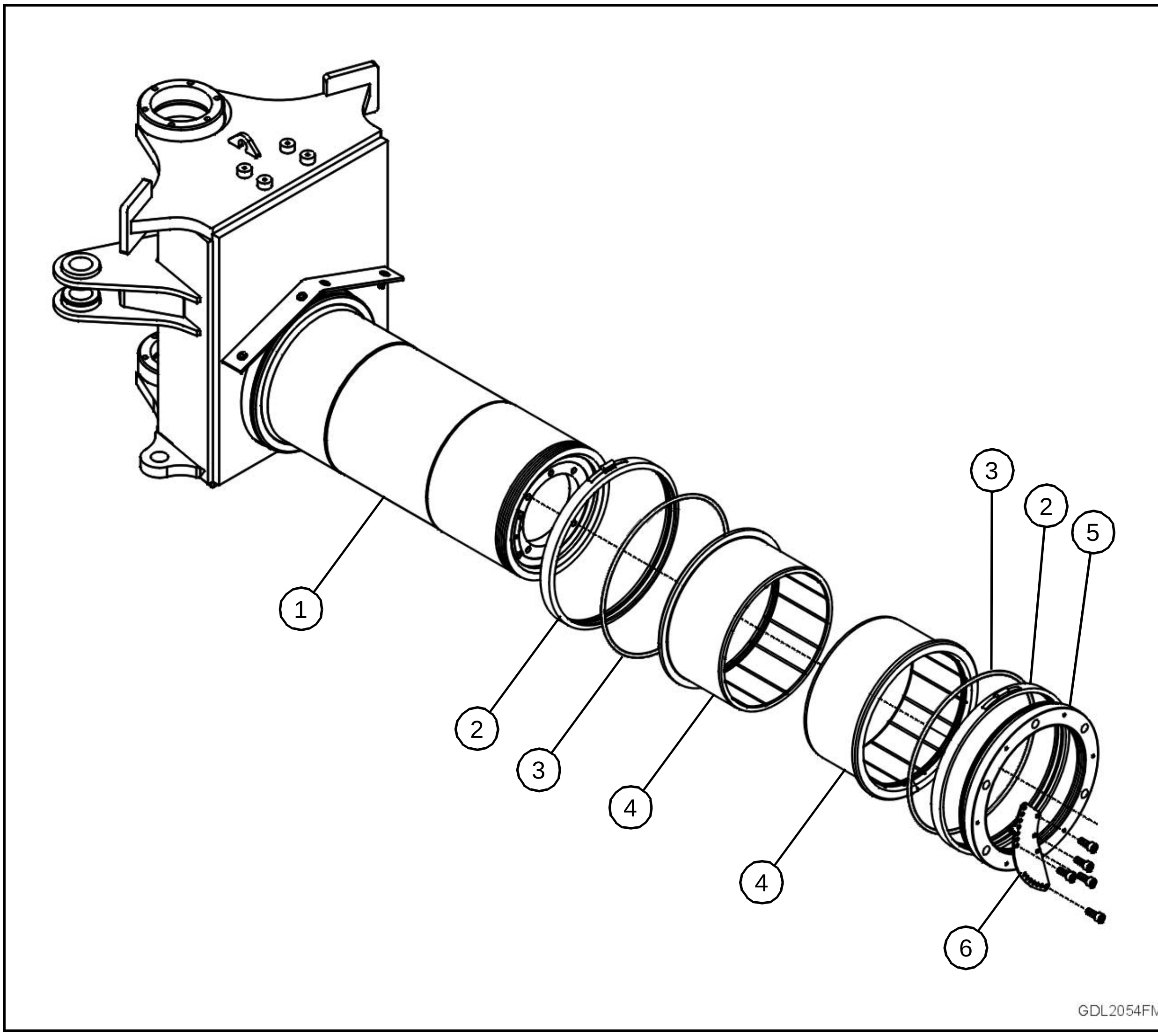


⚠ CAUTION

Machine may tip backwards when separated.

Support rear of front half of machine with 10-ton floor stands.

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1. Inner Oscillation Tube.
2. Seal (2 used).
3. O-Ring (2 used).
4. Bushing (2 used).
5. Oscillation Joint Nut.
6. Lock Plate.

Remove seals (2) and lock plate (6).

⚠ CAUTION

Component is heavy.

Separate Front and Rear Frames Specification

Oscillation Joint Nut Weight- 29 kg (63 lb)

Remove oscillation joint nut (5), using DFT1189 Spanner Wrench.

Attach an overhead hoist to front of rear half machine.

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Attach a forklift to rear of machine.

Slowly pull rear half of machine away from front half.

Remove O-rings (3) from flanges of bushings (4).

Inspect, repair, and replace parts as necessary. **(See "OSCILLATION JOINT" on page 271)**

Install new O-rings (3) on bushings (4).

Use a forklift or other machine to push machine together.

Raise or lower overhead hoist to maintain alignment of inner and outer oscillation tubes as machine comes together.

Install oscillation joint nut (5) and lock plate (6).

Adjust oscillation joint end play. **(See "OSCILLATION JOINT" on page 271).**

Install seals (2).

Install park brake disk, caliper, and pads. **(See "PARK BRAKE" on page 257).**

Install park brake-to-middle axle drive shaft. **(See "DRIVE SHAFTS" on page 21).**

Connect air and hydraulic hoses.

Connect electrical harness.

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ARTICULATION FRAME

Remove and Install

Separate Front and Rear Frames.

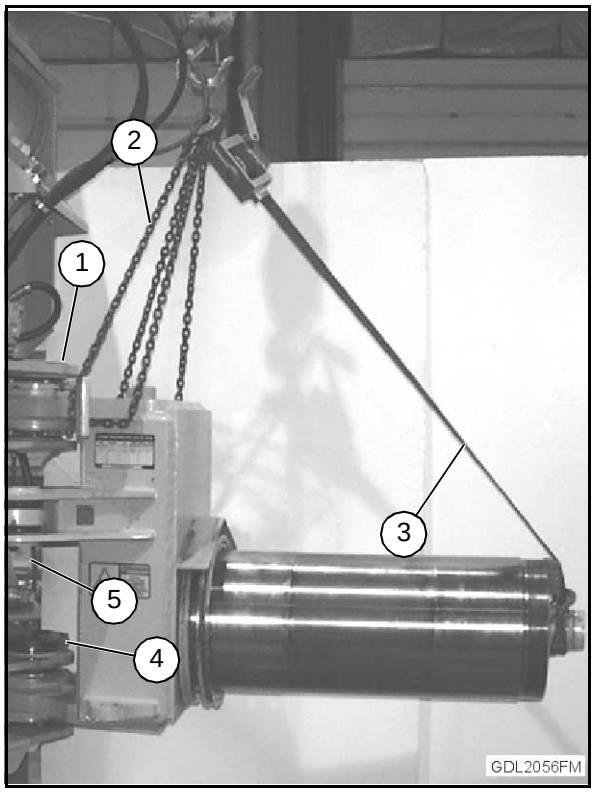
⚠ CAUTION

Component is heavy. Use hoist.

Articulation Frame Specification

Articulation Frame Weight - - - - - - - - - 998 kg (2200 lb)

NOTE: Articulation frame angle must be adjusted during removal.



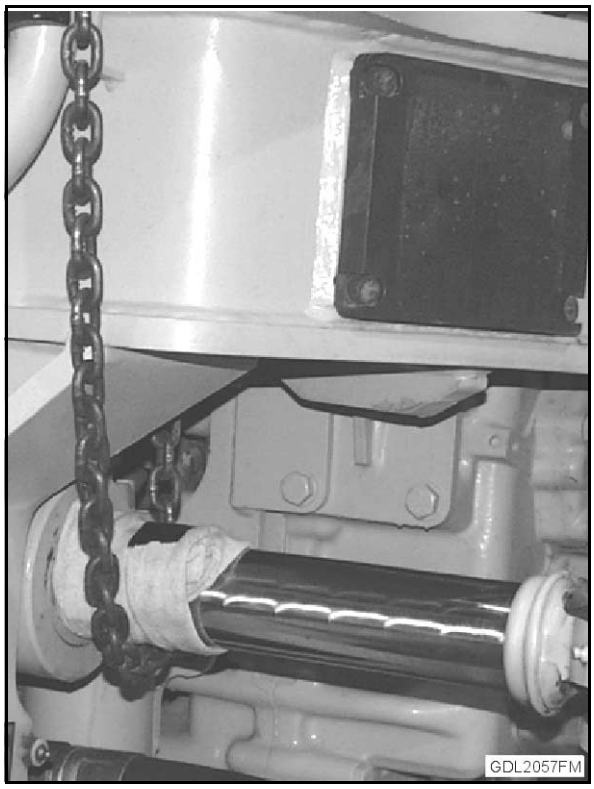
Support articulation frame with hoist, using chains at front and adjustable lifting strap at rear.

⚠ CAUTION

Components are heavy. Support with chains.

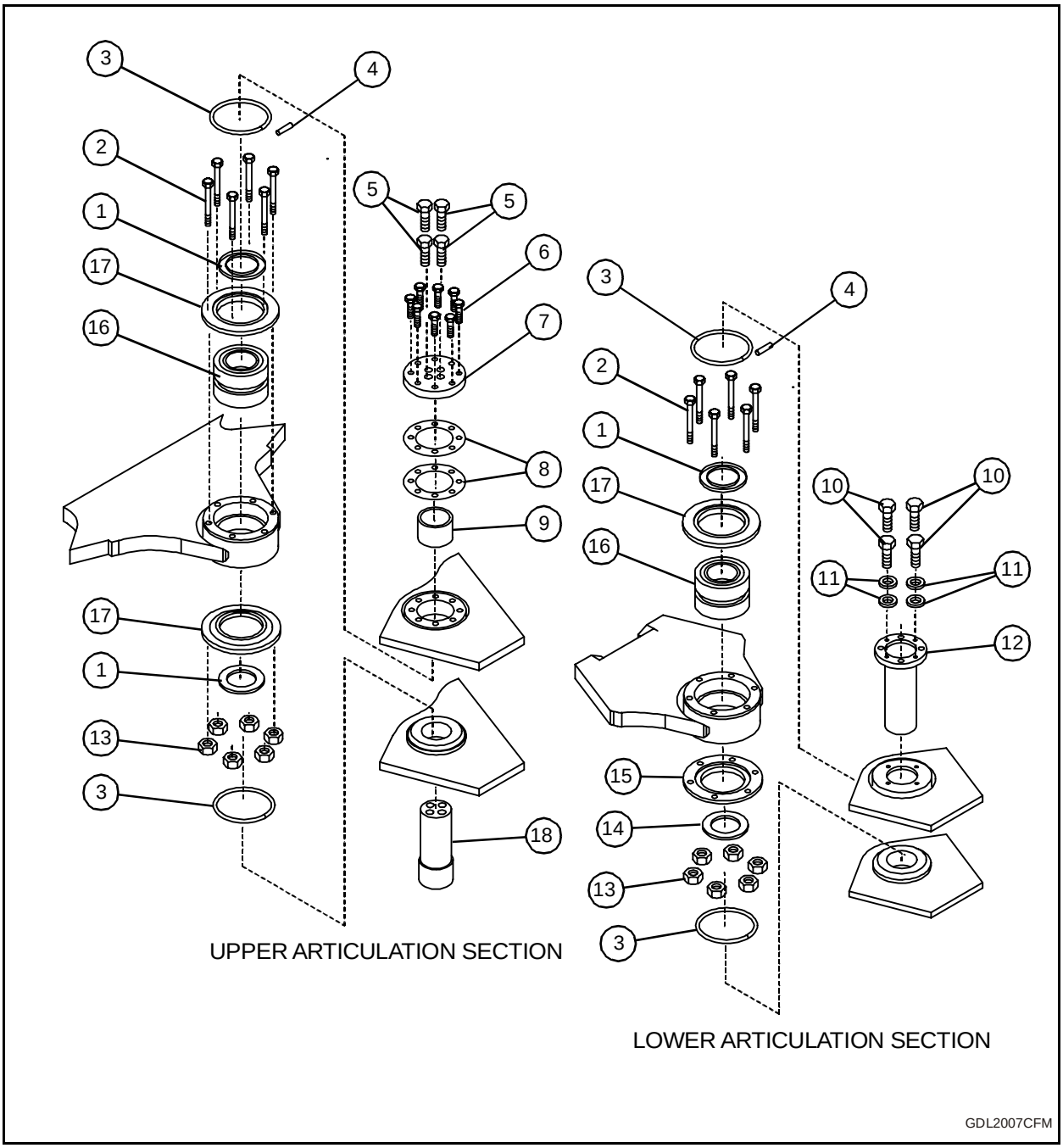
Articulation Frame Specification

Steering Cylinder Weight - - - - - - - - - - - 95 kg (210 lb)



Attach chains from steering cylinders to front frame. Remove steering cylinder rod-end pins. Move rods aside. **(See "Steering Cylinder" on page 232).**

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1. Seal (3 used).
2. Cap Screw (12 used).
3. Joint Seal (4 used).
4. Coupling (4 used).
5. Cap Screw (4 used).
6. Cap Screw (8 used).
7. Retainer.
8. Shim (2 used).
9. Sleeve.
10. Cap Screw (4 used).
11. Washer (4 used).
12. Lower Pivot Pin.
13. Nut (12 used).
14. Seal (1 used).
15. Cover Plate.
16. Bearing (2 used).
17. Cover (3 used).
18. Upper Pivot Pin.

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Remove upper pivot pin (18) by driving downward.

⚠ CAUTION

Sleeve (9) must be removed before upper articulation joint will separate. Failure to do so will cause damage to bearing cover or articulation joint.

Remove sleeve (9) by driving upward.

Remove lower pivot pin (12) by driving upward.

Move articulation frame away from front frame.

Inspect and replace parts as necessary.

Apply anti-seize compound to inner bore of bushings.

Install upper pivot pin (18) using a hydraulic jack.

Install sleeve (9) using a brass hammer.

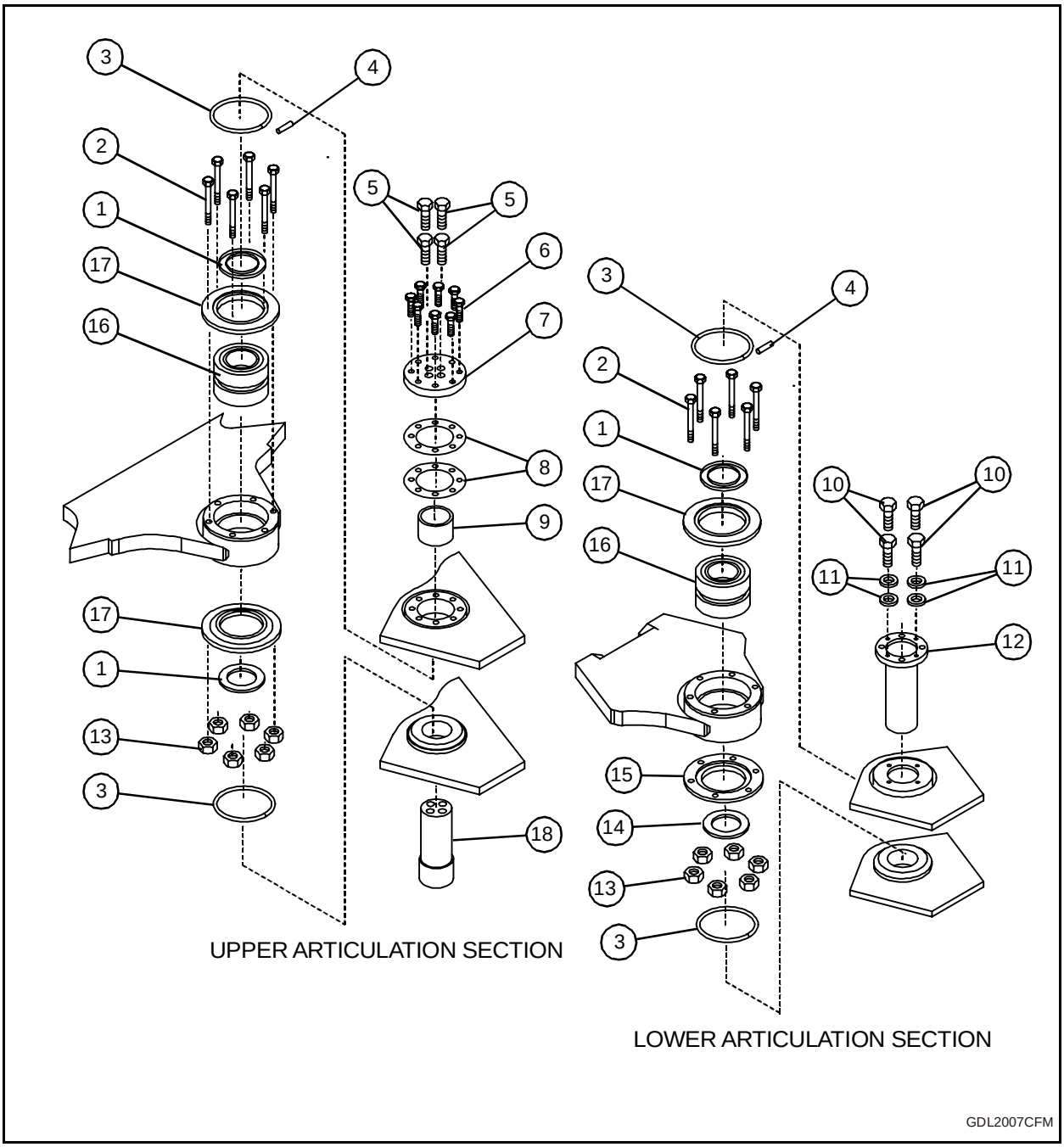
Install retainer (7) and cap screws (5). Do not torque at this time.

Adjust articulation joint bearings.

Install steering cylinder pins. **(See "Steering Cylinder" on page 232).**

Assemble front and rear frames. See Separate Front and Rear Frames.

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Disassemble and Assemble Upper and Lower

Bearings

Remove articulation frame.

⚠ WARNING

The articulation bearing is a matched set of two bearings and a spacer. Do not mix bearings and spacers from upper and lower joints. Bearings and spacers must be replaced as a set.

Remove bearing (16) from frame.

Inspect and replace parts as necessary.

Install bearing (16) in frame centered in bore.

NOTE:Seal (14) is smaller in diameter than seals (1).

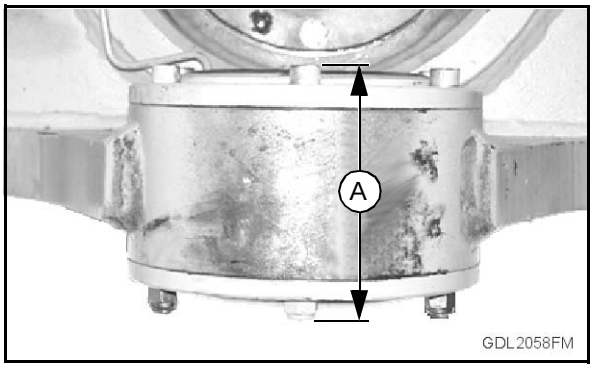
For lower bearing, press seal (14) into cover plate (15) using DFT1188 Bearing Driver.

For upper bearing, press seals (1) into covers (17) using DFT1188 Bearing Driver.

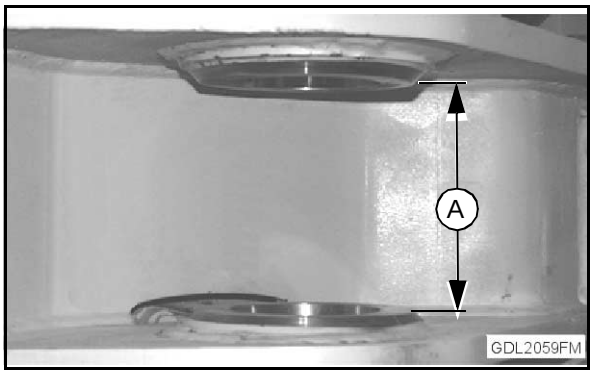
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NOTE: One cover cap screw (2) is shorter than the rest. If new cap screws are installed, the front cap screw must be cut off flush with the nut.

Install cap screws (2) and nuts (13) with shortest cap screw toward front of machine.



Measure length of front bearing cover cap screw and lock nut (A).



Measure distance between bosses (B) on frame.

Shorten cap screw and lock nut (A) so that length is less than distance (B).

Tighten cap screws (2) and nuts (13) to specification.

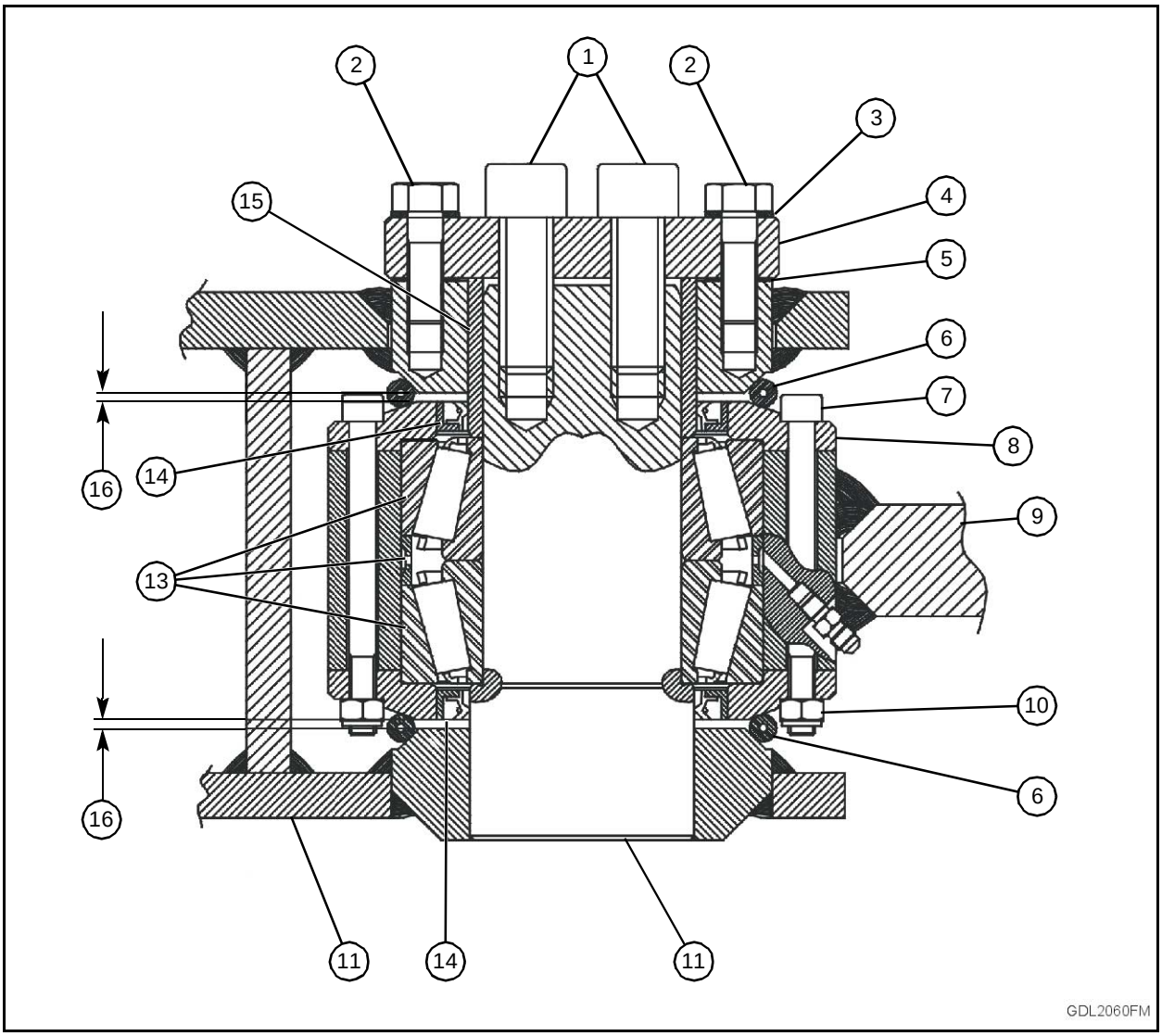
Articulation Frame Specification

Bearing Cover Cap Screw Torque
- 163 Nm (120 lb-ft)

NOTE: Install articulation joint seal after installation of hinge articulation frame.

Install articulation joint seal (3), using connector (4) to assemble.

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1. Cap Screw (4 used).
2. Cap Screw (8 used).
3. Washer (8 used).
4. Retainer.
5. Shim (2 used).
6. Joint Seal (2 used).
7. Cap Screw (6 used).
8. Cover (2 used).
9. Rear Frame.
10. Lock Nut (6 used).
11. Pin.
12. Front Frame.
13. Bearing.
14. Seal.
15. Sleeve.
16. Gap.

Adjust Upper and Lower Bearings

Remove articulation joint seal (6) by pulling apart at coupling.

Measure gap (16) in upper and lower articulation joints.

Remove retainer (4).

NOTE: Adding or subtracting shims from upper articulation joint will change gap.

Add or subtract shims (5) until gap measurements are equal.

Apply medium-strength thread lock and sealer to cap screws (2).

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Install retainer and cap screws (2).

Apply medium-strength thread lock and sealer to cap screws (1).

Install cap screws and tighten to specification.

Articulation Frame Specification

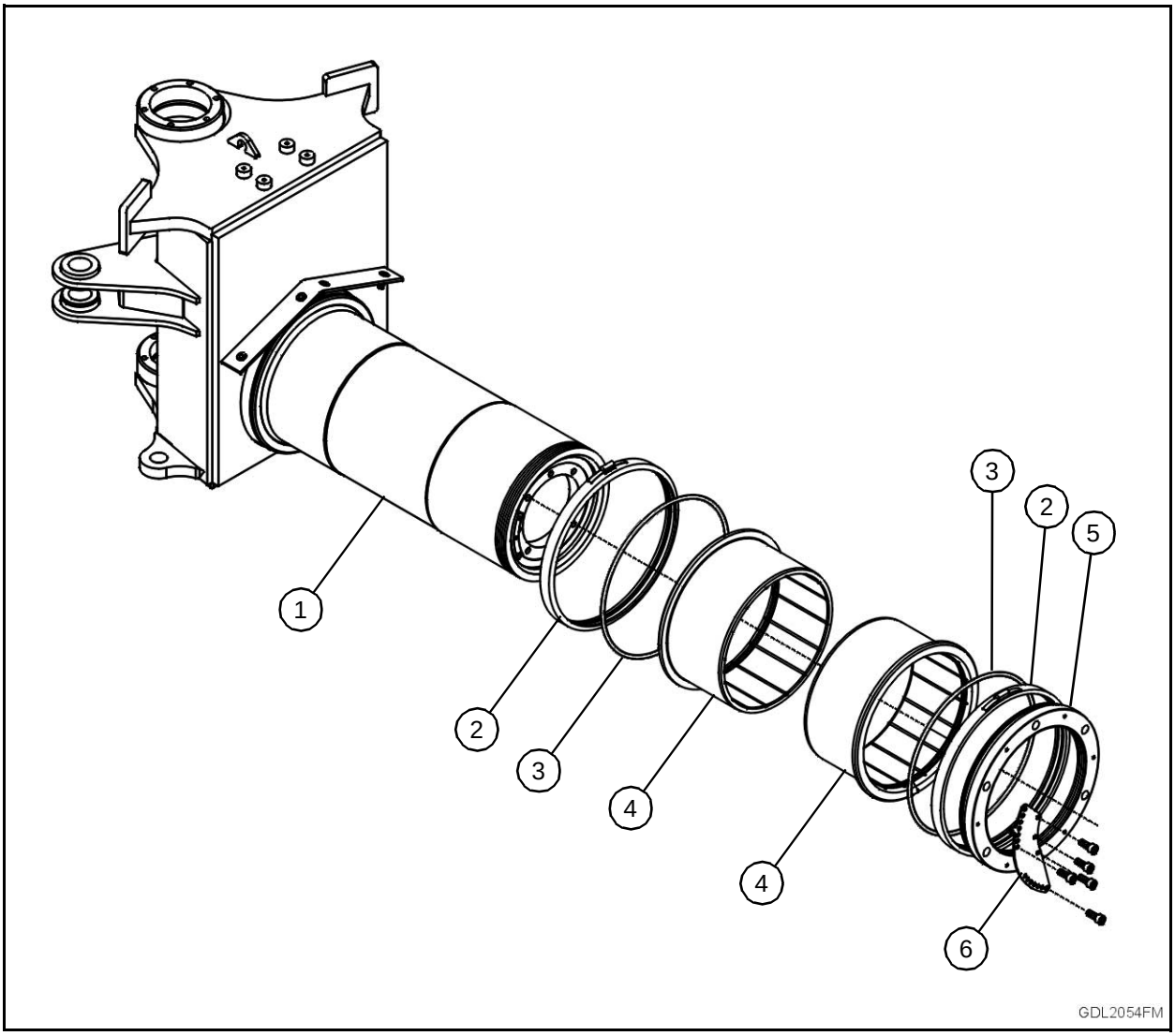
Upper Pivot Pin Cap Screws Torque ---------- 1000 Nm (795 lb-ft)

Install articulation joint seal.

OSCILLATION JOINT

Disassemble and Assemble

Separate Front and Rear Frames.



Inspect and replace parts (1 - 6) as necessary. **NOTE:Replace one bushing at a time.**

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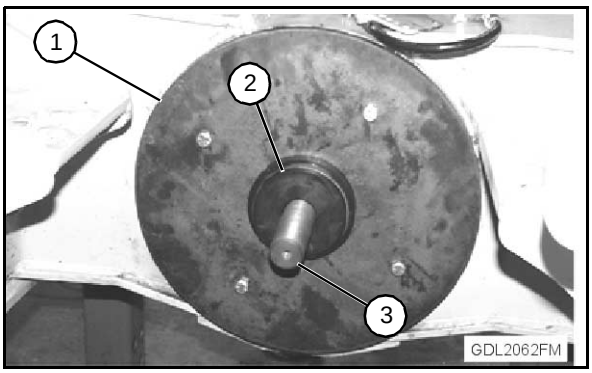
Using a rotary grinder, cut slots through bushing and drive out with a brass drift.

Clean grease and grinding residue from oscillation tube.

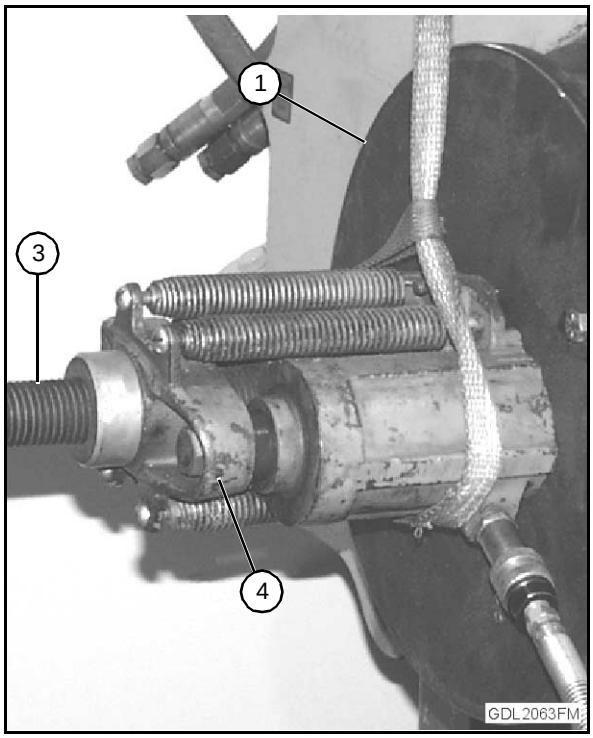
Install new bushing.

Vent passage of front bushing must be aligned at top of tube.

Vent passage of rear bushing must be aligned at bottom of tube.



Assemble DFT1186 Bushing Driver (1), JDG902-1 Screw (3) and JDG902-2 Adapter (2) on oscillation tube.



Assemble porta-power (4) and bushing being installed on other end of oscillation tube.

Press bushing flush with end of bore.

Repeat steps above for other bushing, if necessary.

Assemble front and rear frames. **(See "SEPARATE FRONT AND REAR FRAMES" on page 261).**

Adjust End Play

Tighten oscillation joint nut, using DFT1189 Spanner Wrench.

Loosen oscillation joint nut until first set of eight holes in lock plate and nut align.

Tighten lock plate cap screws to specification.

Oscillation Joint Specification

Lock Plate Cap Screws Torque- - - - -150 Nm (111 lb-ft)

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CHAPTER 12. OPERATOR's STATION

SECTION 1. CAB

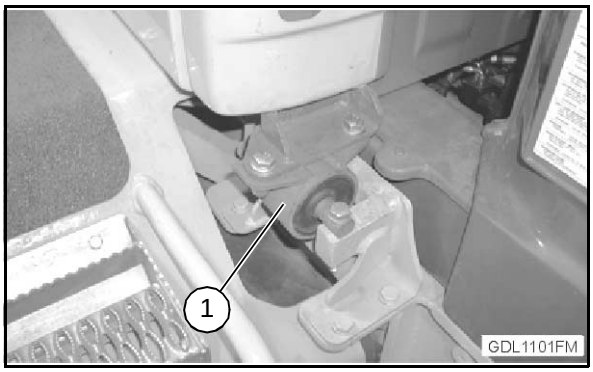
CAB MOUNTINGS

Remove and Install Cab Mounts

⚠ CAUTION

Component is heavy. Use hoist.

Attach hoist to cab.



Remove all cap screws, washers, and nuts from rubber mounts (1) as necessary.

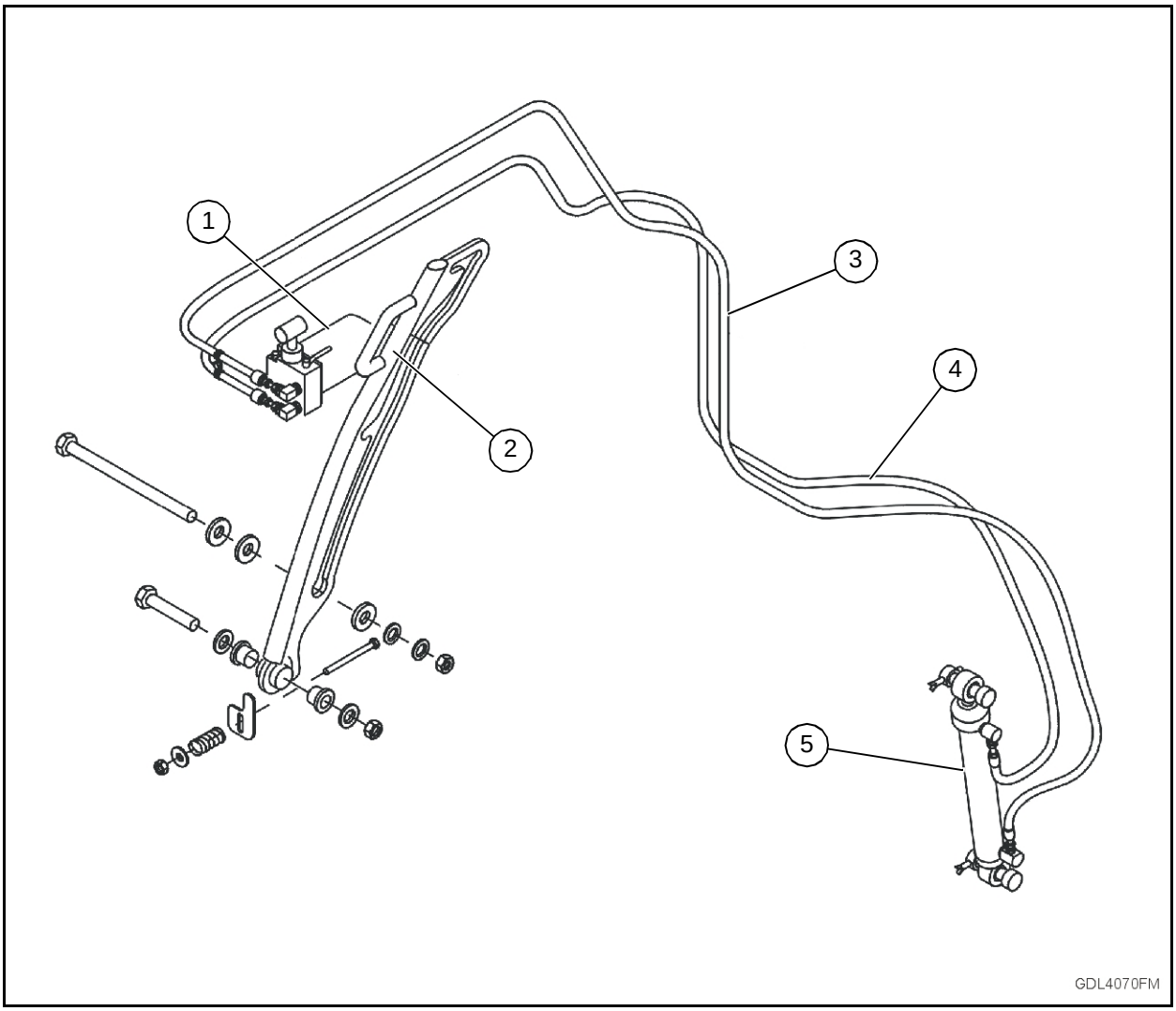
Lift cab slightly and remove rubber mount(s).

Install rubber mount(s).

Install all cap screws, washers, and nuts. Lower cab onto rubber mounts. Tighten cap screws and nuts.

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Remove and Install Cab Tilt Pump and Cylinder



1. Pump.
2. Support Strut.
3. Line to Cylinder Head End.
4. Line to Cylinder Rod End.
5. Cylinder.

Tilt cab. Ensure that support prop is engaged. **(See Tilt Cab Operator's Manual CHAPTER 7).**

Turn pump valve lever clockwise to "Float" position to relieve hydraulic pressure.

Remove pump, if necessary. Remove lines, if necessary. Remove cylinder, if necessary.

Inspect, repair, and replace parts as necessary. **(See "Disassemble and Assemble Cab Tilt Cylinder" on page 275).**

NOTE: Fill each component with oil during assembly, working from bottom to top.

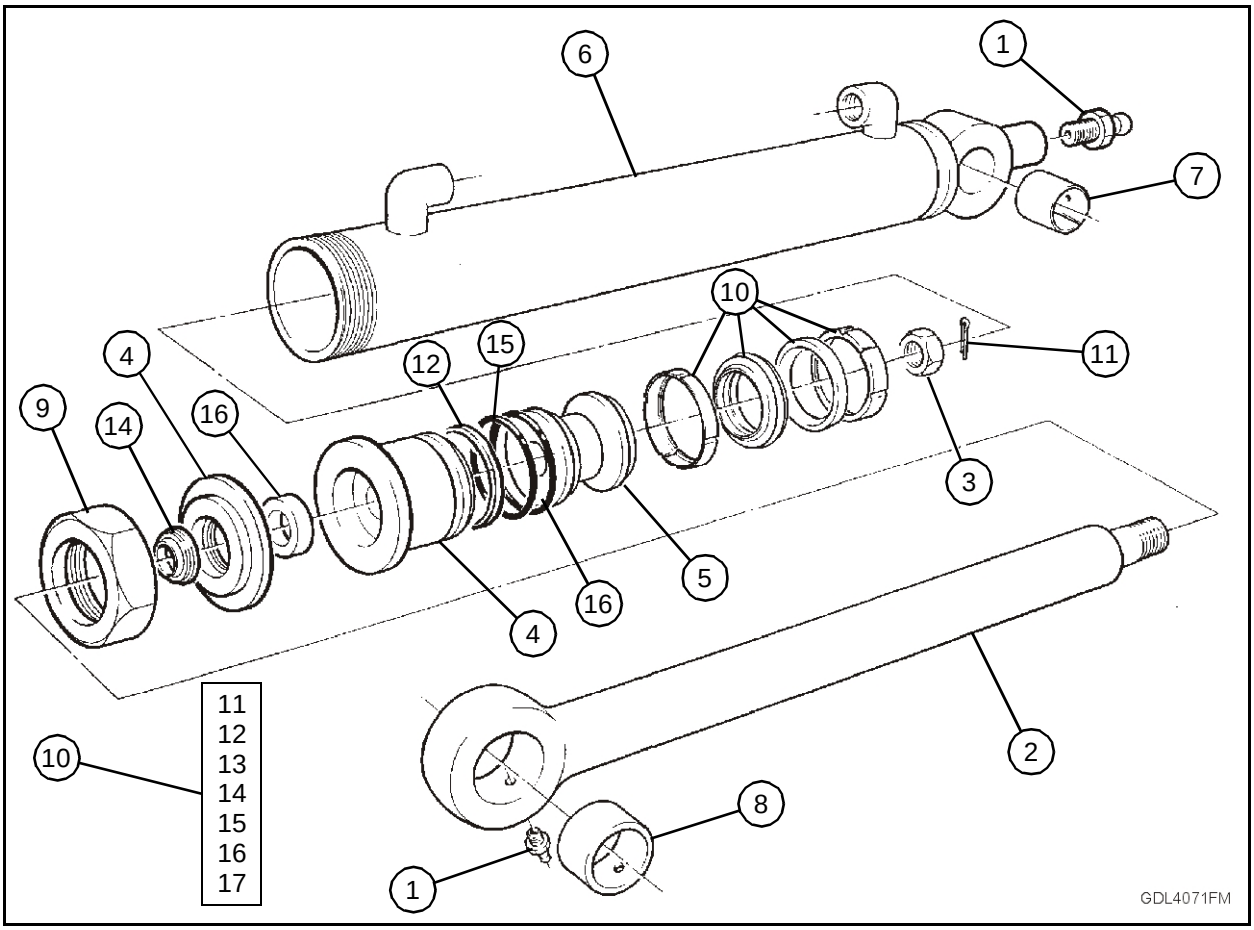
Install cylinder, if removed. Install lines, if removed. Install pump, if removed.

Lower and raise cab several times with pump to move air pockets to top of system.

With cab lowered, remove plug from fill port on top of pump and add oil as necessary.

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Disassemble and Assemble Cab Tilt Cylinder



1. Lubrication Fitting (2 used).
2. Rod.
3. Nut.
4. Rod Guide.
5. Piston.
6. Hydraulic Cylinder Barrel
7. Bushing
8. Bushing
9. Nut.
10. Hydraulic Cylinder Kit.
11. Cotter Pin.
12. Backup Ring
13. Seal.
14. Seal.
15. O-Ring.
16. Seal.
17. O-Ring

Install cylinder in a service stand such as JT30043 Cylinder Service Stand.

Apply rigid form-in-place gasket to threads of nut (3).

Tighten nut to specification. Install cotter pin (11).

Cab Tilt Cylinder Specification

Piston-to-Rod Nut Torque - - - - - - - 500 Nm (370 lb-ft)

Apply clean hydraulic oil to seals (13) and O-rings (15 and 17) before installing piston and rod guide (4) into the barrel.

Apply an anti-seize lubricant to the threads of nut (9).

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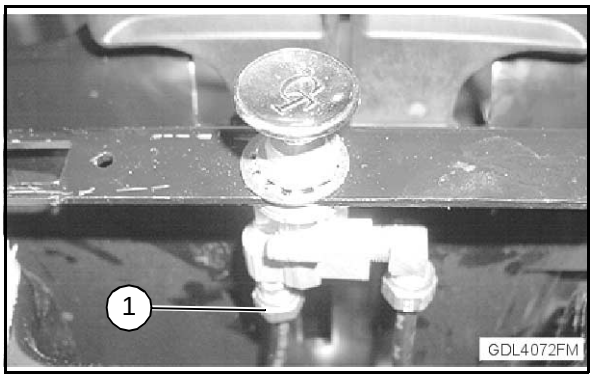
CHAPTER 12. OPERATOR's STATION

SECTION 2. SEAT AND SEAT BELT

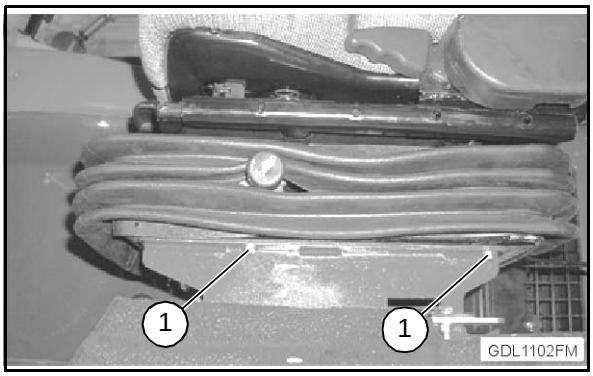
OPERATOR'S SEAT

Remove and Install Seat

Relieve pneumatic pressure. **(See Relieve Pneumatic Pressure Operator's Manual CHAPTER 7).**



Disconnect air supply line (1) at valve. Remove air supply line from seat at rear of boot.



Remove cap screws and washers (1).

⚠ CAUTION

Component is heavy. Use hoist.

Specification

Operator's Seat Weight- - - - 44 kg (97 lb) approximate

Remove seat from cab.

Repair or replace parts as necessary.

Install seat in cab.

Install cap screws and washers.

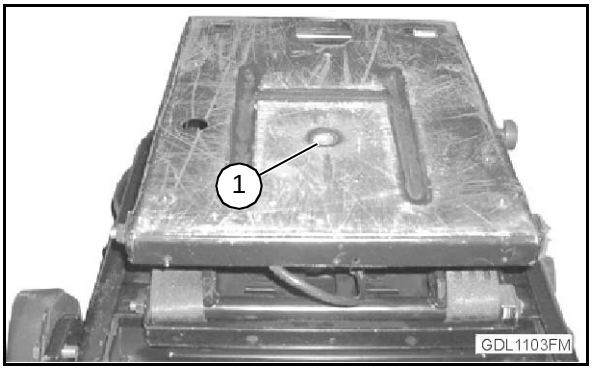
Install air supply line through rear of boot.

Connect air supply line at valve. Ensure boot is properly attached.

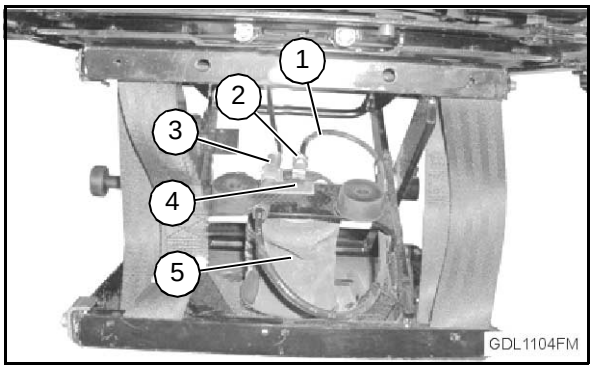
Remove and Install Air Spring

Remove seat from cab.

Operate air spring valve to relieve pneumatic pressure inside air spring.



Remove screw (1) from bottom of seat.



Disconnect air line (1) from fitting (2).

Remove the cap screw (4) and bracket (3). Remove air spring (5) from seat.

Install air spring in seat. Install bracket and cap screw.

Connect air line to fitting.

Install screw in bottom of seat.

Install seat in cab.

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CHAPTER 12. OPERATOR's STATION

SECTION 3. HEATING AND AIR CONDITIONING

REFRIGERANT CAUTIONS AND PROPER HANDLING

⚠ CAUTION

1. DO NOT allow liquid refrigerant to contact eyes or skin. Liquid refrigerant will freeze eyes or skin on contact. Wear goggles, gloves and protective clothing.
2. If liquid refrigerant contacts eyes or skin, DO NOT rub the area. Splash large amounts of COOL water on affected area. Go to a physician or hospital immediately for treatment.
3. DO NOT allow refrigerant to contact open flames or very hot surfaces such as electric welding arc, electric heating element and lighted smoking materials.
4. DO NOT heat refrigerant over 52°C (125°F) in a closed container. Heated refrigerant will develop high pressure which can burst the container.
5. Keep refrigerant containers away from heat sources. Store refrigerant in a cool place.
6. DO NOT handle damp refrigerant container with your bare hands. Skin may freeze to container. Wear gloves.
7. If skin freezes to container, pour COOL water over container to free the skin. Go to a physician or hospital immediately for treatment.

NOTE: To meet government standards relating to the use of refrigerants, R134a is used in the air conditioning system. Because it does not contain chlorine, R134a is not detrimental to the ozone in the atmosphere.

⚠ WARNING

1. It is illegal to discharge any refrigerant into the atmosphere. It must be recovered using the appropriate recovery stations.
2. Use correct refrigerant recovery, recycling and charging stations. Never mix refrigerants, hoses, fittings, components or refrigerant oils.

NOTE: Use only Bell Equipment approved R134a refrigerant products. Mixing of products not compatible will cause system damage and contaminate recovery, recycling and charging station equipment.

⚠ CAUTION

Care must be taken to identify and use equipment, refrigerant oil and refrigerant designed only for R134a refrigerant systems. Refrigerant should be tested for type and purity before recovery, recycling or charging of system. JT02167A refrigerant test instrument should be used before any testing or repair to system is preformed.

Prism Pro Refrigerant Identification Instrument:

----------JT02167A

To safely identify type and check purity of refrigerant prior to recovery, recycling and recharging of A/C systems.

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R134a REFRIGERANT OIL INFORMATION

⚠ CAUTION

1. All new compressors are charged with a mixture of nitrogen, R134a refrigerant and TY22025 (R134a) refrigerant oil. Wear safety goggles and discharge the compressor slowly to avoid possible injury.
2. DO NOT leave system or R134a compressor oil containers open. Refrigerant oil easily absorbs moisture. DO NOT spill R134a compressor oil on acrylic or ABS plastic. This oil will deteriorate these materials rapidly. Identify R134a oil containers and measures to eliminate accidental mixing of different oils.

NOTE: Do not add any more oil than required or maximum cooling will be reduced.

A new compressor from parts depot contains 190 ± 10 mL (6.42 ± .34 fl oz) of new oil. Oil level visible through suction port normally is below drive shaft.

Normal operating oil level of a compressor removed from operation is 30 mL (1.0 fl oz). This level cannot be seen through suction port of compressor.

Compressors can be divided into three categories when determining correct oil for system.

- New compressor from parts depot
- Used compressor removed from operation
- Compressor internally washed with flushing solvent.

Determining the amount of system oil prior to installation of compressor on a machine.

When complete system, lines, and components are flushed add correct amount of oil as described.

- New compressor from parts depot contains amount of new oil of 190 ± 10 mL (6.42 ± .34 fl oz). System requires an additional amount of new oil of 20 mL (1.0 fl oz) of new oil.

Refrigerant Oil Capacity Specification

New Compressor Volume
- - - - - - - - - - - - - - - - - - 190 ± 10 mL (6.42 ± .34 fl oz)

Air Conditioning System Additional Oil Volume
- -20 mL (1.0 fl oz)

Compressor Operating Oil Level Volume
- -30 mL (1.0 fl oz)

- Used compressor removed from operation, oil drained, and system flushed requires 209.6 mL (7.1 fl oz) of new oil.

Refrigerant Oil Capacity Specification

Used Compressor and System Flushed Oil Volume
- 209.6 mL (7.1 fl oz)

When complete system was not flushed add correct amount of oil for compressor plus amount of oil for each component that was serviced.

- New compressor from parts depot, drain and return 30 mL (1 fl oz) of oil to compressor.

Refrigerant Oil Capacity Specification

New Compressor Operating Oil Level Volume Drain and return- 30 mL (1 fl oz)

- Used compressor removed from operation and oil drained. Add 30 mL (1 fl oz) of new oil.

Refrigerant Oil Capacity Specification

Used Compressor Drained-Oil Volume
- 30 mL (1 fl oz)

- Used compressor removed from operation, oil drained, and flushed add 39.6 mL (1.34 fl oz) of new oil.

Refrigerant Oil Capacity Specification

Used Compressor-Flushed Oil Volume
- 39.6 mL (1.34 fl oz)

- Components listed below which have been removed, drained and flushed, require removal of compressor to determine correct oil. Use following chart as a guide for adding oil to components:

Refrigerant Oil Capacity Specification

Evaporator Oil Volume - - - - - - - - - - -30 mL (1.0 fl oz)

Condenser Oil Volume - - - - - - - - - - -30 mL (1.0 fl oz)

Receiver/Dryer Oil Volume - - - - - - - -30 mL (1.0 fl oz)

Flushed Compressor Oil Volume - - - -60 mL (2.0 fl oz)

Hose Oil Volume
- - - 3 mL per 30 cm (0.1 fl oz per ft) Approximate Total Length.

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NOTE:Hoses =3 mL per30cm(0.1 fl oz per ft) Approximate total length equals 600 cm (20 ft).

- If any section of hose is removed and flushed or replaced, measure length of hose and use formula 3 mL per 30 cm (0.1 fl oz per ft) to determine correct amount of oil to be added.
- Drain compressor oil into graduated container while rotating compressor shaft and record amount.
- If oil drained from a compressor removed from operation is very black or amount of oil is less than 6 mL (0.2 fl oz), perform the following and discard oil properly:

  – Determine if R134a leakage was detected, remove component and repair or replace component.

  – Remove and discard receiver/dryer.

  – Flush complete system with TY16134 air conditioning flushing solvent.

If component is serviceable, pour flushing solvent in ports and internally wash out old oil and discard oil properly.

Install a new receiver-dryer. **(See "Remove and Install Receiver-Dryer" on page 288).**

Install required amount of TY22025 refrigerant oil in compressor.

Connect all components.

Evacuate and charge system. **(See "Evacuate R134a System" on page 284 and "Charge R134a System" on page 284).**

R134a Refrigerant Recovery/Recycling and Charging Station Installation Procedure

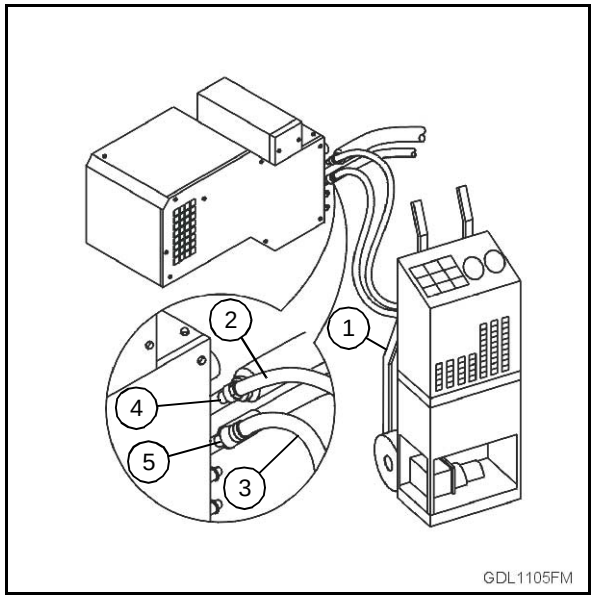
⚠ WARNING

Use only Bell Equipment approved R134a refrigerant products. Mixing of products not compatible will cause system damage and contaminate recovery/recycling and charging station equipment. Care must be taken to identify and use equipment, refrigerant oil and refrigerant designed only for R134a refrigerant systems. Refrigerant should be tested for type and purity before recovery/recycling or charging of system. JT02167A refrigerant test instrument should be used before any testing or repair to system is preformed.

⚠ WARNING

Use only Bell Equipment approved refrigerant recovery/recycling and charging stations. DO NOT mix refrigerant, hoses, fittings, components or refrigerant oils.

Follow refrigerant cautions and proper handling procedures. **(See "REFRIGERANT CAUTIONS AND PROPER HANDLING" on page 279).**



Close both high-side and low-side valves on refrigerant recovery/recycling and charging station (1).

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Remove cap from low pressure charge port (4) and connect blue hose (2).

Remove cap high pressure charge port (5) and connect red hose (3).

Recover R134a Refrigerant

⚠ WARNING

Use correct refrigerant recovery/recycling and charging stations. DO NOT mix refrigerant, hoses, fittings, components or refrigerant oils.

Follow refrigerant cautions and proper handling procedures. **(See "REFRIGERANT CAUTIONS AND PROPER HANDLING" on page 279)**

Run air conditioning system for three minutes to help in recovery process. Turn air conditioning system off before proceeding with recovery steps.

With engine OFF identify refrigerant type using JT02167A refrigerant identification instrument.

Connect refrigerant recovery system. **(See "R134a Refrigerant Recovery/Recycling and Charging Station Installation Procedure" on page 281)**

Follow manufacturer's instructions when using refrigerant recovery/recycling and charging station.

Flush and Purge Air Conditioner System

Add flushing solvent to system with JT02075 Flusher and JT02098 Fitting Kit.

NOTE: Flushing can be performed on machine.

Follow refrigerant cautions and proper handling procedures. **(See "REFRIGERANT CAUTIONS AND PROPER HANDLING" on page 279)**

Recover refrigerant. **(See "Recover R134a Refrigerant" on page 282)**

Add flushing solvent to system with JT02075 Flusher and JT02098 Fitting Kit.

Remove and discard receiver-dryer. **(See "Remove and Install Receiver-Dryer" on page 288)**

Connect flusher outlet hose to inlet end of compressor discharge line using JT02102 Adapter.

Fill flusher tank with 4 L (1gal) of solvent and fasten all connections.

Flush and Purge System Specification

Flusher Tank Capacity 4 L (1 gal)

NOTE: Air pressure must be at least 620 kPa (90 psi) (6.2 bar) for flushing and purging.

Flush and Purge System Specification

Air Pressure Minimum Pressure
--- 620 kPa (90 psi) (6.2 bar) for flushing and purging

Connect a supply line of moisture-free compressed air or dry nitrogen to flusher air valve.

Open air valve to force flushing solvent into condenser circuit. Flusher tank is empty when hose pulsing stops. Additional flushing cycles are required if system is heavily contaminated with burned oil or metal particles.

Clean compressor as follows:

- Remove compressor and measure oil drained from both manifold ports.
- Connect flusher outlet hose to inlet end of compressor discharge line using JT02102 Adapter.
- Pour 240 mL (8 fl oz) of flushing solvent into suction port and 120 mL (4 fl oz) into discharge port. Plug both ports in compressor manifold, using JT02099 and JT03194 Caps.

Flush A/C Compressor Specification

Flushing Solvent in Suction Port Volume
---------- 240 mL (8 fl oz)

Flushing Solvent in Discharge Port Volume
---------- 120 mL (4 fl oz)

- Turn compressor end for end and roll it side to side.
- Remove both plugs from manifold ports and drain solvent from compressor.
- Connect battery power to compressor clutch coil. Rotate pulley at least five revolutions to move solvent out of cylinders.
- Invert compressor. Roll end for end and side to side. Drain thoroughly.
- Repeat previous two steps at least three times.

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Divide system into two circuits:

- Condenser circuit, including inlet and outlet hoses.
- Evaporator circuit, including inlet and outlet hoses.

Condenser:

⚠ WARNING

DO NOT attempt to flush through compressor or receiver/dryer. Flushing through expansion valve is acceptable if refrigerant oil has a normal odor and appearance.

- Flush/Purge Condenser:
- Remove and discard receiver/dryer.
- Connect flusher outlet hose to inlet end of compressor discharge line using JT02102 Adapter.
- Fill flusher tank with 4 L (1gal) of solvent and fasten all connections.

Flush and Purge System Specification

Flusher Tank Capacity - - - - - - - - - - - - - - - 4 L (1 gal)

NOTE: Air pressure must be at least 620 kPa (90 psi) (6.2 bar) for flushing and purging.

Flush and Purge System Specification

Air Pressure Minimum Pressure
- - - 620 kPa (90 psi) (6.2 bar) for flushing and purging.

- Connect a supply line of moisture-free compressed air or dry nitrogen to flusher air valve.
- Open air valve to force flushing solvent into condenser circuit. Flusher tank is empty when hose pulsing stops. Additional flushing cycles are required if system is heavily contaminated with burned oil or metal particles.
- Attach a return hose and aerator nozzle to end of receiver/dryer inlet hose using JT03197 Adapter. Put nozzle in container to collect flushing solvent.

NOTE: Purging condenser circuit takes 10 - 12 minutes to thoroughly remove solvent.

- Disconnect hose from aeration nozzle to check circuit for solvent. Hold hose close to a piece of cardboard; continue purging until cardboard is dry.

See flush evaporator (See "Flush evaporator:" on page 283), if evaporator requires flushing.

If system is contaminated with burned refrigerant oil or debris, remove and bench flush evaporator. See following steps to flush evaporator through expansion valve, if oil appears normal.

Flush evaporator:

- Remove evaporator and expansion valve. **(See "Remove and Install Heater Core and Evaporator Core" on page 290 and "Remove and Install Expansion Valve" on page 289)**
- Force flushing solvent through evaporator inlet with compressed air.
- Purge system until dry.
- Install evaporator and expansion valve. **(See "Remove and Install Heater Core and Evaporator Core" on page 290 and "Remove and Install Expansion Valve" on page 289))**

Flush evaporator through expansion valve:

- Connect flusher outlet hose to connection of receiver/dryer outlet hose using JT03188 Adapter.
- Fill flusher tank with 4 L (1gal) of solvent and fasten all connections.

Flush and Purge System Specification

Flusher Tank Capacity - - - - - - - - - - - - - - - 4 L (1 gal)

NOTE: Air pressure must be at least 620 kPa (90 psi) (6.2 bar) for flushing and purging.

Flush and Purge System Specification

Air Pressure Minimum Pressure
- - - 620 kPa (90 psi) (6.2 bar) for flushing and purging

- Connect a supply line of moisture-free compressed air or dry nitrogen to flusher air valve.
- Attach a hose and aerator nozzle to compressor inlet line using JT02101 Adapter. Put nozzle in a container to collect solvent.

NOTE: Purging evaporator circuit takes 12 - 15 minutes to thoroughly remove solvent.

Disconnect hose from aeration nozzle to check circuit for solvent. Hold hose close to a piece of cardboard and continue purging until cardboard is dry.

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Install receiver-dryer. **(See "Remove and Install Receiver-Dryer" on page 288.)**

Fasten connections and mounting bracket.

Add required oil. **(See "R134a REFRIGERANT OIL INFORMATION" on page 280)**

Install compressor and connect refrigerant lines to manifold.

Connect clutch coil wire and install drive belt.

Evacuate R134a System

Follow refrigerant cautions and proper handling procedures. **(See "REFRIGERANT CAUTIONS AND PROPER HANDLING" on page 279)**

Connect refrigerant recovery system. **(See "R134a Refrigerant Recovery/Recycling and Charging Station Installation Procedure" on page 281)**

Open low-side and high-side valves on refrigerant recovery/recycling and charging station.

Follow manufacturer's instructions and evacuate system.

NOTE: Vacuum specifications listed are for sea level conditions. Subtract 3.4 kPa (34 mbar) (1 in. Hg) from 98 kPa (980 mbar) (29 in. Hg) for each 300 m (1000 ft) elevation above sea level.

Air Conditioning System Specification

Evacuate System Vacuum Subtract
- 3.4 kPa (34 mbar) (1 in. Hg) from 98 kPa (980 mbar) (29 in. Hg) for each 300 m (1000 ft) elevation above sea level

Evacuate system until low-side gauge registers 98 kPa (980 mbar) (29 in. Hg) vacuum.

Air Conditioning System Specification

Evacuate System Vacuum
- - - - - - - - - - - - - - - - - - 98 kPa (980 mbar) (29 in. Hg)

NOTE: If 98 kPa (980 mbar) (29 in. Hg) vacuum cannot be obtained in 15 minutes, test system for leaks. (See Refrigerant Leak Test in CHAPTER 7, SECTION 1 in Operation and Test Manual). Correct any leaks.

When vacuum is 98 kPa (980 mbar) (29 in. Hg), close low-side and high-side valves. Turn vacuum pump off.

If vacuum decreases more than 3.4 kPa (34 mbar) (1 in. Hg) in 5 minutes, there is a leak in system.

Air Conditioning System Specification

Evacuate System Vacuum
- - - - - - - - - - - - - - - - - - 3.4 kPa (34 mbar) (1 in. Hg)

Repair leak.

Evacuate system for 30 minutes after 98 kPa {980 mbar) (29 in. Hg) vacuum is reached.}

Close low-side and high-side valves. Stop evacuation.

Charge system. **(See Charge R134a System below.)**

Charge R134a System

⚠ WARNING

Use only Bell Equipment approved refrigerant recovery/recycling and charging stations. DO NOT mix refrigerant, hoses, fittings, components or refrigerant oils.

Follow refrigerant cautions and proper handling procedures. **(See "REFRIGERANT CAUTIONS AND PROPER HANDLING" on page 279)**

Identify refrigerant type using JT02167A refrigerant identification instrument.

Connect R134a Refrigerant Recovery/Recycling and Charging Station. **(See "R134a Refrigerant Recovery/Recycling and Charging Station Installation Procedure" on page 281)**

Evacuate system. **(See "Evacuate R134a System" on page 284)**

NOTE: Before beginning to charge air conditioning system, the following conditions must exist:
Engine STOPPED, pump must be capable of pulling at least 28.6 in. Hg vacuum (sea level). Subtract 3.4 kPa (34 mbar) (1 in. Hg) from 98 kPa (980 mbar) (29 in. Hg) for each 300 m (1000 ft) elevation above sea level.

Air Conditioning System Specification

Evacuate System Vacuum - - - - - - - - - - - - - - - - - - -
Subtract 3.4 kPa (34 mbar) (1 in. Hg) from 98 kPa (980 mbar) (29 in. Hg) for each 300 m (1000 ft) elevation above sea level.

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Follow manufacturer's instructions and charge system.

Add 1.8 kg (3.97 lb) refrigerant to system.

Air Conditioning System Specification

Air Conditioning System Refrigerant Refrigerant Quantity	1.8 kg (3.97 lb)

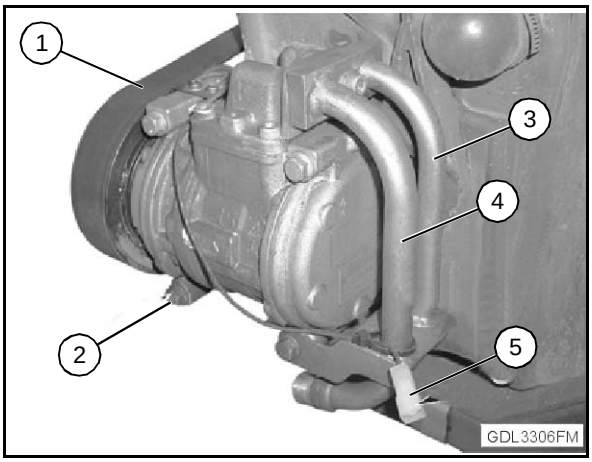
Check air conditioning for proper function. **(See Air Conditioning Operational Checks in CHAPTER 7, SECTION 3).**

Remove and Install Air Conditioner Compressor

Follow refrigerant cautions and proper handling procedures. **(See "REFRIGERANT CAUTIONS AND PROPER HANDLING" on page 279).**

Recover refrigerant. **(See "Recover R134a Refrigerant" on page 282).**

Open hood and lower bottom guard.



Engine Shown Removed for Clarity of Photo

1. Fan Belt.
2. Cap Screw (4 used).
3. Discharge Port.
4. Suction Port.
5. Clutch Solenoid Wire Connector.

Remove fan belt (1) from compressor pulley. **(See "FAN BELT" on page 181).**

Disconnect lines from suction and discharge ports (3 and 4). Close all openings using caps and plugs.

Disconnect compressor clutch solenoid wire connector (5).

Remove cap screws (2). Remove compressor.

Inspect, repair, or replace parts as necessary.

Before installing compressor, check oil. **(See "R134a REFRIGERANT OIL INFORMATION" on page 280).**

Install compressor. Install cap screws.

Connect clutch solenoid wire connector.

Connect lines to discharge and suction ports.

Install fan belt. **(See"FAN BELT" on page 181).**

Evacuate system. **(See "Evacuate R134a System" on page 284).**

Charge system. **(See "Charge R134a System" on page 284).**

Disassemble and Assemble Compressor Clutch

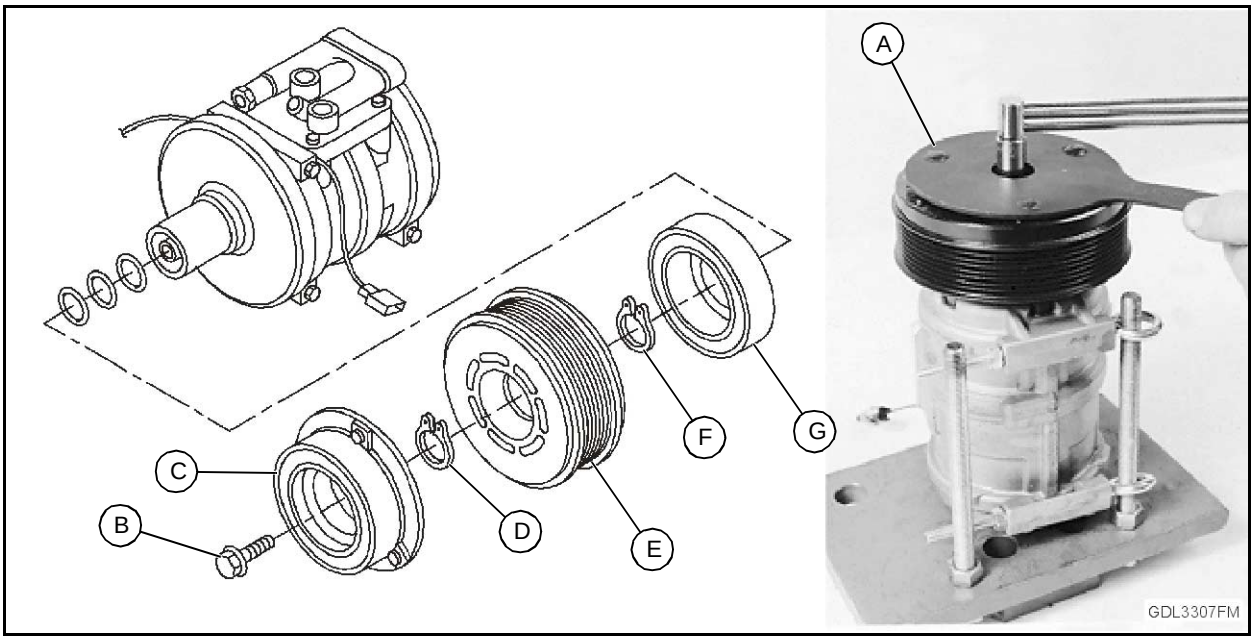
Follow refrigerant cautions and proper handling procedures. **(See "REFRIGERANT CAUTIONS AND PROPER HANDLING" on page 279).**

Remove compressor. **(See "Remove and Install Air Conditioner Compressor" on page 285).**

Install compressor on D01006AA Bench Mounted Holding Fixture.

Remove dust cover.

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A. JDG747 Compressor Clutch Spanner.
B. Clutch Shaft Bolt.
C. Clutch Hub.
D. Pulley Snap Ring.
E. Pulley.
F. Clutch Coil Snap Ring.
G. Clutch Coil.
H. Shims.

Hold clutch hub using JDG747 Compressor Clutch Spanner (A). Remove clutch shaft bolt (B).

Remove clutch hub (C). Remove shims (H) from clutch hub and save for installation.

Remove and discard snap ring (D). Remove pulley (E) using a plastic hammer or JDG220 Puller, JDG748 Jaws, and JDG771 Hub Protector.

Disconnect clutch coil lead wire. Remove and discard snap ring (F) and remove clutch coil (G).

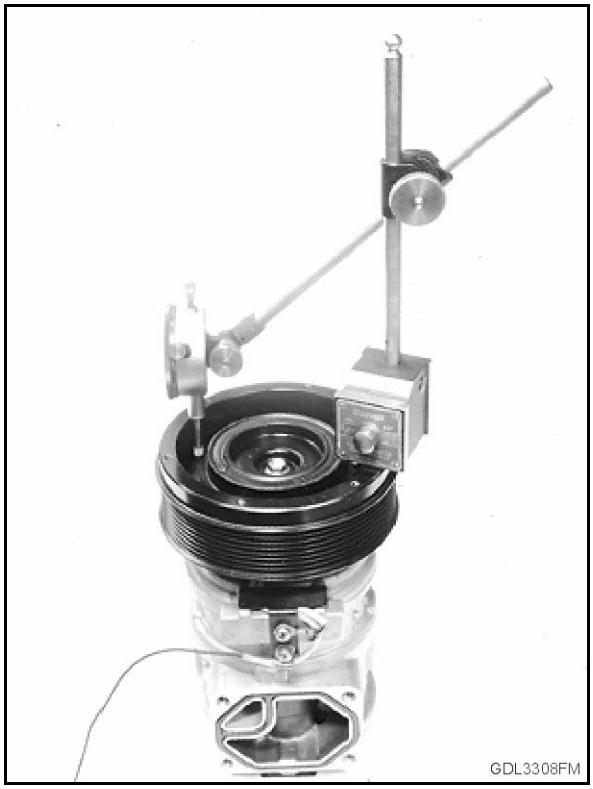
NOTE:Bearing in pulley is NOT serviceable.

Check pulley bearing operation. Replace pulley and bearing as required.

Install clutch coil and new snap ring with flat side of snap ring down. Connect clutch coil lead wire.

Install pulley with new snap ring flat side down.

Apply grease to shims (H) and install in clutch hub.



Check pulley-to-clutch hub clearance using a dial indicator. Mount gauge to pulley as illustrated and connect a set of jumper wires from compressor to a 12V battery.

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Rotate pulley and check clearance in three equally spaced locations around clutch hub. Add or remove shims as required.

Air Conditioning Compressor Specification

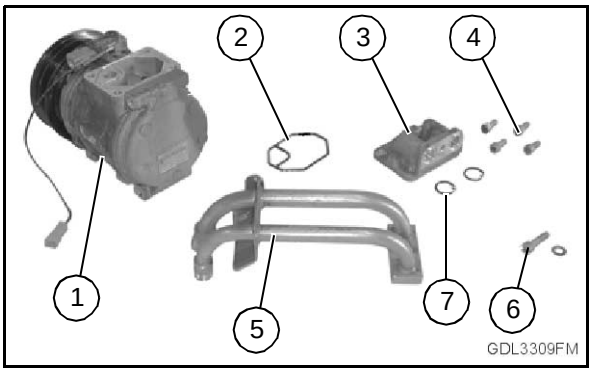
Pulley-to-Clutch Hub Clearance
- - - - - - - - - - - - - - - 0.35 - 0.65 mm (0.014 - 0.026 in.)

Install clutch hub and tighten shaft bolt to specification. Install dust cover.

Air Conditioning Compressor Specification

Clutch Hub and Shaft Bolt Torque
- 14 Nm (120 lb-in.)

Inspect Compressor Manifold



1. Compressor.
2. Manifold Seal.
3. Manifold.
4. Socket Head Cap Screw (4 used).
5. Manifold Tube Assembly.
6. Seal Ring (2 used).
7. Socket Head Cap Screw and Washer.

Remove manifold tube assembly (5) and seal rings (6).

Remove manifold (3) and manifold seal (2).

Clean, inspect, and replace parts as necessary.

Lubricate and install manifold seal. Install manifold.

Install seal rings. Install tube assembly. Tighten cap screws to specification.

Air Conditioning Compressor Specification

Manifold Cap Screws Torque - - - - - - -26 Nm (19 lb-ft)

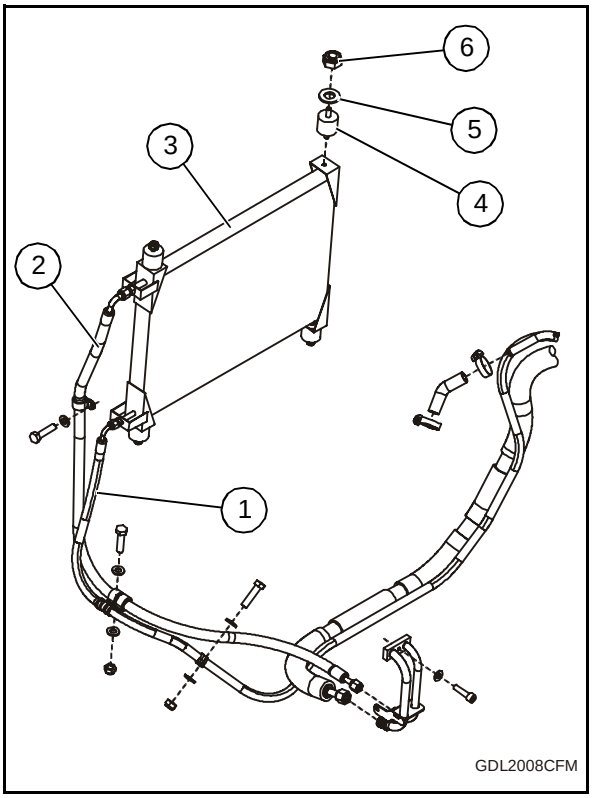
Remove and Install Condenser

NOTE: It is not necessary to remove condenser to just purge and flush system. See Flush and Purge Air Conditioner System.

Follow refrigerant cautions and proper handling procedures. **(See "REFRIGERANT CAUTIONS AND PROPER HANDLING" on page 279).**

Recover refrigerant. **(See R"Recover R134a Refrigerant" on page 282).**

Remove grille and open hood.



1. Line to Receiver-Dryer.
2. Line From Compressor.
3. Condenser.
4. Condenser Mount.
5. Washer Nut.
6. Nut.

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Disconnect lines (1 and 2). Close all openings using caps and plugs.

Remove nuts and washers (5 and 6). Remove condenser (3).

Inspect, repair, and replace parts as necessary.

Before installing condenser, add refrigerant oil. **(See "R134a REFRIGERANT OIL INFORMATION" on page 280).**

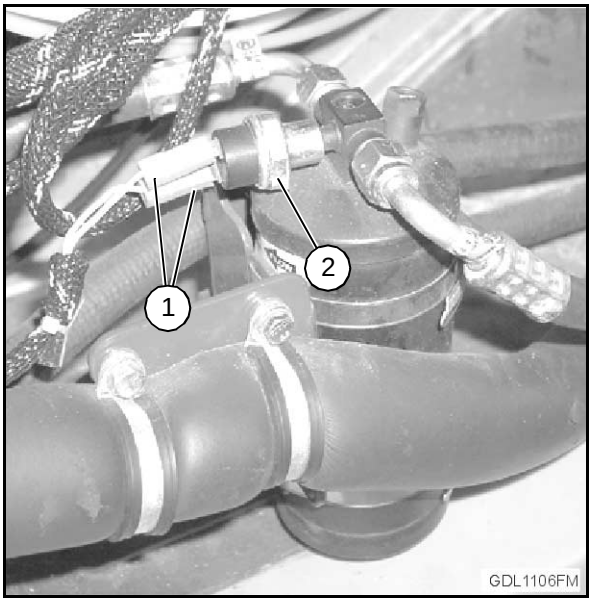
Install condenser.

Evacuate system. **(See "Evacuate R134a System" on page 284).**

Charge system. **(See "Charge R134a System" on page 284).**

Remove and Install High/Low Pressure Switch

NOTE: A valve prevents system from discharging when switch is removed.



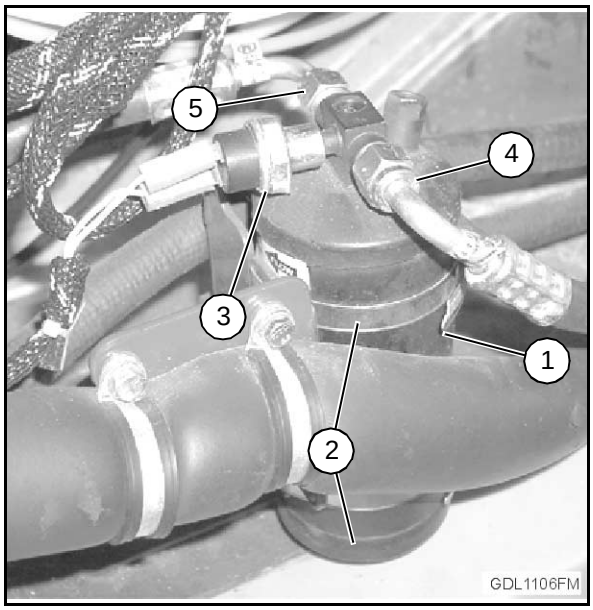
Disconnect wire leads (1) and remove pressure switch (2).

Replace parts as necessary.

Remove and Install Receiver-Dryer

Follow refrigerant cautions and proper handling procedures. **(See "REFRIGERANT CAUTIONS AND PROPER HANDLING" on page 279).**

Recover refrigerant. **(See "Recover R134a Refrigerant" on page 282).**



Disconnect wiring leads from high/low pressure switch (3).

Disconnect lines (4 - 5). Close all openings using caps and plugs.

Loosen clamps (2) to remove receiver-dryer (1).

Before installing new receiver-dryer, add refrigerant oil. **(See "R134a REFRIGERANT OIL INFORMATION" on page 280).**

Install new receiver-dryer. Tighten clamp.

Connect wiring leads and lines.

Evacuate system. **(See "Evacuate R134a System" on page 284).**

Charge system. **(See "Charge R134a System" on page 284).**

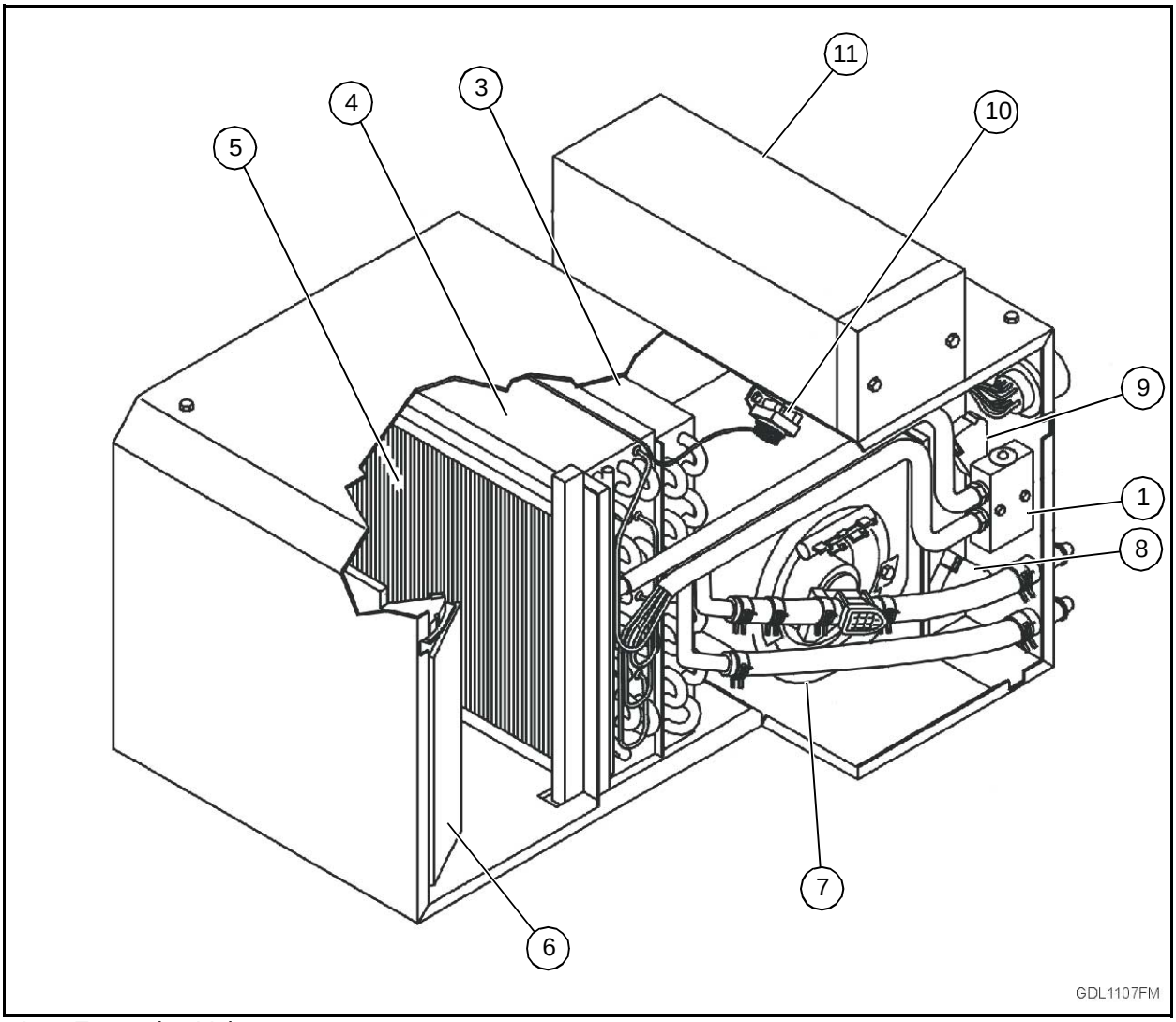
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Remove and Install Expansion Valve

Follow refrigerant cautions and proper handling procedures. **(See "REFRIGERANT CAUTIONS AND PROPER HANDLING" on page 279).**

Recover refrigerant. **(See "Recover R134a Refrigerant" on page 282).**

Remove side panel from air conditioner box.



1. Expansion Valve.
2. Heater Control Valve.
3. Heater Core.
4. Evaporator Core.
5. Air Filter.
6. Recirculating Damper.
7. Blower.
8. Floor Vent Actuator.
9. Defrost Actuator.
10. Freeze Control Switch.
11. Relay Box.

Disconnect lines and remove expansion valve (1). Close all openings using caps and plugs.

Install expansion valve and connect lines.

Install heater and air conditioner module side panel.

Evacuate system. **(See "Evacuate R134a System" on page 284).**

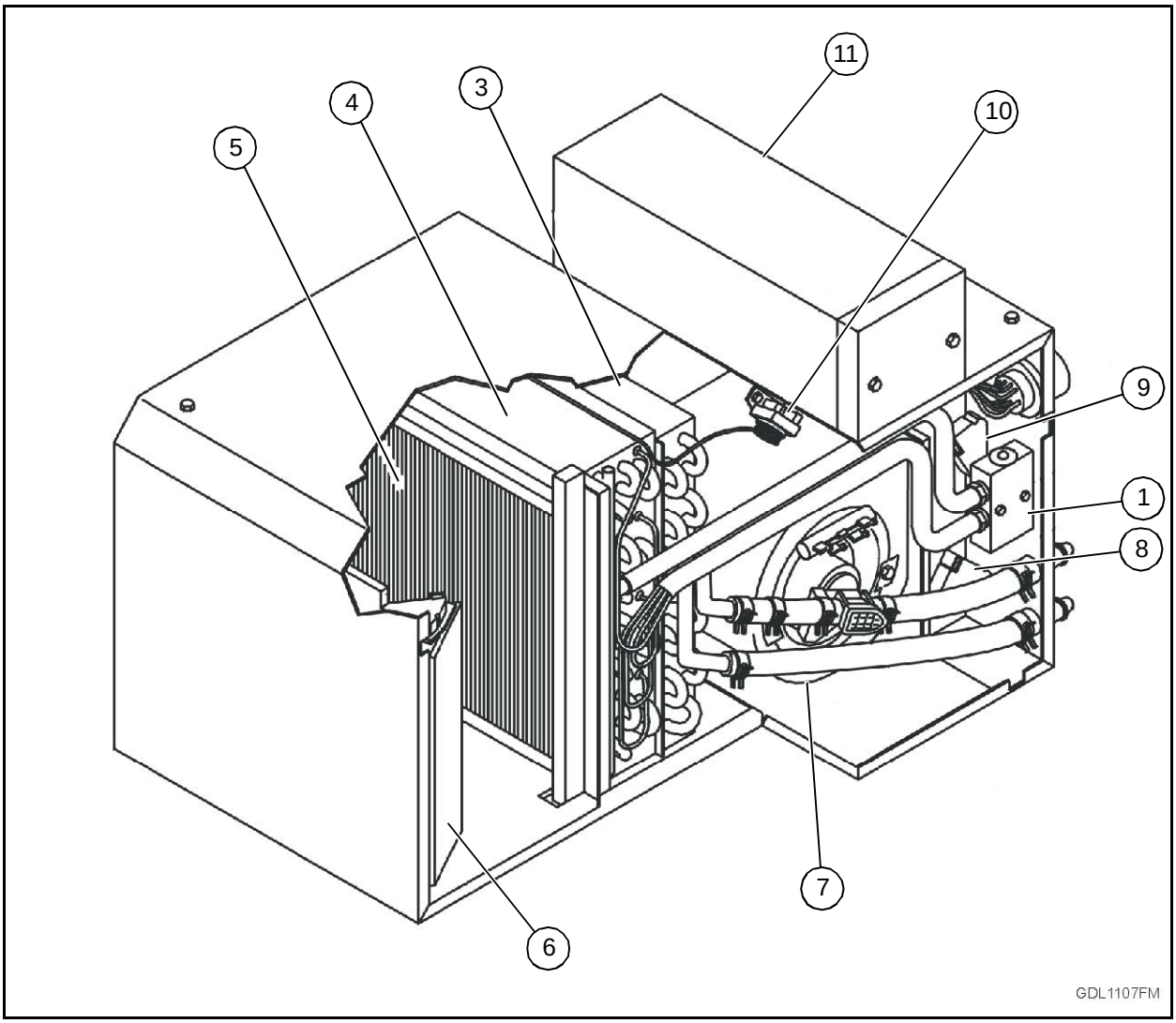
Charge system. **(See "Charge R134a System" on page 284).**

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Remove and Install Heater Core and Evaporator Core

Remove air conditioning box from machine.

- Follow refrigerant cautions and proper handling procedures. **(See "REFRIGERANT CAUTIONS AND PROPER HANDLING" on page 279).**
- Recover refrigerant. **(See R"Recover R134a Refrigerant" on page 282).**
- Drain radiator. **(See Change Engine Coolant Operator's Manual CHAPTER 11, SECTION 2).**
- Disconnect wiring connectors and air ducts from air conditioner box.
- Disconnect refrigerant lines, heater hoses, and drain tubes. Close all openings with caps and plugs.
- Remove air conditioning box from right-side compartment.



Remove heater core (3) and evaporator core (4) from air conditioner box.

- Remove side panel from air conditioner box.
- Remove tray from relay box (11) and disconnect all electrical connectors. Route wiring harness out of relay box.
- Disconnect freeze control switch (10) from top panel. Remove top panel from air conditioner box.
- Disconnect evaporator lines from expansion valve (1). Disconnect heater hoses from heater core. Close all openings with caps and plugs.
- Remove heater core and evaporator core as an assembly.
- Remove clips to disconnect evaporator core from heater core.

Repair or replace parts as necessary.

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Install heater and evaporator cores in air conditioner box.

- Before installing evaporator core, add refrigerant oil. **(See "R134a REFRIGERANT OIL INFORMATION" on page 280).**
- Install clips to connect evaporator core to heater core.
- Install heater core and evaporator core in air conditioner box as an assembly.
- Connect evaporator lines to expansion valve. Connect heater hoses to heater core.
- Install top panel. Connect freeze control switch to top panel.
- Install tray in relay box. Connect all electrical connectors.
- Install side panel on air conditioner box.

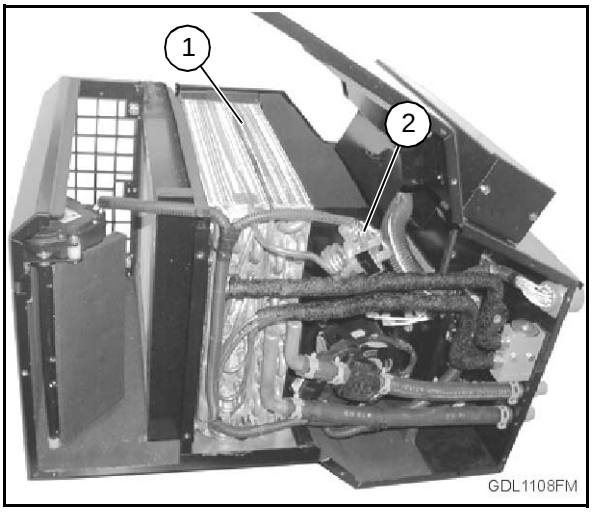
Install air conditioner box in machine.

- Connect air ducts. Connect electrical connectors.
- Connect air conditioner lines, heater hoses, and drain tubes.
- Fill radiator. **(See Change Engine Coolant Operator's Manual CHAPTER 11, SECTION 2).**
- Evacuate system. **(See "Evacuate R134a System" on page 284).**
- Charge system. **(See "Charge R134a System" on page 284).**

Remove and Install Freeze Control Switch

Remove air conditioner box from machine. **(See "Remove and Install Heater Core and Evaporator Core" on page 290).**

Remove side panel from air conditioner box.



Disconnect freeze control switch (2) from top panel. Disconnect wire leads.

Disconnect top panel from air conditioner box. Lift top panel enough to remove capillary tube from evaporator core (1).

Inspect and replace parts as necessary.

Install capillary tube in evaporator core.

Connect wire leads to freeze control switch. Install top panel. Connect freeze control switch to top panel.

Install side panel.

Install air conditioner box in machine. **(See "Remove and Install Heater Core and Evaporator Core" on page 290).**

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CHAPTER 13. SHEET METAL AND STYLING

SECTION 1. BONNET OR ENGINE ENCLOSURE

BONNET

Remove and Install Bonnet

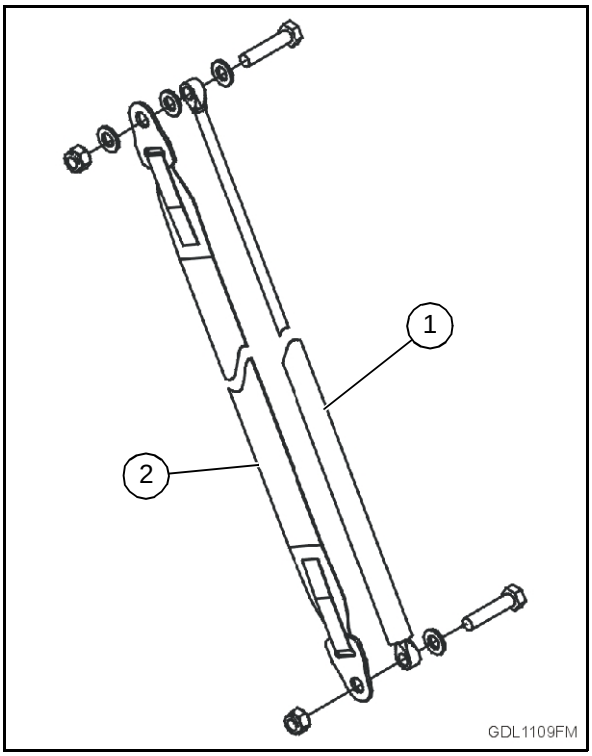
⚠ CAUTION

Component is heavy. Use hoist.

Bonnet Specification

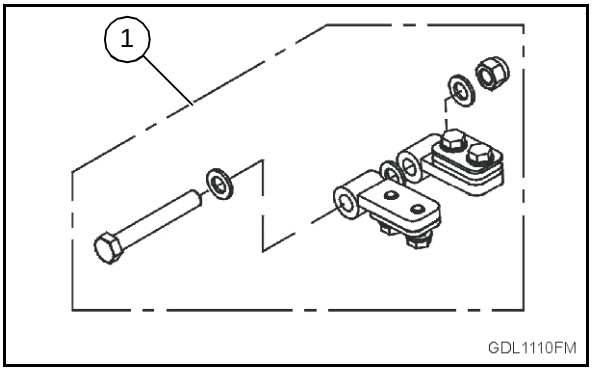
Bonnet Weight - - - - - - - - 57 kg (125 lb) approximate

Open bonnet. Secure bonnet with hoist.



Remove straps (2).

Remove struts (1).



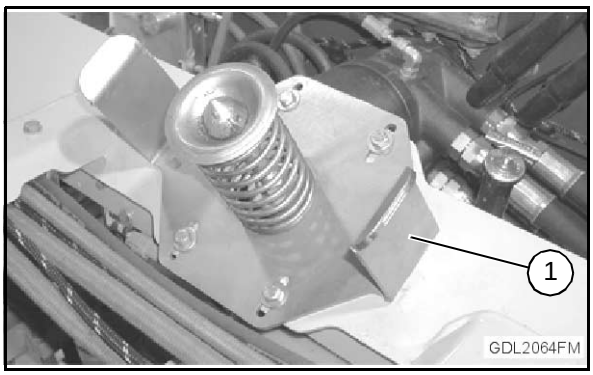
Disconnect hinges (1).

Connect hinges.

Connect straps and struts.

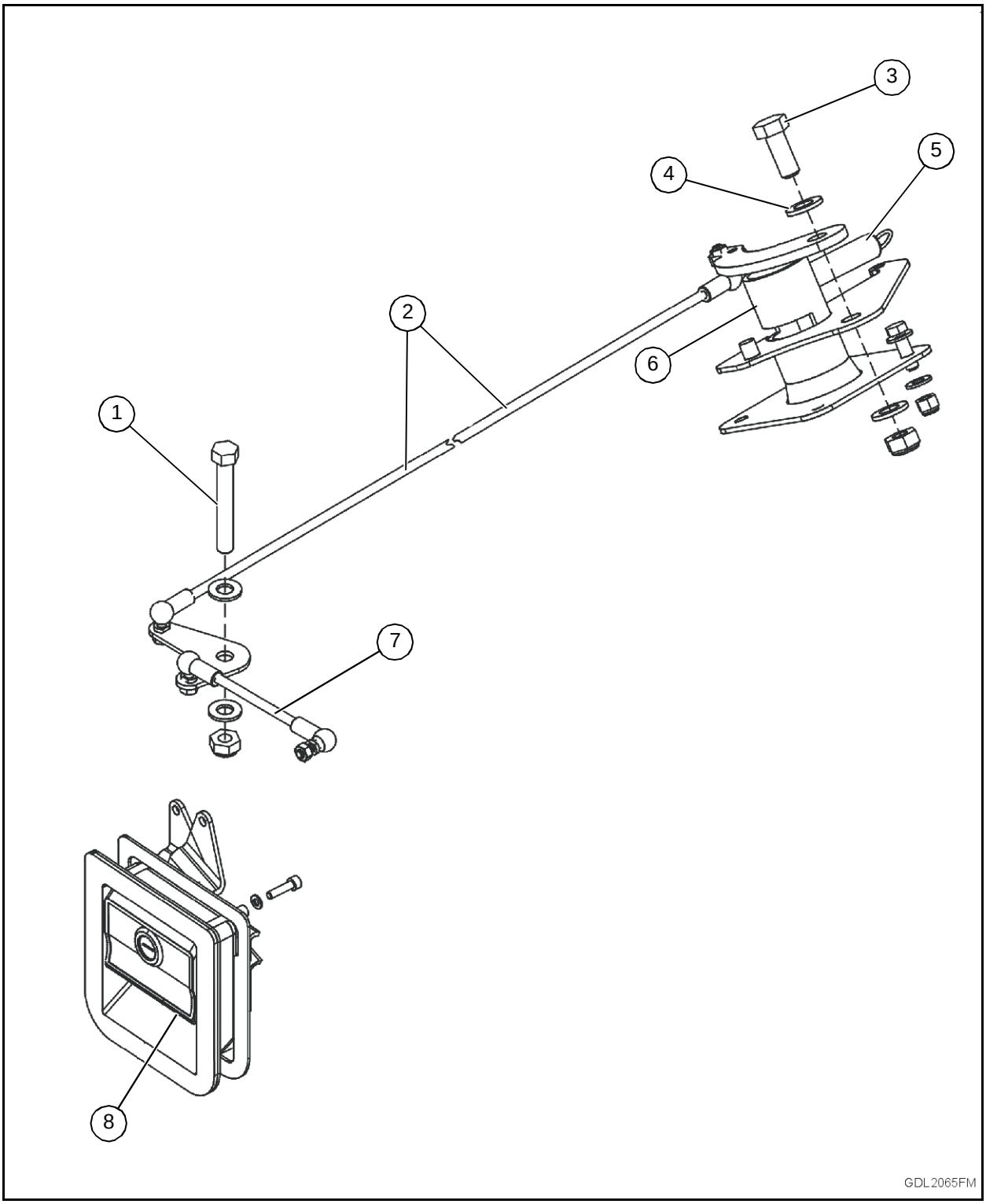
Adjust bonnet latch.

Adjust Bonnet



Remove catch pin assembly (1) from machine. Clean catch pin and strike plate.

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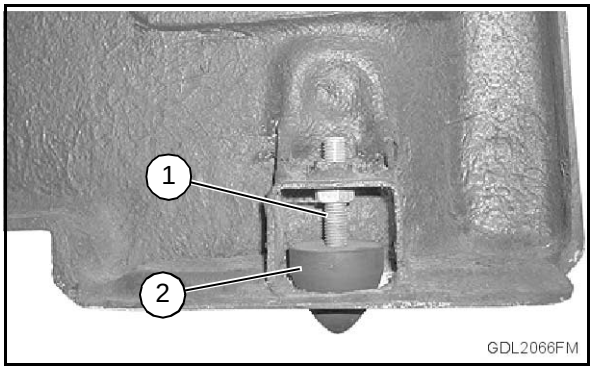
1. Linkage Pivot Cap Screw.
2. Linkage Rod.
3. Latch Arm Pivot Cap Screw.
4. Latch Arm Pin Tube.
5. Return Spring.
6. Catch Pin Tube.
7. Linkage Rod.
8. Latch Release Lever.

Adjust latch linkage.

- Adjust linkage pivot cap screw (1) and latch arm pivot cap screw (3), if necessary. Pivots should not bind or have excess free-play.
- Adjust linkage rods (7 and 2) so latch release lever (8) and latch arm (4) move smoothly through full range of motion.

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- Ensure latch arm returns to engaged position inside catch pin tube (6) when lever is released.
- Replace return spring (5), if necessary. Clean latch arm and catch pin tube.



Adjust stoppers (1) to initial setup specification.

Bonnet Specification

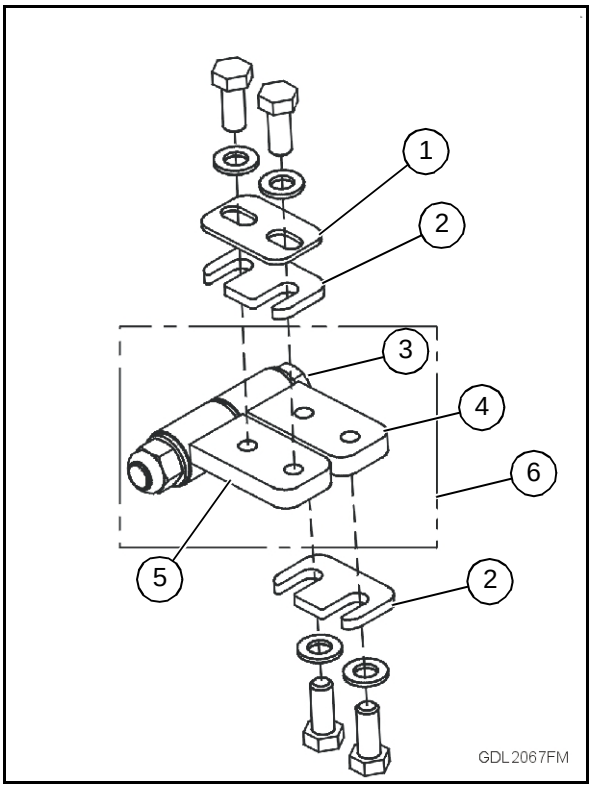
Stopper Tip-to-Bonnet Lower Surface Initial Setup Distance - 20 mm (0.8 in.)

⚠ CAUTION

Component is heavy. Use hoist.

Bonnet Specification

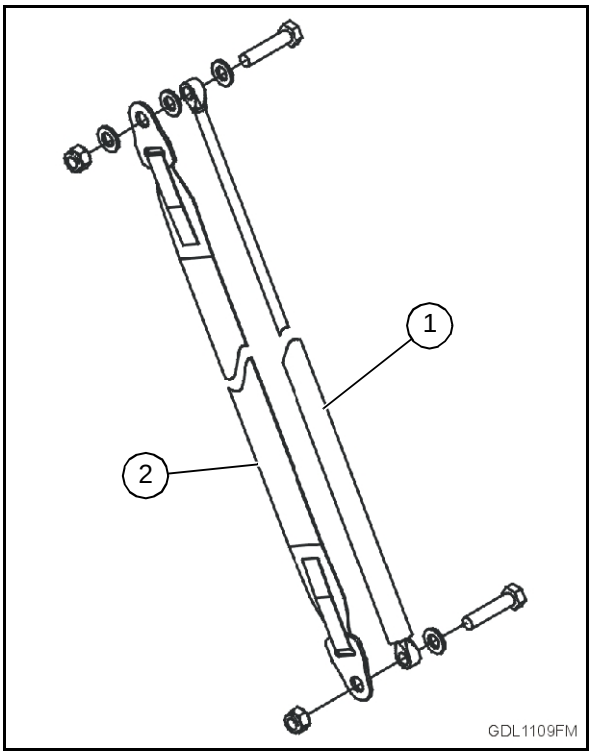
Bonnet Weight - - - - - - - - 57 kg (125 lb) approximate



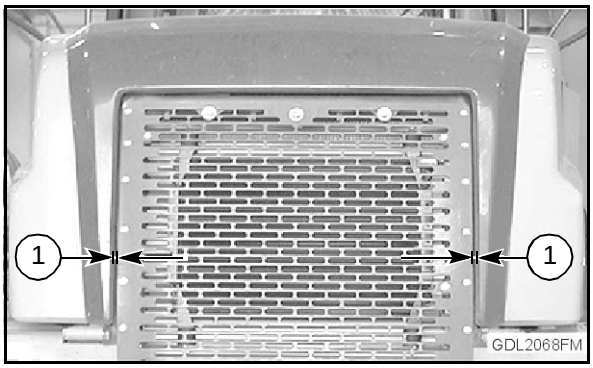
Install support plates (1), spacers (2), and hinges (6) on bonnet.

Lift bonnet with hoist. Install spacers and hinges to frame.

Tighten hardware enough to eliminate gaps between contact surfaces, but ensure that flanges (4 and 5) are loose enough to allow adjustment.



5. Install struts (1) and straps (2).



1. Bonnet-to-Grille Gap

Lower bonnet. Adjust bonnet left-to-right alignment. Bonnet-to-grille gaps (1) should be equal on left and right sides.

Raise bonnet slowly. Ensure that bonnet does not shift left or right. Tighten bonnet-mounted flanges of hinges.

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Lower bonnet. Adjust bonnet front-to-rear alignment.

Ensure that weather seal at bonnet rear edge aligns with mating surface on front of cab.

Front of bonnet should extend approximately 10 mm (0.4 in.) beyond front bumper surface.

Lower radiator bottom guard. Tighten frame-mounted flanges of hinges.

Raise bonnet. Install catch pin assembly.

Tighten hardware enough to eliminate gaps between contact surfaces, but ensure that assembly is loose enough on mounting surface to allow adjustment.

Move assembly to centered position.

Lubricate latch linkage, latch arm, hinges, strike plate, and catch pin with multipurpose grease or dry graphite as necessary.

Lower bonnet. Latch arm should engage catch pin.

Pull latch release lever.

Latch should move smoothly with slight resistance.

Latch arm should release catch pin.

Raise bonnet slowly. Ensure that catch pin assembly does not shift out of alignment. Tighten catch pin assembly.

Lower bonnet and engage latch.

Examine bonnet-to-frame contact. Weather seal surfaces should make even contact.

Stoppers should contact frame, but not be excessively compressed.

Adjust height of catch pin and stoppers, if necessary, and recheck.

Tighten nuts on catch pin and stoppers when adjustment is complete.

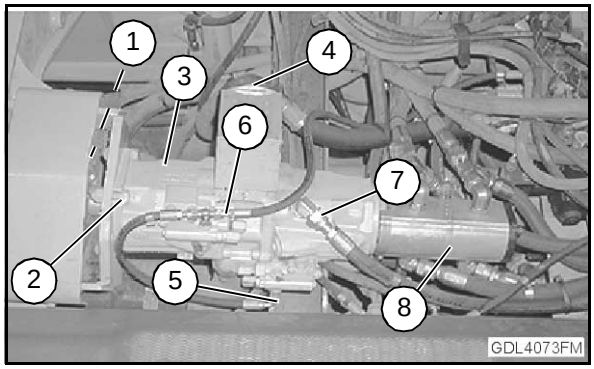
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CHAPTER 14. MAIN HYDRAULIC SYSTEM

SECTION 1. HYDRAULIC SYSTEM

MAIN HYDRAULIC PUMP

Remove and Install Main Hydraulic Pump



Remove wet disk brake cooling oil pumps (8), if equipped. **(See "Wet Disk Brake Cooling Oil Pumps" on page 253).**

Disconnect damper coupler (1). **(See "Hydraulic Pump Drive Shaft" on page 300).**

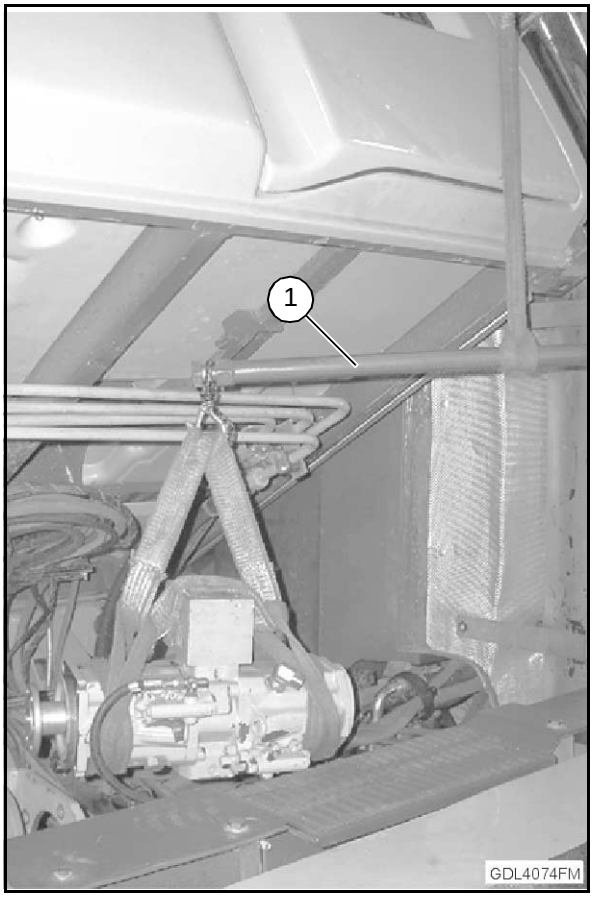
Disconnect hydraulic load sense line (6), case drain line (7), suction tube (5), and pressure tube (4). Close all openings using caps and plugs.

⚠ CAUTION

Component is heavy. Use hoist.

Main Hydraulic Pump Specification

Hydraulic Pump Weight
- 48 kg (105 lb) approximate



Attach DFT1132 Removal and Installation Tool (9) to hydraulic pump (3) with straps. Attach hoist to tool with a strap.

Remove cap screws, washers, and stop nuts (2). Remove pump from machine.

Clean, repair, or replace parts as necessary.

Install pump. Install cap screws, washers, and stop nuts loosely.

Install suction tube and pressure tube.

Tighten cap screws, washers, and stop nuts.

Connect damper coupler. **(See H"Hydraulic Pump Drive Shaft" on page 300)**.

Connect hydraulic load sense line and secondary steering load sense line.

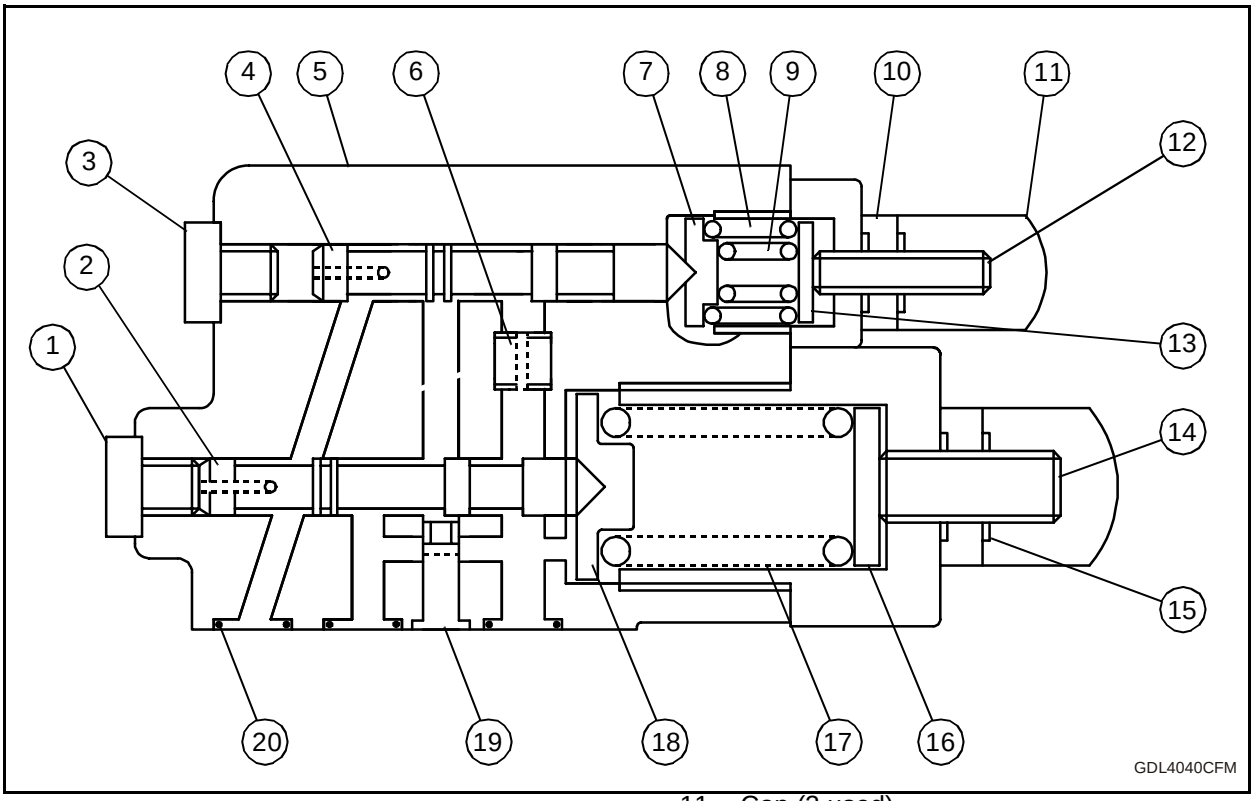
Install wet disk brake cooling oil pumps, if equipped. **(See "Wet Disk Brake Cooling Oil Pumps" on page 253).**

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Disassemble and Assemble

The following procedure should be used for both pumps.

Clean and drain pump.

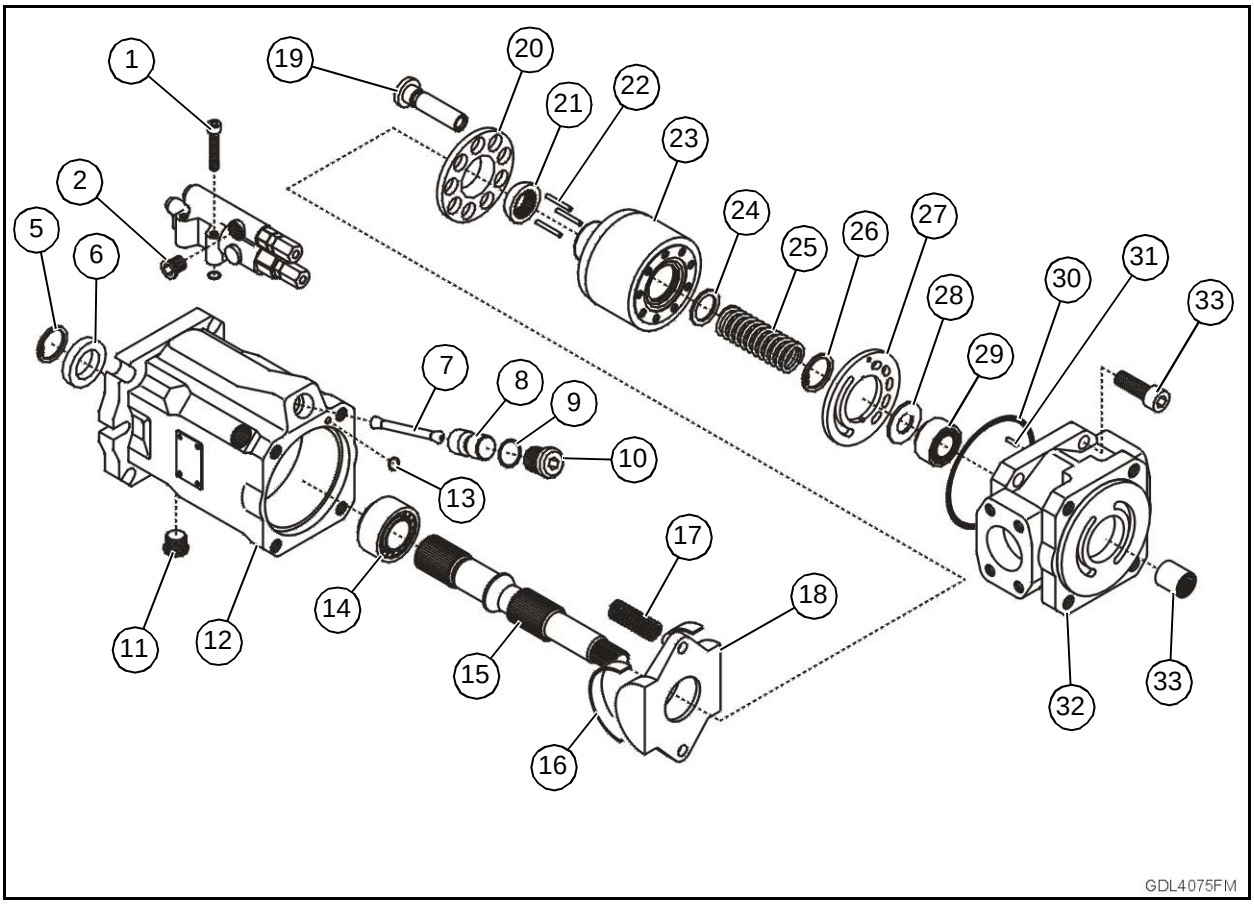


1. Plug.
2. Compensator Valve Spool.
3. Plug.
4. Residual Valve Spool.
5. Pump Regulator Valve.
6. Orifice.
7. Spring Guide.
8. Outer Spring.
9. Inner Spring.
10. Nut (2 used).
11. Cap (2 used).
12. Adjusting Screw.
13. Plate.
14. Adjusting Screw.
15. Sealing Washer (4 used).
16. Plate.
17. Spring.
18. Spring Guide.
19. Orifice Plug.
20. O-Ring (3 used).

Remove regulator valve. Disassemble as necessary.

Remove check valve block. Inspect for wear or damage. Replace block if necessary.

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1. Cap Screw (4 used).
2. Plug.
3. Pump Regulator Valve.
4. O-Ring (3 used).
5. Snap Ring.
6. Oil Seal.
7. Control Rod.
8. Control Piston.
9. O-Ring.
10. Plug.
11. Plug.
12. Pump Housing.
13. O-Ring.
14. Tapered Roller Bearing Cone and Cup.
15. Drive Shaft.
16. Swash Plate Bearing (2 used).
17. Spring.
18. Swash Plate.
19. Piston (9 used).
20. Retainer Plate.
21. Guide Ball.
22. Pin (3 used).
23. Cylinder Block.
24. Washer.
25. Spring.
26. Snap Ring.
27. Distributor Plate.
28. Spacer.
29. Tapered Roller Bearing Cone and Cup.
30. O-Ring.
31. Dowel Pin.
32. Port Plate.
33. Cap Screw (4 used).
34. Splined Coupler.

⚠ CAUTION

The distributor plate may stick to the port plate when removed. The highly machined surface on port plate, distributor plate, and cylinder block must not be damaged. Lay parts on clean, lint-free towels to protect the machine surfaces.

NOTE: The two pumps are joined together by the port plate (32) and the drive shafts are joined by the splined coupler (34).

Remove port plate (32) and distributor plate (27).

Remove tapered roller bearing cone (29) and spacer (28).

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Remove the rotary group (19 - 26) as an assembly.

⚠ CAUTION

Spring (25) is under compression. A press must be used to compress spring to remove snap ring (26).

Inspect cylinder block. Remove spring (25) only if replacement is necessary.

Remove control piston assembly (7 - 10).

Remove swash plate (18), drive shaft (15), spring (17), and bearings (16).

Remove tapered roller bearing cone (14) using a press. Remove bearing only if replacement is necessary.

Remove snap ring (5) and oil seal (6).

Clean and inspect all parts for wear and damage. Replace parts as necessary.

⚠ WARNING

Replace all oil seals and O-rings. Old seals and O-rings will leak.

Install oil seal with lip facing inside of housing. Press seal into housing just far enough to install snap ring. Apply petroleum jelly to sealing lip.

Put pump housing in vise with large opening up, at approximately a 30° angle with control piston port at bottom.

⚠ CAUTION

Apply clean oil to all internal parts as they are assembled.

Install swash plate bearings and spring.

Install tapered roller bearing cone on drive shaft tight against shoulder. Bearing cone is a press fit.

Install drive shaft and swash plate. Position spring (17) on swash plate using a screwdriver.

Install control rod (7) by pushing the swash plate to one side and moving end of control rod in the opposite direction.

Install control piston, O-ring, and plug.

Move pump housing to a horizontal position.

Assemble rotary group (19—26). A press must be used to install spring (25). Pins (22) are installed in cylinder block between washer (24) and guide ball (21).

Install assembled rotary group into pump housing.

Install spacer (28) and bearing cone (29).

Install O-rings (13 and 30).

Apply a small amount of petroleum jelly on the mating surface of distributor plate and port plate.

Install distributor plate onto port plate dowel pin.

Install splined coupler (34) if removed.

Install port plate.

Tighten cap screws to specification using a crisscross pattern.

Main Hydraulic Pump Specification

Port Plate-to-Pump Housing Cap Screw Torque
---------- 225 Nm (165 lb-ft)

Install check valve block.

Install pump regulator valve.

Hydraulic Pump Drive Shaft

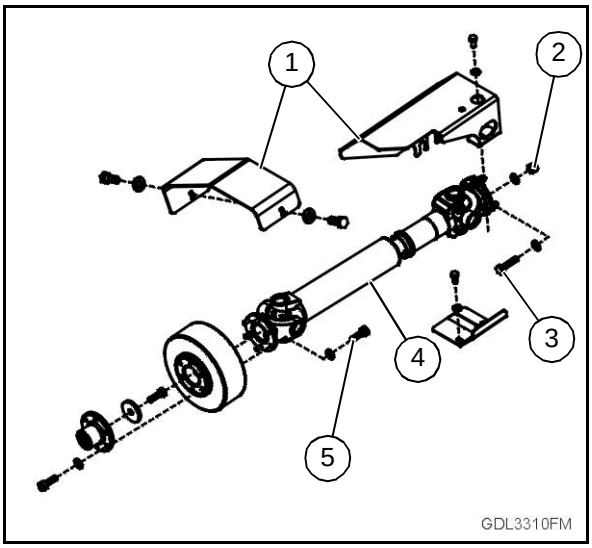
Remove and Install Shaft

Tilt the cab. **(See Tilt Cab Operator's Manual, CHAPTER 7).**

⚠ CAUTION

Exhaust pipes can be hot.

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Remove guards (1).

Remove lock nuts (2), washers, and cap screws (3).

Remove cap screws (5).

Remove drive shaft (4).

Repair or replace parts as necessary.

⚠ CAUTION

Assemble drive shaft so yokes on ends of shaft are aligned. If yokes are not aligned, severe vibration and machine damage may result.

Install drive shaft.

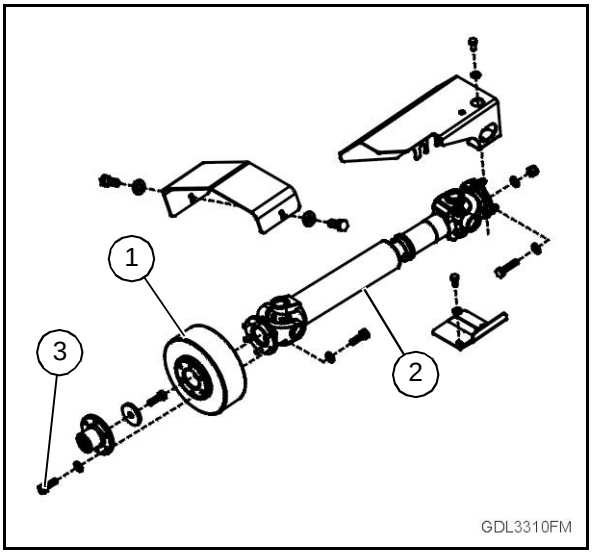
Apply rigid form-in-place gasket to threads of cap screws (5 and 3). Install cap screws, washers, and lock nuts. Tighten hardware to specification.

Specification

Cap Screw and Lock Nut Torque - - - 28 Nm (20.5 lb-ft)

Install guards.

Remove and Install Damper Coupler



Remove drive shaft (2). **(See "Hydraulic Pump Drive Shaft" on page 300).**

Remove cap screws (3) and washers.

Remove damper coupler (1).

Repair or replace parts as necessary.

Install damper coupler.

Apply T43514 Rigid Form-In-Place Gasket to cap screw threads. Install washers and cap screws. Tighten to specification.

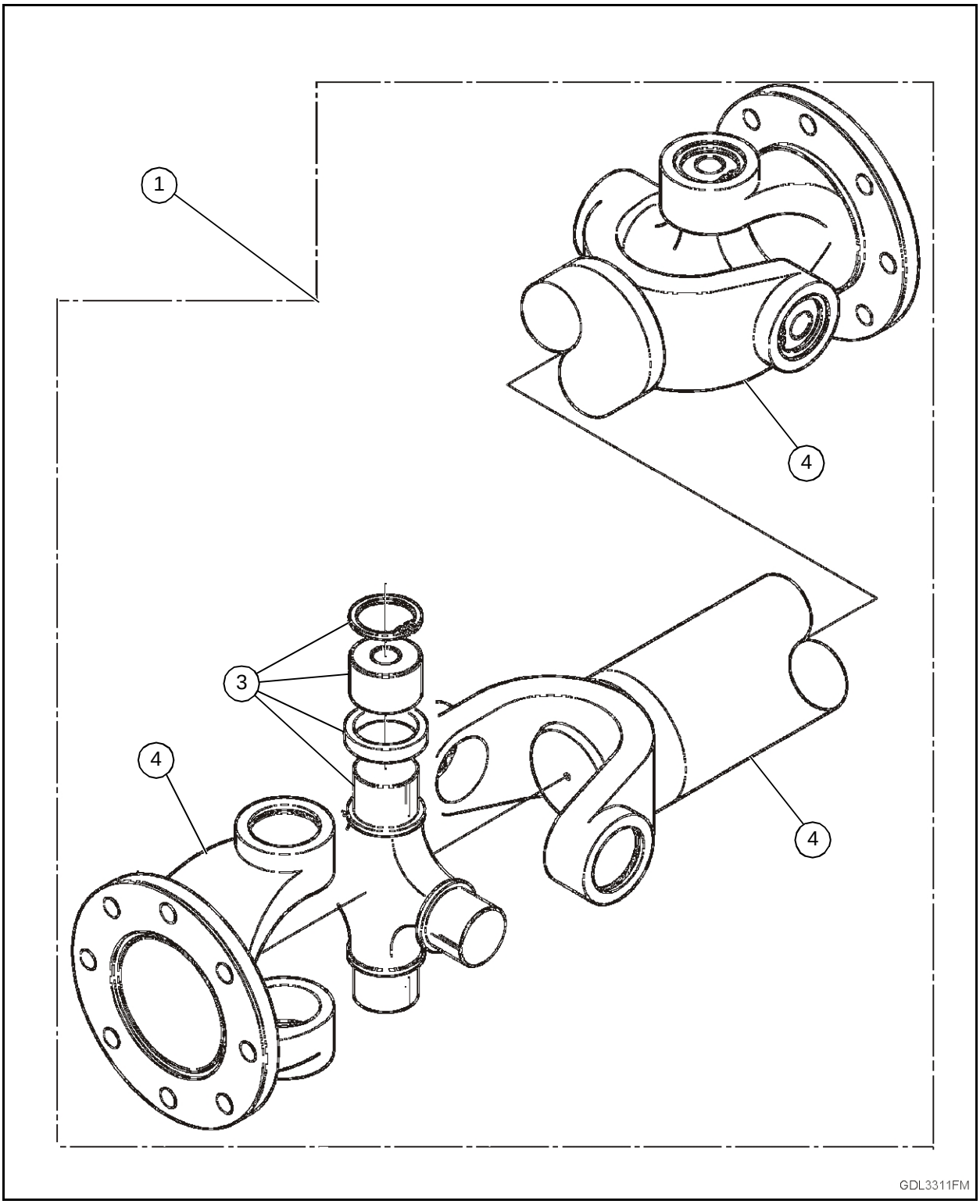
Specification

Cap Screw Torque - - - - - - - - - - - - - 28 Nm (20.5 lb-ft)

Install drive shaft. **(See "Hydraulic Pump Drive Shaft" on page 300).**

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Disassemble and Assemble Shaft



Remove snap rings.

Push on one of the bearing caps to push the opposite bearing cap out of yoke ear as far as possible. Remove the bearing cap.

Turn the drive shaft over. Then push on the cross through the yoke ear where the bearing cap was just removed to push the second bearing cap out as far as possible. Remove the bearing cap.

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Remove the cross from yoke.

Remove the remaining bearing caps.

Clean and inspect the yokes for damage. Replace parts as necessary.

⚠ CAUTION

Assemble drive shaft so yokes on the ends of shaft are aligned. If yokes are not aligned, severe vibration and machine damage may result.

Install the cross into the yoke for the drive shaft.

Check that a seal is installed on each bearing cap.

Install the bearing cap into one of the yoke ears just far enough so snap ring can be installed in its groove. As cap is pushed into the yoke, check that the cross is aligned with the cap. Install the snap ring.

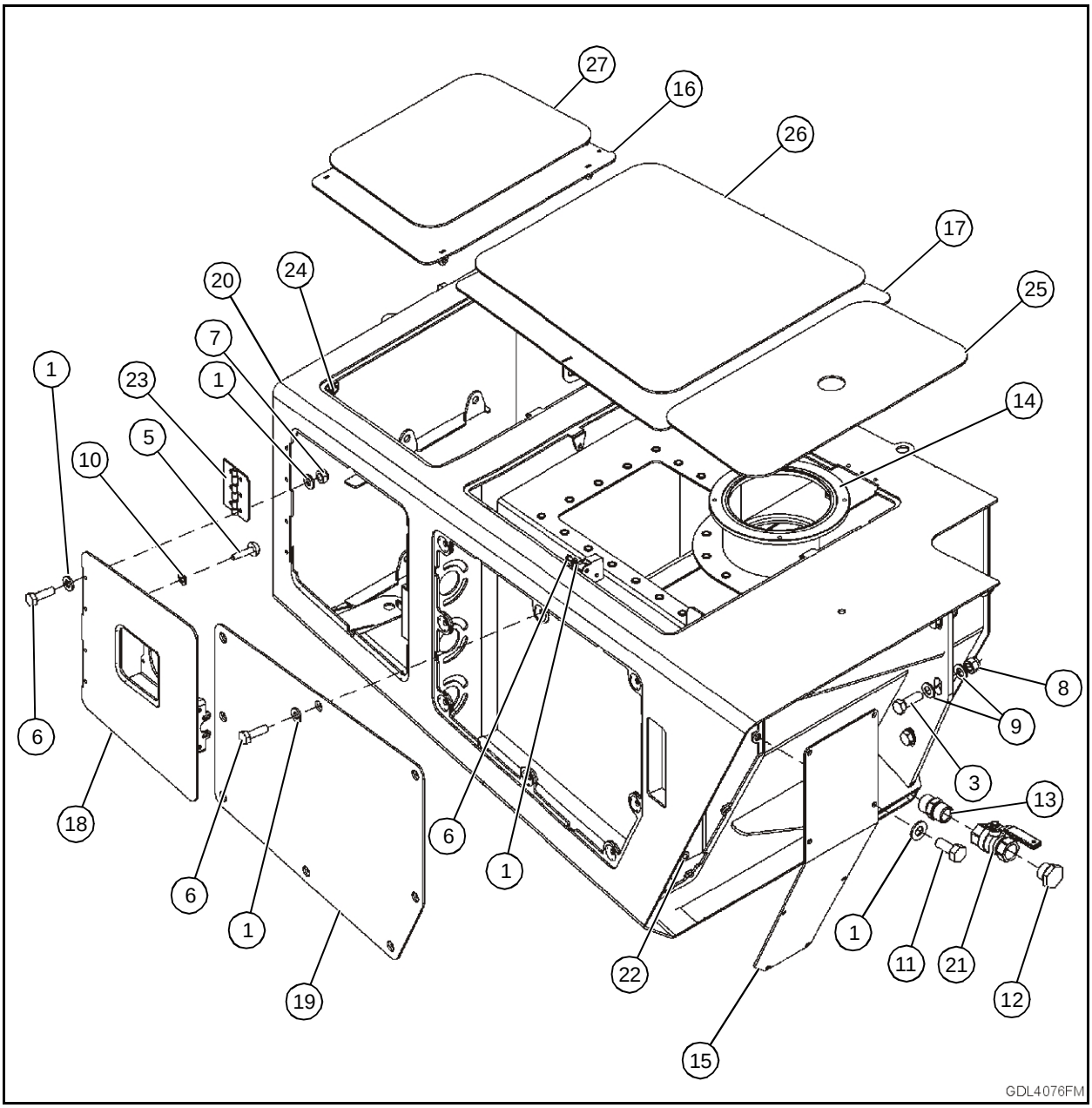
Turn the drive shaft over. Checking that the cross is aligned with the bearing cap, push the second bearing cap into yoke just far enough so snap ring can be installed in its groove. Install the snap ring.

Install the cross into the yoke for the flange.

Install the bearing caps. Install the snap rings, checking to be sure they are seated in the groove.

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Hydraulic Reservoir



1. Washer.
2. Washer.
3. Cap Screw (5 used).
5. Cap screw (4 used).
6. Bolt.
7. Lock Nut.
8. Lock Nut (5 used).
9. Washer (10 used).
10. Washer.
11. Screw.
12. Plug.
13. Nipple.
14. O-Ring.
15. Cover.
16. Cover .
17. Cover.
18. Door.
19. Door.
20. Hydraulic Reservoir.
21. Bleed Valve.
22. Weld Nut.
23. Hinge.
24. Weld Nut.
25. Anti-Skid Pad.
26. Anti-Skid Pad.
27. Anti -Skid Pad.

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Remove and Install

NOTE:The hydraulic reservoir is part of a compartment at the left front of machine that also contains components for the electrical and hydraulic brake systems.

Drain oil from the reservoir. The approximate capacity of reservoir is 177.6 L (46.9 gal).

Lower the front bottom guard.

Turn battery disconnect switch to the **OFF** position.

Disconnect and remove batteries.

Label and disconnect harness wires from relay/ circuit breaker box and battery disconnect switch.

Remove wiring harness and cable from compartment.

Remove front and rear brake accumulators. **(See "Brake Accumulators" on page 249)**

Remove brake accumulator lines from compartment.

Remove left headlight and headlight bracket.

Label and disconnect all hydraulic lines connected to hydraulic reservoir. Close all openings using caps and plugs.

⚠ CAUTION

Use a lifting device for heavy components.

Install JT01748 Lifting Brackets in two holes provided at top of hydraulic reservoir (20). Attach a lifting chain and hoist to brackets.

Remove cap screws (3), nuts (8), washers (9), and hydraulic reservoir.

Remove and install components as necessary to repair or replace reservoir.

Install reservoir on the main frame.

Connect hydraulic lines to back side of reservoir.

Install headlight and headlight bracket.

Install front and rear brake accumulators and lines. **(See "Brake Accumulators" on page 249)**

Connect harness wires to relay/circuit breaker box and battery disconnect switch.

Install and connect batteries.

Fill hydraulic reservoir and Check Hydraulic Oil Level. **(See Operator's Manual CHAPTER 16, SECTION 1).**

Install front bottom guard.

Suction Strainer

Remove and Install

Drain oil from the hydraulic reservoir. The approximate capacity of reservoir is 177.6 L (46.9 gal).

Remove top hydraulic reservoir cover.

Remove suction strainer from fitting.

Clean or replace suction strainer as necessary.

Install suction strainer and reservoir cover.

Fill hydraulic reservoir and Check Hydraulic Oil Level. **(See Operator's Manual CHAPTER 16, SECTION 1).**

Hydraulic System Manifold Assembly

Remove and Install Bin Control Valve Section

Fully lower bin.

Install articulation lock bar.

Stop engine.

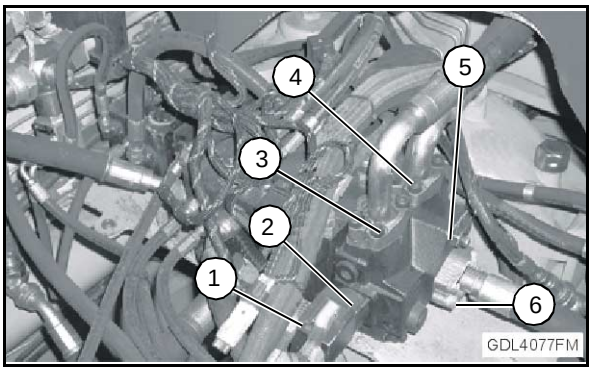
Discharge brake accumulator pressure.

Relieve pneumatic pressure.

Turn off battery disconnect switch. **(See Prepare Machine for Maintenance Operator's Manual, CHAPTER 7)**.

Tilt cab. **(See Tilt Cab Operator's Manual, CHAPTER 7).**

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1. Port XB.
2. Port XA.
3. Port A.
4. Port B.
5. Nut (3 used).
6. Port T2.

Disconnect pneumatic lines from port XB (1) and port XA (2).

Disconnect hydraulic lines from port A (3), port B (4), and port T2 (6). Close all openings with caps and plugs.

Remove nuts (5). Loosen cap screws on underside of hydraulic system manifold section, if necessary. Remove dump body control valve section. Remove shims and O-rings from between valve sections.

Clean, inspect, and replace parts as necessary. Install O-rings and shims. Install dump body control valve section. Install nuts and tighten in sequence to specification.

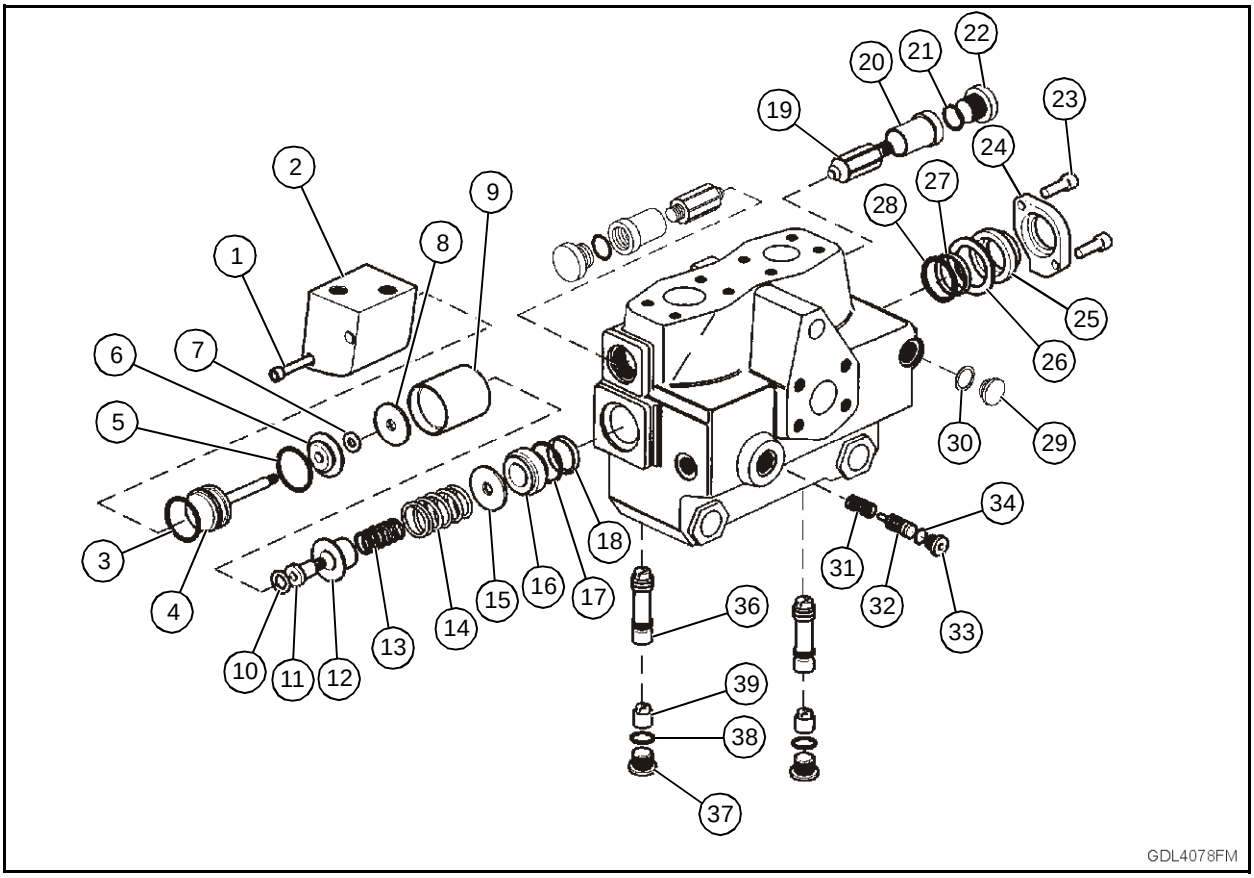
Hydraulic System Manifold Assembly Specification

Valve Section Tie Rod Nut Torque- - - - 80 Nm (59 lb-ft)

Tighten cap screws on underside of hydraulic system manifold section.

Connect hydraulic lines on ports T2, B, and A.

Connect pneumatic lines on ports XA and XB.



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1. Cap Screw (2 used).
2. Air Cylinder Housing.
3. O-Ring.
4. Piston.
5. O-Ring.
6. Piston.
7. O-Ring.
8. Disk.
9. Sleeve.
10. Washer.
11. Retainer.
12. Guide.
13. Spring.
14. Spring.
15. Disk.
16. Seat.
17. O-Ring.
18. Seal.
19. Poppet (2 used).
20. Sleeve (2 used).
21. O-Ring (2 used).
22. Cap (2 used).
23. Cap Screw (2 used).
24. Retainer.
25. Wiper.
26. Seal.
27. Backup Ring.
28. O-Ring.
29. Plug.
30. O-Ring.
31. Spring.
32. Spool.
33. Plug.
34. O-Ring.
35. Housing.
36. Spool (2 used).
37. Plug (2 used).
38. O-Ring (2 used).
39. Spacer (2 used).

Disassemble and Assemble Dump Body Control Valve Section

Disassemble valve as shown.

⚠ WARNING

Replace all seals and O-rings. Old seals and O-rings will leak.

NOTE: Valve housing and main spool are a matched set. If either is found worn or damaged they must be replaced as a matched set.

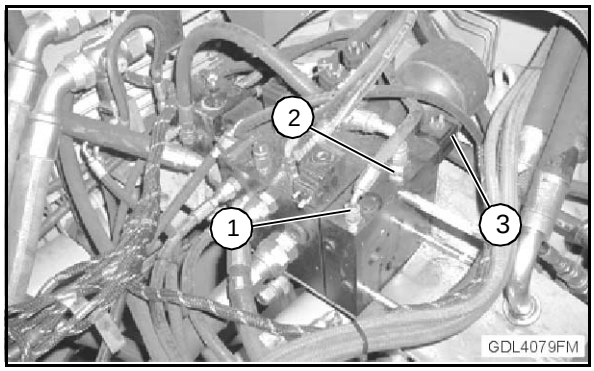
Clean and inspect parts for wear or damage. Replace as necessary.

NOTE: Apply petroleum jelly to seals and O-rings before installation. Apply clean hydraulic oil to all internal parts before assembling.

Assemble parts (1 - 39).

Remove and Install Fan Drive Valve Section

Remove dump body control valve section.



Disconnect connector from fan drive solenoid Y12 (3).

Disconnect hydraulic lines from port LSFD (1) and port FD (2). Close all openings with caps and plugs.

Loosen cap screws on underside of hydraulic system manifold section, if necessary. Remove fan drive valve section. Remove shims and O-rings from between valve sections.

Clean, inspect, and replace parts as necessary.

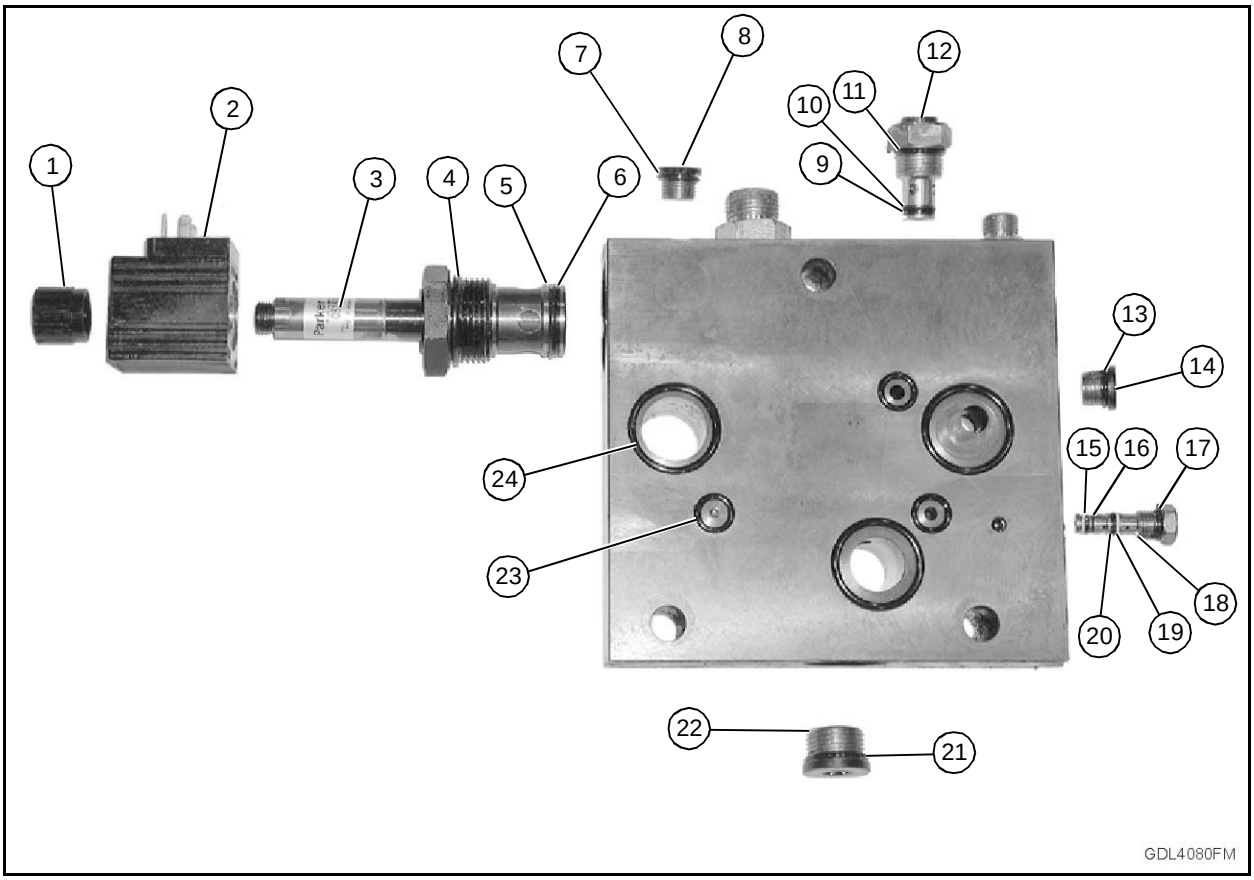
Install O-rings and shims.

Install fan drive valve section. Connect hydraulic lines on ports FD and LSFD.

Connect fan drive solenoid Y12 connector.

Install dump body control valve section.

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1. Plastic Nut.
2. Coil.
3. Solenoid Valve.
4. O-Ring.
5. O-Ring.
6. Backup Ring.
7. O-Ring.
8. Plug.
9. Backup Ring.
10. O-Ring.
11. O-Ring.
12. Check Valve.
13. Plug.
14. O-Ring.
15. Backup Ring.
16. O-Ring.
17. O-Ring.
18. Shuttle Valve.
19. Backup Ring.
20. O-Ring.
21. O-Ring.
22. Plug.
23. O-Ring (3 used).
24. O-Ring (3 used).

Disassemble and Assemble Fan Drive Valve Section

Disassemble valve as shown.

⚠ WARNING

Replace all backup rings and O-rings. Old backup rings and O-rings will leak.

Clean and inspect parts for wear or damage. Replace as necessary.

NOTE: Apply petroleum jelly to backup rings and O-rings before installation. Apply clean hydraulic oil to all internal parts before assembling.

Assemble parts (1 - 24). Tighten solenoid valve (3), check valve (12), and shuttle valve (18) to specification.

Disassemble and Assemble Fan Drive Valve Section Specification

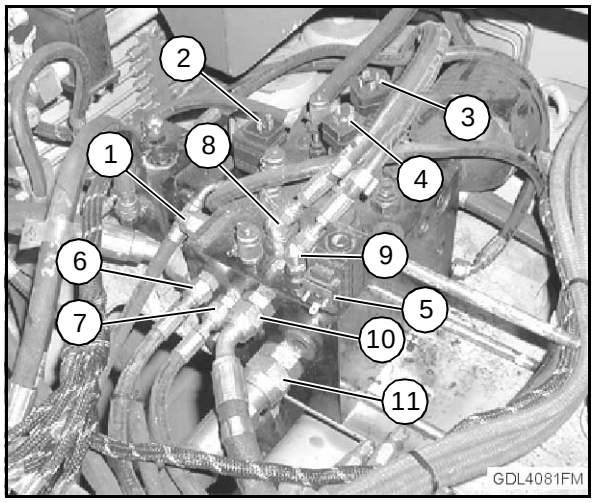
Solenoid Valve Torque	60 Nm (44 lb-ft)
Check Valve Torque	30 Nm (22 lb-ft)
Shuttle Valve Torque	10 Nm (89 lb-in.)

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Remove and Install Hydraulic System Manifold Section

Remove dump body control valve section.

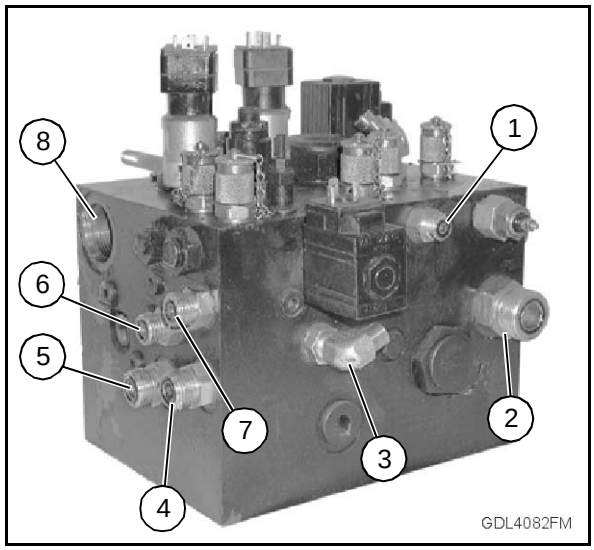
Remove fan drive valve section.



Disconnect connectors from service brake low pressure switch B23 (3), secondary steering low pressure switch B24 (4), body float solenoid Y11 (5), and hydraulic cut-off solenoid Y17 (2). Disconnect wire leads from hydraulic temperature sensor B21 (1).

Disconnect hydraulic lines from port MP1 (9) and port MP2 (8) on top of manifold section.

Disconnect hydraulic lines from port P2 (10), port L1 (6), port L2 (7), and port P1 (11) on front of manifold section.



Shown Removed from Machine for Illustration Purposes Only

Disconnect hydraulic lines from port L3 (1), port P3 (2), and port M4 (3) on right side of manifold section.

Remove accumulator from port A4 (8) on rear of manifold section.

Disconnect hydraulic lines from port B6 (7), port B5 (6), port A5 (5), and port A6 (4) on rear of manifold section.

⚠ CAUTION

Component is heavy. Use hoist.

Hydraulic System Manifold Assembly Specification

Manifold Section Weight - - - 36 kg (80 lb) approximate

Remove cap screws from bottom of manifold section. Remove manifold section from machine.

Install manifold section in machine. Install cap screws in bottom of manifold section, but do not tighten.

Connect hydraulic lines.

Install accumulator.

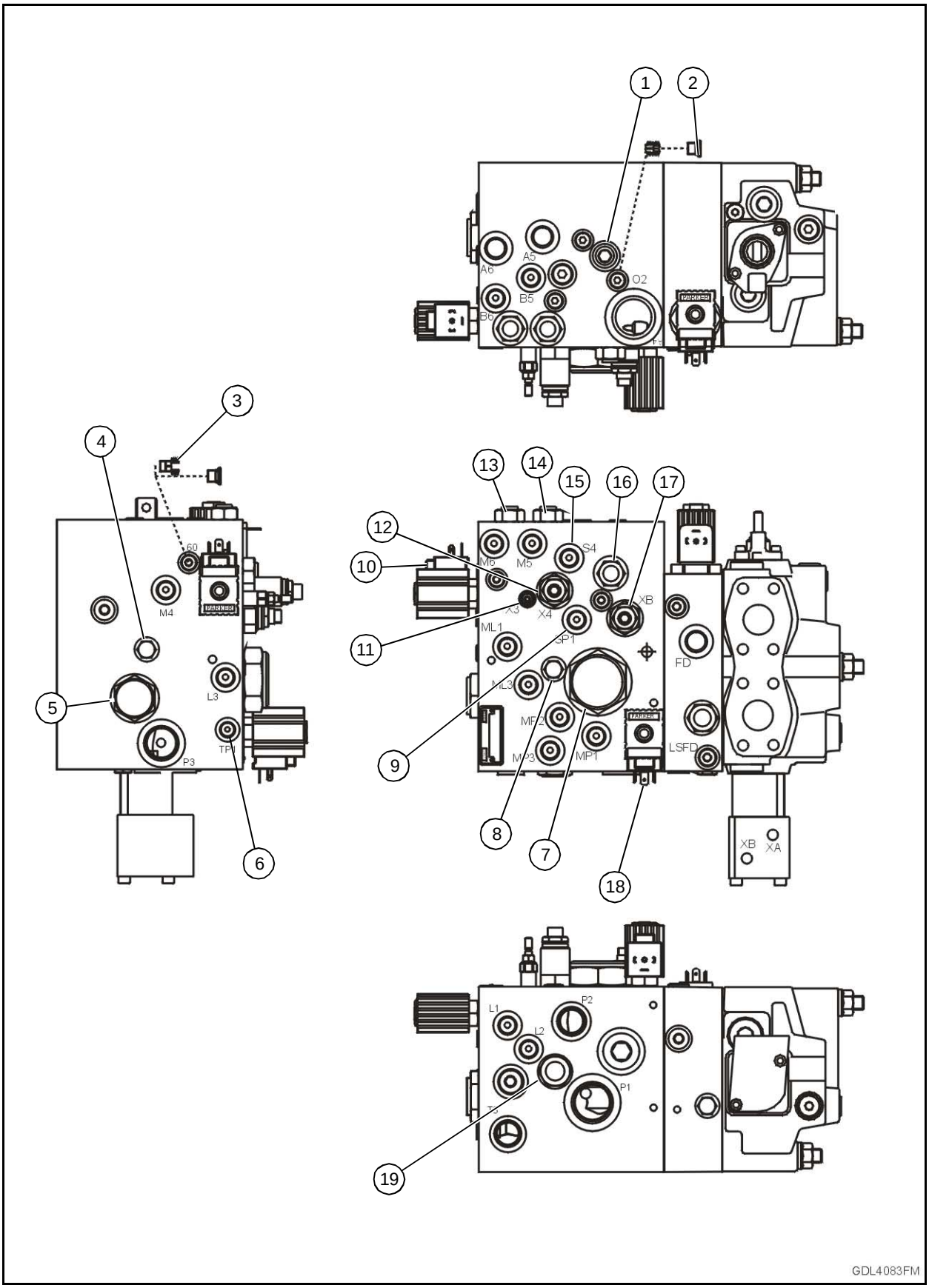
Connect electrical connectors.

Install fan drive valve section.

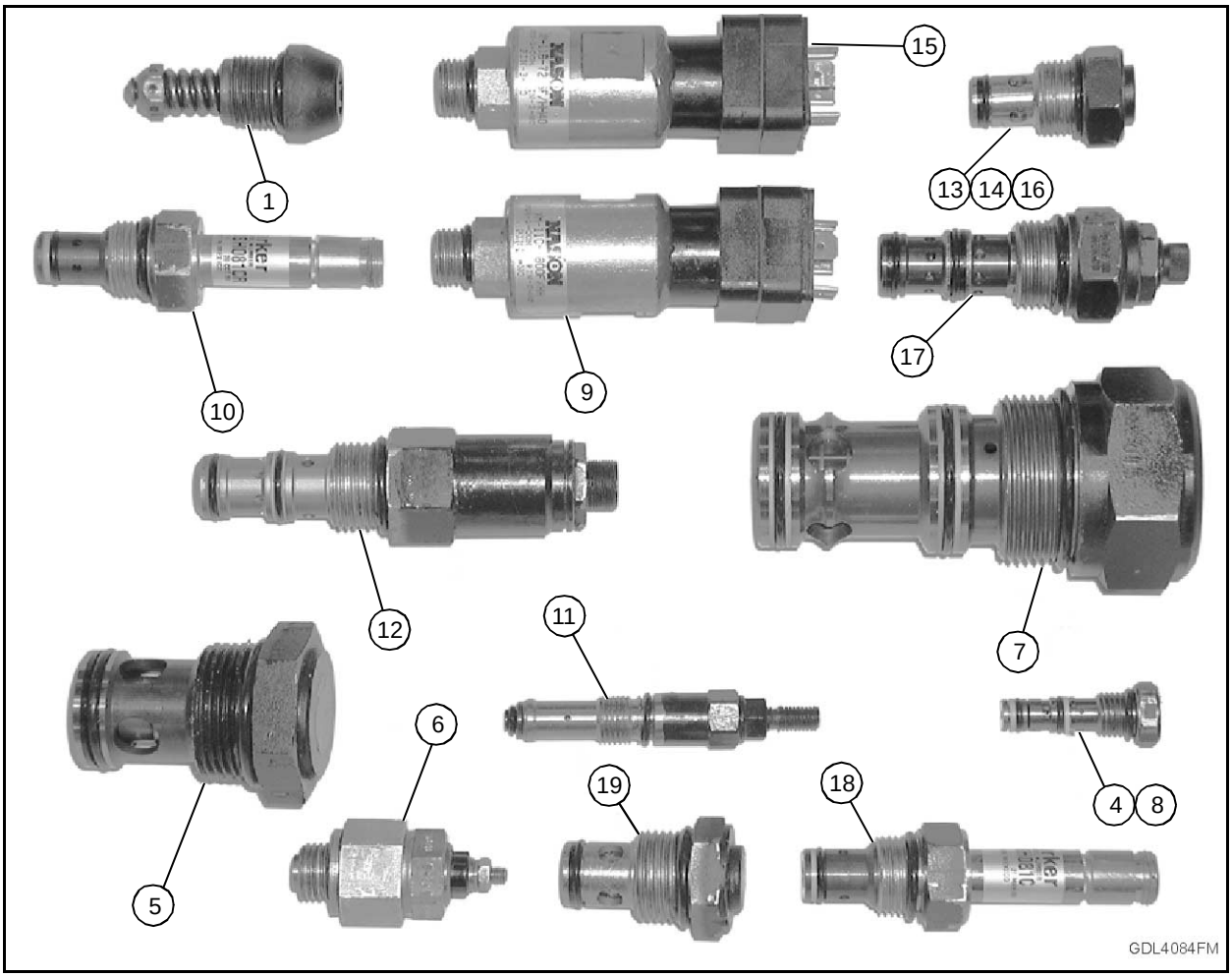
Install dump body control valve section.

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Disassemble and Assemble Hydraulic System Manifold Section



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1. Main Relief Valve.
2. Orifice 2.5 mm.
3. Orifice 0.7 mm.
4. Shuttle Valve.
5. Check Valve.
6. Hydraulic Temperature Sensor.
7. Priority Valve.
8. Shuttle Valve.
9. Pressure Switch.
10. Solenoid Valve.
11. Relief Valve.
12. Accumulator Charge Valve.
13. Check Valve.
14. Check Valve.
15. Pressure Switch.
16. Check Valve.
17. Pressure Reducing Valve.
18. Solenoid Valve.
19. Check Valve.

Disassemble hydraulic system manifold as shown.

⚠ WARNING

Replace all backup rings and O-rings. Old backup rings and O-rings will leak.

Clean and inspect parts for wear or damage. Replace as necessary.

NOTE: Apply petroleum jelly to backup rings and O-rings before installation. Apply clean hydraulic oil to all internal parts before assembling.

Assemble parts (1 - 19). Tighten all components to specification.

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Disassemble and Assemble Hydraulic System Manifold Section Specification

Main Relief Valve Torque - - - - - - - - - 60 Nm (44 lb-ft)
Orifice (2) 2.5 mm Torque- - - - - - - - - - 3 Nm (27 lb-in.)
Orifice (3) 0.7 mm Torque- - - - - - - - - - 3 Nm (27 lb-in.)
Shuttle Valve (4 and 8) Torque - - - - - 10 Nm (89 lb-in.)
Check Valve (5) Torque - - - - - - - - - - 100 Nm (70 lb-ft)
Priority Valve Torque - - - - - - - - - - - 140 Nm (103 lb-ft)
Solenoid Valve (10 and 18) Torque - - - 30 Nm (22 lb-ft)
Relief Valve Torque - - - - - - - - - - - - - 30 Nm (22 lb-ft)
Accumulator Charge Valve Torque - - - 60 Nm (44 lb-ft)
Check Valve (13, 14 and 16) Torque - - 30 Nm (22 lb-ft)
Pressure Reducing Valve Torque - - - - 60 Nm (44 lb-ft)
Check Valve (19) Torque - - - - - - - - - - 65 Nm (48 lb-ft)

Hydraulic Fan Motor

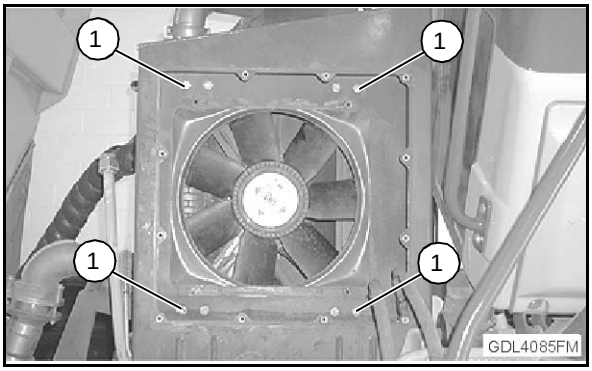
Remove and Install Hydraulic Fan Motor

Remove top cover, left side grille, and right side grille from transmission oil cooler housing.

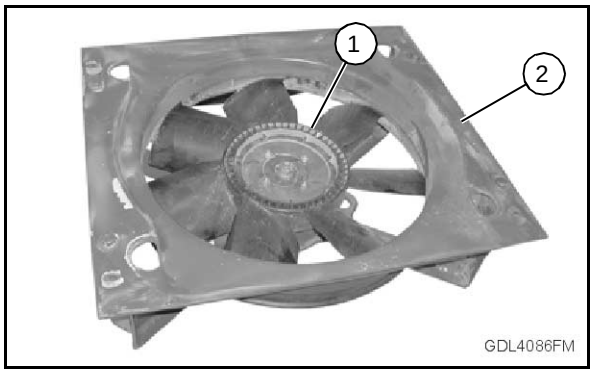
Support fan motor bracket and shroud with proper lifting device.

Disconnect lines from fan motor. Close all openings using caps and plugs.

NOTE:Transmission cooler and wet disk brake cooler shown removed for illurstraion purposes only.

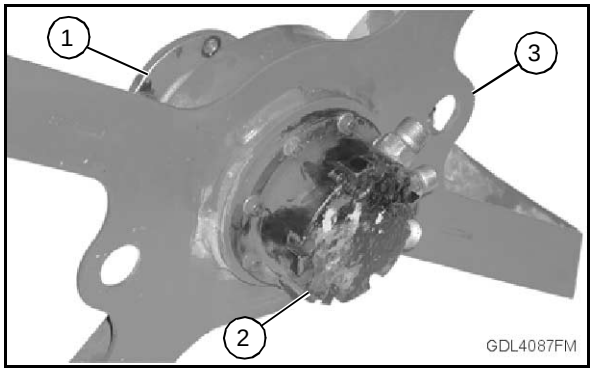


Remove cap screws (1), assembled fan, fan motor, bracket and shroud.



Remove shroud (1).

Remove fan (2).



Remove flange (1) from fan motor.

Remove fan motor (2) from fan motor bracket (3).

Install fan motor to fan motor bracket.

Install flange to fan motor.

Install fan.

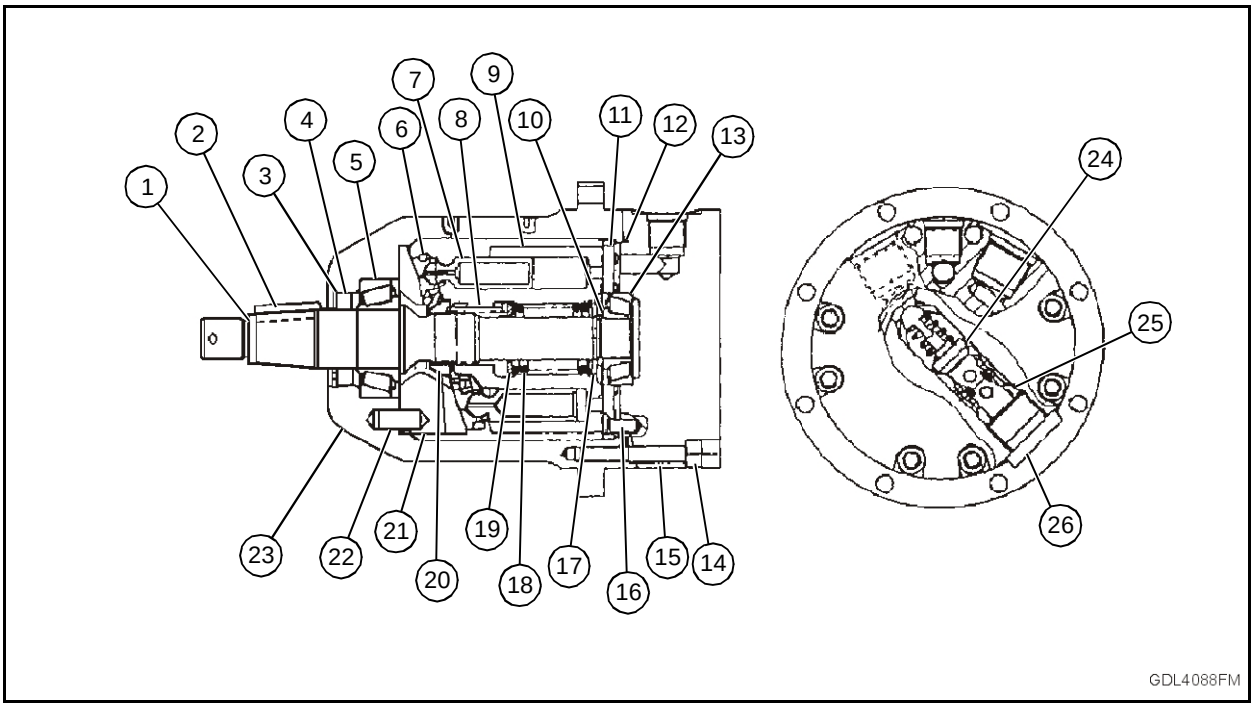
Install fan shroud.

Install assembled fan, fan motor, bracket and shroud.

Connect lines to fan motor.

Install top cover and grilles to transmission oil cooler housing.

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1. Shaft.
2. Key.
3. Snap Ring.
4. Seal.
5. Tapered Roller Bearing.
6. Retainer Plate.
7. Piston (9 used).
8. Pin (3 used).
9. Cylinder Block.
10. Spacer.
11. Distributor Plate.
12. O-Ring.
13. Tapered Roller Bearing.
14. Socket Head Screw (8 used).
15. Port Plate.
16. Dowel Pin.
17. Snap Ring.
18. Spring.
19. Washer.
20. Guide Ball.
21. Swash Plate.
22. Dowel Pin.
23. Housing.
24. Relief Valve.
25. Valve Seat.
26. Plug.

Disassemble and Assemble Fan Motor

Clean and drain motor.

⚠ WARNING

The distributor plate may stick to the port plate when removed. The highly machined surface on port plate, distributor plate, and cylinder block must not be damaged. Lay parts on clean, lint-free towels to protect the machined surfaces.

Remove port plate (15) and distributor plate (11).

Remove tapered roller bearing cone (13) and spacer (10).

Remove the rotary group as an assembly.

⚠ CAUTION

Spring (18) is under compression. A press must be used to compress spring to remove snap ring (17).

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Inspect cylinder block (9). Remove spring (18) only if replacement is necessary.

Remove shaft key (2), swash plate (21), shaft (1), and bearings (5).

Remove snap ring (3) and oil seal (4).

Remove tapered roller bearing cone (5) using a press. Remove bearing only if replacement is necessary.

Remove valve seat (25) and relief valve (24) only if replacement is necessary.

Clean and inspect all parts for wear and damage. Replace parts as necessary.

⚠ WARNING

Replace all oil seals and O-rings. Old seals and O-rings will leak.

Install oil seal with lip facing inside of housing.

Press seal into housing just far enough to install

snap ring.

Apply petroleum jelly to sealing lip.

Put pump housing in vise with large opening up.

NOTE: Apply clean oil to all internal parts as they are assembled.

Install tapered roller bearing cone on shaft tight against shoulder. Bearing cone is a press fit.

Install shaft and swash plate.

Move pump housing to a horizontal position.

Assemble rotary group. A press must be used to install spring (18).

Pins (8) are installed in cylinder block between washer (19) and guide ball (20).

Install assembled rotary group into pump housing.

Install spacer (10) and bearing cone (13).

Install O-ring (12).

Apply a small amount of petroleum jelly on the mating surface of distributor plate and port plate (15).

Install the distributor plate on port plate so notch engages the dowel pin (16).

Install port plate.

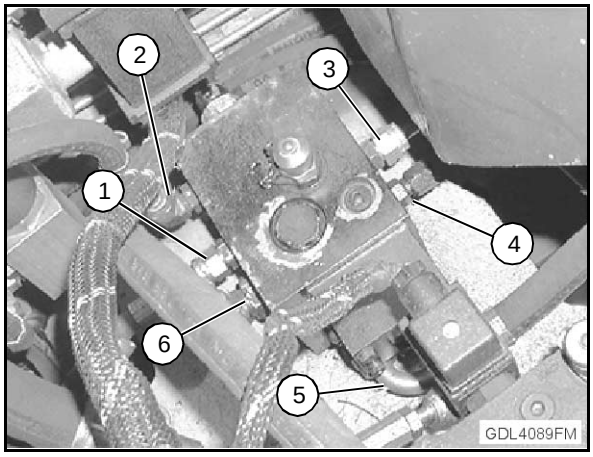
Tighten socket head screws to specification using a crisscross pattern.

Hydraulic Fan Motor Specification

Port Plate-to-Motor Housing Socket Head Screw
Torque - 15 Nm (133 lb-in.)

Fan Drive Controller

Remove and Install



Disconnect lines (1 - 6). Close all openings using caps and plugs.

Remove mounting cap screws and controller.

Replace controller as necessary.

Install controller and connect lines.

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CHAPTER 15. PNEUMATIC SYSTEMS

SECTION 1. PUMPS AND DRIVES

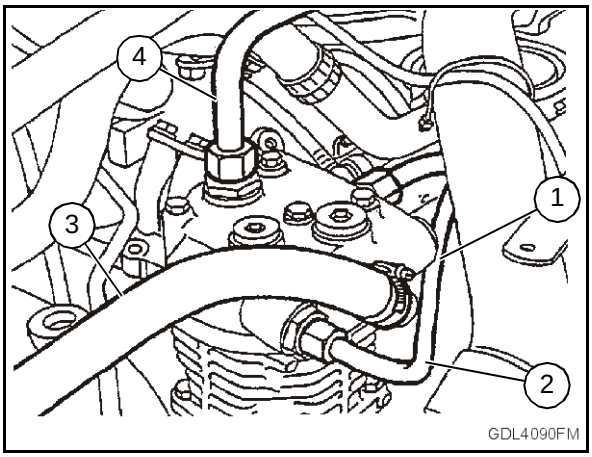
AIR COMPRESSOR

Remove and Install Air Compressor

Remove fuel supply pump. **(See "REMOVE AND INSTALL FUEL SUPPLY PUMP" on page 163).**

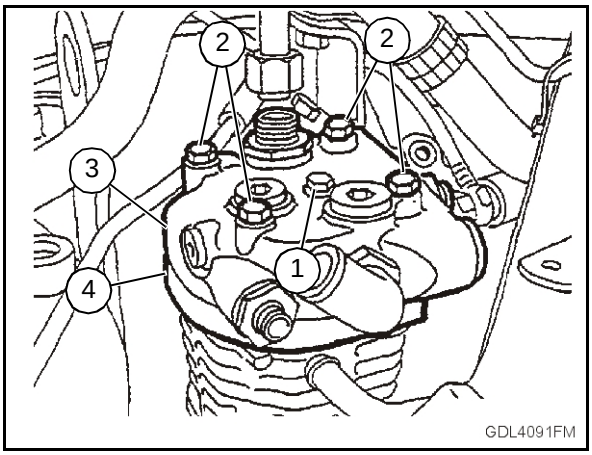
Remove timing case cover and discard gasket. **(See "Remove and Install Timing Case Cover" on page 115).**

Remove Cylinder Head And Intermediate Plate Assemblies



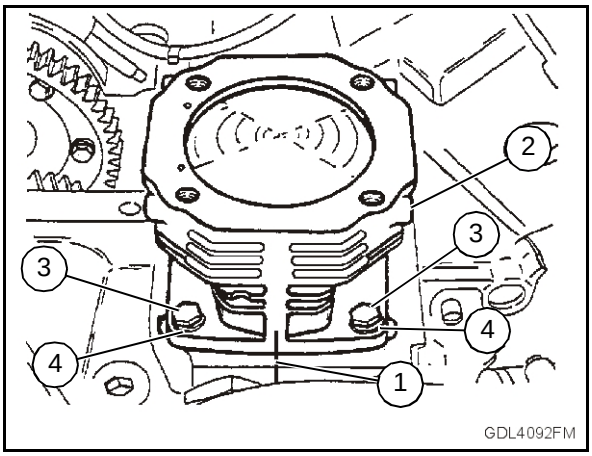
Disconnect coolant supply line (1) and coolant return line (2). Close all openings with caps and plugs.

Disconnect compressed air line (3) and suction line (4).



Remove cap screws (1 and 2). Remove cylinder head and intermediate plate assembly (3 and 4).

Remove Cylinder

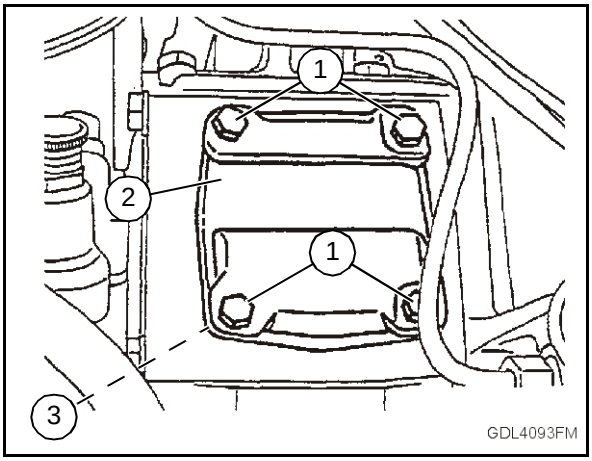


Scribe a line (1) to mark position of cylinder (2) relative to engine block.

Remove cap screws and washers (3 and 4).

Remove cylinder (2).

Remove Side Cover



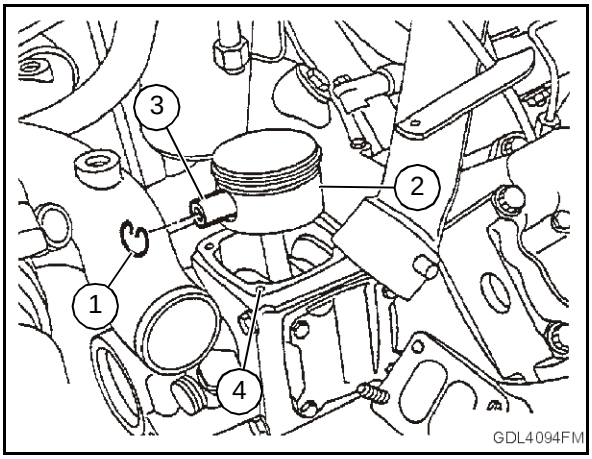
Remove cap screws (1).

Remove side cover (2).

Remove and discard gasket (3).

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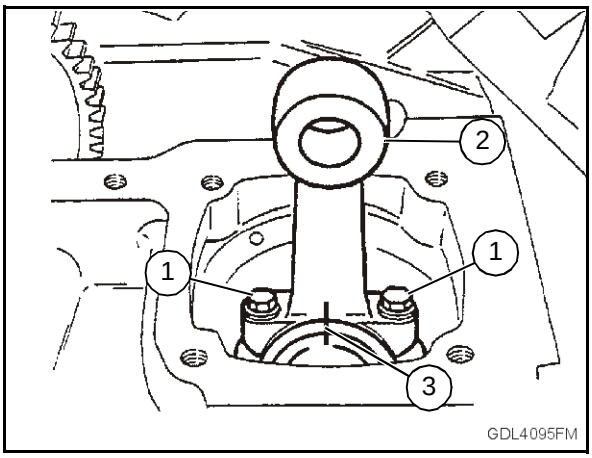
Remove Piston And Connecting Rod



Remove snap rings (1) from piston (2).

Press out piston pin (3). Remove piston (2) from connecting rod.

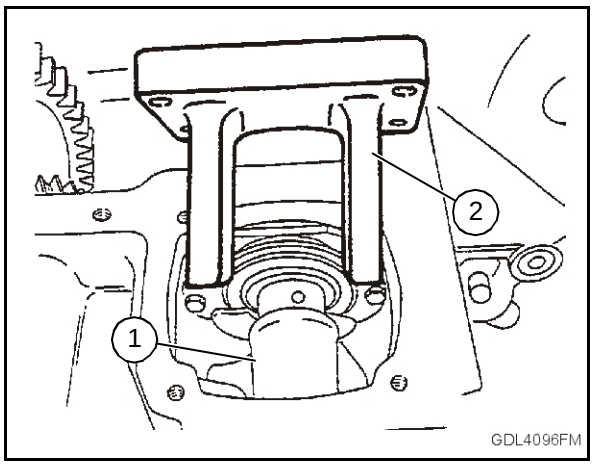
Remove and discard gasket (4).



Scribe a line (3) to mark position of connecting rod bearing relative to connecting rod and connecting rod bearing cap (2).

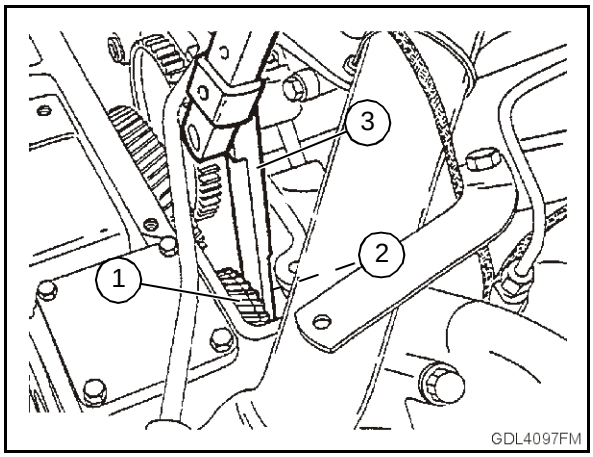
Remove cap screws (1). Remove connecting rod and connecting rod bearing cap (2).

Remove Drive Gear



Rotate crankshaft until crank pin points up.

Install JDG1500-39 Air Compressor Crankshaft Blocker (2) over crankshaft (1). Tighten cap screws.



Remove cap screw (2) on air compressor drive gear (1) using JDG1500-40 Drive Gear Wrench (3).

Remove drive gear.

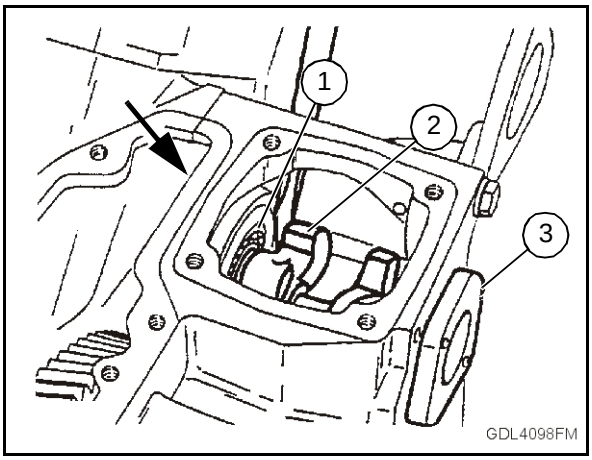
Remove JDG1500-39 Air Compressor Crankshaft Blocker.

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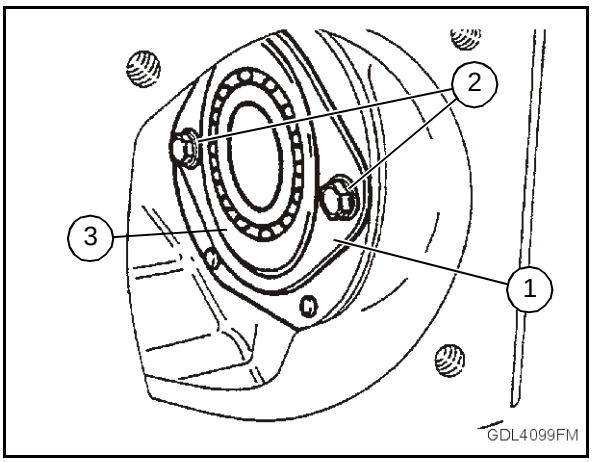
Remove Crankshaft And Bearings

⚠ CAUTION

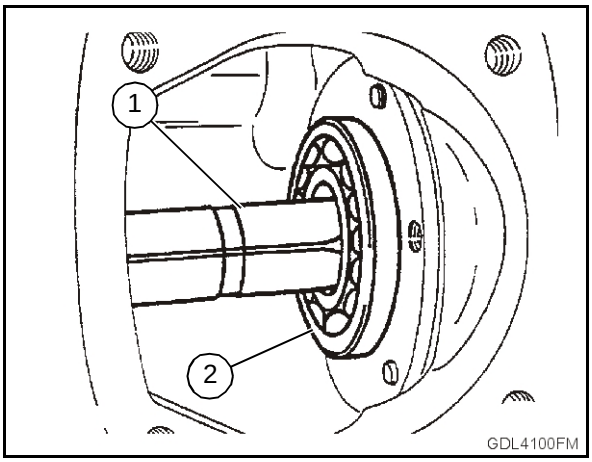
When removing the crankshaft, secure roller bearing inner ring in the timing case (arrow), to prevent it from falling out.



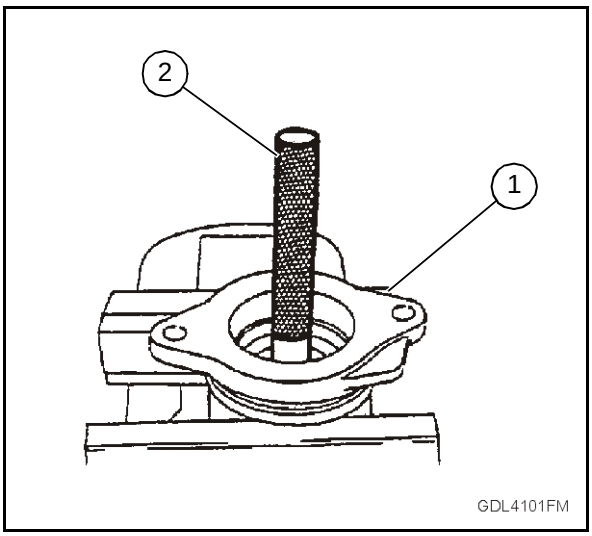
Remove flange (3) and crankshaft (2).



Remove cap screws (2) and bearing flange (1).



Using a bearing removal tool (1), remove bearing (2).

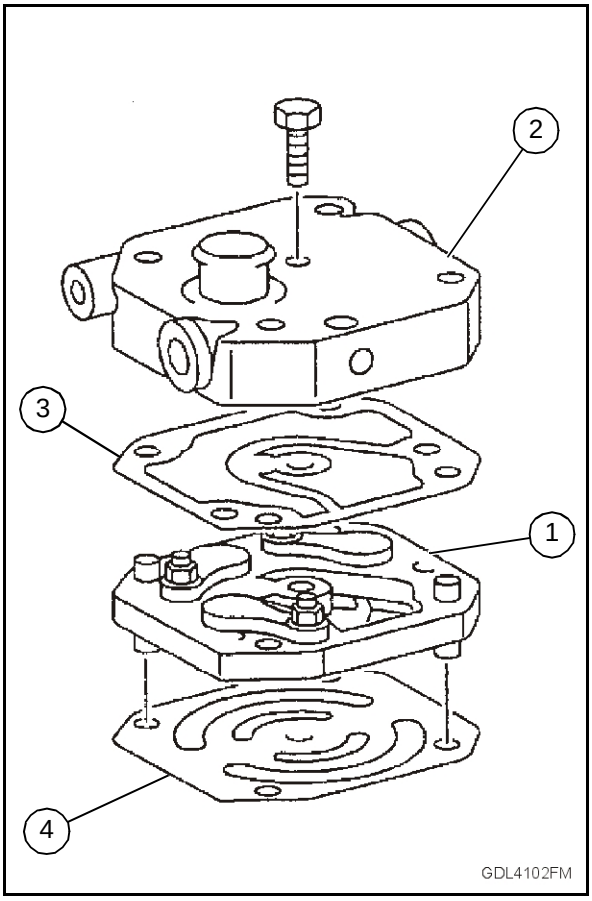


Remove O-ring from flange (1).

Using a bushing removal tool (2), remove bushing from flange (2).

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Inspect Piston Head And Intermediate Plate Assembly



Remove intermediate plate (1) from cylinder head (2).

Remove and discard intermediate plate gasket (3).

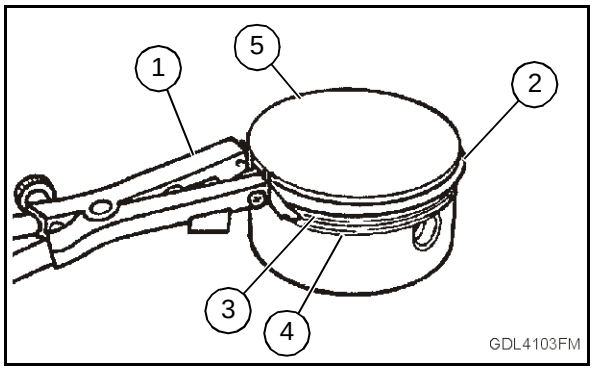
Remove and discard cylinder head gasket (4).

Inspect and replace components as necessary.

Inspect Cylinder Liner, Piston, Connecting Rod, And Crankshaft Assemblies

⚠ CAUTION

Pistons and cylinder liners are marked B, C, or D, based on diameter tolerance ranges. Always use pistons and cylinder liners with matching letter markings.



Using a piston ring expander (1), remove rings (2, 3, and 4) from piston (5).

Measure cylinder liner bore ID.

Remove and Install Air Compressor Specification

Cylinder Liner, Marking B ID - 100.000 - 100.010 mm (3.93700 - 3.93739 in.)

Cylinder Liner, Marking C ID - 100.010 - 100.020 mm (3.93739 - 3.93778 in.)

Cylinder Liner, Marking D ID- 100.020 - 100.030 mm (3.93778 - 3.93818 in.)

Measure piston OD 90° from piston pin bore.

Remove and Install Air Compressor Specification

Piston, Marking B OD - 99.925 - 99.935 mm (3.93404 - 3.93444 in.)

Piston, Marking C OD - 99.935 - 99.945 mm (3.93444 - 3.93483 in.)

Piston, Marking D OD - 99.945 - 99.955 mm (3.93483 - 3.93522 in.)

Measure pin bore ID on piston and pin OD. Subtract OD from ID to obtain clearance measurement.

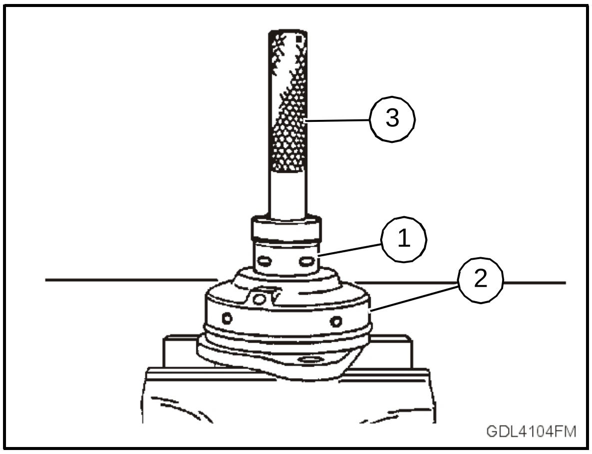
Remove and Install Air Compressor Specification

Piston Pin-to-Pin Bore Clearance - 0.003 - 0.012 mm (0.0001 - 0.0004 in.)

Replace parts as necessary.

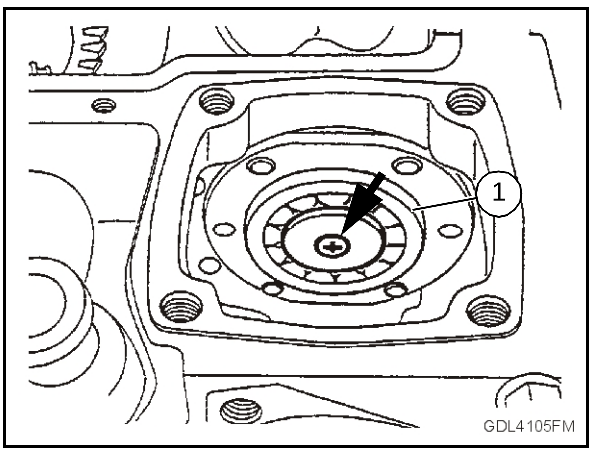
https://truckmanualshub.com/

Install crankshaft and bearings



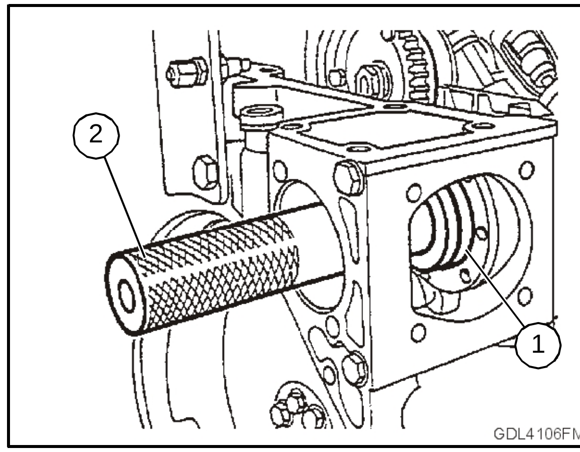
Align oil holes in bushing (1) with holes in bearing flange (2).

Using bearing installation tool (3), install bushing (1) into bearing flange (2).



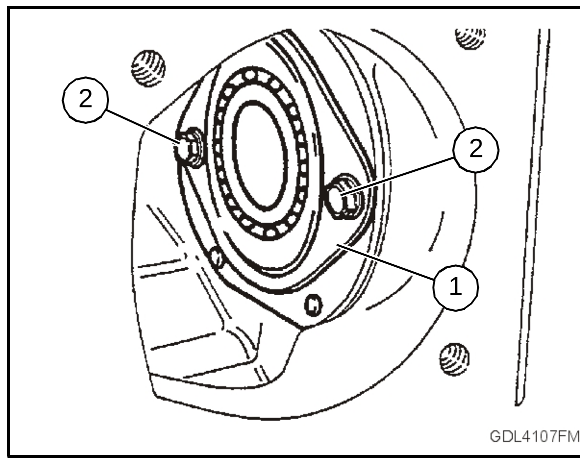
Install two cupped washers (arrow) on inner bearing (1) to protect bearing.

Install bearing so inner ring and collar face fan.



Using bearing installation tool (53), install roller bearing (31) into bearing cap.

Remove cupped washers from bearing.



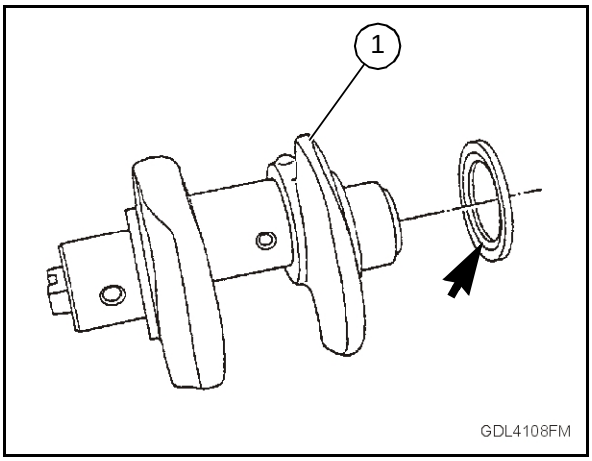
Install bearing flange (1).

Tighten cap screws (2) to specification.

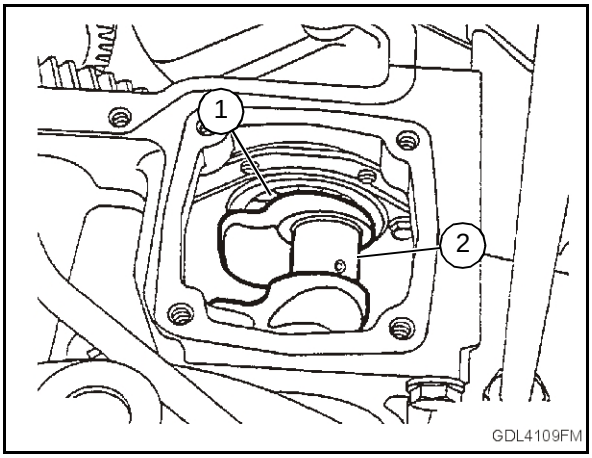
Remove and Install Air Compressor Specification

Inner Bearing Cap Cap Screw Torque -50 Nm (37 lb-ft)

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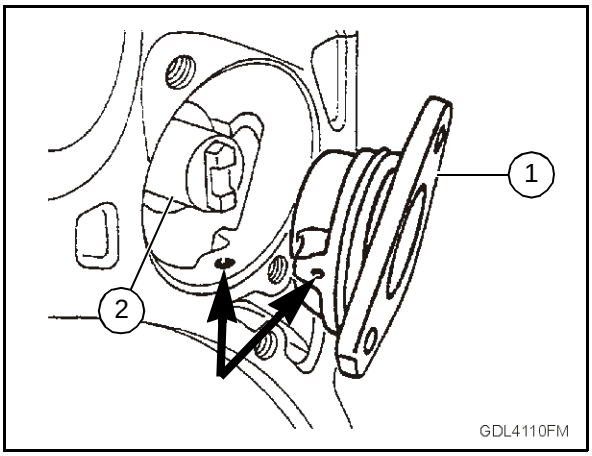
Install bearing washer (arrow) onto crankshaft (1) with chamfer facing crank pin.



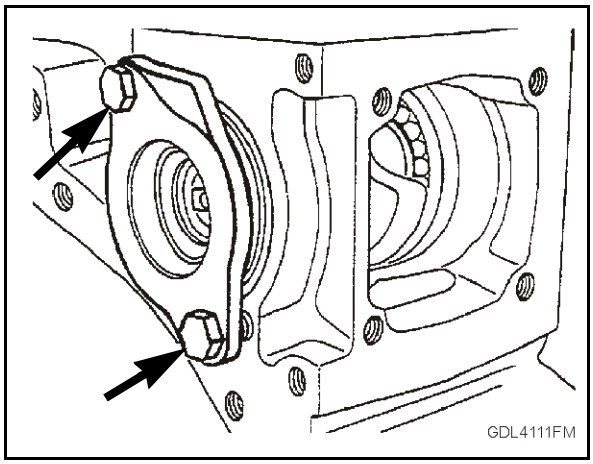
Position roller bearing (1) inner ring and install crankshaft (2).

Lubricate new O-ring and install O-ring onto bearing flange.

Lubricate bearing pilot on flange.

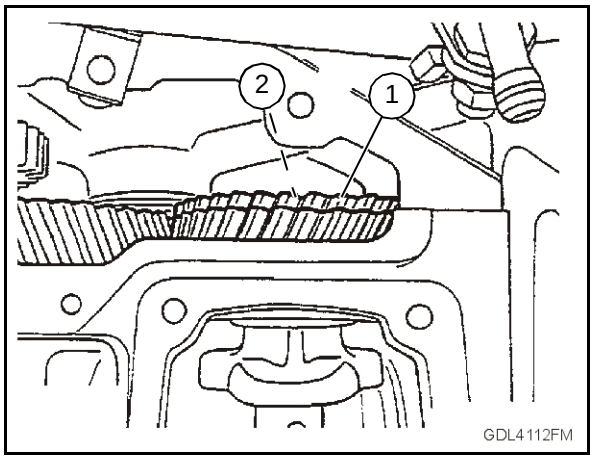


Align oil hole (arrow) on flange (1) to oil hole on housing. Install flange (1) onto crankshaft (2).



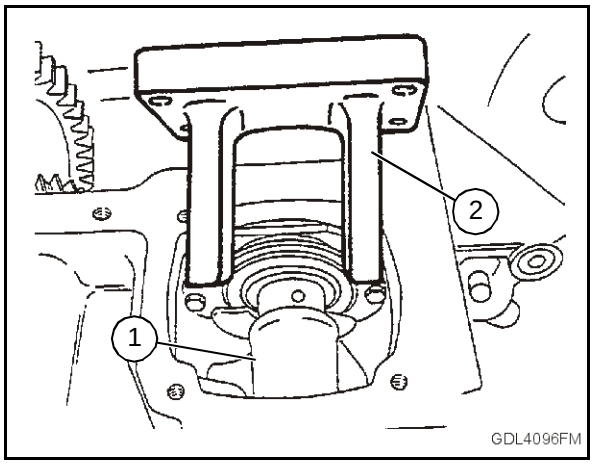
Tighten cap screws (arrows) evenly to seat bearing flange. Remove cap screws. Install caps screws evenly again.

Install Drive Gear



Install drive gear (1). Hand-tighten cap screw (2).

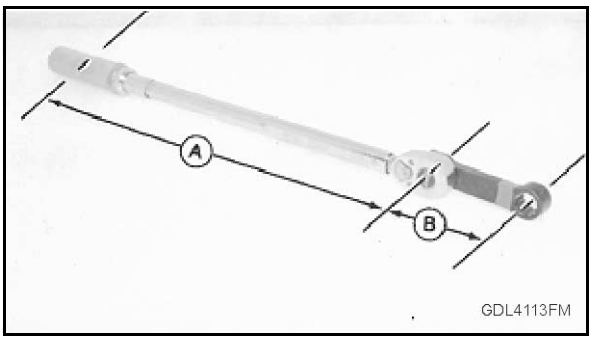
Rotate crankshaft until crank pin points up.



Install JDG1500-39 Air Compressor Crankshaft Blocker (2) over crankshaft (1). Tighten cap screws.

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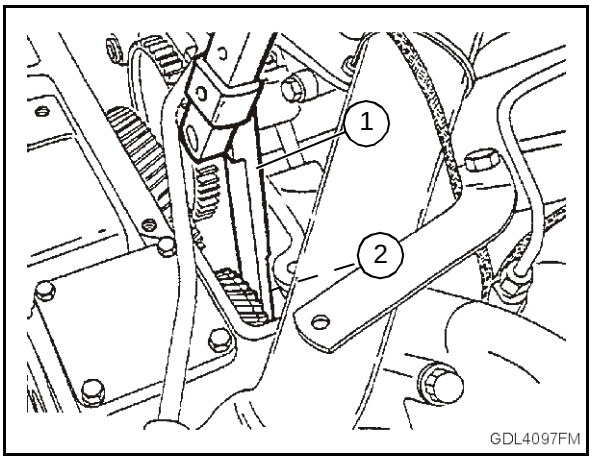
NOTE:If an adapter is fastened to the square drive of a torque wrench, it adds to the leverage distance of the wrench. In this case, the real torque applied is greater than the torque indicated by the torque wrench. Use the formula below to determine the correct torque wrench reading for the intended torque specification.



A. Leverage Distance of Torque Wrench
B. Leverage Distance of Adapter

Torque Reading on = Torque Specification x Wrench A +B

NOTE:1. Leverage distance of torque wrench is measured from center of handle to center of square drive. Leverage distance of wrench with adapter is measured parallel to beam of wrench, from center of handle to center of adapter head.
2. Always measure leverage distance parallel to beam of wrench. If wrench and adapter are assembled at an angle, leverage distance will be shorter. If adapter is assembled at 90° to beam of wrench, it does not affect leverage distance.



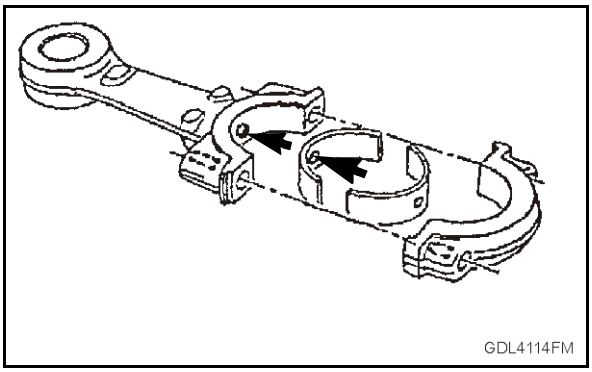
Using a torque wrench and JDG1500-40 Drive Gear Wrench (1), tighten cap screw (2) to specification.

Remove and Install Air Compressor Specification

Drive Gear Cap Screw Torque- 360 Nm (266 lb-ft) actual

Remove JDG1500-39 Air Compressor Crankshaft Blocker.

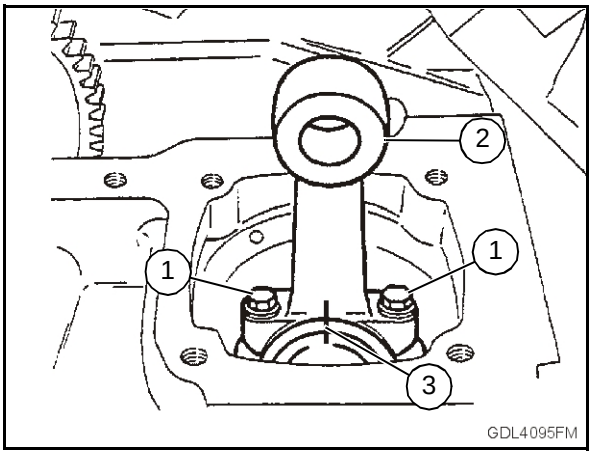
Install Connecting Rod And Piston



Lightly coat connecting rod bearings with clean oil. Install bearings into connecting rod bearing cap and connecting rod.

Ensure that oil holes (arrows) in connecting rod bearing and connecting rod align. Ensure the markings on connecting rod cap and connecting rod align.

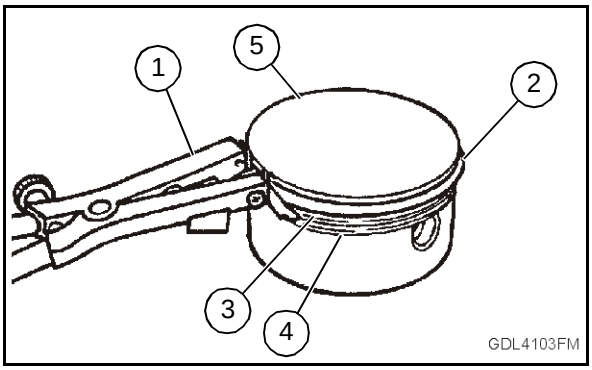
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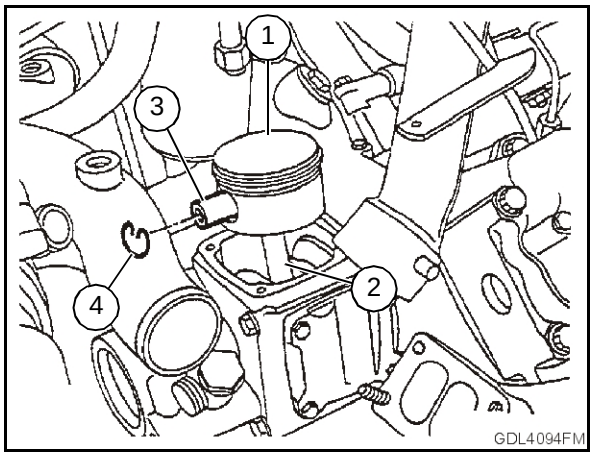
Install connecting rod (2) on crankshaft. Install cap screws (1). Tighten cap screws (1) to specification.

Remove and Install Air Compressor Specification

Connecting Rod Cap Screw Torque- 30 Nm (22 lb-ft)



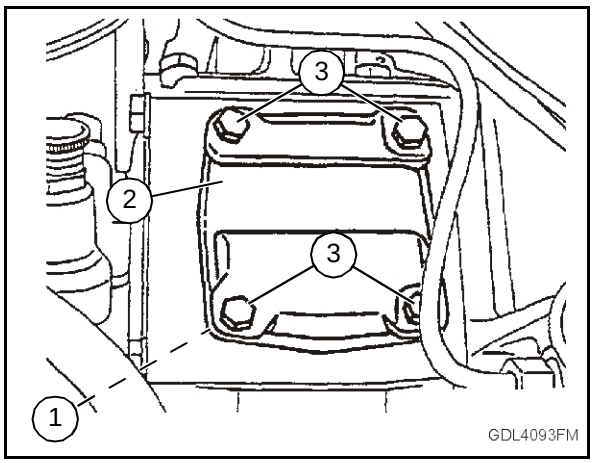
Use a piston ring expander (1) to install rings (2, 3, and 4) onto piston (5). Compression rings (3 and 4) must be installed bevel-side down.



Install piston (1) on connecting rod (2).

Lightly coat piston pin (3) with oil. Install pin. Install snap rings (4).

Install Side Cover



Install new side cover gasket (1).

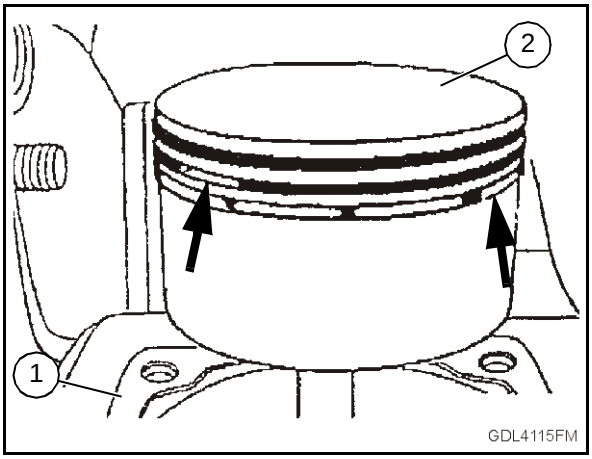
Install side cover (2). Tighten cap screws (3) to specification.

Remove and Install Air Compressor Specification

Side Cover Cap Screw Torque - - - - - - 50 Nm (37 lb-ft)

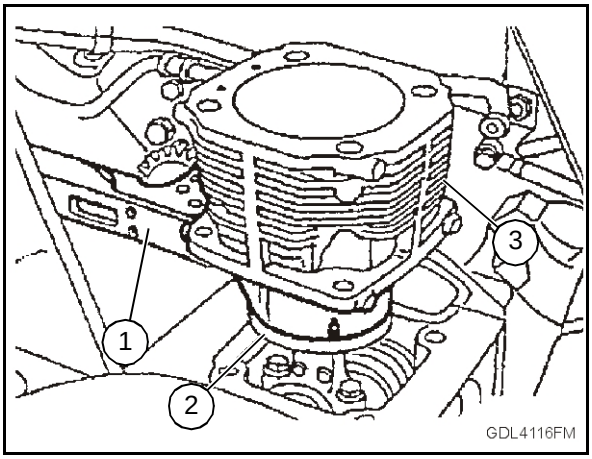
https://truckmanualshub.com/

Install Cylinder Liner



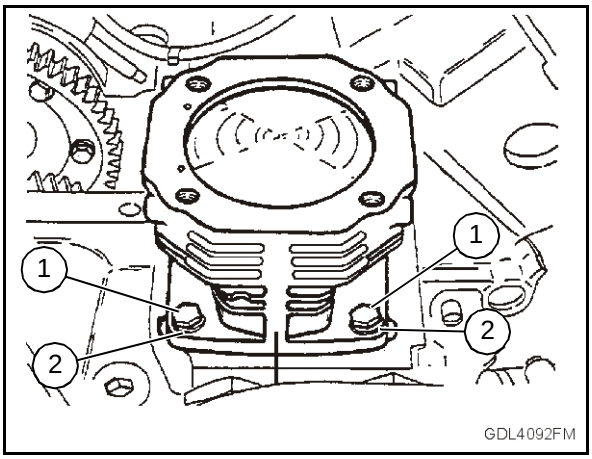
Install new cylinder liner gasket (1) onto timing case.

Lightly coat piston (2) with oil. Offset piston ring gaps by 120° (arrows).



Use a ring compressors tool (1) to compress piston rings to OD of piston (2).

Lightly coat inside of cylinder (3) with clean oil. Push cylinder (3) over piston (2). Remove ring compressor tool (1).

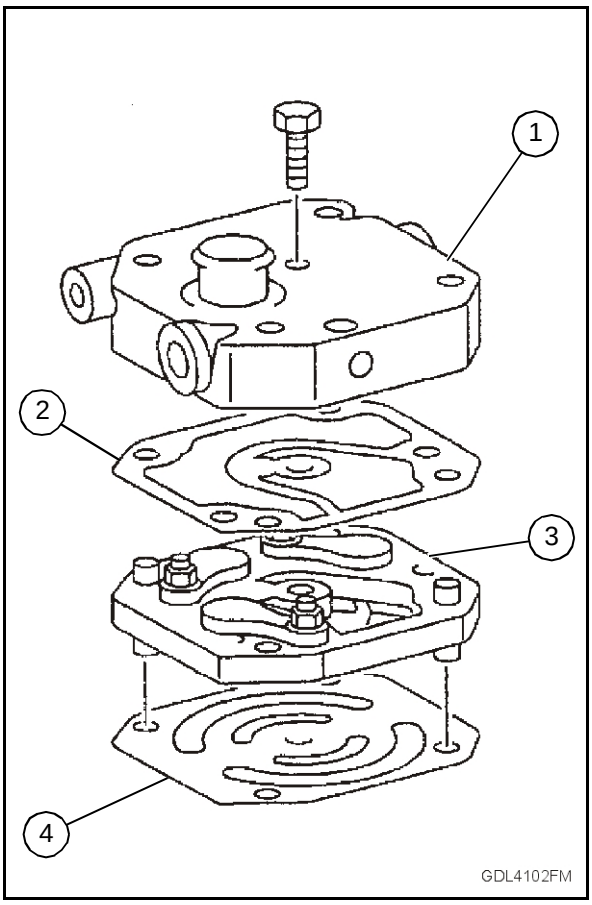


Install cap screws and washers (1 and 2). Tighten cap screws to specification.

Air Compressor Specification

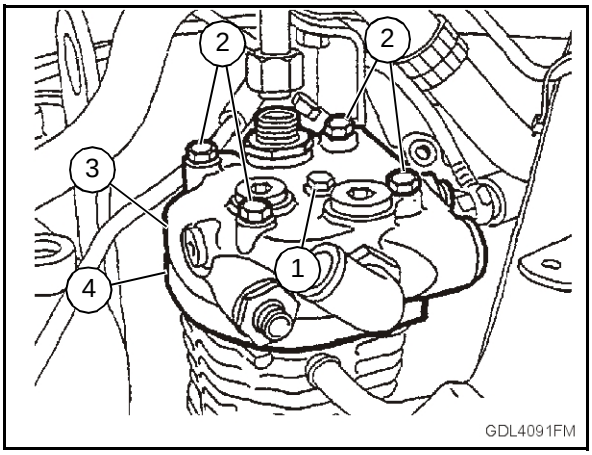
Cylinder Liner Cap Screw Torque - - - -40 Nm (30 lb-ft)

Install Cylinder Head And Intermediate Plate Assembly



Assemble cylinder head (1), intermediate plate gasket (2), intermediate plate (3), and cylinder head gasket (4). Ensure wording “Top” on head gasket (4) is toward the cylinder head (1).

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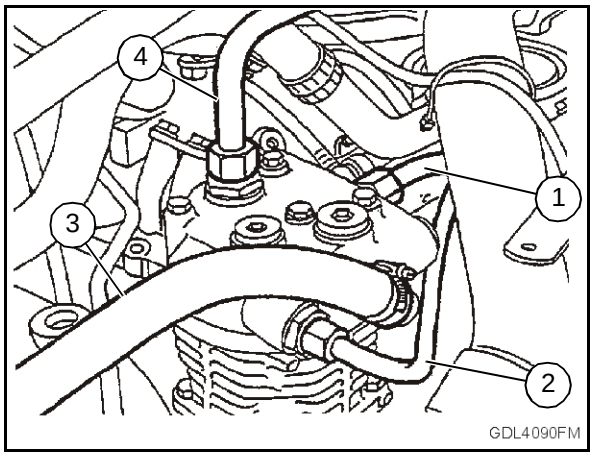


Install cylinder head and intermediate plate assembly (3 and 4). Tighten cap screws (1 and 2) to specification.

Remove and Install Air Compressor Specification

Cylinder Head-to-Cylinder Liner Cap Screw Torque - 40 Nm (30 lb-ft)

Cylinder Head-to-Intermediate Plate Cap Screw Torque - 12 Nm (9 lb-ft)



Connect compressed air line (4). Connect suction line (3).

Connect coolant supply line (1) and coolant return line (2).

Install new timing case cover gasket. Install timing case cover. **(See “Remove and Install Timing Case Cover” on page 115).**

Install fuel supply pump. **(See “REMOVE AND INSTALL FUEL SUPPLY PUMP” on page 163).**

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CHAPTER 15. PNEUMATIC SYSTEMS

SECTION 2. CONTROL VALVES

PNEUMATIC MANIFOLD

Remove and Install Pneumatic Manifold

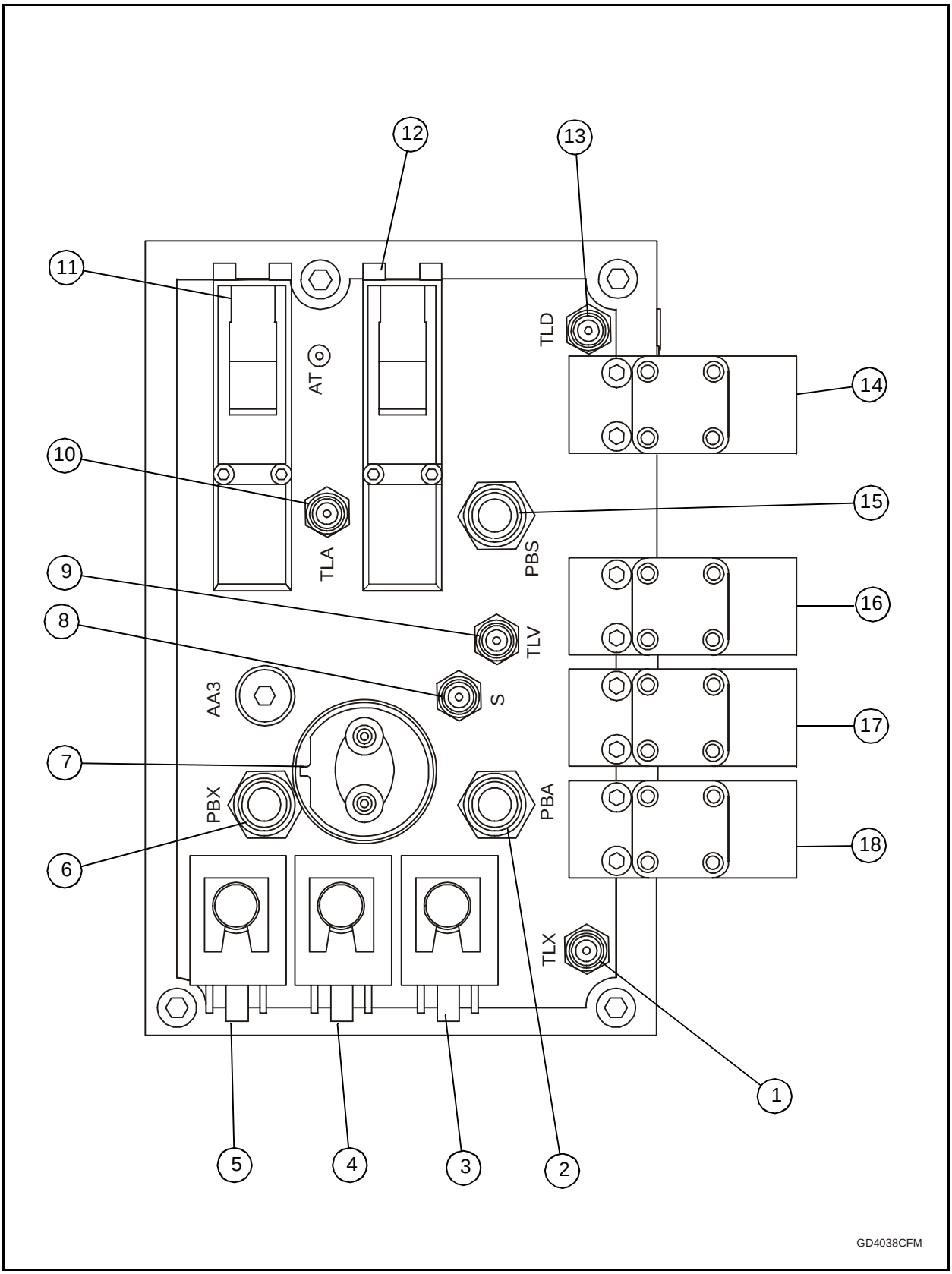
Turn off battery disconnect switch. **(See Battery Disconnect Switch and Battery Circuit Breaker Operator's Manual, CHAPTER 2, SECTION 3).**

Relieve Pneumatic Pressure **(Operator's Manual, CHAPTER 7, SECTION 1).**

Open cab right-side compartment door.

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Pneumatic Manifold Rear



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1. Body Pilot Control Valve Exhaust.
2. Park Brake Supply.
3. Differential Lock Solenoid.
4. Inter-Axle Lock Solenoid.
5. Air Horn Solenoid.
6. Park Brake Exhaust.
7. Supply Air Pressure Sensor.
8. Seat Valve Supply.
9. Body Pilot Control Valve Up.
10. Body Pilot Control Valve Supply.
11. Exhaust Brake and Exhaust Valve Brake Solenoid.
12. Park Brake Solenoid.
13. Body Pilot Control Valve Down.
14. Park Brake Pressure Switch.
15. Park Brake Solenoid Supply.
16. Bin Up Pressure Switch.
17. Inter-Axle Lock Pressure Switch.
18. Differential Lock Pressure Switch.

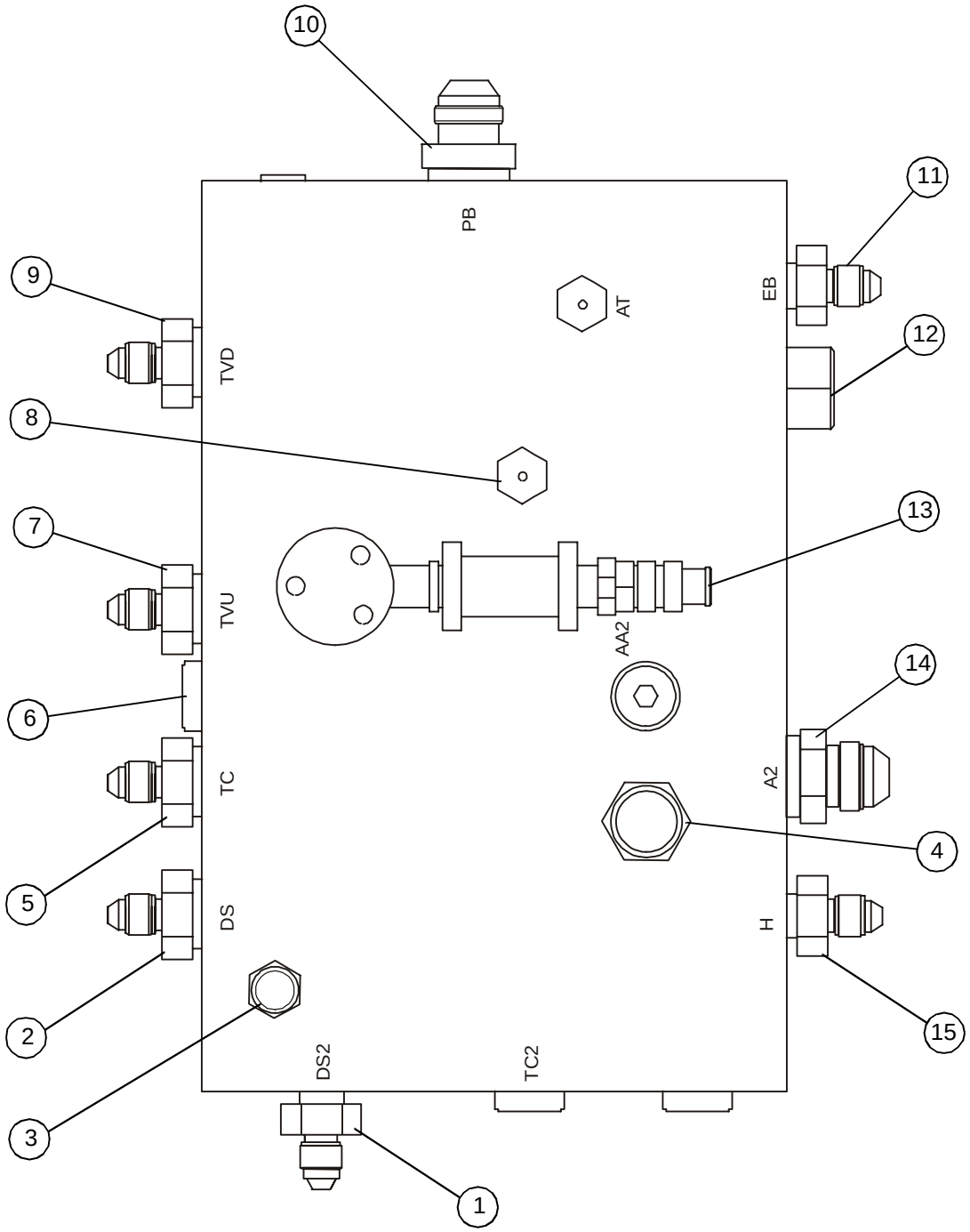
Disconnect wiring connectors from solenoids (3 - 5, 11, 12), sensor (7), and switches (14, 16 - 18).

Remove switches (14, 16 - 18), if necessary.

Remove socket head cap screws. Push manifold forward through cab wall.

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Pneumatic Manifold - Front and Sides



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1. Middle and Rear Axle Differential Lock.
2. Front Axle Differential Lock.
3. Body Pilot Control Valve Exhaust.
4. Park Brake Exhaust.
5. Inter - Axle Lock.
6. Park Brake Check Valve.
7. Body Pilot Control Valve Up.
8. Park Brake Exhaust Orifice.
9. Body Pilot Control Valve Down.
10. Park Brake.
11. Exhaust Brake and Exhaust Valve Brake.
12. Exhaust Brake and Exhaust Valve Brake Exhaust.
13. Quick Coupler.
14. Pneumatic System Supply.
15. Air Horn.

Disconnect air lines (1, 2, 5, 7, 9 - 11, 14, and 15) from sides of manifold.

Disconnect remaining air lines from rear of manifold.

Inspect, repair, and replace parts as necessary.

Connect air lines to rear of manifold.

Connect air lines to sides of manifold.

Install manifold in cab wall and install socket head cap screws.

Install switches on rear of manifold, if removed.

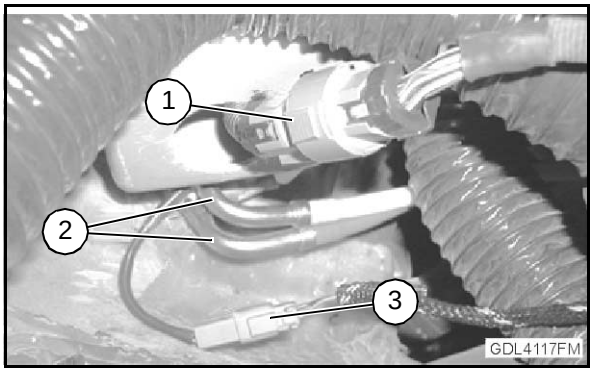
Install wiring connectors on rear of manifold.

Remove and Install Park Brake Control Valve

Turn off battery disconnect switch. **(See Battery Disconnect Switch and Battery Circuit Breaker Operator's Manual CHAPTER 2, SECTION 3).**

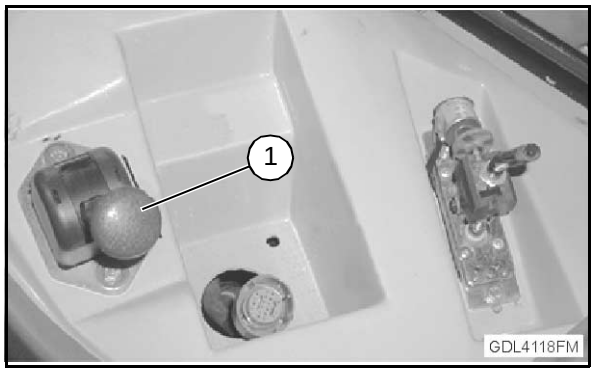
Relieve Pneumatic Pressure **(Operator's Manual CHAPTER 7, SECTION 1)**.

Open cab right-side compartment door.



Disconnect air lines (2) and wiring connectors (1 and 3).

Remove panel from dashboard.



Remove park brake control lever (1).

Inspect, repair, and replace parts as necessary.

Install lever.

Install panel on dashboard.

Connect wiring connectors and air lines.

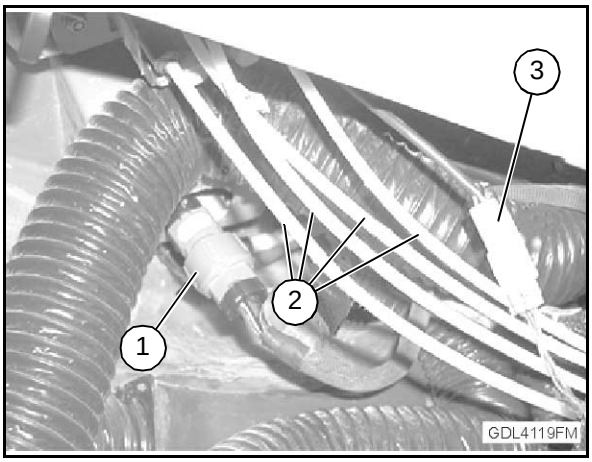
https://truckmanualshub.com/

Remove and Install Body Tip Control Valve

Turn off battery disconnect switch. **(See Battery Disconnect Switch and Battery Circuit Breaker Operator's Manual CHAPTER 2, SECTION 3).**

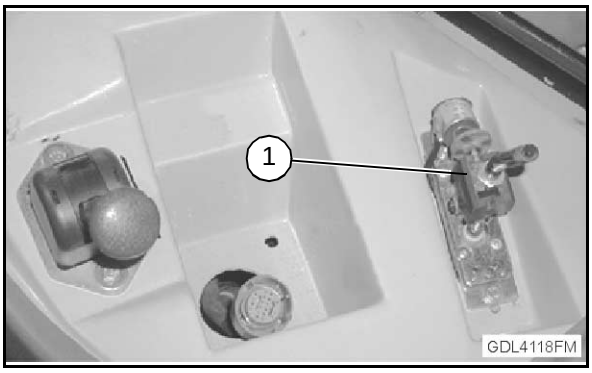
Relieve Pneumatic Pressure **(Operator's Manual CHAPTER 7, SECTION 1).**

Open cab right-side compartment door.



Disconnect air lines (2) and wiring connectors (1 and 3).

Remove panel from dashboard.



Remove body tip control lever (1).

Inspect, repair, and replace parts as necessary.

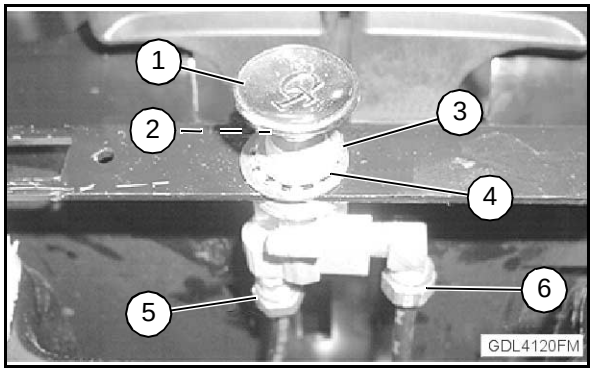
Install lever.

Install panel on dashboard.

Connect wiring connectors and air lines.

Remove and Install Seat Control Valve

Relieve Pneumatic Pressure **(Operator's Manual CHAPTER 7, SECTION 1).**



Disconnect air inlet line (5) and air spring line (6).

Loosen set screw (2) and remove knob (1).

Remove nut (3) and washer (4). Remove valve.

Replace components as necessary.

Install valve, washer, and nut.

Install knob. Tighten set screw.

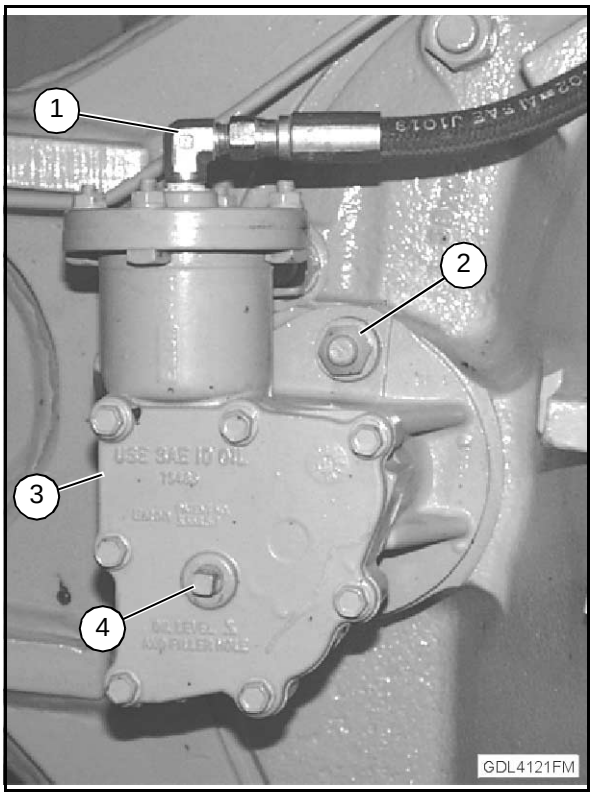
Connect lines.

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Differential Lock Actuator

Remove and Install Differential Lock Actuator

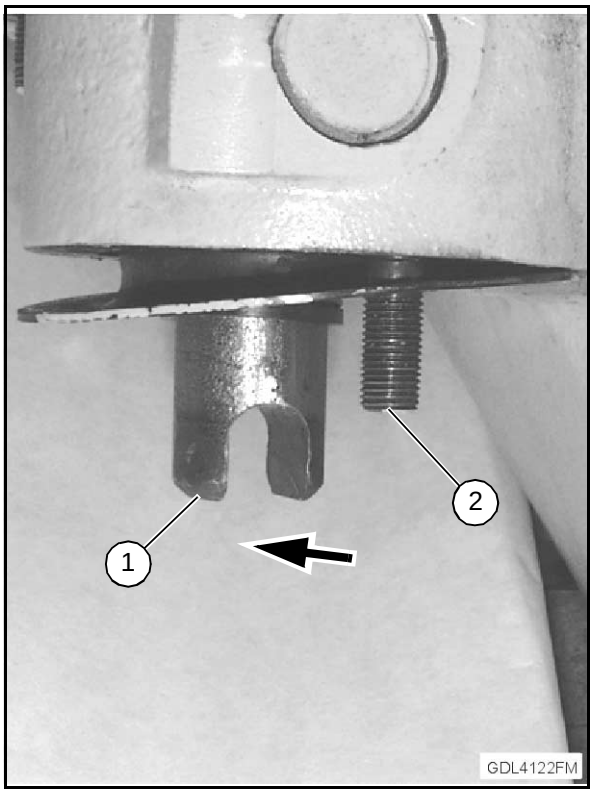
Relieve Pneumatic Pressure. **(Operator's Manual CHAPTER 7, SECTION 1).**



Disconnect air supply line (1).

NOTE: Oil will drain from differential lock actuator when removed.

Remove nuts (2). Remove differential lock actuator (3).



Push shift fork (1) toward the outside (arrow), away from differential. Install differential lock actuator.

Install nuts onto threaded stud (2).

Tighten nuts to specification.

Differential Lock Actuator Specification

Differential Lock Actuator Nuts Torque - 74 - 82 Nm (55 - 61 lb-ft)

Remove sight plug (4) (left picture). Fill actuator (3) (left picture) to bottom of sight hole with SAE 10 oil or automatic transmission fluid.

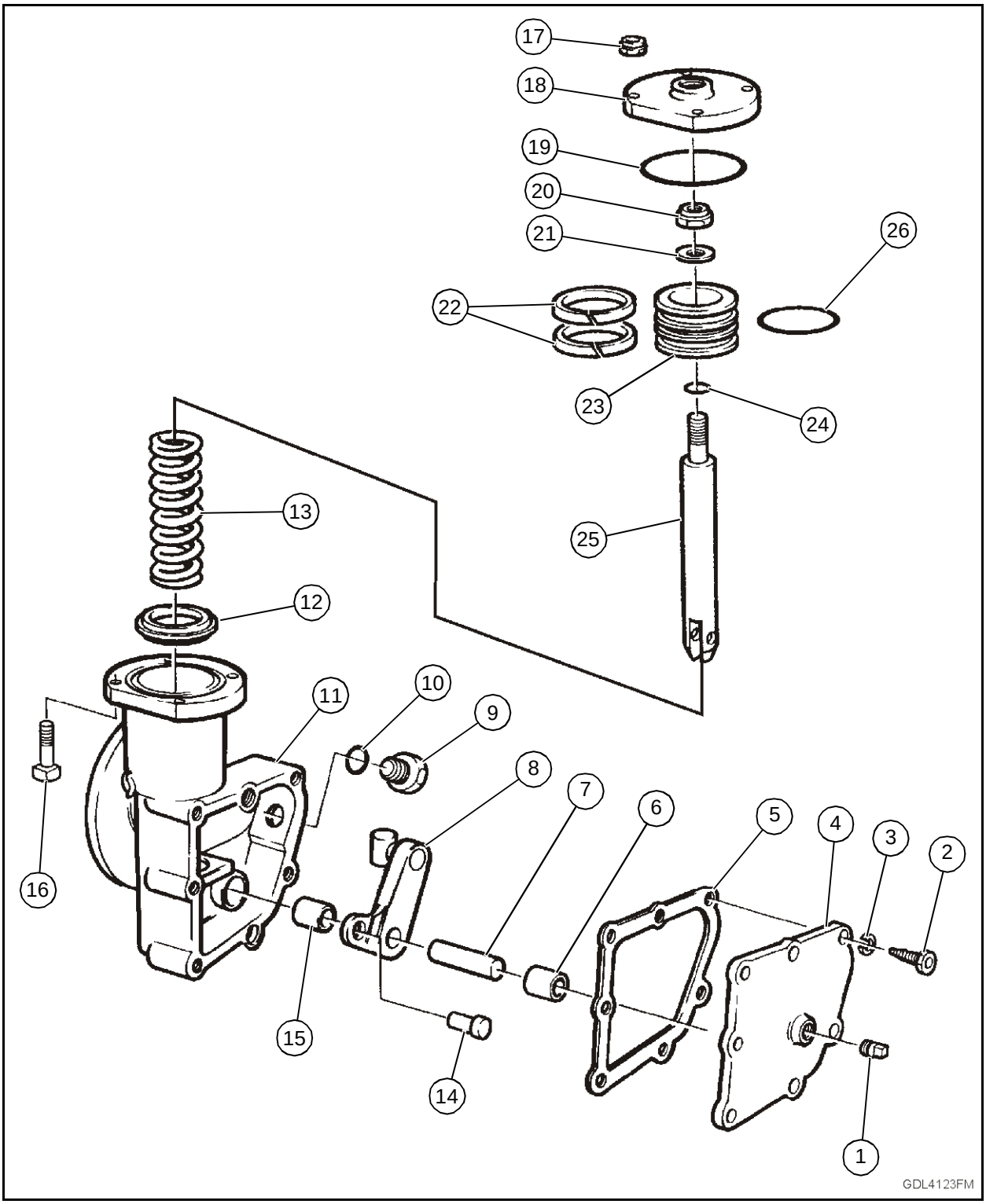
Install sight plug (4). Tighten sight plug (4).

Connect air supply line (1) (left picture).

Disassemble and Assemble Differential Lock Actuator

Clean differential lock actuator to prevent contamination.

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1. Sight Plug.
2. Cap Screw (7 used).
3. Washer (7 used).
4. Cover.
5. Gasket.
6. Bearing.
7. Pin.
8. Lever.
9. Plug.
10. O-Ring.
11. Housing.
12. Stop.
13. Spring.
14. Pin.
15. Bearing.
16. Cap Screw (4 used).

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17. Lock Nut (4 used).
18. Cover.
19. O-Ring.
20. Lock Nut.
21. Washer.

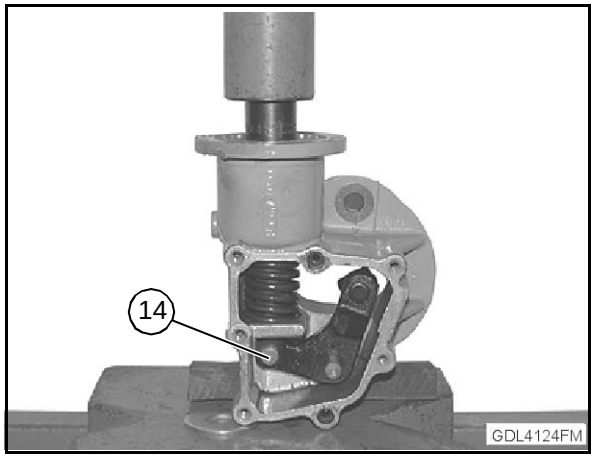
Remove cap screws and washer (2 and 3).

Remove cover (4).

Remove cap screws and lock nuts (16 and 17). Remove cover (18).

⚠ CAUTION

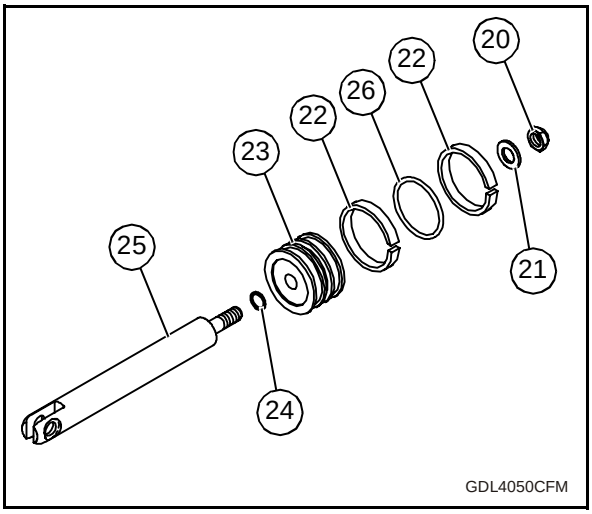
Piston is under spring pressure. Actuator housing must be properly aligned in press to prevent possible injury or damage to parts.



Install housing assembly in press and apply pressure until pin (14) can be removed.

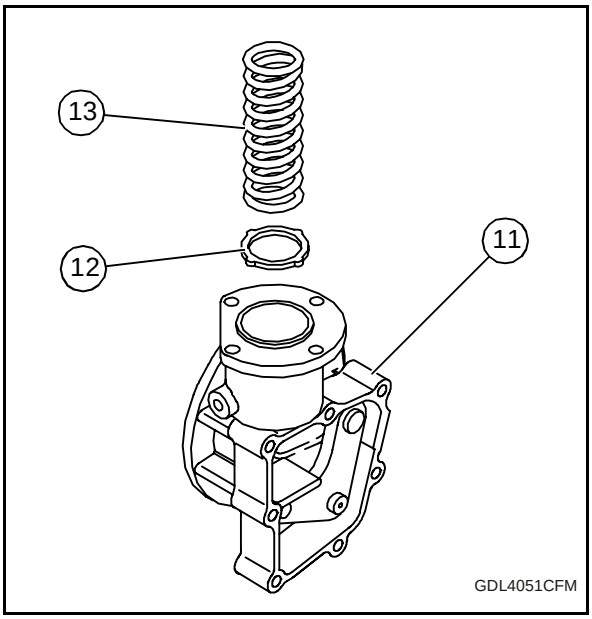
Slowly release press and remove piston with push rod.

22. Oiler (2 used).
23. Piston.
24. O-Ring.
25. Push Rod.
26. O-Ring.



Remove O-ring (26) and oilers (22) from piston (23).

Remove parts (20, 21, 23, and 24) from push rod (25).

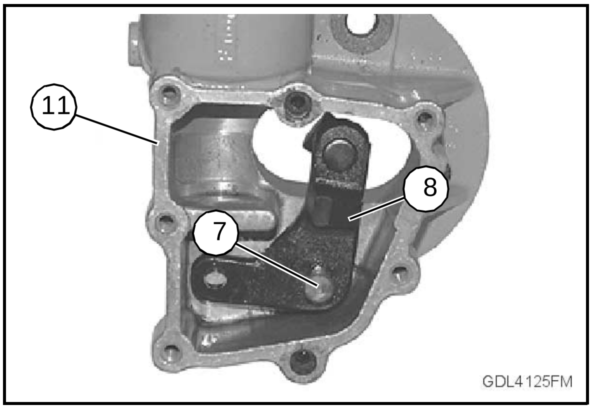


Remove spring (13) and stop (12) from housing (11).

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⚠ CAUTION

Do not disassemble actuating lever (8).



Remove pin (7) and lever (8) from housing (11).

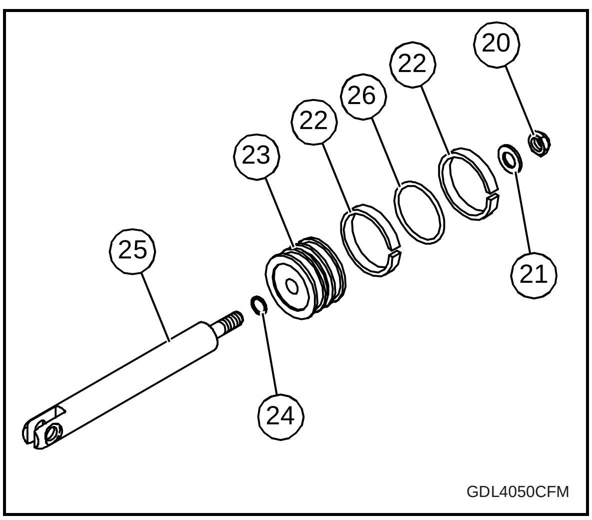
Clean and inspect parts for wear or damage.

Install pin (7) and lever (8) into housing (11).

Soak oilers (22) in SAE 10 oil for one hour before assembly. Lubricate O-ring (26) with high-viscosity silicone oil or barium grease O-ring lubricant.

⚠ WARNING

Piston (23) must be installed on push rod (25) with wording "nut side" facing toward the lock nut (20).

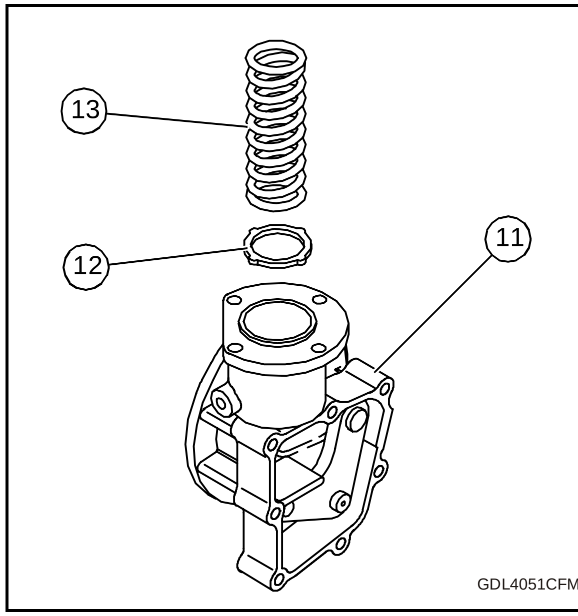


Install parts (24, 23, 21, and 20) onto push rod (25). Tighten lock nut (20) to specification.

Differential Lock Actuator Specification

Push Rod Lock Nut Torque- -14 - 17 Nm (10.5 - 12.5 lb-ft)

Install oilers (22) and O-ring (26) onto piston (23).

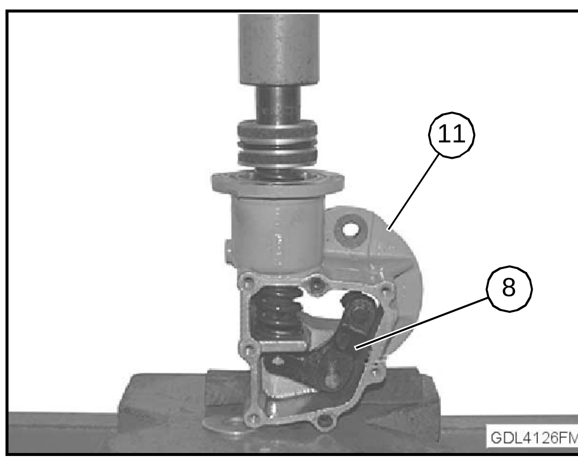


Install stop (12) and spring (13) into housing (11)

Install piston and push rod assembly through spring (13).

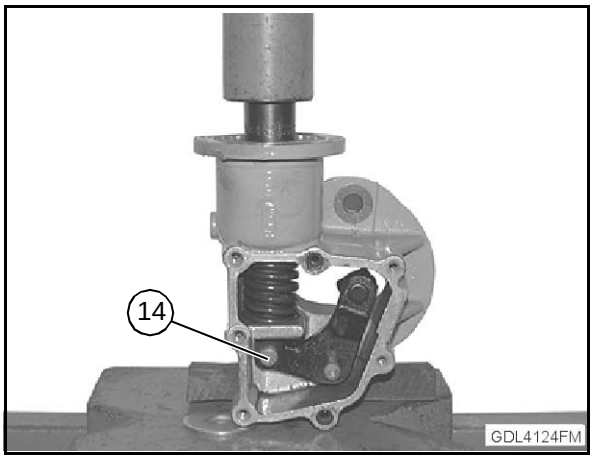
⚠ CAUTION

Actuator housing must be properly aligned in press to prevent possible injury or damage to parts.

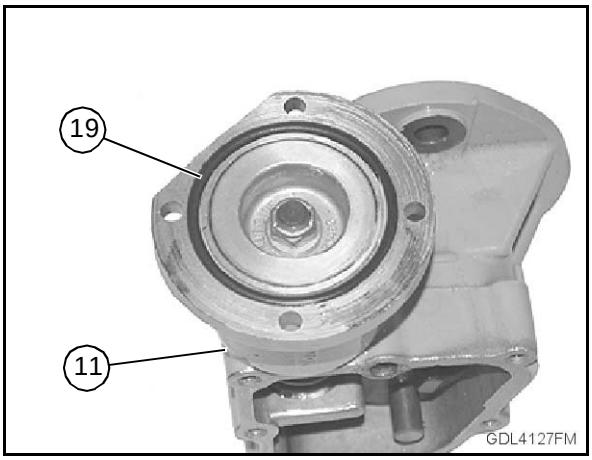


Install housing (11) in press and apply pressure until lever (8) is in alignment with push rod.

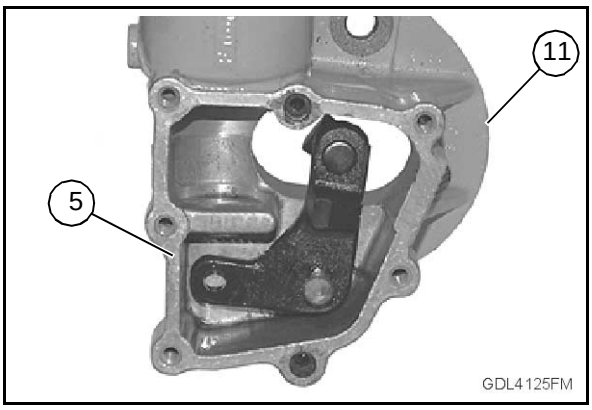
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Install pin (14) and release press.



Install O-ring (19) into groove on housing (11).



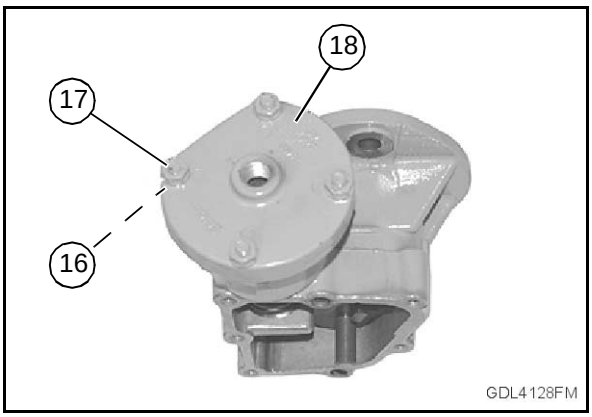
Install gasket (5) on housing (11).

Install cover (4). Apply medium strength thread lock compound to threads of cap screws.

Install cap screws and washers (2 and 3). Tighten cap screws to specification.

Differential Lock Actuator Specification

Housing Cover Cap Screw Torque - 12 - 15 Nm (9 - 11 lb-ft)



Install cover (18). Install cap screws and washers (16 and 17). Tighten to specification.

Differential Lock Actuator Specification

Piston Cover Cap Screw and Nut Torque - 12 - 15 Nm (9 - 11 lb-ft)

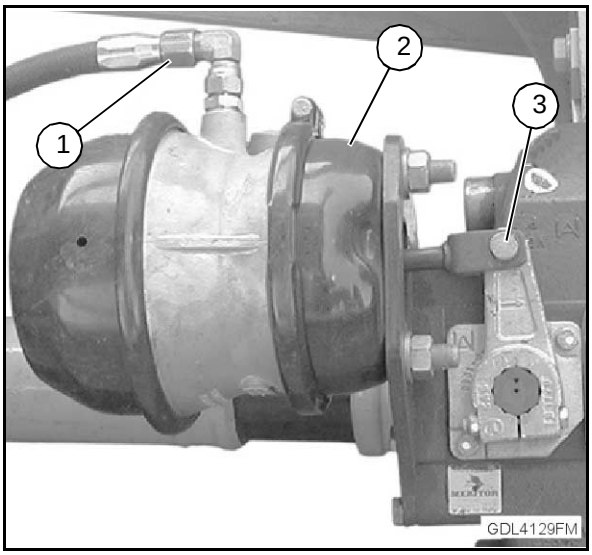
Remove and Install Park Brake Actuator

Install Dump Body Prop **(Operator's Manual CHAPTER 7, SECTION 1).**

Relieve Pneumatic Pressure **(Operator's Manual CHAPTER 7, SECTION 1).**

Release park brake. **(See Mechanically Releasing Park Brake Operator's Manual CHAPTER 6, SECTION 1).**

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Disconnect air line (1).

Remove pin (3).

Remove nuts and washers. Remove actuator (2).

Inspect, repair, and replace parts as necessary.

Install actuator. Install washers and nuts.

Install pin.

Connect air line.

Release park brake. **(See Mechanically Releasing Park Brake Operator's Manual CHAPTER 6, SECTION 1).**

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CHAPTER 15. PNEUMATIC SYSTEMS

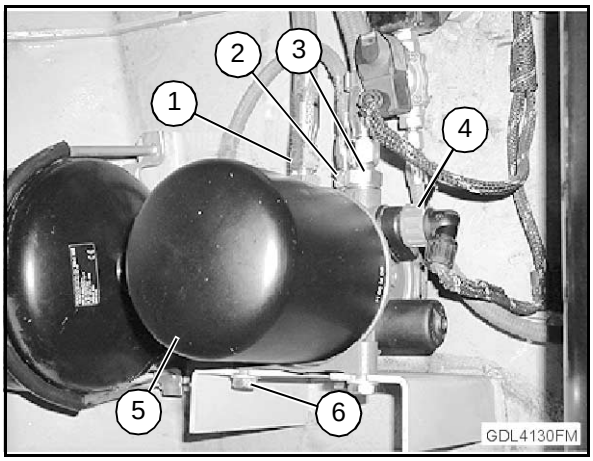
SECTION 3. RESERVOIR, FILTER AND TRAP

AIR UNLOADER VALVE WITH INTEGRAL AIR DRYER

Remove and Install Air Unloader Valve

Turn off battery disconnect switch. **(See Battery Disconnect Switch and Battery Circuit Breaker Operator's Manual CHAPTER 2, SECTION 3).**

Relieve pneumatic pressure. **(See Relieve Pneumatic Pressure Operator's Manual CHAPTER 7, SECTION 1).**



Disconnect heater wire (4).

Disconnect air lines (1 - 3).

Loosen cap screws (6).

Remove unloader valve assembly (5) from machine.

Repair or replace parts as necessary.

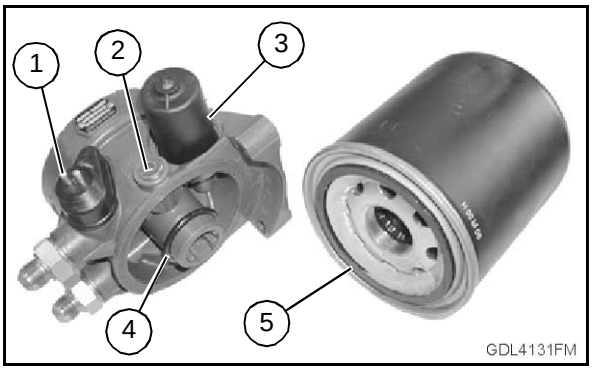
Install unloader valve assembly.

Tighten cap screws.

Connect air lines.

Connect heater wire.

Disassemble and Assemble Air Unloader Valve



Remove element (5) and O-ring (4).

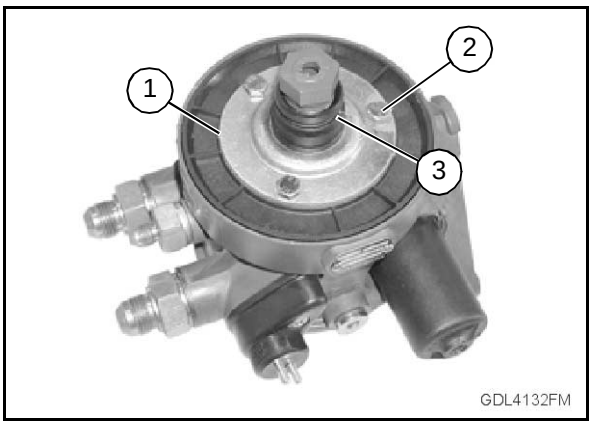
Remove heater and screw (1), if necessary.

Remove plug and sealing ring (2), if necessary.

⚠ CAUTION

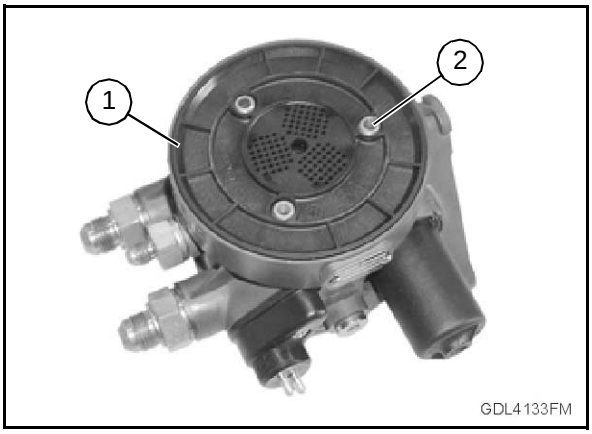
Spring is under load. Hold component securely while removing snap ring.

Remove snap ring and unloader valve spring assembly (3), if necessary.

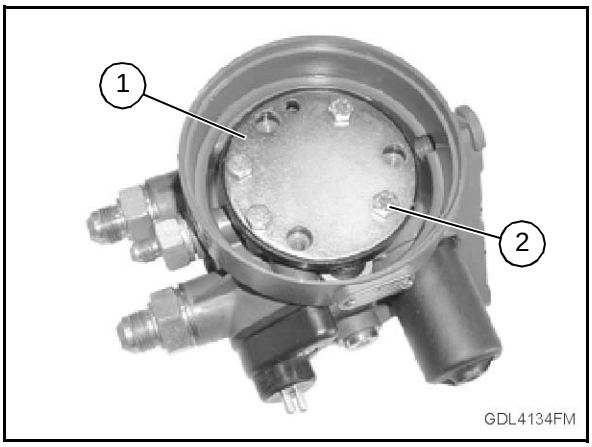


Remove cap screws (1), retaining ring (2), and drain port (3).

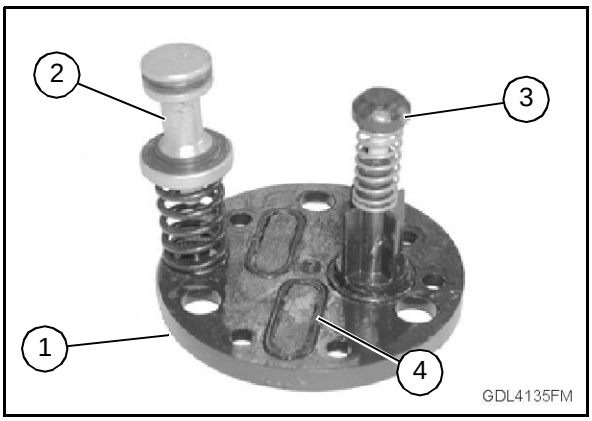
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Remove drain cover (1) and sleeves (2).



Remove cap screws (2) and retaining plate (1).



Remove valve base (1). Remove purging valve and spring (2), check valve and spring (3), and O-rings (4) from valve base.

Clean, repair, or replace parts as necessary.

Install O-rings, check valve and spring, and purging valve and spring on valve base. Install valve base.

Install retaining plate and cap screws.

Install drain cover and sleeves.

Install drain port, retaining ring, and cap screws.

Install unloader valve spring assembly and snap ring, if removed.

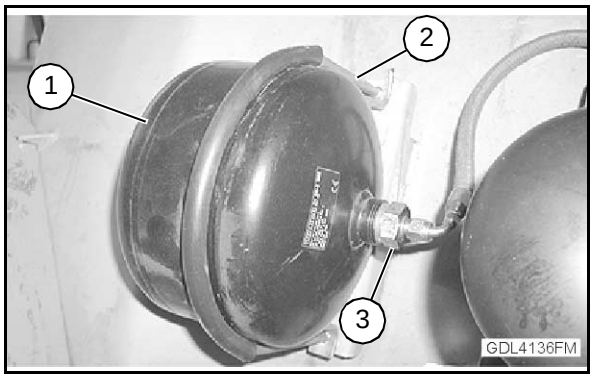
Install sealing ring and plug, if removed.

Install heater and screw, if removed.

Install O-ring and element.

Remove and Install Regeneration Air Reservoir

Relieve pneumatic pressure. **(See Relieve Pneumatic Pressure Operator's Manual CHAPTER 7, SECTON 1).**



Disconnect air line (3).

Remove U-bolt and nuts (2).

Remove reservoir (1).

Repair or replace parts as necessary.

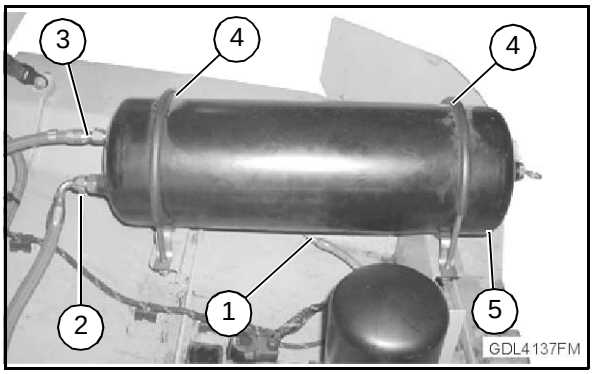
Install reservoir, U-bolt, and nuts.

Connect air line.

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Remove and Install Air Reservoir

Relieve pneumatic pressure. **(See Relieve Pneumatic Pressure Operator's Manual CHAPTER 7, SECTION 1).**



Disconnect air lines (1 - 3).

Remove U-bolts and nuts (4).

Remove reservoir (5).

Repair or replace parts as necessary.

Install reservoir, U-bolts, and nuts.

Connect air lines.

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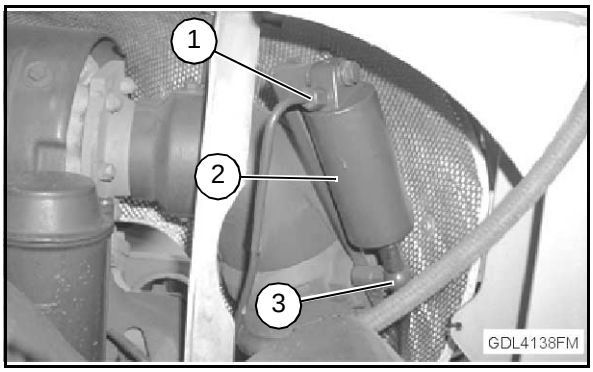
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CHAPTER 15. PNEUMATIC SYSTEMS

SECTION 4. CYLINDERS

REMOVE AND INSTALL EXHAUST BRAKE AIR CYLINDER

Relieve Pneumatic Pressure. **(See Relieve Pneumatic Pressure Operator's Manual CHAPTER 7, SECTION 1).**



Disconnect air line (1).

Disconnect ball joint (3)

Remove cap screw and washer. Remove cylinder (2).

Repair or replace parts as necessary.

Install cylinder. Install washer and cap screw.

Connect ball joint.

Connect air line.

Perform Exhaust Brake Valve Adjustment **(See CHAPTER 2, SECTION 3 in the Operation and Test Manual).**

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CHAPTER 16. HAULAGE DEVICE

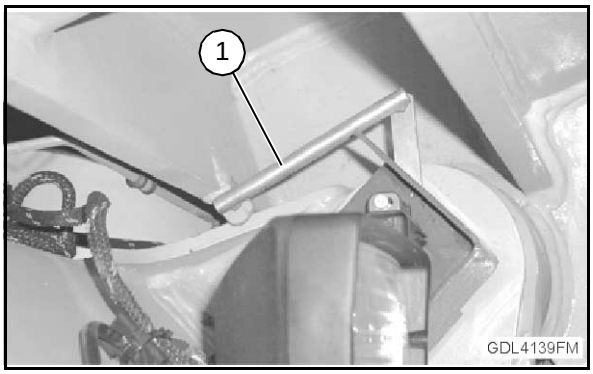
SECTION 1. FRAMES

BODY

Remove and Install Body

Remove rear turn signals and tail and brake lights. **(See Replace Tail and Brake Light and Rear Turn Signal Operator's Manual CHAPTER 18, SECTION 2).**

Remove wiring harnesses from tail light housings.



Disconnect tip angle sensor linkage (1).

Remove body lift cylinders. See Body Lift Cylinder (Group 3560).

⚠ CAUTION

Component is heavy. Use hoist.

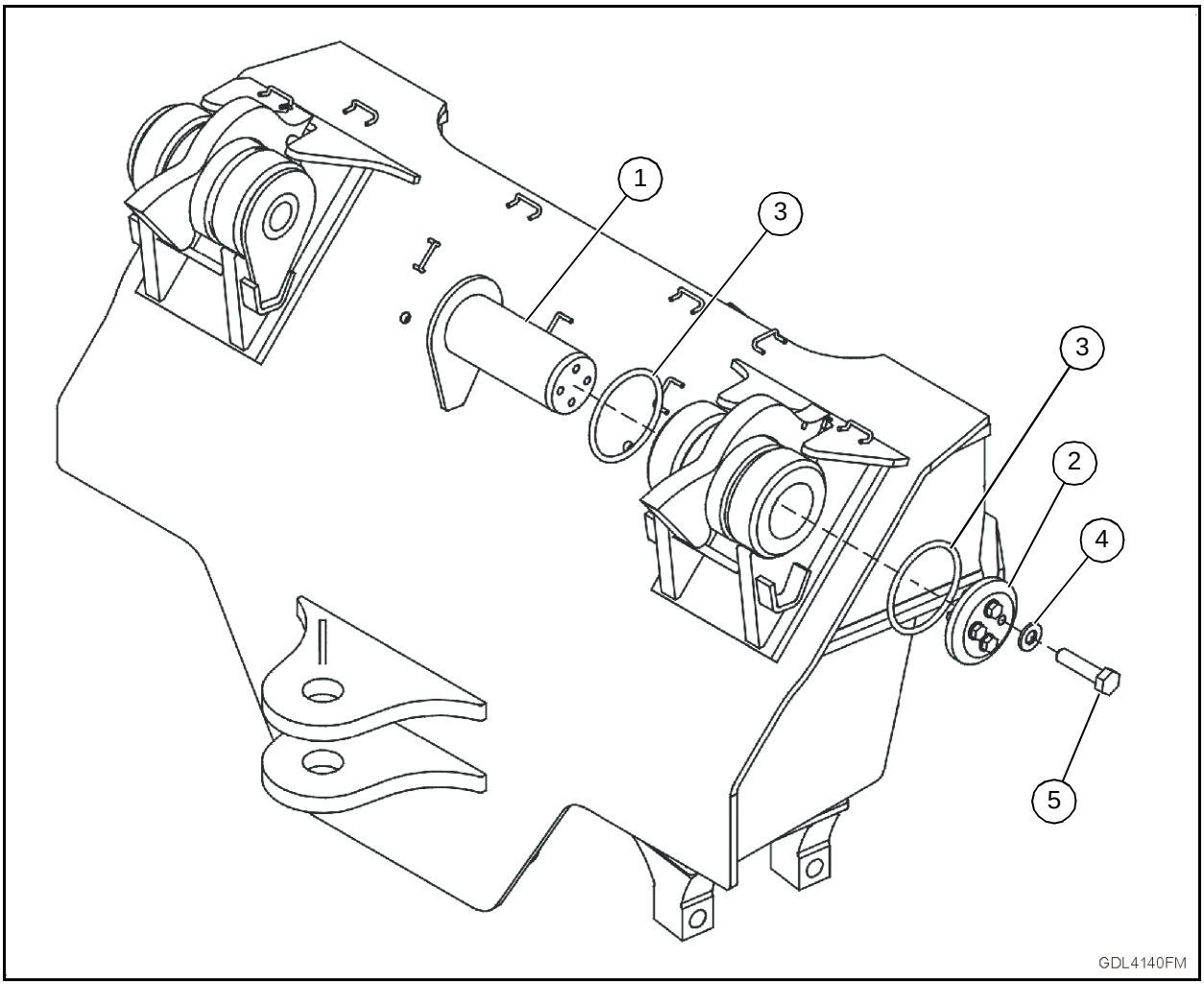
Body Specification

B35D Dump Body Weight - - - - - - - - 4361 kg (9614 lb)

B40D Dump Body Weight - - - - - - 4601 kg (10,143 lb)

Install lifting device on dump body.

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1. Pin (2 used).
2. Retaining Plate (2 used).
3. Seal Ring (4 used).
4. Washer (8 used).
5. Cap Screw (8 used).

⚠ CAUTION

Avoid machine damage. Do not crush electrical components and grease lines under rear edge of dump body.

Remove pivot pins (1). Remove dump body from machine.

Inspect, clean, and replace hardware as necessary.

Grease pivot pins and bores. Install dump body on machine. Install pivot pins.

Install body lift cylinders. **(See "Remove and Install Body Lift Cylinder" on page 347).**

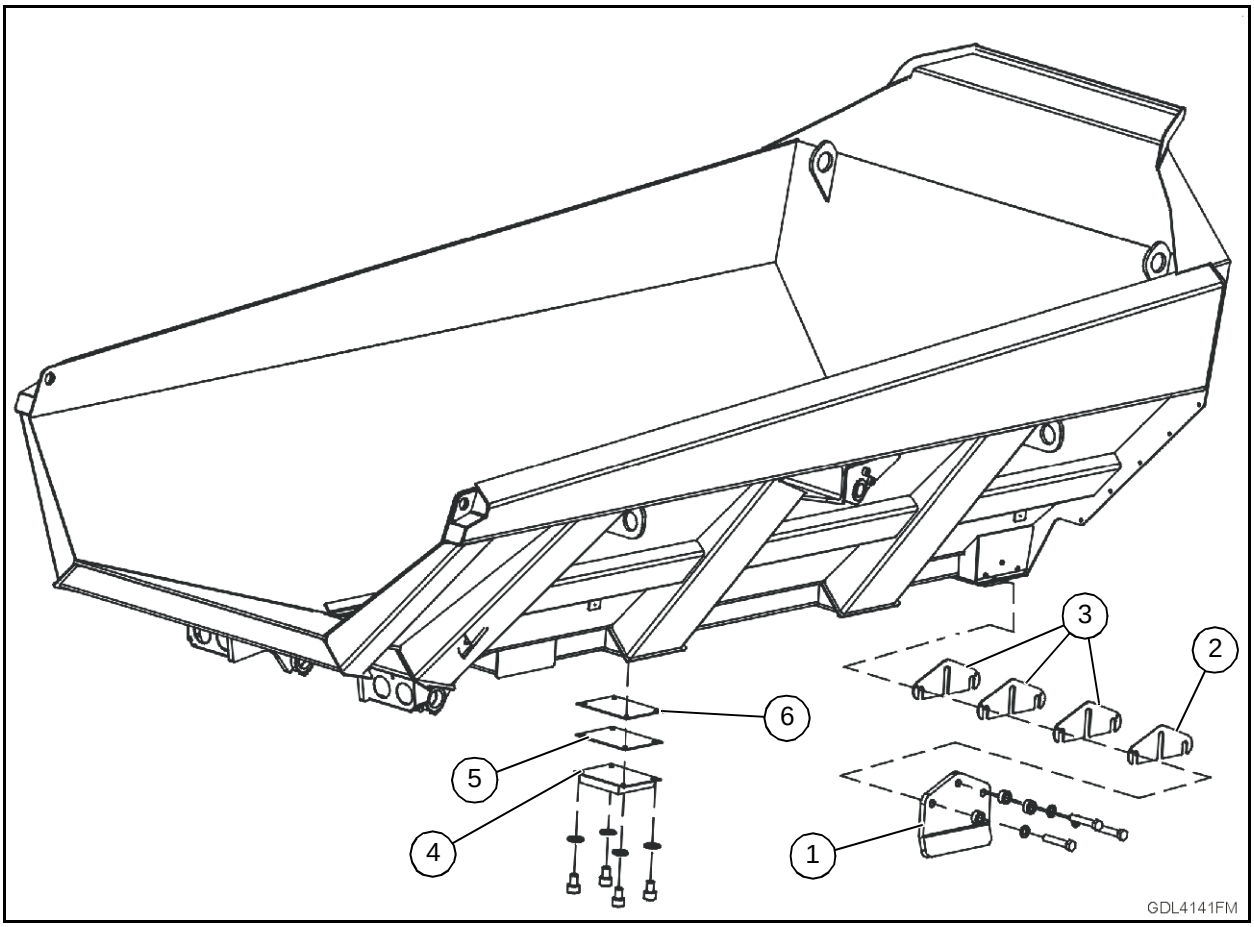
Connect tip angle sensor linkage.

Install wiring harnesses into tail light housings.

Install rear turn signals and tail and brake lights. **(See Replace Tail and Brake Light and Rear Turn Signal Operator's Manual CHAPTER 18, SECTION 2).**

Align dump body, if necessary.

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1. Guide Plate (2 used).
2. Guide Plate Shim, 3 mm (0.12 in.)
3. Guide Plate Shim, 5 mm (0.20 in.)
4. Support Pad (6 used).
5. Support Pad Shim, 1.6 mm (0.06 in.)
6. Support Pad Shim, 4.0 mm (0.16 in.)

Align

Remove support pads (4) and shims (5 and 6) from dump body. Loosen guide plates (1).

Put steel plates on top of rear frame at all support pad positions.

Body Specification

Steel Plate Thickness - - - - - - - - - - - - 38 mm (1.50 in.)

Float dump body onto steel plates.

Check for gaps between dump body and each steel plate. Measure and record all gaps.

Raise dump body. Remove steel plates. Install support pads. Use shim plates as indicated by measurements.

Use an additional 4 mm (0.16 in.) shim (6) with each of the rear four support pads.

Float dump body onto frame. Check for gaps. The rear four support pads should have no gaps.

The front two support pads should have slight gaps.

Add or remove shims (2 and 3) as necessary between body guide plates and frame strike plates, to obtain minimum possible clearance without interference.

Tighten guide plates.

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CHAPTER 16. HAULAGE DEVICE

SECTION 2. HYDRAULIC SYSTEM

BODY LIFT CYLINDER

Remove and Install Body Lift Cylinder

Install articulation lock bar. Install wheel chocks. Fully lower dump body. Discharge hydraulic pressure. **(See Prepare Machine for Maintenance Operator's Manual CHAPTER 7).**

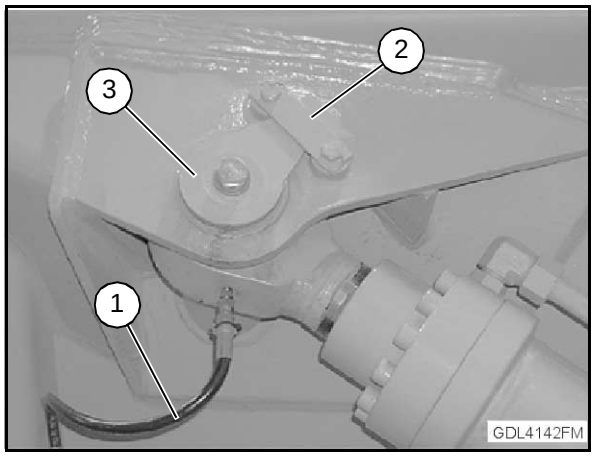
⚠ CAUTION

Component is heavy. Use hoist.

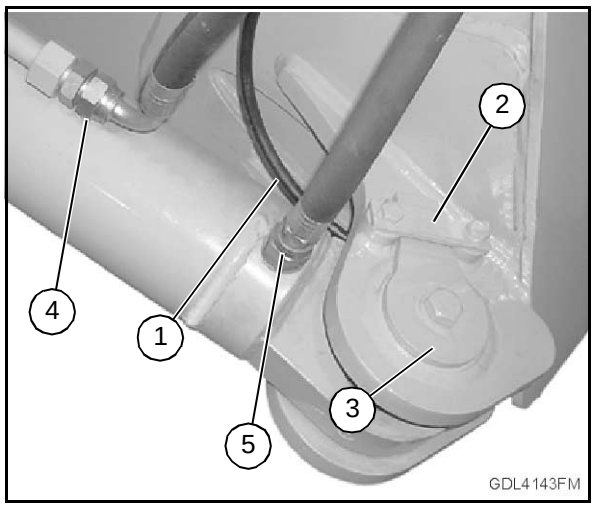
Body Lift Cylinder Specification

Body Lift Cylinder Weight - 325 kg (710 lb) approximate

Support cylinder with hoist.



Disconnect lubrication hoses (1) (top and bottom).



Disconnect hydraulic lines (4 and 5). Close all openings with caps and plugs.

Remove lock plates and retainer plates (2) (top and bottom).

Remove pins (3). Remove cylinder from machine.

Clean, repair, and replace parts as necessary.

NOTE: Rotate cylinder so hydraulic fittings are on top.

Apply a thin layer of fresh grease to pins. Install cylinder on machine. Install pins.

Install retainer plates and lock plates. Tighten cap screws. Bend one corner of lock plate over the head of each cap screw.

Install hydraulic lines.

Connect lubrication hoses.

Disassemble and Assemble Lift Cylinder

⚠ CAUTION

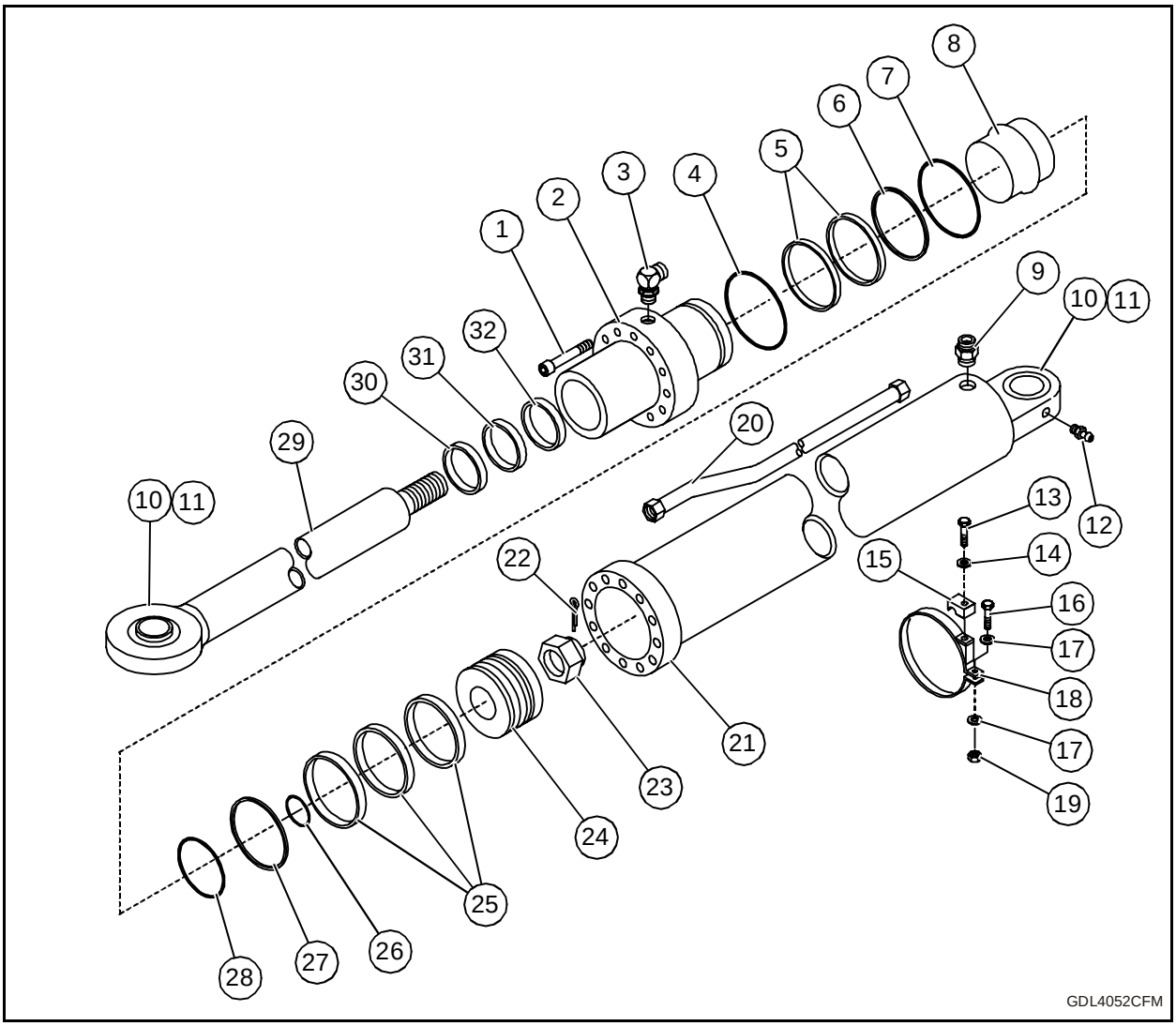
Component is heavy. Use hoist.

Body Lift Cylinder Specification

Body Lift Cylinder Weight - 325 kg (710 lb) approximate

Install cylinder in a cylinder service stand such as JT30043 Cylinder Service Stand.

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1. Cap Screw (12 used).
2. Rod Guide.
3. Fitting.
4. O-Ring.
5. Ring (2 used).
6. Backup Ring.
7. O-Ring.
8. Valve.
9. Fitting.
10. Self-Aligning Bushing (2 used).
11. Snap Ring (2 used).
12. Lubrication Fitting (2 used).
13. Cap Screw (2 used).
14. Washer (2 used).
15. Clamp (2 used).
16. Cap Screw (4 used).
17. Washer (8 used).
18. Clamp (2 used).
19. Lock Nut (4 used).
20. Hydraulic Line.
21. Cylinder Barrel.
22. Cotter Pin.
23. Nut.
24. Piston.
25. Seal (3 used).
26. O-Ring.
27. Backup Ring.
28. O-Ring.
29. Rod.
30. Seal.
31. Dust Seal.
32. Seal.

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Remove snap rings (11), bushings (10), clamps (18), oil line (20), hydraulic fittings (3 and 9), and lubrication fittings (12), if necessary.

Remove socket head cap screws (1). Remove rod (29), rod guide assembly (2, 4 - 8, 27 - 32), and piston assembly (22 - 26) from barrel (21).

Remove and disassemble piston assembly.

Remove and disassemble rod guide assembly.

Clean, inspect, or replace parts as necessary.

Replace all O-rings and seals.

NOTE: Apply clean hydraulic oil to all rod guide and piston components during assembly.

Assemble rod guide assembly and install on rod. Ensure dust seal (31) is installed with lip facing rod end.

Assemble piston assembly and install on rod.

Apply rigid form-in-place gasket to threads of nut. Tighten nut (23) to specification.

Install cotter pin (22).

Body Lift Cylinder Specification

Piston-to-Rod Nut Torque - - - - - - - 500 Nm (370 lb-ft)

Install piston assembly, rod guide assembly, and rod in barrel.

Align hydraulic fitting port on rod guide with hydraulic fitting port on head end of barrel.

Install socket head cap screws and tighten to specification.

Body Lift Cylinder Specification

Rod Guide-to-Cylinder Barrel Socket Head Cap Screw Torque - 308 Nm (230 lb-ft)

Install lubrication fittings, hydraulic fittings, oil line, clamps, bushings, and snap rings, if removed.

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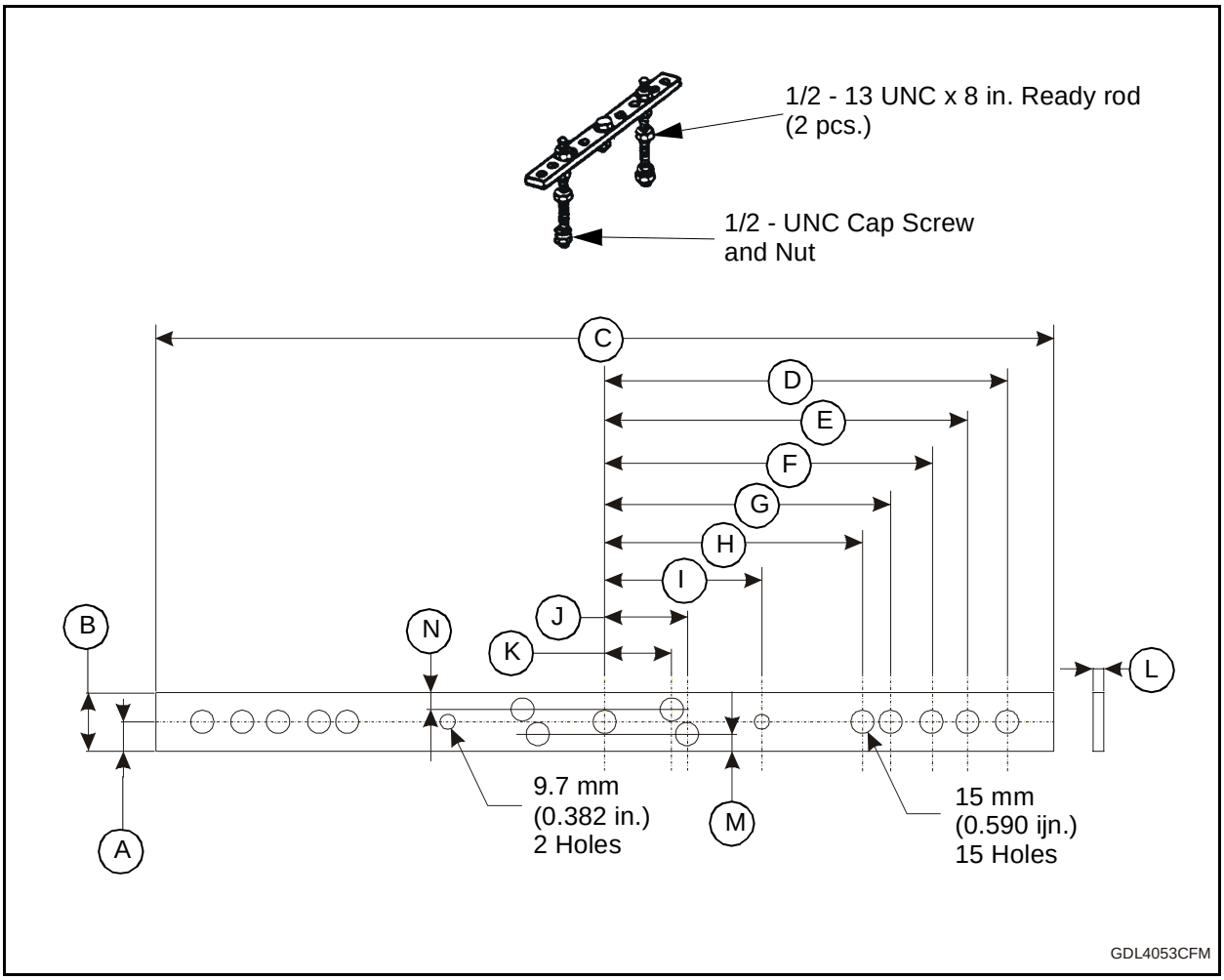
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CHAPTER 17. DEALER FABRICATED TOOLS

SECTION 1. TOOLS

DF1002 ROLLING DRAG TORQUE BAR



A. 19 mm (0.75 in.)
B. 38 mm (1.50 in.)
C. 584 mm (23.00 in.)
D. 261.9 mm (10.31 in.)
E. 236 mm (9.29 in.)
F. 212.7 mm (8.37 in.)
G. 185.7 mm (7.31 in.)
H. 167.4 mm (6.59 in.)
I. 102 mm (4.02 in.)
J. 53.5 mm (2.11 in.)
K. 43.5 mm (1.71 in.)
L. 10 mm (0.38 in.)
M. 11 mm (0.43 in.)
N. 11 mm (0.43 in.)

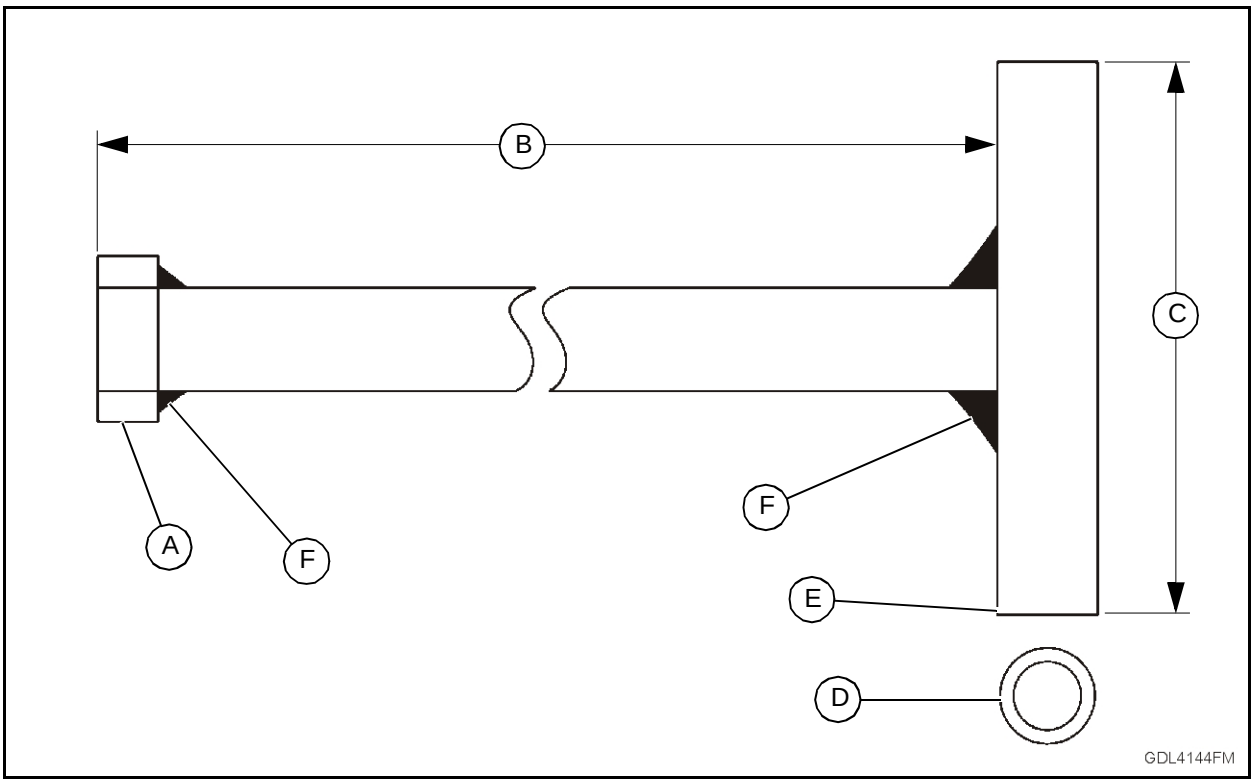
Rolling Drag Torque Bar is used with a torque wrench to measure rolling drag torque.

Material required:

- 10 x 38 x 584 mm (0.38 x 1.50 x 23.00 in.) mild steel (1020) flat.
- 1/2 in. - 13 UNC x 8.00 in. ready rod (2 used).
- 1/2 in. - 13 UNC nuts (9 used).
- 12.7 x 25.4 x 1.5 mm (0.50 x 1.00 x 0.06 in.) washers (8 used).
- 1/2 in. - 13 UNC x 1.00 in. cap screw.

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DFT1132 REMOVAL AND INSTALLATION TOOL



A. M30 (1 in.) Nut.
B. 2.134 m (7 ft) Length of Pipe.
C. 457 mm (18 in.) Length of Pipe.
D. 25 mm (1 in.) ID Heavy Wall Pipe.
E. Pipe.
F. Fillet Weld.
G. Pipe.

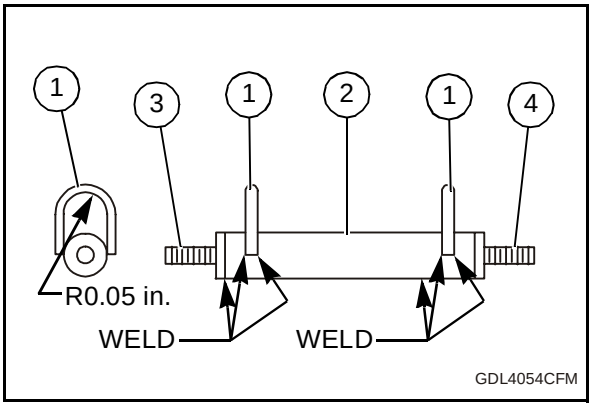
Removal and installation tool is used to remove and install the main hydraulic pump.

Material required:

- 2.591 m (8 ft x 6 in.) length of 25 mm (1 in.) ID heavy wall steel pipe.
- Fillet weld.

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DFT1178 LIFTING TOOL



Lifting tool is used to remove and install axle planetary cover.

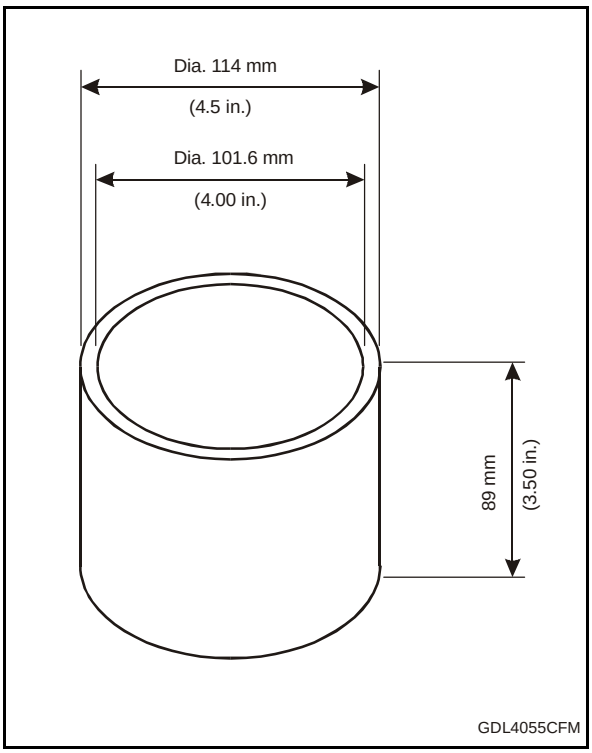
Material required:

- 3/8 in. x 7.5 in. Round Bar (2 used).
- 1.0 in. OD x 0.75 in. ID x 24 in. Pipe.
- M12 x 25 mm Cap Screw.
- M14 x 25 mm Cap Screw.

Weld cap screws to ends of pipe.

Weld round bars to pipe as shown.

DFT1181 BUSHING DRIVER

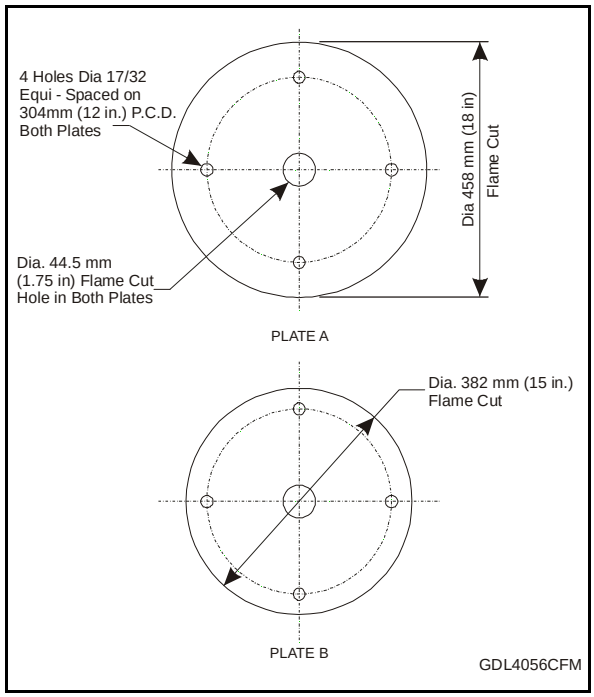


Used to install bushings in axle suspension struts, drag links and stabilizer bars.

Material required:

- Steel pipe 114 mm (4.50 in.) O.D. 101.6 mm (4.00 in.) I.D. 89 mm (3.50 in.) Long.

DFT1186 BUSHING DRIVER



Used to install oscillation joint bushings in machine frame.

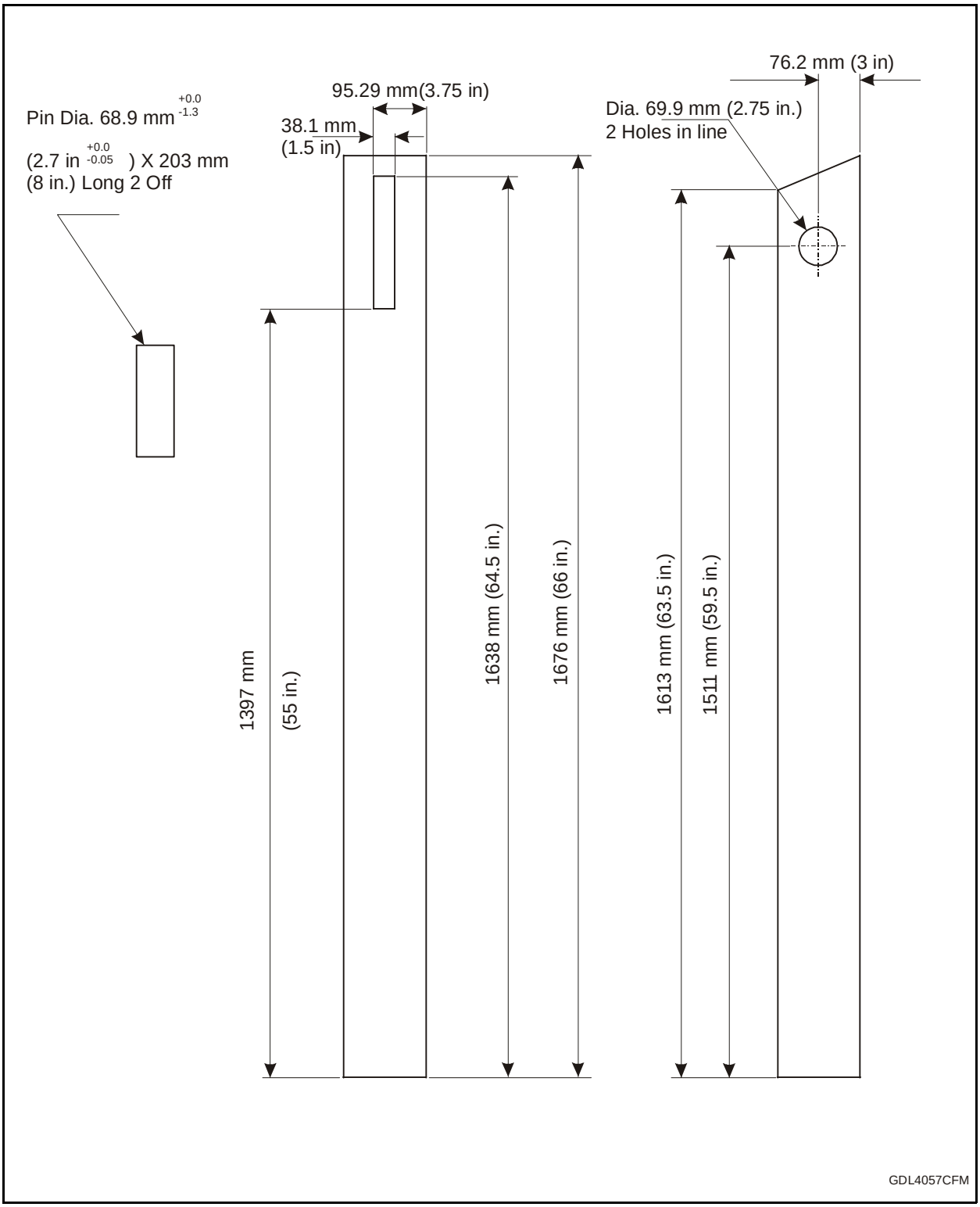
Material required:

- Steel plate 19.1 mm (0.75 in.) thick, 229 mm (9.0 in.) Radius (2 pieces).
- Steel plate 12.7 mm (0.50 in.) thick, 191 mm (7.5 in.) Radius (2 pieces).
- Cap screws 12 mm (0.50 in.) x 45 mm (1.75 in.) (8 used).
- Hex nuts 12 mm (0.50 in.) (8 used).

Attach a small plate to a large plate using 4 cap screws and nuts.

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DFT1185 SUPPORTS



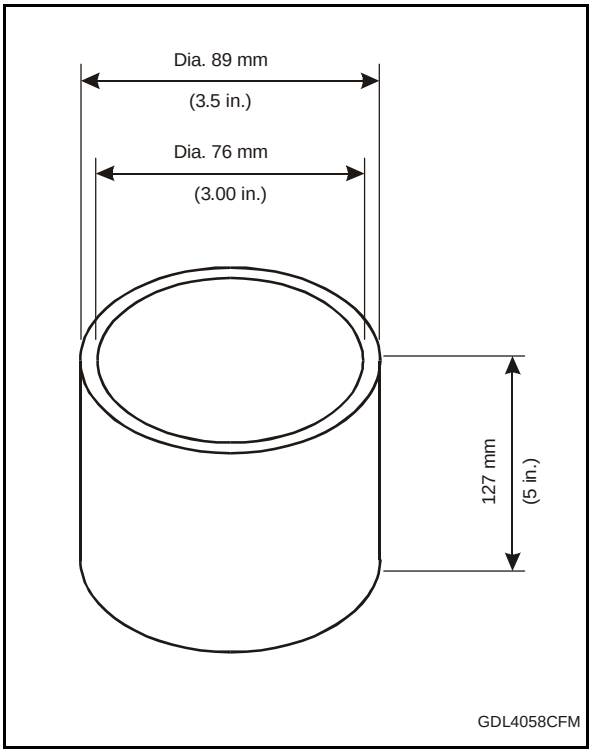
DFT 185 Supports are used to support front of truck when separating frames.

Material required:

- 6.00 x 6.00 x 0.375 in. Steel Square Tube.
- 68.6 mm (2.75 in.) Bar Stock.

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DFT1187 BEARING DRIVER

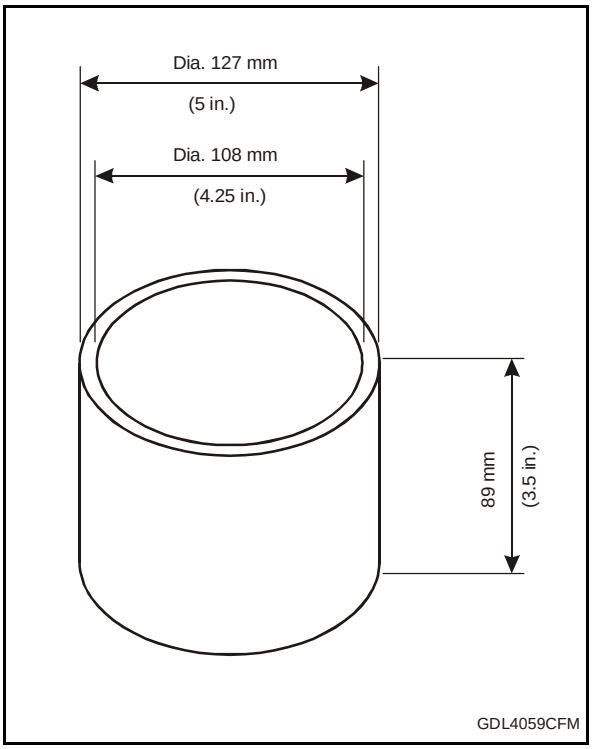


Used to install bearings on oscillation joint-to-park brake drive shaft.

Material required:

- Steel pipe 89 mm (3.50 in.) O.D. 76 mm (3.0 in.) I. D. 127 mm (5.0 in.) long.

DFT1188 BEARING DRIVER



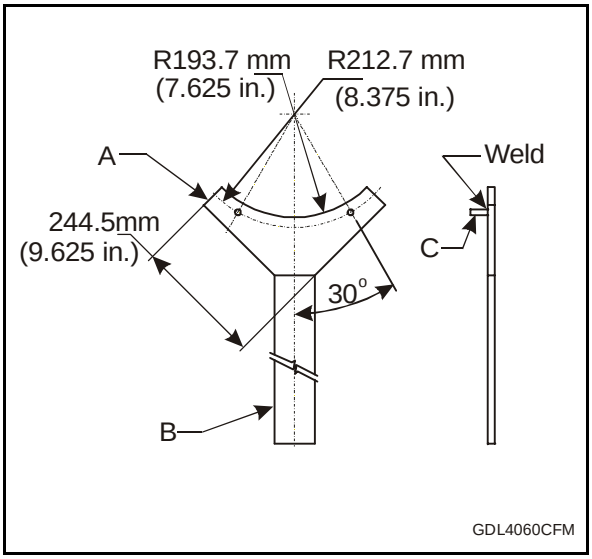
Used to install bearings in articulation joint bearing cover

Material required:

- Steel pipe 127 mm (5.00 in.) O. D. 180 mm (4.25 in.) I. D. 89 mm (3.50 in.) long.

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DFT1189 SPANNER WRENCH



A. Steel Plate.
B. Steel Flat.
C. Steel Rod (2 used).

Spanner wrench is used to remove, install and adjust oscillation joint nut.

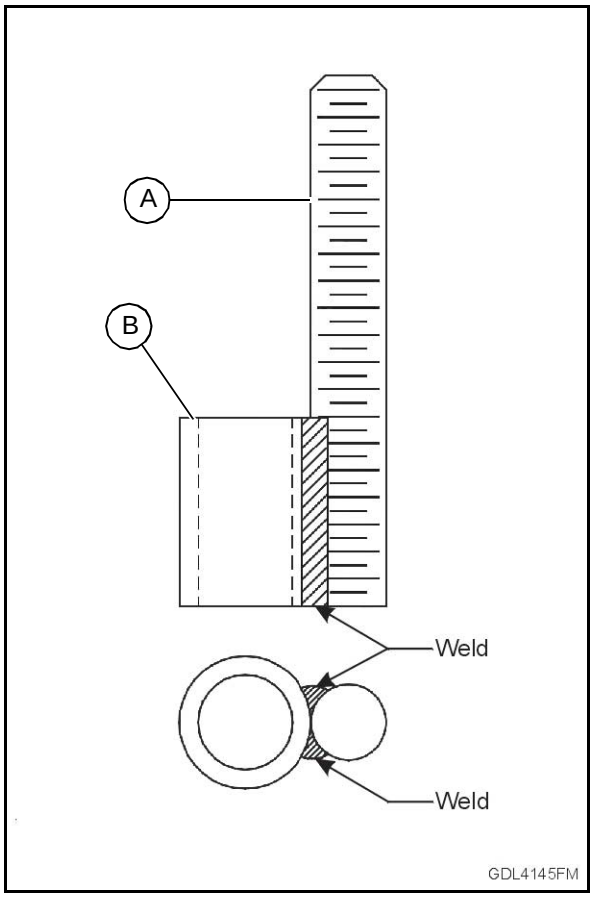
Material required:

- 244.5 mm (9.625 in.) x 244.5 mm (9.625 in.) x 6.3 mm (0.250 in.) steel plate
- 38.1 mm (1.50 in.) x 6.3 mm (0.250 in.) x 711.2 (28 in.) steel flat.
- 32 mm (1.25 in.) long x 22.2 mm (0.875 in.) diameter steel rod (2 used)

Weld rods (C) to plate (A) on front side or drill 19 mm (0.75 in.) holes in plate and weld rods to plate from the back side.

Weld steel flat (B) to plate (A).

DFT1194 BEARING PULLER



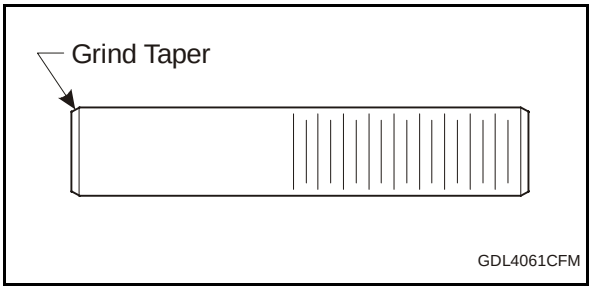
Bearing puller is used to separate differential housing from axle.

Material required:

- Threaded rod 5/8-11 X 229 mm (11.0 in.) (2 pieces).
- Pipe 3/4 in. OD x 1/2 in. ID x 1.5 in. (2 pieces).
- Hex nut 1/2-13 (2 used).
- Flat washer 1/2 in. ID (2 used).
- H-bar from push-puller

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DFT1195 PLANETARY ALIGNMENT STUD

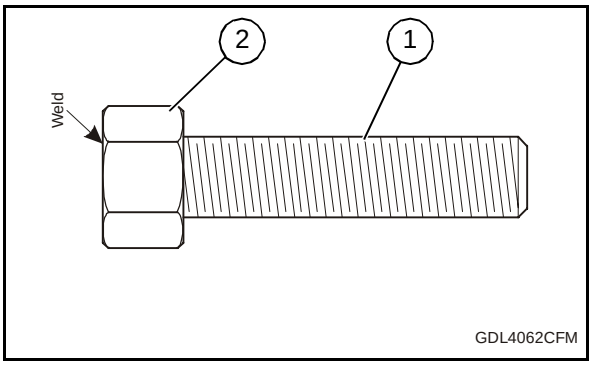


Stud is used to remove and install axle planetary cover.

Material required:

- M14 x 170 mm cap screw (19M8243) (2 used) Remove head from cap screw and grind taper per drawing.

DFT1199 BUSHING PUSHER

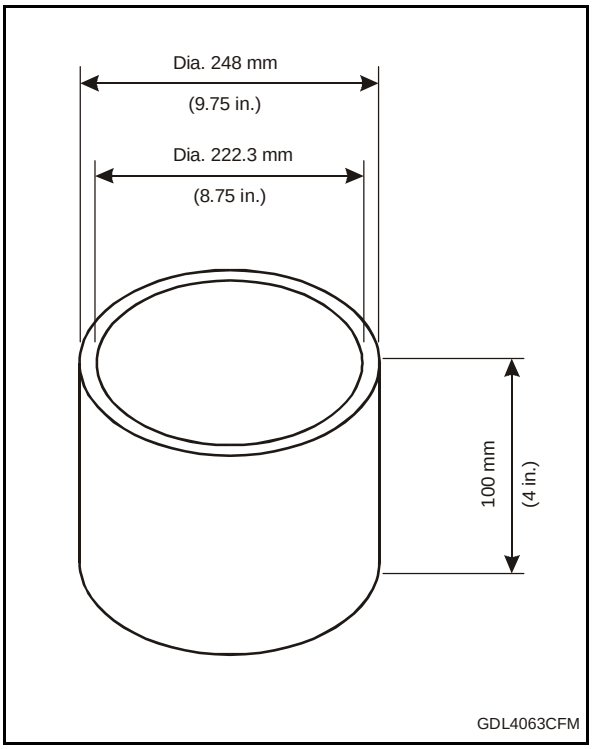


Bushing pusher is used to push the walking beam bushings off the pivot tube.

Material required:

- 1). 20 mm threaded rod 152 mm (6.0 in.) long (3 pieces).
- 2). 20 mm hex nut (3 used).

DFT1200 BUSHING DRIVER



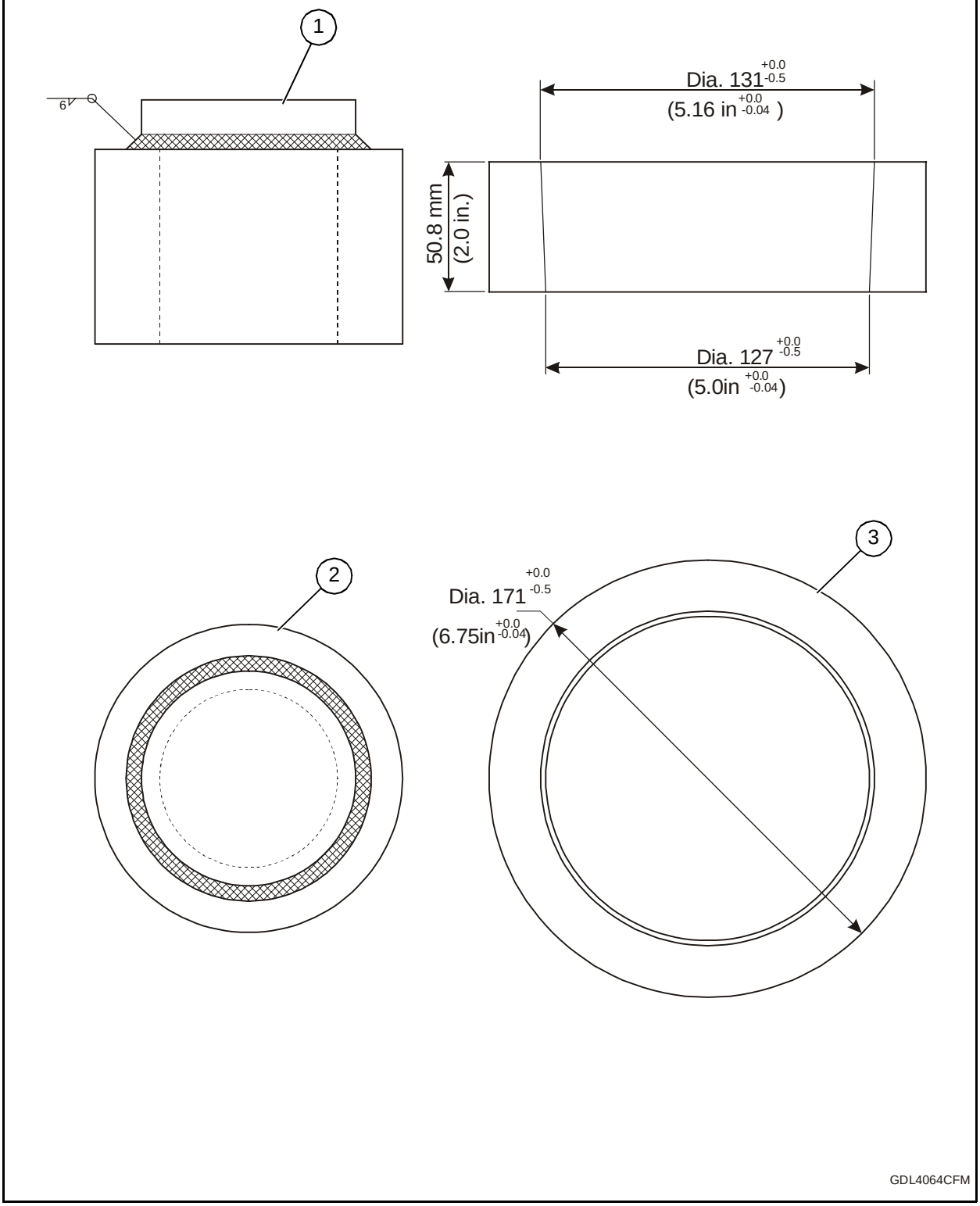
Bushing driver is used to install bushings into walking beams.

Material required:

- 248 mm (9.75 in.) O.D. 222.3 mm (8.75 in.) I. D. 100mm (4.0 in) long steel pipe.

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DFT1196 BUSHING DRIVER



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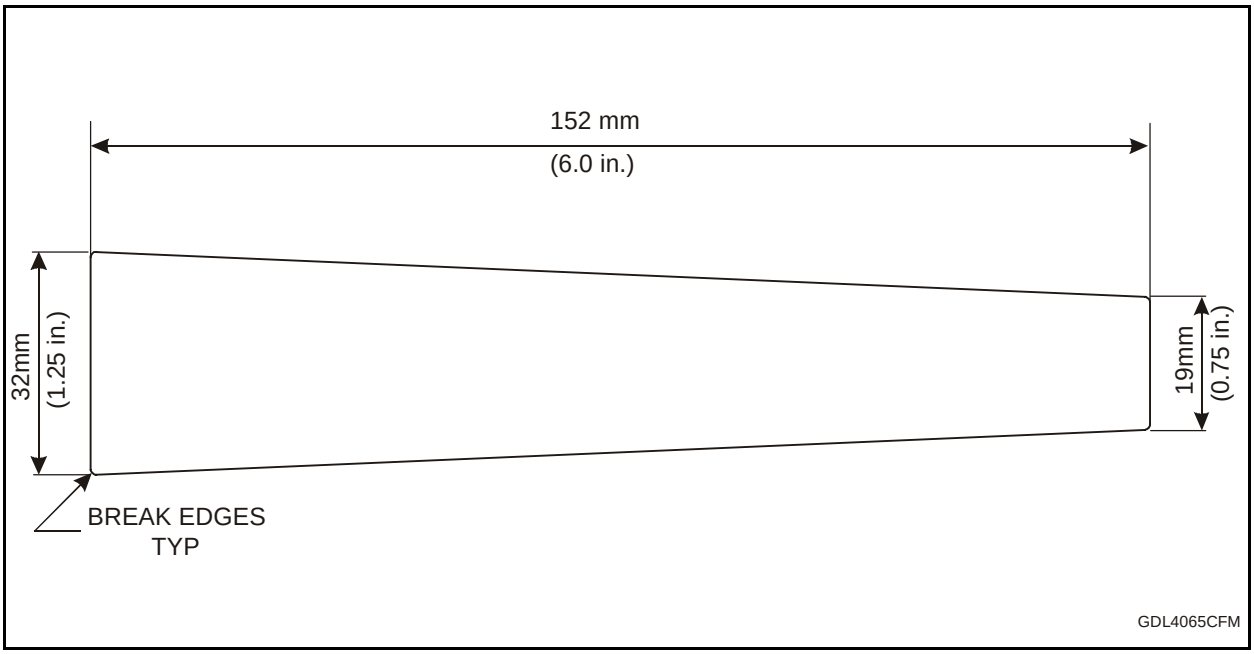
1. 19.05 mm (0.75 in.) x 84.13 mm (3.312 in.) Round Steel.
2. 120.7 mm (4.75 in.) OD x 69.9 mm (2.75 in.) ID x 76.2 mm (3.0 in.) Steel Pipe.
3. 171.5 mm (6.75 in.) OD x 50.8 mm (2.0 in.) Steel.

Bushing driver is used to install bushings in axle drag links, stabilizers and struts.

Material required:

- 19.05 mm (0.75 in.) x 84.13 mm (3.312 in.) Round Steel.
- 120.7 mm (4.75 in.) OD x 69.9 mm (2.75 in.) ID x 76.2 mm (3.0 in.) Steel Pipe.
- 171.5 mm (6.75 in.) OD x 50.8 mm (2.0 in.) Steel.

DFT1222 WET DISK BRAKE PISTON SEAL INSTALLER



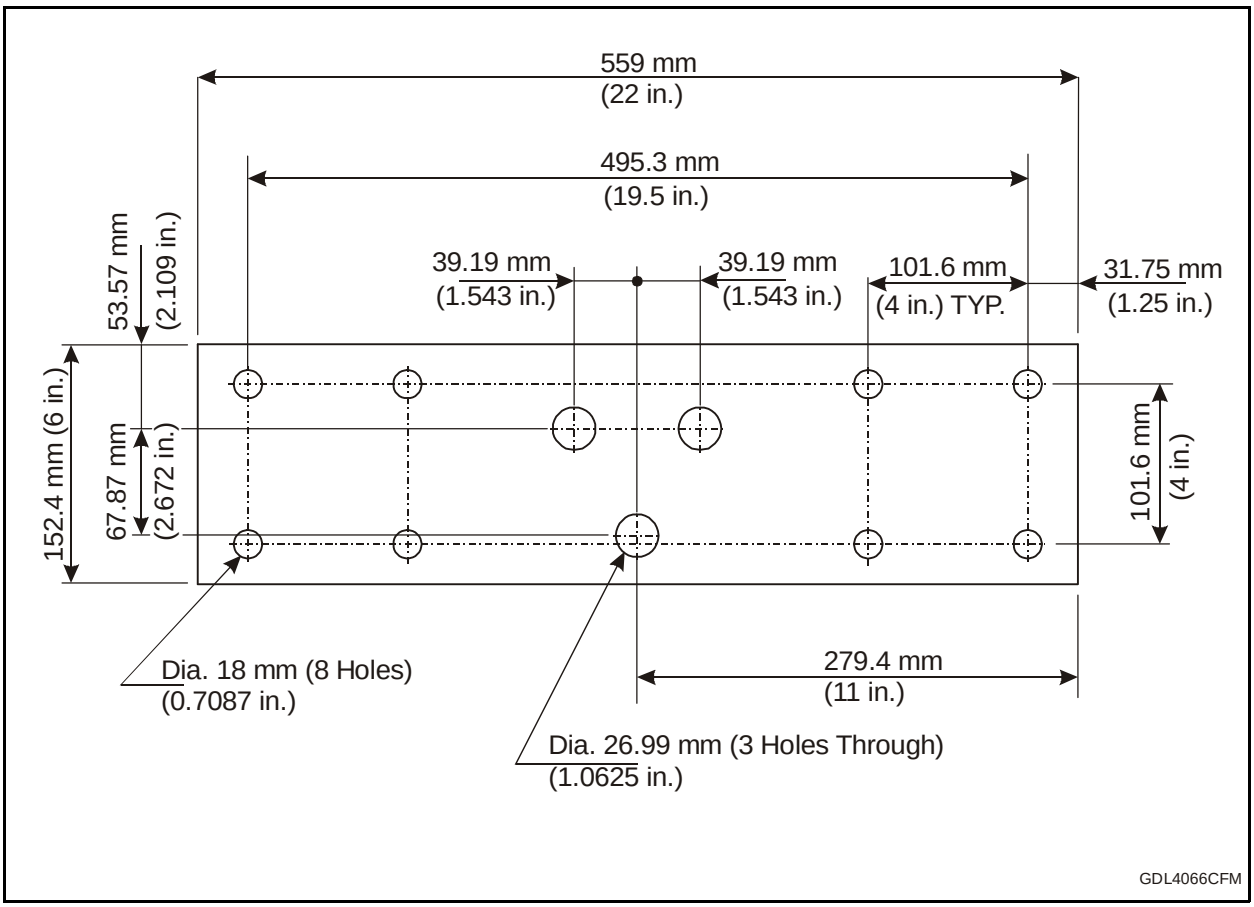
DFT1222 Wet Disk Brake Piston Seal Installer is used to install inner seal between wet disk brake piston and wet disk brake housing.

Material Required:

- 32.00 mm x 152.00 mm x 7.00 mm (1.25 in x 6.00 in. x 0.250 in.) Plexiglass.

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DFT1223 TRANSFER CASE MOUNTING BRACKET



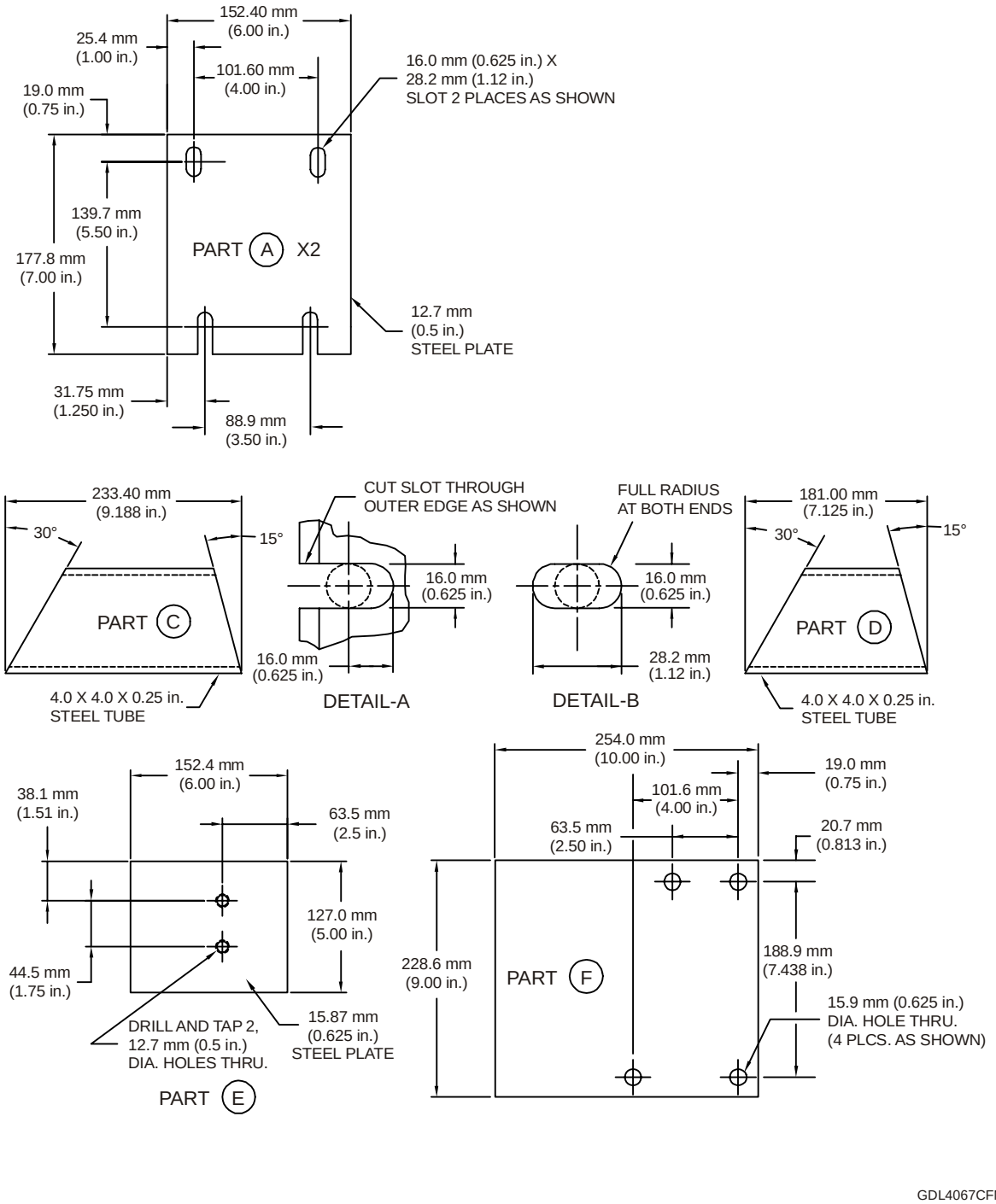
DFT 1223 Transfer Case Mounting Bracket is used to mount the transfer case to D05223ST Repair Stand.

Material required:

- 13.00 x 152.00 x 559.00 mm (0.50 x 6.00 x 22.00 in.) Mild Steel (1020) Flat.

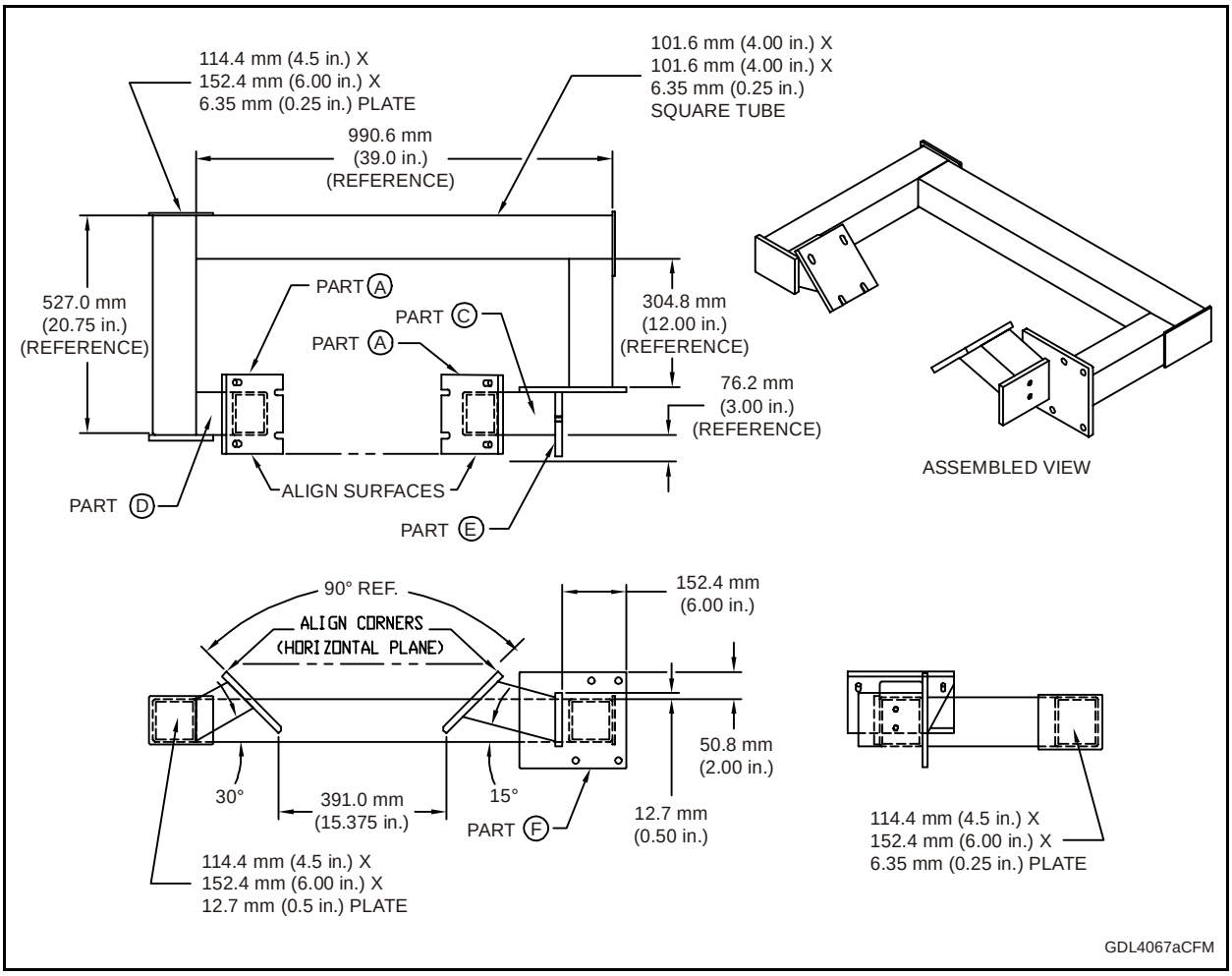
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DFT1224 ENGINE MOUNTING ADAPTER

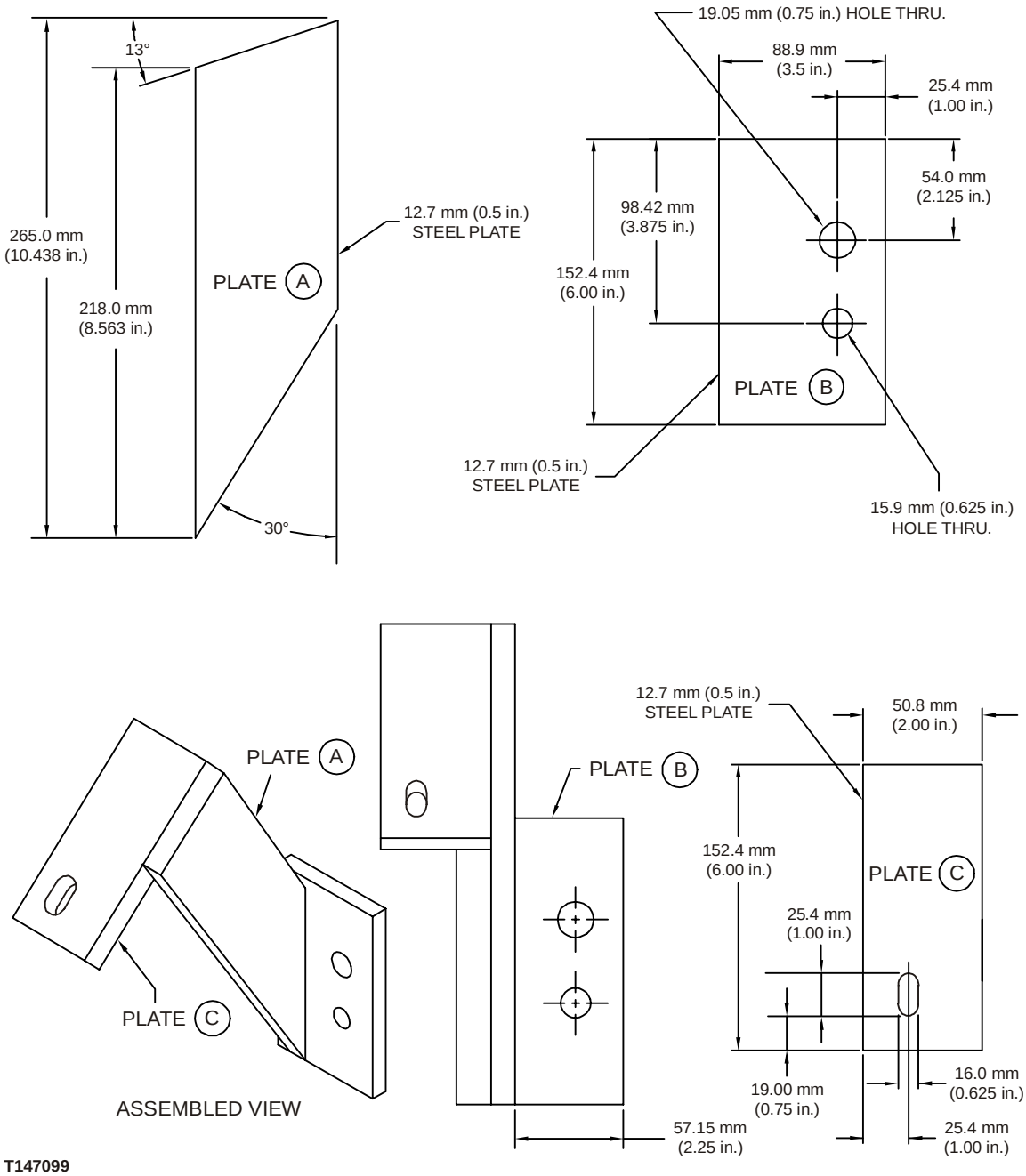


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DFT1224 Engine Mounting Adapter is used to mount the six-cylinder engine to D05223ST Engine Repair Stand.

Materials required:

- 2286 mm x 102 mm x 6 mm (90 x 4 x0.25 in.) Tube.
- 229mm x 152mm x 6 mm (9 x 6 x0.25 in.) Plate.
- 356mm x 152mm x 13 mm (14 x 6 x0.50 in.) Plate
- 229 mm x 254 mm x 13 mm (9 x 10 x 0.50 in.) Plate.
- 356 mm x 254 mm x 16 mm (14 x 10 x 0.625 in.) Plate.
- 305mm x 76 mm x 13 mm (12 x 3 x0.50 in.) Plate.

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