

INTRODUCTION

TO THE READER

- This manual is written for an experienced technician to provide technical information needed to maintain and repair this machine.
- Be sure to thoroughly read this manual for correct product information and service procedures.
- If you have any questions or comments, at if you found any errors regarding the contents of this manual, please contact using "Service Manual Revision Request Form. at the end of this manual.
(Note: Do not tear off the form. Copy it for usage.):
Publications Marketing & Product Support
Hitachi Construction Machinery Co. Ltd.
TEL: 81-298-32-7173
FAX: 81-298-31-1162

ADDITIONAL REFERENCES

- Please refer to the materials listed below in addition to this manual.
 - The Operator's Manual
 - The Parts Catalog
- Operation Manual of the Engine
- Parts Catalog of the Engine
- Hitachi Training Material

MANUAL COMPOSITION

- This manual consists of three portions: the Technical Manual (Operational Principle), the Technical Manual (Troubleshooting) and the Workshop Manual.
- Information included in the Technical Manual (Operational Principle):
technical information needed for redeliver and delivery, operation and activation of all devices and systems.
- Information included in the Technical Manual (Troubleshooting):
technical information needed for operational performance tests, and troubleshooting procedures.
- Information included in the Workshop Manual:
technical information needed for maintenance and repair of the machine, tools and devices needed for maintenance and repair, maintenance standards, and removal/installation and assemble/disassemble procedures.

PAGE NUMBER

- Each page has a number, located on the center lower part of the page, and each number contains the following information:

Example : T 1-3-5

Consecutive Page Number for Each Group

Group Number

Section Number

T: Technical Manual W: Workshop Manual

INTRODUCTION

SAFETY ALERT SYMBOL AND HEADLINE NOTATIONS

In this manual, the following safety alert symbol and signal words are used to alert the reader to the potential for personal injury or machine damage.

 This is the safety alert symbol. When you see this symbol, be alert to the potential for personal injury. Never fail to follow the safety instructions prescribed along with the safety alert symbol. The safety alert symbol is also used to draw attention to component/part weights. To avoid injury and damage, be sure to use appropriate lifting techniques and equipment when lifting heavy parts.

- **CAUTION:**

Indicated potentially hazardous situation which could, if not avoided, result in personal injury or death.

- **IMPORTANT:**

Indicates a situation which, if not conformed to the instructions, could result in damage to the machine.

- **NOTE:**

Indicates supplementary technical information or know-how.

UNITS USED

- SI Units (International System of Units) are used in this manual. MKS system units and English units are also indicated in parentheses just behind SI units.

Example : 24.5 MPa (250 kgf/cm², 3560 psi)

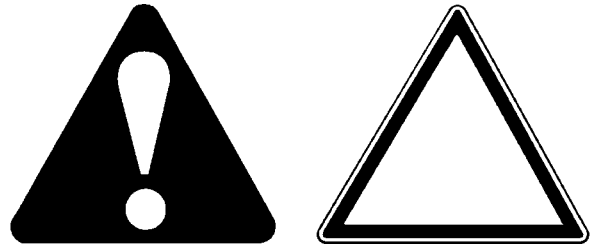
A table for conversion from SI units to other system units is shown below for reference purposes.

Quantity	To Convert From	Into	Multiply By	Quantity	To Convert From	Into	Multiply By
Length	mm	in	0.03937	Pressure	MPa	kgf/cm ²	10.197
	mm	ft	0.003281		MPa	psi	145.0
Volume	L	US gal	0.2642	Power	kW	PS	1.360
	L	US qt	1.057		kW	HP	1.341
	m ³	yd ³	1.308	Temperature	°C	°F	°C×1.8+32
Weight	kg	lb	2.205	Velocity	km/h	mph	0.6214
Force	N	kgf	0.10197		min ⁻¹	rpm	1.0
	N	lbf	0.2248	Flow rate	L/min	US gpm	0.2642
Torque	N·m	kgf·m	1.0197		mL/rev	cc/rev	1.0
	N·m	lbf·ft	0.7375				

SAFETY

RECOGNIZE SAFETY INFORMATION

- This is the **SAFETY ALERT SYMBOL**.
 - When you see this symbol on your machine or in this manual, be alert to the potential for personal injury.
 - Follow recommended precautions and safe operating practices.



001-E01A-0688

SA-688

UNDERSTAND SIGNAL WORDS

- On machine safety signs, signal words designating the degree or level of hazard - **DANGER**, **WARNING**, or **CAUTION** - are used with the safety alert symbol.
 - **DANGER** indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
 - **WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
 - **CAUTION** indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.
 - **DANGER or WARNING safety signs** are located near specific hazards. General precautions are listed on **CAUTION safety signs**.
 - Some safety signs don't use any of the designated signal words above after the safety alert symbol are occasionally used on this machine.
- **CAUTION** also calls attention to safety messages in this manual.
- To avoid confusing machine protection with personal safety messages, a signal word **IMPORTANT** indicates a situation which, if not avoided, could result in damage to the machine.
-  **NOTE** indicates an additional explanation for an element of information.



IMPORTANT



SA-1223

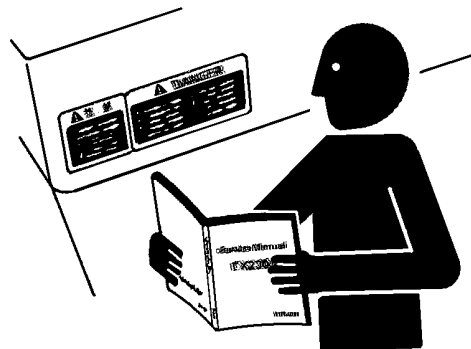
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SAFETY

FOLLOW SAFETY INSTRUCTIONS

- Carefully read and follow all safety signs on the machine and all safety messages in this manual.
- Safety signs should be installed, maintained and replaced when necessary.
 - If a safety sign or this manual is damaged or missing, order a replacement from your authorized dealer in the same way you order other replacement parts (be sure to state machine model and serial number when ordering).
- Learn how to operate the machine and its controls correctly and safely.
- Allow only trained, qualified, authorized personnel to operate the machine.
- Keep your machine in proper working condition.
 - Unauthorized modifications of the machine may impair its function and/or safety and affect machine life.
- The safety messages in this SAFETY chapter are intended to illustrate basic safety procedures of machines. However it is impossible for these safety messages to cover every hazardous situation you may encounter. If you have any questions, you should first consult your supervisor and/or your authorized dealer before operating or performing maintenance work on the machine.

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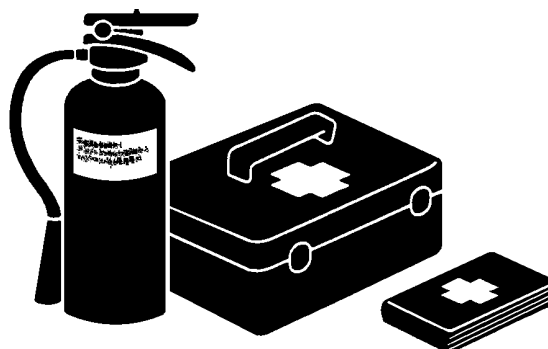


SA-003

PREPARE FOR EMERGENCIES

- Be prepared if a fire starts or if an accident occurs.
 - Keep a first aid kit and fire extinguisher on hand.
 - Thoroughly read and understand the label attached on the fire extinguisher to use it properly.
 - To ensure that a fire-extinguisher can be always used when necessary, check and service the fire-extinguisher at the recommended intervals as specified in the fire-extinguisher manual.
 - Establish emergency procedure guidelines to cope with fires and accidents.
 - Keep emergency numbers for doctors, ambulance service, hospital, and fire department posted near your telephone.

004-E01A-0437



SA-437

SAFETY

WEAR PROTECTIVE CLOTHING

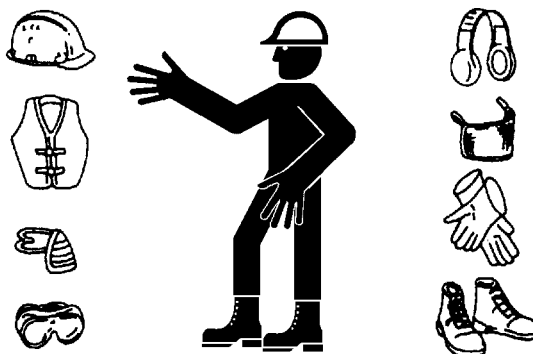
- Wear close fitting clothing and safety equipment appropriate to the job.

You may need:

- A hard hat
- Safety shoes
- Safety glasses, goggles, or face shield
- Heavy gloves
- Hearing protection
- Reflective clothing
- Wet weather gear
- Respirator or filter mask.

Be sure to wear the correct equipment and clothing for the job. Do not take any chances.

- Avoid wearing loose clothing, jewelry, or other items that can catch on control levers or other parts of the machine.
- Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating the machine.



SA-438

005-E01A-0438

PROTECT AGAINST NOISE

- Prolonged exposure to loud noise can cause impairment or loss of hearing.
- Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortably loud noises.



006-E01A-0434

SA-434

INSPECT MACHINE

- Inspect your machine carefully each day or shift by walking around it before you start it to avoid personal injury.
- In the walk-around inspection be sure to cover all points described in the “PRE-START INSPECTION” chapter in the operator’s manual.



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SA-435

SAFETY

GENERAL PRECAUTIONS FOR CAB

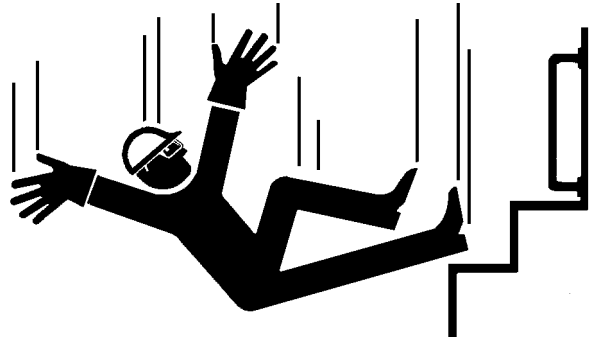
- Before entering the cab, thoroughly remove all dirt and/or oil from the soles of your work boots. If any controls such as a pedal is operated while with dirt and/or oil on the soles of the operator's work boots the operator's foot may slip off the pedal, possibly resulting in a personal accident.
- Don't leave parts and/or tools lying around the operator's seat. Store them in their specified locations.
- Avoid storing transparent bottles in the cab. Don't attach any transparent type window decorations on the windowpanes as they may focus sunlight, possibly starting a fire.
- Refrain from listening to the radio, or using music headphones or mobile telephones in the cab while operating the machine.
- Keep all flammable objects and/or explosives away from the machine.
- After using the ashtray, always cover it to extinguish the match and/or tobacco.
- Don't leave cigarette lighters in the cab. When the temperature in the cab increases, the lighter may explode.

524-E01A-0000

SAFETY

USE HANDHOLDS AND STEPS

- Falling is one of the major causes of personal injury.
 - When you mounting and dismounting the machine, always face the machine and maintain a three-point contact with the steps and handrails.
 - Do not use any controls as hand-holds.
 - Never jump on or off the machine. Never mount or dismount a moving machine.
 - Be careful of slippery conditions on platforms, steps, and handrails when mounting and dismounting the machine.



SA-439

008-E01B-0439

ADJUST THE OPERATOR'S SEAT

- A poorly adjusted seat for either the operator or for the work at hand may quickly fatigue the operator leading to misoperations.
 - The seat should be adjusted whenever changing the operator for the machine.
 - The operator should be able to fully depress the pedals and to correctly operate the control levers with his back against the seat back.
 - If not, move the seat forward or backward, and check again.



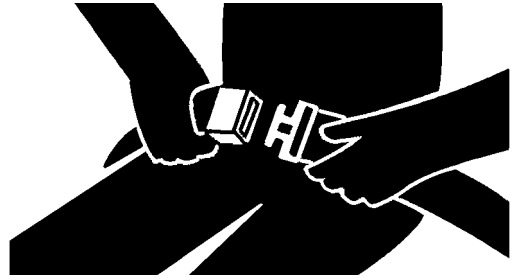
SA-378

009-E01A-0378

SAFETY

FASTEN YOUR SEAT BELT

- If the machine should overturn, the operator may become injured and/or thrown from the cab. Additionally the operator may be crushed by the overturning machine, resulting in serious injury or death.
- Prior to operating the machine, thoroughly examine webbing, buckle and attaching hardware. If any item is damaged or worn, replace the seat belt or component before operating the machine.
- Be sure to remain seated with the seat belt securely fastened at all times when the machine is in operation to minimize the chance of injury from an accident.
- We recommend that the seat belt be replaced every three years regardless of its apparent condition.



SA-237

010-E01A-0237

MOVE AND OPERATE MACHINE SAFELY

- Bystanders can be run over.
- Take extra care not to run over bystanders. Confirm the location of bystanders before moving, swinging, or operating the machine.
- Always keep the travel alarm and horn in working condition (if equipped). It warns people when the machine starts to move.
- Use a signal person when moving, swinging, or operating the machine in congested areas. Coordinate hand signals before starting the machine.



SA-426

011-E01A-0426

SAFETY

OPERATE ONLY FROM OPERATOR'S SEAT

- Inappropriate engine starting procedures may cause the machine to runaway, possibly resulting in serious injury or death.
- Start the engine only when seated in the operator's seat.
- NEVER start the engine while standing on the track or on ground.
- Do not start engine by shorting across starter terminals.
- Before starting the engine, confirm that all control levers are in neutral.

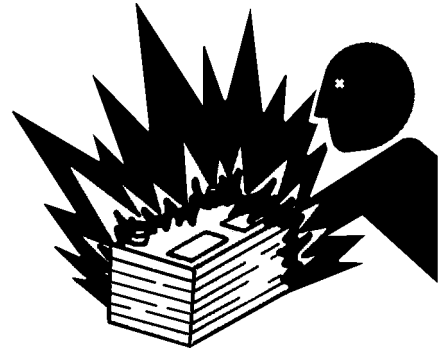


SA-444

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JUMP STARTING

- Battery gas can explode, resulting in serious injury.
- If the engine must be jump started, be sure to follow the instructions shown in the "OPERATING THE ENGINE" chapter in the operator's manual.
- The operator must be in the operator's seat so that the machine will be under control when the engine starts. Jump starting is a two-person operation.
- Never use a frozen battery.
- Failure to follow correct jump starting procedures could result in a battery explosion or a runaway machine.



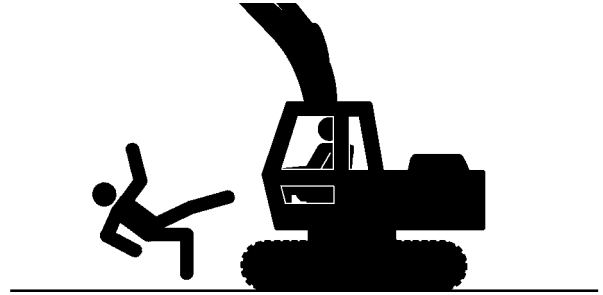
SA-032

S013-E01A-0032

SAFETY

KEEP RIDERS OFF MACHINE

- Riders on machine are subject to injury such as being struck by foreign objects and being thrown off the machine.
- Only the operator should be on the machine. Keep riders off.
- Riders also obstruct the operator's view, resulting in the machine being operated in an unsafe manner.



014-E01B-0379

SA-379

PROVIDE SIGNALS FOR FOBS INVOLVING MULTIPLE NUMBERS OF MACHINES

- For jobs involving multiple numbers of machines, provide signals commonly known by all personnel involved. Also, appoint a signal person to coordinate the job site. Make sure that all personnel obey the signal person's directions.

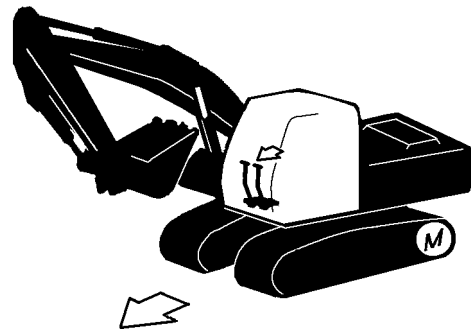


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SA-481

CONFIRM DIRECTION OF MACHINE TO BE DRIVEN

- Incorrect travel pedal/lever operation may result in serious injury death.
- Before driving the machine, confirm the position of the undercarriage in relation to the operator's position. If the travel motors are located in front of the cab, the machine will move in reverse when travel pedals/levers are operated to the front.



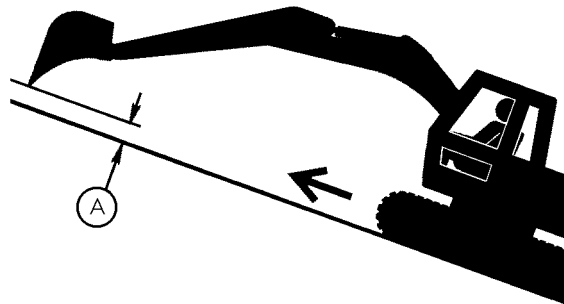
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SA-491

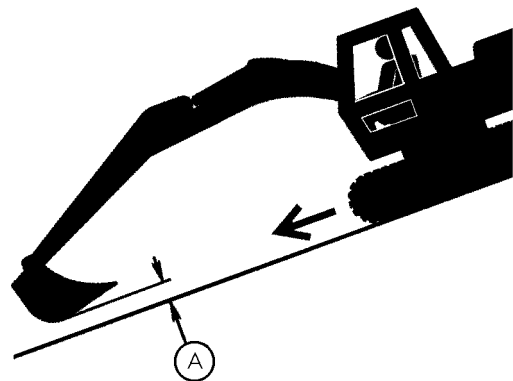
SAFETY

DRIVE MACHINE SAFELY

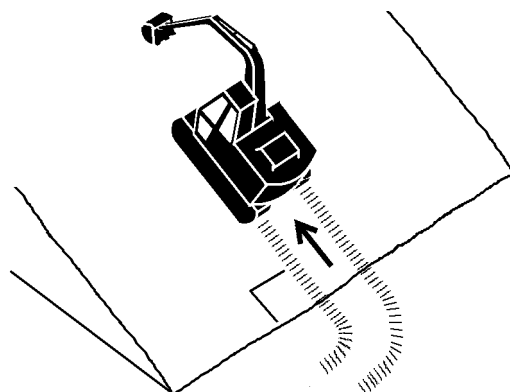
- Before driving the machine, always confirm that the travel levers/pedals direction corresponds to the direction you wish to drive.
- Be sure to detour around any obstructions.
- Avoid traveling over obstructions. Soil, fragments of rocks, and/or metal pieces may scatter around the machine. Don't allow personnel to stay around the machine while traveling.
- Driving on a slope may cause the machine to slip or overturn, possibly resulting in serious injury or death.
 - When driving up or down a slope, keep the bucket facing the direction of travel, approximately 200 to 300 mm (A) above the ground.
 - If the machine starts to skid or becomes unstable, immediately lower the bucket to the ground and stop traveling.
- Driving across the face of a slope or steering on a slope may cause the machine to skid or turnover. If the direction must be changed, move the machine to level ground, then, change the direction to ensure safe operation.



SA-387

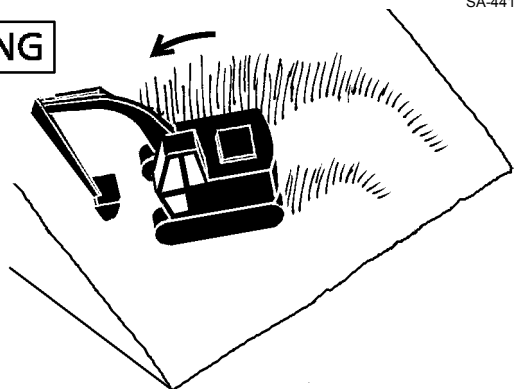


SA-388



SA-441

WRONG



SA-589

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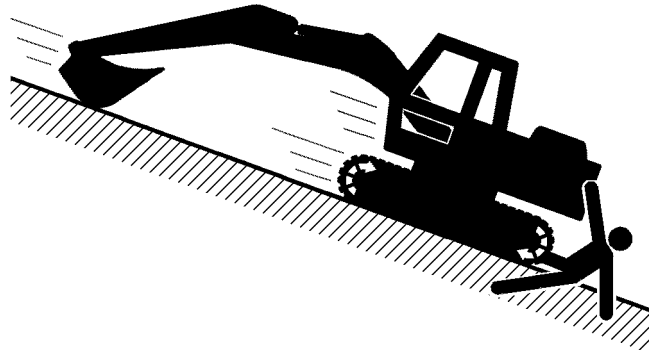
SAFETY

AVOID INJURY FROM ROLLAWAY ACCIDENTS

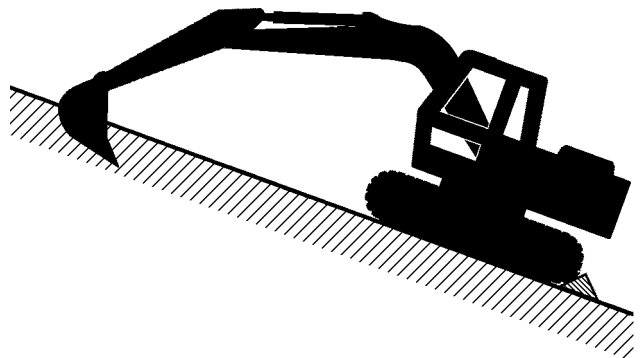
- Death or serious injury may result if you attempt to mount or stop a moving machine.

To avoid rollaways:

- Select level ground when possible to park machine.
- Do not park the machine on a grade.
- Lower the bucket and/or other work tools to the ground.
- Turn the auto-idle / acceleration selector and the H/P mode switch off.
- Run the engine at slow idle speed without load for 5 minutes to cool down the engine.
- Stop the engine and remove the key from the key switch.
- Pull the pilot control shut-off lever to LOCK position.
- Block both tracks and lower the bucket to the ground. Thrust the bucket teeth into the ground if you must park on a grade.
- Position the machine to prevent rolling.
- Park a reasonable distance from other machines.



SA-391



SA-392

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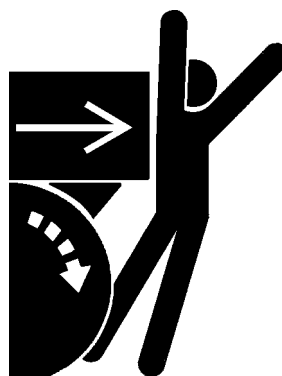
SAFETY

AVOID INJURY FROM BACK-OVER AND SWING ACCIDENTS

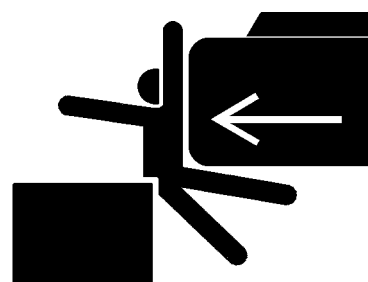
- If any person is present near the machine when backing or swinging the upperstructure, the machine may hit or run over that person, resulting in serious injury or death.

To avoid back-over and swing accidents:

- Always look around **BEFORE YOU BACK UP AND SWING THE MACHINE**. BE SURE THAT ALL BYSTANDERS ARE CLEAR.
- Keep the travel alarm in working condition (if equipped).
ALWAYS BE ALERT FOR BYSTANDERS MOVING INTO THE WORK AREA. USE THE HORN OR OTHER SIGNAL TO WARN BYSTANDERS BEFORE MOVING MACHINE.
- USE A SIGNAL PERSON WHEN BACKING UP IF YOUR VIEW IS OBSTRUCTED. ALWAYS KEEP THE SIGNAL PERSON IN VIEW.
Use hand signals, which conform to your local regulations, when work conditions require a signal person.
- No machine motions shall be made unless signals are clearly understood by both signalman and operator.
- Learn the meanings of all flags, signs, and markings used on the job and confirm who has the responsibility for signaling.
- Keep windows, mirrors, and lights clean and in good condition.
- Dust, heavy rain, fog, etc., can reduce visibility. As visibility decreases, reduce speed and use proper lighting.
- Read and understand all operating instructions in the operator's manual.



SA-383



SA-384

S021-E01A-0494

SAFETY

AVOID TIPPING

DO NOT ATTEMPT TO JUMP CLEAR OF TIPPING MACHINE---SERIOUS OR FATAL CRUSHING INJURIES WILL RESULT

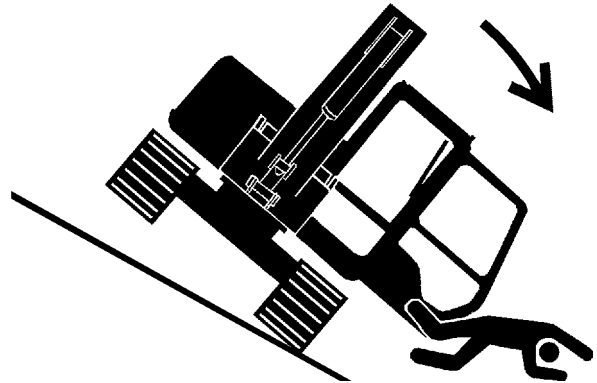
MACHINE WILL TIP OVER FASTER THAN YOU CAN JUMP FREE

FASTEN YOUR SEAT BELT

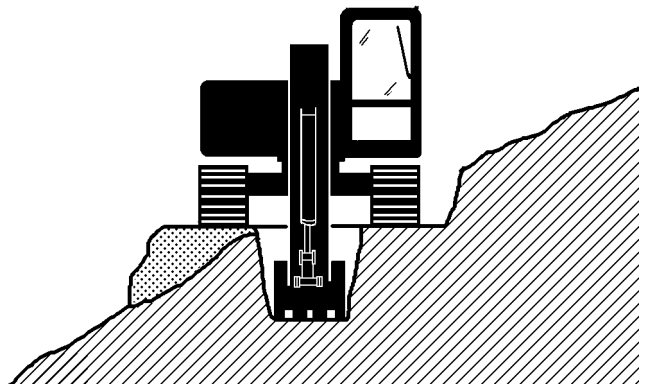
- The danger of tipping is always present when operating on a grade, possibly resulting in serious injury or death.

To avoid tipping:

- Be extra careful before operating on a grade.
 - Prepare machine operating area flat.
 - Keep the bucket low to the ground and close to the machine.
 - Reduce operating speeds to avoid tipping or slipping.
 - Avoid changing direction when traveling on grades.
 - NEVER attempt to travel across a grade steeper than 15 degrees if crossing the grade is unavoidable.
 - Reduce swing speed as necessary when swinging loads.
- Be careful when working on frozen ground.
 - Temperature increases will cause the ground to become soft and make ground travel unstable.



SA-012



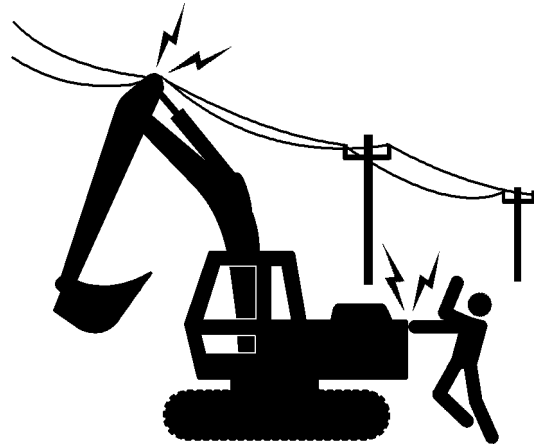
SA-440

S025-E01B-0495

SAFETY

AVOID POWER LINES

- Serious injury or death can result if the machine or front attachments are not kept a safe distance from electric lines.
- When operating near an electric line, NEVER move any part of the machine or load closer than 3 m (10 ft) plus twice the line insulator length.
- Check and comply with any local regulations that may apply.
- Wet ground will expand the area that could cause any person on it to be affected by electric shock. Keep all bystanders or co-workers away from the site.

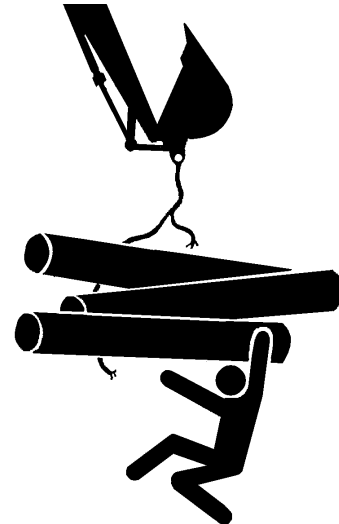


SA-381

029-E01A-0381

OBJECT HANDLING

- If a lifted load should fall, any person nearby may be struck by the falling load or may be crushed underneath it, resulting in serious injury or death.
- When using the machine for craning operations, be sure to comply with all local regulations.
- Do not use damaged chains or frayed cables, cables, slings, or ropes.
- Before craning, position the upperstructure with the travel motors at the rear.
- Move the load slowly and carefully. Never move it suddenly.
- Keep all persons well away from the load.
- Never move a load over a person's head.
- Do not allow anyone to approach the load until it is safely and securely situated on supporting blocks or on the ground.
- Never attach a sling or chain to the bucket teeth. They may come off, causing the load to fall.



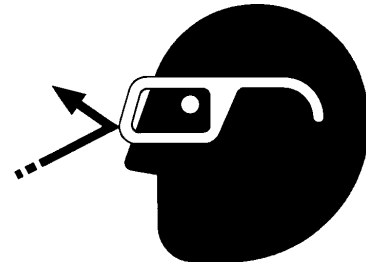
SA-014

032-E01A-0014

SAFETY

PROTECT AGAINST FLYING DEBRIS

- If flying debris hit eyes or any other part of the body, serious injury may result.
- Guard against injury from flying pieces of metal or debris; wear goggles or safety glasses.
- Keep bystanders away from the working area before striking any object.



031-E01A-0432

SA-432

PARK MACHINE SAFELY

To avoid accidents:

- Park machine on a firm, level surface.
- Lower bucket to the ground.
- Turn auto-idle / acceleration selector and H/P mode switch off.
- Run engine at slow idle speed without load for 5 minutes.
- Turn key switch to OFF to stop engine.
- Remove the key from the key switch.
- Pull the pilot control shut-off lever to the LOCK position.
- Close windows, roof vent, and cab door.
- Lock all access doors and compartments.



033-E09B-0390

SA-390

SAFETY

HANDLE FLUIDS SAFELY – AVOID FIRES

- Handle fuel with care; it is highly flammable. If fuel ignites, an explosion and/or a fire may occur, possibly resulting in serious injury or death.
 - Do not refuel the machine while smoking or when near open flame or sparks.
 - Always stop the engine before refueling the machine.
 - Fill the fuel tank outdoors.
- All fuels, most lubricants, and some coolants are flammable.
 - Store flammable fluids well away from fire hazards.
 - Do not incinerate or puncture pressurized containers.
 - Do not store oily rags; they can ignite and burn spontaneously.
 - Securely tighten the fuel and oil filler cap.



SA-018



034-E01A-0496

SA-019

SAFETY

SAFETY TRANSPORTING

- The danger of tipping is present when loading/unloading the machine onto/from a truck or trailer bed.
- Be sure to observe local regulations when transporting the machine on public roads.
- Provide an appropriate truck or trailer for transporting the machine.

Take the following precautions when loading / unloading the machine:

- 1) Select firm level ground.
- 2) Be sure to use a loading dock or ramp.
- 3) Be sure to have a signal person when loading/unloading the machine.
- 4) Always turn the auto-idle / acceleration selector and the H/P mode switch OFF when loading or unloading the machine, to avoid unexpected speed increase due to unintentional operation of a control lever.
- 5) Always select the slow speed mode with the travel mode switches. In the high speed mode, travel speed may automatically increase.
- 6) Avoid steering while driving up or down the ramp as it is extremely dangerous. If steering is unavoidable, first move back to the ground or flatbed, modify traveling direction, and begin to drive again.
- 7) Do not operate any levers besides the travel levers when driving up or down the ramp.
- 8) The top end of the ramp where it meets the flatbed is a sudden bump. Take care when traveling over it.
- 9) Prevent possible injury from machine tipping while the upperstructure is rotating.
- 10) Keep the arm tucked under and rotate the upperstructure slowly for best stability.
- 11) Securely fasten chain or cables to the machine frame. Refer to "transporting" chapter in the operator's manual for details.



SA-395

S035-E08A-0395

SAFETY

PRACTICE SAFE MAINTENANCE

To avoid accidents:

- Understand service procedures before doing work.
- Keep work area clean and dry.
- Do not spray water or steam inside cab.
- Never lubricate or service the machine while it is moving.
- Keep hands, feet and clothing away from power-driven parts.
- Before servicing the machine:
 - 1) Park the machine on a level surface.
 - 2) Lower the bucket to the ground.
 - 3) Turn the auto-idle / acceleration selector off.
 - 4) Run the engine at slow idle speed without load for 5 minutes.
 - 5) Turn the key switch to OFF to stop engine.
 - 6) Relieve the pressure in the hydraulic system by moving the control levers several times.
 - 7) Remove the key from the switch.
 - 8) Attach a "Do Not Operate" tag on the control lever.
 - 9) Pull the pilot control shut-off lever to the LOCK position.
 - 10) Allow the engine to cool.
- If a maintenance procedure must be performed with the engine running, do not leave machine unattended.
- If the machine must be raised, maintain a 90 to 110 angle between the boom and arm. Securely support any machine elements that must be raised for service work.
- Never work under a machine raised by the boom.
- Inspect certain parts periodically and repair or replace as necessary. Refer to the section discussing that part in the "MAINTENANCE" chapter in the operator's manual.
- Keep all parts in good condition and properly installed.
- Fix damage immediately. Replace worn or broken parts. Remove any buildup of grease, oil, or debris.
- When cleaning parts, always use nonflammable detergent oil. Never use highly flammable oil such as fuel oil and gasoline to clean parts or surfaces.
- Disconnect battery ground cable (-) before making adjustments to electrical systems or before welding on the machine.
- Illuminate your work area adequately but safely.



SA-028



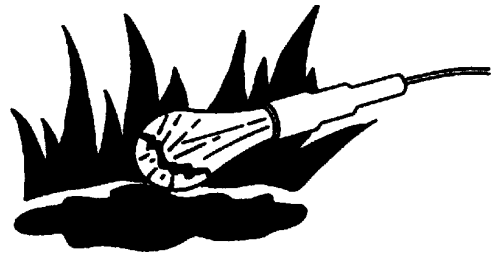
SA-527

SAFETY

- Use a portable safety light for working inside or under the machine.
- Make sure that the bulb is enclosed by a wire cage.

The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.

- Sufficiently illuminate the work site. Use a maintenance work light when working under or inside the machine.
- Always use a work light protected with a guard. In case the light bulb is broken, spilled fuel, oil antifreeze fluid, or window washer fluid may catch fire.



SA-037

S500-E02B-0497

WARN OTHERS OF SERVICE WORK

- Unexpected machine movement can cause serious injury.
- Before performing any work on the machine, attach a “Do Not Operate” tag on the control lever.

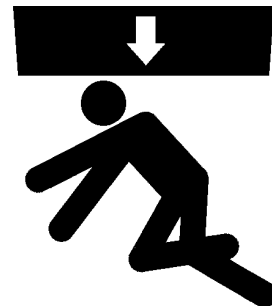


S501-E01A-0287

SA-287

SUPPORT MACHINE PROPERLY

- Never attempt to work on the machine without securing the machine first.
- Always lower the attachment to the ground before you work on the machine.
- If you must work on a lifted machine or attachment, securely support the machine or attachment. Do not support the machine on cinder blocks, hollow tires, or props that may crumble under continuous load. Do not work under a machine that is supported solely by a jack.

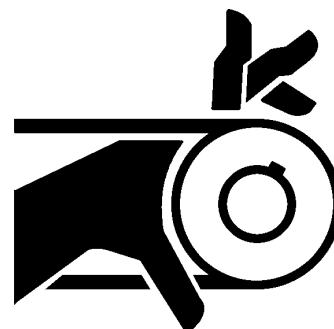


519-E01A-0527

SA-527

STAY CLEAR OF MOVING PARTS

- Entanglement in moving parts can cause serious injury.
- To prevent accidents, care should be taken to ensure that hands, feet, clothing, jewelry and hair do not become entangled when working around rotating parts.



502-E01A-0026

SA-026

SAFETY

PREVENT PARTS FROM FLYING

- Grease in the track adjuster is under high pressure. Failure to follow the precautions below may result in serious injury, blindness, or death.
 - Do not attempt to remove GREASE FITTING or VALVE ASSEMBLY.
 - As pieces may fly off, be sure to keep body and face away from valve.
- Travel reduction gears are under pressure.
 - As pieces may fly off, be sure to keep body and face away from AIR RELEASE PLUG to avoid injury. GEAR OIL is hot.
 - Wait for GEAR OIL to cool, then gradually loosen AIR RELEASE PLUG to release pressure.

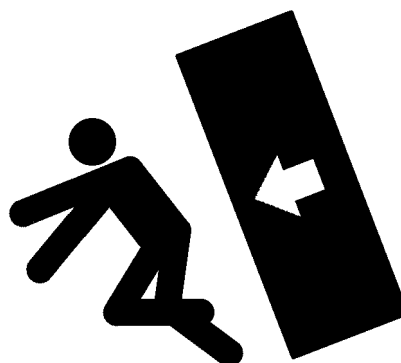


SA-344

503-E01B-0344

STORE ATTACHMENTS SAFELY

- Stored attachments such as buckets, hydraulic hammers, and blades can fall and cause serious injury or death.
- Securely store attachments and implements to prevent falling. Keep children and bystanders away from storage areas.



SA-034

504-E01A-0034

USE TOOLS PROPERLY

- Use tools appropriate for the work to be done.
 - Makeshift tools, parts, and procedures can create safety hazards.
 - For loosening and tightening hardware, use the correct size tools to avoid injury caused by slipping wrenches.
 - Use only recommended replacement parts. (See the parts catalog.)



S522-E01A-0040

SA-040

SAFETY

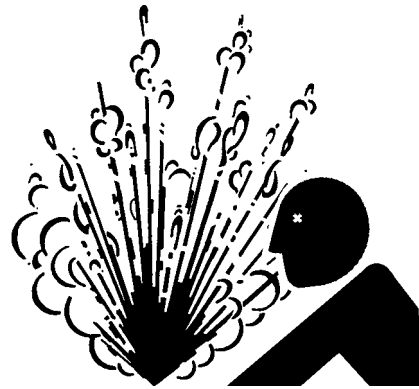
PREVENT BURNS

Hot spraying fluids:

- After operation, engine coolant is hot and under pressure. Hot water or steam is contained in the engine, radiator and heater lines. Skin contact with escaping hot water or steam can cause severe burns.
 - To avoid possible injury from hot spraying water. DO NOT remove the radiator cap until the engine is cool. When opening, turn the cap slowly to the stop. Allow all pressure to be released before removing the cap.
 - The hydraulic oil tank is pressurized. Again, be sure to release all pressure before removing the cap.

Hot fluids and surfaces:

- Engine oil, gear oil and hydraulic oil also become hot during operation. The engine, hoses, lines and other parts become hot as well.
 - Wait for the oil and components to cool before starting any maintenance or inspection work.



SA-039



SA-225

505-E01B-0498

REPLACE RUBBER HOSES PERIODICALLY

- Rubber hoses that contain flammable fluids under pressure may break due to aging, fatigue, and abrasion. It is very difficult to gauge the extent of deterioration due to aging, fatigue, and abrasion of rubber hoses by inspection alone.
 - Periodically replace the rubber hoses. (See the page of "Periodic replacement of parts" in the operator's manual.)
- Failure to periodically replace rubber hoses may cause a fire, fluid injection into skin, or the front attachment to fall on a person nearby, which may result in severe burns, gangrene, or otherwise serious injury or death.



SA-019

S506-E01A-0019

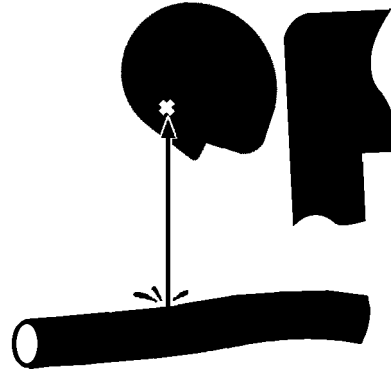
SAFETY

AVOID HIGH-PRESSURE FLUIDS

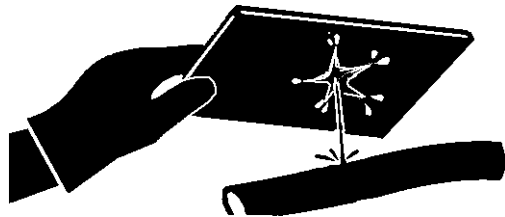
- Fluids such as diesel fuel or hydraulic oil under pressure can penetrate the skin or eyes causing serious injury, blindness or death.
- Avoid this hazard by relieving pressure before disconnecting hydraulic or other lines.
- Tighten all connections before applying pressure.
- Search for leaks with a piece of cardboard; take care to protect hands and body from high-pressure fluids. Wear a face shield or goggles for eye protection.
- If an accident occurs, see a doctor familiar with this type of injury immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result.



SA-031



SA-292



SA-044

507-E03A-0499

SAFETY

PREVENT FIRES

Check for Oil Leaks:

- Fuel, hydraulic oil and lubricant leaks can lead to fires.
 - Check for oil leaks due to missing or loose clamps, kinked hoses, lines or hoses that rub against each other, damage to the oil-cooler, and loose oil-cooler flange bolts.
 - Tighten, repair or replace any missing, loose or damaged clamps, lines, hoses, oil-cooler and oil-cooler flange bolts.
 - Do not bend or strike high-pressure lines.
 - Never install bent or damaged lines, pipes, or hoses.



SA-019

Check for Shorts:

- Short circuits can cause fires.
 - Clean and tighten all electrical connections.
 - Check before starting work for loose, kinked, hardened or frayed electrical cables and wires.
 - Check before starting work for missing or damaged terminal caps.
 - DO NOT OPERATE MACHINE if cable or wires are loose, kinked, etc..

Clean up Flammables:

- Spilled fuel and oil, and trash, grease, debris, accumulated coal dust, and other flammables may cause fires.
 - Prevent fires by inspecting and cleaning the machine daily and by removing spilled or accumulated flammables immediately.

Check Key Switch:

- If a fire breaks out, failure to stop the engine will escalate the fire, hampering fire fighting.
 - Always check key switch function before operating the machine every day:
 - 1) Start the engine and run it at slow idle.
 - 2) Turn the key switch to the OFF position to confirm that the engine stops.
 - If any abnormalities are found, be sure to repair them before operating the machine.

S508-E02B-0019

SAFETY

Check Emergency Engine Stop Switch:

- If a fire breaks out, failure to release pressurized air inside the hydraulic tank will escalate fire, hampering fire fighting.
 - Check the emergency engine stop switch function every 250 hours:
 - 1) Start the engine and run it at slow Idle.
 - 2) Turn the emergency engine stop switch to the EMERG. STOP position.
 - 3) Confirm that both engines stop and that pressurized air inside the hydraulic oil tank is released (a hissing sound should be heard).
- If any abnormalities are found, be sure to repair them before operating the machine.

Check Heat Shields:

- Damaged or missing heat shields may lead to fires.
 - Damaged or missing heat shields must be repaired or replaced before operating the machine.

S508-E02B-0019

EVACUATING IN CASE OF FIRE

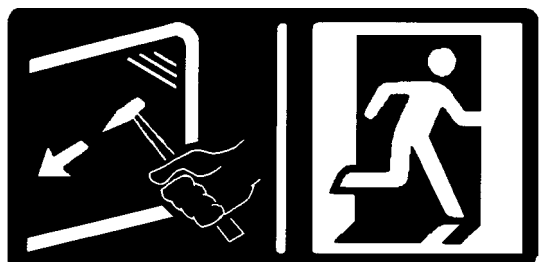
- If a fire breaks out, evacuate the machine in the following way:
 - Stop the engine by turning the key switch to the OFF position if there is time.
 - Use a fire extinguisher if there is time.
 - Exit the machine.



SA-393

- In an emergency, if the cab door and/or the front window cannot be opened, break the front or rear window panes with the emergency evacuation hammer to escape from the cab.
Refer to the explanation page on “EMERGENCY EXIT” in Operator’s Manual.

518-E02B-0393

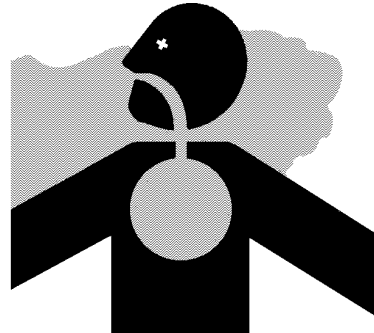


SS-1510

SAFETY

BEWARE OF EXHAUST FUMES

- Prevent asphyxiation. Engine exhaust fumes can cause sickness or death.
- If you must operate in a building, be sure there is adequate ventilation. Either use an exhaust pipe extension to remove the exhaust fumes or open doors and windows to bring enough outside air into the area.

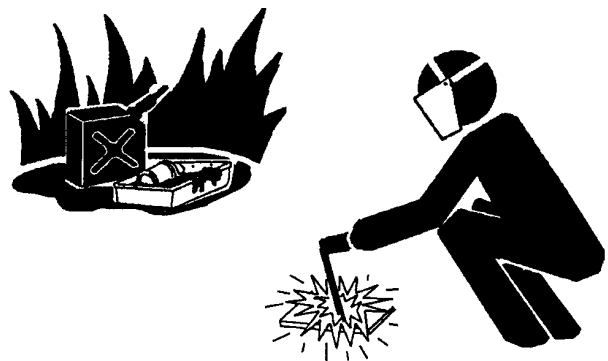


509-E01A-0016

SA-016

PRECAUTIONS FOR WELDING AND GRINDING

- Welding may generate gas and/or small fires.
 - Be sure to perform welding in a well ventilated and prepared area. Store flammable objects in a safe place before starting welding.
 - Only qualified personnel should perform welding. Never allow an unqualified person to perform welding.
- Grinding on the machine may create fire hazards. Store flammable objects in a safe place before starting grinding.
- After finishing welding and grinding, recheck that there are no abnormalities such as the area surrounding the welded area still smoldering.



523-E01A-0818

SA-818

AVOID HEATING NEAR PRESSURIZED FLUID LINES

- Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders.
- Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials.
- Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area. Install temporary fire-resistant guards to protect hoses or other materials before engaging in welding, soldering, etc..



SA-030

AVOID APPLYING HEAT TO LINES CONTAINING FLAMMABLE FLUIDS

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

510-E01B-0030

SAFETY

REMOVE PAINT BEFORE WELDING OR HEATING

- Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch. If inhaled, these fumes may cause sickness.
 - Avoid potentially toxic fumes and dust.
 - Do all such work outside or in a well-ventilated area. Dispose of paint and solvent properly.
- Remove paint before welding or heating:
 - 1) If you sand or grind paint, avoid breathing the dust.
Wear an approved respirator.
 - 2) If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes before welding or heating.

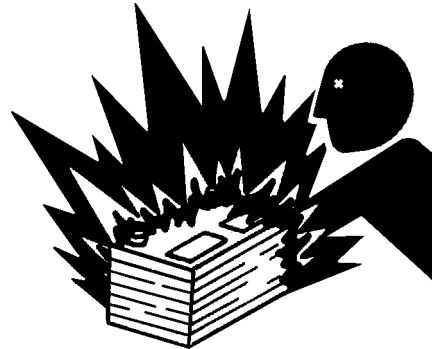


SA-029

511-E01A-0029

PREVENT BATTERY EXPLOSIONS

- Battery gas can explode.
 - Keep sparks, lighted matches, and flame away from the top of battery.
 - Never check battery charge by placing a metal object across the posts. Use a voltmeter or hydrometer.
 - Do not charge a frozen battery; it may explode. Warm the battery to 16 °C (60 °F) first.
 - Do not continue to use or charge the battery when electrolyte level is lower than specified. Explosion of the battery may result.
 - Loose terminals may produce sparks. Securely tighten all terminals.
- Battery electrolyte is poisonous. If the battery should explode battery electrolyte may be splashed into eyes, possibly resulting in blindness.
 - Be sure to wear eye protection when checking electrolyte specific gravity.



SA-032

512-E01C-0032

SAFETY

SERVICE AIR CONDITIONING SYSTEM SAFELY

- If spilled onto skin, refrigerant may cause a cold contact burn.
- Refer to the freon container for proper use when servicing the air conditioning system.
- Use a recovery and recycling system to avoid venting freon into the atmosphere.
- Never let the freon stream make contact with the skin.



SA-405

513-E01A-0405

HANDLE CHEMICAL PRODUCTS SAFELY

- Direct exposure to hazardous chemicals can cause serious injury. Potentially hazardous chemicals used with your machine include such items as lubricants, coolants, paints, and adhesives.
- A Material Safety Data Sheet (MSDS) provides specific details on chemical products: physical and health hazards, safety procedures, and emergency response techniques.
- Check the MSDS before you start any job using a hazardous chemical. That way you will know exactly what the risks are and how to do the job safely. Then follow procedures and use recommended equipment.



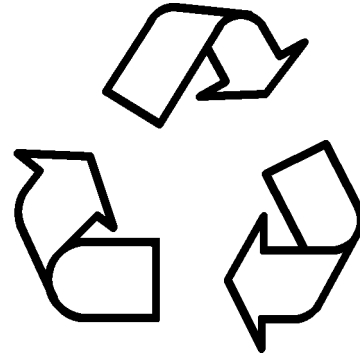
SA-309

S515-E01A-0309

SAFETY

DISPOSE OF WASTE PROPERLY

- Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with HITACHI equipment includes such items as oil, fuel, coolant, brake fluid, filters, and batteries.
- Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.
- Do not pour waste onto the ground, down a drain, or into any water source.
- Air conditioning refrigerants escaping into the air can damage the Earth's atmosphere. Government regulations may require a certified air conditioning service center to recover and recycle used air conditioning refrigerants.
- Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center.



SA-226

S516-E01A-0226

BEFORE RETURNING THE MACHINE TO THE CUSTOMER

- After maintenance or repair work is complete, confirm that:
 - The machine is functioning properly, especially the safety systems.
 - Worn or damaged parts have been repaired or replaced



S517-E01A-0435

SA-435

SAFETY

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All information, illustrations and specifications in this manual are based on the latest product information available at the time of publication. The right is reserved to make changes at any time without notice.

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Tokyo, Japan

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GENERAL / Precautions for Disassembling and Assembling

PRECAUTIONS FOR DISASSEMBLING AND ASSEMBLING

Precautions for Disassembling and Assembling

- **Clean the Machine**

Thoroughly wash the machine before bringing it into the shop. Bringing a dirty machine into the shop may cause machine components to be contaminated during disassembling/assembling, resulting in damage to machine components, as well as decreased efficiency in service work.

- **Inspect the Machine**

Be sure to thoroughly understand all disassembling/assembling procedures beforehand, to help avoid incorrect disassembling of components as well as personal injury.

Check and record the items listed below to prevent problems from occurring in the future.

- The machine model, machine serial number, and hour meter reading.
- Reason for disassembly (symptoms, failed parts, and causes).
- Clogging of filters and oil, water or air leaks, if any.
- Capacities and condition of lubricants.
- Loose or damaged parts.

- **Prepare and Clean Tools and Disassembly Area**

Prepare the necessary tools to be used and the area for disassembling work.

- **Precautions for Disassembling**

- To prevent dirt from entering, cap or plug the removed pipes.
- Before disassembling, clean the exterior of the components and place on a work bench.
- Before disassembling, drain gear oil from the reduction gear.
- Be sure to provide appropriate containers for draining fluids.
- Use matching marks for easier reassembling.
- Be sure to use the specified special tools, when instructed.
- If a part or component cannot be removed after removing its securing nuts and bolts, do not attempt to remove it forcibly. Find the cause(s), then take the appropriate measures to remove it.
- Orderly arrange disassembled parts. Mark and tag them as necessary.
- Store common parts, such as bolts and nuts with reference to where they are to be used and in a manner that will prevent loss.
- Inspect the contact or sliding surfaces of disassembled parts for abnormal wear, sticking, or other damage.
- Measure and record the degree of wear and clearances.

GENERAL / Precautions for Disassembling and Assembling

• Precautions for Assembling

- Be sure to clean all parts and inspect them for any damage. If any damage is found, repair or replace part.
- Dirt or debris on the contact or sliding surfaces may shorten the service life of the machine. Take care not to contaminate any contact or sliding surfaces.
- Be sure to replace O-rings, backup rings, and oil seals with new ones once they are disassembled. Apply a film of grease before installing.
- Be sure that liquid-gasket-applied surfaces are clean and dry.
- If an anti-corrosive agent has been used on a new part, be sure to thoroughly clean the part to remove the agent.
- Utilize matching marks when assembling.
- Be sure to use the designated tools to assemble bearings, bushings and oil seals.
- Keep a record of the number of tools used for disassembly/assembly. After assembling is complete, count the number of tools, so as to make sure that no forgotten tools remain in the assembled machine.

Bleeding Air from Hydraulic System

When hydraulic oil is drained, the suction filter or the suction lines are replaced, or the removal and installation of the pump, swing motor, travel motor or cylinder is done, bleed air from the hydraulic system in the following procedures:

IMPORTANT: If the engine is started with air trapped in the hydraulic pump housing, damage to the pump may result. If the hydraulic motor is operated with air trapped in the hydraulic motor housing, damage to the motor may result. If the cylinder is operated with air trapped in the cylinder tube, damage to the cylinder may result. Be sure to bleed air before starting the engine.

• Bleeding Air from Hydraulic Pump

- Remove the air bleeding plug from the top of the pump and fill the pump housing with hydraulic oil.
- After the pump housing is filled with hydraulic oil, temporarily tighten the plug. Then, start the engine and run at slow idle speed.
- Slightly loosen the plug to bleed air from the pump housing until hydraulic oil oozes out.
- After bleeding all the air, securely tighten the plug.

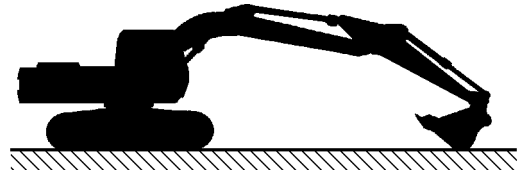
• Bleeding Air from Travel Motor / Swing Motor

- With the drain plug / hose on travel motor / swing motor removed, fill the motor case with hydraulic oil.

GENERAL / Precautions for Disassembling and Assembling

- Bleeding Air from Hydraulic Circuit

- After refilling hydraulic oil, start the engine. While operating each cylinder, swing motor and travel motor evenly, operate the machine under light loads for 10 to 15 minutes. Slowly start each operation (never fully stroke the cylinders during initial operation stage). As the pilot oil circuit has an air bleed device, air trapped in the pilot oil circuit will be bled while performing the above operation for approx. 5 minutes.
- Reposition the front attachment to check hydraulic oil level.
- Stop the engine. Recheck hydraulic oil level. Replenish oil as necessary.



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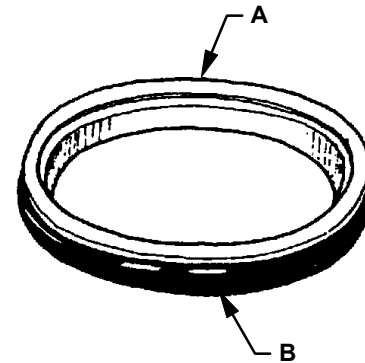
GENERAL / Precautions for Disassembling and Assembling

Floating Seal Precautions

1. In general, replace the floating seal with a new one after disassembling.
If the floating seal is to be reused, follow these procedures:

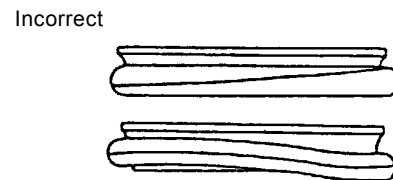
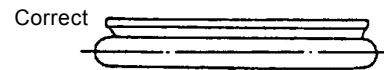
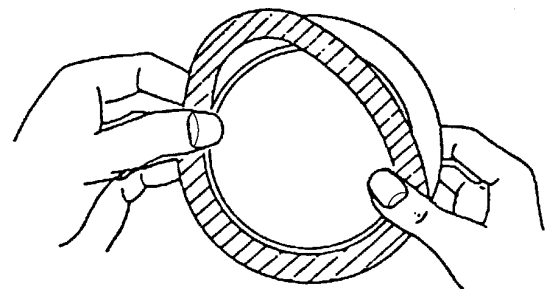
- (1) Keep seal rings together as a matched set with seal ring faces together. Insert a piece of cardboard to protect surfaces.
- (2) Check the slide surface on seal ring (A) for scuffing, scoring, corrosion, deformation or uneven wear.
- (3) Check O-ring (B) for tears, breaks, deformation or hardening.

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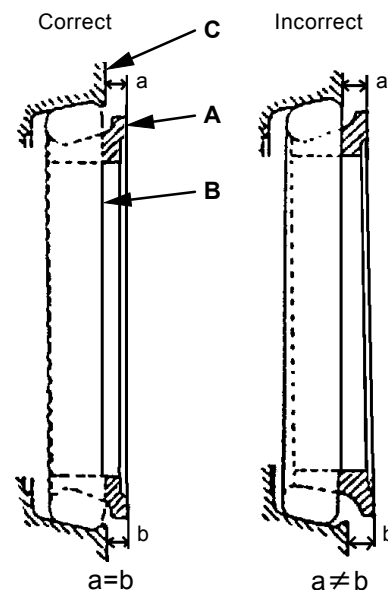


2. If incorrectly assembled, oil leakage or damage will occur. Be sure to do the following, to prevent trouble.

- (1) Clean the floating seal and seal mounting bores with cleaning solvent.
Use a wire brush to remove mud, rust or dirt.
After cleaning, thoroughly dry parts with compressed air.
- (2) Clean the floating seal and seal mounting bores. Check the bore surface for scuffing or scoring by touching the surface with touch.
- (3) Check that the O-ring is not twisted, and that it is installed correctly on the seal ring.
- (4) After installing the floating seal, check that seal ring surface (A) is parallel with seal mating face (C) by measuring the distances (A) and (C) at point (a) and (b), as illustrated. If these distances differ, correct the O-ring seating.



W105-03-05-020

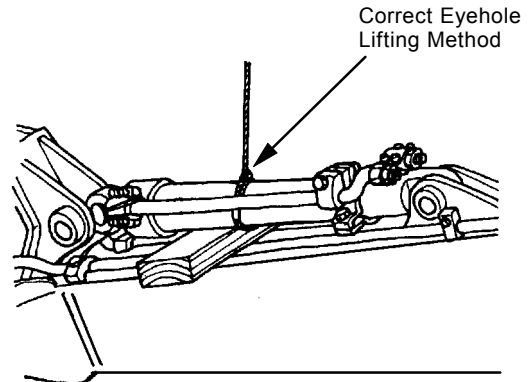


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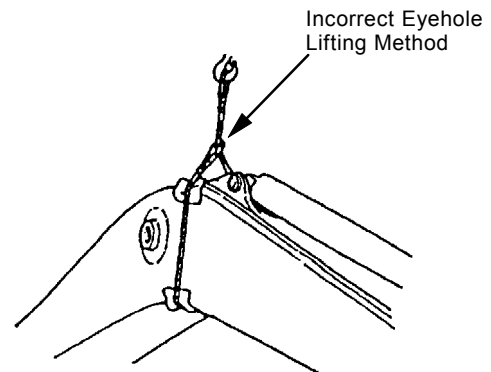
GENERAL / Precautions for Disassembling and Assembling

Precautions for Using Nylon Sling

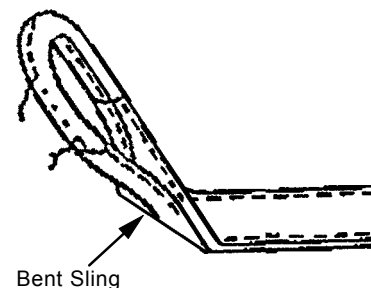
1. Follow the precautions below to use nylon slings safely.
 - Attach protectors (soft material) on the corners of the load so that the nylon sling does not directly contact the corners. This will prevent the nylon sling from being damaged and the lifted load from slipping.
 - Lower the temperature of the lifted load to lower than 100 °C (212 °F). If unavoidably lifting a load with a temperature of 100 °C (212 °F) or more, reduce the load weight.
 - Do not lift acid or alkali chemicals.
 - Take care not to allow the sling to become wet. The load may slip.
 - When required to use more than one sling, use slings with the same width and length to keep the lifted load balanced.
 - When lifting a load using an eyehole, be sure to eliminate any gaps between the sling and load. (Refer to the right illustration.) Reduce the load weight so that it is less than 80 % of the sling breaking force.
 - Avoid using twisted, bound, connected, or hitched slings.
 - Do not place any object on twisted or bent slings. (Refer to the right illustration.)
 - When removing the slings from under the load, take care not to damage the nylon slings. Avoid contact with protrusions.
 - Avoid dragging slings on the ground, throwing slings or pushing slings with a metal object.
 - When using with other types of slings (wire rope) or accessories (shackle), protect the joint so that the nylon sling is not damaged.
 - Store the nylon slings indoors so they won't deteriorate with heat, sun light, or chemicals.



W102-04-02-016



W105-04-01-008



W162-01-01-009

GENERAL / Precautions for Disassembling and Assembling



CAUTION: If a load is lifted with a damaged nylon sling, serious personal injury may result. Be sure to visually check the nylon sling for any damage before using.

2. Before using a nylon sling, visually check the nylon sling for any damage corresponding to examples shown to the right. If any damage is found, cut and discard the sling. Even if no damage is found, do not use slings older than 7-years.

Damaged Appearance

Broken Sewing Thread



W162-01-01-002

Scuffing



W162-01-01-003

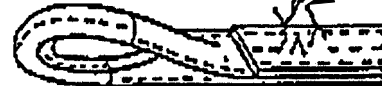
Fuzz

Broken Sewing Thread



W162-01-01-004

Broken Sewing Thread



W162-01-01-005

Broken Sewing Thread



W162-01-01-006

Scoring

Separation of Belt



W162-01-01-007

Fuzz

Scuffing

Broken Warp



W162-01-01-008

GENERAL / Precautions for Disassembling and Assembling

MAINTENANCE STANDARD TERMINOLOGY

“Standard”

1. Dimension for parts on a new machine.
2. Dimension of new components or assemblies adjusted to specification.

“Allowable Limit”

1. Normal machine performance cannot be accomplished after exceeding this limit.
2. Repair or adjustment is impossible after exceeding this limit.
3. Therefore, in consideration of operation efficiency and maintenance expense, proper maintenance shall be carried out before reaching the “Allowable Limit”.

GENERAL / Precautions for Disassembling and Assembling

(Blank)

GENERAL / Tightening

TIGHTENING TORQUE SPECIFICATIONS

(ZAXIS200, 200-E, 225US, 225USR)

Descriptions	Bolt Dia. (mm)	Q'ty	Wrench Size mm	Torque		
				N-m	(kgf·m)	(lbf·ft)
Engine cushion rubber mounting bolt(Pump upper)	18	2	27	360	(37)	(265)
Engine cushion rubber mounting bolt(Pump lower)	16	4	24	210	(21.5)	(155)
Engine cushion rubber mounting nut(Fan side)	14	4	22	140	(14.5)	(103)
Engine bracket mounting bolt	10	8	17	50	(5.1)	(37)
Hydraulic oil tank mounting bolt	16	4	24	210	(21.5)	(155)
Fuel tank mounting bolt	16	4	24	210	(21.5)	(155)
ORS fittings for hydraulic hoses and piping	1-3/16-12UNF		36	175	(18)	(130)
	1-7/16-12UNF		41	210	(215)	(155)
Pump device mounting bolt	10	8	17	50	(5.1)	(37)
Control valve mounting bolt	16	4	24	210	(21.5)	(155)
Control valve bracket mounting bolt	16	4	24	210	(21.5)	(155)
Swing device mounting bolt	20	12	30	500	(51)	(370)
Swing motor mounting bolt	12	8	10	90	(9.2)	(66)
Battery mounting nut	10	2	17	50	(5.1)	(37)
Cab mounting nut	16	4	24	205	(21.5)	(155)
Swing bearing mounting bolt (Upperstructure) (Undercarriage)	20	32	30	510	(52)	(380)
	20	36	30	490	(50)	(360)
Travel device mounting bolt Model:ZAXIS200/200E/225US ZAXIS225USR	20	28	30	630	(64)	(460)
	20	32	30	630	(64)	(460)
Sprocket mounting bolt	20	32	30	470	(48)	(347)
Upper roller mounting bolt	16	16	24	270	(27.5)	(200)
Lower roller mounting bolt Model:ZAXIS200/200E/225US ZAXIS225USR	18	56	27	460	(47)	(340)
	18	64	27	460	(47)	(340)
Shoe bolt Model:ZAXIS200/200E/225US/225USR ZAXIS200LC/200ELC ZAXIS225US/225USR ZAXIS225USRLC	18	368	27	560	(57)	(410)
	18	392	27	560	(57)	(410)
	20	368	27	840	(86)	(622)
	20	392	27	840	(86)	(622)
Track guard mounting bolt	18	8	27	500	(51)	(370)
Flexible master coupling, T bolt clamp for low pressure piping	8		13	10.3 to 12.4	(1.05 to 1.26)	(7.59 to 9.11)
		4	7	5.90	(0.60)	(4.3)
		4	11	5.90	(0.60)	(4.3)
Front pin-retaining nuts	20		30	540	(41)	(398)

GENERAL / Tightening

TIGHTENING TORQUE SPECIFICATIONS

(ZAXIS230, 270)

Descriptions	Bolt Dia. (mm)	Q'ty	Wrench Size mm	Torque		
				N-m	(kgf·m)	(lbf·ft)
Engine cushion rubber mounting bolt(Pump upper)	18	2	27	360	(37)	(265)
Engine cushion rubber mounting bolt(Pump lower)	16	4	24	210	(21.5)	(155)
Engine cushion rubber mounting nut(Fan side)	14	4	22	140	(14.5)	(103)
Engine bracket mounting bolt	10	8	17	50	(5.1)	(37)
Engine oil filter mounting bolt	10	4	17	50	(5.1)	(37)
Radiator mounting bolt(lower)	12	4	19	90	(9.2)	(66)
Hydraulic oil tank mounting bolt	16	4	24	210	(21.5)	(155)
Fuel tank mounting bolt	16	6	24	210	(21.5)	(155)
ORS fittings for hydraulic hoses and piping	1-3/16-12UNF		36	175	(18)	(130)
	1-7/16-12UNF		41	205	(21.5)	(155)
Pump device mounting bolt	10	8	17	50	(5.1)	(37)
Control valve mounting bolt	16	4	24	210	(21.5)	(155)
Control valve bracket mounting bolt	16	4	24	210	(21.5)	(155)
Swing device mounting bolt	22	12	32	640	(65)	(470)
Swing motor mounting bolt	12	8	10	90	(9.2)	(66)
Battery mounting nut	10	2	17	50	(5.1)	(37)
Cab mounting nut	16	4	24	205	(21.5)	(151)
Swing bearing mounting bolt (Upperstructure) (Undercarriage)	22	34	32	640	(65)	(470)
	22	36	32	640	(65)	(470)
Travel device mounting bolt Model:ZAXIS230 ZAXIS270	20	32	30	630	(64)	(460)
	20	40	30	630	(64)	(460)
Sprocket mounting bolt Model:ZAXIS230 ZAXIS270	20	32	30	470	(48)	(347)
	20	40	30	490	(50)	(361)
Upper roller mounting bolt	16	16	24	270	(27.5)	(200)
Lower roller mounting bolt Model:ZAXIS230 ZAXIS230LC ZAXIS270 ZAXIS270LC	18	64	27	460	(47)	(340)
	18	72	27	460	(47)	(340)
	20	64	30	670	(68)	(491)
	20	72	30	670	(68)	(491)
Shoe bolt Model:ZAXIS230 ZAXIS230LC ZAXIS270 ZAXIS270LC	20	376	27	840	(86)	(622)
	20	408	27	840	(86)	(622)
	22	360	30	1130	(115)	(832)
	22	384	30	1130	(115)	(832)
Track guard mounting bolt Model:ZAXIS230 ZAXIS270	18	8	27	500	(51)	(370)
	20	8	30	620	(63)	(456)
Flexible master coupling, T bolt clamp for low pressure piping	8		13	10.3 to 12.4	(1.05 to 1.26)	(7.59 to 9.11)
		4	7	5.90	(0.60)	(4.3)
		4	11	5.90	(0.60)	(4.3)
Front pin-retaining nuts	20		30	540	(55)	(398)

GENERAL / Tightening

-  NOTE 1. Apply lubricant (e.g. white zinc B dissolved into spindle oil) to bolts and nuts to reduce friction coefficient of them.
2. Make sure bolt and nut threads are clean before installing.
3. Apply LOCTITE to threads before installing and tightening swing bearing mounting bolts and lower roller mounting bolts.

GENERAL / Tightening

TORQUE CHART



CAUTION: Use tools appropriate for the work to be done. Makeshift tools and procedures can create safety hazards. For loosening and tightening nuts and bolts, use correct size tools. Otherwise, tightening tools may slip, potentially causing personal injury.

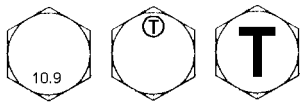


SA-040

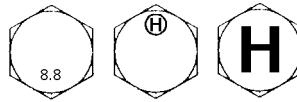
Bolt Types

Tighten nuts or bolts correctly to torque specifications. Four different types and grades of bolt are employed. Make sure to employ correct bolts and tighten them correctly when assembling the machine or components.

Hexagon T Bolt



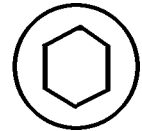
Hexagon H Bolt



Hexagon M Bolt



Socket Bolt



W162-01-01-001

Specified Tightening Torque Chart

Bolt Dia.	Wrench Size	Hexagon Wrench Size	T Bolt			H Bolt, Socket bolt			M Bolt		
			N·m	(kgf·m)	(lbf·ft)	N·m	(kgf·m)	(lbf·ft)	N·m	(kgf·m)	(lbf·ft)
M 8	13	6	29.5	(3)	(22)	19.5	(2)	(14.5)	9.8	(1)	(7.2)
M 10	17	8	64	(6.5)	(47)	49	(5)	(36)	19.5	(2)	(14.5)
M 12	19	10	108	(11)	(80)	88	(9)	(65)	34	(3.5)	(25.5)
M 14	22	12	175	(18)	(130)	137	(14)	(101)	54	(5.5)	(40)
M 16	24	14	265	(27)	(195)	205	(21)	(152)	78	(8)	(58)
M 18	27	14	390	(40)	(290)	295	(30)	(220)	118	(12)	(87)
M 20	30	17	540	(55)	(400)	390	(40)	(290)	167	(17)	(123)
M 22	32	17	740	(75)	(540)	540	(55)	(400)	215	(22)	(159)
M 24	36	19	930	(95)	(690)	690	(70)	(505)	275	(28)	(205)
M 27	41	19	1370	(140)	(1010)	1030	(105)	(760)	390	(40)	(290)
M 30	46	22	1910	(195)	(1410)	1420	(145)	(1050)	540	(55)	(400)
M 33	50	24	2550	(260)	(1880)	1910	(195)	(1410)	740	(75)	(540)
M 36	55	27	3140	(320)	(2310)	2400	(245)	(1770)	930	(95)	(690)

GENERAL / Tightening

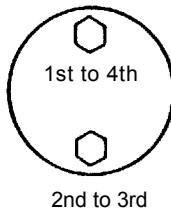
IMPORTANT: The following items are applied to both fine and coarse pitch threads.

1. Apply lubricant (i. e. white zinc B dissolved into Spindle oil) to nuts and bolts to reduce their friction coefficients.
The plated bolts require no lubricant.
2. Torque tolerance is $\pm 10\%$.
3. Be sure to use bolts of correct length. Bolts that are too long cannot be tightened, as the bolt tip comes into contact with the bottom of the bolt hole. Bolts that are too short cannot develop sufficient tightening force.
4. The torques given in the chart are for general use only. Do not use these torques if a different torque is given for a specific application.
5. Make sure that nut and bolt threads are clean before installing.
Remove dirt or corrosion, if any.

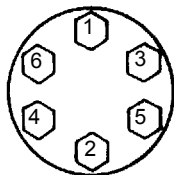
Bolt Tightening Order

When tightening two or more bolts, tighten them alternately, as shown, to ensure even tightening.

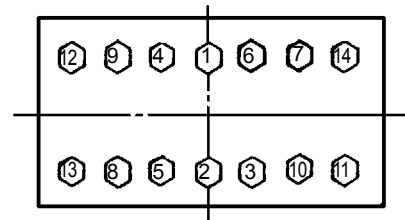
Equally tighten upper and lower alter-



Tighten diagonally



Tighten from center and diago-

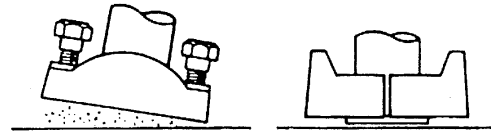


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GENERAL / Tightening

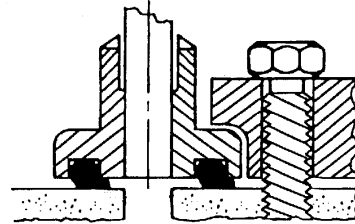
Service Recommendations for Split Flange

- IMPORTANT:**
1. Be sure to clean and inspect sealing surfaces. Scratches / roughness cause leaks and seal wear. Unevenness causes seal extrusion. If defects cannot be polished out, replace the component.
 2. Be sure to use only specified O-rings. Inspect O-rings for any damage. Take care not to file O-ring surfaces. When installing an O-ring into a groove, use grease to hold it in place.
 3. While lightly tightening split flange halves, check that split is centered and perpendicular to the port. Hand-tighten bolts to hold parts in place. Take care not to pinch the O-ring.
 4. Tighten bolts alternately and diagonally, as shown, to ensure even tightening.
 5. Do not use air wrenches. Using an air wrench often causes tightening of one bolt fully before tightening of the others, resulting in damage to O-rings or uneven tightening of bolts.

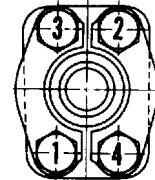


W105-01-01-015

WRONG

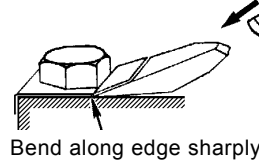


W105-01-01-016



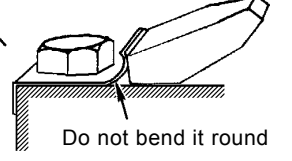
W105-01-01-008

RIGHT



Bend along edge sharply

WRONG



Do not bend it round

Nut and Bolt Locking

• Lock Plate

IMPORTANT: Do not reuse lock plates. Do not try to bend the same point twice.

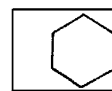
• Cotter Pin

IMPORTANT: Do not reuse cotter pins. Match the holes in the bolt and nut while tightening, not while loosening.

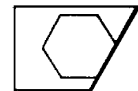
• Lock Wire

IMPORTANT: Apply wire to bolts in the bolt-tightening direction, not in the bolt-loosening direction.

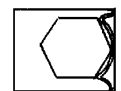
RIGHT



RIGHT

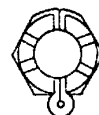


WRONG



Bend along edge sharply

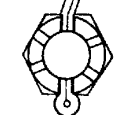
RIGHT



RIGHT

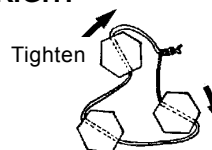


WRONG



W105-01-01-009

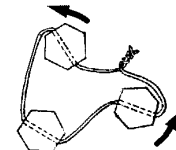
RIGHT



Tighten

Loosen

WRONG

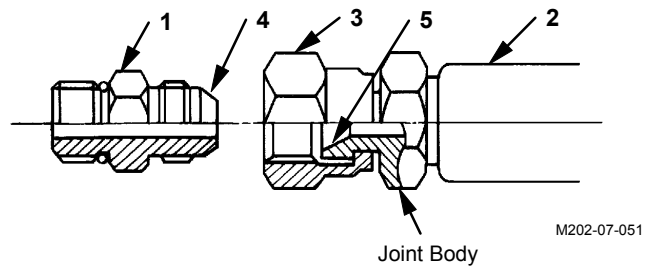


W105-01-01-010

GENERAL / Tightening

PIPING JOINT

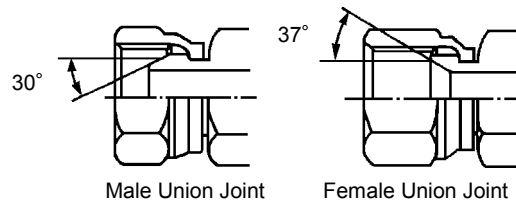
IMPORTANT: The torques given in the chart are for general use only. Do not use these torques if a different torque is given for a specific application.



Union Joint

Metal sealing surfaces (4) and (5) of adapter (1) and hose (2) fit together to seal pressure oil. Union joints are used to join small-diameter lines.

- IMPORTANT:**
1. Do not over-tighten nut (3). Excessive force will be applied to metal sealing surfaces (4) and (5), possibly cracking adapter (1). Be sure to tighten nut (3) to specifications.
 2. Scratches or other damage to sealing surfaces (4) or (5) will cause oil leakage at the joint. Take care not to damage them when connecting/disconnecting.



Description	Wrench Size mm	Wrench Size mm	Tightening Torque
	Union Nut	Hose Fittings	N·m (kgf·m, lbf·ft)
30° male	19	19	59 (6,44)
	22	22	98 (10,72)
	27	27	118 (12,87)
	36	36	235 (24,173)
	41	41	295 (30,218)
	50	50	490 (50,361)
	60	60	670 (68,494)
	70	70	980 (100,723)
37° female	19	17	44 (4,5,32)
	22	19	59 (6,44)
	27	22	118 (12,87)
	36	30,32	235 (24,173)
	41	36	295 (30,218)
	50	46	490 (50,361)

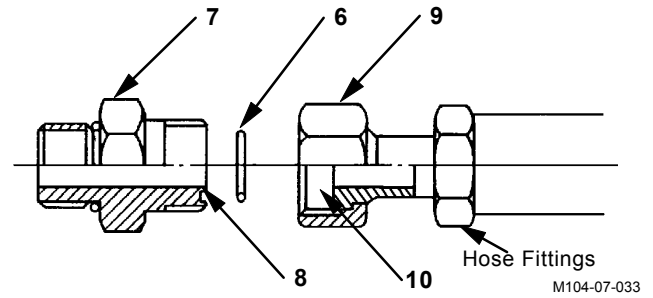
NOTE: Tightening torque of 37° male coupling without union is similar to tightening torque of 37° female.

GENERAL / Tightening

O-ring Seal Joint

O-ring (6) seats against the end face of adapter (7) to seal pressure oil.

- IMPORTANT:**
1. Be sure to replace O-ring (6) with a new one when reconnecting.
 2. Before tightening nut (9), confirm that O-ring (6) is seated correctly in O-ring groove (e). Tightening nut (9) with O-ring (6) displaced will damage O-ring (6), resulting in oil leakage.
 3. Take care not to damage O-ring groove (e) or sealing surface (10). Damage to O-ring (6) will cause oil leakage.
 4. If nut (9) is loose and oil is leaking, do not re-tighten nut (9). Replace O-ring (6) with a new one and check that O-ring (6) is correctly seated in place, tighten nut (9).



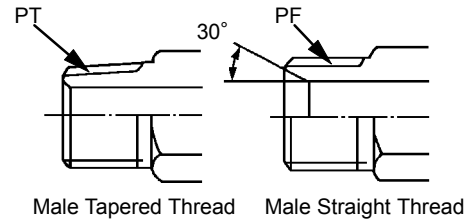
Wrench Size mm	Wrench Size mm	Tightening Torque
Union Nut	Hose Fittings	N·m (kgf·m, lbf·ft)
19	17	59 (6,44)
22	19	98 (10,72)
27	22	118 (12,87)
36	30,32	235 (24,173)
41	36	295 (30,218)
50	46	490 (50,361)

GENERAL / Tightening

Screw-In Connection

Depending on types of screw and sealing, different types of screw fittings are used.

IMPORTANT: Be sure to confirm that the thread pitch and thread type (tapered or straight) are the correct type before using any screw-in connection.



W105-01-01-018

Male Tapered Thread	
Wrench Size mm	Tightening Torque
Hose Fittings	N·m (kgf·m, lbf·ft)
17,19	59 (6,44)
19,22	98 (10,72)
27,22	118 (12,87)
36,32	235 (24,173)
41	295 (30,218)
50	490 (50,301)
60	670 (68,494)
70	980 (100,723)

Seal Tape Application

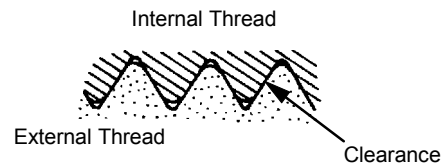
Seal tape is used to seal clearances between male and female threads, so as to prevent any leaks between threads.

Be sure to apply just enough seal tape to fill up thread clearances. Do not overwrap.

• Application Procedure

Confirm that the thread surface is clean and, free of dirt or damage.

Apply seal tape around threads as shown. Wrap seal tape in the same direction as the threads.



W105-01-01-019

Low-Pressure-Hose Clamp Tightening Torque

Low-pressure-hose clamp tightening torque differs depending on the type of clamp.

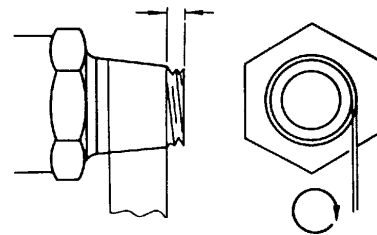
T-Bolt Type Band Clamp:

4.4 N·m (0.45 kgf·m, 3.25 lbf·ft)

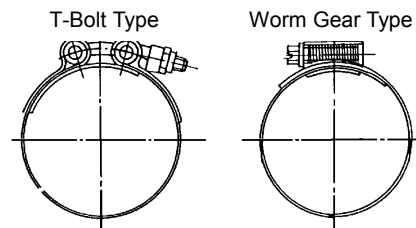
Worm Gear Type Band Clamp:

5.9 to 6.9 N·m (0.6 to 0.7 kg·m, 4.3 to 5.1 lbf·ft)

Leave one to two pitch threads uncovered



M114-07-041



M114-07-043

M114-07-042

GENERAL / Tightening

Connecting Hose



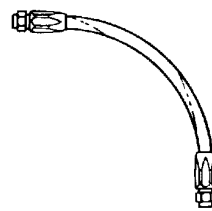
CAUTION: When replacing hoses, be sure to use only genuine Hitachi service parts. Using hoses other than genuine Hitachi hoses may cause oil leaks, hose rupture or Separation of fitting, possibly resulting in a fire on the machine.

Do not install hoses kinked. Application of high oil pressure, vibration, or an impact to a kinked hose may result in oil leaks, hose rupture or separation of fitting. Utilize Print marks on hoses when installing to prevent hose from being kinked.

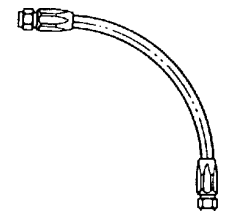
If hoses rub against each other, wear to the hoses will result, leading to hose rupture. Take necessary measures to protect hoses from rubbing against each other.

Take care so that hoses do not come into contact with moving parts or sharp objects.

WRONG

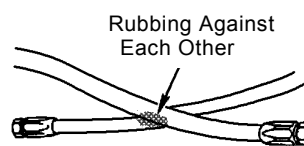


RIGHT

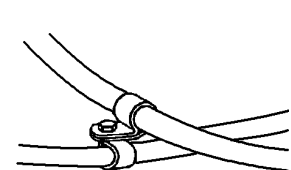


W105-01-01-011

WRONG

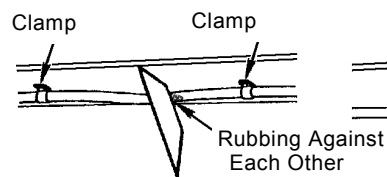


RIGHT

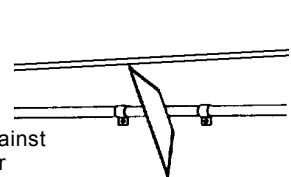


W105-01-01-012

WRONG

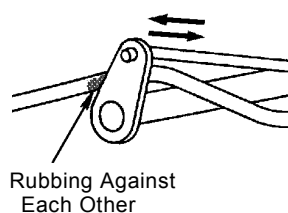


RIGHT

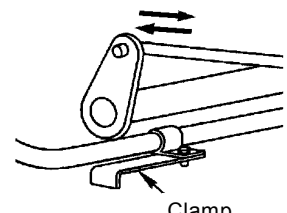


W105-01-01-013

WRONG



RIGHT



W105-01-01-014

GENERAL / Tightening

PERIODIC REPLACEMENT OF PARTS

To ensure safe operation, be sure to conduct periodic inspection of the machine. In addition, the parts listed below, if defective, may pose serious safety/fire hazards. It is very difficult to gauge the extent of deterioration, fatigue, or weakening of the parts listed below simply by visual inspection alone. For this reason, replace these parts at the intervals shown in the table below. However, if any of these parts are found to be defective, replace before starting operation, regardless of the interval.

Also, when replacing hoses, check the clamps for deformation, cracks, or other deterioration, and replace as necessary.

Be sure to perform periodic inspection of all hoses, as shown below, and replace or retighten any defective parts found, as necessary.

Consult your authorized dealer for correct replacement.

Periodic Replacement Parts			Replacement Intervals
Engine		Fuel hose (Fuel tank to filter)	Every 2 years
		Fuel hose (Fuel tank to injection pump)	Every 2 years
		Heater hose (Heater to engine)	Every 2 years
Hydraulic System	Base Machine	Pump suction hose	Every 2 years
		Pump delivery hose	Every 2 years
		Swing hose	Every 2 years
	Front Attachment	Boom cylinder line hose	Every 2 years
		Arm cylinder line hose	Every 2 years
		Bucket cylinder line hose	Every 2 years
		Pilot hose	Every 2 years

 **NOTE:** Be sure to replace seals, such as O-rings and gaskets, when replacing hoses.

GENERAL / Tightening

(Blank)

GENERAL / Painting

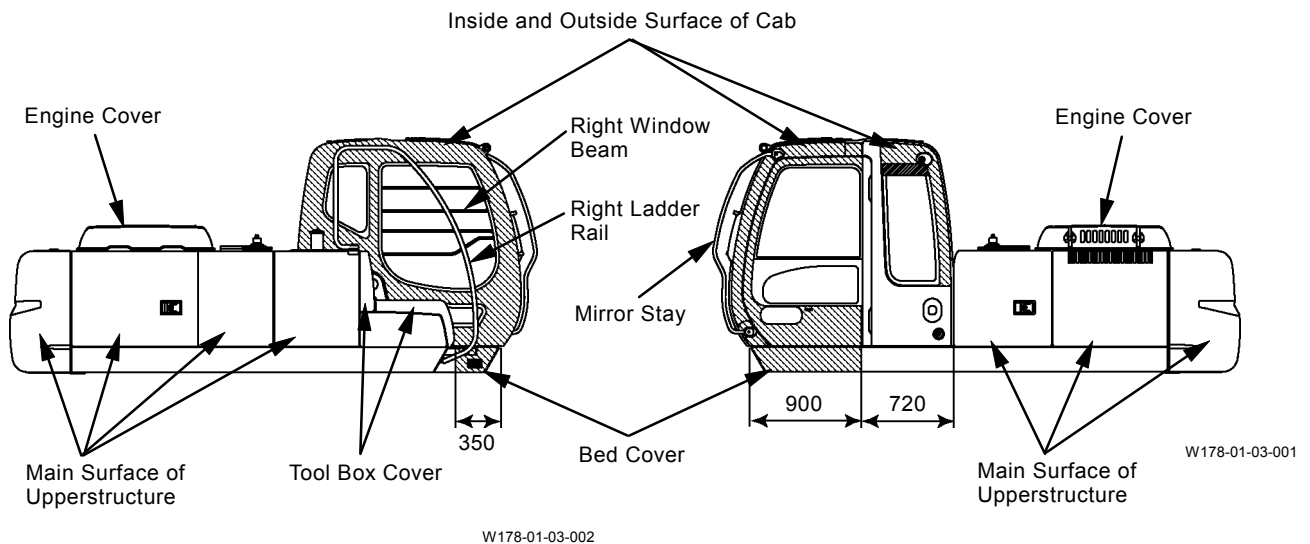
PAINTING

(ZAXIS200, 200-E)

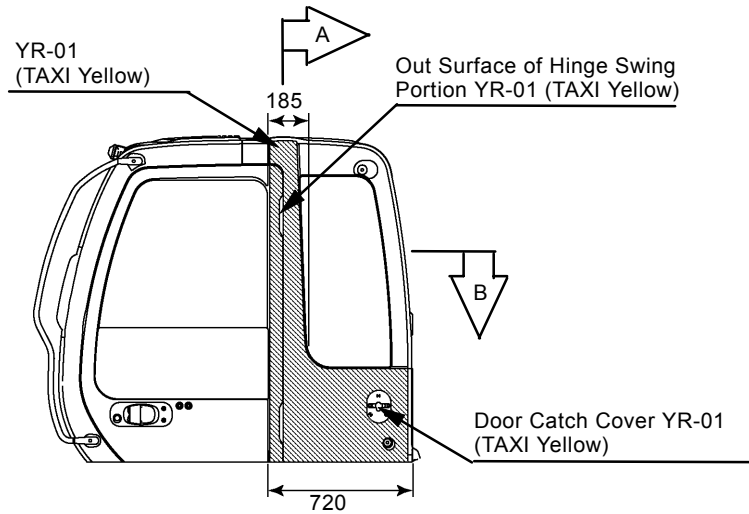
Surfaces to Be Painted	Painting Colour
• Main surface of upperstructure	YR-01 [TAXI yellow]
Bed cover	Warm Grey [Revised] Glossy N4.5 equivalent
Tool box cover	Warm Grey [Revised] Glossy N2.5 equivalent
Inner face	Grey
• Front attachment	YR01 [TAXI yellow]
• Track (undercarriage)	N1.0 [Black]
• Floor plate	M/F cation colour
• A part of rear left of cab	YR-01 [TAXI yellow]

Final painted colour

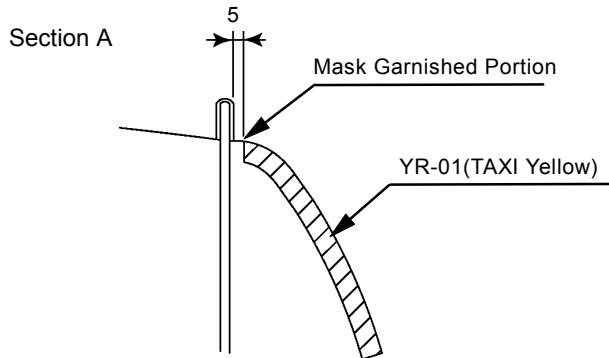
• Inside and outside surface of cab	Warm Grey [Revised] Glossy N 4.5 equivalent
• Right window beam	[KASAI PAINT LF-113-230B (Charcoal series black, semi glossy)]
• Suspension lifter (chair bottom)	[N2.0 (Black)]
• Lever (Travel, lock, foot rest)	[N2.0 (Black)]
• Torsion bar (upper side of cab, tool box)	[N4.0 (Grey)]
• Engine cover	Warm Grey [Revised] Glossy N2.5 equivalent
• Ladder rail on right side of upperstructure	Warm Grey [Revised] Glossy N2.5 equivalent
• Mirror stay	Warm Grey [Revised] Glossy N2.5 equivalent
• Antislip cover	KASAI PAINT Amilack 1400 Deep Black.



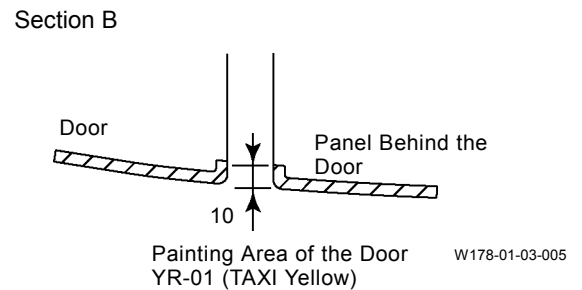
GENERAL / Painting



W178-01-03-003

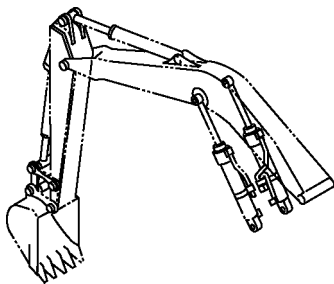


W178-01-03-004



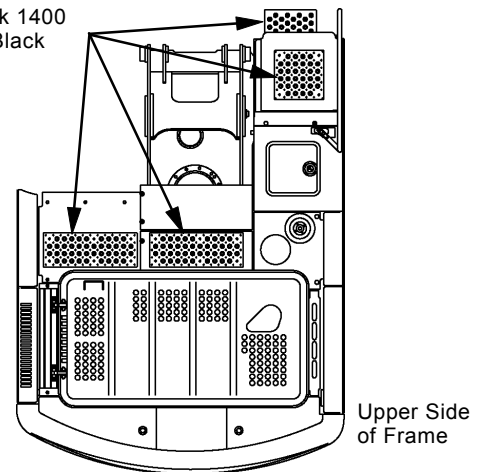
W178-01-03-005

Front Attachment YR-01 (TAXI Yellow)



W178-01-03-007

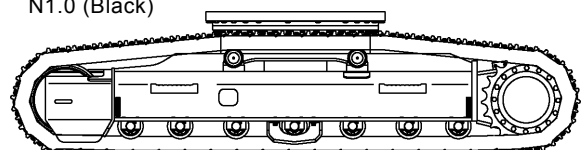
Antislip Cover
KASAI PAINT
Amilack 1400
Deep Black



W178-01-03-006

IMPORTANT: When cleaning arm, cylinder, etc. fitted with HN bushing, take care not to pour washing liquid directly on them. The ambient temperature should not exceed 70 °C when painting and drying.

Track (Undercarriage)
N1.0 (Black)



W178-01-03-008

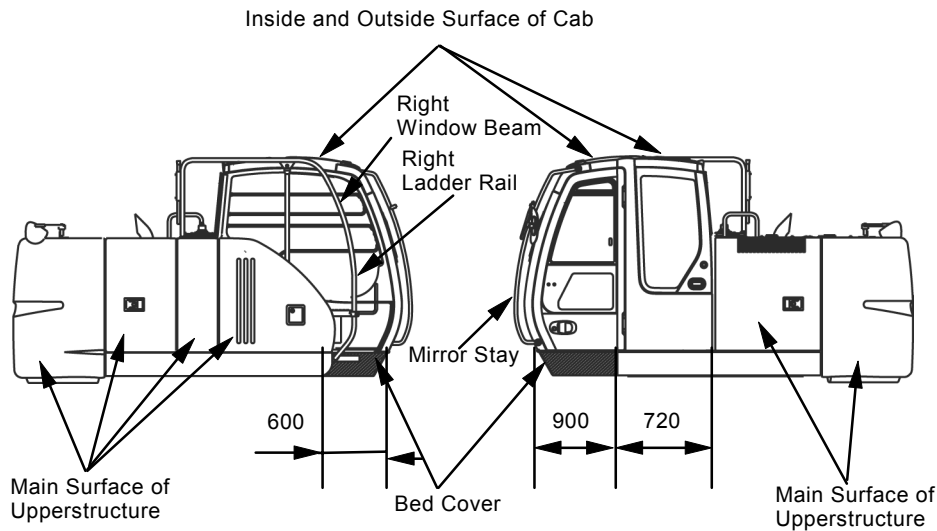
GENERAL / Painting

(ZAXIS225USR)

Surface to Be Painted	Painting Colour
• Main surface of upperstructure	YR-01 [TAXI yellow]
Bed cover	High Grade Beige
Inner face	Grey
• Front attachment	YR01 [TAXI yellow]
• Track (undercarriage)	N1.0 [Black]
• Floor plate	M/F cation colour
• Rear left portion of Cab	YR-01 [TAXI yellow]

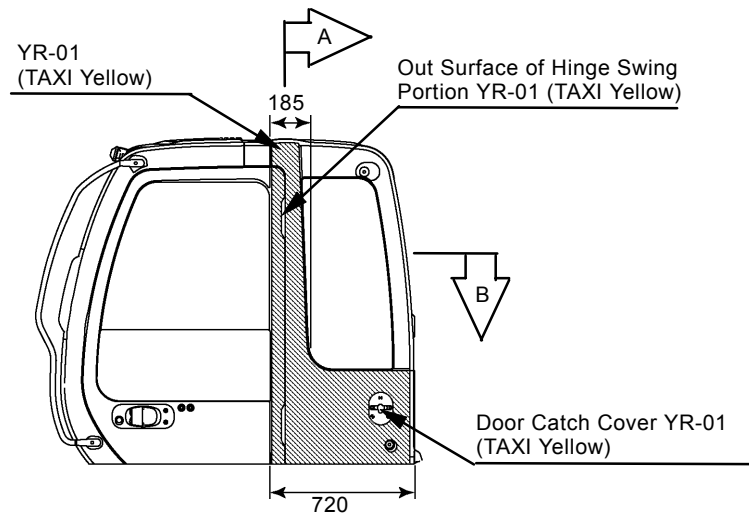
Final painted colour

• Inside and outside surface of cab	High Grade Beige
• Right window beam, U bolt	[KASAI PAINT LF-113-230B (Charcoal series black, semi glossy)]
• Suspension lifter	[N2.0 (Black)]
• Lever (Travel, shut-off, foot rest)	[N2.0 (Black)]
• Side Cover of Control Valve	High Grade Black
• Ladder rail on right side of upperstructure	High Grade Black
• Mirror stay	High Grade Black
• Antislip cover	KASAI PAINT Amilack 1400 deep black.

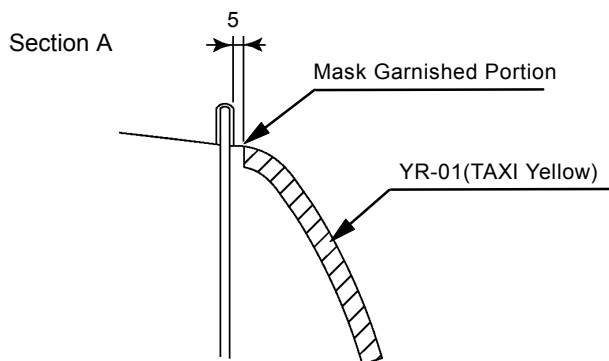


W178-01-03-010

GENERAL / Painting

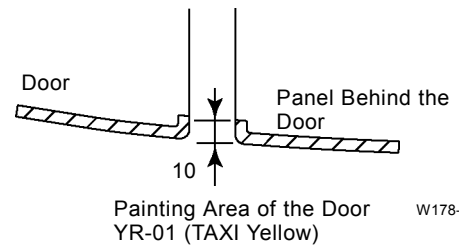


W178-01-03-003



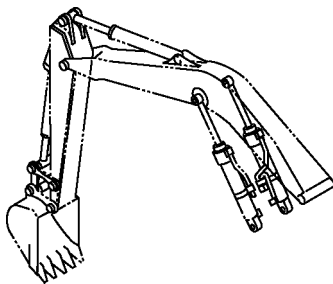
W178-01-03-004

Section B



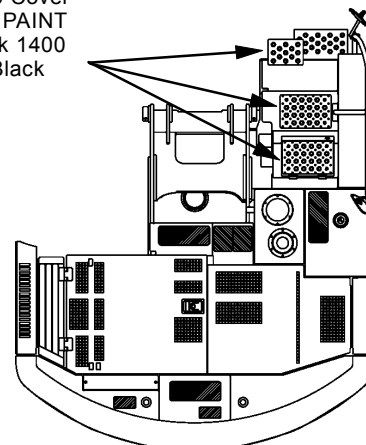
W178-01-03-005

Front Attachment YR-01 (TAXI Yellow)



W178-01-03-007

Antislip Cover
KASAI PAINT
Amilack 1400
Deep Black

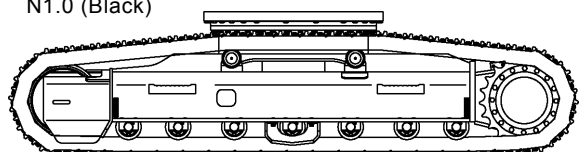


Upper Side of Frame

W178-01-03-012

IMPORTANT: When cleaning arm, cylinder, etc. fitted with HN bushing, take care not to pour washing liquid directly on them. The ambient temperature should not exceed 70 °C when painting and drying.

Track (Undercarriage)
N1.0 (Black)



W178-01-03-008

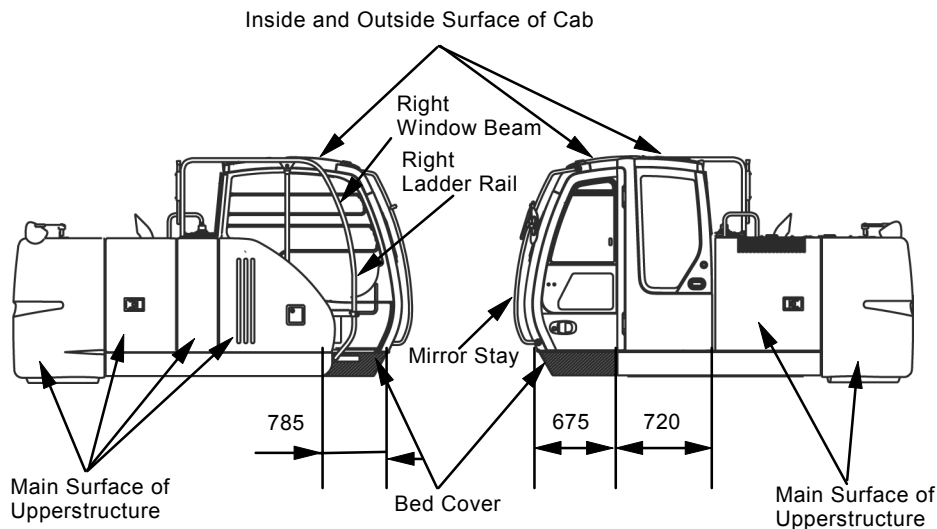
GENERAL / Painting

(ZAXIS225US)

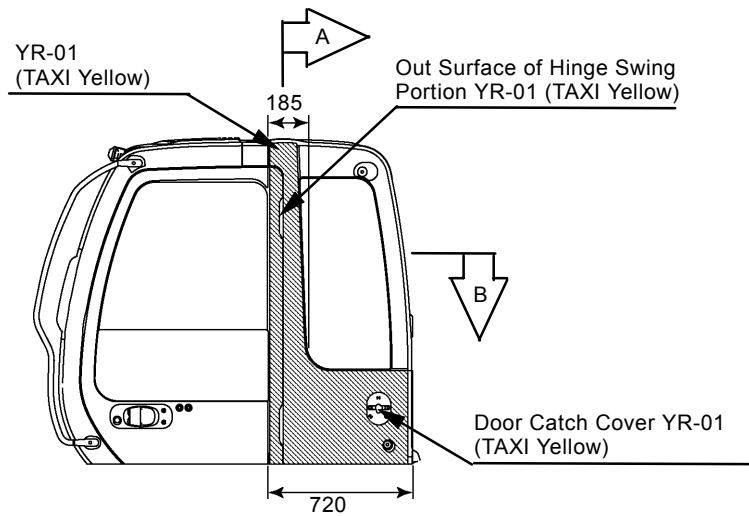
Surface to Be Painted	Painting Colour
• Main surface of upperstructure	YR-01 [TAXI yellow]
Bed cover	High Grade Beige
Side cover of control valve	High Grade Black
Inner face	Grey
• Front attachment	YR01 [TAXI yellow]
• Track (undercarriage)	N1.0 [Black]
• Floor plate	M/F cation colour
• Rear left portion of cab	YR-01 [TAXI yellow]
• Cab except rear left portion	High Grade Beige

Final painted colour

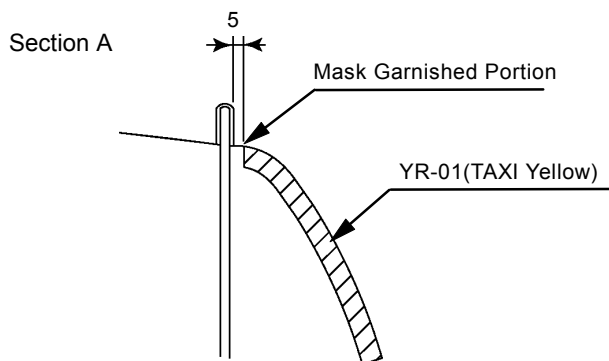
• Inside and outside surface of cab	High Grade Beige, YR-01 [TAXI yellow]
• Right window beam, U bolt	[KASAI PAINT LF-113-230B (Charcoal series black, semi glossy)]
• Suspension lifter	[N2.0 (Black)]
• Lever (Travel, shut-off, foot rest)	[N2.0 (Black)]
• Tool box	YR-01 [TAXI yellow]
• Ladder rail on rear of cab	High Grade Black
• Ladder rail on right side of upperstructure	High Grade Black
• Mirror stay (Cab, Ladder rail on right side of upperstructure, Counterweight top)	High Grade Black
• Antislip cover	KASAI PAINT Amilack 1400 deep black.



GENERAL / Painting

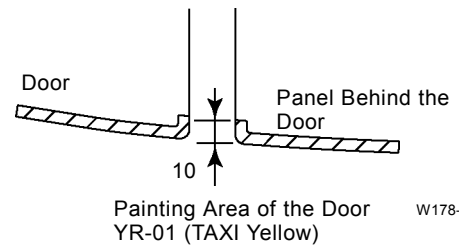


W178-01-03-003



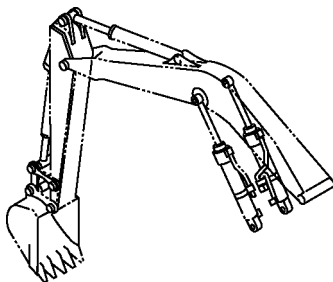
W178-01-03-004

Section B



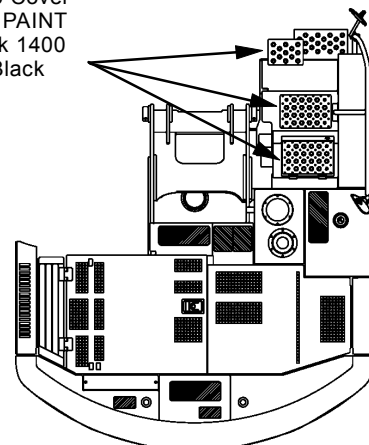
W178-01-03-005

Front Attachment YR-01 (TAXI Yellow)



W178-01-03-007

Antislip Cover
KASAI PAINT
Amilack 1400
Deep Black

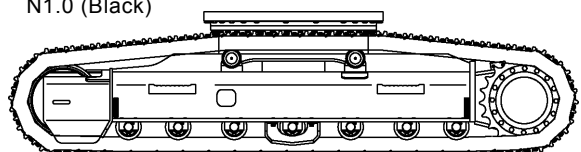


Upper Side of Frame

W178-01-03-012

IMPORTANT: When cleaning arm, cylinder, etc. fitted with HN bushing, take care not to pour washing liquid directly on them. The ambient temperature should not exceed 70 °C when painting and drying.

Track (Undercarriage)
N1.0 (Black)



W178-01-03-008

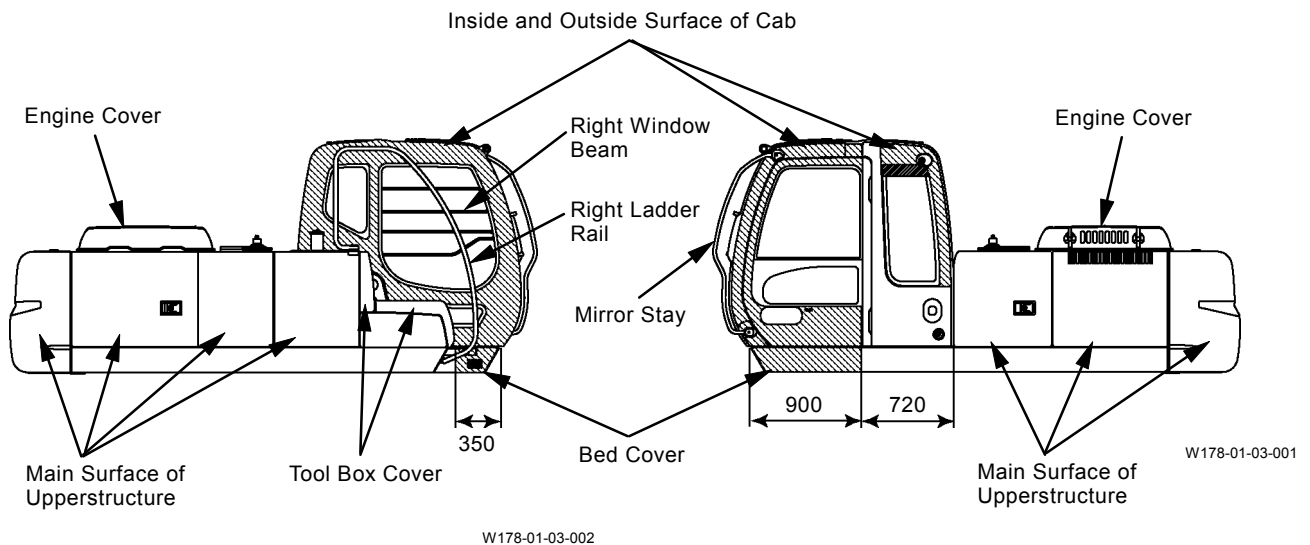
GENERAL / Painting

(ZAXIS230, 270)

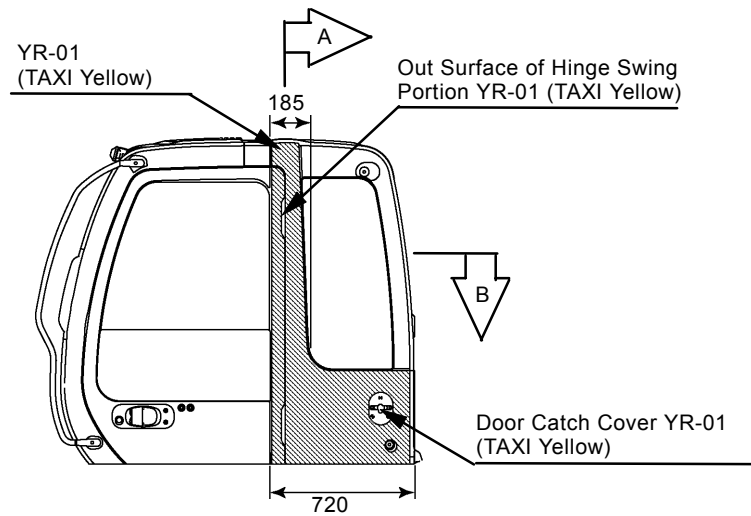
Surfaces to Be Painted	Painting Colour
• Main surface of upperstructure	YR-01 [TAXI yellow]
Bed cover	High Grade Beige
Side cover of control valve	High Grade Black
Inner face	Grey
• Front attachment	YR01 [TAXI yellow]
• Track (undercarriage)	N1.0 [Black]
• Floor plate	M/F cation colour
• A part of rear left of cab	YR-01 [TAXI yellow]

Final painted colour

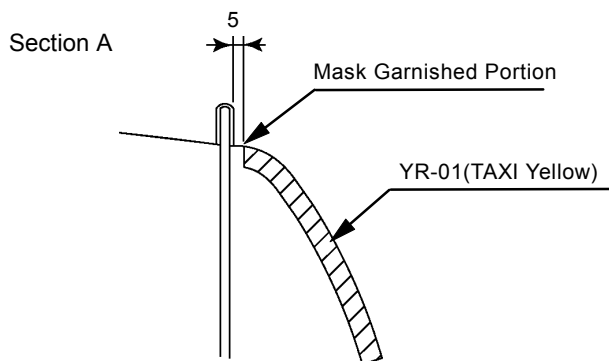
• Inside and outside surface of cab	High Grade Beige
• Right window beam	[KASAI PAINT LF-113-230B (Charcoal series black, semi glossy)]
• Suspension lifter (chair bottom)	[N2.0 (Black)]
• Lever (Travel, lock, foot rest)	[N2.0 (Black)]
• Torsion bar (upper side of cab, tool kit)	[N4.0 (Grey)]
• Engine cover	High Grade Black
• Ladder rail on right side of upperstructure	High Grade Black
• Mirror stay	High Grade Black
• Antislip cover	KASAI PAINT Amilack 1400 Deep Black.



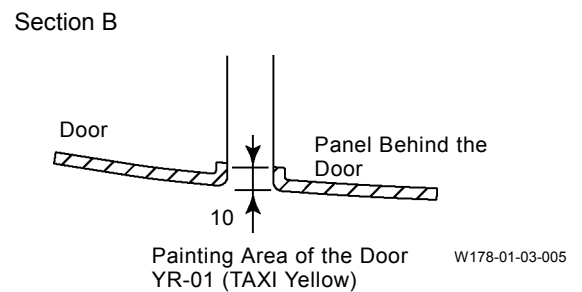
GENERAL / Painting



W178-01-03-003

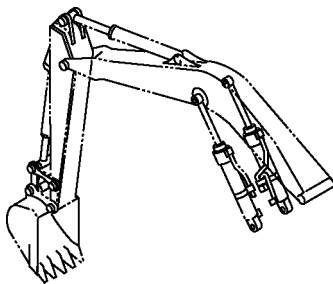


W178-01-03-004



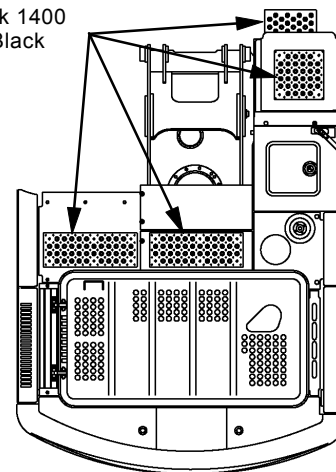
W178-01-03-005

Front Attachment YR-01 (TAXI Yellow)



W178-01-03-007

Antislip Cover
KASAI PAINT
Amilack 1400
Deep Black

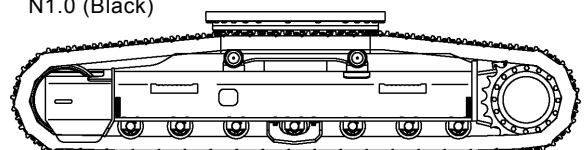


Upper Side of Frame

W178-01-03-006

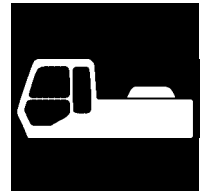
When cleaning arm, cylinder, etc. fitted with HN bushing, take care not to pour washing liquid directly on them. The ambient temperature should not exceed 70 °C when painting and drying.

Track (Undercarriage)
N1.0 (Black)



W178-01-03-008

SECTION 2 UPPERSTRUCTURE



— CONTENTS —

Group 1 Cab

Remove and Install Cab	W2-1-1
Dimensions of the Cab Glass	W2-1-13

Group 2 Counterweight

Remove and Install Counterweight	W2-2-1
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Group 3 Main Frame

Remove and Install Main Frame	W2-3-1
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Group 4 Pump Device

Remove and Install Pump Device	W2-4-1
Disassemble Pump Device	W2-4-4
Assemble Pump Device	W2-4-12
Disassemble Regulator	W2-4-16
Assemble Regulator	W2-4-26
Disassemble Solenoid Valve	W2-4-28
Assemble Solenoid Valve	W2-4-30
Disassemble and Assemble Pilot Pump	W2-4-32
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Group 5 Control Valve

Remove and Install Control Valve	W2-5-1
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Assemble 4-Spool Control Valve	W2-5-20
Assemble 5-Spool Control Valve	W2-5-28

Group 6 Swing Device

Remove and Install Swing Device	W2-6-1
Disassemble Swing Device	W2-6-4
Assemble Swing Device	W2-6-16
Disassemble Swing Motor	W2-6-30
Assemble Swing Motor	W2-6-38
Disassemble and Assemble Parking Release Valve	W2-6-46
Maintenance Standard	W2-6-47

Group 7 Pilot Valve

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Remove and Install Travel Pilot Valve	W2-7-8
Disassemble Right and Left Pilot Valves	W2-7-10
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Assemble Travel Pilot Valve	W2-7-22

Group 8 Pilot Shut-Off Valve

Remove and Install Pilot Shut-Off Valve	W2-8-1
Disassemble Pilot Shut-Off Valve	W2-8-4
Assemble Pilot Shut-Off Valve	W2-8-8

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Remove and Install Signal
Control Valve..... W2-9-1

Group 10 Solenoid Valve

Remove and Install Solenoid
Valve Unit..... W2-10-1
Disassemble Proportional
Solenoid Valve W2-10-4
Assemble Proportional
Solenoid Valve W2-10-6

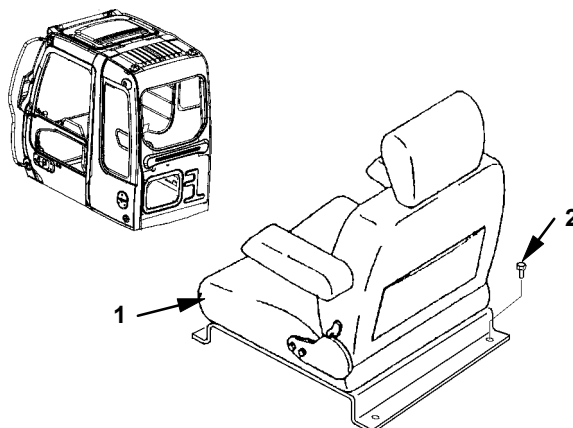
UPPERSTRUCTURE / Cab

REMOVE AND INSTALL CAB

Removal (ZAXIS200, 200-E, 225USR, 230, 270)

1. Remove seat mounting nuts (2) (4 used) to remove seat (1).

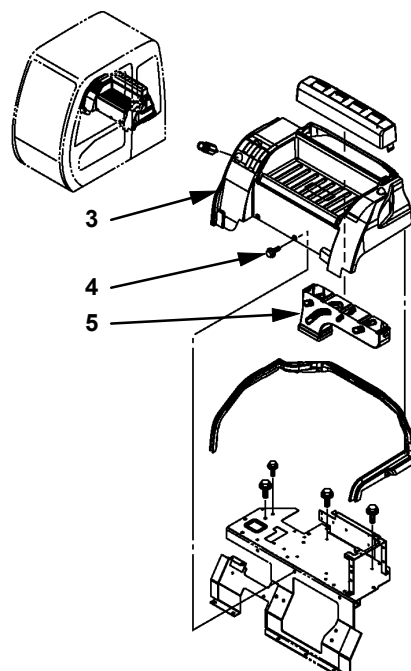
 : 17 mm



W178-02-07-006

2. Remove bolt (4) behind the cab to remove rear box (3).

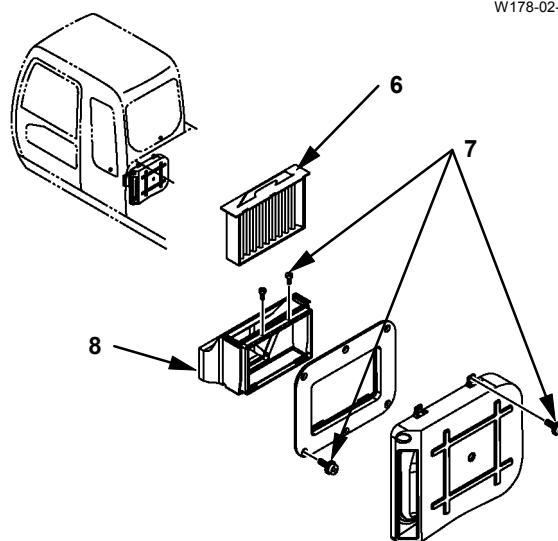
 : 17 mm



3. Raise duct (5) to remove it.

W178-02-01-012

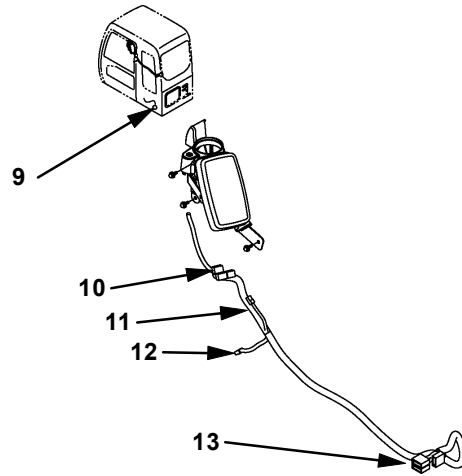
4. Remove air filter (6) to remove screw (7) with a screwdriver, then remove duct (8) from the cab.



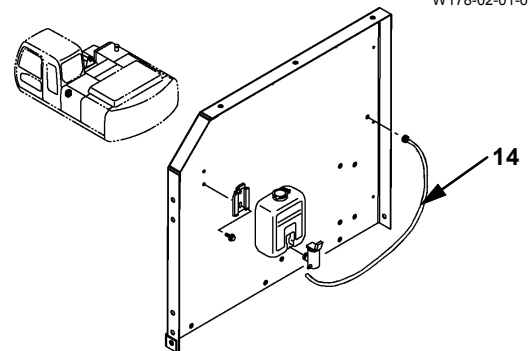
W178-02-01-013

UPPERSTRUCTURE / Cab

5. Disconnect cable connectors (10, 11, 12 and 13) on the right side in the cab and ground (9) at rear side in the cab.

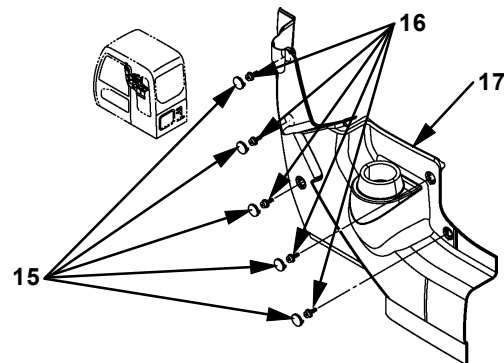


6. Remove washer vinyl hose (14) at rear side in the cab.



W178-02-01-014

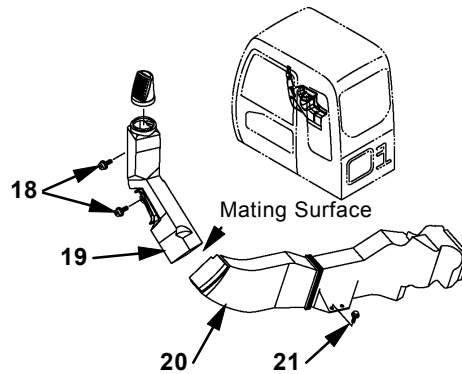
7. Remove cap (15) from duct cover (17) with a screwdriver. Remove screw (16) with a screwdriver to remove duct cover (17).



W178-02-01-015

8. Remove screw (18) and bolt (21) to remove duct (19) and duct (20).

 : 17 mm



W178-02-01-016

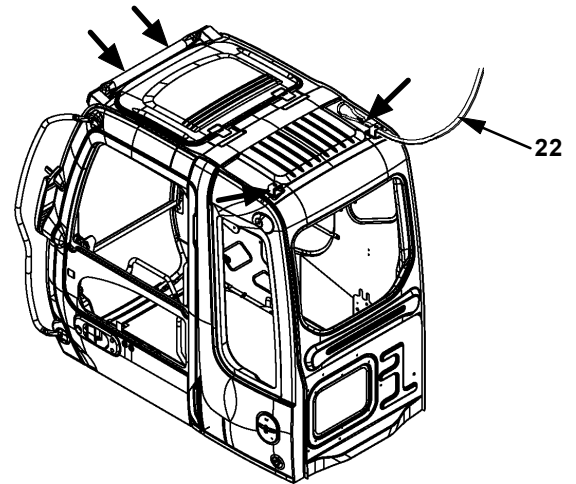
W178-02-01-017

UPPERSTRUCTURE / Cab



CAUTION: Cab weight: 290 kg (640 lb)

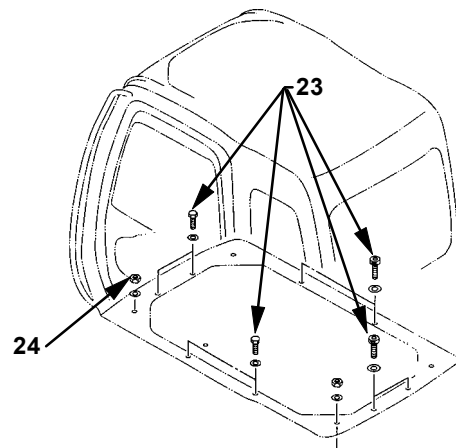
9. Attach lifting straps (22) on the cab upper side.



W178-02-01-018

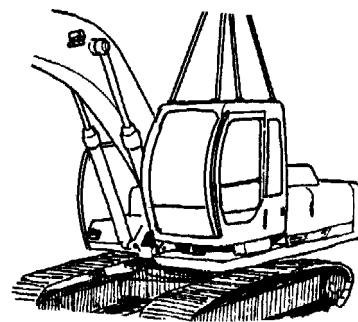
10. Remove cab mounting bolts (23) and nut (24).

 : 17 mm
 : 24 mm
 : 8 mm



W157-02-01-010

11. Carefully hoist the cab to remove it.



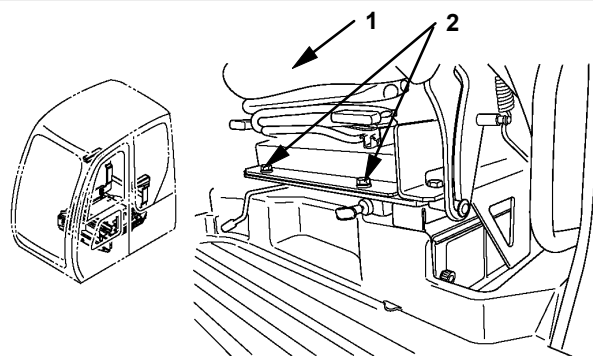
W157-02-01-001

UPPERSTRUCTURE / Cab

Removal (ZAXIS225US)

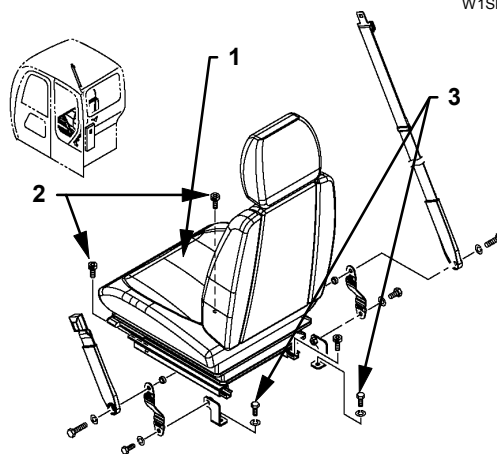
1. Remove seat mounting bolts (2) (4 used) and bolts (3) (2 used) for seat belt to remove seat (1).

🔧 : 17 mm, 16 mm



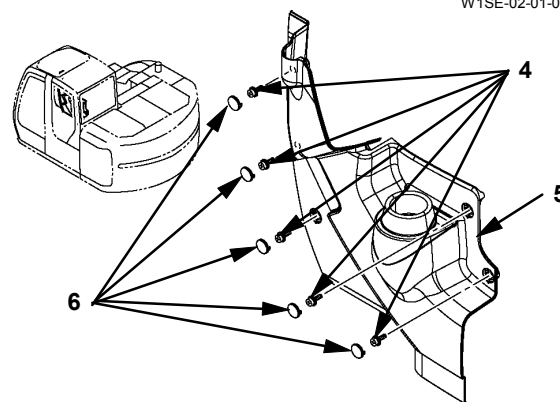
W1SE-02-01-001

2. Remove cap (6) from duct cover (5) with minus driver and remove screw (4) to remove duct cover (5).

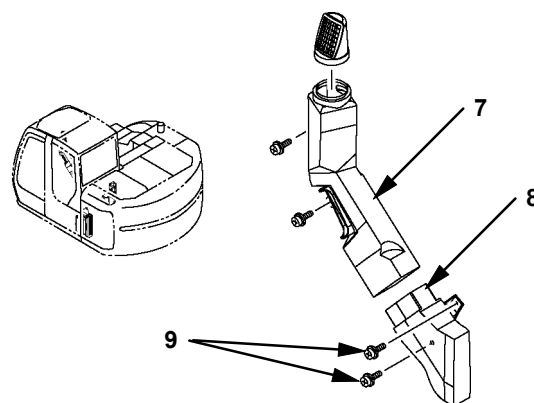


W1SE-02-01-002

3. Remove screw (9) to remove duct (8) from duct (7).



W1SE-02-01-003

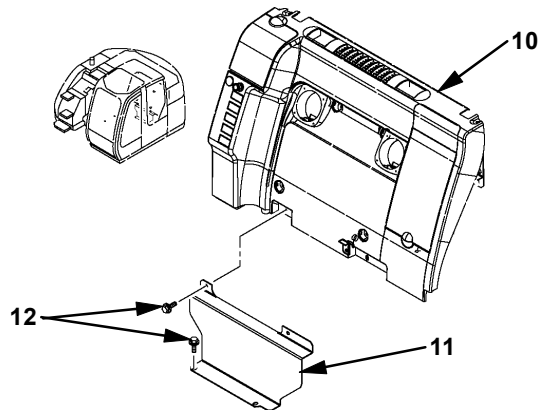


W1SE-02-01-004

UPPERSTRUCTURE / Cab

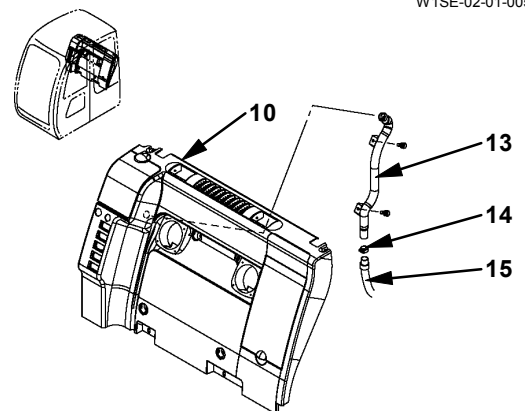
4. Remove bolts (12) (4 used) at rear side of the cab to remove cover (11) from rear cover (10).

 : 13 mm



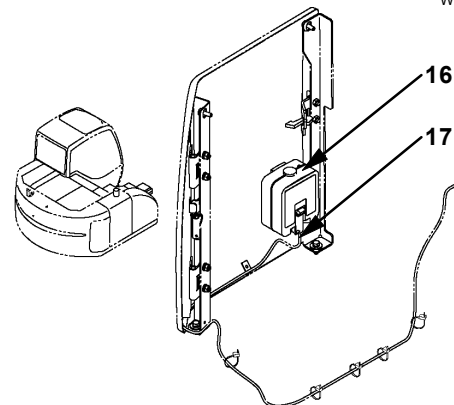
W1SE-02-01-005

5. Remove clamp (14) behind of rear cover (10) to disconnect air conditioner hose (15) from air conditioner hose (13).



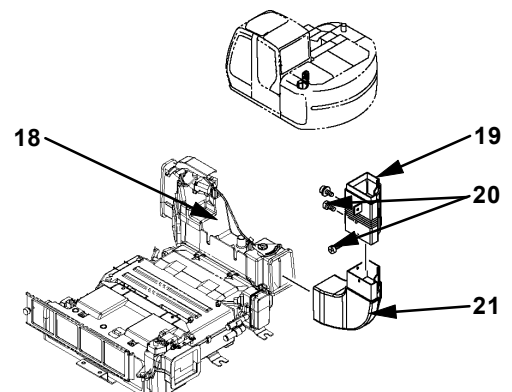
W1SE-02-01-006

6. Disconnect washer vinyl hose (17) from washer tank (16) at the bottom rear side of the cab.



W1SE-02-01-007

7. Remove screws (20) (2 used) to remove duct (21) from duct (18) and duct (19).



W1SE-02-01-008

UPPERSTRUCTURE / Cab

8. Hold and shake the connector of radio antenna feeder (22) to right and left to remove the connector.

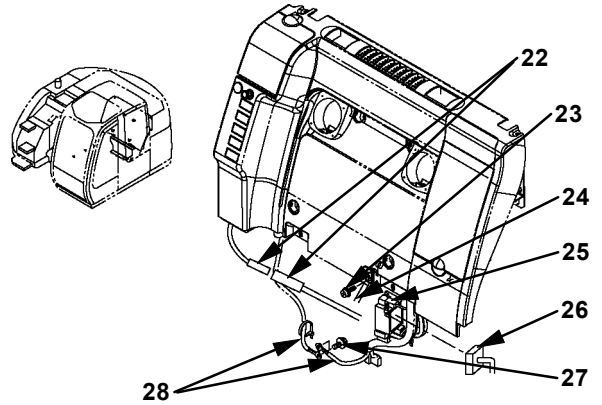
Remove screw (23) to remove ground (24).

Disconnect connectors (25) (6 used).

Remove junction box (26).

Remove bolts (27) (2 used) to remove ground (28).

 : 13 mm

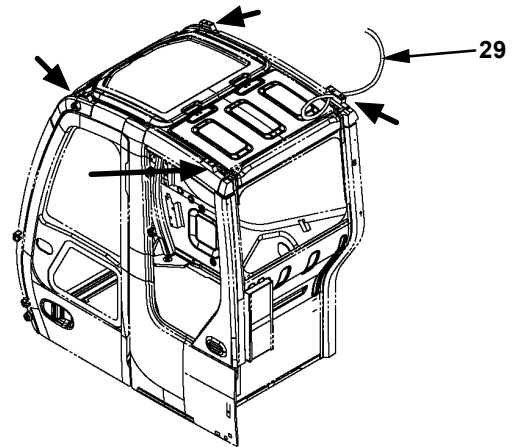


W1SE-02-01-09



CAUTION: Cab weight: 270 kg (600 lb)

9. Attach lifting straps (29) to the upside of the cab. (4 places)



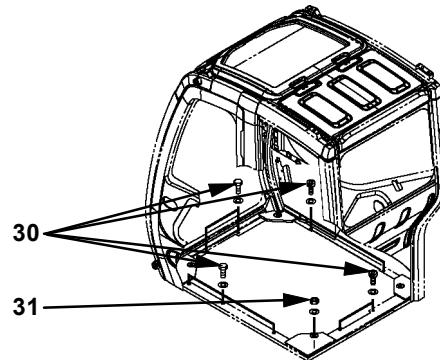
W1SE-02-01-011

10. Remove cab mounting bolts (30)(9 used) and nuts (31) (4 used) from the frame.

 : 17 mm

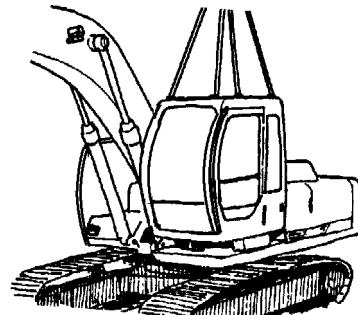
 : 24 mm

 : 8 mm



W1SE-02-01-10

11. Lift the cab by crane and remove the cab from the frame carefully.



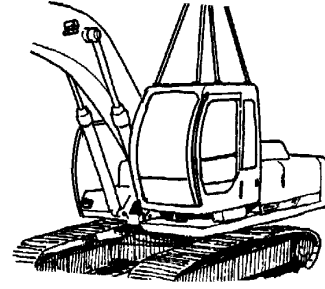
W157-02-01-001

UPPERSTRUCTURE / Cab

Installation (ZAXIS200, 200-E, 225USR, 230, 270)

CAUTION: Cab weight: 290 kg (640 lb)

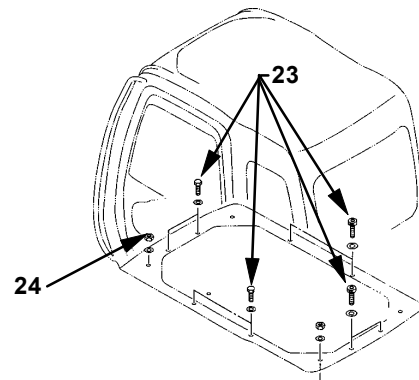
1. Attach the cab with lifting straps to hoist it by crane.



W157-02-01-001

2. Install cab mounting bolt (23) and nut (24).

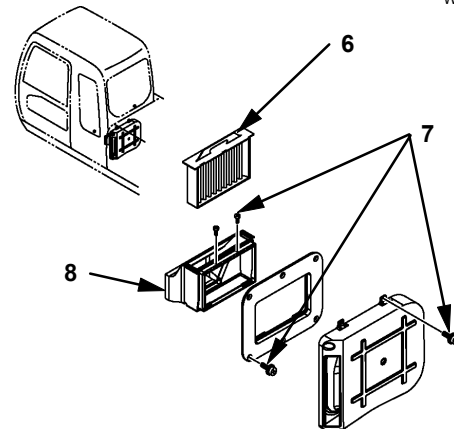
-  : 17 mm
-  : 50 N·m (5.1 kgf·m, 37 lbf·ft)
-  : 24 mm
-  : 205 N·m (21 kgf·m, 152 lbf·ft)
-  : 8 mm
-  : 50 N·m (5.1 kgf·m, 37 lbf·ft)



W157-02-01-010

3. Install duct (8) to the rear console of the cab with screws (7). Install filter (6) into duct (8).

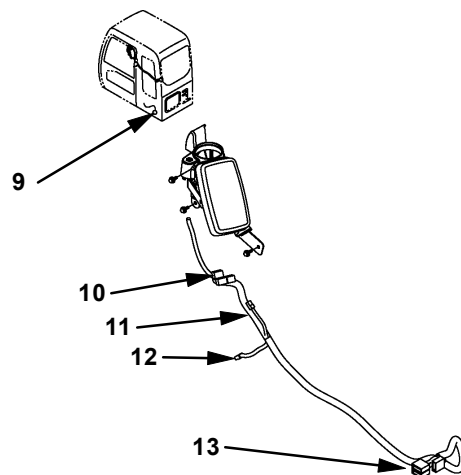
-  : 4.9 N·m (0.5 kgf·m, 3.6 lbf·ft)



W178-02-01-013

4. Install harness connectors (10, 11, 12 and 13) at the right side of the cab and install ground connector (9) at rear side in the cab.

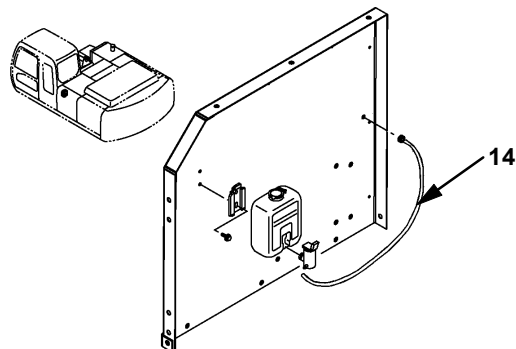
-  : 17 mm
-  : 50 N·m (5.1 kgf·m, 37 lbf·ft)



W178-02-01-014

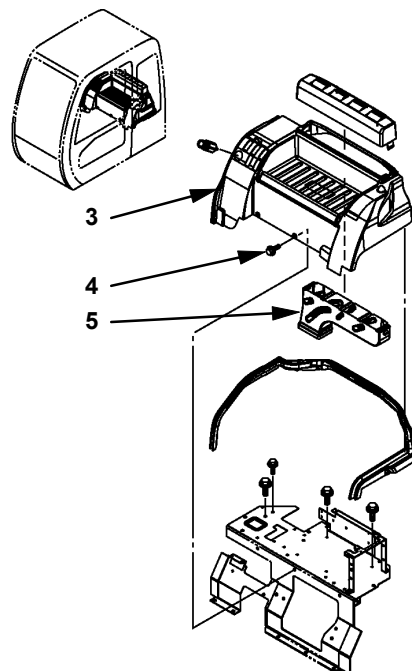
UPPERSTRUCTURE / Cab

5. Connect washer vinyl hose (14) at the rear of the cab inside.



W178-02-01-015

6. Aligning the mounting hole for duct (5), while pressing it to install the hose into the hole.



W178-02-01-012

7. Install rear box (3) with bolt (4).

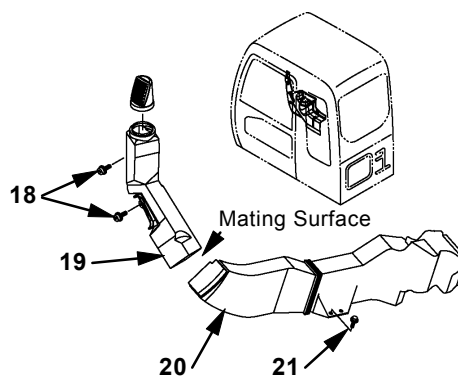
 : 17 mm

 : 50 N·m (5.1 kgf·m, 37 lbf·ft)

8. Install duct (20) with bolt (21). Install duct (19) into duct (20) and fix them via bolt (18).

 : 17 mm

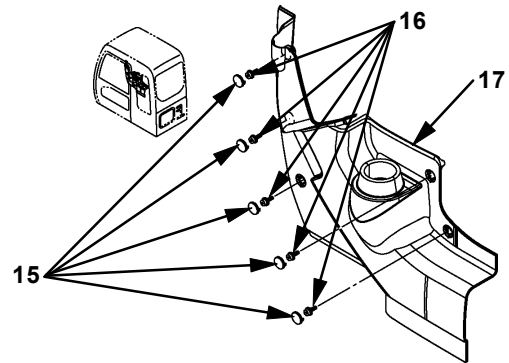
 : 50 N·m (5.1 kgf·m, 37 lbf·ft)



W178-02-01-017

UPPERSTRUCTURE / Cab

9. Install duct cover (17) with screws (16). Install caps (15) onto duct cover (17).

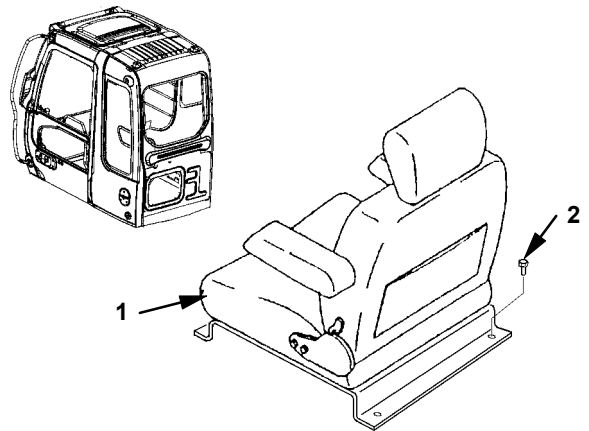


W178-02-01-016

10. Secure seat (1) with nut (2).

 : 17 mm

 : 50 N·m (5.1 kgf·m, 37 lbf·ft)



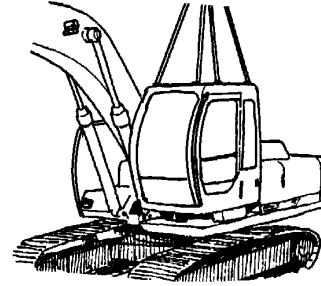
W178-02-07-006

UPPERSTRUCTURE / Cab

Installation (ZAXIS225US)

⚠ CAUTION: Cab weight: 270 kg (600 lb)

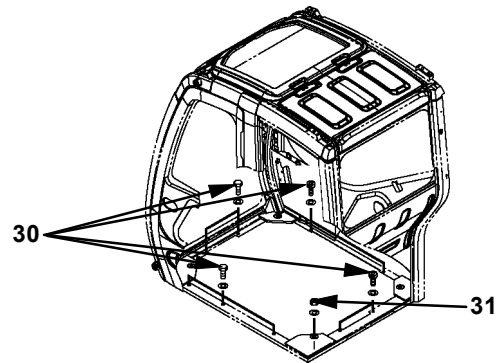
1. Attach lifting straps to the cab (4 places), lift and place the cab onto frame by crane.



W157-02-01-001

2. Install cab mounting bolts (30) and nut (31).

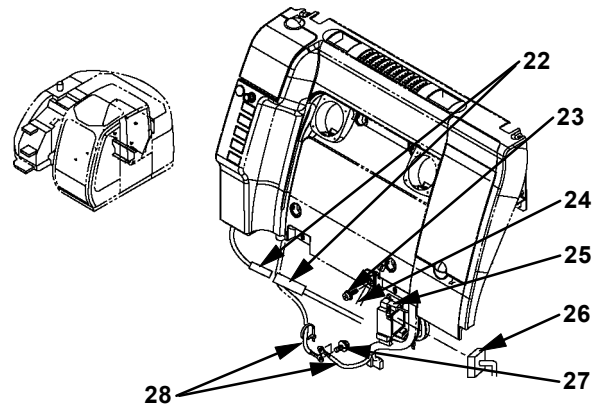
-  : 17 mm
-  : 50 N·m (5.1 kgf·m, 37 lbf·ft)
-  : 24 mm
-  : 210 N·m (21.5 kgf·m, 156 lbf·ft)
-  : 8 mm
-  : 50 N·m (5.1 kgf·m, 37 lbf·ft)



W15E-02-01-10

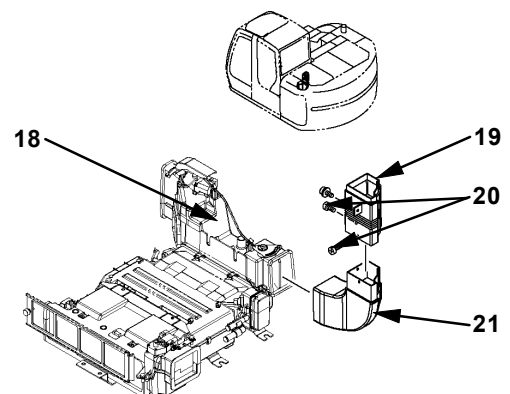
3. Connect ground (28) with bolts (27) (2 used).
Insert junction box (harness side) (26) into the junction box.
Connect connectors (25) (6 used).
Connect ground (24) with screw (23).
Insert the connector of radio antenna feeder (22) from both sides.

-  : 13 mm
-  : 10 N·m (1.0 kgf·m, 7.2 lbf·ft)



W15E-02-01-09

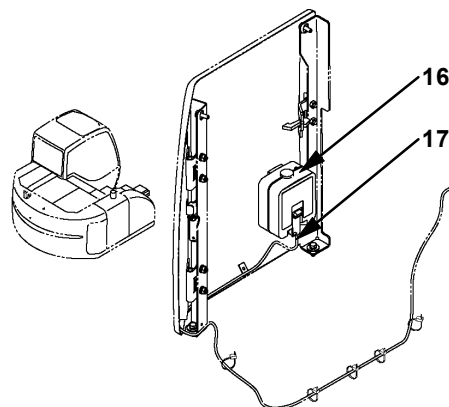
4. Install duct (21) into ducts (18) and (19) with screws (20) (2 used).



W15E-02-01-008

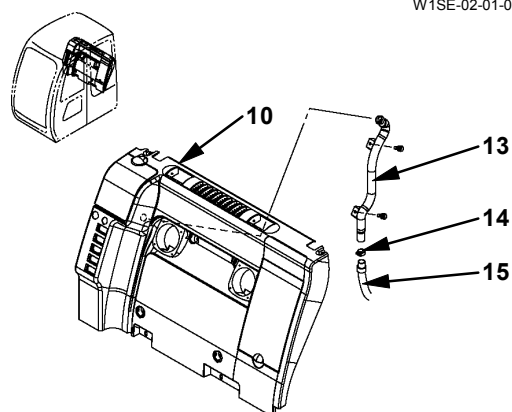
UPPERSTRUCTURE / Cab

5. Connect washer vinyl hose (17) to the bottom side of washer tank (16) at rear side of the cab.



W1SE-02-01-007

6. Press and connect air conditioner hose (15) to air conditioner hose (13) with clamp (14).

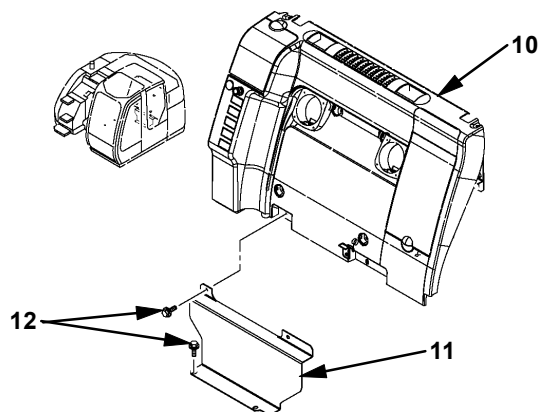


W1SE-02-01-006

7. Install cover (11) to rear cover (10) with bolts (12) (4 used).

 : 13 mm

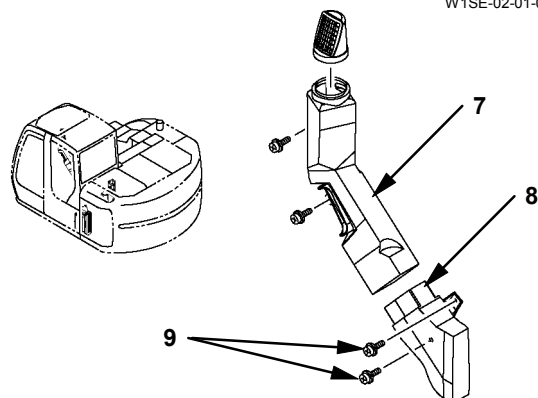
 : 10 N·m (1.0 kgf·m, 7.2 lbf·ft)



W1SE-02-01-005

8. Insert duct (8) into duct (7) and fix them with screws (9) (2 used).

 : 3 N·m (0.3 kgf·m, 2.2 lbf·ft)

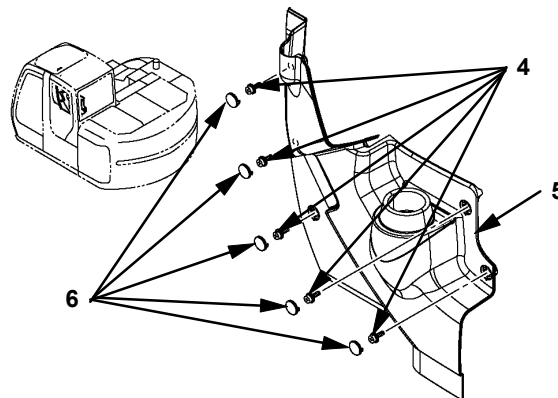


W1SE-02-01-004

UPPERSTRUCTURE / Cab

9. Install duct cover (5) to the cab with screw (4) and install cap (6).

 : 3 N·m (0.3 kgf·m, 2.2 lbf·ft)



W1SE-02-01-003

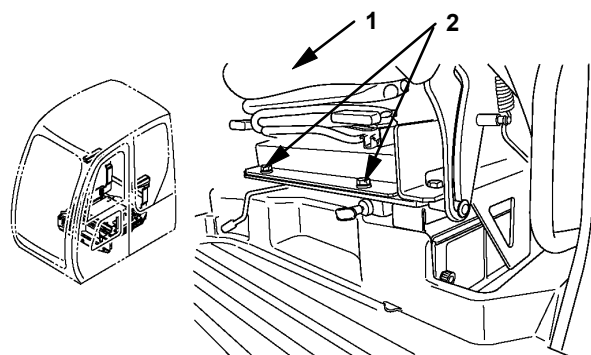
10. Install seat (1) with seat mounting bolts (2) (4 used) and seat belt bolts (3) (2 used).

 : 17 mm

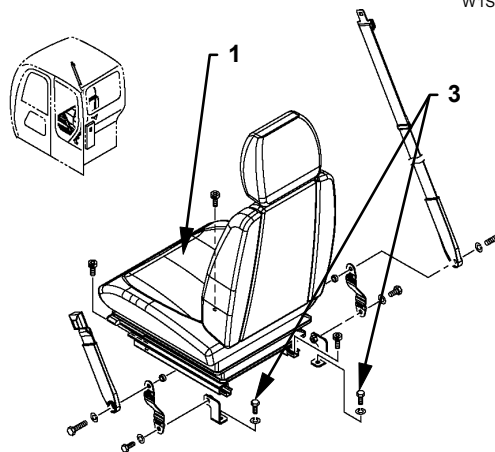
 : 50 N·m (5.1 kgf·m, 37 lbf·ft)

 : 16 mm

 : 70 N·m (7.1 kgf·m, 51 lbf·ft)



W1SE-02-01-001

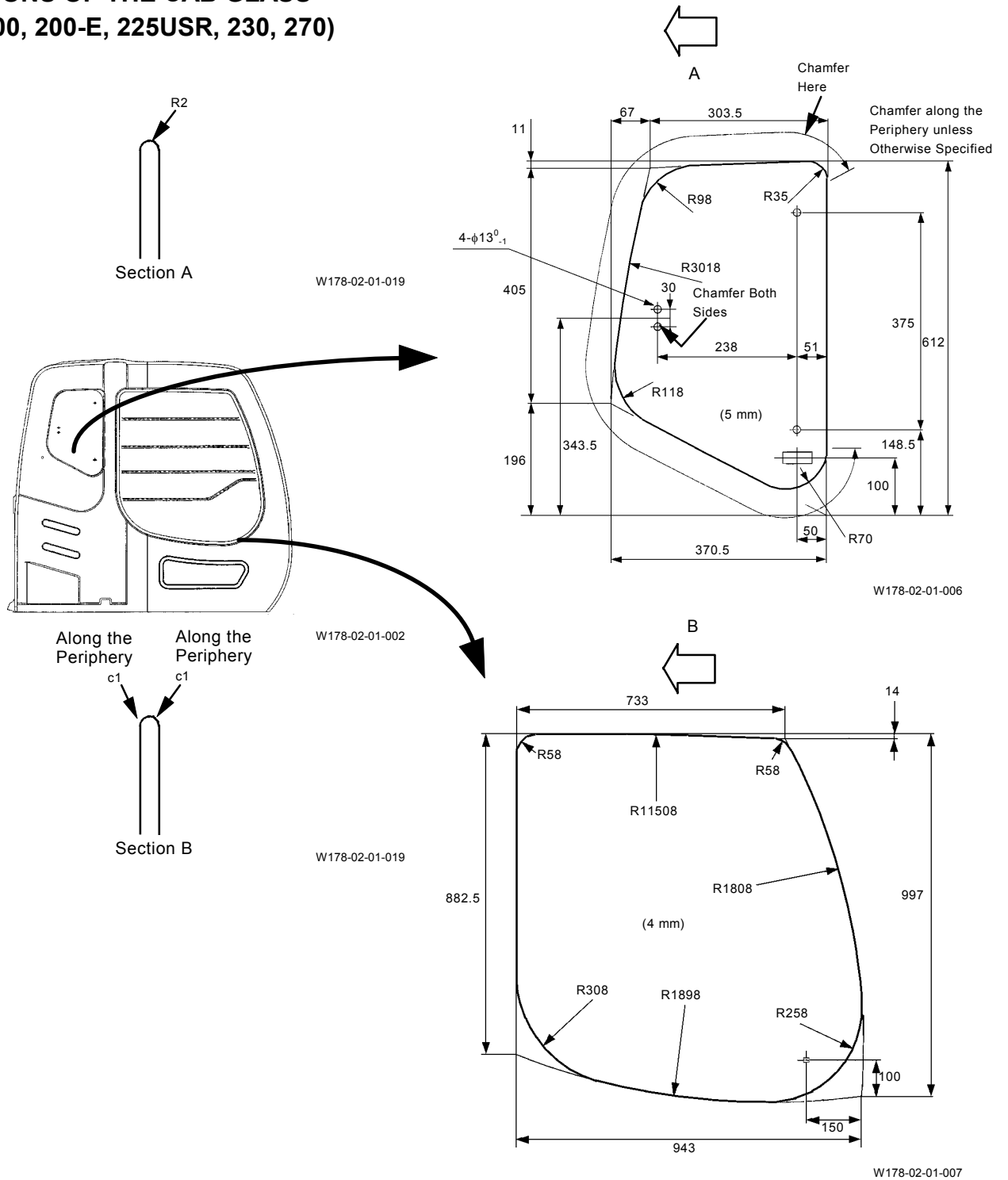


W1SE-02-01-002

UPPERSTRUCTURE / Cab

DIMENSIONS OF THE CAB GLASS (ZAXIS200, 200-E, 225USR, 230, 270)

Unit: mm



(ZAXIS225US)

Along the Periphery	Along the Periphery
------------------------	------------------------

C1 C1

Section A

W178-02-01-019

W1SE-02-01-012

R2

Section B

W178-02-01-019

W1SE-02-01-013

W1SE-02-01-014

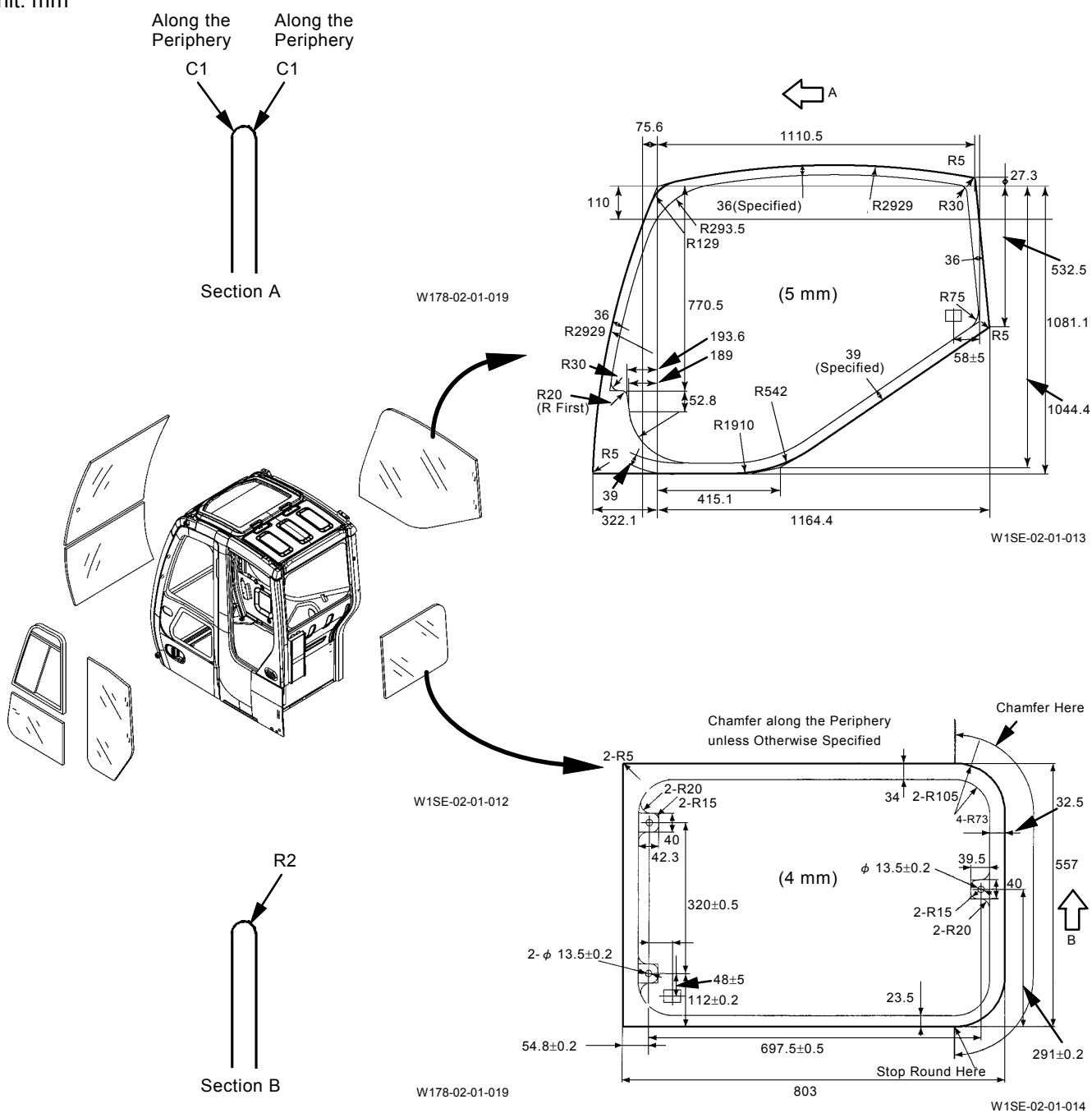
Chamfer along the Periphery
unless Otherwise Specified

Chamfer Here

← A

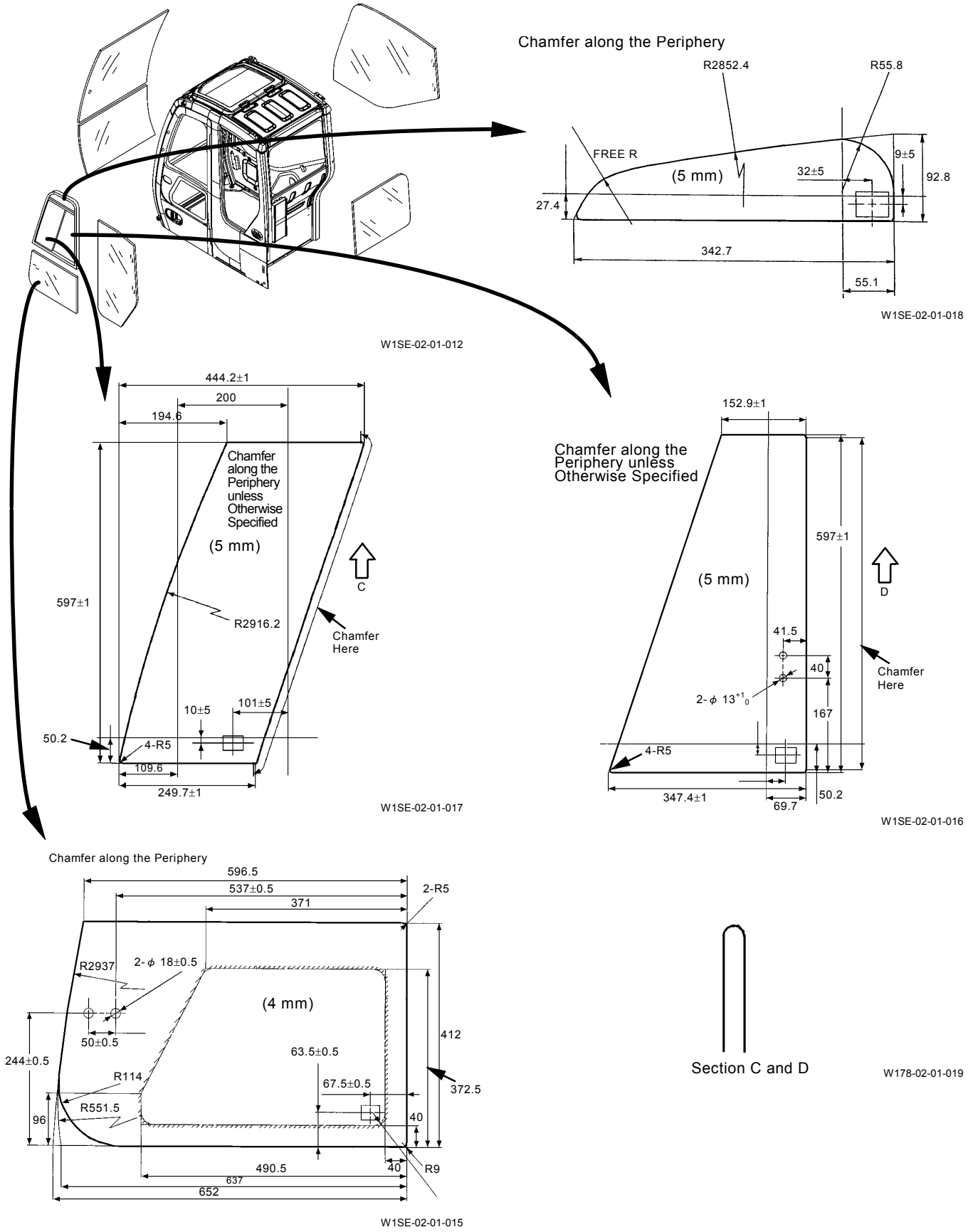

B

W2-1-15



UPPERSTRUCTURE / Cab

Unit: mm



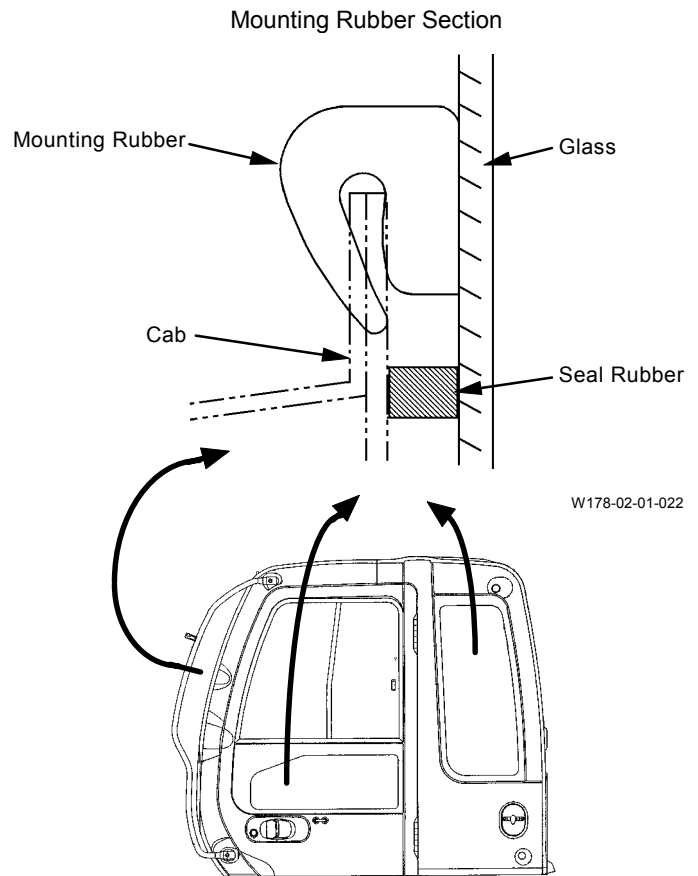
UPPERSTRUCTURE / Cab

Remove Cab Glass (ZAXIS200, 200-E, 225USR, 230, 270)

Procedures to remove left-hand cab glass, lower glass of the door and upper front glass

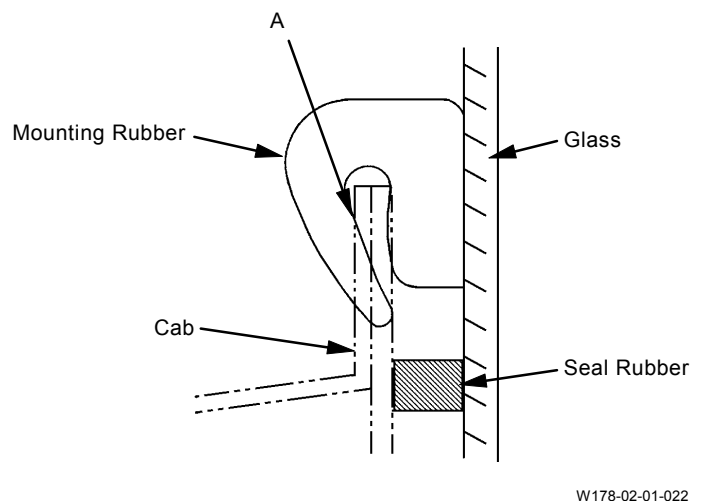


CAUTION: When removing broken or cracked glass beware of the danger of glass shards that may cause serious injury. Before removing, gummed tape or something like should be used to paste the broken or cracked glass ready to reinforce them so as to prevent hurt from occurring. Be sure to remove glass pieces away. Take protective measures before removing. Reinforce broken or cracked glass with gummed tape to assist in safe removal.



1. Insert bamboo spatula into position A in mounting rubber to pry the mounting rubber apart along all periphery. It is easier to remove glass when air is entered between cab and mounting rubber.
2. Tap glass from the side in cab by palm of the hand to take the glass off. Two men are required to do the work.

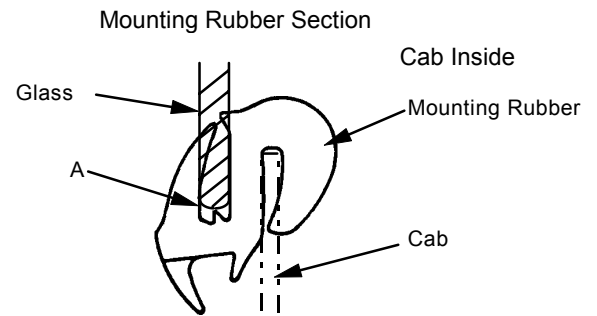
IMPORTANT: Be sure to install the cab glass and mounting rubber using the special bonding agent. The cab glass may fall if the special bonding agent is not used. The cab glass assembly can't be replaced individually. Be sure to change the cab glass as an assembly. The upper front glass is arched-fringed. If this glass needs to be replaced, contact with the nearest HITACHI Office to replace it as an assembly.



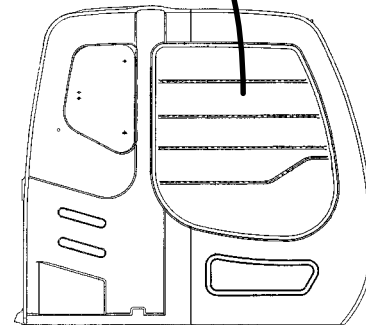
UPPERSTRUCTURE / Cab

Procedures to Remove Right-Hand Cab Glass

1. Insert a bamboo spatula into position A in mounting rubber to pry the mounting rubber apart along all periphery. It is easier to remove the glass when air is entered between cab and mounting rubber.
2. Tap glass from the side in cab by palm of the hand to take the glass off. Two men are required to do the work.



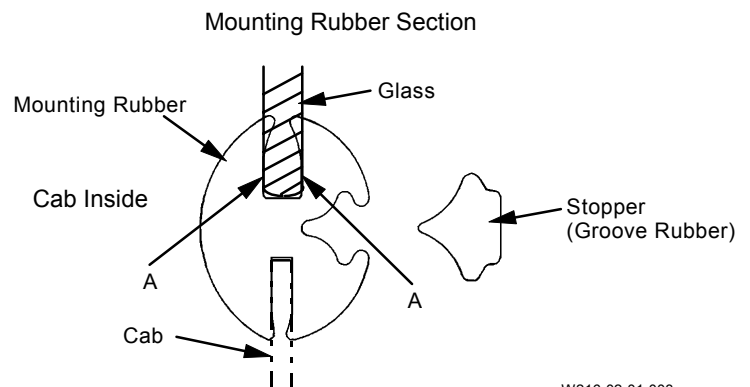
W216-02-01-005



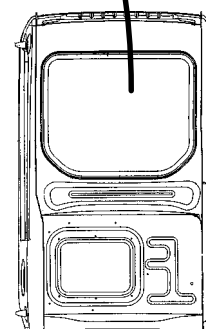
W178-02-01-002

Method to remove rear side cab glass

1. Remove stopper (groove rubber) with a minus screwdriver.
2. Insert a bamboo spatula into position A in mounting rubber to pry the mounting rubber apart along all periphery.
3. Tap glass from the side in cab by palm of the hand to take the glass off. Two men are required to do the work.



W216-02-01-003



W178-02-01-005

Method to Remove Cab Glass (ZAXIS125US, 135US)

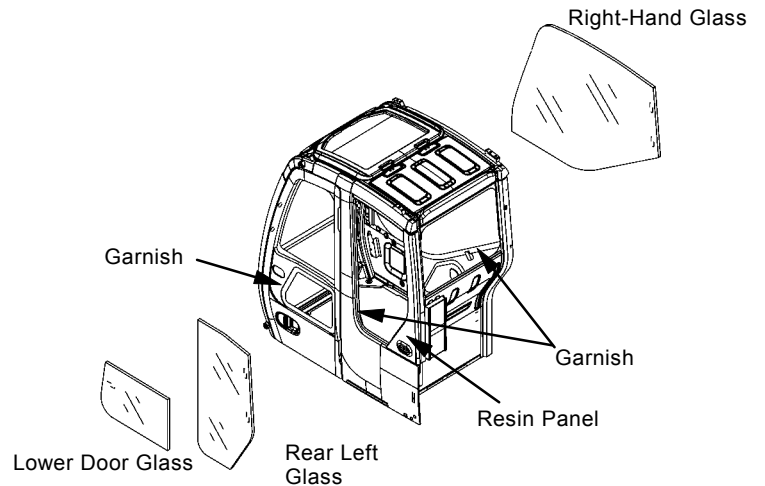
UPPERSTRUCTURE / Cab

Method to remove cab glass (ZAXIS225US)

Procedures to remove right-hand glass, rear left glass and lower door glass



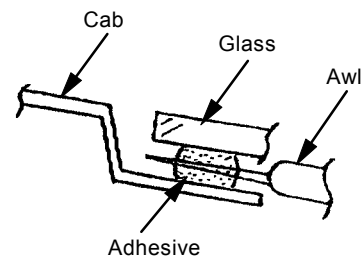
CAUTION: When removing broken or cracked glass beware of the danger of glass shards that may cause serious injury. Before removing, gummed tape or something like should be used to paste the broken or cracked glass ready to reinforce them so as to prevent hurt from occurring. Be sure to remove glass pieces away. Take protective measures before removing. Reinforce broken or cracked glass with gummed tape to assist in safe removal.



W1SE-02-01-042

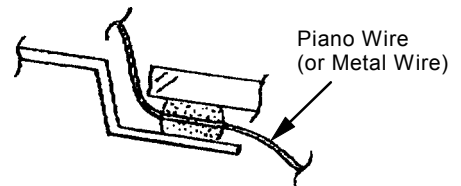
1. Remove the resin panel, garnish, spacer or etc. around the glass.

2. Prick a hole in the bonding agent with an awl (or cutter knife).



W1SE-02-01-033

3. Pass a piano wire (or a wire) through the pricked hole.

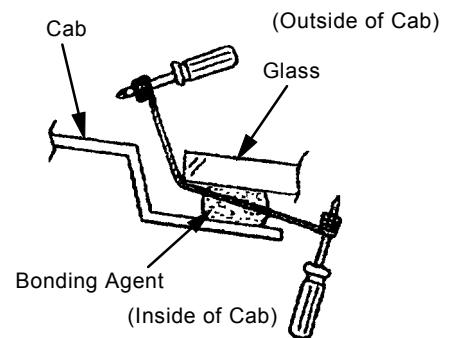


W1SE-02-01-034

UPPERSTRUCTURE / Cab

4. Tie both ends of piano wire to two screwdrivers. Draw the wire back and forth to cut the bonding agent between cab and glass to remove the glass from the cab.

 **NOTE:** Be sure to cut off the bonding agent between glass and cab just in the middle. Piano wire is easily broken if a part of it turns hot. Be sure to change the portion used while cutting the bonding agent.



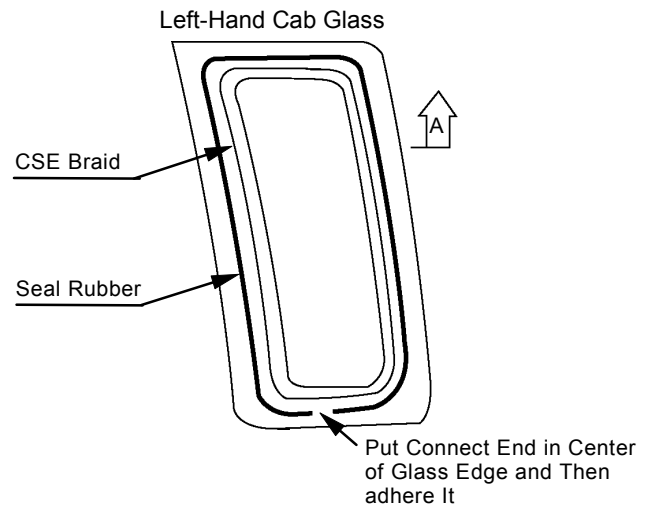
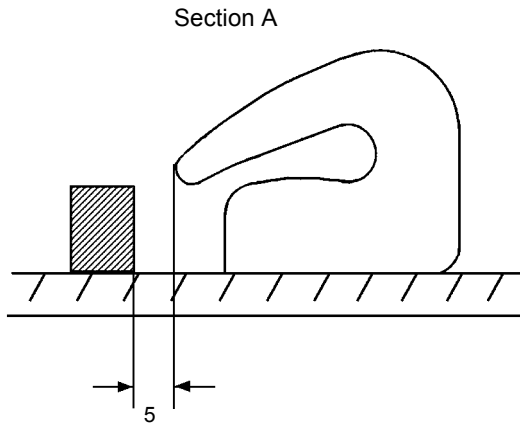
W1SE-02-01-035

UPPERSTRUCTURE / Cab

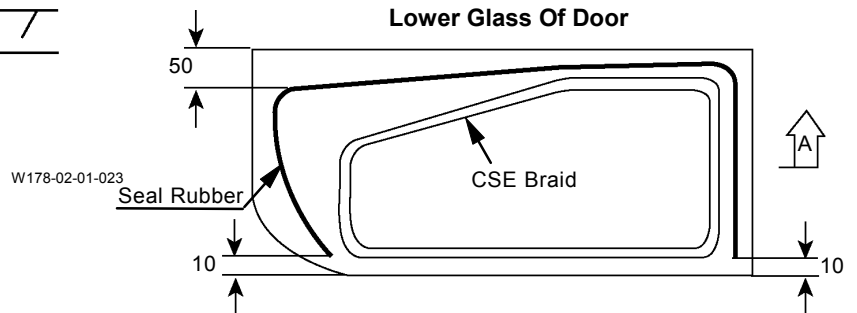
Cab Glass Installation Procedure (ZAXIS200, 200-E, 225USR, 230, 270)

Procedure for installing left-hand cab glass, lower glass of the door and upper front glass

1. Install the seal rubber on the left-hand cab glass and lower glass of the door.



W178-02-01-021

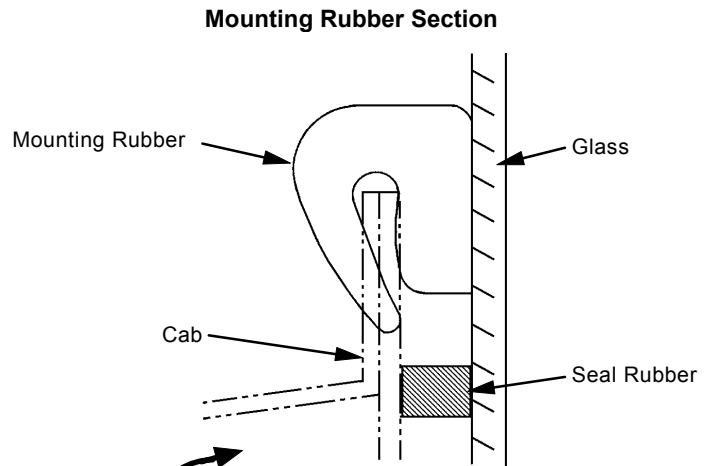


W178-02-01-020

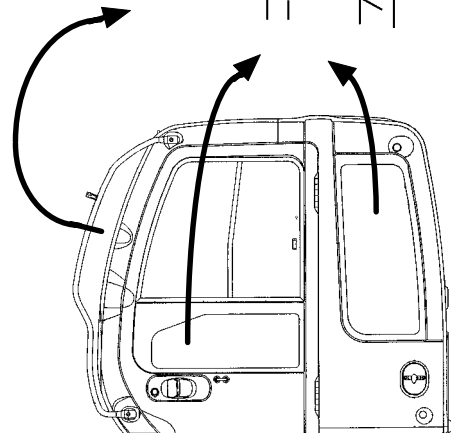
2. When the mounting rubber is already on the glass, pull and fasten the mounting rubber onto the mounting face of cab.

IMPORTANT: Be sure to install the cab glass and mounting rubber using the special bonding agent. The cab glass may fall if the special bonding agent is not used. The cab glass assembly can't be replaced individually. Be sure to change the cab glass as an assembly.

The upper front glass is arched-fringed. If this glass needs to be replaced, replaced it as an assembly.



W178-02-01-022



W178-02-01-004

UPPERSTRUCTURE / Cab

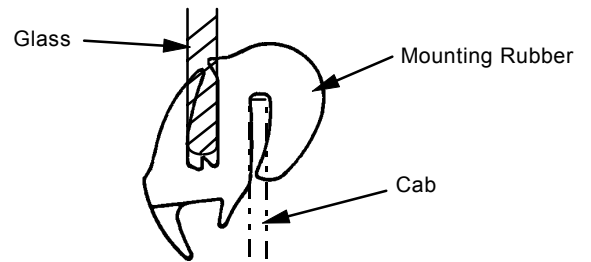
Method for Installing Right-Hand Cab Glass

1. Install the mounting rubber into the surrounding of cab glass. Bond the connectors of mounting rubber with the bonding agent (Cemedine 366 Standard or equivalent).

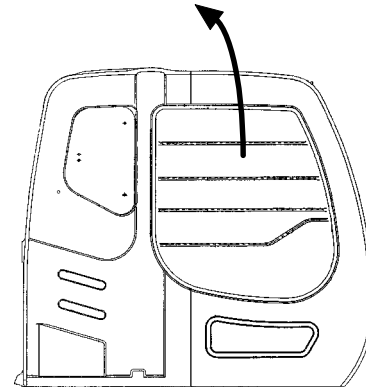
 **NOTE:** Rubber aging will cause the contraction of rubber, be sure to leave a little extra, install by pressing with hands.

2. Put and fasten the mounting rubber on the mounting face of cab after installing rubber.

Mounting Rubber Section



W216-02-01-005



W178-02-01-002

Procedures for Installing Rear Cab Glass

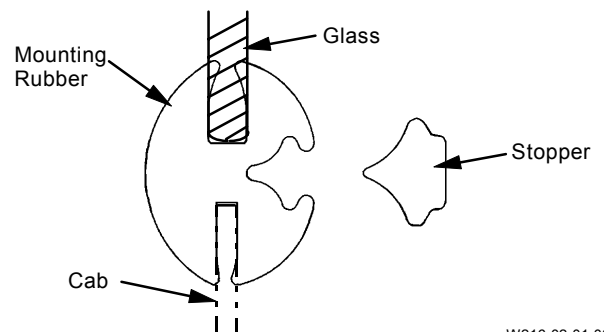
1. Insert mounting rubber around the cab glass. Install the connectors or mounting rubber with the bonding agent (Cemedine 366 Standard or equivalent).

 **NOTE:** Rubber aging will cause the contraction of rubber, be sure to leave a little extra, install by pressing with hands.

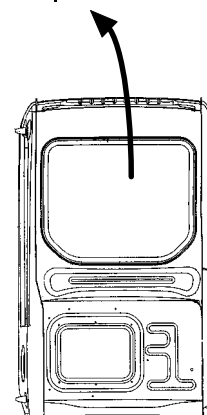
2. After installing the glass assembly on the cab, insert the stopper into rubber.

IMPORTANT: The rear side glass is arched-fringed. If this glass needs to be replaced, contact with the nearest HITACHI Office to replace it as an assembly.

Mounting Rubber Section



W216-02-01-003



W178-02-01-005

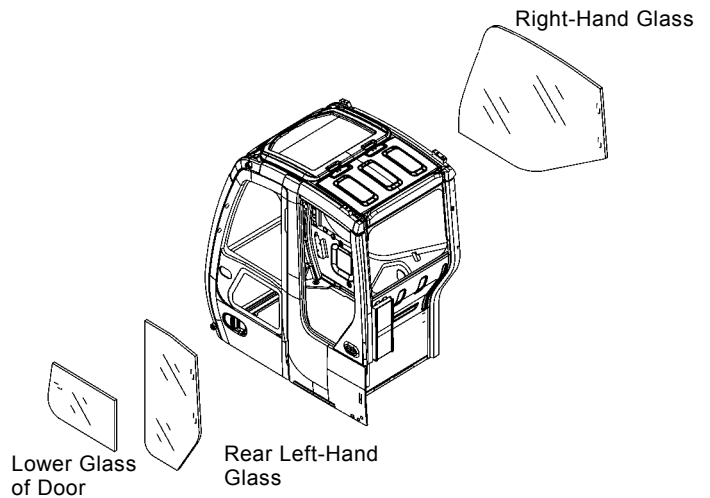
UPPERSTRUCTURE / Cab

Method for Installing Cab Glass (ZAXIS225US)

Procedures for right-hand glass, rear left-hand glass and lower door glass

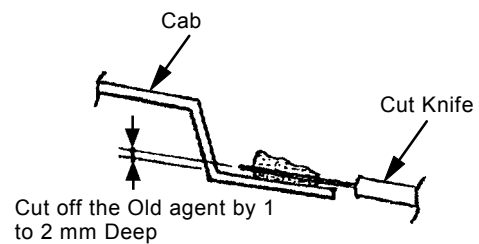
1. Cut the residual bonding agent off from cab side by 1 to 2 mm deep all around with cutter knife or similar.

 **NOTE:** Take care not to damage the cab paint.



W1SE-02-01-042

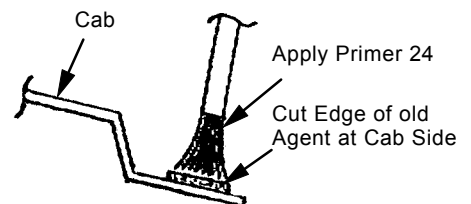
2. Clean the cut edge of the bonding agent at cab side with white spirit.



W1SE-02-01-036

IMPORTANT: Primer 24 should be shaken for about 1 minute to mix thoroughly before opening its cap.

With cap off, apply Primer 24 as quickly as possible, then replace cap immediately after use. All the contents should be used within 3 days after opening (or 2 hours with cap off).



W1SE-02-01-038

3. Painting primer (Sunrise MSI Primer 24).
Apply painting primer to the cut edge of old bonding agent all around and wait for 15 minutes to let it dry by itself.

 **NOTE:** Painting primer should be applied evenly. Leaving no blemishes.

UPPERSTRUCTURE / Cab

4. Clean the mating edge of new glass being installed with clean rag and ethylalcohol.

IMPORTANT: Primer 35 should be shaken for about 1 minute to mix thoroughly before opening. With cap off, apply Primer 24 as quickly as possible, then replace cap immediately after use. All the contents should be used within 3 days after opening (or 2 hours with cap off).

5. Apply glass primer (sunrise MSI primer 35) all around where glass bonding agent should be applied. Wait for about 15 minutes for drying. (As for the position to apply primer 35, refer to W2-1-25)
6. Remove the peel paper from the spacer and install the spacer with its adhesive face to the glass. (As for the positions to install spacers a, b and c, refer to W2-1-25)
7. Cut the nozzle of bonding agent cartridge (sunrise MSI SR seal U90 4463876) into V-shaped with a knife. (Refer to W2-1-25)
8. Remove the seal of cartridge end to fix the cut V-shaped nozzle on.
9. Install the cartridge to the manual cocking gun.
10. When applying bonding agent to the position where needed, the bead triangle formed by the agent should be even. (As for the position to apply the agent, refer to W2-1-23)

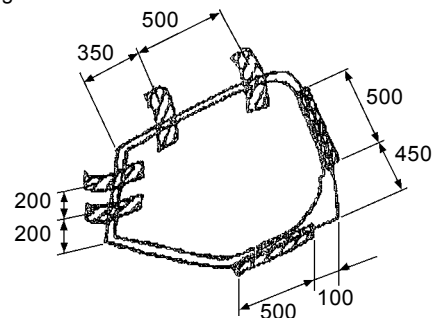
11. After applying agent, suck the glass (with sucker lifter 4355282, refer to W2-1-25) up to adhere it to the cab within 5 minutes.

 **NOTE:** Mount the glass with its spacer being fit ready to the cab while taking the spacer as matching mark. Press to install the glass. Remove all bonding agent, except where on the mounting face, before solidifying with white spirit.

12. The glass should be adequately secured with gummed tape till the bonding agent becomes solid to prevent them from being mispositioned or coming off.

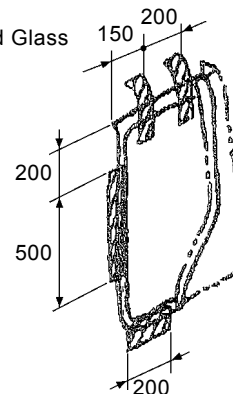
 **NOTE:** Time for the bonding agent (sunrise MSI SR seal U90 4463876) to turn into a solid: 8 hours (just for reference)

Right-Hand Glass



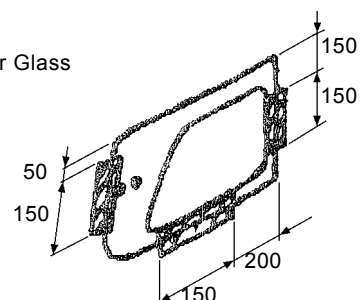
W1SE-02-01-039

Rear Left-Hand Glass



W1SE-02-01-040

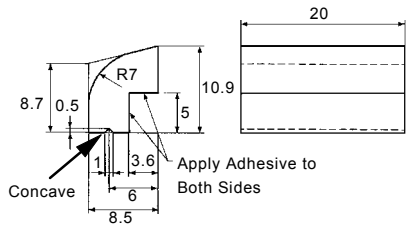
Lower Door Glass



W1SE-02-01-041

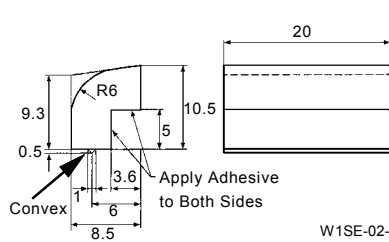
UPPERSTRUCTURE / Cab

Spacer a (4458466)



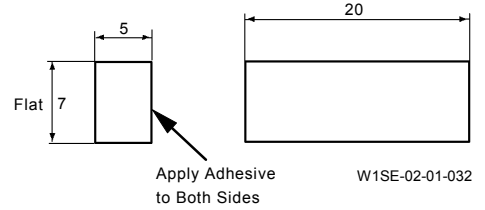
W1SE-02-01-030

Spacer b (4458469)



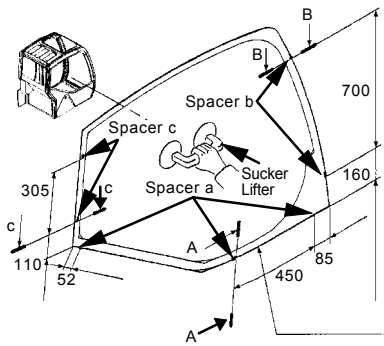
W1SE-02-01-031

Spacer c (4458470)



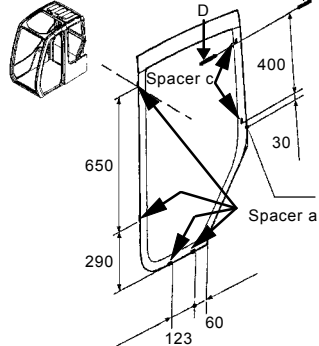
W1SE-02-01-032

Left-Hand Glass



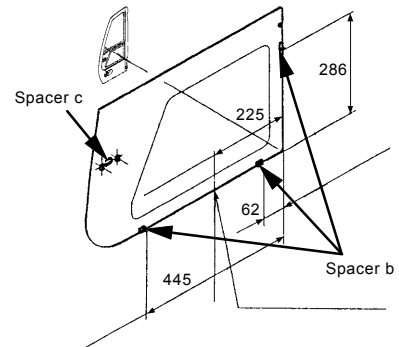
W1SE-02-01-019

Left-Hand Glass



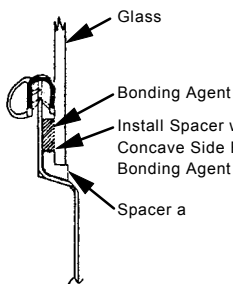
W1SE-02-01-021

Lower Door Glass



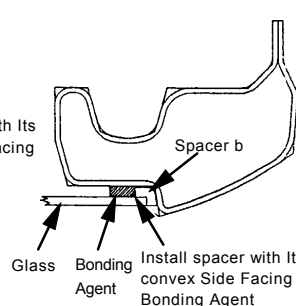
W1SE-02-01-020

Section A-A



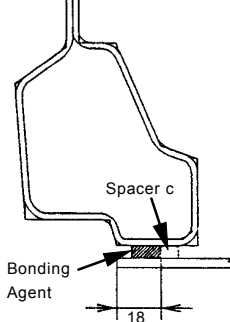
W1SE-02-01-023

Section B-B



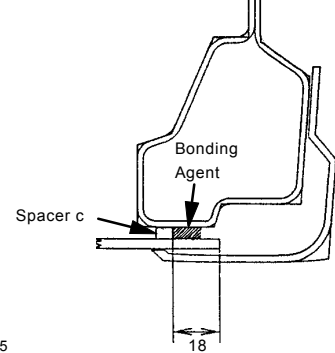
W1SE-02-01-024

Section C-C

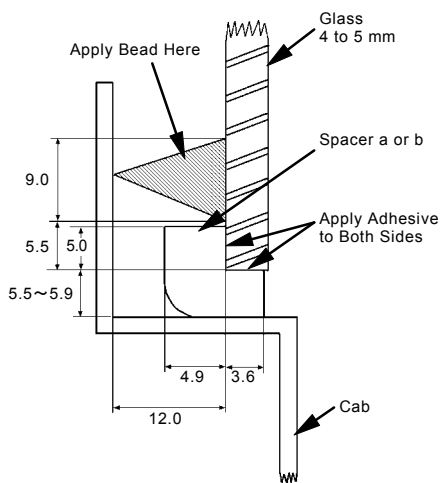


W1SE-02-01-025

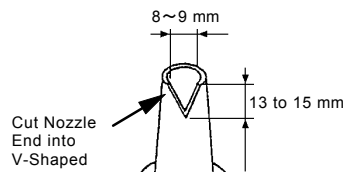
断面 D-D



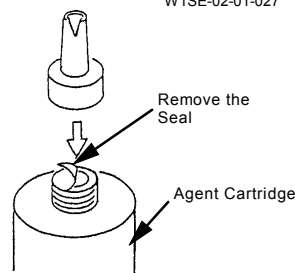
W1SE-02-01-026



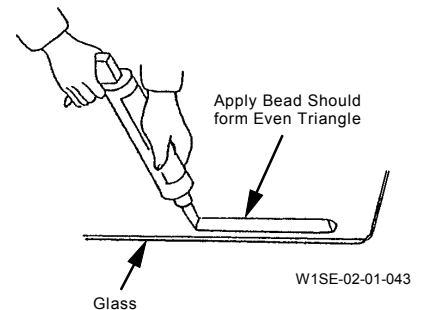
W1SE-02-01-022



W1SE-02-01-027



W1SE-02-01-028



W1SE-02-01-043

UPPERSTRUCTURE / Cab

13. The required amount (just for reference) of bonding agent and primer

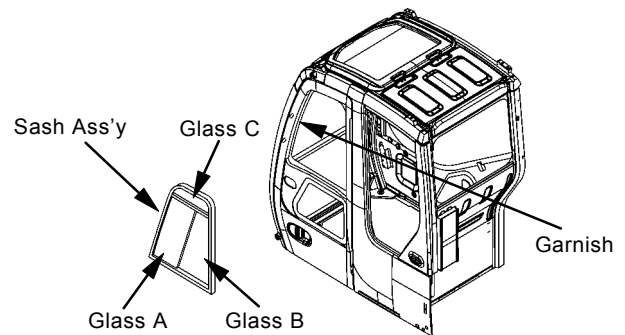
Glass	Bonding Agent: Sunrise MSI SR Seal U90 (4463876) 320 cm ³ Cartridge	Primer: Sunrise MSI Prime 24 (for painting) Primer 35 (for glass) 150 cm ³ for each bin
Right-Hand Glass (1 used)	1 Used	1/10 Used for each
Rear Left-Hand Glass (1 used)	1/2 Used	1/20 Used for each
Lower Door Glass (1 used)	1/3 Used	1/50 Used for each

IMPORTANT: The rear left-hand glass is arched-fringed. If this glass needs to be replaced, contact with the nearest HITACHI Office to replace it as an assembly.

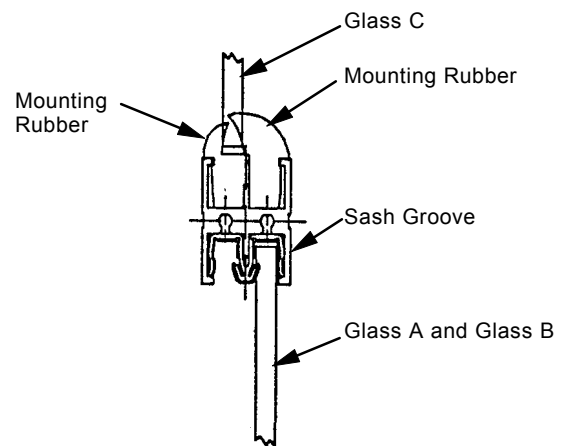
UPPERSTRUCTURE / Cab

Procedures to Install Upper Door Glass

1. Before installing the glass, remove the garnish around sash assembly from the side in the cab. Press sash assembly down by hand and push the sash outside to remove it.
2. Assemble glass A and glass B into sash grooves. Insert glass C into the mounting rubber.
3. Install the sash assembly, which is with glass ready fitted, onto the door from the outside of cab. Then secure the sash assembly at the inside of cab with garnish.



W1SE-02-01-044



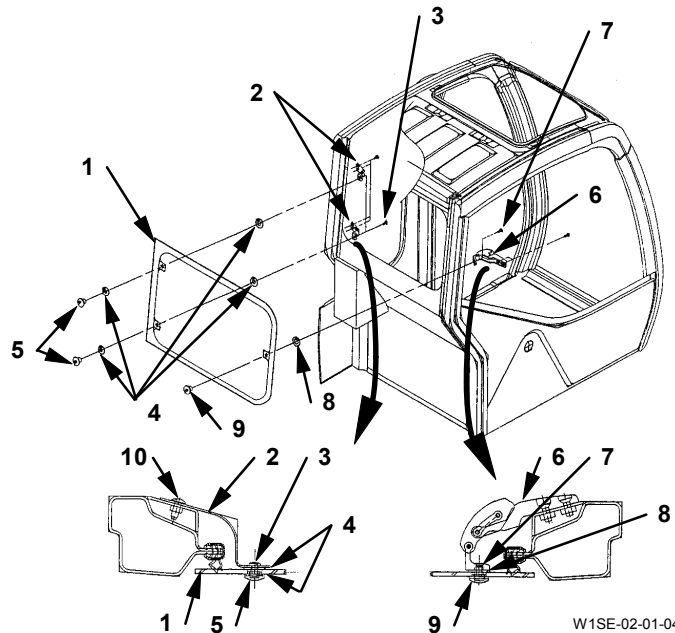
W1SE-02-01-045

UPPERSTRUCTURE / Cab

Procedures to Install Rear Glass

1. Align the rear glass (1) with the mounting position at rear side of the cab.
2. Secure the rear glass temporarily with hinges (2) (2 used) by tightening screws (3) (2 used), washers (4) (4 used) and nuts (5) (2 used).
3. Secure the rear glass temporarily with catch handle (6) by tightening screw (7), washer (8) and nut (9).
4. Tighten screws (3) (2 used) and screw (7) when balance is achieved.
5. The right and left balance of the side facing cab should be adjusted by tightening or loosening screw (10) of hinge (2).

IMPORTANT: The rear glass is arched-fringed. If this glass needs to be replaced, contact with the nearest HITACHI Office to replace it as an assembly.



W1SE-02-01-046

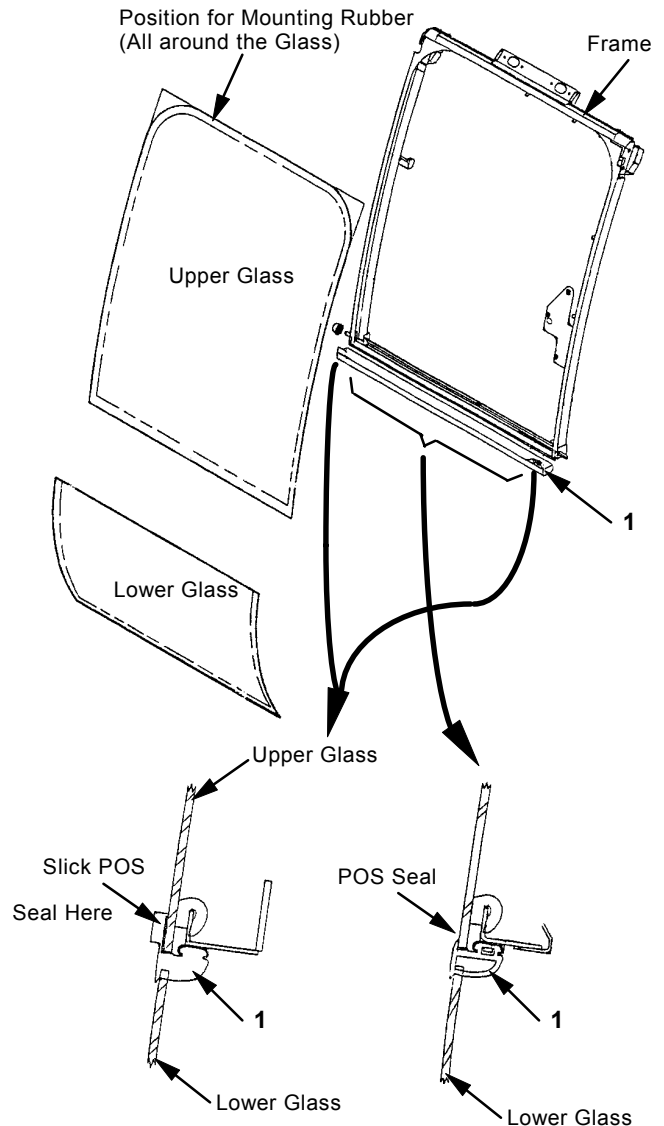
UPPERSTRUCTURE / Cab

Procedures to Install Upper Front Glass

1. Mounting rubber is stuck on glass. Be sure to install the glass with the mounting rubber contacting the cab mounting face, then secure them. (All around the glass)
2. Stick seal (1) to the lower side of the front upper glass with POS seal.
Stick both right and left ends (the thicker part) of seal (1) to the glass and secure it with bonding agent POS seal.
Stick the end of middle lip in seal (1) with POS seal.
Be sure no visible undulation or boss can be found.

 **NOTE:** POS seal:
POS seal (black) of TOSHIBA silicon
Glue-state bonding agent, tubed

IMPORTANT: Be sure to install the cab glass and mounting rubber using the special bonding agent. The cab glass may fall if the special bonding agent is not used. The cab glass assembly can't be replaced individually. Be sure to change the cab glass as an assembly.
The upper front glass is arched-fringed. If this glass needs to be replaced, contact the nearest HI-TACHI Office to replace it as an assembly.



W1SE-02-01-047

UPPERSTRUCTURE / Cab

(Blank)

UPPERSTRUCTURE / Counterweight

REMOVE AND INSTALL COUNTER-WEIGHT

Removal



CAUTION: Counterweight weight:
ZAXIS 200, 200-E 4250 kg (9370 lb)
ZAXIS 225USR 6710 kg (14790 lb)
ZAXIS 225US 7600kg (15550 lb)

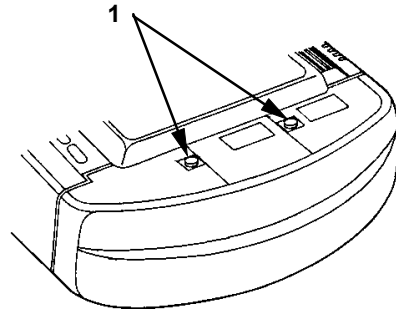
1. Remove caps (1) from upper counterweight. Install sling bolts to the counterweight.



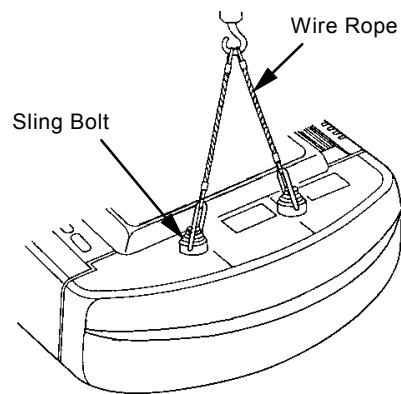
NOTE: Sling bolt specification

ZAXIS 200, 200-E (B-36: M36, Pitch 4.0)
ZAXIS 225US, 225URS, 230, 270 (B-42: M42, Pitch 4.5)

2. Attach wire rope to sling bolts using shackles. Take out slack of wire rope by applying tension slowly by crane or hoist.



W178-02-02-001



W178-02-02-002

3. Remove mounting bolt (2) from the counterweight. Lift and remove the counterweight by crane or hoist.

ZAXIS 200, 200-E

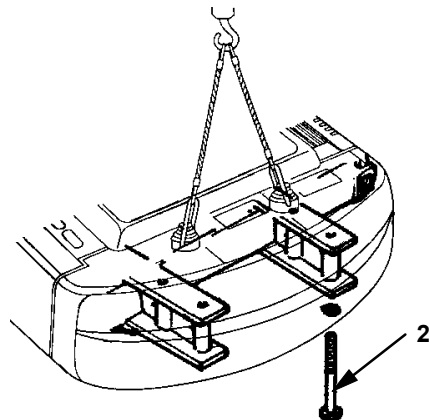
 : 41 mm

ZAXIS 225USR

 : 50 mm

ZAXIS 225USR

 : 60 mm



W178-02-02-003

UPPERSTRUCTURE / Counterweight

Installation



CAUTION: Counterweight weight:

ZAXIS 200, 200-E 4250 kg (9370 lb)

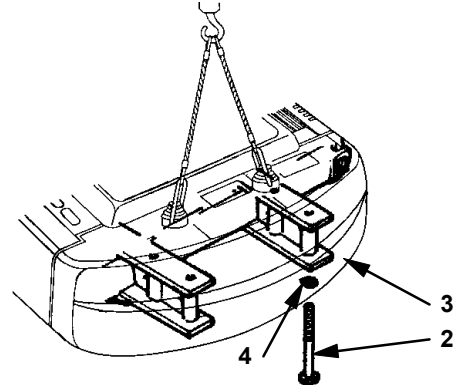
ZAXIS 225USR 6710 kg (14790 lb)

ZAXIS 225US 7600kg (15550 lb)

1. Lift counterweight (3) and install it onto the frame by crane.

Install washer (4) and tighten mounting bolt (2) to counterweight temporarily.

 : 41 mm



W178-02-02-003

2. Remove wire rope. Tighten the counterweight mounting bolts with a power wrench and torque wrench.

ZAXIS 200, 200-E

 : 41 mm

 : 1150 N·m (115 kgf·m, 830 lbf·ft)

ZAXIS 225USR

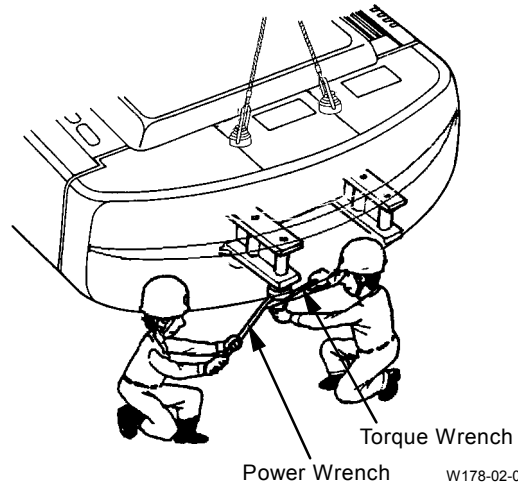
 : 50 mm

 : 2600 N·m (265 kgf·m, 1920 lbf·ft)

ZAXIS 225US

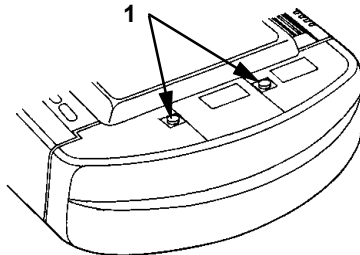
 : 60 mm

 : 3530 N·m (360 kgf·m, 2600 lbf·ft)



W178-02-02-004

3. Remove the sling-bolts. Install caps (1) to the counterweight.



W178-02-02-001

UPPERSTRUCTURE / Main Frame

REMOVE AND INSTALL MAIN FRAME

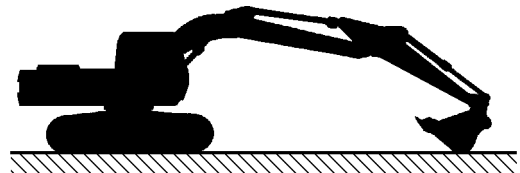


CAUTION: Escaping fluid under pressure can penetrate the skin, causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Hydraulic oil may be hot just after operation, and may spurt, possibly causing severe burns. Be sure to wait for oil to cool before starting work.

The hydraulic oil tank cap may fly off if removed without releasing internal pressure first. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.

Preparation

1. Place the machine on a firm, level surface.
2. Stop the engine. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.
3. Remove hydraulic oil tank cap. Connect a vacuum pump to maintain negative pressure in the hydraulic oil tank.
Be sure to run the vacuum pump continuously while working.



M104-07-021

UPPERSTRUCTURE / Main Frame

Removal



CAUTION: Cab weight:

290 kg (640 lb)

(ZAXIS200, 200-E, 225USR, 230, 270)

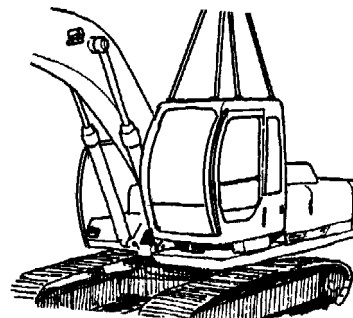
250 kg (550 lb) (ZAXIS225US)

1. Remove cab (See "Remove Cab" in this section).



 : 24mm, 19 mm, 17 mm, 13 mm

 : 8 mm



W157-02-01-001



CAUTION: Counterweight weight:

4250 kg (9370 lb) (ZAXIS200, 200-E)

7600 kg (16750 lb) (ZAXIS225US)

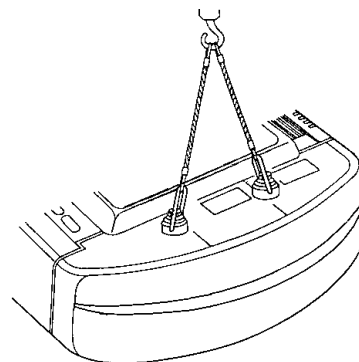
6710 kg (14790 lb) (ZAXIS225USR)

5400 kg (11900 lb) (ZAXIS230)

6100 kg (13450 lb) (ZAXIS270)

2. Remove the counterweight.
(See "Remove Counterweight" in this section.)

 : 41 mm, 46 mm, 50 mm, 60 mm



W178-02-02-002

UPPERSTRUCTURE / Main Frame



CAUTION: Front attachment weight:

3670 kg (8100 lb)

(ZAXIS200, 200-E, 225US, 225USR)

4650 kg (10250 lb) (ZAXIS230)

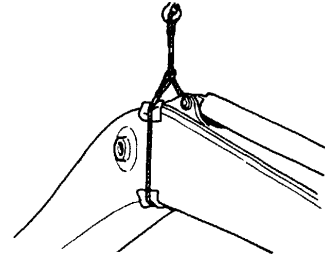
5000 kg (11020 lb) (ZAXIS270)

3. Remove the front attachment assembly.
(See "Removal of Front Attachment" in this section.)

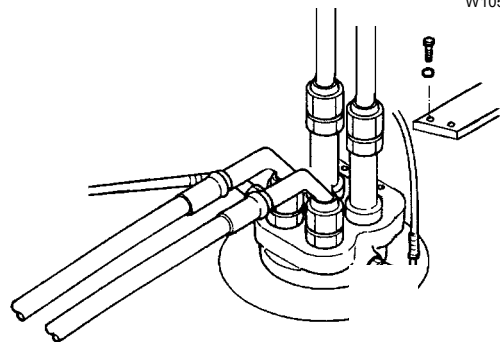
 : 17 mm, 19 mm, 27 mm, 36 mm, 41 mm

4. Remove all hoses from upper side of center joint.
Then remove the stopper.

 : 17 mm, 19 mm, 22 mm, 27 mm, 36 mm



W105-02-03-002



W173-03-03-001



CAUTION: Upperstructure weight:

4650 kg (10250 lb) (ZAXIS200, 200-E)

4850 kg (10690 lb) (ZAXIS225US)

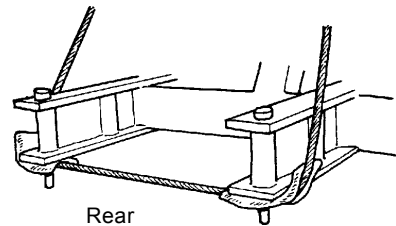
4750 kg (10470 lb) (ZAXIS225USR)

5090 kg (11220 lb) (ZAXIS230)

5270 kg (11620 lb) (ZAXIS270)

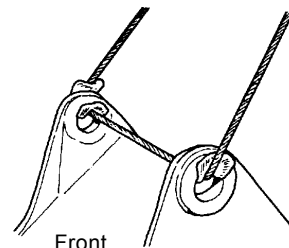
5. Attach wire ropes to the rear (counterweight bracket) of frame and boom bracket. Pull wire ropes taut.

If chain block (1) is used, it is not only easy to adjust the length of wire rope, but also easy to level the frame.



Rear

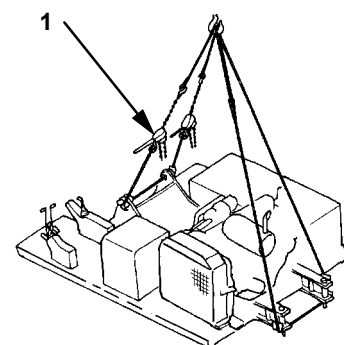
W105-02-03-004



Front

W105-02-03-005

IMPORTANT: Be sure not to damage the engine by the attached wire ropes at rear side of frame.



W157-02-03-001

UPPERSTRUCTURE / Main Frame

6. Put matching marks on the outer race of the upper-structure and the swing bearing.

Loosen and remove mounting bolt (2) of the swing bearing.

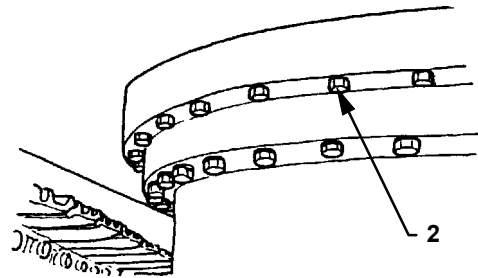
(ZAXIS200, 200-E, 225US, 225USR)

 : 30 mm

(ZAXIS230, 270)

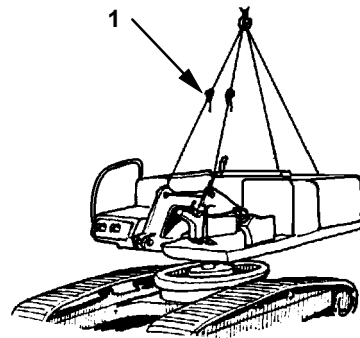
 : 32 mm

 **NOTE:** The mounting angle of swing bearing is specified. (Refer to W3-1)



W105-02-03-007

7. Chain block (1) shall be used to adjust and level the frame, then lift it slightly to remove it from the undercarriage.



W157-02-03-002

UPPERSTRUCTURE / Main Frame

Installation



CAUTION: Upperstructure weight:

4650 kg (10250 lb) (ZAXIS200, 200-E)

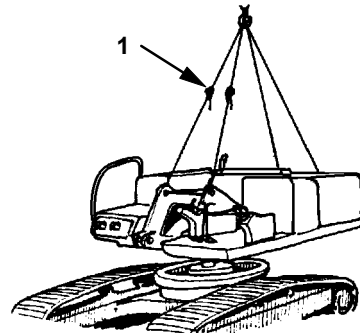
4850 kg (10690 lb) (ZAXIS225US)

4750 kg (10470 lb) (ZAXIS225USR)

5090 kg (11220 lb) (ZAXIS230)

5270 kg (11630 lb) (ZAXIS270)

1. Fasten wire rope to main frame. Level the main frame by adjusting chain block (1).
Lift it by crane to install it to the undercarriage.
As for lifting method, refer to "Removal" section.



W157-02-03-002

2. Align the matching mark on the outer race of the upperstructure and the swing bearing.
Install mounting bolt (2) to the swing bearing and tighten it temporarily. Remove wire rope and tighten the mounting bolts to the swing bearing to specification.

(ZAXIS200, 200-E, 225US, 225USR)

 : 30 mm

 : Swing device section:

510 N·m (52 kgf·m, 380 lbf·ft)

Track section:

490 N·m (50 kgf·m, 360 lbf·ft)

(ZAXIS230, 270)

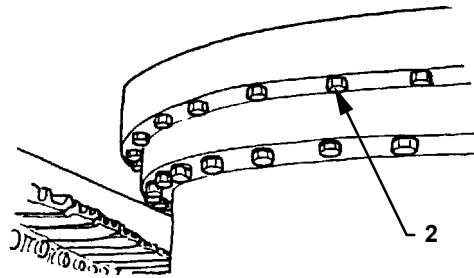
 : 32 mm

 : Swing device section:

640 N·m (65 kgf·m, 470 lbf·ft)

Track section:

640 N·m (65 kgf·m, 470 lbf·ft)



W105-02-03-007

3. Install all hoses to the center joint.

 : 17 mm

 : 25 N·m (2.5 kgf·m, 18 lbf·ft)

 : 19 mm

 : 30 N·m (3 kgf·m, 21.5 lbf·ft)

 : 27 mm

 : 93 N·m (9.5 kgf·m, 69 lbf·ft)

 : 36 mm

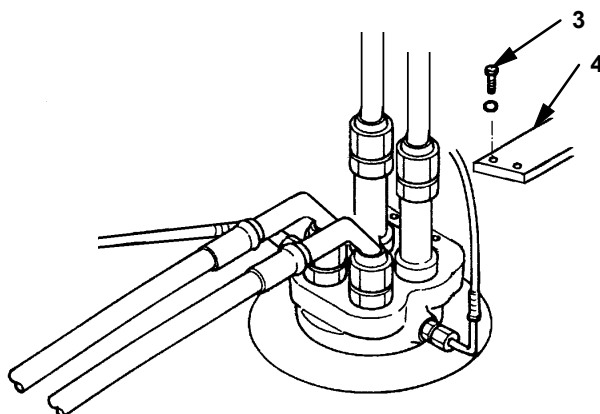
 : 175 N·m (18 kgf·m, 130 lbf·ft)

UPPERSTRUCTURE / Main Frame

4. Install stopper (4) and bolt (3) to the center joint.

 : 22 mm

 : 140 N·m (14.5 kgf·m, 105 lbf·ft)



W173-03-03-001



CAUTION: Cab weight:

290 kg (640 lb)

(ZAXIS200, 200-E, 225USR, 230, 270)

250 kg (550 lb) (ZAXIS225US)

5. Install cab (5).

(See "Removal and Installation of Cab" in this section.)



 : 24 mm

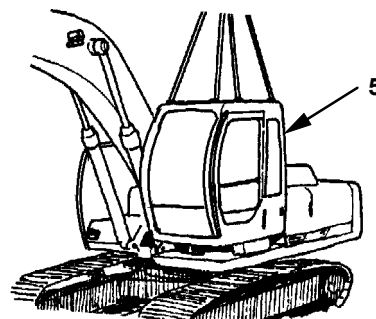
 : 205 N·m (21 kgf·m, 152 lbf·ft)

 : 17 mm

 : 50 N·m (5.1 kgf·m, 37 lbf·ft)

 : 8 mm

 : 50 N·m (5.1 kgf·m, 37 lbf·ft)



W157-02-01-001



CAUTION: Upperstructure weight:

4250 kg (9370 lb) (ZAXIS200, 200-E)

7600 kg (16750 lb) (ZAXIS225US)

6710 kg (14790 lb) (ZAXIS225USR)

5400 kg (11900 lb) (ZAXIS230)

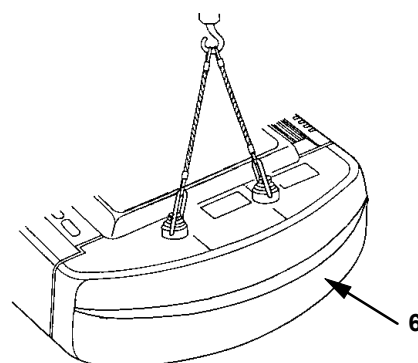
6100 kg (13450 lb) (ZAXIS270)

6. Install counterweight (6).

(See "Counterweight" in this section.)

 : 41 mm

 : 1150 N·m (115 kgf·m, 830 lbf·ft)



W178-02-02-002

UPPERSTRUCTURE / Main Frame



CAUTION: Front attachment weight:

3670 kg (8100 lb)

(ZAXIS200, 200-E, 225US, 225USR)

4650 kg (10250 lb) (ZAXIS230)

5000 kg (11020 lb) (ZAXIS270)

7. Install front attachment assembly (7). And fill hydraulic oil.

(See "Removal and Installation of Front Attachment" in this section.)

 : 17 mm

 : 50 N·m (5.1 kgf·m, 37 lbf·ft)

 : 19 mm

 : 29.5 N·m (3 kgf·m, 21.5 lbf·ft)

 : 27 mm

 : 400 N·m (41 kgf·m, 295 lbf·ft)

 : 30 mm

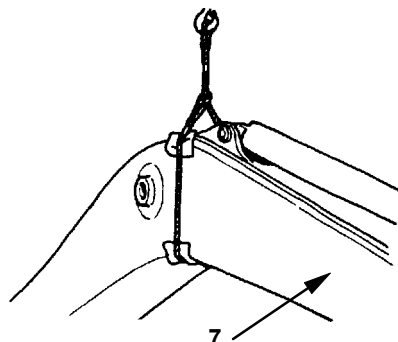
 : 550 N·m (56 kgf·m, 405 lbf·ft)

 : 36 mm

 : 175 N·m (18 kgf·m, 130 lbf·ft)

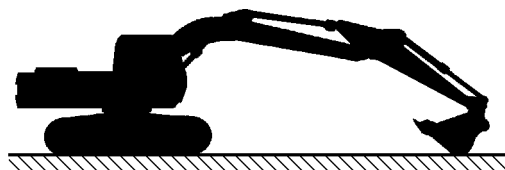
 : 41 mm

 : 205 N·m (21 kgf·m, 152 lbf·ft)



W105-02-03-002

8. Start the engine and set the front attachment in posture for checking hydraulic oil level in its tank. Inspect the hydraulic oil level and check if for any oil leaks.



M104-07-021

UPPERSTRUCTURE / Main Frame

(Blank)

UPPERSTRUCTURE / Pump Device

REMOVE AND INSTALL PUMP DEVICE



CAUTION: Escaping fluid under pressure can penetrate the skin, causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Hydraulic oil may be hot just after operation, and may spurt, possibly causing severe burns. Be sure to wait for oil to cool before starting work.

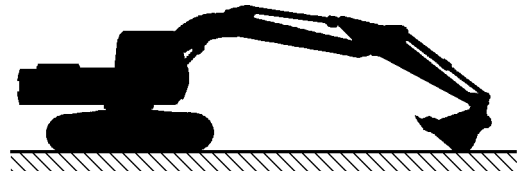
The hydraulic oil tank cap may fly off if removed without releasing internal pressure first. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.

Preparation

1. Place the machine on a firm, level surface.
2. Stop the engine. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.
3. Remove hydraulic oil tank cap. Connect a vacuum pump to maintain negative pressure in the hydraulic oil tank.



NOTE: Be sure to run the vacuum pump continuously while working.



M104-07-021

UPPERSTRUCTURE / Pump Device

Removal

1. Disconnect connectors (4 places).

CAUTION: Pump device weight:
170 kg (375 lb)

2. Disconnect hoses (1 to 4 and 6, 7, 9 to 12) and pipe (8) from the pump device.

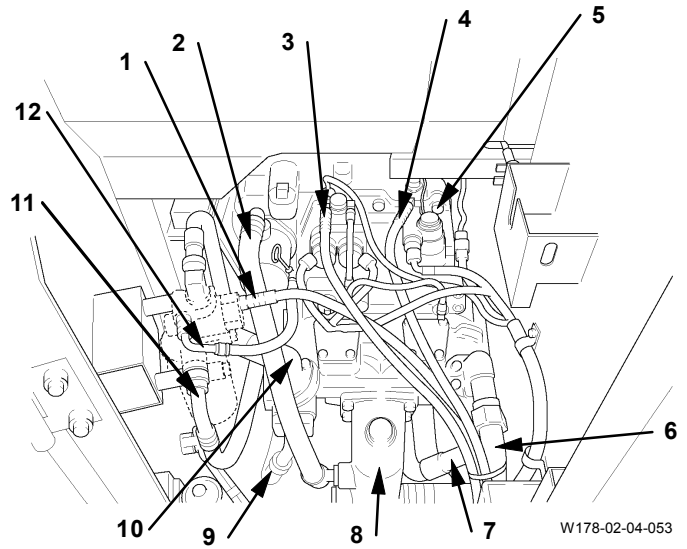
Wrench : 19 mm, 27 mm, 36 mm

Socket : 8 mm, 10 mm

IMPORTANT: Do not install the eyebolt to the regulator which is with solenoid valve.

3. Attach eyebolts (M12, Pitch 1.75) (ST 0002) to the pump device, then hold it by crane.
4. Remove pump device mounting bolts (5) (8 used) to remove the pump device.

Wrench : 17 mm



Installation

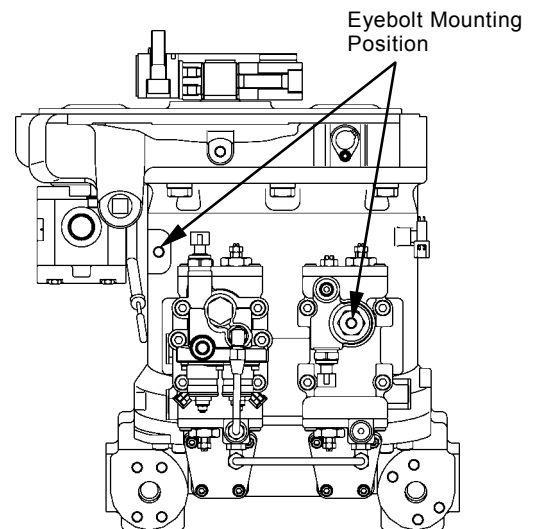
1. Install eyebolt (M12, Pitch 1.75) (ST 0002) on the pump device and lift by crane.
2. Insert the drive shaft of pump device into the pump mission, and install it with pump device mounting bolts (5) (8 used).

Wrench : 17 mm

Socket : 50 N·m (5.1 kgf·m, 37 lbf·ft)

3. Connect hoses (1 to 4 and 6, 7, 9 to 12) and pipe (8).
4. Connect connectors.

Wrench size (mm)	Tightening torque		Remark
	N·m	kgf·m(lbf·ft)	
Wrench : 27	93	9.5 (69)	Hose
Wrench : 36	175	18 (130)	Hose
Socket : 10	90	9.2 (67)	Bolt
Wrench : 17	50	5.1 (37)	Bolt
Socket : 8	50	5.1 (37)	Bolt
Wrench : 19	29.5	3 (21.5)	Hose



IMPORTANT: Bleed the air from the pump. (Refer to W1-1-2).

Be sure to check hydraulic oil level, and any oil leaks, after assembling.

Wrench : 27 mm

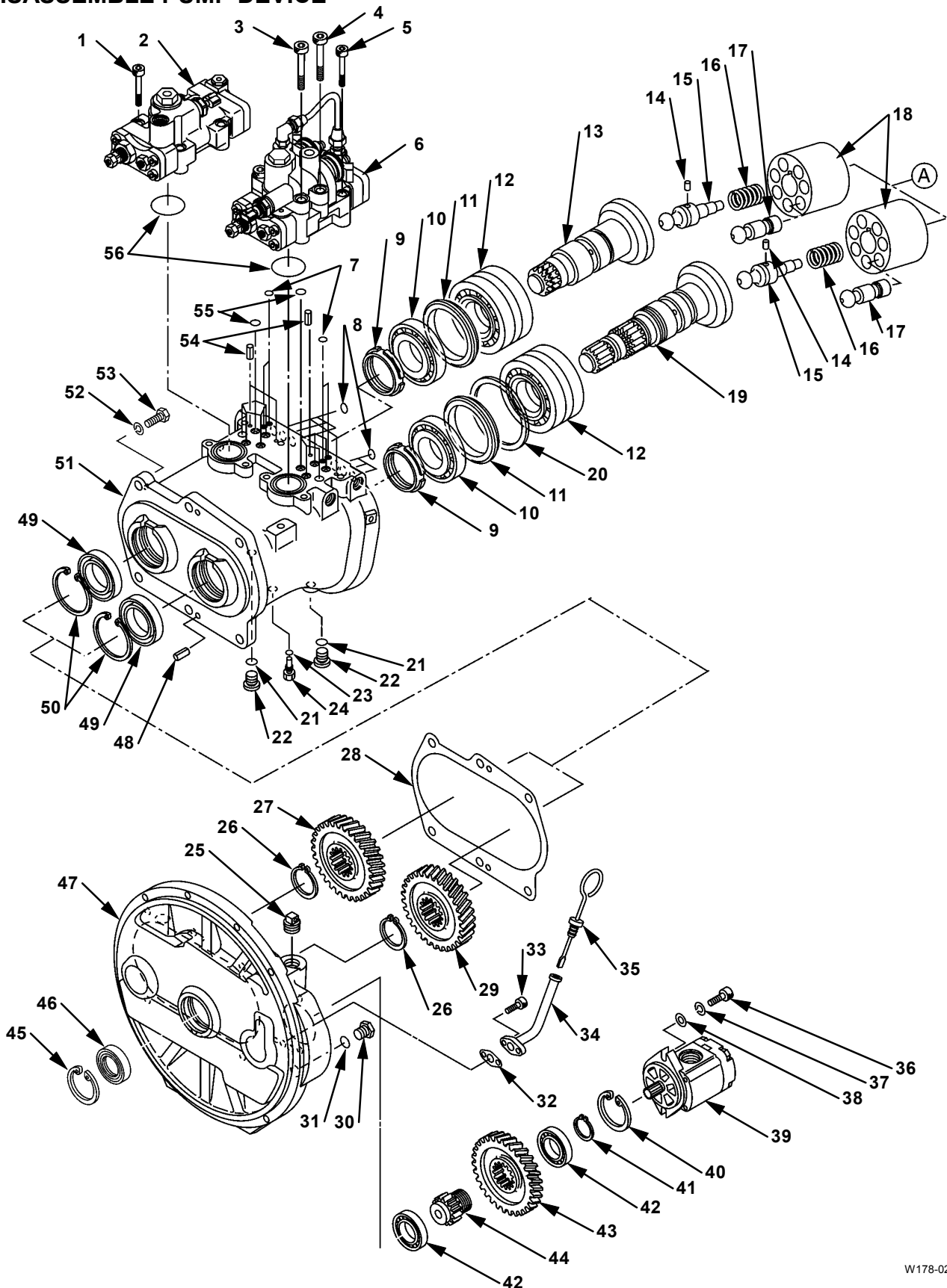
Socket : 49 N·m (5 kgf·m, 36 lbf·ft)

UPPERSTRUCTURE / Pump Device

(Blank)

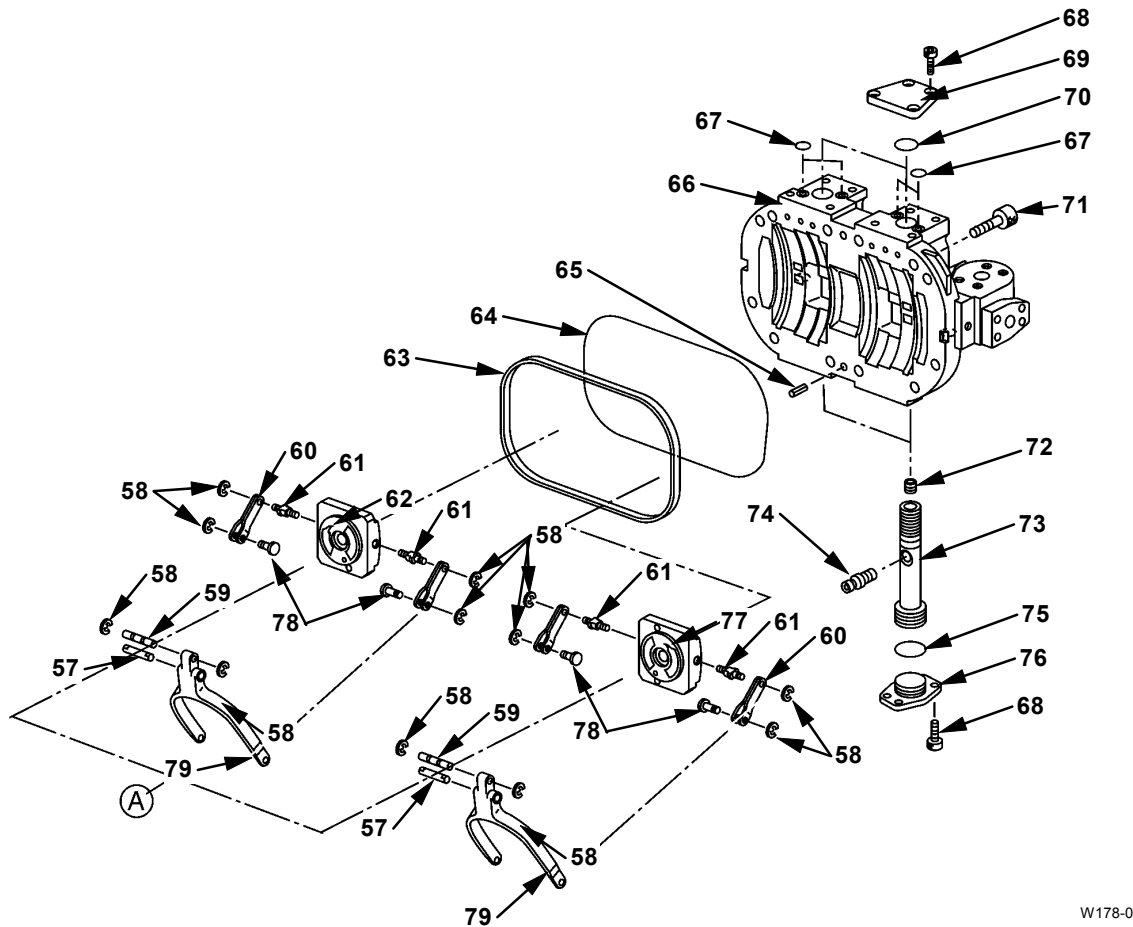
UPPERSTRUCTURE / Pump Device

DISASSEMBLE PUMP DEVICE



W178-02-04-004

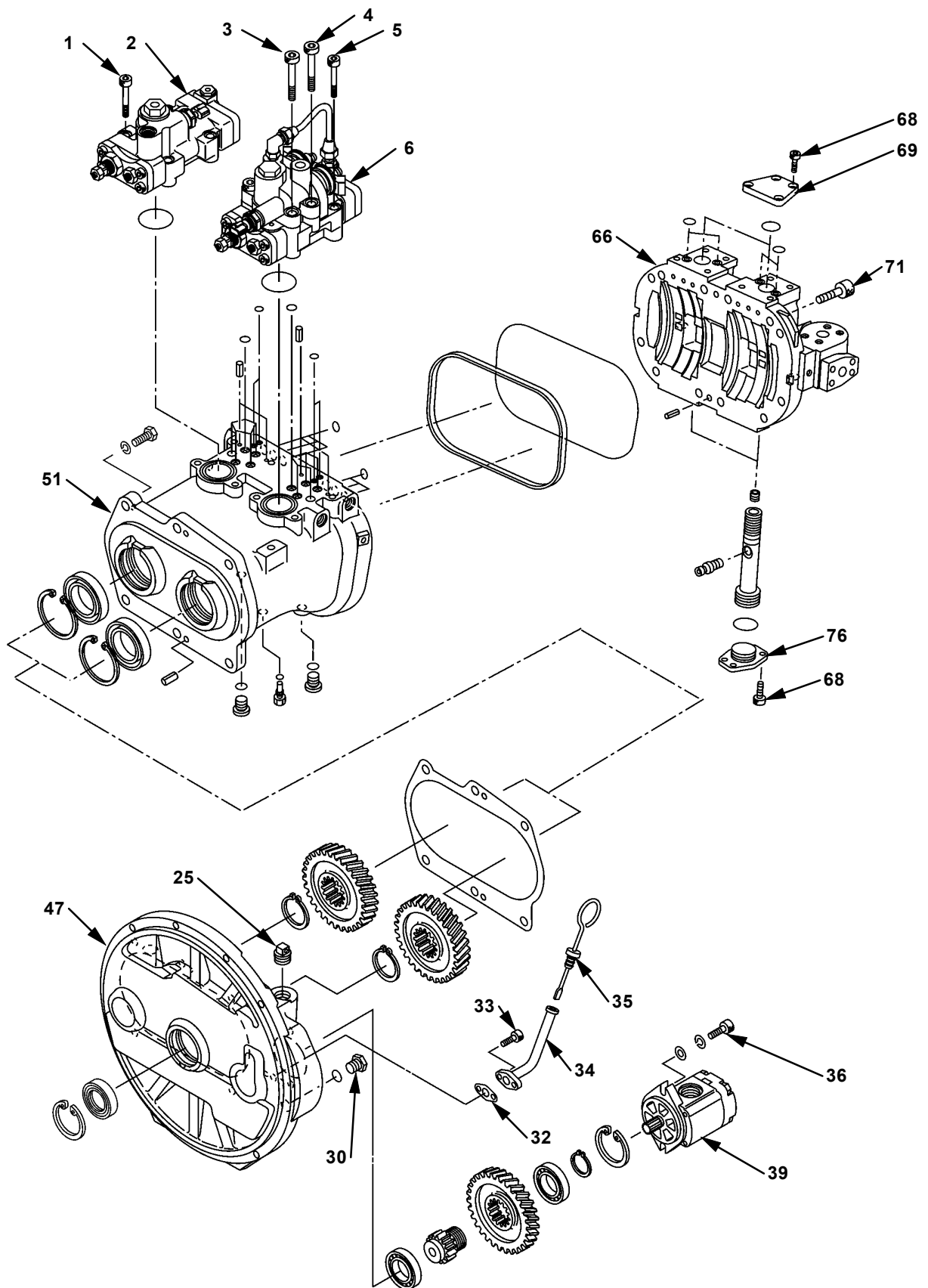
UPPERSTRUCTURE / Pump Device



W178-02-04-005

- | | | | |
|----------------------------|------------------------------|-------------------------------|----------------------------|
| 1 - Socket Bolt (4 Used) | 21 - O-Ring (2 Used) | 41 - Retaining Ring | 61 - Pin (4 Used) |
| 2 - Right Regulator | 22 - Plug (2 Used) | 42 - Ball Bearing (2 Used) | 62 - Right Valve Plate |
| 3 - Socket Bolt (2 Used) | 23 - O-Ring | 43 - Gear | 63 - Backup Ring |
| 4 - Socket Bolt (2 Used) | 24 - Stopper | 44 - Gear Shaft | 64 - O-Ring |
| 5 - Socket Bolt (2 Used) | 25 - Plug | 45 - Retaining Ring | 65 - Spring Pin (2 Used) |
| 6 - Left Regulator | 26 - Retaining Ring (2 Used) | 46 - Oil Seal | 66 - Selector Head |
| 7 - O-Ring (4 Used) | 27 - Gear | 47 - Gear Casing | 67 - O-Ring (4 Used) |
| 8 - O-Ring (6 Used) | 28 - Gasket | 48 - Spring Pin (2 Used) | 68 - Socket Bolt (16 Used) |
| 9 - Bearing Nut (2 Used) | 29 - Gear | 49 - Oil Seal (2 Used) | 69 - Stopper S (2 Used) |
| 10 - Bearing (2 Used) | 30 - Plug | 50 - Retaining Ring (2 Used) | 70 - O-Ring (2 Used) |
| 11 - Ring (2 Used) | 31 - O-Ring | 51 - Pump Casing | 71 - Socket Bolt (12 Used) |
| 12 - Bearing (2 Used) | 32 - Gasket | 52 - Spring Washer (6 Used) | 72 - Set Screw (2 Used) |
| 13 - Shaft | 33 - Socket Bolt (2 Used) | 53 - Bolt (6 Used) | 73 - Servo Piston (2 Used) |
| 14 - Pin (2 Used) | 34 - Pipe | 54 - Spring Pin (2 Used) | 74 - Pin (2 Used) |
| 15 - Center Shaft (2 Used) | 35 - Level Gauge | 55 - O-Ring (2 Used) | 75 - O-Ring (2 Used) |
| 16 - Spring (2 Used) | 36 - Socket Bolt (2 Used) | 56 - O-Ring (2 Used) | 76 - Stopper L (2 Used) |
| 17 - Plunger (14 Used) | 37 - Spring Washer (2 Used) | 57 - Pin (2 Used) | 77 - Left Valve Plate |
| 18 - Rotor (2 Used) | 38 - Washer (2 Used) | 58 - Retaining Ring (12 Used) | 78 - Pin (4 Used) |
| 19 - Shaft | 39 - Pilot Pump | 59 - Pin (2 Used) | 79 - Link (2 Used) |
| 20 - Slide Ring | 40 - Retaining Ring | 60 - Lever (4 Used) | |

UPPERSTRUCTURE / Pump Device



W178-02-04-010

UPPERSTRUCTURE / Pump Device

1. Remove plug (25) from gear casing (47).
🔧 : 17 mm
2. Remove plug (30) from gear casing (47) to drain gear oil. (Approx 1.0 L, 0.2642 US gal)
🔧 : 22 mm
3. Remove socket bolts (1) (4 used) to remove right regulator (2) from pump casing (51).
🔧 : 8 mm

🔧 **NOTE:** Pry up the right regulator to the selector head (66) side for easy removal.

4. Remove socket bolts (3) (2 used) and (5) (2 used), remove left regulator (6) from pump casing (51). Socket bolts (4) are used to install the solenoid valve, don't remove it.

🔧 **NOTE:** Pry up the left regulator to selector head (66) side for easy removal.
🔧 : 8 mm

⚠️ **CAUTION:** Pump device weight:
160 kg (350 lb)

⚠️ **CAUTION:** When lifting, don't take pump casing (51) off the ground. Turn it to the gear casing (47) side.

5. Install eyebolt (M10, Pitch 1.5) to the threaded hole for socket bolts (1) and (3) of pump casing (51), lift it up by crane, position the pump device with gear casing (47) facing down. At this time, place 80 mm square wooden blocks under the gear casing.
6. Remove socket bolts (33) (2 used) from gear casing (47), remove level gauge (35), pipe (34) and gasket (32).
🔧 : 6 mm
7. Remove socket bolt (36) from gear casing (47), remove pilot pump (39).
🔧 : 8 mm

🔧 **NOTE:** *THREEBOND* has been applied to the mounting surface of the pilot pump, tap the flange of the pilot pump along the periphery with a plastic hammer lightly and then remove it.

8. Remove socket bolts (71) (12 used) from selector head (66).
🔧 : 10 mm

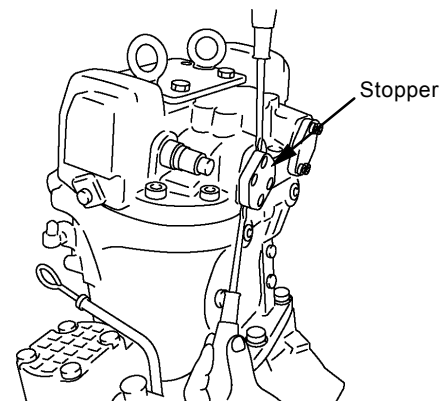
🔧 **NOTE:** When loosening the socket bolts, the selector head will jump out due to the force of spring (16). Be sure to record the clearance between pump casing (51) and the selector head to ensure the internal parts of pump casing is in correct position when reassembling.

⚠️ **CAUTION:** Selector head weight:
28 kg(60 lb)

9. Install eyebolt (M12, pitch 1.75) to the bolt hole on the top of selector head (66), lift it by crane and remove the selector head from pump casing (51). At this time, the O-ring is removed with the lower surface of the selector head. Remove it before setting down.

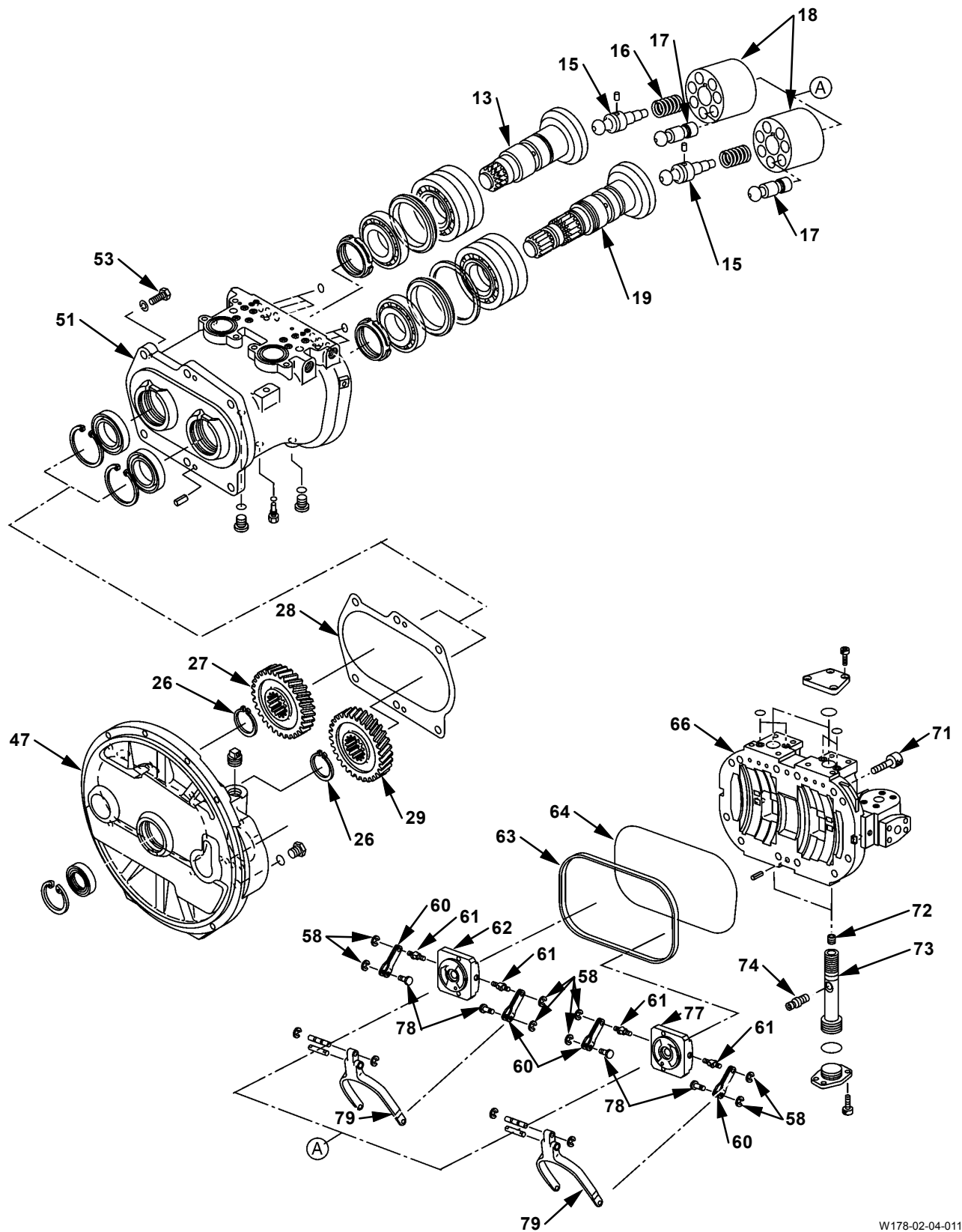
10. Remove socket bolts (68) (16 used) from selector head (66), remove stopper S (69) and stopper L (76). (2 places)
🔧 : 6 mm

🔧 **NOTE:** O-rings (70) and (75) is attached on stopper S (69) and stopper L (76). If they are assembled too tightly to remove, tap the outer periphery of the stopper to the position where about half of the hole for the mounting bolt can be seen. Turn the stopper, insert a screwdriver into the mounting bolt hole to pry the stopper for easy removing.



W178-02-04-055

UPPERSTRUCTURE / Pump Device



W178-02-04-011

UPPERSTRUCTURE / Pump Device

11. Remove set screw (72) out of servo piston (73), then remove pins (74). (2 places)

 **NOTE:** *LOCTITE has been applied to the set screw. Heat it with a drier etc. for easy removal.*

 : 6 mm

12. Pull out servo piston (73) from selector head (66). (2 places)
13. Remove backup ring (63) and O-ring (64) from pump casing (51).

IMPORTANT: Both valve plates (62, right), (77, left) are very similar. Their installation direction are determined. Record their position and direction before disassemble.

14. Remove retaining rings (58) (8 used) from pins (61) (4 used) and (78) (4 used) to remove levers (60) (4 used) and valve plates (62, right) and (77, left) from links (79) (2 used).

 **NOTE:** *Pin (61) has been attached on valve plates (62) and (77) with LOCTITE. Do not remove it unless necessary.*

15. Remove rotor (18), spring (16), center shaft (15) and plunger (17) from pump casing (51) in order. (Both right and left)

 **NOTE:** *When remove the plunger, turn over the plunger inside and pull it out.*

IMPORTANT: If link (79) is distorted, the pump performance will be changed. Don't apply excess loads.

16. Remove the two link (79) assemblies from pump casing (51). Don't disassemble the link assembly unless necessary.

 **NOTE:** *If it is difficult to remove, tap the two roots of the link lightly with a plastic hammer.*

17. Remove bolts (53) (6 used) from gear casing (47).

 : 24 mm

 **CAUTION:** Pump casing weight: 105 kg(230 lb)

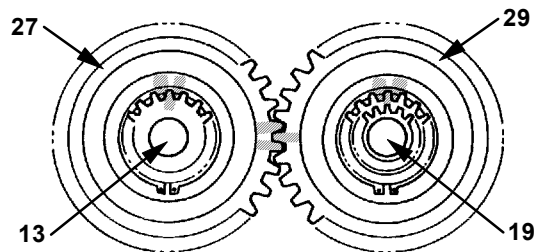
18. Install eye bolt (M12, Pitch 1.75) to the threaded hole for socket bolt (71) of pump casing (51), lift it up by crane, remove the pump casing from gear casing (47). At this time, shafts (13) and (19), gears (27), (29) and etc. are removed with the pump casing.

Place the pump casing with the mounting surface of the regulator facing up.

19. Remove gasket (28) from gear casing (47).

IMPORTANT: The position where the gears engaging is determined. Make aligning marks on the gears for easy reassembling.

20. Make aligning marks on meshed position of splines on shafts (13) (19) and gears (27) (29). And make aligning marks on meshed position of gears (27) and (29).



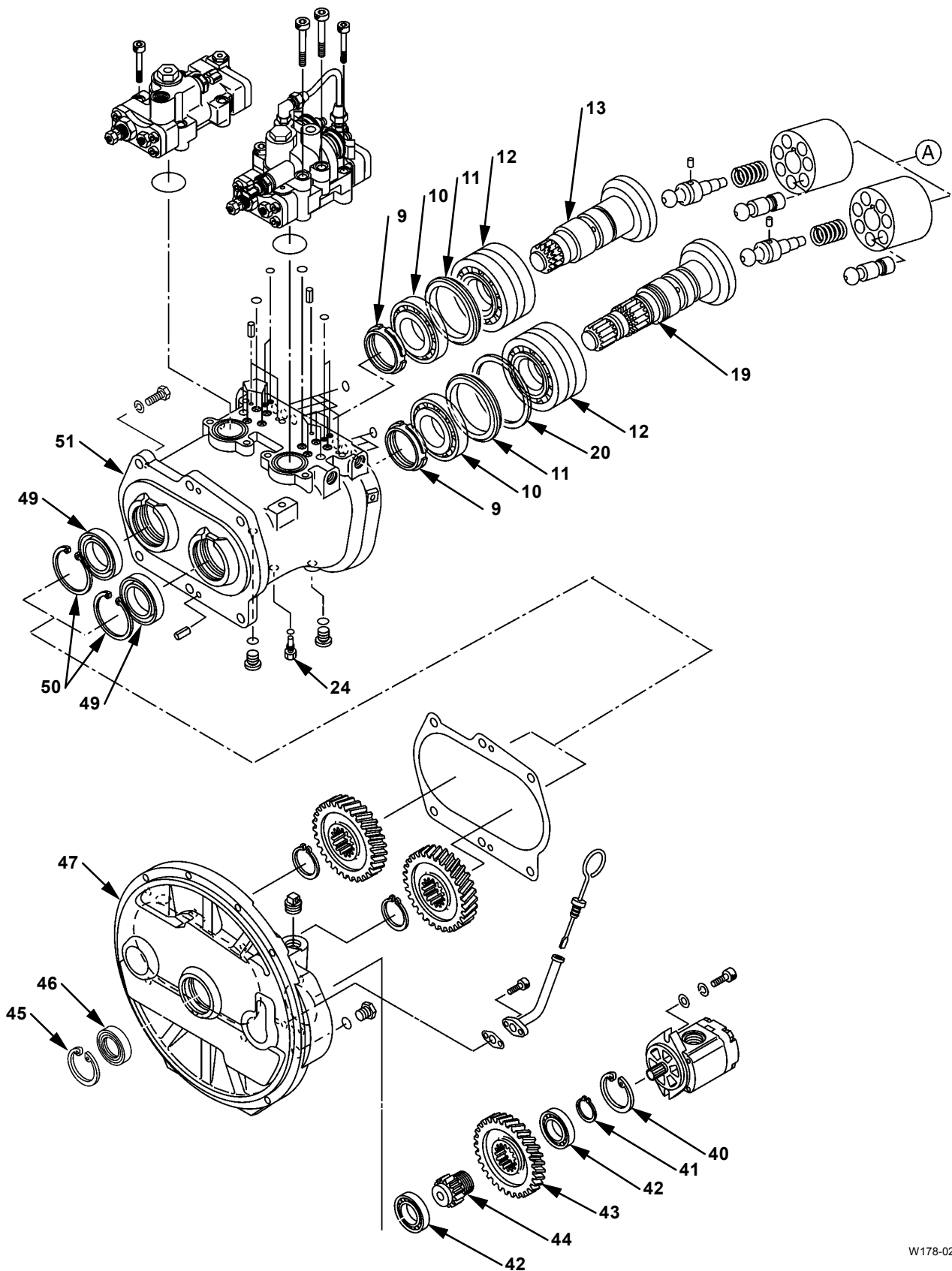
W137-02-04-007

21. Remove retaining rings (26) from shafts (13) and (19), and then remove gears (27) and (29).

 **CAUTION:** Pump casing weight: 70 kg (154 lb)

22. Attach a nylon sling to pump casing (51), lift it up and position selector head (66) with the mounting side facing down.

UPPERSTRUCTURE / Pump Device



W178-02-04-004

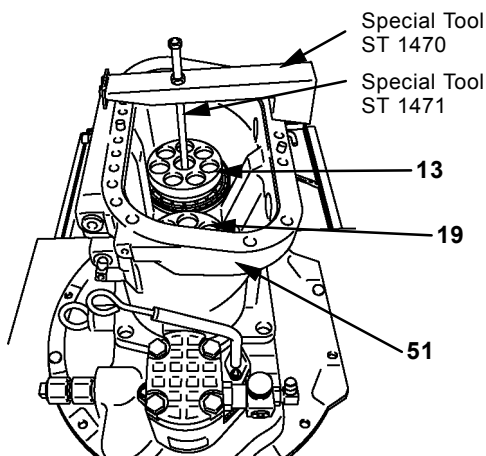
UPPERSTRUCTURE / Pump Device

22. Remove stopper (24) from pump casing (51).

CAUTION: Pump casing weight: 70 kg (154 lb)

23. Attach a nylon sling to pump device (51), lift it up and place the pump casing on the wooden blocks with mission side facing down. Wooden block size: 100 mm or more in width and height.

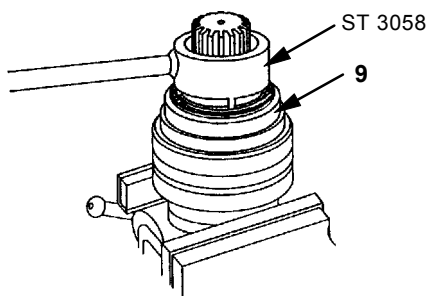
24. Remove shafts (13) and (19) from pump casing (51) with special tool (ST 1470) (ST 1471). At this time, bearings (10) and (12) are removed with the shafts.



W178-02-04-054

25. Remove slide ring (20) from shaft (19).

26. Remove bearing nut (9) from shafts (13) and (19) using special tool (ST 3058).



W137-02-04-023

27. Remove bearings (10) and (12) as well as ring (11) from shafts (13) and (19) with a press.

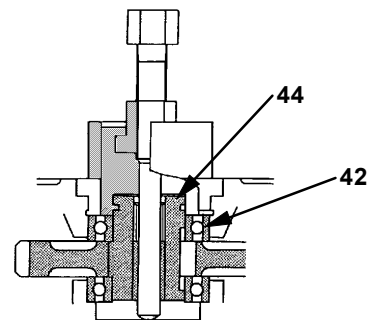
CAUTION: Pump casing weight: 42 kg (93 lb)

28. Attach a nylon sling to pump casing (51), lift it up by crane and position the regulator with the mounting surface facing up.

29. Remove retaining rings (50) (2 used), oil seals (49) (2 used) from pump casing (51).

30. Remove retaining ring (40) from gear casing (47) and remove retaining ring (41) from gear shaft (44).

31. Pull out upper ball bearing (42) and gear shaft (44) from gear casing (47) using special tool (ST 1393).



W178-02-04-009

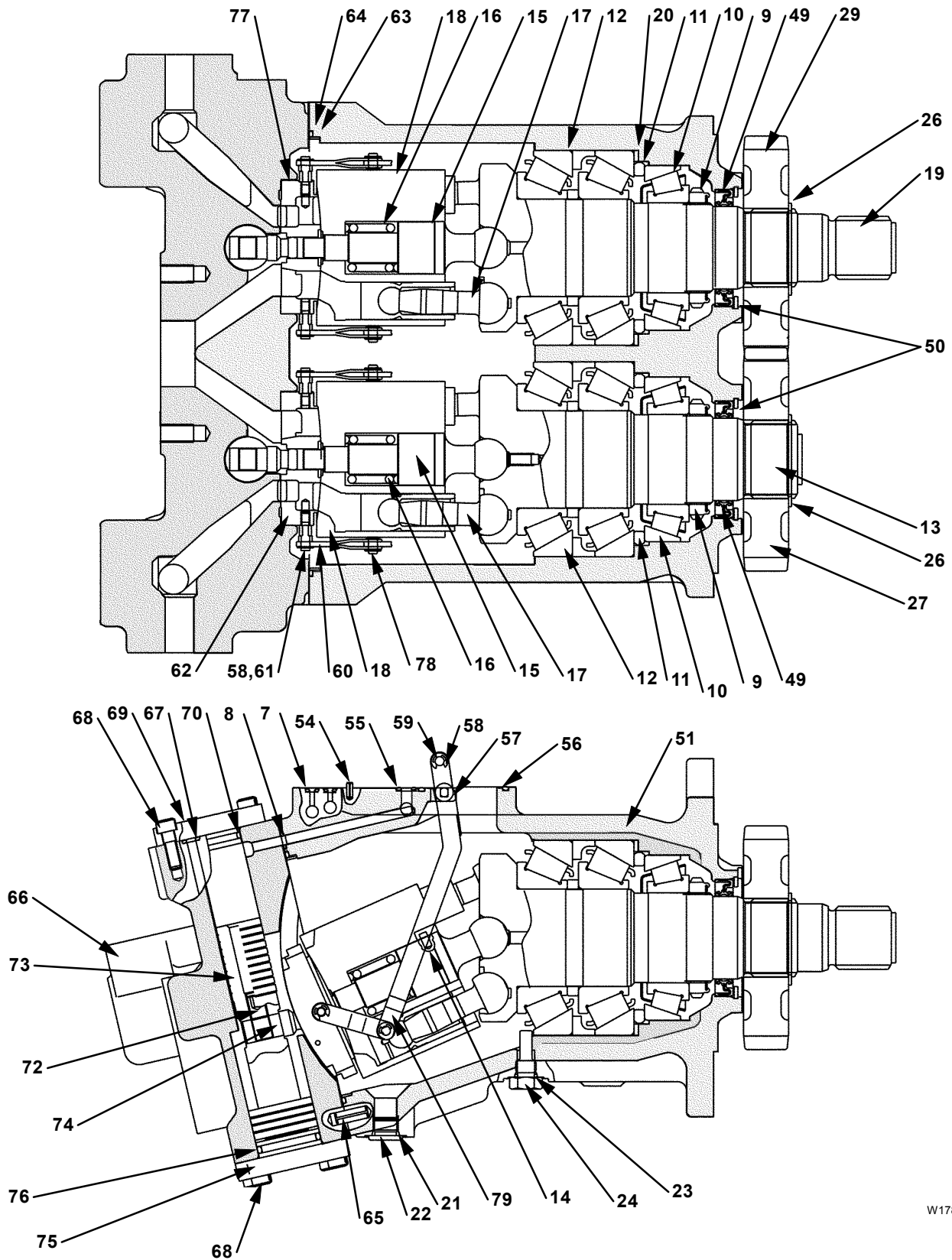
32. Remove gear (43) and ball bearing (42) from gear casing (47).

33. Install a shackle to the bolt hole on the periphery of gear casing (47), lift it up with a rope and turn it over.

34. Remove retaining ring (45), oil seal (46) from gear casing (47).

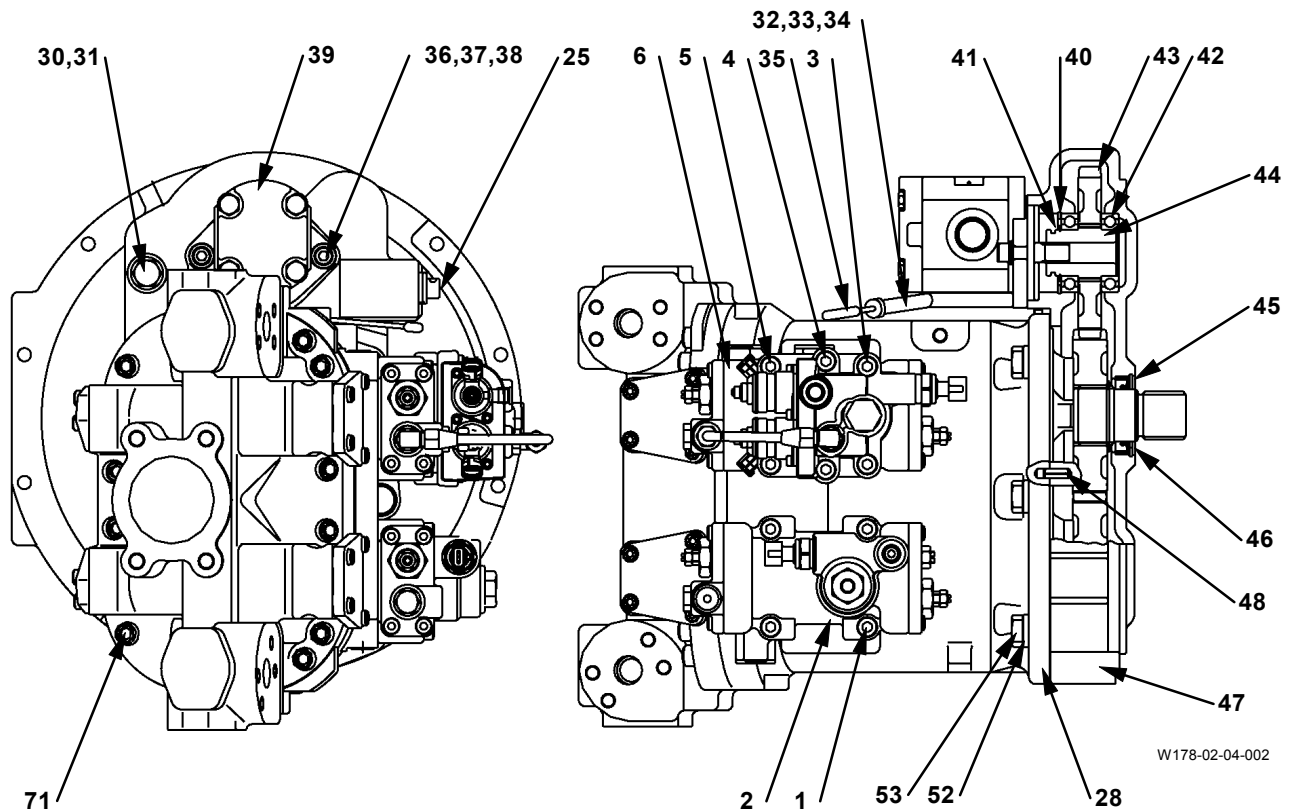
UPPERSTRUCTURE / Pump Device

ASSEMBLE PUMP DEVICE



W178-02-04-003

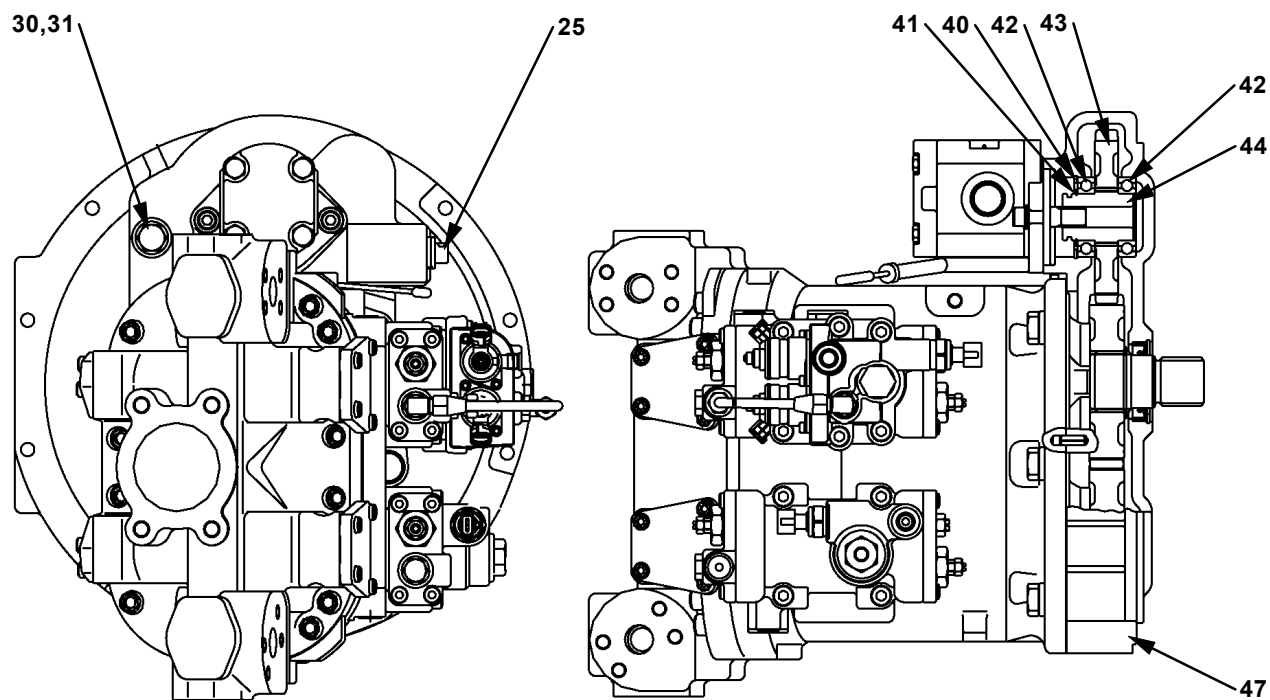
UPPERSTRUCTURE / Pump Device



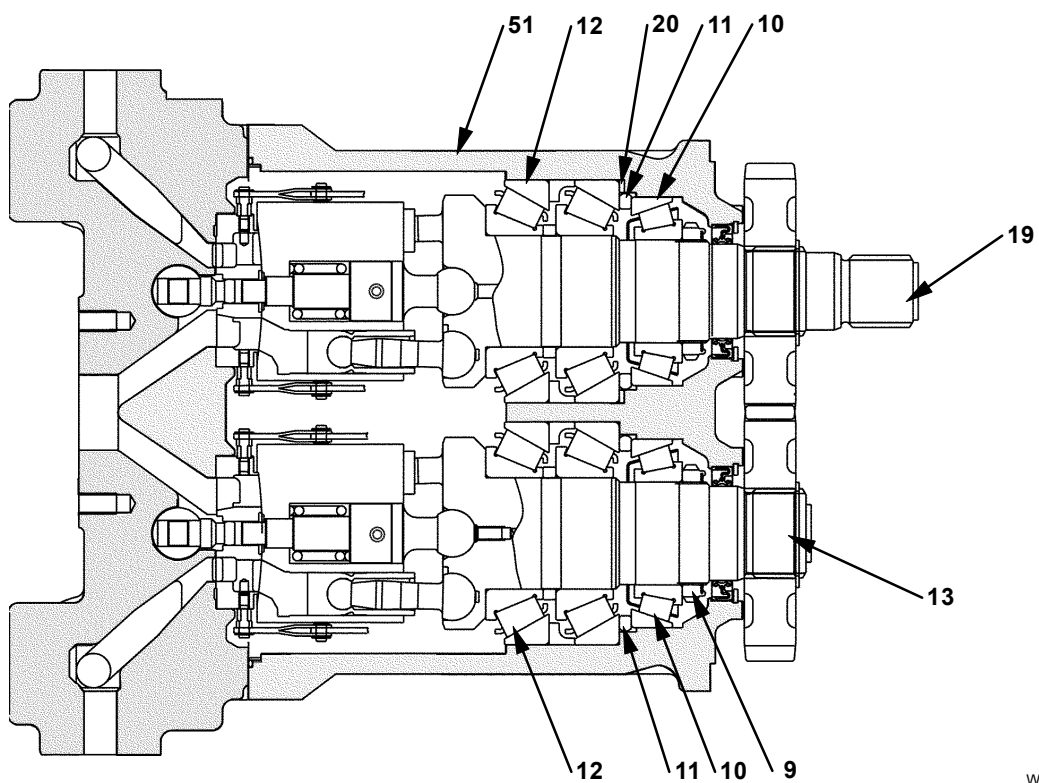
W178-02-04-002

- | | | | |
|----------------------------|------------------------------|-------------------------------|----------------------------|
| 1 - Socket Bolt (4 Used) | 21 - O-Ring (2 Used) | 41 - Retaining Ring | 61 - Pin (4 Used) |
| 2 - Right Regulator | 22 - Plug (2 Used) | 42 - Ball Bearing (2 Used) | 62 - Right Valve Plate |
| 3 - Socket Bolt (2 Used) | 23 - O-Ring | 43 - Gear | 63 - Backup Ring |
| 4 - Socket Bolt (2 Used) | 24 - Stopper | 44 - Gear Shaft | 64 - O-Ring |
| 5 - Socket Bolt (2 Used) | 25 - Plug | 45 - Retaining Ring | 65 - Spring Pin (2 Used) |
| 6 - Left Regulator | 26 - Retaining Ring (2 Used) | 46 - Oil Seal | 66 - Select Head |
| 7 - O-Ring (4 Used) | 27 - Gear | 47 - Gear Casing | 67 - O-Ring (4 Used) |
| 8 - O-Ring (6 Used) | 28 - Gasket | 48 - Spring Pin (2 Used) | 68 - Socket Bolt (16 Used) |
| 9 - Bearing Nut (2 Used) | 29 - Gear | 49 - Oil Seal (2 Used) | 69 - Stopper S (2 Used) |
| 10 - Bearing (2 Used) | 30 - Plug | 50 - Retaining Ring (2 Used) | 70 - O-Ring (2 Used) |
| 11 - Ring (2 Used) | 31 - O-Ring | 51 - Pump Casing | 71 - Socket Bolt (12 Used) |
| 12 - Bearing (2 Used) | 32 - Gasket | 52 - Spring Washer (6 Used) | 72 - Set Screw (2 Used) |
| 13 - Shaft | 33 - Socket Bolt (2 Used) | 53 - Bolt (6 Used) | 73 - Servo Piston (2 Used) |
| 14 - Pin (2 Used) | 34 - Pipe | 54 - Spring Pin (2 Used) | 74 - Pin (2 Used) |
| 15 - Center Shaft (2 Used) | 35 - Level Gauge | 55 - O-Ring (10 Used) | 75 - O-Ring (2 Used) |
| 16 - Spring (2 Used) | 36 - Socket Bolt (2 Used) | 56 - O-Ring (2 Used) | 76 - Stopper L (2 Used) |
| 17 - Plunger (14 Used) | 37 - Spring Washer (2 Used) | 57 - Pin (2 Used) | 77 - Left Valve Plate |
| 18 - Rotor (2 Used) | 38 - Washer (2 Used) | 58 - Retaining Ring (12 Used) | 78 - Pin (4 Used) |
| 19 - Shaft | 39 - Pilot Pump | 59 - Pin (2 Used) | 79 - Link (2 Used) |
| 20 - Slide Ring | 40 - Retaining Ring | 60 - Lever (4 Used) | |

UPPERSTRUCTURE / Pump Device



W178-02-04-002



W178-02-04-013

UPPERSTRUCTURE / Pump Device

1. With a guide bar and hammer, tap the inside ball bearing (42) into gear casing (47), with the stamp mark facing inside.

 **NOTE:** Tap the bearing and listen to ring to confirm installation is completed.

2. Put gear (43) to ball bearing (42), insert gear shaft (44) while aligning the spline.
3. With a guide bar and hammer, tap the outside ball bearing (42) into gear casing (44), with the stamp mark facing outward.

 **NOTE:** Tap the bearing and listen to ring to confirm installation is completed.

4. Install retaining ring (40) onto gear casing (47), and install retaining ring (41) onto gear shaft (44).
5. Install O-ring (31) onto plug (30) and install them to gear casing (47).
 : 22 mm
 : 49 N·m (5 kgf·m, 36 lbf·ft)
6. Heat bearings (10), (12) (each 2 used) to 50 to 80 °C (122 to 176 °F).

 **CAUTION:** Be careful, bearing (12) is hot.

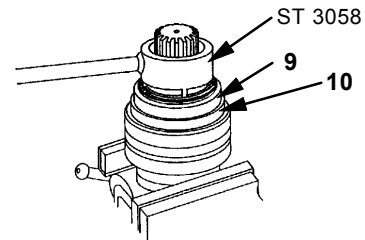
7. Apply a film of hydraulic oil to the inside of bearings (12) (2 used), and install them onto shafts (13) and (19) with a press.
8. Install ring (11) onto shafts (13) and (19).

 **CAUTION:** Be careful, bearing (10) is hot.

9. Apply a film of hydraulic oil to the inside of bearings (10) (2 used), and install them onto shafts (13) and (19) with a press.

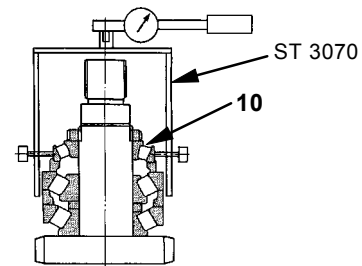
10. Set the pre-loads of bearings (10) and (12) installed on shaft (13) according to the following procedures.

- Apply a film of hydraulic oil to bearing nut (9) threads. Tighten bearing nut (9) until it comes in contact with bearing (10) using special tool (ST 3058).



W137-02-04-023

- Attach special tool (ST 3070) on bearing (10), rotate bearing (10) 2 to 3 turns and measure the starting torque.



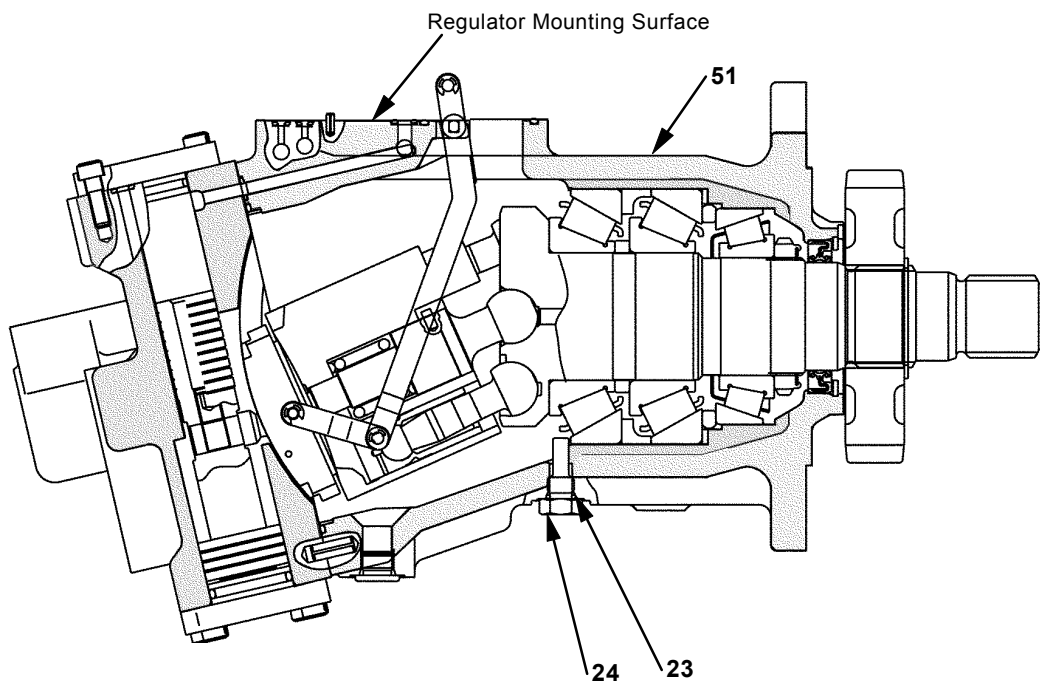
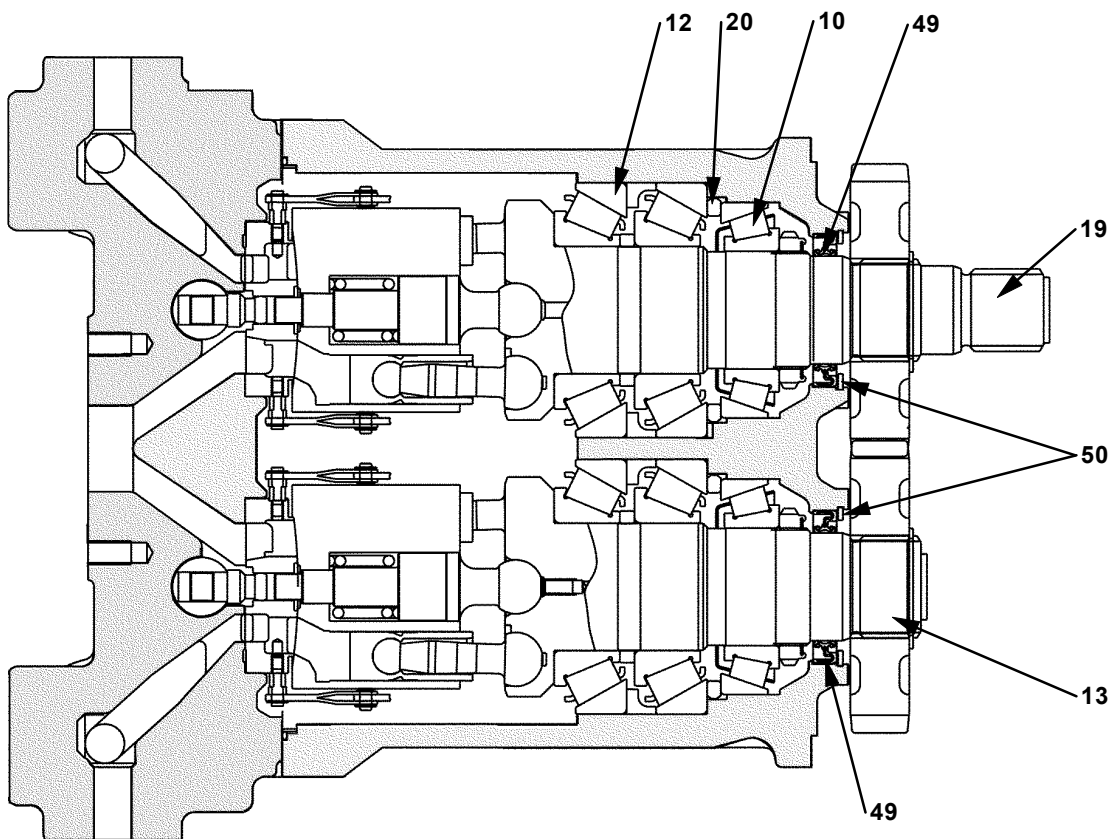
W107-02-04-052

- Adjust the starting torque repeatedly, until it reaches specification.
Torque: $2.16 \pm 0.49 \text{ N} \cdot \text{m}$
($0.22 \pm 0.05 \text{ kgf} \cdot \text{m}$, $1.59 \pm 0.36 \text{ lbf} \cdot \text{ft}$)

 **NOTE:** If the starting torque is higher than the limit of specified torque, loosen the bearing nut, tap the shaft end to release the bearing's load, and repeat the procedure.

11. Set the pre-loads for bearing (10) and (12) installed on shaft (19) by the same procedure as step 10 above mentioned.
12. Install slide ring (20) to the shaft (19) at inserting side to pump casing (51).

UPPERSTRUCTURE / Pump Device



W178-02-04-003

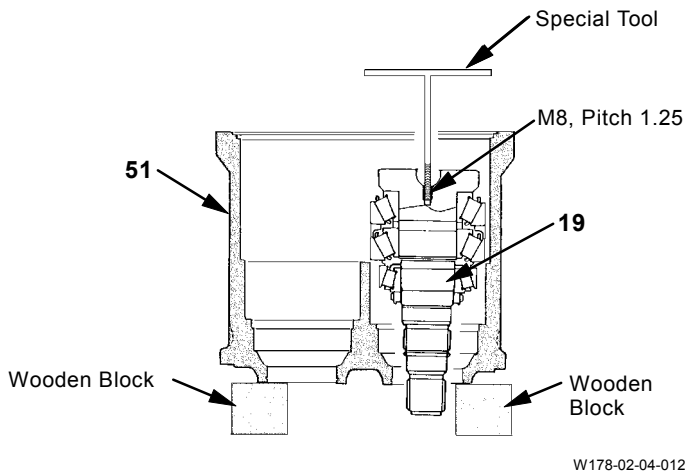
UPPERSTRUCTURE / Pump Device

13. Heat pump casing (51) to 50 to 80 °C (122 to 176 °F).



CAUTION: Use special tool to insert the shaft (19) assembly, because pump casing (51) has been heated.

14. Apply a film of hydraulic oil to the outside of bearings (10), (12) installed on shaft (19), install shaft (19) to pump casing (51) using the special tool. If it is difficult to insert, tap in shaft (19) with a guide bar, etc.



15. Install shaft (13) into pump casing (51), using the same procedure as above step 14.
16. Wait for pump casing (51) cooling down to the temperature lower than 40 °C (104 °F).
17. Install O-rings (23) (2 used) to stoppers (24) (2 used), and install them to pump casing (51).
- 🔧 : 19 mm
- 🔧 : 34.5 N·m (3.5 kgf·m, 25.3 lbf·ft)



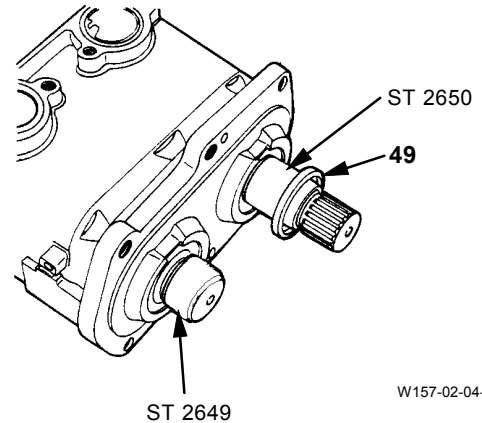
CAUTION: Pump casing weight: 65 kg (143 lb)

18. Attach a nylon sling to pump casing (51), lift it up and position the regulator with the mounting surface facing up.

19. Install special tools (ST 2649), (ST 2650) over the spline parts of shafts (13) and (19).



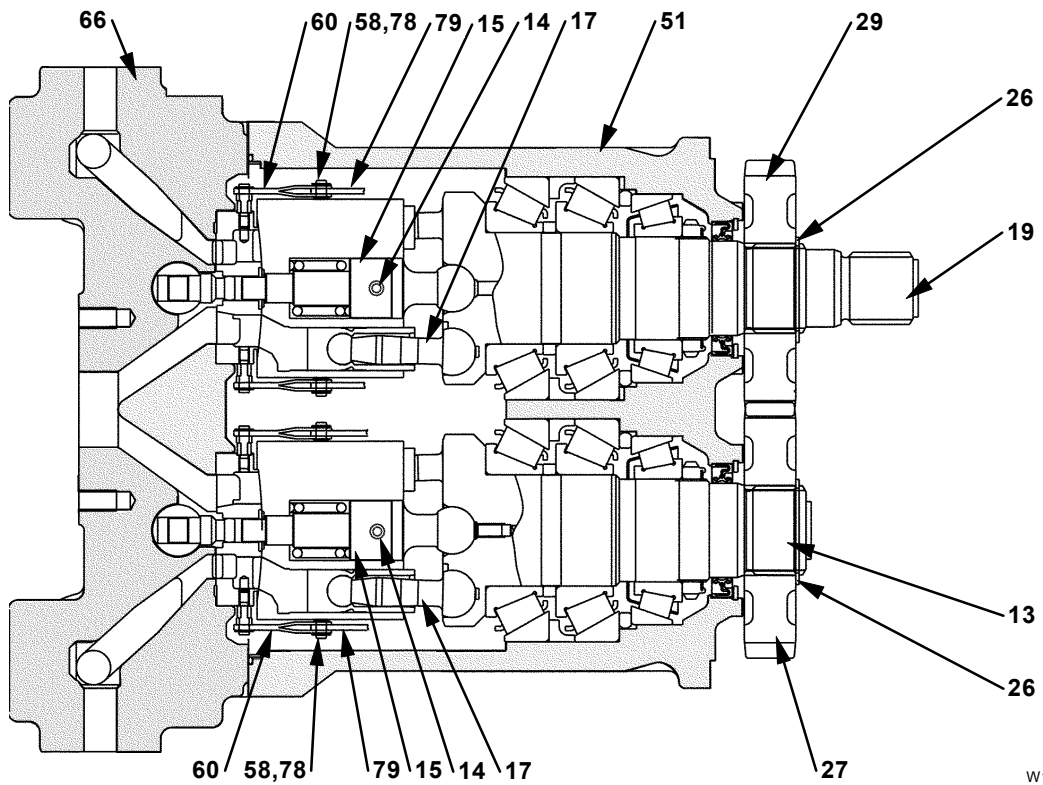
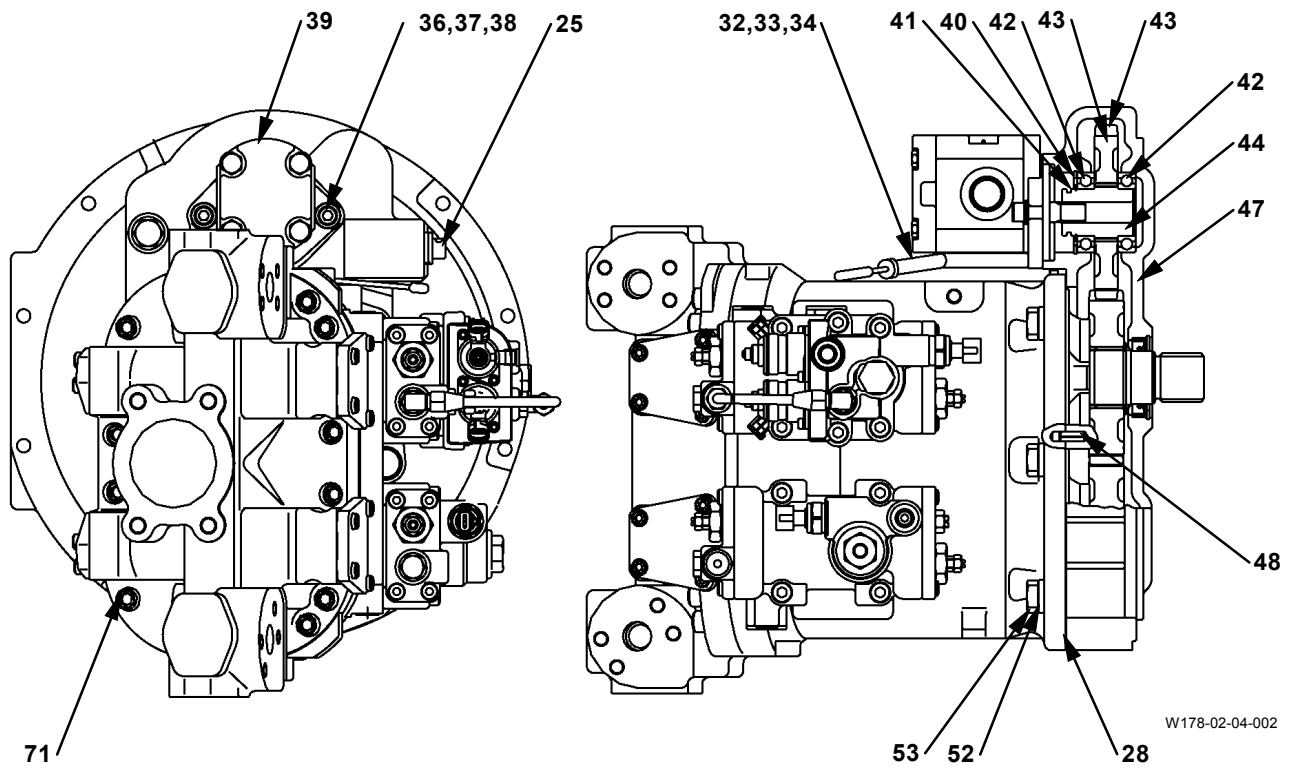
NOTE: If the special tools are not available, wind vinyl tape and etc. over spline part of the shaft to protect the oil seal (49) from being damaged.



IMPORTANT: Apply a film of grease to the inner diameter of oil seals (49) (2 used).

20. Evenly tap oil seals (49) (2 used) onto shafts (13) and (19).
21. Remove special tool (ST 2649), (ST 2650) from shafts (13) and (19).
22. Install retaining rings (50) (2 used) to pump casing (51).

UPPERSTRUCTURE / Pump Device

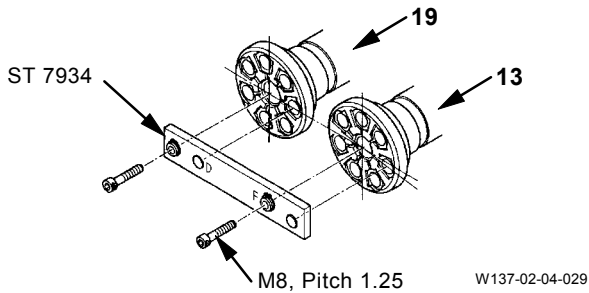


UPPERSTRUCTURE / Pump Device

23. Install gears (27) and (29) onto shafts (13) and (19), aligning the matching marks made when disassembling, and install retaining rings (26) (2 used).

When replacing the shafts and gears, install the gear according to the following procedure.

- Secure the special tool (ST 7934) to the mounting surface of shafts (13) and (19) for plunger (17) .



- Turn shafts (13) and (19) clockwise, viewed from the mounting side of gears (27) and (29), until it comes into contact with the special tool. (To remove the play in periphery direction)
- Install gear (27) and retaining ring (26) to the spline of shaft (13).
- Install gear (29) onto the spline of shaft (19), with engaging to gear (27). If it does not engage, turn shaft (19) in the play range of special tool to find the engaging position.
- Install retaining ring (26) to the spline of shaft (19).
- Remove the special tool.

24. Tap spring pins (48) (2 used) into gear casing (47), and install gasket (28).



CAUTION: Pump casing weight: 70 kg (154 lb)

25. Install eye bolts (M12, Pitch 1.75) (2 used) to the threaded hole for socket bolt (71) in pump casing (51), lift it up by crane.

Engaging gear (43) and gear (29), install the gears into gear casing (47). Install the gear casing to the pump casing with bolts (53), spring washers (52) (6 for each).

: 24 mm

: 147 N·m (15 kgf·m, 108 lbf·ft)

26. Apply THREEBOND #1215 to the mounting surface of pilot pump (39), install the pilot pump to gear casing (47) with socket bolts (36), spring washers (37), washers (38) (2 for each).

: 8 mm

: 49 N·m (5 kgf·m, 36 lbf·ft)

27. Install gasket (32), pipe (34) to gear casing (47). Tighten them with socket bolts (33) (2 used).

: 6 mm

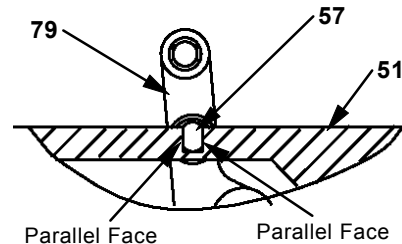
: 19.5 N·m (2 kgf·m, 14 lbf·ft)

28. Install levers (60), pins (78), retaining rings (58) (4 for each) to links (79) (2 used).

IMPORTANT: If link (79) is distorted, the pump performance will be changed. Do not apply unreasonable loads.

29. Install the link (79) assemblies (2 used), aligning the groove for pin (57) in pump casing (51). At this time, lever (60) faces selector head (66).

NOTE: Both surfaces of pin (57) are parallel to each other. Insert the pin aligning the parallel face with the groove.



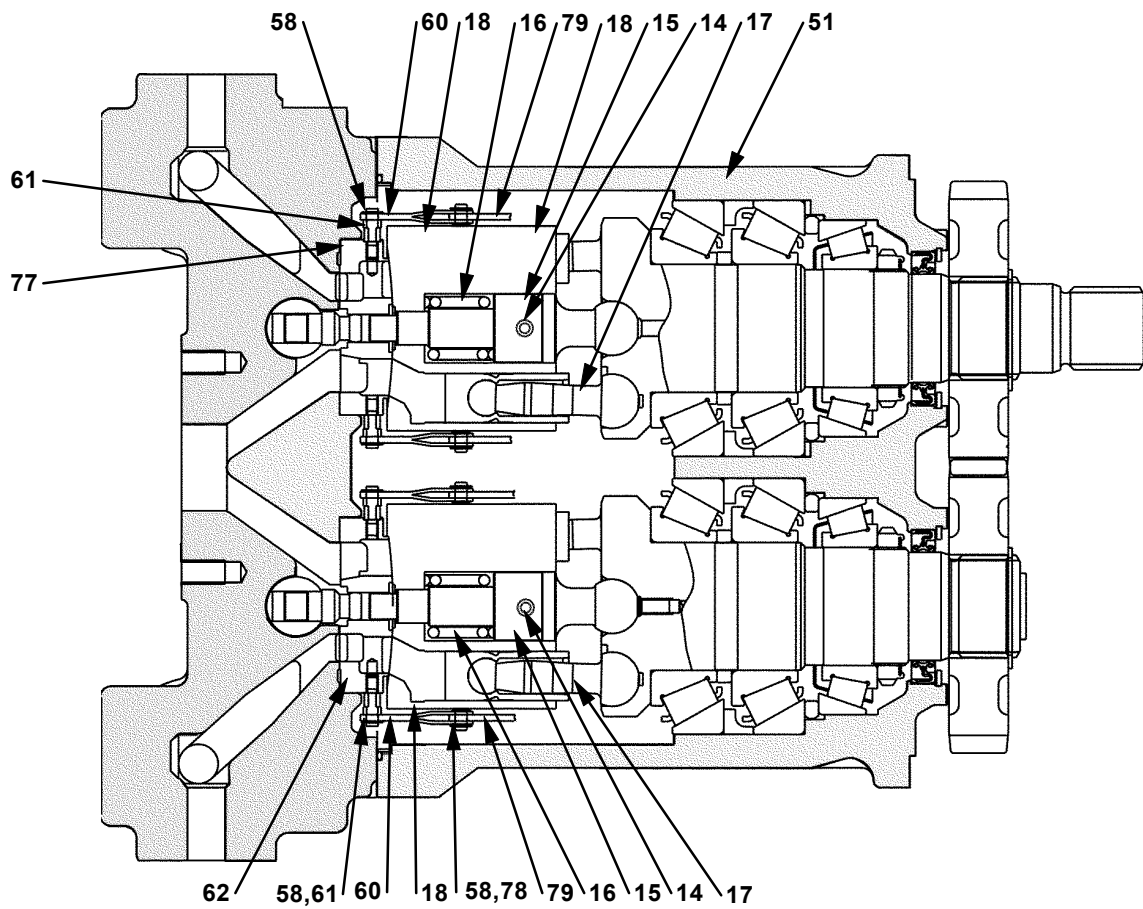
30. Apply hydraulic oil to the plunger (17) mounting surface of shafts (13) and (19).

31. Insert plungers (17) (7 for each) into shafts (13) and (19).

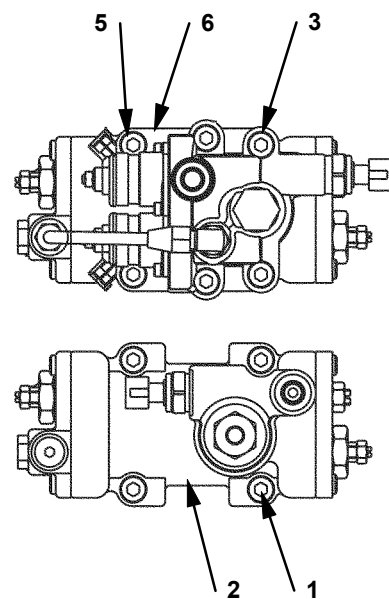
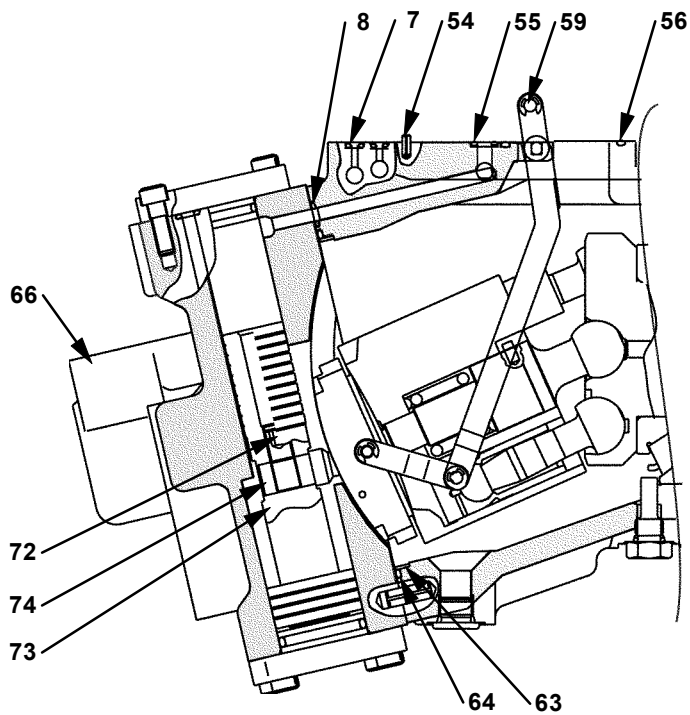
32. Apply a film of grease to pins (14) (2 used), and then install them to center shafts (15) (2 used).

33. Apply a film of grease to the spherical surface of center shafts (15) (2 used), and then install them to shafts (13) and (19).

UPPERSTRUCTURE / Pump Device



W178-02-04-013



W178-02-04-018

UPPERSTRUCTURE / Pump Device

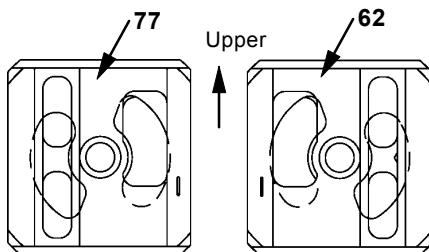
34. Install springs (16) (2 used) to center shafts (15) (2 used).
35. Insert center shafts (15) (2 used) and plungers (17) (14 used) into rotors (18) (2 used).
36. Insert a file's shank etc. into the center hole of center shaft (15), rotate the center shaft to install pin (14) into the groove of rotor (18). (Both right and left pump)

 **NOTE:** If the pin does not enter into the groove of the rotor, selector head (66) cannot be assembled to pump casing (51).

37. Apply a film of LOCTITE LI829 to the threads of pins (61) (4 used), and then install the pins to valve plates (62, right) and (77, left).
-  : 7 mm
 : 9.8 N·m (1 kgf·m, 7.2 lbf·ft)

IMPORTANT: Pay attention to the mounting direction of right regulator (62).

38. Insert pins (61) (2 used) for right valve plate (62) into the hole of levers (60) (2 used) for right regulator (2), and install retaining rings (58) (2 used).



W178-02-04-014

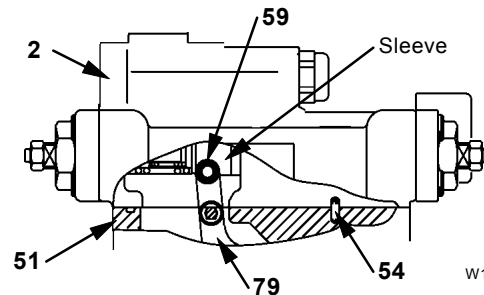
IMPORTANT: Pay attention to the mounting direction of left regulator (77).

39. Insert pins (61) (2 used) for left valve plate (77) into the hole of levers (60) (2 used) for left regulator (6), and install retaining rings (58) (2 used).
40. Install O-rings (56) (2 used), (55) (10 used), (7) (4 used) and spring pins (54) (2 used) into pump casing (51).

41. Install right regulator (2) into pump casing (51), according to the following procedure.
 - Adjust the sleeve position so that the grooves in both sleeves on the right regulator are in a line.
 - Put the right regulator on the pump casing, install pin (59) for link (79) into the both grooves in the sleeve.
 - Move the right regulator, so that spring pin (54) extended from the pump casing can enter into the right regulator.
 - Install the right regulator into the pump casing with socket bolts (1) (4 used).

 : 8 mm

 : 49 N·m (5 kgf·m, 36 lbf·ft)



W178-02-04-015

42. Install left regulator (6) onto pump casing (51) in the same procedure as step 41, and secure the left regulator with socket bolts (3) (2 used) and (5) (2 used).

 : 8 mm

 : 49 N·m (5 kgf·m, 36 lbf·ft)

43. Install backup ring (63), O-ring (64) and O-rings (8) (6 used) into pump casing (51).

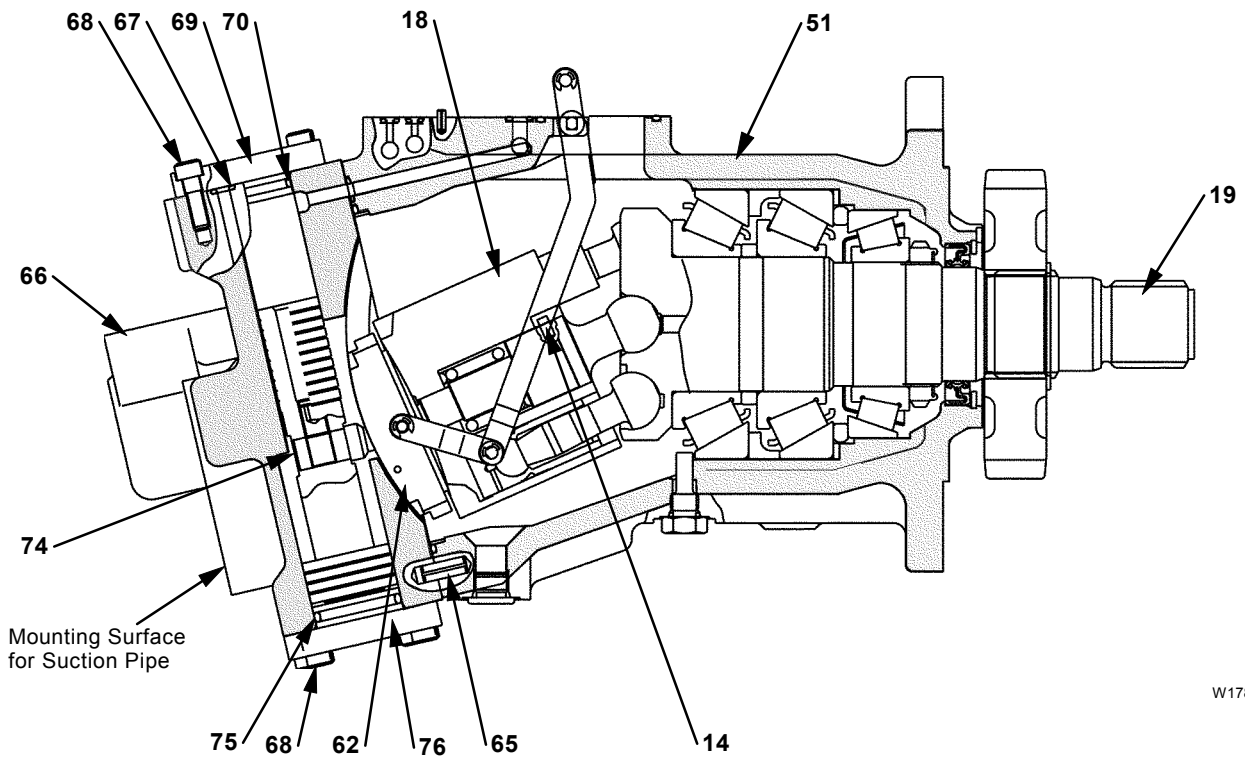
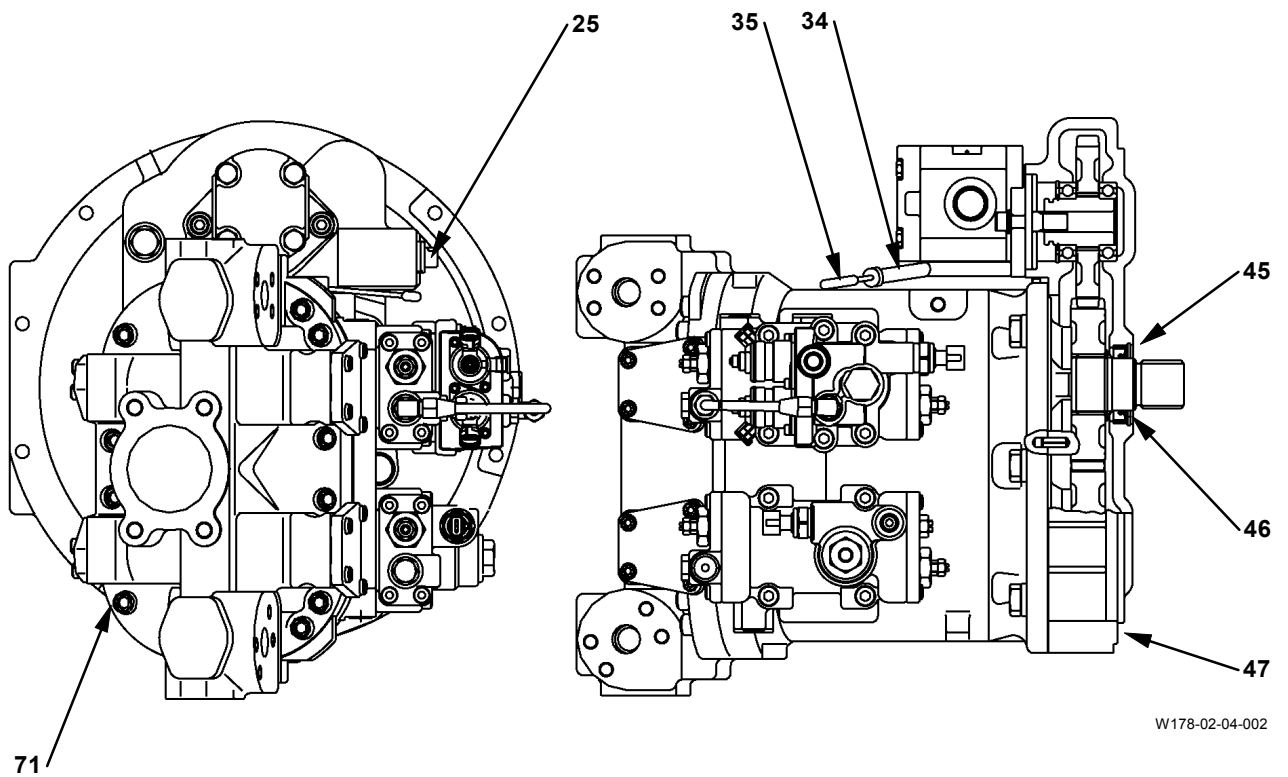
44. Insert servo pistons (73) (2 used) into selector head (66).

45. Install pin (74) into servo piston (73), fix the servo piston with set screw (72). (Both right and left servo pistons)
 Beforehand, apply a film of LOCTITE LI829 to the threads of the set screw.

 : 6 mm

 : 34.3 N·m (3.5 kgf·m, 25 lbf·ft)

UPPERSTRUCTURE / Pump Device



UPPERSTRUCTURE / Pump Device

46. Install spring pins (65) (2 used) into selector head (66).



CAUTION: Selector head weight: 29 kg (64 lb)

47. Install eye bolts (M12, pitch 1.75) (2 used) into the threaded hole for suction pipe in selector head (66), lift it up by crane.
Install the selector head on pump casing (51), while aligning the selector head with spring pin (65).



NOTE: Measure the clearance between the selector head and pump casing. Compare it with the clearance which was recorded during disassembling. If it is larger, pin (14) can't be inserted into the groove in rotor (18), or pin (14) can't be inserted into the holes in valve plates (62) and (77). Please confirm it.

48. Tighten selector head (66) to pump casing (51) with socket bolts (71) (12 used).

 : 10 mm

 : 108 N·m (11 kgf·m, 80 lbf·ft)

49. Install O-rings (67) (4 used) to selector head (66).

50. Install O-ring (70) to stopper S (69). Install the stopper S to selector head (66) with socket bolts (68) (4 used). (2 places)

 : 6 mm

 : 19.5 N·m (2 kgf·m, 14.5 lbf·ft)

51. Install O-ring (75) to stopper L (76). Install the stopper L to selector head (66) with socket bolts (68) (4 used). (2 places)

 : 6 mm

 : 19.5 N·m (2 kgf·m, 14.5 lbf·ft)



**CAUTION: Pump device weight:
160 kg(350 lb)**

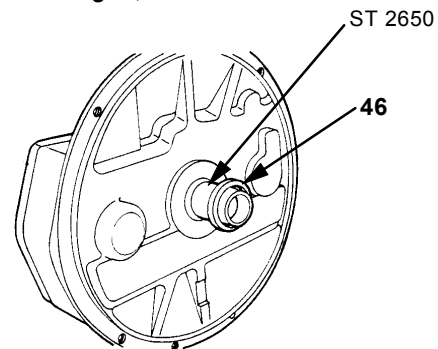
52. Install eye bolts (M12, Pitch 1.75) (4 used) to the threaded hole for suction pipe in selector head (66). Lift the selector head up by crane and position it with the regulator mounting side upward.

53. Insert special tool (ST 2650) on shaft (19). Apply a film of grease to oil seal (46) and install the oil seal to shaft (19).

Pull out the special tool, tap oil seal (46) into the gear casing.



NOTE: If special tool (ST 2650) is not available, wind vinyl tape etc. over the spline parts of shaft (19) to protect the oil seal from being damaged, and then install the oil seal.



W157-02-04-023

54. Install retaining ring (45) to gear casing (47).

55. Supply engine oil 1.0 L (0.2642 US gal) into gear casing (47) through the hole for plug (25).

IMPORTANT: The breather hole for plug (25) locates at left side, seen from the front of gear casing (47).

56. Wind the plug (25) with seal tape and install it to gear casing (47).

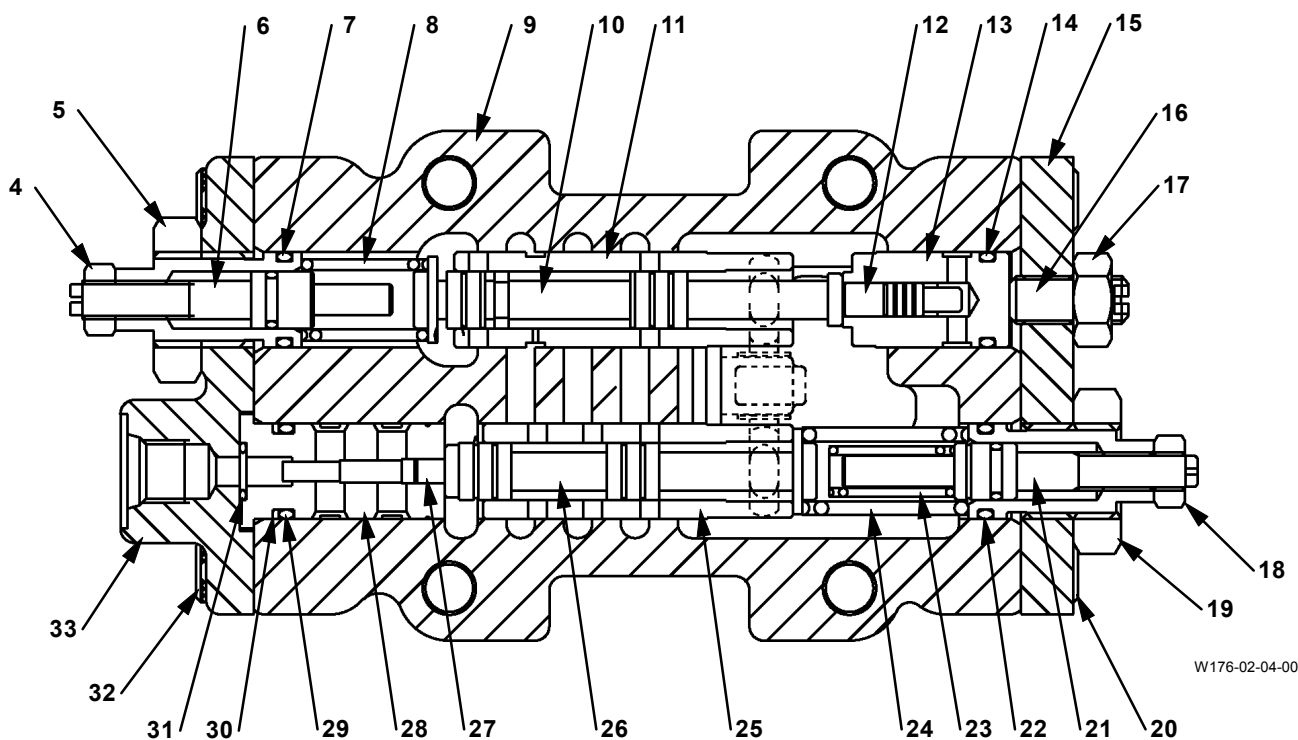
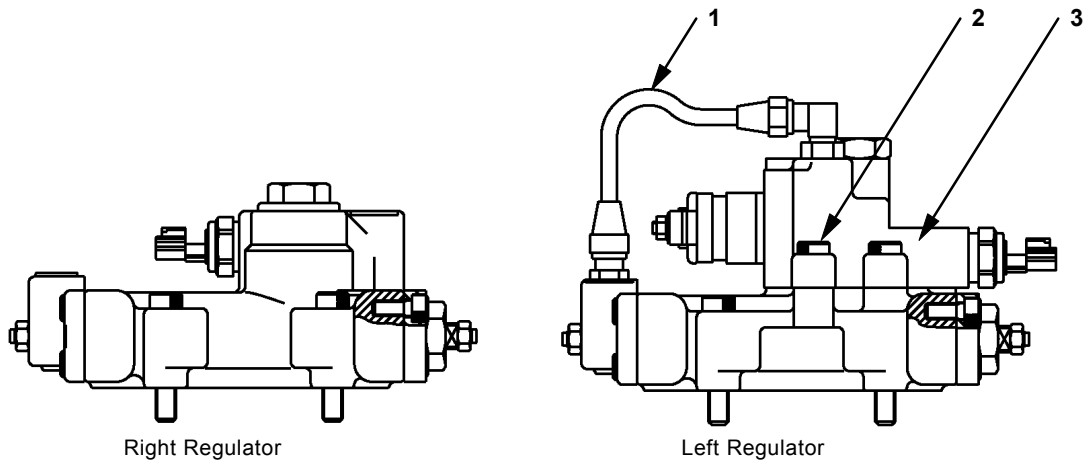
 : 17 mm

 : 39.5 N·m (4 kgf·m, 29 lbf·ft)

57. Insert level gauge (35) into pipe (34).

UPPERSTRUCTURE / Pump Device

DISASSEMBLE REGULATOR



W176-02-04-001

- | | | | |
|--------------------------|---------------|---------------------------|---------------------------|
| 1 - Pipe | 10 - Spool | 18 - Lock Nut | 26 - Spool |
| 2 - Socket Bolt (2 Used) | 11 - Sleeve | 19 - Lock Nut | 27 - Piston |
| 3 - Solenoid Valve | 12 - Piston | 20 - Socket Bolt (4 Used) | 28 - Cylinder |
| 4 - Lock Nut | 13 - Cylinder | 21 - Stopper Assembly | 29 - O-Ring |
| 5 - Lock Nut | 14 - O-Ring | 22 - O-Ring | 30 - Backup Ring |
| 6 - Stopper Assembly | 15 - Cover | 23 - Spring | 31 - O-Ring |
| 7 - O-Ring | 16 - Set Bolt | 24 - Spring | 32 - Socket Bolt (4 Used) |
| 8 - Spring | 17 - Lock Nut | 25 - Sleeve | 33 - Cover |
| 9 - Casing | | | |

UPPERSTRUCTURE / Pump Device

Disassemble Regulator

- Regulators are used for right pump and left pump. The regulator's inner structure is fully identical, and the difference is only in its accessories. Here is the description of left regulator.

IMPORTANT: If adjusting screws (4, 5, 16, 17, 18 and 19) are disassembled, their set values will change. So, do not disassemble them.

When these adjusting screws must be disassembled, carry out adjustment according to the procedure of performance test after assembling.

1. Clamp casing (9) in a vise, then remove pipe (1) from the casing.

 : 17 mm

2. Remove socket bolts (2) (2 used) and remove solenoid valve (3) from the casing (9).

IMPORTANT: Do not loosen set bolt (16), lock nuts (17), (18) and (19). Otherwise, the set values will change.

3. Remove socket bolts (20) (4 used), then remove cover (15) from casing (9). At this time, set bolt (16) and stopper assembly (21) are removed with the cover.

 : 6 mm

IMPORTANT: Do not loosen lock nuts (4) and (5). Otherwise, set values will be changed.

4. Remove socket bolts (32) (4 used), then remove cover (33) from casing (9). At this time, stopper assembly (6) is removed with the cover.

 : 6 mm

5. Pull out springs (23) and (24) from casing (9).

6. Insert a round bar into the hole of casing (9). Pushing the spool (26) end, push out cylinder (28), sleeve (25) and the spool from the casing. At this time, piston (27) is removed with the cylinder.

7. Pull out piston (27) from cylinder (28).

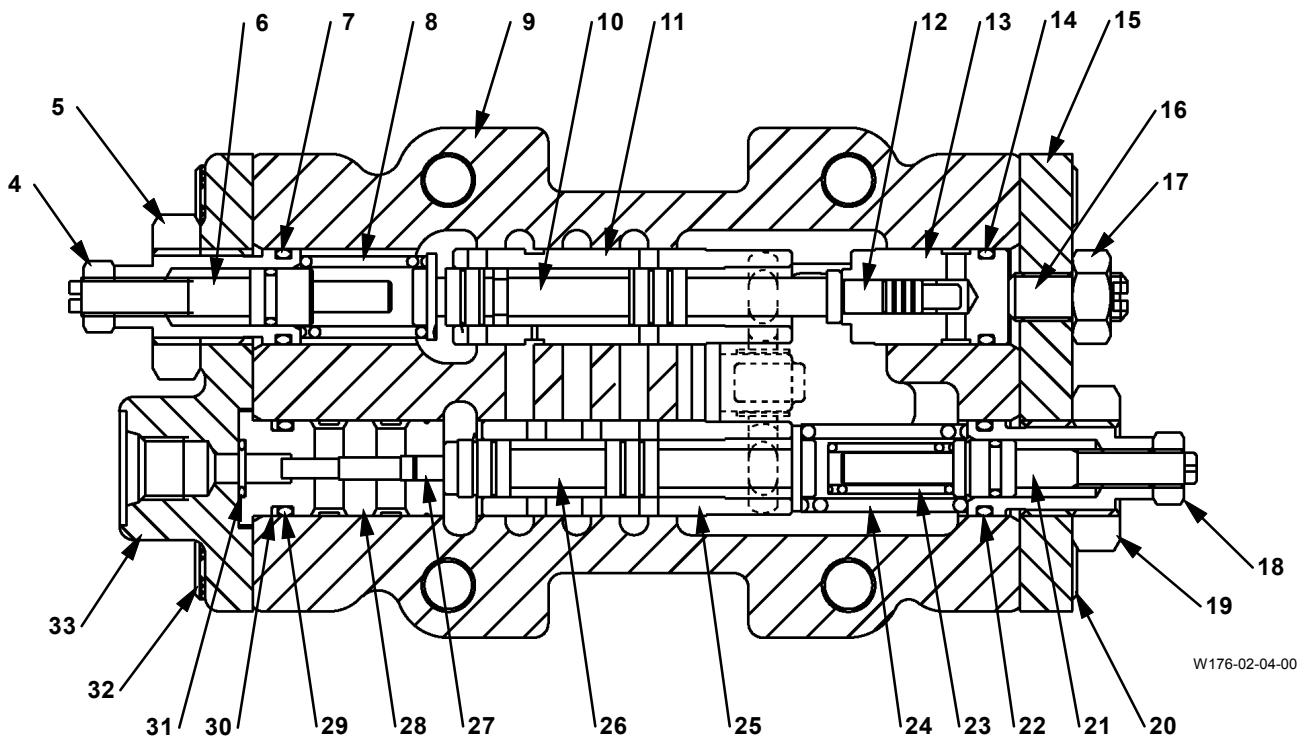
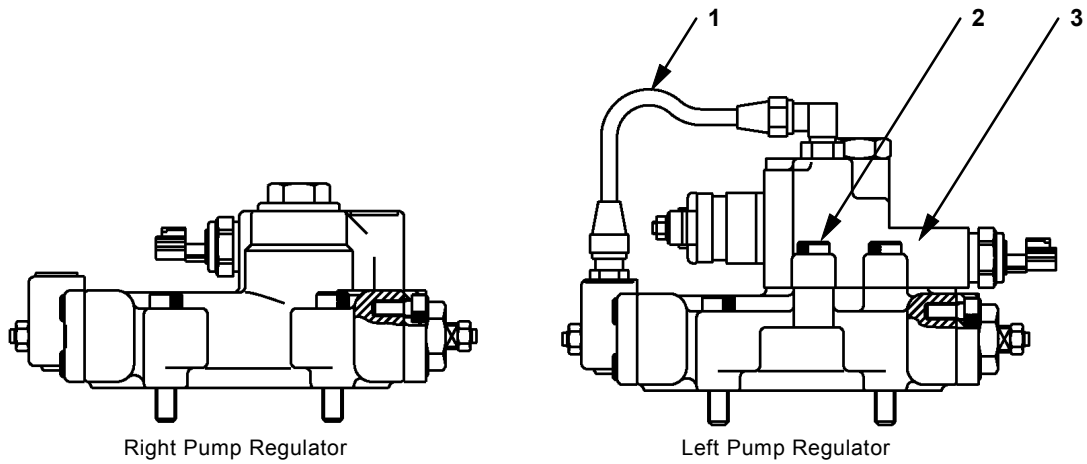
8. Remove spring (8) from casing (9).

9. Insert a round bar into the hole of casing (9). Pushing the spool (10) end, push out cylinder (13), sleeve (11) and the spool. At this time, piston (12) is removed with the cylinder.

10. Pull out piston (12) from cylinder (13).

UPPERSTRUCTURE / Pump Device

ASSEMBLE REGULATOR



W176-02-04-001

- | | | | |
|--------------------------|---------------|---------------------------|---------------------------|
| 1 - Pipe | 10 - Spool | 18 - Lock Nut | 26 - Spool |
| 2 - Socket Bolt (2 Used) | 11 - Sleeve | 19 - Lock Nut | 27 - Piston |
| 3 - Solenoid Valve | 12 - Piston | 20 - Socket Bolt (4 Used) | 28 - Cylinder |
| 4 - Lock Nut | 13 - Cylinder | 21 - Stopper Assembly | 29 - O-Ring |
| 5 - Lock Nut | 14 - O-Ring | 22 - O-Ring | 30 - Backup Ring |
| 6 - Stopper Assembly | 15 - Cover | 23 - Spring | 31 - O-Ring |
| 7 - O-Ring | 16 - Set Bolt | 24 - Spring | 32 - Socket Bolt (4 Used) |
| 8 - Spring | 17 - Lock Nut | 25 - Sleeve | 33 - Cover |
| 9 - Casing | | | |

UPPERSTRUCTURE / Pump Device

Assemble Regulator

IMPORTANT: Two holes for sleeve in casing (9) are with identical bores, and the shapes of various parts are very similar. Pay attention not to misassemble them. Perform assembling as illustrated.

1. Clean all parts neatly and apply hydraulic oil.

IMPORTANT: Pay attention to the direction for sleeve (11), spool (10) and piston (12) when assembling.

2. Insert spool (10) into sleeve (11). With a round bar, assemble it at the position closed to the center of casing (9).
3. Install O-ring (14) onto cylinder (13).
4. Insert piston (12) into cylinder (13), then assemble on casing (9).

IMPORTANT: Pay attention to the direction for sleeve (25) and spool (26) when assembling.

5. Insert spool (26) into sleeve (25), with a round bar to assemble it at the position closed to the center of casing (9).
6. Install O-rings (29), (31) and backup ring (30) onto cylinder (28).
7. Insert piston (27) into cylinder (28), then install the cylinder into casing (9).
8. Install O-ring (7) and spring (8) to stopper assembly (6) on cover (33). Install the cover on casing (9) with socket bolts (32) (4 used).
 : 6 mm
 : 19.6 N·m (2 kgf·m, 14.5 lbf·ft)

9. Install O-ring (22) and springs (23), (24) to stopper assembly (21) on cover (15). Install the cover on casing (9) with socket bolts (20) (4 used).

 : 6 mm
 : 19.6 N·m (2 kgf·m, 14.5 lbf·ft)

10. With socket bolts (2) (2 used), install solenoid valve (3) onto casing (9).

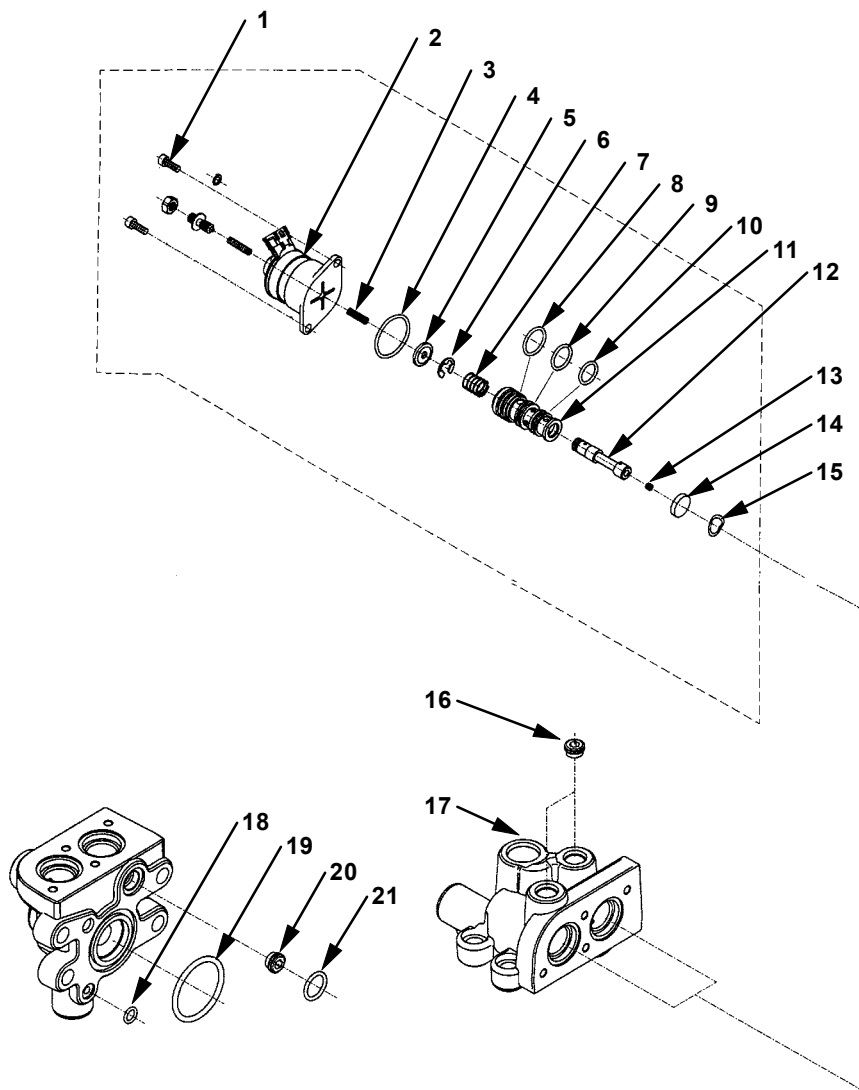
 : 8 mm
 : 49 N·m (5 kgf·m, 36 lbf·ft)

11. Apply a film of grease to the threaded part of pipe (1). Install pipe (1) to casing (9).

 : 17 mm
 : 34 N·m (3.5 kgf·m, 25.3 lbf·ft)

UPPERSTRUCTURE / Pump Device

DISASSEMBLE SOLENOID VALVE



W178-02-04-050

- | | | | |
|--------------------|-------------|------------------|-------------|
| 1 - Socket Bolt | 7 - Spring | 13 - Orifice | 19 - O-Ring |
| 2 - Solenoid | 8 - O-Ring | 14 - Plate | 20 - Filter |
| 3 - Spring | 9 - O-Ring | 15 - Wave Washer | 21 - O-Ring |
| 4 - O-Ring | 10 - O-Ring | 16 - Filter | |
| 5 - Diaphragm | 11 - Sleeve | 17 - Body | |
| 6 - Retaining Ring | 12 - Spool | 18 - O-Ring | |

UPPERSTRUCTURE / Pump Device

Disassemble Solenoid Valve

- Be sure not to damage the mating surface for the regulator.
- When replacing inner parts, replace solenoid valve as an assembly.
- Pay attention not to hit the solenoid part.
- When removing the connector, do not pry, but pull out straight.

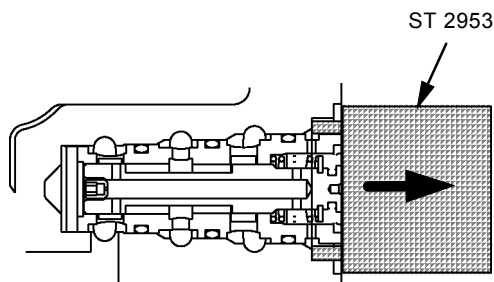
1. Remove socket bolt (1), then remove solenoid (2) and O-ring (4).

 : 4 mm

 **NOTE:** When solenoid (2) is removed, O-ring (4) and spring (3) may come off occasionally.

2. Using special tool (ST 2953), pull out the sleeve (11) assembly from body (17).

 **NOTE:** When pulling out sleeve (11), built-in plate (14) and wave washer (15) may come off occasionally.



W178-02-04-052

3. Remove plate (14) and wave washer (15) from body (17).

IMPORTANT: Do not remove orifice (13) from spool (12).

4. Remove retaining ring (6), then remove spring (7) and spool (12).

 **NOTE:** Spool (7) and spool (12) should be pulled out from the opposite direction.

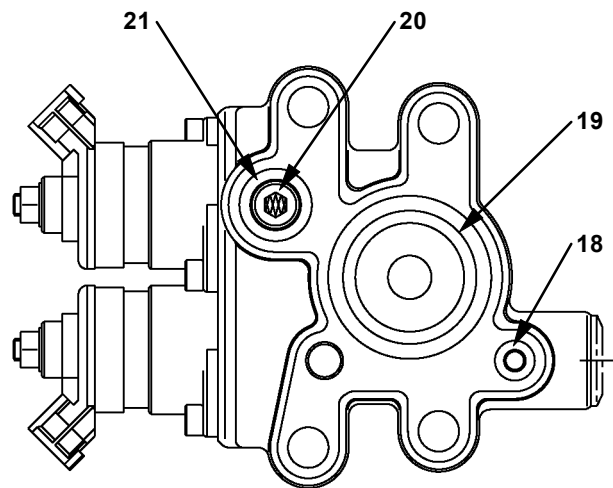
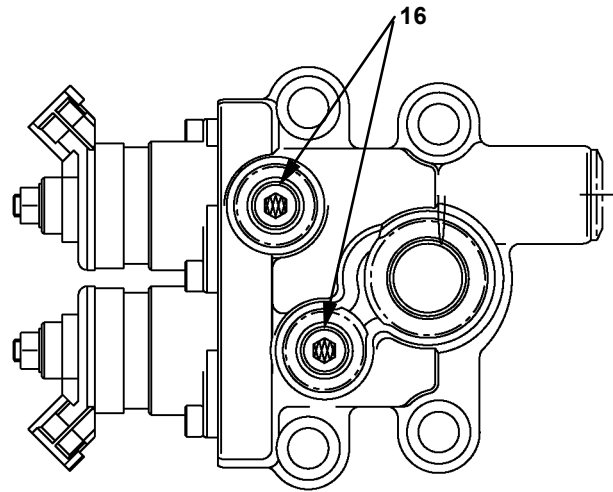
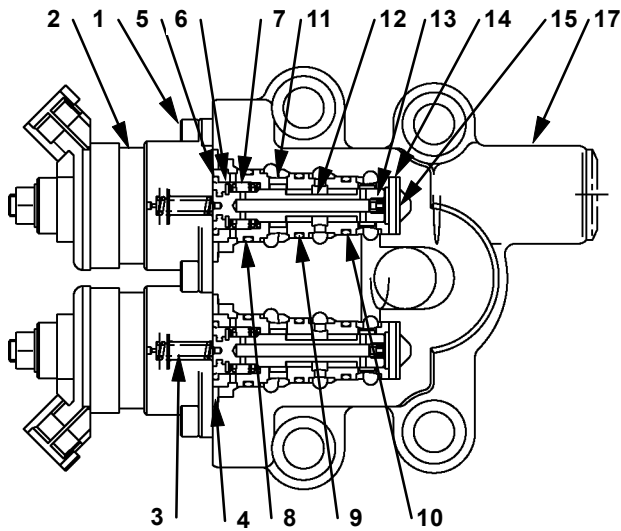
5. Remove filters (16), (20) from body (17).

 : 6 mm

 **NOTE:** When cleaning filter (16), first blow the filter with air from both surfaces, and finally blow the filter with air from outer side (threaded side).

UPPERSTRUCTURE / Pump Device

ASSEMBLE SOLENOID VALVE



W178-02-04-051

- 1 - Socket Bolt
- 2 - Solenoid
- 3 - Spring
- 4 - O-Ring
- 5 - Diaphragm
- 6 - Retaining Ring

- 7 - Spring
- 8 - O-Ring
- 9 - O-Ring
- 10 - O-Ring
- 11 - Sleeve
- 12 - Spool

- 13 - Orifice
- 14 - Plate
- 15 - Wave Washer
- 16 - Filter
- 17 - Body
- 18 - O-Ring

- 19 - O-Ring
- 20 - Filter
- 21 - O-Ring

UPPERSTRUCTURE / Pump Device

Assemble Solenoid Valve

1. Install filters (16), (20) onto body (17).

 : 6 mm

 : 10+3 N·m (1+0.3 kgf·m, 7.2+2.2 lbf·ft)

2. Install wave washer (15) and plate (14) on body (17).

 **NOTE:** When body (17) is horizontally inserted, apply a film of grease to wave washer (15) and plate (14) to prevent them from coming off.
After assembling, check for straight position of plate (14).

3. Install O-rings (8), (9) and (10) to sleeve (11).

4. Insert spool (12) into sleeve (11), then install spring (7), retaining ring (6) and diaphragm (5) on spool (12).

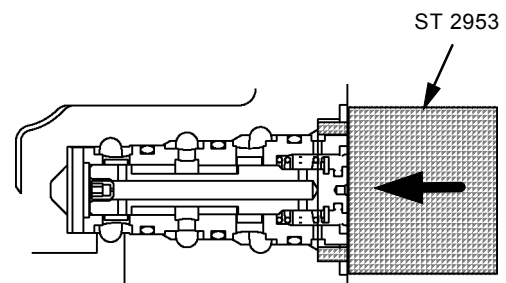
 **NOTE:** Install diaphragm (5) and let it crimp towards out.
After installing, check that spool (12) moves smoothly.

IMPORTANT: When installing sleeve (11), keep the sleeve end and body (17) end in the same position.

In addition, when installing the sleeve, be sure not to pry and cause damage to O-ring.

5. Using special tool (ST 2953), install sleeve (11) assembly to body (17).

 **NOTE:** When there is no special tool (ST 2953) available, tighten solenoid (2) alternately with socket bolts (1) (2 used). Then sleeve (11) end and body (17) end should be placed in the same position. Install the solenoid.



W178-02-04-052

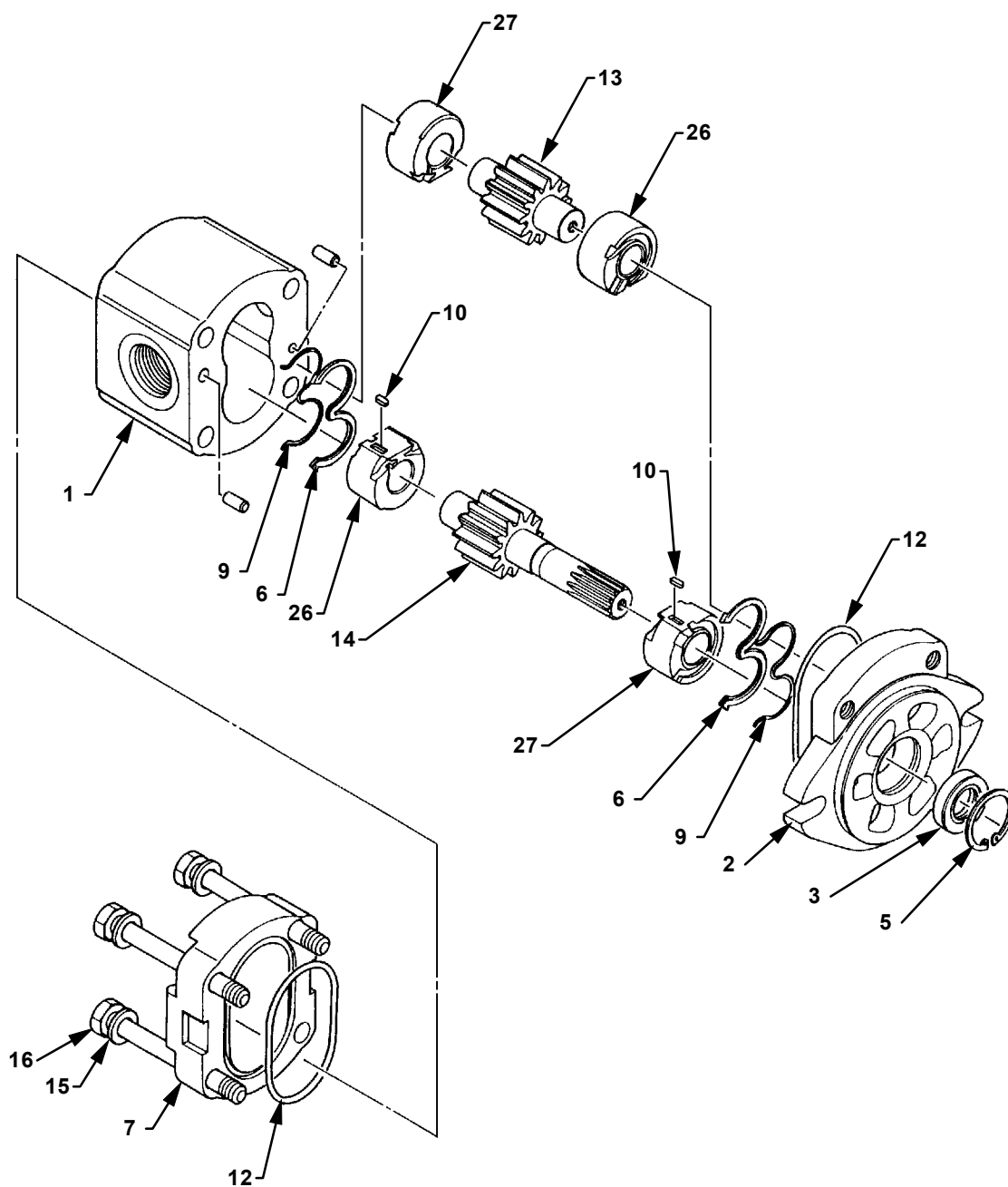
6. Install solenoid (2) to body (17) with socket bolt (1) (2 used).

 : 4 mm

 : 5+2 N·m (0.5+0.2 kgf·m, 3.6+1.4 lbf·ft)

UPPERSTRUCTURE / Pump Device

DISASSEMBLE AND ASSEMBLE PILOT PUMP



W137-02-04-034

UPPERSTRUCTURE / Pump Device

IMPORTANT: The housing is made of aluminum. Be sure not to damage it. Besides, take extreme care to control tightening torque.

Key No.	Part Name	Q'ty	Wrench Size (mm)	Tightening Torque		Remarks
				N·m	kgf·m (lbf·ft)	
1	Housing	1				
2	Flange	1				
3	Oil Seal	1				Apply a film of grease on bushing when installing
5	Retaining Ring	1				
6	Seal	2				Apply a film of grease when installing
7	Cover	1				
9	Backup Ring	2				Apply a film of grease when installing
10	Key	2				
12	O-Ring	2				Apply a film of grease when installing
13	Gear	1				
14	Gear	1				
15	Washer	4				
16	Bolt	4	 : 17	39 to 44	4 to 4.5 (28.9 to 32.5)	
26	Bushing	2				Apply a film of hydraulic oil when installing
27	Bushing	2				Apply a film of hydraulic oil when installing

UPPERSTRUCTURE / Pump Device

MAINTENANCE STANDARD

Pump Device

Unit: mm (in)

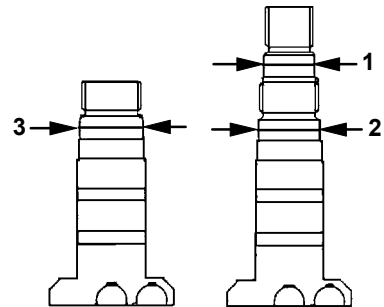
	Standard	Allowable Limit	Remedy
Gear Backlash	0.68 (0.027)	1.5 (0.059)	Replace

Main Pump

1. Drive Disc: Spline tooth thickness.

Unit: mm (in)

	Standard	Allowable Limit
	5.4 (0.213)	3.8 (0.150)

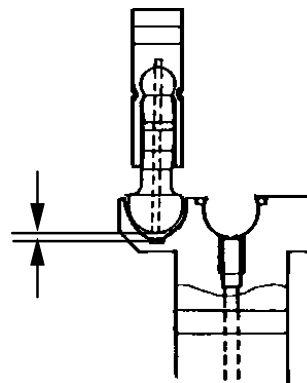


W157-02-04-015

2. Drive Disc: Oil seal outer diameter.

Unit: mm (in)

	Standard	Allowable Limit
1	45 (1.77)	44.8 (1.76)
2	55 (2.17)	54.8 (2.16)
3	55 (2.17)	54.8 (2.16)



W157-02-04-016

3. Spherical joint: The clearance between plunger and drive disc.

Unit: mm (in)

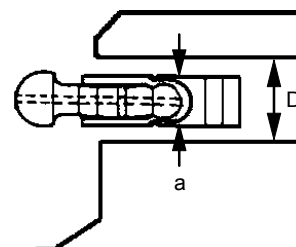
	Standard	Allowable Limit
	0.058 (0.0023)	0.4 (0.0157)

4. Cylinder Block: Clearance between plunger outer diameter and cylinder block bore.

D-a

Unit: mm (in)

	Standard	Allowable Limit
	0.043 (0.0017)	0.08 (0.0031)



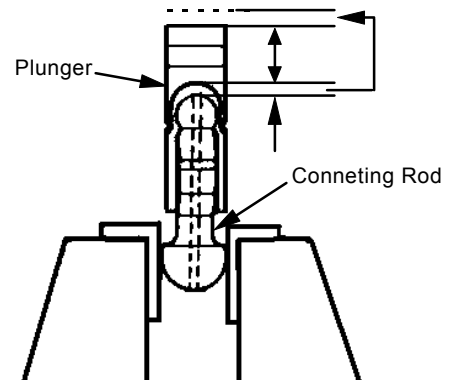
W157-02-04-017

UPPERSTRUCTURE / Pump Device

5. Plunger clearance between connecting rod and plunger

Unit: mm (in)

Standard	Allowable Limit
0.15 (0.0059)	0.4 (0.0157)

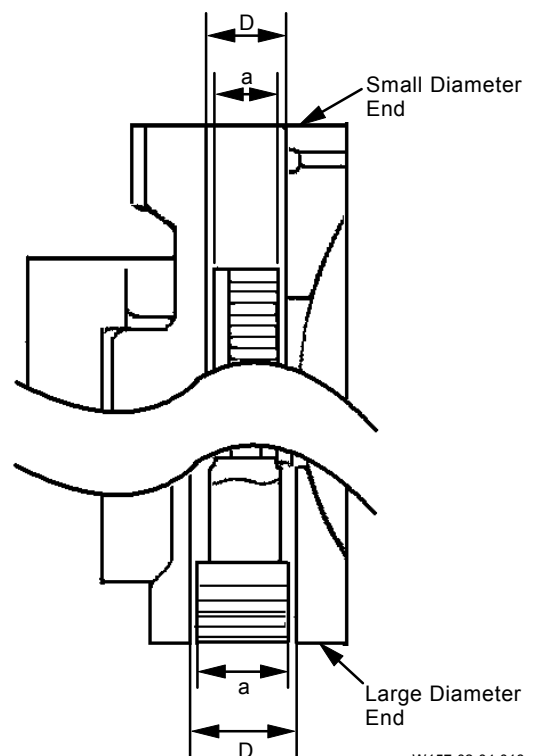


6. Clearance between small chamber I.D. and servo piston O.D.
D—a

Unit: mm (in)

Standard	Allowable Limit
0.083 (0.0033)	0.2 (0.0079)

W157-02-04-033



W157-02-04-018

7. Clearance between large chamber I.D. and servo piston O.D.
D—a

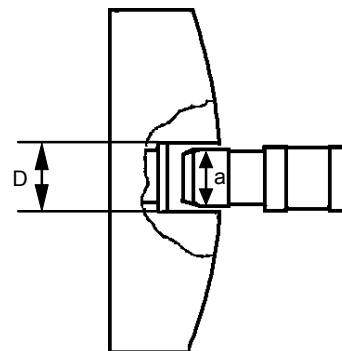
Unit: mm (in)

Standard	Allowable Limit
0.079 (0.0031)	0.2 (0.0079)

8. Clearance between servo pin and valve plate
D—a

Unit: mm (in)

Standard	Allowable Limit
0.051 (0.0020)	0.3 (0.0118)



W157-02-04-019

UPPERSTRUCTURE / Pump Device

(Blank)

UPPERSTRUCTURE / Control Valve

REMOVE AND INSTALL CONTROL VALVE



CAUTION: Escaping fluid under pressure may penetrate the skin, causing serious injury. Avoid this hazard by relieving pressure before disconnecting hydraulic or other lines. Hydraulic oil may be hot just after operation, and may spurt, possibly causing severe burns. Be sure to wait for oil to cool before starting any repair work.

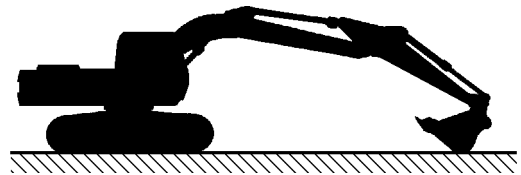
The hydraulic oil tank cap may fly off if removed without releasing accumulated pressure first. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.

Preparation

1. Place the machine on a firm, level surface.
2. Stop the engine. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure. (Refer to "bleed pressure from hydraulic circuit" on page W4-2-15.)
3. Remove hydraulic oil tank cap. Connect a vacuum pump to maintain negative pressure in the hydraulic oil tank.



NOTE: Be sure to run the vacuum pump continuously while working on the hydraulic system.



M104-07-021

UPPERSTRUCTURE / Control Valve

Removal (ZAXIS200, 200-E)

NOTE: Control valves of ZAXIS225US, 225USR are installed in different direction, even if their bodies look same.

IMPORTANT: Attach labels or tags, to aid in reassembling.

IMPORTANT: Cap the ends of all disconnected hoses and pipes.

1. Disconnect all hoses, pipes and connectors from the control valve.

	: 17 mm
	: 9.8 N·m (1 kgf·m, 7.2 lbf·ft)
	: 19 mm
	: 29.5 N·m (3 kgf·m, 21.5 lbf·ft)
	: 36 mm
	: 175 N·m (18 kgf·m, 130 lbf·ft)
	: 8 mm
	: 50 N·m (5.1 kgf·m, 37 lbf·ft)
	: 10 mm
	: 90 N·m (9.2 kgf·m, 67 lbf·ft)

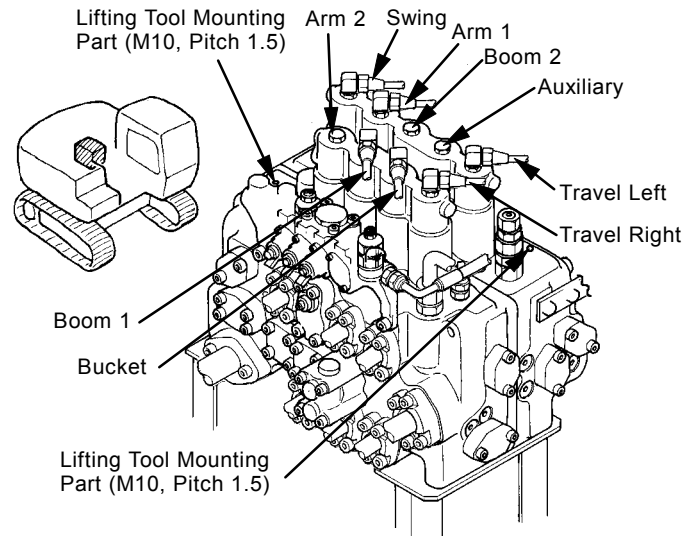
2. Remove control valve mounting bolts (1) (4 used).

	: 24 mm
	: 210 N·m (21 kgf·m, 152 lbf·ft)

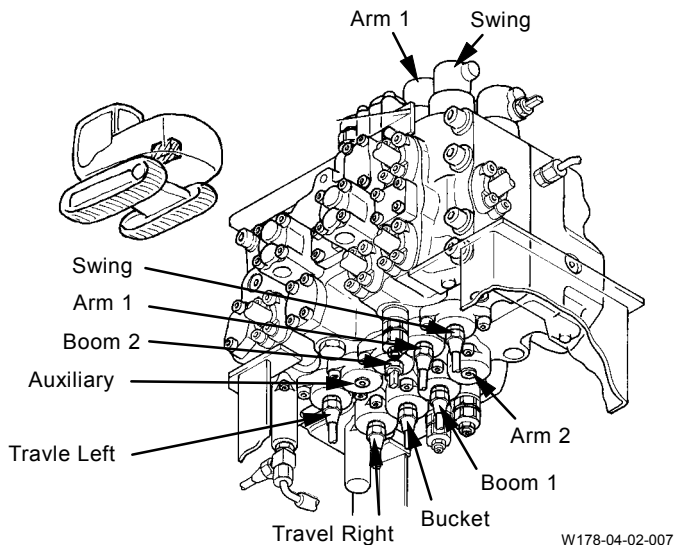


CAUTION: Control valve weight: 183 kg (400 lb)

3. Install eyebolts (M10, Pitch 1.5) (2 used) onto control valve, lift and remove it from bracket (2) by crane.



W178-04-02-030



W178-04-02-007

Installation

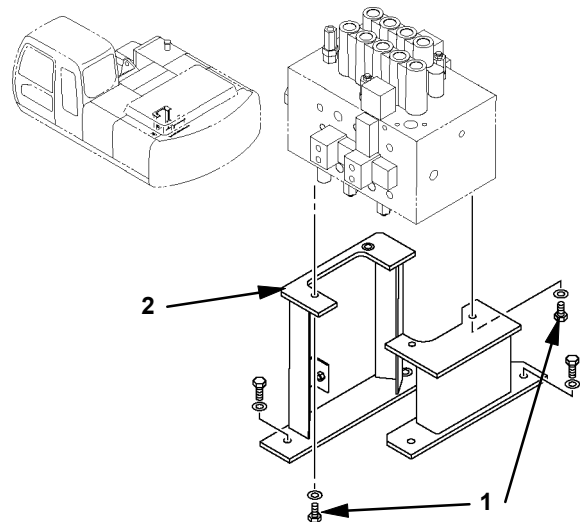
NOTE: Refer to "Removal" section above for wrench sizes and tightening torques.



CAUTION: Control valve weight: 183 kg (400 lb)

1. Install the control valve with bolts (1) (4 used).
2. Connect all hoses, pipes and connectors to the control valve.
3. Connect all hoses and pipes to the control valve.

IMPORTANT: After completing installation, check hydraulic oil level. Add oil as necessary. Run the engine to check the component for any oil leaks.



W178-02-05-001

UPPERSTRUCTURE / Control Valve

Removal (ZAXIS225US, 225USR)

 **NOTE:** Control valves of ZAXIS200, 200-E are installed in different direction, even if their bodies look same.

IMPORTANT: Attach labels or tags to aid in reassembling.

IMPORTANT: Cap the ends of all disconnected hoses and pipes.

1. Disconnect all hoses, pipes and connectors from the control valve.

	: 17 mm
	: 9.8 N·m (1 kgf·m, 7.2 lbf·ft)
	: 19 mm
	: 29.5 N·m (3 kgf·m, 21.5 lbf·ft)
	: 36 mm
	: 175 N·m (18 kgf·m, 130 lbf·ft)
	: 8 mm
	: 50 N·m (5.1 kgf·m, 37 lbf·ft)
	: 10 mm
	: 90 N·m (9.2 kgf·m, 67 lbf·ft)

2. Remove control valve mounting bolts (1) (4 used).

	: 24 mm
	: 210 N·m (21 kgf·m, 152 lbf·ft)

 **CAUTION:** Control valve weight: 183 kg (400 lb)

3. Install eyebolts (M10, Pitch 1.5) (2 used) into control valve, lift and remove the control valve from bracket (2) by crane.

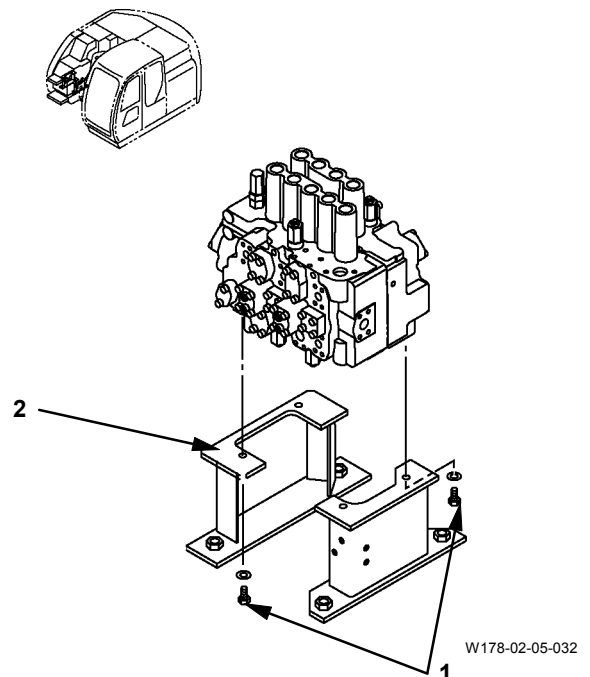
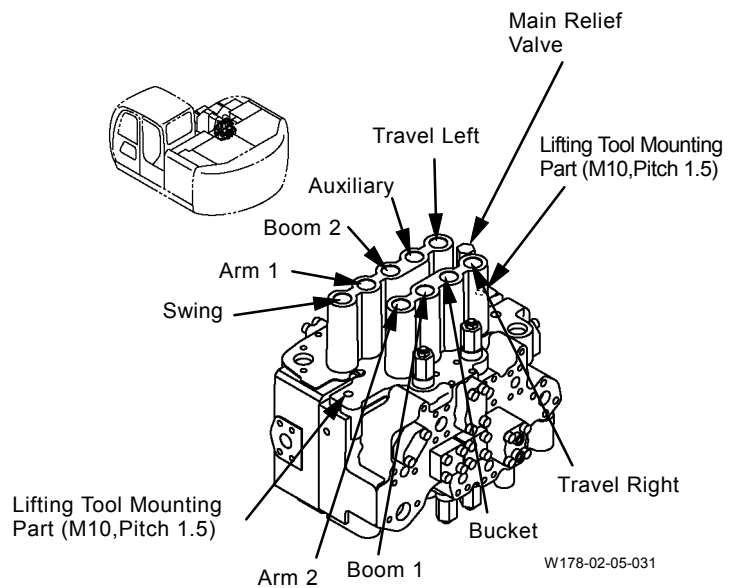
Installation

 **NOTE:** For wrench sizes and tightening torques, refer to "Removal" section.

 **CAUTION:** Control valve weight: 183 kg (400 lb)

1. Install eyebolts (M10, Pitch 1.5) (2 used) into control valve, lift and place the control valve onto bracket (2) by crane.
2. Install control valve onto bracket (2) with bolts (1) (4 used).
3. Connect all hoses and pipes and connectors to the control valve.

IMPORTANT: After completing installation, check hydraulic oil level. Add oil as necessary. Run the engine to check the component for any oil leaks.



UPPERSTRUCTURE / Control Valve

Removal (ZAXIS230, 270)

 **NOTE:** Control valves of ZAXIS200, 200-E, 225UR, 225USR are installed in different direction, even if their bodies look same.

IMPORTANT: Attach labels or tags to aid in reassembling.

IMPORTANT: Cap the ends of all disconnected hoses and pipes.

1. Disconnect all hoses, pipes and connectors from the control valve.

-  : 17 mm
-  : 9.8 N·m (1 kgf·m, 7.2 lbf·ft)
-  : 19 mm
-  : 29.5 N·m (3 kgf·m, 21.5 lbf·ft)
-  : 36 mm
-  : 175 N·m (18 kgf·m, 130 lbf·ft)
-  : 8 mm
-  : 50 N·m (5.1 kgf·m, 37 lbf·ft)
-  : 10 mm
-  : 90 N·m (9.2 kgf·m, 67 lbf·ft)

2. Remove control valve mounting bolts (1) (4 used).

-  : 24 mm
-  : 210 N·m (21 kgf·m, 152 lbf·ft)

 **CAUTION:** Control valve weight: 160 kg (350 lb)

3. Install eyebolts (M10, Pitch 1.5) (2 used) into control valve, lift and remove the control valve from bracket (2) by crane.

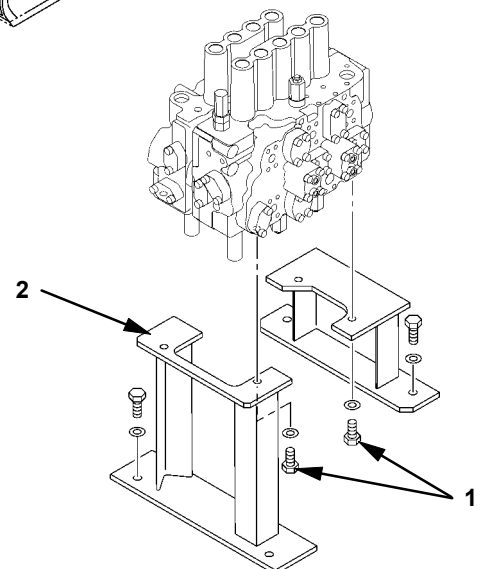
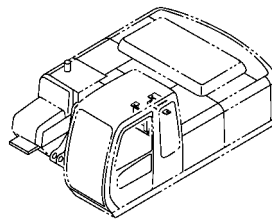
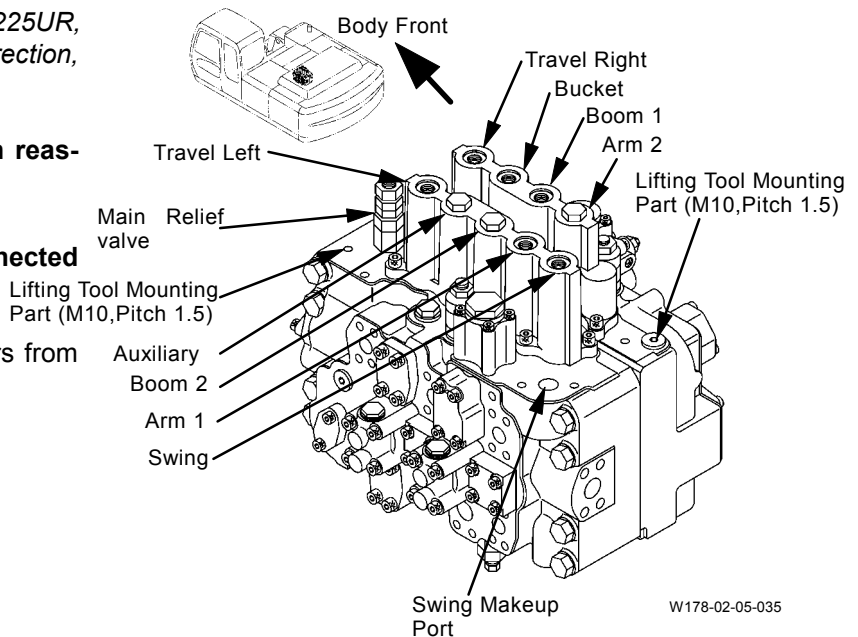
Installation (ZAXIS 230, 270)

 **NOTE:** For wrench sizes and tightening torques, refer to "Removal" section.

 **CAUTION:** Control valve weight: 160kg (350 lb)

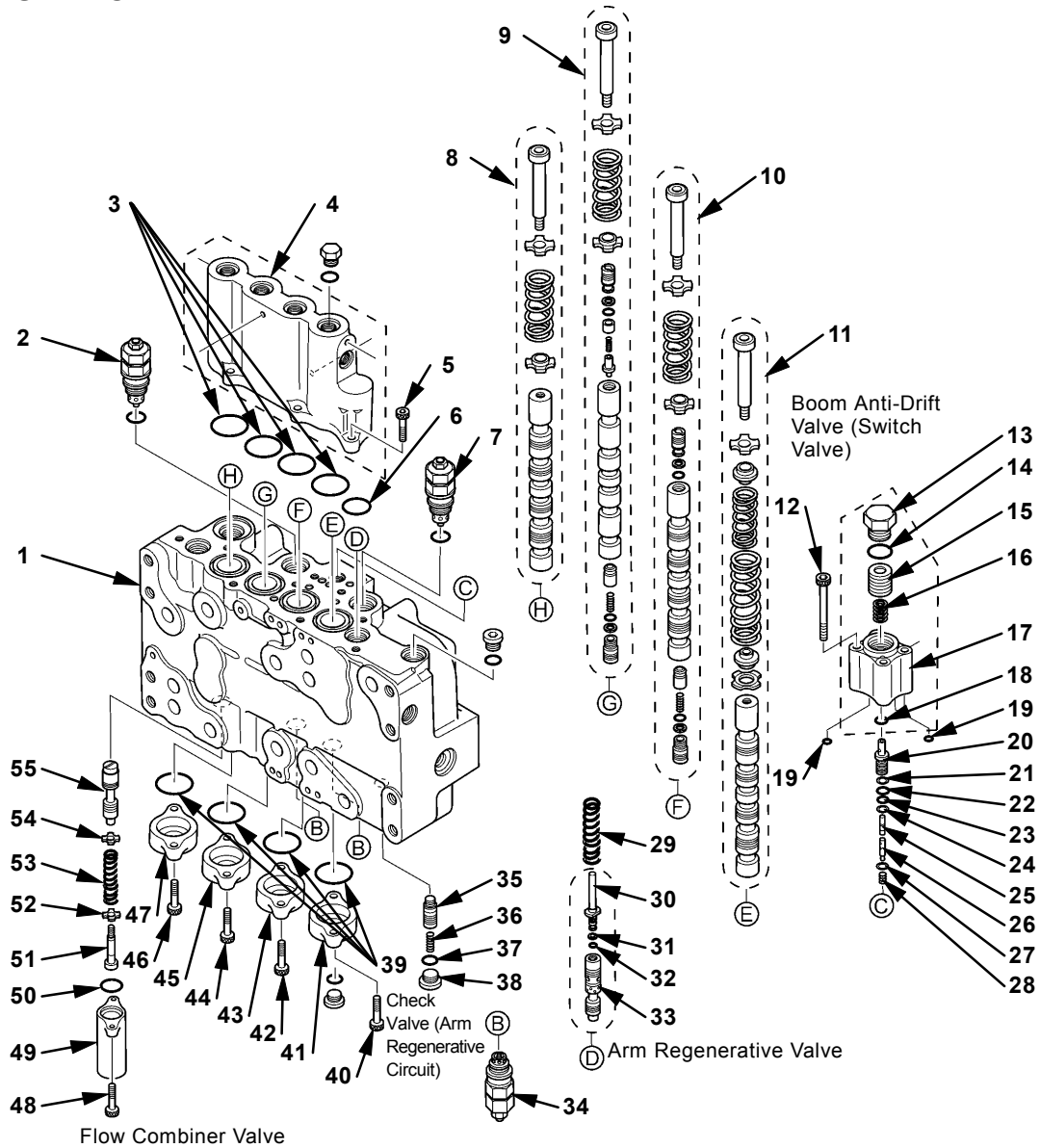
1. Install eyebolts (M10, Pitch 1.5) (2 used) into control valve, lift and place the control valve onto bracket (2) by crane.
2. Install control valve onto bracket (2) with bolts (1) (4 used).
3. Connect all hoses and pipes and connectors to the control valve.

IMPORTANT: After completing installation, check hydraulic oil level. Add oil as necessary. Run the engine to check the component for any oil leaks.



UPPERSTRUCTURE / Control Valve

DISASSEMBLE CONTROL VALVE 4-SPOOL SECTION



W178-02-05-013

- | | | | |
|-----------------------------------|--------------------|----------------------------|------------------|
| 1 - Housing | 15 - Piston | 29 - Spring | 43 - Cap |
| 2 - Overload Relief Valve | 16 - Spring | 30 - Spacer | 44 - Socket Bolt |
| 3 - O-Ring | 17 - Body | 31 - O-Ring | 45 - Cap |
| 4 - Pilot Housing | 18 - O-Ring | 32 - Backup Ring | 46 - Socket Bolt |
| 5 - Socket Bolt | 19 - O-Ring | 33 - Spool | 47 - Cap |
| 6 - O-Ring | 20 - Sleeve | 34 - Overload Relief Valve | 48 - Socket Bolt |
| 7 - Overload Relief Valve | 21 - Backup Ring | 35 - Poppet | 49 - Cap |
| 8 - Spool Assembly (Travel Right) | 22 - O-Ring | 36 - Spring | 50 - O-Ring |
| 9 - Spool Assembly (Bucket) | 23 - O-Ring | 37 - O-Ring | 51 - Bolt |
| 10 - Spool Assembly (Boom 1) | 24 - Backup Ring | 38 - Plug | 52 - Spring Seat |
| 11 - Spool Assembly (Arm 2) | 25 - Spool | 39 - O-Ring | 53 - Spring |
| 12 - Socket Bolt | 26 - Poppet | 40 - Socket Bolt | 54 - Spring Seat |
| 13 - Plug | 27 - Spring Washer | 41 - Cap | 55 - Spool |
| 14 - O-Ring | 28 - Spring | 42 - Socket Bolt | |

UPPERSTRUCTURE / Control Valve

- Be sure to thoroughly read "Precautions for Disassembly and Assembly" (W1-1-1) before starting the disassembly work.
- Attach identification tags to the spool and mounting positions in the housing in order to avoid mis-assembling.

1. Remove socket bolt (5) from housing (1), and remove pilot housing (4) and O-rings (3, 6).

 : 8 mm

**IMPORTANT: Remove spools (8, 9, 10, 11) while carefully moving them. If they stick, even a little, try it again instead of pulling roughly.
Make identification marks on spools (8, 9, 10, 11) and housing (1) in order to avoid confusion during reassembling.**

2. Remove spool assemblies (8, 9, 10, 11), spring (29) and the spool (33) assembly from housing (1).

 **NOTE:** *Don't disassemble the spool (33) assembly unless necessary.*

3. Loosen plug (13) from body (17).

 : 38 mm

4. Remove socket bolt (12) from housing (1).
Remove the body (17) assembly and O-rings (18 and 19).

 : 8 mm

5. Remove plug (13), O-ring (14), piston (15) and spring (16) from body (17).

6. Remove sleeve (20), spool (25), poppet (26), spring washer (27) and spring (28) from housing (1).
Remove backup rings (21, 24), O-rings (22, 23) from sleeve (20).

7. Remove overload relief valves (2, 7) from housing (1).

 : 32 mm

8. Remove socket bolts (40, 42, 44, 46) from housing (1) to remove caps (41, 43, 45, 47) and O-ring (39).

 : 8 mm

9. Remove plug (38), O-ring (37), spring (36), and poppet (35) from housing (1).

 : 6 mm

10. Remove socket bolt (48) from housing (1) to remove cap (49), O-ring (50) and the spool (55) assembly.

 : 4 mm

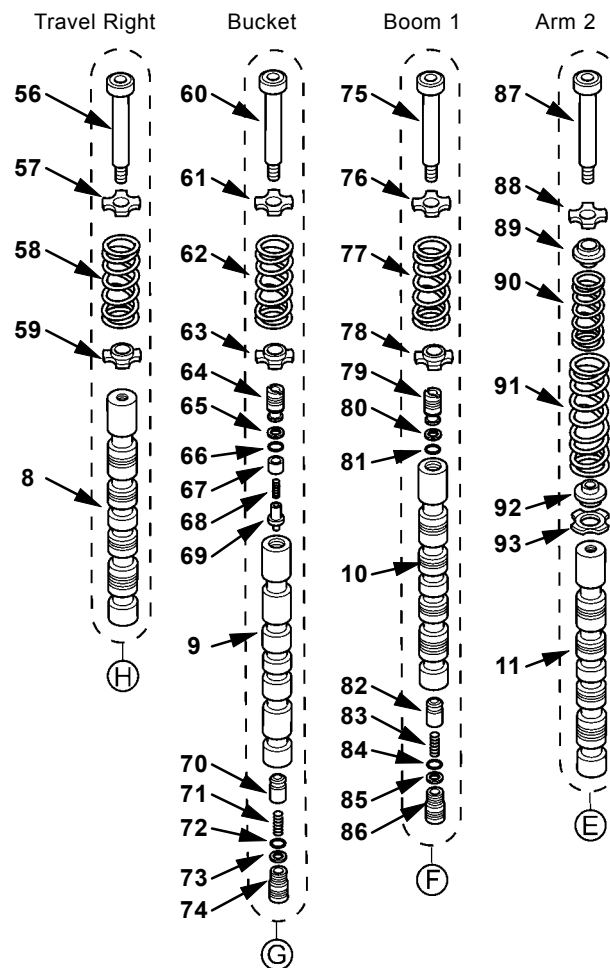
11. Clamp spool (55) with wooden pieces in a vise. Remove bolt (51), spring seat (52), spring (53) and spring seat (54).

 : 8 mm

12. Remove overload relief valve (34) from housing (1).

 : 32 mm

UPPERSTRUCTURE / Control Valve



W178-02-05-016

8 - Spool (Travel Right)
 9 - Spool (Bucket)
 10 - Spool (Boom 1)
 11 - Spool (Arm 2)
 56 - Bolt
 57 - Spring Seat
 58 - Spring
 59 - Spring Seat
 60 - Bolt
 61 - Spring Seat
 62 - Spring

63 - Spring Seat
 64 - Plug
 65 - Backup Ring
 66 - O-Ring
 67 - Sleeve
 68 - Spring
 69 - Poppet
 70 - Poppet
 71 - Spring
 72 - O-Ring
 73 - Backup Ring

74 - Plug
 75 - Bolt
 76 - Spring Seat
 77 - Spring
 78 - Spring Seat
 79 - Plug
 80 - Backup Ring
 81 - O-Ring
 82 - Poppet
 83 - Spring
 84 - O-Ring

85 - Backup Ring
 86 - Plug
 87 - Bolt
 88 - Spring Seat
 89 - Spring Seat
 90 - Spring
 91 - Spring
 92 - Spring Seat
 93 - Spring Seat

UPPERSTRUCTURE / Control Valve

- Disassemble spool (travel right)

13. Clamp spool (8) with wooden pieces in a vise. Remove bolt (56), spring seat (57), spring (58), and spring seat (59).

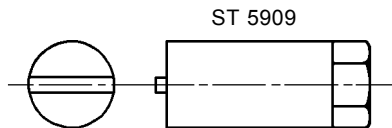
 : 8 mm

- Disassemble bucket spool

14. Clamp spool (9) with wooden pieces in a vise. Remove bolt (60), spring seat (61), spring (62) and spring seat (63).

 : 8 mm

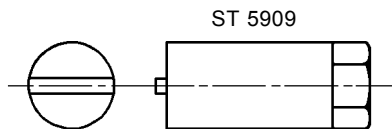
15. Heat the plug (64) part of spool (9) with a drier to melt LOCTITE. Remove plug (64) using tool (ST 5909).



W157-02-05-049

16. Remove sleeve (67), spring (68) and poppet (69) from spool (9).

17. Turn over spool (9) and clamp it in a vise. Heat the plug (74) part of spool (9) with a drier to melt LOCTITE. Remove plug (74) using tool (ST 5909).



W157-02-05-049

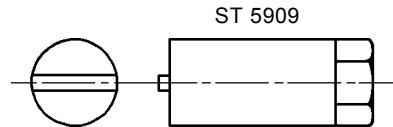
18. Remove spring (71) and poppet (70) from spool (9).

- Disassemble boom 1 spool

19. Clamp spool (10) with wooden pieces in a vise. Remove bolt (75), spring seat (76), spring (77) and spring seat (78).

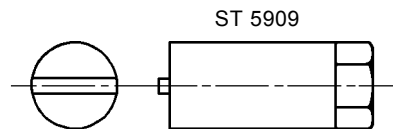
 : 8 mm

20. Heat the plug (79) part of spool (10) with a drier to melt LOCTITE. Remove plug (79) using tool (ST 5909).



W157-02-05-049

21. Turn over spool (10) and clamp it in a vise. Heat the plug (86) part of spool (10) with a drier to melt LOCTITE. Remove plug (86) using tool (ST 5909).



W157-02-05-049

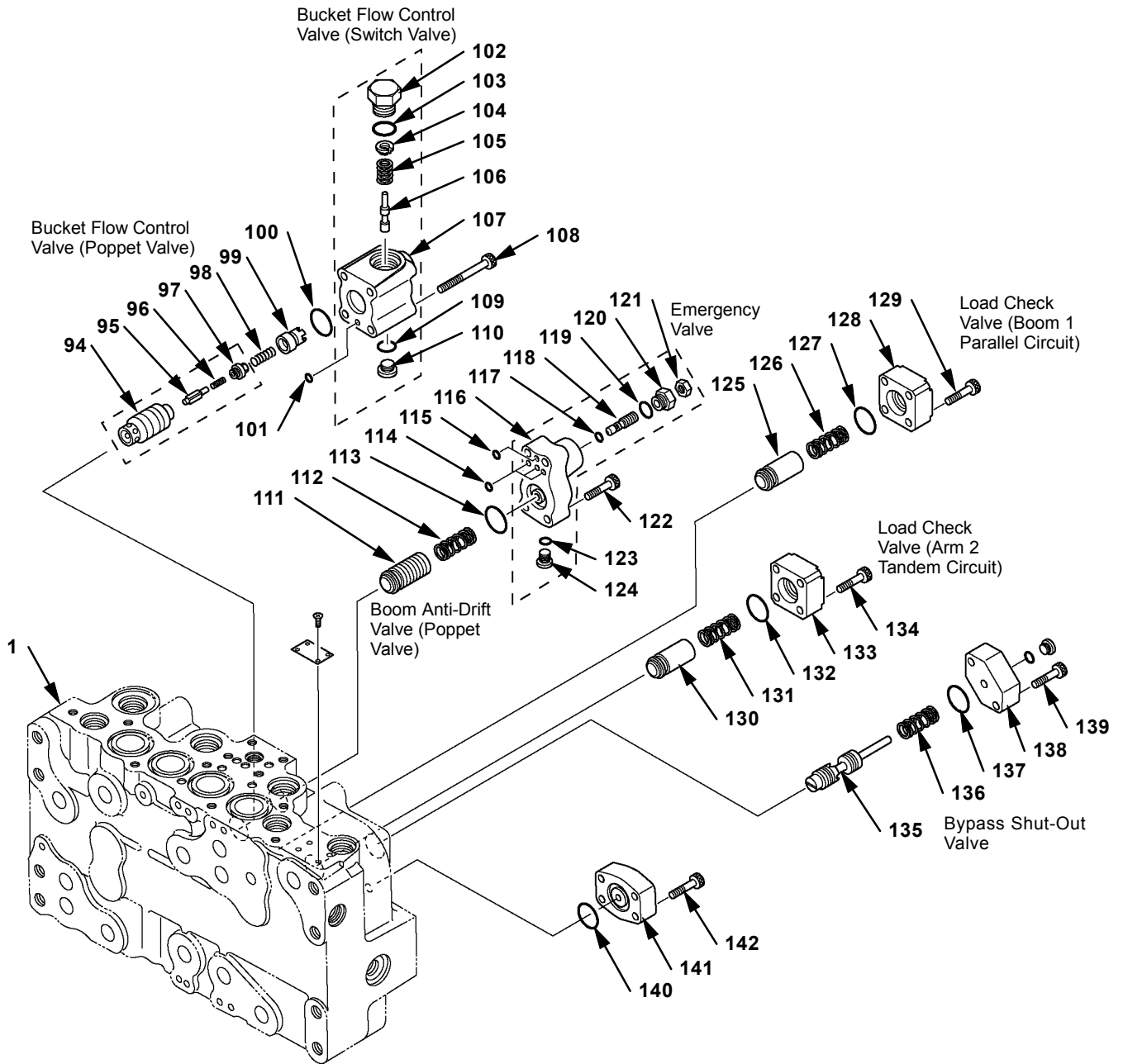
22. Remove spring (83) and poppet (82) from spool (10).

- Disassemble spool (arm 2)

23. Clamp spool (11) with wooden pieces in a vise. Remove bolt (87), spring seats (88, 89), springs (90, 91), and spring seats (92, 93).

 : 8 mm

UPPERSTRUCTURE / Control Valve



W178-02-05-011

1 - Housing	106 - Spool	119 - O-Ring	132 - O-Ring
94 - Poppet	107 - Body	120 - Nut	133 - Flange
95 - Poppet	108 - Socket Bolt	121 - Nut	134 - Socket Bolt
96 - Spring	109 - O-Ring	122 - Socket Bolt	135 - Spool
97 - Plug	110 - Plug	123 - O-Ring	136 - Spring
98 - Spring	111 - Poppet	124 - Plug	137 - O-Ring
99 - Sleeve	112 - Spring	125 - Poppet	138 - Flange
100 - O-Ring	113 - O-Ring	126 - Spring	139 - Socket Bolt
101 - O-Ring	114 - O-Ring	127 - O-Ring	140 - O-Ring
102 - Plug	115 - O-Ring	128 - Flange	141 - Flange
103 - O-Ring	116 - Body	129 - Socket Bolt	142 - Socket Bolt
104 - Spring Seat	117 - O-Ring	130 - Poppet	
105 - Spring	118 - Screw	131 - Spring	

UPPERSTRUCTURE / Control Valve

24. Loosen plug (102) from body (107).

 : 36 mm

25. Remove socket bolt (108), from housing (1) to remove body (107) and O-rings (100, 101).

 : 8 mm

26. Remove plug (102), O-ring (103), spring seat (104), spring (105) and spool (106) from body (107).

27. Remove sleeve (99), spring (98), plug (97), spring (96) and poppets (95, 94) from housing (1).

28. Remove socket bolt (122) from housing (1) to remove the body (116) assembly, O-rings (113, 114, 115).

 : 8 mm

 **NOTE:** *Don't remove nuts (120, 121) and screw (118) from body (116) unless necessary.*

29. Remove spring (112) and poppet (111) from housing (1).

30. Remove socket bolt (129) from housing (1).
Remove flange (128), O-ring (127), spring (126) and poppet (125) from housing (1).

 : 8 mm

31. Remove socket bolt (134) from housing (1).
Remove flange (133), O-ring (132), spring (131) and poppet (130) from housing (1).

 : 8 mm

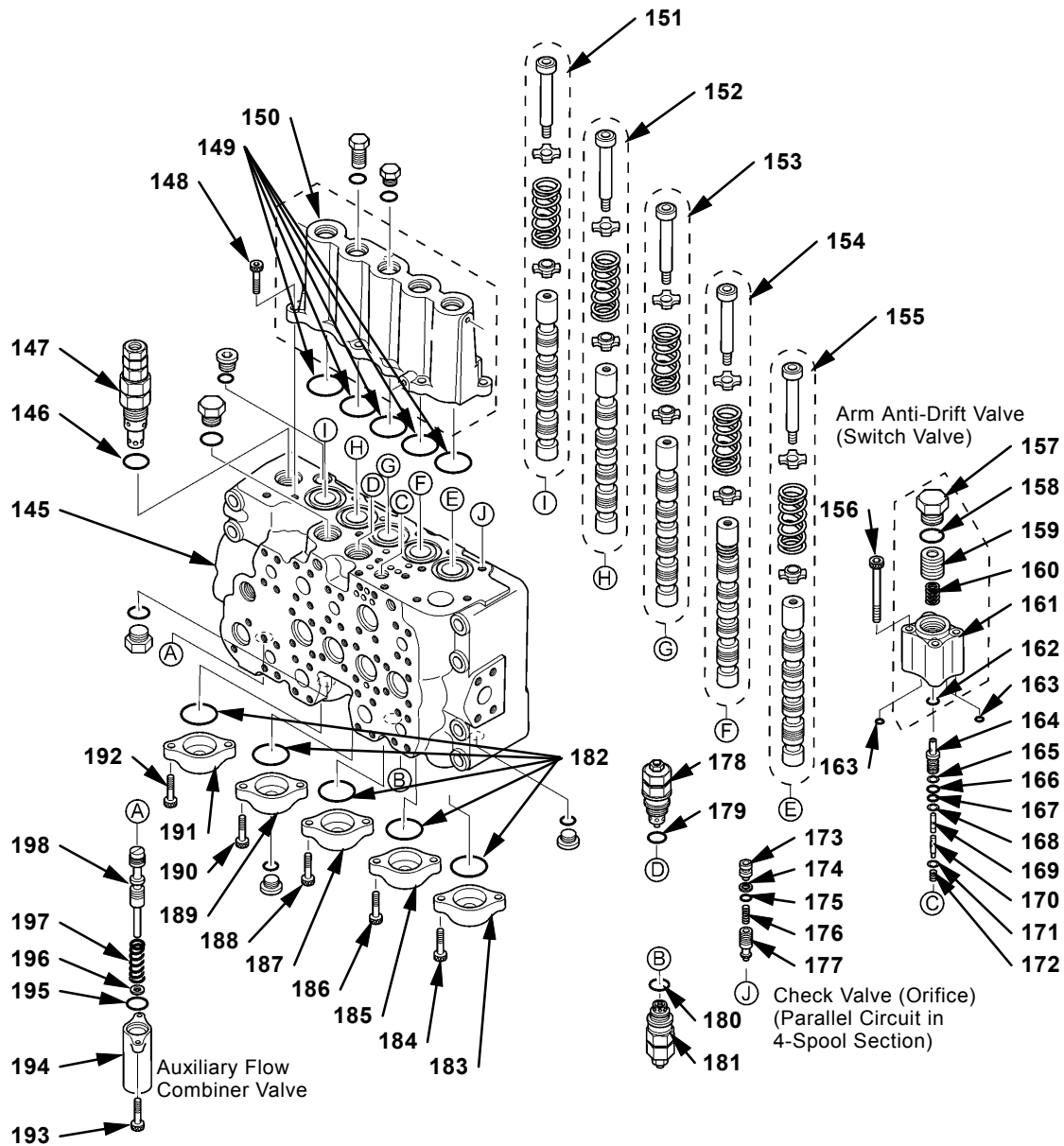
32. Remove socket bolt (139) from housing (1).

Remove flange (138), O-ring (137), spring (136) and spool (135) from housing (1).

 : 8 mm

UPPERSTRUCTURE / Control Valve

DISASSEMBLE CONTROL VALVE 5-SPOOL SECTION



W178-02-05-012

- | | | | |
|---------------------------|--------------------|----------------------------|--------------------|
| 145 -Housing | 159 -Piston | 173 -Plug | 187 -Cap |
| 146 -O-Ring | 160 -Spring | 174 -Backup Ring | 188 -Socket Bolt |
| 147 -Main Relief Valve | 161 -Body | 175 -O-Ring | 189 -Cap |
| 148 -Socket Bolt | 162 -O-Ring | 176 -Spring | 190 -Socket Bolt |
| 149 -O-Ring | 163 -O-Ring | 177 -Poppet | 191 -Cap |
| 150 -Pilot Housing | 164 -Sleeve | 178 -Overload Relief Valve | 192 -Socket Bolt |
| 151 -Spool (Travel Left) | 165 -Backup Ring | 179 -O-Ring | 193 -Socket Bolt |
| 152 -Spool (Auxiliary) | 166 -O-Ring | 180 -O-Ring | 194 -Cap |
| 153 -Spool (Boom 2) | 167 -O-Ring | 181 -Overload Relief Valve | 195 -O-Ring |
| 154 -Spool (Arm 1) | 168 -Backup Ring | 182 -O-Ring | 196 -Spring Washer |
| 155 -Spool (Swing) | 169 -Spool | 183 -Cap | 197 -Spring |
| 156 -Socket Bolt | 170 -Poppet | 184 -Socket Bolt | 198 -Spool |
| 157 -Plug | 171 -Spring Washer | 185 -Cap | |
| 158 -O-Ring | 172 -Spring | 186 -Socket Bolt | |

UPPERSTRUCTURE / Control Valve

- Be sure to thoroughly read "Precautions for Disassembly and Assembly" (W1-1-1) before starting the disassembly work.
- Attach identification tags to the spool and mounting positions in the housing in order to avoid misassembling.

1. Remove socket bolt (148) from housing (145). Remove pilot housing (150) and O-ring (149).

 : 8 mm

IMPORTANT: Remove spools (151, 152, 153, 154, 155) while carefully moving them. If they stick, even a little, try it again instead of pulling roughly. Make identification marks on spools (151, 152, 153, 154, 155) and housing (1) in order to avoid confusion during reassembling.

2. Remove spool (151, 152, 153, 154, 155) assemblies from housing (145).

3. Loosen plug (157) from body (161).

 : 38 mm

4. Remove socket bolt (156) from housing (145). Remove the body (161) assembly and O-ring (162).

 : 8 mm

5. Remove plug (157), O-ring (158), piston (159) and spring (160) from body (161).

6. Remove sleeve (164), spool (169), poppet (170) spring washer (171) and spring (172) from housing (145).

Remove backup rings (165, 168) and O-rings (166, 167) from sleeve (164).

7. Remove plug (173), spring (176) and poppet (177) from housing (145).

8. Remove overload relief valve (178) and main relief valve (147) from housing (145).

 : 32 mm

9. Remove socket bolts (184, 186, 188, 190, 192) from housing (145). Remove caps (183, 185, 187, 189, 191) and O-ring (182) from housing (145).

 : 8 mm

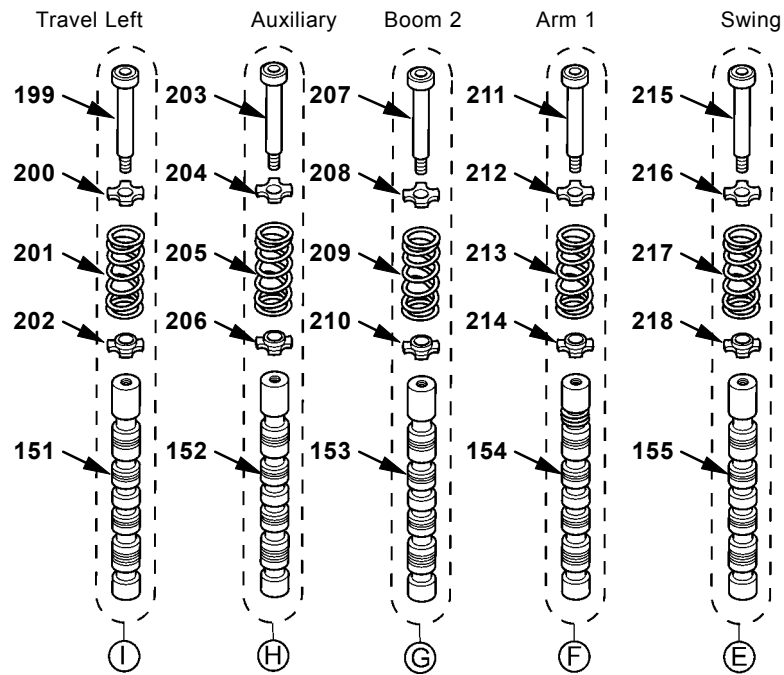
10. Remove socket bolt (193) from housing (145). Remove cap (194), O-ring (195), spring washer (196), spring (197) and spool (198) from housing (145).

 : 4 mm

11. Remove overload relief valve (181) from housing (145).

 : 32 mm

UPPERSTRUCTURE / Control Valve



W178-02-05-015

151 -Spool (Travel Left)
 152 -Spool (Auxiliary)
 153 -Spool (Boom 2)
 154 -Spool (Arm 1)
 155 -Spool (Swing)
 199 -Bolt
 200 -Spring Seat

201 -Spring
 202 -Spring Seat
 203 -Bolt
 204 -Spring Seat
 205 -Spring
 206 -Spring Seat
 207 -Bolt

208 -Spring Seat
 209 -Spring
 210 -Spring Seat
 211 -Bolt
 212 -Spring Seat
 213 -Spring
 214 -Spring Seat

215 -Bolt
 216 -Spring Seat
 217 -Spring
 218 -Spring Seat

UPPERSTRUCTURE / Control Valve

- Disassemble spool (travel left)

12. Clamp spool (151) with wooden pieces in a vise.
Remove bolt (199), spring seat (200), spring (201)
and spring seat (202).

 : 8 mm

- Disassemble spool (auxiliary)

13. Clamp spool (152) with wooden pieces in a vise.
Remove bolt (203), spring seat (204), spring (205)
and spring seat (206).

 : 8 mm

- Disassemble spool (boom 2)

14. Clamp spool (153) with wooden pieces in a vise.
Remove bolt (207), spring seat (208), spring (209)
and spring seat (210).

 : 8 mm

- Disassemble spool (arm 1)

15. Clamp spool (154) with wooden pieces in a vise.
Remove bolt (211), spring seat (212), spring (213)
and spring seat (214).

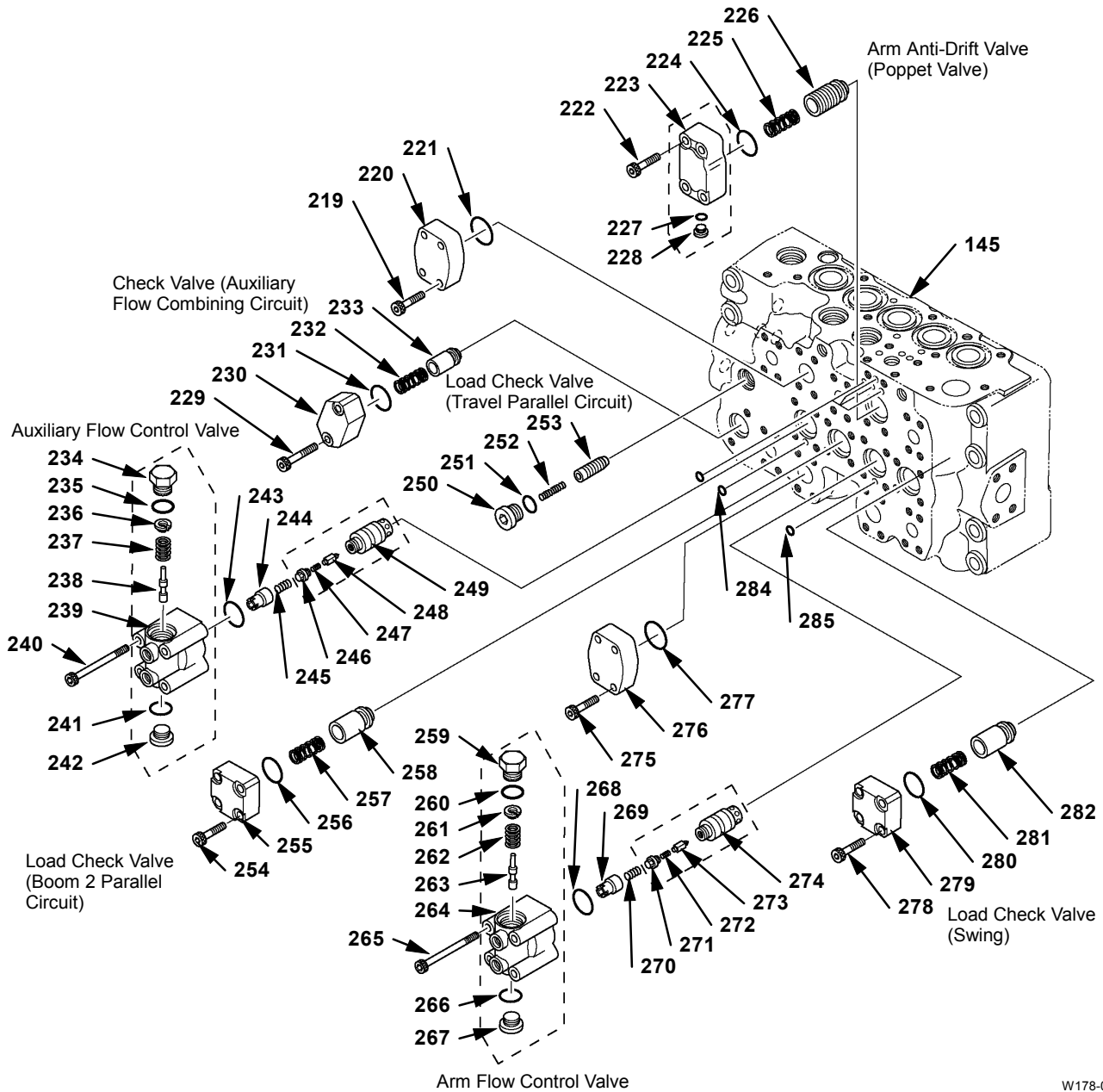
 : 8 mm

- Disassemble spool (swing)

16. Clamp spool (155) with wooden pieces in a vise.
Remove bolt (215), spring seat (216), spring (217)
and spring seat (218).

 : 8 mm

UPPERSTRUCTURE / Control Valve



W178-02-05-010

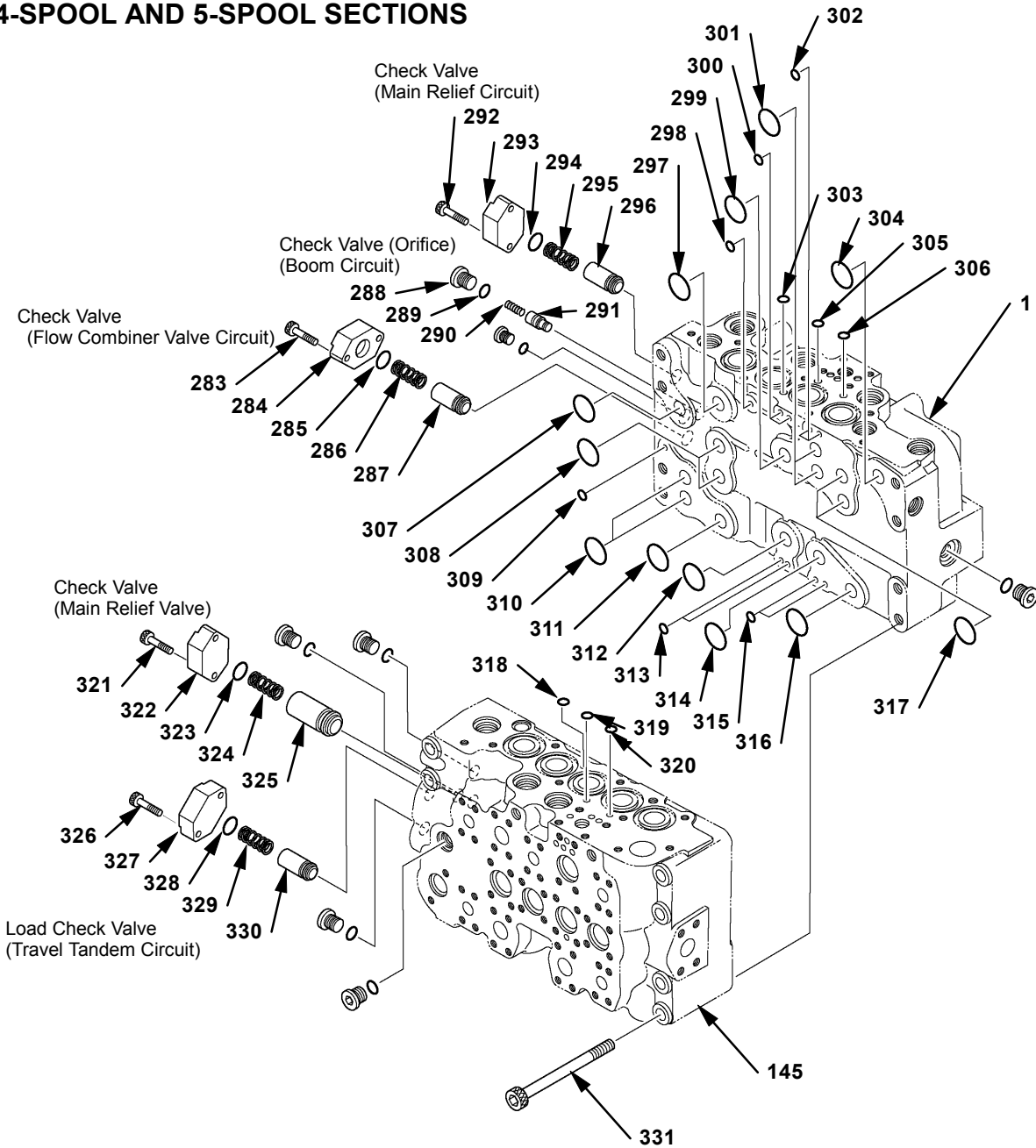
145 -Housing	235 -O-Ring	252 -Spring	269 -Sleeve
219 -Socket Bolt	236 -Spring Seat	253 -Poppet	270 -Spring
220 -Cover	237 -Spring	254 -Socket Bolt	271 -Plug
221 -O-Ring	238 -Spool	255 -Flange	272 -Spring
222 -Socket Bolt	239 -Body	256 -O-Ring	273 -Poppet
223 -Flange	240 -Socket Bolt	257 -Spring	274 -Poppet
224 -O-Ring	241 -O-Ring	258 -Poppet	275 -Socket Bolt
225 -Spring	242 -Plug	259 -Plug	276 -Cover
226 -Poppet	243 -O-Ring	260 -O-Ring	277 -O-Ring
227 -O-Ring	244 -Sleeve	261 -Spring Seat	278 -Socket Bolt
228 -Plug	245 -Spring	262 -Spring	279 -Flange
229 -Socket Bolt	246 -Plug	263 -Spool	280 -O-Ring
230 -Flange	247 -Spring	264 -Body	281 -Spring
231 -O-Ring	248 -Poppet	265 -Socket Bolt	282 -Poppet
232 -Spring	249 -Poppet	266 -O-Ring	
233 -Poppet	250 -Plug	267 -Plug	
234 -Plug	251 -O-Ring	268 -O-Ring	

UPPERSTRUCTURE / Control Valve

17. Remove socket bolt (229) from housing (145) to remove flange (230), O-ring (231), spring (232) and poppet (233).
 : 8 mm
18. Remove plug (250), O-ring (251), spring (252) and poppet (253) from housing (145).
 : 6 mm
19. Remove socket bolt (222) from housing (145) to remove flange (223), O-ring (224), spring (225) and poppet (226).
 : 8 mm
20. Remove socket bolt (254) from housing (145) to remove flange (255), O-ring (256), spring (257) and poppet (258).
 : 8 mm
21. Remove socket bolt (278) from housing (145) to remove flange (279), O-ring (280), spring (281) and poppet (282).
 : 8 mm
22. Loosen plug (234) of body (239).
 : 36 mm
23. Remove socket bolt (240) from housing (145) to remove the body (239) assembly and O-ring (243).
 : 8 mm
24. Remove plug (234), O-ring (235), spring seat (236), spring (237) and spool (238) from body (239).
25. Remove sleeve (244), spring (245), plug (246), spring (247) and poppets (248, 249) from housing (145).
26. Loosen plug (259) of body (264).
 : 36 mm
27. Remove socket bolt (265) from housing (145) to remove the body (264) assembly and O-ring (268).
 : 8 mm
28. Remove plug (259), O-ring (260), spring seat (261), spring (262), and spool (263) from body (264).
29. Remove sleeve (269), spring (270), plug (271), spring (272) and poppets (273, 274) from housing (145).

UPPERSTRUCTURE / Control Valve

DISASSEMBLE AND ASSEMBLE 4-SPOOL AND 5-SPOOL SECTIONS



W178-02-05-014

1 - Housing	294 -O-Ring	307 -O-Ring	320 -O-Ring
145 -Housing	295 -Spring	308 -O-Ring	321 -Socket Bolt
283 -Socket Bolt	296 -Poppet	309 -O-Ring	322 -Flange
284 -Flange	297 -O-Ring	310 -O-Ring	323 -O-Ring
285 -O-Ring	298 -O-Ring	311 -O-Ring	324 -Flange
286 -Spring	299 -O-Ring	312 -O-Ring	325 -Poppet
287 -Poppet	300 -O-Ring	313 -O-Ring	326 -Socket Bolt
288 -Plug	301 -O-Ring	314 -O-Ring	327 -Flange
289 -O-Ring	302 -O-Ring	315 -O-Ring	328 -O-Ring
290 -Spring	303 -O-Ring	316 -O-Ring	329 -Flange
291 -Poppet	304 -O-Ring	317 -O-Ring	330 -Poppet
292 -Socket Bolt	305 -O-Ring	318 -O-Ring	331 -Socket Bolt
293 -Flange	306 -O-Ring	319 -O-Ring	

UPPERSTRUCTURE / Control Valve

- Be sure to thoroughly read "Precautions for Disassembly and Assembly" (W1-1-1) before starting the disassembly work.

Disassemble

1. Remove socket bolts (283, 292) from housing (1) to remove flanges (284, 293), O-rings (285, 294), springs (286, 295) and poppet (287, 296).

 : 8 mm

2. Remove plug (288), O-ring (289), spring (290) and poppet (291) from housing (1).

 : 6 mm

3. Remove socket bolts (321, 326) from housing (145) to remove flanges (322, 327), O-rings (323, 328), springs (324, 329) and poppets (325, 330).

 : 8 mm



**CAUTION: Housing (1) weight: 75 kg (165 lb)
Housing (145) weight: 74 kg (163 lb)**

4. Remove socket bolt (331), and separate housing (1) and housing (145).

 : 14 mm

5. Remove O-rings (297 to 320) from the mounting surface of the housing.

Assemble

1. Install O-rings (297 to 320) onto the mounting surface of the housing.



**CAUTION: Housing (1) weight: 75 kg (165 lb)
Housing (145) weight: 74 kg (163 lb)**

2. Connect housing (1) and housing (145) with socket bolt (331).

 : 14 mm

 : 167 to 177 N·m
(17 to 18 kgf·m, 123 to 130 lbf·ft)

3. Install poppets (325, 330), springs (324, 329), O-rings (323, 328), flanges (322, 327) and socket bolts (321, 326) into housing (145).

 : 8 mm

 : 61±3 N·m
(6.3±0.3 kgf·m, 45.6±2.2 lbf·ft)

4. Install poppet (291), spring (290), O-ring (289) and plug (288) into housing (1).

 : 6 mm

 : 76±3 N·m
(7.8±0.3 kgf·m, 56.4±2.2 lbf·ft)

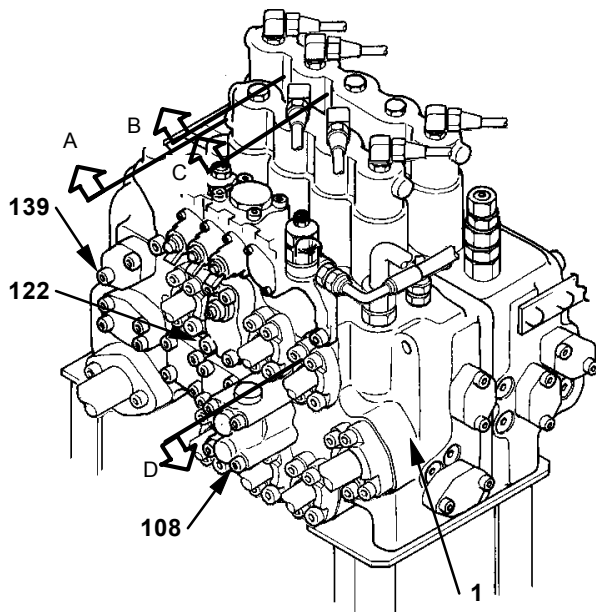
5. Install poppets (287, 296), springs (286, 295), O-rings (285, 294), flanges (284, 293) and socket bolts (283, 292) into housing (1).

 : 8 mm

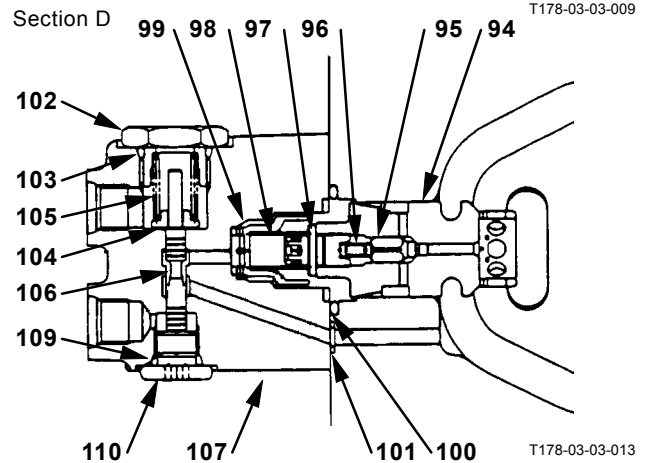
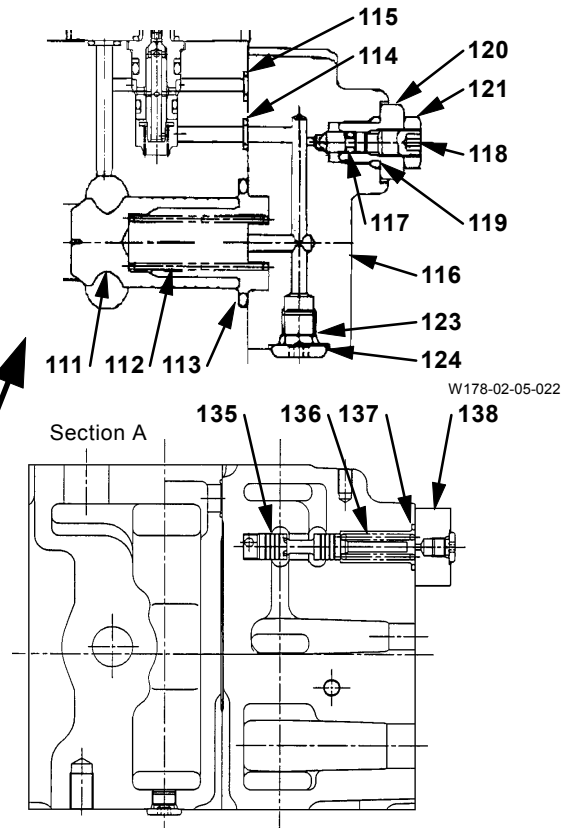
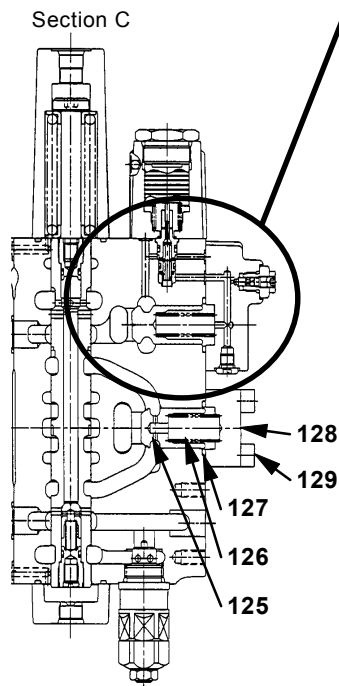
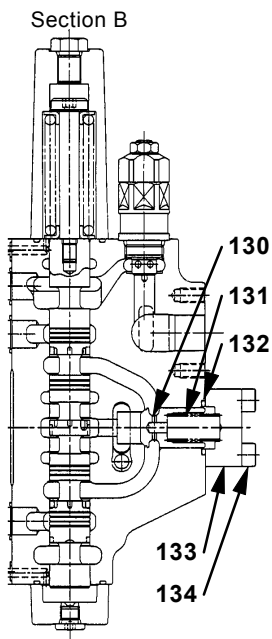
 : 61±3 N·m
(6.3±0.3 kgf·m, 45.6±2.2 lbf·ft)

UPPERSTRUCTURE / Control Valve

ASSEMBLE CONTROL VALVE 4-SPOOL SECTION



W178-02-05-017



T178-03-03-013

1 - Housing
94 - Poppet
95 - Poppet
96 - Spring
97 - Plug
98 - Spring
99 - Sleeve
100 - O-Ring
101 - O-Ring
102 - Plug
103 - O-Ring
104 - Spring Seat
105 - Spring

106 - Spool
107 - Body
108 - Socket Bolt
109 - O-Ring
110 - Plug
111 - Poppet
112 - Spring
113 - O-Ring
114 - O-Ring
115 - O-Ring
116 - Body
117 - O-Ring
118 - Screw

W178-02-05-020

119 - O-Ring
120 - Nut
121 - Nut
122 - Socket Bolt
123 - O-Ring
124 - Plug
125 - Poppet
126 - Spring
127 - O-Ring
128 - Flange
129 - Socket Bolt
130 - Poppet
131 - Spring

132 - O-Ring
133 - Flange
134 - Socket Bolt
135 - Spool
136 - Spring
137 - O-Ring
138 - Flange
139 - Socket Bolt

UPPERSTRUCTURE / Control Valve

- Be sure to read "Precautions for Disassembly and Assembly" (W1-1-1) before starting the assembly work.

1. Install spool (135), spring (136), O-ring (137), flange (138) and socket bolt (139) into housing (1).

 : 8 mm

 : 61±3 N·m
(6.3±0.3 kgf·m, 45.6±2.2 lbf·ft)

2. Install poppet (130), spring (131), O-ring (132), flange (133) and socket bolt (134) into housing (1).

 : 8 mm

 : 61±3 N·m
(6.3±0.3 kgf·m, 45.6±2.2 lbf·ft)

3. Install poppet (125), spring (126), O-ring (127), flange (128) and socket bolt (129) into housing (1).

 : 8 mm

 : 61±3 N·m
(6.3±0.3 kgf·m, 45.6±2.2 lbf·ft)

IMPORTANT: When the emergency valve has been disassembled, tighten nut (120), screw (118) and nut (121) securely. By failing to do so, boom drifting amount will be increased (increasing oil leakage amount).

 : 13 mm

 : 13 N·m (1.3 kgf·m, 9.4 lbf·ft)

 : 4 mm

 : 6.9 N·m (0.7 kgf·m, 5.1 lbf·ft)

4. Install poppet (111) and spring (112) into housing (1). Install the body (116) assembly onto the housing with socket bolt (122).

 : 8 mm

 : 61±3 N·m
(6.3±0.3 kgf·m, 45.6±2.2 lbf·ft)

5. Install poppet (95), spring (96), plug (97), spring (98) and sleeve (99) into poppet (94).

6. Install spool (106), spring (105) and spring seat (104) onto body (107). Tighten plug (102) temporarily.

 : 36 mm

7. Install the poppet (94) assembly into housing (1). Install body (107) onto the housing with socket bolt (108).

 : 8 mm

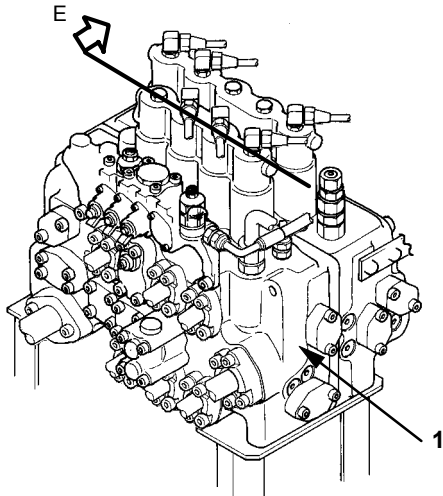
 : 61±3 N·m
(6.3±0.3 kgf·m, 45.6±2.2 lbf·ft)

8. Completely tighten plug (102) which was temporarily tightened in step 6.

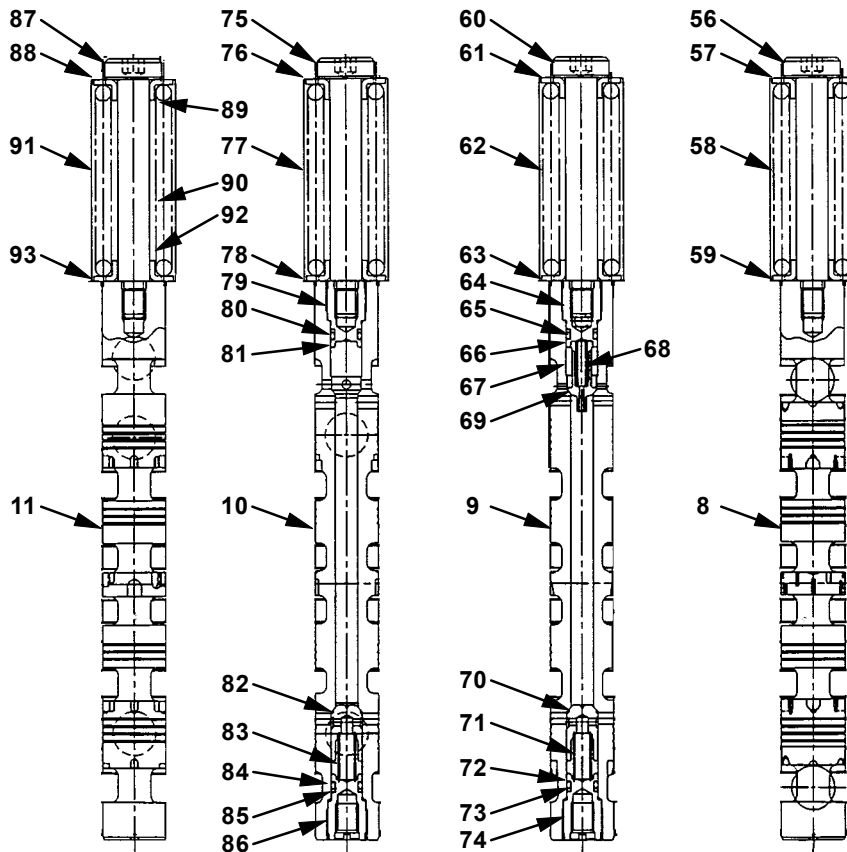
 : 36 mm

 : 98 N·m (10 kgf·m, 72.3 lbf·ft)

UPPERSTRUCTURE / Control Valve



W178-02-05-017



- | | | | |
|---------------------------|------------------|------------------|------------------|
| 8 - Spool (Travel Right) | 63 - Spring Seat | 74 - Plug | 85 - Backup Ring |
| 9 - Spool (Bucket) | 64 - Plug | 75 - Bolt | 86 - Plug |
| 10 - Spool (Boom 1) | 65 - Backup Ring | 76 - Spring Seat | 87 - Bolt |
| 11 - Spool (Arm 2) | 66 - O-Ring | 77 - Spring | 88 - Spring Seat |
| 56 - Bolt | 67 - Sleeve | 78 - Spring Seat | 89 - Spring Seat |
| 57 - Spring Seat | 68 - Spring | 79 - Plug | 90 - Spring |
| 58 - Spring | 69 - Poppet | 80 - Backup Ring | 91 - Spring |
| 59 - Spring Seat | 70 - Poppet | 81 - O-Ring | 92 - Spring Seat |
| 60 - Bolt | 71 - Spring | 82 - Poppet | 93 - Spring Seat |
| 61 - Spring Seat | 72 - O-Ring | 83 - Spring | |
| 62 - Spring | 73 - Backup Ring | 84 - O-Ring | |

W178-02-05-023

UPPERSTRUCTURE / Control Valve

- Assemble spool (travel right)

9. Clamp spool (8) with wooden pieces in a vise. Install spring seat (59), spring (58), spring seat (57) and bolt (56).

 : 8 mm

 : 15 N·m (1.5 kgf·m, 11 lbf·ft)

- Assemble spool (bucket)

10. Clamp spool (9) with wooden pieces in a vise, with the plug (74) side facing up. Install poppet (70) and spring (71) into spool (9).

11. Install O-ring (72) and backup ring (73) onto plug (74). Apply LOCTITE #271 on thread part of plug.

12. Install plug (74) onto spool (9) with tool (ST 5909).

 : 15 N·m (1.5 kgf·m, 11 lbf·ft)

13. Turn over spool (9), then clamp it in a vise. Install poppet (69), spring (68), and sleeve (67).

14. Install O-ring (66) and backup ring (65) onto plug (64). Apply LOCTITE #271 on the threaded part of the plug.

15. Install plug (64) onto spool (9) with tool (ST 5909).

 : 15 N·m (1.5 kgf·m, 11 lbf·ft)

16. Install spring seat (63), spring (62), spring seat (61) and bolt (60) onto spool (9).

 : 8 mm

 : 15 N·m (1.5 kgf·m, 11 lbf·ft)

- Assemble spool (boom 1)

17. Clamp spool (10) with wooden pieces in a vise, with the plug (86) side facing up. Install poppet (82), and spring (83) into spool (10).

18. Install O-ring (84) and backup ring (85) into plug (86). Apply LOCTITE #271 on the threaded part of the plug.

19. Install plug (86) into spool (10) with tool (ST 5909).

 : 15 N·m (1.5 kgf·m, 11 lbf·ft)

20. Turn spool (10) over, then clamp it in a vise. Install O-ring (81) and backup ring (80) into plug (79). Apply LOCTITE #271 on the threaded part of the plug.

21. Install plug (79) into spool (10) with tool (ST 5909).

 : 15 N·m (1.5 kgf·m, 11 lbf·ft)

22. Install spring seat (78), spring (77), spring seat (76) and bolt (75) into spool (10).

 : 8 mm

 : 15 N·m (1.5 kgf·m, 11 lbf·ft)

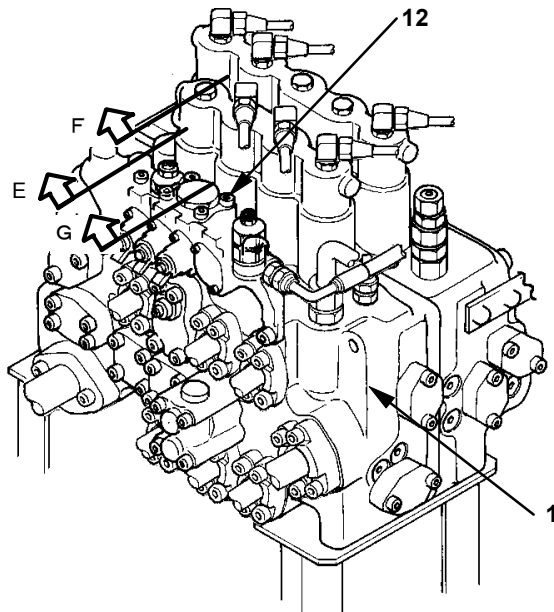
- Assemble spool (arm 2)

23. Clamp spool (11) with wooden pieces in a vise. Install spring seats (93, 92), springs (91, 90), spring seats (89, 88), and bolt (87).

 : 8 mm

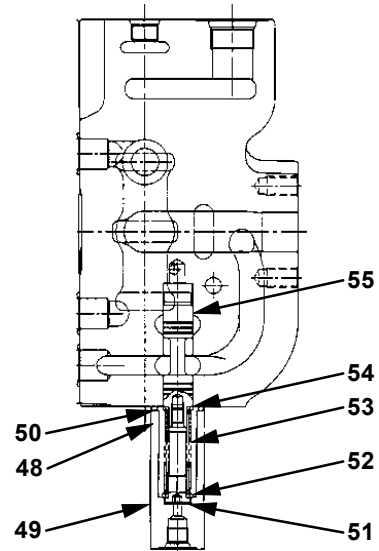
 : 15 N·m (1.5 kgf·m, 11 lbf·ft)

UPPERSTRUCTURE / Control Valve



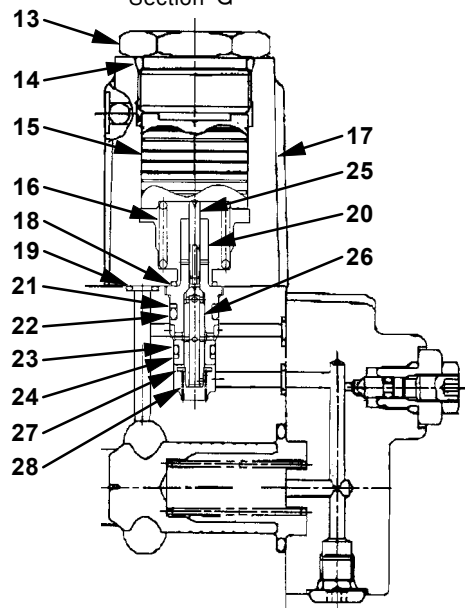
W178-02-05-017

Section E



W178-02-05-025

Section G



W178-02-05-021

- | | | | |
|------------------|------------------|--------------------|------------------|
| 1 - Housing | 19 - O-Ring | 27 - Spring Washer | 49 - Cap |
| 12 - Socket Bolt | 20 - Sleeve | 28 - Spring | 50 - O-Ring |
| 13 - Plug | 21 - Backup Ring | 35 - Poppet | 51 - Bolt |
| 14 - O-Ring | 22 - O-Ring | 36 - Spring | 52 - Spring Seat |
| 15 - Piston | 23 - O-Ring | 37 - O-Ring | 53 - Spring |
| 16 - Spring | 24 - Backup Ring | 38 - Plug | 54 - Spring Seat |
| 17 - Body | 25 - Spool | 48 - Socket Bolt | 55 - Spool |
| 18 - O-Ring | 26 - Poppet | | |

UPPERSTRUCTURE / Control Valve

24. Clamp spool (55) with wooden pieces in a vise. Install spring seat (54), spring (53), spring seat (52) and bolt (51).

 : 4 mm

 : 15 N·m (1.5 kgf·m, 11 lbf·ft)

25. Install the spool (55) assembly, O-ring (50), cap (49) and socket bolt (48) into housing (1).

 : 4 mm

 : 10 ± 1 N·m (1 ± 0.1 kgf·m, 7.2 ± 0.72 lbf·ft)

26. Install poppet (35), spring (36), O-ring (37) and plug (38) into housing (1).

 : 6 mm

 : 76 ± 3 N·m (7.7 ± 0.3 kgf·m, 55.7 ± 2.2 lbf·ft)

27. Install backup rings (21, 24) and O-rings (22, 23) onto sleeve (20).

IMPORTANT: Be sure to place spool (25) with the hole side facing poppet (26) when installing the spool.

28. Install spool (25), poppet (26), spring washer (27) and spring (28) into sleeve (20). Install the sleeve (20) assembly into housing (1).

 **NOTE:** Apply more grease on spring washer (27) and spring (28) to prevent them from coming off.

29. Install spring (16) and piston (15) onto body (17). Install plug (13) with O-ring (14) onto the body temporarily.

 : 38 mm

30. Install O-rings (18, 19), the body (17) assembly and socket bolt (12) into housing (1).

 : 8 mm

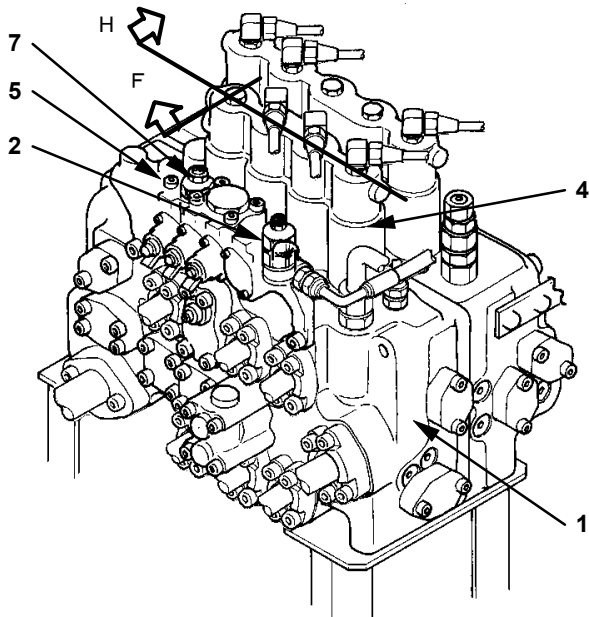
 : 61 ± 3 N·m (6.3 ± 0.3 kgf·m, 45.6 ± 2.2 lbf·ft)

31. Completely tighten plug (13) which was temporarily tightened onto body (17).

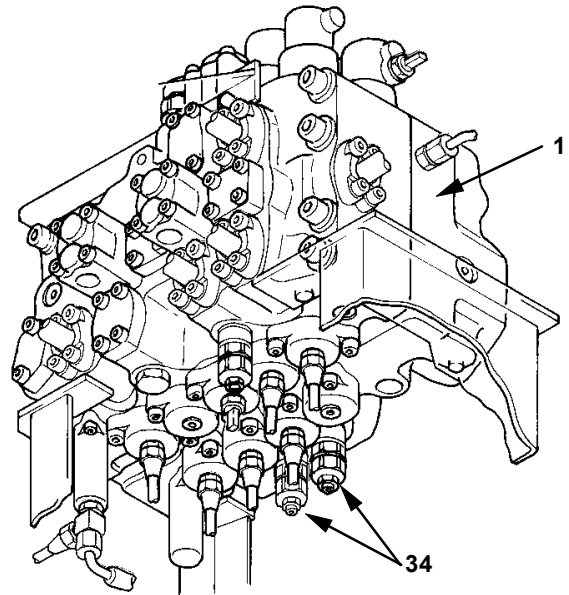
 : 38 mm

 : 93 to 108 N·m
(9.5 to 11 kgf·m, 69 to 80 lbf·ft)

UPPERSTRUCTURE / Control Valve

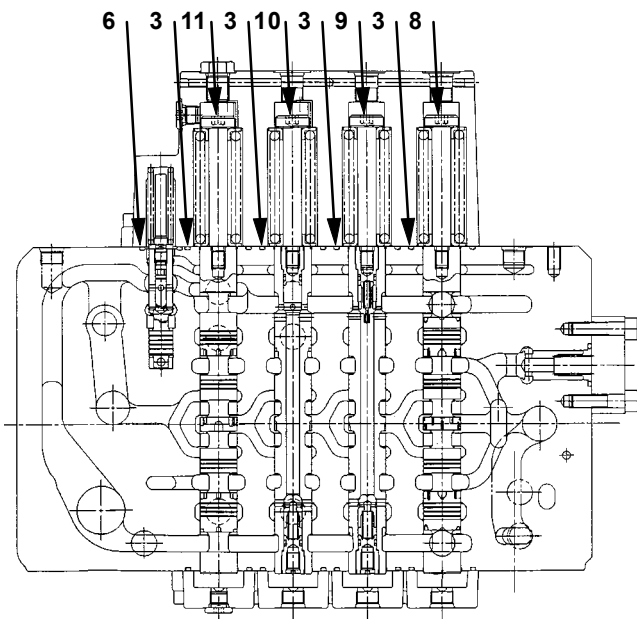


W178-02-05-017



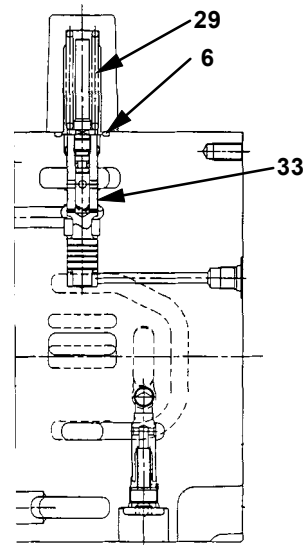
W178-02-05-018

Section H



T178-03-03-042

Section F



T178-03-03-018

- | | | | |
|---------------------------|---------------------------|---------------------|----------------------------|
| 1 - Housing | 5 - Socket Bolt | 9 - Spool (Bucket) | 29 - Spring |
| 2 - Overload Relief Valve | 6 - O-Ring | 10 - Spool (Boom 1) | 33 - Spool |
| 3 - O-Ring | 7 - Overload Relief Valve | 11 - Spool (Arm 2) | 34 - Overload Relief Valve |
| 4 - Pilot Housing | 8 - Spool (Travel Right) | | |

UPPERSTRUCTURE / Control Valve

IMPORTANT: After installing spools (8, 9, 10, 11) into housing (1), push them by hand to confirm smoothness.

32. Install the spools (8, 9, 10, 11) assembly, spool (33) and spring (29) into housing (1).

33. Install O-rings (3, 6), pilot housing (4) and socket bolt (5) into housing (1).

 : 8 mm

 : $42 \pm 2 \text{ N}\cdot\text{m}$ ($4.3 \pm 0.2 \text{ kgf}\cdot\text{m}$, $31.1 \pm 1.4 \text{ lbf}\cdot\text{ft}$)

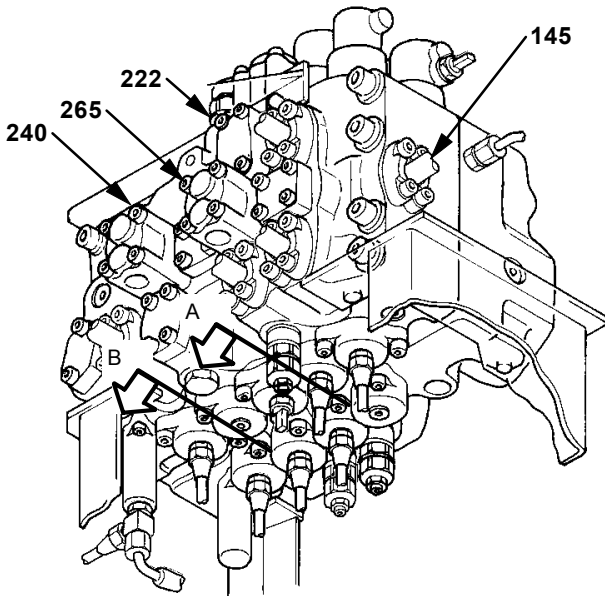
34. Install overload relief valves (2, 7, 34) into housing (1).

 : 32 mm

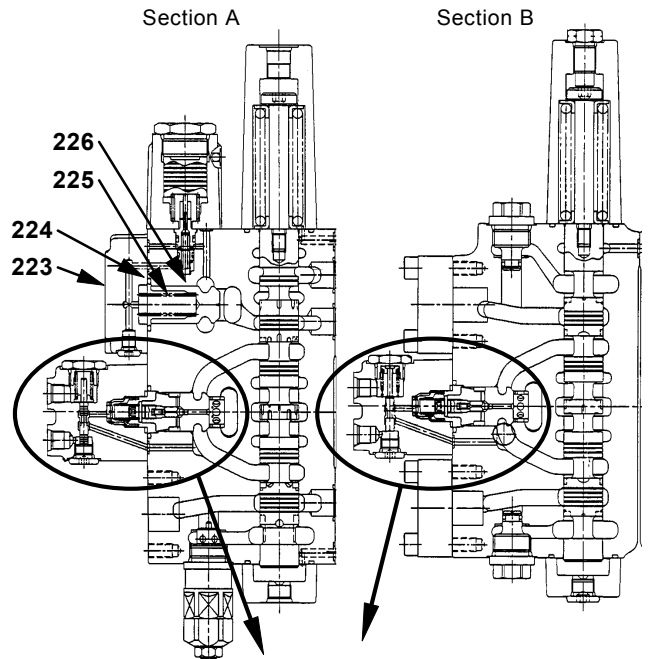
 : $83 \pm 5 \text{ N}\cdot\text{m}$ ($8.5 \pm 0.5 \text{ kgf}\cdot\text{m}$, $61.5 \pm 3.6 \text{ lbf}\cdot\text{ft}$)

UPPERSTRUCTURE / Control Valve

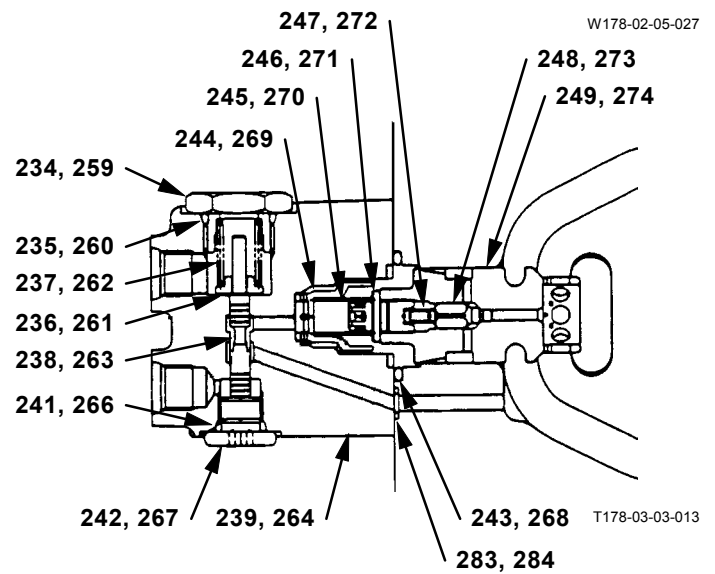
ASSEMBLE CONTROL VALVE 5-SPOOL SECTION



W178-02-05-018



W178-02-05-027



T178-03-03-013

145 -Housing
222 -Socket Bolt
223 -Flange
224 -O-Ring
225 -Spring
226 -Poppet
234 -Plug
235 -O-Ring
236 -Spring Seat
237 -Spring

238 -Spool
239 -Body
240 -Socket Bolt
241 -O-Ring
242 -Plug
243 -O-Ring
244 -Sleeve
245 -Spring
246 -Plug
247 -Spring

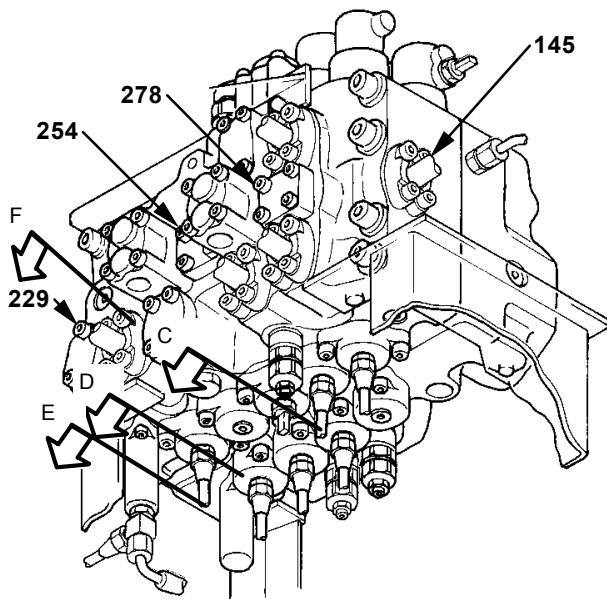
248 -Poppet
249 -Poppet
259 -Plug
260 -O-Ring
261 -Spring Seat
262 -Spring
263 -Spool
264 -Body
265 -Socket Bolt

266 -O-Ring
267 -Plug
268 -O-Ring
269 -Sleeve
270 -Spring
271 -Plug
272 -Spring
273 -Poppet
274 -Poppet

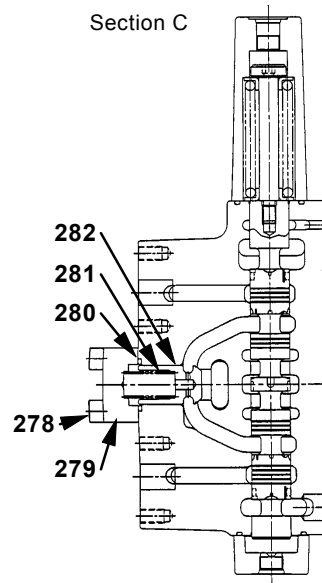
UPPERSTRUCTURE / Control Valve

- Be sure to read "Precautions for Disassembly and Assembly" (W1-1-1) before starting assembly work.
1. Install poppet (273), spring (272), plug (271), spring (270) and sleeve (269) into poppet (274).
 : 36 mm
 2. Install spool (263), spring (262) and spring seat (261) onto body (264). Temporarily tighten plug (259).
 : 8 mm
 : 61±3 N·m (6.3±0.3 kgf·m, 45.6±2.2 lbf·ft)
 3. Install the poppet (274) assembly into housing (145). Install body (264) with socket bolt (265).
 : 8 mm
 : 61±3 N·m (6.3±0.3 kgf·m, 45.6±2.2 lbf·ft)
 4. Completely tighten plug (259) which was temporarily tightened in step 2.
 : 36 mm
 : 98 N·m (10 kgf·m, 72 lbf·ft)
 5. Install poppet (248), spring (247), plug (246), spring (245) and sleeve (244) into poppet (249).
 6. Install spool (238), spring (237) and spring seat (236) into body (239), then temporarily tighten plug (234).
 : 36 mm
 7. Install the poppet (249) assembly into housing (145). Install body (239) with socket bolt (240).
 : 8 mm
 : 61±3 N·m (6.3±0.3 kgf·m, 45.6±2.2 lbf·ft)
 8. Completely plug (234) which was temporarily tightened in step 6.
 : 36 mm
 : 98 N·m (10 kgf·m, 72 lbf·ft)
 9. Install poppet (226), spring (225), O-ring (224), flange (223) and socket bolt (222) into housing (145).
 : 8 mm
 : 61±3 N·m (6.3±0.3 kgf·m, 45.6±2.2 lbf·ft)

UPPERSTRUCTURE / Control Valve

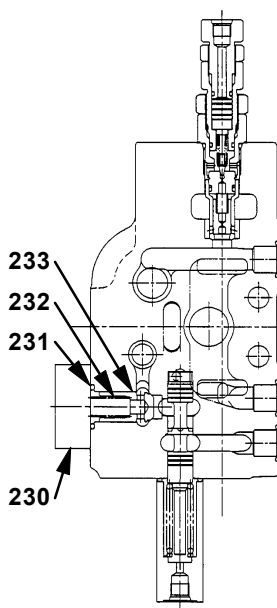


Section C

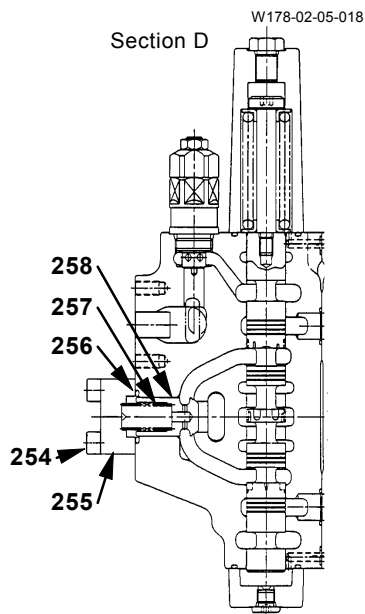


W178-02-05-028

Section E

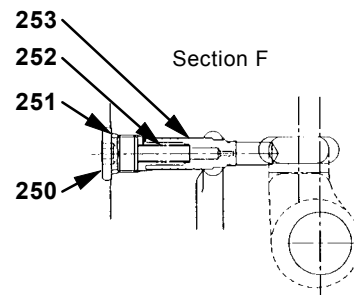


Section D



W178-02-05-018

Section F



T178-03-03-044

W178-02-05-026

145 -Housing
229 -Socket Bolt
230 -Flange
231 -O-Ring
232 -Spring

233 -Poppet
234 -Plug
235 -O-Ring
252 -Spring
253 -Poppet

254 -Socket Bolt
255 -Flange
256 -O-ring
257 -Spring
258 -Poppet

278 -Socket Bolt
279 -Flange
280 -O-Ring
281 -Spring
282 -Poppet

UPPERSTRUCTURE / Control Valve

10. Install poppet (282), spring (281), O-ring (280), flange (279) and socket bolt (278) into housing (145).

 : 8 mm

 : 61 ± 3 N·m (6.3 ± 0.3 kgf·m, 45.6 ± 2.2 lbf·ft)

11. Install poppet (258), spring (257), O-ring (256), flange (255) and socket bolt (254) into housing (145).

 : 8 mm

 : 61 ± 3 N·m (6.3 ± 0.3 kgf·m, 45.6 ± 2.2 lbf·ft)

12. Install poppet (253), spring (252), O-ring (251) and plug (250) into housing (145).

 : 6 mm

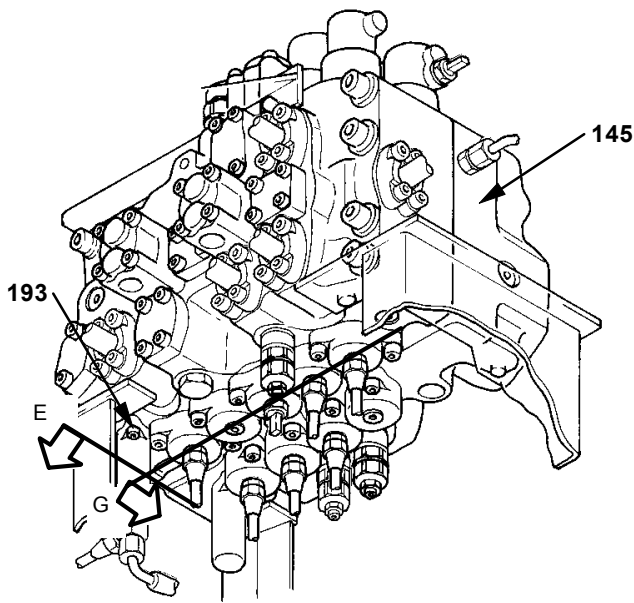
 : 76 ± 3 N·m (7.8 ± 0.3 kgf·m, 56.4 ± 2.2 lbf·ft)

13. Install poppet (233), spring (232), O-ring (231), flange (230) and socket bolt (229) into housing (145).

 : 8 mm

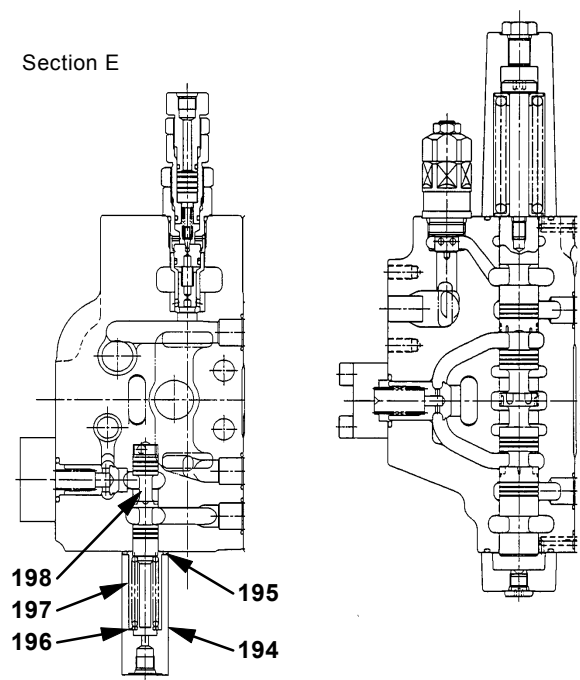
 : 61 ± 3 N·m (6.3 ± 0.3 kgf·m, 45.6 ± 2.2 lbf·ft)

UPPERSTRUCTURE / Control Valve



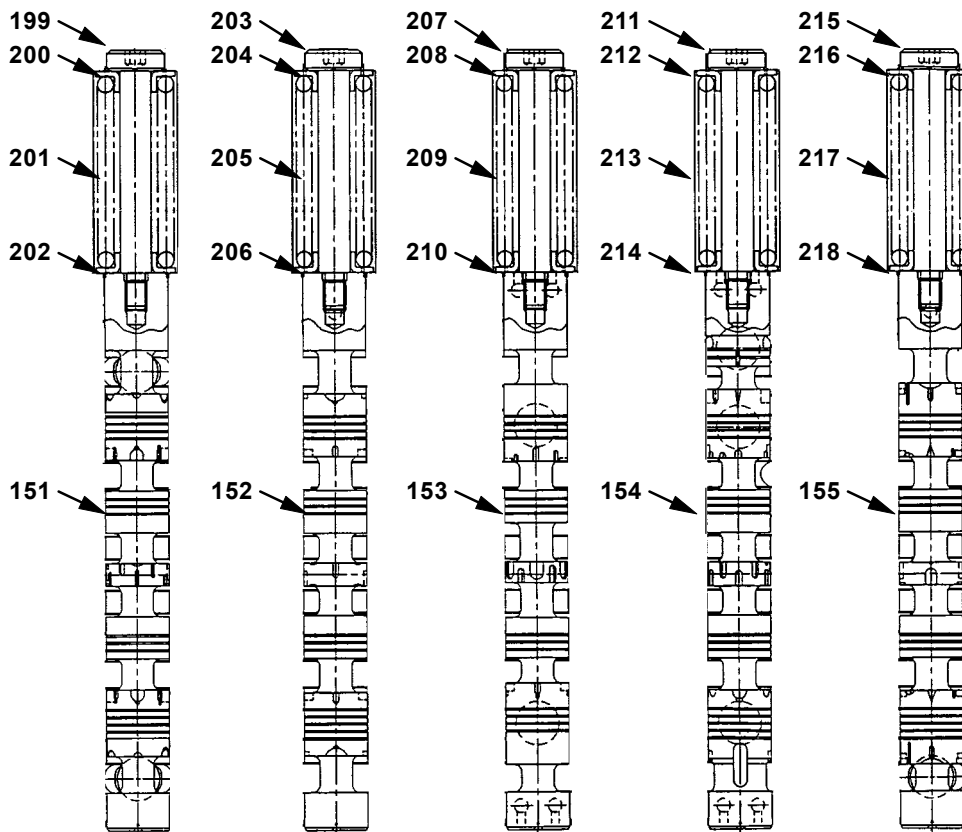
W178-02-05-018

Section E



W178-02-05-026

Section G



W178-02-05-024

- | | | | |
|--------------------------|--------------------|------------------|------------------|
| 151 -Spool (Travel Left) | 196 -Spring Washer | 204 -Spring Seat | 212 -Spring Seat |
| 152 -Spool (Auxiliary) | 197 -Spring | 205 -Spring | 213 -Spring |
| 153 -Spool (Boom 2) | 198 -Spool | 206 -Spring Seat | 214 -Spring Seat |
| 154 -Spool (Arm 1) | 199 -Bolt | 207 -Bolt | 215 -Bolt |
| 155 -Spool (Swing) | 200 -Spring Seat | 208 -Spring Seat | 216 -Spring Seat |
| 193 -Socket Bolt | 201 -Spring | 209 -Spring | 217 -Spring |
| 194 -Cap | 202 -Spring Seat | 210 -Spring Seat | 218 -Spring Seat |
| 195 -O-Ring | 203 -Bolt | 211 -Bolt | |

UPPERSTRUCTURE / Control Valve

- Assemble spool (travel left)

14. Clamp spool (151) with wooden pieces in a vise.
Install spring seat (202), spring (201), spring seat (200) and bolt (199).

 : 8 mm

 : 15 N·m (1.5 kgf·m, 11 lbf·ft)

- Assemble spool (auxiliary)

15. Clamp spool (152) with wooden pieces in a vise.
Install spring seat (206), spring (205), spring seat (204) and bolt (203).

 : 8 mm

 : 15 N·m (1.5 kgf·m, 11 lbf·ft)

- Assemble spool (boom 2)

16. Clamp spool (153) with wooden pieces in a vise,
install spring seat (210), spring (209), spring seat (208) and bolt (207).

 : 8 mm

 : 15 N·m (1.5 kgf·m, 11 lbf·ft)

- Assemble spool (arm 1)

17. Clamp spool (154) with wooden pieces in a vise.
Install spring seat (214), spring (213), spring seat (212) and bolt (211).

 : 8 mm

 : 15 N·m (1.5 kgf·m, 11 lbf·ft)

- Assemble spool (swing)

18. Clamp spool (155) with wooden pieces in a vise.
Install spring seat (218), spring (217), spring seat (216) and bolt (215).

 : 8 mm

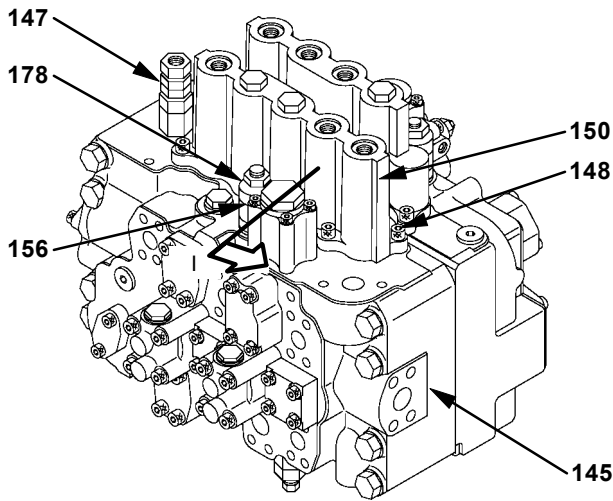
 : 15 N·m (1.5 kgf·m, 11 lbf·ft)

19. Install spool (198), spring (197), spring seat (196), O-ring (195), cap (194) and socket bolt (193) into housing (145).

 : 4 mm

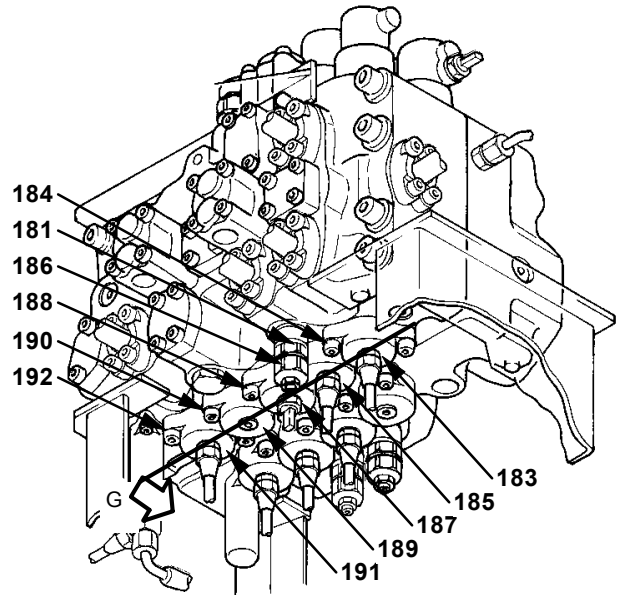
 : 10±1 N·m (1±0.1 kgf·m, 7.2±0.72 lbf·ft)

UPPERSTRUCTURE / Control Valve

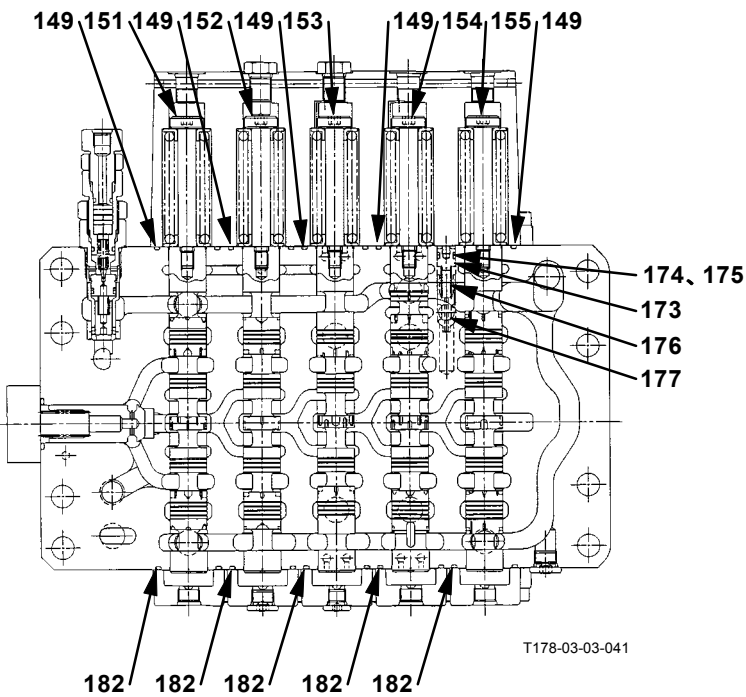


Section G

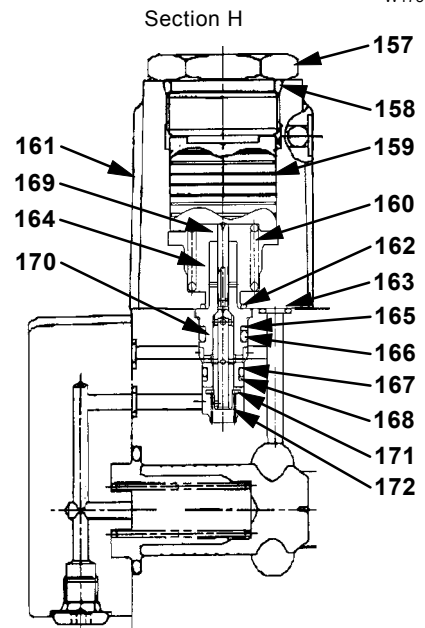
M178-05-003



W178-02-05-018



T178-03-03-041



W178-02-05-029

145 -Housing
146 -Main Relief Valve
147 -Socket Bolt
148 -O-Ring
149 -Pilot Housing
150 -Spool (Travel Left)
151 -Spool (Auxiliary)
152 -Spool (Boom 2)
153 -Spool (Arm 1)
154 -Spool (Swing)
155 -Socket Bolt
156 -Plug
157 -O-Ring

159 -Piston
160 -Spring
161 -Body
162 -O-Ring
163 -O-Ring
164 -Sleeve
165 -Backup Ring
166 -O-Ring
167 -O-Ring
168 -Backup Ring
169 -Spool
170 -Poppet
171 -Spring Washer

172 -Spring
173 -Plug
174 -Backup Ring
175 -O-Ring
176 -Spring
177 -Poppet
178 -Overload Relief Valve
181 -Overload Relief Valve
182 -O-Ring
183 -Cap
184 -Socket Bolt
185 -Cap
186 -Socket Bolt

187 -Cap
188 -Socket Bolt
189 -Cap
190 -Socket Bolt
191 -Cap
192 -Socket Bolt

UPPERSTRUCTURE / Control Valve

20. Install O-ring (182), caps (183, 185, 187, 189, 191) and socket bolts (184, 186, 188, 190, 192) into housing (145).

 : 8 mm

 : 42±2 N·m
(4.4±0.2 kgf·m, 31.8±1.4 lbf·ft)

21. Install backup rings (165, 168), and O-rings (166, 167) onto sleeve (164).

IMPORTANT: Be sure to place spool (169) with the hole side facing poppet (170) when installing the spool.

22. Install spool (169), poppet (170), spring washer (171) and spring (172) into sleeve (164). Then install the sleeve assembly into housing (145).

 **NOTE:** Apply more grease on spring washer (171) and spring (172) to prevent them from coming off.

23. Install spring (160) and piston (159) into body (161). Temporarily tighten plug (157) with O-ring (158) onto the body.

 : 38 mm

24. Install O-rings (162, 163), the body (161) assembly and socket bolt (156) into housing (145).

 : 8 mm

 : 61±3 N·m
(6.3±0.3 kgf·m, 45.6±2.2 lbf·ft)

25. Completely tighten plug (157) which was temporarily tightened, onto body (161).

 : 38 mm

 : 93 to 108 N·m
(9.5 to 11 kgf·m, 68.7 to 79.6 lbf·ft)

26. Install poppet (177), spring (176) and plug (173) onto housing (145).

IMPORTANT: After installing spools (151, 152, 153, 154, 155) into housing (145), push them by hand to confirm smoothness.

27. Install the spools (151, 152, 153, 154, 155) assembly into housing (145).

28. Install O-ring (149), pilot housing (150) and socket bolt (148) into housing (145).

 : 8 mm

 : 42±2 N·m (4.4±0.2 kgf·m, 31.8±1.4 lbf·ft)

29. Install main relief valve (147) and overload relief valves (178, 181) into housing (145).

 : 32 mm

 : 83±5 N·m (8.5±0.5 kgf·m, 61.5±3.6 lbf·ft)

UPPERSTRUCTURE / Swing Device

REMOVE AND INSTALL SWING DEVICE



CAUTION: Escaping fluid under pressure may penetrate the skin, causing serious injury. Avoid this hazard by relieving pressure before disconnecting hydraulic or other lines.

Hydraulic oil may be hot just after operation and may spurt, possibly causing severe burns. Be sure to wait for oil to cool before starting any repair work.

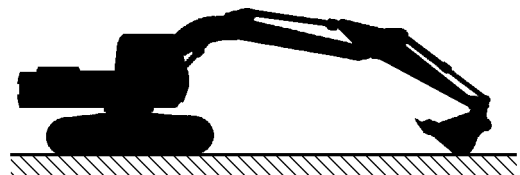
The hydraulic oil tank cap may fly off if removed without releasing accumulated pressure first. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.

Preparation

1. Place the machine on a firm, level surface.
2. Stop the engine. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.
3. Remove hydraulic oil tank cap. Connect a vacuum pump to maintain negative pressure in the hydraulic oil tank.



NOTE: Be sure to run the vacuum pump continuously while working on the hydraulic system.



M104-07-021

UPPERSTRUCTURE / Swing Device

Removal

1. Disconnect hoses (1 to 4 , 8) and cable (7).

	: 36 mm
	: 175 N·m (18 kgf·m, 130 lbf·ft)
	: 17 mm
	: 25 N·m (2.5 kgf·m, 18 lbf·ft)
	: 19 mm
	: 29.5 N·m (3 kgf·m, 21.5 lbf·ft)
	: 8 mm
	: 50 N·m (5.1 kgf·m, 37 lbf·ft)

 **NOTE:** Attach caps to the hoses and pipes.

2. Attach a nylon sling to swing motor (5) so as to lift it by crane.

Nylon sling (eye-type at both ends): 2 pieces

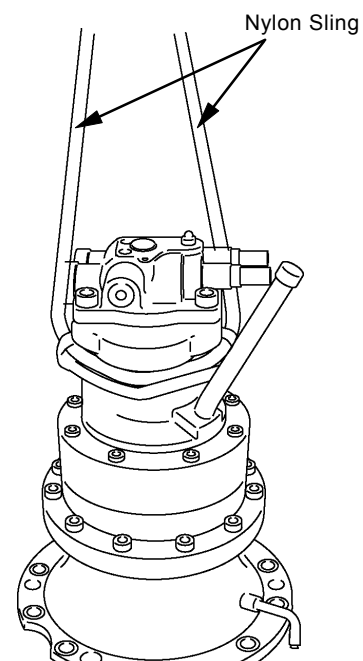
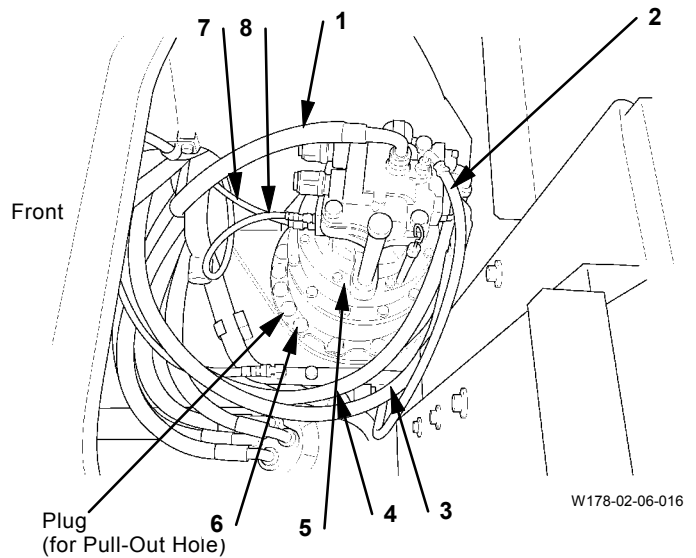
 **CAUTION: Swing device weight:**
220 kg (485 lb)
(ZAXIS200, 200-E, 225US, 225USR)
275 kg (610 lb) (ZAXIS230)
355 kg (780 lb) (ZAXIS270)

3. Remove bolts (6) (12 used) to lift and remove the swing device by crane.

	: 30 mm
	: 500 N·m (50 kgf·m, 360 lbf·ft)

 **NOTE:** When lifting the swing device, the machine may float together with it. Therefore, remove plugs (6) (2 places) to hoist the swing device out from the main frame with pulling bolt (M30, Pitch 2.5).

 **NOTE:** When hoisting the swing device, one part of it will contact with the main frame. Be sure to press cab side while hoisting it slowly.



UPPERSTRUCTURE / Swing Device

Installation

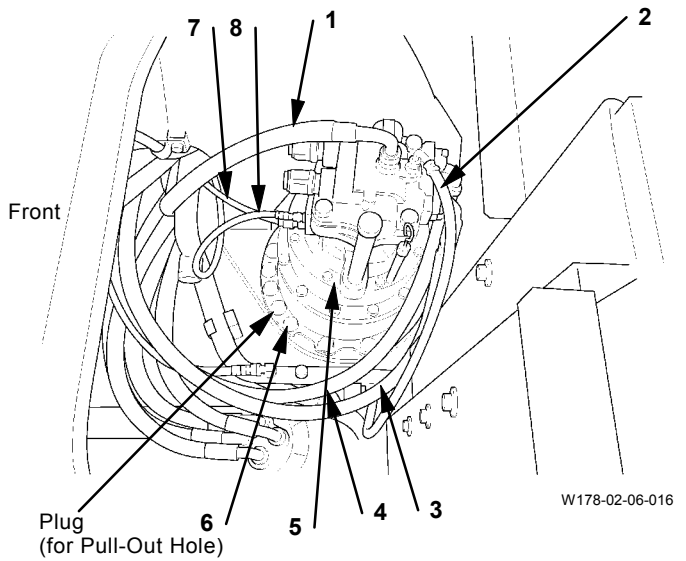
 **NOTE:** Refer to "Removal" section above for wrench sizes and tightening torques.

1. Install the swing device assembly with bolts (6) (12 used).

IMPORTANT: Apply liquid packing to both mounting surfaces on the swing device and frame.

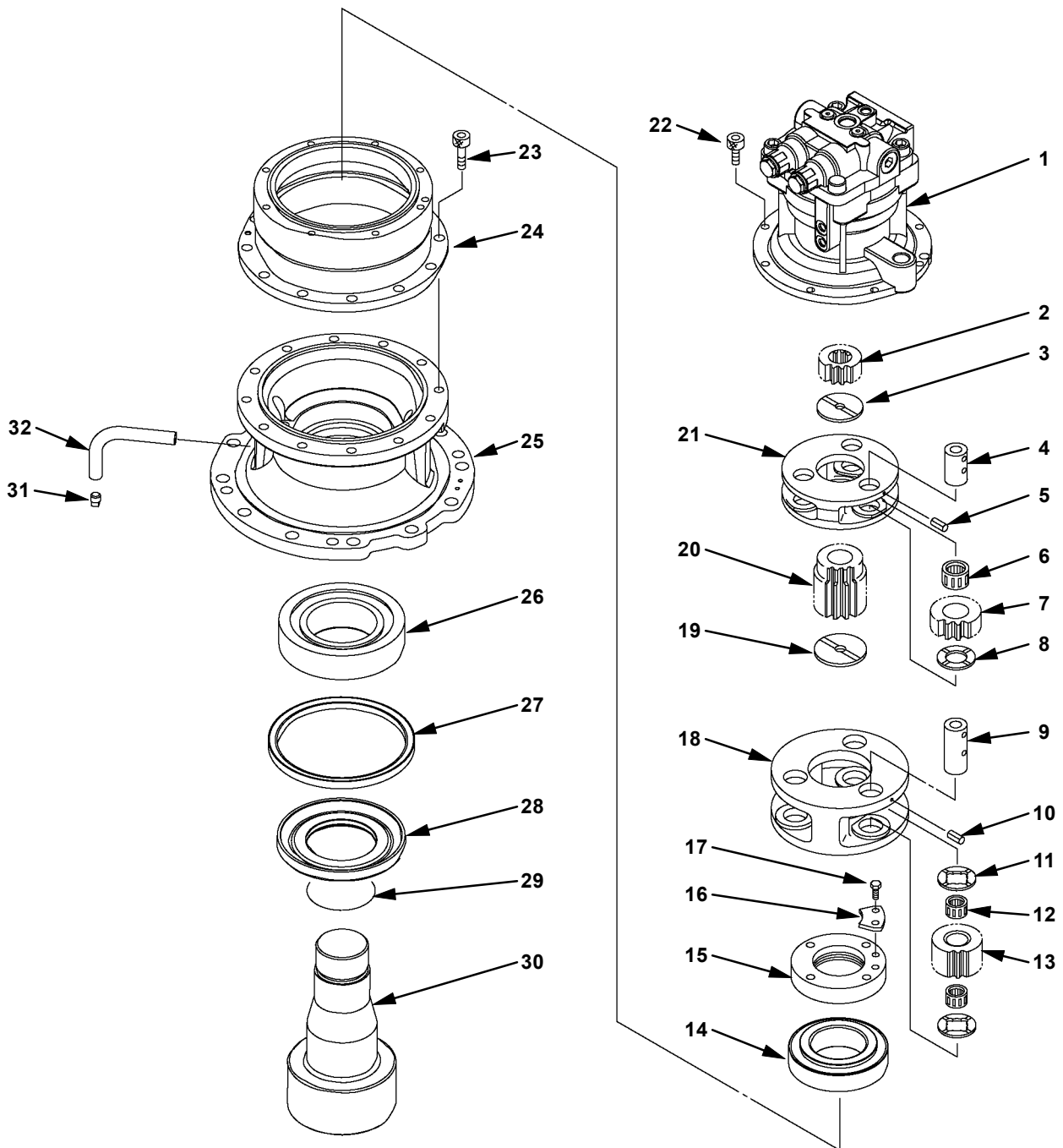
2. Connect hoses (1 to 4, 8) and cable (7).

IMPORTANT: Be sure to fill the swing motor with hydraulic oil after installing it. After completing installation, check hydraulic oil level. Add oil as necessary. Run the engine and check the component for any oil leaks.



UPPERSTRUCTURE / Swing Device

DISASSEMBLE SWING DEVICE (ZAXIS200, 200-E, 225US, 225USR, 230)



W178-02-06-004

- | | | | |
|-----------------------------|------------------------------|----------------------------|---------------------|
| 1 - Motor | 9 - Pin (3 Used) | 17 - Bolt (2 Used) | 25 - Housing |
| 2 - 1st Stage Sun Gear | 10 - Spring Pin (3 Used) | 18 - 2nd Stage Carrier | 26 - Roller Bearing |
| 3 - Thrust Plate | 11 - Thrust Plate (6 Used) | 19 - Thrust Plate | 27 - Oil Seal |
| 4 - Pin (3 Used) | 12 - Needle Bearing (6 Used) | 20 - 2nd Stage Sun Gear | 28 - Sleeve |
| 5 - Spring Pin (3 Used) | 13 - Planetary Gear (3 Used) | 21 - 1st Stage Carrier | 29 - O-Ring |
| 6 - Needle Bearing (3 Used) | 14 - Roller Bearing | 22 - Socket Bolt (8 Used) | 30 - Shaft |
| 7 - Planetary Gear (3 Used) | 15 - Bearing Nut | 23 - Socket Bolt (12 Used) | 31 - Drain Plug |
| 8 - Thrust Plate (3 Used) | 16 - Lock Plate | 24 - Ring Gear | 32 - Pipe |

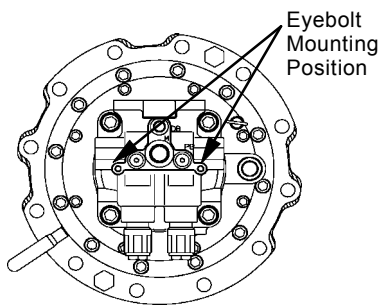
UPPERSTRUCTURE / Swing Device

Disassemble Swing Device (ZAXIS200, 200-E, 225US, 225USR, 230)

CAUTION: Swing device weight:
215 kg (470 lb)

CAUTION: When hoisting the swing device,
don't string the rope suddenly.

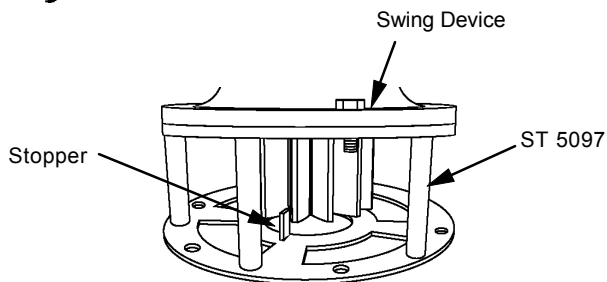
1. Install eyebolts (M10) (2 used) to the swing device,
then lift it by crane.



W178-02-06-005

2. Put the swing device on bracket (ST 5097).
Secure it with 2 bolts (M20). Insert the stopper
located at the bottom of bracket into the middle of
two teeth of pinion gear. Secure the bracket on a
work bench.

: 30 mm



W178-02-06-012

3. Remove drain plug (31), then drain off oil.

: 8 mm

4. Remove pipe (32) from housing (25).

: 18 mm

5. Put alignment marks at the jointed portion
between motor (1) and ring gear (24), between
ring gear (24) and housing (25).

CAUTION: Motor weight: 47 kg (100 lb)

6. Remove motor (1) from ring gear (24).

: 10 mm

NOTE: *THREEBOND has been applied on the joint surface. Insert a screwdriver into the gap between the swing motor and ring gear. Then pry it up for easy removing.*

7. Remove 1st stage sun gear (2) from 1st stage
carrier (21).

8. Remove the 1st stage carrier (21) assembly from
ring gear (24).

9. Remove the ring gear (24) mounting bolt (23).

: 14 mm

CAUTION: Ring gear weight: 23 kg (50 lb)

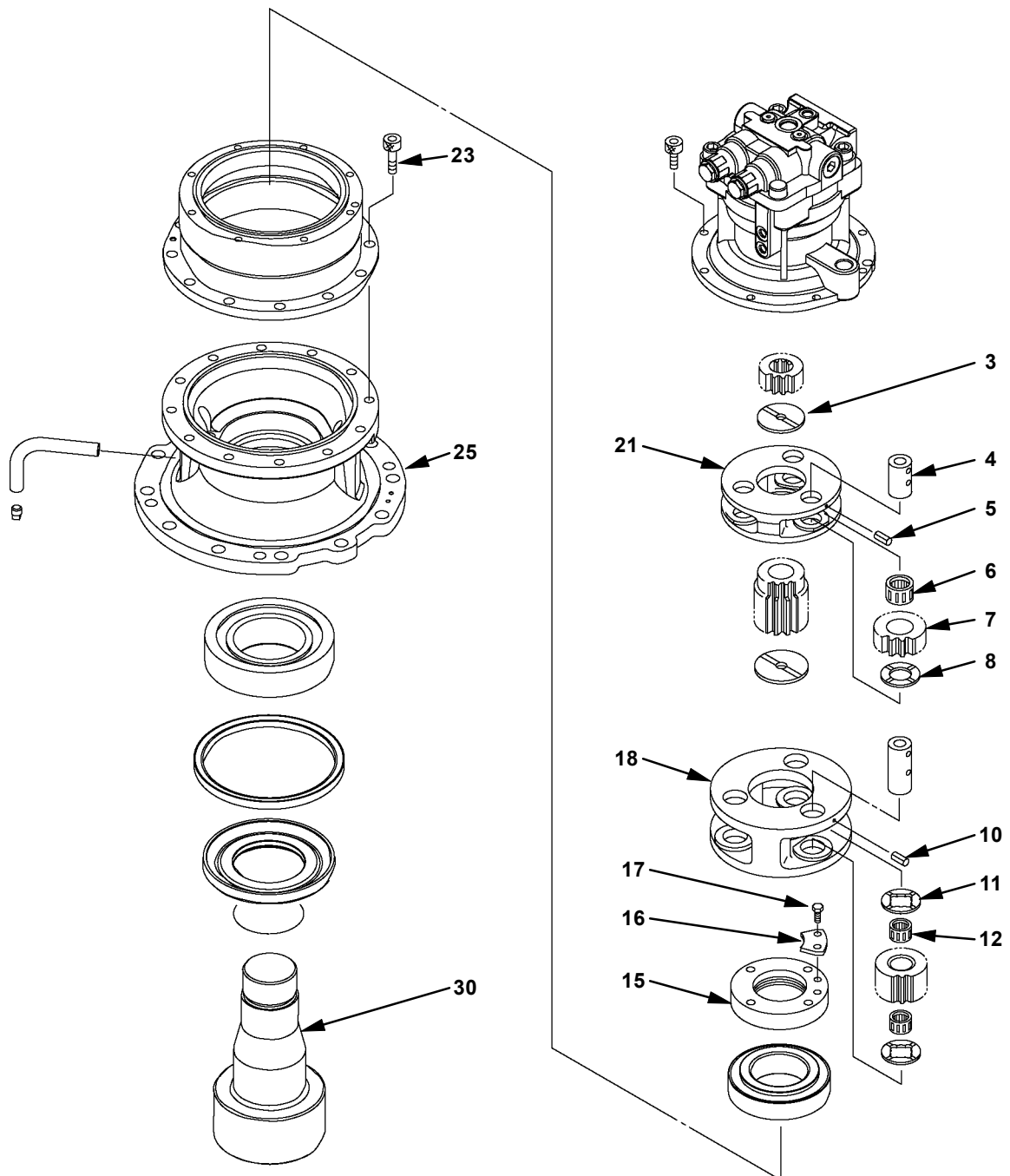
10. Install eyebolts (M12) (2 used) to the hole for the
motor (1) mounting bolt on ring gear (24). Lift and
remove the ring gear from housing (25) by crane.

NOTE: *THREEBOND has been applied on the joint surface. Insert a screwdriver into the gap between the ring gear and housing. Then pry it up for easy removing.*

11. Remove 2nd stage sun gear (20) from 2nd carrier
(18).

12. Remove the 2nd stage carrier (18) assembly from
shaft (30).

UPPERSTRUCTURE / Swing Device



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UPPERSTRUCTURE / Swing Device

IMPORTANT: The hole for the spring pin located on the 1st stage carrier is not a through one. Pay attention to the tapping-in distance when tapping the spring pin in.

13. Tap spring pin (5) on the 1st stage carrier (21) assembly into pin (4) using special tool (ST 1462). Stop tapping when the spring pin is driven to the middle of the pin hole. Don't try to tap spring pin (5) to the end.

14. Remove pin (4), planetary gear (7), needle bearing (6), thrust plate (8) from 1st stage carrier (21).

15. Remove remaining two sets of pin (4), planetary gear (7), needle bearing (6), thrust plate (8) from 1st stage carrier (21) according to the removing procedure in step 13 and step 14.

16. Remove thrust plate (3) from 1st stage carrier (21).

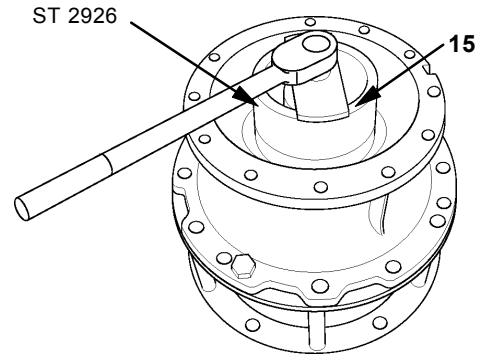
IMPORTANT: The surface of the pin except for both ends is a rotating surface for the needle bearing. Pay attention not to damage it.

17. Clamp the pin (4) with a vise. Push the spring pin out using special removing tool (ST 1462). (3 places)

18. Disassemble the 2nd stage carrier (18) assembly according to the removing procedure for the 1st stage carrier (21) assembly. However 6 needle bearings (12) and 6 thrust plates (11) are used on the 2nd stage carrier (18) assembly. Moreover, use ST 1463 as the extractor for spring pin (10) .

19. Remove bolt (17) to remove lock plate (16).
🔧 : 17 mm

20. Remove bearing nut (15) from shaft (30) using special nut removing tool (ST 2926).



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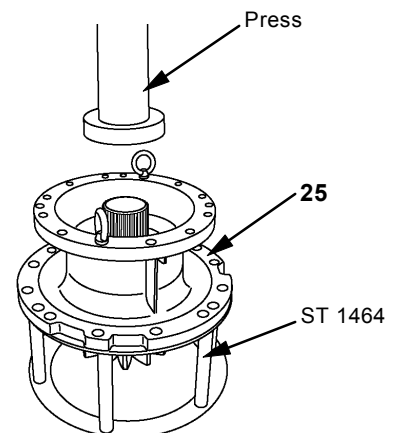
CAUTION: Housing (25) assembly weight:
110 kg (240 lb)

21. Install eyebolt (M16) into bolt (23) hole in housing (25). Lift it by crane. Remove bracket (ST 5097) which has been installed at the pinion gear side.

🔧 : 30 mm

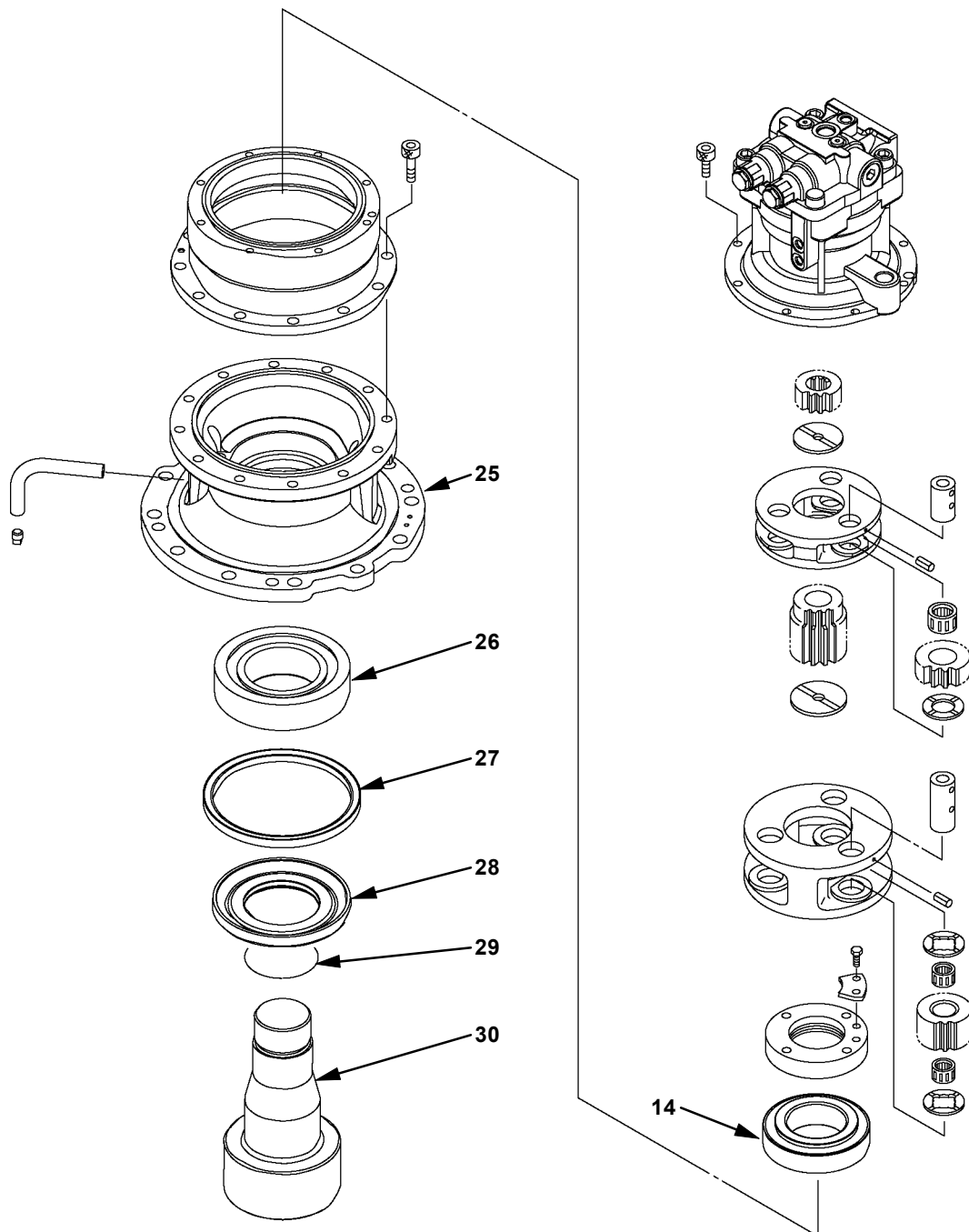
22. After removing bracket (ST 5097), install bracket (ST 1464). Install the housing (25) assembly on a press.

🔧 : 30 mm



W178-02-06-006

UPPERSTRUCTURE / Swing Device

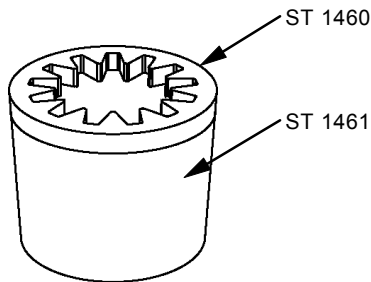


W178-02-06-004

UPPERSTRUCTURE / Swing Device

23. Push the upper end of shaft (30) with a press and remove it from housing (25). The inner race of roller bearing (26) and sleeve (28) are removed with the shaft.

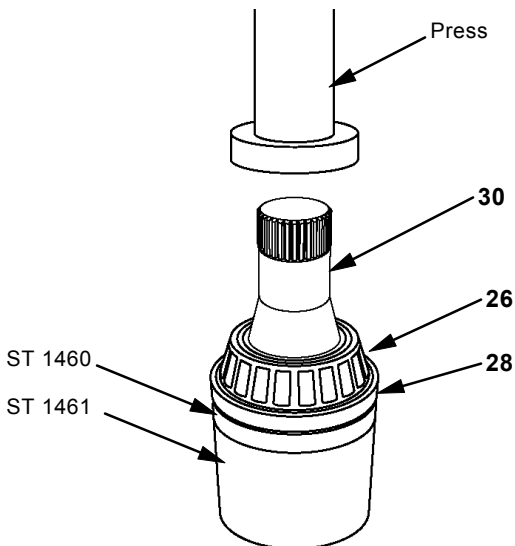
24. Place pulling tool B (ST 1460) of roller bearing (26) onto the stepped part of pulling tool A (ST 1461) for roller bearing (26).



W178-02-06-010

CAUTION: Shaft weight: 40 kg (90 lb)

25. Insert the pinion gear of shaft (30) into the tooth-hole of pulling tool B (ST 1460) for roller bearing (26). Install it onto press.

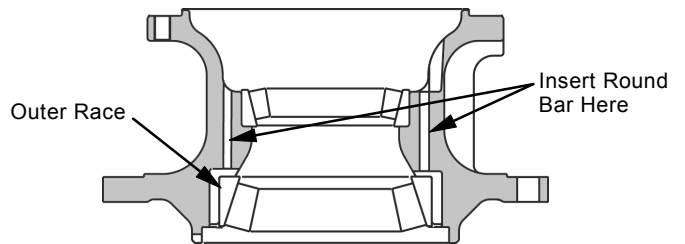


W178-02-06-009

26. Push spline side on propeller shaft (30) with press and remove inner race of roller bearing (26) and sleeve (28).

27. Remove O-ring (29) from sleeve (28).

28. Insert a round bar into the oil passage in housing (25), tap the outer race of roller bearing (26) out.



W178-02-06-001

CAUTION: Housing weight: 60 kg (130 lb)

29. Secure housing (25) body with a nylon sling, lift it by crane. Turn the up side of the housing down.

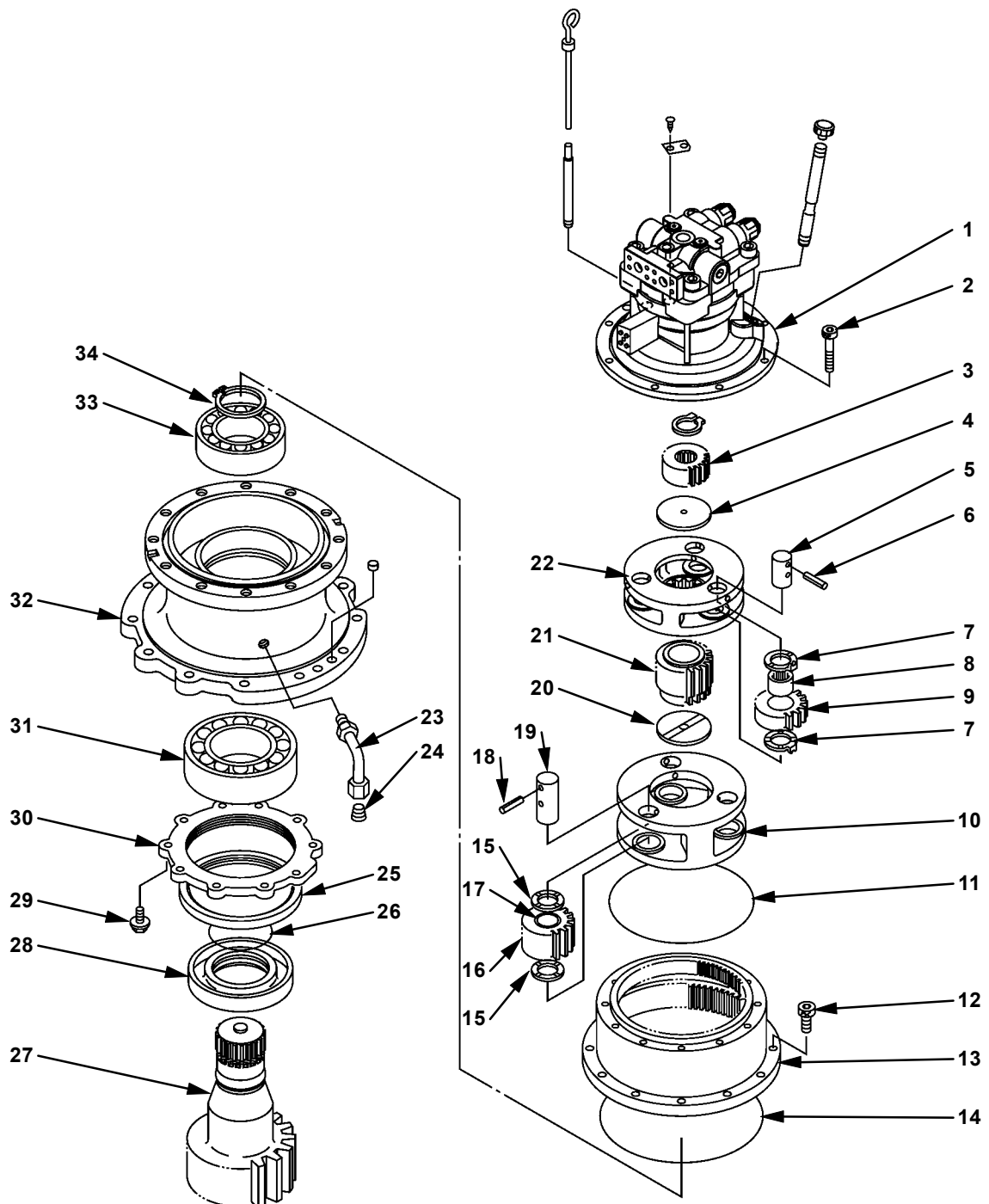
30. Insert a screwdriver into the gap on housing (25) where oil seal (27) is mounted. Remove the oil seal.

NOTE: *THREEBOND has been applied on the periphery of oil seal. Thus, it can't be re-used.*

31. Insert a bar at the back side of the outer race of roller bearing (14). Remove the outer race from housing (25) by tapping with a bar and hammer.

UPPERSTRUCTURE / Swing Device

DISASSEMBLE SWING DEVICE (ZAXIS270)



- | | | | |
|-----------------------------|------------------------------|----------------------------|------------------------|
| 1 - Motor | 10 - Second Stage Carrier | 19 - Pin (3 Used) | 27 - Shaft |
| 2 - Socket Bolt (12 Used) | 11 - O-Ring | 20 - Thrust Plate | 28 - Sleeve |
| 3 - First Stage Sun Gear | 12 - Socket Bolt (12 Used) | 21 - Second Stage Sun Gear | 29 - Bolt (10 Used) |
| 4 - Thrust Plate | 13 - Ring Gear | 22 - First Stage Carrier | 30 - Cover |
| 5 - Pin (3 Used) | 14 - O-Ring | 23 - Pipe | 31 - Spherical Bearing |
| 6 - Spring Pin (3 Used) | 15 - Thrust Plate (6 Used) | 24 - Drain Plug | 32 - Housing |
| 7 - Thrust Plate (6 Used) | 16 - Planetary Gear (3 Used) | 25 - Oil Seal | 33 - Spherical Bearing |
| 8 - Needle Bearing (3 Used) | 17 - Bushing (3 Used) | 26 - O-Ring | 34 - Retaining Ring |
| 9 - Planetary Gear (3 Used) | 18 - Spring Pin (3 Used) | | |

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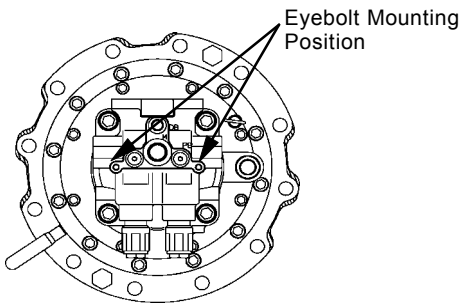
UPPERSTRUCTURE / Swing Device

Disassemble Swing Device (ZAXIS270)

CAUTION: Swing device weight:
Approx. 357 kg (790 lb)

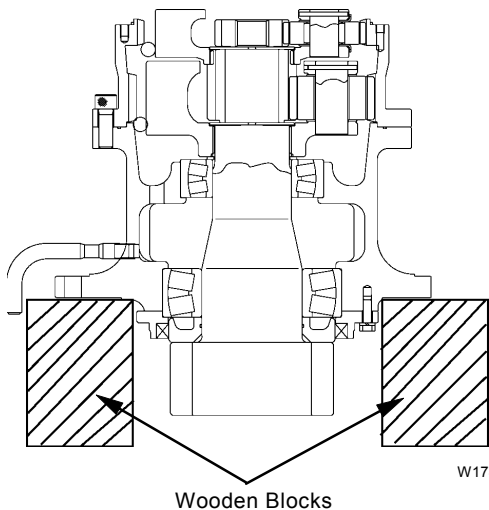
CAUTION: When hoisting the swing device,
don't string the rope suddenly.

1. Install eyebolts (M33, Pitch 2.0) to the swing device,
then lift it by crane.



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2. Put the swing device on wooden block [over 400
mm (15.75 in)]. (400 mm×400 mm×400 mm)
(15.75 in×15.75 in×15.75 in)



W178-02-06-018

3. Remove drain plug (24) from pipe (23), then drain
off oil.

 : 10 mm

4. Remove pipe (23) from housing (32).

 : 27 mm

5. Put alignment marks at the jointed portion be-
tween motor (1) and ring gear (13), between ring
gear (13) and housing (32).

CAUTION: Motor weight: 66 kg (150 lb)

6. Remove socket bolts (2) (12 used), then lift and
remove motor (1) from ring gear (13).

 : 10 mm

NOTE: *THREEBOND has been applied on the joint
surface. Insert a screwdriver into the gap
between the swing motor and ring gear.
Then pry it up for easy removing.*

7. Remove first stage sun gear (3) from first stage
carrier (22).

8. Remove the first stage carrier (22) assembly from
ring gear (13).

9. Remove mounting bolts (12) (12 used) from ring
gear (13).

 : 17mm

CAUTION: Ring gear weight: 36 kg (80 lb)

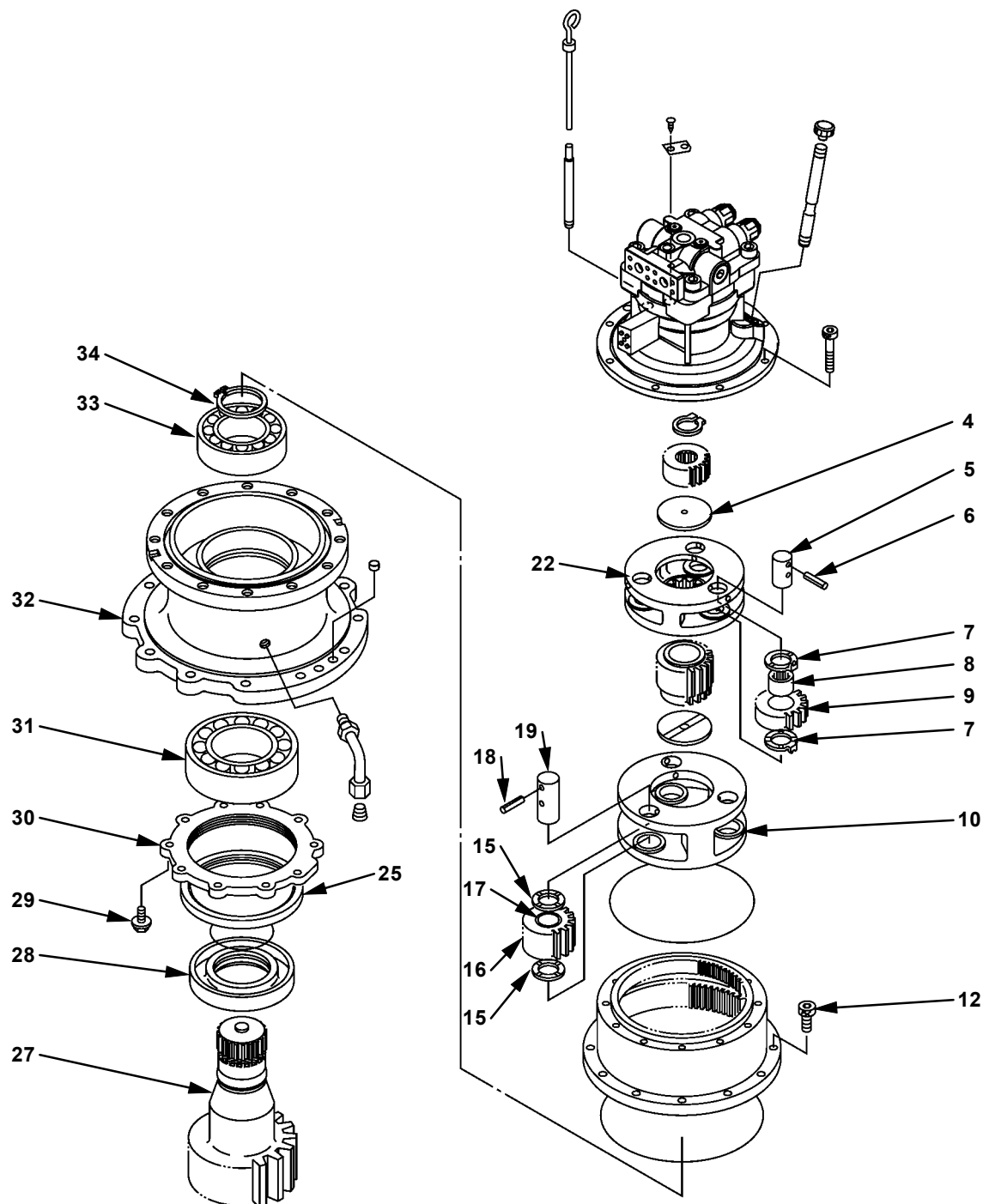
10. Install eyebolts (M16, Pitch 2.0) (2 used) to the
holes for the motor (1) mounting bolts in ring gear
(13). Lift and remove the ring gear from housing
(32) by crane.

NOTE: *THREEBOND has been applied on the joint
surface. Insert a screwdriver into the gap
between the swing motor and ring gear.
Then pry it up for easy removing.*

11. Remove second stage sun gear (21) from second
stage carrier (10).

12. Remove second stage carrier (10) assembly from
shaft (27).

UPPERSTRUCTURE / Swing Device



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UPPERSTRUCTURE / Swing Device

IMPORTANT: The hole for the spring pin located on the 1st stage carrier is not a through one. Pay attention to the tapping-in distance when tapping the spring pin in.

13. Tap spring pin (6) on the 1st stage carrier (22) assembly into pin (5) using special tool (ST 1462). Stop tapping when the spring pin is driven to the middle of the pin hole. Don't try to tap spring pin (6) to the end.
14. Remove pin (5), planetary gear (9), needle bearing (8), thrust plates (7) (2 used) from 1st stage carrier (22).
15. Remove remaining two sets of pin (5), planetary gear (9), needle bearing (8), thrust plate (7) from 1st stage carrier (22) according to the removing procedure in step 13 and step 14.
16. Remove thrust plate (4) from 1st stage carrier (22).

IMPORTANT: The surface of the pin except for both ends is a rotating surface for the needle bearing. Pay attention not to damage it.

17. Clamp the pin (5) with a vise. Push the spring pin out using special removing tool (ST 1462). (3 places)
18. Disassemble the 2nd stage carrier (10) assembly according to the removing procedure for the 1st stage carrier (22) assembly. However, use ST 1463 as the extractor for spring pin (9). Moreover, do not remove bushing (17) unless necessary.

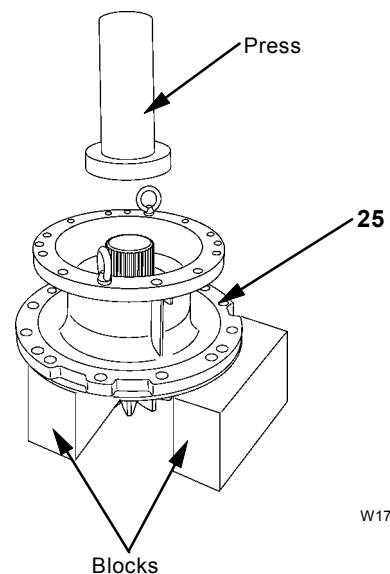
 **NOTE:** Bushing (17) is installed on planetary gear (16).

19. Remove retaining ring (34).



CAUTION: Housing (32) assembly weight: 196 kg (430 lb)

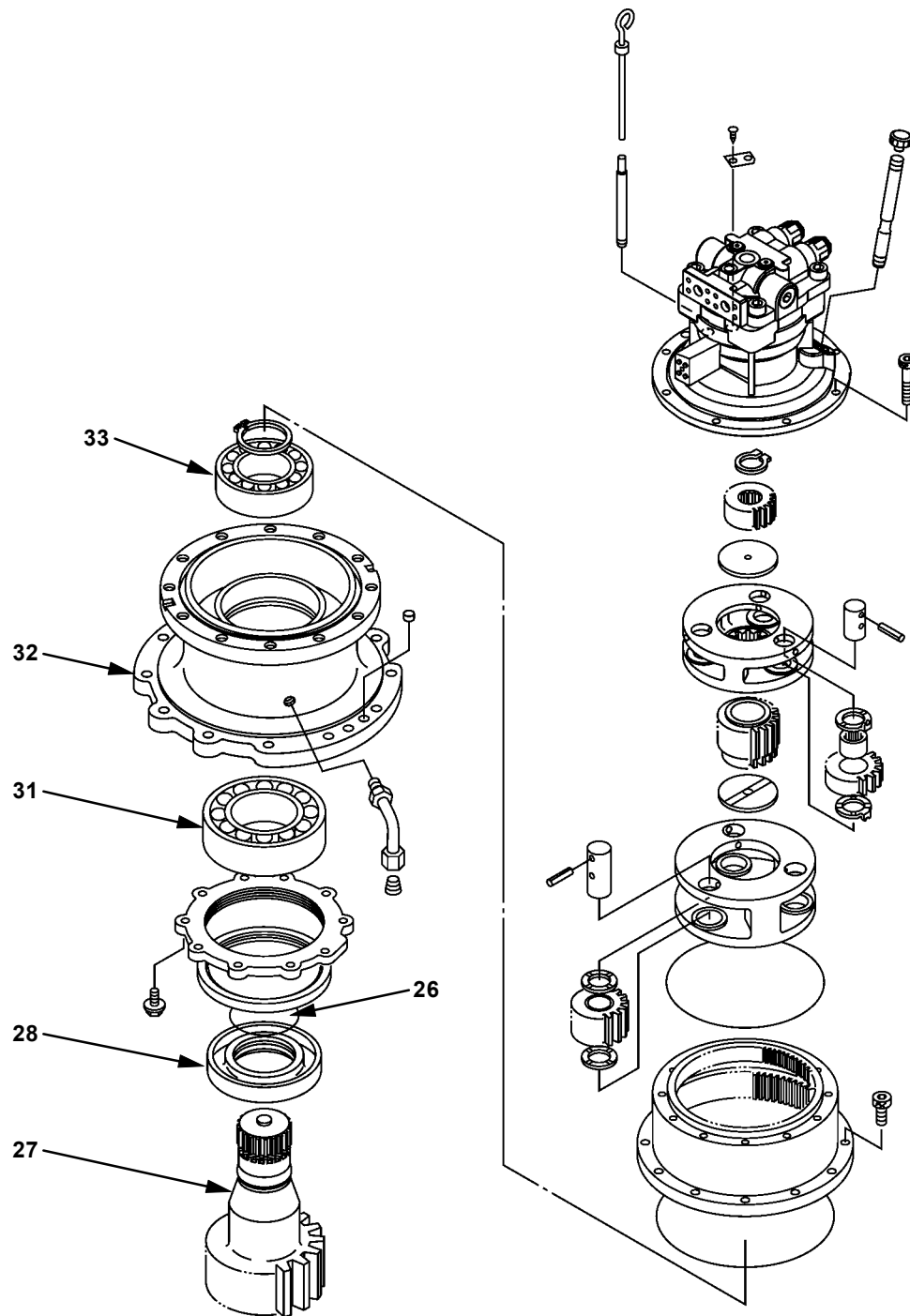
20. Turn housing (32) assembly over, remove mounting bolts (29) (10 used) on cover (30) to remove cover (30).
21. Install eyebolts (M20, Pitch 2.5) into the hole for bolt (12) in housing (32). Lift it by crane, then place the housing on the upper side of the block which has been installed at the press stand.



W178-02-06-020

22. Push the upper end of shaft (27) with a press and remove it from housing (32). At this time, spherical bearing (31) and sleeve (28) are removed with the shaft.
23. Turn housing (32) over to remove spherical bearing (33).
24. Secure cover (30) in a vise, remove oil seal (25) with a screwdriver and hammer.

UPPERSTRUCTURE / Swing Device

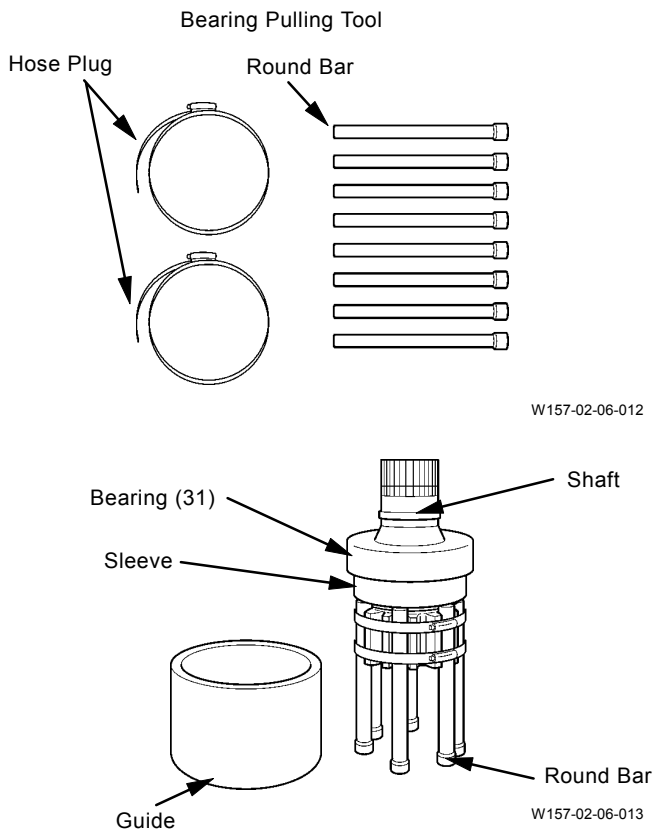


W178-02-06-040

UPPERSTRUCTURE / Swing Device

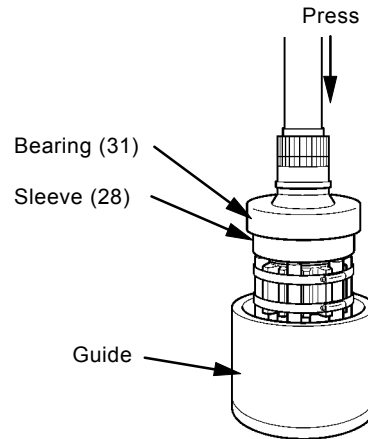
CAUTION: Shaft + sleeve + bearing weight:
75 kg (170 lb)

25. Set the special tool onto shaft (27) assembly.



CAUTION: When pressing shaft (27) with press, it should be carried out inside of the guide.

26. Set shaft (27) with special tool onto a press, then pull bearing (31) out.



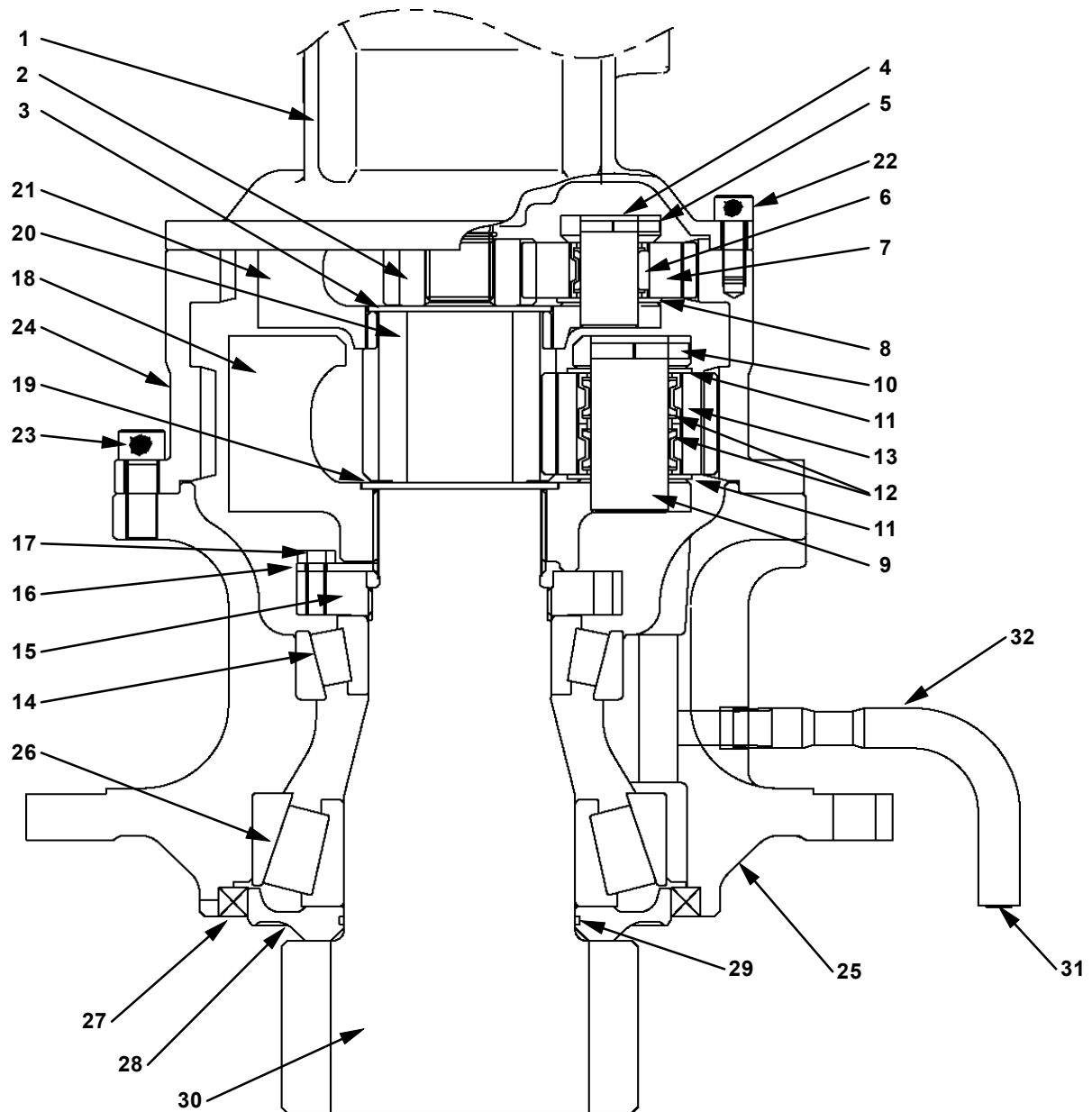
27. Pull sleeve (28) out from shaft (27) and remove O-ring (26) from sleeve (28).

28. Remove spherical bearing (33) from housing (32).

NOTE: Remove bearing (31) with following pulling tools:
 Round bar (or bolt): length 320 mm (12.60 in), dia. 19 mm (0.75 in), 8 used (with same length and no wear and deformation at both ends)
 Material: S35C
 Hose clamp: (Nominal dia. 8-1/2, tightening range: 185 to 215 mm (7.28 to 8.46 in) 2 used
 Guide: height 160 mm (6.30 in), outer dia. 260mm (10.24 in), inner dia. 230 mm (9.06 in)

UPPERSTRUCTURE / Swing Device

ASSEMBLE SWING DEVICE (ZAXIS200, 200-E, 225US, 225USR, 230)



W178-02-06-003

- | | | | |
|-----------------------------|------------------------------|----------------------------|---------------------|
| 1 - Motor | 9 - Pin (3 Used) | 17 - Bolt (2 Used) | 25 - Housing |
| 2 - 1st Stage Sun Gear | 10 - Spring Pin (3 Used) | 18 - 2nd Stage Carrier | 26 - Roller Bearing |
| 3 - Thrust Plate | 11 - Thrust Plate (6 Used) | 19 - Thrust Plate | 27 - Oil Seal |
| 4 - Pin (3 Used) | 12 - Needle Bearing (6 Used) | 20 - 2nd Stage Gear | 28 - Sleeve |
| 5 - Spring Pin (3 Used) | 13 - Planetary Gear (3 Used) | 21 - 1st Stage Carrier | 29 - O-Ring |
| 6 - Needle Bearing (3 Used) | 14 - Roller Bearing | 22 - Socket Bolt (8 Used) | 30 - Shaft |
| 7 - Planetary Gear (3 Used) | 15 - Bearing Nut | 23 - Socket Bolt (12 Used) | 31 - Drain Plug |
| 8 - Thrust Plate (3 Used) | 16 - Lock Plate | 24 - Ring Gear | 32 - Pipe |

UPPERSTRUCTURE / Swing Device

Assemble Swing Device

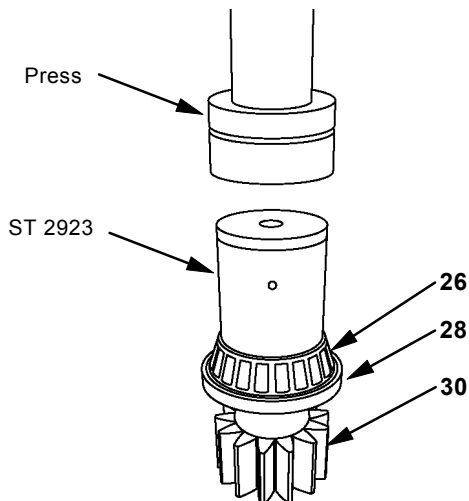
(ZAXIS200, 200-E, 225US, 225USR, 230)

1. Install O-ring (29) onto sleeve (28).

CAUTION: Shaft + sleeve + outer race weight: 36 kg (80 lb)

2. Install sleeve (28) and the inner race of roller bearing (26) into shaft (30). Press sleeve and inner race using bearing mounting tool (ST 2923).

NOTE: Press-in distance of the bearing inner race can be assured by using the bearing mounting tool.



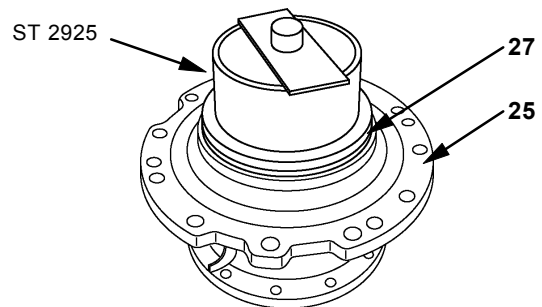
W178-02-06-013

CAUTION: Housing weight: 60 kg (130 lb)

3. Secure housing (25) body with a nylon sling, then lift it up by crane. Place sleeve (28) with the mounting side up.
4. Tap the outer race of roller bearing (26) evenly by using a bar and hammer while installing the outer race into housing (25). Tap the bearing and listen to ring to confirm if installation is completed.

5. Apply THREEBOND #1215 on the outer surface of oil seal (27). Put the oil seal flat on housing (25) and push it in gently. Then place seal mounting tool (ST 2925) on the oil seal and tap it in by hammering directly.

NOTE: If special tool (ST 2925) is used to replace the seal, no need to remove the sleeve.



W178-02-06-007

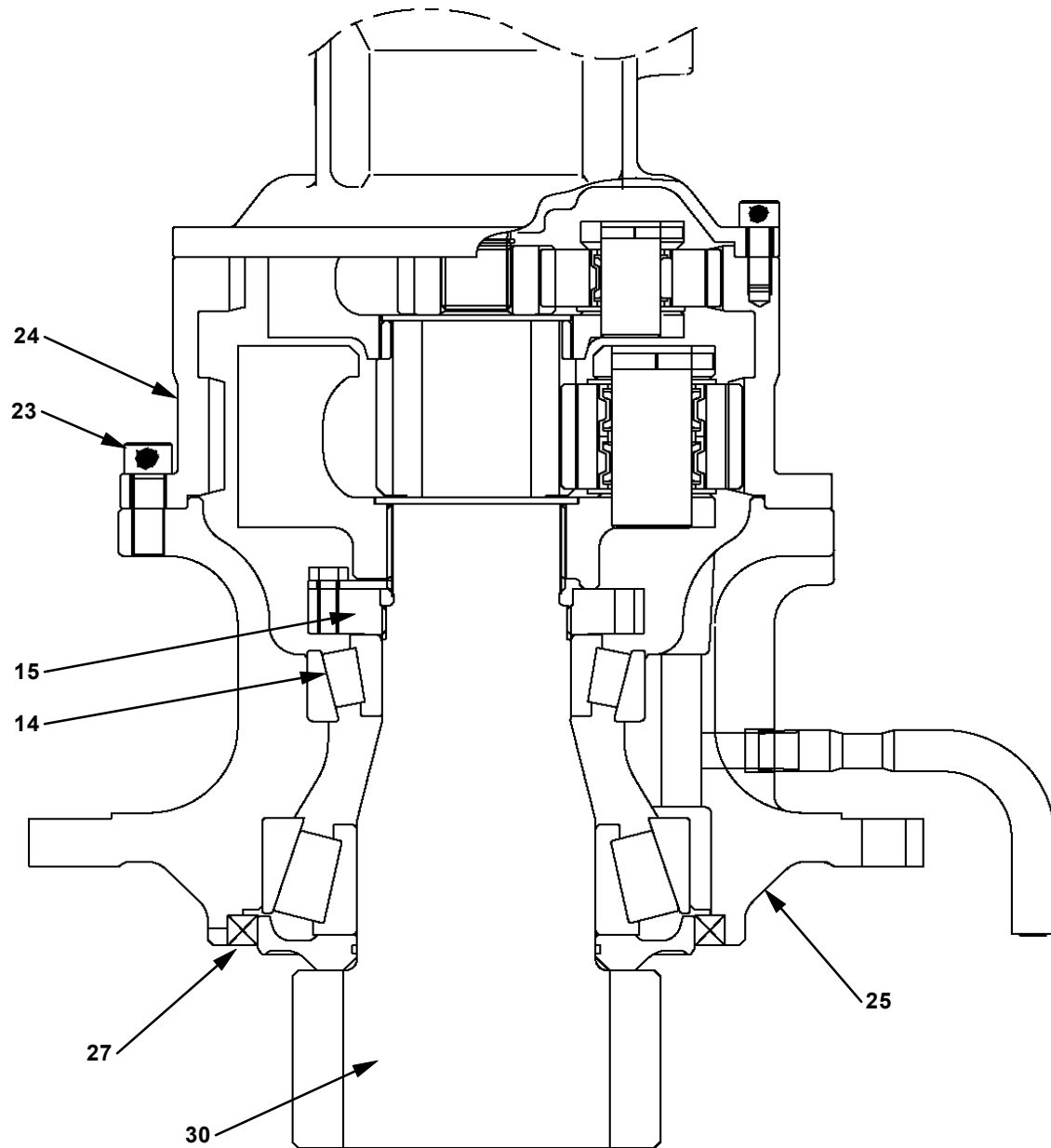
6. Apply grease to the inner surface of oil seal (27) all around. Apply grease to the outer surface of sleeve (28) on shaft (30).

NOTE: Apply grease carefully when installing the shaft to avoid accidental curling of the seal lip from the shaft.

CAUTION: Housing +outer race weight: 63 kg (140 lb)

7. Secure housing (25) body with a nylon sling and lift it up by crane. Place ring gear (24) with the mounting side up.
8. Tap the outer race of roller bearing (14) evenly using a bar and hammer while installing the outer race into housing (25). Tap the bearing and listen to ring to confirm if installation is completed.

UPPERSTRUCTURE / Swing Device



W178-02-06-003

UPPERSTRUCTURE / Swing Device



**CAUTION: Housing + outer races (2 used)
weight: 65 kg (140 lb)**

9. Install eyebolt (M16) into the ring gear mounting bolt (23) hole in housing (25). Then lift and place it on shaft (30) by crane slowly. Check and align carefully to protect the oil seal (27) lip from curling while mounting it.

10. Tap the inner race of roller bearing (14) into shaft (30) with a bar and hammer. Tap the inner race until two threads of shaft bearing nut (15) appear.



NOTE: The fitting between the inner race and shaft is tight.

11. Screw-in bearing nut (15) to shaft (30). Tighten as much as possible by hand.



NOTE: Prevent shaft (30) from falling down when lifting housing (25).



**CAUTION: Housing + shaft + bearing weight:
110 kg (240 lb)**

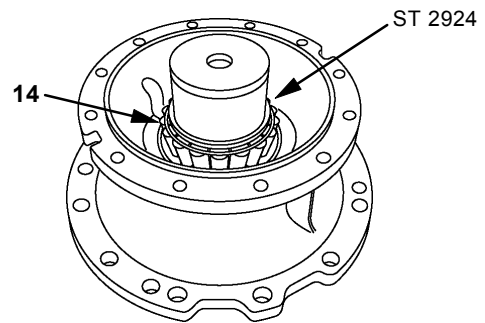
12. Lift housing (25) of ring gear (24) by crane and eyebolt (M16) .
Place it on a press.

13. Remove bearing nut (15) from shaft (30).

14. Place mounting tool (ST 2924) onto the inner race of roller bearing (14). Push the inner race down using a press.



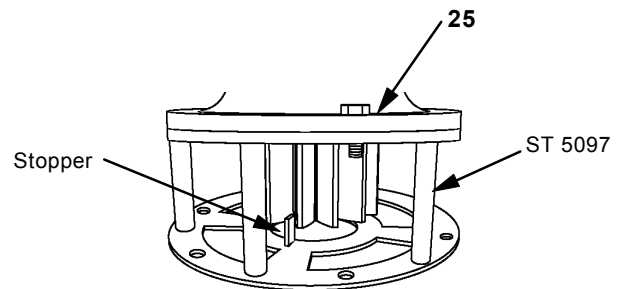
NOTE: Press-in distance of the inner race can be assured by using the mounting tool.



W178-02-06-011

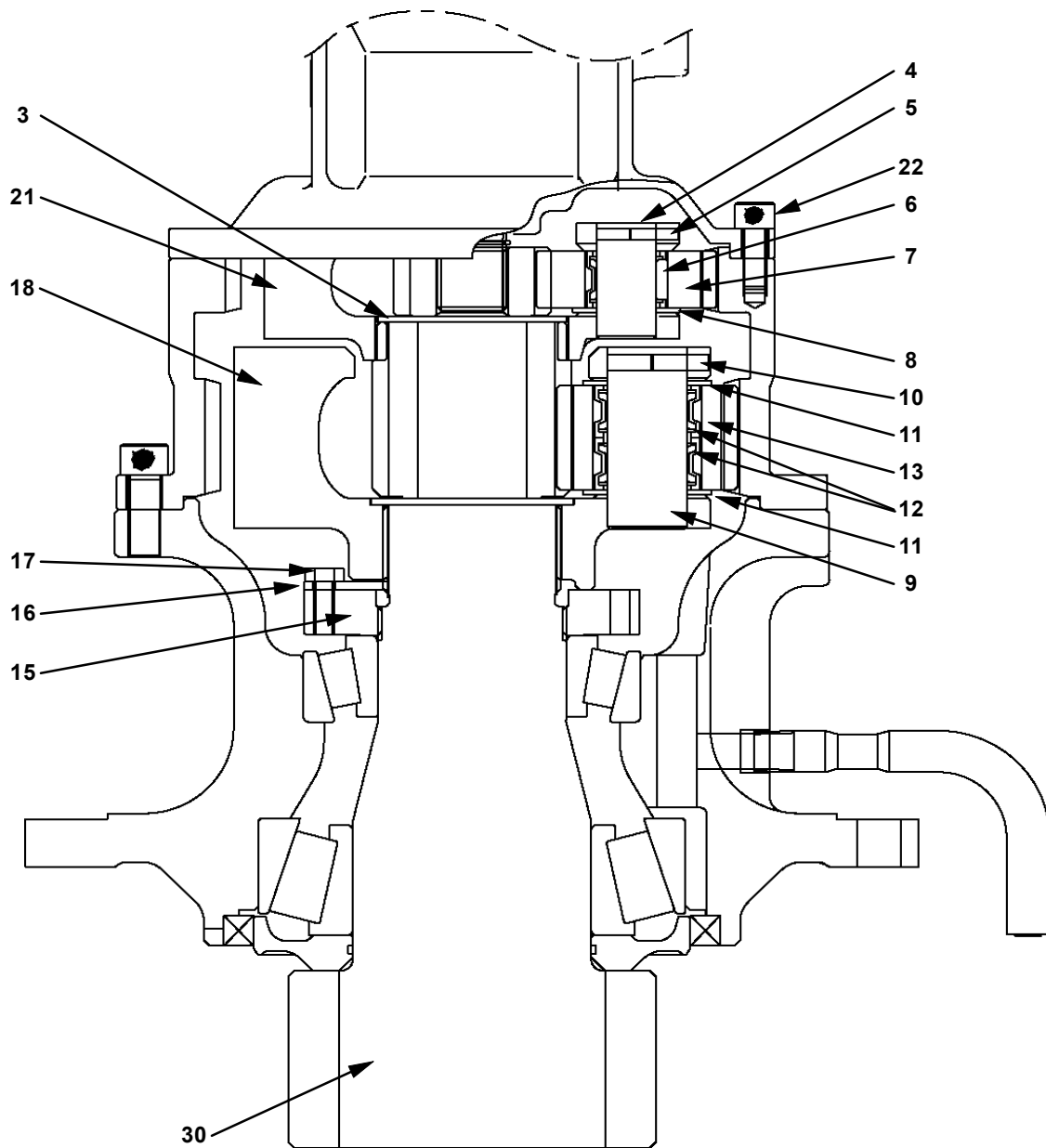
15. Lift the housing (25) assembly and place it on bracket (ST 5097) by crane. Secure it with 2 bolts (M20) while the stopper at the bottom of bracket is located at the middle of two teeth of the pinion gear. Secure the bracket on a work bench.

 : 30 mm



W178-02-06-012

UPPERSTRUCTURE / Swing Device



W178-02-06-003

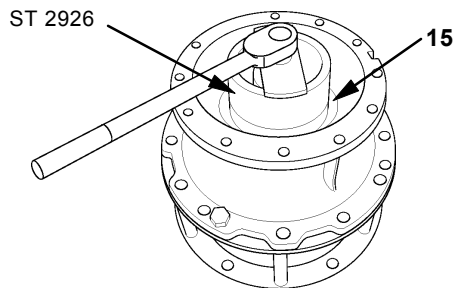
UPPERSTRUCTURE / Swing Device

IMPORTANT: Pay attention to the direction of the bearing nut.

16. Apply a film of grease on the threaded surface of bearing nut (15), then install it on shaft (30) with the stepped side of bearing nut facing roller bearing (14). Tighten the bearing nut using mounting tool (ST 2926).

 : 490 N·m (50 kgf·m, 360 lbf·ft)

 **NOTE:** Grease must be applied for keeping correct tightening torque.



W178-02-06-008

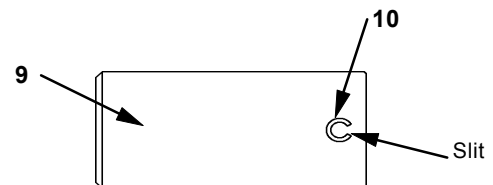
17. Install lock plate (16) onto bearing nut (15) with bolt (17). In case the spline of lock plate and that of shaft (30) are not aligned, tighten the bearing nut in tightening direction until both splines are aligned.

 : 17 mm

18. Clamp planetary gear (13), needle bearings (12) (2 used) with thrust plates (11) (2 used), then install them together into 2nd stage carrier (18).
19. When planetary gear (13) has been installed onto second stage carrier (18), install pin (9) with the spring pin hole facing front. At this time, the spring pin holes both in second stage carrier (18) and pin (9) should be in one line.

IMPORTANT: Pay attention to the direction of the spring pin.

20. Tap spring pin (10) into 2nd stage carrier (18) using tool (ST 1463). At this time, the slit of the spring pin should face to the end of pin (9).



W178-02-06-002

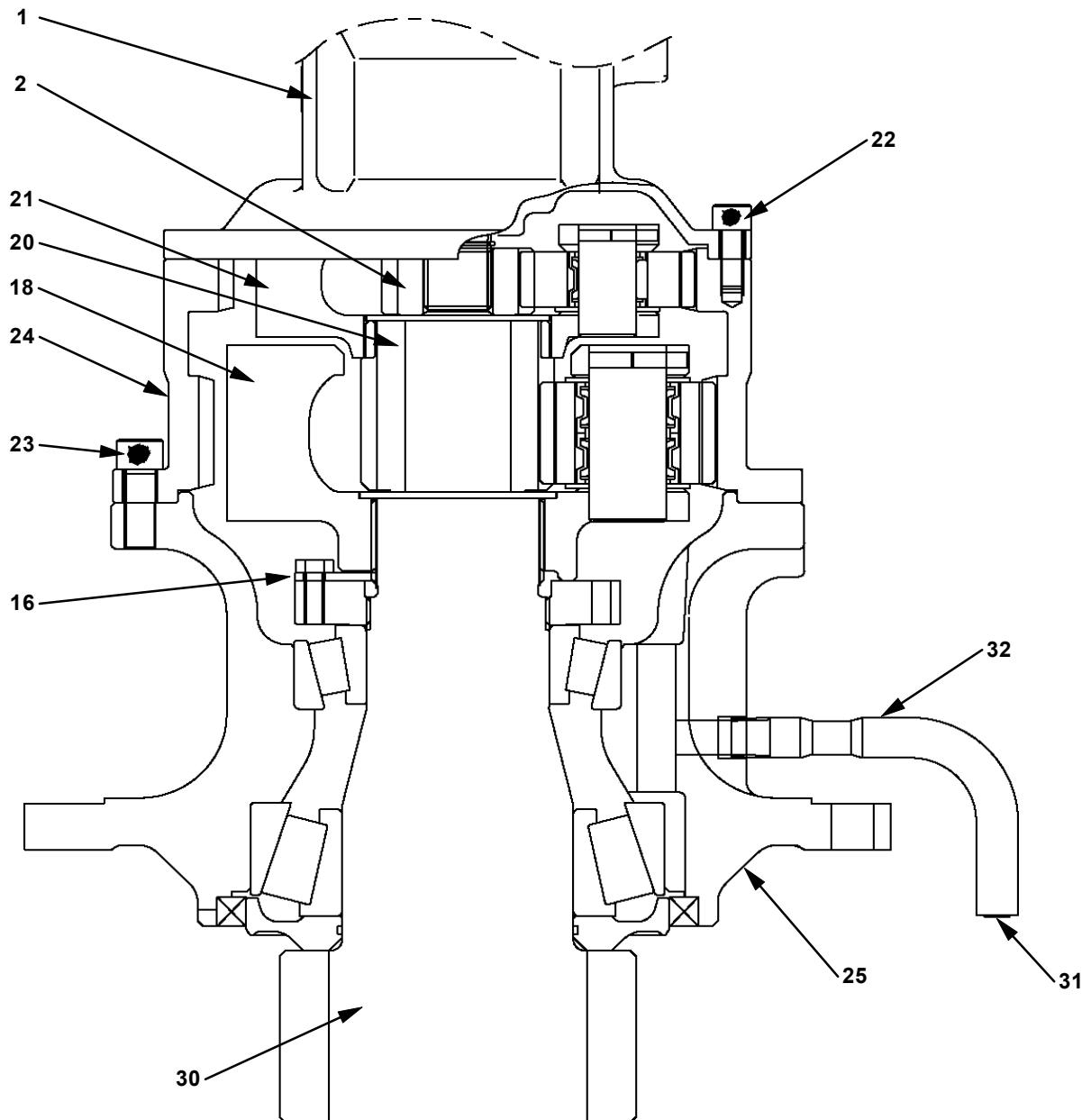
IMPORTANT: Pay attention to the direction of the thrust plate.

21. Install thrust plate (19) into 2nd stage carrier (18), while the oil groove of thrust plate (19) is facing upward.
22. Install planetary gears (13) (2 used), needle bearings (12) (4 used), thrust plates (11) (4 used), pins (9) (2 used) and spring pins (10) (2 used) into the two remaining holes in the 2nd stage carrier (18) according to the same procedures 18 to 20 mentioned above.

IMPORTANT: Pay attention to the mounting location of thrust plate (8).

23. Assemble the following parts to form the 1st stage carrier (21) assembly according to the same procedures 18 to 22 for 2nd stage carrier assembly: planetary gears (7) (3 used), needle bearings (6) (3 used), thrust plates (8) (3 used), pins (4) (3 used), spring pins (5) (3 used) and thrust plate (3). Thrust plate (8) is installed under needle bearing (6). Special tool (ST 1462) should be used as the extractor for the spring pin.

UPPERSTRUCTURE / Swing Device

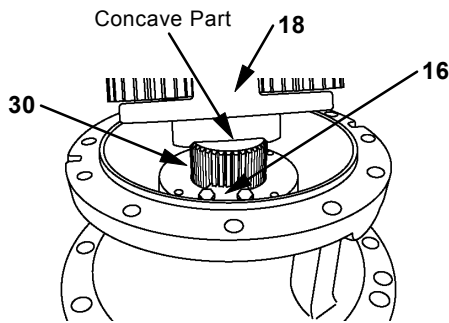


W178-02-06-003

UPPERSTRUCTURE / Swing Device

IMPORTANT: Pay attention to the mounting direction of the 2nd stage carrier.

24. Install the 2nd stage carrier (18) assembly onto the spline of shaft (30), while the concave part of the boss in bottom side of the carrier comes in contact with lock plate (16).



W178-02-06-014

25. Install 2nd stage sun gear (20) into the 2nd stage carrier (18) assembly with the small diameter part of the 2nd stage sun gear facing up.

26. Clean off old THREEBOND and apply new THREEBOND #1215 onto the mounting surface of ring gear (24) inside of housing (25).

27. Install eyebolt (M12) to the motor mounting threaded hole on ring gear (24). Lift the ring gear up by crane, to install it on housing (25) with socket bolts (23) (12 used) while aligning the matching marks made when disassembling.
┌ : 10 mm

28. Install the 1st stage carrier (21) assembly onto the spline of 2nd stage sun gear (20).

IMPORTANT: Pay attention to the mounting direction of the sun gear.

29. Install 1st stage sun gear (2) into the 1st stage carrier (21) assembly with the stepped side of the sun gear facing down.

30. Install pipe (32) into housing (25) with seal tape wound on the threaded part of the pipe.

┌ : 18 mm

31. Wind seal tape on drain plug (31), then install it into pipe (32).

┌ : 8 mm

┌ : 50 N·m (5 kgf·m, 36 lbf·ft)

32. Fill gear oil into ring gear (24) until the middle part of the 1st stage sun gear (2) is submerged. (Approx. 6.5 L, 1.72 Us gal)

33. Clean off the old THREEBOND, then apply new THREEBOND #1212 onto the motor (1) mounting surface of ring gear (24).

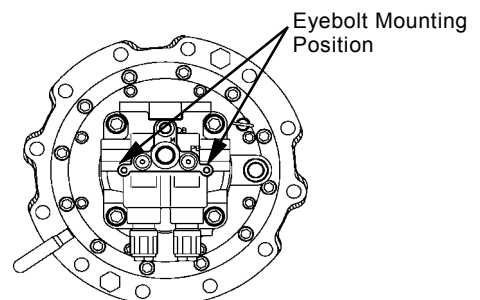


CAUTION: Motor weight: 47 kg (100 lb)

34. Install eyebolt (M10) to motor (1), and lift it up by crane. Align the mating marks, then fasten the swing motor and ring gear (24) with bolts (22) (8 used).

┌ : 10 mm

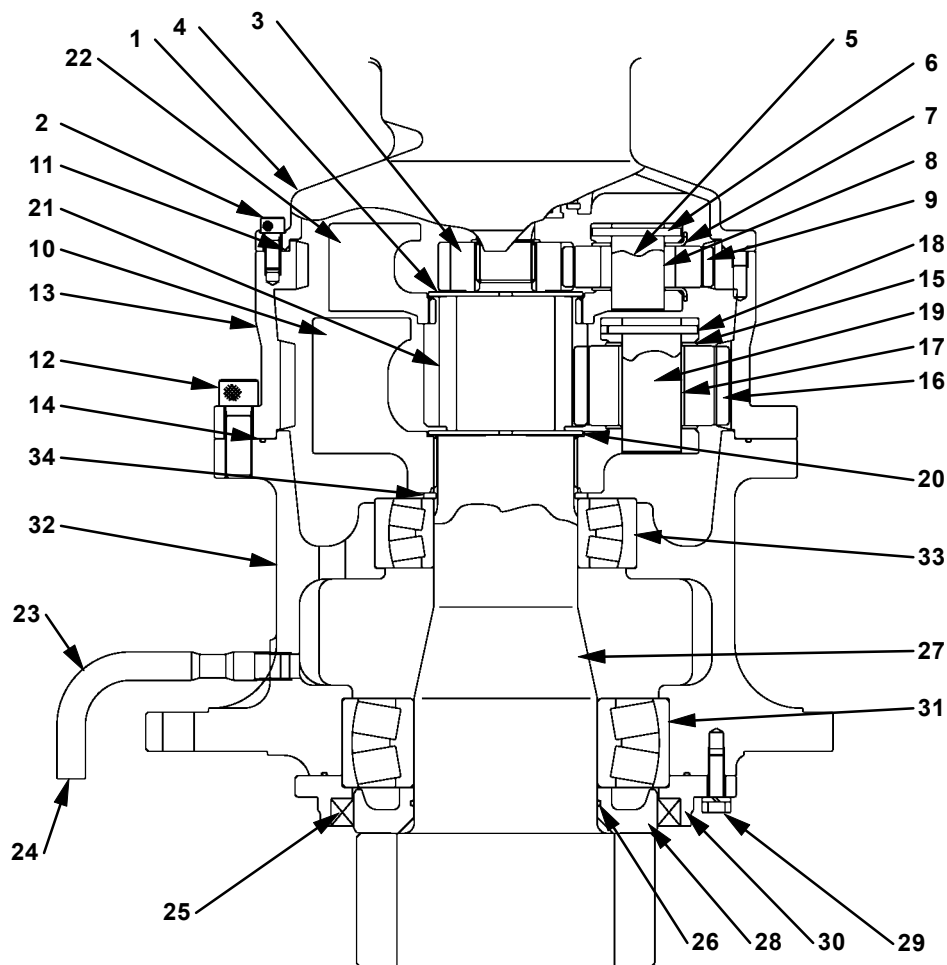
┌ : 88 N·m (9 kgf·m, 65 lbf·ft)



W178-02-06-005

UPPERSTRUCTURE / Swing Device

ASSEMBLE SWING DEVICE (ZAXIS270)



W178-02-06-017

- | | | | |
|-----------------------------|------------------------------|----------------------------|------------------------|
| 1 - Motor | 10 - Second Stage Carrier | 19 - Pin (3 Used) | 27 - Shaft |
| 2 - Socket Bolt (12 Used) | 11 - O-Ring | 20 - Thrust Plate | 28 - Sleeve |
| 3 - First Stage Sun Gear | 12 - Socket Bolt (12 Used) | 21 - Second Stage Sun Gear | 29 - Bolt (10 Used) |
| 4 - Thrust Plate | 13 - Ring Gear | 22 - First Stage Carrier | 30 - Cover |
| 5 - Pin (3 Used) | 14 - O-Ring | 23 - Pipe | 31 - Spherical Bearing |
| 6 - Spring Pin (3 Used) | 15 - Thrust Plate (6 Used) | 24 - Drain Plug | 32 - Housing |
| 7 - Thrust Plate (6 Used) | 16 - Planetary Gear (3 Used) | 25 - Oil Seal | 33 - Spherical Bearing |
| 8 - Needle Bearing (3 Used) | 17 - Bushing (3 Used) | 26 - O-Ring | 34 - Retaining Ring |
| 9 - Planetary Gear (3 Used) | 18 - Spring Pin (3 Used) | | |

UPPERSTRUCTURE / Swing Device

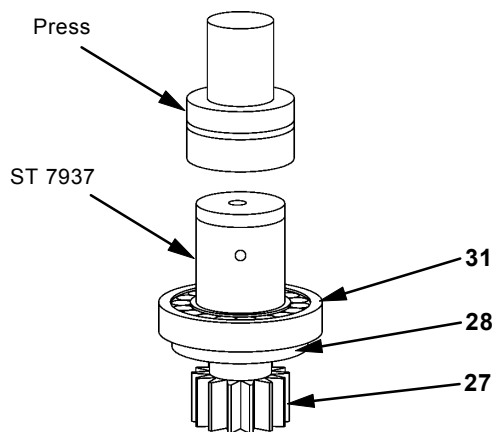
Assemble Swing Device (ZAXIS270)

1. Install O-ring (26) onto sleeve (28).

CAUTION: Shaft + sleeve + bearing weight:
75 kg (170 lb)

2. Install sleeve (28) and spherical ring (31) into shaft (27). Press the sleeve and bearing using bearing mounting tool (ST 7937).

NOTE: Press-in distance of the bearing inner race can be assured by using the bearing mounting tool.



3. Place shaft (27) with pressed sleeve (28) and spherical bearing (31) on flat surface.

4. Install eyebolts (M16, Pitch 2.0) into the socket bolt (12) mounting hole in housing (32).

CAUTION: Housing weight: 107 kg (240 lb)

5. Lift housing (32) by crane and place the housing on the spherical ring (31). Tap the flange of housing (32) evenly by using a bar and hammer while installing the flange into shaft (27). Tap the bearing and listen to ring to confirm if installation is completed.

6. Tap spherical bearing (33) evenly with a bar and hammer while installing it into housing (32). Tap the bearing and listen to ring to confirm if installation is completed.

7. Install retaining ring (34) onto shaft (16).

CAUTION: Housing assembly weight:
195 kg (430 lb)

8. Secure housing (32) body with a nylon sling and lift it up by crane. Place cover (30) with the mounting side up.

9. Apply THREEBOND #1215 on the outer surface of oil seal (25). Put the oil seal flat on cover (30) and push it in gently. Tap the oil seal all around evenly with a plastic hammer, install it on cover (30).

10. Apply grease to the inner surface of oil seal (25) all around. Apply grease to the outer surface of sleeve (28).

IMPORTANT: Pay attention as the seal lip of oil seal (25) is curling up.

11. Install cover (30) onto housing (32) with bolts (29) (10 used).

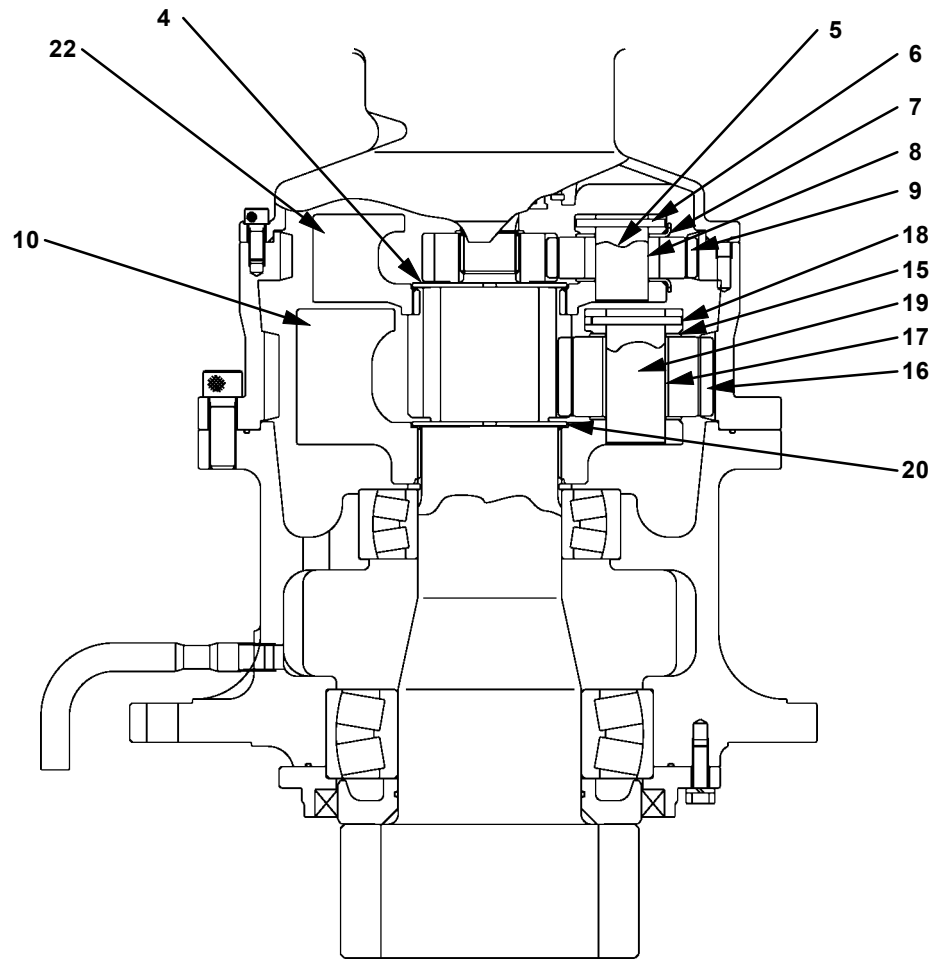
🔧 : 19 mm

🔧 : 34.5 N·m(3.5 kgf·m, 25.5 lbf·ft)

CAUTION: Housing assembly + cover weight: 200 kg (440 lb)

12. Secure housing (32) body with a nylon sling and lift it up by crane. Place ring gear (13) with the mounting side up.

UPPERSTRUCTURE / Swing Device



W178-02-06-017

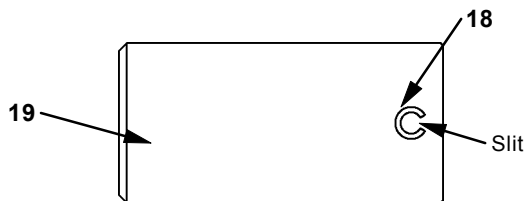
UPPERSTRUCTURE / Swing Device

13. Clamp the planetary gear (16) assembly with thrust plates (15) (2 used), then install it onto second stage carrier (10).

14. When planetary gear (16) has been installed onto second stage carrier (10), install pin (19) with the spring pin hole facing front. At this time, the spring pin holes both in second stage carrier (10) and pin (19) should be in one line.

IMPORTANT: Pay attention to the direction of the spring pin.

15. Tap spring pin (18) into 2nd stage carrier (10) by using tool (ST 1463). At this time, the slit of the spring pin should face to the end of pin (19).



W178-02-06-002

IMPORTANT: Pay attention to the direction of thrust plate.

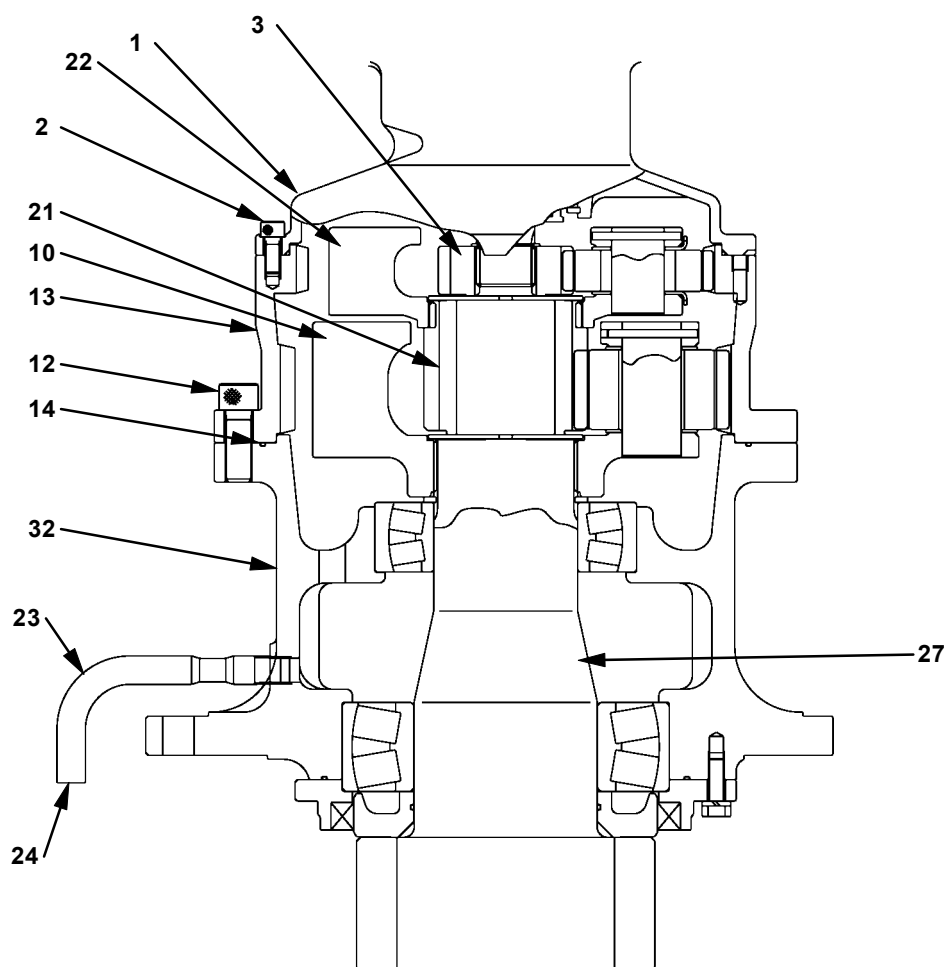
16. Install thrust plate (20) into 2nd stage carrier (10) with its oil groove facing upward.

17. Install planetary gears (13) (2 used), thrust plates (15) (4 used), pins (19) (2 used) and spring pins (18) (2 used) into the two remaining holes in the 2nd stage carrier (10) according to same procedures 13 to 15 mentioned above.

IMPORTANT: Pay attention to the mounting location of thrust plate (7).

18. Assemble the following parts to form the 1st stage carrier (22) assembly according to the same procedures for the 2nd stage carrier assembly: planetary gear (9) (3 used), needle bearings (8) (3 used), thrust plates (7) (6 used), pins (5) (3 used), spring pins (6) (3 used) and thrust plate (4). Special tool (ST 1462) should be used as the extractor for the spring pin.

UPPERSTRUCTURE / Swing Device



W178-02-06-017

UPPERSTRUCTURE / Swing Device

IMPORTANT: Pay attention to the mounting direction of the stage carrier.

CAUTION: Second stage carrier assembly weight: 35 kg (80 lb)

19. Install second stage carrier (10) assembly onto the spline of shaft (27).
20. Install 2nd stage sun gear (21) into the 2nd stage carrier (10) assembly with the small diameter part of the second stage sun gear facing up.
21. Install O-ring (14) into housing (32). Clean off old THREEBOND and apply new THREEBOND #1215 onto the ring gear (13) mounting surface inside of housing (32).
22. Install eyebolt (M12, Pitch 1.75) to the motor threaded mounting hole on ring gear (13). Lift the ring gear up by crane, to install it on housing (32) with bolts (12) (12 used) while aligning the matching marks made when disassembling.
: 17 mm
: 400 N·m (41.0 kgf·m, 300 lbf·ft)
23. Install the 1st stage carrier (22) assembly onto the spline of 2nd stage sun gear (21).

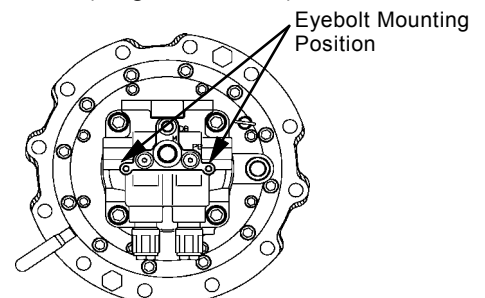
IMPORTANT: Pay attention to the mounting direction of the sun gear.

24. Install 1st stage sun gear (3) into the 1st stage carrier (22) assembly with the stepped side of the sun gear facing down.
25. Install pipe (23) into housing (32) with seal tape wound on the threaded part of the pipe.
: 18 mm
26. Wind seal tape on drain plug (24), then install it into pipe (23).
: 10 mm
: 90 N·m (9.2 kgf·m, 66.5 lbf·ft)
27. Pour gear oil into ring gear (13) until the middle part of the 1st stage sun gear (3) is submerged. (Approx. 17.0 L, 4.49 US gal)
28. Clean off the old THREEBOND, then apply new THREEBOND #1212 onto the motor (1) mounting surface of ring gear (13).

CAUTION: Motor weight: 66 kg (150 lb)

29. Install eyebolt (M13, Pitch 2.0) to motor (1), and lift it up by crane. Fastening the swing motor and ring gear (13) with bolts (2) (12 used), while aligning their mating marks.

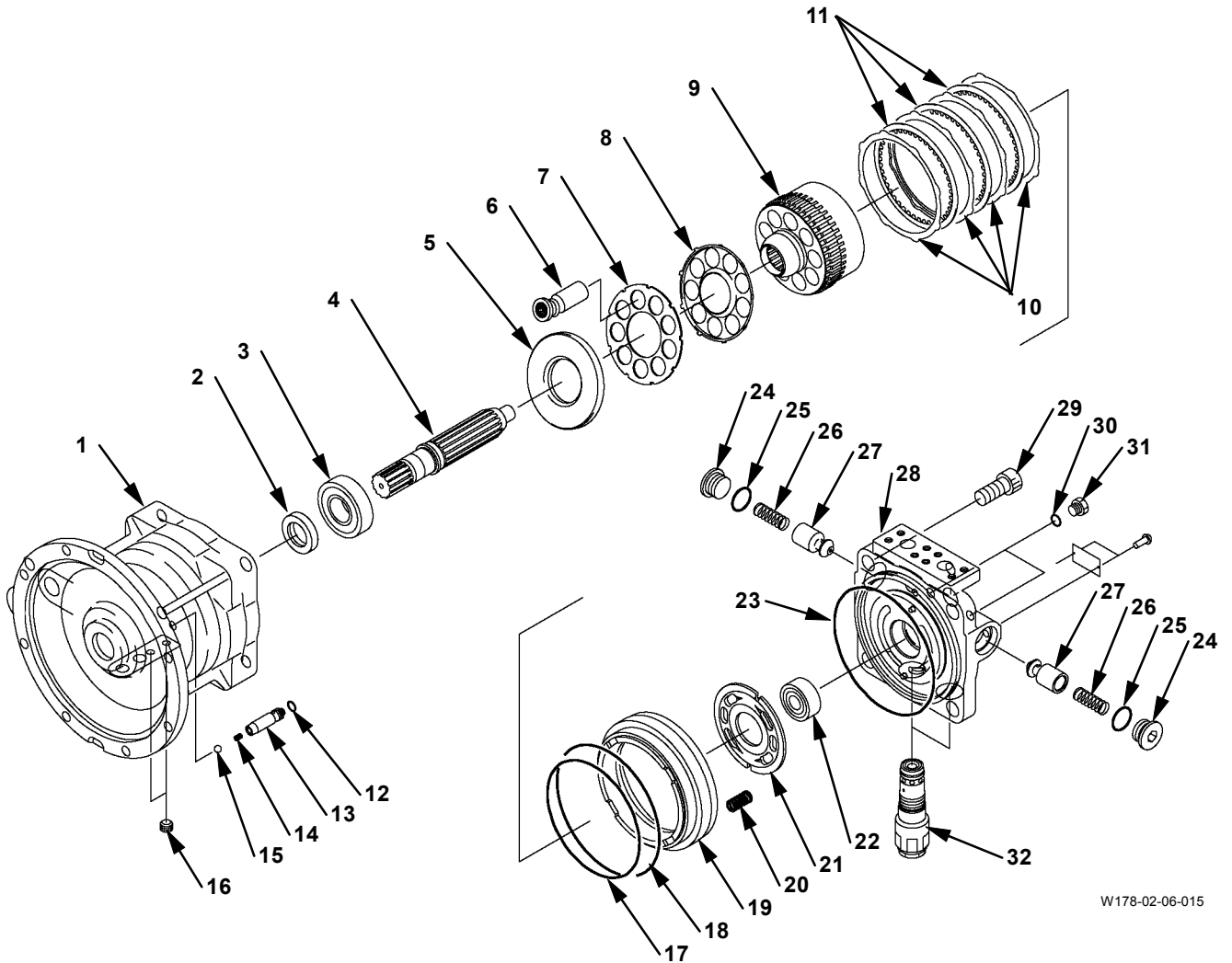
: 10 mm
: 88 N·m (9 kgf·m, 65 lbf·ft)



W178-02-06-005

UPPERSTRUCTURE / Swing Device

DISASSEMBLE SWING MOTOR (ZAXIS200, 200-E, 225US, 225USR, 230)



W178-02-06-015

- | | | | |
|----------------------|------------------------------|-----------------------|----------------------------|
| 1 - Casing | 9 - Rotor | 17 - O-Ring | 25 - O-Ring (2 Used) |
| 2 - Oil Seal | 10 - Plate (4 Used) | 18 - O-Ring | 26 - Spring (2 Used) |
| 3 - Bearing | 11 - Friction Plate (3 Used) | 19 - Brake Piston | 27 - Poppet (2 Used) |
| 4 - Shaft | 12 - O-Ring | 20 - Spring (24 Used) | 28 - Valve Casing |
| 5 - Shoe Plate | 13 - Piston | 21 - Valve Plate | 29 - Socket Bolt (4 Used) |
| 6 - Plunger (9 Used) | 14 - Spring | 22 - Bearing | 30 - O-Ring (2 Used) |
| 7 - Plate | 15 - Ball | 23 - O-Ring | 31 - Plug (2 Used) |
| 8 - Retainer | 16 - Plug (2 Used) | 24 - Plug (2 Used) | 32 - Relief Valve (2 Used) |

UPPERSTRUCTURE / Swing Device

Disassemble Swing Motor

(ZAXIS200, 200-E, 225US, 225USR, 230)

- Be sure to thoroughly read "Precautions for Disassembly and Assembly Work" on page W1-1-1 before starting the disassembly work.



CAUTION: Swing motor assembly weight:
55 kg (120 lb)

Relief valve

IMPORTANT: Don't disassemble relief valve (32).

1. Remove relief valves (32) (2 used) from valve casing (28).

 : 41 mm

2. Remove plugs (24) (2 used) from valve casing (28).

 : 14 mm

3. Remove springs (26) (2 used) and poppets (27) (2 used) from valve casing (28).

4. Make matching marks at the joint surface between valve casing (28) and casing (1). Then loosen socket bolts (29) (4 used). At this moment, there is a clearance between valve casing (28) and casing (1). Take this clearance down.

 : 17 mm

5. Remove valve casing (28) from casing (1).



NOTE: At this moment, valve casing (28) may be with valve plate (21) attached. Pay attention, do not drop valve plate (21).

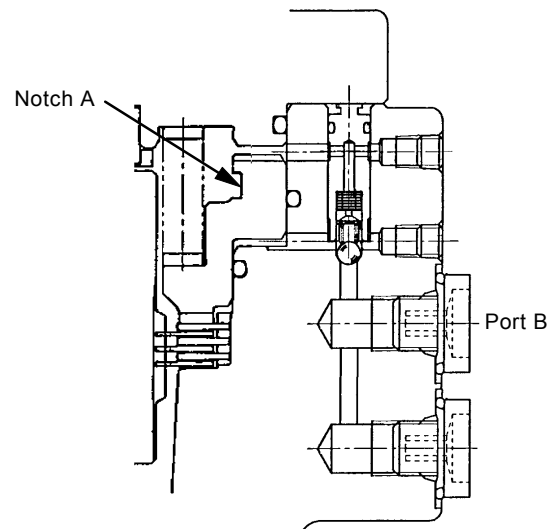
IMPORTANT: Be sure not to damage the mating surface when separating valve plate (21) from valve casing (28) or rotor (9) with a screwdriver. (Be sure not to mismatch the surfaces of the valve plate when installing.)

6. If valve plate (21) is still on rotor (9) in step 5, remove the valve plate from the rotor. Remove springs (20) (24 used).



CAUTION: Another method is to float flood the brake piston by blowing air from port B. However, piston (13) may fly out when blowing air. Don't use this method.

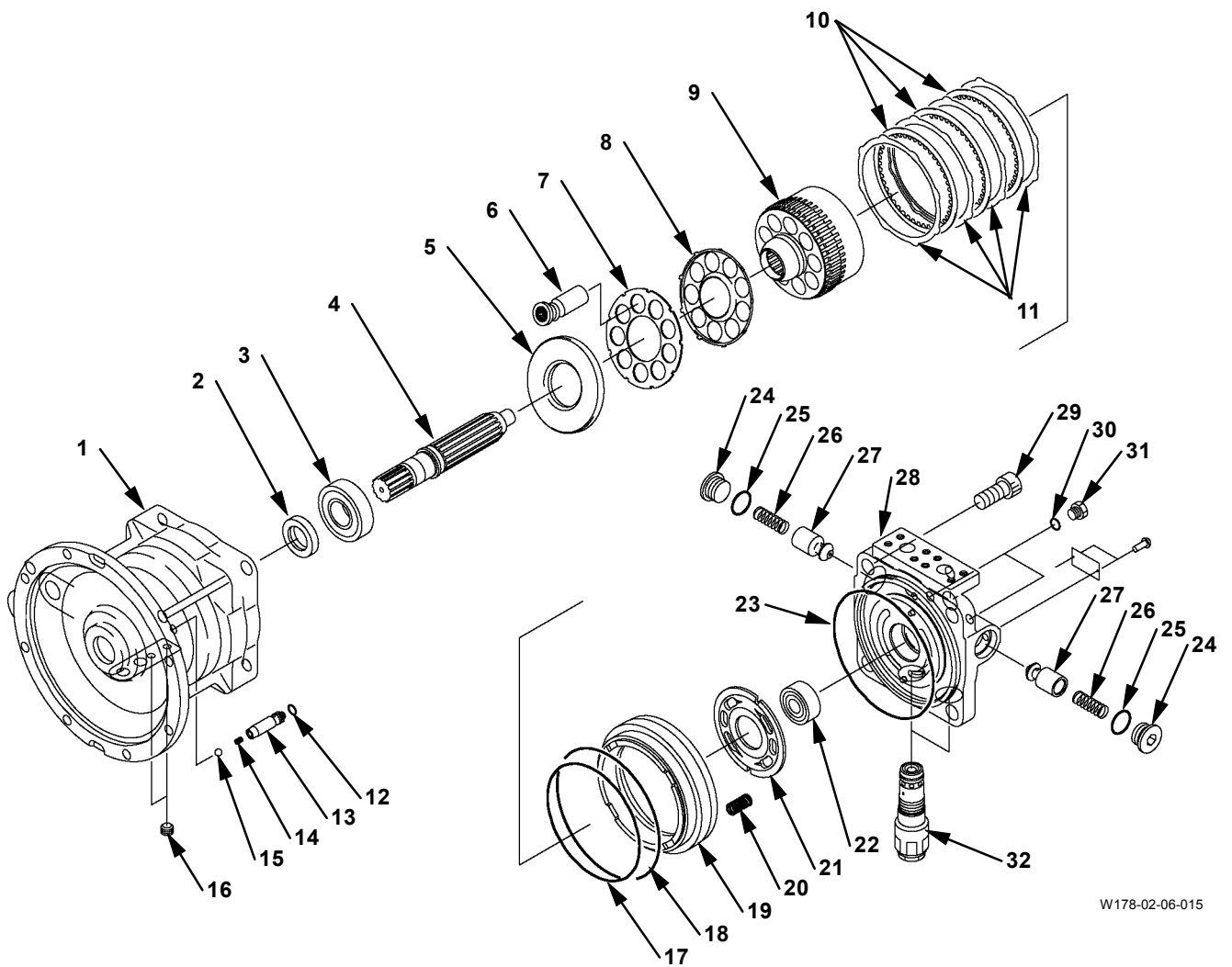
7. Install tool (ST 1468) into notch A of brake piston (19), then pull it out from casing (1).



T178-03-02-003

8. Remove O-rings (17, 18) from casing (1).

UPPERSTRUCTURE / Swing Device



W178-02-06-015

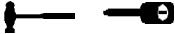
UPPERSTRUCTURE / Swing Device

IMPORTANT: Take care not to damage the slide surface of rotor (9) and plunger (6).

9. Place casing (1) horizontally. Remove rotor (9), retainer (8), plate (7) and plungers (6) (9 used) from shaft (4).
10. Remove plates (10) (4 used), friction plates (11) (3 used) from housing (1).

IMPORTANT: Take care not to damage the slide surface of shoe plate (5).

11. Remove shoe plate (5) from casing (1).
12. Tap shaft (4) with a plastic hammer lightly to remove it from casing (1).

13. Push out oil seal (2) from casing (1).

14. Remove the outer race of bearing (3) from casing (1) with a guide bar.

15. Remove the inner race of roller bearing (3) from shaft (4) with a press.

IMPORTANT: Filter and orifice are mounted inside of piston (13). Do not disassemble them unless they are clogged or deformed. Disassemble them only when absolutely needed. If the inner parts need to be replaced, replace them as an assembly.

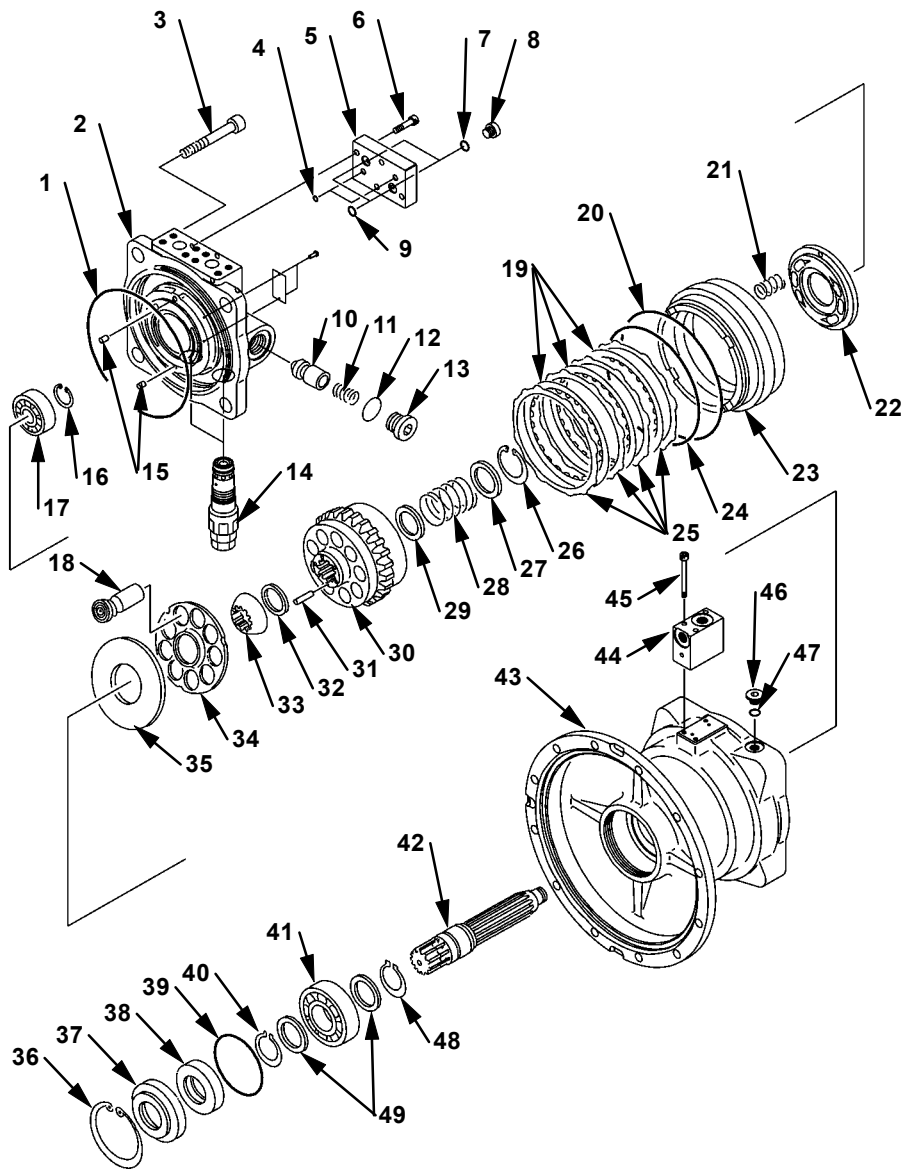
16. Remove piston (13) from casing (1) with pliers.



17. Remove spring (14) and ball (15) from casing (1).

UPPERSTRUCTURE / Swing Device

DISASSEMBLE SWING MOTOR (ZAXIS270)



W178-02-06-027

- | | | | |
|--------------------------|------------------------------|-------------------------|------------------------------------|
| 1 - O-Ring | 14 - Relief Valve (2 Used) | 26 - Retaining Ring | 38 - Oil Seal |
| 2 - Valve Casing | 15 - Pin (2 Used) | 27 - Spacer | 39 - O-Ring |
| 3 - Socket Bolt (4 Used) | 16 - Retaining Ring | 28 - Spring | 40 - Retaining Ring |
| 4 - O-Ring (2 Used) | 17 - Roller Bearing | 29 - Spacer | 41 - Bearing |
| 5 - Plate | 18 - Plunger (9 Used) | 30 - Rotor | 42 - Shaft |
| 6 - Socket Bolt (4 Used) | 19 - Friction Plate (3 Used) | 31 - Push Rod (12 Used) | 43 - Casing |
| 7 - O-Ring (2 Used) | 20 - O-Ring | 32 - Spacer | 44 - Parking Brake Releasing Valve |
| 8 - Plug (2 Used) | 21 - Spring (22 Used) | 33 - Bushing | 45 - Socket Bolt (3 Used) |
| 9 - O-Ring (2 Used) | 22 - Valve Plate | 34 - Retainer plate | 46 - Plug |
| 10 - Poppet (2 Used) | 23 - Brake Piston | 35 - Shoe Plate | 47 - O-Ring |
| 11 - Spring (2 Used) | 24 - O-Ring | 36 - Retaining Ring | 48 - Retaining Ring |
| 12 - O-Ring (2 Used) | 25 - Center Plate (4 Used) | 37 - Front Cover | 49 - Spacer (2 Used) |
| 13 - Plug (2 Used) | | | |

UPPERSTRUCTURE / Swing Device

Disassemble Swing Motor (ZAXIS270)

- Be sure to thoroughly read "Precautions for Disassembly and Assembly Work" on page W1-1-1 before starting the disassembly work.



CAUTION: Swing motor assembly weight:
66 kg (150 lb)

IMPORTANT: Don't disassemble or turn the adjustment screw of relief valve (14).

1. Remove relief valves (14) (2 used) from valve casing (2).

 : 36 mm

2. Remove plugs (13) (2 used) from valve casing (2).

 : 17 mm

3. Remove springs (11) (2 used) and poppets (10) (2 used) from valve casing (2).

4. Remove plate (5), O-rings (4), (9) (4 used) and socket bolts (6) (4 used) from valve casing (2).

 : 6 mm



NOTE: Do not remove bearing (17), pins (15) (2 used) from valve casing (2) unless necessary.

5. Make matching marks at the joint surface between valve casing (2) and casing (43). Then loosen socket bolts (3) (4 used). At this moment, there is a clearance between valve casing (2) and casing (43). Take this clearance down.

 : 17 mm

6. Remove valve casing (2) from casing (43).

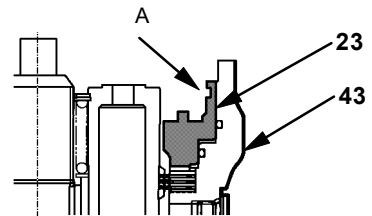


NOTE: Pay attention to valve plate (22) when removing the valve casing (2). It has a tendency to fall.

IMPORTANT: Be sure not to damage the matching surface when separating valve plate (22) and valve casing (2) or rotor (30) with a screwdriver. (Be sure not to mismatch the surfaces of the valve plate when installing.)

7. If valve plate (22) is still attached on rotor (30) in step 6, remove valve plate (22) from the rotor. Remove springs (21) (22 used).

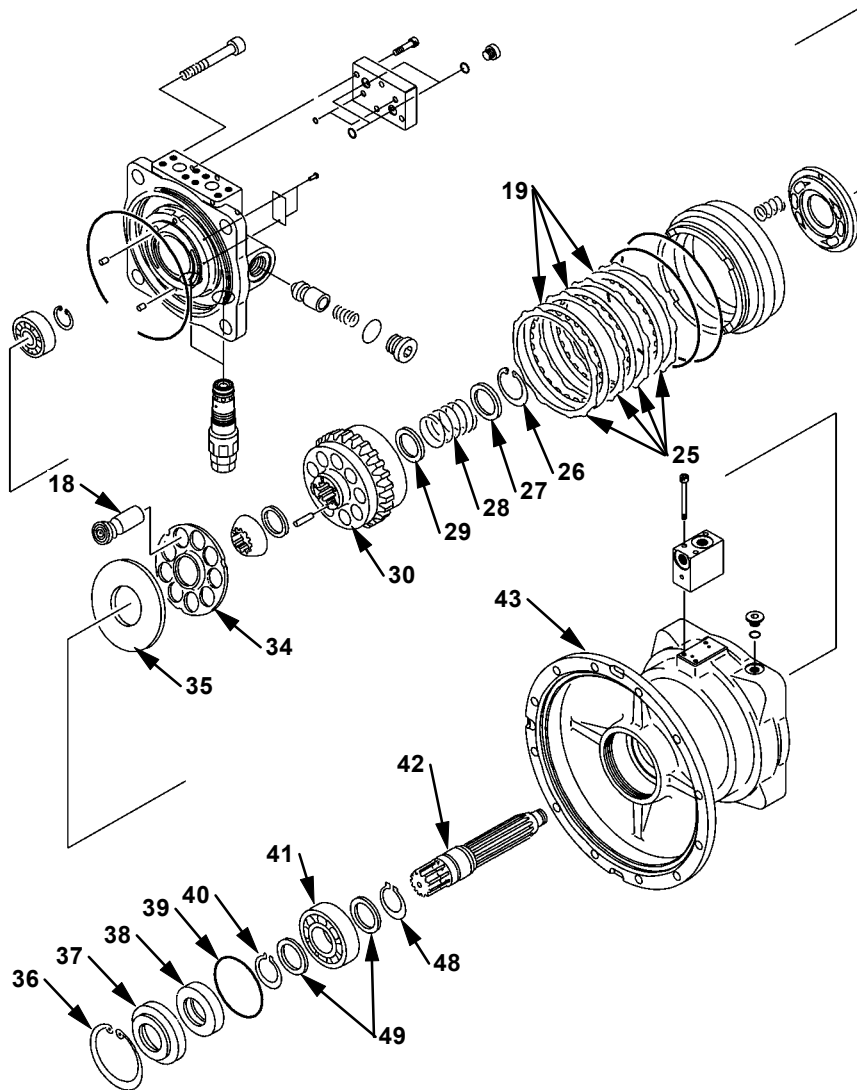
8. Install tool (ST 1468) into notch A of brake piston (23), then pull it out from casing (43).



W157-02-06-005

9. Remove O-rings (20 and 24) from casing (43).

UPPERSTRUCTURE / Swing Device



W178-02-06-027

UPPERSTRUCTURE / Swing Device

IMPORTANT: Take care not to damage the slide surface of rotor (30) and plunger (18).

10. Place casing (43) horizontally. Remove the rotor (30) assembly, retainer plate (34) and plungers (18) (9 used) from shaft (42).

 **NOTE:** Do not remove retaining ring (26), spacers (27 and 29) and spring (28) from rotor (30) unless necessary.

11. Remove plates (25) (4 used), friction plates (19) (3 used) from casing (43).

IMPORTANT: Take care not to damage the slide surface of shoe plate (35).

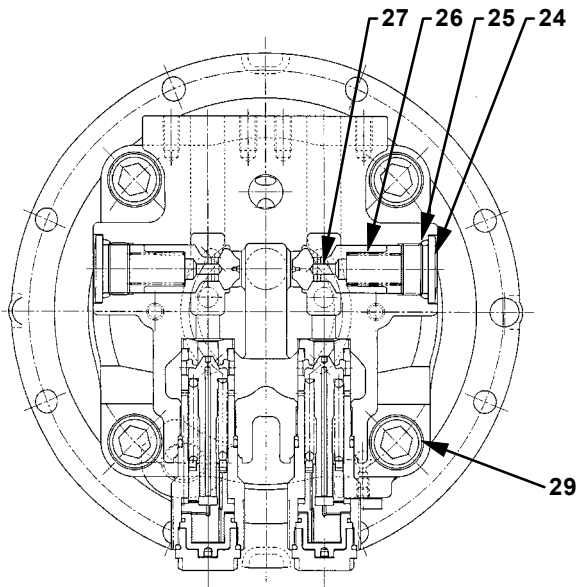
12. Remove shoe plate (35) from casing (43).
13. Remove retaining ring (36) from casing (43) to remove front cover (37), O-ring (39).
14. Tap shaft (42) assembly lightly with a plastic hammer and remove it from casing (43).

 **NOTE:** • At this time, retaining rings (40, 48), spacer (49), bearing (41) are also removed out with shaft (42).
• Do not remove bearing (41) from shaft (42) unless necessary.

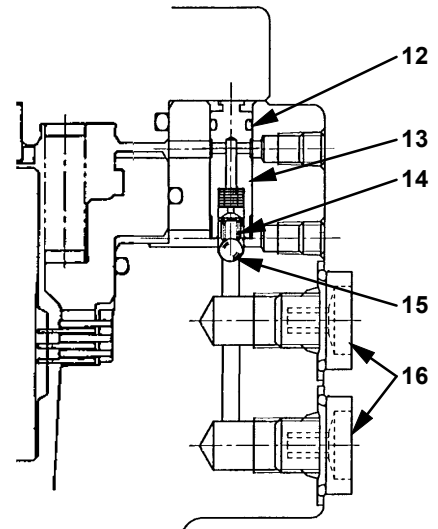
15. Install front cover (37) into a vise, remove oil seal (38) with a minus driver and hammer.

UPPERSTRUCTURE / Swing Device

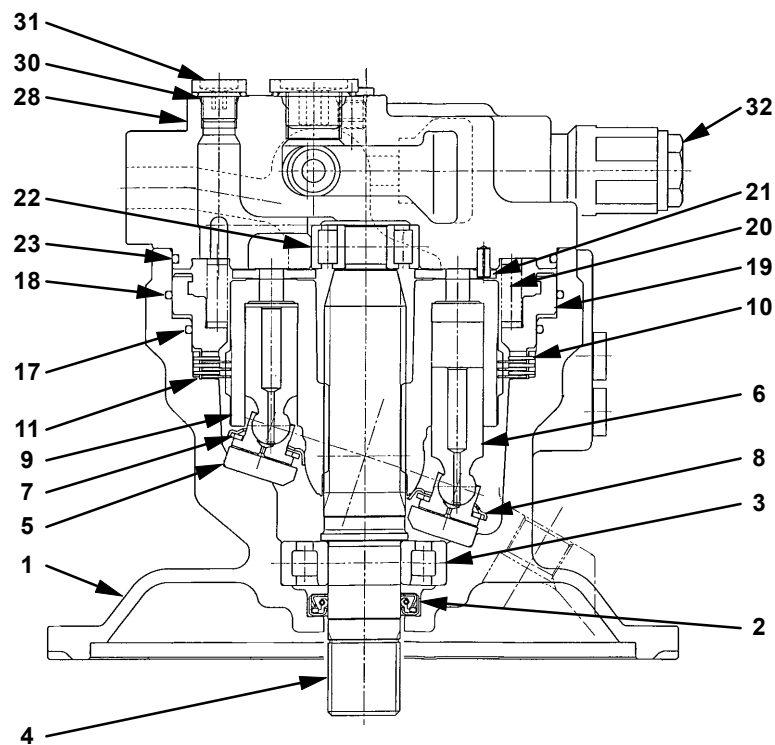
ASSEMBLE SWING MOTOR (ZAXIS200, 200-E, 225US, 225USR, 230)



T178-03-02-004



T178-03-02-003



T178-03-02-002

- | | | | |
|----------------------|------------------------------|-----------------------|----------------------------|
| 1 - Casing | 9 - Rotor | 17 - O-Ring | 25 - O-Ring (2 Used) |
| 2 - Oil Seal | 10 - Plate (4 Used) | 18 - O-Ring | 26 - Spring (2 Used) |
| 3 - Bearing | 11 - Friction Plate (3 Used) | 19 - Brake Piston | 27 - Poppet (2 Used) |
| 4 - Shaft | 12 - O-Ring | 20 - Spring (24 Used) | 28 - Valve Casing |
| 5 - Shoe Plate | 13 - Piston | 21 - Valve Plate | 29 - Socket Bolt (4 Used) |
| 6 - Plunger (9 Used) | 14 - Spring | 22 - Bearing | 30 - O-Ring (2 Used) |
| 7 - Plate | 15 - Ball | 23 - O-Ring | 31 - Plug (2 Used) |
| 8 - Retainer | 16 - Plug (2 Used) | 24 - Plug (2 Used) | 32 - Relief Valve (2 Used) |

UPPERSTRUCTURE / Swing Device

Assemble Swing Motor

(ZAXIS200, 200-E, 225US, 225USR, 230)

IMPORTANT: Be sure to install the inner race of bearing (3) with the flange facing the stepped side of shaft (4).

1. Push the inner races of bearings (3), (22) into shaft (4) with a press.

IMPORTANT: Push oil seal (2) in, with its lip facing up.

2. Push oil seal (2) into casing (1) with a guide plate.
3. Install the outer race of bearing (3) into casing (1) with a guide bar.



IMPORTANT: Wind tape on the spline at the end of shaft (4) to prevent damaging oil seal (2) from being damaged.

4. Place casing (1) horizontally. Install shaft (4) into casing (1).
5. Place casing (1) vertically with the valve casing (28) mounting surface up. Then install shoe plate (5) with its chamfered inner side facing inside.

IMPORTANT: When installing retainer (8) into plunger (6), be sure to place the notch side of the retainer facing shoe plate (5).

6. Assemble plate (7) and retainer (8) with the notch matched. Then install plungers (6) (9 used).

IMPORTANT: Apply hydraulic oil into the plunger hole in rotor (9), then install plunger (6).

7. Insert the plunger (6) assembly into rotor (9).

8. Place casing (1) horizontally. Install the rotor (9) assembly onto shaft (4).

IMPORTANT: 4 notchs are on the outer side of plate (10). And 4 notchs are on the spline teeth side of friction plate (11). Be sure to align each notch at the same place when installing.

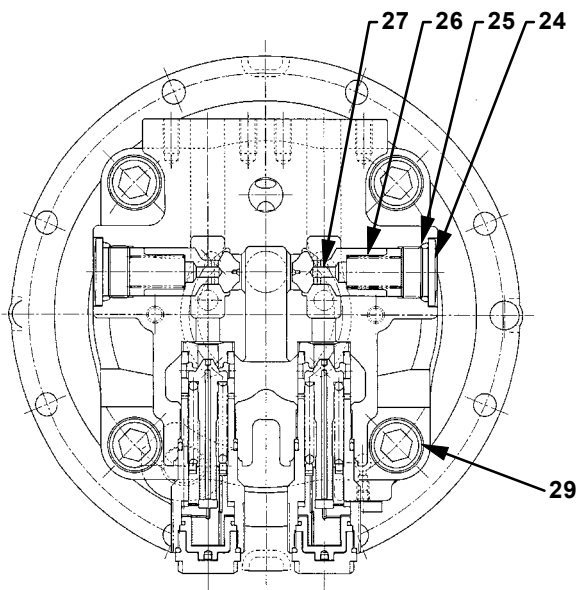
9. Place casing (1) vertically. Alternately install plates (10) (4 used), friction plates (11) (3 used) into casing (1).
10. Install O-ring (17) and (18) onto casing (1).
11. Install brake piston (19) into casing (1) while aligning the mating mark.



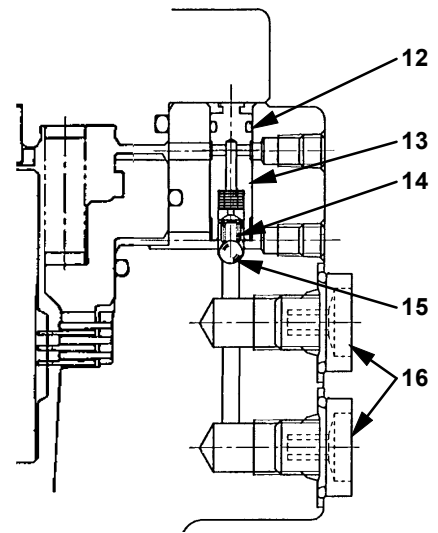
 **NOTE:** If it is not easy to install O-rings (17), (18) into brake piston (19) due to the resistant force from the O-rings, tap them evenly with a plastic hammer to force them in.

12. Install springs (20) (24 used) onto brake piston (19).

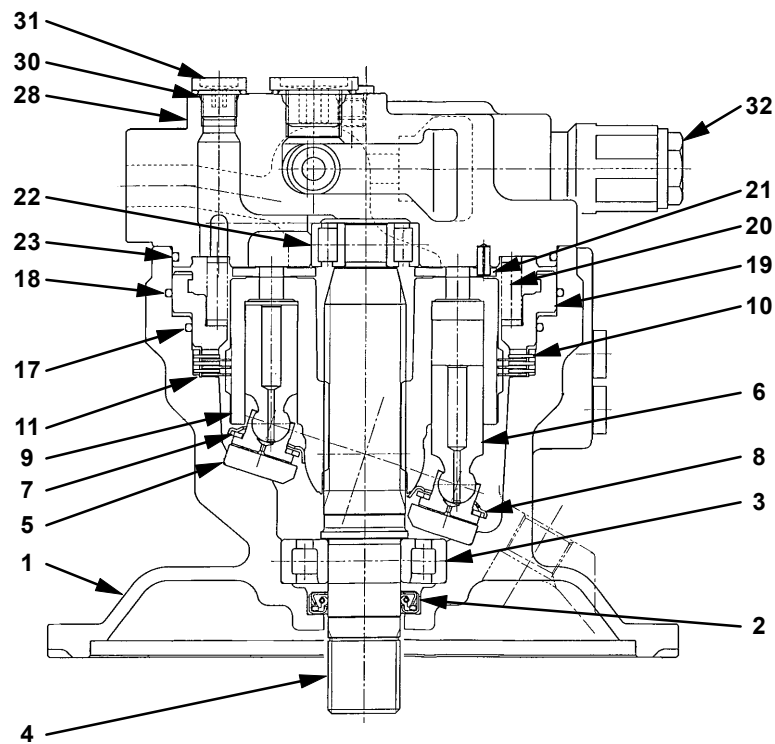
UPPERSTRUCTURE / Swing Device



T178-03-02-004



T178-03-02-003



T178-03-02-002

UPPERSTRUCTURE / Swing Device

IMPORTANT: If the inner parts of piston (13) need to be replaced, replace the piston as an assembly.

Be sure to align the end face of the piston with that of casing (1).

13. Install ball (15), spring (14) and piston (13) into housing (1).

IMPORTANT: Tap the bearing type indicated surface with a plastic hammer while installing roller bearing (22).

14. Tap the outer race of bearing (22) with a plastic hammer while installing it into valve casing (28).



IMPORTANT: Pay attention to the surfaces of valve plate (21).
(Install the valve plate with the notch in the port facing rotor (9).)

15. Install O-ring (23) onto valve casing (28). Then install valve plate (21).

 **NOTE:** Apply grease onto valve plate (21) to avoid it coming off from valve casing (28).

16. Apply grease to the needle part on bearing (22).

 **NOTE:** It is easy to install shaft (4) into bearing (22) by pushing the needle with grease.

17. Align the matching marks in valve casing (28) and casing (1), while placing the valve casing onto casing (1). Be sure to confirm that the clearance between valve casing (28) and casing (1) is same to that before disassembling. If the clearance is larger than that before disassembling, reinstallation shall be carried out from step 5.

18. Install valve casing (28) onto valve casing (1) with socket bolts (29) (4 used).

 : 17 mm

 : 430 N·m (44 kgf·m, 320 lbf·ft)

19. Install poppets (27) (2 used) and springs (26) (2 used) into valve casing (28). Tighten plug (24) with O-ring (25) attached.

 : 14 mm

 : 330 N·m (34 kgf·m, 245 lbf·ft)

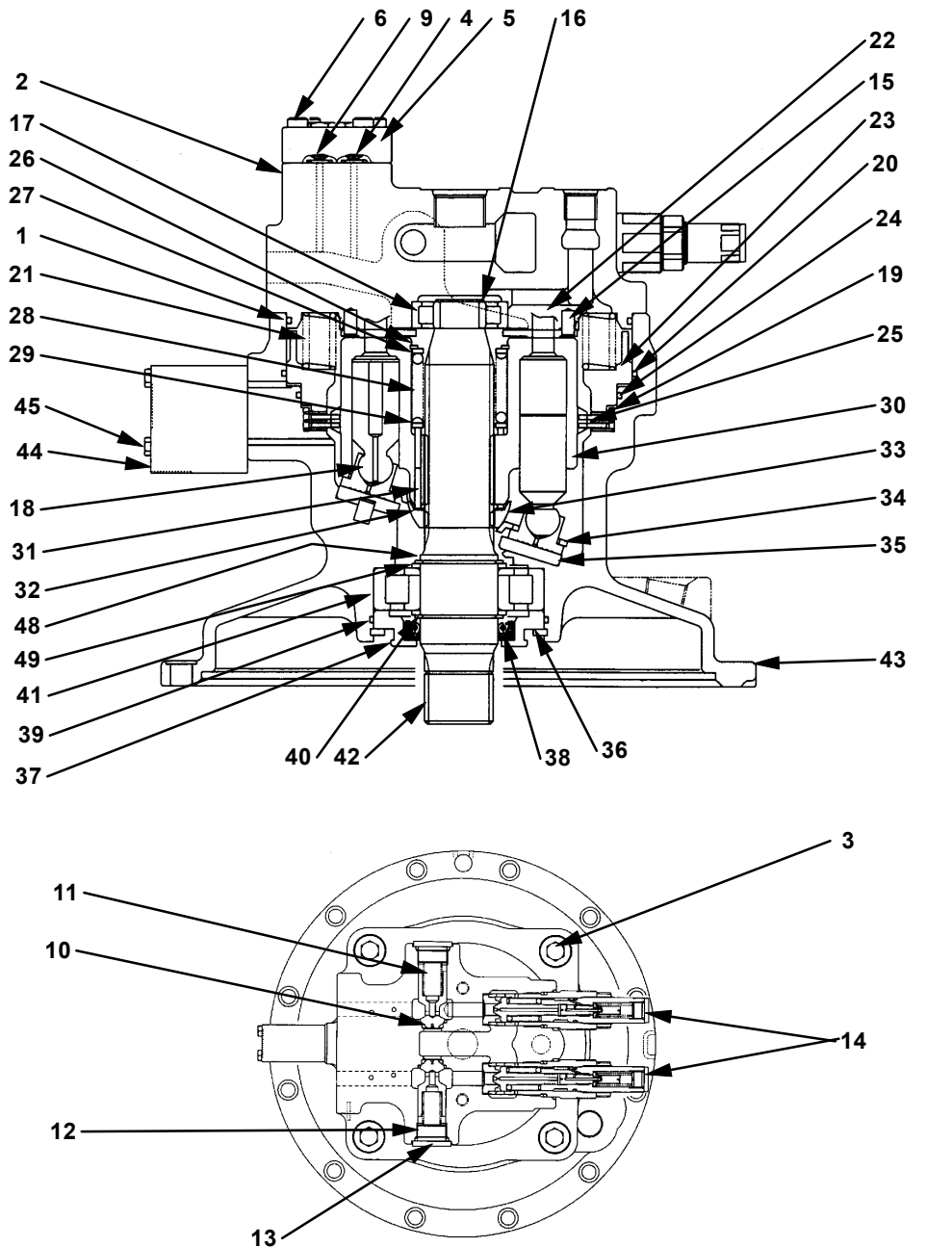
20. Install relief valves (32) (2 used) into valve casing (3).

 : 41 mm

 : 175 N·m (18 kgf·m, 130 lbf·ft)

UPPERSTRUCTURE / Swing Device

ASSEMBLE SWING MOTOR (ZAXIS270)



- | | | | |
|--------------------------|------------------------------|-------------------------|------------------------------------|
| 1 - O-Ring | 14 - Relief Valve (2 Used) | 26 - Retaining Ring | 38 - Oil Seal |
| 2 - Valve Casing | 15 - Pin (2 Used) | 27 - Spacer | 39 - O-Ring |
| 3 - Socket Bolt (4 Used) | 16 - Retaining Ring | 28 - Spring | 40 - Retaining Ring |
| 4 - O-Ring (2 Used) | 17 - Roller Bearing | 29 - Spacer | 41 - Bearing |
| 5 - Plate | 18 - Plunger (9 Used) | 30 - Rotor | 42 - Shaft |
| 6 - Socket Bolt (4 Used) | 19 - Friction Plate (3 Used) | 31 - Push Rod (12 Used) | 43 - Casing |
| 7 - O-Ring (2 Used) | 20 - O-Ring | 32 - Spacer | 44 - Parking Brake Releasing Valve |
| 8 - Plug (2 Used) | 21 - Spring (22 Used) | 33 - Bushing | 45 - Socket Bolt (3 Used) |
| 9 - O-Ring (2 Used) | 22 - Valve Plate | 34 - Retainer plate | 46 - Plug |
| 10 - Poppet (2 Used) | 23 - Brake Piston | 35 - Shoe Plate | 47 - O-Ring |
| 11 - Spring (2 Used) | 24 - O-Ring | 36 - Retaining Ring | 48 - Retaining Ring |
| 12 - O-Ring (2 Used) | 25 - Center Plate (4 Used) | 37 - Front Cover | 49 - Spacer (2 Used) |
| 13 - Plug (2 Used) | | | |

W164-02-06-002

UPPERSTRUCTURE / Swing Device

Assemble Swing Motor (ZAXIS270)

IMPORTANT: Wind tape on the spline at the end of shaft (42) to prevent oil seal (38) from being damaged.



CAUTION: Casing weight: 21 kg (50 lb)

1. Place casing (43) with valve casing (2) side facing down.
2. Apply grease to the part of bearing (41) being inserted into casing (43).
3. Tap shaft (42) assembly with a plastic hammer, then install it into casing (43).
4. Tap oil seal (38) with a plastic hammer and install the oil seal into front cover (37).
5. Install O-ring (39) into casing (43). Tap front cover (37) with a plastic hammer lightly to install it onto casing (43). Install retaining ring (36) into casing (43).



CAUTION: Casing weight: 21 kg (50 lb)

IMPORTANT: Apply grease to the chamfer side of shoe plate (35), then install the shoe plate into casing (43) with the chamfer side facing inside.

6. Place casing (43) with the mounting surface of valve casing (2) facing up.
7. Install shoe plate (35) onto casing (43). At this time, the chamfer surface on inner race of shoe plate (35) should be facing inside.
8. Install push rods (31) (12 used) into rotor (30).



NOTE: If push rod (31) is applied with grease, it is less likely to come off.

9. Install spacer (32), bushing (33) into rotor (30).

10. Install plungers (18) (9 used) into retainer plate (34).

IMPORTANT: Apply hydraulic oil into the plunger hole in rotor (30).
When installing retainer plate (34), be sure to place it with its spherical surface facing bushing (33).

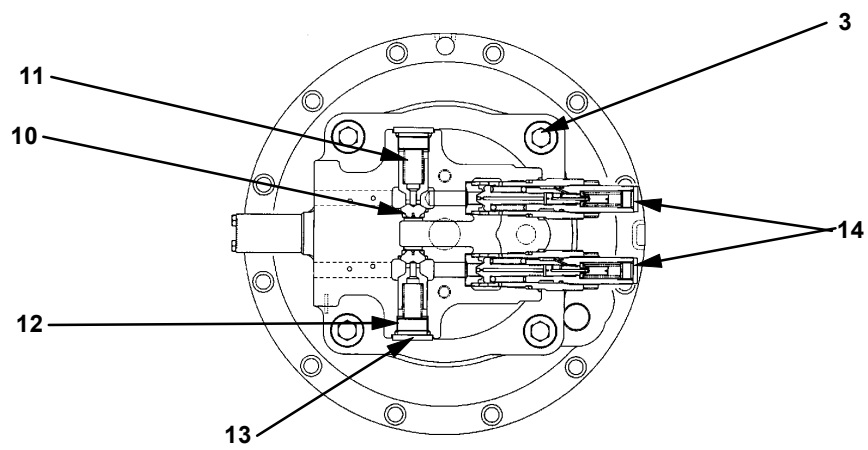
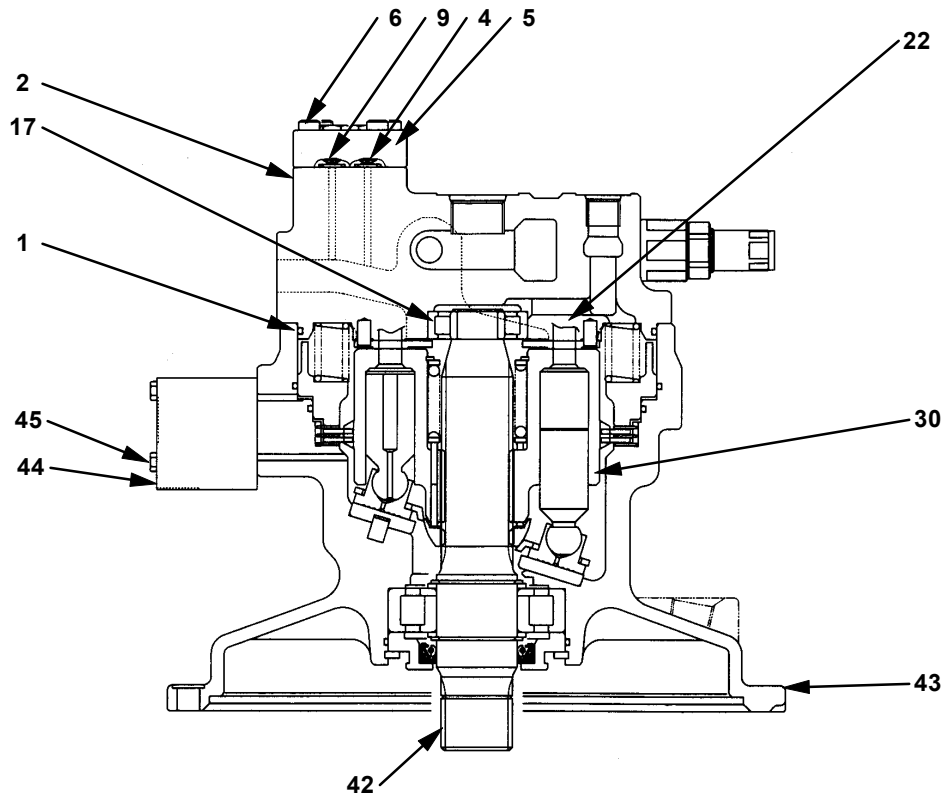
11. Insert plungers (18) (9 used) into rotor (30).
12. Place casing (43) horizontally. Turn shaft (42) to install rotor (30) assembly into casing (43).
13. Place casing (43) vertically. Alternately install plates (25) (4 used), friction plates (19) (3 used) into casing (43).
14. Install O-ring (20, 24) onto casing (43).
15. Install brake piston (23) into casing (43) while aligning their matching marks.



NOTE: If it is not easy to install O-ring (20, 24) into brake piston (23) due to the resistant force from the O-rings, tap them evenly with a plastic hammer to force them in.

16. Install springs (21) (22 used) onto brake piston (23).

UPPERSTRUCTURE / Swing Device



W164-02-06-002

UPPERSTRUCTURE / Swing Device

IMPORTANT: Tap the bearing at type indicated surface with a plastic hammer while installing roller bearing (17).

17. Install bearing (17) into valve casing (2) by tapping the outer race of bearing (17) evenly with a plastic hammer.



IMPORTANT: Pay attention to the surface of valve plate (22). (Install the valve plate with the notch in the port facing rotor (30).)

18. Install O-ring (1) onto valve casing (2), then install valve plate (22).

 **NOTE:** Apply grease onto valve plate (22) to avoid it coming off from valve casing (2).

19. Apply grease to the needle part of bearing (17).

 **NOTE:** Press the needle with grease, so it is easy to install shaft (42) into bearing (17).

20. Align the matching marks in valve casing (2) and casing (1), while placing the valve casing onto casing (43). Be sure to confirm that the clearance between valve casing (2) and casing (43) is same with that when disassembling. If the clearance is larger than that of when disassembling, reinstallation shall be carried out from step 5.

21. Install valve casing (2) onto casing (43) with socket bolts (3) (4 used).

 : 17 mm

 : 400 N·m (41 kgf·m, 300 lbf·ft)

22. Install poppets (10) (2 used), springs (11) (2 used) into valve casing (2). Tighten plug (13) with O-ring (12) attached.

 : 17 mm

 : 400 N·m (41 kgf·m, 300 lbf·ft)

23. Install relief valves (14) (2 used) into valve casing (2).

 : 36 mm

 : 175 N·m (18 kgf·m, 130 lbf·ft)

24. Install O-rings (4) (2 used), (9) (2 used) onto plate (5) with socket bolt (6).

 : 6 mm

 : 20 N·m (2.0kgf·m, 14.5 lbf·ft)

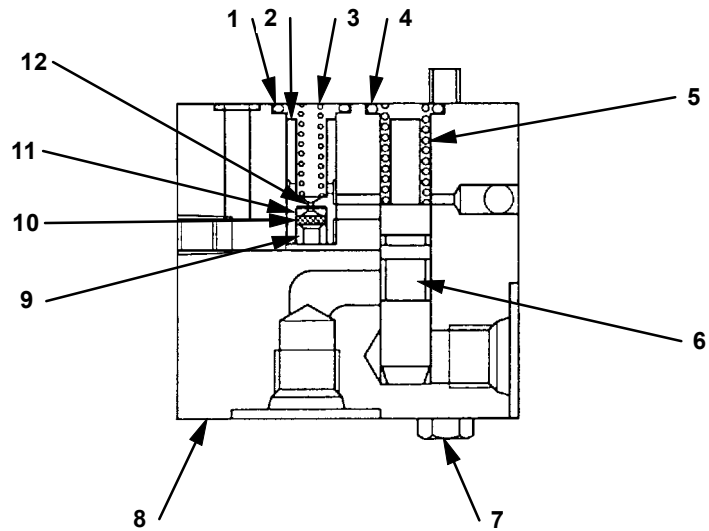
25. Install parking brake releasing valve (2) onto casing (43) with socket bolts (1) (3 used).

 : 5 mm

26. Remove the cap of fitting from valve casing (2), fill hydraulic oil into casing (43).

UPPERSTRUCTURE / Swing Device

DISASSEMBLE AND ASSEMBLE PARKING BEAKE RELEASING VALVE (ZAXIS270)



W178-02-06-025

1 - O-Ring
2 - Plunger
3 - Spring

4 - O-Ring
5 - Spring
6 - Spool

7 - Bolt (3 Used)
8 - Casing
9 - Bushing

10 - Filter
11 - Spacer
12 - Orifice

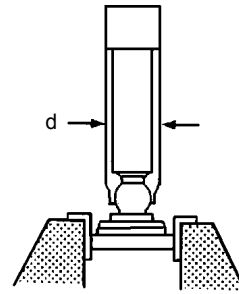
UPPERSTRUCTURE / Swing Device

MAINTENANCE STANDARD

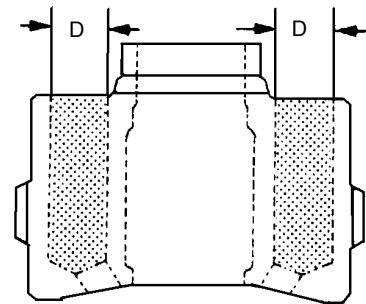
Swing Motor

1. Clearance between the out diameter of plunger and the inner bore of cylinder

D-d		Unit: mm (in)	
Standard		Allowable Limit	
0.027 (0.0011)		0.052 (0.0020)	



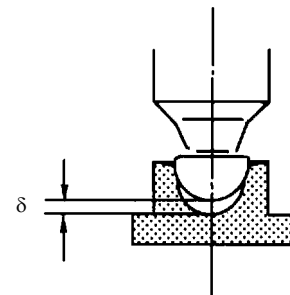
W107-02-06-138



W107-02-06-139

2. Clearance between plunger and shoe at the caulked position

		Unit: mm (in)	
Standard		Allowable Limit	
0 (0)		0.3 mm (0.0118 in)	



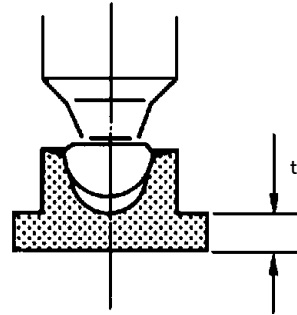
W107-02-06-140

UPPERSTRUCTURE / Swing Device

3. Thickness of shoe

Unit: mm (in)

Standard	Allowable Limit
5.5 (0.22)	5.3 (0.21)

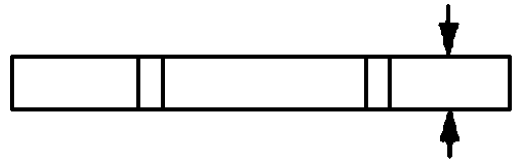


W107-02-06-142

4. Thickness of friction plate

Unit: mm (in)

Standard	Allowable Limit
2.0 (0.08)	1.8 (0.07)



W107-02-06-143

UPPERSTRUCTURE / Pilot Valve

REMOVE AND INSTALL RIGHT PILOT VALVE



CAUTION: Escaping fluid under pressure may penetrate the skin, causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Hydraulic oil may be hot just after operation, and may spurt, possibly causing severe burns. Be sure to wait for oil to cool before starting any repair work.

The hydraulic oil tank cap may fly off if removed without releasing internal pressure first. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.

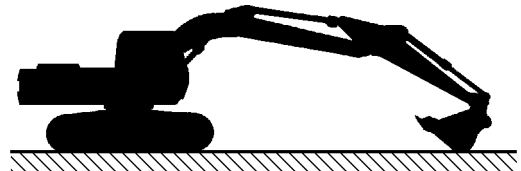
Preparation

1. Place the machine on a firm, level surface.
2. Stop the engine. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.

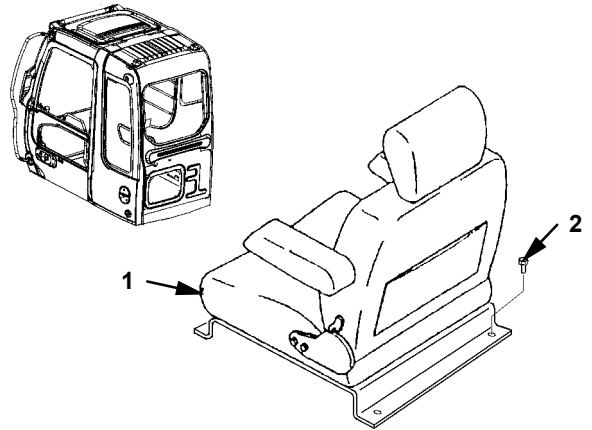
Removal

1. Remove seat mounting bolts (2) (4 used) to remove seat (1) (with seat stand).

 : 17 mm



M104-07-021



W178-02-07-006

UPPERSTRUCTURE / Pilot Valve

2. Remove screws (24) (4 used), cover (23) to move boot (29) up.

 : 17 mm

3. Remove caps (17) (2 used) from cover (18).

4. Remove screws (21) (4 used) and (16) (2 used) to move cover (18) up. Disconnect each harness connectors for key switch (20), air controller (19) and grip (3), then remove cover (18). Remove screws (22), (15) and (13) to remove cover (14).

5. Remove the connector and bolt (11) for switch box (12) to remove switch box (12).

 : 13 mm

IMPORTANT: Attach identification tags on all disconnected hoses to aid in reassembly.

6. Disconnect hoses (31 to 36).

 : 19 mm

 **NOTE:** Attach a cap on all disconnected hose ends.

7. Loosen nut (4) to remove grips (5) and (26). Disconnect connector (6) to remove grip (3) (with harness).

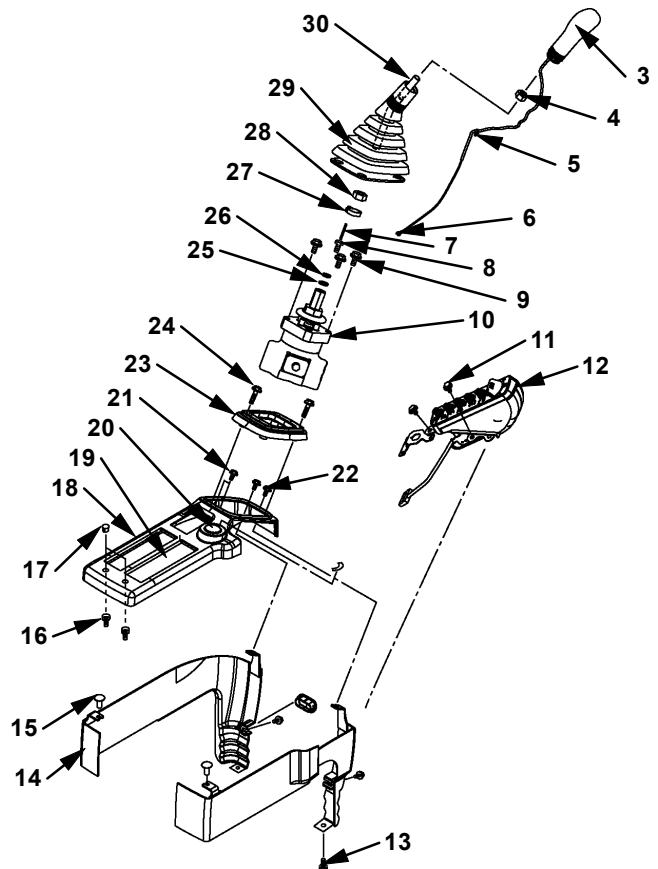
Loosen nut (28) to remove lever (30), washers (25), (26) and boot (29).

 : 22 mm

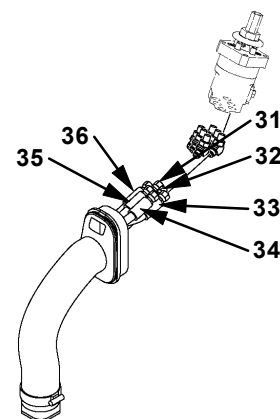
 : 19 mm

8. Remove bolts (9) (3 used) and (8) (with pin (7)) from pilot valve (10) to remove pilot valve (10).

 : 13 mm



W178-02-07-001



W178-02-07-002

- 31 - Hose T3: (To the pilot shut-off valve)
- 32 - Hose B: (To the signal control valve port B for boom lower)
- 33 - Hose G: (To signal control valve port G for bucket roll-in)
- 34 - Hose A3: (From the pilot shut-off valve)
- 35 - Hose A: (To the signal control valve port A for boom raise)
- 36 - Hose H: (To the signal control valve port H for bucket roll-out)

 **NOTE:** Piping location shows that of JIS pattern.

UPPERSTRUCTURE / Pilot Valve

Installation

1. Secure pilot valve (10) with bolts (9) and (8) (with pin (7)).

 : 13 mm

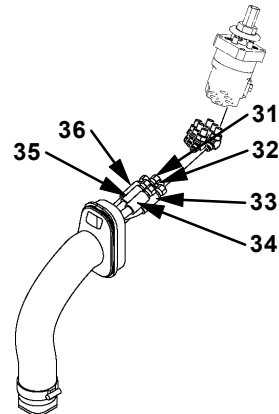
 : 10 N·m (1.0 kgf·m, 7.2 lbf·ft)

2. Connect hoses (31 to 36).

 : 19 mm

 : 29.5 N·m (3 kgf·m, 21.5 lbf·ft)

IMPORTANT: If the harness is arranged to the inside of spring pin (7), it may make contact with the moving part of the pilot valve which may damage the harness. Be sure to arrange the harness to the outside of spring pin (7).



W178-02-07-002

3. Temporarily tighten nut (28) to lever (30), then install washers (25), (26). Install lever (30) onto valve (10) with nut (28). Install boot (29). Temporarily tighten nut (4) to lever (30), then install grip (3) with nut (4).

Pass the harness of grip (3) through the upper hole of boot (29), then connect it to lever (30) via clips (5) and (27). Arrange the harness to the outside of spring pin (7) over bolt (8) head.

Install connector (6).

 : 22 mm

 : 26 N·m (2.0 kgf·m, 14.5 lbf·ft)

 : 19 mm

 : 26 N·m (2.0 kgf·m, 14.5 lbf·ft)

4. Install switch box (12) with bolt (11), then connect the connector.

 : 13 mm

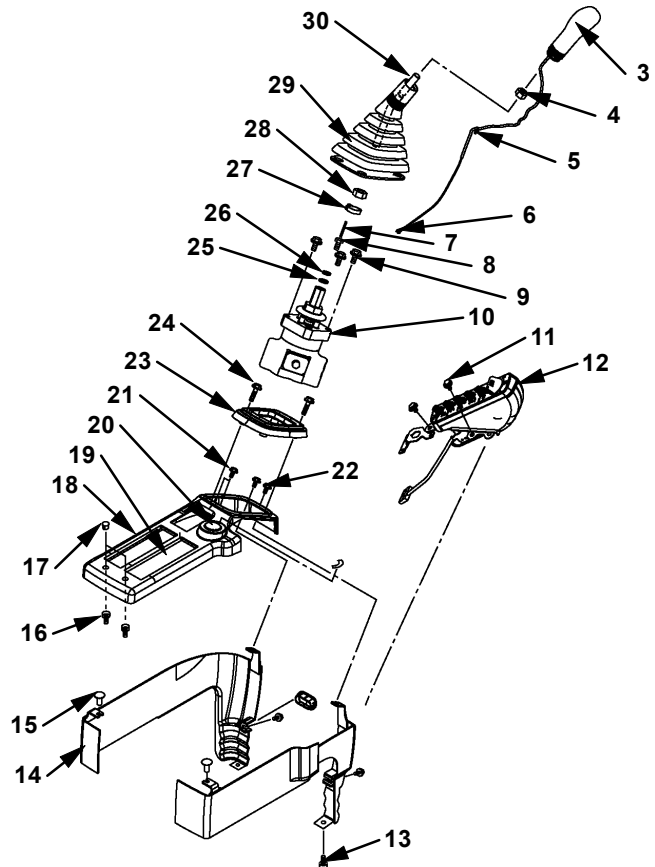
 : 10 N·m (1.0 kgf·m, 7.2 lbf·ft)

5. Connect each harness of key switch (20) and air controller (19).

6. Install cover (14) with screws (22), (15) and (13). Install cover (18) with screws (21) (4 used) and (16) (2 used).

Install caps (17) (2 used) onto cover (18).

7. Install cover (23) with screw (24).



W178-02-07-001

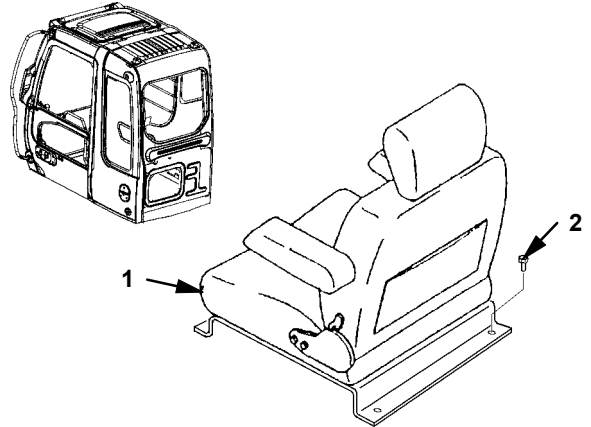
UPPERSTRUCTURE / Pilot Valve

8. Install seat (1) (with the seat stand) with bolts (2) (4 used).

 : 17 mm

 : 50 N·m (5 kgf·m, 36 lbf·ft)

IMPORTANT: After installation, check the oil level, start the engine and check for oil leaks.



W178-02-07-006

UPPERSTRUCTURE / Pilot Valve

REMOVE AND INSTALL LEFT PILOT VALVE



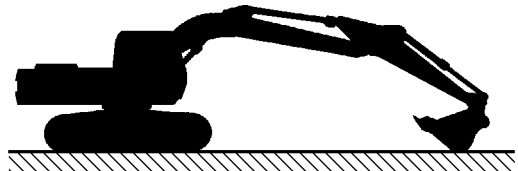
CAUTION: Escaping fluid under pressure may penetrate the skin, causing serious injury. Avoid this hazard by relieving pressure before disconnecting hydraulic or other lines.

Hydraulic oil may be hot just after operation and may spurt, possibly causing severe burns. Be sure to wait for oil to cool before starting any repair work.

The hydraulic oil tank cap may fly off if removed without releasing accumulated pressure first. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.

Preparation

1. Park the machine on a solid level surface. Lower the bucket to the ground.
2. Stop the engine. Push the air release valve on the hydraulic oil tank to release any pressure remaining in the hydraulic tank.



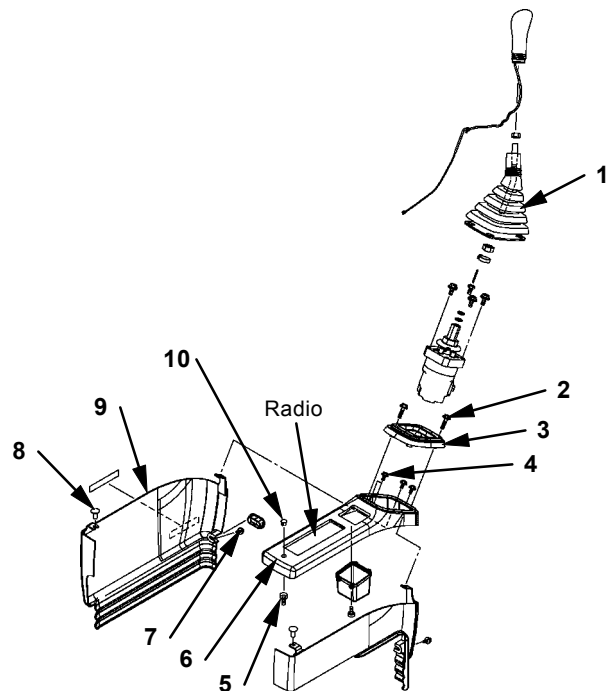
M104-07-021

Removal

1. The console is at the most front position. Remove screws (2) (4 used) and cover (3) to move boot (1) up.

 : 17 mm

2. Remove screws (7), (8) to remove cover (9).
3. Remove cap (10) from cover (6).
4. Remove screws (4) (3 used), (5) to move cover (6) up to disconnect the radio connector, then remove cover (6).



W178-02-07-003

UPPERSTRUCTURE / Pilot Valve

IMPORTANT: Attach identification tags on all disconnected hoses to aid in reassembly.

5. Disconnect hoses (11 to 16).

 : 19 mm

 **NOTE:** Attach a cap on each disconnected hose end.

6. Loosen nut (18) to remove clips (29), (21).
Disconnect connector (28) to remove grip (17) (with harness).
Loosen nut (20) to remove lever (19), washers (25), (26) and boot (1).

 : 22 mm

 : 19 mm

7. Remove bolts (24) and (23) (with pin (22)) to remove pilot valve (27).

 : 13 mm

Installation

1. Install pilot valve (27) with bolts (24) and (23) (with pin (22)).

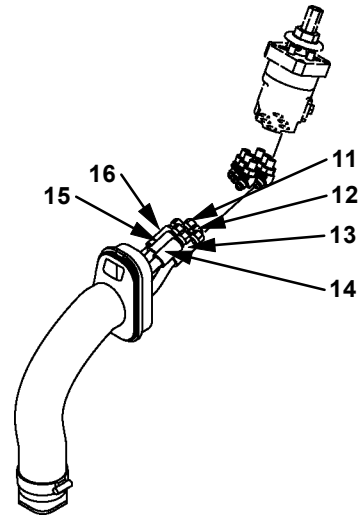
 : 13 mm

 : 10 N·m (1.0 kgf·m, 7.2 lbf·ft)

2. Connect hoses (11 to 16).

 : 19 mm

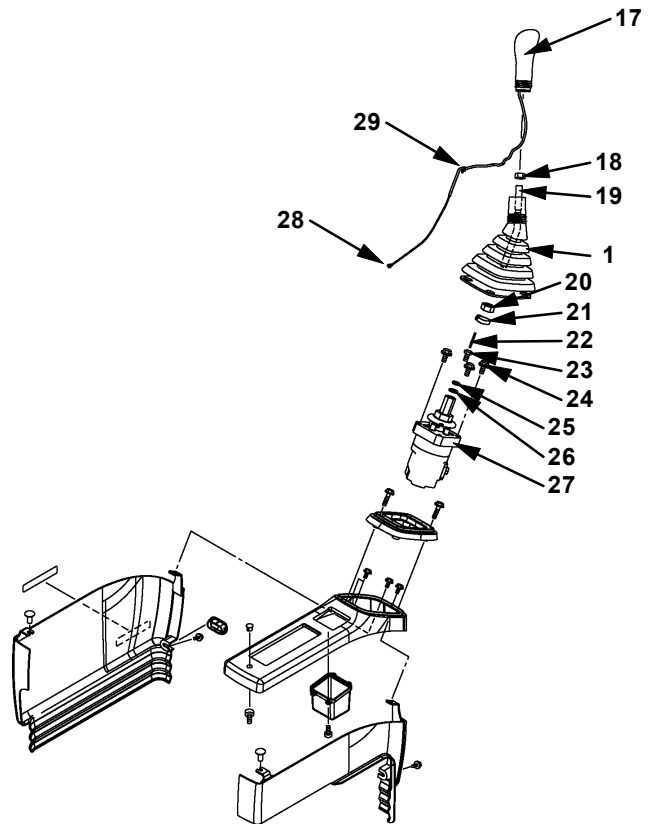
 : 29.5 N·m (3 kgf·m, 21.5 lbf·ft)



W178-02-07-004

- 11 - Hose T3 : (To the pilot shut-off valve)
12 - Hose F : (To the signal control valve port F for swing right)
13 - Hose C : (To the signal control valve port C for arm roll-out)
14 - Hose A2 : (From the pilot shut-off valve)
15 - Hose E : (To the signal control valve port for E swing left)
16 - Hose D : (To the signal control valve port D for arm roll-in)

 **NOTE:** Piping location shows that of JIS pattern.



W178-02-07-003

UPPERSTRUCTURE / Pilot Valve

IMPORTANT: If the harness is arranged to the inside of spring pin (21), it may make contact with the moving part of the pilot valve which may damage the harness. Be sure to arrange harness to the outside of spring pin (21).

3. Temporarily tighten nut (20) to lever (19), then install washers (25) and (26). Install lever (19) onto pilot valve (27) with nut (20). Install boot (1). Temporarily tighten nut (18) to lever (19), then secure grip (17) with nut (18).

Pass the harness of grip (17) through the upper hole of boot (1), then connect it to lever (19) via grips (29). Arrange the harness to the outside of spring pin (22) over bolt (23) head. Connect connector (28).

⌘ : 13 mm

⌘ : 10 N·m (1.0 kgf·m, 7.2 lbf·ft)

⌘ : 22 mm

⌘ : 26 N·m (2.0 kgf·m, 14 lbf·ft)

⌘ : 19 mm

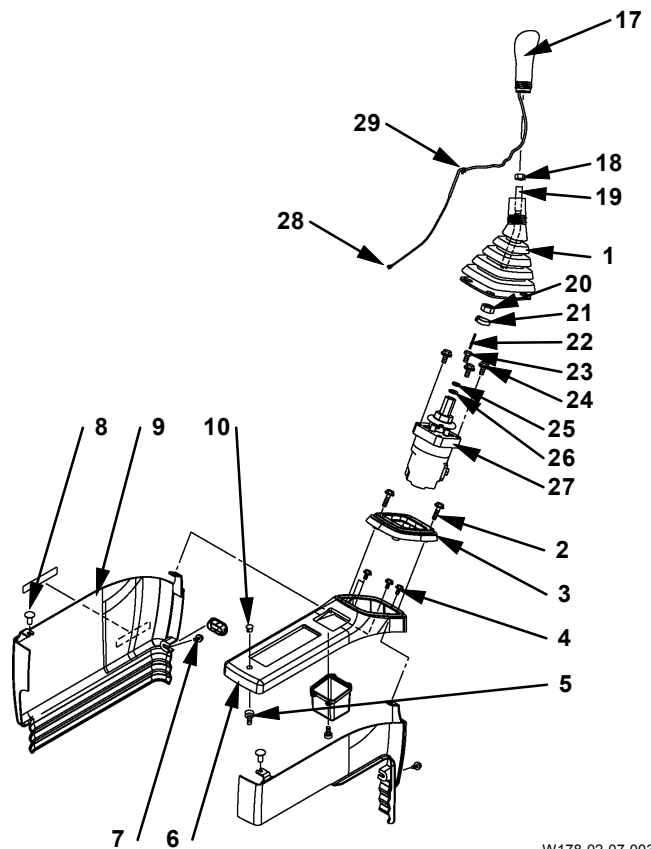
⌘ : 26 N·m (2.0 kgf·m, 14 lbf·ft)

4. Connect the connector of the radio and install cover (6) with screws (4) (4 used) and (5), install cap (10).

Install cover (9) with screws (7), (8).

5. Install boot (1) and cover (3) with screw (2) (4 used).

IMPORTANT: After installation, check the oil level.
Start the engine and check for oil leaks.



W178-02-07-003

UPPERSTRUCTURE / Pilot Valve

REMOVE AND INSTALL TRAVEL PILOT VALVE



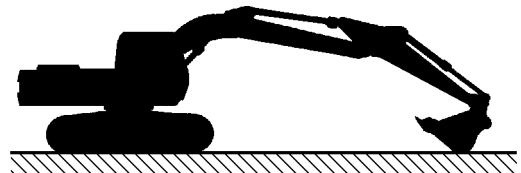
CAUTION: Escaping fluid under pressure may penetrate the skin, causing serious injury. Avoid this hazard by relieving pressure before disconnecting hydraulic or other lines.

Hydraulic oil may be hot just after operation, and may spurt, possibly causing severe burns. Be sure to wait for oil to cool before starting any repair work.

The hydraulic oil tank cap may fly off if removed without releasing accumulated pressure first. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.

Preparation

1. Park the machine on a solid level surface. Lower the bucket to the ground.
2. Stop the engine. Push the air release valve on the hydraulic oil tank to release any pressure remaining in the hydraulic tank.

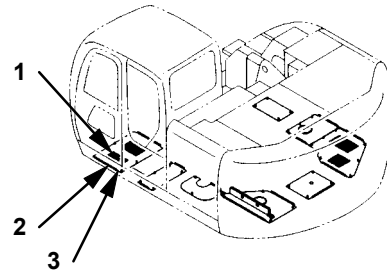


M104-07-021

UPPERSTRUCTURE / Pilot Valve

Removal

1. Remove floor mat (1).
2. Remove bolts (3) (6 used) from swing frame to remove under cover (2).
🔧 : 17 mm
3. Loosen bolts (4) (2 used) to remove pedals (5) (2 used), levers (16) and (17).
🔧 : 17 mm



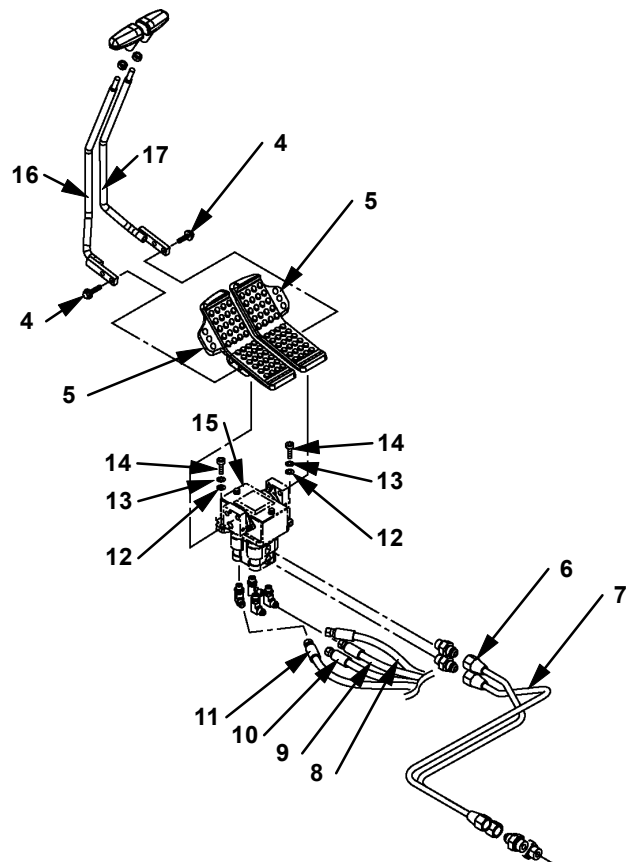
W178-02-07-007

IMPORTANT: Attach identification tags on all disconnected hoses to aid in reassembly.

4. Disconnect pipes (6, 7) and hoses (8 to 11).
🔧 : 19 mm

🔧 NOTE: Attach a cap on each disconnected hose end.

5. Remove socket bolt (14), spring washer (13) and plain washer (12) to remove pilot valve (15).
🔧 : 8 mm



W178-02-07-005

Installation

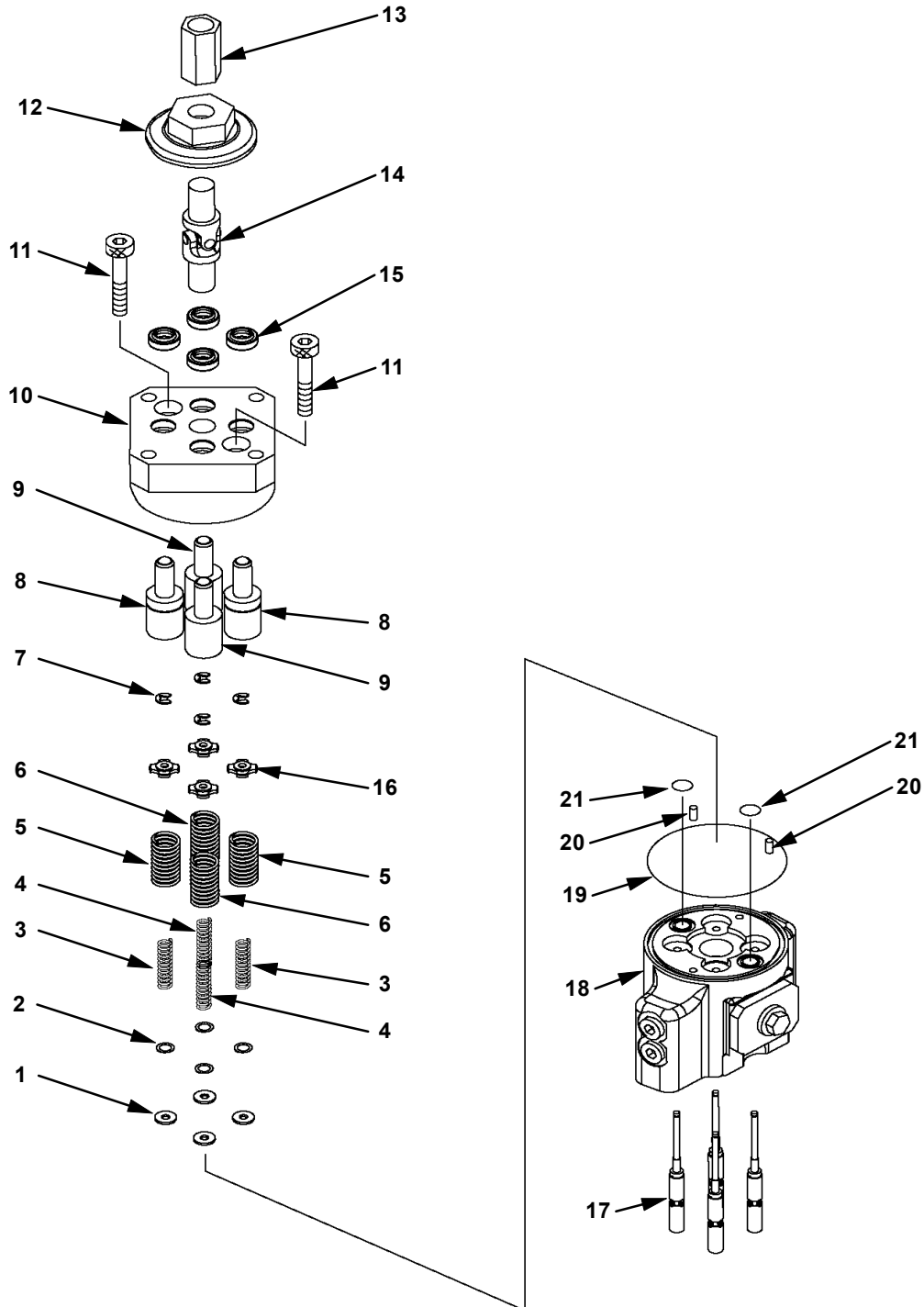
1. Install pilot valve (15) with socket bolt (14), spring washer (13) and plain washer (12).
🔧 : 8 mm
🔧 : 49 N·m (5.0 kgf·m, 36 lbf·ft)
2. Connect pipes (6, 7), hoses (8 to 11).
🔧 : 19 mm
🔧 : 29.5 N·m (3.0 kgf·m, 21.5 lbf·ft)
3. Install pedal (5), levers (16) and (17) with bolts (4).
🔧 : 17 mm
🔧 : 49 N·m (5.0 kgf·m, 36 lbf·ft)
4. Install under cover (2) with bolts (3) (6 used).
🔧 : 17 mm
🔧 : 49 N·m (5.0 kgf·m, 36 lbf·ft)
5. Install floor mat (1).

IMPORTANT: After installation, check the oil level. Start the engine and check for oil leaks.

- 6 - Pipe T2: (To the pilot shut-off valve)
- 7 - Pipe A3: (From the pilot shut-off valve)
- 8 - Hose K: (To the signal control valve port K for travel right and forward)
- 9 - Hose L: (To the signal control valve port L for travel right and reverse)
- 10 - Hose J: (To the signal control valve port J for travel left and reverse)
- 11 - Hose I: (To the signal control valve port I for travel right and forward)

UPPERSTRUCTURE / Pilot Valve

DISASSEMBLE RIGHT AND LEFT PILOT VALVES



W176-02-07-001

- | | | | |
|-------------------------------|-----------------------------|----------------------------|-------------------------|
| 1 - Spacer (4 Used) | 7 - Retaining Ring (4 Used) | 12 - Cam | 17 - Spool (4 Used) |
| 2 - Shim (Several) | 8 - Push Rod A (2 Used) | 13 - Screw Joint | 18 - Housing |
| 3 - Balance Spring A (2 Used) | 9 - Push Rod B (2 Used) | 14 - Universal Joint | 19 - O-Ring |
| 4 - Balance Spring B (2 Used) | 10 - Block | 15 - Oil Seal (4 Used) | 20 - Dowel Pin (2 Used) |
| 5 - Return Spring A (2 Used) | 11 - Socket Bolt (2 Used) | 16 - Spring Guide (4 Used) | 21 - O-Ring (2 Used) |
| 6 - Return Spring B (2 Used) | | | |

UPPERSTRUCTURE / Pilot Valve

Disassemble Right and Left Pilot Valves

IMPORTANT: Block (10) and housing (18) are made of aluminium. Too strong a force can deform, or damage, them. Therefore, be careful while handling them.

IMPORTANT: As spool (17) has been selected to match the hole of housing (18), they must be replaced as a set. In addition, the dimensions of balance springs A (3), B (4) and return springs A (5), B (6) as well as those of push rods A (8), B (9) are different. For this reason, be sure to indicate the port number from which it is removed. Port numbers are stamped on housing (18).

IMPORTANT: Don't clamp housing (18) in a vise to remove the screw joint because the strong torque may act on the screw joint.

1. Secure screw joint (13) in a vise. Then turn cam (12) with a spanner to remove the screw joint.

 : 32 mm

2. Clamp the flat surface of housing (18) in a vise slightly. Remove cam (12) from universal joint (14).

 : 32 mm

 **NOTE:** The universal joint has been secured on block (10) with LOCTITE. Don't remove it unless necessary.

3. Remove socket bolt (11) to remove block (10). At this time, push rods (8) and (9) are still on the block side.

 : 6 mm

IMPORTANT: Two kinds of push rods are used. They must be handled in order of port number after removing.

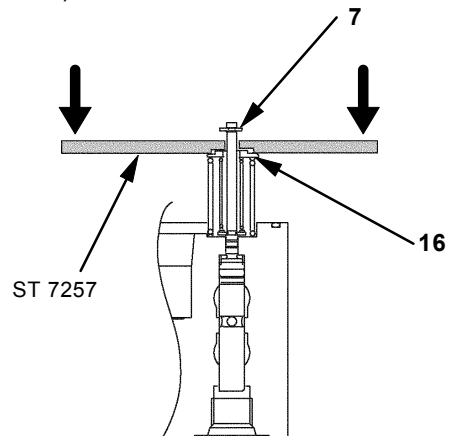
4. Pull push rods (8), (9) out from block (10).

5. With a bamboo spatula, remove oil seals (15) (4 used) from block (10).

 **NOTE:** If a metal bar is used, the mating part of the oil seal may be damaged.

IMPORTANT: The retaining ring may come off while disassembling. Take care not to drop it.

6. Press springs with special tool (ST 7257) from the top of spring guide (16). Retaining ring (7) will appear. Remove it with a screw driver or similar tool. (4 places)

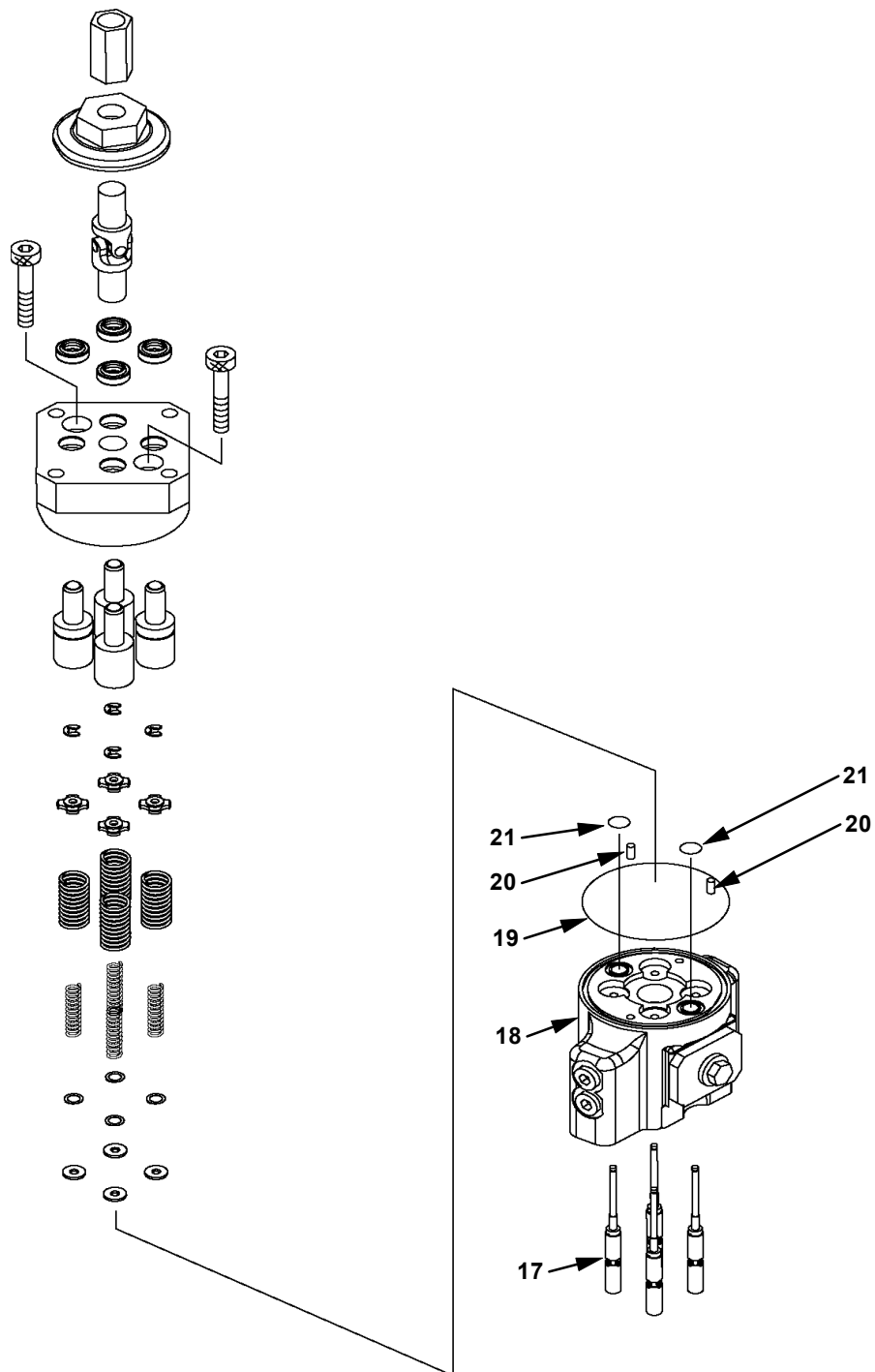


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IMPORTANT: The number of shims has been determined for each port during the performance testing at the factory. Take care not to lose them. Keep them carefully so as to install them to each former port when reassembly.

7. Remove spring guide (16), balance springs (3), (4), return springs (5), (6), shim (2), spacer (1) from spool (17).

UPPERSTRUCTURE / Pilot Valve



W176-02-07-001

UPPERSTRUCTURE / Pilot Valve

IMPORTANT: As the spool has been selected to match the hole in the housing, keep them carefully so as to install them to the former port when reassembling.

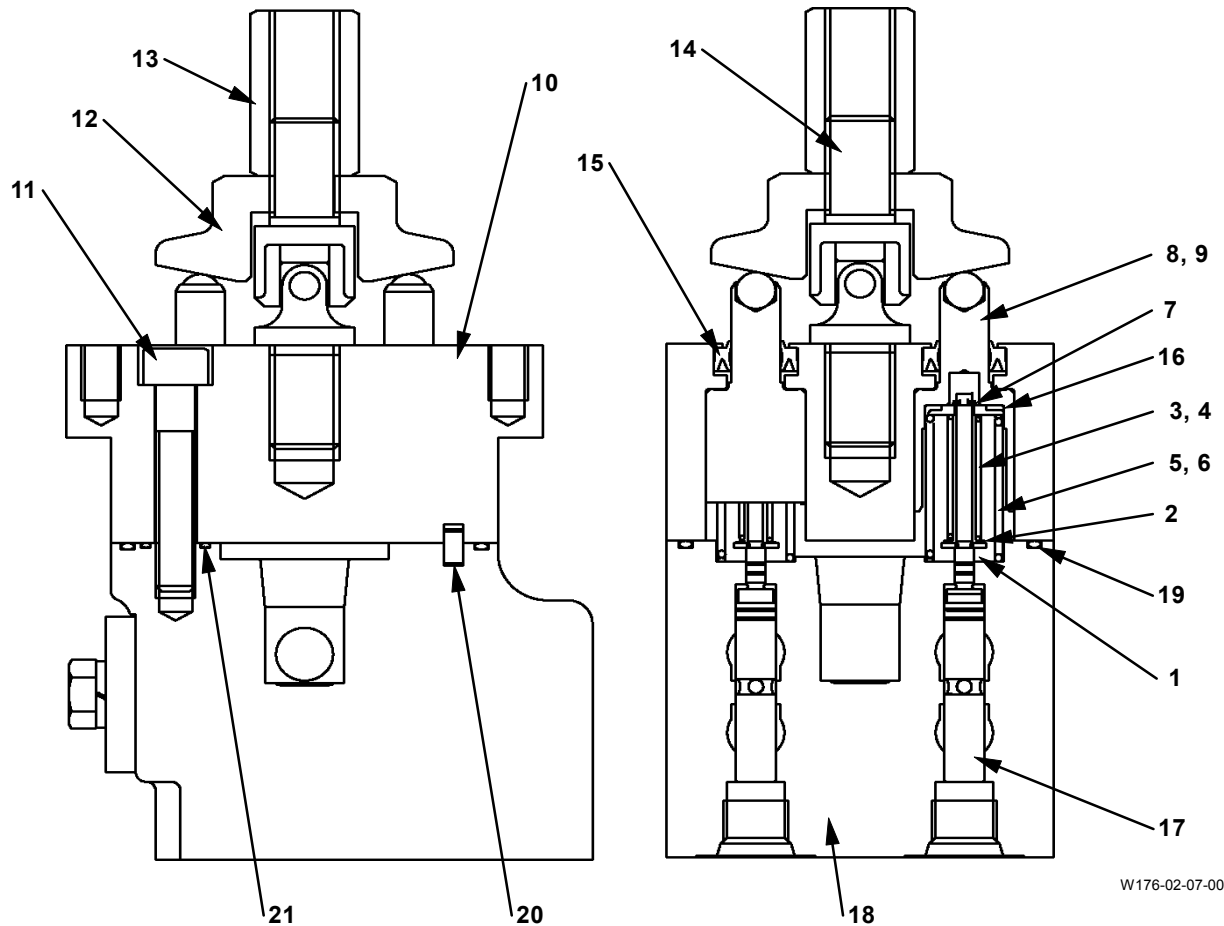
8. Remove spool (17) from housing (18). Pulling it out while turning it.

 **NOTE:** *The spool and housing must be replaced as assembly.*

9. Remove O-rings (19), (21) from housing (18). Don't remove dowel pin (20) unless necessary.

UPPERSTRUCTURE / Pilot Valve

ASSEMBLE RIGHT AND LEFT PILOT VALVES



- | | | | |
|-------------------------------|-----------------------------|----------------------------|-------------------------|
| 1 - Spacer (4 Used) | 7 - Retaining Ring (4 Used) | 12 - Cam | 17 - Spool (4 Used) |
| 2 - Shim (Several) | 8 - Push Rod A (2 Used) | 13 - Screw Joint | 18 - Housing |
| 3 - Balance Spring A (2 Used) | 9 - Push Rod B (2 Used) | 14 - Universal Joint | 19 - O-Ring |
| 4 - Balance Spring B (2 Used) | 10 - Block | 15 - Oil Seal (4 Used) | 20 - Dowel Pin (2 Used) |
| 5 - Return Spring A (2 Used) | 11 - Socket Bolt (2 Used) | 16 - Spring Guide (4 Used) | 21 - O-Ring (2 Used) |
| 6 - Return Spring B (2 Used) | | | |

UPPERSTRUCTURE / Pilot Valve

Assemble Right and Left Pilot Valves

IMPORTANT: The pilot valve is susceptible to contamination.
Keep parts clean when assembling.

 **NOTE:** Table below shows the relations between each port and the components. Take care not to confuse them when assembling.

Port No.	Spool (17)	Shim (2)	Push Rods (8), (9)
1	Same to the former one	Same to the former one	With outer groove
2			Without outer groove
3			With outer groove
4			Without outer groove

Port No.	Return Springs (5), (6)	Balance Springs (3), (4)
1	Short	Short
2	Long	Long
3	Short	Short
4	Long	Long

IMPORTANT: Make sure of the port hole number, and insert the spool to the former port.

1. Insert the thinner end of spool (17) to housing (18), while rotating it.

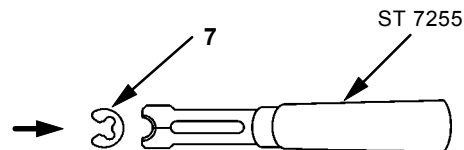
 **NOTE:** The spool has been selected to match the hole of the housing. The spool and housing must be replaced as an assembly.

IMPORTANT: Refer to the table above to assemble them correctly.

2. Install spacer (1), shim (2), balance spring (3) or (4), return spring (5) or (6) onto spool (17) installed in housing (18).

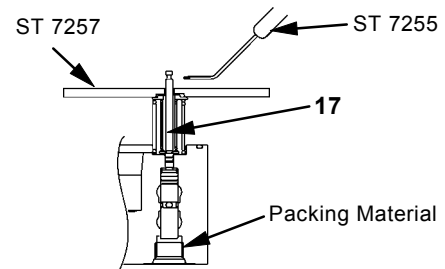
IMPORTANT: Install spring guide with the protrusion facing up.

3. Install spring guide (16) onto the return spring (3) or (4).
4. Install retaining ring (7) onto ring holder (ST 7255).



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5. Insert the spool (17) head into the hole for spring special tool (ST 7257) to press the spring from the top of spring guide (16). Install retaining ring (7) with the ring holder (ST 7255) onto the head of the spool.

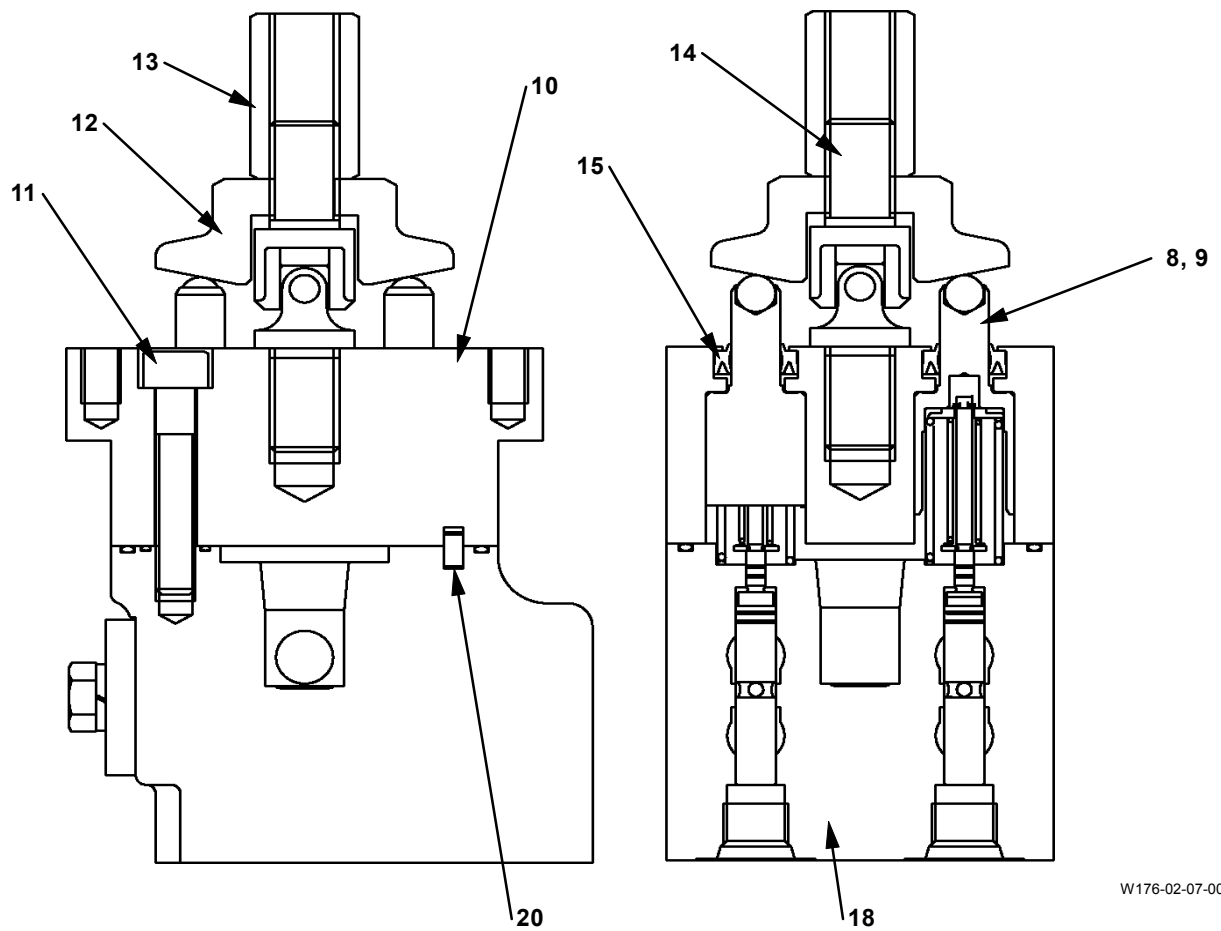


W176-02-07-009

 **NOTE:** Put approx. dia.8 mm, length 10 mm of packing material into the port hole so as to not only make the work easy to do, but also prevent the spool from lowering to the bottom when compressing the spring.

6. Assemble the remained spools (17) (3 used) into housing (18) in the same procedures as step 2 to 5.
7. Install O-rings (19) and (21) (2 used) on to housing (18).

UPPERSTRUCTURE / Pilot Valve

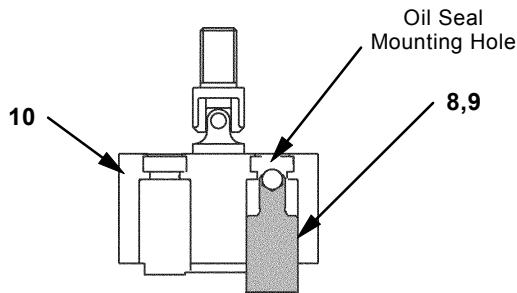


W176-02-07-006

UPPERSTRUCTURE / Pilot Valve

8. Apply grease to the inner face of oil seals (15) (4 used), then install the oil seals (4 used) into block (10) with a bamboo spatula.

 **NOTE:** The oil seal may come into the endmost of the hole during operating. Insert push rods (8 and 9) in first as illustrated to prevent the oil seal from coming into the endmost of the hole during operating.



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IMPORTANT: Make sure of the position to install the push rod.

9. Install push rods (8), (9) to block (10). When installing, install the push rods with periphery groove to ports # 1 and # 3, install the ones without periphery groove to ports # 2 and # 4, respectively.
10. Apply grease to the ball at the ends of push rods (8), (9).
11. Apply grease to the joint part of universal joint (14).
12. Align the position of dowel pin (20), install the block (10) assembly to housing (18) with socket bolts (11) (2 used).
 : 6 mm
 : 19.6 N·m (2 kgf·m, 14.5 lbf·ft)

IMPORTANT: Make sure of the tightness of cam.

13. Clamp housing (18) carefully in a vise and then install cam (12) to universal joint (14). Tighten the universal joint so that the clearance between the cam and push rod (8) (9) become 0 to 0.2 mm.

 : 32 mm

IMPORTANT: Don't clamp housing (18) in a vise because the strong torque may act on the screw joint.

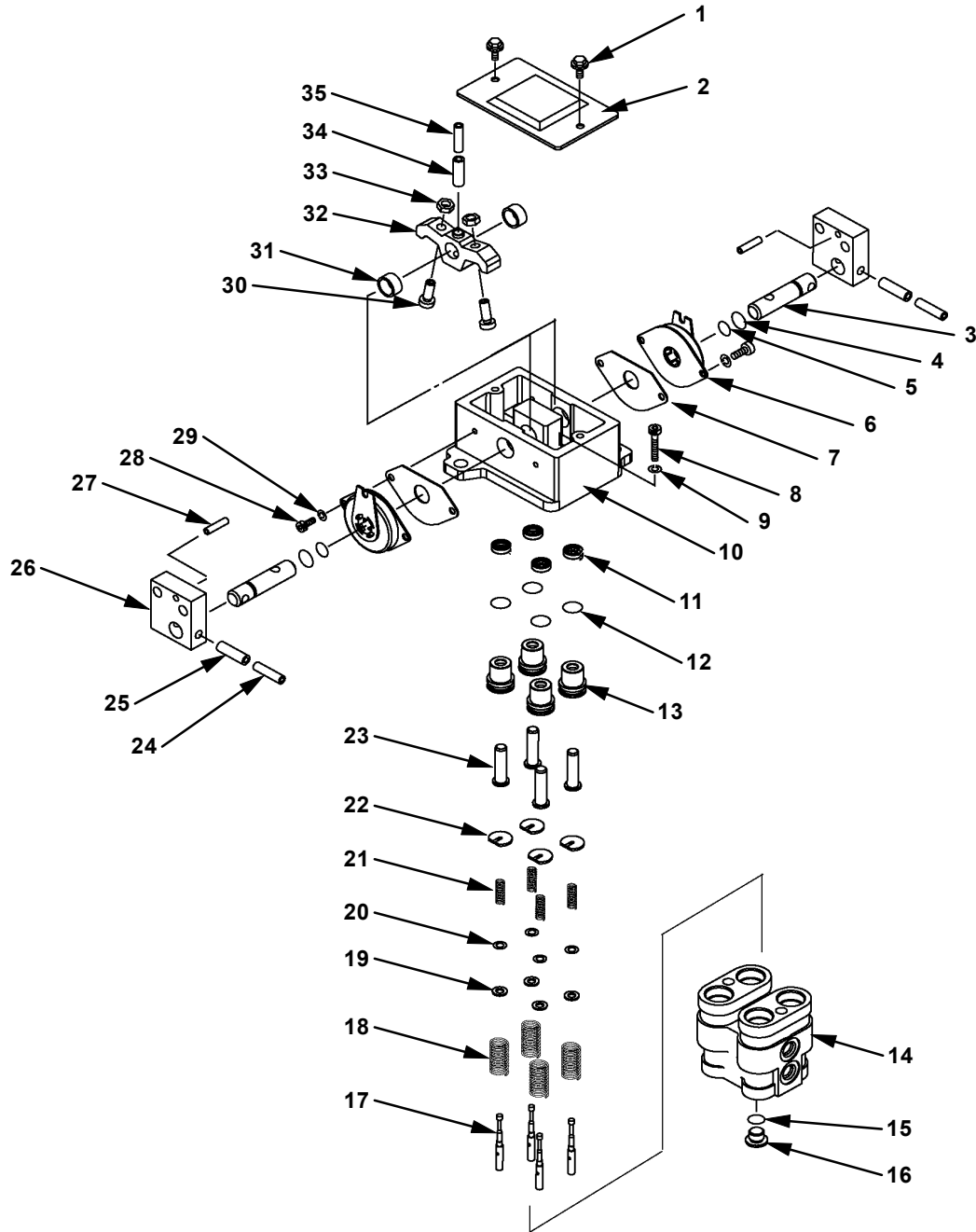
14. Clamp screw joint (13) in a vise to tighten universal joint (14). Tighten cam (12) with a spanner.

 : 32 mm

 : 88.2 N·m (9 kgf·m, 65 lbf·ft)

UPPERSTRUCTURE / Pilot Valve

DISASSEMBLE TRAVEL PILOT VALVE



W176-02-07-002

- | | | | |
|----------------------------|------------------------|------------------------------|------------------------------|
| 1 - Bolt (2 Used) | 10 - Holder | 19 - Spacer (4 Used) | 28 - Socket Bolt (4 Used) |
| 2 - Cover | 11 - Oil Seal (4 Used) | 20 - Shim (Several) | 29 - Spring Washer (4 Used) |
| 3 - Pin (2 Used) | 12 - O-Ring (4 Used) | 21 - Balance Spring (4 Used) | 30 - Adjusting Bolt (4 Used) |
| 4 - O-Ring (2 Used) | 13 - Bushing (4 Used) | 22 - Spring Guide (4 Used) | 31 - Bushing (4 Used) |
| 5 - O-Ring (2 Used) | 14 - Casing | 23 - Pusher (4 Used) | 32 - Cam (2 Used) |
| 6 - Damper (2 Used) | 15 - O-Ring | 24 - Spring Pin (2 Used) | 33 - Lock Nut (4 Used) |
| 7 - Rubber Seat (2 Used) | 16 - Plug | 25 - Spring Pin (2 Used) | 34 - Spring Pin (2 Used) |
| 8 - Socket Bolt (2 Used) | 17 - Spool (4 Used) | 26 - Bracket (2 Used) | 35 - Spring Pin (2 Used) |
| 9 - Spring Washer (2 Used) | 18 - Spring (4 Used) | 27 - Spring Pin (2 Used) | |

UPPERSTRUCTURE / Pilot Valve

Disassemble Travel Pilot Valve

1. Clamp casing (14) in a vise. Remove bolt (1) to remove cover (2) from holder (10).

 : 10 mm

2. Remove socket bolts (8) (2 places) to remove holder (10) from casing (14).

 : 8 mm

3. Pull out pusher (23) from casing (14). (4 places)
Bushing (13) and oil seal (11) are removed with the pusher.

4. Pull out pusher (23) from bushing (13), with a bamboo spatula to remove oil seal (11). (4 places)

IMPORTANT: Put marks on spools (4 used) so as to easily install them to their former position.

5. Pull out the spool (17) assembly from casing (14) turning the spool. (4 places)
Spring guide (22), balance spring (21), shim (20) and spacer (19) are removed with the spool.

 **NOTE:** The spool has been selected to match the hole of the casing. The spool and casing must be replaced as an assembly.

IMPORTANT: The number of shims has been determined during the performance testing at the factory. They must be kept together with their spool.

6. Compress balance spring (21). Remove spring guide (22), balance spring (21), shim (20) and spacer (19) from spool (17). (4 places)

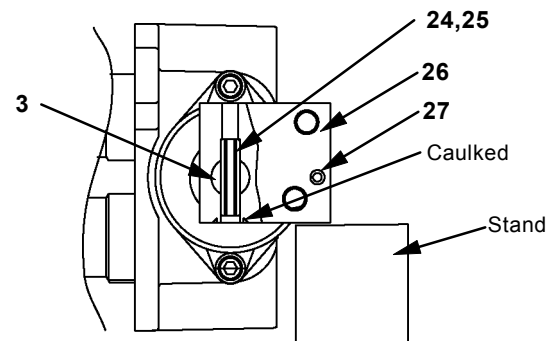
7. Remove spring (18) from casing (14). (4 places)

IMPORTANT: Put a stand under bracket (26) to form an action force. If holder (10) bears the reaction force, a strong force acts on pin (3) and the pin's shape become deformed.

IMPORTANT: The inside of spring pins (24), (25) hole in the bracket is in stepped-shape. Therefore the spring pin can only be pulled out in one direction.

8. Put a stand under bracket (26).
Push out both spring pins (24), (25) from bracket (26) at the same time with special tool (ST 1237). Remove the bracket from pin (3). (2 places)
Don't remove spring pin (27) on bracket unless necessary.

 **NOTE:** The outside end of the spring pin has been caulked.

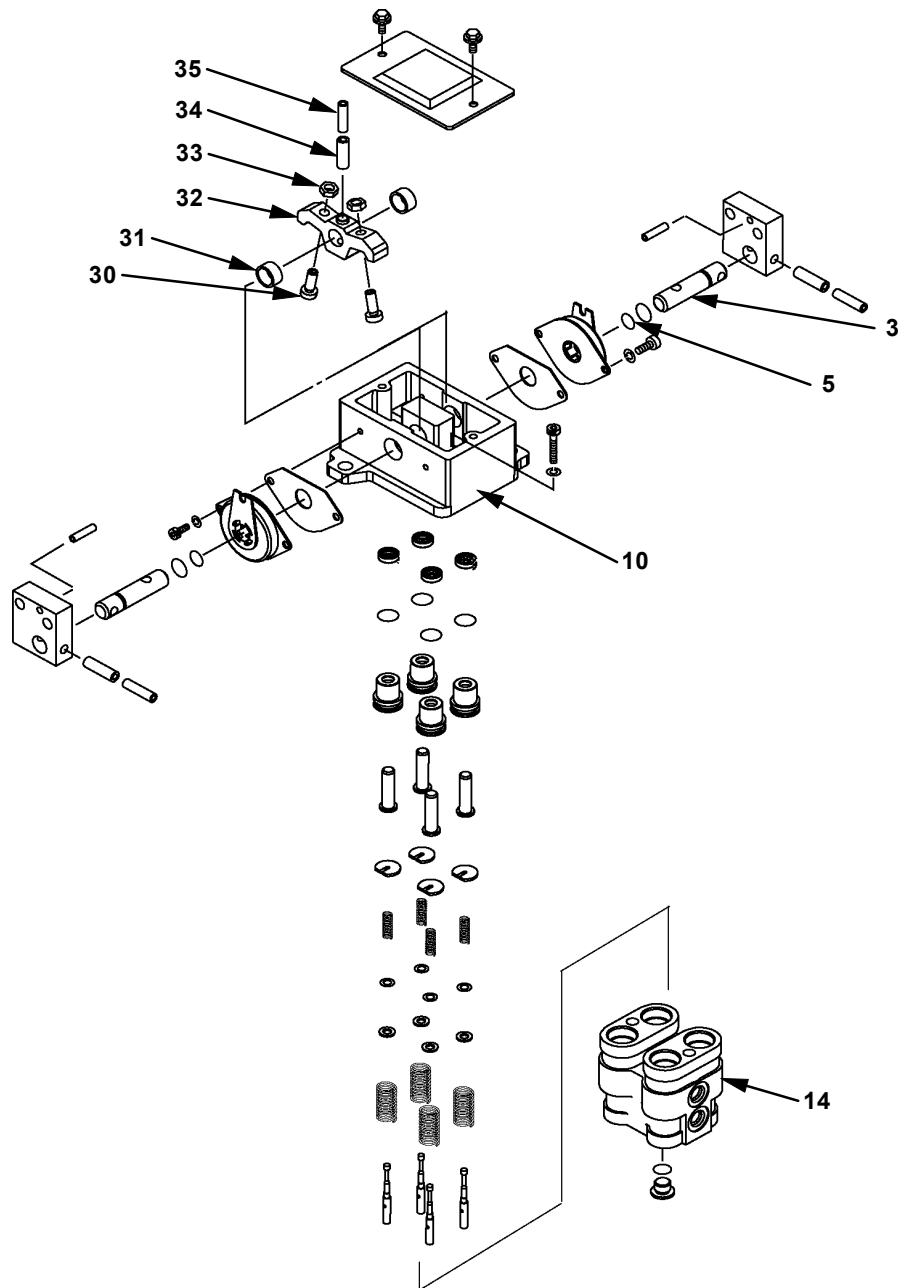


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9. Remove socket bolts (28) (2 used) to remove damper (6) and rubber seat (7) from pin (3). O-ring (4) is removed with them. (2 places)

 : 5 mm

UPPERSTRUCTURE / Pilot Valve



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UPPERSTRUCTURE / Pilot Valve

10. Remove O-ring (5) from pin (3). (2 places)
11. Place holder (10) with the casing (14) mating surface facing up.

IMPORTANT: The holes for spring pins (34), (35) in cam (32) are stepped-shape. Therefore the pins shall be removed from the bottom of the cam.

12. Pull out spring both pins (34), (35) from cam (32) at the same time with special puller (ST 1237). (2 places)

 *NOTE: The spring pin is a double-pin.*

 *NOTE: The spring pin is caulked in its hole, so it may feel tight when removing.*

13. Remove pin (3) with a round bar and a hammer.
At this time cam (32) is also removed. (2 places)

 *NOTE: Don't remove bushings (31) (4 used) left on holder (10) unless necessary. When removal is necessary, the bushing special tool (ST 7256) should be used to tap it out.*

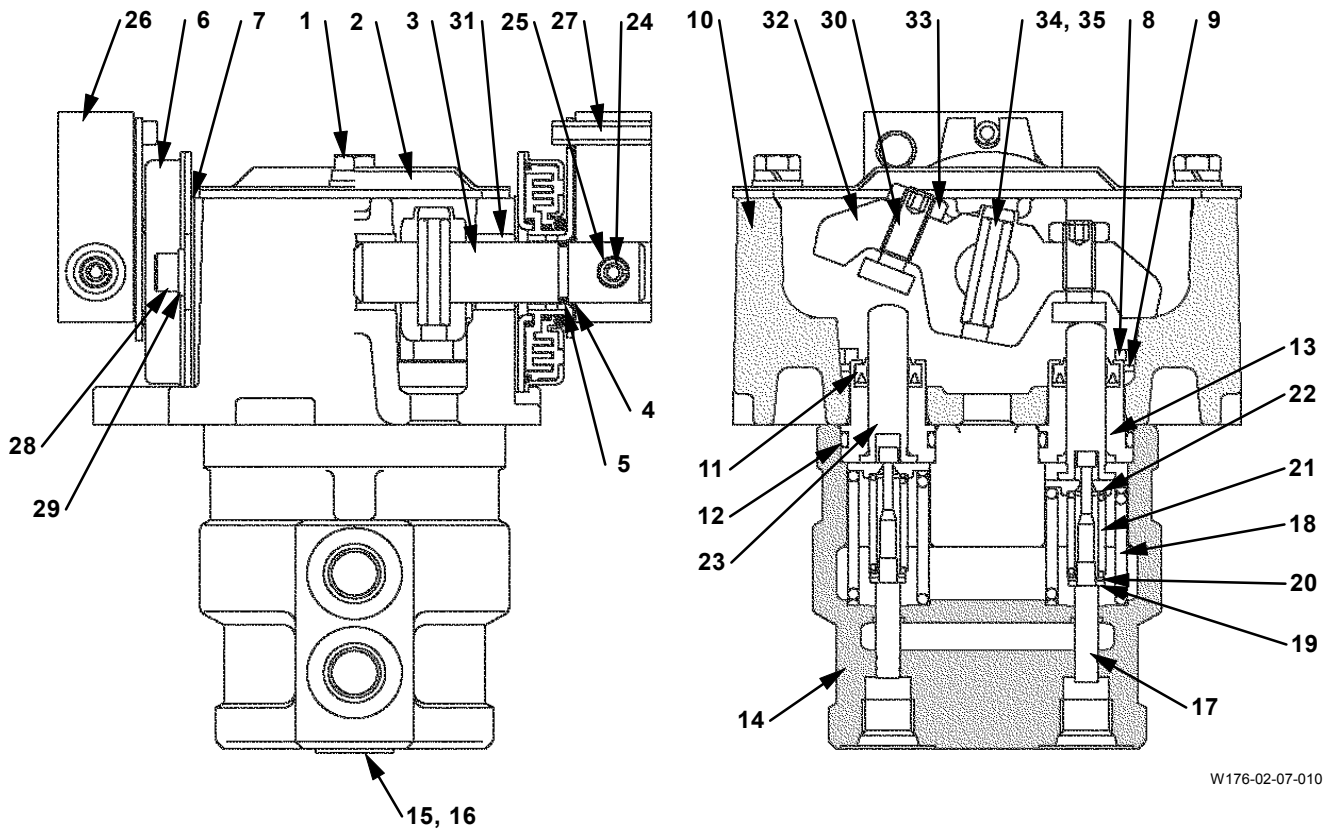
14. Remove lock nuts (33) (2 used) from cam (32) to remove adjusting bolts (30) (2 used). (2 places)

 : 13 mm

 : 4 mm

UPPERSTRUCTURE / Pilot Valve

ASSEMBLE TRAVEL PILOT VALVE



W176-02-07-010

- | | | | |
|----------------------------|------------------------|------------------------------|------------------------------|
| 1 - Bolt (2 Used) | 10 - Holder | 19 - Spacer (4 Used) | 28 - Socket Bolt (4 Used) |
| 2 - Cover | 11 - Oil Seal (4 Used) | 20 - Shim (Several) | 29 - Spring Washer (4 Used) |
| 3 - Pin (2 Used) | 12 - O-Ring (4 Used) | 21 - Balance Spring (4 Used) | 30 - Adjusting Bolt (4 Used) |
| 4 - O-Ring (2 Used) | 13 - Bushing (4 Used) | 22 - Spring Guide (4 Used) | 31 - Bushing (4 Used) |
| 5 - O-Ring (2 Used) | 14 - Casing | 23 - Pusher (4 Used) | 32 - Cam (2 Used) |
| 6 - Damper (2 Used) | 15 - O-Ring | 24 - Spring Pin (2 Used) | 33 - Lock Nut (4 Used) |
| 7 - Rubber Seat (2 Used) | 16 - Plug | 25 - Spring Pin (2 Used) | 34 - Spring Pin (2 Used) |
| 8 - Socket Bolt (2 Used) | 17 - Spool (4 Used) | 26 - Bracket (2 Used) | 35 - Spring Pin (2 Used) |
| 9 - Spring Washer (2 Used) | 18 - Spring (4 Used) | 27 - Spring Pin (2 Used) | |

UPPERSTRUCTURE / Pilot Valve

Assemble Travel Pilot Valve

IMPORTANT: Pay attention to the mounting direction of spring guide (22).

IMPORTANT: Install the former number of shims.

1. Assemble the spool (17) into assembly. (4 used)
 - Insert spacer (19), shim (20), balance spring (21) into the spool in order.
 - Press balance spring by hand. Install spring guide (22) to the spool with the stepped-end facing down.

2. Insert spring (18) to casing (14). (4 places)

IMPORTANT: Insert the spool (17) assembly into the former port.

3. Turn and install the spool (17) assembly into casing (14). (4 places)

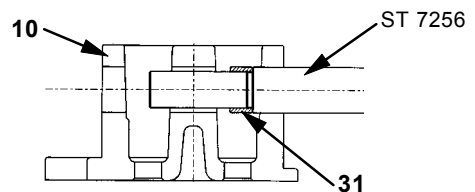
4. Assemble plungers (23) (4 used).
 - Install oil seal (11) onto bushing (13).
 - Apply grease to the inner face of oil seal.
 - Install O-ring (12) to the bushing.
 - Insert pusher (23) to the bushing.
 - Apply grease to the pusher head section.

5. Insert the pusher (23) assembly to holder (10). (4 places).

6. If bushing (31) has been removed from holder (10), it shall be installed on the holder using special tool (ST 7256) in the following procedures.

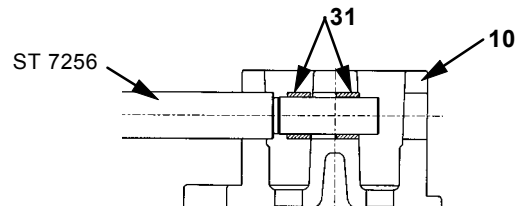
 **NOTE:** The bushings (4 used) are identical.

- Insert the bushing into special tool (ST 7256), then tap on the special tool (ST 7256) to install the bushing into the hole of holder with hammer. Stop tapping when the bushing end is flush with the inside wall.



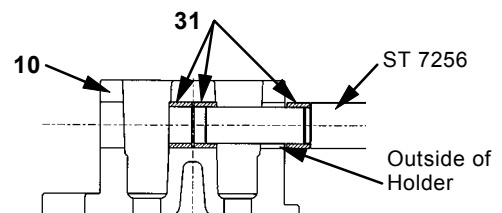
W176-02-07-016

- Install the bushing on the opposite side in the same procedure.



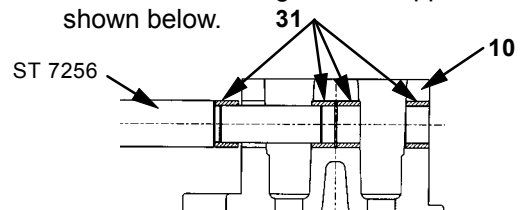
W176-02-07-015

- Install the bushing in near side as shown below. Stop tapping when the bushing end is flush with the outside of holder.



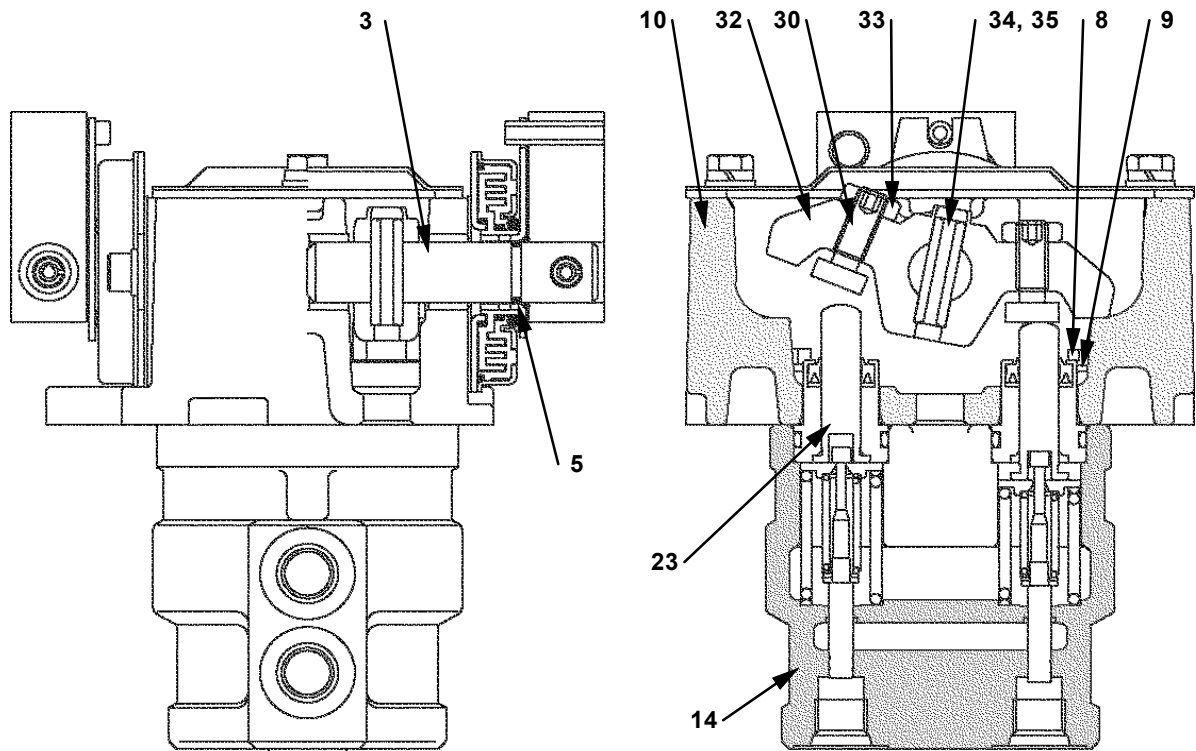
W176-02-07-014

- Install the bushing on the opposite side as shown below.



W176-02-07-013

UPPERSTRUCTURE / Pilot Valve



W176-02-07-010

UPPERSTRUCTURE / Pilot Valve

7. Place adjusting bolt (30) to cam (32). Tighten the bolt by hand, and then lightly secure it temporarily with lock nut (33). (2 places)

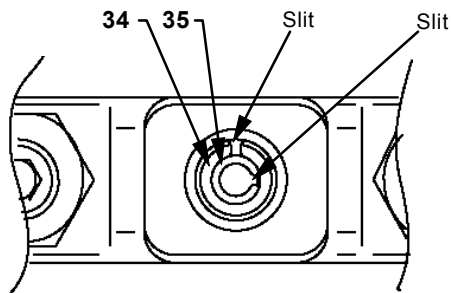
 **NOTE:** Adjust the dimensions later.

8. Apply grease on the head (mating surface for pusher (23)) of adjusting bolts (30). (2 places)
9. Install O-ring (5) to pin (3), then assemble the pin to holder (10) with cam (32). (2 places)

IMPORTANT: Take care of the inserting direction of the spring pin.

IMPORTANT: Tap the spring pin in until it makes contact with the step in hole.

10. Install spring pins (34), (35) to cam (32) using special tool (ST 1237), then secure the cam and pin (3). The spring pins should be displaced with their slits at 90°. (2 places)



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11. Caulk the hole edge of cam (32), where spring pins (34), (35) are inserted, with a punch. (2 places)
12. Place holder (10) on the casing (14) assembly and install it with socket bolts (8) (2 used), spring washers (9) (2 used).

 : 8 mm
 : 49 N·m (5 kgf·m, 36 lbf·ft)

IMPORTANT: Don't adjust the adjusting bolt (30) while pressing the pusher (23) head with the adjusting bolt. The standard clearance between the adjusting bolt and pusher must be 0 to 0.2 mm (0 to 0.008 in).

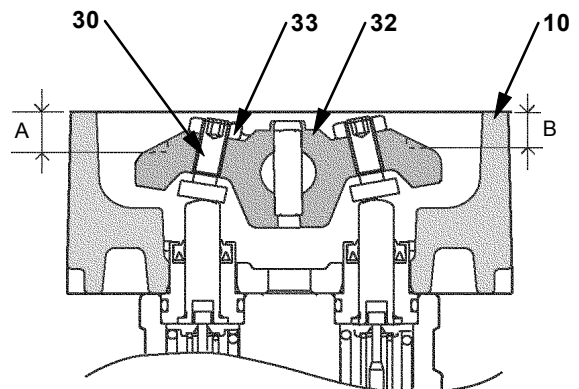
13. Adjust adjusting bolt (30) by the following procedures. (2 places)

 : 13 mm

 : 4 mm

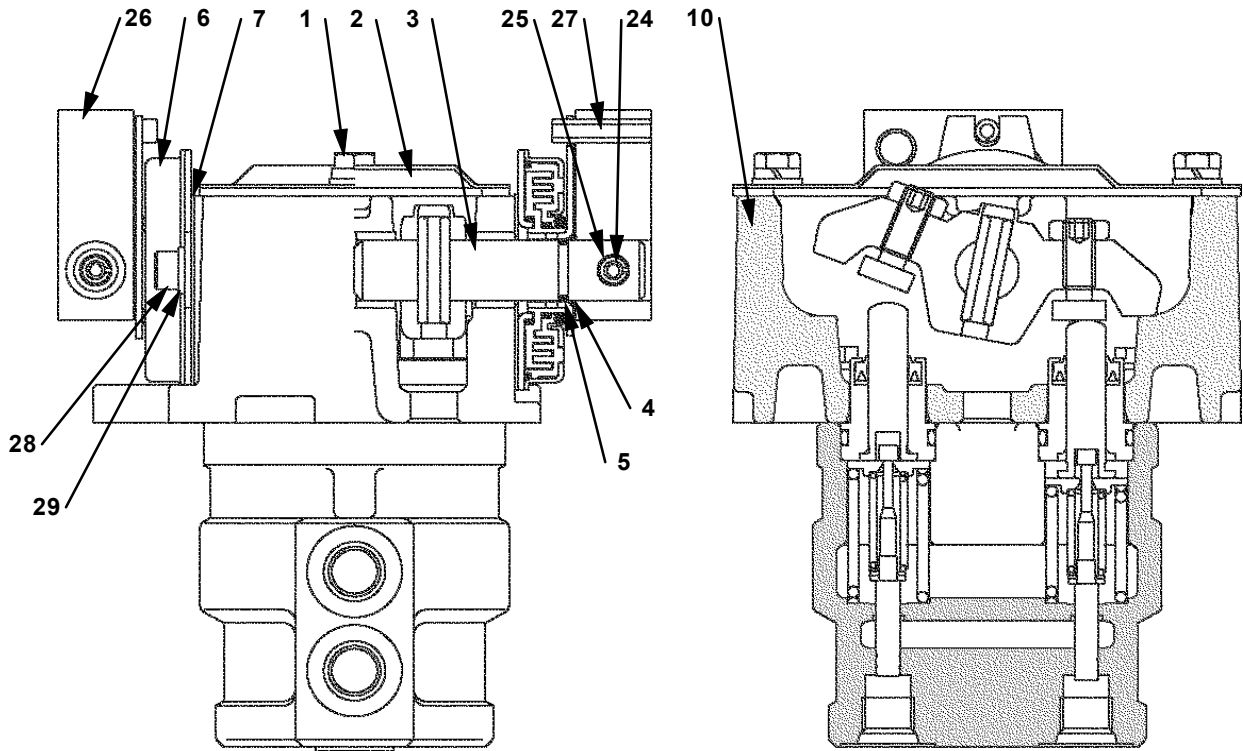
- Loosen lock nut (33).
- Move cam (32) to check whether there is play. If none, turn adjusting bolt to adjust.
- Turn both adjusting bolts on the left and right alternatively to keep the cam horizontal.
- Measure sizes A and B from both left and right caves on the cam to holder (10). Fine adjust the adjusting bolt to get same distance for both left and right.
- Secure the adjusting bolt with a hexagon-headed wrench. Tighten the lock nut to specified torque first, securing the adjusting bolt.
- When adjustment is finished, move cam to check that there is a little play. If there is no play, the pusher may be in compressed condition, and adjustment should be carried out again.

 : 9.8 N·m (1 kgf·m, 7.2 lbf·ft)



W176-02-07-003

UPPERSTRUCTURE / Pilot Valve



W176-02-07-010

UPPERSTRUCTURE / Pilot Valve

14. Install rubber seat (7) to pin (3). (2 places)

15. Apply grease to O-ring (5). (2 places)

IMPORTANT: Pay attention to the direction of damper (6).

IMPORTANT: The inner bore of damper (6) is edged-shape. If the damper is pried upward, O-ring (5) will be damaged.

16. With the lever upward, install damper (6) to pin (3) straight without spring. (2 places)

17. Secure damper (6) to holder (10) with socket bolts (28) (2 used) and spring washers (29) (2 used). (2 places)

 : 8 mm

 : 7 N·m (0.7kgf·m, 5.1 lbf·ft)

18. Apply grease to O-ring (4), then press it to the endmost of pin (3). (2 places)

IMPORTANT: As for the direction to install the bracket, refer to the figure in the disassemble section. Take care not to misassemble it.

19. Install pin (3) into bracket (26), then align the inserting holes of spring pin (24), (25) to fix the pin on bracket.

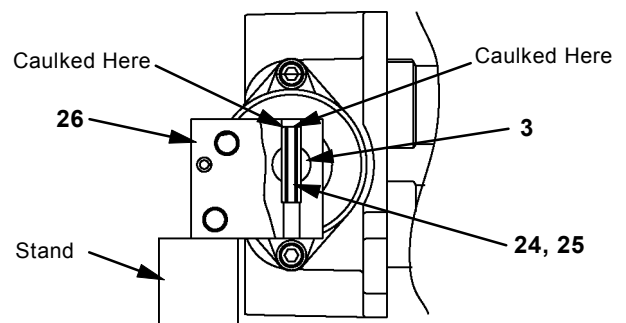
IMPORTANT: Place a stand under the bracket. If holder (10) bears the reaction force, a strong force acts on the pin (3) and the pin may be deformed.

IMPORTANT: The inside of the spring pin hole in the bracket is stepped-shape. Make sure of the direction to insert the spring pin.

IMPORTANT: Make sure the facing direction of the spring pin.

20. Put a stand under bracket (26).

Tap spring pins (24) (25) into the bracket until the spring pin comes to the stepped end using special tool (ST 1237). The spring pins shall be displaced with their slits in 90°.



W176-02-07-011

21. Caulk the hole edge of bracket (26), where spring pins (24), (25) are inserted, with a punch. (2 places)
(Refer to the figure above.)

22. Install pin (3) on other bracket (26) as steps 19 to 21.

23. Install cover (2) to holder (10) with bolts (1) (2 used).

 : 10 mm

 : 5 N·m (0.5 kgf·m, 3.6 lbf·ft)

24. Apply grease to the spring pin (27) contact part of damper (6). (2 places)

UPPERSTRUCTURE / Pilot Valve

(Blank)

UPPERSTRUCTURE / Pilot Shut-Off Valve

REMOVE AND INSTALL PILOT SHUT-OFF VALVE



CAUTION: Escaping fluid under pressure may penetrate the skin, causing serious injury. Avoid this hazard by relieving pressure before disconnecting hydraulic or other lines.

Hydraulic oil may be hot just after operation, and may spurt, possibly causing severe burns. Be sure to wait for oil to cool before starting any repair work.

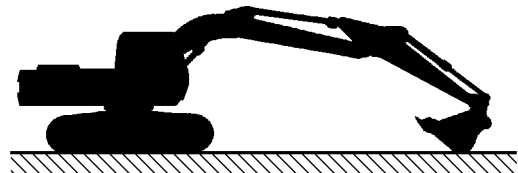
The hydraulic oil tank cap may fly off if removed without releasing accumulated pressure first. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.

Preparation

1. Park the machine on a firm, level surface.
2. Stop the engine. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.
3. Remove hydraulic oil tank cap. Connect a vacuum pump to maintain negative pressure in the hydraulic oil tank.



NOTE: Be sure to run the vacuum pump continuously while working on the hydraulic system.



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UPPERSTRUCTURE / Pilot Shut-Off Valve

Removal (ZAXIS200, 200-E, 225USR, 230, 270)

1. Remove spring (3).

IMPORTANT: Attach tags to hoses to aid in assembly.

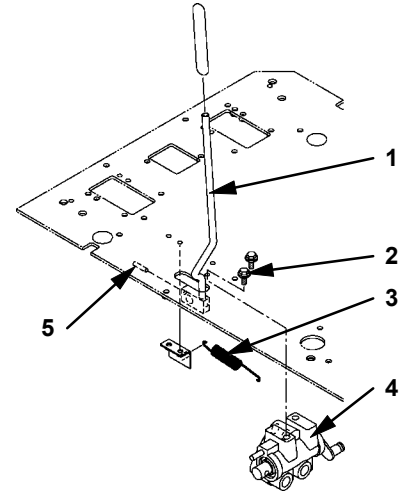
2. Disconnect hoses (6 to 13) and pipes (14, 15).

🔧 : 19 mm

3. Remove spring pin (5) to remove lever (1).

4. Remove bolt (2) to remove pilot shut-off valve (4).

🔧 : 17 mm



W178-02-08-001

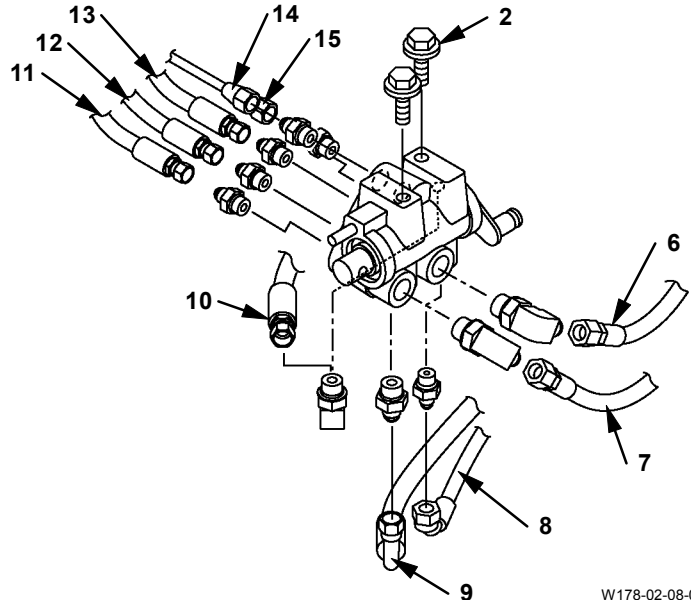
Installation (ZAXIS200, 200-E, 225USR, 230, 270)

1. Install pilot shut-off valve (4) with bolt (2).

2. Install lever (1) with spring pin (5).

3. Connect hoses (6 to 13) and pipes (14, 15).

4. Install spring (3).



W178-02-08-002

Wrench Size (mm)	Tightening Torque		Remark
	N·m	kgf·m (lbf·ft)	
🔧 : 17	49	5 (36)	Bolt
🔧 : 19	29	3 (21.5)	Hose, Pilot

- 6 - Hose DP : (To the oil tank)
- 7 - Hose PH : (To the signal control valve)
- 8 - Hose PI : (To the signal control valve)
- 9 - Hose PD: (From the solenoid valve unit)
- 10 - Hose T6: (From the right pilot valve)
- 11 - Hose P2: (To the left pilot valve)
- 12 - Hose T5: (From the left pilot valve)
- 13 - Hose P3: (To the right pilot valve)
- 14 - Hose P: (To the travel pilot valve)
- 15 - Hose T: (From the travel pilot valve)

UPPERSTRUCTURE / Pilot Shut-Off Valve

Removal (ZAXIS225US)

1. Remove ball joint (10).

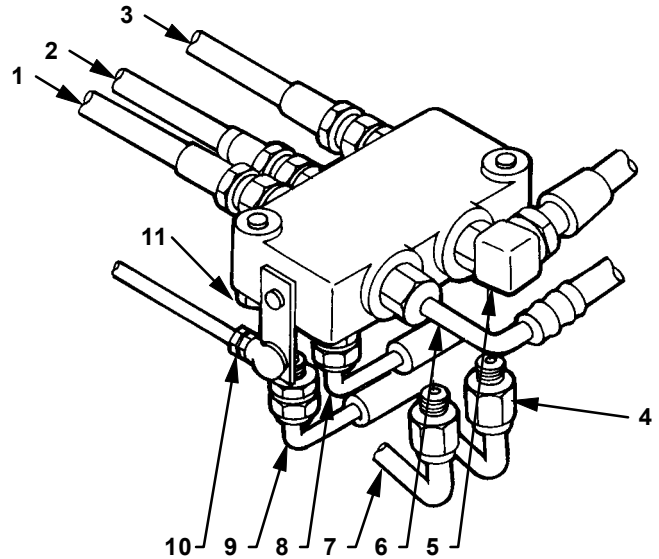
IMPORTANT: Attach identification tags to hoses to aid reassembly.

2. Disconnect hoses (1 to 9).
3. Remove bolt (11) to remove pilot shut-off valve.

 : 13, 22 mm
 : 8 mm

Installation (ZAXIS225US)

1. Install pilot shut-off valve with bolt (11).
2. Connect hoses (1 to 9).
3. Install ball joint (10).



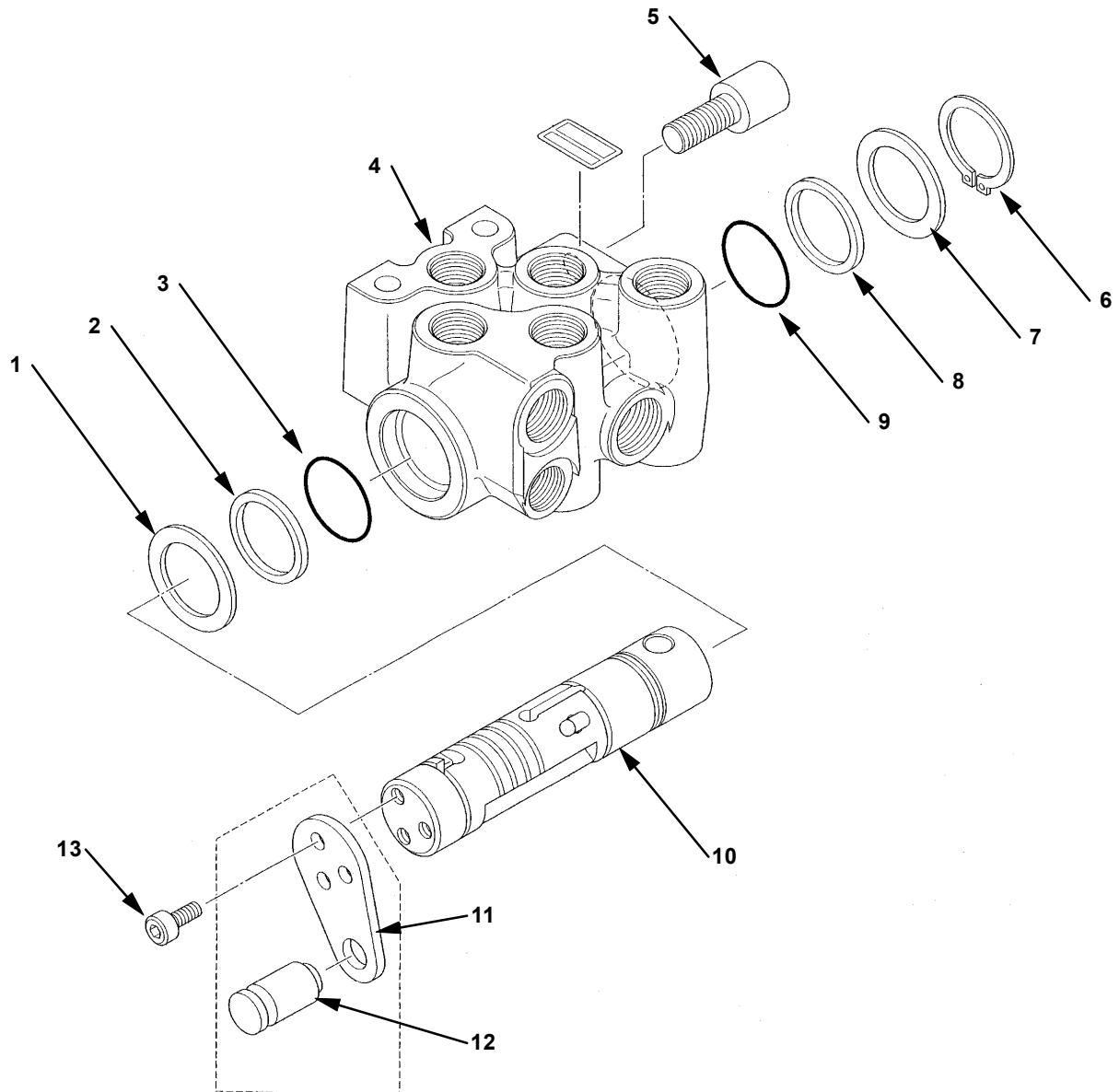
W157-02-08-001

Wrench Size (mm)	Tightening Torque		Remark
	N·m	kgf·m (lbf·ft)	
 : 13	10	1 (7.2)	Nut
 : 22	39	4 (29)	Hose
 : 8	20	2 (14.5)	Bolt
 : 17	49	5 (36)	Bolt
 : 19	29	3 (21.5)	Hose

- 1 - Hose P2: (From the travel pilot valve)
- 2 - Hose P1: (To the swing, arm pilot valve)
- 3 - Hose P3: (To the boom, bucket pilot valve)
- 4 - Hose T6: (From the bucket, boom pilot valve)
- 5 - Hose PD: (To the tank port)
- 6 - Hose DP: (From the pilot valve)
- 7 - Hose T5: (From the swing, arm pilot valve)
- 8 - Hose T4: (From the travel left and right pilot valve)
- 9 - Hose A4: (To the shuttle valve)
- 10 - Ball Joint
- 11 - Bolt

UPPERSTRUCTURE / Pilot Shut-Off Valve

DISASSEMBLE PILOT SHUT-OFF VALVE (ZAXIS200, 200-E, 225USR, 230, 270)



W178-02-08-005

- | | | | |
|-----------------|--------------------|--------------|------------------|
| 1 - Washer | 5 - Socket Bolt | 9 - O-Ring | 13 - Socket Bolt |
| 2 - Backup Ring | 6 - Retaining Ring | 10 - Spool | |
| 3 - O-Ring | 7 - Washer | 11 - Bracket | |
| 4 - Body | 8 - Backup Ring | 12 - Pin | |

UPPERSTRUCTURE / Pilot Shut-Off Valve

Disassemble Pilot Shut-Off Valve (ZAXIS200, 200-E, 225USR, 230, 270)

- Be sure to thoroughly read all "Precautions for Disassembly and Assembly Work" on page W1-1-1 before starting the disassembly work.

1. Put matching marks on body (4) and bracket (11).
Remove retaining ring (6), washer (7), backup ring (8) and O-ring (9) from body (4) to remove spool (10) assembly.



2. Remove washer (1), backup ring (2) and O-ring (3) from body (4).
3. Clamp the spool (10) with wooden pieces in a vise.
Remove socket bolt (13) and bracket (11).

 : 4 mm

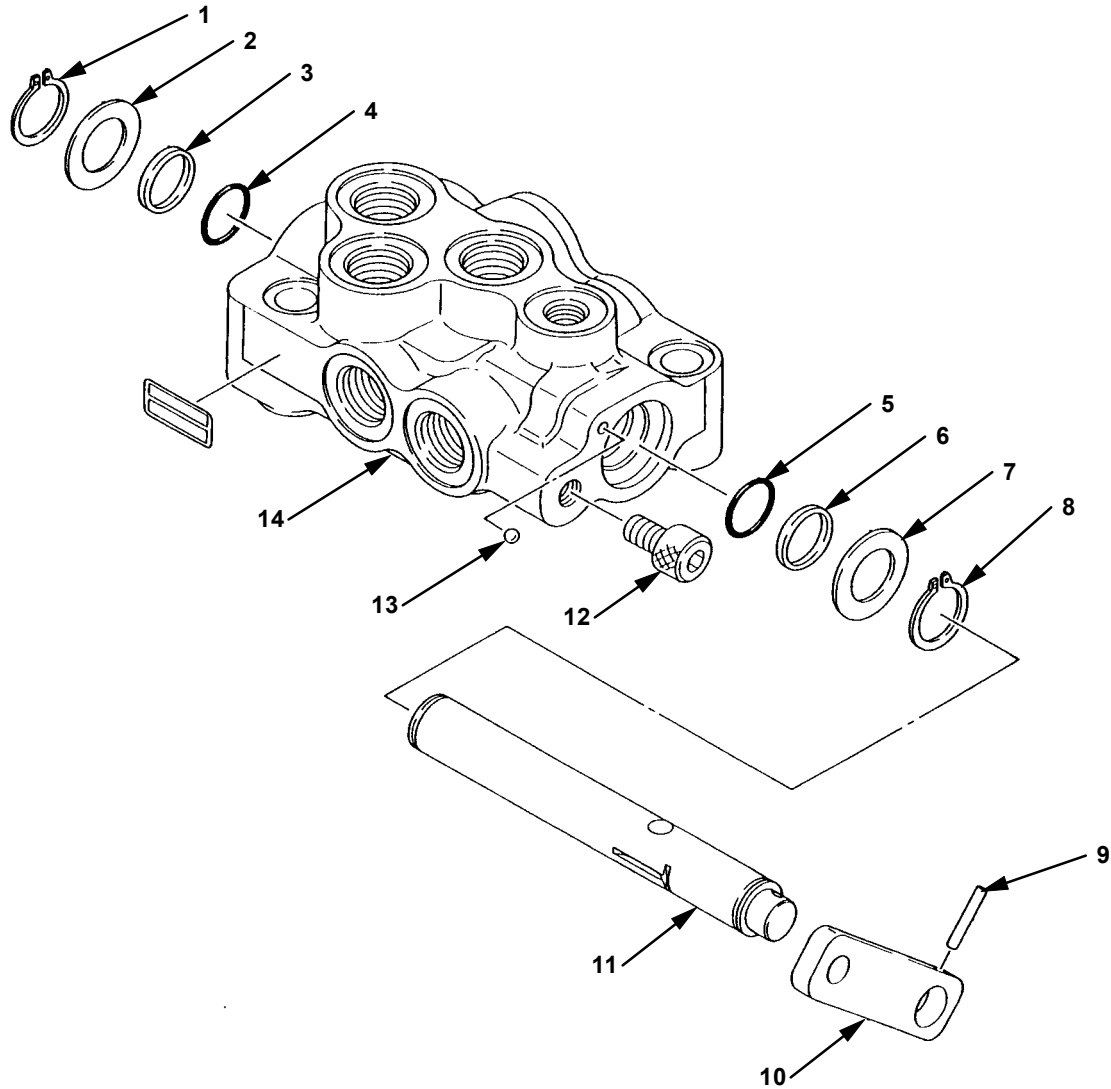
 **NOTE:** Don't remove pin (12) unless necessary.

4. Remove socket bolt (5) from body (4).

 : 8 mm

UPPERSTRUCTURE / Pilot Shut-Off Valve

DISASSEMBLE PILOT SHUT-OFF VALVE (ZAXIS225US)



W155-02-08-001

- | | | | |
|--------------------|--------------------|----------------|------------------|
| 1 - Retaining Ring | 5 - O-Ring | 9 - Spring Pin | 12 - Socket Bolt |
| 2 - Washer | 6 - Backup Ring | 10 - Lever | 13 - Steel Ball |
| 3 - Backup Ring | 7 - Washer | 11 - Spool | 14 - Body |
| 4 - O-Ring | 8 - Retaining Ring | | |

UPPERSTRUCTURE / Pilot Shut-Off Valve

Disassemble Pilot Shut-off Valve (ZAXIS225US)

- Be sure to thoroughly read all "Precautions for Disassembly and Assembly Work" on page W1-1-1 before starting the disassembly work.

1. Remove retaining ring (1), washer (2) to remove spool (11).

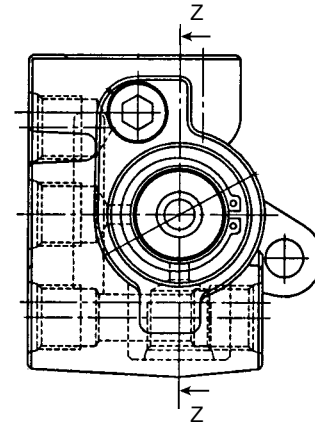
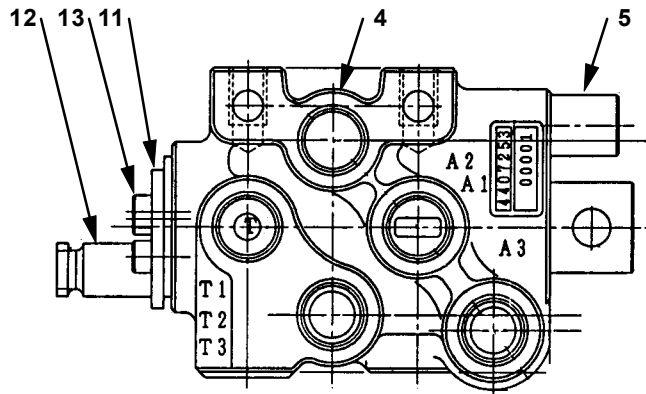
IMPORTANT: Put matching marks to the mounting position of spool (11) and lever (10).

2. Remove spring pin (9) from spool (11) to remove lever (10).
3. Remove washer (7), retaining ring (8) from spool (11).
4. Remove backup rings (3), (6) and O-rings (4, 5) from body (14).
5. Loosen and remove socket bolt (12) from body (14).

 : 6 mm

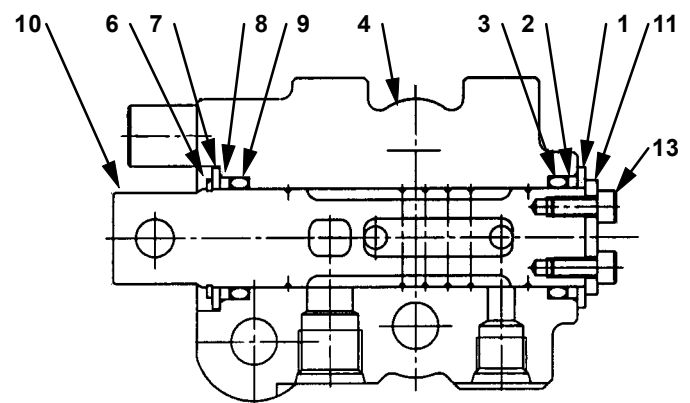
UPPERSTRUCTURE / Pilot Shut-Off Valve

ASSEMBLE PILOT SHUT-OFF VALVE (ZAXIS200, 200-E, 225USR, 230, 270)



Section Z—Z

W178-02-08-006



T178-03-07-002

- | | | | |
|-----------------|--------------------|--------------|------------------|
| 1 - Washer | 5 - Socket Bolt | 9 - O-Ring | 13 - Socket Bolt |
| 2 - Backup Ring | 6 - Retaining Ring | 10 - Spool | |
| 3 - O-Ring | 7 - Washer | 11 - Bracket | |
| 4 - Body | 8 - Backup Ring | 12 - Pin | |

UPPERSTRUCTURE / Pilot Shut-Off Valve

Assemble Pilot Shut-Off Valve (ZAXIS200, 200-E, 225USR, 230, 270)

1. Apply LOCTITE # 262 on socket bolt (5) and install it to body (4).

 : 8 mm

 : 29.4 N·m (3.0 kgf·m, 21.5 lbf·ft)

2. Clamp spool (10) with wooden pieces in a vise. Apply LOCTITE #262 on socket bolt (13), then install bracket (11) on to spool (10).

 : 4 mm

 : 3.9 N·m (0.4 kgf·m, 2.9 lbf·ft)

3. Install O-ring (3), backup ring (2) and washer (1) on to body (4).

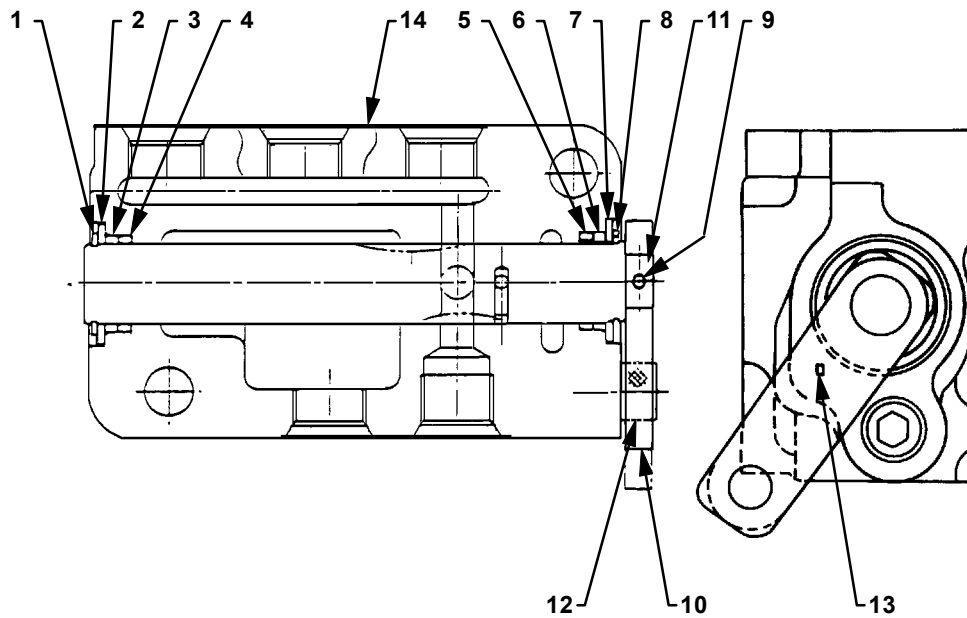
4. Apply hydraulic oil to spool (10) and install it to body (4).

5. Install O-ring (9), backup ring (8) and washer (7) to body (4), and install retaining ring (6) to spool (10).



UPPERSTRUCTURE / Pilot Shut-Off Valve

ASSEMBLE PILOT SHUT-OFF VALVE (ZAXIS225US)



W157-02-08-002

- | | | | |
|--------------------|--------------------|----------------|------------------|
| 1 - Retaining Ring | 5 - O-Ring | 9 - Spring Pin | 12 - Socket Bolt |
| 2 - Washer | 6 - Backup Ring | 10 - Lever | 13 - Steel Ball |
| 3 - Backup Ring | 7 - Washer | 11 - Spool | 14 - Body |
| 4 - O-Ring | 8 - Retaining Ring | | |

UPPERSTRUCTURE / Pilot Shut-Off Valve

Assemble Pilot Shut-off Valve (ZAXIS225US)

IMPORTANT: Apply grease to O-ring (5) and backup ring (6).

1. Install O-ring (5), backup ring (6), washer (7) and retaining ring (8) onto body (14).
2. Align the matching marks on disassembled spool (11) and lever (10), insert spring pin (9) to assemble them together.

IMPORTANT: Apply hydraulic oil to spool (11).

3. Assemble spool (11) onto body (14).

IMPORTANT: Apply grease to O-ring (4) and backup ring (3).

4. Install O-ring (4), backup ring (3), washer (2) to body (14) and install retaining ring (1) to spool (11).
5. Install and tight socket bolt (12).
 : 6 mm
 : 44 N·m (4.5 kgf·m, 32.5 lbf·ft)

UPPERSTRUCTURE / Pilot Shut-Off Valve

(Blank)

UPPERSTRUCTURE / Signal Control Valve

REMOVE AND INSTALL SIGNAL CONTROL VALVE



CAUTION: Escaping fluid under pressure may penetrate the skin, causing serious injury. Avoid this hazard by relieving pressure before disconnecting hydraulic or other lines.

Hydraulic oil may be hot just after operation, and may spurt, possibly causing severe burns. Be sure to wait for oil to cool before starting any repair work.

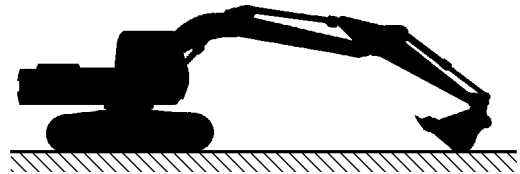
The hydraulic oil tank cap may fly off if removed without releasing accumulated pressure first. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.

Preparation

1. Park the machine on a firm, level surface.
2. Stop the engine. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.
3. Remove hydraulic oil tank cap. Connect a vacuum pump to maintain negative pressure in the hydraulic oil tank.



NOTE: Be sure to run the vacuum pump continuously while working on the hydraulic system.



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UPPERSTRUCTURE / Signal Control Valve

Removal

IMPORTANT: Attach tags to hoses and pipes to aid in assembly.

 **NOTE:** When removing pipe from signal control valve, if a snap-on tool (GAN850812B: tool size: 19.05 mm) is used, it may be easier to remove the pipe.

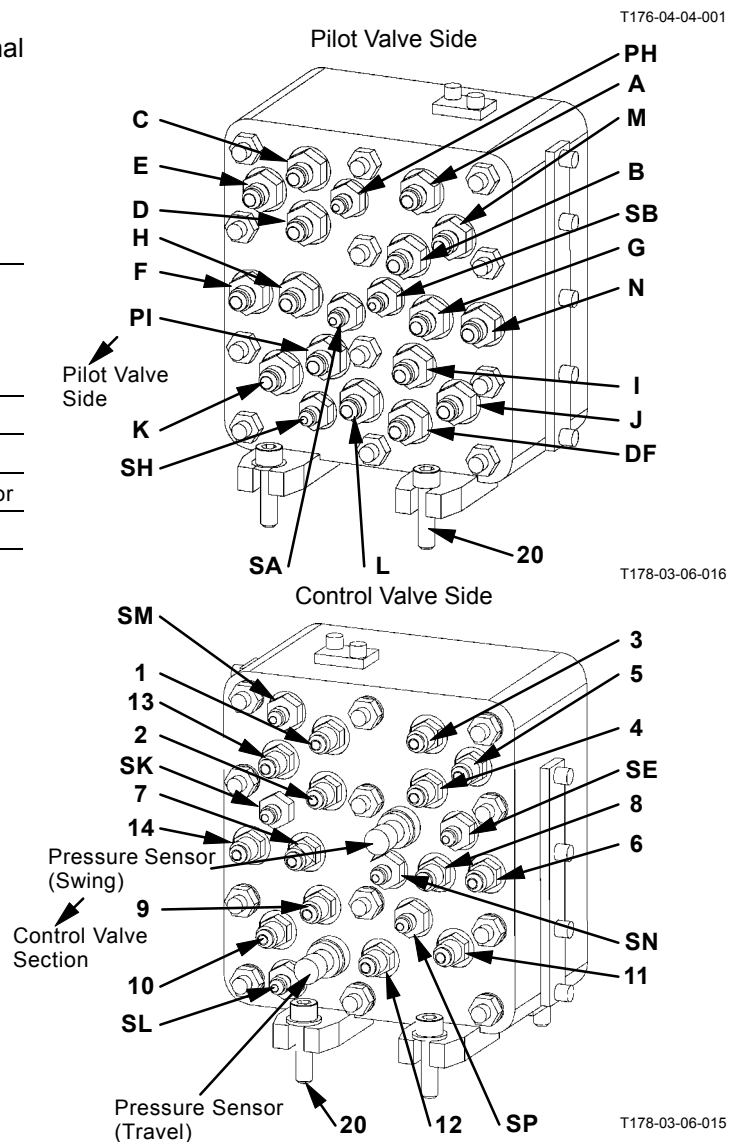
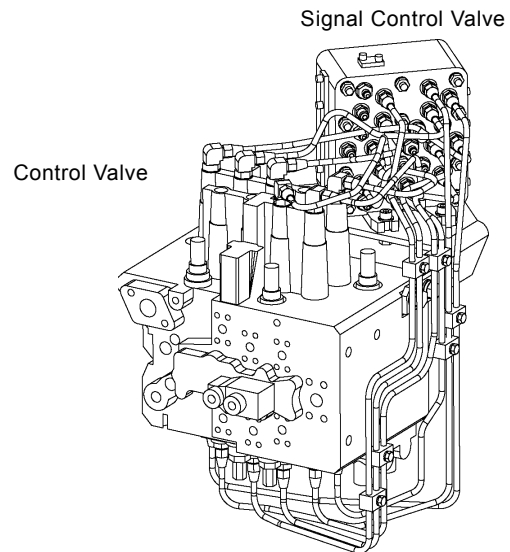
1. Disconnect all hoses and pipes from each port.
2. Remove the pressure sensors (swing, travel).
3. Remove bolt (20) to remove the signal control valve.

 : 8 mm

Installation

1. Apply LOCTITE to bolt (20) and install the signal control valve.
2. Connect all hoses and pipes to each port.
3. Install the pressure sensors (swing, travel).

Wrench Size (mm)	Tightening Torque		Remark
	N·m	kgf·m (lbf·ft)	
 : 17	25	2.5 (18)	Hose, Pipe
 : 19	29.5	3 (21.5)	Hose
 : 24	16	1.6 (11.5)	Pressure Switch, Sensor
 : 8	50	5.1 (37)	Bolt



UPPERSTRUCTURE / Signal Control Valve

Pilot Valve Side

Port Name	Connected To	Remark
Port A	Right pilot valve	Boom raise pilot pressure
Port B	Right pilot valve	Boom lower pilot pressure
Port C	Left pilot valve	Arm roll-out pilot pressure
Port D	Left pilot valve	Arm roll-in pilot pressure
Port E	Left pilot valve	Left swing pilot pressure
Port F	Left pilot valve	Right swing pilot pressure
Port G	Right pilot valve	Bucket roll-in pilot pressure
Port H	Right pilot valve	Bucket roll-out pilot pressure
Port I	Travel pilot valve	Left travel forward pilot pressure
Port J	Travel pilot valve	Left travel reverse pilot pressure
Port K	Travel pilot valve	Right travel forward pilot pressure
Port L	Travel pilot valve	Right travel reverse pilot pressure
Port M	Auxiliary pilot valve	Plug on pilot pressure
Port N	Auxiliary pilot valve	Plug off pilot pressure
Port SA	Pump 1 regulator	Pump 1 control pressure
Port SB	Pump 2 regulator	Pump 2 control pressure
Port PI	Pilot shut-off valve	Primary pilot pressure
Port PH	Pilot shut-off valve	Primary pilot pressure (Heat circuit)
Port SH	Swing parking brake	Brake release pressure
Port DF	Hydraulic oil tank	Return to hydraulic oil tank

Control Valve Side

Port Name	Connected To	Remark
Port 1	Control valve	Boom raise pilot pressure
Port 2	Control valve	Boom lower pilot pressure
Port 3	Control valve	Arm roll-out pilot pressure
Port 4	Control valve	Arm roll-in pilot pressure
Port 5	Control valve	Left swing pilot pressure
Port 6	Control valve	Right swing pilot pressure
Port 7	Control valve	Bucket roll-in pilot pressure
Port 8	Control valve	Bucket roll-out pilot pressure
Port 9	Control valve	Left travel forward pilot pressure
Port 10	Control valve	Left travel reverse pilot pressure
Port 11	Control valve	Right travel forward pilot pressure
Port 12	Control valve	Right travel reverse pilot pressure
Port 13	Control valve (Auxiliary)	Plug
Port 14	Control valve (Auxiliary)	Plug
Port SE	–	Plug
Port SM	Hydraulic oil tank	Return to hydraulic oil tank
Port SN	–	Plug
Port SP	Hydraulic oil tank	Return to hydraulic oil tank
Port SL	Control valve	Flow combiner valve switching pressure
Port SK	Control valve	Bucket flow rate control valve switching pressure

UPPERSTRUCTURE / Signal Control Valve

(Blank)

UPPERSTRUCTURE / Solenoid Valve

REMOVE AND INSTALL SOLENOID VALVE UNIT



CAUTION: Escaping fluid under pressure may penetrate the skin, causing serious injury. Avoid this hazard by relieving pressure before disconnecting hydraulic or other lines.

Hydraulic oil may be hot just after operation, and may spurt, possibly causing severe burns. Be sure to wait for oil to cool before starting any repair work.

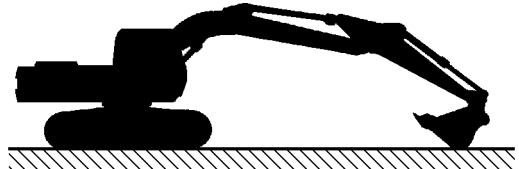
The hydraulic oil tank cap may fly off if removed without releasing accumulated pressure first. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.

Preparation

1. Park the machine on a firm, level surface.
2. Stop the engine. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.
3. Remove hydraulic oil tank cap. Connect a vacuum pump to maintain negative pressure in the hydraulic oil tank.



NOTE: Be sure to run the vacuum pump continuously while working on the hydraulic system.



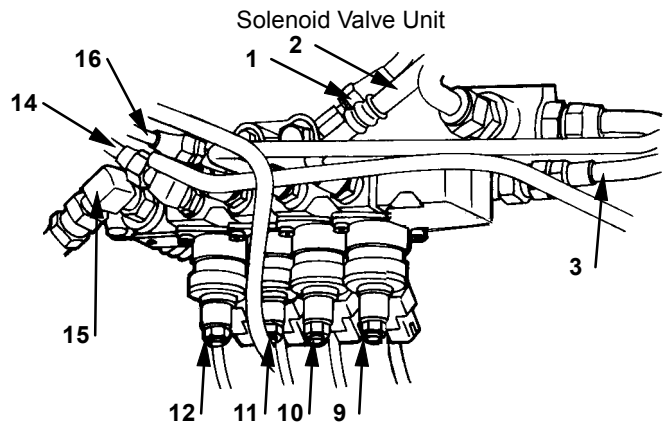
M104-07-021

UPPERSTRUCTURE / Solenoid Valve

Removal

1. Disconnect each harness of solenoid valves (9 to 12).
2. Disconnect pilot pipes (1 to 5, 7, 8, 13 to 16).
3. Remove bolts (6) (2 used) to remove the solenoid valve unit.

 : 19, 22 mm
 : 8 mm

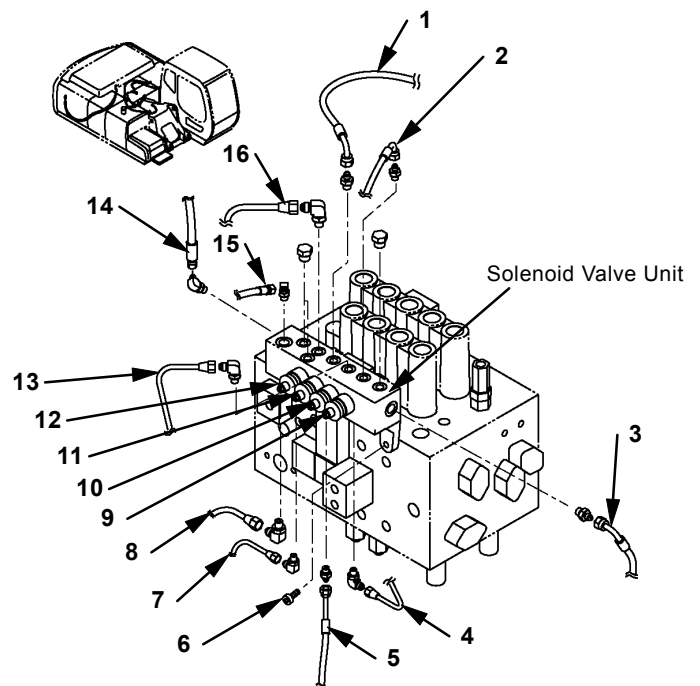


T178-01-02-003

Installation

1. Install solenoid valve unit with bolts (6) (2 used).
2. Connect pilot pipes (1 to 5, 7, 8, 13 to 16).
3. Connect each harness of solenoid valves (9 to 12).

Wrench Size (mm)	Tight Torque		Remark
	N·m	kgf·m (lbf·ft)	
 : 17	25	2.5 (18)	Pipe, Hose
 : 19	30	3 (21.5)	Hose
 : 8	50	5.1 (37)	Bolt



W178-02-10-001

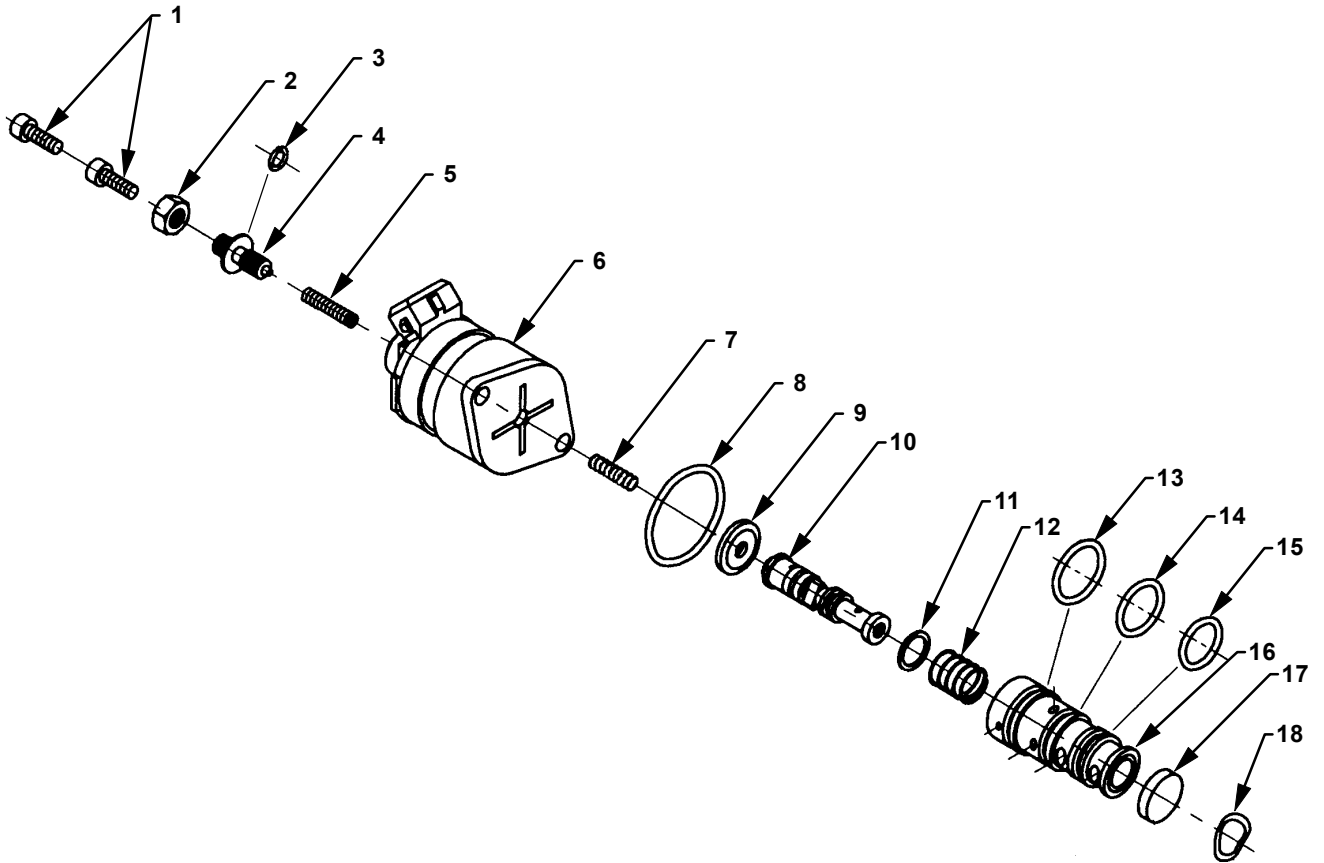
- 1 - Hose DD: To the signal control valve port SP
- 2 - Hose: To the control valve (5-spool section)
- 3 - Hose: To the hydraulic oil tank
- 4 - Pipe: To the main relief valve
- 5 - Hose SI: To the center joint
- 6 - Socket bolt
- 7 - Pipe: To the control valve (4-spool section)
- 8 - Pipe: To the control valve (5-spool section)
- 9 - Proportional solenoid valve (SG)
- 10 - Proportional solenoid valve (SI)
- 11 - Proportional solenoid valve (SC)
- 12 - Proportional solenoid valve (SE)
- 13 - Pipe: To the control valve (4-spool section)
- 14 - Hose PF: From pilot shut-off valve
- 15 - Hose PD: From pilot filter
- 16 - Pipe: To the control valve (5-spool section)

UPPERSTRUCTURE / Solenoid Valve

(Blank)

UPPERSTRUCTURE / Solenoid Valve

DISASSEMBLE PROPORTIONAL SOLENOID VALVE



W157-02-11-016

1 - Socket Bolt (2 Used)
2 - Lock Nut
3 - O-Ring
4 - Adjusting Screw
5 - Spring

6 - Solenoid
7 - Spring
8 - O-Ring
9 - Diaphragm
10 - Spool

11 - Washer
12 - Spring
13 - O-Ring
14 - O-Ring

15 - O-Ring
16 - Sleeve
17 - Plate
18 - Washer

UPPERSTRUCTURE / Solenoid Valve

Disassemble Proportional Solenoid Valve

1. Loosen socket bolts (1) to remove solenoid (6).

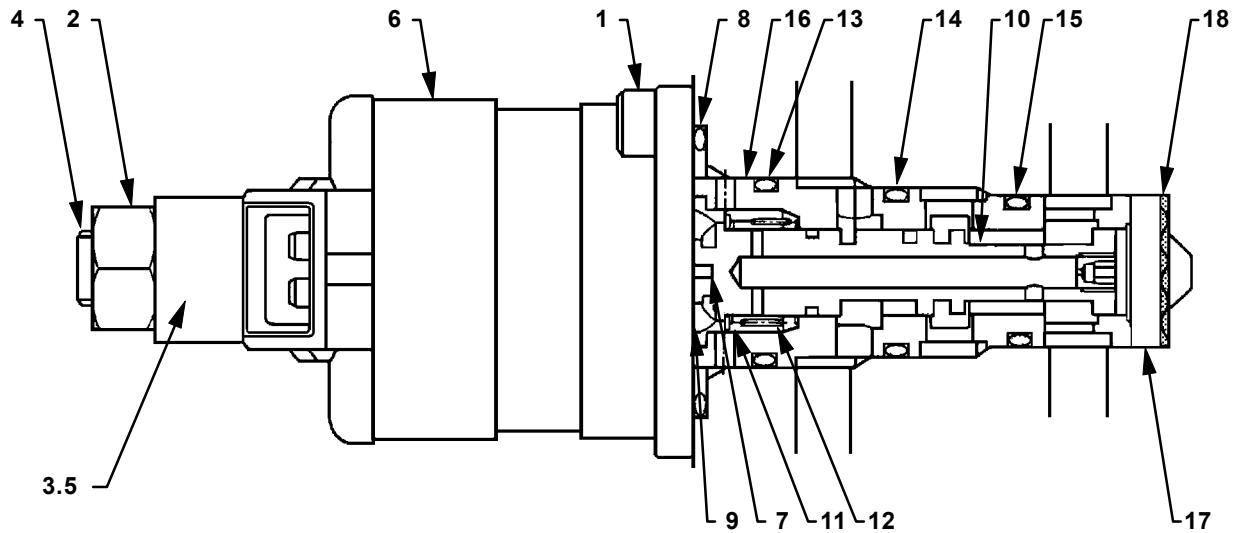
IMPORTANT: Take care not to lose spring (7) provided in the groove of solenoid (6) when removing solenoid (6).
Don't disassemble lock nut (2) and adjusting screw (4).

 : 3 mm

2. Pull out spool (10) and remove diaphragm (9), washer (11) and spring (12).
3. Pull sleeve (16) out and remove O-rings (13), (14) (15), washer (18) and plate (17).

UPPERSTRUCTURE / Solenoid Valve

ASSEMBLE PROPORTIONAL SOLENOID VALVE



W157-02-11-001

- | | | | |
|--------------------------|---------------|-------------|-------------|
| 1 - Socket Bolt (2 Used) | 6 - Solenoid | 11 - Washer | 15 - O-Ring |
| 2 - Lock Nut | 7 - Spring | 12 - Spring | 16 - Sleeve |
| 3 - O-Ring | 8 - O-Ring | 13 - O-Ring | 17 - Plate |
| 4 - Adjusting Screw | 9 - Diaphragm | 14 - O-Ring | 18 - Washer |
| 5 - Spring | 10 - Spool | | |

UPPERSTRUCTURE / Solenoid Valve

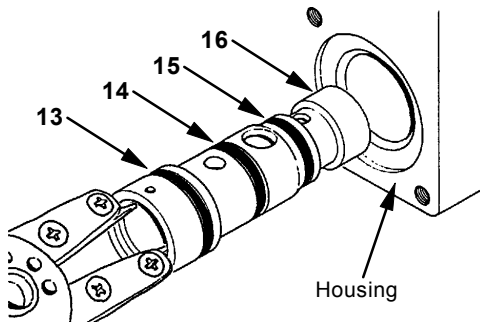
Assemble Proportional Solenoid Valve

IMPORTANT: Apply grease to O-rings (13), (14), (15) and apply a film of hydraulic oil to sleeve (16).

When inserting the sleeve, be sure to align the ports of the sleeve with the ports in the housing.

Install sleeve so that the end faces of sleeve and body come to the same point.

1. Install washer (18), plate (17) into the housing. Install O-rings (13), (14) and (15) on sleeve (16), then insert it into the housing.



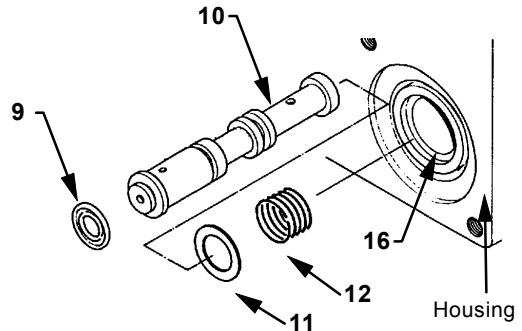
W157-02-11-005

IMPORTANT: Take care not to damage the edge portion in the bore of sleeve (16) when inserting the spool (10) assembly.

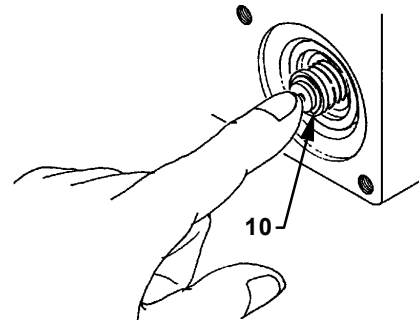
After inserting spool in, check that the spool slides in and out smoothly without any restriction about 3 to 5 mm (0.12 to 0.20 in).

Apply hydraulic oil to the spool.

2. Install diaphragm (9), washer (11), spring (12) to spool (10) and install it into sleeve (16).



W157-02-11-009



W157-02-11-010

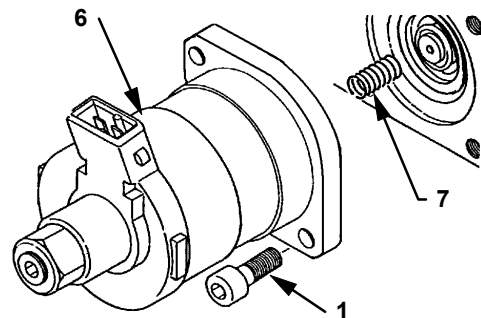
IMPORTANT: Lock nut (2), adjusting screw (4), spring (5) and O-ring (3) are not separated, so no need to assemble them.

When assembling solenoid (6), take care not to drop spring (7).

3. Install solenoid (6) with socket bolts (1) (2 used).

 : 3 mm

 : 2.9 N·m (0.3 kgf·m, 2.2 lbf·ft)

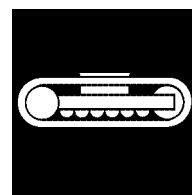


W157-02-11-011

UPPERSTRUCTURE / Solenoid Valve

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SECTION 3 UNDERCARRIAGE



— CONTENTNS —

Group 1 Swing Bearing

Remove and Install Swing Bearing	W3-1-1
Disassemble Swing Bearing	W3-1-4
Assemble Swing Bearing	W3-1-6

Group 2 Travel Device

Remove and Install Travel Device	W3-2-1
Disassemble Travel Device	W3-2-4
Assemble Travel Device	W3-2-10
Disassemble Travel Motor	W3-2-20
Assemble Travel Motor	W3-2-28
Disassemble Travel Brake Valve	W3-2-42
Assemble Travel Brake Valve	W3-2-46
Maintenance Standard	W3-2-50

Group 3 Center Joint

Remove and Install Center Joint	W3-3-1
Disassemble Center Joint	W3-3-4
Assemble Center Joint	W3-3-6
Maintenance Standard	W3-3-9

Group 4 Track Adjuster

Remove and Install Track Adjuster	W3-4-1
Disassemble Track Adjuster	W3-4-2
Assemble Track Adjuster	W3-4-10

Group 5 Front Idler

Remove and Install Front Idler	W3-5-1
Disassemble Front Idler	W3-5-2
Assemble Front Idler	W3-5-6
Maintenance Standard	W3-5-8

Group 6 Upper and Lower Roller

Remove and Install Upper Roller	W3-6-1
Remove and Install Lower Roller	W3-6-5
Disassemble Lower Roller	W3-6-8
Assemble Lower Roller	W3-6-10
Maintenance Standard	W3-6-12

Group 7 Track

Remove and Install Track	W3-7-1
Maintenance Standard	W3-7-7

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UNDERCARRIAGE / Swing Bearing

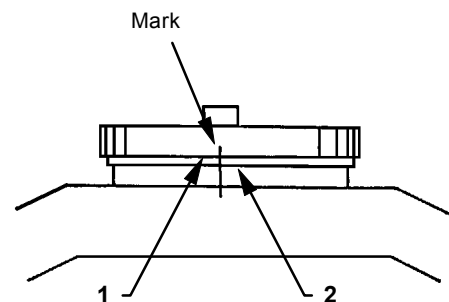
REMOVE AND INSTALL SWING BEARING

Before removing the swing bearing, the upperstructure must be removed first. For removal and installation of the upperstructure, refer to "Remove and Install Main Frame" section.

In this section, the procedure starts on the premise that the upperstructure has already been removed.

Removal

1. Put alignment marks on inner race of swing bearing (1) and track frame (2).

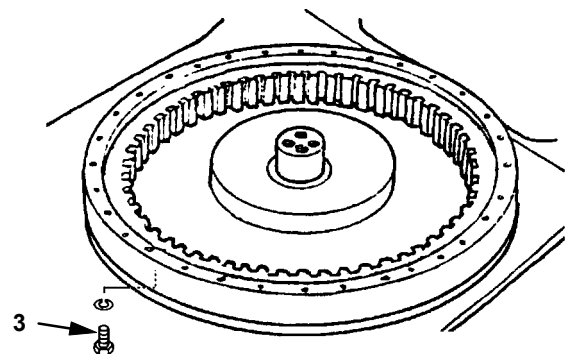


W105-03-01-001

2. Remove all of 36 bolts (3) from inner race of swing bearing.

⚙️ : 30 mm (ZAXIS 200, 200-E, 225US, 225USR)

⚙️ : 32 mm (ZAXIS230, 270)

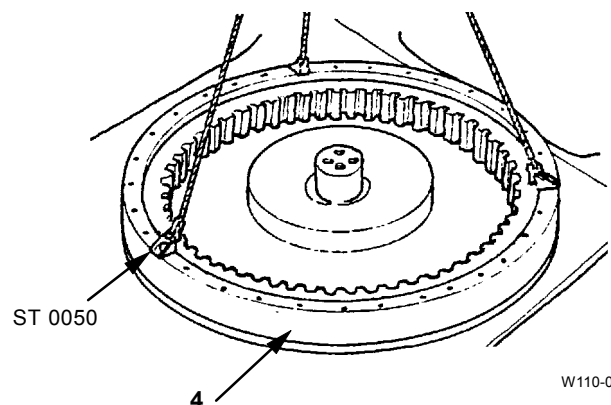


W158-03-01-001



CAUTION: Swing bearing weight:
220 kg (490 lb)
(ZAXIS200, 200-E, 225US, 225 USR)
331 kg (730 lb) (ZAXIS230, 270)

3. Attach lifting tools (ST 0050), hoist swing bearing (4) and remove it.



W110-03-01-004

UNDERCARRIAGE / Swing Bearing

Installation

Clean the matching surfaces of the frame and swing bearing.

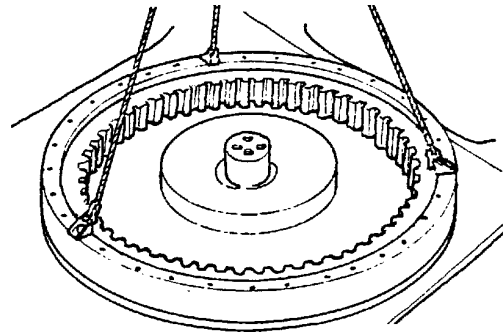
1. Apply THREEBOND # 1102 to the matching surfaces of the track frame and swing bearing.



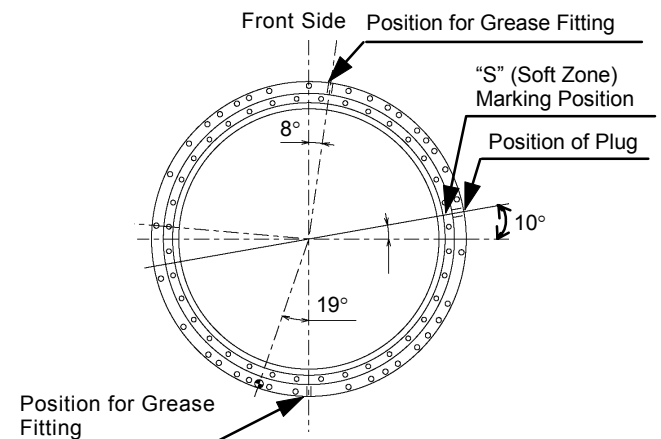
CAUTION: Swing bearing weight:
220 kg (490 lb)
(ZAXIS200, 200-E, 225US, 225 USR)
330 kg (730 lb) (ZAXIS230, 270)

IMPORTANT: Failure to align the marks may result in misalignment of the inner race soft zone.

2. Hoist the swing bearing by crane. Align the alignment marks both on the track frame and swing bearing.



W110-03-01-004



W178-03-01-001

3. Install the mounting bolts (3) (36 used) to the inner race of the swing bearing and tighten to specification.

(ZAXIS200, 200-E, 225US, 225USR)

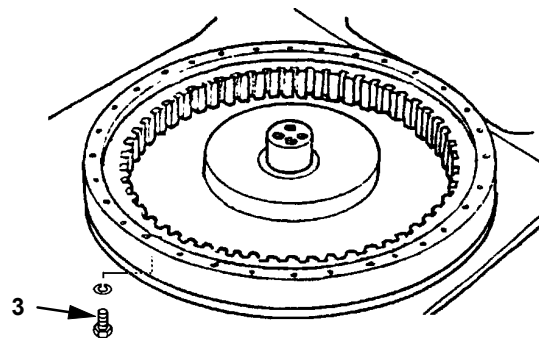
🔧 : 30 mm

🔧 : 490 N·m (50 kgf·m, 360 lbf·ft)

(ZAXIS230, 270)

🔧 : 32 mm

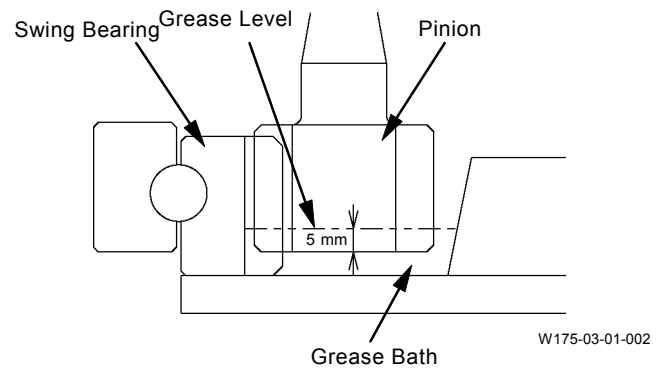
🔧 : 640 N·m (65 kgf·m, 470 lbf·ft)



W158-03-01-001

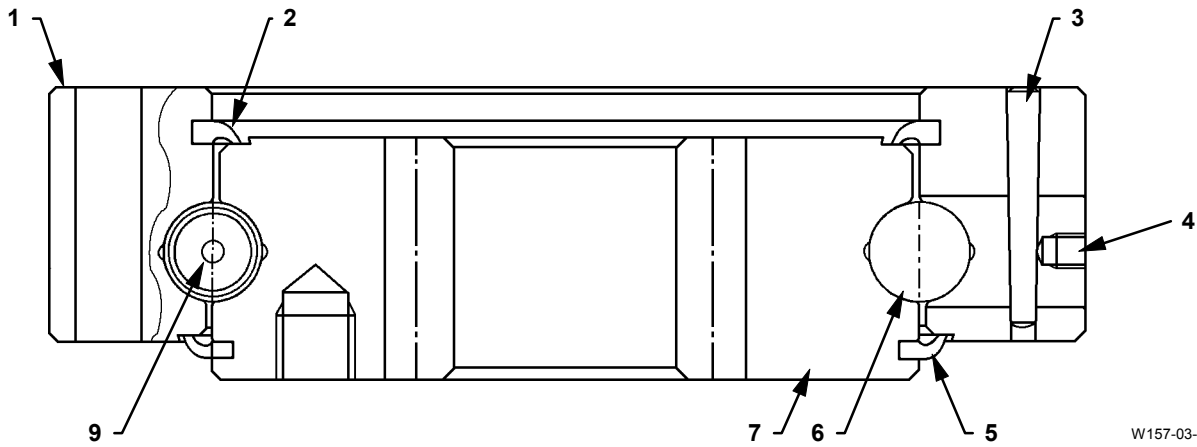
UNDERCARRIAGE / Swing Bearing

4. After installing the swing bearing, fill the grease bath with grease (Shell Alvania EP2 or equivalent) until the pinion of the swing bearing is covered 5 mm in grease.

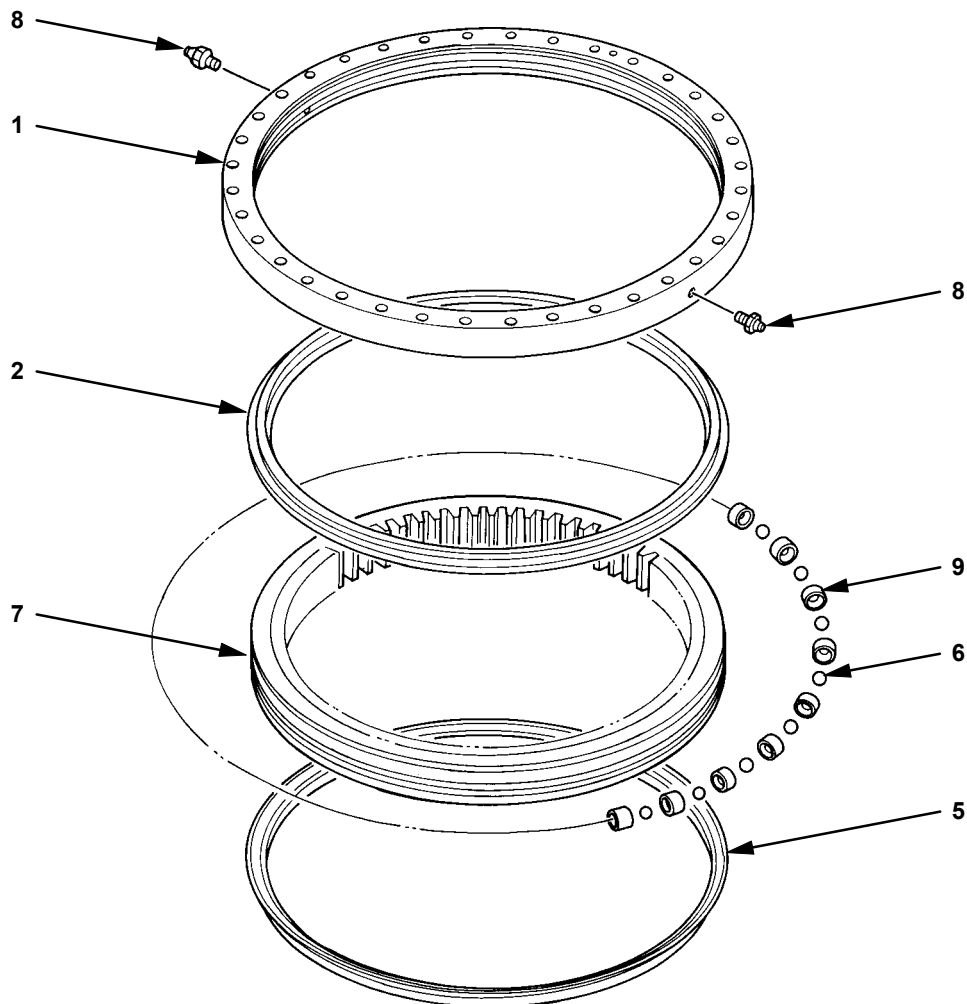


UNDERCARRIAGE / Swing Bearing

DISASSEMBLE SWING BEARING



W157-03-01-003



W157-03-01-002

1 - Outer Race
2 - Seal
3 - Pin

4 - Plug
5 - Seal

6 - *Ball
7 - Inner Race

8 - Grease Fitting (2 Used)
9 - *Support

NOTE: * 6 ZAXIS200, 200-E, 225US, 225USR: 121 used, ZAXIS230, 270: 90 used
* 9 ZAXIS200, 200-E, 225US, 225USR: 121 used, ZAXIS230, 270: 90 used

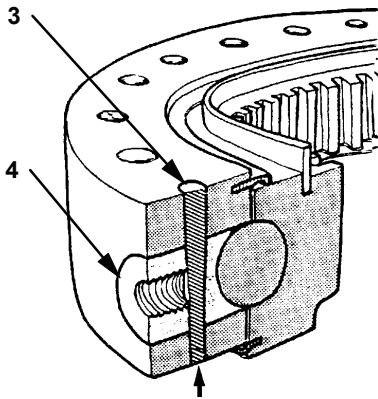
UNDERCARRIAGE / Swing Bearing

Disassemble Swing Bearing

- Be sure to thoroughly read "Precautions for Disassembly and Assembly" on page W1-1-1 before starting the disassembly work.

1. Tap stopper pin (3) of plug (4) up from the bottom side.

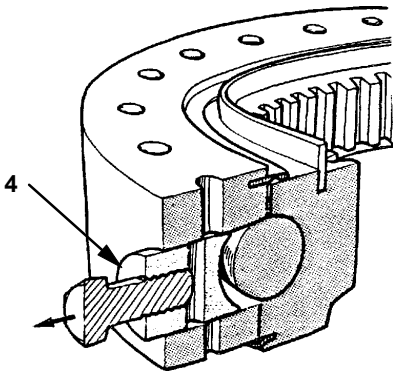
 **NOTE:** Since pin (3) was caulked after being installed, grind the caulked part with a grinder.



W105-03-01-007

2. Pull plug (4) out.

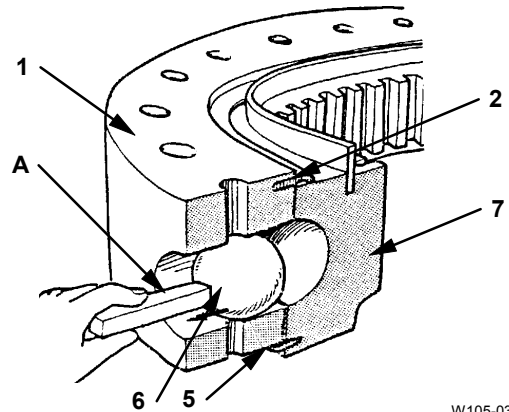
 **NOTE:** Insert a bolt into the hole (M8, Pitch 1.25 mm) from it plug (4) was pull out. Then tap or pull the bolt from inside.



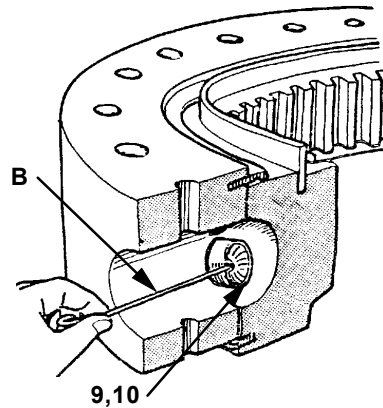
W105-03-01-008

 **CAUTION:** Swing bearing weight:
220 kg (490 lb)

3. Unseat outer race (1) of swing bearing horizontally and slightly by crane with lifting sling (ST 0050). Remove seals (2 and 5).
4. Place the inner race (7) of swing bearing onto wooden blocks while holding outer race (1) by crane.
5. Remove balls (6) (121 used / 90 used) and supports (9) (121 used / 90 used) out from the plug hole, while rotating the outer race (1). Magnet rod (A) can be used to remove the balls out, and a hooked wire (B) can be used to remove supports (9).



W105-03-01-009

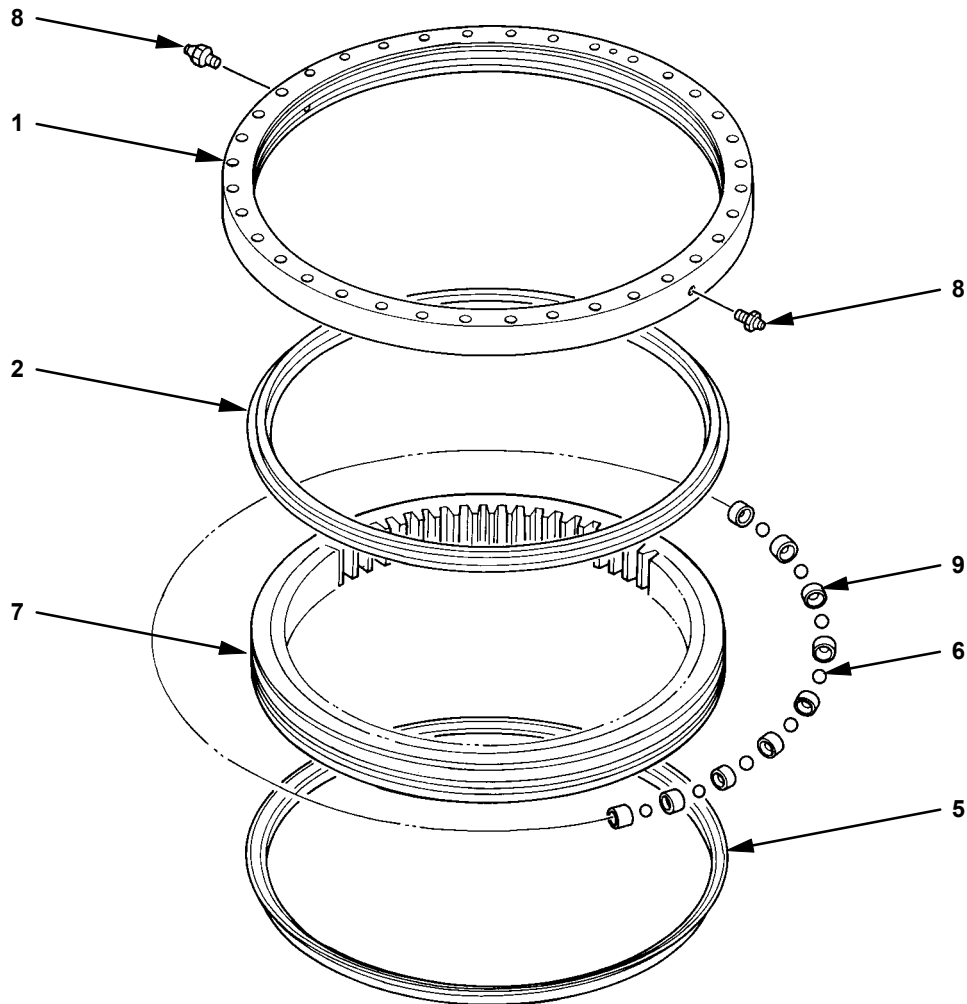
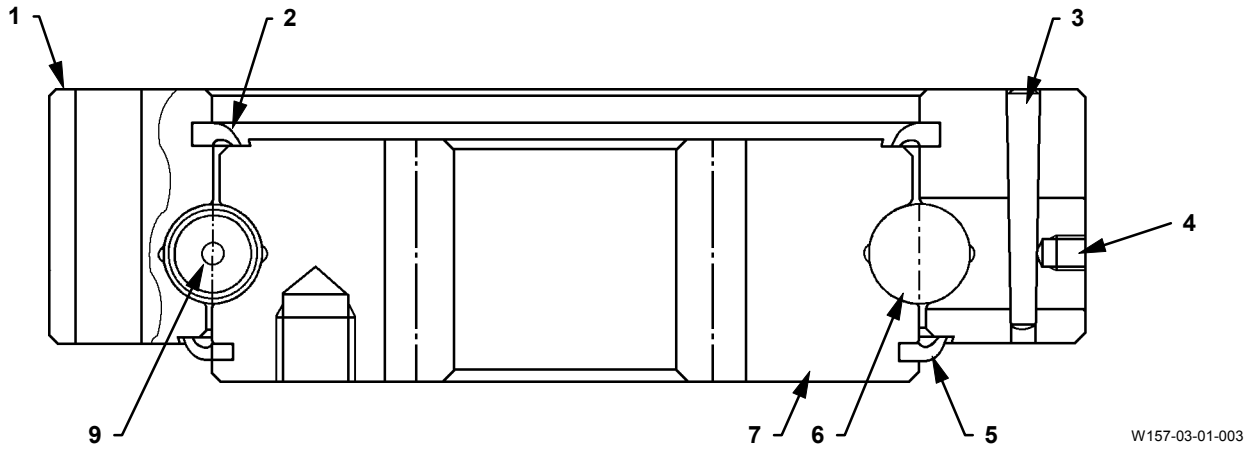


W105-03-01-010

6. Remove seal (2) from outer race (1) and remove seal (5) from inner race (7) with scrapper.

UNDERCARRIAGE / Swing Bearing

ASSEMBLE SWING BEARING



W157-03-01-002

1 - Outer Race
2 - Seal
3 - Pin

4 - Plug
5 - Seal

6 - *Ball
7 - Inner Race

8 - Grease Fitting (2 Used)
9 - *Support

NOTE: * 6 ZAXIS200, 200-E, 225US, 225USR: 121 used, ZAXIS230, 270: 90 used
* 9 ZAXIS200, 200-E, 225US, 225USR: 121 used, ZAXIS230, 270: 90 used

UNDERCARRIAGE / Swing Bearing

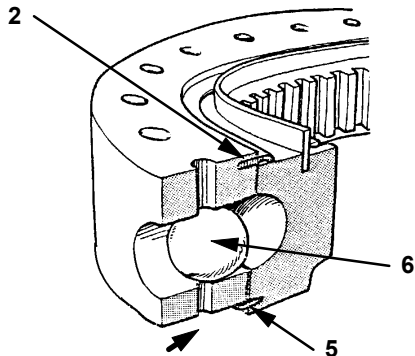
Assemble Swing Bearing

IMPORTANT: Be sure to apply grease to balls (6) and to supports (9).

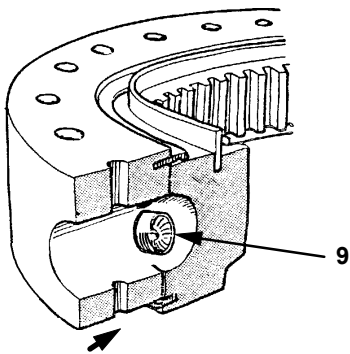


CAUTION: Swing bearing weight:
220 kg (490 lb)
(ZAXIS200, 200-E, 225US, 225 USR)
331 kg (730 lb) (ZAXIS230, 270)

1. Lift the outer race using a crane horizontally and match it with the inner race coaxially. Rotating the outer race, insert balls (6), support (9) into the plug hole one by one with a round bar.

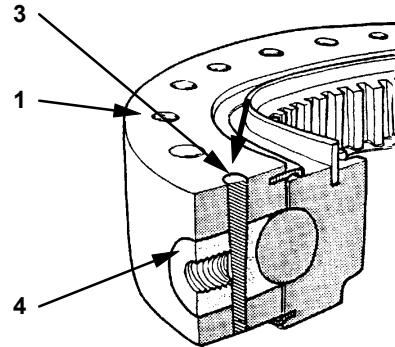


W142-03-01-005



W142-03-01-006

2. Tap plug (4) into outer race (1) and then, drive pin (3) into the pin hole. Caulk the head of pin (3) with a punch.



W142-03-01-007

3. Install lifting tool (ST 0050) onto outer race (4) lift it by crane. Thoroughly degrease the slots for seals (2 and 5). Apply THREEBOND # 1745 (to seal (2)) and # 1735 (to seal (5)). Then assemble seals (2 and 5) into the slots.
4. Fill grease 0.5L (0.132 US gal) (Alvania EP2 grease or equivalent) through the grease fitting (8). Rotate the outer race while filling.



NOTE: Fill grease from two places.
0.30L (ZAXIS200, 200-E, 225US, 225USR)
0.35L (ZAXIS230, 270)

UNDERCARRIAGE / Swing Bearing

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UNDERCARRIAGE / Travel Device

REMOVE AND INSTALL TRAVEL DEVICE



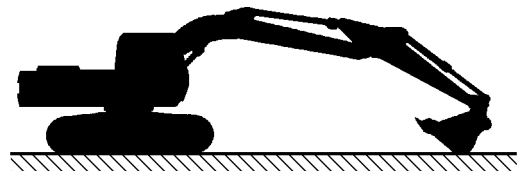
CAUTION: Escaping fluid under pressure may penetrate the skin, causing serious injury. Avoid this hazard by relieving pressure before disconnecting hydraulic lines.

Hydraulic oil may be hot just after operation, and may spurt possibly causing severe burns. Be sure to wait for oil to cool before starting any repair work.

The hydraulic oil tank cap may fly off by remaining pressure if removed quickly. Slowly loosen the cap to completely release any remaining pressure.

Preparation

1. Park the machine on a solid level surface. Lower the bucket to the ground.
2. Stop the engine. Push the air release valve on the hydraulic oil tank to release any pressure remaining in the hydraulic tank.
3. Remove the hydraulic oil tank cap. Connect a vacuum pump and operate it continuously to maintain negative pressure in the hydraulic oil tank.



M104-07-021



NOTE: Run the vacuum pump continuously while working on the hydraulic system.

UNDERCARRIAGE / Travel Device

Removal

The removal procedure below starts on the premise that track has been removed. As for the removal of track, refer to W3-7-1.

1. Remove bolt (7) and cover (6) to disconnect hoses (2 to 5).

Bolt (7)

 : 22 mm

 : 180 N·m (18.5 kgf·m, 134 lbf·ft)

Hoses (2 to 5)

 : 17 mm

 : 25 N·m (2.5 kgf·m, 18 lbf·ft)

 : 19 mm

 : 29 N·m (3.0 kgf·m, 21.5 lbf·ft)

 : 27 mm

 : 95 N·m (9.7 kgf·m, 70 lbf·ft)

 : 36 mm

 : 180 N·m (18.5 kgf·m, 134 lbf·ft)

 **NOTE:** Cap the ends of disconnected hoses and pipes.

2. Make preparation to hoist the travel device with wire rope.



CAUTION: Travel device weight:

310 kg (680 lb) (ZAXIS200, 200-E)

322 kg (710 lb) (ZAXIS225US, 225USR, 230)

480 kg (1060 lb) (ZAXIS270)

3. Remove bolt (1) to lift and remove the travel device by crane.

 : 30 mm

 : 630 N·m (64 kgf·m, 460 lbf·ft)

Installation

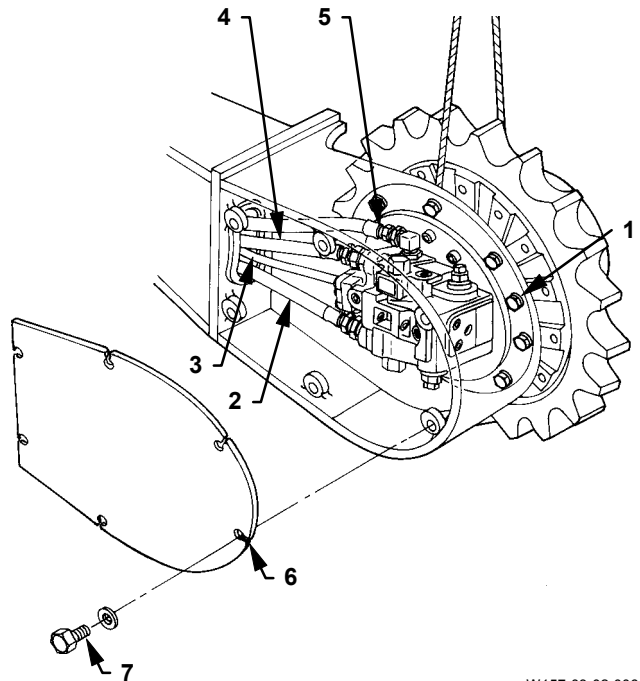
 **NOTE:** Refer to the "Removal" section for wrench sizes and tightening torque.

1. Secure the travel device with bolts (1).
2. Reconnect hoses (2 to 5) to the travel device.
3. Secure cover (6) with bolt (7).

IMPORTANT: After completing travel motor installation, be sure to fill the travel motor with hydraulic oil 1.2 L (0.32 US gal). After completing installation of the travel motor or the travel device, be sure to perform break-in operation to prevent motor seizure. Test drive as follows:

Break-in operation condition:

1. Engine control dial: Min. speed
2. Travel mode switch: Low speed
3. Operation duration: Above two minutes



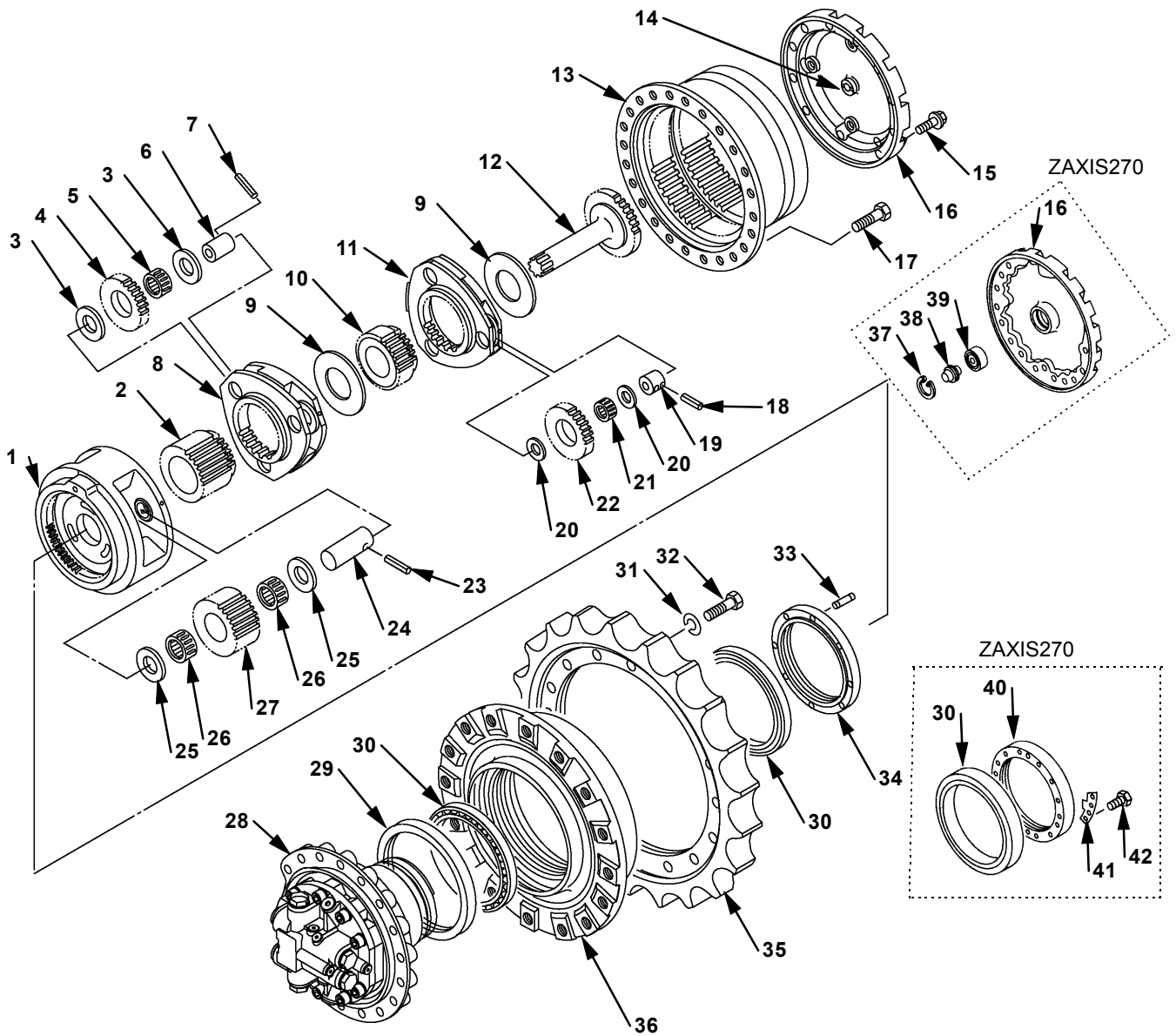
W157-03-02-006

UNDERCARRIAGE / Travel Device

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UNDERCARRIAGE / Travel Device

DISASSEMBLE TRAVEL REDUCER



W178-03-02-021

- | | | | |
|-----------------------------|------------------------------|------------------------------|---------------------|
| 1 - Third Stage Carrier | 12 - Shaft | 23 - Spring Pin (3 Used) | 33 - Knock Pin |
| 2 - Sun Gear | 13 - Ring Gear | 24 - Pin (3 Used) | 34 - Bearing Nut |
| 3 - Thrust Plate (6 Used) | 14 - Stopper | 25 - Thrust Plate (6 Used) | 35 - Sprocket |
| 4 - Planetary Gear (3 Used) | 15 - Bolt (12 Used) | 26 - Needle Bearing (6 Used) | 36 - Drum |
| 5 - Needle Bearing (3 Used) | 16 - Cover | 27 - Planetary gear (3 Used) | 37 - Retaining Ring |
| 6 - Pin (3 Used) | 17 - Bolt (24 Used) | 28 - Motor | 38 - Stopper |
| 7 - Spring Pin (3 Used) | 18 - Spring Pin (3 Used) | 29 - Floating Seal | 39 - Ball Bearing |
| 8 - Second Stage Carrier | 19 - Pin (3 Used) | 30 - Roller Bearing (2 Used) | 40 - Bearing Nut |
| 9 - Spacer (2 Used) | 20 - Thrust Plate (6 Used) | 31 - Spring Washer (16 Used) | 41 - Lock Plate |
| 10 - Sun Gear | 21 - Needle Bearing (3 Used) | 32 - *Bolt | 42 - Bolt (2 Used) |
| 11 - First Stage Carrier | 22 - Planetary Gear (3 Used) | | |

 **NOTE:** *ZAXIS 200, 200-E, 225US, 225USR, 230: 16 used
ZAXIS 270: 20 used

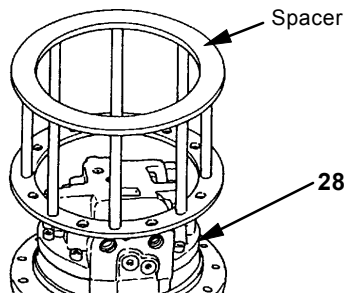
UNDERCARRIAGE / Travel Device

Disassemble Travel Reducer

CAUTION: High pressure may remain in the travel device. Gradually loosen the air vent plug to thoroughly release any remaining pressure.

1. With motor (28) facing upward, secure spacer to the track frame mounting flange of the motor with bolts (M20, Pitch 2.5) (2 used).

 : 30 mm



W105-03-02-007

Spacer ST 5090 (ZAXIS200, 200-E, 225US, 225USR, 230)

Spacer ST 5102 (ZAXIS270)

CAUTION: Travel device weight:
310 kg (680 lb): (ZAXIS200, 200-E)
322 kg (710 lb): (ZAXIS225US, 225USR, 230)
477 kg (1050 lb) : (ZAXIS270)

2. Secure motor (28) body with a nylon sling, then hoist it and turn it over by crane.

 **NOTE:** Secure spacer tightly to receive the reaction force.

3. Remove cover (16) from ring gear (13).

 **NOTE:** *THREEBOND* has been applied between the cover and ring gear. Insert a chisel between the cover and ring gear, lightly tap it with a hammer for easier removal. Don't remove stoppers (14) or (38) from the cover unless damage and wear are found.

 : 19 mm

4. Remove shaft (12), the first stage carrier (11) assembly from ring gear (13).

5. Remove sun gear (10) from ring gear (13).

6. Remove the second stage carrier (8) assembly from ring gear (13).

7. Remove sun gear (2) from ring gear (13).

8. Remove mounting bolt (17) from ring gear (13).

 : 24 mm

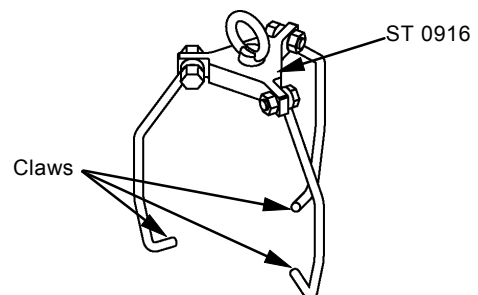
CAUTION: Ring gear weight:
40 kg (90 lb)
(ZAXIS200, 200-E, 225US, 225USR, 230)
55 kg (120 lb) : (ZAXIS270)

9. Install eyebolts (M12, Pitch 1.75) (2 used) to the bolt (15) holes in ring gear (13). Hoist them by crane to remove the ring gear from drum (36).

 **NOTE:** *THREEBOND* has been applied between the drum and ring gear. If it is difficult to remove, use a screwdriver to pry them off.

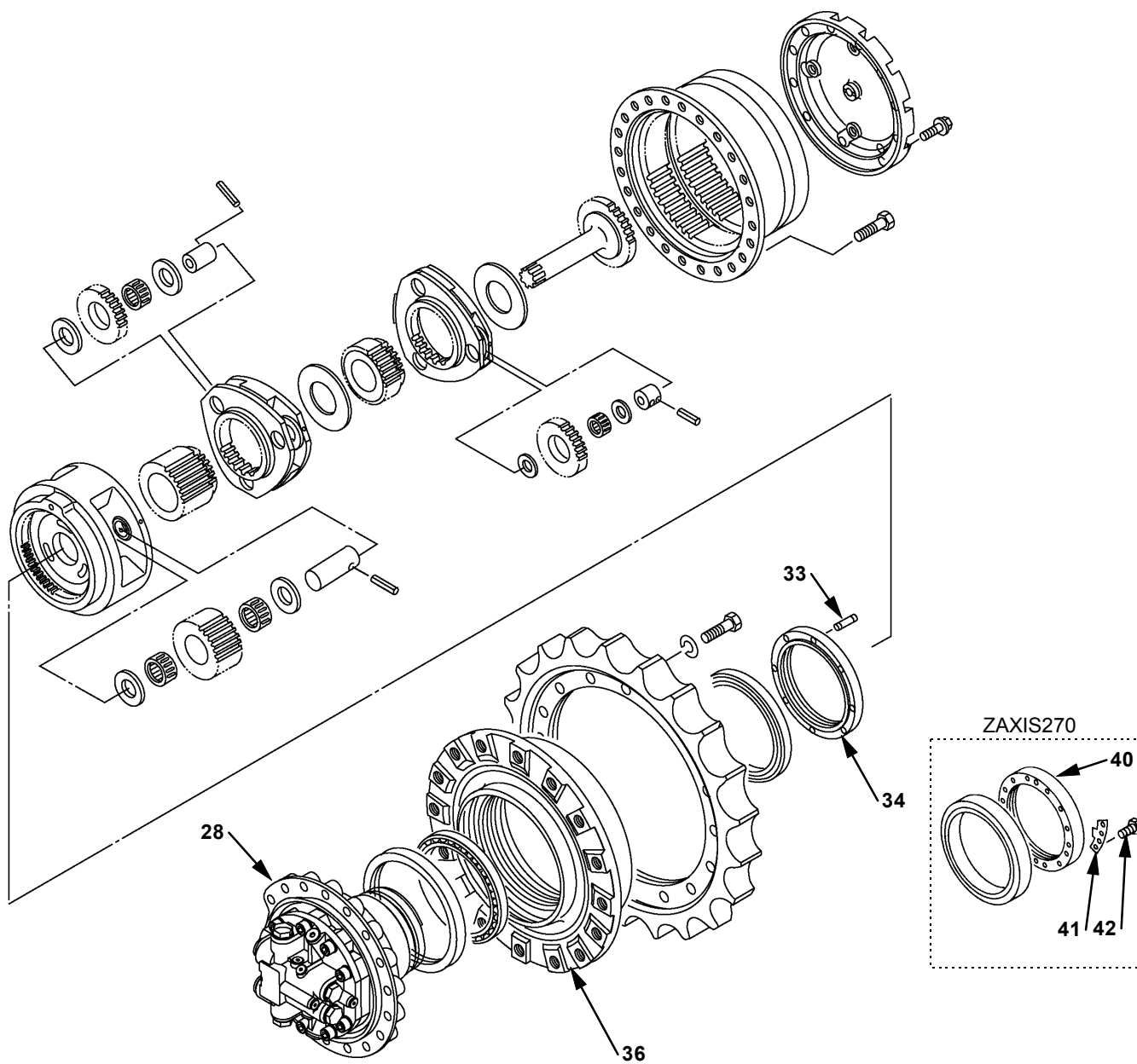
CAUTION: The third stage carrier assembly weight: 31 kg (70 lb)
(ZAXIS200,200-E, 225US, 225USR, 230)
52 kg (110 lb) : (ZAXIS270)

10. Hook claws (ST 0916) to the third stage carrier (1) and lift it by crane to remove the third stage carrier assembly from drum (36).



W178-03-02-001

UNDERCARRIAGE / Travel Device



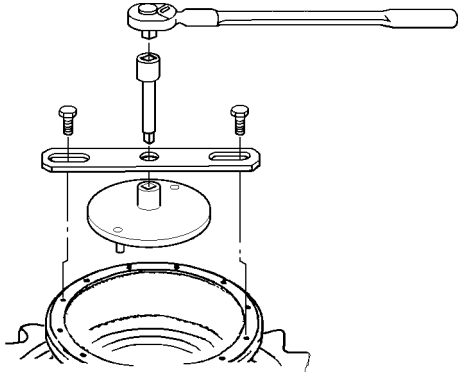
W178-03-02-020

UNDERCARRIAGE / Travel Device

11. (ZAXIS200, 200-E, 225US, 225USR, 230)

Using special tools (ST 7248) and (ST 7249), turn and remove bearing nut (34) from the motor (28) housing.

Do not remove knock pin (33) unless necessary.



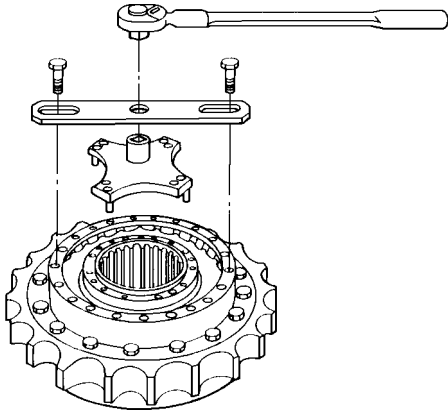
W178-03-02-013

(ZAXIS270)

Remove bolt (42) to remove lock plate (41) from bearing nut (40).

Using special tools (ST 3050), (ST 3051) and (ST 3052), turn and remove bearing nut (40) from motor (28) housing.

🔧 : 19 mm



W157-03-02-005



CAUTION: Sprocket + drum weight:

94 kg (210 lb): (ZAXIS200, 200-E)

100 kg (220 lb): (ZAXIS225US, 225USR, 230)

133kg (290 lb): (ZAXIS270)

IMPORTANT: The motor (28) side of drum (36) is the sliding surface with the motor. Place the drum on wooden blocks after removal.

12. Install eyebolts (M16, Pitch 2.0) (2 used) to drum (36). Hoist it by crane to remove motor (28) from the drum.



NOTE: When it is difficult to remove the motor, turn sprocket (35).

13. Remove floating seal (29) from motor (28).

14. Remove the inner race of roller bearing (30) from drum (36).



CAUTION: Drum weight:

49 kg (110 lb): (ZAXIS200, 200-E)

56 kg (120 lb): (ZAXIS225US, 225USR, 230)

65kg (140 lb): (ZAXIS270)

15. Remove sprocket (35) from drum (36) as follows:

- Remove bolts (32) (16 used). (ZAXIS270 is 20 used)
- Secure the sprocket with a nylon sling and hoist it by crane to remove it slowly.

🔧 : 30 mm



NOTE: LOCTITE has been applied on the bolt.



CAUTION: Drum weight:

49 kg (110 lb): (ZAXIS200, 200-E)

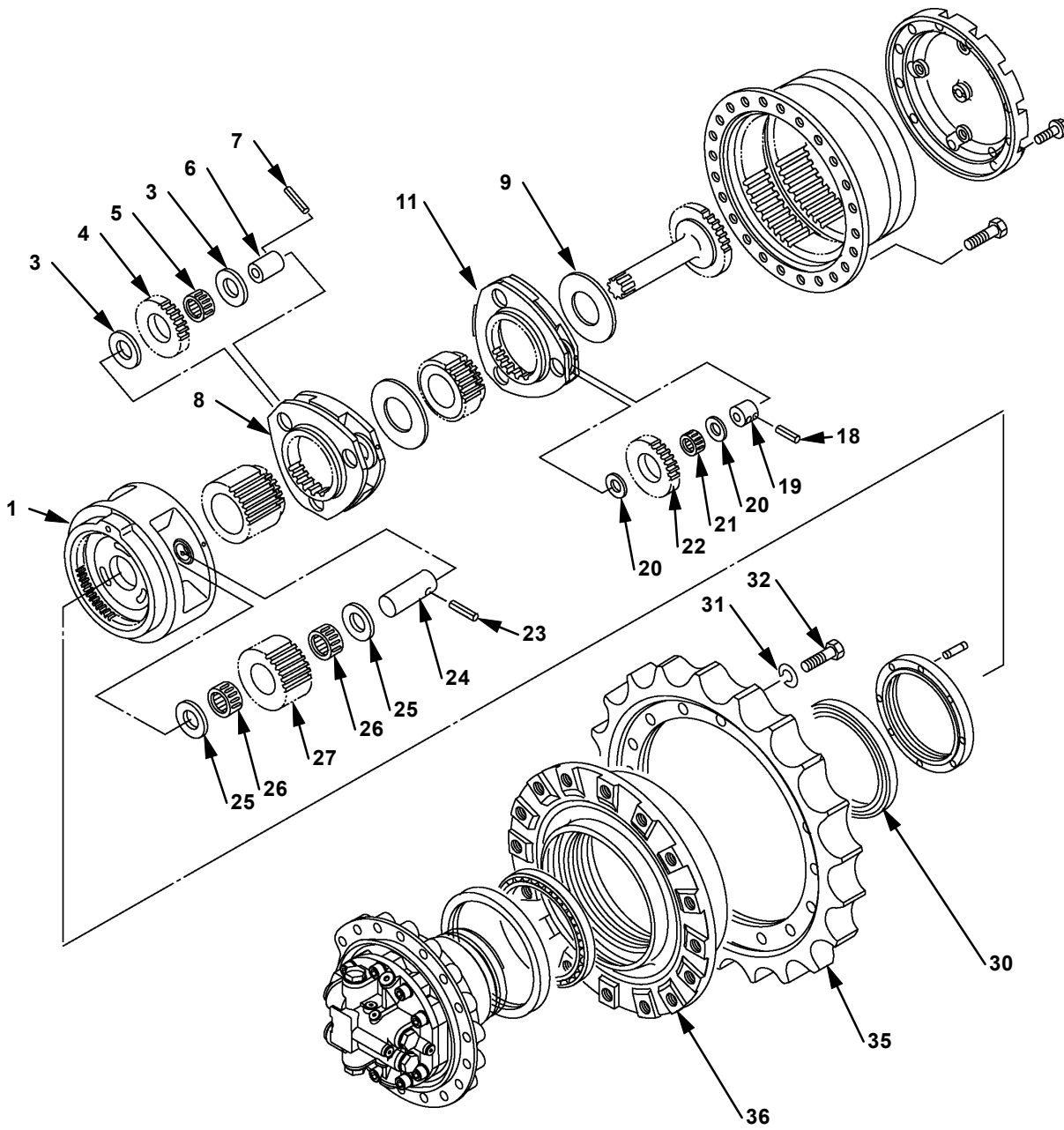
56 kg (120 lb): (ZAXIS225US, 225USR, 230)

65 kg (140 lb): (ZAXIS270)

16. Install eyebolt (M20, Pitch 2.5) to the bolt (32) holes in drum (36) and hoist it by crane to turn it over.

17. Remove floating seal (29) from drum (36).

UNDERCARRIAGE / Travel Device



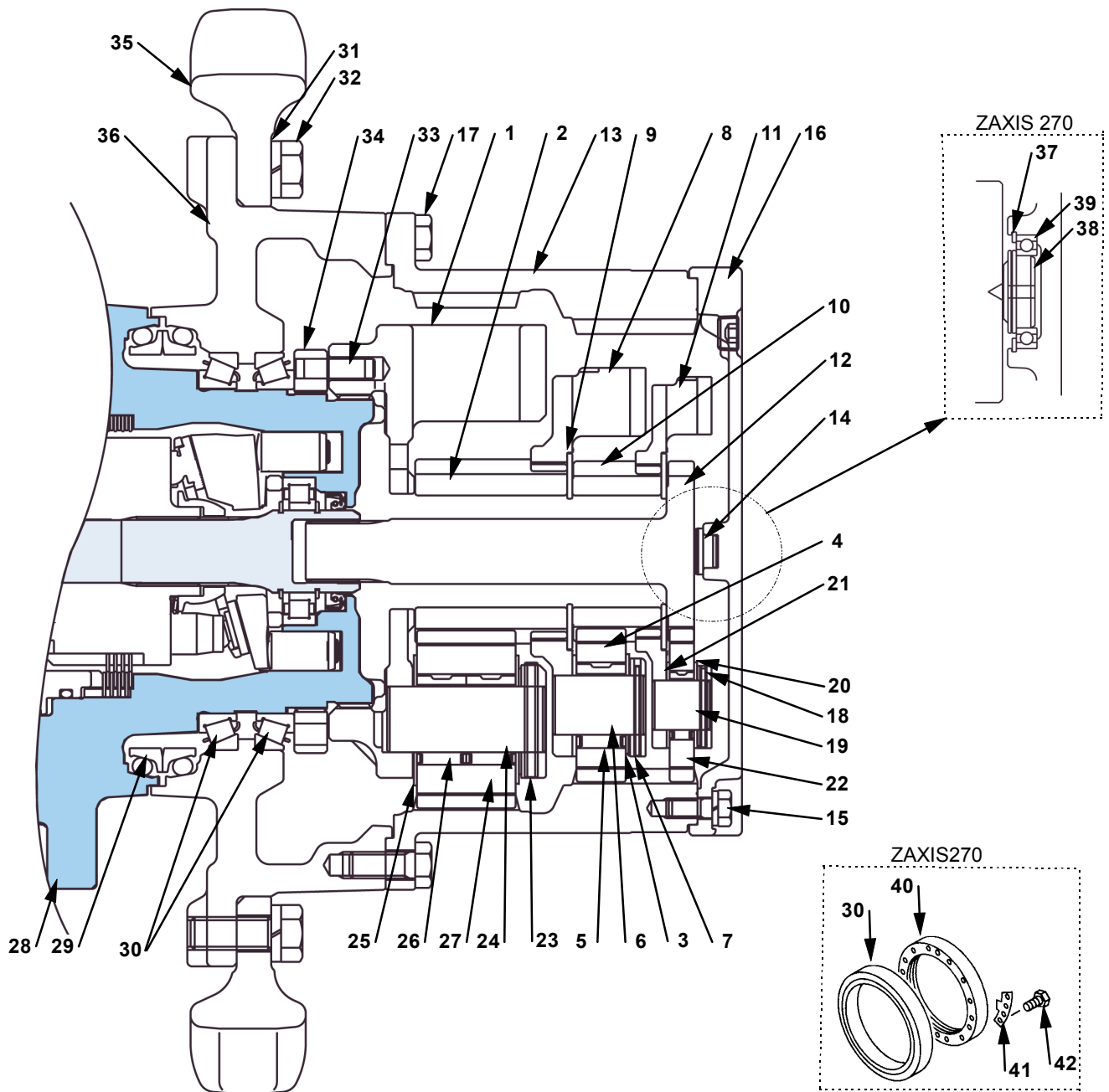
W178-03-02-002

UNDERCARRIAGE / Travel Device

18. Tap on the back of each outer race of roller bearing (30) (2 used) on drum (36) with a bar and hammer evenly to remove it. However, don't remove it unless replacing it.

 **NOTE:** *There is no need to replace the inner race of roller bearing (30) on the motor side, so don't remove it.*

19. Disassemble the first stage carrier (11) assembly.
- Tap spring pin (18) out from the first stage carrier (11) using pin (ST 1391). (3 places)
 - Remove pins (19) (3 used), thrust plates (20) (6 used), planetary gears (22) (3 used), needle bearings (21) (3 used), spacer (9) from the first stage carrier (11).
20. Disassemble the second stage carrier (8) assembly.
- Tap spring pin (7) out from second stage carrier (8) using pin (ST 1391). (3 places)
 - Remove pins (6) (3 used), thrust plates (3) (6 used), planetary gears (4) (3 used), needle bearings (5) (3 used), spacer (9) from second stage carrier (8).
21. Disassemble the third stage carrier (1) assembly.
- Tap spring pin (23) out from third stage carrier (1) using pin (ST 1463). (3 places)
 - Remove pins (24) (3 used), thrust plates (25) (6 used), planetary gears (27) (3 used), needle bearings (26) (6 used) from third stage carrier (1).



W178-03-02-024

- | | | | |
|-----------------------------|------------------------------|------------------------------|---------------------|
| 1 - Third Stage Carrier | 12 - Shaft | 23 - Spring Pin (3 Used) | 33 - Knock Pin |
| 2 - Sun Gear | 13 - Ring Gear | 24 - Pin (3 Used) | 34 - Bearing Nut |
| 3 - Thrust Plate (6 Used) | 14 - Stopper | 25 - Thrust Plate (6 Used) | 35 - Sprocket |
| 4 - Planetary Gear (3 Used) | 15 - Bolt (12 Used) | 26 - Needle Bearing (6 Used) | 36 - Drum |
| 5 - Needle Bearing (3 Used) | 16 - Cover | 27 - Planetary gear (3 Used) | 37 - Retaining Ring |
| 6 - Pin (3 Used) | 17 - Bolt (24 Used) | 28 - Motor | 38 - Stopper |
| 7 - Spring Pin (3 Used) | 18 - Spring Pin (3 Used) | 29 - Floating Seal | 39 - Ball Bearing |
| 8 - Second Stage Carrier | 19 - Pin (3 Used) | 30 - Roller Bearing (2 Used) | 40 - Bearing Nut |
| 9 - Spacer (2 Used) | 20 - Thrust Plate (6 Used) | 31 - Spring Washer (16 Used) | 41 - Lock Plate |
| 10 - Sun Gear | 21 - Needle Bearing (3 Used) | 32 - *Bolt | 42 - Bolt (2 Used) |
| 11 - First Stage Carrier | 22 - Planetary Gear (3 Used) | | |

NOTE: *ZAXIS 200, 200-E, 225US, 225USR, 230: 16 used
ZAXIS 270: 20 used

UNDERCARRIAGE / Travel Device

Assemble Travel Reducer

1. If roller bearing (30) on motor (28) has been replaced with a new one, the inner race should be heated to the temperature of 50 to 70°C (122 to 158 °F) with a heater first, then assemble it to motor (28). Tap the bearing fully with a bar after it cooled.

 **NOTE:** Tap the bearing and listen to ring to confirm installation is completed.

2. Apply enough grease to the O-ring of floating seal (29).
Install one side of the floating seal to motor (28).

 **NOTE:** If it is difficult to insert the O-ring of floating seal to the motor, try to push the O-ring with a bamboo spatula.

IMPORTANT: Do not tap other parts except the outer race.

3. Tap the outer race of roller bearing (30) on bearing nut (34) side evenly with a bar and hammer until it fits steady into drum (36).

 **NOTE:** Tap the bearing and listen to ring to confirm installation is completed.

 **CAUTION: Drum weight:**
49 kg (110 lb): (ZAXIS200, 200-E)
56 kg (120 lb): (ZAXIS225US, 225USR, 230)
65 kg (140 lb): (ZAXIS270)

4. Install eyebolts (M20, Pitch 2.5) to the bolt (32) hole of drum (36). Place the drum with the ring gear (13) mounting side facing downward.

IMPORTANT: Do not tap the other parts except the outer race.

5. Tap the outer race on roller bearing (30) at motor (28) side evenly with a bar and hammer until it fits steady into drum (36).

 **NOTE:** Tap the bearing and listen to ring to confirm installation is completed.

6. Apply enough grease to the O-ring of floating seal (29).
Install one side of the floating seal to drum (36).
7. Install eyebolts (M20, Pitch 2.5) to the bolt (32) hole of drum (36). Lift it and place the drum with the motor (28) mounting side facing downward.

 **CAUTION: Sprocket weight:**
46 kg (100 lb):
(ZAXIS200, 200-E, 225US, 225USR, 230)
70 kg (150 lb): (ZAXIS270)

IMPORTANT: Match the chamfered side of sprocket to the drum.

8. Secure sprocket (35) with a nylon sling, hoist and place it on drum (36).
Apply LOCTITE #262 to bolts (32) (16 used). Then tighten it with the bolts and spring washer (31) (16 used).

 : 30 mm

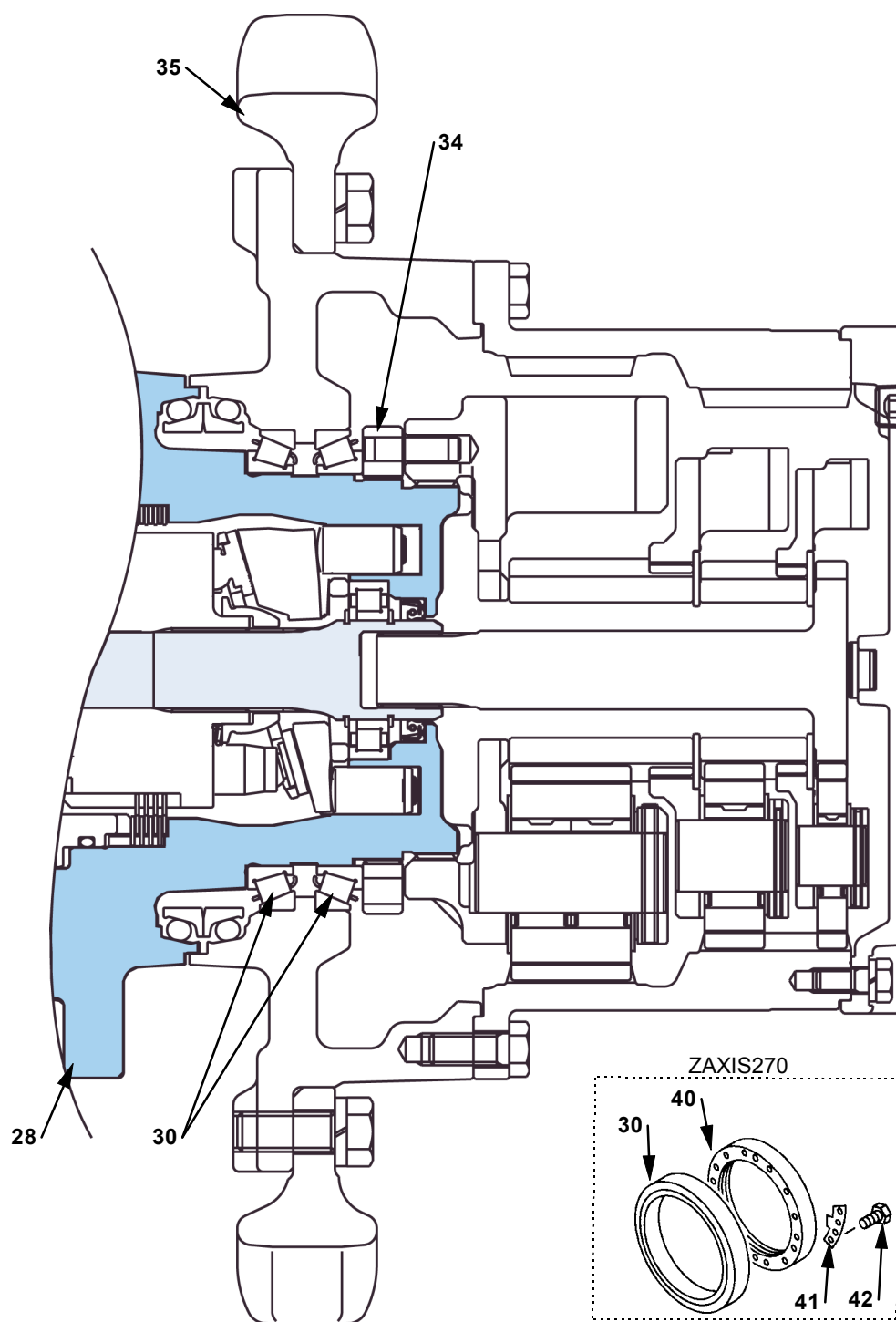
 : 490 N·m (50 kgf·m, 360 lbf·ft)

 **CAUTION: Sprocket + drum weight:**
94 kg (210 lb): (ZAXIS200, 200-E)
100 kg (220 lb): (ZAXIS225US, 225USR, 230)
133 kg (290 lb): (ZAXIS270)

9. Install eyebolts (M16, Pitch 2.0) (2 used) to the threaded hole for bolt (17) on drum (36). Hoist drum (36) by crane and place it on motor (28) straight. Then make sure that the motor contacts with drum evenly.

10. Push drum (36) straight down from above into motor (28) while shaking it.

UNDERCARRIAGE / Travel Device



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UNDERCARRIAGE / Travel Device

11. Install the inner race of roller bearing (30) to motor (28), tapping it with a bar and hammer.

 **NOTE:** It is very stiff to install. Carry out step 10 and 11 repeatedly so that the inner race side of the bearing nut (34) comes to the position that 3 pitches of thread for the bearing nut appears.

12. Apply a little grease to the thread of bearing nut (34).

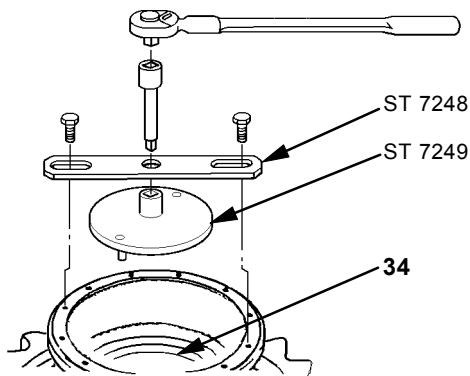
 **NOTE:** Apply grease when tightening it to the specified torque.

IMPORTANT: Assembling the bearing nut with its stepped portion facing inside.

13. Install bearing nut (34) to motor (28) and tighten it by hand.

14. (ZAXIS200, 200-E, 225US, 225USR, 230)
Install special tools (ST 7248, ST 7249) to bearing nut (34) with a torque wrench.

 : 790 N·m (80 kgf·m, 580 lbf·ft)



W178-03-02-013

(ZAXIS270)

Install special tools (ST 3053, ST 3050, ST 3052) to bearing nut (40) with a torque wrench.

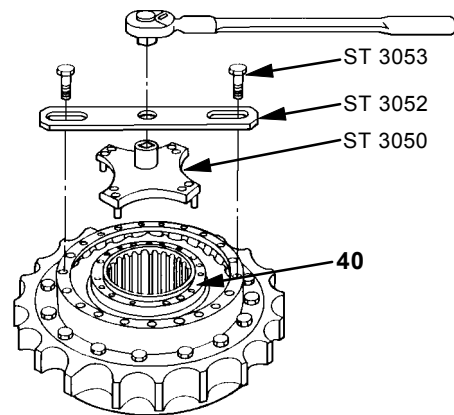
 : 790 N·m(80 kgf·m, 580 lbf·ft)

15. After tightening bearing nut (34) or (40) to specified torque, reduce play on bearing nut (34) by tapping sprocket (35) with a hammer. Then rotate the sprocket both clockwise and counterclockwise 4 to 5 turns.

16. Carry out steps 14 and 15 repeatedly.

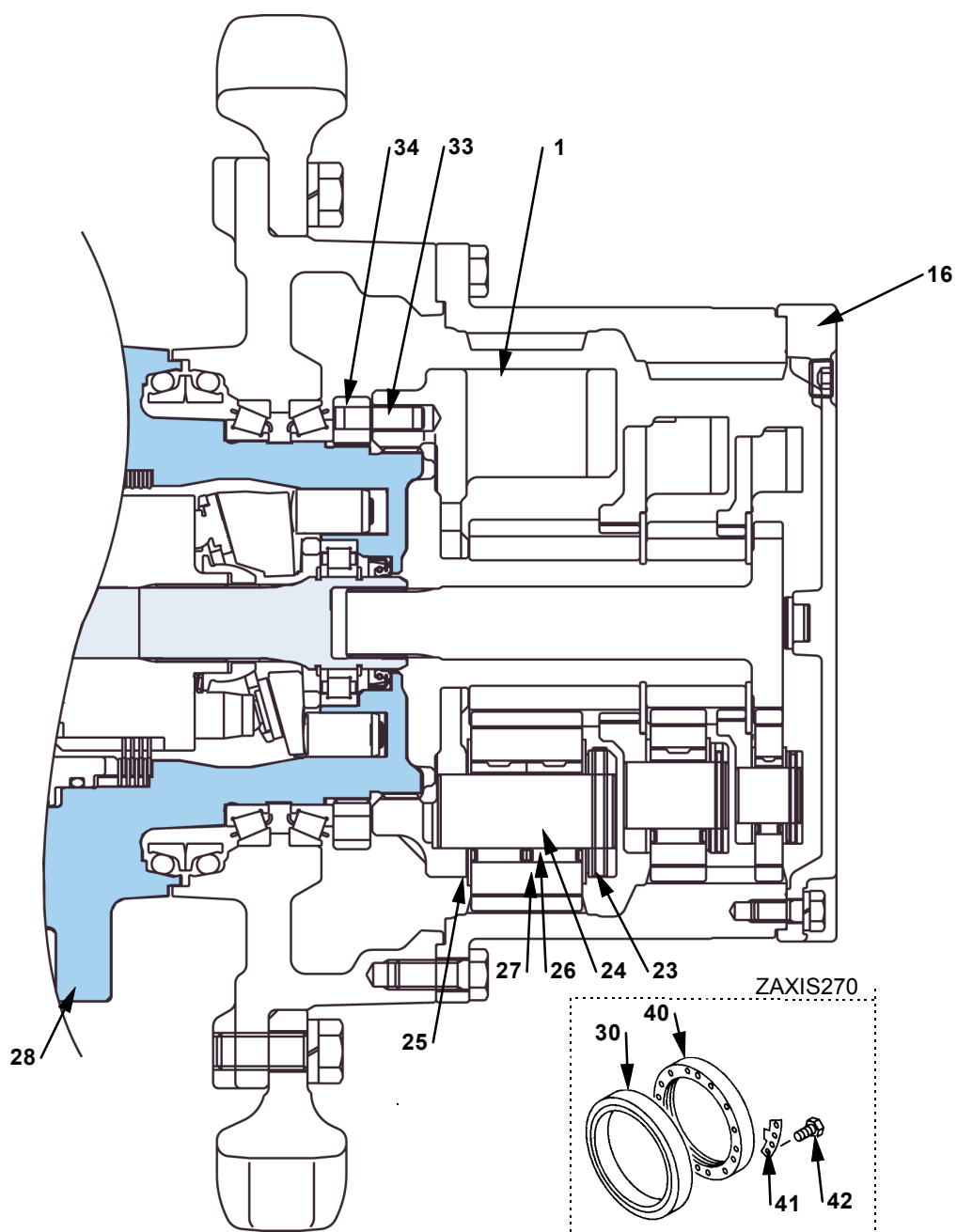
17. Do step 14 again to tighten bearing nut (34) or (40) to specified torque.

 : 790 N·m (80 kgf·m, 580 lbf·ft)



W157-03-02-005

UNDERCARRIAGE / Travel Device



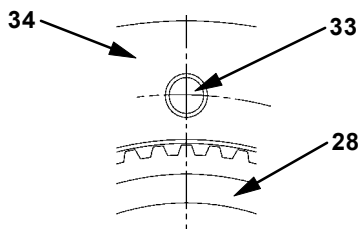
W178-03-02-023

UNDERCARRIAGE / Travel Device

18. (ZAXIS200, 200-E, 225US, 225USR, 230)

Align the spline center of motor (28) with that of knock pin (33). If they can't be aligned well, turn bearing nut (34) to tightening direction to align them.

 **NOTE:** The aim, to do so, is to align the spline of the third stage carrier (1) with knock pin (33). If the work is continued without aligning, cover (16) can't be installed as it will protrude.



W176-03-02-004

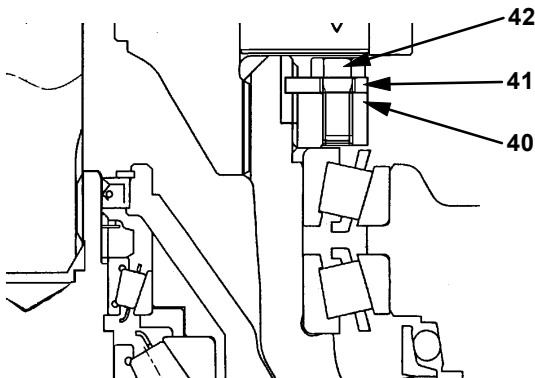
(ZAXIS270)

Apply LOCTITE #262 to bolts (42) (2 used). Install lock plate (41) onto bearing nut (40) with bolt (42).

If the bolt hole of lock plate can't be aligned well, turn bearing nut (40) to tightening direction to align them.

 : 19 mm

 : 88 N·m (9 kgf·m, 65 lbf·ft)



W140-03-02-001

IMPORTANT: There is a mark on one side of third stage planetary gear (27). Be sure that this marked side faces the hole for spring pin (23).

19. Assemble the third stage carrier (1) in the following steps.

- Install needle bearings (26) (2 used) to planetary gear (27).
- Clamp planetary gear (27) with thrust plates (25) (2 used). Insert the planetary gear (27) into third stage carrier (1).
- Install pin (24) to third stage carrier (1) to secure the planetary gear. At this moment, align the spring pin hole in the carrier with that of in the pin.
- Tap in spring pin (23) to third stage carrier (1). Be sure that the slit in the spring pin faces the pin (24) end.



W178-02-06-002

- Install the other two planetary gears (27) to the third stage carrier by same procedures.

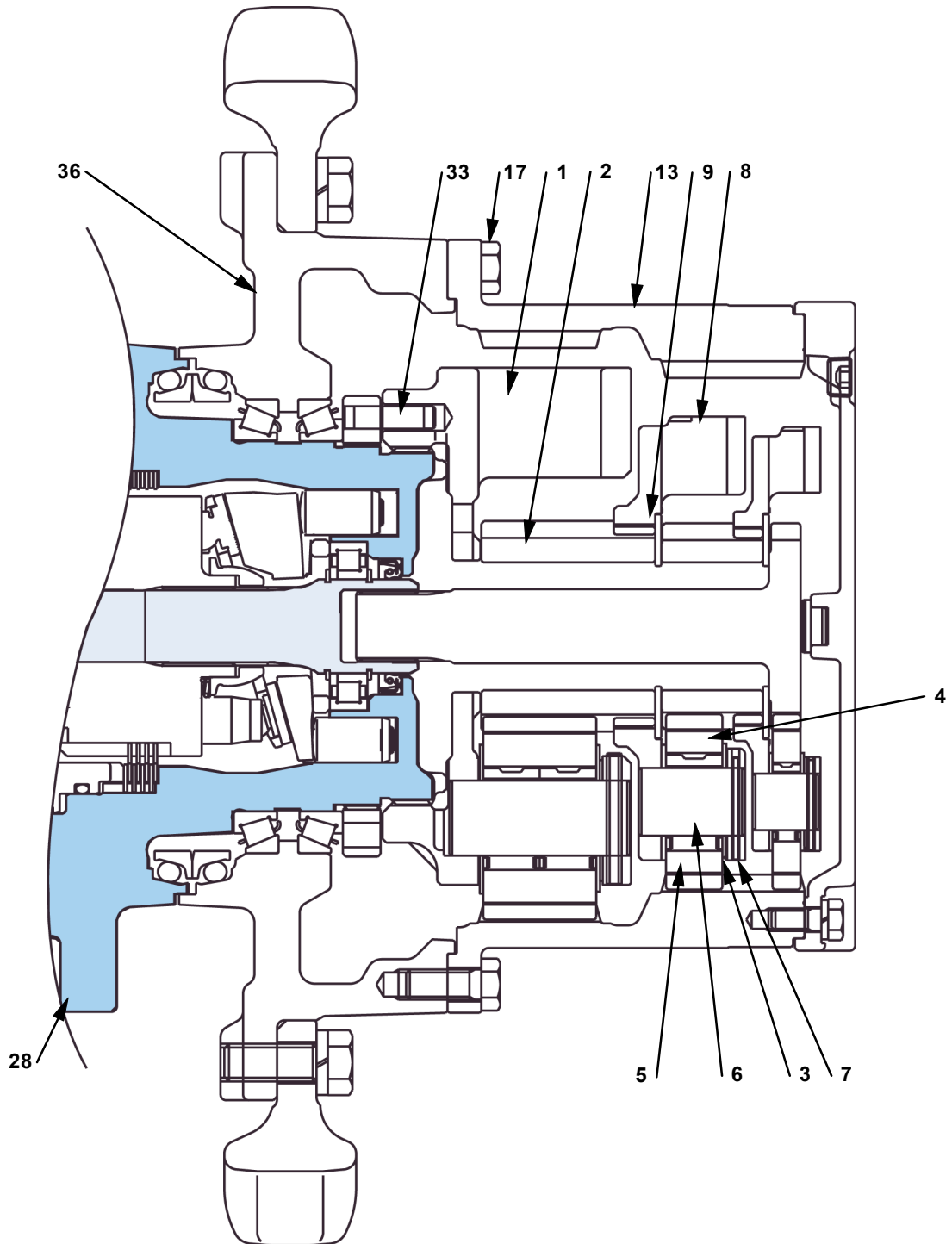


CAUTION: Third stage carrier (1) assembly weight: 31 kg (70 lb): (ZAXIS200, 200-E, 225US, 225USR, 230)
52 kg (110 lb): (ZAXIS270)



CAUTION: When the knock pin fits with the third stage carrier, the third stage carrier will drop down. Take care not to injure your fingers.

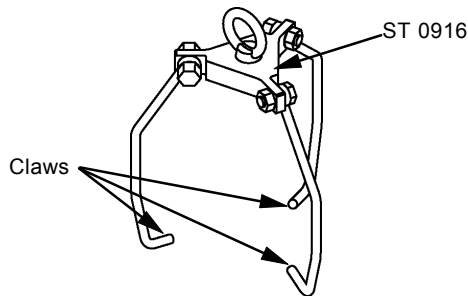
UNDERCARRIAGE / Travel Device



W178-03-02-025

UNDERCARRIAGE / Travel Device

20. Hoist the third stage carrier (1) assembly using special tool (ST 0916) and install it to the motor (28) spline. If alignment work is not carried out as in step 18, knock pin (33) can't be inserted into the third stage carrier.



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21. Clean the ring gear (13) mating surface of drum (36). Apply THREEBOND #1215 on the surface.



CAUTION: Ring gear weight:

40 kg (90 lb):

(ZAXIS200, 200-E, 225US, 225USR, 230)

55 kg (120 lb): (ZAXIS270)

22. Install eyebolts (M12, Pitch 1.75) to the bolt (15) holes in ring gear (13). Hoist to align the bolt (17) hole by crane and install it onto drum (36).

23. Install ring gear (13) to drum (36) with bolt (17).

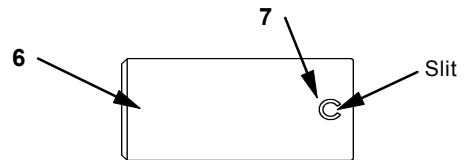
 : 24 mm

 : 265 N·m (27 kgf·m, 195 lbf·ft)

24. Insert sun gear (2) into third stage carrier (1) with the smaller end facing upward.

25. Assemble the second stage carrier (8) in the following steps.

- Install needle bearing (5) to second stage planetary gear (4).
- Clamp planetary gear (4) with thrust plates (3) (2 used). Install the planetary gear to second stage carrier (8).
- Install pin (6) to second stage carrier (8), then align the spring pin (7) hole in the second stage carrier with that in pin (6).
- Tap in the spring pin (7) to second stage carrier (8). Be sure that the slit in the spring pin faces pin (6) end.

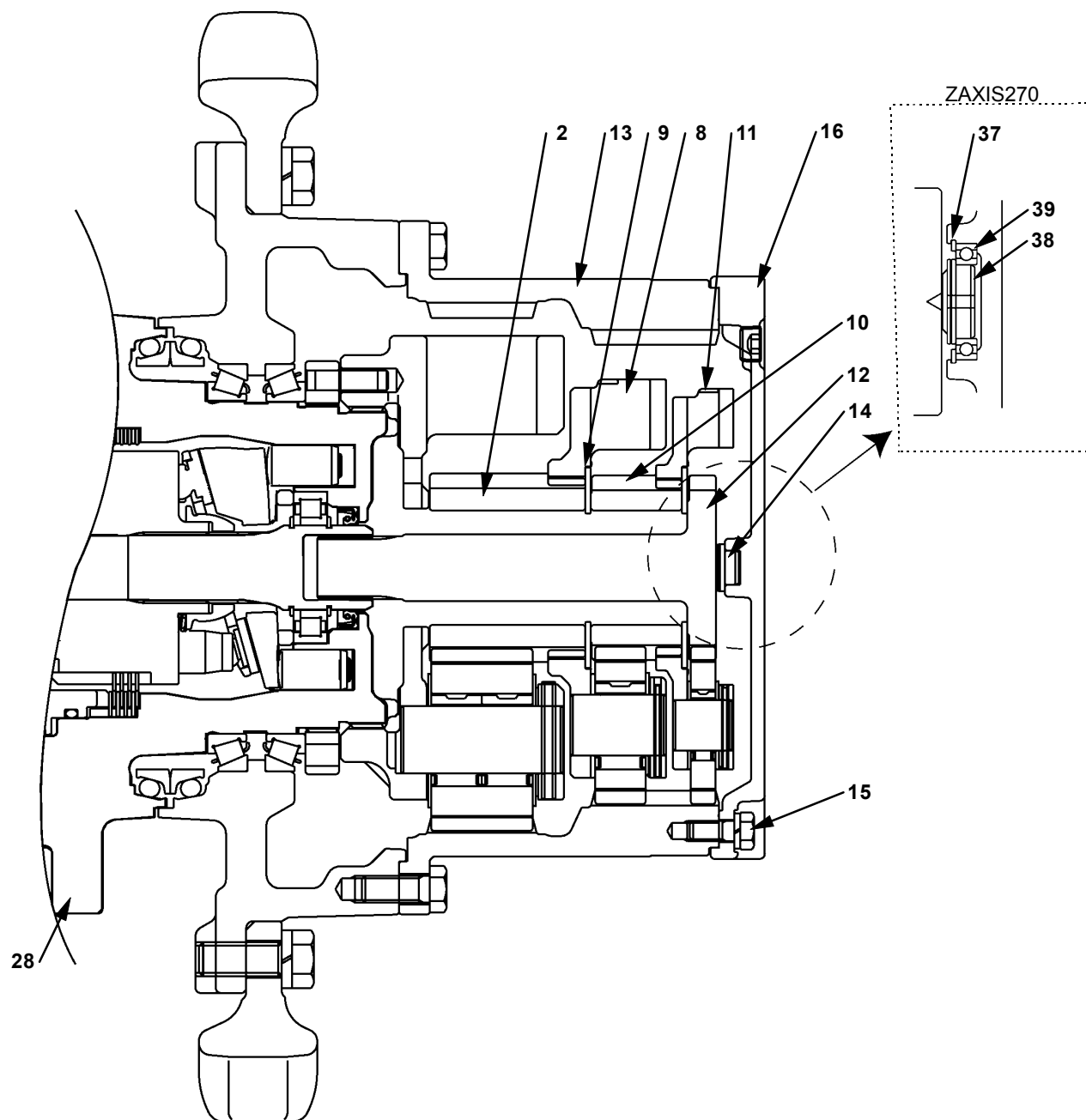


W178-02-06-002

- Install spacer (9) to second stage carrier (8).
- Install the other two planetary gears (4) to second stage carrier (8) by same procedures.

26. Install the second stage carrier (8) assembly to ring gear (13).

UNDERCARRIAGE / Travel Device



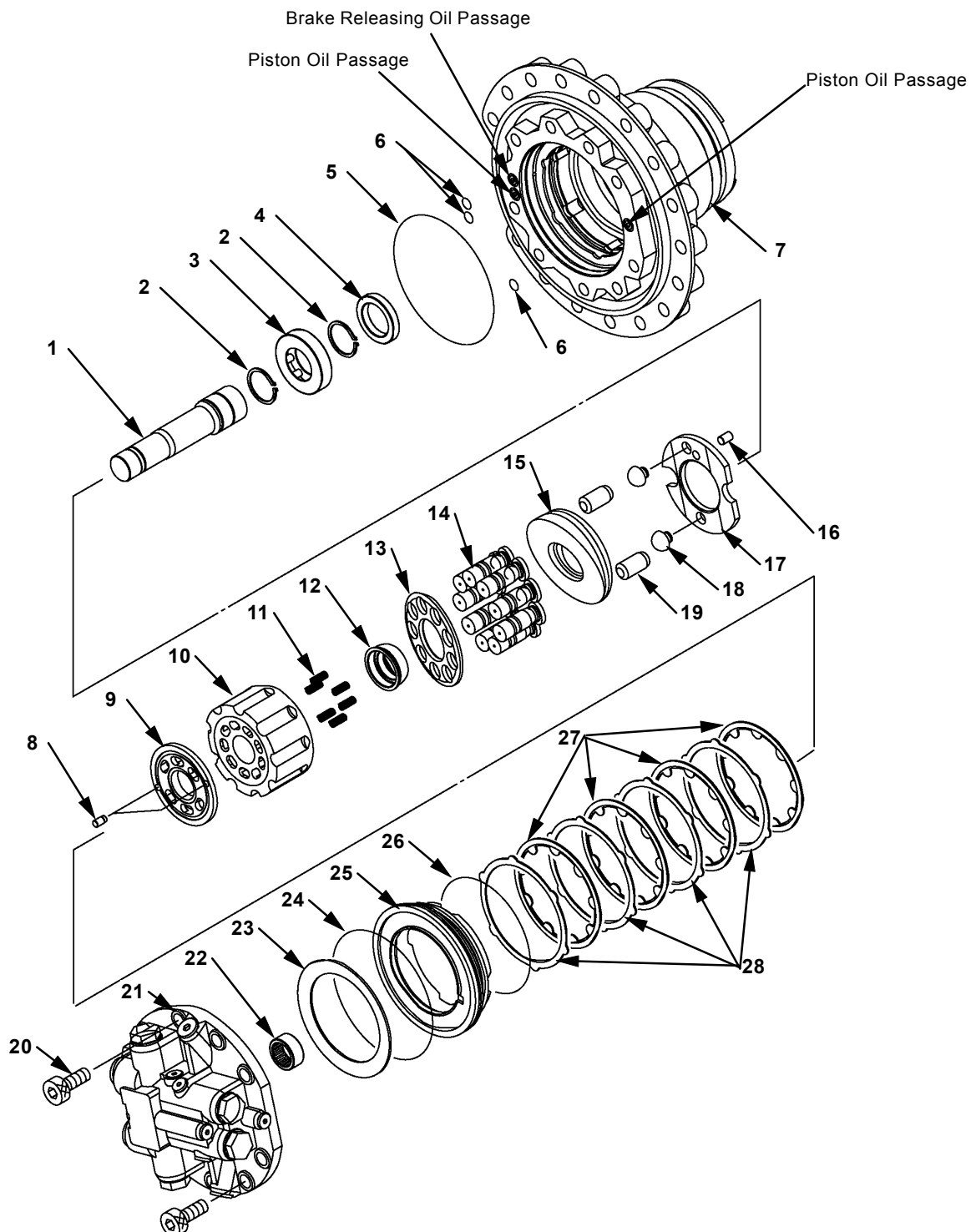
W178-03-02-022

UNDERCARRIAGE / Travel Device

27. Insert sun gear (10) into second stage carrier (8) with the smaller outer diameter end facing upward.
28. Assemble first stage carrier (11) on the second stage carrier (8) by same procedure .
29. Install the first stage carrier (11) assembly to ring gear (13).
30. Insert shaft (12) into the center spline of sun gear (10). Engage the shaft with the motor (28) spline and sun gear (2).
31. Supply gear oil into ring gear (13).
Gear Oil: 7 L (1.8 US gal)
32. (ZAXIS200, 200-E, 225US, 225USR, 230)
Install stopper (14) into cover (16).
(ZAXIS270)
Install bearing (39), retaining ring (37) and stopper (38) into cover (16).
33. Clean the mating surfaces of ring gear (13) and cover (16). Apply THREEBOND #1215 to the surfaces.
34. Install cover (16) to ring gear (13) with bolts (15) (12 used).
 : 19 mm
 : 110 N·m (11.5 kgf·m, 83.2 lbf·ft)
ZAXIS200, 200-E, 225US, 225USR, 230
Bolts (15) (12 used)
ZAXIS270 Bolts (15) (12 used)

UNDERCARRIAGE / Travel Device

DISASSEMBLE TRAVEL MOTOR (ZAXIS200, 200-E, 225US, 225USR, 230)



W178-03-02-003

UNDERCARRIAGE / Travel Device

Disassemble Travel Motor
ZAXIS200, 200-E, 225US, 225USR, 230

CAUTION: Travel motor weight: 92 kg (200 lb)

IMPORTANT: When removing brake valve (21) from the travel motor, valve plate (9) is also removed with the brake valve. Do not drop the valve plate as it easily comes off.

1. Place the travel motor longitudinally.
Remove socket bolt (20) to remove brake valve (21) from housing (7).

 : 14 mm

IMPORTANT: Valve plate (9) is easily cracked and scratched, so handle it with care.

2. Remove valve plate (9) and knock pins (8) (2 used) from brake valve (21). Do not remove needle bearing (22) unless necessary.

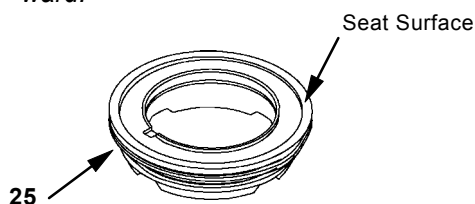
 **NOTE:** Even if a small removing tool is used for removing the needle bearing, the outer race may be deformed. Do not re-use the needle bearing.

3. Wrap tape on the needle bearing (22) rotation surface of shaft (1) for protection.
4. Remove disc spring (23) from housing (7).

CAUTION: When removing the brake piston from the housing filled with air, cover the housing with cloth to prevent the brake piston from flying out.

5. Apply 100 to 300 kPa (1 to 3 kgf/cm², 14 to 43 psi) pressure air to brake releasing oil passage in housing (7), so that brake piston (25) will float up to be removed.

 **NOTE:** The upper surface of brake piston is the seat surface. Place the seat surface upward.



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6. Remove plates (28) and friction plates (27) from housing (7). (4 used for each)
7. Remove rotor (10), springs (11) (6 used), bushing (12), retainer (13) and plungers (14) (9 used) from housing (7).

CAUTION: Housing weight: 55 kg (120 lb)

8. Place housing (7) with the brake releasing oil passage facing downward and horizontal.

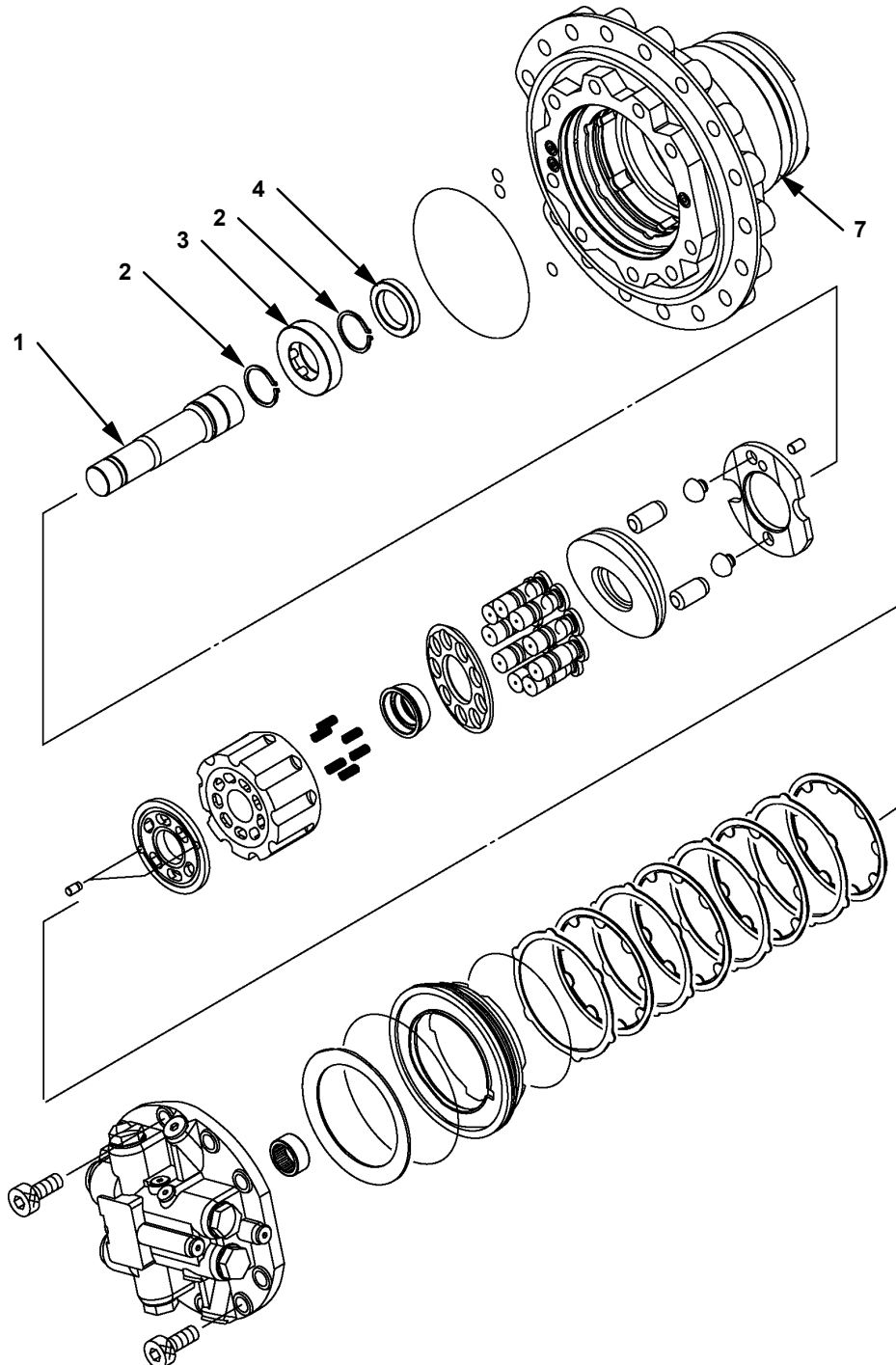
 **NOTE:** When the brake releasing oil passage is positioned up, the thick portion of swash plate (15) faces upward. When housing (7) is placed horizontally, the swash plate may come off suddenly.

9. Remove swash plate (15) from housing (7).

 **NOTE:** If the swash plate can't be removed, apply 100 to 300 kPa (1 to 3 kgf/cm², 14 to 43 psi) pressure air through the piston pushing oil passage port, and the swash plate will be removed with the piston. In order to prevent the piston from popping out, cover it with a cloth. Use a bicycle pump to supply air.

10. Using a magnet, remove balls (18) (2 used) and piston (19) (2 used) from housing (7).
11. Remove plate (17) from housing (7).
12. Tap the bottom in the spline bore of shaft (1) with a bar and plastic hammer to push the shaft out with roller bearing (3) from housing (7).

UNDERCARRIAGE / Travel Device



W178-03-02-003

UNDERCARRIAGE / Travel Device

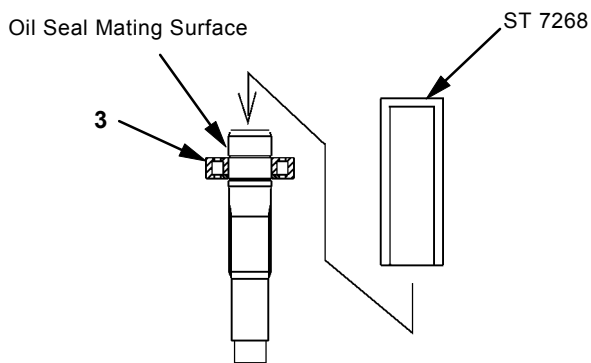
13. Insert a screwdriver into shaft (1) hole in housing (7) to push out oil seal (4).

 **NOTE:** *Since the oil seal has been covered with adhesive, it can't be used again.*

14. Remove retaining rings (2) (2 used) from shaft (1).
15. Remove the inner ring plate of roller bearing (3) from shaft (1).

IMPORTANT: In order to protect the oil seal mating surface of the shaft, insert the special tool from the oil seal mating surface side.

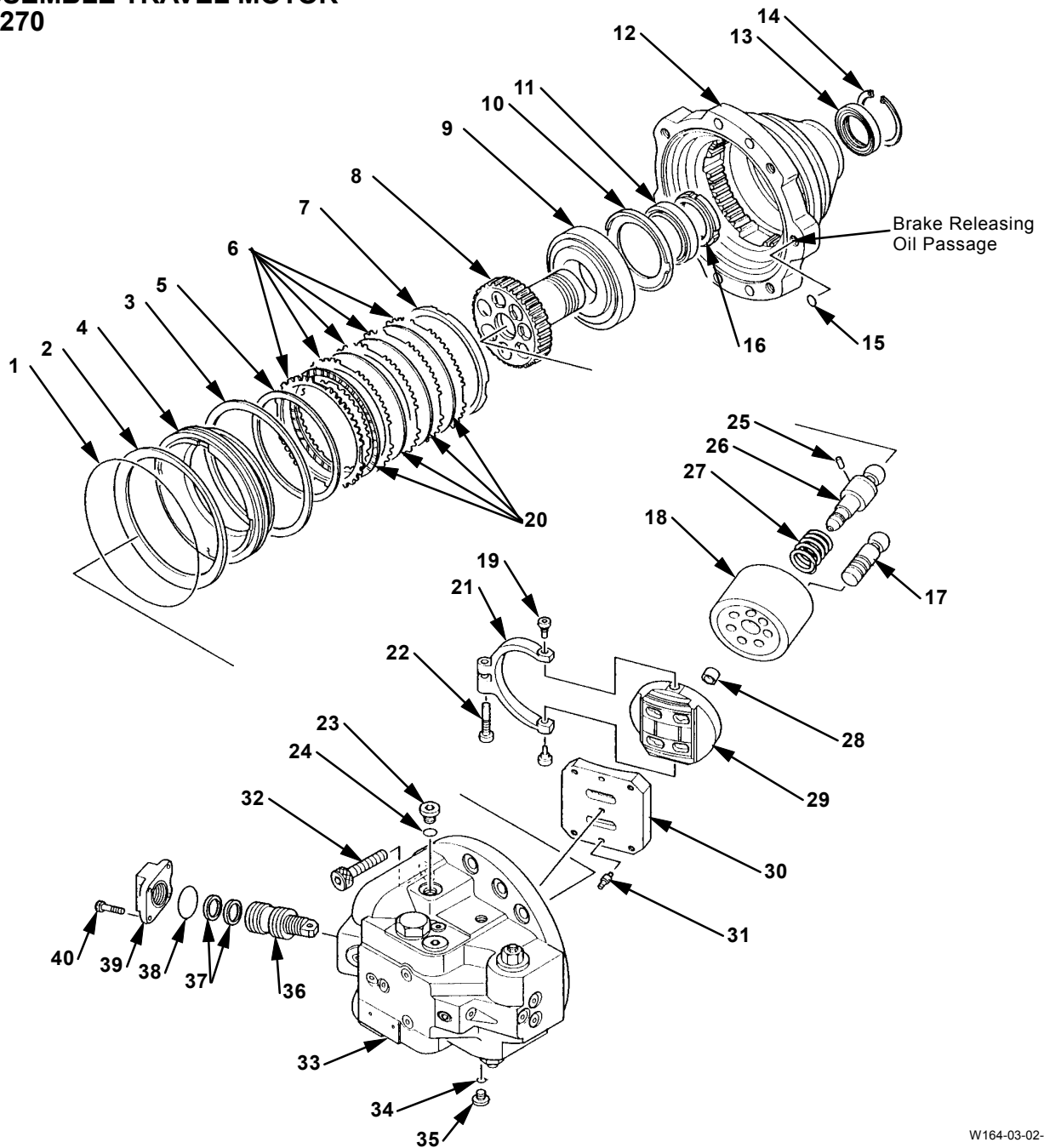
16. Remove roller bearing (3) from shaft (1) using special tool (ST 7268).



W178-03-02-010

UNDERCARRIAGE / Travel Device

DISASSEMBLE TRAVEL MOTOR ZAXIS270



W164-03-02-003

- | | | | |
|--------------------|------------------------------|----------------------|---------------------------|
| 1 - O-Ring | 11 - Bearing | 21 - Ring | 31 - Knock Pin (2 Used) |
| 2 - Disc Spring | 12 - Housing | 22 - Reamer Bolt | 32 - Socket Bolt (4 Used) |
| 3 - D-Ring | 13 - Oil Seal | 23 - Plug (2 Used) | 33 - Brake Valve |
| 4 - Piston | 14 - Retaining Ring | 24 - O-Ring (2 Used) | 34 - O-Ring |
| 5 - D-Ring | 15 - O-Ring | 25 - Pin | 35 - Plug |
| 6 - Plate (5 Used) | 16 - Bearing Nut | 26 - Center Shaft | 36 - Servo Piston |
| 7 - Spacer | 17 - Plunger (7 Used) | 27 - Center Spring | 37 - Piston Ring (2 Used) |
| 8 - Drive Disc | 18 - Rotor | 28 - Bushing | 38 - O-Ring |
| 9 - Bearing | 19 - Plug (2 Used) | 29 - Valve Plate | 39 - Cover |
| 10 - Spacer | 20 - Friction Plate (4 Used) | 30 - Plate | 40 - Socket Bolt (4 Used) |

UNDERCARRIAGE / Travel Device

Disassemble Travel Motor ZAXIS270



CAUTION: Travel motor weight:
90 kg (200 lb)
Brake valve weight: 43 kg (90 lb)

IMPORTANT: Valve plate (29) is easily cracked and scratched, so handle it with care.

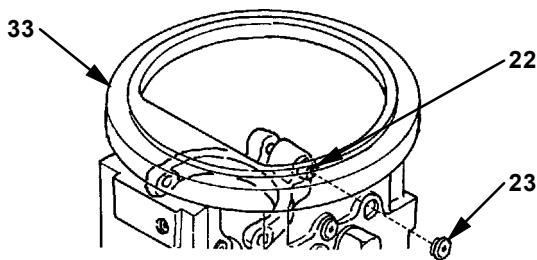
1. Place the travel motor longitudinally. Remove socket bolts (32) (4 used) to remove brake valve (33) from housing (12). At this time, the brake valve side is still with valve plate (29) attached.

 : 14 mm

2. Remove socket bolts (40) (4 used) from brake valve (33) to remove cover (39) and O-ring (38).

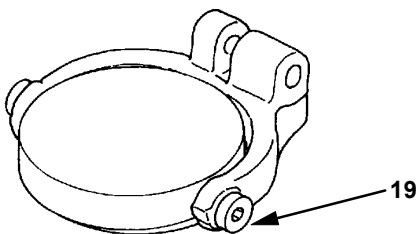
3. Turn brake valve (33) over to remove plug (23) and O-ring (24), then insert a hexagon wrench into the plug (23) hole to remove reamer bolt (22).

 : 8 mm, 10 mm



W178-03-02-014

IMPORTANT: Plug (19) has been bound with LOC-TITE. If removing it by force, its hexagon hole may be damaged. Do not remove plug (19) unless necessary.



W107-03-02-098

4. Remove valve plate (29) from brake valve (33). At this time, the valve plate is still with ring (21) attached.



NOTE: The valve plate (29) is with bushing (28) attached, but do not remove the bushing unless necessary.

5. Remove plate (30) from brake valve (33).
6. Remove servo piston (36) from brake valve (33). At this time, the servo piston is still with piston rings (37) (2 used) attached.
7. Remove O-Rings (1), (15) from housing (12).
8. Remove disc spring (2) from housing (12).

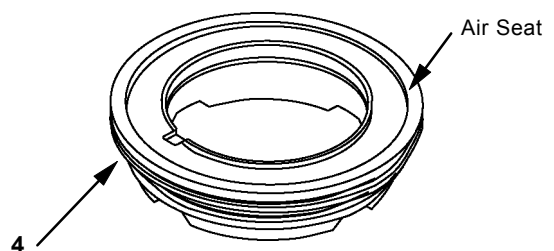


CAUTION: When removing brake piston (4) from the housing filled with air, cover the housing with cloth to prevent the brake piston from flying out.

9. Apply 100 to 300 kPa (1 to 3 kgf/cm², 14 to 43 psi) pressure air to brake releasing oil passage in housing (12), so that brake piston (4) will float up to be removed.



NOTE: There is an air seat on brake piston (4). Be sure to place it with the air seat facing up.

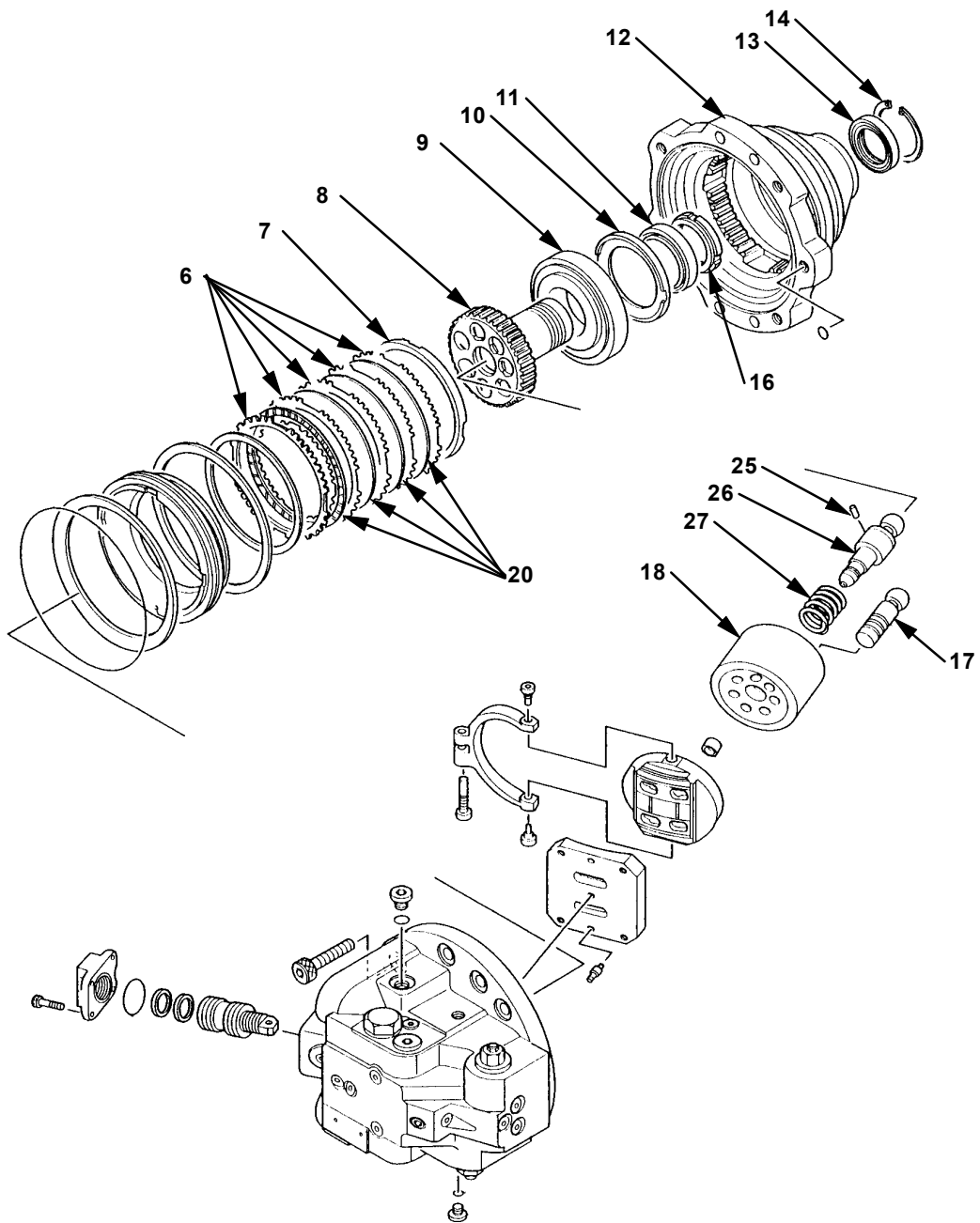


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NOTE: The piston (4) is with D-rings (3), (5) attached, do not remove the D-ring unless necessary.

UNDERCARRIAGE / Travel Device



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UNDERCARRIAGE / Travel Device

10. Remove plates (6) (5 used), friction plates (20) (4 used) from housing (12).

IMPORTANT: When remove center shaft (26), the center shaft will be with pin (25) attached. Be sure not to lose it.

11. Remove rotor (18), spring (27), center shaft (26), plungers (17) (9 used) from housing (12).

 **NOTE:** Tilt plunger (17) in the direction of motor center, the more tilting, the easier removing.

12. Remove spacer (7) from housing (12).

 **CAUTION:** Housing + drive disc + others weight: 50 kg (110 lb)

 **CAUTION:** Drive disc (8) assembly weight: 8.0 kg (20 lb)

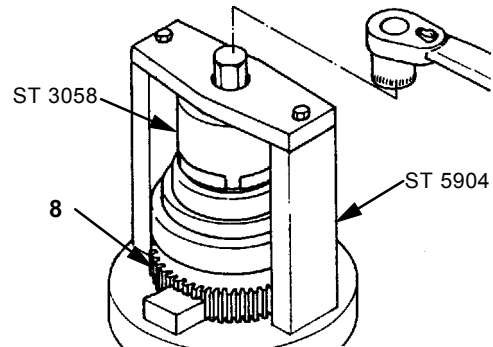
IMPORTANT: As drive disc (8) has tendency to drop off, keep it with wooden block.

13. Place housing (12) with the mounting surface of brake valve facing downward. Tap and remove drive disc (8) from housing (12) with plastic hammer lightly. At this time, the drive disc is still with bearing (9) and bearing (11) attached.

14. Remove retaining ring (14) from housing (12) to remove oil seal (13).

 **CAUTION:** Drive disc (8) assembly weight: 8.0 kg (20 lb)

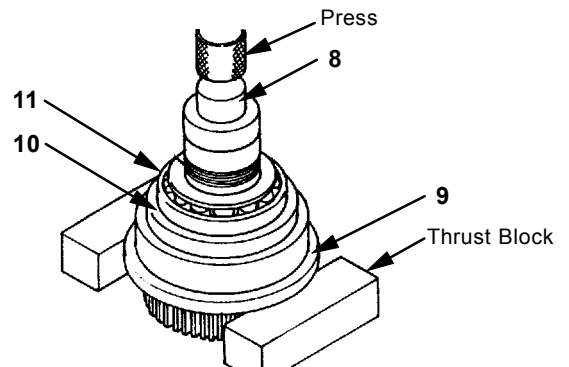
15. Install drive disc (8) assembly into special tools (ST 3058, 5904) to remove bearing nut (16).



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IMPORTANT: The inner race of bearing (9) is left on drive disc (8). Don't remove it unless replacing. In case the inner race of bearing (9) has been removed, don't reuse it.

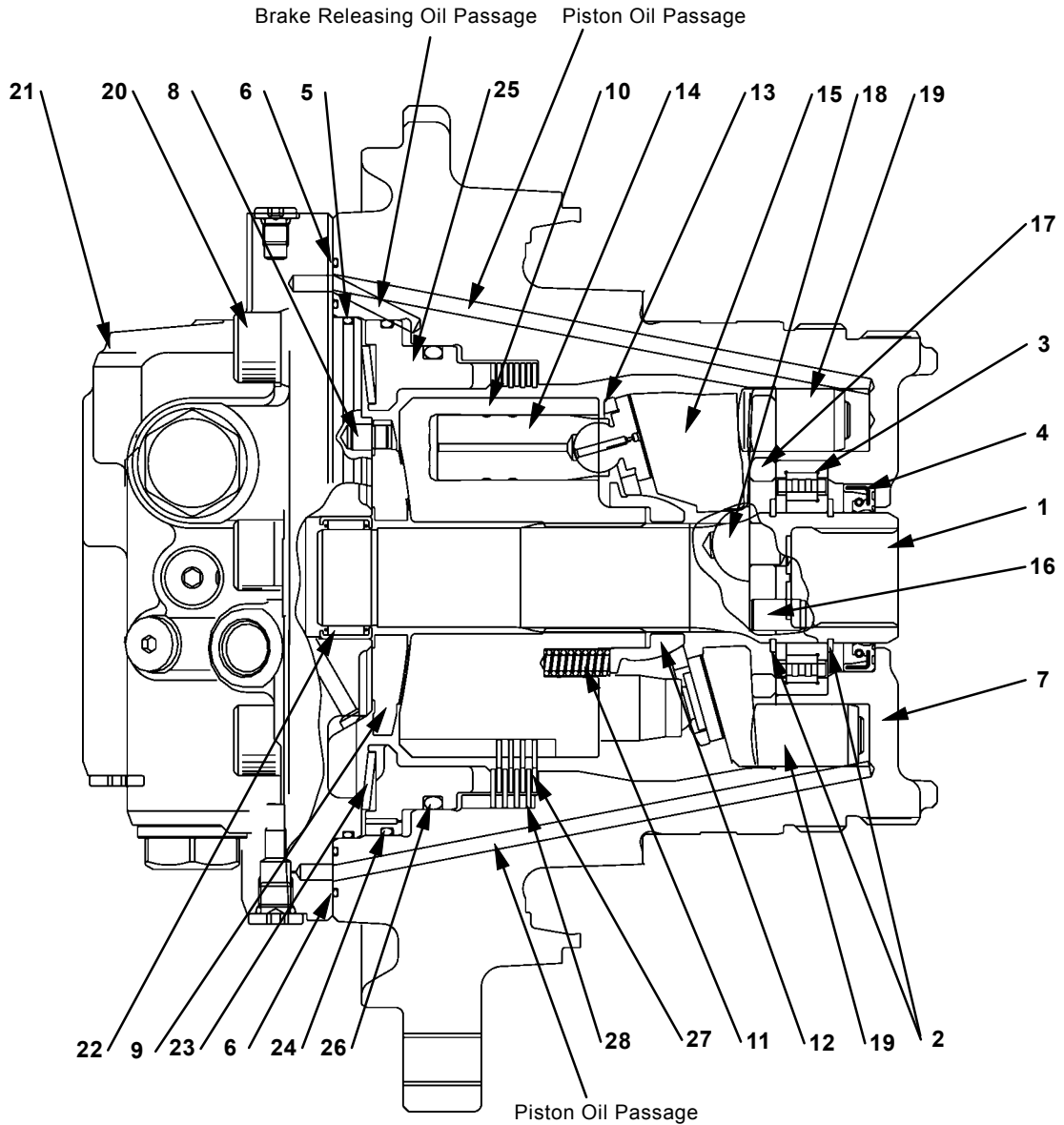
16. Place the outer race of bearing (9) on wooden block. Press drive disc (8) with press to remove bearing (11), spacer (10) from drive disc (8).



W107-03-02-121

UNDERCARRIAGE / Travel Device

ASSEMBLE TRAVEL MOTOR ZAXIS200, 200-E, 225US, 225USR, 230



W178-03-02-006

- | | | | |
|-----------------------------|------------------------|---------------------------|------------------------------|
| 1 - Shaft | 8 - Knock Pin (2 Used) | 15 - Swash Plate | 22 - Needle Bearing |
| 2 - Retaining Ring (2 Used) | 9 - Valve Plate | 16 - Knock Pin | 23 - Disc Spring |
| 3 - Roller Bearing | 10 - Rotor | 17 - Plate | 24 - O-Ring |
| 4 - Oil Seal | 11 - Spring (6 Used) | 18 - Ball (2 Used) | 25 - Brake Piston |
| 5 - O-Ring | 12 - Bushing | 19 - Piston (2 Used) | 26 - O-Ring |
| 6 - O-Ring (3 Used) | 13 - Retainer | 20 - Socket Bolt (9 Used) | 27 - Friction Plate (4 Used) |
| 7 - Housing | 14 - Plunger (9 Used) | 21 - Brake Valve | 28 - Plate (4 Used) |

UNDERCARRIAGE / Travel Device

Assemble Travel Motor

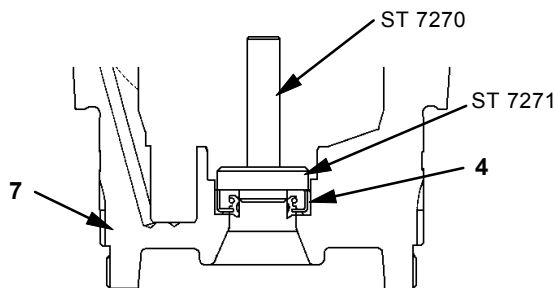
ZAXIS200, 200-E, 225US, 225USR, 230

CAUTION: Housing weight: 50 kg (110 lb)

1. Place housing (7) with the brake valve (21) mating surface facing upward.

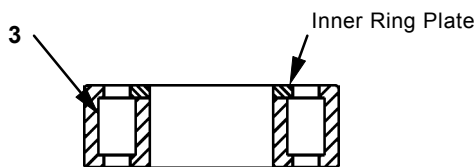
IMPORTANT: Apply OCEAN grease #7 to the inner surface of the oil seal, and apply THREEBOND #1104 or #1215 to the outer surface of the oil seal.

2. Clean the oil seal (4) fitting part of housing (7) neatly.
Tap the oil seal into the housing using special tools (ST 7270), (ST 7271) and a plastic hammer.



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3. There are two retaining ring grooves in shaft (1). Install retaining ring (2) into the end groove.
4. Install the inner ring plate to roller bearing (3) with the stamped mark facing the spline of the shaft.



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5. Install roller bearing (3) onto shaft (1) from the smaller diameter side of the shaft. Tap the bearing using special tool (ST 7268) and a hammer to install it.

6. Install retaining ring (2) onto shaft (1).

7. Apply grease to the flat surface of plate (17).
With the greased surface of plate (17) facing inside, install it into housing (7) while aligning it with knock pin (16).

8. Apply grease to balls (18) (2 used) sufficiently and assemble them to plate (17).

NOTE: Without grease applied to the ball, it is impossible to hold the ball and swash plate (15).

9. Install pistons (19) (2 used) to housing (7) with the stepped side of the piston facing inside.

IMPORTANT: The small diameter side of the shaft may make contact with the inner race of the needle bearing. Take care not to damage it.

10. With a plastic hammer, tap shaft (1) lightly to install it into housing (7).

NOTE: The shaft can be inserted without tapping when aligning them correctly.

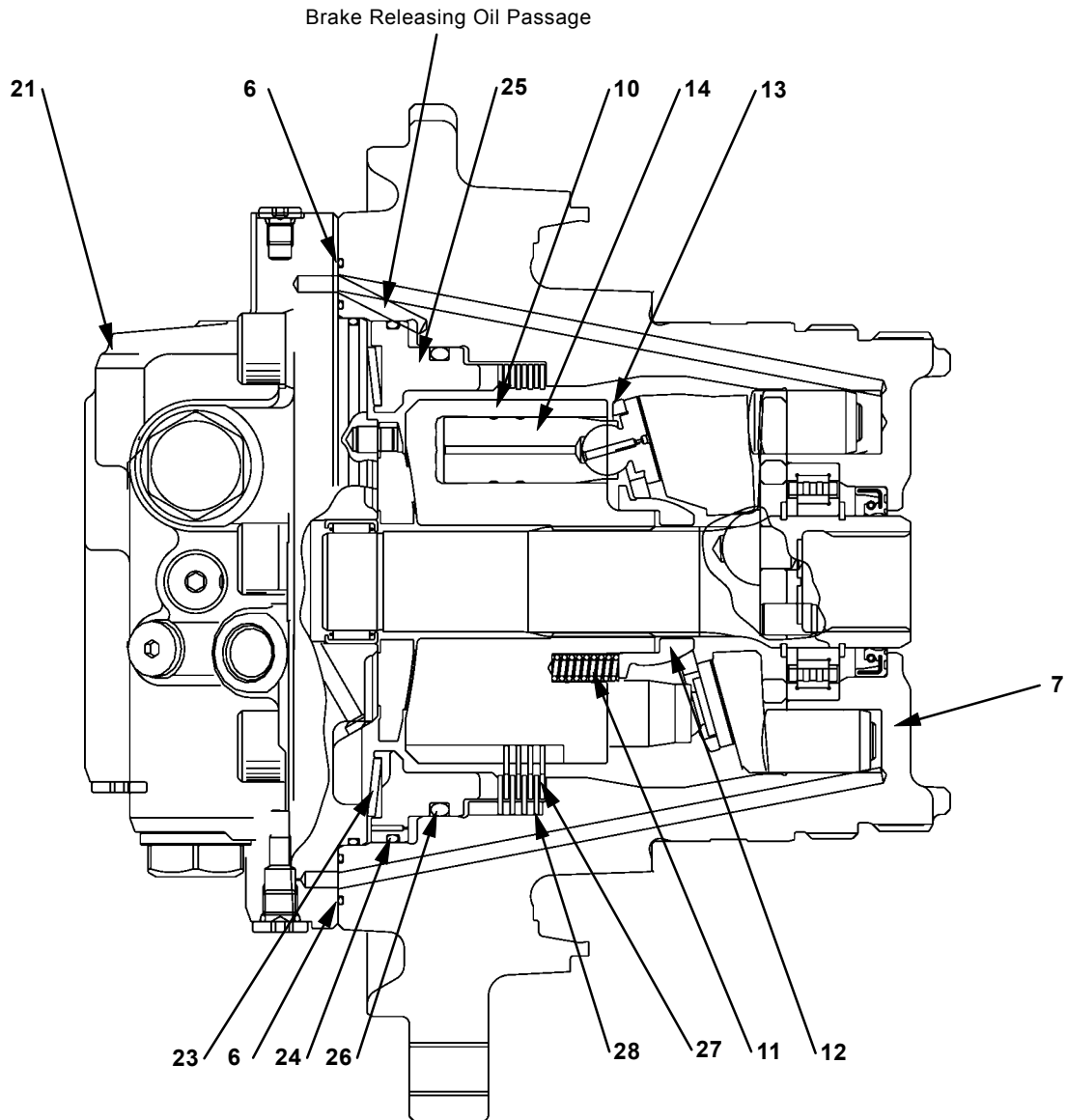
11. Apply grease to the ball hole of swash plate (15). Install the swash plate on housing (7), aligning it with 2 balls (18).

CAUTION: Housing weight: 55 kg (120 lb)

12. Place housing (7) with the brake releasing oil passage at downward and in horizontal.

NOTE: If the housing is placed opposite, swash plate (15) may come off.

UNDERCARRIAGE / Travel Device

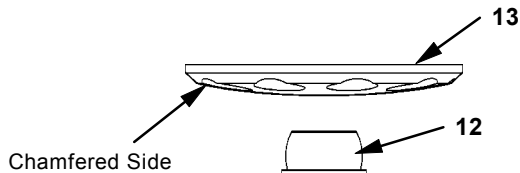


W178-03-02-006

UNDERCARRIAGE / Travel Device

IMPORTANT: Pay attention to the retainer direction.

13. Install springs (11) (6 used), bushing (12), retainer (13), plungers (14) (9 used) onto rotor (10) in that order, with the chamfered side of the retainer facing the bushing.



W172-03-02-001

14. Assemble the rotor (10) assembly into housing (7).



CAUTION: Housing weight: 50 kg (110 lb)

15. Place housing (7) with the brake valve (21) mounting surface facing upward.

IMPORTANT: Pay attention to the order to install friction plate (27) and plate (28).

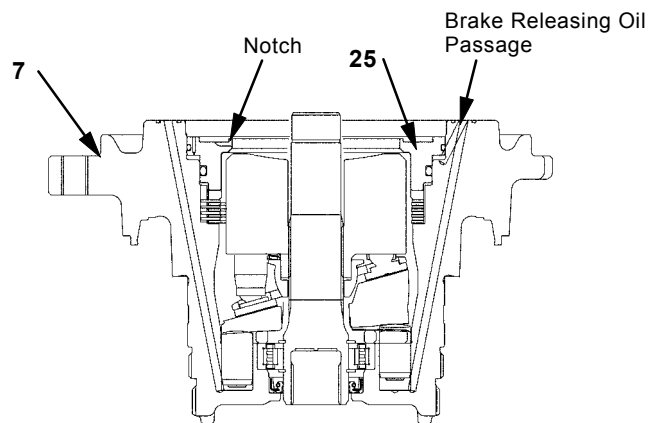
16. Install plates (28) (4 used) and friction plates (27) (4 used) on housing (6) alternately. Install the friction plate first.
17. Apply grease to O-rings (24) and (26). Install them into brake piston (25).

IMPORTANT: The upper surface of brake piston (25) is a seat surface. Take care not to damage it.

IMPORTANT: Install brake piston (25) with the notch on the disc spring (23) mounting surface of the brake piston facing other side of the brake releasing oil passage port.

18. Tap brake piston (25) into housing (7) using special tool (ST 7272), (ST 7273) and a hammer to push it into the housing.

 **NOTE:** Since the O-ring is positioned around the brake piston, the brake piston can't be fully fitted. When installing brake valve (21), push the brake piston with tightening bolts.

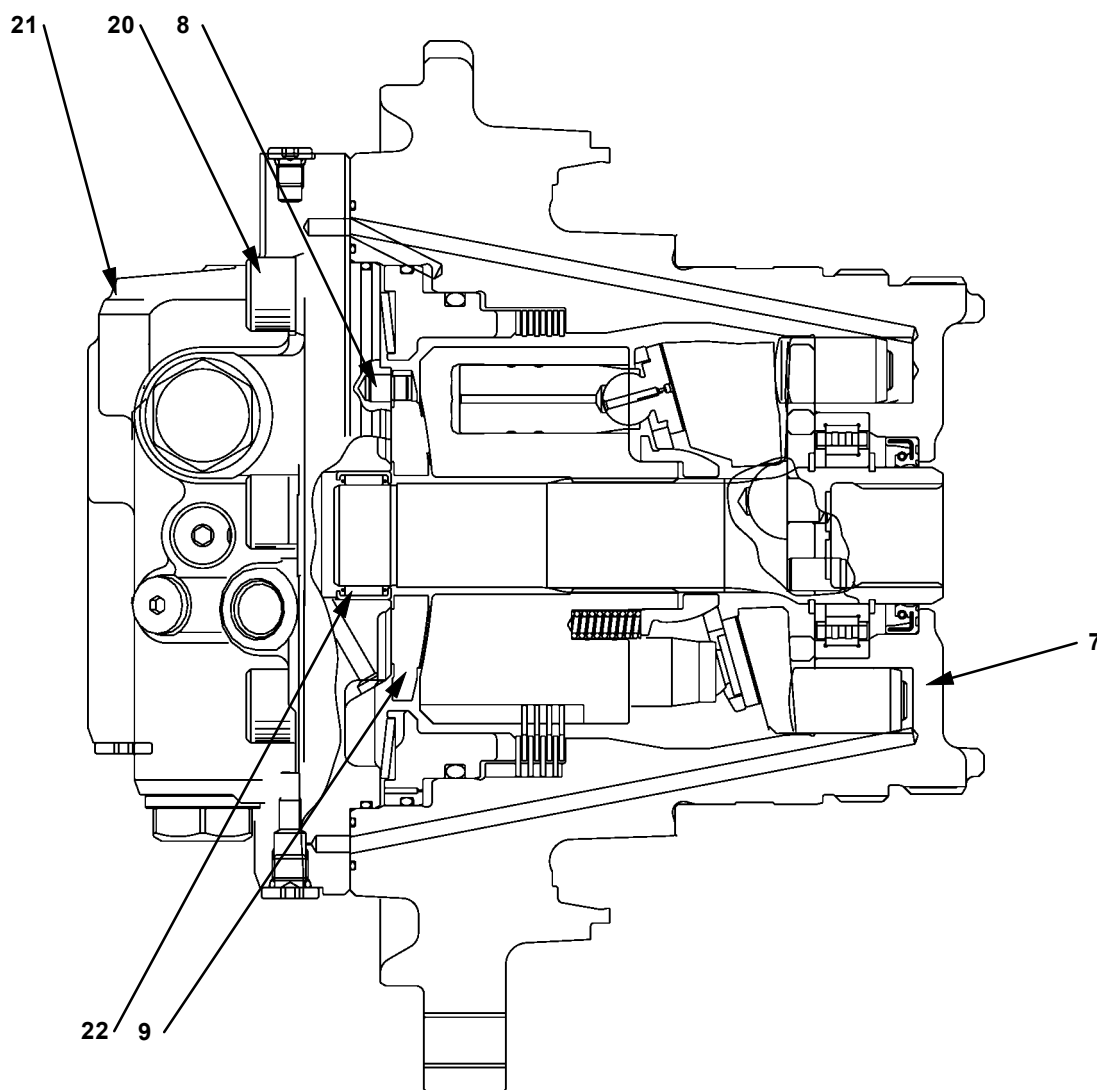


W178-03-02-012

IMPORTANT: Pay attention to the disc spring (23) assemble direction.

19. Put disc spring (23) on brake piston (25) with the inner diameter of the disc spring facing the brake piston.
20. Install O-rings (6) (3 used) to housing (7).
21. Fill hydraulic oil into housing (7) until plate (28) is submerged.

UNDERCARRIAGE / Travel Device



W178-03-02-006

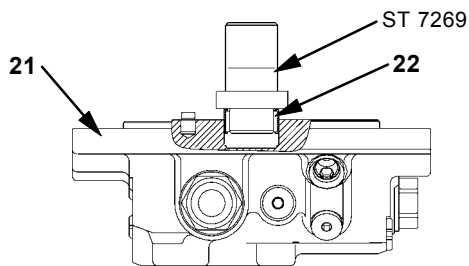
UNDERCARRIAGE / Travel Device

IMPORTANT: Pay attention to the knock pin (8) direction.

22. Install knock pins (8) (2 used) into brake valve (21). Install the large diameter side of knock pins (8) (2 used) to the knock pin hole of brake valve (21).

IMPORTANT: Pay attention to the needle bearing (22) direction.

23. Using special tool (ST 7269), tap needle bearing (22) lightly with a hammer into brake valve (21). Be sure to let the mark on the needle bearing face outside.



W176-03-02-012

24. Apply grease on the flat surface of valve plate (9). Install the valve plate onto brake valve (21) while aligning it with knock pins (8) (2 used).

 **NOTE:** Apply grease sufficiently so that valve plate (9) adheres to brake valve (21). It prevents the valve plate from coming off when the brake valve turns.

IMPORTANT: Take care not to let the valve plate fall down. Otherwise, the valve plate may be damaged and oil leakage will occur.

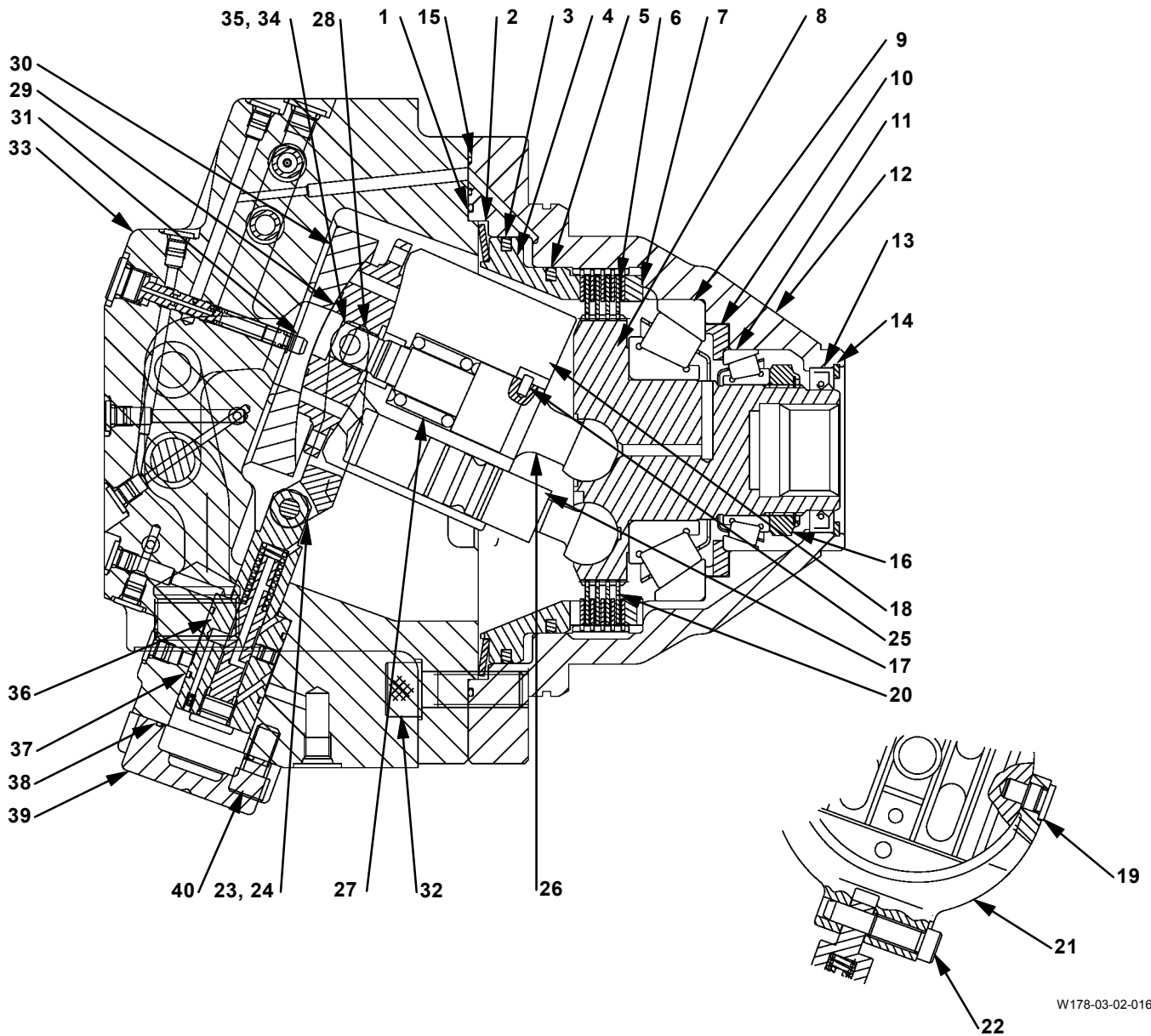
25. Install brake valve (21) to housing (7) and secure it with socket bolts (20) (9 used).

 : 14 mm

 : 300 N·m (31 kgf·m, 225 lbf·ft)

UNDERCARRIAGE / Travel Device

ASSEMBLE TRAVEL MOTOR ZAXIS270



W178-03-02-016

- | | | | |
|--------------------|------------------------------|----------------------|---------------------------|
| 1 - O-Ring | 11 - Bearing | 21 - Ring | 31 - Knock Pin (2 Used) |
| 2 - Disc Spring | 12 - Housing | 22 - Reamer Bolt | 32 - Socket Bolt (4 Used) |
| 3 - D-Ring | 13 - Oil Seal | 23 - Plug (2 Used) | 33 - Brake Valve |
| 4 - Piston | 14 - Retaining Ring | 24 - O-Ring (2 Used) | 34 - O-Ring |
| 5 - D-Ring | 15 - O-Ring | 25 - Pin | 35 - Plug |
| 6 - Plate (5 Used) | 16 - Bearing Nut | 26 - Center Shaft | 36 - Servo Piston |
| 7 - Spacer | 17 - Plunger (7 Used) | 27 - Center Spring | 37 - Piston Ring (2 Used) |
| 8 - Drive Disc | 18 - Rotor | 28 - Bushing | 38 - O-Ring |
| 9 - Bearing | 19 - Plug (2 Used) | 29 - Valve Plate | 39 - Cover |
| 10 - Spacer | 20 - Friction Plate (4 Used) | 30 - Plate | 40 - Socket Bolt (4 Used) |

UNDERCARRIAGE / Travel Device

ASSEMBLE TRAVEL MOTOR

ZAXIS270



CAUTION: Drive disc (8) weight: 5.0 kg (10 lb)

1. Heat the inner race of bearing (9) to 70° to 90°C (158 °F to 194 °F) in oil bath or drier. Press the inner race of bearing (9) into drive disc (8) with special tool (ST 2155) and press.
2. Put the outer race onto the inner race of bearing (9).
3. Tap and insert the outer race of bearing (11) into spacer (10) lightly with plastic hammer.
4. Put spacer (10) on the outer race of bearing (9).
5. Heat the inner race of bearing (11) to 70° to 90°C (158 °F to 194 °F) in oil bath or drier, press the inner race of bearing into drive disc (8) using special tool (ST 2308) and press. Tap the inner race lightly and listen to ring to confirm they are fitting tightly.

IMPORTANT: Apply grease onto bearing nut (16).

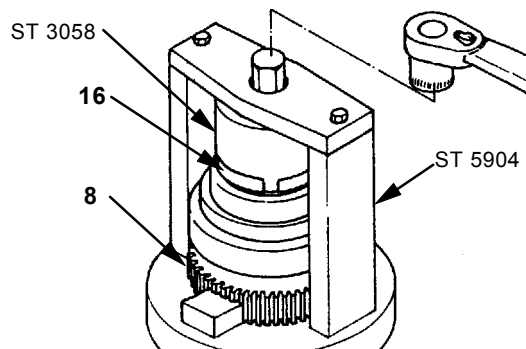
6. Apply grease to the screw part and the side surface of bearing nut (16). Install bearing nut (16) onto drive disc (8), then tighten it by hand. If no grease is applied, it can't be tightened to the specified torque.



NOTE: Apply grease after tightening it to the specified torque.

7. Secure drive disc (8) onto special tools (ST 3058, ST 5904), tighten bearing nut (16) to the specified torque.

 : $3 \pm 0.5 \text{ N}\cdot\text{m}$
($0.3 \pm 0.05 \text{ kgf}\cdot\text{m}$, $2.2 \pm 0.36 \text{ lbf}\cdot\text{ft}$)



W107-03-02-119



CAUTION: Housing (12) weight: 46 kg (100 lb)

8. Place housing (12) with its brake valve mounting side facing down.

IMPORTANT: Apply OCEAN grease #7 to the inner surface of oil seal (13), and apply THREEBOND #104 or 1215 to the outer surface of the oil seal.

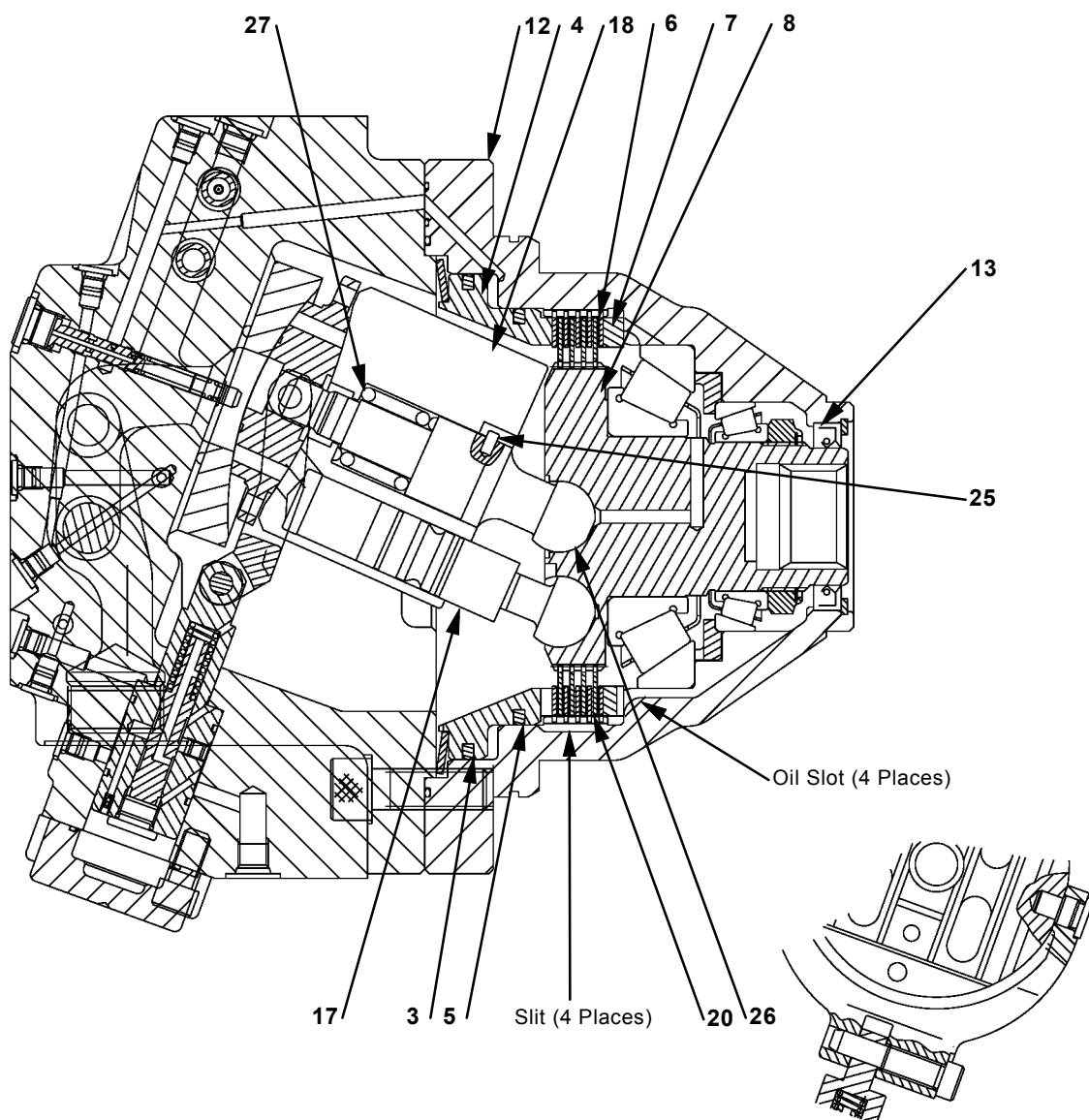
9. Tap oil seal (13) evenly and lightly with plastic hammer to insert oil seal (13) into housing (12). The replaced oil seal can be used as a mat then.
10. Install retaining ring (14).



CAUTION: Housing weight: 46 kg (100 lb)

11. Turn housing (12) over. Tap drive disc (8) assembly lightly with a plastic hammer and brass bar to install it into housing (12).

UNDERCARRIAGE / Travel Device



W178-03-02-019

UNDERCARRIAGE / Travel Device

12. Turn housing (12) over and place it with its oil seal (13) side facing down.

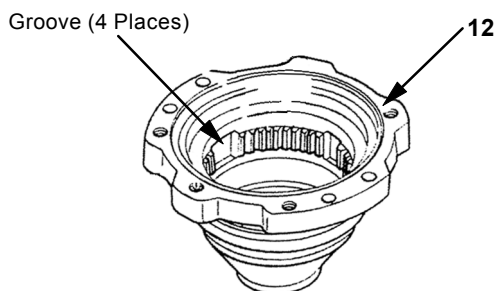
IMPORTANT: Be sure to align the oil slot (slit part) in spacer (7) with that in housing (12).

13. Install spacer (7) into housing (12) with its oil slot (slit part) facing the travel reducer side, while aligning the oil slot in spacer (7) with the oil slot inside of housing (12).

IMPORTANT: Align 5 teeth of plate (6) with the inner grooves in housing (12). In addition, the 4 teeth on friction plate (20) should be placed at same position when installation is carried out.

14. Install plates (6) (5 used) and friction plates (20) (4 used) into housing (12) alternately. Be sure to align the toothless part (no teeth part) of plate (6) (4 places) with the inner slots inside of housing (12) and install them together. Moreover, the toothless part of friction plate (20) should be put at same position to form a straight line when installation is carried out.

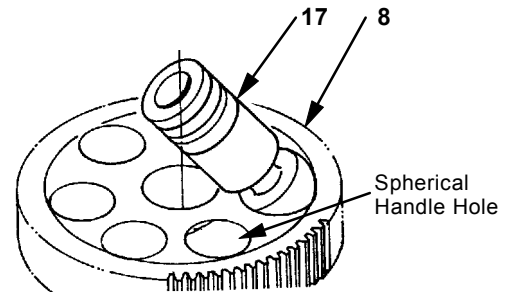
 **NOTE:** In case the toothless part or slot position fail to align with each other, heating may be resulted to motor failure.



W178-03-02-018

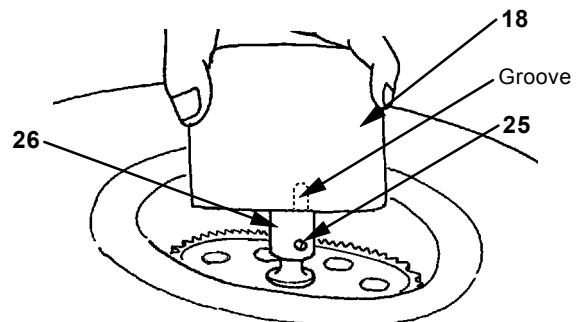
15. Install D-rings (3, 5) into piston (4), then install them into housing (12).

16. Install plungers (17) (7 used) into the spherical handle hole in drive disc (8) one by one. Be sure to confirm plungers (17) (7 used) move smoothly.



W107-03-02-146

17. Install center shaft (26) into drive disc (8). Then install center spring (27) onto center shaft (26).
18. Apply grease to pin (25) to prevent it from coming off. Then install it into center shaft (26).
19. Put center shaft (26) to rotor (18) shallowly. Rotate center shaft (26) so as to make pin (25) come to the place just beneath the slot in rotor (18).



W178-03-02-015

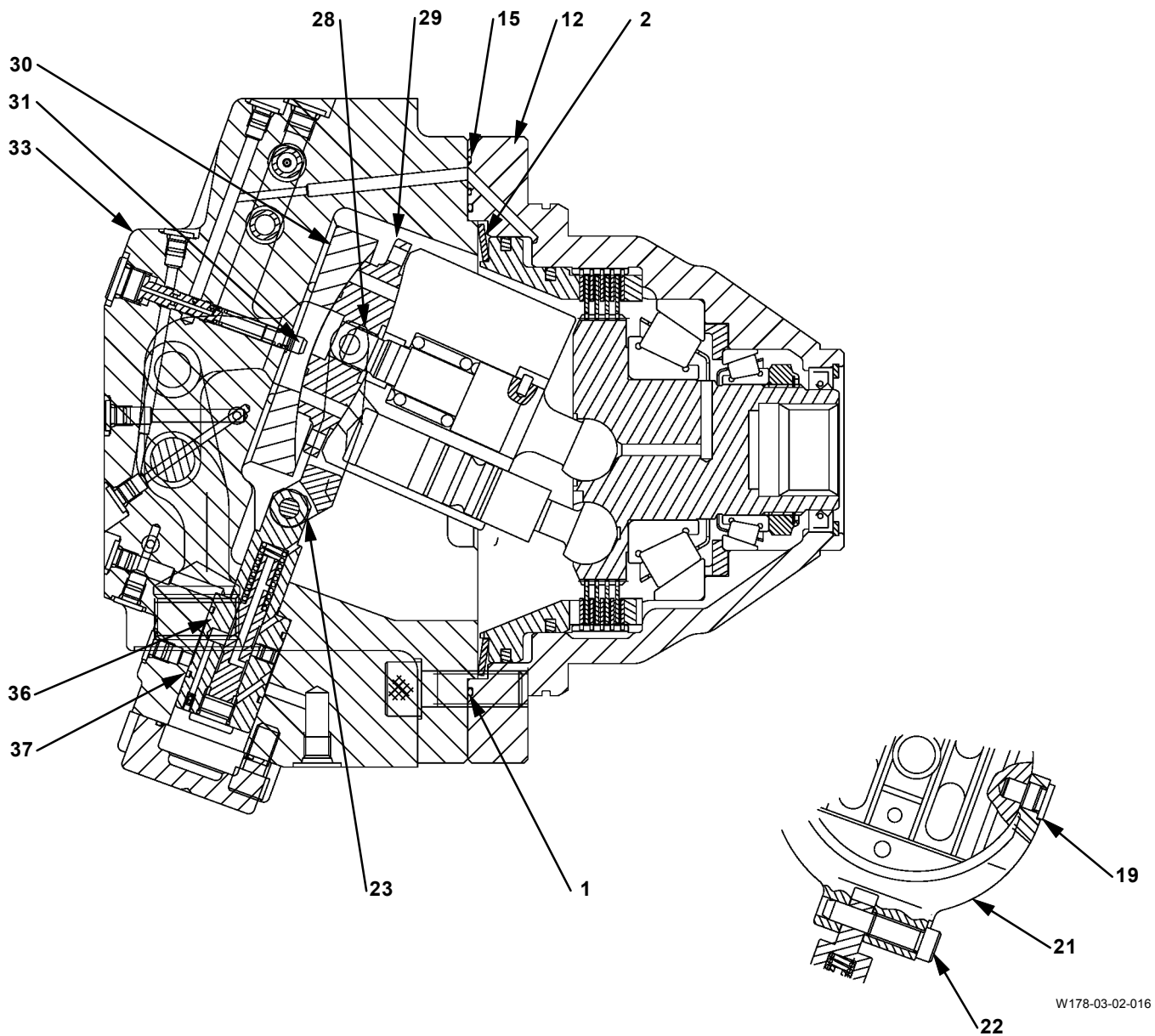
20. Insert plungers (17) (7 used) into rotor (18).

IMPORTANT: Be sure to place pin (25) securely into the rotor groove.

21. Press rotor (18) slowly and install pin (25) into the rotor (18) groove.

 **NOTE:** If the pin can't be installed into the groove, insert the end of round rotor into the top hole of center shaft (26), rotate the center shaft. When doing this work, be sure to remove the dirt and metal chips from the former rotor first.

UNDERCARRIAGE / Travel Device



UNDERCARRIAGE / Travel Device

22. Install O-rings (1) (15) into housing (12).

IMPORTANT: Install disc spring (2) into housing (12) with the outer surface side of the disc spring facing upward.

23. Install disc spring (2) into housing (12).

24. Fill hydraulic oil into housing (12).
Hydraulic oil: 1.3 L (0.34 US gal)

25. Remove plug (23) from brake valve (33).

 : 10 mm

 : 118 N·m(12 kgf·m, 87 lbf·ft)

26. Install plate (30) onto brake valve (33).

27. Install piston rings (37) (2 used) onto servo piston (36).

28. Insert servo piston (36) into brake valve (33).

IMPORTANT: Assemble bushing (28) with the chamfered side facing inside.

29. Install bushing (28) onto valve plate (29) with plastic hammer.

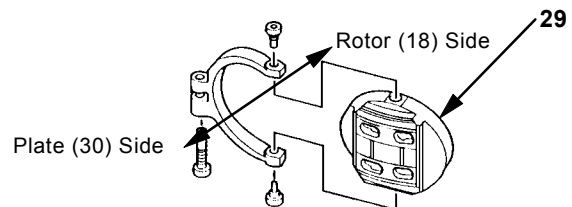
30. Apply LOCTITE #262 on plugs (19) (2 used), then install ring (21) onto valve plate (29) with plugs (19) (2 used).

 : 6 mm

 : 49 N·m(5 kgf·m, 36 lbf·ft)

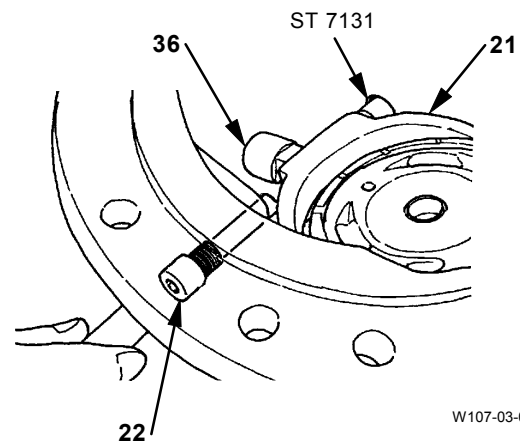
IMPORTANT: Pay attention to the direction of ring (21) assembly.

31. Install link (21) assembly into brake valve (33) while aligning the groove in valve plate (29) with the groove in plate (30). At this time, the sticking part of link (21) should face brake valve side.



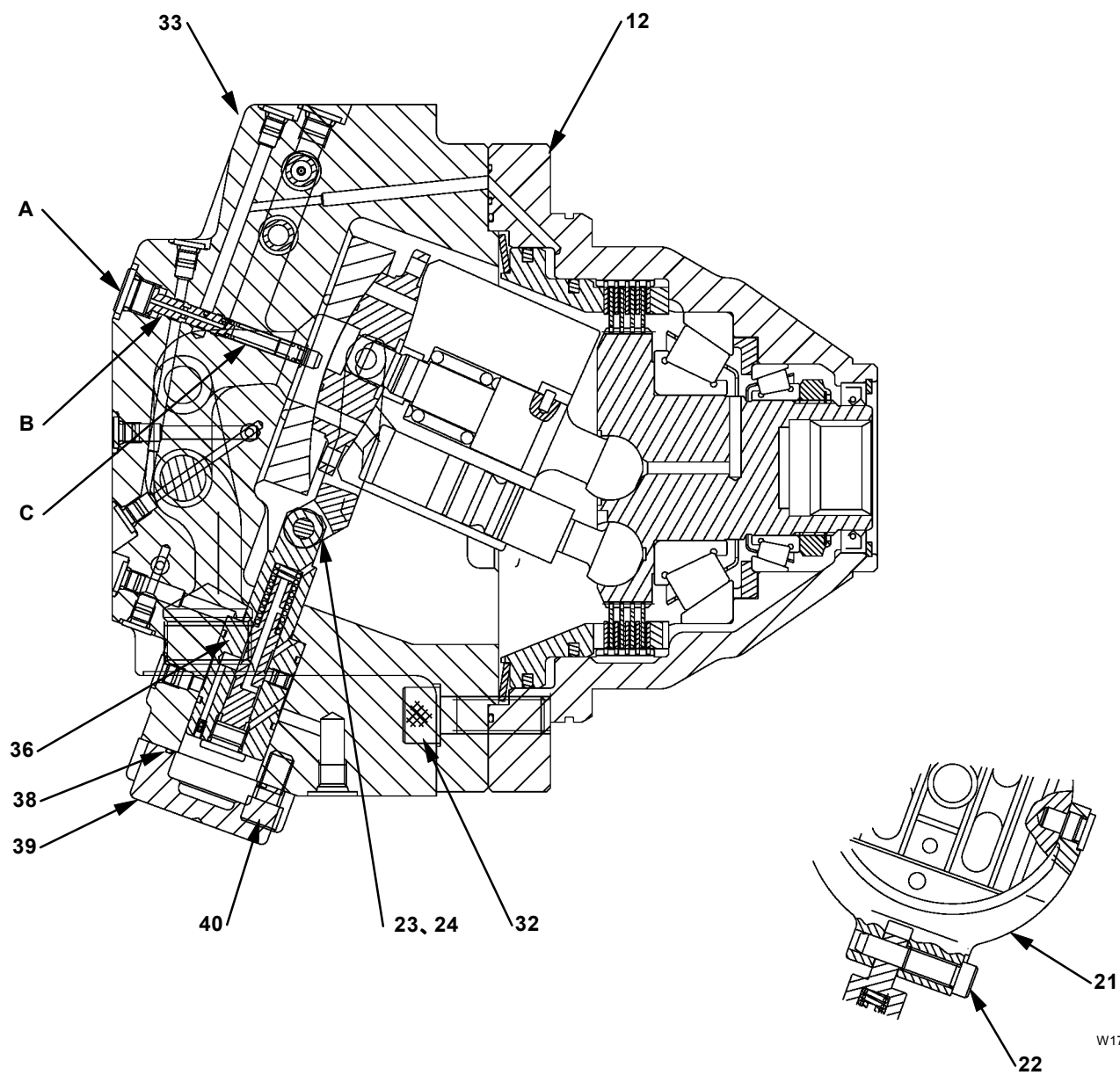
W178-03-02-017

32. Insert special tool (ST 7131) into the mounting hole of plug (23), then align the hole of ring (21) with that of servo piston (36).



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UNDERCARRIAGE / Travel Device



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UNDERCARRIAGE / Travel Device

33. Apply additive grease, Johnson wax JP103, to the end of reamer bolt (22) in order to prevent it from seizing.

Install reamer bolt (22) to link (21) and servo piston (36) through the opposite mounting hole of plug (23).

 : 8 mm

 : 49 N·m(5 kgf·m, 36 lbf·ft)

34. Install O-ring (24) onto plug (23), then install it to brake valve (33). (2 Places)

 : 10 mm

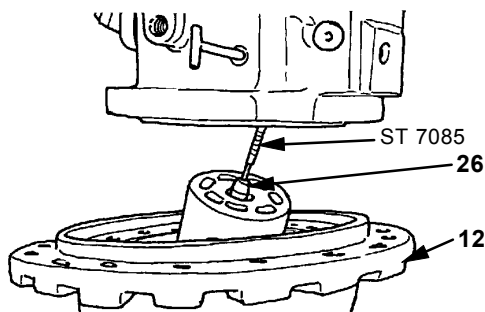
 : 118 N·m(12 kgf·m, 87 lbf·ft)

35. Install O-ring (38) onto cover (39) and install it to brake valve (33) with socket bolts (40) (4 used).

 : 10 mm

 : 88 N·m(9 kgf·m, 65 lbf·ft)

36. Install special tool (ST 7085) into the end of center shaft (26).



W107-03-02-183

37. Remove plug (A) from brake valve (33) to remove spool (B) and spring (C).

 : 8 mm



CAUTION: Brake valve weight: 43 kg (90 lb)

38. Lift and install brake valve (33) onto housing (12) by crane, while aligning the hole in removed plug (A) with special tool (ST 7085).

39. Remove special tool (ST 7085) from brake valve (33).

40. Install spool (B), spring (C) and plug (A) into brake valve (33).

 : 8 mm

 : 34 N·m(3.5 kgf·m, 25.5 lbf·ft)

41. Install brake valve (33) onto housing (12) with socket bolts (32) (4 used).

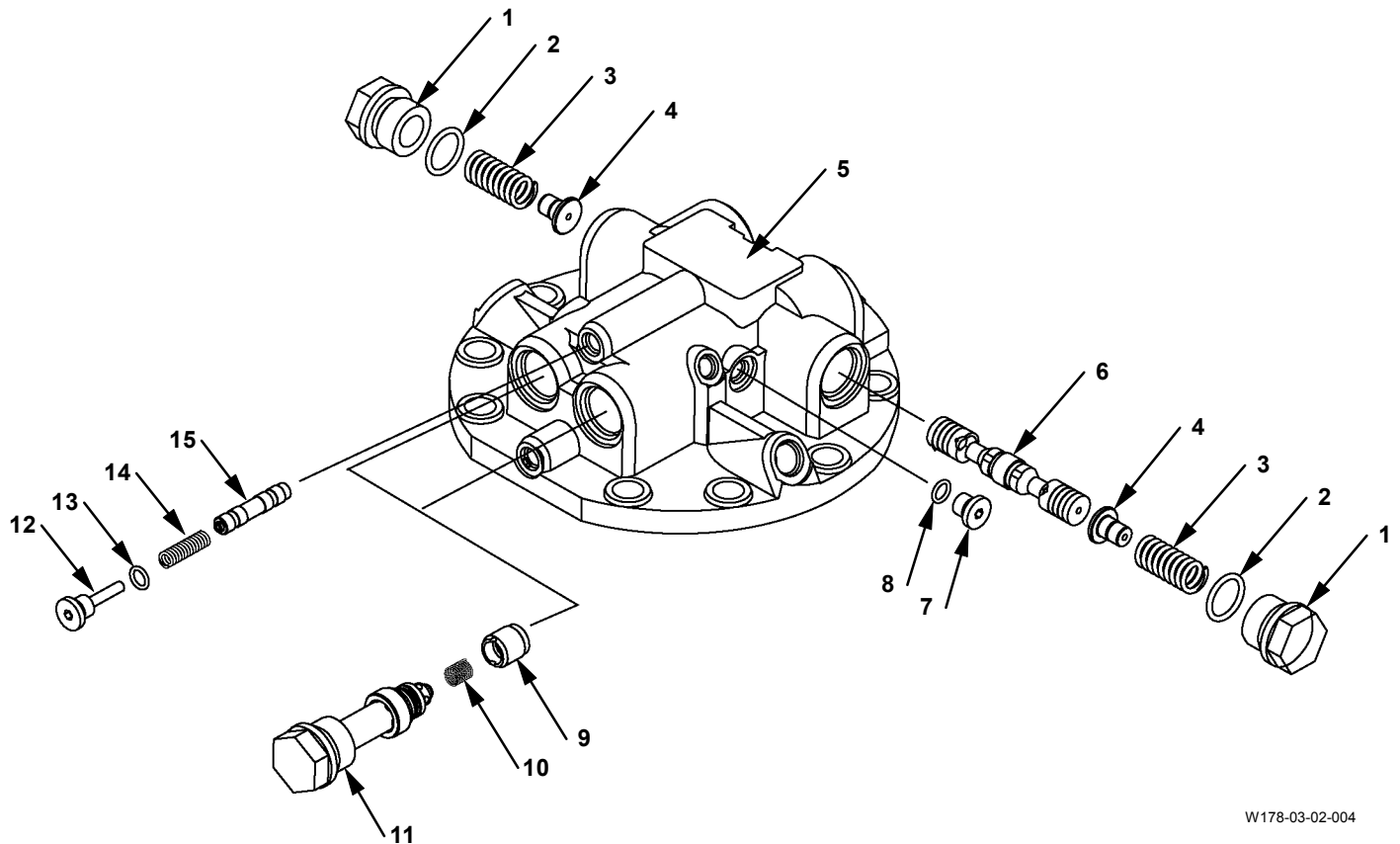
 : 14 mm

 : 390 N·m(40 kgf·m, 290 lbf·ft)

UNDERCARRIAGE / Travel Device

DISASSEMBLE BRAKE VALVE

(ZAXIS200, 200-E, 225US, 225USR, 230)



W178-03-02-004

- | | | | |
|----------------------|-------------------|----------------------------|-------------|
| 1 - Plug (2 Used) | 5 - Valve Housing | 9 - Poppet (2 Used) | 13 - O-Ring |
| 2 - O-Ring (2 Used) | 6 - Spool | 10 - Spring (2 Used) | 14 - Spring |
| 3 - Spring (2 Used) | 7 - Plug | 11 - Relief Valve (2 Used) | 15 - Spool |
| 4 - Stopper (2 Used) | 8 - O-ring | 12 - Plug | |

UNDERCARRIAGE / Travel Device

Disassemble Brake Valve

1. Remove plug (1) from valve housing (5). (2 places).

 : 36 mm

2. Remove spring (3) and stopper (4) from valve housing (5) using a magnet. (2 places)

3. Remove spool (6) from valve housing (5) with a magnet.

4. Remove plug (7) from valve housing (5).
The plug inserted in the hole has been applied with LOCTITE. Do not remove it unless necessary.

 : 6 mm

6. Remove springs (10), poppets (9) from valve housing (5) with a magnet. (2 places)

7. Remove plug (12) from valve housing (5). (2 places)

 : 6 mm

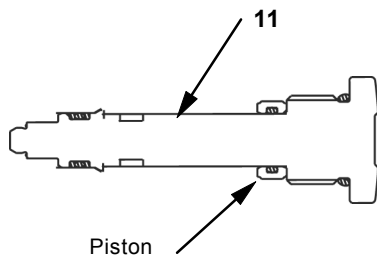
8. Remove spring (14), spool (15) from valve housing (5) with a magnet.

IMPORTANT: Do not disassemble the relief valve (11). If it is disassembled, its setting pressure may change.

IMPORTANT: Do not move the piston on the relief valve, otherwise the O-ring may be damaged by the slot in cartridge.

5. Remove relief valves (11) from valve housing (5). (2 places)

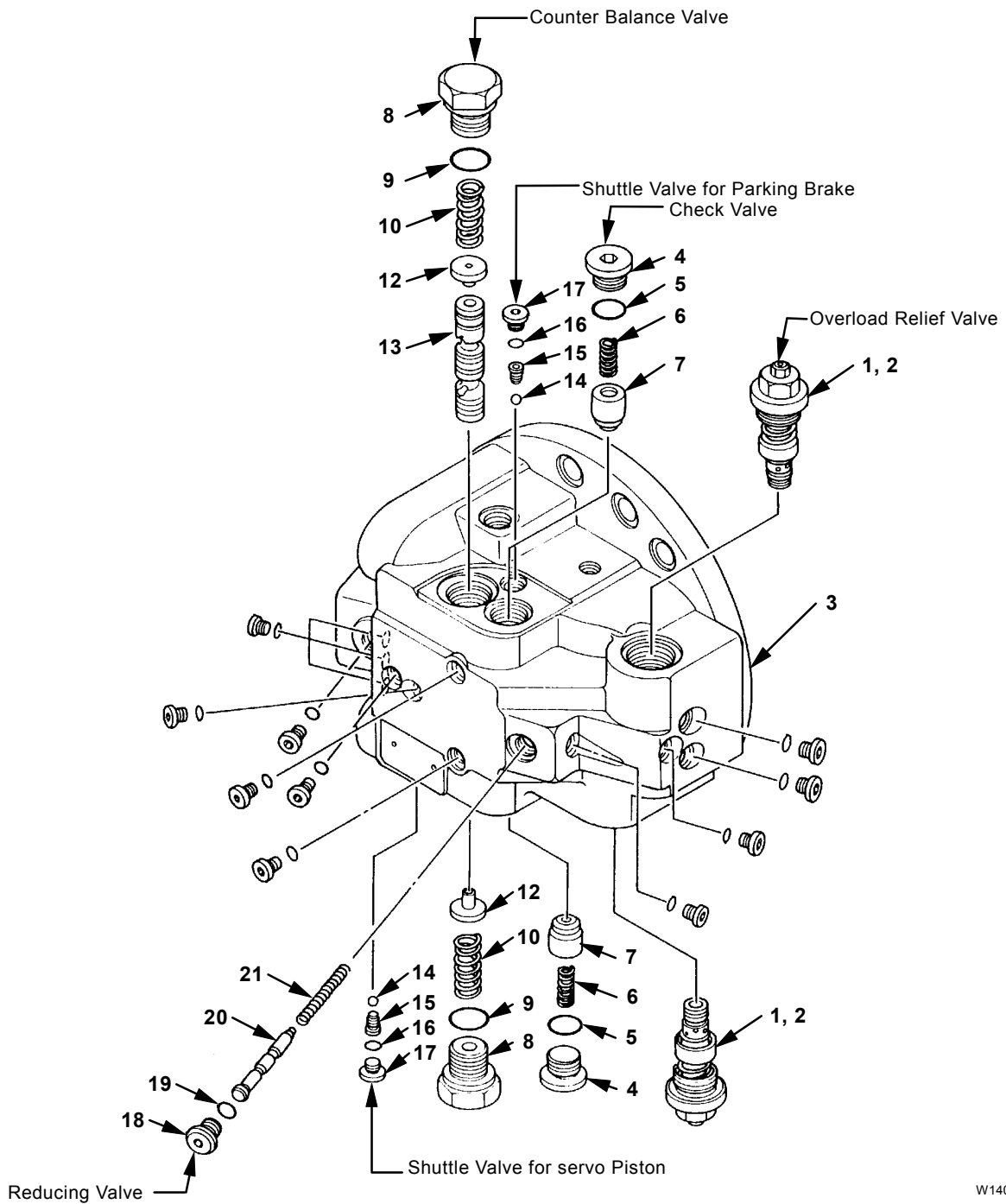
 : 30 mm



W176-03-02-011

UNDERCARRIAGE / Travel Device

DISASSEMBLE BRAKE VALVE ZAXIS270



W140-03-02-003

- | | | | |
|------------------------------------|----------------------|-----------------------|--------------------|
| 1 - O-Ring (2 Used) | 6 - Spring (2 Used) | 12 - Stopper (2 Used) | 17 - Plug (2 Used) |
| 2 - Overload Relief Valve (2 Used) | 7 - Poppet (2 Used) | 13 - Spool | 18 - Plug |
| 3 - Casing | 8 - Plug (2 Used) | 14 - Ball (2 Used) | 19 - O-Ring |
| 4 - Plug (2 Used) | 9 - O-Ring (2 Used) | 15 - Seat (2 Used) | 20 - Spool |
| 5 - O-Ring (2 Used) | 10 - Spring (2 Used) | 16 - O-Ring (2 Used) | 21 - Spring |

UNDERCARRIAGE / Travel Device

Disassemble Brake Valve ZAXIS270

Be sure to thoroughly read "Precautions for Disassembly and Assembly Work" on page W1-1-1 before starting the disassembly work.



CAUTION: Brake valve weight: 43 kg (90 lb)

- Counter Balance Valve

1. Remove plugs (8) (2 used) from casing (3).

 : 41 mm

2. Remove springs (10) (2 used), stoppers (12) (2 used) from casing (3).

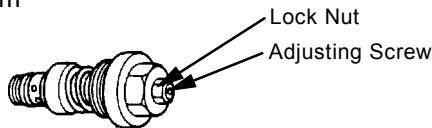
3. Remove spool (13) from casing (3).

- Overload Relief Valve

IMPORTANT: Do not turn the lock nut for adjusting screw on overload relief valve, or its setting pressure may change.

4. Remove overload relief valves (2) (2 used) from casing (3).

 : 27 mm



W140-03-02-005

- Check Valve

5. Remove plug (4) from casing (3) to remove springs (6) (2 used) and poppets (7) (2 used).

 : 12 mm

- Shuttle valve for servo piston and for parking brake

IMPORTANT: The LOCTITE was applied on seat (15). Do not remove the seat unless necessary.

6. Remove plugs (17) (2 used) from casing (3) to remove balls (14) (2 used) and seats (15) (2 used).

 : 5 mm, 6 mm

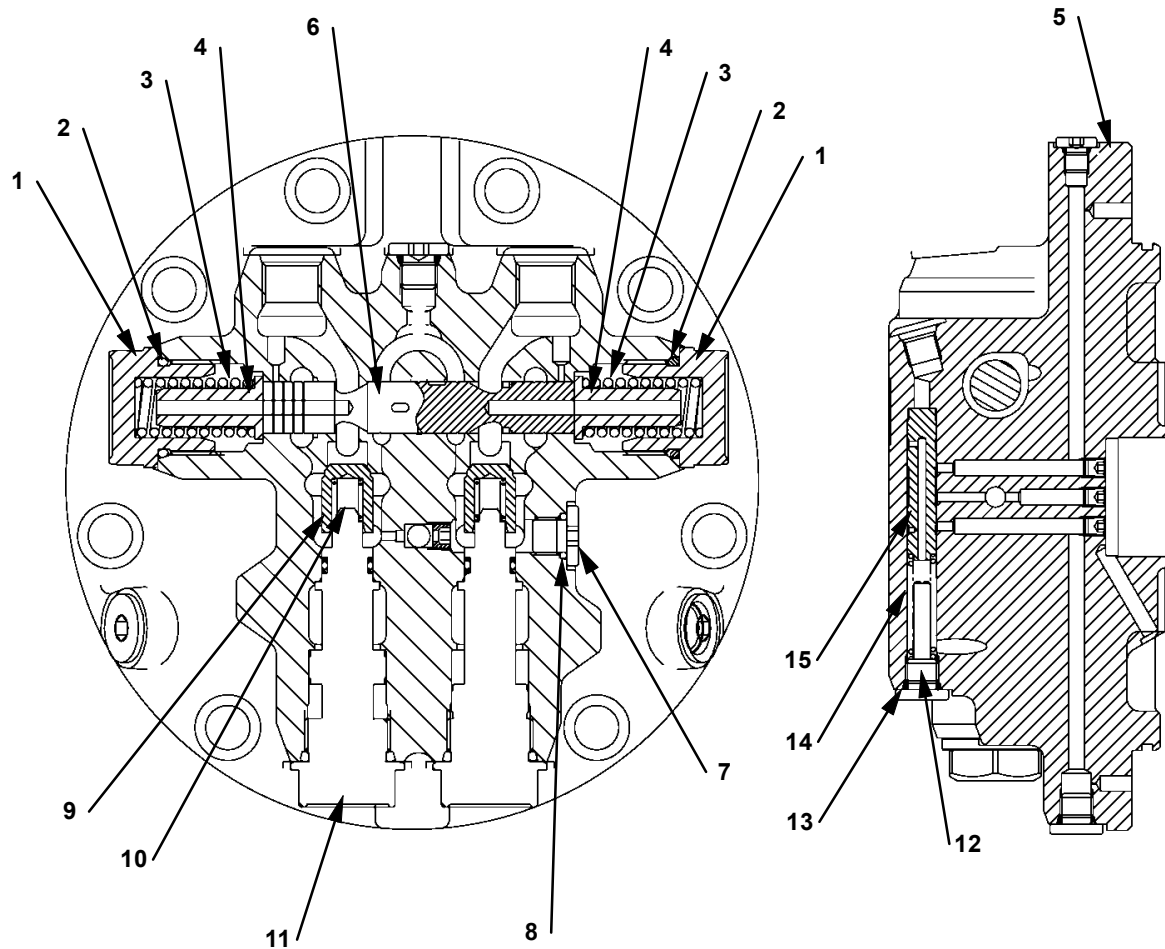
- Reducing Valve

7. Remove plug (18) from casing (3) to remove spool (20) and spring (21).

 : 8 mm

UNDERCARRIAGE / Travel Device

ASSEMBLE BRAKE VALVE (ZAXIS200, 200-E, 225US, 225USR, 230)



W178-03-02-005

- | | | | |
|----------------------|-------------------|----------------------------|-------------|
| 1 - Plug (2 Used) | 5 - Valve Housing | 9 - Poppet (2 Used) | 13 - O-Ring |
| 2 - O-Ring (2 Used) | 6 - Spool | 10 - Spring (2 Used) | 14 - Spring |
| 3 - Spring (2 Used) | 7 - Plug | 11 - Relief Valve (2 Used) | 15 - Spool |
| 4 - Stopper (2 Used) | 8 - O-Ring | 12 - Plug | |

UNDERCARRIAGE / Travel Device

Assemble Brake Valve

(ZAXIS200, 200-E, 225US, 225USR, 230)

1. Insert spool (6) approximately half way into valve housing (5).

2. Install O-ring (2), spring (3), stopper (4) onto plug (1) at one side. Install the plug into valve housing (5) with a thread left out.

 **NOTE:** If the plug is fully installed, it is difficult to assemble the plug to other side as spool (6) may be pushed out.

3. Install O-ring (2), spring (3) and stopper (4) into another plug (1). Install plug (1) into valve housing (5). Tighten the plug by hand.

4. Tighten plug (1) on both sides with spanner.

 : 36 mm

 : 440 N·m (45 kgf·m, 325 lbf·ft)

5. Install O-ring (8) into plug (7), then install plug (7) into valve housing (5).

 : 6 mm

 : 34 N·m (3.5 kgf·m, 25 lbf·ft)

6. Install spring (10) into poppet (9). Install poppet (9) flush with the hole entrance of valve housing (5). (2 places)

 **NOTE:** If the poppet is installed into the farthest end, the spring may come off from the poppet.

7. Press poppet (9) installed in step 6 with relief valve (11) into valve housing (5), while slowly installing the relief valve. (2 places)

 : 30 mm

 : 310 N·m (32 kgf·m, 230 lbf·ft)

IMPORTANT: Be sure to assemble spool in correct direction.

8. Install spool (15) into valve housing (5) with the hole end facing front.

9. Install spring (14) into valve housing (5).

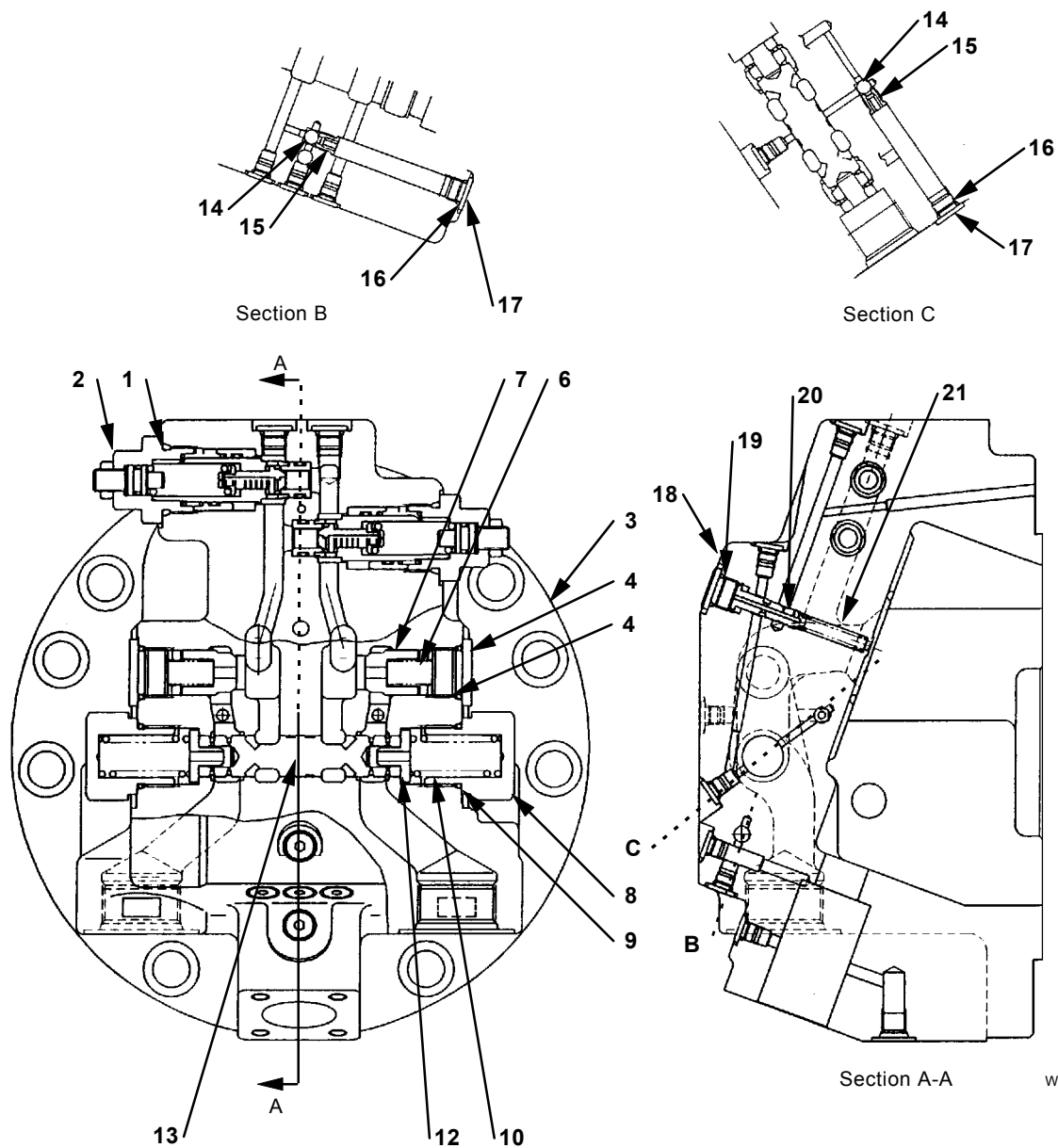
10. Install O-ring (13) on plug (12) to valve housing (5).

 : 6 mm

 : 34 N·m (3.5 kgf·m, 25 lbf·ft)

UNDERCARRIAGE / Travel Device

DISASSEMBLE BRAKE VALVE ZAXIS270



W164-03-02-005

- | | | | |
|------------------------------------|----------------------|-----------------------|--------------------|
| 1 - O-Ring (2 Used) | 6 - Spring (2 Used) | 12 - Stopper (2 Used) | 17 - Plug (2 Used) |
| 2 - Overload Relief Valve (2 Used) | 7 - Poppet (2 Used) | 13 - Spool | 18 - Plug |
| 3 - Casing | 8 - Plug (2 Used) | 14 - Ball (2 Used) | 19 - O-Ring |
| 4 - Plug (2 Used) | 9 - O-Ring (2 Used) | 15 - Seat (2 Used) | 20 - Spool |
| 5 - O-Ring (2 Used) | 10 - Spring (2 Used) | 16 - O-Ring (2 Used) | 21 - Spring |

UNDERCARRIAGE / Travel Device

ASSEMBLE TRAVEL BRAKE VALVE ZAXIS270

- Releasing Valve

1. Insert spring (21) and spool (20) into casing (3).
Install O-ring (19) onto plug (18) to casing (3).
 : 8 mm
 : 69 N·m(7 kgf·m, 51 lbf·ft)

- Shuttle Valve for Servo Piston and for Parking Brake
(Section B-B, Section C-C)

2. Install balls (14) (2 used) with casing (3) tilted.
Apply LOCTITE #262 onto seats (15) (2 used) and install the seat into casing (3). Install O-rings (16) (2 used) onto plugs (17) (2 used) and install the plugs into casing (3).
 : 5 mm
 : 14.5 N·m(1.5 kgf·m, 11.0 lbf·ft)
 : 6 mm
 : 34 N·m(3.5 kgf·m, 25 lbf·ft)

- Check Valve

3. Install springs (6) (2 used) into poppets (7) (2 used) and insert the poppet into casing (3). Install O-rings (5) (2 used) onto plugs (4) (2 used) and install the plugs into casing (3).
 : 12 mm
 : 235 N·m(24 kgf·m, 174 lbf·ft)

 **NOTE:** When poppet (7) is installed into casing (3), check its actuation by finger.

- Overload Relief Valve

4. Install overload relief valves (2) (2 used) into casing (3).
 : 27 mm
 : 540 N·m(55 kgf·m, 400 lbf·ft)

- Counter Balance Valve

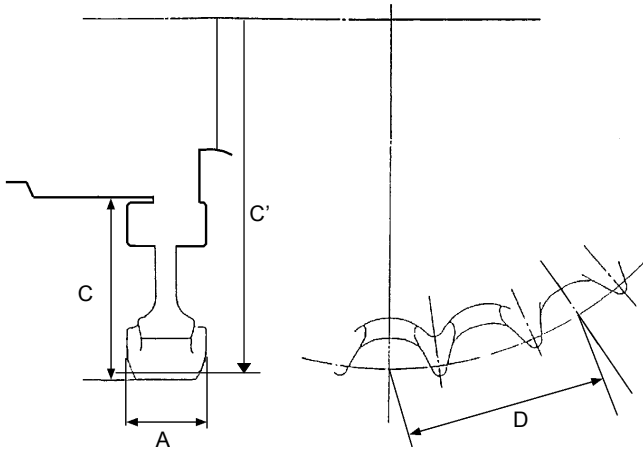
IMPORTANT: Apply hydraulic oil to spool (13) before assembling. If any resistant force is felt, move it back and reassemble it. Never assemble it by force.

5. Insert spool (13) into casing (3). Be sure that spool (13) can move smoothly in casing (3).
6. Install spring (10) onto stoppers (12) (2 used), then insert the stoppers into casing (3).
7. Install O-rings (5) (2 used) onto plugs (8) (2 used), then install the plugs into casing (3).
 : 41 mm
 : 340 N·m(35 kgf·m, 250 lbf·ft)

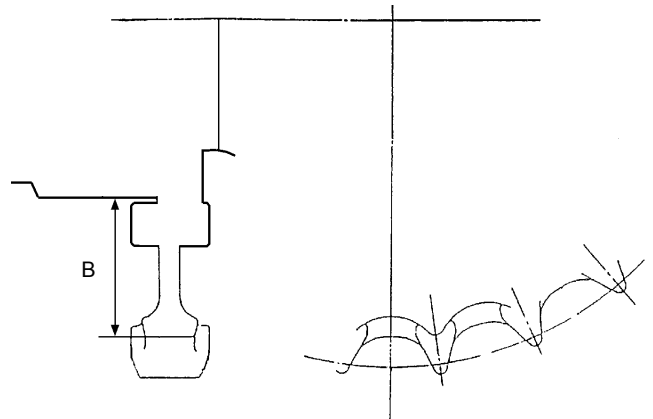
UNDERCARRIAGE / Travel Device

MAINTENANCE STANDARD

Sprocket



W1SE-03-02-001



W105-03-07-040

ZAXIS200, 200-E, 225US, 225USR, 230 Unit: mm (in)

	Standard	Allowable Limit	
A	70 (2.8)	[62 (2.4)]	Bulid up and finishing
B	110.8 (4.4)	105 (4.1)	
C	150.2 (5.9)	145 (5.7)	
C'	644.6 (25.4)	—	
D			

ZAXIS270 Unit: mm (in)

	Standard	Allowable Limit	
A	87 (3.4)	77 (3.0)	Bulid up and finishing
B	89.5 (3.5)	79 (3.1)	
C	133.6 (5.3)	—	
C'	732.5 (28.8)	723 (28.5)	
D	216.0 (8.5)	—	

 NOTE: Values in [] are just for reference.

UNDERCARRIAGE / Travel Device

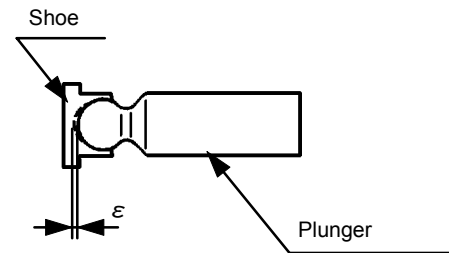
Travel Motor

1. Clearance between plunger and shoe

Unit: mm (in)

Standard	Allowable Limit
0	0.2 (0.0079)

$$\varepsilon \leq 0.2 \text{ mm (0.0079 in)}$$



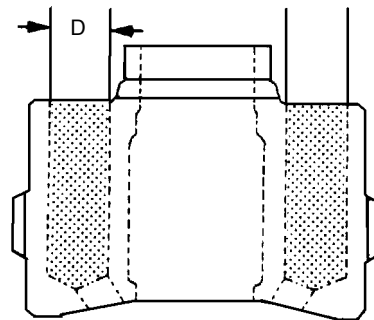
W105-02-06-130

2. The clearance between plunger outer diameter and rotor bore

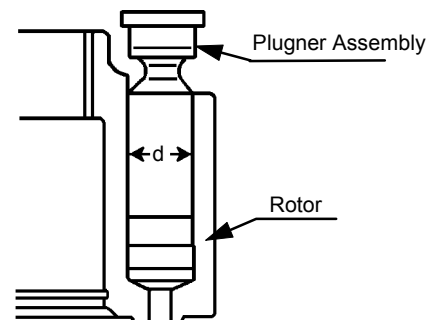
Unit: mm (in)

Standard	Allowable Limit
0	0.04 (0.0016)

$$D - d \leq 0.04 \text{ mm (0.0016 in)}$$



W105-02-06-134

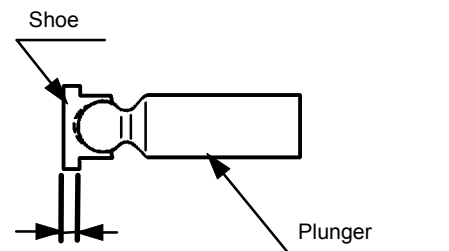


W105-02-06-135

3. Shoe thickness

Unit: mm (in)

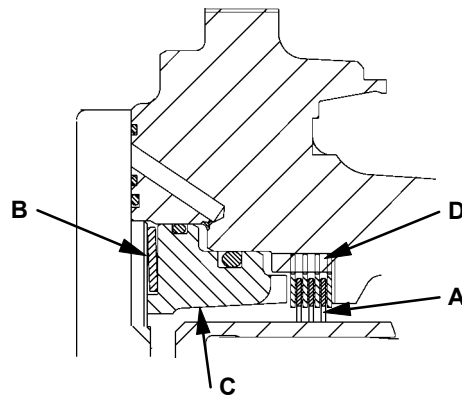
Standard	Allowable Limit
6.0 (0.24)	5.7 (0.22)



W105-02-06-130

UNDERCARRIAGE / Travel Device

Parking Brake



W176-03-02-014

ZAXIS200, 200-E, 225US, 225USR, 230

Unit: mm (in)

	Part Name	Standard	Allowable Limit	Remedy
A	Friction plate	Thickness 2.75 (0.11)	2.70 (0.11)	
B	Disc spring	(Overall height) 7.0 (0.28)	6.9 (0.27)	
C	Piston	Thickness 44.1 (1.74)	—	
D	Plate	Thickness 1.80 (0.07)	1.75 (0.07)	
Remarks		No wear on the piston as it does not slide.		

ZAXIS270

Unit: mm (in)

	Part Name	Standard	Allowable Limit	Remedy
A	Friction plate	Thickness 3.3 (0.13)	32.5 (1.28)	
B	Disc spring	(Overall height) 7.6 (0.30)	72.0 (2.83)	
C	Piston	Thickness 49.6 (1.95)	—	
D	Plate	Thickness 1.80 (0.07)	1.75 (0.07)	

UNDERCARRIAGE / Center Joint

REMOVE AND INSTALL CENTER JOINT



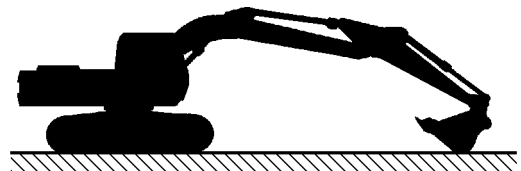
CAUTION: Hydraulic flue under pressure can penetrate the skin or eyes, causing serious injury. Avoid this hazard by releasing pressure before disconnecting hydraulic or other lines.

Hydraulic oil may be hot just after operation and may spurt, causing severe burns. Be sure to wait for oil to cool before starting work.

The hydraulic oil tank cap may fly off if removed without first releasing internal pressure. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.

Preparation

1. Park the machine on a firm, level surface. Lower the front attachment onto the ground.
2. Stop the engine. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.
3. Remove hydraulic oil tank cap, connect a vacuum pump and put it into operation to keep negative pressure in the hydraulic oil tank.
Be sure to run the vacuum pump continuously while working.



M104-07-021

UNDERCARRIAGE / Center Joint

Removal

1. Attach tags to hoses and adapters of the center joint to aid in assembly.

Disconnect all hoses and adapters from the center joint. Plug all disconnected ends.

-  : 17 mm
-  : 25 N·m (2.5 kgf·m, 18 lbf·ft)
-  : 19 mm
-  : 30 N·m (3.1 kgf·m, 22 lbf·ft)
-  : 27 mm
-  : 93 N·m (9.5 kgf·m, 69 lbf·ft)
-  : 36 mm
-  : 175 N·m (18 kgf·m, 130 lbf·ft)

2. Remove mounting bolt (1) from the center joint to remove stopper plate (2).

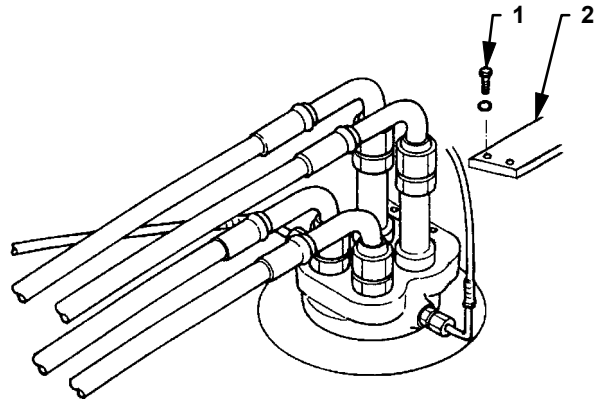
-  : 22 mm
-  : 140 N·m (14.5 kgf·m, 105 lbf·ft)



CAUTION: Center joint weight: 26.5 kg (60 lb)

3. Remove mounting bolt (3) from the center joint. Lift the center joint and remove it by crane.

-  : 22 mm
-  : 140 N·m (14.5 kgf·m, 105 lbf·ft)



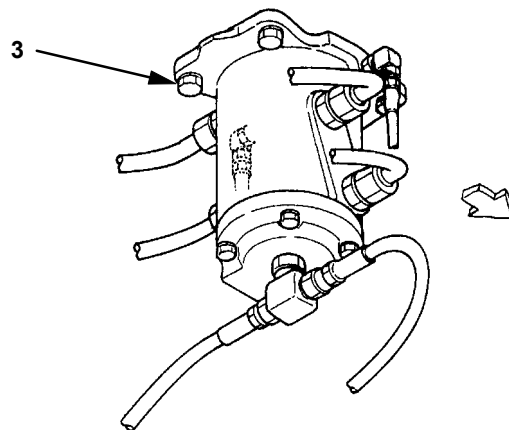
W157-03-03-003

Installation

 **NOTE:** Refer to "Removal" section above for wrench sizes and tightening torque.

1. Install the center joint using mounting bolts (3).
2. Install stopper plate (2) to the center joint using mounting bolts (1).
3. Connect all hoses to center joint.

IMPORTANT: After installation, start engine and check the component for any oil leaks.



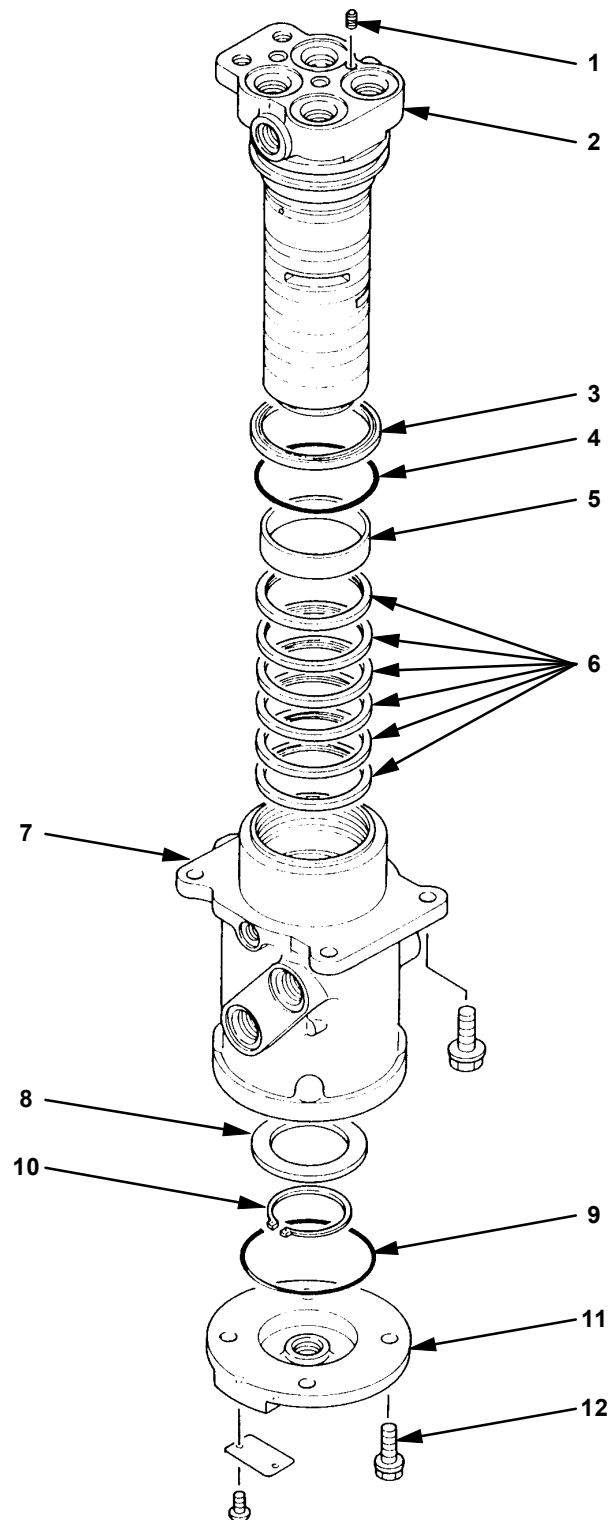
W105-03-03-003

UNDERCARRIAGE / Center Joint

(Blank)

UNDERCARRIAGE / Center Joint

DISASSEMBLE CENTER JOINT



W157-03-03-002

1 - Plug (With Ball)
2 - Spindle
3 - Dust Seal

4 - O-Ring
5 - Bushing
6 - Oil Seal (6 Used)

7 - Body
8 - Ring
9 - O-Ring

10 - Retaining Ring
11 - Cover
12 - Bolt (4 Used)

UNDERCARRIAGE / Center Joint

Disassemble Center Joint

- Be sure to thoroughly read "Precautions for Disassembly and Assembly Work" on page W1-1-1 before starting the disassembly work.



CAUTION: Center joint weight: 26.5 kg (60 lb)

1. Remove mounting bolt (12) from cover (11) diagonally. Using eyebolts M10 (pitch 1.5, length 18 mm), hoist the center joint then secure it on a work bench.

IMPORTANT: Put matching marks on body (7) and spindle (2).

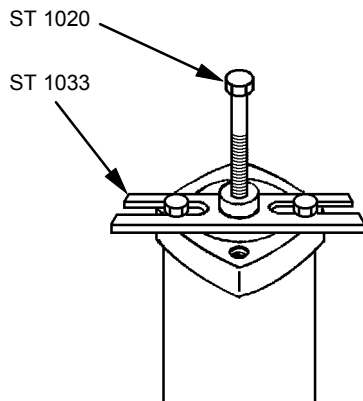
2. Remove bolts (12) to remove cover (11) from body (7).

 : 17 mm

3. Remove O-ring (9), retaining ring (10) and ring (8) from body (7).

4. Attach the special tool (ST 1033, ST 1020) to body (7) with mounting bolts (12) (2 used) on cover (11).

 : 17 mm



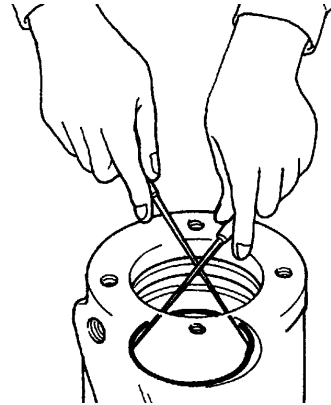
W506-03-03-002

IMPORTANT: Take care not to damage the sliding surface of the spindle (2) seal.

5. Remove spindle (2) from body (7).

IMPORTANT: For easy removal, two pins can be used to pry out oil seals (6). Take care not to damage the seal groove with the pins.

6. Remove oil seals (6) (6 used) and O-ring (4) from body (7).



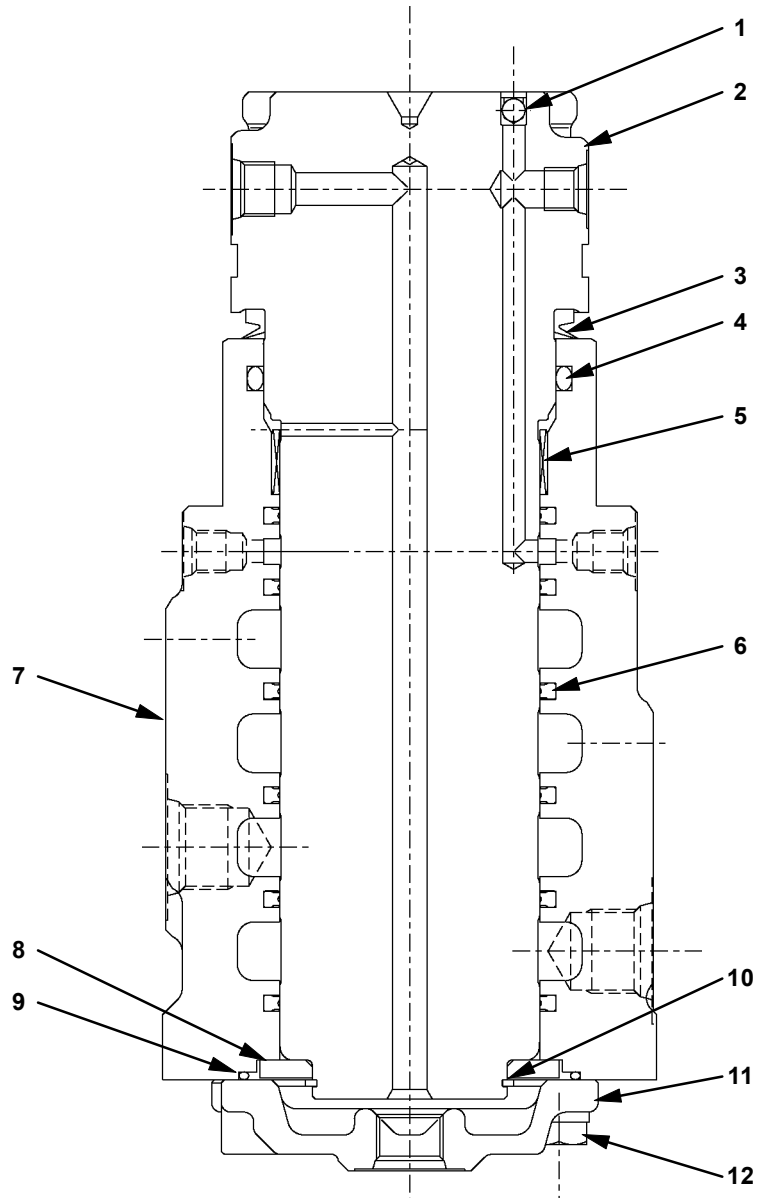
W105-03-03-015

IMPORTANT: While welding, be sure to cover the seal surface to prevent it from being spattered.

7. When replacing bushing (5), build-up weld at 4 places in its inner diameter with welding rod, shrink bushing (5) to pull it out.

UNDERCARRIAGE / Center Joint

ASSEMBLE CENTER JOINT



W178-03-03-001

1 - Plug (With Ball)
2 - Spindle
3 - Dust Seal

4 - O-Ring
5 - Bushing
6 - Oil Seal (6 Used)

7 - Body
8 - Ring
9 - O-Ring

10 - Retaining Ring
11 - Cover
12 - Bolt (4 Used)

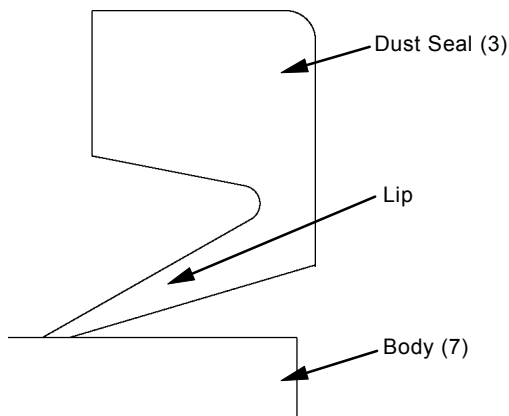
UNDERCARRIAGE / Center Joint

Assemble Center Joint

IMPORTANT: If bushing is removed, be sure to reinstall bushing (5) first. (Refer to page W3-3-8.)

IMPORTANT: Install dust seal (3) with its lip side facing body (6).

1. Install spindle (2) and dust seal (3).

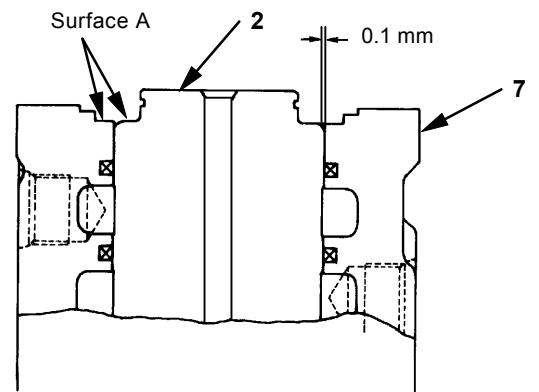


W178-03-03-002

2. Install oil seals (6) (6 used) and o-ring (4) into body (7).
3. Secure spindle (2) to a work bench. Install body (7) on spindle (2) with their matching marks aligned.

IMPORTANT: Clearance between body (7) and spindle (2) is approximately 0.1 mm (0.004 in), so the spindle must be inserted along axis straight and slowly.

4. Tap body (7) with a plastic hammer until its surface A is flush with that of spindle (2).



W105-03-03-024

IMPORTANT: Be sure to install ring (8) with the chamfered side facing spindle.

5. Install ring (8) and O-ring (9) to body (7).
6. Install retaining ring (10) to spindle (2).
7. Install cover (11) with bolts (12) (4 used).
 -  : 17 mm
 -  : 49 N·m (5 kgf·m, 36 lbf·ft)

UNDERCARRIAGE / Center Joint

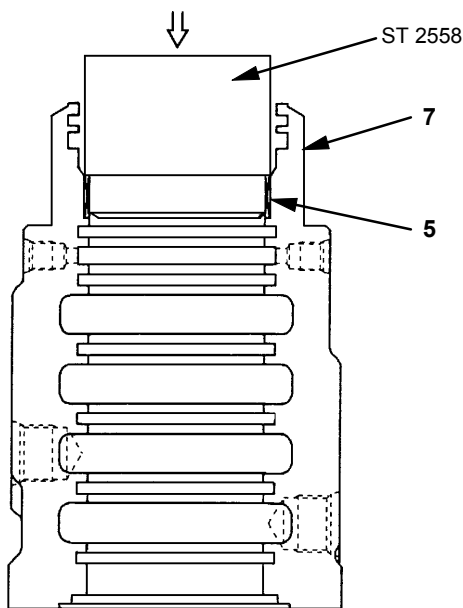
When replacing the body or spindle with new one, the following procedures are required.

IMPORTANT: When press bushing (5) into body (7), grease or molybdenum disulphide shall be applied to the fitting surface.

Replacing Body (7)

Press bushing (5) into body (7).

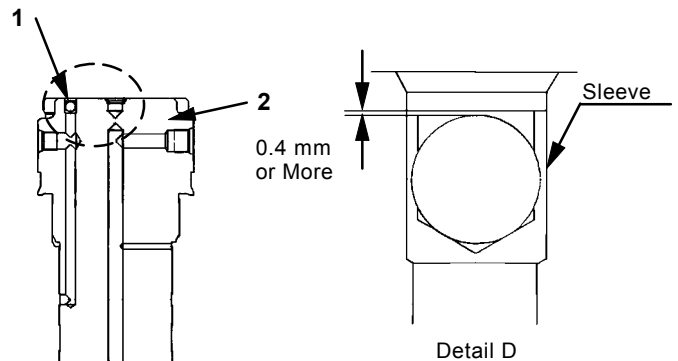
1. Clean body (7) and bushing (5).
2. Press bushing (5) into body (7), using the pressing tool.
Pressing force: 0.5 to 1.5 t (1100 to 3300 lb)
Pressing tool: ST 2558



W105-03-03-029

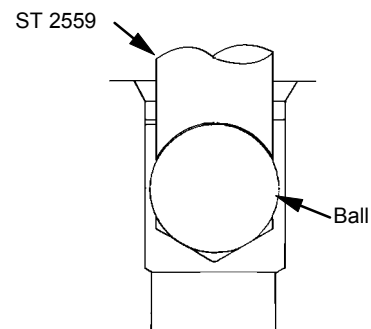
Replacing Spindle (2)

1. Clean spindle (2).
2. Tap plugs (1) into spindle (2) using special tools (ST 2559).
3. Tap the balls of plug (1) so that the top of each ball is 0.4 mm (0.016 in) or more lower than the respective sleeve edge as illustrated in detail D.



W136-03-03-031

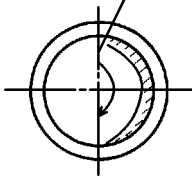
W135-03-03-001



W157-03-03-004

UNDERCARRIAGE / Center Joint

MAINTENANCE STANDARD

Item		Allowable limit (basis for judgment)	Remedy
Bushing		1. Wear more than 0.2 mm (0.008 in)	Replace
		2. Scored, abnormal wear	Replace
		3. Uneven wear (wear range is within 180°)	Replace
		 T157-01-01-040	
Body · spindle	Sliding surface and sealed part	Scored or serious damage	Replace
	Sliding surface of body and spindle, except sealed part	1) Scored or abnormal wear of more than 0.1 mm (0.004 in)	Replace
		2) Scored less than 0.1 mm (0.004 in) deep	Repair and finish with oil stone
	Sliding surface and ring	1) Wear more than 0.5 mm (0.02 in) deep And abnormal wear	Replace
		2) Wear less than 0.5 mm (0.02 in) deep	Repair and finish
		3) Scored or abnormal worn less than 0.5 mm (0.02 in) deep and able to be repaired.	Repair and finish
Cover	Sliding surface and ring	1) Wear more than 0.5 mm (0.02 in)	Replace
		2) Wear less than 0.5 mm (0.02 in)	Repair and finish
		3) Scored or abnormal wear less than 0.5 mm (0.02 in) and able to be repaired.	Repair and finish

UNDERCARRIAGE / Center Joint

(Blank)

UNDERCARRIAGE / Track Adjuster

REMOVE AND INSTALL TRACK ADJUSTER

Before removing and adjusting the track adjuster, the tracks and the front idler must be removed first. For removal of the tracks and front idler, refer to their Removal / Installation sections.

In this section, the procedure starts on the premise that the tracks and front idler have already been removed.

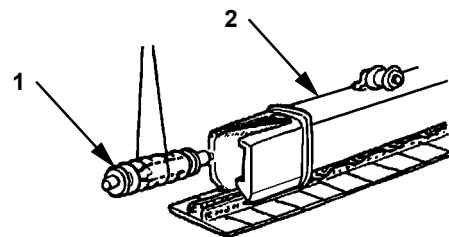
Removal

CAUTION: Track adjuster weight:
129 kg (280 lb)
(ZAXIS 200, 200-E, 225US, 225USR, 230)
180 kg (400 lb) (ZAXIS 270)

CAUTION: The front idler may jump out due to strong spring force when disconnecting the tracks adjuster (1). Do not stand in the same direction as to track adjuster's (1) removal, nor any vicinity where there may be a clanged of being injured by the idler flying off.

Particularly, a strong spring force is always applied to the threaded part of the rod. If the rod and/or the threads are damaged, metal fragments under spring force may fly off. Take due care.

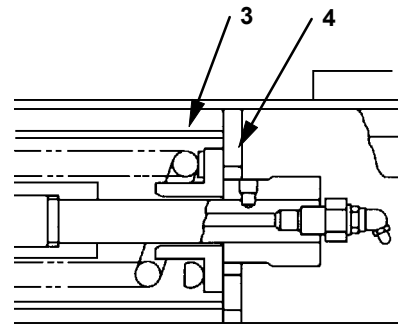
1. After removing the front idler with yoke, remove track adjuster (1) from track frame (2) by prying it out with a pry bar.



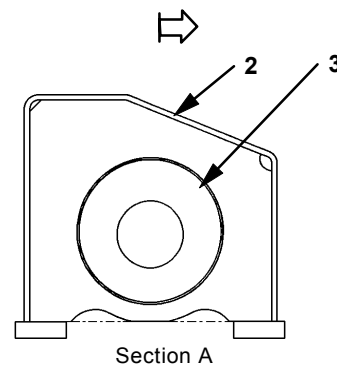
W157-03-04-003

Installation

1. As illustrated, install track adjuster (1) into spring guide (3) on track frame (2). Check that the end face of track adjuster (1) comes into contact with the face of plate (4).



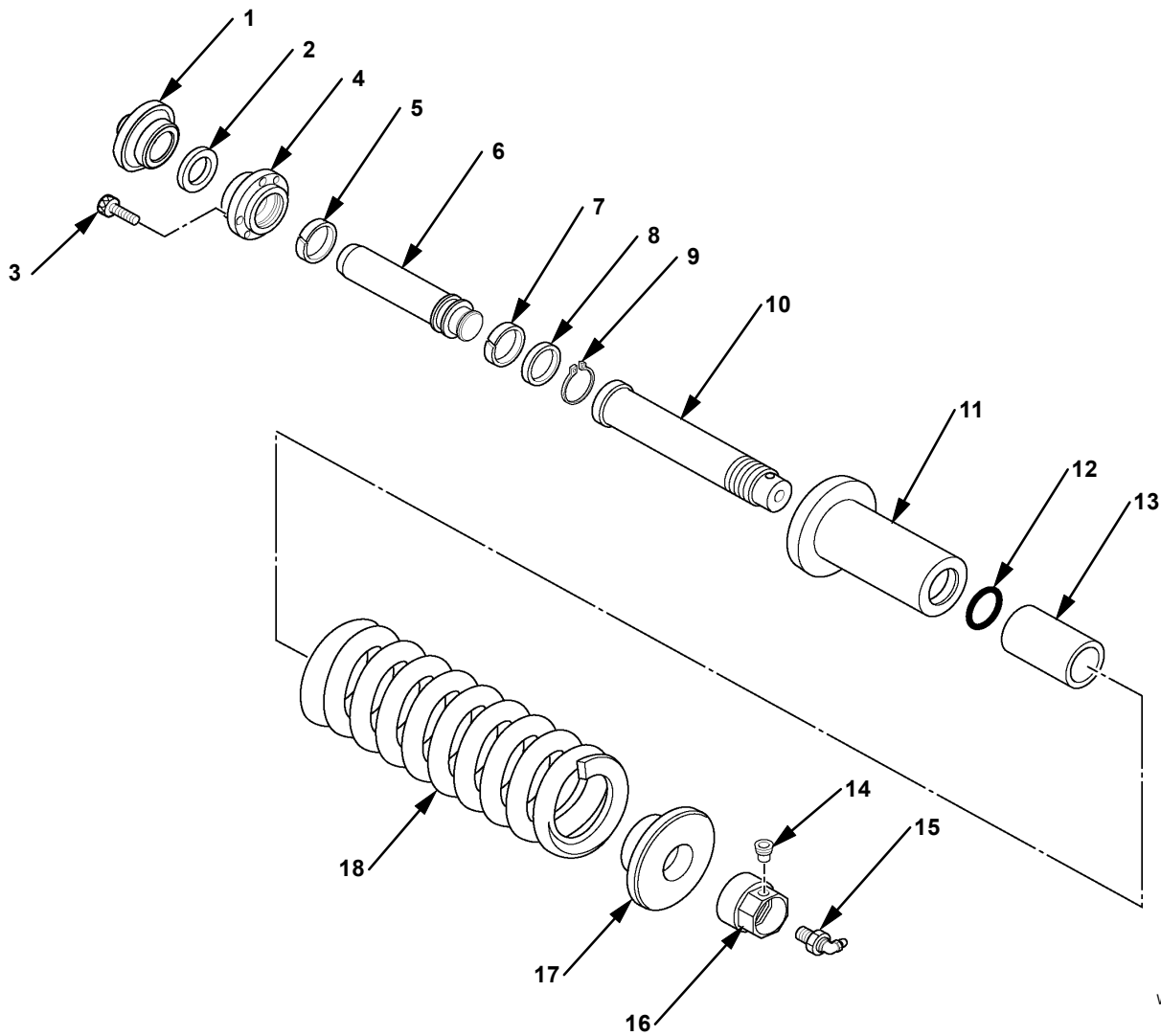
W157-03-04-002



W157-03-04-001

UNDERCARRIAGE / Track Adjuster

DISASSEMBLE TRACK ADJUSTER



W178-03-04-001

- 1 - Holder
- 2 - Dust Seal
- 3 - Socket Bolt (3 Used)
- 4 - Flange
- 5 - Wear Ring

- 6 - Piston Rod
- 7 - Wear Ring
- 8 - U-Ring
- 9 - Retaining Ring
- 10 - Rod

- 11 - Cylinder
- 12 - O-Ring
- 13 - Spacer
- 14 - Plug

- 15 - Valve
- 16 - Nut
- 17 - Washer
- 18 - Spring

UNDERCARRIAGE / Track Adjuster

Disassemble Track Adjuster

- Be sure to thoroughly read "Precautions for Disassembly and Assembly Work" on page W1-1-1 before starting the disassembly work.

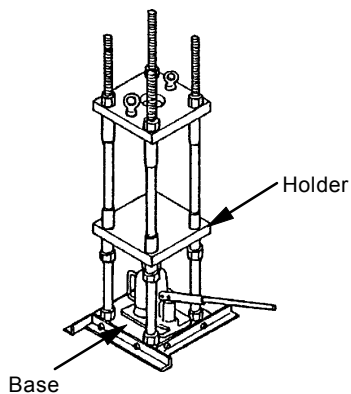
Be sure to use special tool (ST 4920) for assembly / disassembly of the track adjuster.

The spring force is extremely large, so disassembly and assembly work must be carried out carefully. In addition, it is necessary to inspect the special tool for any damage thoroughly to ensure safety.



**CAUTION: Special tool weight:
225 kg (500 lb)**

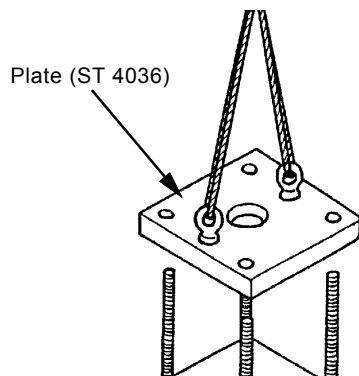
1. Place an oil jack (30 t) between the base and holder.



W105-03-04-006

2. Loosen the nuts from the special tool to remove plate (ST 4036).

 : 46 mm

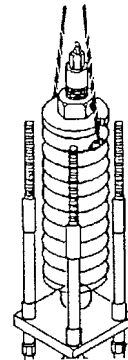


W105-03-04-007



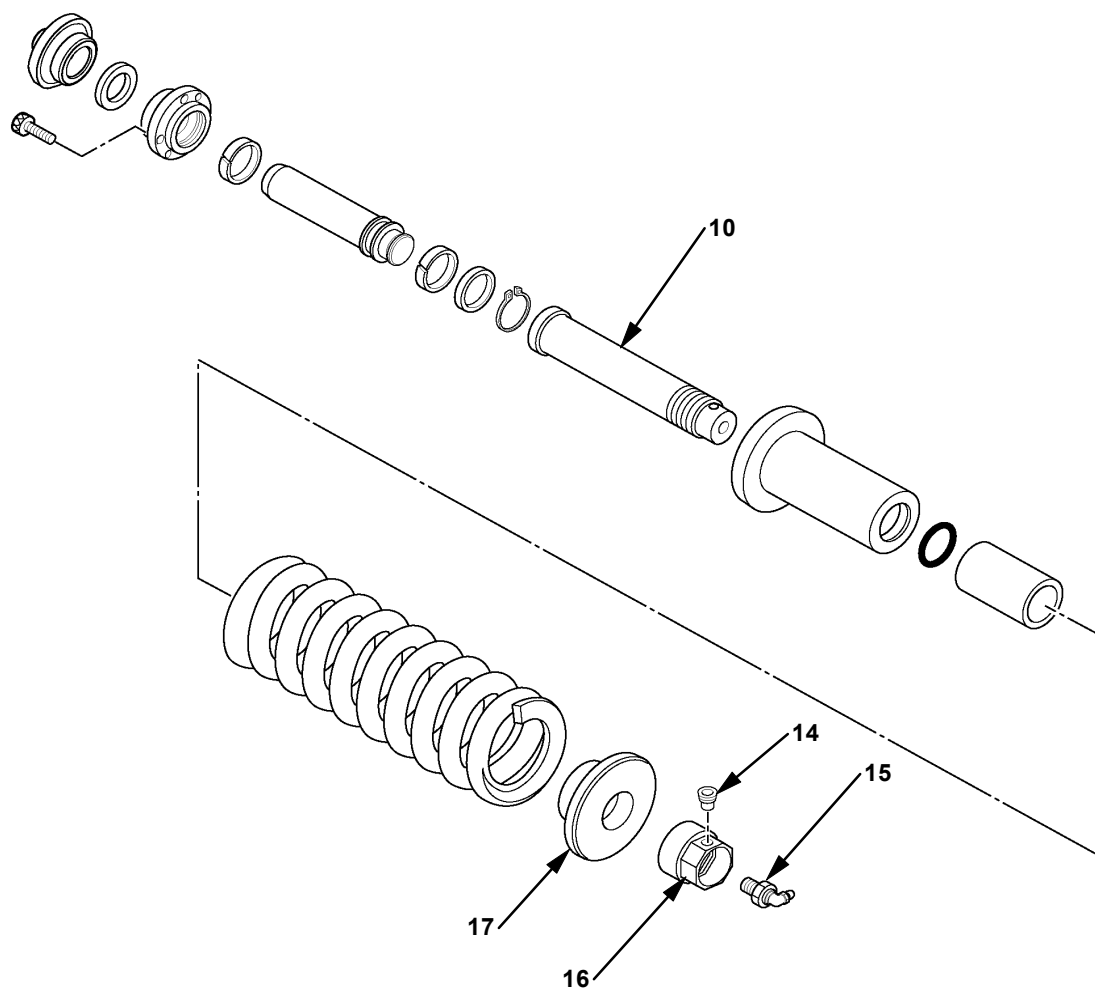
**CAUTION: Track adjuster weight:
129 kg (280 lb)
(ZAXIS200, 200-E, 225US, 225USR, 230)
180 kg (400 lb) (ZAXIS 270)**

3. Attach wire rope to the track adjuster as illustrated. Lift and place it on the holder of special tool by crane.



W105-03-04-009

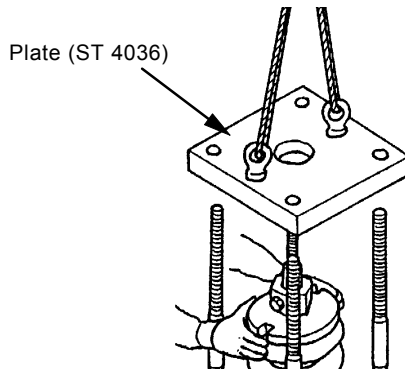
UNDERCARRIAGE / Track Adjuster



W178-03-04-001

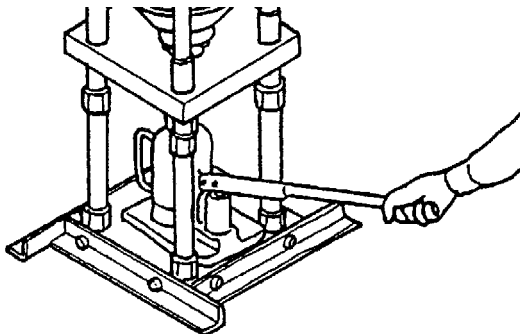
UNDERCARRIAGE / Track Adjuster

4. Install plate (ST 4036) on the track adjuster and secure them together.



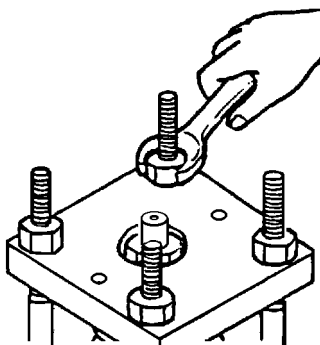
W105-03-04-011

5. Operate the oil jack to jack up with nut (16) facing the top surface of the plate (till spanner can be used).



W105-03-04-013

6. Tighten the nuts of the special tool to secure the track adjuster.



W105-03-04-012

7. Operate the oil jack to compress the track adjuster approximately 10 mm (0.4 in) until a clearance is observed between washer (17) and nut (16).

 : 46 mm

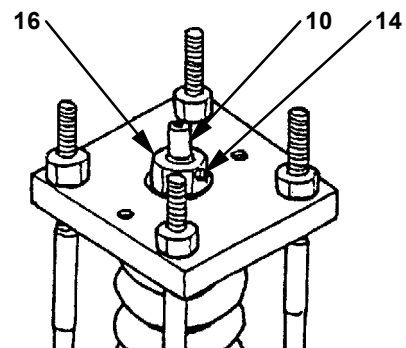
8. Remove plug (14) from nut (16). Remove nut (16) and valve (15) from rod (10).

 : 5 mm

 : 75 mm (ZAXIS 200, 200-E, 225US, 225USR, 230)

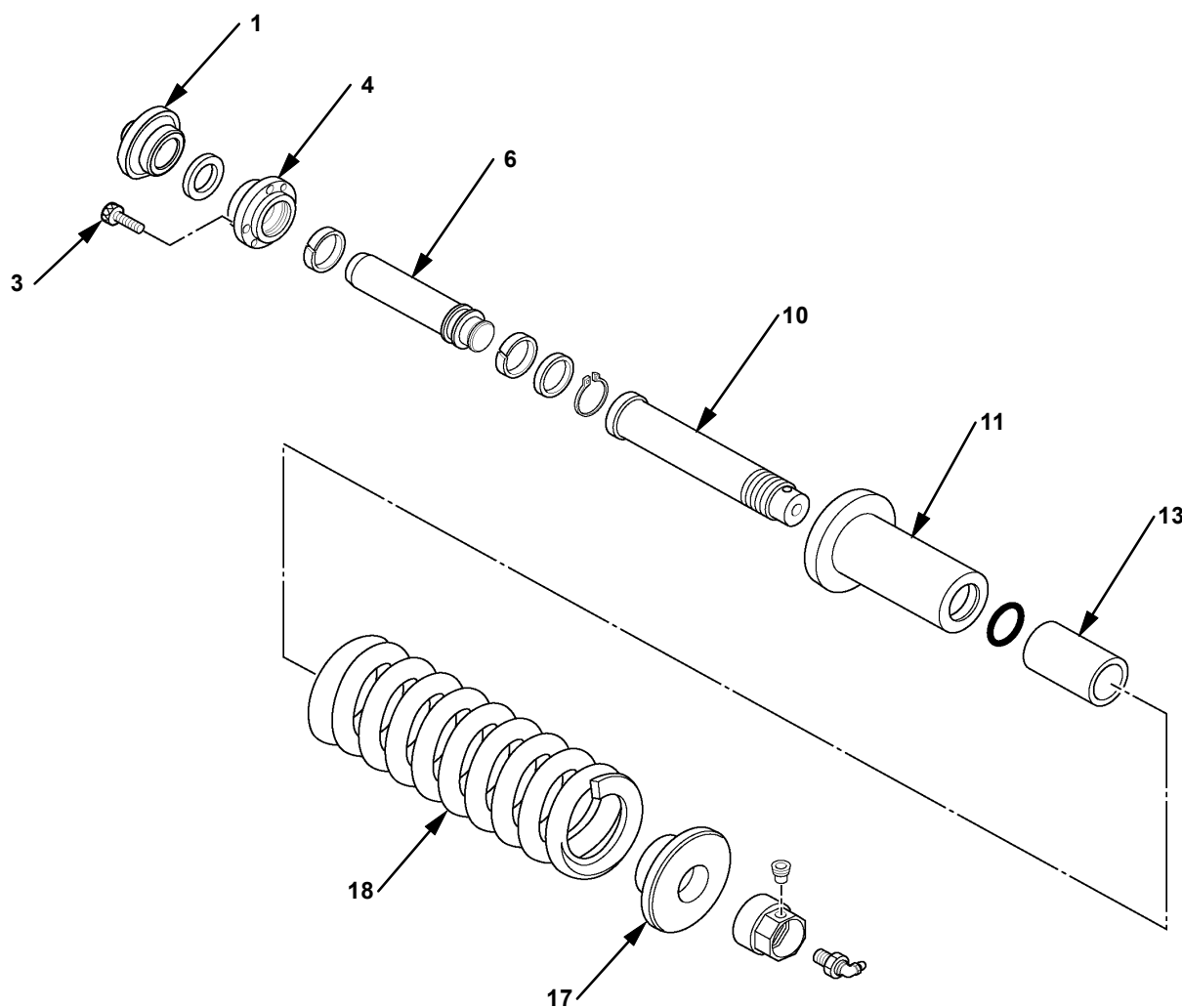
 : 24 mm

 : 85 mm (ZAXIS 270)



W105-03-04-014

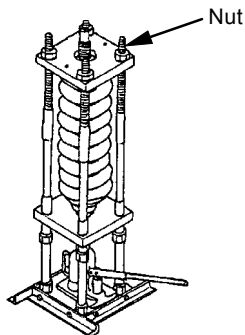
UNDERCARRIAGE / Track Adjuster



W178-03-04-001

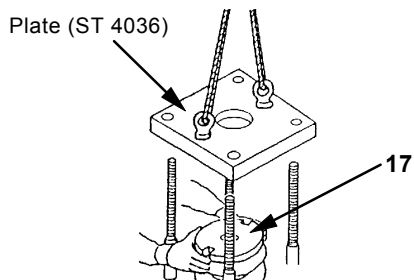
UNDERCARRIAGE / Track Adjuster

9. Lower the oil jack slowly.



W105-03-04-015

10. Remove the nuts of the special tool to remove plate (ST 4036) and washer (17).

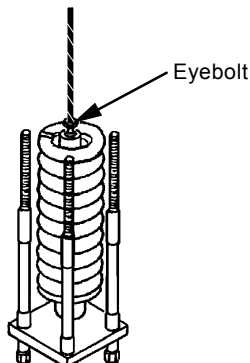


W105-03-04-016



CAUTION: Track adjuster weight:
129 kg (280 lb)
(ZAXIS 200, 200-E, 225US, 225USR, 230)
180 kg (400 lb) (ZAXIS 270)

11. Install eyebolt (M16, pitch 1.5) to rod (10) and lift the track adjuster up by crane to remove it from the special tool.



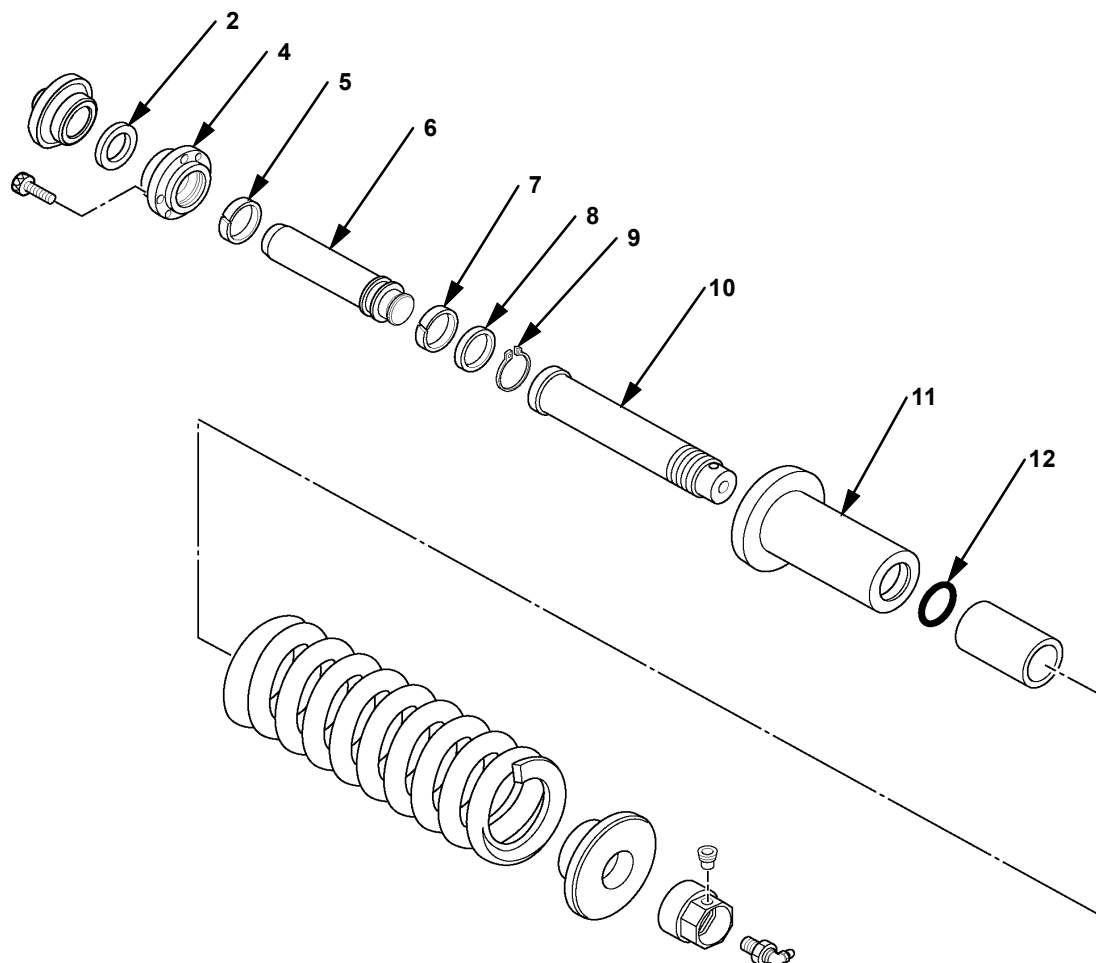
W105-03-04-017



CAUTION: Spring weight:
71 kg (160 lb)
(ZAXIS 200, 200-E, 225US, 225USR, 230)
180 kg (400 lb) (ZAXIS 270)

12. After removing the eyebolt, remove spring (18) from rod (10).
13. Remove spacer (13) from rod (10).
14. Remove socket bolts (3) (3 used) and then move flange (4) in the direction of the holder.
└ : 6 mm
15. Pull out the piston rod (6) assembly from cylinder (11).
16. Pull out holder (1) from the piston rod (6) assembly using a press.
■ : 30 mm

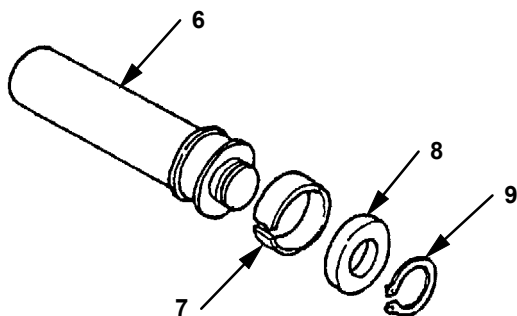
UNDERCARRIAGE / Track Adjuster



W178-03-04-001

UNDERCARRIAGE / Track Adjuster

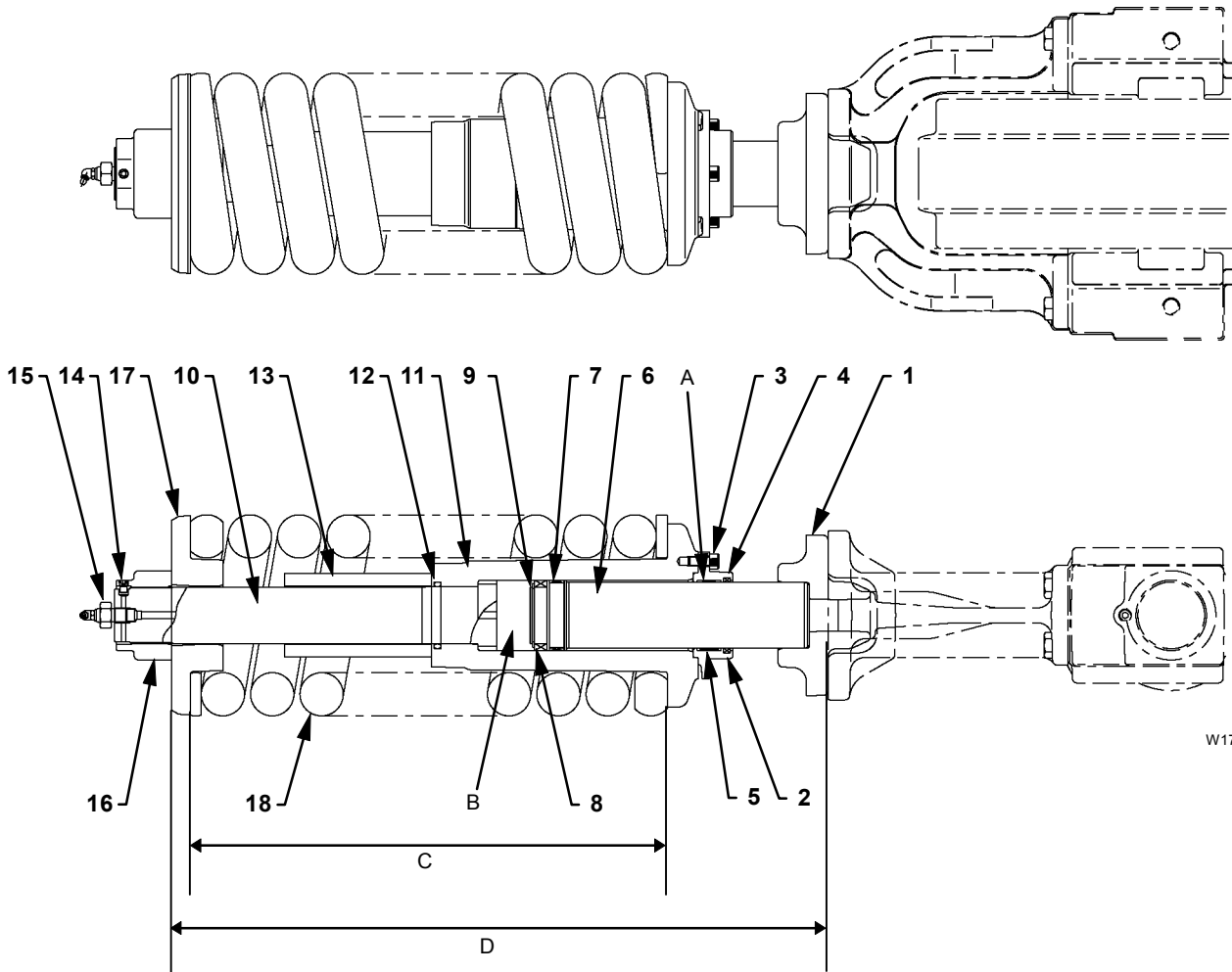
17. Remove flange (4) from piston rod (6). Remove dust seal (2) and wear ring (5) from flange (4).
18. Remove rod (10) and O-ring (12) from cylinder (11).
19. Remove, retaining ring (9), U-ring (8) and wear ring (7) from piston rod (6).



W105-03-04-025

UNDERCARRIAGE / Track Adjuster

ASSEMBLE TRACK ADJUSTER



	ZAXIS: 200, 200-E, 225US, 225USR, 230	ZAXIS: 270
C	521 mm(Free Length 626 mm)	557 mm(Free Length 679 mm)
D	712 mm	778 mm

- | | | | |
|--------------------------|--------------------|---------------|-------------|
| 1 - Holder | 6 - Piston Rod | 11 - Cylinder | 15 - Valve |
| 2 - Dust Seal | 7 - Wear Ring | 12 - O-Ring | 16 - Nut |
| 3 - Socket Bolt (3 Used) | 8 - U-Ring | 13 - Spacer | 17 - Washer |
| 4 - Flange | 9 - Retaining Ring | 14 - Plug | 18 - Spring |
| 5 - Wear Ring | 10 - Rod | | |

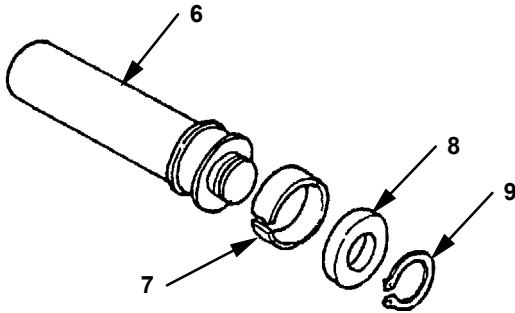
UNDERCARRIAGE / Track Adjuster

Assemble Track Adjuster

1. Clean all parts. Then install dust seal (2) and wear ring (5) to flange (4) after applying grease on them.

IMPORTANT: Fill (A) portion of flange (4) with full of grease.

2. Install flange (4) to piston rod (6).
3. Apply grease into holder (1) and press it into piston rod (6) using a press and special tool (ST 7229).
4. Install wear ring (7), U-ring (8), retaining ring (9) onto piston rod (6).

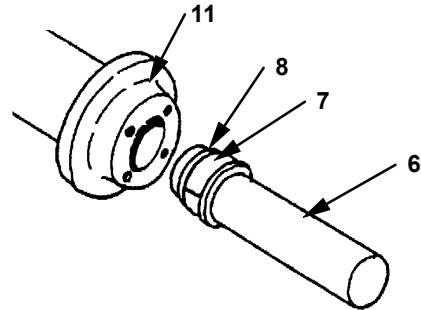


W105-03-04-025

5. Apply grease to O-ring (12) and install it on cylinder (11). Install rod (10) into cylinder (11).

IMPORTANT: Fill (B) portion of cylinder (11) with grease. Push the piston rod (6) assembly into the cylinder to completely bleed air from portion (B) and rod (10).

6. Apply grease to U-ring (8) and wear ring (7). Install the piston rod (6) assembly into cylinder (11).



W105-03-04-021

7. Tighten flange (4) with socket bolts (3) (3 used).

 : 8 mm

 : 50 N·m (5.1 kgf·m, 37 lbf·ft)

8. Install spacer (13) onto rod (10).



CAUTION: Spring weight:

71 kg (160 lb)

(ZAXIS 200, 200-E, 225US, 225USR, 230)

95 kg (210 lb) (ZAXIS 270)

9. Install spring (18) onto rod (10).



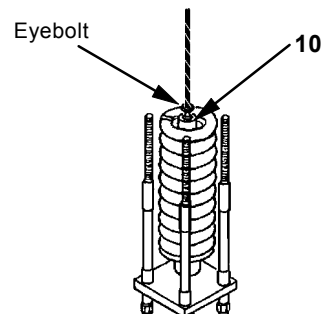
CAUTION: Spring assembly weight:

129 kg (280 lb)

(ZAXIS 200, 200-E, 225US, 225USR, 230)

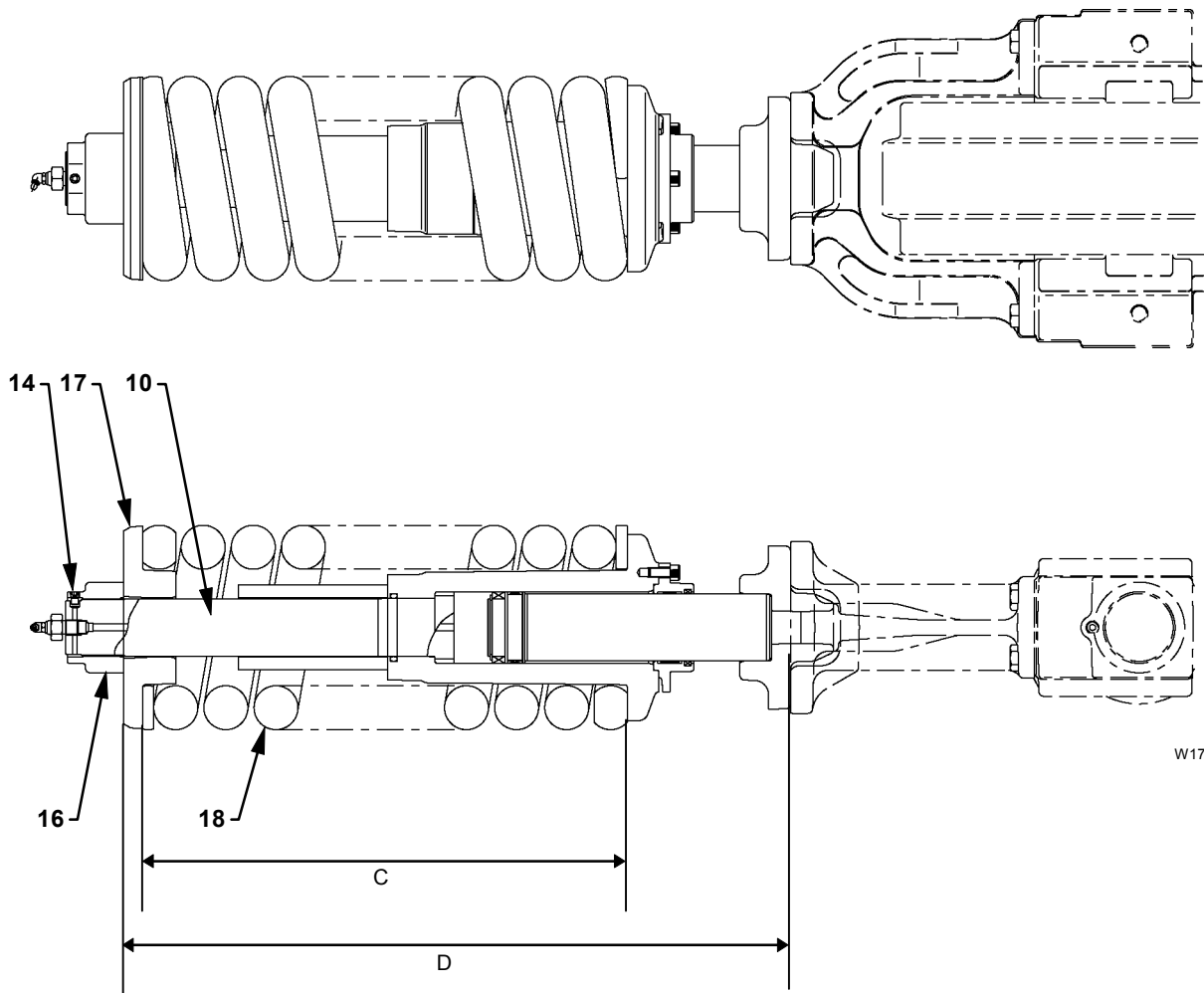
180 kg (400 lb) (ZAXIS 270)

10. Install eyebolt (M16, pitch 1.5) to rod (10). Lift the spring assembly up by crane and put it on the special tool.



W105-03-04-017

UNDERCARRIAGE / Track Adjuster

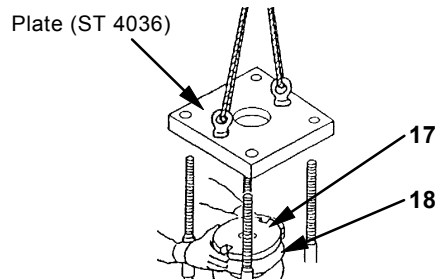


W178-03-04-002

	ZAXIS: 200, 200-E, 225US, 225USR, 230	ZAXIS: 270
C	521 mm(Free Length 626 mm)	557 mm(Free Length 679 mm)
D	712 mm	778 mm

UNDERCARRIAGE / Track Adjuster

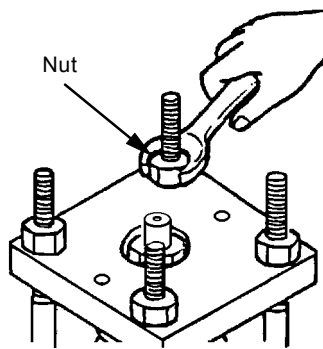
11. After removing the eyebolt from installed rod (10). Put washer (17) on spring (18) and install plate (ST 4036).



W105-03-04-016

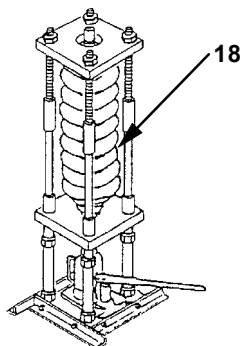
12. Tighten the nuts of the special tool to secure the spring assembly.

🔧 : 46 mm



W105-03-04-012

13. Operate the oil jack to compress spring (18) to specified length.
Specified Length: 521 mm (20.5 in) (ZAXIS 200, 200-E, 225US, 225USR, 230)
Specified Length: 557 mm (21.9 in) (ZAXIS 270)



W105-03-04-026

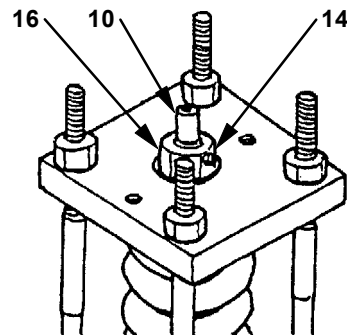
14. Install nut (16) to rod (10), and then install plug (14).

🔧 : 75 mm (ZAXIS 200, 200-E, 225US, 225USR, 230)

🔧 : 85 mm (ZAXIS 270)

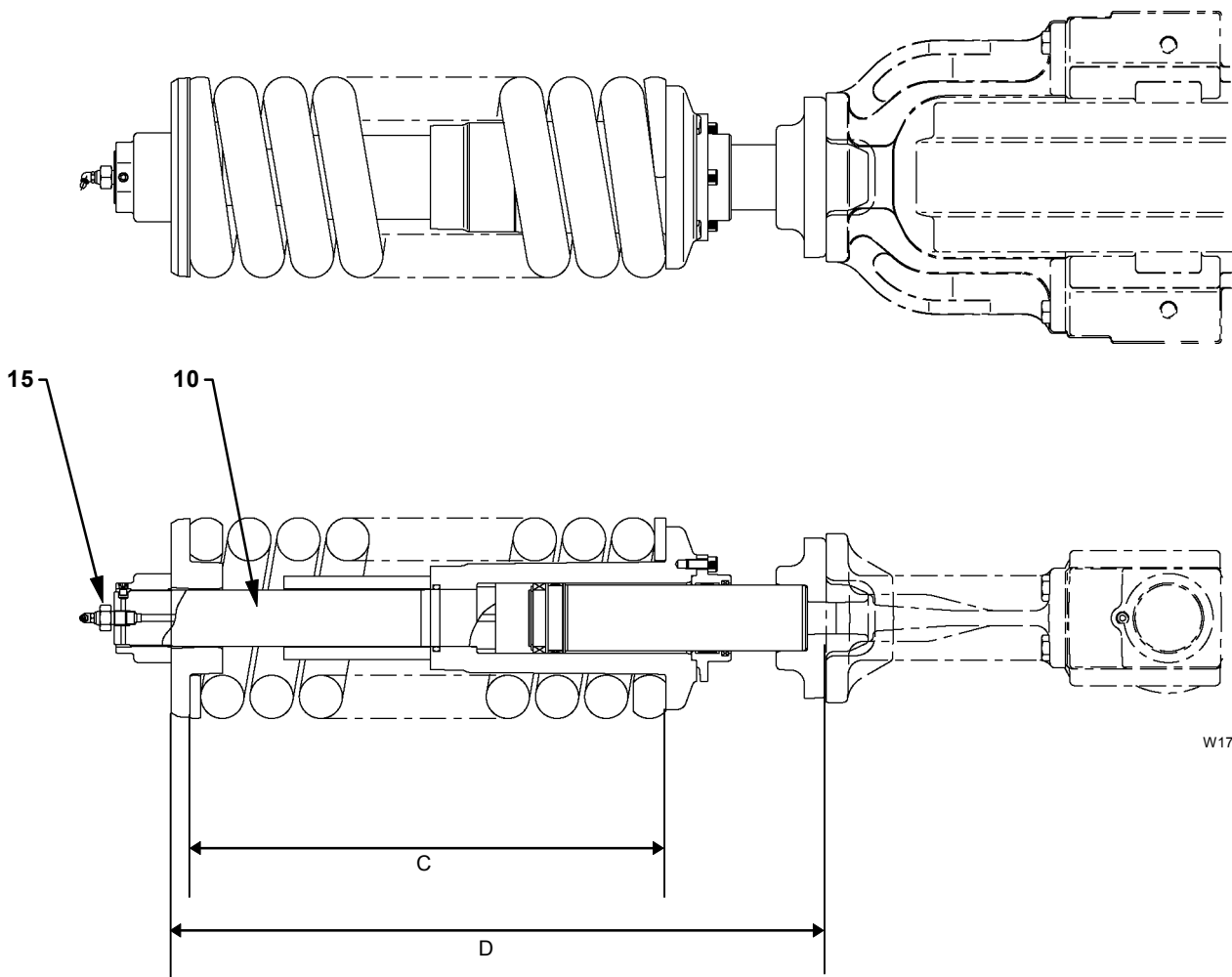
🔧 : 5 mm

🔧 : 14.5 N·m (1.5 kgf·m, 11.0 lbf·ft)



W105-03-04-014

UNDERCARRIAGE / Track Adjuster



W178-03-04-002

	ZAXIS 200, 200-E, 225US, 225USR, 230	ZAXIS: 270
C	521 mm(Free Length 626 mm)	557 mm(Free Length 679 mm)
D	712 mm	778 mm

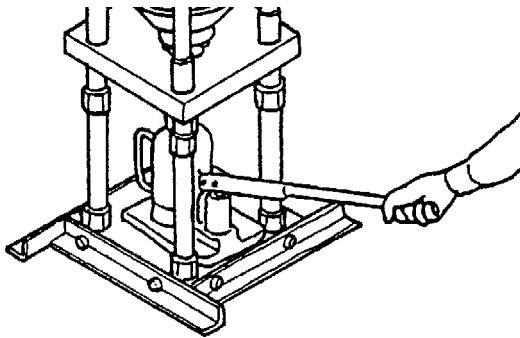
UNDERCARRIAGE / Track Adjuster

15. Install valve (15) to rod (10).

 : 24 mm

 : 88 N·m (9 kgf·m, 65 lbf·ft)

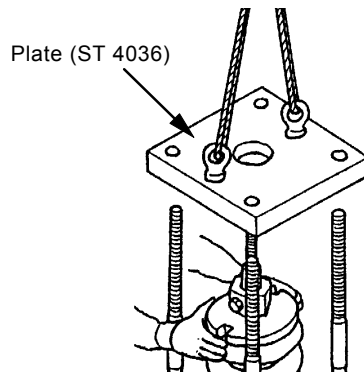
16. Lower the oil jack.



W105-03-04-013

17. Remove the nuts of the special tool and plate (ST 4036)

 : 46 mm



W105-03-04-011



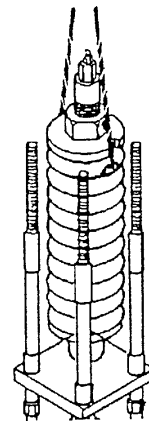
CAUTION: Spring assembly weight:

129 kg (280 lb)

(ZAXIS 200, 200-E, 225US, 225USR, 230)

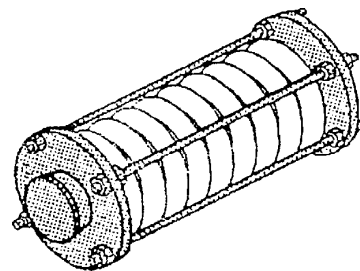
180 kg (400 lb) (ZAXIS 270)

18. Connect the track adjuster to a hoist using a wire rope as illustrated. Lift it up by crane and remove it from the special tool.



W105-03-04-009

IMPORTANT: If only the spring assembly is to be transported, be sure to use a special tool, such as the one illustrated, to carry the spring assembly safely.



W105-03-04-028

UNDERCARRIAGE / Track Adjuster

(Blank)

UNDERCARRIAGE / Front Idler

REMOVE AND INSTALL FRONT IDLER

Removal

Before removing the front idler, the tracks must be removed first. For removal of the tracks, refer to "Remove and Install Tracks" section.

In this section, the procedure starts on the premise that the tracks has already been removed.

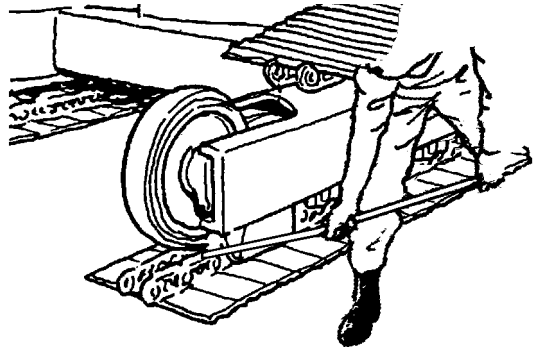
CAUTION: Front idler weight:
100 kg (240 lb)
(ZAXIS 200, 200-E, 225US, 225URS, 230)
160 kg (350 lb) (ZAXIS 270)

CAUTION: The front idler (1) may jump out of position due to strong spring force when the tracks is disconnected. Particularly, a strong spring force is always applied to the threaded part of the rod. If the rod and/or the threads are damaged, metal fragments may fly when the track is disconnected. Take necessary precautions to prevent any personal injury from occurring.

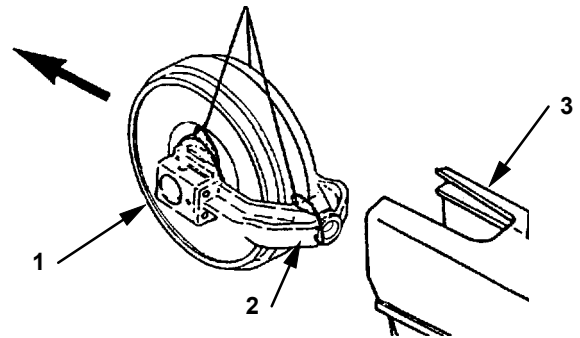
1. Pry front idler (1) using a pry bar to move it out from track frame (3) with yoke (2).
2. Attach the bearing portion and yoke (2) portion of front idler (1) with sling as illustrated and remove the front idler assembly from track frame (3).
3. If it is necessary to remain the front idler for a time, be sure to place it on wooden blocks as shown to keep it stable.

Installation

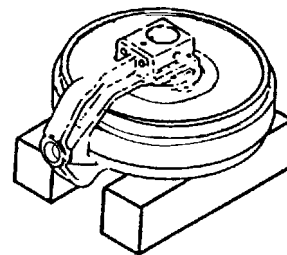
1. Install the front idler according to the reversed procedures of removal and pay attention to the following precautions when installation is carried out.
 - Clean the sliding surface (a) of yoke (2) and sliding surface (b) of track frame (3), then apply grease on them.



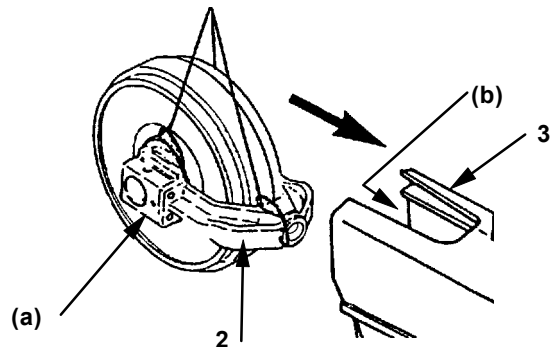
W110-03-05-001



W178-03-05-001



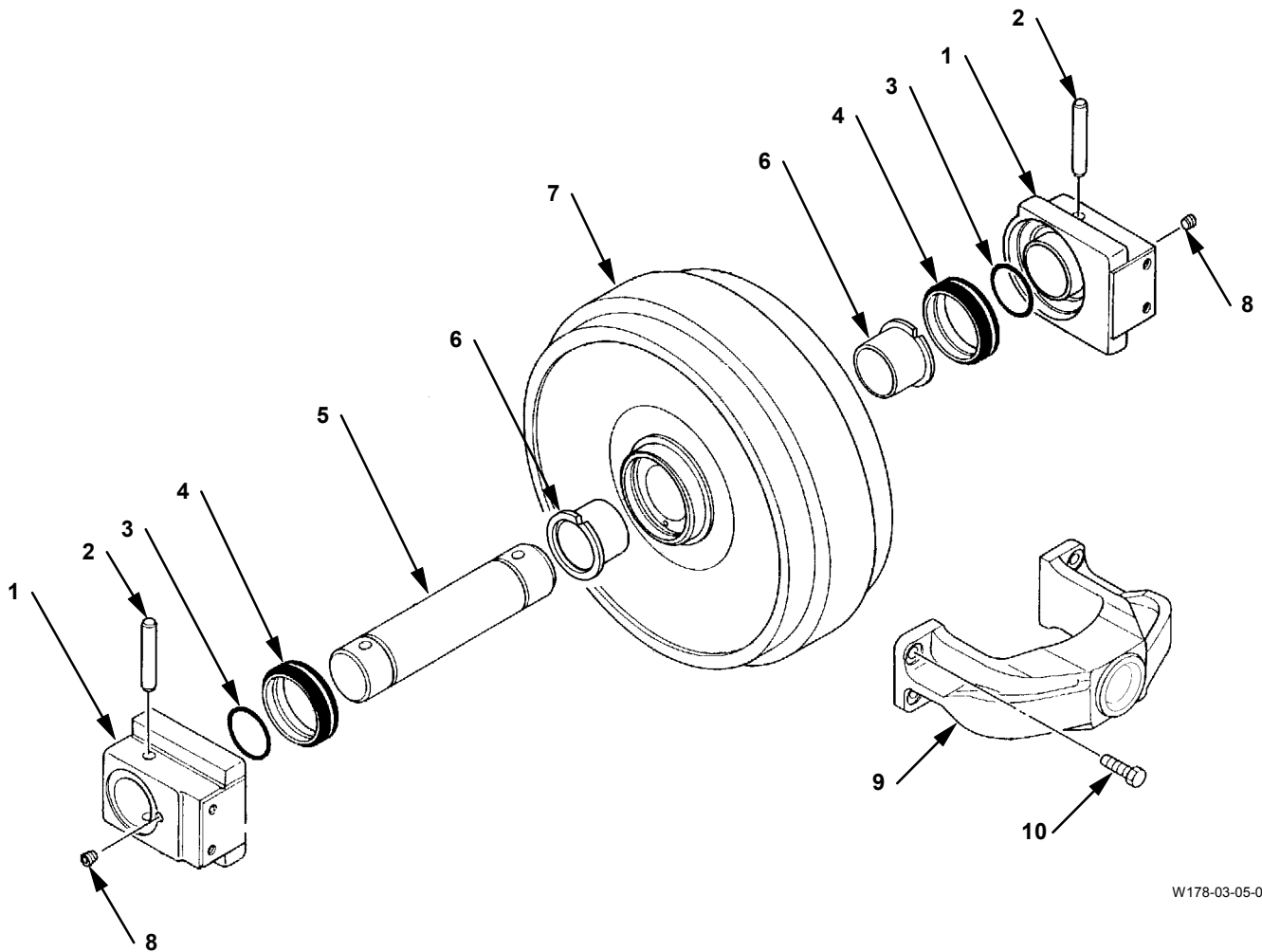
W178-03-05-002



W178-03-05-004

UNDERCARRIAGE / Front Idler

DISASSEMBLE FRONT IDLER



W178-03-05-003

1 - Bearing (2 Used)
2 - Pin (2 Used)
3 - O-Ring (2 Used)

4 - Floating Seal (2 Used)
5 - Axle
6 - Bushing (2 Used)

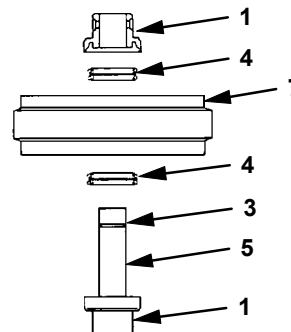
7 - Idler
8 - Plug (2 Used)

9 - Yoke
10 - Bolt (4 Used)

UNDERCARRIAGE / Front Idler

Disassemble Front Idler

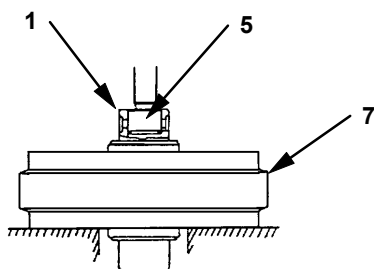
- Be sure to thoroughly read "Precautions for Disassembly and Assembly Work" on page W1-1-1 before starting the disassembly work.
1. Loosen bolt (10) to remove yoke (9). Remove plug (8) from bearing (1) to drain oil into a container.
🔧 : 24 mm
🔩 : 6 mm
 2. Remove pin (2).
🔧 : 16 mm
 4. Remove floating seal (4) from bearing (1) and idler (7).



CAUTION: Idler, etc. weight:
83 kg (180 lb)
(ZAXIS 200, 200-E225US, 225USR, 230)
136 kg (300 lb) (ZAXIS 270)

W105-03-05-009

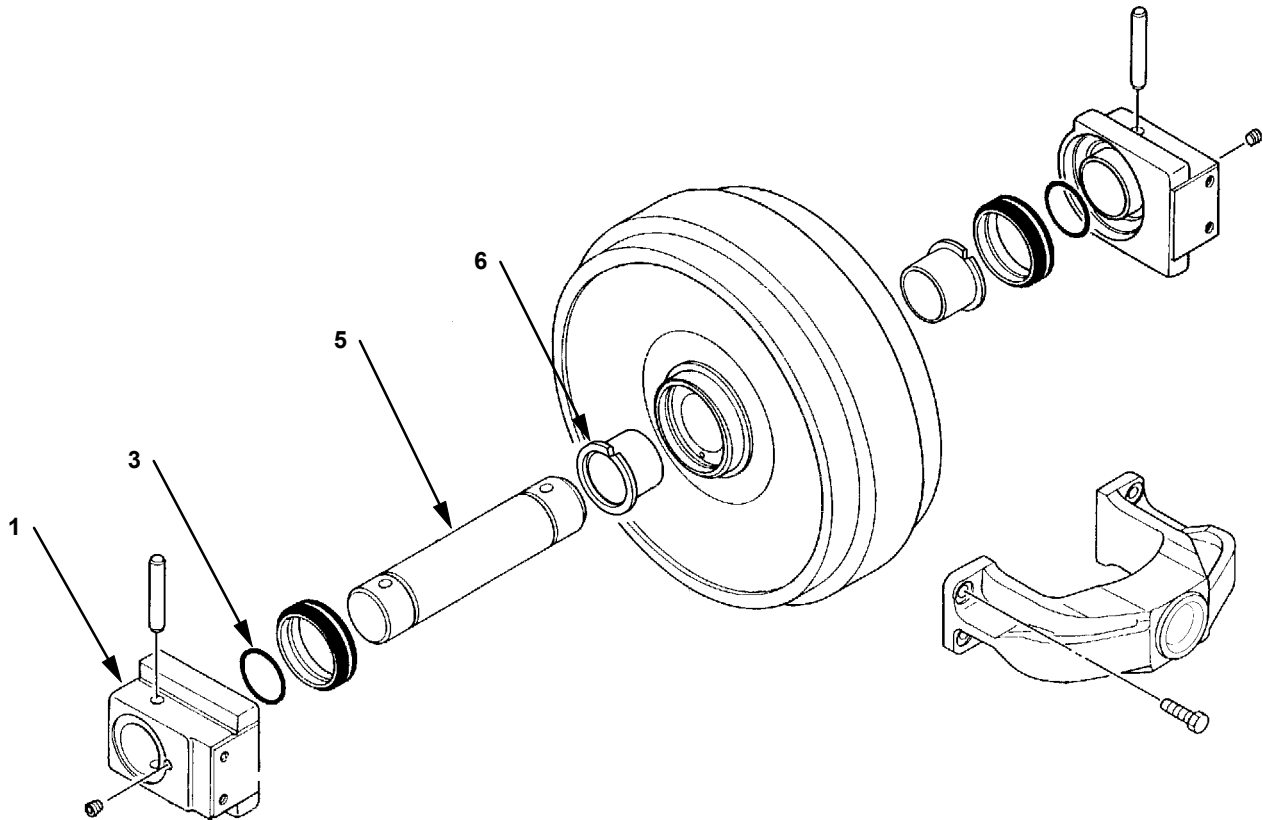
3. Push out axle (5) from bearing (1) via a press. Bearing (1) in opposite side shall be pushed out from idler (7) with its axle (5). Remove O-ring (3) from axle (5).



W105-03-05-008

IMPORTANT: For handling of floating seal (4), refer to the section "Precautions for Floating Seal Handling" on page W1-1-4.

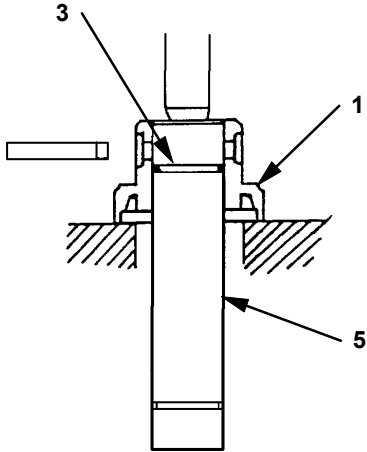
UNDERCARRIAGE / Front Idler



W178-03-05-003

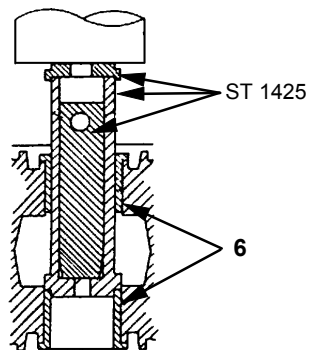
UNDERCARRIAGE / Front Idler

5. Push axle (5) out from bearing (1) via a press.
Remove O-ring (3) from axle (5).



W105-03-05-010

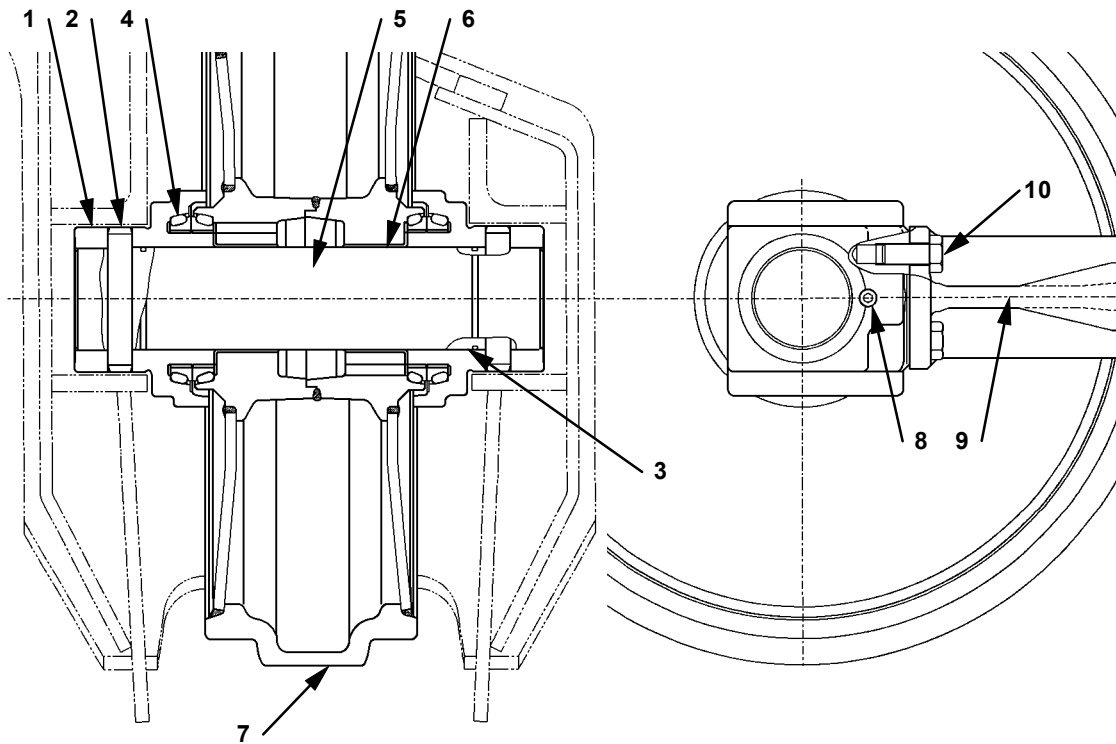
6. When replacing bushing (6), special tool (ST 1425) can be used to push it out via a press.



W105-03-05-011

UNDERCARRIAGE / Front Idler

ASSEMBLE FRONT IDLER



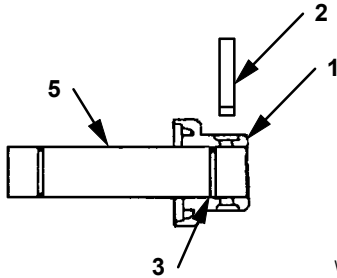
W157-03-05-003

- | | | | |
|----------------------|----------------------------|-------------------|--------------------|
| 1 - Bearing (2 Used) | 4 - Floating Seal (2 Used) | 7 - Idler | 9 - Yoke |
| 2 - Pin (2 Used) | 5 - Axle | 8 - Plug (2 Used) | 10 - Bolt (4 Used) |
| 3 - O-Ring (2 Used) | 6 - Bushing (2 Used) | | |

UNDERCARRIAGE / Front Idler

Assemble Front Idler

1. Install bushing (6) (2 used) into idler (7) from both ends.
2. Install O-ring (3) (1 used) onto axle (5). Aligning the pin holes, install axle (5) into bearing (1) at one side and secure it with pin (2). While doing this, take care not to damage O-ring (3).

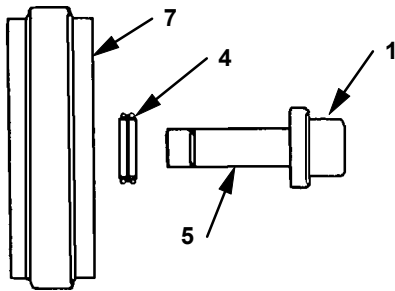


W105-03-05-014

3. Install floating seals (4) a set into idler (7) and bearing (1).

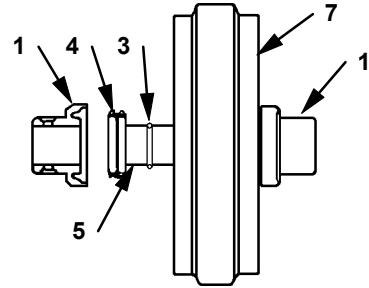
IMPORTANT: For handling of floating seal (4), refer to the section "Precautions for Floating Seal Handling" on page W1-1-4.

4. Insert axle (5) into idler (7) from the side installed with floating seal. Install O-ring (3) onto axle (5).



W157-03-05-006

5. Install the other floating seal (4) into idler (7) and into bearing (1).



W157-03-05-005

6. Install bearing (1) onto axle (5), aligning the pin holes of axle (5). Secure them using pin (2).

7. Add engine oil via plug (8) hole on bearing (1). Apply sealant (LOCTITE # 503 or equivalent) to plug (8). Tighten plug (8).

⌘ : 6 mm

⌘ : 20 N·m (2 kgf·m, 14.5 lb f·ft)

Engine oil: API CD Class SAE 30

Quantity: 265 mL (0.07 US gal)

(ZAXIS 220, 200-E, 225US,
225USR, 230)

300 mL (0.08 US gal)(ZAXIS 270)

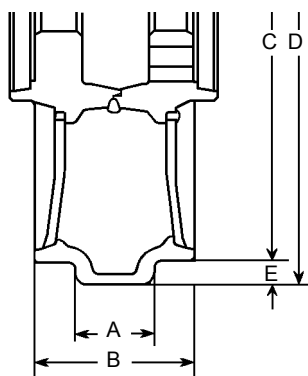
8. Install yoke (9) and tighten bolts (10).

⌘ : 24 mm

⌘ : 210 N·m (21.5 kgf·m, 156 lbf·ft)

UNDERCARRIAGE / Front Idler

MAINTENANCE STANDARD



W157-03-05-001

Unit: mm (in)

	Standard		Allowable Limit		Remedy
	ZAXIS200, 200-E, 225US, 225URS, 230	ZAXIS 270	ZAXIS200, 200-E, 225US, 225URS, 230	ZAXIS 270	
A	84 (3.31)	102 (4.0)	[66 (2.60)]	80.4 (3.15)	Build-up weld and finishing
B	159 (6.26)	204 (1.64)	—	—	
C	500 (19.69)	572 (22.5)	488 (19.21)	552.2 (21.74)	
D	538 (21.18)	617 (24.3)	—	—	
E	19 (0.75)	23 (0.90)	25 (0.98)	32.4 (1.28)	

Axle and Bushing

Unit: mm (in)

		Standard		Allowable Limit		Remedy
		ZAXIS200, 200-E, 225US, 225URS, 230	ZAXIS 270	ZAXIS200, 200-E, 225US, 225URS, 230	ZAXIS 270	
Axle	Outside Dia.	75.0 (2.95)	85.0 (3.35)	[74.2 (2.93)]	[84.2(3.31)]	Replace
Bushing	Inside Dia.	75.0 (2.95)	85.2 (3.35)	[76 (2.997)]	[86.0 (3.39)]	
	Flange Thickness	2 (0.08)	2.0 (0.08)	[1.2(0.05)]	[1.2 (0.05)]	

NOTE: Values in [] are just for reference.

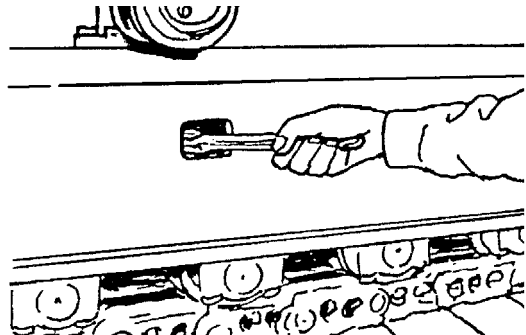
UNDERCARRIAGE / Upper And Lower Roller

REMOVE AND INSTALL UPPER ROLLER

Removal



CAUTION: Do not loosen valve (1) quickly or loosen it too much as high-pressure grease in the adjusting cylinder may spurt out. Loosen carefully, keeping body parts and face away from valve (1). Never loosen grease fitting (2).

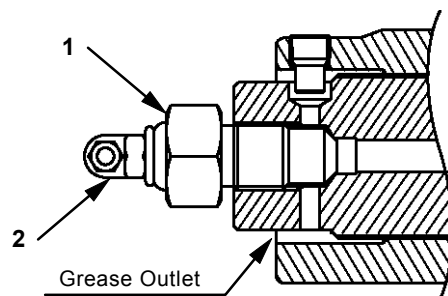


W105-03-06-001

IMPORTANT: Clean off gravel or mud packed between the sprockets and tracks before loosening valve (1).

1. Loosen valve (1) of the track adjuster to drain grease.

 : 24 mm

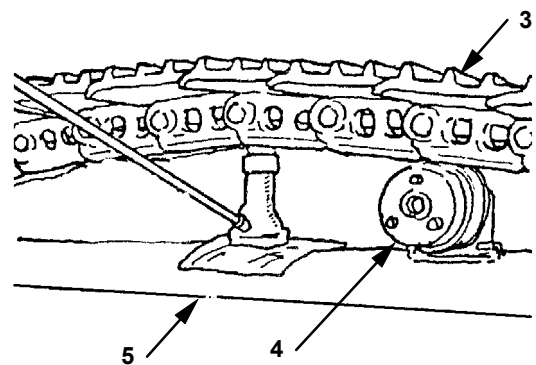


W178-03-06-001



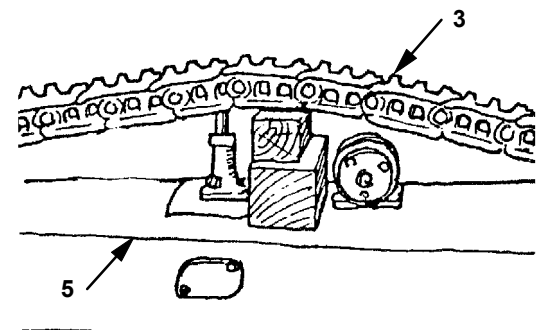
CAUTION: Use a non-skid cloth between track frame (5) and an oil jack to prevent slipping.

2. Jack up tracks (3) high enough to permit upper roller (4) removal.



W105-03-06-002

3. Insert wooden blocks between tracks (3) and track frame (5).

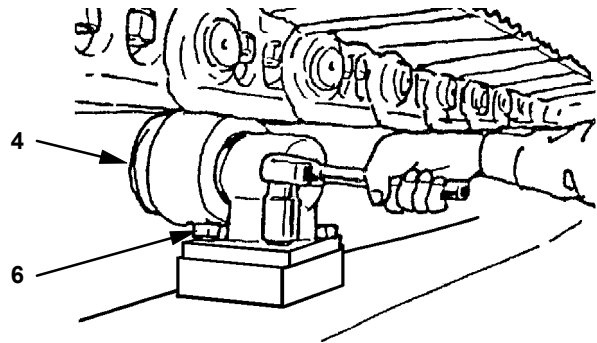


W105-03-06-003

UNDERCARRIAGE / Upper And Lower Roller

- Loosen mounting bolts (6) of upper roller (4).

 : 24 mm

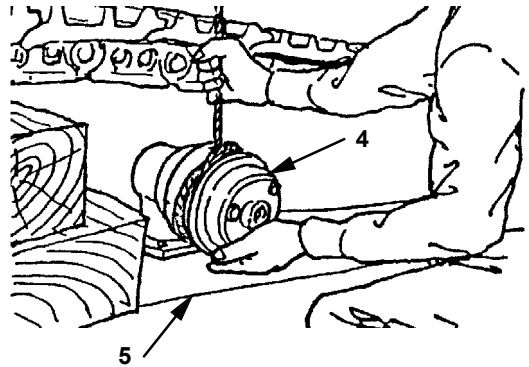


W157-03-06-001



CAUTION: Upper roller weight:
18 kg (40 lb)
(ZAXIS200, 200-E, 225US, 225USR, 230)
20 kg (40 lb) (ZAXIS 270)

- Remove upper roller (4) from track frame (5).



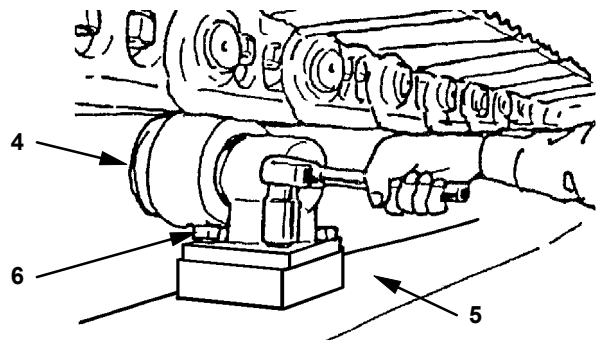
W105-03-06-005

Installation

- Install upper roller (4) onto track frame (5) using bolts (6).

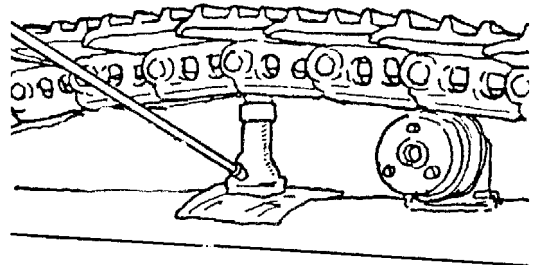
 : 24 mm

 : 270 N·m (28 kgf·m, 200 lbf·ft)



W157-03-06-001

- Remove the wooden blocks and oil jack.



W105-03-06-002

UNDERCARRIAGE / Upper And Lower Roller

3. Install valve (1) of the track adjuster.

 : 24 mm

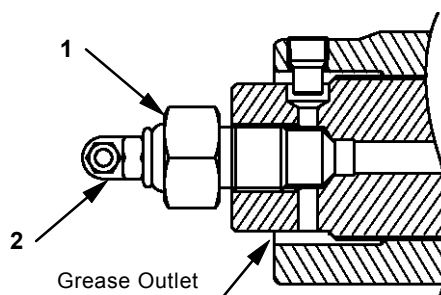
 : 88 N·m (9 kgf·m, 65 lbf·ft)



CAUTION: Securely support the raised track using wooden blocks.

4. Jack up the track at the side being adjusted and rotate slightly in reverse direction.

5. Fill grease from grease fitting (2) to make the track being in tension.



W178-03-06-001

Track sag specifications (A):

300 to 335 mm (11.8 to 13.19 in) (ZAXIS 200, 200-E, 225US, 225USR, 230)

340 to 380 mm (13.39 to 14.96 in) (ZAXIS 270)



NOTE: Replace the upper roller as assembly.

6. Fill lubrication oil from the hole of plug (8) on cover (7), then tighten plug (8).

Apply LOCTITE # 503 or equivalent to the plug.

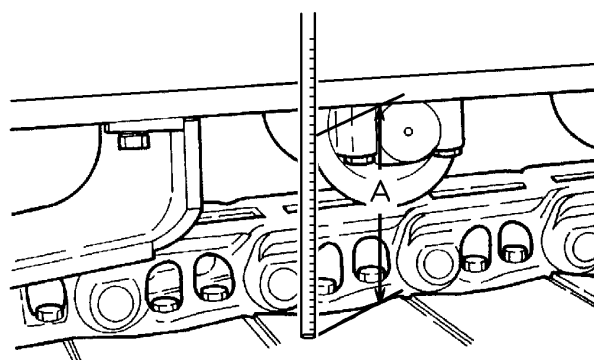
 : 6 mm

 : 20 N·m (2 kgf·m 14.5 lbf·ft)

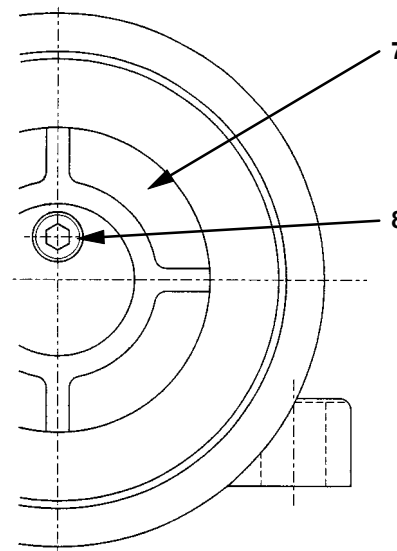
Lubrication oil: Engine oil API CD Class SAE30

Quantity: 70 mL(0.018 US gal) (ZAXIS 200, 200-E, 225US, 225USR, 230)

75 mL(0.020 US gal) (ZAXIS 270)



W157-03-06-002



W158-03-06-001

UNDERCARRIAGE / Upper And Lower Roller

(Blank)

UNDERCARRIAGE / Upper And Lower Roller

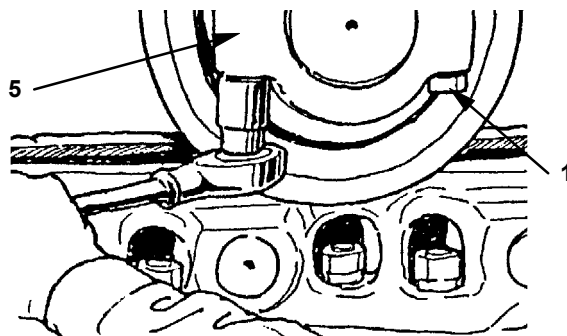
REMOVE AND INSTALL LOWER ROLLER

Removal

1. Remove mounting bolts (1) of lower roller (5) after removing the track guard.

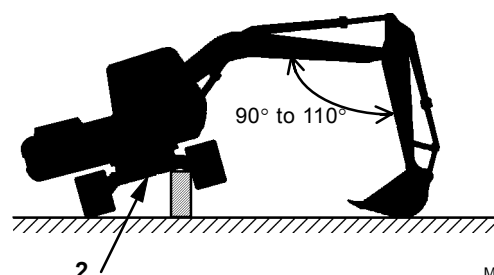
🔧 : 27 mm (ZAXIS200, 200-E, 225US, 225USR, 230)

🔧 : 30 mm (ZAXIS 270)



W105-03-06-008

2. Operate the boom and arm so that the angle between them is 90° to 110°. Lower the boom with the bucket rolled-in to jack up the machine. Then place a block under track frame (2) to support the machine.

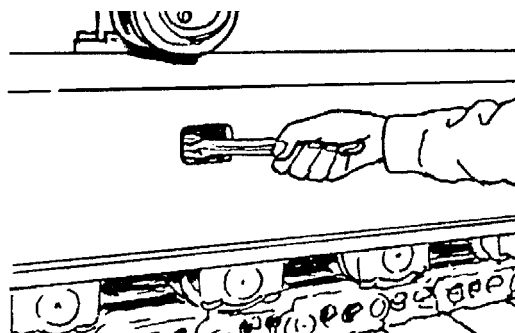


M104-07-067

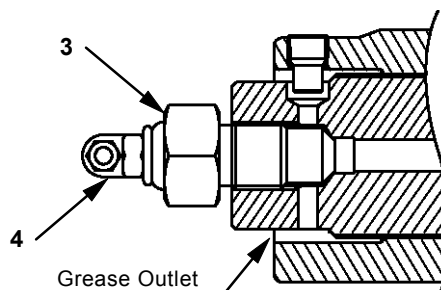
⚠ CAUTION: Do not loosen valve (3) quickly or loosen it too much as high-pressure grease in the adjusting cylinder may spurt out. Loosen carefully, keeping body parts and face away from valve (3). Never loosen grease fitting (4).

3. Loosen valve (3) of the track adjuster to maintain the track in such tension that lower roller (5) can be removed.

🔧 : 24 mm



W105-03-06-001



W178-03-06-001

UNDERCARRIAGE / Upper And Lower Roller



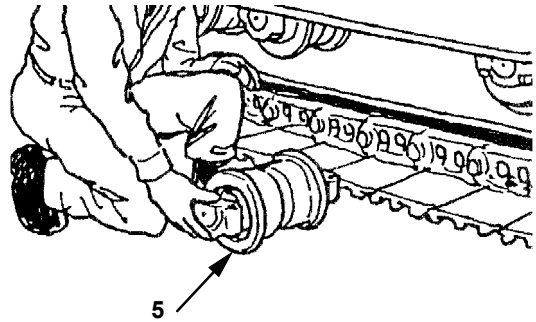
CAUTION: Lower roller weight:

35 kg (77 lb)

(ZAXIS 200, 200-E, 225US, 225USR, 230)

54 kg (120 lb) (ZAXIS 270)

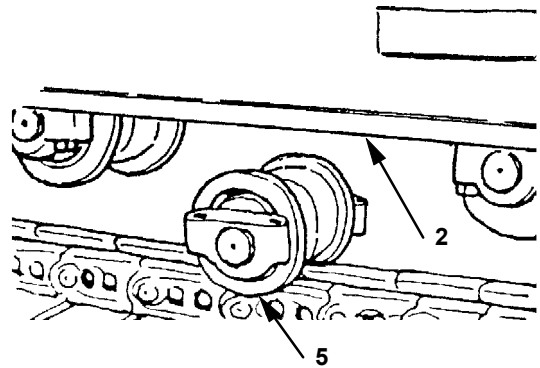
4. Remove lower roller (5) using a fork lift, etc.



W105-03-06-010

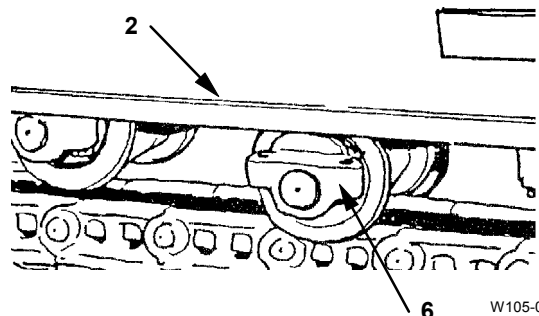
Installation

1. Place lower rollers (5) under the tracks (2) as illustrated using a fork lift, etc.



W105-03-06-011

2. Lower track frame (2) enough to gain a little clearance between collar (6) and track frame (2).



W105-03-06-012

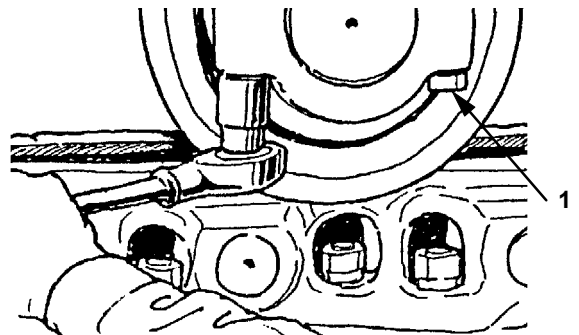
3. Align the bolt holes and tighten bolt (1).

 : 27 mm

 : 460 N·m (47 kgf·m, 340 lbf·ft)
(ZAXIS 200, 200-E, 225US, 225USR, 230)

 : 30 mm

 : 670 N·m (68 kgf·m, 490 lbf·ft)
(ZAXIS 270)



W105-03-06-008

UNDERCARRIAGE / Upper And Lower Roller

4. Install valve (3) of the track adjuster.

 : 24 mm

 : 88 N·m (9 kgf·m, 65 lbf·ft)



CAUTION: Securely support the raised track using wooden blocks.

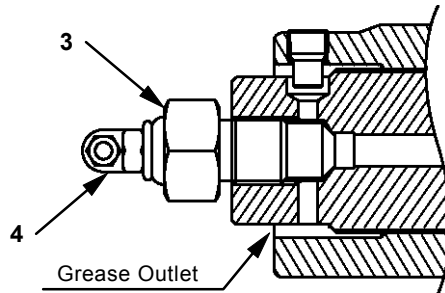
5. Jack up the track at the side being adjusted and rotate slightly in reverse direction.

6. Fill grease from grease fitting (4) to make the track be in tension.

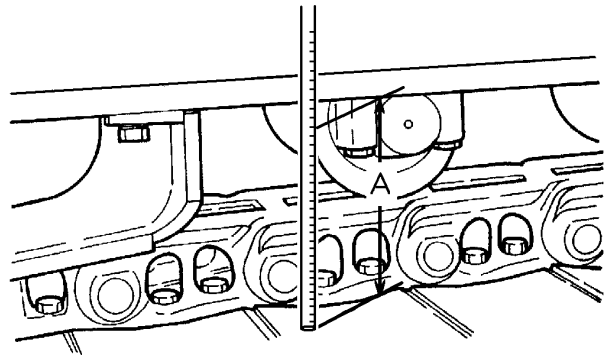
Track sag specification (A):

300 to 335 mm (11.8 to 13.2 in) (ZAXIS 200, 200-E, 225US, 225USR, 230)

340 to 380 mm (13.4 to 14.96 in) (ZAXIS 270)



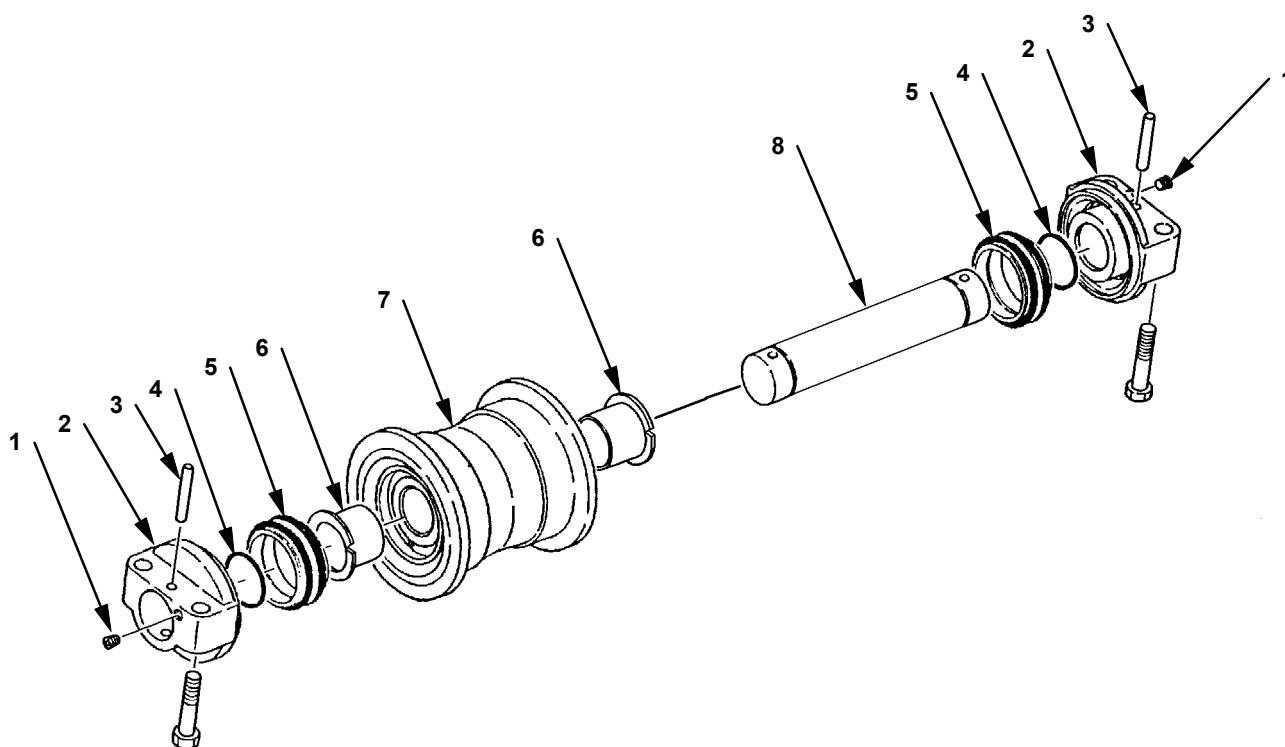
W178-03-06-001



W157-03-06-002

UNDERCARRIAGE / Upper And Lower Roller

DISASSEMBLE LOWER ROLLER



W157-03-06-004

1 - Plug (2 Used)
2 - Collar (2 Used)

3 - Pin (2 Used)
4 - O-Ring (2 Used)

5 - Floating Seal (2 Used)
6 - Bushing (2 Used)

7 - Roller
8 - Axle

UNDERCARRIAGE / Upper And Lower Roller

Disassemble Lower Roller

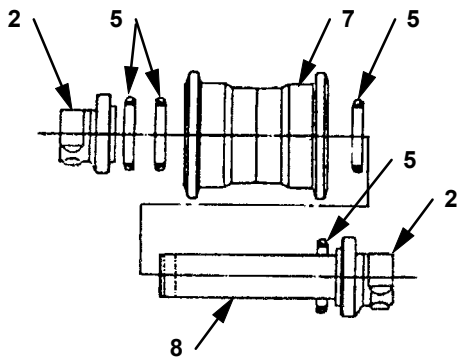
- Be sure to thoroughly read "Precautions for Disassembly and Assembly Work" on page W1-1-1 before starting the disassembly work.

1. Remove plug (1) from collars (2) and drain oil.

└ :6 mm

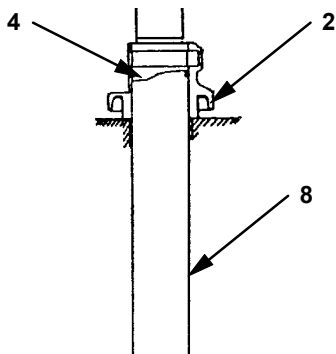
2. Remove pin (3) from collar (2) at one side only. Remove axle (8) from roller (7) by the side where pin (3) was removed. At this moment, the pin and collar at opposite side are also removed together.

■ : 14 mm



W105-03-06-026

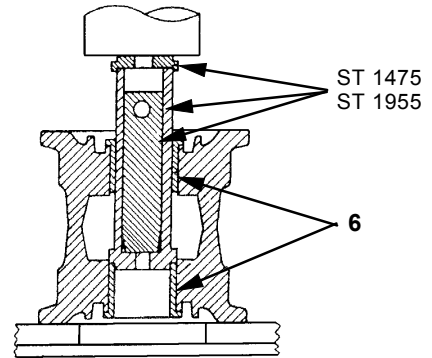
3. Remove floating seal (5) from both sides of roller (7) and collars (2) (2 used).
4. Remove pin (3) from axle (8) assembly to push out the axle from collar (2).



W105-03-06-027

5. Remove O-rings (4) (2 used) from axle (8).

6. In case of replacing bushing (6), push out bushing (6) via a press and special tools.



W105-03-06-028

Pulling Tool:

ZAXIS 200, 200-E, 225US, 225USR, 230

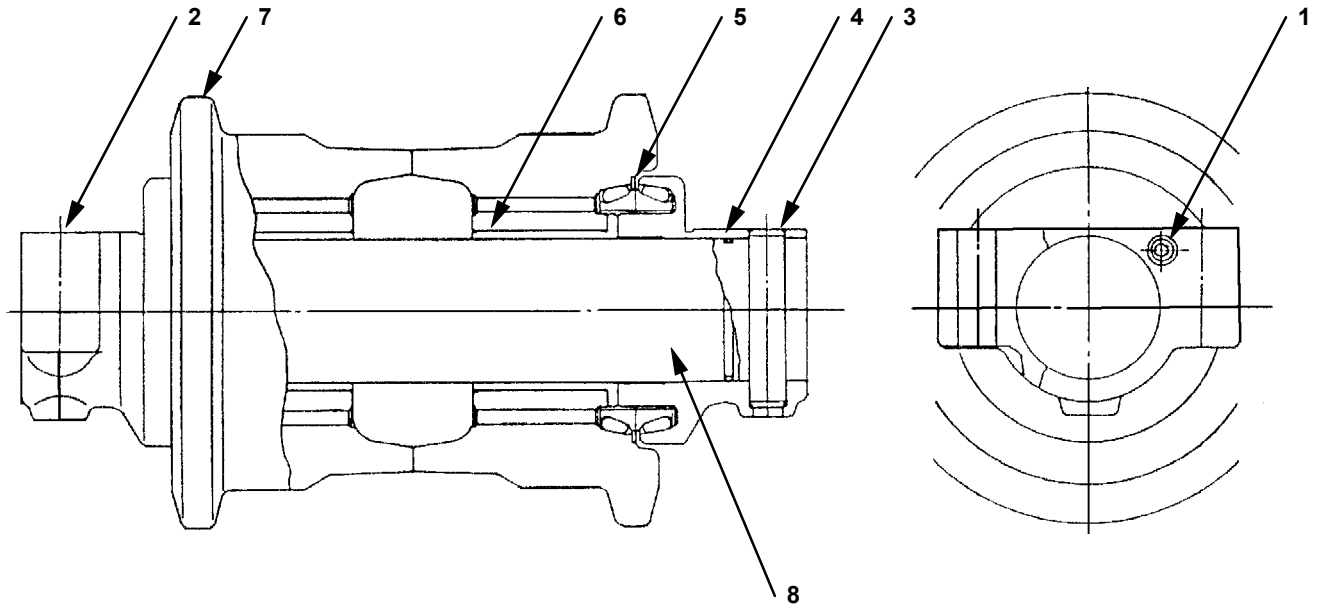
ST-1955

ZAXIS 270

ST-1475

UNDERCARRIAGE / Upper And Lower Roller

ASSEMBLE LOWER ROLLER



W105-03-06-023

1 - Plug (2 Used)
2 - Collar (2 Used)

3 - Pin (2 Used)
4 - O-Ring (2 Used)

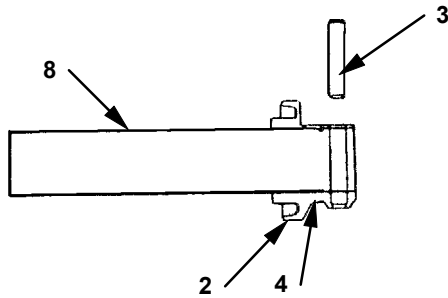
5 - Floating Seal (2 Used)
6 - Bushing (2 Used)

7 - Roller
8 - Axle

UNDERCARRIAGE / Upper And Lower Roller

Assemble Lower Roller

1. Install bushings (6) (2 used) onto roller (7) using a press. Take care not to dent the flange surface of bushing (6).
Apply a film of grease to O-ring (4) and install it onto axle (8).
2. Install collar (2) of one side onto axle (8), aligning the pin holes. Secure them with pin (3). Take care not to damage O-ring (4).



W105-03-06-031

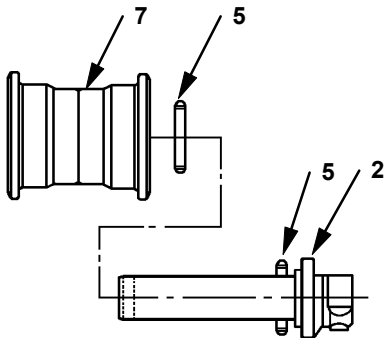
4. Insert axle (8) into roller (7). Install O-ring (4). The other collar (2) shall be assembled in the same way. Secure them with pin (3).
5. Add engine oil via the plug (1) hole on collar (2). Tighten plug (1).
Apply LOCTITE # 503 or equivalent to the plug.
: 6 mm
: 20 N·m (2 kgf·m, 14.5 lbf·ft)
Engine oil: API CD class, SAE30
Quantity: 260 mL (0.069 US gal) (ZAXIS 200, 200-E, 225US, 225USR, 230)
Quantity: 420 mL (0.11 US gal) (ZAXIS 270)

IMPORTANT: Coat grease on O-ring of floating seal and then install it.

When installing O-ring, take care not to twist it and install it at the correct angle.

The floating seals are in pairs. So don't use them randomly with other seals.

3. Install floating seal (5) to roller (7) and collar (2).

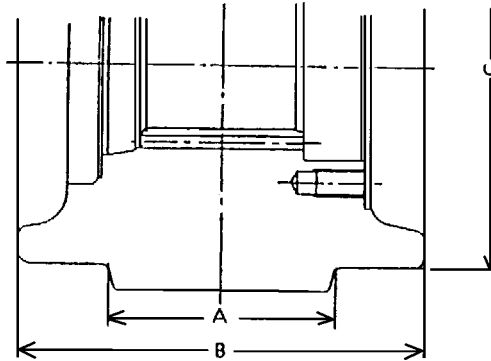


W157-03-06-008

UNDERCARRIAGE / Upper And Lower Roller

MAINTENANCE STANDARD

Upper Roller



W105-03-06-032

ZAXIS 200, 200-E, 225US, 225USR, 230 Unit: mm (in)

	Standard	Allowable Limit	Remedy
A	84(3.31)	—	Replace
B	150(5.91)	—	
C	120(4.72)	[110(4.33)]	

NOTE: Values in [] are just for reference.

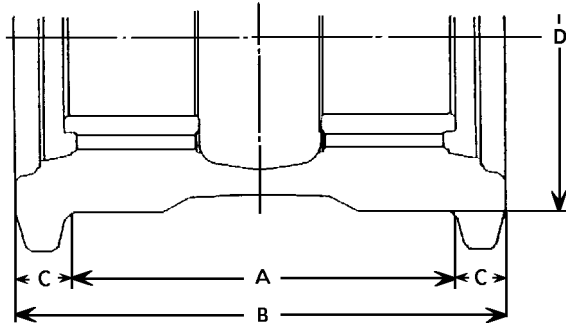
ZAXIS 270 Unit: mm (in)

	Standard	Allowable Limit	Remedy
A	98(3.86)	—	Replace
B	165(6.50)	—	
C	120(4.72)	[110(4.33)]	

NOTE: Values in [] are just for reference.

UNDERCARRIAGE / Upper And Lower Roller

Lower Roller



W157-03-06-003

Roller

Unit: mm (in)

	Standard		Allowable Limit		Remedy
	ZAXIS 200, 200-E, 225US, 225USR, 230	ZAXIS 270	ZAXIS 200, 200-E, 225US, 225USR, 230	ZAXIS 270	
A	169.0(6.65)	203.0(7.99)	[193.5(7.62)]	[229.5(9.04)]	Build-up weld and finishing
B	218.0(8.58)	256.0(10.08)	—	—	
C	24.5(0.96)	26.5(0.04)	[12.3(0.48)]	[13.25(0.52)]	
D	150.0(5.90)	175.0(6.89)	132(5.19)	157.0(6.18)	

Axle and Bushing

Unit: mm (in)

		Standard		Allowable Limit		Remedy
		ZAXIS 200, 200-E, 225US, 225USR, 230	ZAXIS 270	ZAXIS 200, 200-E, 225US, 225USR, 230	ZAXIS 270	
Axle	Outside Dia.	65(2.56)	75(2.95)	[64.2(2.53)]	[74.2(2.92)]	Replace
Bushing	Inside Dia.	65(2.56)	75(2.95)	[66.0(2.60)]	[76.0(2.99)]	
	Flange Thickness	2(0.079)	2(0.08)	[1.2(0.047)]	[1.2(0.05)]	

 NOTE: Values in [] are just for reference.

UNDERCARRIAGE / Upper And Lower Roller

(Blank)

UNDERCARRIAGE / Track

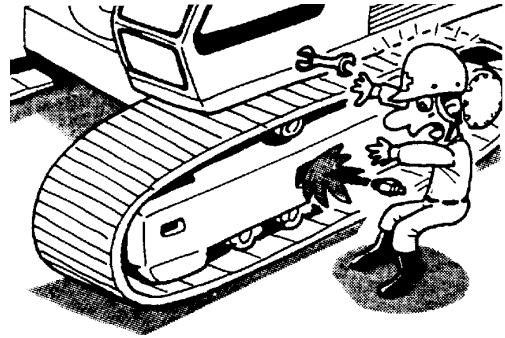
REMOVE AND INSTALL TRACKS

Removal



CAUTION: Do not loosen valve (1) quickly or loosen too much since high-pressure grease in the adjusting cylinder may spurt out. Loosen carefully, keeping body parts and face away from valve (1). Never loosen grease fitting (2).

1. Rotate the tracks so that master pin (3) is positioned over front idler (4). Put a wooden block under track shoes (5) to jack track shoes up.



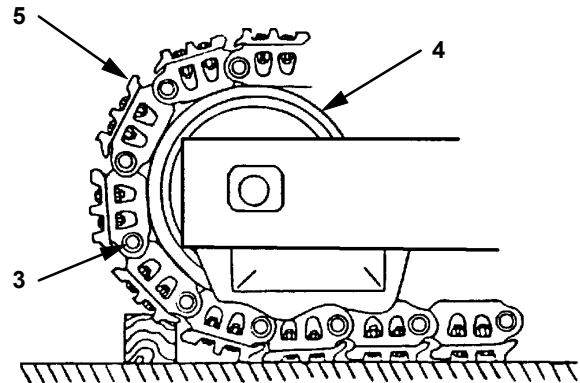
W105-03-07-001

2. Loosen the track tension.

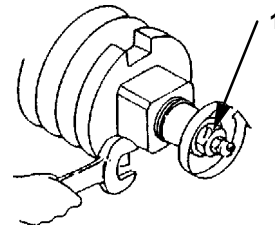
 : 24 mm



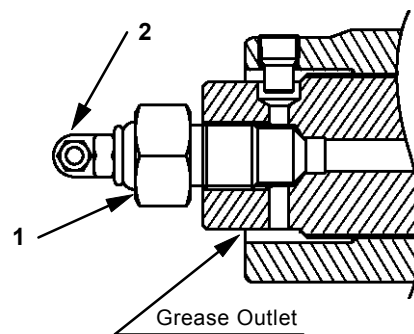
NOTE: To loosen the track tension, slowly turn valve (1) counterclockwise one turn, grease will escape from grease outlet.



W105-03-07-006



W105-03-07-002



W178-03-06-001

UNDERCARRIAGE / Track

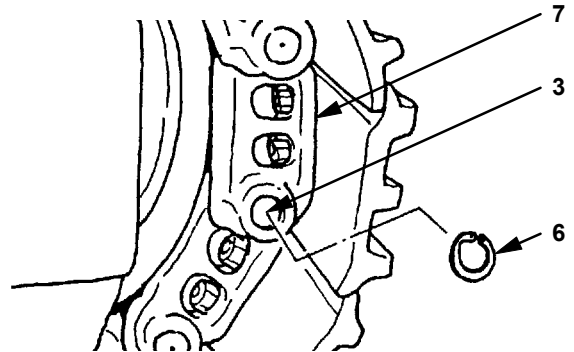
3. Remove retaining ring (6), which is used to prevent the master pin from coming off.

 **NOTE:** If retaining ring (6) interferes with master link (7), drive master pin (3) in to make clearance between retaining ring (6) and master pin (3) before attempting to remove retaining ring (6).

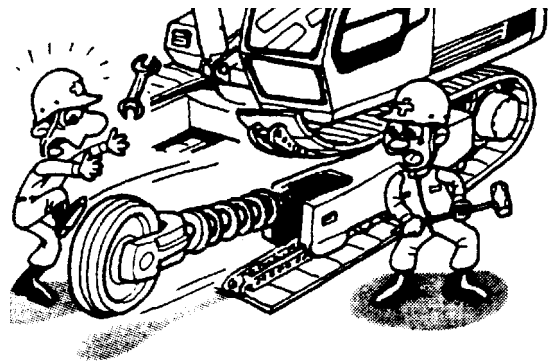
 **CAUTION:** The front idler may jump out of position due to strong spring force when the tracks are disconnected. Particularly, a strong spring force is always applied to the thread portion of the rod. If the rod and/or the thread are damaged, metal fragments may fly out when the tracks are disconnected. Take necessary precautions to prevent any personal injury from occurring.

IMPORTANT: Master pin (3) is directional. Be sure to strike the pin in or pull it out in correct direction.

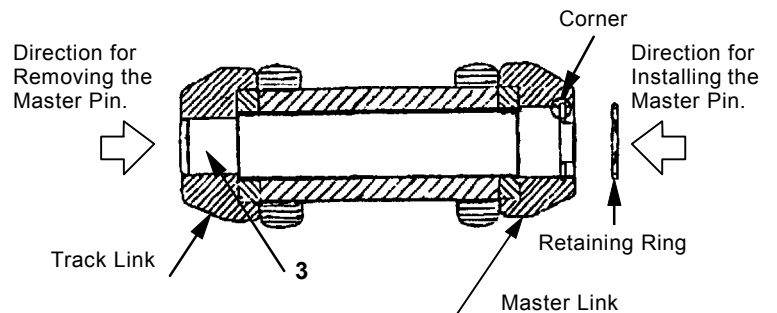
4. Remove master pin (3) using special tool (ST 1970).



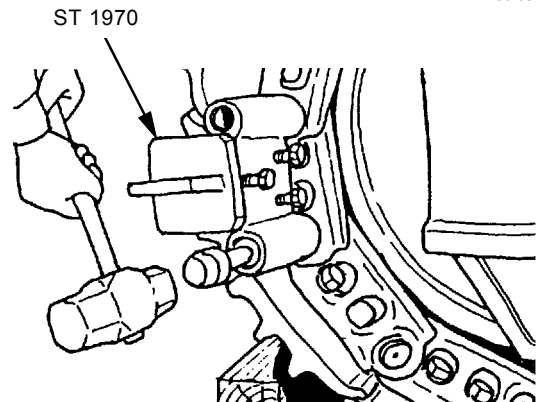
W105-03-07-009



W105-03-07-005



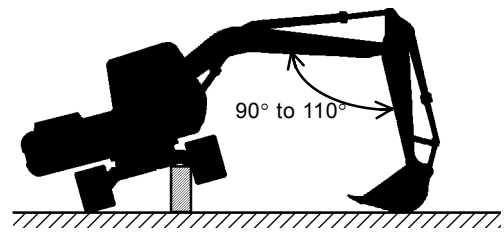
W105-03-07-010



W105-03-07-008

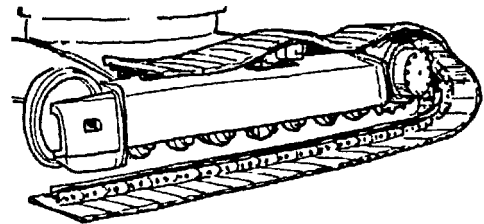
UNDERCARRIAGE / Track

5. Operate the boom and arm so that the angle between them is 90° to 110° . Lower the boom with the bucket rolled-in to jack up the machine so as to pull the track out. Then place a block under the track frame to support the machine.



M104-07-067

6. Slowly drive the machine in reverse until the whole length of the track being removed comes on the ground.

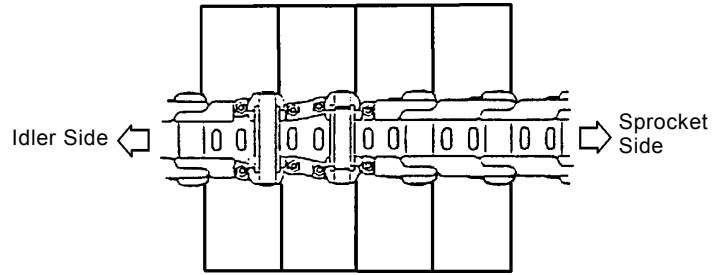


W105-03-07-011

UNDERCARRIAGE / Track

Installation

1. Jack up the machine and put the track under the lower roller so that the sprocket teeth mesh with the end of the track. Be sure to position the track in correct direction as illustrated.



W105-03-07-013

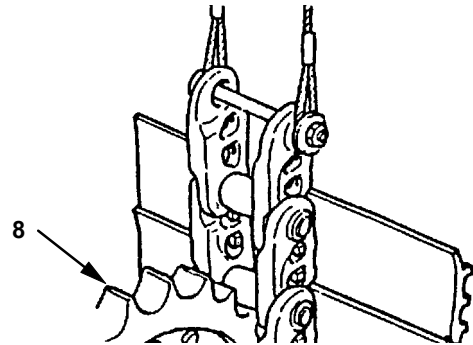
2. Hoist the trucks and place it on sprocket (8) by crane.



CAUTION: Truck assembly weight:

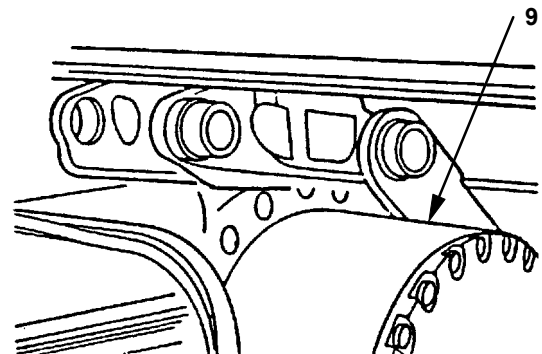
1295 kg (2850 lb) (ZAXIS 200, 200-E)
1276 kg (2810 lb) (ZAXIS 225US, 225USR)
1414 kg (3120 lb) (ZAXIS 230)
1815 kg (4000 lb) (ZAXIS 270)

3. With the machine being jacked up, operate the travel lever for the side the track being installed in forward direction. Wind the track while rotating travel device (9).

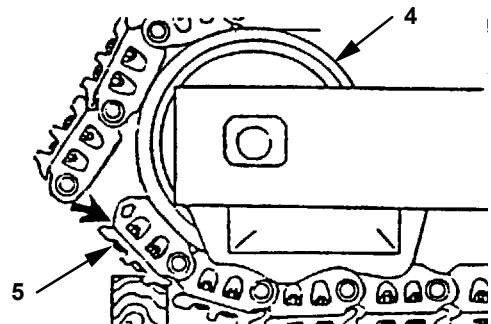


W105-03-07-014

4. When wind the connecting part of track link onto front idler (4), lower the machine and place a wooden block under shoe (5) to support shoe (5).



W105-03-07-015

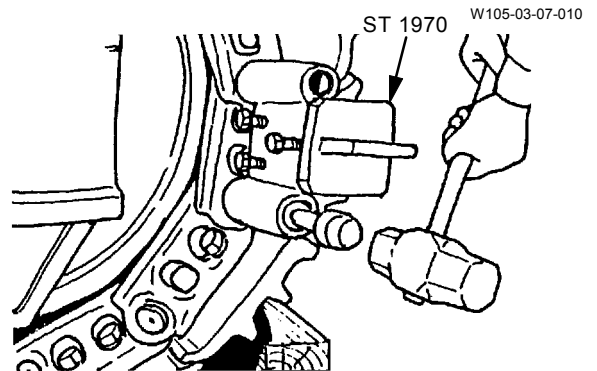
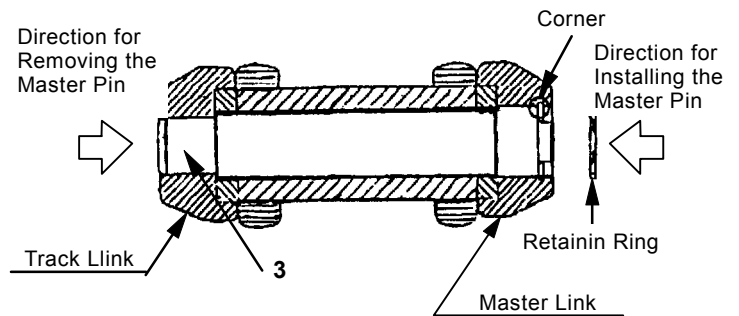


W105-03-07-016

UNDERCARRIAGE / Track

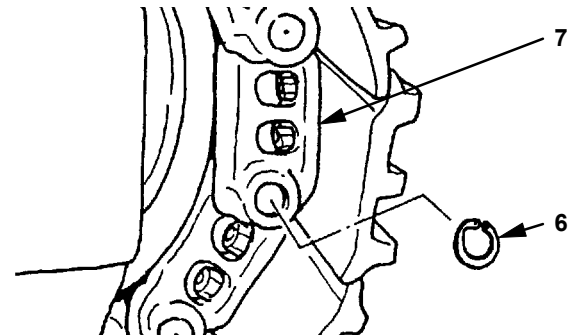
IMPORTANT: Master pin (3) is directional. Be sure to install it in the correct direction.

5. Install master pin (3) using special tool (ST 1970).



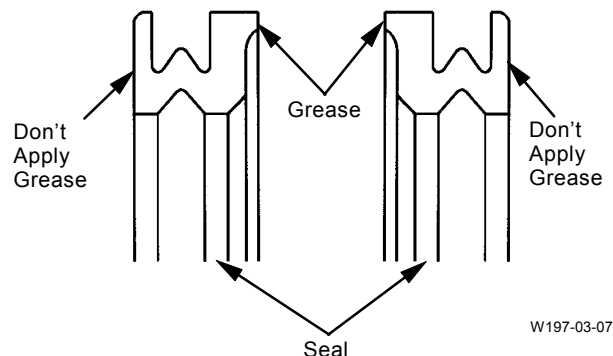
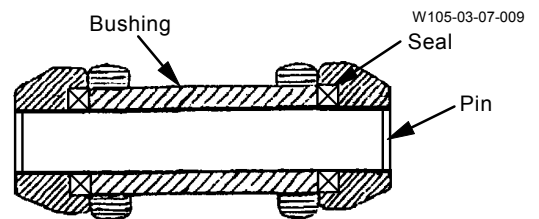
IMPORTANT: Old retaining ring (6) can't be reused as it deforms easily. Replace it with a new one.

6. Install retaining ring (6). Retaining ring (6) is directional. Install retaining ring (6) into master link (7) groove with the flat side of puller insert hole facing outward.



IMPORTANT: If any links have been removed from the track, be sure to fill the grease (Daphne Epone SR or equivalent) into the clearance between the pin and busing when reconnecting the links.

Stand the bushing on a flat plate. Fill the bushing bore with grease. Insert the pin into the bushing while pushing the bushing onto the plate (so that the bushing end stays on the plate). Wipe off excess grease. Install the seal in the direction as illustrated.



UNDERCARRIAGE / Track

7. Tighten adjuster valve (1). Apply grease to grease fitting (2) to adjust the track link tension.

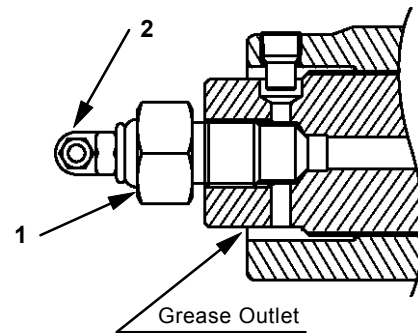
🔧 : 24 mm

🔩 : 88 N·m (9 kgf·m, 65 lbf·ft)

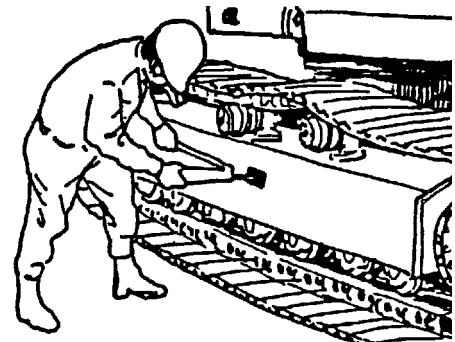
Track sag specification (A):

300 to 335 mm (11.8 to 13.19 in) (ZAXIS 200,
200-E, 225US, 225USR, 230)

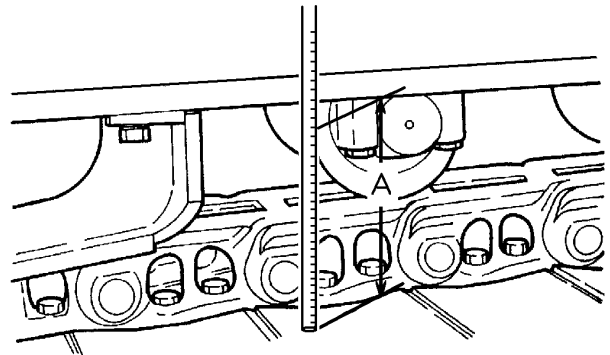
340 to 380 mm (13.39 to 14.96 in) (ZAXIS 270)



W178-03-06-001



W105-03-07-018



W157-03-06-002

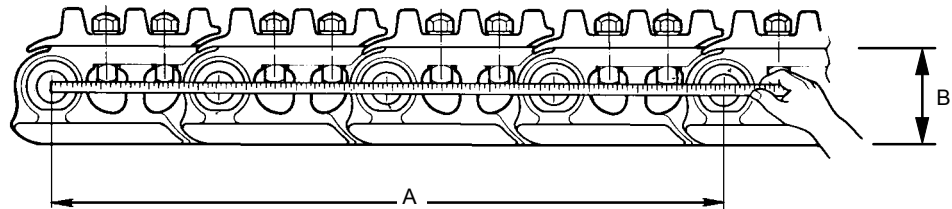
UNDERCARRIAGE / Track

MAINTENANCE STANDARD

Link

Measure the length of four links.

- Master pin is not included in measurement part.
- Measurement shall be carried out with the track in tension.



W155-03-07-001

ZAXIS 200, 200-E, 225US, 225USR, 230

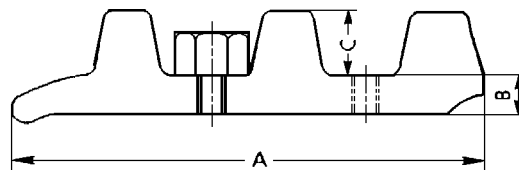
Unit: mm (in)

	Standard	Allowable Limit	Remedy
A	761.8(29.99)	785.8(30.94)	Build-up weld and finishing or replace
B	105(4.13)	97(3.82)	

ZAXIS 270

	Standard	Allowable Limit	Remedy
A	865.92(34.09)	893.0(35.16)	Build-up weld and finishing or replace
B	116(4.57)	109(4.29)	

Grouser shoe



W105-03-07-024

ZAXIS 200, 200-E, 225US, 225USR, 230

Unit: mm (in)

Shoe Size	600 mm Grouser		
	Standard	Allowable Limit	Remedy
A	219 (8.61)	—	Build-up weld and finishing or replace
B	8.5 (0.33)	—	
C	26 (1.02)	18.2 (0.72)	

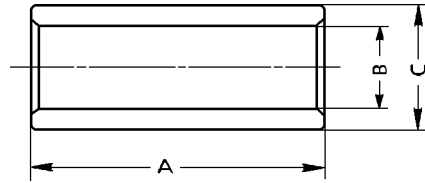
ZAXIS 270

Unit: mm (in)

Shoe Size	600 mm Grouser		
	Standard	Allowable Limit	Remedy
A	217.5 (8.56)	—	Build-up weld and finishing or replace
B	9.0 (0.35)	—	
C	26.0 (1.02)	18.2 (0.72)	

UNDERCARRIAGE / Track

Master Bushing



W105-03-07-023

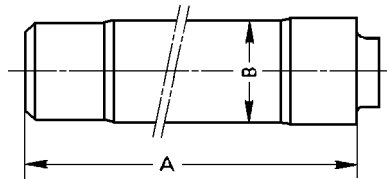
ZAXIS 200, 200-E, 225US, 225USR, 230 Unit: mm (in)

	Standard	Allowable Limit	Remedy
A	129.2 (5.09)	—	Replace
B	38.7 (1.52)	[41.7 (1.63)]	
C	59 (2.32)	[54 (2.13)]	

ZAXIS 270 Unit: mm (in)

	Standard	Allowable Limit	Remedy
A	158.9 (6.26)	—	Replace
B	45.45 (1.79)	48.5 (1.91)	
C	66.91 (2.63)	61.9 (2.44)	

Master Pin



W105-03-07-021

ZAXIS 200, 200-E, 225US, 225USR, 230 Unit: mm (in)

	Standard	Allowable Limit	Remedy
A	203 (7.99)	—	Replace
B	38.4 (1.51)	[35.4 (1.39)]	

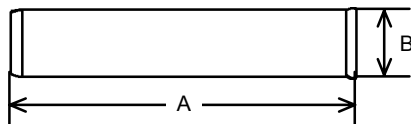
ZAXIS 270 Unit: mm (in)

	Standard	Allowable Limit	Remedy
A	228.5 (9.0)	—	Replace
B	45.0 (1.77)	[42.0 (1.65)]	

 NOTE: Values in [] are just for reference.

UNDERCARRIAGE / Track

Pin



W142-03-07-004

ZAXIS 200, 200-E, 225US, 225USR, 230 Unit: mm (in)

	Standard	Allowable Limit	Remedy
A	212(8.35)	—	Replace
B	38(1.496)	[35(1.38)]	

ZAXIS 270 Unit: mm (in)

	Standard	Allowable Limit	Remedy
A	242(9.53)	—	Replace
B	44.69(1.76)	41.7(1.64)	

NOTE: Values in [] are just for reference.

Bushing



W105-03-07-023

ZAXIS 200, 200-E, 225US, 225USR, 230 Unit: mm (in)

	Standard	Allowable Limit	Remedy
A	137.5(5.41)	—	Replace
B	38.7(1.52)	[39.7(1.56)]	
C	59(2.32)	[54(2.13)]	

ZAXIS 270 Unit: mm (in)

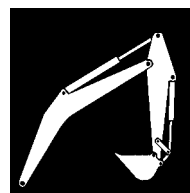
	Standard	Allowable Limit	Remedy
A	158.9(6.26)	—	Replace
B	45.45(1.79)	46.5(1.83)	
C	66.91(2.63)	61.9(2.44)	

NOTE: Values in [] are just for reference.

UNDERCARRIAGE / Track

(Blank)

SECTION 4 FRONT ATTACHMENT



— CONTENTS —

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Maintenance Standard.....	W4-1-8
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Arm and Bucket Connection	W4-1-18
Standard Dimensions for	
Arm and Boom Connection	W4-1-19

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Remove and Install Cylinder	W4-2-1
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Procedure.....	W4-2-15
Disassemble Cylinder.....	W4-2-16
Assemble Cylinder	W4-2-32
Maintenance Standard	W4-2-48

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FRONT ATTACHMENT / Front Attachment

REMOVE AND INSTALL FRONT ATTACHMENT



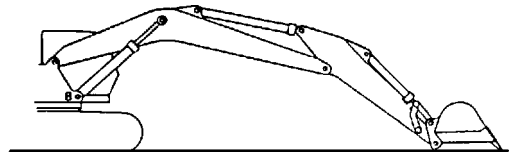
CAUTION: Escaping fluid under pressure may penetrate the skin, causing serious injury. Avoid this hazard by relieving pressure before disconnecting hydraulic or other lines.

Hydraulic oil may be hot just after operation, and may spurt, possibly causing severe burns. Be sure to wait for oil to cool before starting any repair work.

The hydraulic oil tank cap may fly off if removed without releasing accumulated pressure first. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.

Preparation

1. Park the machine on a solid level surface. Fully retract the bucket and arm cylinders and lower the bucket to the ground.
2. Stop the engine. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.
3. Remove hydraulic oil tank cap. Connect a vacuum pump to maintain negative pressure in the hydraulic oil tank.
Be sure to run the vacuum pump continuously while working on the hydraulic system.



W105-04-02-001

FRONT ATTACHMENT / Front Attachment

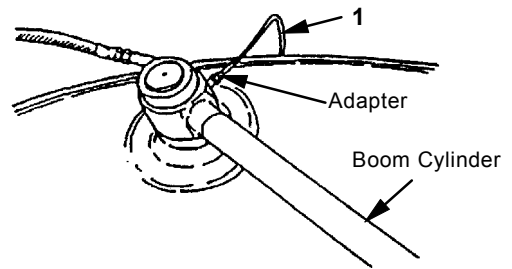
Removal

1. Remove grease hose (1) from the adapter on the boss at the boom cylinder rod side.
(2 places on both left and right)

 : 17 mm

2. Remove nuts (4) and bolts (6) from boom cylinder rod front pin (3). Then remove stopper (5).
(2 places on both left and right)

 : 30 mm



W105-04-01-002



CAUTION: Boom cylinder weight:

171 kg (380 lb)

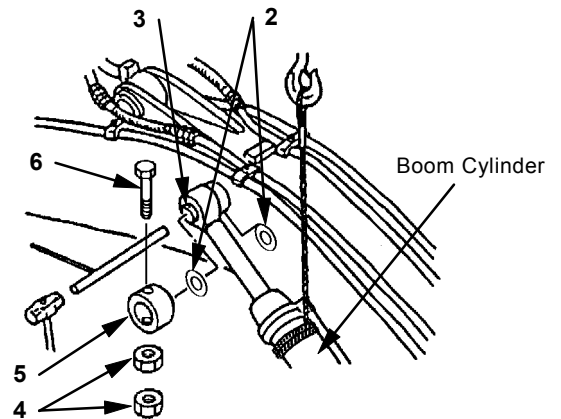
(ZAXIS 200, 200-E, 225US, 225USR)

217 kg (480 lb) (ZAXIS 230)

247 kg (540 lb) (ZAXIS 270)

Prevent personal injury. Metal fragments may fly when a hammer is used to remove pins. Be sure to wear necessary protection, such as goggles, hard hat, etc.

3. Use a crane to hoist the boom cylinder. With a bar and a hammer drive pin (3) into the position where thrust plate (2) can be removed. Remove thrust plate (2).



W178-04-01-004



NOTE: When pin (3) is impossible to pull out. Start the engine, slightly operate the boom lever and align the boom cylinder rod pin hole.

FRONT ATTACHMENT / Front Attachment

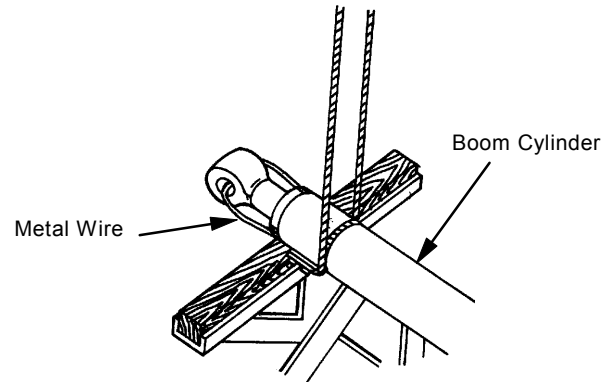
4. Place the boom cylinder on a bench of 1 m height. Start engine, operate the boom lever to retract the boom cylinder, use a wire to secure the boom cylinder rod as illustrated. Stop the engine.
5. Remove boom cylinder. Refer to "Remove Boom Cylinder" (W4-2-10).
6. Remove other boom cylinder in the same procedures as steps 3, 4, 5.



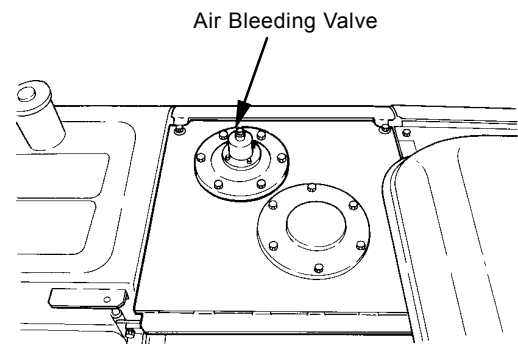
CAUTION: The pin sometimes releases suddenly. Be sure no one stands in the way.

7. Using a bar and a hammer, drive the pin (3) out. Remove thrust plate (2).
8. After stopping engine, push the air release valve on the top of hydraulic oil tank to release any remaining pressure. Then remove the cap. Completely release the residual pressure from the hydraulic circuit by performing the "Hydraulic Circuit Pressure Release Procedure". Refer to page W4-2-15.
9. Disconnect hoses (7), (8) for bucket cylinder and arm cylinder, cover all openings of disassembled hoses and pipes with cap.

 : 36, 41 mm

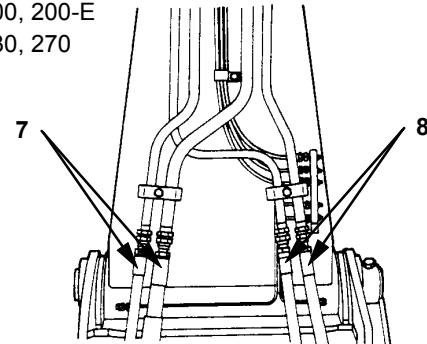


W554-02-03-007



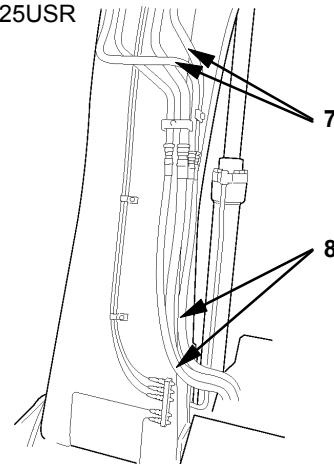
M157-07-173

ZAXIS200, 200-E
ZAXIS230, 270



ZAXIS225US, 225USR

W157-04-01-001



W178-04-01-006

FRONT ATTACHMENT / Front Attachment

10. Remove the cover.

For ZAXIS200, 200-E, 230, 270

Remove mounting bolts (8 used) to remove tool box and the cover.

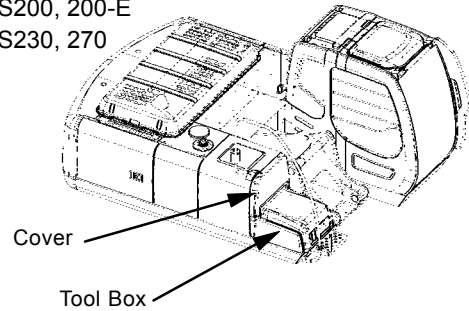
For ZAXIS225US, 225USR

Remove mounting bolts (13 used) and nuts (4 used) to remove side cover assembly and cover assembly.

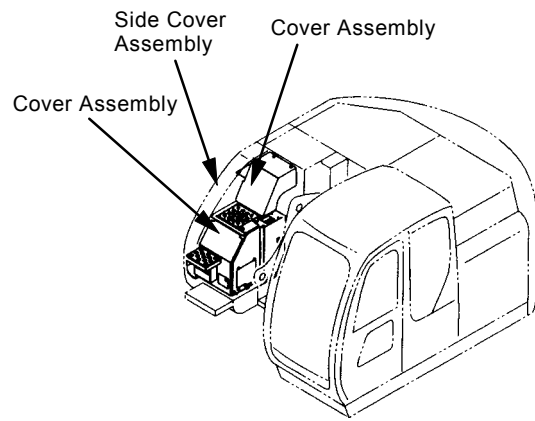
 : 17 mm

ZAXIS200, 200-E

ZAXIS230, 270



ZAXIS225US, 225USR



FRONT ATTACHMENT / Front Attachment

11. Remove bolt (12), spring washer (13), plate (11) and block (10) from the plate of boom foot pin (9).

🔧 : 27 mm



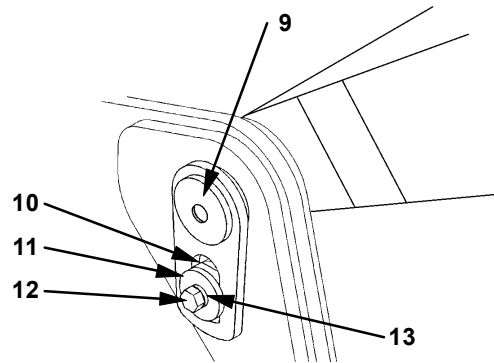
CAUTION: Front attachment weight:

3670 kg (8090 lb)

(ZAXIS200, 200-E, 225US, 225USR)

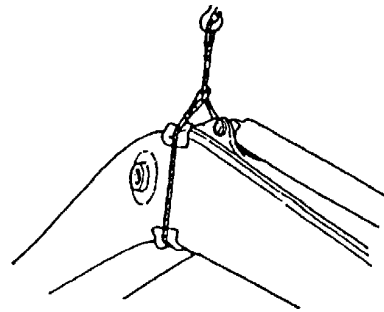
4797 kg (10580 lb) (ZAXIS 230)

5222 kg (11510 lb) (ZAXIS 270)



W178-04-01-001

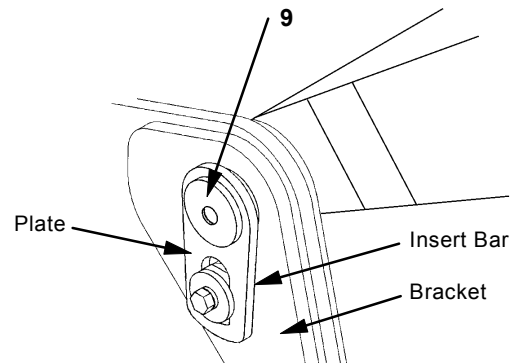
12. Attach the front attachment to a crane.
Slightly hoist to take up any slack of wire rope.



13. Insert a bar between the plate of boom foot pin (9) and the bracket, slightly pull the plate out.

W105-04-01-008

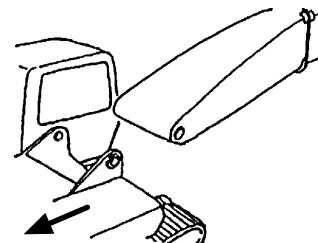
14. Turn the plate upward by hand and turn boom foot pin (9) left and right to pull it out.
(Adjust the position of the boom foot pin hole by hoisting and lowering the front attachment.)



15. After hoisting the front attachment, move the machine backward.

W178-04-01-001

16. Place the front attachment on wooden blocks.



W178-04-01-005

FRONT ATTACHMENT / Front Attachment

Installation



CAUTION: Front attachment weight:
3670 kg (8090 lb)
(ZAXIS200, 200-E, 225US, 225USR)
4797 kg (10580 lb) (ZAXIS 230)
5222 kg (11510 lb) (ZAXIS 270)

1. Hoist the front attachment by crane.
Move the machine forward, aligning the boom foot pin holes.
Insert the thrust plates into boom left and right sides and adjust the clearance between the plate and frame within 1 mm.
(Adjust the boom foot pin hole by hoisting and lowering the front attachment.)



CAUTION: Prevent personal injury. Metal fragments may fly when a hammer is used to remove pins. Be sure to wear necessary protection, such as goggles, hard hats, etc.

2. Drive in boom foot pin (9). Install stopper bolt (12), washer (13), plate (11) and block (10).

: 27 mm

: 400 N·m (41 kgf·m, 295 lbf·ft)

: 27 mm

: 400 N·m (41 kgf·m, 295 lbf·ft)

3. Install the cover.

For ZAXIS200, 200-E, 230, 270

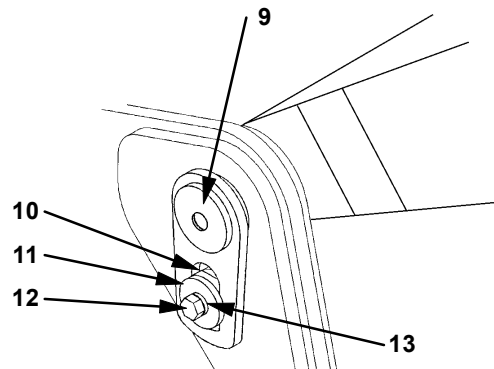
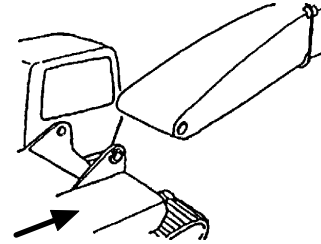
Install the tool box and cover with bolts (8 used).

For ZAXIS225US, 225USR

Install the side cover and cover assembly with bolts (13 used) and nuts (4 used).

: 17 mm

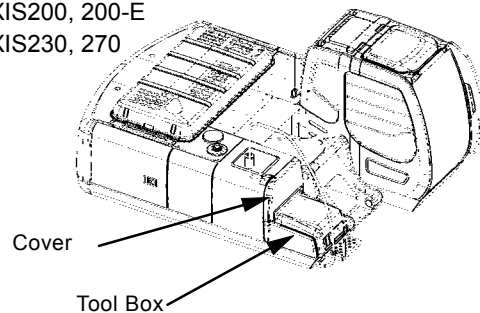
: 50 N·m (5.1 kgf·m, 37 lbf·ft)



W178-04-01-005

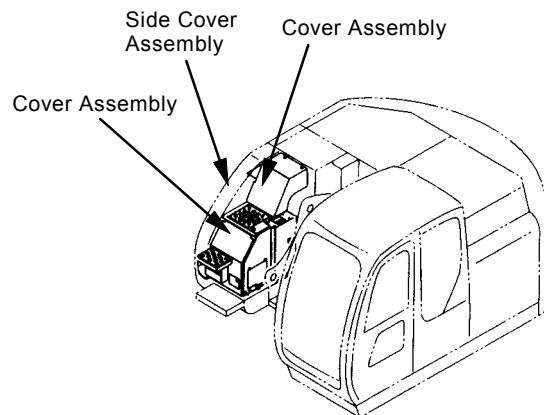
W178-04-01-001

ZAXIS200, 200-E
ZAXIS230, 270



W178-04-01-002

ZAXIS225US, 225USR



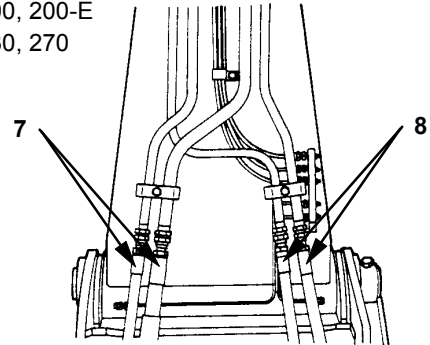
W178-04-01-008

FRONT ATTACHMENT / Front Attachment

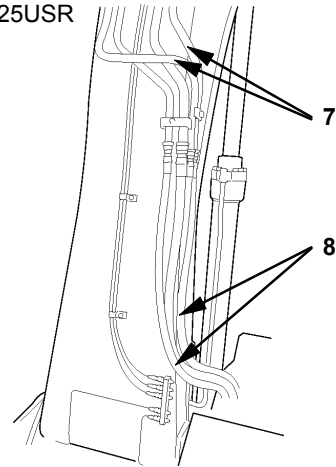
4. Remove caps from hoses and pipings. Install bucket cylinder hoses (7) and arm cylinder hoses (8).

-  : 41 mm
-  : 205 N·m (21 kgf·m, 152 lbf·ft)
-  : 36 mm
-  : 175 N·m (18 kgf·m, 130 lbf·ft)

ZAXIS200, 200-E
ZAXIS230, 270



ZAXIS225US, 225USR



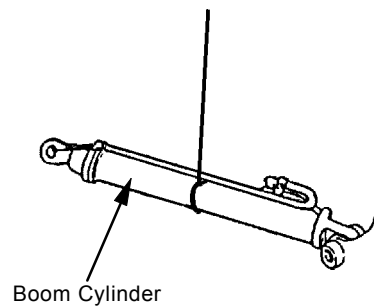
W157-04-01-001



CAUTION: Boom cylinder weight:
171 kg (380 lb)
(ZAXIS200, 200-E, 225US, 225USR)
271 kg (600 lb) (ZAXIS230)
247 kg (540 lb) (ZAXIS270)

W178-04-01-006

5. Install boom cylinder.
Refer to "Install Boom Cylinder" on page W4-2-12.



W105-04-02-040

FRONT ATTACHMENT / Front Attachment



CAUTION: Prevent personal injury. Metal fragments may fly off when a hammer is used. Be sure to wear necessary protection, such as goggles, hard hats, etc.

6. Use a crane to hoist boom cylinder. Insert thrust plates (2) (2 used), then drive in pin (3) to install boom cylinders to both sides.

7. Install stopper (5) and secure with bolt (6) and nuts (4) (2 used). (2 places on both left and right)

 : 30 mm

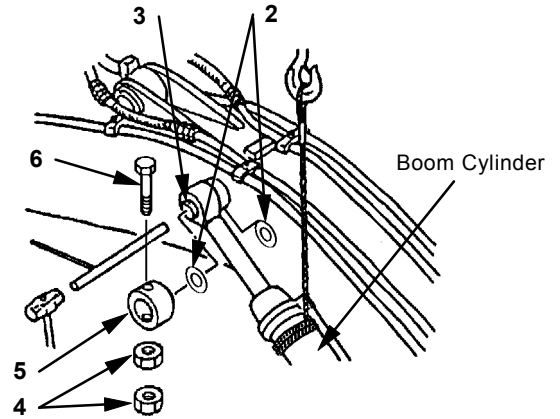
 : 550 N·m (56 kgf·m, 405 lbf·ft)

8. Connect grease pipe (1) onto the boss at boom cylinder rod side. (2 places on both left and right)

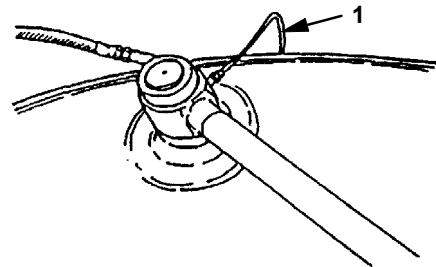
 : 17 mm

 : 29.5 N·m (3 kgf·m, 21.5 lbf·ft)

9. Add grease to the boom cylinder rod side, bottom side and boom foot side.

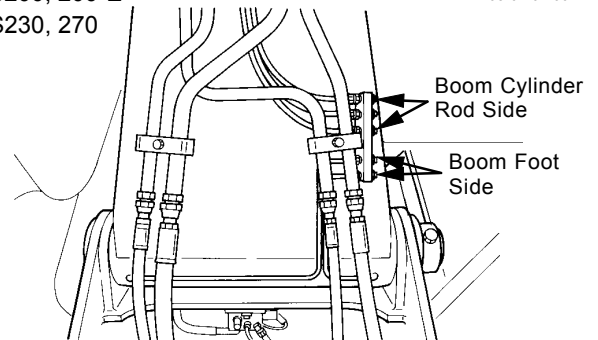


W178-04-01-004



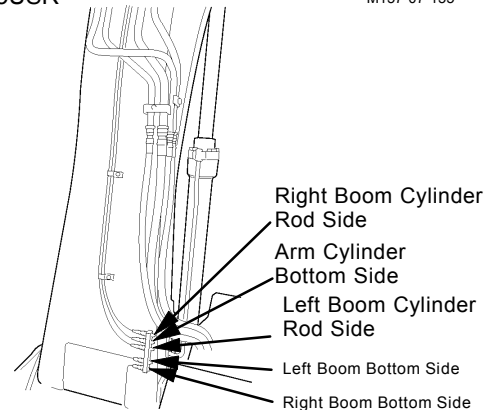
ZAXIS200, 200-E
ZAXIS230, 270

W105-04-01-002



ZAXIS225US, 225USR

M157-07-155



W178-04-01-007

FRONT ATTACHMENT / Front Attachment

IMPORTANT: When the arm has been removed from the boom, perform the following steps when installing the arm.

10. Install thrust plates (14) into arm left and right sides. Adjust total clearance of left and right within 1.5 mm or less.
11. After installing arm, add grease to grease fitting (15) on the boom connecting boss of the arm.

IMPORTANT: For handling of HN bushing for the front attachment, pay attention to following requirements.

Precautions for pressing the bushing in:

If a hammer is used to drive the bushing in, the bushing may be damaged. Use a press.

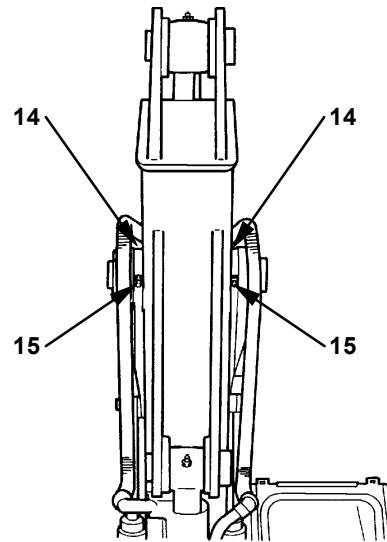
Precautions when reinforcing the arm:

Welding heat for arm reinforcement may cause oil to leak from the bushing and decrease lubrication performance.

If oil leak occurs because of heated bushing after welding, replace the bushing.

Special tools should be used to pull the bushing out or press it in.

Tool: ST 1454 (ZAXIS200, 200-E, 225US, 225USR)
ST 1477 (ZAXIS230, 270)



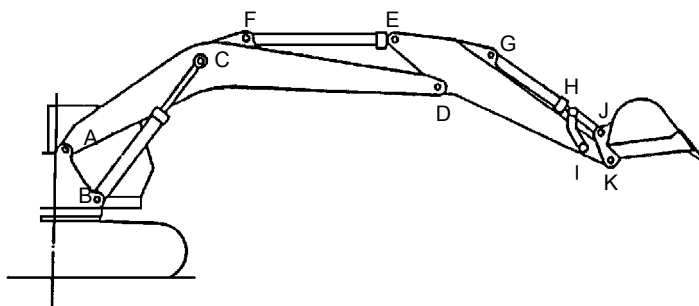
M157-07-157

FRONT ATTACHMENT / Front Attachment

MAINTENANCE STANDARD

Pin and Bushing

ZAXIS200, 200-E, 225US, 225USR



W105-04-01-018

Unit: mm (in)

	Part Name	Standard	Allowable Limit	Remedy
A	Pin	90 (3.54)	89.0 (3.50)	Replace
	Bushing	90 (3.54)	91.5 (3.60)	
B	Pin	80 (3.15)	79.0 (3.11)	
	Boss (Main Frame)	80 (3.15)	81.5 (3.21)	
	Bushing (Boom Cylinder)	80 (3.15)	81.5 (3.21)	
C	Pin	90 (3.54)	89.0 (3.50)	
	Bushing (Boom Cylinder)	90 (3.54)	91.5 (3.60)	
	Boss (Boom)	90 (3.54)	91.5 (3.60)	
D	Pin	90 (3.54)	89.0 (3.50)	
	Bushing	90 (3.54)	91.5 (3.60)	
E	Pin	80 (3.15)	79.0 (3.11)	
	Boss (Arm)	80 (3.15)	81.5 (3.21)	
	Bushing (Arm Cylinder)	80 (3.15)	81.5 (3.21)	
F	Pin	80 (3.15)	79.0 (3.11)	
	Boss (Boom)	80 (3.15)	81.5 (3.21)	
	Bushing (Arm Cylinder)	80 (3.15)	81.5 (3.21)	

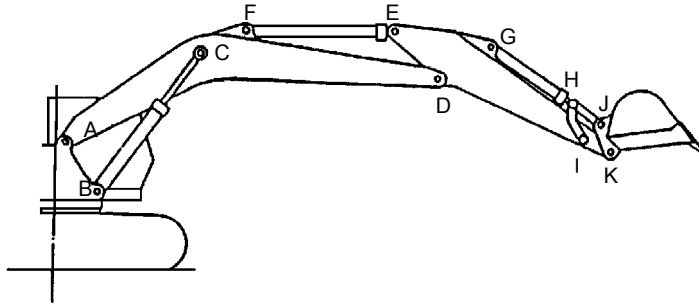
FRONT ATTACHMENT / Front Attachment

Unit:mm (in)				
	Part Name	Standard	Allowable Limit	Remedy
G	Pin	71 (2.80)	70.0 (2.76)	Replace
	Boss (Arm)	71 (2.80)	72.5 (2.85)	
	Bushing (Bucket Cylinder)	71 (2.80)	72.5 (2.85)	
H	Pin	80 (3.15)	79.0 (3.11)	
	Bushing	80 (3.15)	81.5 (3.21)	
	Bushing (Bucket Cylinder)	80 (3.15)	81.5 (3.21)	
I	Pin	71 (2.80)	70.0 (2.76)	
	Bushing	71 (2.80)	72.5 (2.85)	
J	Pin	80 (3.15)	79.0 (3.11)	
	Bushing	80 (3.15)	81.5 (3.21)	
K	Pin	80 (3.15)	79.0 (3.11)	
	Bushing	80 (3.15)	81.5 (3.21)	

IMPORTANT: When replacing HN bushing, press fit it in with a press.

FRONT ATTACHMENT / Front Attachment

Pin and Bushing
ZAXIS230



W105-04-01-018

Unit:mm (in)

	Part Name	Standard	Allowable Limit	Remedy
A	Pin	100 (3.94)	99.0 (3.90)	Replace
	Bushing	100 (3.94)	101.5 (4.0)	
B	Pin	90 (3.54)	89.0 (3.50)	
	Boss (Main Frame)	90 (3.54)	91.5 (3.60)	
	Bushing (Boom Cylinder)	90 (3.54)	91.5 (3.60)	
C	Pin	90 (3.54)	89.0 (3.50)	
	Bushing (Boom Cylinder)	90 (3.54)	91.5 (3.60)	
	Boss (Boom)	90 (3.54)	91.5 (3.60)	
D	Pin	100 (3.94)	99.0 (3.90)	
	Bushing	100 (3.94)	101.5 (4.0)	
E	Pin	90 (3.54)	89.0 (3.50)	
	Boss (Arm)	90 (3.54)	91.5 (3.60)	
	Bushing (Arm Cylinder)	90 (3.54)	91.5 (3.60)	
F	Pin	90 (3.54)	89.0 (3.50)	
	Boss (Boom)	90 (3.54)	91.5 (3.60)	
	Bushing (Arm Cylinder)	90 (3.54)	91.5 (3.60)	

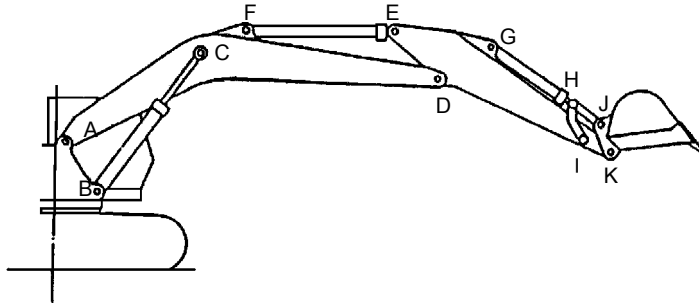
FRONT ATTACHMENT / Front Attachment

Unit:mm (in)				
	Part Name	Standard	Allowable Limit	Remedy
G	Pin	80 (3.15)	79.0 (3.11)	Replace
	Boss (Arm)	80 (3.15)	81.5 (3.21)	
	Bushing (Bucket Cylinder)	80 (3.15)	81.5 (3.21)	
H	Pin	90 (3.54)	89 (3.50)	
	Bushing	90 (3.54)	91.5 (3.60)	
	Bushing (Bucket Cylinder)	90 (3.54)	91.5 (3.60)	
I	Pin	80 (3.15)	79.0 (3.11)	
	Bushing	80 (3.15)	81.5 (3.21)	
J	Pin	90 (3.54)	89.0 (3.50)	
	Bushing	90 (3.54)	91.5 (3.60)	
K	Pin	90 (3.54)	89.0 (3.50)	
	Bushing	90 (3.54)	91.5 (3.60)	

IMPORTANT: When replacing HN bushing, press fit it in with a press.

FRONT ATTACHMENT / Front Attachment

Pin and Bushing
ZAXIS270



W105-04-01-018

Unit:mm (in)

	Part Name	Standard	Allowable Limit	Remedy
A	Pin	100 (3.94)	99.0 (3.90)	Replace
	Bushing	100 (3.94)	101.5 (4.0)	
B	Pin	100 (3.94)	99.0 (3.90)	
	Boss (Main Frame)	100 (3.94)	101.5 (4.0)	
	Bushing (Boom Cylinder)	100 (3.94)	101.5 (4.0)	
C	Pin	100 (3.94)	99.0 (3.90)	
	Bushing (Boom Cylinder)	100 (3.94)	101.5 (4.0)	
	Boss (Boom)	100 (3.94)	101.5 (4.0)	
D	Pin	100 (3.94)	99.0 (3.90)	
	Bushing	100 (3.94)	101.5 (4.0)	
E	Pin	90 (3.54)	99.0 (3.90)	
	Boss (Arm)	90 (3.54)	91.5 (3.60)	
	Bushing (Arm Cylinder)	90 (3.54)	91.5 (3.60)	
F	Pin	90 (3.54)	89.0 (3.50)	
	Boss (Boom)	90 (3.54)	91.5 (3.60)	
	Bushing (Arm Cylinder)	90 (3.54)	91.5 (3.60)	

FRONT ATTACHMENT / Front Attachment

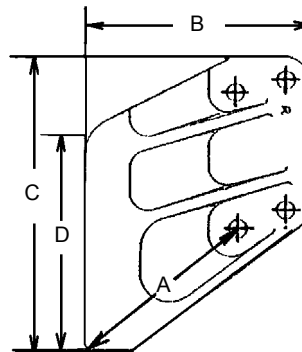
Unit:mm (in)				
	Part Name	Standard	Allowable Limit	Remedy
G	Pin	80 (3.15)	79.0 (3.11)	Replace
	Boss (Arm)	80 (3.15)	81.5 (3.21)	
	Bushing (Bucket Cylinder)	80 (3.15)	81.5 (3.21)	
H	Pin	90 (3.54)	89.0 (3.50)	
	Bushing	90 (3.54)	91.5 (3.60)	
	Bushing (Bucket Cylinder)	90 (3.54)	91.5 (3.60)	
I	Pin	80 (3.15)	79.0 (3.11)	
	Bushing	80 (3.15)	81.5 (3.21)	
J	Pin	90 (3.54)	89.0 (3.50)	
	Bushing	90 (3.54)	91.5 (3.60)	
K	Pin	90 (3.54)	89.0 (3.50)	
	Bushing	90 (3.54)	91.5 (3.60)	

IMPORTANT: When replacing HN bushing, press fit it in with a press.

FRONT ATTACHMENT / Front Attachment

Side Cutter

(ZAXIS200, 200-E, 225US, 225USR)



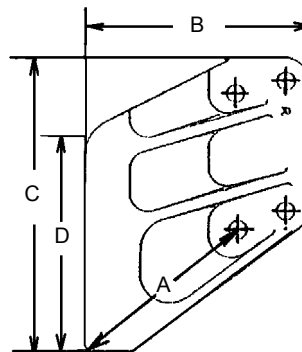
W155-04-01-002

Unit: mm (in)

	Standard	Allowable Limit	Remedy
A	278 (10.9)	181 (7.1)	Replace
B	295 (11.6)	—	
C	433 (17.0)	—	
D	135 (5.3)	—	

Point

(ZAXIS230, 270)



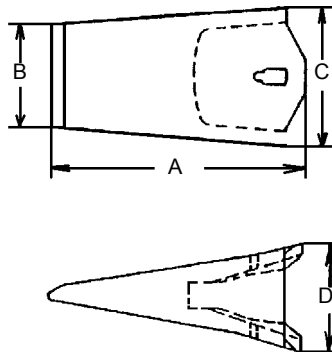
W155-04-01-002

Unit: mm (in)

	Standard	Allowable Limit	Remedy
A	290 (11.42)	180 (7.09)	Replace
B	300 (11.81)	—	
C	400 (15.75)	—	
D	300 (11.81)	—	

FRONT ATTACHMENT / Front Attachment

Side Cutter
(ZAXIS200, 200-E, 225US, 225USR)

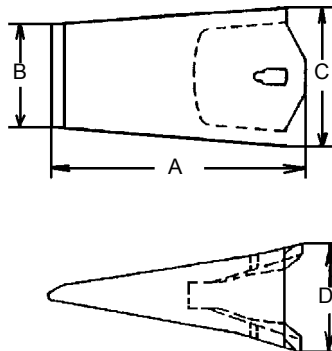


Unit: mm (in)

W105-04-01-020

	Standard	Allowable Limit	Remedy
A	215 (8.5)	107.5 (4.2)	Replace
B	95 (3.7)	—	
C	108 (4.3)	—	
D	95 (3.7)	—	

Point
(ZAXIS230, 270)



Unit: mm (in)

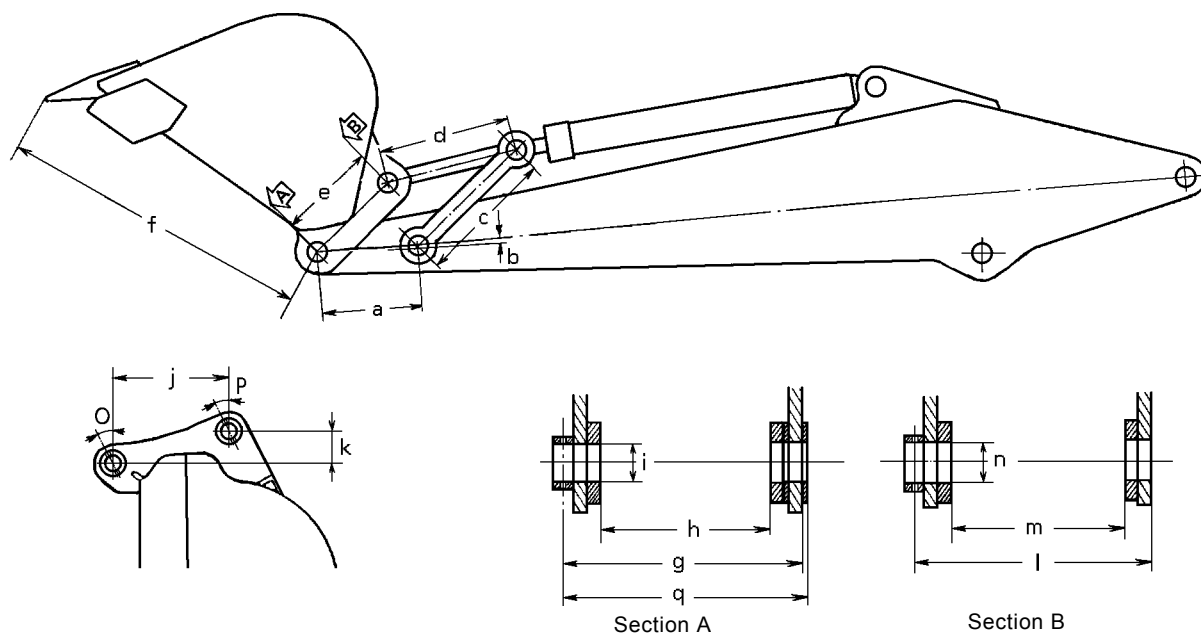
W105-04-01-020

	Standard	Allowable Limit	Remedy
A	240 (9.45)	120 (4.72)	Replace
B	96 (3.78)	—	
C	130 (5.12)	—	
D	105 (4.13)	—	

FRONT ATTACHMENT / Front Attachment

STANDARD DIMENSIONS FOR ARM AND BUCKET CONNECTION

IMPORTANT: If the front attachment for previous model machine is used, use the grease intervals for the previous model machine.



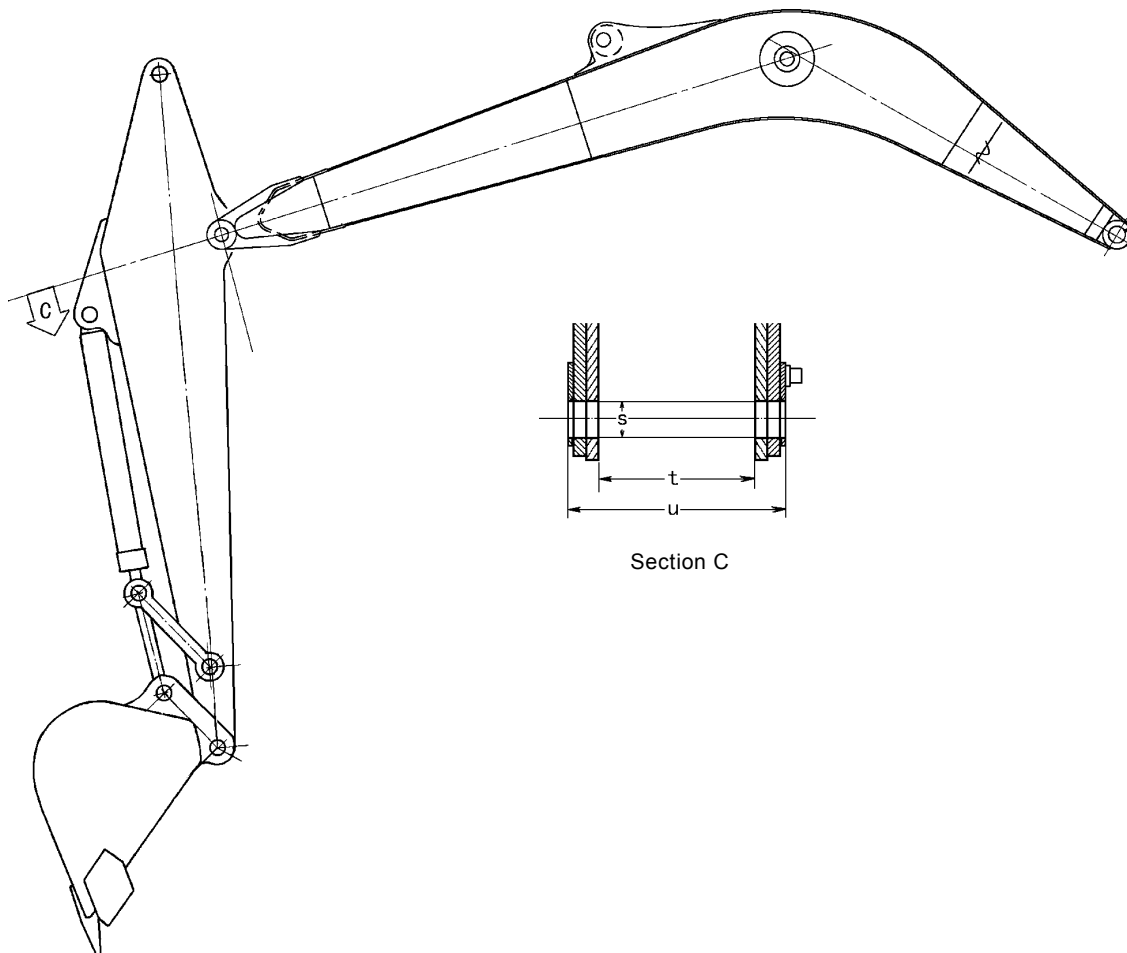
W187-04-01-003

Unit: mm (in)

	ZAXIS200	ZAXIS 225US	EX200-5、EX225USR	EX200-3	EX200-2	ZAXIS230	ZAXIS270
a	450 (17.7)	←	←	←	←	460 (18.11)	475 (18.70)
b	0 (0)	←	←	←	←	5 (0.20)	0
c	604 (23.8)	←	←	←	←	620 (24.41)	622 (24.49)
d	580 (22.8)	←	←	←	←	580 (22.83)	600 (23.62)
e	—	—	—	—	—	470 (18.50)	470 (18.50)
f	1471 (57.9)	←	1460 (57.5)	←	←	1547 (60.91)	1558 (61.34)
g	433 (17.0)	←	←	←	←	549 (21.61)	555 (21.85)
h	305.5 (12.0)	←	←	←	←	430 (16.93)	430 (16.93)
i	80 (3.1)	←	←	←	←	90 (3.54)	90 (3.54)
j	475 (18.7)	←	←	←	←	470 (18.50)	470 (18.50)
k	31 (1.2)	←	←	←	←	69 (2.72)	69 (2.72)
l	433 (17.0)	←	←	←	←	549 (21.61)	555 (21.85)
m	307 (12.1)	←	←	←	←	410 (16.14)	410 (16.14)
n	80 (3.1)	←	←	←	←	90 (3.54)	90 (3.54)
o	3.7°	←	←	←	←	8.4°	8.4°
p	3.7°	←	←	←	←	8.4°	8.4°
q	449 (17.7)	←	←	←	←	565 (22.24)	571 (22.48)

FRONT ATTACHMENT / Front Attachment

STANDARD DIMENSIONS FOR ARM AND BOOM CONNECTION



W187-04-01-002

Unit:mm (in)

	ZAXIS200	ZAXIS225US ZAXIS225USR	EX200-5	EX200-3	EX200-2	ZAXIS230	ZAXIS270
s	90 (3.5)	←	80 (3.1)	←	←	100 (3.94)	100 (3.94)
t	352 (13.9)	←	345 (13.6)	←	←	369 (14.53)	409 (16.10)
u	490 (19.3)	←	482 (19.0)	←	←	532 (20.94)	578 (22.76)

IMPORTANT: If the front attachment for a previous model machine is used, use the grease intervals for the previous model machine.

FRONT ATTACHMENT / Front Attachment

(Blank)

FRONT ATTACHMENT / Cylinder

REMOVE AND INSTALL CYLINDER

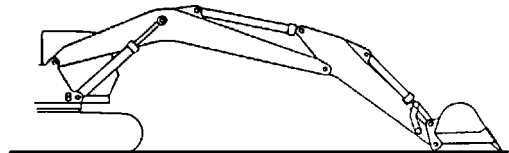


CAUTION: Escaping fluid under pressure may penetrate the skin, causing serious injury. Avoid this hazard by relieving pressure before disconnecting hydraulic or other lines. Hydraulic oil may be hot just after operation, and may spurt, possibly causing severe burns. Be sure to wait for oil to cool before starting any repair work.

The hydraulic oil tank cap may fly off if removed without releasing accumulated pressure first. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.

Preparation

1. Park the machine on a solid level surface. Fully retract the bucket and arm cylinders and lower the bucket to the ground.
2. Stop the engine. Push the air release valve on top of the hydraulic oil tank to release any remaining pressure.
3. Release pressure from hydraulic oil circuit according to the introduction on page W4-2-15.

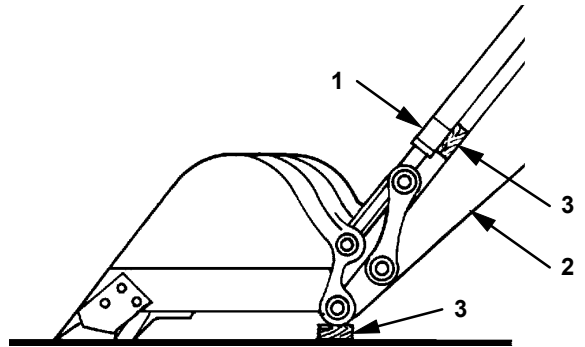


W105-04-02-001

FRONT ATTACHMENT / Cylinder

Remove Bucket Cylinder

1. Insert wooden block (3) between bucket cylinder (1) and arm (2).
2. After stopping the engine, push the air release valve to release any remaining pressure from the hydraulic oil tank, then remove the cap. Release bucket circuit pressure. Refer to "Hydraulic Circuit Pressure Release Procedure" on page W4-2-15.



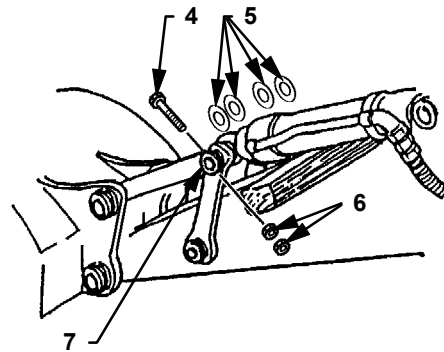
W554-04-02-006

CAUTION: Secure the link with a wire to prevent it from falling before pushing pin (7) out.

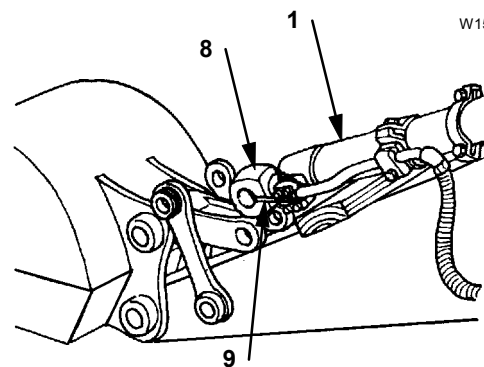
CAUTION: Prevent personal injury. Metal fragments may fly when a hammer is used. Be sure to wear necessary protection, such as goggles, hard hats, etc.

3. Remove nut (6) and bolt (4). Push out pin (7). Remove thrust plates (5).

 : 30 mm



4. To prevent rod (8) of bucket cylinder (1) from stretching, pass wire (9) through the cylinder rod hole and secure it to the bucket cylinder (1) tube.



W158-04-02-006

W102-04-02-005

FRONT ATTACHMENT / Cylinder

5. Disconnect bucket cylinder hoses (12) (2 used) at the bucket cylinder (1) bottom. Cover all openings with cap.

(ZAXIS200, 200-E, 225US, 225USR 230)

 : 36 mm

(ZAXIS270)

 : 41 mm



CAUTION: Bucket cylinder weight:

145 kg (320 lb):

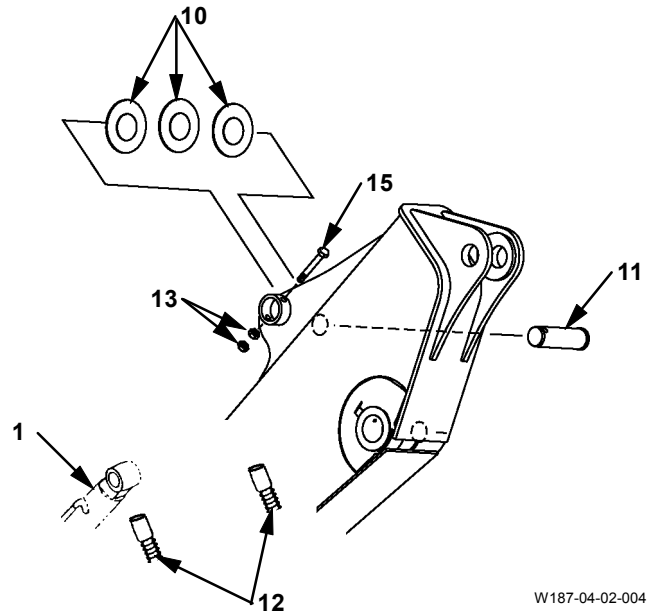
(ZAXIS 200, 200-E, 225US, 225USR)

182 kg (400 lb): (ZAXIS230)

216 kg (480 lb): (ZAXIS270)



CAUTION: Prevent personal injury. Metal fragments may fly when a hammer is used. Be sure to wear necessary protection, such as goggles, hard hats, etc.



W187-04-02-004

6. Hoist bucket cylinder (1) by crane, remove nut (13) and bolt (15). Push pin (11) out. Remove thrust plate (10).

 : 24 mm

7. Remove bucket cylinder (1).

FRONT ATTACHMENT / Cylinder

Install Bucket Cylinder

IMPORTANT: When pressing the bushing in, if a hammer is used, the bushing may be damaged. Use a press.

CAUTION: Bucket cylinder weight:
145 kg (320 lb):
(ZAXIS200, 200-E, 225US, 225USR)
182 kg (400 lb): (ZAXIS230)
216 kg (480 lb): (ZAXIS270)

CAUTION: Prevent personal injury. Metal fragments may fly when a hammer is used to install pin (11). Be sure to wear necessary protection, such as goggles, hard hats, etc.

1. Hoist bucket cylinder (1) by crane. Align cylinder tube side pin hole with the bucket cylinder mounting hole on arm. Insert thrust plate (10) and install pin (11).

2. Insert bolt (15) into arm stopper (14) and pin (11). Install nut (13).

(ZAXIS200, 200-E, 225US, 225USR)

🔧 : 24 mm

🔩 : 270 N·m (27.5 kgf·m, 200 lbf·ft)

(ZAXIS230, 270)

🔧 : 32 mm

🔩 : 235 N·m (24 kgf·m, 175 lbf·ft)

IMPORTANT: After installing hoses, fill hydraulic oil to specified level, start the engine, check the connections for any oil leaks.

3. Install bucket cylinder hoses (12) (2 used).

(ZAXIS200, 200-E, 225US, 225USR)

🔧 : 36 mm

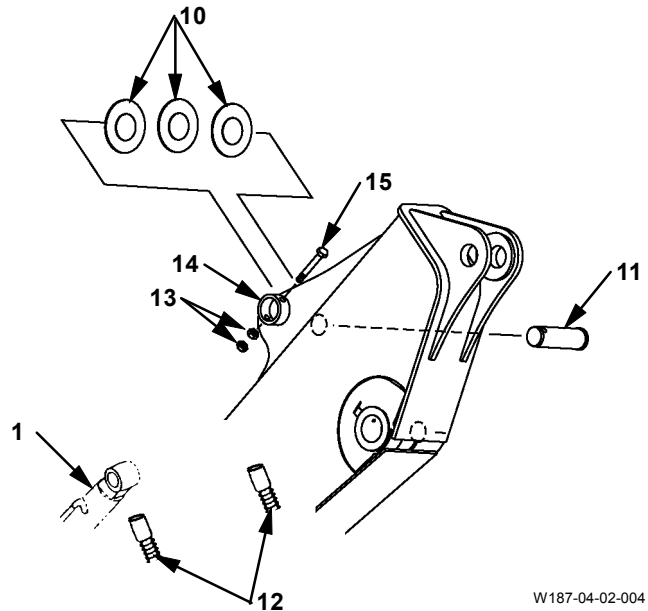
🔩 : 175 N·m (18 kgf·m, 130 lbf·ft)

(ZAXIS230, 270)

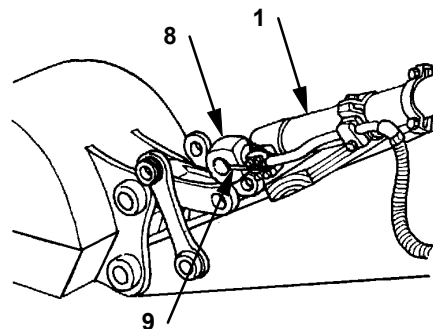
🔧 : 41 mm

🔩 : 205 N·m (21 kgf·m, 152 lbf·ft)

4. Remove wire (9) from rod (8) of bucket cylinder (1).



W187-04-02-004



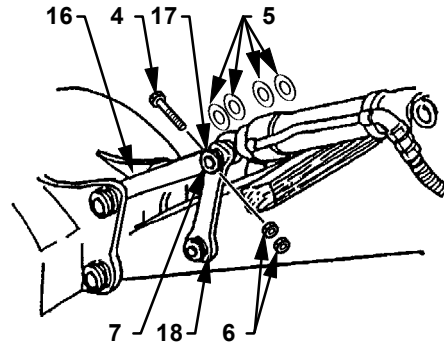
W102-04-02-005

FRONT ATTACHMENT / Cylinder



CAUTION: Prevent personal injury. Metal fragments may fly when a hammer is used. Be sure to wear necessary protection, such as goggles, hard hats, etc.

5. Start the engine and operate the bucket lever to align the cylinder rod side pin hole with those of links (16), (18). Insert thrust plate (5) and pin (7).



W158-04-02-006

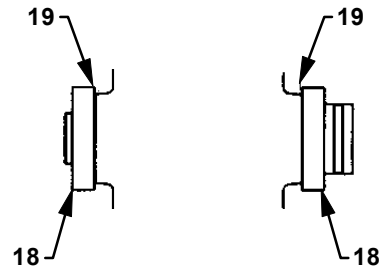
6. Insert bolt (4) into stopper (17) and pin (7), install nut (6).

 : 30 mm

 : 550 N·m (56.0 kgf·m, 405 lbf·ft)

IMPORTANT: In case link (18) has been removed from the arm, never forget to reinsert thrust plate (19).

IMPORTANT: After all work is completed, run bucket cylinder for several times to stroke end to bleed air from the circuit.



W157-04-01-015

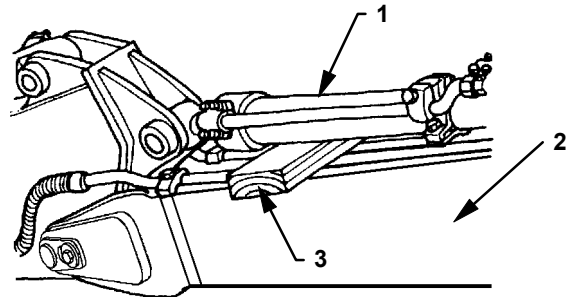
FRONT ATTACHMENT / Cylinder

Remove Arm Cylinder

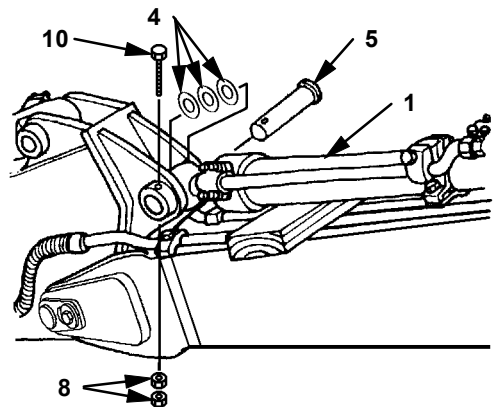
1. Insert wooden block (3) between arm cylinder (1) and boom (2).
2. After stopping the engine, push the air release valve to release any remaining pressure from the hydraulic oil tank, then remove the cap.
Release arm circuit pressure.
Refer to "Hydraulic Circuit Pressure Release Procedure" on page W4-2-15.
3. Remove nut (8) and bolt (10) from pin (5) at the arm cylinder (1) rod side.
(ZAXIS200, 200-E, 225US, 225USR 230)
🔧 : 30 mm
(ZAXIS230, 270)
🔧 : 32 mm



CAUTION: Prevent personal injury. Metal fragments may fly when a hammer is used. Be sure to wear necessary protection, such as goggles, hard hats, etc.

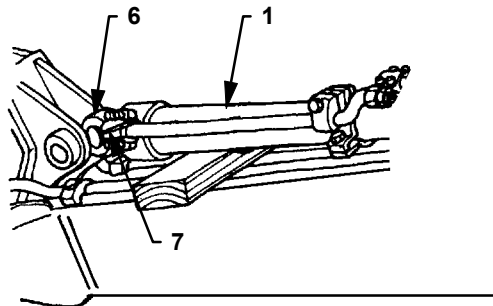


W187-04-02-005



W187-04-02-006

4. Push pin (5) out, then remove thrust plate (4).
5. To prevent arm cylinder (1) rod (6) from extending, pass wire (7) through the cylinder rod hole and secure it to the arm cylinder (1) tube.



W187-04-02-010

FRONT ATTACHMENT / Cylinder

6. Disconnect hoses (11) (2 used) from the bottom of arm cylinder (1) and cover all openings with cap.

(ZAXIS200, 200-E, 225US, 225USR)

🔧 : 36 mm

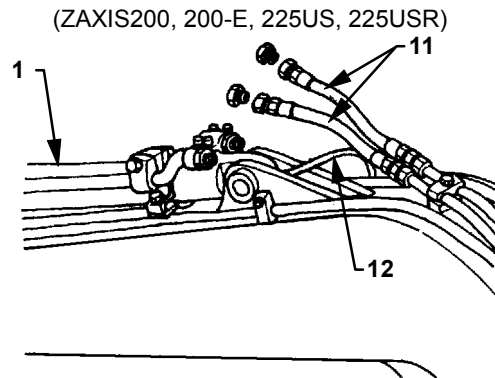
(ZAXIS230, 270)

🔧 : 36 mm, 41 mm

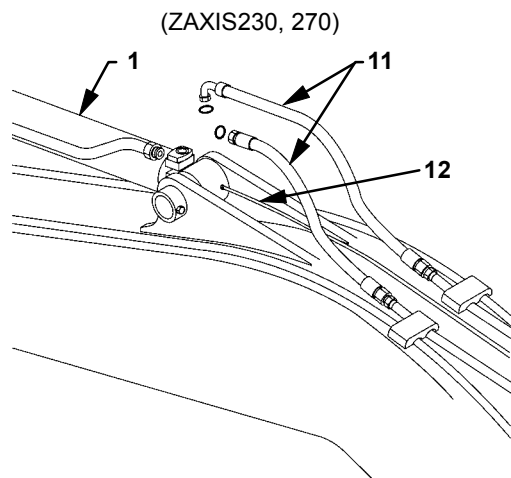
🔧 : 10 mm

7. Remove grease hose (12) from arm cylinder (1).

🔧 : 17 mm



W102-04-02-014



W178-04-02-023



CAUTION: Arm cylinder weight:
 259 kg (570 lb):
 (ZAXIS200, 200-E, 225US, 225USR)
 285 kg (630 lb): (ZAXIS230)
 307 kg (680 lb): (ZAXIS270)

8. Attach a sling at the center of gravity of arm cylinder (1). Hoist it with a crane.



CAUTION: Prevent personal injury. Metal fragments may fly when a hammer is used. Be sure to wear necessary protection, such as goggle, hard hats, etc.

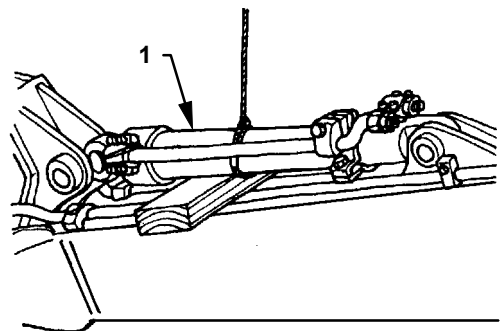
9. Remove nuts (15) and bolt (17) from the tube side of arm cylinder (1). Push out pin (14), remove thrust plates (13) and remove arm cylinder (1).

(ZAXIS200, 200-E, 225US, 225USR)

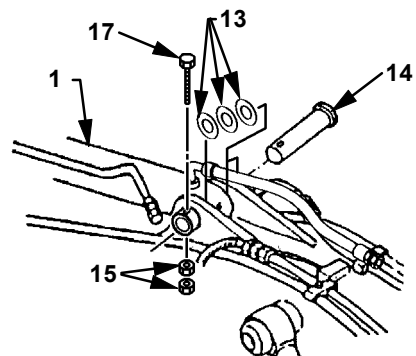
🔧 : 30 mm

(ZAXIS230, 270)

🔧 : 32 mm



W102-04-02-016



W187-04-02-007

FRONT ATTACHMENT / Cylinder

Install Arm Cylinder

IMPORTANT: When pressing the bushing in, if a hammer is used, the bushing may be damaged. Use a press.

CAUTION: Arm cylinder weight:
 259 kg (570 lb):
 (ZAXIS200, 200-E, 225US, 225USR)
 285 kg (630 lb): (ZAXIS230)
 307 kg (680 lb): (ZAXIS270)

1. Attach a sling at arm cylinder (1) where can make the cylinder level. Hoist it by crane. Align the cylinder tube side hole with the arm cylinder mounting hole on boom.

CAUTION: Prevent personal injury. Metal fragments may fly when a hammer is used. Be sure to wear necessary protection, such as goggles, hard hats, etc.

2. Insert thrust plate (13), then install pin (14). Install bolt (17) to the pin and stopper (16), and put nut (15) on the bolt.

(ZAXIS200, 200-E, 225US, 225USR)

⌘ : 30 mm

⌘ : 550 N·m (56 kgf·m, 405 lbf·ft)

(ZAXIS230, 270)

⌘ : 32 mm

⌘ : 750 N·m (76.5 kgf·m, 550 lbf·ft)

3. Install grease hose (12) and arm cylinder hoses (11) (2 used).

(ZAXIS200, 200-E, 225US, 225USR)

⌘ : 17 mm

⌘ : 29.5 N·m (3 kgf·m, 21.5 lbf·ft)

⌘ : 36 mm

⌘ : 175 N·m (18 kgf·m, 130 lbf·ft)

⌘ : 41 mm

⌘ : 205 N·m (21 kgf·m, 152 lbf·ft)

(ZAXIS230, 270)

⌘ : 17 mm

⌘ : 29.5 N·m (3 kgf·m, 21.5 lbf·ft)

⌘ : 36 mm

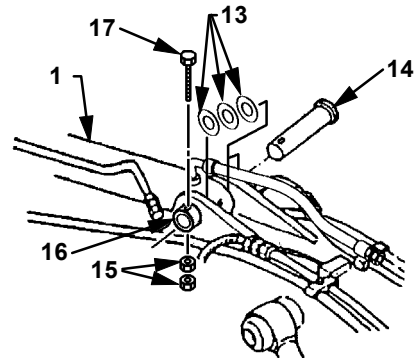
⌘ : 175 N·m (18 kgf·m, 130 lbf·ft)

⌘ : 41 mm

⌘ : 205 N·m (21 kgf·m, 152 lbf·ft)

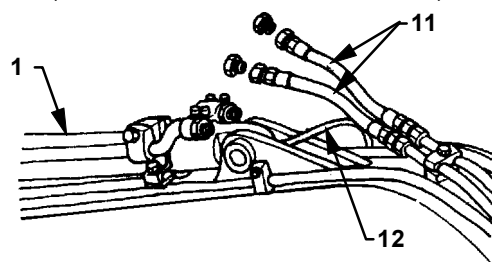
⌘ : 10 mm

⌘ : 90 N·m (9.2 kgf·m, 67 lbf·ft)



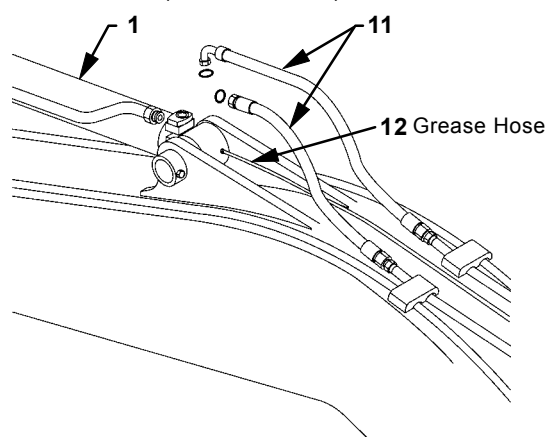
W187-04-02-007

(ZAXIS200, 200-E, 225US, 225USR)



W102-04-02-014

(ZAXIS230, 270)



W178-04-02-023

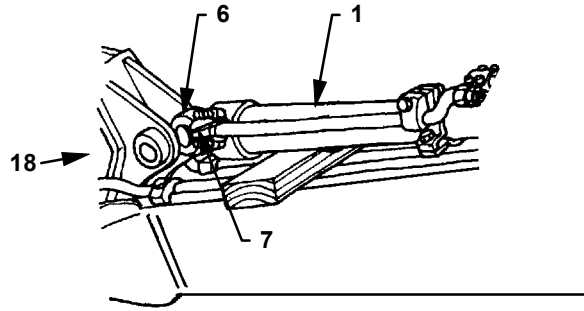
IMPORTANT: After filling hydraulic oil to specified level, start the engine and check the connections for any oil leaks.

FRONT ATTACHMENT / Cylinder

4. Remove wire (7) from arm cylinder (1) rod (6). Start the engine, operate arm lever and align the arm cylinder rod side pin hole with the arm cylinder mounting hole on arm (18).



CAUTION: Prevent personal injury. Metal fragments may fly when a hammer is used. Be sure to wear necessary protection, such as goggles, hard hats, etc.



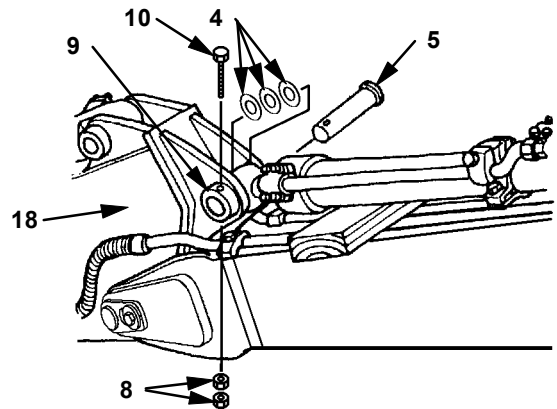
W187-04-02-010

5. Insert thrust plate (4), then install pin (5). Insert bolt (10) into pin (5) and stopper (9), then put nut (8) on the bolt.

 : 30 mm

 : 550 N·m (56 kgf·m, 405 lbf·ft)

IMPORTANT: When all work is completed, operate the arm cylinder several times to stroke end to bleed air from the circuit.



W187-04-02-006

FRONT ATTACHMENT / Cylinder

Remove Boom Cylinder

1. Remove grease hoses (1) from boom cylinder.

 : 17 mm



CAUTION: Boom cylinder weight:

171 kg (380 lb):

(ZAXIS200, 200-E, 225US, 225USR)

217 kg (480 lb): (ZAXIS230)

247 kg (540 lb): (ZAXIS270)

2. Attach a wire rope to boom cylinder (2) and hoist by crane.

W105-04-02-032



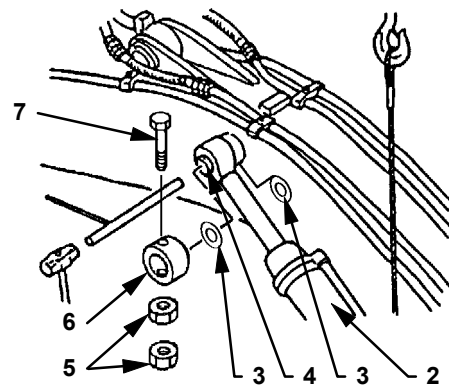
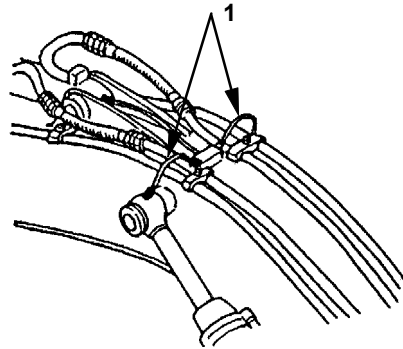
CAUTION: Prevent personal injury. Metal fragments may fly when a hammer is used. Be sure to wear necessary protection, such as goggles, hard hats, etc.

3. Remove nut (5), bolt (7) and stopper (6) from the boom cylinder (2) rod to push pin (4) out. Remove thrust plate (3).

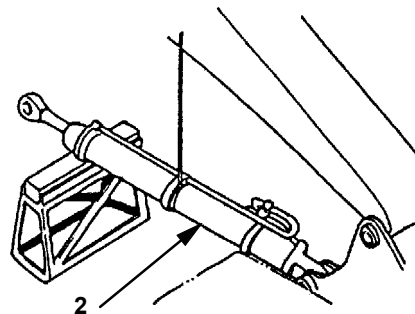
4. Place boom cylinder (2) on a bracket. Remove the other boom cylinder by same method.

5. Operate the boom lever to retract the boom.
To prevent the boom cylinder (2) rod from stretching, pass the wire through the cylinder rod hole and secure it to the cylinder tube.

6. After stopping the engine, push the air release valve to release any remaining pressure from hydraulic oil tank. Then remove the cap. Release circuit pressure.
Refer to "Release Hydraulic Circuit Pressure Procedure" on page W4-2-15.



W158-04-02-013



W105-04-02-035

FRONT ATTACHMENT / Cylinder

7. Remove hoses (12) (4 used) from boom cylinder (2) at the boom cylinder bottom. Cover all openings with plug to hoses and with cap to boom cylinder.

plug 1 3/16-12UN(ZAXIS200, 200-E, 225US, 225USR)

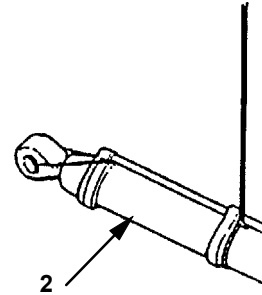
1 7/16-12UN(ZAXIS230, 270)

(ZAXIS200, 200-E, 225US, 225USR 230)

🔧 : 36 mm

(ZAXIS270)

🔧 : 41 mm



W105-04-02-036



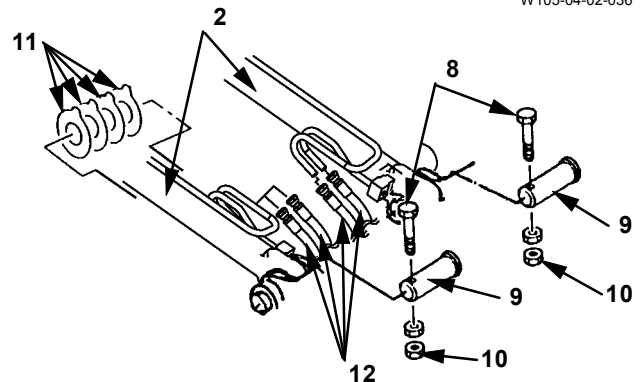
CAUTION: Prevent personal injury. Metal fragments may fly when a hammer is used. Be sure to wear necessary protection, such as goggles, hard hats, etc.

8. Loosen nut (10) at the boom cylinder bottom side of the main frame, and remove bolt (8). Pull pin (9) out.

Remove thrust plate (11).

🔧 : 24 mm

🔧 : 30 mm



W178-04-02-009



CAUTION: Boom cylinder weight:

171 kg (380 lb):

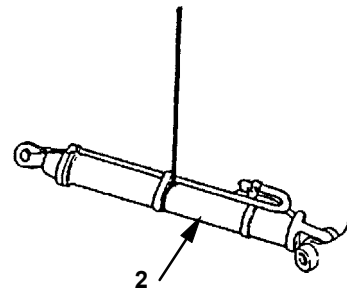
(ZAXIS200, 200-E, 225US, 225USR)

217 kg (480 lb): (ZAXIS230)

247 kg (540 lb): (ZAXIS270)

9. Attach a wire rope at boom cylinder (2) where can make the cylinder level. Hoist it by crane.

Remove boom cylinder at other side by the same method.



W105-04-02-040

FRONT ATTACHMENT / Cylinder

Install Boom Cylinder

IMPORTANT: When pressing the bushing in, if a hammer is used, the bushing may be damaged. Use a press.



CAUTION: Boom cylinder weight:

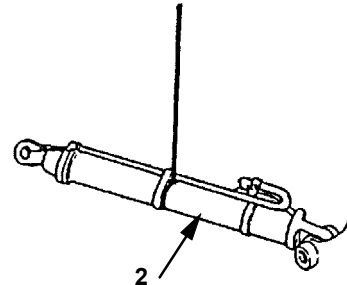
171 kg (380 lb):

(ZAXIS200, 200-E, 225US, 225USR)

217 kg (480 lb): (ZAXIS230)

247 kg (540 lb): (ZAXIS270)

1. Attach a wire rope at boom cylinder (2) where can make the cylinder level, hoist it by crane. Align the pin hole at boom cylinder bottom side with the boom cylinder mounting hole on the main frame.

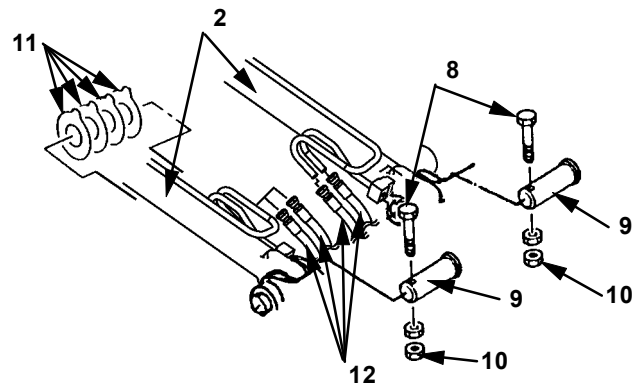


W105-04-02-040



CAUTION: Prevent personal injury. Metal fragments may fly when a hammer is used. Be sure to wear necessary protection, such as goggles, hard hats, etc.

2. Insert thrust plate (11) and pin (9). Install bolt (8), then tighten with nut (10).
(ZAXIS200, 200-E, 225US, 225USR)
🔧 : 24 mm
🔩 : 270 N·m (27.5 kgf·m, 200 lbf·ft)
(ZAXIS230, 270)
🔧 : 30 mm
🔩 : 550 N·m (56 kgf·m, 405 lbf·ft)



W178-04-02-009

3. Install the boom cylinder at other side by same method.
4. Install hoses (12) (4 used) on boom cylinders (2) (2 used).
(ZAXIS200, 200-E, 225US, 225USR, 230)
🔧 : 36 mm
🔩 : 175 N·m (18 kgf·m, 130 lbf·ft)
(ZAXIS270)
🔧 : 41 mm
🔩 : 205 N·m (21 kgf·m, 152 lbf·ft)

IMPORTANT: After filling hydraulic oil to specified level, start the engine and check the connections for any oil leaks.

FRONT ATTACHMENT / Cylinder

5. Hoist boom cylinder (2) by crane. Operate boom lever, align the pin hole at cylinder rod side with the mounting hole of the boom cylinder.

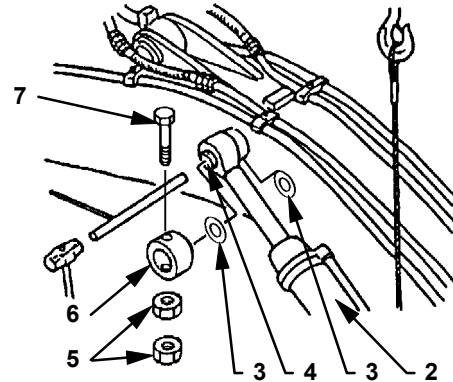
CAUTION: Prevent personal injury. Metal fragments may fly when a hammer is used. Be sure to wear necessary protection, such as goggle, hard hats, etc.

6. Install thrust plate (3), drive in pin (4).
7. Install bolt (7) to pin (4) and stopper (6), then install nut (5).
🔧 : 30 mm
🔧 : 550 N·m (56 kgf·m, 405 lbf·ft)

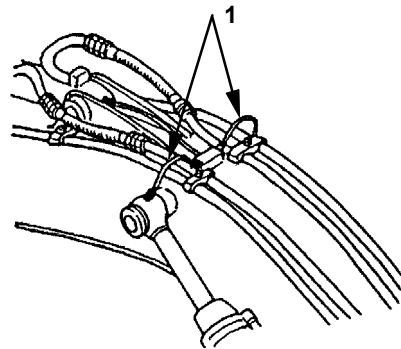
8. Connect grease hoses (1).
🔧 : 17 mm
🔧 : 29.5 N·m (3 kgf·m, 21.5 lbf·ft)

9. Install the boom cylinder at other side by same method.

IMPORTANT: When all work is completed, run the boom cylinder for several times to stroke end to bleed air from the circuit.



W158-04-02-013



W105-04-02-032

FRONT ATTACHMENT / Cylinder

(Blank)

FRONT ATTACHMENT / Cylinder

HYDRAULIC CIRCUIT PRESSURE RELEASE PROCEDURE

 **NOTE:** *Following method can be used. Do not start the engine. Operate pilot pump with the power from battery to deliver pilot pressure to the spool of control valve.*

1. Push the lock lever forward. (Be in OFF condition)

IMPORTANT: Be sure to pull the handle for stopping engine fully out.

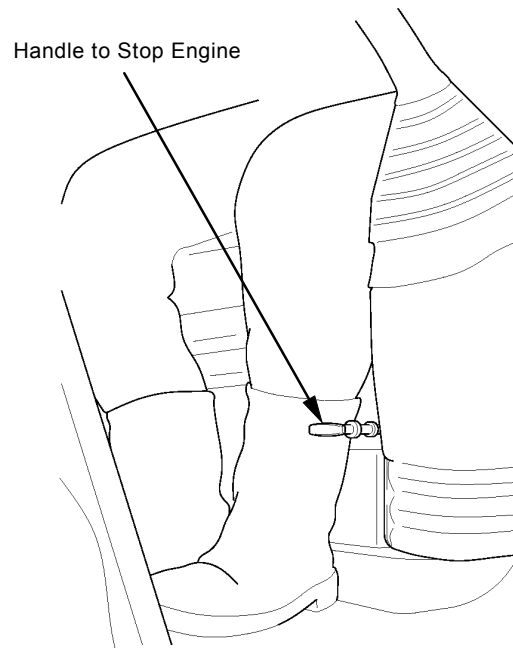
2. Pull the handle for stopping engine out and secure it by left foot.

IMPORTANT: Battery will deplete. Be sure to operate key switch for short period.

3. Turn the key switch to START position and operate the lever for releasing pressure from hydraulic circuit 4 to 5 times.

IMPORTANT: Push the handle for stopping engine in.

4. Reset the handle for stopping engine.

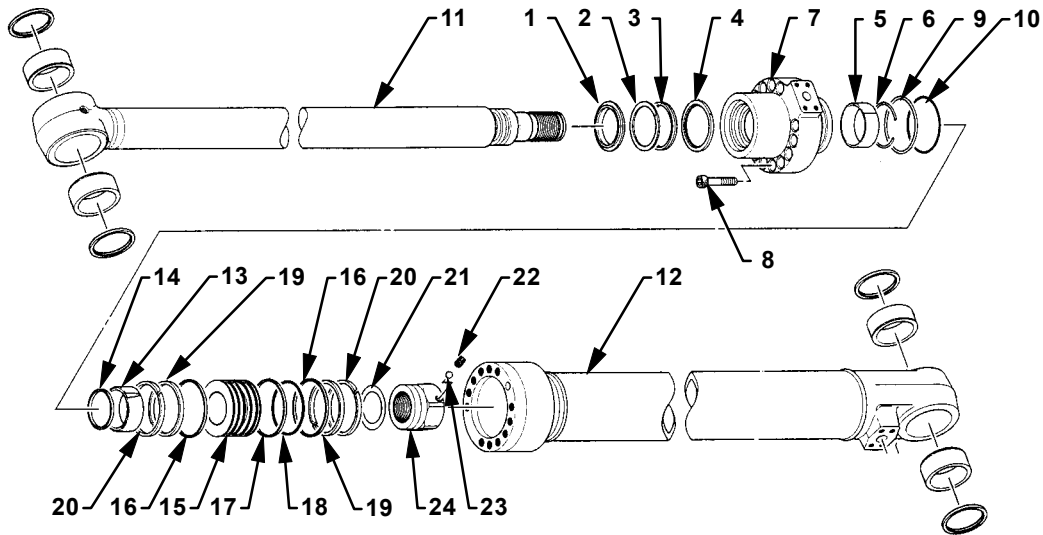


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FRONT ATTACHMENT / Cylinder

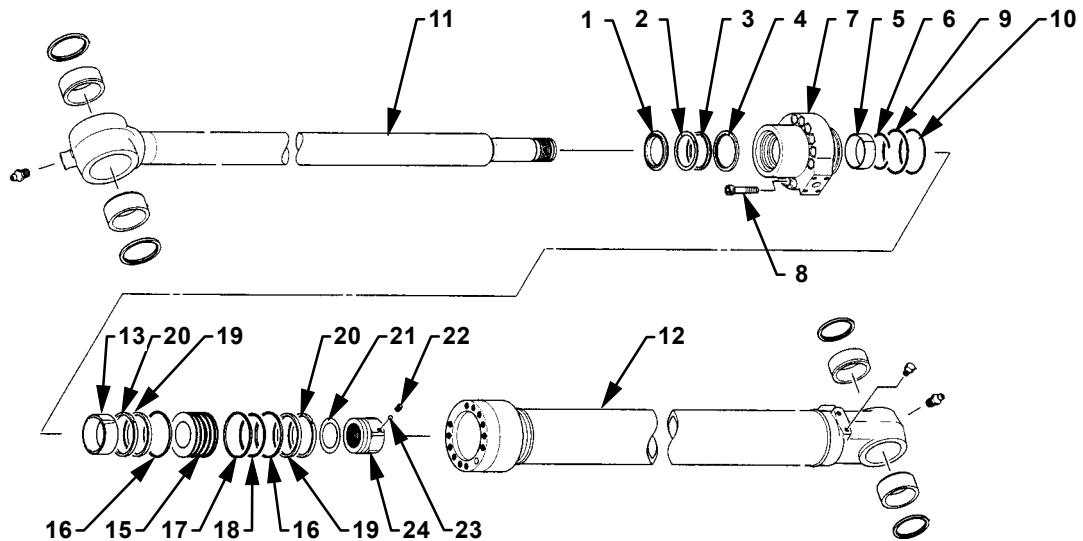
DISASSEMBLE CYLINDER (ZAXIS200, 200-E, 225US, 225USR, 270)

Boom Cylinder



W158-04-02-016

Bucket Cylinder



W158-04-02-018

- | | | | |
|-----------------|---------------------------|---------------------------|--------------------------|
| 1 - Wiper Ring | 7 - Cylinder Head | 13 - Cushion Bearing | 19 - Slide Ring (2 Used) |
| 2 - Backup Ring | 8 - Socket Bolt (12 Used) | 14 - Cushion Seal | 20 - Slide Ring (2 Used) |
| 3 - U-Ring | 9 - Backup Ring | 15 - Piston | 21 - Shim |
| 4 - Buffer Ring | 10 - O-Ring | 16 - Backup Ring (2 Used) | 22 - Set Screw |
| 5 - Bushing | 11 - Piston Rod | 17 - Seal Ring | 23 - Steel Ball |
| 6 - Snap Ring | 12 - Cylinder Tube | 18 - O-Ring | 24 - Nut |

FRONT ATTACHMENT / Cylinder

Disassemble Boom and Bucket Cylinder (ZAXIS200, 200-E, 225US, 225USR, 270)

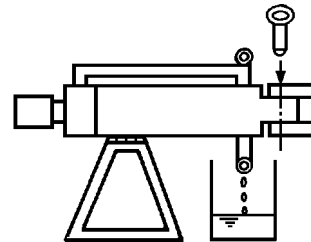
- Be sure to thoroughly read “Precautions for Disassembly and Assembly Work” on page W1-1-1 before starting the disassembly work.

The disassembly procedure below starts on the premise that the hydraulic line and the line securing bands have been removed.



CAUTION: Cylinder weight:
(ZAXIS200, 200-E, 225US, 225USR)
Boom cylinder: 171 kg (380 lb) (ZAXIS270)
Bucket cylinder: 247 kg (540 lb)
(ZAXIS200, 200-E, 225US, 225USR)
Boom cylinder: 145 kg (320 lb) (ZAXIS270)
Bucket cylinder: 216 kg (480 lb)

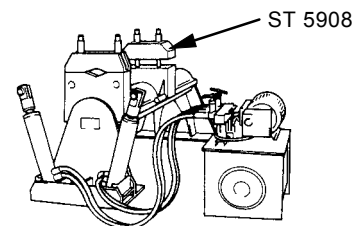
1. Lift and securely place the cylinder on a workbench by crane. Be sure that the cylinder is placed horizontally. Drain hydraulic oil from the cylinder.
2. Fully extend cylinder rod (11). Hold the rod end by crane. Remove socket bolts (8) from cylinder head (7).
 : 14 mm
3. Pull out cylinder head (7) from cylinder tube (12) by tapping with a plastic hammer.



W102-04-02-027

IMPORTANT: Be sure to pull out cylinder rod (11) straight to prevent the sliding surfaces from being damaged.

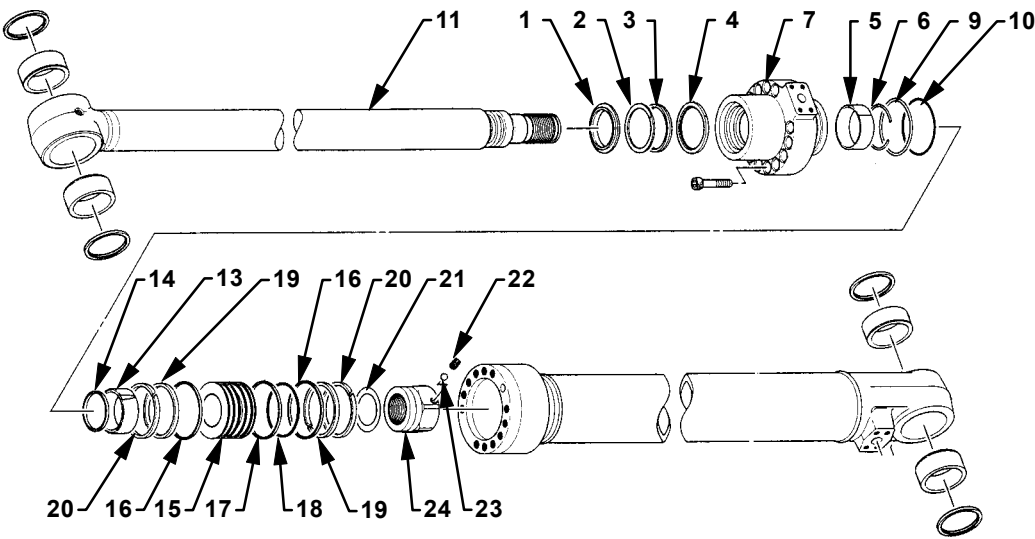
4. Secure cylinder rod (11) on special tool (ST 5908). Put matching marks between cylinder rod (11) and nut (24).



W158-04-02-022

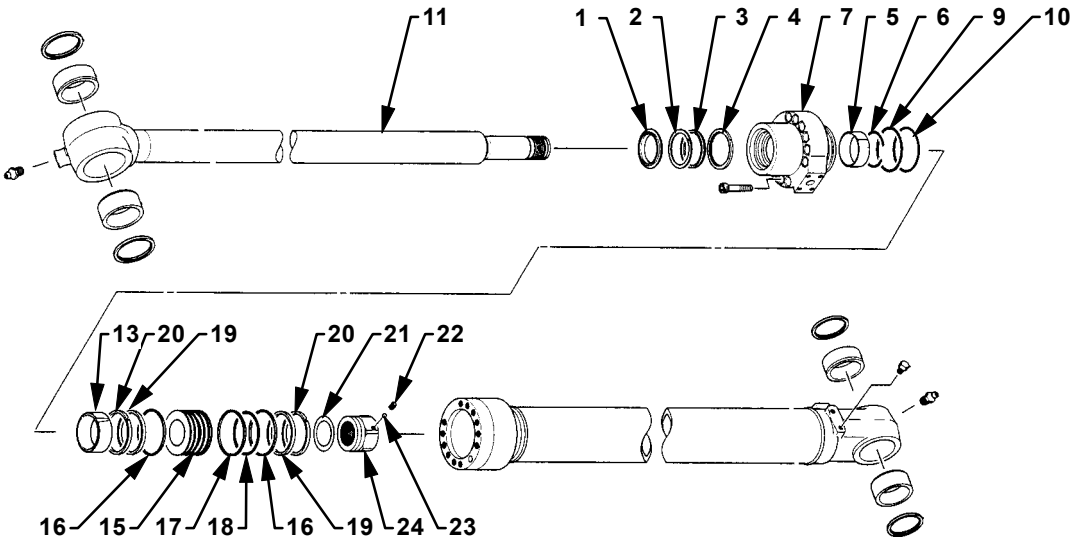
FRONT ATTACHMENT / Cylinder

Boom Cylinder



W158-04-02-016

Bucket Cylinder



W158-04-02-018

FRONT ATTACHMENT / Cylinder

5. Remove set screw (22) and steel ball (23).

 **NOTE:** As set screw (22) was mushroomed with a punch and hammer at two places after it had been screwed in, cut its mushroomed portion away with a drill first.

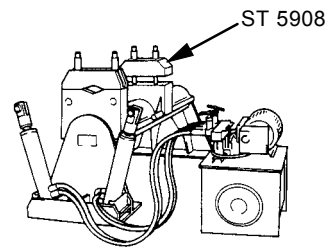
 : 10 mm

6. Loosen nut (24) using special tool (ST 5908). Remove piston (15), shim (21) and cushion bearing (13).

(For boom cylinder, remove cushion seal (14), in addition.)

Tool for turning nut: 90 mm (3.54 in) (ST 3263)

7. Remove seal ring (17), slide rings (19 and 20) (2 used for each), O-ring (18), backup rings (16) (2 used) from piston (15).



W158-04-02-022

8. Remove cylinder head (7) from cylinder rod (11).

9. Remove O-ring (10) and backup rings (9 and 2) from cylinder head (7). Then remove wiper ring (1), U-ring (3), backup ring (4), snap ring (6) and bushing (5).

Tool for removing bushing:

ZAXIS200, 200-E, 225US, 225USR

Boom 85 mm (3.35 in) (ST 8020)

Bucket 80 mm (3.15 in) (ST 8019)

ZAXIS270

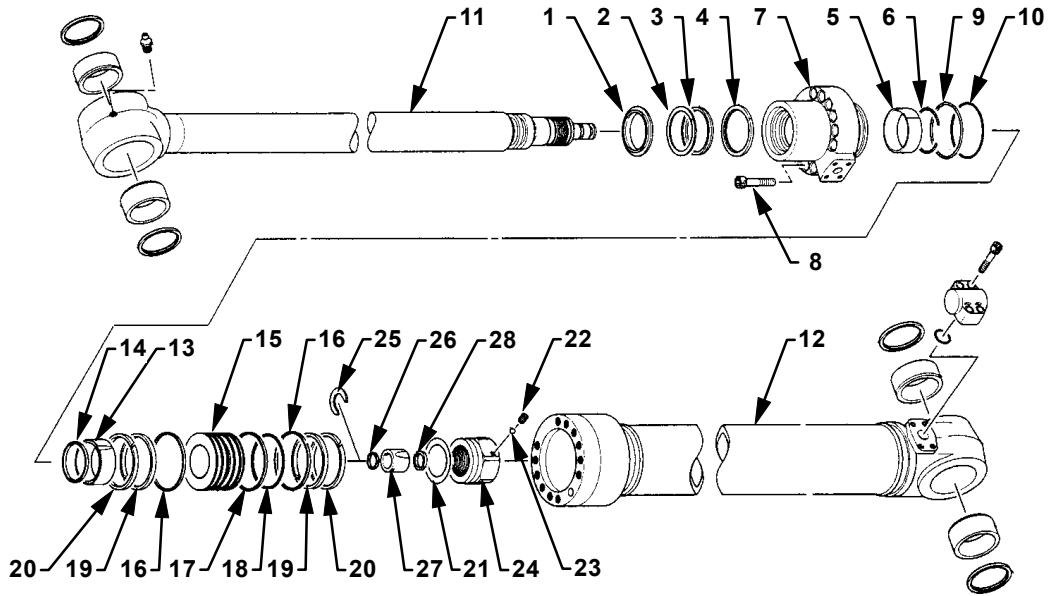
Boom 95 mm (3.74 in) (ST 8021)

Bucket 90 mm (3.54 in) (ST 8024)

FRONT ATTACHMENT / Cylinder

Arm Cylinder

(ZAXIS200, 200-E, 225US, 225USR, 270)



W158-04-02-017

- | | | | |
|-------------------|--------------------------|---------------------------|-----------------------|
| 1 - Wiper Ring | 8 - Socket Bolt(12 Used) | 15 - Piston | 22 - Set Screw |
| 2 - Backup Ring | 9 - Backup Ring | 16 - Backup Ring (2 Used) | 23 - Steel Ball |
| 3 - U-Ring | 10 - O-Ring | 17 - Seal Ring | 24 - Nut |
| 4 - Buffer Ring | 11 - Piston Rod | 18 - O-Ring | 25 - Snap Ring |
| 5 - Bushing | 12 - Cylinder Tube | 19 - Slide Ring (2 Used) | 26 - Cushion Seal |
| 6 - Snap Ring | 13 - Cushion Bearing | 20 - Slide Ring (2 Used) | 27 - Cushion Bearing |
| 7 - Cylinder Head | 14 - Cushion Seal | 21 - Shim | 28 - Stopper (2 Used) |

FRONT ATTACHMENT / Cylinder

Disassemble Arm Cylinder (ZAXIS200, 200-E, 225US, 225USR, 270)

- Be sure to thoroughly read “Precautions for Disassembly and Assembly Work” on page W1-1-1 before starting the disassembly work.

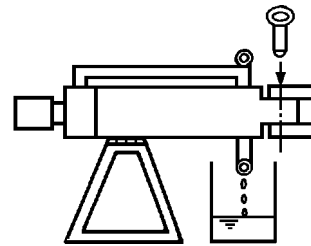
The disassembly procedure below starts on the premise that the hydraulic line and the line securing bands have been removed.



CAUTION: Cylinder weight:
(ZAXIS200, 200-E, 225US, 225USR)
Boom cylinder: 259 kg (570 lb) (ZAXIS270)
Boom cylinder: 307 kg (680 lb)

1. Place the cylinder horizontally on a workbench by crane and secure it. Drain hydraulic oil out from the cylinder.
2. Fully extend cylinder rod (11). Hold the rod end by crane. Remove socket bolts (8) from cylinder head (7).

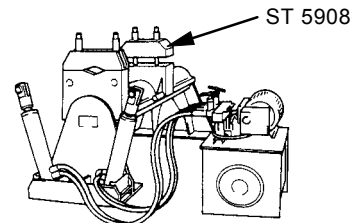
 : 14 mm



W102-04-02-027

IMPORTANT: Be sure to pull out cylinder rod (11) straight to prevent the sliding surfaces from being damaged.

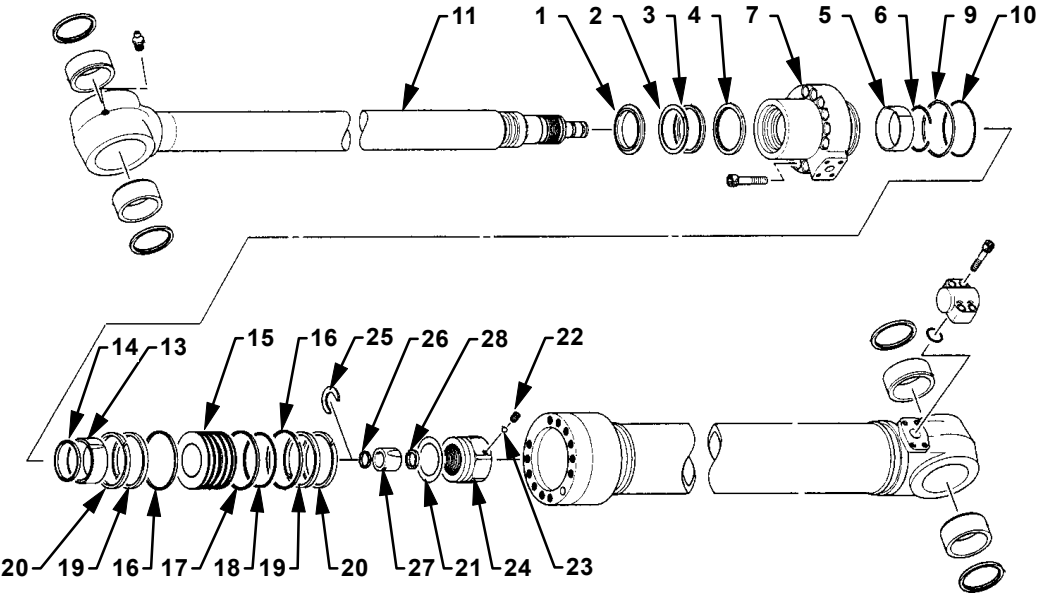
3. Pull out cylinder head (7) with piston rod still attached from cylinder tube (12) by tapping with a plastic hammer.
4. Secure cylinder rod (11) on special tool (ST 5908). Put matching marks between cylinder rod (11) and nut (24).



W158-04-02-022

FRONT ATTACHMENT / Cylinder

Arm Cylinder



W158-04-02-017

FRONT ATTACHMENT / Cylinder

5. Remove set screw (22) and steel ball (23).

 **NOTE:** As set screw (22) was mushroomed with a punch and hammer at two places after it had been screwed in, cut its mushroomed portion away using a drill first.

 : 10 mm

6. Loosen nut (24) using special tool (ST 5908) to remove piston (15), shim (21), cushion bearing (13) and cushion seal (14).

Tool for turning nut: 100 mm (3.94 in) (ST 3264)

7. Remove seal ring (17), slide rings (19 and 20) (2 used for each), O-ring (18), backup rings (16) (2 used) from piston (15).

8. Remove cylinder head (7) from piston rod (11).

9. Remove O-ring (10), backup rings (9 and 2) from cylinder head (7). Then remove wiper ring (1), U-ring (3), backup ring (4), snap ring (6) and bushing (5).

Special tool for bushing removal:

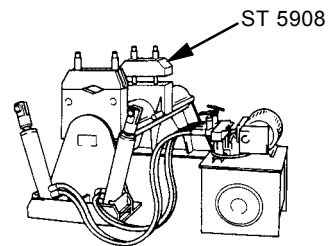
ZAXIS200, 200-E, 225US, 225USR

Arm 95 mm (3.74 in) (ST 8021)

ZAXIS270

Arm 100 mm (3.94 in) (ST 8026)

10. Remove stopper (28) from cylinder rod (11) with a screwdriver. Remove cushion bearing (27), cushion seal (26) and snap ring (25).

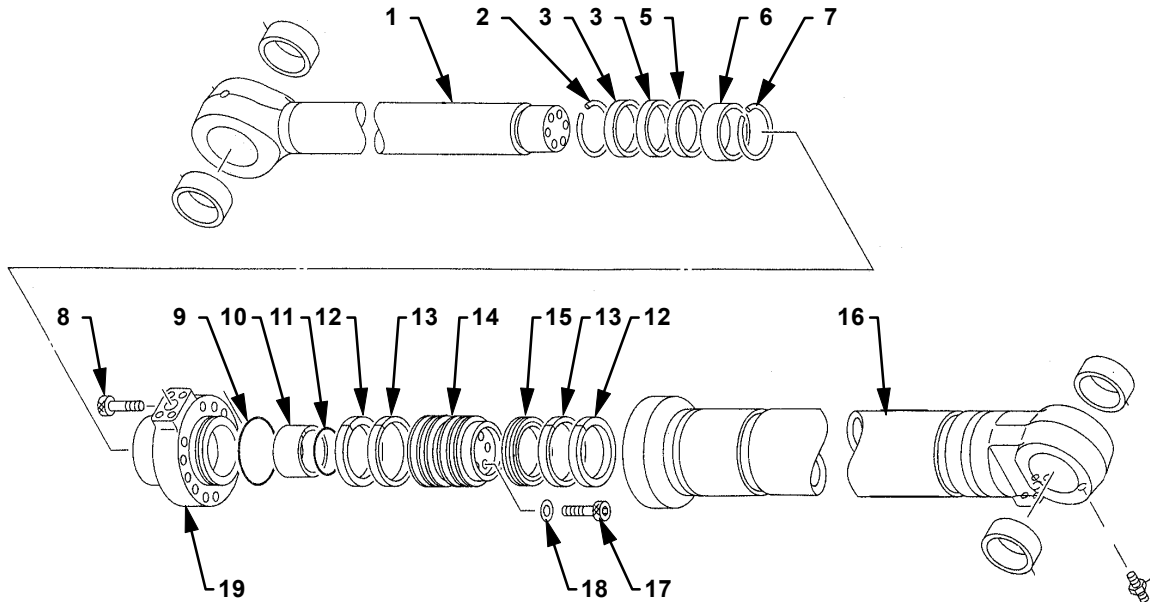


W158-04-02-022

FRONT ATTACHMENT / Cylinder

DISASSEMBLE CYLINDER (ZAXIS230)

Boom Cylinder
Bucket Cylinder



W178-04-02-026

- | | | | |
|--------------------|---------------------------|---------------------------|---------------------------|
| 1 - Piston Rod | 6 - Bushing | 11 - O-Ring | 16 - Cylinder Tube |
| 2 - Retaining Ring | 7 - Retaining | 12 - Piston Ring (2 used) | 17 - Socket bolt (6 used) |
| 3 - Dust Seal | 8 - Socket bolt (12 used) | 13 - Wear Ring (2 used) | 18 - Washer |
| 4 - Seal | 9 - O-Ring | 14 - Piston | 19 - Cylinder Head |
| 5 - Ring | 10 - Cushion Ring | 15 - Seal Ring | |

FRONT ATTACHMENT / Cylinder

Disassemble Boom and Bucket Cylinder (ZAXIS230)

- Be sure to thoroughly read “Precautions for Disassembly and Assembly Work” on page W1-1-1 before starting the disassembly work.

The disassembly procedure below starts on the premise that the hydraulic line and the line securing bands have been removed.



CAUTION: Cylinder weight:

Boom cylinder: 217 kg (480 lb)

Bucket cylinder: 182 kg (400 lb)

1. Lift and securely place the cylinder on a workbench by crane. Be sure that the cylinder is placed horizontally. Drain hydraulic oil out from the cylinder.

2. Fully extend piston rod (1). Hold the rod end by crane. Remove socket bolts (8) (12 used) from cylinder head (19).

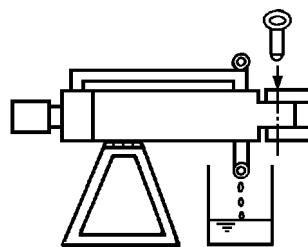
 : 14 mm

3. Pull out cylinder head (19) from cylinder tube (16) by tapping with a plastic hammer.

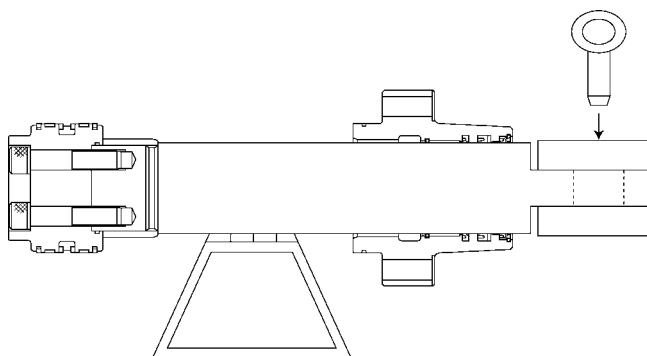
IMPORTANT: Be sure to pull out piston rod (1) straight to prevent the sliding surfaces from being damaged.

4. Secure piston rod (1) on work bench. Remove socket bolts (17) (6 used), washer (18) (6 used) from piston (14).

 : 14 mm



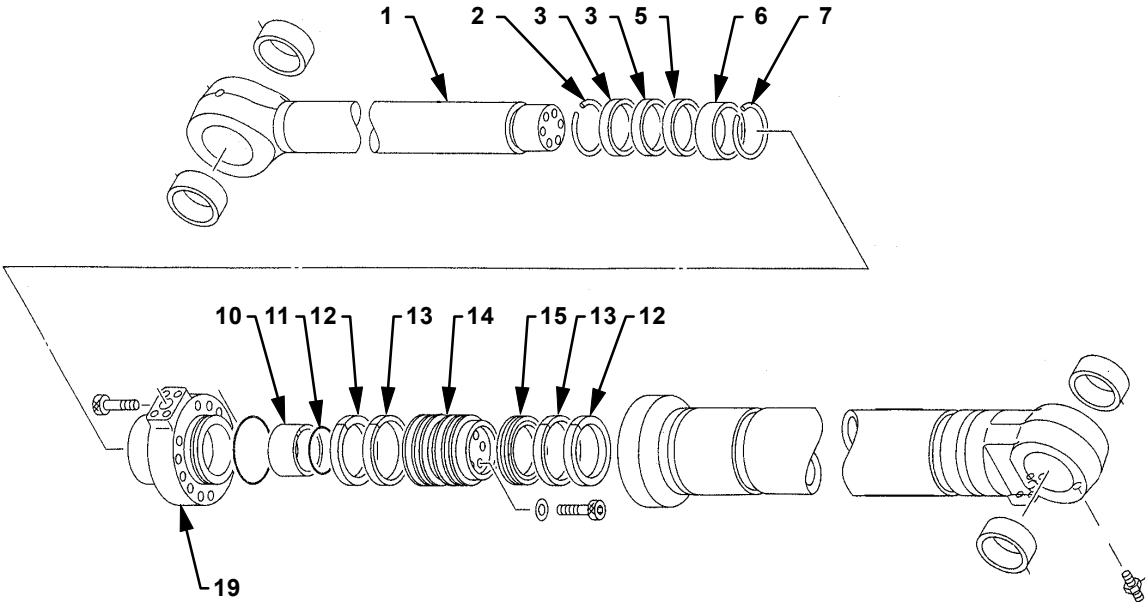
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W178-04-02-034

FRONT ATTACHMENT / Cylinder

Boom Cylinder
Bucket Cylinder



W178-04-02-026

FRONT ATTACHMENT / Cylinder

5. Remove Piston (14) assembly, cushion ring (10), cylinder head (19) from piston rod (1).
6. Remove piston rings (12) (2 used), wear rings (13) (2 used), seal ring (15) and O-ring (11) from piston (14).
7. Remove retaining ring (2), dust seal (3), seal (4), ring (5), retaining ring (7), bushing (6) from cylinder head (19).

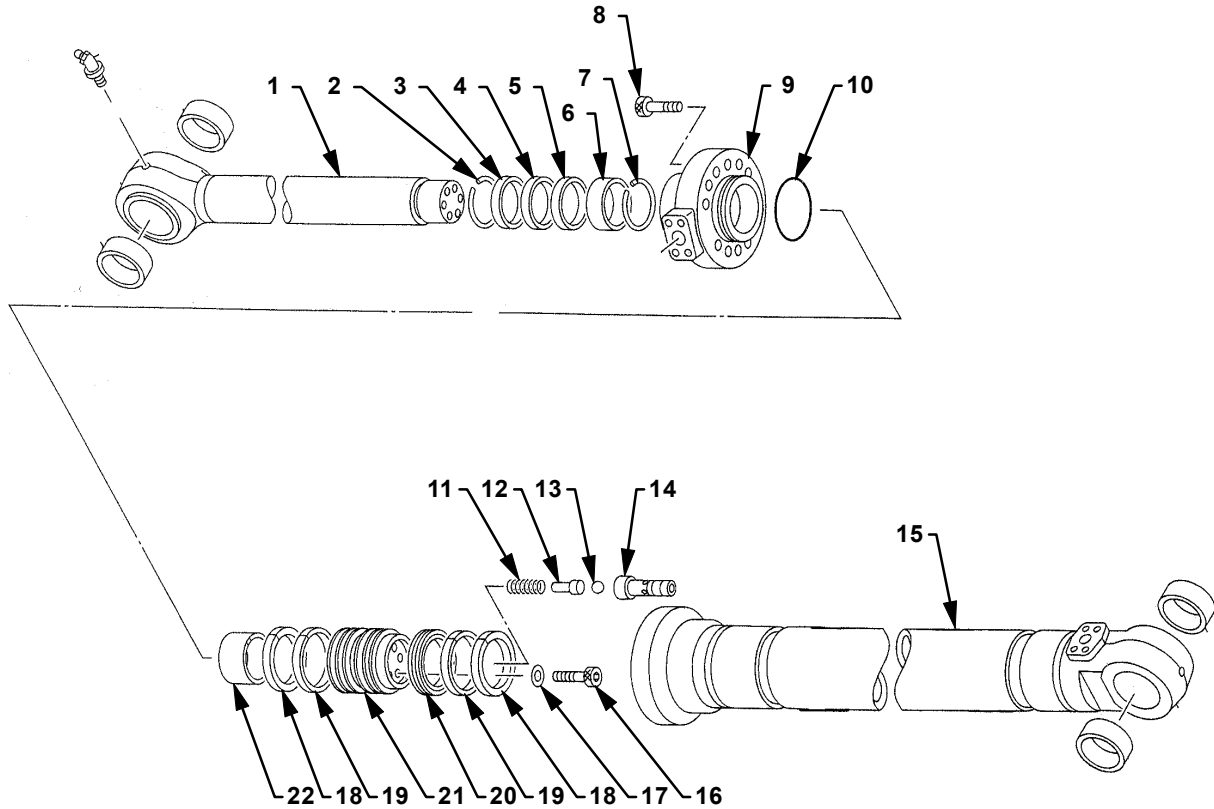
Tool for removing bushing:

Boom 90 mm (3.54 in) (ST 8024)

Bucket 90 mm (3.54 in) (ST 8024)

FRONT ATTACHMENT / Cylinder

Arm Cylinder (ZAXIS230)



W178-04-02-027

- | | | | |
|--------------------|---------------------------|---------------------------|---------------------------|
| 1 - Piston Rod | 7 - Retaining Ring | 13 - Ball | 18 - Teflon Ring (2 Used) |
| 2 - Retaining Ring | 8 - Socket Bolt (14 Used) | 14 - Plunger | 19 - Wear Ring (2 Used) |
| 3 - Dust Seal | 9 - Cylinder Head | 15 - Cylinder Tube | 20 - Seal Ring |
| 4 - Seal | 10 - O-Ring | 16 - Socket Bolt (6 Used) | 21 - Piston |
| 5 - Ring | 11 - Spring | 17 - Washer (6 Used) | 22 - Cushion Ring |
| 6 - Bushing | 12 - Stopper | | |

FRONT ATTACHMENT / Cylinder

Disassemble Arm Cylinder (ZAXIS230)

- Be sure to thoroughly read “Precautions for Disassembly and Assembly Work” on page W1-1-1 before starting the disassembly work.

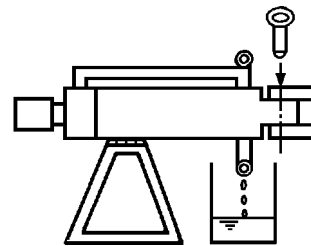
The disassembly procedure below starts on the premise that the hydraulic line and the line securing bands have been removed.



CAUTION: Cylinder weight:
Arm cylinder 285 kg (630 lb)

1. Place the cylinder horizontally on a workbench by crane and secure it. Drain hydraulic oil out from the cylinder.
2. Fully extend piston rod (1). Hold the rod end by crane. Remove socket bolts (8) (14 used) from cylinder head (9).

 : 14 mm

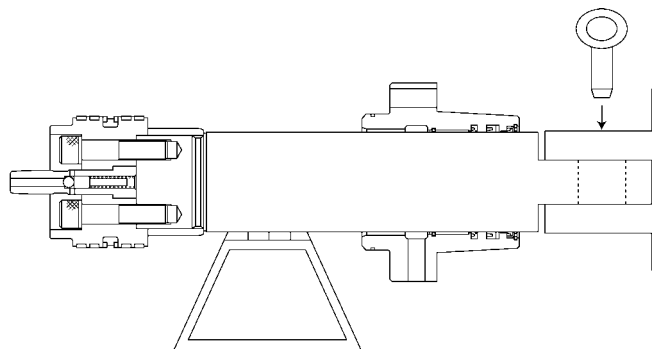


W102-04-02-027

IMPORTANT: Be sure to pull out piston rod (1) straight to prevent the sliding surfaces from being damaged.

3. Pull out cylinder head (9) with piston rod still attached from cylinder tube (15) by tapping with a plastic hammer.
4. Secure piston rod (1) on work bench horizontally. Loosen and remove socket bolts (16) (6 used) and washers (17) (6 used) from piston (21).

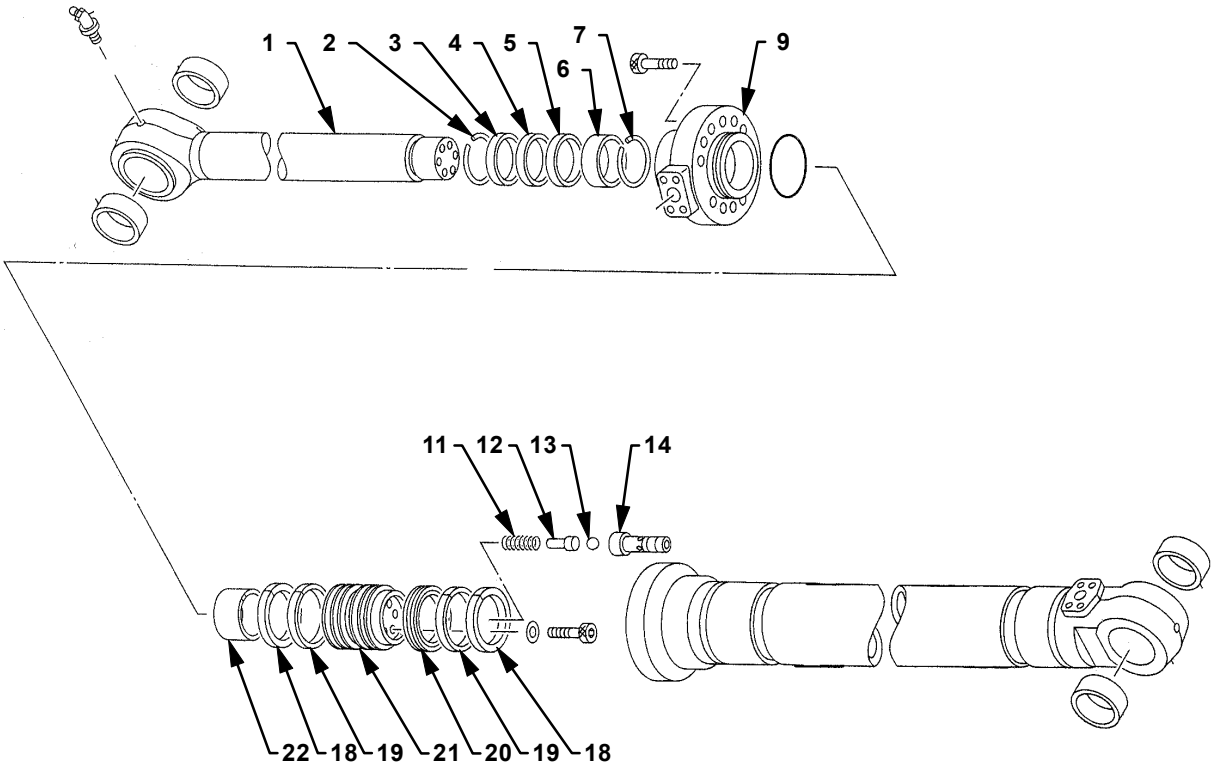
 : 17 mm



W178-04-02-033

FRONT ATTACHMENT / Cylinder

Arm Cylinder



W178-04-02-027

FRONT ATTACHMENT / Cylinder

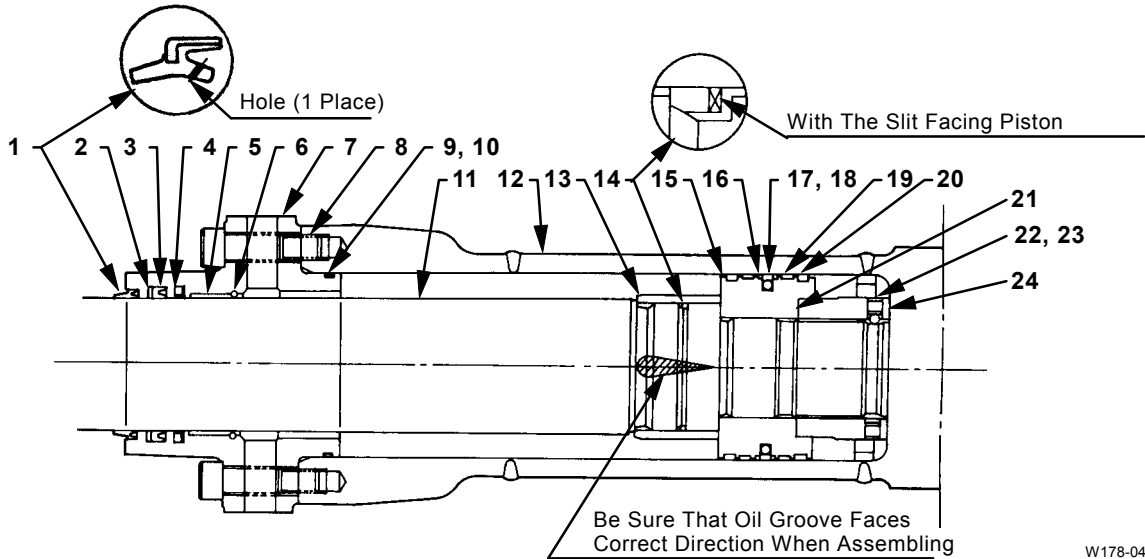
5. Remove the piston (21) assembly, cushion ring (22), cylinder head (19) from piston rod (1).
6. Remove spring (11), stopper (12), ball (13), plunger (14) from piston (21).
7. Remove teflon rings (18) (2 used), wear rings (19) (2 used), seal ring (20) from piston (21).
8. Remove retaining ring (2), dust seal (3), seal (4), ring (5), retaining ring (7), bushing (6) from cylinder head (9).

Tool for removing Bushing
105 mm (4.13 in) (ST 1993)

FRONT ATTACHMENT / Cylinder

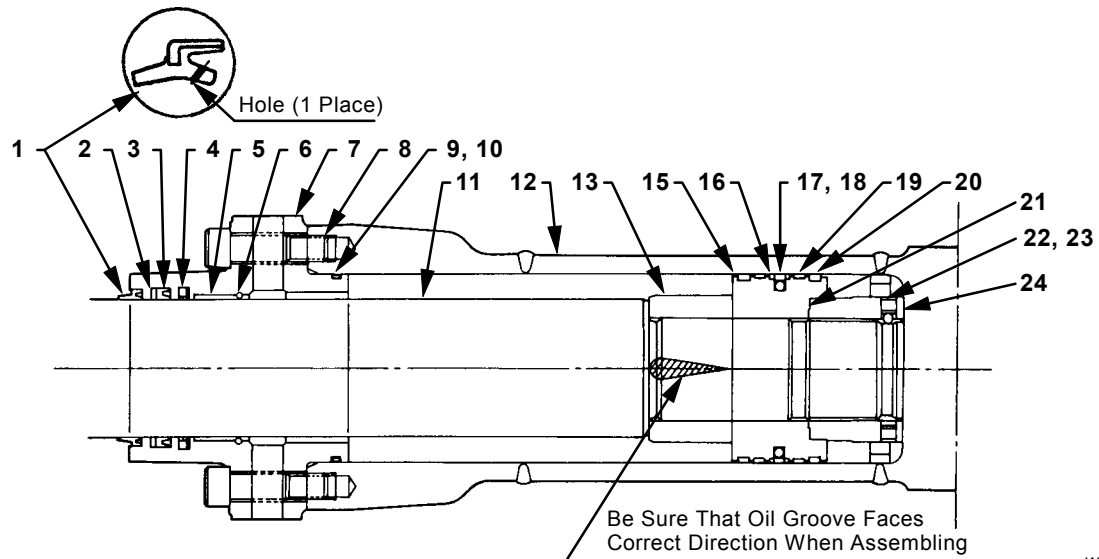
ASSEMBLE CYLINDER (ZAXIS200, 200-E, 225US, 225USR, 270)

Boom Cylinder



W178-04-02-003

Bucket Cylinder



W178-04-02-004

- | | | | |
|-----------------|---------------------------|---------------------------|--------------------------|
| 1 - Wiper Ring | 7 - Cylinder Head | 13 - Cushion Bearing | 19 - Slide Ring (2 Used) |
| 2 - Backup Ring | 8 - Socket Bolt (12 Used) | 14 - Cushion Seal | 20 - Slide Ring (2 Used) |
| 3 - U-Ring | 9 - Backup Ring | 15 - Piston | 21 - Shim |
| 4 - Buffer Ring | 10 - O-Ring | 16 - Backup Ring (2 Used) | 22 - Set Screw |
| 5 - Bushing | 11 - Cylinder Rod | 17 - Seal Ring | 23 - Steel Ball |
| 6 - Snap Ring | 12 - Cylinder Tube | 18 - O-Ring | 24 - Nut |

FRONT ATTACHMENT / Cylinder

Assemble Boom Bucket Cylinder (ZAXIS200, 200-E, 225US, 225USR, 270)

1. Install bushing (5) to cylinder head (7) with a press.

Tools for bushing installation:

- Boom 85 mm (3.35 in) (ST 8020)
- Bucket 80 mm (3.15 in) (ST 8019)

IMPORTANT: Be sure to install the rings in correct direction.

2. Install U-ring (3), backup ring (2), buffer ring (4), snap ring (6) onto cylinder head (7).

3. Install wiper ring (1) to cylinder head (7) with a plastic hammer.

Tools for installing wiper ring:

- Boom (ST 8020/ST 1298)
- Bucket (ST 8019/ST 1297)

4. Install O-ring (10), backup ring (9) to cylinder head (7).

5. Install O-ring (18), backup rings (16) (2 used), seal ring (17), slide rings (19 and 20) (2 used for each) to piston (15).

6. Install the cylinder head (7) assembly to cylinder rod (11).

Tool for installing cylinder head:

- Boom (ST 8020/ST 2362)
- Bucket (ST 8019/ST 2345)

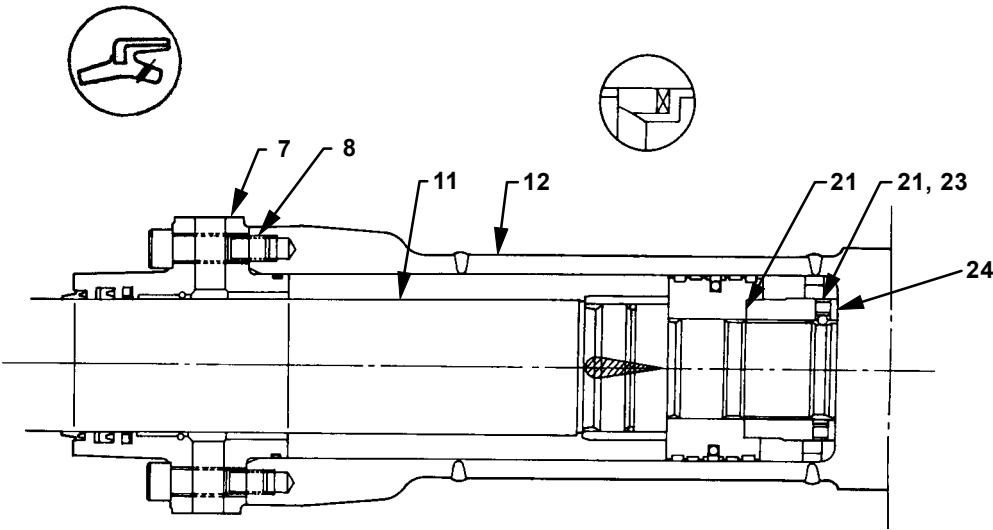
IMPORTANT: Be sure with the cushion seal (14) slit facing piston and with cushion bearing (13) oil groove facing correct direction.

7. Install cushion bearing (13) to piston rod (11).
Install the piston (15) assembly to the piston rod (11).

(For boom cylinder: install cushion seal (14), in addition.)

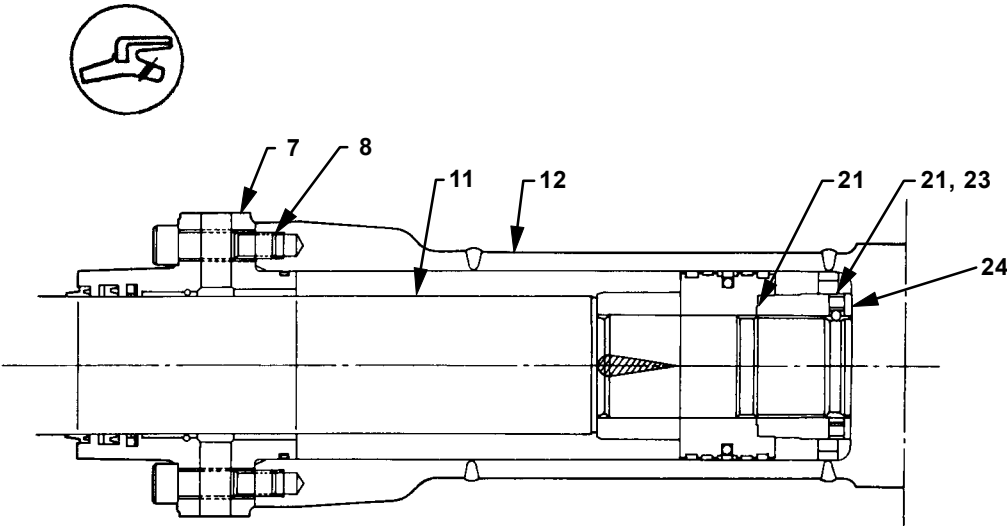
FRONT ATTACHMENT / Cylinder

Boom Cylinder



W178-04-02-003

Bucket Cylinder



W178-04-02-004

FRONT ATTACHMENT / Cylinder

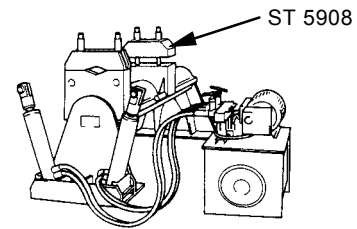
8. Install shim (21) to piston rod (11). Tighten nut (24) using special tool (ST 5908) while aligning the matching mark on the rod with that on the nut.

Tool for tightening nut:

Boom 90 mm (3.54 in) (ST 3263)

Bucket 90 mm (3.54 in) (ST 3263)

 : Boom cylinder
4780 N·m (487 kgf·m, 3520 lbf·ft)
Bucket cylinder
6570 N·m (670 kgf·m, 4850 lbf·ft)



W158-04-02-022

9. Align the hole on cylinder rod (11) with that on nut (24). Insert steel ball (23) into the hole and tighten set screw (22).

IMPORTANT: Mushroom the head of set screw (22) at two places with a punch and hammer.

 : 10 mm (Boom, Bucket)
 : 56.9±10.7 N·m
(5.8±1.09 kgf·m, 42.0 ± 7.9 lbf·ft)
(Boom, Bucket)



CAUTION: Be sure to align cylinder rod (11) with the center of cylinder tube (12) when inserting, in order to prevent the rings from damaging.

10. Secure cylinder tube (12) horizontally on a work bench. Insert cylinder rod (11) into cylinder tube (12).

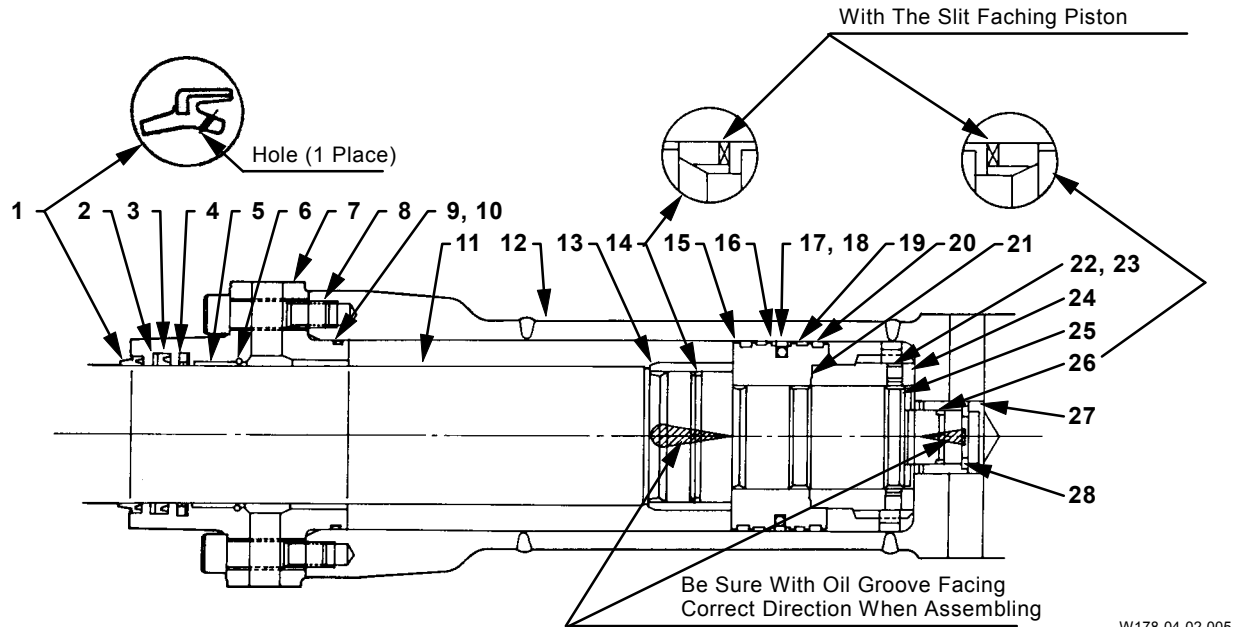
11. Install cylinder head (7) to cylinder tube (12). Tighten socket bolts (8) (12 used).

 : 14 mm (Boom, Bucket)
 : 267 N·m (27.2 kgf·m, 200 lbf·ft)

FRONT ATTACHMENT / Cylinder

Arm Cylinder

(ZAXIS200, 200-E, 225US, 225USR, 270)



W178-04-02-005

- | | | | |
|-------------------|---------------------------|---------------------------|-----------------------|
| 1 - Wiper Ring | 8 - Socket Bolt (12 Used) | 15 - Piston | 22 - Set Screw |
| 2 - Backup Ring | 9 - Backup Ring | 16 - Backup Ring (2 Used) | 23 - Steel Ball |
| 3 - U-Ring | 10 - O-Ring | 17 - Seal Ring | 24 - Nut |
| 4 - Buffer Ring | 11 - Cylinder Rod | 18 - O-Ring | 25 - Snap Ring |
| 5 - Bushing | 12 - Cylinder Tube | 19 - Slide Ring (2 Used) | 26 - Cushion Seal |
| 6 - Snap Ring | 13 - Cushion Bearing | 20 - Slide Ring (2 Used) | 27 - Cushion Bearing |
| 7 - Cylinder Head | 14 - Cushion Seal | 21 - Shim | 28 - Stopper (2 Used) |

FRONT ATTACHMENT / Cylinder

Assemble Arm Cylinder

(ZAXIS200, 200-E, 225US, 225USR, 270)

1. Install bushing (5) to cylinder head (7) with a press.

Tool for pressing bushing:

95 mm (3.74 in) (ST 8021/ST 1288)

IMPORTANT: Be sure to install rings in correct direction.

2. Install U-ring (3), backup ring (2), buffer ring (4), snap ring (6) to cylinder head (7).

3. Install wiper ring (1) to cylinder head (7) with a plastic hammer.

Tool for pressing wiper ring: ST 8021 (1299)

4. Install O-ring (10), backup ring (9) to cylinder head (7).

5. Install seal ring (17), O-ring (18), slide rings (19 and 20) (2 used for each) to piston (15).

6. Install cylinder head (7) assembly to cylinder rod (11).

Tool for installing cylinder head: (ST 8021/ST 2363)

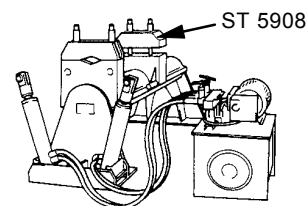
IMPORTANT: Be sure that the slit in cushion seal (14) is facing piston and that the oil groove in cushion bearing (13) is facing correct direction.

7. Install cushion seal (14) to cylinder rod (11). Install cushion bearing (13), the piston (15) assembly to cylinder rod (11).

8. Install shim (21) to cylinder rod (11). Tighten nut (24) with special tool (ST 5908) while aligning the matching mark on the rod with that on the nut.

Tool for tightening nut: 100 mm (3.94 in) (ST 3264)

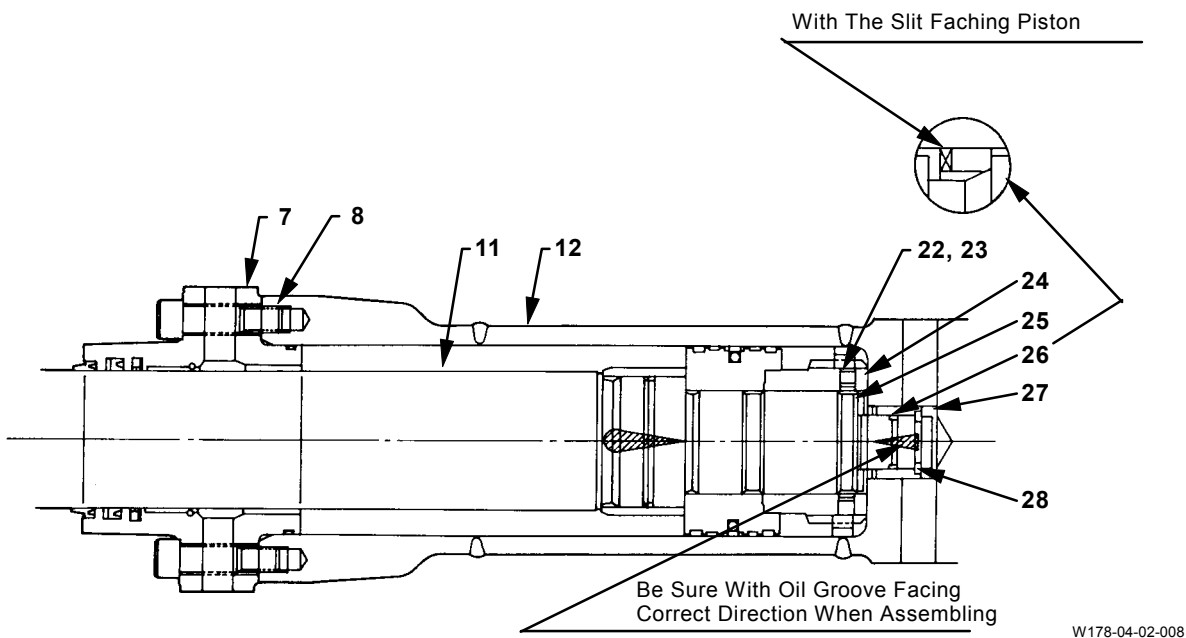
 : 10200 N·m (1040 kgf·m, 7520 lbf·ft)



W158-04-02-022

FRONT ATTACHMENT / Cylinder

Arm Cylinder



FRONT ATTACHMENT / Cylinder

- Align the holes both on cylinder rod (11) and nut (24). Insert steel ball (23) into the hole, and tighten set screw (22).

IMPORTANT: Mushroom the head of set screw (22) at two places with a punch .

 : 10 mm
 : $56.9 \pm 10.7 \text{ N}\cdot\text{m}$
($5.8 \pm 1.09 \text{ kgf}\cdot\text{m}$, $42.0 \pm 7.9 \text{ lbf}\cdot\text{ft}$)

IMPORTANT: Be sure that cushion seal (26) slit is facing piston and that the oil groove in cushion bearing (27) is facing correct direction.

- Install snap ring (25), cushion seal (26) to cylinder rod (11). Install cushion bearing (27), stopper (28) to the cylinder rod.



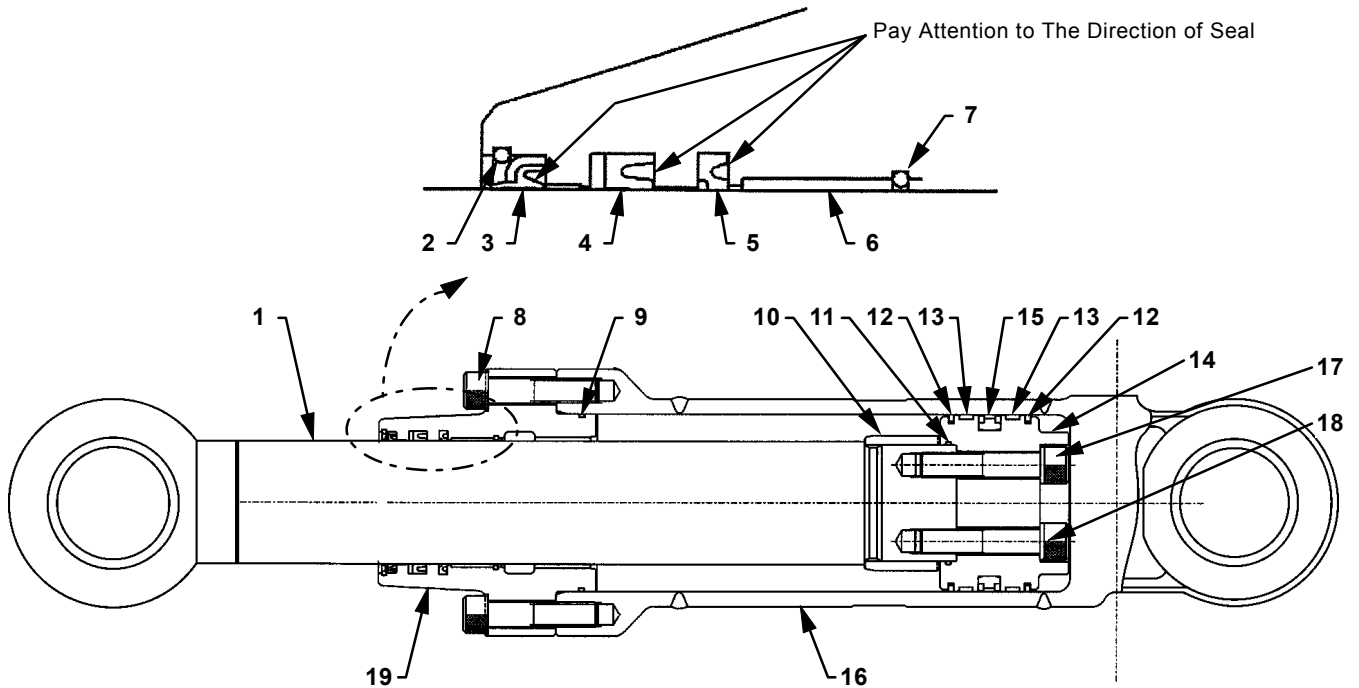
CAUTION: Be sure to keep cylinder rod (11) aligning with the center of cylinder tube (12) when inserting in order to avoid damaging rings.

- Secure cylinder tube (12) horizontally on a work bench. Insert cylinder rod (11) into cylinder tube (12).
- Install cylinder head (7) to cylinder tube (12). Tighten socket bolts (8) (12 used).
 : 14 mm
 : $365 \text{ N}\cdot\text{m}$ ($37.4 \text{ kgf}\cdot\text{m}$, $270 \text{ lbf}\cdot\text{ft}$)

FRONT ATTACHMENT / Cylinder

ASSEMBLE CYLINDER (ZAXIS230)

Boom, Bucket Cylinder



W178-04-02-035

- | | | | |
|--------------------|---------------------------|---------------------------|---------------------------|
| 1 - Piston Rod | 6 - Bushing | 11 - O-Ring | 16 - Cylinder Tube |
| 2 - Retaining Ring | 7 - Retaining | 12 - Piston Ring (2 Used) | 17 - Socket bolt (6 Used) |
| 3 - Dust Seal | 8 - Socket bolt (12 Used) | 13 - Wear Ring (2 Used) | 18 - Washer (6 Used) |
| 4 - Seal | 9 - O-Ring | 14 - Piston | 19 - Cylinder Head |
| 5 - Ring | 10 - Cushion Ring | 15 - Seal Ring | |

FRONT ATTACHMENT / Cylinder

Assemble Boom, Bucket Cylinder (ZAXIS230)

1. Press bushing (6) into cylinder head (19).
Tool for installing bushing:
Boom 90 mm (3.54 in) (ST 8024)
Bucket 90 mm (3.54 in) (ST 8024)
2. Install retaining ring (7), ring (5), seal (4), dust seal (3) and retaining ring (2) onto cylinder head (19).

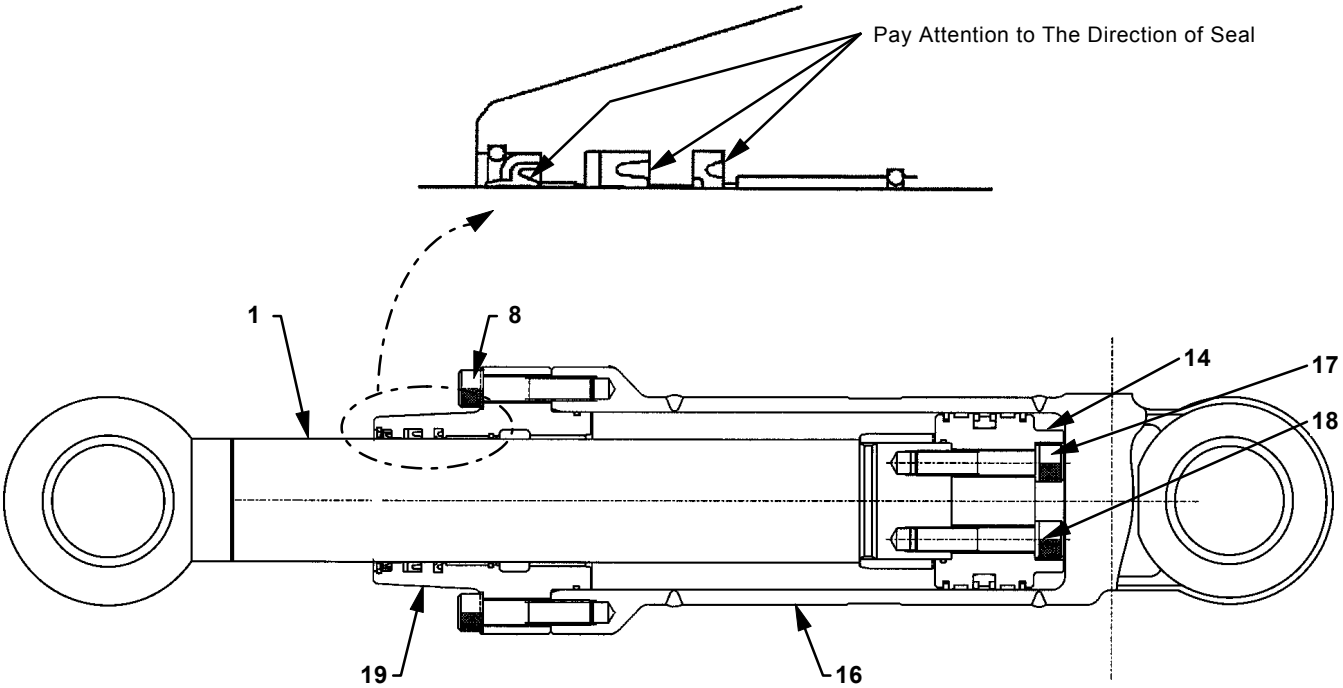
**IMPORTANT: Never install ring, seal, dust seal in wrong direction.
(Be sure that the slotted side is facing the pressure port.)**

3. Install O-ring (11), seal ring (15), wear rings (13) (2 used) and piston rings (12) (2 used) onto piston (14).
4. Install the cylinder head (19) assembly to piston rod (1).
5. Install Cushion ring (10) onto piston rod (1).

**IMPORTANT: Never install the cushion ring in wrong direction.
(Be sure that the slotted end (2 places) of the cushion ring is facing piston.)**

FRONT ATTACHMENT / Cylinder

Boom Cylinder, Bucket Cylinder



W178-04-02-035

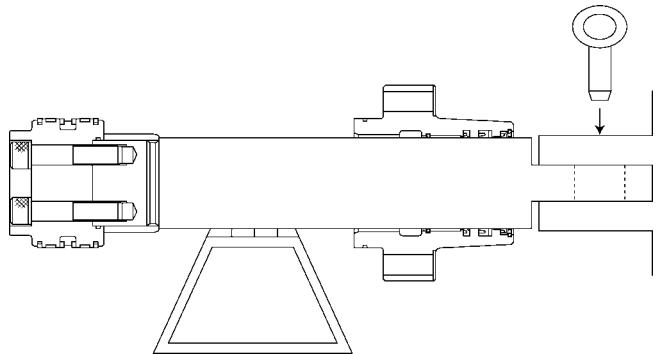
FRONT ATTACHMENT / Cylinder

6. Install the piston (14) assembly to piston rod (1) and tighten socket bolts (17) (6 used) and washers (18) (6 used) temporarily.
7. Secure piston rod (1) assembly on the work bench and tighten socket bolts (17) (6 used) with washers (18) (6 used).
 -  : 14 mm (Boom, Bucket)
 -  : 39.5 N·m (40 kgf·m, 290 lbf·ft)

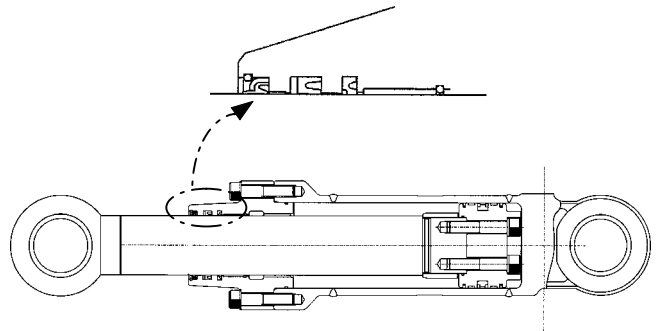


CAUTION: Take care not to damage rings. Install the piston rod (1) assembly into cylinder tube (16) while aligning it with the center of cylinder tube (16).

8. Secure Cylinder tube (16) on the work bench horizontally. Insert the piston rod (1) assembly into cylinder tube (16).
9. Install cylinder head (19) into cylinder tube (16) with socket bolts (8) (12 used).
 -  : 14 mm (Boom, Bucket)
 -  : 395 N·m (40 kgf·m, 290 lbf·ft)



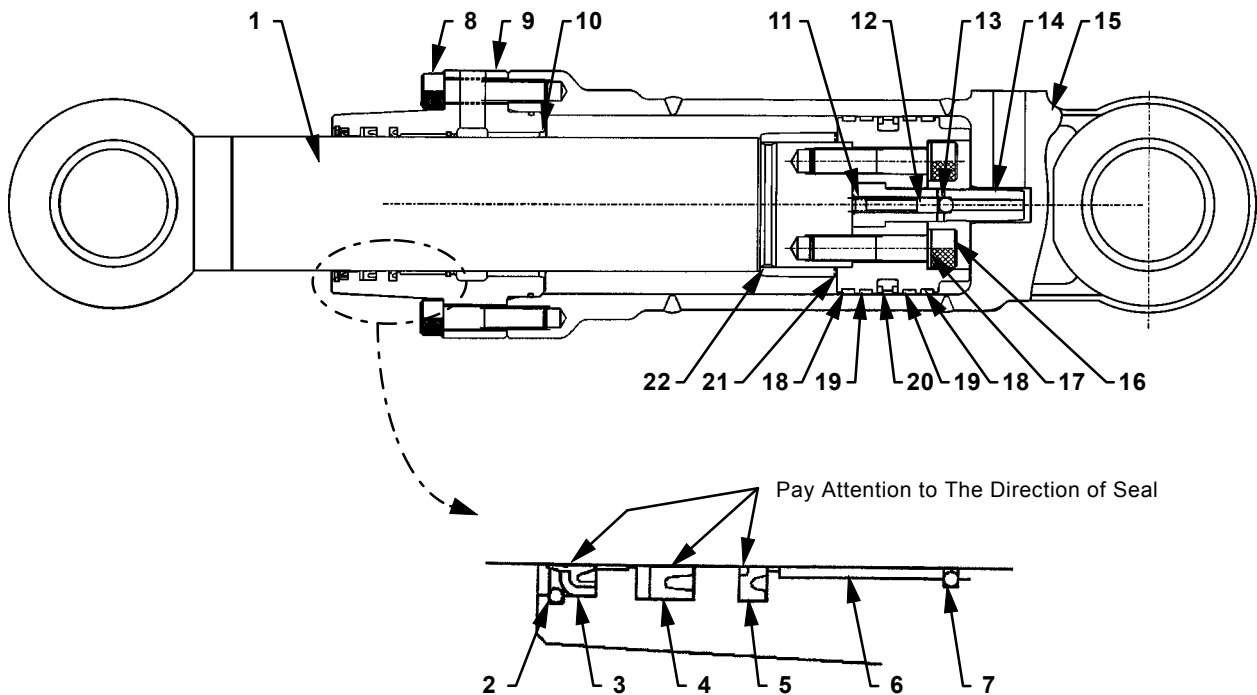
W178-04-02-034



W178-04-02-035

FRONT ATTACHMENT / Cylinder

Arm Cylinder (ZAXIS230)



W178-04-02-031

- | | | | |
|--------------------|---------------------------|---------------------------|---------------------------|
| 1 - Piston Rod | 7 - Retaining Ring | 13 - Ball | 18 - Teflon Ring (2 Used) |
| 2 - Retaining Ring | 8 - Socket Bolt (14 Used) | 14 - Plunger | 19 - Wear Ring (2 Used) |
| 3 - Dust Seal | 9 - Cylinder Head | 15 - Cylinder Tube | 20 - Seal Ring |
| 4 - Seal | 10 - O-Ring | 16 - Socket Bolt (6 Used) | 21 - Piston |
| 5 - Ring | 11 - Spring | 17 - Washer (6 Used) | 22 - Cushion Ring |
| 6 - Bushing | 12 - Stopper | | |

FRONT ATTACHMENT / Cylinder

Assemble Arm Cylinder (ZAXIS230)

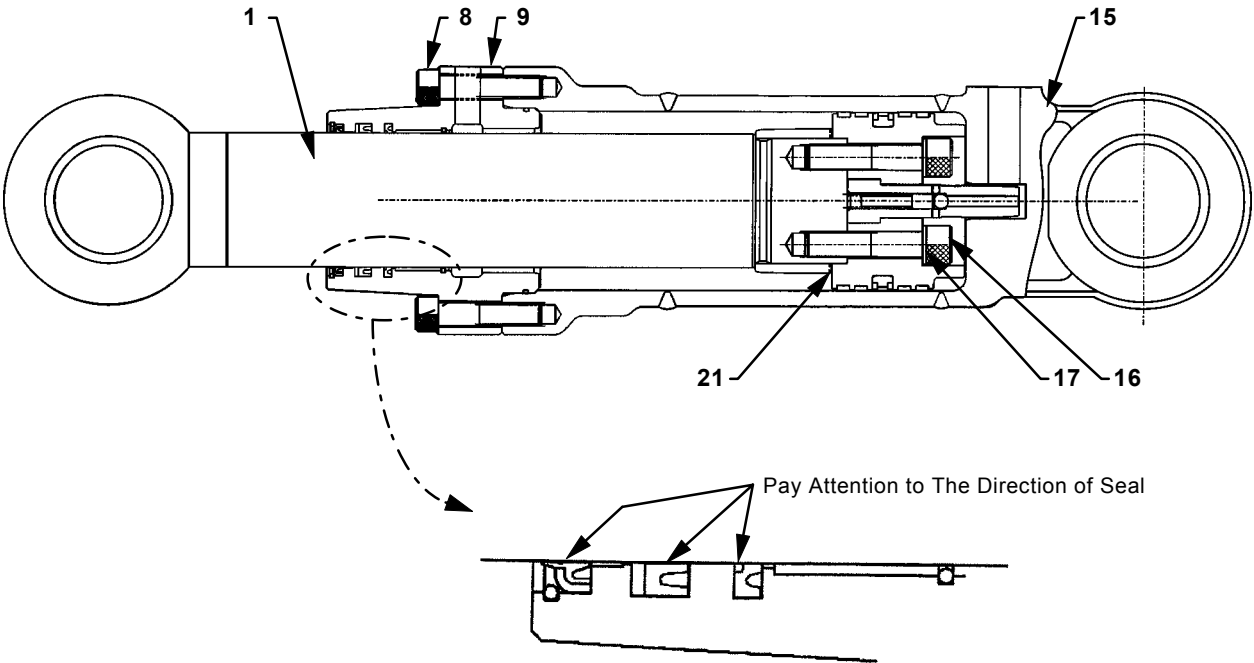
1. Press bushing (6) into cylinder head (9).
Tool for installing bushing: 105 mm (4.13 in) (ST 1993)
2. Install retaining ring (7), ring (5), seal (4), dust seal (3) and retaining ring (2) onto cylinder head (9).

**IMPORTANT: Never install ring, seal, dust seal in wrong direction.
(Be sure that the slotted side is facing the pressure port.)**

3. Install seal ring (20), wear rings (19) (2 used), teflon rings (18) (2 used) into piston(21).
4. Install plunger (14), ball (13), stopper (12) and spring (11) into piston (21).
5. Install the cylinder head (9) assembly into piston rod (1).
6. Install cushion ring (22) into piston rod (1).

**IMPORTANT: Never install the cushion ring in wrong direction.
(Be sure that the slotted end (2 places) of the cushion ring is facing piston.)**

FRONT ATTACHMENT / Cylinder



W178-04-02-031

FRONT ATTACHMENT / Cylinder

7. Install the piston (21) assembly into piston rod (1), tighten socket bolts (16) (6 used) and washers (17) (6 used) temporarily.

8. Secure the piston rod (1) assembly on the work bench horizontally and tighten socket bolts (16) with washers (17) (6 used).

 : 17 mm

 : 539 N·m (55 kgf·m, 400 lbf·ft)



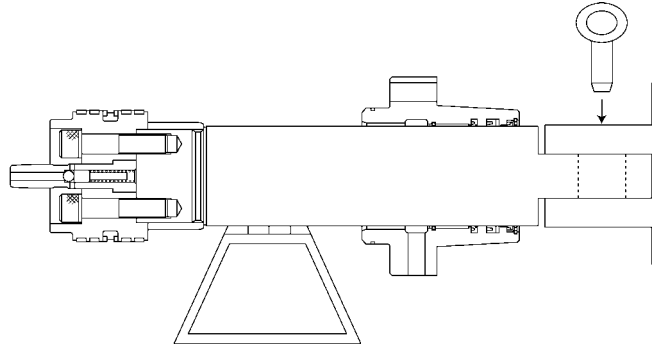
CAUTION: Take care not to damage rings when inserting the piston rod (1) assembly into cylinder tube (15).

9. Secure cylinder tube (9) on the work bench horizontally. Insert piston rod (1) assembly into cylinder tube (15).

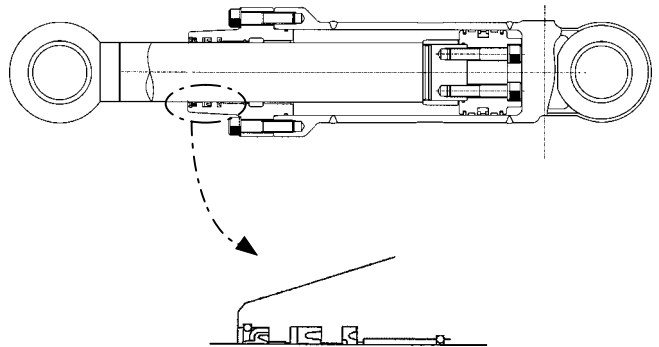
10. Install cylinder head (9) into cylinder tube (15) with socket bolts (8) (14 used).

 : 14 mm

 : 395 N·m (40 kgf·m, 290 lbf·ft)



W178-04-02-033

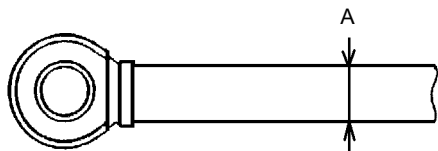


W178-04-02-032

FRONT ATTACHMENT / Cylinder

MAINTENANCE STANDARD

Rod



W105-04-02-094

ZAXIS200, 200-E, 225US, 225USR unit: mm (in)

Cylinder Name	Recommended Size After Re-manufacturing (A)			
Boom	85	-0.012 -0.027	(3.35 -0.0005 -0.001)	
Arm	95	-0.012 -0.027	(3.74 -0.0005 -0.001)	
Bucket	80	-0.01 -0.023	(3.15 -0.0004 -0.0009)	

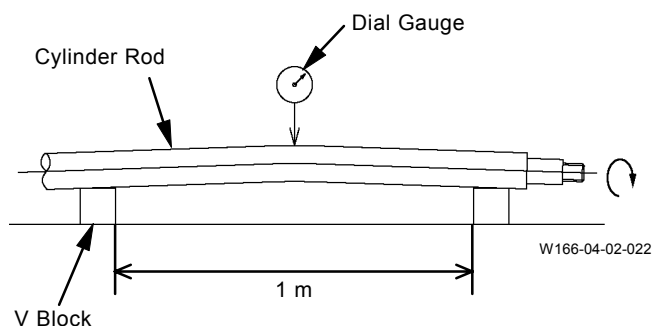
ZAXIS230 unit: mm (in)

Cylinder Name	Recommended Size After Re-manufacturing (A)			
Boom	90	-0.036 -0.090	(3.54 -0.001 -0.004)	
Arm	105	-0.036 -0.090	(4.13 -0.001 -0.004)	
Bucket	90	-0.036 -0.090	(3.54 -0.001 -0.004)	

ZAXIS270 unit: mm (in)

Cylinder Name	Recommended Size After Re-manufacturing (A)			
Boom	95	-0.036 -0.090	(3.74 -0.001 -0.004)	
Arm	100	-0.036 -0.090	(3.94 -0.001 -0.004)	
Bucket	90	-0.036 -0.090	(3.54 -0.001 -0.004)	

Rod Run Out



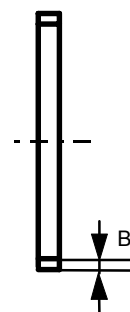
	unit:mm (in)		
	Bend	Run out	Remedy
Allowable limit	0.5 (0.020)	1.0 (0.039)	Repair
Allowable limit	1.0 (0.039)	2.0 (0.079)	Replace

FRONT ATTACHMENT / Cylinder

Wear to Slide Ring Thickness

ZAXIS200, 200-E, 225US, 225USR unit: mm (in)

Standard Thickness	Allowable Limit Thickness	Remedy
2.42 to 2.48 (0.095 to 0.098)	2.37 (0.093)	Replace



Wear to Wear Ring Thickness

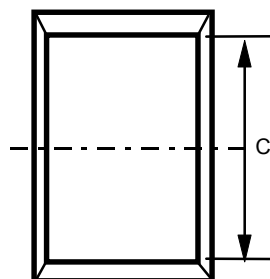
ZAXIS230 unit: mm (in)

Standard		Allowable Limit	Remedy
Boom	2.92 to 3.0 (0.115 to 0.118)	2.89 (0.114)	Replace
Arm, Bucket	3.47 to 3.50 (0.137 to 0.138)	3.39 (0.133)	Replace

Wear to The Inner Diameter of Rod Bushing

ZAXIS200, 200-E, 225US, 225USR unit: mm (in)

Cylinder Name	Standard inner Diameter (C)	Allowable Limit	Remedy
Boom	85 ^{-0.06} _{-0.19} (3.35 ^{-0.002} _{-0.007})	+0.3 (0.012)	Replace
Arm	95 ^{-0.06} _{-0.19} (3.74 ^{-0.002} _{-0.007})	+0.3 (0.012)	Replace
Bucket	80 ^{-0.06} _{-0.19} (3.15 ^{-0.002} _{-0.007})	+0.3 (0.012)	Replace



ZAXIS230 unit: mm (in)

Cylinder Name	Standard inner Diameter (C)	Allowable Limit	Remedy
Boom	90 ^{-0.06} _{-0.19} (3.54 ^{-0.002} _{-0.007})	+0.3 (0.012)	Replace
Arm	105 ^{-0.06} _{-0.19} (4.13 ^{-0.002} _{-0.007})	+0.3 (0.012)	Replace
Bucket	90 ^{-0.06} _{-0.19} (3.54 ^{-0.002} _{-0.007})	+0.3 (0.012)	Replace

ZAXIS270 unit: mm (in)

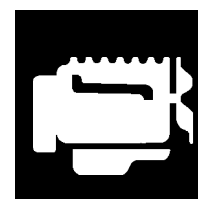
Cylinder Name	Standard inner Diameter (C)	Allowable Limit	Remedy
Boom	95 ^{-0.06} _{-0.19} (3.74 ^{-0.002} _{-0.007})	+0.3 (0.012)	Replace
Arm	100 ^{-0.06} _{-0.19} (3.94 ^{-0.002} _{-0.007})	+0.3 (0.012)	Replace
Bucket	90 ^{-0.06} _{-0.19} (3.54 ^{-0.002} _{-0.007})	+0.3 (0.012)	Replace

FRONT ATTACHMENT / Cylinder

(Blank)

SECTION 5

ENGINE AND ACCESSORY



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SECTION 1

GENERAL INFORMATION



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GENERAL REPAIR INSTRUCTIONS

1. Before performing any service operation with the engine mounted, disconnect the grounding cable from the battery.
This will reduce the chance of cable damage and burning due to short circuiting.
2. Always use the proper tool or tools for the job at hand.
Where specified, use the specially designed tool or tools.
3. Use genuine ISUZU parts referring ISUZU PARTS CATALOG for the engines surely.
4. Never reuse cotter pins, gaskets, O-rings, lock washers, and self locking nuts. Discard them as you remove them. Replace them with new ones.
5. Always keep disassembled parts neatly in groups. This will ensure a smooth reassembly operation.
It is especially important to keep fastening parts separate. These parts vary in hardness and design, depending on their installation position.
6. All parts should be carefully cleaned before inspection or reassembly.
Oil ports and other openings should be cleaned with compressed air to make sure that they are completely free of obstructions.
7. Rotating and sliding part surfaces should be lubricated with oil or grease before reassembly.
8. If necessary, use a sealer on gaskets to prevent leakage.
9. Nut and bolt torque specifications should be carefully followed.
10. Always release the air pressure from any machine-mounted air tank(s) before dismantling the engine or disconnecting pipes and hoses. To not do so is extremely dangerous.
11. Always check and recheck you work. No service operation is complete until you have done this.
12. Information contained in the "Main Data and Specifications" of the Workshop Manual and the Instruction Book may differ. In this case, the information contained in the Instruction Book should be considered applicable.

NOTES ON THE FORMAT OF THIS MANUAL

This Workshop Manual is applicable to the 6BG1T of industrial diesel engines. Unless otherwise specified, these engines have common parts and components as well as data and specifications.

Illustrations used in this Workshop Manual are based on the 6BG1T engines.

The 6BG1T engine are turbocharged.

1. Find the applicable section by referring to the Table of Contents at the beginning of the Manual.
2. Common technical data such as general maintenance items, service specifications, and tightening torques are included in the "General Information" section.
3. Each section is divided into sub-sections dealing with disassembly, inspection and repair, and reassembly.
The section ENGINE ASSEMBLY is an exception. This part is divided into three sections to facilitates quick indexing.
4. When the same servicing operation is applicable to several different units, the manual will direct you to the appropriate page.
5. For the sake of brevity, self-explanatory removal and installation procedures are omitted.
More complex procedures are covered in detail.

6. Each service operation section in this Workshop Manual begins with an exploded view of the applicable area. A brief explanation of the notation used follows.

Disassembly Steps - 2

- 1. Water by-pass hose
- 2. Thermostat housing
- 3. Water pump
- ▲ 4. Injection nozzle holder
- 5. Glow plug and glow plug connector
- 6. Cylinder head cover
- ▲ 7. Rocker arm shaft and rocker arm
- 8. Push rod
- ▲ 9. Cylinder head
- 10. Cylinder head gasket
- ▲ 11. Crankshaft damper pulley with dust seal
- 12. Timing gear case cover (Option)
- 13. Timing gear cover
- 14. Timing gear oil pipe
- 15. Idler gear "B" and shaft
- 16. Idler gear "A"
- 17. Idler gear shaft

Inverted Engine

Parts marked with an asterisk (*) are included in the repair kit.

Parts within a square frame are to be removed and installed as a single unit.

All parts within an irregularly shaped frame form a single assembly. They are considered a "major component". Individual parts within the irregularly shaped frame are considered "minor components".

The number tells you the service operation sequence.

Removal of unnumbered parts is unnecessary unless replacement is required.

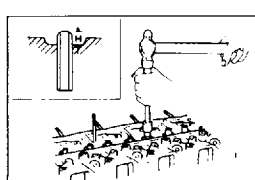
The "* Repair Kit" indicates that a repair kit is available.

The parts listed under "Reassembly Steps" or "Installation Steps" are in the service operation sequence.

The removal or installation of parts marked with a triangle (▲) is an important operation. Detailed information is given in the text.

1-4 GENERAL INFORMATION

7. Below is a sample of the text of the Workshop Manual.



Valve Guide Installation

1. Lubricate the valve guide outer face with engine oil.
2. Attach the installer to the valve guide.
3. Use a hammer to drive the valve guide into position from the cylinder head upper face.
4. Measure the height of the valve guide upper end from the upper face of the cylinder head.

Valve Guide Installer: 1-85220-001-0

Valve Guide Upper End Height (H)	mm (in)
	14.1 (0.56)

Note:
If the valve guide has been removed, both the valve and the valve guide must be replaced with new ones as a set.
Be absolutely sure to discard the used valves and valve guides.

This is the item shown in the illustration. It is marked with a triangle (▲) on the Major Components page.

Special tools are identified by the tool name and/or number.

The illustration shows how the special tool is to be used.

Letters and numbers contained in a circle refer to the illustration.

Symbols indicate the type of service operation or step to be performed. A detailed explanation of these symbols follows.

Service data and specifications are given in this table.

8. The following symbols appear throughout this Workshop Manual. They tell you the type of service operation or step to perform.



... Removal



... Adjustment



... Installation



... Cleaning



... Disassembly



... Important Operation Requiring Extra Care



... Reassembly



... Specified Torque (Tighten)



... Alignment (Marks)



... Special Tool Use Required or Recommended (Isuzu Tool or Tools)



... Directional Indication



... Commercially Available Tool Use Required or Recommended



... Inspection



... Lubrication (Oil)



... Measurement



... Lubrication (Grease)



... Sealant Application

9. Measurement criteria are defined by the terms "standard" and "limit".

A measurement falling within the "standard" range indicates that the applicable part or parts are serviceable.

"Limit" should be thought of as an absolute value.

A measurement which is outside the "limit" indicates that the applicable part or parts must be either repaired or replaced.

10. Components and parts are listed in the singular form throughout the Manual.

11. Directions used in this Manual are as follows:

Front

The cooling fan side of the engine viewed from the flywheel.

Right

The injection pump side of the engine.

Left

The exhaust manifold side of the engine.

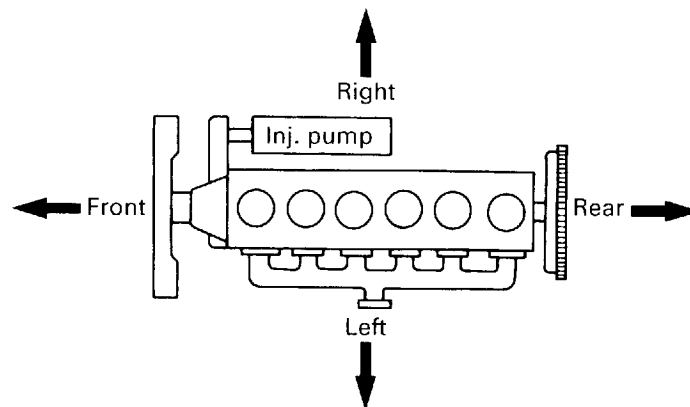
Rear

The flywheel side of the engine.

Cylinder numbers are counted from the front of the engine.

The front most cylinder is No. 1 and rear most cylinder is No. 6.

The engine's direction of rotation is counterclockwise viewed from the flywheel.



MAIN DATA AND SPECIFICATIONS

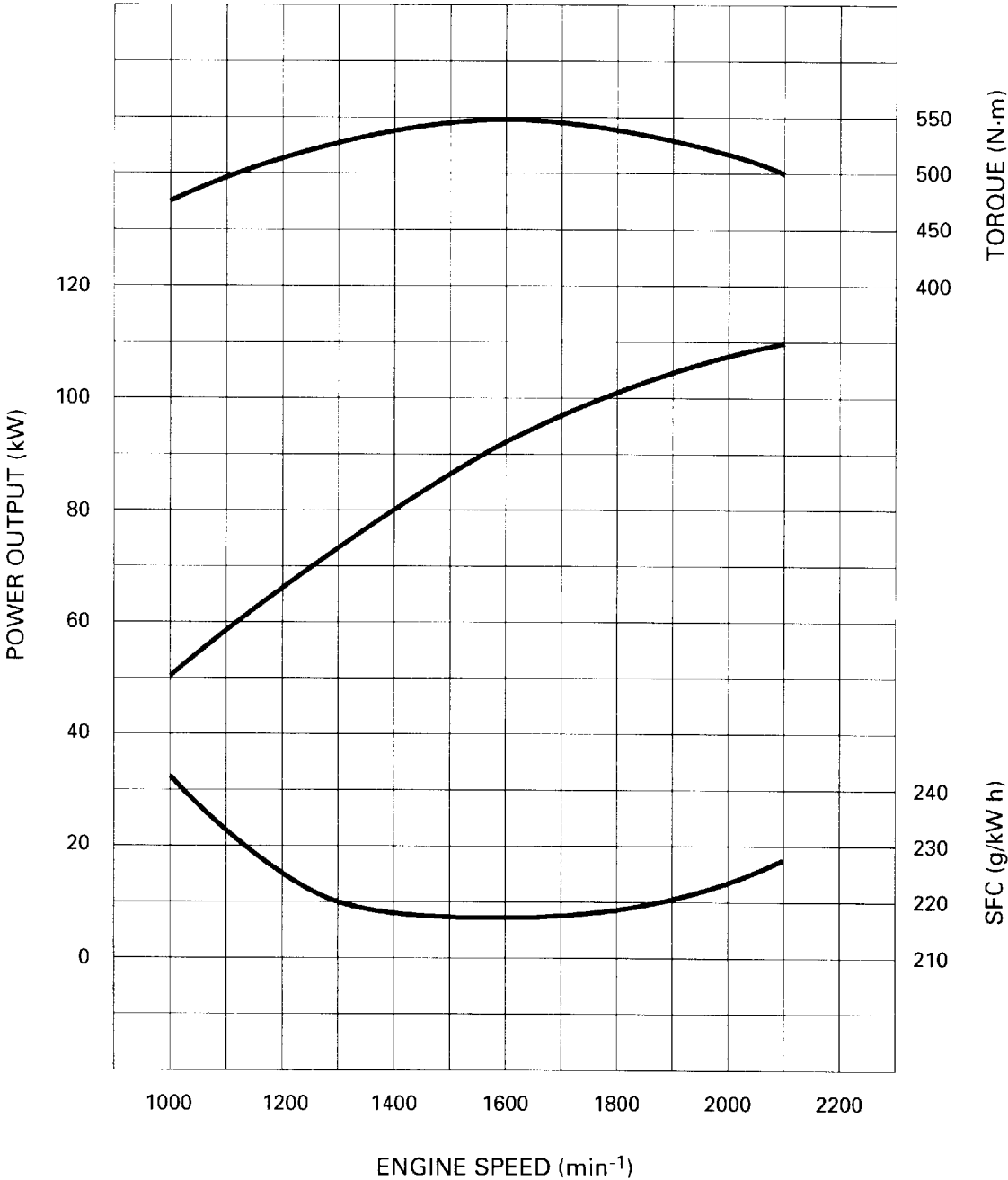
Engine Model		AA-6BG1TRA
Item		
Engine type		Water cooled, four cycle, vertical in-line overhead valve
Combustion chamber type		Direct injection
Cylinder liner type		Dry
No. of cylinders – bore × stroke	mm (in)	6 – 105 × 125 (4.13 × 4.92)
Total piston displacement	L (cid)	6.494 (396)
Compression ratio		18 to 1
Engine dimensions	mm (in)	1206 × 814.6 × 996
Length × width × height		(47.5 × 32.1 × 39.2)
Engine mass (Dry)	kg (lb)	490 (1080)
Fuel injection order		1–5–3–6–2–4
Fuel injection timing (BTDC)	degrees	10
Specified fuel		Diesel fuel
Injection pump		In-line plunger, Bosch A type
Governor		Mechanical, RSV type
Low idle speed	min ⁻¹	880–920
Injection nozzle		Hole type (with four orifices)
Injection starting pressure	MPa (kgf/cm ² /psi)	18.1 (185/2,630)
Fuel filter type		Cartridge (spin-on)
Water sedimentor		Sediment/water level indicating type
Compression pressure	MPa (kgf/cm ² /psi)	3.0 (440) at 200 min ⁻¹ at sea level
(At warm)		
Valve clearances (At cold)	Intake mm (in)	0.40 (0.016)
	Exhaust mm (in)	0.40 (0.016)
Lubrication method		Pressurized circulation
Oil pump		Gear type
Main oil filter type		Cartridge (spin-on)
Lubricating oil volume (Oil Pan)	L (US gal)	21.5 (5.68)
Oil cooler		Water cooled integral type
Cooling method		Pressurized forced circulation
Coolant volume	L (US gal)	12.0 (3.2) Engine only
Water pump		Belt driven impeller type
Thermostat type		Wax pellet type
Alternator	V-A	24–50
Starter	V-KW	24–4.5
Turbocharger manufacturer		IHI
Turbocharger model		RHG6

PERFORMANCE CURVE

MODEL AA-6BG1TRA

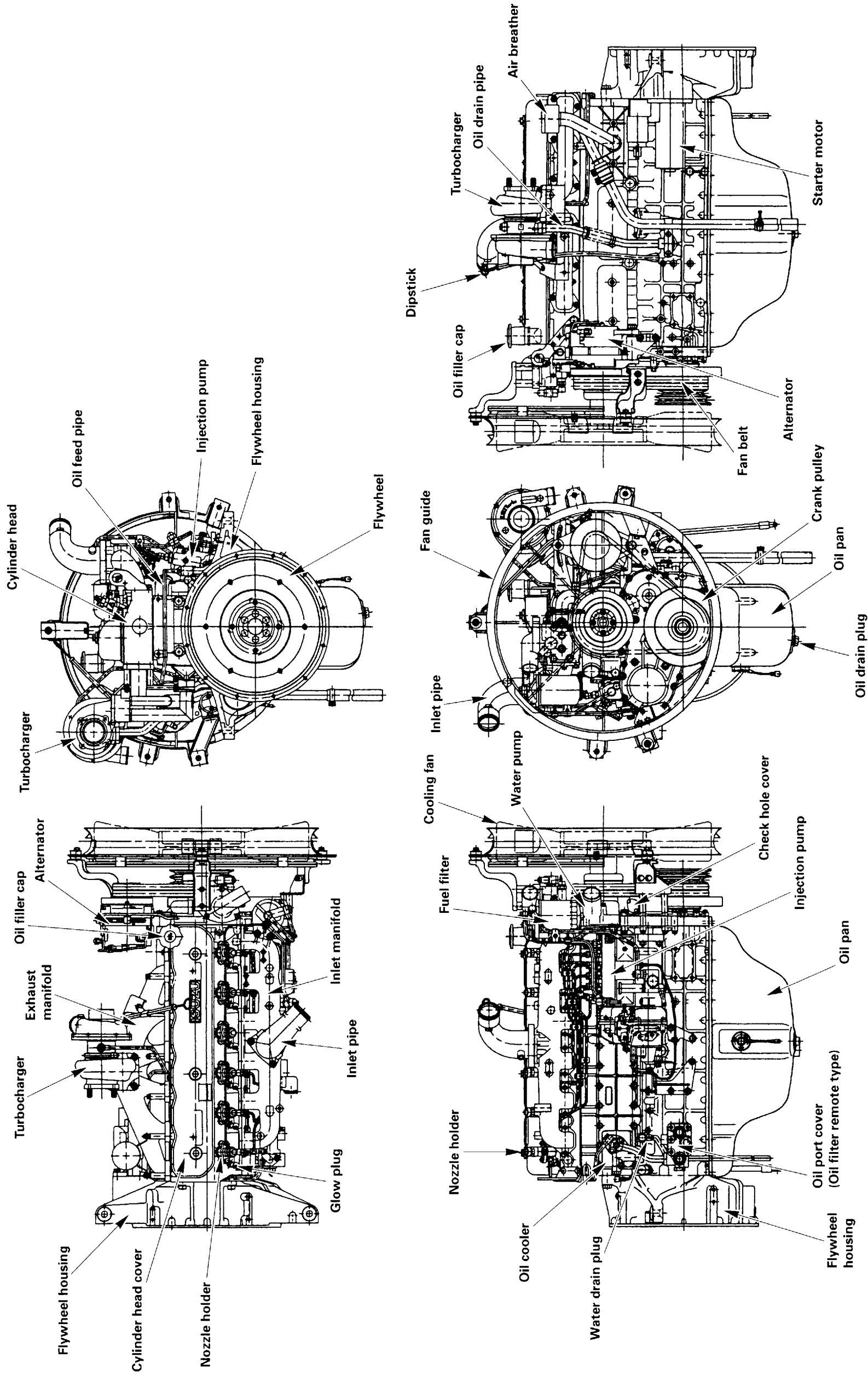
CONDITION:

Ambient condition	: JIS standard	Air cleaner	: None
Break-in	: More than 30 hours	Alternator	: No Load
Cooling fan	: 650φ	Exhaust silencer	: None



EXTERNAL VIEW

MODEL AA-6BG1TRA



TIGHTENING TORQUE SPECIFICATIONS

The tightening torque values given in the table below are applicable to the bolts unless otherwise specified.

STANDARD BOLT

N·m (kgf·m/lb.ft)

Bolt Identification Bolt Diameter × pitch (mm)				
				
M 6 × 1.0	3.9-7.8 (0.4-0.8/2.9-5.8)	4.9-9.8 (0.5-1.0/3.6-7.2)		
M 8 × 1.25	7.8-17.7 (0.8-1.8/5.8-13.0)	11.8-22.6 (1.2-2.3/8.7-16.6)		16.7-30.4 (1.7-3.1/12.3-22.4)
M10 × 1.25	20.6-34.3 (2.1-3.5/5.2-25.3)	27.5-46.1 (2.8-4.7/20.3-33.4)		37.3-62.8 (3.8-6.4/27.5-46.3)
* M10 × 1.5	19.6-33.4 (2.0-3.4/14.5-24.6)	27.5-45.1 (2.8-4.6/20.3-33.3)		36.3-59.8 (3.7-6.1/26.8-44.1)
M12 × 1.25	49.1-73.6 (5.0-7.5/36.2-54.2)	60.8-91.2 (6.2-9.3/44.8-67.3)		75.5-114.0 (7.7-11.6/55.7-83.9)
* M12 × 1.75	45.1-68.7 (4.6-7.0/33.3-50.6)	56.9-84.4 (5.8-8.6/42.0-62.2)		71.6-107.0 (7.3-10.9/52.8-78.8)
M14 × 1.5	76.5-115.0 (7.8-11.7/56.4-84.6)	93.2-139.0 (9.5-14.2/68.7-103.0)		114.0-160.0 (11.6-17.4/83.9-126.0)
* M14 × 2.0	71.6-107.0 (7.3-10.9/52.8-78.8)	88.3-131.0 (9.0-13.4/65.1-96.9)		107.0-160.0 (10.9-16.3/78.8-118.0)
M16 × 1.5	104.0-157.0 (10.6-16.0/76.7-115.7)	135.0-204.0 (13.8-20.8/99.8-150.0)		160.0-240.0 (16.3-24.5/118.0-177.0)
* M16 × 2.0	100.0-149.0 (10.2-15.2/73.8-110.0)	129.0-194.0 (13.2-19.8/95.5-143.0)		153.0-230.0 (15.6-23.4/113.0-169.0)
M18 × 1.5	151.0-226.0 (15.4-23.0/111.0-166.0)	195.0-293.0 (19.9-29.9/144.0-216.0)		230.0-345.0 (23.4-35.2/169.0-255.0)
* M18 × 2.5	151.0-226.0 (15.4-23.0/111.0-166.0)	196.0-294.0 (20.0-30.0/145.0-217.0)		231.0-346.0 (23.6-35.3/171.0-255.0)
M20 × 1.5	206.0-310.0 (21.0-31.6/152.0-229.0)	270.0-405.0 (27.5-41.3/199.0-299.0)		317.0-476.0 (32.3-48.5/234.0-351.0)
* M20 × 2.5	190.0-286.0 (19.4-29.2/140.0-211.0)	249.0-375.0 (25.4-38.2/184.0-276.0)		293.0-440.0 (29.9-44.9/216.0-325.0)
M22 × 1.5	251.0-414.0 (25.6-42.2/185.0-305.0)	363.0-544.0 (37.0-55.5/268.0-401.0)		425.0-637.0 (43.3-64.9/313.0-469.0)
* M22 × 2.5	218.0-328.0 (22.2-33.4/161.0-242.0)	338.0-507.0 (34.5-51.7/250.0-374.0)		394.0-592.0 (40.2-60.4/291.0-437.0)
M24 × 2.0	359.0-540.0 (36.6-55.0/265.0-398.0)	431.0-711.0 (43.9-72.5/318.0-524.0)		554.0-831.0 (56.5-84.7/409.0-613.0)
* M24 × 3.0	338.0-507.0 (34.5-51.7/250.0-374.0)	406.0-608.0 (41.4-62.0/299.0-448.0)		521.0-782.0 (53.1-79.7/384.0-576.0)

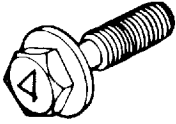
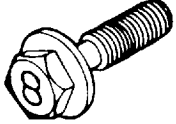
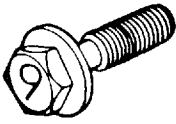
An asterisk (*) indicates that the bolts are used for female threaded parts that are made of soft materials such as casting.

TIGHTENING TORQUE SPECIFICATIONS

The tightening torque values given in the table below are applicable to the bolts unless otherwise specified.

FLANGED HEAD BOLT

N·m (kgf·m/lb.ft)

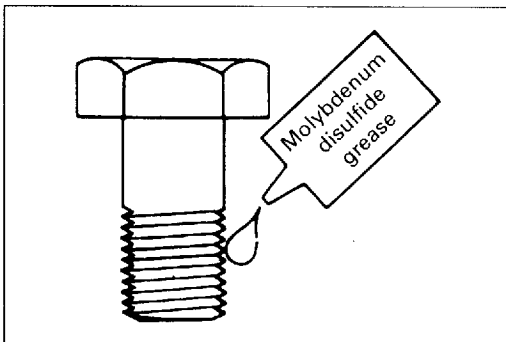
Bolt Identification Bolt Diameter × pitch (mm)	  		
M 6 × 1.0	4.6–8.5 (0.5–0.9/3.6–6.5)	6.6–12.2 (0.6–1.2/4.3–8.7)	—————
M 8 × 1.25	10.5–196 (1.1–2.0/8.0–14.5)	15.3–28.4 (1.6–2.9/11.6–21.0)	18.1–33.6 (2.1–3.4/15.2–25.0)
M10 × 1.25	23.1–38.5 (2.4–3.9/17.4–28.2)	35.4–58.9 (3.6–6.1/26.0–44.1)	42.3–70.5 (4.3–7.2/31.1–52.1)
* M10 × 1.5	22.3–37.2 (2.3–3.8/16.6–27.5)	34.5–57.5 (3.5–5.8/25.3–42.0)	40.1–66.9 (4.1–6.8/29.7–49.2)
M12 × 1.25	54.9–82.3 (5.6–8.4/40.1–60.8)	77.7–117.0 (7.9–11.9/57.1–86.1)	85.0–128.0 (8.7–13.0/62.9–94.0)
* M12 × 1.75	51.0–76.5 (5.2–7.8/37.6–56.4)	71.4–107.0 (7.3–10.9/52.8–78.8)	79.5–119.0 (8.1–12.2/58.6–88.2)
M14 × 1.5	83.0–125.0 (8.5–12.7/61.5–91.9)	115.0–172.0 (11.7–17.6/84.6–127.0)	123.0–185.0 (12.6–18.9/91.1–137.0)
* M14 × 2.0	77.2–116.0 (7.9–11.8/57.1–85.3)	108.0–162.0 (11.1–16.6/80.3–120.0)	116.0–173.0 (11.8–17.7/85.3–128)
M16 × 1.5	116.0–173.0 (11.8–17.7/85.3–128)	171.0–257.0 (17.4–26.2/124.0–187.0)	177.0–265.0 (18.0–27.1/130.0–196.0)
* M16 × 2.0	109.0–164.0 (11.2–16.7/81.0–121.0)	163.0–244.0 (16.6–24.9/120.0–180.0)	169.0–253.0 (17.2–25.8/124.0–187.0)

A bolt with an asterisk (*) is used for female screws of soft material such as cast iron.

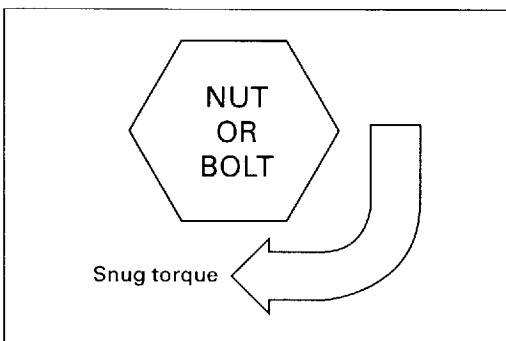
ANGULAR NUT AND BOLT TIGHTENING METHOD



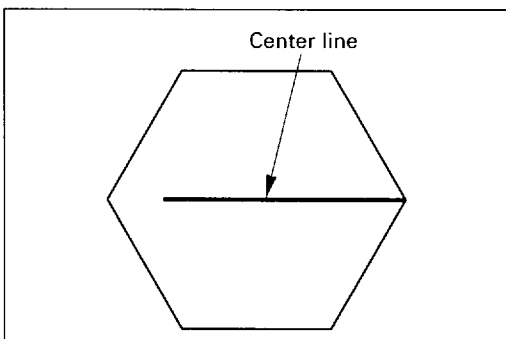
1. Carefully wash the nuts and bolts to remove all oil and grease.



2. Apply a coat of molybdenum disulfide grease to the threads and setting faces of the nuts and bolts.

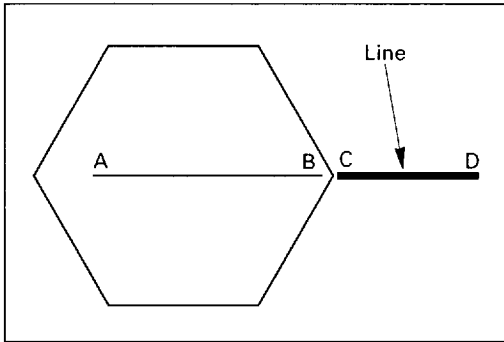


3. Tighten the nuts and bolts to the specified torque (snug torque) with a torque wrench.

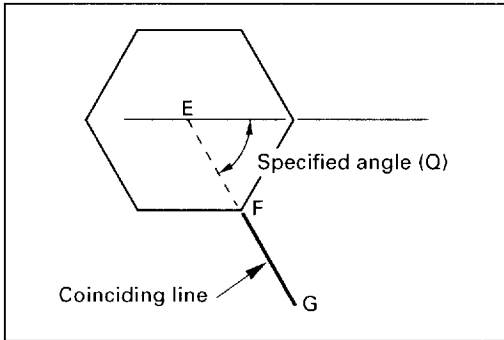


4. Draw a line [A-B] across the center of each bolt.

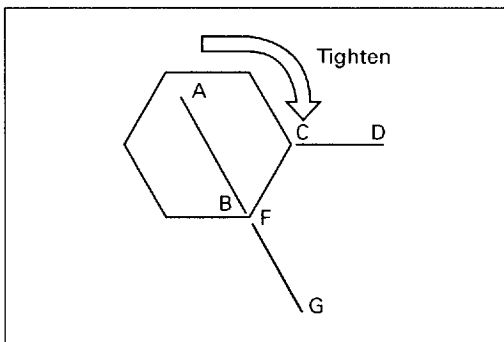
1-14 GENERAL INFORMATION



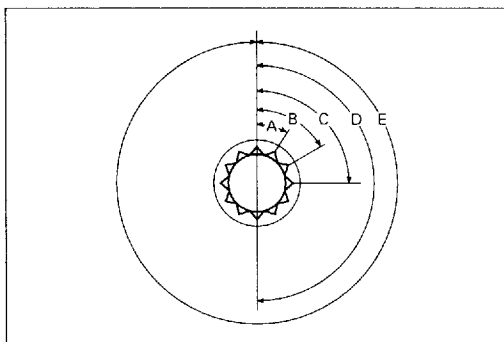
5. Draw another line (C-D) on the face of each of the parts to be clamped. This line should be an extension of the line [A-B].



6. Draw another line [F-G] on the face of each of the parts to be clamped. This line will be in the direction of the specified angle (Q) across the center [E] of the nut or bolt.



7. Use a socket wrench to tighten each nut or bolt to the point where the line [A-B] is aligned with the line [F-G].



Example: Specified Angle and Tightening Rotation

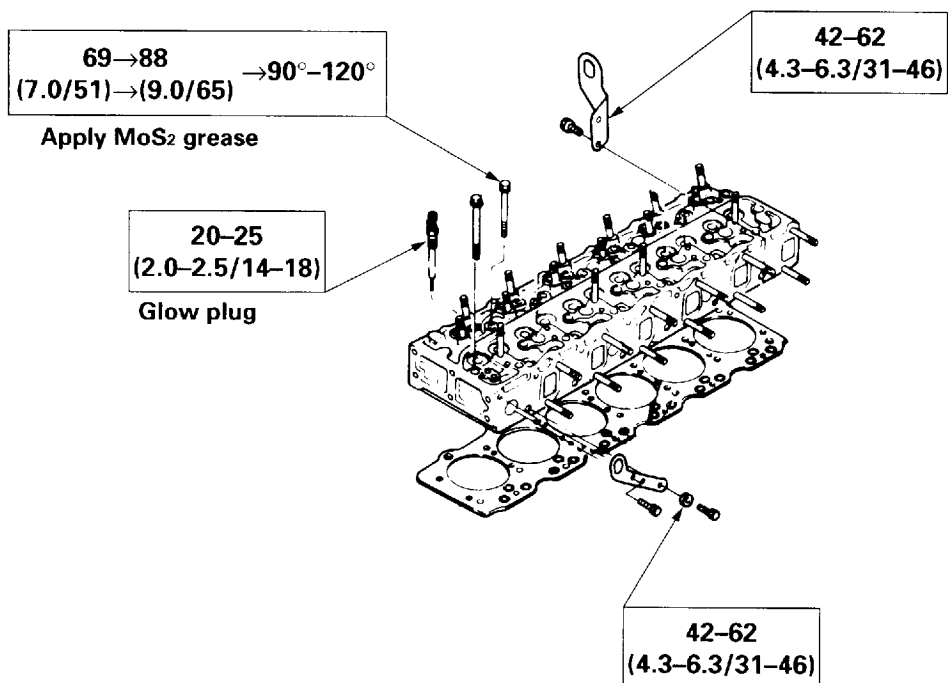
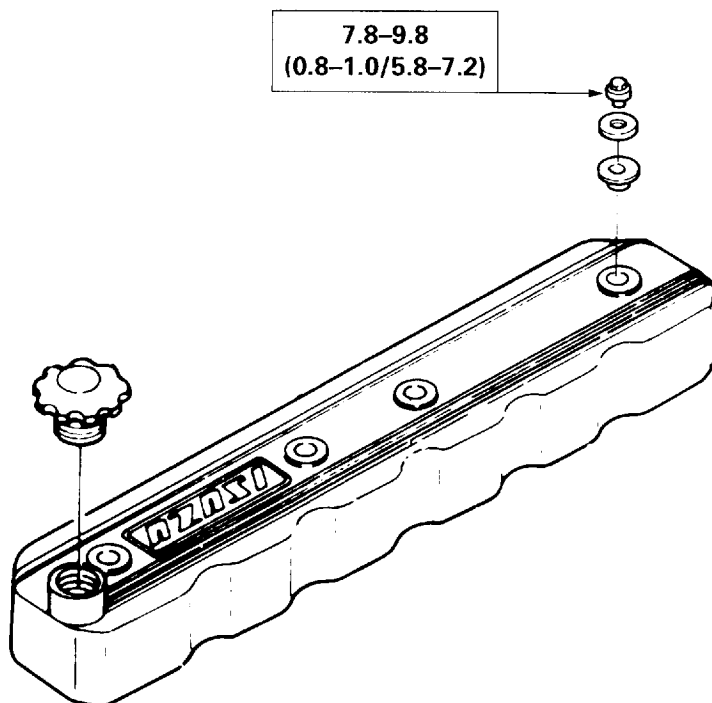
A	30°	1/12 of a turn
B	60°	1/6 of a turn
C	90°	1/4 of a turn
D	180°	1/2 of a turn
E	360°	One full turn



MAJOR PART FIXING NUTS AND BOLTS

Cylinder Head and Cover

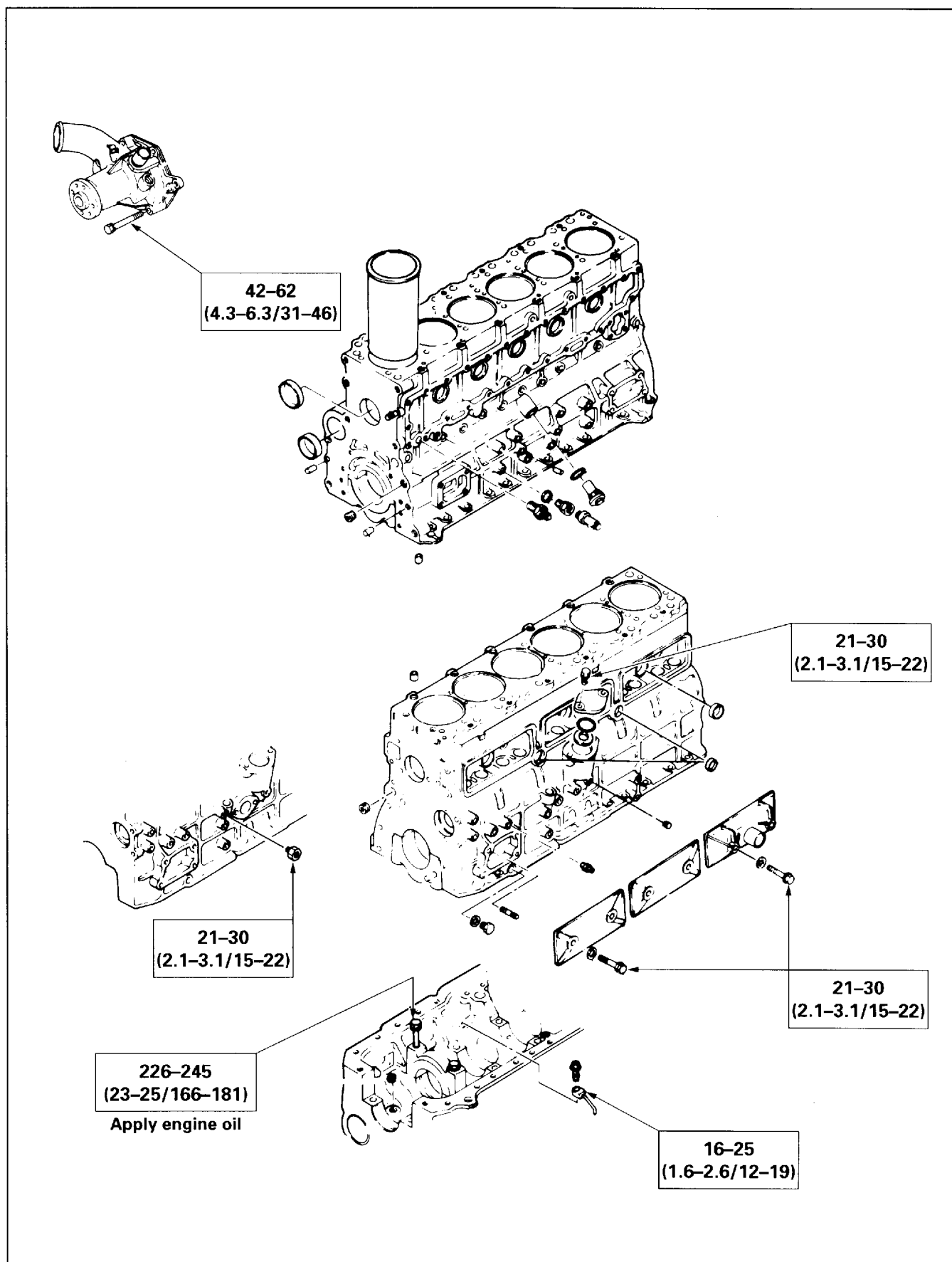
N·m (kgf·m/lb.ft)



Mos2 Molybdenum disulfide paste.

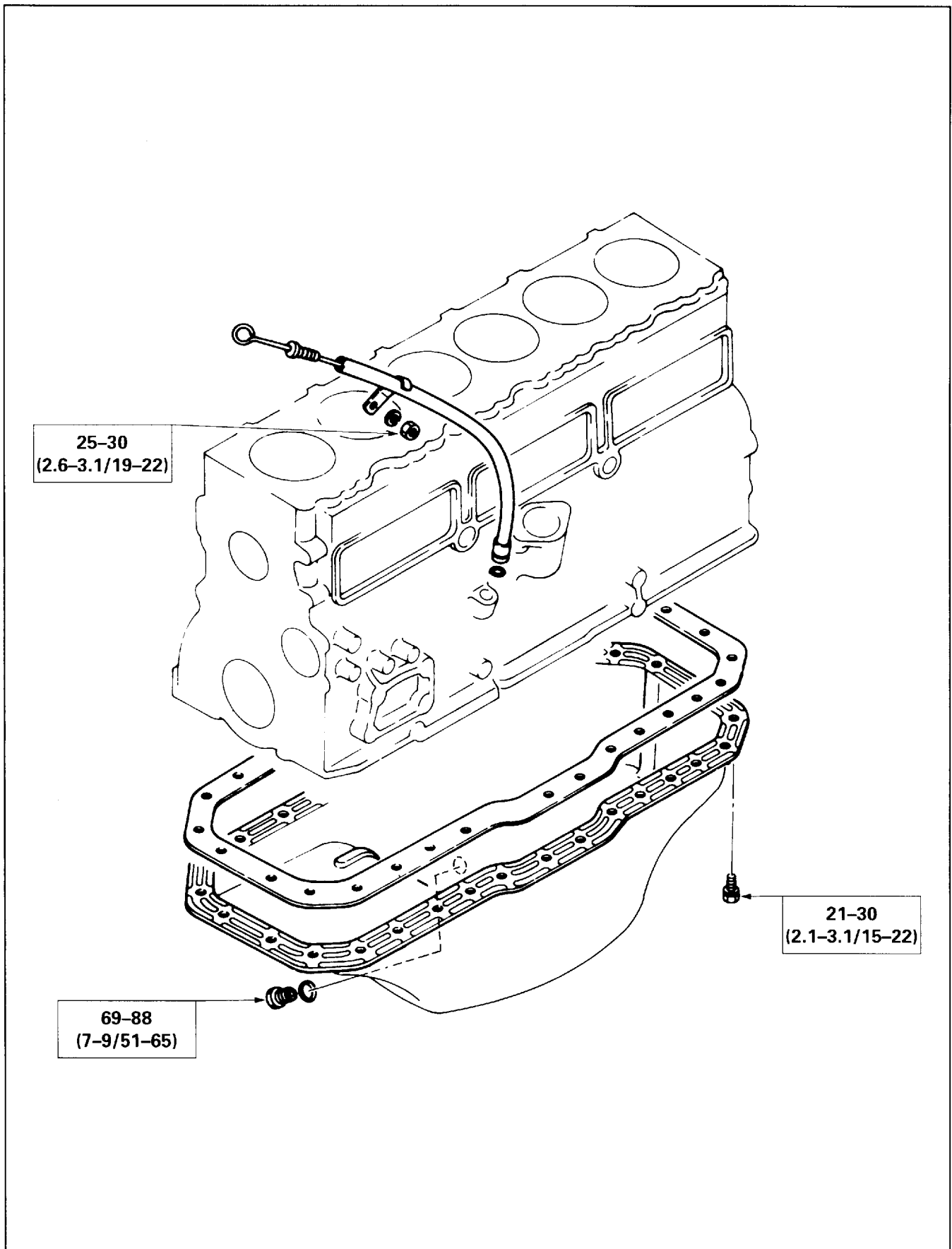
Cylinder Body

N·m (kgf·m/lb.ft)



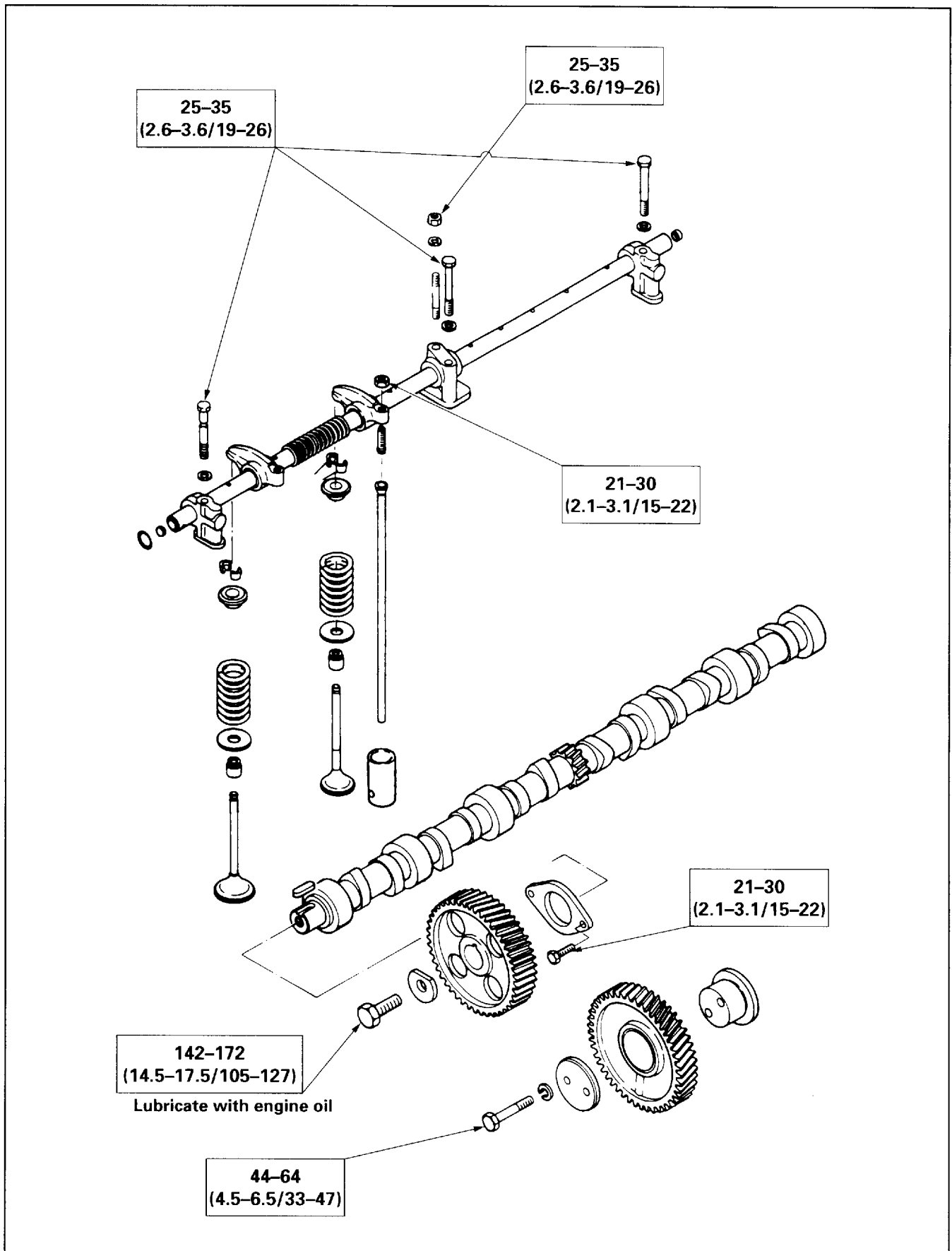
Oil Pan and Dipstick

N·m (kgf·m/lb.ft)



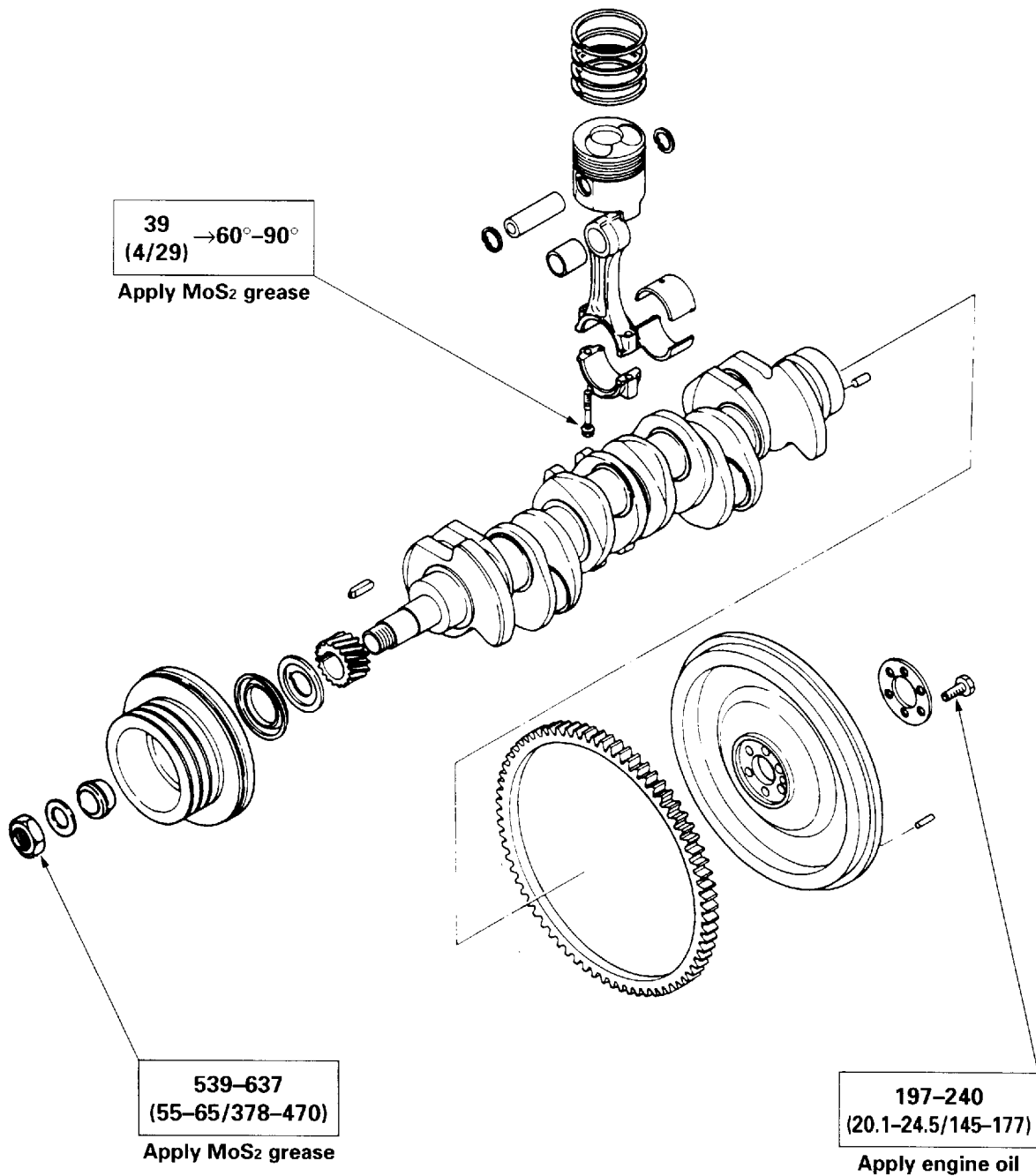
Camshaft and Rocker Arm

N·m (kgf·m/lb.ft)



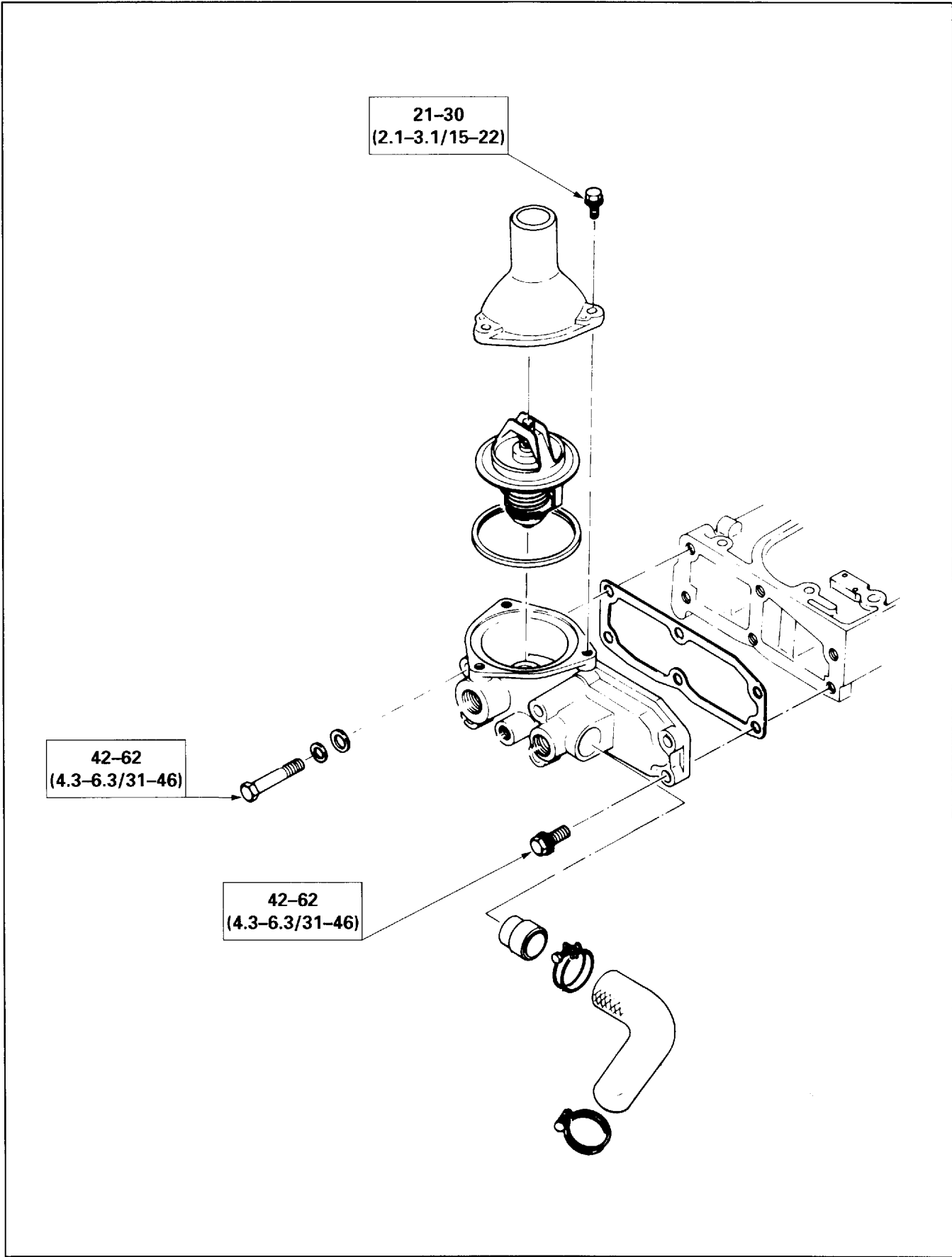
Crankshaft, Piston, and Flywheel

N·m (kgf·m/lb.ft)



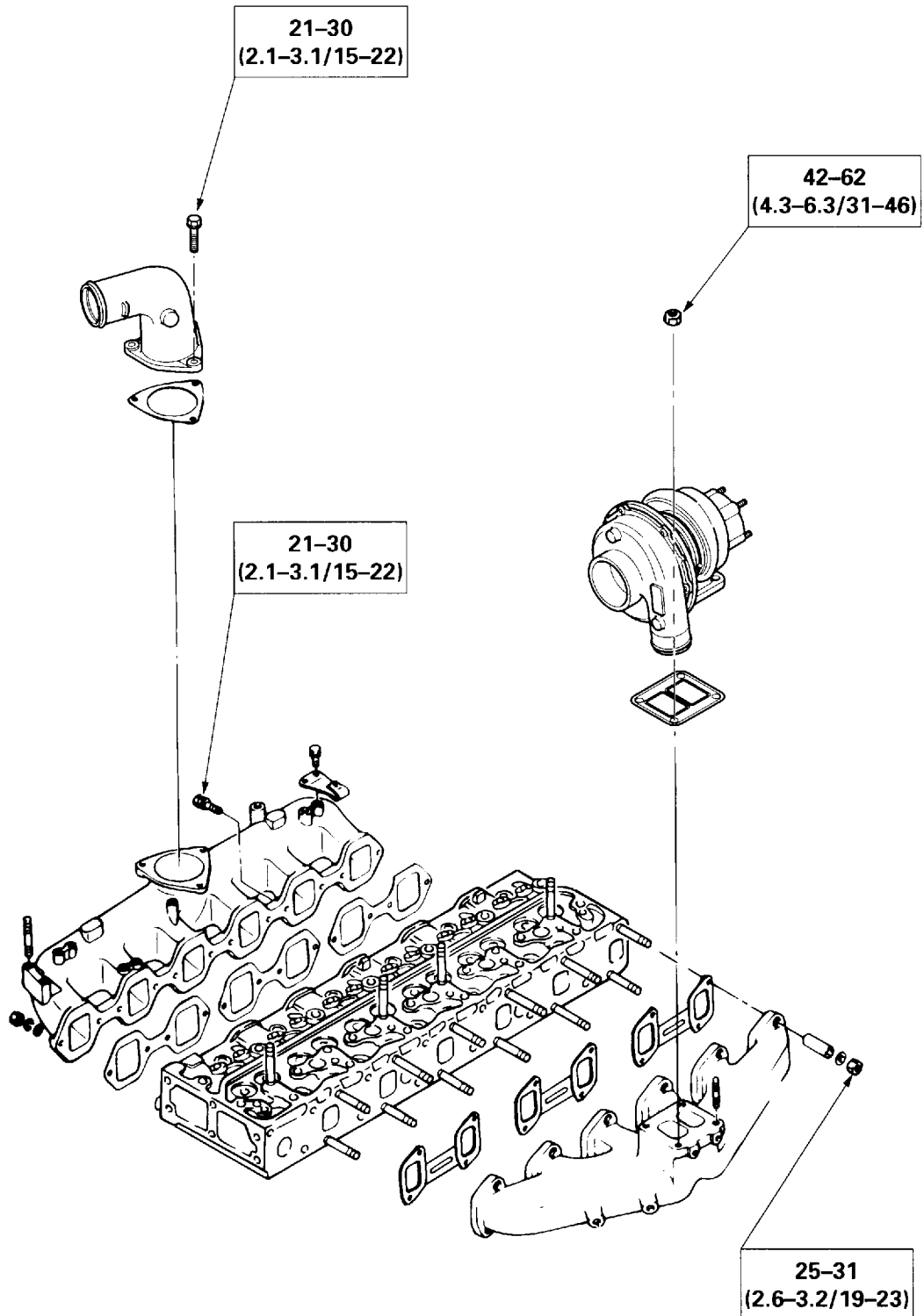
Thermostat and Thermostat Housing

N·m (kgf·m/lb.ft)



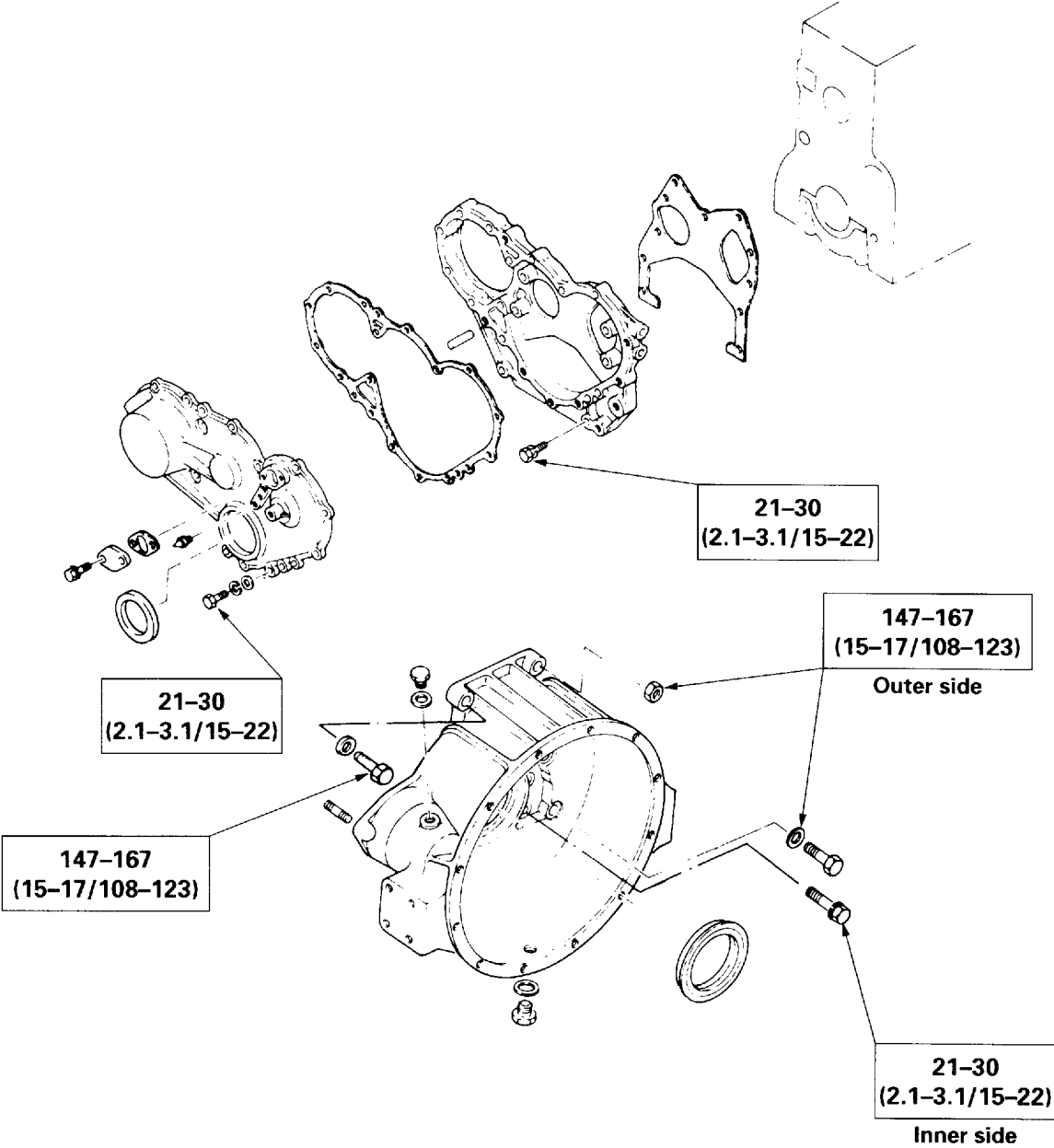
Intake and Exhaust Manifold

N·m (kgf·m/lb.ft)



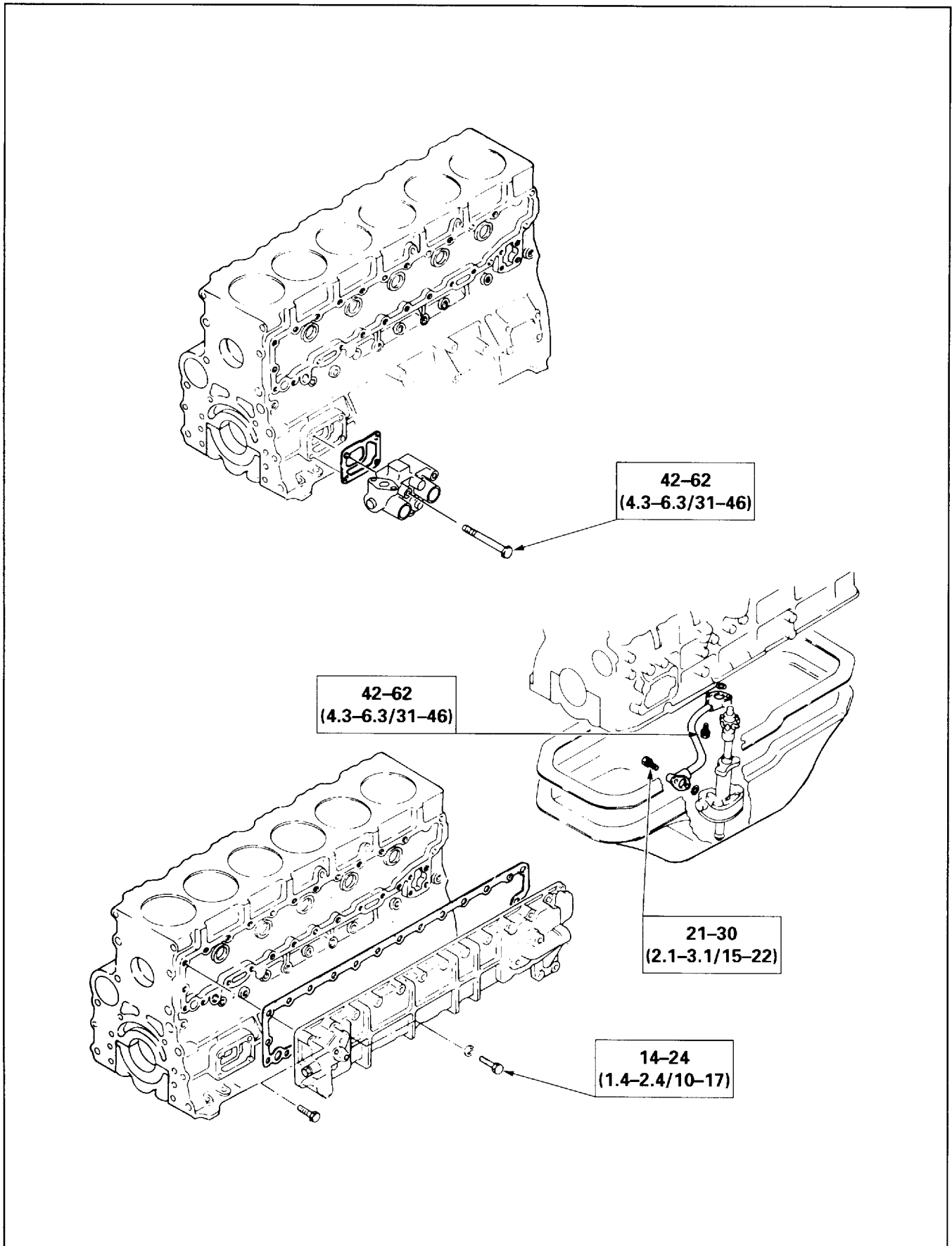
Timing Gear Case and Flywheel Housing

N·m (kgf·m/lb.ft)



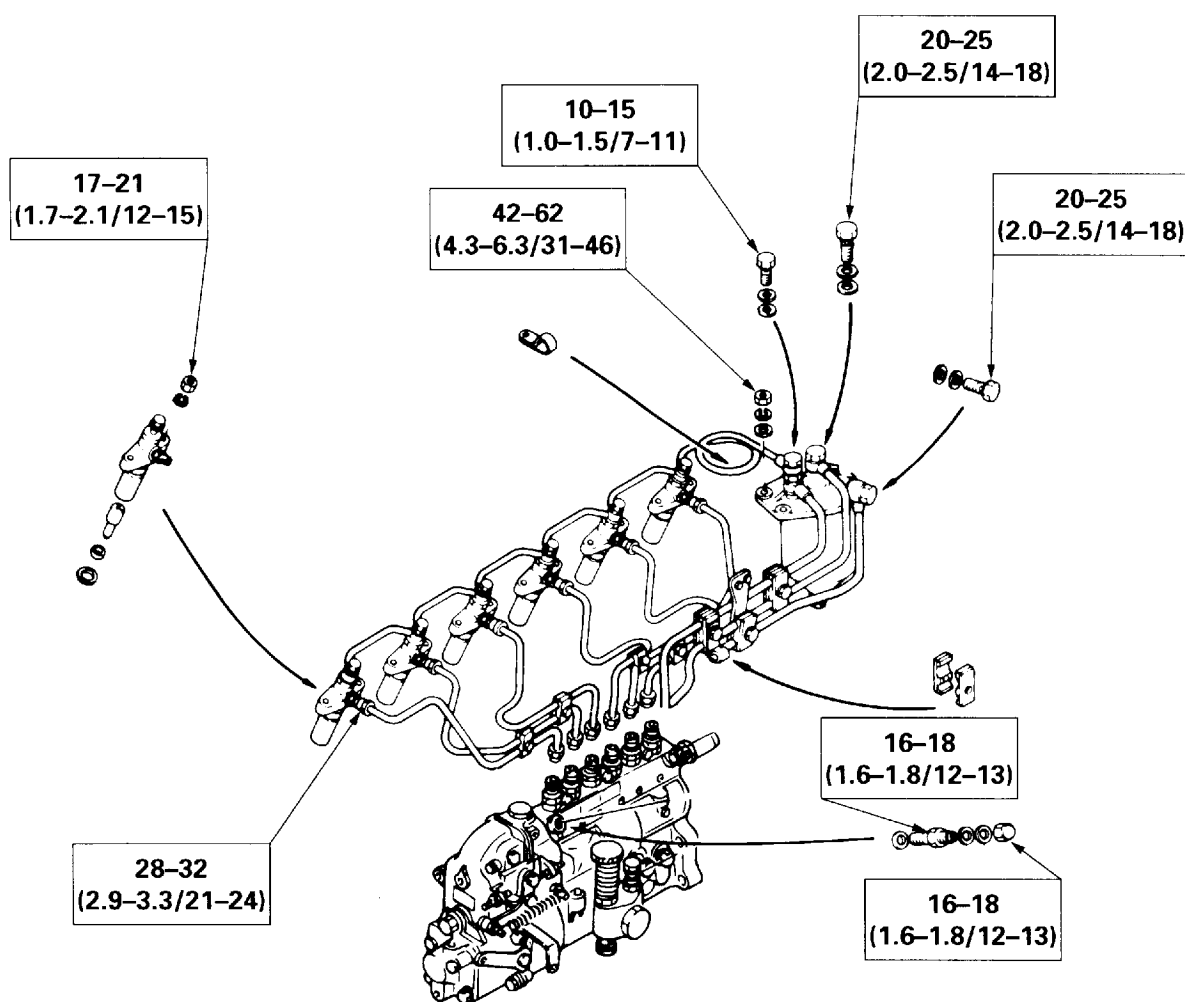
Oil Cooler, Oil Filter, and Oil Pump

N·m (kgf·m/lb.ft)



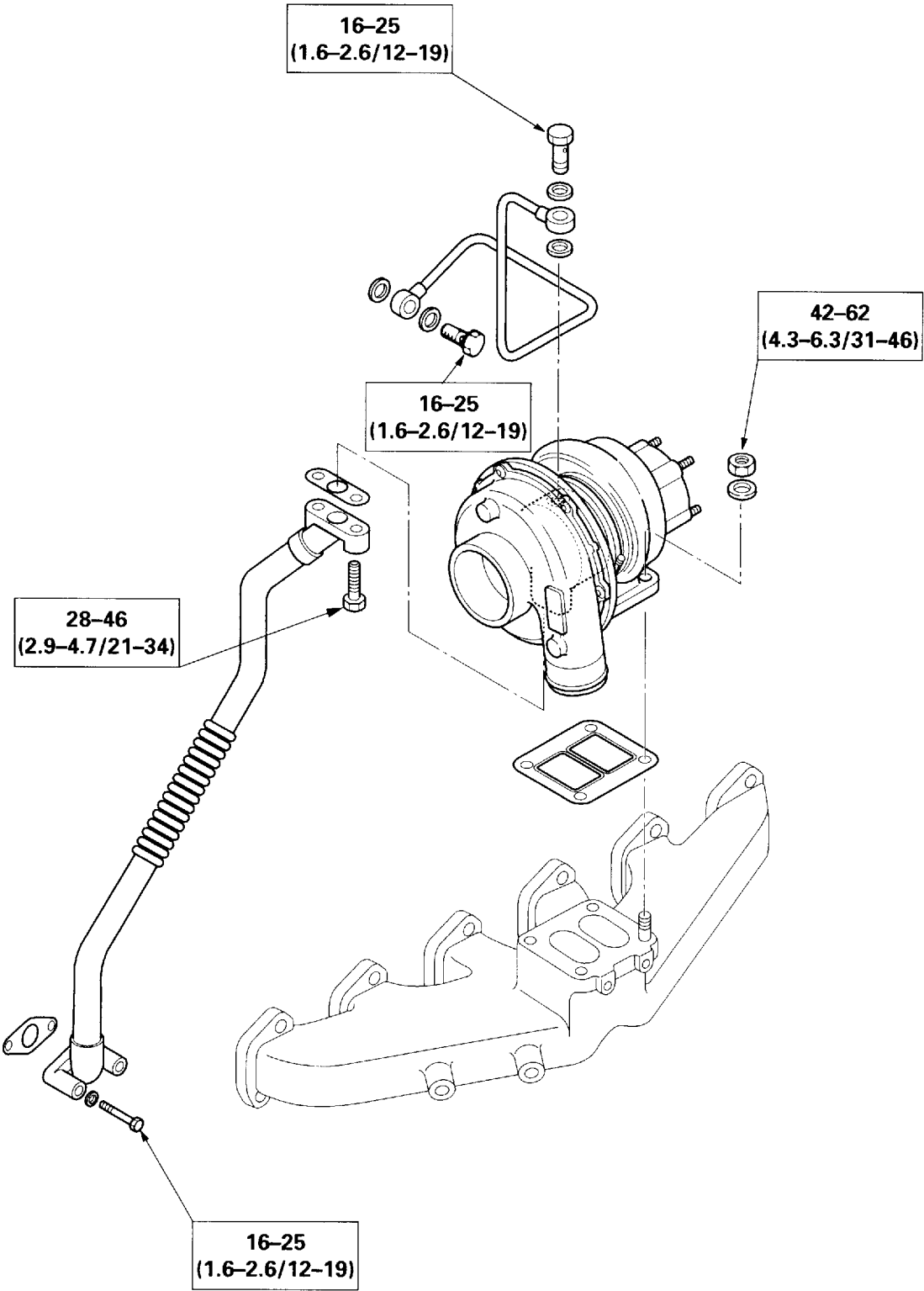
Fuel System

N·m (kgf·m/lb.ft)

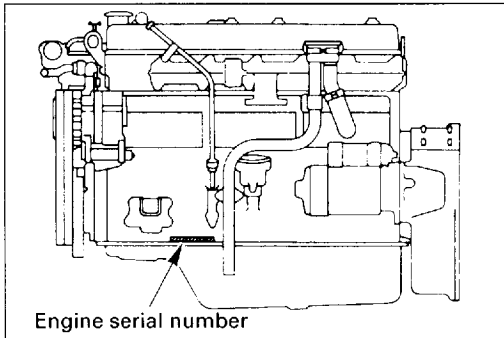


Turbocharger

N·m (kgf·m/lb.ft)



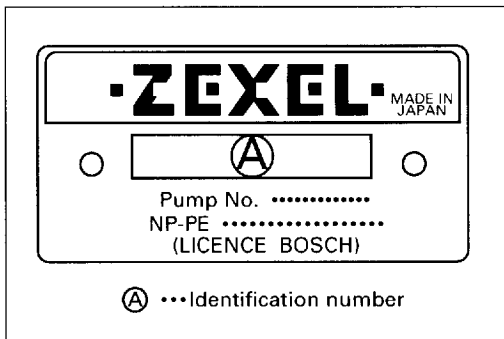
IDENTIFICATIONS



MODEL IDENTIFICATION

Engine Serial Number

The engine number is stamped on the front left hand side of the cylinder body.



INJECTION PUMP IDENTIFICATION

Injection Pump Number

Injection volume should be adjusted after referring to the adjustment data applicable to the injection pump installed.

The injection pump identification number (A) is stamped on the injection pump identification plate.

Note:

Always check the identification number before beginning a service operation.

Applicable service data will vary according to the identification number. Use of the wrong service data will result in reduced engine performance and engine damage.

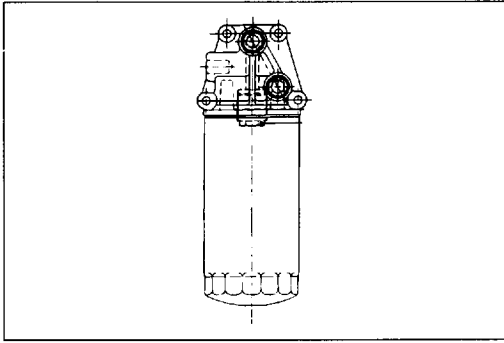
SECTION 2

MAINTENANCE

TABLE OF CONTENTS

ITEM	PAGE
Lubricating system	2- 2
Fuel system	2- 3
Cooling system	2- 7
Valve clearance adjustment	2- 7
Injection timing	2- 9
Compression pressure measurement.....	2-14
Turbocharger inspection	2-15
Engine repair kit.....	2-16
Recommended lubricants.....	2-17
Engine oil viscosity chart	2-17

Note: Maintenance intervals such as fuel or oil filter changes should be referred to INSTRUCTION BOOK.



LUBRICATING SYSTEM

Main Oil Filter Replacement

Cartridge (Spin-On) Type (Remote mount type)

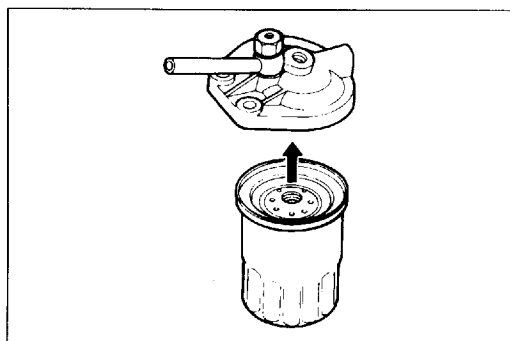
Removal

Removal and Installer: Filter Wrench

1. Loosen the used oil filter by turning it counterclockwise with the filter wrench.
2. Discard the used oil filter.

Installation

1. Wipe the oil filter mounting face with a clean rag.
This will allow the new oil filter to seat properly.
2. Lightly oil the O-ring.
3. Turn in the new oil filter until the sealing face is fitted against the O-ring.
4. Use the filter wrench to turn in the oil filter an additional $\frac{3}{4}$ of a turn or one turn.
5. Check the engine oil level and replenish to the specified level if required.
6. Start the engine and check for oil leakage from the oil filter.



FUEL SYSTEM

Fuel Filter Replacement

Cartridge (Spin-On) Type

Removal



1. Loosen the fuel filter by turning it counterclockwise with the filter wrench or your hand. Discard the used filter.



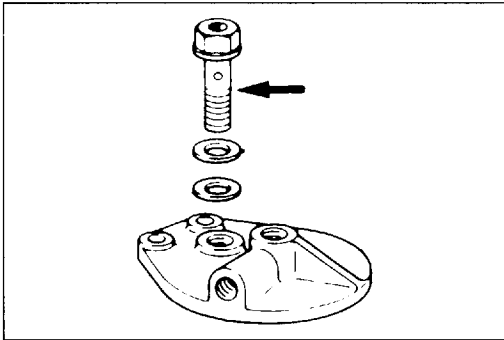
Filter Wrench

2. Wipe the fuel filter fitting face clean with a rag. This will allow the new fuel filter to seat properly.



Installation

1. Apply a light coat of engine oil to the O-ring.
2. Supply fuel to the new fuel filter.
This will facilitate air bleeding.
3. Turn in the new fuel filter until the filter O-ring is fitted against the sealing face.
4. Use the filter wrench to turn in the fuel filter an additional 2/3 of a turn.



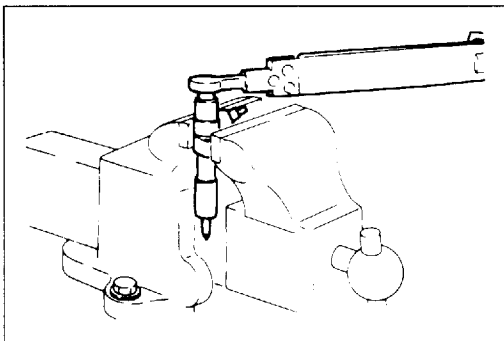
Overflow Valve

Check the overflow valve for clogging.

Check the ball side for suction leakage

kPa (kgf/cm²/psi)

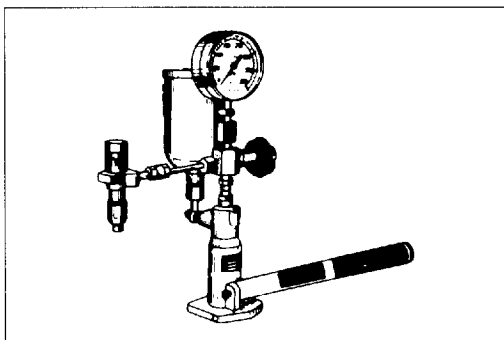
Overflow Valve Opening Pressure (Reference)	147 (1.5/21)
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Injection Nozzle

Inspection procedure

1. Clamp the injection nozzle holder in a vise.
2. Use a wrench to remove the injection nozzle holder cap.
3. Remove the injection nozzle holder from the vise.



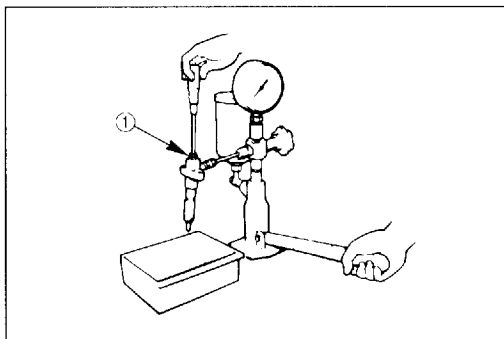
Adjusting Procedure

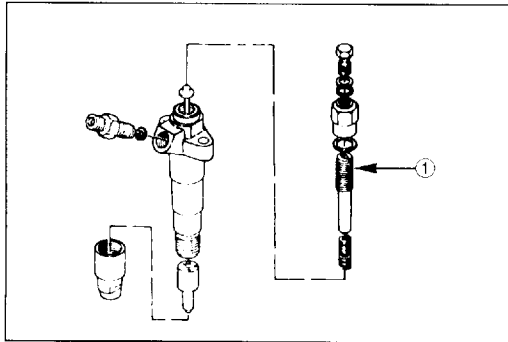
Injection Starting Pressure Check

1. Attach the injection nozzle holder to the injection nozzle tester.
2. Loosen the adjusting screw ①.
3. Check the injection nozzle starting pressure and the spray condition by operating the injection nozzle tester.
4. Adjust the injection nozzle starting pressure.



Turn the adjusting screw clockwise while operating the injection nozzle tester handle.



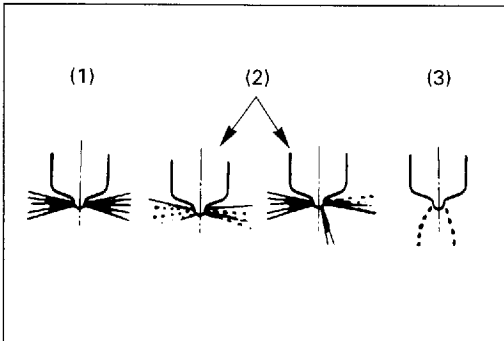


MPa (kgf/cm²/psi)

Injection Starting Pressure	18.1 (185/2630)
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WARNING

TEST FLUID FROM THE NOZZLE TESTER WILL SPRAY OUT UNDER GREAT PRESSURE. IT CAN EASILY PUNCTURE A PERSON'S SKIN. KEEP YOUR HANDS AWAY FROM THE NOZZLE TESTER AT ALL TIMES.



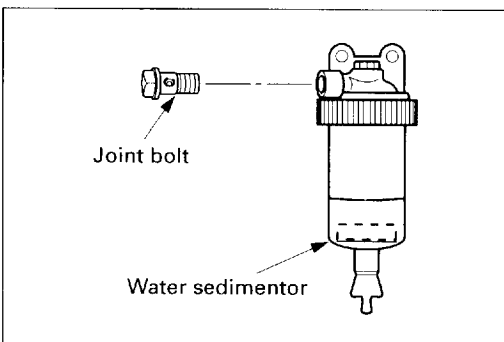
Spray Condition Check (During Injection Nozzle Tester Operation)

1. Tighten the cap nut.
2. Check the injection nozzle starting pressure.
3. Check the injection nozzle spray condition.

Operate the injection nozzle tester hand lever 4 to 6 times a second while looking for abnormal injection nozzle spray conditions.

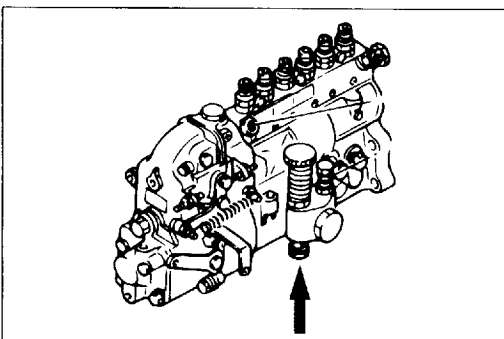
Refer to the illustration for different spray conditions.

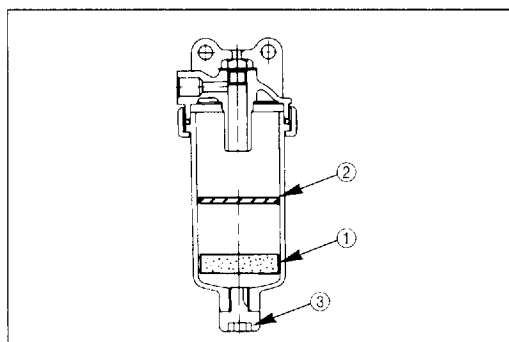
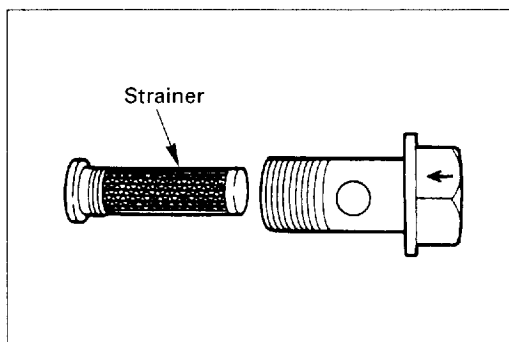
- (1) Good
- (2) Bad (Restrictions in orifice)
- (3) Bad (Dripping)



Water Sedimentor and Feed Pump Strainer

1. Remove the joint bolt.
2. Use a screwdriver to remove the strainer.
3. Wash the strainer in clean diesel fuel.





Water Separator (Water Sedimentor) (Optional Equipment)

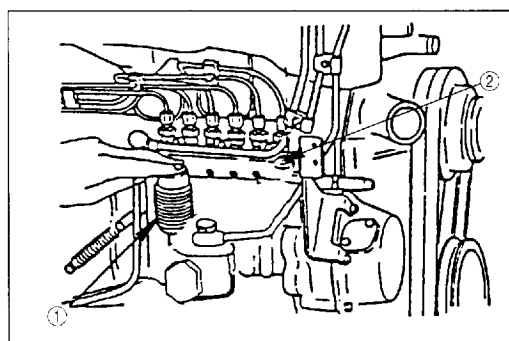
Check the water separator float ① level.

If the float ① has reached level ②, loosen the drain plug ③ (at the bottom side of the water separator) to drain the water.

N·m (kgf·m/lb.ft)

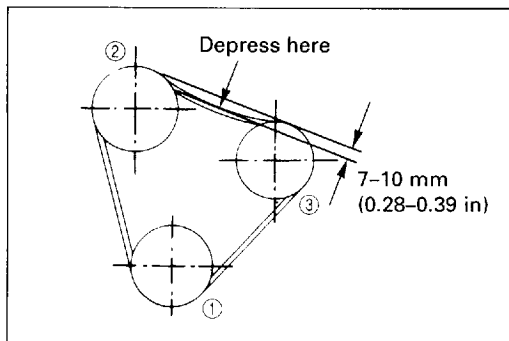


Drain Plug Torque	9-15 (0.9-1.5/7-11)
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Air Bleeding

1. Loosen the feed pump cap ① on the injection pump.
2. Loosen the bleeding screw ② on the injection pump.
3. Operate the feed pump until there are no more bubbles visible in the fuel being discharged from the loosened bleeding screw.
4. Retighten the bleeding screw.
5. Operate the feed pump several times and check for fuel leakage around the injection pump and the fuel filter.



COOLING SYSTEM

Cooling Fan Drive Belt



Adjustment

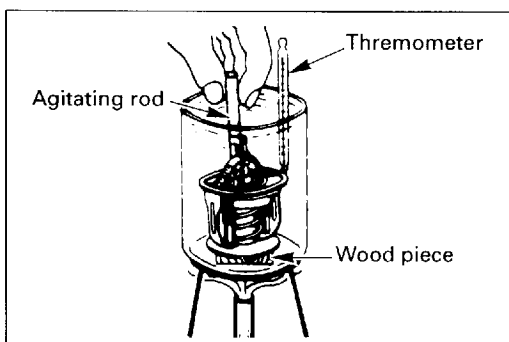


1. Check the cooling fan drive belt for cracking and other damage.
2. Check the drive belt tension by exerting a force of 10 kg (22lb) midway between the fan pulley ② and the generator ③.
3. Adjust the belt tension by loosening the alternator mounting bolt and the generator adjusting bolt and pivoting the generator.

Be sure to retighten the bolts after adjusting the belt tension.

mm (in)

Cooling Fan Drive Belt Deflection	7-10 (0.28-0.39)
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Thermostat

Inspection



Visually inspect the thermostat.

Replace the thermostat if excessive wear or damage is discovered during inspection.

Measure the valve lift.

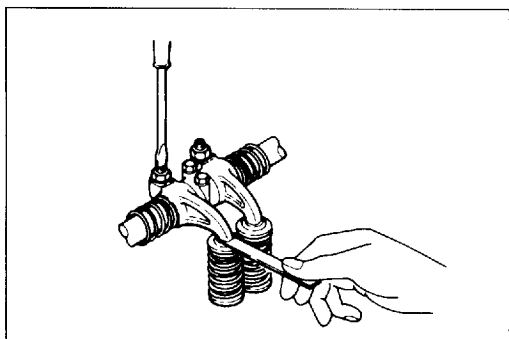
mm (in)



Amount of Valve Lift at 95°C (203°F)	10.0 (0.39)
--------------------------------------	-------------

°C(°F)

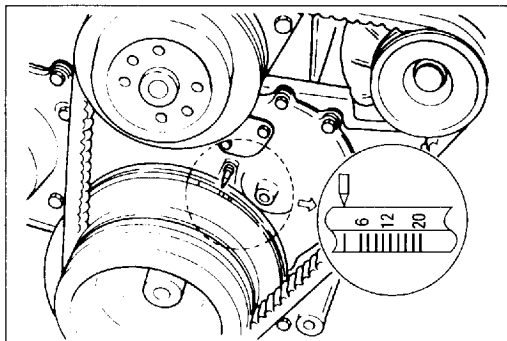
Valve Opening Temperature	80-84 (176-183)
---------------------------	-----------------



VALVE CLEARANCE AND ADJUSTMENT

Note:

The cylinder head bolts were previously tightened with the "Angular Tightening Method". Therefore, it is not necessary to retighten the cylinder head bolts before adjusting the valve clearance.

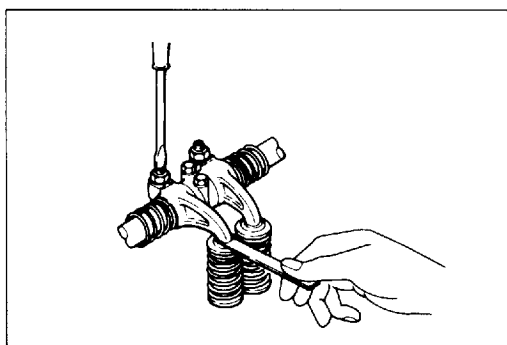


1. Bring the piston in either the No. 1 cylinder or the No. 6 cylinder to Top Dead Center on the compression stroke by turning the crankshaft until the TDC notched line on the crankshaft pulley is aligned with the timing pointer.

2. Check to see if there is play in the No. 1 intake and exhaust valve rocker arms.

If the No. 1 cylinder intake and exhaust valve rocker arms have play, the No. 1 piston is at TDC on the compression stroke.

If the No. 1 cylinder intake and exhaust valve rocker arms are depressed, the No. 6 piston is at TDC on the compression stroke.

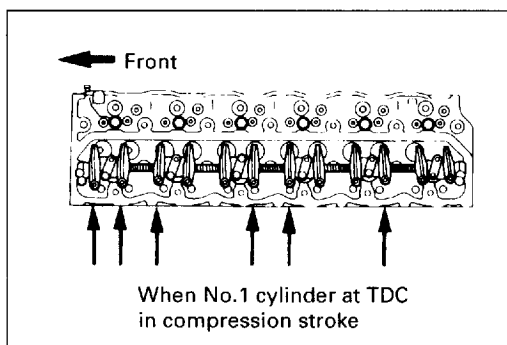


Adjust the No. 1 or the No. 6 cylinder valve clearances while their respective cylinders are at TDC on the compression stroke.

mm (in)

Intake and Exhaust Valve Clearance (cold)	0.40 (0.016)
---	--------------

3. Loosen each valve clearance adjusting screw as shown in the illustration.
4. Insert a 0.40 mm (0.016 in) feeler gauge between the rocker arm and the valve stem end.
5. Turn the valve clearance adjusting screw until a slight drag can be felt on the feeler gauge.
6. Tighten the lock nut securely.

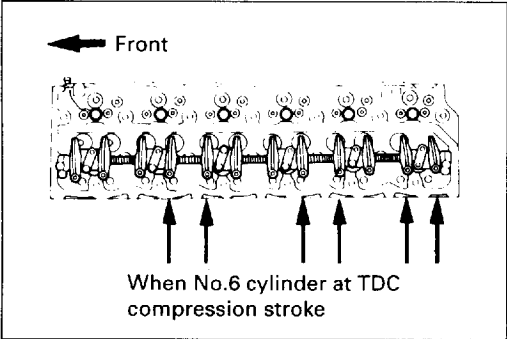


7. Rotate the crankshaft 360°.

Realign the crankshaft pulley TDC notched line with the timing pointer.



8. Adjust the clearances for the remaining valves as shown in the illustration.

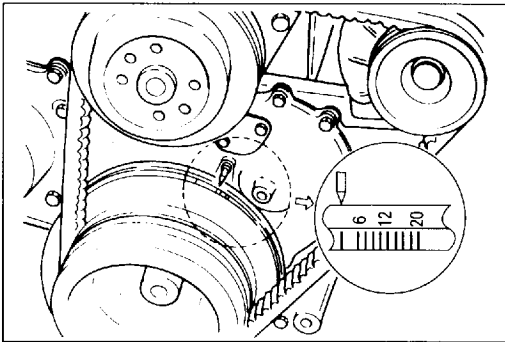


N·m (kgf·m/lb.ft)	
Rocker Arm Screw Lock Nut Torque	21-30 (2.1-3.1/15-22)

INJECTION TIMING



Note:
Take care to avoid entry of dust or foreign particles into the pump interior when the timing adjustment is made.



Checking Procedure

1. Align the crankshaft pulley TDC mark with the pointer.

Remove the inspection hole cover at the front of the injection pump on the timing gear case cover.

Check the alignment between the pointer ④ on the injection pump gear nut lock plate and the projection area mark ③ on the injection pump gear case.

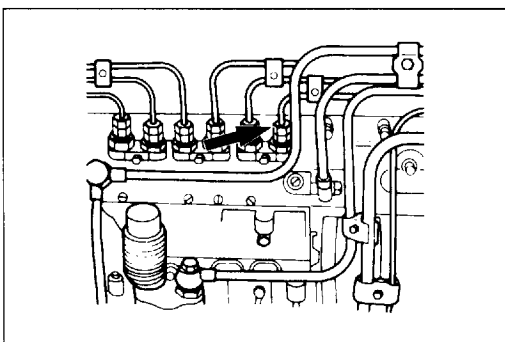
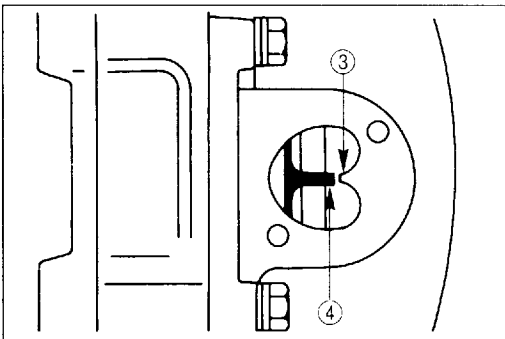
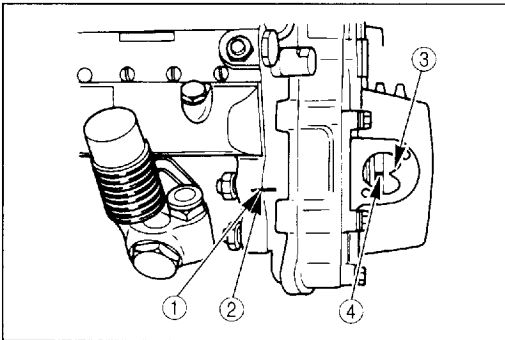
If it is in misalignment, recheck with turning the crankshaft pulley one more turn to repeat the foregoing procedure to mark sure that it is in alignment.

Check the alignment of the notched lines ① and ②.

(These notched lines were aligned at the factory to set the injection pump body and the mounting flange.)

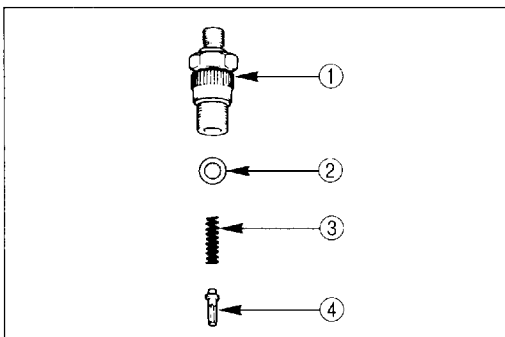
Next, inspect the crankangle position of the injection starting.

2. Reversely turn the crankshaft pulley counterclockwise about 30° crankangle.



3. Disconnect the injection pipe from the No. 1 plunger.

This will allow you to visually check the full injection starting flow at No. 1 plunger.



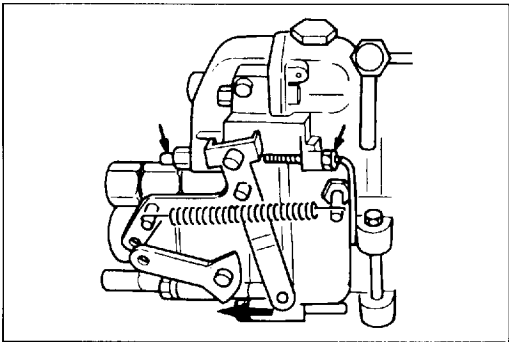
4. Remove the delivery valve holder ①, the valve seat ②, valve spring ③ the delivery valve ④ from the No. 1 plunger.



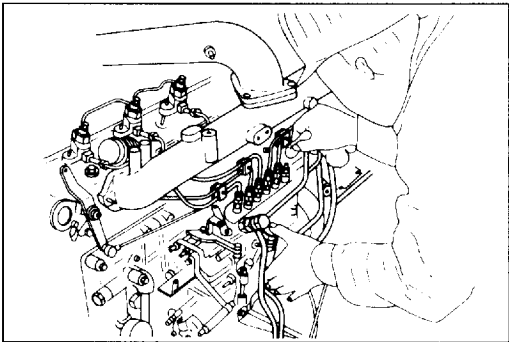
5. Reinstall the delivery holder ① and tighten it to the specified torque.

Do not reinstall the delivery valve spring, the valve seat and the delivery valve.

These parts will be reinstalled later.



6. Hold the fuel control lever at the fully open position.



7. Slowly turn the crankshaft pulley clockwise, at the same time, continue to feed the fuel with pumping the priming pump.

When the fuel stop to flow out from the No. 1 delivery valve holder, stop the pump instantaneously.

This crankangle position is the injection starting of the engine.

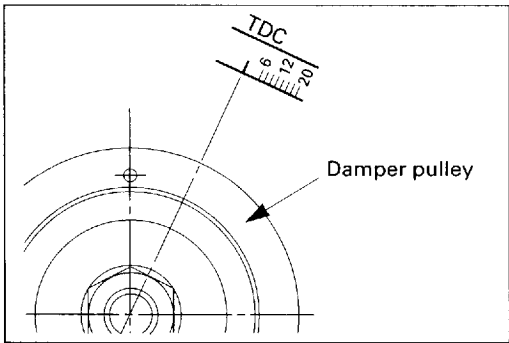


8. Observe and make sure that mark (injection starting angle line α°) on the crankshaft pulley is aligning with the pointer.

The timing line shows the injection starting angle of the engine.

Blow out the remaining fuel from the delivery valve holder.

Make sure that there is no fuel being delivered from the priming pump.



015ES002

Note

6BG1 engine has eight timing notch lines punched on the crankshaft damper pulley.

These notched lines must be aligned for correct engine timing.

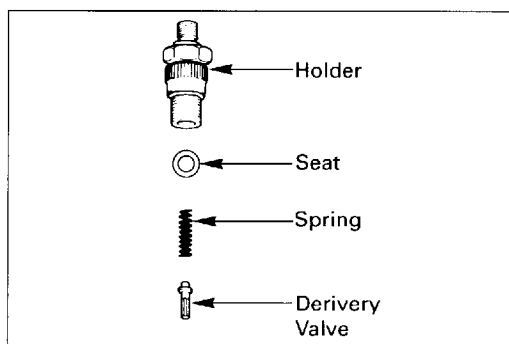
Refer to the illustration.

Degree	
Injection Timing B.T.D.C	104

Note:

Injection pump injection timing will vary among identical engines contact your machine supplier or nearest ISUZU engine service outlet for the specifications applicable to your engine.

These specifications have been set by ISUZU and the OEM manufacturer.



9. Remove the delivery valve holder from the No. 1 plunger.
10. Reinstall the delivery valve internal parts (seat, spring, and valve) to the delivery valve holder.
11. Reinstall the delivery valve holder assembly to the No. 1 plunger and tighten it to the specified torque.

N·m (kgf·m/lb.ft)

Delivery Valve Holder Torque	39-44 (4-4.5/29-33)
------------------------------	---------------------

12. Install the No. 1 cylinder injection pipe and tighten it to the specified torque.

N·m (kgf·m/lb.ft)



Injection Pipe Nut Torque	28-32 (2.9-3.3/21-24)
---------------------------	-----------------------

Note:

DO NOT OVERTIGHTEN THE INJECTION PUMP BODY.

THE INJECTION PUMP BODY IS MADE OF ALUMINUM. OVERTIGHTENING WILL DISTORT THE INJECTION PUMP BODY SHAPE AND ADVERSELY AFFECT CONTROL RACK OPERATION.

Adjusting Procedure



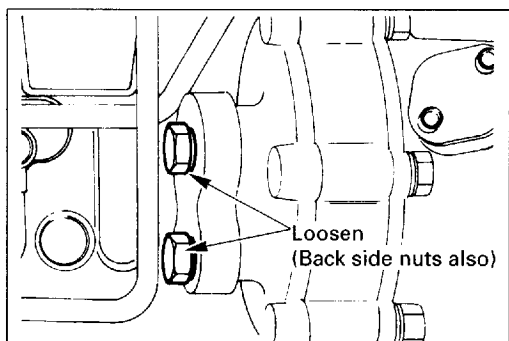
1. Align the pointer and the specified timing mark on the crank pulley.
2. Perform the operations described on page 2-10, 11, paragraphs 3, 4, 5, 6.
3. Loosen the four injection pump fixing nut.
4. To advance the timing

Pivot the injection pump at the pump driveshaft toward out.

To retard the timing.

Pivot the injection pump at the pump driveshaft toward in. (toward the cylinder block)

Reference; the 1 mm misalignment between the two setting mark lines corresponds to about 2° in crankangle.



5. Do a fine injection pump position adjustment, while continue the pumping operation to feed the fuel, and stop to pivot the injection pump when the fuel stop to flow out from the No. 1 delivery valve holder.

6. Tighten the four injection pump fixing nuts.

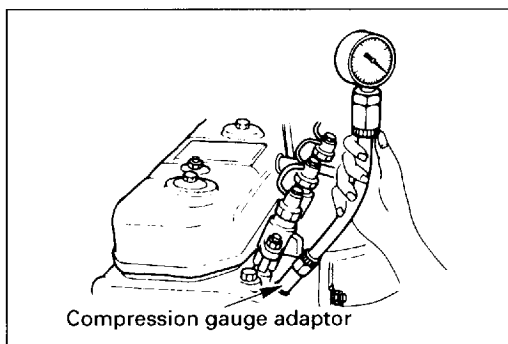


7. Once remove the No. 1 delivery valve holder, and reinstall the delivery valve, spring and the valve holder with the specified torque.



8. Install the No. 1 injection pipe and tighten it to the specified torque.





COMPRESSION PRESSURE MEASUREMENT

1. Operate the engine to warm-up until the coolant temperature reaches to 75°C (167°F).
2. Remove all of the glow plugs and the injection pipes.
3. Attach a compression gauge to the No. 1 cylinder glow plug installation threads.

Note:

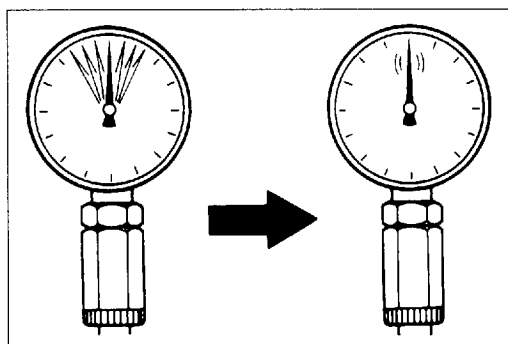
Compression pressure may be measured starting at any cylinder and in no particular cylinder order. However, it is very important that the compression pressure be measured in each cylinder.

Therefore, start at the No.1 cylinder and work back. In this way, you will be sure to measure the compression pressure in each cylinder.

Compression Gauge:



Compression Gauge Adapter: 5-85317-001-0



4. Crank the engine with the starter motor and take the compression gauge reading.

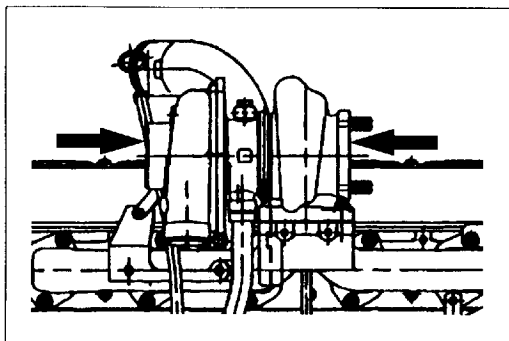
MPa (kgf/cm²/psi) at 200 min⁻¹ at sea level

Standard	Limit
3.0 (31/440)	2.5 (26/370)

5. Repeat the procedure (Steps 2 and 3) for the remaining cylinders.

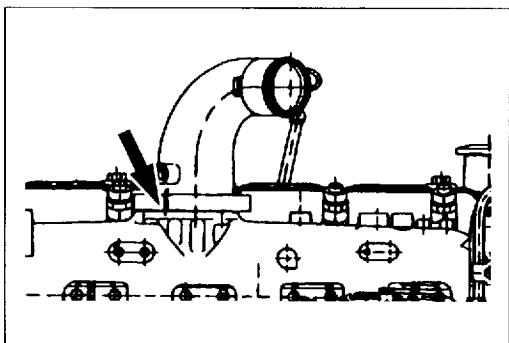
Compression pressure should be approximately the same for each cylinder. A variation exceeding 200 kPa (2 kgf/cm²/28 psi) is unacceptable.

If the measured value exceeds the specified limit, the related parts must be checked.

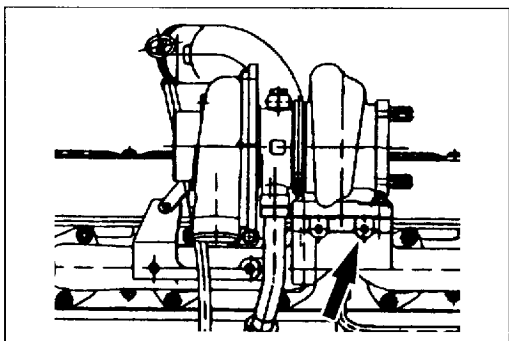


TURBOCHARGER INSPECTION

1. Check the air intake duct connections for air leakage. Check the turbine wheel for damage. Check the compressor blade for damage.

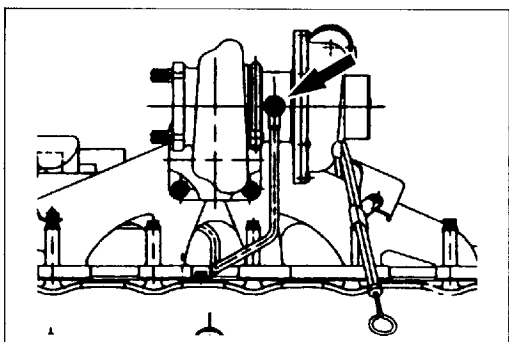


2. Check the intake manifold connections for air leakage.

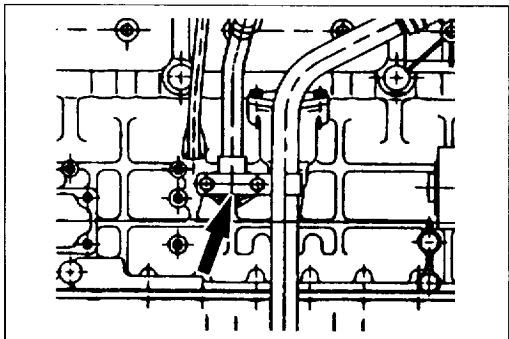


3. Check the exhaust duct connections for smoke leakage.

4. Check the turbocharger mounting nuts for looseness.

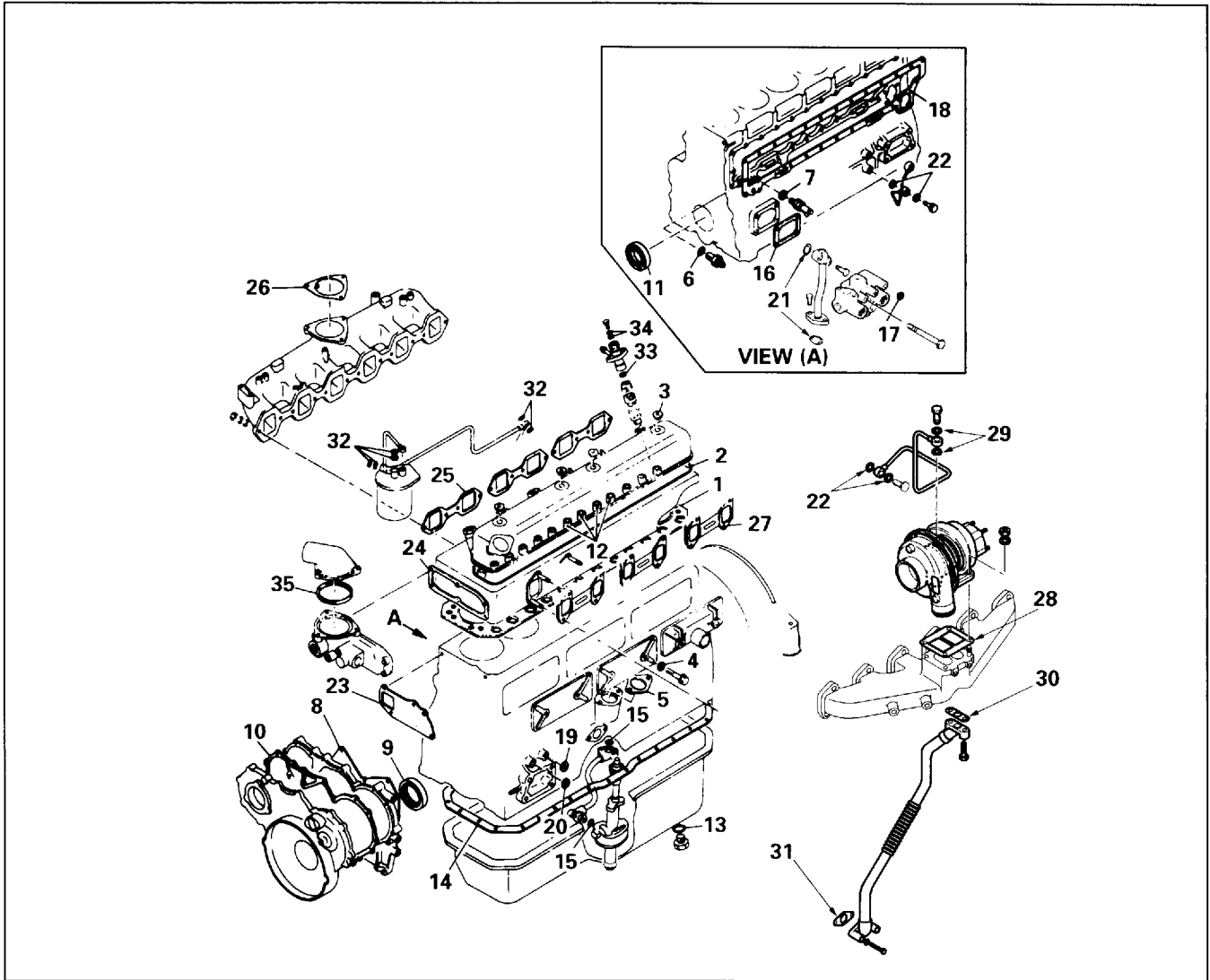


5. Check the oil feed pipe for oil leakage.



6. Check the oil return pipe joints for oil leakage.

ENGINE REPAIR KIT

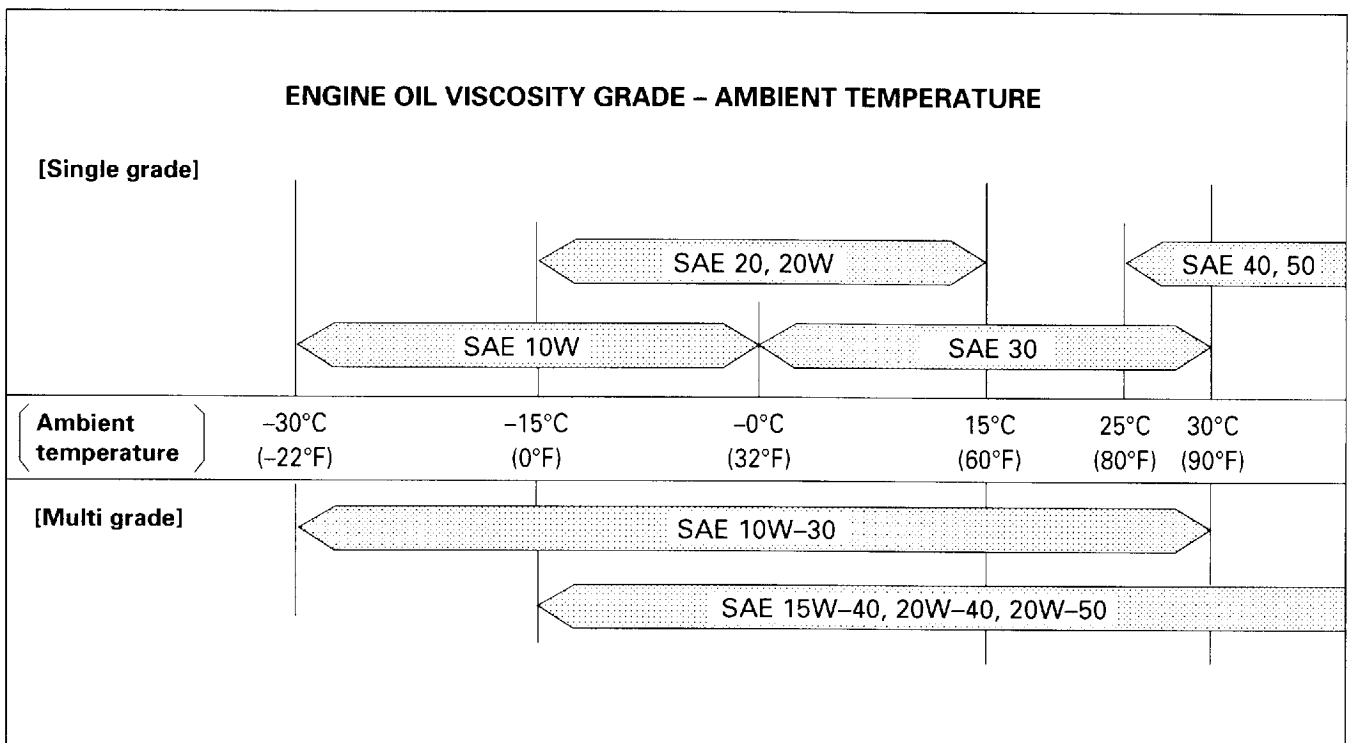


- | | |
|---------------------------------------|---|
| 1. Cylinder head gasket | 19. Oil pipe joint gasket |
| 2. Cylinder head cover gasket | 20. Joint bolt gasket |
| 3. Cylinder head cover nut gasket | 21. Oil pipe gasket |
| 4. Chamber cover fixing bolt gasket | 22. Injection pump oil pipe gasket |
| 5. Oil pump hole cover gasket | 23. Water pump gasket |
| 6. Oil relief valve gasket | 24. Thermostat housing gasket |
| 7. Water drain valve gasket | 25. Intake manifold gasket |
| 8. Gear case to cylinder block gasket | 26. Inlet pipe manifold gasket |
| 9. Crank pulley to gear case oil seal | 27. Exhaust manifold gasket |
| 10. Gear case cover gasket | 28. Exhaust manifold to turbocharger gasket |
| 11. Crankshaft rear end oil seal | 29. Oil feed pipe gasket |
| 12. Valve guide oil seal | 30. Oil drain pipe gasket |
| 13. Drain plug gasket | 31. Oil drain pipe gasket |
| 14. Oil pan gasket | 32. Overflow fuel pipe gasket |
| 15. Oil pipe gasket | 33. Injection nozzle gasket |
| 16. Oil port cover gasket | 34. Injection nozzle leak off pipe gasket |
| 17. Oil filter fixing bolt gasket | 35. Thermostat gasket |
| 18. Oil cooler gasket | |

RECOMMENDED LUBRICANTS

ENGINE TYPE	TYPES OF LUBRICANTS (API)
With turbocharger	Diesel engine oil CD grade

ENGINE OIL VISCOSITY CHART



MEMO

SECTION 3

ENGINE ASSEMBLY I
(DISASSEMBLY)

TABLE OF CONTENTS

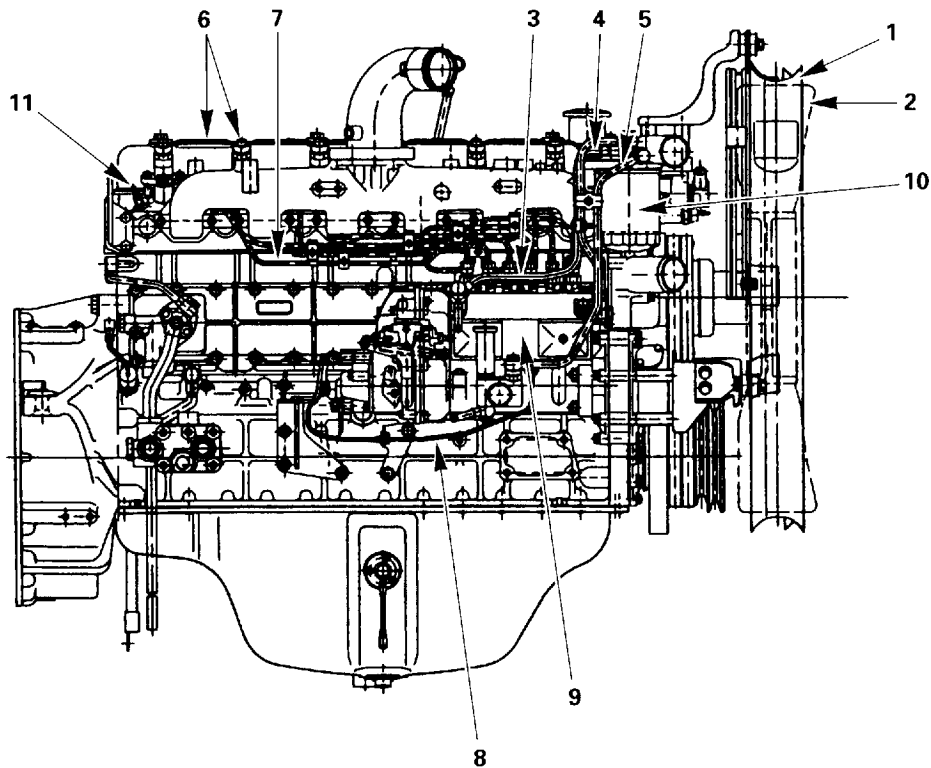
ITEM	PAGE	
External parts disassembly steps.....	3- 2	
Major components.....	3- 6	
Rocker arm and rocker arm shaft disassembly steps.....	3-11	
Cylinder head disassembly steps.....	3-12	
Piston and connecting rod disassembly steps.....	3-13	



EXTERNAL PARTS DISASSEMBLY STEPS

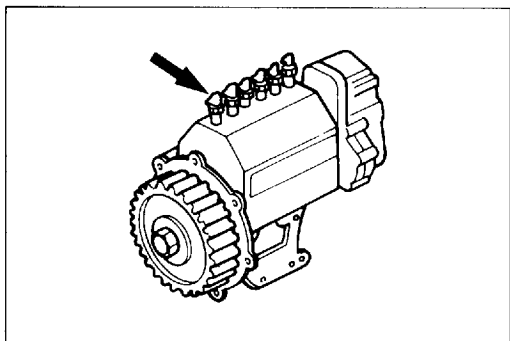
(Right-hand side)

MODEL AA-6BG1T



Disassembly Steps

- | | |
|--|-------------------------------------|
| 1. Fan guide and bracket | 7. Injection pipe |
| 2. Cooling fan | 8. Oil pipe; body to injection pump |
| 3. Fuel pipe; return | 9. Injection pump |
| 4. Fuel pipe; filter to injection pump | 10. Fuel filter |
| 5. Fuel pipe; feed pump to filter | 11. Glow plug |
| 6. Leak off pipe and injection nozzles | |



Important Operations

9. Injection Pump with Injection Pump Gear

Use the shipping plugs (or something similar) to seal the injection pump delivery valve ports. This will prevent the entry of foreign material.

Flange Mounted Injection Pump Removal

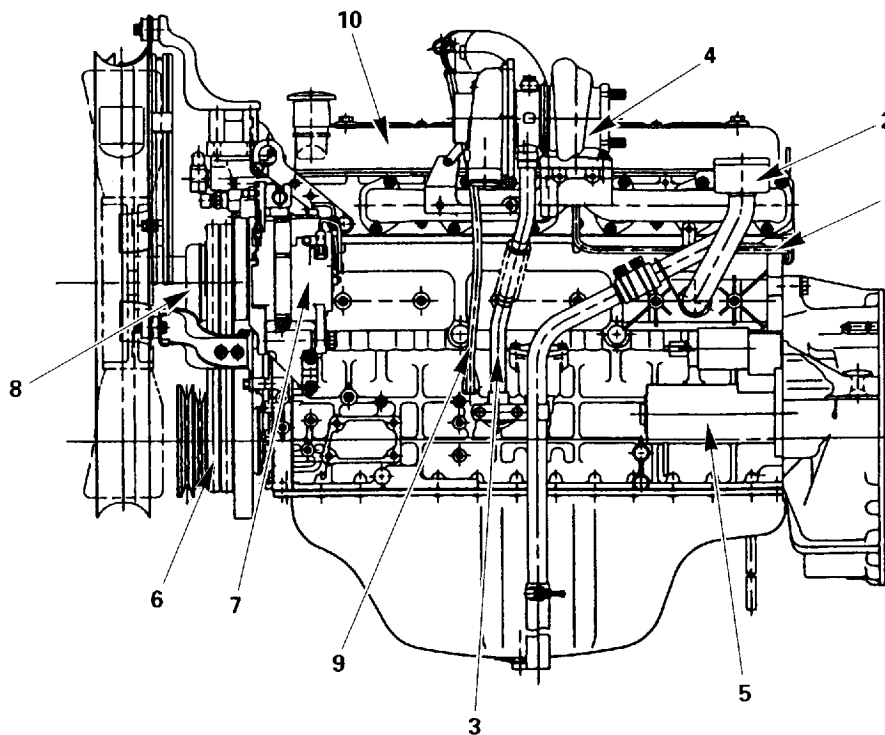
- 1) Remove the injection pump flange bolts.
- 2) Pull the injection pump with the injection pump drive gear free.

Refer to the illustration.



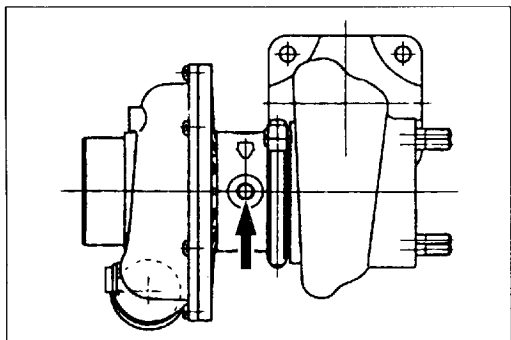
EXTERNAL PARTS DISASSEMBLY STEPS (Left-hand side)

MODEL 6BG1T



Disassembly Steps

- | | |
|-------------------|--------------------------------|
| 1. Oil feed pipe | 6. Fan belt |
| 2. Air breather | 7. Alternator |
| 3. Oil drain pipe | 8. Fan pulley |
| 4. Turbocharger | 9. Oil dipstick and guide tube |
| 5. Starter motor | 10. Cylinder head cover |

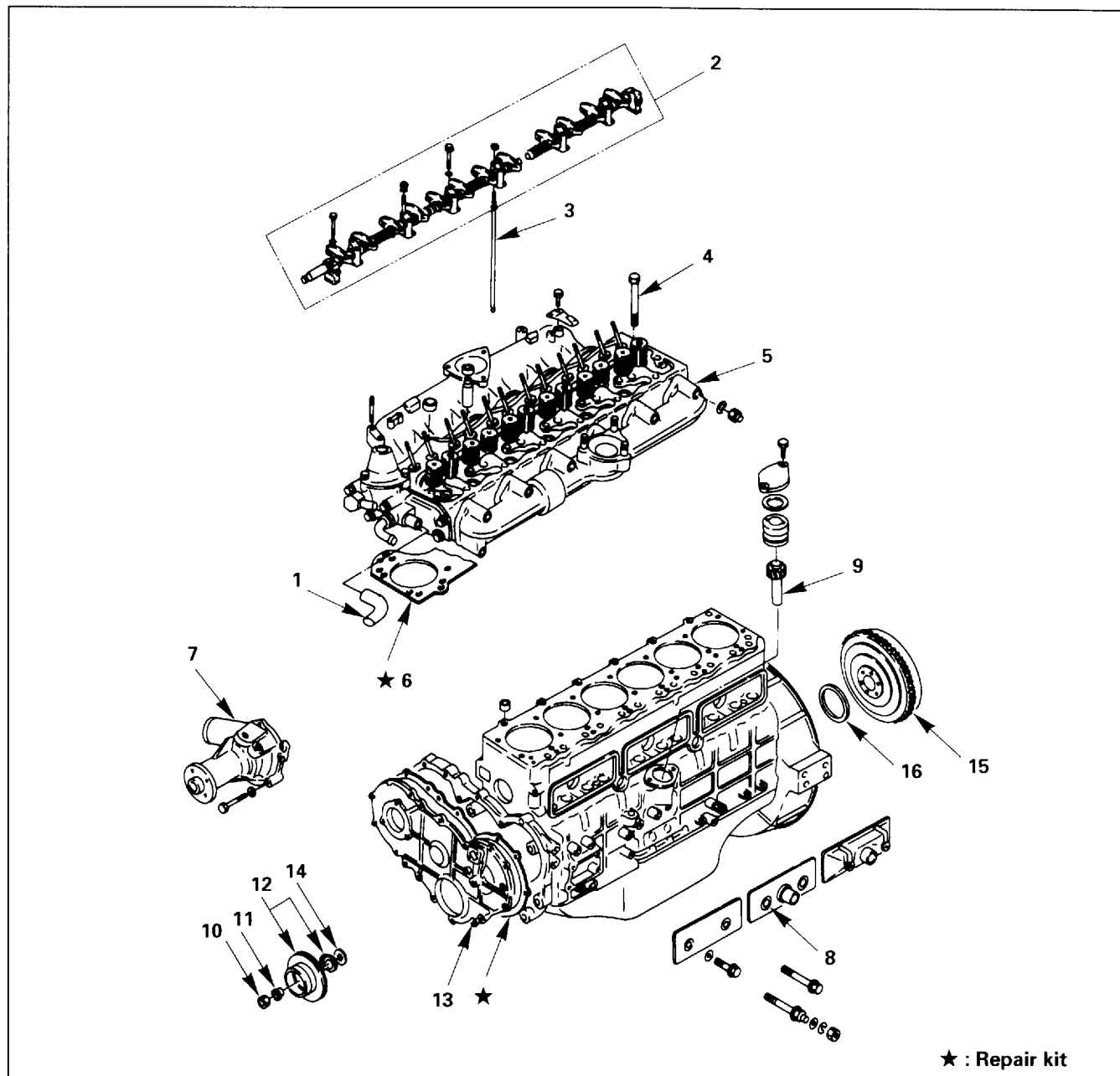


Important Operations

4. Turbocharger

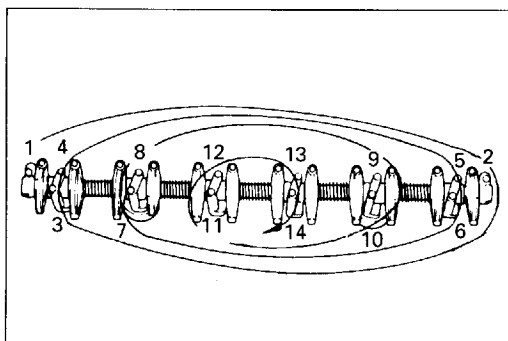
Plug oil ports in turbocharger body immediately after removal of the turbocharger.

MAJOR COMPONENTS - I



Disassembly Steps

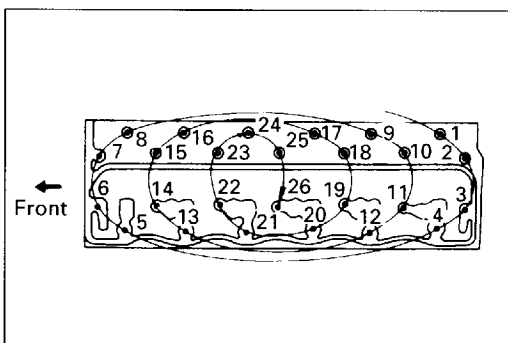
- | | |
|--------------------------------|--|
| 1. Rubber hose ; water by-pass | 9. Oil pump driving pinion |
| ▲ 2. Rocker arm shaft assembly | ▲ 10. Crankshaft pulley nut |
| 3. Push rod | ▲ 11. Taper bushing |
| ▲ 4. Cylinder head bolt | 12. Crankshaft pulley and dust thrower |
| 5. Cylinder head assembly | 13. Timing gear cover |
| 6. Cylinder head gasket | 14. Oil thrower |
| 7. Water pump assembly | ▲ 15. Flywheel |
| 8. Tappet chamber cover | ▲ 16. Rear oil seal |



Important Operations

2. Rocker Arm Shaft

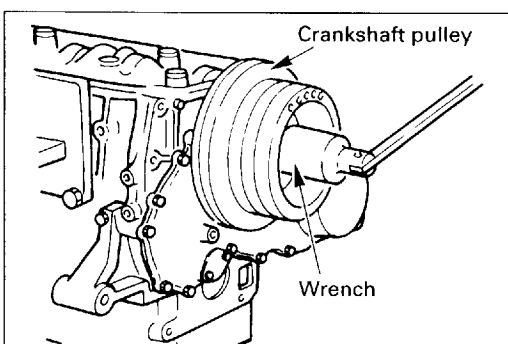
Loosen the rocker arm shaft fixing bolts a little at a time in numerical sequence as specified.



4. Cylinder Head Bolts

Loosen the cylinder head bolts a little at a time in the numerical order shown in the illustration.

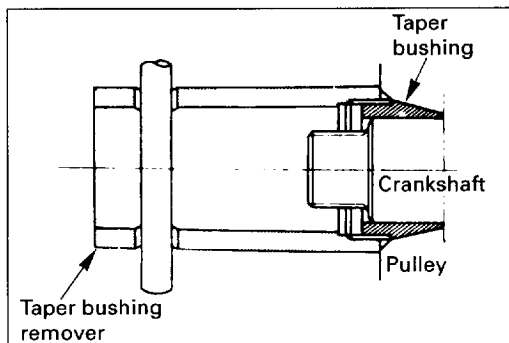
Cylinder head bolt wrench: 1-85111-003-0



10. Crankshaft Pulley Nut

Wrench: 54 mm (2.13 in)

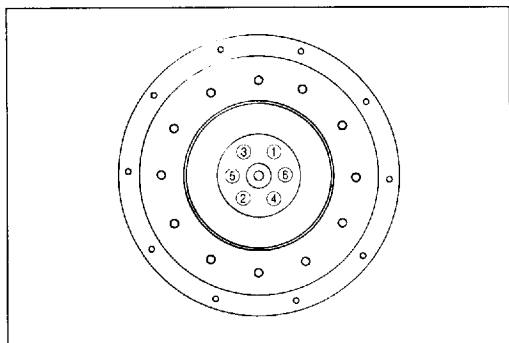
Use an appropriate wrench to remove the crankshaft pulley nut.



11. Taper Bushing

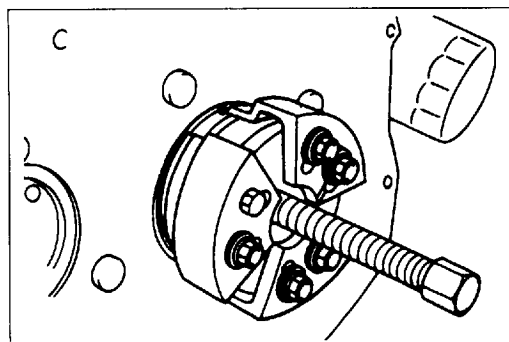
Remover: 9-8521-0122-0

Use the taper bushing remover to remove the crankshaft end taper bushing.



15. Flywheel

Loosen the flywheel bolt a little at a time in the numerical order as specified.

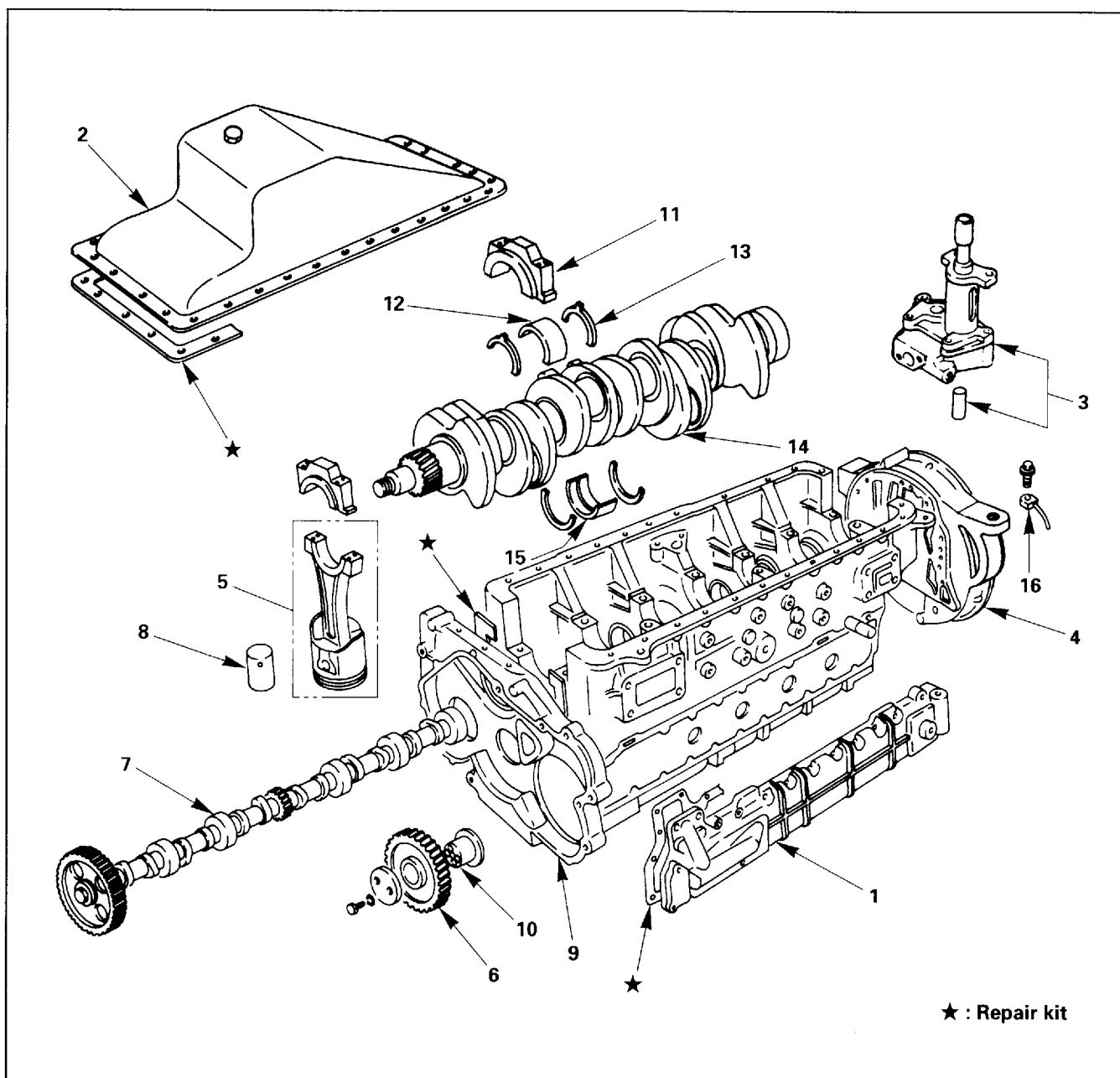


16. Crankshaft Rear Oil Seal (Axial Type)

With the oil seal pushed in deep, install the special tool as shown in the illustration and remove the oil seal.

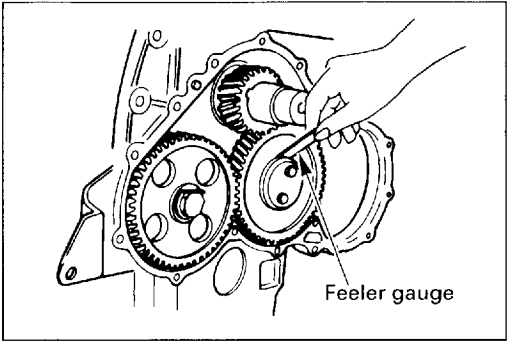
Oil Seal Remover: 5-8840-2360-0

MAJOR COMPONENTS - II



Disassembly Steps

- | | |
|------------------------------|-------------------------------------|
| 1. Oil cooler | 9. Timing gear case |
| 2. Oil pan | 10. Idler gear shaft |
| 3. Oil pump and coupling | ▲ 11. Crankshaft bearing cap |
| 4. Flywheel housing | 12. Crankshaft bearing (lower half) |
| 5. Piston and connecting rod | 13. Thrust bearing |
| ▲ 6. Idler gear | 14. Crankshaft |
| ▲ 7. Camshaft | 15. Crankshaft bearing (upper half) |
| 8. Tappet | 16. Oiling jet |



Important Operations

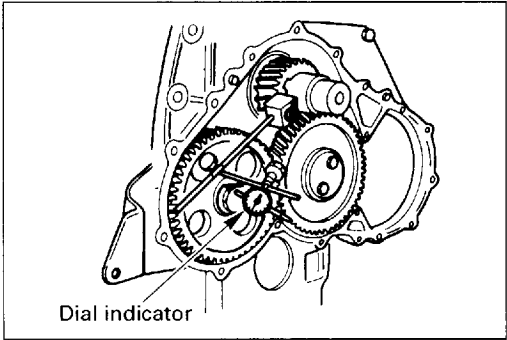


6. Idler Gear

Measure the following points before disassembly.

mm (in)

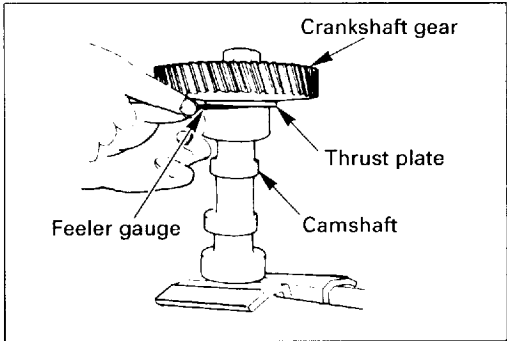
	Standard	Limit
Idler Gear End Play	0.128–0.185 (0.005–0.0070)	0.2 (0.008)



mm (in)

	Standard	Limit
Timing Gears Backlash	0.10–0.17 (0.004–0.007)	0.3 (0.012)

Includes the crankshaft gear, the camshaft gear, and the idler gear.

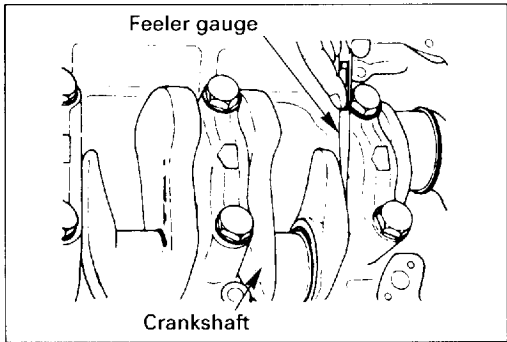


7. Camshaft

Measure the following points before disassembly.

mm (in)

	Standard	Limit
Cam Gear End Play	0.050–0.114 (0.002–0.005)	0.2 (0.008)



11. Crankshaft Bearing Cap

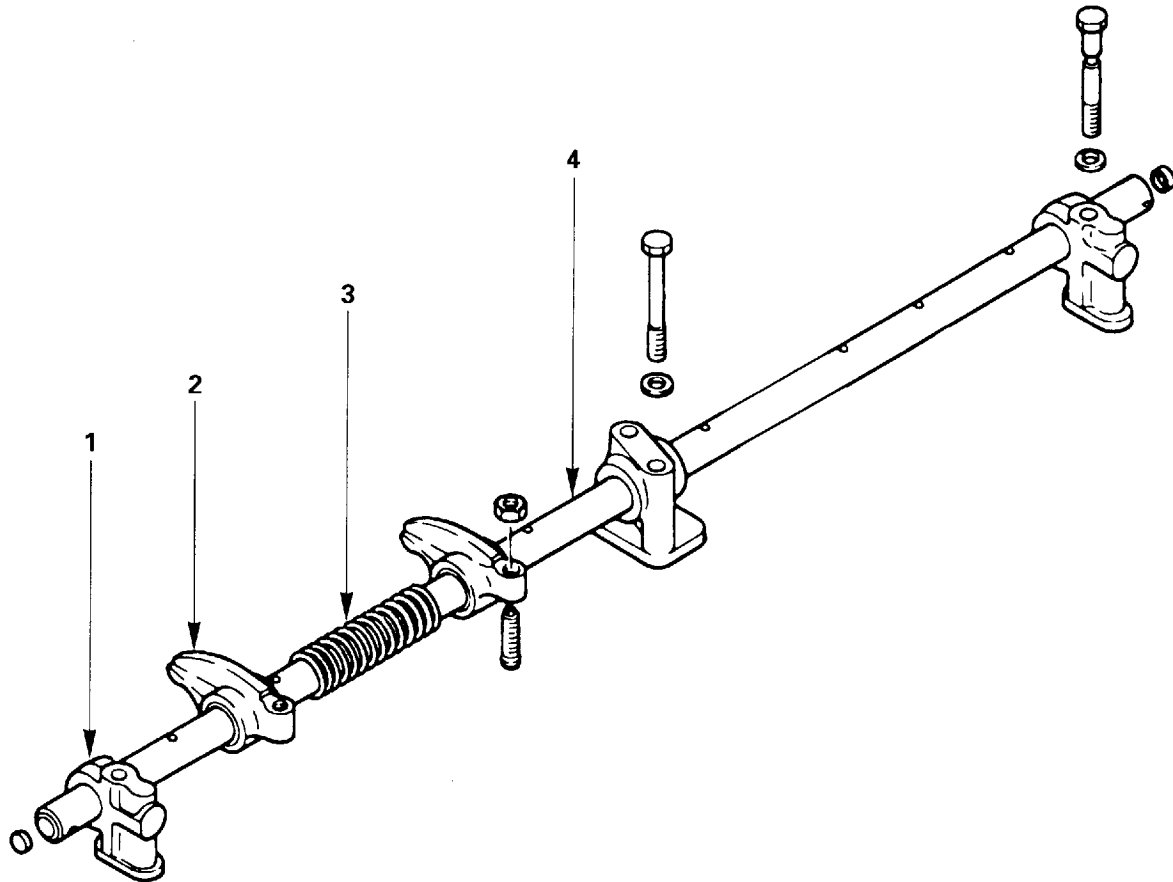
Measure the crankshaft end play at the thrust bearing (center main bearing) before disassembly.

mm (in)

	Standard	Limit
Crankshaft End Play	0.15–0.33 (0.006–0.013)	0.4 (0.016)



ROCKER ARM, AND ROCKER ARM SHAFT DISASSEMBLY STEPS

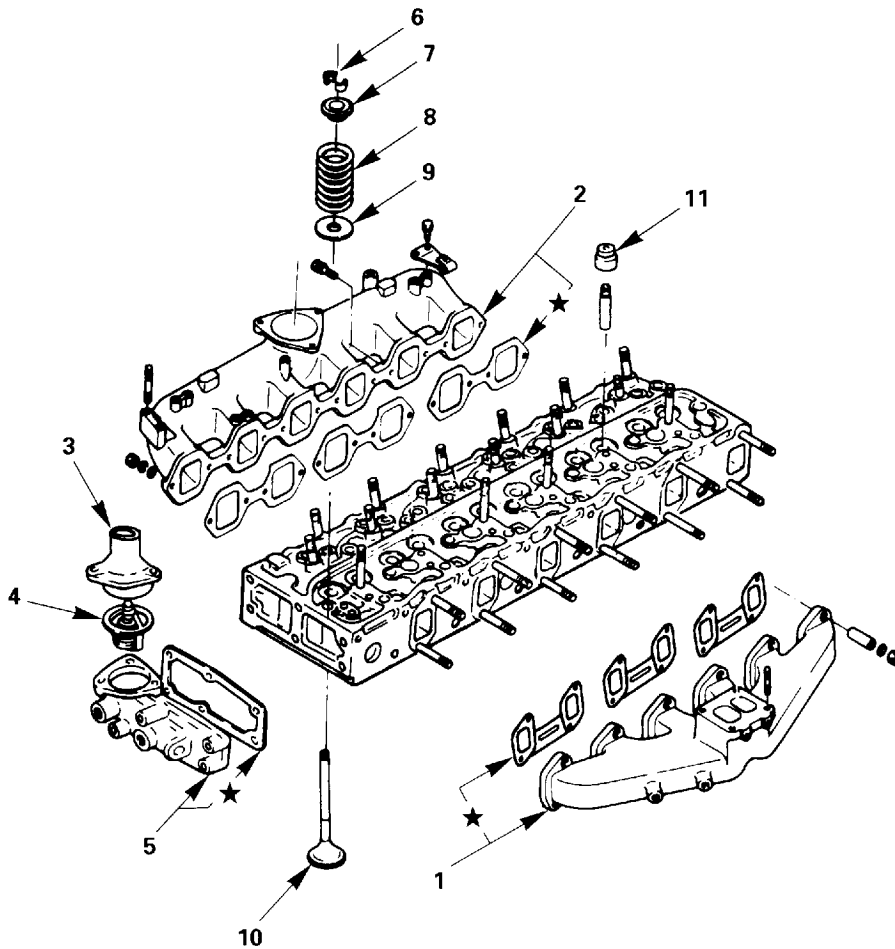


Disassembly Steps

1. Bracket
2. Rocker arm
3. Spring
4. Rocker arm shaft



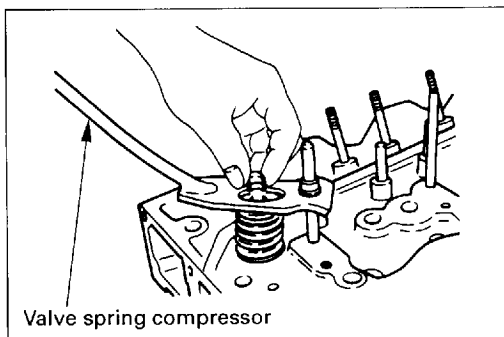
CYLINDER HEAD DISASSEMBLY STEPS



★ : Repair kit

Disassembly Steps

- | | |
|----------------------------------|-------------------------|
| 1. Exhaust manifold and gasket | 7. Spring seat (upper) |
| 2. Intake manifold and gasket | 8. Valve spring |
| 3. Water outlet pipe | 9. Spring seat (lower) |
| 4. Thermostat | 10. Valve |
| 5. Thermostat housing and gasket | 11. Valve stem oil seal |
| ▲ 6. Split collar | |



Important Operation



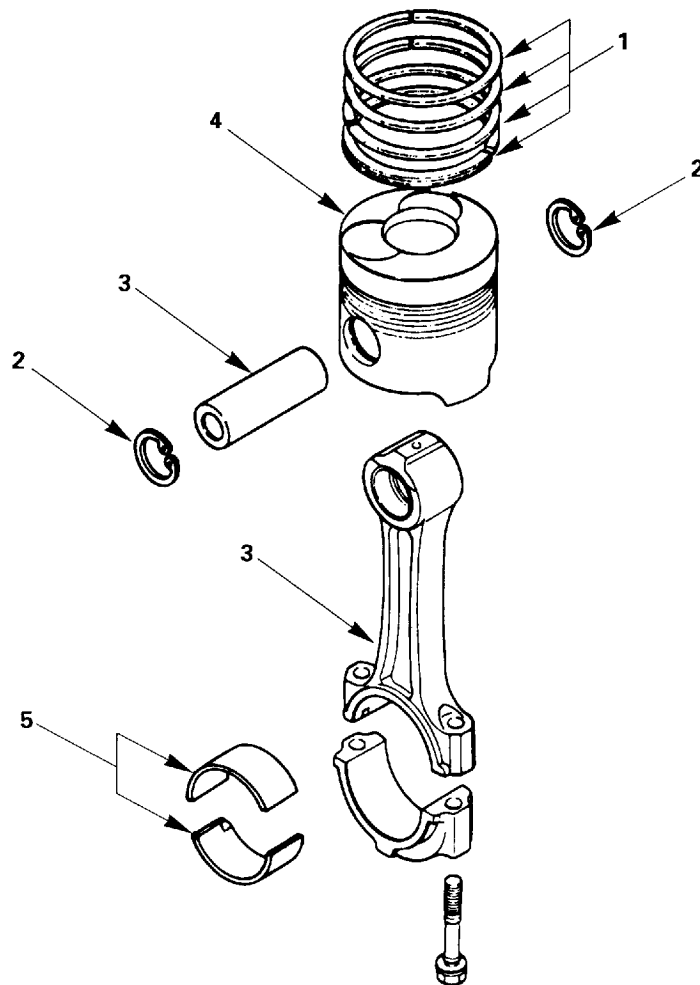
6. Split collar

Use the valve spring compressor to remove the split collar.

Valve Spring Compressor: 1-85235-006-0

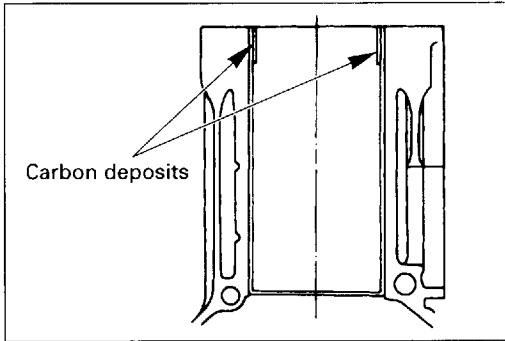


PISTON AND CONNECTING ROD DISASSEMBLY STEPS



Disassembly Steps

- ▲ 1. Piston rings
- ▲ 2. Snap ring
- ▲ 3. Piston pin and connecting rod
- 4. Piston
- 5. Connecting rod bearing

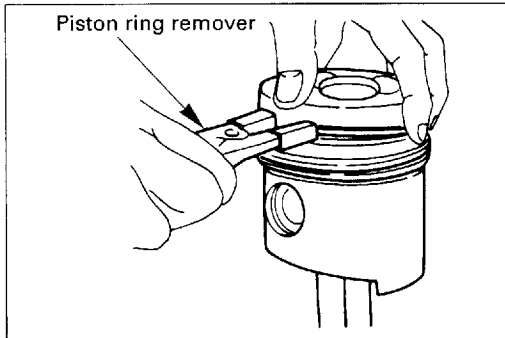


Important Operation

Note:

Remove any carbon deposits from the upper part of the cylinder bore.

This will prevent damage to the piston and the piston rings when they are removed from the cylinder bore.

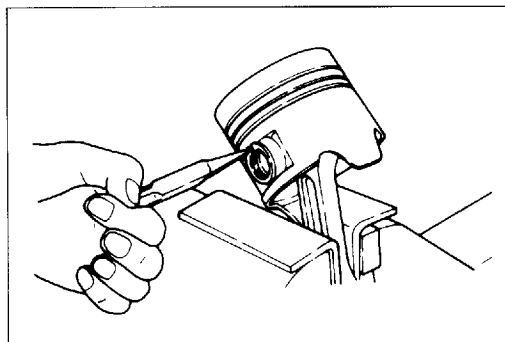


1. Piston Rings

Use a piston ring remover to remove the piston rings.

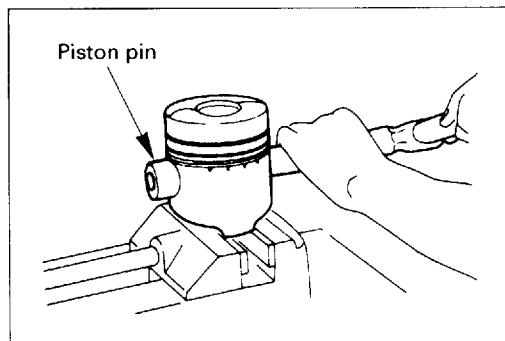
Do not attempt to use some other tool. Piston ring stretching will result in reduced piston ring tension.

Piston ring remover:



2, 3. Snap Ring and Piston Pin

(1) Use a pair of snap ring pliers to remove the snap ring.



(2) Tap the piston pin out with a hammer and brass bar.

SECTION 4

**ENGINE ASSEMBLY II
(INSPECTION & REPAIR)**

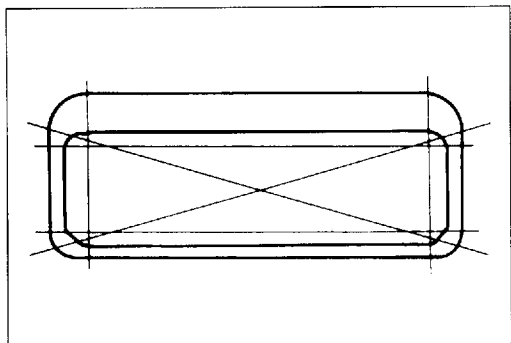
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INSPECTION AND REPAIR

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.



CYLINDER HEAD

Cylinder Head Lower Face Warpage

1. Use a straight edge and a feeler gauge to measure the four sides and the two diagonals of the cylinder head lower face.
2. Regrind the cylinder head lower face if the measured values are greater than the specified limit but less than the maximum grinding allowance.

If the measured values exceed the maximum grinding allowance, the cylinder head must be replaced.

Cylinder Head Lower Face Warpage mm (in)

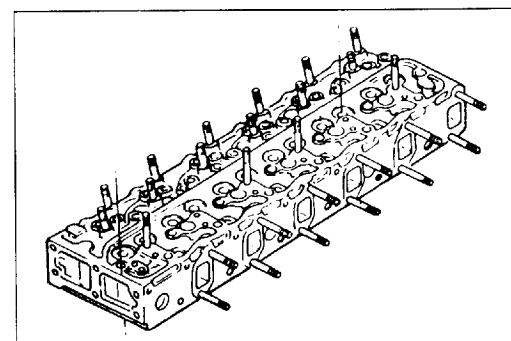
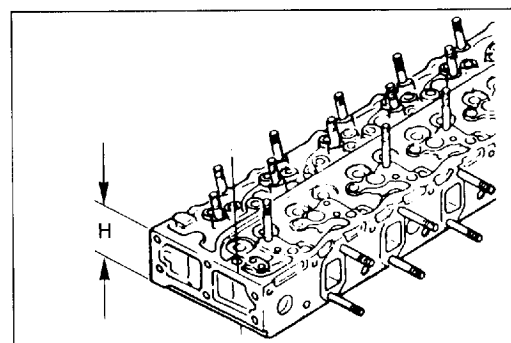
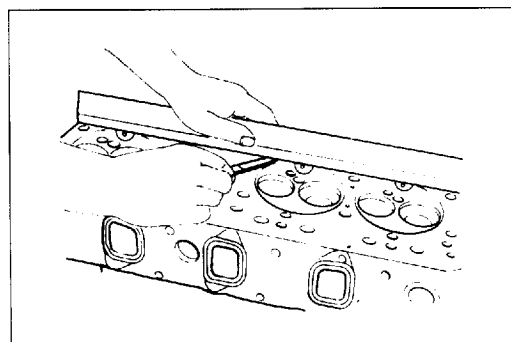
Standard	Limit	Maximum Grinding Allowance
0.075 (0.003) or less	0.2 (0.0079)	0.3 (0.012)

Cylinder Head Height (Reference) mm (in)

Standard	Limit
89.95 (3.541)–90.05 (3.545)	89.65 (3.530)

Note:

If the cylinder head lower face is reground, valve depression must be checked.

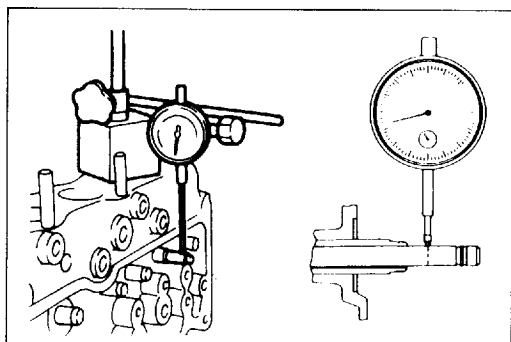


Water Jacket Water Pressure Test

Use the hydraulic gauge to check the water jacket water pressure.

Apply water pressure to the water jacket at 490 kPa (5 kgf/cm²/71.1 psi) for three minutes.

Check the entire cylinder head for water leakage.



VALVE GUIDE

Valve Stem and Valve Guide Clearance

Measuring Method - 1

1. With the valve stem inserted in the valve guide, set the dial indicator needle to "0".

2. Move the valve head from side to side

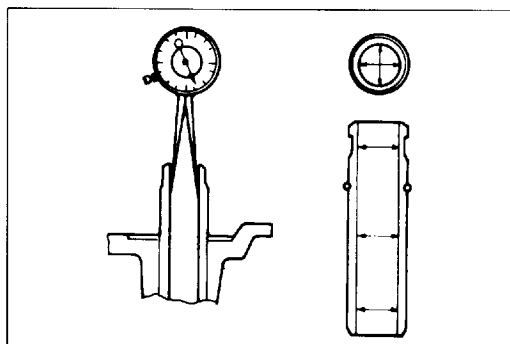
Note the total dial indicator reading (TIR).

This value is the clearance between the valve stem and the valve guide.

If the measured values exceed the specified limit, the valve and the valve guide must be replaced as a set.

Valve Stem Clearance mm (in)

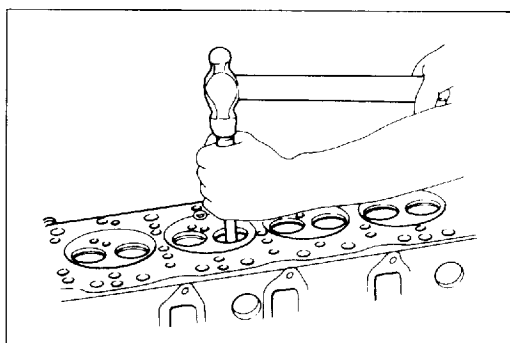
	Standard	Limit
Intake Side TIR	0.039-0.071 (0.0015-0.0028)	0.20 (0.008)
Exhaust Side TIR	0.064-0.096 (0.0025-0.0038)	0.25 (0.0098)



Measuring Method - II

1. Measure the valve stem outside diameter.
2. Use a caliper calibrator or a telescoping gauge to measure the valve guide inside diameter.

The difference between the valve stem outside diameter and the valve guide inside diameter is equal to the valve stem clearance.

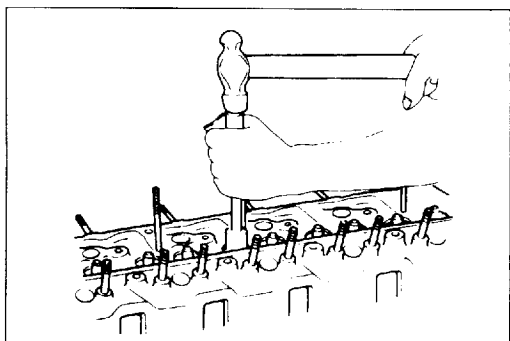


Valve Guide Replacement

Valve Guide Removal

Use a hammer and the valve guide remover to drive out the valve guide from the cylinder head lower face.

Valve Guide Remover: 9-85220-035-0



Installation

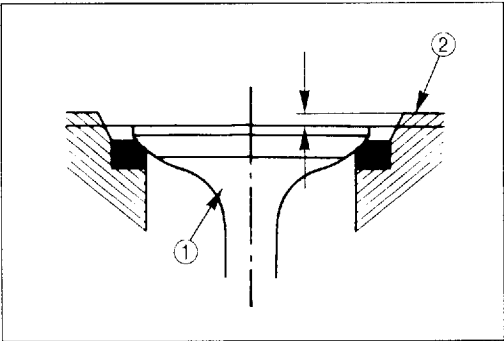
1. Apply clean engine oil the outer periphery of the valve guide.
2. Attach the installer to the valve guide.
3. Use a hammer to drive in the valve guide from the upper face of the head until the installer's lower edge meets the head surface.

Valve guide installer: 1-85232-001-0

4. After installation, measure the distance (height) from the cylinder head's upper surface to the upper edge of the valve guide.

Height to valve guide upper edge mm (in)

14.1 (0.555)



Valve Depression

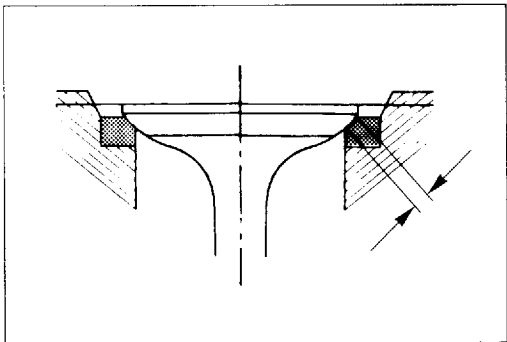
1. Install the valve ① to the cylinder head ②.
2. Use a depth gauge or a straight edge with steel rule to measure the valve depression from the cylinder head lower surface.

If the measured value exceeds the specified limit, the valve seat insert and/or valve must be replaced.

If the valve is replaced, the valve guide must be also replaced.

mm (in)

	Standard	Limit
Intake and Exhaust Valve Depression	1.0 (0.039)	2.5 (0.098)



Valve Contact Width

1. Inspect the valve contact faces for roughness and unevenness.

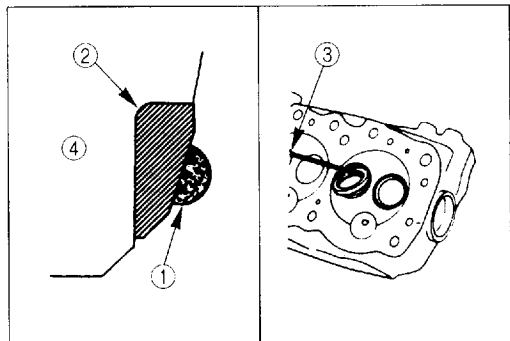
Make smooth the valve contact surfaces.

2. Measure the valve contact width.

If the measured value exceeds the specified limit, the valve seat insert must be replaced.

mm (in)

	Standard	Limit
Valve Contact Width	1.5 (0.059)	2.0 (0.079)



Valve Seat Insert Replacement

Valve Seat Insert Removal

1. Arc weld the entire inside circumference ① of the valve seat insert ②.

2. Allow the valve seat insert to cool for a few minutes.

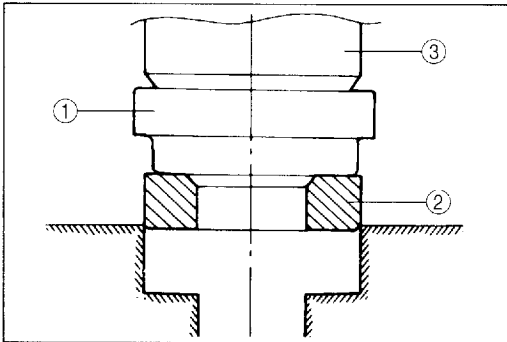
This will invite contraction and make removal of the valve seat insert easier.

3. Use a screwdriver ③ to pry the valve seat insert free.

Take care not to damage the cylinder head ④.



4. Carefully remove carbon and other foreign material from the cylinder head insert bore.



Valve Seat Installation

1. Carefully place the attachment ① (having the smaller outside diameter than the valve seat insert) on the valve seat insert ②.

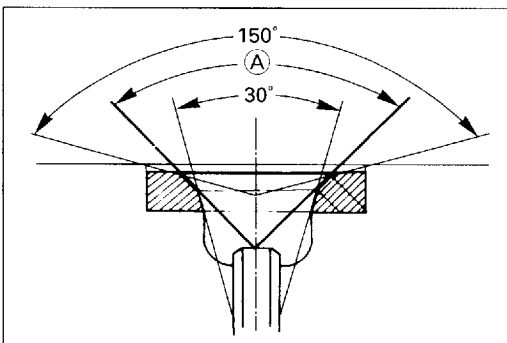
Note:

The smooth side of the attachment must contact the valve seat insert.

2. Use a bench press ③ to slowly apply pressure to the attachment and press the valve seat insert into place. (Amount of pressure needed is more than 25 kN (2,500 kgf/5,512 lb))

Note:

Do not apply an excessive amount of pressure with the bench press. Damage to the valve seat insert will result.

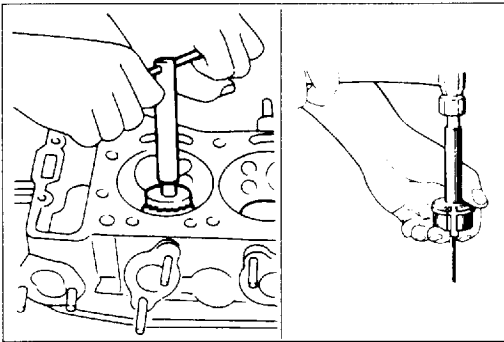


Valve Seat Insert Correction

1. Remove the carbon deposits from the valve seat insert surface.
2. Use valve cutters (15°, 30°, or 75° blades) to remove scratches and other rough areas.

This will bring the contact width back to the standard value of 90° (A).

Remove only the scratches and rough areas. Do not cut away too much. Take care not to cut away unblemished areas of the valve seat surfaces.

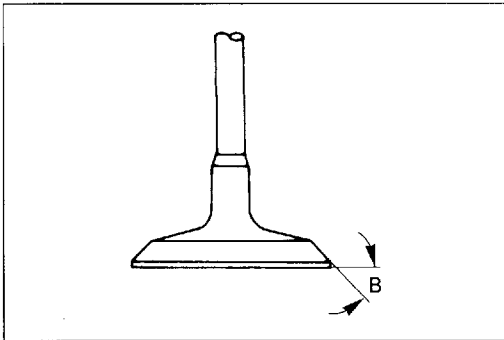


Angle Location	Standard
Intake Valve Seat Angle (B)	45°
Exhaust Valve Seat Angle (B)	45°

Note:

Use an adjustable valve cutter pilot.

Do not allow the cutter pilot to wobble inside the valve guide.



3. Apply abrasive compound to the valve seat insert surface.

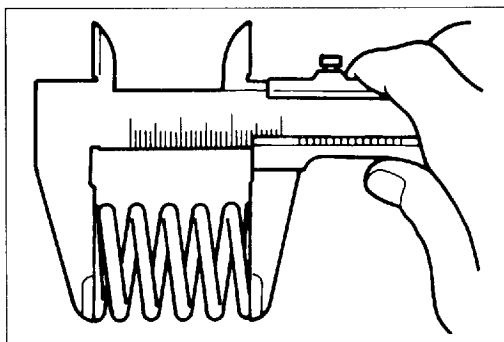
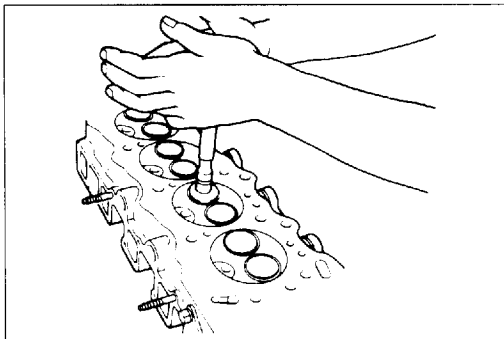
4. Insert the valve into the valve guide.

5. Hand lap the valve and the valve seat with a lapping cup.

This will provide optimum valve and valve seat contact for effective gas sealing.

6. Check that the valve contact width is correct.

7. Check that the valve seat insert surface is in contact with the entire circumference of the valve.



VALVE SPRING

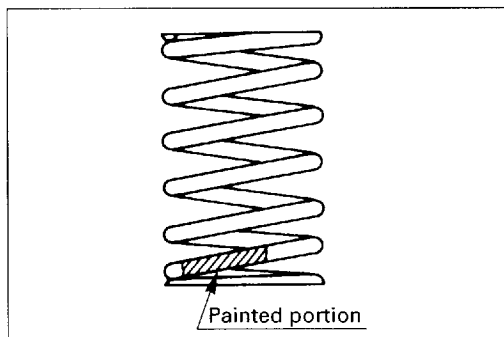
Valve Spring Free Length

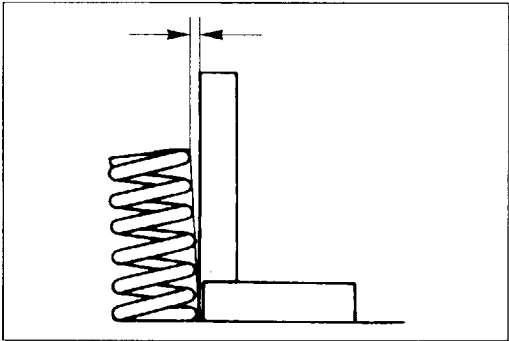
Use a vernier caliper to measure the valve spring free length.

If the measured value is less than the specified limit, the valve spring must be replaced.

mm (in)

	Color	Standard	Limit
Exhaust and Intake Valve Spring Free Length	blue	60.6 (2.39)	58.0 (2.28)





Valve Spring Inclination

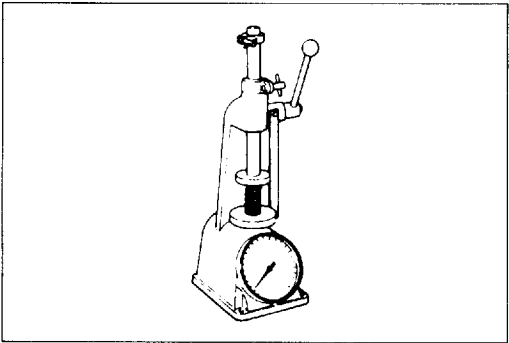


Use a surface plate and a square to measure the valve spring inclination.

If the measured value exceeds the specified limit, the valve spring must be replaced.

mm (in)

	Standard	Limit
Valve Spring Inclination	less than 1.9 (0.075)	2.7 (0.106)



Valve Spring Tension

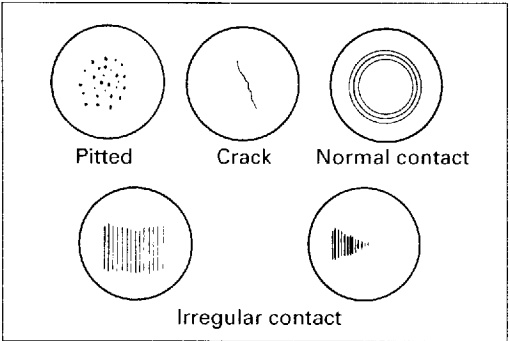


Use a spring tester to measure the valve spring tension.

If the measured value is less than the specified limit, the valve spring must be replaced.

N (kg/lb)

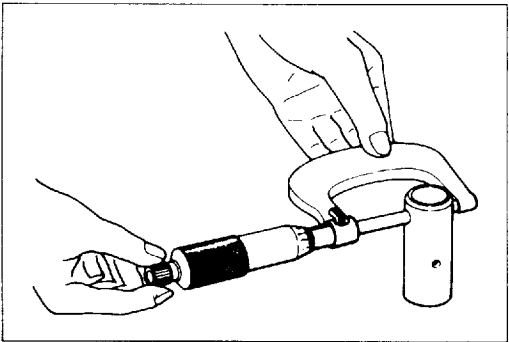
Set Length	Standard	Limit
44.5 mm (1.752 in)	142 (14.5/30.9)	127 (13.0/28.7)



TAPPET (Cam Follower or Valve Lifter)



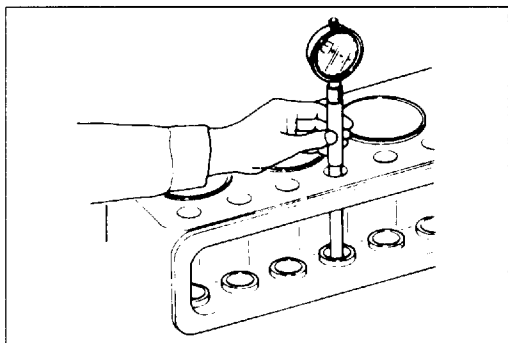
Inspect the tappets for excessive wear, damage and any abnormalities.



Use a micrometer to measure the tappet diameter.

mm (in)

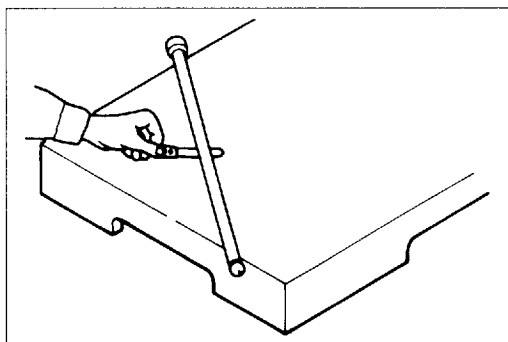
	Standard	Limit
Tappet Diameter	27.97–27.98 (1.1020–1.1024)	27.92 (1.1000)



Use a dial indicator to measure the clearance between the tappet and cylinder body tappet travelling bore.

mm (in)

	Standard	Limit
Tappet and Tappet Travelling Bore Clearance	0.020–0.054 (0.001–0.002)	0.1 (0.004)



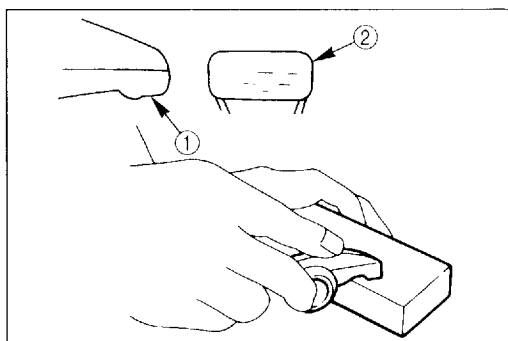
PUSH ROD

Use a filler gauge to measure the valve push rod run out.

Roll the push rod along a smooth flat surface (illustration).

mm (in)

	Limit
Push Rod Run-Out	0.3 (0.012)

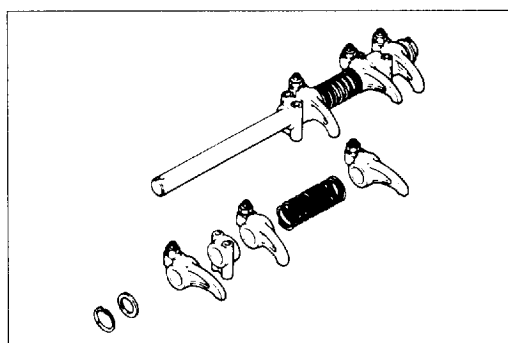


Rocker Arm Correction

Inspect the rocker arm valve stem contact surfaces for ridge ① and scoring ②.

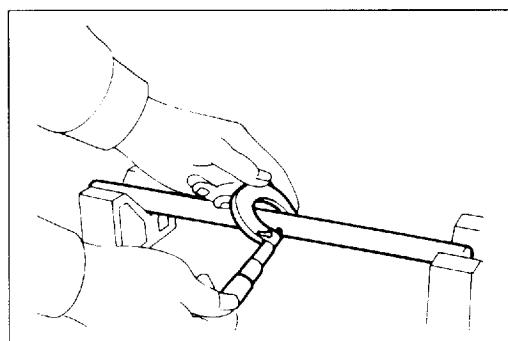
If the surfaces have light ridge or scoring, they may be honed with an oil stone.

If the ridge or scoring is severe, the rocker arm must be replaced.



ROCKER ARM SHAFT AND ROCKER ARM

Inspect all disassembled parts for wear, damage and any abnormalities.



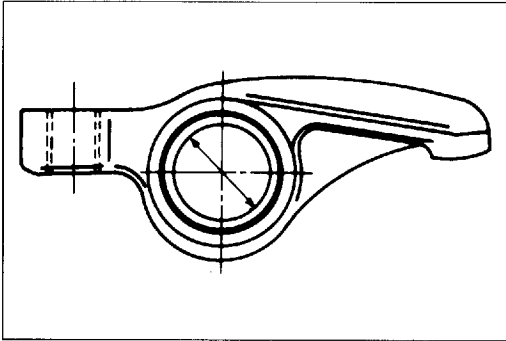
Rocker Arm Shaft Outside Diameter

Use a micrometer to measure the rocker arm outside diameter.

If the measured value is less than the specified limit, the shaft must be replaced.

mm (in)

	Standard	Limit
Rocker Arm Shaft Diameter	18.98–19.00 (0.747–0.748)	18.85 (0.742)



Rocker Arm Shaft and Rocker Arm Clearance

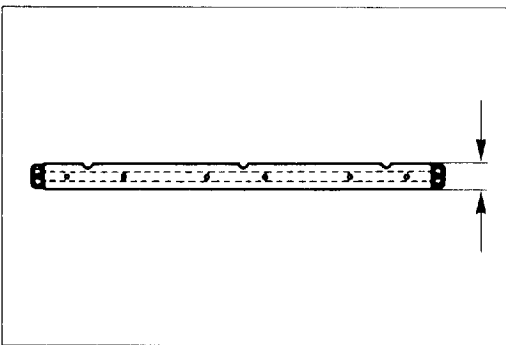
1. Use a vernier caliper to measure the rocker arm bushing inside diameter.

mm (in)

	Standard	Limit
Rocker Arm Bushing Inside Diameter	19.01–19.03 (0.749–0.750)	19.05 (0.751)

2. Measure the rocker arm shaft outside diameter.

Replace either the rocker arm or the rocker arm shaft if the clearance exceeds the specified limit.

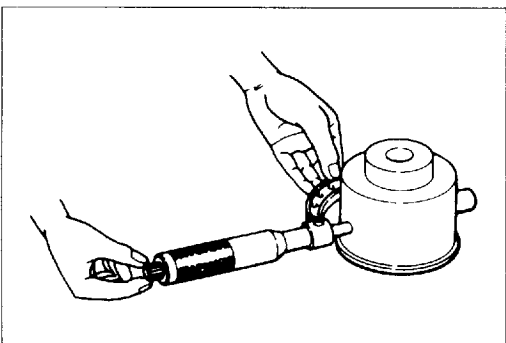


mm (in)

	Standard	Limit
Rocker Arm Bushing and Rocker Arm Shaft Clearance	0.01–0.05 (0.0004–0.0020)	0.2 (0.0079)

3. Check that the rocker arm oil port is free of obstructions.

If necessary, use compressed air to clean the rocker arm oil port.



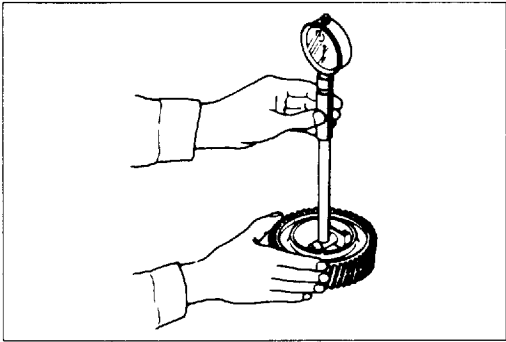
IDLER GEAR AND IDLER GEAR SHAFT

1. Use a micrometer to measure the idler gear shaft outside diameter.

If measured diameter exceeds specified limit, replace the idler gear shaft.

mm (in)

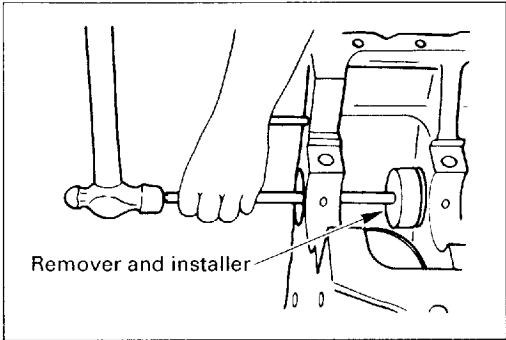
	Standard	Limit
Idler Gear Shaft Outside Diameter	44.945–44.975 (1.769–1.771)	44.9 (1.768)



2. Use a dial indicator to measure the idler gear inside diameter.

mm (in)

	Standard	Limit
Idler Gear and Idler Gear Shaft Clearance	0.025–0.085 (0.001–0.003)	0.2 (0.008)



CAMSHAFT

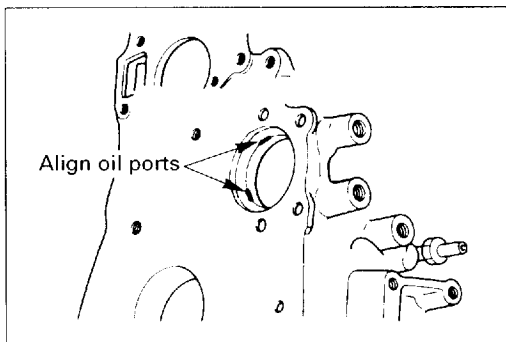
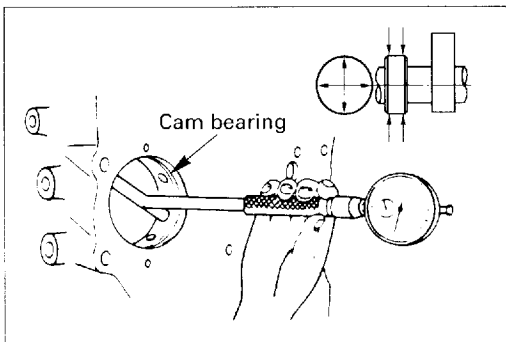
1. Use the camshaft bearing remover and installer to remove camshaft bearing from the cylinder body.

Camshaft Bearing Remover and Installer: 9-8523-1818-0

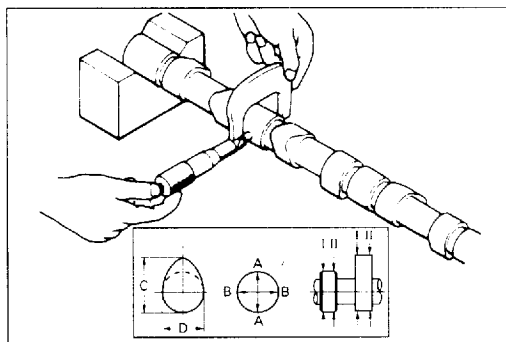
2. Measure the clearance between the cam journal and the camshaft bearing.

mm (in)

	Standard	Limit
Cam Journal and Cam Bearing Clearance	0.03–0.09 (0.001–0.004)	0.15 (0.006)



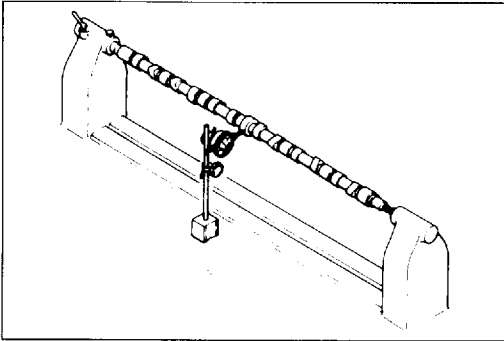
3. Align the camshaft bearing oil holes with the mating oil ports (machined on the cylinder body camshaft bearing fitting bore).



4. Use a micrometer to measure the cam lobe height.
If the cam lobe height is less than the specified limit, the camshaft must be replaced.

mm (in)

	Standard	Limit
Cam Lobe Height (C-D)	7.71 (0.304)	7.21 (0.284)
Cam Journal Diameter	55.94–55.97 (2.202–2.204)	55.6 (2.189)



5. Place the camshaft on a measuring stand.

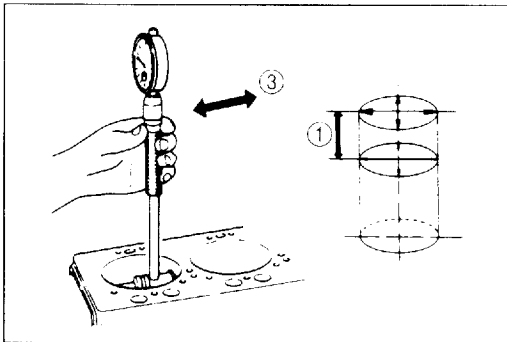
Use a dial indicator to measure the camshaft runout.

Note the total indicator reading (TIR).

If the measured run-out exceeds the specified limit, the camshaft must be replaced.

mm (in)

	Limit
Camshaft Run-Out TIR	0.12 (0.005)



CYLINDER BODY AND LINER

Cylinder Liner Bore Measurement

Use a cylinder indicator to measure the cylinder liner bore at measuring position ① in line with the crankshaft ② and across the crankshaft ③.

Measuring Point ① mm (in): 20.0 (0.79) (Maximum Wear Portion)

If the measured value exceeds the specified limit, the cylinder liner must be replaced.

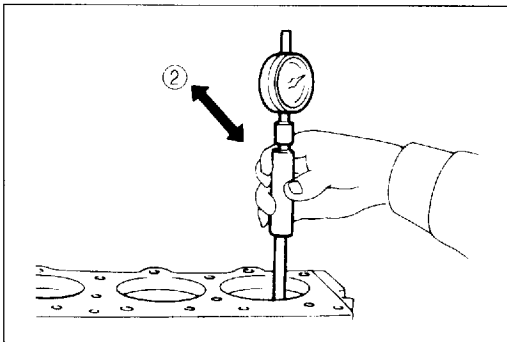
mm (in)

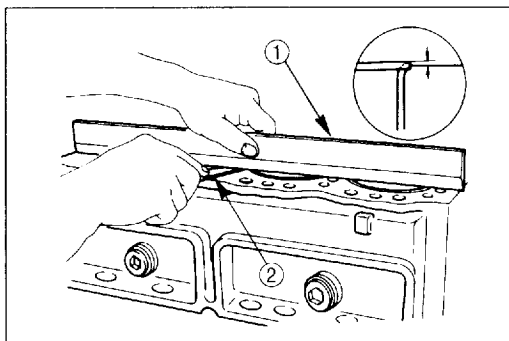
	Standard	Limit
Cylinder Liner Bore Total Indicator Reading	105.021–105.060 (4.1347–4.1362)	105.20 (4.1417)

Note:

The inside of the dry type cylinder liner is chrome plated. It cannot be rebored or honed.

If the inside of the cylinder liner is scored or scorched, the cylinder liner must be replaced.





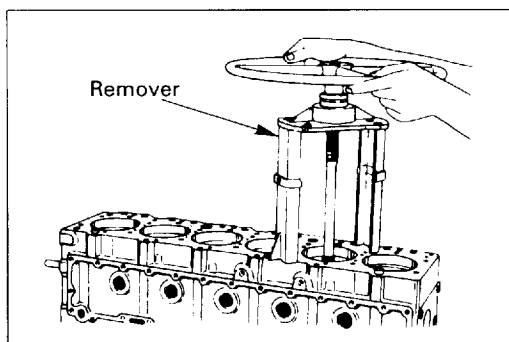
Cylinder Liner Projection Inspection

1. Hold a straight edge ① along the top edge of the cylinder liner to be measured.
2. Use a feeler gauge ② to measure each cylinder liner projection.

mm (in)

	Standard
Cylinder Liner Projection	0.03–0.10 (0.001–0.004)

The difference in the cylinder liner projection height between any two adjacent cylinders must not exceed 0.03 mm (0.001 in).



Cylinder Liner Replacement

Cylinder Liner Removal

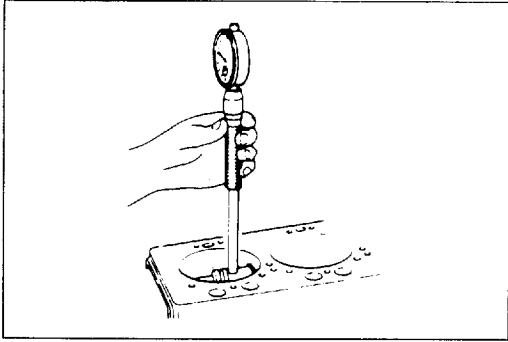
1. Set the cylinder liner remover to the cylinder liner.
2. Check that the remover shaft ankle is firmly gripping the cylinder liner bottom edge.
3. Slowly turn the remover shaft handle counterclockwise to pull the cylinder liner free.

Cylinder Liner Remover: 9-8523-1169-0

Cylinder Liner Remover Ankle: 5-8523-1004-0

Note:

Take care not to damage the cylinder body upper face during the cylinder liner removal procedure.



Cylinder Bore Measurement

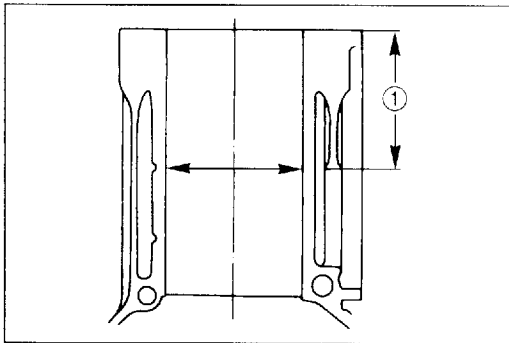
Cylinder Liner Grade Selection



The term "grade" refers to the cylinder body inside diameter and the cylinder liner outside diameter combination. Measure the cylinder body inside diameter and select the appropriate cylinder liner grade.

Loose fitting cylinder liners (the liner is too small for the cylinder bore) will adversely affect engine cooling efficiency and may lead to serious engine damage.

Cylinder liners which are too large for the cylinder bore will be difficult to install.

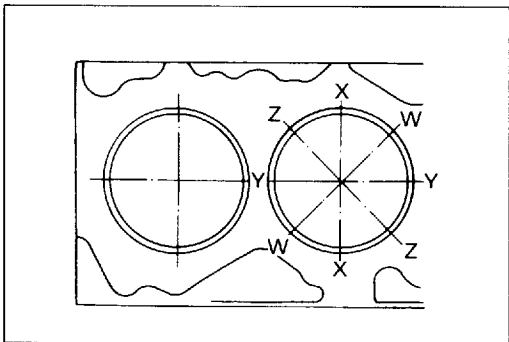


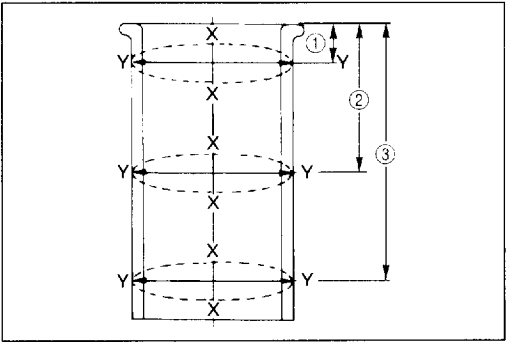
Cylinder Body Inside Diameter Measurement

1. Take measurements at measuring point ① across the positions W-W, X-X, Y-Y, and Z-Z.

Measuring Point ① : 115 mm (4.531 in)

2. Calculate the average value of the four measurements to determine the correct cylinder liner grade.





Cylinder Liner Outside Diameter Measurement

1. Take measurements at measuring point ①, ②, and ③.

Measuring Points mm (in):

- ① 20.0 (0.788)
- ② 105.0 (4.137)
- ③ 195.0 (7.683)

2. Calculate the average value of the 6 measurements to determine the correct cylinder liner grade.

mm (in)

Cylinder Liner Fitting Clearance Standard	0.001–0.019 (0.00004–0.0007)
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Cylinder Bore and Cylinder Liner Outside Diameter Combinations

(Reference)

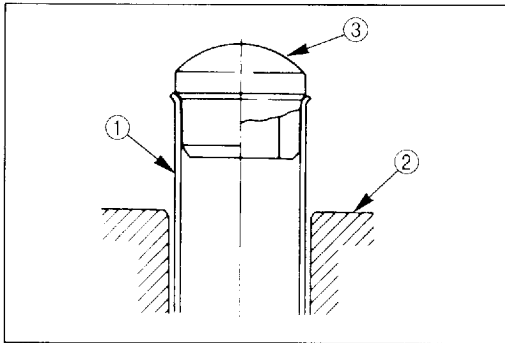
mm (in)

Grade	Cylinder Bore	Cylinder Liner Outside Diameter
1	107.001–107.010 (4.2126–4.2130)	107.011–107.020 (4.2130–4.2134)
2	107.011–107.020 (4.2130–4.2134)	107.021–107.030 (4.2134–4.2138)
3	107.021–107.030 (4.2134–4.2138)	107.031–107.040 (4.2138–4.2142)



Cylinder Liner Installation

1. Carefully wipe away any foreign material from the cylinder liner inside and outside surfaces and the cylinder bore.
2. Use new kerosene or diesel oil to thoroughly clean the cylinder liner and bore surfaces.
3. Use a clean rag to remove all traces of kerosene or diesel oil from the cylinder liner and bore surfaces.



4. Insert the cylinder liner ① into the cylinder body ② from the top of the cylinder body.
5. Set the cylinder liner installer ③ to the top of the cylinder liner.

Cylinder Liner Installer: 5-8522-1018-0

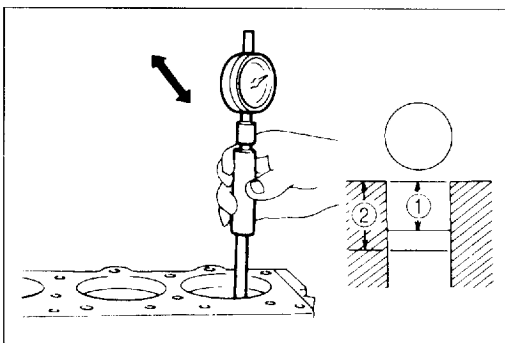
6. Position the cylinder body so that the installer center ③ is directly beneath the bench press shaft center ④.
7. Check that the cylinder liner is set perpendicular to the cylinder.

Check that the cylinder liner does not wobble.



8. Use the bench press to apply an initial seating force of 5 kN (500 kgf/1,102 lb) to the cylinder liner.
9. Use the bench press to apply a final seating force of 25 kN (2,500 kgf/5,512 lb) to fully seat the cylinder liner.
10. After installing the cylinder liner, measure the cylinder liner projection.

Refer to "Cylinder Liner Projection Inspection."



Piston Grade Selection

The term "piston grade" refers to the piston diameter and cylinder liner bore combination.

Selection of the proper piston grade will ensure efficient engine operation, free from cylinder liner and piston problems.

Cylinder Liner Bore Measurement



1. Locate the two measuring points.
Cylinder Liner Measuring Point ①: 20 mm (0.788 in)
Cylinder Liner Measuring Point ②: 105 mm (4.173 in)
2. Measure the cylinder liner bore at measuring point ① and ② in four different directions (W-W, X-X, Y-Y, and Z-Z).
3. Calculate the average value of the eight measurements.

mm (in)

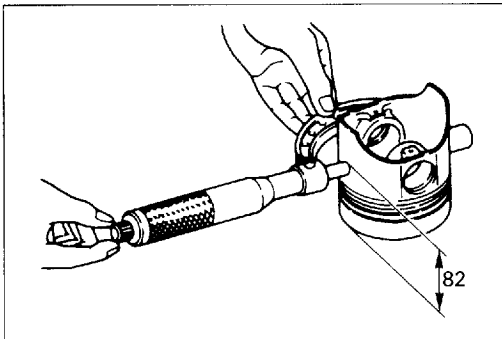
Cylinder Liner Bore Total Indicator Reading	105.021–105.060 (4.1347–4.1362)
---	------------------------------------

Relation between liner bore and piston grade mm (in)

Liner Bore Diameter	Piston Grade
105.021–105.040 (4.1347–4.1354)	AX
105.041–105.060 (4.1355–4.1362)	CX

Note:

It is most important that the correct piston grade be used. Failure to select the correct piston grade will result in piston seizure.



Piston Outside Diameter

Measure the piston outside diameter at the measuring point shown in the illustration.

Piston Grade (For service parts) mm (in)

Piston Outside Diameter	Piston Grade
104.959–104.974 (4.1322–4.1328)	AX
104.975–104.990 (4.1329–4.1335)	CX

Cylinder Liner Bore and Piston Clearance

mm (in)

Cylinder Liner Bore and Piston Clearance	0.051–0.085 (0.002–0.0033)
--	-------------------------------

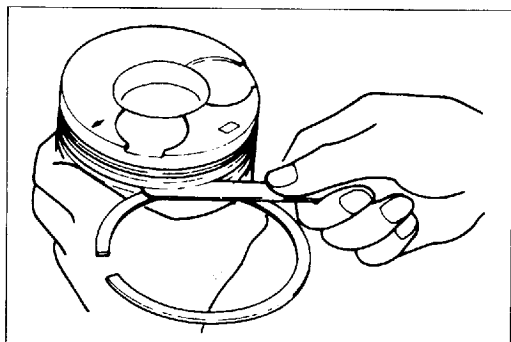
Note:

Cylinder liner piston kit clearances are preset. However, the cylinder liner installation procedure may result in slight decreases in cylinder liner bore clearances.

Piston Selection

Select the same grade number as the one for the cylinder liner inside diameter.

Grade of cylinder inside diameter	Grade of piston	Combination
AX	AX	OK
CX	CX	OK
AX	CX	NG
CX	AX	NG



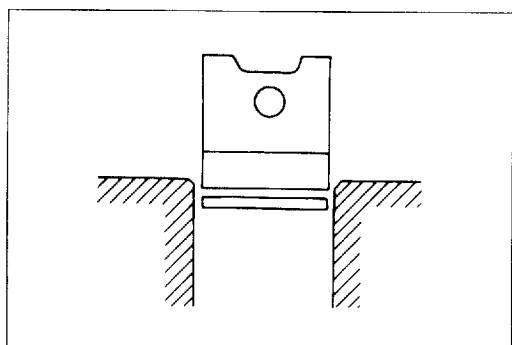
PISTON AND PISTON RING

Piston Ring and Piston Ring Groove Clearance

Use a feeler gauge to measure the clearance between the piston ring and the piston ring groove.

Do this at several points around the piston.

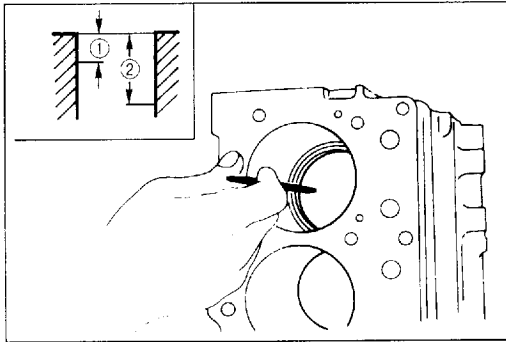
If the clearance between the piston ring and the piston ring groove exceeds the specified limit, the piston ring must be replaced.



Piston Ring and Piston Ring Groove Clearance

mm (in)

	Standard	Limit
1st Compression Ring	—	—
2nd Compression Ring	0.07–0.11 (0.0027–0.0043)	0.15 (0.0059)
3rd Compression Ring	0.05–0.09 (0.0020–0.0035)	
Oil Ring	0.03–0.07 (0.0012–0.0028)	



Piston Ring Gap

1. Insert the piston ring horizontally (in the position it would assume if it were installed to the piston) into the cylinder liner.
2. Use an inverted piston to push the piston ring into the cylinder liner until it reaches either measuring point ① or measuring point ②. Cylinder liner diameter is the smallest at these two points.

Do not allow the piston ring to slant to one side or the other. It must be perfectly horizontal.

Cylinder Liner Measuring Point ①: 10mm (0.39 in)

Cylinder Liner Measuring Point ②: 130mm (5.12 in)

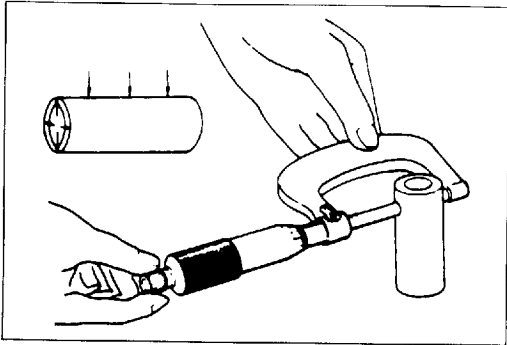
3. Use a feeler gauge to measure the piston ring gap.

If the measured value exceeds the specified limit, the piston ring must be replaced.

Piston Ring Gap

mm (in)

	Standard	Limit
1st Compression Ring	0.35–0.50 (0.014–0.020)	1.5 (0.059)
2nd Compression Ring	0.60–0.75 (0.0236–0.0295)	
3rd Compression Ring	0.60–0.75 (0.0236–0.0295)	
Oil Ring	0.30–0.50 (0.012–0.020)	



PISTON PIN

Piston Pin Outside Diameter

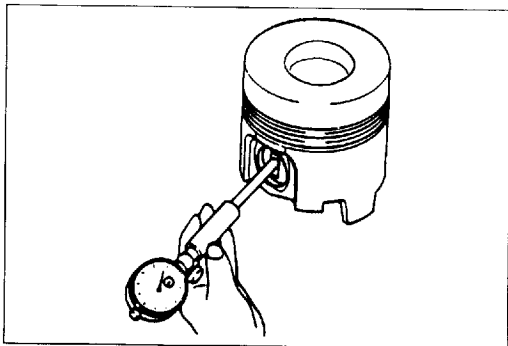


Use a micrometer to measure the piston pin outside diameter at several points.

If the measured piston pin outside diameter exceeds the specified limit, the piston pin must be replaced.

mm (in)

	Standard	Limit
Piston Pin Outside Diameter	35.000–35.005 (1.3780–1.3781)	34.95 (1.3760)



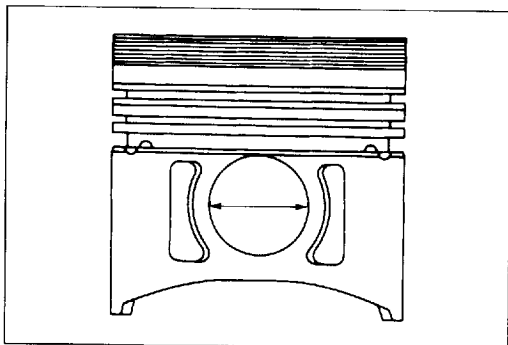
Piston Pin and Piston Clearance



Use an inside dial indicator to measure the piston pin hole.

mm (in)

	Standard
Piston Pin Hole Diameter	35.010–35.018 (1.3783–1.3787)

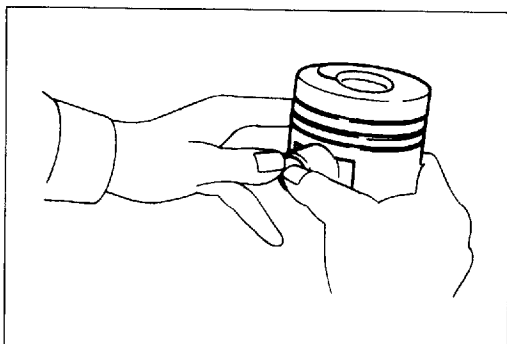


Piston Pin and Piston Pin Hole Clearance

Determine the clearance between the piston pin and the piston pin hole by calculating the difference between the piston pin hole diameter and the piston pin outside diameter.

mm (in)

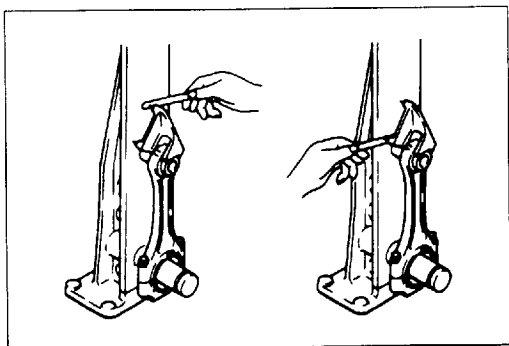
	Standard	Limit
Piston Pin and Piston Pin Hole Clearance	0.010–0.023 (0.00039–0.0009)	0.050 (0.00197)



If an inside dial indicator is not available, use the following procedure to check the piston pin fit.

1. Use a piston heater to heat the piston to approximately 60°C (140°F).
2. Push strongly against the piston pin with your thumbs.

The piston pin fitting should feel tight.



CONNECTING ROD

Connecting Rod Alignment



Use a connecting rod aligner to measure the connecting rod's twist distortion and parallelism between the rod's large and small ends.

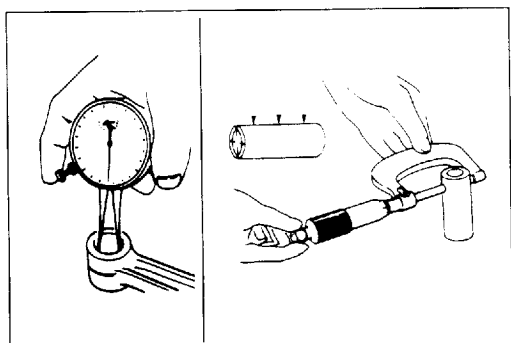
If the measured value exceeds the limit, replace the connecting rod.

Connecting Rod Alignment

(Per Length of 100 mm (3.94 in))

mm (in)

	Standard	Limit
Twist, Parallelism	0.05 (0.002) or less	0.20 (0.0079)



Piston Pin and Connecting Rod Small End Bushing Clearance

Use a caliper calibrator and a micrometer to measure the piston pin and connecting rod small end bushing clearance.

If the clearance between the piston pin and the connecting rod small end bushing exceeds the specified limit, replace either the piston pin or the connecting rod bushing.

mm (in)

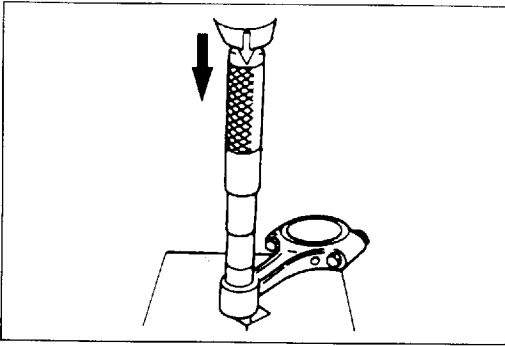
	Standard	Limit
Piston Pin and Connecting Rod Small End Bushing Clearance	0.012–0.025 (0.00047–0.00098)	0.05 (0.00197)

Connecting Rod Bushing Replacement

Connecting Rod Bushing Removal



1. Clamp the connecting rod in a vise.
2. Use a brass bar and a bench press or hammer to remove the connecting rod bushing.



Connecting Rod Bushing Installation

Use the connecting rod bushing installer to install the connecting rod bushing.



Connecting Rod Bushing Installer: 9-8523-1369-0

Note:

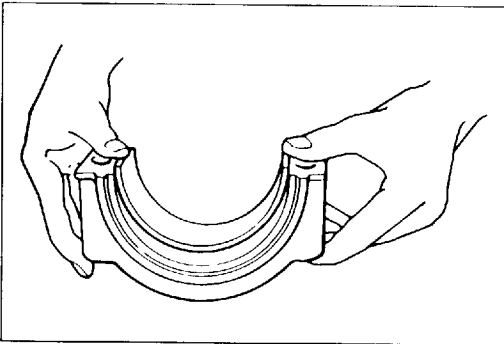
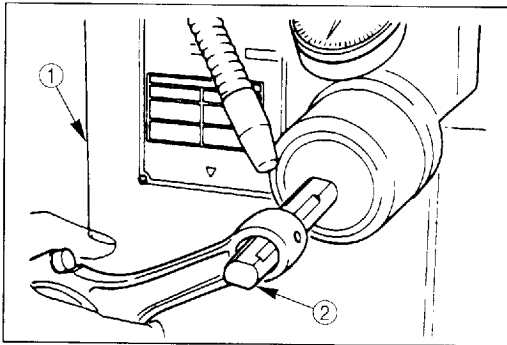


The connecting rod bushing oil port must be aligned with the connecting rod oil port.

3. Use a piston pin hole grinder ① fitted with a reamer ② or an adjustable pilot reamer to ream the piston pin hole.

mm (in)

	Standard
Connecting Rod Bushing Inside Diameter	35.017–35.025 (1.3786–1.3789)



Connecting Rod Bearing Inspection

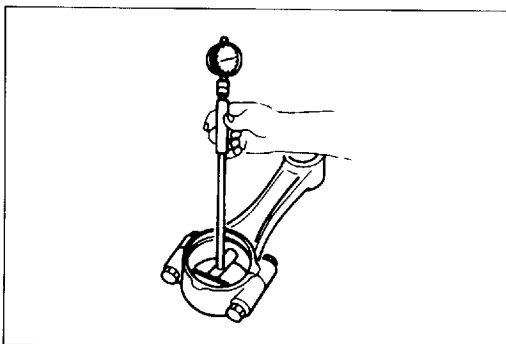


1. Fit the connecting rod bearing lower half into the connecting rod bearing cap.
2. Check the connecting rod bearing lower half tension. If the tension is insufficient, the bearing must be replaced.
3. Tighten the connecting rod and the bearing cap to the specified torque.



N·m (kgf·m/lb.ft)

	1st step	2nd step
Connecting Rod and Bearing Cap Bolt Tightening Torque	39 (4/29)	60°–90°



4. Use an inside dial indicator to measure the connecting rod inside diameter.

mm (in)

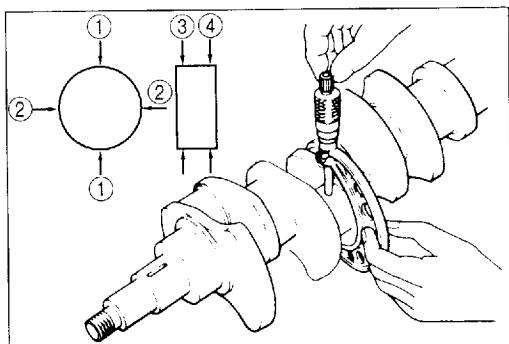
Connecting Rod Bearing Nominal Diameter	64 (2.520)
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CRANKSHAFT

Crankshaft and Bearing Inspection



1. Inspect the crankshaft journal surfaces and the crank pin surfaces for excessive wear and damage.
2. Inspect the oil seal fitting surfaces of the crankshaft front and rear ends for excessive wear and damage.
3. Replace or repair the crankshaft if any excessive wear or damage is discovered.
4. Inspect the crankshaft oil ports for obstructions.
5. Use high pressure air to clean the oil ports if necessary.



Crankshaft Journal and Crankpin Outside Diameter

1. Use a micrometer to measure the crankshaft journal outside diameter across points ① – ① and ② – ②.
2. Use the micrometer to measure the crankshaft journal outside diameter at the two points (③ and ④).
3. Repeat steps 1 and 2 to measure the crankshaft outside diameter.

mm (in)

	Position at	Standard
Crankshaft Journal Diameter	Center Bearing Only	79.905–79.925 (3.1459–3.1467)
	Other Bearings	79.919–79.939 (3.1464–3.1472)

mm (in)

	Standard
Crankshaft Pin Diameter	63.924–63.944 (2.5167–2.5175)

4. Measure the crankshaft journal outside diameter (and/or the crankpin outside diameter) and the bearing inside diameters to determine the bearing clearance.

Crankshaft Journal and Bearing Clearances

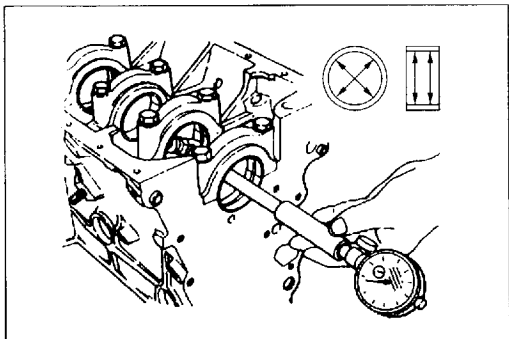
mm (in)

	Position at	Standard	Limit
Crankshaft Journal and Main Bearing Clearance	Center Bearing Only	0.039–0.098 (0.0015–0.0039)	0.11 (0.0043)
	Other Bearings	0.025–0.084 (0.0010–0.0033)	

Crankshaft Pin and Bearing Clearances

mm (in)

	Standard	Limit
Crankpin and Connecting Rod Bearing Clearance	0.03–0.073 (0.0012–0.0029)	0.10 (0.0039)



Crankshaft Journal Bearing Inside Diameter

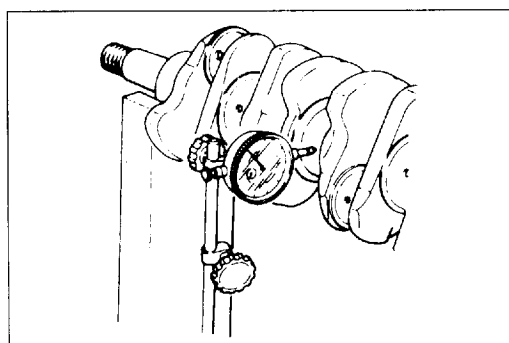
1. Install the main bearing cap with bearings to the cylinder body with the specified torque and facing the arrow mark on the bearing cap toward front. Place them in order of punched cylinder numbers.
2. Use an inside dial indicator to measure the main bearing diameters.

N·m (kgf·m/lb.ft)

Main Bearing Cap Torque	226 – 245 (23 – 25/166 – 181)
-------------------------	----------------------------------

mm (in)

Main Bearing Nominal Diameter	80 (3.1496)
-------------------------------	----------------



Crankshaft Run-Out

1. Mount the crankshaft on a set of V-blocks.
2. Set a dial indicator to the center of the crankshaft journal.
3. Gently turn the crankshaft in the normal direction of engine rotation.

Read the dial indicator (TIR) as you turn the crankshaft.

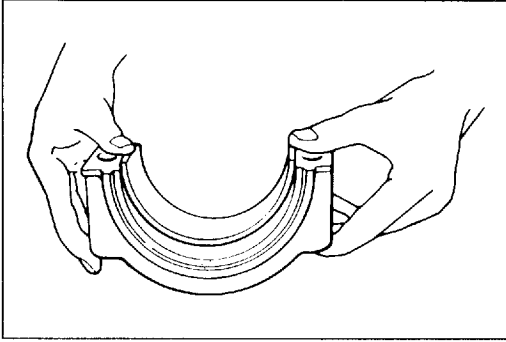
If the measured value exceeds the specified limit, the crankshaft must be replaced.

mm (in)

	Standard	Limit
Crankshaft Run-Out	0.05 (0.002) or less	0.40 (0.016)

If the crankshaft generated a crack after repair, replace the crankshaft.

Crankshaft can not be bench pressed, because it is finished with tuffride method.

**Main Bearing and Connecting Rod Bearing Tension**

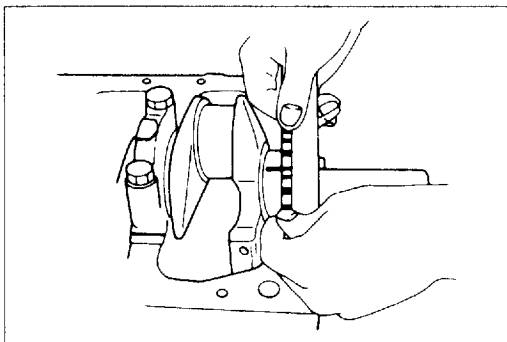
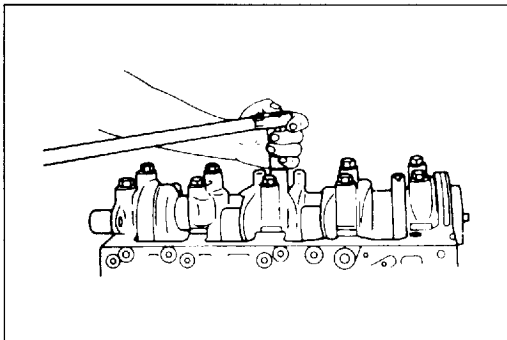
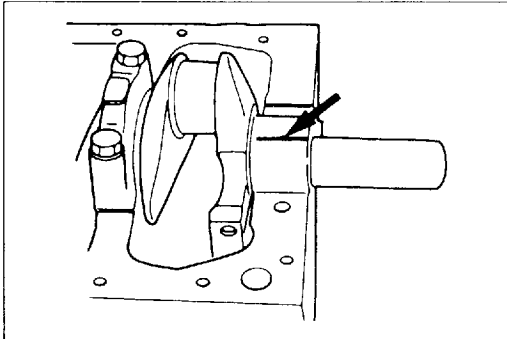
Check to see if the bearing has enough tension, so that good finger pressure is needed to fit the bearing into position.

Crankshaft Regrinding**Note:**

Crankshaft for 6BG1T can not be reground because it is finished with TUFFTRIDE method.

For the crankshaft on 6BG1T, no attempt should be made to grind finish the faces of the journals and crankpins as they are TUFFTRIDED (Special hardening treatment).

Therefore, the undersize bearings are not prepared:



Plastigage Clearance Measurements

This is another method to measure the crankjournal bearing clearance.

Crankshaft Journal Bearing Clearance

1. Clean the cylinder body, the journal bearing fitting portions, the bearing cap, and the inside the outside surfaces of the bearing.
2. Install the new journal bearing to the cylinder body.
3. Carefully place the crankshaft on the bearing.
4. Rotate the crankshaft approximately 30° to seat the bearing.
5. Place the Plastigage (arrow) over the crankshaft journal across the full width of the bearing.

Apply engine oil to the Plastigage to keep it from falling.

6. Install the bearing cap with the bearing.
7. Tighten the bearing cap to the specified torque.
Do not allow the crankshaft to turn during bearing cap installation and tightening.
8. Remove the bearing cap.
9. Compare the width of the plastigage attached to either the crankshaft or the bearing against the scale printed on the plastigage container.

If the measured value exceeds the limit, perform the following additional steps.

- 1) Use a micrometer to measure the crankshaft outside diameter.
- 2) Use an inside dial indicator to measure the bearing inside diameter.
- 3) Replace the crankshaft and/or the bearing if the measured value(s) exceed the limit.

Crankshaft Pin Bearing Clearance

1. Clean the crankshaft, the connecting rod, the bearing cap, and the bearings.
2. Install the bearing to the connecting rod.
Do not allow the crankshaft to move when installing the bearing cap.
3. Hold the connecting rod (with the bearing installed) against the crankshaft pin.
4. Attach the plastigage to the crankshaft pin.
Apply engine oil to the plastigage to keep it from falling.

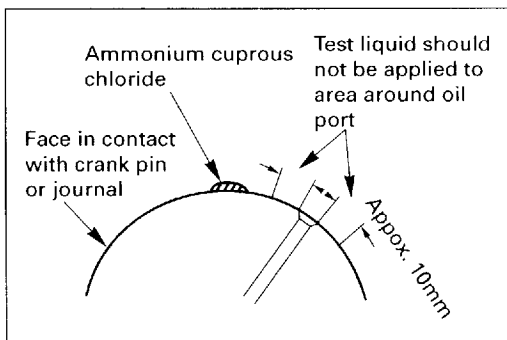


5. Install the connecting rod bearing cap and tighten it to the specified torque.
Do not allow the connecting rod to move when installing and tightening the bearing cap.



6. Remove the bearing cap.
7. Compare the width of the plastigage attached to either the crankshaft or the bearing against the scale printed on the plastigage container.
If the measured value exceeds the limit, perform the following additional steps.

- 1) Use a micrometer to measure the crankshaft outside diameter.
- 2) Use an inside dial indicator to measure the bearing inside diameter.
- 3) Replace the crankshaft and/or the bearing if the measured value(s) exceed the limit.

**Crankshaft Tufftriding Inspection****Inspection**

1. Use an organic cleaner to thoroughly clean the crankshaft. There must be no traces of oil on the surfaces to be inspected.
2. Prepare a 10% solution of ammonium cuprous chloride (dissolved in distilled water).
3. Use a spot glass rod to apply the solution to the surface to be inspected.

Hold the surface to be inspected perfectly horizontal to prevent the solution from running.

Note:

Do not allow the solution to come in contact with the oil ports and their surrounding area.

Judgement

1. Wait for thirty to forty seconds.

If there is no discoloration after thirty or forty seconds, the crankshaft is usable.

If discoloration appears (the surface being tested will become the color of copper), the crankshaft must be replaced.

2. Clean the surface being tested with clean water or steam immediately after completing the test.

Note:

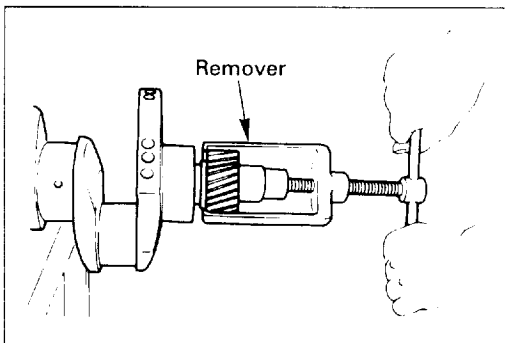
The ammonium cuprous chloride solution is highly corrosive. Because of this, it is imperative that the surfaces being tested be cleaned immediately after completing the test.



Crankshaft Gear Inspection

Visually inspect the crankshaft gear.

Replace the crankshaft gear if excessive wear or damage is discovered.



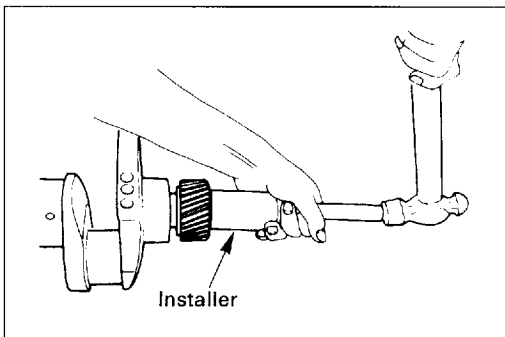
Crankshaft Gear Replacement

Removal



Use the crankshaft gear remover to remove the crankshaft gear.

Crankshaft Gear Remover: 9-8521-0141-0

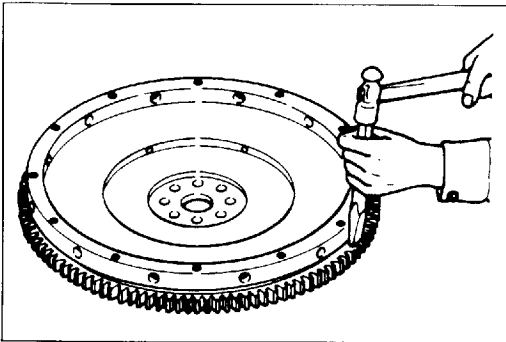


Installation



Use the crankshaft gear installer to install the crankshaft gear.

Crankshaft Gear Installer: 9-8522-0033-0



FLYWHEEL

Ring Gear Inspection

Inspect the ring gear.

If the ring gear teeth are broken or excessively worn, the ring gear must be replaced.

Ring Gear Replacement

Ring Gear Removal

Strike around the edges of the ring gear with a hammer and chisel to remove it.

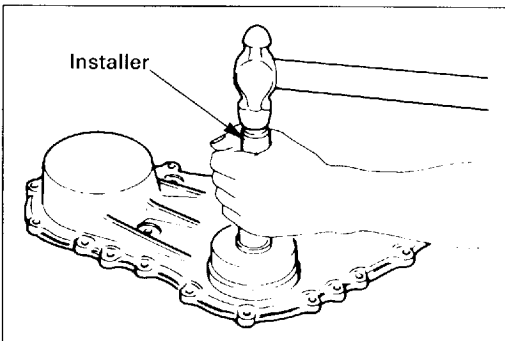
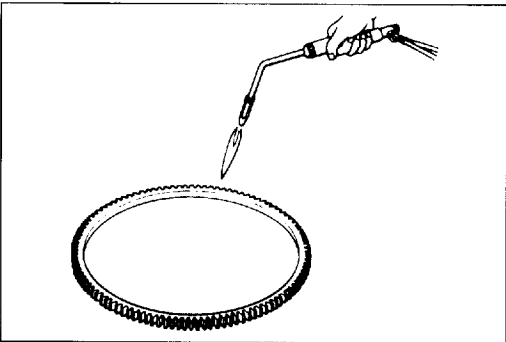


Ring Gear Installation

1. Heat the ring gear evenly with a gas-burner to invite thermal expansion.

Do not allow the temperature of the ring gear to exceed 200°C (390°F).

2. Use a hammer to install the ring gear when it is sufficiently heated.



TIMING GEAR CASE COVER

Crankshaft Front Oil Seal Replacement

Removal



Use an adapter and a hammer to remove the crankshaft front end oil seal.

Installation



Use the crankshaft front oil seal installer to install the crankshaft front oil seal.



Crankshaft Front Oil Seal Installer: 9-8522-0034-0

MEMO

SECTION 5

**ENGINE ASSEMBLY III
(REASSEMBLY)**

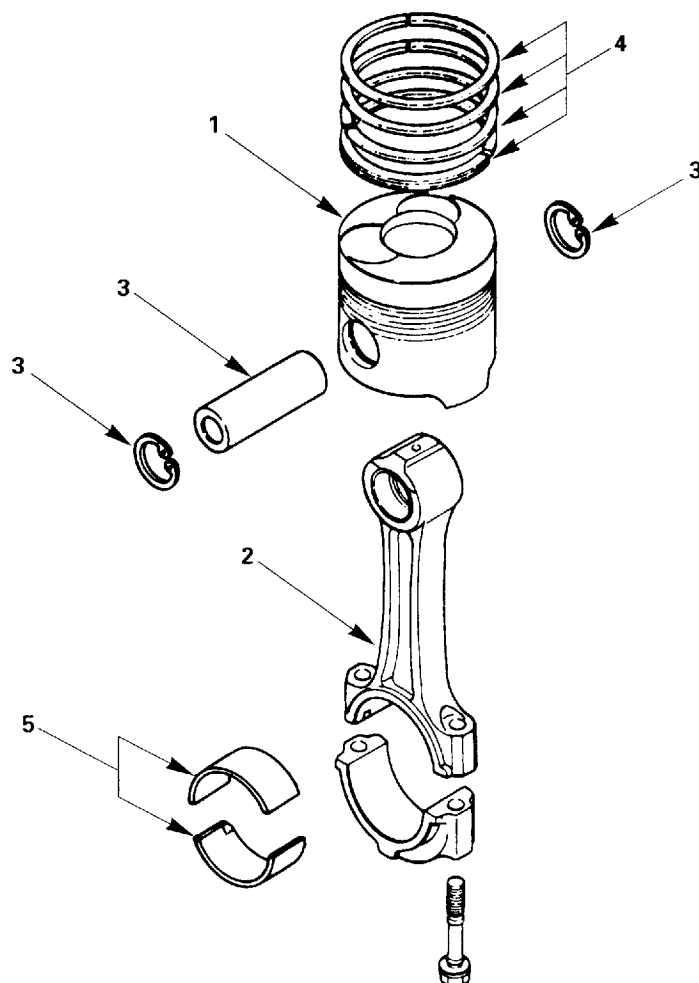
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Rocker arm and rocker arm shaft reassembly steps.....	5- 7
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External parts reassembly steps (Right-Hand Side)	5-21
Engine tuning operation	5-25



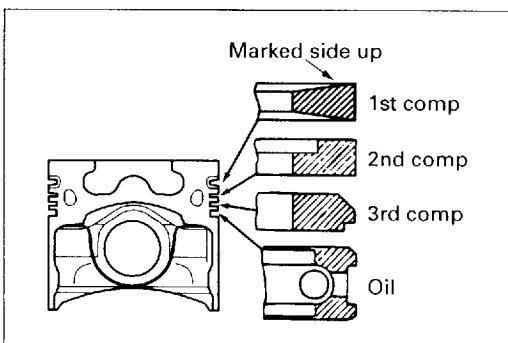
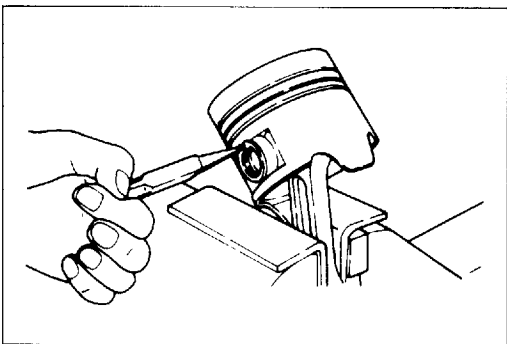
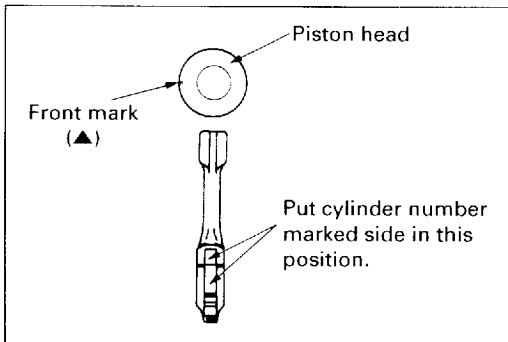
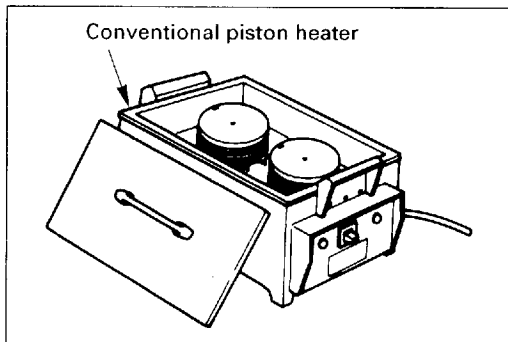
PISTON AND CONNECTING ROD REASSEMBLY STEPS

MIRROR COMPONENT



Reassembly Steps

- ▲ 1. Piston
- ▲ 2. Connecting-rod
- ▲ 3. Piston pin, Snap ring
- ▲ 4. Piston ring
- ▲ 5. Connecting rod bearing



PISTON AND CONNECTING ROD

Important Operations

1. Piston

Use a piston heater to heat the pistons to approximately 60°C (140°F).

2. Connecting Rod

- 1) Install the connecting rod to the piston with setting the marks as illustrated.
- 2) Install the piston pin into the piston and the connecting rod bushing.

Refer the description of piston pin in page 4-19.

3. Piston Pin, Snap Ring

- 1) Use a pair of snap ring pliers to install the piston pin snap ring.
- 2) Check that the piston moves smoothly on the piston pin.

4. Piston Ring

- 1) Use a piston ring installer to install the three piston rings.

Piston Ring Installer

Install the piston rings in the following order.

- (1) Oil ring
- (2) 3rd compression ring
- (3) 2nd compression ring
- (4) 1st compression ring

The marked side of the three compression rings must be facing up.

The undercut side of the 3rd compression ring will be facing down.

As the oil ring has no any facing mark, it may face in either direction.

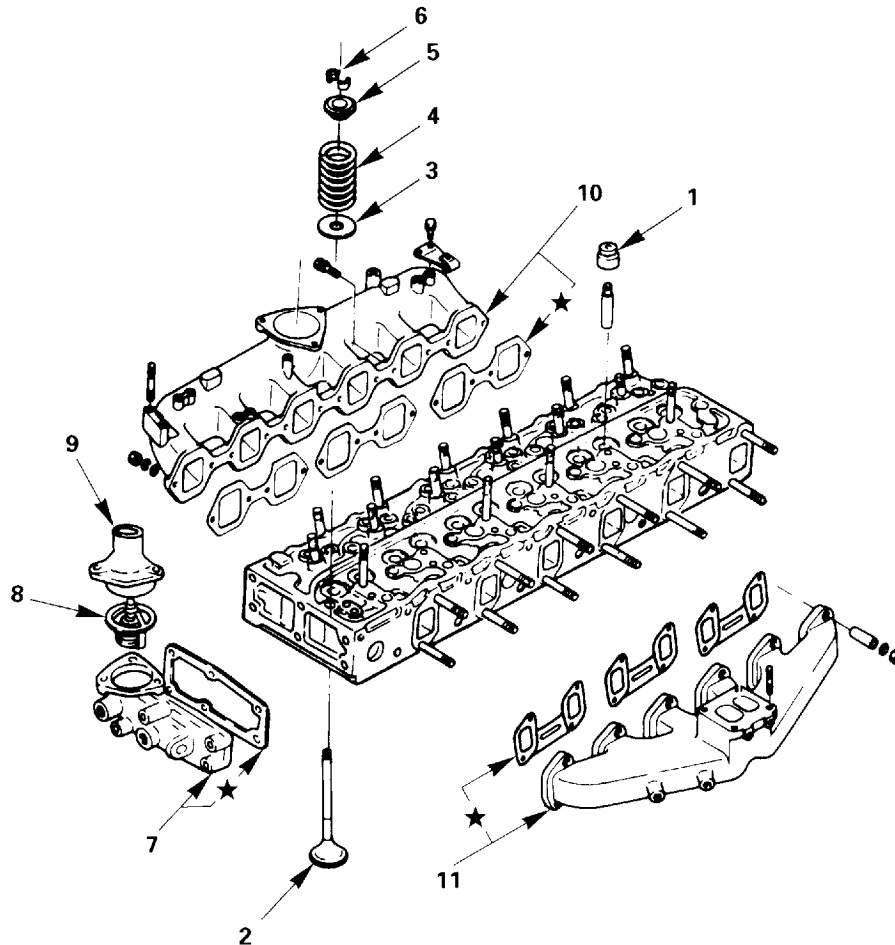
- 2) Lubricate the piston ring surfaces with engine oil.
- 3) Check that the piston rings rotate smoothly in the piston ring grooves.

5. Connecting Rod Bearing

- 1) Install the connecting rod bearings to the connecting rod large-end and the connecting rod cap.
- 2) Install the bearing cap to the connecting rod with semi-tightening the cap bolts.
- 3) Lubricate the bearing with engine oil.



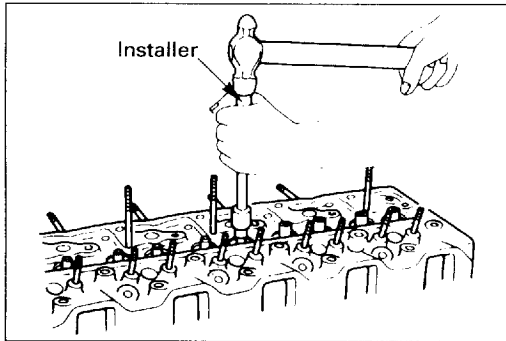
CYLINDER HEAD REASSEMBLY STEPS



★ : Repair kit

Reassembly Steps

- ▲ 1. Valve stem oil seal
- ▲ 2. Intake and exhaust valves
- 3. Spring seat (Lower)
- ▲ 4. Intake and exhaust valve springs
- 5. Spring seat (Upper) or valve rotator
- ▲ 6. Spring seat split collar
- 7. Thermostat housing and gasket
- 8. Thermostat
- 9. Water outlet pipe
- ▲ 10. Intake manifold and gasket
- ▲ 11. Exhaust manifold and gasket



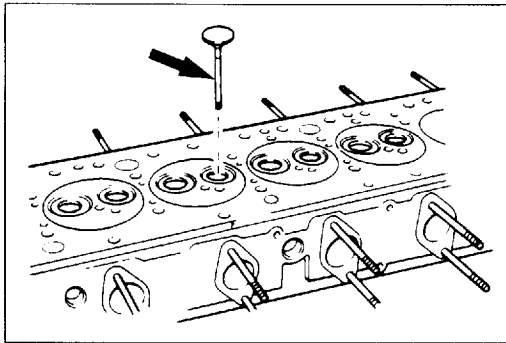
Important Operations



1. Valve Stem Oil Seal

- 1) Lubricate the oil seals and valve stem sealing areas with engine oil.
- 2) Use a valve stem oil seal installer to install the oil seal.

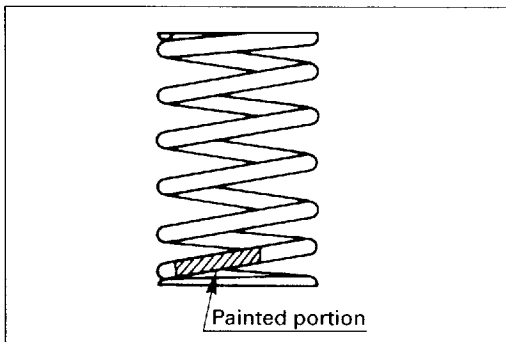
Valve Stem Oil Seal Installer: 1-85221-005-0



2. Intake and Exhaust Valves

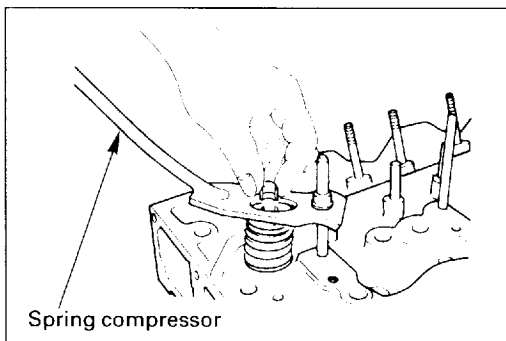
- 1) Place the cylinder head on a flat wooden surface.
- 2) Lubricate valve stems with engine oil.
- 3) Install the valves to the intake or exhaust guides.

Install the valves to their original lapped valve seats.



4. Intake and Exhaust Valve Springs

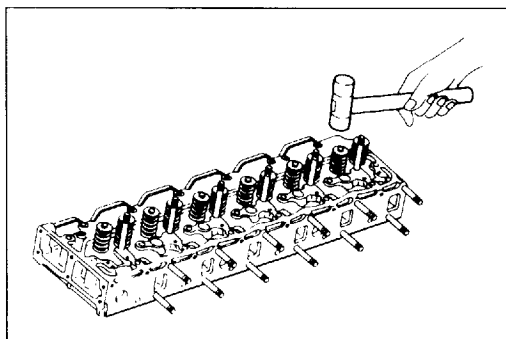
Install the valve springs with their painted end (the close pitched end) facing down.

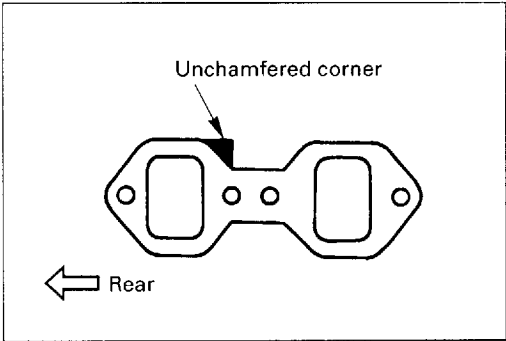


6. Spring Seat Split Collar

- 1) Use a spring compressor to push the valve spring into position.
- 2) Install the spring seat split collar.
- 3) Set the spring seat split collar by tapping lightly around the head of the collar with a rubber hammer.

Spring Compressor: 1-85235-006-0





10. Intake Manifold and Gasket

- 1) Install the intake manifold gasket.

The intake manifold gasket must be installed with its unchamfered corner facing up and to the front of the engine.

Refer to the illustration.

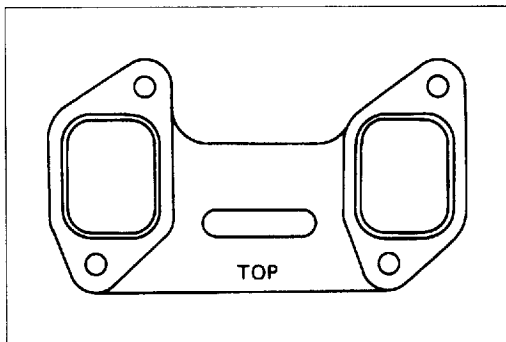
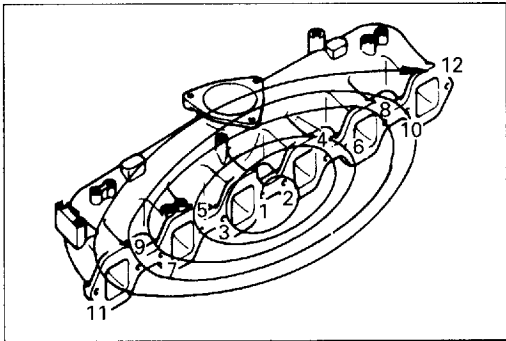
- 2) Install the intake manifold.
- 3) Tighten the intake manifold bolts to the specified torque a little at a time in the numerical order shown in the illustration.

N·m (kgf·m/lb.ft)



Intake Manifold
Bolt Torque

21-30 (2.1-3.1/15-22)



11. Exhaust Manifold and Gasket

- 1) Install the exhaust manifold gasket.

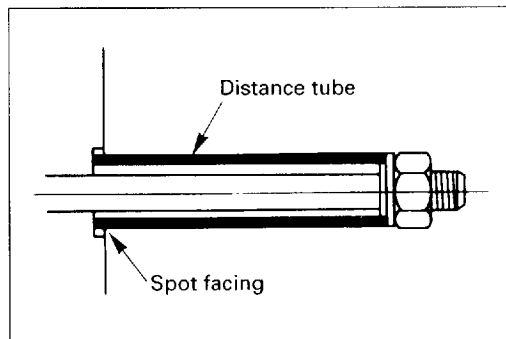
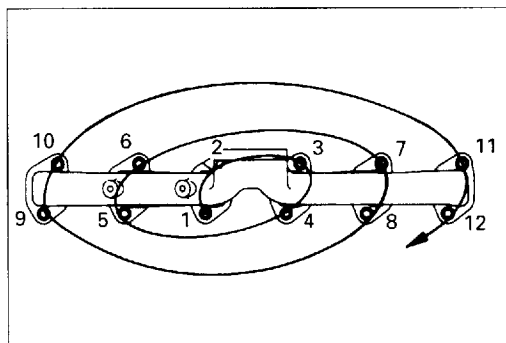
The "TOP" mark must be facing up.

- 2) Install the exhaust manifold.
- 3) Tighten the exhaust manifold bolts to the specified torque a little at a time in the numerical order shown in the illustration.

N·m (kgf·m/lb.ft)

Exhaust Manifold
Bolt Torque

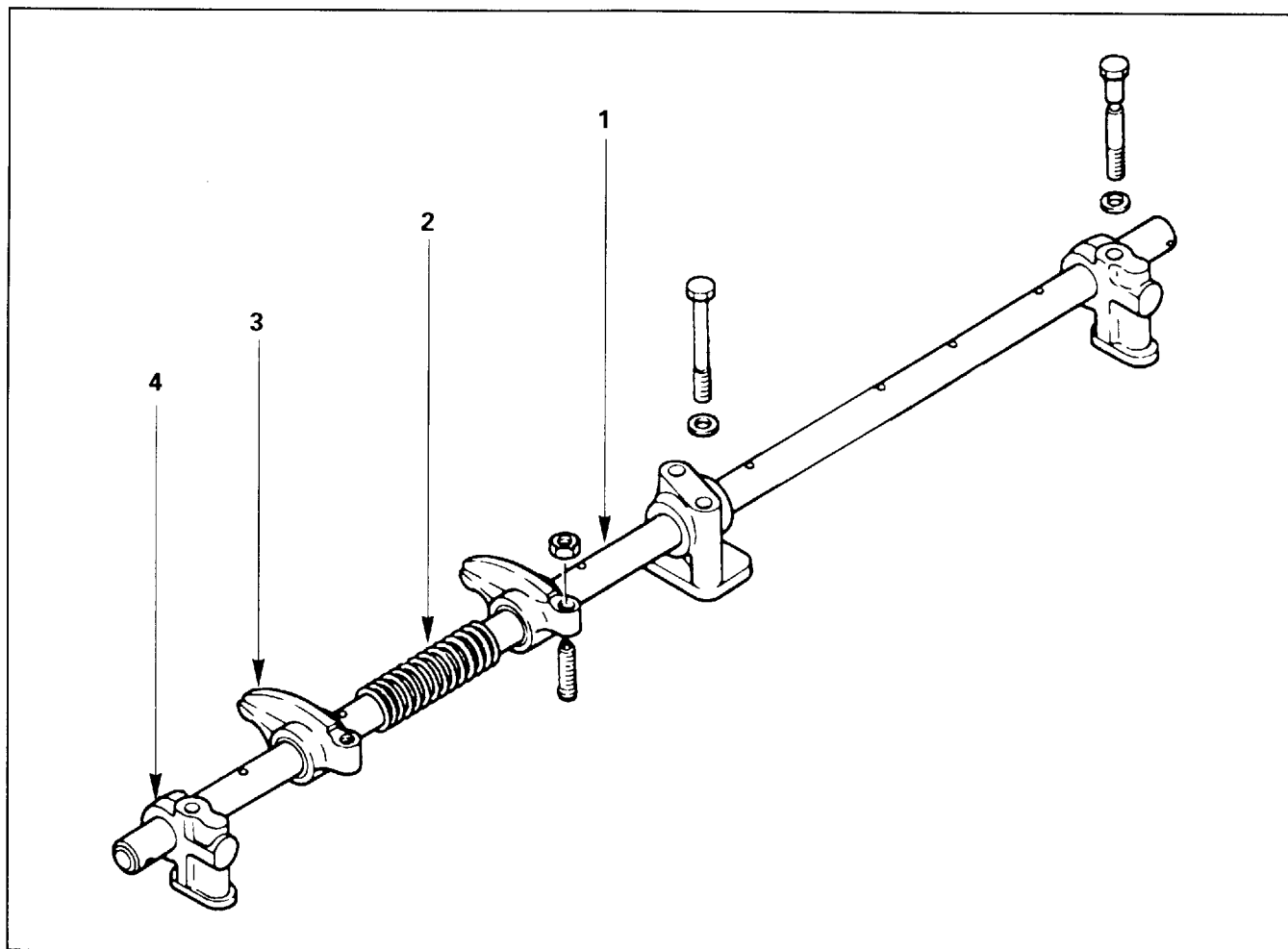
25-31 (2.6-3.2/19-23)



- 4) Install either end of the distance tube to the spot facing.



ROCKER ARM AND ROCKER ARM SHAFT REASSEMBLY STEPS



Reassembly Steps

- ▲ 1. Rocker arm shaft
- 2. Spring

- 3. Rocker arm
- 4. Bracket



Important Operation

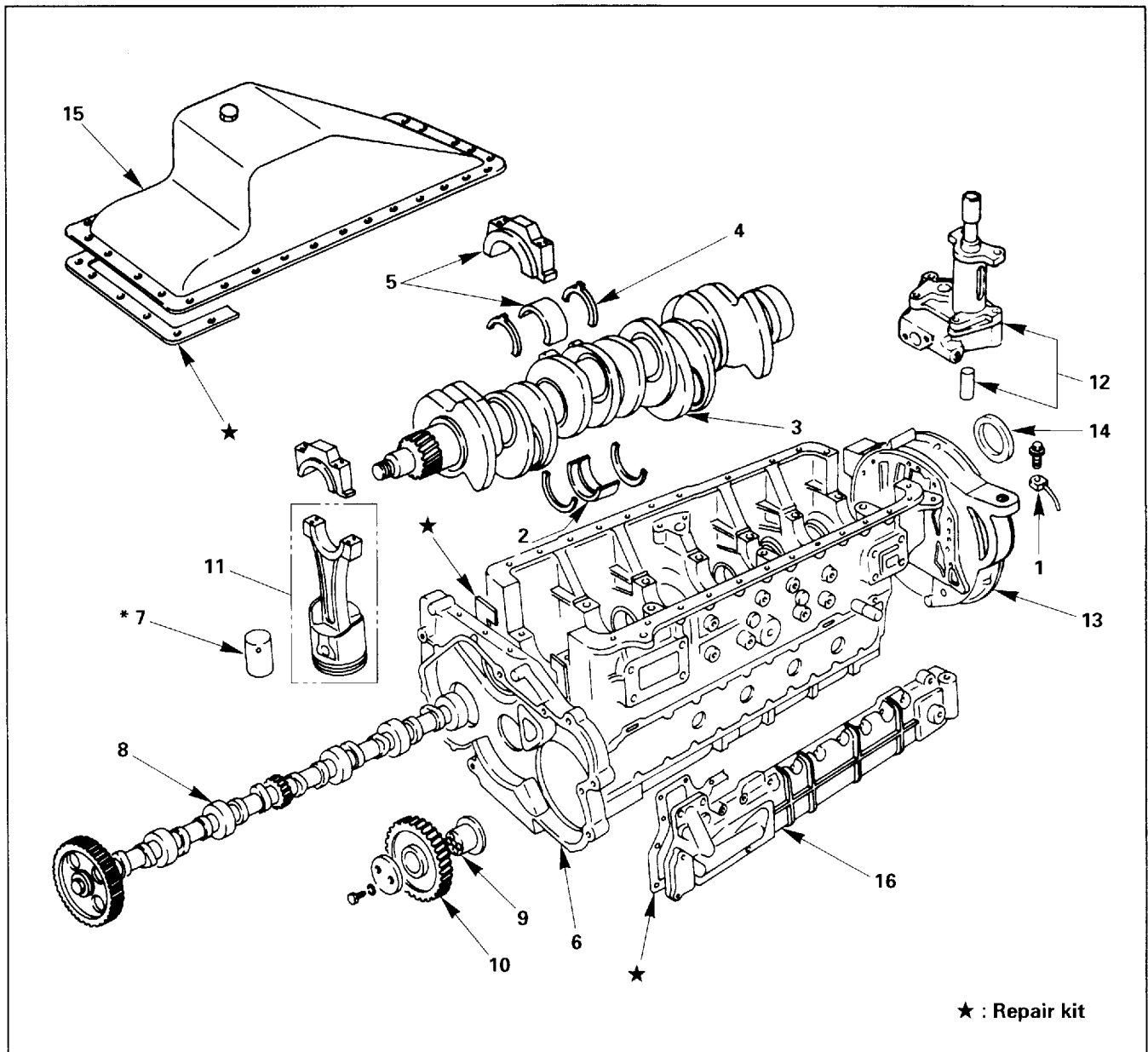
1. Rocker Arm Shaft



The rocker arm shaft must be installed with the oil ports facing up.

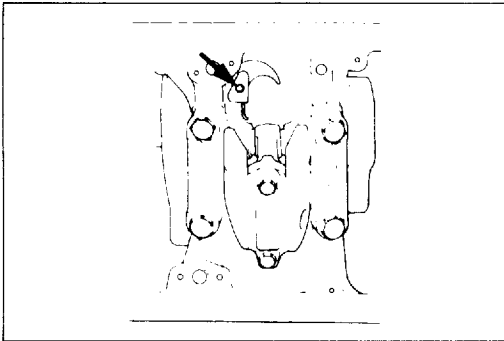


MAJOR COMPONENT REASSEMBLY STEPS I



Reassembly Steps

- | | |
|---|---------------------------------|
| ▲ 1. Oil jet | ▲ 9. Idler gear shaft |
| ▲ 2. Crankshaft bearing (upper half) | ▲ 10. Idler gear |
| ▲ 3. Crankshaft | ▲ 11. Piston and connecting rod |
| ▲ 4. Thrust bearing | ▲ 12. Oil pump and coupling |
| ▲ 5. Crankshaft bearing (lower half) and crankshaft bearing cap | ▲ 13. Flywheel housing |
| ▲ 6. Timing gear case | ▲ 14. Rear oil seal |
| * 7. Tappet | ▲ 15. Oil pan |
| ▲ 8. Camshaft | ▲ 16. Oil cooler |
- * The tappet must be installed before the camshaft installation.



Important Operations



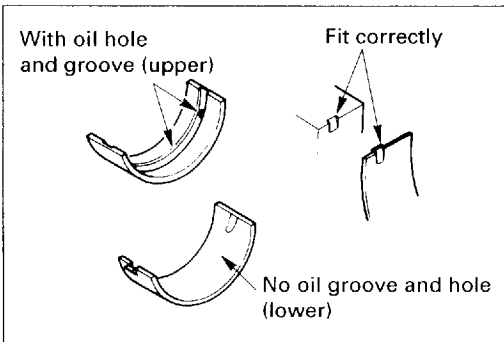
1. Oil Jet

Install the oil jets taking care not to damage the oil jet nozzles.



N·m (kgf·m/lb.ft)

Oil Jet Torque	16-25 (1.6-2.6/12-19)
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2. Crankshaft Bearing (Upper Half)

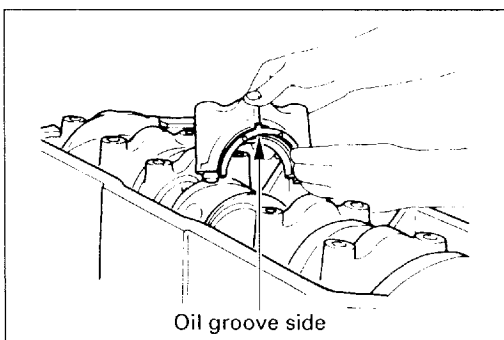


5. Crankshaft Bearing (Lower Half) and Crankshaft Bearing Cap

The Crankshaft Bearing Configuration

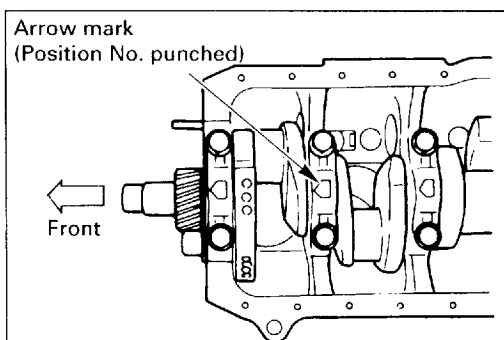
	With Oil Groove	Without Oil Groove
Bearing Upper Half	All Upper Halves	—
Bearing Lower Half	—	All Lower Halves

Take care not to misinstall the bearing halves.



4. Thrust Bearing

Install the thrust bearings with the oil groove side facing the crankshaft sliding face.



5. Crankshaft Bearing Cap

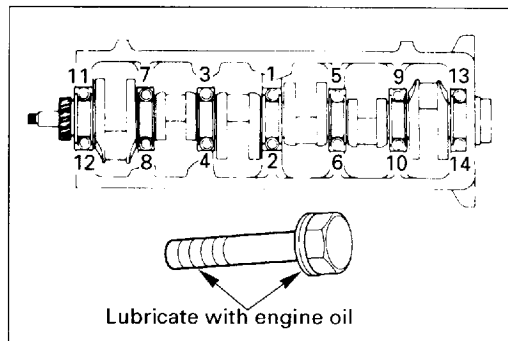
1) Lubricate the bearing cap bolts with engine oil.

2) Install the bearing caps to the crankshaft.

The arrow mark must be pointing to the front of the engine.

3) Tighten the bearing cap bolts to the specified torque a little at a time in the numerical order shown in the illustration.

5-10 ENGINE ASSEMBLY III

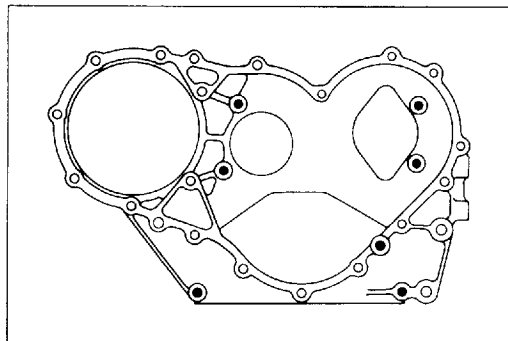


Crankshaft Bearing Cap Bolt Torque

N·m (kgf·m/lb.ft)

226-245 (23.0-25.0/166-181)

- 4) Check that the crankshaft turns smoothly by manually rotating it.



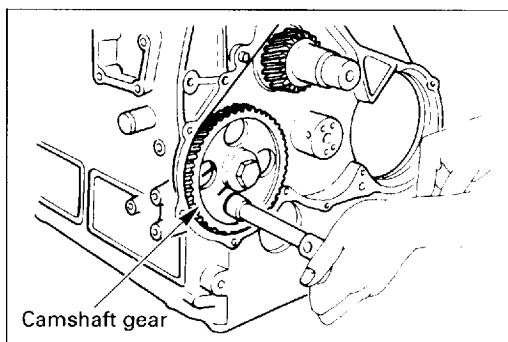
6. Timing Gear Case

- 1) Apply liquid gasket to the timing gear case surfaces contacting the cylinder body.
- 2) Tighten the timing gear case bolts to the specified torque.

N·m (kgf·m/lb.ft)

Timing Gear Case Bolt Torque

21-30 (2.1-3.1/15-22)



8. Camshaft

Tighten the thrust plate bolts through the camshaft gear hole.

N·m (kgf·m/lb.ft)

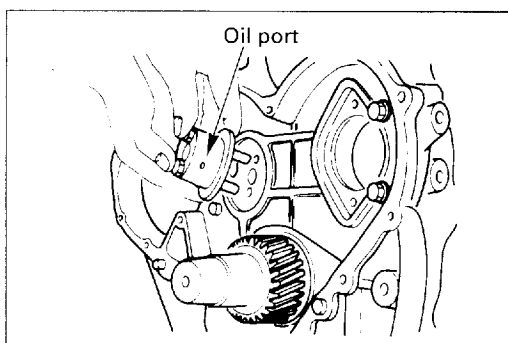
Thrust Plate Bolt Torque

21-30 (2.1-3.1/15-22)

N·m (kgf·m/lb.ft)

Camshaft Gear Bolt Torque

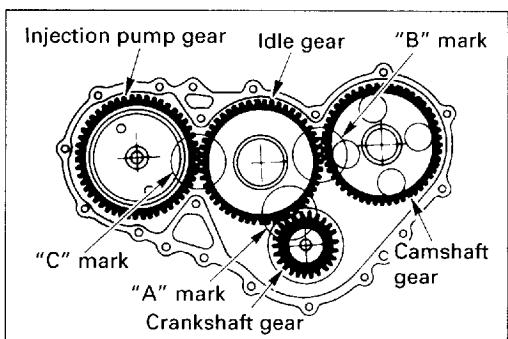
142-172 (14.5-17.5/105-127)



9. Idler Gear Shaft

Use the thrust collar fixing bolt as a guide to install the idler gear shaft.

The oil port must be facing the camshaft.



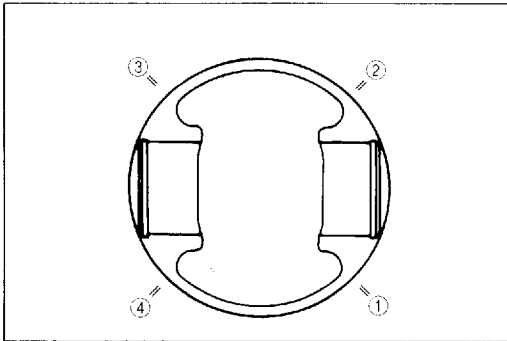
10. Idler Gear

- 1) Install the idler gear.
Set the timing marks [A] and [B] as shown in the illustration.
- 2) Tighten the idler gear bolts seating the thrust collar to the specified torque.
The thrust collar must be installed with the chamfered side facing the front of the engine.

N·m (kgf·m/lb.ft)

Idle Gear Bolt Torque

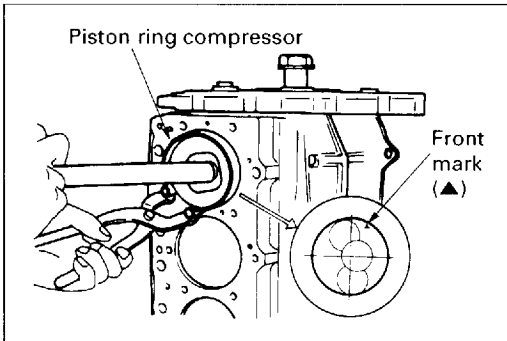
44-64 (4.5-6.5/33-47)



11. Piston and Connecting Rod

Position the piston ring gaps as shown in the illustration.

- 1) Set the piston ring gaps as shown in the illustration.
- 2) Lubricate the piston, the piston rings, and the connecting rod bearings with engine oil.
- 3) Position the piston front mark towards the front of the engine.

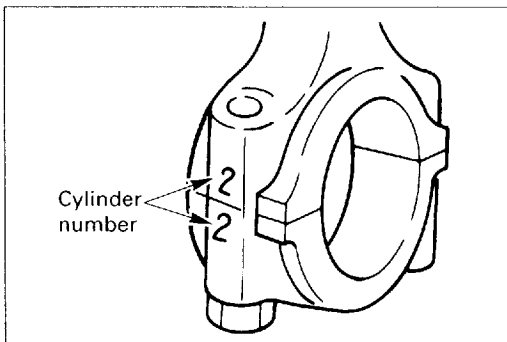


- 4) Use the piston ring compressor to compress the piston rings.

Piston Ring Compressor: 9-8522-1251-0

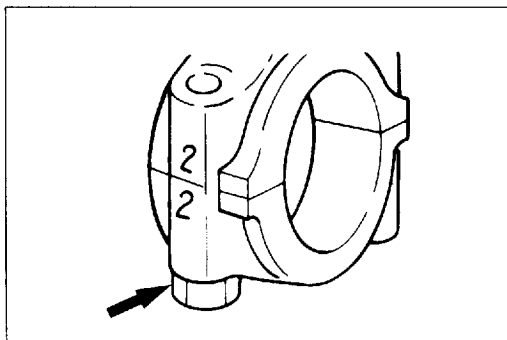
- 5) Use a hammer grip to push the piston in until it makes contact with the crankpin.

At the same time, rotate the crankshaft until the crankpin reaches its highest point.



- 6) Set the bearing cap cylinder number marks and the connecting rod cylinder number marks.

The marks must be facing the exhaust manifold.

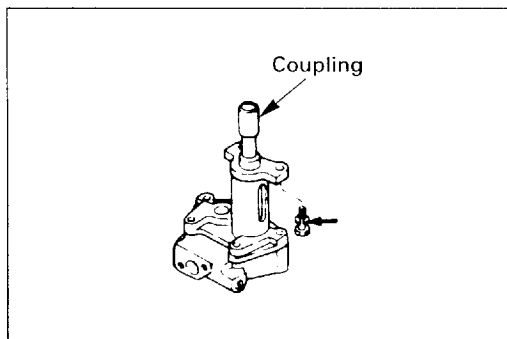


- 7) Lubricate the connecting rod cap bolt threads and setting faces with Mos grease.

- 8) Use the angular tightening method to tighten the connecting rod cap bolts to the specified torque.

N·m (kgf·m/lb.ft)

	1st step	2nd step
Connecting Rod Bolt Torque and Angle	39 (4/29)	60°-90°

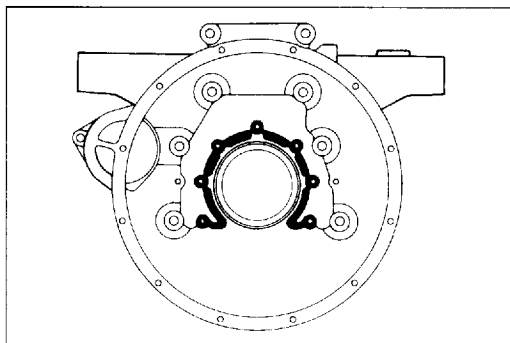


12. Oil Pump and Coupling

- 1) Lubricate the oil pump with the specified grade of engine oil.
- 2) Install the oil pump with the coupling.
- 3) Tighten the oil pump bolts to the specified torque.

N·m (kgf·m/lb.ft)

Oil Pump Bolt Torque	42-62 (4.3-6.3/31-46)
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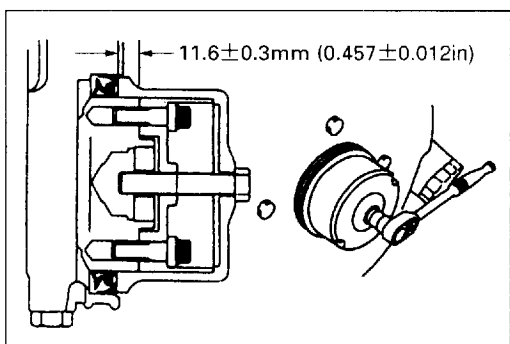
13. Flywheel Housing

- 1) Apply a sealant to the shaded area of the illustration.
- 2) Install the flywheel housing.

Tighten the flywheel housing bolts to the specified torque.

N·m (kgf·m/lb.ft)

Flywheel Housing Bolt Torque	Outer Bolt	147-167(15.0-17.0/108-123)
	Inner Bolt	21-30 (2.1-3.1/15-22)

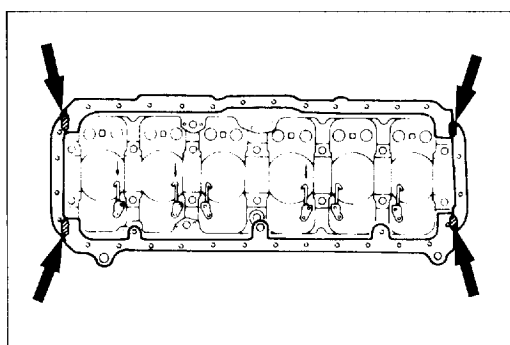


14. Rear Oil Seal (Axial Type)

- 1) Tighten the adapter to the crankshaft rear and section with 2 bolts.
- 2) Insert the oil seal into the peripheral section of adapter.
- 3) Insert the sleeve into the adapter section, and 1) tighten it with a bolt until the adapter section hits the sleeve.
- 4) Remove the adapter and the sleeve.
- 5) With the seal pressed in, check the dimension of the oil seal section.

Standard Dimension = 11.6 ± 0.3 mm
(0.457 ± 0.012 in)

Rear oil Seal Installer: 5-8840-9025-0



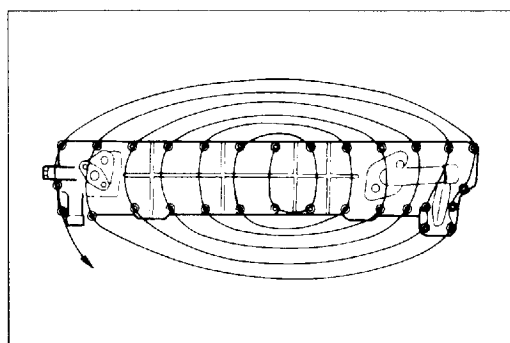
15. Oil Pan

- 1) Apply sealant to the area indicated by the arrows in the illustration.
- 2) Install the oil pan gasket
- 3) Install the oil pan.

Tighten the oil pan bolts to the specified torque.

N·m (kgf·m/lb.ft)

Oil Pan Bolt Torque	21-30 (2.1-3.1/15-22)
---------------------	-----------------------



16. Oil Cooler

- 1) Apply sealant to the oil cooler gasket.
- 2) Install the oil cooler gasket to the oil cooler body case.
- 3) Install the oil cooler.

Tighten the oil cooler bolts to the specified torque.

Start from the middle and work out to either side.

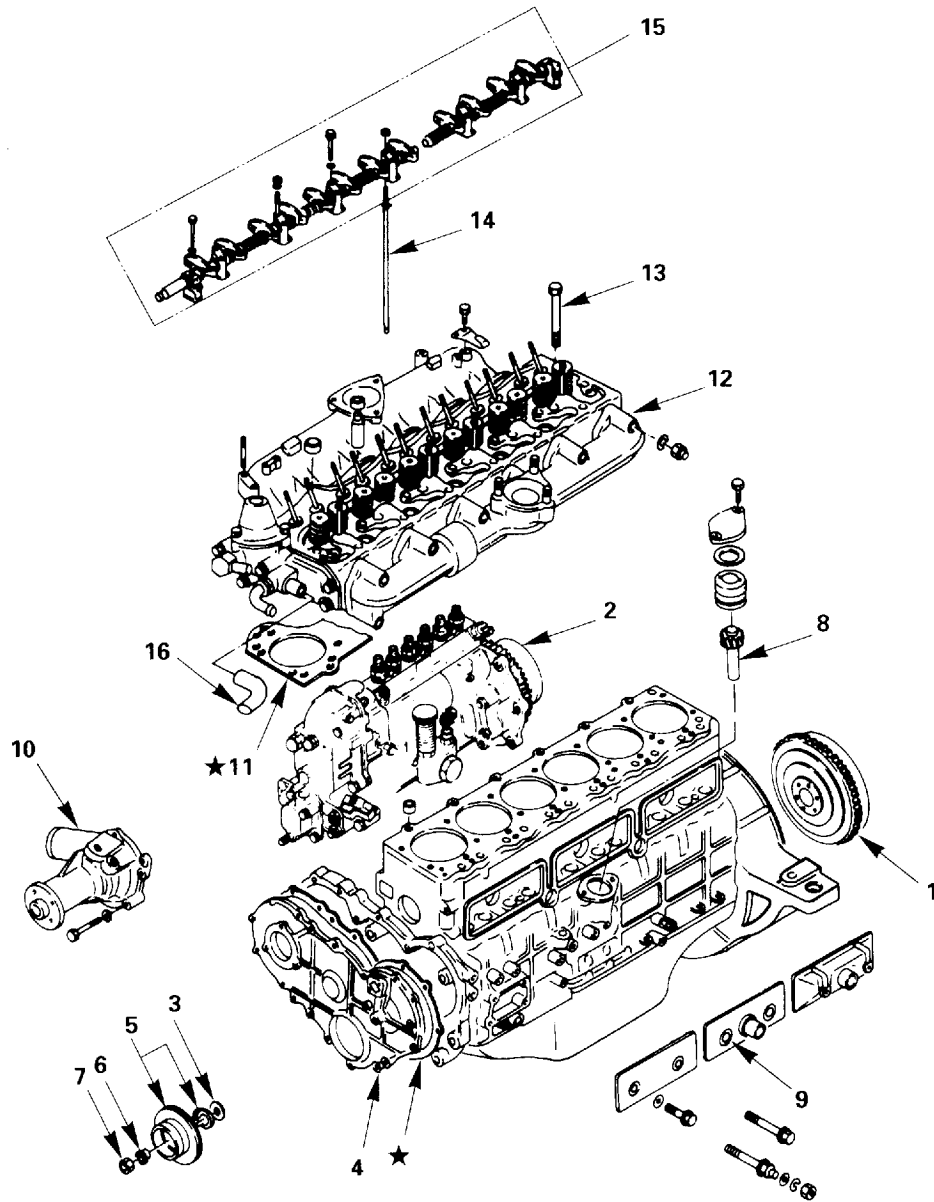
Refer to the illustration

N·m (kgf·m/lb.ft)

Oil Cooler Torque	14-24 (1.4-2.4/10-17)
-------------------	-----------------------



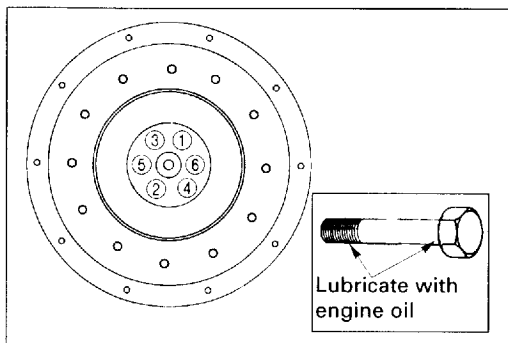
MAJOR COMPONENT REASSEMBLY STEPS II



★ : Repair kit

Reassembly Steps

- | | |
|---|---------------------------------------|
| ▲ 1. Flywheel | ▲ 9. Tappet chamber cover |
| ▲ 2. Injection pump and injection pump gear | ▲ 10. Water pump |
| 3. Oil thrower | ▲ 11. Cylinder head gasket |
| 4. Timing gear cover | ▲ 12. Cylinder head |
| 5. Crankshaft pulley and dust thrower | ▲ 13. Cylinder head bolt |
| 6. Taper bushing | 14. Push rod |
| ▲ 7. Crankshaft pulley nut | ▲ 15. Rocker arm and rocker arm shaft |
| 8. Oil pump driving pinion | 16. Rubber hose (Water by-pass) |



Important Operations

1. Flywheel



1) Lubricate the flywheel bolt threads.



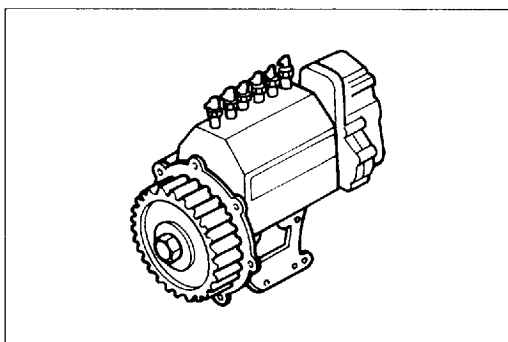
2) Install the flywheel.

The crankshaft rear end dowel pin and the flywheel dowel hole must be aligned.

3) Tighten the flywheel bolts to the specified torque in the numerical order shown in the illustration.

N·m (kgf·m/lb.ft)

Flywheel Bolt Torque	197-240(20.1-24.5/145-177)
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2. Injection Pump and Injection Pump Gear Assembly

1) Install the injection pump bracket with the injection pump to the timing gear case.

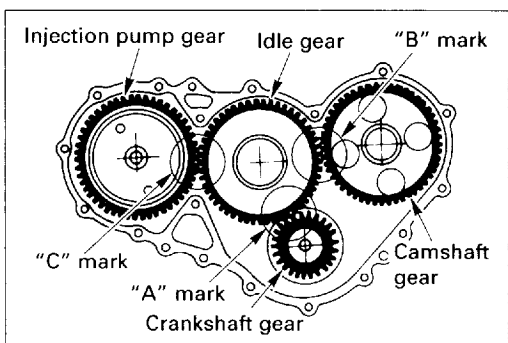
Dowel the injection pump bracket with the timing gear case.



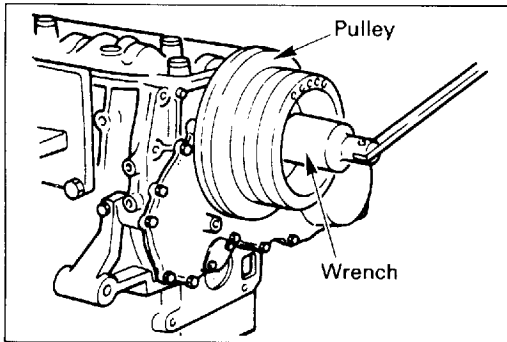
2) Tighten the injection pump bolts to the specified torque.

N·m (kgf·m/lb.ft)

Injection Pump Bolt Torque	21 - 30 (2.1 - 3.1/15 - 22)
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3) Align the injection pump gear "C" timing mark with the idler gear "C" timing mark.

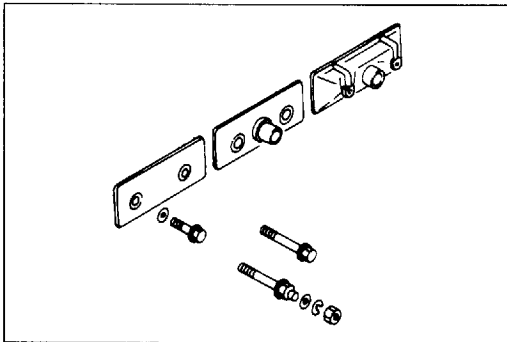


7. Crankshaft Pulley Nut

- 1) Apply MoS2 to the crankshaft pulley nut threads and fitting face.
- 2) Use the appropriate wrench to tighten the crankshaft pulley nut to the specified torque.

N·m (kgf·m/lb.ft)

Crankshaft Pulley Nut Torque	539-637 (55-65/378-470)
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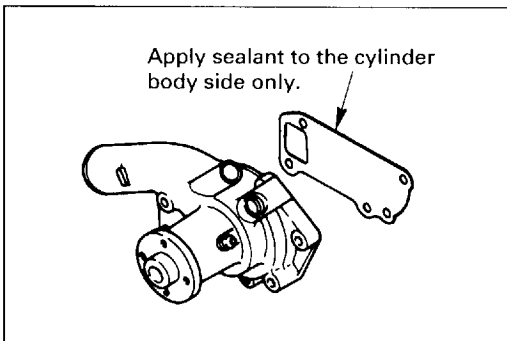


9. Tappet Chamber Cover

- 1) Apply sealant (TB 1207B) to the tappet chamber cover.
- 2) Install the tappet chamber cover and tighten the bolts to the specified torque.

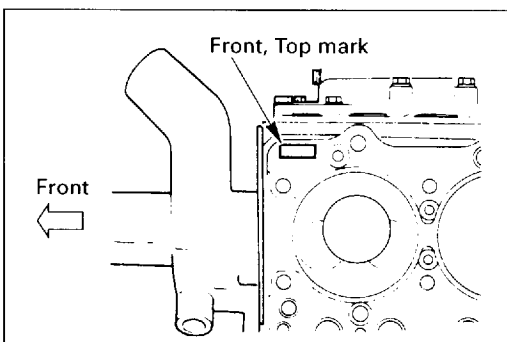
N·m (kgf·m/lb.ft)

Tappet Chamber Cover Bolt Torque	21-30 (2.1 - 3.1/15 - 22)
----------------------------------	---------------------------



10. Water Pump

Apply sealant (Belco Bond No. 4) to the water pump gasket before installing the water pump.



11. Cylinder Head Gasket

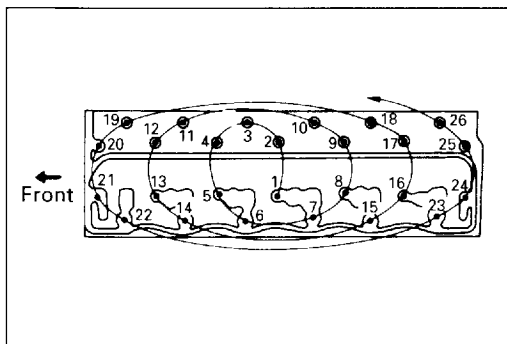
12. Cylinder Head

13. Cylinder Head Bolt

- 1) Carefully place the cylinder head gasket on the cylinder body upper surface.

The gasket "TOP" mark must be facing up.

- 2) Align the cylinder body dowels and the cylinder head dowel holes.



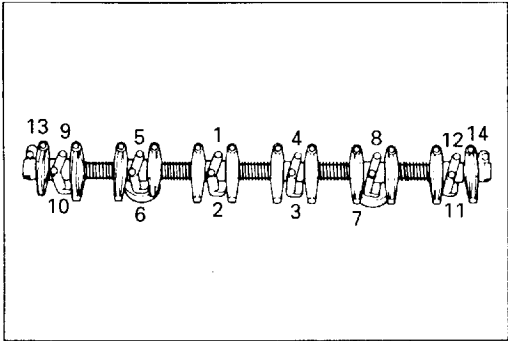
- 3) Carefully place the cylinder head on the cylinder body.
- 4) Tighten the cylinder head bolt as follows.
 - 1) As cylinder head bolts have two kinds of length, install them at proper location.
The shorter ones (6 bolts) must be used at the injection pump side.
 - 2) Follow the numerical sequence shown in the illustrations.
 - 3) The cylinder head bolt tightening method vary depending on the gasket type to be used.

Apply molybdenum disulfide grease to the cylinder head bolt threads and setting faces.

Use the Angular Tightening Method.

N·m (kgf·m/lb.ft)

	1st step	2nd step	3rd step
Bolt Torque	69 (7.0/51)	88 (9.0/65)	90°–120°



15. Rocker Arm and Rocker Arm Shaft

- 1) Check that the rocker arm shaft bracket lower surface oil port is free from obstruction.
- 2) Install the rocker arm shaft with the bracket to the cylinder head.
- 3) Tighten the rocker arm bracket bolts to the specified torque a little at a time in the numerical order shown in the illustration.
- 4) Lubricate the rocker arm and the rocker arm shaft with engine oil.

N·m (kgf·m/lb.ft)

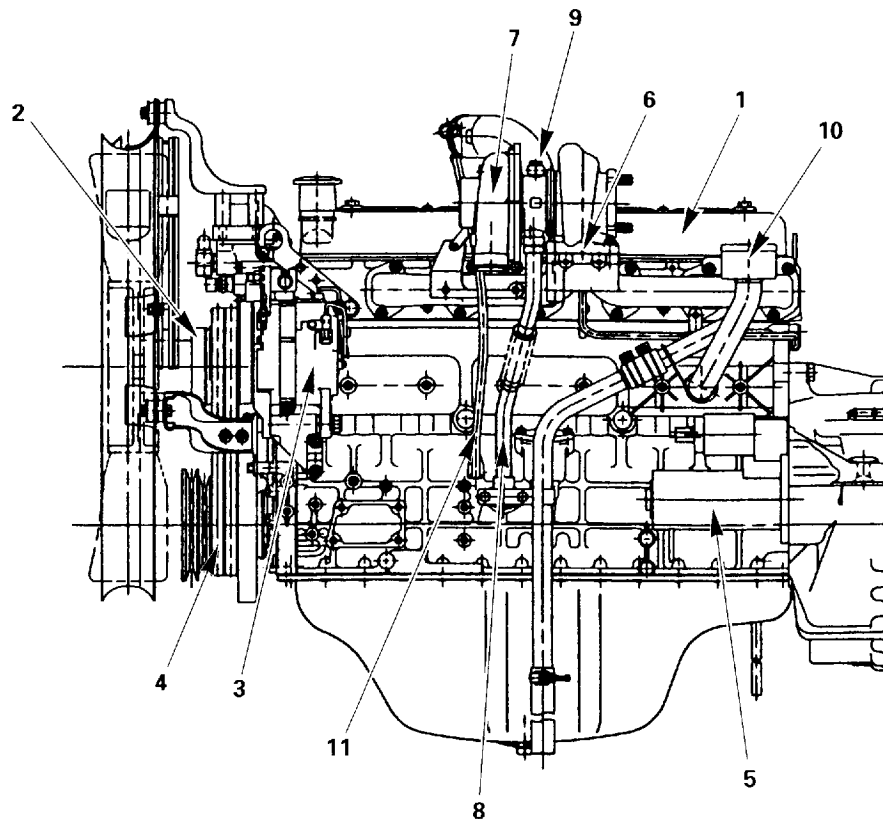
Rocker Arm Shaft Bracket Bolt and Nut Torque	25-35 (2.6-3.6/19-26)
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- 5) Adjust the valve clearance.
Refer to MAINTENANCE for the valve clearance adjustment procedure.

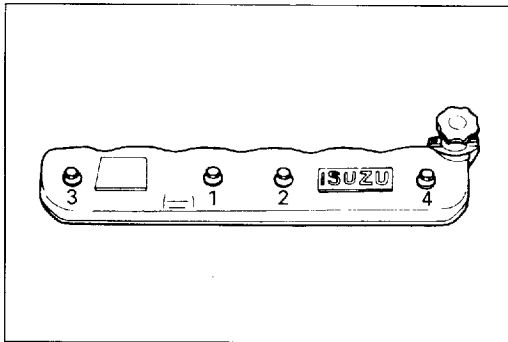


EXTERNAL PARTS REASSEMBLY STEPS (Left-hand side)



Reassembly Steps

- | | |
|---|-----------------------------|
| ▲ 1. Cylinder head cover | ▲ 7. Turbocharger |
| 2. Fan pulley | ▲ 8. Oil drain pipe |
| 3. Alternator | ▲ 9. Oil feed pipe |
| ▲ 4. Fan belt | 10. Air breather |
| ▲ 5. Starter | 11. Dipstick and guide tube |
| ▲ 6. Turbocharger mounting flange gasket. | |



Important Operations

1. Cylinder Head Cover

- 1) Check that the rocker arms, the rocker arm shafts, and the valve springs are thoroughly lubricated with engine oil.

If required, relubricate these parts.

- 2) Place the cylinder head cover gasket on the cylinder head cover.

Check the head cover gasket for looseness.

- 3) Tighten the cylinder head cover bolts to the specified torque a little at a time in the sequence shown in the illustration.



N·m (kgf·m/lb.ft)

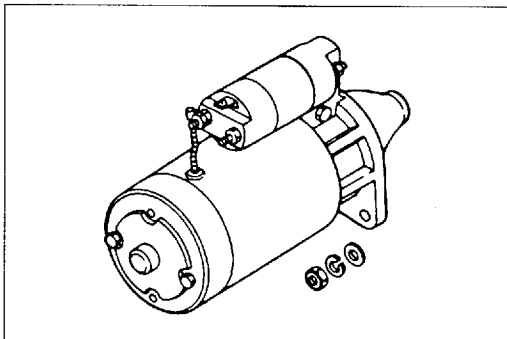
Cylinder Head Cover Bolt Torque	7.8 – 9.8 (0.8 – 1.0/5.8 – 7.2)
---------------------------------	---------------------------------



4. Fan Belt

Adjust the fan belt tension.

Refer to MAINTENANCE for the fan belt tension adjustment.

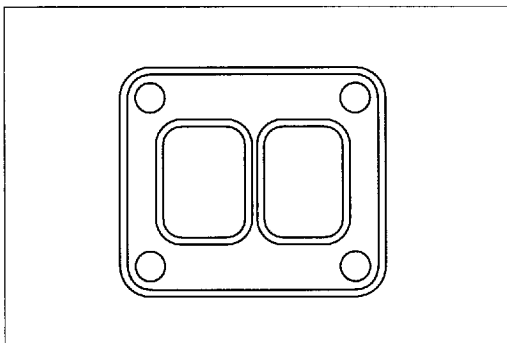


5. Starter

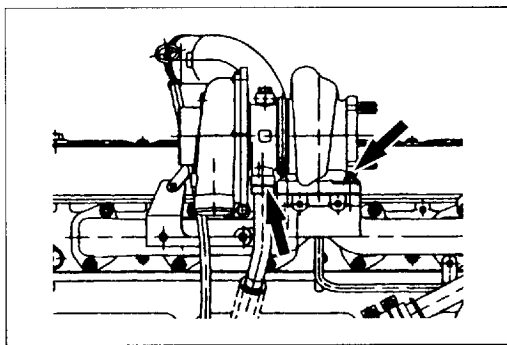
Install the starter to the flywheel housing and tighten the bolts to the specified torque.

N·m (kgf·m/lb.ft)

Starter Fixing Bolts Torque	75 – 91 (7.6 – 9.3/55 – 67)
-----------------------------	-----------------------------

**6. Turbocharger Mounting Flange Gasket**

Carefully position the gasket with the edged side facing up.

**7. Turbocharger**

Semitighten the turbocharger mounting nuts.

The nuts will be fully tightened after installation of the oil pipes.

N·m (kgf·m/lb.ft)

Turbocharger Mounting Nut Torque	42 – 62 (4.3 – 6.3/31 – 46)
----------------------------------	-----------------------------

**8. Oil Drain Pipe**

- 1) Remove the exhaust manifold distance tube immediately beneath the turbocharger.

This will make it easier to install the oil drain pipe.

- 2) Install the oil drain pipe and tighten the oil drain pipe flange nuts to the specified torque.

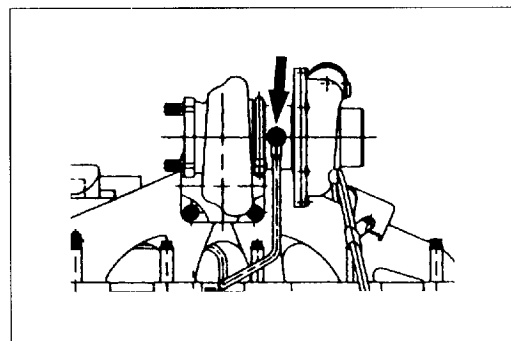
N·m (kgf·m/lb.ft)

Oil Drain Pipe Torque	28 – 46 (2.9 – 4.7/21 – 34)
-----------------------	-----------------------------



- 3) Reinstall the exhaust manifold distance tube and tighten it to the specified torque.

Exhaust manifold nut torque is shown in the page 5-6.

**9. Oil Feed Pipe**

- 1) Pre-lubricate the turbocharger with CD grade oil through the oil port shown by the arrow in the illustration.

- 2) Install the oil feed pipe and tighten the pipe flange bolts to the specified torque.

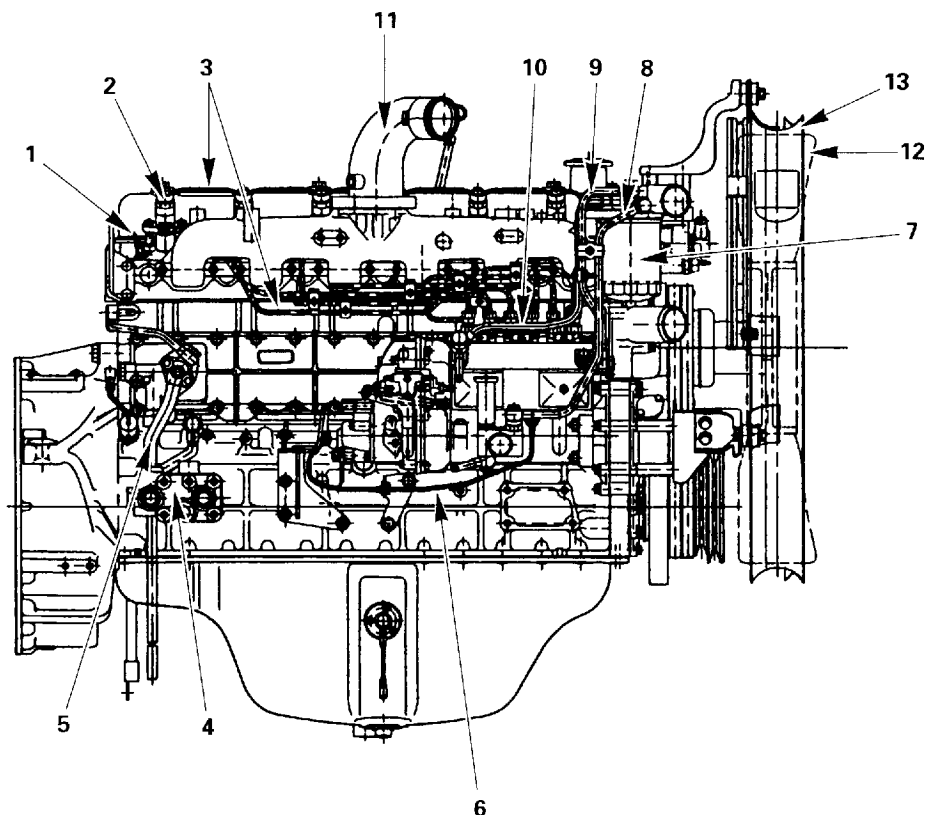
N·m (kgf·m/lb.ft)

Oil Feed Pipe Flange Bolt Torque	16 – 25 (1.6 – 2.6/12 – 19)
----------------------------------	-----------------------------



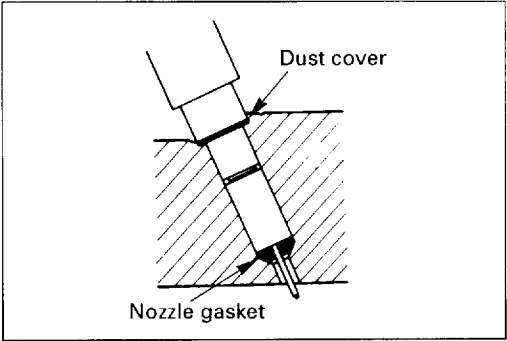
EXTERNAL PARTS REASSEMBLY STEPS (Right-hand Side)

MODEL 6BG1T



Reassembly Steps

- | | |
|--|---|
| 1. Glow plug | 7. Fuel filter |
| ▲ 2. Injection nozzle | ▲ 8. Fuel pipe; feed pump to fuel filter |
| ▲ 3. Injection pipe and fuel leak off pipe | ▲ 9. Fuel pipe; fuel filter to injection pump |
| ▲ 4. Oil port cover | ▲ 10. Fuel return pipe |
| 5. Oil pipe; filter to cooler | ▲ 11. Inlet pipe |
| 6. Oil pipe; injection pump to engine body | 12. Cooling fan |
| | ▲ 13. Fan guide |



Important Operation



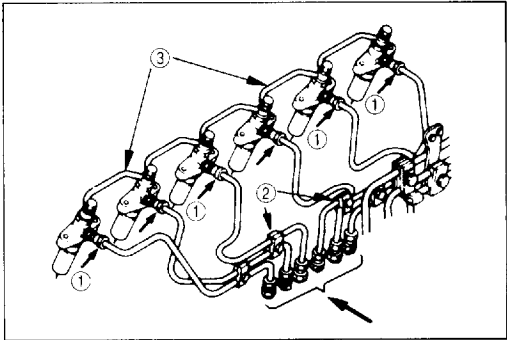
2. Injection Nozzle

Install the injection nozzles with the injection nozzle gaskets.

Be careful not to damage the nozzle tips.

N·m (kgf·m/lb.ft)

Injection Nozzle Bolt Torque	17 – 21 (1.7 – 2.1/12 – 15)
------------------------------	-----------------------------



3. Injection Pipe and Fuel Leak Off Pipe

- 1) Install the fuel injection pipes ① and tighten the bolts to the specified torque.

N·m (kgf·m/lb.ft)

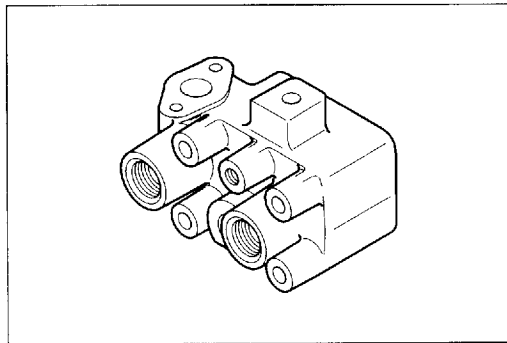
Injection Pipe Torque	28 – 32 (2.9 – 3.3/21 – 24)
-----------------------	-----------------------------

- 2) Carefully position and set the clips ②.

It is very important that each clip be positioned correctly.

An improperly positioned clip will result in objectionable fuel pulsing noise and injection pipe breakage.

- 3) Install the fuel leak off pipes ③.

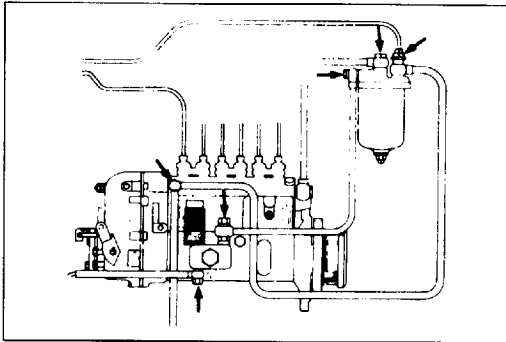


4. Oil port cover

Install the oil port cover with tightening the bolts securely.

N·m (kgf·m/lb.ft)

Oil Port Cover Bolt Torque	42 – 62 (4.3 – 6.3/31 – 46)
----------------------------	-----------------------------

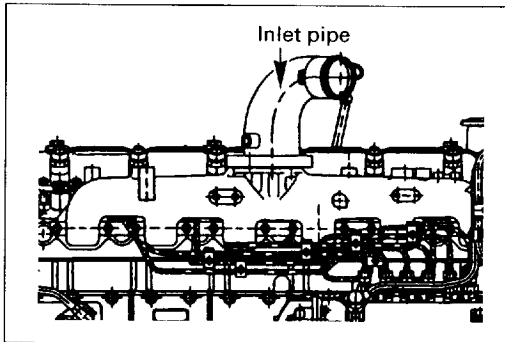
**8. Fuel Pipe (Feed Pump to Fuel Filter)****9. Fuel Pipe (Fuel Filter to Injection Pump)****10. Fuel Return Pipe**

Install the fuel pipes and tighten the fuel pipe joint bolts to the specified torque.

Take care not to interchange the check valves and joint bolts.

N·m (kgf-m/lb.ft)

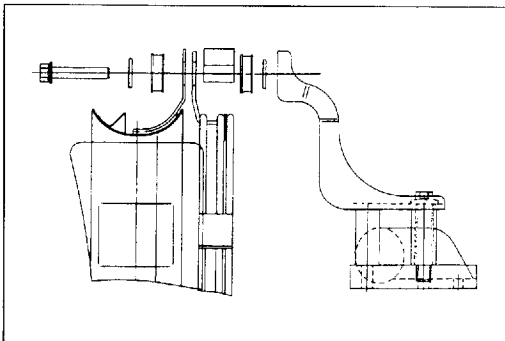
Fuel Pipe Joint Bolt Torque	16 – 18 (1.6 – 1.8/12 – 13)
-----------------------------	-----------------------------

**11. Inlet Pipe**

Install the inlet pipe and tighten the inlet pipe flange bolts to the specified torque.

N·m (kgf-m/lb.ft)

Inlet Pipe Flange Bolt Torque	21 – 30 (2.1 – 3.1/15 – 22)
-------------------------------	-----------------------------

**13. Fan guide**

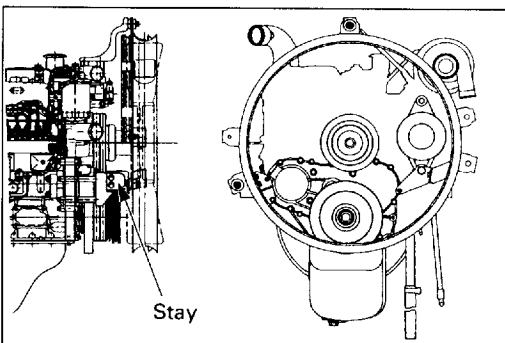
Install the upper bracket, mount rubber, fan guide and fan guard, and tighten the bolts to the specified torque.

N·m (kgf-m/lb.ft)

Mount Rubber Fixing Bolt Torque	30 (3.1/22)
---------------------------------	-------------

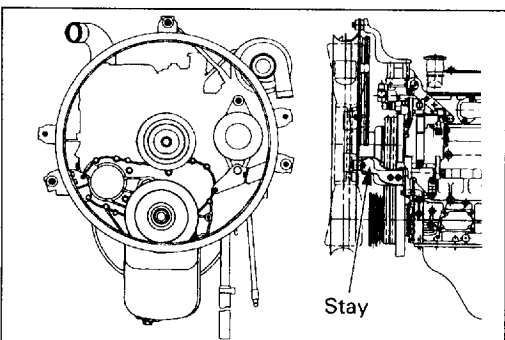
N·m (kgf-m/lb.ft)

Bracket Fixing Bolt Torque	40 (4.1/30)
----------------------------	-------------

**Stay (Right side)**

N·m (kgf-m/lb.ft)

Stay Fixing Bolt Torque	40 (4.1/30)
-------------------------	-------------

**Stay (Left side)**

N·m (kgf-m/lb.ft)

Stay Fixing Bolt Torque	40 (4.1/30)
-------------------------	-------------



Fan and Fan guide clearance

Adjust the clearance between the fan and fan guide.

mm (in)

Clearance between fan and fan guide	4 – 8 (0.157 – 0.315)
-------------------------------------	-----------------------



Injection Timing Adjustment

Check that the fuel injection timing is correct.

Refer to "MAINTENANCE" for the injection timing adjustment.

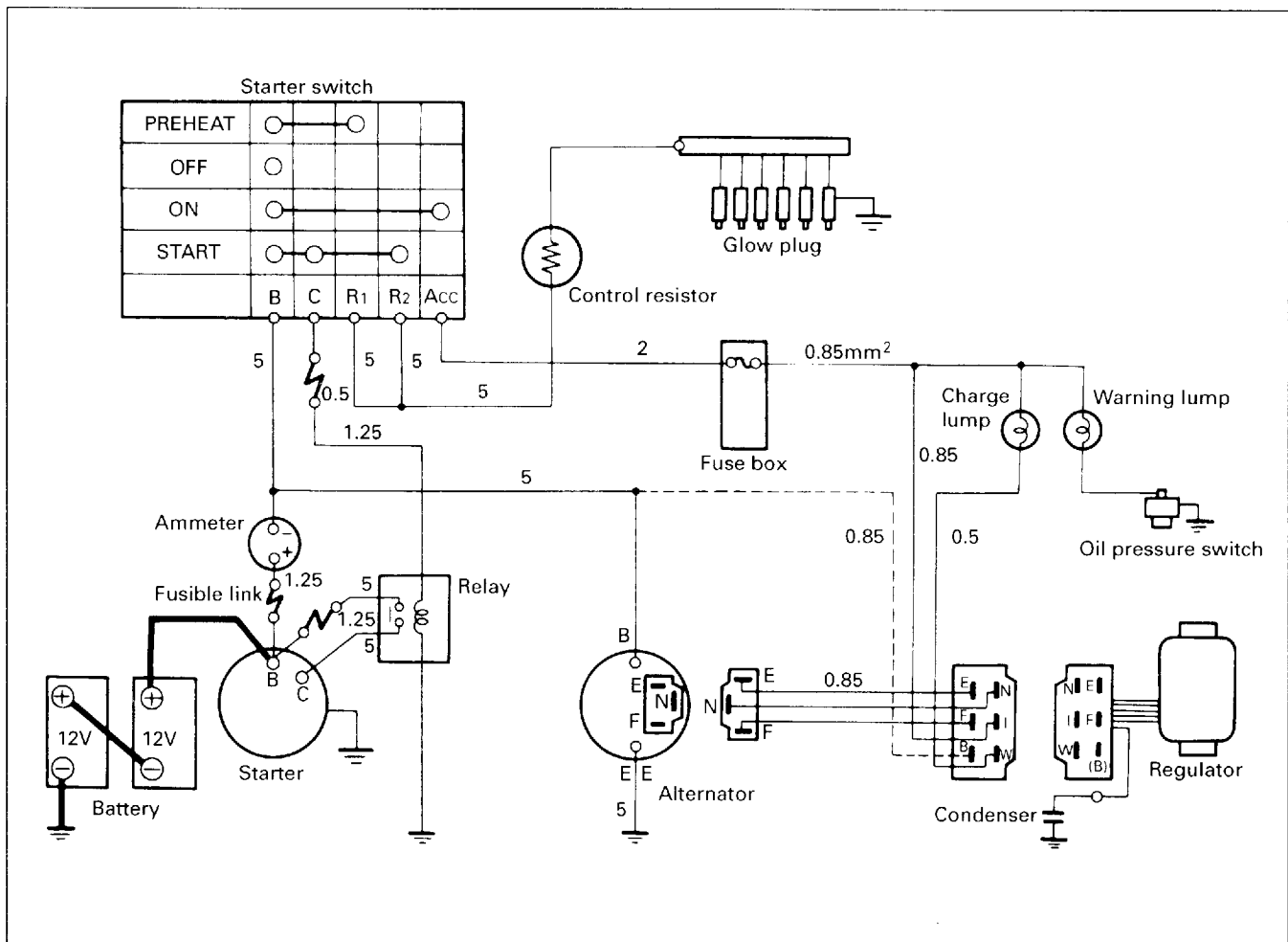
ENGINE TUNING OPERATION

After reassembly, the engine must be tuned. This will ensure that the engine operates at its maximum efficiency.



1. Mount the engine on a test bench.
2. Fill the engine with the specified oil.
3. Connect the cooling pipes and the fuel pipes.

Reference



4. Connect the electrical wiring.
Refer to the wiring diagram.
5. Connect the air intake line to the air cleaner.
6. Connect the exhaust pipe.
7. Manually operate the fuel feed pump to feed fuel to the engine.
8. Bleed the fuel lines of air.
Refer to Page 2-6 of Section 2 MAINTENANCE for the air bleeding procedure.

9. Crank the engine with the starter (non-ignition operation) for about twenty seconds.

This will prelubricate the engine internal components.

10. Start the engine and allow it to run at 750 to 800 min^{-1} for five minutes.



11. Remove the cylinder head cover while the engine is running.



12. Check that the engine oil is continuously circulating from the oil pump to the valve rockers through the cylinder head.

If there is no oil circulation or if the oil circulation is sluggish, stop the engine and make the appropriate repairs or adjustments.

Reinstall the cylinder head cover.



13. Increase the engine speed to 1,500 min^{-1} to do the engine warming-up operation.



14. Check the engine for oil, fuel, coolant, and air intake leakage.



15. Check for abnormal noise and odor.



16. Check for abnormal electrical charging.



17. Check the engine fastening parts for looseness.



18. When the engine coolant temperature reached to 75°C (167°F) or more, increase the engine speed to 2,000 min^{-1} and allow it to run for twenty minutes.

This will give the engine the essential run-in operating time.



19. Adjust the engine operation speed to the specified value.

20. Stop the engine to complete the tuning procedure.

SECTION 6

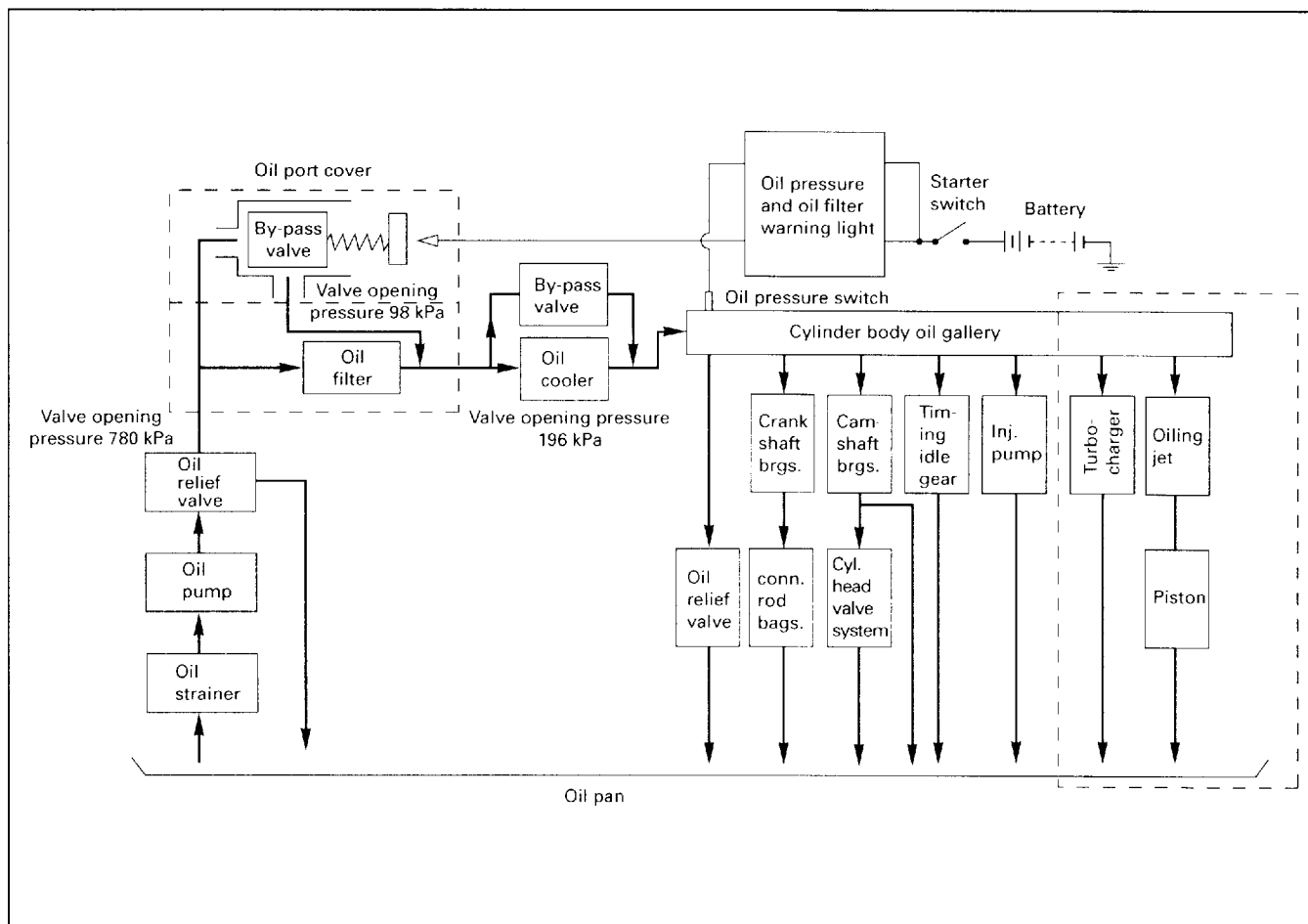
LUBRICATING SYSTEM

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Oil pump.....	6- 3
Oil cooler	6- 5



GENERAL DESCRIPTION



This family of engines uses a normal forced circulation lubricating system.

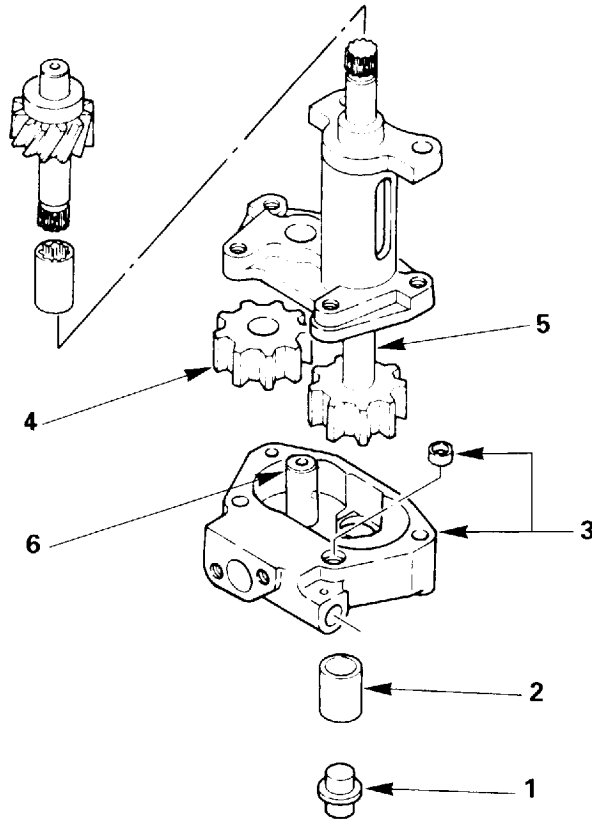
The gear type oil pump is driven by the camshaft oil pump drive.

The cartridge (spin-on) type oil filter is used.

OIL PUMP



DISASSEMBLY



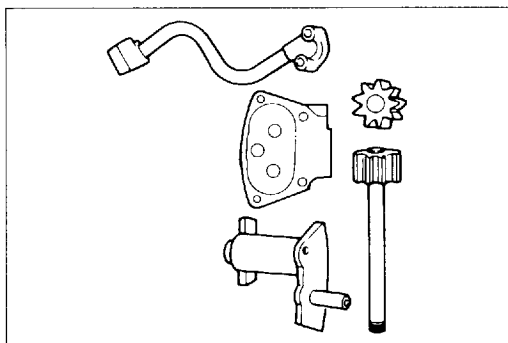
Disassembly Steps

- | | |
|--------------------|-------------------------|
| 1. Strainer | 4. Driven gear |
| 2. Suction pipe | 5. Drive shaft and gear |
| 3. Cover and dowel | 6. Driven gear shaft |



INSPECTION REPAIR

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.



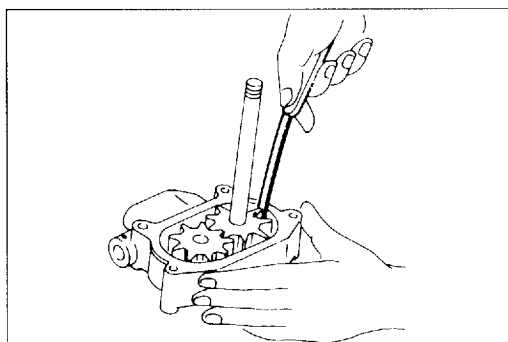
Visually inspect the disassembled parts for excessive wear and damage.



Oil Pump Drive Gear

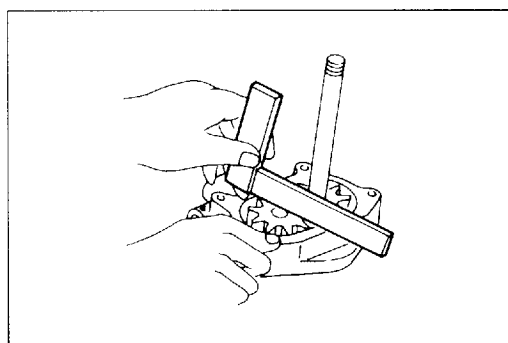
Use a feeler gauge to measure the clearance between the oil pump cover (oil pump case) inside surface and the drive gear.

If the clearance exceeds the specified limit, the drive gear and/or the oil pump cover must be replaced.



mm (in)

	Limit
Oil Pump Cover and Oil Pump Drive Gear Clearance	0.20 (0.0079)



Oil Pump Driven Gear

Use a feeler gauge to measure the clearance between the oil pump case cover inside surface and the driven gear.

If the clearance exceeds the specified limit, the driven gear or the oil pump cover must be replaced.

mm (in)

	Limit
Oil Pump Body and Driven Gear Clearance	0.15 (0.0059)



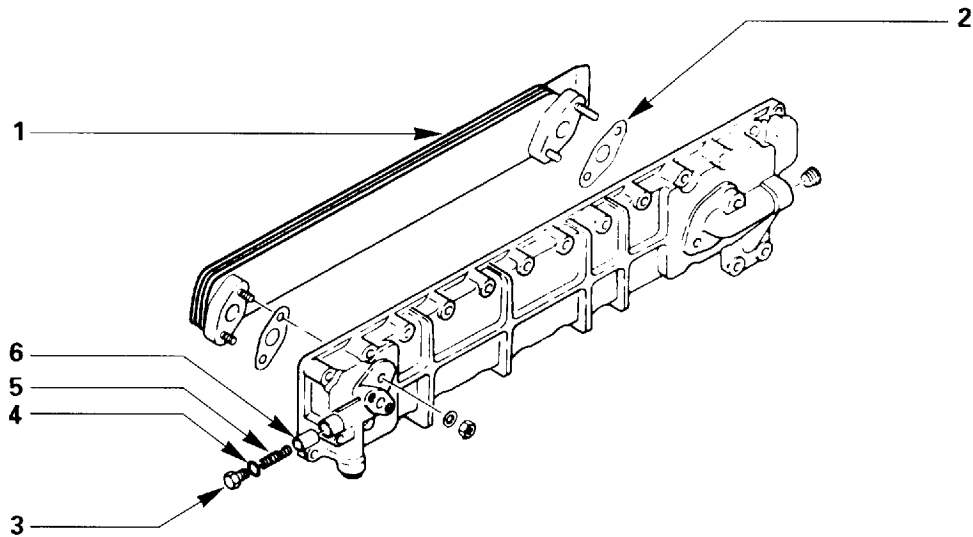
REASSEMBLY

To assemble, follow the disassembly procedures in reverse order.

OIL COOLER



DISASSEMBLY



Disassembly Steps

- | | |
|-----------------------|-------------------------|
| 1. Oil cooler element | 4. O-ring; plug |
| 2. Element gasket | 5. By-pass valve spring |
| 3. By-pass valve plug | 6. By-pass valve |

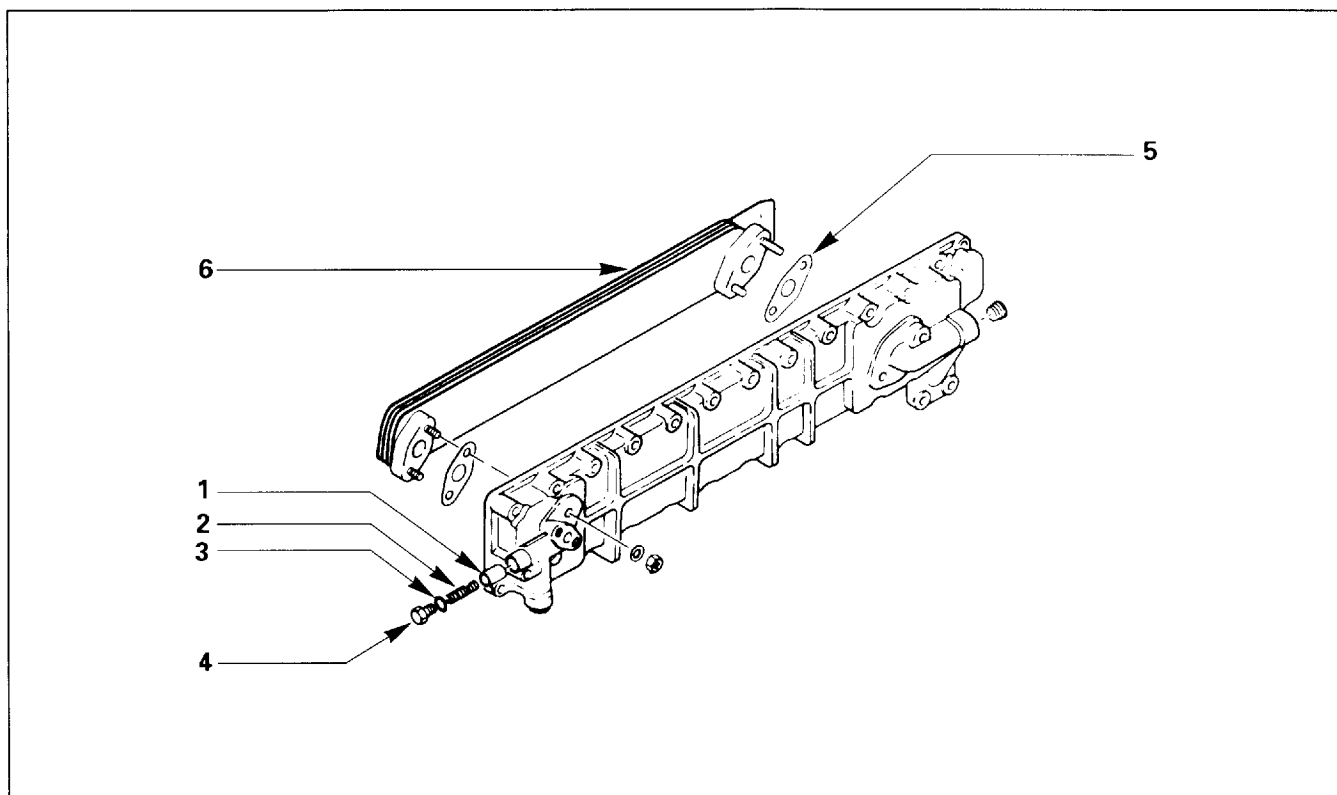


INSPECTION AND REPAIR

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

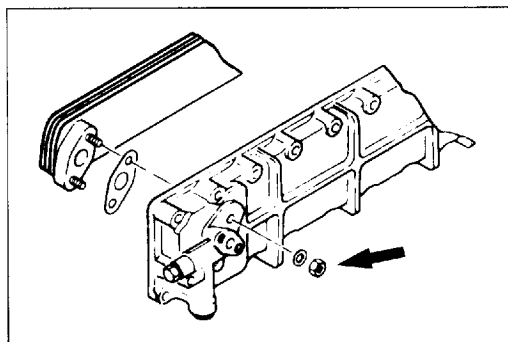


REASSEMBLY



Reassembly Steps

1. By-pass valve
2. By-pass valve spring
3. O-ring; plug
4. By-pass valve plug
5. Element gasket
- ▲ 6. Oil cooler element



Important Operation

6. Oil Cooler Element

Install the oil cooler element to the oil cooler, and tighten the cooler element fixing nuts to the specified torque.

N·m (kgf·m/lb.ft)

Oil Cooler Element Fixing Nut Torque	25-34 (2.5-3.5/18-25)
---	-----------------------

SECTION 7

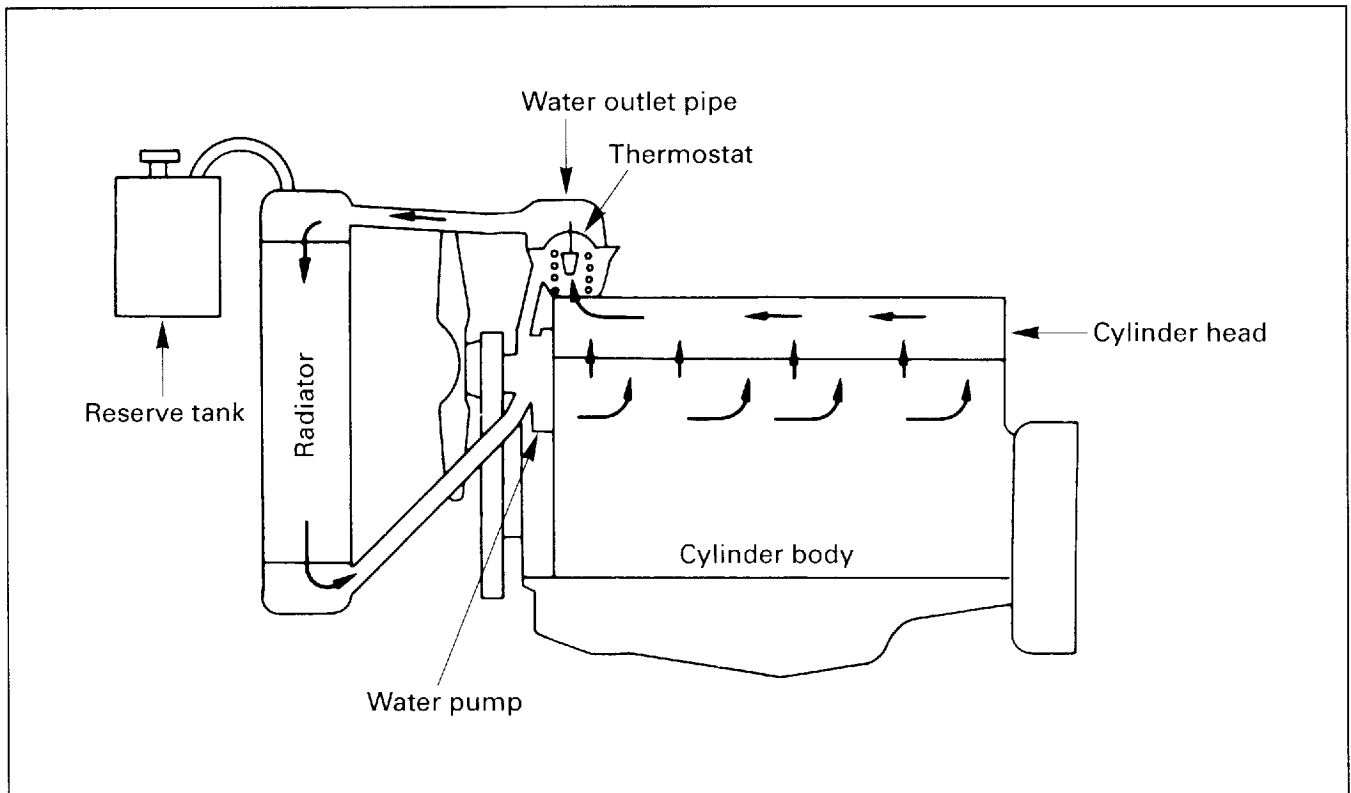
COOLING SYSTEM

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GENERAL DESCRIPTION



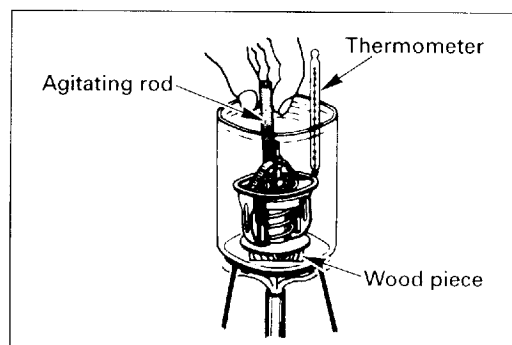
This family of engines uses a pressurized, forced circulation cooling system with a V-belt driven centrifugal water pump and a wax pellet thermostat with jiggle valve.

THERMOSTAT



INSPECTION AND REPAIR

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.



Visually inspect the thermostat function referring Section 2 MAINTENANCE in page 2-7.

MEMO

SECTION 8

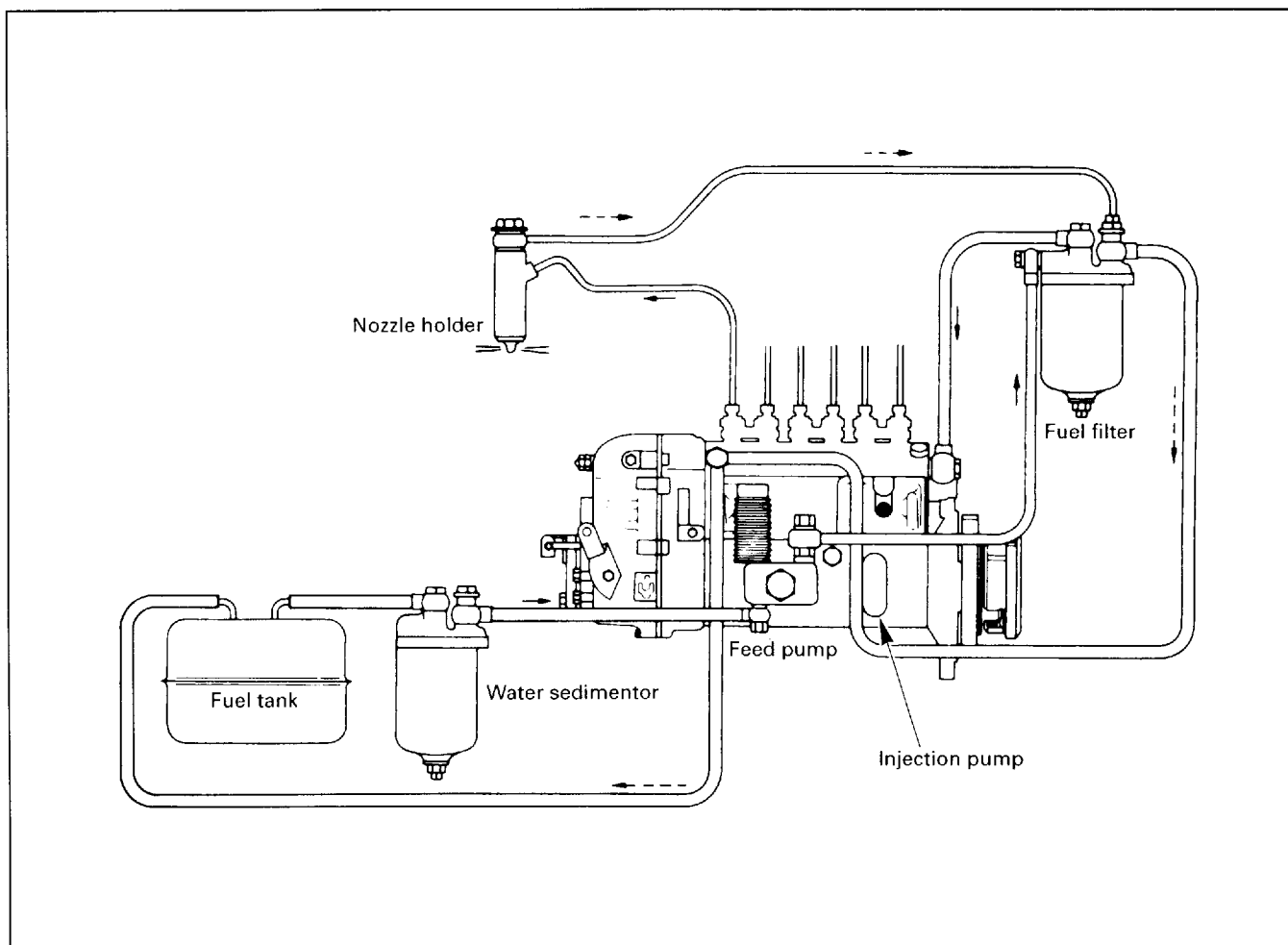
FUEL SYSTEM

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Injection nozzle.....	8- 3
Injection pump calibration data.....	8- 8



GENERAL DESCRIPTION



The fuel system consists of the fuel tank, the water sedimentor, the fuel filter, the injection pump, and the injection nozzle.

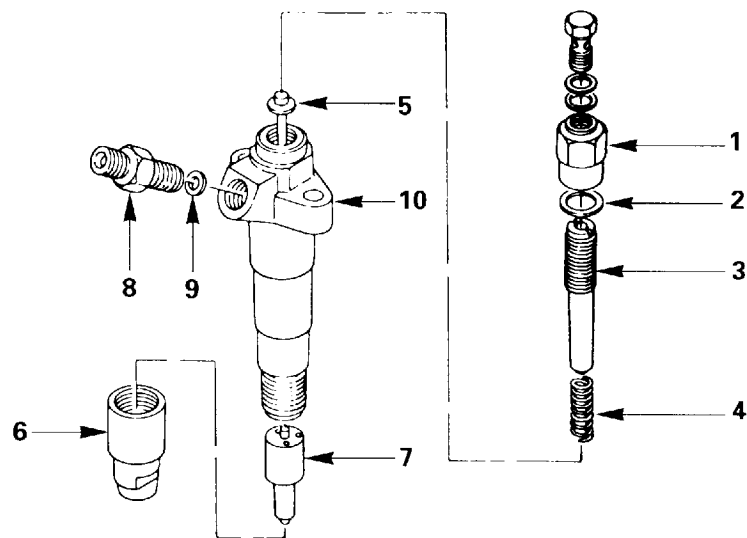
The fuel from the fuel tank passes through the water sedimentor and the fuel filter where water particles and other foreign material are removed from the fuel.

Fuel, fed by the injection pump plunger, is delivered to the injection nozzle in the measured volume at the optimum timing for efficient engine operation.

INJECTION NOZZLE

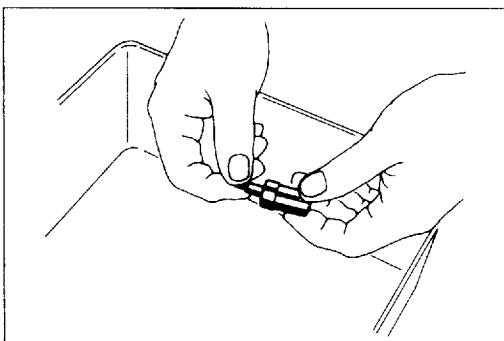


DISASSEMBLY



Disassembly Steps

- | | |
|---------------------------|-----------------------------|
| 1. Nozzle holder cap nut | 6. Retaining nut |
| 2. Cap nut gasket | ▲ 7. Injection nozzle |
| 3. Nozzle adjusting screw | 8. Injection pipe connector |
| 4. Push rod spring | 9. Connector gasket |
| 5. Nozzle holder push rod | 10. Nozzle holder body |



Important Operation

7. Nozzle

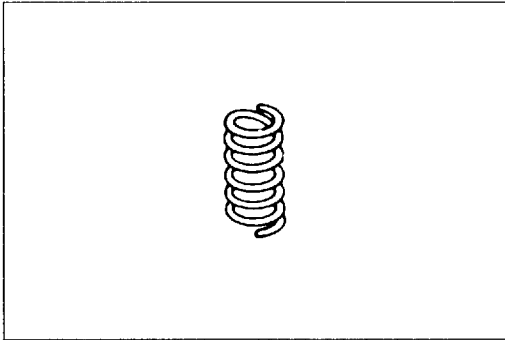
Remove the nozzle assembly from the nozzle body.

Keep the parts separately to maintain the proper needle valve to body combination.



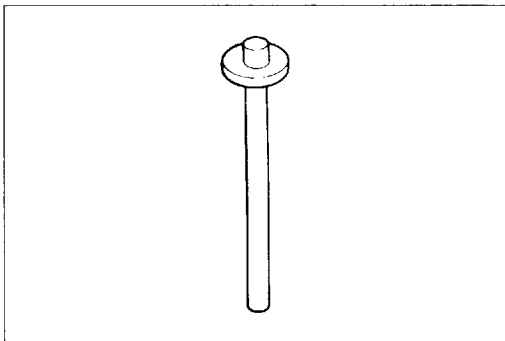
INSPECTION AND REPAIR

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.



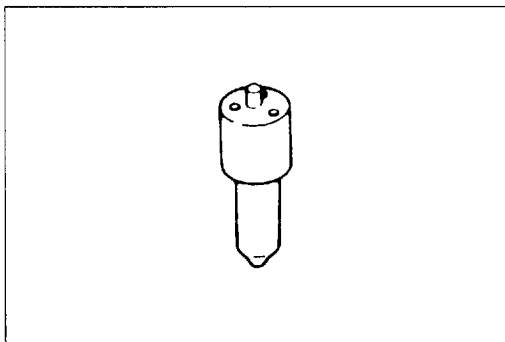
Push Rod Spring

Check the push rod spring for wear, weakness, and corrosion.



Nozzle Holder Push Rod

1. Check the nozzle holder push rod curvature.
2. Check the nozzle holder push rod and needle valve contact surfaces for excessive wear and poor contact.



Injection Nozzle

1. Check the injection nozzle needle valve, the valve seat, and the injection nozzle hole for carbon deposits.

If carbon deposits are present, the injection nozzle and the needle valve must be replaced.

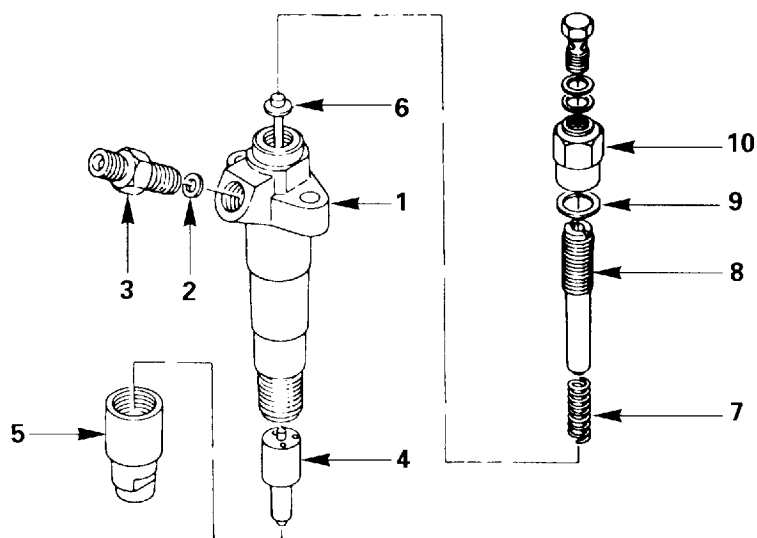
2. Hold the nozzle body vertically.

Pull the needle valve about one-third of the way out of the nozzle body.

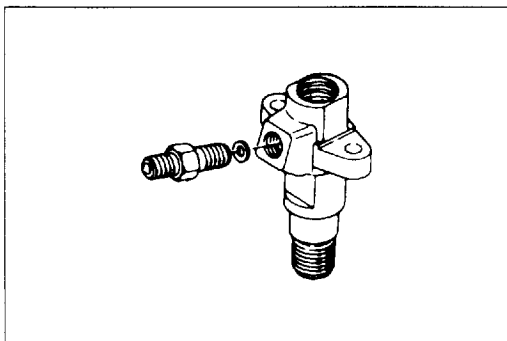
Release the needle valve.

Check that the needle valve falls back into the nozzle body as far as the valve seat.

If the needle valve does not fall back into the nozzle body as far as the valve seat, the injection nozzle and the needle valve must be replaced.

**REASSEMBLY****Reassembly Steps**

- | | |
|-------------------------------|-----------------------------|
| 1. Nozzle holder body | 6. Nozzle holder push rod |
| 2. Connector gasket | 7. Push rod spring |
| ▲ 3. Injection pipe connector | 8. Nozzle adjusting screw |
| ▲ 4. Injection nozzle | 9. Cap nut gasket |
| ▲ 5. Retaining nut | ▲ 10. Nozzle holder cap nut |



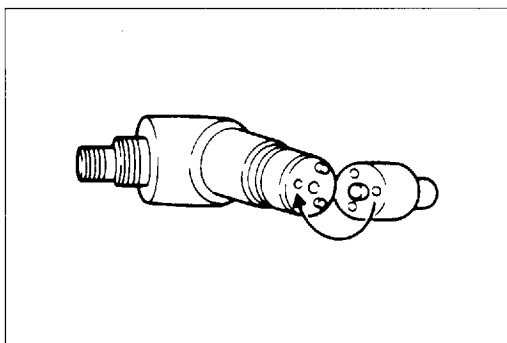
Important Operation

3. Injection Pipe Connector



N·m (kgf·m/lb.ft)

Nozzle Connector Torque	49 – 59 (5.0 – 6.0/36 – 43)
-------------------------	-----------------------------



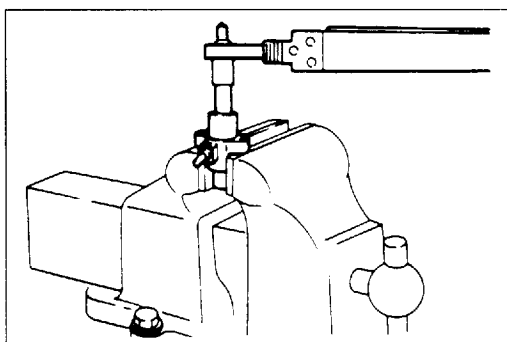
4. Injection Nozzle

There must be no oil on the contact surfaces of the injection nozzle and the injection nozzle holder.

Clean these contact surfaces with diesel fuel before installation.



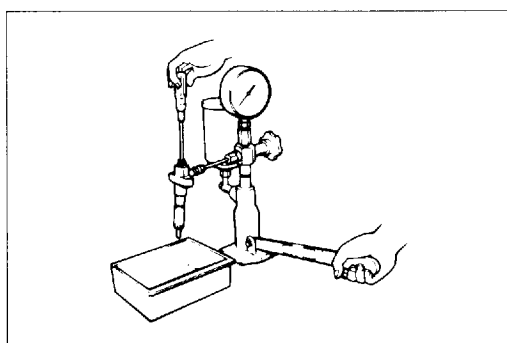
The nozzle dowel pin must be aligned with the dowel hole in the nozzle holder body.



5. Retaining Nut

N·m (kgf·m/lb.ft)

Nozzle Retaining Nut Torque	59 – 78 (6.0 – 8.0/43 – 58)
-----------------------------	-----------------------------



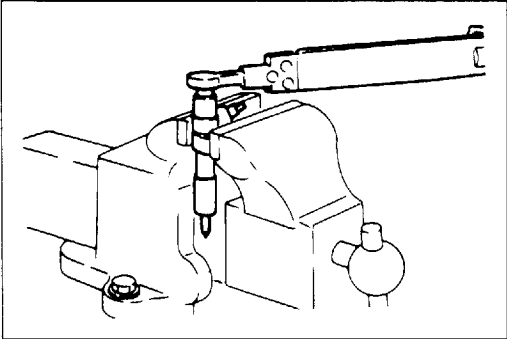
Injection Starting Pressure Adjustment

The injection nozzle injection starting pressure can be adjusted after the adjusting screw is installed.

Refer to "FUEL SYSTEM" on Page 2-4 of the "MAINTENANCE" Section of this Workshop Manual.

MPa (kgf/cm²/psi)

Injection Starting Pressure	18.1 (185/2630)
-----------------------------	-----------------



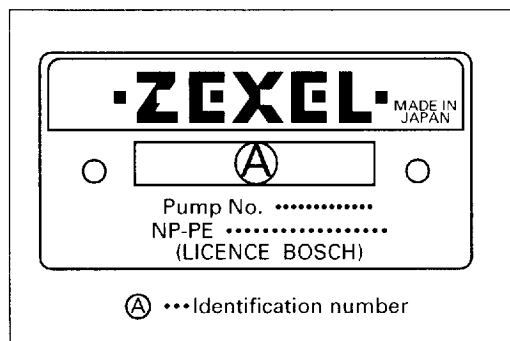
10. Nozzle Holder Cap Nut



N·m (kgf·m/lb.ft)

Cap Nut Torque	39 – 49 (4.0 – 5.0/29 – 36)
----------------	-----------------------------

INJECTION PUMP CALIBRATION DATA



IDENTIFICATION PLATE AND PRODUCT SERIAL NUMBER

1. Injection pump adjustment and repair should be made by the nearest ZEXEL CORPORATION or ROBERT BOSCH Authorized Service Outlet.
2. When you ask such authorized service outlet the adjustment or repair, the identification Plate and Product Serial Number will give them a necessary clue to get technical data distributed by the manufacturers previously.

Without this data, the Service Outlet will be unable to effectively service your injection pump.

If you are unable to locate the data applicable to your injection pump, please contact ISUZU MOTORS LTD through your machine supplier.

3. Do not remove the Identification Plate and Product Serial Number from the injection pump.

Keep the Identification Plate and Product Serial Number clean at all times. Do not allow it to rust or become illegible.

Note: Examples of test conditions and calibration data are as follows.

TEST CONDITIONS REQUIRED FOR THE FUEL INJECTION AMOUNT ADJUSTMENT

Injection Nozzle		*ZEXEL No.: 105160-5130 Bosch Type No.: NP-DLLA149SM304
Injection Nozzle Holder		ZEXEL No.: 105030-4750
Injection Starting Pressure	MPa (kgf/cm ² /psi)	18.1 (185/2630)
Injection Line Dimensions	mm (in.)	
Inside Diameter		1.8 (0.071)
Outside Diameter		6.0 (0.236)
Length		600.0 (23.6)
Transfer Pump Pressure	kPa (kgf/cm ² /psi)	157 (1.6/23)
Testing Diesel Fuel		ISO4113 or SAE Standard Test Oil (SAEJ967D)
Operating Temperature	°C (°F)	40 – 45 (104 – 113)
Pump Rotation Direction		Clockwise (Viewed from the drive side)

INJ. PUMP CALIBRATION DATA

ENGINE MODEL 6BG1-TRA

Ass'y No. 101602-8950

Date : 29 Oct 1999 1

Company : ISUZU

No. 1-15603-328-0

Injection pump : PES6AD
101062-8390Governor : EP/RSV
105419-4030

Timing device :

1. Test Conditions :

Pump rotation : clockwise (viewed from drive side)

Nozzle & Nozzle Holder Ass'y : 105780-8140 (BOSCH Type No. EF8511/9A)

Nozzle : 105780-0000

(BOSCH Type No. DN12SD12T)

Nozzle Holder : 105780-2080

(BOSCH Type No. EF8511/9)

Nozzle opening pressure : 17.2 MPa (175 kgf/cm²)Transfer pump pressure : 157 kPa (1.6 kgf/cm²)

Injection pipe : Outer Dia. 6 mm × Inner Dia. 2 mm – Length 600 mm

Test Oil : ISO4113 or SAE Standard Test Oil (SAE J967d)

Oil Temp. : 40^{±5} °COverflow valve opening pressure : 127 kPa (1.3 kgf/cm²)**2. Injection Timing :**

Pre-stroke : No. 1 Plunger 4.0 ± 0.05 mm Note : Adjust with rack position of mm

Injection order : 1 — 5, 1 — 3, 1 — 6, 1 — 2, 1 — 4
60°±30' 120°±30' 180°±30' 240°±30' 300°±30'

(interval : °± 30')

Plungers are numbered from the Driver side.

Tappet clearance : Bolt adjustment type ; More than 0.3 mm for all cylinders.

Shim adjustment type ; Manually rotate the camshaft 2~3 times and confirm that it rotates smoothly.

4. Injection Quantity :

Adjusting point	Rack Position (mm)	Pump Speed (r/min)	Injection q'ty (cm ³ /1000 strokes)	Max. var bet. cyl (%)	Fixed	Remarks
A	10.3	1,075	89 ± 1.5	± 2	Lever	Basic
C	Approx. 7.5	450	9 ± 1.3	± 14	Rack	
D	—	100	150 ± 5	—	Lever	Rack limit

5. Timing advance specification :

Pump speed (r/min)							
Advance angle (°)							

·ZEXEL·

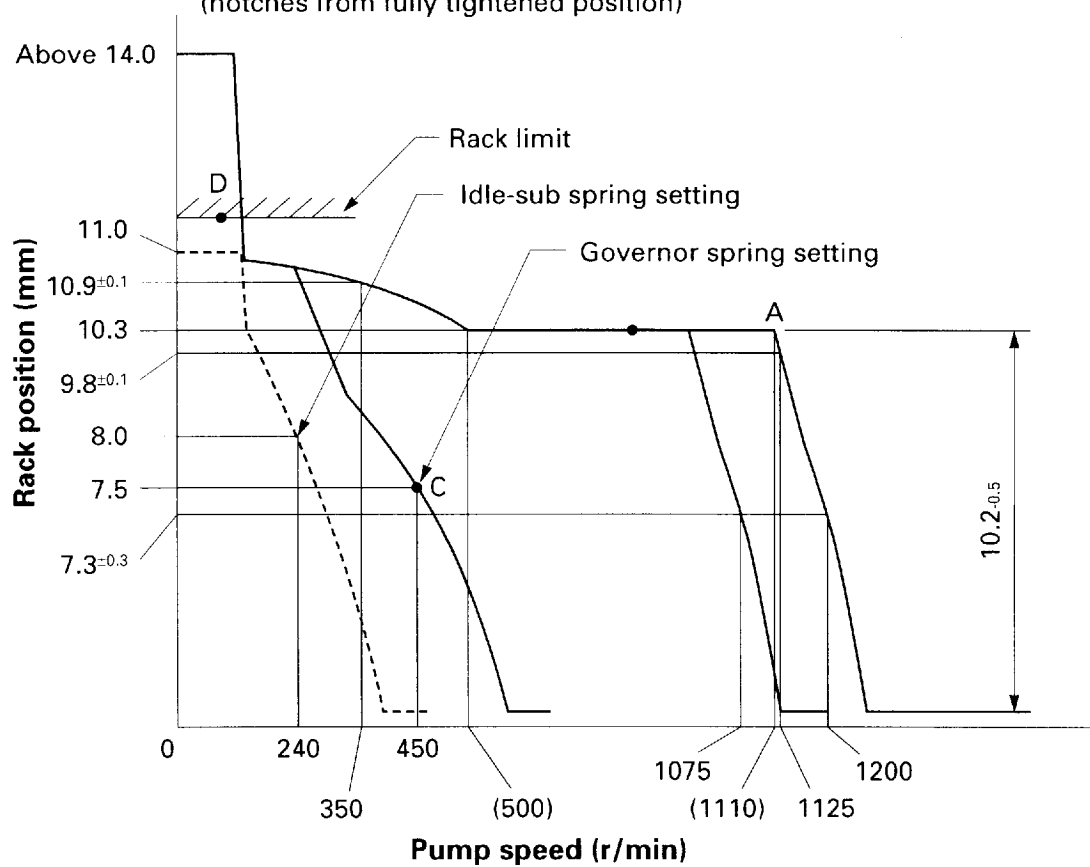
ZEXEL CORPORATION

Service Department 1

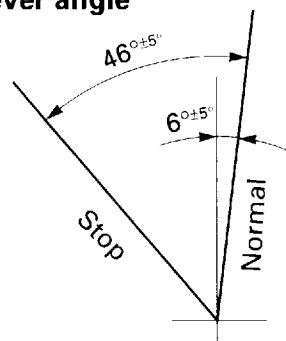
3. Governor adjustment

101602-8950

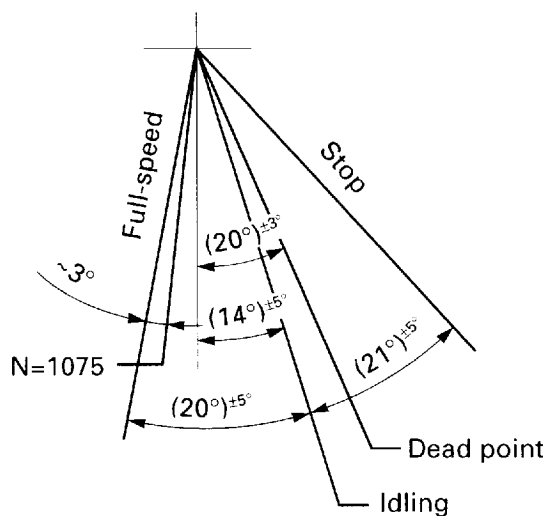
Recommended speed droop adjustment screw position: 9
(notches from fully tightened position)



Stop lever angle

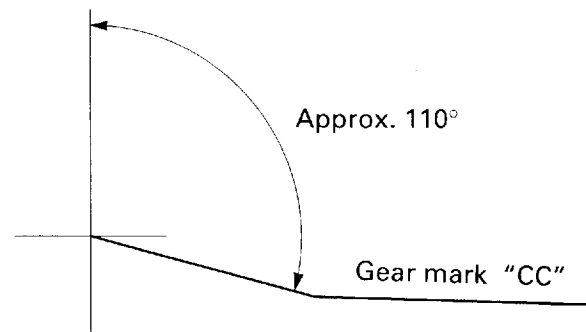


Speed control lever angle



Timing setting

At No.1 plunger's beginning
of injection position
B. T. D. C. : 10°



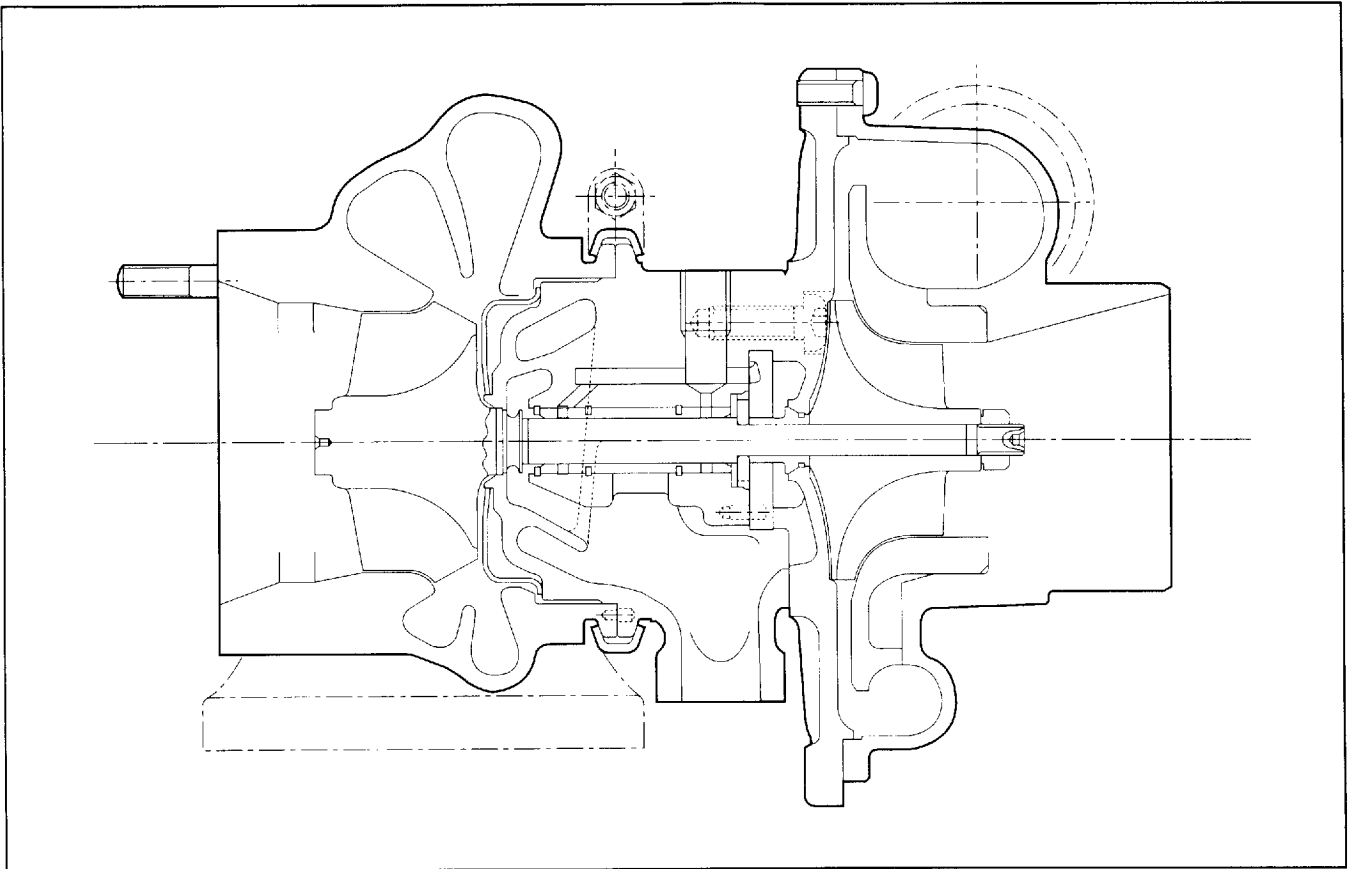
SECTION 9

TURBOCHARGER

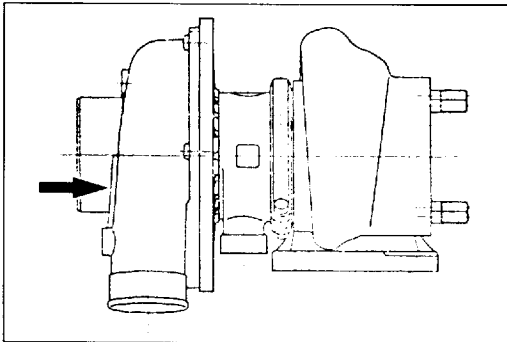
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Inspection and repair	9- 7

GENERAL DESCRIPTION



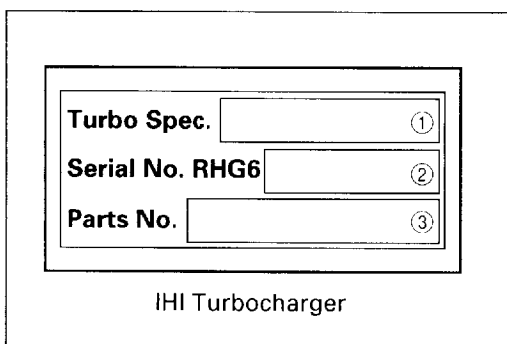
TURBOCHARGER IDENTIFICATION



IDENTIFICATION

The IHI Turbocharger nameplate gives the date of manufacture and other important information required to identify the unit when service inquiries or part orders are made.

The arrow in the illustration indicates the location of the Turbocharger nameplate.



The turbocharger nameplate has the following information stamped on it. Refer to the illustration at the left.

- (1) Turbo Specification Number, Production Year and Month
- (2) Production Date, Daily Serial Number
- (3) ISUZU Parts Number

ITEM CONFIRMED ON TURBOCHARGER

Before removing the turbocharger, be sure to check the following items:

- (1) Oil leak from turbocharger
- (2) Abnormal noise from turbocharger
- (3) Acceleration is not felt. The engine is out of order.

Caution:

The turbocharger is heated hot right after the engine stops.

Be sure to cool the engine sufficiently for safety before inspection.

TURBOCHARGER CHECKING PROCEDURES

- (1) Idle the engine on the machine and visually check all parts around the turbocharger to find abnormal phenomena.

Record the phenomena and their locations if any.

- (2) Pay special attention to the states of the air inlet and outlet hoses of the turbocharger, and check that the bands are not loose and no oil is leaking.
- (3) Inspect the appearance of the turbocharger referring to the checkpoints for each problem (oil leak, abnormal noise, irregular acceleration and insufficient output).

TROUBLESHOOTING

OIL LEAK

Check the appearance of the turbocharger to find oil leak positions.

Checkpoint	Cause	Remedy
Turbine housing gas inlet and outlet tightening positions. Mating face between turbine housing and bearing housing.	Abrasion of turbo bearing due to trouble in the oil supply system.	Check the turbo air inlet side.
Turbo oil inlet side tightening position.	Loosening of bolt. Damage of O-ring.	Tighten the bolts additionally. Replace the O-ring with a new one.
Outer periphery of compressor housing.	Oil leak from tightening position due to oil leak from the air compressor.	The turbocharger is in order.

ABNORMAL NOISE

Check the situation when an abnormal noise occurs.

Abnormal noise can be divided into the following three types:

Phenomenon	Cause	Remedy
Noise like something passing through the air (Whistling noise).	This noise occurs when the turbocharger rotates at a high speed.	The rotor generally generates this sound. This is not a problem.
Metallic noise	Breakage of foreign matter entered from outside the turbocharger. Abrasion of turbo bearing due to trouble in the oil supply system.	Check the air inlet side of the turbocharger.
Air or gas leaking noise	Loosening or disconnection of air or gas pipe to the turbocharger.	Tighten bolts, screws, hose band, etc. additionally at the air or gas pipe connections.

9-6 TURBOCHARGER

IRREGULAR ACCELERATION, INSUFFICIENT OUTPUT

The life of the turbocharger has terminated except damage due to abrasion of the bearing.

Checkpoint	Cause	Remedy
Check looseness and disconnection of air and gas pipes to the turbocharger.	Malperformance due to leak of air or exhaust gas.	Tighten bolts, screws and hose bands additionally at the air and gas pipe tightening positions.
Check the air inlet side of the turbo.		
Check the engine body.		

Check of Air Inlet Side of Turbocharger

Disconnect the hose from the air inlet side for the inspection.

Checkpoint	Cause	Remedy
Check if oil adheres the inside and the outside of the air inlet of the turbo.	Oil leak from tightening position due to oil leak from the air compressor.	The turbo is in order.
Looseness or drop of shaft end nuts, bent of blade (Abrasion or damage).	Breakage of foreign matter entered from outside the turbo. Abrasion of the turbo bearing due to trouble in the oil supply system.	Replace the turbo with a new one due to malfunction. When replace the turbo, check if the feed oil pipe is clogged.
Check contact between the blade and the compressor housing.	Abrasion of turbo bearing due to trouble in the oil supply system.	Replace the turbo with a new one due to malfunction. When replacing the turbo, check if the feed oil pipe is clogged.



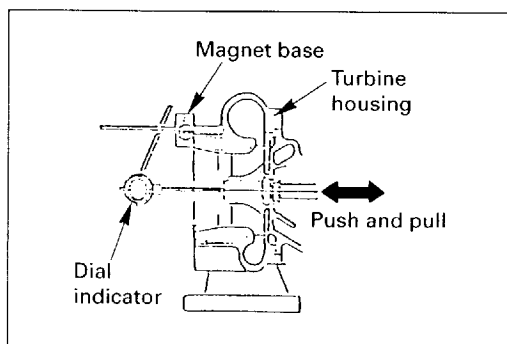
INSPECTION AND REPAIR

If excessive wear or damage is discovered during inspection, the appropriate parts must be adjusted, repaired, or replaced. Damage or improper adjustment of the turbocharger will inhibit sufficient air flow to the engine, preventing it from delivering full performance.

If the engine demonstrates a significant drop in performance, check for engine damage or wear. If no significant engine damage or wear can be found, it is likely that the turbocharger is at fault.

When reduced performance is the result of a faulty turbocharger, contact your nearest IHI or Mitsubishi Service Center for the proper repairs.

The following is primarily a description of the particularly important rotor shaft end play, and bearing clearance standard and limit values.



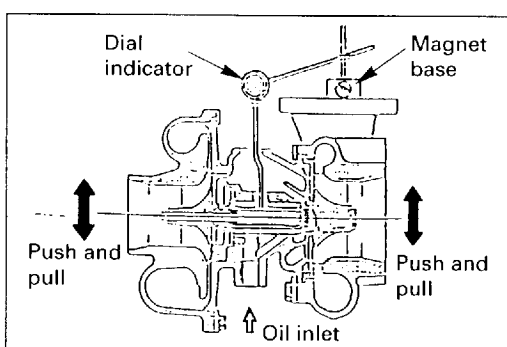
Rotor Shaft Axial Play Measurement

- 1) Install a dial indicator on the turbine housing as illustrated.
- 2) Use the dial indicator to measure the rotor shaft axial play with moving the shaft push and pull. Read the total indicator reading (TIR).

mm (in)

IHI RHG6	Limit
Rotor Shaft Axial Play TIR	0.11 (0.00433)

- 3) If the measured value exceeds the specified limit the shaft must be replaced.



Rotor Shaft Radial Play Measurement

- 1) Turn over the turbocharger with the turbine exhaust inlet flange facing up.
- 2) Install a dial indicator to measure the rotor shaft radial play.
- 3) Use the dial indicator to measure the play. Read the TIR.

mm (in)

IHI RHG6	Limit
Rotor Shaft Radial Play TIR	0.205 (0.00807)

- 4) If the measured value exceeds the specified limit replace the shaft.

MEMO

SECTION 10

ENGINE ELECTRICALS

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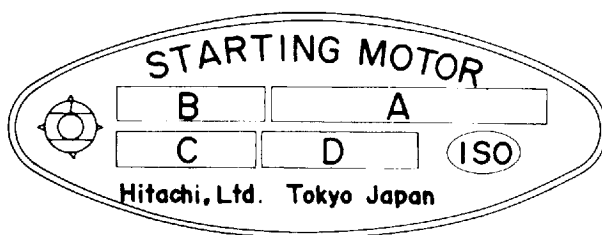
STARTER IDENTIFICATION

The starter identification plate is attached to the starter motor outside yoke. The ISUZU part number, the manufacturer's code number, and other important information are stamped on the plate.

Refer to the identification plate together with the "Main Data and Specifications" Tables and accompanying charts in this Manual when requesting service assistance from a qualified electrical repair shop.

If you are unable to locate the data applicable to your engine, please contact ISUZU MOTORS LIMITED through your machine supplier.

HITACHI IDENTIFICATION PLATE



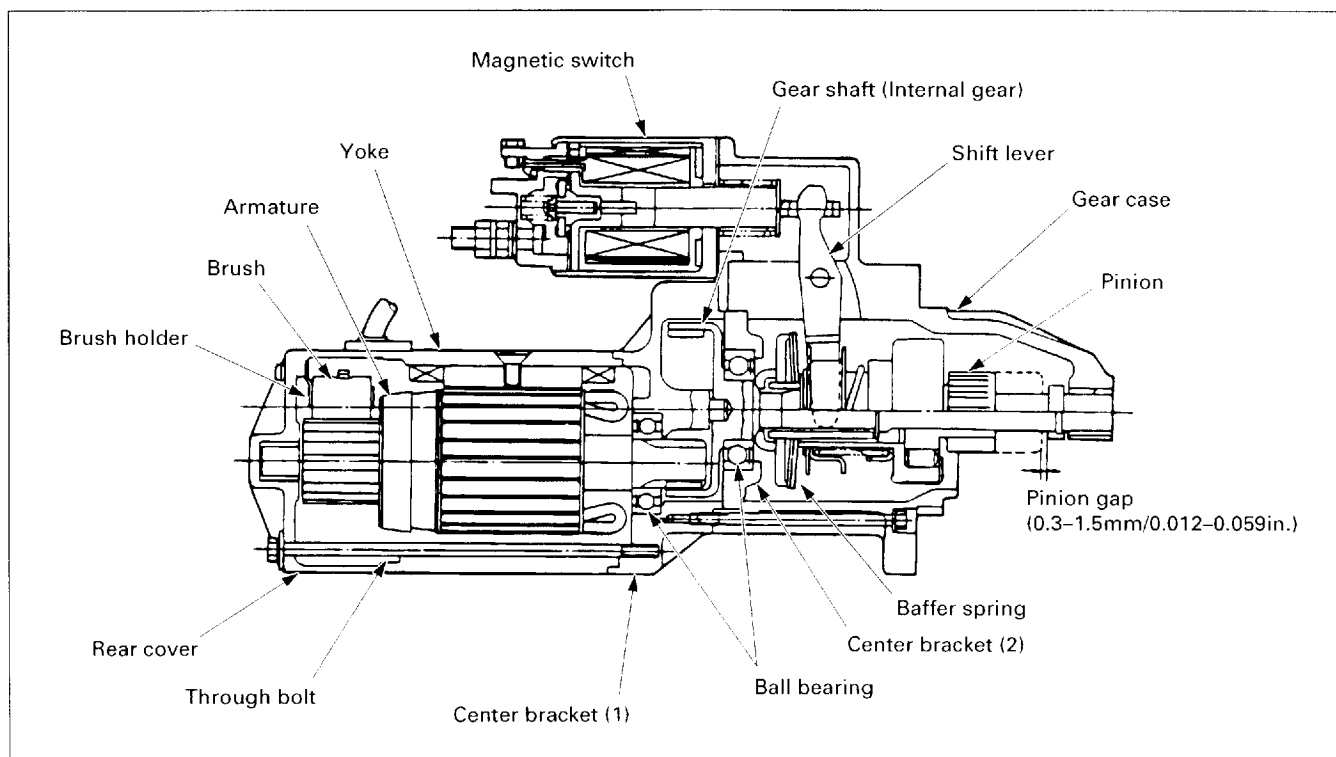
- A: Isuzu part number
- B: Manufacturer's code number
- C: Rated output
- D: Manufacturer's production mark

STARTER

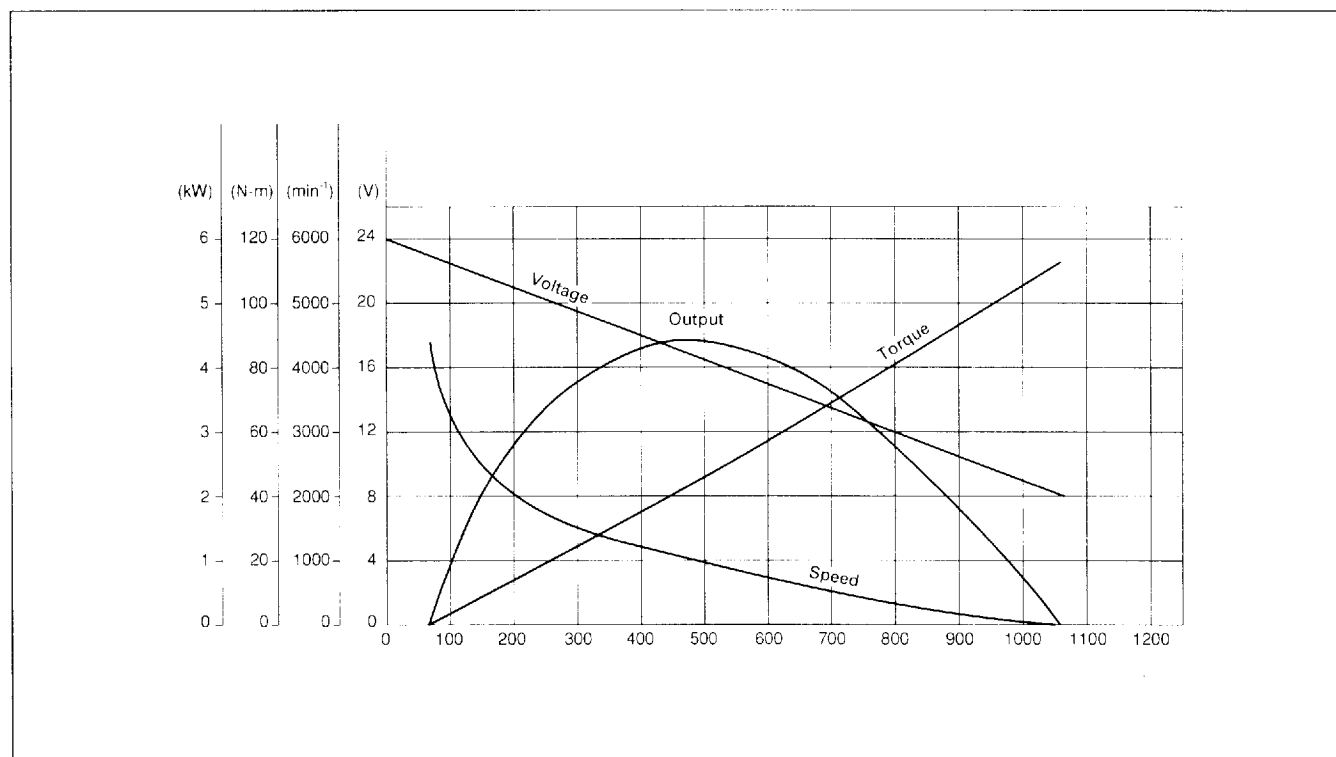
MAIN DATA AND SPECIFICATIONS

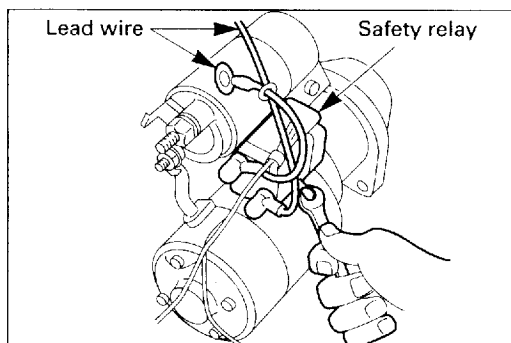
Isuzu Part No.		181100-3420
Manufacturer's code No. (HITACHI)		S25-172
Rated voltage (V)		24
Rated output (kW)		4.5
Rating (Sec)		30
Direction of rotation (Viewed from the pinion side)		Clockwise
Clutch type		Roller
Terminal voltage (No load) (V)		24
Minimum current (No load) (A)		Less than 100
Starter motor minimum operating speed (No load) (min ⁻¹)		More than 3500
Pinion gear		
Modules		3
Number of teeth		11
Outside diameter mm (in.)		40.64 (1.60)
Travel distance mm (in.)		1.5 (0.032)
Yoke outside diameter mm (in.)		90 (3.54)
Number of poles		4
Magnetic switch (at 20°C [68°F])		
Series coil resistance (Ω)		0.187
Shunt coil resistance (Ω)		1.31
Brush length		
Standard mm (in.)		22 (0.866)
Limit mm (in.)		14 (0.551)
Brush spring standard fitting load N (kg/lbs.)		38 (3.85/8.49)
Commutator		
Outside diameter		
Standard mm (in.)		37.0 (1.457)
Limit mm (in.)		36.5 (1.437)
Difference between the largest and smallest diameters (Run-out)		
Limit mm (in.)		0.1 (0.004)
Depth of undercut mica		
Standard mm (in.)		0.5-0.8 (0.020-0.031)
Limit mm (in.)		0.2 (0.008)

STARTER MOTOR SECTIONAL VIEW



PERFORMANCE



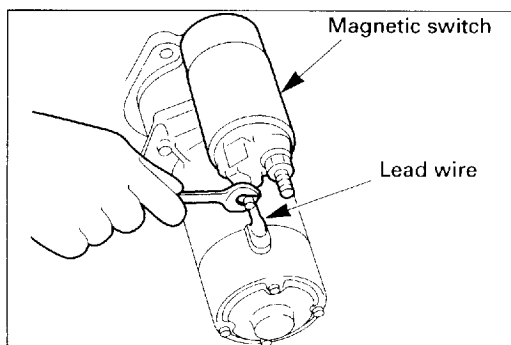


DISASSEMBLY

Removal of Safety Relay

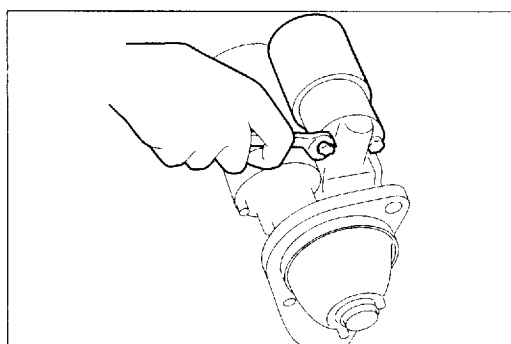
Remove the nut M10 (17 mm/0.669 in) and bolt M5 (8 mm/0.315 in) from the magnetic switch.

Then remove 2 pieces of the bolt M6 (10 mm/0.393 in).



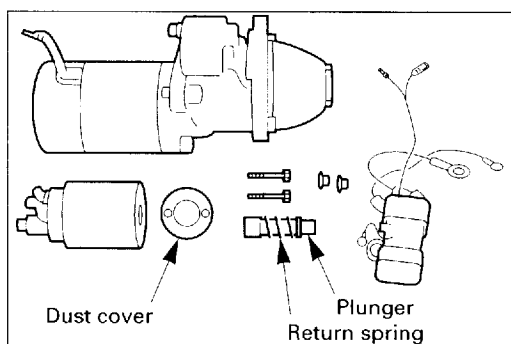
Disconnection of Lead Wire

Remove the nut M10 (17 mm/0.669 in) from the magnetic switch and disconnect the lead wire.



Removal of Magnetic Switch

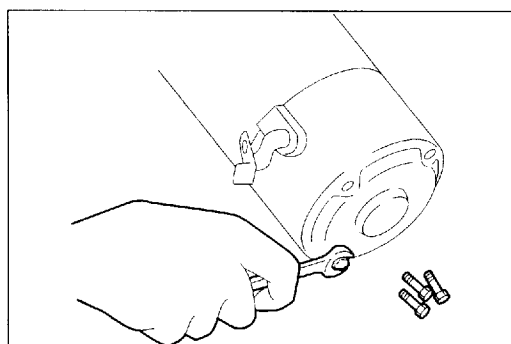
Remove 2 pieces of the bolts M6 (10 mm/0.393 in).

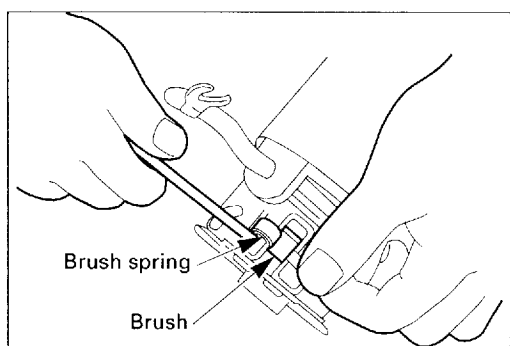
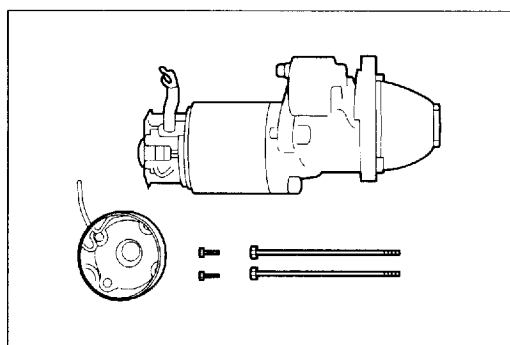
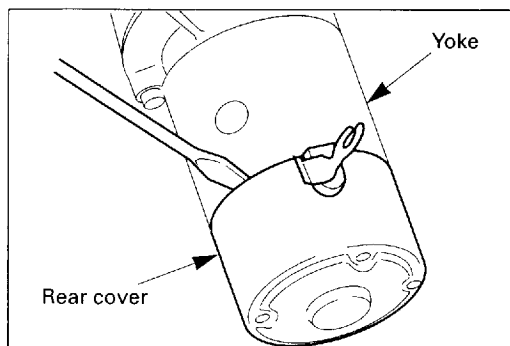


Removal of Rear Cover

Remove 2 pieces of the brush holder tightening screw M4 and then remove 2 pieces of the through bolt M6 (10 mm/0.393 in).

Then, remove the rear cover and the yoke using a straight screwdriver.



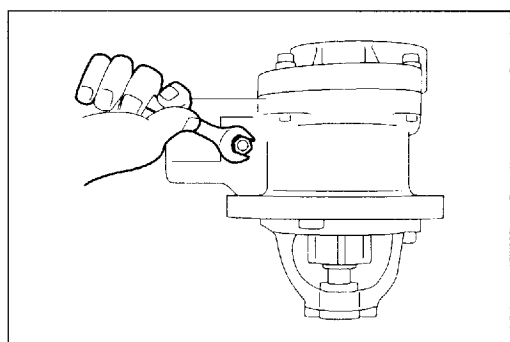
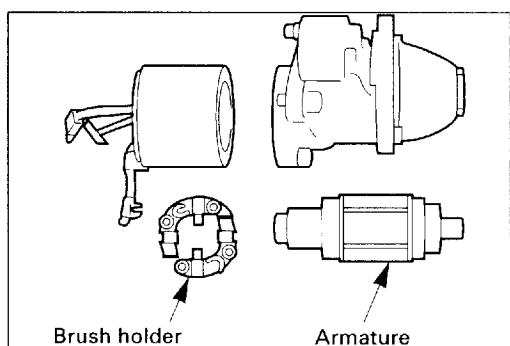


Removal of Brush Holder

For the brush on the (-) side, press the brush spring to the brush side to raise the brush from the commutator face of the armature.

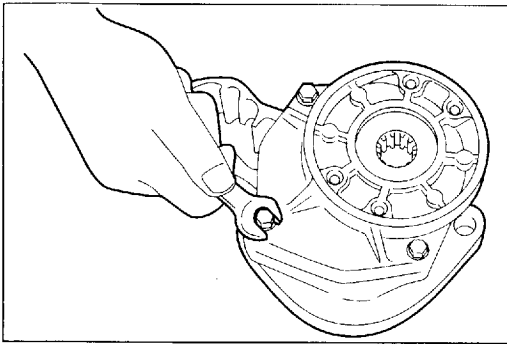
For the brush on the (+) side, pull it out of the brush holder.

When the brush holder is removed, the yoke can be separated from the center bracket.

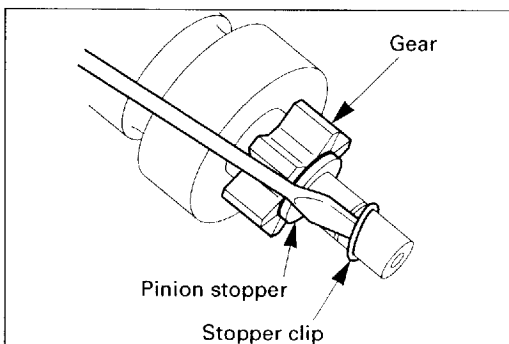
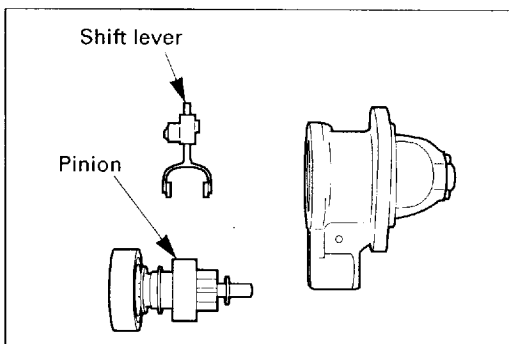
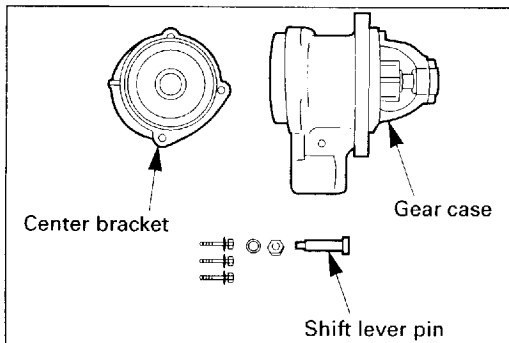


Removal of Shift Lever Pin

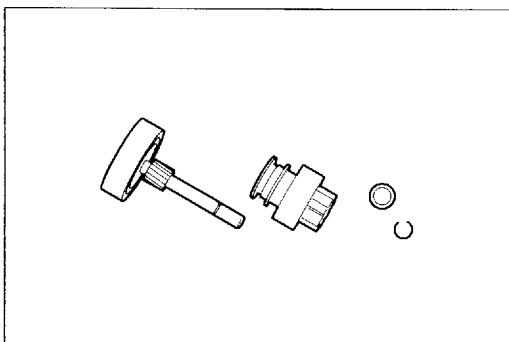
Remove the nut M10 (17 mm/0.669 in) and pull out the shift lever pin.

**Disassembly of Gear Case and Center Bracket**

Remove bolts and separate center bracket from gear case.

**Removal of Pinion**

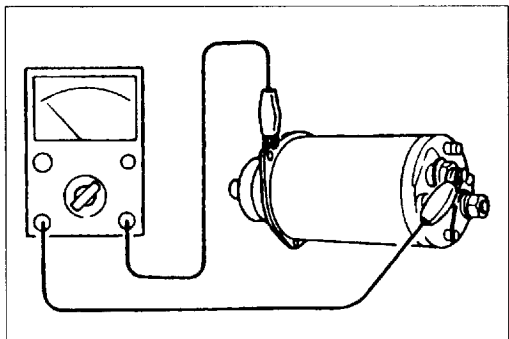
Slide the pinion stopper to the pinion side and remove the pinion stopper grip using a straight screwdriver.



INSPECTION AND REPAIR

1. Magnetic Switch Assembly

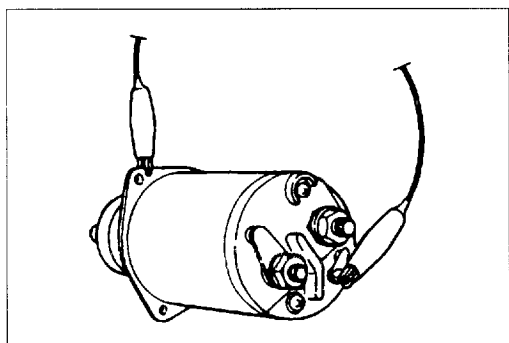
Never perform an operation test of the magnetic switch alone.



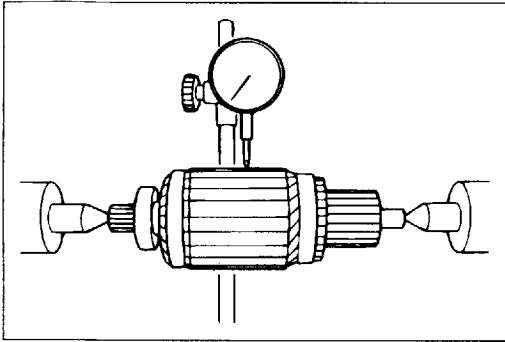
(1) Coil inspection

- 1) Use a tester to check for shorts in the shunt coil and the series coil.

Check for continuity between the magnetic switch's M terminal and the case; if continuity is not present, a short is likely (resistance value: about 1.0 Ω).



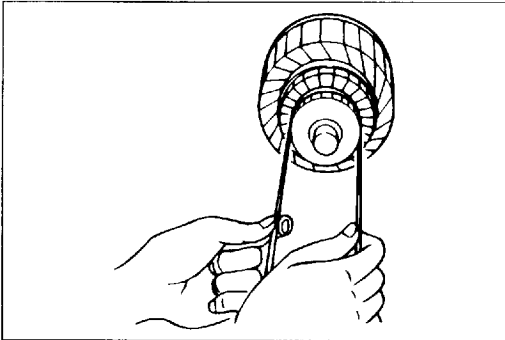
- 2) Apply 24 V between the case and the magnetic switch's M terminal; if the coil is good, the plunger should not retract; if the plunger attempts to retract, the coil is defective.



2. Armature assembly

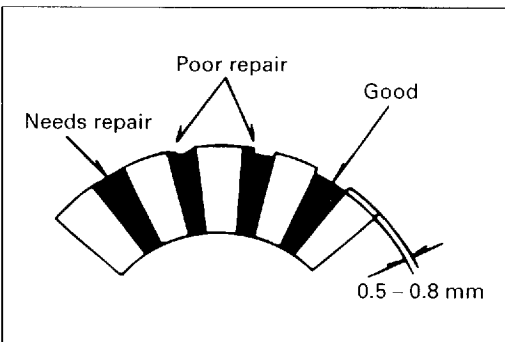
(1) Shaft runout measurement

Measure shaft runout using a dial gauge; if the runout is 0.05 mm (0.002 in) or more, repair or replacement is required.

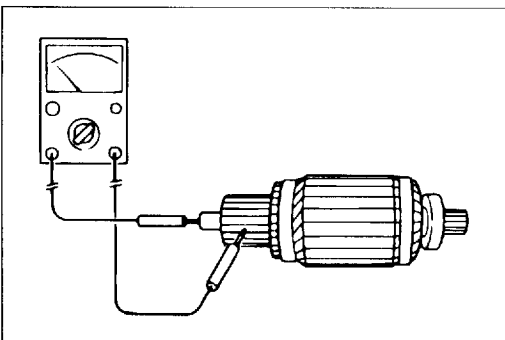


(2) Commutator Inspection

- 1) Inspect the surface of the commutator. If the surface is rough, sand with #400 – 600 sandpaper; if severely tarnished, or if the runout is 0.1 mm (0.004 in) or more, repair on a lathe.

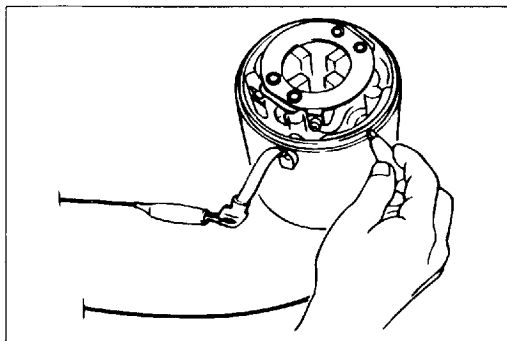


- 2) Inspect the depth of segment mica undercut, and repair if 0.2 mm (0.008 in) or less.



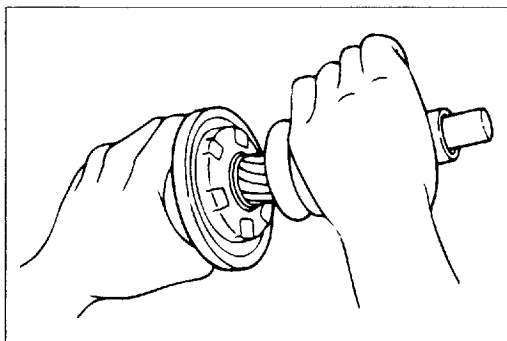
(3) Armature coil inspection

- 1) Place the armature on a growler tester and hold a piece of steel to the armature core. No vibration should be felt in the steel piece.
- 2) Check the armature with a tester; no continuity should be present between the commutator and shaft.



3. Field coil Inspection

- (1) Use a tester to check for any broken winding. A broken wire is indicated if no continuity is found between the field coil's M terminal and the brush lead wire (shunt coil resistance about 4.3 Ω).
- (2) Check for continuity between the field coil and the yoke; repair or replace if continuity is found. (Perform this measurement with the shunt coil's $\ominus$ terminal disconnected from the yoke.)



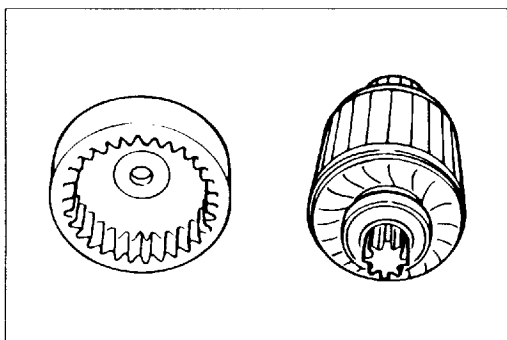
4. Overrunning clutch

Rotate the pinion by hand and confirm that it turns in one direction only.

Inspect the pinion's teeth and replace those demonstrating excessive wear or damage.

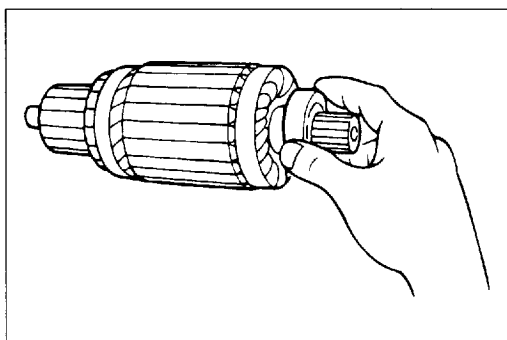
Note:

When cleaning the overrunning clutch, do not immerse the entire clutch in the cleaning solution, since the grease inside the clutch will be dissolved, leading to seizure.



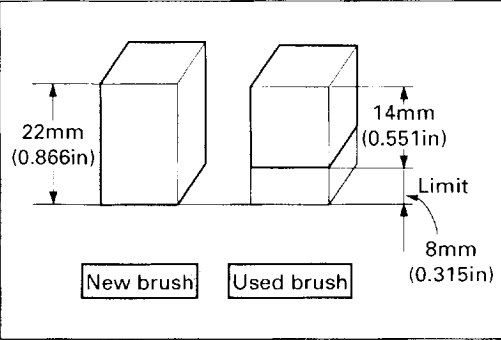
5. Reduction gear

Inspect the reduction gear for excessive wear.



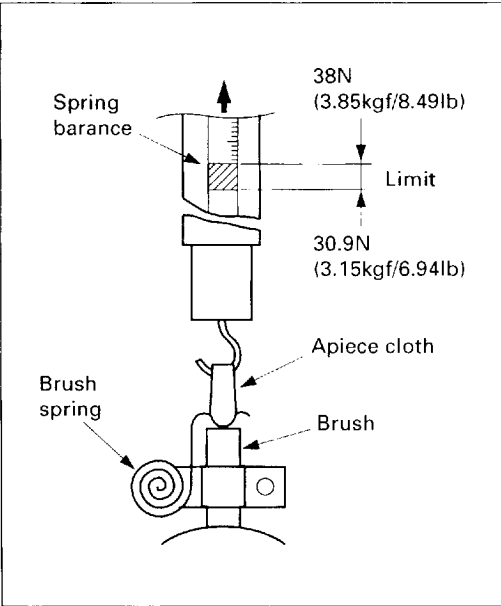
6. Bearings

Rotate the armature bearings' outer race by hand, and confirm that it turns smoothly.



7. **Brush**

- (1) Check the brush wear state and the brush spring pressure.



- (2) Check the brush checking action.
When the brush does not move well, check if the brush holder is bent or if the brush holder sliding surface is soiled.
Repair it if necessary and clean the brush holder.

**REASSEMBLY**

Reassembly is made in reverse of disassembly, but pay attention to the following.

Grease at designated position.

Pinion sliding section, Magnetic switch plunger sliding section.	NPC FG-6A
Reduction gear	MUL TEMP SRL
Shift lever	NPC FG-6A

Gear shaft thrust

One 0.25 mm (0.01 in) thick thrust washer is set between the center bracket and the gear shaft.

One 0.25 mm (0.01 in) thick thrust washer is set on top of gear shaft also.

At the time of reassembling, be sure to check that there are the washers.

The appropriate thrust ranges from 0.1 – 0.4 mm (0.004 – 0.016 in), but if it is more than 0.7 mm (0.028 in), add a thrust washer but use care not to reduce it to zero.

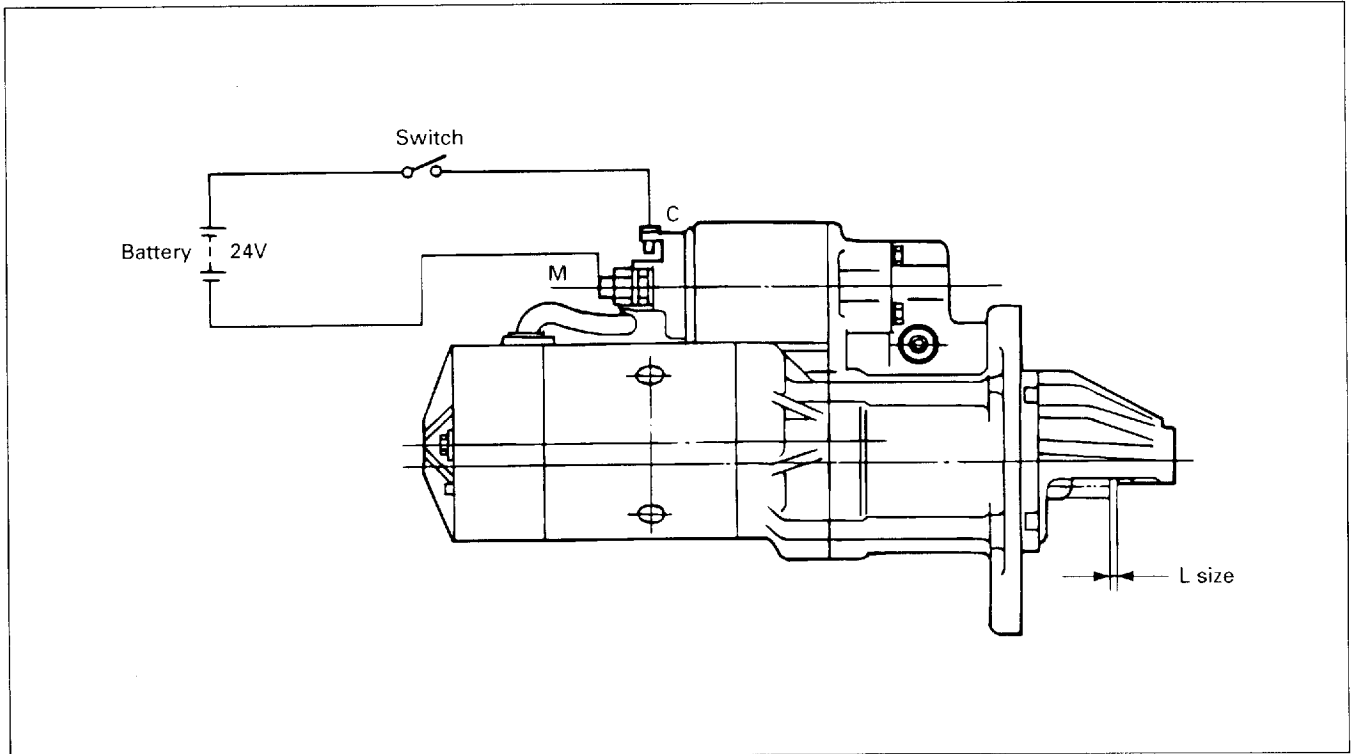
Screw Tightening Torque

Tightening position	Tightning Torque N·m (kgf·cm/lb.ft)
Brush tightening screw, M4	1.7–2.4 (17–24/1.2–1.7)
C terminal tightening bolt, M5	2.5–3.4 (25–35/1.8–2.5)
Magnetic switch tightening bolt, M6	6.4–8.3 (65–85/4.7–6.1)
Motor tightening through bolt, M6	6.9–7.8 (70–80/5.1–5.8)
Shift lever pin tightening nut, M10	6.4–8.3 (65–85/4.7–6.1)
M terminal tightening nut, M10	7.4–9.8 (75–100/5.4–7.2)

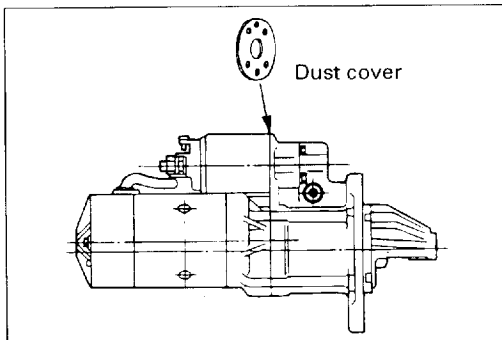


ADJUSTMENT

Size, L, of Pinion Pop-up with Magnetic Switch.



Connection Diagram



Adjustment of L size

When the pinion is pushed out with the magnetic switch, the pinion move size, L, (0.3–1.5 mm/0.012–0.06 in) in the thrust direction is measured.

When the L size is out of the normal range, insert the dust cover as shown in left Fig. to adjust the size.

PERFORMANCE TEST

For the performance test of the starter, a no-load test is conducted according to the procedures mentioned below.

Before the performance test, fix the starter on the test bench.

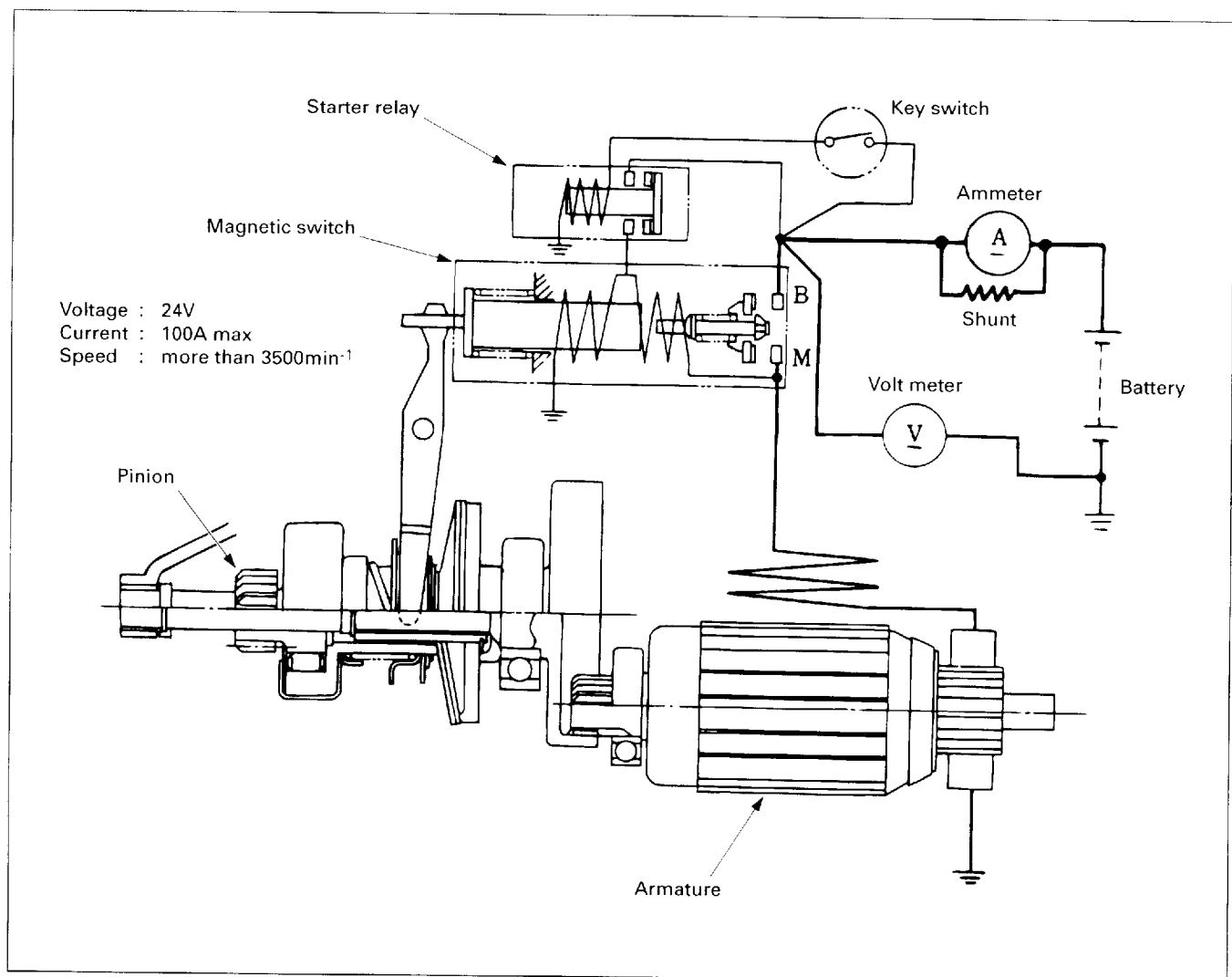
Note: Since the rated time is 30 sec., conduct the test promptly.

No-Load Test

See the following figure for connection.

Close the key switch, and the starter will be energized and will start rotating.

Then, measure the current and the number of revolutions.



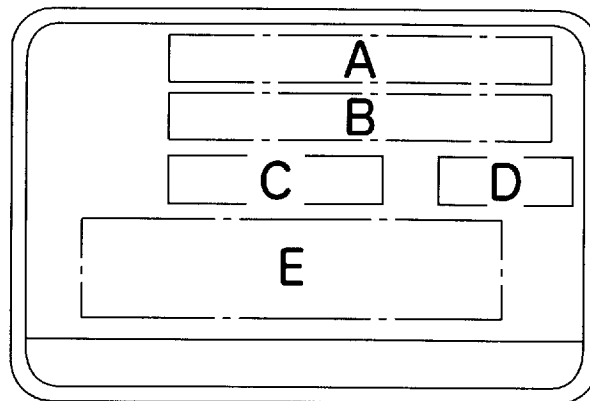
ALTERNATOR IDENTIFICATION

The alternator identification plate is attached to the alternator rear bracket. The ISUZU part number, the manufacturer's code number, and other important information are stamped on the plate.

Refer to the identification plate together with the "Main Data and Specifications" Tables and accompanying charts in this Manual when requesting service assistance from a qualified electrical repair shop.

If you are unable to locate the data applicable to your engine, please contact ISUZU MOTORS LIMITED through your machine supplier.

mitsubishi IDENTIFICATION PLATE

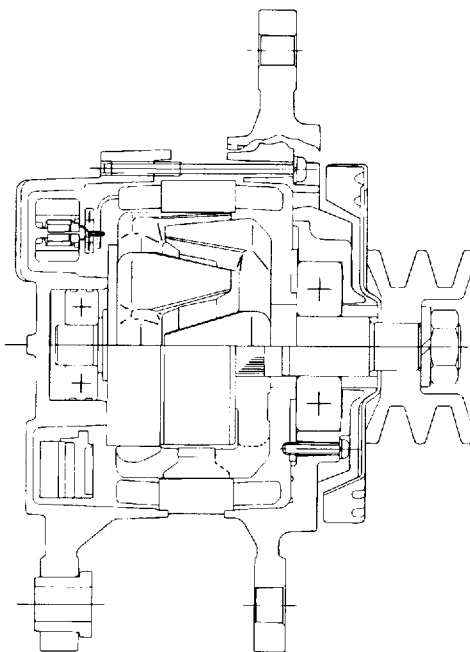


- A: Isuzu part number
- B: Manufacturer's short type name
- C: System voltage output
- D: Manufacturer's lot no.
- E: Bar code

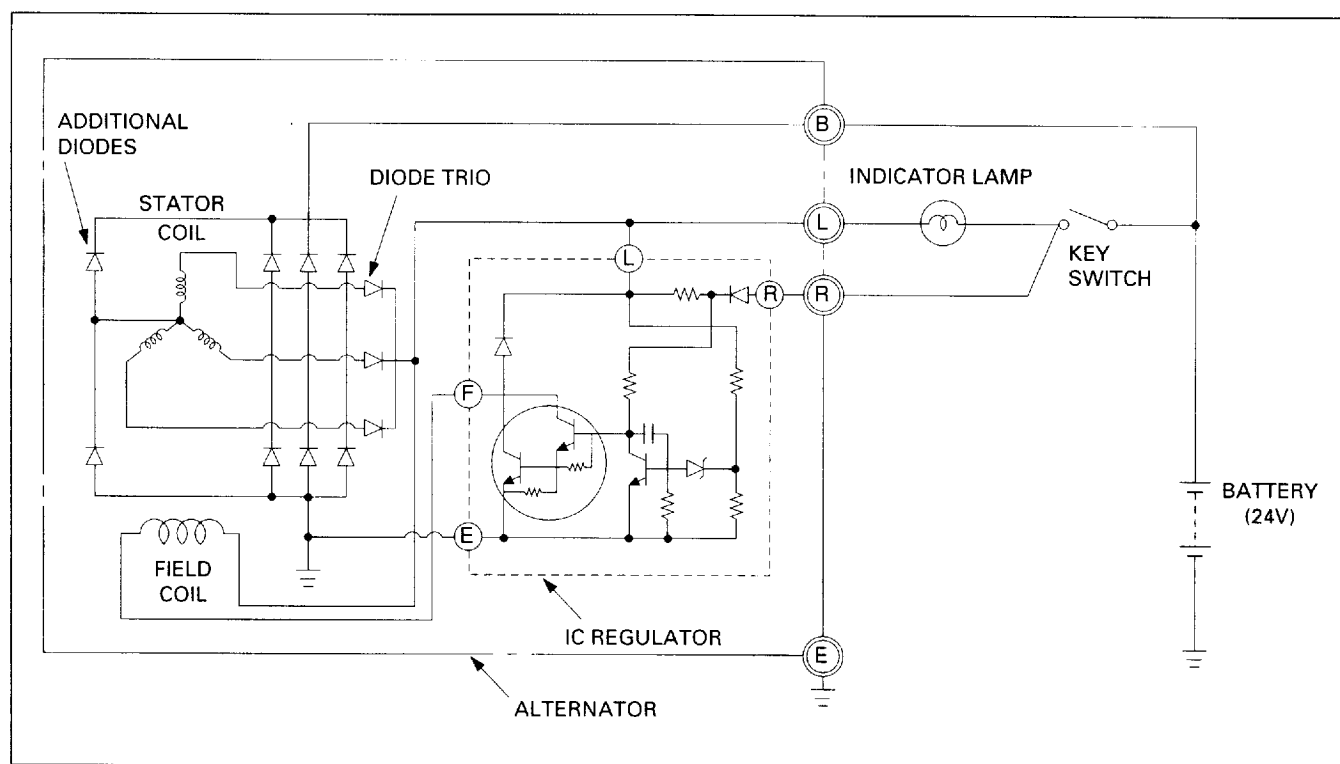
MAIN DATA AND SPECIFICATIONS

ALTERNATOR

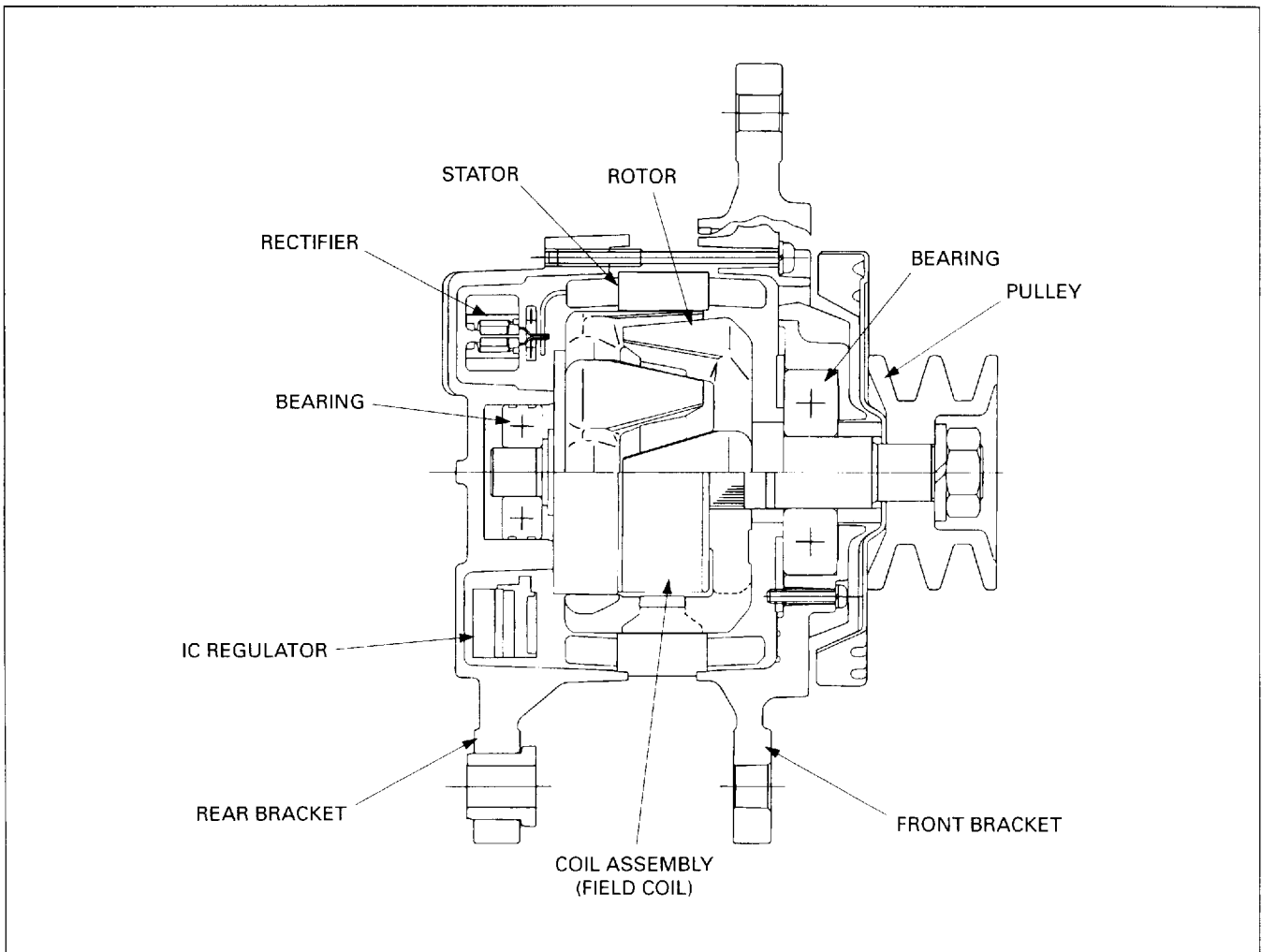
Isuzu Part No.	1-81200-5301
Manufacturer's code No. (MITSUBISHI)	A004T05486
Rated voltage (V)	24
Rated output (A)	50
Rated speed (min ⁻¹)	5000
Rated output at r.p.m (Amp./Volt/min ⁻¹)	50/27/5000
No-load output at 0 Amp. (Volt/min ⁻¹)	24/900
Direction of rotation as viewed from pulley side	Clockwise
Polarity grounded	(—)
Pulley diameter mm (in.)	80 (3.15)
Coil resistance at 20°C	
Field coil (Ω)	4.4-5.2
Regulator's applicable	
Isuzu part No.	1-81260-0170
Manufacturer's code No.	A866X38282



CHARGING CIRCUIT



STRUCTURE



This alternator is a brushless unit.

The main components are the rotor, stator, rectifier assembly, front bracket, rear bracket, IC regulator, bearings and pulley.

The movable parts in the assembly are the rotor and pulley.

The field coil is fixed to the rear bracket.

To rectify 3-phase Alternator in the stator coil to direct current, 6 main diodes and 2 additional diodes are used: 3 main diodes are called "positive diode", while the others are called "negative" diode.

Also, 3 small diodes called "diode trio" are used and the field current is supplied from these diodes.

This alternator has three terminals; a terminal-B (DC power output terminal), terminal-L and terminal-R.

Since terminal-L is connected to the field coil, it is an input terminal of initial exciting current together with terminal-R until the alternator begins to generate.

Also, it has another function of a voltage output terminal (current output capacity is only one ampere).

When terminal-L voltage reaches to battery voltage it turns the indicator lamp off.

The bearings are sealed so no periodic lubrication is required.

The IC regulator is a solid state unit so that it can be serviced as an assembly.

DISASSEMBLY

Note:

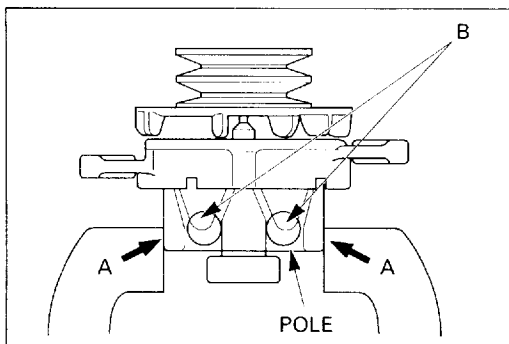
Before disassembling alternator, be sure to put match marks at two locations (front bracket and rear bracket) so that any possible mistake can be avoided.



- (1) Remove four through bolts. Pry between stator and front bracket with the blade of a screwdriver. Carefully separate the front bracket, pulley and rotor assembly away from the stator and rear bracket assembly.

Note:

Do not insert screwdriver too deep, or the starter coil will be damaged.



- (2) Cramp the rotor in a vice, being careful not to distort the rotor poles, and remove the pulley securing nut, pulley, fan, spacer and front bracket.

Note:

When vice or tool is used to secure the rotor, be sure to hold the location "A". Do not hold the location "B" as it does not have enough structural strength.



- (3) If necessary remove the front bracket bearing, remove four retainer screws and press the bearing out of bracket with a suitable socket.

Note:

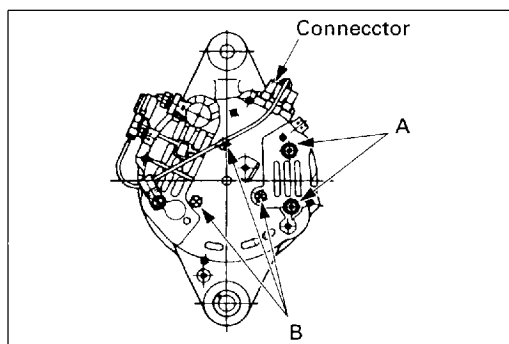
Do not remove bearing for normal service. If bearing is removed, the bearing must be replaced.



- (4) If necessary to remove the rotor bearing, remove the bearing with a normal bearing puller.

Note:

Do not remove bearing for normal service. If bearing is removed, the bearing must be replaced.



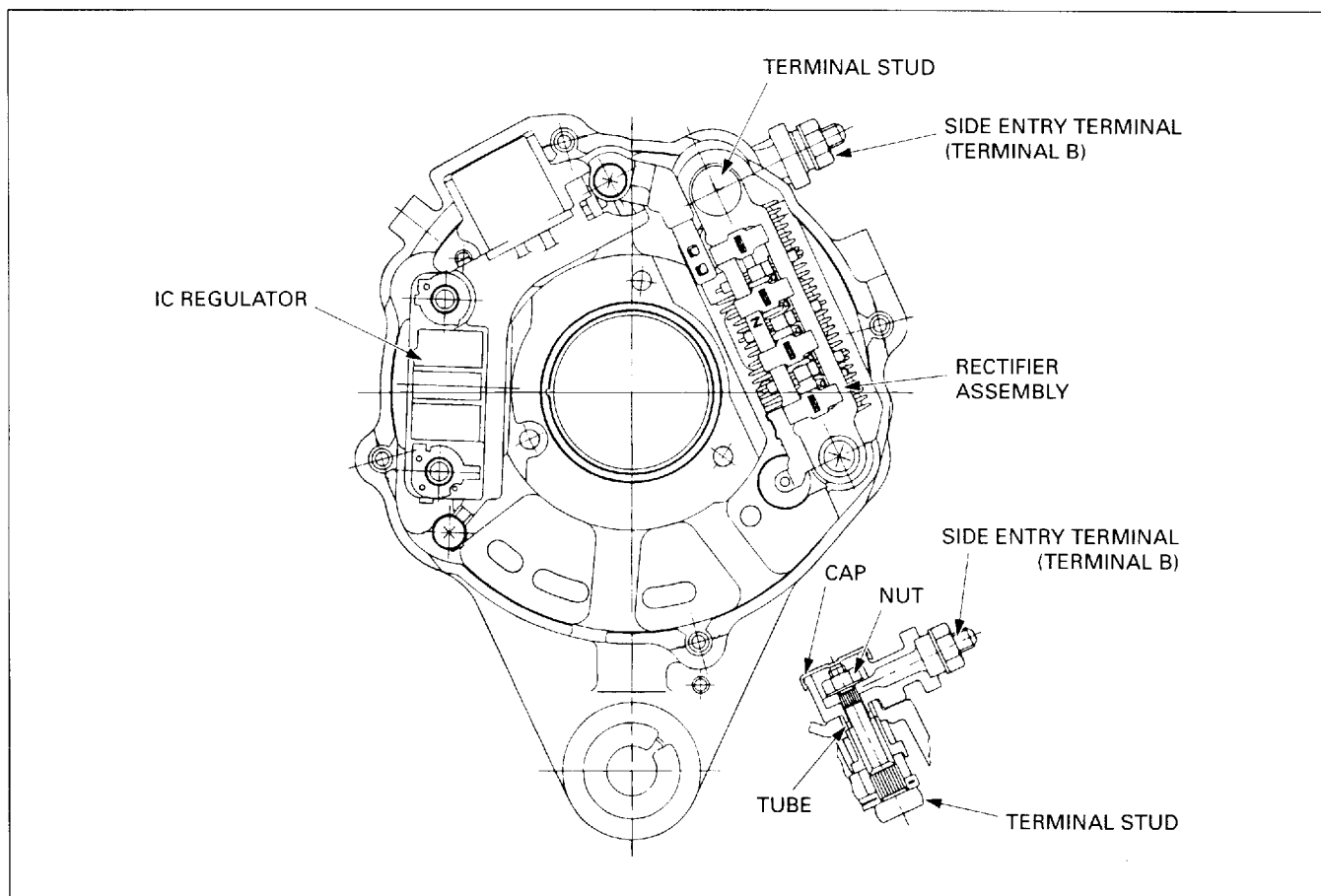
- (5) To move the coil assembly from the rear bracket; first, remove two screws "A" that hold the terminal plate of coil to the IC regulator. If the screws "A" are removed before removing screws B that hold the coil assembly to the rear bracket, the terminal plate may be broken. While being careful not to damage the terminal plate, hold the coil assembly by hand. Then, remove the coil assembly by removing the screw "B".



- (6) Disconnect the connector
- (7) Remove the cap and nut from the terminal stud on the rectifier. Pry between the rear bracket and side entry terminal, and remove the side entry terminal. The tube will remain in the bracket.

Note:

Do not loss the tube.





- (8) Remove the rectifier retaining screw and two IC regulator retaining screws. Separate the starter and rectifier assemblies, as a unit, from the rear bracket. Then remove IC regulator.



- (9) Unsolder four stator coil leads and remove the stator from the rectifier.

Note:

High temperature solder (Melting point of 446° F) is used to secure stator coil leads to rectifier terminals.

Disconnect quickly, use a 180–270 watts soldering iron more than about 5 seconds because the diode may be damaged if it is overheated.

INSPECTIONS

(1) Stator

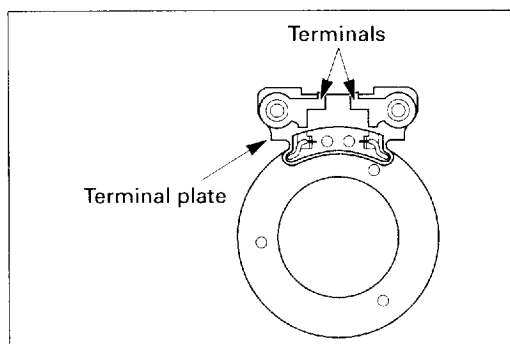
Visually inspect the starter for damage, a loose connection, or discolored windings.

- a. Check for continuity between each pair of the stator coil leads using a circuit tester.
Replace the stator if there is no continuity.
- b. Check for continuity between the stator coil leads and core using a circuit tester.
Replace the stator if there is no continuity.

(2) Rotor

- a. Check the bearing for any scraping noise, roughness, or grease leakage (If the amount of grease leakage is very small, wipe it away.), and replace it as necessary.

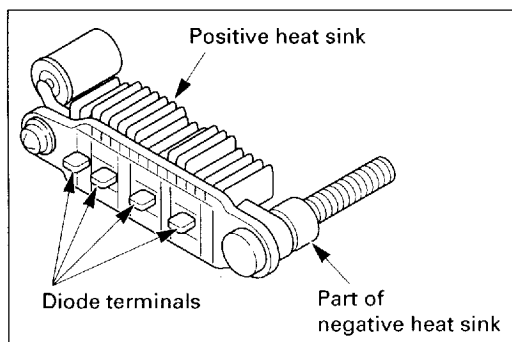
It is more effective to check with the bearing fitted onto the rotor shaft than to check the bearing itself (with no parts mounted).



(3) Coil assembly

- a. Measure the coil resistance between both terminals on the terminal plate using an ohmmeter.

If it is not within specification, replace the coil assembly.



(4) Rectifier assembly

- a. Positive diodes and positive side additional diode.

Check for continuity between the positive heat sink and each of four diodes terminals with a circuit tester.

If there is continuity in both directions, the diode is shorted.

Replace the rectifier assembly.

If there is no continuity in both directions, the diode is open-circuit.

Replace the rectifier assembly.

- b. Negative diodes and negative side additional diode.

Check for continuity between the negative heat sink and each of four diodes terminals with a circuit tester. If there is continuity in both directions, the diode is shorted. Replace the rectifier assembly.

If there is no continuity in both directions, the diode is open-circuit.

Replace the rectifier assembly.

- c. Diode trio (Three small diodes)

Using a circuit tester, check the diode trio for continuity in both directions.

If there is either continuity or open circuit in both directions, the diode trio is defective.

Replace the rectifier assembly.

(5) Front bracket bearing

Check the bearing for any scraping noise, roughness, or grease leakage (If the amount of leakage is very small, wipe it away.) and replace it as necessary.

It is more effective to check with the bearing fitted into the front bracket than to check the bearing itself (with no parts mounted).

(6) Regulator

The regulator cannot be checked with a circuit tester.

After the alternator has been completely assembly, the unit should be tested to make certain it will control the alternator voltage properly.

REASSEMBLY

To reassemble the alternator, follow the reverse of disassembling procedure, and observe the following precautions:

- (1) Lubrication is not required. Both bearing are prelubricated.

Note:

For the rotor bearing with resin bands, grease should not be applied. Remove oils completely to prevent creep of the bearing if found on the bearing box.

- (2) High temperature solder (Melting point of 466° F) should be used.

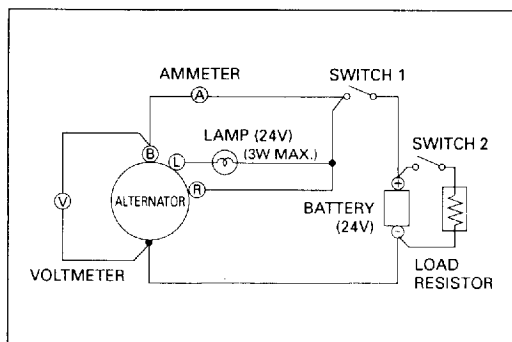
Solder quickly, use a 180–270 watts soldering iron no more than about 5 seconds because the rectifier may be damaged if it is overheated.

- (3) Tightening torque.

• Pulley securing nut.	: 147 N·m
• Through bolts.	: 4.9 N·m
• Bearing retainer screws.	: 3.4 N·m
• Coil assembly retaining screws.	: 3.4 N·m
• Rectifier retaining screw.	: 3.4 N·m
• Regulator retaining screws.	: 3.4 N·m
• Nut for stud bolt.	: 8.8 N·m

- (4) To assemble the rear bracket / starter assembly and front bracket / rotor assembly.

- Since the rotor bearing and rear bracket fitting is tight, before installing the rotor into the rear bracket assembly, heat the area around the bearing box of the rear bracket to 122 to 144° F.
- After the alternator has been completely assembled, rotate the pulley slowly by hand to be sure that the rotor turns smoothly.



BENCH TEST

To check the alternator on a test bench, proceed as follows:

Regulated Voltage Test

- (1) Make connections as shown in Fig.

Use a 0–100 ampere scale ammeter and a 0–30 volt scale voltmeter.

Use a variable load resistor of capacity 0–50 ampere minimum.

- (2) Close switch 1. Open switch 2.

Lamp should light. If the lamp does not light, check voltage at terminal-L.

When the voltage is nearly to battery voltage check the alternator.

When the voltage is low the lamp or relational wiring is open circuit.

- (3) Slowly increase the alternator speed.

Be sure the lamp goes out until the alternator speed reaches to approx. 1300 min^{-1} .

Observe the voltage.

If the voltage is uncontrolled with speed and increases above 30V, a defective IC regulator is suspected.

If the voltage does not increase higher than battery voltage, this means alternator does not generate.

Recheck the alternator.

- (4) Increase the alternator speed to approx. 500 min^{-1} and take the ammeter reading.

If the ammeter reading is 5A or less, take the voltmeter reading without changing the alternator speed (approx. 500 min^{-1}).

The reading is the regulated voltage.

If the ammeter reading is more than 5A, continue to charge battery until the reading falls to less than 5A or replace the battery with a fully charged one.

If the regulated voltage does not meet specifications limits, it will have to be replaced.

CURRENT OUTPUT TEST

The current output test determines whether or not alternator is capable of supplying its rated current output.

- (1) After the regulated voltage test is completed reduce the alternator revolution.
- (2) Close the switch 1. Be sure the lamp lights.
- (3) Set the load resistor in maximum resistance value position (Minimum current draw) and close the switch 2.
- (4) Increase and hold the alternator speed to 5000 min^{-1} and adjust the load resistor to obtain maximum current output.

Run the alternator for 15 minutes at this speed and output to rise in the alternator temperature.

After 15 minutes rotate the alternator to specified speed (2500 and 5000 min^{-1}) and adjust the load resistor to obtain maximum current output.

The output should be within specifications limits.

If the output is less than specifications limits, recheck the alternator as overed in [INSPECTIONS].

FAULT FINDING

SYMPTOM	PROBABLE CAUSE
No output	a. Defective IC regulator b. Open field coil
Low output	a. Defective diode b. Defective starter coil c. Defective rectifier d. Field coil rare short
Regulated voltage too high	a. Defective IC regulator
Abnormal noise	a. Bearing fault b. Rectifier fault c. Interference due to entry of foreign materials

SPECIFICATIONS

Make	Mitsubishi electric co.		
Isuzu Part Number	181200-5300		
Maker Model code	A004TU5486		
Rated output	24V-50A		
Output characteristic (at hot condition)	Volts Current min ⁻¹	27V 42A Min. 2500	27V 50A Min. 5000
Field coil resistance (at 20°C)	4.4-5.2 Ω		
Regulator regulated voltage	28-29V		
Rotational direction (viewed from pulley)	Clockwise		

MEMO

SECTION 11

TROUBLESHOOTING

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Note:

Use this section to quickly diagnose and repair engine failures.

Each troubleshooting chart has three headings arranged from left to right

(1) Check point (2) Trouble cause (3) Remedy

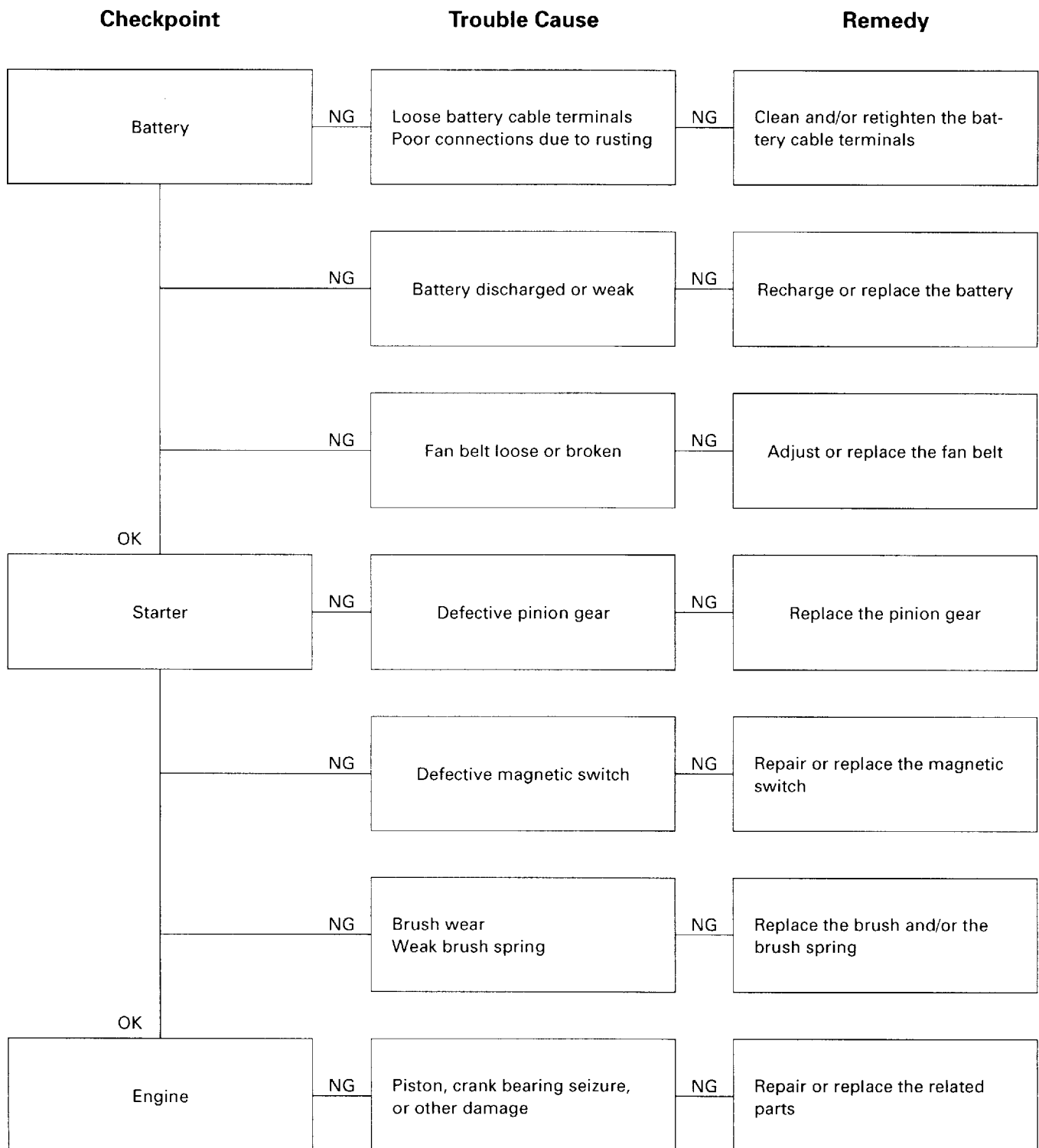
HARD STARTING

1) STARTER INOPERATIVE

Checkpoint		Trouble Cause		Remedy
Neutral switch (If so equipped)	NG	Defective neutral switch	NG	Replace the neutral switch
Battery	NG	Loose battery cable terminals Poor connections due to rusting	NG	Clean and/or retighten the battery cable terminals
	NG	Battery discharged or weak	NG	Recharge or replace the battery
	NG	Fan belt loose or broken	NG	Adjust or replace the fan belt
	OK			
Fusible link	NG	Fusible link shorted	NG	Replace the fusible link
Starter switch	NG	Defective starter switch or starter relay	NG	Replace the starter switch or the starter relay
	OK			
Starter	NG	Defective magnetic switch or starter relay	NG	Repair or replace the magnetic switch
Starter	NG	Defective starter motor	NG	Repair or replace the starter motor
	OK			

HARD STARTING

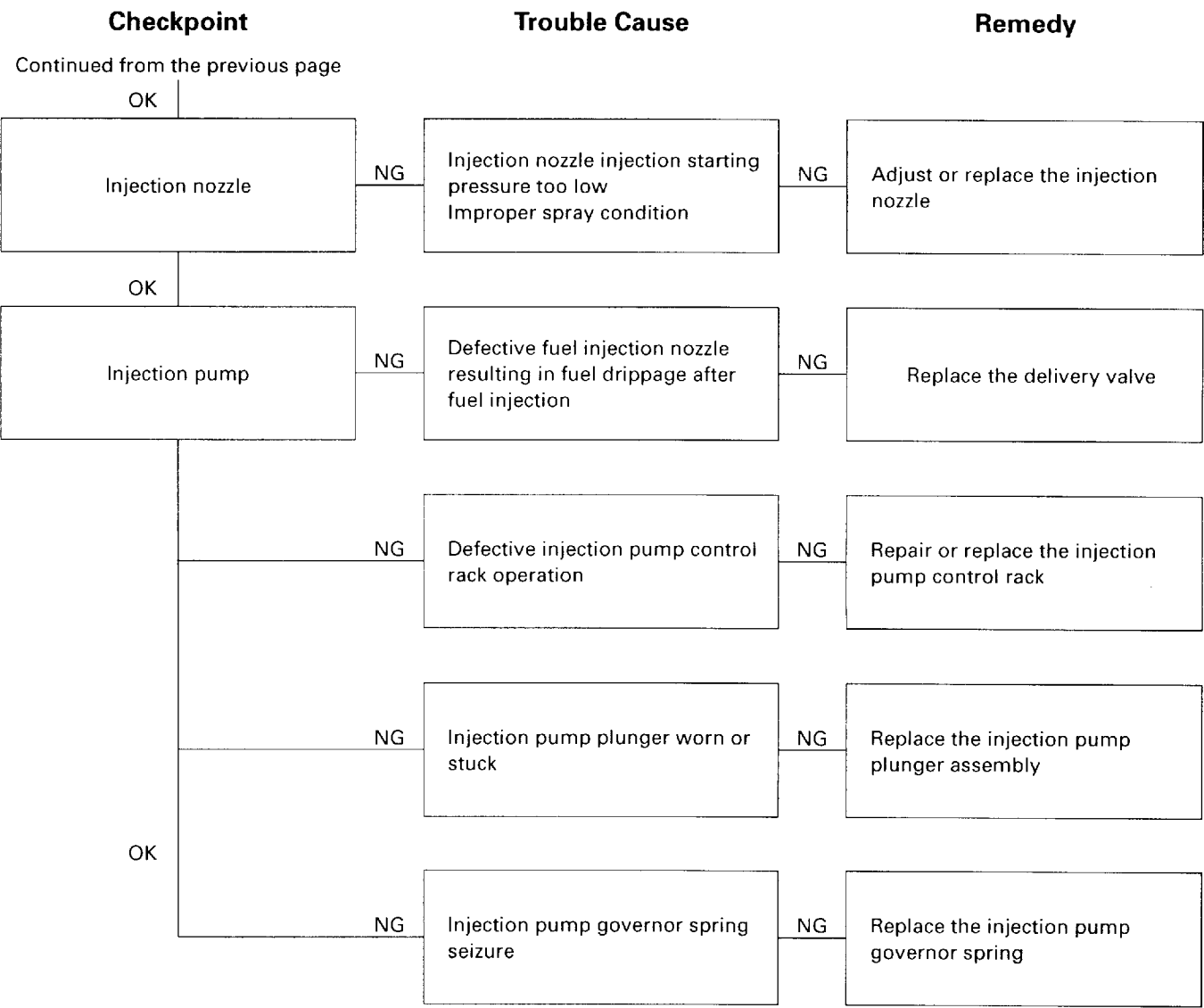
2) STARTER OPERATES BUT ENGINE DOES NOT TURN OVER



HARD STARTING

3) ENGINE TURNS OVER BUT DOES NOT START

FUEL IS BEING DELIVERED TO THE INJECTION PUMP



HARD STARTING**4) ENGINE TURNS OVER BUT DOES NOT START****Checkpoint****Trouble Cause****Remedy**

Engine stop mechanism	NG	Defective engine stop mechanism control wire improperly adjusted	NG	Replace the engine stop mechanism Adjust the control wire
-----------------------	----	---	----	---

FUEL IS NOT BEING DELIVERED TO THE INJECTION PUMP

Fuel	NG	Fuel tank is empty	NG	Fill the fuel tank
OK				
Fuel piping	NG	Clogged or damaged fuel lines Loose fuel line connections	NG	Repair or replace the fuel lines Retighten the fuel line connections
OK				
Fuel filter	NG	Fuel filter overflow valve does not close	NG	Repair or replace the fuel filter overflow valve
	NG	Clogged fuel filter element	NG	Replace the fuel filter element or the fuel filter cartridge
OK				
Fuel system	NG	Air in the fuel system	NG	Bleed the air from the fuel system

Continued on the next page

UNSTABLE LOW IDLING

Checkpoint		Trouble Cause		Remedy
Low idling system	NG	Low idling improperly adjusted	NG	Adjust the low idling
OK				
Low idling speed control device	NG	Defective low idling speed control device	NG	Repair or replace the low idling speed control device
OK				
Throttle control system	NG	Throttle control system improperly adjusted	NG	Adjust the throttle control system
OK				
Fuel system	NG	Fuel system leakage or blockage	NG	Repair or replace the fuel system
	NG	Air in the fuel system	NG	Bleed the air from the fuel system
	NG	Water particles in the fuel system	NG	Change the fuel
OK				
Fuel filter	NG	Clogged fuel filter element	NG	Replace the fuel filter element or the fuel filter cartridge

Continued on the next page

UNSTABLE LOW IDLING

Checkpoint	Trouble Cause		Remedy
Continued from the previous page			
OK			
Injection pump	NG	Defective governor lever operation	NG Repair or replace the governor lever
	NG	Broken plunger spring	NG Replace the plunger spring
	NG	Worn plunger	NG Replace the plunger assembly
	NG	Worn camshaft	NG Replace the camshaft
	NG	Worn roller tappet	NG Replace the roller tappet
	OK		
Valve clearance	NG	Valve clearance improperly adjusted	NG Adjust the valve clearance
OK			
Compression pressure	NG	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking or broken Improper seating between the valve and the valve seat	NG Replace the related parts

INSUFFICIENT POWER

Checkpoint		Trouble Cause		Remedy
Air cleaner	NG	Clogged air cleaner element	NG	Clean or replace the air cleaner element
OK				
Fuel	NG	Water particles in the fuel	NG	Replace the fuel
OK				
Fuel filter	NG	Clogged fuel filter element	NG	Replace the fuel filter element or the fuel filter cartridge
OK				
Fuel feed pump	NG	Defective fuel feed pump	NG	Repair or replace the fuel feed pump
OK				
Injection nozzle	NG	Injection nozzle sticking	NG	Replace the injection nozzle
	NG	Injection nozzle injection starting pressure too low Improper spray condition	NG	Adjust or replace the injection nozzle
OK				
Fuel injection pipes	NG	Fuel injection pipes damaged or obstructed	NG	Replace the fuel injection pipes

Continued on the next page

INSUFFICIENT POWER

Checkpoint

Trouble Cause

Remedy

Continued from the previous page

OK

Injection pump	NG	Defective delivery valve	NG	Replace the delivery valve
	NG	Defective timer	NG	Repair or replace the timer
	NG	Improper control lever operation	NG	Adjust or replace the control lever
	NG	Defective injection timing	NG	Adjust the injection timing Repair or replace the injection pump timer
	NG	Weak governor spring	NG	Replace the governor spring
	NG	Worn plunger	NG	Replace the plunger assembly
	NG	Worn camshaft	NG	Replace the camshaft

Continued on the next page

INSUFFICIENT POWER

Checkpoint	Trouble Cause		Remedy
Continued from the previous page			
OK			
Injection pump	NG	Worn roller tappet	NG Replace the roller tappet
OK			
Turbocharger	NG	Exhaust gas leakage from the exhaust system Air leakage from the intake system	NG Repair or replace the related parts
	NG	Defective turbocharger assembly	NG Replace the turbocharger assembly
OK			
Compression pressure	NG	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking or broken Improper seating between the valve and the valve seat	NG Replace the related parts
OK			
Valve clearance	NG	Valve clearance improperly adjusted	NG Adjust the valve clearance
OK			
Valve spring	NG	Valve spring weak or broken	NG Replace the valve spring
OK			
Exhaust system	NG	Exhaust pipe clogged	NG Clean the exhaust pipe
OK			
Full load adjusting screw seal	NG	Open and improperly set adjusting screw seal	NG Adjust and reseal the adjusting screw

EXCESSIVE FUEL CONSUMPTION

Checkpoint		Trouble Cause		Remedy
Fuel system	NG	Fuel leakage	NG	Repair or replace the fuel system related parts
OK				
Air cleaner	NG	Clogged air cleaner element	NG	Clean or replace the air cleaner element
OK				
Low idling speed	NG	Poorly adjusted low idle speed	NG	Adjust the low idle speed
OK				
Injection nozzle	NG	Injection nozzle injection starting pressure too low Improper spray condition	NG	Adjust or replace the injection nozzle
OK				
Fuel injection timing	NG	Fuel injection timing improperly adjusted	NG	Adjust the fuel injection timing
OK				
Injection pump	NG	Defective delivery valve resulting in fuel drippage after fuel injection	NG	Replace the delivery valve
OK				
Turbocharger	NG	Air leakage from the turbocharger intake side	NG	Repair the turbocharger intake side

Continued on the next page

EXCESSIVE FUEL CONSUMPTION

Checkpoint	Trouble Cause		Remedy	
Continued from the previous page				
OK				
Turbocharger	NG	Defective turbocharger assembly	NG	Replace the turbocharger assembly
OK				
Valve clearance	NG	Valve clearance improperly adjusted	NG	Adjust the valve clearance
OK				
Compression pressure	NG	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking or broken Improper seating between the valve and the valve seat	NG	Replace the related parts
OK				
Valve spring	NG	Valve spring weak or broken	NG	Replace the valve spring

EXCESSIVE OIL CONSUMPTION

Checkpoint		Trouble Cause		Remedy
Engine oil	NG	Engine oil unsuitable Too much engine oil	NG	Replace the engine oil Correct the engine oil volume
OK				
Oil seal and gasket	NG	Oil leakage from the oil seal and/or the gasket	NG	Replace the oil seal and/or the gasket
OK				
Air breather	NG	Clogged air breather	NG	Clean the air breather
OK				
Inlet and exhaust valves Valve seals	NG	Defective valve seals Worn valve stems and valve guides	NG	Replace the valve seals, the valves, and the valve guides
OK				
Piston rings	NG	Piston rings worn, broken or improperly installed	NG	Replace the piston rings or properly install
OK				
Cylinder liners	NG	Cylinder lines scored or worn	NG	Replace the cylinder liners

OVERHEATING

Checkpoint		Trouble Cause		Remedy
Cooling water	NG	Insufficient cooling water	NG	Replenish the cooling water
OK				
Fan belt	NG	Fan belt loose or cracked causing slippage	NG	Replace the fan belt
OK				
Radiator	NG	Defective radiator cap or clogged radiator core	NG	Replace the radiator cap or clean the radiator core
OK				
Water pump	NG	Defective water pump	NG	Repair or replace the water pump
OK				
Cylinder head and cylinder body sealing cap	NG	Defective sealing cap resulting in water leakage	NG	Replace the sealing cap
OK				
Thermostat	NG	Defective thermostat	NG	Replace the thermostat
OK				
Cooling system	NG	Cooling system clogged by foreign material	NG	Clean the foreign material from the cooling system

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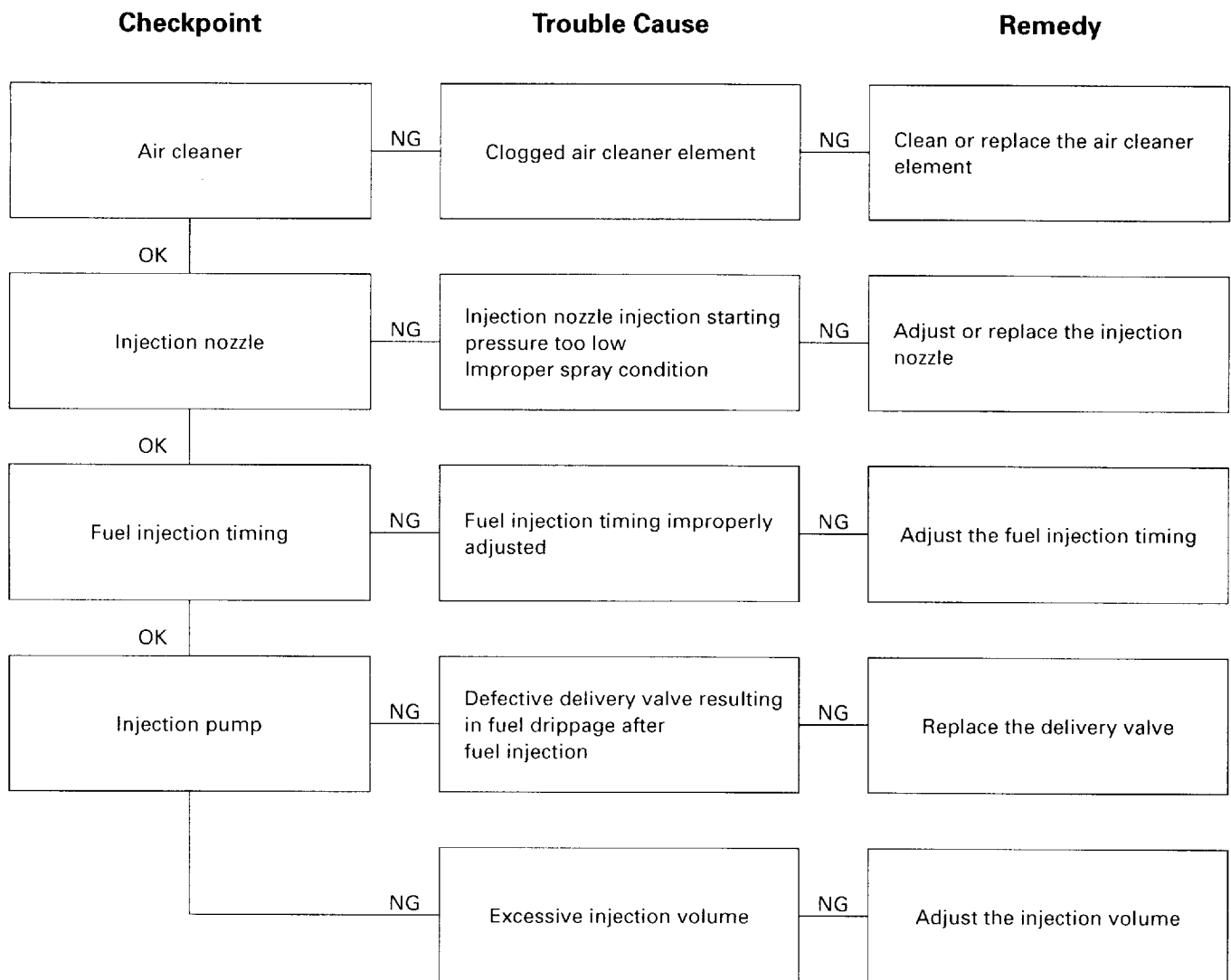
OVERHEATING

Checkpoint		Trouble Cause		Remedy
Continued from the previous page				
OK				
Fuel injection timing	NG	Fuel injection timing improperly adjusted	NG	Adjust the fuel injection timing

WHITE EXHAUST SMOKE

Checkpoint		Trouble Cause		Remedy
Fuel	NG	Water particles in the fuel	NG	Replace the fuel
OK				
Fuel injection timing	NG	Delayed fuel injection timing	NG	Adjust the fuel injection timing
OK				
Compression pressure	NG	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking or broken Improper seating between the valve and the valve seat	NG	Replace the related parts
OK				
Turbocharger	NG	Defective turbocharger	NG	Replace the turbocharger
OK				
Inlet and exhaust valves Valve seals	NG	Defective valve seals Worn valves stems and valve guides	NG	Replace the valve seals, the valves, and the valve guides
OK				
Piston rings	NG	Piston rings worn, broken or improperly installed	NG	Replace the piston rings or properly install
OK				
Cylinder liners	NG	Cylinder lines scored or worn	NG	Replace the cylinder liners

DARK EXHAUST SMOKE



OIL PRESSURE DOES NOT RISE

Checkpoint		Trouble Cause		Remedy
Engine oil	NG	Improper viscosity engine oil Too much engine oil	NG	Replace the engine oil Correct the engine oil volume
OK				
Oil pressure gauge or unit Oil pressure indicator light	NG	Defective oil pressure gauge or unit Defective indicator light	NG	Repair or replace the oil pressure gauge or unit Replace the indicator light
OK				
Oil filter	NG	Clogged oil filter element	NG	Replace the oil filter element or the oil filter cartridge
OK				
Relief valve and by-pass valve	NG	Relief valve sticking and/or weak by-pass valve spring	NG	Replace the relief valve and/or the by-pass valve spring
OK				
Oil pump	NG	Clogged oil pump strainer	NG	Clean the oil pump strainer
	NG	Worn oil pump related parts	NG	Replace the oil pump related parts
OK				
Rocker arm shaft	NG	Worn rocker arm bushing	NG	Replace the rocker arm bushing

Continued on the next page

OIL PRESSURE DOES NOT RISE**Checkpoint****Trouble Cause****Remedy**

Continued from the previous page

OK

Camshaft

NG

Worn camshaft and camshaft bearing

NG

Replace the camshaft and the camshaft bearings

OK

Crankshaft and bearings

NG

Worn crankshaft and bearings

NG

Replace the crankshaft and/or the bearings

ABNORMAL ENGINE NOISE

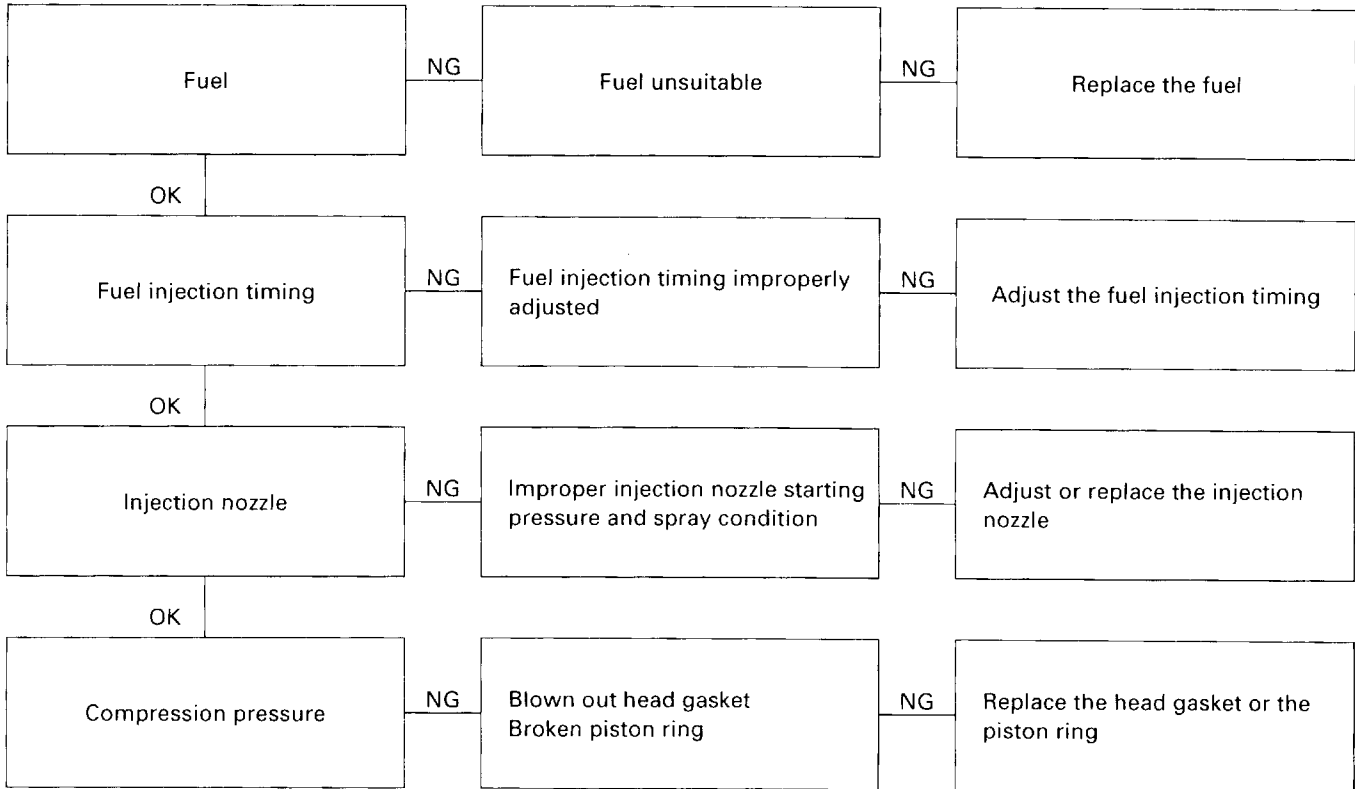
1. Engine Knocking

Checkpoint

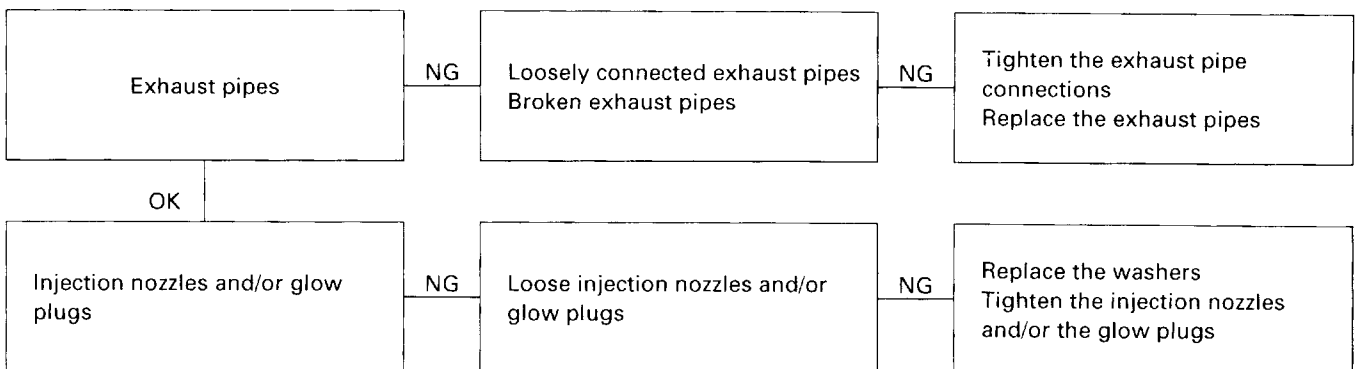
Trouble Cause

Remedy

Check to see that the engine has been thoroughly warmed up before beginning the troubleshooting procedure.



2. Gas Leakage Noise



Continued on the next page

ABNORMAL ENGINE NOISE

2. Gas Leakage Noise

Checkpoint

Trouble Cause

Remedy

Continued from the previous page

OK

Exhaust manifold

NG

Loosely connected exhaust manifold and/or glow plugs

NG

Tighten the exhaust manifold connections

OK

Cylinder head gasket

NG

Damaged cylinder head gasket

NG

Replace the cylinder head gasket

3. Continuous Noise

Fan belt

NG

Loose fan belt

NG

Readjust the fan belt tension

OK

Cooling fan

NG

Loose cooling fan

NG

Retighten the cooling fan

OK

Water pump bearing

NG

Worn or damaged water pump bearing

NG

Replace the water pump bearing

OK

Alternator or vacuum pump

NG

Defective alternator or vacuum pump

NG

Repair or replace the alternator or the vacuum pump

OK

Valve clearance

NG

Valve clearance improperly adjusted

NG

Adjust the valve clearance

ABNORMAL ENGINE NOISE

4. Slapping Noise

Checkpoint	Trouble Cause		Remedy
Valve clearance	NG	Valve clearance improperly adjusted	Adjust the valve clearance
OK			
Rocker arm	NG	Damaged rocker arm	Replace the rocker arm
OK			
Flywheel	NG	Loose flywheel bolts	Retighten the flywheel bolts
OK			
Crankshaft and thrust bearings	NG	Worn or damaged crankshaft and/or thrust bearings	Replace the crankshaft and/or the thrust bearings
OK			
Crankshaft and connecting rod bearings	NG	Worn or damaged crankshaft and/or connecting rod bearings	Replace the crankshaft and/or the connecting rod bearings
OK			
Connecting rod bushing and piston pin	NG	Worn or damaged connecting rod bushing and piston pin	Replace the connecting rod bushing and/or the piston pin
OK			
Piston and cylinder liner	NG	Worn or damaged piston and cylinder liner Foreign material in the cylinder	Replace the piston and the cylinder liner

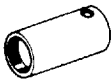
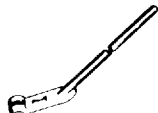
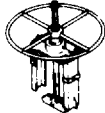
SECTION 12

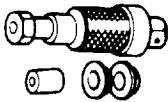
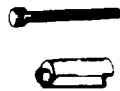
SPECIAL TOOL LIST

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SPECIAL TOOL LIST

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15.		1-85221-005-0	Valve stem oil seal installer	5-5
16.		9-8522-1251-0	Piston ring compressor	5-11
17.		5-8840-9025-0	Rear oil seal installer	5-12

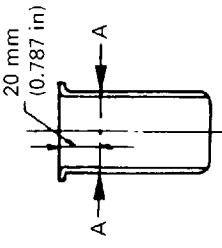
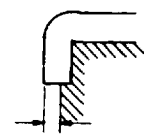
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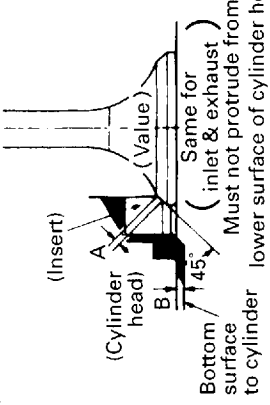
SECTION 13

REPAIR STANDARDS**GENERAL RULES**

1. These tables provide standards relating the repair of the following diesel engine;
Model AA-6BG1TRA
2. These Repair Standards are based on inspection items, together with dimensions, assembly standards, limit values, and repair procedures.
 - (1) Nominal dimensions are the standard production values.
 - (2) Assembly standards considered to be the values used as objectives during the assembly procedures which follow repairs; as a result, they may be somewhat at variance with the assembly dimensions of a new engine.
 - (3) Limit values refer to the measured values resulting from wear, etc., beyond which a part must not be used. If a measured value falls beyond the limit value, the part involved must be repaired or replaced.
 - (4) "Repair Procedures" indicates normal repair methods.
 - (5) Unless otherwise stated, the unit of numerical values in tables should be taken to refer to millimeters. mm (in).
3. Explanation of Terms Used in Tables
 - (1) The dimension of "wear" refers to the difference between the dimensions of a part which is not worn (or the "nominal dimension" of a part without wear) and the dimension of the part suffering from the most wear (the dimension of the worn part).
 - (2) Uneven wear means the difference between the maximum and minimum wear values.
4. When repairs are requested on the overall engine, first perform bench tests to determine what parts require repairs, then perform the minimum disassembly and repairs required to correct the problems. When repairs on a specific engine part are requested, repairs to be made in reference to the relevant items in accordance with the repair standards listed in this manual.

13-2 REPAIR STANDARDS

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Time for engine disassembly and repair		Cylinder compression pressure MPa (kgf/cm ² /psi)	3.0 (31/440)		2.5 (26/370)	Disassemble and repair engine	Water temperature 70 – 85°C, (158 – 185°F) engine speed 200 min ⁻¹ (varies depending on altitude)
		Fuel consumption L/h	100%		140%		New engine performance is assumed 100%
		Lubricating oil consumption L/h	100%		200%		
		Wear on liner bore Measured at A-A					
Engine Body	Cylinder Block		Dia. 105 (4.1339)		Dia 105.2 (4.1417)	Upper step wear must be repaired, or replaced with standard dimension liner	(Ref) Cylinder & liner interference 0.001 – 0.019 (0.00004 – 0.0007)
		Liner projection 		0.03 – 0.10 (0.001 – 0.004)		Some projection must be present	Difference in liner projection between neighboring cylinders not to exceed 0.03 (0.001)
		Cylinder block upper face warpage		0.05 or less (0.002)	0.2 (0.0079)	Must be repairable	0.3 (0.0118)
		Pressure test: 3 minutes kPa (kgf/cm ² /psi)		490 (5/71.1)		Leaks require repair or replacement	

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Engine Body	Cylinder Head	Valve seat depression: B (both inlet and exhaust)		1.0 (0.039)	2.5 (0.098)	Replace insert	Valve seat angle: α 45°
						Repair with valve seat cutter	After repair, be sure to lap contact surfaces
		Contact width with valve seat: A		1.5 (0.059)	2.0 (0.079)	Cannot be repaired: must replace cylinder head	
		Warpage and flatness of cylinder head lower face (mounting surface)		0.075 or less (0.003)	0.2 0.079	repair	
		Warpage of manifold mounting surface		0.05 or less (0.002)	0.4 (0.016)	Leaks require repair or replacement	
		Water-pressure test, 3 minutes kPa (kgf/cm ² /psi)		490 (5/71.1)		- Clean bolt mounting surfaces and threads, and apply molybdenum disulfide grease. - Never tighten again after using angular tightening method. - Reuse bolts max. 2 times	
		Cylinder head bolts tightening torque (angular tightening method) N·m (kgf-m/lb-ft)		69 (7.0/51) ↓ 88 (9.0/65) ↓ 90° – 120°			

13-4 REPAIR STANDARDS

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Main Operating Parts	Pistons	Clearance with cylinder: grade position from upper face 82 mm (3.228 in)		Clearance with major axis 0.051 – 0.085 (0.002 – 0.0033)			
		Piston pin and piston pin hole clearance		0.010 – 0.023 (0.00039 – 0.0009)	0.05 (0.00197)	Replace piston or piston pin	
		Pin wear		35.000 – 35.005 (1.3780 – 1.3781)	34.95 (1.3760)	Replace piston pin	
	Piston Ring	Piston Ring Gap	No. 1 compression ring	0.35 – 0.50 (0.014 – 0.020)	1.5 (0.059)	Replace rings when performing engine disassembly and repair	Gauge inner standard diameter 105 (4.134)
			No. 2 compression ring	0.60 – 0.75 (0.0236 – 0.0295)			
			No. 3 compression ring	0.60 – 0.75 (0.0236 – 0.0295)			
			Oil ring	0.30 – 0.50 (0.014 – 0.020)			
		Tension N (kgf/lb)	No. 1 compression ring	20.4 – 30.6 (2.08 – 3.12/ 4.59 – 6.88)	9.8 (1.0/2.2)	Replace	Measure with ring compressed to standard ring gap.
			No. 2 compression ring	14.1 – 21.2 (1.44 – 2.16/ 3.17 – 4.76)	4.9 (0.5/1.1)		
			No. 3 compression ring	14.1 – 21.2 (1.44 – 2.16/ 3.17 – 4.76)	4.9 (0.5/1.1)		
			Oil ring	36.3 – 55.9 (3.7 – 5.7/ 8.16 – 12.6)	31 (3.2/7.05)	Replace	Measure with expander attached

Major Category	Name of Part	Inspection Item		Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Main Operating Parts	Piston Ring	Clearance between piston ring and ring groove	No. 1 compression ring		-	-	Replace rings or piston	When assembling compression rings on piston, be sure ring's marked surface is up. Backwards installation will result in excessive oil consumption. No top/bottom to oil ring.
			No. 2 compression ring		0.070 - 0.110 (0.0028 - 0.0043)	0.15 (0.0059)		
			No. 3 compression ring		0.050 - 0.090 (0.0020 - 0.0035)	0.15 (0.0059)		
			Oil ring		0.030 - 0.070 (0.0012 - 0.0028)	0.15 (0.0059)		
		Ring gap orientation					At 90° intervals	

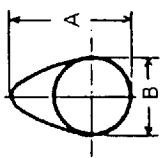
13-6 REPAIR STANDARDS

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Main Operating Parts	Crankshaft	Uneven wear on journal and pins	Dia. 80 (3.1496) Dia. 64 (2.5197)		0.05 (0.002)	Replace	Do not attempt to grind: always replace with new parts
		Journal Diameter	Center Bearing only	79.905 – 79.925 (3.1459 – 3.1467)		Replace	
			Other Bearing	79.919 – 79.939 (3.1464 – 3.1472)		Replace	
		Pin Diameter		63.924 – 63.944 (2.5167 – 2.5175)		Replace	
		Journal and pin finish precision (taper and ellipse)		Ellipse and taper 0.007 (0.0003)			
		Journal and bearing arc spread				Use those with projection and proper arc; take care with back side fit	
		Clearance between journal and bearing	Center Bearing only	0.039 – 0.098 (0.0015 – 0.0039)	0.11 (0.0043)	Replace bearing	
			Other Bearing	0.025 – 0.084 (0.0010 – 0.0033)			
		Journal bearing undersize				Undersize bearings cannot be used	
		Crankshaft end play		0.15 – 0.33 (0.006 – 0.013)	0.4 (0.016)	Replace thrust bearings	Measure at crankshaft's No. 4 bearing thrust surface
		Crankshaft runout		0.05 or less (0.002)	0.4 (0.016)	Replace	
		Ring gear				Perform lapping on gears with burrs; in cases of severe damage, replace.	
		Crankshaft balance (g-cm)		36 or less		Check dynamic balance	(Ref. value) At ends of journal

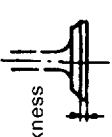
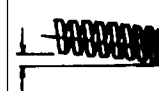
Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Main Operating Parts	Crankshaft	Crankshaft bearing cap bolt torque N·m (kgf-m/lb·ft)		226 – 245 (23 – 25/166 – 181)		Apply engine oil to threads and seating areas of bolts before tightening	Do not catch foreign matter in bolts
		Crankshaft rear oil seal wear				In case of oil leak, replace oil seal	Check for oil seal collapse

13-8 REPAIR STANDARDS

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Main Operating Parts	Connecting Rod	Connecting rod bearing arc spread				Use those with projection and proper arc; take care work back side fit	
		Clearance between connecting rod bearing and crankpin		0.030 – 0.073 (0.0012 – 0.0029)	0.10 (0.0039)	Replace bearing or crankshaft	Take special care with crankpin precision
		Contact between connecting rod bearing and crankpin				Replace parts with poor contact or abrasions	
		Clearance between smallend bushing and piston pin		0.012 – 0.025 (0.00047 – 0.00098)	0.05 (0.00197)	Replace bushing or pin	Sufficient gap to allow smooth rotation when holding big end
		Connecting rod bearing undersize					Crank must not be ground (no undersizes available)
		Connecting rod and crankpin end play		0.17 – 0.30 (0.0067 – 0.011)	0.35 (0.014)	Replace connecting rod	
		Center distance between big end and small end (mm)	192 (7.559)				Reference value
		Big end to small end hole twist (per 100 mm)		0.05 or less (0.002)	0.2 (0.0079)	Repair or replace	
		Big end to small end hole parallelism (per 100 mm)		0.05 or less (0.002)	0.2 (0.0079)	Repair or replace	
		Piston weight difference after assembly g		20 or less		Repair or replace	
		Bearing cap bolt tightening torque (angular tightening method) N·m (kgf-m/lb·ft)	39 (4.0/29) ↓ 60° – 90°			Apply molybdenum disulfide grease to bolts before tightening	

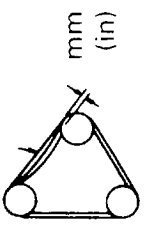
Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Main Operating Parts	Camshaft	Journal uneven wear	Dia. 56 (2.205)		0.05 (0.002)	Replace camshaft	
		Clearance between journal and bearing		0.03 – 0.09 (0.001 – 0.004)	0.15 (0.006)	Replace camshaft or bearing	
		Journal wear	Dia. 56 (2.205)	Dia. 55.94 – 55.97 (2.202 – 2.204)	Dia. 55.6 (2.189)	Replace camshaft	
		Cam height: A – B 	7.71 (0.304)		7.21 (0.284)	Replace camshaft	Minor step wear on cams can be repaired
		Camshaft runout			0.12 (0.005)	Replace camshaft	Measure with dial gauge at No. 3 or No. 4 journal, runout during one rotation.
		Camshaft play (front-back direction)		0.050 – 0.114 (0.002 – 0.005)	0.2 (0.008)		

13-10 REPAIR STANDARDS

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Valve System	Valves	Inlet valve stem wear	Dia. 9 (0.3543)		Dia. 8.88 (0.3496)	Replace valve and valve guide together	Measure valve stem at three positions
		Exhaust valve stem wear					
		Clearance between inlet valve stem and valve guide		0.039 – 0.071 (0.0015 – 0.0028)	0.20 (0.008)	Replace valve and valve guide together	
		Clearance between exhaust valve stem and guide		0.064 – 0.096 (0.0025 – 0.0038)	0.25 (0.0098)		
		Interference between valve guide and cylinder head		0.024 (0.0009)			Apply oil to valve guide and press in
		Valve thickness 	1.5 (0.059)		1.00 (0.039)	Replace valve and valve guide together	
		Height of valve guide above cylinder head 	14.1 (0.555)				Reference value
		Valve stem oil seal lip	Dia. 8.5 (0.335)		Dia. 8.8 (0.346)	Replace oil seal	Don't damage lip.
		Valve spring 	Tension N (kgf/lb) (When compressed to installed length) 44.5mm(1.752in)	142 (14.5/30.9)	127 (13.0/28.7)	Replace valve spring	
			Free height mm (in)	60.6 (2.39)	58.0 (2.28)		
			Inclination mm (in)	less than 1.9 (0.075)	2.7 (0.106)		

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Valve System	Valves	Valve clearance (inlet & exhaust) (cold)		0.4 (0.016)		Adjust	
		Clearance between rocker arm shaft and rocker arm		0.01 – 0.05 (0.0004 – 0.002)	0.2 (0.0079)	Replace bushing or shaft	
		Rocker arm shaft wear		18.98 – 19.00 (0.747 – 0.748)	Dia. 18.85 (0.742)	Replace	
Intake System	Air cleaner	Air cleaner element condition					Special order item from manufacturer

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Lubricating System	Oil Pressure	Lubricating oil pressure kPa (kgf/cm ² /psi)		290 – 390 (3.0 – 4.0/43 – 57)	196 (2.0/28)		
		Clearance between pump body inner wall and gear teeth mm		0.075 – 0.150 (0.003 – 0.0059)	0.2 (0.0079)	Replace bushing, gear or body	
	Oil Pump and Relief Valve	Pumping rate 1650 min ⁻¹ , SAE #30, pumping pressure 392 kPa (4 kgf/cm ² /57 psi) oil temp. 80°C (176°F)		53.3			
		End gap between pump cover and gear		0.040 – 0.094 (0.0016 – 0.0037)	0.15 (0.0059)	Replace gear or cover	
		Clearance between drive shaft and pump body		0.032 – 0.070 (0.0013 – 0.0028)	0.15 (0.0059)		
		Clearance between drive shaft and bushing		0.045 – 0.078 (0.0018 – 0.0031)	0.15 (0.0059)	Replace bushing	
	Oil filter	Diameter of drive shaft	Dia. 16 (0.6299)		Dia 15.9 (0.626)	Replace shaft	
		Initial operating pressure of relief valve kPa (kgf/cm ² /psi)		441 (4.5/64)			Reference value
		Oil gallery		785 (8/114)			
		Oil pump					
	Oil filter	Clogging and damage to oil filter				Replace	Replace cartridge every 500 hours of operation
		Initial operating pressure of main oil filter relief valve kPa (kgf/cm ² /psi)		196 (2.0/28)			

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Cooling System	Water pump	Water pump ball bearing chatter (radial direction)		0.008 – 0.010 (0.0003 – 0.0004)	0.2 (0.0079)	Replae	#6305 (2) #6205 (1)
		Pumping rate L/min (pumping speed 3720 min ⁻¹ , water temp 30°C (86°F) Total head 13.5m(531.5in) or more)		300			
		Clearance between pump impeller and pump body mm (in)		0.3 – 1.0 (0.0118 – 0.039)		Repair or replace if impeller and pump body are touching	
		Fan belt deflection  mm (in)		About 7 – 10 (0.276 – 0.394)		Adjust	(Reference) 98N (10kgf/22lb)
		Initial thermostat operating temperature (at sea level)		82 ± 2°C (179.6 ± 35.6°F)			Replace thermostat if operation is incorrect.
		Thermostat full-open temperature (at sea level)		95°C (203°F)		Temperature at which thermostat lift reaches 10mm(0.394in) or more.	
		Fan center and bearing shaft interference		0.07 – 0.11 (0.003 – 0.004)		Replace water pump ASM	
		Bearing shaft and impeller interference		0.020 – 0.060 (0.0008 – 0.0024)		Replace water pump ASM	
		Pulley and fan center clearance		0.14 or less (0.006)		Replace water pump ASM	

13-14 REPAIR STANDARDS

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Fuel System	Piping, etc.	Clogged, cracked, loose fuel pipes, injection pipes, nozzle holders; defective seals.				Repair or replace	
		Fuel filter element clogging or damage				Replace	Cartridge type
	Injection pump	Delivery valve Delivery valve wear				Inspect for damage to valve's piston and seat; replace in case of severe vertical cracks on piston or impact scars on seat with loss of finish gloss. Immerse delivery valve in clean diesel fuel, then lightly press lower part of valve seat with finger and release; replace assembly if valve does not return to original state when finger is released.	

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments			
Fuel System	Injectipn pump	Pump Part No.		1-15603-328-0						
		Adjustment Item								
		Adjustment Conditions		Rotation Direction	Clockwise (viewed from drive side)					
				Nozzle	105780-0000 (BOSCH Type No. DN12SD12T)					
				Nozzle holder assembly	105780-2080 (BOSCH Type No. EF8511/9)					
				Nozzle opening pressure	MPa (kgf/cm ² /psi)	17.2 (175/2490)				
				Fuel pumping pressure	kPa (kgf/cm ² /psi)	157 (1.6/23)				
				Pipe (o.d. x i.d. x lenght)	mm (in)	Dia. 6(0.236) x Dia. 2(0.079) x 600(23.62)				
				Test fuel	ISO4113 or SAE Standard Oil (SAE J967d)					
				Fuel temperature	°C (°F)	40 – 45 (104 – 113)				
		Injection adjustment		Adjustment point	Rack position mm (in)	Pump speed (min ⁻¹)	Injection q'ty (mm ³ /1000 strokes)	Max. var bet. cyl (%)	Fixed	Remarks
				A	10.3 (0.4449)	1075	89 ± 1.5	± 2	Lever	Basic
				C	Approx 7.5 (0.295)	450	9 ± 1.3	± 14	Rack	
				D	–	100	150 ± 5	–	Lever	Rack limit

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Fuel System	Injectin pump	Governor performance curve Recommended speed droop adjustment screw position:9 (notched from fully tightened position) Governor spring setting A: 10.2 ± 0.5 mm B: 10.9 ± 0.1 mm C: 7.3 ± 0.3 mm D: 11.0 mm Rack limit 14.0 mm Idle-sub spring setting 11.0 mm Pump speed (r/min) 0, 240, 350, 450, 500, 1075, 1110, 1125, 1200				Stop lever angle Speed lever angle Stop lever angle Normal: 6° ± .5 Stop: 46° ± .5 Speed lever angle Full-speed: 3° Dead point: 20° ± .5 Idling: 14° ± .5 Stop: 27° ± .5 N=1075	

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Fuel system	Injection Nozzle	Technology Needle valve seat: 7.8MPa (80 kgf/cm ² /138psi)				Repair or replace parts with leaks from seat area	
		Needle valve shaft seat: seconds Impress fuel pressure of 29.4MPa (300kgf/cm ² /4267psi) (nozzle starting pressure and measure time required for pressure to drop from 24.5MPa (250kgf/cm ² /3556psi) to 19.6MPa (200kgf/cm ² /2845psi).		5.0 or more		Replace	Fuel used: diesel fuel; clay (Redwood); 37 – 40 seconds 120°C (248°F)
		Fuel spray and injection Impress fuel pressure of Adjust needs valve opening pressure to 19.1MPa (195kgf/cm ² /2770psi)	① Visually inspect, no relatively large drops scattered. ② No drops scattered to one side. ③ No unevenness of spray from jets.			Replace faulty parts	
Electrical	Charge/Discharge Indication	Warning lamp indication				If warning indicator lights when engine is operating at normal speeds, check and repair electrical system.	
	Wiring	Check for looseness, cuts or damaged insulation to wiring.				Repair	
	(MITSUBISHI 1-81200-530-1) Alternator 24V, 50A	Rotor Shaft runout		0.06 or less (0.0024)	0.1 (0.0038)	Replace rotor	Rotate by hand and check for smooth rotation; no abnormal sound or resistance should be felt.
		Bearing chatter				Replace bearings	
	Perform-ance	Rated output current 27 V (5000 min ⁻¹)		50A			

13-18 REPAIR STANDARDS

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Electrical	Starter 24V, 7.4 KW (HITACHI 1-81100-342-0)	Loose mount				Repair	
		Brush height		22 (0.866)	14 (0.551)	Replace	
		Magnetic switch	Series coil resistance value (Ω)	0.187 20°C (68°F)			If coil resistance value is severely abnormal, replace switch.
			Shunt coil resistance value (Ω)	1.31 20°C (68°F)			
		Commutator	O.D.		Dia. 36.5 (1.437)	Replace armature	
			Undercut depth	0.5 – 0.8 (0.02 – 0.031)	0.2 (0.008)	Repair	
		Ball bearings	Rear side (armature)			6001 D	Replace if rotation is not smooth or if abnormal sounds are heard.
			Front (armature)			6905 D	
			Pinion shaft (shaft)				
		Performance	Unloaded characteristics (24V, 100A or less)	3500 min ⁻¹			Smooth pinion operation without noise
	Preheater	Control register, glow plug				Replace if cut wiring or shorts are found	
	Battery	Battery terminals					Special order from original manufacturer; manufacturer's specs.
		Plates, separator plates, container, etc.					
		Electrolyte turbidity					

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Electrical	Battery	Electrolyte specific gravity (at recharging, 20°C)					Special order from original manufacturer
		Capacity (20 hours)					
		Electrode voltage					
		Electrolyte surface height					
Final Inspection		Engine run-in operation				30 minutes or more	
		Cylinder compression pressure MPa (kgf/cm ² /psi) [water temp. 70 – 85°C, (158 – 185°F) about 200 min ⁻¹]		3.0 (31/44.1)	2.5 (26/370)	Inspect	Warm engine
		Difference in compression between cylinders kPa (kgf/cm ² /psi) [water temp. 70 – 85°C, (158 – 185°F) about 200 min ⁻¹]			²⁹⁰ (3.0/43)	Inspect	Warm engine
		Lubricating oil pressure kPa (kgf/cm ² /psi)		290 – 390 (3.0 – 4.0/43 – 57)	200 or less (2.0/28)	Adjust	
		Output check		85% or more			When new engine output is 100%
		Fuel consumption check		110% or less			

MEMO

SECTION 14

CONVERSION TABLE

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LENGTH

MILLIMETERS TO INCHES

mm	in.	mm	in.	mm	in.	mm	in.
1	0.0394	26	1.0236	51	2.0079	76	2.9921
2	0.0787	27	1.0630	52	2.0472	77	3.0315
3	0.1181	28	1.1024	53	2.0866	78	3.0709
4	0.1575	29	1.1417	54	2.1260	79	3.1102
5	0.1969	30	1.1811	55	2.1654	80	3.1496
6	0.2362	31	1.2205	56	2.2047	81	3.1890
7	0.2756	32	1.2598	57	2.2441	82	3.2283
8	0.3150	33	1.2992	58	2.2835	83	3.2677
9	0.3543	34	1.3386	59	2.3228	84	3.3071
10	0.3937	35	1.3780	60	2.3622	85	3.3465
11	0.4331	36	1.4173	61	2.4016	86	3.3858
12	0.4724	37	1.4567	62	2.4409	87	3.4252
13	0.5118	38	1.4961	63	2.4803	88	3.4646
14	0.5512	39	1.5354	64	2.5197	89	3.5039
15	0.5906	40	1.5748	65	2.5591	90	3.5433
16	0.6299	41	1.6142	66	2.5984	91	3.5827
17	0.6693	42	1.6535	67	2.6378	92	3.6220
18	0.7087	43	1.6929	68	2.6772	93	3.6614
19	0.7480	44	1.7323	69	2.7165	94	3.7008
20	0.7874	45	1.7717	70	2.7559	95	3.7402
21	0.8268	46	1.8110	71	2.7953	96	3.7795
22	0.8661	47	1.8504	72	2.8346	97	3.8189
23	0.9055	48	1.8898	73	2.8740	98	3.8583
24	0.9449	49	1.9291	74	2.9134	99	3.8976
25	0.9843	50	1.9685	75	2.9528	100	3.9370

101	3.9764	111	4.3701	121	4.7638	131	5.1575
102	4.0157	112	4.4094	122	4.8031	132	5.1969
103	4.0551	113	4.4488	123	4.8425	133	5.2362
104	4.0945	114	4.4882	124	4.8819	134	5.2756
105	4.1339	115	4.5276	125	4.9213	135	5.3150
106	4.1732	116	4.5669	126	4.9606	136	5.3543
107	4.2126	117	4.6063	127	5.0000	137	5.3937
108	4.2520	118	4.6457	128	5.0394	138	5.4331
109	4.2913	119	4.6850	129	5.0787	139	5.4724

INCHES TO MILLIMETERS

in.	mm	in.	mm
1/64	0.3969	33/64	13.0969
1/32	0.7938	17/32	13.4938
3/64	1.1906	35/64	13.8906
1/16	1.5875	9/16	14.2875
5/64	1.9844	37/64	14.6844
3/32	2.3813	19/32	15.0813
7/64	2.7781	39/64	15.4781
1/8	3.1750	5/8	15.8750
9/64	3.5719	41/64	16.2719
5/32	3.9688	21/32	16.6688
11/64	4.3656	43/64	17.0656
3/16	4.7625	11/16	17.4625
13/64	5.1594	45/64	17.8594
7/32	5.5563	23/32	18.2563
15/64	5.9531	47/64	18.6531
1/4	6.3500	3/4	19.0500
17/64	6.7469	49/64	19.4469
9/32	7.1438	25/32	19.8438
19/64	7.5406	51/64	20.2406
5/16	7.9375	13/16	20.6375
21/64	8.3344	53/64	21.0344
11/32	8.7313	27/32	21.4313
23/64	9.1281	55/64	21.8281
3/8	9.5250	7/8	22.2250
25/64	9.9219	57/64	22.6219
13/32	10.3188	29/32	23.0188
27/64	10.7156	59/64	23.4156
7/16	11.1125	15/16	23.8125
29/64	11.5094	61/64	24.2094
15/32	11.9063	31/32	24.6063
31/64	12.3031	63/64	25.0031
1/2	12.7000	1	25.4000

14-2 CONVERSION TABLE

LENGTH

FEET TO METERS

ft.	0	1	2	3	4	5	6	7	8	9	ft.
	m	m	m	m	m	m	m	m	m	m	
—	—	0.305	0.610	0.914	1.219	1.524	1.829	2.134	2.438	2.743	—
10	3.048	3.353	3.658	3.962	4.267	4.572	4.877	5.182	5.486	5.791	10
20	6.096	6.401	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839	20
30	9.144	9.449	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887	30
40	12.192	12.497	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935	40
50	15.240	15.545	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983	50
60	18.288	18.593	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031	60
70	21.336	21.641	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079	70
80	24.384	24.689	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127	80
90	27.432	27.737	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175	90
100	30.480	30.785	31.090	31.394	31.699	32.004	32.309	32.614	32.918	33.223	100

METERS TO FEET

m	0	1	2	3	4	5	6	7	8	9	
	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	
—	—	3.2808	6.5617	9.8425	13.1234	16.4042	19.6850	22.9659	26.2467	29.5276	—
10	32.8084	36.0892	39.3701	42.6509	45.9318	49.2126	52.4934	55.7743	59.0551	62.3360	10
20	65.6168	68.8976	72.1785	75.4593	78.7402	82.0210	85.3018	88.5827	91.8635	95.1444	20
30	98.4252	101.7060	104.9869	108.2677	111.5486	114.8294	118.1102	121.3911	124.6719	127.9528	30
40	131.2336	134.5144	137.7953	141.0761	144.3570	147.6378	150.9186	154.1995	157.4803	160.7612	40
50	164.0420	167.3228	170.6037	173.8845	177.1654	180.4462	183.7270	187.0079	190.2887	193.5696	50
60	196.8504	200.1312	203.4121	206.6929	209.9738	213.2546	216.5354	219.8163	223.0971	226.3780	60
70	229.6588	232.9396	236.2205	239.5013	242.7822	246.0630	249.3438	252.6247	255.9055	259.1864	70
80	262.4672	265.7480	269.0289	272.3097	275.5906	278.8714	282.1522	285.4331	288.7139	291.9948	80
90	295.2756	298.5564	301.8373	305.1181	308.3990	311.6798	314.9606	318.2415	321.5223	324.8032	90
100	328.0840	331.3648	334.6457	337.9265	341.2074	344.4882	347.7690	351.0499	354.3307	357.6116	100

MILES TO KILOMETERS

miles	0	1	2	3	4	5	6	7	8	9	
	km	km	km	km	km	km	km	km	km	km	
—	—	1.609	3.219	4.828	6.437	8.047	9.656	11.265	12.875	14.484	—
10	16.093	17.703	19.312	20.921	22.531	24.140	25.749	27.359	28.968	30.577	10
20	32.187	33.796	35.405	37.015	38.624	40.234	41.843	43.452	45.062	46.671	20
30	48.280	49.890	51.499	53.108	54.718	56.327	57.936	59.546	61.155	62.764	30
40	64.374	65.983	67.592	69.202	70.811	72.420	74.030	75.639	77.248	78.858	40
50	80.467	82.076	83.686	85.295	86.904	88.514	90.123	91.732	93.342	94.951	50
60	96.560	98.170	99.779	101.388	102.998	104.607	106.216	107.826	109.435	111.044	60
70	112.654	114.263	115.872	117.482	119.091	120.701	122.310	123.919	125.529	127.138	70
80	128.747	130.357	131.966	133.575	135.185	136.794	138.403	140.013	141.622	143.231	80
90	144.841	146.450	148.059	149.669	151.278	152.887	154.497	156.106	157.715	159.325	90
100	160.934	162.543	164.153	165.762	167.371	168.981	170.590	172.199	173.809	175.418	100

KILOMETERS TO MILES

km	0	1	2	3	4	5	6	7	8	9	
	miles	miles	miles	miles	miles	miles	miles	miles	miles	miles	
—	—	0.621	1.243	1.864	2.485	3.107	3.728	4.350	4.971	5.592	—
10	6.214	6.835	7.456	8.078	8.699	9.321	9.942	10.563	11.185	11.806	10
20	12.427	13.049	13.670	14.292	14.913	15.534	16.156	16.777	17.398	18.020	20
30	18.641	19.262	19.884	20.505	21.127	21.748	22.369	22.991	23.612	24.233	30
40	24.855	25.476	26.098	26.719	27.340	27.962	28.583	29.204	29.826	30.447	40
50	31.069	31.690	32.311	32.933	33.554	34.175	34.797	35.418	36.039	36.661	50
60	37.282	37.904	38.525	39.146	39.768	40.389	41.010	41.632	42.253	42.875	60
70	43.496	44.117	44.739	45.360	45.981	46.603	47.224	47.845	48.467	49.088	70
80	49.710	50.331	50.952	51.574	52.195	52.816	53.438	54.059	54.681	55.302	80
90	55.923	56.545	57.166	57.787	58.409	59.030	59.652	60.273	60.894	61.516	90
100	62.137	62.758	63.380	64.001	64.622	65.244	65.865	66.487	67.108	67.729	100

AREA**SQUARE INCHES TO SQUARE CENTIMETERS**

in ²	0	1	2	3	4	5	6	7	8	9	in ²
	cm ²	cm ²	cm ²	cm ²	cm ²	cm ²	cm ²	cm ²	cm ²	cm ²	
—	—	6.452	12.903	19.355	25.806	32.258	38.710	45.161	51.613	58.064	—
10	64.516	70.968	77.419	83.871	90.322	96.774	103.226	109.677	116.129	122.580	10
20	129.032	135.484	141.935	148.387	154.838	161.290	167.742	174.193	180.645	187.096	20
30	193.548	200.000	206.451	212.903	219.354	225.806	232.258	238.709	245.161	251.612	30
40	258.064	264.516	270.967	277.419	283.870	290.322	296.774	303.225	309.677	316.128	40
50	322.580	329.032	335.483	341.935	348.386	354.838	361.290	367.741	374.193	380.644	50
60	387.096	393.548	399.999	406.451	412.902	419.354	425.806	432.257	438.709	445.160	60
70	451.612	458.064	464.515	470.967	477.418	483.870	490.322	496.773	503.225	509.676	70
80	516.128	522.580	529.031	535.483	541.934	548.386	554.838	561.289	567.741	574.192	80
90	580.644	587.096	593.547	599.999	606.450	612.902	619.354	625.805	632.257	638.708	90
100	645.160	651.612	658.063	664.515	670.966	677.418	683.870	690.321	696.773	703.224	100

SQUARE CENTIMETERS TO SQUARE INCHES

cm ²	0	1	2	3	4	5	6	7	8	9	cm ²
	in ²	in ²	in ²	in ²	in ²	in ²	in ²	in ²	in ²	in ²	
—	—	0.155	0.310	0.465	0.620	0.775	0.930	1.085	1.240	1.395	—
10	1.550	1.705	1.860	2.015	2.170	2.325	2.480	2.635	2.790	2.945	10
20	3.100	3.255	3.410	3.565	3.720	3.875	4.030	4.185	4.340	4.495	20
30	4.650	4.805	4.960	5.115	5.270	5.425	5.580	5.735	5.890	6.045	30
40	6.200	6.355	6.510	6.665	6.820	6.975	7.130	7.285	7.440	7.595	40
50	7.750	7.905	8.060	8.215	8.370	8.525	8.680	8.835	8.990	9.145	50
60	9.300	9.455	9.610	9.765	9.920	10.075	10.230	10.385	10.540	10.695	60
70	10.850	11.005	11.160	11.315	11.470	11.625	11.780	11.935	12.090	12.245	70
80	12.400	12.555	12.710	12.865	13.020	13.175	13.330	13.485	13.640	13.795	80
90	13.950	14.105	14.260	14.415	14.570	14.725	14.880	15.035	15.190	15.345	90
100	15.500	15.655	15.810	15.965	16.120	16.275	16.430	16.585	16.740	16.895	100

VOLUME**CUBIC INCHES TO CUBIC CENTIMETERS**

in ³	0	1	2	3	4	5	6	7	8	9	in ³
	cm ³ (cc)	cm ³ (cc)	cm ³ (cc)	cm ³ (cc)	cm ³ (cc)	cm ³ (cc)	cm ³ (cc)	cm ³ (cc)	cm ³ (cc)	cm ³ (cc)	
—	—	16.387	32.774	49.161	65.548	81.935	98.322	114.709	131.097	147.484	—
10	163.871	180.258	196.645	213.032	229.419	245.806	262.193	278.580	294.967	311.354	10
20	327.741	344.128	360.515	376.902	393.290	409.677	426.064	442.451	458.838	475.225	20
30	491.612	507.999	524.386	540.773	557.160	573.547	589.934	606.321	622.708	639.095	30
40	655.483	671.870	688.257	704.644	721.031	737.418	753.805	770.192	786.579	802.966	40
50	819.353	835.740	852.127	868.514	884.901	901.289	917.676	934.063	950.450	966.837	50
60	983.224	999.611	1015.998	1032.385	1048.772	1065.159	1081.546	1097.933	1114.320	1130.707	60
70	1147.094	1163.482	1179.869	1196.256	1212.643	1229.030	1245.417	1261.804	1278.191	1294.578	70
80	1310.965	1327.352	1343.739	1360.126	1376.513	1392.900	1409.288	1425.675	1442.062	1458.449	80
90	1474.836	1491.223	1507.610	1523.997	1540.384	1556.771	1573.158	1589.545	1605.932	1622.319	90
100	1638.706	1655.093	1671.481	1687.868	1704.255	1720.642	1737.029	1753.416	1769.803	1786.190	100

CUBIC CENTIMETERS TO CUBIC INCHES

cm ³ (cc)	0	1	2	3	4	5	6	7	8	9	cm ³ (cc)
	in ³	in ³	in ³	in ³	in ³	in ³	in ³	in ³	in ³	in ³	
—	—	0.0610	0.1220	0.1831	0.2441	0.3051	0.3661	0.4272	0.4882	0.5492	—
10	0.6102	0.6713	0.7323	0.7933	0.8543	0.9153	0.9764	1.0374	1.0984	1.1594	10
20	1.2205	1.2815	1.3425	1.4035	1.4646	1.5256	1.5866	1.6476	1.7086	1.7697	20
30	1.8307	1.8917	1.9527	2.0138	2.0748	2.1358	2.1968	2.2579	2.3189	2.3799	30
40	2.4409	2.5019	2.5630	2.6240	2.6850	2.7460	2.8071	2.8681	2.9291	2.9901	40
50	3.0512	3.1122	3.1732	3.2342	3.2952	3.3563	3.4173	3.4783	3.5393	3.6004	50
60	3.6614	3.7224	3.7834	3.8444	3.9055	3.9665	4.0275	4.0885	4.1496	4.2106	60
70	4.2716	4.3326	4.3937	4.4547	4.5157	4.5767	4.6377	4.6988	4.7598	4.8208	70
80	4.8818	4.9429	5.0039	5.0649	5.1259	5.1870	5.2480	5.3090	5.3700	5.4310	80
90	5.4921	5.5531	5.6141	5.6751	5.7362	5.7972	5.8582	5.9192	5.9803	6.0413	90
100	6.1023	6.1633	6.2243	6.2854	6.3464	6.4074	6.4684	6.5295	6.5905	6.6515	100

14-4 CONVERSION TABLE

VOLUME

GALLONS (U.S.) TO LITERS

U.S. gal.	0	1	2	3	4	5	6	7	8	9	U.S.gal.
	liters	liters	liters	liters	liters	liters	liters	liters	liters	liters	
—	—	3.7854	7.5709	11.3563	15.1417	18.9271	22.7126	26.4980	30.2834	34.0688	—
10	37.8543	41.6397	45.4251	49.2106	52.9960	56.7814	60.5668	64.3523	68.1377	71.9231	10
20	75.7085	79.4940	83.2794	87.0648	90.8502	94.6357	98.4211	102.2065	105.9920	109.7774	20
30	113.5628	117.3482	121.1337	124.9191	128.7045	132.4899	136.2754	140.0608	143.8462	147.6317	30
40	151.4171	155.2025	158.9879	162.7734	166.5588	170.3442	174.1296	177.9151	181.7005	185.4859	40
50	189.2714	193.0568	196.8422	200.6276	204.4131	208.1985	211.9839	215.7693	219.5548	223.3402	50
60	227.1256	230.9110	234.6965	238.4819	242.2673	246.0528	249.8382	253.6236	257.4090	261.1945	60
70	264.9799	268.7653	272.5507	276.3362	280.1216	283.9070	287.6925	291.4779	295.2633	299.0487	70
80	302.8342	306.6196	310.4050	314.1904	317.9759	321.7613	325.5467	329.3321	333.1176	336.9030	80
90	340.6884	344.4739	348.2593	352.0447	355.8301	359.6156	363.4010	367.1864	370.9718	374.7573	90
100	378.5427	382.3281	386.1136	389.8990	393.6844	397.4698	401.2553	405.0407	408.8261	412.6115	100

LITERS TO GALLONS (U.S.)

liters	0	1	2	3	4	5	6	7	8	9	liters
	gal.	gal.	gal.	gal.	gal.	gal.	gal.	gal.	gal.	gal.	
—	—	0.2642	0.5283	0.7925	1.0567	1.3209	1.5850	1.8492	2.1134	2.3775	—
10	2.6417	2.9059	3.1701	3.4342	3.6984	3.9626	4.2268	4.4909	4.7551	5.0193	10
20	5.2834	5.5476	5.8118	6.0760	6.3401	6.6043	6.8685	7.1326	7.3968	7.6610	20
30	7.9252	8.1893	8.4535	8.7177	8.9818	9.2460	9.5102	9.7744	10.0385	10.3027	30
40	10.5669	10.8311	11.0952	11.3594	11.6236	11.8877	12.1519	12.4161	12.6803	12.9444	40
50	13.2086	13.4728	13.7369	14.0011	14.2653	14.5295	14.7936	15.0578	15.3220	15.5861	50
60	15.8503	16.1145	16.3787	16.6428	16.9070	17.1712	17.4354	17.6995	17.9637	18.2279	60
70	18.4920	18.7562	19.0204	19.2846	19.5487	19.8129	20.0771	20.3412	20.6054	20.8696	70
80	21.1338	21.3979	21.6621	21.9263	22.1904	22.4546	22.7188	22.9830	23.2471	23.5113	80
90	23.7755	24.0397	24.3038	24.5680	24.8322	25.0963	25.3605	25.6247	25.8889	26.1530	90
100	26.4172	26.6814	26.9455	27.2097	27.4739	27.7381	28.0022	28.2664	28.5306	28.7947	100

GALLONS (IMP.) TO LITERS

Imp gal.	0	1	2	3	4	5	6	7	8	9	Imp gal.
	liters	liters	liters	liters	liters	liters	liters	liters	liters	liters	
—	—	4.5459	9.0918	13.6377	18.1836	22.7295	27.2754	31.8213	36.3672	40.9131	—
10	45.4590	50.0049	54.5508	59.0967	63.6426	68.1885	72.7344	77.2803	81.8262	86.3721	10
20	90.9180	95.4639	100.0098	104.5557	109.1016	113.6475	118.1934	122.7393	127.2852	131.8311	20
30	136.3770	140.9229	145.4688	150.0147	154.5606	159.1065	163.6524	168.1983	172.7442	177.2901	30
40	181.8360	186.3819	190.9278	195.4737	200.0196	204.5655	209.1114	213.6573	218.2032	222.7491	40
50	227.2950	231.8409	236.3868	240.9327	245.4786	250.0245	254.5704	259.1163	263.6622	268.2081	50
60	272.7540	277.2999	281.8458	286.3917	290.9376	295.4835	300.0294	304.5753	309.1212	313.6671	60
70	318.2130	322.7589	327.3048	331.8507	336.3966	340.9425	345.4884	350.0343	354.5802	359.1261	70
80	363.6720	368.2179	372.7638	377.3097	381.8556	386.4015	390.9474	395.4933	400.0392	404.5851	80
90	409.1310	413.6769	418.2228	422.7687	427.3146	431.8605	436.4064	440.9523	445.4982	450.0441	90
100	454.5900	459.1359	463.6818	468.2277	472.7736	477.3195	481.8654	486.4113	490.9572	495.5031	100

LITERS TO GALLONS (IMP.)

liters	0	1	2	3	4	5	6	7	8	9	liters
	gal.	gal.	gal.	gal.	gal.	gal.	gal.	gal.	gal.	gal.	
—	—	0.2200	0.4400	0.6599	0.8799	1.0999	1.3199	1.5399	1.7598	1.9798	—
10	2.1998	2.4198	2.6398	2.8597	3.0797	3.2997	3.5197	3.7397	3.9596	4.1796	10
20	4.3996	4.6196	4.8396	5.0595	5.2795	5.4995	5.7195	5.9395	6.1594	6.3794	20
30	6.5994	6.8194	7.0394	7.2593	7.4793	7.6993	7.9193	8.1393	8.3592	8.5792	30
40	8.7992	9.0192	9.2392	9.4591	9.6791	9.8991	10.1191	10.3391	10.5590	10.7790	40
50	10.9990	11.2190	11.4390	11.6589	11.8789	12.0989	12.3189	12.5389	12.7588	12.9788	50
60	13.1988	13.4188	13.6388	13.8587	14.0787	14.2987	14.5187	14.7387	14.9586	15.1786	60
70	15.3986	15.6186	15.8386	16.0585	16.2785	16.4985	16.7185	16.9385	17.1584	17.3784	70
80	17.5984	17.8184	18.0384	18.2583	18.4783	18.6983	18.9183	19.1383	19.3582	19.5782	80
90	19.7982	20.0182	20.2382	20.4581	20.6781	20.8981	21.1181	21.3381	21.5580	21.7780	90
100	21.9980	22.2180	22.4380	22.6579	22.8779	23.0979	23.3179	23.5379	23.7578	23.9778	100

MASS**POUNDS TO KILOGRAMS**

lbs.	0	1	2	3	4	5	6	7	8	9	lbs.
	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	
—	—	0.454	0.907	1.361	1.814	2.268	2.722	3.175	3.629	4.082	—
10	4.536	4.989	5.443	5.897	6.350	6.804	7.257	7.711	8.165	8.618	10
20	9.072	9.525	9.979	10.433	10.886	11.340	11.793	12.247	12.701	13.154	20
30	13.608	14.061	14.515	14.968	15.422	15.876	16.329	16.783	17.236	17.690	30
40	18.144	18.597	19.051	19.504	19.958	20.412	20.865	21.319	21.772	22.226	40
50	22.680	23.133	23.587	24.040	24.494	24.947	25.401	25.855	26.308	26.762	50
60	27.215	27.669	28.123	28.576	29.030	29.483	29.937	30.391	30.844	31.298	60
70	31.751	32.205	32.658	33.112	33.566	34.019	34.473	34.926	35.380	35.834	70
80	36.287	36.741	37.194	37.648	38.102	38.555	39.009	39.462	39.916	40.370	80
90	40.823	41.277	41.730	42.184	42.637	43.091	43.545	43.998	44.452	44.905	90
100	45.359	45.813	46.266	46.720	47.173	47.627	48.081	48.534	48.988	49.441	100

KILOGRAMS TO POUNDS

kg	0	1	2	3	4	5	6	7	8	9	kg
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
—	—	2.205	4.409	6.614	8.818	11.023	13.228	15.432	17.637	19.842	—
10	22.046	24.251	26.455	28.660	30.865	33.069	35.274	37.479	39.683	41.888	10
20	44.092	46.297	48.502	50.706	52.911	55.116	57.320	59.525	61.729	63.934	20
30	66.139	68.343	70.548	72.752	74.957	77.162	79.366	81.571	83.776	85.980	30
40	88.185	90.389	92.594	94.799	97.003	99.208	101.413	103.617	105.822	108.026	40
50	110.231	112.436	114.640	116.845	119.049	121.254	123.459	125.663	127.868	130.073	50
60	132.277	134.482	136.686	138.891	141.096	143.300	145.505	147.710	149.914	152.119	60
70	154.323	156.528	158.733	160.937	163.142	165.347	167.551	169.756	171.960	174.165	70
80	176.370	178.574	180.779	182.983	185.188	187.393	189.597	191.802	194.007	196.211	80
90	198.416	200.620	202.825	205.030	207.234	209.439	211.644	213.848	216.053	218.257	90
100	220.462	222.667	224.871	227.076	229.280	231.485	233.690	235.894	238.099	240.304	100

KILOGRAMS TO NEWTON

kg	0	1	2	3	4	5	6	7	8	9	kg
	N	N	N	N	N	N	N	N	N	N	
—	—	9.81	19.61	29.42	39.23	49.03	58.84	68.65	78.45	88.26	—
10	98.07	107.87	117.68	127.49	137.29	147.10	156.91	166.71	176.52	186.33	10
20	196.13	205.94	215.75	225.55	235.36	245.17	254.97	264.78	274.59	284.39	20
30	294.20	304.01	313.81	323.62	333.43	343.23	353.04	362.85	372.65	382.46	30
40	392.27	402.07	411.88	421.69	431.49	441.30	451.11	460.91	470.72	480.53	40
50	490.34	500.14	509.95	519.76	529.56	539.37	549.18	558.98	568.79	578.60	50
60	588.40	598.21	608.02	617.82	627.63	637.44	647.24	657.05	666.86	676.66	60
70	686.47	696.28	706.08	715.89	725.70	735.50	745.31	755.12	764.92	774.73	70
80	784.54	794.34	804.15	813.96	823.76	833.57	843.38	853.18	862.99	872.80	80
90	882.60	892.41	902.22	912.02	921.83	931.64	941.44	951.25	961.06	970.86	90
100	980.67	990.48	1000.28	1010.09	1019.90	1029.70	1039.51	1049.32	1059.12	1068.93	100

NEWTON TO KILOGRAMS

N	0	10	20	30	40	50	60	70	80	90	N
	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	
—	—	1.020	2.039	3.059	4.079	5.099	6.118	7.138	8.158	9.177	—
100	10.197	11.217	12.237	13.256	14.276	15.296	16.316	17.335	18.355	19.375	100
200	20.394	21.414	22.434	23.454	24.473	25.493	26.513	27.532	28.552	29.572	200
300	30.592	31.611	32.631	33.651	34.670	35.690	36.710	37.730	38.749	39.769	300
400	40.789	41.809	42.828	43.848	44.868	45.887	46.907	47.927	48.947	49.966	400
500	50.986	52.006	53.025	54.045	55.065	56.085	57.104	58.124	59.144	60.163	500
600	61.183	62.203	63.223	64.242	65.262	66.282	67.302	68.321	69.341	70.361	600
700	71.380	72.400	73.420	74.440	75.459	76.479	77.499	78.518	79.538	80.558	700
800	81.578	82.597	83.617	84.637	85.656	86.676	87.696	88.716	89.735	90.755	800
900	91.775	92.795	93.814	94.834	95.854	96.873	97.893	98.913	99.933	100.952	900
1000	101.972	102.992	104.011	105.031	106.051	107.071	108.090	109.110	110.130	111.149	1000

14-6 CONVERSION TABLE

PRESSURE

POUNDS PER SQUARE INCHES TO KILOGRAMS PER SQUARE CENTIMETERS

lb/in ²	0	1	2	3	4	5	6	7	8	9	lb/in ²
(psi)	kg/cm ²	kg/cm ²	kg/cm ²	kg/cm ²	kg/cm ²	kg/cm ²	kg/cm ²	kg/cm ²	kg/cm ²	kg/cm ²	(psi)
—	—	0.0703	0.1406	0.2109	0.2812	0.3515	0.4218	0.4921	0.5625	0.6328	—
10	0.7031	0.7734	0.8437	0.9140	0.9843	1.0546	1.1249	1.1952	1.2655	1.3358	10
20	1.4061	1.4764	1.5468	1.6171	1.6874	1.7577	1.8280	1.8983	1.9686	2.0389	20
30	2.1092	2.1795	2.2498	2.3201	2.3904	2.4607	2.5311	2.6014	2.6717	2.7420	30
40	2.8123	2.8826	2.9529	3.0232	3.0935	3.1638	3.2341	3.3044	3.3747	3.4450	40
50	3.5154	3.5857	3.6560	3.7263	3.7966	3.8669	3.9372	4.0075	4.0778	4.1481	50
60	4.2184	4.2887	4.3590	4.4293	4.4996	4.5700	4.6403	4.7106	4.7809	4.8512	60
70	4.9215	4.9918	5.0621	5.1324	5.2027	5.2730	5.3433	5.4136	5.4839	5.5543	70
80	5.6246	5.6949	5.7652	5.8355	5.9058	5.9761	6.0464	6.1167	6.1870	6.2573	80
90	6.3276	6.3979	6.4682	6.5386	6.6089	6.6792	6.7495	6.8198	6.8901	6.9604	90
100	7.0307	7.1010	7.1713	7.2416	7.3119	7.3822	7.4525	7.5228	7.5932	7.6635	100

KILOGRAMS PER SQUARE CENTIMETERS TO POUNDS PER SQUARE INCHES

kg/cm ²	0	1	2	3	4	5	6	7	8	9	kg/cm ²
	lb/in ² (psi)	lb/in ² (psi)	lb/in ² (psi)	lb/in ² (psi)	lb/in ² (psi)	lb/in ² (psi)	lb/in ² (psi)	lb/in ² (psi)	lb/in ² (psi)	lb/in ² (psi)	
—	—	14.22	28.45	42.67	56.89	71.12	85.34	99.56	113.78	128.01	—
10	142.23	156.45	170.68	184.90	199.12	213.35	227.57	241.79	256.01	270.24	10
20	284.46	298.68	312.91	327.13	341.35	355.58	369.80	384.02	398.24	412.47	20
30	426.69	440.91	455.14	469.36	483.58	497.81	512.03	526.25	540.47	554.70	30
40	568.92	583.14	597.37	611.59	625.81	640.04	654.26	668.48	682.70	696.93	40
50	711.15	725.37	739.60	753.82	768.04	782.27	796.49	810.71	824.93	839.16	50
60	853.38	867.60	881.83	896.05	910.27	924.50	938.72	952.94	967.16	981.39	60
70	995.61	1009.83	1024.06	1038.28	1052.50	1066.73	1080.95	1095.17	1109.39	1123.62	70
80	1137.84	1152.06	1166.29	1180.51	1194.73	1208.96	1223.18	1237.40	1251.62	1265.85	80
90	1280.07	1294.29	1308.52	1322.74	1336.96	1351.19	1365.41	1379.63	1393.85	1408.08	90
100	1422.30	1436.52	1450.75	1464.97	1479.19	1493.42	1507.64	1521.86	1536.08	1550.31	100

KILOGRAMS PER SQUARE CENTIMETERS TO KILO PASCAL

kg/cm ²	0	1	2	3	4	5	6	7	8	9	kg/cm ²
	KPa	KPa	KPa	KPa	KPa	KPa	KPa	KPa	KPa	KPa	
—	—	98.1	196.1	294.2	392.3	490.3	588.4	686.5	784.5	882.6	—
10	980.7	1078.7	1176.8	1274.9	1372.9	1471.0	1569.1	1667.1	1765.2	1863.3	10
20	1961.3	2059.4	2157.5	2255.5	2353.6	2451.7	2549.7	2647.8	2745.9	2843.9	20
30	2942.0	3040.1	3138.1	3236.2	3334.3	3432.3	3530.4	3628.5	3726.5	3824.6	30
40	3922.7	4020.7	4118.8	4216.9	4314.9	4413.0	4511.1	4609.1	4707.2	4805.3	40
50	4903.4	5001.4	5099.5	5197.6	5295.6	5393.7	5491.8	5589.8	5687.9	5786.0	50
60	5884.0	5982.1	6080.2	6178.2	6276.3	6374.4	6472.4	6570.5	6668.6	6766.6	60
70	6864.7	6962.8	7060.8	7158.9	7257.0	7355.0	7453.1	7551.2	7649.2	7747.3	70
80	7845.4	7943.4	8041.5	8139.6	8237.6	8335.7	8433.8	8531.8	8629.9	8728.0	80
90	8826.0	8924.1	9022.2	9120.2	9218.3	9316.4	9414.4	9512.5	9610.6	9708.6	90
100	9806.7	9904.8	10002.8	10100.9	10199.0	10297.0	10395.1	10493.2	10591.2	10689.3	100

KILO PASCAL TO KILOGRAMS PER SQUARE CENTIMETERS

KPa	0	100	200	300	400	500	600	700	800	900	KPa
	kg/cm ²	kg/cm ²	kg/cm ²	kg/cm ²	kg/cm ²	kg/cm ²	kg/cm ²	kg/cm ²	kg/cm ²	kg/cm ²	
—	—	1.020	2.039	3.059	4.079	5.099	6.118	7.138	8.158	9.177	—
1000	10.197	11.217	12.237	13.256	14.276	15.296	16.316	17.335	18.355	19.375	1000
2000	20.394	21.414	22.434	23.454	24.473	25.493	26.513	27.532	28.552	29.572	2000
3000	30.592	31.611	32.631	33.651	34.670	35.690	36.710	37.730	38.749	39.769	3000
4000	40.789	41.809	42.828	43.848	44.868	45.887	46.907	47.927	48.947	49.966	4000
5000	50.986	52.006	53.025	54.045	55.065	56.085	57.104	58.124	59.144	60.163	5000
6000	61.183	62.203	63.223	64.242	65.262	66.282	67.302	68.321	69.341	70.361	6000
7000	71.380	72.400	73.420	74.440	75.459	76.479	77.499	78.518	79.538	80.558	7000
8000	81.578	82.597	83.617	84.637	85.656	86.676	87.696	88.716	89.735	90.755	8000
9000	91.775	92.795	93.814	94.834	95.854	96.873	97.893	98.913	99.933	100.952	9000
10000	101.972	102.992	104.011	105.031	106.051	107.071	108.090	109.110	110.130	111.149	10000

TORQUE**FOOT POUNDS TO KILOGRAMMETERS**

ft. lbs.	0	1	2	3	4	5	6	7	8	9	ft. lbs.
	kg-m	kg-m	kg-m	kg-m	kg-m	kg-m	kg-m	kg-m	kg-m	kg-m	
—	—	0.138	0.277	0.415	0.553	0.691	0.830	0.968	1.106	1.244	—
10	1.383	1.521	1.659	1.797	1.936	2.074	2.212	2.350	2.489	2.627	10
20	2.765	2.903	3.042	3.180	3.318	3.457	3.595	3.733	3.871	4.010	20
30	4.148	4.286	4.424	4.563	4.701	4.839	4.977	5.116	5.254	5.392	30
40	5.530	5.669	5.807	5.945	6.083	6.222	6.360	6.498	6.636	6.775	40
50	6.913	7.051	7.190	7.328	7.466	7.604	7.743	7.881	8.019	8.157	50
60	8.296	8.434	8.572	8.710	8.849	8.987	9.125	9.263	9.402	9.540	60
70	9.678	9.816	9.955	10.093	10.231	10.370	10.508	10.646	10.784	10.923	70
80	11.061	11.199	11.337	11.476	11.614	11.752	11.890	12.029	12.167	12.305	80
90	12.443	12.582	12.720	12.858	12.996	13.135	13.273	13.411	13.549	13.688	90
100	13.826	13.964	14.103	14.241	14.379	14.517	14.656	14.794	14.932	15.070	100

KILOGRAMMETERS TO FOOT POUNDS

kg-m	0	1	2	3	4	5	6	7	8	9	kg-m
	ft. lbs.	ft. lbs.	ft. lbs.	ft. lbs.	ft. lbs.	ft. lbs.	ft. lbs.	ft. lbs.	ft. lbs.	ft. lbs.	
—	—	7.23	14.47	21.70	28.93	36.17	43.40	50.63	57.86	65.10	—
10	72.33	79.56	86.80	94.03	101.26	108.50	115.73	122.96	130.19	137.43	10
20	144.66	151.89	159.13	166.36	173.59	180.83	188.06	195.29	202.52	209.76	20
30	216.99	224.22	231.46	238.69	245.92	253.16	260.39	267.62	274.85	282.09	30
40	289.32	296.55	303.79	311.02	318.25	325.49	332.72	339.95	347.18	354.42	40
50	361.65	368.88	376.12	383.35	390.58	397.82	405.05	412.28	419.51	426.75	50
60	433.98	441.21	448.45	455.68	462.91	470.15	477.38	484.61	491.84	499.08	60
70	506.31	513.54	520.78	528.01	535.24	542.48	549.71	556.94	564.17	571.41	70
80	578.64	585.87	593.11	600.34	607.57	614.81	622.04	629.27	636.50	643.74	80
90	650.97	658.20	665.44	672.67	679.90	687.14	694.37	701.60	708.83	716.07	90
100	723.30	730.53	737.77	745.00	752.23	759.47	766.70	773.93	781.16	788.40	100

KILOGRAMMETERS TO NEWTONMETERS

kg-m	0	1	2	3	4	5	6	7	8	9	kg-m
	N-m	N-m	N-m	N-m	N-m	N-m	N-m	N-m	N-m	N-m	
—	—	9.81	19.61	29.42	39.23	49.03	58.84	68.65	78.45	88.26	—
10	98.07	107.87	117.68	127.49	137.29	147.10	156.91	166.71	176.52	186.33	10
20	196.13	205.94	215.75	225.55	235.36	245.17	254.97	264.78	274.59	284.39	20
30	294.20	304.01	313.81	323.62	333.43	343.23	353.04	362.85	372.65	382.46	30
40	392.27	402.07	411.88	421.69	431.49	441.30	451.11	460.91	470.72	480.53	40
50	490.34	500.14	509.95	519.76	529.56	539.37	549.18	558.98	568.79	578.60	50
60	588.40	598.21	608.02	617.82	627.63	637.44	647.24	657.05	666.86	676.66	60
70	686.47	696.28	706.08	715.89	725.70	735.50	745.31	755.12	764.92	774.73	70
80	784.54	794.34	804.15	813.96	823.76	833.57	843.38	853.18	862.99	872.80	80
90	882.60	892.41	902.22	912.02	921.83	931.64	941.44	951.25	961.06	970.86	90
100	980.67	990.48	1000.28	1010.09	1019.90	1029.70	1039.51	1049.32	1059.12	1068.93	100

NEWTONMETERS TO KILOGRAMMETERS

N-m	0	10	20	30	40	50	60	70	80	90	N-m
	kg-m	kg-m	kg-m	kg-m	kg-m	kg-m	kg-m	kg-m	kg-m	kg-m	
—	—	1.020	2.039	3.059	4.079	5.099	6.118	7.138	8.158	9.177	—
100	10.197	11.217	12.236	13.256	14.276	15.296	16.315	17.335	18.355	19.374	100
200	20.394	21.414	22.433	23.453	24.473	25.493	26.512	27.532	28.552	29.571	200
300	30.591	31.611	32.630	33.650	34.670	35.690	36.709	37.729	38.749	39.768	300
400	40.788	41.808	42.827	43.847	44.867	45.887	46.906	47.926	48.946	49.965	400
500	50.985	52.005	53.024	54.044	55.064	56.084	57.103	58.123	59.143	60.162	500
600	61.182	62.202	63.221	64.241	65.261	66.281	67.300	68.320	69.340	70.359	600
700	71.379	72.399	73.418	74.438	75.458	76.478	77.497	78.517	79.537	80.556	700
800	81.576	82.596	83.615	84.635	85.655	86.675	87.694	88.714	89.734	90.753	800
900	91.773	92.793	93.812	94.832	95.852	96.872	97.891	98.911	99.931	100.950	900
1000	101.970	102.990	104.009	105.029	106.049	107.069	108.088	109.108	110.128	111.147	1000

14-8 CONVERSION TABLE

TEMPERATURE

FAHRENHEIT TO CENTIGRADE

°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C
-60	-51.1	-2	-18.9	56	13.3	114	45.6	172	77.8	230	110.0	288	142.2	346	174.4
-58	-50.0	0	-17.8	58	14.4	116	46.7	174	78.9	232	111.1	290	143.3	348	175.6
-56	-48.9	2	-16.7	60	15.6	118	47.8	176	80.0	234	112.2	292	144.4	350	176.7
-54	-47.8	4	-15.6	62	16.7	120	48.9	178	81.1	236	113.3	294	145.6	352	177.8
-52	-46.7	6	-14.4	64	17.8	122	50.0	180	82.2	238	114.4	296	146.7	354	178.9
-50	-45.6	8	-13.3	66	18.9	124	51.1	182	83.3	240	115.6	298	147.8	356	180.0
-48	-44.4	10	-12.2	68	20.0	126	52.2	184	84.4	242	116.7	300	148.9	358	181.1
-46	-43.3	12	-11.1	70	21.1	128	53.3	186	85.6	244	117.8	302	150.0	360	182.2
-44	-42.2	14	-10.0	72	22.2	130	54.4	188	86.7	246	118.9	304	151.1	362	183.3
-42	-41.1	16	-8.9	74	23.3	132	55.6	190	87.8	248	120.0	306	152.2	364	184.4
-40	-40.0	18	-7.8	76	24.4	134	56.7	192	88.9	250	121.1	308	153.3	366	185.6
-38	-38.9	20	-6.7	78	25.6	136	57.8	194	90.0	252	122.2	310	154.4	368	186.7
-36	-37.8	22	-5.6	80	26.7	138	58.9	196	91.1	254	123.3	312	155.6	370	187.8
-34	-36.7	24	-4.4	82	27.8	140	60.0	198	92.2	256	124.4	314	156.7	372	188.9
-32	-35.6	26	-3.3	84	28.9	142	61.1	200	93.3	258	125.6	316	157.8	374	190.0
-30	-34.4	28	-2.2	86	30.0	144	62.2	202	94.4	260	126.7	318	158.9	376	191.1
-28	-33.3	30	-1.1	88	31.1	146	63.3	204	95.6	262	127.8	320	160.0	378	192.2
-26	-32.2	32	0.0	90	32.2	148	64.4	206	96.7	264	128.9	322	161.1	380	193.3
-24	-31.1	34	1.1	92	33.3	150	65.6	208	97.8	266	130.0	324	162.2	382	194.4
-22	-30.0	36	2.2	94	34.4	152	66.7	210	98.9	268	131.1	326	163.3	384	195.6
-20	-28.9	38	3.3	96	35.6	154	67.8	212	100.0	270	132.2	328	164.4	386	196.7
-18	-27.8	40	4.4	98	36.7	156	68.9	214	101.1	272	133.3	330	165.6	388	197.8
-16	-26.7	42	5.6	100	37.8	158	70.0	216	102.2	274	134.4	332	166.7	390	198.9
-14	-25.6	44	6.7	102	38.9	160	71.1	218	103.3	276	135.6	334	167.8	392	200.0
-12	-24.4	46	7.8	104	40.0	162	72.2	220	104.4	278	136.7	336	168.9	400	204.4
-10	-23.3	48	8.9	106	41.1	164	73.3	222	105.6	280	137.8	338	170.0	410	210.0
-8	-22.2	50	10.0	108	42.2	166	74.4	224	106.7	282	138.9	340	171.1	420	215.6
-6	-21.1	52	11.1	110	43.3	168	75.6	226	107.8	284	140.0	342	172.2	430	221.1
-4	-20.0	54	12.2	112	44.4	170	76.7	228	108.9	286	141.1	344	173.3	440	226.7

CENTIGRADE TO FAHRENHEIT

°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
-50	-58.0	-18	-0.4	14	57.2	46	114.8	78	172.4	110	230.0	142	287.6	174	345.2
-49	-56.2	-17	1.4	15	59.0	47	116.6	79	174.2	111	231.8	143	289.4	175	347.0
-48	-54.4	-16	3.2	16	60.8	48	118.4	80	176.0	112	233.6	144	291.2	176	348.8
-47	-52.6	-15	5.0	17	62.6	49	120.2	81	177.8	113	235.4	145	293.0	177	350.6
-46	-50.8	-14	6.8	18	64.4	50	122.0	82	179.6	114	237.2	146	294.8	178	352.4
-45	-49.0	-13	8.6	19	66.2	51	123.8	83	181.4	115	239.0	147	296.6	179	354.2
-44	-47.2	-12	10.4	20	68.0	52	125.6	84	183.2	116	240.8	148	298.4	180	356.0
-43	-45.4	-11	12.2	21	69.8	53	127.4	85	185.0	117	242.6	149	300.2	181	357.8
-42	-43.6	-10	14.0	22	71.6	54	129.2	86	186.8	118	244.4	150	302.0	182	359.6
-41	-41.8	-9	15.8	23	73.4	55	131.0	87	188.6	119	246.2	151	303.8	183	361.4
-40	-40.0	-8	17.6	24	75.2	56	132.8	88	190.4	120	248.0	152	305.6	184	363.2
-39	-38.2	-7	19.4	25	77.0	57	134.6	89	192.2	121	249.8	153	307.4	185	365.0
-38	-36.4	-6	21.2	26	78.8	58	136.4	90	194.0	122	251.6	154	309.2	186	366.8
-37	-34.6	-5	23.0	27	80.6	59	138.2	91	195.8	123	253.4	155	311.0	187	368.6
-36	-32.8	-4	24.8	28	82.4	60	140.0	92	197.6	124	255.2	156	312.8	188	370.4
-35	-31.0	-3	26.6	29	84.2	61	141.8	93	199.4	125	257.0	157	314.6	189	372.2
-34	-29.2	-2	28.4	30	86.0	62	143.6	94	201.2	126	258.8	158	316.4	190	374.0
-33	-27.4	-1	30.2	31	87.8	63	145.4	95	203.0	127	260.6	159	318.2	191	375.8
-32	-25.6	0	32.0	32	89.6	64	147.2	96	204.8	128	262.4	160	320.0	192	377.6
-31	-23.8	1	33.8	33	91.4	65	149.0	97	206.6	129	264.2	161	321.8	193	379.4
-30	-22.0	2	35.6	34	93.2	66	150.8	98	208.4	130	266.0	162	323.6	194	381.2
-29	-20.2	3	37.4	35	95.0	67	152.6	99	210.2	131	267.8	163	325.4	195	383.0
-28	-18.4	4	39.2	36	96.8	68	154.4	100	212.0	132	269.6	164	327.2	196	384.8
-27	-16.6	5	41.0	37	98.6	69	156.2	101	213.8	133	271.4	165	329.0	197	386.6
-26	-14.8	6	42.8	38	100.4	70	158.0	102	215.6	134	273.2	166	330.8	198	388.4
-25	-13.0	7	44.6	39	102.2	71	159.8	103	217.4	135	275.0	167	332.6	199	390.2
-24	-11.2	8	46.4	40	104.0	72	161.6	104	219.2	136	276.8	168	334.4	200	392.0
-23	-9.4	9	48.2	41	105.8	73	163.4	105	221.0	137	278.6	169	336.2	210	410.0
-22	-7.6	10	50.0	42	107.6	74	165.2	106	222.8	138	280.4	170	338.0	220	428.0
-21	-5.8	11	51.8	43	109.4	75	167.0	107	224.6	139	282.2	171	339.8	230	446.0
-20	-4.0	12	53.6	44	111.2	76	168.8	108	226.4	140	284.0	172	341.6	240	464.0
-19	-2.2	13	55.4	45	113.0	77	170.6	109	228.2	141	285.8	173	343.4	250	482.0

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