# Technical Manual

EX33Mu, 58Mu

# 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 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

- Two types of manual are available. One is Technical Manual(T/M). The other is Workshop Manual(W/M).
  Use the manuals according to purpose.

  · Information included in the T/M:
  technical information needed for redelivery and delivery, operation and activation of all devices and systems, operational performance tests, and troubleshooting procedures.

  · Information included in the W/M:
  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.

## 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

## 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 01-03-05

  - 05 → Consecutive Page Number for Each Group
  - 03 → Group Number
  - 01 → Section Number
  - T → T: Technical Manual W: Workshop Manual

## 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 a 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.
  MKSA system units and English units are also indicated in parentheses just behind SI units.

Example: 24.5 MPa ( 250 kgf/cm$^2$, 3 560 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 | 0.039 37 | Pressure | MPa | kgf/cm$^2$ | 10.197 |
| | mm | ft | 0.003 281 | | MPa | psi | 145.0 |
| Volume | L | US gal | 0.264 2 | 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 | 0.621 4 |
| Force | N | kgf | 0.101 97 | | min$^{-1}$ | rpm | 1.0 |
| | N | lbf | 0.224 8 | Flow rate | L/min | US gpm | 0.264 2 |
| Torque | N·m | kgf·m | 1.019 7 | | mL/rev | cc/rev | 1.0 |
| | N·m | lbf·ft | 0.737 5 | | | | |

## 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.

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## 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.**
- **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.


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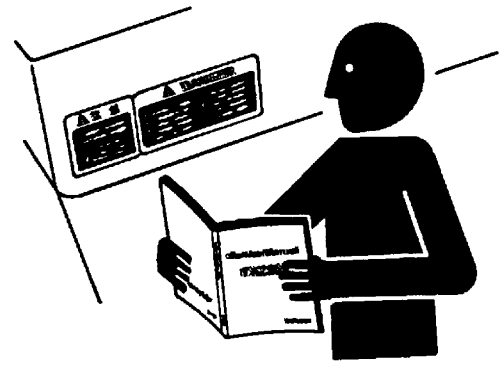
## FOLLOW SAFETY INSTRUCTIONS



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- 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 operator's manual is damaged or missing, replace it with new one.
- 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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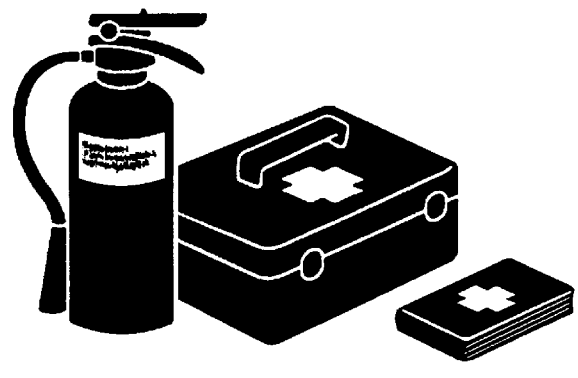
## PREPARE FOR EMERGENCIES



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- 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.
  - · 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.

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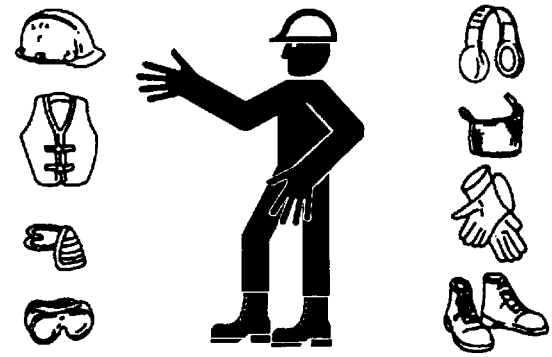
## WEAR PROTECTIVE CLOTHING



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- 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 machine.

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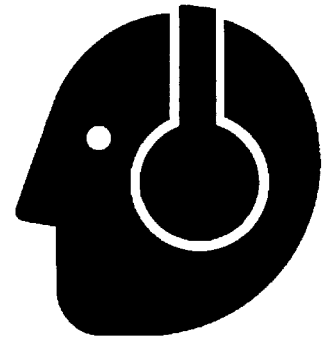
## PROTECT AGAINST NOISE



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- 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.

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## INSPECT MACHINE

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- 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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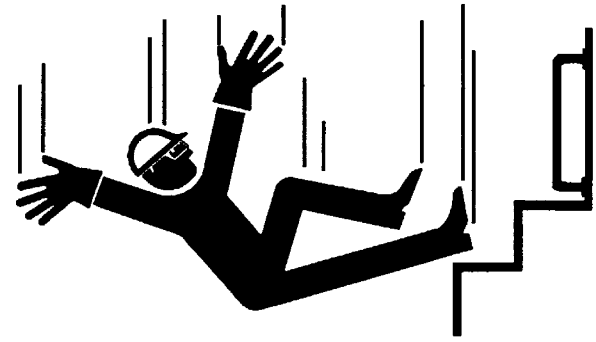
## USE HANDHOLDS AND STEPS

- Falling is one of the major causes of personal injury.
  - · When you get on and off the machine, always face the machine and maintain a three-point contact with the steps and handrails.
  - · Do not use any controls as handholds.
  - · 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 leaving the machine.



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## 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.

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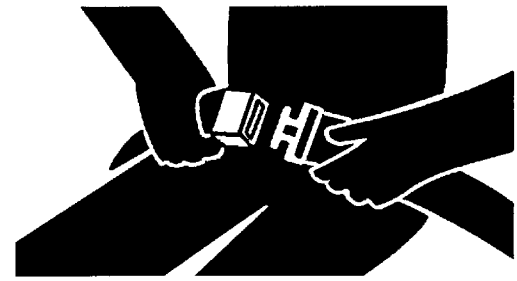
## FASTEN YOUR SEAT BELT(IF EQUIPPED)

- 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.



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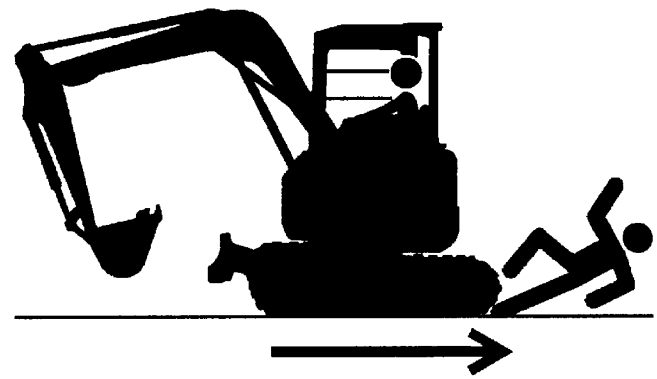
## MOVE AND OPERATE MACHINE SAFELY

- 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.



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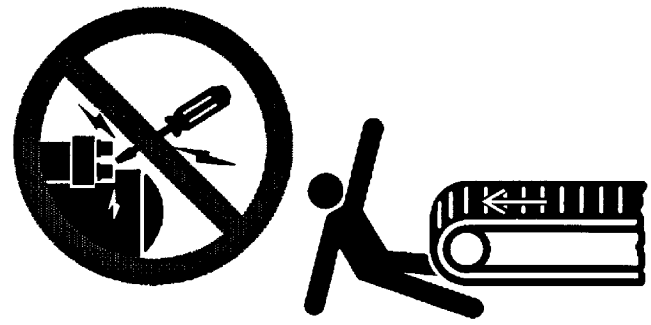
## OPERATE ONLY FROM OPERATOR'S SEAT

- Inappropriate engine starting procedure may cause the machine to runaway, possibly resulting in serious injury or death.

  · Start the engine only from 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.



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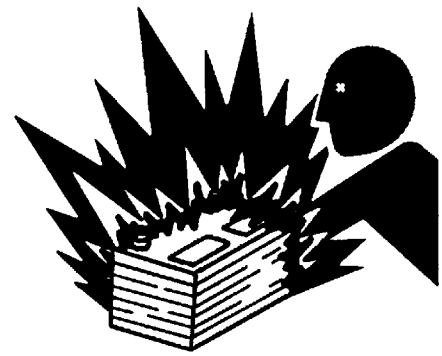
## JUMP STARTING

- 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.



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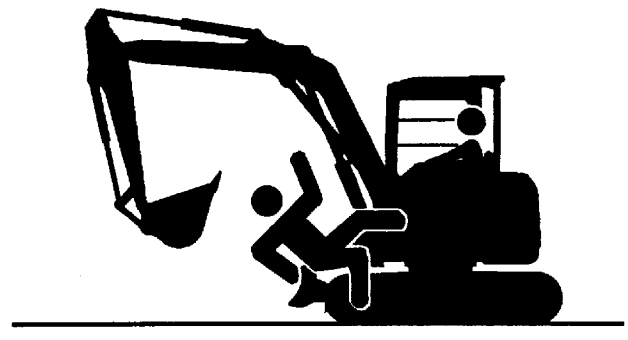
## KEEP RIDERS OFF MACHINE

- 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.



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## PROVIDE SIGNALS FOR JOBS 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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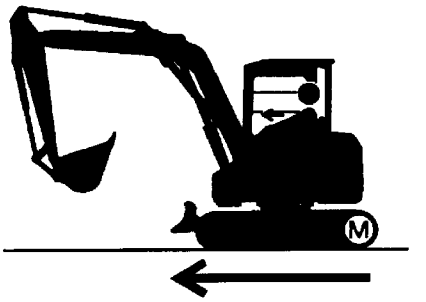
## CONFIRM DIRECTION OF MACHINE TO BE DRIVEN

- Incorrect travel pedal/lever operation may result in serious injury or 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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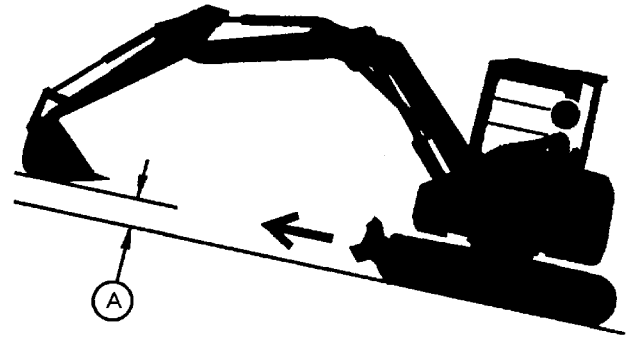
## DRIVE MACHINE SAFELY

- Before moving the machine, confirm which way to move travel pedals/levers for the corresponding direction you wish to go.

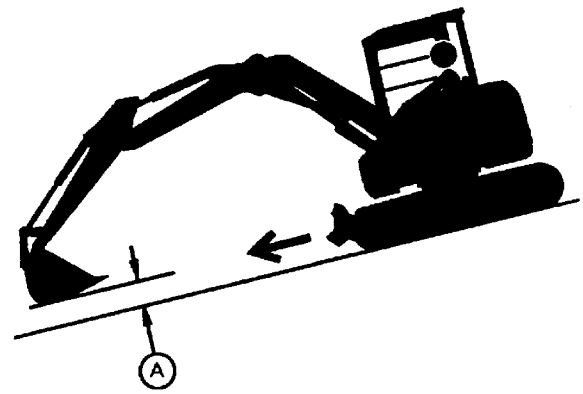
  · Pushing down on the front of the travel pedals or pushing the levers forward moves the machine towards the idlers. (Refer to the Steering the Machine Using Pedals/Levers section in the operator's manual for correct travel operation.)




SA-533

- Traveling on a grade may cause the machine to slip or to overturn, possibly resulting in serious injury or death.

  · When traveling up or down a grade, keep the bucket in the direction of travel, approximately 200 to 300 mm ( 8 to 12 in )(A) above the ground.
  · If machine starts to skid or becomes unstable, lower the bucket immediately.

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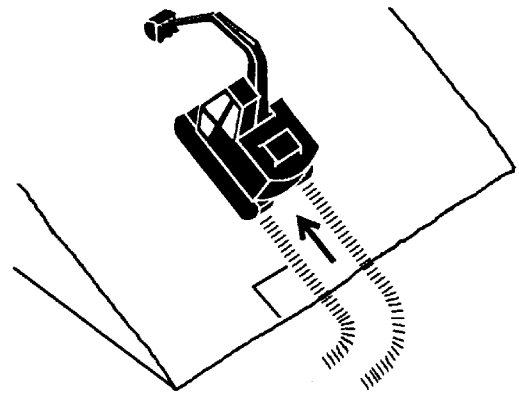
· Traveling across the face of a slope may cause the machine to skid or to turnover. When traveling (ascending/descending) on a slope, be sure to point the tracks uphill/downhill.



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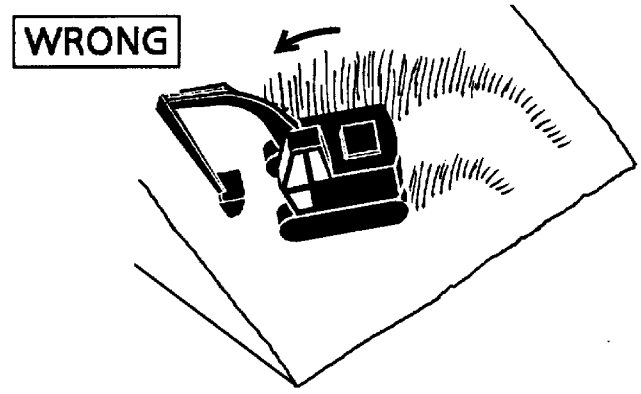
· Turning on an incline may cause the machine to tip over.
If turning on an incline is absolutely unavoidable, do so at a place where the slope is gentle and the surface is firm.

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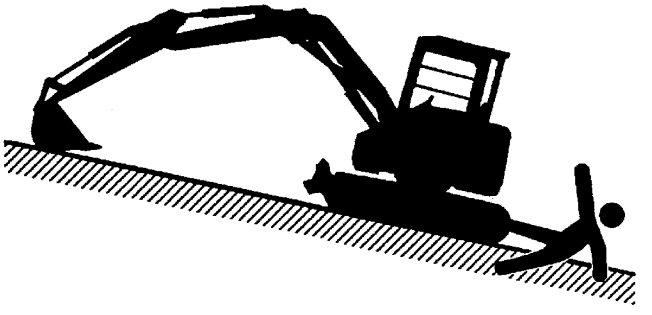
## AVOID INJURY FROM ROLLAWAY ACCIDENTS

- 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 switch off (if equipped).
- 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.



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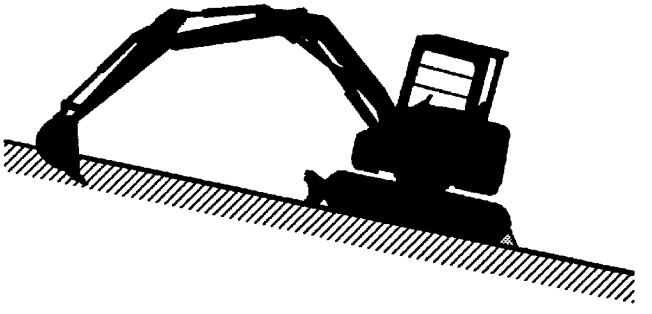

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## AVOID INJURY FROM BACK-OVER AND SWING ACCIDENTS

- 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.

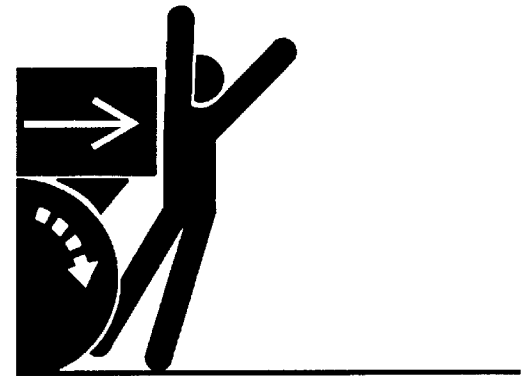
  · No machine motions shall be made unless signals are clearly understood by both signalman and operator.

  · 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.



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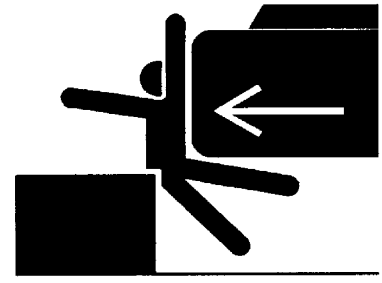

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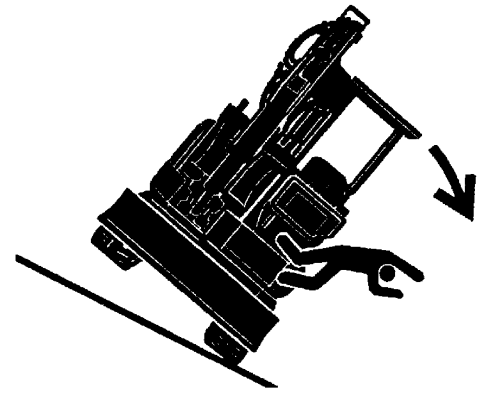
## AVOID TIPPING



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- 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.

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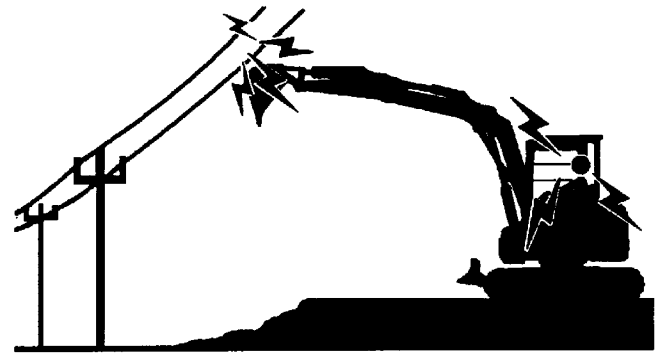
## AVOID POWER LINES

- 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.



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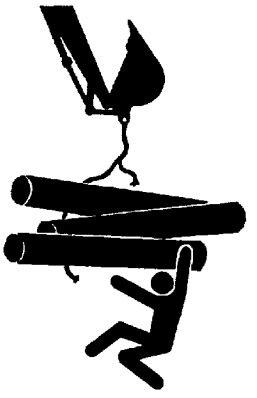
## OBJECT HANDLING

- 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, sables, 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.



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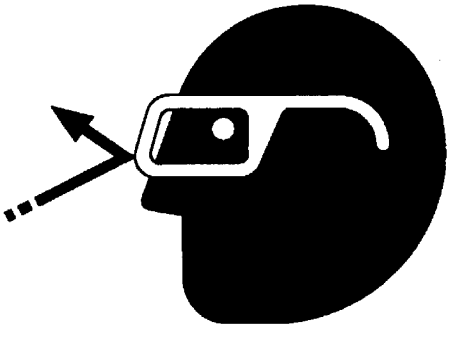
## PROTECT AGAINST FLYING DEBRIS

- 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.



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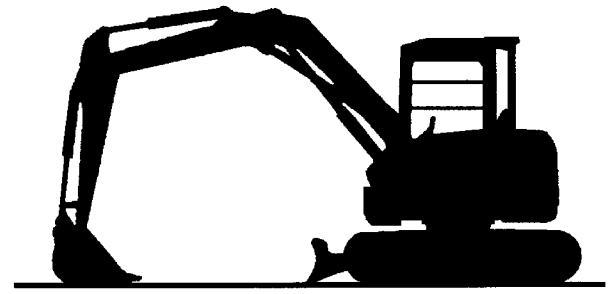
## PARK MACHINE SAFELY

To avoid accidents:
- Park machine on a firm, level surface.
- Lower bucket and/or other work tools to the ground.
- Turn auto-idle switch off (if equipped).
- 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.



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## 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.

SA-018

- 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.

034-E01A-0496-4

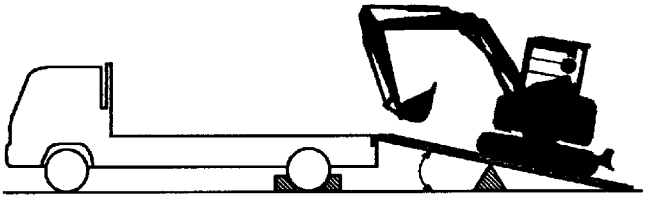
SA-019

## 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 switch OFF (if equipped) when loading or unloading the machine, to avoid unexpected speed increase due to unintentional operation of a control lever.
  5) Be sure to load/unload the machine at slow speed.
  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-546

S035-E10A-0546-8

## PRACTICE SAFE MAINTENANCE

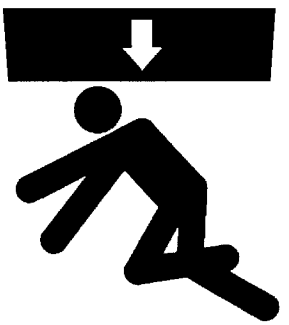
To avoid accidents:

- 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.

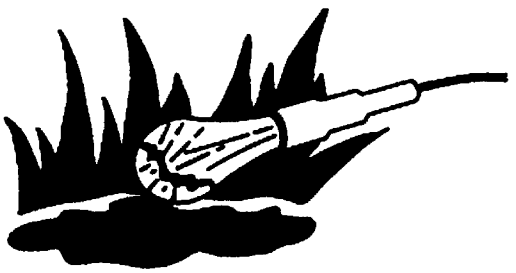
- Before servicing the machine:
  1) Park the machine on a firm, level surface.
  2) Lower the bucket and/or other work tools to the ground.
  3) Turn the auto-idle switch off (if equipped).
  4) Run the engine at slow idle speed without load for 5 minutes.
  5) Turn the key switch to OFF to stop engine.
  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.

SA-028

- 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.
- Disconnect battery ground cable (−) before making adjustments to electrical systems or before welding on the machine.
- Illuminate your work area adequately but safely.
- 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.



SA-527



SA-037

S500-E09A-0497-8

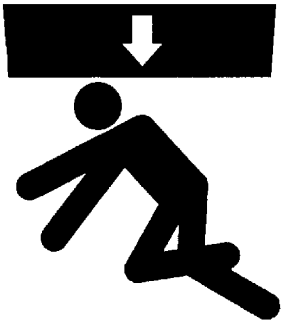
## WARN OTHERS OF SERVICE WORK

- 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-0287-2 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.

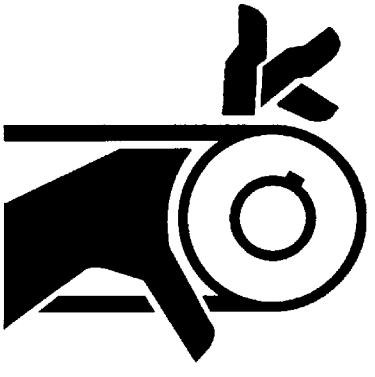


SA-527

519-E01A-0527-3

## STAY CLEAR OF MOVING PARTS

- Entanglements 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-0026-2 SA-026

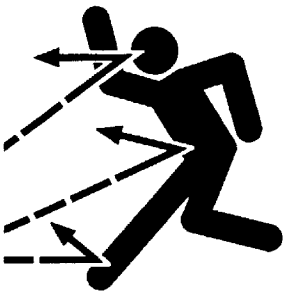
## USE TOOLS PROPERLY

- 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-0040-2 SA-040

## 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-0344-4

## 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.

504-E01A-0034-2 SA-034

## 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.

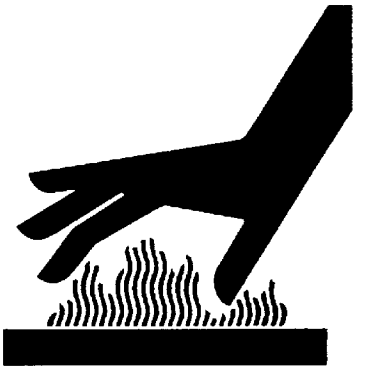
  · To avoid possible injury from hot spraying water. DO NOT remove the radiator cap until the engine is cool. When opening, turn the cap slowly to the stop. Allow all pressure to be released before removing the cap.
  · The hydraulic oil tank is pressurized. Again, be sure to release all pressure before removing the cap.

SA-039

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-225

505-E01B-0498-5

## 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.)

SA-019

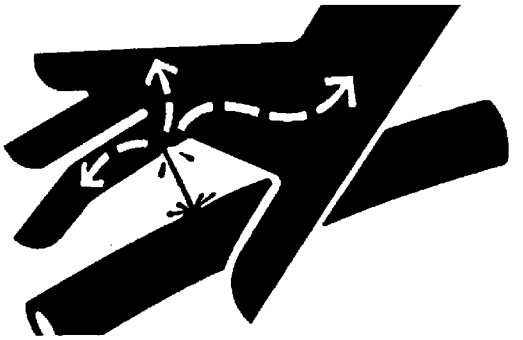
- Failure to periodically replace rubber hoses may cause a fire, fluid injection into skin, or the front attachment to fall on a person nearby, which may result in severe burns, gangrene, or otherwise serious injury or death.

S506-E01A-0019-3

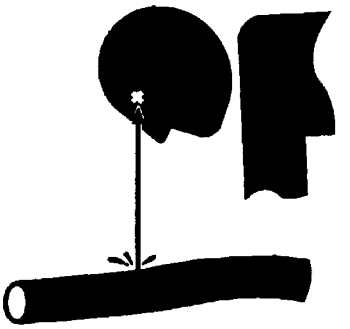
## AVOID HIGH-PRESSURE FLUIDS

- Fluids such as diesel fuel or hydraulic oil under pressure can penetrate the skin or eyes causing serious injury, blindness or death.

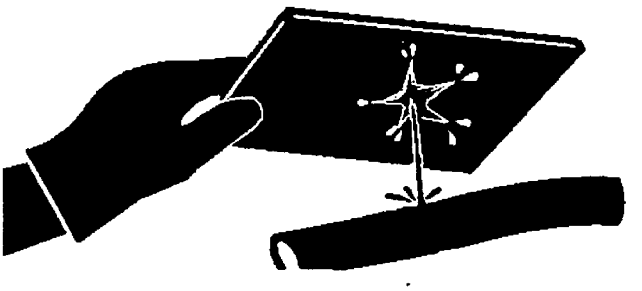
  · Avoid this hazard by relieving pressure before disconnecting hydraulic or other lines.
  · Relieve the pressure by moving the control levers several times.
  Tighten all connections before applying pressure.
  · Search for leaks with a piece of cardboard; take care to protect hands and body from high-pressure 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



507-E01A-0499-5

SA-044

## 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.

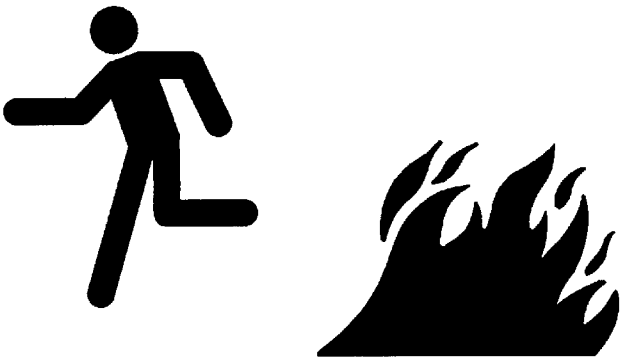
  · Always check key switch function before operating the machine every day:
    1) Start the engine and run it at slow idle.
    2) Turn the key switch to the OFF position to confirm that the engine stops.

  · If any abnormalities are found, be sure to repair them before operating the machine.

508-E04B-0019-8

## EVACUATING IN CASE OF FIRE

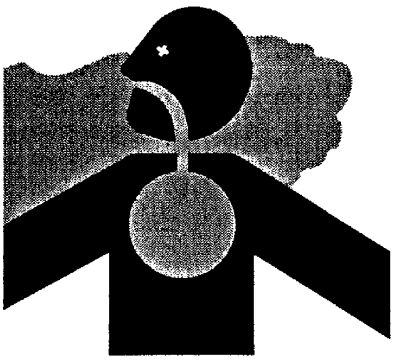
- If a fire breaks out, evacuate the machine in the following way:
  - · Stop the engine by turning the key switch to the OFF position if there is time.
  - · Use a fire extinguisher if there is time.
  - · Exit the machine.



518-E02A-0393-2 SA-393

## 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-0016-2 SA-016

## 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-0030-4

## REMOVE PAINT BEFORE WELDING OR HEATING

SA-029

- 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.

511-E01A-0029-4

## PREVENT BATTERY EXPLOSIONS

SA-032

- Battery gas can explode.

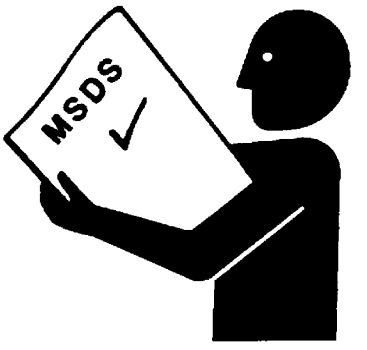
  · Keep sparks, lighted matches, and flame away from the top of battery.
  · Never check battery charge by placing a metal object across the posts. Use a voltmeter or hydrometer.
  · Do not charge a frozen battery; it may explode. Warm the battery to 16 °C ( 60 °F ) first.

- 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.

512-E01B-0032-4

## HANDLE CHEMICAL PRODUCTS SAFELY




SA-309

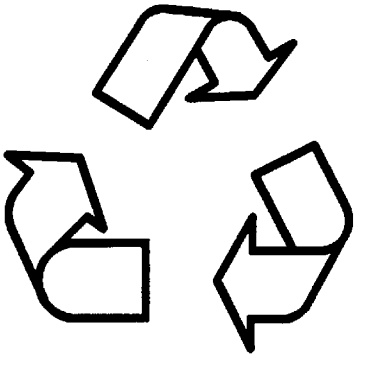
- Direct exposure to hazardous chemicals can cause serious injury. Potentially hazardous chemicals used with your machine include such items as lubricants, coolants, paints, and adhesives.

  · 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.

S515-E01A-0309-4

## DISPOSE OF WASTE PROPERLY



SA-226

- 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.

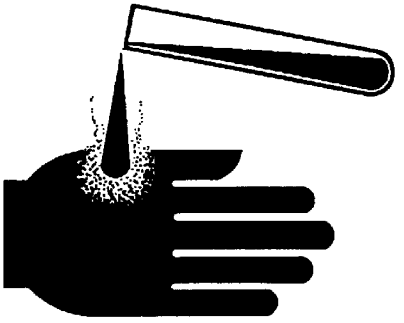
  · Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.
  · Do not pour waste onto the ground, down a drain, or into any water source.
  · Air conditioning refrigerants escaping into the air can damage the Earth's atmosphere. 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.

S516-E01A-0226-4

## 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-0405-3

## AVOID HARMFUL ASBESTOS DUST

- Inhaled asbestos fibers may cause lung cancer.

  · Avoid breathing dust that may be generated when handling components containing asbestos fibers.
  · Components that may contain asbestos fibers are some gaskets. The asbestos used in these components is usually found in a resin or sealed in some way. Normal handling is not hazardous as long as airborne dust containing asbestos is not generated.
  · Avoid creating dust. Never use compressed air for cleaning. Avoid brushing or grinding asbestos-containing materials. When servicing, wear an approved respirator. A special vacuum cleaner is recommended to clean asbestos. If not available, wet the asbestos containing materials with a mist of oil or water.
  · Be sure to comply with all applicable rules and regulations for the work place.
  Follow all local environmental rules and regulations for the disposal of asbestos.
  · Keep bystanders away from the areas where asbestos particles may be in the air.

SA-029

514-E01A-0029-5

## 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-0435-2

SA-435

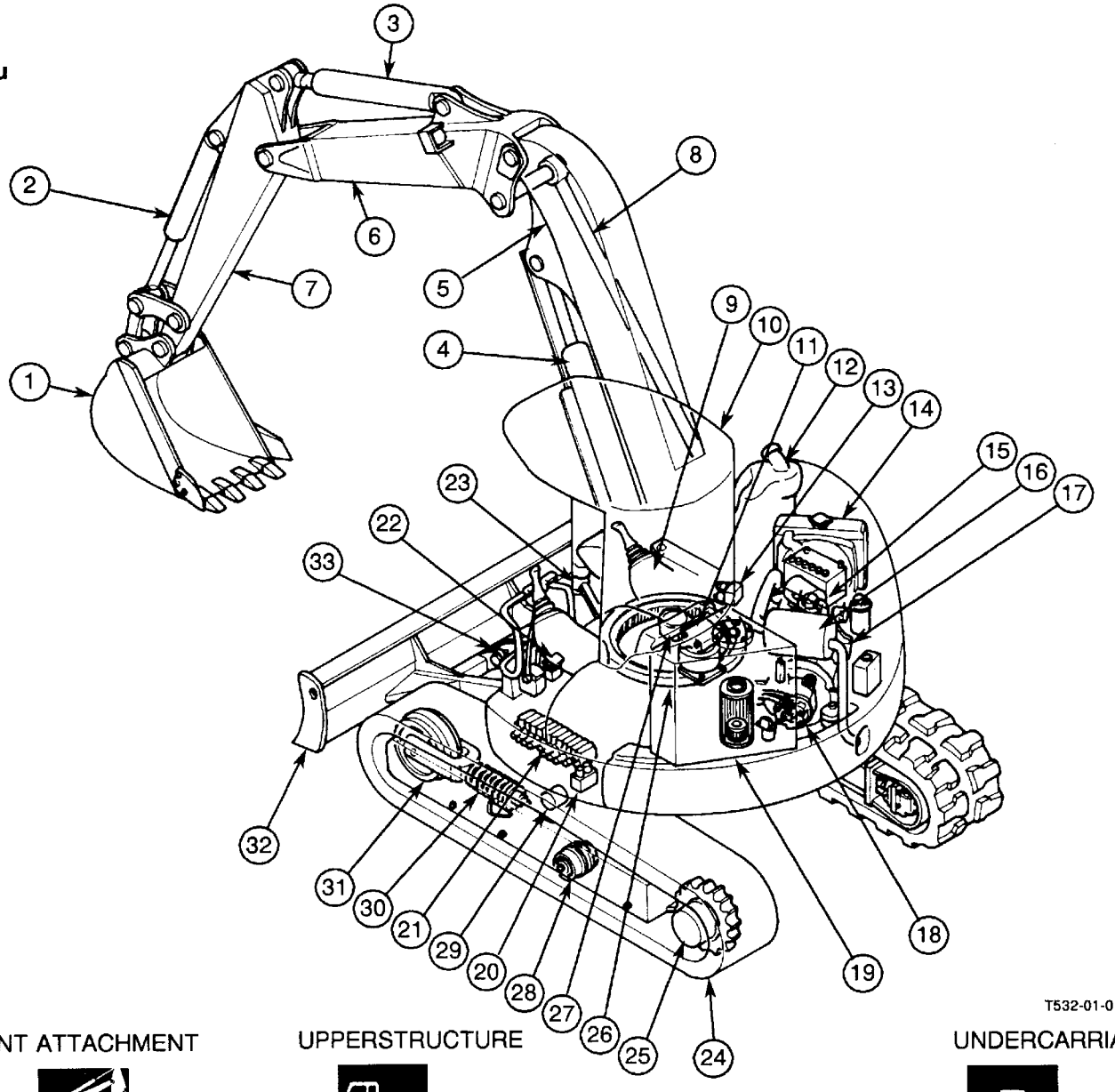
# SECTION 01
# GENERAL

## CONTENTS

## OUTLINE

The hydraulic excavator consists of three main sections, front attachment, upper structure and undercarriage.

**33Mu**




FRONT ATTACHMENT

1— Bucket
2— Bucket Cylinder
3— Arm Cylinder
4— Boom Cylinder
5— Lower Boom
6— Upper Boom
7— Arm
8— Cross Rod

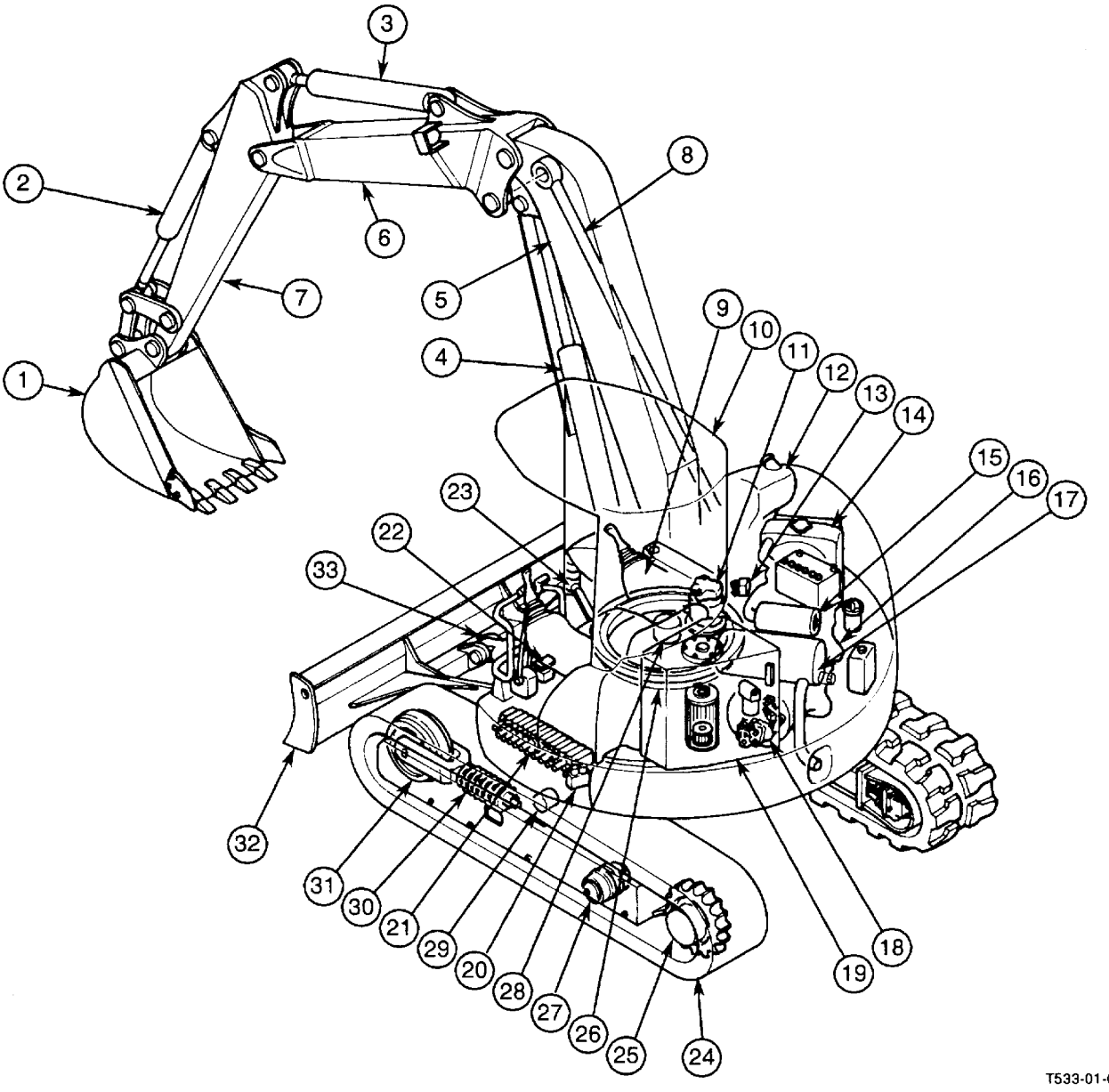
UPPERSTRUCTURE

9— Pilot Valve (Front Attachment)
10— Canopy
11— Swing Device
12— Fuel Tank
13— Solenoid Valve (Pilot Control Shut-Off Lever, Travel Speed Selector)
14— Radiator
15— Air Cleaner
16— Muffler
17— Engine
18— Pump Device
19— Hydraulic Oil Tank
20— Proportional Solenoid Valve (Auto Boom-Stop)
21— Control Valve
22— Pilot Valve (Boom-Swing)
23— Boom-Swing Cylinder

UNDERCARRIAGE

24— Track
25— Travel Device
26— Swing Bearing
27— Center Joint
28— Lower Roller
29— Upper Roller
30— Track Adjuster
31— Front Idler
32— Blade
33— Blade Cylinder

58Mu

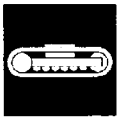



T533-01-01-001

FRONT ATTACHMENT

UPPERSTRUCTURE

UNDERCARRIAGE



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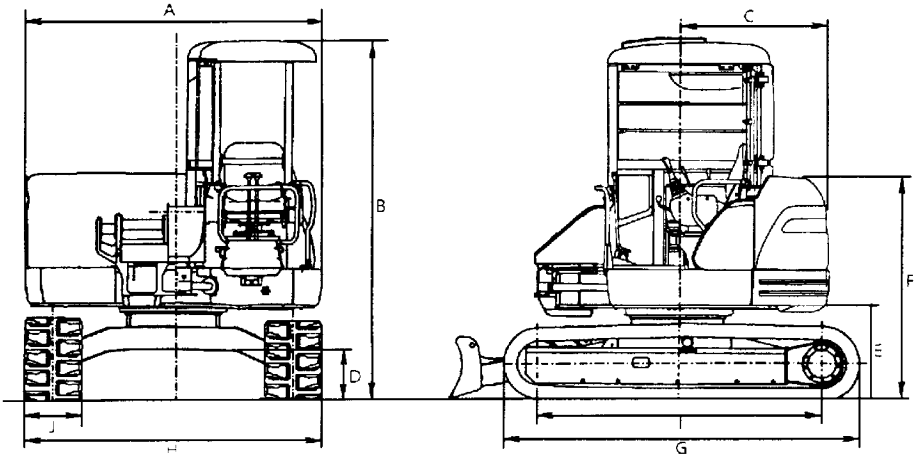
## SPECIFICATIONS

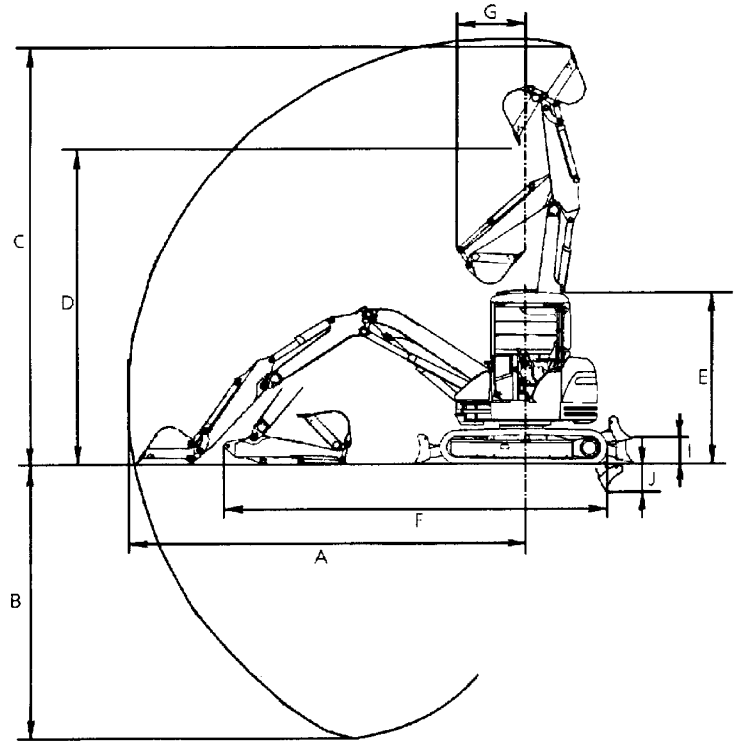



M588-11-001

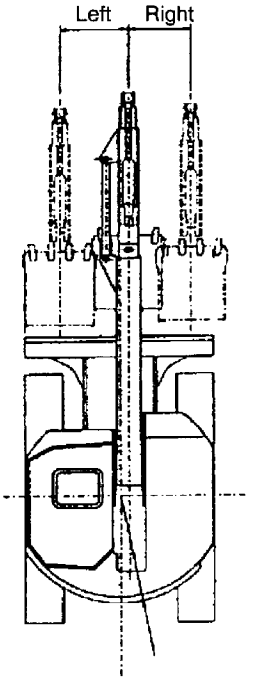
| Description \ Model | | 33Mu | | 58Mu | |
|---|---|---|---|---|---|
| | | Canopy | Cab | Canopy | Cab |
| Type of Front-End Attachment | | Boom Swing Type | | | |
| Bucket Capacity | $m^3$ ($yd^3$) | 0.09 (※0.12) | | 0.24 (※0.31) | |
| Machine Weight | kg (lb) | 3 100 (6 840) | 3 130 (6 900) | 5 550 (12 240) | 5 580 (12 300) |
| Base Machine Dry Weight | kg(lb) | 2 330 (5 140) | 2 360 (5 200) | 4 110 (9 060) | 4 140 (9 130) |
| Engine | | KUBOTA D1503-KA<br>16.9 kW / 2 000 $min^{-1}$<br>(23 PS / 2 000 rpm) | | ISUZU 4LE1<br>29.4 kW / 2 100 $min^{-1}$<br>(40 PS / 2 100 rpm) | |
| A: Overall Width | mm (ft in) | 1 670 (5' 6") | | 2 090 (6' 10") | |
| B: Canopy Cab Height | mm (ft in) | 2 505 (8' 3") | | 2 570 (8' 5") | |
| C: Rear-End Swing Radius | mm (ft in) | 845 (2' 9") | | 1 055 (3' 6") | |
| D: Minimum Ground Clearance | mm (ft in) | 330 (1' 1") | | 330 (1' 1") | |
| E: Counterweight Clearance | mm (ft in) | 595 (1' 11")<br>(Rubber Crawler) | | 660 (2' 2")<br>(Rubber Crawler) | |
| F: Engine Cover Height | mm (ft in) | 1 540 (5' 1") | | 1 610 (5' 3") | |
| G: Undercarriage Length | mm (ft in) | 2 015 (6' 7")<br>(Rubber Crawler) | | 2 515 (8' 3")<br>(Rubber Crawler) | |
| H: Undercarriage Width | mm (ft in) | 1 620 (5' 4") | | 2 040 (6' 8") | |
| I: Sprocket Center to Idler Center | mm (ft in) | 1 590 (5' 3") | | 2 000 (6' 7") | |
| J: Track Shoe Width | mm (ft in) | 300 (12")<br>(Rubber Crawler) | | 400 (16")<br>(Rubber Crawler) | |
| Ground Pressure | kPa ($kgf/cm^2$) | 29.1 (0.30) | 29.4 (0.30) | 31.2 (0.32) | 31.4 (0.32) |
| Swing Speed | $min^{-1}$ (rpm) | 10 | | 11 | |
| Travel Speed (Fast / Slow) | km (h) | 4.0 / 2.4 | | 4.4 / 2.7 | |
| Gradeability | % (Degree) | 58 (30) | | 58 (30) | |

*NOTE: Figures marked with ※ equals CECE heaped capacity.*

## WORKING RANGES AND MACHINE DIMENSIONS FOR TRANSPORTATION




M588-11-002




M552-11-003

| Description \ Model | | 33Mu | | 58Mu | |
|---|---|---|---|---|---|
| | | Canopy | Cab | Canopy | Cab |
| A: Maximum Digging Reach | mm (ft in) | 4 820 (15′ 10″) | ← | 5 950 (19′ 6″) | ← |
| B: Maximum Digging Depth | mm (ft in) | 2 870 (9′ 5″) | ← | 4 000 (13′ 2″) | ← |
| C: Maximum Cutting Height | mm (ft in) | 5 920 (19′ 5″) | ← | 7 340 (24′ 1″) | ← |
| D: Maximum Dumping Height | mm (ft in) | 4 560 (15′ 0″) | ← | 5 610 (18′ 5″) | ← |
| E: Transport Height | mm (ft in) | 2 505 (8′ 3″) | ← | 2 570 (8′ 5″) | ← |
| F: Overall Transport Length | mm (ft in) | 4 320 (14′ 2″) | ← | 5 240 (17′ 2″) | ← |
| G: Minimum Swing Radius | mm (ft in) | 835 (2′ 9″) | ← | 1 045 (3′ 5″) | ← |
| I: Blade Bottom Highest Position (above ground level) | mm (ft in) | 330 (1′ 1″) | ← | 440 (1′ 5″) | ← |
| J: Blade Bottom Lowest Position (below ground level) | mm (ft in) | 360 (1′ 2″) | ← | 345 (1′ 2″) | ← |
| K: Maximum Boom-Swing Angle | (°) | Left 50.5<br>Right 65.5 | – | Left 66<br>Right 62 | – |
| L: Offset Distance | mm (ft in) | Left 410 (1′ 4″)<br>Right 630 (2′ 1″) | Left 410 (1′ 4″)<br>Right 630 (2′ 1″) | Left 490 (1′ 7″)<br>Right 810 (2′ 8″) | Left 490 (1′ 7″)<br>Right 810 (2′ 8″) |

*NOTE: Transport height E does not include the shoe lug height.*

## ENGINE SPECIFICATIONS

| Description \ Model | 33Mu | 58Mu |
|---|---|---|
| Engine | | |
| Manufacturer | KUBOTA | ISUZU |
| Model | D1503-KA | 4LE1PA-01 |
| Type | Diesel, 4-cycle,water-cooled, vertical inline, swirl chamber type | ← |
| Cyl. No - bore × stroke | 3 – 83 mm × 92.4 mm | 4 – 85 mm × 96 mm |
| Piston displacement | 1.499 L | 2.179 L |
| Rated output | 16.9 kW/2 000 $min^{-1}$<br>23 PS/2 000 rpm | 29.4 kW/2 100 $min^{-1}$<br>40 PS/2 100 rpm |
| Compression ratio | 23 | 21.5 |
| Dry weight | 154 kg | 155 kg |
| Firing order | 1–2–3 | 1–3–4–2 |
| Rotation direction | Clockwise (view from fan side) | ← |
| Starter | | |
| Manufacturer | NIPPON DENSO | Hitachi Ltd |
| Motor | DC Series reduction type | Electromagnetic pinion shift type |
| Output voltage | 12 V · 2.0 kW | ← |
| Alternator | | |
| Manufacturer | NIPPON DENSO | ← |
| Type | AC type with IC regulator | ← |
| Output voltage | 12 V · 45 A | 12 V · 35 A |
| Fuel system | | |
| Type | BOSCH K-type mini pump | BOSCH PFR1KX type |
| Governor | Centrifugal ball type | Centrifugal splash type |

## COMPONENT INTERCHANGEABILITY LIST

The following list shows the component interchangeability among the different models.

Only the components connected with the bold line " ——— " are interchangeable between models.

| | Description \ Model | 33Mu | 30-2 | 58Mu | 55UR |
|---|---|---|---|---|---|
| Upperstructure | Engine | ● | ● | ● | ● |
| | Pump Device | ● | ● | ● | ● |
| | Swing Device | ● | ● | ● | ● |
| | Control Valve | ● | ● | ● | ● |
| | Pilot Valve | ● | ● | ● | ● |
| | Boom-Swing Cylinder | ● | ● | ● | – |
| Undercarriage | Travel Device | ● | ● | ● | ● |
| | Swing Bearing | ● | ● | ● | ● |
| | Center Joint | ● | ● | ● | ● |
| | Track Adjuster | ● | ● | ● | ● |
| | Front Idler | ● | ● | ● | ● |
| | Upper Roller | ● | ● | ● | ● |
| | Lower Roller | ● | ● | ● | ● |
| | Rubber Crawler | ● | ● | ● | ● |
| | Blade | ● | ● | ● | ● |
| | Blade Cylinder | ● | ● | ● | ● |
| Front attachment | Boom | ● | ● | ● | ● |
| | Arm | ● | ● | ● | ● |
| | Bucket | ● | ● | ● | ● |
| | Boom Cylinder | ● | ● | ● | ● |
| | Arm Cylinder | ● | ● | ● | ● |
| | Bucket Cylinder | ● | ● | ● | ● |

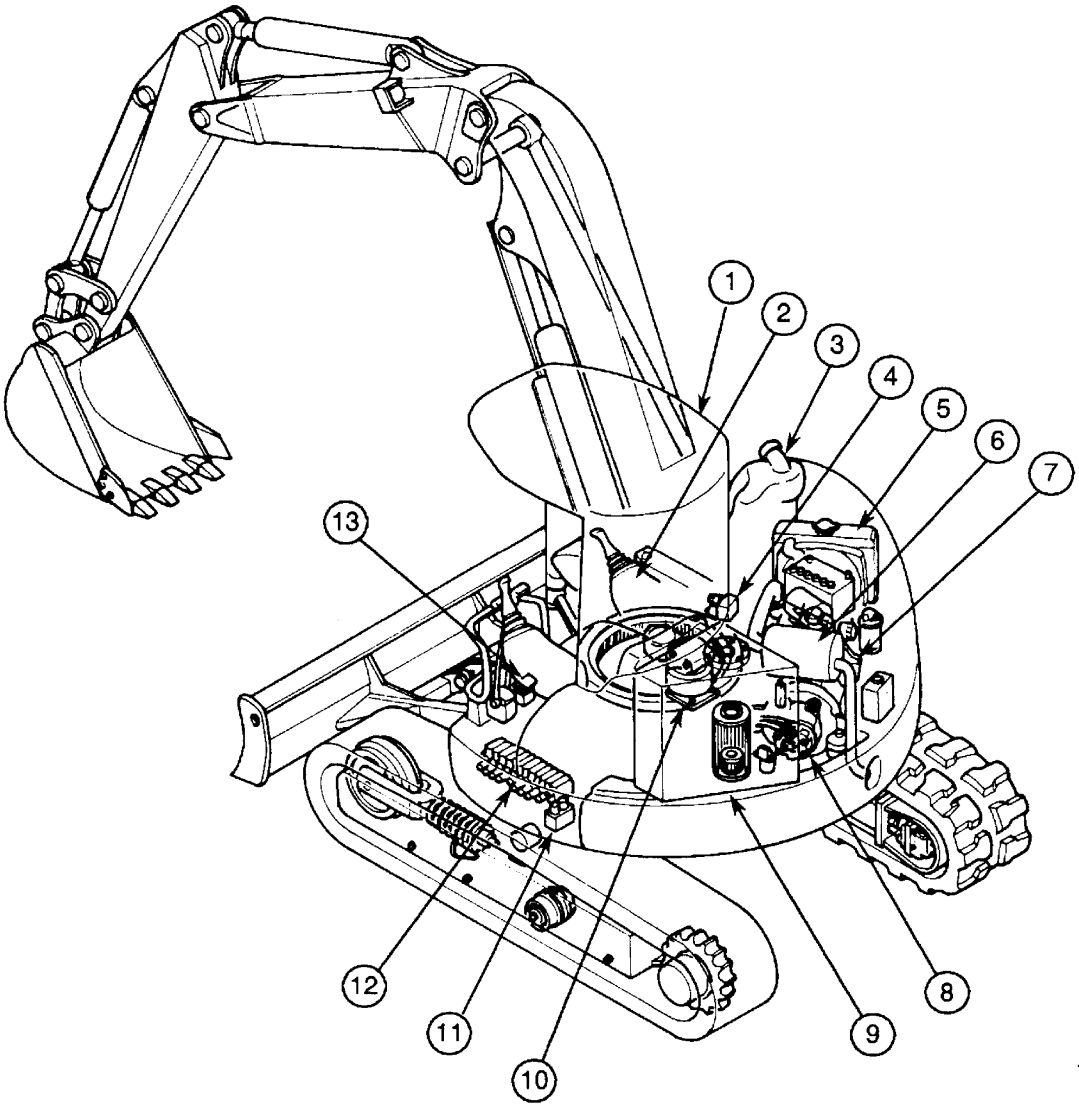
# SECTION 02
# UPPERSTRUCTURE

## CONTENTS

## OUTLINE

The upperstructure consists of the main frame, engine (7), pump device (8), control valve (12), swing device (10), fuel tank (3), hydraulic oil tank (9), canopy (1), and the counterweight.

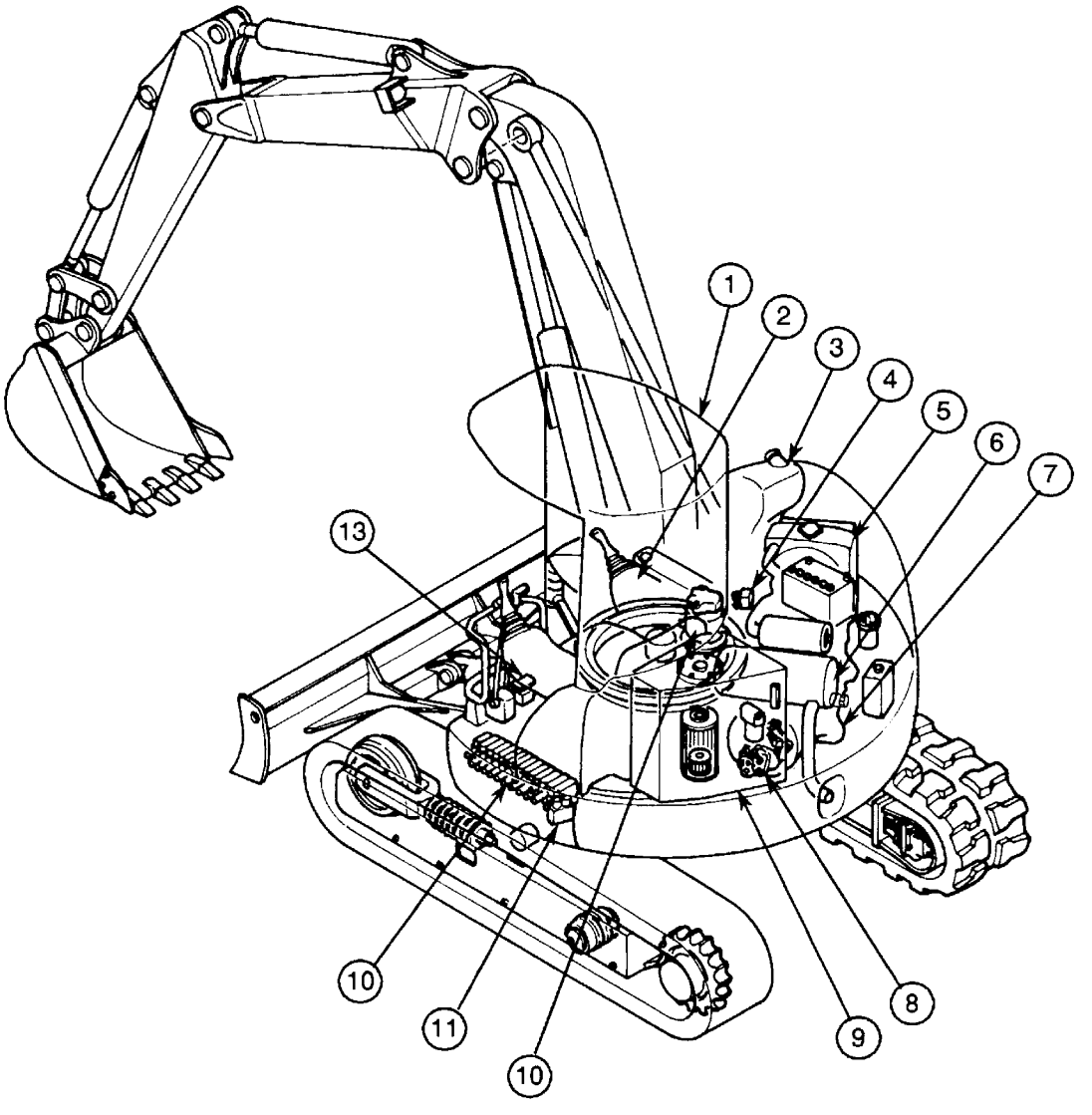
**33Mu**




T532-01-01-001

1— Canopy
2— Pilot Valve (Front Attachment)
3— Fuel Tank
4— Solenoid Valve (Pilot Control Shut-off Lever / Travel Speed Selector)
5— Radiator
6— Muffler
7— Engine
8— Pump Device
9— Hydraulic Oil Tank
10— Swing Device
11— Proportional Solenoid Valve (Auto Boom-Stop System)
12— Control Valve
13— Pilot Valve (Boom-Swing)

58Mu



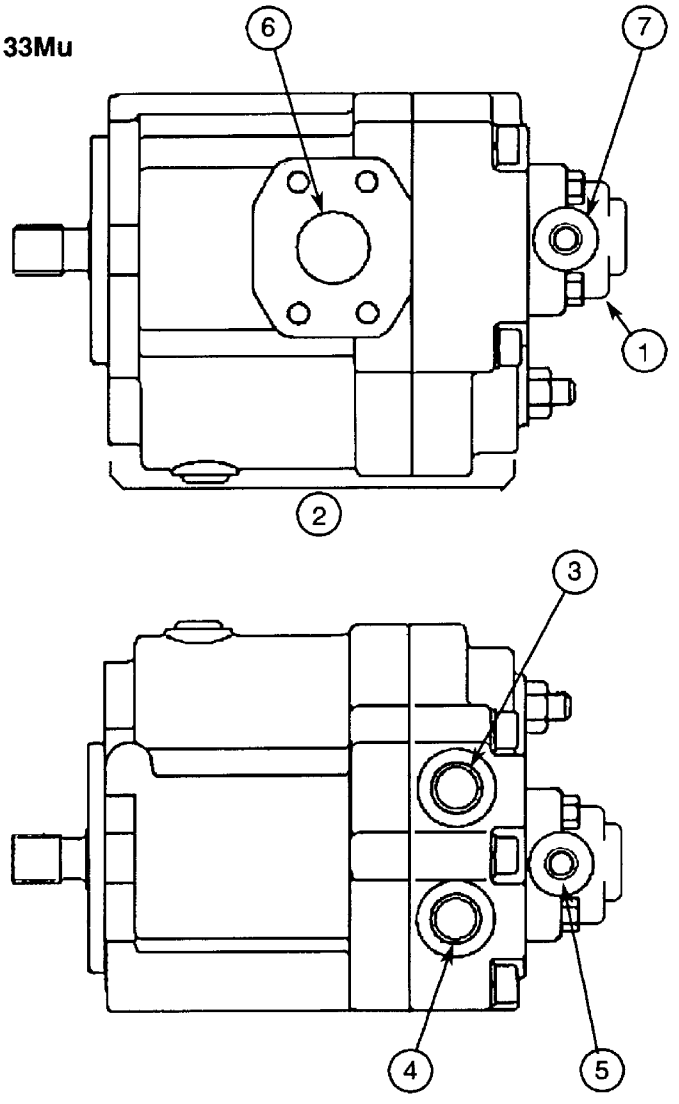

T533-01-01-001

1— Canopy
2— Pilot Valve (Front Attachment)
3— Fuel Tank
4— Solenoid Valve (Pilot Control Shut-off Lever/Travel Speed Selector)
5— Radiator
6— Muffler
7— Engine
8— Pump Device
9— Hydraulic Oil Tank
10— Swing Device
11— Proportional Solenoid Valve (Auto Boom-Stop System)
12— Control Valve
13— Pilot Valve (Boom-Swing)

## OUTLINE

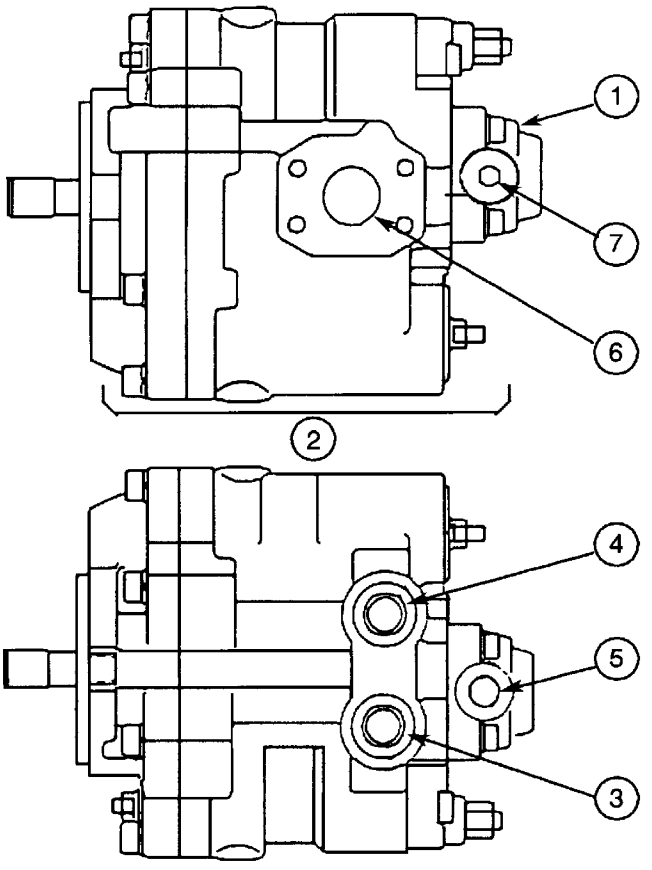
The main pump and the pilot pump are a combined unit directly driven by the engine.
Main pump (2) supplies high hydraulic oil pressure and pilot pump (1) supplies pilot control oil pressure.
Main pump (2) is a variable displacement swash plate type axial plunger pump having suction port (6) and delivery ports 1 and 2 (3 and 4).
Pilot pump (1) is a gear pump.

**33Mu**




T562-02-02-001

**58Mu**




T527-02-02-001

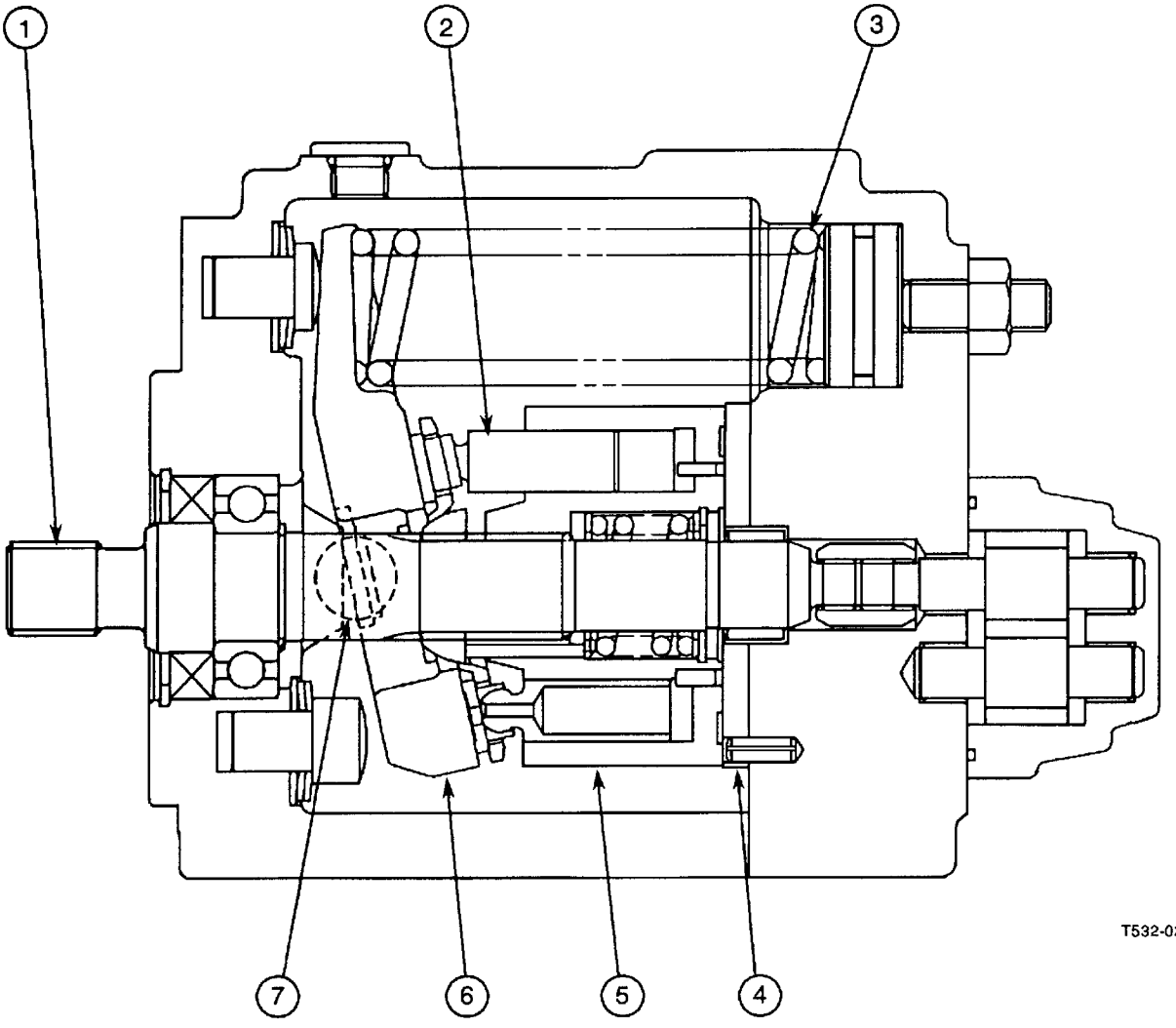
1— Pilot Pump
2— Main Pump
3— Delivery Port 1 (Main Pump)
4— Delivery Port 2 (Main Pump)
5— Delivery Port (Pilot Pump)
6— Suction Port (Main Pump)
7— Suction Port (Pilot Pump)

## MAIN PUMP

**33Mu**

Ten plunger (2) assemblies are installed in cylinder block (5). Shaft (1) is connected to cylinder block (5) via a spline joint so that when shaft (1) is rotated, cylinder block (5) rotates and slides along the surface of valve plate (4).

Delivery flow rate is controlled depending on pump load changes. When pressure at the delivery port of plunger (2) increases, swash plate (6) is pushed by plunger (2) against spring (3) force. When plunger (2) force exceeds spring (3) force, swash plate (6) rotates around ceramic ball (7), reducing the delivery flow rate.



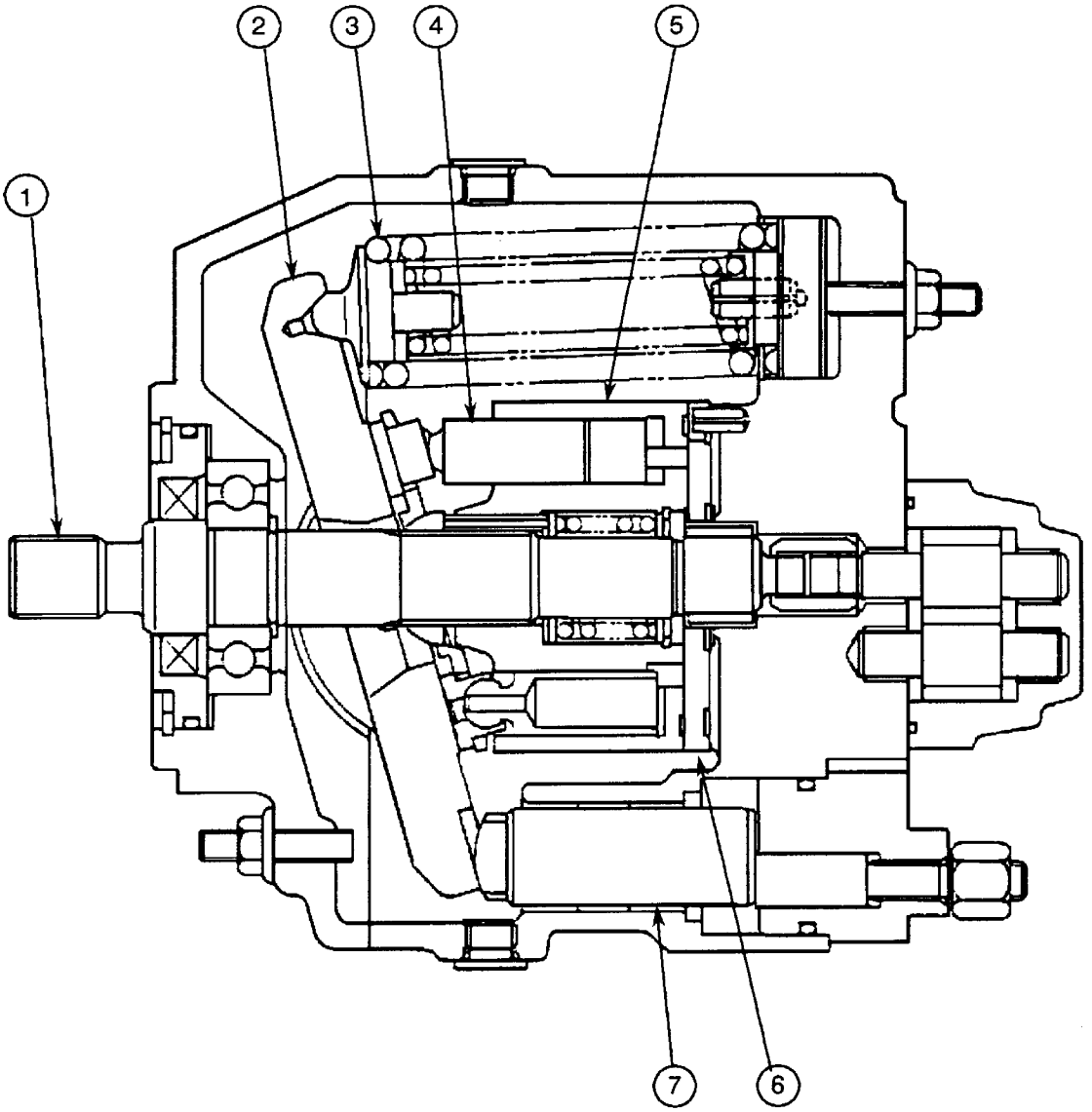

T532-02-02-001

1— Shaft
2— Plunger
3— Spring
4— Valve Plate
5— Cylinder Block
6— Swash Plate
7— Ceramic Ball

58Mu

Ten plunger (4) assemblies are installed in cylinder block (5). Shaft (1) is connected to cylinder block (5) via a spline joint so that when shaft (1) is rotated, cylinder block (5) rotates and slides along the surface of valve plate (6).

Delivery flow rate is controlled depending on pump load changes. Pump delivery pressure is conducted to control piston (7). Control piston (7) is moved in proportion to the delivery pressure, tilting swash plate (2) regulating the flow rate.



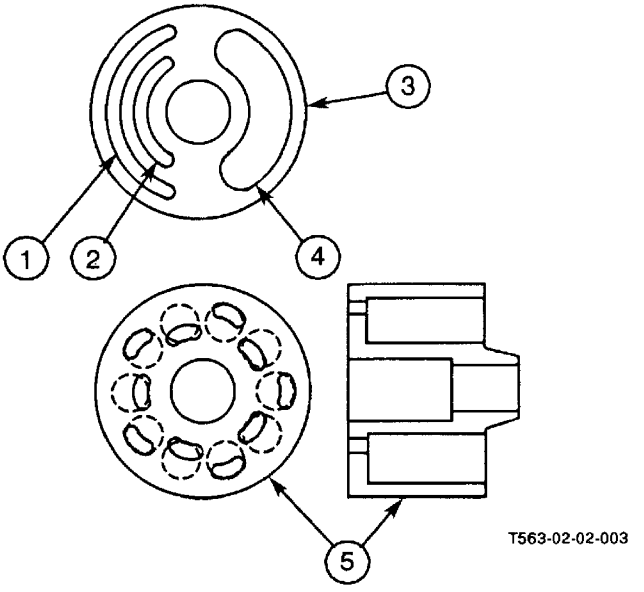

T533-02-02-001

1— Shaft
2— Swash Plate
3— Spring
4— Plunger
5— Cylinder Block
6— Valve Plate
7— Control Piston

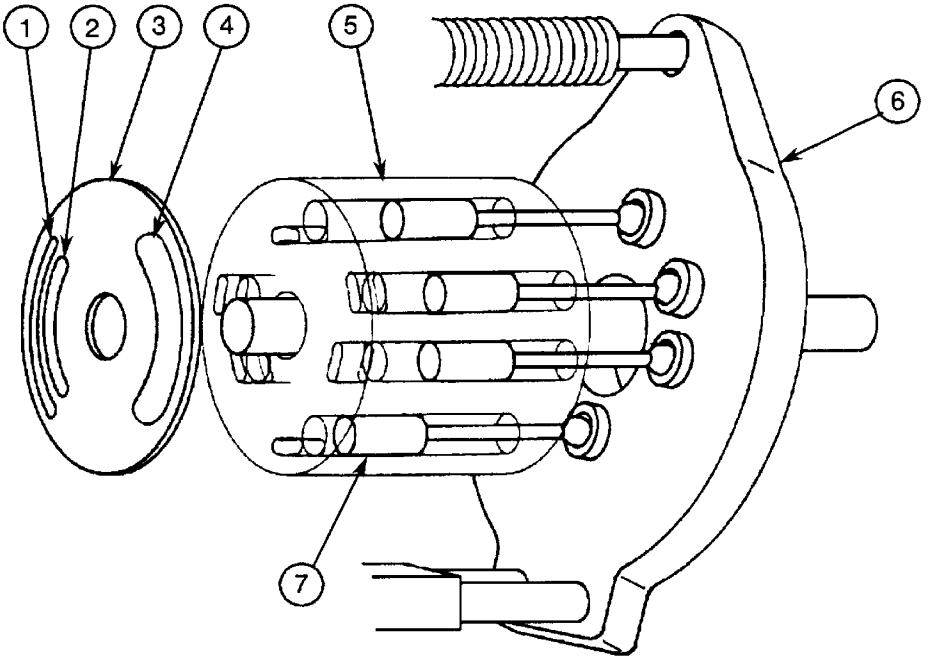
Valve plate (3) has delivery ports P1 (1) and P2 (2) in the outside and inside positions, respectively. Cylinder block (5) has delivery ports with positions to align with delivery ports P1 and P2 in valve plate (3) alternately.

This double-deck delivery port alignment functions as two independent pump systems having identical capacity with five plungers each.

**33Mu, 58Mu**




T563-02-02-003



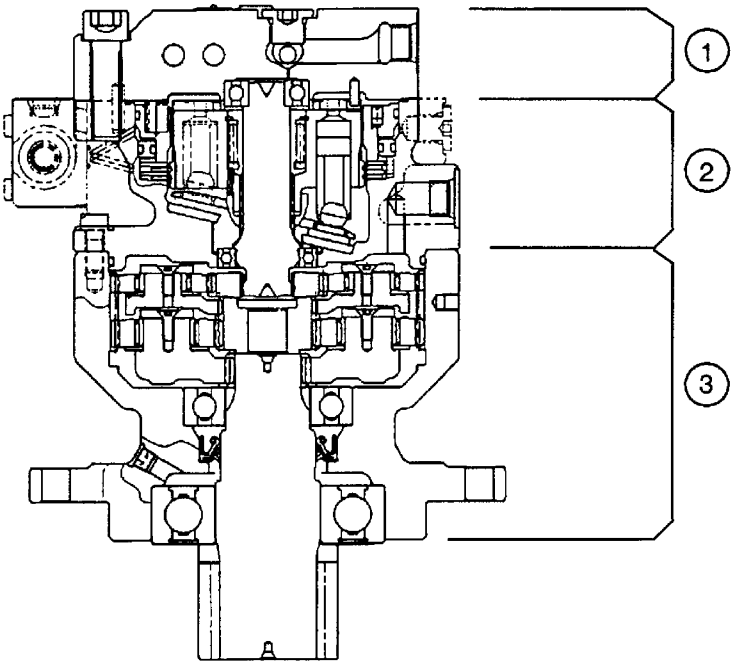

T508-02-03-003

1— Delivery Port P1
2— Delivery Port P2
3— Valve Plate
4— Suction Port
5— Cylinder Block
6— Swash Plate
7— Plunger

## OUTLINE

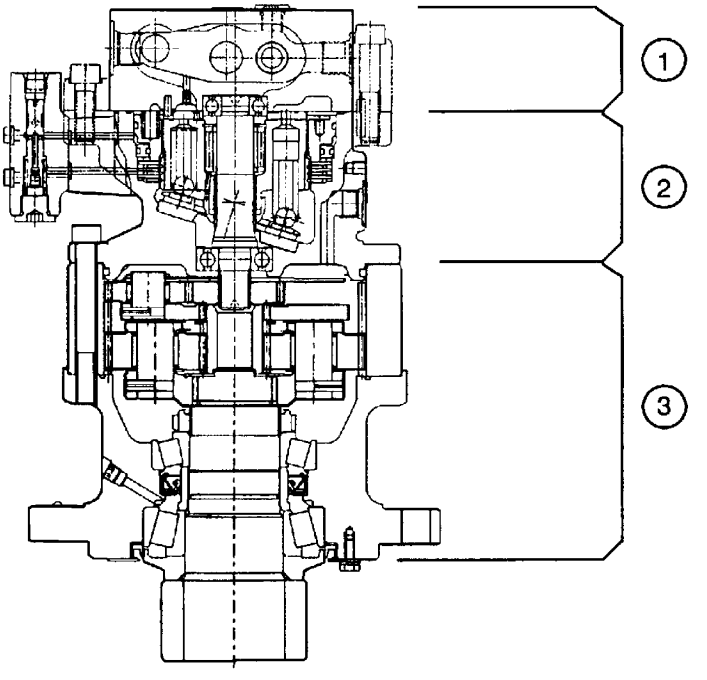
Swing device consists of brake valve (1), swing motor (2), and swing reduction gears (3).

**33Mu**




T525-02-03-001

**58Mu**



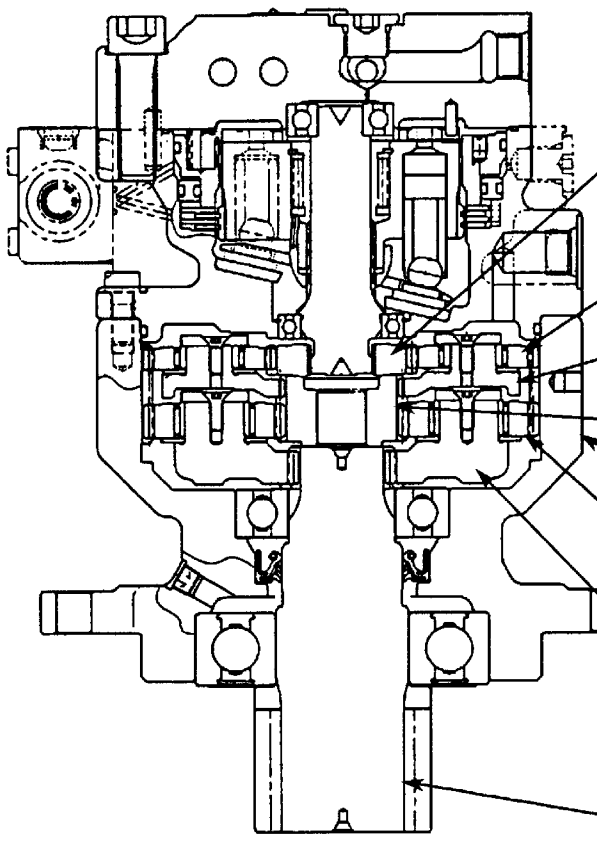

T529-02-03-001

1— Brake Valve 2— Swing Motor 3— Swing Reduction Gear

## SWING REDUCTION GEARS

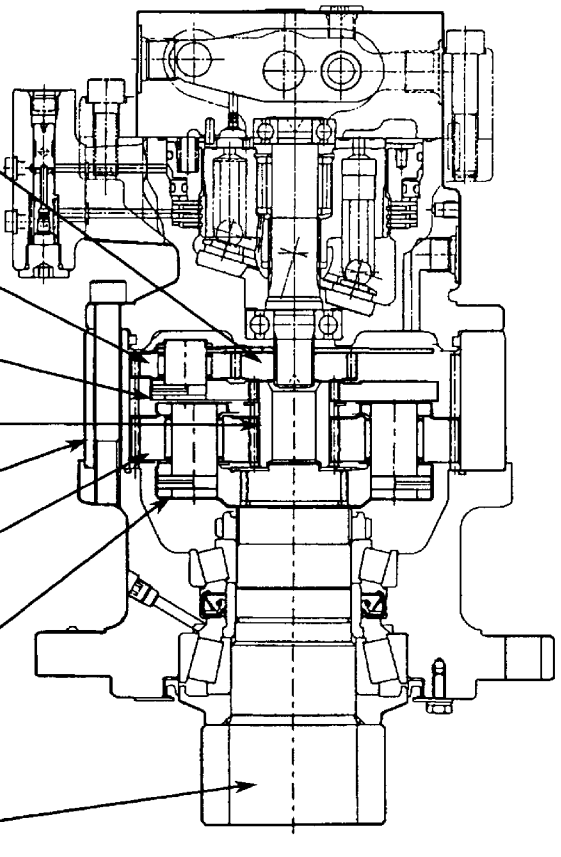
This swing reduction gear is a two-stage planetary gear type. The swing motor rotates first-stage sun gear (1). After the first reduction of speed is made between planetary gear (2) and ring gear (5), this rotation power is transmitted to second-stage sun gear (4) via first-stage carrier (3). Rotation speed of second-stage sun gear (4) is reduced between second-stage planetary gear (6) and ring gear (5) and transmitted to shaft (8) via second-stage carrier (7). Shaft (8) meshes with the swing bearing internal gear secured on the undercarriage to rotate the upperstructure.

**33Mu**



T525-02-03-001

**58Mu**



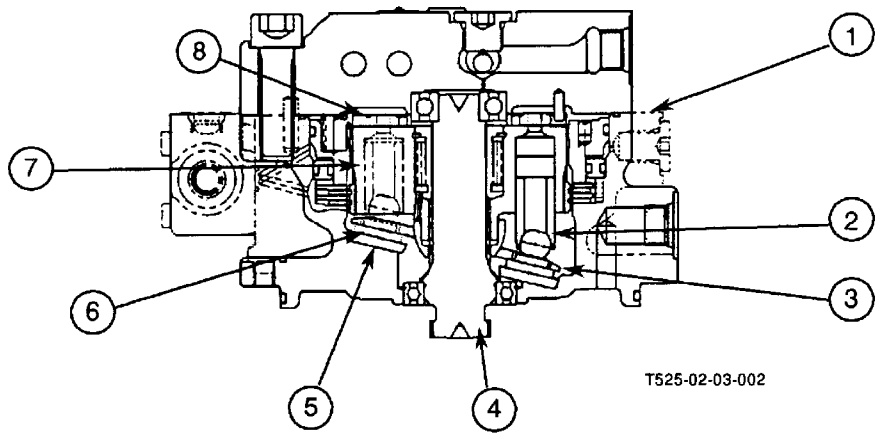

T529-02-03-001

1— First-Stage Sun Gear
2— First-Stage Planetary Gear
3— First-Stage Carrier
4— Second-Stage Sun Gear
5— Ring Gear (Casing)
6— Second-Stage Planetary Gear
7— Second-Stage Carrier
8— Shaft

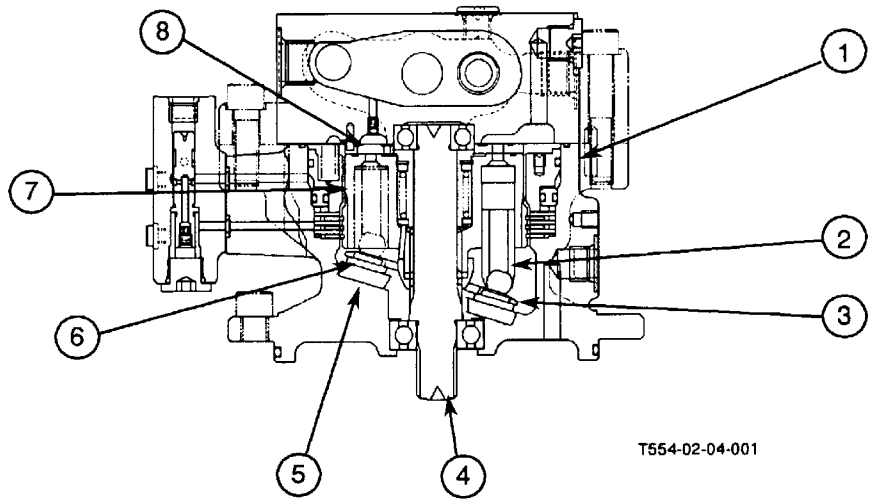
## SWING MOTOR

The swing motor is a swash plate type axial plunger motor. Major constituent parts are housing (1), valve plate (8), rotor (7), plunger (2), and swash plate (5). Each plunger (2) has shoe (6) which is pushed onto swash plate (5) with retainer (3) and slides along the surface of swash plate (5). Rotor (7) is connected to shaft (4) by a spline joint so that rotation of rotor (7) is transmitted to shaft (4).

**33Mu**



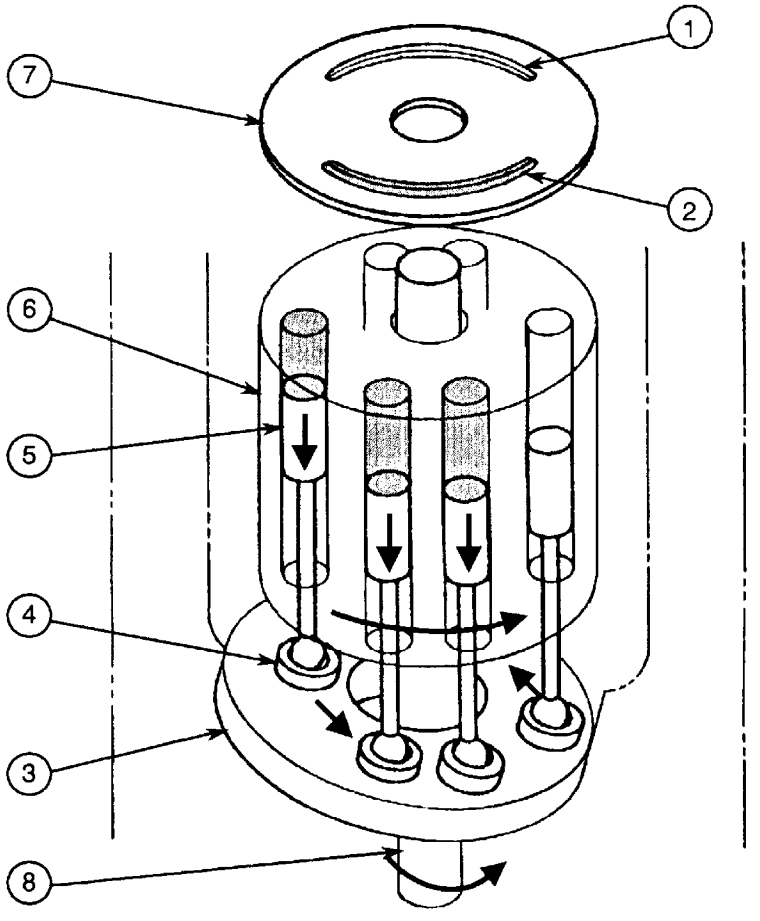

**58Mu**




1— Housing
2— Plunger
3— Retainer
4— Shaft
5— Swash Plate
6— Shoe
7— Rotor
8— Valve Plate

Swing speed changes depending on the oil flow rate delivered from the main pump. When high pressure oil enters from port BM (2), plunger (5) is moved from the bottom dead center to top dead center.

Shoe (4) slides along the surface of swash plate (3), developing torque which is transmitted to the swing reduction gears via shaft (8). Return oil flows from port AM (1) to the hydraulic oil tank. When high pressure oil is supplied from port AM (1), the motor rotates in the reverse direction.

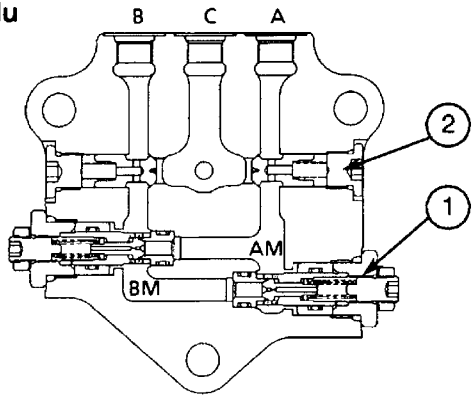



T503-02-04-004

1— Port AM
2— Port BM
3— Swash Plate
4— Shoe
5— Plunger
6— Rotor
7— Valve Plate
8— Shaft

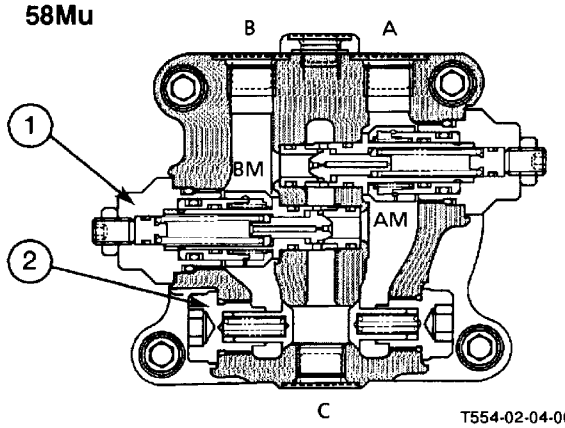
The brake valve is provided on the swing motor, and comprises relief valve (1) and make-up valve (2). Pressure oil from the control valve enters from port A (or port B) and flows out to the swing motor from port AM (or port BM). Return oil from the swing motor flows back to the control valve via port BM (or port AM) and port B (or port A).

**33Mu**




T523-02-03-003

**58Mu**




T554-02-04-002

**RELIEF VALVE**

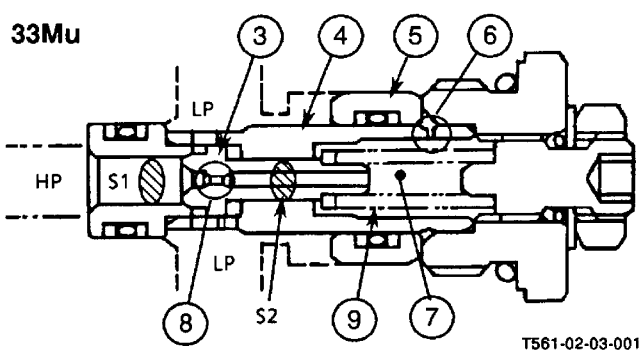
Relief valve (1) has a shockless function (two-stage pressure increase function) to reduce shock load encountered when swing is started or stopped.

**33Mu**

First-Stage: When oil pressure at port HP increases, high pressure oil in port HP is guided to the back side of piston (5) via orifice (8) of poppet (3), spring chamber (7), and orifice (6) to move piston (5) to the left. Until piston (5) moves full stroke, pressure in spring chamber (7) does not increase.
Then, pressure receiving area on poppet (3) is S1. Accordingly, although pressure is low, poppet (3) pushing force overcomes spring (9) force, allowing poppet (3) to move to the right by which pressure oil is released.

Second Stage: As soon as piston (5) reaches the stroke end, oil pressure in spring chamber (7) comes equal to pressure in port HP. Therefore, effective pressure receiving area of poppet (3) is reduced to S1 - S2. Then, pressure in port HP increases higher than that in the first stage to move poppet (3) to the right.

**33Mu**




T561-02-03-001

1— **Relief Valve**
2— **Make-Up Valve**
3— **Poppet**
4— **Housing**
5— **Piston**
6— **Orifice**
7— **Spring Chamber**
8— **Orifice**
9— **Spring**

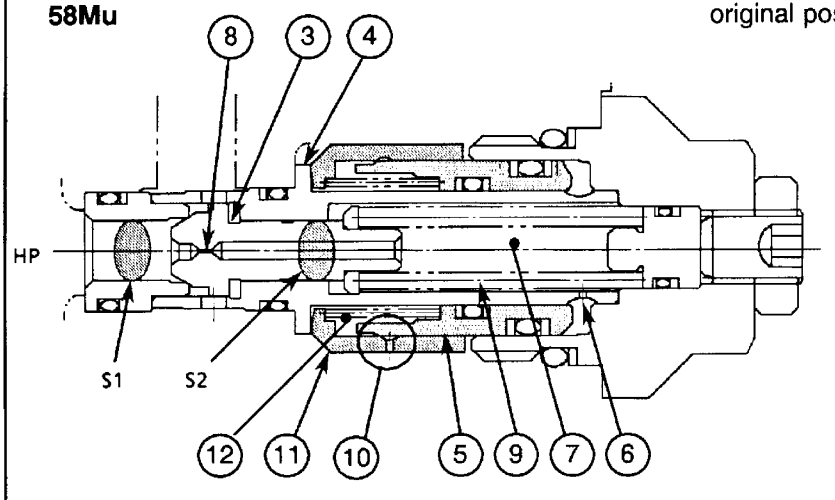
**58Mu**

First Stage: When oil pressure at port HP increases, high pressure oil at port HP is guided to the back side of piston (5) via orifice (8) of poppet (3), spring chamber (7), and orifice (6) to move piston (5) to the left. Damper functions to increase pressure smoothly in the second stage operation.Until piston (5) movement blocks holes (10) through which oil in damper chamber (12) is released, without pressure in spring chamber (7) increasing. Then, the pressure receiving area on poppet (3) is S1. Accordingly, although pressure is low, poppet (3) pushing force overcomes spring (9) force, allowing poppet (3) to move to the right by which pressure oil is released.

Second Stage: As soon as piston (5) blocks hole (10), pressure oil in damper chamber (12) flows out through a quite narrow clearance between outer diameter of piston (5) and inner diameter of piston guide (11), increasing pressure in damper chamber (12). As oil pressure in spring chamber (7) increases in proportion to oil pressure in damper chamber (12). This increased pressure acts on area S2. Therefore, pressure in port HP increases to higher than that in the first stage. When piston (5) reaches the stroke end, pressure in spring chamber (7) becomes equal to that in port HP, allowing oil pressure to release at the relief valve set pressure.

When pressure decreases, main pressure in the counter part circuit is guided to damper chamber (12) via around piston guide (11) to quickly return piston (5) in the stroke end. Then, piston (5) can promptly return to the original position so that response remains the same.

**58Mu**

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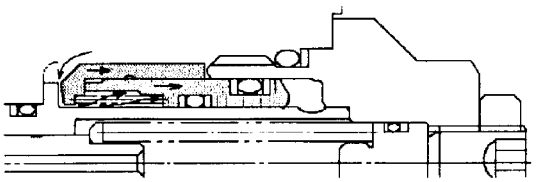


T529-02-03-004

3— Poppet
4— Housing
5— Piston
6— Orifice
7— Spring Chamber
8— Orifice
9— Spring
10— Hole
11— Piston Guide
12— Damper Chamber

**MAKE-UP VALVE**

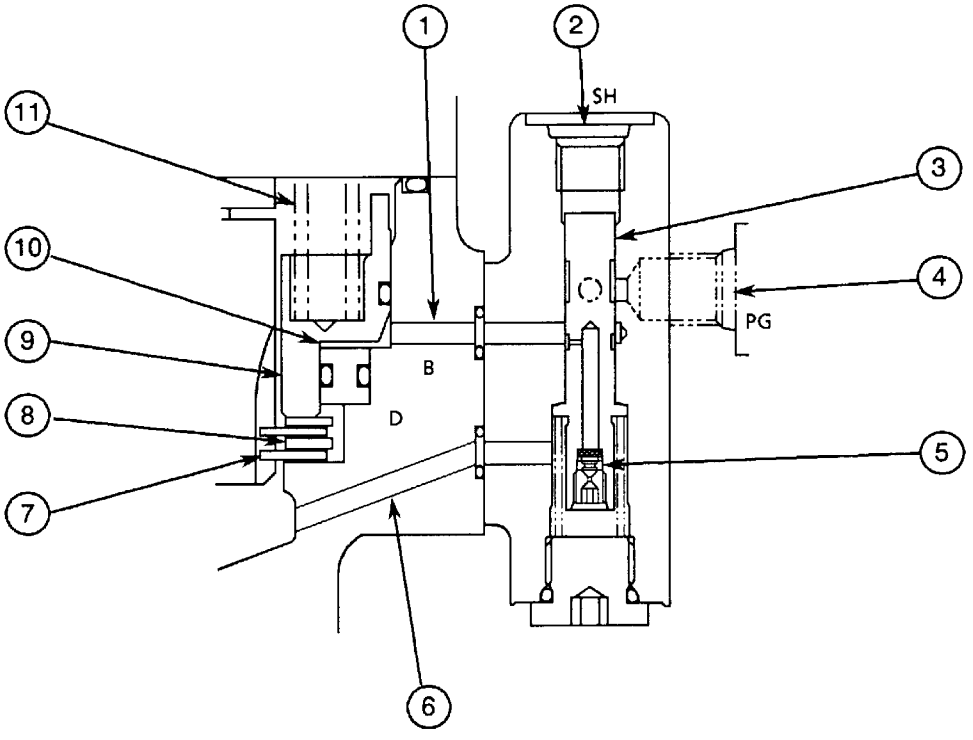
When stopping swing operation, the swing motor is driven by the upperstructure inertia force.

Then, hydraulic oil is discharged more than oil supplied from the pump, causing cavitation to occur in the motor. To prevent cavitation, the make-up valve opens to draw hydraulic oil from the return circuit (port C) in the motor circuit to compensate.

## PARKING BRAKE

The parking brake is a wet type multiple disk brake. Normally, this brake is kept applied by spring (11) force, and is released only when the pilot oil pressure is guided into brake cylinder chamber (10) (negative type brake). When the engine stops, pilot pressure is reduced to zero so that the parking brake is automatically applied. Brake operation ON or OFF is controlled by shuttle valve (3) (brake release valve) which is regulated by the signal oil pressure supplied to port SH (2). The signal oil pressure (brake release signal pressure) to port SH (2) is supplied from the control valve signal core when control levers, except for travel, are operated. Therefore, during digging operation, the parking brake is kept released so that the swing reduction gears is protected from being loaded by digging reaction force from the front attachment. Hydraulic timer (5) to retard the parking brake activation is also provided.

**When the brake is "ON"(all control levers are in neutral):**
When all control levers are in neutral, the brake release signal pressure is not supplied to port SH (2). Therefore, as shuttle valve (3) closes the circuit, the brake release pressure is not routed into port B (1). On the one hand, port B (brake cylinder chamber) is opened to port PG (4) via the passage in shuttle valve (3).Disc plates (8) are meshed with the outer diameter of the rotor. Friction plates (7) are meshed with the inner diameter of the motor case. Both disc and friction plates are pushed downward by spring (11) force, preventing the rotor from rotating by friction force created between disc and friction plates by spring force. Thereby, the motor shaft engaged in the rotor is held stationary.

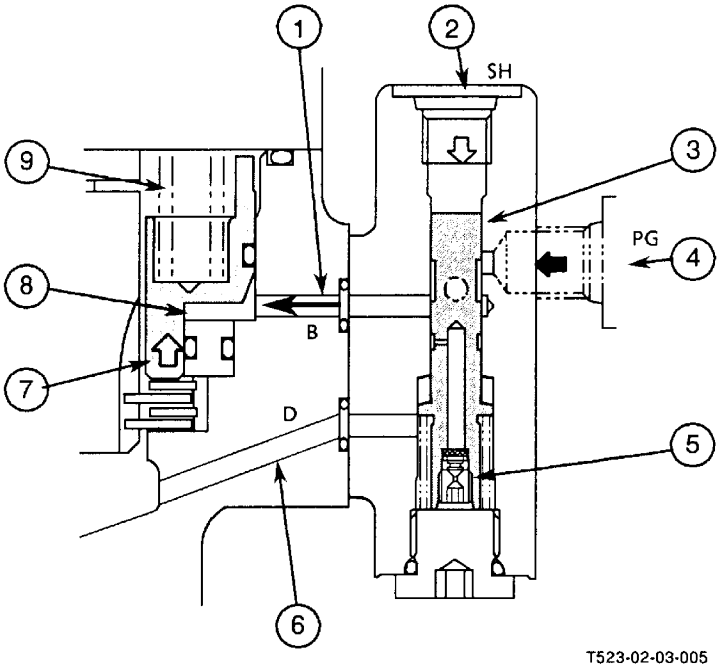



T523-02-03-004

1— Port B
2— Port SH
3— Shuttle Valve
4— Port PG
5— Orifice (Hydraulic Timer)
6— Port D
7— Friction Plate
8— Disc Plate
9— Brake Piston
10— Brake Cylinder Chamber
11— Spring

**When the brake is "OFF"(when the control levers except for travel are operated):**

When control levers, except for travel, are operated, brake release signal pressure is routed to port SH (2), moving shuttle valve (3) downward. Then, brake release pressure in port PG (4) is guided into brake cylinder chamber (8). When the brake release pressure overcomes spring (9) force, brake piston (7) is moved upward, allowing the bake to release.

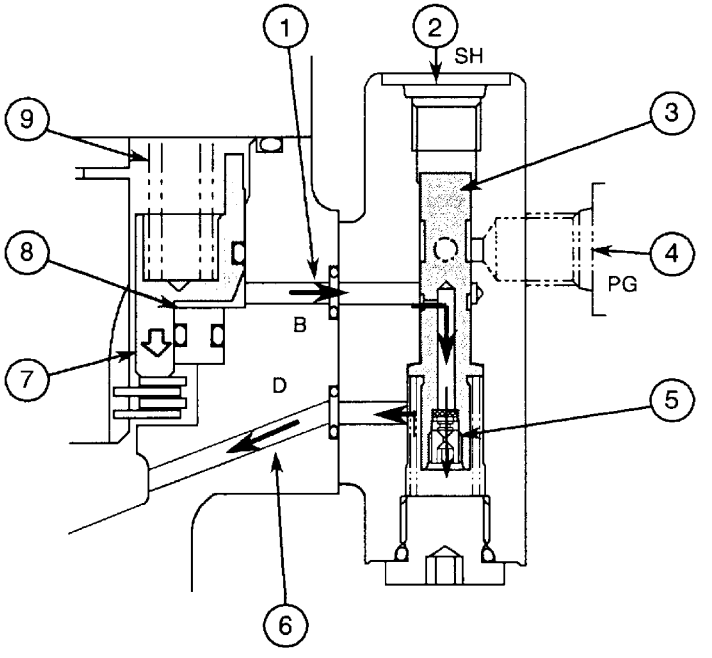



T523-02-03-005

**Hydraulic Timer Operation**

Orifice (5) (hydraulic timer) prevents the brake drag before the upperstructure stops swinging. Even after the swing lever is returned to neutral, the upperstructure is rotated by swing inertia force for a while. During this operation, orifice (5) (hydraulic timer) functions to retard the return oil flow from brake cylinder chamber (8). The hydraulic timer is a multi-steped orifice by which the return oil flow is restricted so that a four-second time lag is provided before the brake is applied.

When control levers are returned to neutral, shuttle valve (3) is moved upward, opening the return oil passage to port D (6). Then, the return oil from brake cylinder chamber (8) flows out through orifice (5), allowing brake piston (7) to move downward by spring (9) force. At this moment, the above hydraulic timer functions to smoothly stop the swing operation.




T523-02-03-006

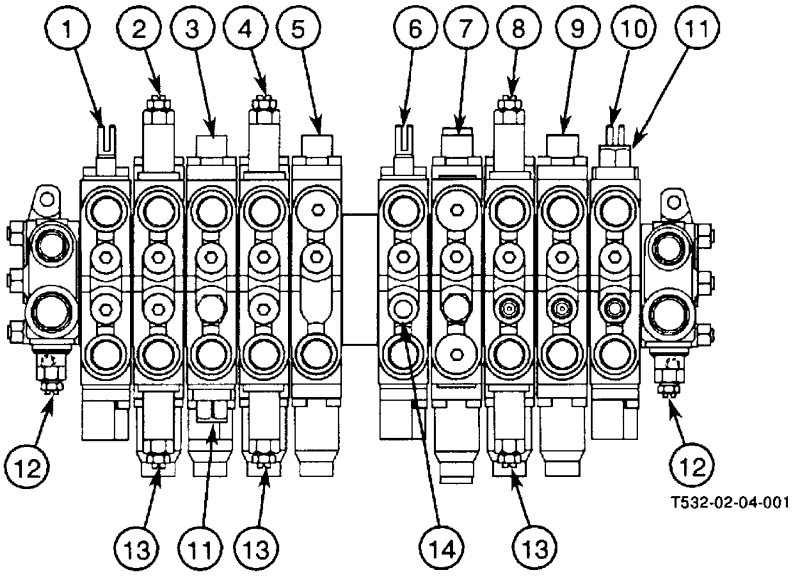
1— Port B
2— Port SH
3— Shuttle Valve
4— Port PG
5— Orifice (Hydraulic Timer)
6— Port D
7— Brake Piston
8— Brake Cylinder Chamber
9— Spring

## OUTLINE

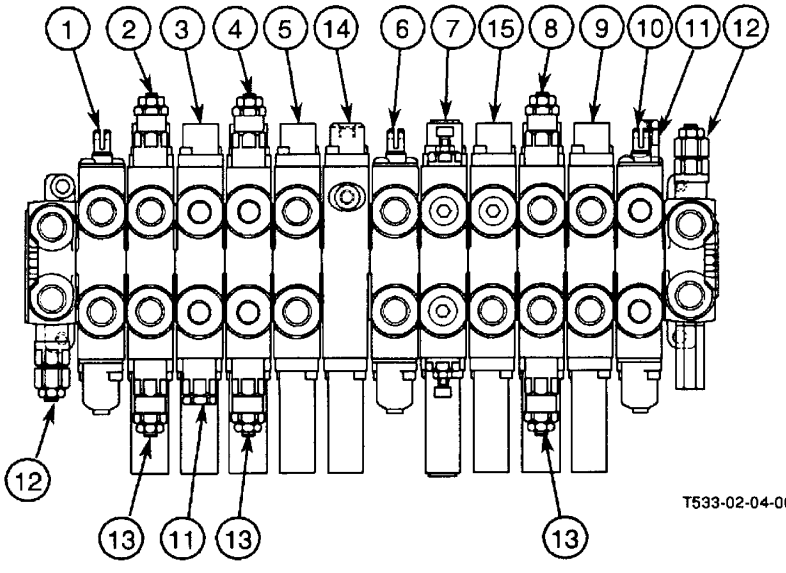
The control valve regulates the main circuit oil pressure, flow rate, and flow direction. Spools for right and left travel, and blade control are manually operated. Spools for boom, arm, bucket, swing, and auxiliary and swing control are operated by hydraulic pilot.

Main relief valves (12) are provided on both ends of the control valve. Overload relief valves (13) are provided in the boom, arm, and bucket control hydraulic circuit. Make-up valves (11) are provided in the swing and blade control hydraulic circuits.

33Mu




58Mu



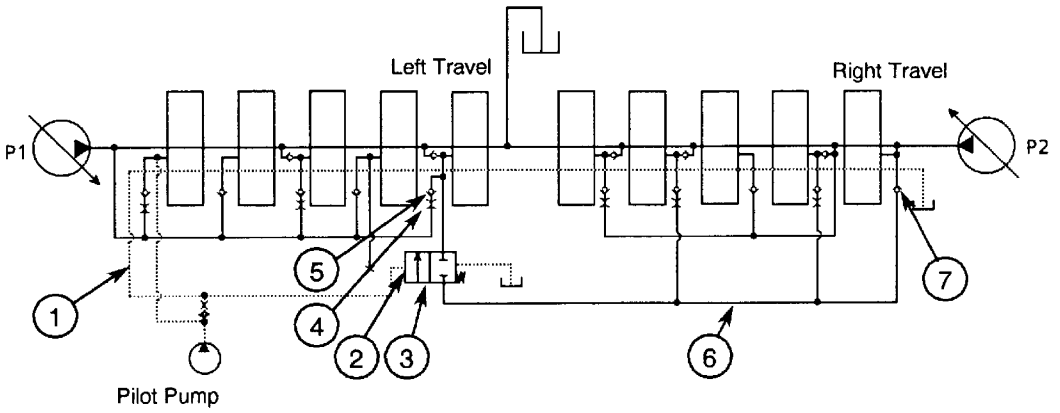

1— Right Travel Section
2— Boom Section (58Mu: Boom 1)
3— Boom-Swing Section
4— Bucket Section
5— Arm Section 2
6— Left Travel Section
7— Auxiliary Section
8— Arm Section 1
9— Swing Section
10— Blade Section
11— Make-Up Valve
12— Main Relief Valve
13— Overload Relief Valve
14— Flow Combiner Valve
15— Boom Section 2 (only for 58Mu )

## FLOW COMBINER VALVE

### 33Mu

Flow combiner valve (3) is provided in the left travel section to ensure that the machine can travel straight when travel combined operation is performed. When other functions are operated while traveling, the operated spool blocks pilot signal passage (1) to the hydraulic oil tank.

Then, pilot pressure in port (2) on the flow combiner valve increases to shift flow combiner valve (3), allowing pressure oil from pump 2 to flow to the right travel port as well as pass through parallel passage (6) and flow combiner valve (3) after opening check valve (7). Pressure oil from pump 1 is supplied to the left travel spool together with pressure oil from pump 2 after passing orifice (4) and check valve (5). Accordingly, all travel combined operation except with swing function can be performed.

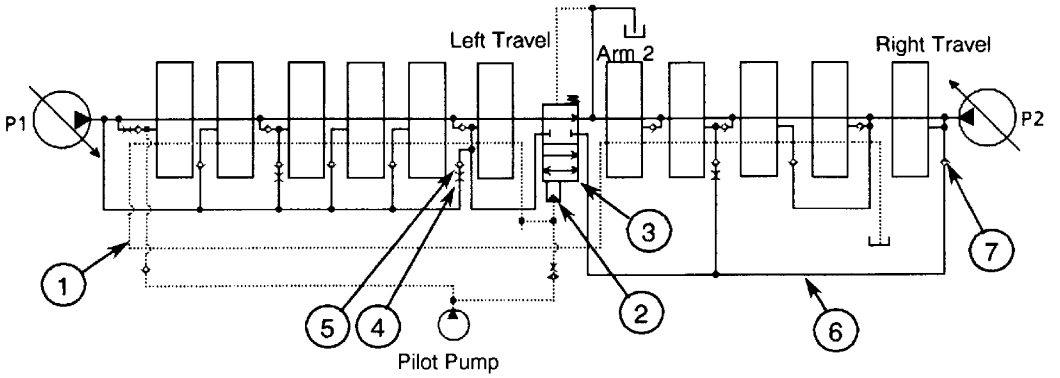



T532-02-04-002

### 58Mu

Flow combiner valve (3) is provided between the arm section 2 and left travel section to ensure that the machine can travel straight when travel combined operations are performed. When other functions are operated while traveling, the operated spool blocks pilot signal passage (1) to the hydraulic oil tank.

Then, pilot pressure in port (2) on the flow combiner valve increases to shift flow combiner valve (3), allowing pressure oil from pump 2 to flow to the right travel port as well as pass through parallel passage (6) and flow combiner valve (3) after opening check valve (7). Pressure oil from pump 1 is supplied to the left travel spool together with pressure oil from pump 2 after passing orifice (4) and check valve (5). Accordingly, all travel combined operation, except with swing function, can be performed.




T533-02-04-002

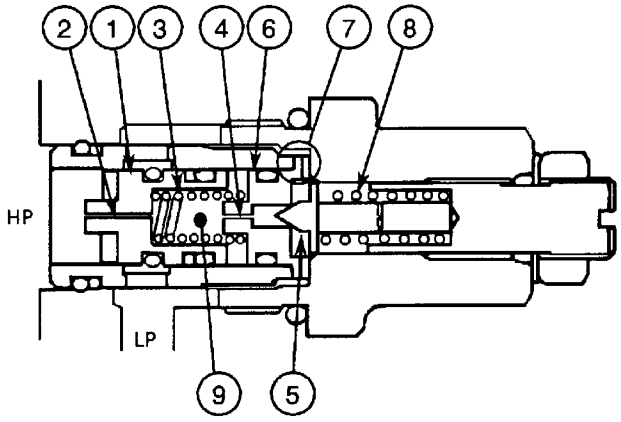
1— Pilot Signal Passage
2— Flow Combiner Valve Shift Port
3— Flow Combiner
4— Orifice
5— Check Valve
6— Parallel Passage
7— Check Valve

## MAIN RELIEF VALVE

The main relief valve is provided in the control valve main circuit to prevent the main circuit pressure from rising over the set pressure.
The main circuit pressure acts on pilot poppet (5) through orifice (2) of main poppet (1) and orifice (4) of seat (6). When the main circuit pressure increases and overcomes spring (8) force, pilot poppet (5) opens.

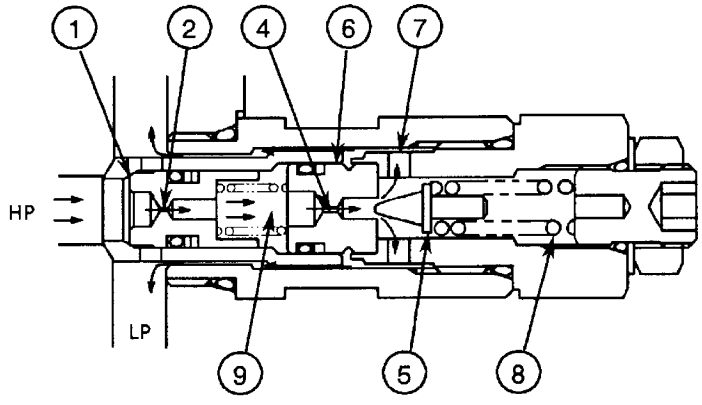
Then, the small amount of the main circuit pressure oil passes through passage (7) on seat (6) and is released to tank port LP. Thereby, pressure difference between high pressure port HP and spring chamber (9) is increased by orifice (2), causing main poppet (1) to open. Accordingly, a large amount of pressure oil is released to tank port LP.

**33Mu**




T563-02-04-002

**58Mu**




T554-02-06-010

1— Main Poppet
2— Orifice
3— Spring
4— Orifice
5— Pilot Poppet
6— Seat
7— Passage
8— Spring
9— Spring Chamber

## OVERLOAD RELIEF VALVE

The overload relief valve is provided between the control valve and cylinder port and has both relief and make-up functions. The relief function prevents the pressure oil in the actuator circuit from rising over the set pressure and the make-up function prevents the occurrence of cavitation.

### Relief Function

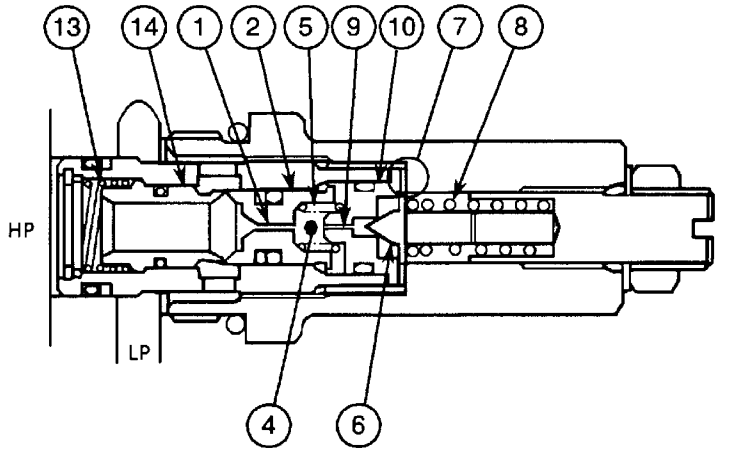
33Mu
The actuator circuit pressure acts on pilot poppet (6) through orifice (1) of main poppet (2) and orifice (9) of seat (10). When the actuator circuit pressure increases and overcomes spring (8) force, pilot poppet (6) opens. Then, a small amount of the actuator circuit pressure oil is released to tank port LP. Thereby, pressure difference between high pressure port HP and spring chamber (4) is increased, causing main poppet (2) to open. Accordingly, a large amount of pressure oil is released to the tank port LP.

58Mu
The actuator circuit pressure acts on pilot poppet (6) through orifice (1) of piston (3). When the actuator circuit pressure increases and overcomes spring (8) force, pilot poppet (6) opens. Then, the small amount of the actuator circuit pressure oil is released to tank port LP. Thereby, pressure difference between high pressure port HP and spring chamber (4) is increased, causing piston (3) to come in contact with pilot poppet (6). Accordingly, spring (5) force which is holding main poppet (2) in the closed position is eliminated so that main poppet is opened by the pressure difference between port HP and spring chamber (4), allowing a large amount of pressure oil to release to the tank port LP.

### Make-Up Function

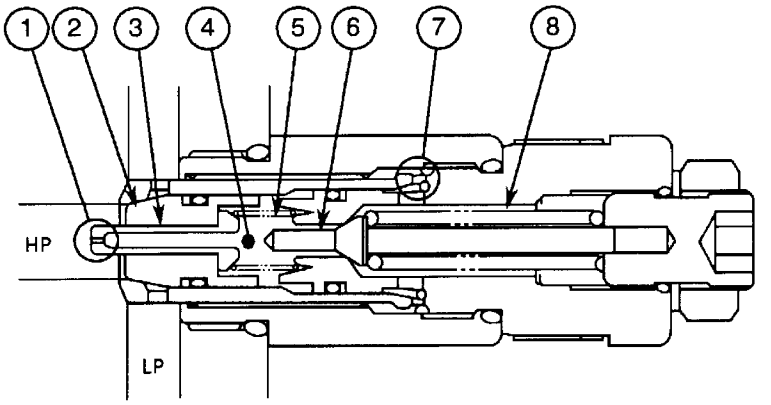
When oil pressure in port Hp decreases lower than that in port LP, main poppet (2) [valve (14) on the 33Mu] is opened so that pressure oil is supplied to port HP, preventing the occurrence of cavitation.

**33Mu**




T563-02-04-003

**58Mu**




T561-02-04-002

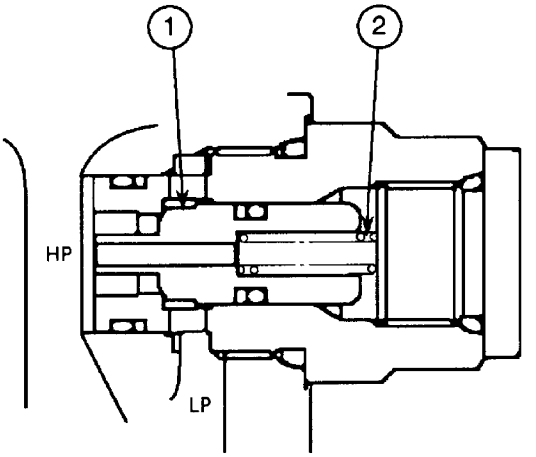
1— Orifice
2— Main Poppet
3— Piston
4— Spring Chamber
5— Spring
6— Pilot Poppet
7— Passage
8— Spring
9— Orifice
10— Seat
13— Spring
14— Valve

## MAKE-UP VALVE

The make-up valve is provided between cylinder port HP and tank port LP and functions to prevent the occurrence of cavitation.

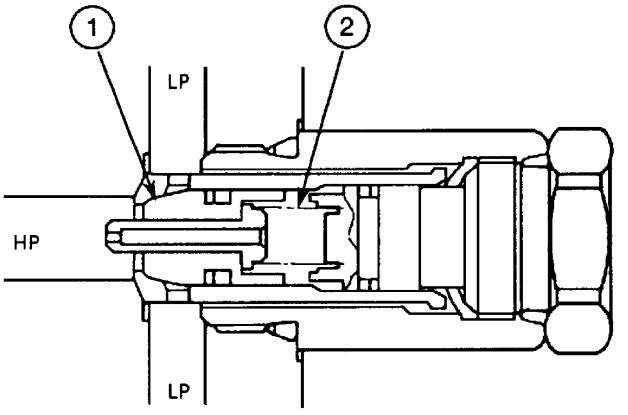
**Make-Up Function**
When oil pressure in port Hp decreases lower than that in port LP, poppet (1) is opened so that pressure oil is supplied to port HP, preventing the occurrence of cavitation.

**33Mu**




T563-02-04-004

**58Mu**




T561-02-04-003

1— Poppet 2— Spring

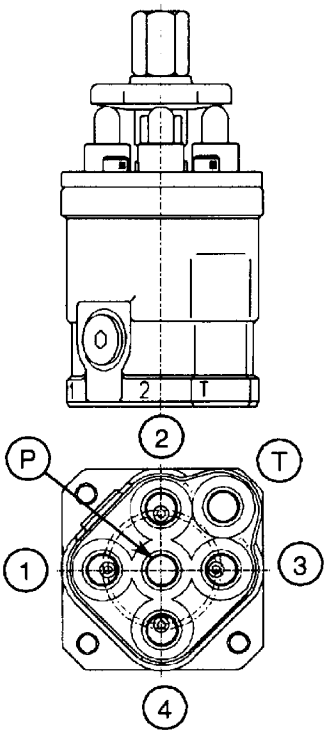
## OUTLINE

The pilot valve regulates pilot pressure to operate the control valve spool. Four port pilot valve is used for the front attachment and swing function control. Two port pilot valve is used for the boom-swing function control.

### Front Attachment and Swing Function Control Pilot Valve

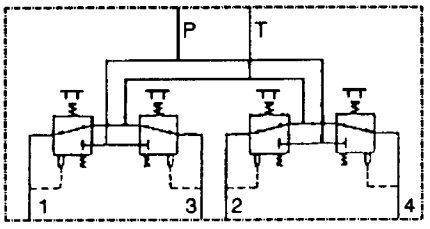
Port Connection List

| | Port No. | Hitachi Design Arrangement | JIS Arrangement |
|---|---|---|---|
| Right Valve | 1 | Bucket Roll-In | ← |
| | 2 | Boom Raise | ← |
| | 3 | Bucket Roll-Out | ← |
| | 4 | Boom Lower | ← |
| Left Valve | 1 | Right Swing | Arm Roll-Out |
| | 2 | Arm Roll-Out | Left Swing |
| | 3 | Left Swing | Arm Roll-In |
| | 4 | Arm Roll-In | Right Swing |




T532-02-05-001

Hydraulic Symbol

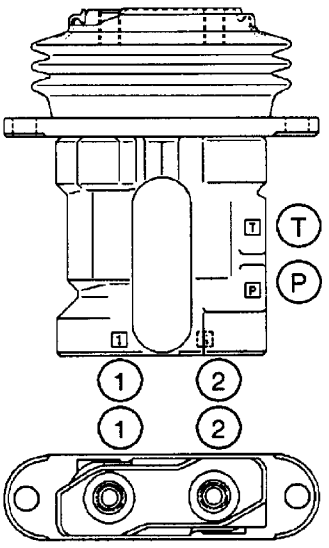


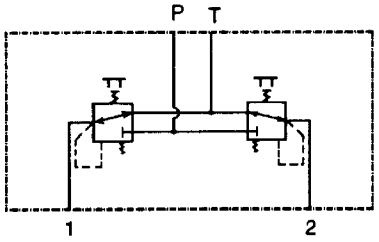

T105-02-07-020

### Boom-Swing Pilot Valve

Port Connection List

| | Port No. | |
|---|---|---|
| | 1 | Right Boom-Swing |
| | 2 | Left Boom-Swing |




T532-02-05-012

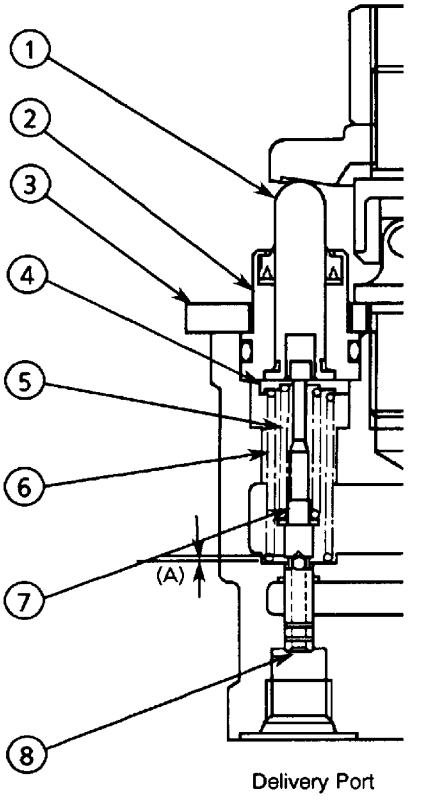
T532-02-05-011

## CONSTRUCTION

Spool (7) is held upward by return spring (6) via spring guide (4). Bushing (2) is immovable in position so that pusher (1) flange or spring guide (4) top surface function as a stopper, not allowing return spring (6) to move upward further.

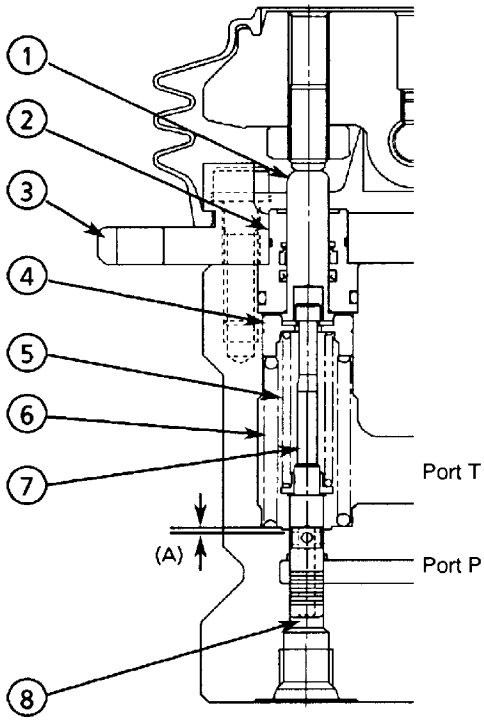
With the spool placed in this position, the delivery port is connected to oil tank port T via a notch provided on spool (7) equalizing oil pressure above and below spool (7). Then, spool (7) receives no unbalanced pressure force. This is the neutral position. Under this condition, distance (A) of spool (7) notch section is kept constant connecting the delivery port to oil tank port T.

Front Attachment and Swing Function Control Pilot Valve




T532-02-05-004

Boom Swing Control Pilot Valve




T532-02-05-010

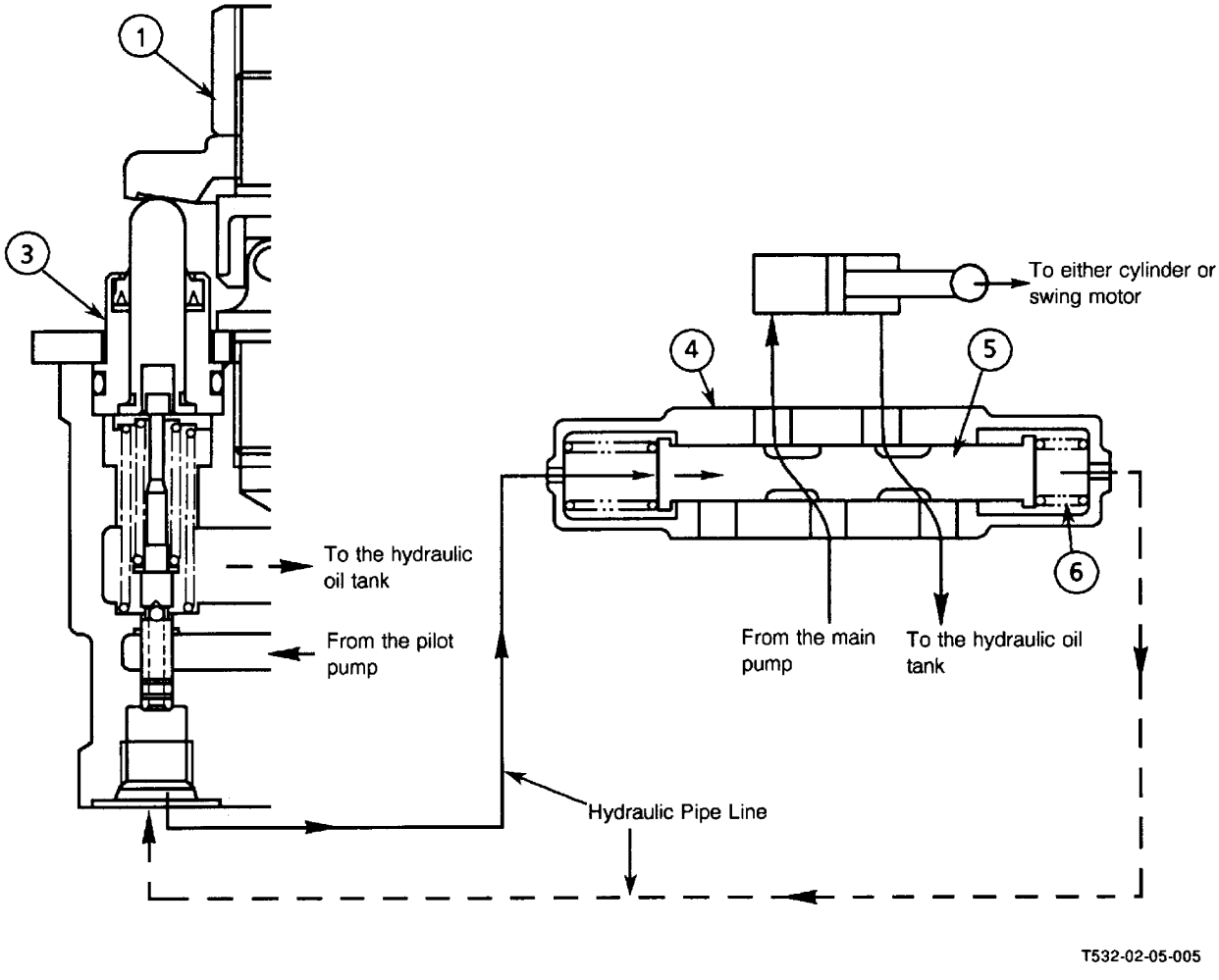
1— Pusher
2— Bushing
3— Plate
4— Spring Guide
5— Balance Spring
6— Return Spring
7— Spool
8— Pressure Bearing Area

## FUNCTION

When control lever (1) is operated, pilot valve (3) produces pilot pressure in proportion to the control lever stroke. Then pilot valve (3) delivers pilot pressure to control valve (4) via the pipe line to move spool (5) up to the position where pilot pressure comes to balance with spring (6) force.

Return oil from control valve (4) flows back to the hydraulic oil tank via another port on pilot valve (3).

**Front Attachment and Swing Function Control Pilot Valve**




T532-02-05-005

1— Control Lever
3— Pilot Valve
4— Control Valve
5— Spool
6— Spring

## OPERATION

### NEUTRAL (Pusher Stroke: A to B)

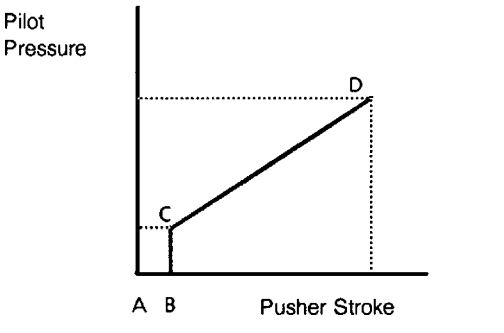
When neutral, spool (6) totally blocks pressure oil port P (from the pilot pump) and port T is opened to the hydraulic oil tank. Then, oil pressure at the delivery port to the control valve is equal to that at port T. In the next stage, when cam (1) is tilted to push pusher (2), pusher (2) compresses return spring (5) and balance spring (4) via spring guide (3). At this moment, as oil pressure above and below spool (6) is equal to hydraulic oil tank pressure, spool (6) moves downward while keeping the under face of the spool head in contact with spring guide (3) until clearance A becomes zero.

### During metering or decompressing (Pusher Stroke : C to D)

When the control lever is tilted further to depress pusher (2) more, the lower edge of the notch on spool (6) is opened so that oil pressure at port P is led to the delivery port. When the delivery port oil pressure increases, spool (6) moves upward to maintain constant delivery port pressure. During this operation, the notch section is almost closed. Therefore, even if pusher (2) is depressed further, only return spring (5) and balance spring (4) are compressed, holding spool (6) in a stationary state. As the deflection of balance spring (4) increases, spring force increases. Consequently, delivery port pressure increases in proportion to spring force.

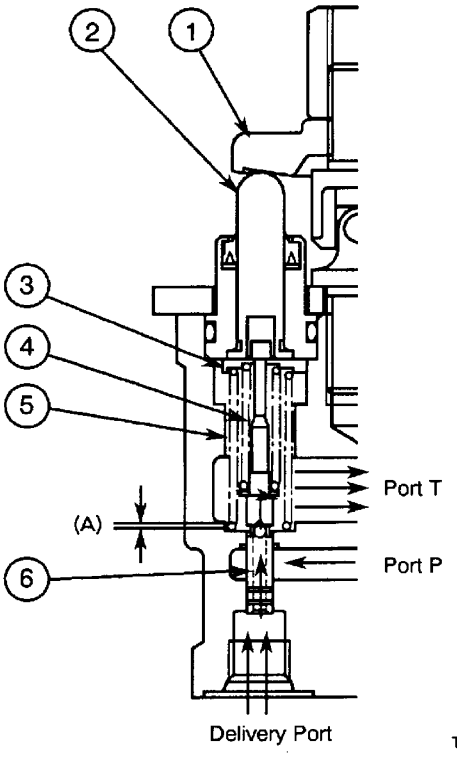
### Full Stroke (Pusher Stroke: Full Stroke)

When pusher (2) is moved downward further, spool (6) comes into contact with pusher (2). Then, both spool (6) and pusher (2) are moved together downward, allowing the lower edge of the notch on the spool to open. At this moment, the delivery pressure equals to the port P pressure. Pusher (2) is moved downward until spring guide (3) comes into contact with the stepped section on the casing (lever stroke end position). Overall lever stroke is determined by stroke C of pusher (2).




T523-02-05-001

Pusher Stroke: A to B

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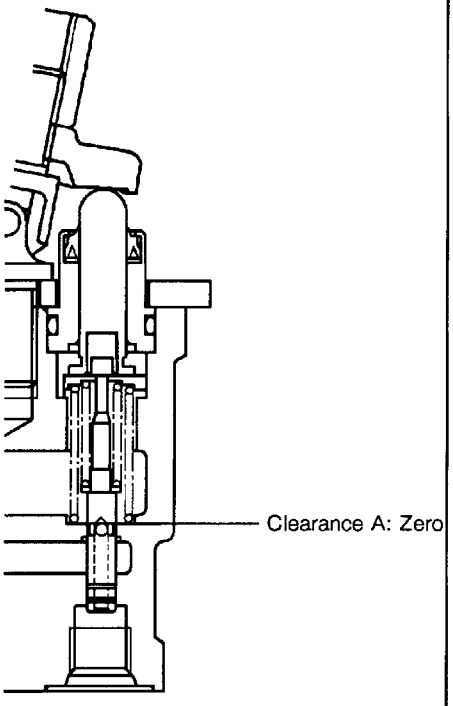
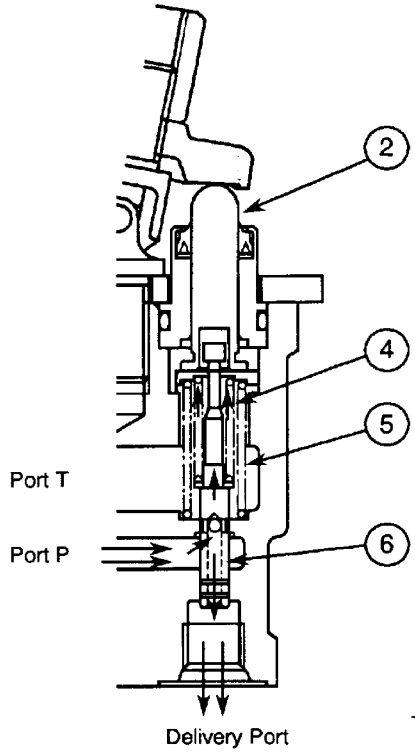


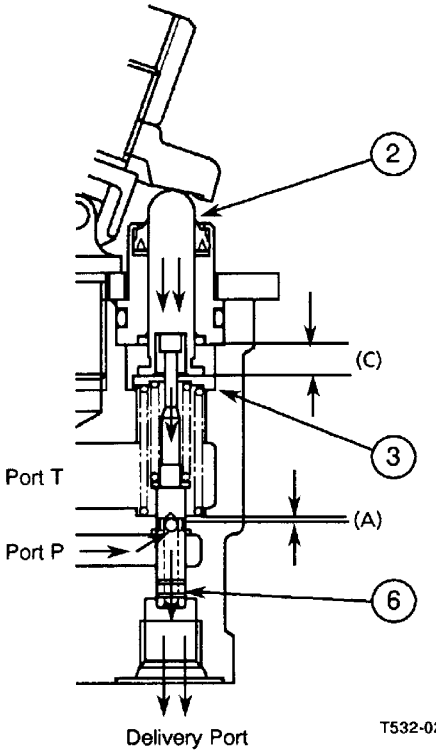

T532-02-05-006

Pusher Stroke: C to D




T532-02-05-007

Pusher Stroke: Full Stroke

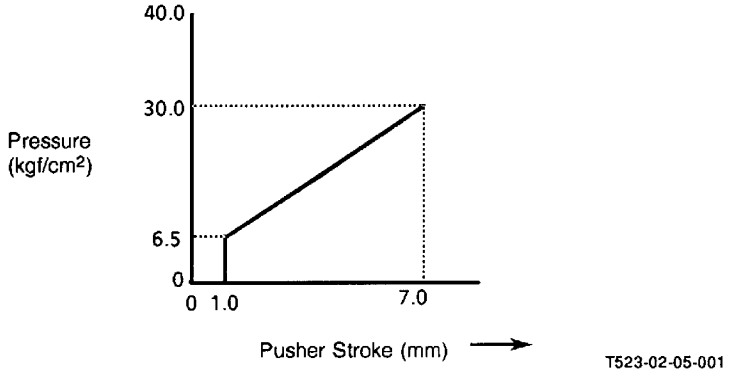



T532-02-05-008

1— Cam
2— Pusher
3— Spring Guide
4— Balance Spring
5— Return Spring
6— Spool

**Operational Pressure Characteristics**

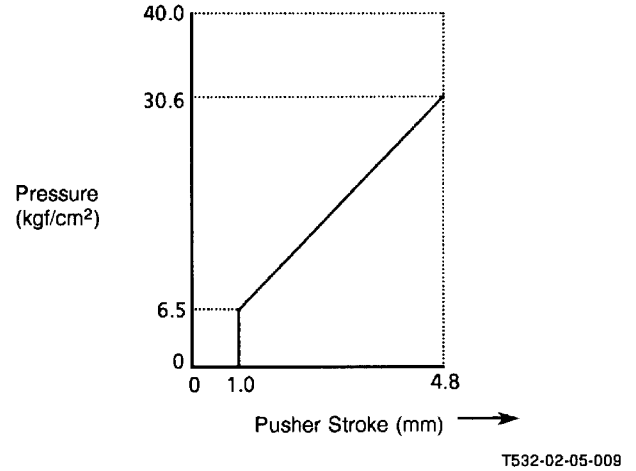
Ports 1, 2, 3, and 4 (Bucket, Boom, Arm, and Swing Ports) on Pilot Valve




T523-02-05-001

*NOTE: 1 kgf/cm² = 0.09807 MPa*

**Ports 1, and 2 (Swing Ports) on Pilot Valve**




T532-02-05-009

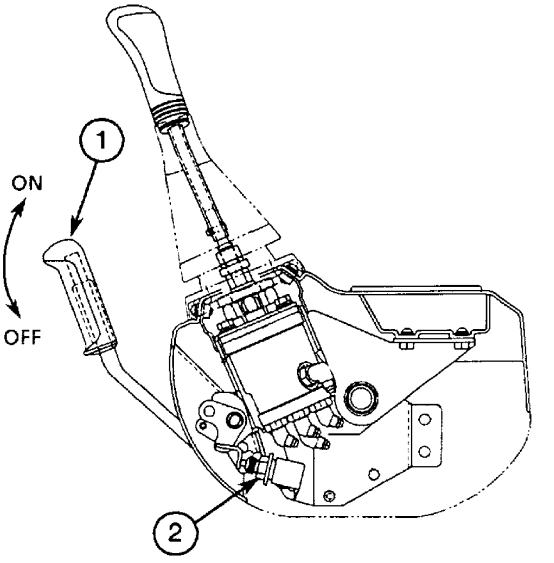
*NOTE: 1 kgf/cm² = 0.09807 MPa*

## SOLENOID VALVE

**(ON-OFF Type: Pilot Control Shut-Off Valve and Travel Motor Swash Angle Control)**

This solenoid valve is applied to either close (OFF) or open (ON) pilot pressure oil to the pilot valve (front attachment, swing, and boom swing) and to shift travel speeds.

- When the pilot control shut-off lever is in the ON position (slow travel speed):
  Placing pilot control shut-off lever provided at the operator*s seat to the ON position, or travel speed change pedal to the OFF position cuts off electric current to solenoid (4). Then, spool (8) is moved upward by spring (9) force, blocking pump port (5) and opening return port S (6) to tank port T (7). Accordingly, even if the pilot valve is operated, the machine cannot be operated.
  In this case, the travel motor swash plate angle control spool is returned by spring force so that the return oil is routed to the tank port, slanting the swash plate angle to the maximum position (slow speed).

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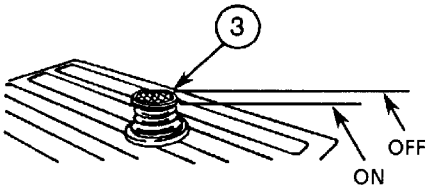
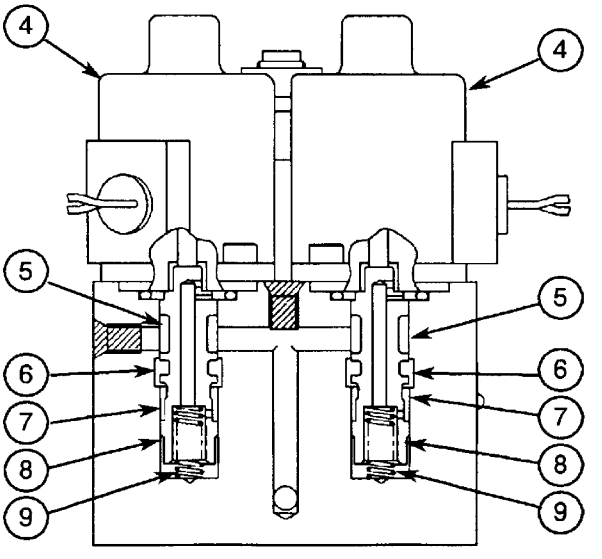



T532-02-06-005

Solenoid Valve for Pilot Control Shut-Off Lever and Travel Speed Motor Swash Angle Control

- When the pilot control shut-off lever is in the OFF position (fast travel speed):
  Placing pilot control shut-off lever provided at the operator*s seat to the OFF position, or travel speed change pedal to the ON position supplies electric current to solenoid (4). Then, spool (8) is moved downward by electromagnetic force, opening pump port (5) to return port S (6) and blocking tank port T (7). Accordingly, pressure oil from port S (6) is routed to the pilot valve so that the machine can be operated by the pilot valve.
  In this case, the travel motor swash plate angle control spool is shifted against spring force, slanting the swash plate angle to the minimum position (fast speed).

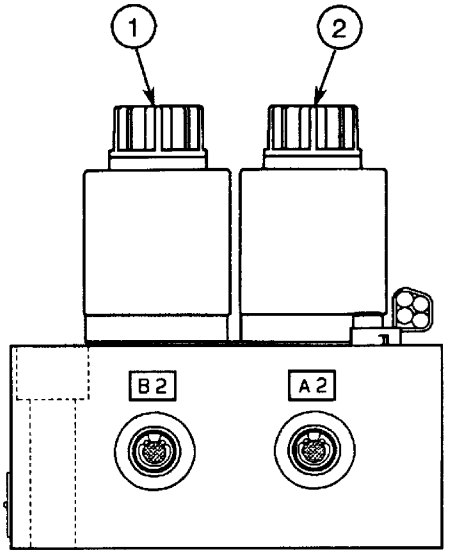



T532-02-06-004

1— Pilot Control Shut-Off Lever
2— Gate Lock Switch
3— Travel Speed Control Pedal
4— Solenoid
5— P (Pump Port)
6— S (Return Port)
7— T (Tank Port)
8— Spool
9— Spring

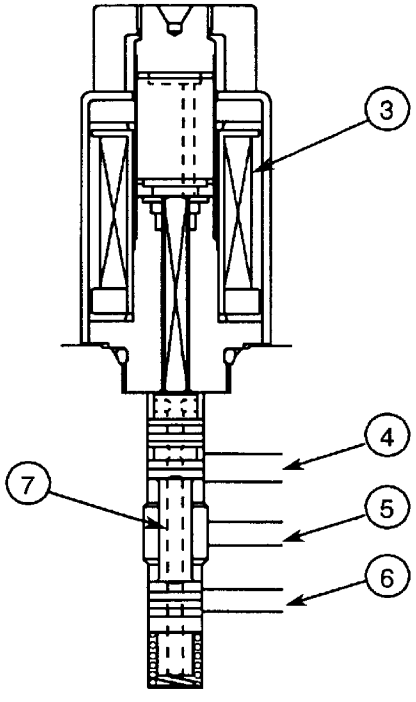
(Proportional Solenoid Valve: Auto Boom-Stop Function)

This solenoid valve regulates boom raise and right boom-swing operation. Proportional solenoid valves (1 and 2) have auto boom-stop function. With the system activated, if the boom enters the buffer zone, the control valve spool is regulated to decelerate or stop the boom.



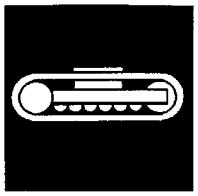

T532-02-06-001

The proportional solenoid valve functions as a pressure reducing valve which supplies oil pressure in proportion to the applied voltage (current) to port A (5). Pressure at port A (5) acts on spool (7) and balances with solenoid force. When pressure at port A (5) increases, spool (7) is moved upward, opening tank port (4) so that pressure at port A (5) decreases up to the balance pressure.
When pressure at port A (5) decreases lower than solenoid force, spool (7) is moved downward, closing tank port (4) so that pressure at port A (5) increases up to the balance pressure.




T532-02-06-003

1— **Proportional Solenoid Valve (Boom Raise)**
2— **Proportional Solenoid Valve (Right Boom-Swing)**
3— **Solenoid**
4— **Tank Port**
5— **Port A: C/V Side**
6— **Port P: P/V Side**
7— **Spool**



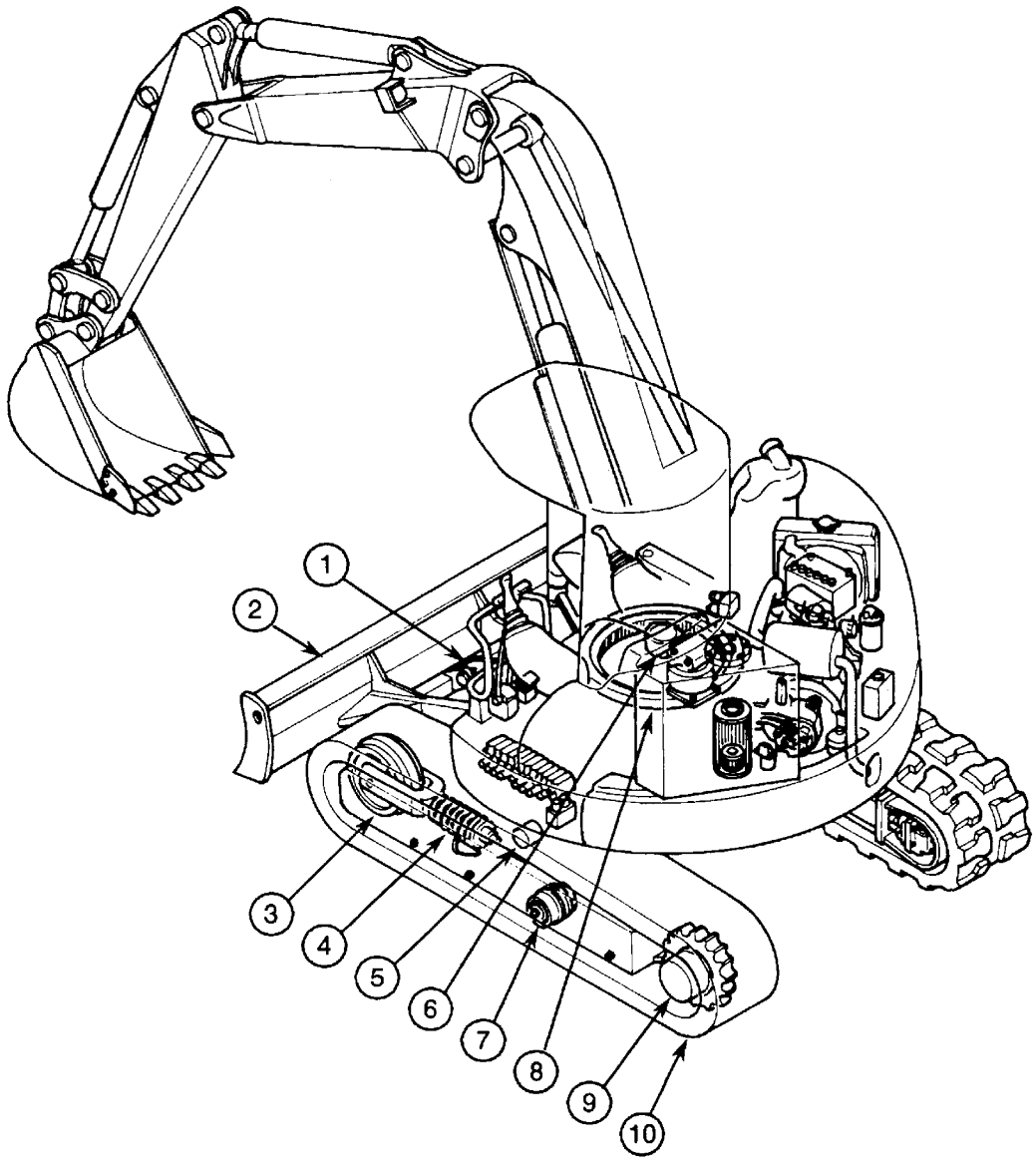
# SECTION 03
# UNDERCARRIAGE

## CONTENTS

## OUTLINE

Undercarriage supports the weight of track and upperstructure. Undercarriage consists of track frame, blade (2), blade cylinder (1), center joint (6), swing bearing (8), front idler (3), track adjuster (4), upper roller (5), lower roller (7), track (10), and travel device (9).

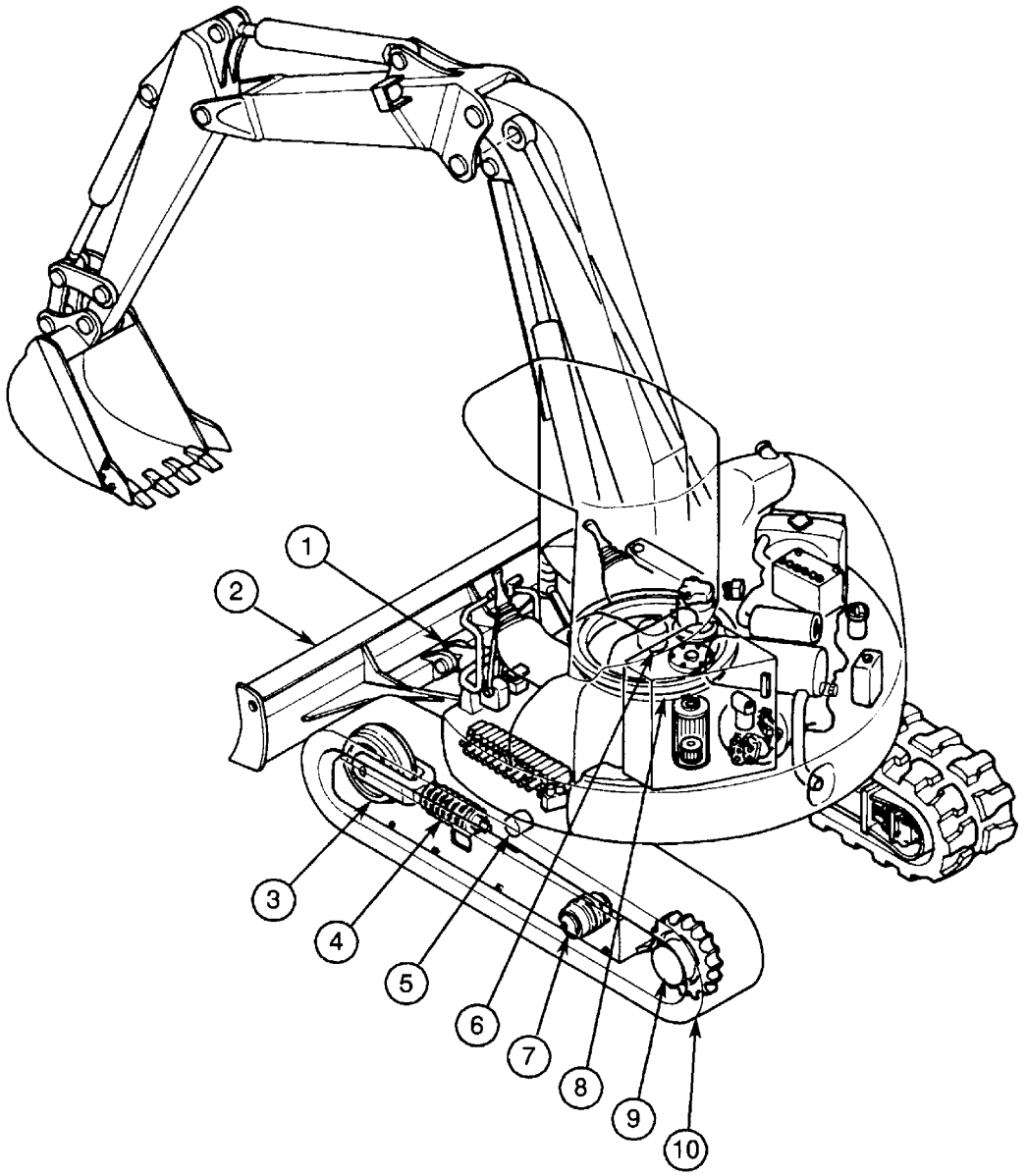
**33Mu**




T532-01-01-001

1— Blade Cylinder
2— Blade
3— Front Idler
4— Track Adjuster
5— Upper Roller
6— Center Joint
7— Lower Roller
8— Swing Bearing
9— Travel Device
10— Track

58Mu



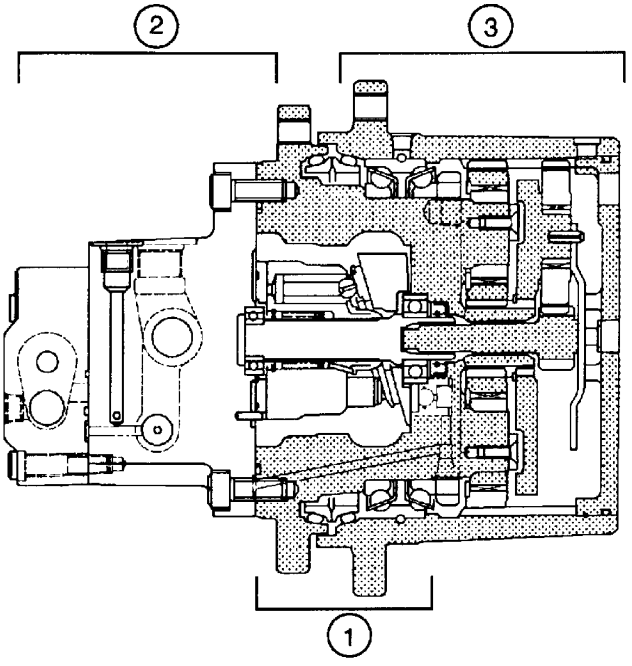

T533-01-01-001

1— Blade Cylinder
2— Blade
3— Front Idler
4— Track Adjuster
5— Upper Roller
6— Center Joint
7— Lower Roller
8— Swing Bearing
9— Travel Device
10— Track

## OUTLINE

Travel device consists of travel motor (1), brake valve (2), two stage reduction planetary type reduction gears (3) and sprocket.

**33Mu**

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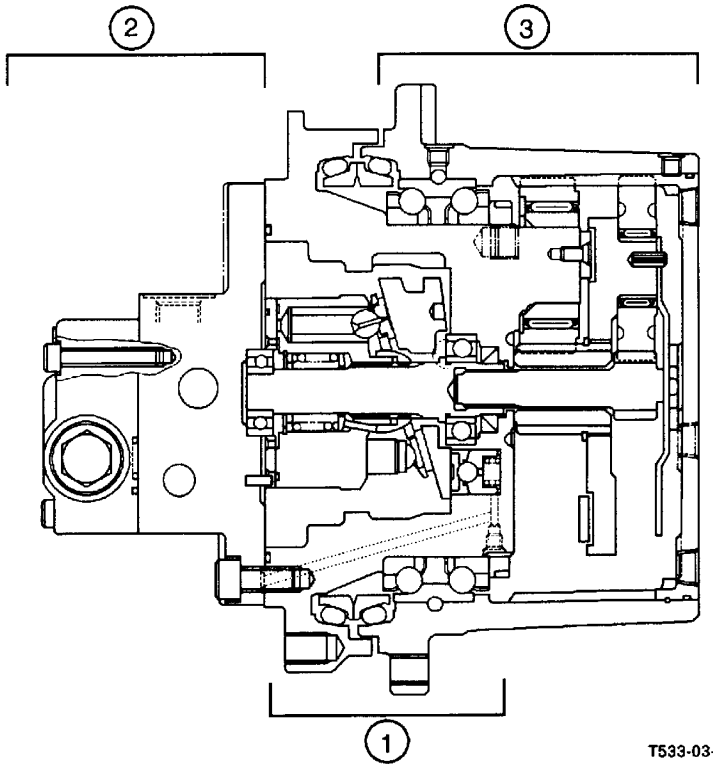
**58Mu**




T533-03-02-001

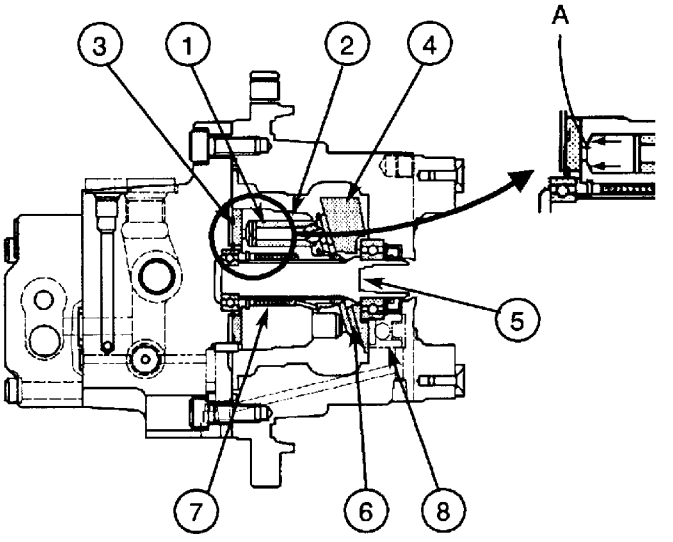
1— Travel Motor 2— Brake Valve 3— Reduction Gears

## TRAVEL MOTOR

The travel motor is a swash plate type variable displacement axial plunger motor. Major components are valve plate (3), rotor (2), plunger (1), shaft (5), swash plate (4), and swash plate control piston (8).

Rotor (2) is brought into contact with valve plate (3) by spring (7). Then, when pressure in rotor (2) increases, the pressure acts on rotor bore end face (A) so that contact between rotor (2) and valve plate (3) is brought more tightly.

**33Mu**

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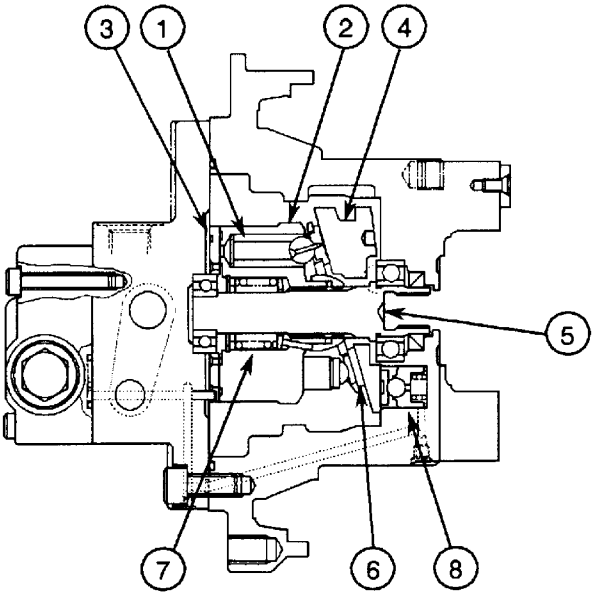
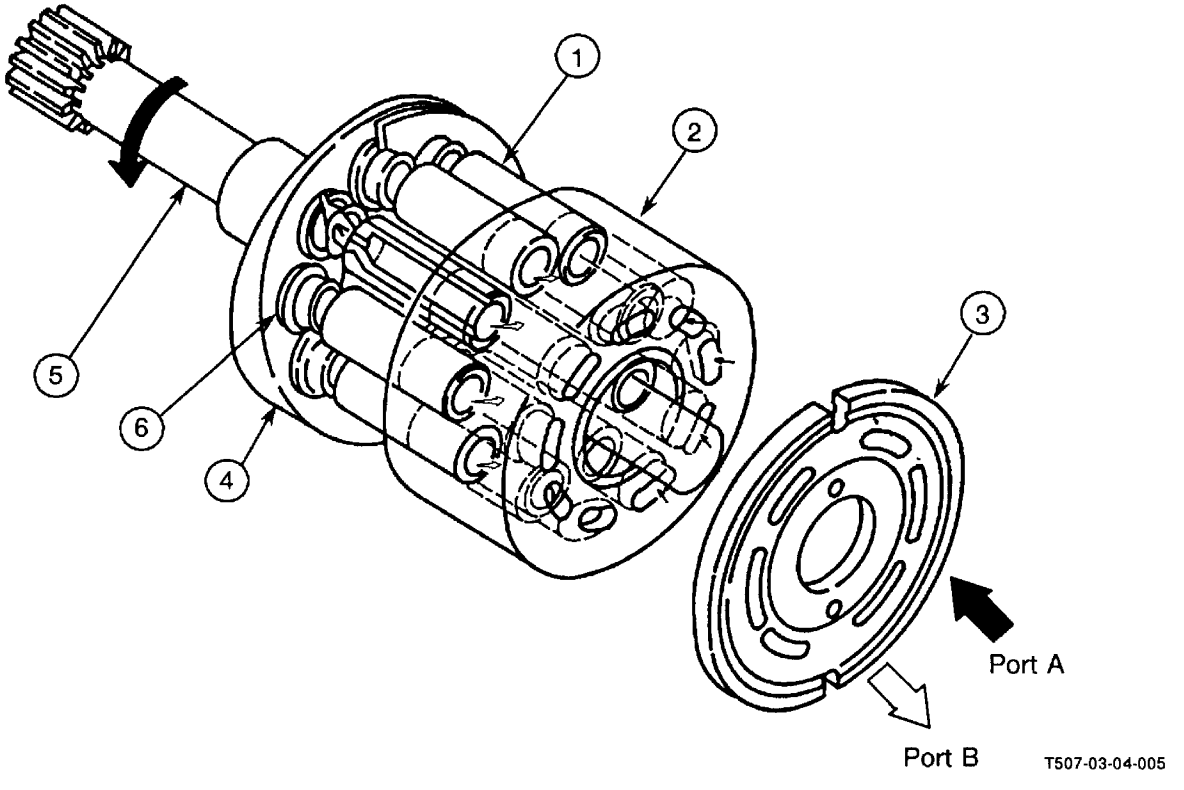
**58Mu**




T533-03-02-002

1— Plunger
2— Rotor
3— Valve Plate
4— Swash Plate
5— Shaft
6— Shoe
7— Spring
8— Swash Plate Control Piston

When pressure oil is fed through port A of valve plate (3) to the one side of rotor (2), plunger (1) is pushed to the axial direction. By means of the slant of swash plate (4), shoe (6) slides along the surface of swash plate (4), causing rotor (2) and shaft (5) to rotate. When rotor (2) is rotated until plunger reaches port B, pressure oil is routed to the hydraulic oil tank. Whether moving forward or reverse is determined by which port (A or B) the pressure oil is supplied to.

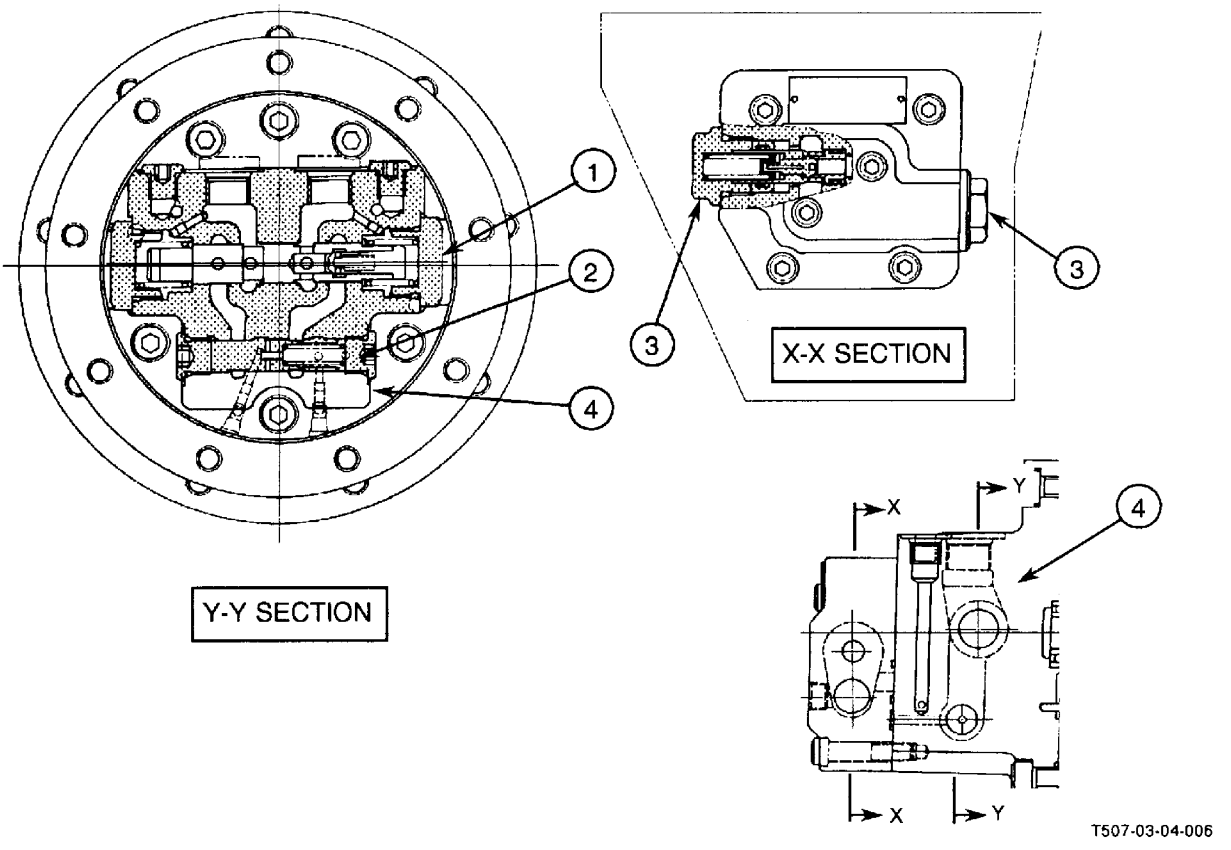



1— Plunger
2— Rotor
3— Valve Plate
4— Swash Plate
5— Shaft
6— Shoe

## TRAVEL BRAKE VALVE

The travel brake valve is provided on the travel motor head and consists of the following valves:

Counterbalance valve (1): ensures smooth starts and stops and prevents the machine from running away on slopes.
Travel motor swash angle control valve (2): feeds pressure oil from the solenoid valve to the swash plate control piston.
Relief valve (3): prevents overload and surge pressure in the motor circuit.



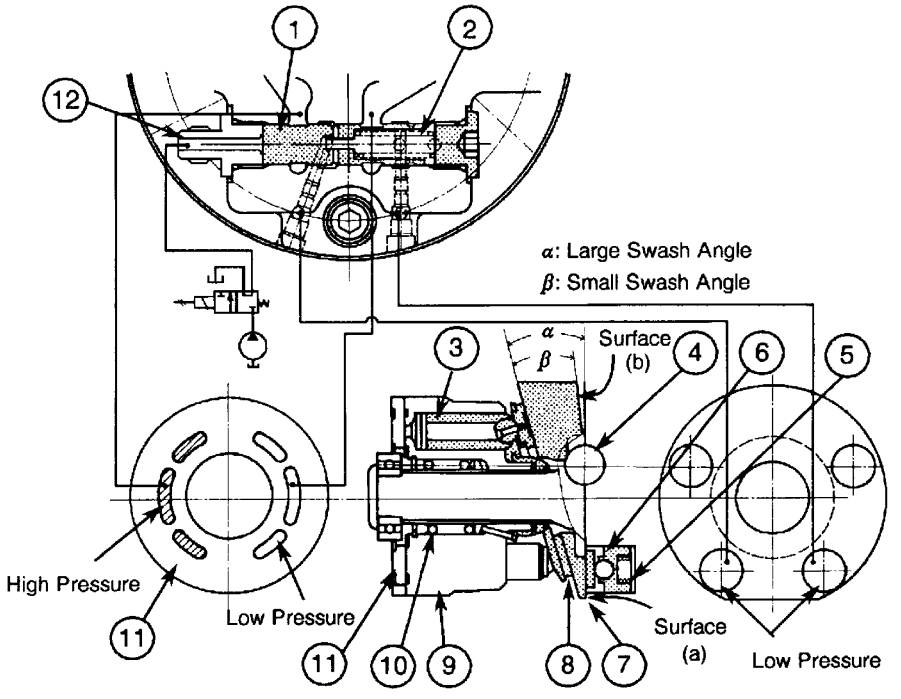

1— Counterbalance Valve
2— Travel Motor Swash Angle Control Valve
3— Relief Valve
4— Brake Valve

## TRAVEL MOTOR SWASH ANGLE CONTROL

- **Swash Angle Increase**

Swash plate (7) has two surfaces (a and b) to contact with the housing. Two steel balls (4) are provided in the upper position slightly higher than the motor center.

When travel speed control pedal is in the slow speed position, spool (1) is pushed to plug (12) side by spring (2). Then, swash plate control piston (6) chamber (s) (33Mu: one, 58Mu: two) is (are) opened to the tank port. Accordingly, swash control piston (6) has no power to raise swash plate (7) so that surface (a) comes into contact with the housing by means of oil pressure force acting on plunger (3) and spring (10) force. Thereby, swash plate angle becomes $\alpha$ (large swash angle), increasing the motor displacement by which travel speed is reduced.



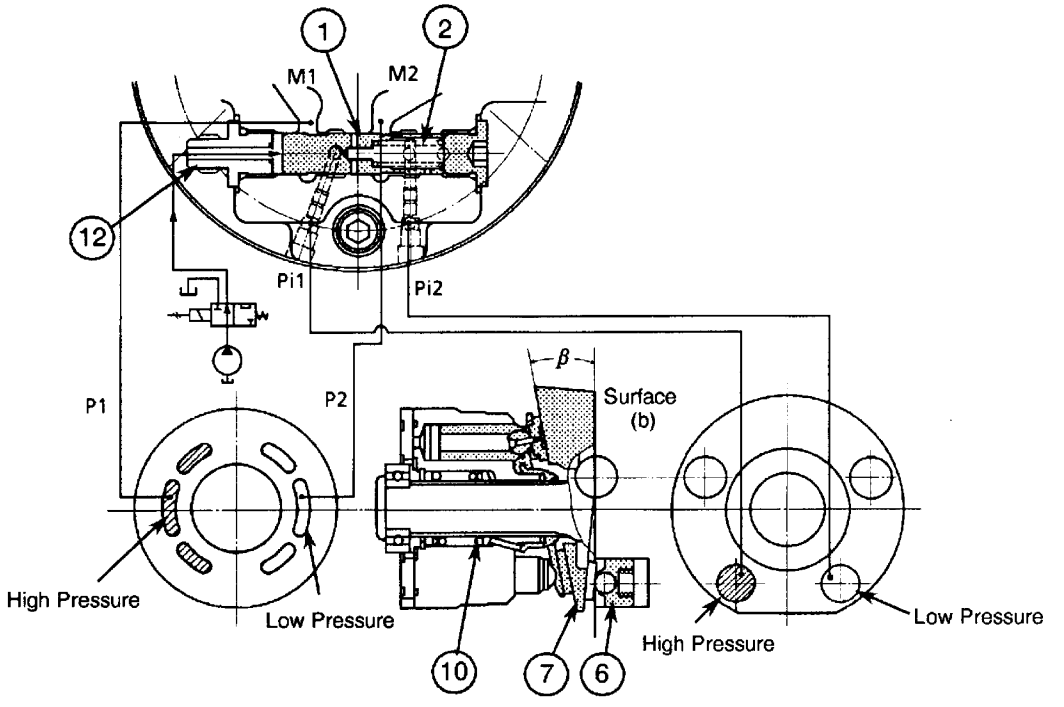

T554-03-04-005

1— Spool
2— Spring
3— Plunger
4— Steel Ball
5— Spring
6— Swash Plate Control Piston
7— Swash Plate
8— Shoe
9— Rotor
10— Spring
11— Valve Plate
12— Plug

- **Swash Angle Decrease**

When travel speed control pedal is in the fast speed position, oil pressure from the pilot pump acts on the left end face of spool (1), moving spool (1) to the right against spring (2). Then, motor drive pressure P1 (P2) is routed to swash plate control piston (6) chamber (s) via port M1 (M2) and Pi1 (Pi2). Thereby, swash plate control piston (6) raises swash plate (7), reducing swash plate angle to $\beta$.Consequently, the motor displacement is reduced so that travel speed increases.

When the engine is stopped, the pressure oil is not supplied from the pilot pump. Then, spool (1) is moved back to plug (12) side by spring (2) force. As swash plate control piston (6) chamber (s) is (are) opened to the tank port, swash plate (7) is pushed by spring (2) force, increasing swash angle to $\alpha$. Thereby, the machine can start to travel at slow speed.

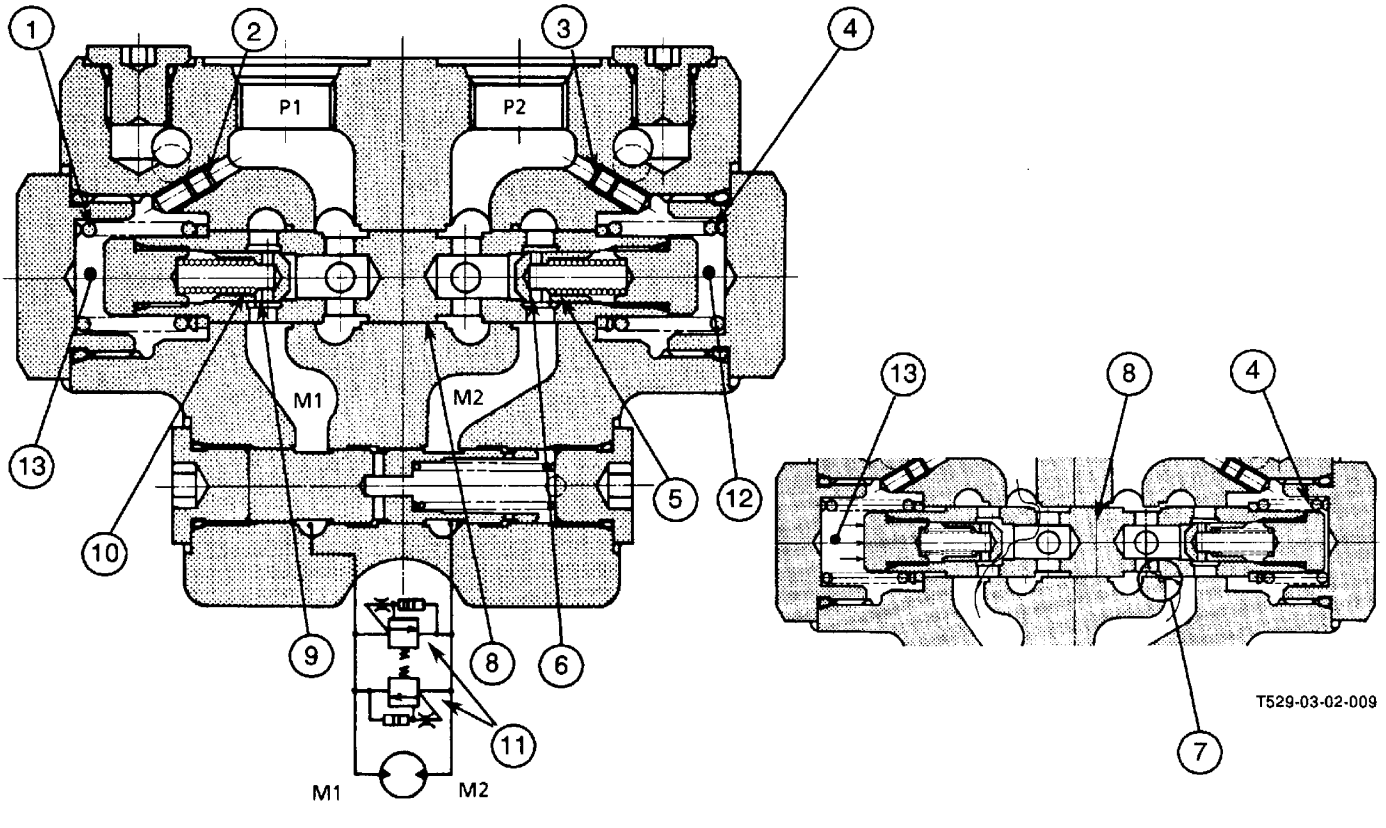



1— Spool
2— Spring
5— Spring
6— Swash Plate Control Piston
7— Swash plate
10— Spring
12— Plug

## COUNTERBALANCE VALVE

- When traveling:
  Oil supplied from the control valve enters port P1 and led to chamber L (13) through orifice (2). Other port P1 oil flows into motor port M1 after going through check valve L (9). The return oil from the travel motor flows out of port M2. But until oil pressure in port P1 increases, spool (8) and check valve R (6) blocks the oil passage to port P2. When pressure in port P1 increases, pressure in chamber L (13) also increases, moving spool (8) against spring R (4).

  Consequently, return oil from the travel motor flows into port P2 after going through notch (7) on spool (8). Thereby, oil starts to flow through the circuit so that the travel motor begins to rotate.
  When the travel lever is returned to neutral, spool (8) is return to the original position by spring R (4) force, closing the circuit to stop the rotation of the travel motor.




T507-03-04-009

| | | | |
|---|---|---|---|
| 1— Spring L | 5— Spring R | 8— Spool | 11— Relief Valve |
| 2— Orifice L | 6— Check Valve R | 9— Check Valve L | 12— Chamber R |
| 3— Orifice R | 7— Spool Notch | 10— Spring L | 13— Chamber L |
| 4— Spring R | | | |

- When descending a slope:
  While descending a slope, the travel motor is forcibly rotated by machine weight. Then, the motor operates like a pump. Under this condition, if the motor sucks more oil than oil supplied from the pump, pressure in port P1 and chamber L (13) is reduced so that spool (8) is moved to the left to restrict the return circuit from the motor.

  Consequently, pressure in motor port M1 side increases, by which the travel motor is braked. Once oil flow is restricted, pressure in port P1 increases to move spool (8) to the right opening the return circuit. Repeating this operation prevents the machine from running away (hydraulic brake operation).

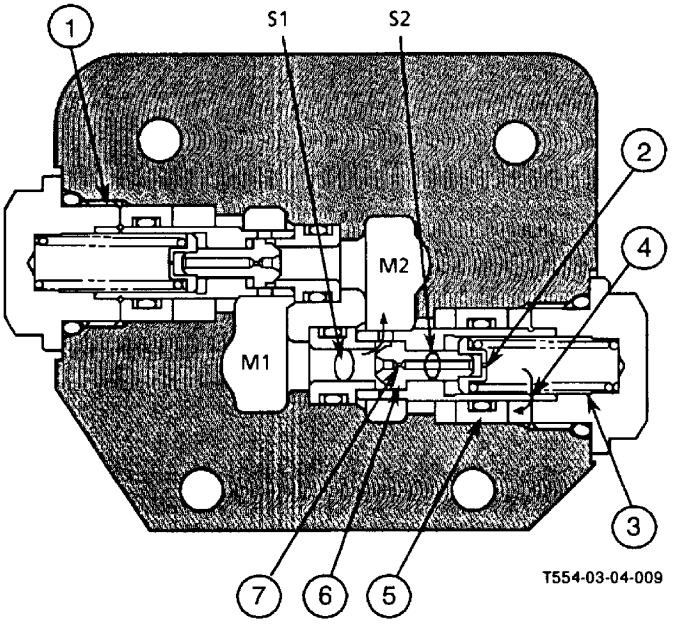
## RELIEF VALVE

- Circuit Protection
  When pressure in the circuit increases higher than set pressure, this valve opens to relieve high pressure to the low pressure side, protecting the travel motor from over loading. In addition, this valve relieves surge pressure developed by inertia force when the travel motor stops.

- Shockless Mechanism
  The relief valve has a shockless mechanism to reduce shocks developed during acceleration or deceleration. This mechanism consists of a differential-area type direct acting relief valve and a free piston. The relief valve operates in the following two stages.

  · First Stage:
  Pressure in port M1 acts on poppet (6). At the same time, pressure oil is guided into spring (3) chamber via orifice (2). During the first stage of operation, pressure oil flows further into free piston (5) chamber via orifice (4) to move free piston (5) to the left. Until free piston (5) reaches the stroke end, pressure in spring (3) chamber does not increase. Namely, pressure acting on area S2 behind poppet (6) is low so that even if pressure acting on area S1 is low, poppet (6) moves to relieve pressure in port M1.

  · Second Stage:
  When free piston (5) reaches the stroke end, pressure in spring (3) chamber increases, equalizing pressures in both front and rear of poppet (6). In this stage, differential area (S1 - S2) of poppet (6) is reduced smaller than the first stage, causing poppet (6) to move to the right by pressure higher than the first stage.



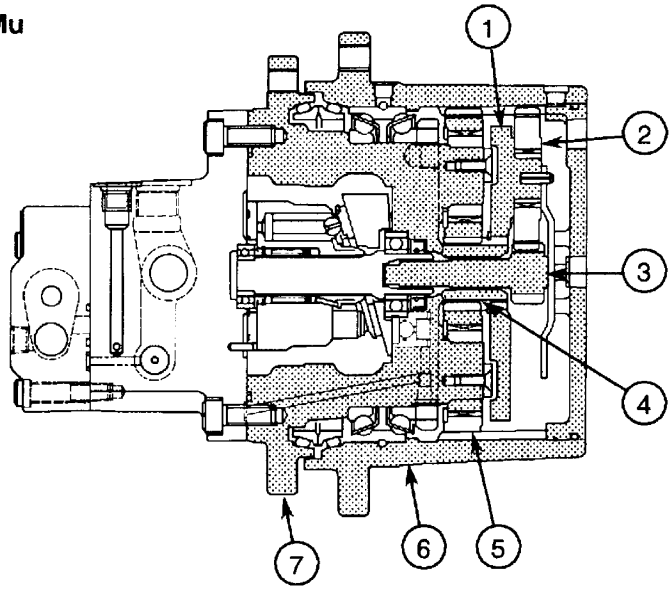

1— Relief Valve Assembly
2— Orifice
3— Spring
4— Orifice
5— Free Piston
6— Poppet
7— Orifice

## TRAVEL REDUCTION GEARS

The travel reduction gears are a two stage reduction planetary gear type. Drive gear (3) is rotated by the travel motor. Then, this rotation is transferred to first stage carrier (1) after the rotation speed is reduced in the first stage between first stage planetary gears (2) and ring gear (6).

First stage carrier (1) rotates second stage sun gear (4) and planetary gears (5). Second stage planetary gears (5) are installed on motor housing (second stage carrier) (7) which does not rotate. Thereby, the second stage speed reduction is conducted between second sun gear (4), second planetary gears (5), and ring gear (6). Then, ring gear (6) as well as the sprocket installed on ring gear (6) rotate.

**33Mu**

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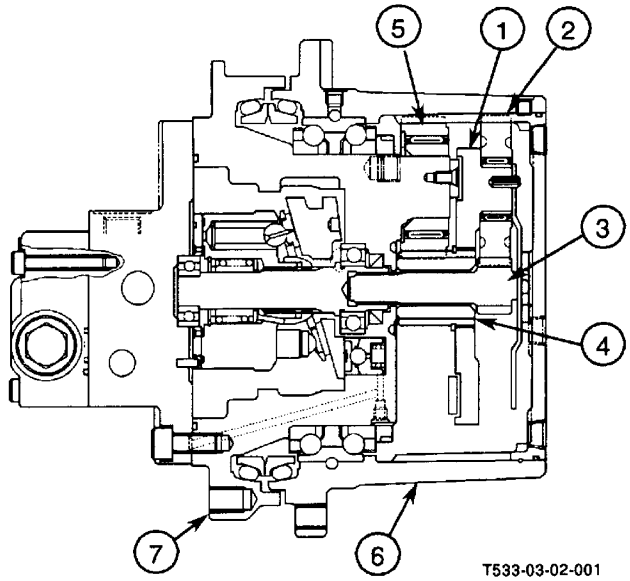
**58Mu**

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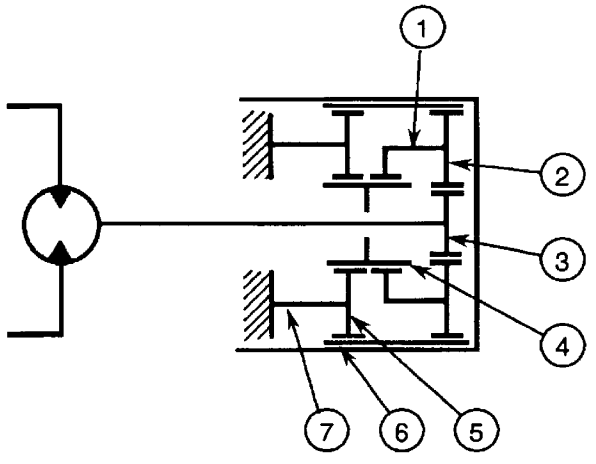


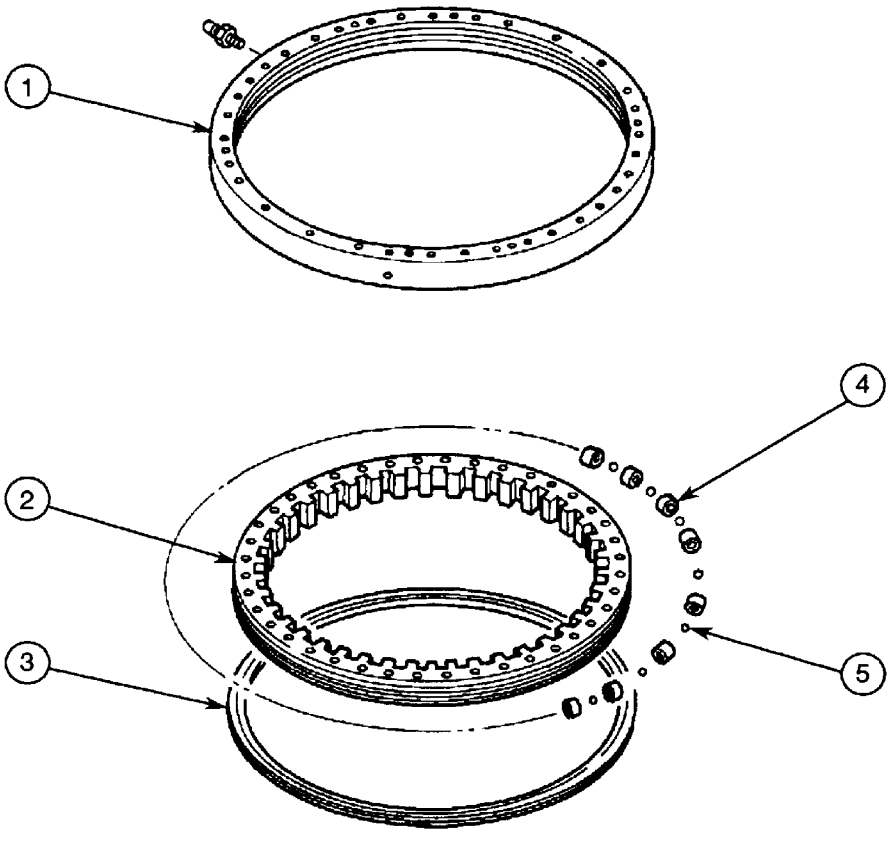

T507-03-04-003

1— First Stage Carrier
2— First Stage Planetary Gear
3— Drive Gear (First Stage Sun Gear)
4— Second Stage Sun Gear
5— Second Stage Planetary Gear
6— Ring Gear
7— Motor Housing (Second Stage Carrier)

## SWING BEARING

The swing bearing supports the weight of the upperstructure as well as allows smooth swing operation. This bearing a single-row ball type bearing, comprising outer race (1), inner race (2), balls (5), supports (4), and seal (3). Outer race (1) is bolted to the upperstructure and inner race (2) is bolted to the undercarriage.

The internal gear of inner race (2) engages with the output shaft of the swing reduction gears.




T507-03-02-001

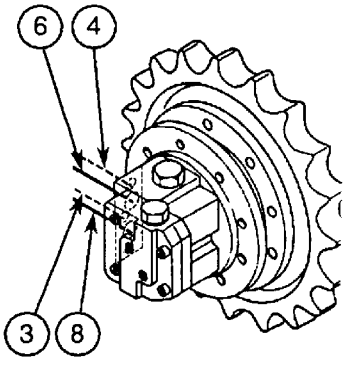
1— Outer Race
2— Inner Race
3— Seal
4— Support
5— Ball

## CENTER JOINT

The center joint is a 360°- rotating joint. When the upperstructure rotates, the center joint avoids twisting of hoses and allows hydraulic oil to flow or from the travel motors and blade cylinder. Spindle (10) is attached to the undercarriage with four bolts, and body (5) is attached to the upperstructure with a lock pin.

Accordingly, when the upperstucture rotates, spindle (10) stays stationary together with the undercarriage, and body (5) rotates.Pressure oil flows into right and left travel motors (12) and blade cylinder (13) via oil passages in body (5) and spindle (10). Seals (11) prevent oil leaks from clearance between spindle (10) and body (5).

33Mu

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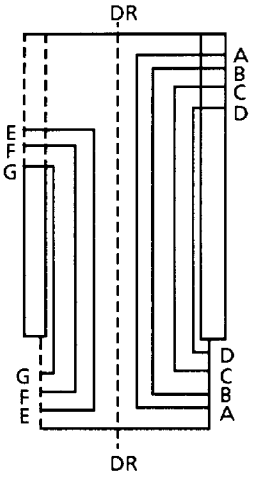
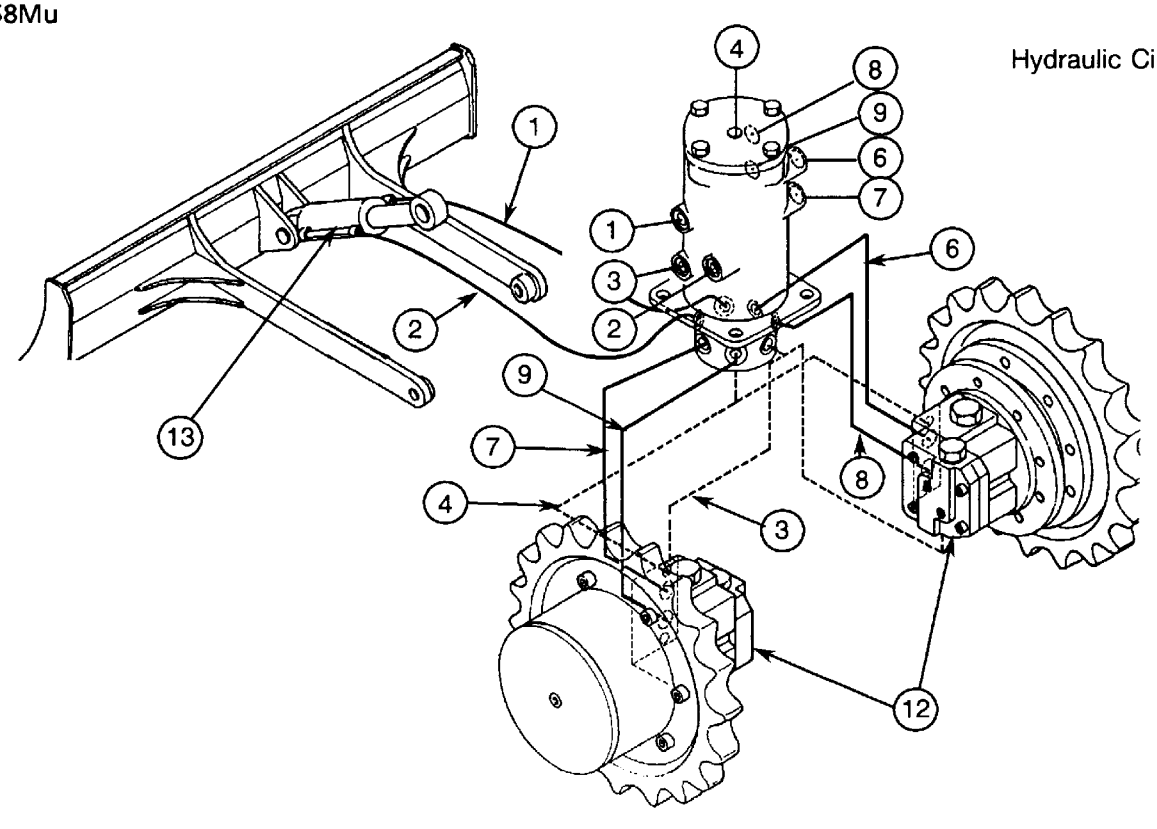



Hydraulic Circuit Diagram

58Mu

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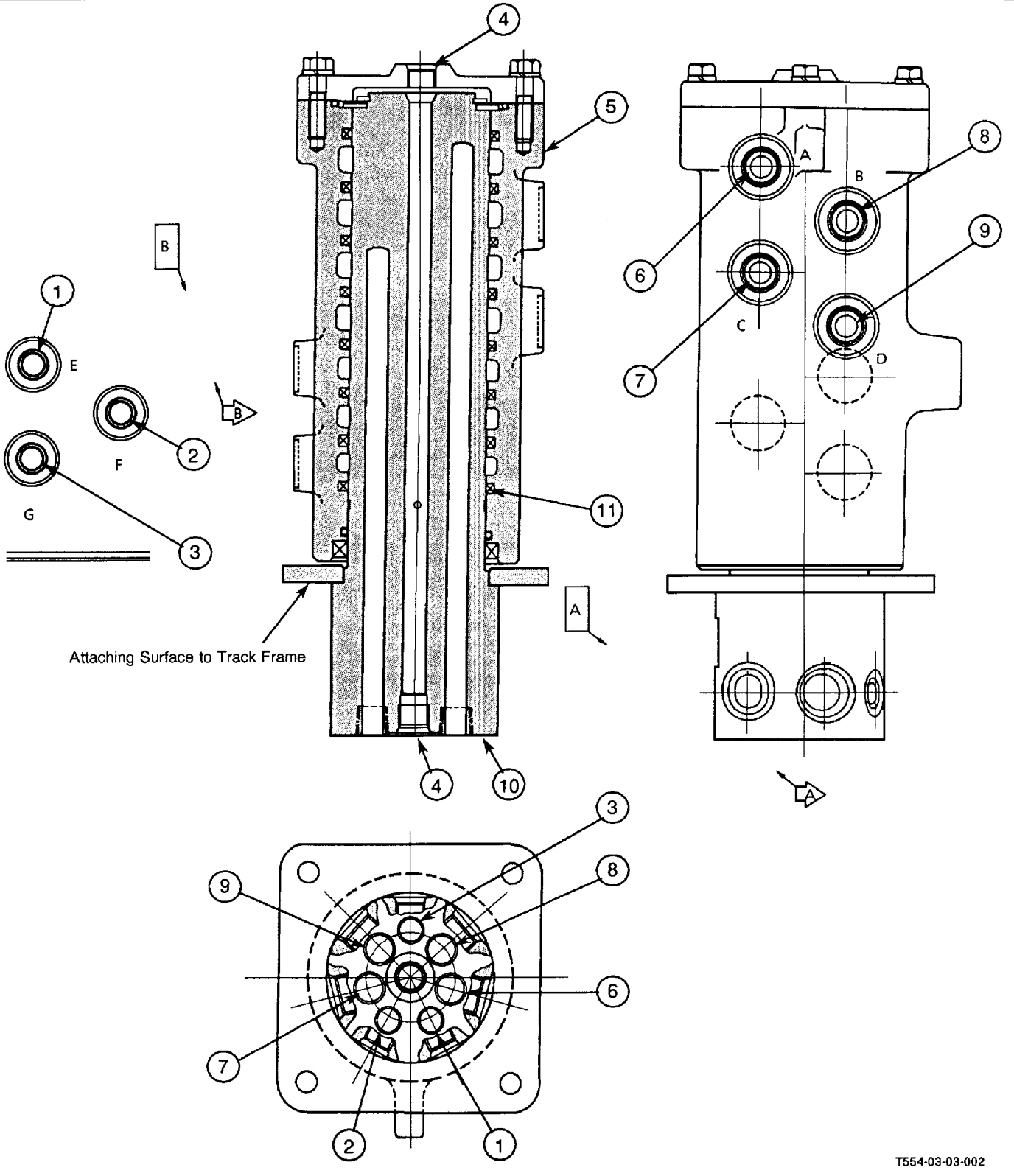
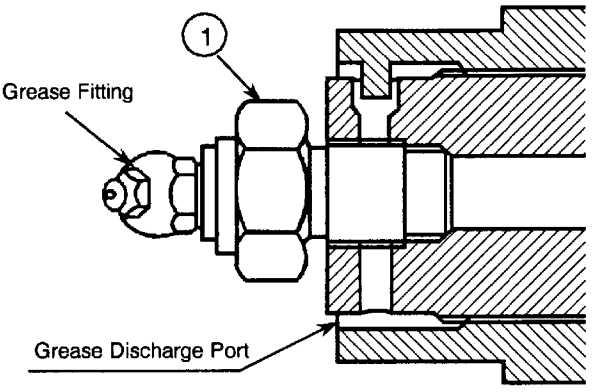



1— Port E (Blade Raise Pipe Line)
2— Port F (Blade Lower Pipe Line)
3— Port G (Travel Speed Change Pipe Line)
4— Port DR (Drain Pipe Line)
5— Body
6— Port A (Right Travel Forward Pipe Line)
7— Port C (Left Travel Forward Pipe Line)
8— Port B (Right Travel Reverse Pipe Line)
9— Port D (Left Travel Reverse Pipe Line)
10— Spindle
11— Seal
12— Travel Motor
13— Blade Cylinder

## TRACK ADJUSTER

The track adjuster consists of spring (4), adjuster cylinder (5), and is installed on the side frame. The track adjuster absorbs loads applied to the front idler with spring (4). Adjuster cylinder (5) adjusts track sag.

- When grease is fed through the grease fitting, grease fills chamber A in adjuster cylinder (5). Then, piston rod (6) is pushed out to reduce track sag.
- When increasing track sag, slacken valve (1) 1 to 1.5 turns to discharge grease.

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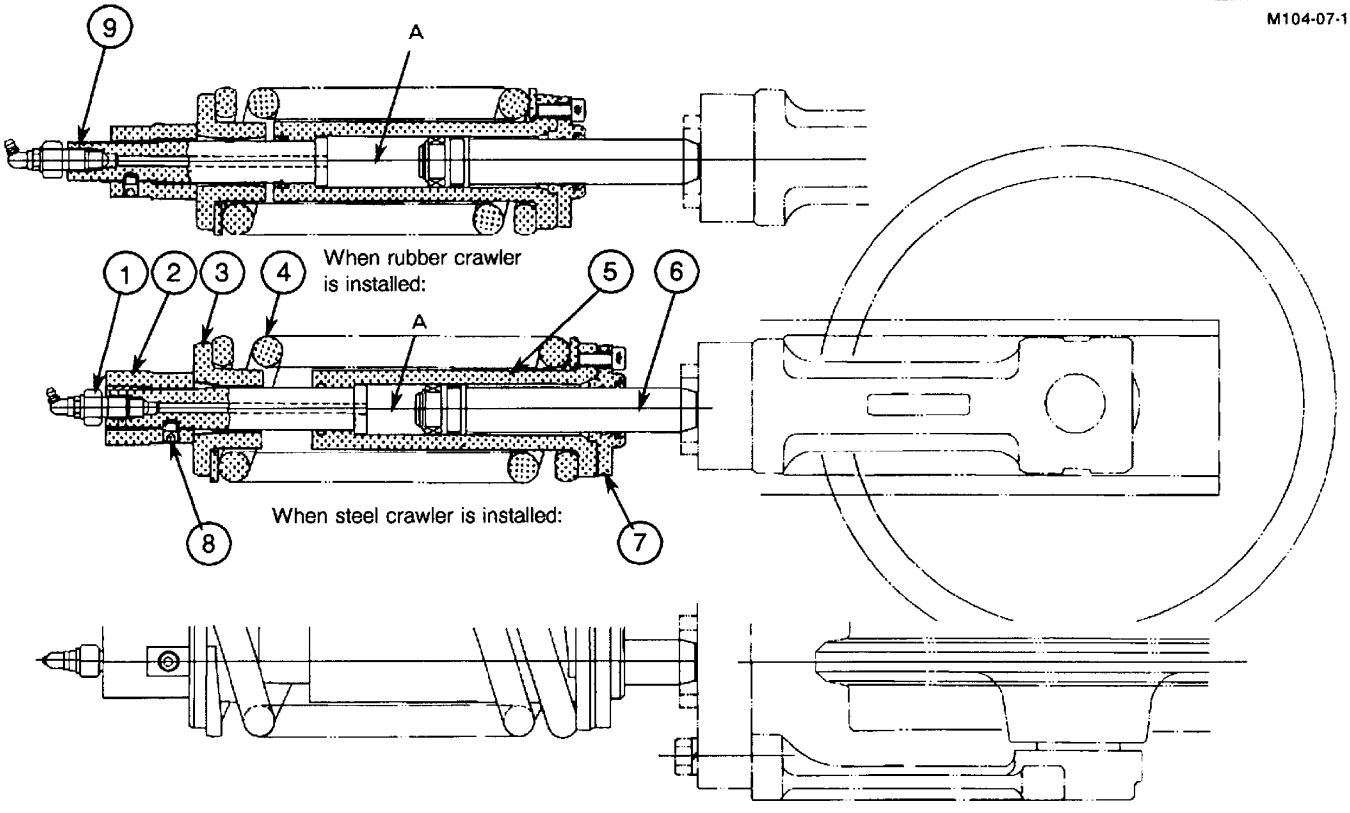



T507-03-05-001

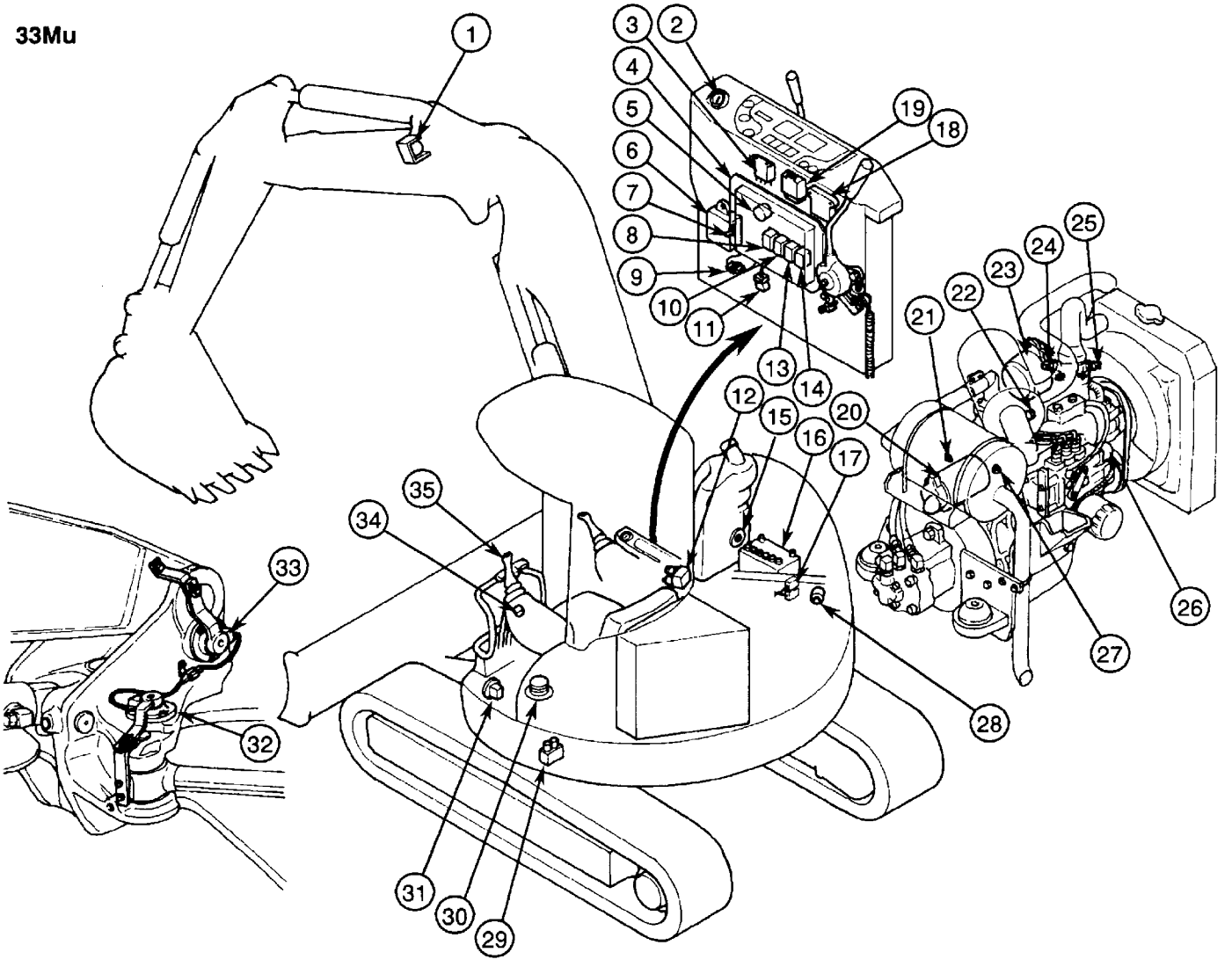
1— Valve
2— Nut
3— Washer
4— Spring
5— Adjuster Cylinder
6— Piston Rod
7— Flange
8— Plug
9— Rod

# SECTION 04
# ELECTRICAL SYSTEM

## CONTENTS

## ELECTRICAL PART LATOUT

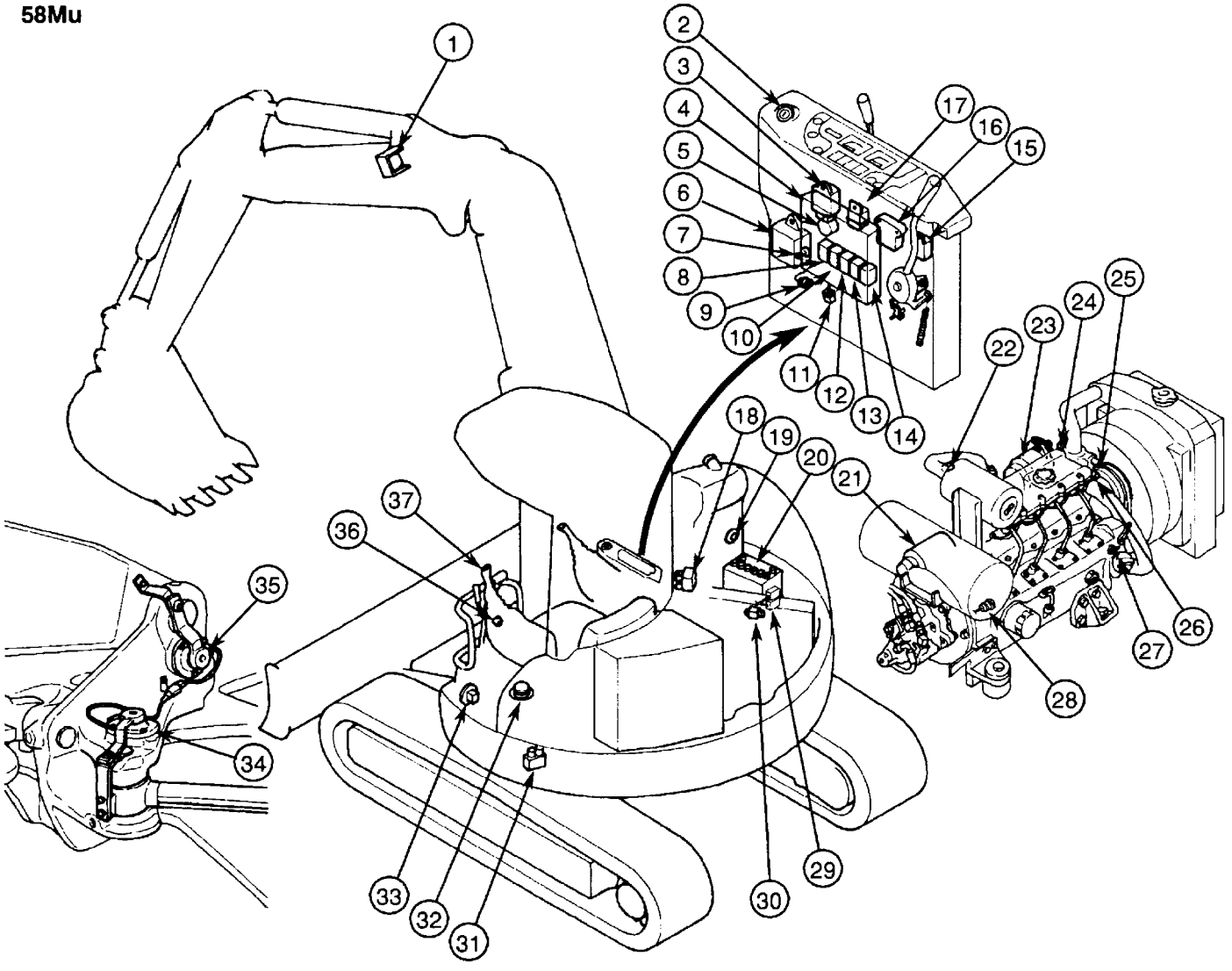
33Mu




T532-04-01-002

1— Work Light
2— Key Switch
3— Glow Plug Relay
4— Controller
5— Buzzer (Auto Boom-Stop)
6— Fuse Box
7— Emergency Release Switch (Auto Boom-Stop)
8— Travel Speed Control Relay
9— Initial Set Connector (Auto Boom-Stop)
10— Work Light Relay
11— Connector (Dr. EX)
12— Solenoid Valve (Pilot Control Shut-Off Lever, Travel Speed Control)
13— Horn Relay
14— Pilot Control Shut-Off Valve Relay
15— Fuel Level Sensor
16— Battery
17— Fusible Link
18— Starter Controller
19— Preheat Timer
20— Starter
21— Engine Oil Pressure Switch
22— Air Filter Restriction Switch
23— Alternator
24— Overheat Switch
25— Glow Plug Sensor
26— Engine Stop Solenoid
27— Coolant Temperature Sensor
28— Fuel Pump
29— Proportional Solenoid Valve (Auto Boom-Stop)
30— Travel Speed Control Switch
31— Horn
32— Swing Angle Sensor
33— Boom Angle Sensor
34— Pilot Control Shut-Off Lever
35— Horn Switch

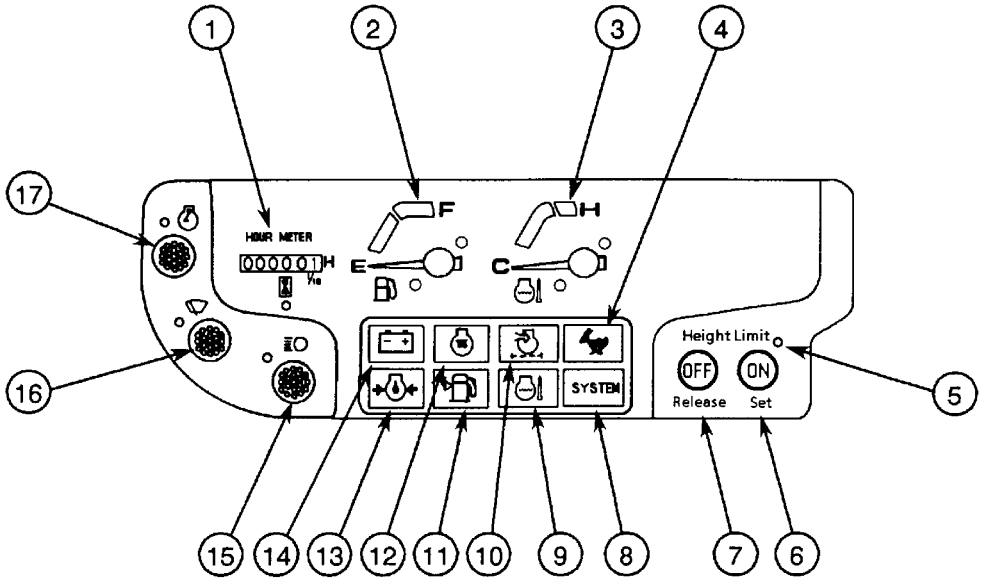
58Mu



T533-04-01-001

1— Work Light
2— Key Switch
3— Preheat Timer
4— Controller
5— Buzzer (Auto Boom-Stop)
6— Fuse Box
7— Emergency Release Switch (Auto Boom-Stop)
8— Auto Boom-Stop Relay
9— Initial Set Connector (Auto Boom-Stop)
10— Travel Speed Control Relay
11— Connector (Dr. EX)
12— Work Light Relay
13— Horn Relay
14— Pilot Control Shut-Off Valve Relay
15— Starter Relay (1)
16— Glow Relay
17— Starter Relay
18— Solenoid Valve (Pilot Control Shut-Off Lever, Travel Speed Control)
19— Fuel Level Sensor
20— Battery
21— Starter
22— Air Filter Restriction Switch
23— Alternator
24— Overheat Switch
25— Glow Plug Sensor
26— Coolant Temperature Sensor
27— Engine Oil Pressure Switch
28— Engine Stop Solenoid
29— Fusible Link
30— Fuel Pump
31— Proportional Solenoid Valve (Auto Boom-Stop)
32— Travel Speed Control Switch
33— Horn
34— Swing Angle Sensor
35— Boom Angle Sensor
36— Pilot Control Shut-Off Lever
37— Horn Switch

## MONITOR PANEL AND SWITCH PANEL

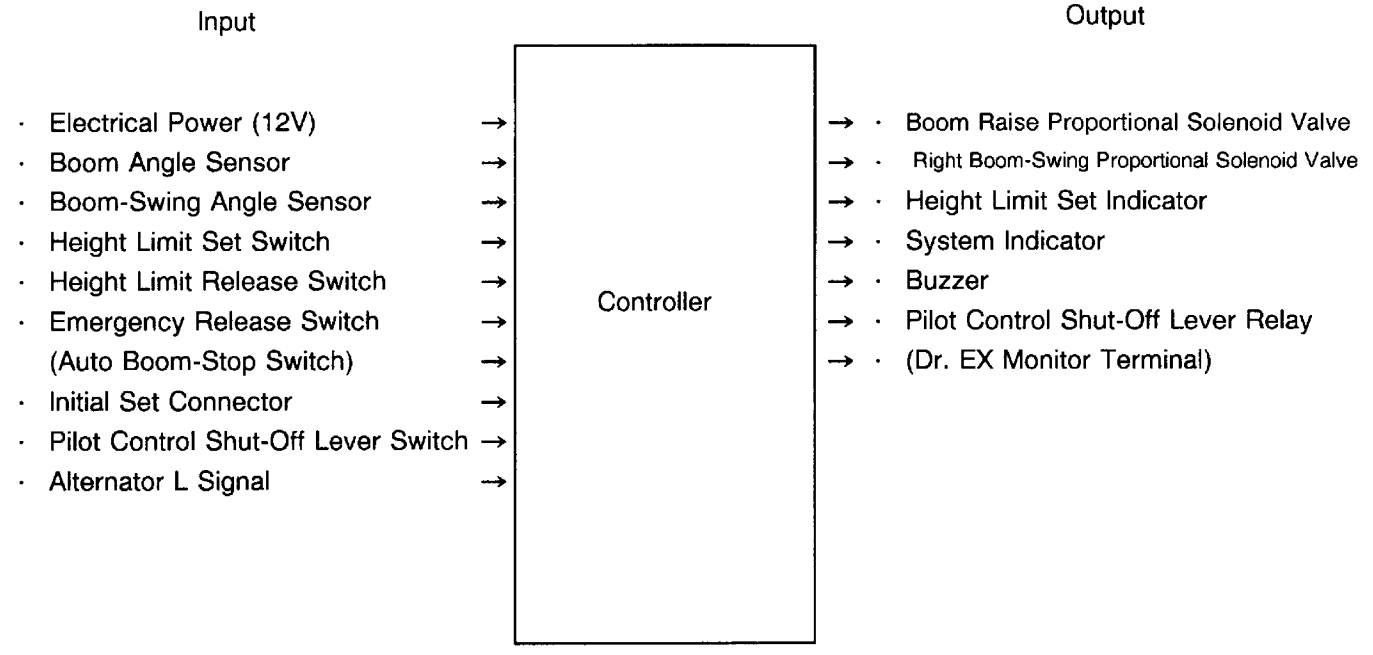



T532-04-01-001

1— Hour Meter
2— Fuel Gauge
3— Coolant Temperature Gauge
4— Fast Travel Indicator
5— Height Limit Set Indicator
6— Height Limit Set Switch
7— Height Limit Reset Switch
8— System Indicator (Auto Boom-Stop)
9— Overheat Indicator
10— Air Filter Restriction Indicator
11— Fuel Level Indicator
12— Preheat Indicator
13— Engine Oil Pressure Indicator
14— Alternator Indicator
15— Work Light Switch
16— Wiper Switch (Option)
17— Auto-Idle Switch

## OUTLINE

This machine is equipped with the auto boom-stop and height limit systems.



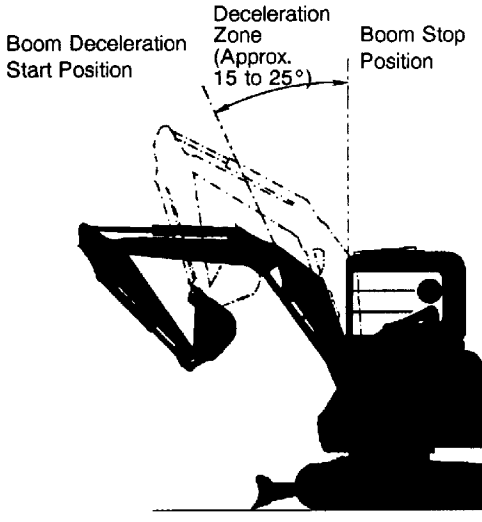
## AUTO BOOM-STOP SYSTEM

The auto boom-stop system prevents the boom from coming into contact with the cab or canopy. The angle sensor provided in the swing post detects the boom and swing angles.
Receiving a signal from the angle sensor, the controller locates the boom position.

Then, the controller regulates the boom raise and right boom-swing proportional solenoid valves. When the boom enters the buffer zone provided to prevent the boom from coming into contact with the cab or canopy, the controller decelerates or stops the boom movement by operating the two-speed proportional solenoid valve.

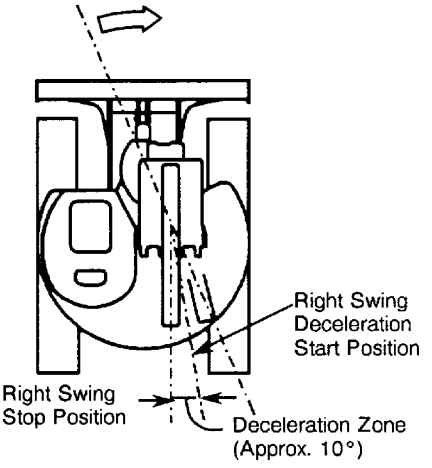
### Deceleration Start and Stop Positions

When the boom is raised with the boom swung to the right:



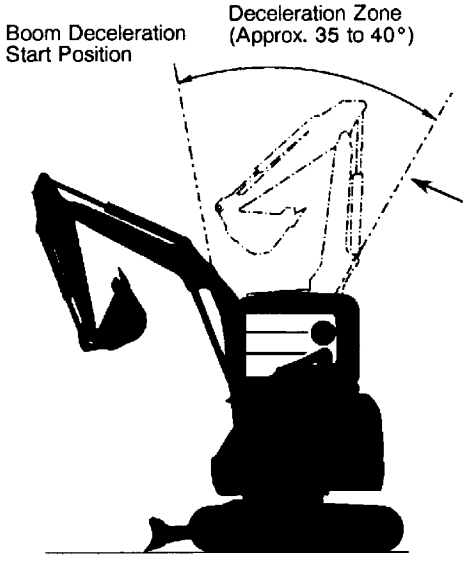

M588-05-053

When the boom is swung from the left swung position with the boom raised:




T532-04-02-004

When the boom is raised with the boom swung to the left:

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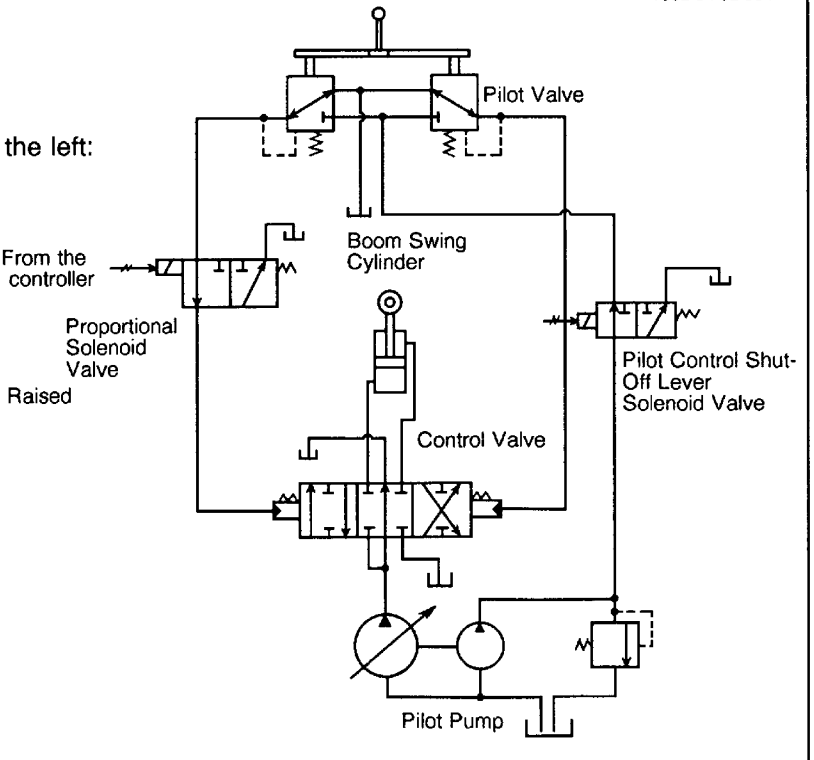


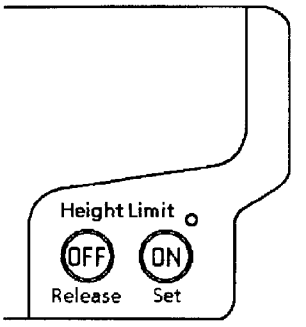

T532-04-02-002

## HEIGHT RESTRICTION SYSTEM

The boom raise operation limit can be set as required. The boom stops at the raised limit position. The angle sensor provided in the swing post detects the boom angles. Receiving a signal from the angle sensor, the controller locates the boom position. Then, the controller regulates the boom raise proportional solenoid valves. When the boom reaches the boom height limit position, the controller stops the boom movement by operating the proportional solenoid valve limiting the boom height.

*NOTE: Either depressing the release switch or turning the key switch OFF deactivates the operation zone limit setting.*

**CAUTION: When setting height limit, be sure to set the limit with the arm rolled out. If height limit is set with the arm rolled in, the bucket may exceed the height limit as illustrated to the right figure.**

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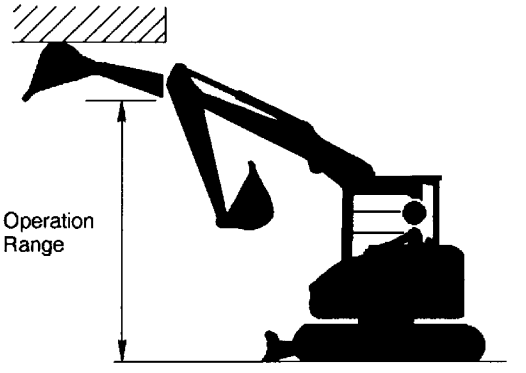



M588-05-043

## AUTO BOOM-STOP SYSTEM INITIAL SETTING

Perform the initial setting in the following cases:

- When the boom is replaced.
- When the angle sensor and / or the sensor link is reinstalled.
- When error in output or position of the angle sensor is presented. (Error in position is caused by sensor link and / or lever deformation.)
- When the controller is replaced.

**Procedures:**

Start the engine.

↓

Swing the boom to the left and fully raise the boom (fully extend the boom cylinder).

※It is not necessary to fully swing to the left provided that the boom is fully raised.

↓

Swing the boom to the right until the boom side face becomes parallel to the canopy (cab) side face.

※In case right swing stops before the boom side face becomes parallel to the canopy (cab) side face, turn the emergency release switch ON. Then, swing the boom so that the boom side face becomes parallel to the canopy (cab) side face.

↓

With the key switch turned OFF, disconnect the initial set connector.

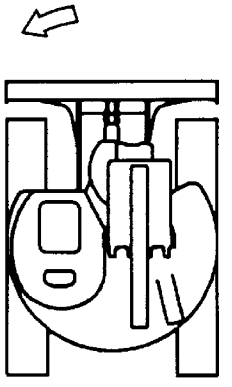
↓

With the key switch turned ON, connect the initial set connector.

※Connecting the initial set connector after the engine is started is acceptable.

↓

The buzzer sounds once shortly. Initial setting is complete.



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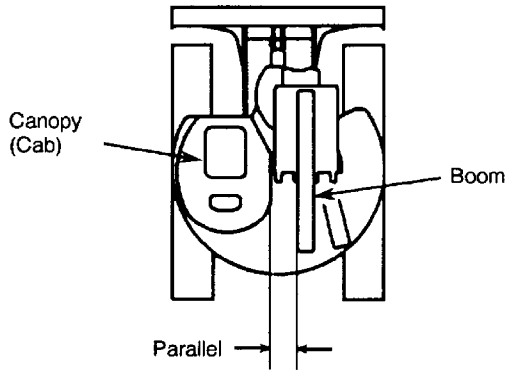


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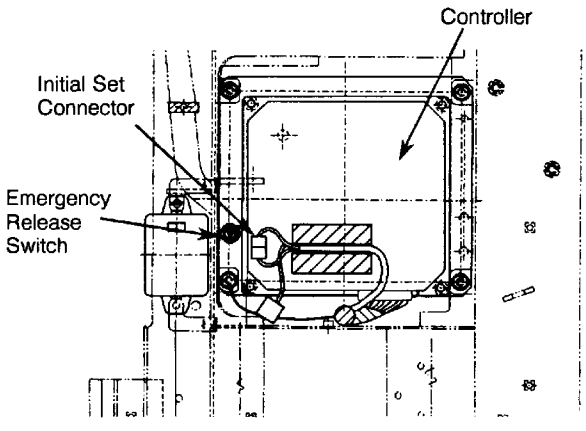


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※ If the buzzer continues sounding after initial setting is complete, initial setting is incorrect. Check the angle sensor system and repair as necessary. Then, retry initial setting.

**Abnormal symptoms in faulty initial setting:**

1. If initial setting is made with the boom raised at slightly lower than the highest position:
   - The boom will stop at a position further than the normal position from the canopy (cab) if the boom is raised in the right side from the swing center.
2. If initial setting is performed with the boom positioned in the left side of swing center:
   - The boom will stop before the boom becomes parallel to the canopy (cab) if the boom is swung to the right with the boom raised.
   - The boom will stop in front of the canopy (cab) if the boom is raised at the swing center.

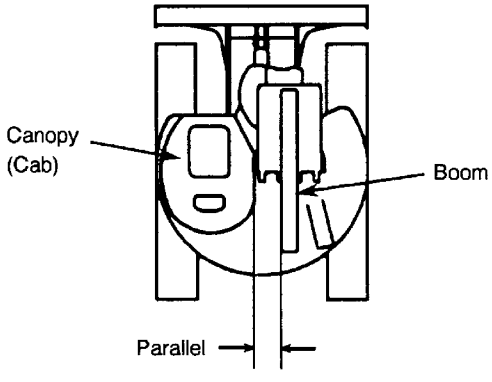
3. If initial setting is performed with the boom positioned in the right side of swing center:
   - The boom will approach much closer to the canopy (cab) or come into contact with the canopy (cab), if the boom is swung to the right with the boom raised (at the position beside the canopy or cab.)
   - The boom may come into contact with the canopy (cab) if the boom is raised in the right side from the swing center.

**When initial setting is not performed:**

When performing initial setting with the boom raised to the highest position (the boom cylinder is fully extended) at the swing center (the boom is parallel to the canopy or cab), initial setting will not be performed correctly if the set values from the boom angle sensor and swing angle sensor are outside the following range. The buzzer continues sounding and the previous initial set values remain without being renewed.

Angle Sensor Initial Set Value (Dr. EX Displays).
With the boom raised to the highest position at the swing center:
Boom Angle Sensor Output: 3.5 ± 0.3 V
Swing Angle Sensor Output: 2.25 ± 0.3 V

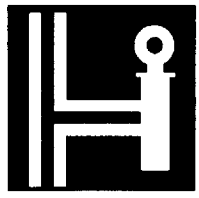
**IMPORTANT: When performing initial setting , be sure to raise the boom to the highest position (the boom cylinder is fully extended) at the swing center (the boom should be parallel to the canopy or cab).**




T532-04-02-007

※ In case the initial setting was not performed, boom deformation, faulty angle sensor, or angle sensor link deformation may be the cause of the trouble. After checking and repairing, recheck the angle sensor value and reset the initial setting.

# SECTION 05
# HYDRAULIC SYSTEM



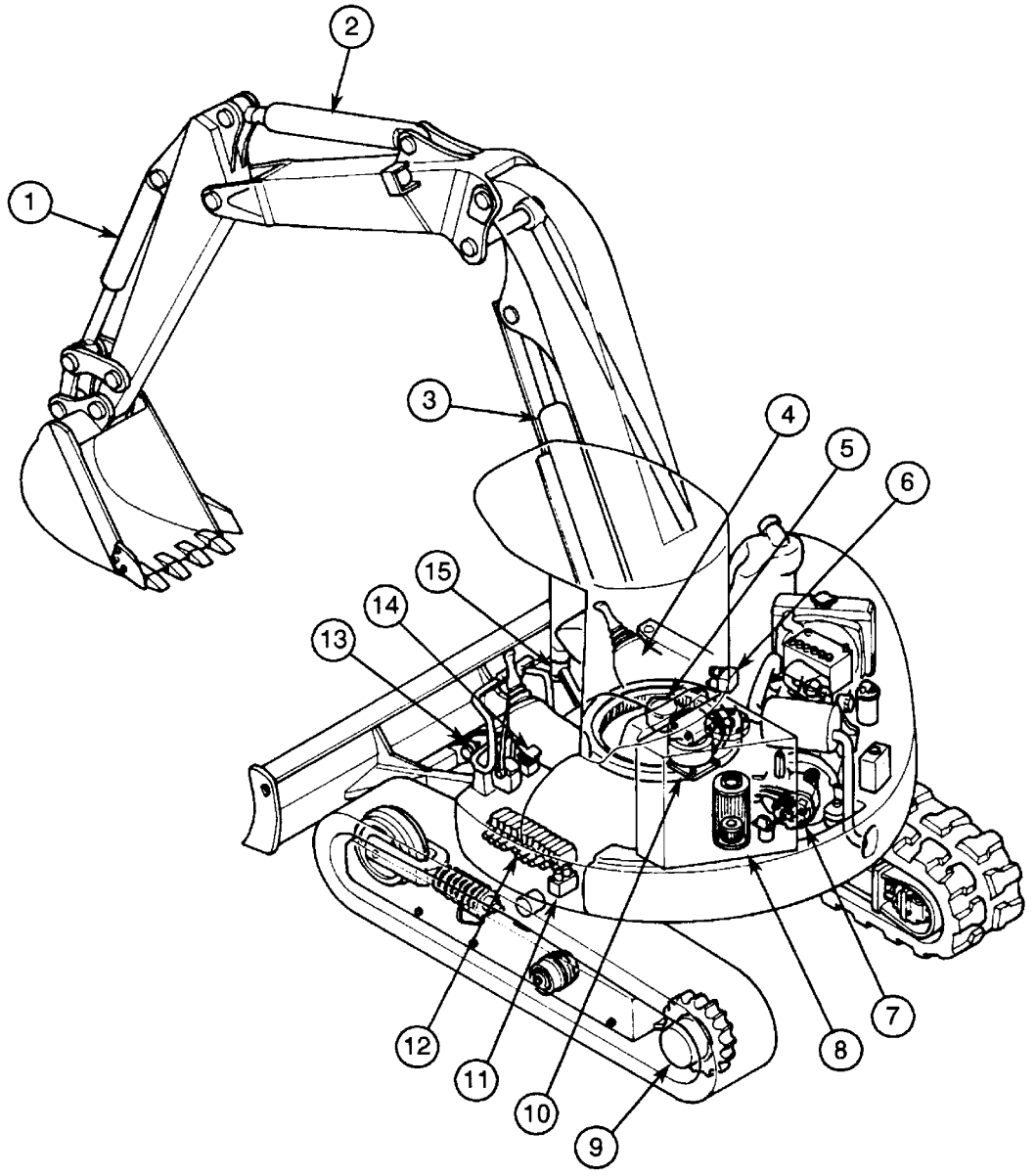
## CONTENTS

## OUTLINE

Hydraulic system consists of major components such as pump device (7), bucket cylinder (1), arm cylinder (2), boom cylinder (3) swing cylinder (15), swing device (10), two travel device (9) units and hydraulic oil tank (8), and pipe lines. Pipe lines fall into two groups.

One is the main pipe line (delivery / main / suction / return / drain) to supply pressure oil to each actuator. The other is the pilot pipe line to control hydraulic components.

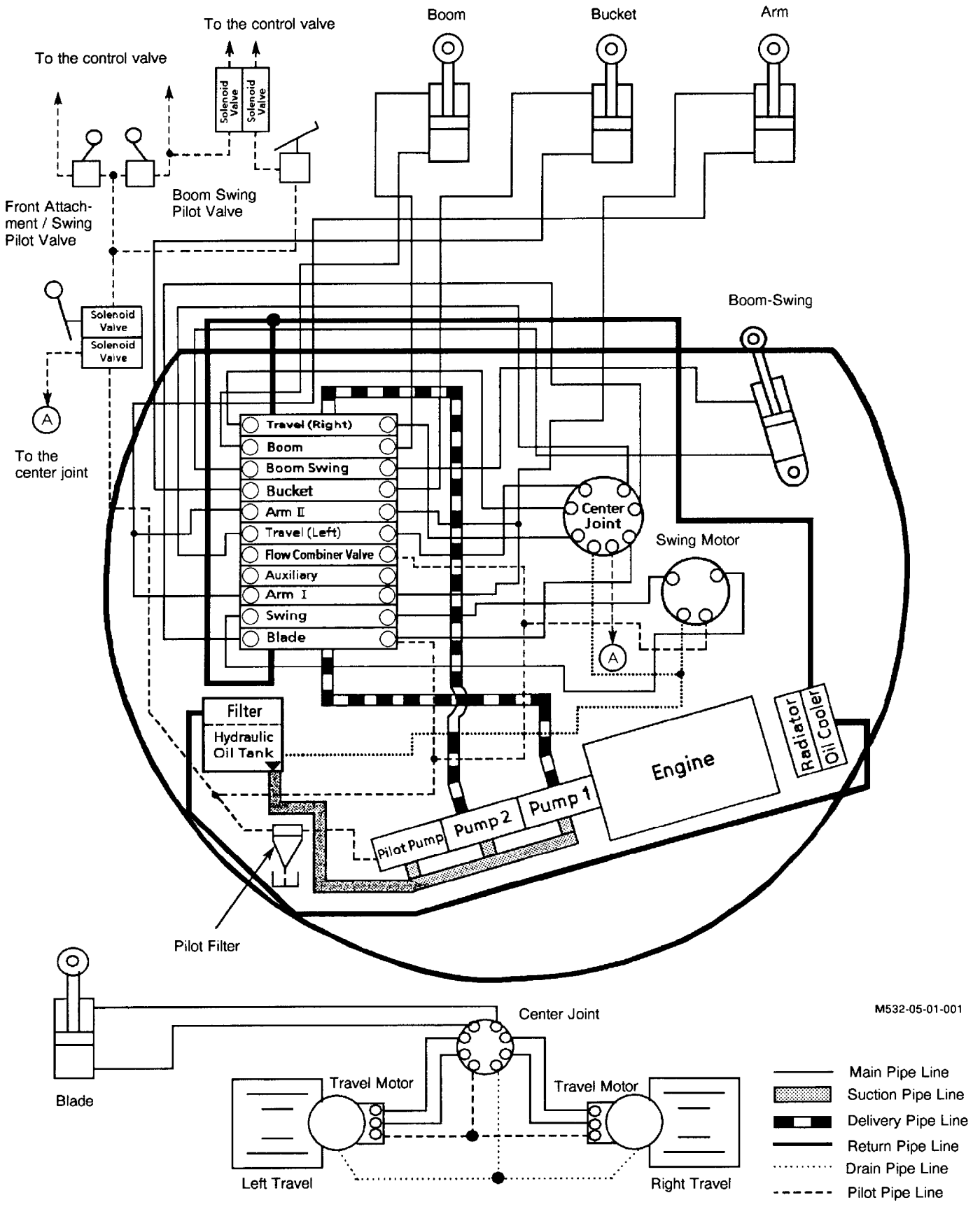
**33Mu**



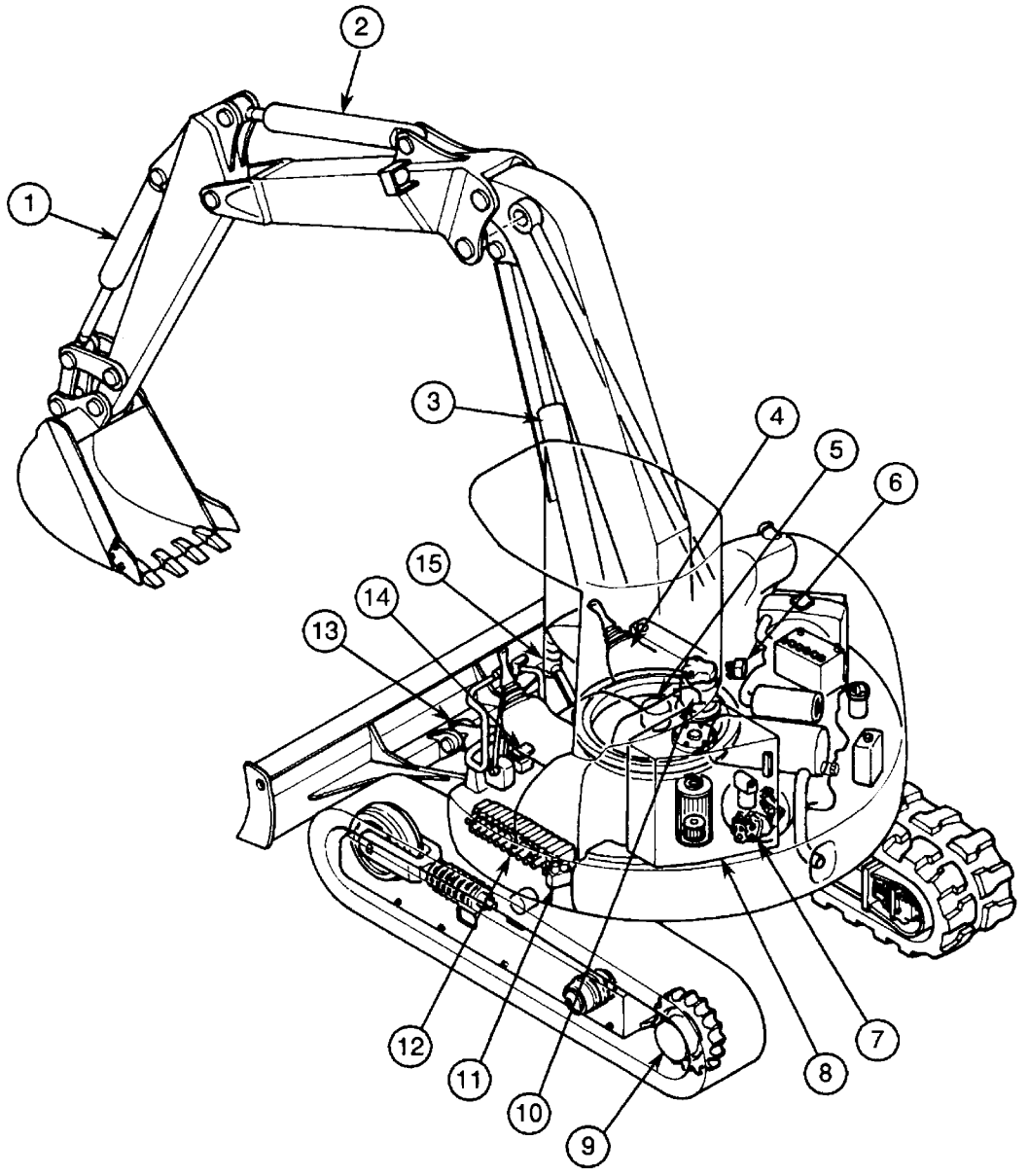

T532-01-01-001

1— Bucket Cylinder
2— Arm Cylinder
3— Boom Cylinder
4— Pilot Valve (Front Attachment)
5— Center Joint
6— Solenoid Valve (Pilot Control Shut-Off Lever / Travel Speed Control)
7— Pump Device
8— Hydraulic Oil Tank
9— Travel Device
10— Swing Device
11— Proportional Solenoid Valve (Auto Boom-Stop)
12— Control Valve
13— Blade Cylinder
14— Pilot Valve (Boom Swing)
15— Boom-Swing Cylinder

## Hydraulic Circuit 33Mu



58Mu




T533-01-01-001

1— Bucket Cylinder
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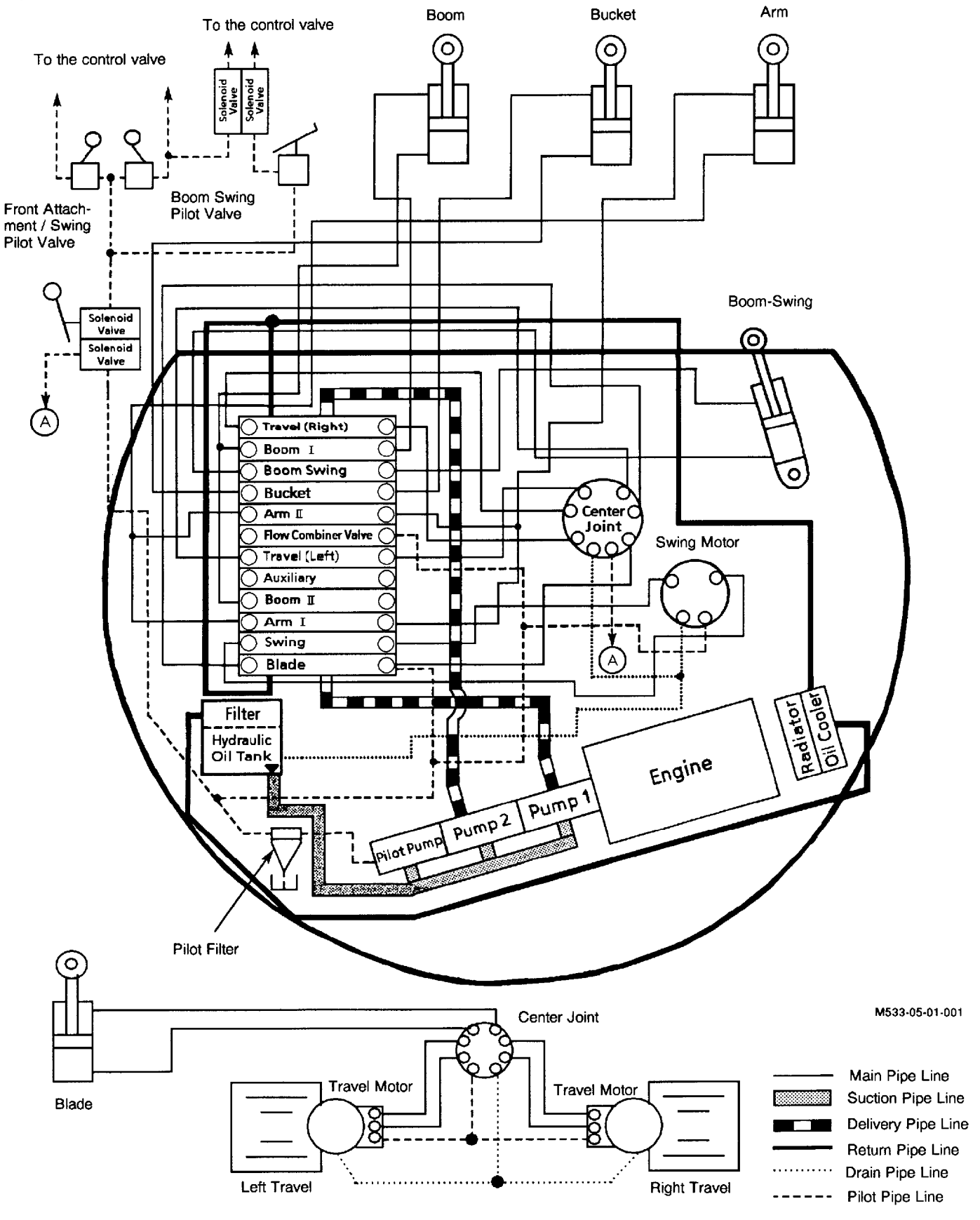
14— Pilot Valve (Boom Swing)
15— Boom-Swing Cylinder

## Hydraulic Circuit 58Mu



SECTION 06

# OPERATIONAL PERFORMANCE TEST

## CONTENTS

## PURPOSE

Performance tests are used to quantitatively check the performance level of each function and component.

Kinds of Tests

1. Machine Performance Tests: To check machines functional performances, such as those of the engine, travel, swing and hydraulic cylinders.
2. Hydraulic Component Performance Tests: To check function of each hydraulic component, such as hydraulic pumps, motors, and valves.

Purpose of Tests

1. To evaluate the function of each component by comparing measured data with specifications.
2. To restore machines performance to its original level by repairing or replacing components as necessary, based on test evaluation results.
3. To attain safe and economical machine operation.

Performance Standard

The performance standard is shown in this section as "STANDARD" to compare with when evaluating measured data.

Precautions for Evaluation

1. Be sure to take performance standards "STANDARD" into account when evaluating measured data.
2. Also, take machines total operation hours, working conditions, and past maintenance record into consideration.

As the machine is operated for a long period of time, performance gradually deteriorates. The expected machine performance level after repairing, replacing, or readjusting parts on an older machine must be realistically considered.

TERMINOLOGY

"STANDARD"

1. Specifications applied to the brand-new machine, or
2. Specifications applied to new, correctly-adjusted components and parts.

   Allowances are provided with the STANDARDS as necessary.

"ALLOWABLE LIMIT" or "MAXIMUM ALLOWABLE"

The lowest acceptable performance level.
When the performance of the machine falls below this level, the machine must be removed from work and repaired.
Parts and components must be replaced before their performance levels fall below this level.

At this level:

1. The normal machine operation is hard, and/or
2. Repairing or adjusting is difficult, or
3. Repairing or adjusting is impossible.

   Therefore, servicing the components or parts before falling to this level is required for effective machine operation at reasonable maintenance costs.

## PREPARATION FOR PERFORMANCE TESTS

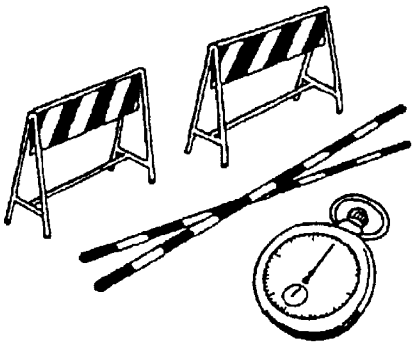
Observe the following rules in order to carry out performance tests accurately and safely.

The Machine

1. Before testing, inspect the machine. If any failure or damage is found, be sure to repair it beforehand.
2. Before testing, consult the record of daily and monthly inspections.
   Determine the extent to which they have been conducted properly.

Preparations

1. Select a firm, level surface, long enough to travel more than 20 m ( 65 ft 7 in. ) straight and wide enough to make a full swing with the front attachment fully extended.
2. Provide necessary tools and measuring instruments for testing. Utilize the Dr. EX when applicable.
3. Be sure to rope off the test area and provide signboards to keep unauthorized personnel out.
4. Provide required test weight or an object having an equivalent weight.



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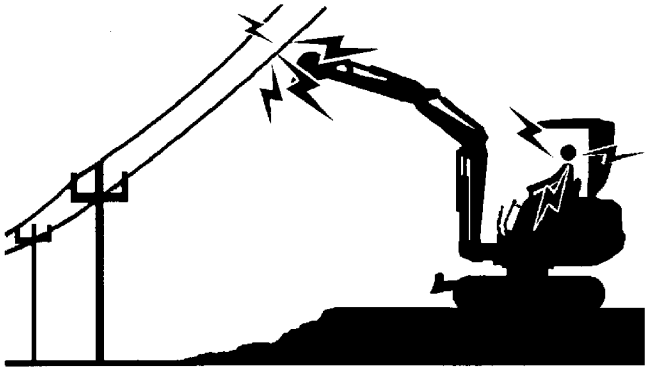
Precautions

1. Before testing, be sure to agree on the signals to be employed for communication among co-workers. Once the test is started, communicate with each other using these signals and be sure to follow them.
2. While testing, always pay attention to surroundings, such as ground stability, obstacles within and around the test area, power lines, etc., so as to operate the machine safely within the test area.
3. Operate the machine carefully and always give priority to safety.
4. When disconnecting hydraulic lines, be sure to drain hydraulic oil into proper containers, so as to avoid contaminating the ground or making the machine dirty.
5. After completing the test, be sure to clean the test area and the machine, and properly dispose of waste oil and any rags used in the cleaning.



SA-374

Make Precise Measurements

1. Accurately calibrate test instruments in advance in order to obtain correct data.
2. Perform tests under the exact test conditions prescribed for each test.
3. Repeat tests and reconfirm that the test data obtained matches repeatedly.
   Use mean values of multiple measurements.
4. Always strive to improve your testing techniques.

## 2.1 ENGINE SPEED

Be sure to check the engine speed before performing any kind of operational check, since it always affects test results.

**Preparation:**

1. Warm up the machine, until the engine coolant temperature reaches 50 °C ( 122 °F ) or more, and hydraulic oil temperature is 50 ± 5 °C ( 122 ± 9 °F ).
2. Move the engine speed control lever from slow idle to fast idle. Confirm that the fuel injection pump governor lever comes into contact with the slow-idle and fast-idle stoppers.
3. Connect an engine tachometer to the fuel injection line.

**Measurement:**

1. Slow idle.
   Start the engine. Place the engine speed control in the slow idle position and measure the speed of the engine.
2. Fast idle.
   Start the engine. Place the engine speed control in the fast idle position and measure the speed of the engine.

Optional

3. Auto-idle control (Optional)

3-1. Start the engine. Place the engine speed control in the fast idle position.

3-2. Move the bucket lever to the dig position and return it to neutral. After about four seconds, the engine speed will automatical reduce. Mesure the speed of the engine.

**Evaluation:**

Refer to T06-05 Standard.

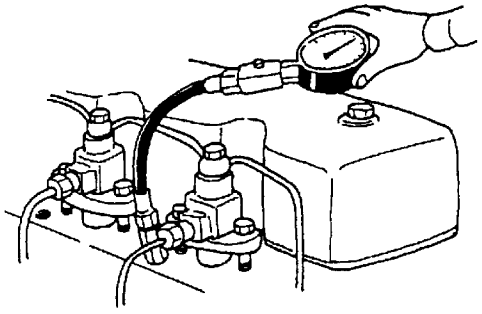
## 2.2 ENGINE COMPRESSION PRESSURE

1. Measure compression pressure in the cylinders to check for a reduction in engine power.
2. Check exhaust gas color and the amount of blow-by gas from the crankcase. Keep track of engine oil consumption.
3. Check for abnormalities in the intake system, including the air cleaner.

**Preparation:**

**33Mu**

1. Confirm that valve clearances are correct.
2. Confirm that the battery is charged properly.
3. Run the engine until the coolant temperature gauge reaches the operating range.
4. Stop the engine. Remove the injection nozzles from each cylinder.
5. Install an adaptor and compression gauge in place of the injection nozzles in one cylinder. (Be sure to sufficiently tighten the adaptor and compression gauge to prevent air leakage.)



T105-06-02-001

**58Mu**

1. Confirm that valve clearances are correct.
2. Confirm that the battery is charged properly.
3. Run the engine until the coolant temperature gauge reaches the operating range.
4. Stop the engine. Remove the glow plugs from each cylinder.
5. Install an adaptor and compression gauge in place of the glow plug in one cylinder. (Be sure to sufficiently tighten the adaptor and compression gauge to prevent air leakage.)

**Measurement:**

1. Turn the starter to crank the engine. Record the compression pressure of each cylinder.
2. Repeat measurement three times and calculate the mean value.

**Evaluation:**

Refer to T06-05 Standard.

## 2.3 VALVE CLEARANCE

*NOTE: 1. Measure while the engine is cool.*
*2. Before starting, clean the head cover and cover mounting vicinity to prevent dust from entering the engine.*

**Preparation:**

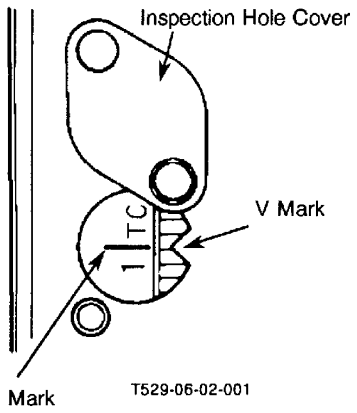
1. Remove the head cover.
2. Locate the top dead center (TDC) in the compression stroke. Refer to the following description for locating the TDC of No.1 piston
   33Mu: Align 『 1TC mark 』 on the flywheel with 『 V mark 』 on the rear end plate.
   58Mu: Align 『 Mark groove 』 on the crank pulley with 『 TDC mark 』 on the timing gear case cover.

*NOTE: Remove the glow plug on each cylinder to easily rotate the flywheel.*

**Measurement:**

1. Measure the valve clearance between the rocker arm and the valve.
2. When the measurement is started from No.1 cylinder, measure the clearance of the valves marked "○" in the following table.

33Mu



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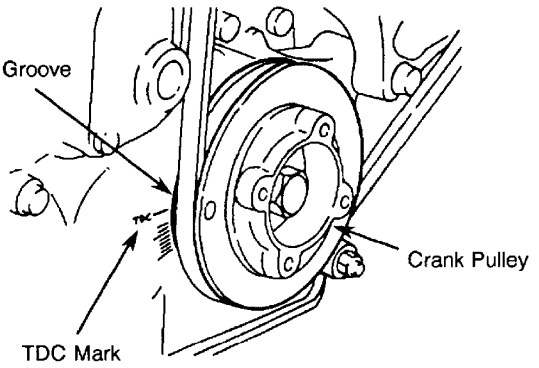
58Mu



T533-06-02-001

(33Mu)

| Cylinder No. | 1 | | 2 | | 3 | |
|---|---|---|---|---|---|---|
| Valve | I | E | I | E | I | E |
| Cylinder No.1 at top dead center | ○ | ○ | | ○ | ○ | |
| Cylinder No.2, 3 at top dead center | | | × | | | × |

(58Mu)

| Cylinder No. | 1 | | 2 | | 3 | | 4 | |
|---|---|---|---|---|---|---|---|---|
| Valve | I | E | I | E | I | E | I | E |
| Cylinder No.1 at top dead center | ○ | ○ | ○ | | | ○ | | |
| Cylinder No.4 at top dead center | | | | × | × | | × | × |

I : Intake Valve
E: Exhaust Valve

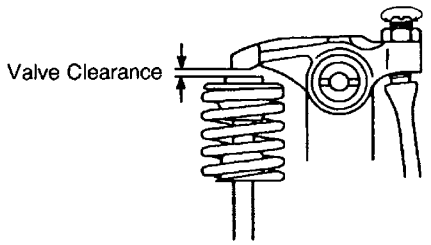
3. Turn the flywheel 360°. Then, measure the valve indicated with the mark "×."

**Evaluation:**

Refer to the Performance Standard Table in Group T06-05.

**Adjustment:**

If the results are outside the specification, adjust the clearance using the adjusting bolt. Then, lock the bolt with the lock nut.



T532-06-02-001

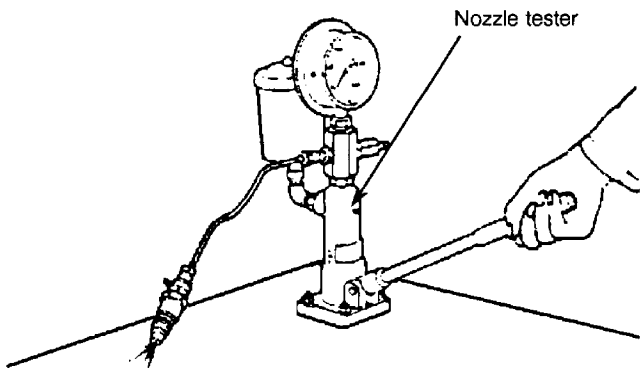
## 2.4 TEST FUEL INJECTION NOZZLES

**CAUTION: Never point the nozzle tip towards yourself or anyone else. Fuel from the spray orifices can penetrate skin and clothing, causing serious injury. For safety, enclose the nozzle in a transparent cover or glass beaker.**
**Before applying pressure to the nozzle tester, be sure that all connections are tight and that the fittings are not damaged. Fuel escaping from a very small hole can be almost invisible. Use a piece of cardboard or wood, rather than your hands, to search for suspected leaks.**
**If any fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury, or gangrene may result.**

Test for: Opening Pressure, Leakage, Chatter and Spray Pattern.

**Preparation:**
1. Before removing the nozzle holders, clean the area around the nozzle holders to prevent engine contamination.
2. Remove the nozzle holders, fuel injection lines and all related parts.
3. Connect the nozzle holder to the nozzle tester.

**Important: 1. Always use clean, filtered diesel fuel when performing tests.**
**2. Be sure to keep the test area clean.**
**3. Calibrate the nozzle tester monthly, to ensure correct measurement results.**



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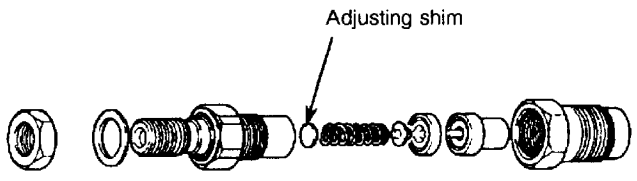


T523-06-02-002

**Test:**
1. Opening pressure test.
(1) Attach the injection nozzle to the nozzle tester. Forcibly operate the pump handle several times.

(2) Operate the pump handle at a speed of 60 strokes per minute and read the pressure.
Use the adjusting shims to adjust the pressure. Increasing the number of the shims increases the pressure, and vice versa.

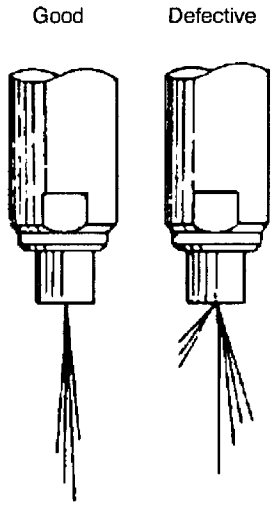
*NOTE: 58Mu: Adjusting shim 0.1 mm = 20.6 kPa (2.1 kgf/cm²)*
*33Mu: Adjusting shim 0.025 mm = 30 kPa (3 kgf/cm²)*

**Evaluation:**
Refer to T06-05 Standard.

2. Perform chatter and spray pattern test.

(1) Attach the injection nozzle to the nozzle tester.
Forcibly operate the pump handle several times.
Observe the spray pattern.
For this test, do not activate the pressure gauge.

Spray pattern standards
(1) No visibly coarse distribution
(2) No side distribution
(3) No post-injection dripping
(4) Gradual, detailed
(5) Correct injection angles



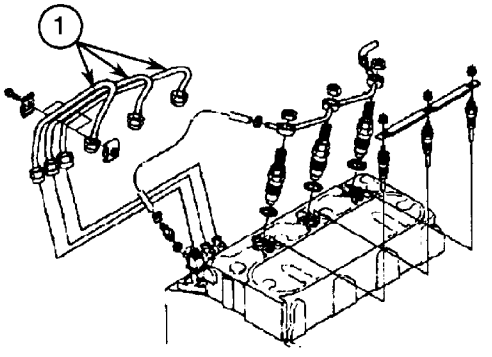

T523-06-02-001

## 2.5 INJECTION TIMING

**33Mu**

**Inspection:**

1. Remove injection Pipes (1).
2. While turning the flywheel counterclockwise, check that the fuel flows out of the injection pump delivery holder.
3. Rotate the flywheel until the "Angle mark" on the flywheel diameter comes close to the "V mark" on the flywheel housing.
4. Slowly rotate the flywheel further from this point. When the fuel starts to rise from the injection pump delivery holder, check that the "Angle mark" aligns with the "V mark." If these do not align, adjustment is required.

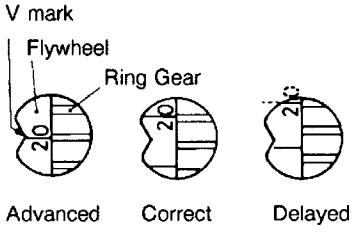



T523-06-02-004

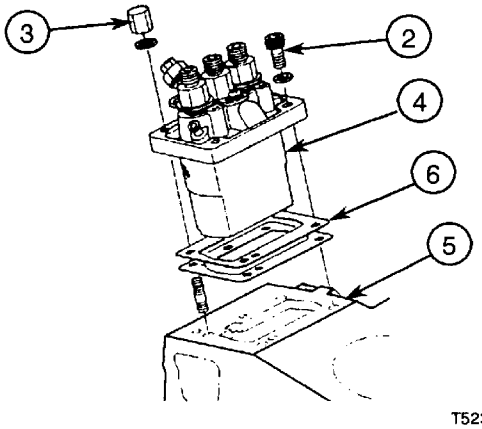
**Adjustment:**

1. Remove bolts (2) and nuts (3) for injection pump (4).
2. Adjust timing by either increasing or decreasing the number of shims (6) between injection pump (4) and body (5).
3. Increase the number of shims (6) to delay timing. Decrease the number of shims (6) to advance timing.

*NOTE: 0.15 mm shim thickness changes crank angle by 1.5 to 2.0°.*




T529-06-02-002

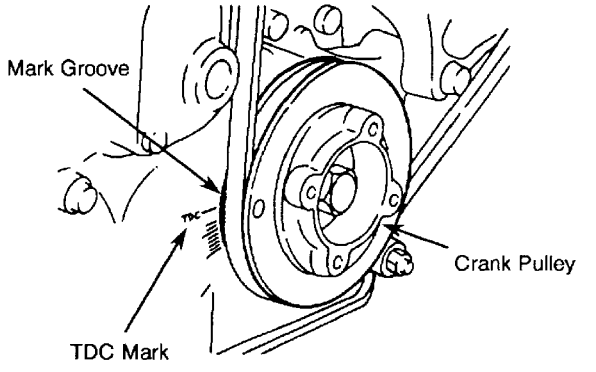



T523-06-02-003

**58Mu**

**Inspection**

1. Remove No.1 injection pipe (1).
2. Remove No. 1 delivery valve holder (2) for injection pipe (1). Take out delivery valve (4) and spring (3) and reconnect delivery valve holder (2) to injection pump (5).
   Tightening torque: 39 to 44 N·m (4 to 4.5 kgf·m)
3. Open the fuel filter lever.
4. Turn the key switch ON. While delivering the fuel by the fuel pump, slowly rotate the crank pulley clockwise. The moment the fuel delivery stops from the delvery valve holder end, check that the "Mark groove" on the crank pulley aligns with the "TDC mark" on the timing gear case cover. If these do not align, adjustment is required. (16° before the top dead center in the compression stroke)

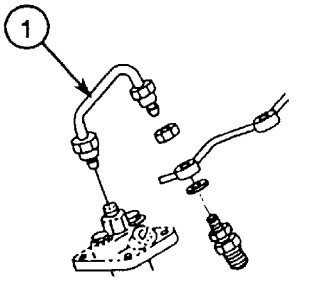



T533-06-02-001

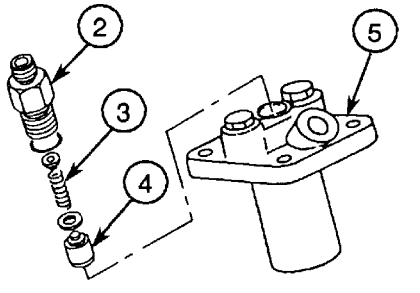
**Adjustment:**

1. Remove bolts (7) and nuts (6) for injection pump (5).
2. Adjust timing by either increasing or decreasing the number of shims (8) between injection pump (5) and body (9).
3. Increase the number of shims (8) to delay timing. Decrease the number of shims (8) to advance timing.

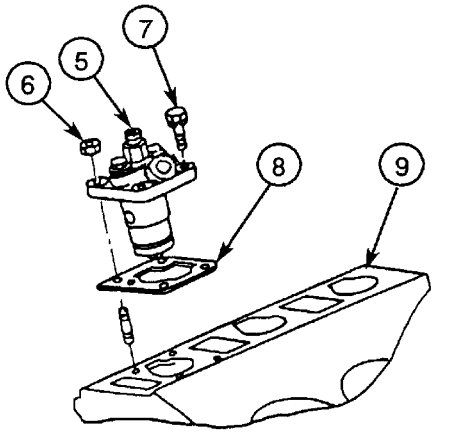
*NOTE: 0.1 mm shim thickness changes crank angle by 1°.*




T533-06-02-004




T533-06-02-003



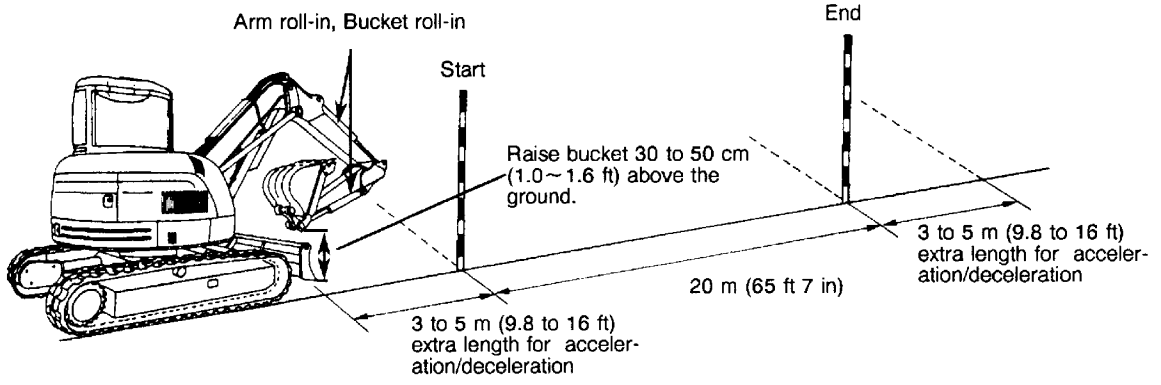

T533-06-02-002

## 3.1 TRAVEL SPEED

Measure the time required for the excavator to travel a 20 m test track.

**Preparation:**

1. Adjust the track sag of both tracks to be equal.
2. Prepare a level and solid test track 20 m (65 ft 7 in) in length, with an extra length of 3 to 5 m (9.8 to 16 ft) on both ends for machine acceleration and deceleration.
3. Hold the bucket 0.3 to 0.5 m (1.0~1.6 ft) above the ground with the arm and bucket rolled in.
4. Maintain the hydraulic oil temperature at 50° ± 5°C (122 ± 9°F).




T532-06-03-001

**Measurement:**

1. Start traveling the machine in the acceleration zone with the travel levers at full stroke.
2. Measure the time required to travel 20 m (65 ft 7 in).
3. After measuring the forward travel speed, turn the upperstructure 180° and measure the reverse travel speed.
4. Repeat steps (2) and (3) three times in each direction and calculate the mean values.

**Evaluation:**

Refer to T06-05 Standard.

**Corrective Action:**

Refer to T07-05 Troubleshooting.

## 3.2 TRACK REVOLUTION SPEED

With the track raised off ground, measure the track revolution cycle time to check the total track drive system.

**Preparation:**

1. Adjust the track sag of both side tracks equally.
2. On the track to be measured, mark one shoe with chalk
3. Swing the upperstructure 90° and lower the bucket to raise the track off ground. Keep the boom-arm angle between 90 to 110° as shown. Place blocks under the machine frame.
4. Maintain the hydraulic oil temperature at 50° ± 5°C (122 ± 9°C).

**Measurement:**

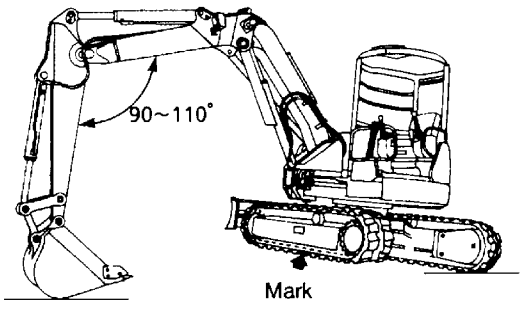
1. Operate the travel control lever of the raised track in full forward and reverse.
2. Measure the time required for 3 revolutions in both directions.
3. Raise the other track and repeat the procedure.
4. Repeat steps (2) and (3) three times for each track and calculate the mean values.

**Evaluation:**

Refer to T06-05 Standard.

**Corrective Action:**

Refer to T07-05 Troubleshooting.



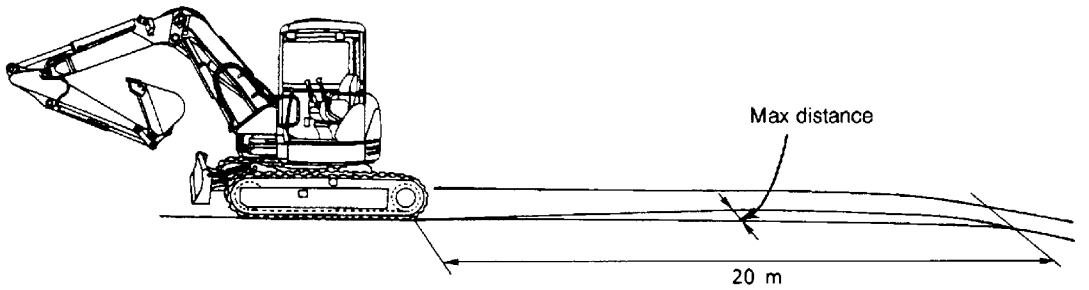

T532-06-03-002

## 3.3 MISTRACK CHECK

Measure the amount of mistrack from a 20 m (65 ft 7 in) straight line to check deviation between the right and left track drive system performance.

**Preparation:**

1. Adjust the track sag of both tracks equally.
2. Provide a level, solid test yard 20 m (65 ft 7 in) in length, with an extra length of 3 to 5 m (9.8 to 16 ft) on both ends for machine acceleration and deceleration.
3. Hold the bucket 0.3 to 0.5 m (1.0 to 1.6 ft) above the ground with the arm and bucket rolled in.
4. Maintain the hydraulic oil temperature at 50° ± 5°C (122 ± 9°F).




T532-06-03-003

**Measurement:**

1. Measure the amount of mistracking in 1st and 2nd travel speeds.
2. Start traveling the machine in the acceleration zone with the travel levers pushed fully forward.
3. Measure the distance between a straight 20 m (65 ft 7 in) line and the track made by the machine.
4. After measuring the tracking deviation in forward travel, swing the upperstructure 180° and measure that in reverse travel.
5. Repeat steps (3) and (4) three times in each direction and calculate the mean values.

**Evaluation:**

Refer to T06-05 Standard.

**Corrective Action:**

Refer to T07-05 Troubleshooting.

## 3.4 TRAVEL MOTOR LEAKAGE

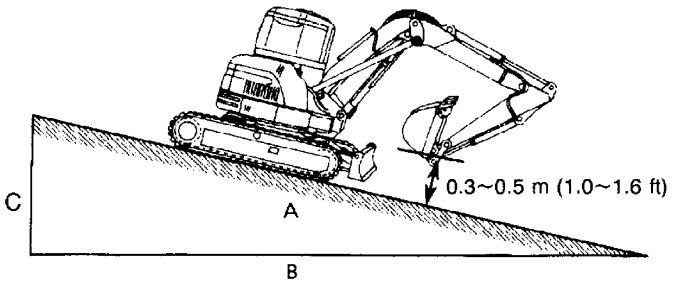
Measure the amount of travel motor slippage on a slope, which is due to travel motor inner oil leak.

**Preparation:**

1. The face of the test slope must be even, with a gradient of 15%.

Specified Gradient Calculation Table

| A | B | C |
|---|---|---|
| 1.0 | 0.97 | 0.26 |
| 1.04 | 1.0 | 0.27 |
| 3.86 | 3.74 | 1.0 |

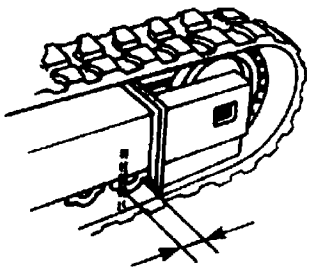



T532-06-03-004

2. Raise the bucket 30 to 50 cm (1.0 to 1.6 ft) above the ground with the arm and bucket cylinders fully extended(roiied in).
3. Maintain the hydraulic oil temperature at 50 ± 5°C (122 ± 9°F).

**Measurement:**

1. Climb the slope and place the travel levers in neutral.
2. Stop the engine.
3. After parking the machine, make aligning marks on the side frame and a track link or shoe.
4. After 3 minutes, measure discrepancy between the marks.



Amount of slippage after 5 minutes

T505-06-03-005

**Evaluation:**

Refer to T06-05 Standard.

**Corrective Action:**

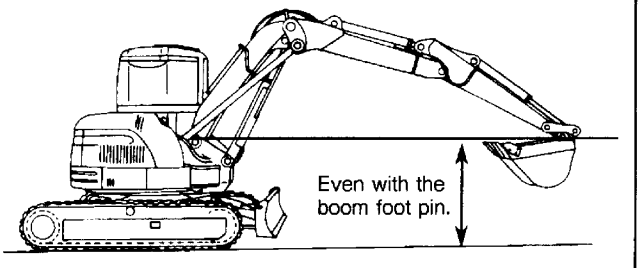
Refer to T07-05 Troubleshooting.

## 3.5 SWING SPEED

Measure the time required to swing three complete turns to check the total swing drive system.

**Preparation:**

1. Check the lubrication of the swing gear and swing bearing.
2. Place the machine on level, and solid ground with ample space for swinging. Do not conduct this test on slopes.
3. With the arm rolled out and bucket rolled in, hold the bucket so that the height of the bucket bottom is even with the boom foot pin. The bucket must be empty.
4. Maintain the hydraulic oil temperature at 50° ± 5°C (122 ± 9F°).




T532-06-03-005

**Measurement:**

1. Operate swing control lever fully.
2. Measure the time required to swing 3 turns in one direction.
3. Operate swing control lever fully in the opposite direction and measure the time required for 3 turns.
4. Repeat steps (2) and (3) three times each and calculate the average values.

**Evaluation:**

Refer to T06-05 Standard.

**Corrective Action:**

Refer to T07-05 Troubleshooting.

## 3.6 SWING FUNCTION DRIFT CHECK

To check the brake valve performance, measure the swing drift on the bearing outer circumference when stopping after a 90° full-speed swing.

**Preparation:**

1. Check the lubrication of the swing gear and swing bearing.
2. Place the machine on level, and solid ground with ample space for swinging. Do not conduct this test on slopes.
3. With the arm rolled out and bucket rolled in, hold the bucket so that the height of the bucket pin is even with the boom foot pin. The bucket must be empty.
4. Make two chalk marks: one on the swing bearing and one directly below it on the track frame.
5. Swing the upperstructure 90°.
6. Maintain the hydraulic oil temperature at 50° ± 5°C (122 ± 9°F).

**Measurement:**

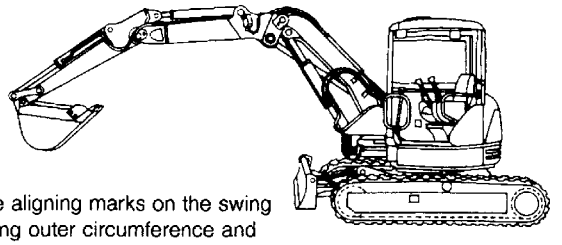
1. Operate the swing control lever fully to swing the upperstructure. When the aligning mark on the swing bearing and track frame meet, return the swing lever to the neutral position.
2. After the swing movement stops, measure the arc length between two aligning marks along the circumference of the swing bearing.
3. Align the marks again, swing 90°, and then test in the opposite direction.
4. Repeat steps (4) and (5) three times each and calculate the mean values.

**Evaluation:**

Refer to T06-05 Standard.

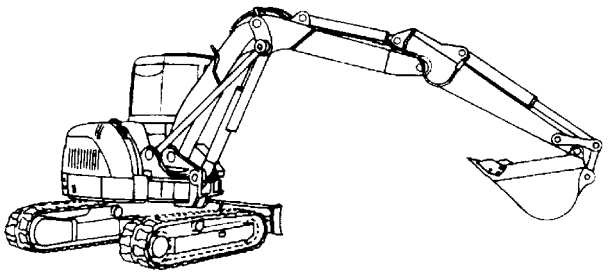
**Corrective Action:**

Refer to T07-05 Troubleshooting.



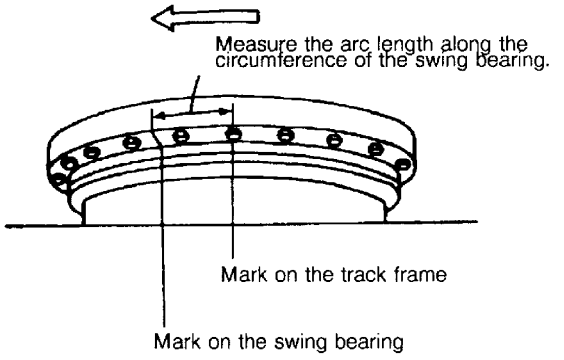
Make aligning marks on the swing bearing outer circumference and track frame.

T532-06-03-006



Swing the upperstructure 90° to the test start position.

T532-06-03-007




T505-06-03-009

## 3.7 SWING MOTOR LEAKAGE

To check for swing motor leakage, measure the upperstructure drift after parking the machine on a slope with the upperstructure positioned 90° to the slope.

**Preparation:**

1. Check the lubrication of the swing gear and swing bearing.
2. Park the machine on a flat slope with a gradient of 26.8 %.
3. Roll the arm out, roll the bucket in, and position the arm top pin height evenly with the boom foot pin. Be sure not to operate the boom swing function during the test.

Check under two conditions :

(1) With a rated load in the bucket.
(2) With no load in the bucket.

*NOTE: Rated load (tons) = 1.5 × bucket capacity ($m^3$)*
*Measure swing cylinder leakage at the same time on the extended side.*

Specified Gradient Calculation Table

| A | B | C |
|---|---|---|
| 1.0 | 0.97 | 0.26 |
| 1.04 | 1.0 | 0.27 |
| 3.86 | 3.74 | 1.0 |

4. Climb the slope, then swing the upperstructure 90° toward the slope. Make aligning marks on the swing bearing circumference and track frame. Then, make aligning marks on the swing cylinder rod.
5. Maintain the hydraulic oil temperature at 50 ± 5°C (122 ± 9°F).

**Measurement:**

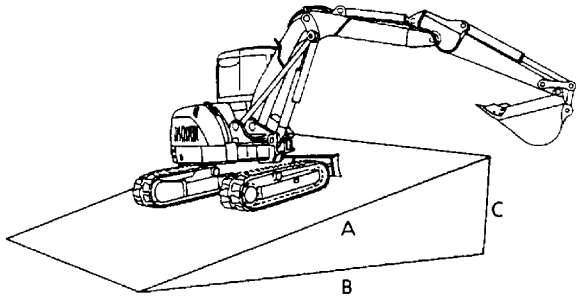
1. Stop the engine. After five minutes, measure the difference between the marks along the swing bearing periphery and the track frame. At this time, measure the swing cylinder leak amount while extending.
2. Perform the measurement on both right and left swing directions.
3. Perform the measurement three times in each direction and calculate the average values.

**Evaluation:**

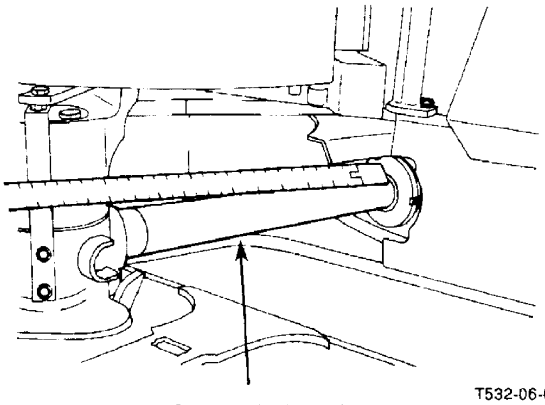
Refer to T06-05 Standard.

**Corrective Action:**

Refer to T07-05 Troubleshooting.



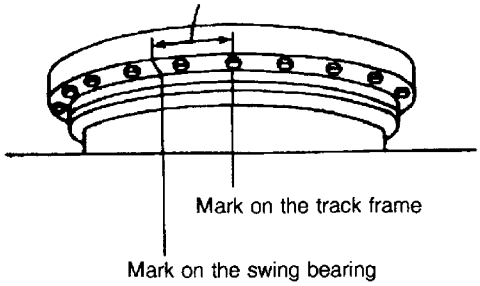

T532-06-03-008



T532-06-03-009

Swing cylinder rod

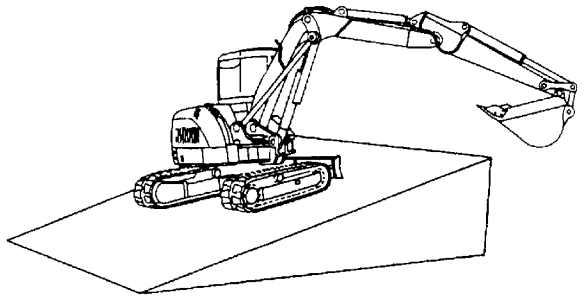
Measure the arc length along circumference of the swing bearing




T505-06-03-009

## 3.8 MAXIMUM SWINGABLE SLANT ANGLE

With the upperstructure swung 90°toward the track, check the maximum slope angle on which the upperstructure can swing to the uphill side.
Maintain the hydraulic oil temperature at 50° ± 5°C (122 ± 9°F).



T532-06-03-008

**Preparation:**

1. Check that the swing gear and swing bearing are sufficiently lubricated.
2. With the arm cylinder fully retracted and the bucket cylinder fully extended, hold the bucket pin so that the boom foot pin is level with the bucket pin without swinging the boom. Test the machine with the rated bucket loads[Bucket Capacity($m^3$) × 1.5(ton/$m^3$)]
3. Climb the slope and rotate the upperstructure 90° toward the track.

**Measurement:**

1. Fully stroke the swing lever to rotate the upperstructure to the uphill side.
2. When the machine can swing, measure the cab floor slant angle.
3. Increase the slope angle and repeat steps (1 and 2) in both clockwise and counterclockwise directions.
4. Repeat step (3) three times and calculate the mean values.

**Evaluation:**

Refer to T06-05 Standard.

**Corrective Action:**

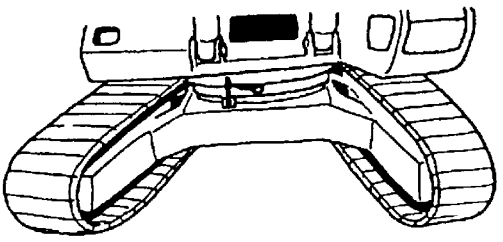
Refer to T07-05 Troubleshooting.

## 3.9 SWING BEARING PLAY

Measure the swing bearing play using a dial gauge to check the wear of bearing races and balls.

**Preparation:**

1. Check swing bearing mounting bolt for looseness.
2. Check the lubrication of the swing bearing. Confirm that bearing rotation is smooth and noiseless.
3. Install a dial gauge on the track frame as shown, employing a magnetic base.
4. Position the upperstructure so that the boom aligns with the tracks facing towards the front idlers.
5. Position the dial gauge so that its needle point comes into contact with the bottom face of the bearing outer race.
6. Bucket should be empty.

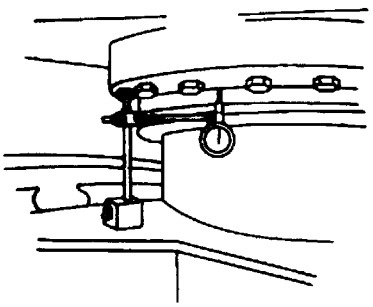


T105-06-03-014

**Measurement:**

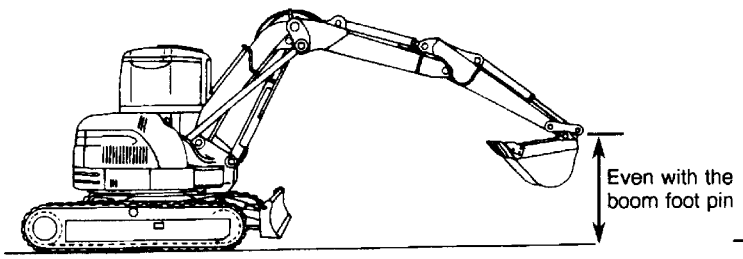
1. With the arm rolled out and bucket rolled in, hold the bucket so that the height of the bucket pin is even with the boom foot pin. Record the dial gauge reading ($h_1$).
2. Lower the bucket to the ground and use it to raise the front idler 50 cm (1.6 ft). Record the dial gauge reading ($h_2$).
3. Calculate bearing play (H) from this data ($h_1$ and $h_2$) as follows:

$$H = h_2 - h_1$$



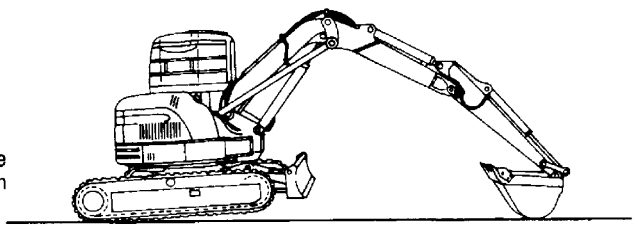
T505-06-03-012

Measurement of ($h_1$)




T532-06-03-005

Measurement of ($h_2$)



T532-06-03-010

**Evaluation:**

Refer to T06-05 Standard.

**Corrective Action:**

Refer to T07-05 Troubleshooting.

## 3.10 HYDRAULIC CYLINDER CYCLE TIME

To check overall hydraulic system performance, measure the cycle time of the boom, arm, bucket, boom swing and blade cylinders. (Test the machine with the standard arm and bucket attached.)

Maintain the hydraulic oil temperature at 50° ± 5°C (122 ± 9°F).

1. To measure the cycle time of the boom cylinder:
   With the arm rolled out and the empty bucket rolled in, lower the bucket to the ground, as shown.
   Measure both the times it takes to raise the boom and to lower the boom while operating the control lever full stroke.

2. To measure the cycle time of the arm cylinder:
   With the empty bucket rolled in, position the arm so that it is vertical to the ground. Lower the boom until the bucket is 50 cm (1.6 ft) above the ground.
   Measure both the times it takes to roll in the arm and to roll out the arm while operating the control lever full stroke.

3. To measure the cycle time of the bucket cylinder:
   With the bucket empty, adjust the boom and arm so that the bucket cylinder middle stroke position is vertical to the ground, as illustrated.
   Measure both the times it takes to roll in the bucket and to roll out the bucket while operating the control lever full stroke.

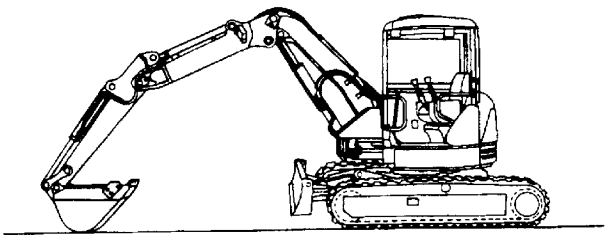
4. To measure the cycle time of the boom swing cylinder:
   Fully retract or extend the boom swing cylinder.
   Measure both the times it takes to swing the boom fully from left to right and to swing the boom from right to left while operating the control lever full stroke.

5. To measure the cycle time of the blade cylinder:
   Use the boom and arm to raise the front of the machine off the ground high enough to operate the blade cylinder full stroke.
   Measure both the times it takes to raise the blade and to lower the blade while operating the blade control lever full stroke.

Repeat each maasurement three times and calculate the mean values.

**Evaluation:**
Refer to T06-05 Standard.

**Corrective Action:**
Refer to T07-05 Troubleshooting.



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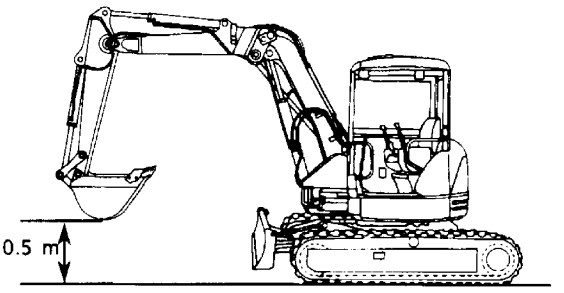
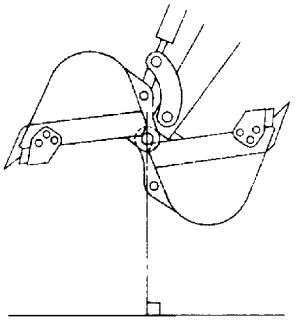



T532-06-03-013



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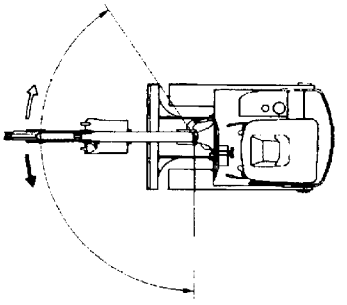
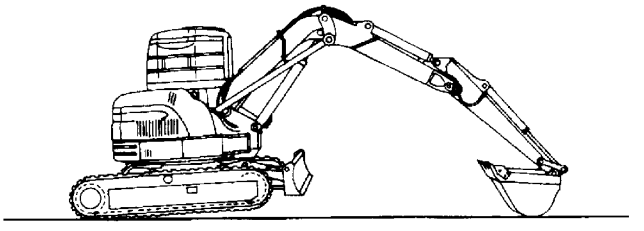


T523-06-03-006



T532-06-03-010

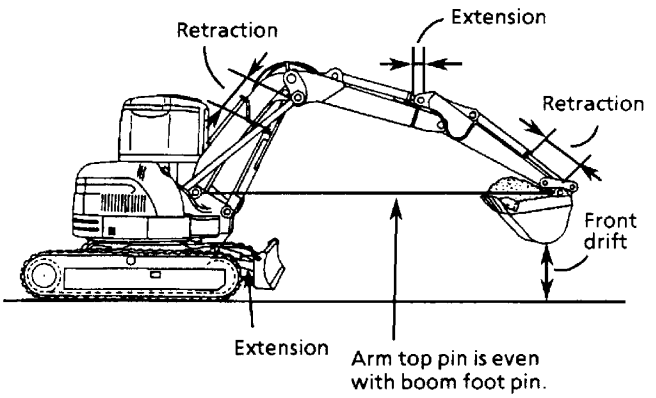
## 3.11 DIG FUNCTION DRIFT CHECK

With the bucket loaded, measure dig function drift, which can be caused by oil leakage in the control valve and/or boom, arm, and bucket cylinders.

*NOTE: When testing the dig function drift just after cylinder replacement, slowly operate each cylinder to its stroke end to purge trapped air prior to testing.*

Maintain the hydraulic oil temperature at 50° ± 5°C (122 ± 9°F).

1. Load bucket fully. Calculate the load weight using the following formula.
   $W = V \times 1.5$
   where: V = Bucket heaped to capacity ($m^3$)
   1.5 = Soil specific gravity
2. Fully extend the bucket cylinder, then retract it 20 to 30 mm (approx. an inch).
3. Fully retract the arm cylinder, then extend it 20 to 30 mm (approx. an inch).
4. Hold the bucket so that the height of the bucket pin is even with the boom foot pin.




T532-06-03-011

**Measurement:**

1. Stop the engine.
2. Wait for one minute, then mark start points for measurement.
3. After five minutes, measure boom and bucket cylinder retraction, arm cylinder extension, and amount of bucket drift.
4. Repeat step (2) three times and calculate the mean values.

**Evaluation:**

Refer to T06-05 Standard.

**Corrective Action:**

Refer to T07-05 Troubleshooting.

## 3.12 CONTROL LEVER AND PEDAL OPERATING FORCE

Use a spring scale to measure the maximum force needed to move each control lever and pedal.
Measure the operating force at the center of each lever grip.
Maintain the hydraulic oil temperature at 50° ± 5°C (122 ± 9°F).

**Measurement:**

1. Start the engine.
2. Operate each boom, arm, bucket, blade, swing lever and boom swing pedal full stroke. Measure the maximum operating force.
3. When measuring the operating force of the travel levers, raise one track off the ground with the front attachment, and operate the control lever of that track full stroke. Measure the maximum operating force.
4. When measuring the operating force of the engine speed control lever, do so while moving the engine speed control lever from the slow idle position to the fast idle position.
5. Repeat each measurement three times and calculate the mean values.

**Evaluation:**

Refer to T06-05 Standard.

## 3.13 CONTROL LEVER AND PEDAL STROKE

Measure each lever stroke at the center of each lever grip. Measure the boom swing pedal stroke at the top of the pedal.

**Preparation:**
Maintain the hydraulic oil temperature at 50° ±5°C (122 ± 9°F).

**Measurement:**
1. Stop the engine.
2. Measure the boom, arm, bucket, blade, swing, and travel control lever strokes at the grip top center from the neutral position to the stroke end.
   Measure the boom-swing pedal stroke at the pedal tip end by depressing the pedal to the stopper from the neutral position.
   Measure the fuel control lever stroke at the grip top center from the slow idle position to the fast idle position.
3. Take the measurements of straight stroke distances.
4. Conduct the measurement three times. Compute the average.

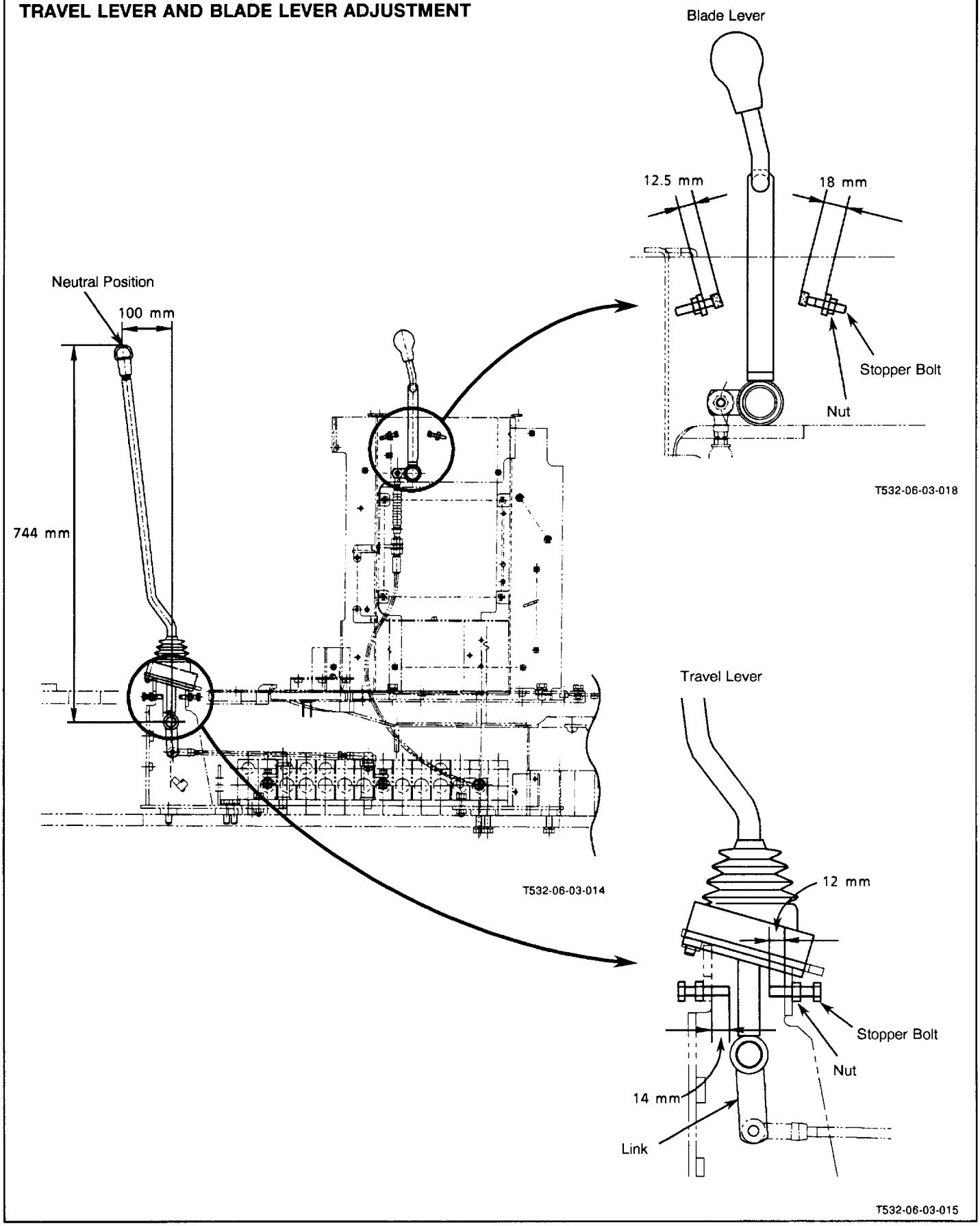
**Evaluation:**
Refer to T06-05 Standard.

**Adjustment:**
- Stroke adjustment of the travel lever, blade lever, and boom-swing pedal.

**IMPORTANT: Before adjusting the travel lever strokes, set the neutral position upright as illustrated.**

1. Remove the covers and related parts around the levers.
2. Loosen the stopper bolt and nuts.
3. Operate each lever and pedal to move the spool in the control valve to the stroke end.
4. Tighten the stopper bolt until the stopper bolt end comes in contact with the link or pedal. Then, tighten the nut.

## TRAVEL LEVER AND BLADE LEVER ADJUSTMENT



- Adjustment of The Engine Speed Control Lever

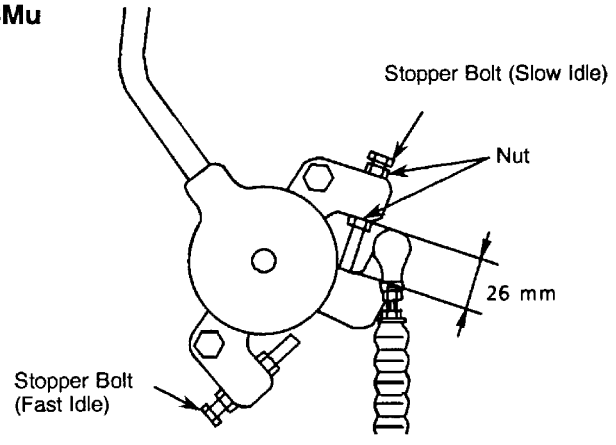
**IMPORTANT: Never adjust the governor lever stopper positions for the slow and fast idle speeds.**

1. Remove the covers nearby.
2. Loosen the stopper bolt lock nuts.
3. Adjust the stretched length of the slow idle stopper bolt to the specification, and tighten the nuts.

   Specifications of the stretched length of the slow idle stopper bolt:
   33Mu: 26 mm
   58Mu: 23 mm

   Move the engine speed control lever until the lever comes into contact with the slow idle stopper. Check that the governor lever comes into contact with the slow idle stopper at the same time. (If not, adjust the cable length.)
4. Operate the engine speed control lever until the governor lever comes into contact with the fast idle stopper. Tighten the engine speed control lever fast idle stopper bolt so that the clearance between the engine speed control lever and the stopper bolt is 1 to 2 mm. Then, secure the bolt with the nut in this position.

**33Mu**

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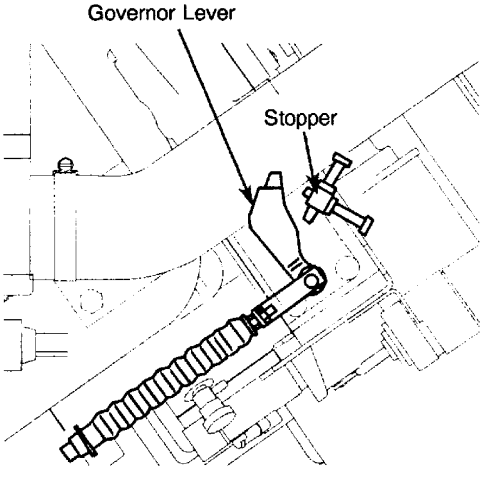


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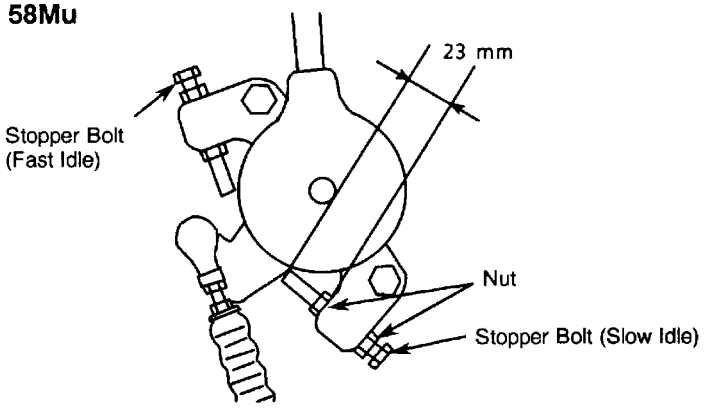
**58Mu**

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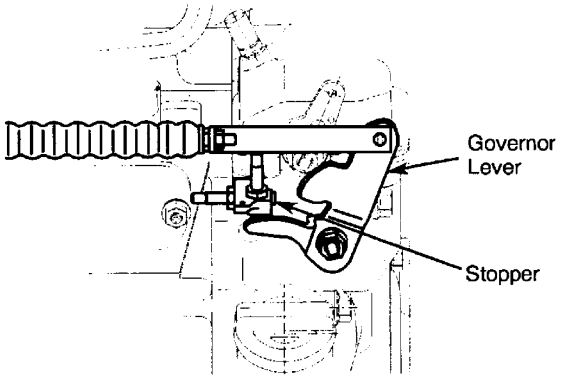



T533-06-03-002

## 4.1 PILOT PRESSURE

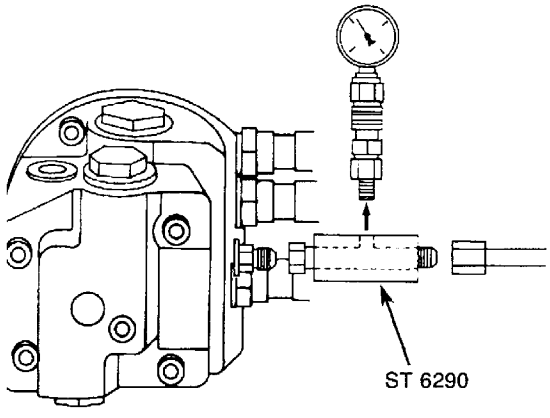
**Preparation:**

1. Maintain the hydraulic oil temperature at 50° ± 5°C (122 ± 9°F).
2. Stop the engine.
3. Loosen the hydraulic oil tank cap to release air pressure trapped in the hydraulic oil tank.
4. Install adapter (ST6290 or ST6451) and pressure gauge assembly (ST6932) to the travel motor pilot pipe line.

: 19 mm, 22 mm

5. Start the engine. Check that no oil is leaking around the gauge connection port.

33Mu




T505-06-04-001

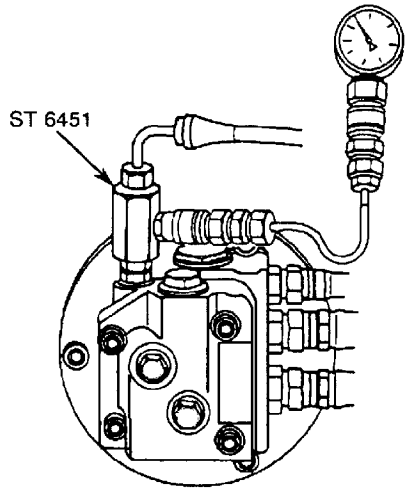
**Measurement:**

1. Measure the pressure at fast idle speed.

| Engine Speed | Fast Speed Travel Pedal |
|---|---|
| Maximum Speed | PUSH |

2. Raise one track off the ground with the front attachment. While operating the control lever for the raised track full stroke, measure the pilot pressure by the pressure gauge.
3. Repeat step (2) three times for each track and calculate the average values.

58Mu




T554-06-04-001

**Evaluation:**

Refer to T06-05 Standard.

**Corrective Action:**

Refer to T07-05 Troubleshooting.

## 4.2 MAIN RELIEF VALVE PRESSURE SETTING

**Summery:**
The main relief valve set pressure is measured at the main pump delivery port.

**Preparation:**
1. Maintain the hydraulic oil temperature at 50° ± 5°C (122 ± 9°F).
2. Stop the engine.
3. Loosen the hydraulic oil tank cap to release air pressure trapped in the hydraulic oil tank.
4. Remove the plug from the pressure check port provided in the main pump delivery port.
   Install nipple (ST6069) and pressure gauge (ST6933) to the plug port.

: 9 mm, 17 mm

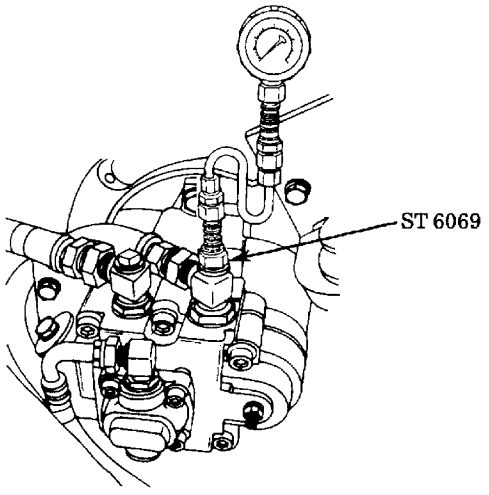
5. Start the engine. Check for oil leakage around the gauge connection port.

**Measurement:**
1. Measure the pressure at fast idle speed.
2. Slowly operate each control lever of the bucket, arm, boom, or blade. Move each cylinder to the stroke end to relieve each function.
3. When measuring with the swing function, secure the upperstructure so that it is immovable. Slowly operate the swing lever to relieve the swing function.
4. When measuring with the travel function, secure the tracks against an immovable object. Slowly operate the travel lever to relieve the travel function.
5. Measure the relief pressure of each functions.
6. Repeat steps 2 through 4 three times and calculate the average values.

**Evaluation:**
Refer to T06-05 Standard.

*NOTE: In case the pressures in all functions are lower than the specification, a reduced set pressure of the main relief valve is the probable cause of the trouble.*
*In case the pressure in only a particular function is lower, the probable cause is other than the main relief valve.*

33Mu

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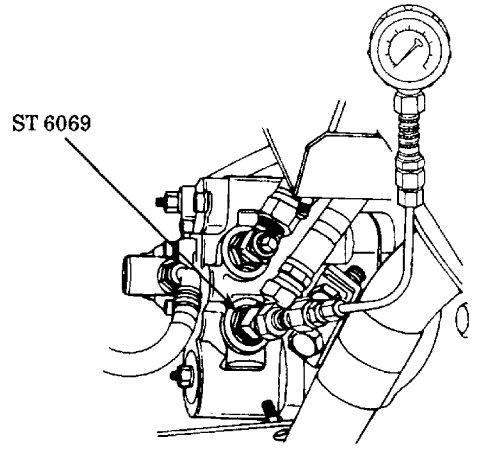
58Mu

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## 4.3 OVERLOAD RELIEF VALVE PRESSURE SETTING

Checking the pressure setting of the overload relief valves on the machine is not recommended for the following reasons:

1. With the return circuit from the control valve blocked, the circuit pressure must be increased by applying an external load. This checking method is hazardous and the results obtained with this method are unreliable.

2. Pressure setting of the overload relief valve must be made at a specified oil flow rate normally far smaller than the delivery flow rate of the main pump. Accordingly, even if the main relief valve pressure setting can be reset higher than the setting pressure of the overload relief valve, the main pump supplies too much oil to correctly measure the setting pressure of the overload valve.

   Therefore, when the setting pressure of the overload relief valve must be checked correctly, remove the overload relief valve from the machine and check the overload relief valve unit performance using the test stand prepared for this purpose.

3. As an easier method, however, measure each relief pressure of the front operation. Then, when each relief pressure meets its respective specifications, judge that the setting pressure of the overload relief valve is correct.

## 4.4 SWING MOTOR RELIEF VALVE PRESSURE SETTING

**Summery:**
Swing motor relief valve set pressure is checked by measuring the differential pressure between the motor inlet and outlet.

**Preparation:**
1. Maintain the hydraulic oil temperature at 50° ± 5°C (122 ± 9°F).
2. Stop the engine.
3. Loosen the hydraulic oil tank cap to release air pressure trapped in the hydraulic oil tank.
4. Remove the plug from the pressure check port of the swing brake valve. Install seal washer (ST6361), nipple (ST6069) and pressure gauge assembly (ST6933) to the port.

: 6 mm

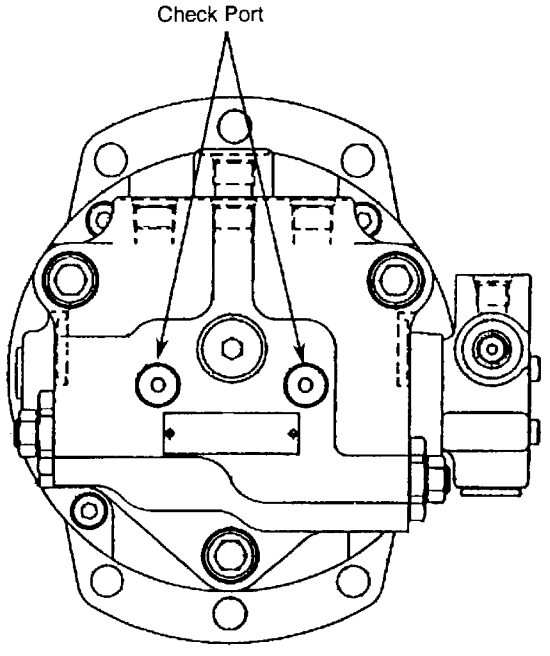
: 9 mm, 17 mm

**Measurement:**
1. Be sure to measure the relief pressure at fast idle speed.
2. Lock the upperstructure by carefully placing the front attachment against an immovable object.
3. Slowly operate the control lever for swing function at full stroke over relief pressure.
4. Measure the relief pressure of swing function using a pressure gauge.
5. Repeat measurement three times at both left and right sides. Calculate mean values.

**Evaluation:**
Refer to T06-05 Standard.

**Corrective Action:**
When the swing relief pressure is not within specifications, replace it.
Adjust the setting pressure of the relief valve using the test stand prepared for this purpose.

EX33Mu

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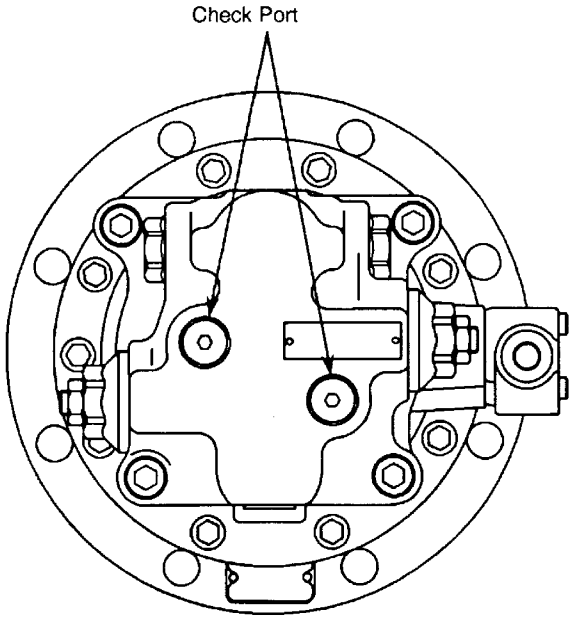
EX58Mu




T533-06-04-001

## PERFORMANCE STANDARD TABLE

Refer to Group T06-02 and after for the relevant measurement procesures.

*Measure at oil temperaure of 50 ± 5 ℃ unless specified.

| | Item \ Model | 33Mu | 58Mu | |
|---|---|---|---|---|
| 2-1 | **Engine Speed** (min$^{-1}$) | | | |
| | Fast Idle Speed | 2 140 ± 50 | 2 230 ± 50 | |
| | Slow Idle Speed | 975 ± 50 | 1 000 ± 50 | |
| 2-2 | **Engine Compression Pressure** (After warming up operation) (kgf/cm$^2$) | 35≦ | 31≦ | |
| 2-3 | **Valve Clearance** (mm) | 0.18 ~ 0.22 | 0.40 ± 0.05 | |
| 2-4 | **Nozzle Injection Pressure** (kgf/cm$^2$) | 140 | 135 | |
| 2-5 | **Injection Timing** (Before TDC) | 16° | 16° | |
| 3-1 | **Travel Speed** (sec/20 m) | | | |
| | Fast Speed (Rubber/Steel) | 18.5 ± 1.5 / 19.0 ± 1.5 | 16.6 ± 1.5 / 17.6 ± 1.5 | |
| | Slow Speed (Rubber/Steel) | 30.0 ± 1.5 / 31.0 ± 1.5 | 26.5 ± 1.5 / 28.4 ± 1.5 | |
| 3-2 | **Track Revolution Speed** (sec/3 rev) | | | |
| | Fast Speed (Rubber/Steel) | 12.1 ± 1.5 / 12.3 ± 1.5 | 13.2 ± 1.5 / 13.9 ± 1.5 | |
| | Slow Speed (Rubber/Steel) | 19.8 ± 1.5 / 20.2 ± 1.5 | 22.1 ± 1.5 / 22.4 ± 1.5 | |
| 3-3 | **Mistrack** (mm/20 m) | | | |
| | Fast Speed | | | |
| | Slow Speed | 200≧ | 200≧ | |
| 3-4 | **Travel Motor Leakage** (mm/3 min) | 60≧ | 60≧ | |
| 3-5 | **Swing Speed** (sec/3 rev) | 18.9 ± 1.0 | 17.1 ± 1.0 | |
| 3-6 | **Swing Function Drift** (mm/90°) | 300≧ | 300≧ | |
| 3-7 | **Swing Motor Leakage** (mm/5 min) | 0 | 0 | |
| | **Boom Swing Cylinder Drift Check** (mm/5 min) | 3≧ | 3≧ | |
| 3-8 | **Maximum Swingable Slant Angle** | 15≦ | 15≦ | |
| 3-9 | **Swing Bearing Play** (mm) | 0.6≧ | 0.4≧ | |
| 3-10 | **Hydraulic Cylinder** (sec) | | | |
| | Boom Raise | 2.8 ± 0.8 | 3.0 ± 0.8 | |
| | Boom Lower | 1.8 ± 0.3 | 2.7 ± 0.3 | |
| | Arm Roll-in | 2.5 ± 0.3 | 3.1 ± 0.3 | |
| | Arm Roll-out | 2.2 ± 0.3 | 2.2 ± 0.3 | |
| | Bucket Roll-in | 2.9 ± 0.3 | 4.0 ± 0.3 | |
| | Bucket Roll-out | 2.0 ± 0.3 | 2.8 ± 0.3 | |
| | Right Boom Swing | 7.0 ± 1.0 | 7.5 ± 1.0 | |
| | Left Boom Swing | 6.5 ± 1.0 | 8.0 ± 1.0 | |
| | Blade Raise | 2.0 ± 0.5 | 2.0 ± 0.5 | |
| | Blade Lower | 2.0 ± 0.5 | 2.0 ± 0.5 | |

*NOTE: 1 kgf/cm$^2$ = 98.07 kPa*

# OPERATIONAL PERFORMANCE TEST / Standard

| | Item \ Model | 33Mu | 58Mu | |
|---|---|---|---|---|
| 3-11 | **Cylinder Drift Check** (mm/5 min) | | | |
| | Boom Cylinder(Retraction) | 10≧ | 10≧ | |
| | Arm Cylinder(Extension) | 10≧ | 15≧ | |
| | Bucket Cylinder(Retraction) | 10≧ | 10≧ | |
| | Blade Cylinder(Extension) | 3≧ | 3≧ | |
| | Dig Function Drift | 150≧ | 150≧ | |
| 3-12 | **Control Lever and Pedal Operating Force** (kgf) | | | |
| | Boom | 1.5≧ | 1.5≧ | |
| | Arm | 1.5≧ | 1.5≧ | |
| | Bucket | 1.5≧ | 1.5≧ | |
| | Swing | 1.5≧ | 1.5≧ | |
| | Travel | 2.0≧ | 2.0≧ | |
| | Blade | 2.5≧ | 2.5≧ | |
| | Boom Swing | 8.0≧ | 8.0≧ | |
| | Engine Speed Control | 5.0≧ | 5.0≧ | |
| 3-13 | **Control Lever and pedal Stroke** (mm) | | | |
| | Boom | 93 ± 5 | 93 ± 5 | |
| | Arm | 93 ± 5 | 93 ± 5 | |
| | Bucket | 93 ± 5 | 93 ± 5 | |
| | Swing | 93 ± 5 | 93 ± 5 | |
| | Travel | 93 ± 10 | 98 ± 10 | |
| | Blade | 70 ± 10 | 70 ± 10 | |
| | Boom Swing | 14 ± 5 | 14 ± 5 | |
| | Engine Speed Control | 163 ± 10 | 163 ± 10 | |
| 4-1 | **Pilot Pressure** ($kgf/cm^2$) | 65 ± 5 | 65 ± 5 | |
| 4-2 | **Main Relief Valve Pressure Setting** ($kgf/cm^2$) | 220 ± 10 | 260 ± 10 | |
| | Flow Rate (L/min) | | | |
| 4-3 | **Overload Relief Valve Pressure Setting (Reference)** ($kgf/cm^2$) | 250 ± 10 | 280 ± 10 | |
| | Flow Rate (L/min) | | | |
| 4-4 | **Swing Motor Relief Valve Pressure Setting** ($kgf/cm^2$) | 170 ± 10 | 245 ± 10 | |
| | Flow Valve (L/min) | | | |

*NOTE: 1 kgf = 9.807 N*
*1kgf / $cm^2$ = 0.09807 MPa*

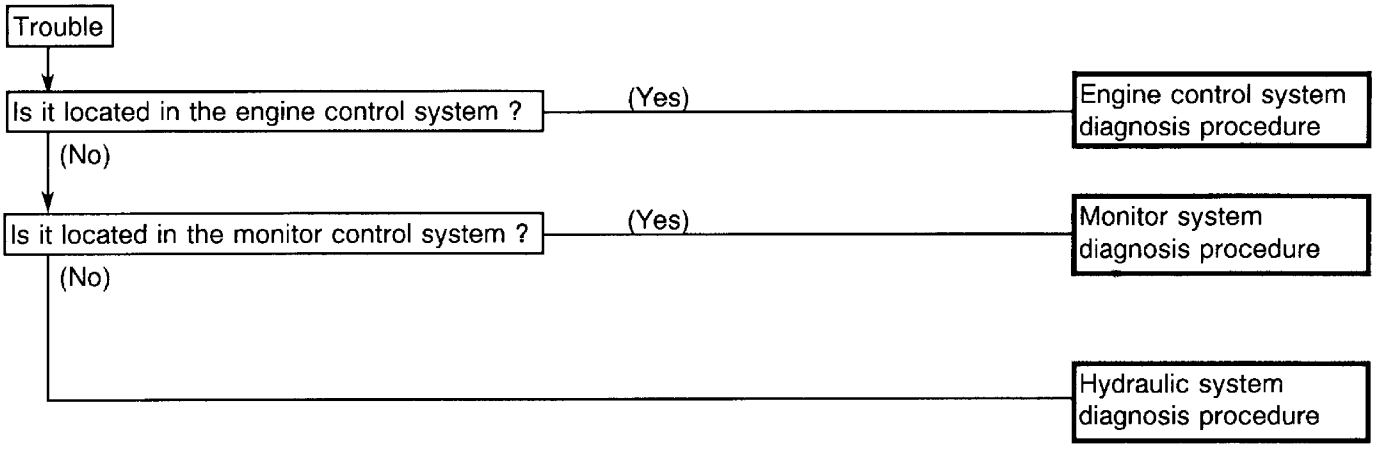
# SECTION 07
# TROUBLESHOOTING

## CONTENTS

## INTRODUCTION

Troubleshooting charts shown in this section indicate the orderly procedures for inspecting and locating the cause(s) of problems in the machine. This section is comprised of three groups: engine control system diagnosis procedure, monitor system diagnosis procedure and hydraulic system diagnosis procedure.

Check in which group the system in trouble is located first, and refer to the group corresponding to the system involved.




## DIAGNOSING PROCEDURE

Follow the five basic steps shown below for efficient troubleshooting.

1. Know the system

   Study the appropriate technical manuals. Know what the system is composed of and how it works, as well as the construction, functions and specifications of the system components.

2. Ask the operator

   Before inspecting, get the full story of malfunctions from a witness--- the operator.

   (a) How the machine is used and serviced?
   (b) When was the trouble noticed, and what work was the machine doing at that time?
   (c) What is the character of the trouble? Did the trouble slowly get worse, or did it appear suddenly for the first time?
   (d) Did the machine have any trouble previously? If so, which parts were repaired or replaced before?

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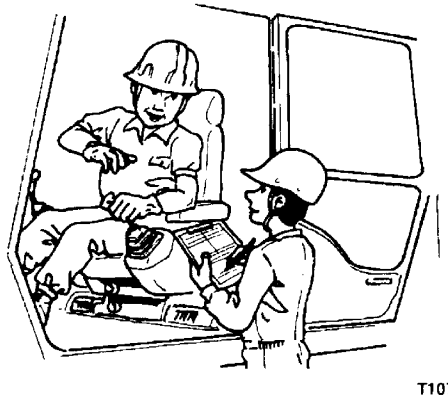

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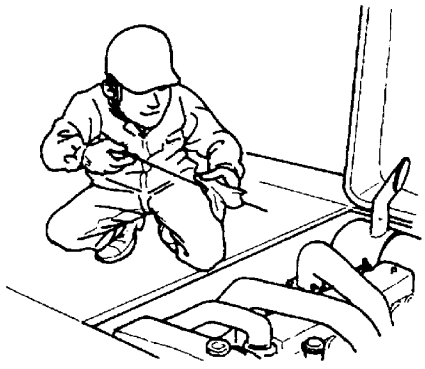
3. Inspect the machine

Before starting troubleshooting, check the machine's daily maintenance points, as shown in the operator's manual.

Check the electrical system, including batteries.
Trouble in the electrical system such as low battery voltage, loose connections and blown fuses will result in malfunction of the controllers, causing total operational failure of the machine.



T107-07-01-003

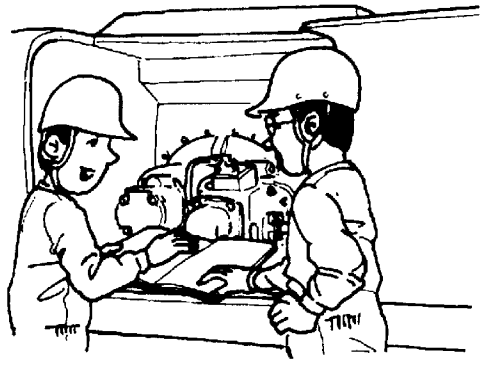
4. Inspect the actual trouble on the machine

In case some trouble cannot be actually confirmed, obtain the details of the malfunction from the operator.
Also, check for any incomplete connections of the wire harnesses.

5. Trace causes

Before reaching a conclusion, check the most suspectable causes again. Try to trace what the real cause of the trouble is.

Make a plan of appropriate repairing procedure, to avoid consequential malfunctions.



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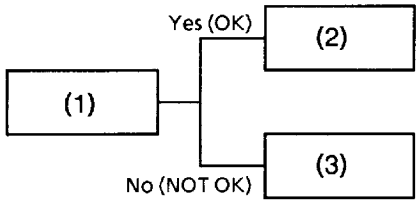
## HOW TO READ THE TROUBLESHOOTING FLOW CHARTS




· After checking or measuring item (1), select either Yes (OK) or No (NOT OK) and proceed to item (2) or (3) next.

· Key Switch : ON
· Refer to T07-03-18

· As shown to the left, measuring methods or pages to be referred to are indicated in the spaces under the box. Take care to measure or check correctly. Incorrect measuring or checking methods may result in making troubleshooting impossible, and may damage components.

## CHECK BATTERY VOLTAGE

1. Turn key switch OFF.
2. Measure voltage between battery plus terminal and the ground (chassis) using a voltmeter.

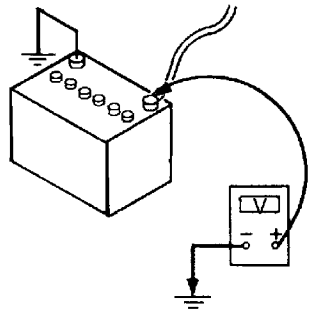
   Correct Voltage Reading : Approximately 12 V

*NOTE : If voltage is abnormal, charge or replace the battery.*

3. Start the engine.
4. Measure the battery voltage again.

   Correct Voltage Reading : Approximately 14.5 V

*NOTE : If voltage is abnormal, check the charging system.*



T505-07-01-002

## EX OPERATION MANUAL FOR AUTO BOOM-STOP SYSTEM

### Foreword

This Dr.EX is a troubleshooting tool to be used for the Auto Boom-Stop System on the Mu series. When any trouble occurs in the system or after repair work on the system is complete, connect Dr.EX to the machine and display the operation menu screen first. Then, start to check the Auto-Boom-Stop System by selecting the most appropriate work items on the screen.

### How to Connect Dr.EX

Turn the key switch OFF.
Remove the small oval shape cap from the resin cover located on the right side of the cab.
Take the connector from the oval hole and connect Dr.EX.

### How to Operate Dr.EX

Conduct the troubleshooting in the following procedures. After the repair work or operational function check is complete, be sure to check that no new fault codes have been added and to delete all the stored fault codes before bringing the machine into operation.

1. Connect Dr.EX to the controller.
2. Turn the key switch ON or start the engine.
3. Select the item for the Mini-Mu on the Machine Model Menu Screen. Then, touch key F1 to display the Title Screen.
4. Touch key F1 key on the Title Screen to go to the Operation Menu Screen.
5. Select the function items desired to operate. (Refer to "Troubleshooting Functions" described below in Section 4.)
6. When the cause of the trouble is located, take the corrective measures.
7. If necessary, reset the initial setting.
8. Check the auto-boom stop function.
9. After checking that no additional fault code is displayed on the Stored Fault Code Screen of Dr.EX, be sure to delete all the fault codes. (Initial setting or system deactivation performed by the service personnel will be additionally displayed. But, they should be ignored from the additional fault codes.)
10. After operation is complete, turn the power switch OFF. Then, disconnect Dr.EX.

### Troubleshooting Functions

1. Stored Fault Code and Operation Record Screen
   After the previously stored codes and operation records have been deleted, if any trouble or abnormal operation occurs, all the fault codes or operation records are displayed in the order of occurrrence. The code displayed in the most upper-left corner is the newest one. Up to 59 codes are stored and displayed. If the number of codes exceeds 59, older faults are replaced with newer ones in order.
   Do not delete the stored fault codes until the cause of trouble is traced, repair is complete, and operational function is checked.
   Avoid deactivating the auto-boom-stop system repeatedly. Otherwise, the old fault codes may be deleted, resulting in difficult troubleshooting.
   All fault codes are stored in the memory in the controller. Each number of a fault code has a specific meaning. Even if the batteries are disconnected, the stored fault codes are not erased.
2. Stored Fault Code Deletion
   After the repair and function check are complete, check that no new fault code is displayed. Then, delete the stored fault codes. Once deleted, the fault code will not be displayed again.
3. Troubleshooting
   Locate where the trouble exists using this screen. These data are sent from the CPU in the controller so that they are not stored in the memory. If all items indicate "Normal," it means that no trouble exists. Select the item indicated as "Abnormal," and read the message displayed on the screen.
4. Zone Check
   By comparing the boom location data and each of the specified zone data, the boom position is traced. Each of the boom position and swing position is displayed.
5. Item Monitoring
   When the monitor display item is selected, the item monitoring screen is displayed. Then, select the item as required. Up to three items can be selected at the same time.

6. Current Correction
   When the current correction item is selected, boom and swing deceleration current value can be corrected by ±100 mA. Use this function when deceleration speed is too slow. In addition, boom raise stop position in front of the cab can be corrected by ±20° when the stop position is too close or too afar.

**CAUTION: When temperature is low, oil viscosity increases, reducing valve response. Thereby, if correction is made to minus (–) side on the machine with the standard cab or canopy, potential of boom collision with the cab or canopy will increase. Never attempt to correct to minus (–) side.**

**Screen Flow Chart**

Refer to the the screen flow chart shown on page 16 and 17.

*NOTE: Swing displayed on Dr.EX screen shows Boom-Swing.*

**Screen Description**

1. Title Screen

```
Dr.EX
58Mu        33Mu
F1  :  Start
F10:  Machine Model Menu
```

F1 : Go to the Operation Menu Screen
F10: Go to the Model Screen

2. Operation Menu Screen

```
          Select Item
F1  :  Fault Code Display
F2  :  Fault Code Deletion
F3  :  Troubleshooting
F4  :  Zone Check
F5  :  Monitor Display
F6  :  Current Correction
```

F1 : Go to the Stored Fault Code Screen.
F2 : Go to the Fault Code Deletion Screen.
F3 : Go to the Troubleshooting Screen.
F4 : Go to the Zone Check Screen.
F5 : Go to the Item Monitoring Screen.
F6 : Go to the Current Correction Menu Screen.

3. Stored Fault Code Screen
   Fault Code List & Selection Screen

```
Detected Fault Codes:
40  F0  F2  F1

F1 :← F2 : → F5 : Prev
F7 : Next ↓ ENT : More Info
```

F1, F2: Move the cursor to select the fault code.
F5 : Go back to the Operation Menu Screen.
F6 : Refer to the previous page. (When the fault code are listed on two pages, this key is displayed.)
F7 : Refer to the next page. (When the fault code are listed on two pages, this key is displayed.)
ENT : Go to the More Information Screen.

More Information Screen

```
Fault Code: 40

Solenoid Disconnection /
Short Circuit (Boom Raise)

Touch any key
```

4. Fault Code Deletion
   Fault Code Deletion Screen

```
Delete all fault codes?

F1:  Yes        F5:  NO
```

F1: Delete fault codes and go to the Fault Code Deletion Completed Screen.
F5: Do not delete fault codes and go back to the Operation Menu Screen.

*NOTE: Do not delete the fault code until the troublecause is detected. Recommended to write this info down.*

Fault Code Deletion Completed Screen

| |
|---|
| Fault codes were deleted |
| Touch any key |

Any Key: Go back to the Operation Menu Screen.

*NOTE: Once deleted, deleted fault codes cannot be displayed*

5. Troubleshooting Screen
   Troubleshooting Result Screen

| Select Item | |
|---|---|
| F1 : CPU | Normal |
| F2 : Boom Position | Normal |
| F3 : Solenoid | Abnormal |
| F4 : Sensor | Normal |
| F5 : Initial Set Val | Normal |
| F6 : Power Voltage | Normal |
| F10: Prev | |

When all items are displayed as "Normal," no trouble is present. To display the trouble location, touch the key for the item displaying "Abnormal".

F10: Go back to the Operation Menu Screen.

Trouble Location Screen (Example: When key F3 is selected on the troubleshooting screen.)

| |
|---|
| Abnormalities found in the following locations: |
| Boom Solenoid |
| F5 : Prev |

6. Zone Check Screen

| | |
|---|---|
| Present Zone Check | |
| Boom Position: | B6 |
| Boom: Normal Zone | |
| Swing Position: | S5 |
| Swing: Normal Zone | |
| F5 : Prev | |

Present boom position and swing position are shown by zone No..

F5: Go back to the Operation Menu Screen.
B1: Boom Critical Zone
B2: Boom Stop Zone
B3: Boom Deceleration Zone
B4: Boom Deceleration Zone (Forward position of operator's seat.)
B5: Boom Deceleration Zone
B6: Boom Normal Zone
B7: Boom Deceleration Zone (Boom Height Restriction)
S1: Swing Critical Zone
S2: Swing Stop Zone
S3: Swing Deceleration Zone
S4: Swing Deceleration Zone
S5: Swing Normal Zone
S6: Swing Deceleration Zone (Right Swing End)

7. Item Monitoring Display
   Item Monitoring Screen

| Select Item |
|---|
| F1 : Angle Sensor Input |
| F2 : Valve Activate Output |
| F3 : Controller Input |
| F4 : Controller Output |
| F5 : Initial Set Value |
| F6 : Mach Model Indn |
| F10: Prev |

F1 to F6: Perform individual monitoring.
F10 : Go back to the Operation Menu Screen.

Angle Sensor Input Selection Screen (Example: After selecting F1 key "Angle Sensor Input" on the Item Monitoring Screen, F6 key "Boom Angle Sensor V" was selected.)

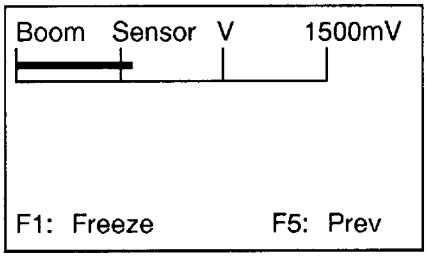
```
Select Item
F6 : Boom Angle Sensor V
F7 : Swing Angle Sensor V
F8 : Boom Angle
F9 : Swing Angle
F10:
No. of Selected Data: 1

F1 : Start              F5: Prev
```

F1: Go to the Input Data Screen.
F5: Go back to the Item Monitoring Screen.

*NOTE: Up to 3 items can be displayed on the screen. (When the fourth item is selected, the first item is deleted.)*

Input Data Screen (Example: When the boom angle sensor V is selected.)




Monitored data for the selected item is displayed.

F1: Freeze (To obtain static image).
F5: Go back to the Angle Sensor Input Selection Screen.

8. Current Correction Display (Overall)
Current Correction Menu Screen

```
Select Item
F1 : Boom Current Value
F2 : Swing Current Value
F3 : Boom Stop Position
F5 : Prev
```

F1 to F3: Perform individual current correction.
F5 : Go back to the Operation Menu Screen.

Correction Value Selection Screen

```
Input Boom Current
Correction Value

Correction Value: ±0 mA

F1: Up          F2: Down
                ENT:OK
```

F1: Up-Correction (Step: 10 mA)
F2: Down-Correction (Step: 10 mA)
ENT: Go to the Correction Value Screen.

*NOTE: Correction is possible within the range of ±100 mA.*

Correction Value Screen

```
Boom Current Value Correction

Correction Value : +10 mA

Is the value correct?

F1: Yes          F2: No
```

F1: Go to the Password Input Screen.
F2: Go back to the Current Correction Menu Screen.

Password Input Screen

```
Input password

        [    ]

Touch key F5 to stop
```

Input Password : After touching SFT key, touch key 9 (F) twice.
F5 : Go back to the Current Correction Menu screen.

Correction Value Selection Screen

```
Input boom stop position cor-
rection Value

Correction Value: ±0°
(+: Boom Lower)

F1: Up          F2: Down
                ENT : OK
```

F1: Up-Correction (Step: 1°)
F2: Down-Correction (Step: 1°)
ENT: Go to the Correction Value Screen.

**CAUTION: Minus (–) correction (Boom Raise) may cause the boom to collide the canopy (cab). Avoid minus correction.**

Correction Value Screen

```
Boom Stop Position Value
Correction

Correction Value: +10°

Is the value correct?

F1: Yes          F2: No
```

F1: Go to the Password Input Screen.
F2: Go back to the Current Correction Menu Screen.

Password Input Screen

```
Input password

          [   ]

Touch key F5 to stop
```

Input Password: After touching SFT key, touch key 9 (F) twice.
F5: Go back to the Current Correction Menu Screen.

9. Model Screen

```
<Machine Model-Controller
Version>
33 Mu                VER: 1.00
<Correction Values>
Boom Current         : +20 mA
Swing Current        : +20 mA
Boom Stop Position   : +2°
Touch any key
```

Machine model and CPU version No. are displayed.
Correction values of current and the boom stop position are shown with ± sign.
(±0° means that no correction was made.)
Any key: Go back to the Item Monitoring Screen.

10. Other Displays
Wrong Machine Selection Screen

```
Selected Program/Machine
Mismatch


Touch any key
```

Any Key: Go back to the Machine Model Menu Screen.

Incomplete Interface Screen

```
Can not communicate with
controller
Check:
• Controller Power
• Comm. Harness

F1: Retry          F5: Prev
```

Communication error between the controller and Dr.EX.

F1: Retry.
F5: Goback to the Operation Menu Screen.

No Trouble Detected Screen

```
No trouble exists or trouble is
beyond Dr.EX capabilities

                   F5: Prev
```

When no fault codes and operation records are found by Dr.EX, this screen is displayed.

F5: Go back to the Operation Menu Screen.

## FAULT CODE LIST

| Code | Description | Note |
|---|---|---|
| 10 | Abnormal CPU Condition Code Register | |
| 11 | Abnormal CPU General Register | |
| 12 | Abnormal CPU Mode Diagnosis (One Chip Mode) | |
| 18 | Abnormal Interruption Test | |
| 19 | Abnormal 16 Bit Timer (CH1) | |
| 1A | Abnormal 16 Bit Timer (CH2) | |
| 1B | Abnormal 16 Bit Timer (CH3) | |
| 1C | Abnormal 8 Bit Timer | |
| 1D | Abnormal Internal Watch Dog | |
| 20 | Abnormal RAM Read / Write | |
| 40 | Solenoid Disconnection / Short Circuit (Boom Raise) | After repairing, turn key switch ON to return to normal operation.<br>Buzzer Sound Mode: Long Intermittent Sound |
| 41 | Solenoid Disconnection / Short Circuit (Clockwise Swing) | |
| 43 | Pilot Shut-Off Relay Disconnection / Short Circuit | |
| 50 | Boom Sensor Disconnection / Short Circuit (0 V Side) | After repairing, turn key switch ON to return to normal operation.<br>Buzzer Sound Mode: Continuous Sound |
| 51 | Swing Sensor Disconnection / Short Circuit (0 V Side) | |
| 54 | Boom Sensor Disconnection / Short Circuit (5 V Side) | |
| 55 | Swing Sensor Disconnection / Short Circuit (5 V Side) | |
| 60 | Faulty Boom Sensor Initial Set Value (Lower Limit) | Initial set operation is not executed. (Previous initial set value does not change.) Sensor input signal shall be checked in the initial set position.<br>Buzzer Sound Mode: Continuous Sound |
| 62 | Faulty Swing Sensor Initial Set Value (Lower Limit) | |
| 64 | Faulty Boom Sensor Initial Set Value (Upper Limit) | |
| 66 | Faulty Swing Sensor Initial Set Value (Upper Limit) | |
| 70 | Excessive Boom Sensor Output Variation (0 V Side) | Turn key switch ON to return to normal operation. (If the same trouble is repeated, the sensor mayhave failed.)<br>Buzzer Sound Mode: Continuous Sound |
| 71 | Excessive Swing Sensor Output Variation (0 V Side) | |
| 74 | Excessive Boom Sensor Output Variation (5 V Side) | |
| 75 | Excessive Swing Sensor Output Variation (5 V Side) | |
| 80 | Abnormal Boom Sensor Angle (0 V Side) | After repairing, turn key switch ON to return to normal operation.<br>Buzzer Sound Mode: Continuous Sound |
| 81 | Abnormal Swing Sensor Angle (0 V Side) | |
| 84 | Abnormal Boom Sensor Angle (5 V Side) | |
| 85 | Abnormal Swing Sensor Angle (5 V Side) | |
| A0 | Abnormal 12 V Power Voltage (10 V or Less) | System Indicator Blinks.<br>Deactivate the system to move the front attachment. |
| A1 | Abnormal 12 V Power Voltage (16 V or Greater) | |

## OPERATION RECODE LIST

| Code | Description | Note |
|---|---|---|
| F0 | Initial setting is correct. | One short buzzer sound is heard. |
| F1 | Auto Boom-Stop function deactivated. | Buzzer Sound Mode: Short intermittent sound |
| F2 | Auto Boom-Stop function reactivated. | |
| F3 | Boom moved into the critical zone with the Auto Boom-Stop system deactivated. | |
| F4 | Boom moved into the critical zone with the Auto Boom-Stop system activated. | Buzzer Sound Mode: Short intermittent sound.<br>Restart the engine and move the boom out of the critical zone to restore normal operation. |
| F5 | Boom moved out of the critical zone. | |
| F6 | Boom moved deeper in the critical zone. | Buzzer Sound Mode: Short intermittent sound.<br>Restart the engine and move the boom out of the critical zone to restore normal operation. |

## MONITORING ITEM LIST

| Item Selection Screen | Corr. Key | Item | Remarks |
|---|---|---|---|
| Angle Sensor Input | F6 | Boom Angle Sensor V | Value (mV) and bar graph are shown. |
| | F7 | Swing Angle Sensor V | Value (mV) and bar graph are shown. |
| | F8 | Boom Angle | Angle from max. boom raised position |
| | F9 | Swing Angle | Angle from swing center |
| Valve Activation Output | F6 | Boom Current | Value (mA) and bar graph are shown. |
| | F7 | Swing Current | Value (mA) and bar graph are shown. |
| Controller Input Signal | | Pilot Shut-off SW input Signal | ON or OFF is shown in reverse video. |
| | | Input Signal | ON or OFF is shown in reverse video. |
| | | Alternator L | ON or OFF is shown in reverse video. |
| | | System Deactivation SW | ON or OFF is shown in reverse video. |
| | | Sensor Initial Setting | ON or OFF is shown in reverse video. |
| | Next Page | (Boom Height restriction) | |
| | | Set Signal SW | ON or OFF is shown in reverse video. |
| | | Reset Signal SW | ON or OFF is shown in reverse video. |
| Controller Output Signal | | System Indication Signal | ON or OFF is shown in reverse video. |
| | | Buzzer Activate Signal | ON or OFF is shown in reverse video. |
| | | Pilot Shut-Off Relay Active Signal | ON or OFF is shown in reverse video. |
| | | Setting LED Signal | ON or OFF is shown in reverse video. |
| Initial Value Set Item | F6 | Boom Sensor Voltage | Value (mV) is shown with Std. Value. |
| | F7 | Swing Sensor Voltage | Value (mV) is shown with Std. Value. |
| | F9 | Boom Angle | Dev. from Theoretical Value in angle. |
| | F10 | Swing Angle | Dev. from Theoretical Value in angle. |
| Machine Model | | Machine Model | |
| | | Version No. | |
| | | Correction Value | Overall correction value is displayed. |

## AUTO BOOM-STOP SYSTEM INITIAL SETTING

Perform the initial setting in the following cases:

- When the boom is replaced.
- When the angle sensor and / or the sensor link is reinstalled.
- When error in output or position of the angle sensor is presented. (Error in position is caused by sensor link and / or lever deformation.)
- When the controller is replaced.

**Procedures:**

Start the engine.

↓

Swing to the left and fully raise the boom (fully extend the boom cylinder).

※ Full swing to the left is not required when the boom can be raise fully.

↓

Swing to the right until the boom side face becomes parallel to the canopy (cab) side face.

※ In case right swing stops before the boom side face becomes parallel to the canopy (cab) side face, turn the System Deactivation switch ON. Then, swing the boom so that the boom side face becomes parallel to the canopy (cab) side face.

↓

With the key switch turned OFF, disconnect the initial set connector.

↓

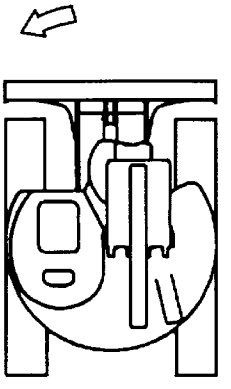
With the key switch turned ON, connect the initial set connector.

※ Connecting the initial set connector after the engine is started is acceptable.

↓

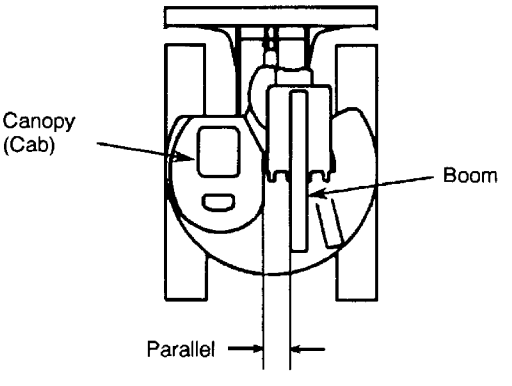
The buzzer sounds once shortly. Initial setting is complete.

※ If the buzzer continues sounding after initial setting is complete, initial setting is incorrect. Check the angle sensor system and repair as necessary. Then, retry initial setting.

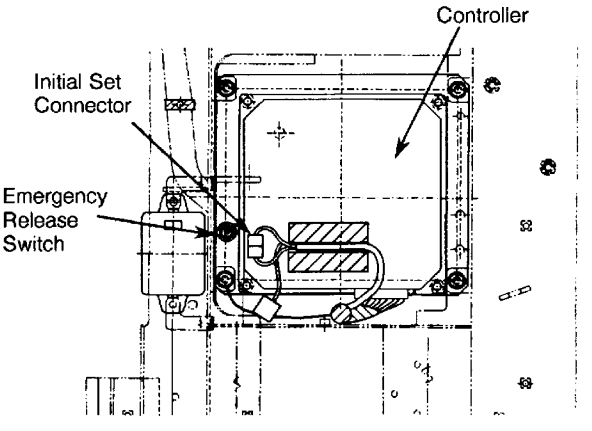


T532-04-02-006

T532-04-02-005




T532-04-02-007




T532-04-02-008

## ABNORMAL SYMPTOMS IN FAULTY INITIAL SETTING

1. If initial setting is made with the boom raised at slightly lower than the highest position, the boom will stop at a position further than the normal position from the canopy (cab) if the boom is raised in the right side from the swing center.
2. If initial setting is performed with the boom positioned in the left side of swing center:
   - The boom will stop before the boom becomes parallel to the canopy (cab) when the boom is swung with the boom raised.
   - The boom will stop in front of the canopy (cab) when the boom is raised at the swing center.

3. If initial setting is performed with the boom positioned in the right side of swing center:
   - The boom will approach much closer to the canopy (cab) or come into contact with the canopy (cab), when the boom is swung right with the boom raised (at the position beside the canopy or cab.)
   - The boom may come into contact with the canopy (cab) if the boom is raised in the right side from the swing center.

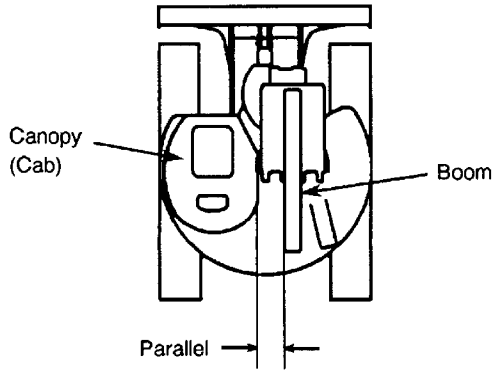
## WHEN INITIAL SETTING IS NOT PERFORMED

When performing initial setting with boom fully raised (the boom cylinder is fully extended) at the swing center (the boom is parallel to the canopy or cab), initial setting will not be performed correctly if the set values from the boom angle sensor and swing angle sensor are outside the following range. The buzzer continues sounding and the previous initial set values remain without being renewed.

Angle Sensor Initial Set Value (Dr. EX Displays).
With the boom raised to the highest position at the swing center:
Boom Angle Sensor Output: 3.5 ± 0.3 V
Swing Angle Sensor Output: 2.25 ± 0.3 V

**IMPORTANT: When performing initial setting, be sure to raise the boom to the highest position (the boom cylinder is fully extended) at the swing center (the boom should be parallel to the canopy or cab).**

※ In case the initial setting was not performed, boom deformation, faulty angle sensor, or angle sensor link deformation may be the cause of the trouble. After checking and repairing, recheck the angle sensor value and reset the initial setting.



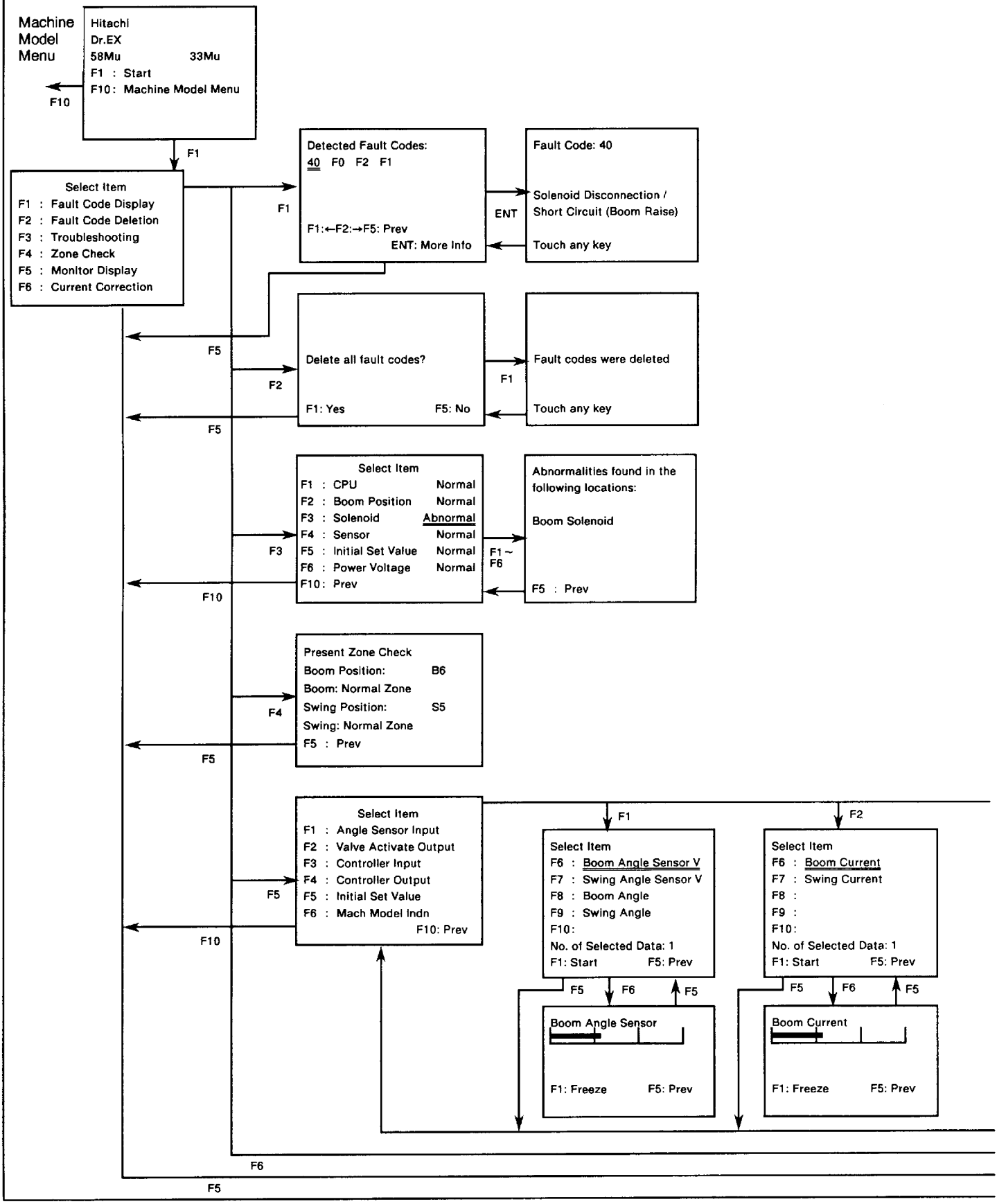

T532-04-02-007

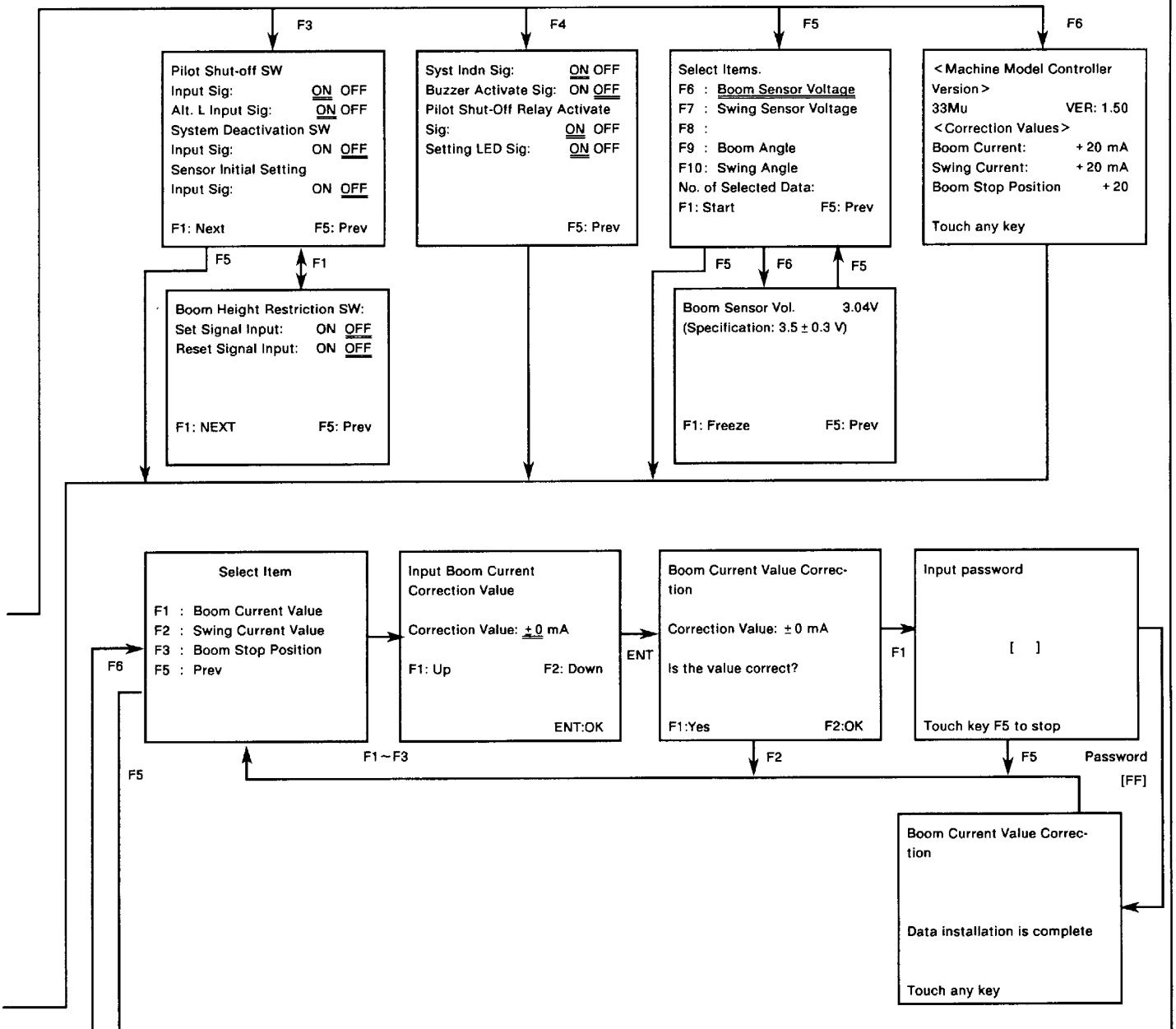
## SYSTEM OPERATION STATUS

| Description | Buzzer | System Indicator | Proportional Solenoid Valve | Pilot Shut-Off Relay | Resumption, Check and Repair Method |
|---|---|---|---|---|---|
| Normal | | | | | |
| With key switch ON, controller initialization is in process. | Short beep once | ON for one second | Inoperative for one second | No output (Front attachment is inoperative) | Normal operation is resumed after initialization. |
| When stopped by Auto Boom-Stop system | Short beeps 3 times. | OFF | Boom raise or right swing is inoperative. | Activated depending on input from pilot shut-off SW. | Move boom or swing to normal operation zone. |
| When stopped by height restriction system | Short beeps 3 times. | OFF | Boom cannot be raised. | Activated depending on input from pilot shut-off SW. | Move boom or swing to normal operation zone. |
| Normal status | Silent | OFF | Activated depending on zone check result. | Activated depending on input from pilot shut-off SW. | |
| Mis-Operation | | | | | |
| Faulty sensor initial setting | Beep | ON | Boom raise and right swing are inoperative. | No output (Front attachment is inoperative) | Reset initial setting correctly. |
| Boom drifted into the Critical zone while parking with engine stopped. (This status occurs when engine is restarted.) | Short beeps repeat. | OFF | Boom raise and right swing are inoperative. | Output is delivered (boom lower and left swing are operative). | Move boom out of the buffer zone. |
| Deactivation | | | | | |
| When auto boom-stop function is deactivated (system deactivation). | Short beeps repeat. | Blinking | Speed is reduced in Critical zone. | Output is delivered (boom lower and left swing are operative). | Normal operation is resumed when activated. |

| Description | Buzzer | System Indicator | Proportional Solenoid Valve | Pilot Shut-Off Relay | Resumption, Check and Repair Method |
|---|---|---|---|---|---|
| Trouble | | | | | |
| Boom enters in the critical zone while auto boom-stop system operates. (Emergency stop status) | Short beep repeat | ON | Boom raise and right swing are inoperative. | No output | Move boom out of the buffer zone after reconnecting power source. |
| Disconnection / short circuit of boom / swing sensors or disconnection of link<br>: 0.2V to 0V<br>: 4.8V to 5.0V | Beep | ON | Activated depending on zone check result when boom is fully raised or swung to the right. | Output is delivered (boom lower and left swing are operative). | Re-connect power source. |
| Dislocation of boom / swing sensor or deformation of link<br>: 0.2V to 0.5V<br>: 4.5V to 4.8V | Beep | ON | Activated depending on zone check result when boom is fully raised or swung to the right. | Output is delivered (boom lower and left swing are operative). | Re-connect power source. |
| Excessive sensor output variation from boom / swing sensor | Beep | ON | Activated depending on zone check result when boom is fully raised or swung to the right. | Output is delivered (boom lower and left swing are operative). | Re-connect power source. (When same troubles are repeated, replace the corresponding sensor.) |
| Faulty solenoid valve | Beep | ON | No output delivered from boom raise or right swing solenoid valve. | Output is delivered (boom lower and left swing are operative). | Re-connect power source. |
| Disconnection / short circuit of pilot shut-off relay | Beep | ON | Activated depending on zone check result. | No output (Front attachment is inoperative). | Re-connect power source. |
| Disconnection / short circuit of pilot shut-off switch (※) | Silent | OFF | Activated depending on zone check result. | No output (Front attachment is inoperative). | Normal operation is resumed when voltage becomes normal. |
| Abnormal 12V electrical power voltage | Silent | Blinking | Boom raise and right swing are operative. | No output (Front attachment is inoperative). | Normal operation is resumed when voltage becomes normal. |

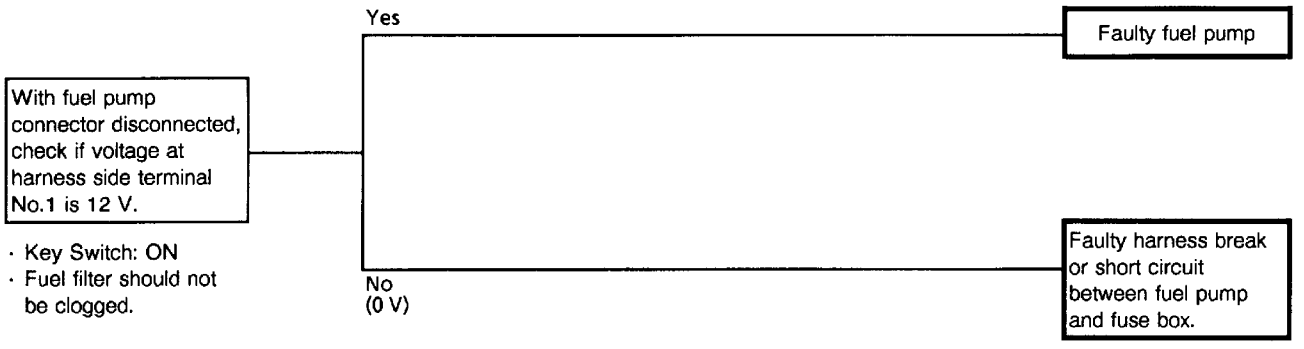
## TROUBLESHOOTING SCREEN FLOW CHART




F3
F4
F5
F6
Pilot Shut-off SW
Input Sig: ON OFF
Alt. L Input Sig: ON OFF
System Deactivation SW
Input Sig: ON OFF
Sensor Initial Setting
Input Sig: ON OFF
F1: Next F5: Prev
Syst Indn Sig: ON OFF
Buzzer Activate Sig: ON OFF
Pilot Shut-Off Relay Activate
Sig: ON OFF
Setting LED Sig: ON OFF
F5: Prev
Select Items.
F6 : Boom Sensor Voltage
F7 : Swing Sensor Voltage
F8 :
F9 : Boom Angle
F10: Swing Angle
No. of Selected Data:
F1: Start F5: Prev
<Machine Model Controller Version>
33Mu VER: 1.50
<Correction Values>
Boom Current: +20 mA
Swing Current: +20 mA
Boom Stop Position +20
Touch any key
F5
F1
Boom Height Restriction SW:
Set Signal Input: ON OFF
Reset Signal Input: ON OFF
F1: NEXT F5: Prev
F5
F6
F5
Boom Sensor Vol. 3.04V
(Specification: 3.5 ± 0.3 V)
F1: Freeze F5: Prev
Select Item
F1 : Boom Current Value
F2 : Swing Current Value
F3 : Boom Stop Position
F5 : Prev
F6
F5
Input Boom Current Correction Value
Correction Value: ±0 mA
F1: Up F2: Down
ENT:OK
F1~F3
ENT
Boom Current Value Correction
Correction Value: ±0 mA
Is the value correct?
F1:Yes F2:OK
F2
F1
Input password
[ ]
Touch key F5 to stop
F5
Password [FF]
Boom Current Value Correction
Data installation is complete
Touch any key

## ENGINE

### E-1 Starter Rotates But Engine Does Not Fire



### E-2 Starter Does Not Rotate

Guidance:
If the batteries are normal, check the voltage as shown in the following table while referring to VOLTAGE CHECK PROCEDURE on page T07-03-18.

Check if battery voltage and electrolyte density are normal.
- Voltage: 12 volts or more
- Density: 1.28 or more

Yes

With key switch positioned as shown in the table below, check if each terminal voltage on starter is normal.

Unit : V

| Terminal \ Key switch | OFF | ON | START |
|---|---|---|---|
| B (M8) | 12 | 12 | 12 |
| 50 | 0 | 0 | 12 |

Yes

Voltage at terminal B is lower than 12V.

No

Voltage at terminal No.50 is lower than 12 V.
- Key Switch: START

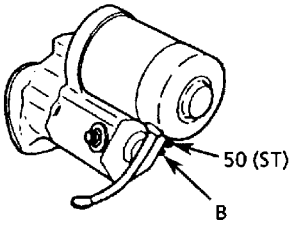
No

(When key switch is turned to the START position, if voltage at terminal B is lower than 9 volts, battery may be faulty.)

### Starter Voltage Check

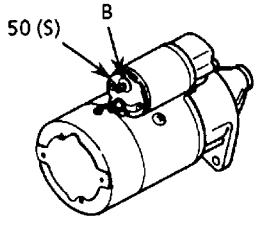
1. Turn the key switch to the ON or START position.
2. Contact the minus (−) probe of a circuit tester to the vehicle ground (ground to unpainted area like bolt head) and the plus (+) probe to terminals on the starter. Then, check voltages with the harness connected.

33Mu

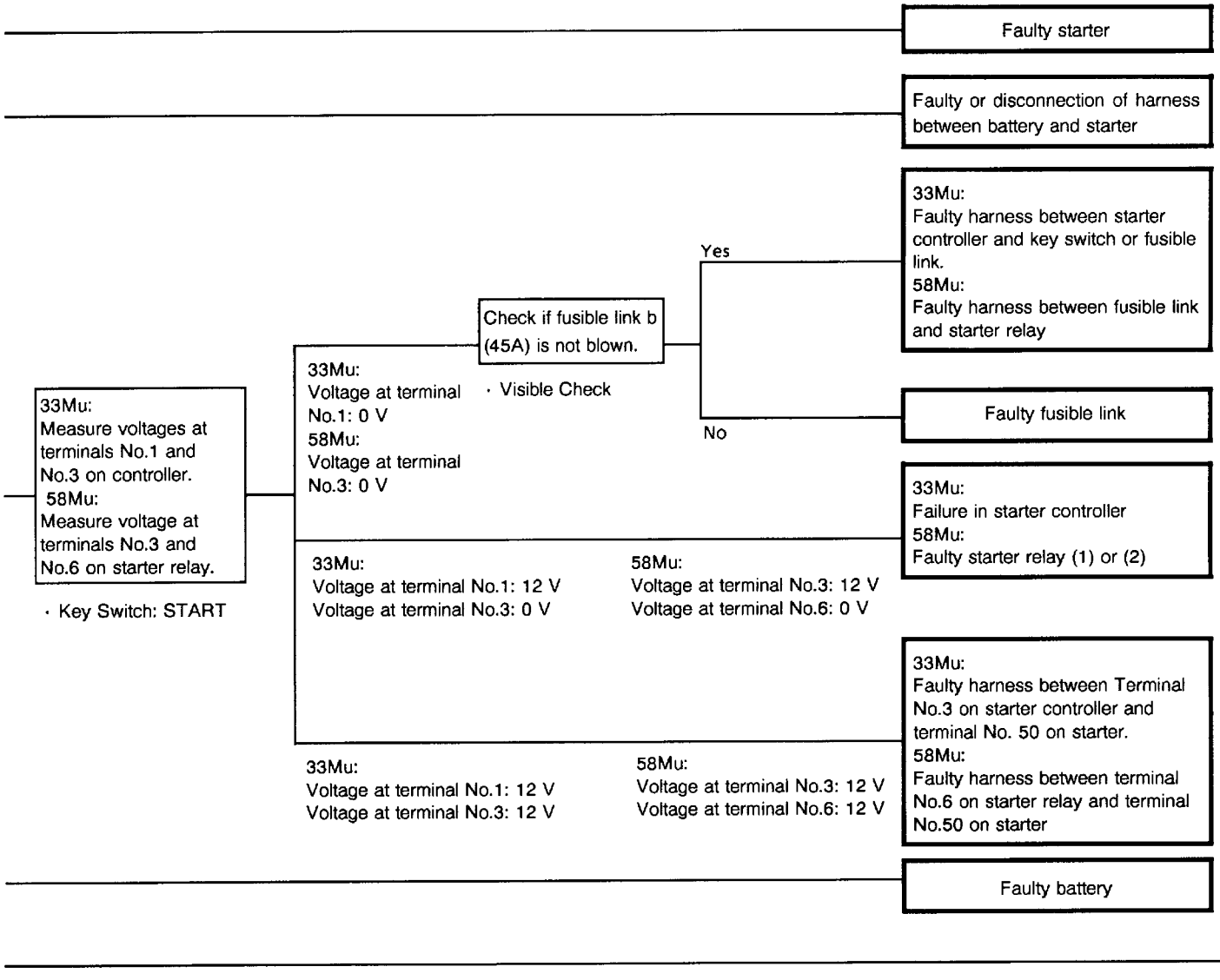



T523-07-02-001

58Mu

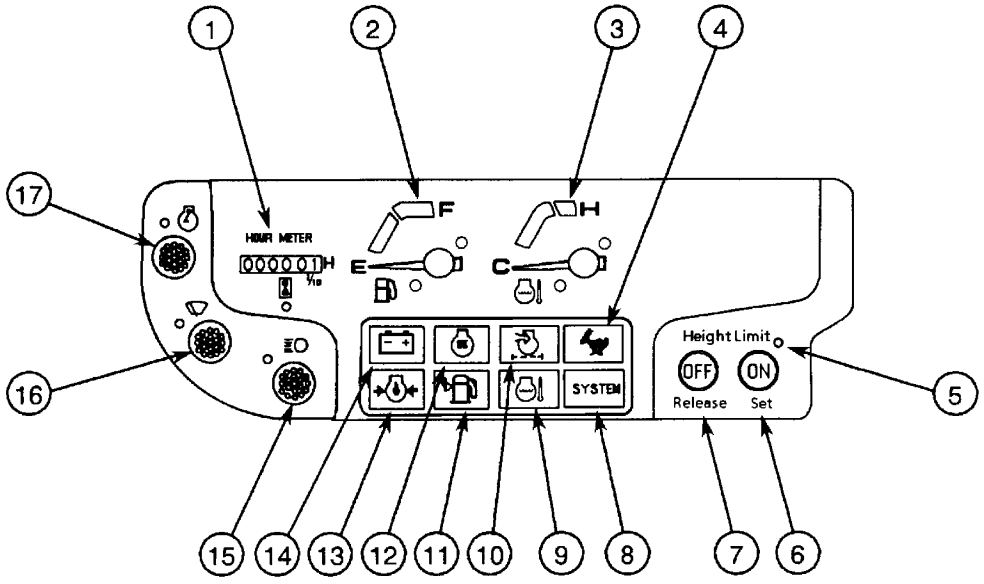



T533-07-02-001


Faulty starter
Faulty or disconnection of harness between battery and starter
33Mu:
Faulty harness between starter controller and key switch or fusible link.
58Mu:
Faulty harness between fusible link and starter relay
Yes
Check if fusible link b (45A) is not blown.
· Visible Check
No
Faulty fusible link
33Mu:
Measure voltages at terminals No.1 and No.3 on controller.
58Mu:
Measure voltage at terminals No.3 and No.6 on starter relay.
· Key Switch: START
33Mu:
Voltage at terminal No.1: 0 V
58Mu:
Voltage at terminal No.3: 0 V
33Mu:
Failure in starter controller
58Mu:
Faulty starter relay (1) or (2)
33Mu:
Voltage at terminal No.1: 12 V
Voltage at terminal No.3: 0 V
58Mu:
Voltage at terminal No.3: 12 V
Voltage at terminal No.6: 0 V
33Mu:
Faulty harness between Terminal No.3 on starter controller and terminal No. 50 on starter.
58Mu:
Faulty harness between terminal No.6 on starter relay and terminal No.50 on starter
33Mu:
Voltage at terminal No.1: 12 V
Voltage at terminal No.3: 12 V
58Mu:
Voltage at terminal No.3: 12 V
Voltage at terminal No.6: 12 V
Faulty battery

## MONITOR PANEL

Monitor Panel and Switch Panel




T532-04-01-001

1— Hour Meter
2— Fuel Gauge
3— Coolant Temperature Gauge
4— Fast Travel Indicator
5— Height Restriction Set Indicator
6— Height Restriction System Set Switch
7— Height Restriction System Reset Switch
8— Auto Boom-Stop System Indicator
9— Overheat Indicator
10— Air Filter Restriction Indicator
11— Fuel Level Indicator
12— Preheat Indicator
13— Engine Oil Pressure Indicator
14— Alternator Indicator
15— Work Light Switch
16— Wiper Switch (Option)
17— Auto-Idle Switch (Option)

## FUSE FAILS

Fuse failure for work lights is explained here. Checking other fuse failures is done in the same way as explained here.

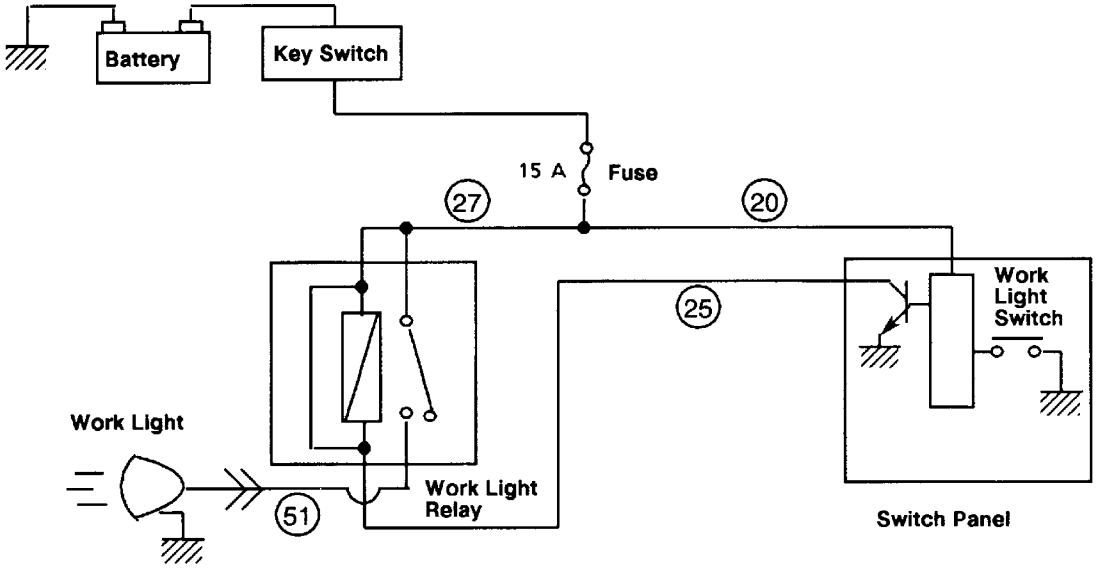
When a fuse fails soon after it is replaced, disconnect all parts related to the fuse from the circuit and check the circuit in the current flow direction, reconnecting each part one by one.

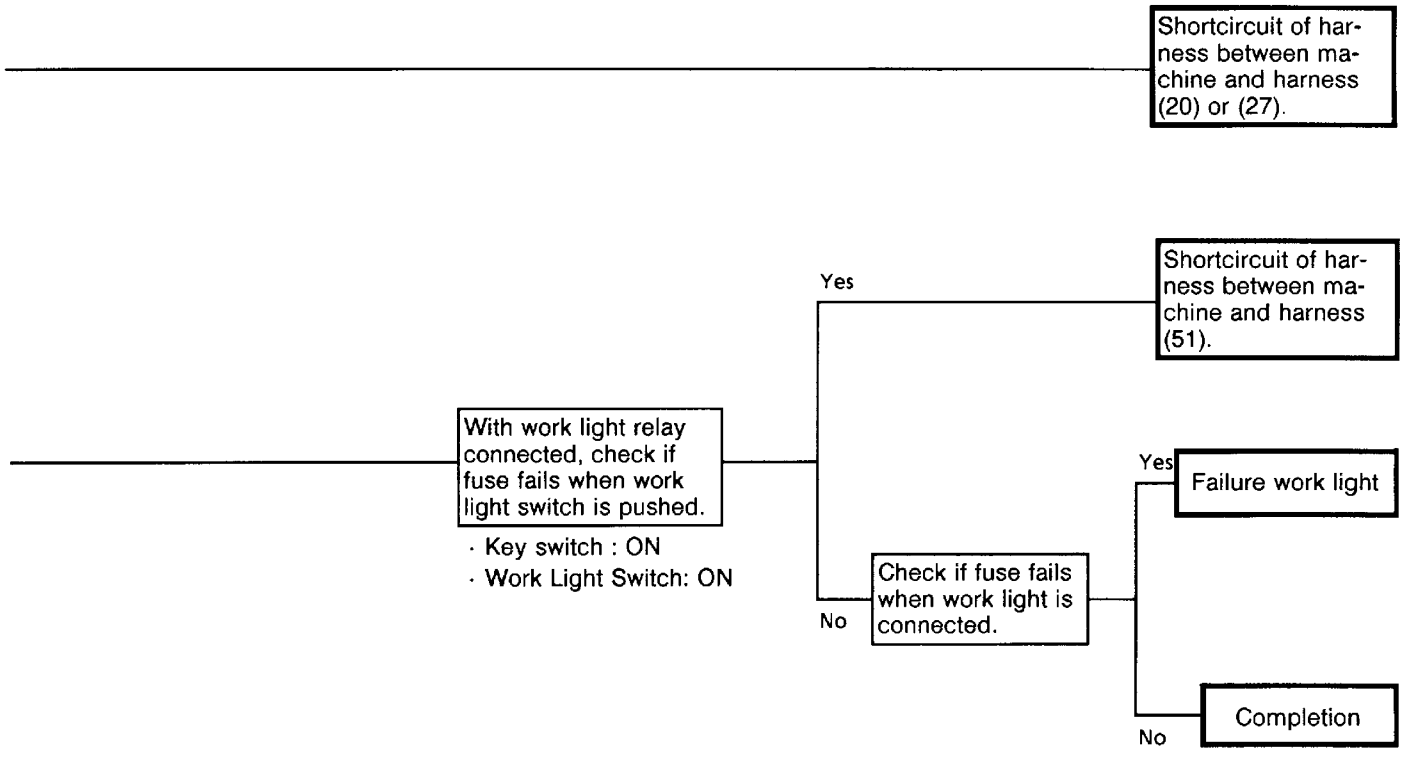
Yes

After disconnecting connectors for light relay and work light, check if fuse fails soon after fuse is replaced.

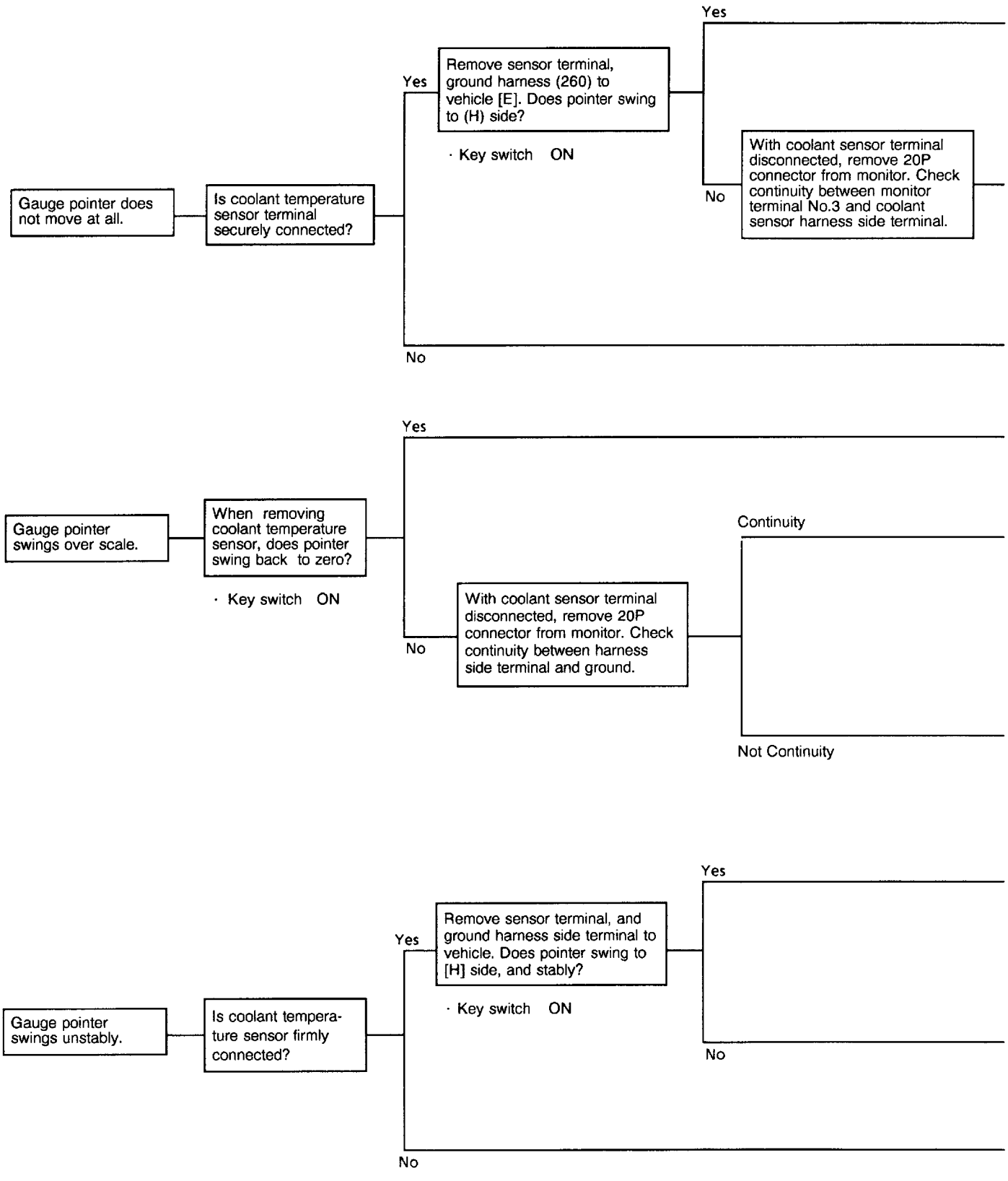
· Key Switch: ON

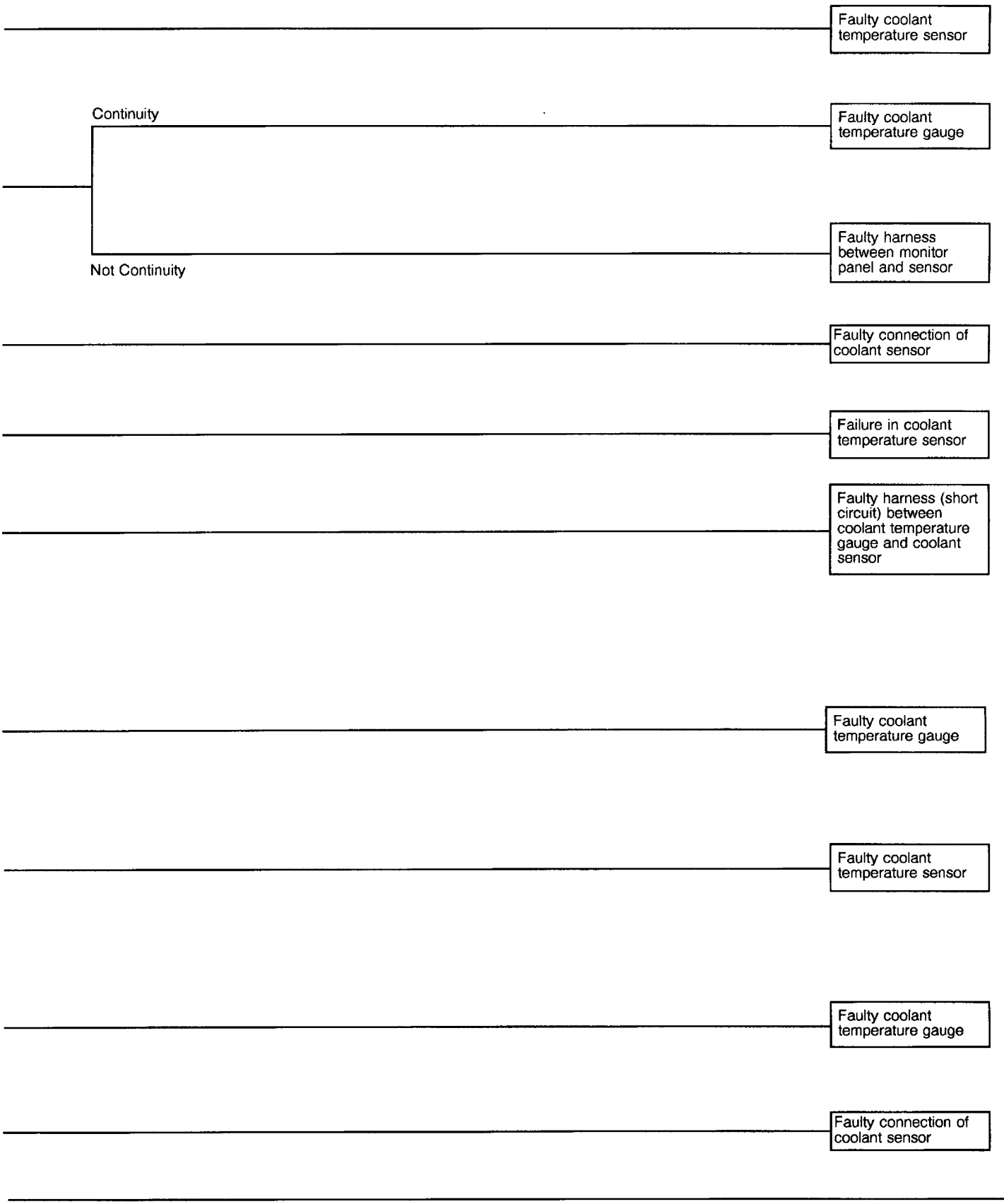
No



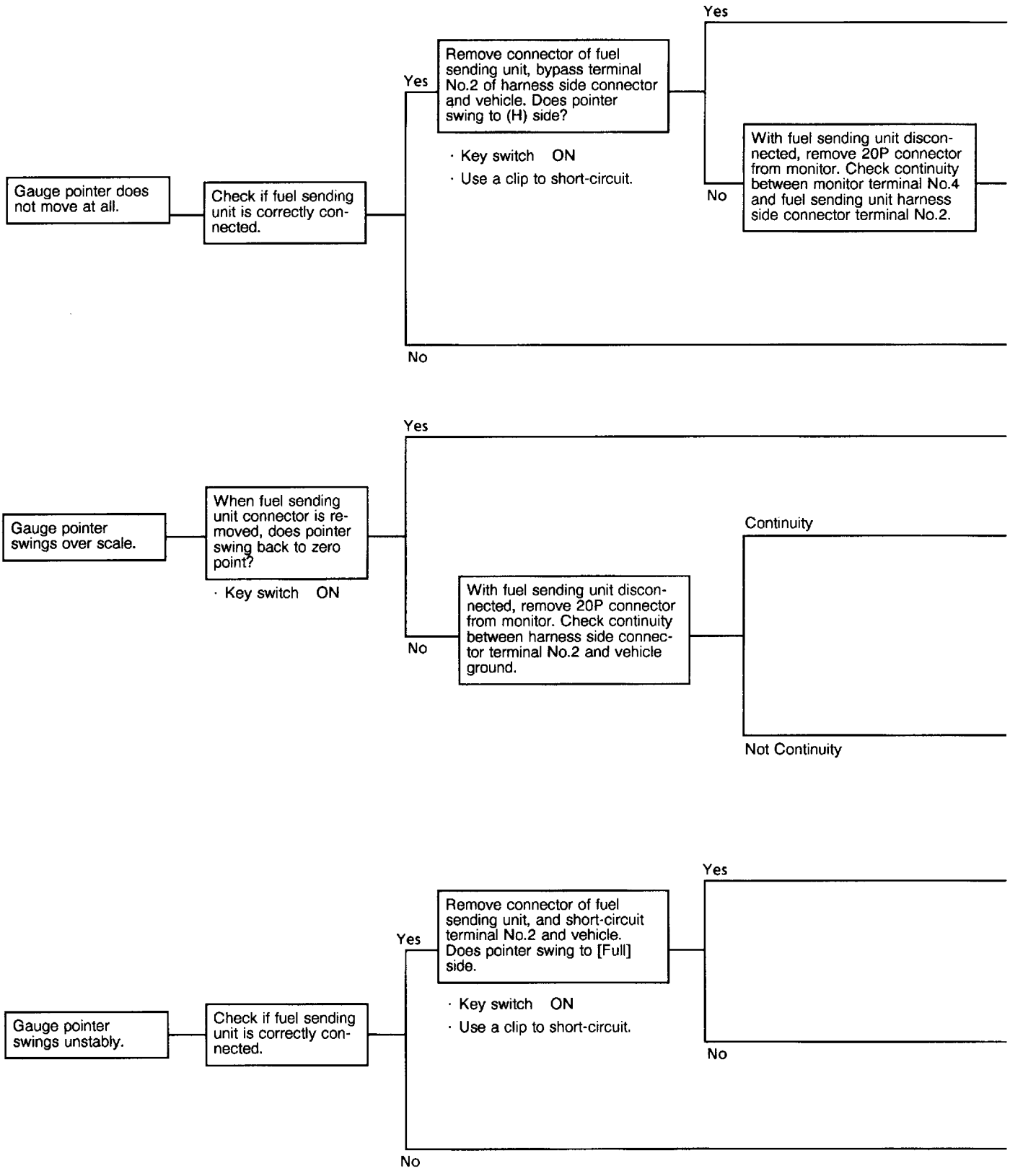

Shortcircuit of harness between machine and harness (20) or (27).
Shortcircuit of harness between machine and harness (51).
Yes
With work light relay connected, check if fuse fails when work light switch is pushed.
· Key switch : ON
· Work Light Switch: ON
Yes
Failure work light
Check if fuse fails when work light is connected.
No
Completion
No

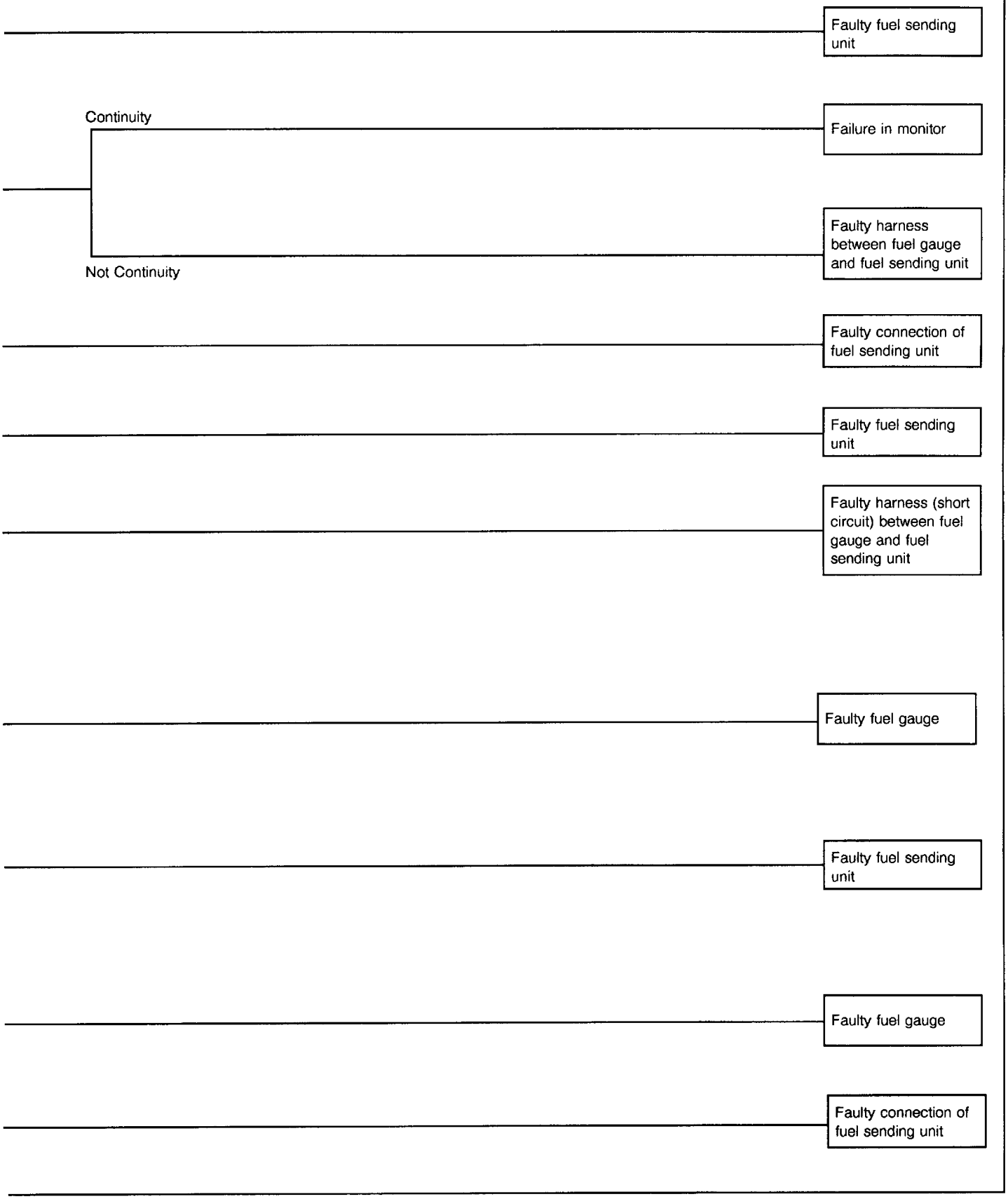
## MALFUNCTION OF COOLANT TEMPERATURE GAUGE



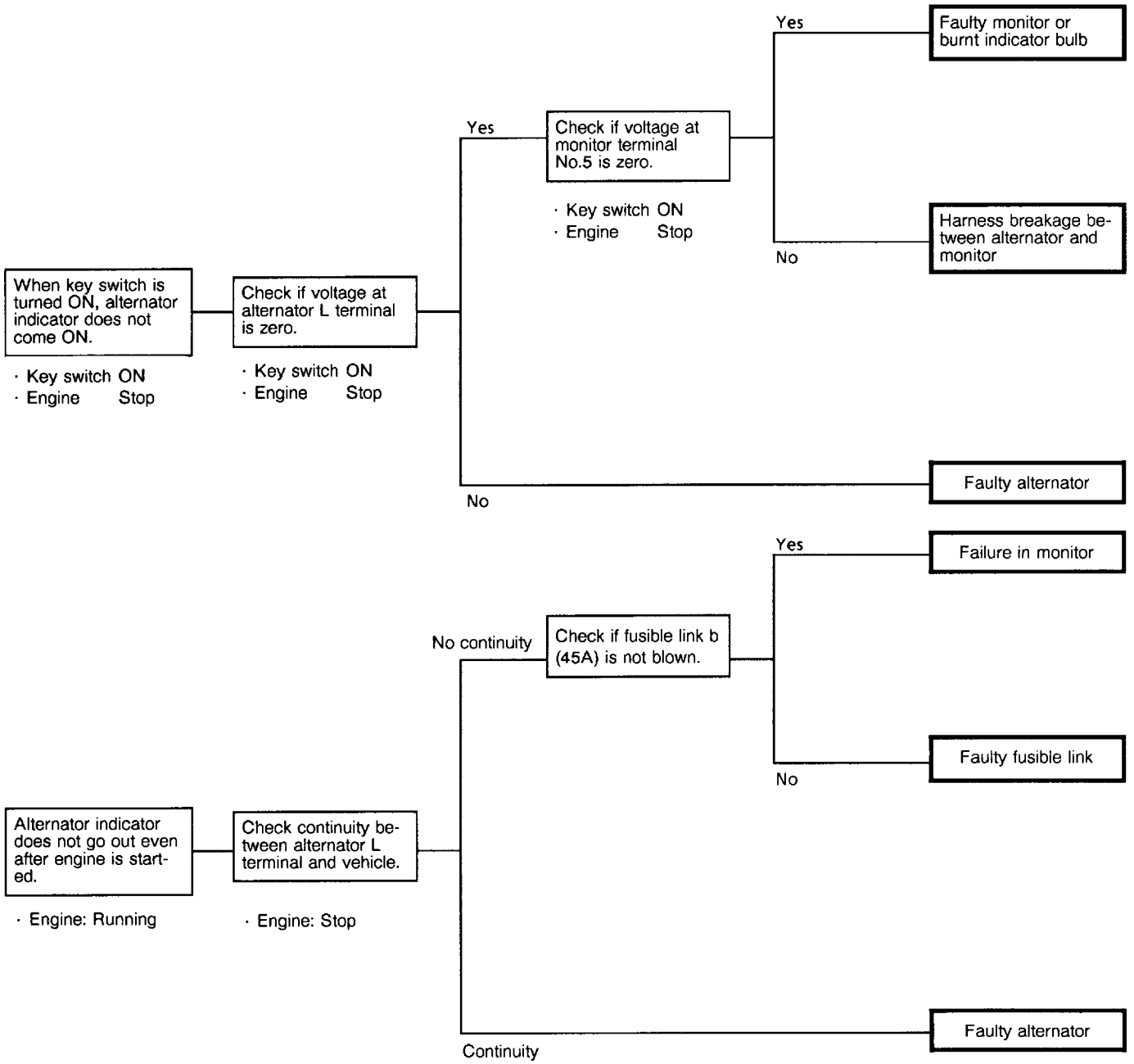

Faulty coolant temperature sensor
Continuity
Faulty coolant temperature gauge
Faulty harness between monitor panel and sensor
Not Continuity
Faulty connection of coolant sensor
Failure in coolant temperature sensor
Faulty harness (short circuit) between coolant temperature gauge and coolant sensor
Faulty coolant temperature gauge
Faulty coolant temperature sensor
Faulty coolant temperature gauge
Faulty connection of coolant sensor

## MALFUNCTION OF FUEL GAUGE

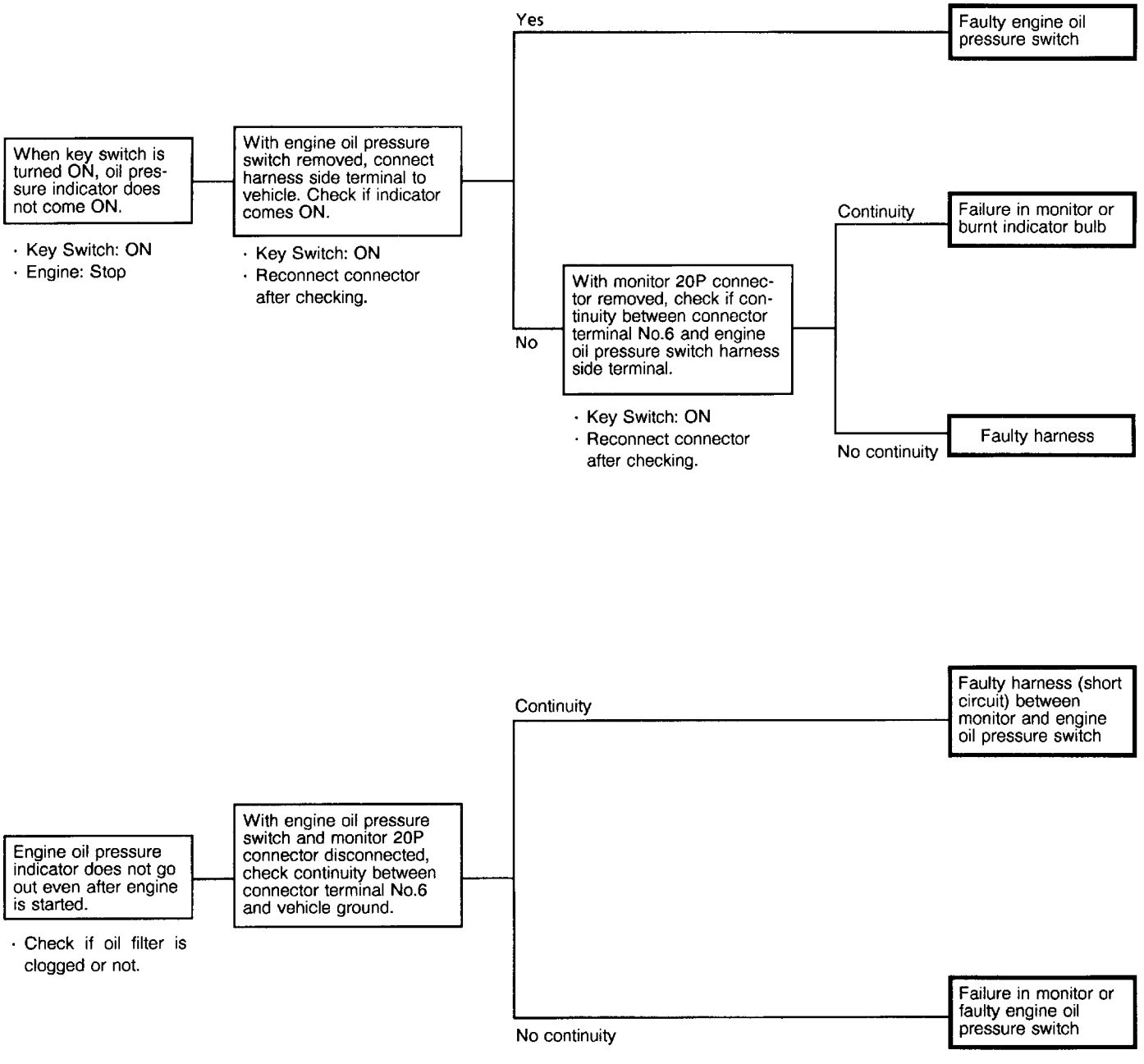



Faulty fuel sending unit
Continuity
Failure in monitor
Faulty harness between fuel gauge and fuel sending unit
Not Continuity
Faulty connection of fuel sending unit
Faulty fuel sending unit
Faulty harness (short circuit) between fuel gauge and fuel sending unit
Faulty fuel gauge
Faulty fuel sending unit
Faulty fuel gauge
Faulty connection of fuel sending unit

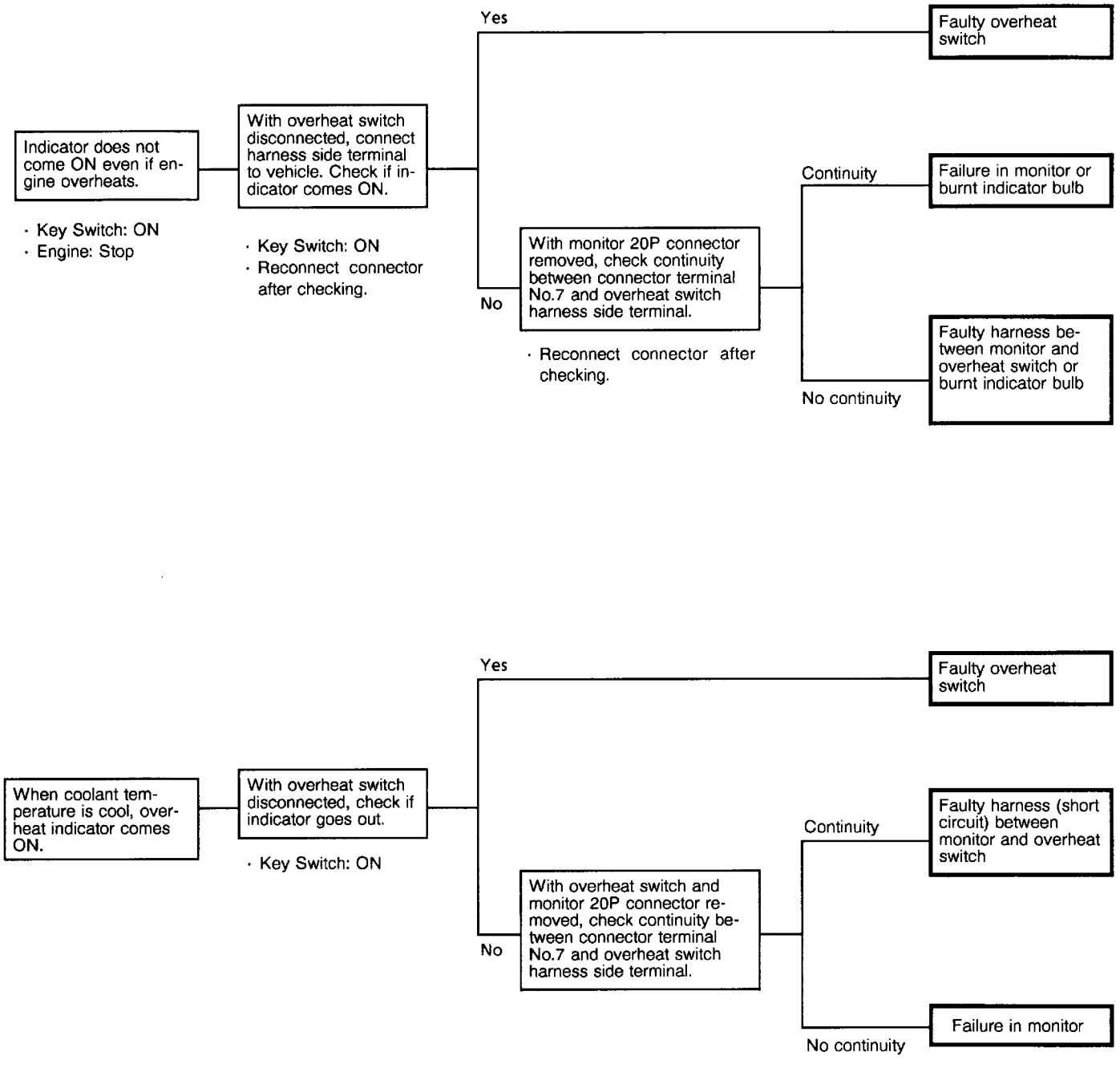
## MALFUNCTION OF ALTERNATOR INDICATOR



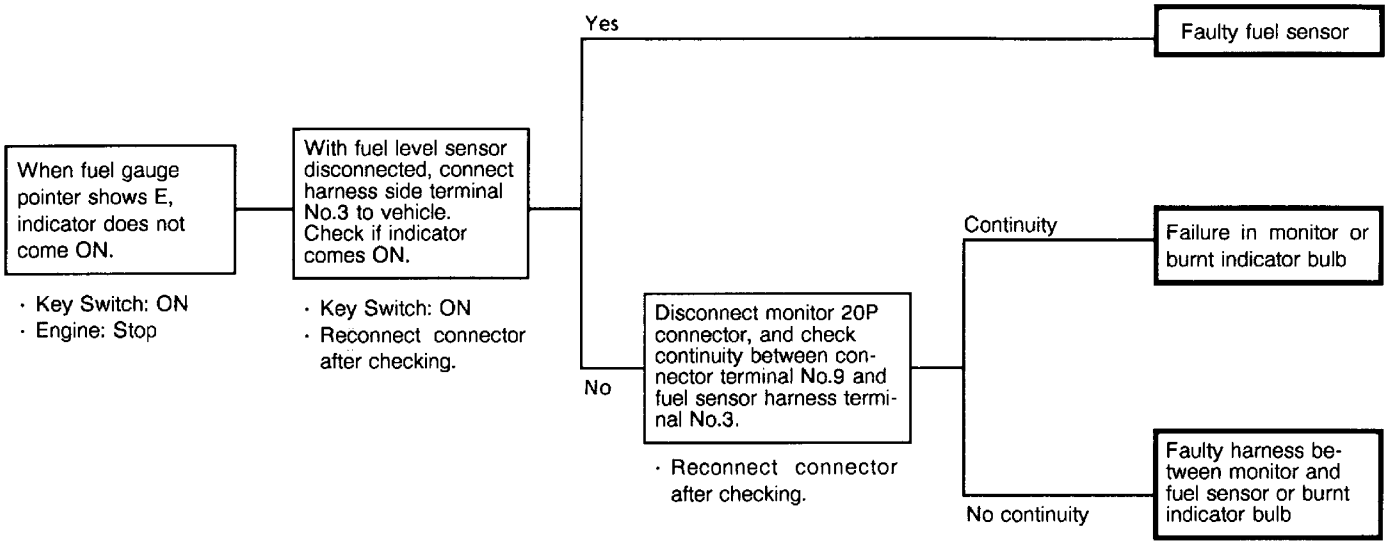
## MALFUNCTION OF ENGINE OIL PRESSURE INDICATOR

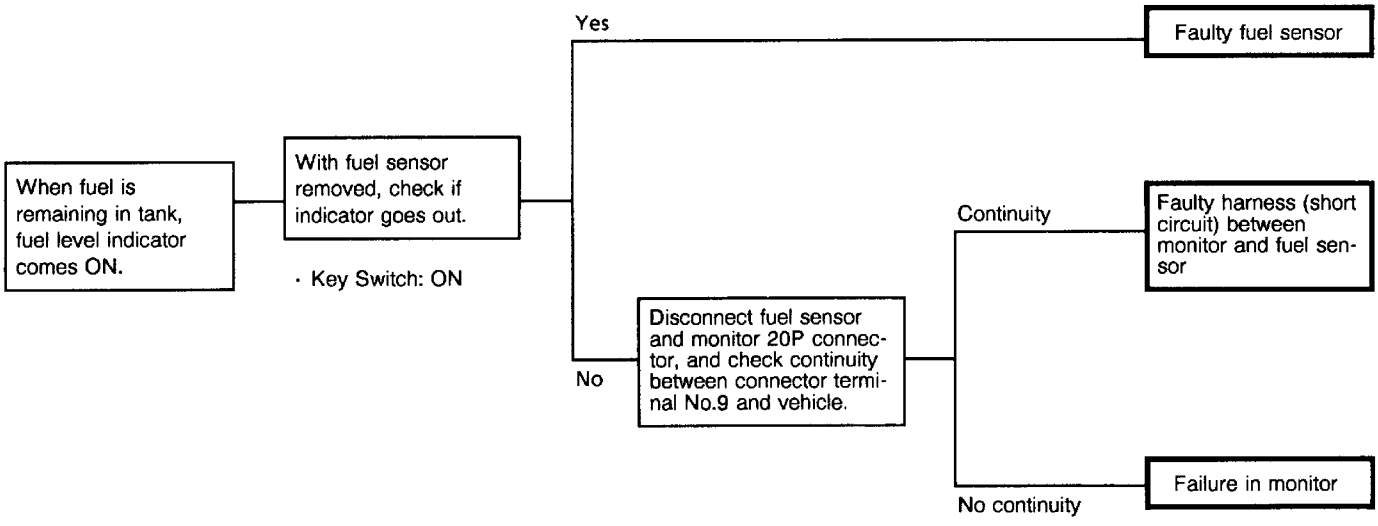


## MALFUNCTION OF OVERHEAT INDICATOR

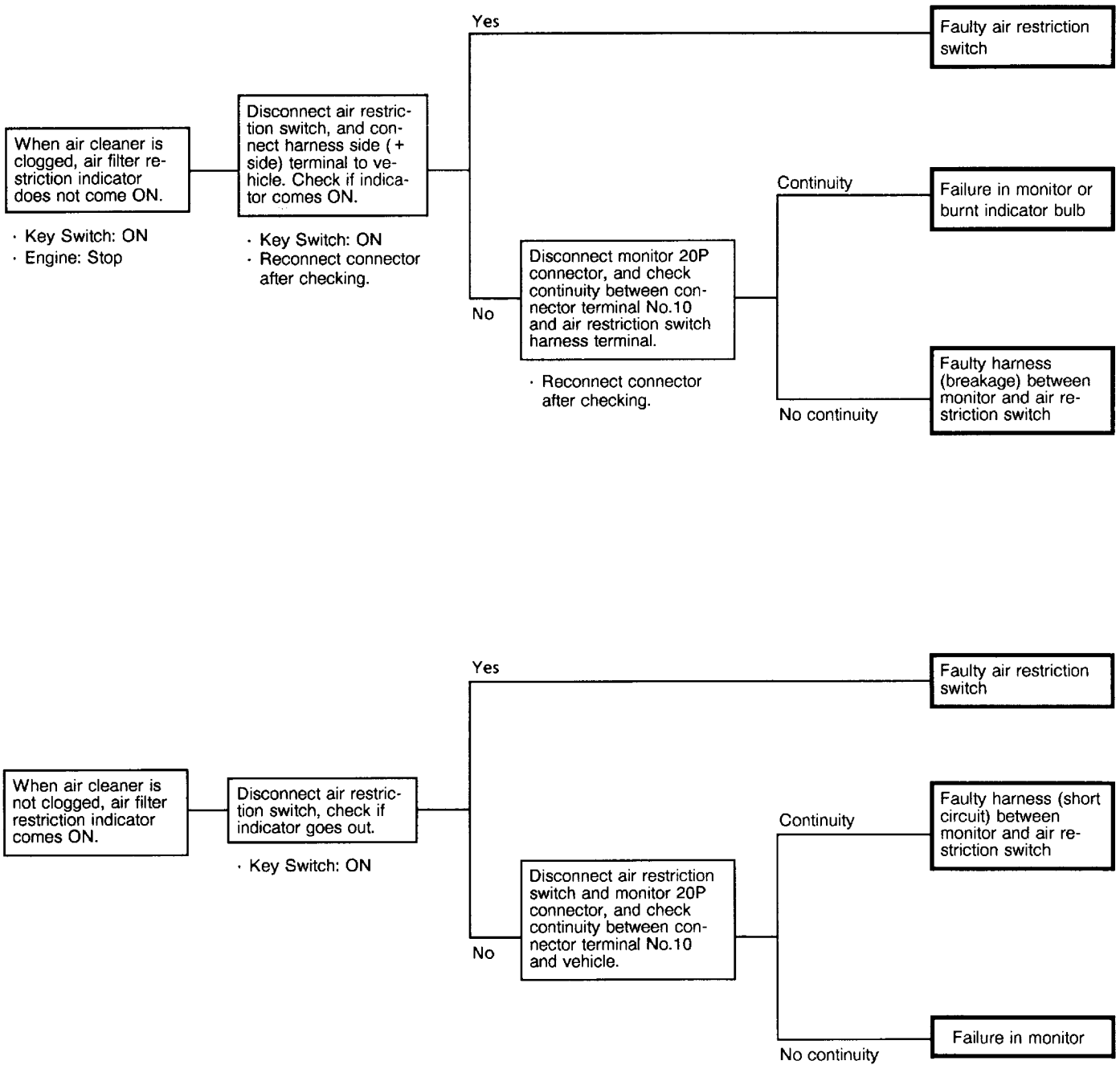


## MALFUNCTION OF FUEL LEVEL INDICATOR

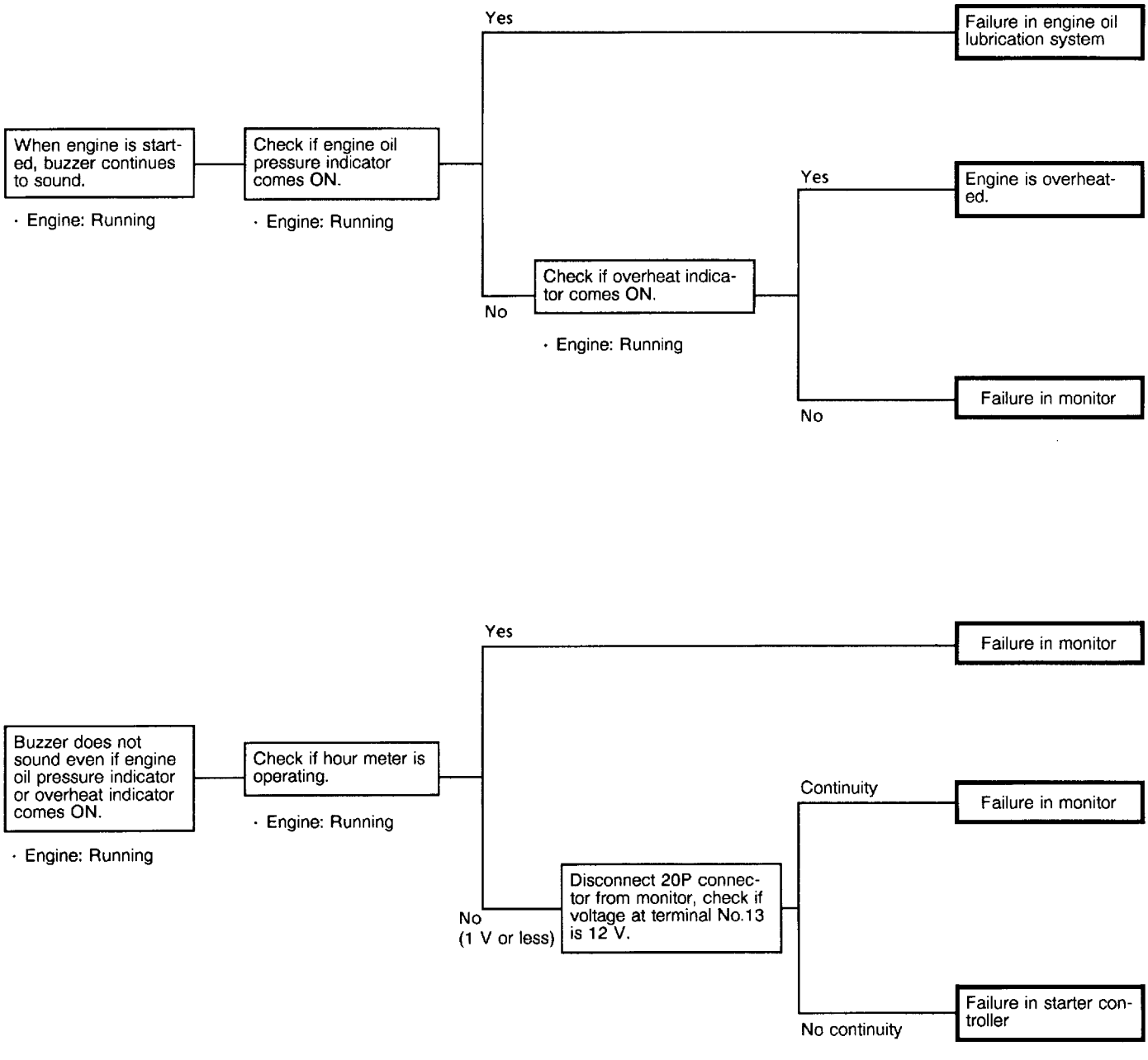


## MALFUNCTION OF AIR FILTER RESTRICTION INDICATOR

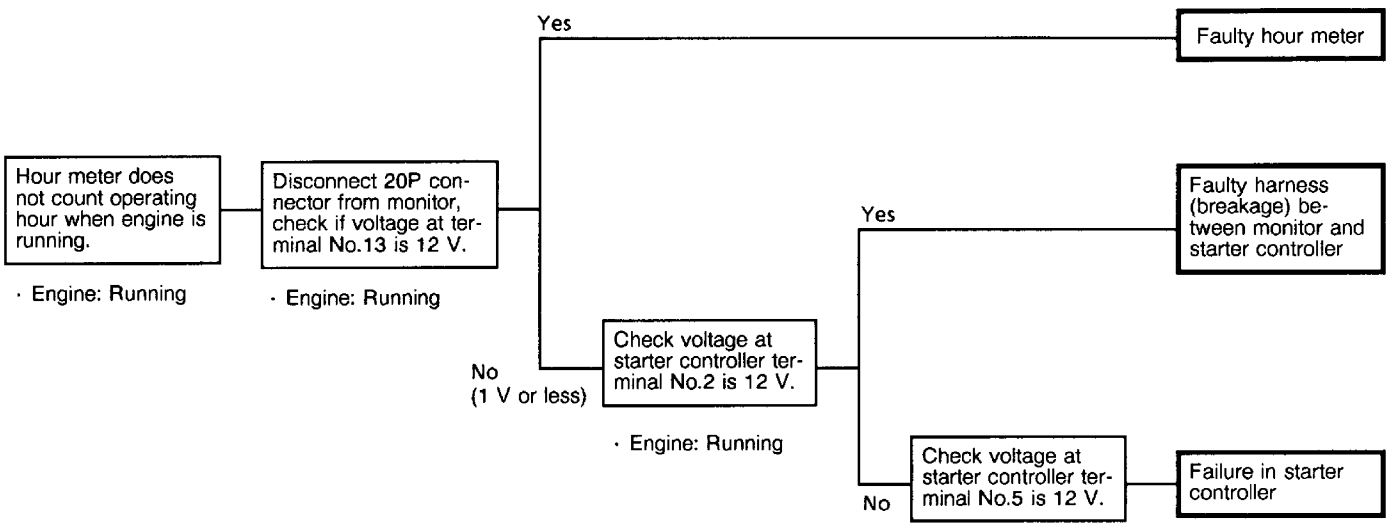


## MALFUNCTION OF BUZZER

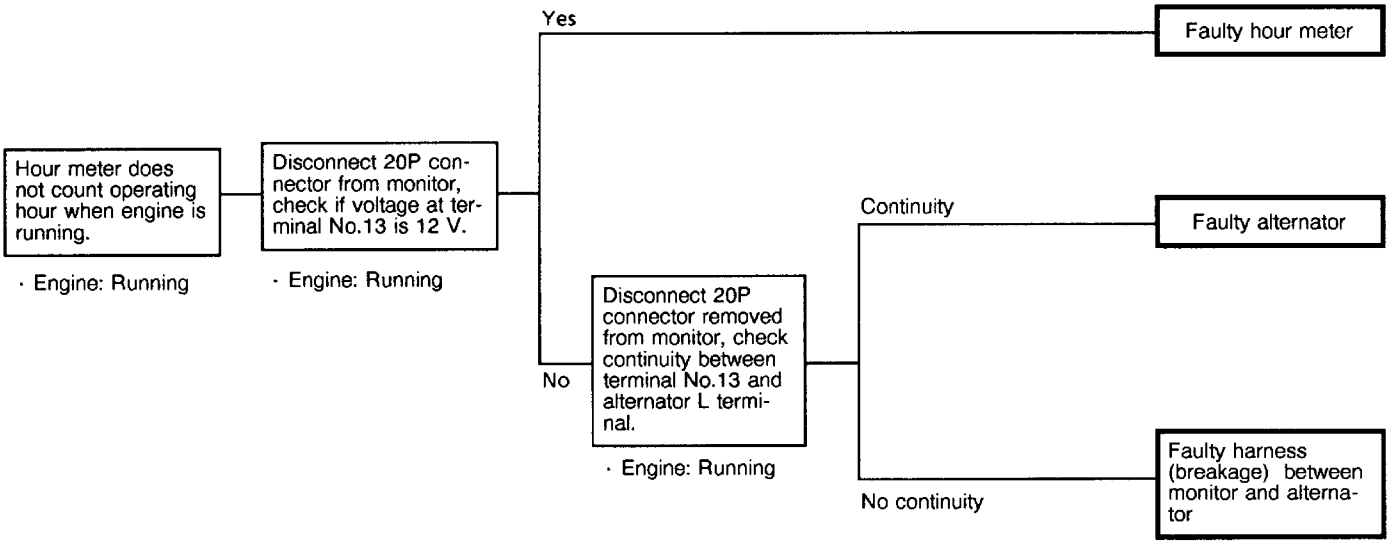


## MALFUNCTION OF HOUR METER

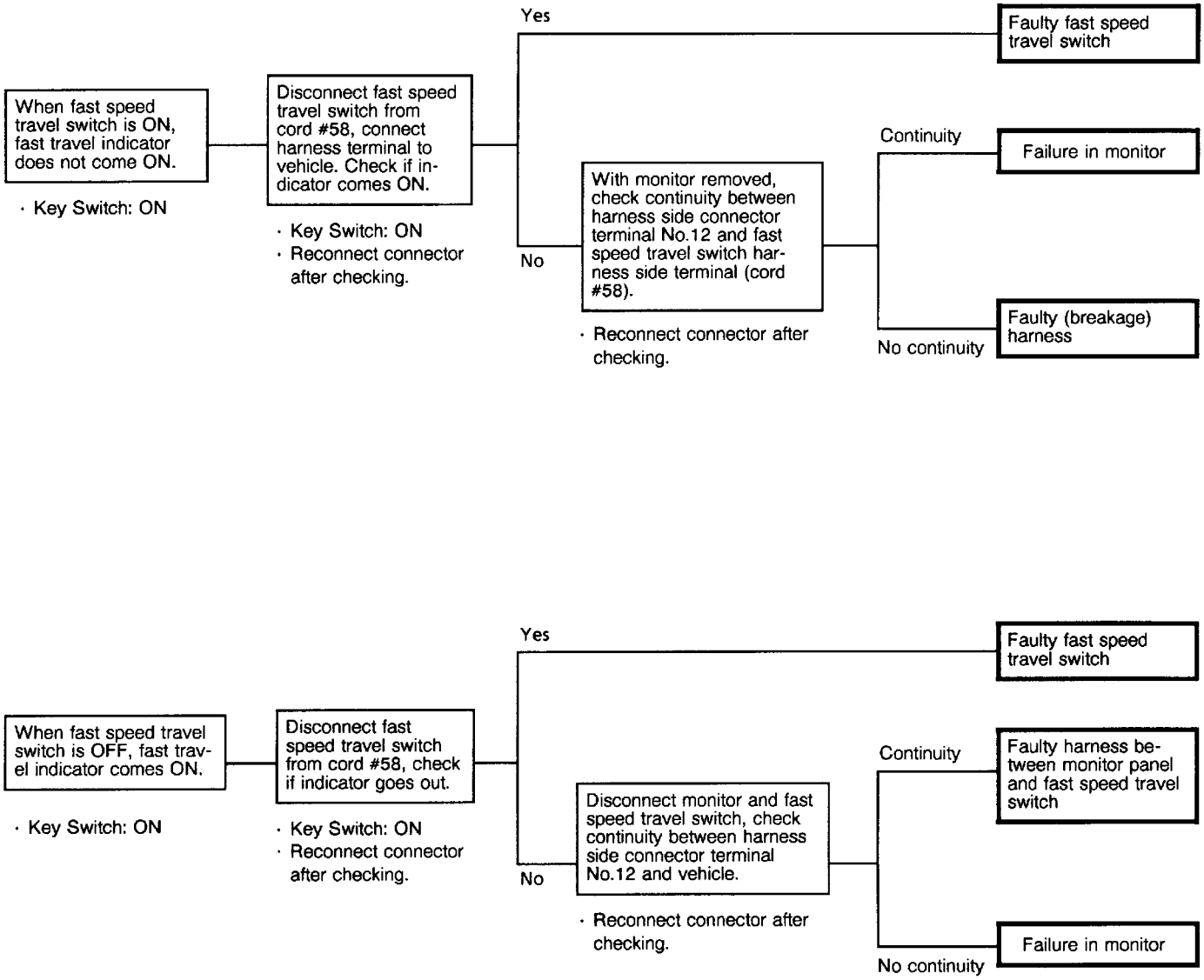
33Mu




58Mu



## MALFUNCTION OF FAST TRAVEL INDICATOR



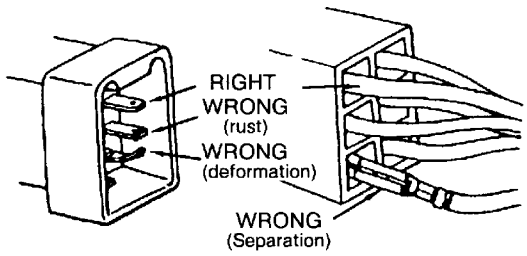
## ELECTRICAL TEST PRECAUTIONS

1. Be sure to turn the key switch OFF before disconnecting or connecting any connectors.

2. Do not attempt to disconnect connectors by pulling on wires or harnesses. Always grasp the connector to pull it apart.

3. Most connectors are made of brass. Before inserting connectors, check that the connector terminals are straight, intact and free from corrosion.

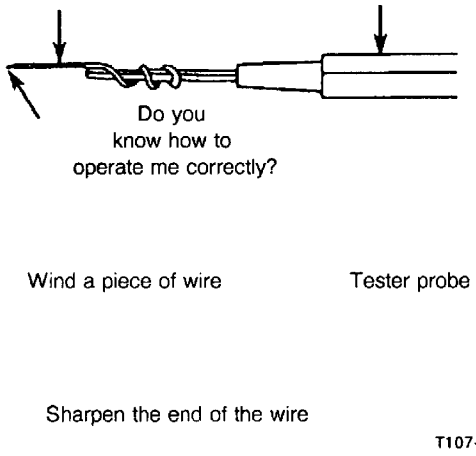

T107-07-06-001




T107-07-06-002

4. Before using a circuit tester, refer to the instructions in the circuit tester manual.
   Then, set the circuit tester to meet the voltage range and current polarity of the object to be measured.

5. Before starting the connector test, always check the connector terminal numbers, referring to the circuit diagram.
   When the connector size is very small, and the standard probe size is too large to be used for testing, wind a fine piece of sharpened wire or a pin around the probe to make the test easier.




T107-07-06-003

## CONTINUITY CHECK

**Single- line continuity check**
Disconnect both end connectors of the harness and check continuity between both ends:
If the Ohm-meter reading is: 0Ω = Continuity
∞Ω = Discontinuity

*NOTE: When the one end connector is far apart from the other, connect one end of connector (A) to the vehicle using a clip. Then, check continuity of the harness through the vehicle as illustrated.*

If the Ohm-meter reading is: 0 Ω = Continuity
∞ Ω = Discontinuity

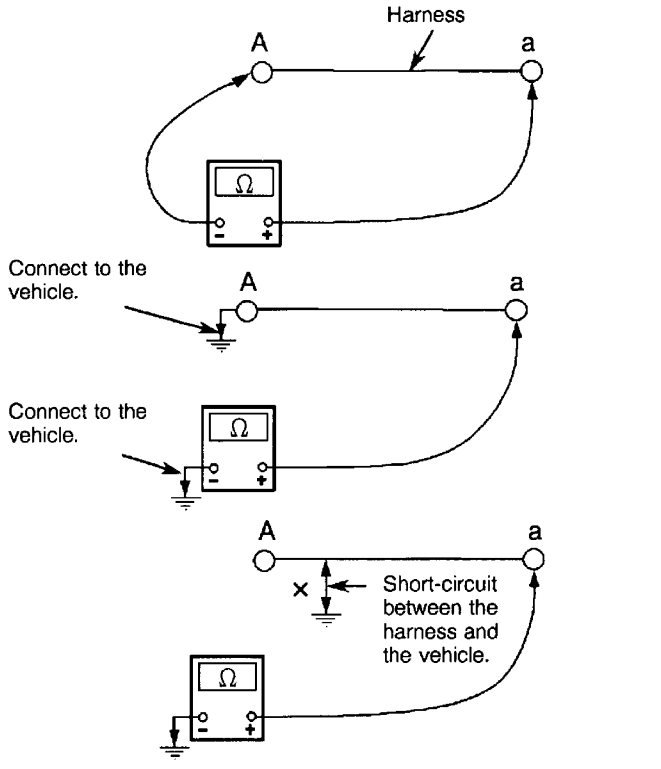
**Single-line short-circuit check**
Disconnect both end connectors of the harness and check continuity between one end connector of the harness and the vehicle:
If the Ohm-meter reading is:
0 Ω = Short circuit is present.
∞ Ω = No short circuit is present.

**Multi-line continuity check**
Disconnect both end connectors of the harness, and short-circuit two terminals, (A) and (B), at one end of the connector, as illustrated. Then, check continuity between terminals (a) and (b) at the other connector. If the ohm-meter reading is ∞Ω, either line (A) – (a), or (B) – (b) is in discontinuity. To find out which line is discontinued, conduct the single line continuity check on both lines individually, or, after changing the short-circuit terminals from (A) – (B) to (A) – (C). Check continuity once more between terminals (a) and (c).

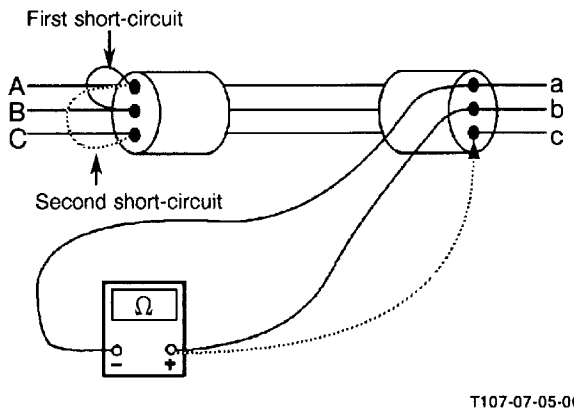
*NOTE: By conducting the multi-line continuity check twice, it is possible to find out which line is discontinued. With terminals (A) and (C) short-circuited, check continuity between terminals (a) and (c).*
If the Ohm-meter reading is:
0 Ω = Line (B) – (b) has discontinuity.
∞ Ω = Line (A) – (a) has discontinuity.

**Multi-line short-circuit check**
Disconnect both end connectors of the harness, and check continuity between terminals (A) and (B) or (C).
If the Ohm-meter reading is:
0 Ω = Short-circuit exists between the lines.
∞ Ω = No short-circuit exists between the lines.

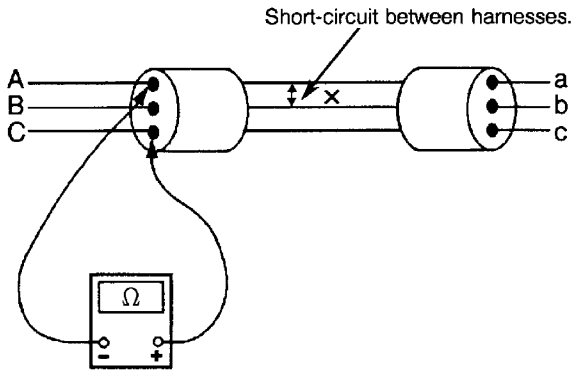
*NOTE: Refer to the ELECTRICAL SYSTEM SECTION for details of the connectors, electric circuit diagrams, and harness drawings.*



T107-07-05-003



T107-07-05-004



T107-07-05-005

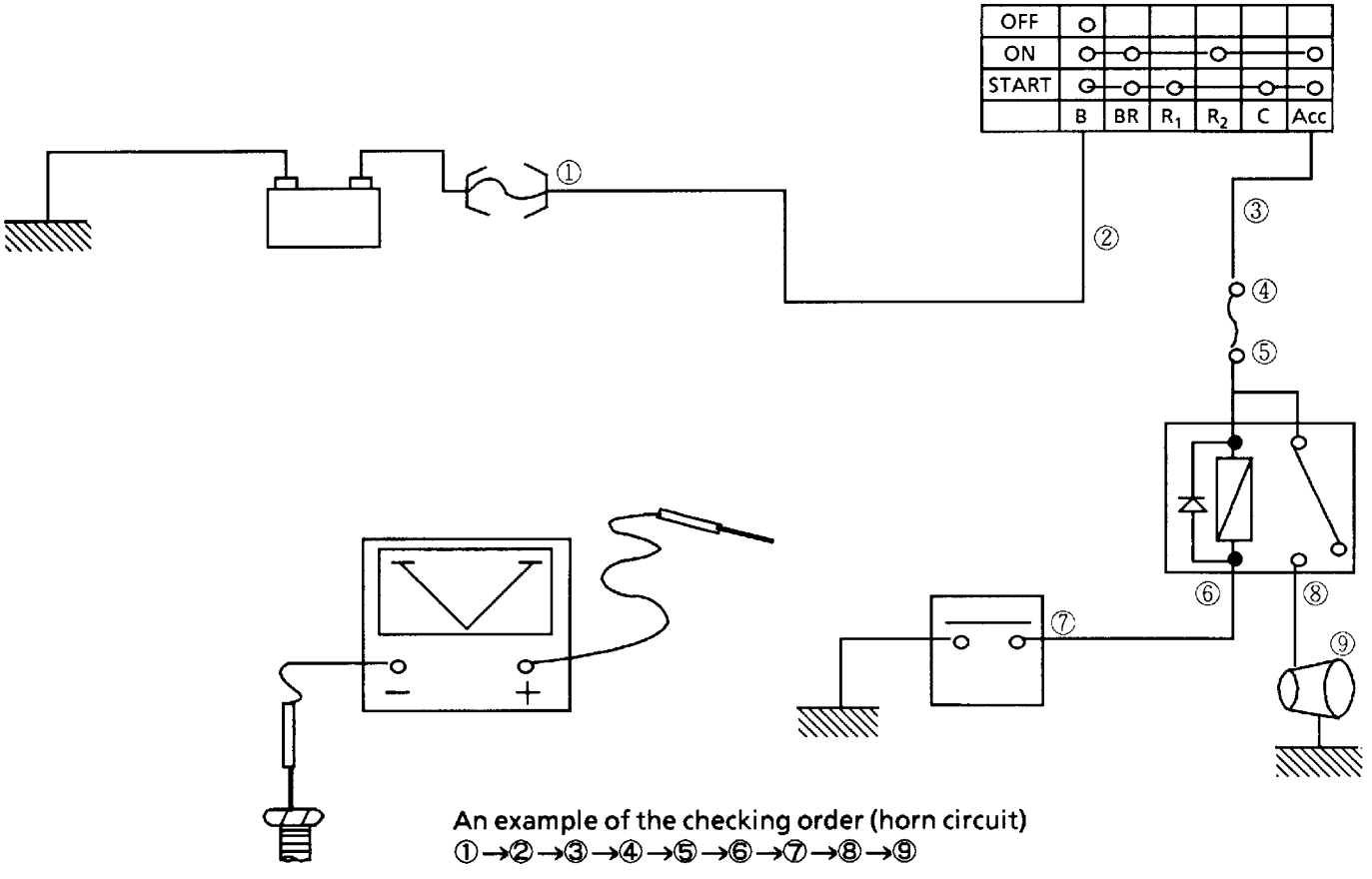
## VOLTAGE CHECK

Switch ON in the relevant circuit so that the specified voltage can be applied to the check point. Then, measure the voltage to check the circuit condition.
Check the circuit in either the upstream (from power source) or downstream (from accessory) order.
Connect the tester black (negative) probe to the vehicle ground and red (positive) probe to the check point.

**Evaluation**
Measured voltage must equals 12V (battery voltage). If the measured voltage is less than the battery voltage by 0.5 or more, faulty connection may be a possible cause of the trouble.

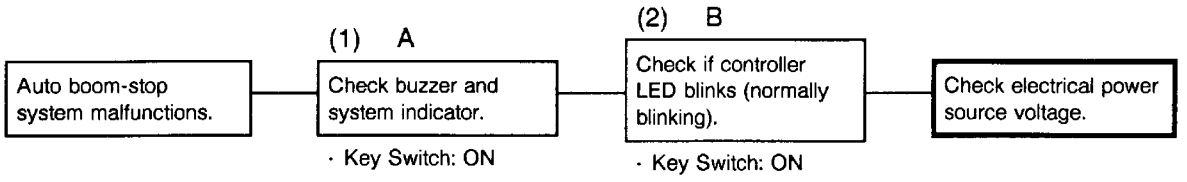
**<Example: Horn Circuit>**

When checking point③ to ⑤: Key switch ON
When checking point⑥ to ⑨: Horn switch ON



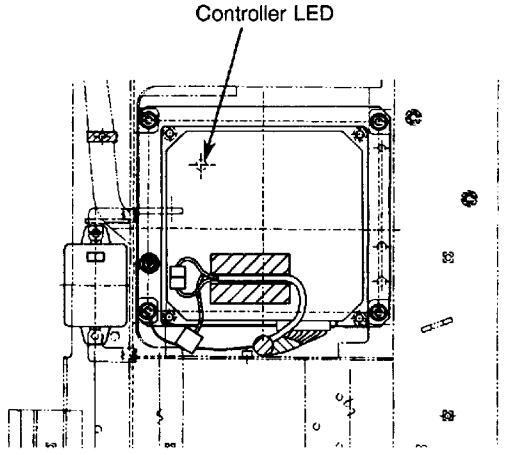

An example of the checking order (horn circuit)
①→②→③→④→⑤→⑥→⑦→⑧→⑨

## AUTO BOOM-STOP FUNCTION CHECK




1. Checking at Step A
   When the buzzer sounds and the system indicator comes ON or blinks, conduct troubleshooting referring to the system operation status list.

2. Checking at Step B
   When the controller LED does not blink, check the connection of the controller connector.



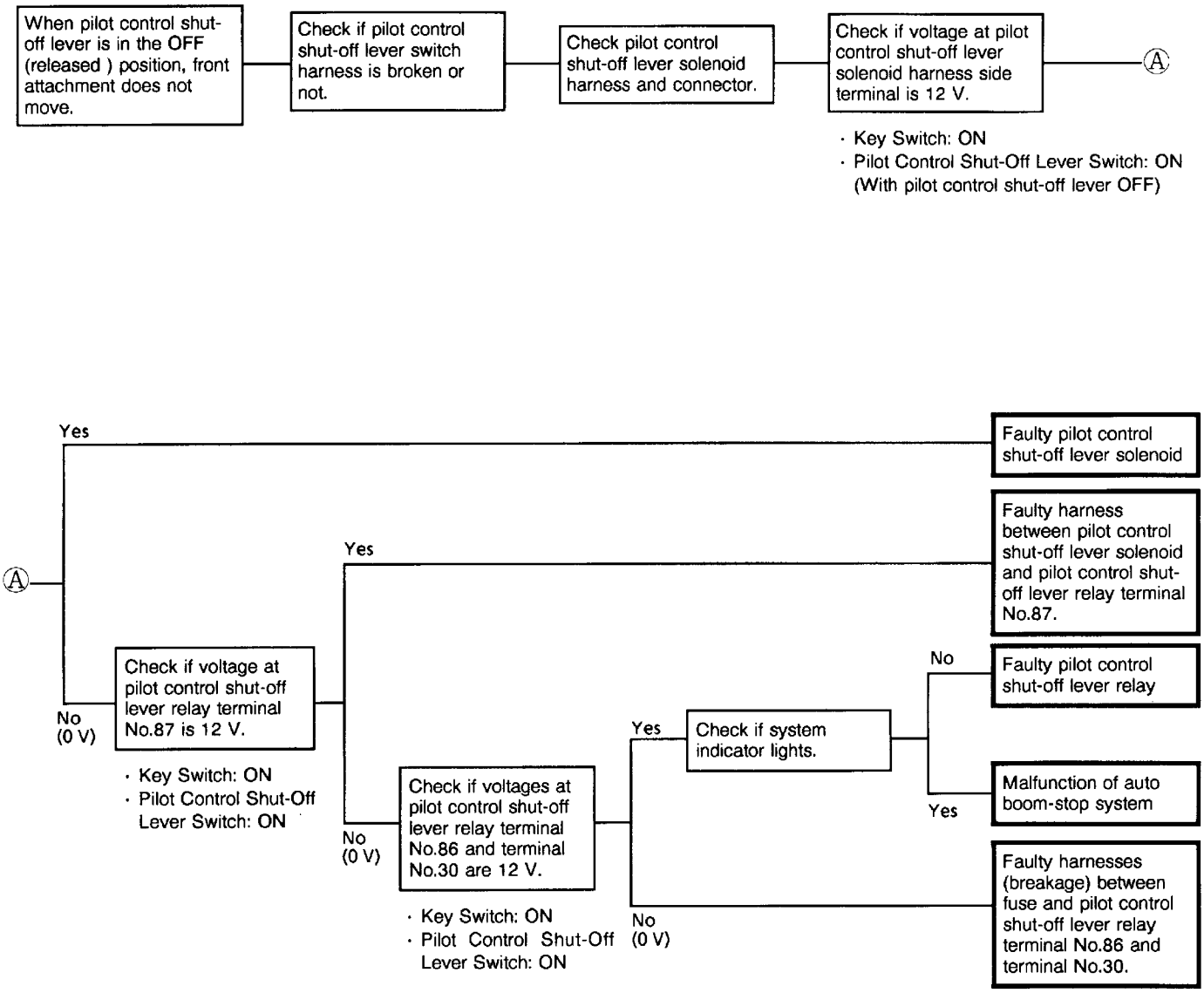

T532-04-02-008

## System Operation Status

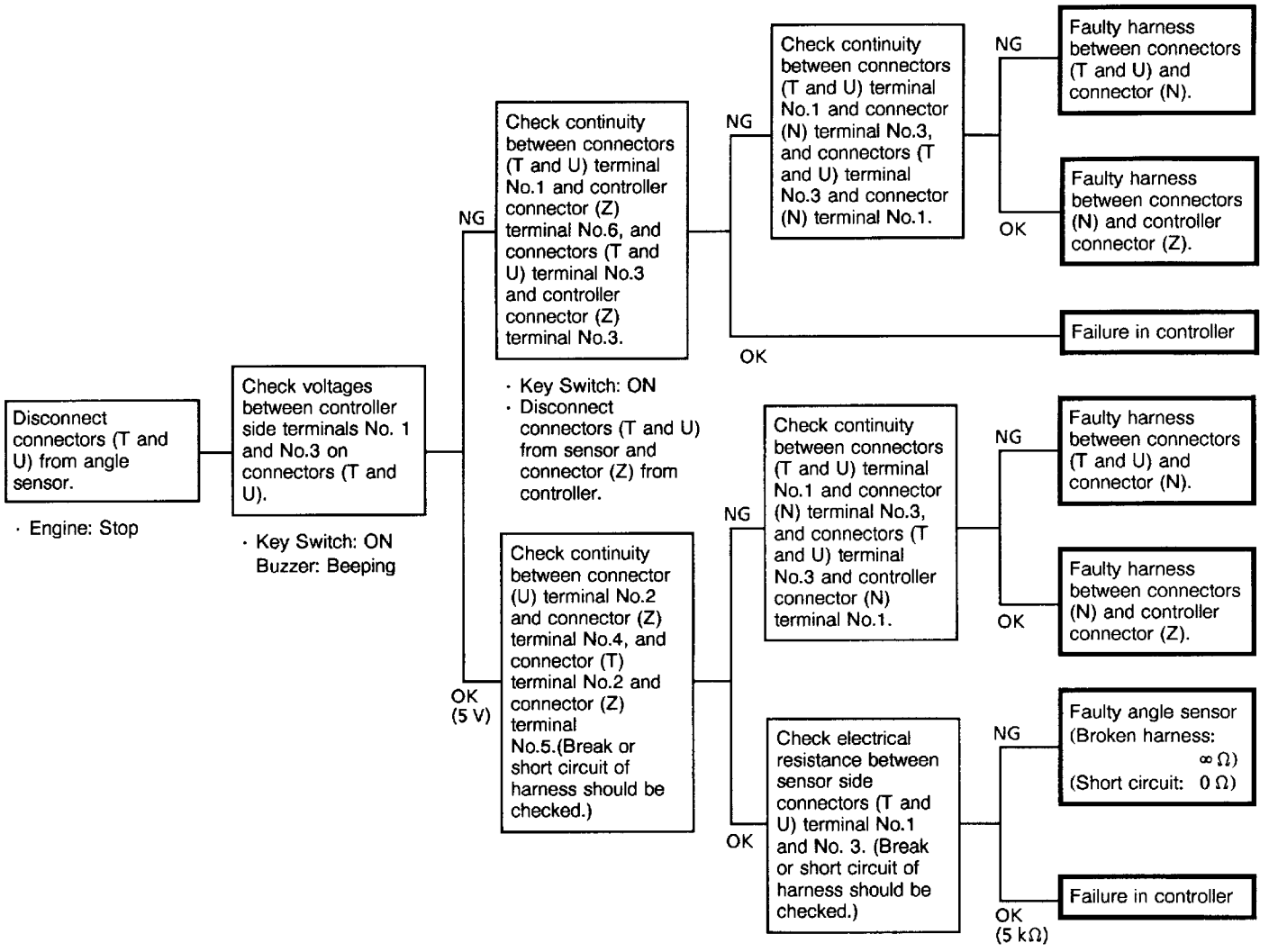
| | Description | Buzzer | System Indicator | Proportional Solenoid Valve | Pilot Shut-Off Lever Relay | Resume, Check and Repair Method |
|---|---|---|---|---|---|---|
| Normal | With key switch ON, controller initialization is in process. | Beep | ON for one second | Inoperative for one second | No output (Front attachment is inopertive) | Normal operation is resumed after initialization. |
| | When stopped by auto boom-stop system | Short beeps repeat. | OFF | Boom raise or boom right swing is inopera-tive. | Activated depending on input from pilot shut-off lever SW. | Move boom to normal operation zone. |
| | When stopped by height restriction system | Short beeps repeat. | OFF | Boom cannot be raised. | Activated depending on input from pilot shut-off lever SW. | Move boom to normal operation zone. |
| | Normal status | Silent | OFF | Activated depending on zone check result. | Activated depening on input from pilot shut-off lever SW. | |
| Mis-Operation | Faulty sensor initial setting | Beep | ON | Boom raise and boom right swing are inoperative. | No output (Front attachment is inoperative) | Reset initial setting correctly. |
| | Boom drifted into the buffer zone while parking with engine stopped. (This status occurs when engine is re-started.) | Short beeps repeat. | OFF | Boom raise and boom right swing are inoperative. | Output is delivered (boom lower and boom left swing are operative). | Move boom out of the buffer zone. |
| Deactivation | When auto boom-stop function is deactivated (system deactivation). | Short beeps repeat. | Blinking | Speed is reduced in deceleration zone. | Output is delivered (boom lower and boom left swing are operative). | Normal operation is resumed when reactivated. |
| Trouble | Boom enters while auto boom-stop system operates. (Emergency stop status) | Short beeps repeat | ON | Boom raise and boom right swing are inoperative. | No output | Move boom out of the buffer zone after re-connecting power source. |
| | Disconnection / short circuit of boom / swing sensors or disconnection of link<br>※ : 0.2 V~0 V<br>※ : 4..8~5.0 V | Beep | ON | Activated depending on zone check result when boom is fully raised or swung to the right. | Output is delivered (boom lower and boom left swing are operative). | Re-connect power source after repairing. (Refer to T07-04-04.) |
| | Dislocation of boom / swing sensor or disconnection of link<br>※ : 0.2 V~0.5 V<br>※ : 4.5 V~4.8 V | Beep | ON | Activated depending on zone check result when boom is fully raised or swung to the right. | Output is delivered (boom lower and boom left swing are operative). | Initialization<br>※ (Check output at initialization position.) |
| | Excessively great output from boom / swing sensor | Beep | ON | Activated depending on zone check result when boom is fully raised or swung to the right. | Output is delivered (boom lower and boom left swing are operative). | Re-connect power source. ( When the same trouble repeats, replace the corresponding sensor.) |
| | Faulty proportional solenoid valve | Beep | ON | No output delivered from boom raise or right swing solenoid valve | Output is delivered (boom lower and boom left swing are operative). | Re-connect power source after repairing. (Refer to T07-04-04.) |
| | Disconnection / short circuit of pilot shut-off lever relay | Beep | ON | Activated depending on zone check result. | No output (Front attachment is inoperative) | Re-connect power source after repairing. (Refer to T07-04-03.) |
| | Disconnection / short circuit of pilot shut-off lever switch | Silent | OFF | Activated depending on zone check result. | No output (Front attachment is inoperative) | (Impossible to check abnormality) (Refer to T07-04-03.) |
| | Abnormal 12 V electrical power voltage | Silent | Blinking | Boom raise and right swing are inoperative. | No output (Front attachment is inoperative.) | Normal operation is resumed when voltage becomes normal. |

※ Measure the voltage between terminals No.1 and No.2 on the sensor connectors (T) and (U).
Sensor Output (Normal): Boom Raise: 3.5 ± 0.3 V
Right Swing: 2.25 ± 0.3 V

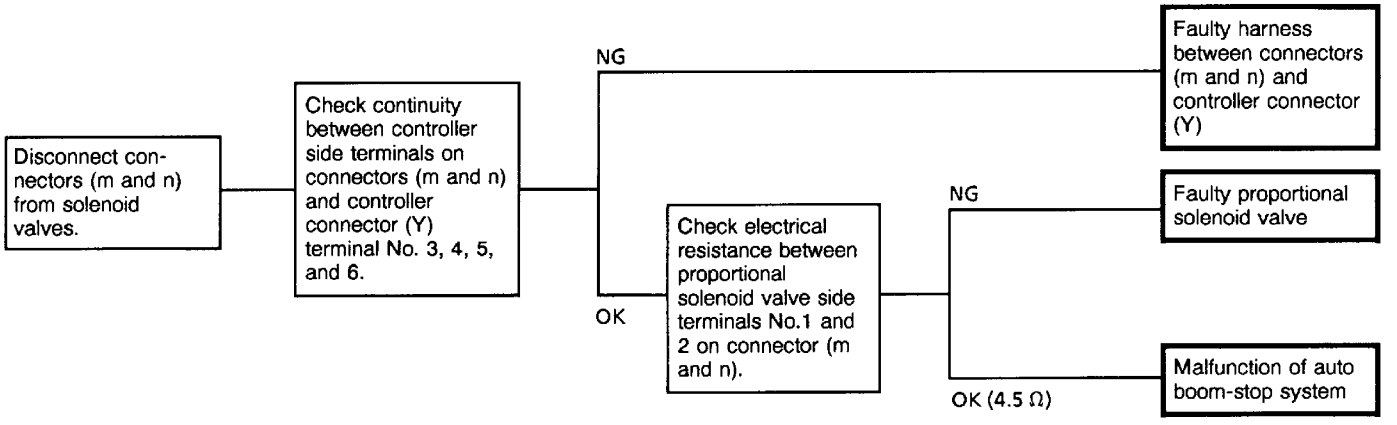
## PILOT CONTROL SHUT-OFF LEVER CIRCUIT CHECK



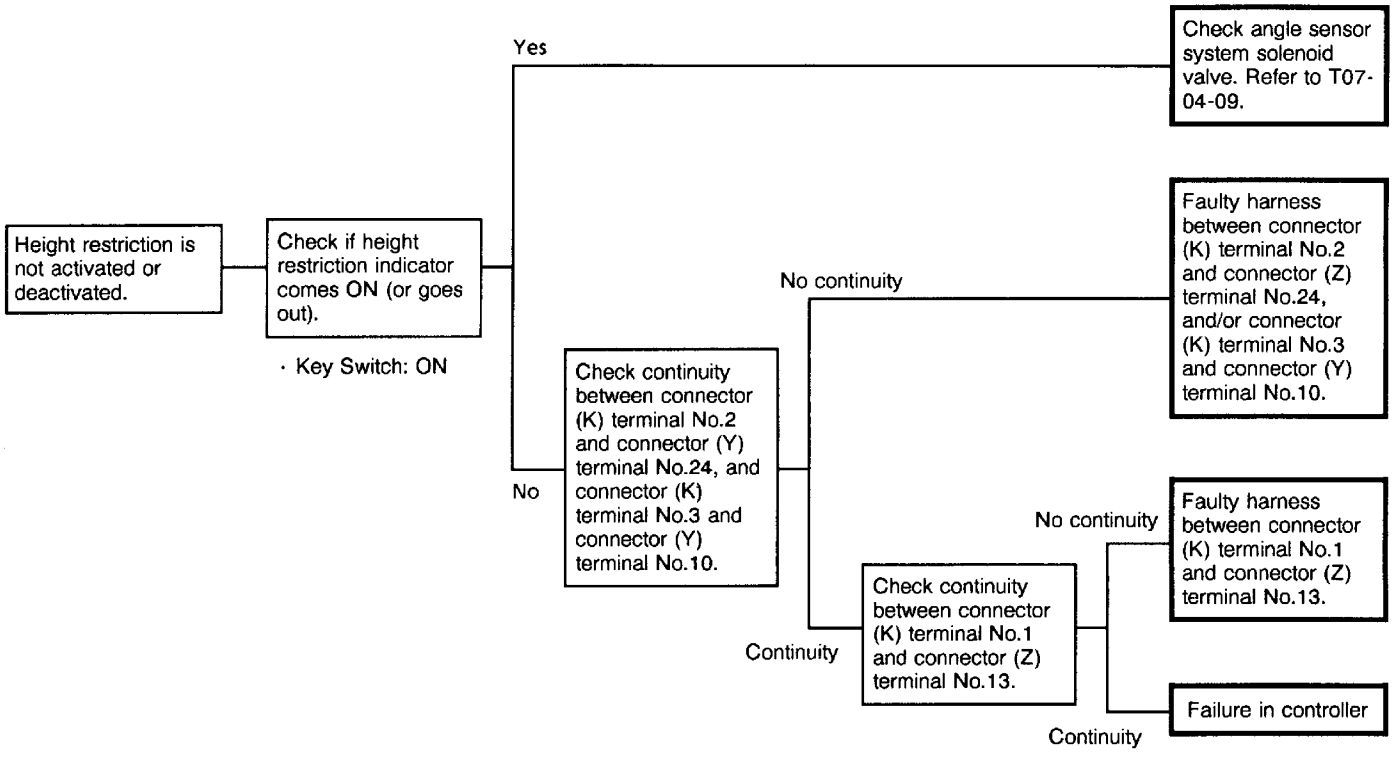
## ANGLE SENSOIR SYSTEM CHECK




## SOLENOID VALVE SYSTEM CHECK



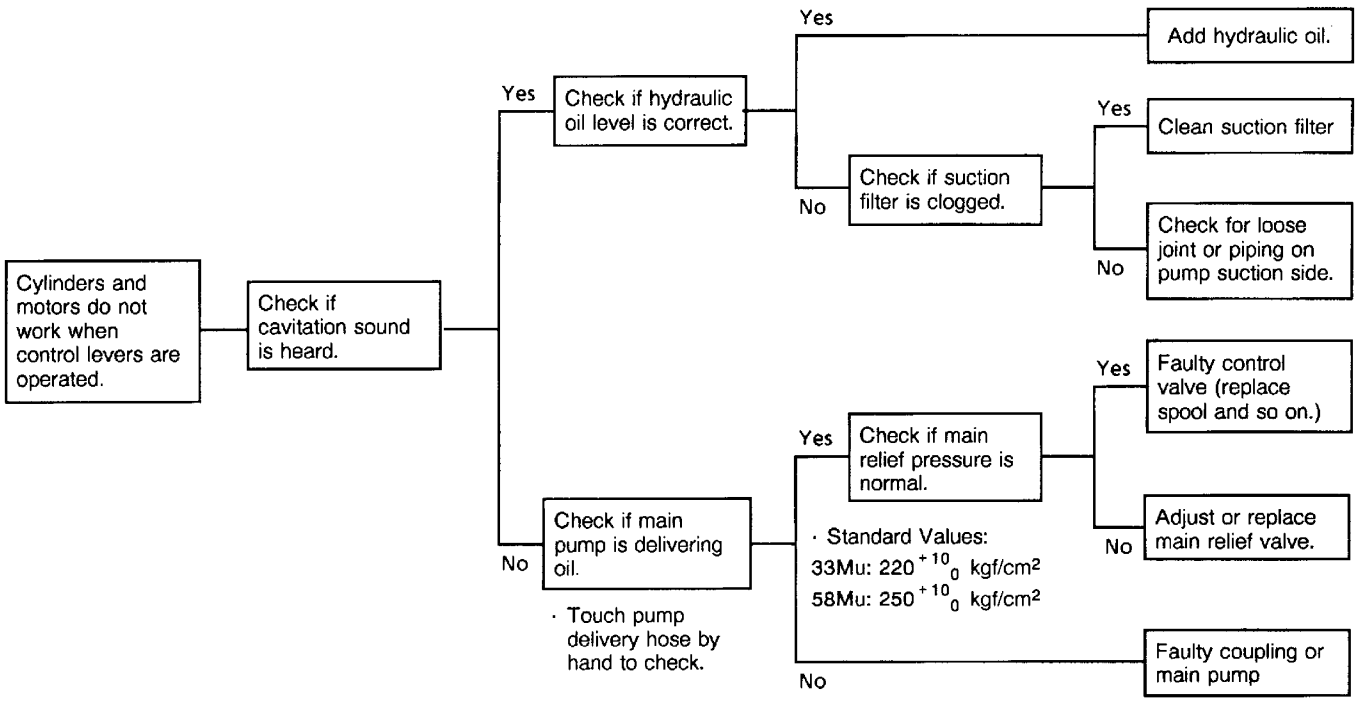
## HEIGHT RESTRICTION FUNCTION CHECK



## ACTUATOR SYSTEM TROUBLESHOOTING

### A-1 All cylinders and motors do not move.

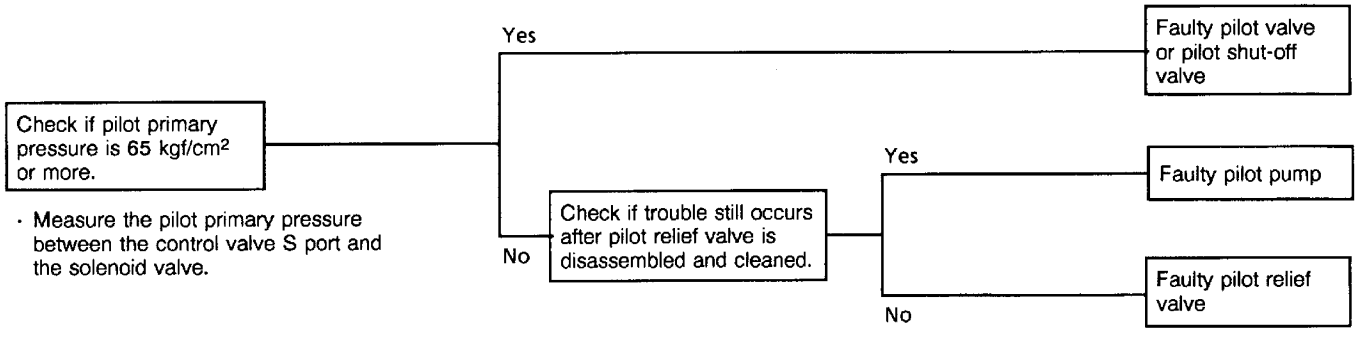
**Guidance:**
Suction system (suction filter, pipe lines, and so on) and / or pressure control system may have trouble.




*NOTE: 1kgf/cm² = 0.09807 MPa*

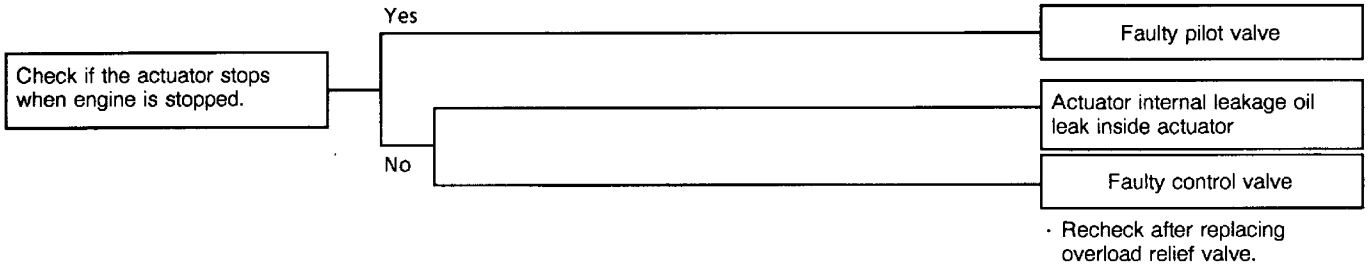
### A-2 Boom, arm, bucket, and swing do not move at all.

**Guidance:**
In case four functions do not move, abnormality may exist in the pilot circuit between the pilot pump and the pilot control shut-off lever solenoid, or deactivation current may not be supplied to the pilot control shut-off lever solenoid.(Refer to T07-04-03 for the pilot control shut-off lever check.)



**A-3 Actuator moves even after control levers are returned to neutral.**

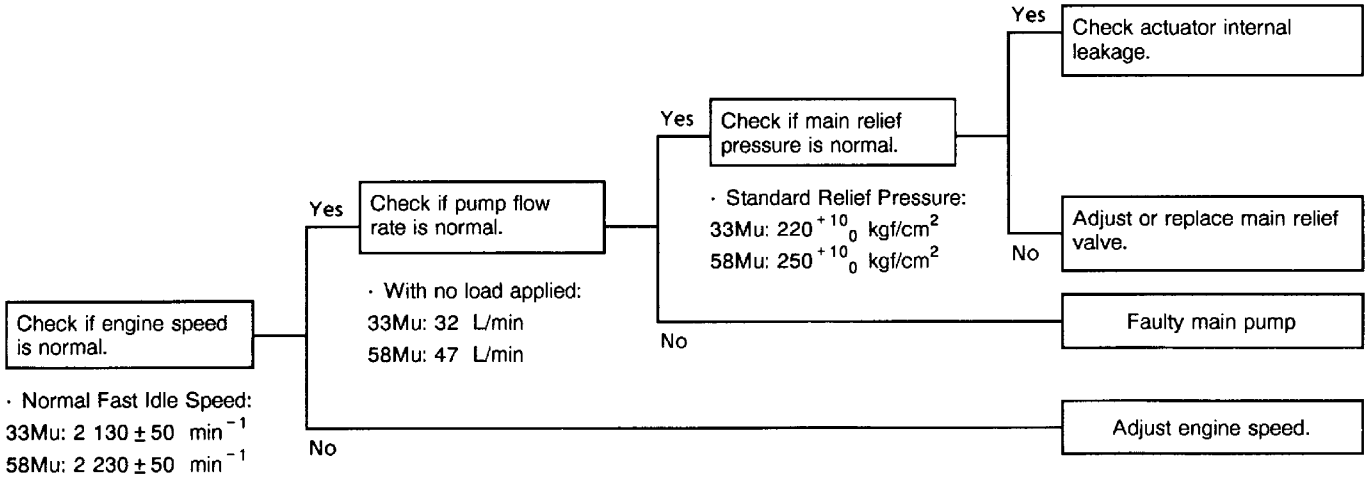
**Guidance:**
Sticking of spools in pilot valve or control valve may be the cause.




**A-4 All actuator speeds are slow.**

**Guidance:**
In case all actuator speeds are slow, a possible cause may exist in the following points:

1. Slow engine speed
2. Low pump flow rate due to faulty pump
3. Lower set pressure of main relief valve

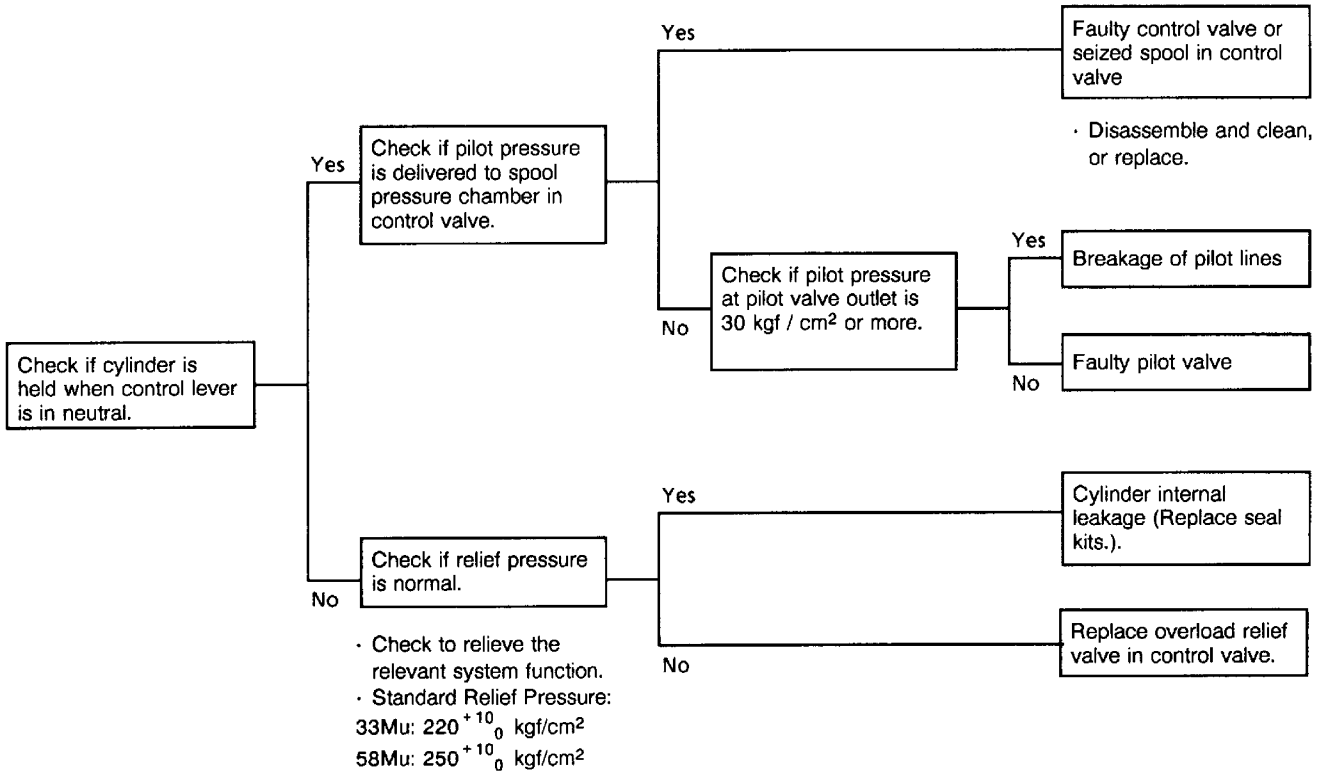



*NOTE: 1kgf/cm² = 0.09807 MPa*

## FRONT ATTACHMENT SYSTEM TROUBLESHOOTING

**F-1 Boom, arm, bucket, or swing cylinder does not move.**

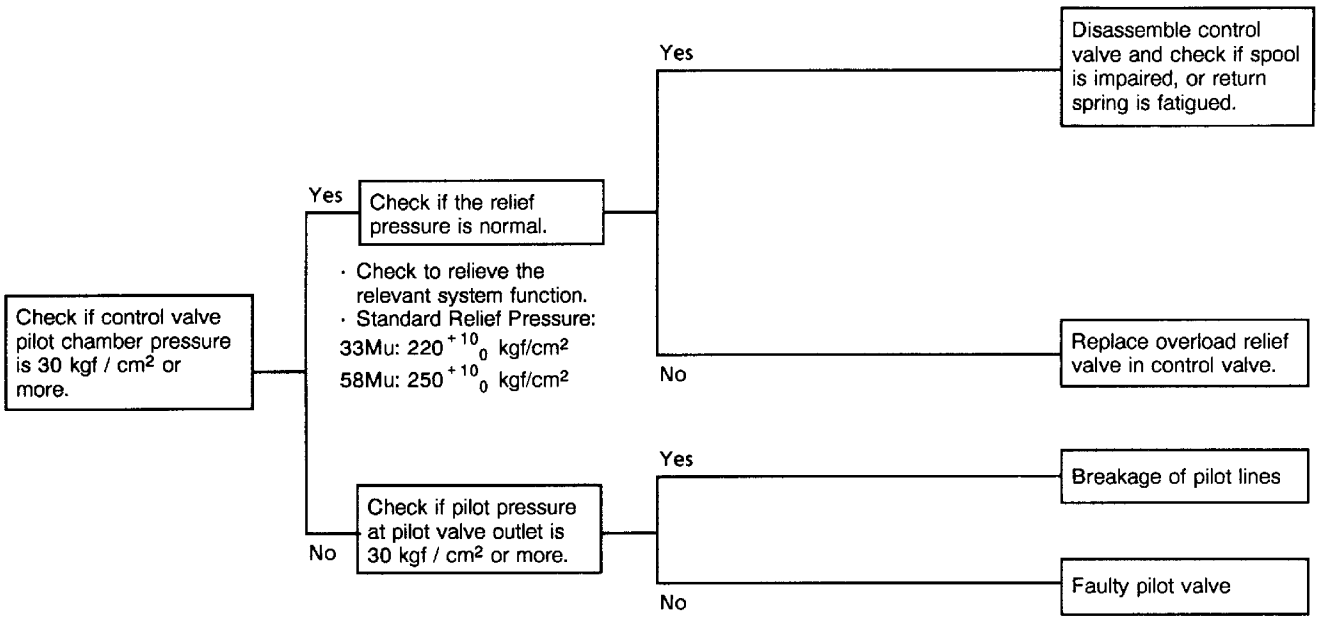
**Guidance:**
In case only one cylinder does not move, check the relevant pilot system first.. Then, proceed to check the main hydraulic system down to the control valve.




*NOTE: 1kgf/cm² = 0.09807 MPa*

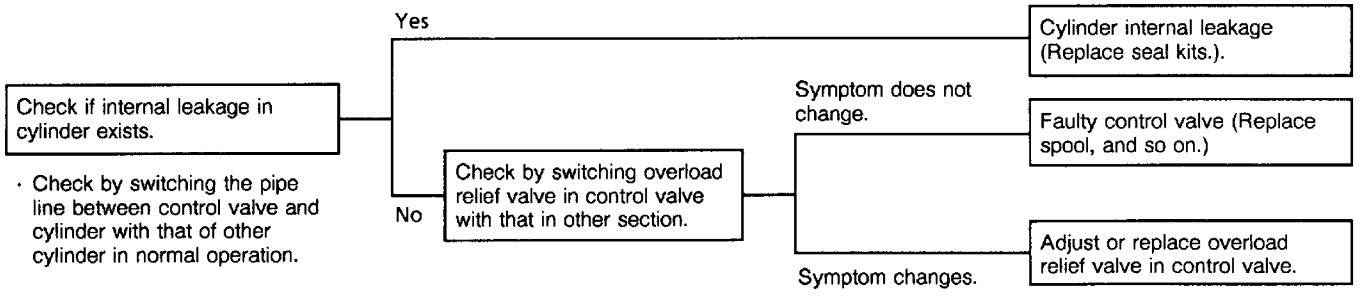
**F-2 Boom, arm, bucket, or boom swing cylinder speed is slow or does not have power.**

**Guidance:**
In case only one cylinder is abnormal, check the relevant pilot system first. Then proceed to check the main hydraulic system down to the control valve.

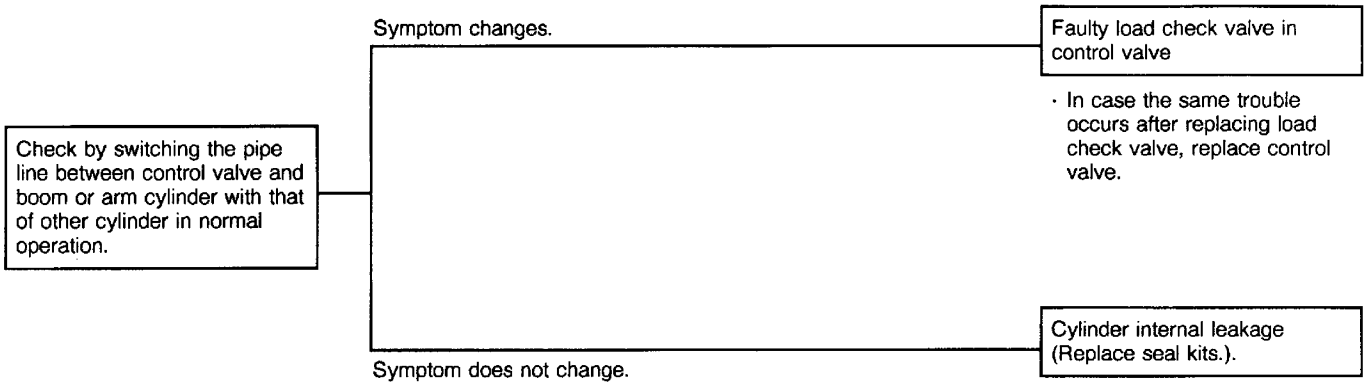



*NOTE: 1kgf/cm² = 0.09807 MPa*

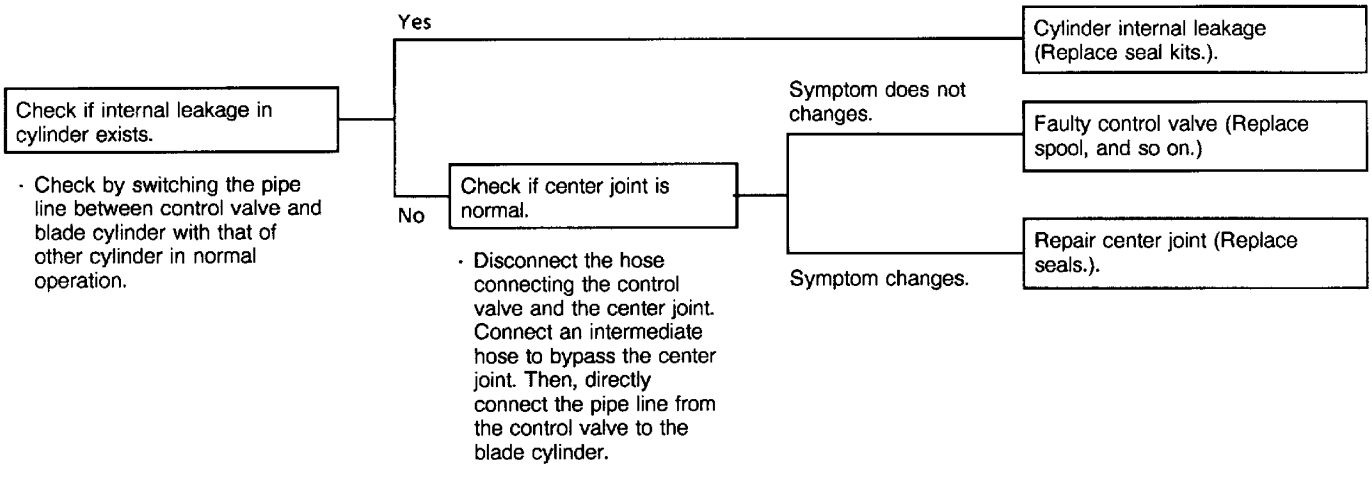
**F-3 Cylinder drift is large.**



## F-4 When boom or arm is operated, boom or arm drops briefly first, then, begins to move.



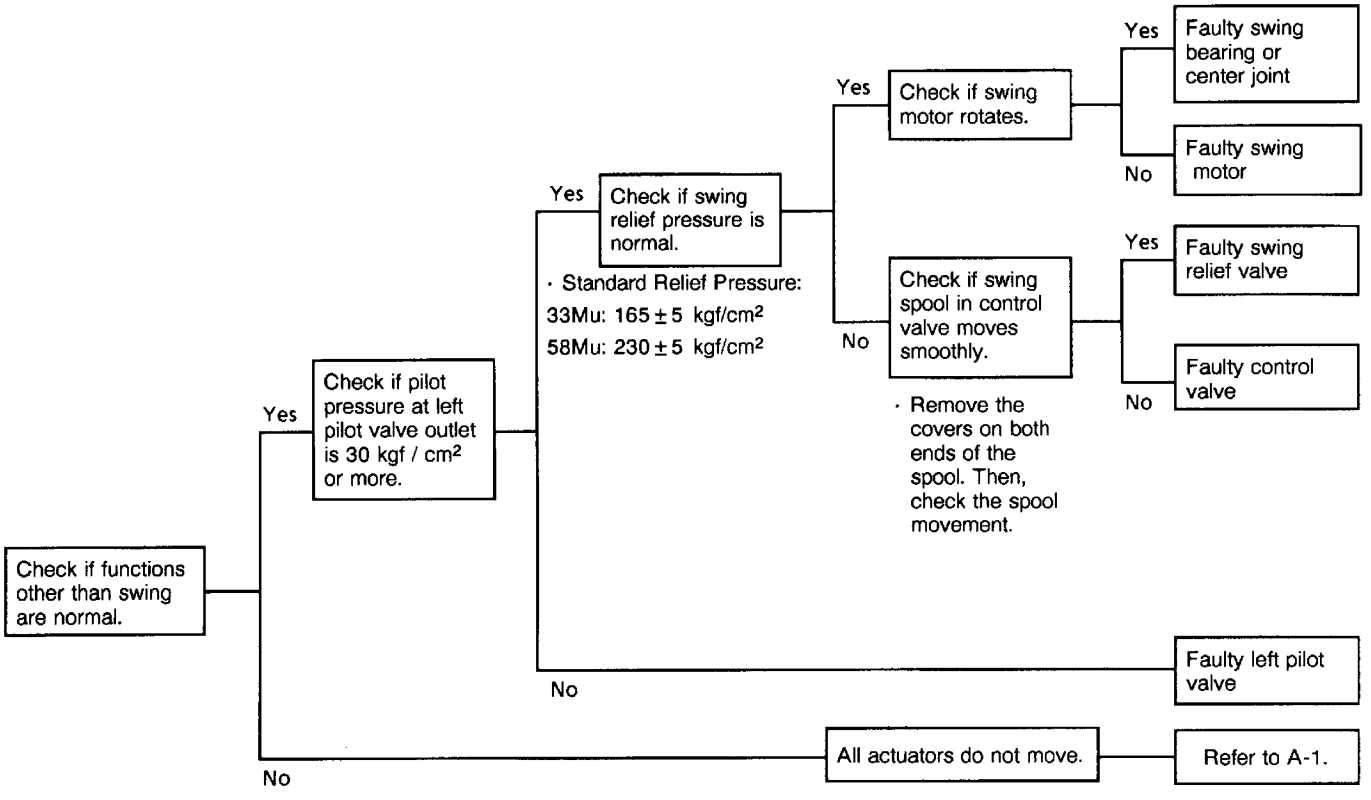

## F-5 Blade drift is large.



## SWING SYSTEM TROUBLESHOOTING

**S-1 Upperstructure does not swing.**

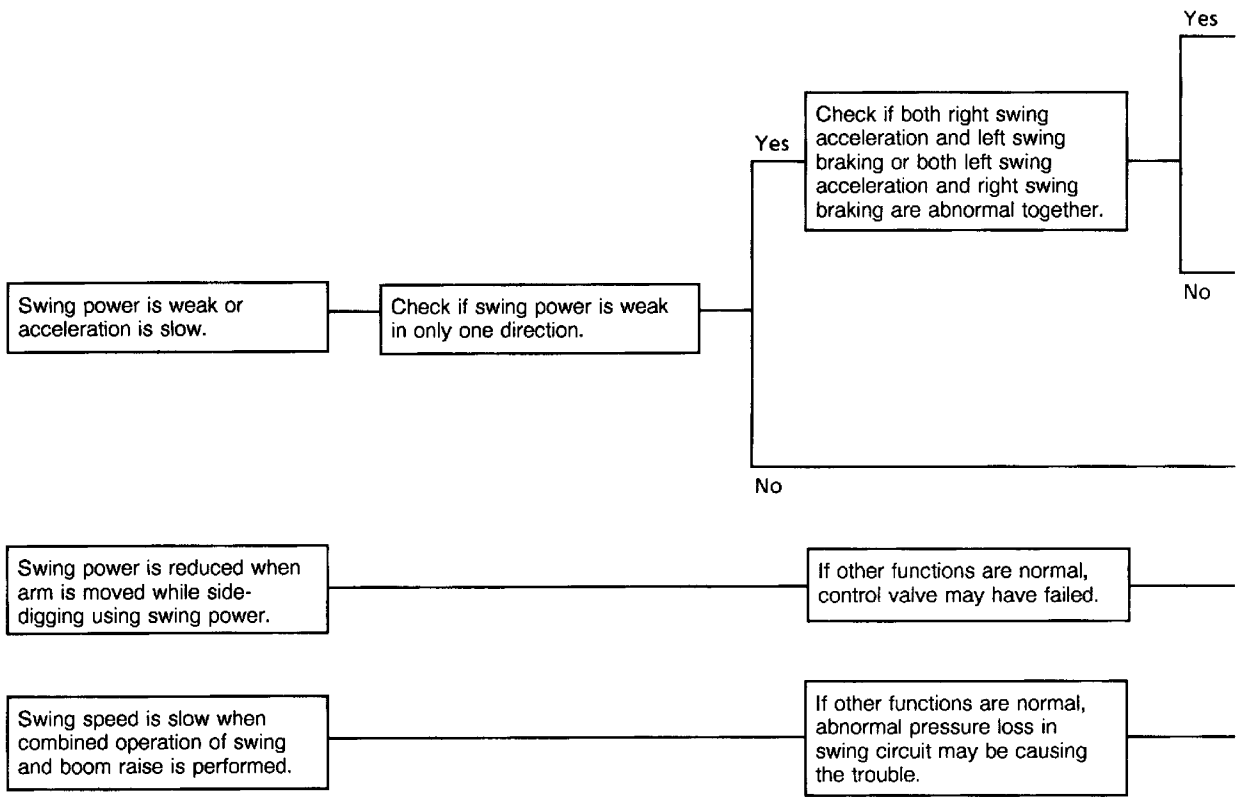
**Guidance:**
Check first if the trouble is caused by a failure in either the pilot system or the main circuit.



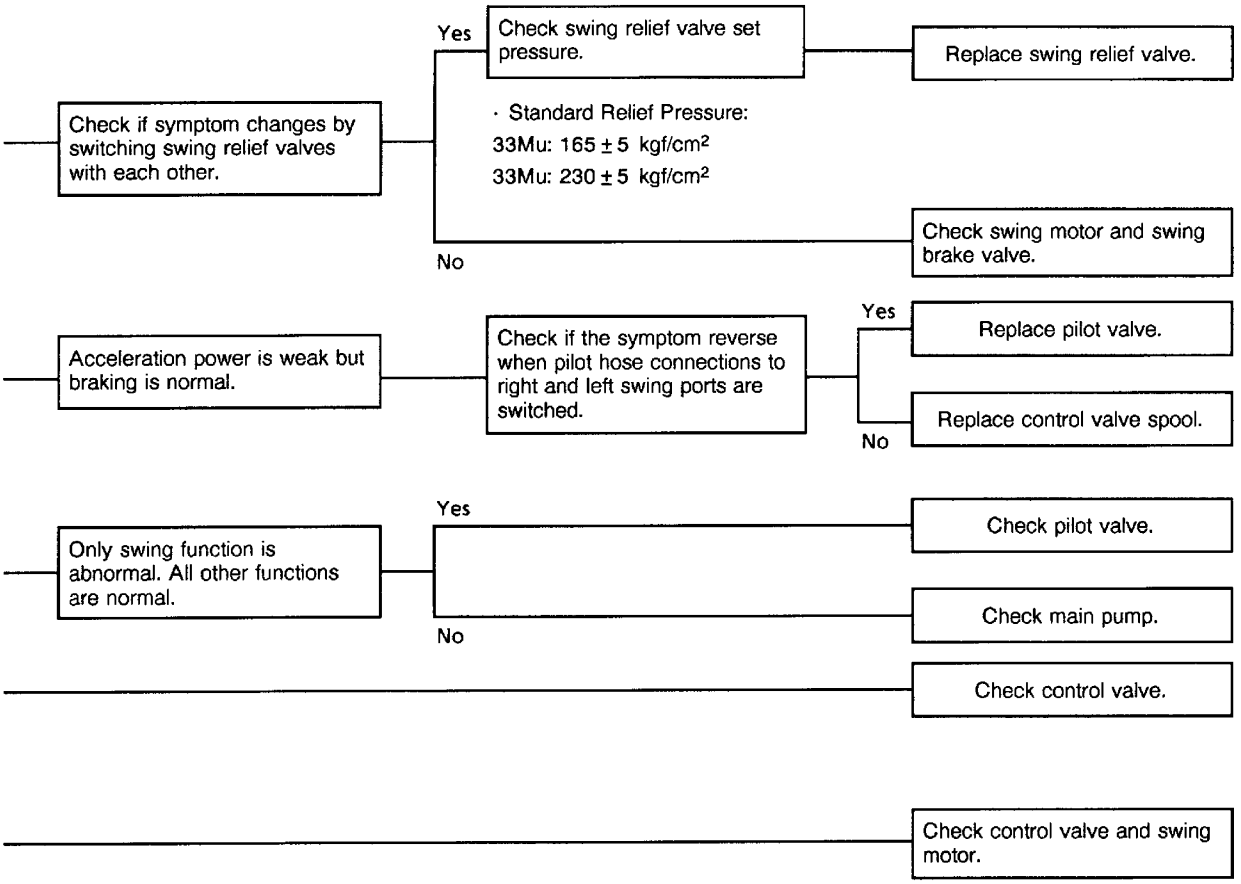

*NOTE: 1kgf/cm² = 0.09807 MPa*

**S-2 Swing speed is slow or swing power is weak.**

**Guidance:**
In case only the swing function is abnormal, check the swing device (including reduction gears and relief valve) or the pilot system first. Then, proceed to check the main hydraulic system down to the control valve.

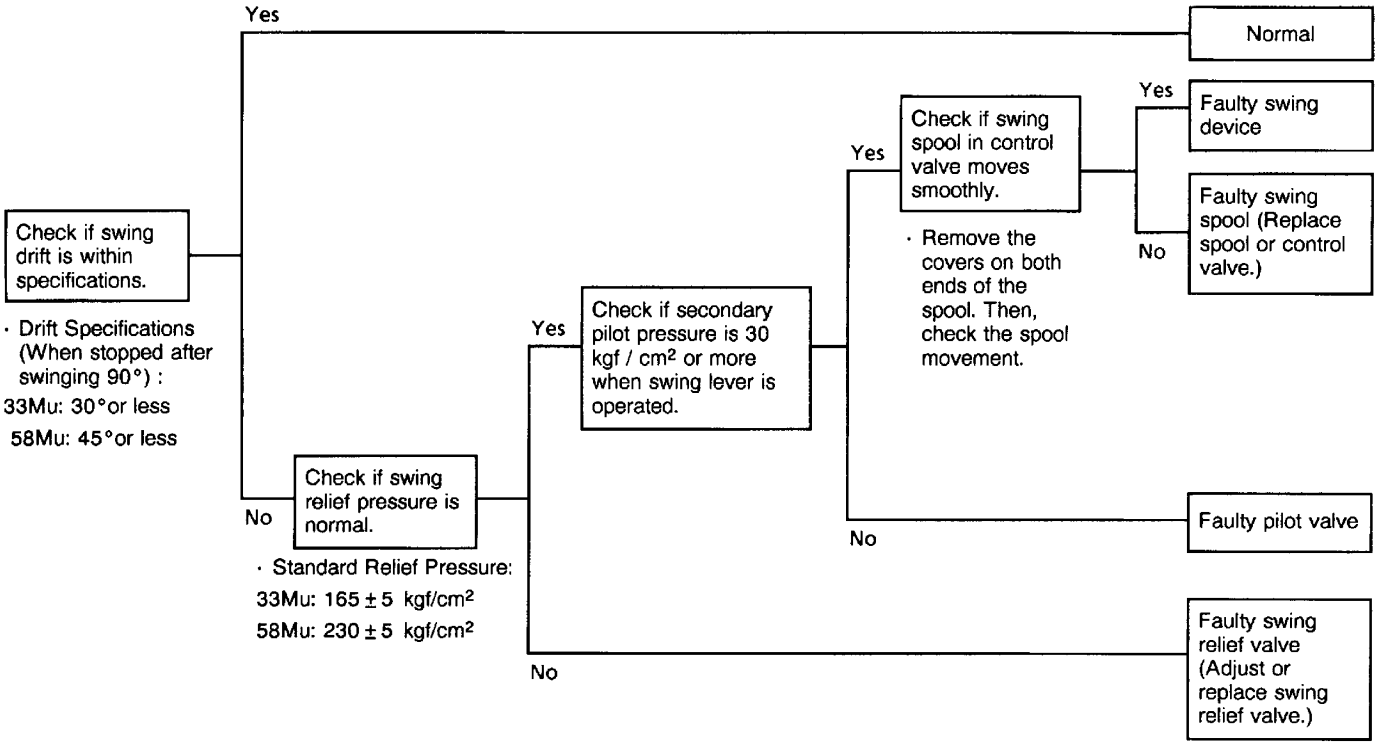



*NOTE: 1kgf/cm² = 0.09807 MPa*


Check if symptom changes by switching swing relief valves with each other.
Yes
Check swing relief valve set pressure.
Replace swing relief valve.
· Standard Relief Pressure:
33Mu: 165 ± 5 kgf/cm²
33Mu: 230 ± 5 kgf/cm²
No
Check swing motor and swing brake valve.
Acceleration power is weak but braking is normal.
Check if the symptom reverse when pilot hose connections to right and left swing ports are switched.
Yes
Replace pilot valve.
No
Replace control valve spool.
Only swing function is abnormal. All other functions are normal.
Yes
Check pilot valve.
No
Check main pump.
Check control valve.
Check control valve and swing motor.

**S-3 Swing drift is large when swing is stopped.**

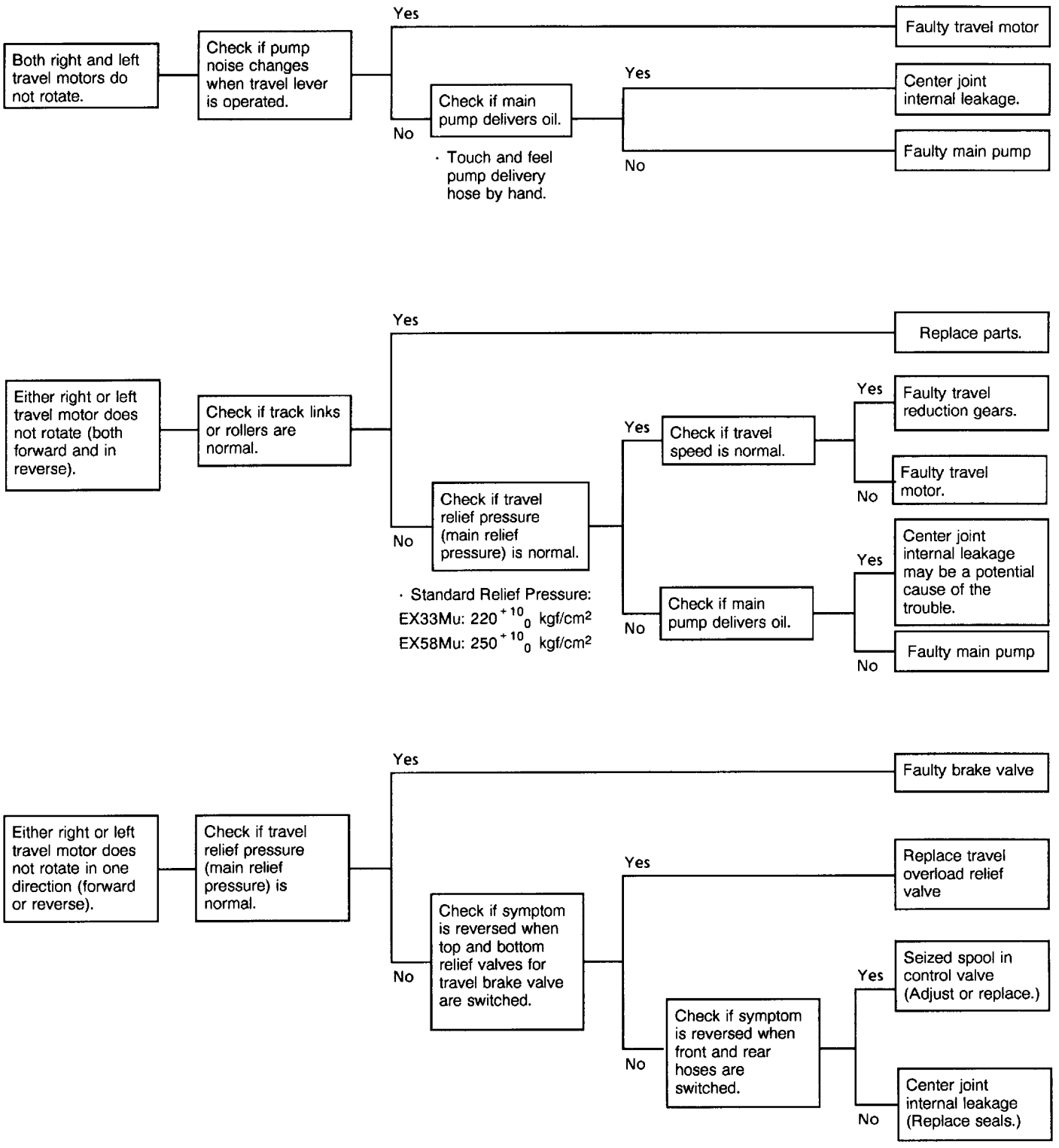
**Guidance:**
When swing drifts roughly, the related swing brake valve may have trouble. When swing drifts smoothly, the related spool in the control valve may be impaired.




*NOTE: 1kgf/cm² = 0.09807 MPa*

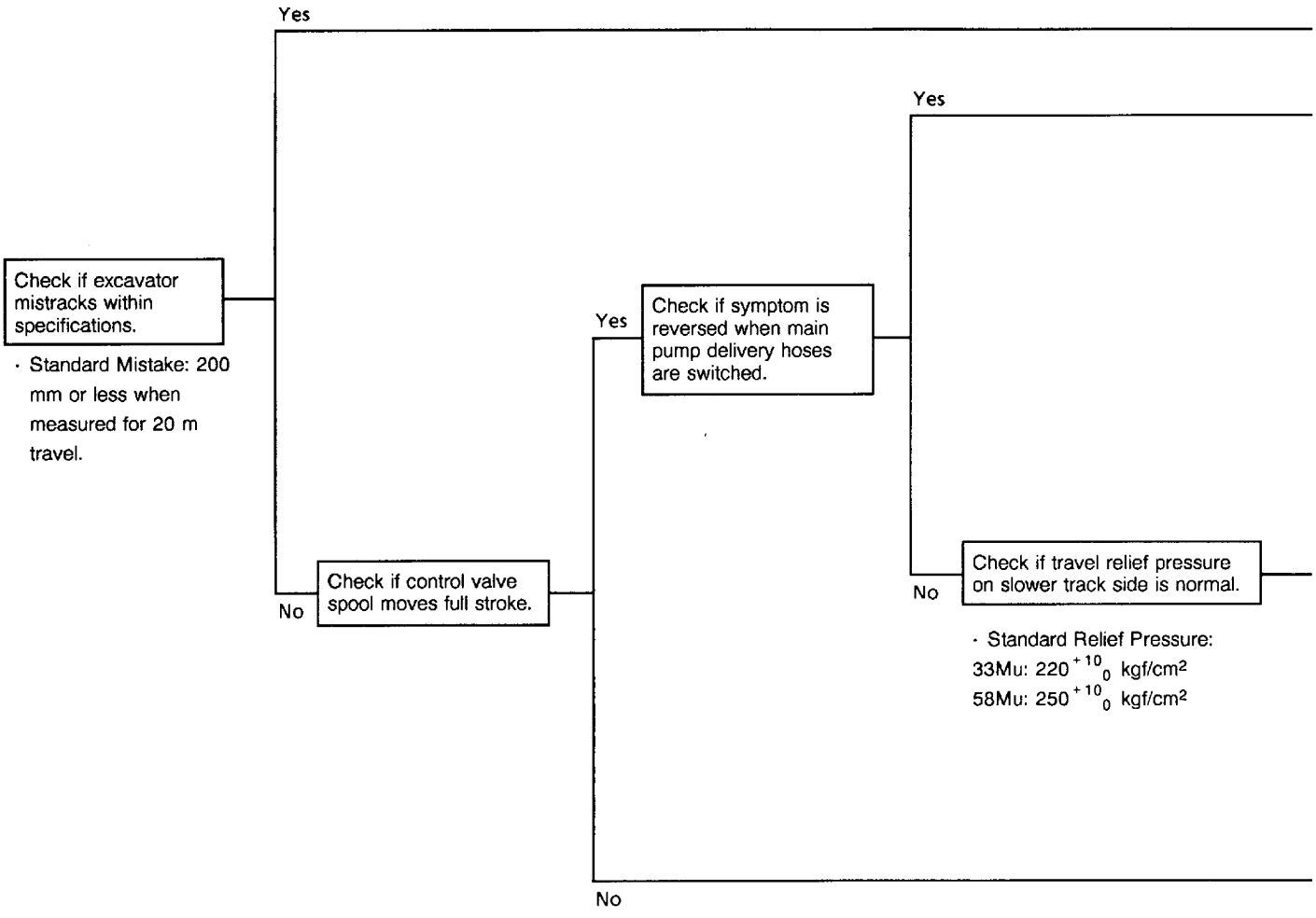
## TRAVEL SYSTEM TROUBLESHOOTING

### T-1 Travel motor does not rotate.

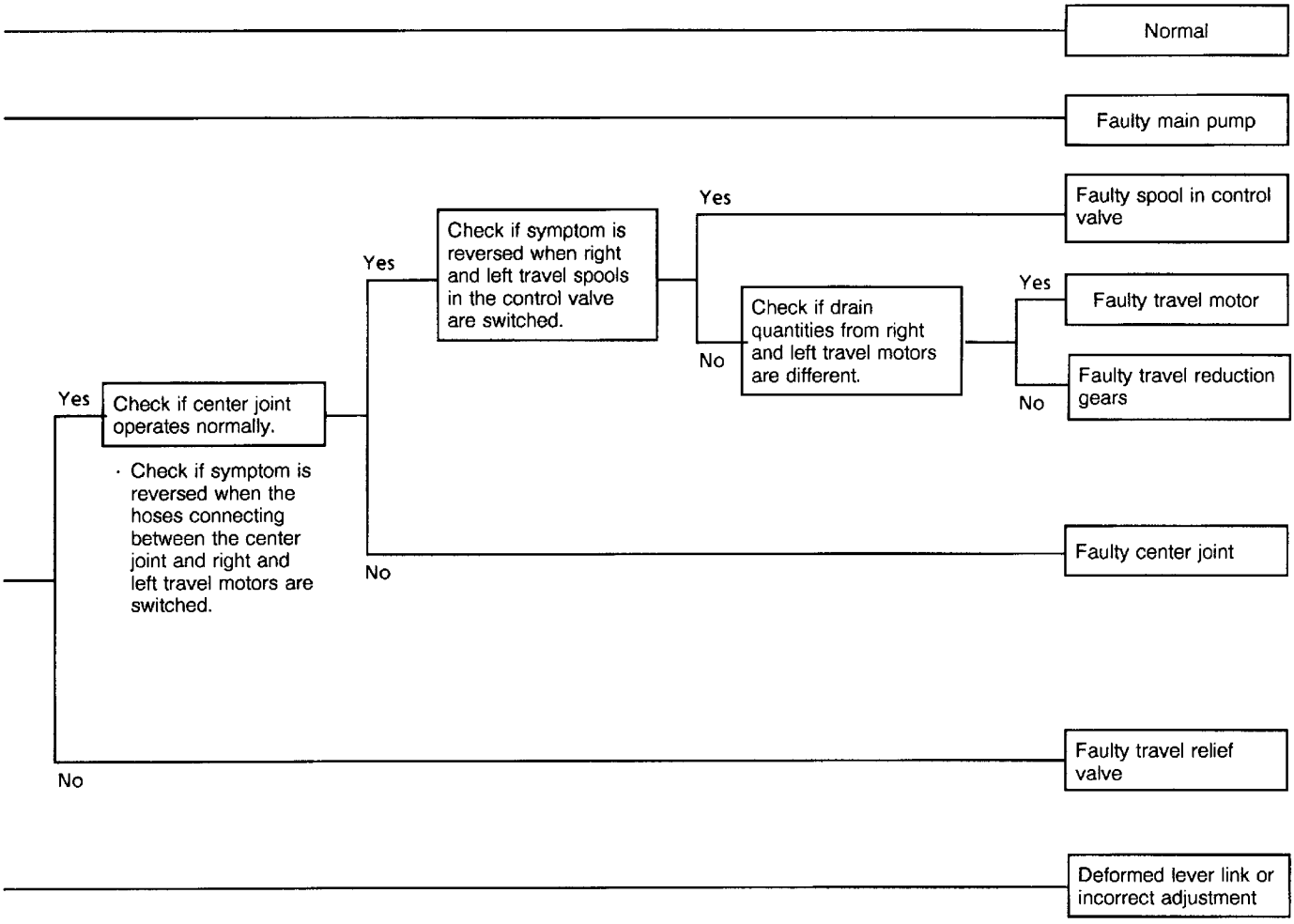



*NOTE: 1kgf/cm² = 0.09807 MPa*

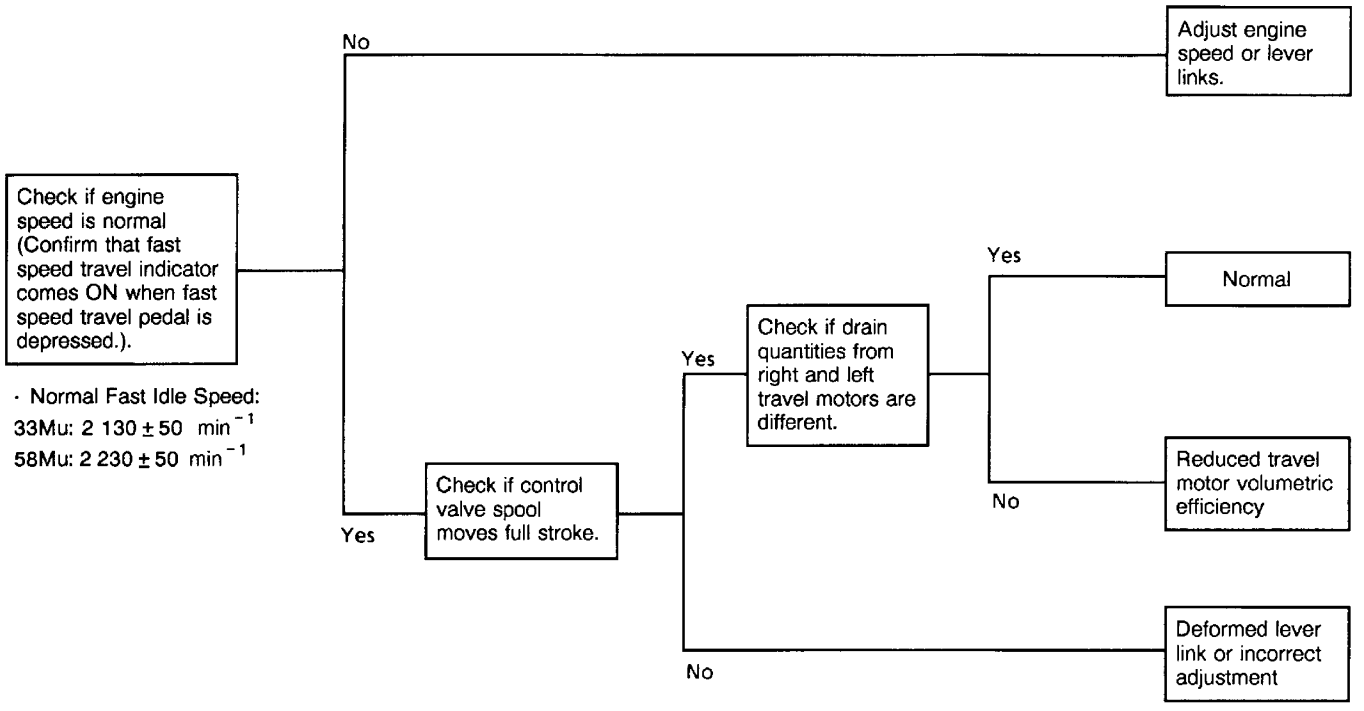
**T-2 The excavator mistracks.**




*NOTE: 1kgf/cm² = 0.09807 MPa*

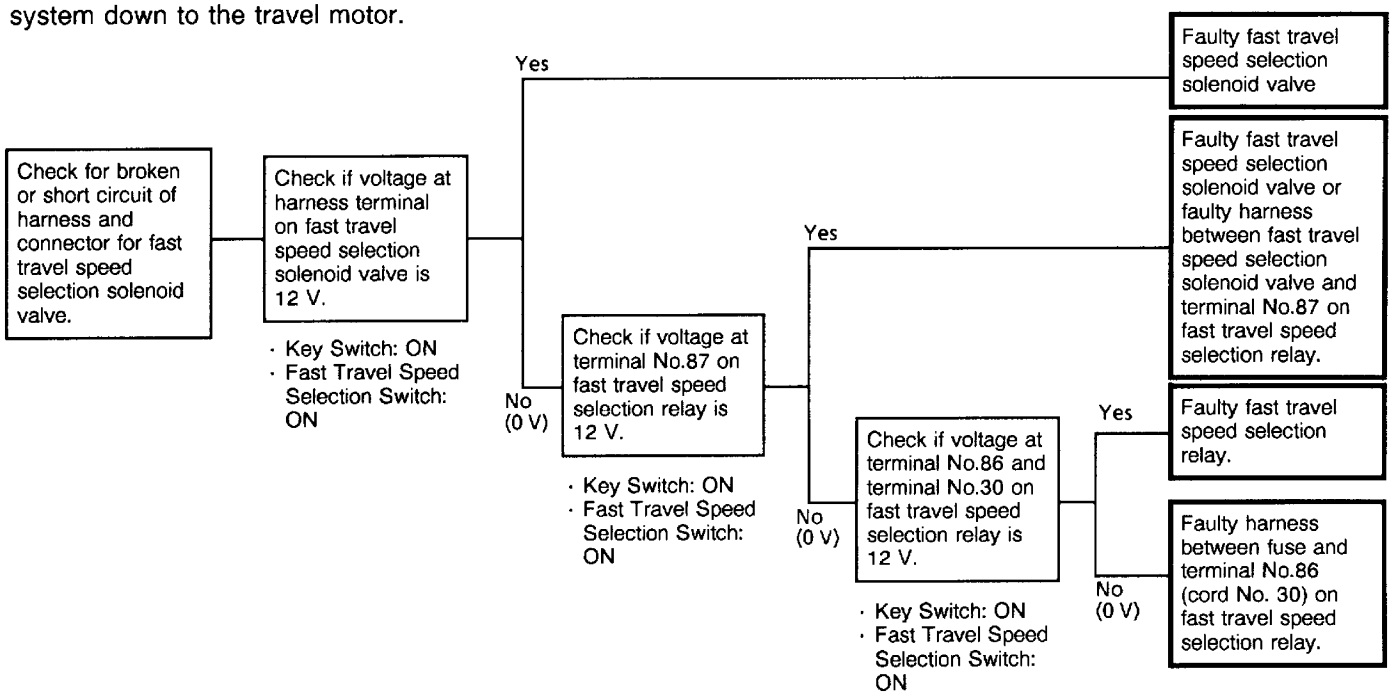

Normal
Faulty main pump
Yes
Faulty spool in control valve
Check if symptom is reversed when right and left travel spools in the control valve are switched.
Yes
Check if drain quantities from right and left travel motors are different.
Yes
Faulty travel motor
No
Faulty travel reduction gears
Yes
Check if center joint operates normally.
· Check if symptom is reversed when the hoses connecting between the center joint and right and left travel motors are switched.
No
Faulty center joint
No
Faulty travel relief valve
Deformed lever link or incorrect adjustment

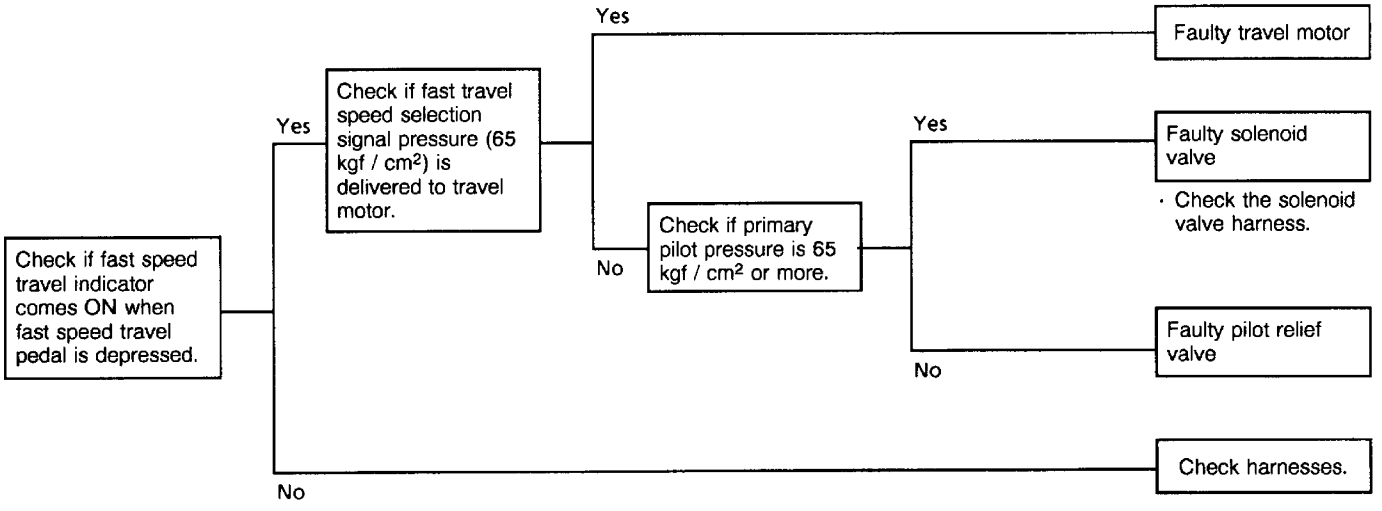
**T-3 Travel speed is slow.**



**T-4 Travel mode does not change.**

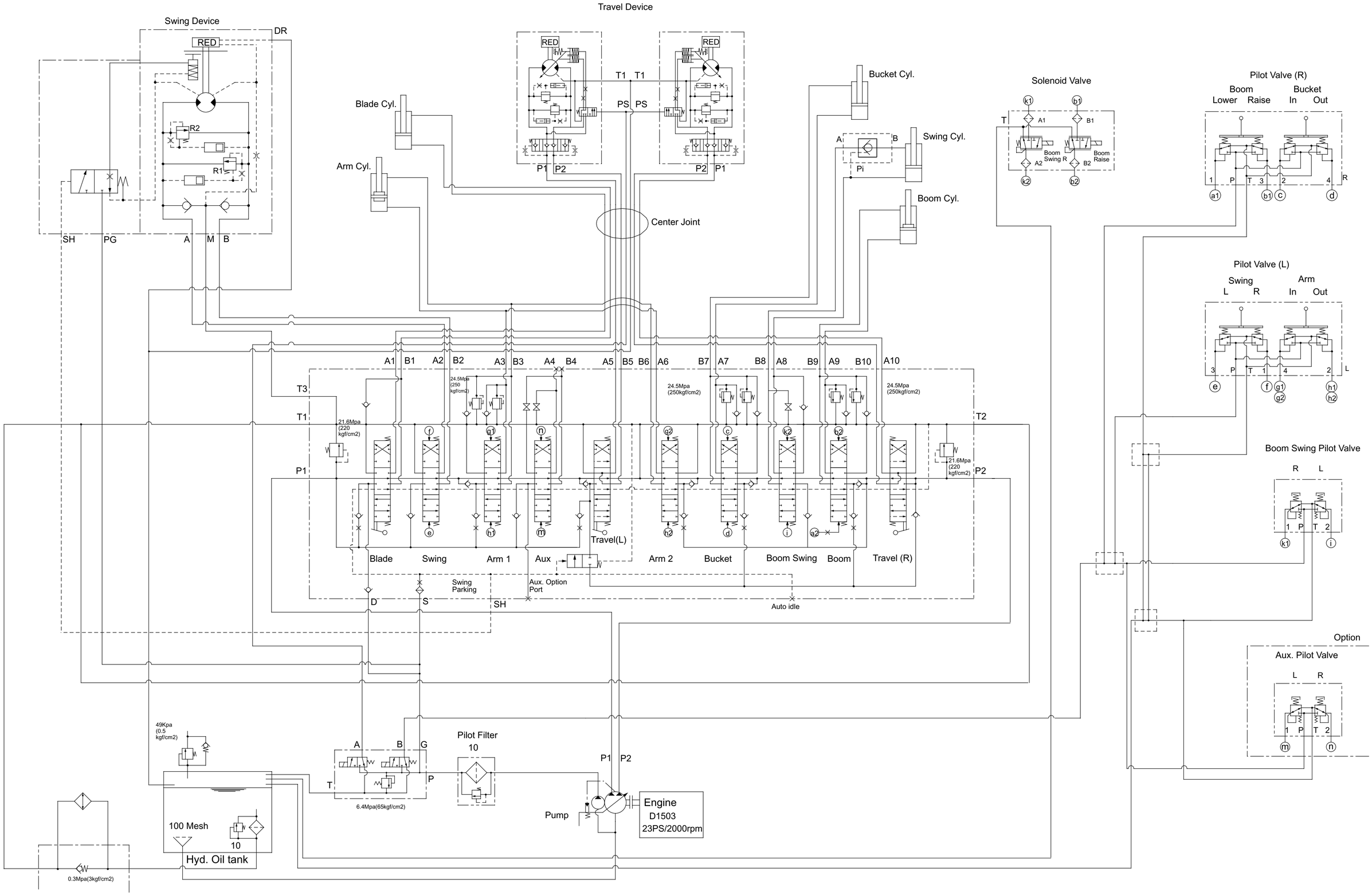
**Guidance:**
When the fast speed travel indicator does not come ON even if the fast speed travel pedal is depressed, check the fast travel speed selection solenoid valve, fast travel speed selection relay, and the relevant harnesses. In case travel mode does not change though the fast speed travel indicator comes ON, check the pilot system first, then proceed to check the main hydraulic system down to the travel motor.



# EX33Mu Hyd. Circuit

Hitachi Authorized Dealer Use Only



# EX58Mu Hyd. Circuit

Hitachi Authorized Dealer Use Only

Swing Device

RED

DR

SH PG A M B

Travel Device

RED RED

T1 T1

Ps Ps

P1 P2 P2 P1

Blade Cyl.

Arm Cyl.

Center Joint

Bucket Cyl.

A B Swing Cyl.

Pi

Boom Cyl.

Solenoid Valve

T A1 B1

Boom Swing R Boom Raise

A2 B2

k1 b1 k2 b2 b3

Pilot Valve (R)

Boom Bucket

Lower Raise In Out

4 P T 2 1 3 R

a1 b1 c d

Pilot Valve (L)

Swing Arm

L R In Out

3 P T 1 4 2 L

e f g1 g2 h1 h2

Boom Swing Pilot Valve

R L

1 P T 2

k1 i

Optional

Aux. Pilot Valve

L R

1 P T 2

m n

P

A1 B1 A2 B2 A3 B3 A4 B4 A5 B5 A6 B6 B7 A7 B8 A8 B9 A9 B10 A10 B11 A11

T3

T1

24.5Mpa (250 kgf/cm2)

26.5Mpa (270kgf/cm2)

26.5Mpa (290kgf/cm2)

26.5Mpa (270kgf/cm2)

T2

24.5Mpa (250 kgf/cm2)

P1

P2

f g1 b3 n q2 c k2 b2

e h1 p m h2 d i a1

Blade Swing Arm 1 Boom 2 Aux. Travel (L) Arm 2 Bucket Boom Swing Boom 1 Travel (R)

D

49Kpa (0.5 kgf/cm2)

A B G

Pilot Filter 10

T P

6.4Mpa (65kgf/cm2)

P1 P2

Pump

Engine

29kw/2100min -1

(40PS/2100rpm)

Oil Cooler

100 Mesh

10

Hyd. Oil Tank

0.3Mpa(3kgf/cm2)

# Workshop Manual

EX33Mu, 58Mu

# 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 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

- Two types of manual are available. One is Technical Manual(T/M). The other is Workshop Manual(W/M).
  Use the manuals according to purpose.

  · Information included in the T/M:
  technical information needed for redelivery and delivery, operation and activation of all devices and systems, operational performance tests, and troubleshooting procedures.

  · Information included in the W/M:
  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.

## ADDITIONAL REFERENCES

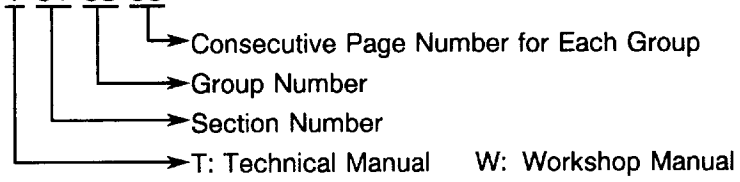
- Please refer to the materials listed below in addition to this manual.

  · The Operator's Manual
  · The Parts Catalog
  · Operation Manual of the Engine
  · Parts Catalog of the Engine
  · Hitachi Training Material

## 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 01-03-05

## 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 a potentially hazardous situation which could, if not avoided, result in personal injury or death.
- **IMPORTANT:** indicates a situation which, if not avoided, 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.
  MKSA system units and English units are also indicated in parentheses just behind SI units.

Example: 24.5 MPa ( 250 kgf/cm$^2$, 3 560 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 | 0.039 37 | Pressure | MPa | kgf/cm$^2$ | 10.197 |
| | mm | ft | 0.003 281 | | MPa | psi | 145.0 |
| Volume | L | US gal | 0.264 2 | 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 | 0.621 4 |
| Force | N | kgf | 0.101 97 | | min$^{-1}$ | rpm | 1.0 |
| | N | lbf | 0.224 8 | Flow rate | L/min | US gpm | 0.264 2 |
| Torque | N·m | kgf·m | 1.019 7 | | mL/rev | cc/rev | 1.0 |
| | N·m | lbf·ft | 0.737 5 | | | | |

## 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-0001-2 SA-001

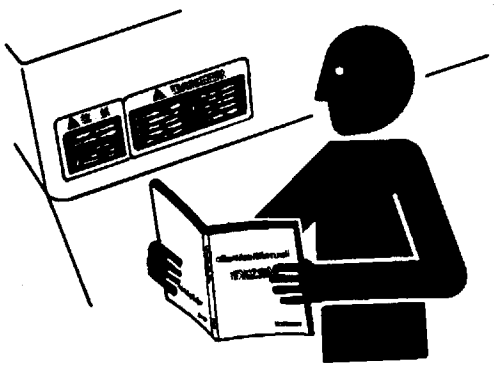
## UNDERSTAND SIGNAL WORDS

- 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.**
- **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.


SA-461

002-E01A-0461-6

## FOLLOW SAFETY INSTRUCTIONS



SA-003

- 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 operator's manual is damaged or missing, replace it with new one.
- 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.

S003-E01B-0003-5

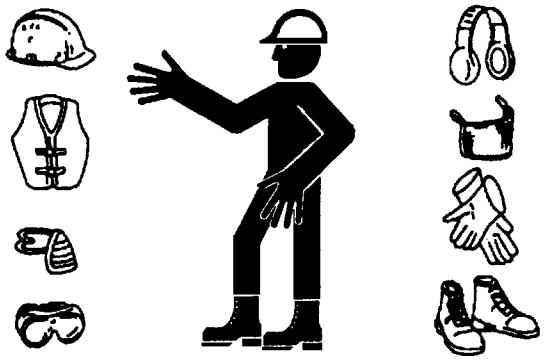
## PREPARE FOR EMERGENCIES

SA-437

- 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.
  - · 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-0437-3

## WEAR PROTECTIVE CLOTHING



SA-438

- 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 machine.

005-E01A-0438-4

## PROTECT AGAINST NOISE

006-E01A-0434-2 SA-434

- 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.

## INSPECT MACHINE

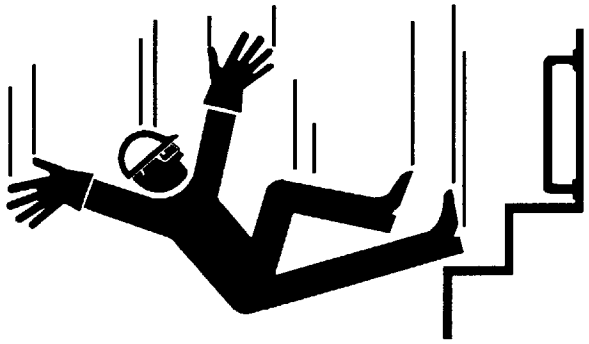
S007-E01A-0435-2 SA-435

- 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.

## USE HANDHOLDS AND STEPS

- Falling is one of the major causes of personal injury.
  - · When you get on and off the machine, always face the machine and maintain a three-point contact with the steps and handrails.
  - · Do not use any controls as handholds.
  - · 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 leaving the machine.



SA-439

008-E01A-0439-3

## 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.

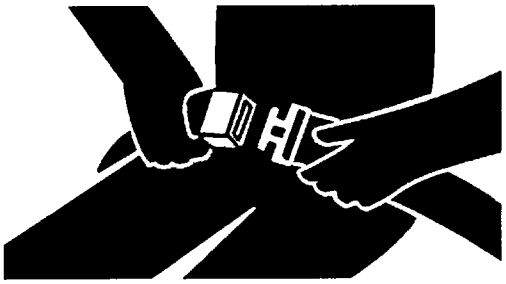
SA-378

009-E01A-0378-3

## FASTEN YOUR SEAT BELT(IF EQUIPPED)

- 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.



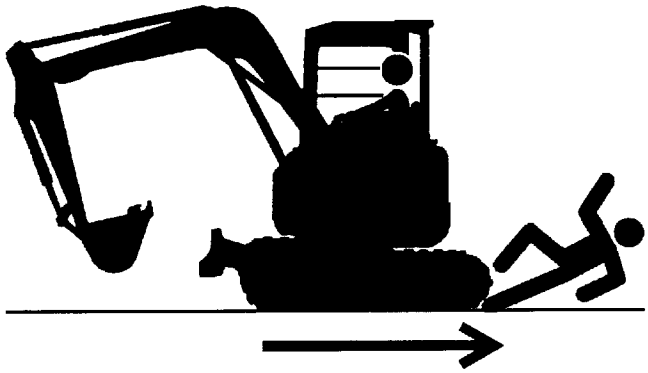
SA-237

010-E02B-0237-3

## 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.



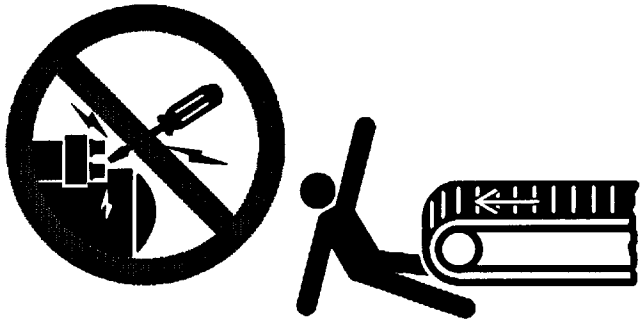
SA-529

011-E01A-0529-3

## OPERATE ONLY FROM OPERATOR'S SEAT

- Inappropriate engine starting procedure may cause the machine to runaway, possibly resulting in serious injury or death.

  · Start the engine only from 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

012-E01A-0444-3

## 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.

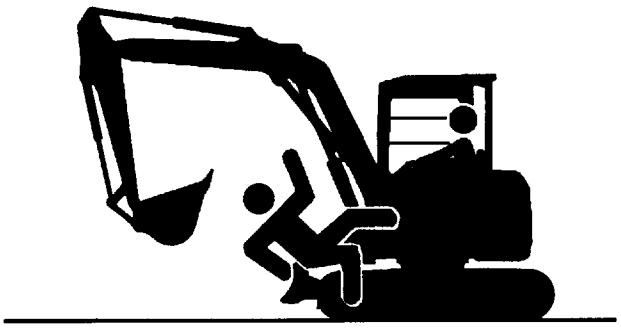
SA-032

S013-E01A-0032-3

## 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-0530-2

SA-530

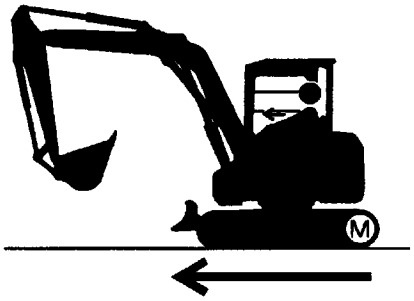
## PROVIDE SIGNALS FOR JOBS INVOLVING MULTIPLE NUMBERS OF MACHINES

- 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.

018-E01A-0481-2 SA-481

## CONFIRM DIRECTION OF MACHINE TO BE DRIVEN

- Incorrect travel pedal/lever operation may result in serious injury or 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.

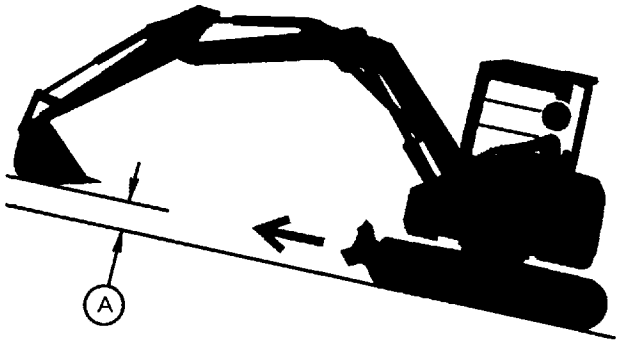



017-E01A-0532-2 SA-532

## DRIVE MACHINE SAFELY

- Before moving the machine, confirm which way to move travel pedals/levers for the corresponding direction you wish to go.

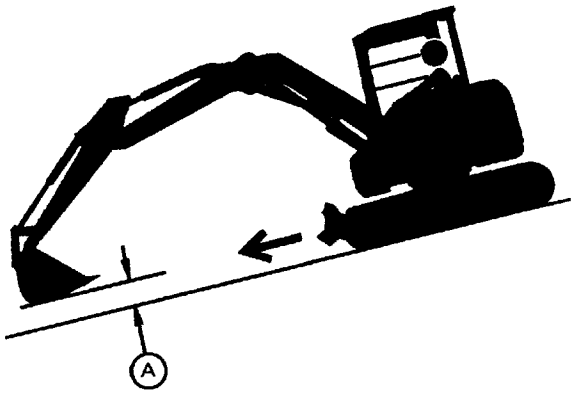
  · Pushing down on the front of the travel pedals or pushing the levers forward moves the machine towards the idlers. (Refer to the Steering the Machine Using Pedals/Levers section in the operator's manual for correct travel operation.)




SA-533

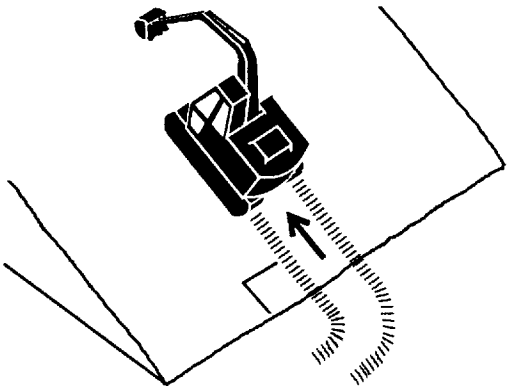
- Traveling on a grade may cause the machine to slip or to overturn, possibly resulting in serious injury or death.

  · When traveling up or down a grade, keep the bucket in the direction of travel, approximately 200 to 300 mm ( 8 to 12 in )(A) above the ground.
  · If machine starts to skid or becomes unstable, lower the bucket immediately.



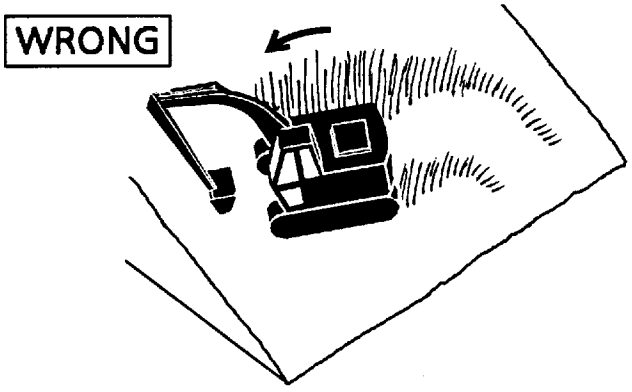

SA-534

· Traveling across the face of a slope may cause the machine to skid or to turnover. When traveling (ascending/descending) on a slope, be sure to point the tracks uphill/downhill.



SA-441

· Turning on an incline may cause the machine to tip over.
If turning on an incline is absolutely unavoidable, do so at a place where the slope is gentle and the surface is firm.



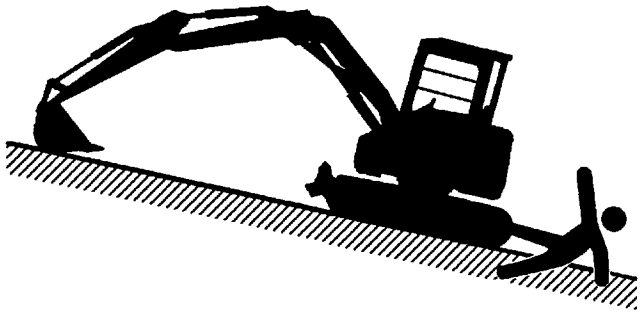

SA-591

S019-E02A-0635-4

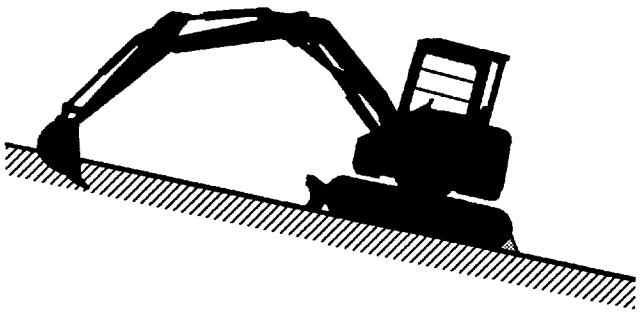
## AVOID INJURY FROM ROLLAWAY ACCIDENTS

- 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 switch off (if equipped).
- 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-535



SA-536

020-E09A-0548-4

## 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.

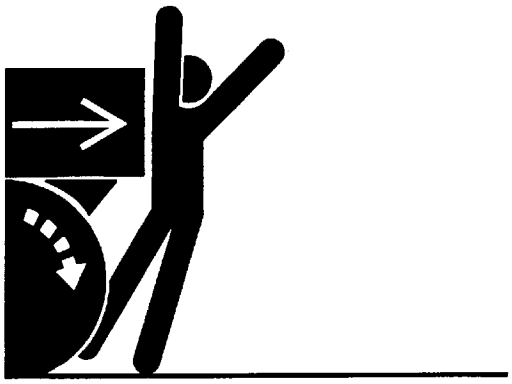
  · No machine motions shall be made unless signals are clearly understood by both signalman and operator.

  · Learn the meanings of all flags, signs, and markings used on the job and confirm who has the responsibility for signaling.

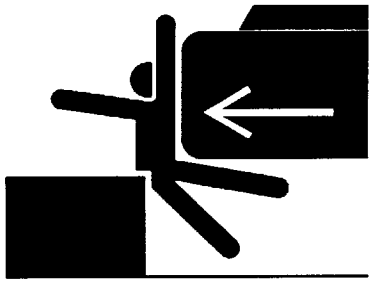
  · Keep windows, mirrors, and lights clean and in good condition.

  · 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.



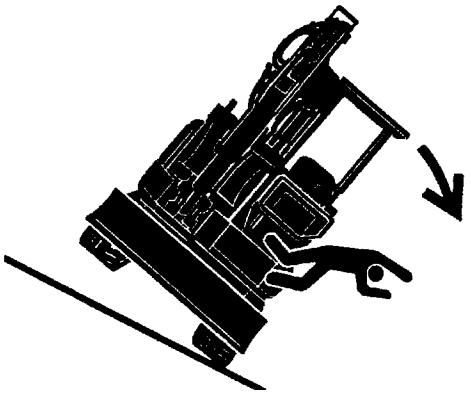
SA-383



SA-384

S021-E01A-0494-8

## AVOID TIPPING



SA-540

- 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.

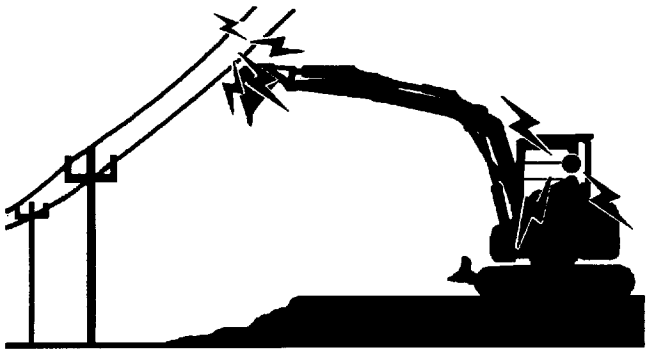
  · Prepare machine operating area flat.
  · Keep the bucket low to the ground and close to the machine.
  · Reduce operating speeds to avoid tipping or slipping.
  · Avoid changing direction when traveling on grades.
  · NEVER attempt to travel across a grade steeper than 15 degrees if crossing the grade 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.

025-E01B-0540-5

## AVOID POWER LINES



SA-544

- Serious injury or death can result if the machine or front attachments are not kept a safe distance from electric lines.

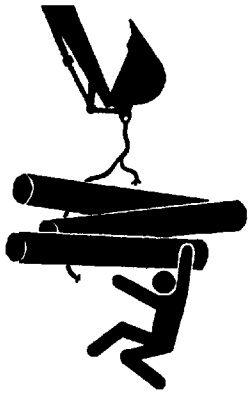
  · When operating near an electric line, NEVER move any part of the machine or load closer than 3 m (10 ft) plus twice the line insulator length.
  · Check and comply with any local regulations that may apply.
  · Wet ground will expand the area that could cause any person on it to be affected by electric shock. Keep all bystanders or co-workers away from the site.

029-E01A-0544-3

## 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, sables, 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.



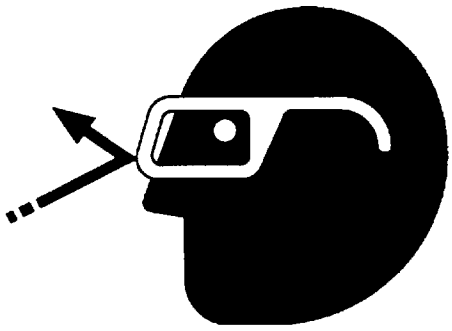
SA-014

032-E01A-0014-4

## 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.

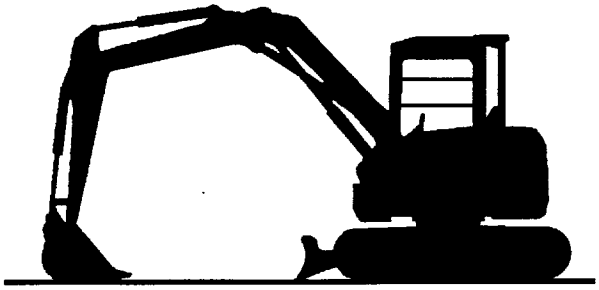


031-E01A-0432-2

SA-432

## PARK MACHINE SAFELY

To avoid accidents:
- Park machine on a firm, level surface.
- Lower bucket and/or other work tools to the ground.
- Turn auto-idle switch off (if equipped).
- 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.



SA-545

033-E10A-0545-3

## 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.

SA-018

- 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.

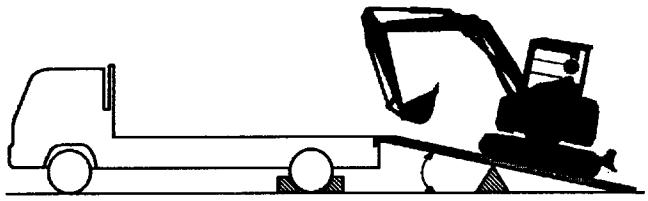
034-E01A-0496-4

SA-019

## 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.



SA-546

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 switch OFF (if equipped) when loading or unloading the machine, to avoid unexpected speed increase due to unintentional operation of a control lever.
5) Be sure to load/unload the machine at slow speed.
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.

S035-E10A-0546-8

## 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 firm, level surface.
  2) Lower the bucket and/or other work tools to the ground.
  3) Turn the auto-idle switch off (if equipped).
  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.

SA-028

- 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.
- Disconnect battery ground cable (−) before making adjustments to electrical systems or before welding on the machine.
- Illuminate your work area adequately but safely.
- 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.

SA-527

SA-037

S500-E09A-0497-8

## 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-0287-2 SA-287

## SUPPORT MACHINE PROPERLY

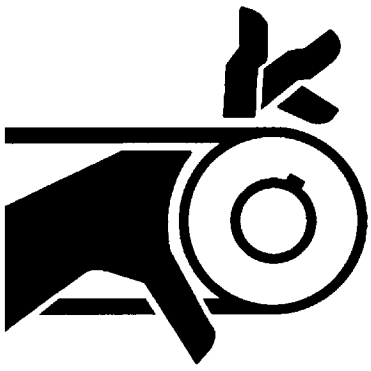
- Never attempt to work on the machine without securing the machine first.
  - · Always lower the attachment to the ground before you work on the machine.
  - · If you must work on a lifted machine or attachment, securely support the machine or attachment. Do not support the machine on cinder blocks,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

SA-527

519-E01A-0527-3

## STAY CLEAR OF MOVING PARTS

- Entanglements 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-0026-2 SA-026

## 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-0040-2

SA-040

## PREVENT PARTS FROM FLYING

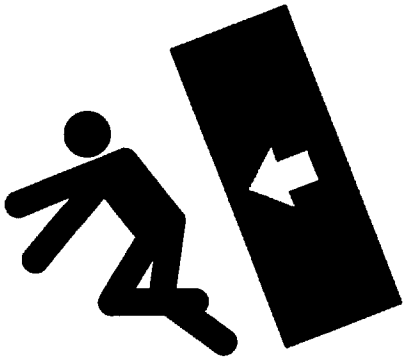
- Grease in the track adjuster is under high pressure. Failure to follow the precautions below may result in serious injury, blindness, or death.
  - · Do not attempt to remove GREASE FITTING or VALVE ASSEMBLY.
  - · As pieces may fly off, be sure to keep body and face away from valve.
- Travel reduction 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-0344-4

## 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.



504-E01A-0034-2

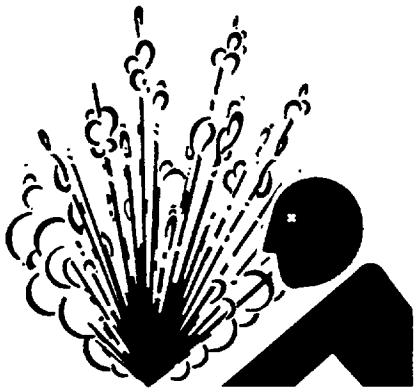
SA-034

## 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.

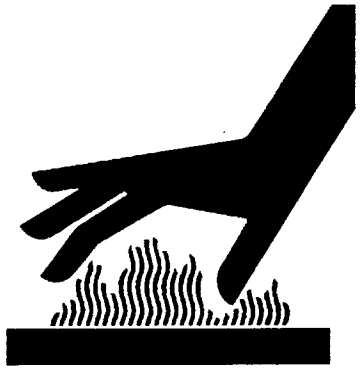


SA-039

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-225

505-E01B-0498-5

## 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.)

SA-019

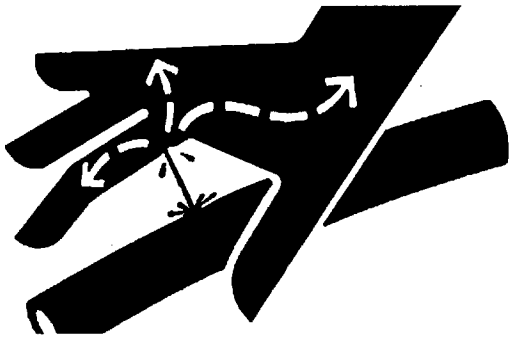
- Failure to periodically replace rubber hoses may cause a fire, fluid injection into skin, or the front attachment to fall on a person nearby, which may result in severe burns, gangrene, or otherwise serious injury or death.

S506-E01A-0019-3

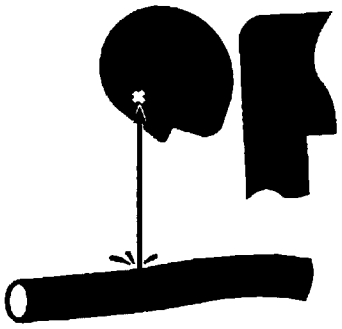
## AVOID HIGH-PRESSURE FLUIDS

- Fluids such as diesel fuel or hydraulic oil under pressure can penetrate the skin or eyes causing serious injury, blindness or death.

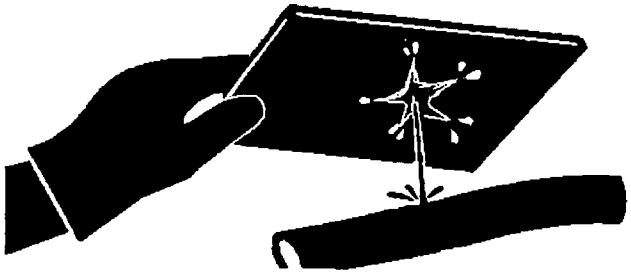
  · Avoid this hazard by relieving pressure before disconnecting hydraulic or other lines.
  · Relieve the pressure by moving the control levers several times.
  Tighten all connections before applying pressure.
  · Search for leaks with a piece of cardboard; take care to protect hands and body from high-pressure 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



507-E01A-0499-5

SA-044

## 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.

508-E04B-0019-8

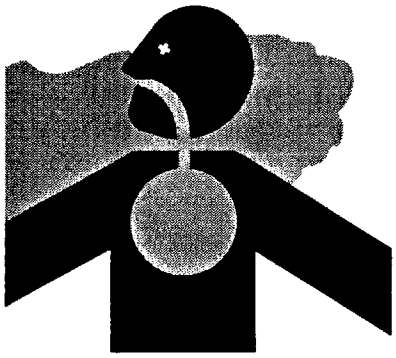
## EVACUATING IN CASE OF FIRE

- 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.

518-E02A-0393-2 SA-393

## 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-0016-2 SA-016

## 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-0030-4

## REMOVE PAINT BEFORE WELDING OR HEATING

SA-029

- 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.

511-E01A-0029-4

## PREVENT BATTERY EXPLOSIONS

SA-032

- 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.

- 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.

512-E01B-0032-4

## HANDLE CHEMICAL PRODUCTS SAFELY


SA-309

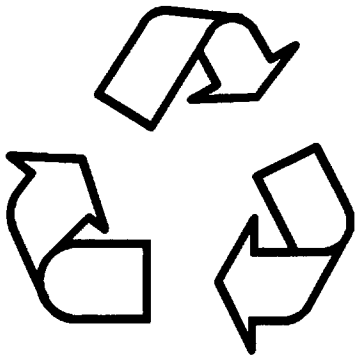
- Direct exposure to hazardous chemicals can cause serious injury. Potentially hazardous chemicals used with your machine include such items as lubricants, coolants, paints, and adhesives.

  · 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.

S515-E01A-0309-4

## DISPOSE OF WASTE PROPERLY



SA-226

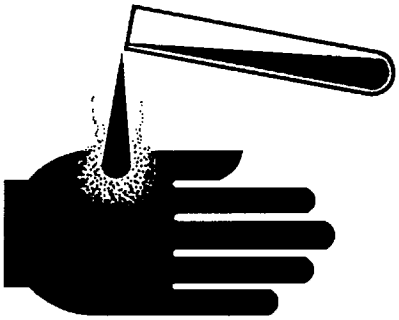
- Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with HITACHI equipment includes such items as oil, fuel, coolant, brake fluid, filters, and batteries.

  · 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.

S516-E01A-0226-4

## 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.

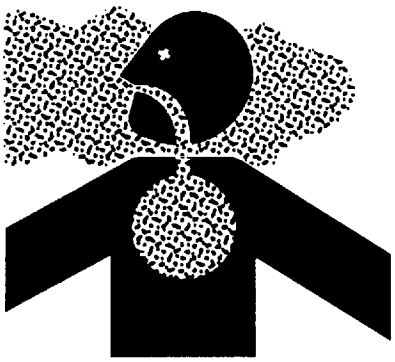


SA-405

513-E01A-0405-3

## AVOID HARMFUL ASBESTOS DUST

- Inhaled asbestos fibers may cause lung cancer.
  - · Avoid breathing dust that may be generated when handling components containing asbestos fibers.
  - · Components that may contain asbestos fibers are some gaskets. The asbestos used in these components is usually found in a resin or sealed in some way. Normal handling is not hazardous as long as airborne dust containing asbestos is not generated.
  - · Avoid creating dust. Never use compressed air for cleaning. Avoid brushing or grinding asbestos-containing materials. When servicing, wear an approved respirator. A special vacuum cleaner is recommended to clean asbestos. If not available, wet the asbestos containing materials with a mist of oil or water.
  - · Be sure to comply with all applicable rules and regulations for the work place.
    Follow all local environmental rules and regulations for the disposal of asbestos.
  - · Keep bystanders away from the areas where asbestos particles may be in the air.



SA-029

514-E01A-0029-5

## 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-0435-2

SA-435

# SECTION 01
# GENERAL INFORMATION

## CONTENTS

## PRECAUTIONS FOR DISASSEMBLING AND ASSEMBLING

### Preparations for Disassembling

- 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 disassembling procedures beforehand, to help avoid incorrect disassembling of components as well as the purchase of unnecessary service parts.
  Check and record the items listed below to help 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 or air leakages, if any.
  · Capacities and dirtiness of lubricants.
  · Loose or damaged parts.

- Prepare and Clean Tools and Disassembly Area

  Prepare tools to be used and areas for disassembling as well as for disassembled parts. Clean the tools and areas.

### Precautions for Disassembling and Assembling

- Precautions for Disassembling

  · Be sure to provide appropriate containers for draining fluids.
  · Plug all disconnected ends of hoses, lines and ports.
  · Use matching marks for easier reassembling.
  · Be sure to use specified special tools, when so 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 appropriate measures to remove it.
  · Orderly arrange disassembled parts. Put marks and tags on them as necessary.
  · Store common parts, such as nuts and bolts with reference to where they are to be used and in a manner that will prevent loss.
  · Inspect contact or sliding surfaces of disassembled parts for abnormal wear, sticking, or other damage.
  · Measure and record degrees of wear and clearances.

- Precautions for Assembling

  · Be sure to clean all parts and inspect them for any damage. If any damage is found on a part, repair or replace it with a new one.
  · Dirt or debris on contact or sliding surfaces may shorten the service life of the machine. Take care not to contaminate any contact or sliding surfaces of the parts to be assembled.
  · 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 so as to remove the agent.
  · Utilize matching marks when assembling.
  · Be sure to use designated tools to assemble bearings, bushings and oil seals.
  · Keep a record of the number of tools used for disassembling/assembling. After assembling is complete, count the number of tools, so as to make sure that no tools are left in the assembled components.

### 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:

- Bleeding Air from Hydraulic Pump

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

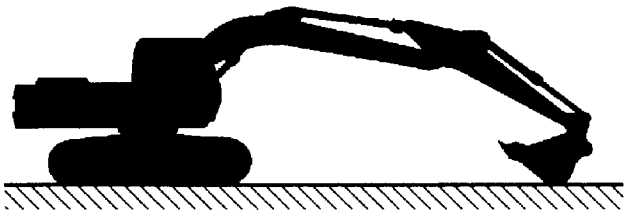
- Remove the air bleeding plug from the top of the pump and fill the pump housing with hydraulic oil.
- After the pump housing is filled with hydraulic oil, temporarily tighten the plug. Then, start the engine and run at slow idle speed.
- Slightly loosen the plug to bleed air from the pump housing until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

- 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.



M104-07-021

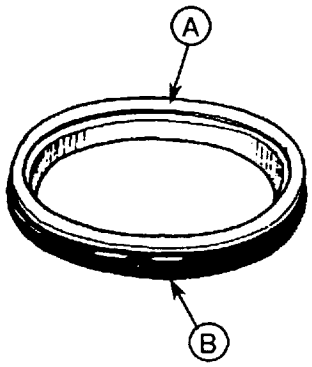
### Floating Seal Precautions

1. In general, replace the floating seal with a new one. If the floating 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 seal ring face (C) for scuffing, scoring, corrosion, deformation or uneven wear.

(3) Check O-ring (B) for tears, breaks, deformation or hardening.




W105-03-05-019

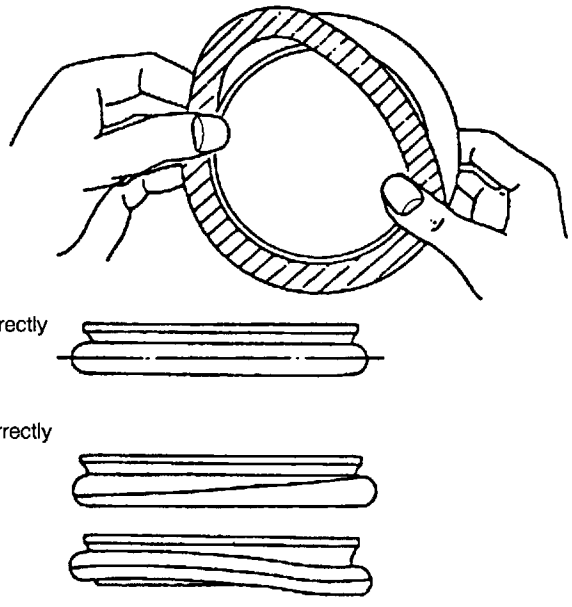
2. If incorrectly assembled, oil leakage or damage will occur. Be sure to do the following, to prevent trouble.

(1) Clean floating seal (A) 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, as dust on them tends to enter the floating seal when installing it.

(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 surface (C) is parallel with seal mounting bores ring face (D) by measuring the distances (C) and (D) at point (a) and (b), as illustrated. If these distances differ, correct the O-ring seating.

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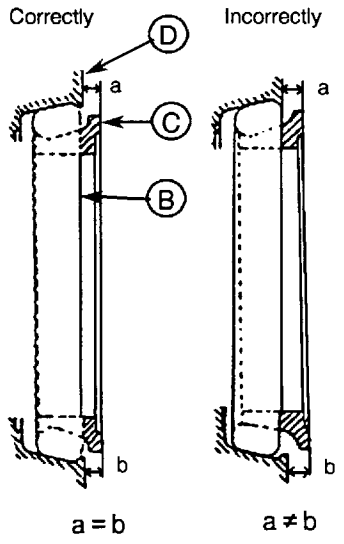



W110-03-05-004

## MAINTENANCE STANDARD TERMINOLOGY

**"Standard"**

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

Body dimensions are shown with tolerances as necessary.

**"Allowable Limit"**

1. Normal machine performance cannot be accomplished after exceeding this limit.
2. Repair or replacement is required before reaching this limit.

Machine performance will decrease, and maintenance and down time expense will increase as machine operating hours accumulate. It is recommended that parts are repaired or replaced before reaching the **"Allowable Limit"**.

## TIGHTENING TORQUE SPECIFICATIONS

33Mu

| No. | Descriptions | Bolt Dia mm | Qty | Wrench Size mm | Torque | | |
|---|---|---|---|---|---|---|---|
| | | | | | N·m | kgf·m | lbf·ft |
| 1 | Engine cushion rubber mounting nut | 14 | 4 | 22 | 137 | 14 | 101 |
| | | 12 | 7 | 19 | 88 | 9 | 65 |
| 2 | Engine bracket mounting bolt (Front) | 12 | 8 | 19 | 88 | 9 | 65 |
| | Engine bracket mounting bolt (Rear) | 10 | 6 | 17 | 49 | 5 | 36 |
| 3 | Hydraulic oil tank mounting bolt | 12 | 3 | 19 | 88 | 9 | 36 |
| 4 | Fuel tank mounting bolt | 10 | 4 | 17 | 20 | 2 | 15 |
| 5 | Hydraulic hoses and Union joints | UNF7/16-20 | | 19 | 29 | 3 | 22 |
| | | UNF9/16-18 | | 22 | 39 | 4 | 29 |
| | | UNF3/4-16 | | 27 | 64 | 6.5 | 47 |
| 6 | Pump mounting bolt | 12 | 2 | 19 | 88 | 9 | 65 |
| 7 | Pump cover mounting bolt | 10 (Fine thread) | 6 | 17 | 49 | 5 | 36 |
| 8 | Control valve mounting bolt | 10 | 4 | 17 | 49 | 5 | 36 |
| | Control valve bracket mounting bolt | 12 | 7 | 17 | 49 | 5 | 36 |
| 9 | Swing device mounting bolt | 12 | 6 | 19 | 88 | 9 | 65 |
| 10 | Battery mounting bolt | 8 | 2 | 13 | 9.8 | 1 | 7 |
| | | 10 | 1 | 17 | 49 | 5 | 36 |
| 11 | Canopy mounting bolt | 10 | 1 | 17 | 49 | 5 | 36 |
| | | 14 | 3 | 22 | 137 | 14 | 101 |
| 12 | Cab mounting bolt | 14 | 4 | 22 | 137 | 14 | 101 |
| 13 | Swing bearing mounting bolt to upperstructure | 12 | 21 | 19 | 108 | 11 | 80 |
| | Swing bearing mounting bolt to undercarriage | 12 | 20 | 19 | 108 | 11 | 80 |
| 14 | Travel device mounting bolt | 12 | 22 | 19 | 108 | 11 | 80 |
| 15 | Sprocket mounting socket bolt | 12 | 22 | 19 | 108 | 11 | 80 |
| 16 | Upper roller mounting bolt | 14 | 2 | 22 | 137 | 14 | 101 |
| 17 | Lower roller mounting bolt | 14 | 16 | 22 | 245 | 25 | 181 |
| 18 | Cover mounting bolt | 6 | | 10 | 5 | 0.5 | 3.6 |
| | | 8 | | 13 | 9.8 | 1 | 7.2 |
| | | 10 | | 17 | 49 | 5 | 36 |
| 19 | Counterweight mounting bolt | 18 | 3 | 27 | 294 | 30 | 217 |

*NOTE: (1) Apply lubricant (i.e. white zinc B dissolved into spindle oil) to bolts and nuts to stabilize their friction coefficients.*

*(2) Make sure bolt and nut threads are clean before installing.*

*(3) Apply Loctite to threads of engine cushion rubber mounting bolts, lower roller mounting bolts, and swing-post vertical-pin mounting bolts before installing them.*

58Mu

| No. | Descriptions | Bolt Dia mm | Qty | Wrench Size mm | Torque | | |
|---|---|---|---|---|---|---|---|
| | | | | | N·m | kgf·m | lbf·ft |
| 1 | Engine cushion rubber mounting nut | 14 | 4 | 22 | 137 | 14 | 101 |
| | Engine cushion rubber mounting bolt | 16 | 2 | 24 | 205 | 21 | 152 |
| 2 | Engine bracket mounting bolt (Front) | 10 | 8 | 17 | 49 | 5 | 86 |
| | Engine bracket mounting bolt (Rear) | 10 | 8 | 17 | 49 | 5 | 36 |
| 3 | Hydraulic oil tank mounting bolt | 10 | 5 | 17 | 49 | 5 | 36 |
| 4 | Fuel tank mounting bolt | 10 | 4 | 17 | 20 | 2 | 15 |
| 5 | Fittings for hydraulic hoses and piping | UNF7/16-20 | | 19 | 29.5 | 3 | 21.5 |
| | | UNF9/16-18 | | 22 | 39 | 4 | 29 |
| | | UNF3/4-16 | | 27 | 64 | 6.5 | 69 |
| 6 | Pump mounting bolt | 12 | 2 | 19 | 88 | 9 | 65 |
| 7 | Pump cover mounting bolt | 10 | 4 | 17 | 49 | 5 | 36 |
| 8 | Control valve mounting bolt | 10 | 4 | 17 | 49 | 5 | 36 |
| | Control valve bracket mounting bolt | 10 | 2 | 17 | 49 | 5 | 36 |
| | | 12 | 7 | 19 | 88 | 9 | 65 |
| 9 | Swing device mounting bolt | 16 | 8 | 24 | 265 | 27 | 195 |
| 10 | Battery mounting nut | 8 | 2 | 13 | 9.8 | 1 | 7.2 |
| | | 10 | 1 | 17 | 49 | 5 | 36 |
| 11 | Canopy mounting bolt | 10 | 1 | 17 | 49 | 5 | 36 |
| | | 14 | 3 | 22 | 137 | 14 | 101 |
| 12 | Cab mounting bolt | 14 | 4 | 22 | 137 | 14 | 101 |
| 13 | Swing bearing mounting bolt to upperstructure | 14 | 24 | 22 | 175 | 18 | 130 |
| | Swing bearing mounting bolt to undercarriage | 12 | 24 | 19 | 108 | 11 | 80 |
| 14 | Travel device mounting bolt | 14 | 18 | 22 | 216 | 22 | 159 |
| 15 | Sprocket mounting bolt | 14 | 18 | 22 | 216 | 22 | 159 |
| 16 | Upper roller mounting bolt | 16 | 2 | 24 | 205 | 21 | 152 |
| 17 | Lower roller mounting bolt | 18 | 20 | 27 | 451 | 46 | 333 |
| 18 | Covers mounting bolt | 6 | | 10 | 5 | 0.5 | 3.6 |
| | | 8 | | 13 | 9.8 | 1 | 7.2 |
| | | 10 | | 17 | 49 | 5 | 36 |
| | | 12 | | 19 | 88 | 9 | 65 |
| 19 | Counterweight mounting bolt | 24 | 3 | 36 | 735 | 75 | 542 |

*NOTE: (1) Apply lubricant (i.e. white zinc B dissolved into spindle oil) to bolts and nuts to stabilize their friction coefficients.*

*(2) Make sure bolt and nut threads are clean before installing.*

*(3) Apply Loctite to threads of engine cushion rubber mounting bolts, lower roller mounting bolts, and swing-post vertical-pin mounting bolts before installing them.*

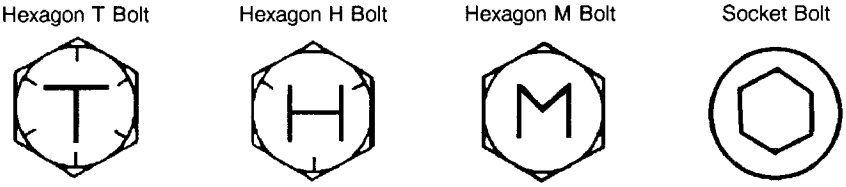
## TORQUE CHART

**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.




W105-01-01-007

### Specified Tightening Torque Chart

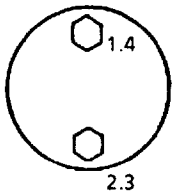
| Bolt Dia. | Wrench Size | Hexagon Wrench Size | T Bolt, Socket bolt | | | H Bolt | | | M Bolt | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | N·m | kgf·m | lbf·ft | N·m | kgf·m | lbf·ft | N·m | kgf·m | lbf·ft |
| M 8 | 13 | 6 | 29.5 | 3 | 22 | 19.5 | 2 | 14.5 | 9.8 | 1 | 7.2 |
| M 10 | 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 | 1 370 | 140 | 1 010 | 1 030 | 105 | 760 | 390 | 40 | 290 |
| M 30 | 46 | 22 | 1 910 | 195 | 1 410 | 1 420 | 145 | 1 050 | 540 | 55 | 400 |
| M 33 | 50 | 24 | 2 550 | 260 | 1 880 | 1 910 | 195 | 1 410 | 740 | 75 | 540 |
| M 36 | 55 | 27 | 3 140 | 320 | 2 310 | 2 400 | 245 | 1 770 | 930 | 95 | 690 |

**IMPORTANT:** **(1) Apply lubricant (i. e. white zinc B dissolved into spindle oil) to nuts and bolts to stabilize their friction coefficients.**
**(2) Torque tolerance is ±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.**

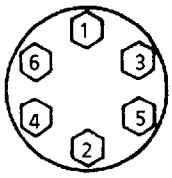
### Bolt Tightening Order

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

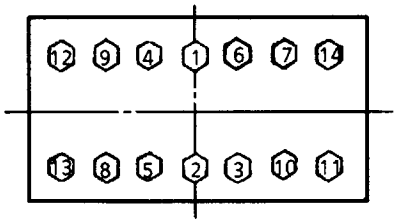
Equally tighten upper and lower alternately




Tighten diagonally



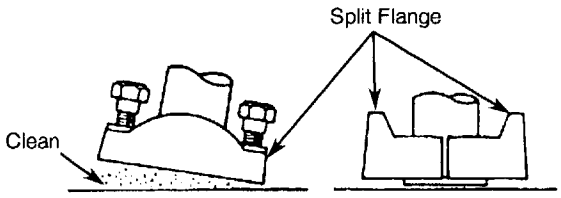

Tighten from center and diagonally




W105-01-01-003

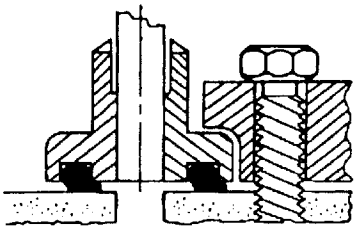
**Service Recommendations for Split Flange**

**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) Loosely assemble split flange halves. Make sure that split is centrally located 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



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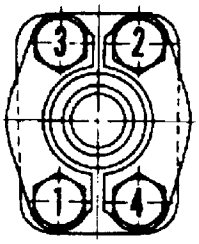


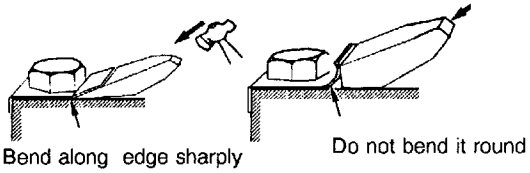

W105-01-01-008

**Nut and Bolt Lockings**

- Lock Plate

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

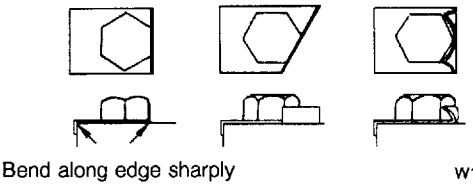
RIGHT WRONG




- Split Pin

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

RIGHT RIGHT WRONG

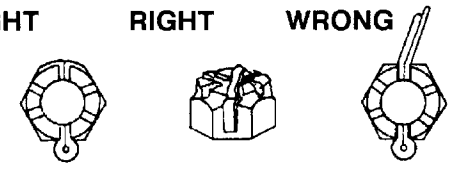



W105-01-01-009

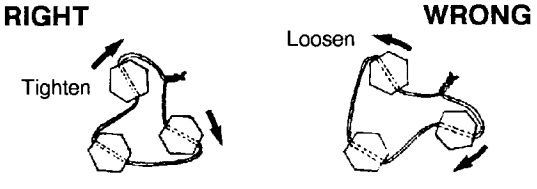
- Lock Wire

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

RIGHT RIGHT WRONG



RIGHT WRONG



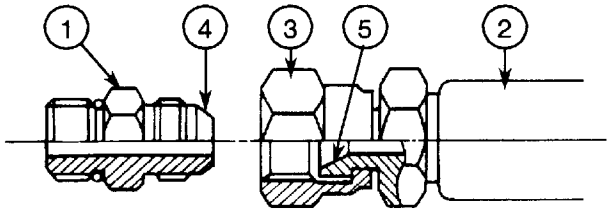

W105-01-01-010

## PIPING JOINT

### Pipe Thread Connection / Union Joint Tightening Torque Specifications

### Union Joint

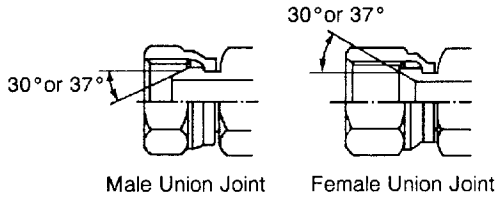
Metal sealing surfaces (4) and (5) of adaptor (1) and hose (2) fit together to seal pressure oil. Union joints are used to join small-diameter lines.




M202-07-051

**IMPORTANT: (1) Do not over-tighten nut (3). Excessive force will be applied to metal sealing surfaces (4) and (5), possibly cracking adaptor (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.**




W105-01-01-017

| Wrench Size mm | Tightening Torque N·m ( kgf·m, lbf·ft ) |
|---|---|
| 19 | 29.5 ( 3.0, 22 ) |
| 22 | 39 ( 4.0, 29 ) |
| 27 | 64 ( 6.5, 47 ) |
| 32 | 137 ( 14, 101 ) |
| 36 | 175 ( 18, 130 ) |
| 41 | 205 ( 21, 152 ) |
| 50 | 255 ( 26, 188 ) |

### O-ring Seal Joint

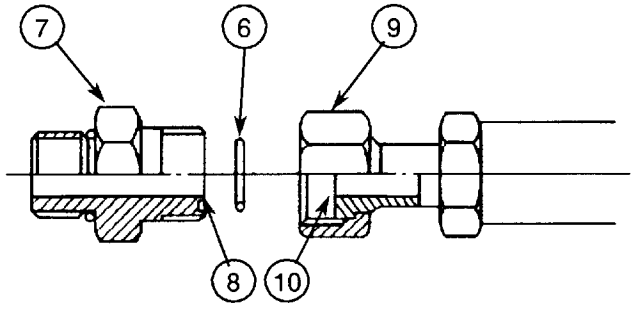
O-ring (6) seats against the end face of adaptor (7) to seal pressure oil.

**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 (8). 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 (8) or sealing surface (10). Damage to O-ring (6) will cause oil leakage.**

**(4) If loose nut (9) is found to be loose, causing oil leakage, do not tighten it to stop leakage. Instead, replace O-ring (6) with a new one, then tighten nut (9) after confirming that O-ring (6) is securely seated in place.**

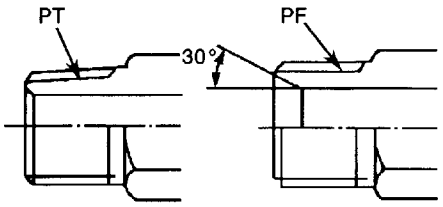



M104-07-033

| Wrench Size mm | Tightening Torque N·m ( kgf·m, lbf·ft ) |
|---|---|
| 27 | 93 ( 9.5, 69 ) |
| 32 | 137 ( 14, 101 ) |
| 36 | 175 ( 18, 130 ) |
| 41, 46 | 205 ( 21, 152 ) |

### Screwed-In Connection

**IMPORTANT: Many types of screwed-in connections are used for hose connections. Be sure to confirm that the thread pitch and thread type (tapered or straight) are the correct type before using any screw-in connection.**




Male Tapered Thread  Male Straight Thread

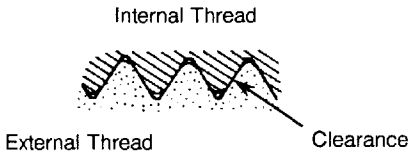
W105-01-01-018

*NOTE: Cast Iron: For tightening screwed-in connection to cast-iron components.*
*Steel : For tightening screwed-in connection to steel components.*

| Wrench Size mm | Tightening Torque N·m ( kgf·m, lbf·ft ) | |
|---|---|---|
| | Cast Iron | Steel |
| 19 | 14.5 ( 1.5, 10 ) | 34 ( 3.5, 25 ) |
| 22 | 29.5 ( 3.0, 22 ) | 49 ( 5.0, 36 ) |
| 27 | 49 ( 5.0, 36 ) | 93 ( 9.5, 69 ) |
| 36 | 69 ( 7.0, 51 ) | 157 ( 16, 116 ) |
| 41 | 108 ( 11, 80 ) | 205 ( 21, 152 ) |
| 50 | 157 ( 16, 116 ) | 410 ( 42, 300 ) |
| 60 | 195 ( 20, 145 ) | |
| 70 | 255 ( 26, 190 ) | |

### Seal Tape Application

Seal tape is used to seal clearances between male and female threads, so as to prevent any leakage between threads.
Be sure to apply just enough seal tape to fill up thread clearances. Do not overwrap.

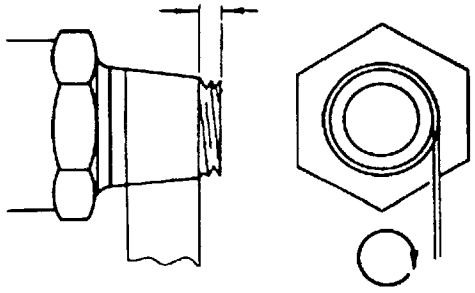



W105-01-01-019

- Application Procedure

  Confirm that the thread surface is clean, free of dirt or damage.
  Apply seal tape around threads as shown. Wrap seal tape in the same direction as the threads.

Leave one to two pitch threads uncovered



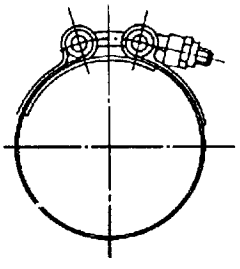
M114-07-041

### Low-Pressure-Hose Clamp Tightening Torque

Low-pressure-hose clamp tightening torque differs depending on the type of clamp.
See below for correct tightening torque of each type of low-pressure-hose clamp.

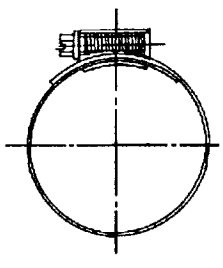
T-Bolt Type Band Clamp:
4.4 N·m ( 0.45 kgf·m, 3.25 lbf·ft )
Worm Gear Type Band Clamp:
5.9 to 6.9 N·m ( 0.6 to 0.7 kgf·m, 4.3 to 5.1 lbf·ft )

T-Bolt Type



M114-07-042

Worm Gear Type



M114-07-043

Connecting Hose

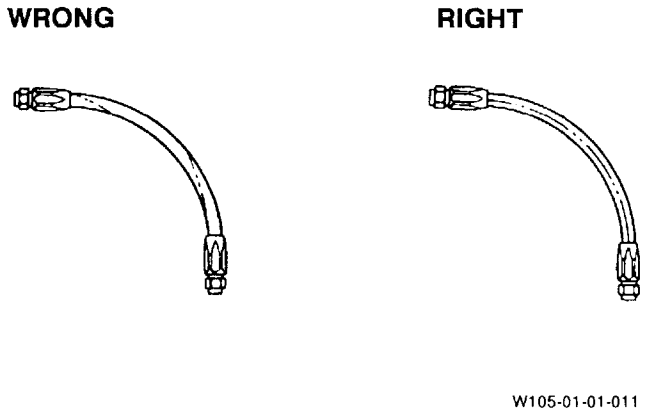
**CAUTION:**

(1) When replacing hoses, be sure to use only genuine AIRMAN service parts. Using hoses other than genuine AIRMAN hoses may cause oil leakage, hose rupture or separation of fitting, possibly resulting in a fire on the machine.

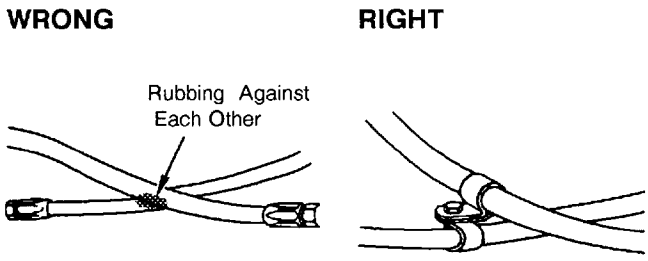
(2) Do not install hoses kinked. Application of high oil pressure, vibration, or an impact to a kinked hose may result in oil leakage, hose rupture or separation of fitting. Utilize print marks on hoses when installing hoses to prevent hose from being installed kinked.

(3) 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.

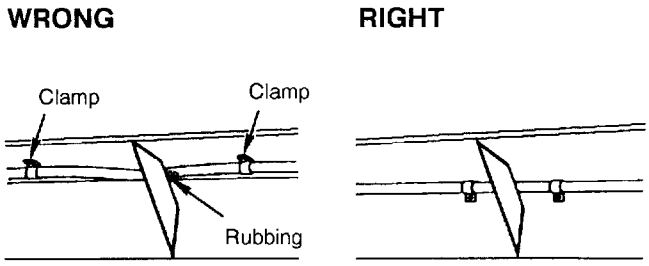
(4) Take care that hoses do not come into contact with moving parts or sharp objects.



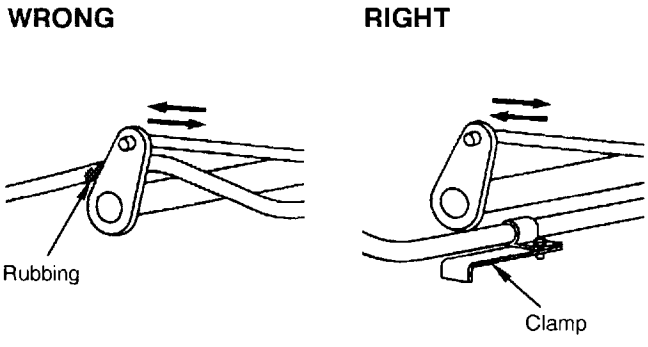

W105-01-01-011




W105-01-01-012

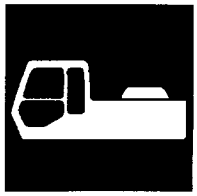



W105-01-01-013




W105-01-01-014

# SECTION 02
# UPPERSTRUCTURE



## CONTENTS

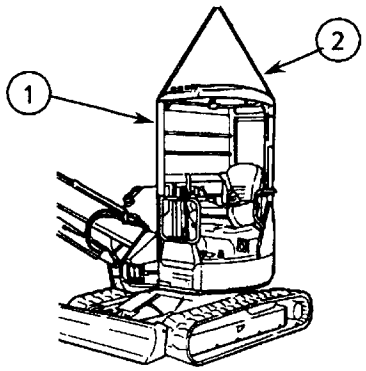
## REMOVE AND INSTALL CANOPY

(The illustration shows the 33Mu.)

### Remove Canopy

1. Attach sling belt (2) to canopy (1).

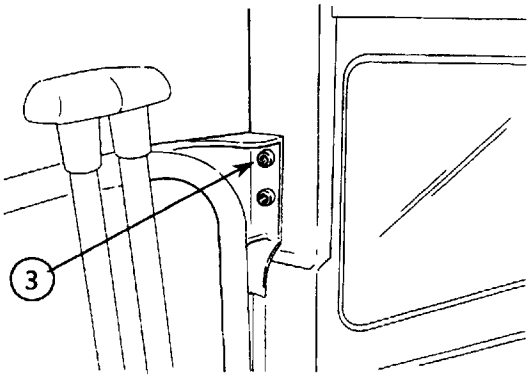
**CAUTION: Canopy weight: 72 kg**




W532-02-01-001

2. Remove stay mounting bolts (3).

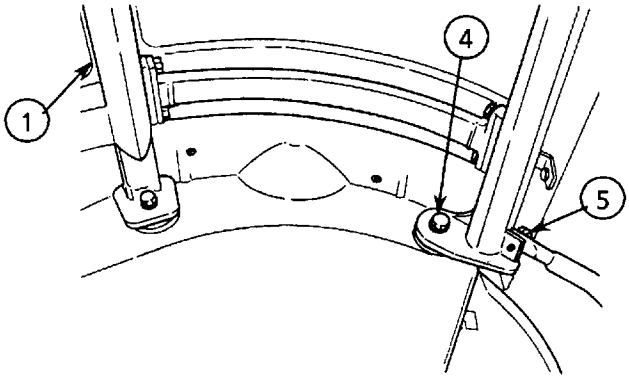
: 8 mm




W532-02-01-002

3. Loosen bolts (4, 5) to remove canopy (1).

: 13 mm, 17 mm, 22 mm

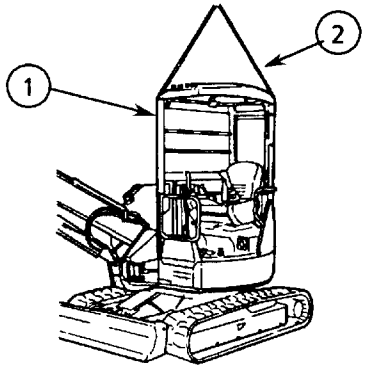



W532-02-01-003

### Install Canopy

1. Attach sling belt (2) to canopy (1). Install canopy (1) on the frame using a crane.

**CAUTION: Canopy weight: 72 kg**



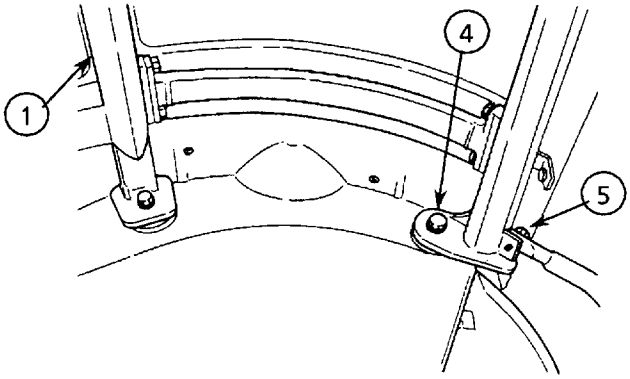

W532-02-01-001

2. Tighten bolts (4, 5) to secure canopy (1).

:13 mm : 9.8 N·m ( 1 kgf·m )

:17 mm : 49 N·m ( 5 kgf·m )

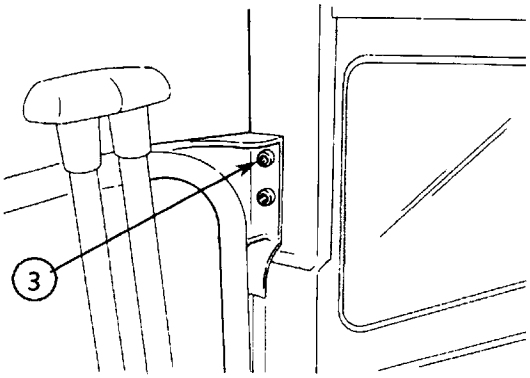
:22 mm : 137 N·m ( 14 kgf·m )




W532-02-01-003

3. Tighten stay mounting bolts (3).

: 8 mm : 49 N·m ( 5 kgf·m )




W532-02-01-002

## REMOVE AND INSTALL COUNTERWEIGHT

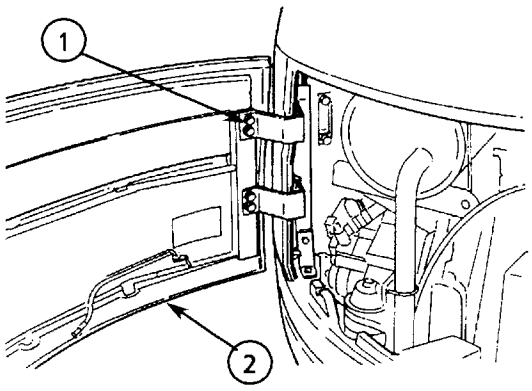
(The illustration shows the 33Mu.)

### Remove Counterweight

1. Remove the canopy.(Refer to "REMOVE AND INSTALL CANOPY")

2. Loosen bolts (1) and remove engine access cover (2).

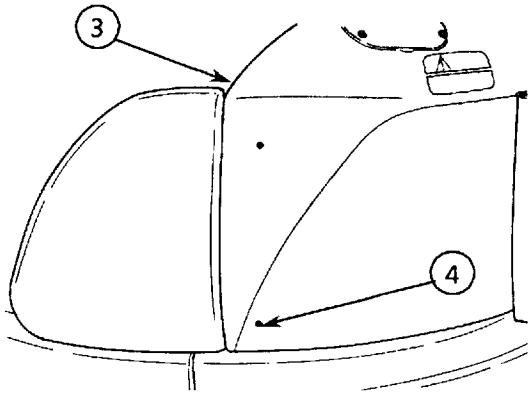
: 13 mm (33Mu)
: 17 mm (58Mu)



W532-02-02-001

3. Remove engine cover (3) mounting bolts (4).

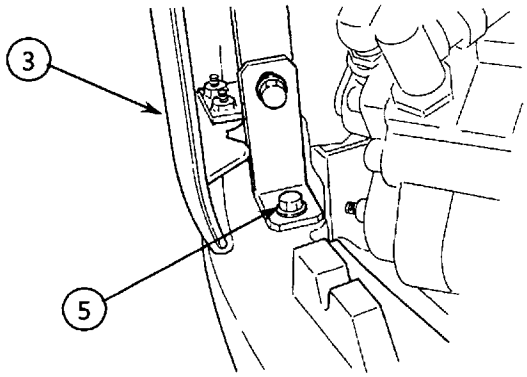
: 13 mm



W532-02-02-002

4. Loosen bracket mounting bolts (5) and remove engine cover (3).

: 13 mm, 17 mm

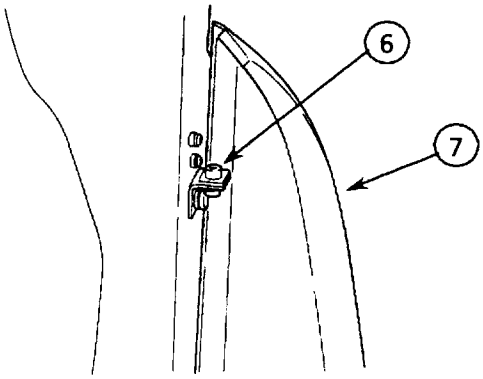


W532-02-02-003

5. Loosen bolt (6) and remove cover (7).

: 6 mm

: 17 mm

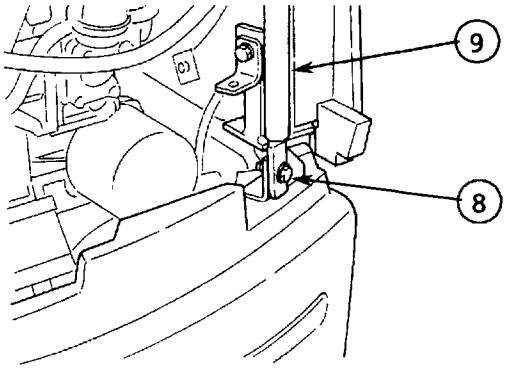


W532-02-02-004

6. Loosen bolt (8) and remove stay (9).

: 13 mm( 33Mu )

: 17 mm( 58Mu )



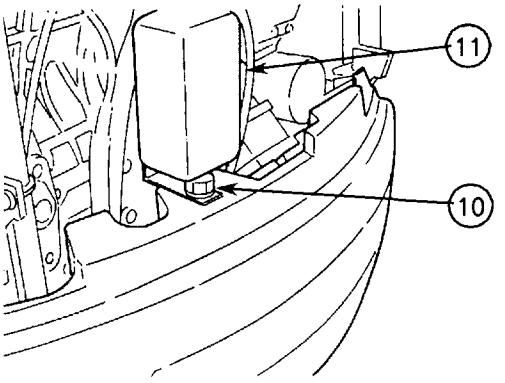

W532-02-02-005

7. Loosen bolt (10) and remove coolant reservoir (11).

: 30 mm

8. Attach the counterweight to a crane with wire ropes.

**CAUTION: Counterweight weight:**
**: 282 kg ( 33Mu )**
**: 922 kg ( 58Mu )**

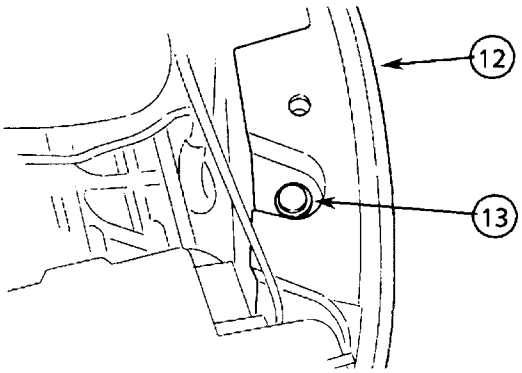



W532-02-02-006

9. Remove counterweight mounting bolts (13).

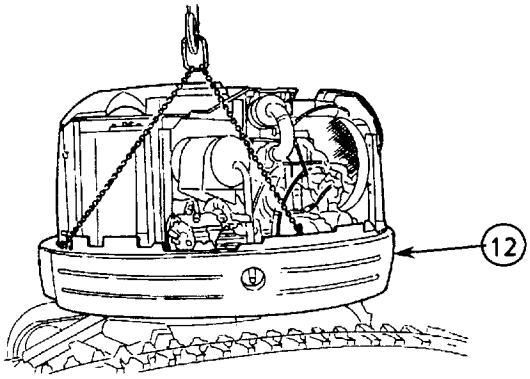
: 27 mm ( 33Mu )

: 36 mm ( 58Mu )




W532-02-02-007

10. Install eyebolts. Raise counterweight (12) using a crane.

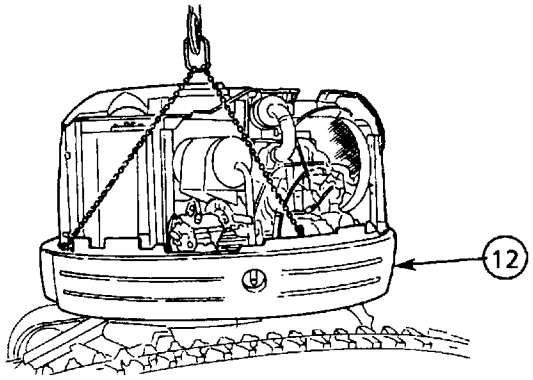



W532-02-02-008

**Install Counterweight**

1. Attach counterweight (12) to a crane with wire ropes and move it forward onto the frame.

**CAUTION: Counterweight weight:**
**: 282 kg ( 33Mu )**
**: 922 kg ( 58Mu )**

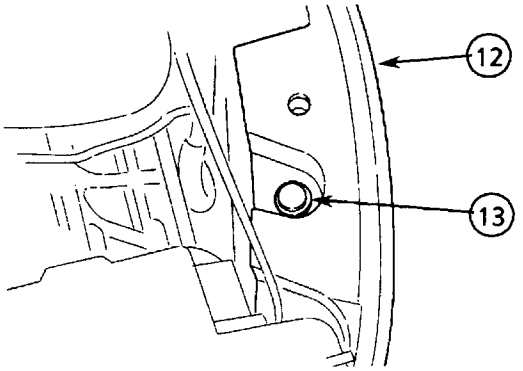



W532-02-02-008

2. Tighten bolts (13) to hold the counterweight in position.

: 27 mm : 295 N·m ( 30 kgf· m ) (33Mu)

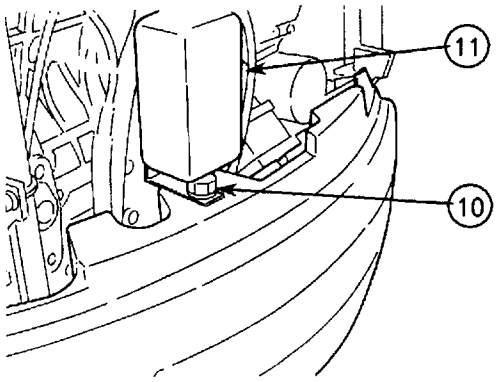
: 36 mm : 735 N·m ( 75 kgf· m ) (58Mu)




W532-02-02-007

3. Install coolant reservoir (1) and tighten bolts (10).

: 30 mm : 167 N·m ( 17 kgf· m )

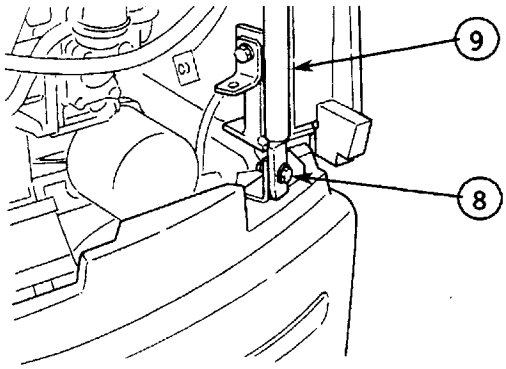



W532-02-02-006

4. Install stay (9) and tighten bolts (8).

: 13 mm : 9.8 N·m ( 1 kgf· m ) (33Mu)

: 17 mm : 49 N·m ( 5 kgf· m ) (58Mu)

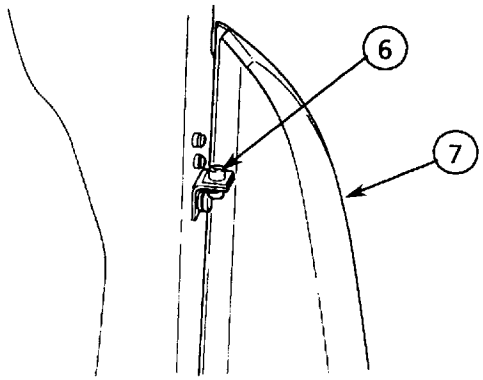



W532-02-02-005

5. Install cover (7) and tighten bolts (6).

: 6 mm : 9.8 N·m ( 1 kgf· m )

: 17 mm : 49 N·m ( 5 kgf· m )

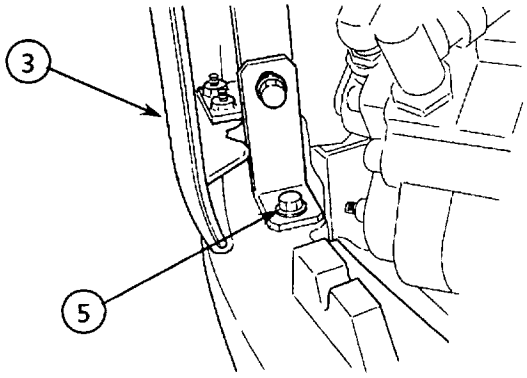



W532-02-02-004

6. Install engine cover (3) and tighten bracket mounting bolt (5).

: 13 mm : 9.8 N·m ( 1 kgf· m )

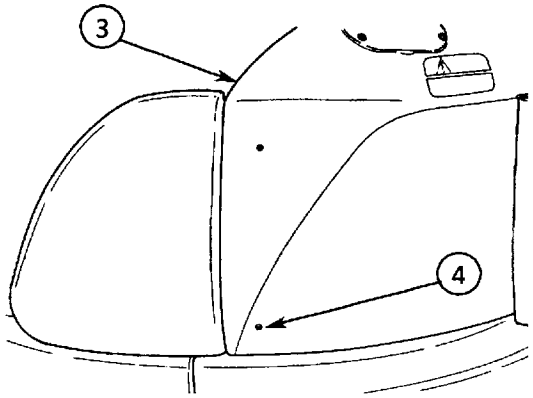
: 17 mm : 49 N·m ( 5 kgf· m )




W532-02-02-003

7. Tighten engine cover mounting bolts (4).

: 4 mm : 5 N·m ( 0.5 kgf· m )



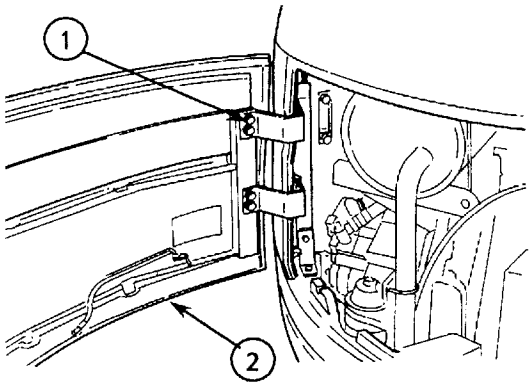

W532-02-02-002

8. Install engine access cover (2) and tighten bolts (4).

: 13 mm : 9.8 N·m (1 kgf· m) (33Mu)

: 17 mm : 49 N·m (5 kgf· m) (58Mu)

9. Install the canopy. (Refer to "REMOVE AND INSTALL CANOPY")




W532-02-02-001

## REMOVE AND INSTALL PUMP DEVICE

(The illustration shows the 33Mu)

**CAUTION:**

1. **Hydraulic fluid under pressure can penetrate the skin or eyes causing serious injury. Avoid this hazard by relieving pressure before disconnecting any hydraulic lines.**
2. **Hydraulic oil becomes hot during operation. Disconnecting hydraulic lines soon after operation can result in severe burns. Wait for the oil and components to cool before removing any parts.**

Preparation:

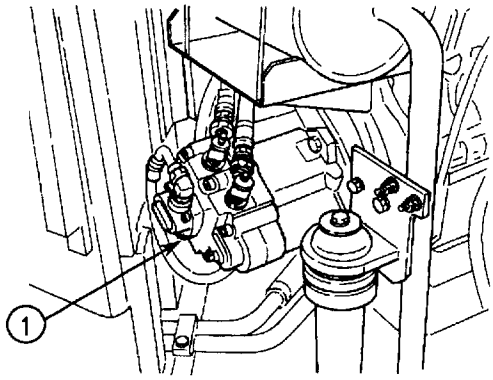
1. Place the machine on a solid, level surface, and lower the bucket to the ground.
2. Stop the engine. Operate the control levers several times to release any residual pressure in the hydraulic lines. Slowly loosen the hydraulic oil tank cap to release any pressure in the hydraulic oil tank.
3. Remove the cap. Install a vacuum pump on the hydraulic oil tank. Operate the vacuum pump to create negative pressure in the tank.

*NOTE: Keep the vacuum pump running continuously while working on the system.*

### Remove Pump Device

1. Remove the canopy. (Refer to "REMOVE AND INSTALL CANOPY")
2. Remove the counterweight. (Refer to "REMOVE AND INSTALL COUNTERWEIGHT")
3. Disconnect all hoses from pump (1).

: 22 mm, 27 mm



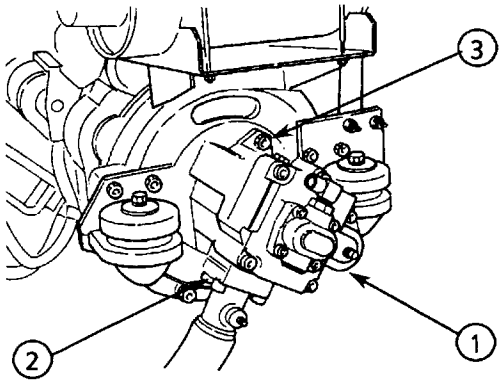

W532-02-03-003

4. Remove suction pipe mounting bolts (2). Attach sling belts to pump (1). Slightly raise pump (1) using a crane and sling belts, and remove bolts (3). Remove pump (1) with a crane.

: 8 mm

: 19 mm

**CAUTION: Pump device weight:**
**: 17 kg ( 33Mu )**
**: 21 kg ( 58Mu )**




W532-02-03-004

**Install Counterweight**

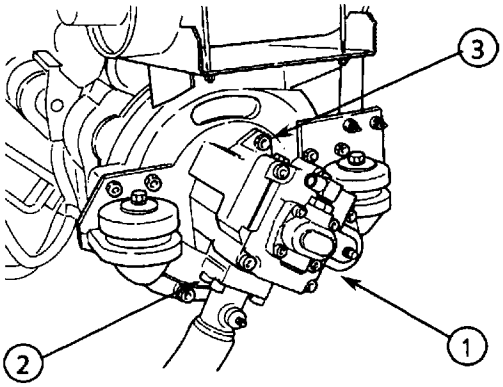
1. Raise pump (1) using a crane. Tighten bolts (3) to secure pump (1) in position.

**CAUTION: Pump device weight:**
**: 17 kg ( 33Mu )**
**: 21 kg ( 58Mu )**

Tighten suction pipe mounting bolts (2).

: 19 mm : 88 N·m ( 9 kgf·m )

: 8 mm : 64 N·m ( 6.5 kgf·m )

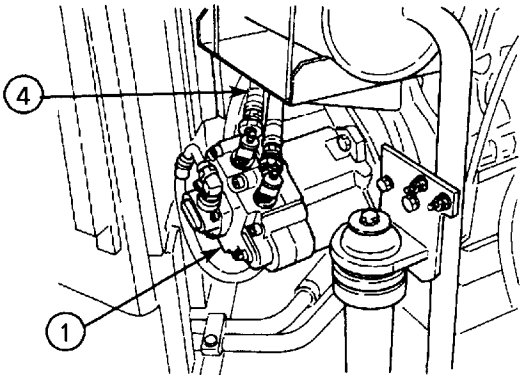



W532-02-03-004

2. Connect all hoses to pump (1).

: 22 mm : 39 N·m ( 4 kgf·m )

: 27 mm : 64 N·m ( 6.5 kgf·m )



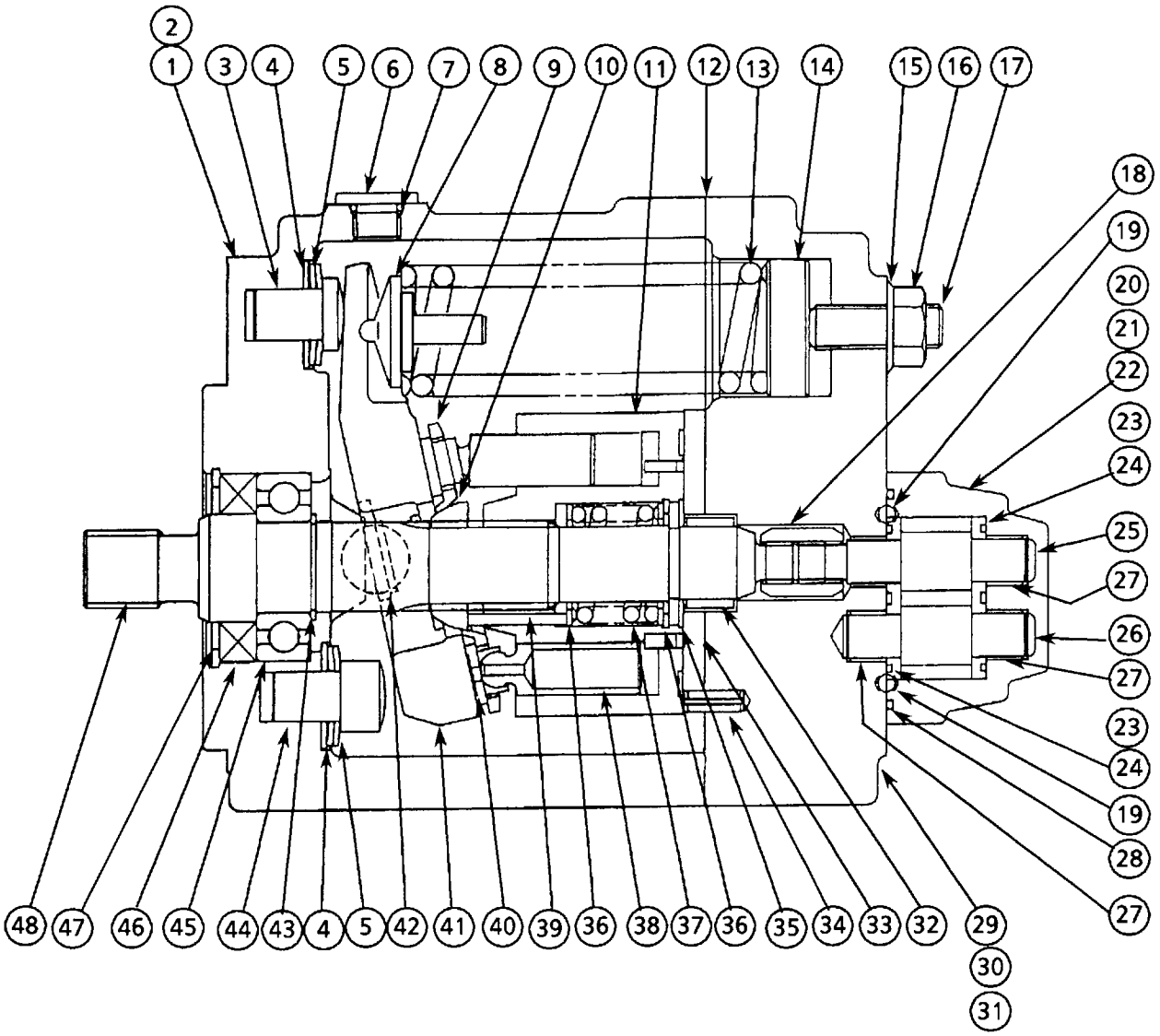

W532-02-03-003

**IMPORTANT: After installing pump (1), disconnect hose (4) from the pump housing. Fill the pump housing with hydraulic oil. Lightly tighten hose (4). Start the engine and run it at slow idle speed. Bleed air until oil seeps out from the clearance. Stop the engine and tighten hose (4).**

3. Install the counterweight. (Refer to "REMOVE AND INSTALL COUNTERWEIGHT")

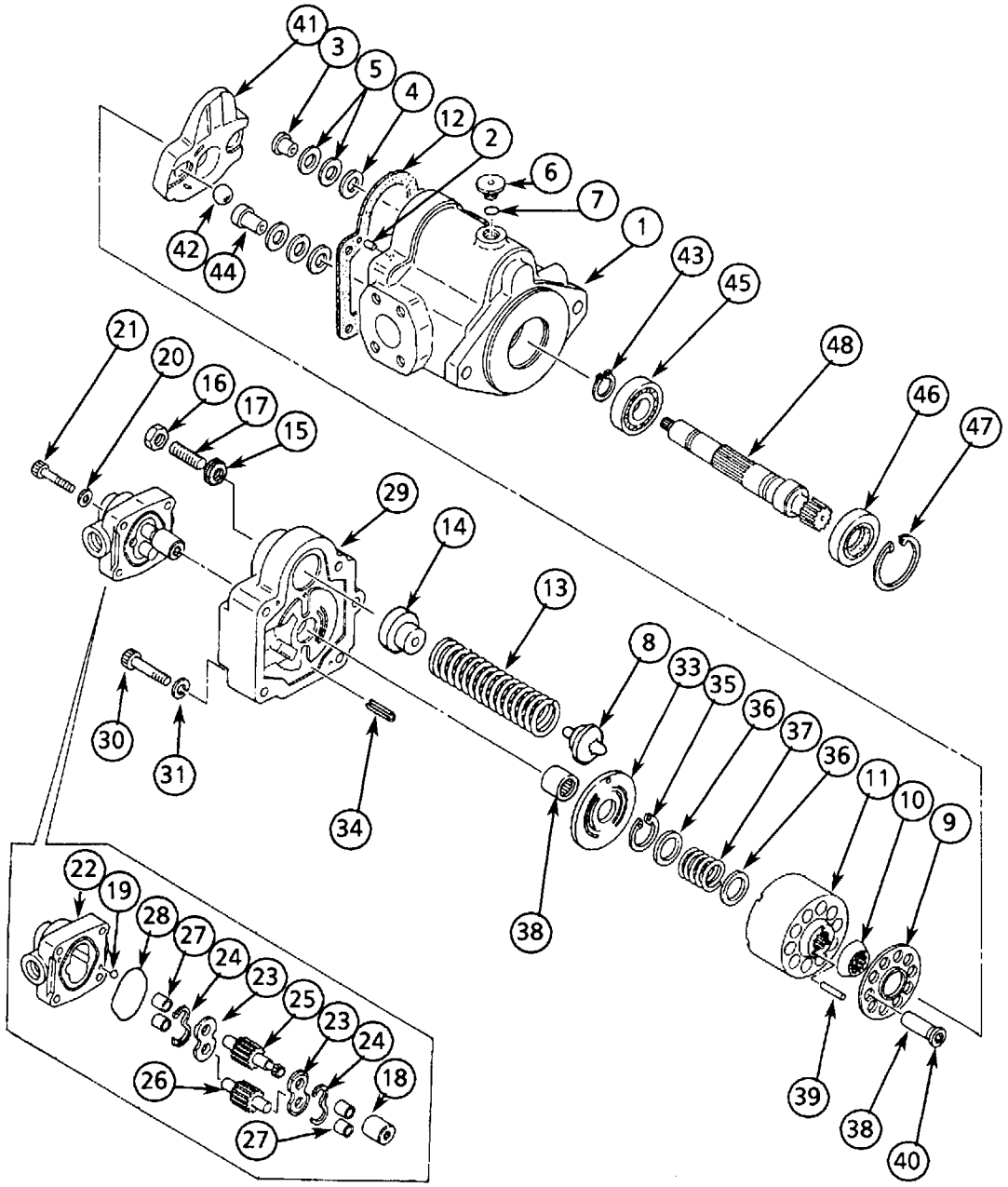
4. Install the canopy. (Refer to "REMOVE AND INSTALL CANOPY")

## DISASSEMBLE AND ASSEMBLE PUMP DEVICE (33Mu)




W532-02-03-001

1— Housing S
2— Pin (2 used)
3— Stopper Pin A
4— Washer (2 used)
5— Disc Springs (4 used)
6— Plug
7— O-Ring
8— Spring Holder
9— Retainer
10— Holder
11— Cylinder Block
12— Packing
13— Spring
14— Spring Guide
15— Seal Washer
16— Nut
17— Bolt
18— Joint
19— Steel Ball (2 used)
20— Spring Washer (4 used)
21— Socket Bolt (4 used)
22— Housing
23— Side plate (2 used)
24— Gasket (2 used)
25— Gear (A)
26— Gear (B)
27— Bushing (4 used)
28— O-Ring
29— Housing H
30— Socket Bolt (5 used)
31— Spring Washer (5 used)
32— Needle Bearing
33— Valve Plate
34— Spring Pin
35— Retaining Ring
36— Retainer (2 used)
37— Spring
38— Plunger (10 used)
39— Needle (3 used)
40— Shoe
41— Swash Plate
42— Ceramic Ball (2 used)
43— Retaining Ring
44— Stopper Pin B
45— Ball Bearing
46— Oil Seal
47— Retaining Ring
48— Shaft



W532-02-03-002

1— Housing S
2— Pin (2 used)
3— Stopper Pin A
4— Washer (2 used)
5— Disc Springs (4 used)
6— Plug
7— O-Ring
8— Spring Holder
9— Retainer
10— Holder
11— Cylinder Block
12— Packing
13— Spring
14— Spring Guide
15— Seal Washer
16— Nut
17— Bolt
18— Joint
19— Steel Ball (2 used)
20— Spring Washer (4 used)
21— Socket Bolt (4 used)
22— Housing
23— Side plate (2 used)
24— Gasket (2 used)
25— Gear (A)
26— Gear (B)
27— Bushing (4 used)
28— O-Ring
29— Housing H
30— Socket Bolt (5 used)
31— Spring Washer (5 used)
32— Needle Bearing
33— Valve Plate
34— Spring Pin
35— Retaining Ring
36— Retainer (2 used)
37— Spring
38— Plunger (10 used)
39— Needle (3 used)
40— Shoe
41— Swash Plate
42— Ceramic Ball (2 used)
43— Retaining Ring
44— Stopper Pin B
45— Ball Bearing
46— Oil Seal
47— Retaining Ring
48— Shaft

**Disassemble Pump Device (33Mu)**

Thoroughly clean the pump and place it on a workbench. Before disassembling, make matching marks on the mating surfaces of housing S (1), housing H (29) and housing (22).

1. Remove socket bolts (21) and housing (22). Remove O-ring (28) from housing (22).

   : 6 mm

2. Remove side plate (23) and gasket (24) from housing (22).

3. Remove gear A (25) and gear B (26) from housing (22).

4. Remove side plate (23) and gasket (24) from housing (22) bottom.

5. Loosen nut (16) and remove seal washer (15) and bolt (17).

   : 19 mm : 6 mm

*NOTE: Before loosening socket bolt (17), measure the bolt height from the surface of housing H (29).*

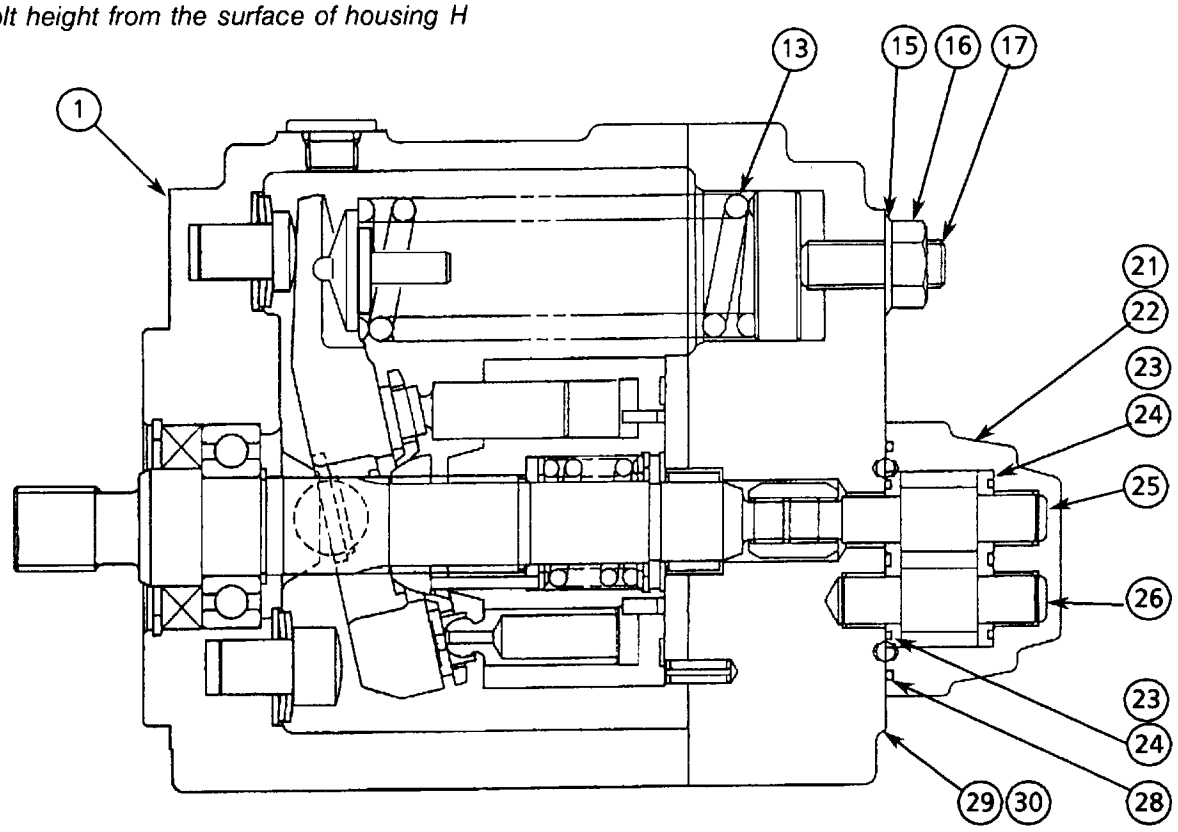
6. Remove two upper socket bolts (30) and install temporary fastening bolt (M10 x 65L) into each bolt hole.

   : 8 mm

**CAUTION: Be sure to use temporary fastening bolts (M10 x 65L). Otherwise, spring (13) may fly out when removing lower socket bolts (30), causing serious injury.**

7. Remove other three socket bolts (30).

   : 8 mm




W532-02-03-001

8. Alternately loosen and remove two temporary fastening bolts from housing H (29).

9. Remove housing H (29). Remove packing (12), two pins (2) and valve plate (33) in this order.

*NOTE: Be careful not to drop valve plate (33) when removing housing H (29).*

10. Remove spring (13) and spring holder (8), plungers (38) and cylinder block (11) assembly from housing S (1).

11. Remove plungers (38), retainer (9), holder (10) and needles (39) from cylinder block (11).

12. Remove retaining ring (35), retainer (36), spring (37) and retainer (36) from cylinder block (11).

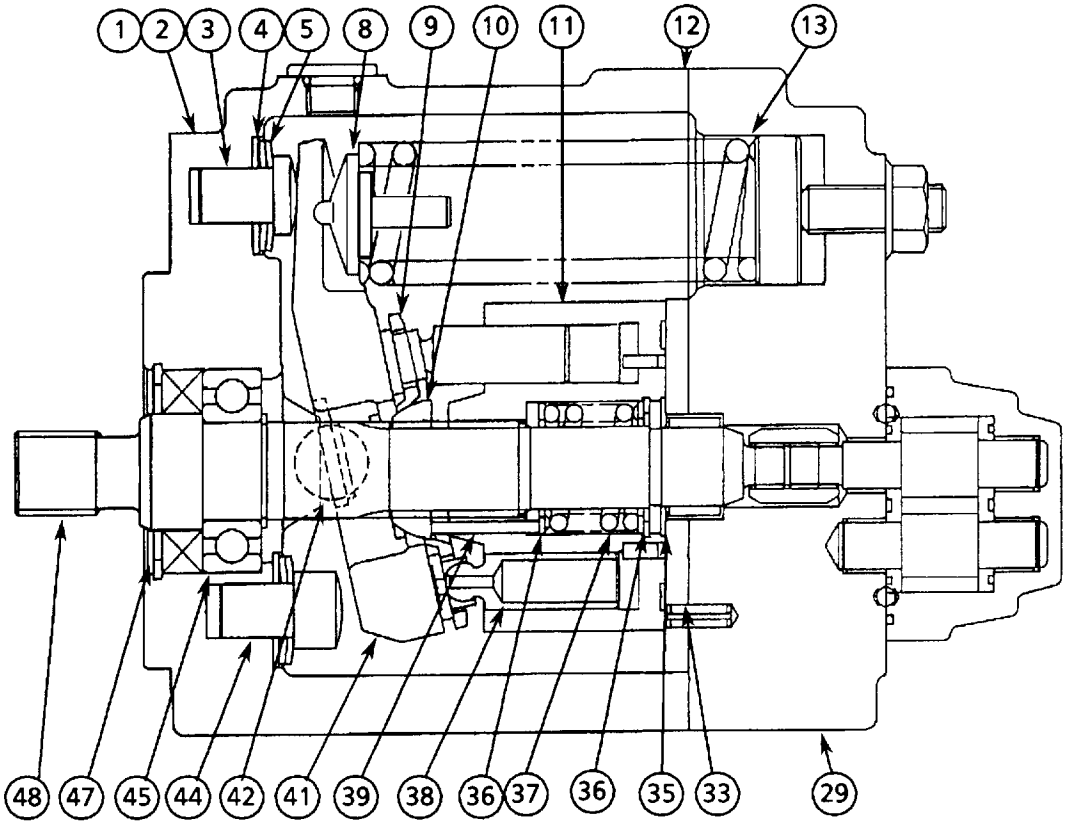
**CAUTION: Always hold spring (37) with a press when removing retaining ring (35). Otherwise, spring (37) will fly out when removing retaining ring (35), potentially causing injury.**

13. Remove swash plate (41) and two ceramic balls (42) from housing S (1).

14. Remove stopper pin A (3), stopper pin B (44), two disc springs (5) and washers (4).

15. Remove retaining ring (47) from housing S (1). Lightly tap shaft (48) with a plastic hammer; oil seal (46) and bearing (45) will automatically come out.

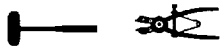
*NOTE: Do not remove ball bearing (45) unless replacement is required.*



**Assemble Pump Device (33Mu)**

Before assembling, clean components and parts with cleaning oil and dry completely. Apply a film of clean hydraulic oil to inner parts, sliding parts in particular, before assembling in order to prevent seizures.
After disassembling, always replace used O-rings, oil seals, packings and needle bearings with new ones.

1. Insert shaft (48) into housing S (1). Tap in oil seal (46) and install retaining ring (47).



*NOTE: If ball bearing (45) is to be replaced, press new bearing (45) on shaft (48) and install retaining ring (43) before inserting shaft (48) into housing S (1).*

2. Install retainer (36), spring (37) and retainer (36) in cylinder block (11) in this order.

3. Install retaining ring (35) while holding retainers (36) and spring (37) with a press.

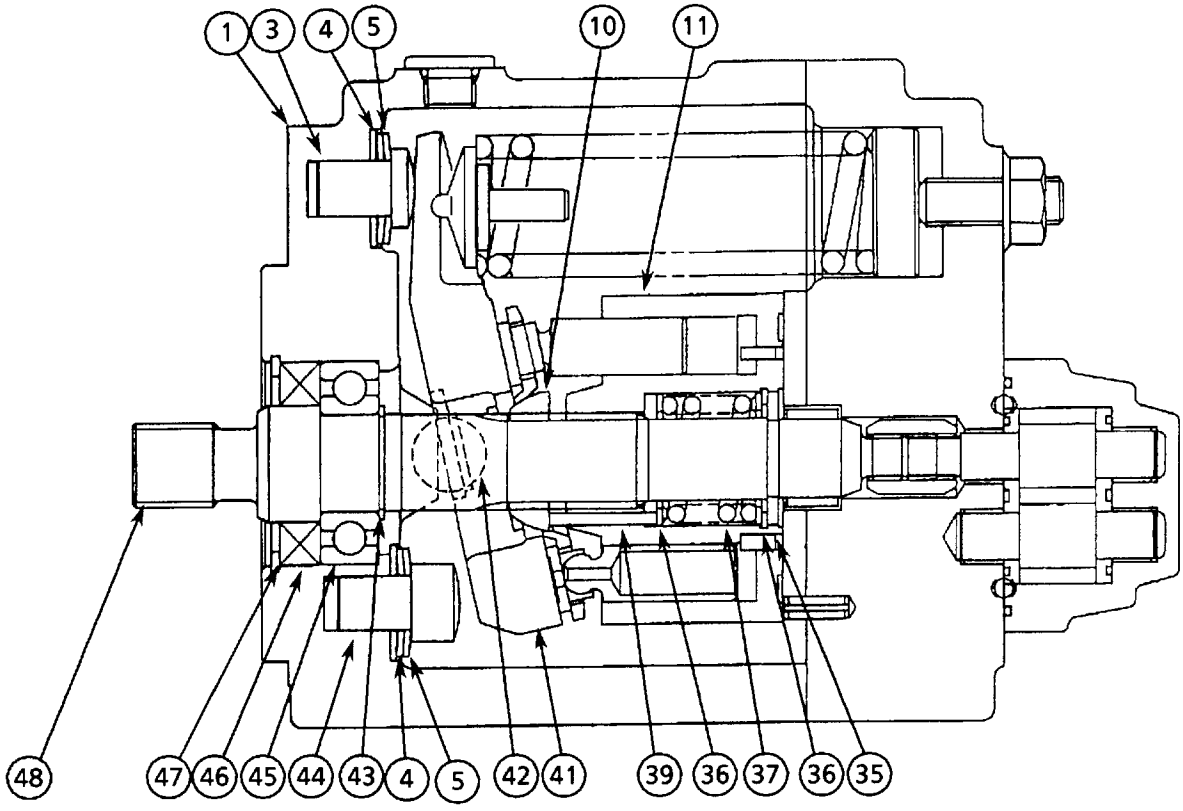
4. Install three needles (39) in cylinder block (11) and install holder (10) on the needles.

5. Install two disc springs (5) and washer (4) onto stopper pin A (3). Install stopper pin A (3) assembly in housing S (1).

6. Install two disc springs (5) and washer (4) onto stopper pin B (44). Install stopper pin B (44) assembly in housing S (1).

*NOTE: Stopper pins A (3) and B (44) are different in length. Refer to the assembly drawing when installing them.*

7. Install two ceramic balls (42) on swash plate (41). Install swash plate (41) in housing S (1).




W532-02-03-001

8. Install cylinder block (10) assembly, spring holder (8) and spring (13) in housing S (1).

9. Install valve plate (33) in housing S (1).

10. Install pins (2) and packing (12) on housing S (1).

11. Install joint (18) on shaft (48).

12. Place housing H (29) on housing S (1). Install and tighten two temporary fastening bolts (M10 x 65L) in the bolt holes on the spring (13) side.

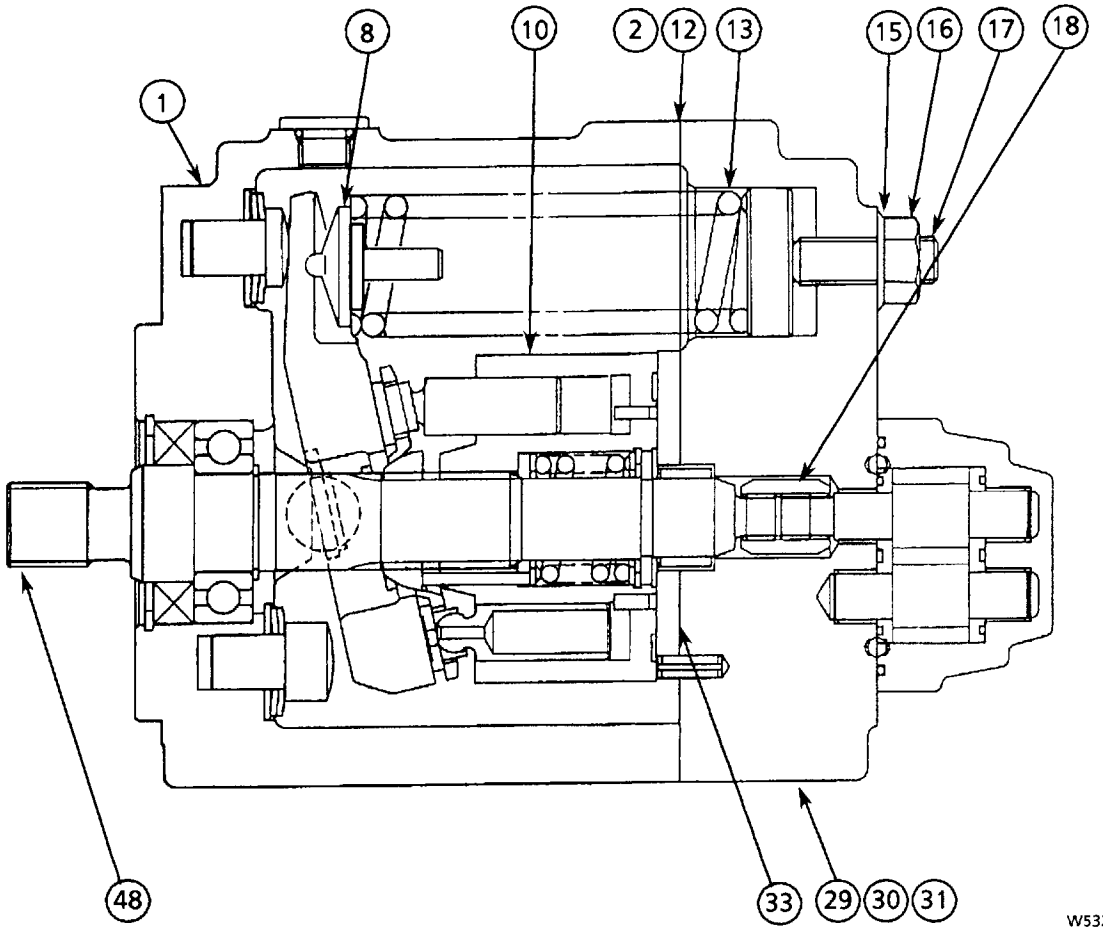
13. Install three socket bolts (30) with spring washers (31). Lightly tighten bolts (30).

14. Remove one temporary fastening bolt (M10 x 65L) and install socket bolt (30) with spring washer (31). Lightly tighten bolt (30). Remove the other temporary fastening bolt (M10 x 65L) and install socket bolt (30) with spring washer (31). Lightly tighten bolt (30).

15. Tighten five socket bolts (30) to specification.

: 8 mm : 54 to 64 N·m (5.5 to 6.5 kgf·m)

16. Install seal washer (15) and bolt (17) on housing H (29). Adjust the bolt (17) height from the housing face as it was before disassembling. After adjusting, tighten locknut (16).

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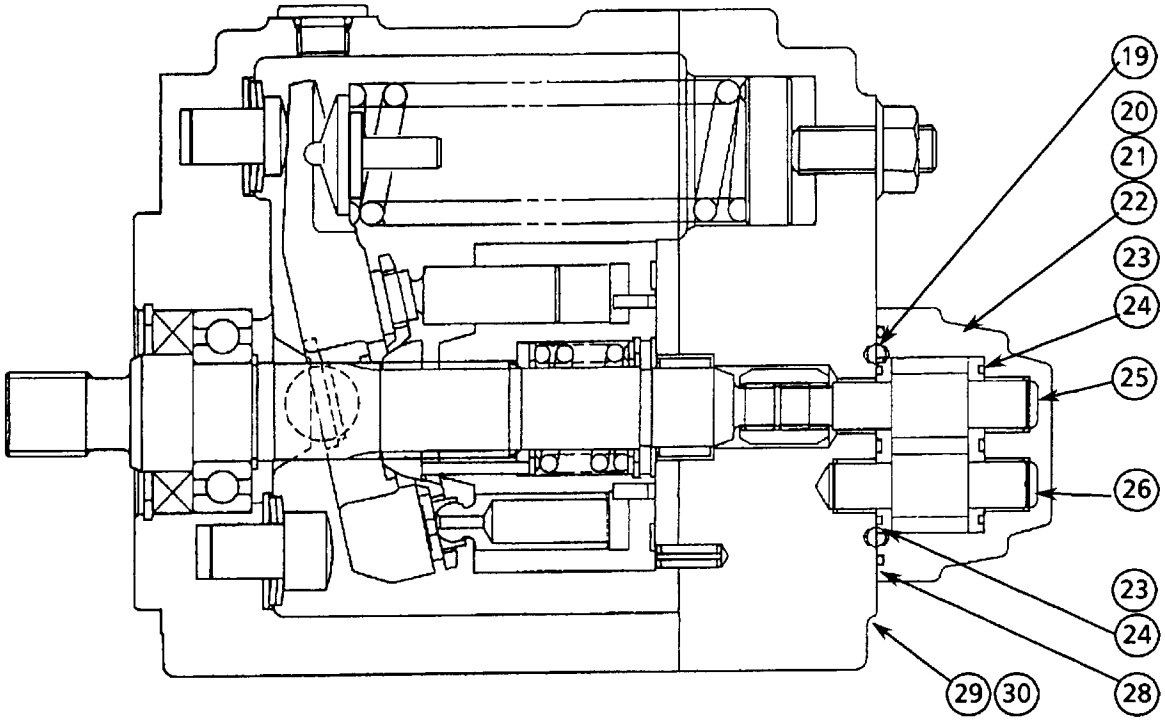
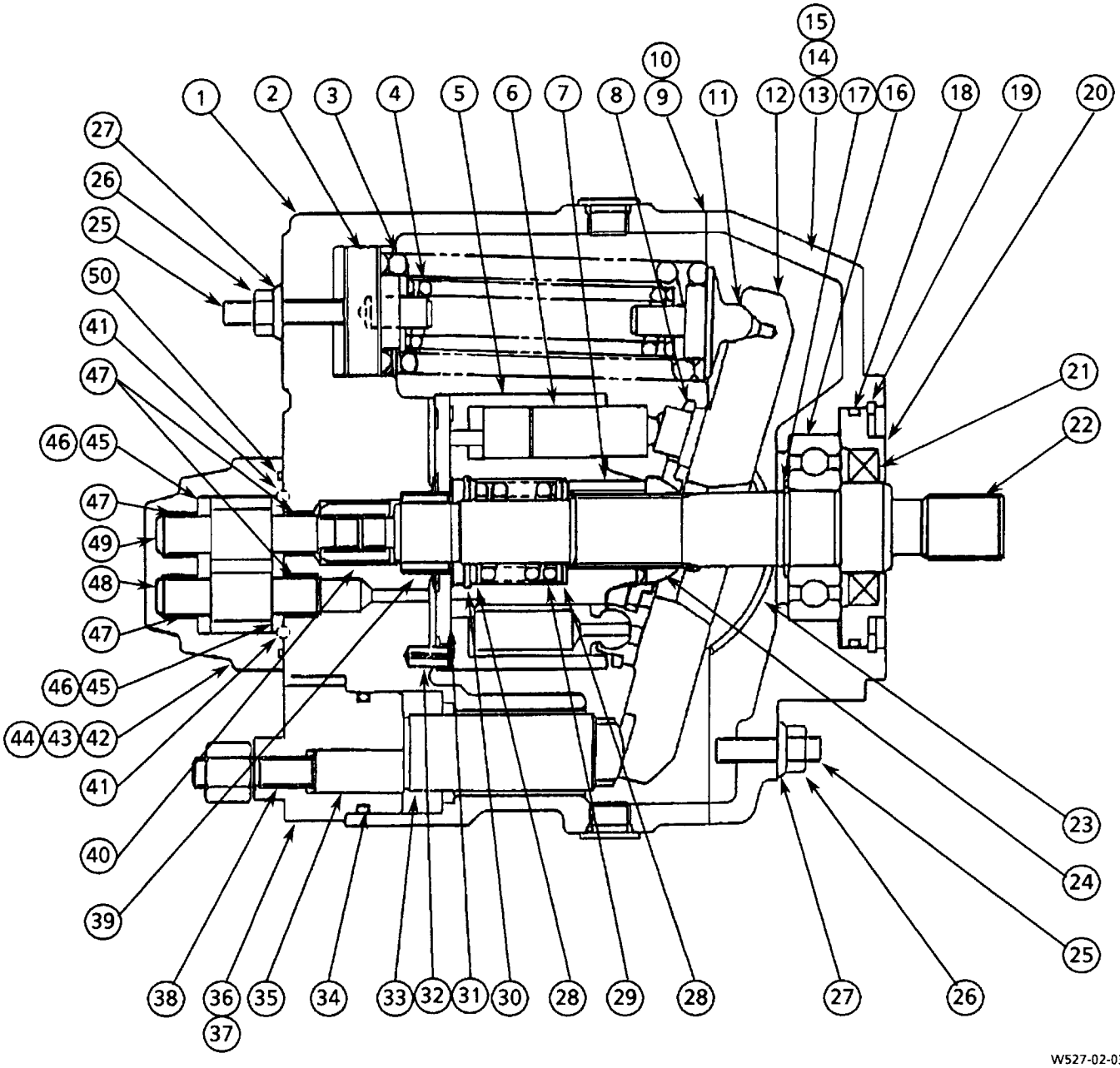
17. Attach gasket (24) to side plate (23). Install side plate (23) in housing (22) bottom.
18. Install gear A (25) and gear B (26) in housing (22).
19. Install side plate (23) and gasket (24) on gear A (25) and gear B (26).
20. Install O-ring (28) on housing (22).
21. Install steel balls (19) on housing H (29).
22. Install housing (22) assembly on housing H (29). Install spring washers (20) and socket bolts (21). Tighten socket bolts (21) to specification.

: 6 mm : 25 to 27 N·m (2.5 to 2.8 kgf·m)



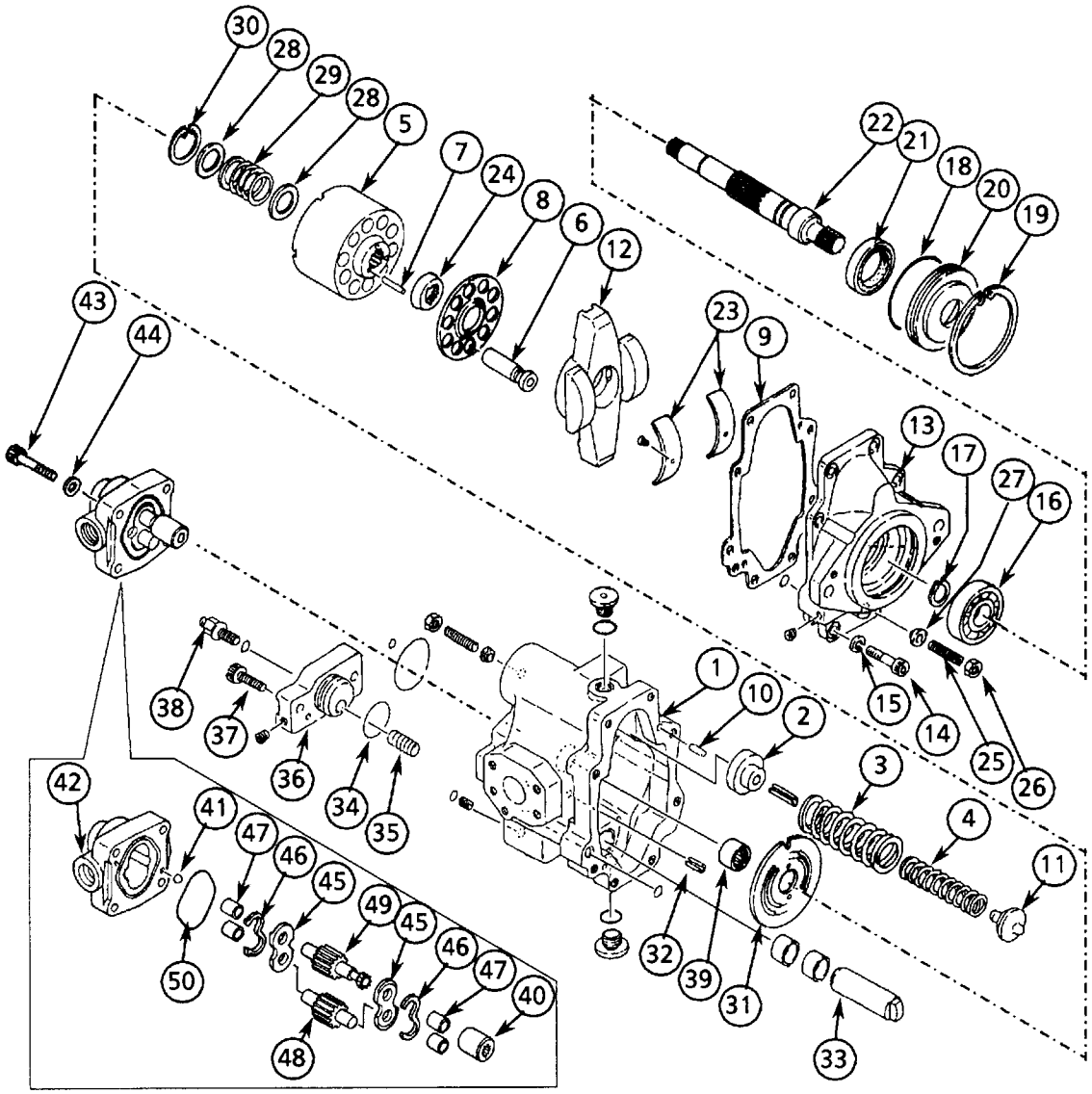

W532-02-03-001

## DISASSEMBLE AND ASSEMBLE PUMP DEVICE (58Mu)



W527-02-03-005

1— Housing H
2— Spring Guide
3— Spring
4— Spring
5— Cylinder Block
6— Plunger (10 used)
7— Needle (3 used)
8— Retainer
9— Packing
10— Pin (2 used)
11— Spring Holder
12— Swash Plate
13— Housing S
14— Sicket Bolt (8 used)
15— Spring Washer (8 used)
16— Ball Bearing
17— Retaining Ring
18— O-Ring
19— Retaining Ring
20— Seal Holder
21— Oil Seal
22— Shaft
23— Thrust Bushing (2 used)
24— Holder
25— Bolt (2 used)
26— Nut (2 used)
27— Seal Washer (2 used)
28— Retainer (2 used)
29— Spring
30— Retaining Ring
31— Valve Plate
32— Spring Pin
33— Control Piston
34— O-Ring
35— Rod
36— Sleeve
37— Socket Bolt (2 used)
38— Bolt
39— Needle Bearing
40— Joint
41— Steel Ball (2 used)
42— Housing
43— Socket Bolt (4 used)
44— Spring Washer (4 used)
45— Side Plate (2 used)
46— Gusket (2 used)
47— Bushing (4 used)
48— Gear (A)
49— Gear (B)
50— O-Ring



W527-02-03-006

1— Housing H
2— Spring Guide
3— Spring
4— Spring
5— Cylinder Block
6— Plunger (10 used)
7— Needle (3 used)
8— Retainer
9— Packing
10— Pin (2 used)
11— Spring Holder
12— Swash Plate
13— Housing S
14— Socket Bolt (8 used)
15— Spring Washer (8 used)
16— Ball Bearing
17— Retaining Ring
18— O-Ring
19— Retaining Ring
20— Seal Holder
21— Oil Seal
22— Shaft
23— Thrust Bushing (2 used)
24— Holder
25— Bolt (2 used)
26— Nut (2 used)
27— Seal Washer (2 used)
28— Retainer (2 used)
29— Spring
30— Retaining Ring
31— Valve Plate
32— Spring Pin
33— Control Piston
34— O-Ring
35— Rod
36— Sleeve
37— Socket Bolt (2 used)
38— Bolt
39— Needle Bearing
40— Joint
41— Steel Ball (2 used)
42— Housing
43— Socket Bolt (4 used)
44— Spring Washer (4 used)
45— Side Plate (2 used)
46— Gusket (2 used)
47— Bushing (4 used)
48— Gear (A)
49— Gear (B)
50— O-Ring

### Disassemble Pump Device (58Mu)

Thoroughly clean the pump and place it on a work-bench. Before disassembling, make matching marks on the mating surfaces of housing S (13), housing H (1), housing (42) and sleeve (36).

1. Remove socket bolts (43) and housing (42). Remove O-ring (50) from housing (42).

   : 6 mm

2. Remove side plate (45) and gasket (46) from housing (42).

3. Remove gear A (48) and gear B (49) from housing (42).

4. Remove side plate (45) and gasket (46) from housing (42) bottom.

5. Loosen socket bolts (14) and remove housing (13), shaft (22) and packing (9).

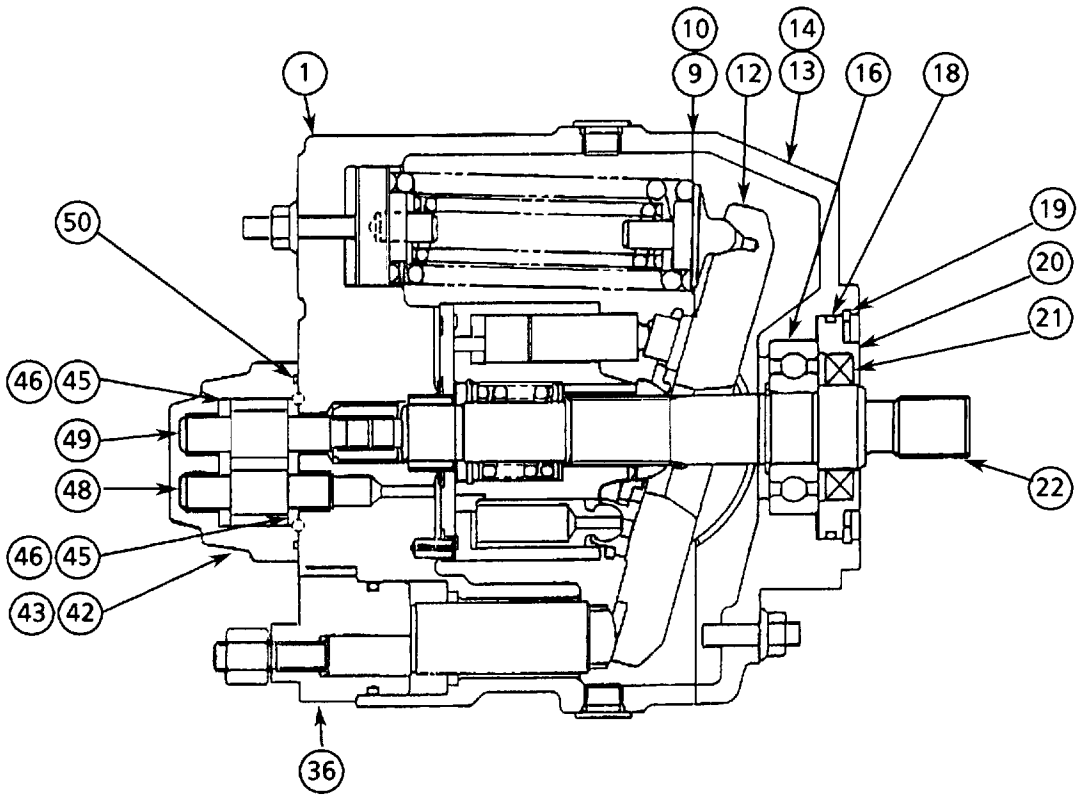
   : 8 mm

6. Remove retaining ring (19) from housing (13).

7. Lightly tap shaft (22), ball bearing (16) and seal holder (20) out from housing (13).

8. Remove oil seal (21) and O-ring (18) from seal holder (20).

9. Remove pins (10) and swash plate (12) from housing H (1).




W527-02-03-005

10. Remove cylinder block (5) assembly from housing H (1).

11. Remove plungers (10), retainer (8), holder (8) and needles (7) from cylinder block (5).

12. Remove retaining ring (30), retainer (28) and spring (37) from cylinder block (5).

**CAUTION: Always hold spring (29) with a press when removing retaining ring (30). Otherwise, spring (29) will fly out when removing retaining ring (30), potentially causing injury.**

13. Remove spring holder (11) and springs (3, 4) from housing H (1).

14. Remove valve plate (31) from housing H (1).

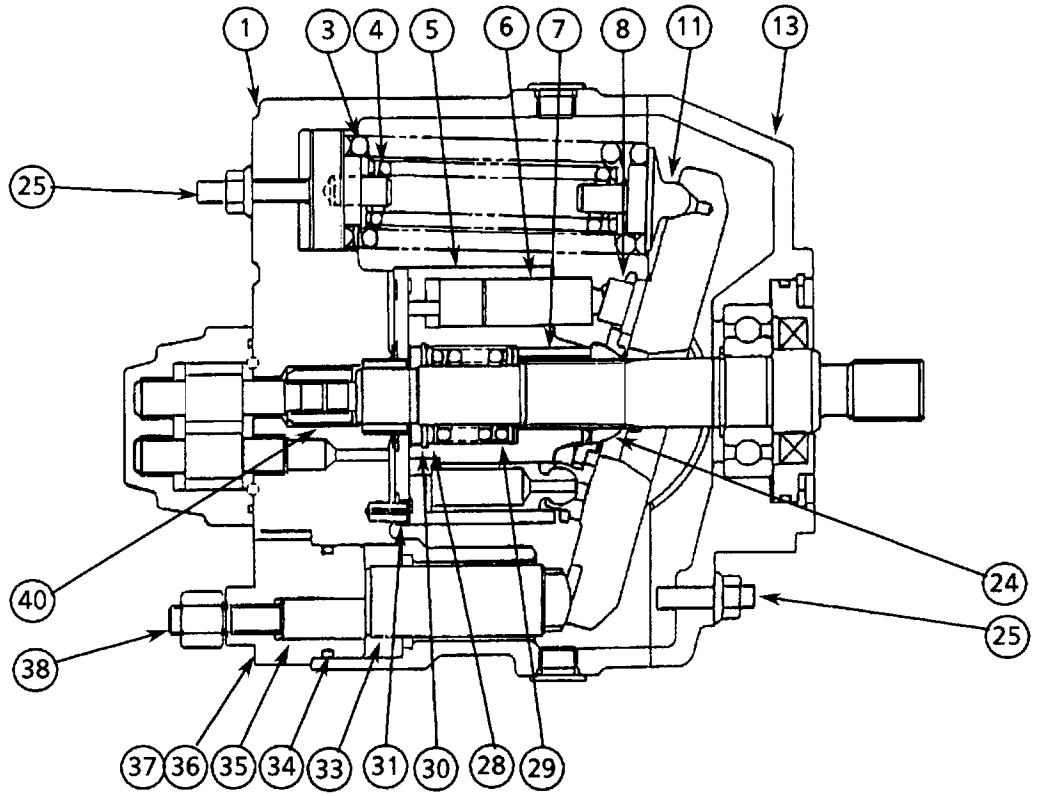
15. Remove joint (40) from housing H (1).

16. Remove control piston (33) from housing H (1).

17. Remove two socket bolts (37) and sleeve (36).

: 8 mm

18. Remove rod (35) and O-ring (34) from sleeve (36).




W527-02-03-005

**Assemble Pump Device(58Mu)**

Before assembling, clean components and parts with cleaning oil and dry completely. Apply a film of clean hydraulic oil to inner parts, sliding parts in particular, before assembling in order to prevent seizures.
After disassembling, always replace used O-rings, oil seals, packings and needle bearings with new ones.

1. Install O-ring (34) onto sleeve (36). Install rod (35) into sleeve (36).
2. Install sleeve (36) onto housing H (1) and tighten socket bolts (37) to specification.

: 8 mm

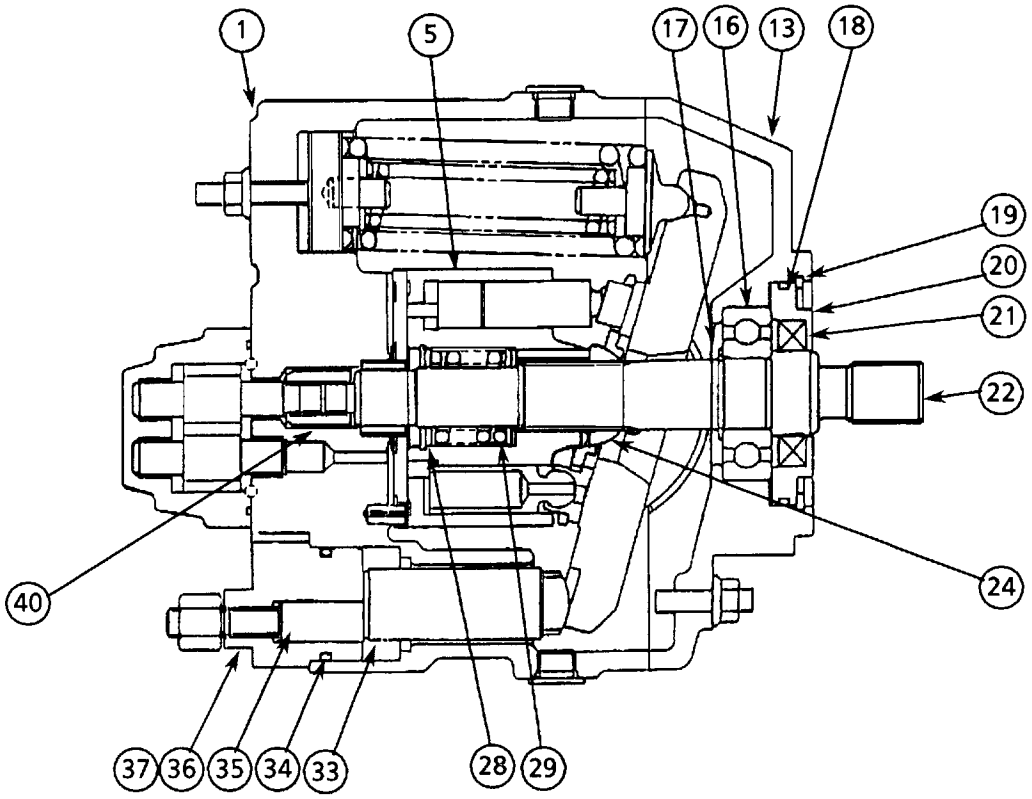
: 54 to 64 N·m ( 5.5 to 6.5 kgf·m )

*NOTE: Align the matching marks when installing sleeve (36).*

3. Install control piston (33) into housing H (1).
4. Install O-ring (18) and oil seal (21) on seal holder (20).
5. Install seal holder (20) onto shaft (22). Tap shaft (22) into housing S (13) with a plastic hammer.

*NOTE: If ball bearing (16) is to be replaced, tap new bearing (16) on shaft (22) and install retaining ring (17) before inserting shaft (22) into housing S (13).*

6. Install retaining ring (19) on housing S (13).
7. Install retainers (28) and spring (29) in cylinder block (5).




W527-02-03-005

8. Install retaining ring (30) while holding retainer (28) and spring (29) with a press.

9. Install needles (7) in cylinder block (5). Install holder (24) on needles (7).

10. Install plungers (6) into cylinder block (5). Install retainer (8).

11. Install valve plate (31) in housing H (1).

12. Install cylinder block (5) assembly in housing H (1).

13. Install springs (3, 4) and spring holder (11) in housing H (1).

14. Install swash plate (12) on cylinder block (5) assembly.

15. Install pins (10) on housing H (1).

16. Install packing (9) on housing H (1) end surface.

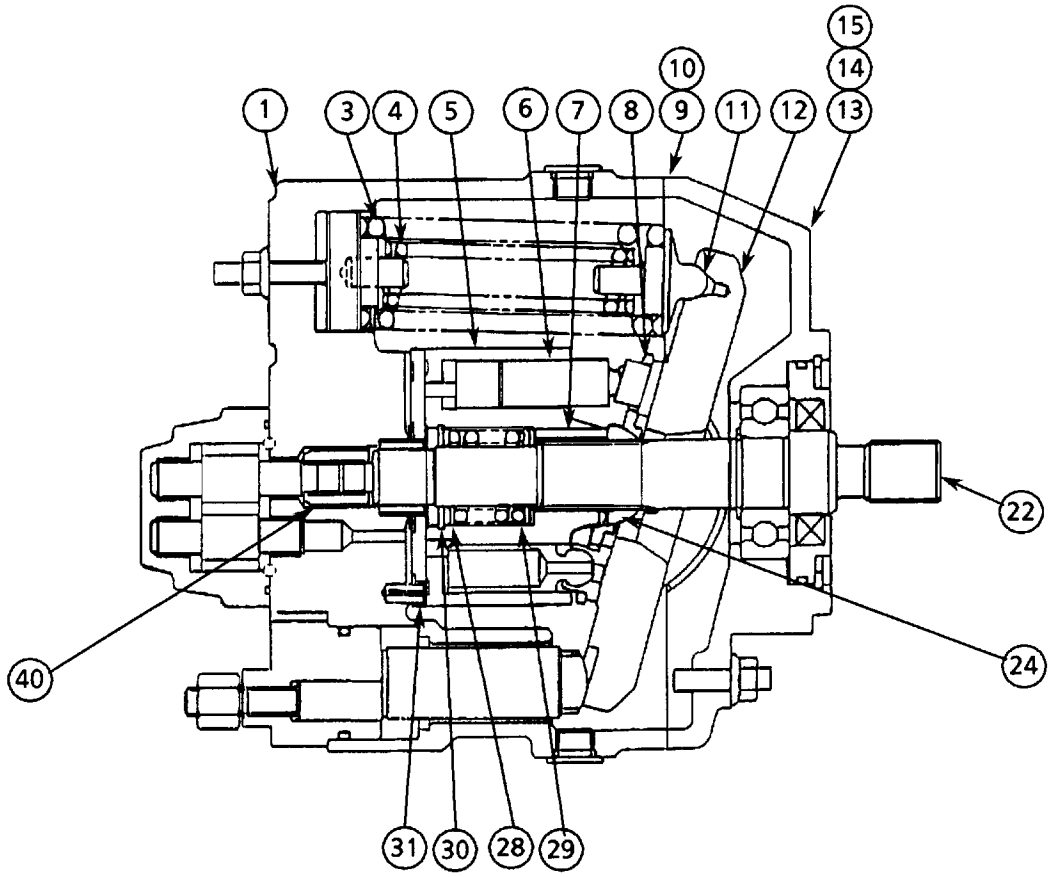
17. Install joint (40) on shaft (22).

18. Assemble housing H (1) and housing S (13) while aligning the matching marks on both housings together with shaft (22) assembly. Tighten socket bolts (14) with spring washers (15) to specification.

: 8 mm

: 54 to 64 N·m ( 5.5 to 6.5 kgf·m )

*NOTE: Evenly tighten socket bolts (14) while lightly pressing housing S (13).*

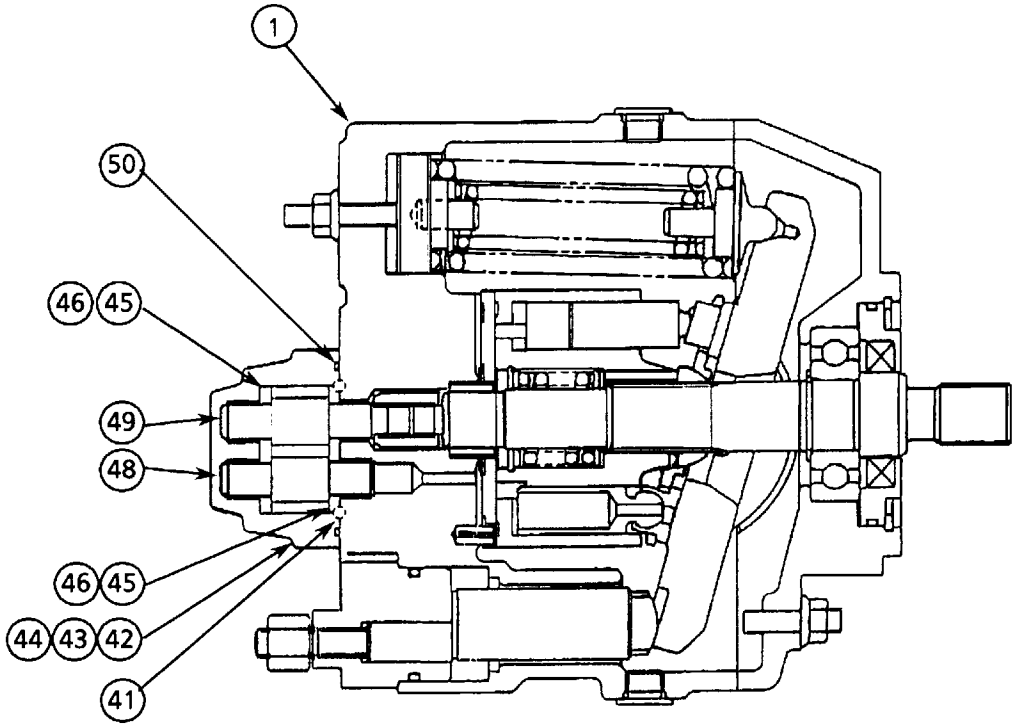



W527-02-03-005

19. Attach gasket (46) to side plate (45). Install side plate (45) in housing (42) bottom.
20. Install gear A (48) and gear B (49) in housing (42).
21. Install side plate (45) and gasket (46) on gear A (48) and gear B (49).
22. Install O-ring (50) on housing (42).
23. Install steel balls (41) on housing H (1).
24. Install housing (42), gear A (48) and gear B (49) assembly on housing H (1). Tighten socket bolts (43) with spring washers (44) to specification.

: 6 mm

: 24 to 27 N·m
( 2.5 to 2.8 kgf·m )

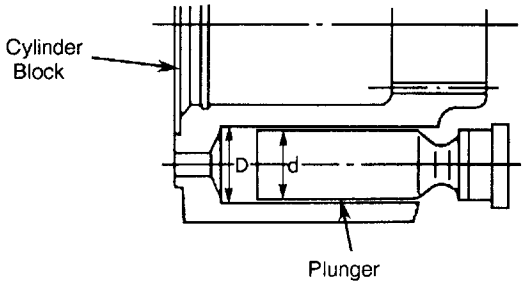



W527-02-03-005

## MAINTENANCE STANDARDS

1. Clearance between cylinder block bore and plunger:

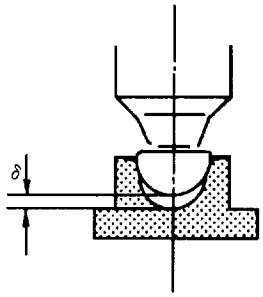
   (D-d) must be 0.050 mm or less.



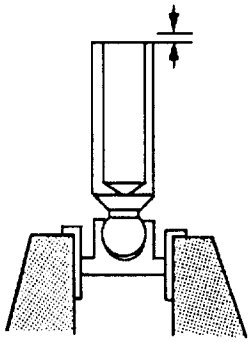

W507-02-04-009

2. Clearance between plunger tip and shoe bottom:

   $\delta$ must be 0.2 mm or less.



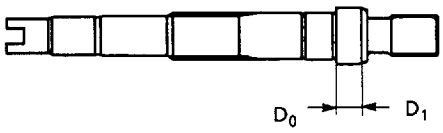

W107-02-06-140



W107-02-06-141

3. Wear amount of the shaft surface where oil seal was mounted:
   The surface must be free from scratches or abnormal wear.

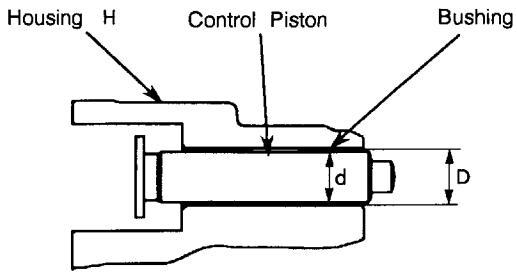
   ($D_0 - D_1$) must be 0.025 mm or less.




W507-02-04-010

4. Clearance between bushing bore and control piston:

   (D–d) must be 0.050 mm or less.

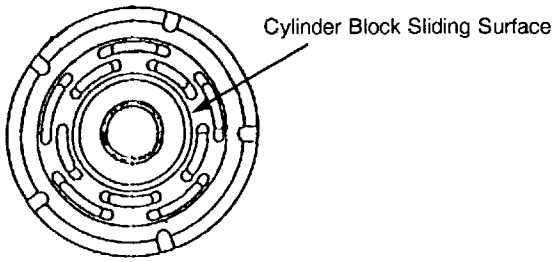



W507-02-04-011

5. Wear amounts on the cylinder block and valve plate sliding surface:

   The surface must be free from abnormal scratches, wear or seizure.

   Scratch depth or wear amount must be 0.030 mm or less.

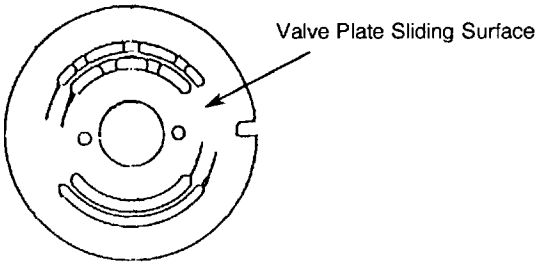



W509-02-04-001

6. Wear amounts on the valve plate and cylinder block sliding surface:

   The surface must be free from abnormal scratches, wear or seizure.

   Scratch depth or wear amount must be 0.030 mm or less.




W509-02-04-002

## REMOVE AND INSTALL CONTROL VALVE

(The illustration shows the 33Mu control valve.)

**CAUTION:**

1. **Hydraulic fluid under pressure can penetrate the skin or eyes causing serious injury. Avoid this hazard by relieving pressure before disconnecting any hydraulic lines.**
2. **Hydraulic oil becomes hot during operation. Disconnecting hydraulic lines soon after operation can result in severe burns. Wait for the oil and components to cool before removing any parts.**

**Preparation:**

1. Place the machine on a solid, level surface, and lower the bucket to the ground.
2. Stop the engine. Operate the control levers several times to release any residual pressure in the hydraulic lines. Slowly loosen the hydraulic oil tank cap to release any pressure in the hydraulic oil tank.
3. Remove the cap. Install a vacuum pump on the hydraulic oil tank. Operate the vacuum pump to create negative pressure in the tank.

*NOTE: Keep the vacuum pump running continuously while working on the system.*

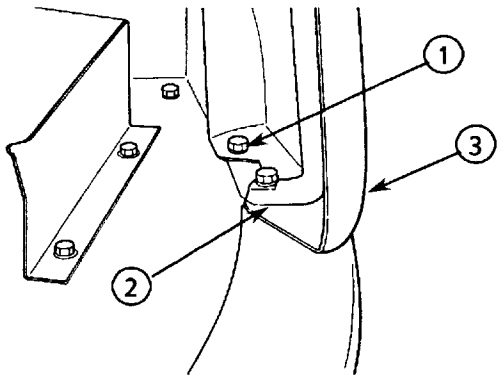
**Remove Control Valve**

1. Remove the pilot valve. (Refer to "REMOVE AND INSTALL PILOT VALVE")

2. Loosen bolts (1) to remove stay (2) and cover (3).

: 17 mm

: 6 mm



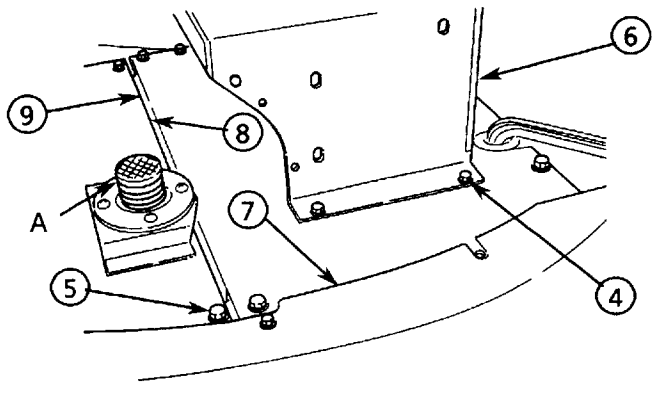

W532-02-04-005

3. Loosen bolts (4, 5) to remove seat base (6), cover (7) and floor plates (8, 9).

: 13 mm

: 17 mm

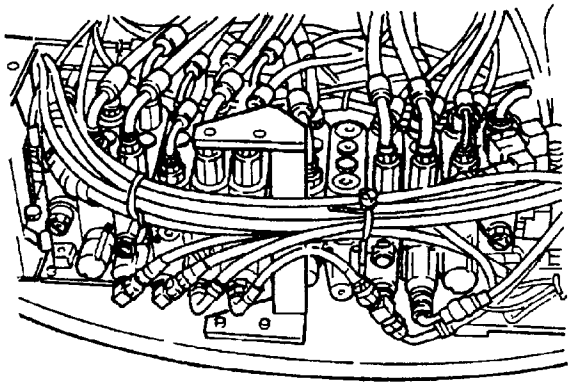
*NOTE: Disconnect harness from travel speed change pedal(A).*




W532-02-04-006

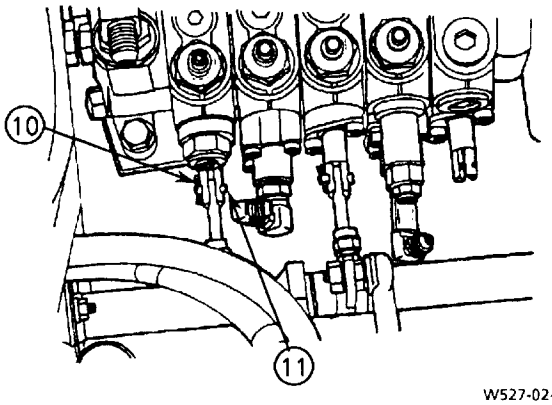
4. Disconnect all hoses from the control valve. Place a cap on the end of each hose.

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



W532-02-04-007

5. Remove split pin (10), then remove joint pin (11) from the travel and blade spools.

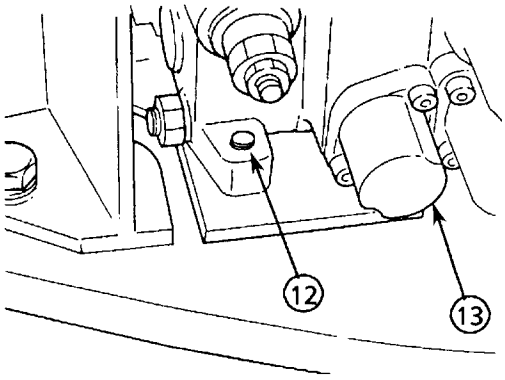



W527-02-04-012

6. Remove bolts (12). Attach control valve (13) to a crane to remove it.

: 17 mm

**CAUTION: Control valve weight:**
**41 kg ( 33Mu, 58Mu )**



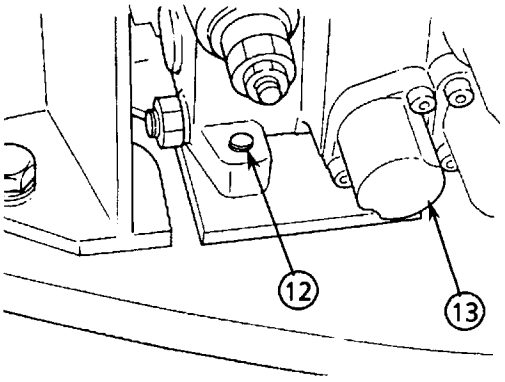

W532-02-04-008

### Install Control Valve

1. Install control valve (13) on the frame with a crane. Tighten bolts (12).

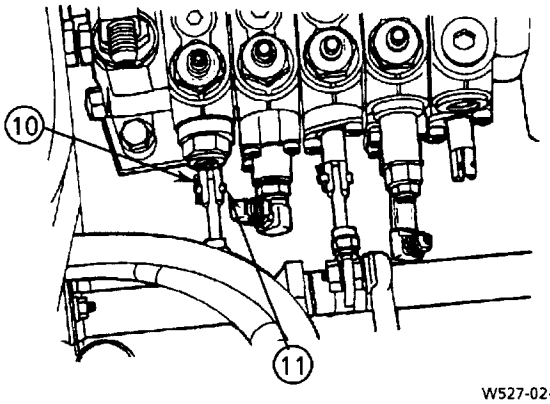
: 17 mm

: 49 N·m ( 5 kgf·m )




W532-02-04-008

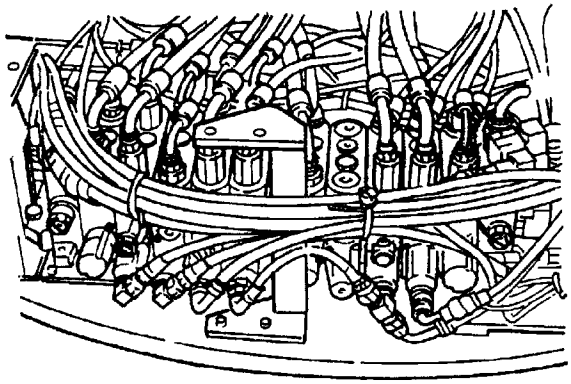
2. Insert joint pins (11) into the travel and blade spools and install a split pin (10) onto each joint pin.




W527-02-04-012

3. Connect all hoses to the control valve.

: 19 mm, : 29 N·m ( 3 kgf·m )
: 22 mm, : 39 N·m ( 4 kgf·m )
: 27 mm, : 64 N·m ( 6.5 kgf·m )
: 36 mm, : 175 N·m ( 18 kgf·m )



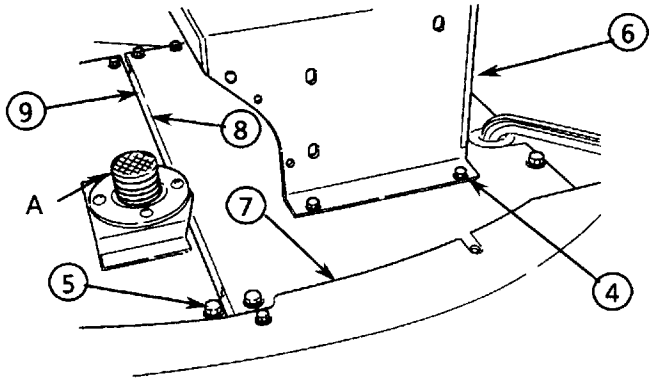
W532-02-04-007

4. Install floor plates (9, 8), cover (7) and seat base (6), and tighten bolts (5, 4).

: 13 mm, : 9.8 N·m ( 1 kgf·m )

: 17 mm, : 49 N·m ( 5 kgf·m )

*NOTE: Connect harness to travel speed change pedal (A).*

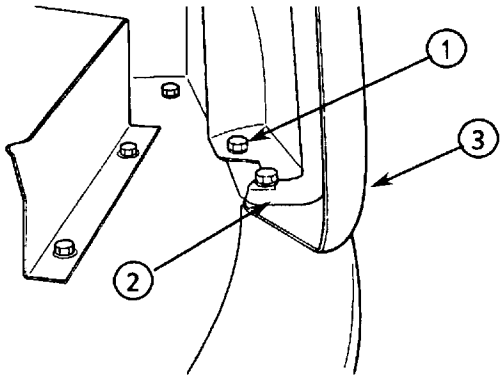



W532-02-04-006

5. Install cover (3) and stay (2), and tighten bolts (1).

: 13 mm, : 9.8 N·m ( 1 kgf·m )

: 6 mm, : 9.8 N·m ( 1 kgf·m )



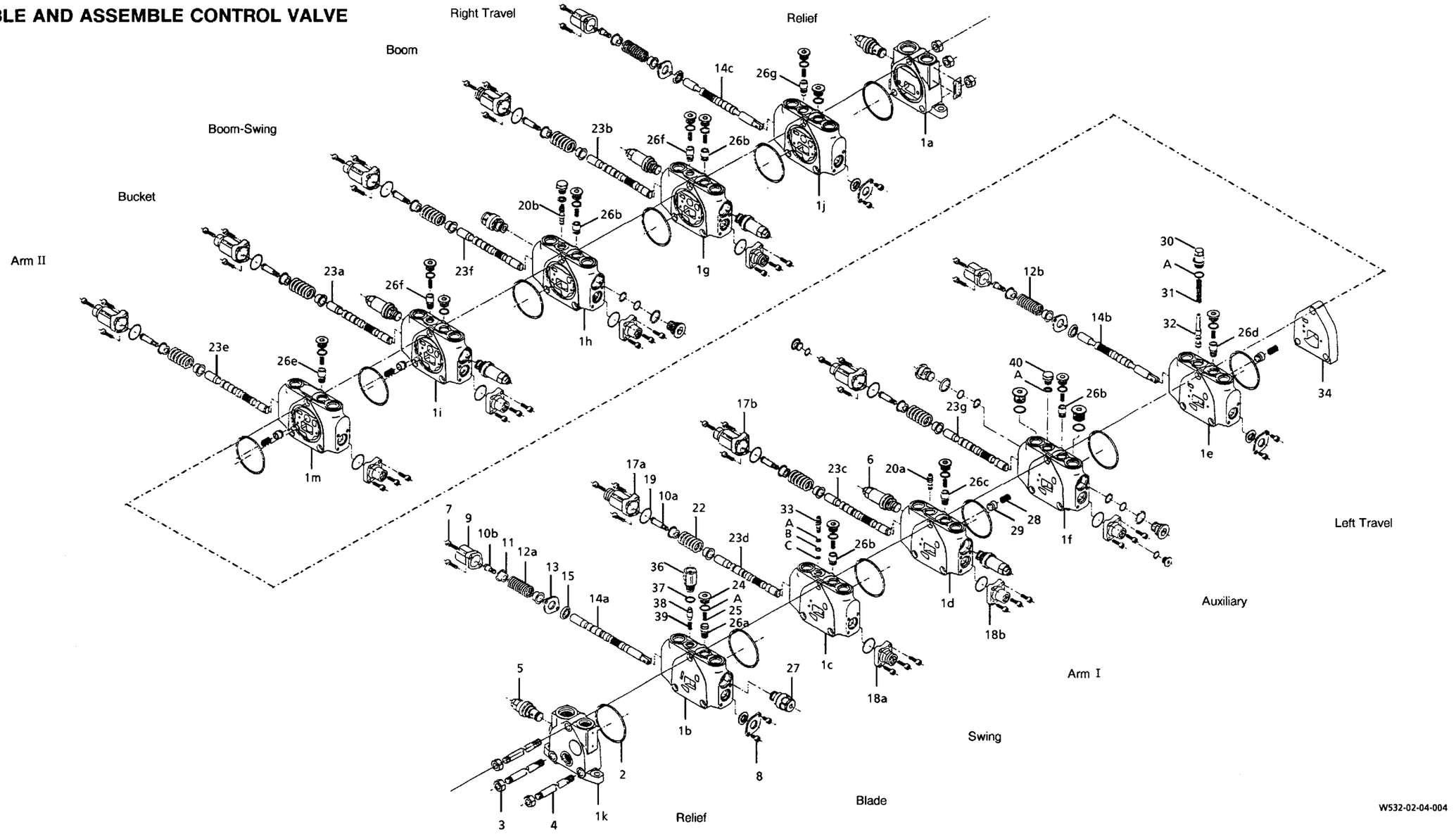

W532-02-04-005

6. Install the pilot valve. (Refer to "REMOVE AND INSTALL PILOT VALVE")

**IMPORTANT: After connecting the hoses, check the hydraulic oil level. Start the engine and check the hoses for leakage.**

## DISASSEMBLE AND ASSEMBLE CONTROL VALVE

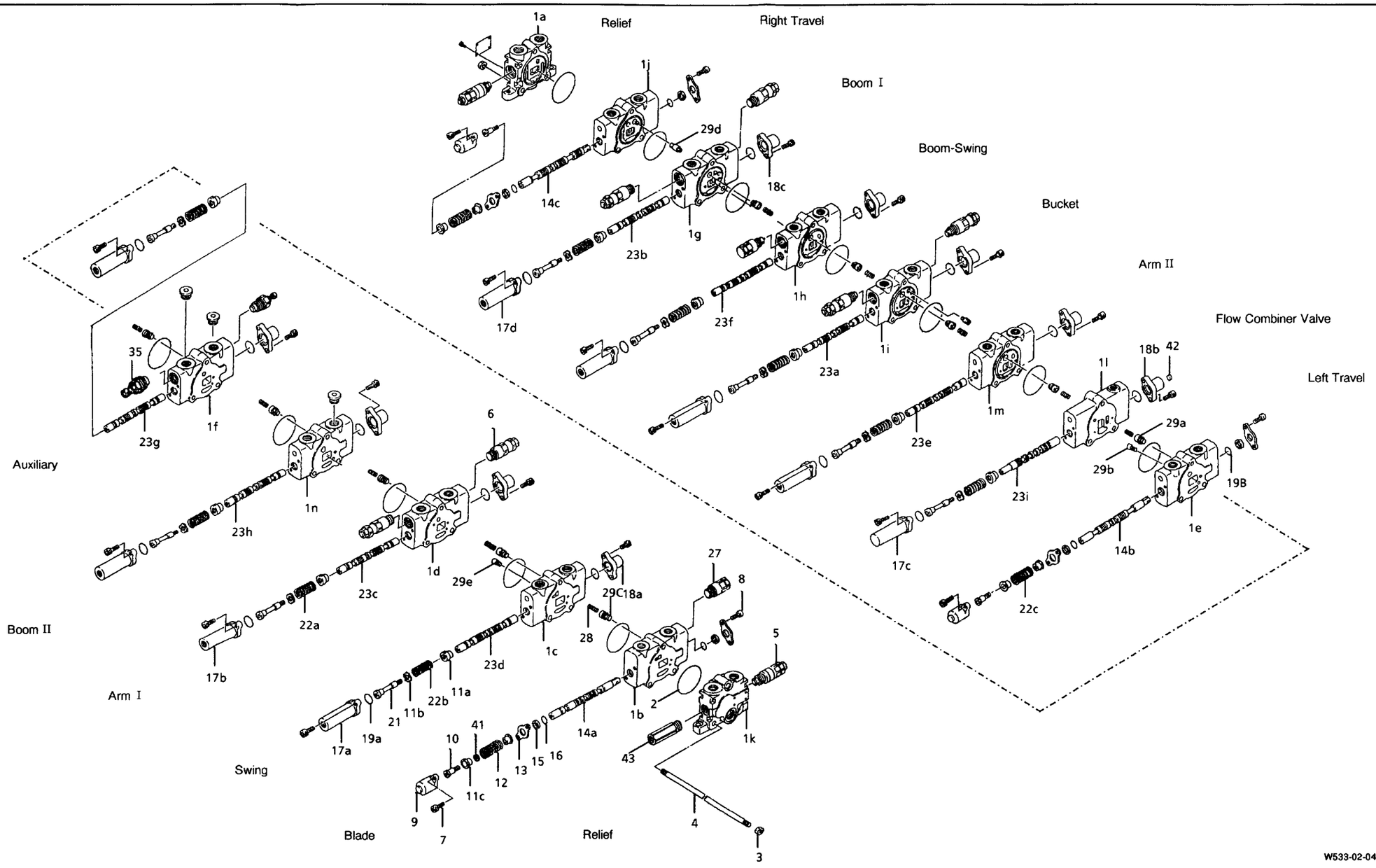
**33Mu**




W532-02-04-004

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1a— Housing (Relief) | 1j— Housing (Right Travel) | 8— Socket Bolt (6 used) | 14b— Spool (Left Travel) | 22— Spring (7 used) | A— O-Ring (12 used) | 27— Make-Up Valve (2 used) | B— O-Ring |
| 1b— Housing (Blade) | 1k— Housing (Relief) | 9— Cover (3 used) | 14c— Spool (Right Travel) | 23a— Spool (Bucket) | 25— Spring (11 used) | 28— Spring (4 used) | C— O-Ring |
| 1c— Housing (Swing) | 1m— Housing (Arm II) | 10a— Socket Bolt (7 used) | 15— Oil Seal (6 used) | 23b— Spool (Boom) | 26a— Check Valve (2 used) | 29— Ceck Valve (4 used) | 34— Plate |
| 1d— Housing (Arm I) | 2— O-Ring (12 used) | 10b— Socket Bolt (3 used) | 17a— Cover (2 used) | 23c— Spool (Arm I) | 26b— Check Valve (4 used) | 30— Plug | 36— Plug |
| 1e— Housing (Left Travel) | 3— Nut (6 used) | 11— Spring Seat (20 used) | 17b— Cover (5 used) | 23d— Spool (Swing) | 26c— Check Valve | A— O-Ring | 37— O-Ring |
| 1f— Housing (Auxiliary) Auxiliary | 4— Rod (3 used) | 12a— Spring (3 used) | 18a— Cover (2 used) 18b— Cover (5 used) | 23e— Spool (Arm II) | 26d— Check Valve | 31— Spring | 38— Valve |
| 1g— Housing (Boom) | 5— Main Relief Valve (2 used) | 12b— Spring | 19— O-Ring (14 used) | 23f— Spool (Swing) | 26e— Check Valve | 32— Spool | 39— Spring |
| 1h— Housing (Boom Swing) | 6— Overload Relief Valve (6 used) | 13— Plate (6 used) | 20a— Bushing | 23g— Spool (Auxiliary) | 26f— Check Valve (2 used) | 33— Orifice | 40— Plug |
| 1i— Housing (Bucket) | 7— Socket Bolt (48 used) | 14a— Spool (Blade) | 20b— Bushing | 24— Plug (12 used) | 26g— Check Valve | A— Backup Ring | A—O-Ring |

58Mu




W533-02-04-002

1a— Housing (Relief)
1b— Housing (Blade)
1c— Housing (Swing)
1d— Housing (Arm I)
1e— Housing (Left Travel)
1f— Housing (Auxiliary)
1g— Housing (Boom I)
1h— Housing (Boom Swing)
1i— Housing (Bucket)
1j— Housing (Right Travel)
1k— Housing (Relief)
1l— Housing (Flow Combiner Valve)
1m— Housing (Arm II)
1n— Housing (Boom II)
2— O-Ring (13 used)
3— Nut (6 used)
4— Rod (3 used)
5— Main Relief Valve (2 used)
6— Overload Relief Valve (6 used)
7— Socket Bolt (42 used)
8— Screw (6 used)
9— Cover (3 used)
10— Socket Bolt (3 used)
11a— Spring Seat (9 used)
11b— Spring Seat (9 used)
11c— Spring Seat (6 used)
12— Spring (3 used)
13— Plate (6 used)
14a— Spool (Blade)
14b— Spool (Left Travel)
14c— Spool (Right Travel)
15— Wiper (6 used)
16— O-Ring (6 used)
17a— Cover
17b— Cover (6 used)
17c— Cover
17d— Cover
18a— Cover (7 used)
18b— Cover
18c— Cover
19a— O-Ring (17 used)
19b— O-Ring
21— Spool End (9 used)
22a— Spring (7 used)
22b— Spring
22c— Spring
23a— Spool (Bucket)
23b— Spool (Boom)
23c— Spool (Arm I)
23d— Spool (Swing)
23e— Spool (Arm II)
23f— Spool (Swing)
23g— Spool(Auxilliary)
23h— Spool(Boom II)
23i— Spool (Flow Combiner Valve)
27— Make-Up Valve (2 used)
28— Spring (10 used)
29a— Poppet (9 used)
29b— Poppet (2 used)
29c— Poppet
29d— Poppet
29e— Poppet
35— Shut-Off Valve
41— Washer
42— Filter
43— Check Valve

### Disassemble Control Valve

Thoroughly clean the valve periphery and place it on a workbench. Keep disassembled parts of each section in order separately.

### Remove Relief Valves and Make-Up Valve

1. Remove main relief valve (5), overload relief valve (6), make-up valve (27) and shut-off valve (35).

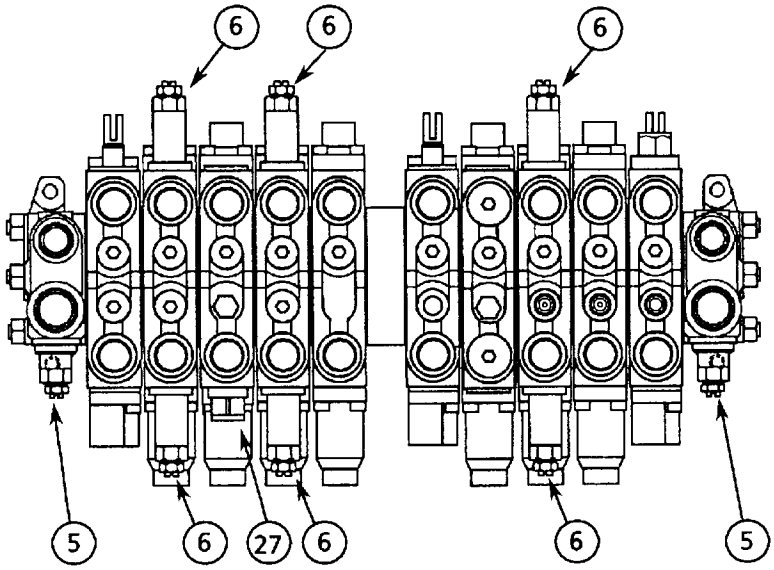
Wrench Size:

Main Relief Valve
: 19 mm (33Mu)
24 mm (58Mu)

Make-up valve
: 24 mm (33Mu)
24 mm (58Mu)

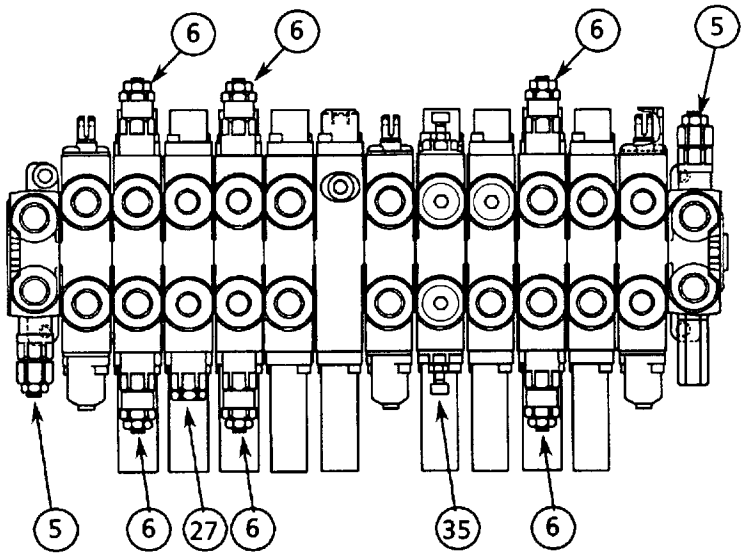
Shut-off valve
: 24 mm (58Mu)

**33Mu**




W532-02-04-001

**58Mu**




W533-02-04-001

5— Main Relief Valve 6— Overload Relief Valve 27— Make-Up Valve 35— Shut-Off Valve

**Disassemble Direct Acting Spool**

**(Right Travel, Left Travel, Blade)**

1. Remove socket bolts (7, 8), cover (9) and plate (13).

*NOTE: In the 58Mu, screw (8) is used in place of socket bolt (8).*

: 5 mm

2. Remove spool (14) together with socket bolt (10), spring seats (11), spring (12) and plate (13).

3. Remove oil seal (15) from housing (1).

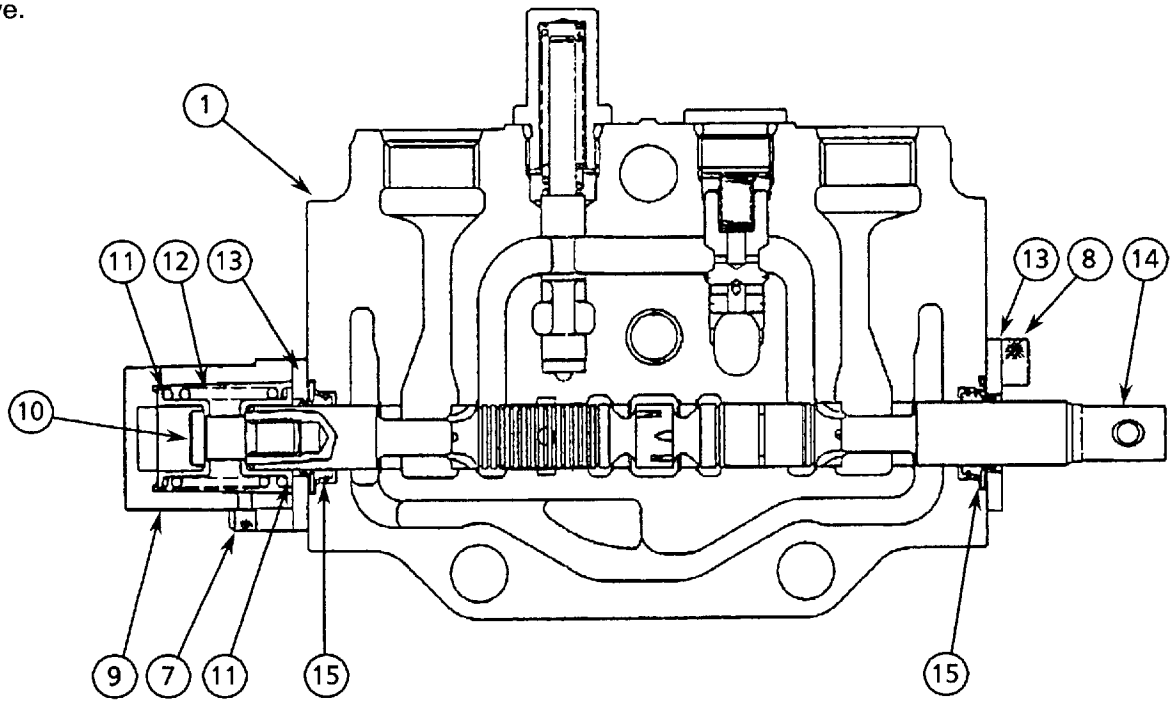
*NOTE: In the 33Mu, remove wiper (15) and O-ring (16).*

**CAUTION: Socket bolt (10) and spring seats (11) may fly off by the force of spring (12) when removing socket bolt (10). Prevent personal injury by holding down spring seats (11) and spring (12) while slowly loosening socket bolt (10).**

4. Attach wood on both sides of spool (14) to protect and clamp spool (14) in a vise. Remove socket bolt (10), two spring seats (11), spring (12) and plate (13) from spool (14).

: 5 mm

The illustration shows the left travel section of the 33Mu control valve.




W532-02-04-002

1— Housing
7— Socket Bolt (2 used)
8— Socket Bolt (2 used)
9— Cover
10— Socket Bolt
11— Spring Seat (2 used)
12— Spring
13— Plate
14— Spool
15— Oil Seal (2 used)

**Disassemble Pilot Operated Spool**

**〔 Boom I, Boom Swing, Bucket, Arm II, Auxiliary, Arm I, Swing 〕**
**(Flow Combiner Valve [58Mu], Boom II [58Mu])**

1. Remove socket bolts (7), covers (17, 18) and O-rings (19).

   : 5 mm

2. Remove spool (23) together with socket bolt (10), spring seats (11) and spring (22).

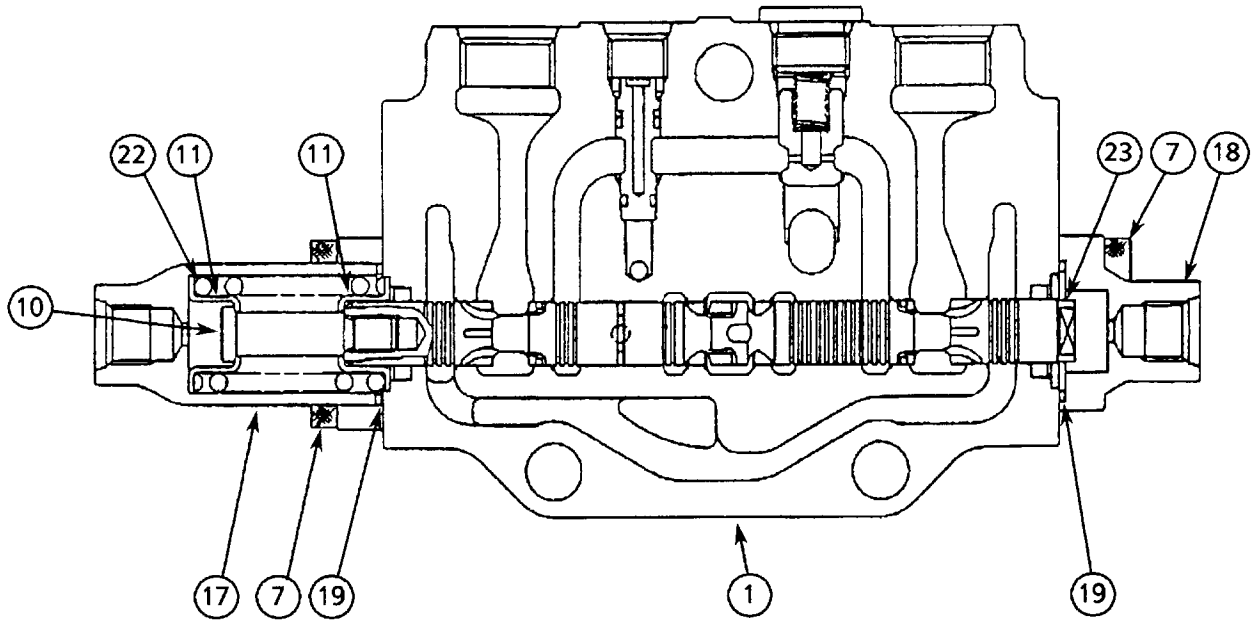
*NOTE: In the 58Mu, spool end (21) is used in place of socket bolt (10).*

3. Attach wood on both sides of spool (23) to protect and clamp spool (23) in a vise. Remove socket bolt (10), two spring seats (11), spring (12) and plate (13) from spool (23).

   : 5 mm

**CAUTION: Socket bolt (10) and spring seats (11) may fly off by spring (22) when removing socket bolt (10). Prevent personal injury by holding down spring seats (11) and spring (22) while slowly loosening socket bolt (10).**

The illustration shows the swing section of the 33Mu control valve.




W527-02-04-014

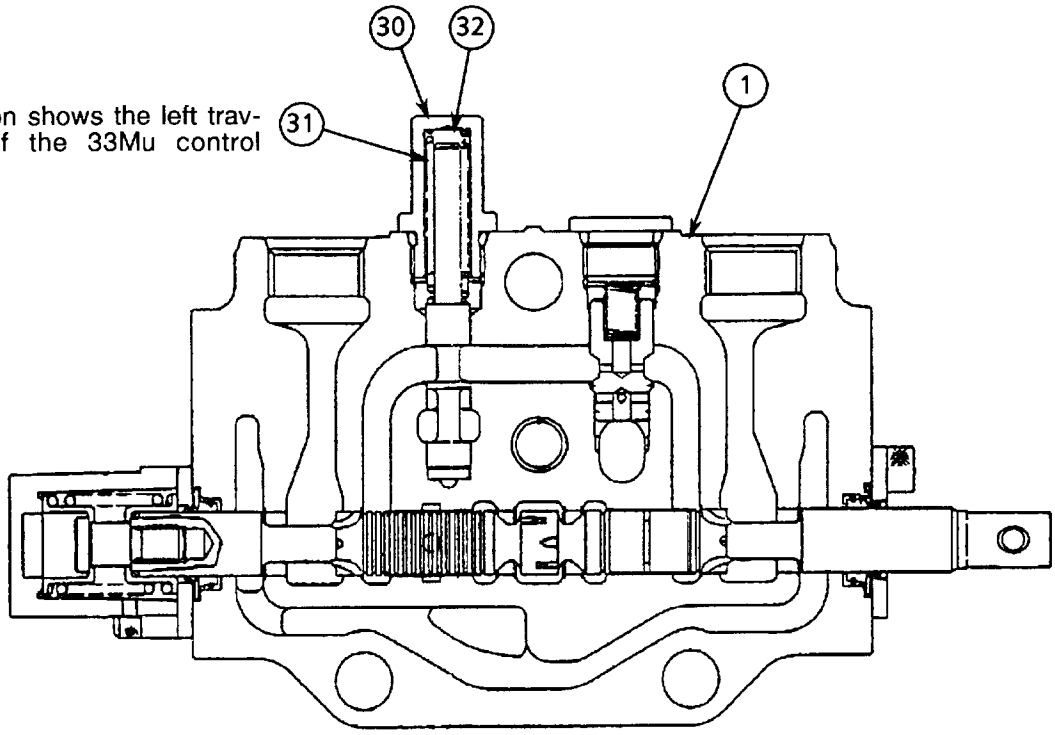
1— Housing
7— Socket Bolt (4 used)
10— Socket Bolt
11— Spring Seat(2 used)
17— Cover
18— Cover
19— O-ring (2 used)
22— Spring
23— Spool

**Disassemble Flow Combiner Valve (33Mu)**

1. Remove plug (30), spring (31) and spool (32) from housing (1).

   ⌐ : 14 mm

The illustration shows the left travel section of the 33Mu control valve.




W532-02-04-002

1— Housing 30— Plug 31— Spring 32— Spool

### Disassemble Housing

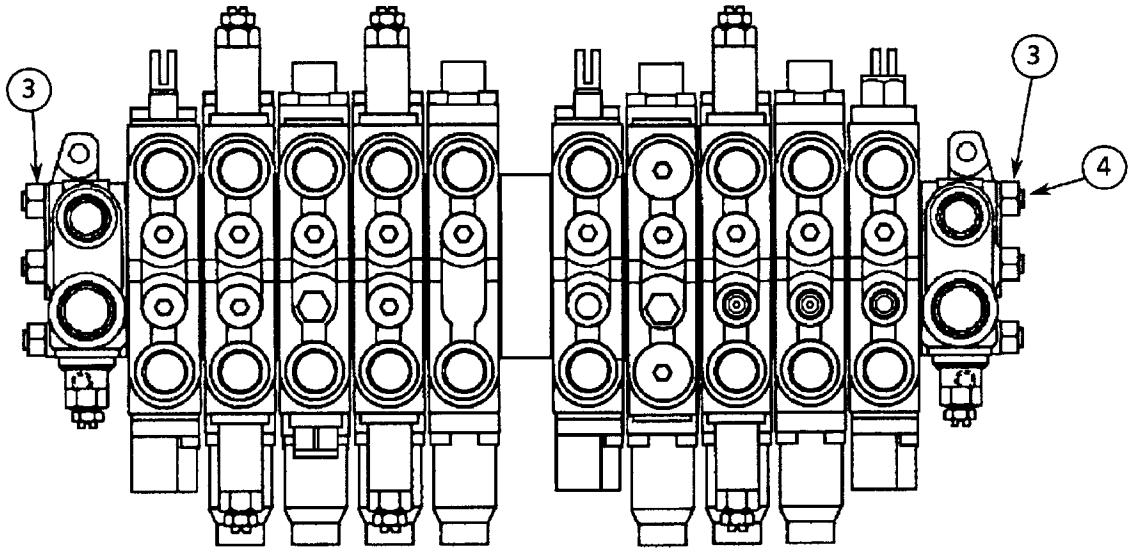
1. Remove nuts (3) and rods (4). Disassemble housing (1) of each section.

: 17 mm (33Mu)
14 mm (58Mu)

2. Remove O-ring (2), spring (28) and check valve (29) from housing (1).

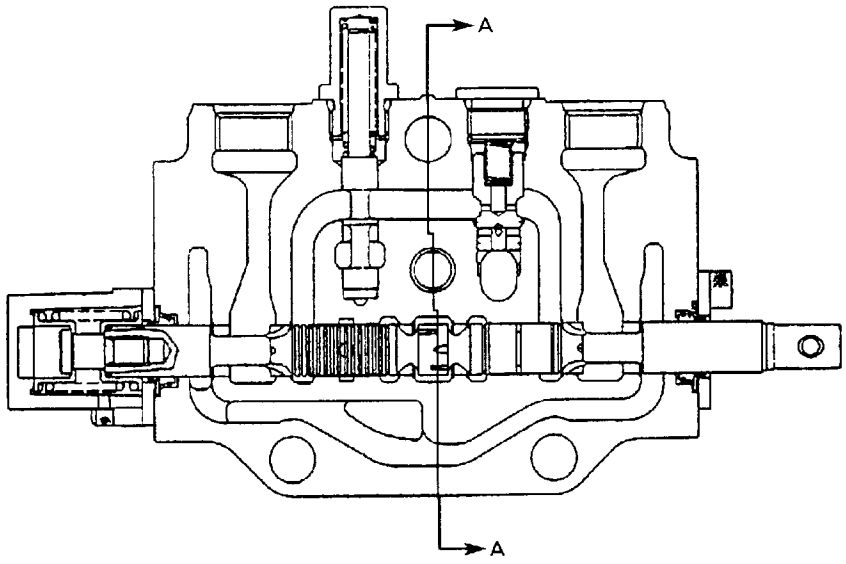
*NOTE: In the 58Mu, poppet (29) is used in place of check valve (29)*

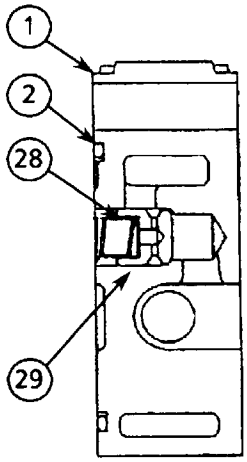
The illustration shows the 33Mu control valve.




W532-02-04-001

The illustration shows the travel left section of the 33Mu control valve.




Section A-A

W532-02-04-03

W527-02-04-017

1— Housing
2— O-Ring
3— Nut
4— Rod
28— Spring
29— Check Valve

### Assemble Control Valve

Before reassembling, clean components and parts with cleaning oil and dry them completely. Apply a film of clean hydraulic oil to inner parts, sliding parts in particular, before assembling in order to prevent seizures.
After disassembling, always replace used O-rings and oil seals with new ones.

### Assemble Housing

1. Install check valve (29) and spring (28) into housing (1) of each section. Install O-ring (2) onto housing (1).

*NOTE: In the 58Mu, poppet (29) is used in place of check valve (29).*

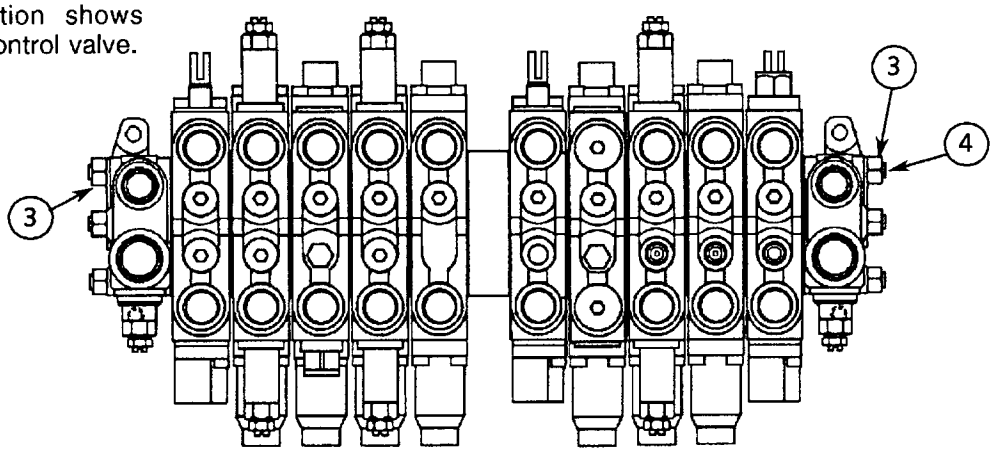
2. Align housing (1) of each section in the same order as they were before disassembling. Insert rods (4) and tighten nuts (3).

**IMPORTANT: Apply Loctite #271 to the threads of rods (4).**

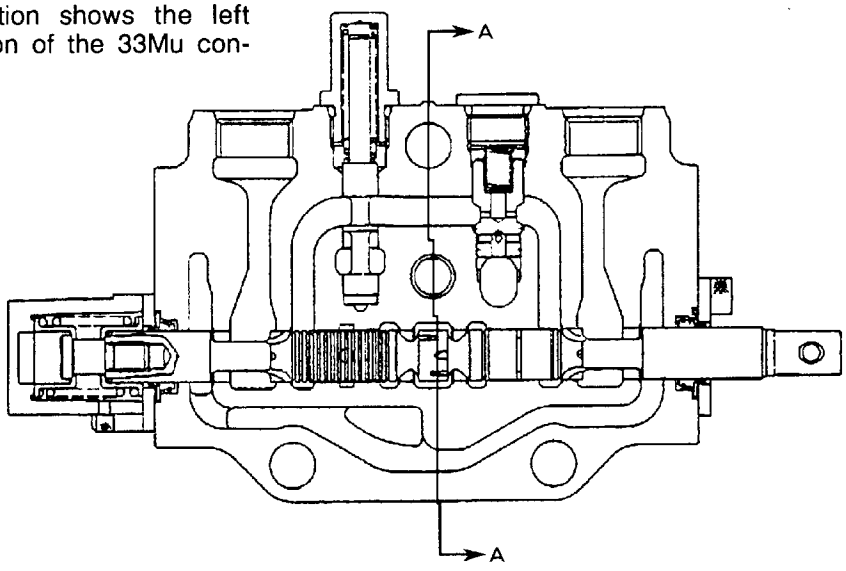
: 17 mm ( 33Mu )
14 mm ( 58Mu )

: $59^{+5}$ N·m ( $6^{+0.5}$ kgf·m )
$46 \pm 2$ N·m ( $4.7 \pm 0.2$ kgf·m )

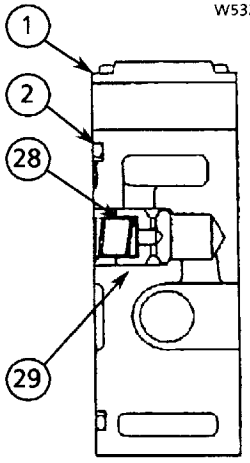
The illustration shows the 33Mu control valve.




The illustration shows the left travel section of the 33Mu control valve.




W532-02-04-001




Section A-A

W532-02-04-003

W527-02-04-017

1— Housing
2— O-Ring
3— Nut
4— Rod
28— Spring
29— Check Valve

**Assemble Direct Acting Spool**

**(Right Travel, Left Travel, Blade)**

1. Attach wood on both sides of spool (14) to protect and clamp spool (14) in a vise. Install plate (13), spring(12) and two spring seats (21), and tighten socket bolt (10).

: 5 mm

: 9.8$^{+3}$ N·m ( 1$^{+0.3}$ kgf·m ) ( 33Mu )
19 to 22 N·m (1.9 to 2.2 kgf·m) (58Mu)

**IMPORTANT: Apply Loctite #271 to the threads of socket bolt (10).**

2. Install oil seals (15) into housing (1).

*NOTE: In the 33Mu, install wiper (15) and O-ring (16).*

3. Install spool (14) assembly into housing (1).

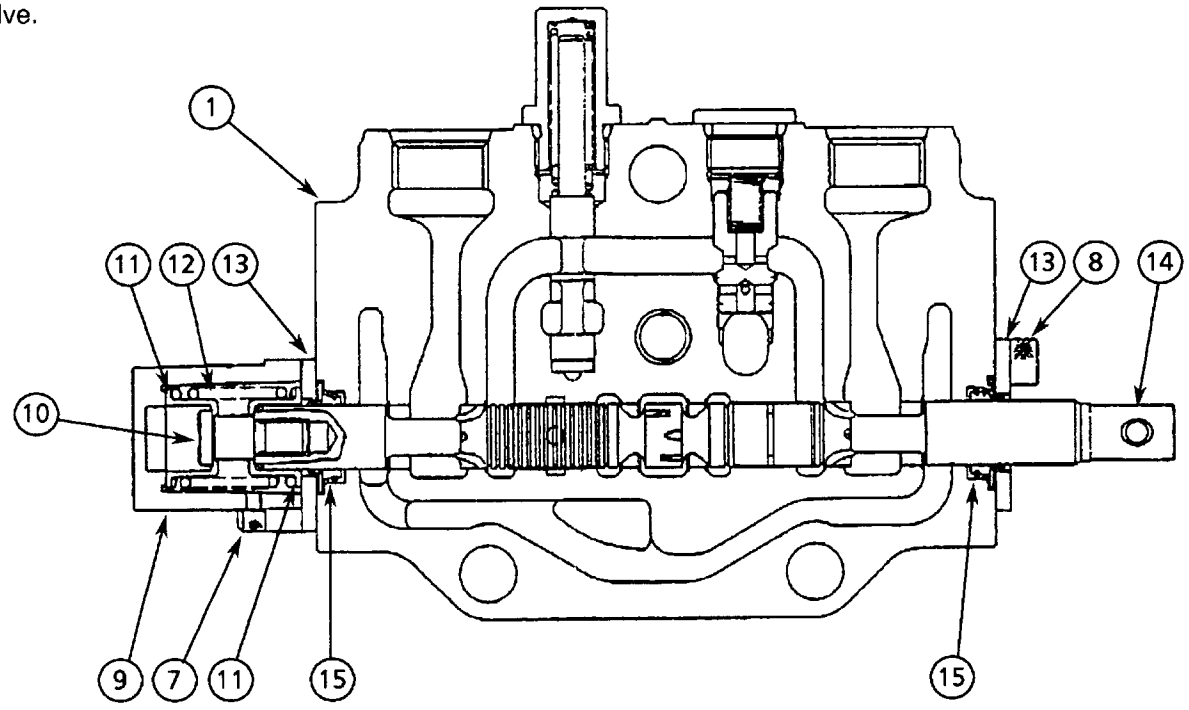
4. Install cover (9) and plates (13) on housing (1) and tighten socket bolts (7, 8).

*NOTE: In the 58Mu, screw (8) is used in place of socket bolt (8).*

: 5 mm

: 9.8$^{+3}$ N·m ( 1$^{+0.3}$ kgf·m ) ( 33Mu )
8.8 to 10.8 N·m (0.8 to 1.1 kgf·m) (58Mu)

The illustration shows the left travel section of the 33Mu control valve.




W532-02-04-002

1— Housing
7— Socket Bolt (2 used)
8— Socket Bolt (2 used)
9— Cover
10— Socket Bolt
11— Spring Seat (2 used)
12— Spring
13— Plate
14— Spool
15— Oil Seal (2 used)

**Assemble Pilot Operated Spool**

**(Boom I, Boom Swing, Bucket, Arm II, Auxiliary, Arm I, Swing)**
**(Flow Combiner Valve[58Mu], Boom II [58Mu])**

1. Attach wood on both sides of spool (23) to protect and clamp spool (23) in a vise. Install spring (22) and spring seats (21), and tighten socket bolt (10).

**IMPORTANT: Apply Loctite #271 to the threads of socket bolt (10).**

*NOTE: In the 58Mu, spool end (21) is used in place of socket bolt(10).*

: 5 mm

: 9.8$^{+3}$ N·m ( 1$^{+0.3}$ kgf·m ) (33Mu)
6.4 to 7.6 N·m (0.64 to 0.74 kgf·m) (58Mu)

2. Install spool (23) assembly into housing (1).

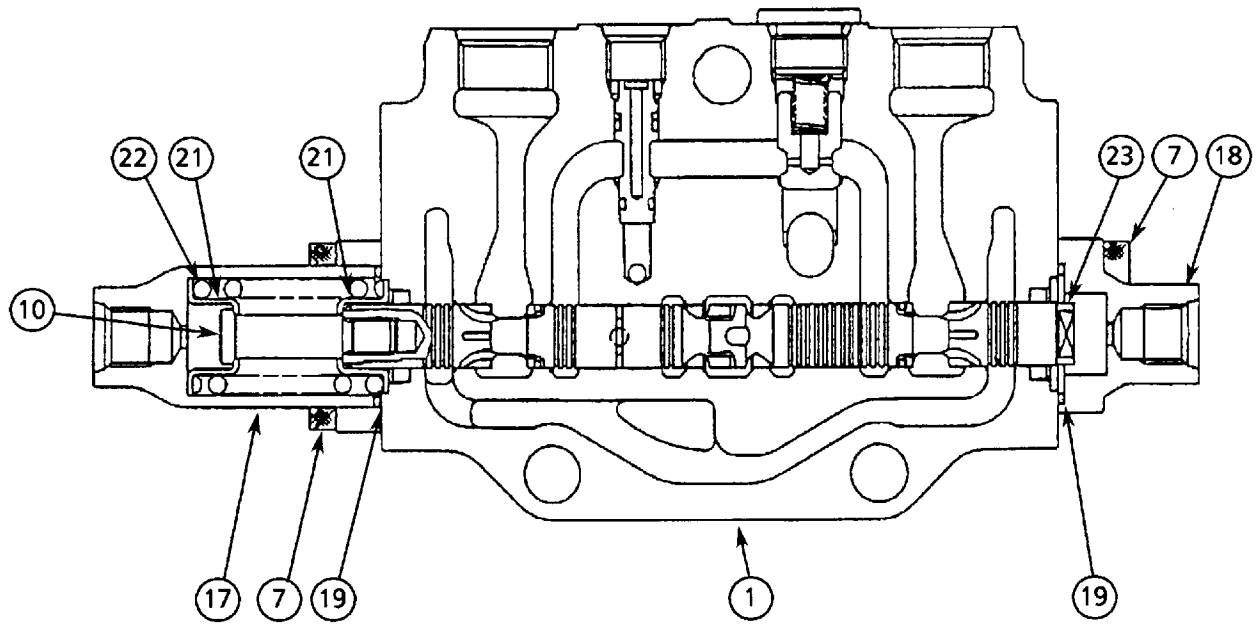
3. Install O-rings (19) onto covers (17, 18). Install covers (17, 18) on housing (1).

**IMPORTANT: Confirm that filter (42) is installed in cover(18) for the 58Mu flow combiner valve section.**

: 5 mm

: 9.8$^{+3}$ N·m ( 1$^{+0.3}$ kgf·m ) ( 33Mu )
8.8 to 10.8 N·m (0.9 to 1.1 kgf·m) (58Mu)

The illustration shows the swing section of the 33Mu control valve.




W527-02-04-014

1— Housing
7— Socket Bolt (4 used)
10— Socket Bolt
17— Cover
18— Cover
19— O-Ring (2 used)
21— Spring Seat (2 used)
22— Spring
23— Spool

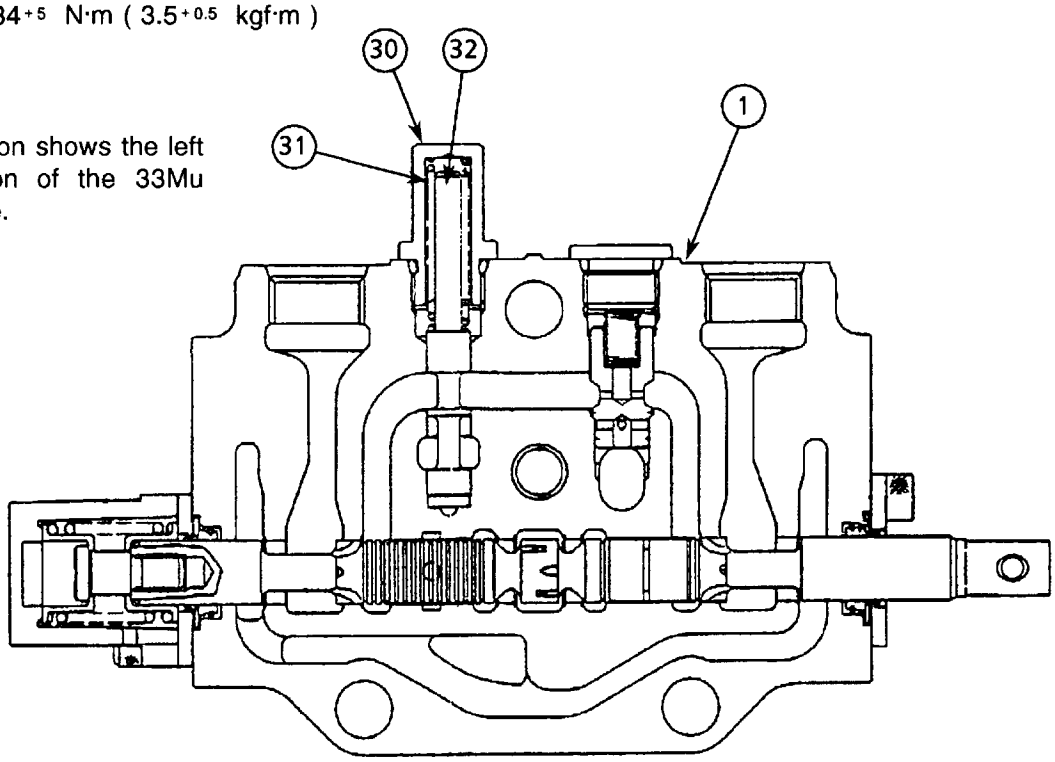
**Assemble Flow Combiner Valve (33Mu)**

1. Install spool (32) and spring (31) onto housing (1), and tighten plug (30).

: 14 mm

: $34^{+5}$ N·m ( $3.5^{+0.5}$ kgf·m )

The illustration shows the left travel section of the 33Mu control valve.




W532-02-04-002

1— Housing 30— Plug 31— Spring 32— Spool

### Install Relief Valves and Make-up Valve

1. Install main relief valves (5), overload relief valves (6), make-up valve (27) and shut-off valve (35) onto the housing.

Wrench Size and Tightening Torque Specifications:
Main Relief Valve
Overload relief valve
: 19 mm (33Mu)
24 mm (58Mu)

: 34 + 5 N·m (3.5 + 0.5 kgf·m)
69 to 78 N·m (7 to 8 kgf·m)

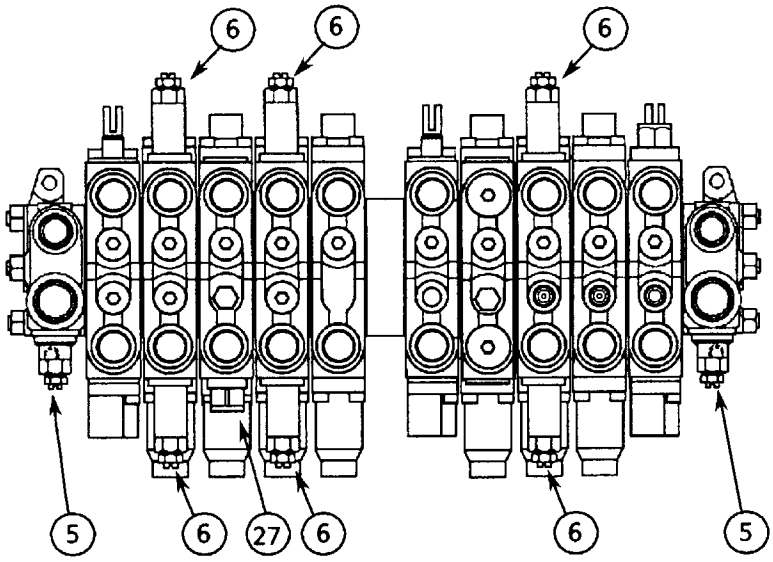
Make-up valve
: 24 mm (33Mu)
24 mm (58Mu)

: 20 + 4 N·m (2 + 0.4 kgf·m)
69 to 78 N·m (7 to 8 kgf·m)

Shut-off valve
: 24 mm (58Mu)

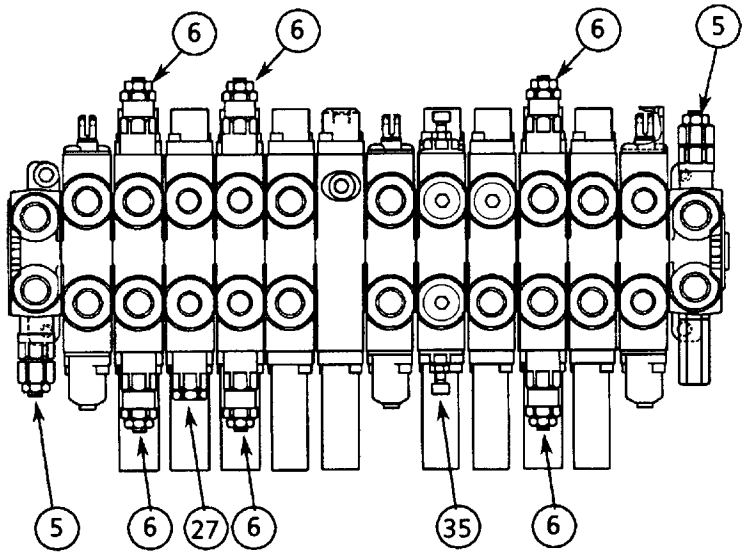
: 69 to 78 N·m (7 to 8 kgf·m)

33Mu




W532-02-04-001

58Mu




W533-02-04-001

5— Main Relief Valve 6— Overload Relief Valve 27— Make-Up Valve 35— Shut-Off Valve

## REMOVE AND INSTALL Swing Device

(The illustration shows the 33Mu)

**CAUTION:**

1. **Hydraulic fluid under pressure can penetrate the skin or eyes causing serious injury. Avoid this hazard by relieving pressure before disconnecting any hydraulic lines.**
2. **Hydraulic oil becomes hot during operation. Disconnecting hydraulic lines soon after operation can result in severe burns. Wait for the oil and components to cool before removing any parts.**

**Preparation:**

1. Place the machine on a solid, level surface, and lower the bucket to the ground.
2. Stop the engine. Operate the control levers several times to release any residual pressure in the hydraulic lines. Slowly loosen the hydraulic oil tank cap to release any pressure in the hydraulic oil tank.
3. Remove the cap. Install a vacuum pump on the hydraulic oil tank. Operate the vacuum pump to create negative pressure in the tank.

*NOTE: Keep the vacuum pump running continuously while working on the system.*

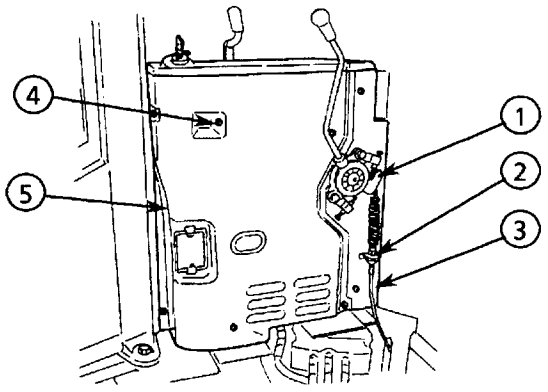
Remove Swing Device

1. Remove the pilot valve, stay, seat base, cover and floor plates.(Refer to "REMOVE AND INSTALL CONTROL VALVE" on page W02-04-01.)

2. Loosen bolts (1, 2) and disconnect accelerator wire (3).

: 13 mm, 19 mm

3. Loosen bolt (4) and remove cover (5).

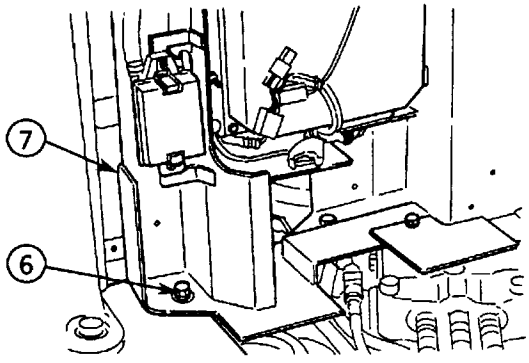



W532-02-05-001

4. Loosen bolt (6) and the socket bolt on the cover front. Remove control box (7).

: 17 mm

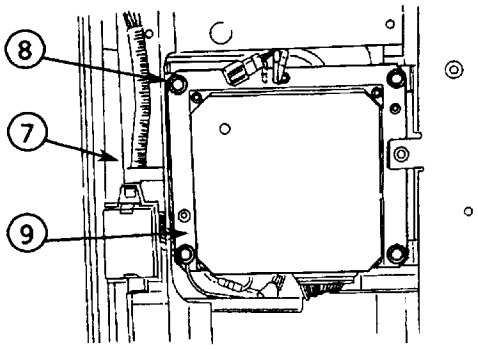
: 13 mm




W532-02-05-002

5. Loosen bolts (8) and remove controller (9). Disconnect all harnesses from control box (7).

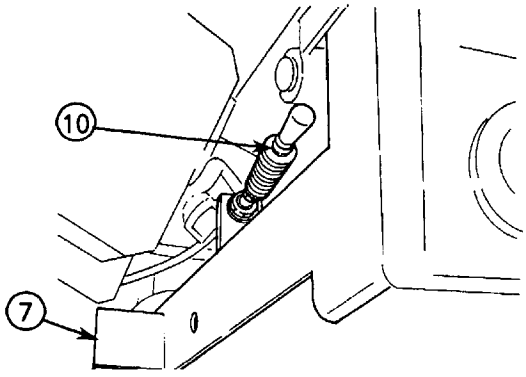
: 13 mm




W532-02-05-003

6. Disconnect blade wire (10) and remove control box (7).

: 10 mm, 17 mm

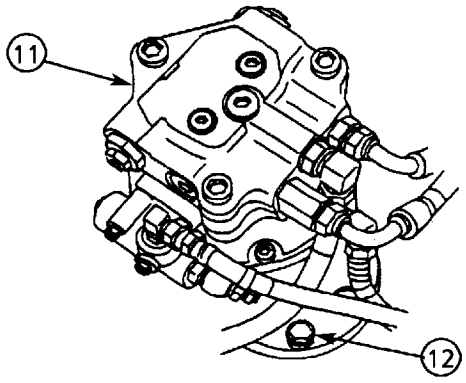



W532-02-05-004

7. Disconnect all hoses from swing device (11). Place a plug on each hose end. Remove six mounting bolts (12) on swing device (11).

: 19 mm ( 33Mu )

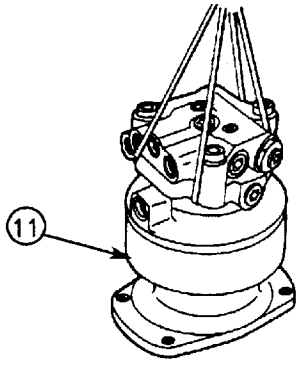
: 24 mm ( 58Mu )




W527-02-05-001

8. Attach swing device (11) to a crane with sling belts. Remove swing device (11) using the crane.

**CAUTION: Swing device weight:**
**33 kg ( 33Mu )**
**55 kg ( 58Mu )**



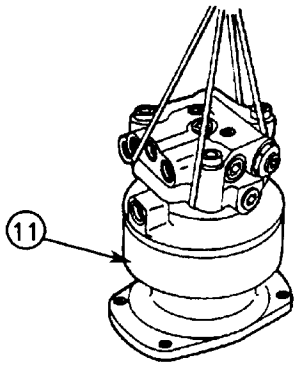

W527-02-05-002

### Install Swing Device

1. Attach swing device (11) to a crane with sling belts. Lower swing device (11) onto the frame so that the matching marks align. Tighten six mounting bolts (12).

: 19 mm, : 88 N·m (9 kgf·m) (33Mu)

: 24 mm, : 265 N·m (27 kgf·m) (58Mu)



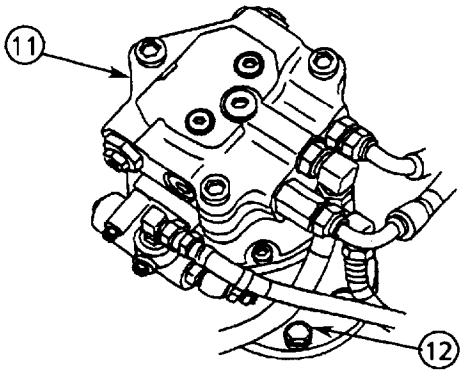

W527-02-05-002

2. Connect all hoses to the swing device.

: 19 mm, : 29 N·m ( 3 kgf·m )

: 22 mm, : 39 N·m ( 4 kgf·m )

**IMPORTANT: After connecting the hoses, fill the hydraulic oil tank with oil to the correct level. Start the engine and check the hoses for leakage.**

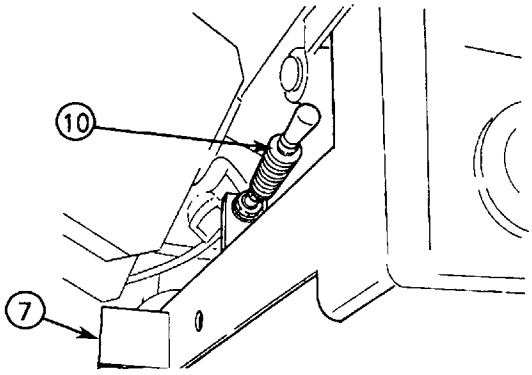



W527-02-05-001

3. Connect blade wire (10) to control box (7).

: 10 mm, : 5 N·m ( 0.5 kgf·m )

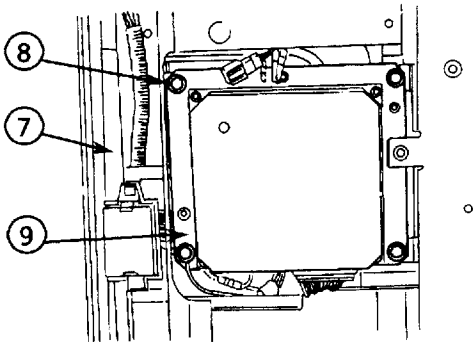
: 17 mm, : 49 N·m ( 5 kgf·m )




W532-02-05-004

4. Install controller (9) and tighten bolts (8). Connect all harnesses.

: 13 mm, : 9.8 N·m ( 1 kgf·m )

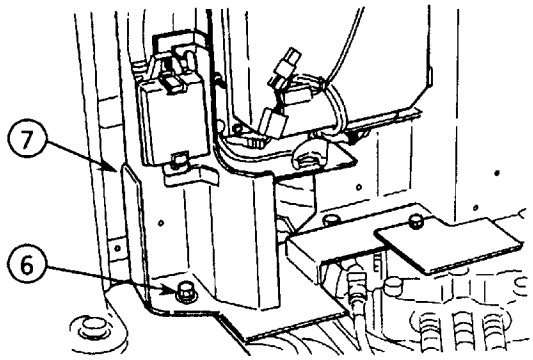



W532-02-05-003

5. Tighten bolt (6) and the socket bolt on the cover front. Install control box (7).

: 4 mm : 5 N·m ( 0.5 kgf·m )

: 17 mm : 49 N·m ( 5 kgf·m )



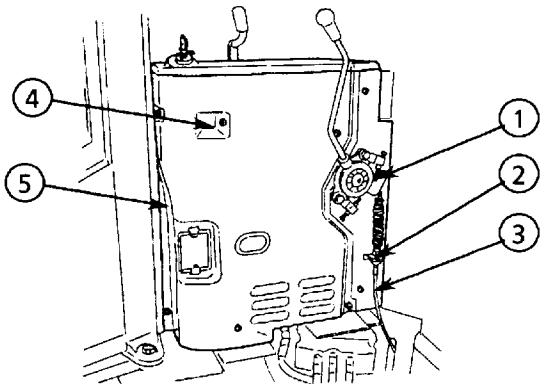

W532-02-05-002

6. Install cover (5) and tighten bolts (4).

7. Connect accelerator wire (3) and tighten bolts (2, 1).

: 13 mm : 9.8 N·m ( 1 kgf·m )

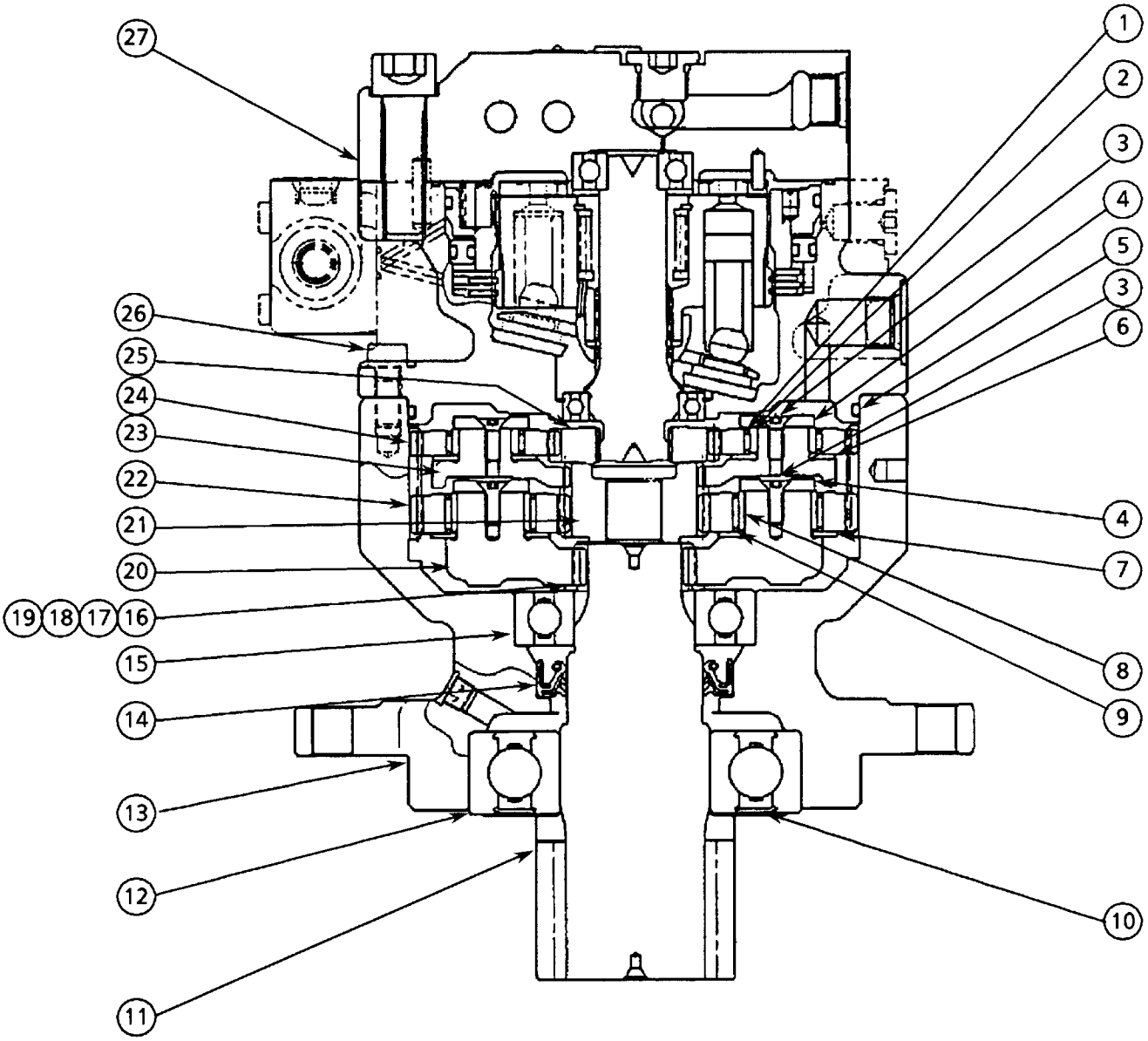
: 19 mm : 49 N·m ( 5 kgf·m )




W532-02-05-001

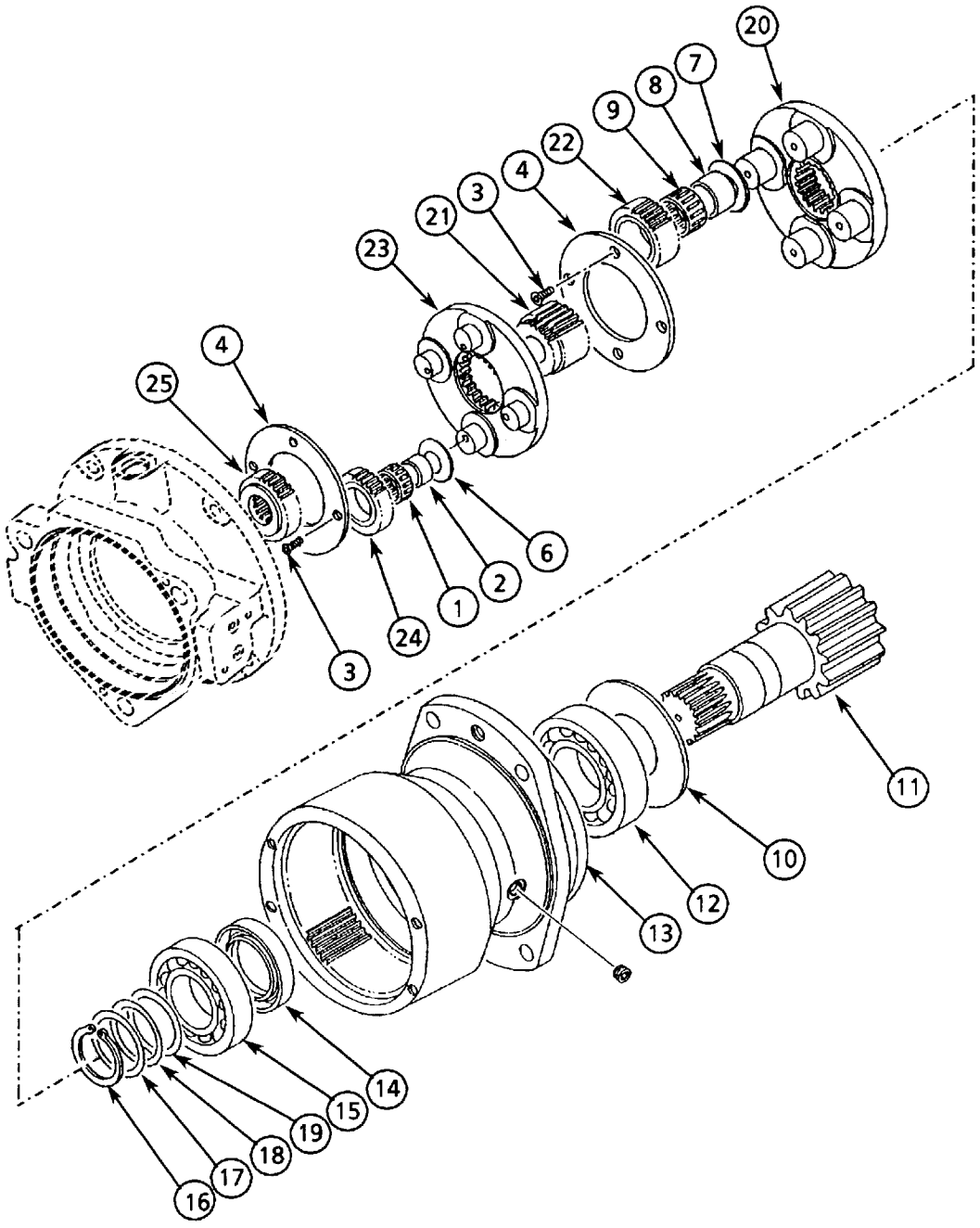
8. Install the pilot valve, stay, seat base, cover and floor plates. (Refer to "REMOVE AND INSTALL CONTROL VALVE" on page W02-04-01.

## DISASSEMBLE AND ASSEMBLE SWING REDUCTION GEAR (33Mu)




T525-02-03-001

1— Needle Bearing (4 used)
2— Inner Race (4 used)
3— Flat Head Bolt (8 used)
4— Thrust Plate (2 used)
5— O-Ring
6— Thrust Washer (4 used)
7— Thrust Washer (4 used)
8— Inner Race (4 used)
9— Needle Bearing (4 used)
10— Plate
11— Shaft
12— Ball Bearing
13— Ring Gear (Case)
14— Oil Seal
15— Ball Bearing
16— Retaining Ring
17— Shim (0.05 mm)
18— Shim (0.1 mm)
19— Shim (0.3 mm)
20— Second Stage Carrier
21— Second Stage Sun Gear
22— Second Stage Planetary Gear (4 used)
23— First Stage Carrier
24— First Stage Planetary Gear (4 used)
25— First Stage Sun Gear
26— Socket Bolt (4 used)
27— Swing Motor




W527-02-05-004

1— Needle Bearing (4 used)
2— Inner Race (4 used)
3— Flat Head Bolt (8 used)
4— Thrust Plate (2 used)
5— O-Ring
6— Thrust Washer (4 used)
7— Thrust Washer (4 used)
8— Inner Race (4 used)
9— Needle Bearing (4 used)
10— Plate
11— Shaft
12— Ball Bearing
13— Ring Gear (Case)
14— Oil Seal
15— Ball Bearing
16— Retaining Ring
17— Shim (0.05 mm)
18— Shim (0.1 mm)
19— Shim (0.3 mm)
20— Second Stage Carrier
21— Second Stage Sun Gear
22— Second Stage Planetary Gear (4 used)
23— First Stage Carrier
24— First Stage Planetary Gear (4 used)
25— First Stage Sun Gear

**Disassemble Swing Reduction Gear (33Mu)**

Thoroughly clean the periphery of the swing device. Before disassembling, make matching marks on the mating surfaces of swing motor (27) and ring gear (13) to aid when reassembling. Do not remove ball bearings (15, 12) unless necessary.

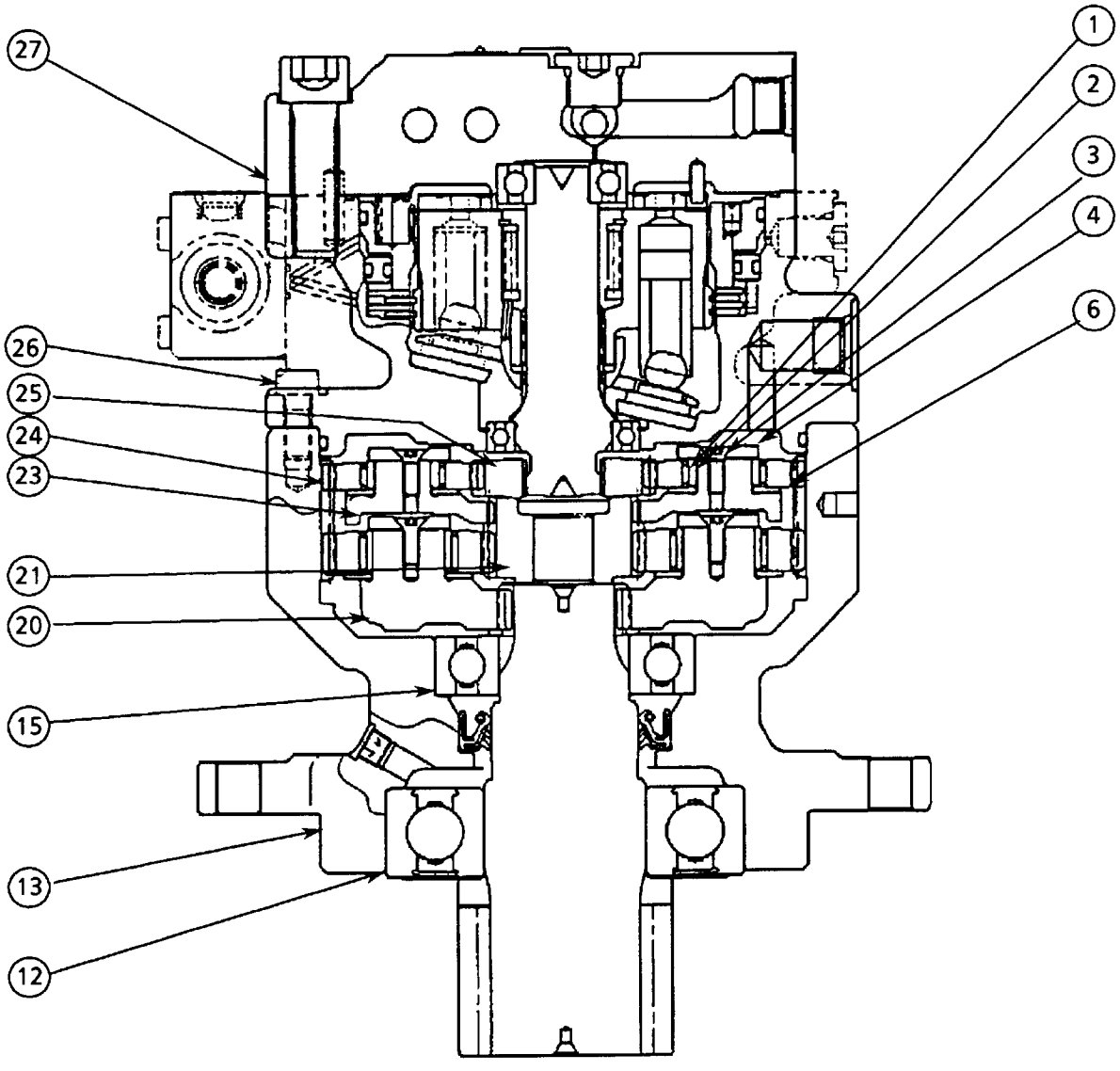
1. Secure ring gear (13) on a workbench and remove socket bolts (26), to remove swing motor (27).

   ⌐ : 6 mm

2. Remove first stage sun gear (25), first stage carrier (23), second stage sun gear (21) and second stage carrier (20) from ring gear (13).

3. Clamp first stage carrier in a vise. Remove flat head bolts (3) (4 used). Remove thrust plate (4), first stage planetary gears (24), needle bearings (1), inner races (2) and thrust washers (6) in that order.

   ⌐ : 3 mm




T525-02-03-001

4. Clamp second stage carrier in a vise. Remove flat head bolts (3) (4 used). Remove thrust plate (4), second stage planetary gears (22), needle bearings (9), inner races (8) and thrust washers (7) in that order.

: 3 mm

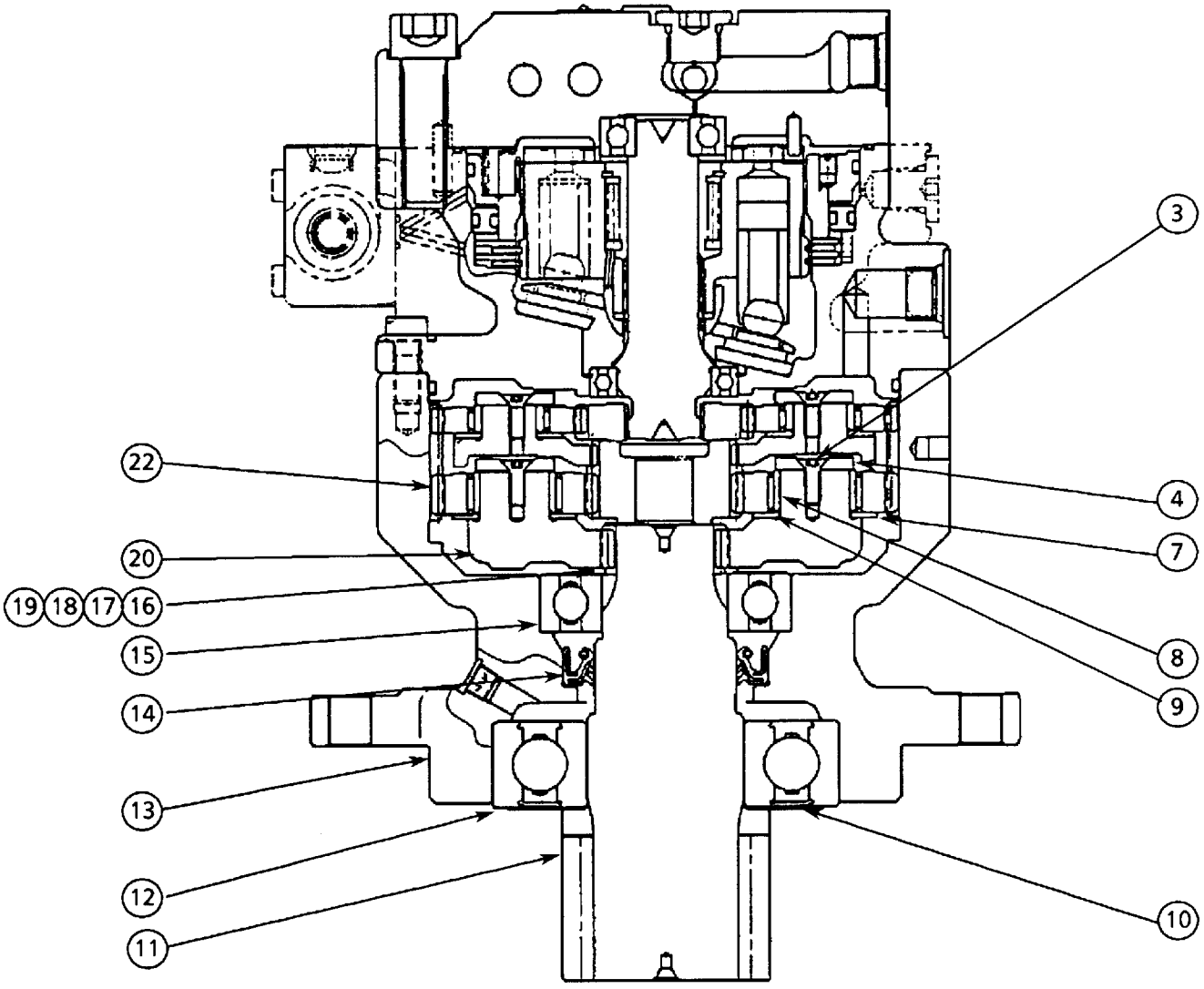
5. Remove retaining ring (16) and shims (17, 18 and 19) from ring gear (13).

6. Remove shaft (11) from ring gear (13) by holding the end of shaft (11) with a press.

7. Remove ball bearing (12) and plate (10) by holding the end of shaft (11) with a press.

8. Remove ball bearing (15) from ring gear (13) by lightly tapping ball bearing (15) using a bar and plastic hammer.

9. Remove oil seal (14) from ring gear (13).




T525-02-03-001

**Assemble Swing Reduction Gear (33Mu)**

Before reassembling, clean components and parts with cleaning oil and dry completely. Apply a film of clean hydraulic oil to inner parts, sliding parts in particular, before assembling in order to prevent seizures. Apply grease to bearings.
Always replace used O-rings, seals and oil seals with new ones when re-assembling.

1. Install plate(10) onto shaft (11). Press ball bearing (12) onto shaft (11).

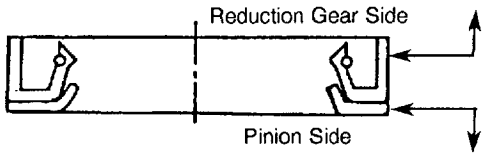
*NOTE: Install ball bearing (12) with the seal side facing toward the gear side of shaft (11).*

*NOTE: Bearing grease: 14 to 50 cm³ of Alvania Grease No.2.*

2. Press oil seal (14) in ring gear (13).

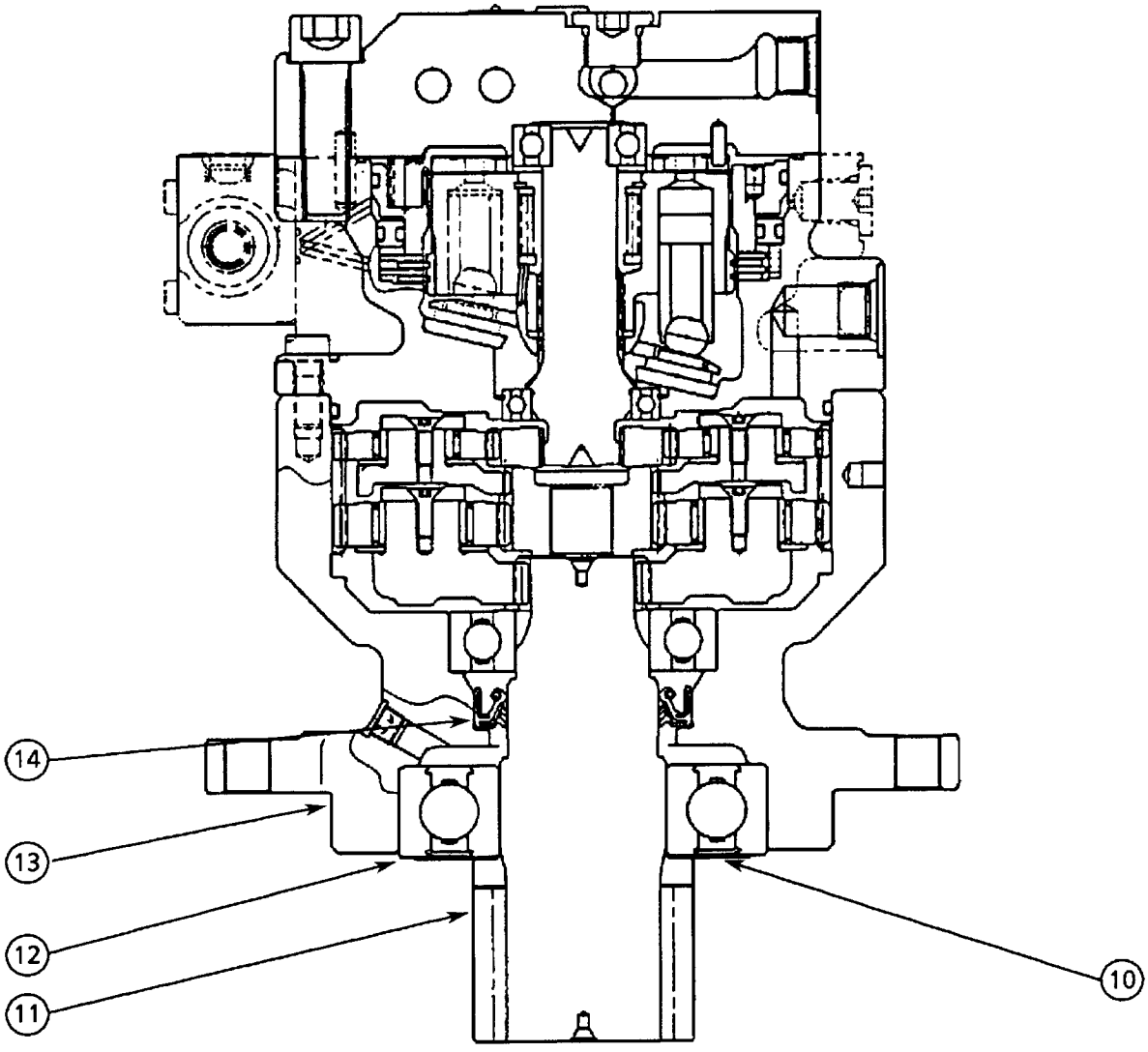
*NOTE: Apply grease to the sealing surface of oil seal (14).*

*NOTE: Install oil seal (14) in the direction as illustrated.*




W506-02-06-004

3. Press shaft (11) into ring gear (13).




T525-02-03-001

4. Press ball bearing (15) in ring gear (13).

5. Install shims (17, 18 and 19) and retaining ring (16) onto shaft (11).

*NOTE: Install and adjust shims (17, 18 and 19) so that shaft (11) does not move longitudinally but rotates freely after installing retaining ring (16). Shim size: 0.05 mm, 0.1 mm and 0.3 mm.*

*NOTE: Install retaining ring (16) with the rounded side facing toward the shims.*

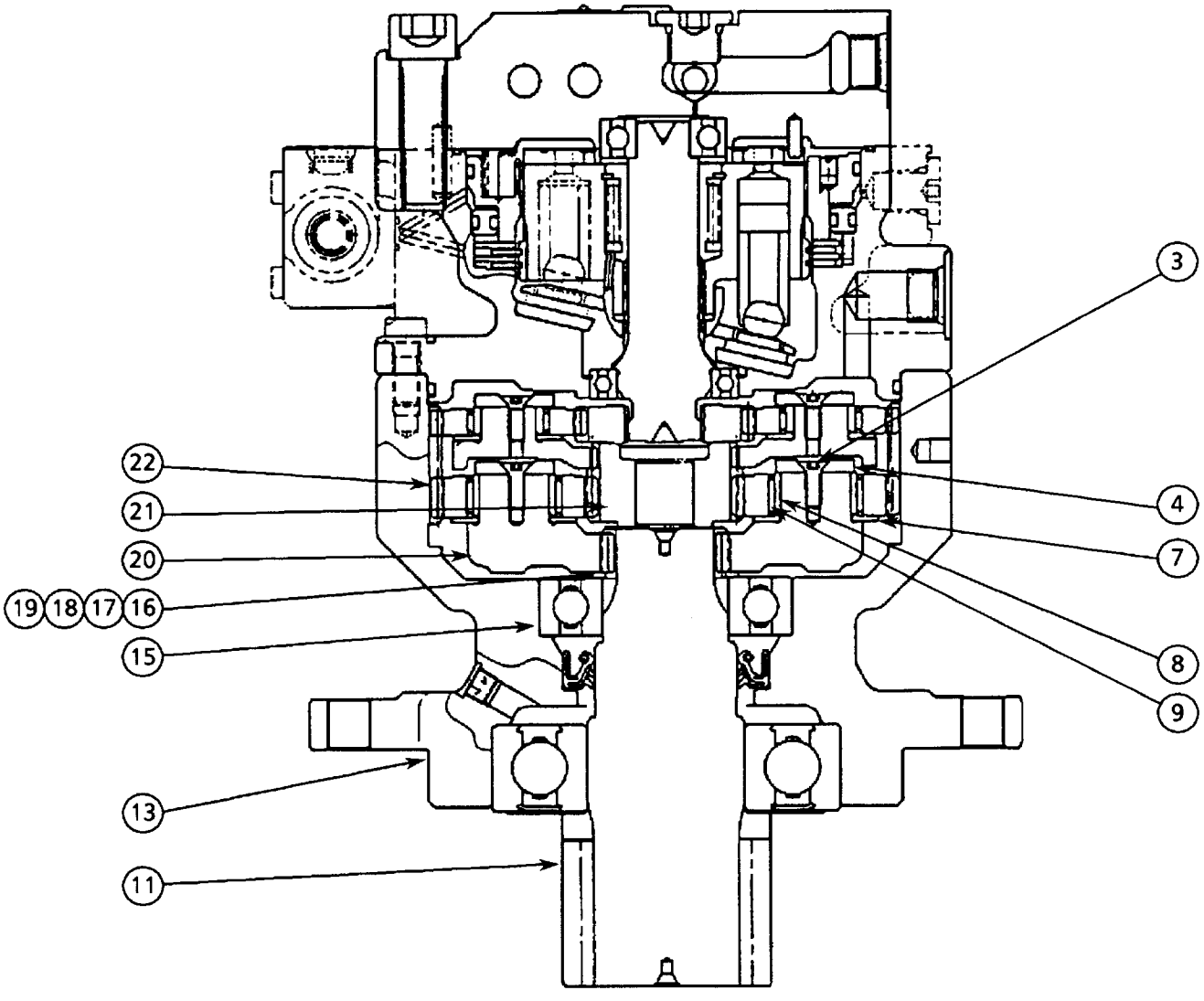
6. Install thrust washers (7), inner races (8), needle bearings (9), second stage planetary gears (22) and thrust plate (4) on second stage carrier (20) in order. Tighten flat head bolts (3).

: 3 mm

: 4±0.5 N·m
( 0.4±0.05 kgf·m )

*NOTE: Install second stage planetary gears (22) with the convex side up. Degrease flat head bolts (3) and apply Loctite #242 before installing.*

7. Install second stage carrier (20) in ring gear (13). Install second stage sun gear (21).




T525-02-03-001

8. Install thrust washers (6), inner races (2), needle bearings (1), first stage planetary gears (24) and thrust plate (4) on first stage carrier (23) in order. Tighten flat head bolts (3).

: 3 mm

: 4±0.5 N·m ( 0.4±0.05 kgf·m )

*NOTE: Install first stage planetary gears (24) with the convex side up. Degrease flat head bolts (3) and apply Loctite #242 before installing.*

9. Install first stage carrier (23) in ring gear (13). Install first stage sun gear (25).

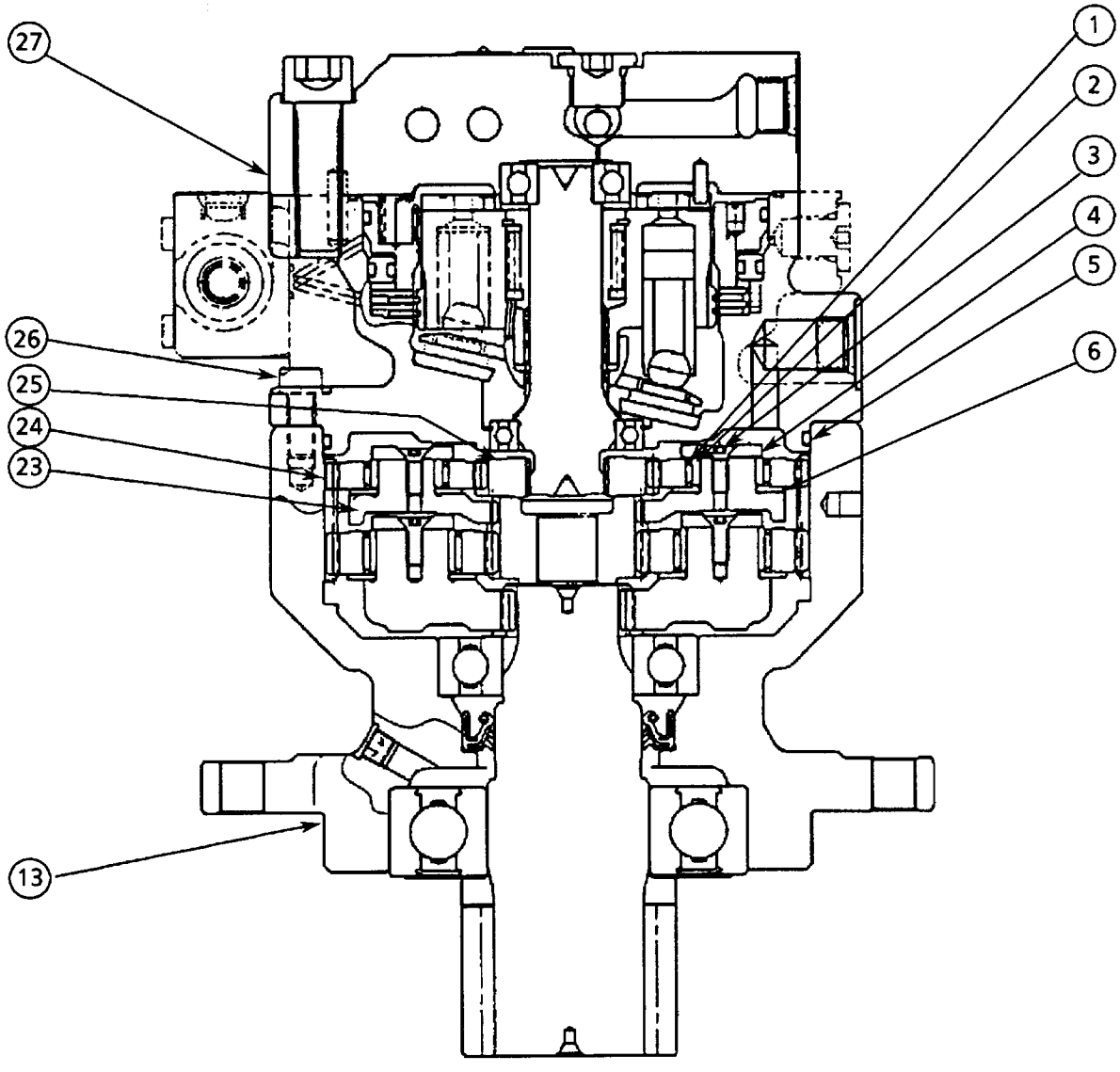
10. Install O-ring (5) onto swing motor (27).

*NOTE: Apply grease to O-ring (5) before installing.*

11. Install swing motor (27) on ring gear (13) while aligning the matching marks on both of them. Tighten four socket bolts (26).

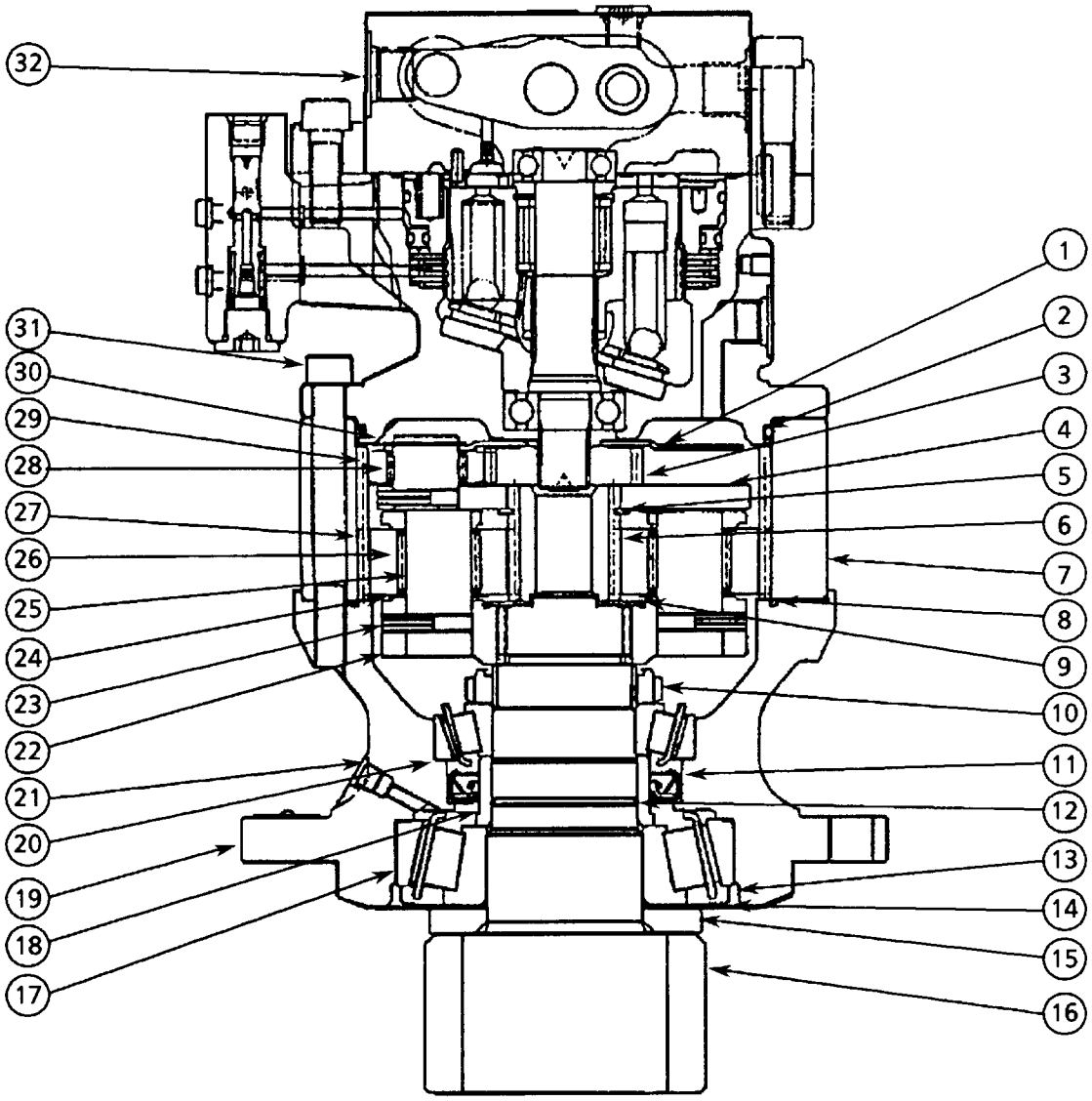
: 6 mm

: 32.4±2 N·m ( 3.3±0.2 kgf·m )



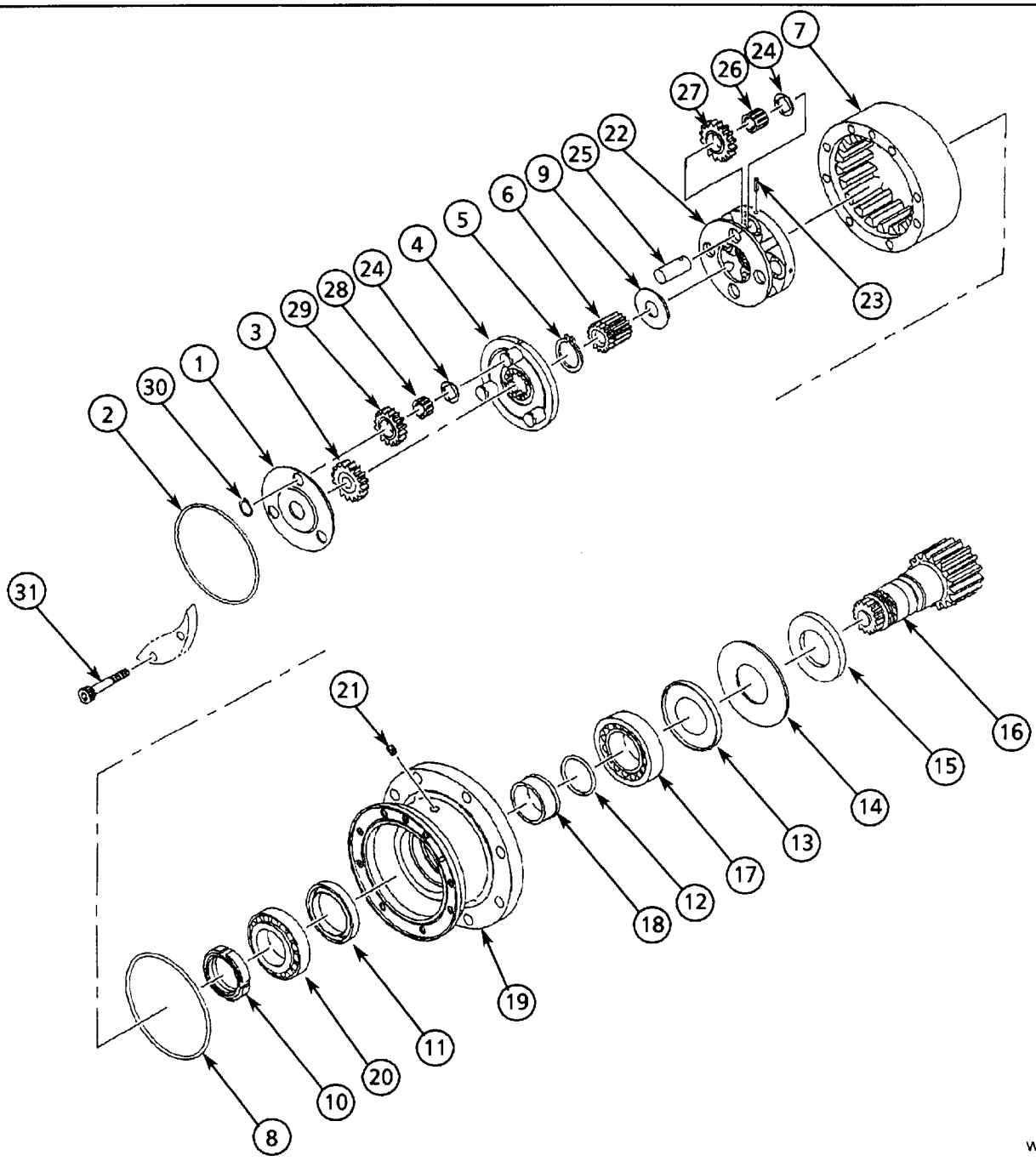

T525-02-03-001

## DISASSEMBLE AND ASSEMBLE SWING REDUCTION GEAR (58Mu)




W533-02-05-001

1— Plate
2— O-ring
3— First Stage Sun Gear
4— First Stage Carrier
5— Retaining Ring
6— Second Stage Sun Gear
7— Ring Gear
8— O-ring
9— Thrust Plate
10— Bearing Nut
11— Oil Seal
12— O-ring
13— Spring Plate
14— Plate
15— Plate
16— Shaft
17— Roller Bearing
18— Collar
19— Case
20— Roller Bearing
21— Plug (2 Used)
22— Second Stage Carrier
23— Spring Pin (4 Used)
24— Thrust Plate (7 Used)
25— Pin (4 Used)
26— Needle Bearing (4 Used)
27— Second Stage Planetary Gear (4 Used)
28— Needle Bearing (3 Used)
29— First Stage Planetary Gear (3 Used)
30— Retaining Ring (3 Used)
31— Socket Bolt (9 Used)
32— Swing Motor




1— Plate
2— O-ring
3— First Stage Sun Gear
4— First Stage Carrier
5— Retaining Ring
6— Second Stage Sun Gear
7— Ring Gear
8— O-ring
9— Thrust Plate
10— Bearing Nut
11— Oil Seal
12— O-ring
13— Spring Plate
14— Plate
15— Plate
16— Shaft
17— Roller Bearing
18— Collar
19— Case
20— Roller Bearing
21— Plug (2 Used)
22— Second Stage Carrier
23— Spring Pin (4 Used)
24— Thrust Plate (7 Used)
25— Pin (4 Used)
26— Needle Bearing (4 Used)
27— Second Stage Planetary Gear (4 Used)
28— Needle Bearing (3 Used)
29— First Stage Planetary Gear (3 Used)
30— Retaining Ring (3 Used)
31— Socket Bolt (9 Used)

**Disassemble Swing Reduction Gear (58Mu)**

Thoroughly clean the swing device. Before disassembling, make matching marks on the mating surfaces of swing motor (32), ring gear (7) and case (19) to aid when re-assembling.

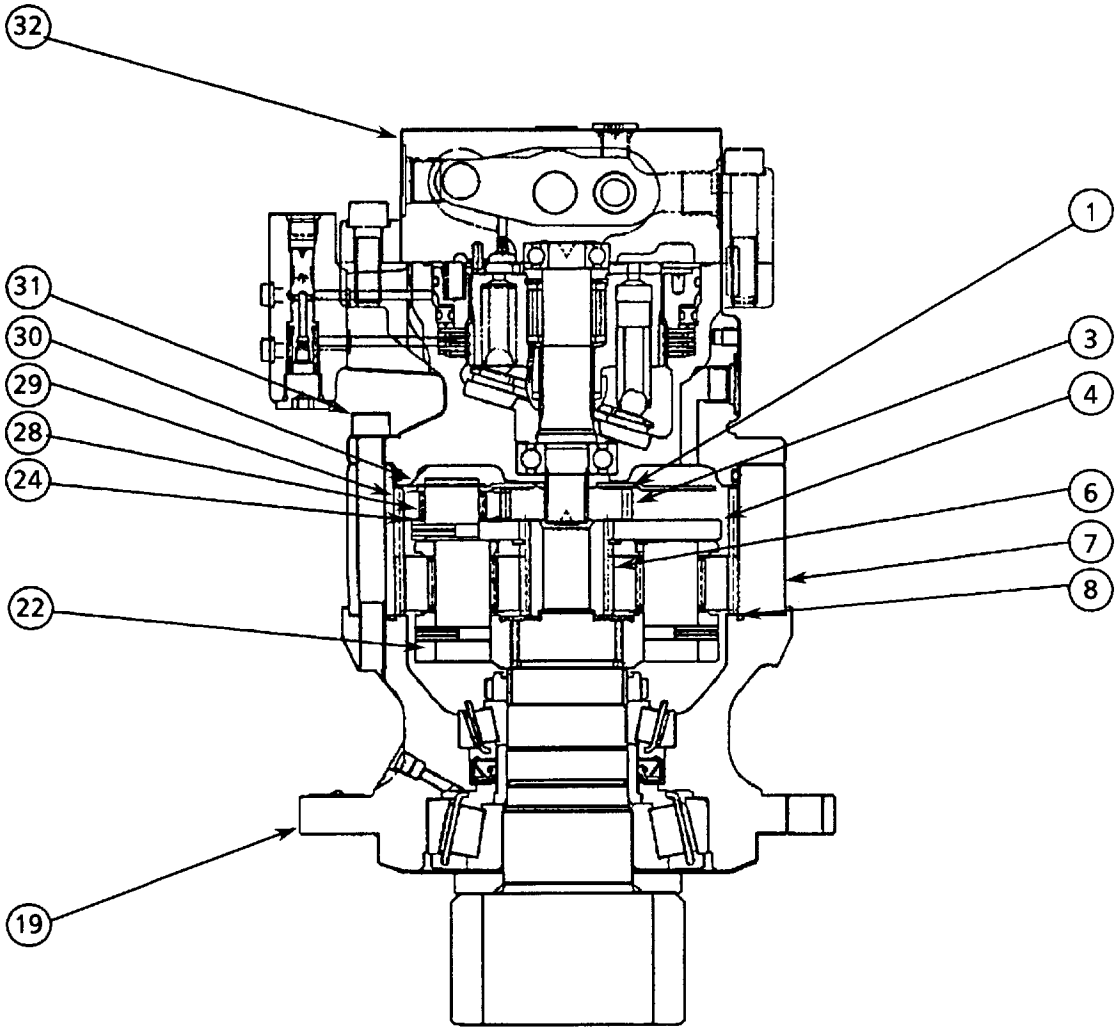
1. Secure case (19) on a workbench and remove socket bolts (31) (9 used), then remove swing motor (32).

   : 10 mm

2. Remove first stage carrier (4), second stage sun gear (6) and second stage carrier (22) from ring gear (7).

3. Remove ring gear (7) and O-ring (8) from case (19).

4. Remove retaining rings (30) (3 used), plate (1), first stage sun gear (3), first stage planetary gears (29) (3 used), needle bearings (28) (3 used) and thrust plates (24) (3 used), in that order, from first stage carrier (4).




W533-02-05-001

5. Remove spring pins (23) (4 used), pins (25) (4 used), second stage planetary gears (27) (4 used), needle bearings (4 used), thrust plates (24) (4 used) and thrust plate (9), in that order, from second stage carrier (22).

6. Remove bearing nut (10) from shaft (16).

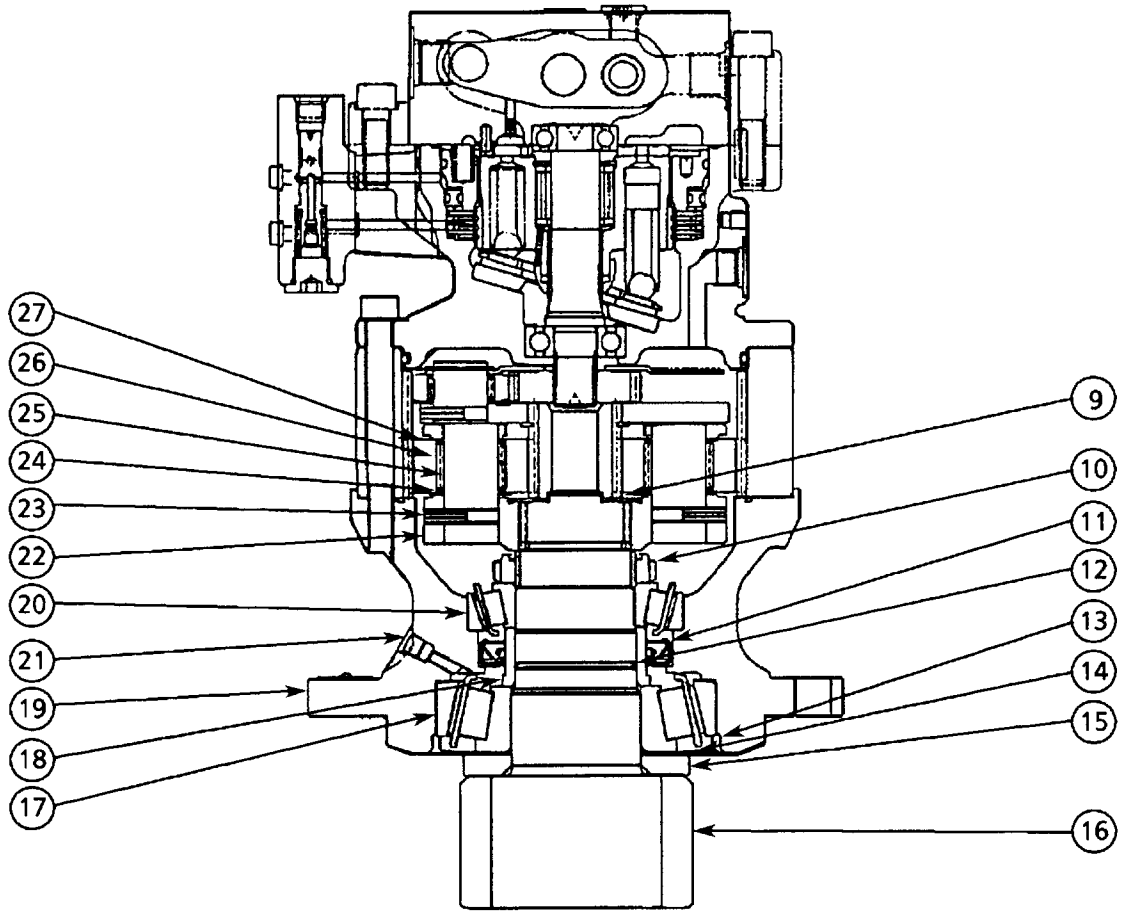
7. Remove plugs (21) (2 used) from case (19).

: 5 mm

8. Remove shaft (16) from case (19) by pushing the end of shaft (16) with a press.

9. Remove collar (18), O-ring (12), roller bearing (17) inner race, spring plate (13), plate (14) and plate (15), in that order, from shaft (16).

10. Remove roller bearing (17) outer race, oil seal (11) and roller bearing (20) outer race from case (19).




W533-02-05-001

**Assemble Swing Reduction Gear (58Mu)**

Before reassembling, clean components and parts with cleaning oil and dry completely. Apply a film of clean hydraulic oil to inner parts, sliding parts in particular, before assembling in order to prevent seizures. Apply grease to bearings.
Always replace used O-rings, seals and spring pins with new ones when re-assembling.

1. Press oil seal (11) and roller bearing (20) outer race in case (19).
2. Press roller bearing (17) outer race in case (19).
3. Install plate (15), plate (14) and spring plate (13) onto shaft (16). Press roller bearing (17) inner race onto shaft (16).

*NOTE: Apply Nisseki New Molinox Grease 2 or equivalent to the roller end surfaces of roller bearing (17).*

4. Install O-ring (12) and collar (18) onto shaft (16).
5. Install shaft (16) into case (19).
6. Press roller bearing (20) inner race onto shaft (16) and tighten bearing nut (10).

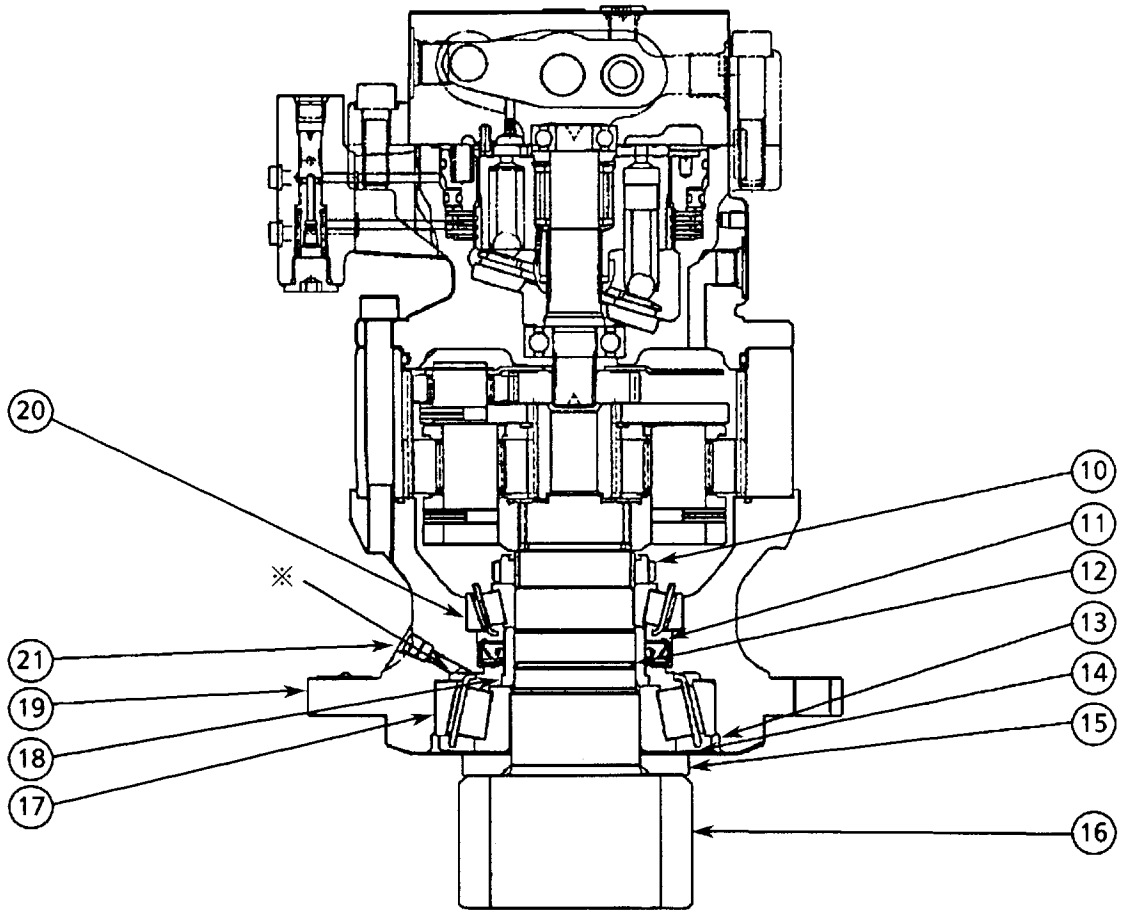
   : 883 ± 98 N·m (90 ± 10 kgf·m)

7. Add grease via the plug hole marked with ※. Install plugs (21) (2 used) on case (19).

   : 5 mm

   : 10 ± 1 N·m (1 ± 0.1 kgf·m)

*NOTE: Bearing grease: 35 to 40 g of Nisseki Molinox Grease 2 or equivalent.*




W533-02-05-001

8. Install thrust plate (9), thrust plates (24) (4 used), needle bearings (26) (4 used), second stage planetary gears (27) (4 used), pins (25) (4 used) and spring pins (23) (4 used), in that order, onto second stage carrier (22).

9. Install thrust plates (24) (3 used), needle bearings (28) (3 used), first stage planetary gears (29) (3 used), first stage sun gear (3), plate (1) and retaining ring (30) (3 used), in that order, onto first stage carrier (4).

10. Install second stage carrier (22) assembly onto shaft (16).

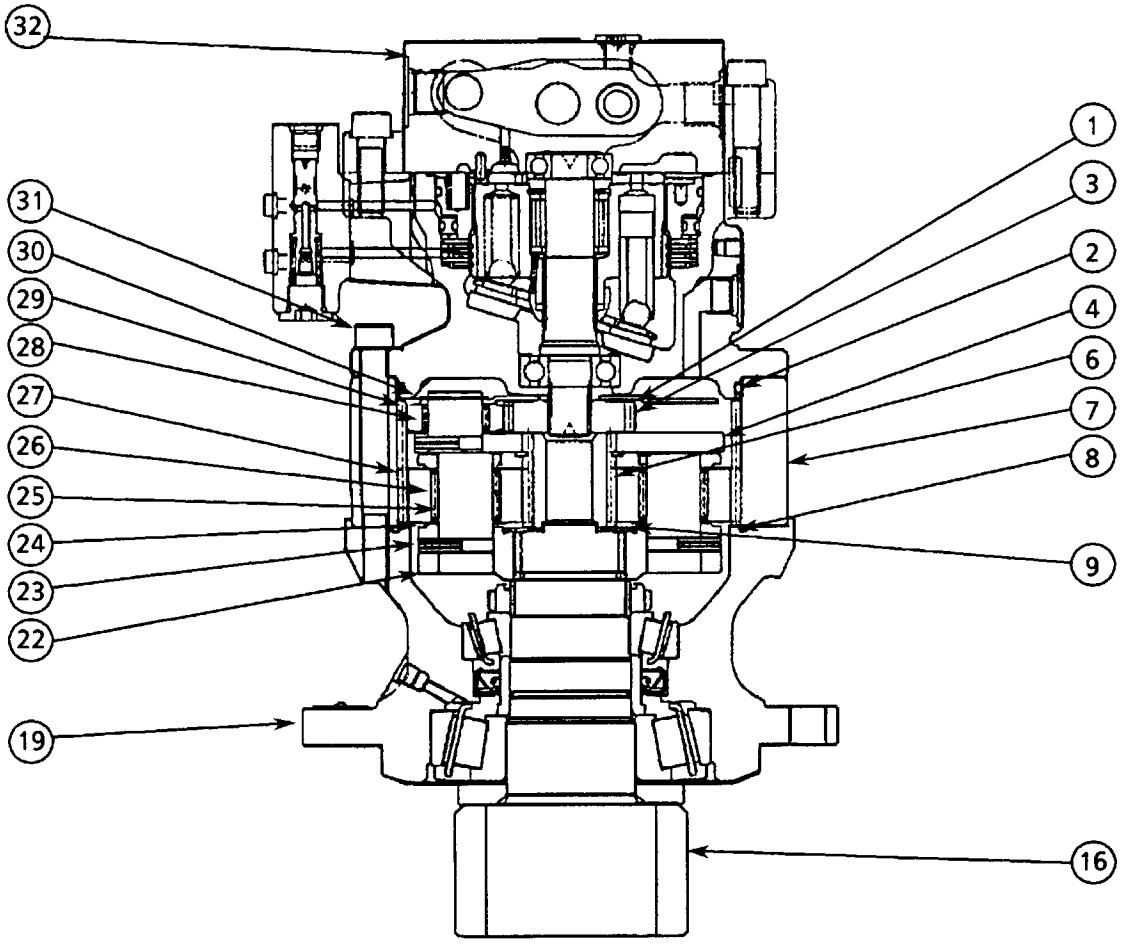
11. Install O-ring (8) on case (19). Install ring gear (7) on case (19) so that the bolt holes align.

12. Install second stage sun gear (6) and first stage carrier (4) assembly onto second stage carrier (22).

13. Install O-ring (2) onto swing motor (32). Install swing motor (32) on ring gear (7) while aligning the matching marks. Tighten socket bolts (31) (9 used).

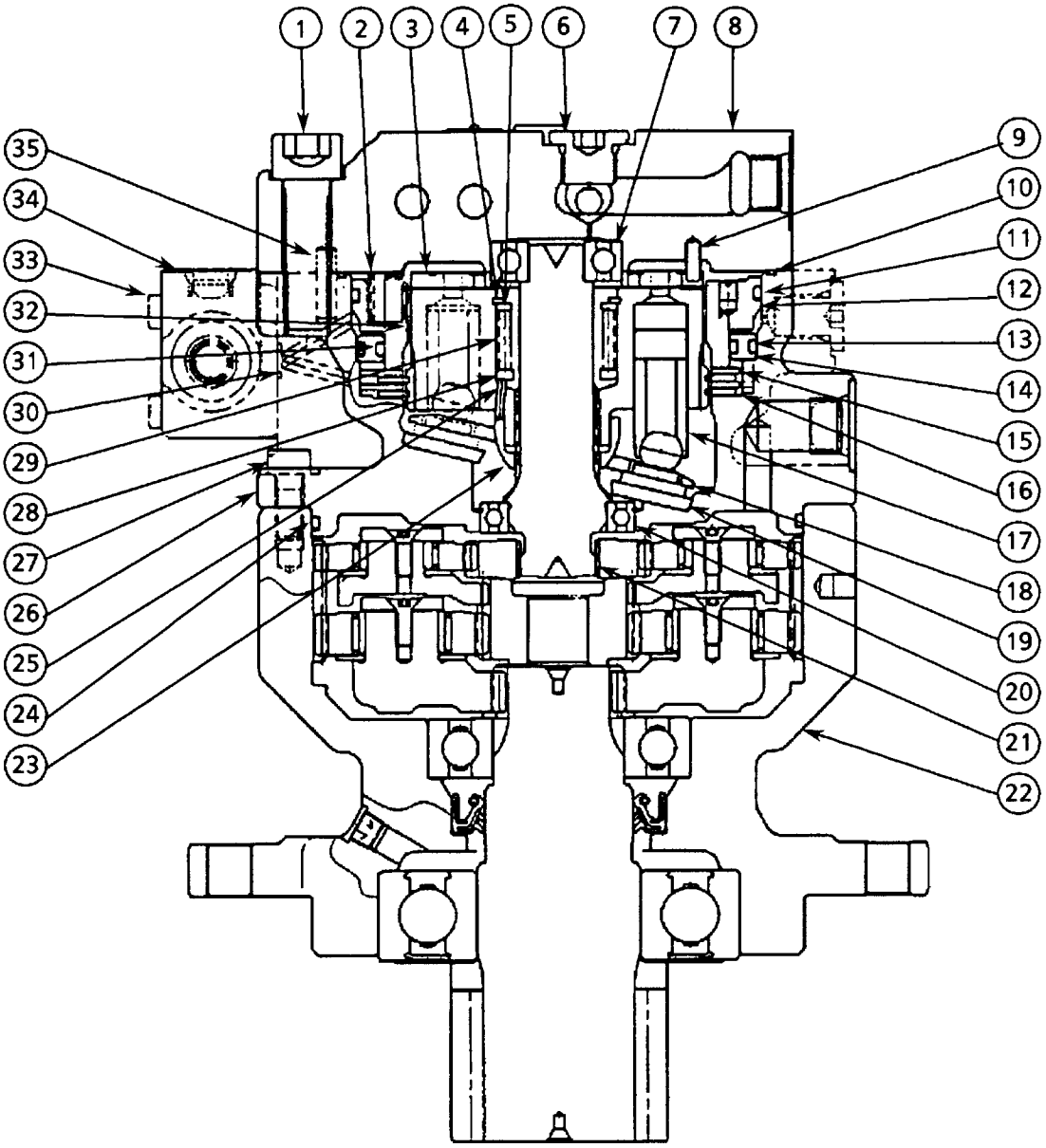
: 10 mm

: 108±10 N·m ( 11±1 kgf·m)



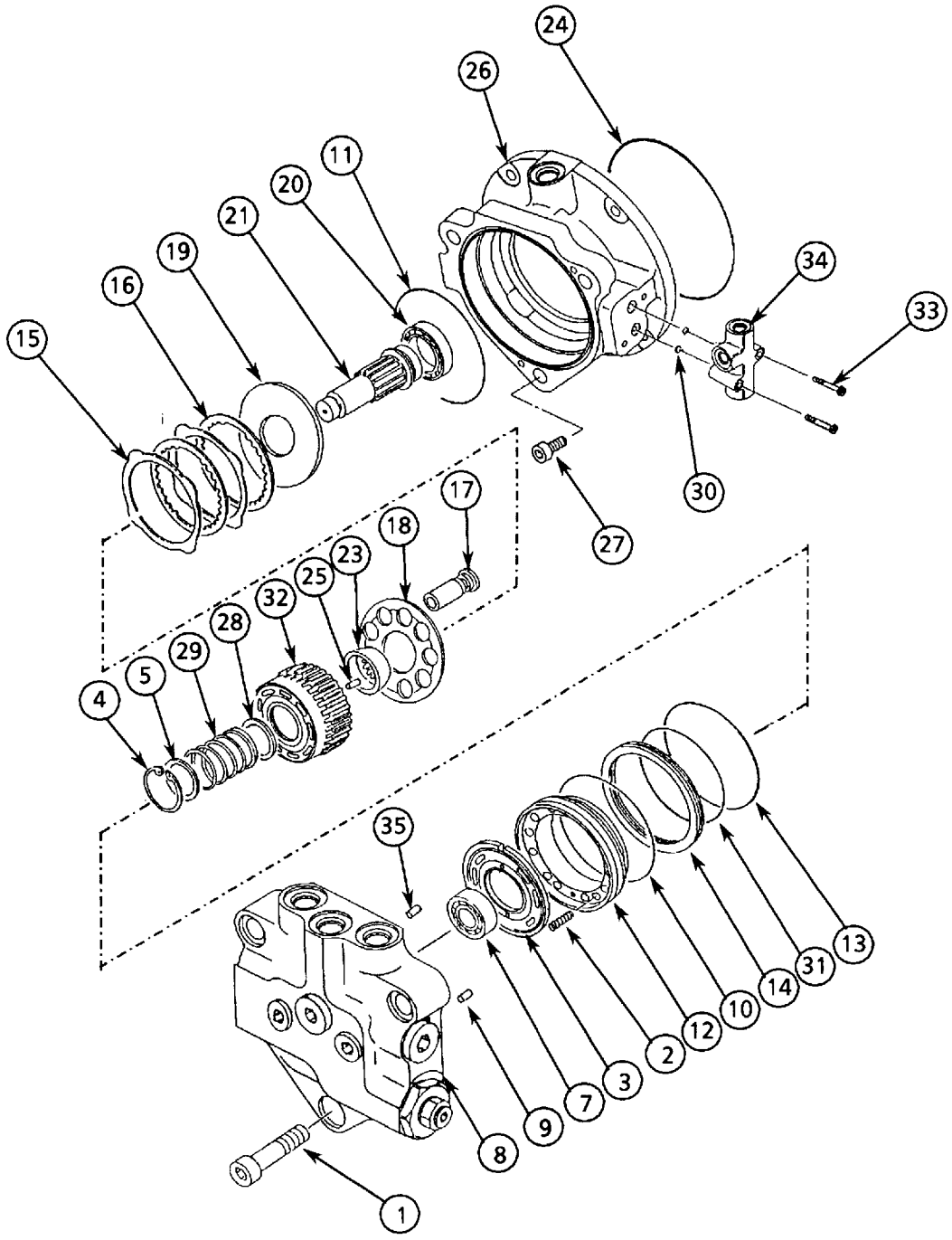

W533-02-05-001

## DISASSEMBLE AND ASSEMBLE SWING MOTOR (33Mu)




T525-02-03-001

1— Socket Bolt (3 used)
2— Spring
3— Valve Plate
4— Retaining Ring
5— Washer
6— Plug
7— Ball Bearing
8— Cover
9— Pin
10— O-Ring
11— O-Ring
12— Brake Piston
13— O-Ring
14— Collar
15— Friction Plate (2 used)
16— Disc Plate (2 used)
17— Plunger (9 used)
18— Retainer
19— Swash Plate
20— Ball Bearing
21— Shaft
22— Ring Gear (Case)
23— Holder
24— O-Ring
25— Pin (3 used)
26— Case
27— Socket Bolt (4 used)
28— Collar
29— Spring
30— O-Ring
31— O-Ring
32— Rotor
33— Socket Bolt (2 used)
34— Parking Brake Switch Valve
35— Pin (2 used)




W527-02-05-005

1— Socket Bolt (3 used)
2— Spring
3— Valve Plate
4— Retaining Ring
5— Washer
7— Ball Bearing
8— Cover
9— Pin
10— O-Ring
11— O-Ring
12— Brake Piston
13— O-Ring
14— Collar
15— Friction Plate (2 used)
16— Disc Plate (2 used)
17— Plunger (9 used)
18— Retainer
19— Swash Plate
20— Ball Bearing
21— Shaft
23— Holder
24— O-Ring
25— Pin (3 used)
26— Case
27— Socket Bolt (4 used)
28— Collar
29— Spring
30— O-Ring
31— O-Ring
32— Rotor
33— Socket Bolt (2 used)
34— Parking Brake Switch Valve
35— Pin (2 used)

**Disassemble Swing Motor (33Mu)**

Thoroughly clean the swing device. Before disassembling, make matching marks on the mating surfaces of cover (8), parking brake switch valve (34), case (26) and ring gear (22) to aid in re-assembly. Do not remove pins (9, 35) or ball bearings (7, 20) unless necessary.

1. Secure ring gear (22) on a workbench and remove socket bolts (33), parking brake switch valve (34) and O-rings (30).

: 5 mm

*NOTE: Take care as O-ring (30) may come off first when removing parking brake switch valve (34).*

2. Loosen socket bolts (1). Remove cover (8) and valve plate (3).

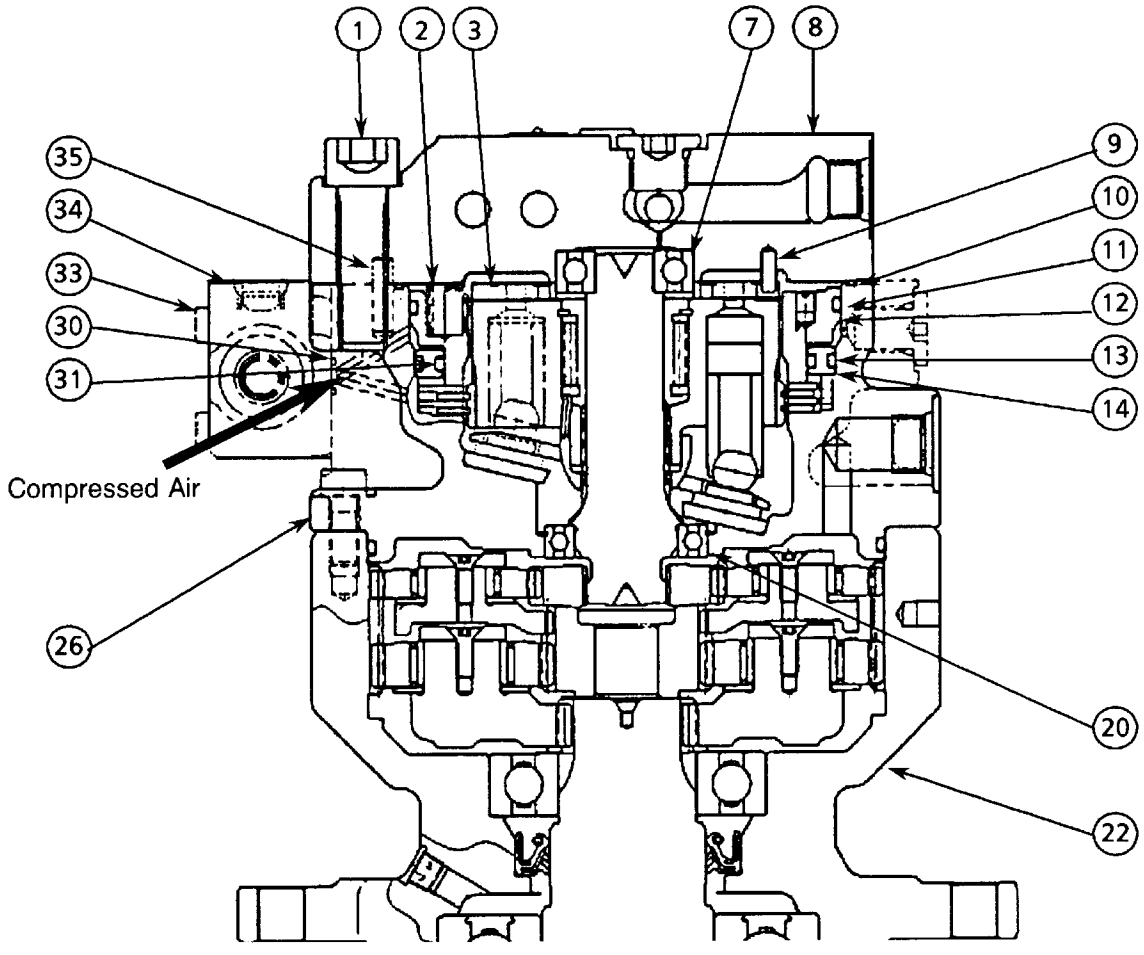
: 12 mm

*NOTE: Valve plate (3) may come off first when removing cover (8). Take care not to drop valve plate (3).*

3. Remove spring (2) and O-ring (10) from case (26).

4. Remove brake piston (12) and O-ring (11) from case (26) by applying compressed air via the pilot port on case (26).

5. Remove collar (14) and O-rings (13, 31).




T525-02-03-001

6. Remove rotor (32) and plungers (17) assembly. Remove swash plate (19), friction plates (15), and disk plates (16).

*NOTE: Take care not to damage the sliding surface of swash plate (19) when removing it.*

7. Remove plungers (17) (9 used), retainer (18), holder (23) and pins (25) (3 used) from rotor (32).

**CAUTION: Always apply a tool to washer (5) to hold spring (29) with a press when removing retaining ring (4). If spring (29) is not held with a press when removing retaining ring (4), washer (5) and spring (29) may fly out, potentially causing serious injury.**

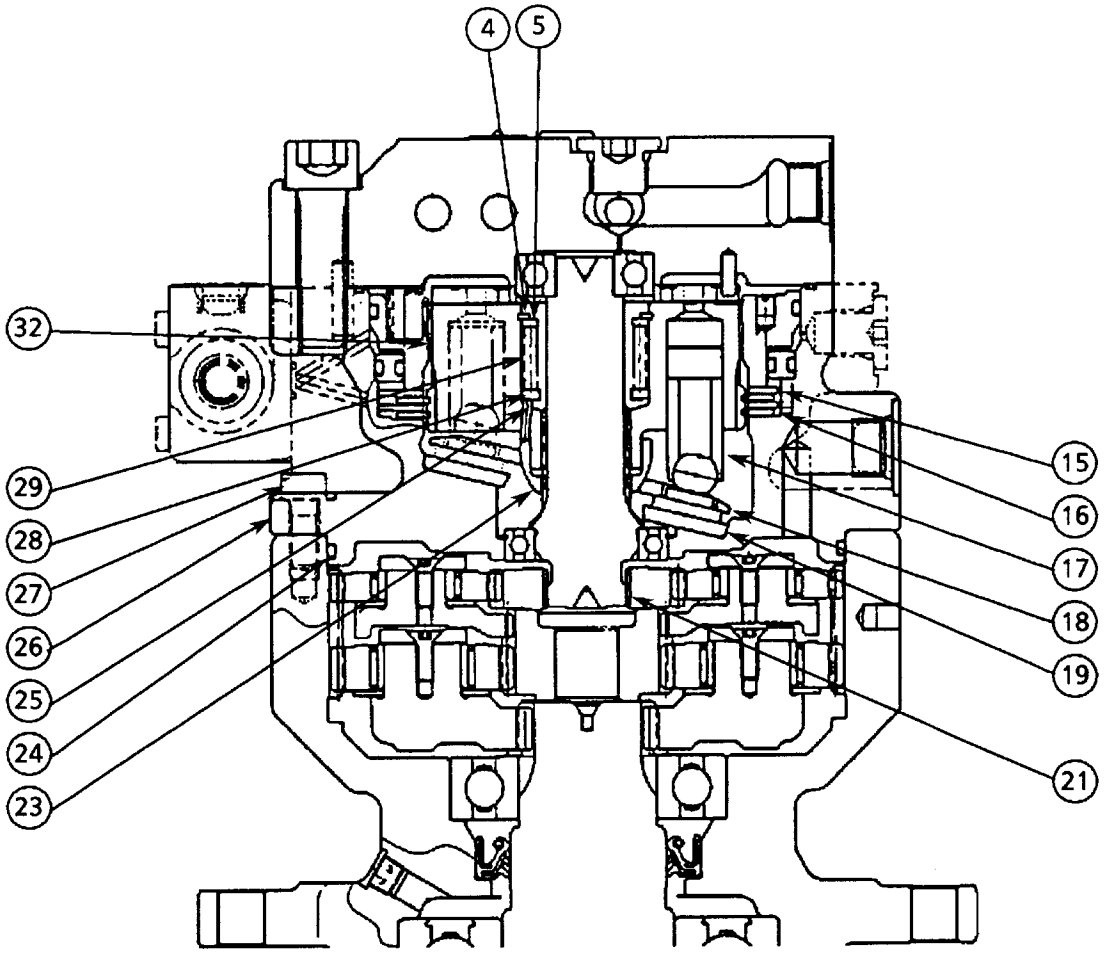
8. Remove retaining ring (4), then remove washer (5), spring (29) and collar (28) from rotor (32).

9. Loosen and remove socket bolts (27).

: 6 mm

10. Remove shaft (21) from case (26) by lightly tapping the shaft with a plastic hammer.

11. Remove O-ring (24) from case (26).




T525-02-03-001

**Assemble Swing Motor (33Mu)**

Before reassembling, clean components and parts with cleaning oil and dry completely. Apply a film of clean hydraulic oil to inner parts, sliding parts in particular, before assembling in order to prevent seizures. Apply grease to O-rings and small parts to prevent them from falling off when installing. Always replace used O-rings and oil seals with new ones when re-assembling.

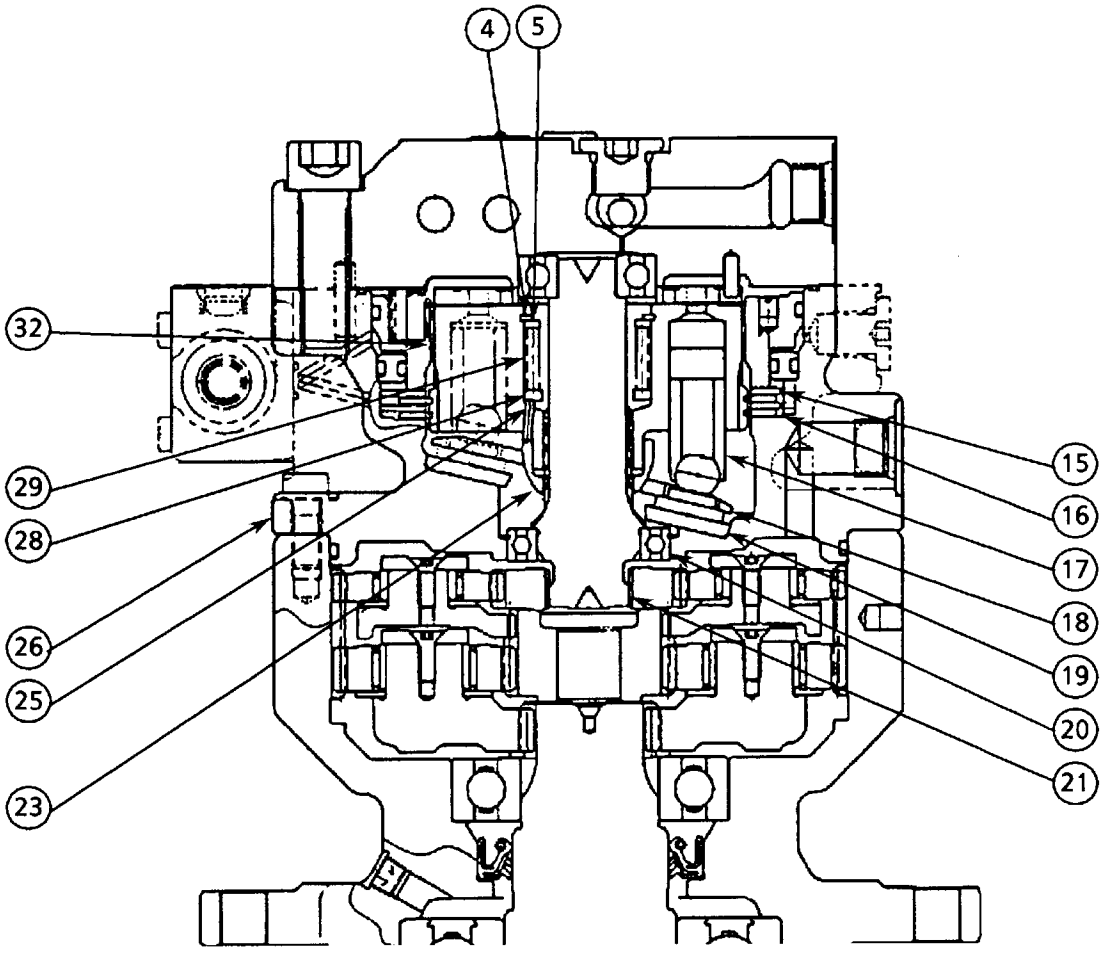
1. Press shaft (21) and ball bearing (20) assembly into case (26).

*NOTE: Press the assembly until the end of ball bearing (20) is flush with the end surface of case (26).*

*NOTE: If ball bearing (20) has been removed, press bearing (20) onto shaft (21) beforehand.*

2. Install collar (28), spring (29) and washer (5) in rotor (32).
3. Install retaining ring (4) while pushing washer (5) and spring (29) with a press.

4. Install pins (25) in rotor (32). Place holder (23) on pins (25).
5. Install plungers (17) and retainer (18) assembly in rotor (32).
6. Install swash plate (19) in case (26).
7. Install rotor (32) and plungers (17) assembly in case (26).
8. Install disk plates (16) (2 used) and friction plates (15) (2 used).




T525-02-03-001

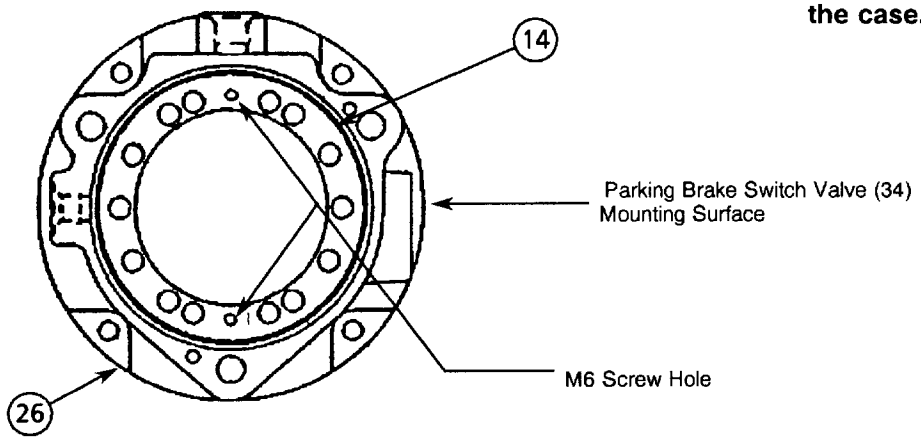
9. Install O-rings (13, 31) onto collar (14). Press collar (14) into case (26).

**IMPORTANT: Be sure to use a press when installing collar (14) into case (26). Do not tap collar (14) into case (26) using a plastic hammer or similar tool as this may damage collar (14).**

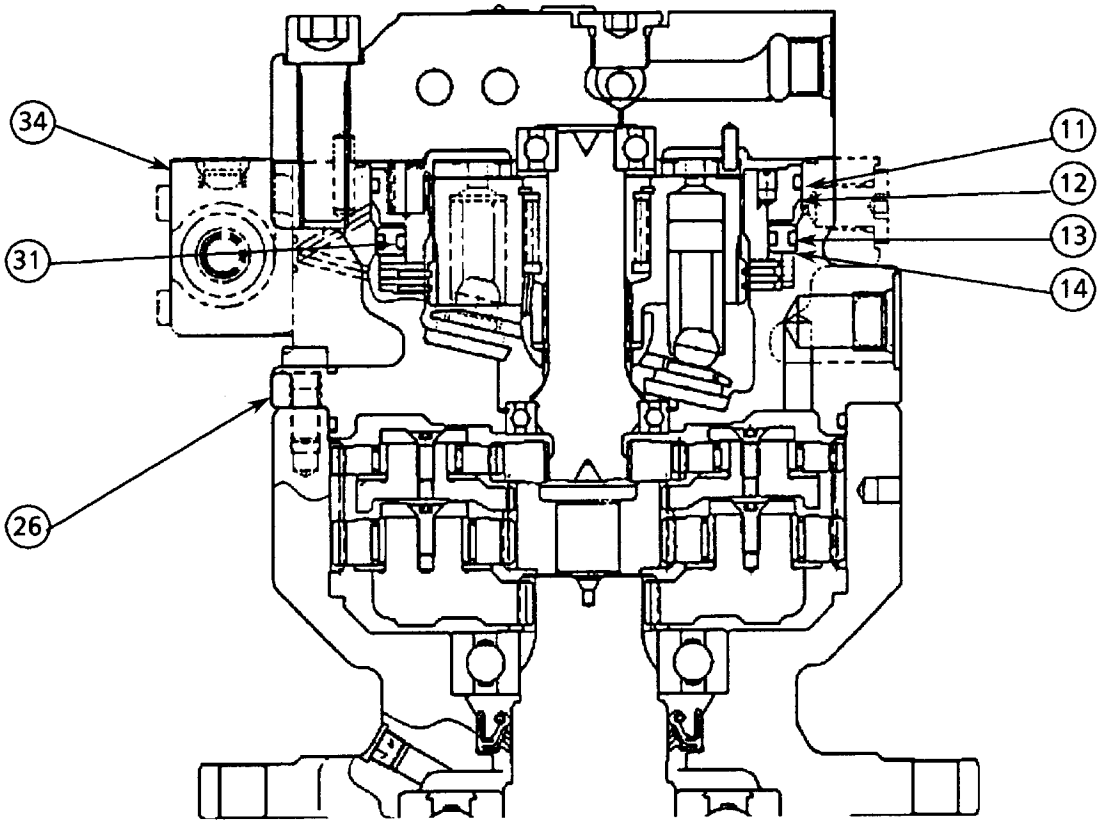
10. Install O-ring (11) onto brake piston (12). Press brake piston (12) into case (26).

**IMPORTANT: Be sure to use a press when installing brake piston (12) into case (26). Do not tap brake piston (12) into case (26) using a plastic hammer or similar tool as this may damage brake piston (12).**

**IMPORTANT: Position the brake piston as illustrated below when pressing it into the case.**




W527-02-05-003




T525-02-03-001

11. Install spring (2) (14 used) in case (26). Install O-ring (10) in case (26).

12. Attach valve plate (3) to cover (8). Install cover (8) on case (26) so that the matching marks align. Tighten socket bolts (1) (3 used).

*NOTE: Apply grease to valve plate (3) before attaching it to cover (8) in order to prevent it from separating.*

*NOTE: If pins (9, 35) have been removed, install them before insalling cover (8).*

: 12 mm

: 177±10 N·m
( 18±1 kgf·m )

13. Install O-rings (30) in case (26). Install parking brake switch valve (34) on case (26) and tighten socket bolts (33) (2 used).

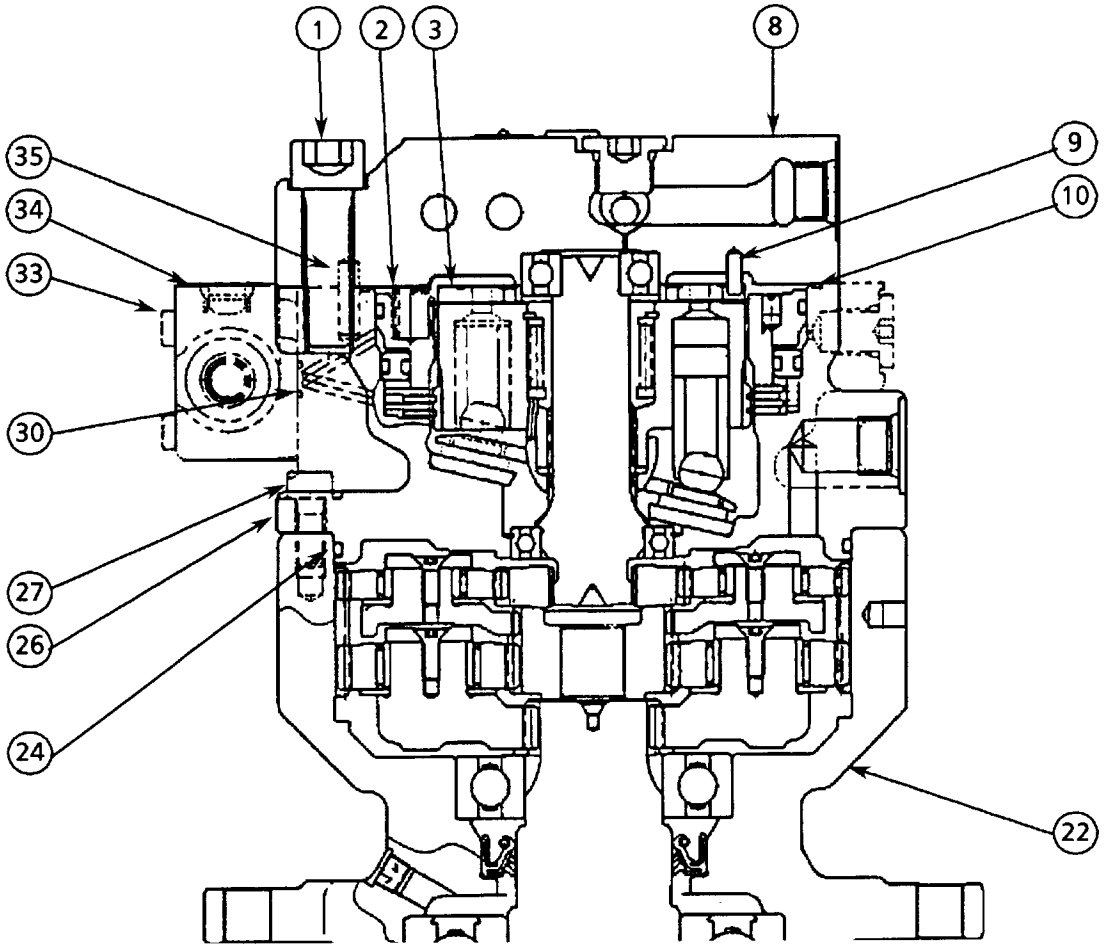
: 5 mm

: 9.8±1.0 N·m
( 1±0.1 kgf·m )

14. Install O-ring (24) onto case (26). Install case (26) on ring gear (22) so that the matching marks align. Tighten socket bolts (27) (4 used).

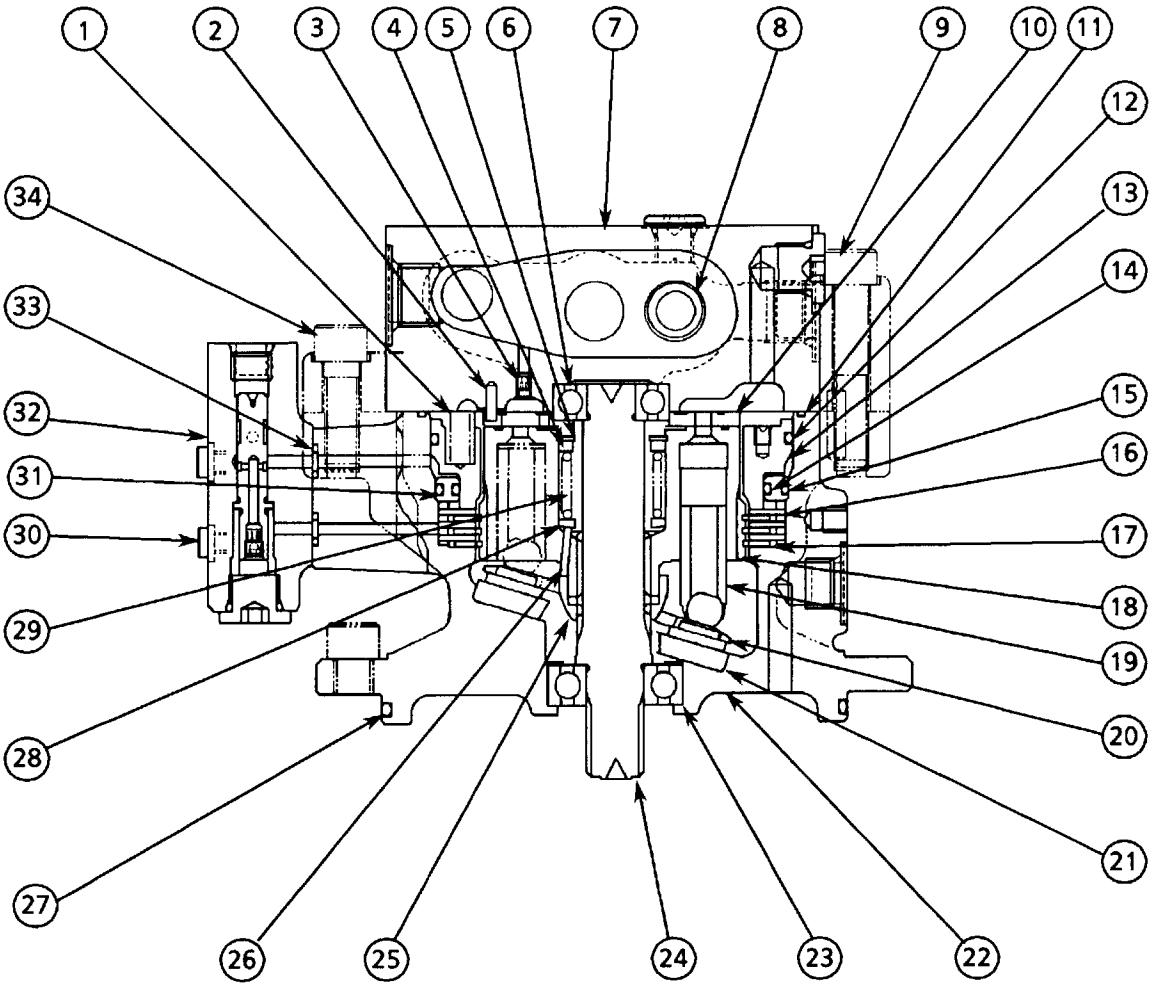
: 6 mm

: 32.4±2.0 N·m
( 3.3±0.2 kgf·m )



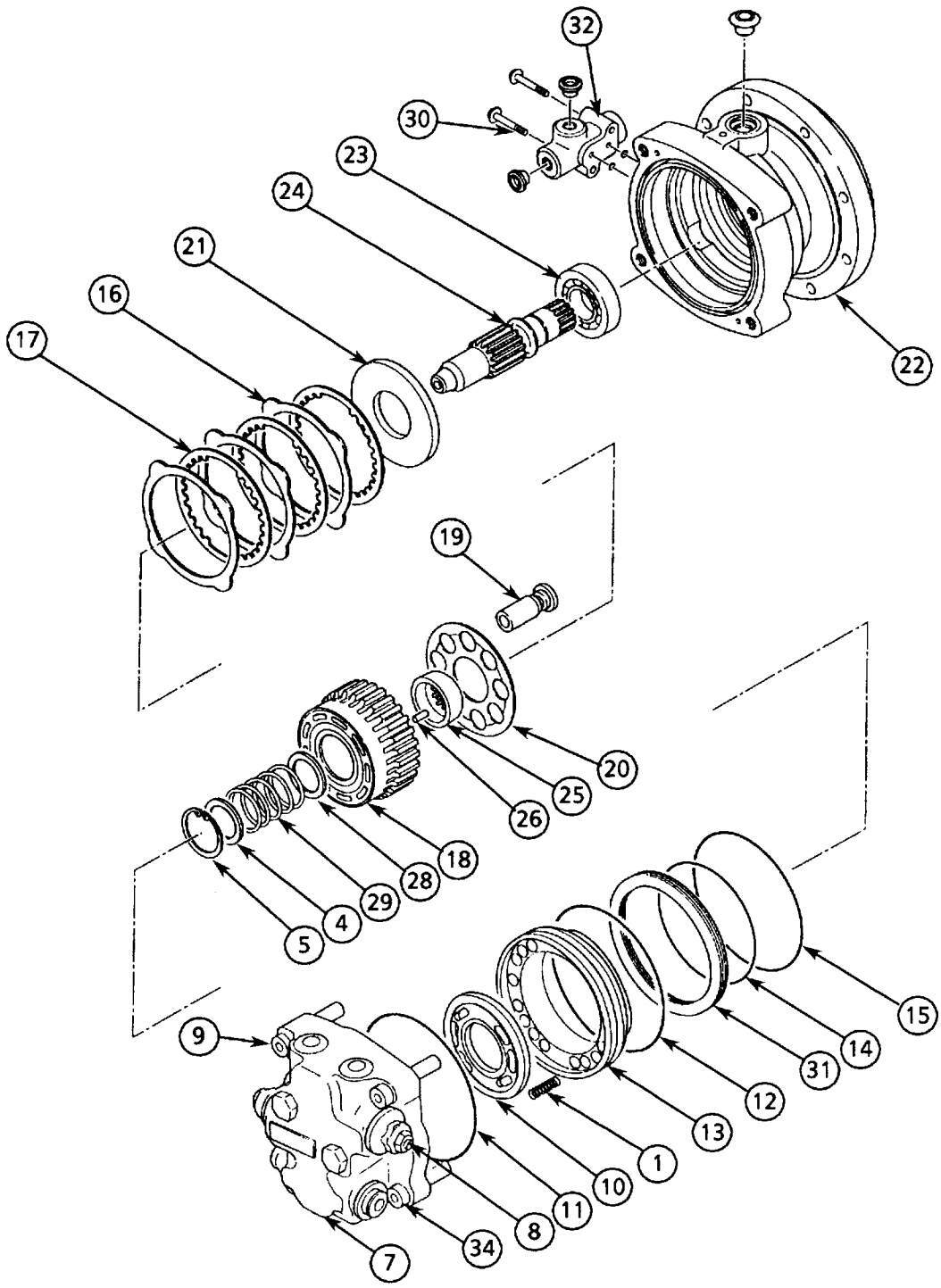

T525-02-03-001

## DISASSEMBLE AND ASSEMBLE SWING MOTOR (58Mu)




T554-02-04-001

1— Spring (22 Used)
2— Pin
3— Orifice
4— Washer
5— Retaining Ring
6— Ball Bearing
7— Cover
8— Relief Valve (2 Used)
9— Socket Bolt (2 Used)
10— Valve Plate
11— O-ring
12— O-ring
13— Brake Piston
14— O-ring
15— O-ring
16— Friction Plate (3 Used)
17— Disk Plate (3 Used)
18— Rotor
19— Plunger (9 Used)
20— Retainer
21— Swash Plate
22— Case
23— Ball Bearing
24— Shaft
25— Holder
26— Pin (3 Used)
27— O-ring
28— Collar
29— Spring
30— Socket Bolt (2 Used)
31— Collar
32— Parking Brake Switch Valve
33— O-ring (2 Used)
34— Socket Bolt (2 Used)




W554-02-06-013

1— Spring (22 Used)
4— Washer
5— Retaining Ring
7— Cover
8— Relief Valve (2 Used)
9— Socket Bolt (2 Used)
10— Valve Plate
11— O-ring
12— O-ring
13— Brake Piston
14— O-ring
15— O-ring
16— Friction Plate (3 Used)
17— Disk Plate (3 Used)
18— Rotor
19— Plunger (9 Used)
20— Retainer
21— Swash Plate
22— Case
23— Ball Bearing
24— Shaft
25— Holder
26— Pin (3 Used)
28— Collar
29— Spring
30— Socket Bolt (2 Used)
31— Collar
32— Parking Brake Switch Valve
34— Socket Bolt (2 Used)

**Disassemble Swing Motor (58Mu)**

Thoroughly clean the swing motor. Before disassembling, make matching marks on the mating surfaces of cover (7) and case (22) to aid when reassembling. Do not remove the plugs, pin (2) or ball bearings (6, 23) unless necessary.

1. Secure the motor on a workbench. Remove relief valve (8) from the motor.

   : 32 mm

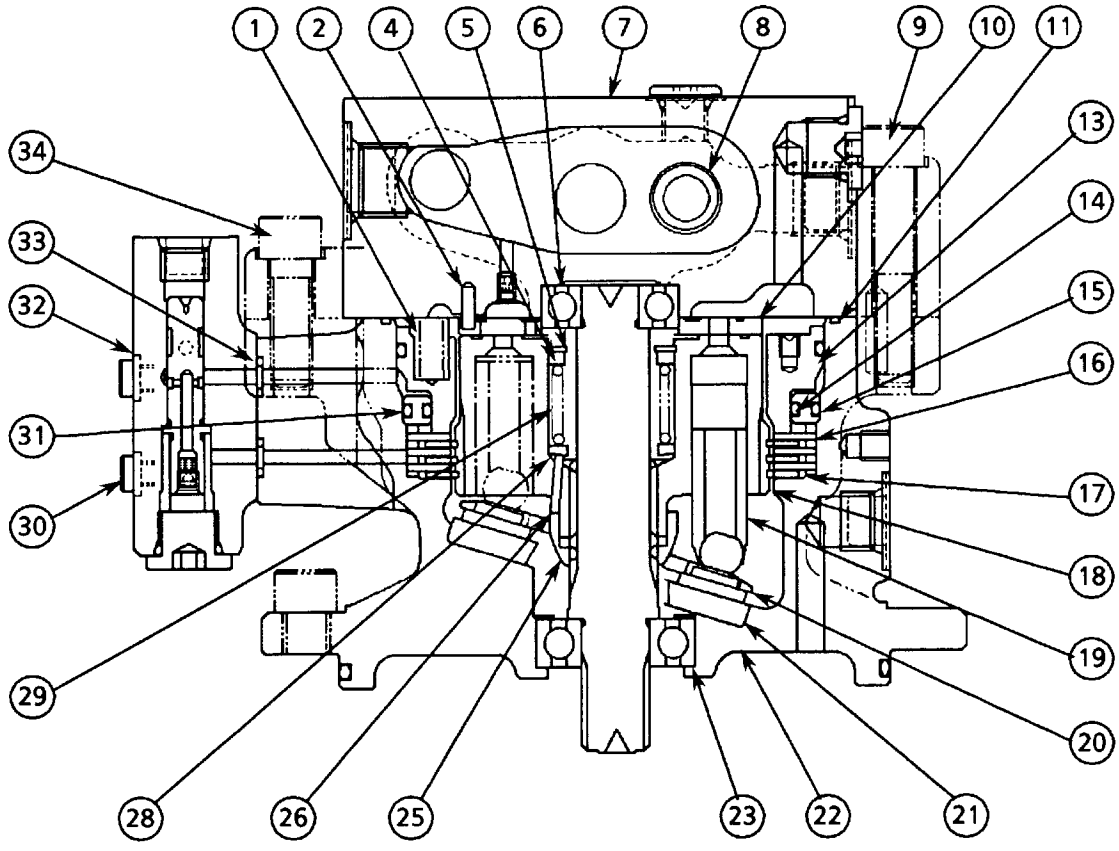
2. Remove socket bolts (9, 30 and 34), then remove cover (7) and parking brake switch valve (32).

   : 5 mm, 10 mm

3. Remove valve plate (10) from cover (7).

**IMPORTANT: Take care not to drop or damage valve plate (10). In some cases, valve plate (10) remains in case (22) when cover (7) is removed.**

4. Remove spring (1) and O-rings (11, 33).
5. Remove brake piston (13) from case (22) using socket bolts (30).
6. Remove collar (31) from case (22). Remove O-rings (14, 15).
7. Rotate case (22) 90° so that shaft (24) is horizontal. Remove rotor (18) assembly from case (22). Remove plungers (19), retainer plate (20), holder (25), pins (26), collar (28), spring (29), washer (4), retaining ring (5), friction plates (16) and disk plates (17).
8. Remove swash plate (21).



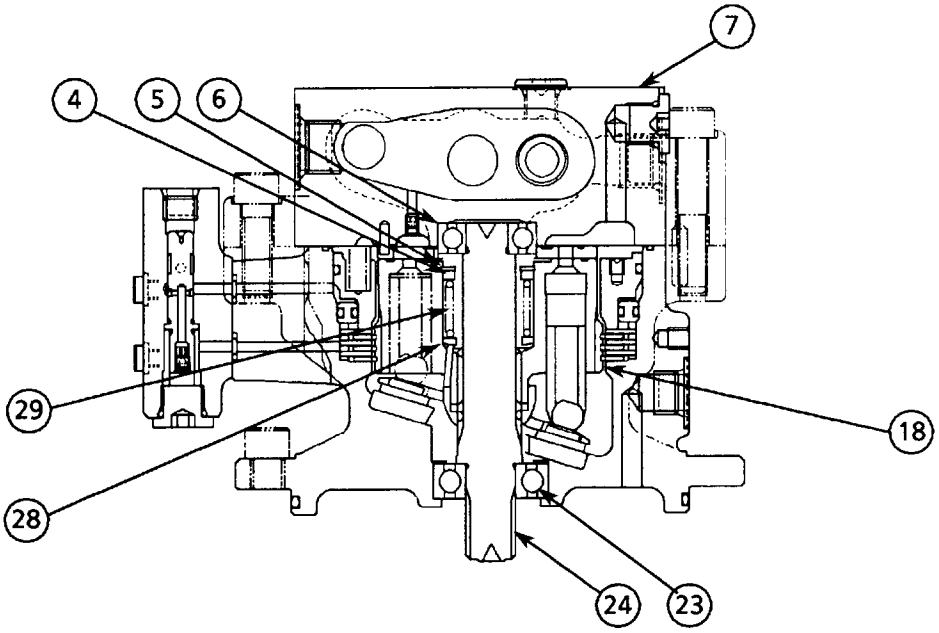

T554-02-04-001

9. Remove retaining ring (5) from rotor (18). Remove washer (4), spring (29) and collar (28).

10. Remove shaft (24) by tapping it from the the reduction gear side.

11. Remove ball bearing (23) from shaft (24) using a press.

12. Remove ball bearing (6) from cover (7) using a puller.




T554-02-04-001

**Assemble Swing Motor (58Mu)**

Before reassembling, clean components and parts with cleaning oil and dry completely. Apply a film of clean hydraulic oil to inner parts, sliding parts in particular, before assembling in order to prevent seizures. Always replace used O-rings and oil seals with new ones when re-assembling.

1. Press bearing (23) onto shaft (24).
2. Install shaft (24) and swash plate (21) in case (22).

**IMPORTANT: Install swash plate (21) with the heat-treated side up.**

*NOTE: Apply grease to the swash plate back (the side not heat treated) to prevent it from falling when case (22) is rotated 90 °.*

3. Install pins (26), holder (25), collar (28), spring (29) and washer (4) in rotor (18). Install retaining ring (5).

4. Alternately install disk plates (17) (3 used) and friction plates (16) (2 used) on rotor (18).

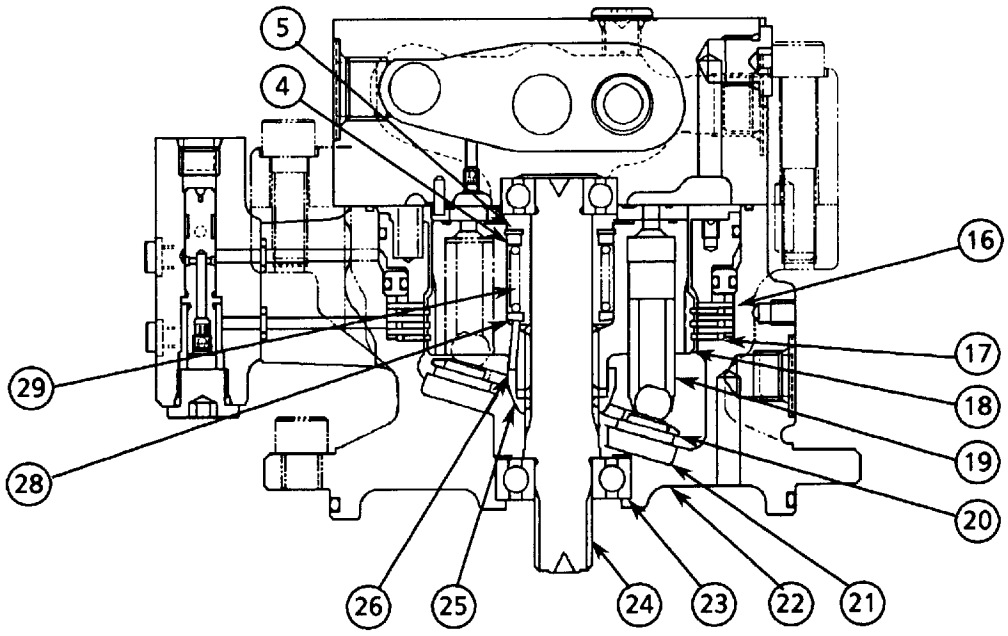
**IMPORTANT: Align the removed tooth section of three disk plates (17) when installing them in case (22) for proper oil lubrication.**

5. Install plungers (19) onto retainer (20) and install the assembly into rotor (18).

**IMPORTANT: Be sure to position retainer (20) correctly when installing the plungers. Apply a film of sufficient lubrication oil to the plunger bores of rotor (18) before installing the plungers.**

6. Turn case (22) 90° so that shaft (24) is horizontal. Install rotor (18) assembly onto shaft (24) in case (22).

**IMPORTANT: After installing, raise case (22) and check that the rotor is correctly installed.**




T554-02-04-001

7. Install friction plate (16), the last of three, in case (22).

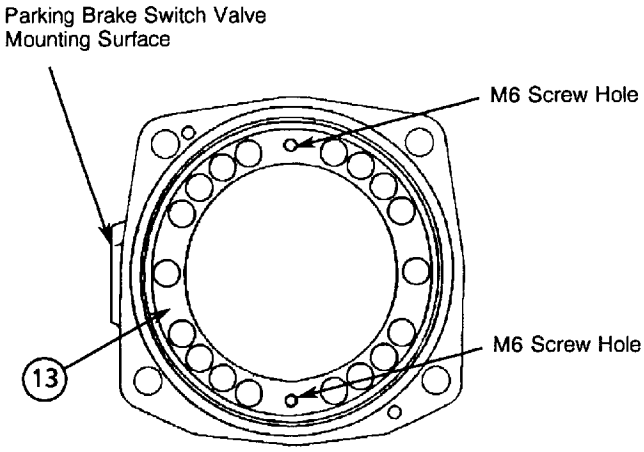
8. Install O-rings (14, 15) onto collar (31), then press collar (31) in case (22).

**IMPORTANT: Always use a press when installing collar (31) in case (22). Do not tap collar (31) with a plastic hammer, as this vibrates rotor (18), causing disk plates (17) to fall off.**

9. Install O-ring (12) onto brake piston (13), then press brake piston (13) in case (22).

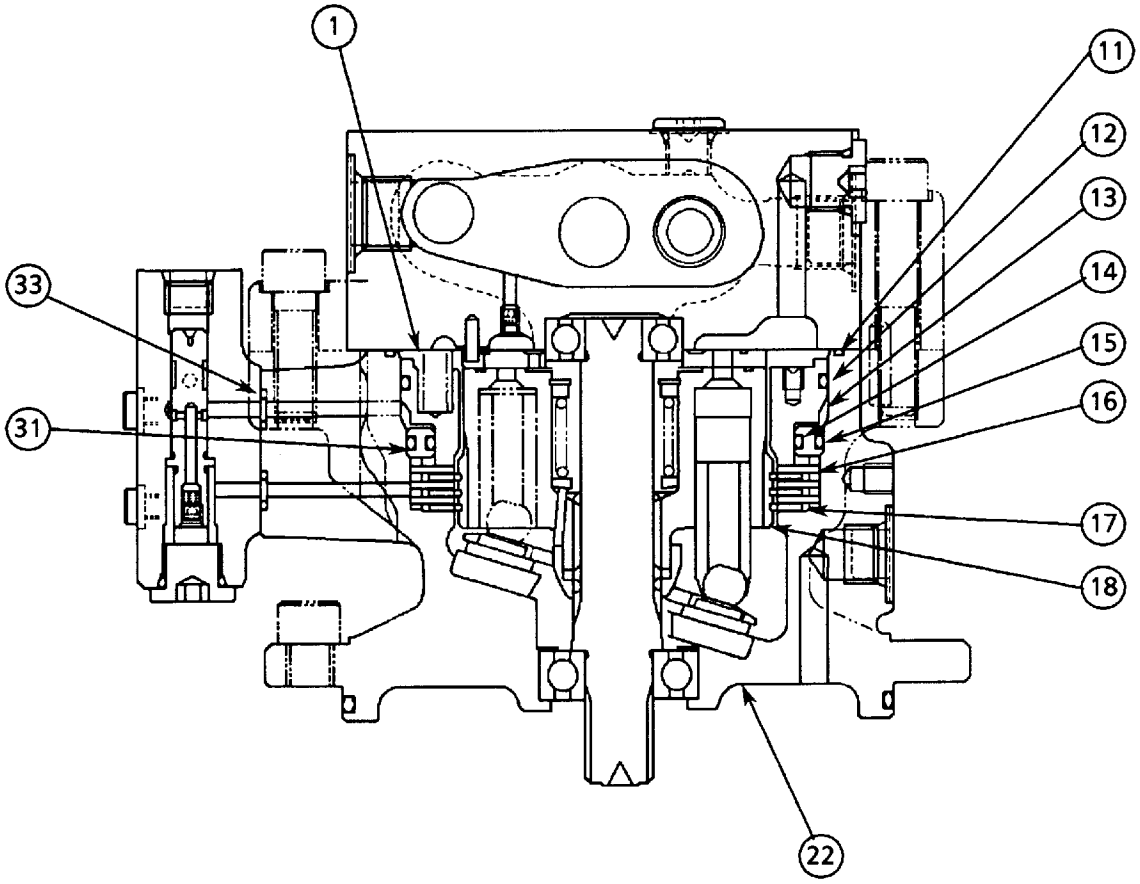
**IMPORTANT: Position brake piston (13) as illustrated to the right when installing it in case (22).**

**IMPORTANT: Always use a press when installing brake piston (13) in case (22). Do not tap brake piston (13) with a plastic hammer, as this vibrates rotor (18), causing disk plates (17) to fall off.**




W102-02-06-034

10. Install springs (1) and O-rings (11, 33).




T554-02-04-001

11. Press ball bearing (6) in brake valve cover (7).

12. Apply grease to valve plate (10) and install it on cover (7).

13. Install cover (7) on case (22).

*NOTE: Take care not to drop valve plate (10) when installing cover (7).*

: 10 mm

: 128 ± 7 N·m (13.1 ± 0.7 kgf·m)

14. Install relief valves (8) on cover (7).

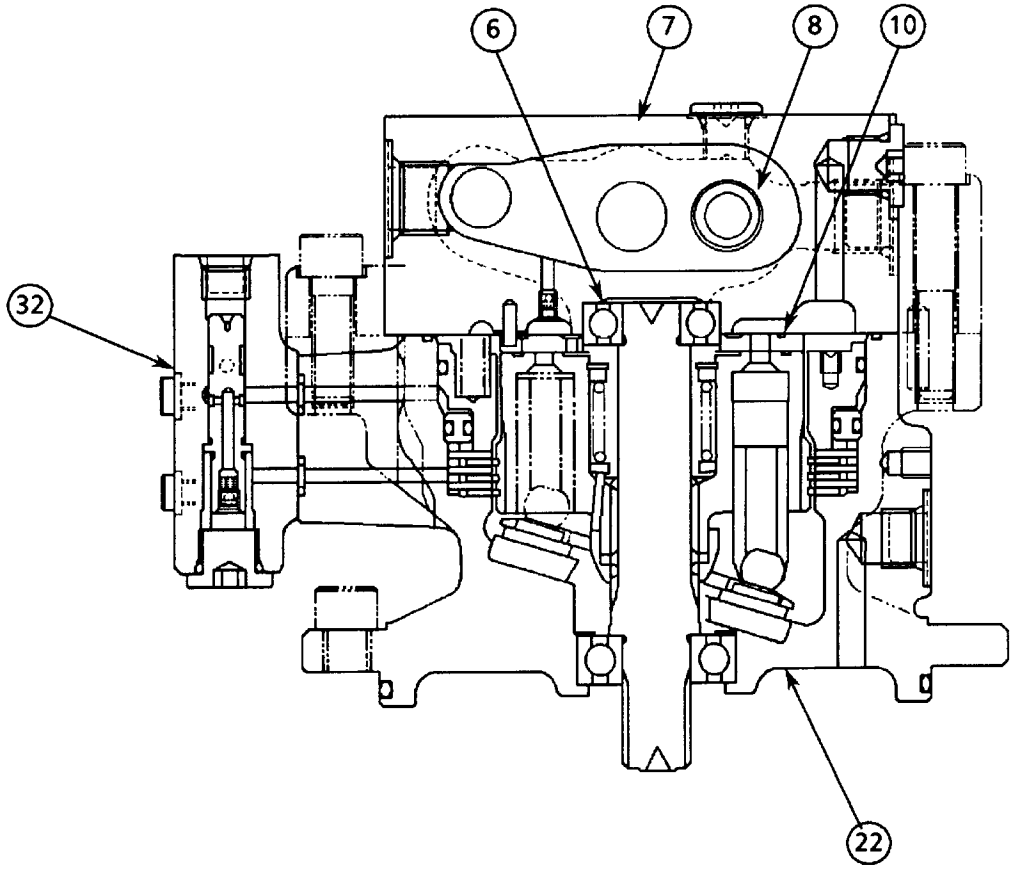
: 32 mm

: 275 ± 10 N·m (28 ± 1 kgf·m)

15. Install parking brake switch valve (32) on case (22).

: 5 mm

: 10 ± 1 N·m (1 ± 0.1 kgf·m)




T554-02-04-001

## DISASSEMBLE AND ASSEMBLE PARKING BRAKE SWITCH VALVE

### Disassemble Parking Brake Switch Valve

1. Clamp valve housing (9) in a vise. Remove plug (6), spring (8) and spool (1) from housing (9).

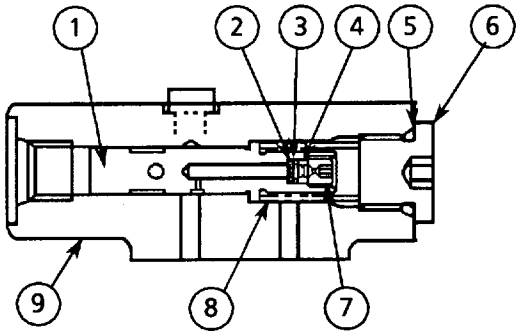
**IMPORTANT: Do not clamp the mating surface of valve housing (9) with the motor housing when clamping housing (9) in a vise.**

: 8 mm

2. Clamp spool (1) in a vise. Remove orifice (7), orifice (4), washer (3) and filter (2).

**IMPORTANT: Take care not to deform spool (1) by applying excessive force or to damage its sliding surfaces when clamping it in a vise.**

: 3 mm




W102-02-06-020

**Assemble Parking Brake Switch Valve**

1. Clamp spool (1) in a vise. Install filter (2), washer (3) and orifice (4) into spool (1). Apply Loctite #572 to orifice (7). Install orifice (7) into spool (1) and tighten to specification.

**IMPORTANT: Do not apply too much Loctite #572 to orifice (7), otherwise plugging may occur.**

**IMPORTANT: Take care not to deform spool (1) by applying excessive force or to damage its sliding surfaces when clamping it in a vise.**

: 3 mm

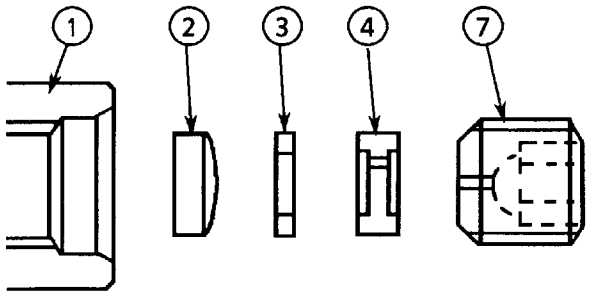
: 4.9 N·m ( 0.5 kgf·m )

2. Clamp valve housing (9) in a vise. Install spool (1) and spring (8) into housing (9). Install O-ring (5) on plug (6). Install plug (6) into housing (9) and tighten to specification.

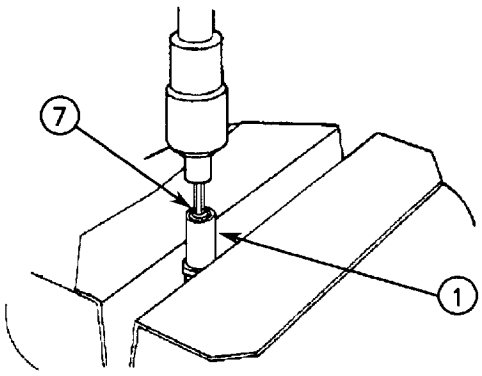
**IMPORTANT: Do not clamp the mating surface of valve housing (9) with the motor housing when clamping housing (9) in a vise.**

: 8 mm

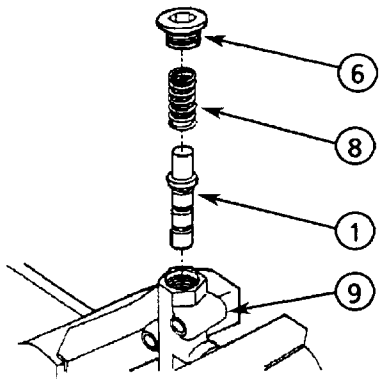
: 39.2 N·m ( 4 kgf·m)




W102-02-06-023




W102-02-06-022

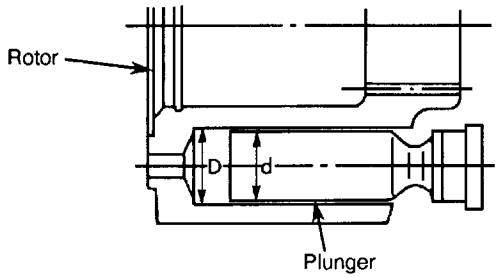



W102-02-06-021

## MAINTENANCE STANDARD

1. Clearance between rotor bore (D) and plunger diameter (d):

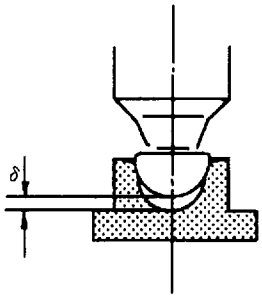
   $D - d \leq 0.040$ mm



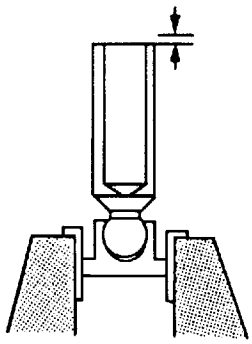

W507-02-04-009

2. Clearance between the plunger and shoe:

   $\delta \leq 0.4$ mm




W107-02-06-140

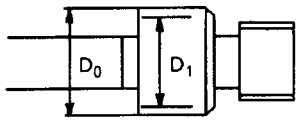


W107-02-06-141

3. The wear amount of oil seal mounting surface:

   $D_0 - D_1 \leq 0.025$ mm

   The surface must be free of scratches.




W509-02-04-010

## REMOVE AND INSTALL FRONT PILOT VALVE

**CAUTION:**

1. **Hydraulic fluid under pressure can penetrate the skin or eyes, causing serious injury. Avoid this hazard by relieving pressure before disconnecting any hydraulic lines.**
2. **Hydraulic oil becomes hot during operation. Disconnecting hydraulic lines soon after operation can result in severe burns. Wait for the oil and components to cool before starting work.**

**Preparation:**

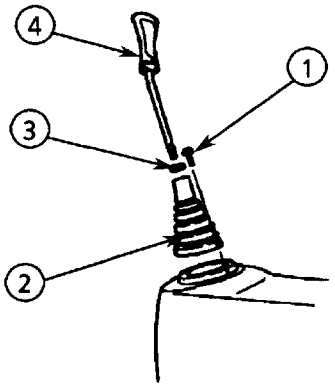
1. Place the machine on a solid, level surface, and lower the bucket to the ground.
2. Stop the engine. Operate the control levers several times to release any residual pressure in the hydraulic lines. Slowly remove the cap to release the pressure in the hydraulic oil tank.

Remove Front Pilot Valve

1. Remove pins (1). Loosen nut (3) and remove lever (4).

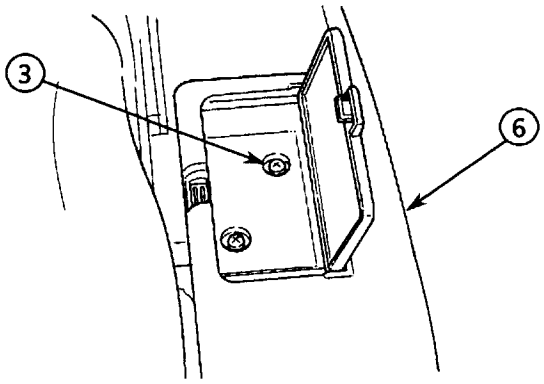
: 22 mm

*NOTE: Disconnect harnesses in boot (2).*




W532-02-06-001

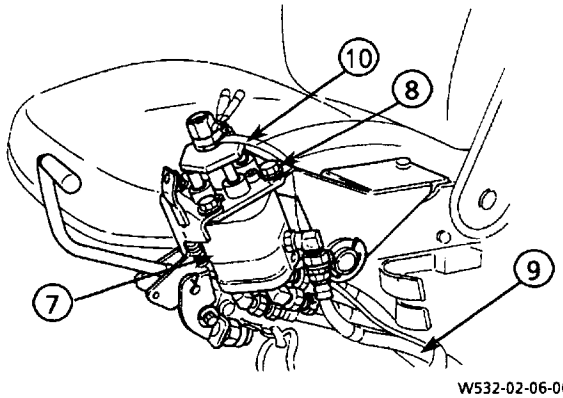
2. Loosen screws (3) and remove cover (6).




W532-02-06-002

3. Remove pilot valve (7) mounting bolts (8). Disconnect hoses (9) and harnesses (10) from pilot valve (7).

: 13 mm, 19 mm



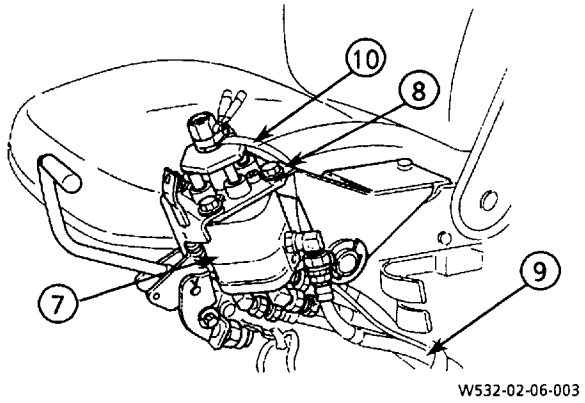

W532-02-06-003

**Install Front Pilot Valve**

1. Connect hoses (9) and harnesses (10). Install pilot valve (7) and tighten bolts (8).

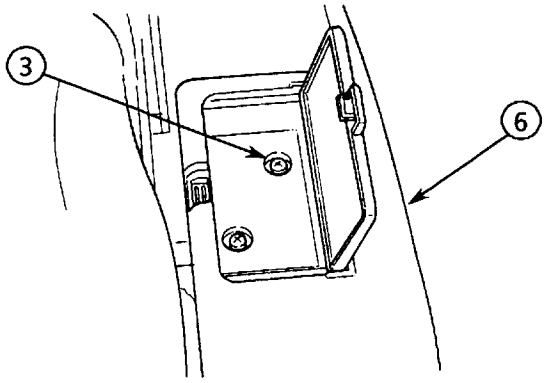
: 19 mm : 29 N·m ( 3 kgf·m )

: 13 mm : 9.8 N·m ( 1 kgf·m )




W532-02-06-003

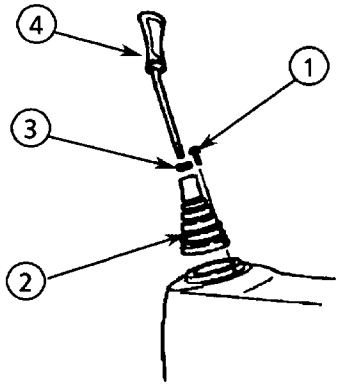
2. Install cover (6) and tighten bolts (3).




W532-02-06-002

3. Install lever (4) and tighten nut (3). Install pins (1) to secure boot (2).

: 22 mm : 137 N·m ( 14 kgf·m )




W532-02-06-001

*NOTE: Connect harnesses in boot (2).*

**IMPORTANT: After connecting the hoses, fill the hydraulic oil tank with oil to the correct level. Start the engine and check the hoses for leakage.**

## REMOVE AND INSTALL SWING PILOT VALVE

**CAUTION:**

1. **Hydraulic fluid under pressure can penetrate the skin or eyes, causing serious injury. Avoid this hazard by relieving pressure before disconnecting any hydraulic lines.**
2. **Hydraulic oil becomes hot during operation. Disconnecting hydraulic lines soon after operation can result in severe burns. Wait for the oil and components to cool before starting work.**

**Preparation:**

1. Place the machine on a solid, level surface, and lower the bucket to the ground.
2. Stop the engine. Operate the control levers several times to release any residual pressure in the hydraulic lines. Slowly remove the cap to release the pressure in the hydraulic oil tank.

### Remove Swing Pilot Valve

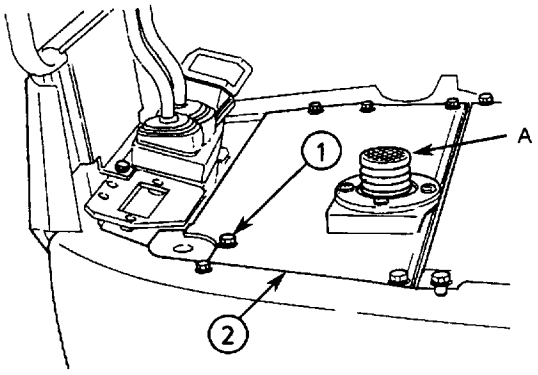
1. Remove the floor mat. Loosen bolts (1) and remove floor plate (2).

: 17 mm

*NOTE: Disconnect harnesses from travel speed change pedal (A).*

2. Loosen bolts (3) and remove pilot valve (4). Disconnect hoses (5) from pilot valve (4).

: 8 mm : 19 mm




W532-02-06-004

### Install Swing Pilot Valve

1. Connect hoses (5) to pilot valve (4).

: 19 mm : 29 N·m ( 3 kgf·m )

2. Install pilot valve (4) and tighten bolts (3).

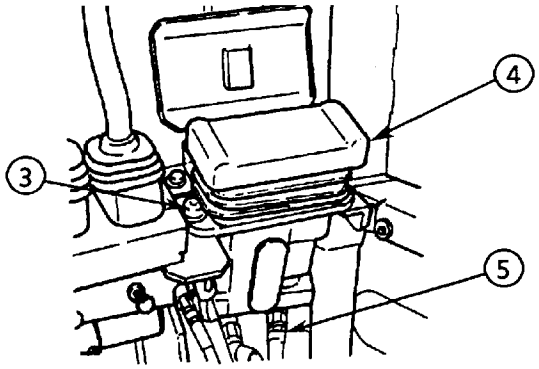
: 8 mm : 49 N·m ( 5 kgf·m )

3. Install floor plate (2) and tighten bolts (1).

*NOTE: Connect harnesses to travel speed change pedal (A).*

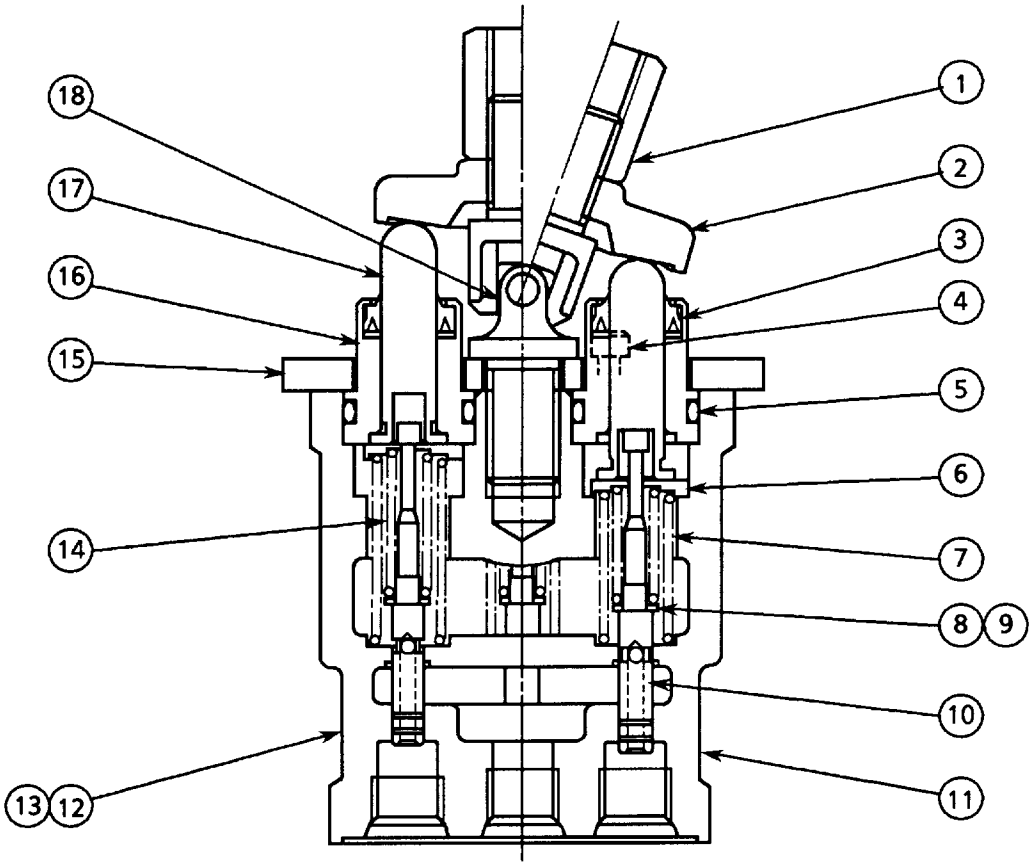
: 17 mm : 49 N·m ( 5 kgf·m )

**IMPORTANT: After connecting the hoses, fill the hydraulic oil tank with oil to the correct level. Start the engine and check the hoses for leakage.**




W532-02-06-005

## DISASSEMBLE FRONT PILOT VALVE




W532-02-06-006

1— Screw Joint
2— Cam
3— Oil Seal
4— Socket Bolt
5— O-Ring
6— Spring Guide
7— Spring
8— Spacer
9— Shim
10— Spool
11— Housing
12— Plug
13— O-Ring
14— Spring
15— Plate
16— Bushing
17— Pusher
18— Universal Joint

**Disassemble Front Pilot Valve**

- As housing (11) and spool (10) are finished in the selective fit dimension, they must be replaced as a set. Do not attempt to replace only one part.
- Attach tags with port number to the disassembled parts so that they can be grouped by the port No.. Port No. are cast on the periphery of housing (11).

1. First, loosen cam (2), then remove universal joint (18) from housing (11).

   : 50 mm

2. Remove cam (2) and screw joint (1) from universal joint (18).

   : 19 mm, 50 mm

3. Remove plug (12) from housing (11).

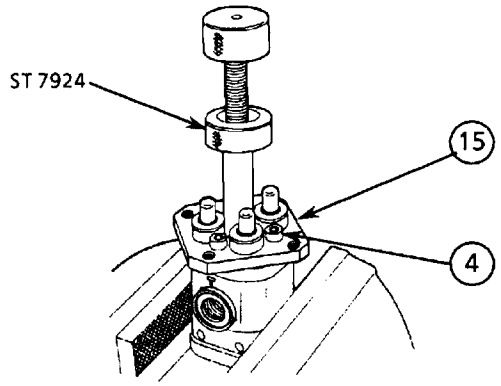
   : 6 mm

4. Install special tool (ST 7924) to the universal joint mounting hole on housing (11), then tighten plate (15). Remove four socket bolts (4).

   Special Tool: ST 7924

   : 5 mm

5. Gradually loosen tool (ST 7924); spool (10) assembly and plate (15) are raised by spring force.



W554-02-07-006

6. Remove tool (ST 7924) and plate (15) from housing (11).

   Special Tool: ST 7924

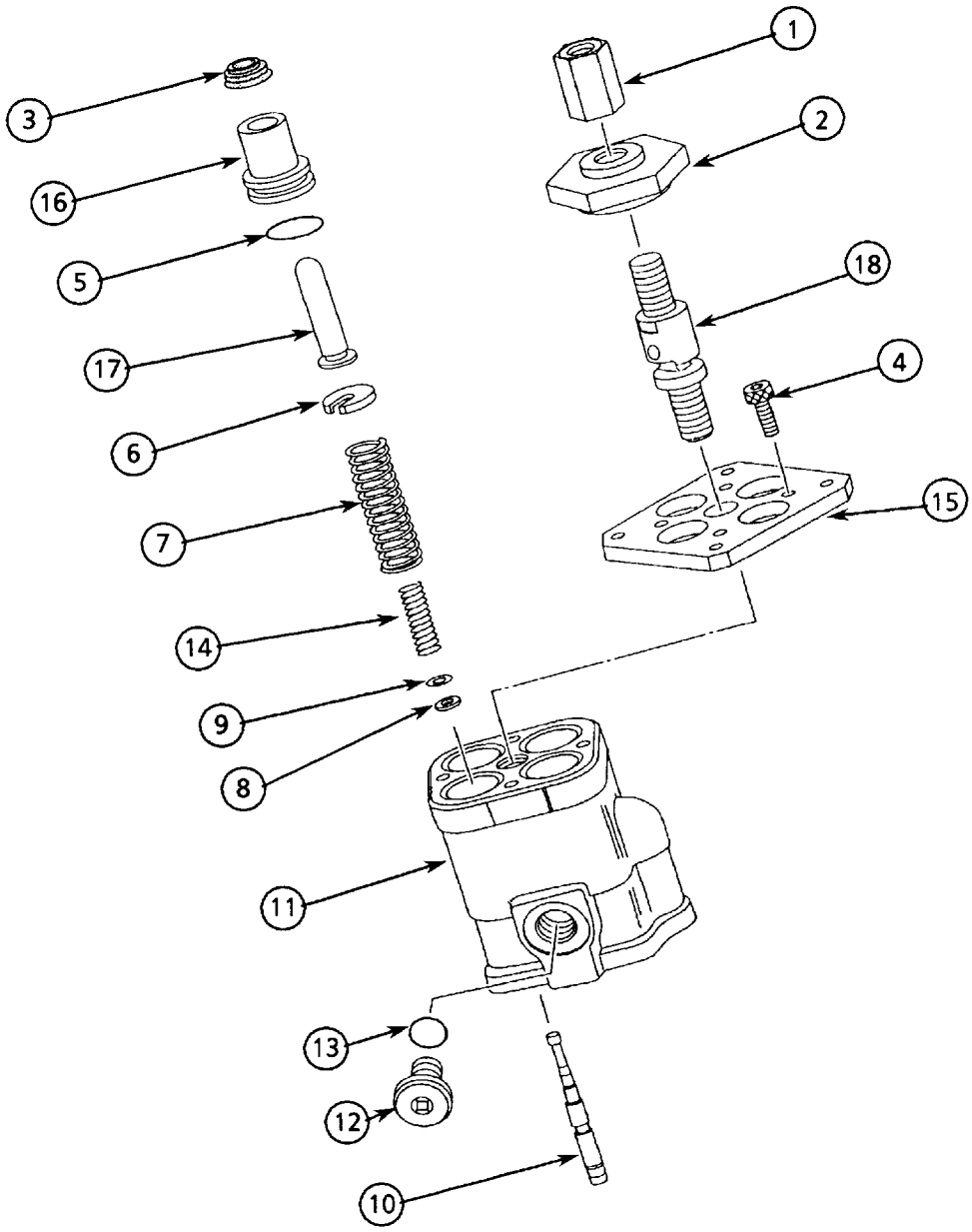
7. Remove pusher (17) assembly. Remove pusher (17), O-ring (5) and oil seal (3) from bushing (16).

8. Remove spool (10) assemblies from each port.

**IMPORTANT: In order to avoid mixing the parts up, attach the port No. tags to the parts to discriminate from which ports the parts were removed.**

9. Compress spring (7) to remove spring guide (6) from spool (10). Remove spacer (8) and shims (9) from spool (10).

## ASSEMBLE FRONT PILOT VALVE




W532-02-06-007

1— Screw Joint
2— Cam
3— Oil Seal
4— Socket Bolt
5— O-Ring
6— Spring Guide
7— Spring
8— Spacer
9— Shim
10— Spool
11— Housing
12— Plug
13— O-Ring
14— Spring
15— Plate
16— Bushing
17— Pusher
18— Universal Joint

**Assemble Front Pilot Valve**

Clean all disassembled parts with cleaning oil. In order to avoid mixing them up, group them by port No..

1. Install shims (9), spacer (8) and spring (14) on spool (10). Compress spring (14) and install spring guide (6) between spool (10) and spring (14).

*NOTE: Since the number of the shims is determined during performance testing at the factory, take care not to lose them.*

**IMPORTANT: One face of spring guide (6) is the spring seat. Be sure to install spring guide (6) with the spring seat side down (facing toward spring (14)).**

2. Install springs (7) into housing (11).

3. Insert spool (10) assemblies into housing (1).

**IMPORTANT: Be sure to install each spool (10) assembly to the same port from which the spool assembly was removed.**

4. Install oil seal (3) and O-ring (5) on bushing (16). Insert pusher (17) into bushing (16).

**IMPORTANT: Install oil seal (3) in the correct direction.**
**Apply grease to the lips of oil seal (3) and the inside of bushing (16).**

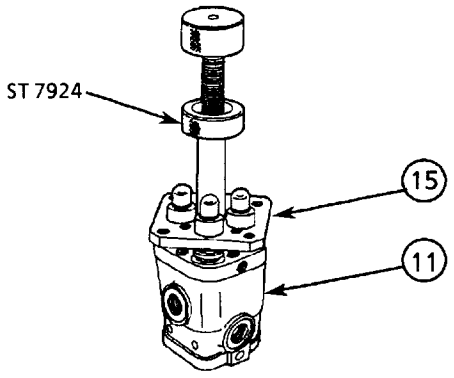
Use one of the following greases:
- Apolloil Autorex (Idemitsu)
- Ocean 7 (Nihon Ore Louve)
- Screw Bar L60 (NOK)

Oil Seal Installer: ST 2292

5. Place pushers (17) (4 used) on each spool (10) assembly.

6. Install plate (15) on pushers (17). Install special tool (ST 7924) to the universal joint mounting hole on housing (11).

Special Tool: ST 7924

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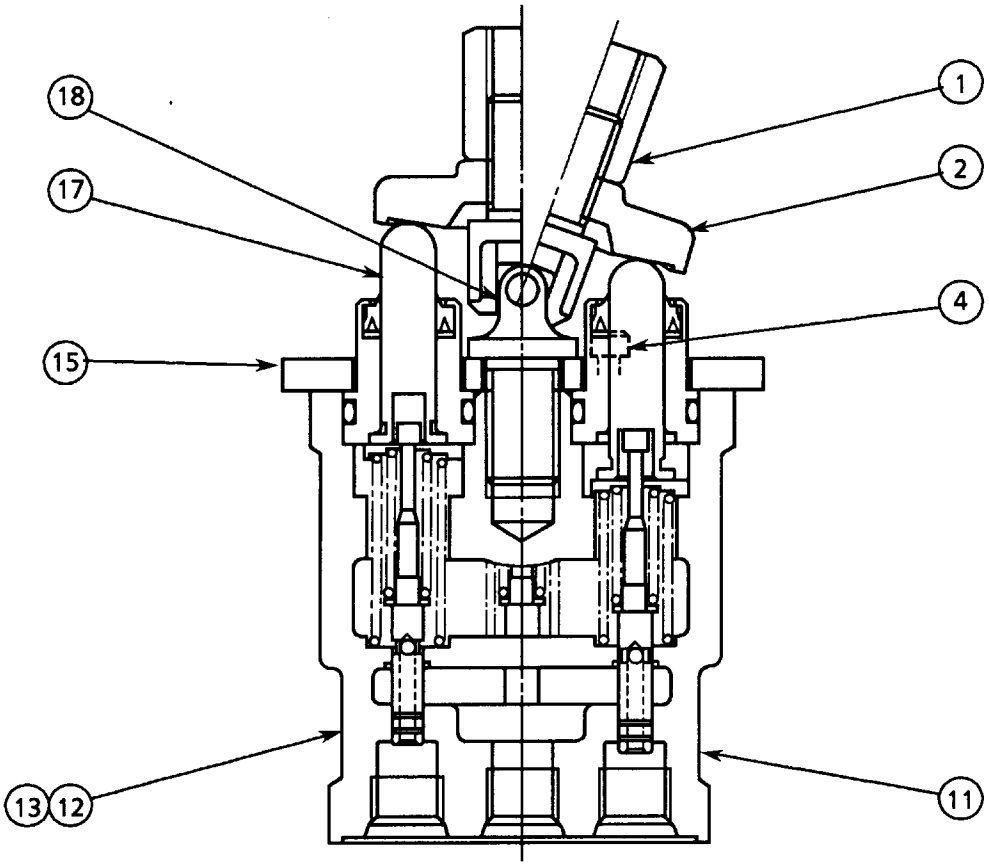



W532-02-06-006

7. Tighten four socket bolts (4) to secure plate (15).

: 14.7 N·m ( 1.5 kgf·m )

: 5 mm

8. Install screw joint (1) on universal joint (18). Apply Loctite #262 to universal joint (18) threads. Install universal joint (18) onto housing (11).
Remove screw joint (1).

**IMPORTANT: In order to keep universal joint (18) from loosening, tightly hold it using a screw driver when removing joint screw (1).**

: 24.5 N·m ( 2.5 kgf·m )

: 19 mm

Loctite: #262

9. Apply sufficient grease to the joint of universal joint (18). Apply grease to the top of pushers (17).

10. Install cam (2) on universal joint (18).

11. Tighten cam (2) so that the clearance between pushers (17) and cam (2) is 0 to 0.2 mm (use a thickness gauge). Tighten screw joint (1) to lock pushers (17) and cam (2) in position.

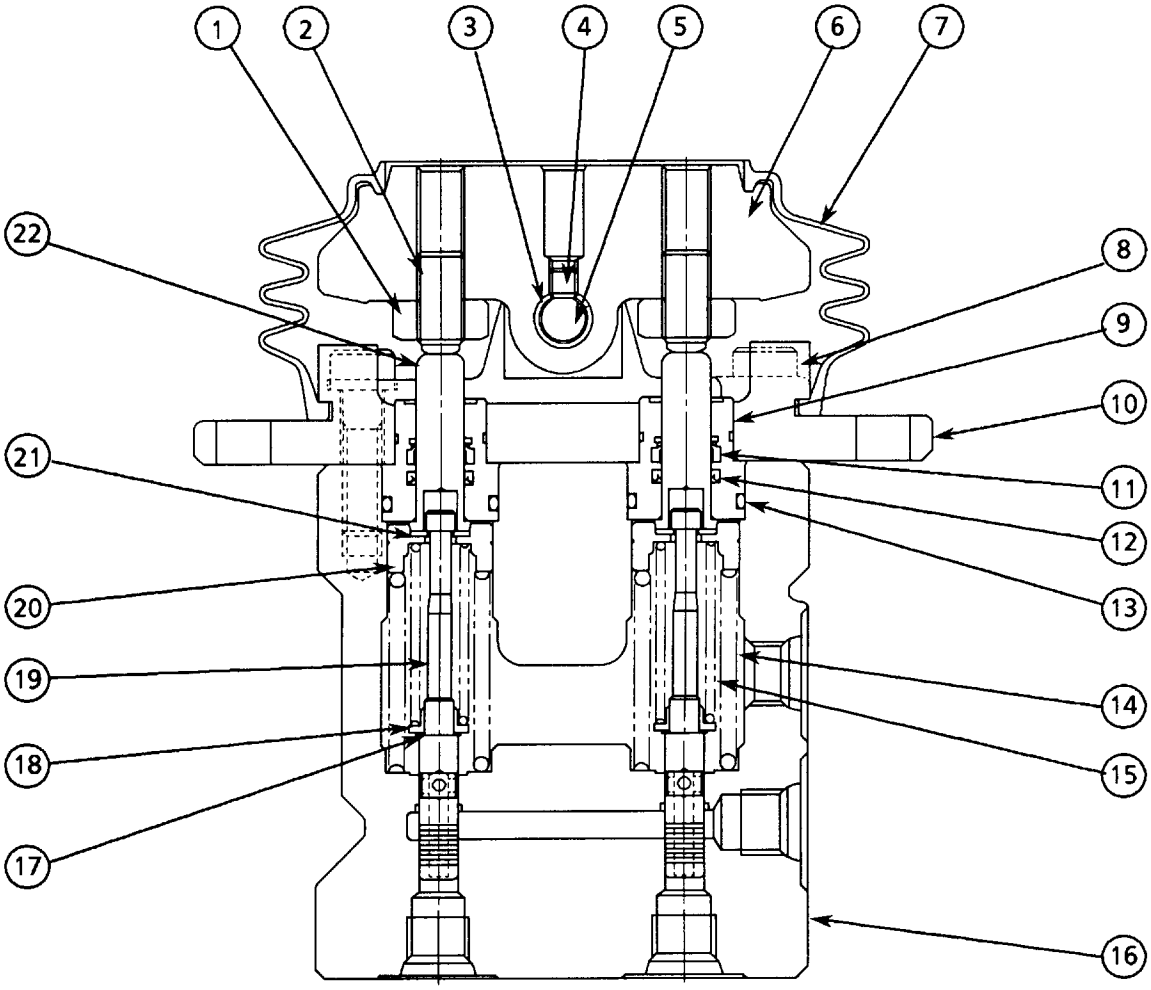
: 68.6 to 88.3 N·m ( 7 to 9 kgf·m )

: 19, 50 mm

12. Install plug (12) on housing (11).

: 34.3 N·m ( 3.5 kgf·m )

## DISASSEMBLE SWING PILOT VALVE




T554-02-07-010

1— Locknut
2— Setscrew
3— Bushing
4— Setscrew
5— Pin
6— Cam
7— Boot
8— Socket Bolt
9— Bushing
10— Plate
11— Dust Seal
12— Oil Seal
13— O-Ring
14— Return Spring
15— Balance Spring
16— Housing
17— Shims
18— Spacer
19— Spool
20— Spring Guide
21— Washer
22— Pusher

**Disassemble Swing Pilot Valve**

1. Clamp the pilot valve in a vise. Loosen setscrew (4) and remove pin (5). Remove cam (6) from plate (10).

: 3 mm : less than 8 mm

2. Alternately loosen socket bolts (8), and remove plate (10) and pusher (22) assemblies.

**IMPORTANT: Record the relative locations between pusher (22) assemblies and housing. Pusher (22) assemblies may fly off by the force of springs (14).**

: 6 mm

3. Remove pusher (22), O-ring (13), oil seal (12) and dust seal (11) from bushing (9).

4. Remove spool (19) assemblies and springs (14) from each port.

**IMPORTANT: In order to avoid mixing the parts up, attach the port No. tags to the parts to discriminate from which ports the parts were removed.**

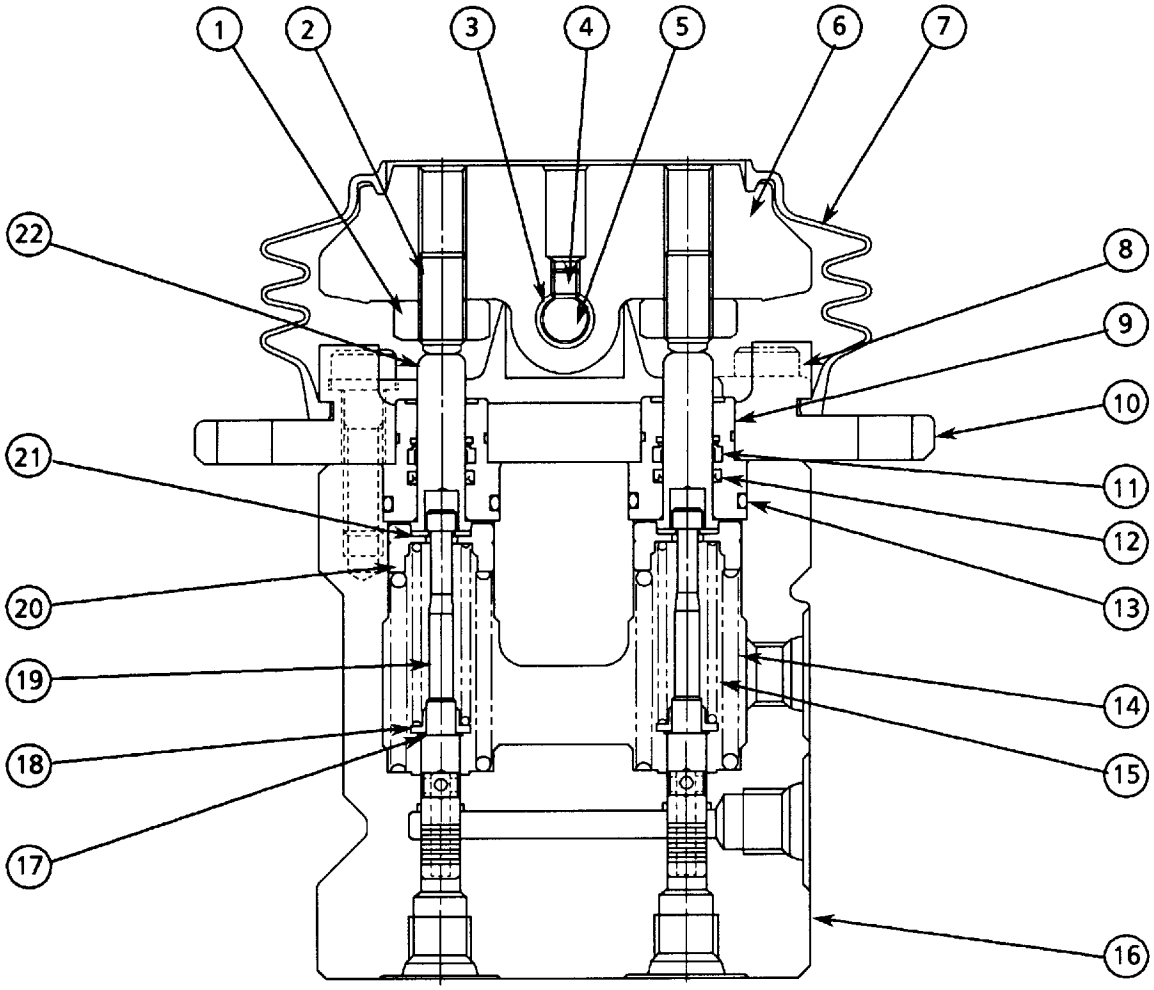
5. Compress spring (15) to remove washer (21) and spring guide (22) from spool (19). Remove spacer (18) and shims (17) from spool (19). Disassemble other three spool (19) assemblies in the same manner.

6. Clamp cam (6) assembly in a vise. Remove locknut (1) and setscrew (2).

**IMPORTANT: Do not remove setscrew (2) unless replacement is necessary, as the neutral adjustment is required when reassembling it.**

: 17 mm : 5 mm

## ASSEMBLE SWING PILOT VALVE




T554-02-07-010

1— Locknut
2— Setscrew
3— Bushing
4— Setscrew
5— Pin
6— Cam
7— Boot
8— Socket Bolt
9— Bushing
10— Plate
11— Dust Seal
12— Oil Seal
13— O-Ring
14— Return Spring
15— Balance Spring
16— Housing
17— Shims
18— Spacer
19— Spool
20— Spring Guide
21— Washer
22— Pusher

**Assemble Swing Pilot Valve**

Clean all disassembled parts with cleaning oil. In order to avoid mixing them up, group them by port numbers. Always replace used O-rings, oil seals and dust seals with new ones when re-assembling.

1. Install shims (17), spacer (18) and spring (15) on spool (19). Compress spring (15) and install spring guide (20) and washer (21) between spool (19) and spring (15).

**IMPORTANT: Install washer (21) with the sharp edge side up. Do not lower spring guide (20) more than 4 mm. One face of spring guide (20) is the spring seat. Install spring guide (20) in the correct direction.**

2. Insert spring (14) and spool (19) assembly into housing (16).

**IMPORTANT: Be sure to install each spool (19) assembly to the same port from which the spool assembly was removed.**

3. Install oil seal (12), dust seal (11) and O-ring (13) on bushing (9). Insert pusher (22) into bushing (9).

**IMPORTANT: Install oil seal (12) and dust seal (11) in the correct direction. Apply grease to the lips of oil seal (12) and dust seal (11) and the inside of bushing (9).**

Use one of the following greases:
- Apolloil Autorex (Idemitsu)
- Ocean 7 (Nihon Ore Louve)
- Screw Bar L60 (NOK)

4. Place pushers (22) and plate (10) on each spool (19), and alternately tighten socket bolts (8) (2 used).

: 6 mm

: 29.4 ± 2.9 N·m ( 3.0 ± 0.3 kgf·m )

5. Temporarily install setscrews (2) and locknuts (1) onto cam (6) and install them on plate (10). Insert pin (5).

: 5 mm

6. Apply Loctite #241 to setscrew (4) and install it into cam (6). Loctite: #241

: 3 mm

: 6.9 ± 1 N·m ( 0.7 ± 0.1 kgf·m )

7. Adjust setscrews (2) so that the clearance between pushers (22) and setscrews (2) is 0 mm. Tighten locknuts (1).

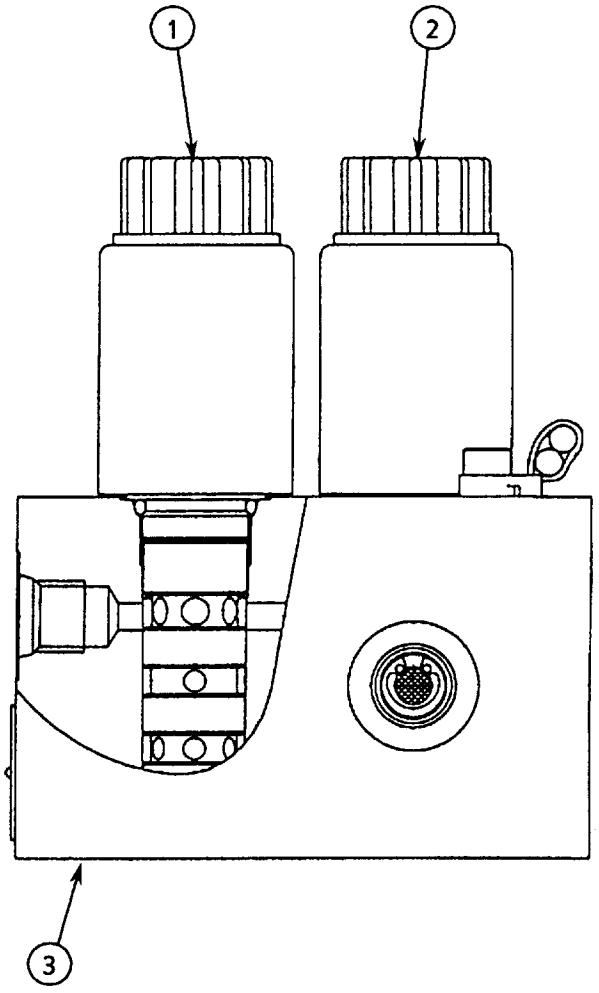
: 17 mm : 5 mm

: 33.3 ± 3.4 N·m ( 3.4 ± 0.4 kgf·m )

8. Apply grease to pushers (22) while tilting cam (6).

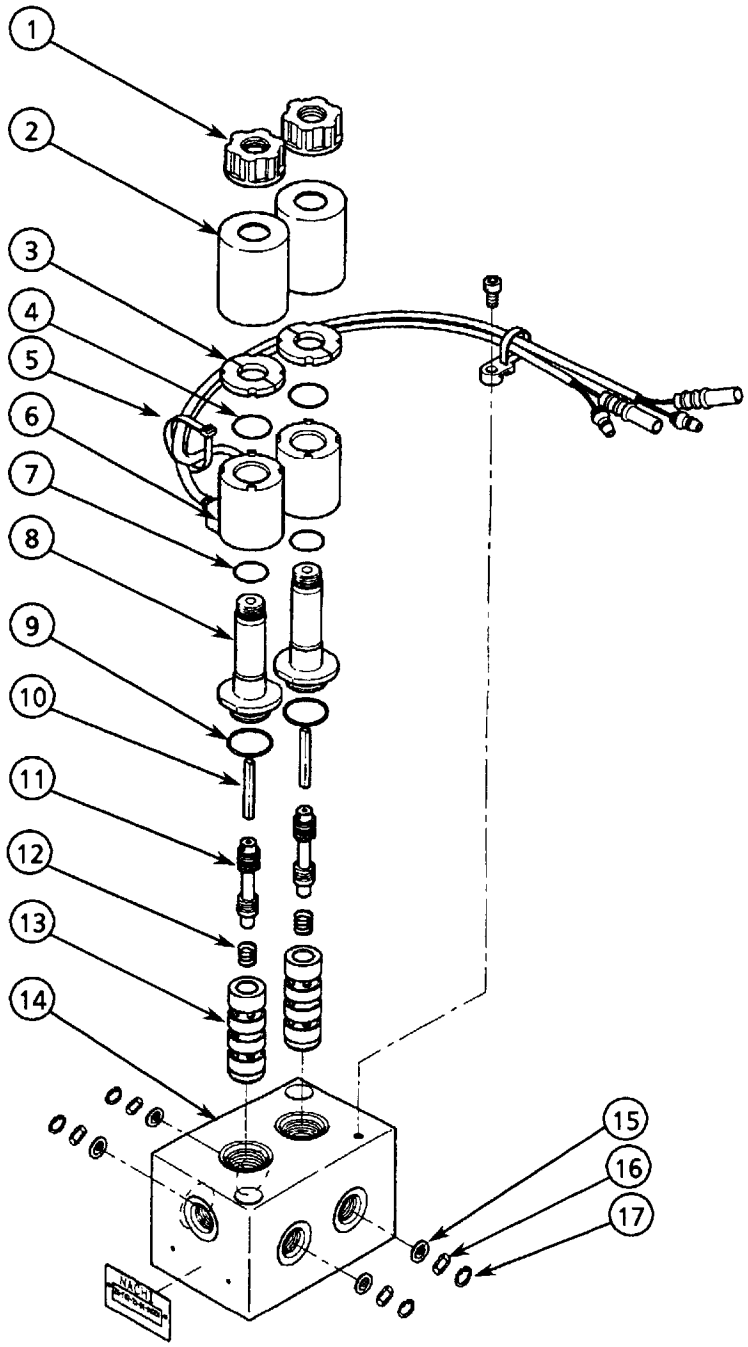
9. Install boot (7) on plate (10).

## DISASSEMBLE AND ASSEMBLE AUTO BOOM-STOP SOLENOID VALVE




W532-02-07-001

1— Proportional Solenoid Valve (Boom Raise)
2— Proportional Solenoid Valve (Swing Right)
3— Housing




W532-02-07-002

1— Nut (2 used)
2— Coil Case (2 used)
3— Coil Yoke (2 used)
4— O-Ring (2 used)
5— Harness Clamp
6— Coil (2 used)
7— O-Ring (2 used)
8— Guide (2 used)
9— O-Ring (2 used)
10— Rod (2 used)
11— Spool (2 used)
12— Spring (2 used)
13— Sleeve (2 used)
14— Housing
15— Filter (4 used)
16— Washer (4 used)
17— Retaining (4 used)

### Disassemble Auto Boom-Stop Solenoid Valve

Thoroughly clean the valve periphery and place it on a workbench.

1. Clamp housing (14) in a vise.
2. Cut harness clamp (5) and remove it.
3. Loosen nuts (1) and remove coil cases (2).

: 27 mm

4. Remove coil yokes (3), O-rings (4), coils (6) and O-rings (7).
5. Remove guides (8) from housing (14).

: 30 mm

6. Remove O-ring (9) and rod (10) from guide (8).
7. Remove spools (11), springs (12) and sleeves (13) from housing (14).
8. Remove retaining rings (17) from housing (14), then remove washers (16) and filters (15).

### Assemble Auto Boom-Stop Solenoid Valve

Before assembling, clean components and parts with cleaning oil and dry completely. Apply a film of clean hydraulic oil to inner parts before assembling. Always replace used O-rings and seals with new ones when re-assembling.

1. Install filter (15) and washer (16) into each port on housing (14), then install retaining ring (17) to secure them in position.
2. Insert sleeves (13), springs (12) and spools (11) into housing (14), in that order.
3. Insert rods (10) into guides (8). Install O-rings (9) onto guides (8)and install them into housing (14).

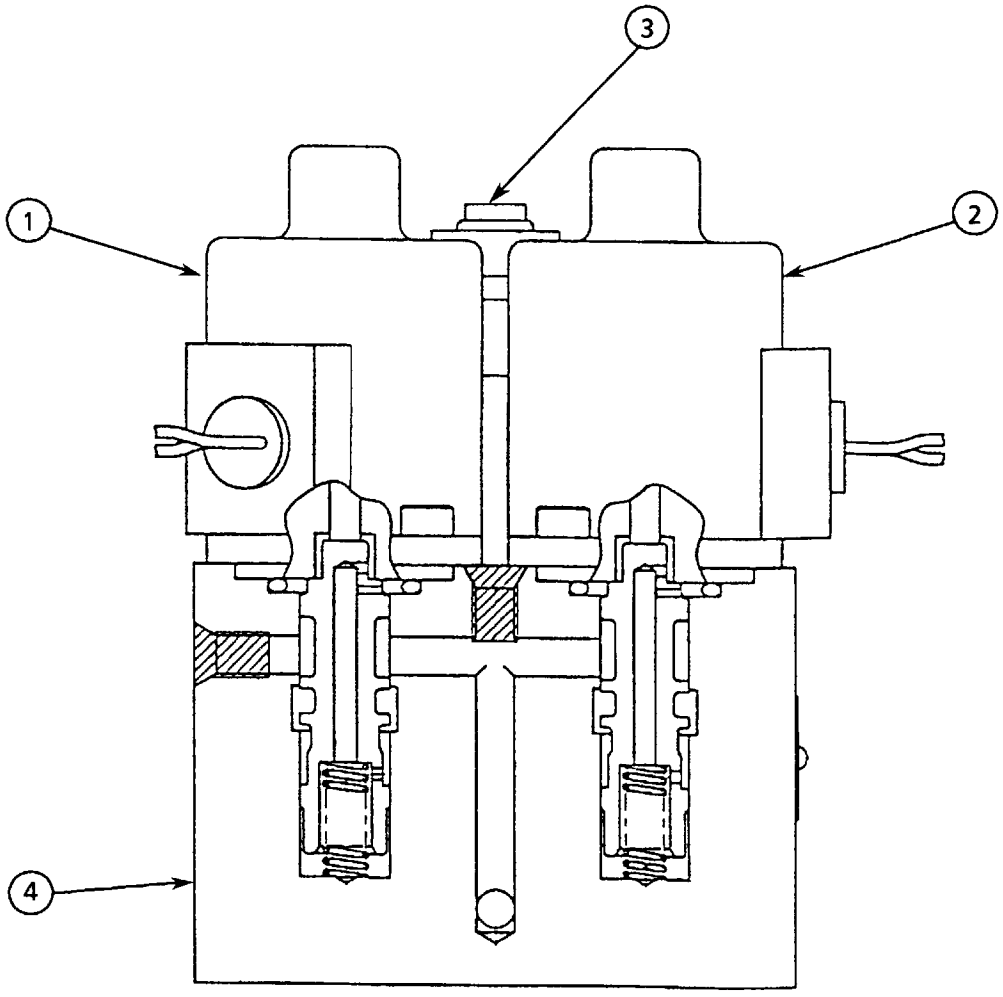
: 30 mm : 18 to 23 N·m (1.84 to 2.35 kgf·m)

4. Install O-rings (7), coils (6), O-rings (4) and coil yokes (3).
5. Install coil cases (2) and tighten nuts (1).

: 27 mm : 5 to 7 N·m (0.51 to 0.71 kgf·m)

6. Install harness clamp (5) to secure the harness in position.

## DISASSEMBLE AND ASSEMBLE PILOT CONTROL SHUT-OFF LEVER/TRAVEL SPEED CHANGE SOLENOID VALVE



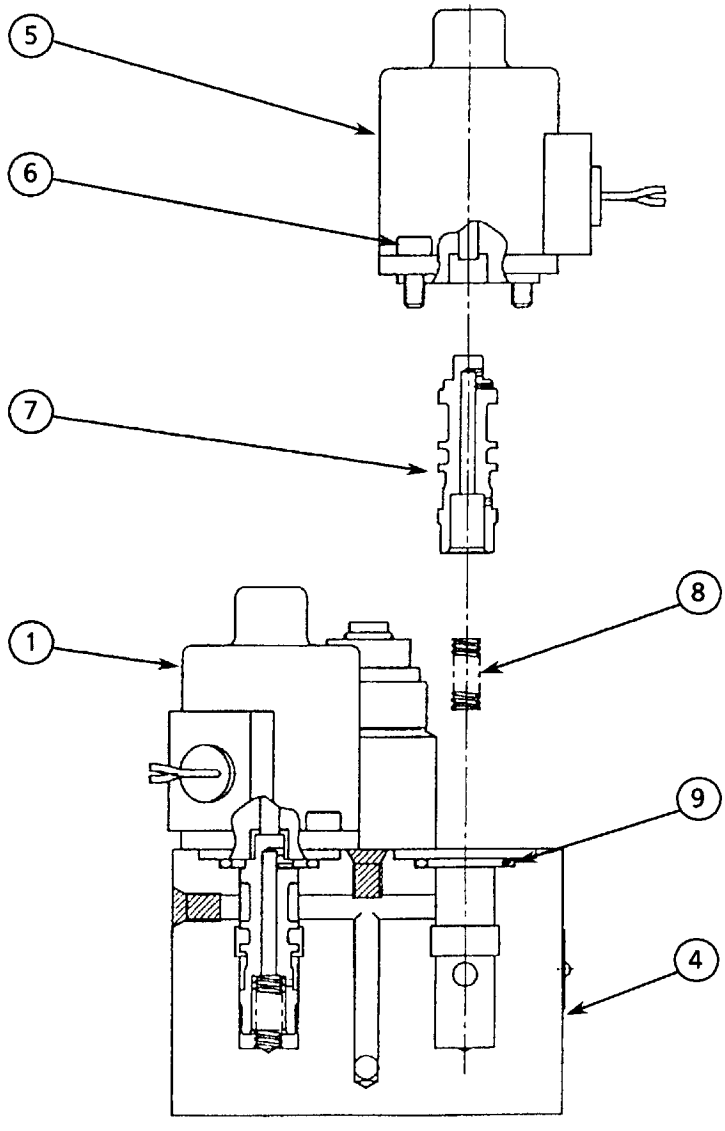

W532-02-07-003

1— On-Off Solenoid Valve (Travel Speed Changing)

2— On-Off Solenoid Valve (Pilot Control Shut-Off Lever)

3— Relief Valve

4— Housing




W532-02-07-004

1— On-Off Solenoid Valve (Travel Speed Changing)
4— Housing
5— Solenoid
6— Socket Bolt
7— Spool
8— Spring
9— O-Ring

### Disassemble Pilot Control Shut-Off Lever/Travel Speed Change Solenoid Valve

Thoroughly clean the valve and place it on a work-bench.

1. Clamp housing (4) in a vise.
2. Loosen socket bolts (6), then remove solenoid (5).

: 4 mm

*NOTE: Take care not to lose the pin when removing solenoid (5).*

3. Remove spool (7), spring (8) and O-ring (9) from housing (4).

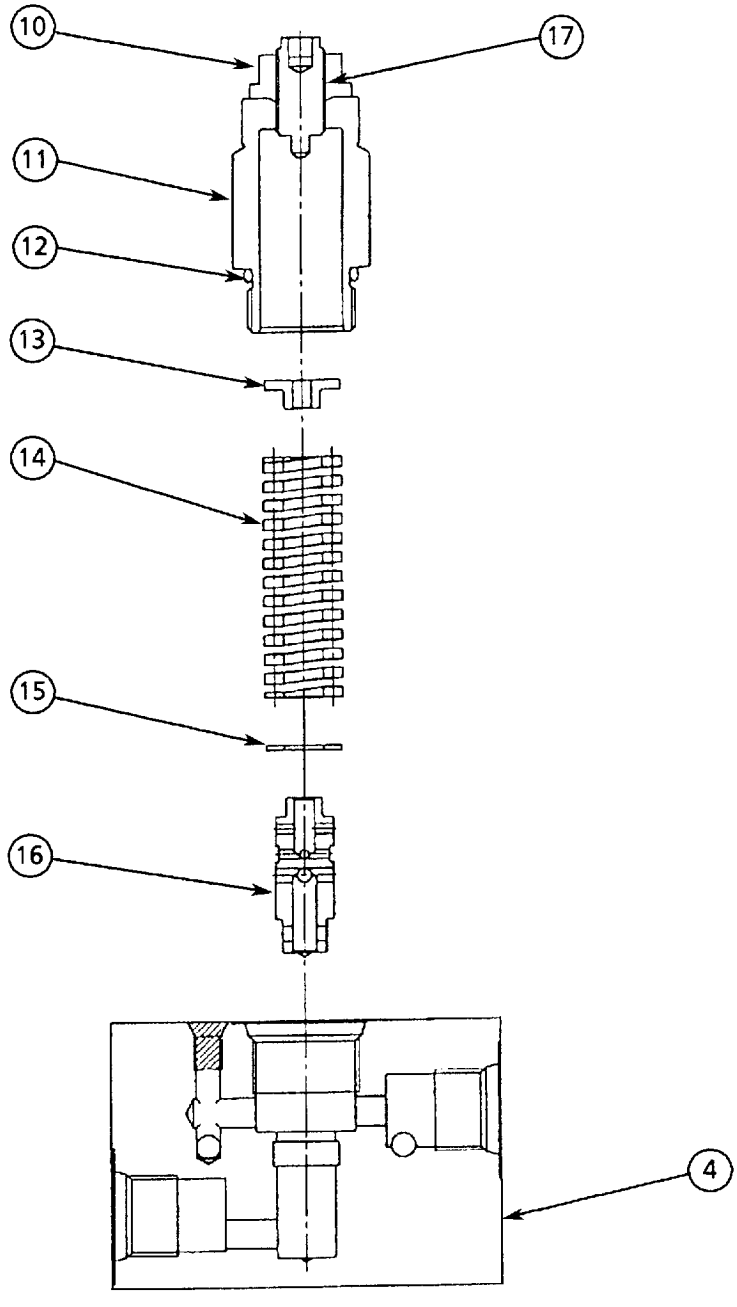
### Assemble Pilot Control Shut-Off Lever/Travel Speed Change Solenoid Valve

Before assembling, clean components and parts with cleaning oil and dry completely. Apply a film of clean hydraulic oil to inner parts before assembling. Always replace used O-rings and seals with new ones when re-assembling.

1. Install O-ring (9), spring (8) and spool (7) into housing (4), in that order.
2. Install solenoid (5) and tighten socket bolts (6).

: 4 mm : 3.3 to 4.4 N·m (0.35 to 45 kgf·m)

## DISASSEMBLE AND ASSEMBLE PILOT RELIEF VALVE




W532-02-07-005

4— Housing
10— Nut
11— Guide
12— O-ring
13— Spring Seat
14— Spring
15— Spring Seat
16— Spool
17— Adjusting Screw

### Disassemble Pilot Relief Valve

Thoroughly clean the valve and place it on a workbench.

1. Clamp housing (4) in a vise.
2. Loosen guide (11) and remove it from housing (4).

: 24 mm

**IMPORTANT: Do not loosen nut (10) as it has been tightened to lock adjusting screw (17) to keep the pressure setting.**

3. Remove spring seat (13), spring (14), spring seat (15) and spool (16) from housing (4), in that order.

### Assemble Pilot Relief Valve

Before assembling, clean components and parts with cleaning oil and dry completely. Apply a film of clean hydraulic oil to inner parts before assembling. Always replace used O-rings and seals with new ones when re-assembling.

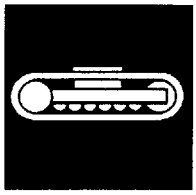
1. Install spool (16), spring seat (15), spring (14) and spring seat (13) into housing (4), in that order.
2. Install guide (11) on housing (4) and tighten to specification.

: 24 mm : 74 to 88 N·m (7.5 to 9 kgf·m)

**IMPORTANT: If nut (10) has been unavoidably removed, tighten it after adjusting the pressure while turning adjusting screw (17).**

: 17 mm : 20 to 29 N·m (2 to 3 kgf·m)

# SECTION 03
# UNDERCARRIAGE



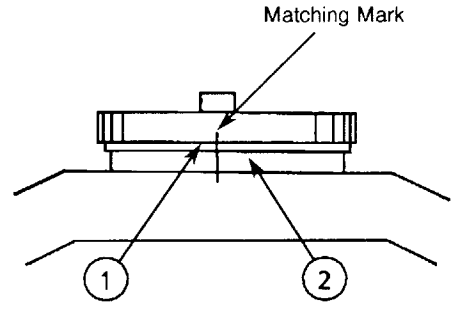
## CONTENTS

## REMOVE AND INSTALL SWING BEARING

### Remove Swing Bearing

The procedures given here should be followed after removing the upperstructure.

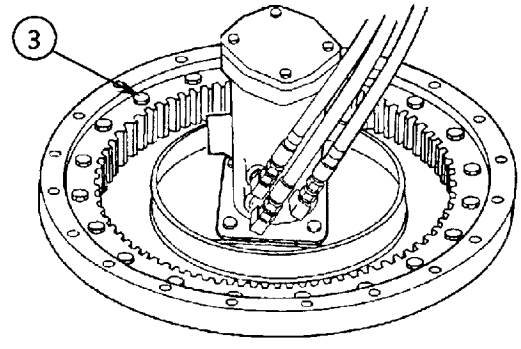
1. Make matching marks on the surfaces of swing bearing (1) inner and outer races and track frame (2) as illustrated.




W105-03-01-001

2. Remove bearing inner race mounting bolts (3).

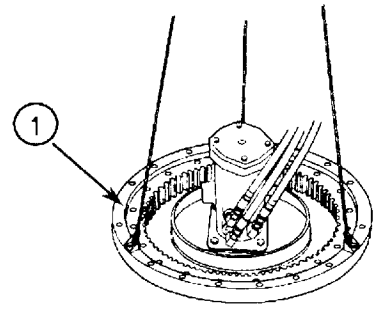
: 19 mm




W507-02-03-002

3. Attach swing bearing (1) to a crane using slings and lift it.

**CAUTION: Swing bearing weight :**
**45 kg ( 33Mu )**
**69.3 kg ( 58Mu )**

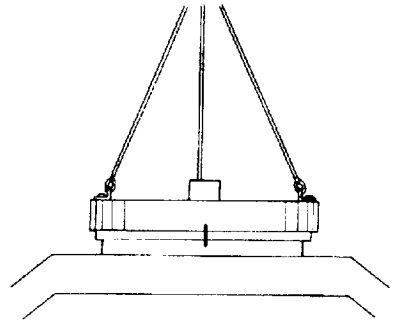



W507-03-01-001

### Install Swing Bearing

Thoroughly clean the mating surfaces of the track frame and swing bearing. Apply THREEBOND to the mating surfaces.

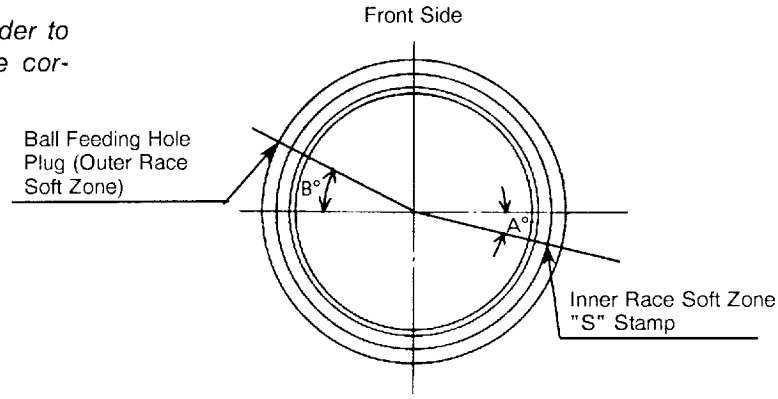
1. Lift the swing bearing using a crane. Align the matching marks on the track frame and swing bearing inner race.



W507-03-01-002

*NOTE: Be sure to align the matching marks in order to correctly position the inner race soft zone correctly.*

**A° : 33Mu ( 9° )**
**58Mu ( 15° )**
**B° : 33Mu ( 14° )**
**58Mu ( 21° )**

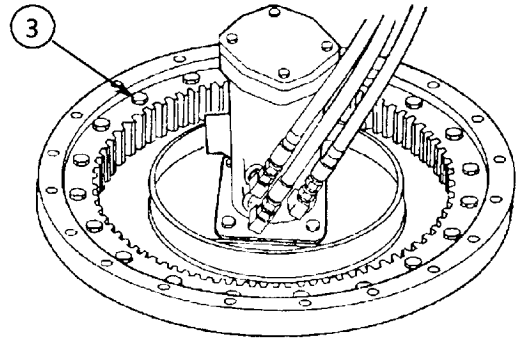



W532-03-01-001

2. Tighten bearing inner race mounting bolts (3).

: 19 mm

: 108 N·m ( 11 kgf·m )




W507-02-03-002

## REMOVE AND INSTALL TRAVEL DEVICE

(The illustration shows the travel device of 33Mu)

**CAUTION:**

1. **Hydraulic fluid under pressure can penetrate the skin or eyes causing serious injury. Avoid this hazard by relieving pressure before disconnecting any hydraulic lines.**
2. **Hydraulic oil becomes hot during operation. Disconnecting hydraulic lines soon after operation can result in severe burns.**
   **Wait for the oil and components to cool before removing any parts.**

**Preparation:**

1. Place the machine on a solid, level surface, and lower the bucket to the ground.
2. Stop the engine. Operate the control levers several times to release any residual pressure in the hydraulic lines. Remove the cap to release the pressure in the hydraulic oil tank.
3. Install a vacuum pump on the cap opening on the hydraulic oil tank. Operate the vacuum pump to create negative pressure in the tank.

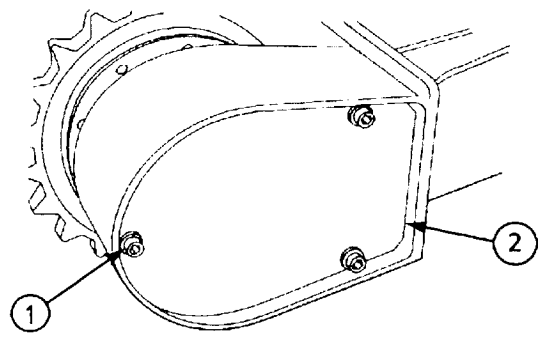
*NOTE: Keep the vacuum pump running continuously while working on the system.*

Remove Travel Device

1. Remove the track link assembly (Refer to "REMOVE AND INSTALL TRACK LINK ASSEMBLY").

2. Loosen bolts (1) and remove cover (2).

   : 8 mm



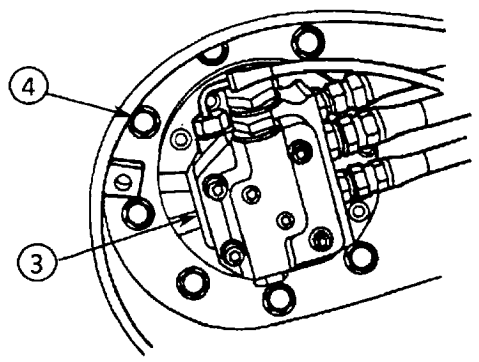

W507-03-02-001

3. Disconnect all hoses from travel device (3). Put a cap on each hose end.

   : 19 mm, 22 mm, 27 mm

4. Remove travel device (3) mounting bolts (4).

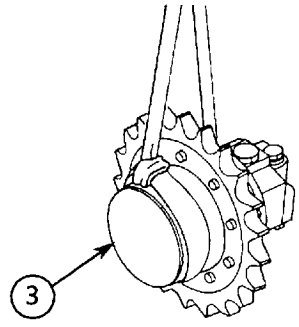
   : 19 mm ( 33Mu )
   22 mm ( 58Mu )




W554-03-02-005

5. Remove travel device (3) using a crane, as illustrated.

**CAUTION: Travel device weight:**
**: 45 kg ( 33Mu )**
**: 77 kg ( 58Mu )**



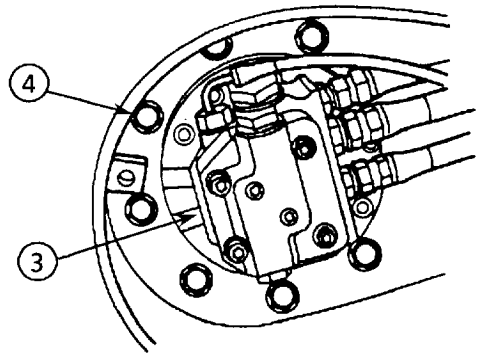

W507-03-02-004

**Install Travel Device**

1. Install travel device (3) and tighten bolts (4).

: 19 mm : 108 N·m (11 kgf·m) (33Mu)

: 22 mm : 216 N·m (22 kgf·m) (58Mu)




W554-03-02-005

2. Connect all hoses to travel device (3).

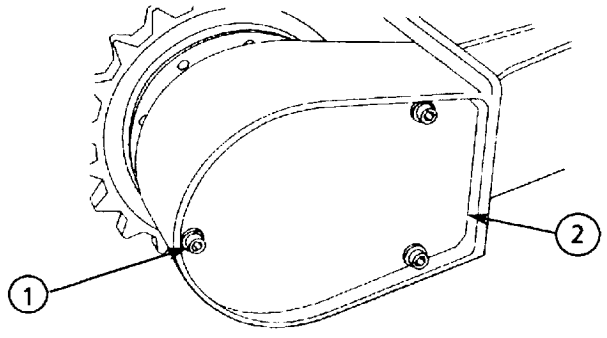
:19 mm : 29.5 N·m ( 3 kgf·m )

:22 mm : 39 N·m ( 4 kgf·m )

:27 mm : 64 N·m ( 6.5 kgf·m )

3. Install cover (2) and tighten bolts (1).

:8 mm :49 N·m ( 5 kgf·m )

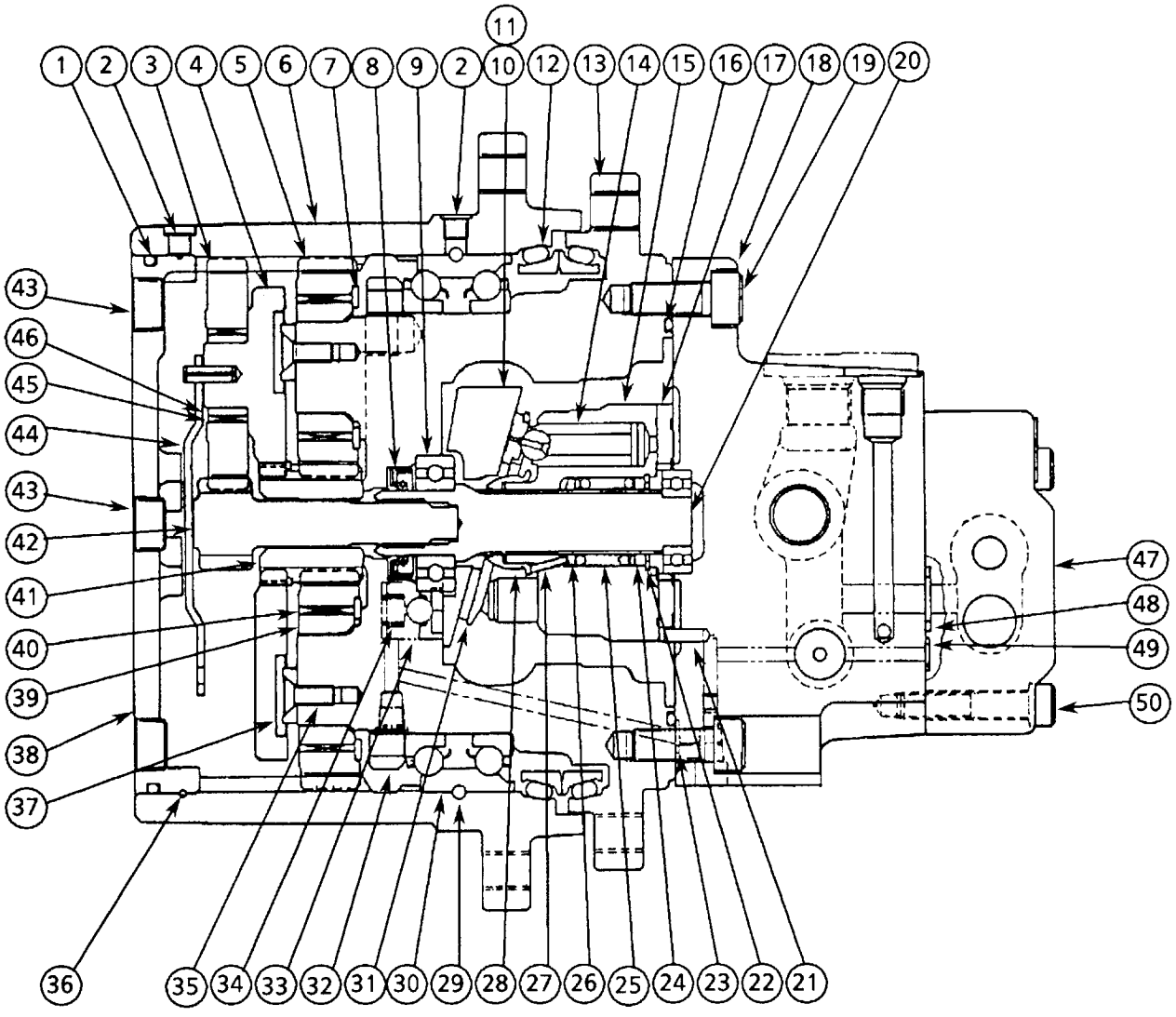



W507-03-02-001

**IMPORTANT: After installing the travel motor, fill the motor with hydraulic oil. Be sure to perform break-in running test of the travel motor under the following conditions to avoid motor seizure.**
**Test Running Conditions:**
**(1) Engine speed: Lowest speed**
**(2) Travel pedal: Low speed**
**(3) Time: Two minutes or more**

4. Install the track link assembly (Refer to "REMOVE AND INSTALL TRACK LINK ASSEMBLY").

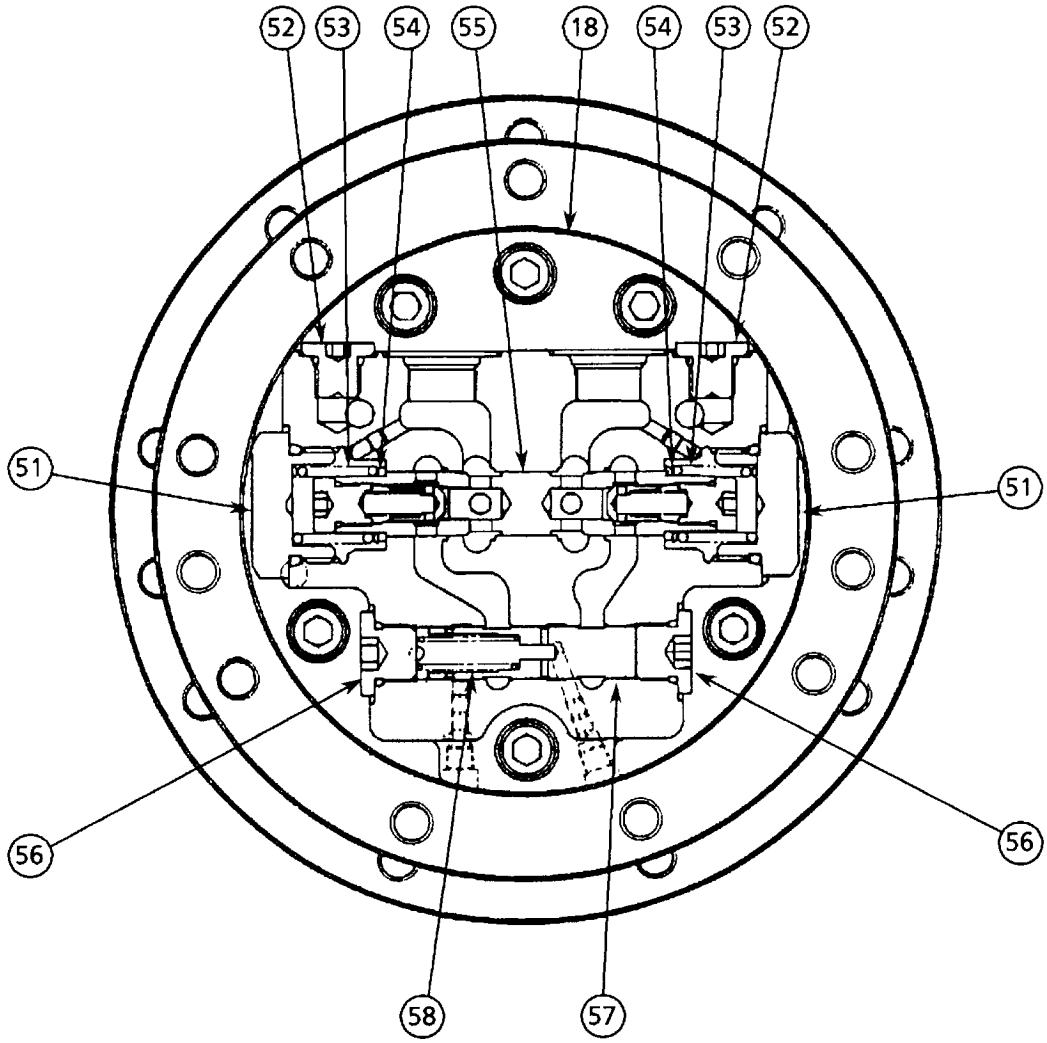
## DISASSEMBLE AND ASSEMBLE TRAVEL DEVICE (33Mu)



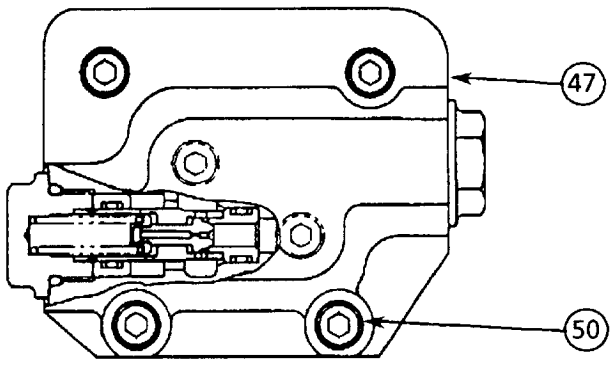

W527-03-02-001

1— O-Ring
2— Plug (2 used)
3— First Stage Planetary Gear (3 used)
4— First Stage Carrier
5— Second Stage Planetary Gear (4 used)
6— Ring Gear
7— Thrust Washer (4 used)
8— Oil Seal
9— Ball Bearing
10— Swash Plate
11— Steel Ball (2 used)
12— Floating Seal
13— Housing
14— Plunger (9 used)
15— Rotor
16— O-Ring
17— Valve Plate
18— Housing
19— Socket Bolt (6 used)
20— Shaft
21— Pin (2 used)
22— Retaining Ring
23— O-Ring (3 used)
24— Washer
25— Spring
26— Spring Seat
27— Pin (3 used)
28— Holder
29— Steel Ball (132 used)
30— Bearing
31— Retainer
32— Bearing Nut
33— Swash Plate Control Piston (2 used)
34— Spring (2 used)
35— Screw (4 used)
36— Wire
37— Thrust Plate
38— Cover
39— Inner Race (4 used)
40— Needle Bearing (4 used)
41— Sun Gear
42— Drive Gear
43— Plug (3 used)
44— Thrust Plate
45— Needle Bearing (3 used)
46— Collar (3 used)
47— Overload Relief Valve
48— O-Ring
49— O-Ring
50— Socket Bolt (4 used)

(Brake Valve)

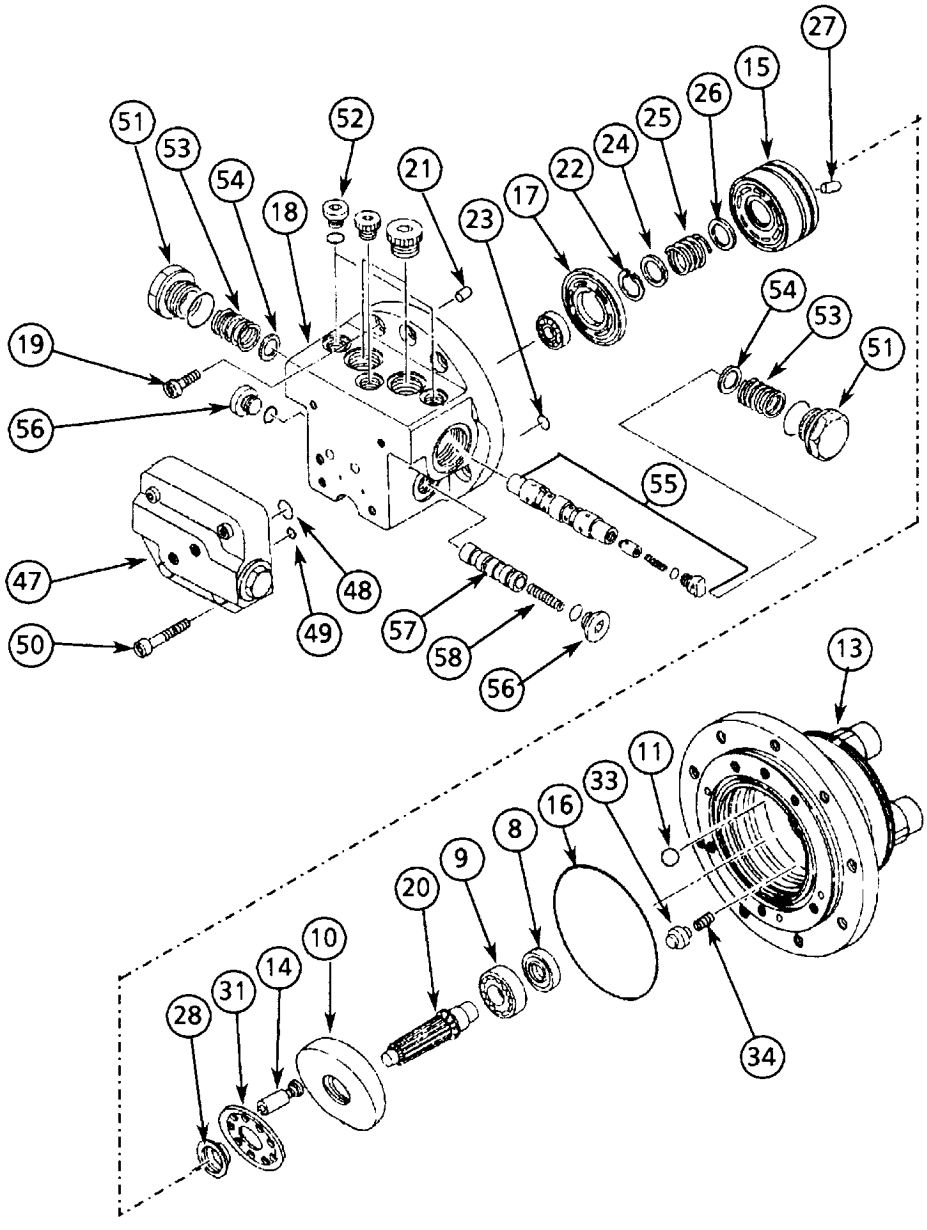



W527-03-02-002



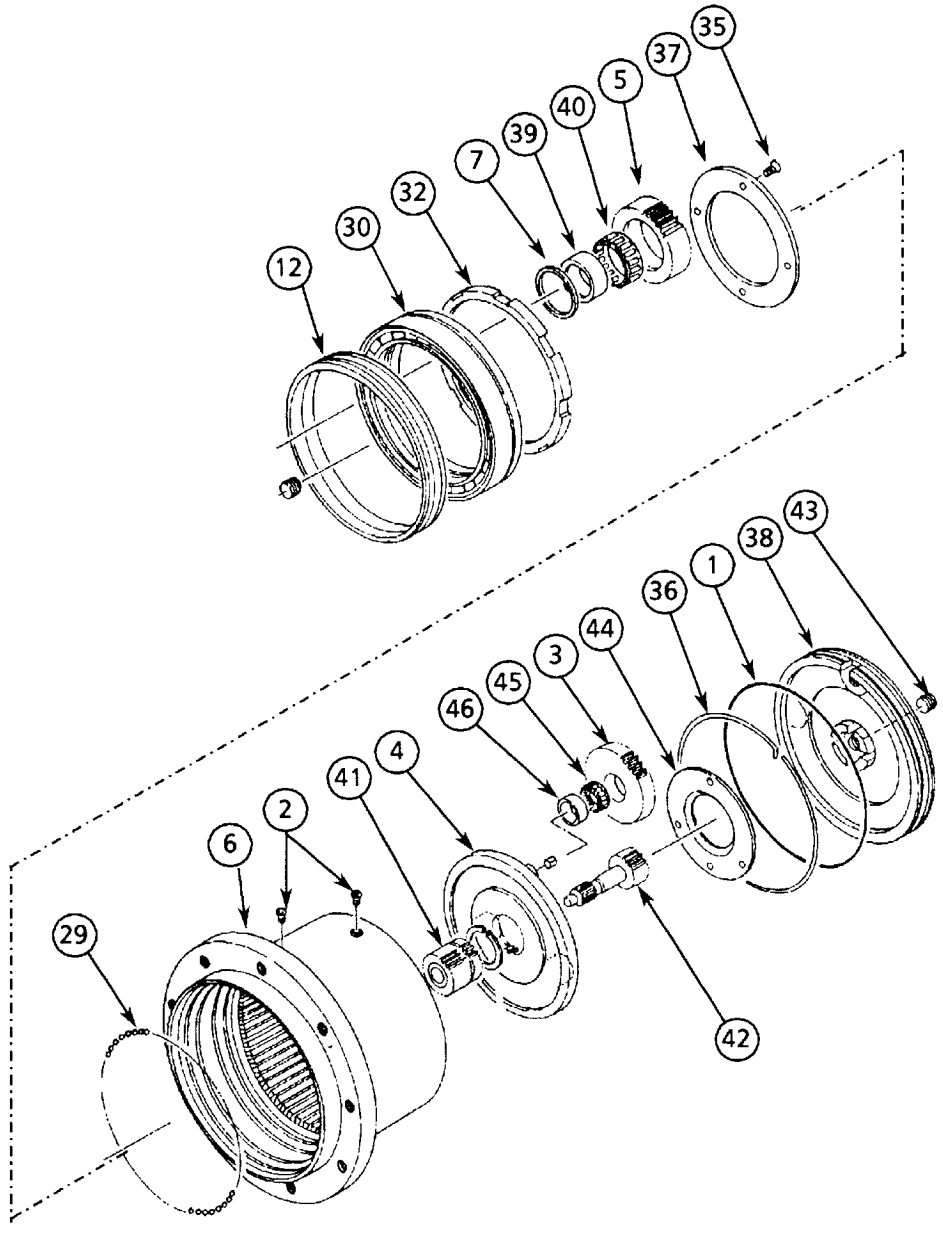

W527-03-02-003

18— Housing
47— Overload Relief Valve
50— Socket Bolt (4 used)
51— Plug (2 used)
52— Plug (2 used)
53— Spring
54— Spring Seat
55— Spool
56— Plug (2 used)
57— Spool
58— Spring



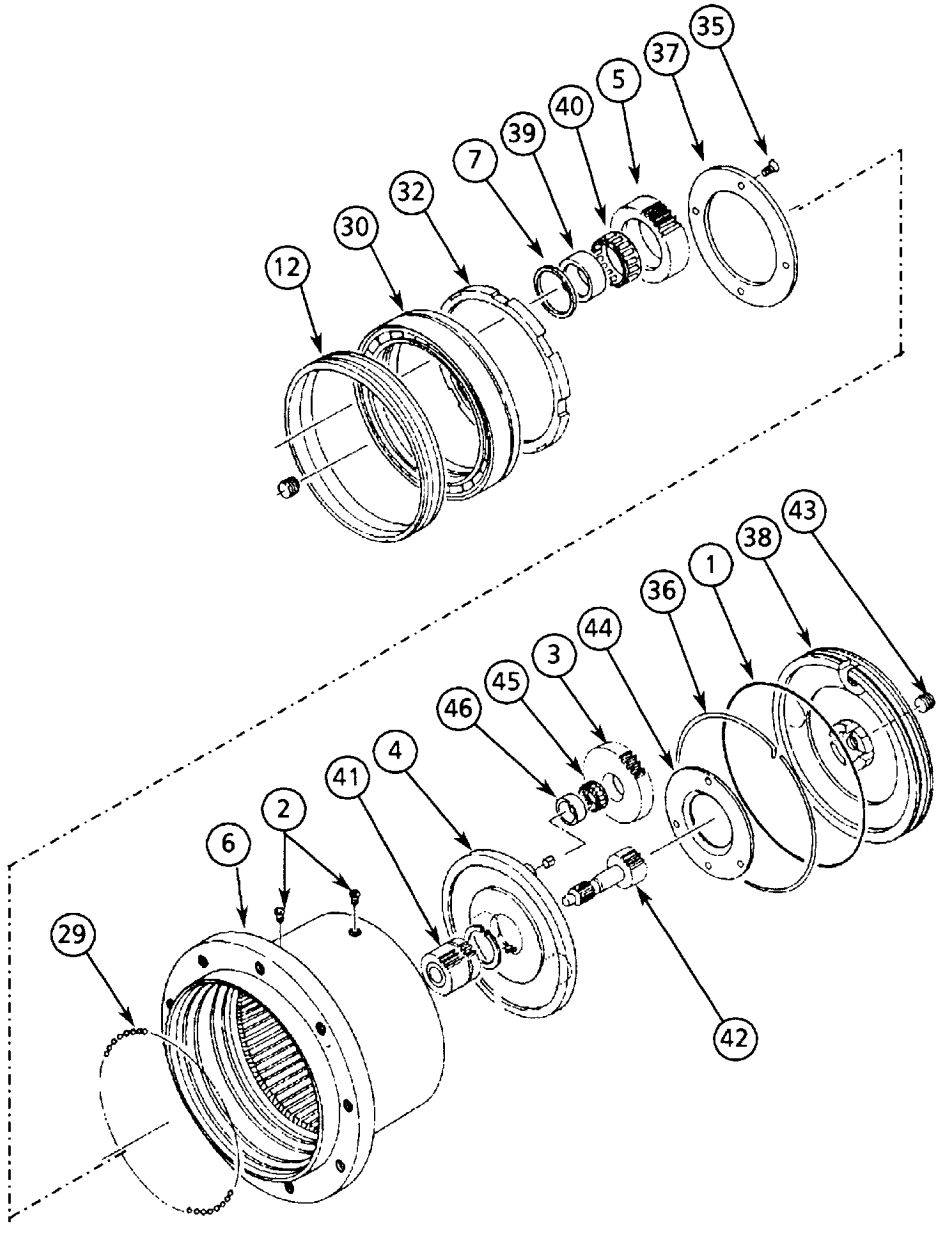

| | | | |
|---|---|---|---|
| 8— Oil Seal | 18— Housing | 27— Pin (3 used) | 51— Plug (2 used) |
| 9— Ball Bearing | 19— Socket Bolt (6 used) | 28— Holder | 52— Plug (2 used) |
| 10— Swash Plate | 20— Shaft | 31— Retainer | 53— Spring |
| 11— Steel Ball (2 used) | 21— Pin (2 used) | 33— Swash Plate Control Piston (2 used) | 54— Spring Seat |
| 13— Housing | 22— Retaining Ring | 34— Spring (2 used) | 55— Spool |
| 14— Plunger (9 used) | 23— O-Ring (3 used) | 47— Overload Relief Valve | 56— Plug (2 used) |
| 15— Rotor | 24— Washer | 48— O-Ring | 57— Spool |
| 16— O-Ring | 25— Spring | 49— O-Ring | 58— Spring |
| 17— Valve Plate | 26— Spring Seat | 50— Socket Bolt (4 used) | |

W527-03-02-004



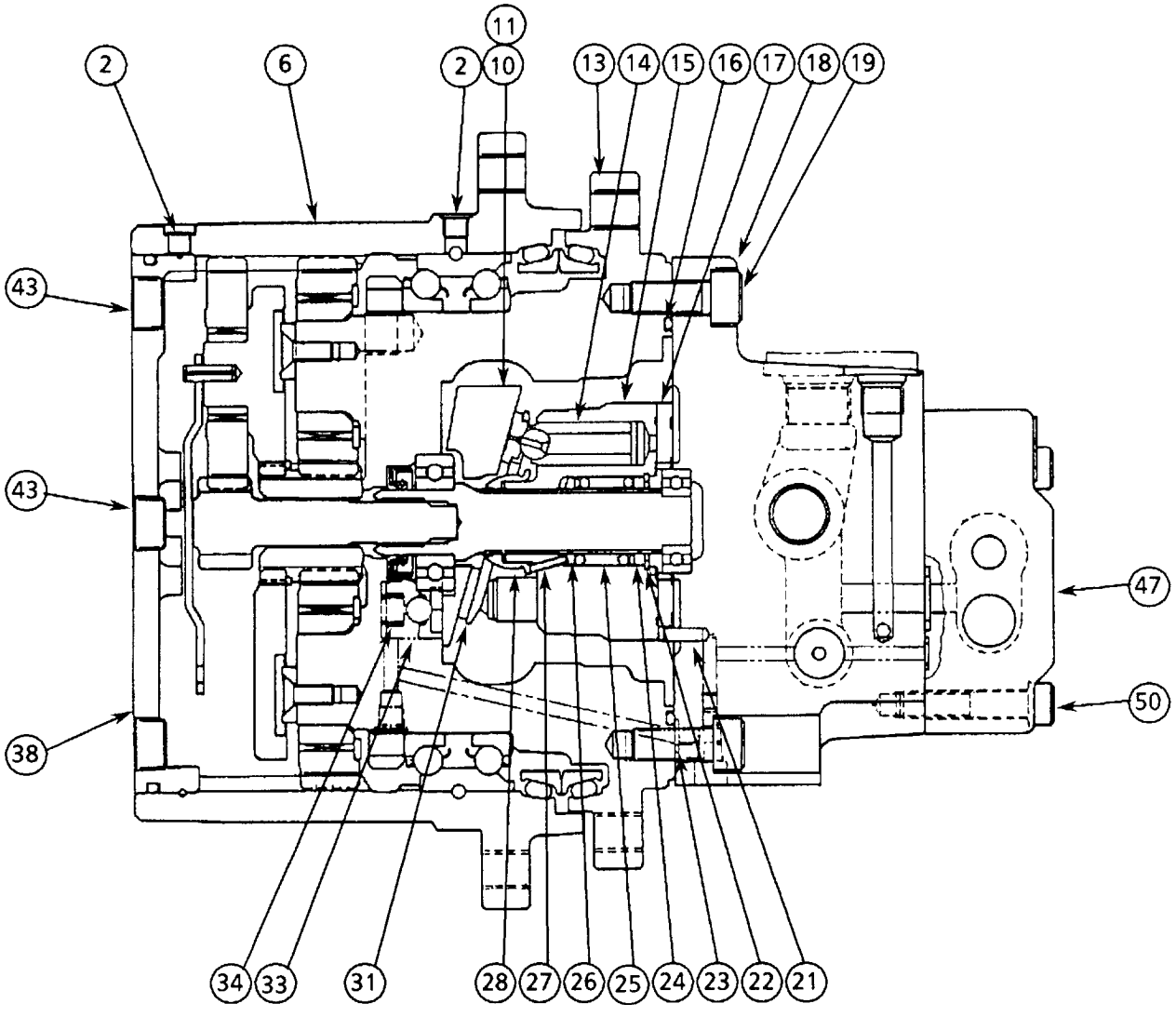

W527-03-02-005

1— O-Ring
2— Plug (2 used)
3— First Stage Planetary Gear (3 used)
4— First Stage Carrier
5— Second Stage Planetary Gear (4 used)
6— Ring Gear
7— Thrust Washer (4 used)
12— Floating Seal
29— Steel Ball (132 used)
30— Bearing
32— Bearing Nut
35— Screw (4 used)
36— Wire
37— Thrust Plate
38— Cover
39— Inner Race (4 used)
40— Needle Bearing (4 used)
41— Sun Gear
42— Drive Gear
43— Plug (3 used)
44— Thrust Plate
45— Needle Bearing (3 used)
46— Collar (3 used)




W527-03-02-005

1— O-Ring
2— Plug (2 used)
3— First Stage Planetary Gear (3 used)
4— First Stage Carrier
5— Second Stage Planetary Gear (4 used)
6— Ring Gear
7— Thrust Washer (4 used)
12— Floating Seal
29— Steel Ball (132 used)
30— Bearing
32— Bearing Nut
35— Screw (4 used)
36— Wire
37— Thrust Plate
38— Cover
39— Inner Race (4 used)
40— Needle Bearing (4 used)
41— Sun Gear
42— Drive Gear
43— Plug (3 used)
44— Thrust Plate
45— Needle Bearing (3 used)
46— Collar (3 used)




W527-03-02-001

2— Plug (2 used)
6— Ring Gear
10— Swash Plate
11— Steel Ball (2 used)
13— Housing
14— Plunger (9 used)
15— Rotor
16— O-Ring
17— Valve Plate
18— Housing
19— Socket Bolt (6 used)
21— Pin (2 used)
22— Retaining Ring
23— O-Ring (3 used)
24— Washer
25— Spring
26— Spring Seat
27— Pin (3 used)
28— Holder
31— Retainer
33— Swash Plate Control Piston (2 used)
34— Spring (2 used)
38— Cover
43— Plug (3 used)
47— Overload Relief Valve
50— Socket Bolt (4 used)

**Disassemble Travel Device (33Mu)**

Before disassembling, make matching marks on the mating surfaces of housing (13), brake valve housing (18) and overload relief valve (47). Clean disassembled parts with cleaning oil and group them by component section.

1. Remove socket bolts (19) (6 used), housing (18) and valve plate (17).

*NOTE: Valve plate (17) may stick to housing (18). Take care not to drop valve plate (17) when removing housing (18).*

: 8 mm

2. Remove pins (21) (2 used) and O-rings (23) (3 used) from brake valve housing (18).

3. Install eyebolts into socket bolt (19) holes on housing (13). Remove housing (13) from the vise using a crane.

: M10×P1.5×ℓ18

4. Remove O-ring (16) from body (13).

5. Remove rotor (15), swash plate (10), then remove steel balls (11), swash-plate control pistons (33) and springs (34) from housing (13) (two used each).

6. Remove plungers (14) (9 used), retainer (31), holder (28) and pins (27) (3 used) from rotor (15).

7. Remove retaining ring (22) from rotor (15), then remove washer (24), spring (25) and spring seat (26).

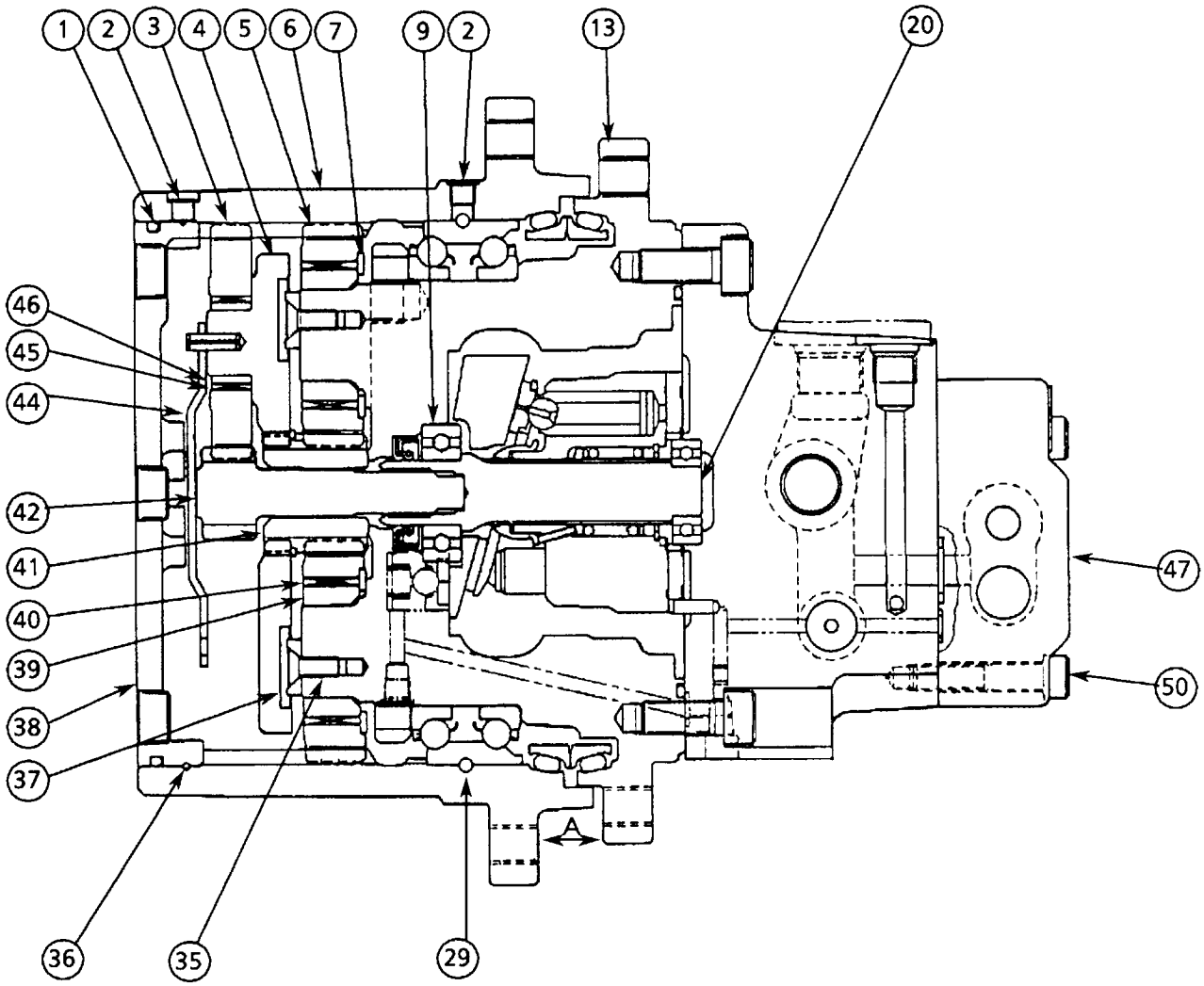
**CAUTION: Always hold washer (24) and spring (25) with a press when removing retaining ring (22). If washer (24) and spring (25) are not held with a press, when removing retaining ring (22), they may fly out potentially causing serious injury.**

8. Remove plugs (43) (3 used) from cover (38). Remove plugs (2) from ring gear (6).

Wrench Size:

: 5 mm [ Plug (2) ]

: 8 mm [ Plug (43) ]




W527-03-02-001

1— O-Ring
2— Plug (2 used)
3— First Stage Planetary Gear (3 used)
4— First Stage Carrier
5— Second Stage Planetary Gear (4 used)
6— Ring Gear
7— Thrust Washer (4 used)
9— Ball Bearing
13— Housing
20— Shaft
29— Steel Ball (132 used)
35— Screw (4 used)
36— Wire
37— Thrust Plate
38— Cover
39— Inner Race (4 used)
40— Needle Bearing (4 used)
41— Sun Gear
42— Drive Gear
44— Thrust Plate
45— Needle Bearing (3 used)
46— Collar (3 used)
47— Overload Relief Valve
50— Socket Bolt (4 used)

9. Install the eyebolts into the plug openings on cover (38). Insert a steel pipe through the eyebolt holes.

: ST 0018

10. Pull out wire (36) from the plug opening on ring gear (6) while rotating cover (38) with the steel pipe.

11. Remove cover (38) from ring gear (6).

12. Remove O-ring (1) from cover (38).

13. Remove thrust plate (44), drive gear (42), first stage carrier (4) and sun gear (41) from ring gear (6).

14. Remove first stage planetary gears (3), needle bearings (45) and collars (46) from first stage carrier (4) (three used each).

15. Remove screws (35) (4 used) and thrust plate (37) from housing (13). Remove second stage planetary gears (5), needle bearings (40), inner races (39) and thrust washers (7) (four used each).

: 4 mm

16. Remove shaft (20) from housing (13).

*NOTE: Remove shaft (20) by tapping it out with a bar and hammer. Do not remove ball bearing (9) unless replacement is required.*

17. Remove plugs (2) from ring gear (6).

: 5 mm

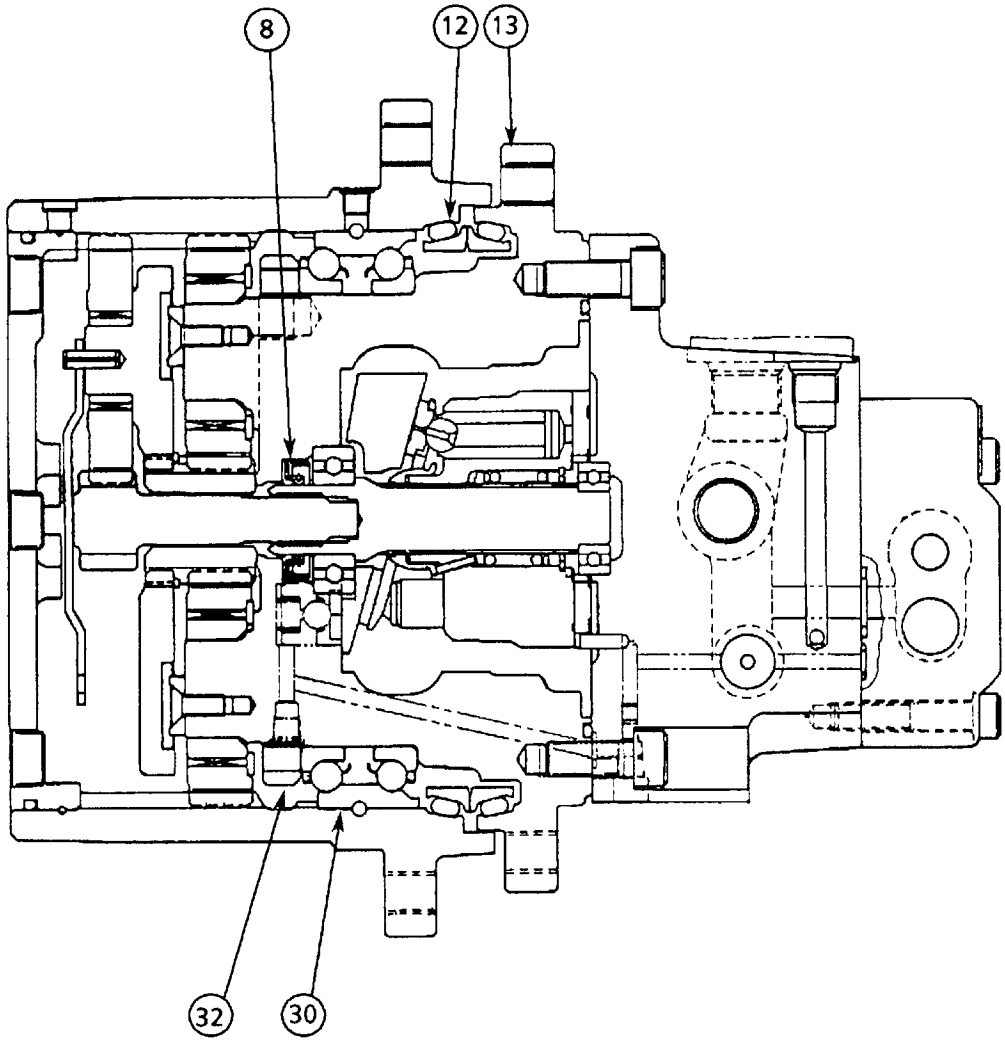
18. Remove steel balls (29) (132 used) via the plug holes on ring gear (6).

19. Insert two or three pieces of a steel plate in clearance A spaced evenly around the circumference.

20. Remove housing (13) from ring gear (6) by evenly tightening the 2 to 3 bolts installed into the sprocket mounting bolt holes on ring gear (6).

Bolt size : M12×P1.75×ℓ45

: 18 mm




W527-03-02-001

8— Oil Seal
12— Floating Seal
13— Housing
30— Bearing
32— Bearing Nut

21. Clamp housing (13) in a vise. Remove bearing nut (32) with special tool.

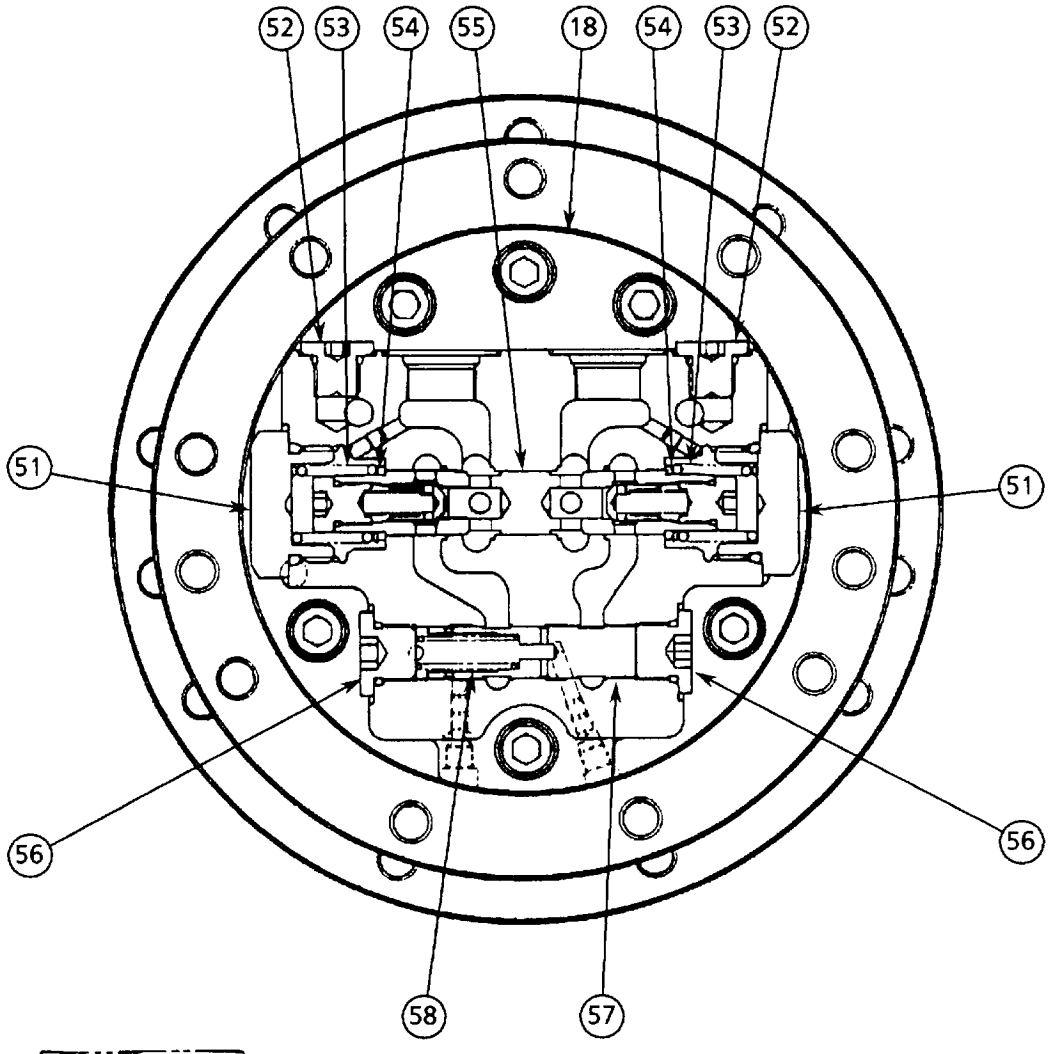
    Special Tool: ST 3146

22. Remove bearing (30) from housing (13).

**IMPORTANT: Remove bearing (30) by lightly tapping it out with a bar and hammer. Replace bearing (30) with new one if disassembled.**

23. Remove floating seal (12) from housing (13).

24. Remove oil seal (8) from housing (13).

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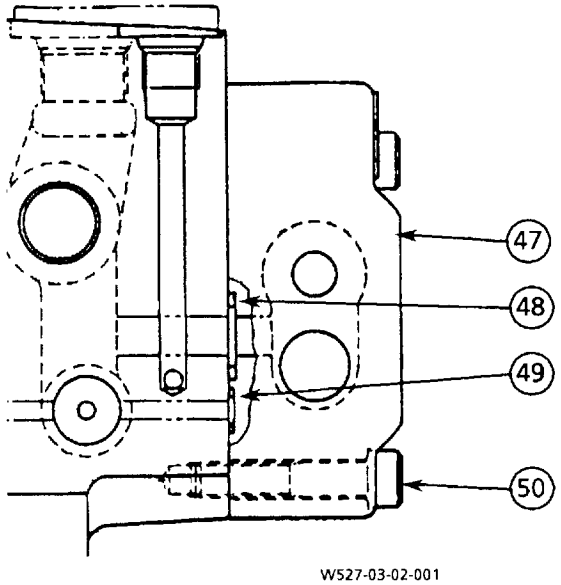



W527-03-02-001

18— Housing
47— Overload Relief Valve
48— O-Ring
49— O-Ring
50— Socket Bolt (4 used)
51— Plug (2 used)
53— Spring
54— Spring Seat
55— Spool
56— Plug (2 used)
57— Spool
58— Spring

25. Remove socket bolts (50) (4 used). Remove overload relief valve (47) and O-rings (48, 49).

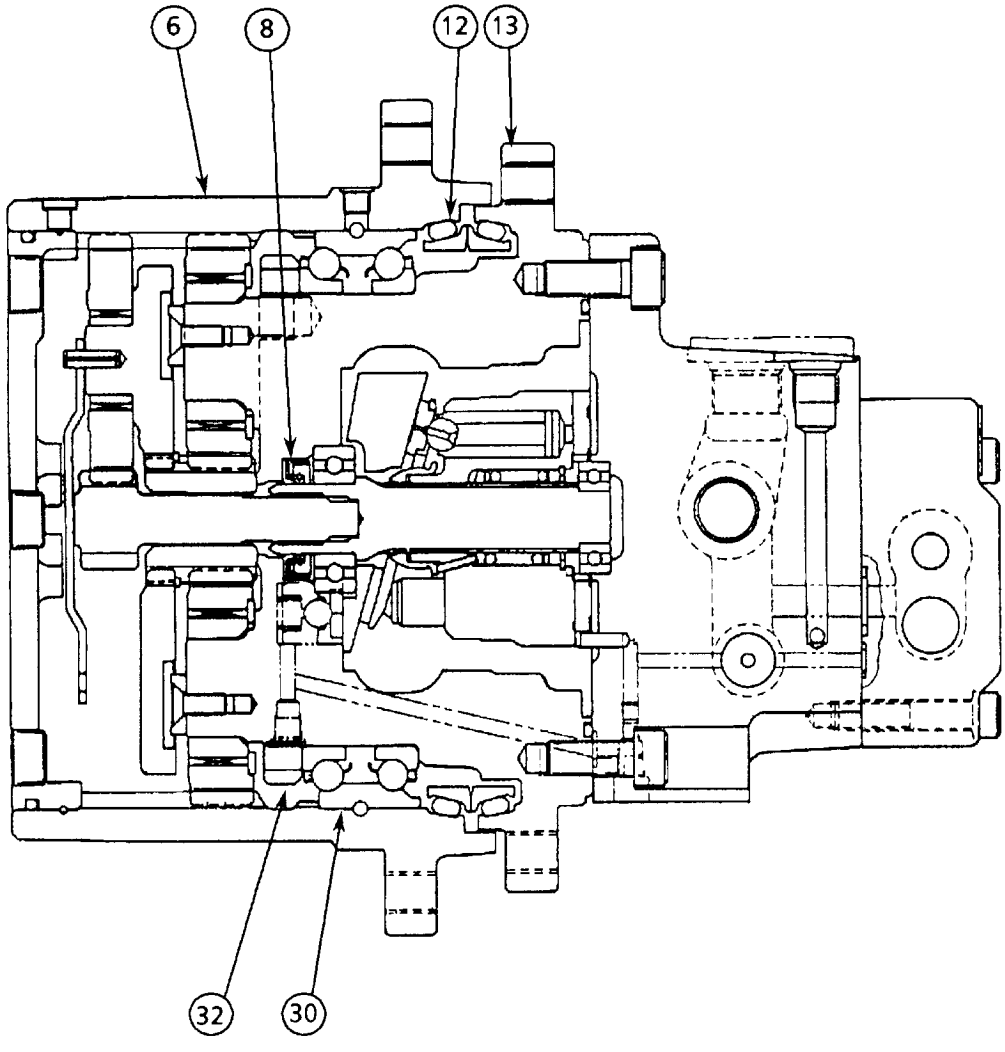
: 6 mm

26. Remove plugs (51) (2 used) from housing (18), then remove springs (53) (2 used), spring seats (54) (2 used) and spool (55).

: 36 mm

27. Remove plugs (56) (2 used), spring (58) and spool (57) from housing (18).

: 8 mm




W527-03-02-001

6— Ring Gear
8— Oil Seal
12— Floating Seal
13— Housing
30— Bearing
32— Bearing Nut

**Assemble Travel Device (33Mu)**

Before assembling, clean components and parts with cleaning oil and dry completely. Apply a film of clean hydraulic oil to inner parts, sliding parts in particular, before assembling in order to prevent seizures. Always replace used O-rings, oil seals and seals with new ones when re-assembling.

1. Install oil seal (8) into housing (13).
2. Install floating seal (12) on housing (13).
3. Tap bearing (30) onto housing (13) and tighten bearing nut (32).

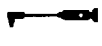
Tightening Tool: ST 3146

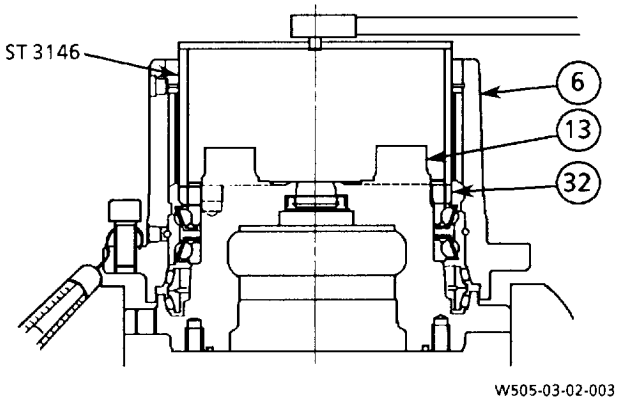
4. Tap ring gear (6) on housing (13) with a plastic hammer.

5. Adjust bearing (30) pre-load as follows:
   - Install tightening tool (ST 3146), torque wrench and a spring balance as illustrated to the right.
   - Rotate ring gear (6) 2 to 3 times for break-in test running.
   - Measure starting torque (F).
   - Tighten bearing nut (32) until the correct starting torque of F + (1.7 to 2.5) kgf·m is obtained.

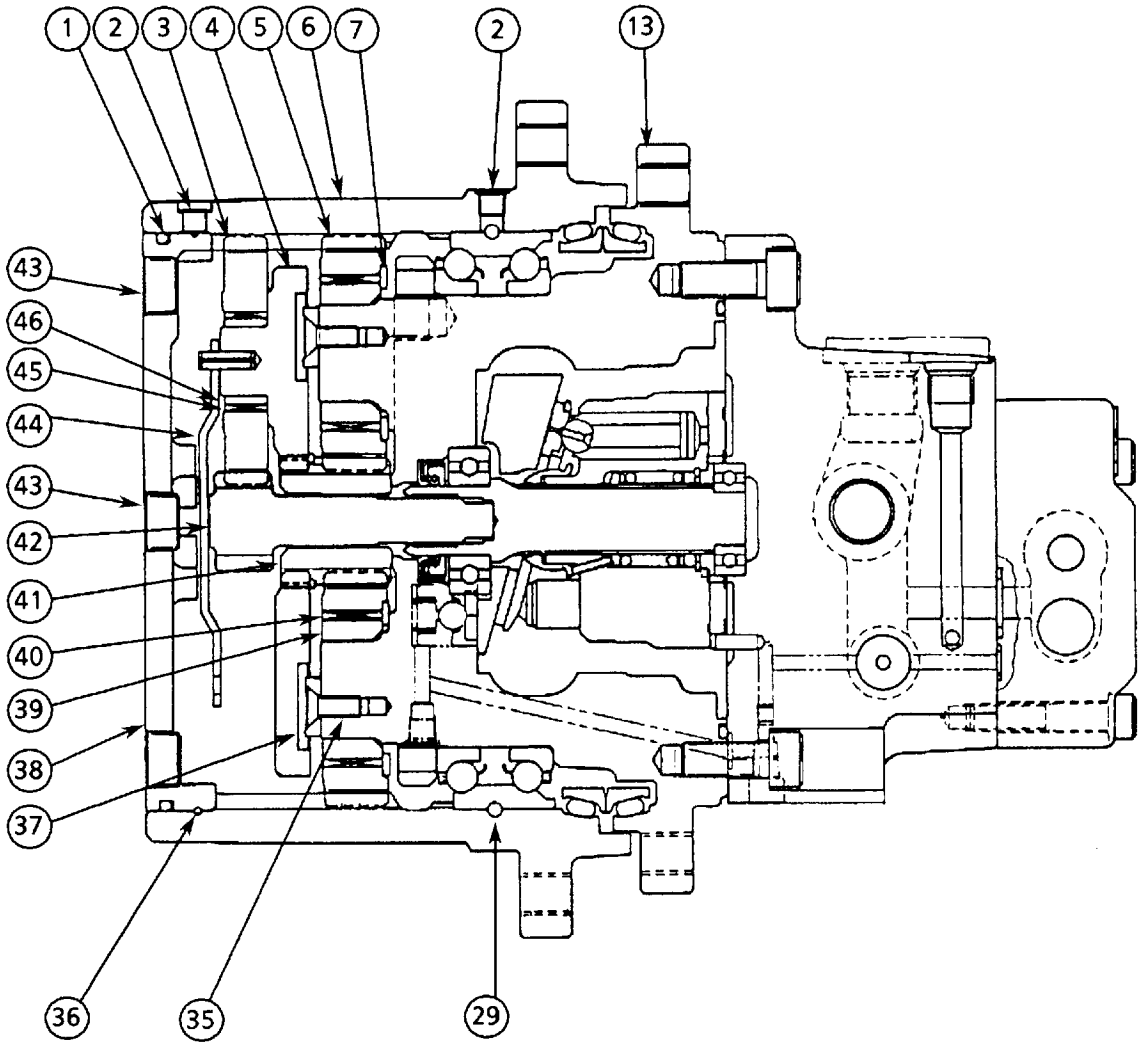
*NOTE: If the measured starting torque exceeds the upper limit of the specified torque, reset the pre-load as follows:*
*(1) Loosen bearing nut (32).*
*(2) Remove housing (13) from the vise.*
*(3) Tap housing (13) end facing the ring gear to release load.*
*(4) Readjust pre-load following step 5.*

Spring Balance
Tightening Tool: ST 3146





W505-03-02-003




W527-03-02-001

1— O-Ring
2— Plug (2 used)
3— First Stage Planetary Gear (3 used)
4— First Stage Carrier
5— Second Stage Planetary Gear (4 used)
6— Ring Gear
7— Thrust Washer (4 used)
13— Housing
29— Steel Ball (132 used)
35— Screw (4 used)
36— Wire
37— Thrust Plate
38— Cover
39— Inner Race (4 used)
40— Needle Bearing (4 used)
41— Sun Gear
42— Drive Gear
43— Plug (3 used)
44— Thrust Plate
45— Needle Bearing (3 used)
46— Collar (3 used)

6. Install steel balls (29) (132 used) via the plug holes and tighten plugs (2).

**IMPORTANT: Be sure to apply seal tape to plug (2) threads before installing.**

: 5 mm, : 7.8±1 N·m ( 0.8±0.1 kgf·m )

7. Install thrust washers (7), inner races (39), needle bearings (40) and second stage planetary gears (5) (four used each) to housing (13). Install thrust plate (37) and tighten screws (35) (4 used).

**IMPORTANT: Apply Loctite #262 to screws (35) before installing.**

: 4 mm, : 6.1±2 N·m ( 0.62±0.2 kgf·m )

8. Install sun gear (41) to ring gear (6).

9. Install first stage carrier (4) onto sun gear (41).

10. Install collars (46), needle bearings (45) and first stage planetary gears (3) (three used each)onto first stage carrier (4).

11. Install drive gear (42) in ring gear (6).

12. Install thrust plate (44) onto first stage carrier (4).

13. Install O-ring (1) onto cover (38).

14. Install cover (38) in ring gear (6).

15. Install two eyebolts into the plug openings on cover (38). Insert a steel pipe through the eyebolt holes.

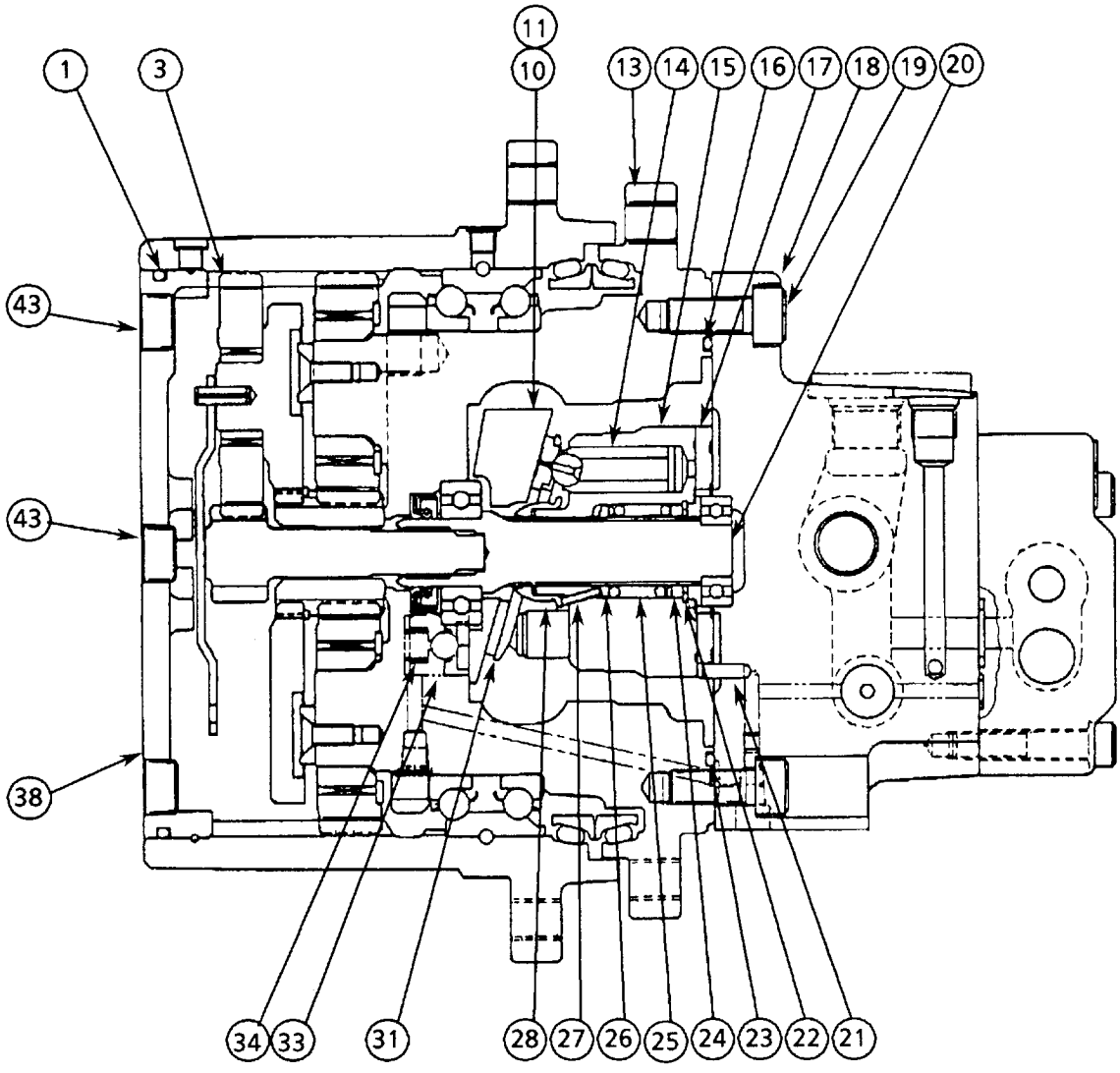
: ST 0018

16. Insert wire (36) into the plug opening, with its tip (approximately 6 mm) bent 90°. Turn cover (38) using a steel pipe to wind wire (36) further.

17. Tighten plugs (43).

**IMPORTANT: Be sure to apply seal tape to plug (43) threads before install**

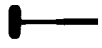
: 5 mm, : 7.8±1 N·m ( 0.8±0.1 kgf·m )




W527-03-02-001

1— O-Ring
3— First Stage Planetary Gear (3 used)
10— Swash Plate
11— Steel Ball (2 used)
13— Housing
14— Plunger (9 used)
15— Rotor
16— O-Ring
17— Valve Plate
18— Housing
19— Socket Bolt (6 used)
20— Shaft
21— Pin (2 used)
22— Retaining Ring
23— O-Ring (3 used)
24— Washer
25— Spring
26— Spring Seat
27— Pin (3 used)
28— Holder
31— Retainer
33— Swash-Plate Control Piston (2 used)
34— Spring (2 used)
38— Cover
43— Plug (3 used)

18. Drive shaft (20) in housing (13) with a plastic hammer.



19. Install steel balls (11), springs (34) and control pistons (33) (two each) in housing (13), then install swash plate (10).

20. Install spring seat (26), spring (25) and washer (24) into rotor (15).

21. Hold washer (24) and spring (25) down with a press, and install retaining ring (22).

    Pusher: ST 4115

22. Install pins (27) (3 used) into rotor (15), then install holder (28) onto them.

23. Install the assembly of plungers (14) (9 used) and retainer (31) into rotor (15).

24. Install rotor (15) in housing (13).

25. Install O-ring (16) and pins (21) (2 used) onto housing (13).

26. Install O-ring (23) and valve plate (17) to brake valve housing (18).

*NOTE: Apply grease to the mating surfaces between brake valve (18) and valve plate (17) to prevent valve plate (17) from falling off.*

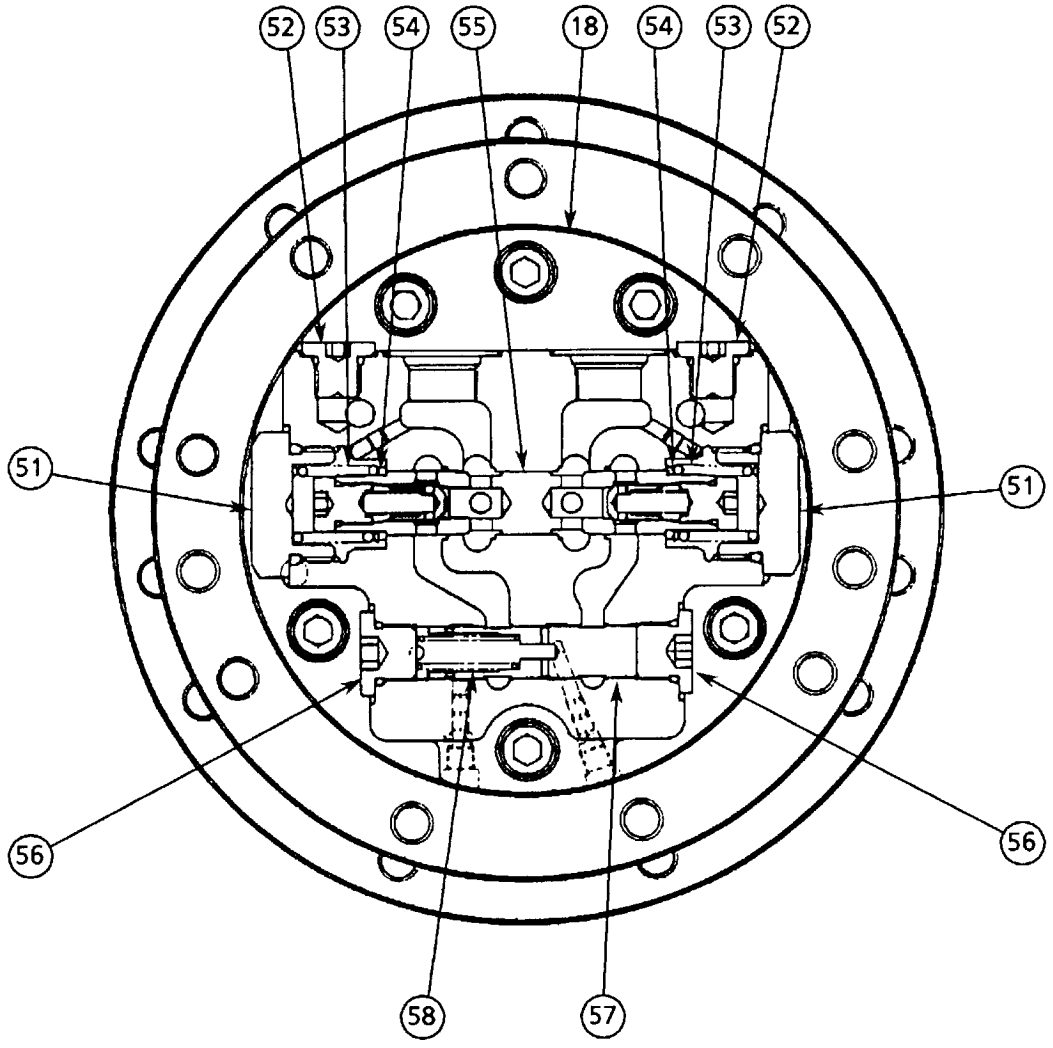
27. Install brake valve housing (18) onto housing (13) and tighten socket bolts (19) (6 used).

 : 8 mm,  : 64±4.9 N·m
( 6.5±0.5 kgf·m )

28. Fill the travel device with gear oil of 0.5 L via the plug openings on cover (38). Tighten plugs (43) (3 used).

*NOTE: Apply seal tape to plug (43) threads before installing.*

 : 8 mm,  : 34±4.9 N·m
( 3.5±0.5 kgf·m )

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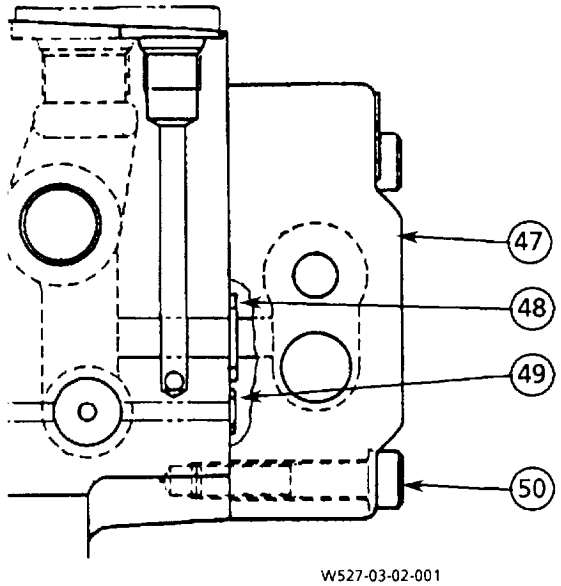



W527-03-02-001

18— Housing
47— Overload Relief Valve
48— O-Ring
49— O-Ring
50— Socket Bolt (4 used)
51— Plug (2 used)
53— Spring
54— Spring Seat
55— Spool
56— Plug (2 used)
57— Spool
58— Spring

29. Install spool (57) and spring (58) in housing (18) and tighten plugs (56) (2 used).

: 8 mm, : 54±4.9 N·m
( 5.5±0.5 kgf·m )

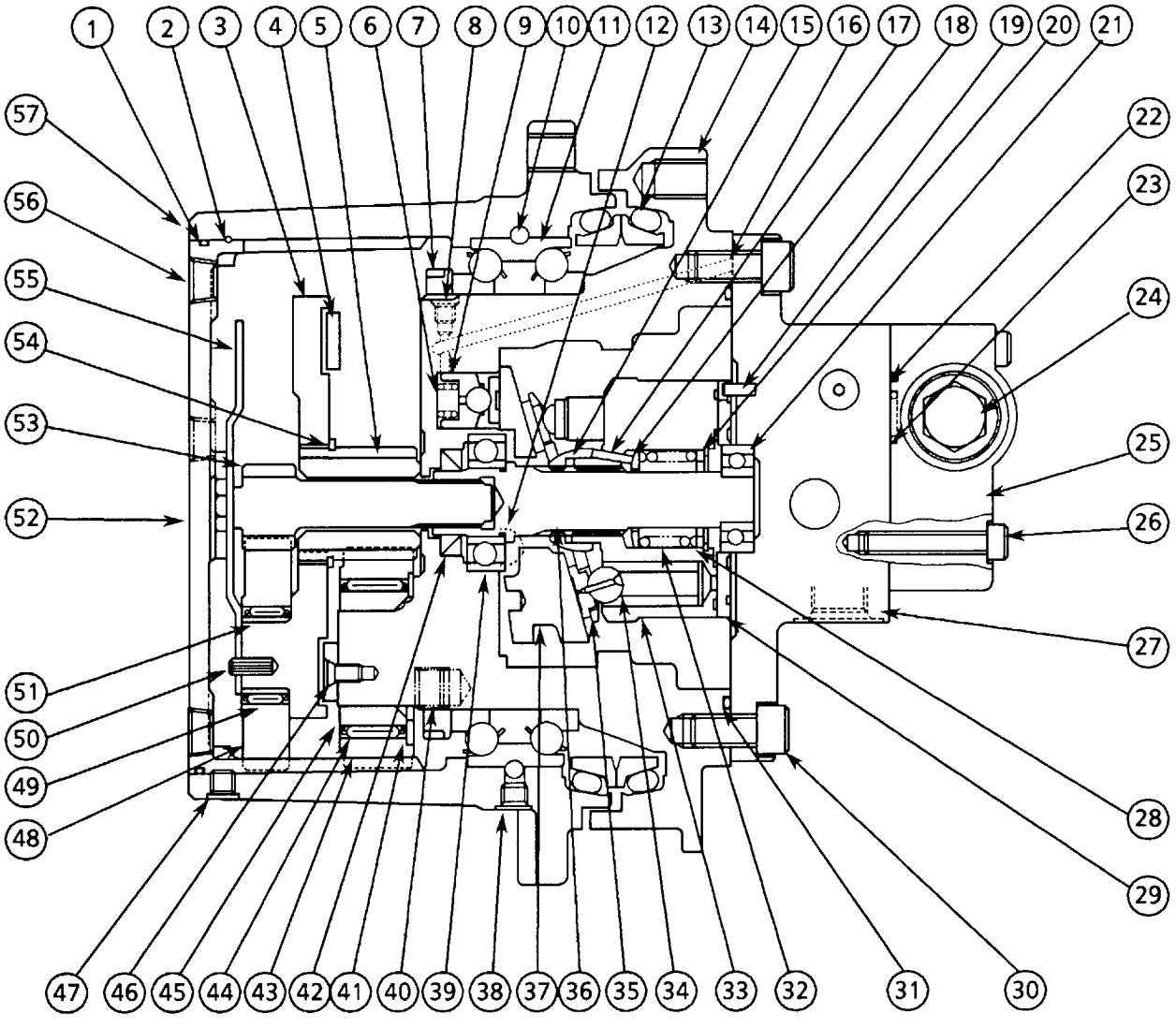
30. Install spool (55) in housing (18), then install spring seats (54) and springs (53) and tighten plugs (51) (two each).

: 36 mm, : 240±5.0 N·m
( 24.5±0.5 kgf·m )

31. Assemble overload relief valve (47), O-rings (47, 48) and housing (18), and tighten socket bolts (50) (4 used).

: 6 mm, : 30±2 N·m
( 3±0.2 kgf·m )

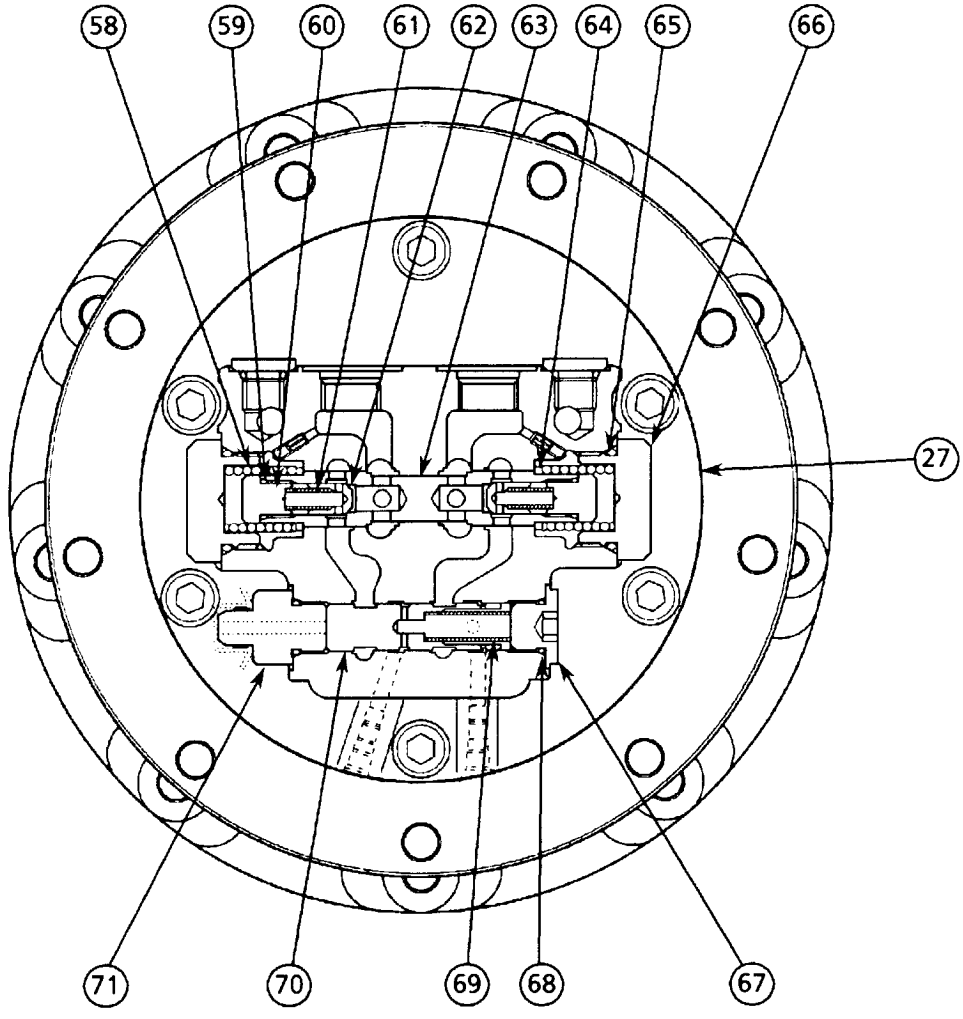
## DISASSEMBLE AND ASSEMBLE TRAVEL DEVICE (58Mu)



W533-03-02-001

1— O-Ring
2— Wire
3— Carrier
4— Thrust Plate
5— Sun Gear
6— Spring (2 used)
7— Bearing Nut
8— Plugs (2 used)
9— Swash Plate Control Piston (2 used)
10— Steel Ball (99 used)
11— Bearing
12— Steel Ball (2 used)
13— Floating Seal
14— Housing
15— Holder
16— O-Ring
17— Pin (3 used)
18— Collar
19— Pin
20— Retaining Ring
21— Ball Bearing
22— O-ring (3 used)
23— O-Ring (2 used)
24— Overload Relief Valve
25— Valve Housing
26— Socket Bolt (4 used)
27— Brake Valve
28— Washer
29— Valve Plate
30— Socket Bolt (6 used)
31— O-Ring
32— Spring
33— Rotor
34— Plunger (9 used)
35— Retainer
36— Shaft
37— Swash Plate
38— Plug (2 used)
39— Ball Bearing
40— Plug (7 used)
41— Thrust Washer (4 used)
42— Oil Seal
43— Planetary Gear (4 used)
44— Needle Bearing (4 used)
45— Collar (4 used)
46— Screw (4 used)
47— Plug (2 used)
48— Planetary Gear (3 used)
49— Needle Bearing (3 used)
50— Spring Pin (3 used)
51— Inner Race (3 used)
52— Cover
53— Drive Gear
54— Retaining Ring
55— Thrust Plate
56— Plug (7 used)
57— Ring Gear

(Brake Valve)

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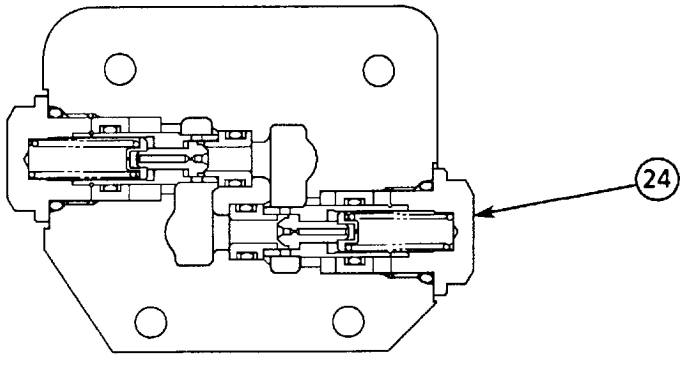
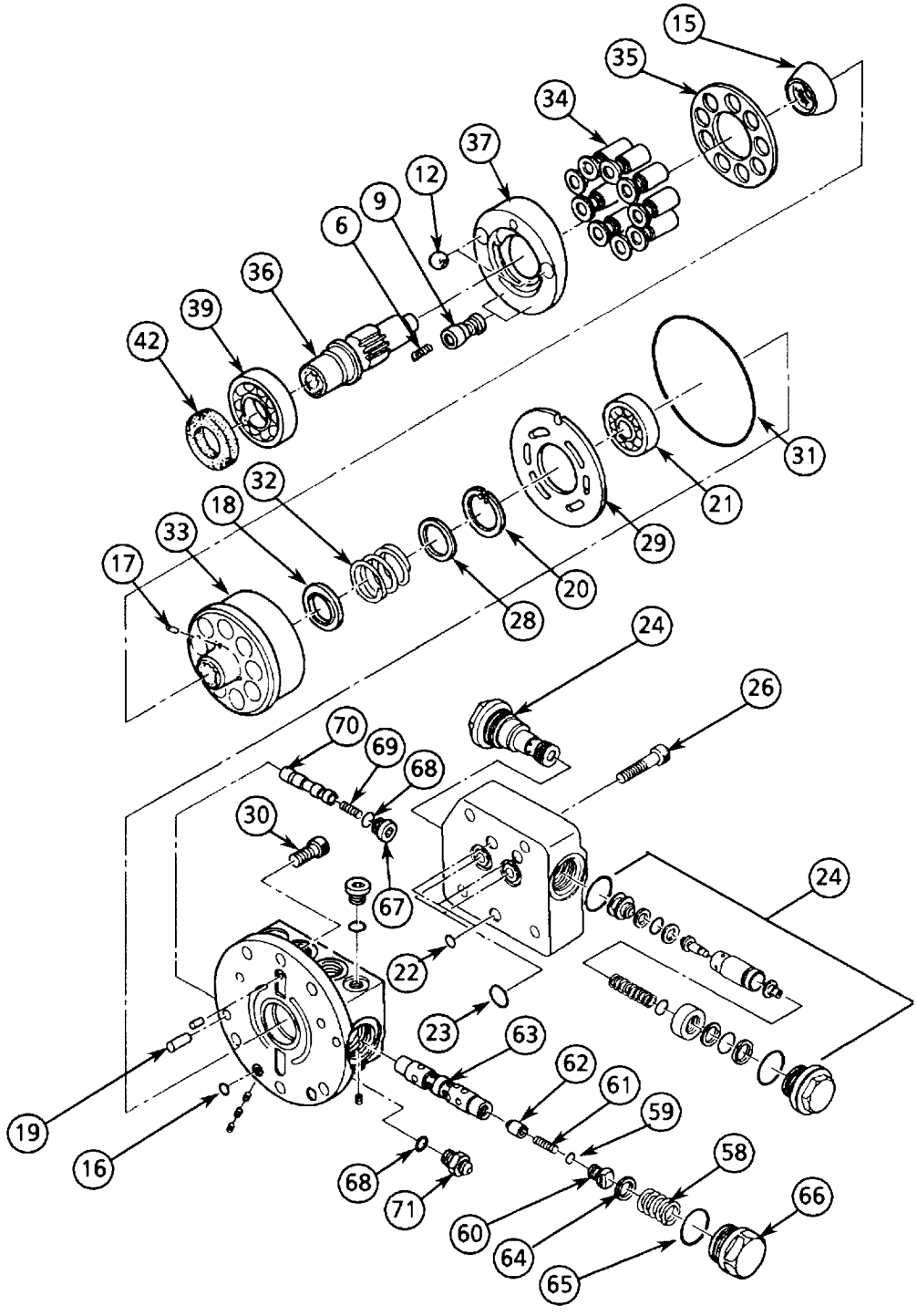


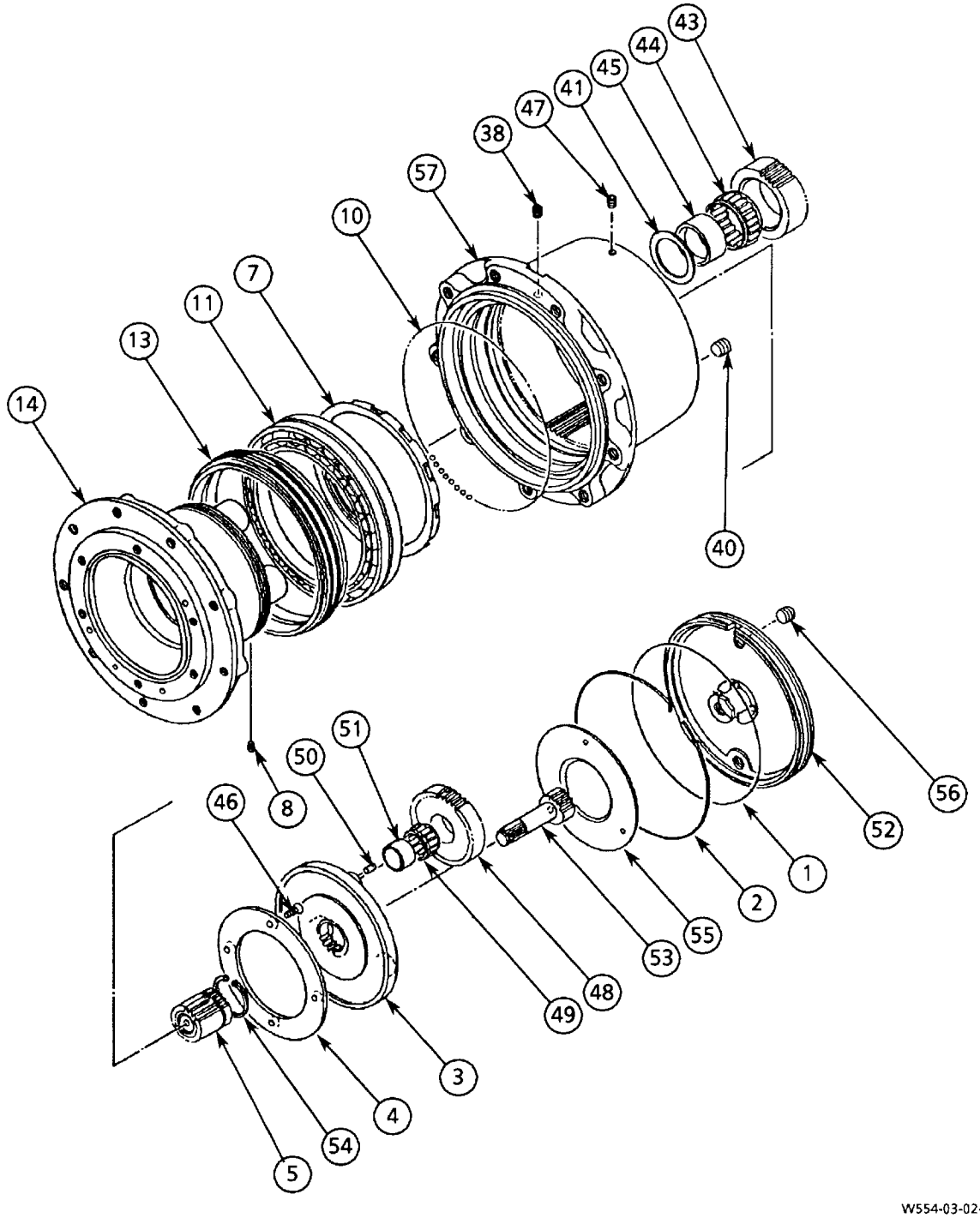

W554-03-02-002

24— Overload Relief Valve
27— Housing
58— Spring (2 used)
59— O-Ring (2 used)
60— Plug (2 used)
61— Spring (2 used)
62— Check Valve (2 used)
63— Spool
64— Seat (2 used)
65— O-Ring (2 used)
66— Plug (2 used)
67— Plug
68— O-Ring (2 used)
69— Spring
70— Spool
71— Plug



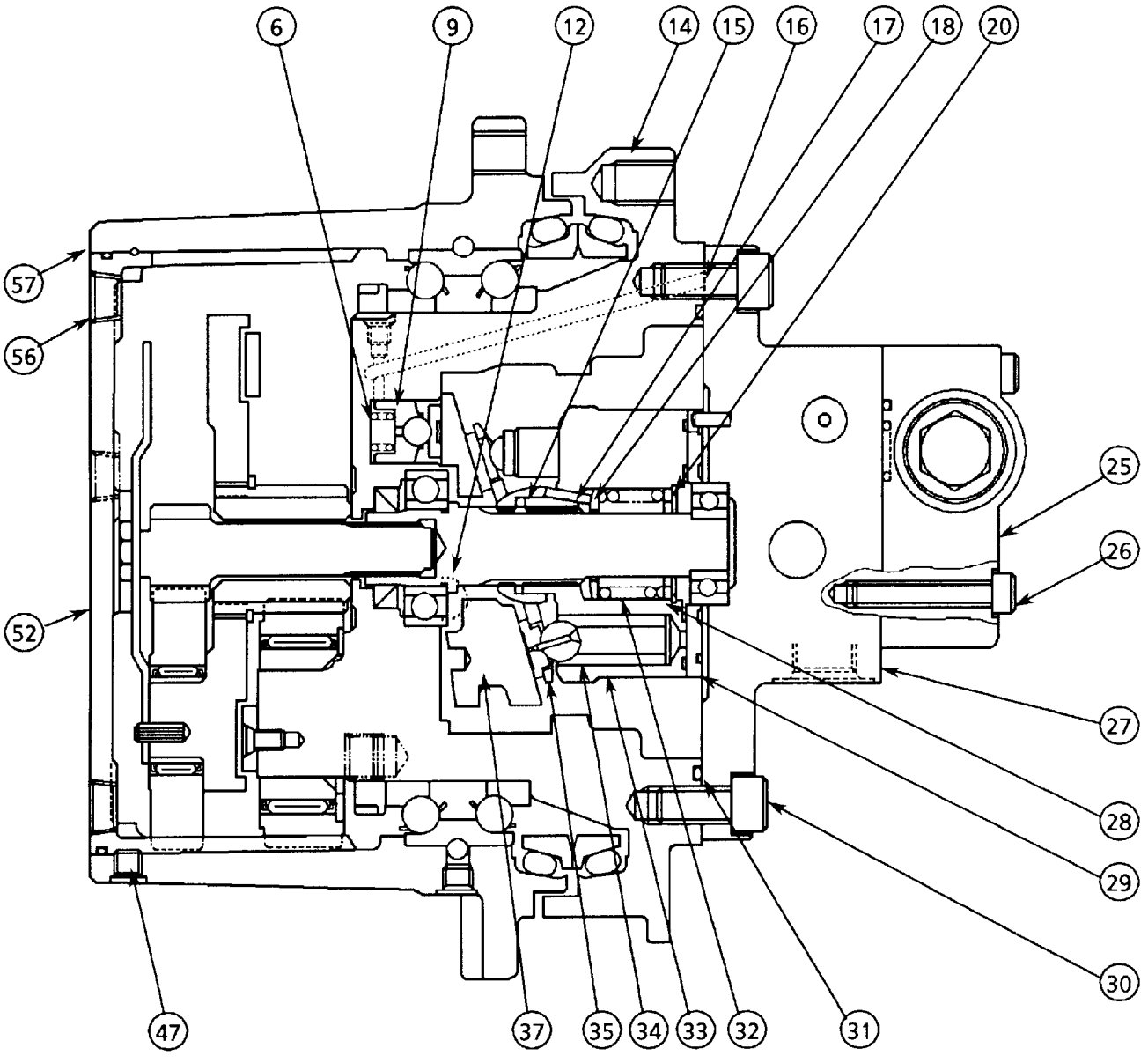

W554-03-02-003

| | | | |
|---|---|---|---|
| 6— Spring (2 used) | 22— O-ring (3 used) | 34— Plunger (9 used) | 62— Check Valve (2 used) |
| 9— Swash Plate Control Piston (2 used) | 23— O-Ring (2 used) | 35— Retainer | 63— Spool |
| 12— Steel Ball (2 used) | 24— Overload Relief Valve | 36— Shaft | 64— Seat (2 used) |
| 15— Holder | 26— Socket Bolt (4 used) | 37— Swash Plate | 65— O-Ring (2 used) |
| 16— O-Ring | 28— Washer | 39— Ball Bearing | 66— Plug (2 used) |
| 17— Pin (3 used) | 29— Valve Plate | 42— Oil Seal | 67— Plug |
| 18— Collar | 30— Socket Bolt (6 used) | 58— Spring (2 used) | 68— O-Ring (2 used) |
| 19— Pin | 31— O-Ring | 59— O-Ring (2 used) | 69— Spring |
| 20— Retaining Ring | 32— Spring | 60— Plug (2 used) | 70— Spool |
| 21— Ball Bearing | 33— Rotor | 61— Spring (2 used) | 71— Plug |




W554-03-02-004

1— O-Ring
2— Wire
3— Carrier
4— Thrust Plate
5— Sun Gear
7— Bearing Nut
8— Plugs (2 used)
10— Steel Ball (99 used)
11— Bearing
13— Floating Seal
14— Housing
38— Plug (2 used)
40— Plug (7 used)
41— Thrust Washer (4 used)
43— Planetary Gear (4 used)
44— Needle Bearing (4 used)
45— Collar (4 used)
46— Screw (4 used)
47— Plug (2 used)
48— Planetary Gear (3 used)
49— Needle Bearing (3 used)
50— Spring Pin (3 used)
51— Inner Race (3 used)
52— Cover
53— Drive Gear
54— Retaining Ring
55— Thrust Plate
56— Plug (7 used)
57— Ring Gear




W533-03-02-001

6— Spring (2 used)
9— Swash Plate Control Piston (2 used)
12— Steel Ball (2 used)
14— Housing
15— Holder
16— O-Ring
17— Pin (3 used)
18— Collar
20— Retaining Ring
25— Valve Housing
26— Socket Bolt (4 used)
27— Brake Valve
28— Washer
29— Valve Plate
30— Socket Bolt (6 used)
31— O-Ring
32— Spring
33— Rotor
34— Plunger (9 used)
35— Retainer
37— Swash Plate
47— Plug
52— Cover
56— Plug (3 used)
57— Ring Gear

**Disassemble Travel Device (58Mu)**

Before disassembling, make matching marks on the mating surfaces of housing (14), brake housing (27) and valve housing (25). Clean disassembled parts with cleaning oil and group them by component section.

1. Loosen socket bolts (26) (4 used) and remove valve housing (25).

   : 6 mm

2. Remove socket bolts (30) (6 used), brake valve (27) and valve plate (29).

*NOTE: Valve plate (29) may stick to brake valve (27). Take care not to drop valve plate (29) when removing brake valve (27).*

   : 10 mm

3. Remove O-ring (16) from brake valve (27).

4. Remove O-ring (31) from housing (14).

5. Remove rotor (33), swash plate (37), then remove steel balls (12), swash-plate control pistons (9) and springs (6) (two used each) from housing (14).

6. Remove plungers (34) (9 used), retainer (35), holder (15) and pins (17) (3 used) from rotor (33).

7. Remove retaining ring (20) from rotor (33), then remove washer (28), spring (32) and collar (18).

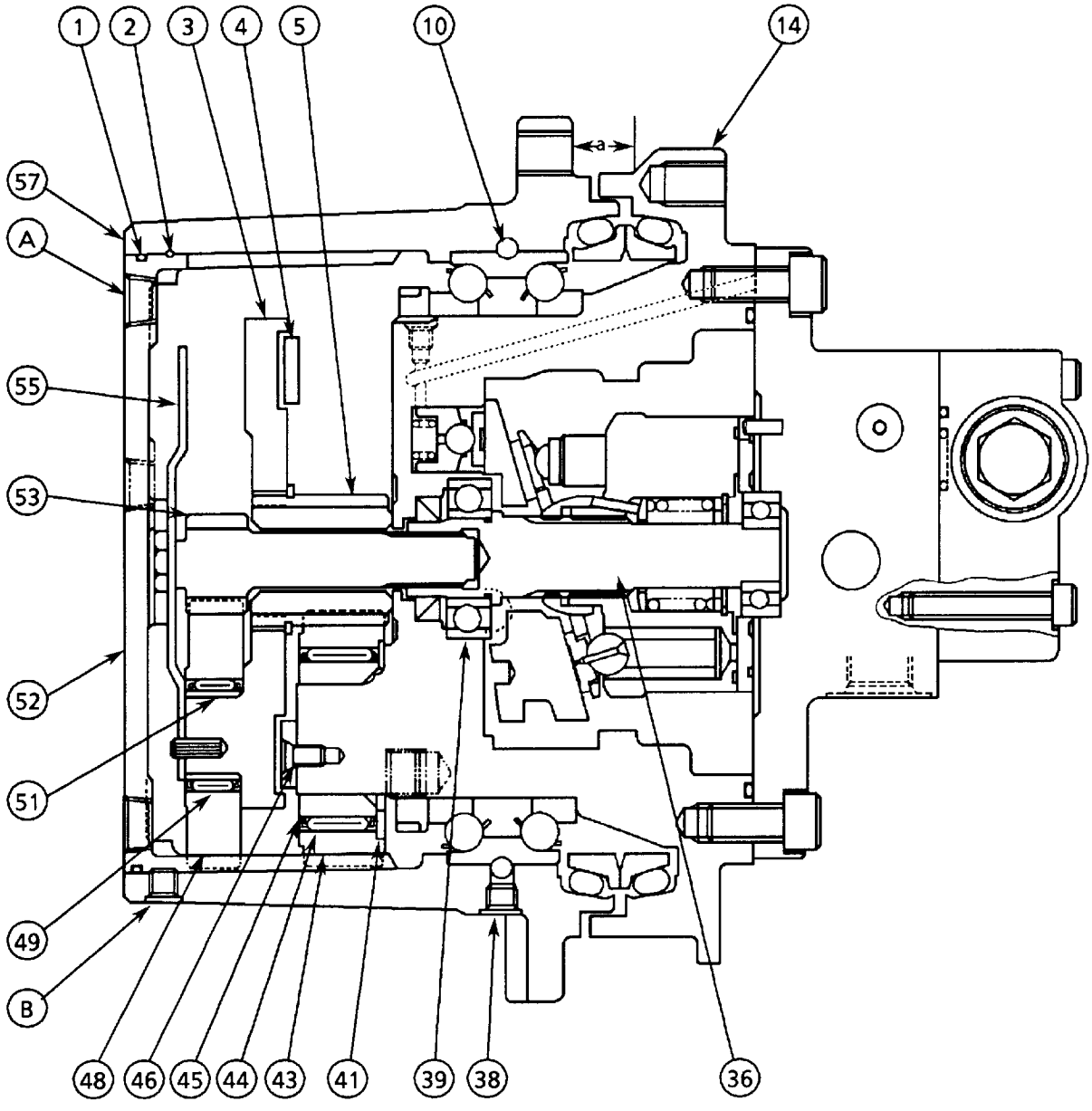
**CAUTION: Always hold washer (28) and spring (32) with a press when removing retaining ring (20). If washer (28) and spring (32) are not held with a press, when removing retaining ring (20), they may fly out potentially causing serious injury.**

8. Remove plugs (56) (3 used) from cover (52). Remove plugs (47) from ring gear (57).

   Wrench Size:

   : 5 mm [ Plug (47) ]

   : 8 mm [ Plug (56) ]




W533-03-02-001

1— O-Ring
2— Wire
3— Carrier
4— Thrust Plate
5— Sun Gear
10— Steel Ball (99 used)
14— Housing
36— Shaft
38— Plug (2 used)
39— Ball Bearing
41— Thrust Washer (4 used)
43— Planetary Gear (4 used)
44— Needle Bearing (4 used)
45— Collar (4 used)
46— Screw (4 used)
48— Planetary Gear (3 used)
49— Needle Bearing (3 used)
51— Inner Race (3 used)
52— Cover
53— Drive Gear
55— Thrust Plate
57— Ring Gear

9. Install two eyebolts into plug (A) openings on cover (52). Insert a steel pipe through the eyebolt holes.

: ST 0018

10. Pull out wire (2) from plug (B) openings on ring gear (57) while rotating cover (52) with the steel pipe.

11. Remove cover (52) from ring gear (57).

12. Remove O-ring (1) from cover (52).

13. Remove thrust plate (55), drive gear (53), carrier (3) and sun gear (5) from ring gear (57).

14. Remove planetary gears (48), needle bearings (49) and inner races (51) (three used each) from carrier (3).

15. Remove screws (46) (4 used) and thrust plate (4) from housing (14). Remove, planetary gears (43), needle bearings (44), collars (45) and thrust washers (41) (four used each).

: 4 mm

16. Remove shaft (36) from housing (14).

*NOTE: Remove shaft (36) by tapping it out with a bar and hammer.Do not remove ball bearing (39) unless replacement is required.*

17. Remove plugs (38) from ring gear (57).

: 5 mm

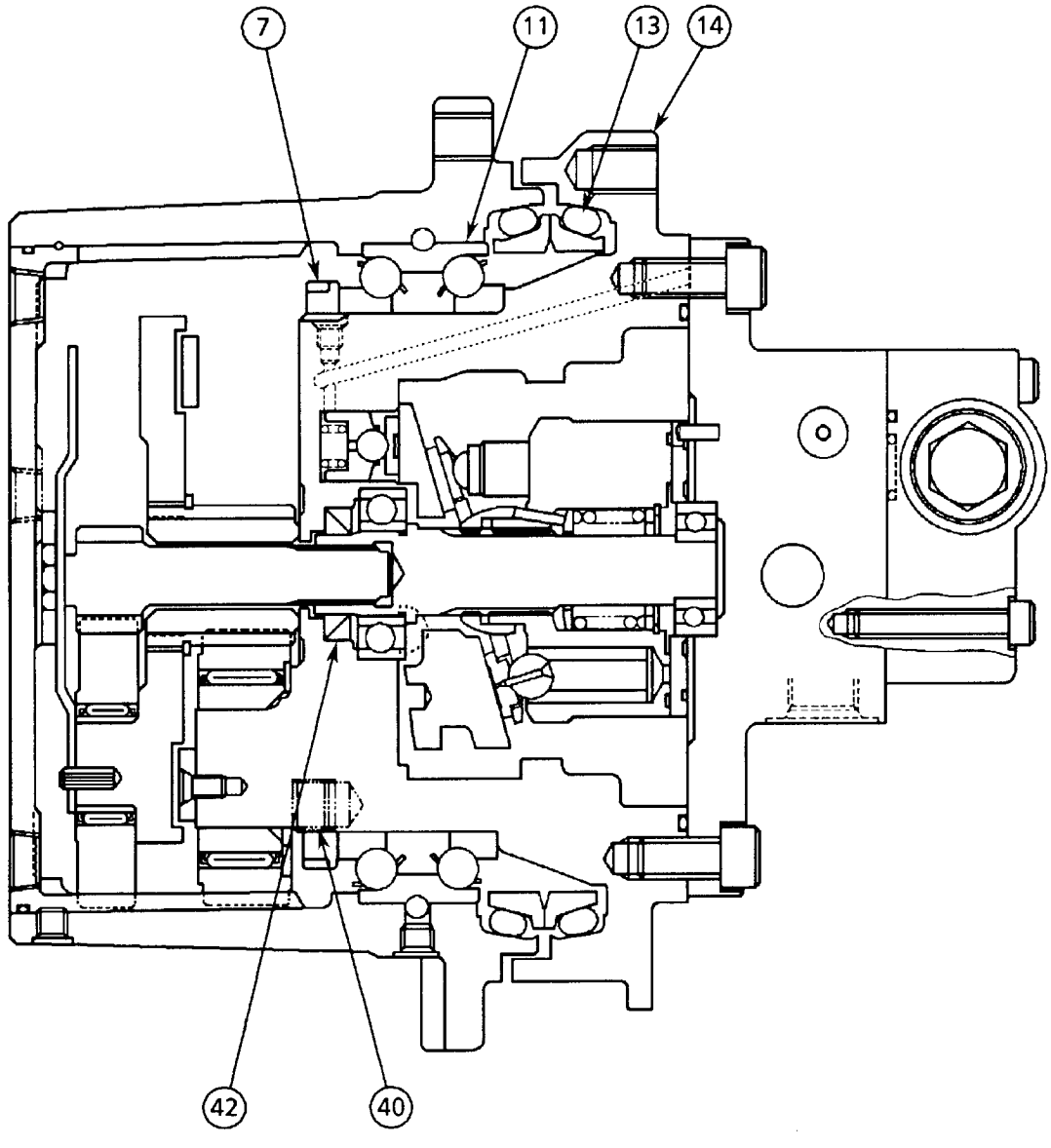
18. Remove steel balls (10) (99 used) via the plug holes on ring gear (57).

19. Insert two or three pieces of a steel plate in clearance "a" spaced evenly around the circumference.

20. Remove housing (14) from ring gear (57) by evenly tightening 2 to 3 bolts installed into the sprocket mounting bolt holes on ring gear (57).

Bolt size : M12×P1.75×ℓ45

: 18 mm




W533-03-02-001

7— Bearing Nut
11— Bearing
13— Floating Seal
14— Housing
40— Plug (7 used)
42— Oil Seal

21. Remove plug (40) from housing (14).


: 8 mm

22. Remove bearing nut (7) from housing (14) with special tool.

Special Tool: ST 3146

23. Remove bearing (11) from housing (14).

**IMPORTANT: Remove bearing (11) by lightly tapping it out with a bar and hammer. Replace bearing (11) if disassembled.**

24. Remove floating seal (13) from housing (14).

25. Remove oil seal (42) from housing (14).

26. Remove plugs (66) (2 used) from brake valve housing (27), then remove springs (58) (2 used), spring seats (64) (2 used) and spool (63).

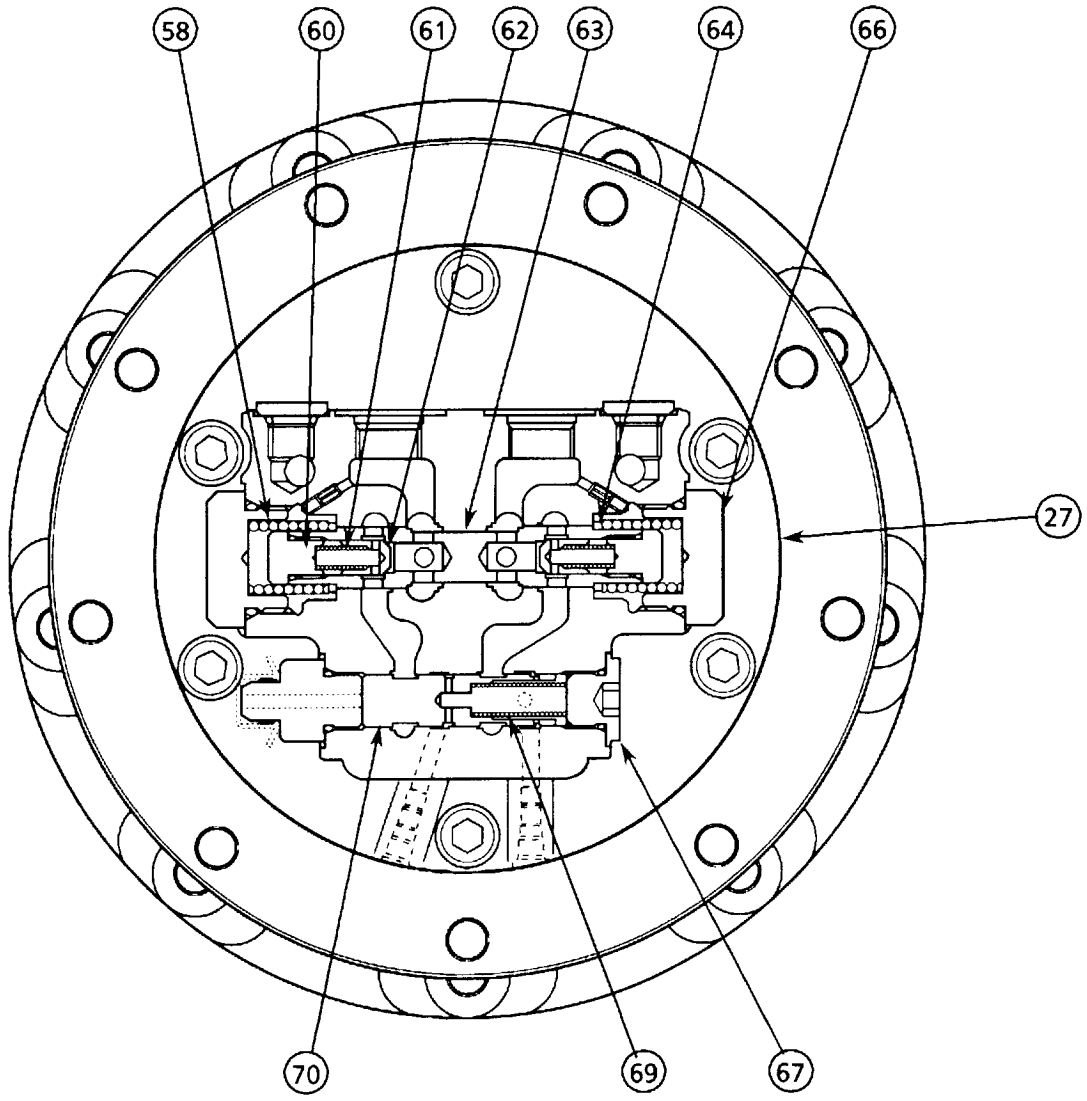
: 32 mm

27. Remove plugs (60) (2 used), spring (61) and check valve (62) from spool (63).

: 12 mm

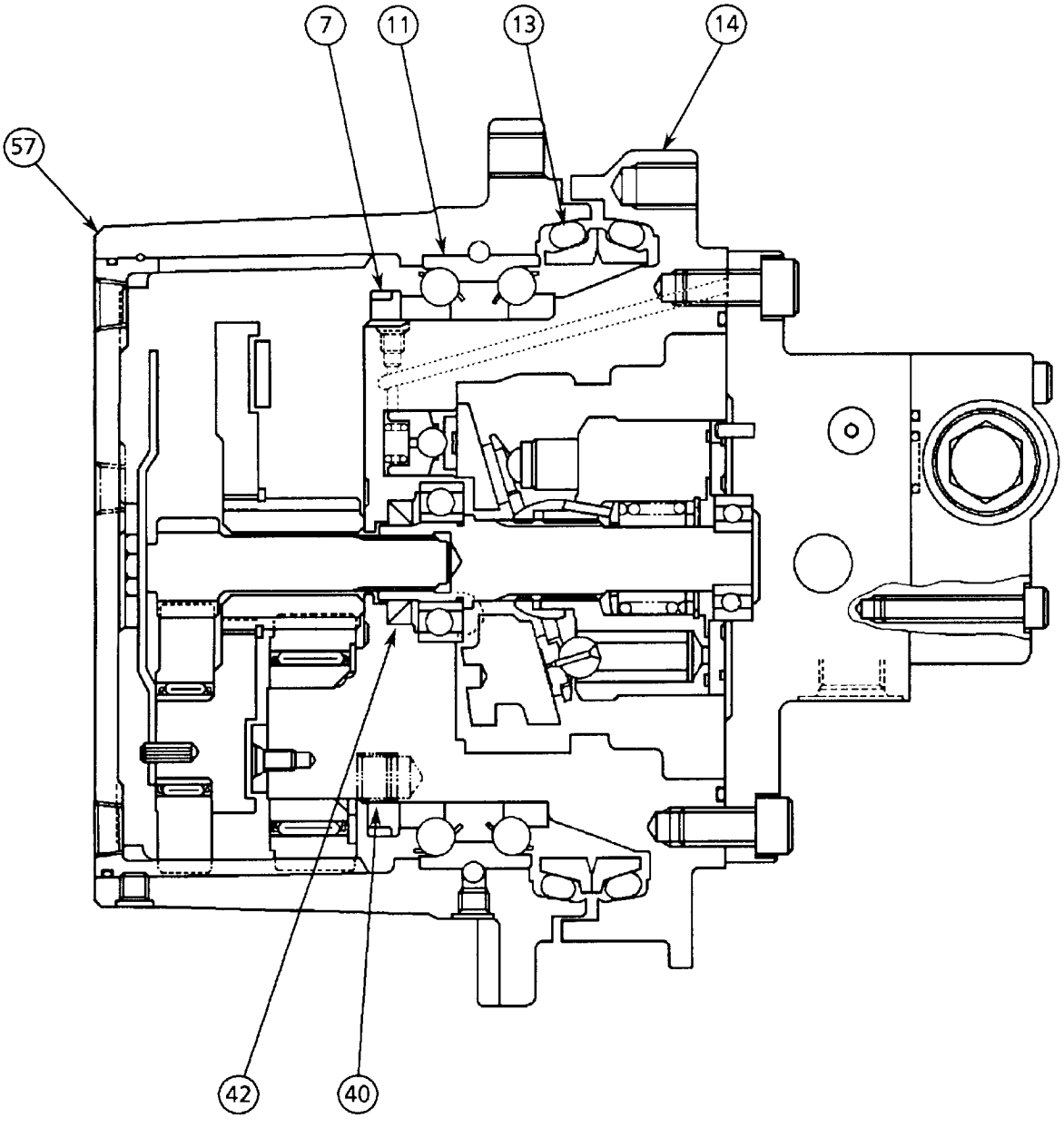
28. Remove plugs (67) (2 used), spring (69) and spool (70) from brake valve housing (27).

: 8 mm




W554-03-02-001

27— Housing
58— Spring (2 used)
60— Plug (2 used)
61— Spring (2 used)
62— Check Valve (2 used)
63— Spool
64— Seat (2 used)
66— Plug (2 used)
67— Plug
69— Spring
70— Spool




W533-03-02-001

7— Bearing Nut
11— Bearing
13— Floating Seal
14— Housing
40— Plug (7 used)
42— Oil Seal
57— Ring Gear

**Assemble Travel Device (58Mu)**

Before assembling, clean components and parts with cleaning oil and dry completely. Apply a film of clean hydraulic oil to inner parts, sliding parts in particular, before assembling. Always replace used O-rings, oil seals and floating seals with new ones when re-assembling.

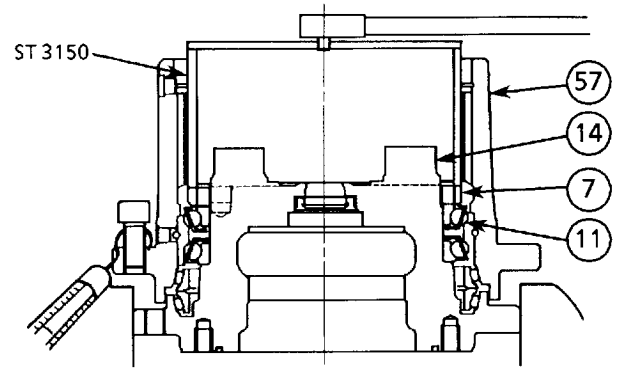
1. Install oil seal (42) in housing (14).
2. Install floating seal (13) on housing (14).
3. Tap bearing (11) onto housing (14) and tighten bearing nut (7).

Tightening Tool: ST 3150

4. Tap ring gear (57) on housing (14) with a plastic hammer.
5. Rotate ring gear (6) 2 to 3 times for break-in run.

Tightening Tool: ST 3150

: 235 ± 10 N·m ( 24 ± 1.0 kgf·m )

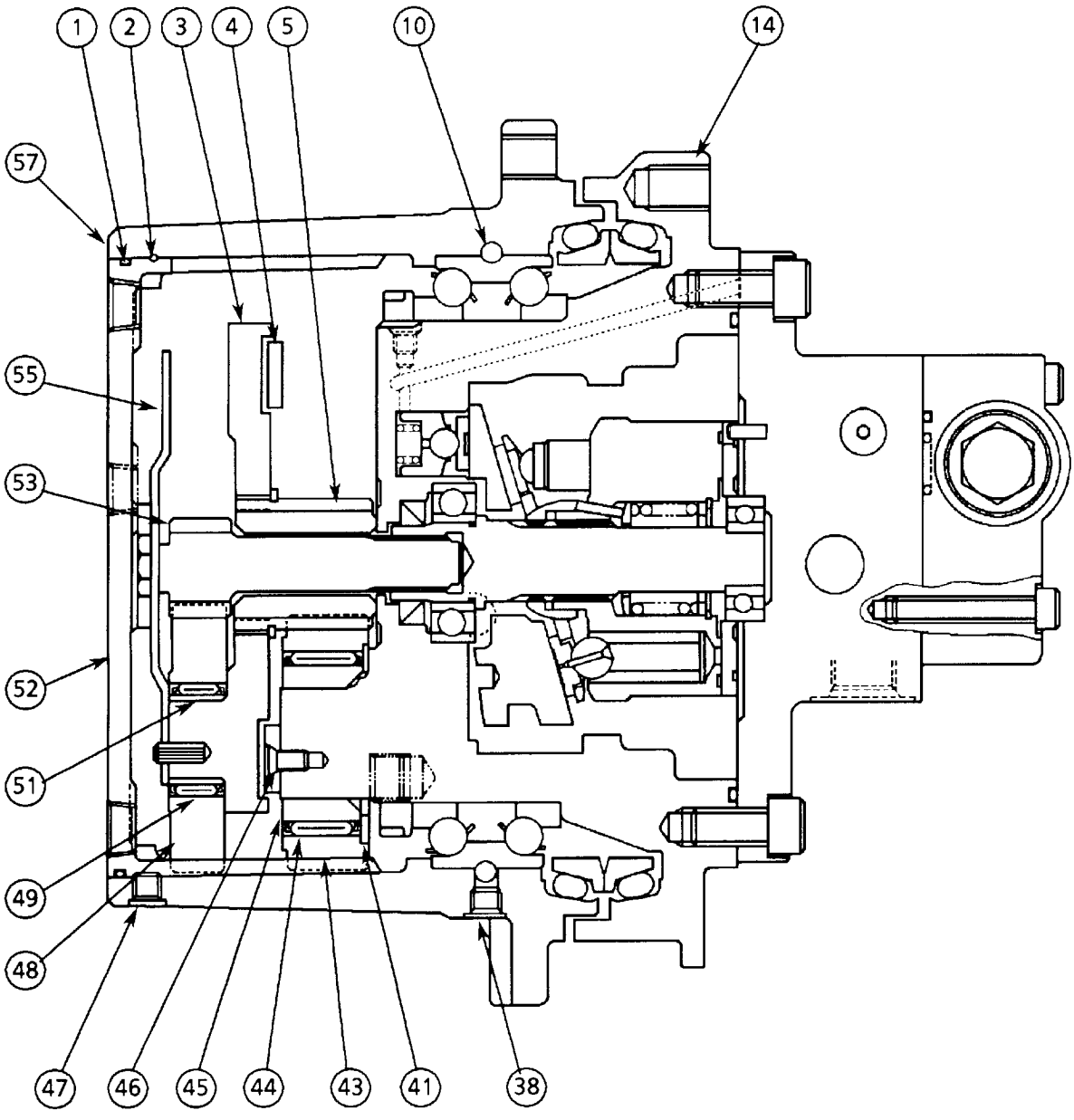


W505-03-02-003

6. Install plugs (40) on housing (14).
7. Lock each plug by mushrooming its top in at least two places with a punch.

: 8 mm

: 34.3 ± 4.9 N·m ( 3.5 ± 0.5 kgf·m )




W533-03-02-001

1— O-Ring
2— Wire
3— Carrier
4— Thrust Plate
5— Sun Gear
10— Steel Ball (99 used)
14— Housing
38— Plug (2 used)
41— Thrust Washer (4 used)
43— Planetary Gear (4 used)
44— Needle Bearing (4 used)
45— Collar (4 used)
46— Screw (4 used)
47— Plug (2 used)
48— Planetary Gear (3 used)
49— Needle Bearing (3 used)
51— Inner Race (3 used)
52— Cover
53— Drive Gear
55— Thrust Plate
57— Ring Gear

8. Install steel balls (10) (99 used) via the plug holes and tighten plugs (38).

**IMPORTANT: Be sure to apply seal tape to plug (38) threads before installing.**

: 5 mm, : 7.8±1 N·m ( 0.8±0.1 kgf·m )

9. Install thrust washers (41), collars (45), needle bearings (44) and planetary gears (43) (four used each) to housing (14), in that order. Install thrust plate (4) and tighten screws (46) (4 used).

**IMPORTANT: Apply Loctite #262 to screws (46) before installing.**

: 4 mm, : 24.5±4.9 N·m ( 2.5±0.5 kgf·m )

10. Install sun gear (5) to planetary gear (43).

11. Install carrier (3) onto sun gear (5).

12. Install inner races (51), needle bearings (49) and planetary gears (48) (three used each) onto carrier (3), in that order.

13. Install drive gear (53) onto carrier (3).

14. Install thrust plate (55) onto carrier (3).

15. Install O-ring (1) onto cover (52). Install cover (52) in ring gear (57).

16. Install two eyebolts into the plug openings on cover (52). Insert a steel pipe through the eyebolt holes.

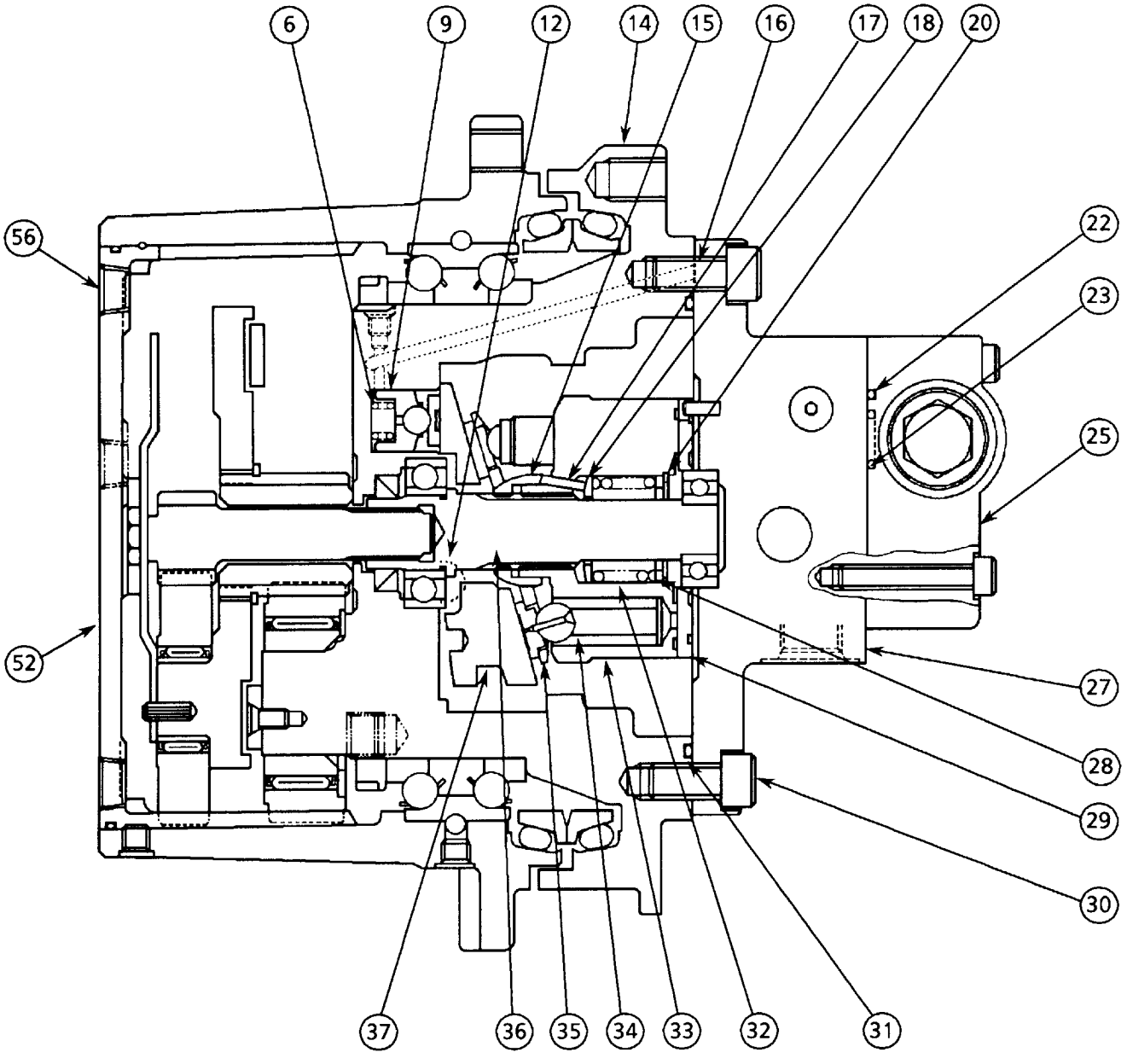
: ST 0018

17. Insert wire (2) into the plug opening, with its tip (approximately 6 mm) bent 90°. Turn cover (52) using a steel pipe to wind wire (2) further.

18. Tighten plugs (47).

**IMPORTANT: Be sure to apply seal tape to plug (47) threads before installing.**

: 5 mm, : 7.8±1 N·m ( 0.8±0.1 kgf·m )




W533-03-02-001

6— Spring (2 used)
9— Swash Plate Control Piston (2 used)
12— Steel Ball (2 used)
14— Housing
15— Holder
16— O-Ring
17— Pin (3 used)
18— Collar
20— Retaining Ring
22— O-ring (3 used)
23— O-Ring (2 used)
25— Valve Housing
27— Brake Valve
28— Washer
29— Valve Plate
30— Socket Bolt (6 used)
31— O-Ring
32— Spring
33— Rotor
34— Plunger (9 used)
35— Retainer
36— Shaft
37— Swash Plate
52— Cover
56— Plug (3 used)

19. Rotate housing (14) 180°. Press shaft (36) into housing (14).

20. Install steel balls (12), springs (6) and control pistons (9) (two used each) in housing (14), then install swash plate (37).

21. Install collar (18), spring (32) and washer (28)into rotor (33).

22. Hold washer (28) and spring (32) down with a press, and install retaining ring (20).

23. Install pins (17) (3 used) into rotor (33), then install holder (15) onto them.

24. Install the assembly of plungers (34) (9 used) and retainer (35) into rotor (33).

25. Install rotor (33) in housing (14).

26. Install O-ring (31) onto housing (14).

27. Install O-ring (16) and valve plate (29) to brake valve (27).

*NOTE: Apply grease to the mating surfaces of brake valve (27) and valve plate (29) to prevent valve plate (29) from falling off.*

28. Install brake valve (27) onto housing (14) and tighten socket bolts (30) (6 used).

: 8 mm, : 108 ± 10 N·m
( 11 ± 1 kgf·m )

29. Install O-rings (22, 23) onto valve housing (25). Install valve housing (25) onto brake valve (27).

: 6 mm, : 29.4 ± 2.0 N·m
( 3.0 ± 0.2 kgf·m )

30. Rotate the travel device 180°. Fill the travel device with 1.2 L of gear oil via the plug openings on cover (52). Tighten plugs (56) (3 used).

*NOTE: Apply seal tape to plug (43) threads before installing.*

: 8 mm, : 34 ± 4.9 N·m
( 3.5 ± 0.5 kgf·m )

Gear Oil: 1.2L

31. Install spool (70) and spring (69) in brake valve housing (27) and tighten plug (67).

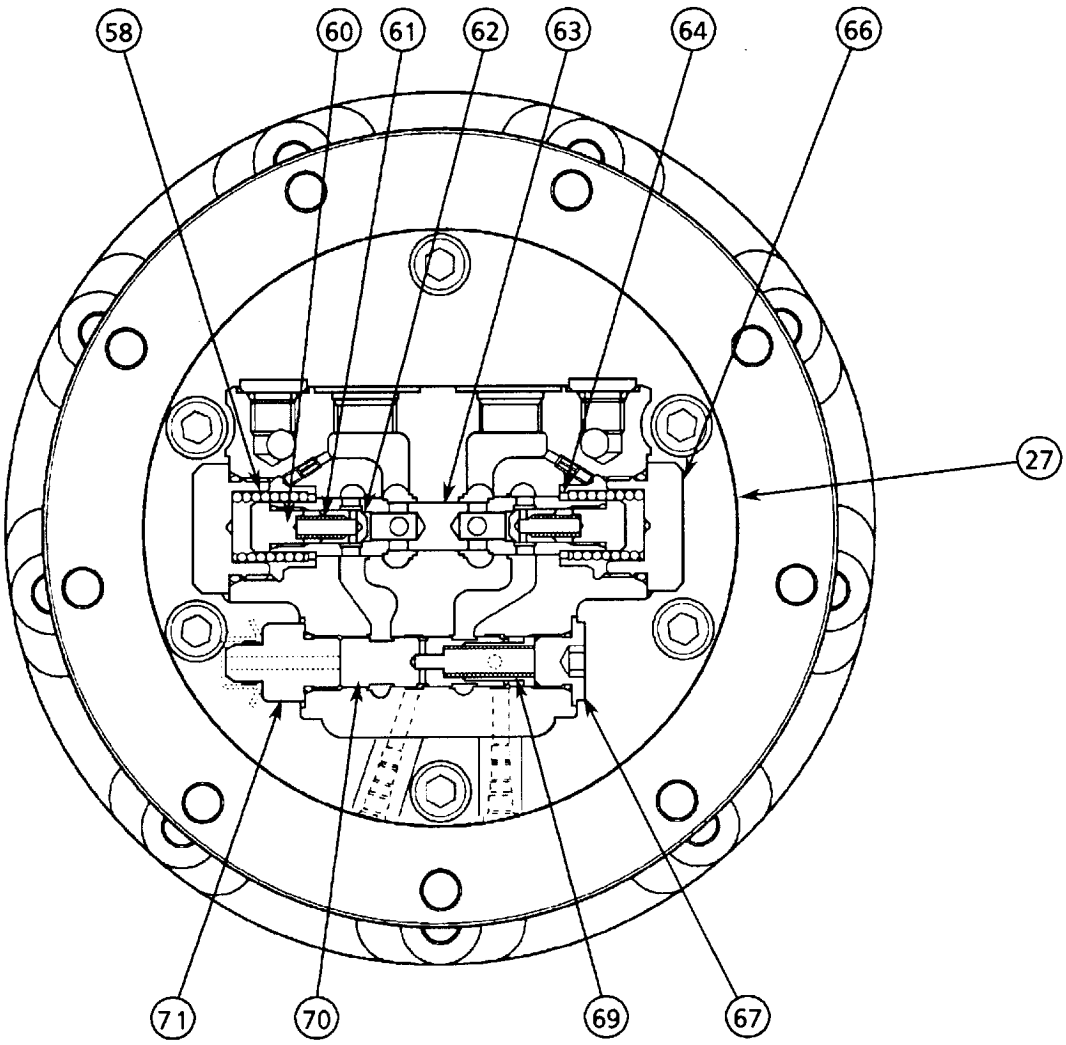
: 8 mm, : 53.9 ± 4.9 N·m (5.5 ± 0.5 kgf·m)

32. Install check valves (62) and springs (61) to spool (63) and tighten plugs (60) (2 used).

: 12 mm, : 31.9 ± 2.5 N·m (3.3 ± 0.3 kgf·m)

33. Install spool (63) in brake valve housing (27), then install seats (64) and springs (58) (two used each) and tighten plugs (66) (2 used).

: 32 mm, : 240 ± 5 N·m (24.5 ± 0.5 kgf·m)




W554-03-02-001

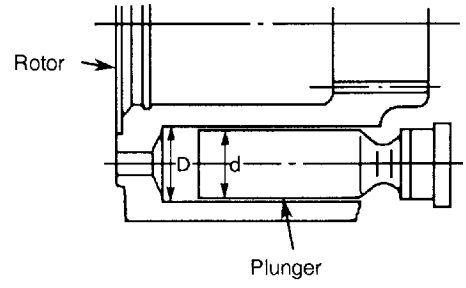
27— Housing
58— Spring (2 used)
60— Plug (2 used)
61— Spring (2 used)
62— Check Valve (2 used)
63— Spool
64— Seat (2 used)
66— Plug (2 used)
67— Plug
69— Spring
70— Spool
71— Plug

## MAINTENANCE STANDARDS

### Travel Motor

1. Clearance between rotor bore and plunger diameter:

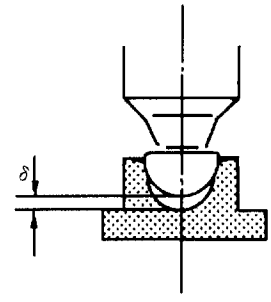
   (D - d) must be 0.04 mm or less.



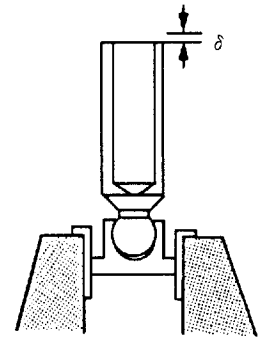

W507-02-04-009

2. Clearance between the plunger tip and shoe bottom:

   $\delta$ must be 0.4 mm or less.




W107-02-06-140




W107-02-06-141

3. Wear amount on rotor (with valve plate) sliding surface:

   The surface must be free of abnormal scratches, wear or seizure.

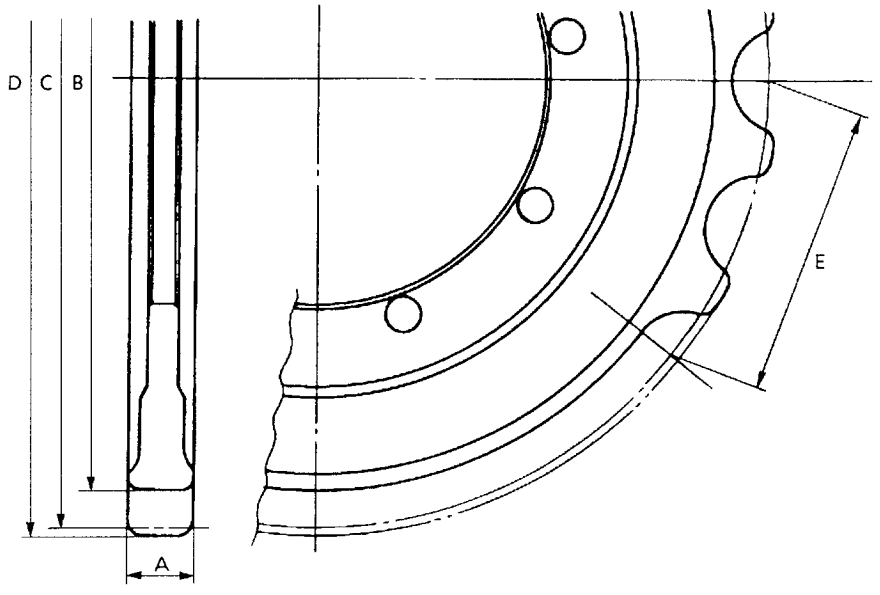
   Scratch depth or wear amount must be 0.02 mm or less.

4. Wear amount on valve plate (with rotor) sliding surface:

   The surface must be free of abnormal scratches, wear or seizure.

   Scratch depth or wear amount must be 0.02 mm or less.

## Sprocket




W503-03-02-004

**33Mu**

Unit: mm

| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 28.5 | 22.5 | Overlaying and Hand Finishing |
| B | 309.0 | 303.0 | |
| C | PCD344.7 | – | |
| D | 352.0 | 346.0 | |
| E | 101.6 | – | |

**58Mu**

Unit: mm

| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 47.6 | 42.6 | Overlaying and Hand Finishing |
| B | 377.6 | 372.3 | |
| C | PCD415.8 | – | |
| D | 423.2 | 418.2 | |
| E | 135.0 | – | |

## REMOVE AND INSTALL CENTER JOINT

(The illustration shows the center joint of the 33Mu)

**CAUTION:**

1. **Hydraulic fluid under pressure can penetrate the skin or eyes causing serious injury. Avoid this hazard by relieving pressure before disconnecting any hydraulic lines.**
2. **Hydraulic oil becomes hot during operation. Disconnecting hydraulic lines soon after operation can result in severe burns. Wait for the oil and components to cool before removing any parts.**

**Preparation:**

1. Place the machine on a solid, level surface, and lower the bucket to the ground.
2 Stop the engine. Operate the control levers several times to release any residual pressure in the hydraulic lines. Remove the cap to release the pressure in the hydraulic oil tank.
3. Install a vacuum pump on the cap opening on the hydraulic oil tank. Operate the vacuum pump to create negative pressure in the tank.

*NOTE: Keep the vacuum pump running continuously while working on the system.*

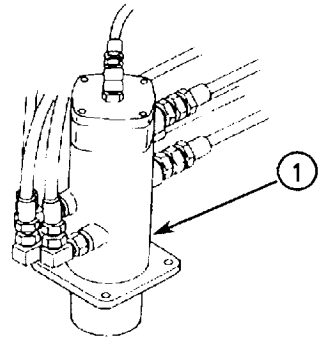
### Remove Center Joint

1. Remove the pilot valve, stay, seat base, cover, floor plates, accelerator wire, control box, controller, harnesses and blade wire. (Refer to "REMOVE AND INSTALL SWING DEVICE" on page W02-05-01.)

2. Disconnect all the housing-side hoses. Remove the lock bolts of center joint (1).

: 19 mm, 22 mm, 27 mm

*NOTE: Attach an identification tag to each hose to aid when re-assembling.*

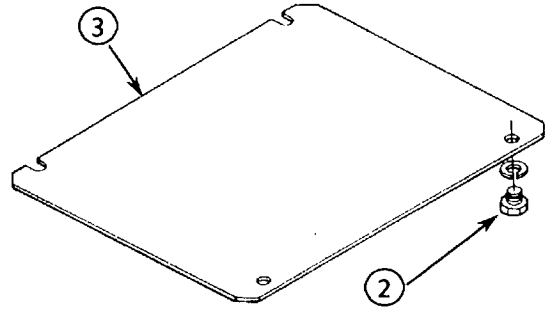



W507-03-03-001

3. Remove bolts (2) and track frame under cover (3).

: 17 mm ( 33Mu )

: 19 mm ( 58Mu )

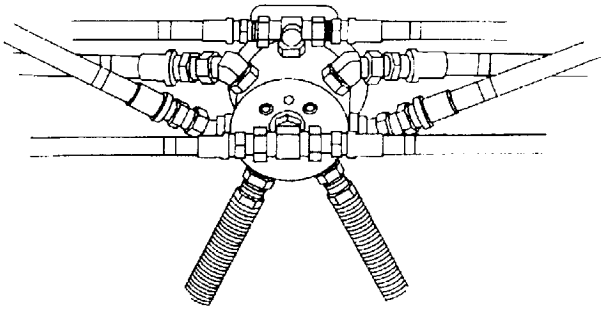



W507-03-03-003

4. Disconnect all the spindle-side hoses.

: 19 mm, 22 mm, 27 mm

*NOTE Attach an identification tag to each hose to aid when re-assembling.*

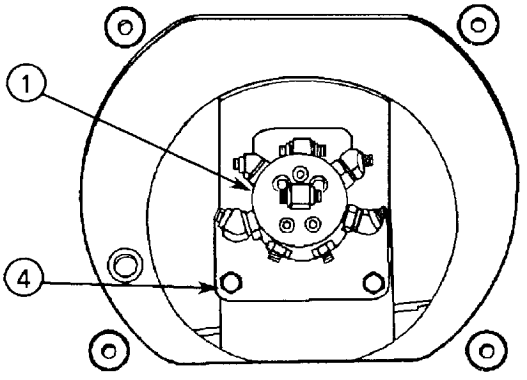


W507-03-03-004

5. Remove center joint mounting bolts (4) and center joint (1).

: 17 mm

**CAUTION: Center joint weight:**
**: 19 kg ( 33Mu, 58Mu )**



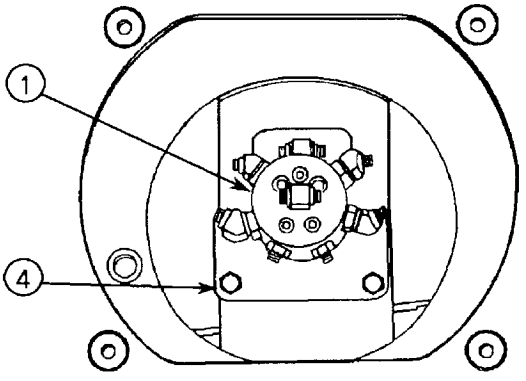

W562-03-03-003

**Install Center Joint**

1. Install center joint (1) and tighten bolts (4).

*NOTE: Apply Loctite #262 to bolt (4) threads.*

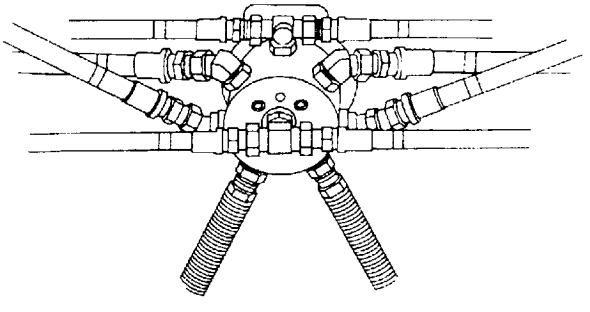
: 17 mm : 49 N·m ( 5 kgf·m )




W562-03-03-003

2. Connect all the spindle-side hoses.

: 19 mm : 29.5 N·m ( 3 kgf·m )
: 22 mm : 39 N·m ( 4 kgf·m )
: 27 mm : 64 N·m ( 6.5 kgf·m )

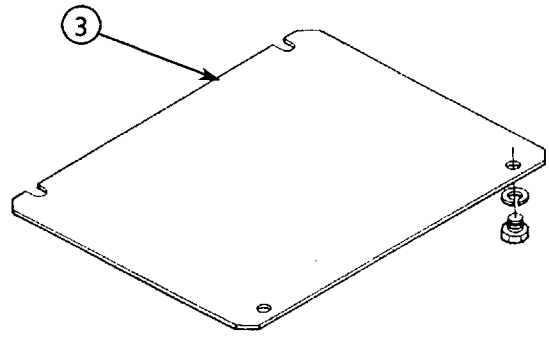


W507-03-03-004

3. Install track frame under cover (3).

: 17 mm : 49 N·m ( 5 kgf·m ) (33Mu)

: 19 mm : 88 N·m ( 9 kgf·m ) (58Mu)




W507-03-03-003

4. Install center joint (1) lock bolts.

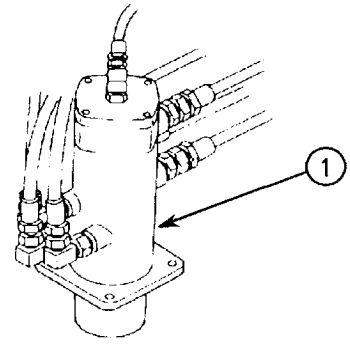
: 19 mm : 88 N·m ( 9 kgf·m )

Connect all the housing-side hoses.

: 19 mm : 29.5 N·m ( 3 kgf·m )

: 22 mm : 39 N·m ( 4 kgf·m )

: 27 mm : 64 N·m ( 6.5 kgf·m )

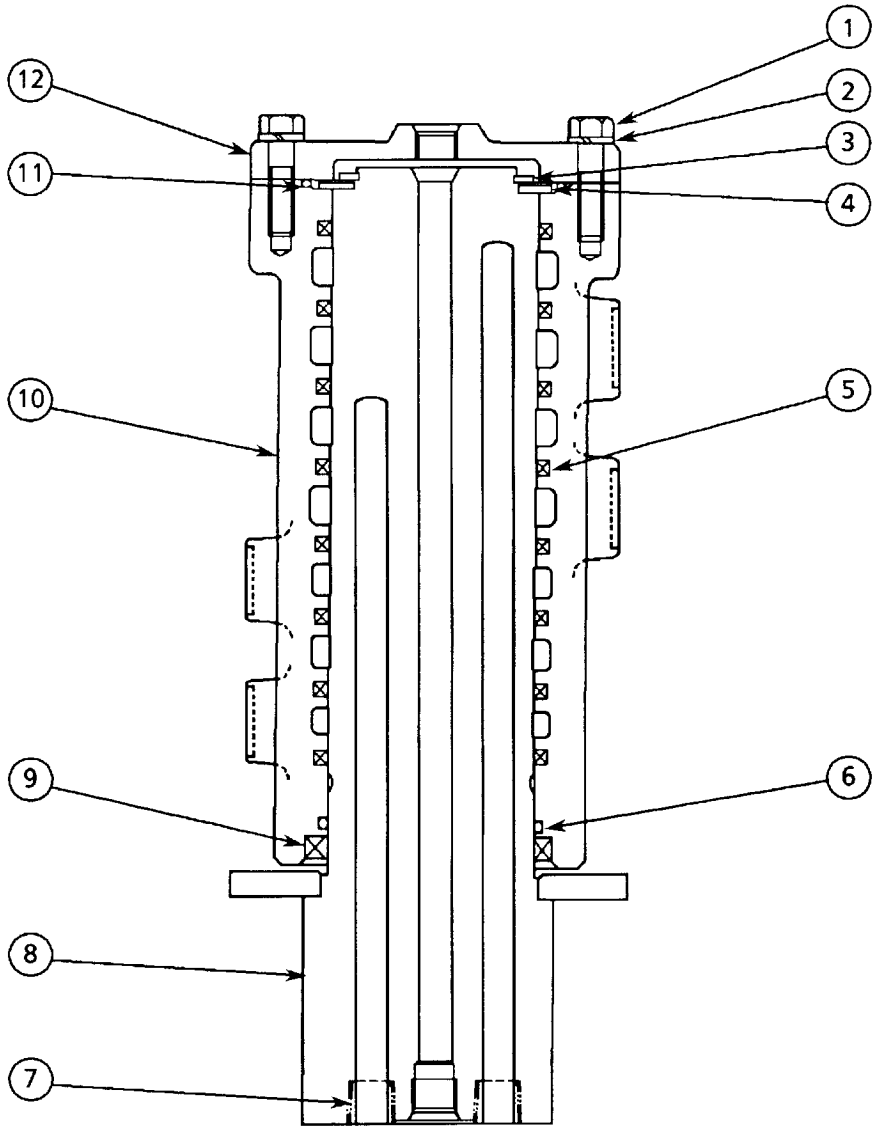



W507-03-03-001

5. Install the blade wire, harnesses, controller, control box, accelerator wire, floor plates, cover, seat base, stay and pilot valve. (Refer to "REMOVE AND INSTALL SWING DEVICE" on page W02-05-01.)

**IMPORTANT: After connecting the hoses, fill the hydraulic oil tank to the correct level. Start the engine and check the hoses for leakage.**

## DISASSEMBLE CENTER JOINT




W554-03-03-007

1— Bolt (4 used)
2— Spring Washer (4 used)
3— Retaining Ring
4— Ring
5— Oil Seal (8 used)
6— O-Ring
7— Plug
8— Spindle
9— Dust Seal
10— Housing
11— O-Ring
12— Cover

**Disassemble Center Joint**

Thoroughly clean the center joint and place it on a workbench.

**IMPORTANT: Clean the center joint with all the ports plugged.**

1. Remove two diagonally-positioned cover (12) mounting bolts (1)and install an eyebolt in each bolt (1) opening. Raise the center joint, using the eyebolts and a crane, and clamp it in a vise.

   Eyebolt Size : M8×1.25, Length: 15 mm

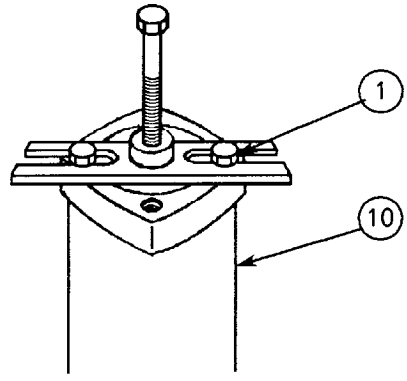
2. Remove the other two bolts (1) and cover (12).

   : 13 mm

3. Remove O-ring (11).

4. Remove retaining ring (3).

5. Remove ring (4).




W506-03-03-002

6. Install a puller on housing (10) with two cover mounting bolts (1), as illustrated.

   : 13 mm

7. Remove housing (10) from spindle (8) using a puller.

**IMPORTANT: Take care not to damage the seal sliding surfaces of spindle (8) when removing housing (10). When laying spindle (8)horizontally on the ground, take extra care not to damage or contaminate the spindle surfaces with hard material such as sand. Put matching marks on housing (10) and spindle (8).**

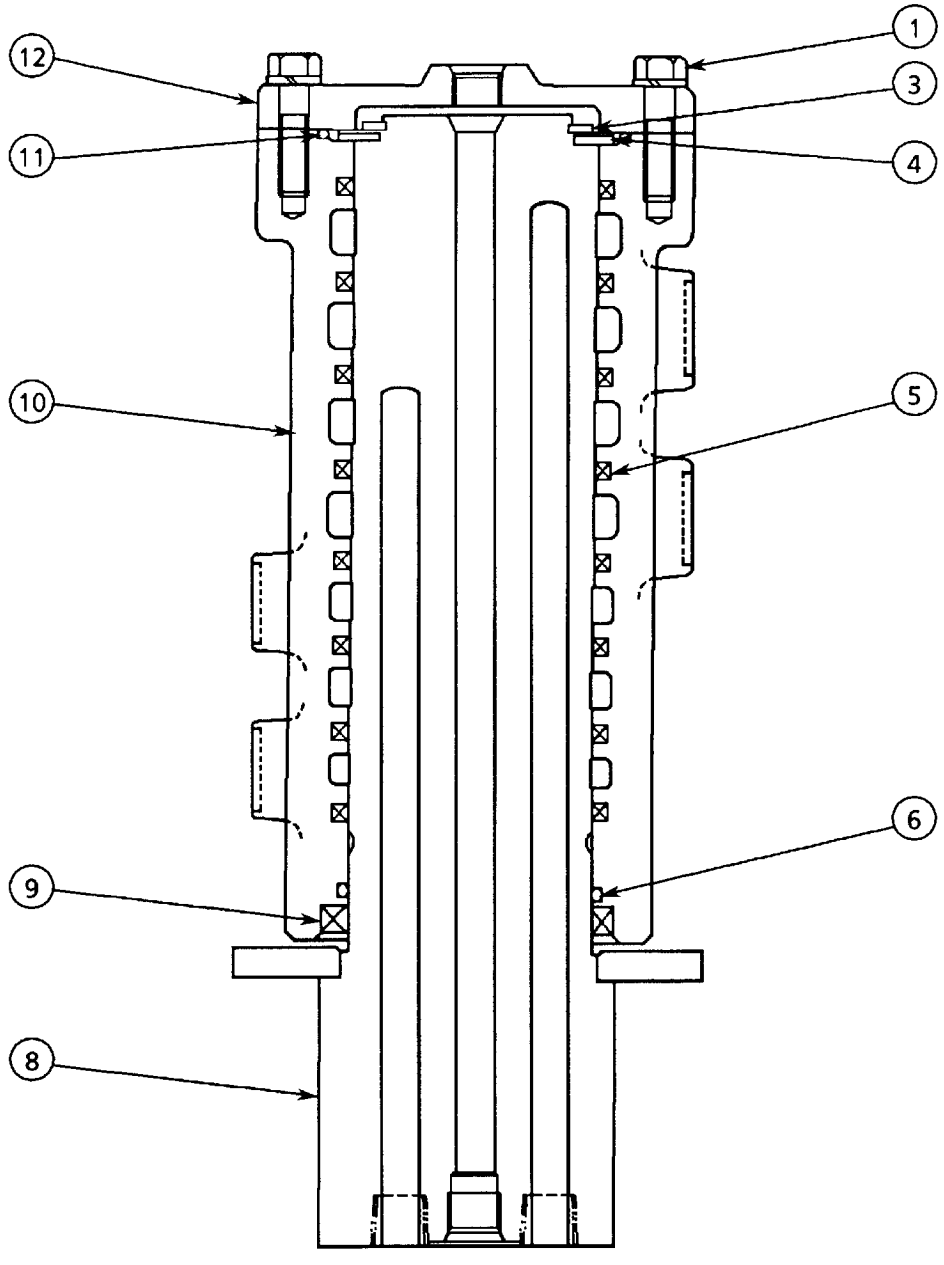
8. Remove eight oil seals (5) from housing (10).

*NOTE: Use pins able to pierce oil seal (5) when removing it from the oil seal groove in housing (10). Use two pins to allow oil seal (5) to easily come out. Take care not to damage the seal groove with pins when removing.*

9. Remove dust seal (9) from housing (10).

10. Remove O-ring (6) from housing (10).

## ASSEMBLE CENTER JOINT




W554-03-03-007

1— Bolt (4 used)
3— Retaining Ring
4— Ring
5— Oil Seal (8 used)
6— O-Ring
8— Spindle
9— Dust Seal
10— Housing
11— O-Ring
12— Cover

**Assemble Center Joint**

Before assembling, clean components and parts with cleaning oil and dry completely. Apply a film of clean hydraulic oil to inner parts, sliding parts in particular, before assembling in order to prevent seizures. Always replace used O-rings and oil seals with new ones when re-assembling.

1. Install O-ring (6) in housing (10).
2. Install dust seal (9) in housing (10).
3. Install eight oil seals (5) in housing (10).

**IMPORTANT: Before installing O-ring (6), oil seals (5) or dust seal (9) into each groove, lightly apply a film of grease or oil. After installing , apply grease to the inner surfaces (lips of seals).**

4. Place spindle on a workbench. Install housing (10) to spindle (8).

**IMPORTANT: Align the matching marks when installing housing (10).**

5. Install housing (10) by tapping it with a plastic hammer until housing (10) comes into contact with spindle (8) flange.

**IMPORTANT: Slowly lower housing (10) not to damage the seals. If housing (10) is lowered quickly, spindle (8) may damage the seals.**

6. Install ring (4) on housing (10).
7. Install O-ring (11) on spindle (8).
8. Install retaining ring (3).

**IMPORTANT: Install retaining ring (3) with the chamfered side down. Confirm that retaining ring (3) is correctly installed.**

9. Install cover (12) and tighten bolts (1).

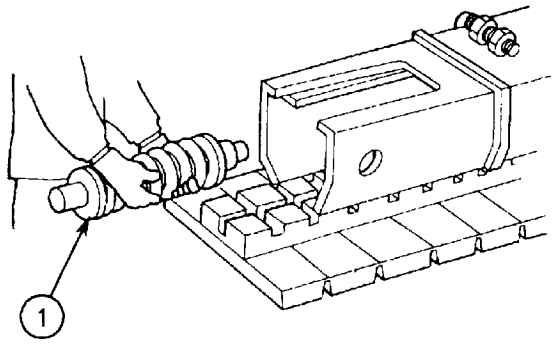
 : 13 mm  : 10.8 N·m ( 1.1 kgf·m )

## REMOVE AND INSTALL TRACK ADJUSTER

### Remove Track Adjuster

The procedures given here should be followed after removing the rubber tracks and front idler. Refer to the respective sections on removal and installation of the rubber tracks and front idler.

1. After removing the front idler assembly, remove track adjuster (1) assembly from the track frame.

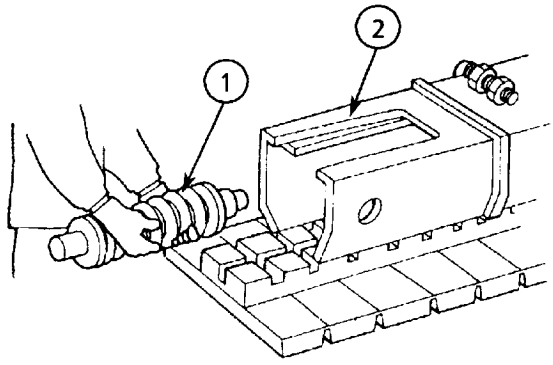



W507-03-04-001

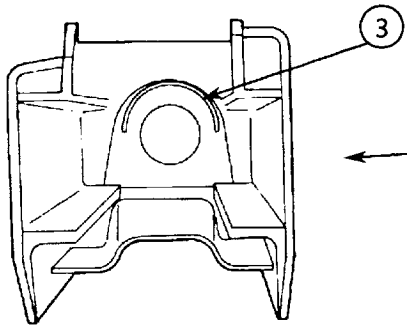
*NOTE: Track adjuster assembly weight:*
*: 9.1 kg ( 33Mu )*
*: 14.6 kg ( 58Mu )*

### Install Track Adjuster

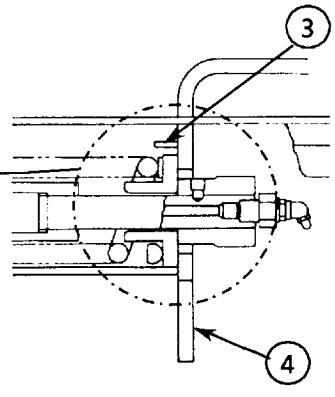
1. Hold track adjuster (1) as illustrated, and insert it into track frame (2). Be sure that track adjuster (1) is inserted until its spring seat comes into contact with plate (4), not with spring guide (3).




W507-03-04-001




W507-03-04-003



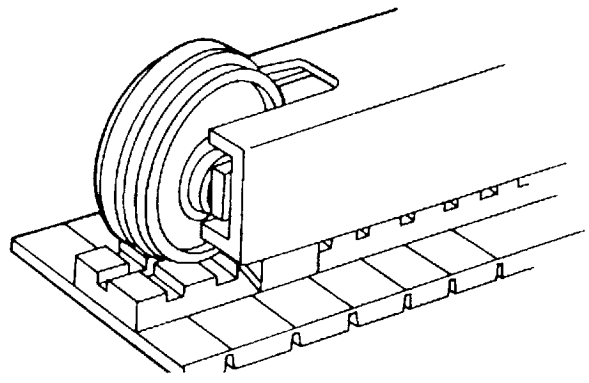

W507-03-04-002

## REMOVE AND INSTALL FRONT IDLER

### Remove Front Idler

The procedures given here should be followed after removing the rubber tracks. Refer to "Remove and Install Rubber Tracks" in Group 07 for removal and installation of the rubber tracks.

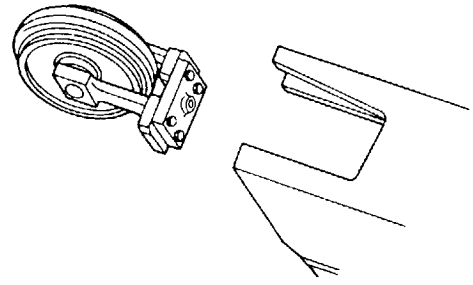
1. Remove the front idler and yoke assembly from the track frame using a crowbar.



W507-03-05-001

**CAUTION: Front idler weight:**
**: 23.1 kg (33Mu)**
**: 42.8 kg (58Mu)**

**CAUTION: When temporarily storing the front idler, lay it on square wooden blocks so that the front idler will not roll away.**

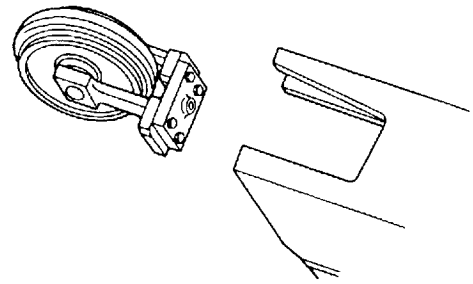


W562-03-05-001

### Install Front Idler

1. To install the front idler, simply perform the removing procedures in reverse.

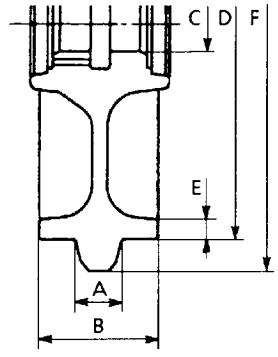
*NOTE: Before installing, check that the top and bottom of the yoke is correctly positioned. Apply grease to the sliding surfaces of the track frame and bearing after cleaning them.*



W562-03-05-001

## MAINTENANCE STANDARDS

### Front Idler




W503-03-05-001

**33Mu**

Unit: mm

| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 31 | 25 | Overlaying and Hand Finishing |
| B | 80 | – | |
| C | 39 | – | |
| D | 269 | 263 | |
| E | 10 | – | |
| F | 307 | – | |

### Axle and Bushing

Unit: mm

| | | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|---|
| Axle | Outer Diameter | 35.0 | 34.2 | Replace |
| Bushing | Inner Diameter | 35.0 | 35.5 | |
| | Flange Thickness | 2.0 | 1.5 | |

**58Mu**

Unit: mm

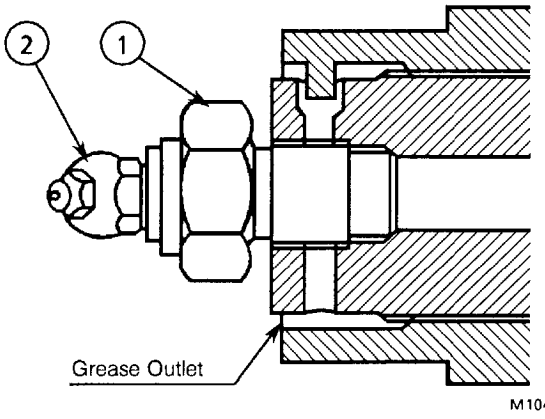
| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 53 | 47 | Overlaying and Hand Finishing |
| B | 92 | – | |
| C | 44 | – | |
| D | 315 | 309 | |
| E | 10 | – | |
| F | 359 | – | |

**Axle and Bushing**

Unit: mm

| | | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|---|
| Axle | Outer Diameter | 40.0 | 39.2 | Replace |
| Bushing | Inner Diameter | 40.0 | 40.5 | |
| | Flange Thickness | 2.0 | 1.5 | |

## REMOVE AND INSTALL UPPER ROLLER




M104-07-119

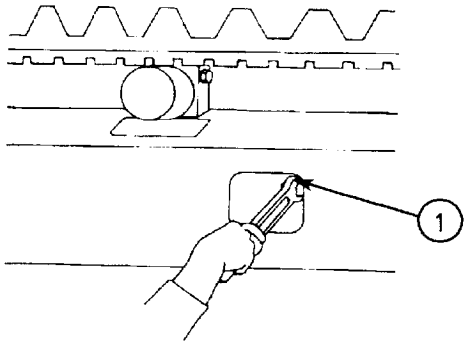
### Remove Upper Roller

**CAUTION: Grease pressure in the adjuster cylinder is high.**
**Do not loosen valve (1) quickly or loosen it too much. Valve (1) may fly out or high-pressure grease in the adjusting cylinder may spout out. Loosen carefully, keeping body parts and face well away from valve (1). Never loosen grease fitting (2).**

1. Slowly loosen track adjuster valve (1); grease will escape from the grease outlet.

: 19 mm

**IMPORTANT: If gravel or mud is packed between sprockets and track links, be sure to remove it before loosening.**




W507-03-06-001

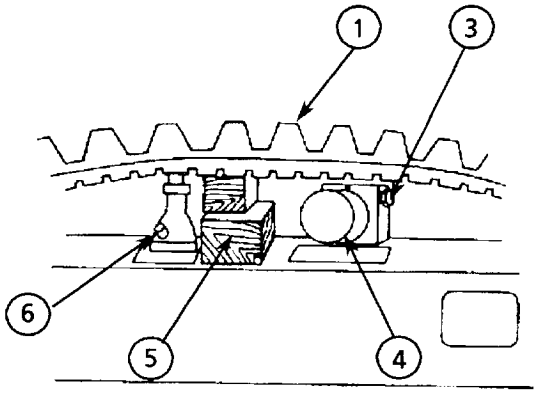
2. Raise track (1) until the clearance between track (1) and upper roller (4) is widened. Then insert wooden blocks (5).

**CAUTION: Place pads between track (1) and oil jack (6) when jacking up to prevent them from slipping.**

3. Loosen bolt (3) and remove upper roller (4).

: 22 mm ( 33Mu )

: 24 mm ( 58Mu )




W507-03-06-003

*NOTE: Upper roller assembly weight: 2.8 kg.*

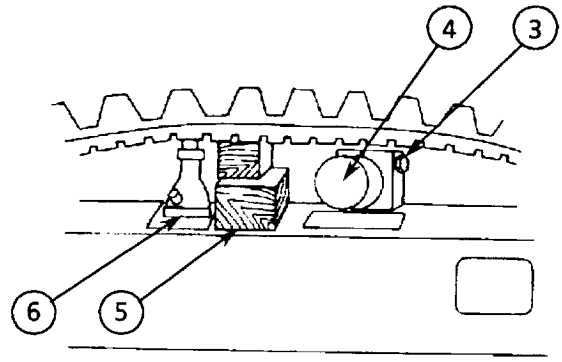
**Install Upper Roller**

1. Install upper roller (4) and tighten bolt (3).

: 22 mm : 137 N·m ( 14 kgf·m ) ( 33Mu )

: 24 mm : 206 N·m ( 21 kgf·m ) ( 58Mu )

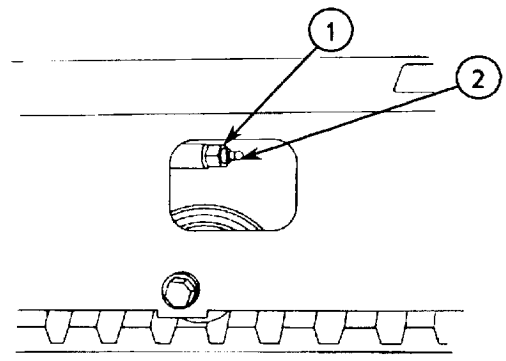
2. Remove wooden square blocks (5) and oil jack (6).



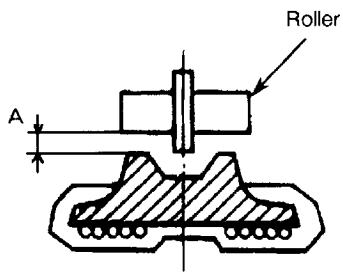

W507-03-06-003

3. Tighten track adjuster valve (1) and add grease via fitting (2)until the track sag is within specifications.

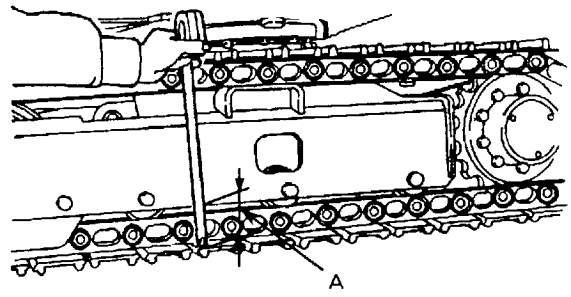
Track Sag Specifications A:
Steel Track : 120~140 mm (33Mu)
: 170~180 mm (58Mu)
Rubber Crawler : 10~15 mm




W507-03-06-005




Rubber Crawler M503-05-050



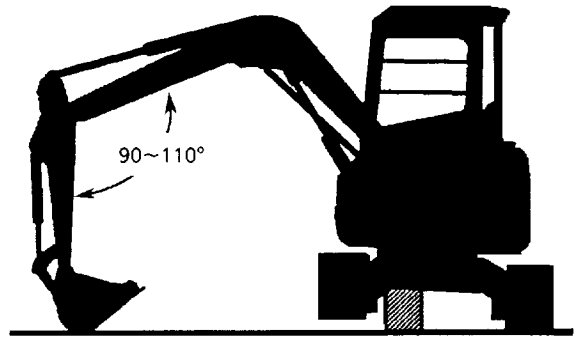

Steel Track M552-07-037

## REMOVE AND INSTALL LOWER ROLLER

### Remove Lower Roller

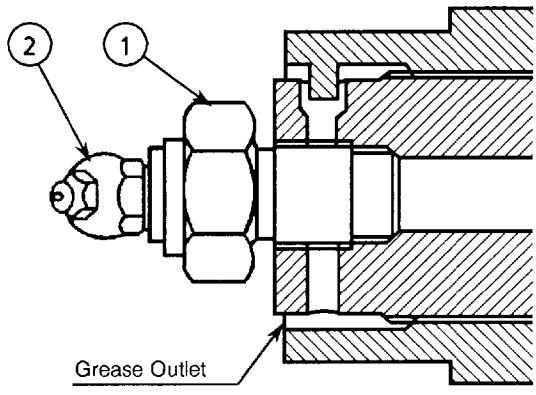
1. Raise one track off the ground using the front attachment, and place wooden blocks under the track frame.

**IMPORTANT: If gravel or mud is packed between the sprockets and track links, be sure to remove it before loosening.**




W532-03-06-001

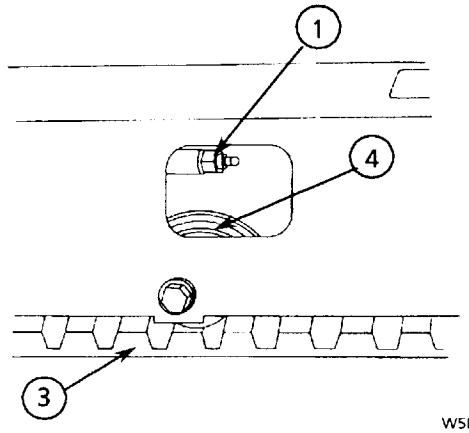
**CAUTION: Grease pressure in the adjuster cylinder is high. Do not loosen valve (1) quickly or loosen it too much. Valve (1) may fly out or high-pressure grease in the adjusting cylinder may spout out. Loosen carefully, keeping body parts and face well away from valve (1). Never loosen grease fitting (2).**




M104-07-119

2. Loosen track (3) by loosening track adjuster valve (1) to allow lower roller to be removed.

: 19 mm



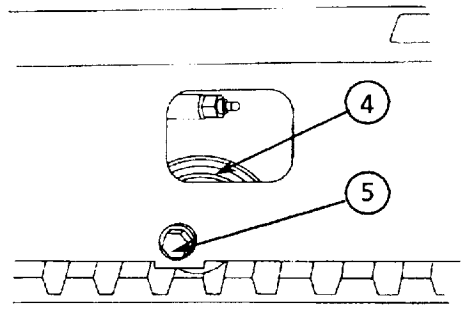

W507-03-06-005

3. Loosen bolt (5) and remove lower roller (4).

: 22 mm ( 33Mu )

: 27 mm ( 58Mu )

*NOTE: Lower roller assembly weight:*
*: 6 kg ( 33Mu )*
*9 kg ( 58Mu )*



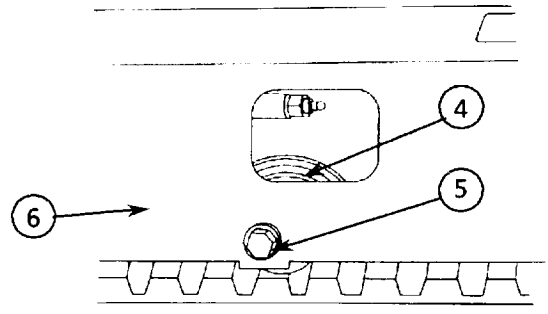

W507-03-06-005

**Install Lower Roller**

1. Install lower roller (4) to the underside of track frame (6), aligning the bolt holes. Apply Loctite #262 to bolt (5) threads and tighten to specifications.

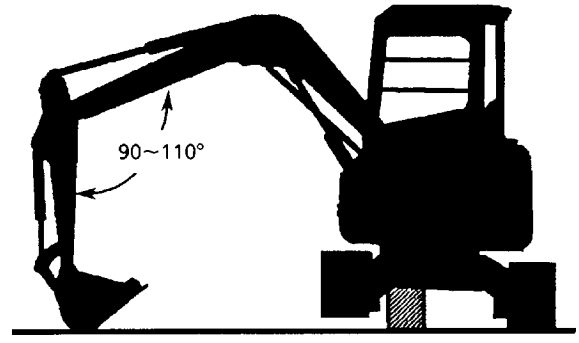
: 22 mm : 245 N·m (25 kgf·m) (33Mu)

: 27 mm : 451 N·m (46 kgf·m) (58Mu)




W507-03-06-005

2. Raise one track off the ground using the front attachment and remove wooden blocks.



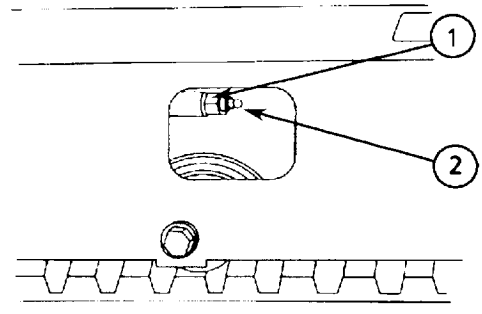

W532-03-06-001

3. Tighten track adjuster valve (1) and add grease via fitting (2)until the track sag is within specifications.

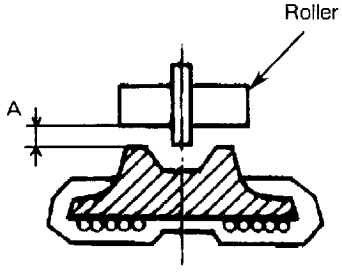
Track Sag Specifications (A)

Steel Track : 120 to 140 mm (33Mu)
170 to 180 mm (58Mu)

Rubber Crawler : 10 to 15 mm

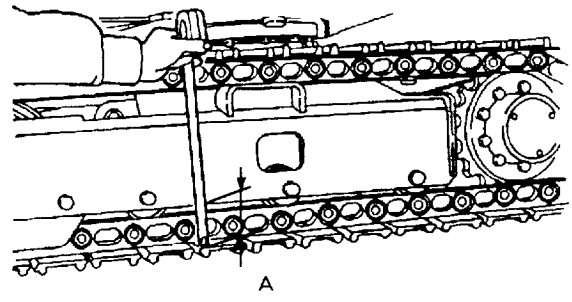



W507-03-06-005




Rubber Crawler

M503-05-050

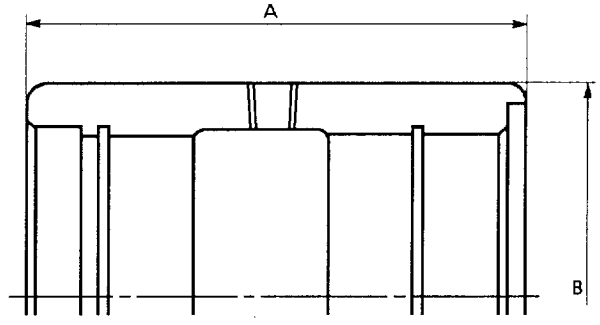



Steel Track

M552-07-037

## MAINTENANCE STANDARDS

### Upper Roller

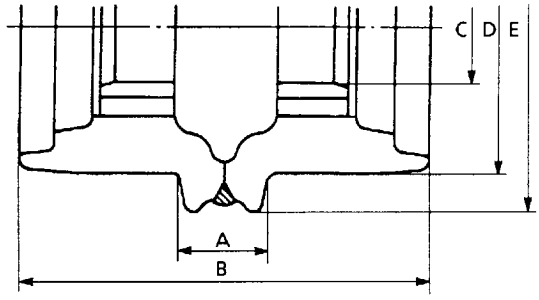



W554-03-06-001

Unit: mm

| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 95 | – | Overlaying and Hand Finishing |
| B | 80 | 74 | |

## Lower Roller




W503-03-06-001

### 33Mu

Unit: mm

| Key Letter | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 31 | 23 | Overlaying and Hand Finishing |
| B | 112 | – | |
| C | 34 | – | |
| D | 85 | 77 | |
| E | 107 | – | |

### Axle and Bushing

Unit: mm

| | | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|---|
| Axle | Outer Diameter | 30.0 | 29.2 | Replace |
| Bushing | Inner Diameter | 30.0 | 30.5 | |
| | Flange Thickness | 2.0 | 1.5 | |

**58Mu**

Unit: mm

| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 53 | 45 | Overlaying and Hand Finishing |
| B | 142 | – | |
| C | 39 | – | |
| D | 95 | 87 | |
| E | 122 | – | |

**Axle and Bushing**

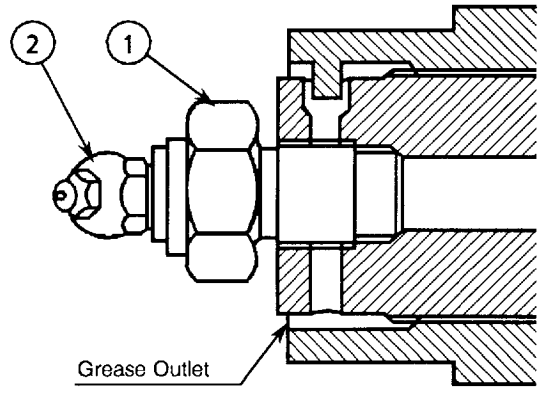
Unit: mm

| | | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|---|
| Axle | Outer Diameter | 35.0 | 34.2 | Replace |
| Bushing | Inner Diameter | 35.0 | 35.5 | |
| | Flange Thickness | 2.0 | 1.5 | |

## REMOVE AND INSTALL RUBBER CRAWLER

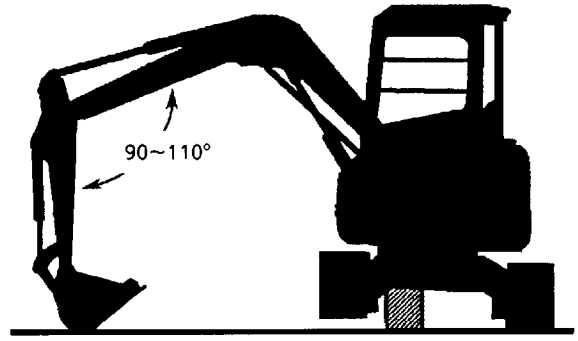
### Remove Rubber Crawler

**CAUTION: Grease pressure in the adjuster cylinder is high. Do not loosen valve (1) quickly or loosen it too much. Valve (1) may fly out or high-pressure grease in the adjusting cylinder may spout out. Loosen carefully, keeping body parts and face well away from valve (1). Never loosen grease fitting (2).**




M104-07-119

1. Raise one track off the ground using the front attachment, and place wooden blocks under the track frame.

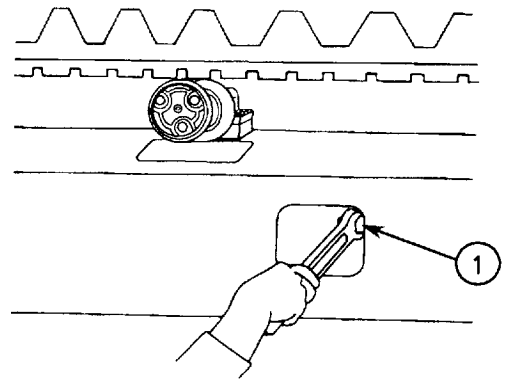



W532-03-06-001

2. Slowly loosen track adjuster valve (1); grease will escape from the grease outlet.

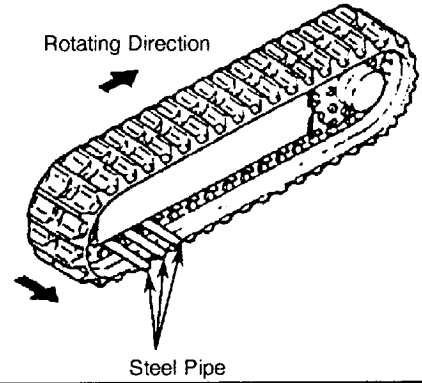
: 19 mm

**IMPORTANT: If gravel or mud is packed between the sprockets and track links, be sure to remove it before loosening.**




W190-03-06-001

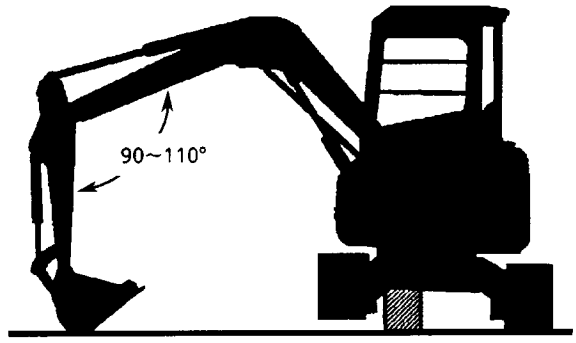
3. Insert pieces of a steel pipe into gaps between the rubber crawler and track frame. Then, rotate the sprocket in the reverse direction. After the rubber crawler is raised off the sprocket teeth with the steel pipes, slide the rubber crawler away from the track frame and remove it.




M503-07-062

**Install Rubber Crawler**

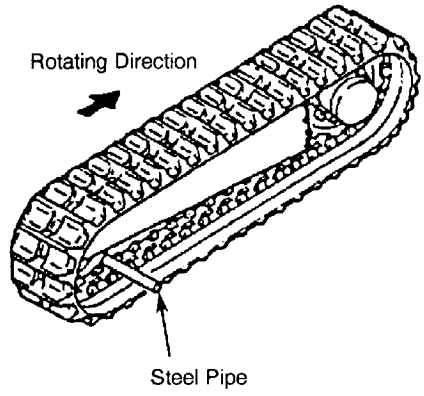
1. Raise one track off the ground using the front attachment, and place wooden blocks under the track frame.




W532-03-06-001

2. Temporarily install one end of the rubber crawler on the sprocket, and hang the other end over the front idler. Slightly rotate the sprocket in the reverse direction so that the rubber crawler is pushed back to rotate with the sprocket.

3. Insert a steel pipe into gaps between the rubber crawler and track frame. Rotate the sprocket again in reverse so that the rubber crawler rotates with the sprocket and front idler.



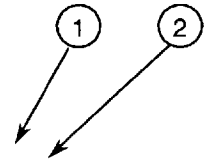

M503-07-063

**CAUTION: Confirm that the rubber crawler rotates with the sprocket and front idler.**

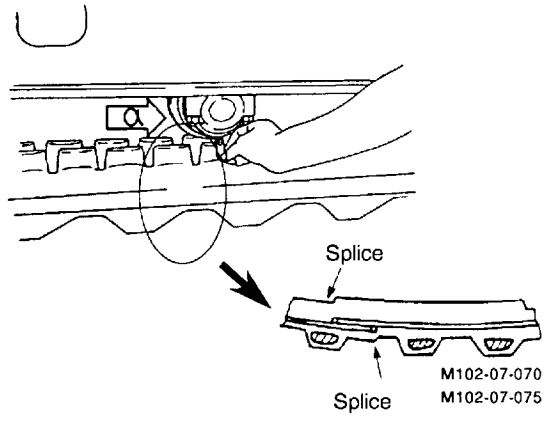
4. Tighten track adjuster valve (1) and add grease via fitting (2)until the track sag is within specifications. When measuring the track sag, position the rubber crawler joint section at the center of the track, as illustrated.

   Track sag specification (A): Rubber Crawler :
   10 to 15 mm

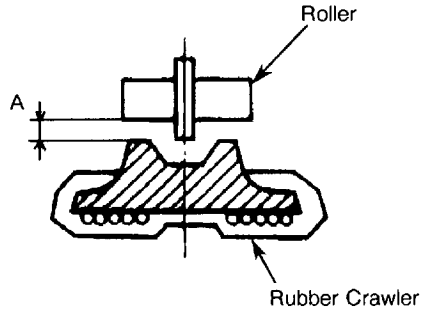
**CAUTION: Safely support the raised machine using wooden blocks.**




W190-03-06-003




M102-07-070
M102-07-075

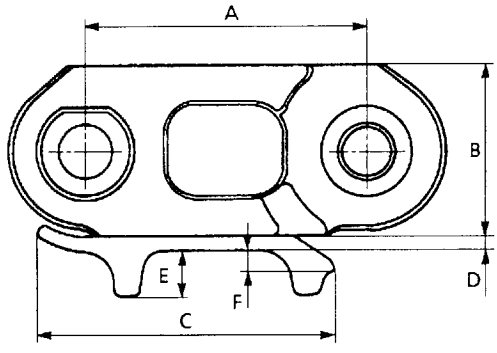



Section a

M503-05-050

## MAINTENANCE STANDARD

### Track Link, Shoe

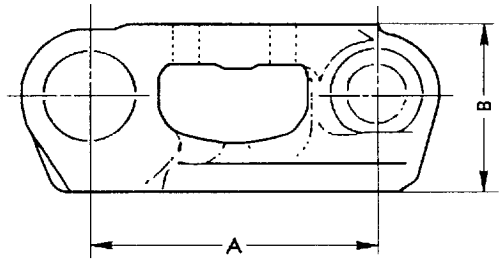



W507-03-07-001

**33Mu**

Unit: mm

| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 101.6 | 105.0 | Replace |
| B | 60.0 | 55.0 | |
| C | 109.0 | – | |
| D | 5.5 | – | |
| E | 16.5 | 7.5 | |
| F | 7.5 | – | |

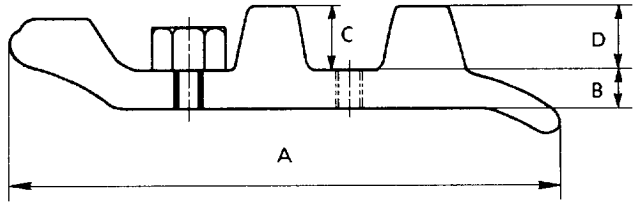



W554-03-07-001

**58Mu**

Unit: mm

| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 135 | 139 | Overlaying and Hand Finishing |
| B | 67 | 60 | |



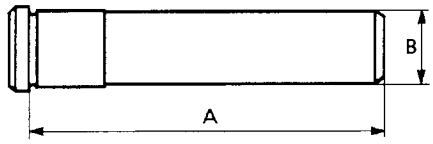

W554-03-07-002

**58Mu**

Unit: mm

| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 154 | – | Overlaying Lug and Hand Finishing |
| B | 6 | – | |
| C | 14 | 7 | |
| D | 14 | 7 | |

**Master Pin**

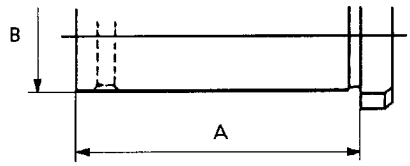



W507-03-07-002

**33Mu**

Unit: mm

| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 92.50 | — | Replace |
| B | 18.90 | 16.00 | |



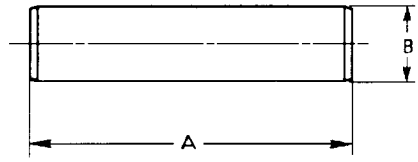

W503-03-07-002

**58Mu**

Unit: mm

| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 133.0 | — | Replace |
| B | 22.15 | 16.00 | |

## Link Pin




W105-03-07-022

### 33Mu

Unit: mm

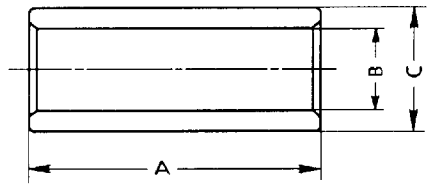
| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 92.50 | — | Replace |
| B | 19.17 | 17.50 | |

### 58Mu

Unit: mm

| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 140.0 | — | Replace |
| B | 22.3 | 20.5 | |

## Bushing




W105-03-07-023

### 33Mu

Unit: mm

| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 52.0 | — | Replace |
| B | 19.5 | 20.5 | |
| C | 32.2 | 30.2 | |

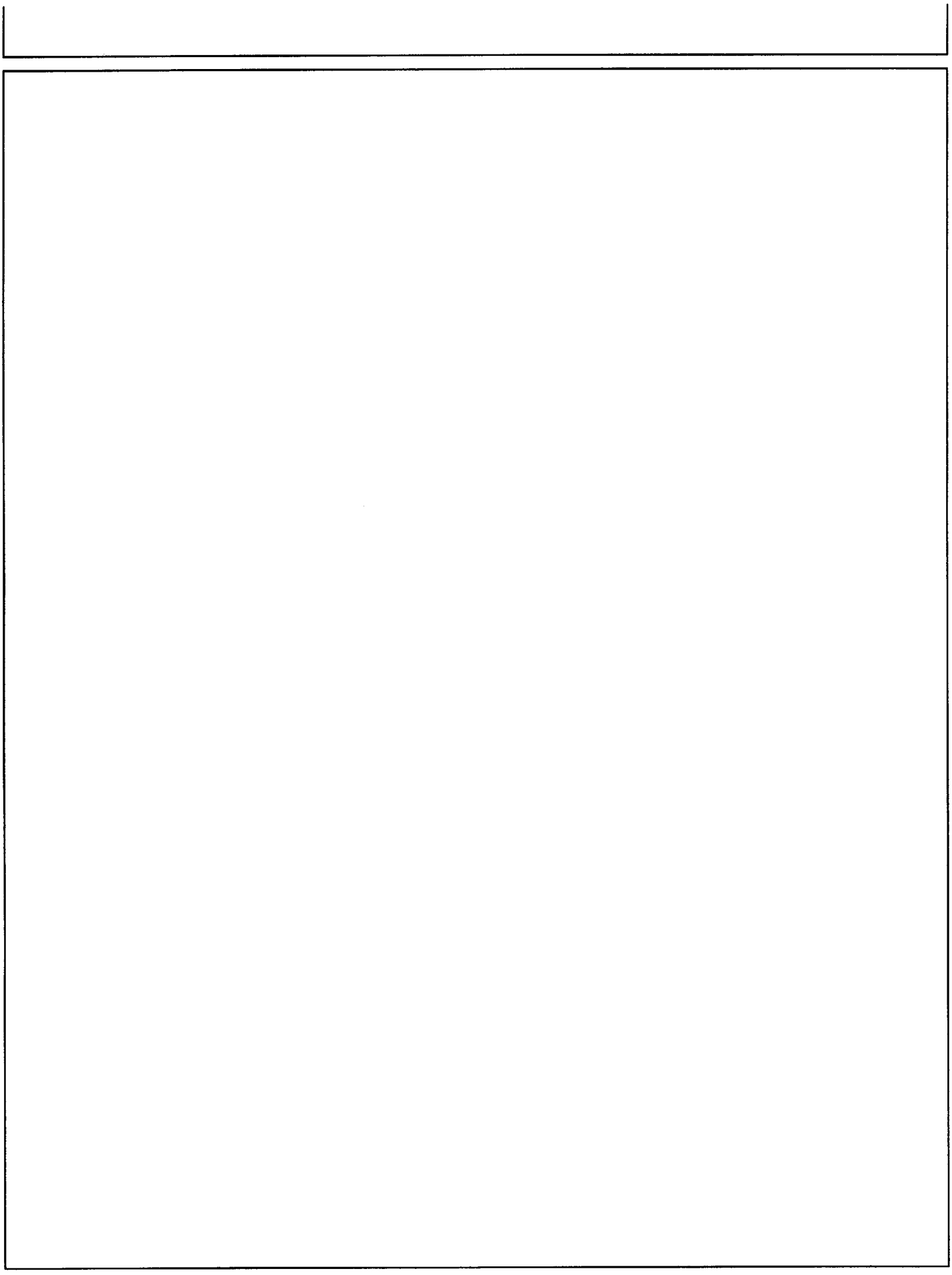
### 58Mu

Unit: mm

| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 79.8 | — | Replace |
| B | 22.5 | 23.5 | |
| C | 35.0 | 33.0 | |

# SECTION 04
# FRONT ATTACHMENT

## CONTENTS



## REMOVE AND INSTALL FRONT ATTACHMENT

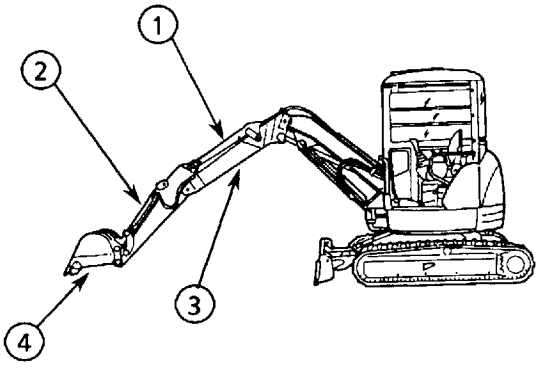
(The illustration shows the front attachment of the 33Mu.)

**CAUTION:**

1. **Hydraulic fluid under pressure can penetrate the skin or eyes, causing serious injury. Avoid this hazard by relieving pressure before disconnecting any hydraulic lines.**
2. **Hydraulic oil becomes hot during operation. Disconnecting hydraulic lines soon after operation can result in severe burns. Wait for the oil and components to cool before removing any parts.**

### Remove Front Attachment

1. Park the machine on a solid, level surface, with arm cylinder (1) and bucket cylinder (2) fully retracted, and lower upper boom (3) so that bucket (4) teeth come into contact with the ground, as illustrated.

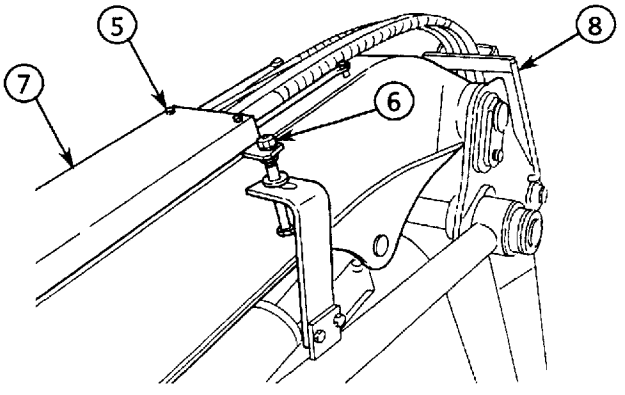



W532-04-02-006

2. Stop the engine and remove the hydraulic oil tank cap to release the pressure in the hydraulic oil tank.

3. In order to make the hoses free, loosen bolts (5, 6) to remove cover (7) and clamp (8).

: 13 mm, 22mm




W532-04-01-001

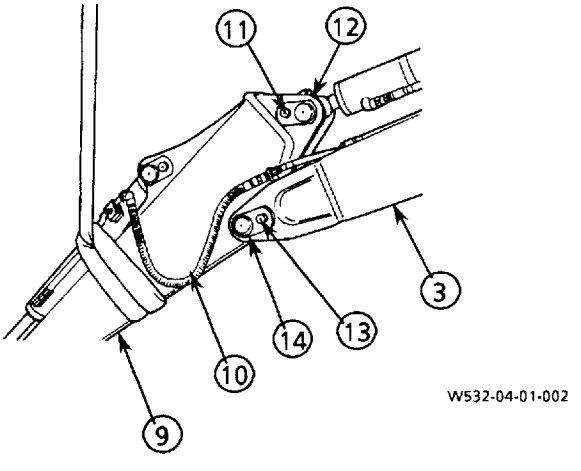
4. Attach arm (9) to a crane with sling belts and slightly raise it. Disconnect hoses (10) (2 used) and put a plug on each hose end. Insert wooden blocks between arm (9) and upper boom (3).

: 22mm

5. Loosen bolt (11) and remove pin (12).

: 19mm ( 33Mu )

: 22mm ( 58Mu )




W532-04-01-002

6. Loosen bolt (13) and remove pin (14). Remove arm (9) using a crane.

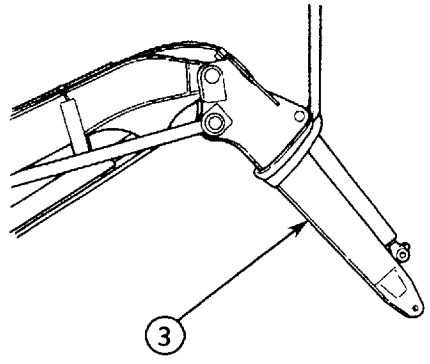
: 24mm

**CAUTION: Bucket and arm assembly weight:**
**: 181 kg ( 33Mu )**
**: 334 kg ( 58Mu)**

7. After checking if the plugs on the bucket cylinder hoses are securely installed, start the engine and lower the tip of upper boom (3) to the ground.

8. Stop the engine and remove the hydraulic oil tank cap to release the pressure in the hydraulic oil tank.

9. Attach upper boom (3) to a crane with sling belts and slightly raise it.

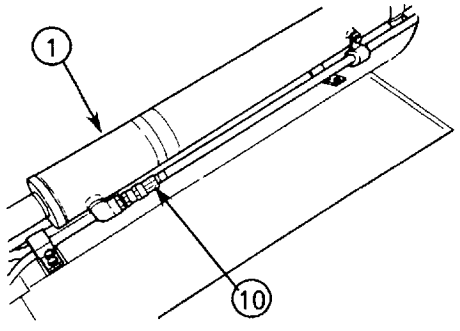



W532-04-01-003

10. Disconnect hoses (10) (2 used) from arm cylinder(1) and put a plug on each hose end.

: 22 mm ( 33Mu )

: 27 mm ( 58Mu )



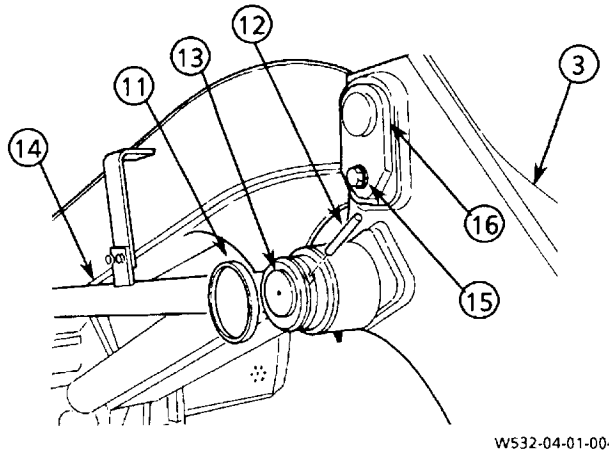

W532-04-02-003

11. Remove ring (11) and stopper pin (12), then remove pin (13) and cross rod (14).

12. Loosen bolt (15) and remove pin (16). Remove upper boom (3) using a crane.

: 24 mm

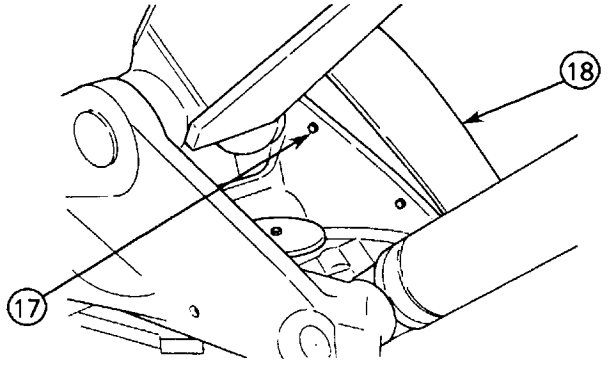
**CAUTION: Upper boom weight:**
**: 113 kg ( 33Mu )**
**: 239 kg ( 58Mu )**




W532-04-01-004

13. Loosen bolts (17) (4 used) and remove sensor cover (18).

: 13 mm



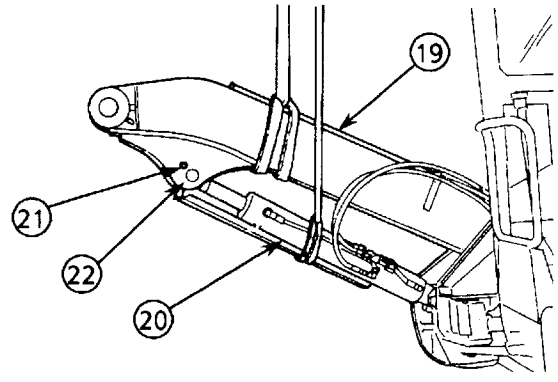

W532-04-01-005

14. Attach lower boom (19) to a crane with sling belts and slightly raise it.

15. Attach boom cylinder (20) to a crane with other sling belts and raise the cylinder slightly. Remove bolt (21) and pin (22).

: 19 mm ( 33Mu )

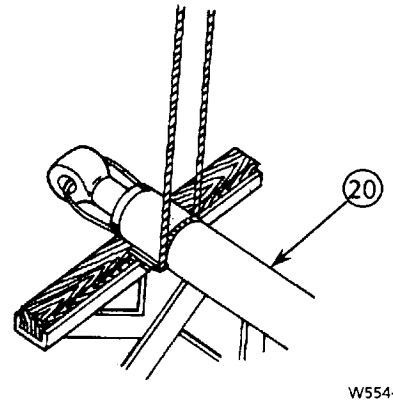
: 24 mm ( 58Mu )




W532-04-01-006

16. Place a stand under the tip of cylinder tube to support it. Fully retract cylinder (20) rod by operating the boom control lever. Reeve wire through the rod end hole and bind it to cylinder (20) to prevent cylinder (20) rod from extending.

**CAUTION: Boom cylinder weight:**
**: 38 kg ( 33Mu )**
**: 83 kg ( 58Mu )**




W554-02-03-007

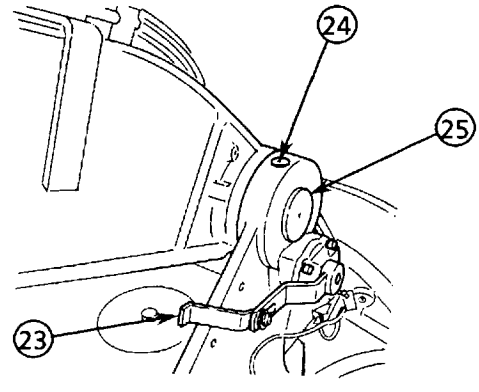
17. Loosen the bolts and remove lever (23).

: 13 mm

18. Remove bolts (24) and the stopper pin, then remove pin (25).

: 8 mm ( 33Mu )

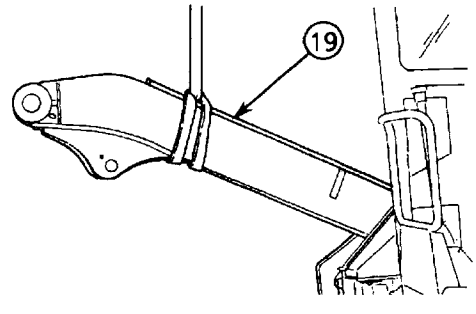
: 10 mm ( 58Mu )




W532-04-01-007

19. Remove lower boom (19) using a crane.

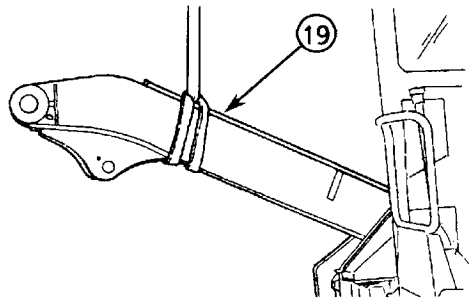
**CAUTION: Lower boom weight:**
**: 148 kg ( 33Mu )**
**: 305 kg ( 58Mu )**




W532-04-01-008

**Install Front Attachment**

1. Raise lower boom (19) in position with a crane and align its pin hole with those on the swing post.




2. Drive pin (25) into the pin holes. Install the stopper pin and tighten bolt (24).

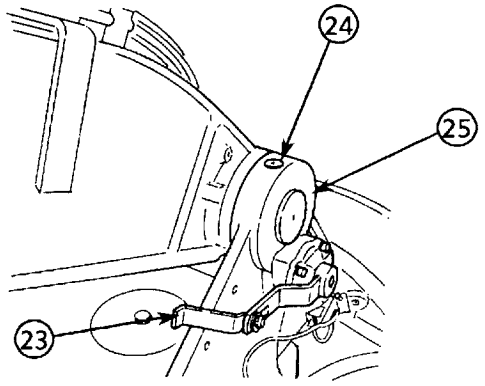
W532-04-01-008

: 8 mm : 39 N·m ( 4 kgf·m ) ( 33Mu )

: 10 mm : 64 N·m ( 6.5 kgf·m ) ( 58Mu )

3. Install lever (23).

: 13 mm : 20 N·m ( 2 kgf·m )

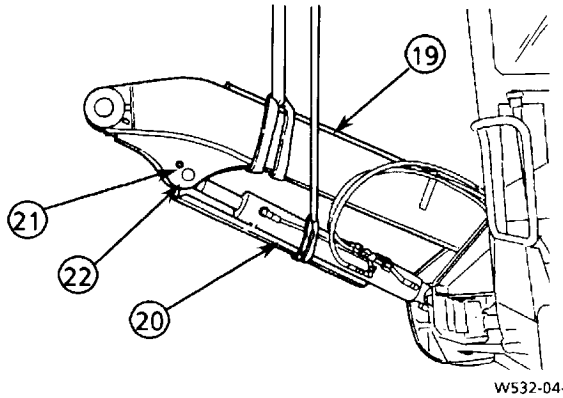



W532-04-01-007

4. Attach boom cylinder (20) to a crane with sling belts so that the pin hole aligns with those on lower boom (19). Drive pin (22) into the pin holes and tighten bolt (21).

: 19 mm : 88 N·m ( 9 kgf·m ) ( 33Mu )

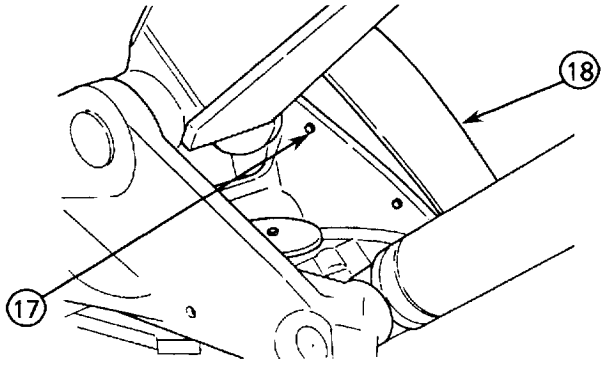
: 24 mm : 205 N·m ( 21 kgf·m ) ( 58Mu )




W532-04-01-006

5. Install sensor cover (18) and tighten bolts (17).

: 13 mm : 9.8 N·m ( 1 kgf·m )

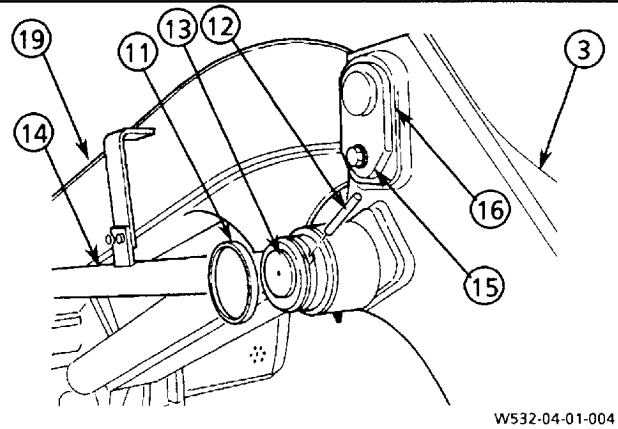



W532-04-01-005

6. Raise upper boom (3) with a crane so that the pin hole on upper boom (3) aligns with that on lower boom (19). Drive pin (16) into the pin holes and tighten bolt (15).

: 24 mm : 205 N·m ( 21 kgf·m )

7. Align the pin hole on upper boom (3) with that on cross rod (14). Drive pin (13) into the pin holes and install stopper pin (12) and ring (11).



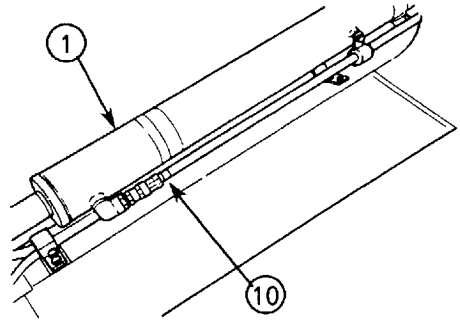
W532-04-01-004

8. Connect hoses (10) to arm cylinder (1).

: 22 mm : 39 N·m ( 4 kgf·m ) ( 33Mu )

: 27 mm : 64 N·m ( 6.5 kgf·m ) ( 58Mu )

9. Start the engine and raise upper boom (3) into position so that arm (9) can be connected.



W532-04-02-003

10. Raise arm (9) with a crane so that the pin hole on upper boom (3) aligns with that on arm (9). Drive pin (14) into the pin holes and tighten bolt (13).

: 24 mm : 205 N·m ( 21 kgf·m )

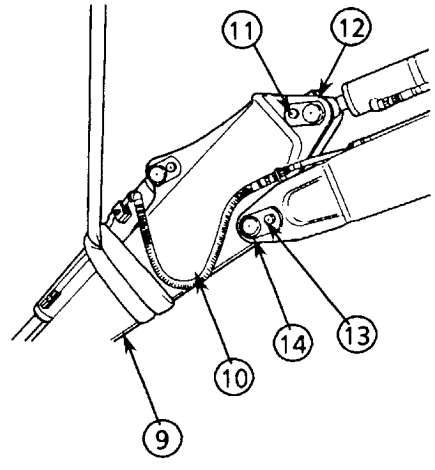
11. Start the engine and extend the arm cylinder rod to align the rod end hole with the pin holes on arm (9). Install pin (12) into the pin holes and tighten bolt (11) to secure pin (12).

: 19 mm : 88 N·m ( 9 kgf·m ) ( 33Mu )

: 22 mm : 137 N·m ( 14 kgf·m ) ( 58Mu )

12. Connect hoses (10) to bucket cylinder.

: 22 mm : 39 N·m ( 4 kgf·m )

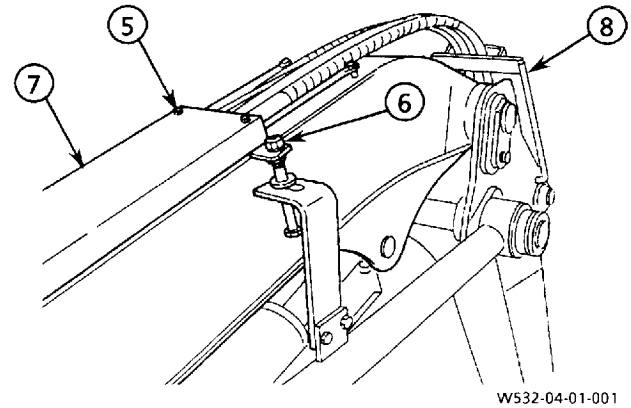


W532-04-01-002

13. Install cover (7) and clamp (8) to secure the hoses.

: 13 mm : 9.8 N·m ( 1 kgf·m )

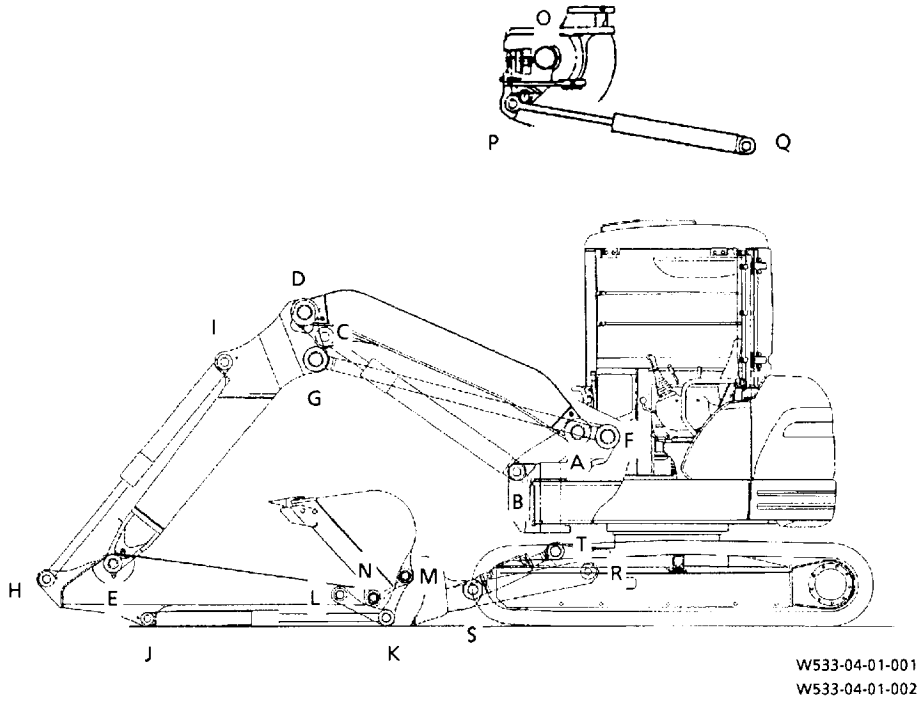
: 22 mm : 137 N·m ( 14 kgf·m )



W532-04-01-001

## MAINTENANCE STANDARDS

**33Mu**




W533-04-01-001
W533-04-01-002

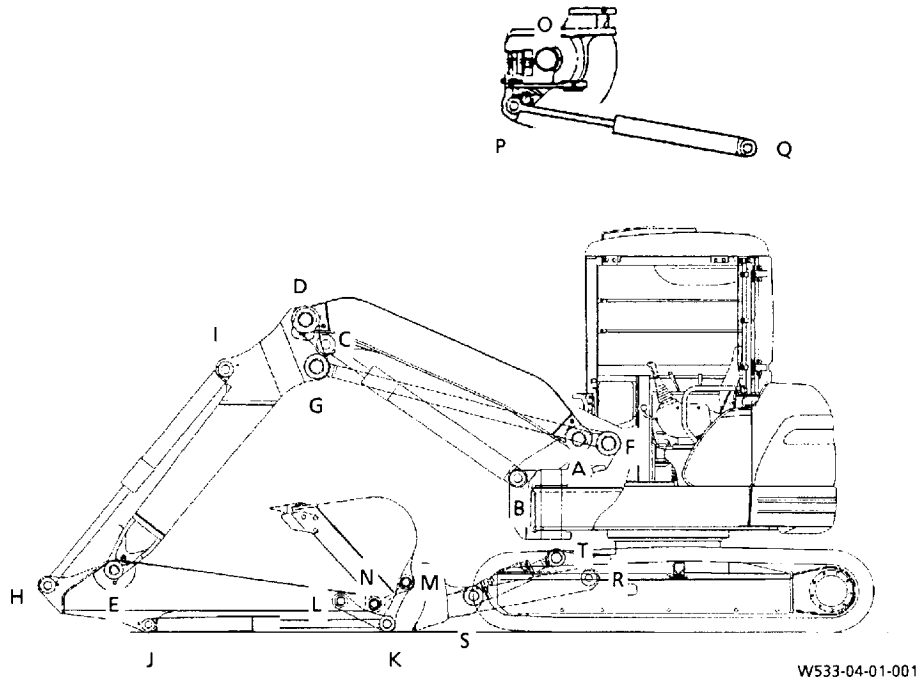
Unit: mm

| | Part Name | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|---|
| A | Pin | 65 | 64.0 | Replace |
| | Bushing (Lower Boom) | 65 | 66.5 | |
| B | Pin | 40 | 39.0 | |
| | Bushing (Boom Cylinder) | 40 | 41.5 | |
| C | Pin | 40 | 39.0 | |
| | Bushing (Boom Cylinder) | 40 | 41.5 | |
| D | Pin | 60 | 59.0 | |
| | Bushing (Boom) | 60 | 61.5 | |
| E | Pin | 40 | 39.0 | |
| | Bushing (Arm) | 40 | 41.5 | |
| F | Pin | 55 | 54.0 | |
| | Bushing (Cross Link) | 55 | 56.5 | |
| G | Pin | 60 | 59.0 | |
| | Busing (Cross Link) | 60 | 61.5 | |

Unit: mm

| | Part Name | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|---|
| H | Pin | 40 | 39.0 | Replace |
| | Bushing (Arm Cylinder) | 40 | 41.5 | |
| I | Pin | 40 | 39.0 | |
| | Bushing (Arm Cylinder) | 40 | 41.5 | |
| J | Pin | 40 | 39.0 | |
| | Bushing (Bucket Cylinder) | 40 | 41.5 | |
| K | Pin | 40 | 39.0 | |
| | Bushing (Bucket Cylinder) | 40 | 41.5 | |
| | Bushing (Link A) | 40 | 41.5 | |
| | Link B | 40 | 41.5 | |
| L | Pin | 40 | 39.0 | |
| | Bushing (Arm) | 40 | 41.5 | |
| | Link B | 40 | 41.5 | |
| M | Pin | 40 | 39.0 | |
| | Bushing (Link A) | 40 | 41.5 | |
| N | Pin | 40 | 39.0 | |
| | Bushing (Arm) | 40 | 41.5 | |
| O | Pin | 90 | 89.0 | |
| | Bushing (Main Frame) | 90 | 91.5 | |
| P | Pin | 45 | 44.0 | |
| | Bushing (Boom Swing Cylinder) | 45 | 46.5 | |
| Q | Pin | 45 | 44.0 | |
| | Bushing (Boom Swing Cylinder) | 45 | 46.5 | |
| R | Pin | 45 | 44.0 | |
| | Bushing (Blade) | 45 | 46.5 | |
| S | Pin | 45 | 44.0 | |
| | Bushing (Blade Cylinder) | 45 | 46.5 | |
| T | Pin | 45 | 44.0 | |
| | Bushing (Blade Cylinder) | 45 | 46.5 | |

**58Mu**




W533-04-01-001
W533-04-01-002

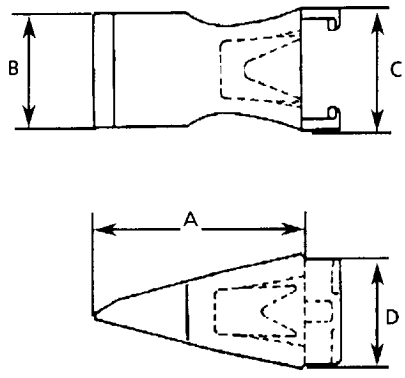
Unit: mm

| | Part Name | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|---|
| A | Pin | 90 | 89.0 | Replace |
| | Bushing (Lower Boom) | 90 | 91.5 | |
| B | Pin | 55 | 54.0 | |
| | Bushing (Boom Cylinder) | 55 | 56.5 | |
| C | Pin | 60 | 59.0 | |
| | Bushing (Boom Cylinder) | 60 | 61.5 | |
| D | Pin | 80 | 79.0 | |
| | Bushing (Boom) | 80 | 81.5 | |
| E | Pin | 60 | 59.0 | |
| | Bushing (Arm) | 60 | 61.5 | |
| F | Pin | 80 | 79.0 | |
| | Bushing (Cross Link) | 80 | 81.5 | |
| G | Pin | 90 | 89.0 | |
| | Busing (Cross Link) | 90 | 91.5 | |

Unit: mm

| | Part Name | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|---|
| H | Pin | 50 | 49.0 | Replace |
| | Bushing (Arm Cylinder) | 50 | 51.5 | |
| I | Pin | 55 | 54.0 | |
| | Bushing (Arm Cylinder) | 55 | 56.5 | |
| J | Pin | 45 | 44.0 | |
| | Bushing (Bucket Cylinder) | 45 | 46.5 | |
| K | Pin | 50 | 49.0 | |
| | Bushing (Bucket Cylinder) | 50 | 51.5 | |
| | Bushing (Link A) | 50 | 51.5 | |
| | Link B | 50 | 51.5 | |
| L | Pin | 45 | 44.0 | |
| | Bushing (Arm) | 45 | 46.5 | |
| | Link B | 45 | 46.5 | |
| M | Pin | 45 | 44.0 | |
| | Bushing (Link A) | 45 | 46.5 | |
| N | Pin | 45 | 44.0 | |
| | Bushing (Arm) | 45 | 46.5 | |
| O | Pin | 110 | 109.0 | |
| | Bushing (Main Frame) | 110 | 111.5 | |
| P | Pin | 55 | 54.0 | |
| | Bushing (Boom Swing Cylinder) | 55 | 56.5 | |
| Q | Pin | 55 | 54.0 | |
| | Bushing (Boom Swing Cylinder) | 55 | 56.5 | |
| R | Pin | 45 | 44.0 | |
| | Bushing (Blade) | 45 | 46.5 | |
| S | Pin | 60 | 59.0 | |
| | Bushing (Blade Cylinder) | 60 | 61.5 | |
| T | Pin | 60 | 59.0 | |
| | Bushing (Blade Cylinder) | 60 | 61.5 | |

**Point**

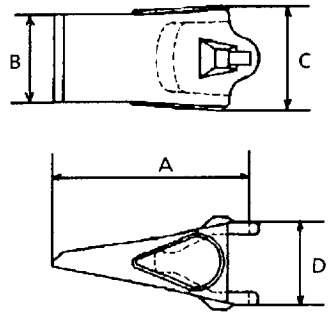



W527-04-01-005

**33Mu**

Unit: mm

| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 115 | 60 | Replace |
| B | 50 | — | |
| C | 53.6 | — | |
| D | 46.4 | — | |



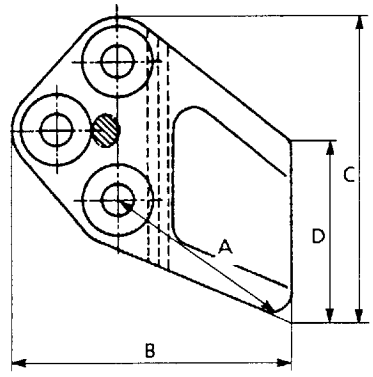

W554-04-01-003

**58Mu**

Unit: mm

| | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 128 | 65 | Replace |
| B | 56 | — | |
| C | 62 | — | |
| D | 51 | — | |

**Side Cutter**




W505-04-01-001

**33Mu**

Unit: mm

| Key Letter | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 104 | 70 | Replace |
| B | 138 | — | |
| C | 153 | — | |
| D | 90 | — | |

**58Mu**

Unit: mm

| Key Letter | Standard Dimensions | Allowable Limit | Corrective Measure |
|---|---|---|---|
| A | 127 | 85 | Replace |
| B | 163 | — | |
| C | 223 | — | |
| D | 130 | — | |

## REMOVE AND INSTALL CYLINDERS

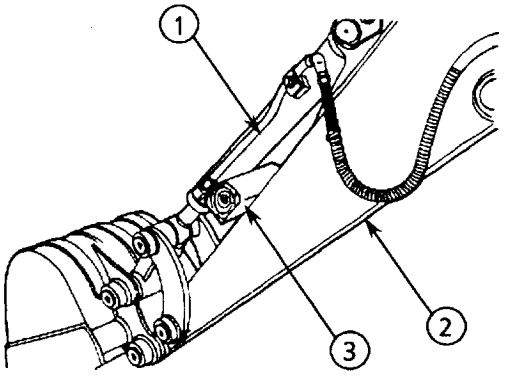
(The illustration shows the cylinders of the 33Mu)

**CAUTION:**

1. **Hydraulic fluid under pressure can penetrate the skin or eyes causing serious injury. Avoid this hazard by relieving pressure before disconnecting any hydraulic lines.**
2. **Hydraulic oil becomes hot during operation. Disconnecting hydraulic lines soon after operation can result in severe burns. Wait for the oil and components to cool before removing any parts.**

### Remove Bucket Cylinder

1. Park the machine on a solid, level surface, with bucket cylinder (1) fully retracted, and lower the bucket to the ground. Insert blocks (3) between bucket cylinder (1) and arm (2).

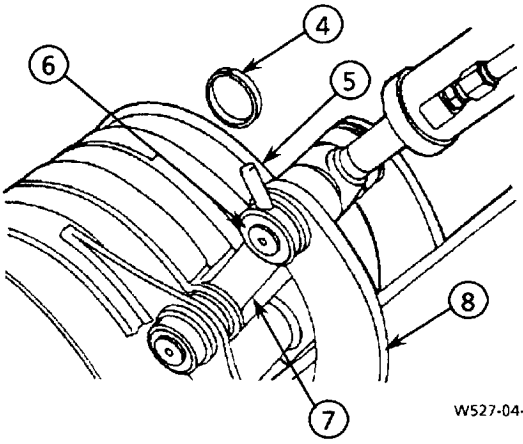



W527-04-02-001

2. Stop the engine and remove the hydraulic oil tank cap to release the pressure in the hydraulic oil tank.

3. Remove ring (4) and stopper pin (5) on the cylinder rod end.

4. Remove bucket cylinder rod end pin (6). Take care not to drop links (7, 8) when removing rod end pin (6).

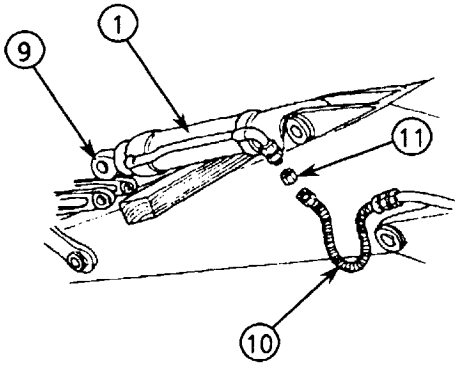



W527-04-02-002

5. Reeve wire rope through the rod end hole and bind it to cylinder (1) to prevent cylinder rod (9) from extending.

6. Disconnect hoses (10) from bucket cylinder (1) at the cylinder bottom. Put plugs (11) on each opening.

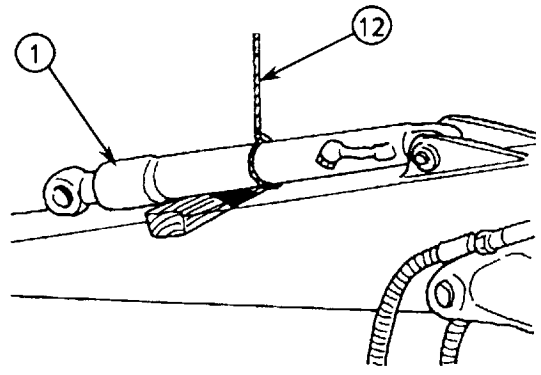
 : 22 mm




W507-04-02-006

7. Attach cylinder (1) to a crane using sling belt (12) and raise it. Attach sling belt (12) to the center of gravity of cylinder (1).

**CAUTION: Bucket cylinder weight:**
**: 20 kg ( 33Mu )**
**: 33 kg ( 58Mu )**

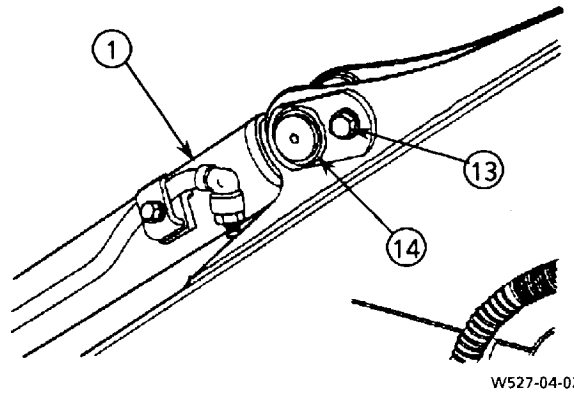



W507-04-02-007

8. Remove bolt (13) and pin (14) from the arm. Remove cylinder (1).

: 19 mm (33Mu )

: 22 mm (58Mu )




W527-04-02-003

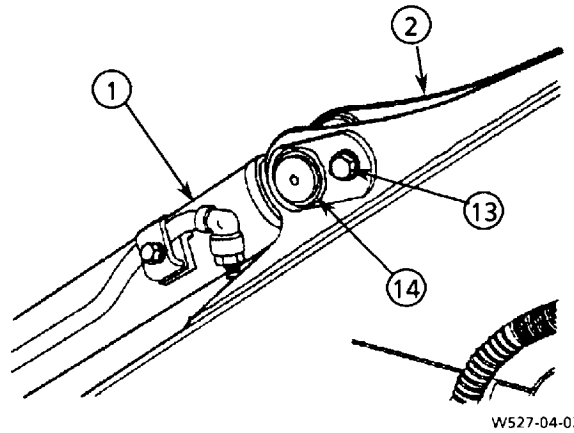
**Install Bucket Cylinder**

1. Attach sling belts to the gravity center of cylinder (1). Raise cylinder (1) with a crane and align the cylinder bottom end hole with the pin holes on arm (2).

2. Install pin (14) and tighten bolts (13).

: 19 mm : 88 N·m ( 9 kgf·m ) (33Mu )

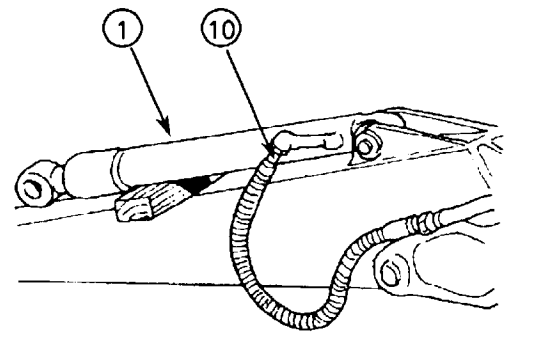
: 22 mm : 137 N·m ( 14 kgf·m ) (58Mu )




W527-04-02-003

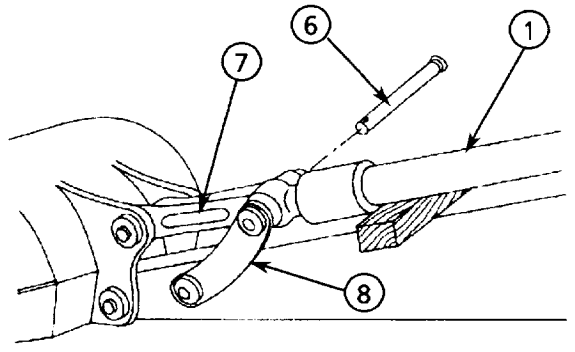
3. Connect hoses (10) to bucket cylinder (1).

: 22 mm : 39 N·m ( 4 kgf·m )



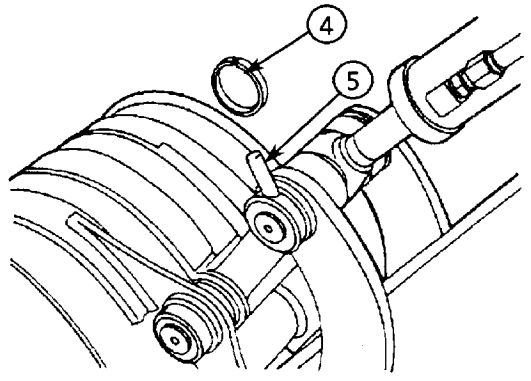

W507-04-02-009

4. Support cylinder (1) with a crane. Start the engine and extend the cylinder rod to align the rod end hole with the pin holes on links (7, 8) by operating the bucket control lever. Install pin (6) into the pin holes.




W507-04-02-004

5. Install stopper pin (5) and ring (4).

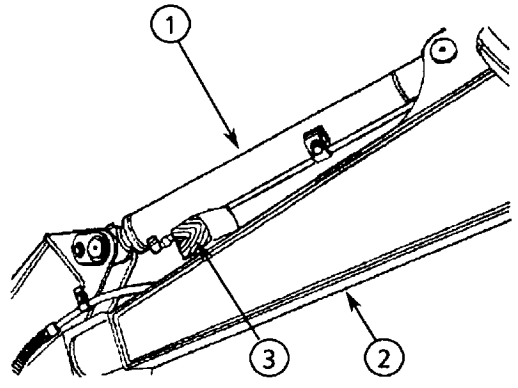



W527-04-02-002

**Remove Arm Cylinder**

1. Park the machine on a solid, level surface with the arm cylinder and bucket cylinder fully retracted, and lower the bucket to the ground. Insert blocks (3) between bucket cylinder (1) and arm (2).

2. Stop the engine and remove the hydraulic oil tank cap to release the pressure in the hydraulic oil tank.



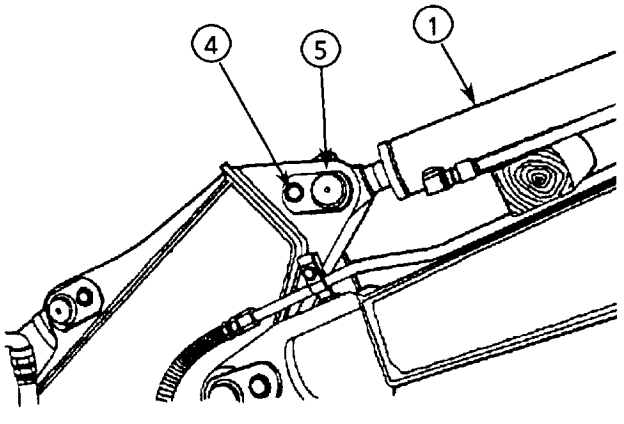

W532-04-02-001

3. Remove bolt (4) on the cylinder rod end, then remove pin (5).

 : 19 mm ( 33Mu )

 : 22 mm ( 58Mu )

4. Reeve wire rope through the rod end hole and bind it to cylinder (1) to prevent the cylinder rod from extending.

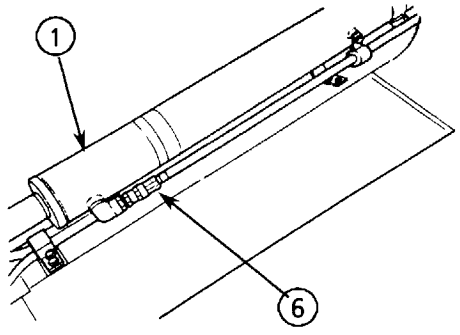



W532-04-02-002

5. Disconnect hoses (6) (2 used) from arm cylinder (1). Put a plug on each hose (6) end.

: 22 mm ( 33Mu )

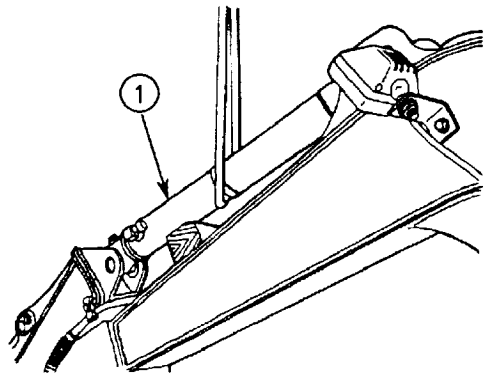
: 27 mm ( 58Mu )




W532-04-02-003

6. Connect sling belts to the center of gravity of arm cylinder (1). Raise cylinder (1) with a crane.

**CAUTION: Arm cylinder weight:**
**: 24 kg( 33Mu )**
**: 45 kg ( 58Mu )**

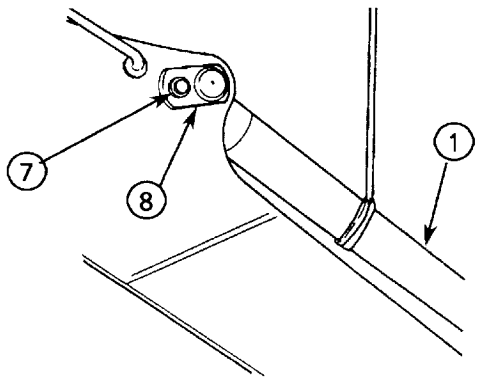



W532-04-02-004

7. Remove bolt (7) on the cylinder bottom end. Remove pin (1), then remove arm cylinder (1).

: 19 mm ( 33Mu )

: 22 mm ( 58Mu )




W532-04-02-005

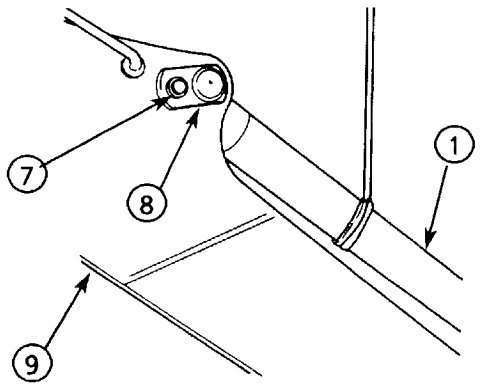
**Install Arm Cylinder**

1. Attach sling belts to the gravity center of arm cylinder (1). Raise cylinder (1) with a crane and align the cylinder bottom end hole with the pin holes on boom (9).

2. Install pin (8) into the pin holes and tighten bolts (7).

: 19 mm : 88 N·m ( 9 kgf·m ) ( 33Mu )

: 22 mm : 137 N·m ( 14 kgf·m ) ( 58Mu )

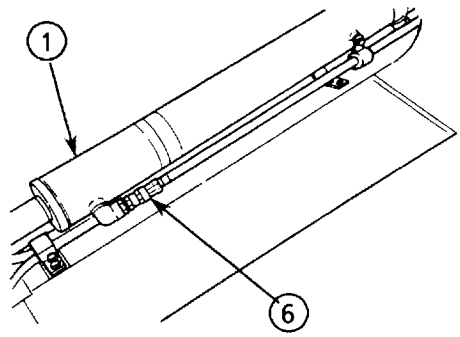



W532-04-02-005

3. Connect hoses (6) to arm cylinder (1).

: 22 mm : 39 N·m ( 4 kgf·m ) ( 33Mu )

: 27 mm : 64 N·m ( 6.5 kgf·m ) ( 58Mu )



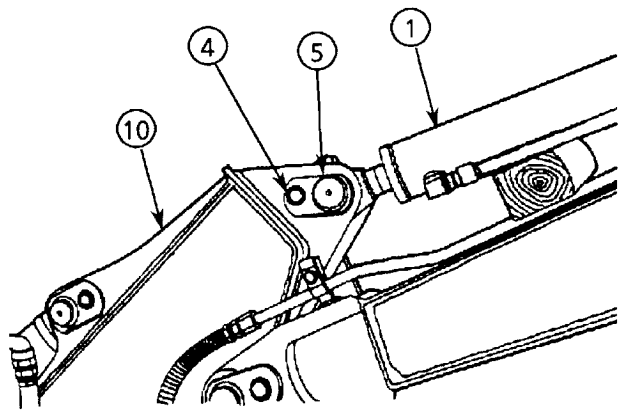

W532-04-02-003

4. Support arm cylinder (1) with a crane. Start the engine and extend the cylinder rod to align the rod end hole with the pin holes on arm (10).

5. Install pin (5) and tighten bolts (4).

: 19 mm : 88 N·m ( 9 kgf·m ) ( 33Mu )

: 22 mm : 137 N·m ( 14 kgf·m ) ( 58Mu )




W532-04-02-002

**Remove Boom Cylinder**

1. Park the machine on a solid, level surface with the arm cylinder and bucket cylinder fully retracted and lower the teeth of bucket (4) to the ground.

2. Loosen bolt (5) and remove cover (6).

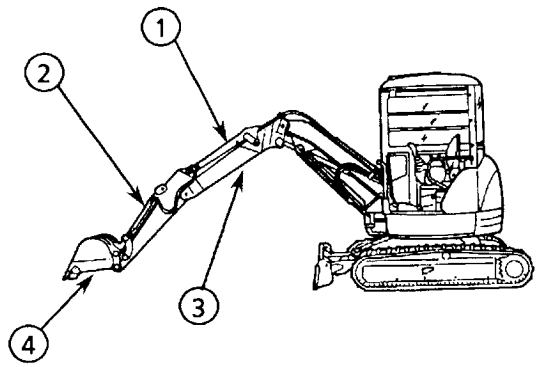
: 17 mm ( 33Mu )

: 19 mm ( 58Mu )

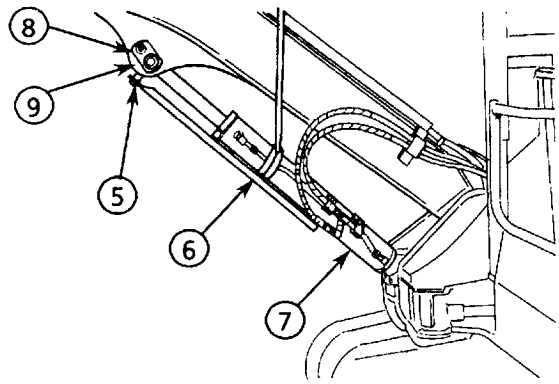
3. Attach boom cylinder (7) to a crane with sling belts and slightly raise it. Remove bolt (8) and pin (9).

: 19 mm ( 33Mu )

: 24 mm ( 58Mu )

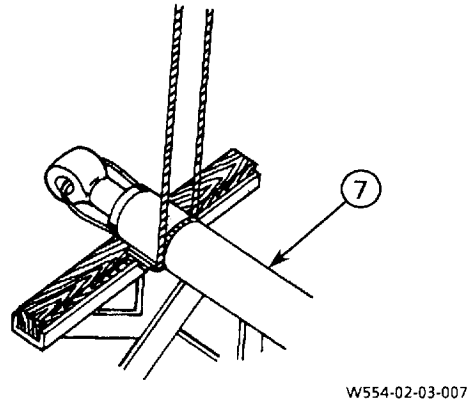



W532-04-02-006




W532-04-02-007

4. Place a stand under the tip of cylinder tube to support it. Fully retract cylinder (7) rod by operating the boom control lever. Reeve wire through the rod end hole and connect it to cylinder (7) to prevent cylinder (7) rod from extending.



W554-02-03-007

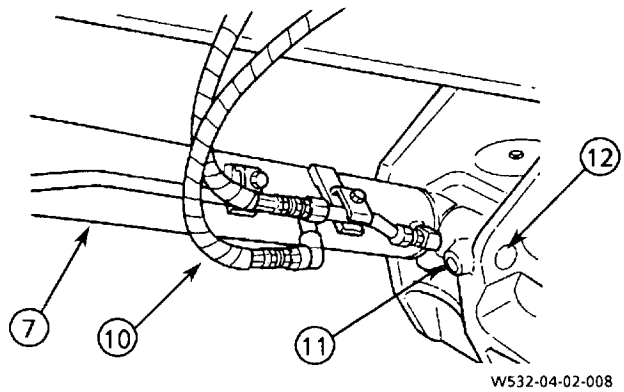
**CAUTION: Boom cylinder weight:**
**: 38 kg ( 33Mu )**
**: 83 kg ( 58Mu )**

5. Stop the engine and remove the hydraulic oil tank cap to release the pressure in the hydraulic oil tank.

6. Disconnect hoses (10) (2 used) from the bottom of cylinder (7). Put a plug on each opening.

: 22 mm ( 33Mu )

: 27 mm ( 58Mu )



W532-04-02-008

7. Remove bolt (11) and the stopper pin, then remove pin (12).

: 8 mm ( 33Mu )

: 10 mm ( 58Mu )

8. Attach sling belt to the gravity center of boom cylinder (7). Remove boom cylinder (7) with a crane.

**Install Boom Cylinder**

1. Support boom cylinder (7) with a crane and align the pin holes. Drive boom cylinder mounting pin (12) into the pin holes. Install the stopper pin and bolt (11) to secure pin (12).

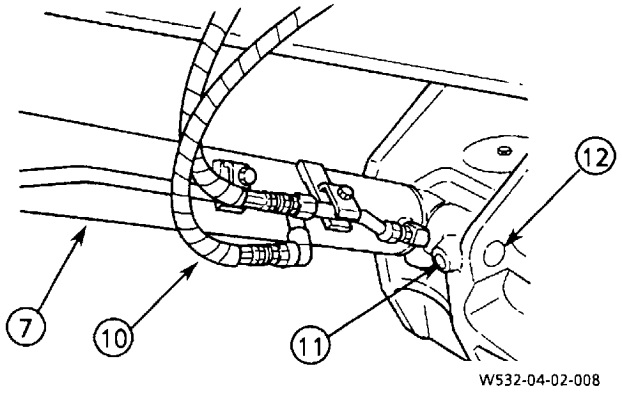
: 8 mm : 39 N·m ( 4 kgf·m ) ( 33Mu )

: 10 mm : 64 N·m ( 6.5 kgf·m ) ( 58Mu )

2. Connect hoses (10) (2 used) to boom cylinder (7).

: 22 mm : 39 N·m ( 4 kgf·m ) ( 33Mu )

: 27 mm : 64 N·m ( 6.5 kgf·m ) ( 58Mu )

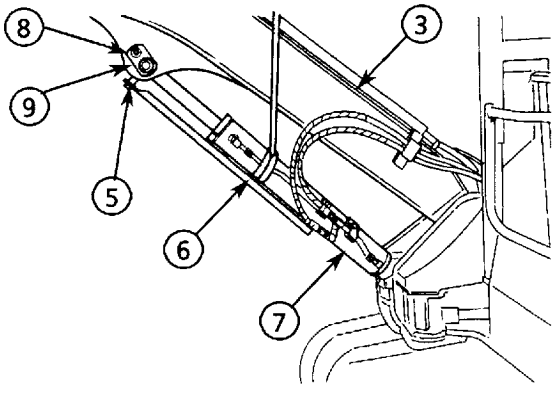


W532-04-02-008

3. Support boom cylinder (7) with a crane so that the pin hole of cylinder (7) aligns with that on lower boom (3). Drive pin (9) into the pin holes. Tighten bolts (8).

: 19 mm : 88 N·m ( 9 kgf·m ) ( 33Mu )

: 24 mm : 205 N·m ( 21 kgf·m ) ( 58Mu )



W532-04-02-007

4. Install cover (6) and tighten bolts (5).

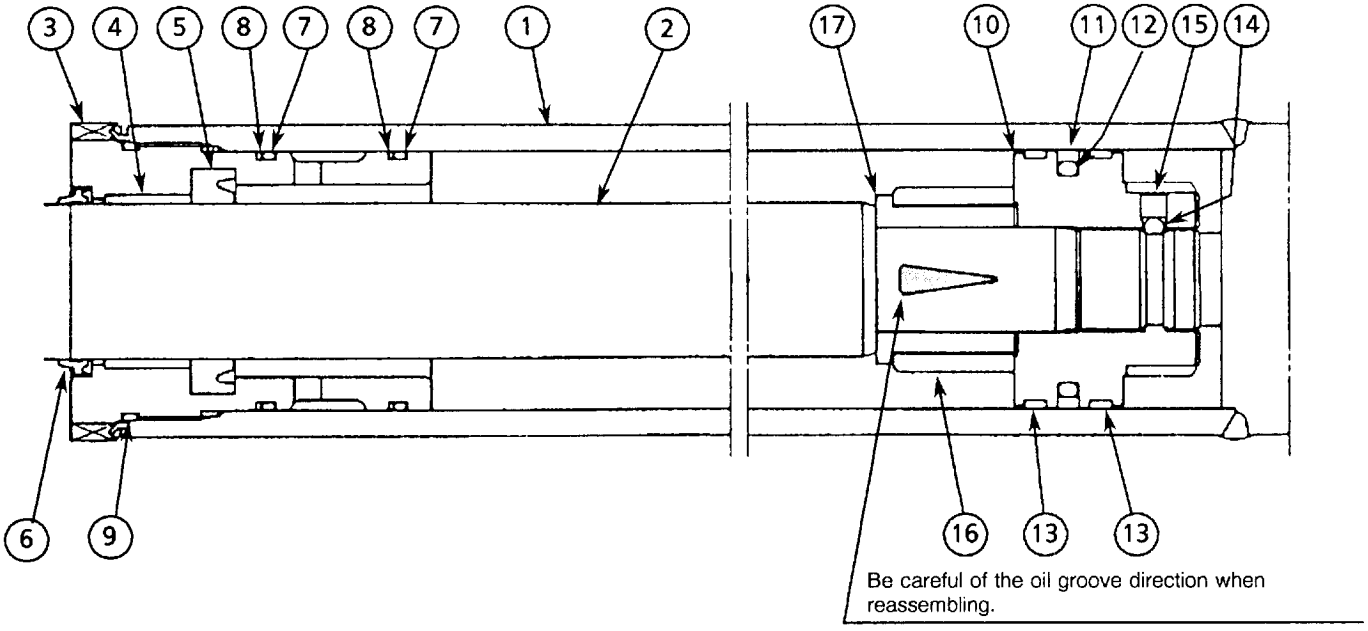
: 17 mm : 49 N·m ( 5 kgf·m ) ( 33Mu )

: 19 mm : 88 N·m ( 9 kgf·m ) ( 58Mu )

*NOTE: Check the hydraulic oil level. Add oil if necessary.*

## DISASSEMBLE CYLINDERS

### Boom Cylinder




W527-04-02-012

1— Cylinder Tube
2— Piston Rod
3— Cylinder Head
4— Bushing
5— U-Ring
6— Wiper Ring
7— O-Ring (2 used)
8— Backup Ring (2 used)
9— O-Ring
10— Piston
11— Seal Ring
12— O-Ring
13— Slide Ring (2 used)
14— Steel Ball
15— Set Screw
16— Cushion Bearing
17— Spacer

**Disassemble Boom Cylinder**

1. Secure the cylinder horizontally on a work-bench using a crane. Drain hydraulic oil from the cylinder.

**CAUTION: Boom cylinder weight:**
**38 kg (33Mu)**
**83 kg (58Mu)**

2. Unlock cylinder head (3) by unbending the lock washer.

*NOTE: Be careful not to damage cylinder tube (1) when locking or unlocking cylinder head (3).*

3. Pull out piston rod (2) approximately 200 mm and loosen cylinder head (3). Remove piston rod (2) from cylinder tube (1).

**IMPORTANT: Be sure to pull piston rod (2) straight out so as not to damage the sliding surfaces.**

4. Secure piston rod (2) horizontally on a work-bench.

5. Remove setscrew (15) and steel ball (14).

*NOTE: As the setscrew head has been mush-roomed with a punch in two places when in-stalled, remove the mushroomed part using a hand drill before loosening setscrew (15).*

: 4 mm ( 33Mu ), 5 mm ( 58Mu )

6. Loosen piston (10), then remove piston (10), cushion bearing (16) and spacer (17).

: 55 mm ( 33Mu ), 75 mm ( 58Mu )

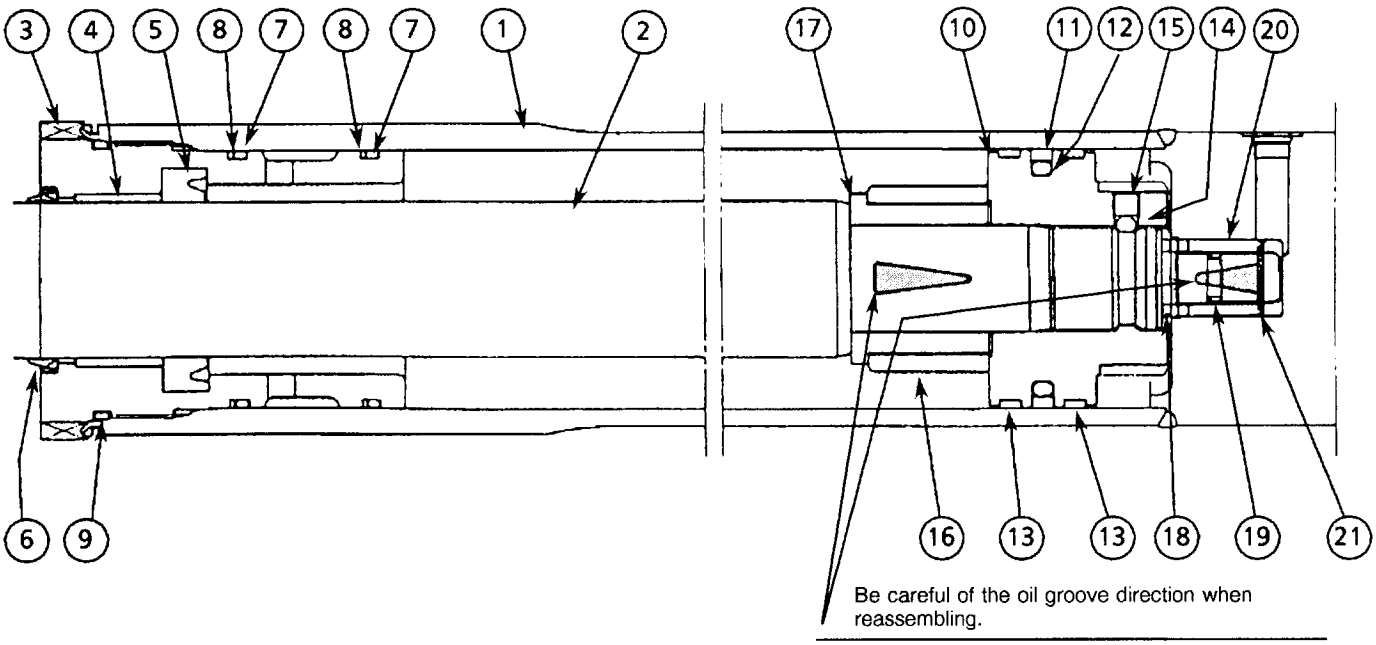
7. Remove slide ring (13) (2 used), seal ring (11) and O-ring (12) from piston (10).

8. Remove cylinder head (3) from piston rod (2). Remove O-rings (7, 9) and backup rings(8) from cylinder head (3).

9. Remove wiper ring (6) from cylinder head (3).

10. Remove bushing (4) from cylinder head (3).

## Arm Cylinder




W527-04-02-013

1— Cylinder Tube
2— Piston Rod
3— Cylinder Head
4— Bushing
5— U-Ring
6— Wiper Ring
7— O-Ring (2 used)
8— Backup Ring (2 used)
9— O-Ring
10— Piston
11— Seal Ring
12— O-Ring
13— Slide Ring (2 used)
14— Steel Ball
15— Set Screw
16— Cushion Bearing
17— Spacer
18— Retaining Ring
19— Cushion Seal
20— Cushion Bearing
21— Stopper

**Disassemble Arm Cylinder**

1. Secure the cylinder horizontally on a workbench using a crane. Drain hydraulic oil from the cylinder.

**CAUTION: Arm cylinder weight:**
**24 kg (33Mu)**
**45 kg (58Mu)**

2. Unlock cylinder head (3) by unbending the lock washer.

*NOTE: Be careful not to damage cylinder tube (1) when locking or unlocking cylinder head (3).*

3. Pull out piston rod (2) approximately 200 mm and loosen cylinder head (3). Remove piston rod (2) from cylinder tube (1).

**IMPORTANT: Be sure to pull piston rod (2) straight out so as not to damage the sliding surfaces.**

4. Secure piston rod (2) horizontally on a workbench.

5. Remove setscrew (15) and steel ball (14).

*NOTE: As the setscrew head has been mushroomed with a punch in two places when installed, remove the mushroomed part using a hand drill before loosening setscrew (15).*

: 4 mm

6. Loosen piston (10), then remove piston (10), cushion bearing (16) and spacer (17).

: 50 mm ( 33Mu ), 60 mm ( 58Mu )

7. Remove slide ring (13) (2 used), seal ring (11) and O-ring (12) from piston (10).

8. Remove cylinder head (3) from piston rod (2). Remove O-rings (7, 9) and backup rings (8) from cylinder head (3).

9. Remove wiper ring (6) from cylinder head (3).

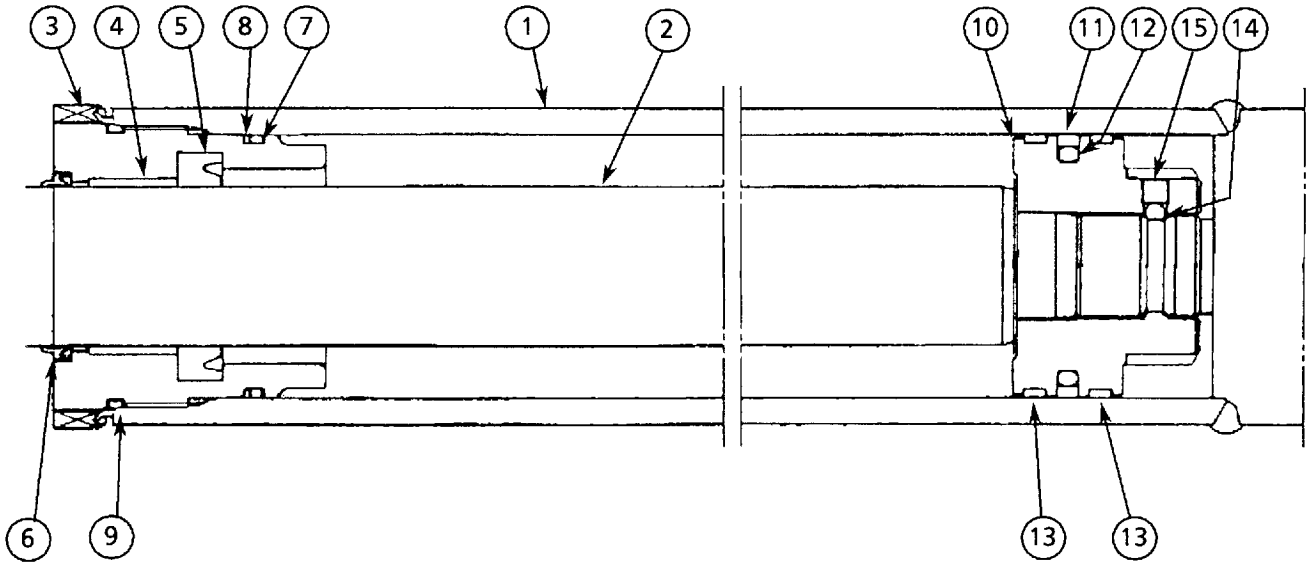
10. Remove bushing (4) from cylinder head (3).

11. Remove retaining ring (18) from piston rod (2).

12. Remove stopper (21) from piston rod (2) while sliding cushion bearing (20) to the screw side of piston rod (2).

13. Remove cushion bearing (20). Open the split of cushion seal (19) and remove it from piston rod (2).

**Bucket, Swing and Blade Cylinders**




W527-04-02-011

1— Cylinder Tube
2— Piston Rod
3— Cylinder Head
4— Bushing
5— U-Ring
6— Wiper Ring
7— O-Ring
8— Backup Ring
9— O-Ring
10— Piston
11— Seal Ring
12— O-Ring
13— Slide Ring (2 used)
14— Steel Ball
15— Setscrew

**Disassemble Bucket, Swing and Blade Cylinders**

1. Secure the cylinder horizontally on a workbench using a crane. Drain hydraulic oil from the cylinder.

**CAUTION: Cylinder weight:**

| Bucket | Swing | Blade |
|---|---|---|
| 20 kg, | 28 kg, | 22 kg (33Mu) |
| 33 kg, | 42 kg, | 42 kg (58Mu) |

2. Unlock cylinder head (3) by unbending the lock washer.

*NOTE: Be careful not to damage cylinder tube (1) when locking or unlocking cylinder head (3).*

3. Pull out piston rod (2) approximately 200 mm and loosen cylinder head (3). Remove piston rod (2) from cylinder tube (1).

**IMPORTANT: Be sure to pull piston rod (2) straight out so as not to damage the sliding surfaces.**

4. Secure piston rod (2) horizontally on a workbench.

5. Remove setscrew (15) and steel ball (14).

*NOTE: As the setscrew head has been mushroomed with a punch in two places when installed, remove the mushroomed part using a hand drill before loosening setscrew (15).*

Wrench Size:

Bucket 3 mm, Swing 4 mm, Blade 4 mm (33Mu)
Bucket 4 mm, Swing 4 mm, Blade 5 mm (58Mu)

6. Loosen and remove piston (10).

Wrench Size:

Bucket 41 mm, Swing 55 mm, Blade 55 mm (33Mu)
Bucket 55 mm, Swing 55 mm, Blade 70 mm (58Mu)

7. Remove slide ring (13) (2 used), seal ring (11) and O-ring (12) from piston (10).

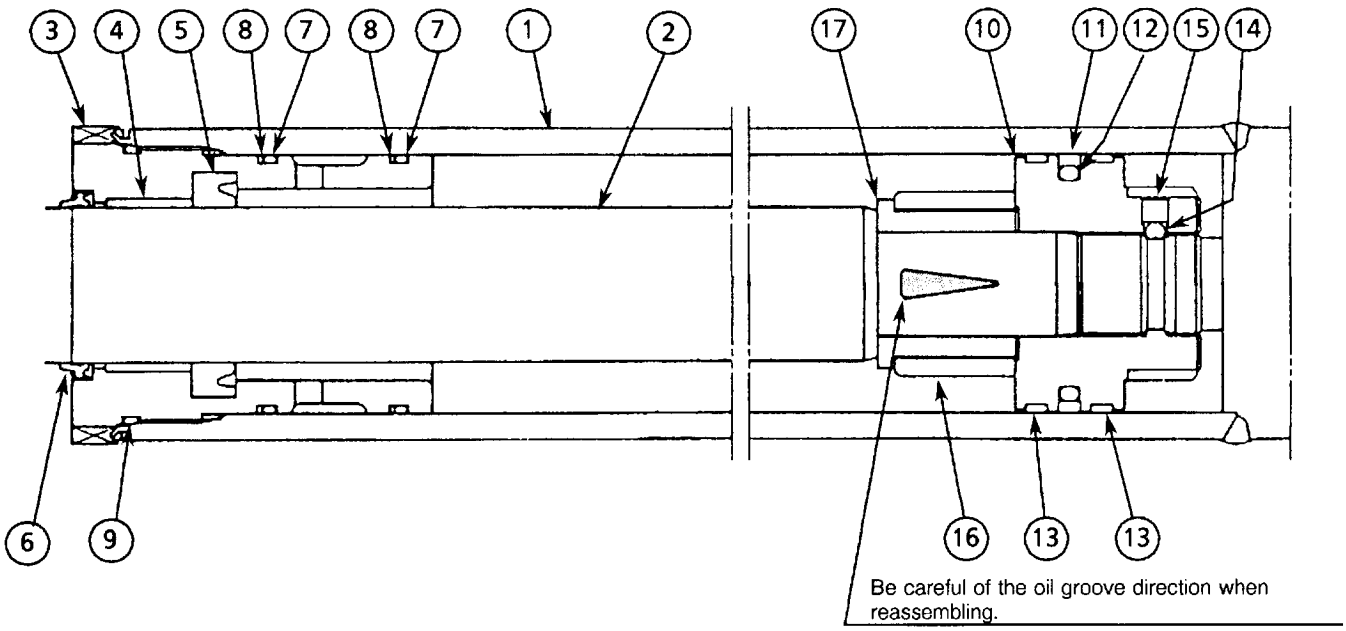
8. Remove cylinder head (3) from piston rod (2). Remove O-rings (7, 9) and backup rings (8) from cylinder head (3).

9. Remove wiper ring (6) from cylinder head (3).

10. Remove bushing (4) from cylinder head (3).

## ASSEMBLE CYLINDERS

### Boom Cylinder




W527-04-02-012

1— Cylinder Tube
2— Piston Rod
3— Cylinder Head
4— Bushing
5— U-Ring
6— Wiper Ring
7— O-Ring (2 used)
8— Backup Ring (2 used)
9— O-Ring
10— Piston
11— Seal Ring
12— O-Ring
13— Slide Ring (2 used)
14— Steel Ball
15— Setscrew
16— Cushion Bearing
17— Spacer

**Assemble Boom Cylinder**

1. Press bushing (4) into cylinder head (3) (crevice).

**IMPORTANT: After pressing bushing (4) in, check that bushing (4) end surface is flush with cylinder head (3) U-ring mounting surface. If bushing (4) protrudes, U-ring will be damaged when installed.**

2. Install U-ring (5) in cylinder head (3).

**IMPORTANT: Install U-ring (3) in the correct direction.**

3. Install wiper ring (6) in cylinder head (3) with a plastic hammer.

4. Install backup rings (8) and O-rings (7, 9) onto cylinder head (3).

5. Install O-ring (12), seal ring (11) and slide ring (13) (2 used) onto piston (10).

6. Install cylinder head (3) onto piston rod (2).

7. Install piston(10) onto piston rod (2). For the cylinders with the cushion bearing, install spacer (17) and cushion bearing (16) onto piston rod (2), then install piston (10).

**IMPORTANT: Be careful about the oil groove direction when installing cushion bearing (16).**

8. Tighten piston (10).

: 55 mm ( 33Mu ), 70 mm ( 58Mu )

*NOTE: Refer to page W04-02-20 for tightening torque.*

9. Insert steel ball (14) into the screw hole on the hexagonal head of piston (10) and tighten setscrew (15).

**IMPORTANT: After tightening setscrew (15), mushroom the screw head in two places to lock it.**

: 4 mm ( 33Mu ), 5 mm ( 58Mu )

*NOTE: Refer to page W04-02-20 for the tightening torque.*

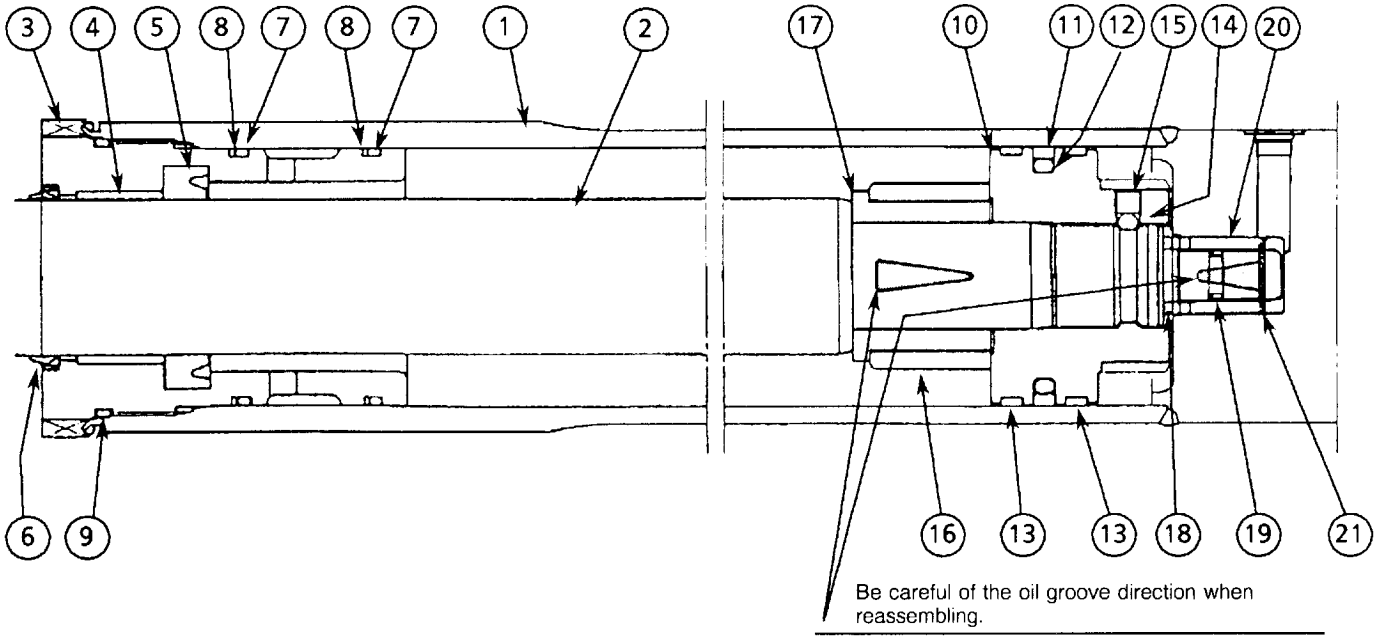
**CAUTION: Take care not to damage the seal ring and slide rings when inserting the piston rod assembly. After aligning the center of the piston rod with the center of the cylinder tube, insert the rod straight into the tube.**

10. Securely clamp cylinder tube (1) horizontally in a vise. Insert piston rod (2) assembly into cylinder tube (1).

11. Tighten cylinder head (3). Bend the lock washer to secure the cylinder head.

*NOTE: Refer to page W04-02-20 for the tightening torque.*

## Arm Cylinder




W527-04-02-013

1— Cylinder Tube
2— Piston Rod
3— Cylinder Head
4— Bushing
5— U-Ring
6— Wiper Ring
7— O-Ring (2 used)
8— Backup Ring (2 used)
9— O-Ring
10— Piston
11— Seal Ring
12— O-Ring
13— Slide Ring (2 used)
14— Steel Ball
15— Setscrew
16— Cushion Bearing
17— Spacer
18— Retaining Ring
19— Cushion Seal
20— Cushion Bearing
21— Stopper

**Assemble Arm Cylinder**

1. Press bushing (4) into cylinder head (3) (crevice).
2. Install U-ring (5) in cylinder head (3).

**IMPORTANT: Install U-ring (3) in the correct direction.**

3. Install wiper ring (6) in cylinder head (3) with a plastic hammer.
4. Install backup rings (8) and O-rings (7, 9) onto cylinder head (3).
5. Install O-ring (12), seal ring (11) and slide ring (13) (2 used) onto piston (10).
6. Install cylinder head (3) onto piston rod (2).
7. Install spacer (17) and cushion bearing (16) onto piston rod (2).
8. Install cushion seal (19) and cushion bearing (20) onto piston rod (2).

**IMPORTANT: Install cushion seal (19) with the slit facing toward the piston. Be careful about the oil groove direction when installing cushion bearings (16, 20).**

9. Install stopper (21) and retaining ring (18) onto piston rod (2).
10. Install piston (10) onto piston rod (2) and tighten it.

: 50 mm ( 33Mu ), 60 mm ( 58Mu )

*NOTE: Refer to page W04-02-20 for tightening torque*

11. Insert steel ball (14) into the screw hole on the hexagonal head of piston (10) and tighten setscrew (15).

**IMPORTANT: After tightening setscrew (15), mushroom the screw head in two places to lock it.**

: 4 mm

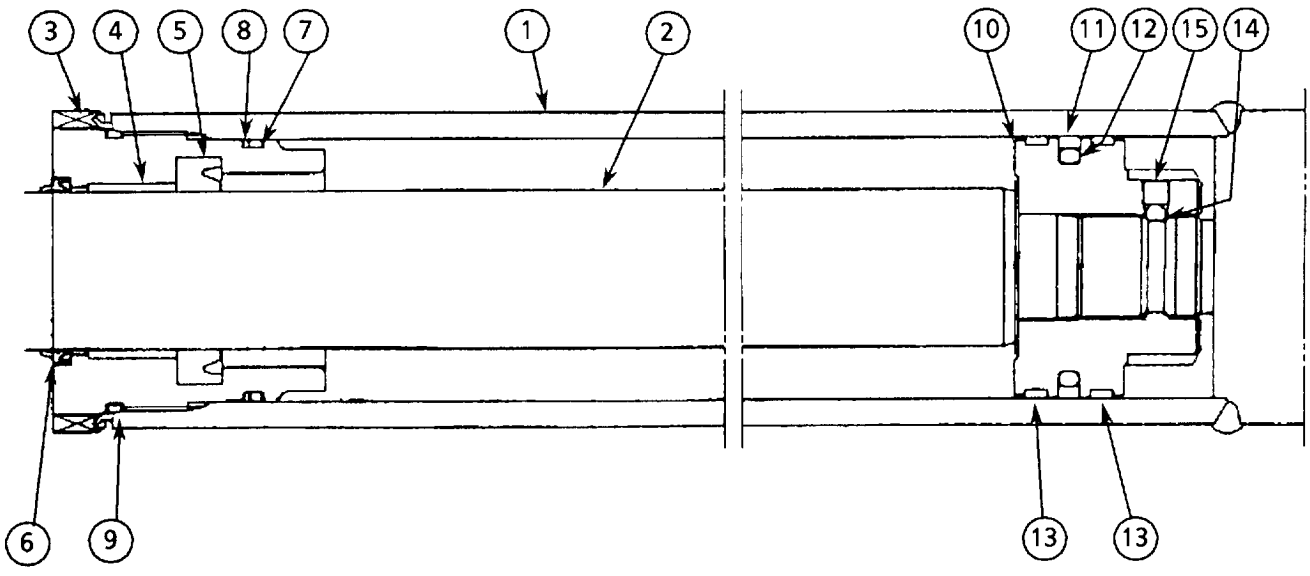
*NOTE: Refer to page W04-02-20 for the tightening torque.*

**CAUTION: Take care not to damage the seal ring and slide rings when inserting the piston rod assembly. After aligning the center of the piston rod with the center of the cylinder tube, insert the rod straight into the tube.**

12. Securely clamp cylinder tube (1) horizontally in a vise. Insert piston rod (2) assembly into cylinder tube (1).
13. Tighten cylinder head (3). Bend the lock washer to secure the cylinder head.

*NOTE: Refer to page W04-02-20 for the tightening torque.*

## Bucket, Swing and Blade Cylinders




W527-04-02-011

1— Cylinder Tube
2— Piston Rod
3— Cylinder Head
4— Bushing
5— U-Ring
6— Wiper Ring
7— O-Ring
8— Backup Ring
9— O-Ring
10— Piston
11— Seal Ring
12— O-Ring
13— Slide Ring (2 used)
14— Steel Ball
15— Setscrew

**Assemble Bucket, Swing and Blade Cylinders**

1. Press bushing (4) into cylinder head (3) (crevice).

**IMPORTANT: After pressing bushing (4) in, check that bushing (4) end surface is flush with cylinder head (3) U-ring mounting surface. If bushing (4) protrudes, U-ring will be damaged when installed.**

2. Install U-ring (5) in cylinder head (3).

**IMPORTANT: Install U-ring(3) in the correct direction.**

3. Install wiper ring (6) in cylinder head (3) with a plastic hammer.
4. Install backup rings (8) and O-rings (7, 9) onto cylinder head (3).
5. Install O-ring (12), seal ring (11) and slide ring (13) (2 used) onto piston (10).
6. Install cylinder head (3) onto piston rod (2).
7. Install piston (10) onto piston rod (2).
8. Tighten piston (10).

Wrench Size:

Bucket 41 mm, Swing 55 mm, Blade 55 mm (33Mu)
Bucket 55 mm, Swing 55 mm, Blade 70 mm (58Mu)

*NOTE: Refer to page W04-02-20 for tightening torque.*

9. Insert steel ball (14) into the screw hole on the hexagonal head of piston (10) and tighten setscrew (15).

**IMPORTANT: After tightening setscrew (15), mushroom the screw head in two places to lock it.**

Wrench Size:

Bucket 3 mm, Swing 4 mm, Blade 4 mm (33Mu)
Bucket 4 mm, Swing 4 mm, Blade 5 mm (58Mu)

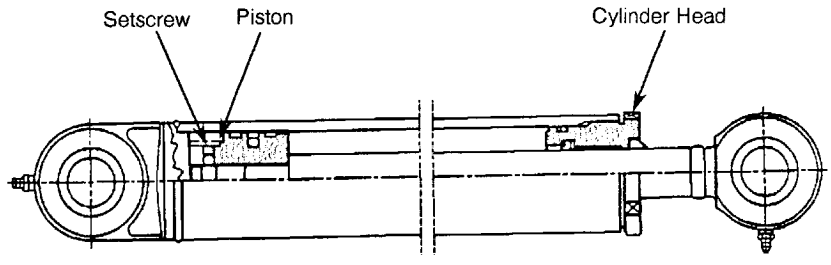
*NOTE: Refer to page W04-02-20 for tightening torque.*

**CAUTION: Take care not to damage the seal ring and slide rings when inserting the piston rod assembly. After aligning the center of the piston rod with the center of the cylinder tube, insert the rod straight into the tube.**

10. Securely clamp cylinder tube (1) horizontally in a vise. Insert piston rod (2) assembly into cylinder tube (1).
11. Tighten cylinder head (3). Bend the lock washer to secure the cylinder head.

*NOTE: Refer to page W04-02-20 for tightening torque.*

## TIGHTENING TORQUE SPECIFICATIONS




W506-04-02-020

**33Mu**

unit: N·m(kgf·m)

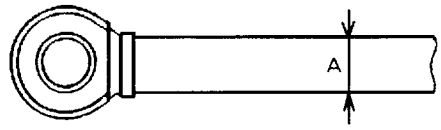
| Cylinder Name | Cylinder Head | Piston Nut | Setscrew |
|---|---|---|---|
| Boom | 490 ( 50 ) | 1 370 ( 140 ) | 16.2 ( 1.65 ) |
| Arm | 422 ( 43 ) | 785 ( 80 ) | 16.2 ( 1.65 ) |
| Bucket | 343 ( 35 ) | 588 ( 60 ) | 6.8 ( 0.7 ) |
| Boom Swing | 490 ( 50 ) | 1 180 ( 120 ) | 16.2 ( 1.65 ) |
| Blade | 530 ( 54 ) | 834 ( 85 ) | 16.2 ( 1.65 ) |

**58Mu**

unit: N·m(kgf·m)

| Cylinder Name | Cylinder Head | Piston Nut | Setscrew |
|---|---|---|---|
| Boom | 833 ( 85 ) | 3 140 ( 320 ) | 31.4 ( 3.21 ) |
| Arm | 529 ( 54 ) | 1 820 ( 185 ) | 16.2 ( 1.65 ) |
| Bucket | 451 ( 46 ) | 1 180 ( 120 ) | 16.2 ( 1.65 ) |
| Boom Swing | 569 ( 58 ) | 1 570 ( 160 ) | 16.2 ( 1.65 ) |
| Blade | 834 ( 85 ) | 2 255 ( 230 ) | 31.4 ( 3.21 ) |

## MAINTENANCE STANDARDS




W105-04-02-094

**33Mu**

unit: mm

| Cylinder Name | Standard Diameter(A) | Allowable Wear Limit | Corrective Measure |
|---|---|---|---|
| Boom | 55 | 0.05 | Replace or Apply Plating |
| Arm | 40 | | |
| Bucket | 40 | | |
| Boom Swing | 45 | | |
| Blade | 45 | | |

**58Mu**

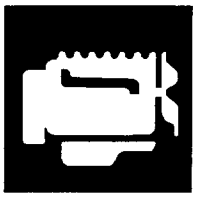
unit: mm

| Cylinder Name | Standard Diameter(A) | Allowable Wear Limit | Corrective Measure |
|---|---|---|---|
| Boom | 60 | 0.05 | Replace or Apply Plating |
| Arm | 55 | | |
| Bucket | 50 | | |
| Boom Swing | 50 | | |
| Blade | 70 | | |

# CONTENTS

# SECTION 05
# ENGINE

33Mu





## M. MECHANISM



## S. DISASSEMBLING AND SERVICING

# TABLE DES MATIERES



## M. MECANISME



## S. DEMONTAGE ET ENTRETIEN

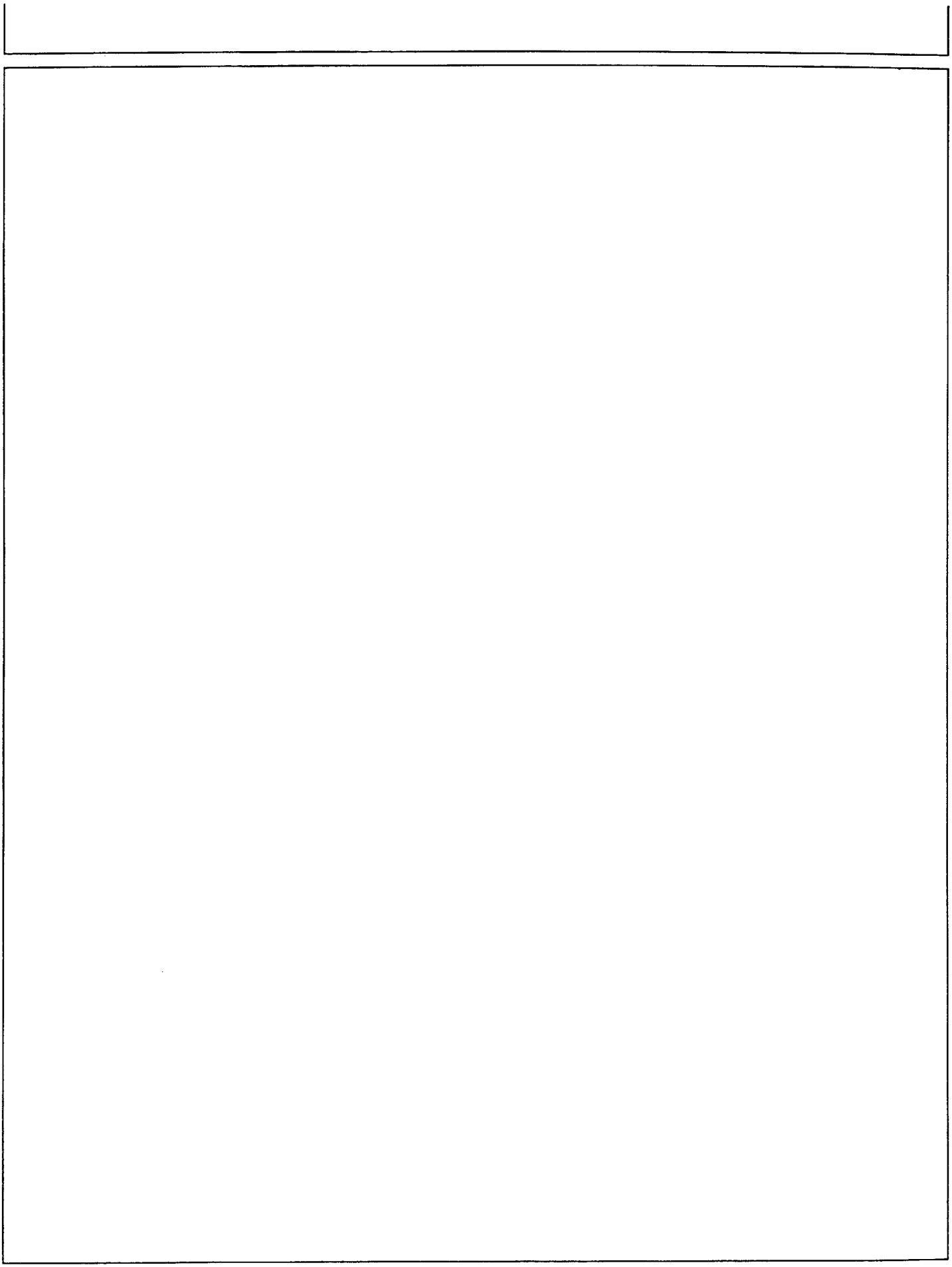
# VERZEICHNIS



## M. MECHANISMUS



## S. AUSBAU UND WARTUNG



# SAFETY FIRST

This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and decals on the engine itself to warn of the possibility of personal injury. Read these instructions carefully.
It is essential that you read the instructions and safety regulations before you attempt to repair or use this unit.

**DANGER** : Immediate hazards which WILL result in severe personal injury or death.

**WARNING** : Hazards or unsafe practices which COULD result in severe personal injury or death.

**CAUTION** : Hazards or unsafe practices which COULD result in minor personal injury.

■ **IMPORTANT** : Indicates that equipment or property damage could result if instructions are not followed.

■ **NOTE** : Gives helpful information.

# SAFETY SERVICING AND REPAIRING

(1) Before working on the engine :
- Stop the engine, and remove the key.
- Allow the engine to cool before proceeding.
- Place the engine on a firm and level surface.
- Disconnect the battery's ground cable.
- Clean the work area and engine.

(2) Do not work on the engine while under the influence of alcohol, medication, or other substances or while fatigued.

(3) Do not wear a necktie, scarf, necklace, loose or bulky clothing when you work near machine tools or moving parts.

(4) Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

(5) Use tools appropriate to the work. Makeshift tools, parts, and procedures will not make good repairs.

(6) When servicing is performed together by two or more persons, take care to perform all work safely.

(7) If the engine must be running to do some work, make sure the area is well ventilated. Never run the engine in a closed area. The exhaust gas contains poisonous carbon monoxide.

(8) Do not touch the rotating or hot parts while the engine is running.

(9) Fuel is extremely flammable and explosive under certain conditions. Do not smoke or allow flames or sparks in your working area.

(10) To avoid sparks from an accidental short circuit, always disconnect the battery's ground cable first and connect it last.

(11) Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, clothing and cause blindness if splashed into eyes. Keep electrolyte away from eyes, hands and clothing. If you spill electrolyte on yourself, flush with water, and get medical attention immediately.

(12) Battery gas can explode. Keep sparks and open flame away from the top of battery, especially when charging the battery.

(13) Never remove the radiator cap while the engine is running, or immediately after stopping. Otherwise, hot water will spout out from radiator. Wait for more than ten minutes to cool the radiator, before removing the cap.

(14) Escaping fuel fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel lines. Tighten all connections before applying pressure.

(15) Do not start the engine by shorting across starter terminals.

(16) Unauthorized modifications to the engine may impair the function and / or safety and affect engine life.

# LA SECURITE D'ABORD

Ce symbole, le "symbole de sécurité" adopté par l'industrie en question, est utilisé dans ce manuel et sur les autocollants apposés sur le moteur lui-même pour avertir les utilisateurs de la présence d'un danger pouvant provoquer des blessures corporelles. Lisez ces instructions attentivement. Il est essentiel que vous lisiez ces instructions et les règles de sécurité avant que vous n'essayiez de réparer ou d'utiliser cette unité.

**DANGER** : Dangers immédiats qui provoqueront directement des blessures graves ou la mort.

AVERTISSEMENT : Risques ou pratiques peu sûres qui PEUVENT occasionner des blessures graves ou la mort.

ATTENSION : Risques ou pratiques peu sûres qui PEUVENT occasionner des blessures légères.

■ IMPORTANT : Ceci indique que si les instructions ne sont pas suivies, des dommages ou dégats peuvent être occasionnés à l'équipement ou à des biens.

■ NOTA : Donne des informations utiles

# ENTRETIEN ET REPARATION DE SECURITE

(1) Avant de travailler sur le moteur :
- Arrêter le moteur et retirer la clé.
- Laisser au moteur le temps de refroidir avant d'opérer.
- Placer le moteur sur une surface ferme et plane.
- Déconnecter la câble de mise à la tere de la batterie.
- Nettoyer l'aire de travail et le moteur.

(2) Ne pas travailler sur le moteur en étant sous l'influence de l'alcool, de médicaments, d'autres substances ou en état de fatigue.

(3) Ne pas porter de cravate, de foulard, de collier, ou des vêtements trop larges et mal ajustés au corps lorsque l'on travaille à proximité des machines outil ou de pièces en mouvement.

(4) Porter un dispositif protecteur auditif approprié tel qu'un protège-oreilles ou un protège-tympans pour se protéger contre des bruits retentissants désagréables ou gênants.

(5) Utiliser des outils appropriés au travail. Des outils de fortune, des pièces bricolées et des expédients ne peuvent assurer des réparations satisfaisantes.

(6) Lorsque l'entretien est effectué par deux ou plus de deux personnes ensemble, veiller à ce que toutes les opérations soient effectuées dans de parfaites conditions de sécurité.

(7) Si le moteur doit être mis en marche pour effectuer le travail, s'assurer que le local est bien aéré. Ne jamais faire tourner le moteur dans un local fermé. Les gaz d'échappement contiennent du monoxyde de carbone qui est toxique.

(8) Ne pas toucher les pièces rotatives ou chaudes pendant que le moteur est en train de fonctionner.

(9) Le carburant est extrèmement inflammable et explosif dans certaines conditions. Ne pas fumer d'une part, et éviter la présence de flammes ou d'étincelles dans votre aire de travail.

(10) Afin d'éviter les érincelles provoquées par un court-circuit accidentel, il convient de toujours déconnecter en premier le câble de mise à la terre de la batterie et de le connecter en dernier.

(11) L'acide sulfurique de l'électrolyte de la batterie est toxique. La concentration est assez forte pour brûler la peau et les vêtements et provoquer la perte de la vue si l'acide pénètre dans les yeux. Si vous renversez de l'acide de remplissage (électrolyte) sur vous-même, nettoyer avec de l'eau et consulter immédiatement un médecin.

(12) Le gaz de la batterie peut exploser. Maintenir les flammes vives et les étincelles éloignées de la partie supérieure de la batterie, tout spécialement lorsque la batterie est en charge.

(13) Ne jamais retirer le bouchon du radiateur alors que le moteur fonctionne ou immédiatement après l'arrêt du moteur. Sinon, de l'eau bouillante jaillira du radiateur. Attendre plus de dix minutes, temps nécessaire pour que le radiateur refroidisse, avant de retirer le bouchon du raidateur.

(14) Un jet de carburant sous pression peut pénétrer dans la peau et causer de sérieux troubles. Eliminer la pression avant de déconnecter les tuyaux pour le carburant. Reserrer tous les raccords avant de mettre sous pression.

(15) Ne pas démarrer en court-circuitant les terminaux du démarreur.

(16) Des modifications non autorisées au moteur reiquent de diminuer ou de compromettre le fonctionnement et/ou la sécurité ainsi que la durabilité du moteur.

# SICHERHEIT ZUERST

Dieses Symbol, das Sicherheits-Warnsymbol des Industriezweigs, wird in dieser Bedienungsanleitung und auf Warnaufklebern am Motor verwendet, um auf die Gefahr von Verletzungen hinzuweisen. Diese Auweisungen sind sorgfältig durchzulesen.

Vor der Verwendung oder der Reparatur dieses Geräts müssen die Anweisungen und Sicherheitsbinweise unbedingt durchgelesen werden.

**GEFAHR** : Schwere oder sogar tödliche Verletzungen sind **MIT SICHERHEIT** die Folge, wenn diese Anweisungen nicht beachtet werden.

**WARNUNG** : Schwere oder sogar tödliche Verletzungen **KÖNNEN** die Folge sein, wenn diese Anweisungen nicht beachtet werden.

**ACHTUNG** : Verletzungen **KÖNNEN** eintreten, wenn diese Anweisungen nicht beachtet werden.

■ **WICHTIG** : Weist darauf hin, daß dieses oder andere Geräte beschädigt werden können, wenn die Anweisungen nicht beachtet werden.

■ **ANMERKUNG** : Enthält hilfreiche Informationen.

# SICHERHEITSHINWEISE FÜR WARTUNGS-UND REPARATURARBEITEN

(1) Vor Beginn irgendwelcher Arbeiten am Motor :
- Den motor abstellen, und den Zündschlüssel abziehen.
- Den Motor abkühlen lassen.
- Den Motor auf einer festen und ebenen Unterlage abstellen.
- Das Batterie-Massekabel abtronnen.
- Den Arbeitsbereich und den Motor reinigen.

(2) Keine Arbeiten am Motor ausführen, wenn Sie ermüdet sind, oder unter dem Einfluß von Alkohol oder Arzneimitteln stehen.

(3) Bei allen Arbeiten an Geräten, die bewegliche Teile aufweisen. niemals eine Krawatte, einen Schal, eine Halskette oder locker sitzende bzw. unhandliche Kleidungsstücke tragen.

(4) Zum Schutz vor übermäßig lauten und daher gehörschädigenden Geräuschen ist ein Gehörschutz, wie zum Beispiel Ohrenschützer oder Ohrenstopfen, zu tragen.

(5) Zur Ausführung der Arbeiten die Korrekten Werkzeuge verwenden. Behelfsmäßige Werkzeuge, Teile und Reparaturen stellen ein Sicherheitsrisiko dar.

(6) Wenn die Arbeiten von mehreren Personen ausgeführt werden, auf klare Verständigung achten, damit die Sicherheit aller gewährleistet ist.

(7) Wenn der Motor zur Ausführung von Wartungsarbeiten laufen muß, auf ausreichende Belüftung des Arbeitsbereichs achten. Den Motor niemals in einem geschlossenen Raum laufen lassen, da die Auspuffgase giftiges Kohlenmonoxidgas enthalten.

(8) Bei laufendem Motor auf einen ausreichenden Sicherheitsabstand von sich drehenden oder heißen Teilen achten.

(9) Kraftstoff ist extrem feuergefährlich und unter gewissen Bedingungen explosiv. Im Arbeitsbereich nicht rauchen: offene Flammen und Funken sind fernzuhalten.

(10) Um Funkenbildung durch einen unbeabsichtigten Kurzschluß zu vermeiden, immer das Batterie-Massekabel zuerst abtrennen und danach als letztes anschließen.

(11) Die im Elektrolyt enthaltene Schwefelsäure ist giftig. Sie ist ebenfalls ausreichend stark, um Hautverätzungen hervorzurufen, Kleidung zu zerstören und Erblindung hervorzurufen, wenn sie in die Augen gelangt. Wenn Elektrolyt auf Ihre Haut oder in Ihre Augen gelangt, mit reichlich Wasser abspülen und sofort einen Arzt aufsuchen.

(12) Batteriegase können zur Explosion führen. Deshalb ganz besonders während des Ladevorgangs offenes Feuer und Funken von der Batterie fernhalten.

(13) Den Kühlerdeckel niemals bei laufendem Motor oder unmittelbar nach dem Abstellen des Motors abnehmen, da heiße Kühlflüssigkeit aus dem Kühler herausspritzen kann. Vor dem Abnehmen des Kühlerdeckels mindestens zehn Minuten warten.

(14) Wenn der unter hohem Druck stehende Kraftstoff herausspritzt, kann er die Haut durchdringen und schwere Verletzungen verursachen. Vor dem Abnehmen der Kraftstoffleitungen daher unbedingt den Druck ablassen. Bevor das System wieder unter Druck gesetzt wird, müssen alle Verbindungen gut festgezogen werden.

(15) Den Motor nicht durch Kurzschließen der Batterie anlassen.

(16) Unzulässige Veränderungen am Motor können die Funktion und/oder Sicherheit beeinträchtigen und die Lebensdauer des Motors reduzieren.

# SPECIFICATIONS

| Model | | | D1403-B (E) | D1503-B (E) |
|---|---|---|---|---|
| Number of Cylinders | | | 3 | |
| Type | | | Vertical, water-cooled, 4-cycle diesel engine | |
| Bore x Stroke | | mm (in.) | 80 x 92.4 (3.15 x 3.64) | 83 x 92.4 (3.27 x 3.64) |
| Total Displacement | | $cm^3$ (cu. in.) | 1393 (85.01) | 1499 (91.5) |
| Engine | SAE Net Cont. | kW/rpm (HP/rpm) | 18.6/2800 (25.0/2800) | 20.1/2800 (27/2800) |
| | SAE Net Intermittent | kW/rpm (HP/rpm) | 21.6/2800 (29.0/2800) | 23.4/2800 (31.5/2800) |
| | SAE Gross Intermittent | kW/rpm (HP/rpm) | 23.1/2800 (31.0/2800) | 25.3/2800 (34/2800) |
| | DIN6271-NA | kW/rpm (PS/rpm) | 18.4/2800 (25.0/2800) | 20.1/2800 (27/2800) |
| | DIN6271-NB | kW/rpm (PS/rpm) | 20.6/2800 (28.0/2800) | 22.7/2800 (30.5/2800) |
| | DIN70020 | kW/rpm (PS/rpm) | 22.1/2800 (30.0/2800) | 24.2/2800 (32.5/2800) |
| Maximum Bare Speed | | rpm | 3000 | |
| Minimum Idling Speed | | rpm | 700 to 750 | |
| Combustion Chamber | | | Spherical Type | |
| Fuel Injection Pump | | | Bosch Type Mini Pump (PFR 3M) | |
| Governor | | | Centrifugal Ball Mechanical Governor | |
| Direction of Rotation | | | Counter-clockwise (Viewed from flywheel side) | |
| Injection Nozzle | | | BOSCH Throttle-Type | |
| Injection Timing | | | 0.314 rad. (18°) Before T.D.C | |
| Firing Order | | | 1-2-3 | |
| Injection Pressure | | | 13.73 MPa (140 kgf/$cm^2$, 1991 psi) | |
| Compression Ratio | | | 23 : 1 | |
| Lubricating System | | | Forced Lubrication by trochoid Pump | |
| Oil Pressure Indicating | | | Electrical Type Switch | |
| Lubricating Filter | | | Full Flow Paper Filter (Cartridge Type) | |
| Cooling System | | | Pressurized radiation, forced Circulation with Water Pump | |
| Starting System | | | Electric Starting with Starter | |
| | | | 12 V 1.2 kw | |
| Starting Support Device | | | By Glow Plug in Combustion Chamber | |
| Battery | | | 12V 70 to 80 AH | |
| Dynamo for Charing | | | 12V, 360W | |
| Fuel | | | Diesel Fuel No.2-D (ASTM D975) | |
| Lubricating Oil | | | Better than CD class (API) | |
| * Lubricating Oil Capacity | Oil pan depth 90 mm (3.54 in.) | | 5.6 ℓ (1.48 US gals, 1.23 Imp gals) | |
| | Oil pan depth 124 mm (4.88 in.) | | 7.0 ℓ (1.85 US gals, 1.54 Imp gals) | |
| Weight (Dry) | | kg (lbs) | 148 (326) | |

*90 mm (3.54 in.) Oil pan depth is optional

| V1903-B (E) | V2203-B (E) | F2803-B (E) |
|---|---|---|
| 4 | | 5 |
| Vertical, water-cooled, 4-cycle diesel engine | | |
| 80 x 92.4 (3.15 x 3.64) | 87 x 92.4 (3.43 x 3.63) | 87 x 92.4 (3.43 x 3.64) |
| 1857 (113.37) | 2197 (134.08) | 2746 (167.59) |
| 25.4/2800<br>(34.0/2800) | 29.8/2800<br>(40.0/2800) | 37.3/2800<br>(50.0/2800) |
| 29.1/2800<br>(39.0/2800) | 34.3/2800<br>(46.0/2800) | 42.9/2800<br>(57.5/2800) |
| 31.3/2800<br>(42.0/2800) | 36.9/2800<br>(51.0/2800) | 46.2/2800<br>(62.0/2800) |
| 25.0/2800<br>(34.0/2800) | 29.4/2800<br>(40.0/2800) | 36.8/2800<br>(50.0/2800) |
| 27.6/2800<br>(37.5/2800) | 32.7/2800<br>(44.5/2800) | 40.8/2800<br>(55.5/2800) |
| 29.8/2800<br>(40.5/2800) | 35.3/2800<br>(48.5/2800) | 44.1/2800<br>(60.0/2800) |
| 3000 | | |
| 700 to 750 | | |
| Spherical Type | | |
| Bosch type Mini Pump (PFR 4M) | | Bosch type Mini Pump (PFR 5M) |
| Centrifugal Ball Mechanical Governor | | |
| Counter-clockwise (Viewed from flywheel side) | | |
| BOSCH Throttle-Type | | |
| 0.314 rad. (18°) Before T.D.C | | 0.332 rad. (19°) Before T.D.C. |
| 1-3-4-2 | | 1-3-5-4-2 |
| 13.73 MPa (140 kgf/cm$^2$, 1991 psi) | | |
| 23 : 1 | | |
| Forced Lubrication by trochoid Pump | | |
| Electrical Type Switch | | |
| Full Flow Paper Filter (Cartridge type) | | |
| Pressurized radiation, Forced Circulation with water Pump | | |
| Electric Starting with Starter | | |
| 12V, 1.4 kW | | |
| By Glow Plug in Combustion Chamber | | |
| 12V, 110 to 120AH | | |
| 12V, 360W | 12V, 420W | |
| Diesel Fuel No.2-D (ASTM D975) | | |
| Better than CD Class (API) | | |
| 7.6 ℓ (2.01 US gals, 1.672 Imp gals) | | - |
| 9.5 ℓ (2.51 US gals, 2.09 Imp gals) | | 12.0 ℓ (3.17 US gals, 2.64 Imp gals) |
| 180 (397) | | 223 (492) |

# SPECIFICATIONS

| Modèle | | D1403-B (E) | D1503-B (E) |
|---|---|---|---|
| Nombre de cylindres | | 3 | |
| Type | | Vertical, à refroidissement par eau, 4 temps, Diesel | |
| Alésage x course | mm | 80 x 92,4 | 83 x 92.4 |
| Cylindrée totale | $cm^3$ | 1393 | 1499 |
| Moteur | Puissance continue SAE, Net kW/tr/mn (HP/tr/mn) | 18,6/2800 (25,0/2800) | 20.1/2800 (27/2800) |
| Moteur | Puissance intermittente SAE, Net kW/tr/mn (HP/tr/mn) | 21,6/2800 (29,0/2800) | 23.4/2800 (31.5/2800) |
| Moteur | Puissance intermittente SAE, brute kW/tr/mn (HP/tr/mn) | 23,1/2800 (31,0/2800) | 25.3/2800 (34/2800) |
| Moteur | DIN6271-NA kW/tr/mn (CV/tr/mn) | 18,4/2800 25,0/2800 | 20.1/2800 (27/2800) |
| Moteur | DIN6271-NB kW/tr/mn (CV/tr/mn) | 20,6/2800 (28,0/2800) | 22.7/2800 (30.5/2800) |
| Moteur | DIN70020 kW/tr/mn (CV/tr/mn) | 22,1/2800 (30,0/2800) | 24.2/2800 (32.5/2800) |
| Régime maximum à vide | tr/mn | 3000 | |
| Régime minimum à vide | tr/mn | 700 à 750 | |
| Chambre de combustion | | Sphérique | |
| Pompe d'injection | | Bosch Type Mini (PFR 3M) | |
| Régulateur | | Mécanique centrifuge à bille | |
| Sens de rotation | | En sens inverse des aiguilles d'une montre (en regardant côté volant) | |
| Injecteurs | | BOSCH Type à jet étrangleur | |
| Calage de l'injection | | 0,314 rad. (18°) avant PMH | |
| Order d'injection | | 1-2-3 | |
| Pression d'injection | | 13,73 MPa (140 $kgf/cm^2$) | |
| Taux de compression | | 23 : 1 | |
| Lubrication | | Forcée, par pompe | |
| Indication de pression d'huile | | Par contact électrique | |
| Filtre de lubrification | | Filtre à élément papier (à type cartouche) | |
| Refroidissement | | Radiateur sous pression, circulation forcée avec pompe à eau | |
| Démarragae | | Démarrage électrique avec démarreur | |
| | | 12 V, 1,2 kW | |
| Dispositif auxiliaire au démarrage | | Par bougie de préchauffage, dans la chambre de combustion | |
| Batterie | | 12V, 70 à 80 AH | |
| Circuit de charge | | 12V, 360 W | |
| Carburant | | Gas-oil N° 2-D (ASTM D975) | |
| Huile de lubrification | | Supérieure à la classe CD (API) | |
| * Capacité en huile de lubrification | Profondeur du carter d'huile 90 mm | 5,6 ℓ | |
| | Profondeur du carter d'huile 124 mm | 7,0 ℓ | |
| Poids (à sec) | | 148 | |

*La profondeur du carter d'huile de 90 mm est optionnelle.

| V1903-B (E) | V2203-B (E) | F2803-B (E) |
|---|---|---|
| 4 | | 5 |
| Vertical, à refroidissement par eau, 4 temps, Diesel | | |
| 80 x 92,4 | 87 x 92,4 | 87 x 92,4 |
| 1857 | 2197 | 2746 |
| 25,4/2800<br>(34,0/2800) | 29,8/2800<br>(40,0/2800) | 37,3/2800<br>(50,0/2800) |
| 29,1/2800<br>(39,0/2800) | 34,3/2800<br>(46,0/2800) | 42,9/2800<br>(57,5/2800) |
| 31,3/2800<br>(42,0/2800) | 36,9/2800<br>(49,5/2800) | 46,2/2800<br>(62,0/2800) |
| 25,0/2800<br>(34,0/2800) | 29,4/2800<br>(40,0/2800) | 36,8/2800<br>(50,0/2800) |
| 27,6/2800<br>(37,5/2800) | 32,7/2800<br>(44,5/2800) | 40,8/2800<br>(55,5/2800) |
| 29,8/2800<br>(40,5/2800) | 35,3/2800<br>(48,0/2800) | 44,1/2800<br>(60,0/2800) |
| 3000 | | |
| 700 à 750 | | |
| Sphérique | | |
| Bosch Type Mini (PFR 4M) | | Bosch Type Mini (PFR 5M) |
| Mécanique centrifuge à bille | | |
| En sens inverse des aiguilles d'une montre (en regardant côté volant) | | |
| BOSCH Type à jet étrangleur | | |
| 0,314 rad. (18°) avant PMH | | 0,332 rad. (19°) avant PMH |
| 1-3-4-2 | | 1-3-5-4-2 |
| 13,73 MPa (140 kgf/cm$^2$) | | |
| 23 : 1 | | |
| Forcée, par pompe | | |
| Par contact électrique | | |
| Filtre à élément papier (à type cartouche) | | |
| Radiateur sous pression, circulation forcée avec pompe à eau | | |
| Démarrage électrique avec démarreur | | |
| 12 V, 1,4 kW | | |
| Par bougie de préchauffage, dans la chambre de combustion | | |
| 12V, 110 à 120 AH | | |
| 12V, 360W | 12V, 420W | |
| Gas-oil N° 2-D (ASTM D975) | | |
| Supérieure à la classe CD (API) | | |
| 7,6 ℓ | | – |
| 9,5 ℓ | | 12,0 ℓ |
| 180 | | 223 |

# TECHNISCHE MERKMALE

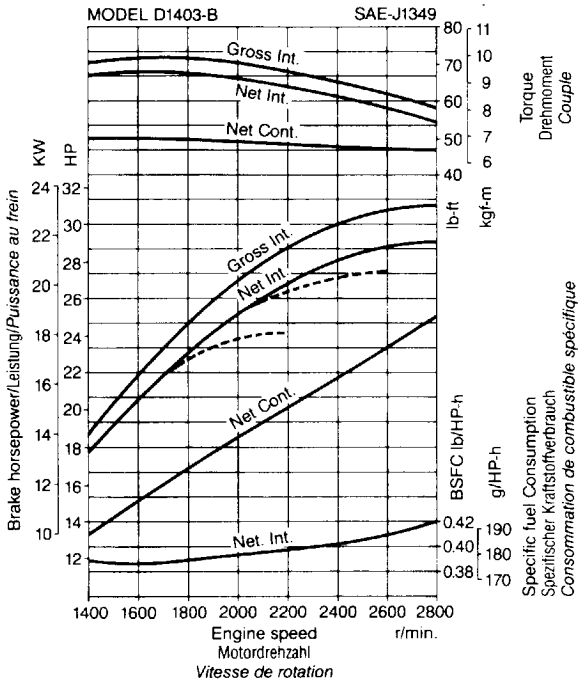
| Modell | | | D1403-B (E) | D1503-B (E) |
|---|---|---|---|---|
| Zylinderzahl | | | 3 | |
| Typ | | | Vertical, wassergekühlter Vietakt-Dieselmotor | |
| Bohrung x Hub | | mm | 80 x 92,4 | 83 x 92.4 |
| Hubrauminhalt | | $cm^3$ | 1393 | 1499 |
| Motor | SAE Netto-PS kontinuierlich | kW/U/Min (HP/U/Min) | 18,6/2800 (25,0/2800) | 20.1/2800 (27/2800) |
| | SAE Netto-PS intermittierend | kW/U/Min (HP/U/Min) | 21,6/2800 (29,0/2800) | 23.4/2800 (31.5/2800) |
| | SAE Brutto-PS intermittierend | kW/U/Min (HP/U/Min) | 23,1/2800 (31,0/2800) | 25.3/2800 (34/2800) |
| | DIN6271-NA | kW/U/Min (PS/U/Min) | 18,4/2800 25,0/2800 | 20.1/2800 (27/2800) |
| | DIN6271-NB | kW/U/Min (PS/U/Min) | 20,6/2800 (28,0/2800) | 22.7/2800 (30.5/2800) |
| | DIN70020 | kW/U/Min (PS/U/Min) | 22,1/2800 (30,0/2800) | 24.2/2800 (32.5/2800) |
| Maximaldrehzahl | | U/Min | 3000 | |
| Minimal-Leerlaufdrehzahl | | U/Min | 700 bis 750 | |
| Verbrennungskammer | | | Kugelförmig | |
| Kraftstoff-Einspritzpumpe | | | Bosch Typ Mini (PFR 3M) | |
| Drehzahlregler | | | Mechanischer Fliehkraft Kugelregler | |
| Drehrichtung | | | Entgegen dem Uhrzeigersinn (von der Schwungradseite aus gesehen) | |
| Einspritzdüse | | | BOSCH Drosseltyp | |
| Einspritztakt | | | 0,314 rad. (18°) Vor O.T. | |
| Einspritzfolge | | | 1-2-3 | |
| Einspritzdruck | | | 13,73 MPa (140 $kp/cm^2$) | |
| Verdichtungsverhältnis | | | 23 : 1 | |
| Schmierungssystem | | | Druckschmierung durch Getriebepumpe | |
| Öldruckanzeige | | | Elektrischer Schalter | |
| Schmierungsölfilter | | | Vollfluß-Papierfilter (Patronentyp) | |
| Kühlungssystem | | | Druckkühler (Zwangsumlauf mit Wasserpumpe) | |
| Anlaßsystem | | | Elektrisch mit Zellenanlasser | |
| | | | 12 V, 1,2 kW | |
| Anlaß-Unterstützungsvorrichtung | | | Durch Glühkerze im Verbrennungskammer | |
| Batterie | | | 12V, 70 bis 80 AH | |
| Lichtmaschine für Ladung | | | 12V, 360 W | |
| Kraftstoff | | | Diesel-Kraftstoff Nr. 2-D (ASTM D975) | |
| Schmierungsöl | | | MIL-L-2104C, bessere Qualität als Klasse CD (API) | |
| * Schmierungsöl-menge | 90 mm Tiefölwanne | | 5,6 ℓ | |
| | 124 mm Tiefölwanne | | 7,0 ℓ | |
| Anwendung | | kg | 148 | |

*Die Ölwanne (T = 90 mm) ist optional.

| V1903-B (E) | V2203-B (E) | F2803-B (E) |
|---|---|---|
| 4 | | 5 |
| Vertikal, wassergekühlter Viertakt-Dieselmotor | | |
| 80 x 92,4 | 87 x 92,4 | 87 x 92,4 |
| 1857 | 2197 | 2746 |
| 25,4/2800<br>(34,0/2800) | 29,8/2800<br>(40,0/2800) | 37,3/2800<br>(50,0/2800) |
| 29,1/2800<br>(39,0/2800) | 34,3/2800<br>(46,0/2800) | 42,9/2800<br>(57,5/2800) |
| 31,3/2800<br>(42,0/2800) | 36,9/2800<br>(49,5/2800) | 46,2/2800<br>(62,0/2800) |
| 25,0/2800<br>(34,0/2800) | 29,4/2800<br>(40,0/2800) | 36,8/2800<br>(50,0/2800) |
| 27,6/2800<br>(37,5/2800) | 32,7/2800<br>(44,5/2800) | 40,8/2800<br>(55,5/2800) |
| 29,8/2800<br>(40,5/2800) | 35,3/2800<br>(48,0/2800) | 44,1/2800<br>(60,0/2800) |
| 3000 | | |
| 700 bis 750 | | |
| Kugelförmig | | |
| Bosch Typ Mini (PFR 4M) | | Bosch Typ Mini (PFR 5M) |
| Mechanischer Fliehkraft Kugelregler | | |
| Entgegen dem Uhrzeigersinn (von der Schwungradseite aus gesehen) | | |
| BOSCH Drosseltyp | | |
| 0,314 rad. (18°) Vor O.T. | | 0,332 rad. (19°) Vor O.T. |
| 1-3-4-2 | | 1-3-5-4-2 |
| 13,73 MPa (140 kp/cm$^2$) | | |
| 23 : 1 | | |
| Druckschmierung durch Getriebepumpe | | |
| Elektrischer Schalter | | |
| Vollfluß-Papierfilter (Patronentyp) | | |
| Druckkühler (Zwangsumlauf mit Wasserpumpe) | | |
| Elektrisch mit Zellenanlasser | | |
| 12 V, 1,4 kW | | |
| Durch Glühkerze im Verbrennungskammer | | |
| 12V, 110 bis 120 AH | | |
| 12V, 360W | 12V, 420W | |
| Diesel-Kraftstoff Nr. 2-D (ASTM D975) | | |
| MIL-L-2104C, bessere Qualität als Klasse CD (API) | | |
| 7,6 ℓ | | – |
| 9,5 ℓ | | 12,0 ℓ |
| 180 | | 223 |

# PERFORMANCE CURVES COURBES DE PERFORMANCE LEISTUNGSKURVEN

## D1403-B (E)

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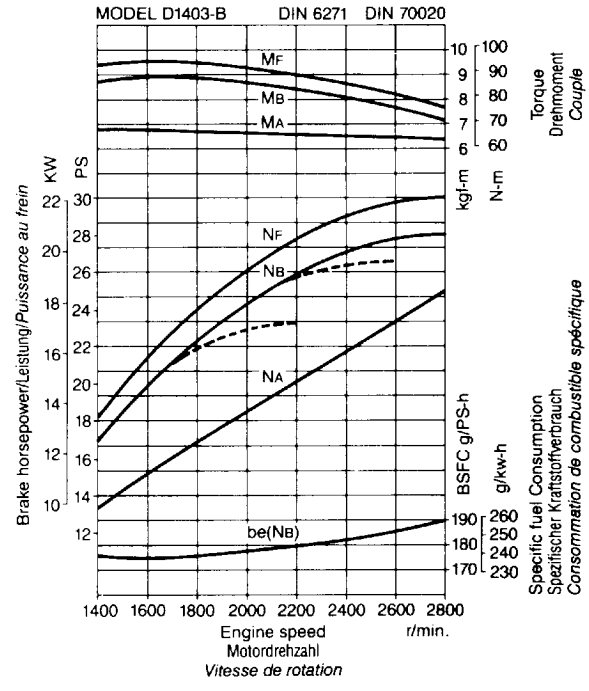


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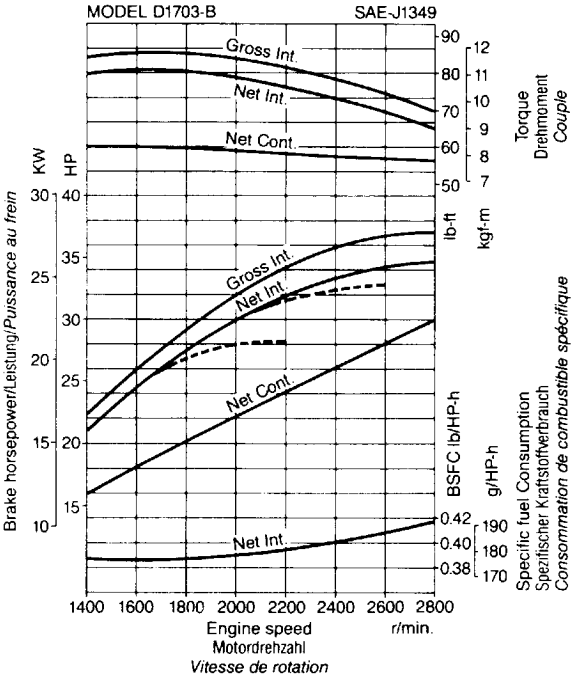


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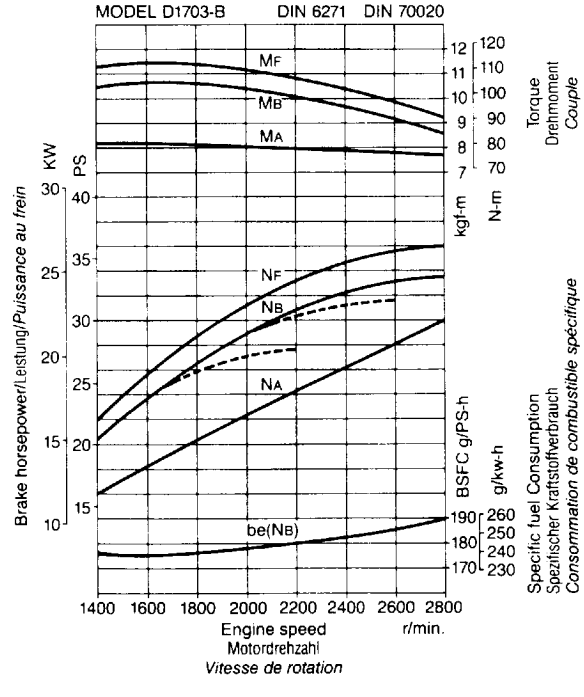


A109F004

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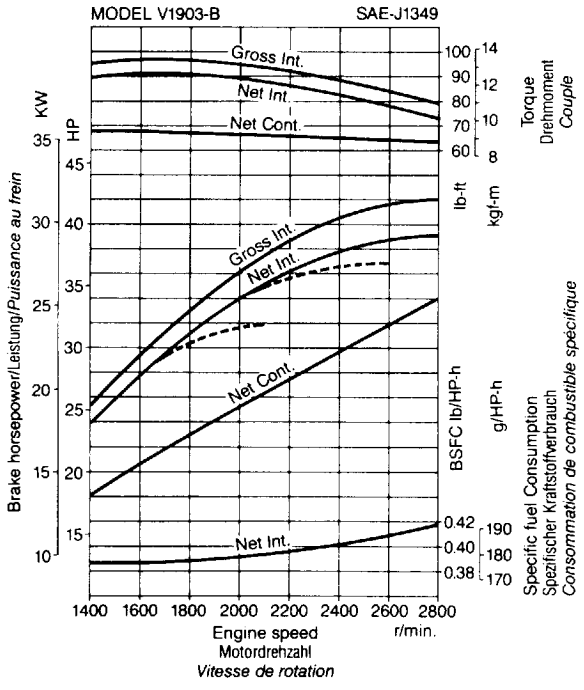


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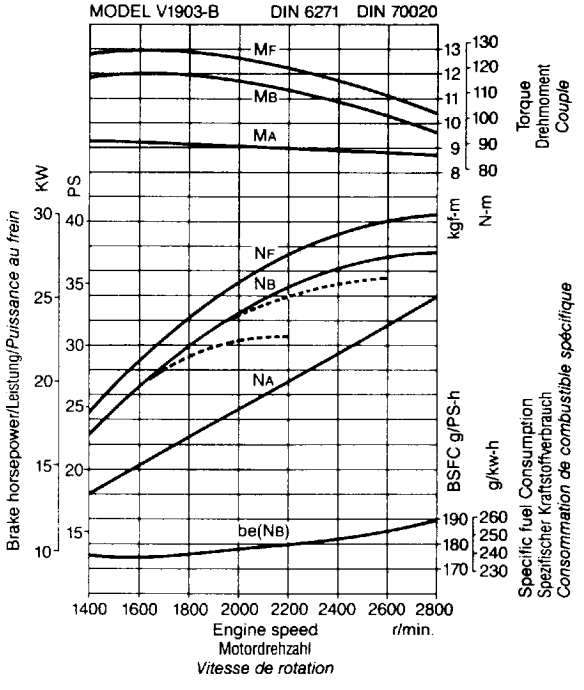


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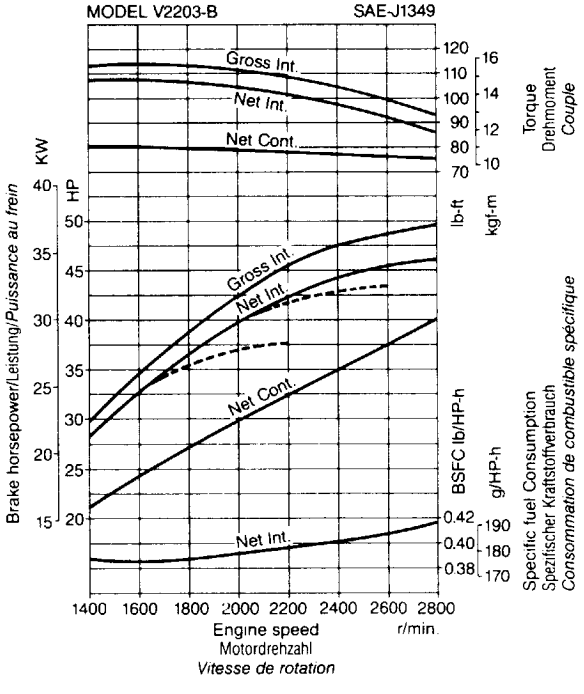


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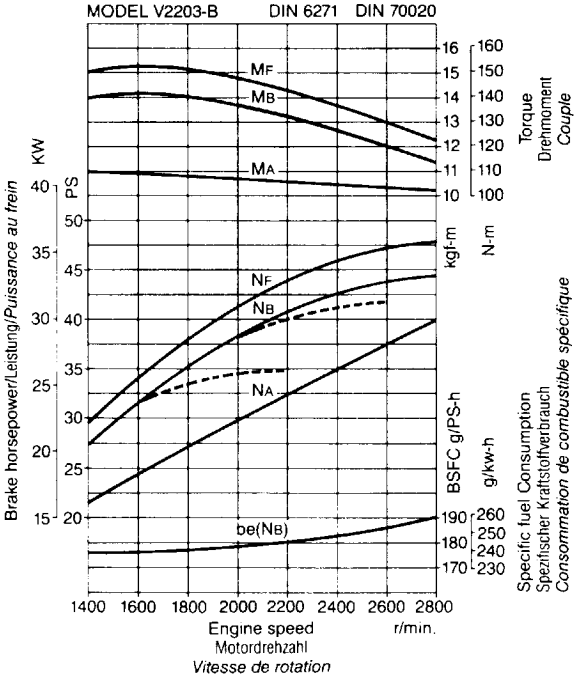


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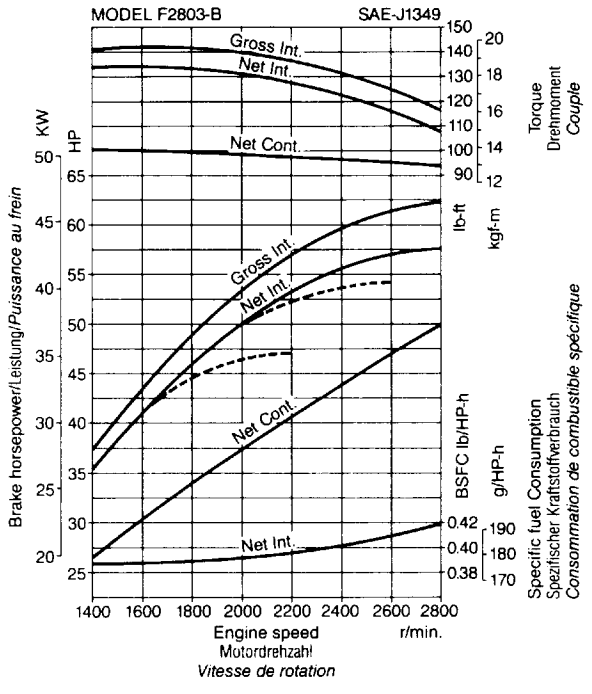


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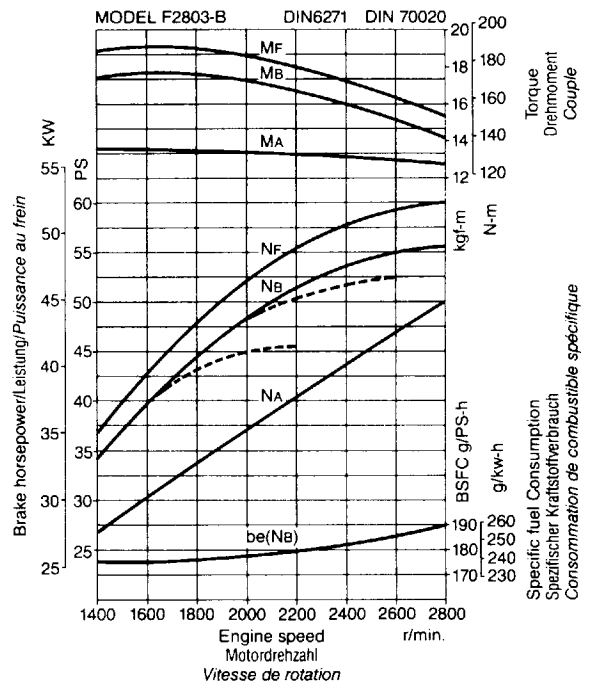
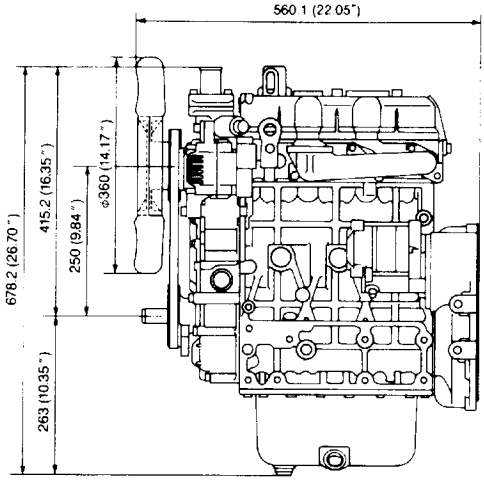



A109F012

# DIMENSIONS DIMENSIONS ABMESSUNGEN

## D1403-B (E), D1703-B (E)

Unit, Unité, Einheit: mm (in.)

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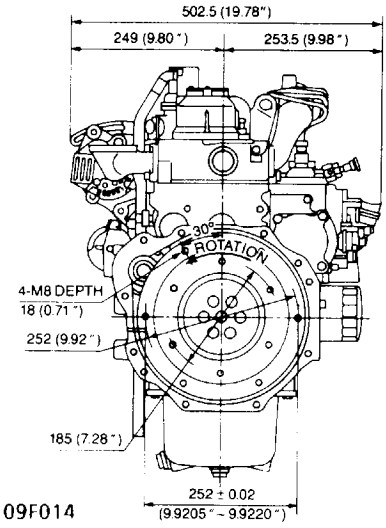


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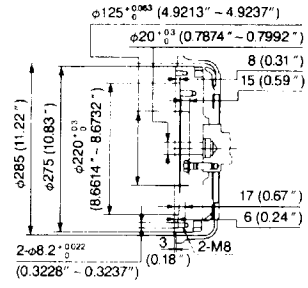
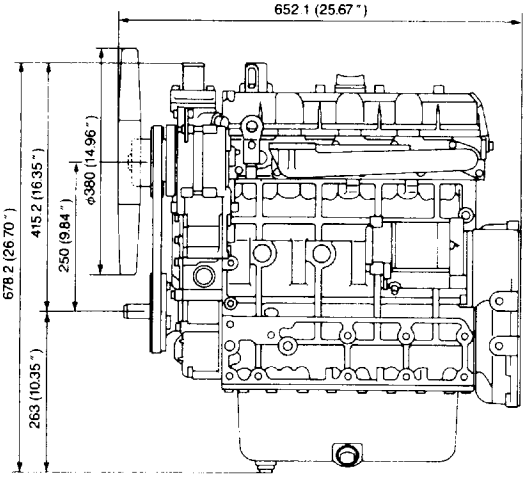



A109F015

## V1903-B (E), V2203-B (E)

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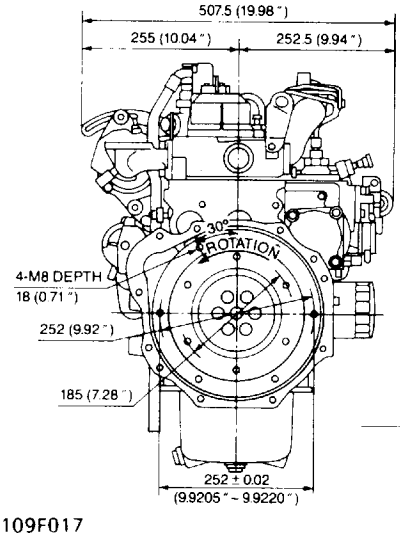


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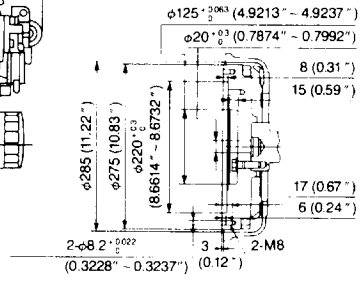


A109F018

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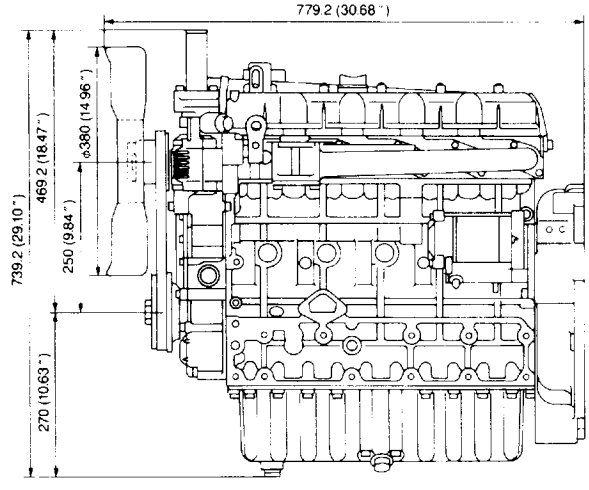


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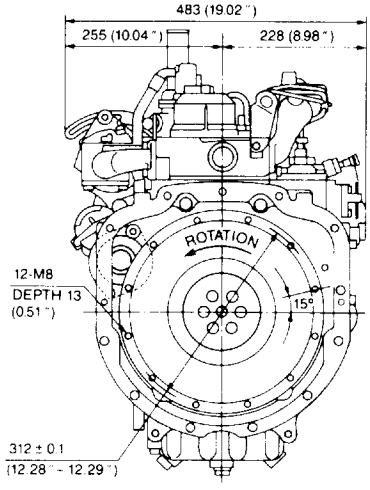
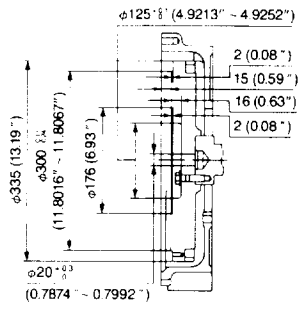


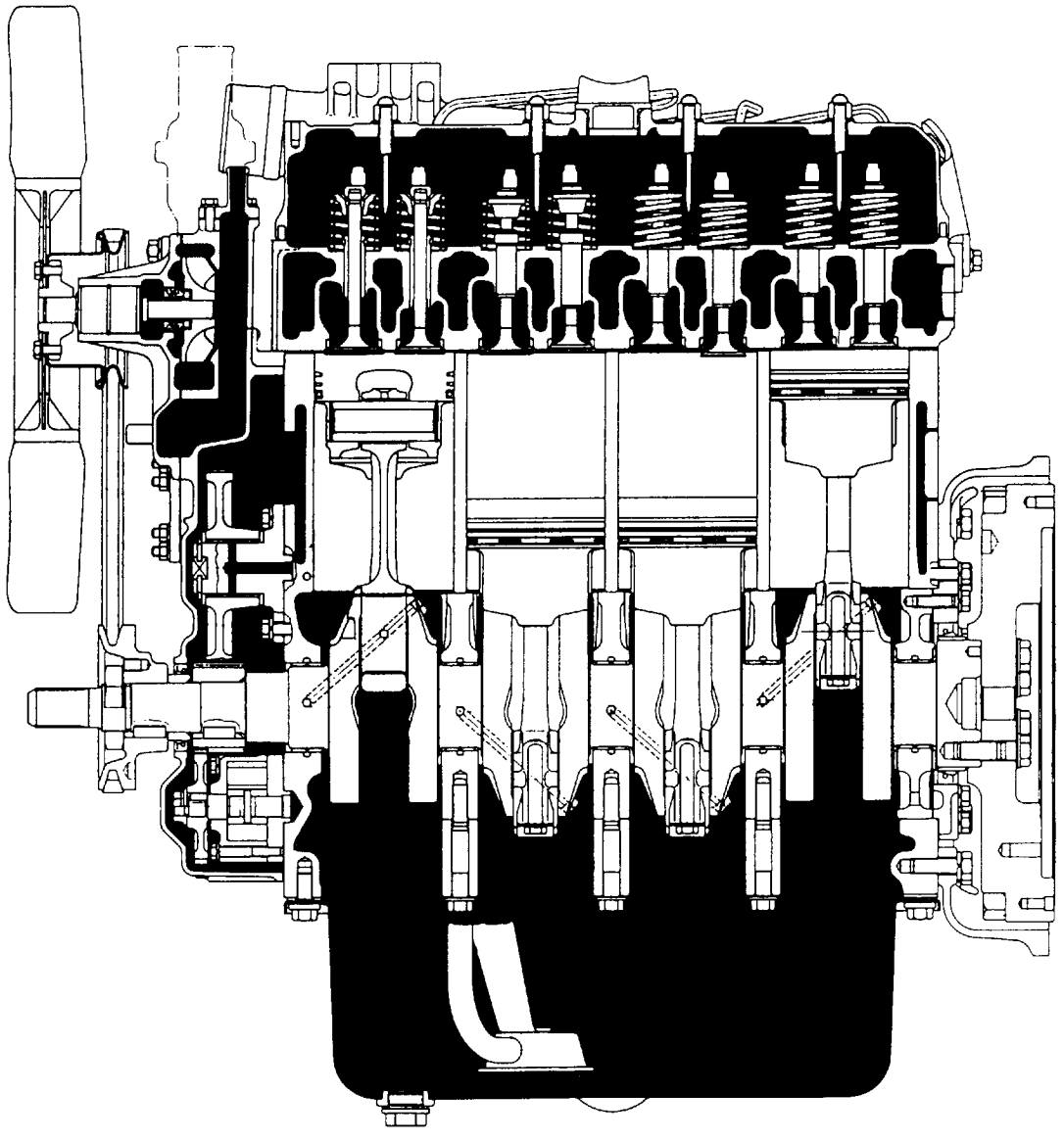

A109F022




A109F020

# M. MECHANISM
# MECANISME
# MECHANISMUS

# F FEATURE



A109F003

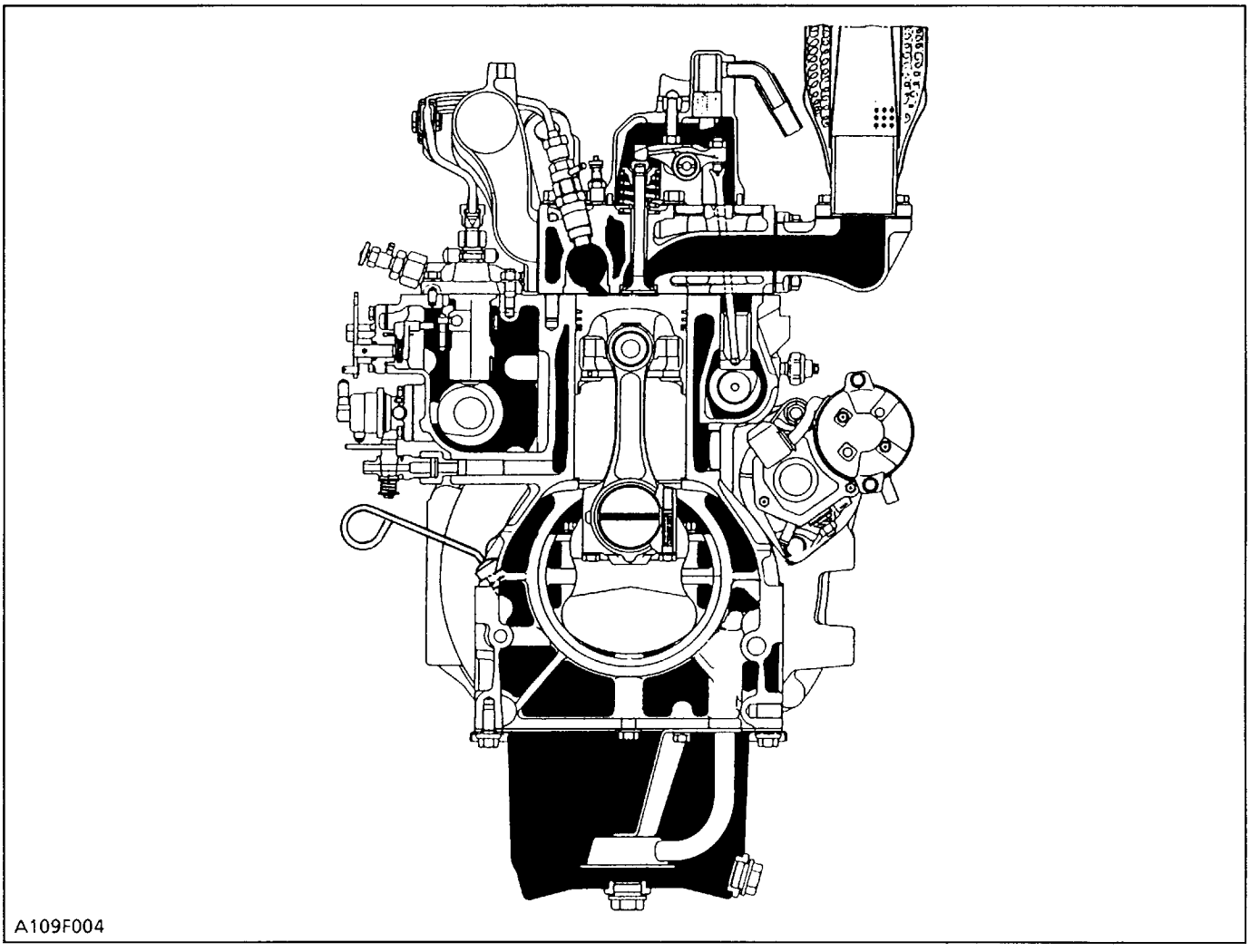
The 92.4 mm STROKE SERIES ENGINE are vertical, water-cooled, 4-cycle diesel engine.

It is incorporated KUBOTA's foremost technologies. With KUBOTA's New TVCS (Three Vortex Combustion System), well-known Bosch type injection pump and the well-balanced designs, they give greater power, low fuel consumption, little vibration and quiet operation.

■ **NOTE**

- Since January 1994, E-TVCS has been used for the combustion chamber of our products instead of traditional N-TVCS.
  E-TVCS was developed with an eye toward clean exhaust gas which is more environmentally friendly.
  The combustion chamber models mentioned hereinafter refers to E-TVCS.
  Model of combustion chamber :
  E-TVCS Serial Number : D1403 ; 12212 & above
  D1703 ; 4254 & above
  V1903 ; 1563 & above
  V2203 ; 60897 & above
  F2803 ; 105568 & above

# F CARACTERISTIQUES F ALLGEMEINES



A109F004

Les moteus moteur de série 92,4 mm de course sont de moteur diesel à 4 temps, à cylindres verticaux et refroidissement par eau. Ils incorporent les technologies les plus avancées KUBOTA. Les Nouveau TVCS (Système de combustion à trois turbulences) de KUBOTA, les pompes d'injection Bosch type bien connues, et une conception bien équilibrée donnent à ces moteurs une puissance accrue, une consommation très basse, un faible niveau de vibrations et un fonctionnement silencieux.

■ **NOTA**

- **La chambre d'explosion, auparavant modèle N-TVCS, des appareils produits depuis Janvier 1994 a été remplacée par le modèle E-TVCS, plus écologique et produisant des gaz d'échappement moins polluants.**
  **Le modèle des chambres d'explosion suivantes sera indiqué par E-TVCS.**
  **Modèle de la chambre d'explosion :**
  **E-TVCS Numéro de sprie : postérieur à**
  **D1403 ; 12212 et au-delà**
  **D1703 ; 4254 et au-delà**
  **V1903 ; 1563 et au-delà**
  **V2203 ; 60897 et au-delà**
  **F2803 ; 105568 et au-delà**

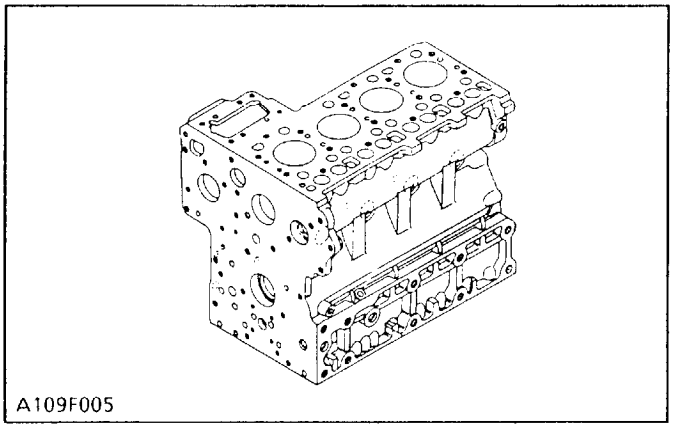
Bei den Motoren Serienmotor mit 92,4 mm Hub handelt es sich um vertikale, wassergekühlte, Viertakt-Dieselmotoren. Sie sind nach der neuesten Technologie KUBOTAS ausgelegt. Mit der Das neue TVCS (Drei-Wirbel-Verbrennungssystem) von KUBOTA, der bekannten Einspritzpumpe Typ von Bosch und der durchdachten, ausgewogenen Konstruktion bieten sie höhere Leistung, geringen Kraft-stoffvrebrauch sowie vibrationsarmen und ruhigen Lauf.

■ **ANMERKUNG**

- **In allen ab 1. Januar 1994 produzierten Anlagen wurde der bisherige Brennkammertyp N-TVCS durch den neu entwickelten Typ E-TVCS ersetzt, der dank reinerer Abluft besonders umweltfreundlich ist.**
  **Die folgenden Beschreibungen beziehen sich auf den Brennkammertype E-TVCS.**
  **Brennkammertyp :**
  **E-TVCS Seriennummern :**
  **D1403 ; 12212 und darüber**
  **D1703 ; 4254 und darüber**
  **V1903 ; 1563 und darüber**
  **V2203 ; 60897 und darüber**
  **F2803 ; 105568 und darüber**

# 1 ENGINE BODY

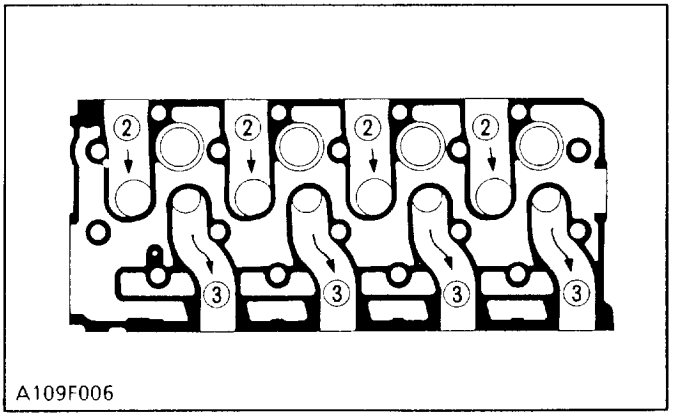
## [1] CYLINDER BLOCK



A109F005

The engine has a high durability tunnel-type cylinder block in which the crank bearing component is a constructed body. Furthermore, liner less type, allow effective cooling, less distortion, and greater wear-resistance. The noise level is reduced to a minimum because each cylinder has its own chamber.

## [2] CYLINDER HEAD

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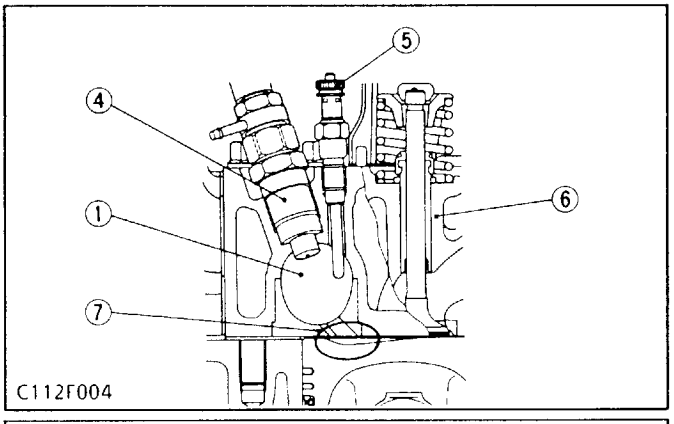


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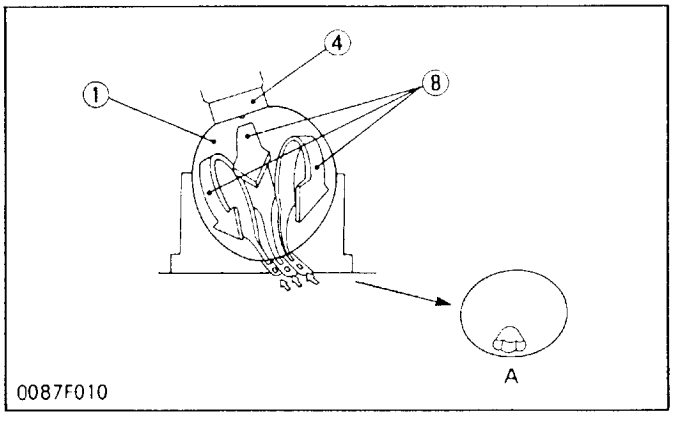


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The cross-flow type intake/exhaust ports in this engine have their openings at both sides of the cylinder head. Because overlaps of intake/exhaust ports are smaller than in ports of other types which have openings on one side, the suction air can be protected from being heated and expanded by heated exhaust air. The cool, high density suction air has high volume efficiency and raises the power of the engine. Furthermore, distortion of the cylinder head by heated exhaust gas is reduced because intake ports are arranged alternately. The combustion chamber is of KUBOTA's exclusive New TVCS combustion chamber type. Suction air is whirled to be mixed effectively with fuel, prompting combustion and reducing fuel consumption.

In the combustion chamber are installed throttle type injection nozzle and rapid heating sheathed type glow plug. This glow plug assures easier than ever engine starts even at −15°C (5°F).

(1) Combustion Chamber
(2) Intake Port
(3) Exhaust Port
(4) Nozzle Assembly
(5) Glow Plug
(6) Cylinder Head
(7) Depression
(8) Compressed Air

**[A] Connect to Combustion Chamber**

# 1 CORPS DU MOTEUR

## [1] BLOC-MOTEUR

Le moteur est doté d'un palier de type tunnel, avec le logement des paliers de vilebrequin faisant corps. De plus, les sans chemises, assurent un refroidissement efficace, réduisent les risquent de déformation, et favorisent une meilleure résistance à l'usure; en outre, le fait que chaque cylindre est doté de sa propre chambre contribue au silence de fonctionnement du moteur.

## [2] CULASSE

Ce moteur est doté d'une culasse à flux transversant, dont les lumières d'admission/échappement sont placées de part et d'autre. Par suite du fait que le chevauchement des lumières admission/échappement est moindre que dans les autres types de moteur à lumières placées du même côté, l'air aspiré peut être protégé du réchauffement et de l'expansion causés par la proximité des gaz d'échappement chauds. L'air frais, aspiré à haute densité, possède un rendement volumétriqque élevée, ce qui augmente la puissance du moteur. De plus, les risques de déformation de la culasse provoquée par les gaz déchappement brûlants sont moindres, étant donné que les chapelles d'admission se trouvent de l'autre côté. La chambre de combustion est de type Nouveau TVCS, une exclusivité KUBOTA. L'air aspiré est mis en turbulance, ce qui donne un mélange efficace avec le carburant, améliorant la combustion et réduisant la consommation.

Dans la chambre de combustion se trouvent les injecteur à jet et les bougies de préchauffage. Ces bougies améliorent le démarrage à des températures pouvant descendre jusqu'à −15°C.

(1) Chambre de combustion
(2) Lumière d'admission
(3) Lumière d'échappement
(4) Ensemble injecteur
(5) Bougie de préchauffage
(6) Culasse
(7) Dépression
(8) Air comprimé

**[A] Brancher avec la chambre de combustion**

# 1 MOTORKÖRPER

## [1] ZYLINDERBLOCK

Der Motor ist mit einem hochstabilen, tunnelartig ausgelegten Zylinderblock ausgerüstet. Außerdem sorgen ohne Zylinderbüchen, Zylinderlaufbuchsen für eine wirksame Kühlung sowie für eine verminderte Verformung und eine höhere Verschleißfestigkeit. Da für jeden Zylinder eine eigene Kammer vorgesehen ist, wird die Lärmentwicklung auf ein Mindestmaß reduziert.

## [2] ZYLINDERKOPF

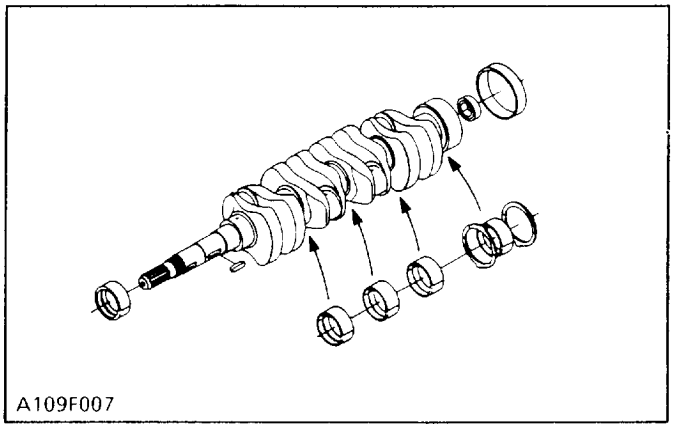
Die in Querstromausführung vorgesehenen Ein- und Auslaßschlitze sind beiderseits des Zylinderkopfes angeordnet. Da die Überlappungen der Ein- und Auslaßschlitze kleiner sind, als bei den Schlitzen anderer Ausführungen, die nur an einer Seite vorgesehen sind, wird eine Erwärmung der angesaugten Luft und eine Ausdehnung durch die erwärmten Abgase vermieden. Die kühle, hochdichte Ansaugluft trägt zu einer Verstärkung der Motorleistung bei. Außerdem wird die Gefahr einer Verformung des Zylinderkopfes durch erwärmte Abgase eingeschränkt, da die Ansaugöffnungen abwechselnd angeordnet sind. Die Verbrenungskammer ist als Das neue TVCS, von KUBOTA speziell entwickelte, Verbrennungskammer ausgelegt. Die angesaugte Luft wird durchwirbelt und sorgfältig mit dem Kraftstoff vermischt, wodurch die Verbrennung begünstigt und der Kraftstoffverbrauch eingeschränkt wird.

In der Verbrennungskammer ist die mit einer Drosselklappe versehene Einspritzdüse und die abgeschirmte, schnell heizende Glühkerze untergebracht. Diese Glühkerze sorgt für ein noch schnelleres Anspringen des Motors, selbst bei −15°C.

(1) Verbrennungskammer
(2) Einlaßkanal
(3) Auslaßkanal
(4) Düsen
(5) Glühkerze
(6) Zylinderkopf
(7) Vertiefung
(8) Druckluft

**[A] Mit dem Brennraum Verbinden**

## [3] CRANKSHAFT


A109F007

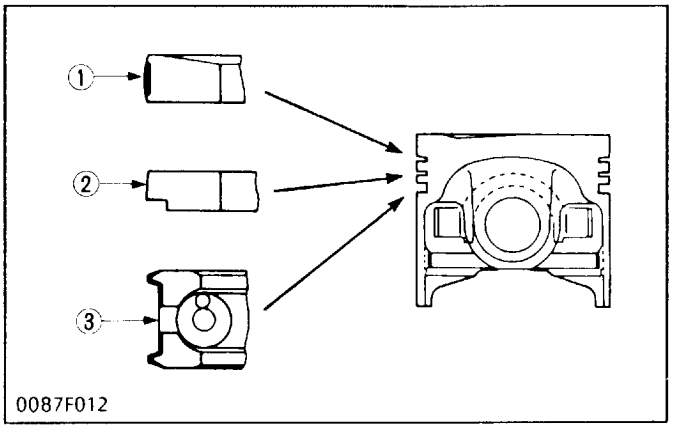
The crankshaft with the connecting rod converts the reciprocating motion of the piston into the rotating motion.

The crankshaft is made of tough special alloy steel, and the journals, pins and oil seal sliding portions are induction hardened to increase the hardness for higher wear resistance.

The front journal is supported by a solid type bearing, the intermediate journal by a split type, and the rear journal by a split type with thrust bearings.

The crankshaft is provided with an oil gallery, through which engine oil is fed to the crank pin portion, and lubricate it.

## [4] PISTON AND PISTON RINGS



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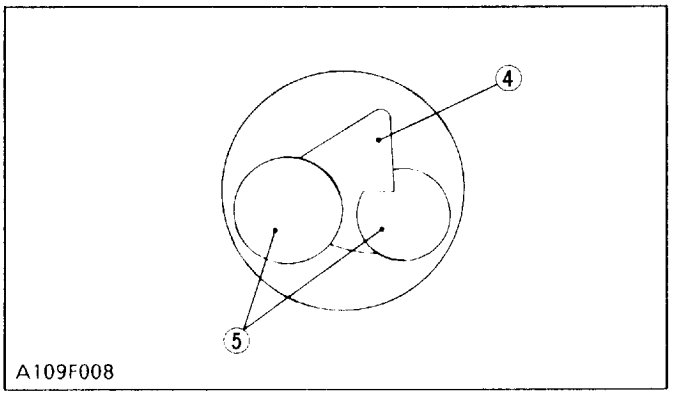


A109F008

The piston has a slightly oval shape when cold (in consideration of thermal expansion) and a concave head.

Three rings are installed in grooves in the piston.

The top ring (1) is a keystone type, which can stand against heavy loads, and the barrel face on the ring fits well to the cylinder wall.

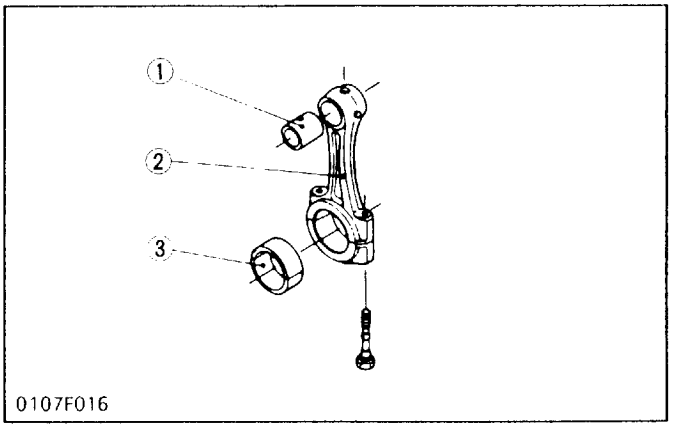
The second ring (2) is an undercut type, which effectively prevents the oil from being carried up.

The oil ring (3) has chamfered contact faces and an expander ring, which increase the pressure of the oil ring against the cylinder wall.

Several grooves are cut on the topland to help heat dissipate and to prevent scuffing.

(1) Top Ring
(2) Second Ring
(3) Oil Ring
(4) Depression
(5) Valve Recess

## [5] CONNECTING ROD



0107F016

Connecting rod (2) is used to connect the piston with the crankshaft. The big end of the connecting rod has a crank pin bearing (3) (split type) and the small end has a small end bushing (1) (solid type).

(1) Small End Bushing
(2) Connecting Rod
(3) Crank pin Bearing

## [3] VILEBREQUIN

Le vilebrequin avec la bielle convertit le mouvement alternatif du piston en mouvement rotatif.

Le vilebrequin est en acier allié spécial, et les tourillons, les axes et les parties de glissement de bague d'étanchéité sont trempés par induction afin d'augmenter la dureté pour une plus haute résistance à l'usure.

Le tourillon avant est supporté par un manchon du type solide, celui du milieu par un du type à fente et celui de derrière par un du type à fente avec des paliers de butée.

Le vilebrequin est muni d'une galerie d'huile à partir de laquelle l'huile moteur est distribuée au maneton de vilebrequin pour le graisser.

## [4] PISTON ET SEGMENTS

Le piston a une forme légèrement ovale à froid (en considération de la dilatation thermique) avec une tête concave.

Il y a trois segments glissés dans des cannelures sur le piston.

Le premier segment (1) est du type à claveau qui résiste aux lourdes charges et s'adapte parfaitement à la paroi du cylindre grâce à son profil arrondi.

Le deuxième segment (2) est du type conique qui empêchent parfaitement l'huile de rèmonter.

Le segment racleur (3) a des surfaces de contact chanfreinées et un anneau d'expansion qui fait augmenter la pression du segment racleur contre la paroi du cylindre.

Il y a plusieurs gorges creusées dans cordon supérieur de piston pour permettre la fuite de chaleur et réduire le frottement.

(1) Premier segment
(2) Deuxième segment
(3) Segment racleur
(4) Dépression
(5) Enpreinte de soupape

## [5] BIELLES

La bielle (2) est utilisée pour lier le piston au vilebrequin. La tête de bielle a un coussinet de tâte de bielle (3) (type à fente) et le pied de bielle a un bague (1) (type solide).

(1) Bague de pied de bielle
(2) Bielle
(3) Coussinet de tâte de bielle

## [3] KURBELWELLE

Die Kurbelwelle mit der Pleuelstange wandelt die Hubkolbenbewegung in eine Drehbewegung um.

Die Kurbelwelle ist aus einer zähen Edelstahllegierung gefertigt und die Gleitlagersitze, Kurbelzapfen und Öldichtungs-Gleitteile sind induktionsgehärtert, um die Verschleißfestigkeit zu erhöhen.

Gestützt wird der vordere Gleitlagersitz mit einer festen Lagerbuchse, der Zwischen-Gleitlagersitz mit einer geteilten Lagerbuchse und der hintere Gleitlagersitz mit einer geteilten mit Drucklager versehenen Lagerbuchse.

Die Kurbelwelle ist mit einem Saugraum ausgestattet, durch welchen das Motoröl zum Kurbelzapfenteil gespeist wird und diesen gleichzeitig ölt.

## [4] KOLBEN UND KOLBENRINGE

Der Kolben weist bei Kälte eine leicht ovale Form (in Anbetracht der Wärmeausdehnung) auf und hat einen gewölbten Kopf.

Drei Ringe sitzen in den vorgesehenen Nuten des Kolbens.

Der Oberer Ring (1) ist ein Trapez-ring, welcher hohen Beanspruchungen standhalten kann, und die trommelförmige Spannfläche des Rings paßt sich gut in die Zylinder-wandung ein.

Der Zweiter Ring (2) ist ein unter-schnittener Ring, weloher einen Anstieg des Öls wirkungsvoll verhindert.

Der Ölabstreifring (3) hat diagonal abgeschrägte Kontaktflächen und besitzt einen Ausdehnungspring Icher den Druck des Ölabstreifrings an die Zylinderwandung erhöht.

Die Nuten sind in dem oberen Kolbenabschnitt eingeschnitten, um die Wärme zu und Abrieb zu verhindern.

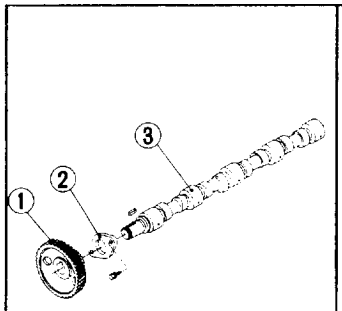
(1) Oberer Ring
(2) Zweiter Ring
(3) Ölabstreifring
(4) Vertiefung
(5) Ventilaussparung

## [5] PLEUELSTANGE

Die Pleuelstange (2) verbindet den Kolben mit der Kurbenwelle. Der Pleuelstangenfuß besitzt eine (geteilte) Pleuellagerschale (3) und der Pleuelstangenkopf eine (feste) Pleuelbuchse (1).

(1) Pleuelbuchse
(2) Pleuelstange
(3) Pleuellagerschale

## [6] CAMSHAFT



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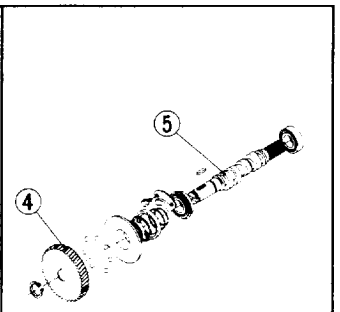
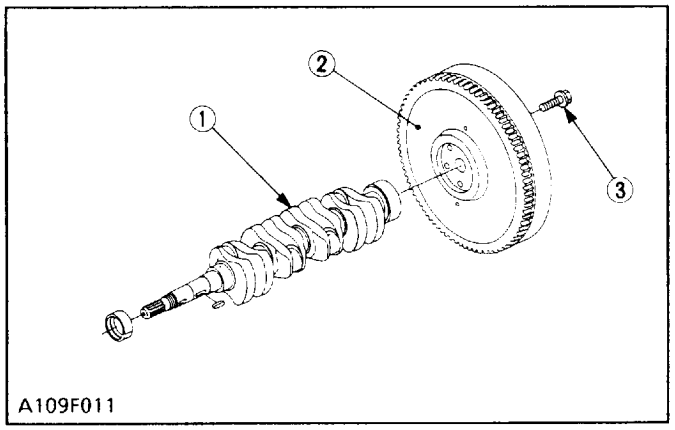


A109F010

The camshaft (3) is made of special cast iron and the journal and cam sections are chilled to resist wear. The journal sections are force-lubricated. The fuel camshaft (5) controls the reciprocating movement of the injection pump. The fuel camshaft is made of carbon steel and the cam sections are quenched and tempered to provide greater wear resistance.

(1) Cam Gear
(2) Camshaft Stopper
(3) Camshaft
(4) Injection Pump Gear
(5) Fuel Camshaft

## [7] FLYWHEEL



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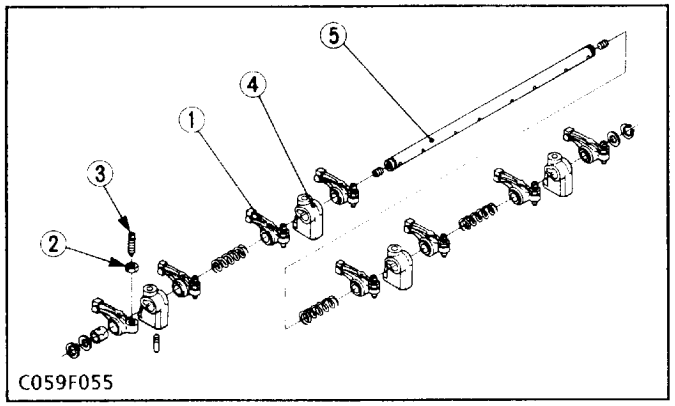
The flywheel stores the rotating force in the combustion stroke as inertial energy, reduces crankshaft rotating speed fluctuation and maintains the smooth rotating conditions.

The flywheel periphery is inscribed with the marks showing fuel injection timing angle lines and top dead center mark **TC**.

The flywheel has gear teeth around its outer rim, which mesh with the drive pinion of the starter.

(1) Crankshaft
(2) Flywheel
(3) Flywheel Screw

## [8] ROCKER ARM



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The rocker arm assembly includes the rocker arms (1), rocker arm brackets (4) and rocker arm shaft (5) push rods to an open/close movement of the inlet and exhaust valves.

Lubricating oil pressurized through the bracket to the rocker arm shaft, which serves as a fulcrum so that the rocker arm and the entire system are lubricated sufficiently.

(1) Rocker Arm
(2) Lock Nut
(3) Adjusting Screw
(4) Rocker Arm Bracket
(5) Rocker Arm Shaft

## [6] ARBRE A CAMES ET CAME DE POMPE D'ALIMENTATION

L'arbre à cames (3) est réalisé en fonte spéciale, tandis que les tourillons et les cames sont trempés afin de résister à l'usure. La lubrification des sections tourillon est forcée. L'arbre à came d'alimentation (5) commande le mouvement alternatif de la pompe d'injection. L'arbre à came d'alimentation est en acier au carbone et la section de came est trempée, ce qui assure une meilleure résistance à l'usure.

(1) Pignon à cames
(2) Butée d'arbre à cames
(3) Arbre à cames
(4) Pignon de pompe d'injection
(5) Arbre à came d'alimentation

## [7] VOLANT

Le volant retient la force de rotation, par force d'inertie, lors de la course d'explosion. Il réduit les variations du régime de rotation du vilebrequin et assure une rotation régulière.

On trouvera sur la circonférence du volant le repère servant au réglage de l'injection de carburant et le repère correspondant au point mort haut **TC**.

Le volant est doté de dents d'engrenage sur la peripherie de sa jante extérieure qui sengrenent du démarreur.

(1) Vilebrequin
(2) Volant
(3) Vis de bielle

## [8] CULBUTEURS

La rampe de culbuteurs comprend les culbuteurs (1), les supports de culbuteurs (4) et l'axe de culbuteurs (5); elle transforme le mouvement alternatif des tiges de poussoirs en un mouvement d'ouverture/fermeture des soupapes d'admission et d'échappement.

L'huile de lubrification est envoyée sous pression à travers les supports vers les culbuteurs, qui servent de pivot, de manière à ce que les culbuteur et le système tout entier soient correctement lubrifiés.

(1) Culbuteur
(2) Contre-écrou
(3) Vis de réglage
(4) Support de culbuteur
(5) Axe de culbuteurs

## [6] NOCKENWELLE UND KRAFTSTOFF-NOCKENWELLE

Die Nockenwelle (3) ist aus speziellem Gußeisen gefertigt. Die Zapfen- und Nockenabschnitte sind gehärtet und bieten eine erhöhte Verschleißfestigkeit. Die Zapfenabschnitte sind druckgeschmiert. Die Kraftstoff-Nockenwelle (5) sorgt für die Steuerung der Hin. Sie ist mit einer Stahlkugel zur Steuerung des Reglers ausgerüstet. Die Kraftstoff-Nockenwelle ist aus Kohlenstoffstahl gefertigt. Die Nockenabschnitte sind vergütet und bieten eine erhöhte Verschleißfestigkeit.

(1) Nockengetriebe
(2) Nockenwellenbegrenzer
(3) Nockenwelle
(4) Einspritzpumpe
(5) Kraftstoff-Nockenwelle

## [7] SCHWUNGRAD

Das Schwungrad speichert die Drehkraft des Verbrennungstakt als Masseträgheit und verringert die Umdrehungsschwankungen der Kurbelwelle. Daher sorgt es für gleichmäßiges Drehen des Motors.

Die Außenfläche des Schwungrads ist mit den Einstellmarkierungen für den Einspritzzeitpunkt und für den oberen Totpunkt **TC** versehen.

Am Außenkranz des Schwungrads sind Radzähne, die mit deden des Ausgleichkegelrads des Anlassers einrasten.

(1) Kurbelwelle
(2) Schwungrad
(3) Schwungrad Schrauden

## [8] KIPPHEBEL

Die Kipphebelanordnung beinhaltet die Kipphebel (1), die Kipphebelböcke (4) und die Kipphebelachse (5). Sie sorgt für die Umsetzung der Hin- und Herbewegung der Stößelstangen in einer Auf/Zu-Bewegung der Ein- und Auslaßventile.

Das Schmierungsöl wird durch den Bock zur Kipphebelachse gepreßt, die als Drehpunkt dient, so daß die Kipphebel und das gesamte System ausreichend geschmiert werden.

(1) Kipphebel
(2) Gegenmutter
(3) Stellschraube
(4) Kipphebelbock
(5) Kipphebelachse

# 2 LUBRICATING SYSTEM

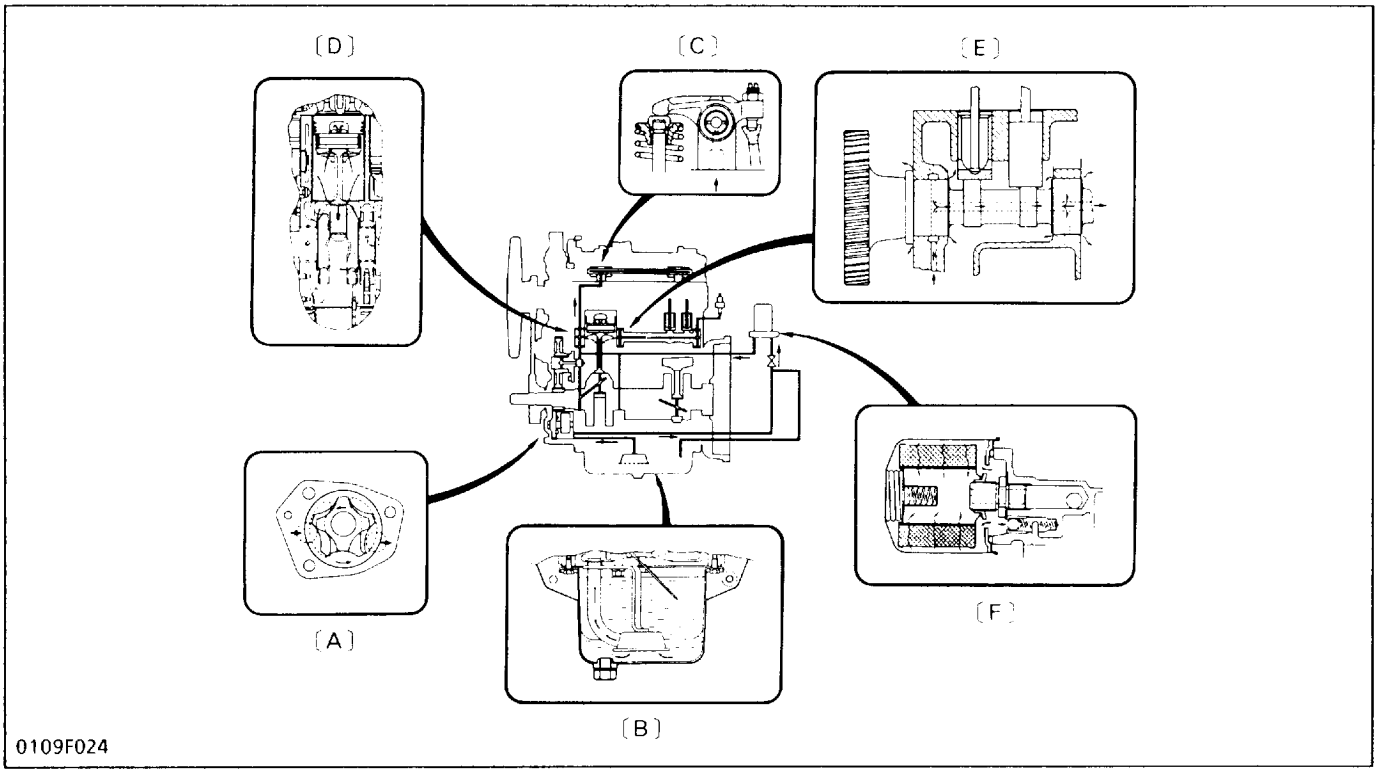
# 2 SYSTEME DE LUBRIFICATION

# 2 SCHMIERUNGS-SYSTEM

## [1] GENERAL

## [1] GENERALITES

## [1] ALLGEMEINES




This engine's lubricating system consists of oil strainer, oil pump, relief valve, oil filter cartridge and oil switch. The oil pump sucks lubricating oil from the oil pan through the oil strainer and the oil flows down to the filter cartridge, where it is further filtered. Then the oil is forced to crankshaft, connecting rods, idle gear, camshaft and rocker arm shaft to lubricate each part. Some part of oil, splashed by the crankshaft or leaking and dropping from gaps of each part, lubricates these parts: pistons, cylinders, small ends of connecting rods, tappets, pushrods, inlet and exhaust valves and timing gears.

[A] Oil Pump
[B] Oil Strainer
[C] Rocker Arm and Rocker Arm Shaft
[D] Piston
[E] Camshaft
[F] Oil Filter Cartridge and Relief Valve

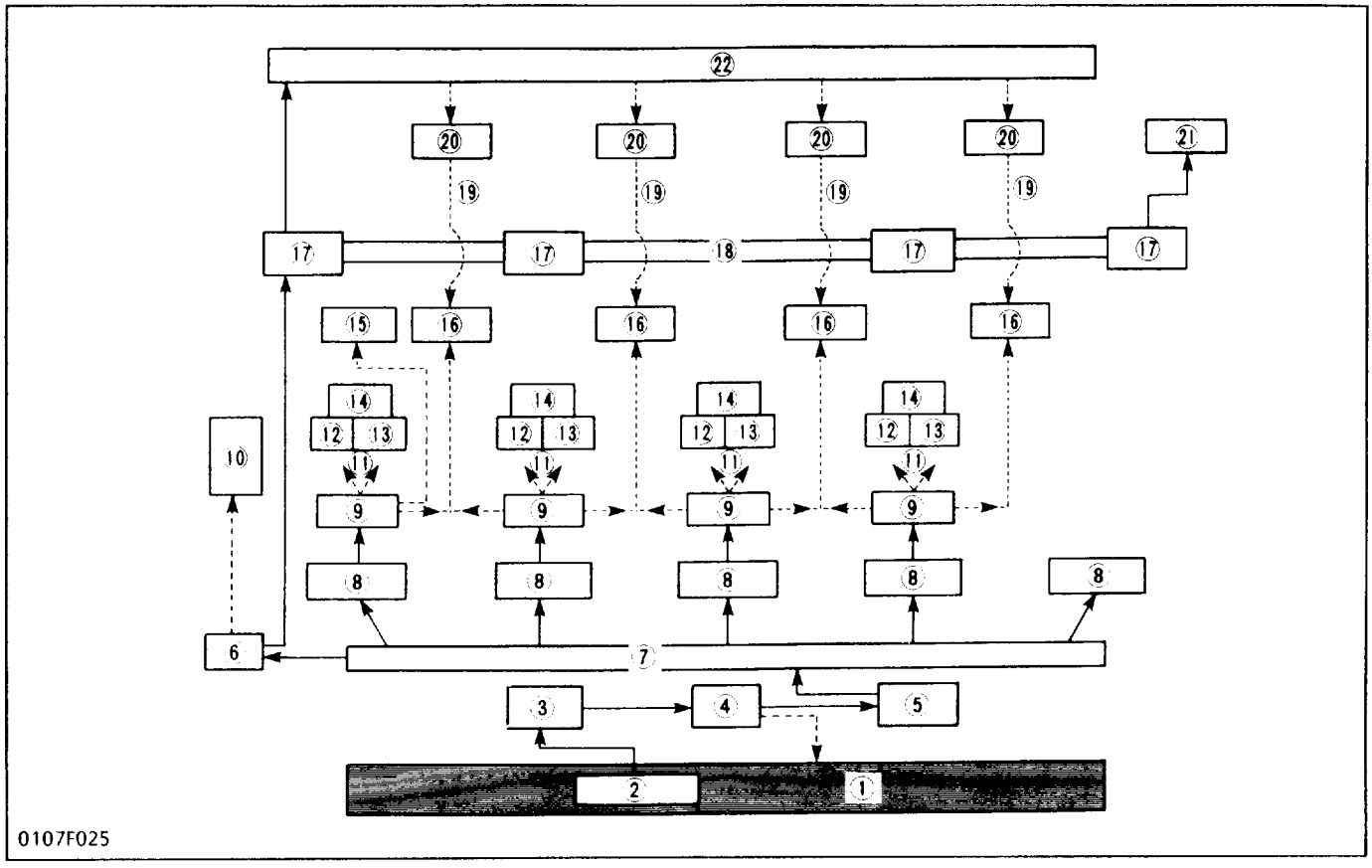
Le système de lubrification du moteur se compose d'une crépine, d'une pompe à huile, d'une soupape de décharge, d'un filtre à huile à cartouche et d'un manocontact de pression d'huile. La pompe à huile aspire l'huile du carter par l'intermédiaire de la crépine et la force au travers de la cartouche filtre, qui en assure une filtration plus parfaite. Ensuite, l'huile est forcée vers le vilebrequin, les bielles, le pignon de renvoi, l'arbre à cames et l'axe de culbuteurs, afin de lubrifier toutes ces pièces.

L'huile éclaboussée par le vilebrequin ou dégouttant des orifices des différentes pièces lubrifie les pièces suivantes: pistons, cylindres, pied de bielle et bielle, poussoirs, tiges de poussoirs, soupapes d'admission et d'échappement et pignons de distribution.

[A] Pompe à huile
[B] Crépine
[C] Culbuteur et axe de culbuteur
[D] Piston
[E] Arbre à cames
[F] Cartouche de filtre à huile et soupape de décharge

Dieses Motorschmierungssystem umfaßt den Ölfilter, die Ölpumpe, das Überdruckventil, die Ölfilterpatrone und den Ölschalter. Die Ölpumpe saugt das Schmierungsöl aus der Ölwanne durch den Ölfilter an. Das Öl fließt sodann in die Filterpatrone, wo es weiter gefiltert wird. Anschließend wird das Öl zur Kurbelwelle sowie zu den Pleuelstangen, dem Leerlaufgetriebe, der Nockenwelle und der Kipphebelachse gepreßt und sorgt für dir Schmierung eines jeden dieser Teile. Ein Teil des Öls, der von der Kurbelwelle abgeschleudert wird oder an den Zwischenräumen der Teile austritt und heruntertropft, übernimmt die Schmierung dieser Teile: Kolben, Zylinder, Pleuelstangenkopf, Stößel, Stößelstangen, Ein- und Auslaßventile und Steuerungen.

[A] Ölpumpe
[B] Ölfilter
[C] Kipphebel und Kipphebelachse
[D] Kolben
[E] Nockenwelle
[F] Ölfilterpatrone und Überdruckventil




## Engine Oil Flow

(1) Oil Pan
(2) Oil Strainer
(3) Oil Pump
(4) Relief Valve
(5) Oil Filter Cartridge
(6) Idle Gear
(7) Main Oil Gallery
(8) Main Bearing
(9) Big End
(10) Timing Gear
(11) Splash
(12) Bore
(13) Small End
(14) Piston
(15) Fuel Camshaft
(16) Tappets
(17) Camshaft Bearing
(18) Camshaft
(19) Drain
(20) Rocker Arm
(21) Oil Switch
(22) Rocker Arm Shaft

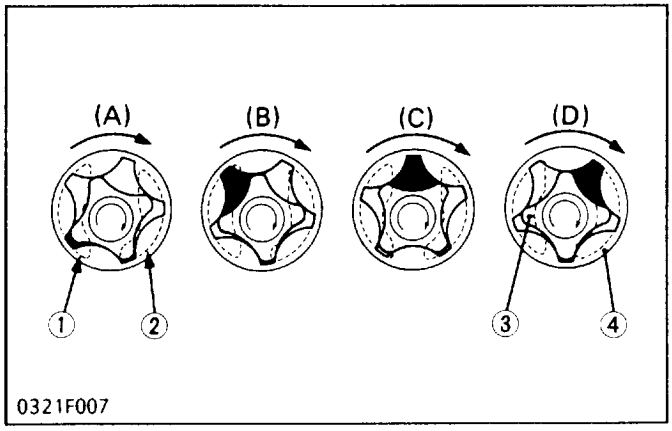
## circuit d'huile

(1) Carter d'huile
(2) Crépine
(3) Pompe à huile
(4) Soupape de décharge
(5) Cartouche de filtre à huile
(6) Pignon de renvoi
(7) Rampe de distribution d'huile
(8) Palier principal
(9) Tête de bielle
(10) Pignon de distribution
(11) Eclaboussement
(12) Alésage
(13) Pied de bielle
(14) Piston
(15) Arbre à cames d'alimentation
(16) Poussoirs
(17) Paliers d'arbre à cames
(18) Arbre à cames
(19) Retour
(20) Culbuteur
(21) Manocontact de pression d'huile
(22) Arbre de culbuteur

## Motorölstrom

(1) Ölwanne
(2) Ölfilter
(3) Ölpumpe
(4) Überdruckventil
(5) Ölfilterpatrone
(6) Leerlaufgetriebe
(7) Hauptölkanal
(8) Hauptlager
(9) Pleuelstangenfuß
(10) Steuerung
(11) Ölspritzer
(12) Bohrung
(13) Pleuelstangenkopf
(14) Kolben
(15) Kraftstoff-Nockenwelle
(16) Stößel
(17) Nockenwellenlager
(18) Nockenwelle
(19) Ablauf
(20) Kipphebel
(21) Ölschalter
(22) Kipphebelachse

## [2] OIL PUMP



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The oil pump in this engine is a trochoid pump.

Inside the pump body, the 4 lobe inner rotor (3) is eccentrically engaged with the 5 lobe outer rotor (4). The inner rotor is driven by the crankshaft via gears, which in turn rotate the outer rotor.

When the inner rotor rotates, the outer rotor also rotates in the same direction.

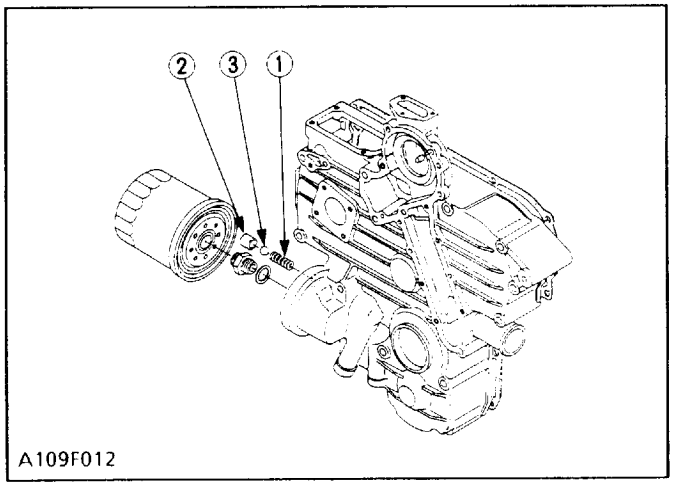
The two rotors have differences in lobe number and center, which generates space between lobes as shown in the figure.

At position (A), there is little space between lobes in the inlet port. As the rotor rotates towards position (B), the space between the lobes becomes larger, creating a negative pressure which sucks in oil.

Outside the inlet port, as shown in position (C), the space between the lobes becomes gradually smaller, and oil pressure increases. At position (D), oil is discharged from the outlet port.

(1) Inlet
(2) Outlet
(3) Inner Rotor
(4) Outer Rotor

## [3] RELIEF VALVE



A109F012

The relief valve prevents the damage of the lubricating system due to high oil pressure. This relief valve is a ball type direct acting relief valve, and is best suited for low pressures.

When oil pressure exceeds the upper limit, the ball (3) is pushed back by the pressure oil and the oil escapes.

(1) Spring
(2) Valve Seat
(3) Ball

## [2] POMPE A HUILE

La pompe à huile de ce moteur est une pompe cycloïde.

A l'intérieur du corps de pompe, un rotor intérieur à quatre lobes (3) est engrené de manière excentrique avec un rotor extérieur à cinq lobes (4). Le rotor intérieur est entraîné par le vilebrequin, par l'intermédiaire de pignons qui entraînent à leur tour le rotor extérieur.

Lorsque le rotor intérieur tourne, le rotor extérieur tourne également et dans la même direction.

Les deux rotors ont un centre et un nombre de lobes différents, ce qui engendre un espace entre les lobes comme l'indique la figure. En position (A), il y a peu d'espace entre les lobes du côté de l'orifice d'entrée. Lorsque le rotor tourne vers la position (B) l'espace entre les lobes s'accroît ce qui crée une dépression aspirant l'huile.

A l'extérieur de la lumière d'entrée indiquée en position (C), l'espace entre les lobes diminue progressivement, et la pression d'huile augmente. En position (D), l'huile est refoulée par l'orifice de sortie.

(1) Entrée
(2) Sortie
(3) Rotor intérieur
(4) Rotor extérieur

## [3] SOUPAPE DE DECHARGE

La soupape de décharge évite les détériorations du circuit de lubrification due à une pression trop élevée de l'huile. Cette soupape est du type direct à bille, qui est le mieux adapté aux basses pressions.

Lorsque la pression d'huile dépasse la limite supérieure, la bille (3) est repoussée par la pression de l'huile si bien que cette dernière peut s'échapper.

(1) Ressort
(2) Siège de soupape
(3) Bille

## [2] ÖLPUMPE

Die in diesem Motor vorgesehene Ölpumpe ist als Trochoidpumpe ausgelegt.

Innerhalb des Pumpengehäuses ist das inneres 4-Flügelrad (3) exzentrisch mit dem äußeres 5-Flügelrad (4) gekoppelt. Das innere Flügelrad wird über Getriebe durch die Kurbelwelle angetrieben, die ihrerseits für die Umdrehung des äußeren Flügelrades sorgt.

Wenn das innere Flügelrad dreht, so dreht auch das äußere Flügelrad in gleicher Richtung.

Die beiden Flügelräder verfügen über eine unterschiedliche Anzahl an Flügeln, sowieüber einen unterschiedlichen Mittel-punkt, der für einen Abstand zwischen den Flügeln, wie in der Abbildung gezeigt, sorgt. In position (A) ist nur ein geringer Abstand zwischen denFlügeln am Einlaßschlitz vorhanden. Wenn das Flügelrad in Position (B) dreht, so vergrößert sich der Abstand zwischen den Flügeln und schafft einen Negativdruck, durch den das Öl angesaugt wird.

Außerhalb des Einlaßschlitzes wird der Abstand zwischen den Flügeln, wie in Position (C) gezeigt, allmählich geringer und der Öldruck steigt an. In Position (D) wird das Öl über den Auslaßschlitz abgeführt.

(1) Einlaß
(2) Auslaß
(3) Inneres Flügelrad
(4) Äußeres Flügelrad

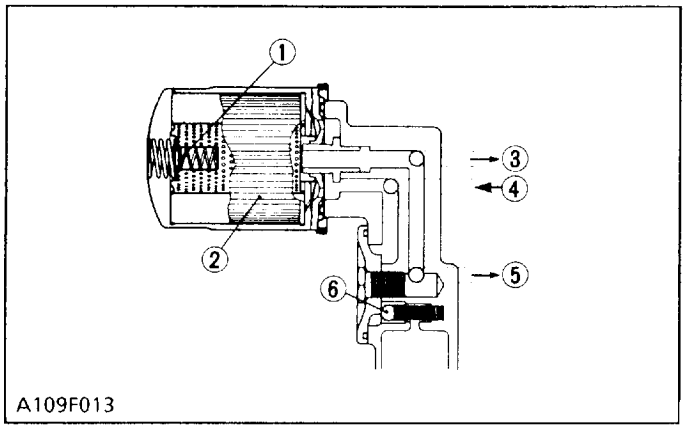
## [3] ÜBERDRUCKVENTIL

Das Überdruckventil verhindert eine Beschädigung des Schmierungssystems infolge hohen Öldrucks. Dieses Überdruckventil ist als unmittelbar wirkendes Kugelventil ausgelegt und insbesondere für niederen Druck geeignet.

Wenn der Öldruck die obere Grenze überschreitet, wird die Kugel (3) durch den Öldruck zurückgeschoben, so daß das Öl austritt.

(1) Feder
(2) Ventilsitz
(3) Kugel

## [4] OIL FILTER CARTRIDGE



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Oil filter, relief valve

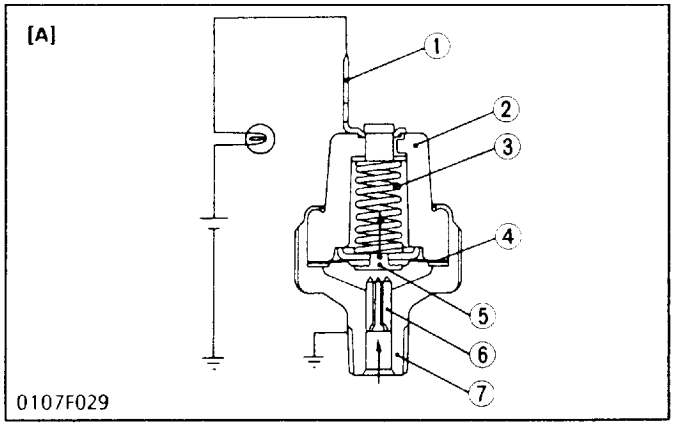
Engine oil being fed from the oil pump is filtered through the filter element and then supplied to the related parts. A relief valve is provided just before the oil filter in order to maintain the oil at a constant pressure and to let excessive oil flow into the oil pan.

The oil comes into the filter element through its outer surface and out of its inner surface.

A bypass valve is provided inside the filter. When the element gets dirty and the oil starts flowing against a resistance of 1 kgf / $cm^2$ or higher, the oil does not flow thorugh the element, but through this bypass valve.

(1) Bypass Valve
(2) Filter Element
(3) To idle gear, cam shaft and rocker arm shaft
(4) From oil pump
(5) To crank shaft journal and crank pin
(6) Relief valve

## [5] OIL PRESSURE SWITCH



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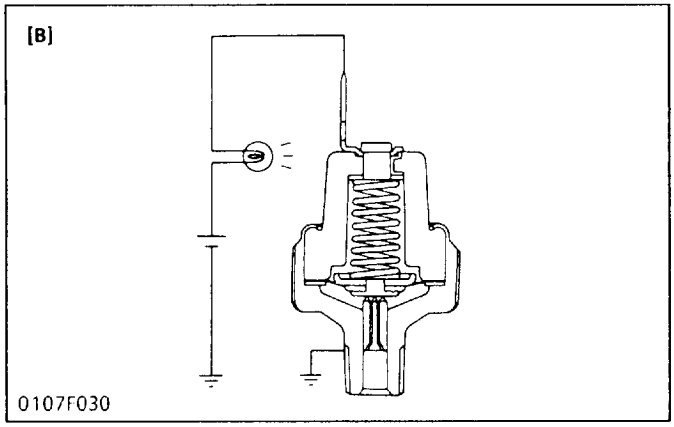

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The oil pressure switch is mounted on the cylinder-block, to warn the operator that the lubricating oil pressure is poor.

If the oil pressure falls below 49 kPa (0.5 kgf/$cm^2$, 7 psi), the oil warning lamp will light up, warning the operator. In this case, stop the engine immediately and check the cause of pressure drop.

**[A] At Proper Oil Pressure**
**[B] At Oil Pressures of 49 kPa (0.5 kgf/$cm^2$, 7 psi) or Less**

(1) Terminal
(2) Insulator
(3) Spring
(4) Diaphragm
(5) Contact Rivet
(6) Contact
(7) Oil Switch Body

## [4] CARTOUCHE DE FILTRE A HUILE

Filtre à huile, soupape de détente

L'huile à moteur ayant été distribuée à la pompe à huile est filtrée à travers l'élément du filtre et fournie ensuite aux pièces qui s'y rapportent. Une soupape de détente est installée juste avant le filtre à huile de façon à maintenir l'huile à une pression constante et à laisser l'huile en excès s'écouler dans le carter inférieur.

L'huile pénètre dans l'élément du filtre par l'intermédiaire de sa surface extérieure et ressort de sa surface intérieure.

Un clapet de dérivation est installé à l'intérieur du filtre. Lorsque l'élément devient sale et que l'huile commence à circuler par rapport à une résistance de 1 kgf / $cm^2$ ou plus, l'huil ne s'écoule pas à travers l'élément, mais à travers le clapet de dérivation.

(1) Soupape de dérivation
(2) Elément de filtre
(3) Au pignon intermédiaire, à l'arbre à cames et à l'axe des culbuteurs
(4) A partir de la pompe à huile
(5) A la portée du vilebrequin et au maneton
(6) Clapet de decharge

## [5] MANOCONTACT DE PRESSION D'HUILE

Le manocontact de pression d'huile, monté sur le bloc-cylindress, est destiné à prévenir l'opérateur lorsque la pression d'huile de lubrification est trop basse.

Si la pression tombe en-dessous de 49 kPa (0,5 kgf/$cm^2$), le témoin de pression d'huile s'allumera, ce qui prévient l'opérateur. Dans ce cas, mettre immédiatement le moteur à l'arrêt et rechercher le cause de la chute de pression.

**[A] Lorsque la pression d'huile est adéquate**
**[B] Lorsque la pression d'huile est de 49 kPa (0,5 kgf/$cm^2$, 0,49 bar), ou moins**

(1) Borne
(2) Isolant
(3) Ressort
(4) Diaphragme
(5) Doigt de contact
(6) Contact
(7) Corps de manocontact

## [4] ÖLFILTERPATRONE

Ölfilter, Überdruckventil

Das von der Ölpumpe geförderte Motoröl durchläuft den Ölfiltereinsatz und erreicht die zu schmierenden Teile. Vor dem Ölfilter ist ein Überdruckventil eingebaut, das für einen gleichmäßigen Öldruck und einen Rückfluß des überschüssigen Öls zur Ölwanne sorgt.

Das Motoröl durchströmt den Ölfiltereinsatz von außen nach innen.

Im Innern des Ölfilters befindet sich ein Bypass-Ventil. Wenn durch starke Verschmutzung der interne widerstand im Ölfiltereinsatz so stark ansteigt, daß ein Wert von 1 kgf / $cm^2$ oder mehr erreicht wird, kann der Ölstrom den Ölfiltereinsatz nicht mehr durchfließen, sondern strömt durch das Bypass-Ventil.

(1) Umlaufventil
(2) Filtereinsatz
(3) Zum Zwischenrad, zur Nockenwelle und zur Kipphebelwelle
(4) Von der Ölpumpe
(5) Zum Kurbelwellen-Lagerzapfen und Hauptlagerzapfen
(6) Sicherheitsventil

## [5] ÖLDRUCKSCHALTER

Der Öldruckschalter ist auf dem Zylinderblock angeordnet und zeigt einen Abfall des Schmierungs-öldruckes an.

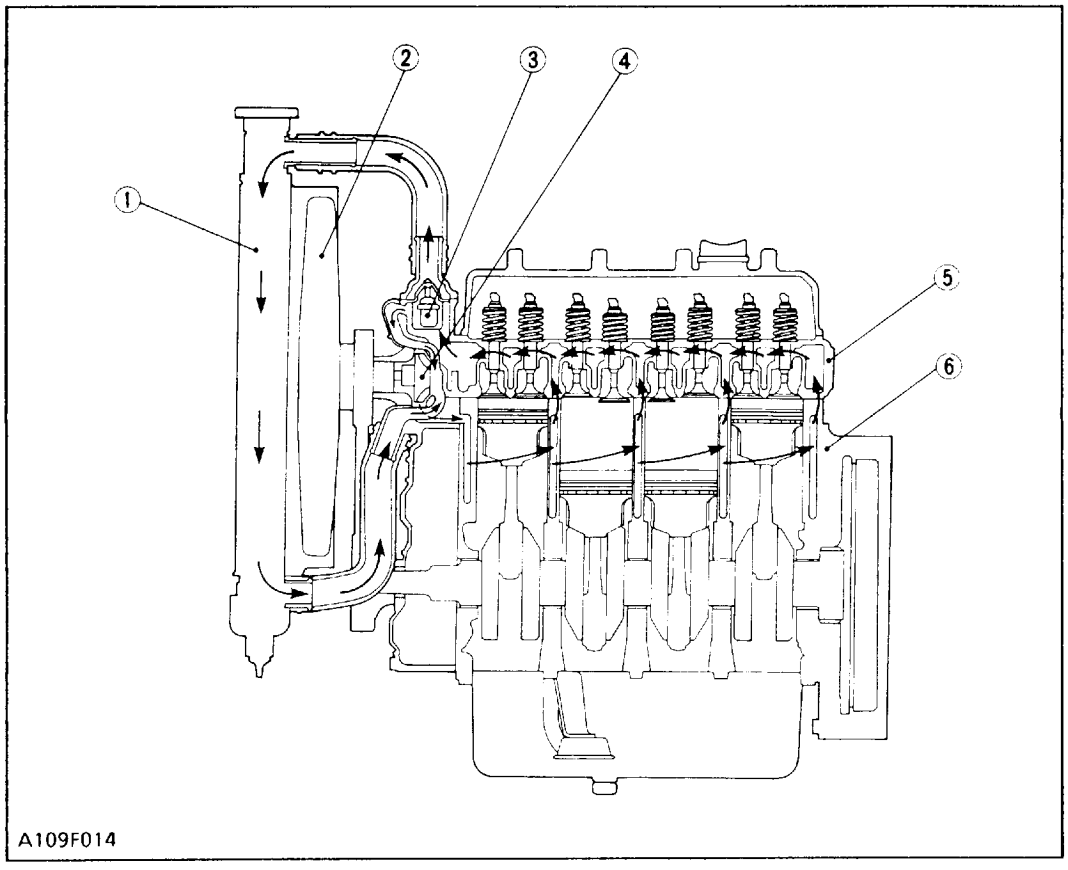
Wenn der Öldruck unter 49 kPa (0,5 kp/$cm^2$) abfällt, leuchtet die Öldruck-warnlampe auf, wodurch die Bedienungsperson gewarnt wird. In diesem Fall ist der Motor sofort einzuschaltenund die Ursache des Druckabfalls zu überprüfen.

**[A] Bei richtigem Öldruck**
**[B] Bei Öldruck 49 kPa (0.5 kp/$cm^2$, 0,49 bar) oder weniger**

(1) Klemme
(2) Isolierstoff
(3) Feder
(4) Membrane
(5) Kontaktniet
(6) Kontakt
(7) Ölschalterkörper

# 3 COOLING SYSTEM

## [1] GENERAL



A109F014

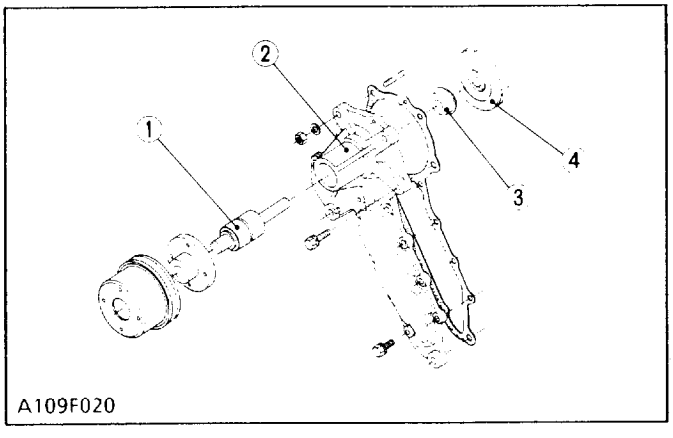
(1) Radiator
(2) Suction Fan
(3) Thermostat
(4) Water Pump
(5) Cylinder Head
(6) Cylinder Block

The cooling system consists of a radiator (1) (not included in the basic engine), centrifugal water pump (4), suction fan (2) and thermostat (3).

The water is cooled through the radiator core, and the fan set behind the radiator pulls cooling air through the core to improve cooling.

The water pump sucks the cooled water, forces it into the cylinder block and draws out the hot water. Then the cooling is repeated. Furthermore, to control temperature of water, a thermostat is provided in the system. When the thermostat opens, the water moves directly to radiator, but when it closes, the water moves toward the water pump through the bypass between thermostat and water pump. The opening temperature of thermostat is approx. 71°C (159.8°F).

## [2] WATER PUMP



A109F020

The water pump is driven by the crankshaft via a V-belt. Water cooled in the radiator is sucked into the water pump from its lower portion and is sent from the center of the water pump impeller (4) radially outward into the water jacket in the crankcase.

(1) Bearing Unit
(2) Water Pump Body
(3) Mechanical Seal
(4) Water Pump Impeller

# 3 SYSTEM DE REFROIDISSEMENT

## [1] GENERALITES

Le système de refroidissement se compose d'un radiateur (1) (non compris dans le moteur de base), d'une pompe à eau centrifuge (4), d'un ventilateur aspirant (2) et d'un thermostat (3).

L'eau est refroidie en passant dans les éléments du radiateur, et le ventilateur placé derrière le radiateur aspire l'air de refroidissement à travers les éléments, pour améliorer le refroidissement.

La pompe à eau aspire l'eau refroidie, la force dans le bloc-moteur et refoule l'eau réchauffée. Ce cycle de refroidissement est alors répété. Pour réguler la température de l'eau, un thermostat est monté dans le système. Lorsque le thermostat s'ouvre, l'eau est dirigée directement vers le radiateur; lorsqu'il est fermé, l'eau se dirige vers la pompe à eau, par la dérivation qui se trouve entre le thermostat et la pompe à eau. La température d'ouverture du thermostat est de 71°C environ.

(1) Radiateur
(2) Ventilateur aspirant
(3) Thermostat
(4) Pompe à eau
(5) Culasse
(6) Bloc-moteur

## [2] POMPE A EAU

La pompe à eau est entraînée par le vilebrequin par l'intermédiaire d'une courroie trapézoidale. L'eau refroidie dans le radiateur est aspirée dans la pompe à eau à partir de la partie inférieure du radiateur et renvoyée depuis le centre de la tubine (4) vers l'extérieur, dans la chemise de refroidissement du bloc-moteur.

(1) Palier
(2) Corps de pompe à eau
(3) Joint mécanique
(4) Turbine de pompe à eau

# 3 KÜHLUNGSSYSTEM

## [1] ALLGEMEINES

Das Kühlungssystem umfaßt einen Kühler (1) (nicht im Basismotor enthalten), eine Zentrifugalwasserpumpe (4), ein Saugventilator (2) und einen Thermostat (3).

Das Wasser wird im Radiatorkern abgekühlt und die Kühluft durch den Radiatorkern mit Hilfe des hinter dem Kühler angeordneten Ventilators abgezogen. Hierdurch wird eine bessere Kühlung erzielt.

Die Wasserpumpe saugt das gekühlte Wasser an, drückt es in den Motorblock und zieht das heiße Wasser heraus. Dann wird der Kühlvorgang wiederholt. Zur Überwachung der Wassertemperatur ist außerdem ein Thermostats in diesem Kreislauf vorgesehen. Bei Öffnung des Thermostats wird das Wasser direkt zum Kühler geführt. Wenn der Thermostat schließt, wird das Wasser der Wasserpumpe über die Umgehungsleitung zwischen Thermostat und Wasserpumpe zugeführt. Die Öffnungstemperatur des Thermostats beträgt etwa 71°C.

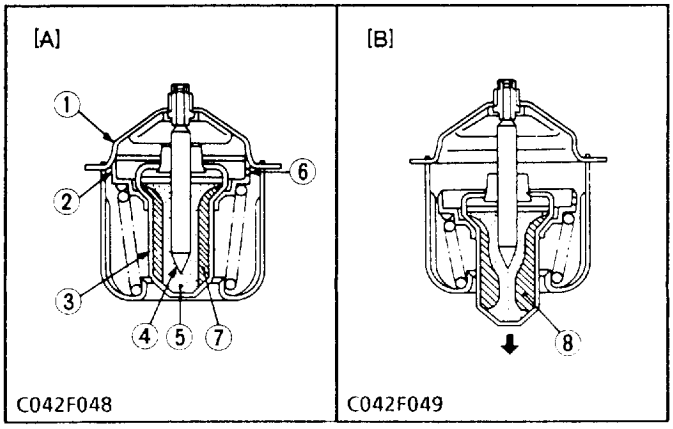
(1) Kühler
(2) Saugventilator
(3) Thermostat
(4) Wasserpumpe
(5) Zylinderkopf
(6) Motorblock

## [2] WASSERPUMPE

Die Wasserpumpe wird durch die Kurbelwelle über einen Keilriemen angetrieben. Das im Kühler abgekühlte Wasser wird im unteren Teil der Wasserpumpe angesaugt und von der Mitte des Flügelrades (4) der Wasserpumpe ausradial in den Wasserkühlmantel des Kurbelgehäuses geführt.

(1) Lagereinheit
(2) Wasserpumpengehäuse
(3) Mechanische Dichtung
(4) Wasserpumpenflügelrad

## [3] THERMOSTAT



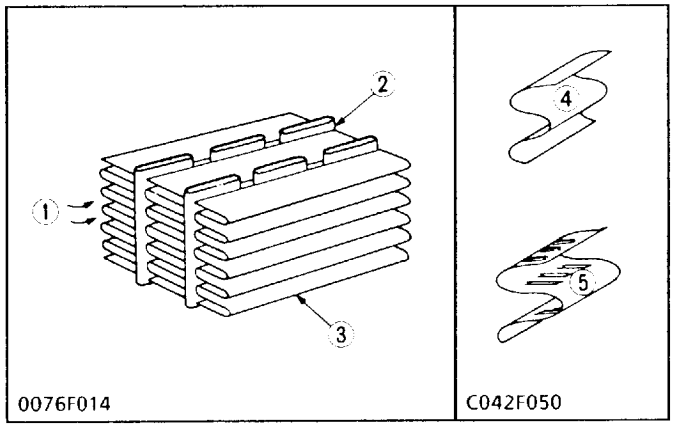

(1) Seat
(2) Valve
(3) Pellet
(4) Spindle
(5) Synthetic Rubber
(6) Leak Hole
(7) Wax (solid)
(8) Wax (liquid)

The thermostat maintains the cooling water at correct temperature. KUBOTA's engine uses a wax pellet type thermostat. Wax is enclosed in the pellet. The wax is solid at low temperatures, but turns liquid at high temperatures, expands and opens the valve.

(A) At low temperatures (lower than 71°C (159.8°F) ). As the thermostat is closed, cooling water circulates in the engine through the water return pipe without running to the radiator. Air in the water jacket escapes to the radiator side through leak hole (6) of the thermostat.

(B) At high temperatures (higher than 71°C (159.8°F). When the temperature of cooling water exceeds 71°C (159.8°F), wax in the pellet turns liquid and expands. Because the spindle (4) is fixed, the pellet (3) is lowered, the valve (2) is separated from the seat (1), and then cooling water is sent to the radiator.

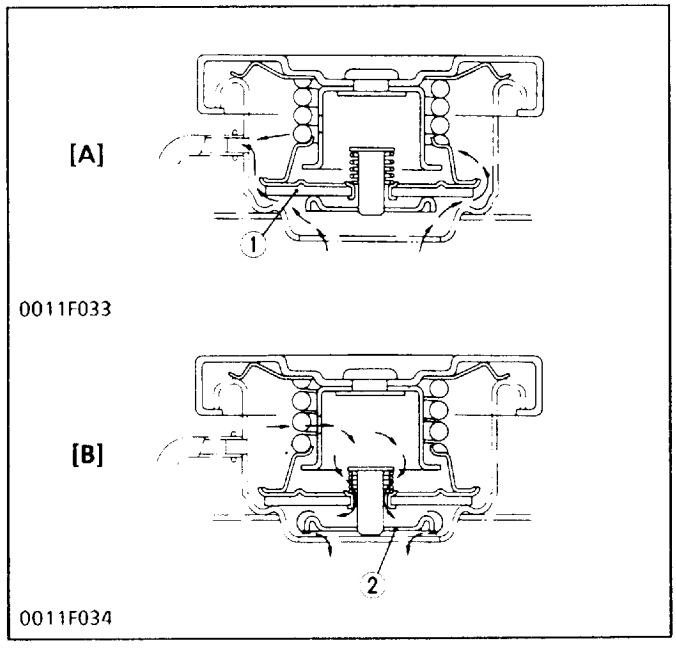
## [4] RADIATOR (not included in the basic engine)




The radiator core consists of water carrying tubes and fins (3) at a right angle to the tubes (2). Heat of hot water in the tubes is radiated from the tube walls and fins. KUBOTA's engine uses corrugated fin type core which has a light weight and high heat transfer rate. Clogging is minimized by the louverless corrugated fins.

(1) Cooling Air
(2) Tube
(3) Fin
(4) Louverless Corrugated Fin
(5) Louvered Corrugated Fin

## [5] RADIATOR CAP




The radiator cap is for sustaining the internal pressure of the cooling system at the specified level 88 kPa (0.9 kgf/cm$^2$, 13 psi) when the engine is in operation. The cap consists of a pressure valve (1) a vacuum valve (2), valve springs, gasket, etc.

Cooling water is pressurized by thermal expansion of steam, and as its boiling temperature rises, generation of air bubbles will be suppressed. (Air bubbles in cooling water lowers the cooling effect.)

**[A] When radiator internal pressure is high**
**[B] When radiator internal pressure is negative**

(1) Pressure Valve
(2) Vacuum Valve

## [3] THERMOSTAT

le thermostat maintient l'eau de refroidissement à une température correcte. Les moteurs KUBOTA sont équipés de thermostat à dilatation, comprenant une partie contenant de la cire. La cire est solide à basse température et se liquifie à température élevée, gonfle et ouvre le clapet.

A) A basse température (en-dessous de 71°C).
Lorsque le thermostat est fermé, l'eau de refroidissement circule dans le moteur par le conduit de retour, sans passer par le radiateur. L'air qui se trouve dans la chemise de refroidissement s'échappe du côté radiateur par le trou d'échappement (6) du thermostat.

B) A haute température (au-dessus de 71°C).
Lorsque la température de l'eau de refroidissement dépasse 71°C, la cire dans la pastille se liquifie et gonfle. Comme la tige (4) est fixe, la pastille (3) s'abaisse, le clapet (2) est séparé du siège (1) et l'eau est dirigée vers le radiateur.

(1) Siège
(2) Clapet
(3) Pastille
(4) Tige
(5) Elastomère
(6) Trou d'échappement
(7) Cire (solide)
(8) Cire (liquide)

## [4] RADIATEUR (non compris dans le moteur de base)

Les éléments du radiateur sont composés de tubes à eau et d'ailettes (3) montées perpendiculairement sur les tubes (2). La chaleur de l'eau dans les tubes est dissipée dans les parois des tubes et les ailettes. Sur le moteur KUBOTA, on trouve des éléments à ailettes légères et présentant un taux d'échange thermique très élevé. Les risquent d'obstruction sont réduits au minimum parce que les ailettes n'ont pas de fentes.

(1) Air de refroidissement
(2) Tube
(3) Ailette
(4) Ailette sans fentes
(5) Ailette à fentes

## [5] BOUCHON DU RADIATEUR

Le bouchon de radiateur est destiné à maintenir la pression interne du circuit de refroidissement à une valeur spécifiée de 88 kPa (0,9 kgf/cm$^2$, 0,88 bar) lorsque le moteur est en fonctionnement. Le bouchon de radiateur comprend une soupape de surpression (1), une soupape de dépression (2), des ressorts de soupape, un joint, etc.

Le liquide de refroidissement est pressurisée par dilatation thermique de la vapeur. Et, lorsque sa température d'ébullition augmente, la génération de bulles d'air est supprimée. (Les bulles d'air dans l'eau de refroidissement réduit l'effet de refroidissement.)

**[A] Lorsque la pression interne du radiateur est haute:**
**[B] Lorsque la pression interne du radiateur est négative:**

(1) Crapet à pression
(2) Crapet à dépression

## [3] THERMOSTAT

Der Thermostat sorgt für die richtige Temperatur des Kühlwassers. Für den KUBOTA Motor wird ein Wachskugel-Thermostat benutzt, wobei das Wachs in der Kugel eingeschlossen ist. Das Wachs ist bei niedriger Temperatur fest, wird jedoch bei hoher Temperatur flüssig, dehnt sich aus und öffnet das ventil.

A) Bei niedriger Temperatur (unter 71°C).
Bei geschlossenem Thermostat wird das Kühlwasser durch den Wasserrücklaufschlauch in Umlauf gesetzt, ohne zum Kühler zu fließen. Die im Wassermantel enthaltene Luft tritt durch die Auslaßöffnung (6) des Thermostats zur Kühlerseite hin aus.

B) Bei hoher Temperatur (über 71°C).
Wenn die temperatur des Kühlwassers 71°C überschreitet, verflüssigt sich das in der Kugel enthaltene Wachs und dehnt sich aus. Da die Spindel (4) feststehend ist, sinkt die Kugel (3) nach unten. Das Ventil (2) wird von der Platte (1) getrennt und das Kühlwasser zum Kühler hin geleitet.

(1) Platte
(2) Ventil
(3) Kugel
(4) Spindel
(5) Sythetischer Gummi
(6) Auslaßöffnung
(7) Wachs (fest)
(8) Wachs (flüssig)

## [4] KÜHLER (nicht im Basismotor enthalten)

Der Kühlerblock umfaßt die Rohre und die Rippen (3), die im rechten Winkel zu den Rohren (2) angeordnet sind. Die Wärme des Warmwassers in den Rohren wird über die Rohrwände und Rippen ansgestrahlt. Für den KUBOTA Motor wird ein gewellter Rippenblock benutzt, der leichtgewichtig ist und eine hohe Wärmeübertragung bietet. Eine Verstopfung wird durch die gewellten, schlitzfreien Rippen weitgehend ausgeschlossen.

(1) Kühlluft
(2) Rohr
(3) Rippe
(4) Schlitzfreie, gewellte Rippe
(5) Mit Schlitzen versehene, gewellte Rippe

## [5] KÜHLERVERSCHLUSSKAPPE

Mit der Kühlerverschlußkappe wird bei laufendem Motor der Innendruck der Kühlanlage am vorgeschriebenen Pegel von 88 kPa (0,9 kp/cm$^2$, 0,88 bar) erhalten. Die Kappe besteht aus einem Druckventil (1), einem Unterdruckventil (2), Ventilfedern, Dichtungen usw.

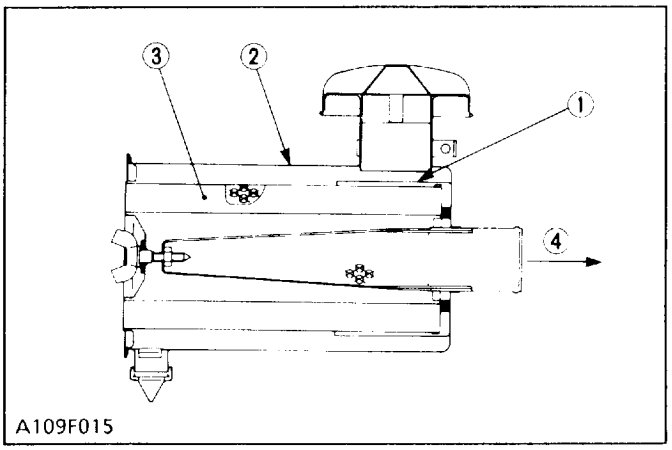
Das Kühlwasser wird durch die thermische Volumenausdehnung des Wasserdampfes unter Druck gesetzt und bei steigender Siedetemperatur wird die Erzeugung von Luftblasen unterdrückt. (Im Kühlwasser vorhandene Luftblasen verringern die Kühlwirkung.)

**[A] Wenn der Innendruck im Kühler hoch ist**
**[B] Wenn ein Unterdruck im Kühler vorhanden ist**

(1) Druckventil
(2) Vakuumventil

# 4 INTAKE AND EXHAUST SYSTEM

## [1] AIR CLEANER (not included in the basic engine)

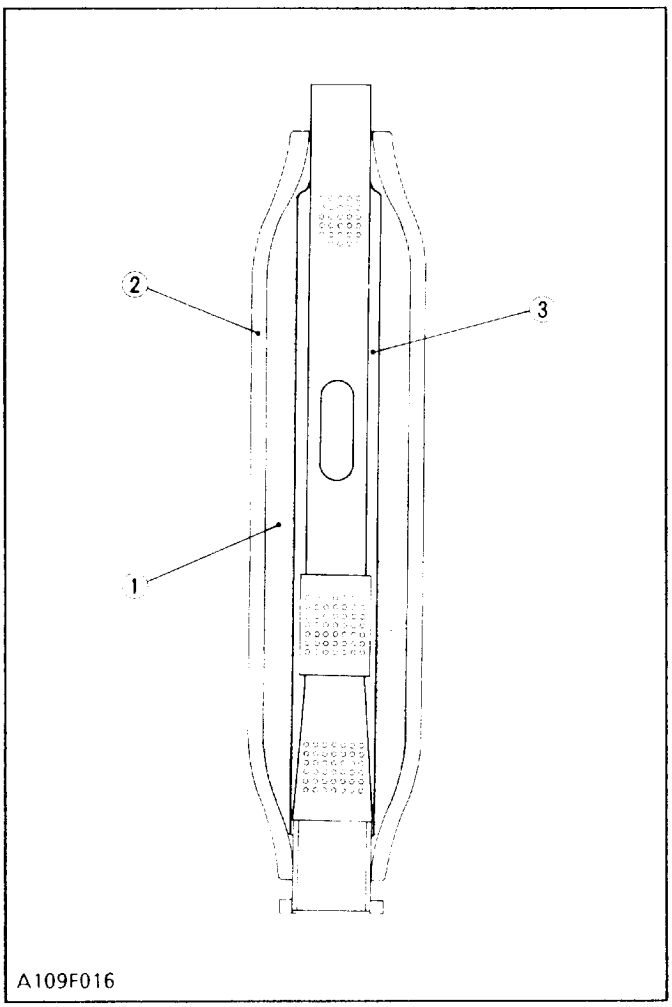


A109F015

The air cleaner is a dry-cyclone type for easy maintenance. Sucked air is caused to flow in a whirling way with air guide (1). The dust, while circulating in the air flow, is absorbed by the element (3) and thus prevented from entering the engine.

(1) Air Guide
(2) Air Cleaner Body
(3) Air Filter Element
(4) To Cylinder

## [2] MUFFLER (not included in the basic engine)



A109F016

High temperature and high pressure exhaust gas is intermittently discharged by fuel combustion generating pressure waves inside the exhaust pipe which will result in noise.

The muffler is used to reduce this noise.

This muffler consists of a perforated inner tube (3) and outer tube (2), glass wool (1), etc. The glass wool placed between the outer tube and main body, absorbs the exhaust noise of higher frequency.

(1) Glass Wool
(2) Outer Tube
(3) Inner Tube

# 4 ADMISSION ET ECHAPPEMENT

## [1] FILTRE A AIR (non compris dans le moteur de base)

Le filtre à air de type sec à cyclone permet un entretien facile. L'air aspiré est mis en turbulence par une guide de l'air (1). La poussière fine qui circule dans le courant d'air est absorbée par l'élément (3), ce qui lui barre le chemin vers le moteur.

(1) Guide de l'air
(2) Corps de filtre à air
(3) Elément de filtre à air
(4) Vers le cylindre

## [2] POT D'ECHAPPEMENT (non compris dans le moteur de base)

Les gaz à haute pression et haute température engendrés par la combustion sont envoyés de manière intermittente dans le tuyau d'échappement, ce qui engendre des variations de pression se traduisant par du bruit.

Le pot d'échappement sert à réduire ce bruit.

Le pot d'échappement se compose d'un tuyau interne perforé (3) et d'un tuyau externe perforé (2), de laine de verre (1), etc. La laine de verre placée entre le tuyau externe et le corps principal absorbe les fréquences les plus élevées du bruit d'échappement.

(1) Laine de verre
(2) Tuyau externe
(3) Tuyau interne

# 4 ANSAUG- UND AUSPUFFSYSTEM

## [1] LUFTFILTER (nicht im Basismotor enthalten)

Der Luftfilter arbeitet nach dem Fliehkraftsystem und bietet eine mühelose Wartung. Der angesaugte Luftstrom wird durchgewirbelt und an einer Luftführung (1) vorbeigeführt. Feiner im Luftstrom enthaltener Staub wird im Einsatz (3) gesammelt, der verhindert, daß der Staub in den Motor gelangt.

(1) Luftführung
(2) Luftfilterkörper
(3) Lufttiltereinsatz
(4) Zum Zylinder

## [2] AUSPUFFTOPF (nicht im Basismotor enthalten)

Die heißen Hochdruckabgase werden stoßweise über Druckwellen durch die Kraftstoffverbrennung in das Auspuffrohr abtransportiert. Hierdurch entstehen Druckwellen innerhalb des Auspuffrohres, die eine Geräuschentwicklung bewirken.

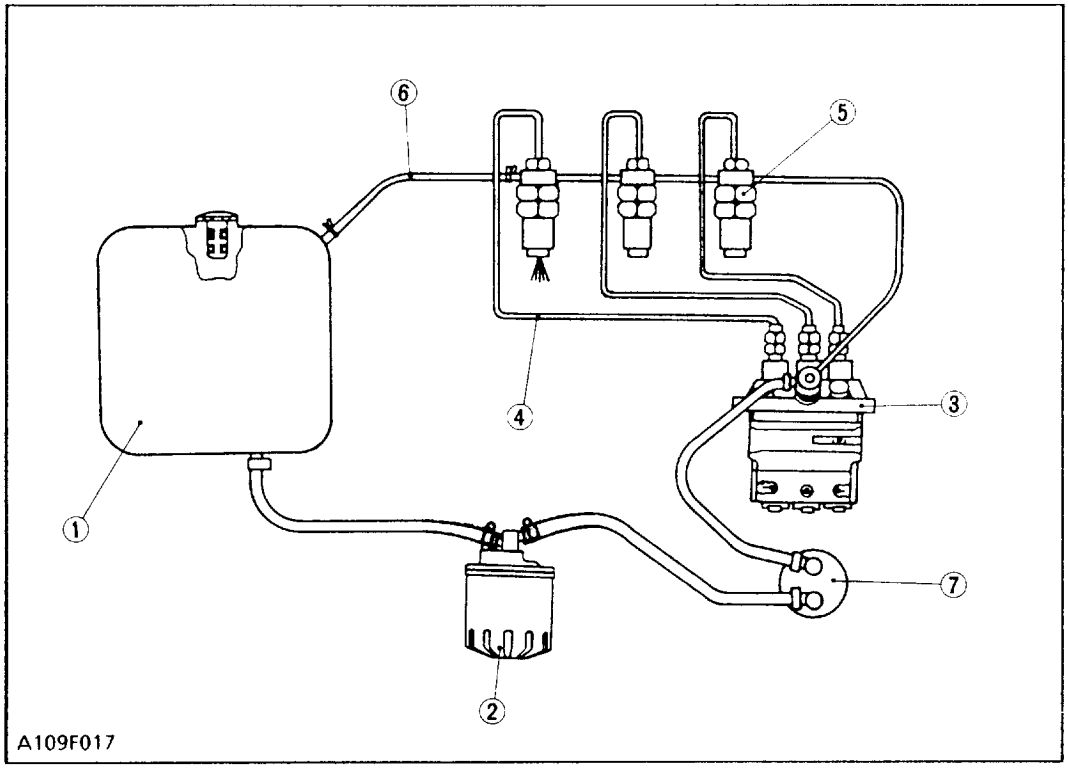
Durch den Auspufftopf wird diese Geräuschentwicklung eingeschränkt.

Der Auspufftopf besteht aus dem mit Löchern versehenen inneren (3) und äußeren Rohr (2), der Glaswolle (1), usw. Die zwischen dem äußeren Rohr und dem Hauptkörper angeordnete Glaswolle absorbiert die höheren Frequenzen der Auspuffgeräusche.

(1) Glaswolle
(2) Äußeres Rohr
(3) Inneres Rohr

# 5 FUEL SYSTEM

## [1] GENERAL



A109F017

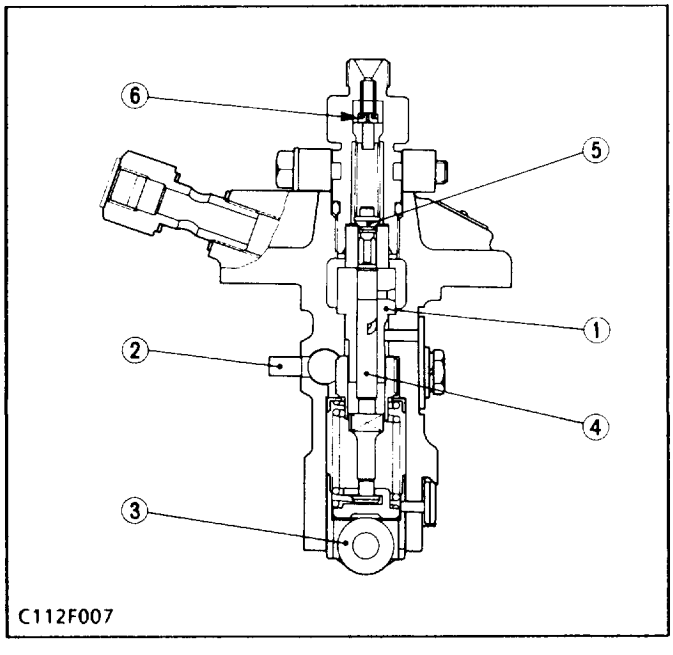
(1) Fuel Tank
(2) Fuel Filter
(3) Injection Pump
(4) Injection Pipe
(5) Injection Nozzle
(6) Fuel Overflow Pipe
(7) Fuel Feed Pump

Fuel from the fuel tank (1) passes through the fuel filter (2), and then enters the injection pump (3) after impurities such as dirt, water, etc. are removed.

The fuel pressurized by the injection pump to the opening pressure (13.73 to 14.71 MPa, 140 to 150 kgf/cm$^2$, 1991 to 2062 psi), of the injection nozzle (5) is injected into the combustion chamber.

Part of the fuel fed to the injection nozzle (5) lubricates the moving parts of the plunger inside the nozzle, then returns to the fuel tank through the fuel overflow pipe (6) from the upper part of the nozzle holder.

## [2] INJECTION PUMP



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A Bosch type mini pump is used for the injection pump. It is small, lightweight and easy to handle.

The plunger (4) with a right-hand lead reciprocates via the tappet roller (3) by means of the camshaft fuel cam, causing the fuel to be delivered into the injection nozzle.

(1) Cylinder
(2) Control Rack
(3) Tappet Roller
(4) Plunger
(5) Delivery Valve
(6) Dumping Valve

# 5 SYSTEM D'ALIMENTATION

## [1] GENERALITES

Le carburant parvient du réservoir (1), passe par le filtre à carburant (2) et pénètre dans la pompe d'injection (3) une fois que les impuretés telles que poussière, eau, etc. ont été séparées.

Le carburant est préssurisé dans la pompe d'injection au niveau de la pression d'ouverture (13,73 à 14,71 MPa, 140 à 150 kgf/cm$^2$, 137,3 à 147,1 bar), de l'injecteur.

L'injecteur (5) injecte le carburant dans la chambre de compression. Une partie du carburant parvenant à l'injecteur (5) lubrifie les pièces mobiles du plongeur à l'intérieur de l'injecteur, puis retourne au réservoir par l'intermédiaire du tuyau de trop-plein (6) qui est situé sur la partie supérieure du porte-injecteur.

(1) Réservoir de carburant
(2) Filtre à carburant
(3) Pumpe d'injection
(4) Tuyau d'injection
(5) Injecteur
(6) Tuyau de trop-plein de carburant
(7) Pompe d'alimentation de combustible

# 5 KRAFTSSTOFF-SYSTEM

## [1] ALLGEMEINES

Der Kraftstoff fließt vom Tank (1) durch den Kraftstofffilter (2) hindurch und dann in die Einspritzpumpe (3), nachdem Verunreinigungen durch Schmutz, Wasser usw. herausgefiltert worden sind.

Der Kraftstoff wird durch die Einspritzpumpe auf den Abspritzdruck (13,73 bis 14,71 MPa, 140 bis 150 kp/cm$^2$, 137,3 bis 147,1 bar) der Einspritzdüse gebracht und wird dann von der Einspritzdüse (5) in die Verbrennungs-kammer eingespritzt.

Ein Teil des der Einspritzdüse (5) zugeführten Kraftstoffs wird zur Schmierung des sich bewegenden Kolbens in der Einspritzdüse verwendet und dann über die Überlaufleitung (6), die oben an der Einspritzdüsenhalterung angeschlossen ist, an den Kraftstofftank zurückgegeben.

(1) Kraftstofftank
(2) Kraftstofffilter
(3) Einspritzpumpe
(4) Einspritzleitung
(5) Einspritzdüse
(6) Überlaufleitung
(7) Kraftstoff-Förderpumpe

## [2] POMPE D'INJECTION

On utilise une mini-pompe d'injection, modèle Bosch. Elle est petite, légère et facilement manipulable.

Le piston (4), présentant un pas la main droite, va et vient avec le galet de poussoir (3) par l'intermédiaire de la came de carburant de l'arbre à cames. Le carburant est alors fourni à l'injecteur.

(1) Cylindre
(2) Tige de réglage
(3) Galet de poussoir
(4) Piston
(5) Clapet de refoulement
(6) Soupape de décharge

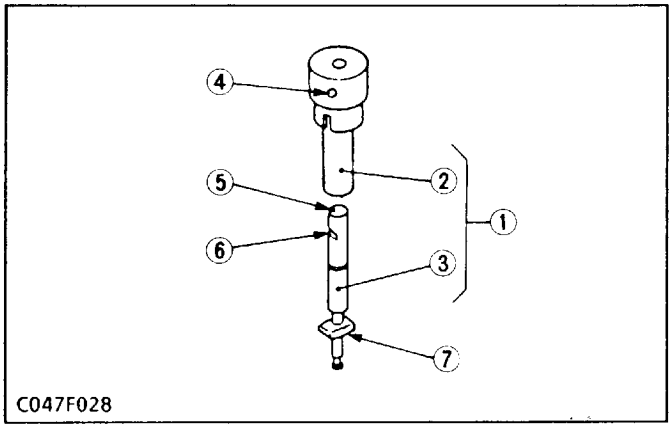
## [2] EINSPRITZPUMPE

Eine Bosch Minipumpe dient als Einspritzpumpe. Sie zeichnet sich durch ihre geringe Größe, ihr geringes Gewicht und leichte Handhabung aus.

Der Kolben (4) wird über die Stößelrolle (3) durch die Einspritzungsnocke auf der Nockenwelle hinund herbewegt, wodurch der Einspritzdüse Kraftstoff zugeführt wird.

(1) Zylinder
(2) Regelstange
(3) Stößelrolle
(4) Kolben
(5) Druckventil
(6) Ablaßventil

## (1) Pump Element



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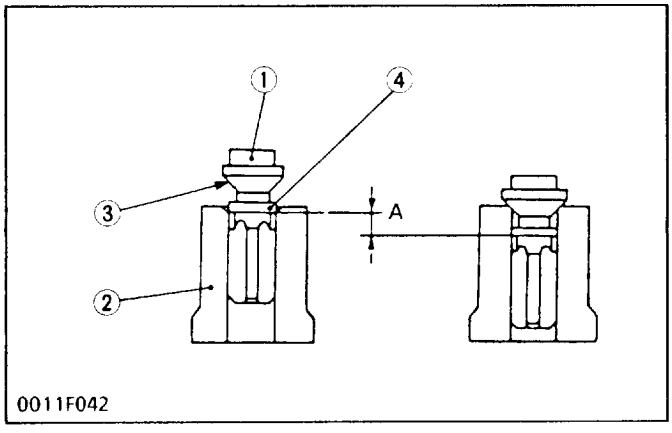
The pump element (1) is consist of the plunger (3) and cylinder (2).

The sliding surfaces are super-precision machined to maintain injection pressure at engine low speeds. Since the driving face (7) fits in the control sleeve, the plunger (3) is rotated by the movement of the control rack to increase or decrease of fuel delivery.

As described above, the plunger (3) is machined to have the slot (5) and the control groove (6).

(1) Pump Element
(2) Cylinder
(3) Plunger
(4) Feed Hole
(5) Slot
(6) Control Groove
(7) Driving Face

## (2) Delivery Valve



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The delivery valve consists of the delivery valve (1) and delivery valve seat (2).

The delivery valve performs the following functions.

1. **Reverse flow preventing function**
   If the fuel flow reverse from the injection nozzle side when the plunger lowers, the time lag between the next delivery start and the nozzle injection start increases. To avoid this, the delivery chamber to injection pipe interruption by delivery valve (1) prevents this reverse flow, thus keeping fuel always filled in the nozzle and pipe.
2. **Suck-back function**
   After completing the fuel delivery, the delivery valve lowers, and the relief plunger (4) end contacts the delivery valve seat (2). The valve further lowers until its seat surface (3) seats firmly the delivery valve seat. During this time, the amount of fuel corresponding to (A) is sucked back from inside the injection pipe, the pressure inside the pipe is reduced, thus leading to an improved injection shut off and preventing after leakage dribbling.

(1) Delivery Valve
(2) Delivery Valve Seat
(3) Seat Surface
(4) Relief Plunger

## (1) Elément de pompe

L'élément de pompe (1) comporte un piston (3) et un cylindre (2).

Les surfaces de glissement sont usinées avec précision pour maintenir la pression d'injection au régime lent du moteur. Etant donné que le doigh de comande (7) s'emboîte dans le macnchon de contrôle, le piston (3) est tourné par le mouvement de la tige crémaillère pour augmenter ou diminuer le débit de refoulement de carburant.

Comme décrit ci-dessus, le piston (3) est usiné pour avoir la rainure verticale (5) et la rainure de contrôle (6).

(1) Elément de pompe
(2) Cylindre
(3) Piston
(4) Orifice d'admission
(5) Rainure verticale
(6) Rainure de contrôle
(7) Doigh de commande

## (2) Clapet de refoulement

La clapet de refoulement comporte un clapet (1) et un siège de clapet (2).

La clapet de refoulement remplit les fonctions suivantes.

**1. Fonction anti-retour**

Si le carburant retourne de l'injecteur lorsque le piston descend, le temps depuis le commencement du refoulement suivant jusqu'au début d'injection est prolongé. Afin d'éviter un tel phénomène, l'écoulement de la chambre de refoulement au tuyau d'injection est interrompu par la clapet de refoulement, permettant ainsi de maintenir le carburant dans l'injecteur et le tuyau.

**2. Fonction aspiration**

Après le refoulement de carburant, le clapet descend, et la collerette cylindrique (4) entre en contact avec le siège de clapet (2). Le clapet descend davantage jusqu'à ce que sa surface de siège (3) se colle contre le siège de clapet. Pendant ce temps, le volume de carburant correspondant à (A) est aspiré depuis l'intérieur du tuyau d'injection et la pression interne du tuyau est réduite, permettant ainsi d'améliorer l'arrêt d'injection et de prèvenir le dégouttement de carburant après fuite.

(1) Clapet de refoulement
(2) Siège de clapet
(3) Surface de siège
(4) Collerette cylindrique

## (1) Pumpenelement

Das Pumpenelement (1) besteht aus einem Kolben (3) und einem Zylinder (2).

Die Gleitflächen sind besonder feinbearbeitet, um den Einspritzdruck bei niedriger Motordrehzahl aufrechtzuerhalten. Da der Antriebsflansch (7) in die Regelhülse einpaßt, wird der Kolben (3) durch die Bewegung der Regelstange gedreht, und dadurch wird die Kraftstofförderung erhöht bzw. vermindert.

Wie vorstehend beschrieben, ist der Kolben (3) derart ausgeführt, daß er eine Längsnut (5) und eine Regelnut (6) besitzt.

(1) Pumpenelement
(2) Zylinder
(3) Kolben
(4) Zufuhröffnung
(5) Längsnut
(6) Regelnut
(7) Antriebsflansch

## (2) Druckventill

Das Druckventil besteht aus dem Druckventil (1) und dem Druckventilsitz (2).

Das Druckventil funktiolniert wie folgt.

**1. Verhinderung eines Gegenstroms**

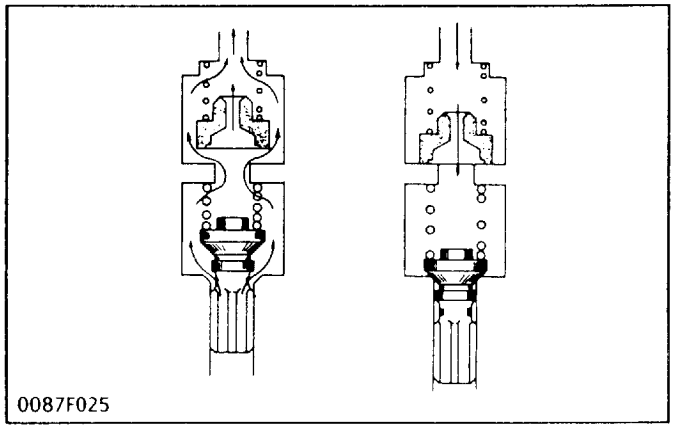
Wird der Kraftstoffluß aus der Einspritzdüsenseite bei Senken des Kolbens umgekehrt, erhöht sich der Zeitabstand zwischen dem Beginn der nächsten Zuführung und dem Beginn der Düseneinspritzung. Um dies zu vermeiden, unterbricht das Druckventil den Durchfluß zwischen dem Druckraum und Einspritzrohr und verhindert dadurch einen Gegenstrom, so daß die Düse und das Rohr stets mit Kraftstoff gefüllt ist.

**2. Rücksaugfunktion**

Nach erfolgter Kraftstofförderung senkt sich das Druckventil und der Kopf des Entlastungskolbens (4) kommt mit dem Druckventilsitz (2) in Berührung. Das Ventil sinkt weiter, bis seine Sitzfläche (3) fest am Druckventilsitz aufsitzt. Während dieser Zeit wird die Kraftstoffmenge (A) aus dem Inneren des Einzspritzrohrs zurückgesaugt, der Druck im Rohr fällt ab, eine verbesserte Einspritzabsperrung erfolgt und ein Leckagetröpfeln wird verhindert.

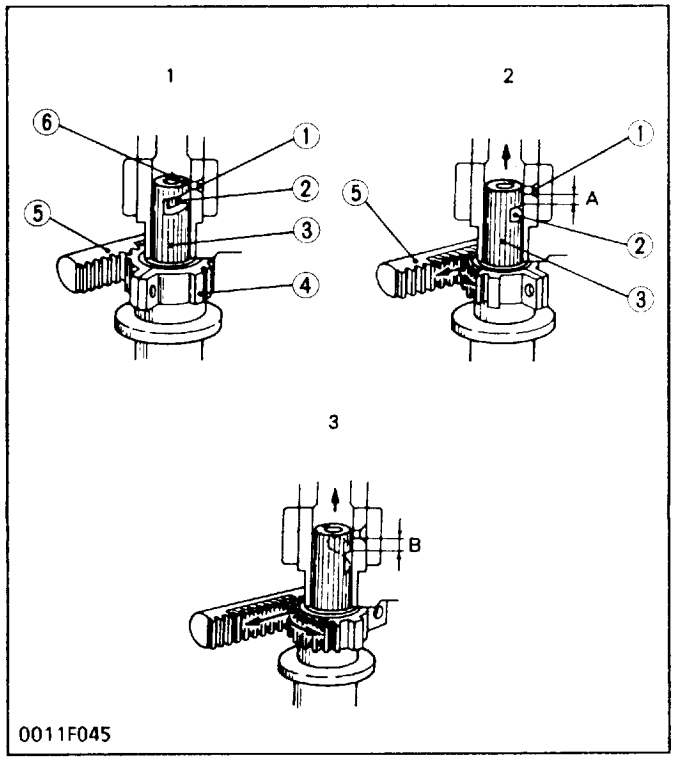
(1) Druckventil
(2) Druckventilsitz
(3) Sitzfläche
(4) Entlastungskolben

## (3) Dumping Valve




1. **At fuel injection**
   Since dumping valve is pushed up to press the spring, fuel is pressure-fed to injection nozzle the same as without dumping valve.
2. **At suck-back**
   At suck-back by delivery valve after fuel injection fuel returns through dumping valve orifice Generally second injection is apt to occur by reflex pressure due to reaction of sudden pressure drop when changing into suck-back by delivery valve from high injection pressure. As a result of preventing this second injection perfectly by dumping valve and dissolving nozzle clogging, durability of injection nozzle is improved.

## (4) Injection Control




1. **No fuel delivery ····· Engine stop**
   When the control rack (5) is set at the engine stop position, the plunger does not force fuel and no fuel is delivered since the feed hole (1) aligns with the slot (6) in the plunger (3).
2. **Partial fuel delivery**
   When the plunger (3) is rotated by the control rack (5) in the direction of arrow, the fuel is delivered to the injection nozzle.
   The amount of fuel corresponds to the effective stroke (A) from closing the feed hole (1) by the plunger head to contact of the control groove (2) with the feed hole.
3. **Maximum fuel delivery**
   When the control rack is moved to the extreme end in the direction of the arrow, the effective stroke (B) of the plunger is at its maximum, thus the maximum fuel delivery occurs.

(1) Feed Hole
(2) Control Groove
(3) Plunger
(4) Control Sleeve
(5) Control Rack
(6) Slot

## (3) Soupape de décharge

1. **A l'injection de carburant**
   Comme la soupape de décharge est poussée vers le haut pour presser le ressort, le carburant est alimenté sous pression dans la tubulure d'injection la même chose que sans la soupape de décharge.
2. **A l'aspiration en retour**
   A l'aspiration en retour par la soupape de refoulement après l'injection de carburant, le carburant retourne par l'orifice de soupape de décharge. En général, une deuxième injection peut prendre place par la pression de réaction due à la réaction d'une chute de pression brusque lors du changement en aspiration en retour par la soupape de refoulement de la pression d'injection levée. Grâce de la prévention parfaite de cette deuxième injection par la soupape de décharge et de dissoudre l'obstruction de tubulure, la durabilité de la tubulure d'injection est améliorée.

## (4) Règlage d'injection

1. **Aucune alimentation en carburant ... Arrêt du moteur**
   Lorsque la tige de réglage (5) est mise sur la position d'arrêt du moteur, le piston n'agit pas sur le carburant et aucun carburant n'est envoyé, car l'orifice d'alimentation (1) s'aligne sur la rainure verticale (6) du piston (3).
2. **Alimeentation partielle en carburant**
   Lorsque le piston (3) est tourné par la tige de réglage (5) dans le sens de la flèche, le carburant est fourni à l'injecteur.
   Le volume de carburant correspond à la course effective (A): de la fermeture de l'orifice d'alimentation (1) par la tête de piston jusqu'au contact de la rainure contrôle (2) avec l'orifice d'alimentation.
3. **Alimentation maximum en carburant**
   Lorsque la tige crémaillère est déplacée à fond dans le sens de la flèche, la course effective (B) du piston devient maximum, conduidant ainsi à une alimentation maximum en carburant.

(1) Orifice d'alimentation
(2) Rainure contrôle
(3) Piston
(4) Douille de réglage
(5) Tige de réglage
(6) Rainure verticale

## (3) Ablaßventil

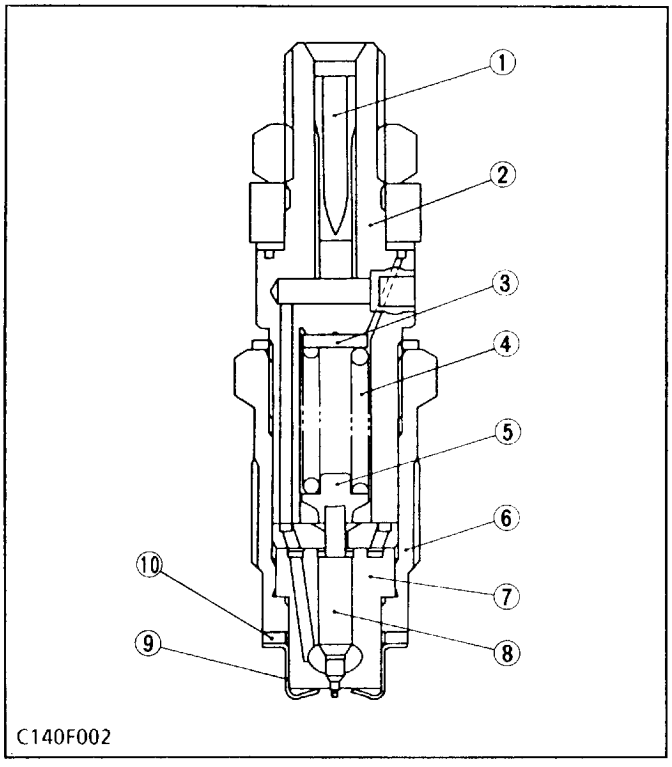
1. **Kraftstoffeinspritzung (Rücksaugung)**
   Da das Auslaßventil nach oben gedrückt wird, um die Feder zusammenzudrücken, wird der Kraftstoff unter Druck in die Einspritzdüse gepreßt (gleich wie ohne Ablaßventil).
2. **Ansaugvorgang**
   Beim Ansaugen durch das Ausflußventil nach der Kraftstoffeinspritzung fließt Kraftstoffdurch die Öffnung im Auslaßventil zurück. Im Allgemeinen neigt der Mechanismus zu einer zweiten Einspritzphase durch die Reaktion des plötzlichen Druckabfalls (Differenz von Ansaug-Ausflußventildruck und hohem Einspritzdruck) Durch Verhinderung dieser zweiten Einspritzphase hervorgerufen durch das Zusetzen des.

## (4) Einspritzregelung

1. **Keine Kraftstofförderung ... Motorstopp**
   Wird die Regelstange (5) auf die Motorstopp-Position gestellt, wird kein Kraftstoff durch den Kolben unter Druck gesetzt und kein Kraftstoff gefördert, da sich die Zulauföffnung (1) mit der Längsnut (6) im Kolben (3) ausrichtet.
2. **Teilweise Kraftstofförderung**
   Während der Kolben (3) durch die Regelstange (5) in Pfeilrichtung gedreht wird, wird der Kraftstoff zur Einspritzdüse gefördert.
   Die Kraftstoffmenge entspricht dem effektiven Hub (A) d.h. vom Schließen der Zulauföffnung (1) druch den Kolbenboden bis die Regelnut (2) die Zulauföffnung berührt.
3. **Maximale Kraftstofförderung**
   Wird die Regelstange bis zum Ende in Pfeilrichtung bewegt, erreicht der effektive Hub (B) des Kolbens seinen Höchstwert und die maximale Kraftstofförderung erfolgt.

(1) Zulauföffnung
(2) Regelnut
(3) Kolben
(4) Regelhülse
(5) Regelstange
(6) Längsnut

## [3] INJECTION NOZZLE



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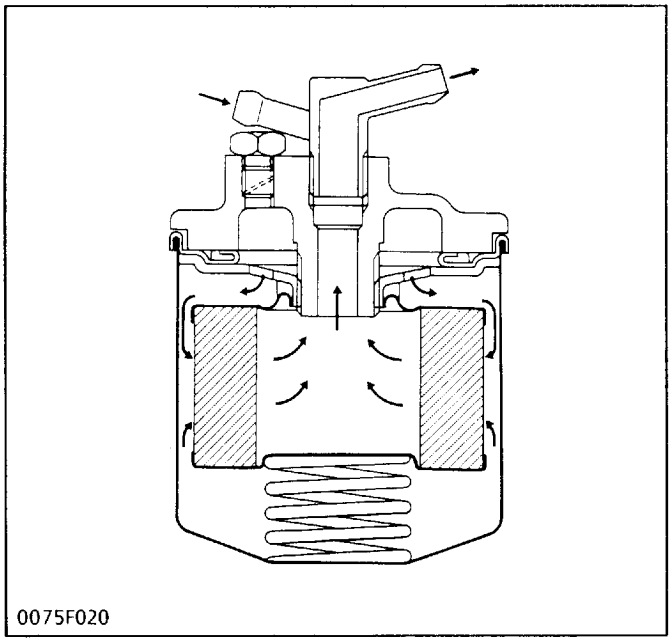
Used as the injection nozzle, the small-sized NIPPONDENSO-made OPD mini nozzle is of a flat-cut-provided double throttle type. This type of nozzle is designed to control the injection quantity when the lift rate is low at start of the injection, and to cut down on the knocking sound caused by excessive fuel injection by giving the needle valve section more taper than before to prevent the rapid increase in the injection quantity when the initial injection turns into the full-force injection.

Also, employed to prevent the injection quantity loss in the throttle section caused by carbon, the flat cut provided at the needle valve section helps the throttle withstand long use and reduce as much knocking sound as when it was new.

The heat seal is employed to improve the durability and reliability of the nozzle.

(1) Bar Filter
(2) Nozzle Holder Body
(3) Adjusting Washer
(4) Nozzle Spring
(5) Push Rod
(6) Retaining Nut
(7) Nozzle Body
(8) Needle Valve
(9) Heat Seal
(10) Packing

## [4] FUEL FILTER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A fuel filter is used to prevent dirty fuel from reaching the injection pump and injection nozzles.

The filter cartridge will require occasional replacement to maintain an adequate flow of fuel to the injection pump. The frequency of this service will vary according to the cleanliness of available fuel and the care used in storage.

The fuel filter eliminates the foreign matter which is fed from the fuel tank and protects injection pump and injection nozzles. When fuel enters the filter, it passes from the filter element's circumference foward the center for filtering.

(1) Cover
(2) Fuel filter cartridge
(3) Air vent plug

## [3] INJECTEURS

Utilisé en tant quéinjecteur, le mini-injecteur OPD de faible dimension fabriqué par NIPPONDENSO est du type à découpe plane muni d'un double étranglement. Ce type d'injecteur est conçu pour contrôler la quantité d'injection lorsque le taux d'élévation est faible au démarrage de l'injection, et pour réduire le bruit de cognement provoqué par une injection excessive du carburant en donnant à la section du pointeau plus de conicité qu'auparavant pour éviter l'augmentation rapide de la quantité d'injection lorsque l'injection initiale se transforme en une force d'injection totale.

De même, employée pour empêcher une déperdition de la quantité d'injection dans la section de l'étranglement provoquée pour empêcher une déperdition de la quantité d'injection dans la section de l'étranglement provoquée par le carbone, la découpe plane se trouvant dans la section du pointeau aide l'étrangleur à supporter une utilisation prolongée et diminue le bruit de cognement autant que lorsqu'il était neuf.

Un thermosoudage est employé pour améliorer la durabilité et la fiabilité de l'injecteur.

(1) Filtre à barres
(2) Corps du porte-injecteur
(3) Rondelle d'ajustement
(4) Ressort de l'injecteur
(5) Tige de poussoir
(6) Ecrou de fixation
(7) Corps de l'injecteur
(8) Pointeau
(9) Thermosoudure
(10) Garniture

## [4] FILTRE A CARBURANT

On utilise un filtre à combustible pour empêcher qu'un combustible souillé n'atteigne la pompe d'injection et les pulvérisateurs.

L'élément filtrant doit être remplacé de temps à autre pour maintenir un flux adéquat de combustible à la pompe. La fréquence de ce remplacement dépend de la pureté du combustible disponible et du soin apporté au stockage.

Le filtre élimine les corps étrangers venant du réservoir et protèage la pompe d'injection et les injecteurs. Quand le combustible passe dans le filtre, il circule de la périphérie de l'élément de filtre au centre de celui-ci.

(1) Capot
(2) Cartouche de filtre à combustible
(3) Valve du filtre

## [3] EINSPRITZDÜSE

Die von NIPPONDENSO hergestellte OPD-Minidüse ist als Flachsitz-Drosselzapfendüse ausgelegt. Diese Einspritzdüsen-Bauweise erlaubt eine präzise Regulierung der Einspritzmenge am Anfang des Einspritzvorgangs, wenn der Nadelhub noch gering ist. Außerdem gewährleistet dieser Düsentyp einen leiseren Motorlauf, da der Konusbereich des Nadelventils stärker zuläuft und somit ein rapides Ansteigen der eingespritzten Kraftsoffmenge bei einer Drehzahlerhöhung des Motors verhindert.

Um einen Kraftstoffverlust im Drosselbereich zu verhindern, ist das Nadelventil als Flachsitz-Ausführung ausgelegt. Dies garantiert über lange Zeit einen zuverlässigen, störungsfreien Betrieb und ruhigen Motorlauf.

Um die Haltbarkeit und Zuverlössigkeit der Einspritzdüse zu erhöhen, ist diese mit einem hitzebeständigen Abdichtring versehen.

(1) Stabfilter
(2) Einspritzdüsenhalter
(3) Einstellscheibe
(4) Einspritzdüsenfeder
(5) Stößel
(6) Haltemutter
(7) Einspritzdüsengehäuse
(8) Nadelventil
(9) Hitzebeständiger Abdichtring
(10) Abdichtung

## [4] KRAFTSTOFFFILTER

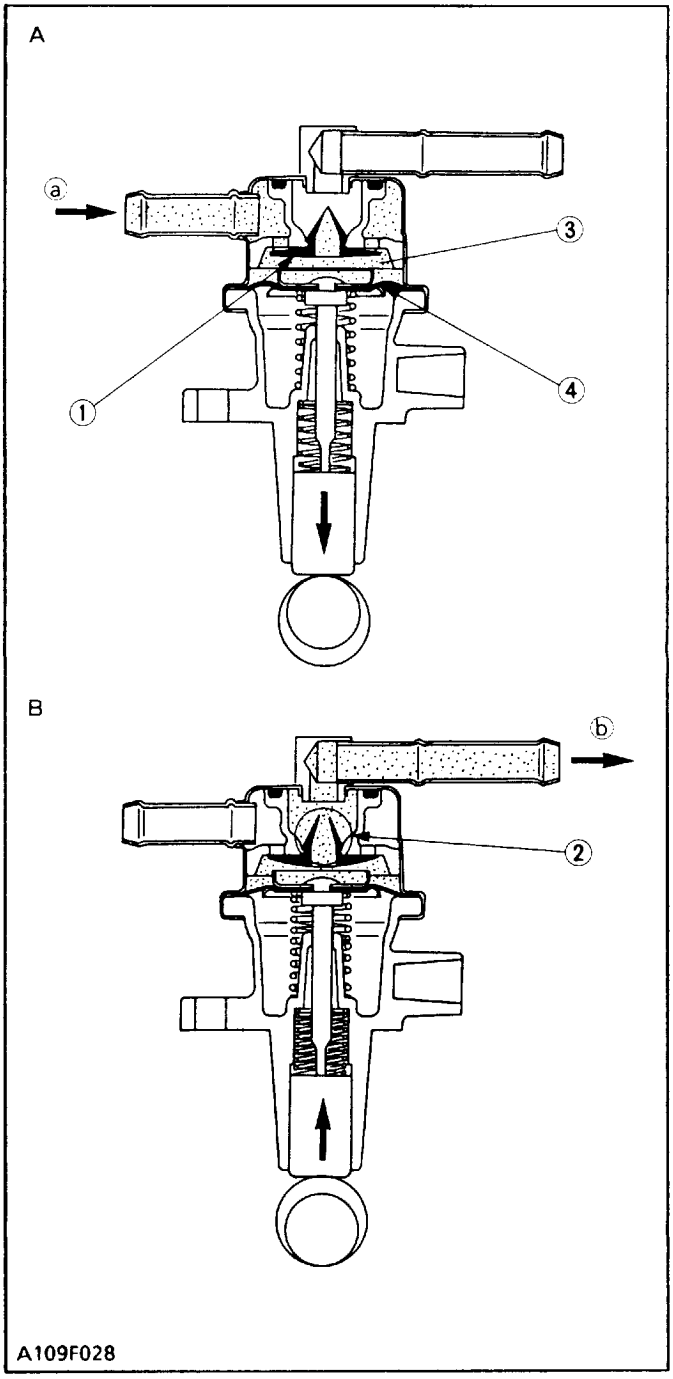
Ein Treibstoff-Filter wird verwendet, um Schmutzteilchen im Treibstoff nicht zu erlauben zur Einspritzdüse zu gelangen.

Das Filterelement muß von Zeit zu Zeit ausgewechselt werden, um dessen Filtereigenschaften und einen ausreichenden Fluß von Treibstoff zur Einspritzdüse zu gewährleisten. Die Häufigkeit dieser Auswechslungsarbeiten häangt vom Reinheitsgrad des verwendeten Treibstoffs und von den Vorsichtsmaßnahmen bei der Lagerung von Treibstoff ab.

Durch diesen Filter werden Fremdstoffe im Treibstoff auf dem Weg vom Tank zur Einspritzdüse eliminiert, wodurch die Einspritzpumpe und die Einspritzdüse vor Beschädigungen geschützt werden können. Beim Einlaufen des Treibstoffes in den Filter wird dieses vom Außenumfang des Filters zur Mitte geleitet, um hier gefiltert zu werden.

(1) Abdeckung
(2) Treibstoff-Filter Cartridge
(3) Enlüfterstutzen

# [5] FUEL LIFT PUMP




Filtered fuel is fed to the injection pump by the fuel lift pump. The fuel lift pump operates as shown in the figure. Power is applied to the tappet by an eccentric movement on the fuel camshaft. As the fuel camshaft rotates, the eccentric movement causes the tappet to move up and down. The tappet is linked to a flexible diaphragm (4) via the pull rod.

When the diaphragm is pulled down, a low vacuum or low pressure area is created above the diaphragm. This causes atmospheric pressure in the fuel tank to force fuel into the fuel lift pump. The inlet valve (1) opens to admit fuel into the chamber (3).

When the diaphragm is pushed up, pressure is created in the area above the diaphragm. This pressure closes the inlet valve and opens the outlet valve (2), forcing fuel from the pump through the fuel pipe to the injection pump.

**[A] Inlet Stroke**
**[B] Discharge Stroke**
**(a) From Fuel Filter**
**(b) To Injection Pump**

(1) Inlet Valve
(2) Outlet Valve
(3) Chamber
(4) Diaphragm

## [5] POMPE D'ALIMENTATION

Après filtration, le carburant est envoyé à la pompe d'injection par la pompe d'alimentation. La pompe d'alimentation fonctionne comme indiqué dans la figure. Un excentrique de l'arbre à came d'alimentation agit sur le poussoir. Lorsque l'arbre à came d'alimentation tourne, l'excentrique fait monter et descendre le poussoir. Le poussoir est relié à une membrane (4) par l'intermédiaire d'une tige de traction.

Lorsque la membrane est attirée vers le bas, il se forme une légère dépression ou zone de basse pression au-dessus de la membrane. Cette dépression crée un appel de pression atmosphérique dans le réservoir à carburant, ce qui force le carburant dans la pompe d'alimentation. Le clapet d'aspiration (1) s'ouvre pour laisser passer le carburant dans le compartiment (3).

Lorsque la membrane est repoussée vers le haut, il se forme une pression dans la zone au-dessus de la membrane. Cette pression ferme le clapet d'aspiration et ouvre le clapet de refoulement (2), poussant à force le carburant de la pompe dans le conduit d'alimentation menant à la pompe d'injection.

**[A] Course d'aspiration**
**[B] Course de refoulement**
**(a) En provenance du filtre à carburant**
**(b) En direction de la pompe d'injection**

(1) Clapet d'aspiration
(2) Clapet de refoulement
(3) Compartiment
(4) Membrane

## [5] KRAFTSTOFF-FÖRDERPUMPE

Der gefilterte Kraftstoff wird über die Kraftstoff-Förderpumpe der Einspritzpumpe zugeführt. Die Kraftstoff-Förderpumpe arbeitet, wie in der Abbildung dargestellt. Der Stößel wird über einen Exzenter auf der Kraftstoff-Nockenwelle betrieben. Bei Drehung der Kraftstoff-Nockenwelle wird der Stößel durch den Exzenter nach oben und unten bewegt. Der Stößel ist über die Stößelstange mit einer flexibeln Membrane (4) verbunden.

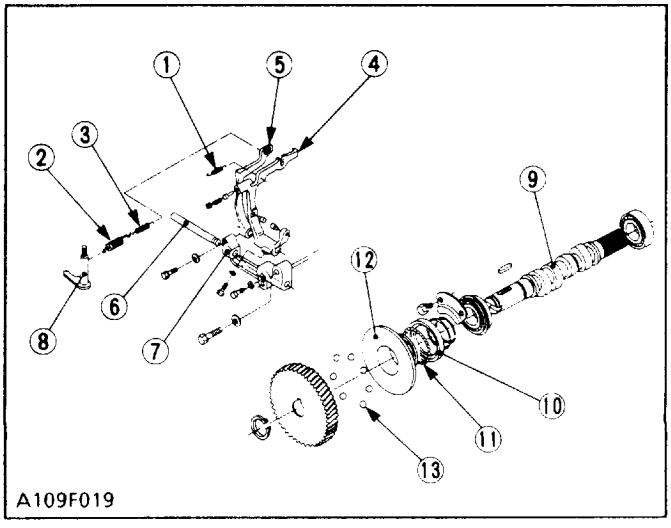
Wenn die Membrane heruntergezogen wird, entsteht oberhalb der Membrane ein Unterdruck, der bewirkt, daß der Kraftstoff durch den im Kraftstoffbehälter vorhandenen Luftdruck in die Kraftstoff-Förderpumpe gepreßt wird.

Das Einlaßventil (1) öffnet und läßt den Kraftstoff in die Kammer (3) einströmen. Wenn die Membrane nach oben gedrückt wird, wird oberhalb der Membrane ein Druck aufgebaut. Dieser schließt das Einlaßventil und öffnet das Auslaßventil (2), wodurch der Kraftstoff von der Pumpe durch die Kraftstoffleitung zur Einspritzpumpe hin gepreßt wird.

**[A] Einlaßhut**
**[B] Auslaßhub**
**(a) Vom Kraftstoff-Filter**
**(b) Zur Einspritzpumpe**

(1) Einlaßventil
(2) Auslaßventil
(3) Kammer
(4) Membrane

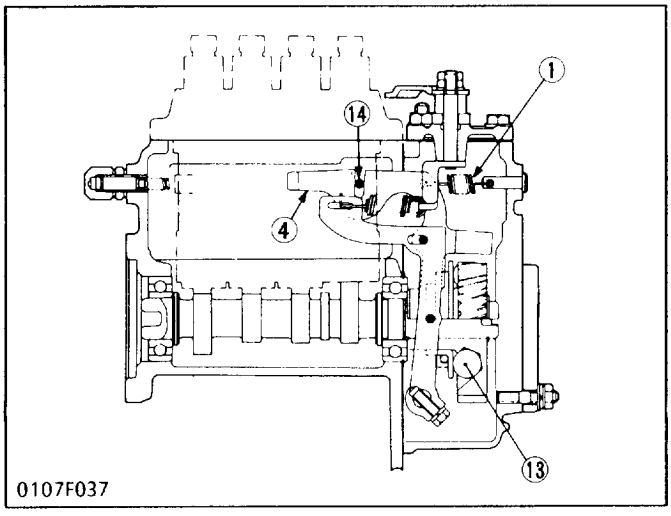
# [6] GOVERNOR




The governor serves to keep engine speed constant by automatically adjusting the amount of fuel supplied to the engine according to changes in the load. This engine employs an all-speed governor which controls the centrifugal force of the steel ball (13) weight, produced by rotation of the fuel camshaft (9), and the tension of the governor spring 1 (2) and 2 (3) are balanced.

(1) Start Spring
(2) Governor Spring 1
(3) Governor Spring 2
(4) Fork Lever 1
(5) Fork Lever 2
(6) Fork Lever Shaft
(7) Fork Lever Holder
(8) Governor Lever
(9) Fuel Camshaft
(10) Governor Ball Case
(11) Steel Ball
(12) Governor Sleeve
(13) Steel Ball

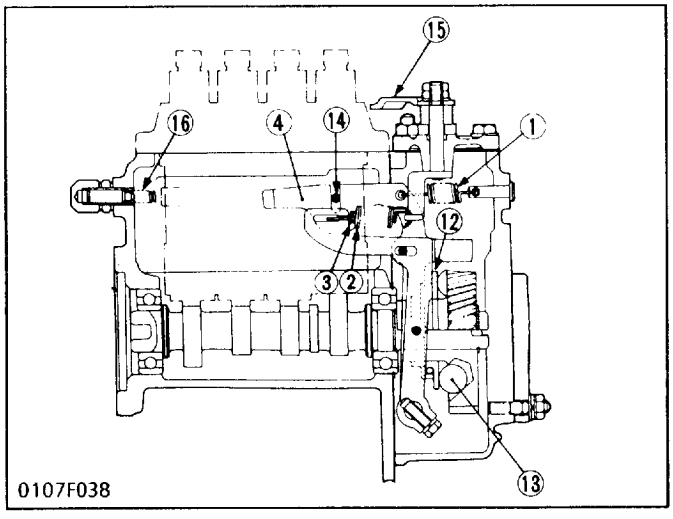
## ■ At start




Since the steel ball (13) have no centrifugal force, a fork lever 1 (4) is pulled to the right by the starter spring (1). Accordingly, the control rack (14) moves to the maximum injection position to assure easy starting.

(14) Control Rack

## ■ At idling




When the speed control lever (15) is set at the idling position after the engine starts, the governor spring 1 (2) does not work at all and the governor spring 2 (3) does only act slightly. The governor sleeve (12) is pushed leftward by a centrifugal force of steel ball (13).

Therefore, the fork lever 1 (4) and control rack (14) are moved to the left by the governor sleeve and then the idling limit spring (16) is compressed by the control rack. As a result, the control rack is kept at a position where a centrifugal force of steel ball and forces start spring (1), governor spring 2 and idling limit spring are balanced, providing stable idling.

(15) Speed Control Lever
(16) Idling Limit Spring

## [6] REGULATEUR

Le régulateur sert à maintenir le régime moteur constant en dosant automatiquement la quantité de carburant envoyée au moteur, en fonction des variations de charge. Ce moteur possède un régulateur tous régimes qui commande la force centrifuge des billes en acier (13), force produite par la rotation de l'arbre à came d'alimentation (9), afin d'équilibrer la charge entre le ressort de régulateur 1 (2) et le ressort 2 (3).

(1) Ressort de démarrage
(2) Ressort de régulateur 1
(3) Ressort de régulateur 2
(4) Levier à chape 1
(5) Levier à chape 2
(6) Axe de levier à chape
(7) Porte-levier à chape
(8) Levier de régulateur
(9) Arbre à came d'alimentation
(10) Boîtier de bille de régulateur
(11) Bille en acier
(12) Manchon de régulateur
(13) Bille en acier

### ■ Au démarrage

Etant donné qu'aucune force centnrifuge ne s'exerce sur les billes en acier (13), le levier à chape 1 (4) est tiré en position verticale par le ressort de démarrage (1). En conséquence, la crémaillère de pilotage (14) est placée en position d'injection maximum ce qui assure un démarrage facile.

(14) Crémaillère de pilotage

### ■ Au ralenti

Lorsque, après mise en marche du moteur, le levier de commande de vitesse (15) est placé en position de ralenti, le ressort 1 du régulateur (2) ne travaille pas du tout et le ressort 2 (3) n'a qu'une faible action. Le manchon de régulateur (12) est poussé vers la gauche par la force centrifuge des billes (13).

En conséquence, le levier à chape 1 (4) et la crémaillère de pilotage (14) sont déplacés vers la gauche par le manchon du régulateur et, ainsi, le ressort limiteur de ralenti (16) est comprimé par la crémaillère de pilotage. Ils s'ensuit que la crémaillère de pilotage est maintenue dans une position d'équilibre entre la force centrifuge des billes et les forces du ressort de démarrage (1), du ressort 2 de régulateur et du ressort limiteur de ralenti, ce qui donne un ralenti régulier.

(15) Levier de commande de vitesse
(16) Ressort limiteur de ralent

## [6] DREHZAHLREGLER

Der Drehzahlregler sorgt für eine automatische Konstanthaltung der Motorendrehzahl, indem er die Kraftstoffmenge, die dem Motor je nach Ladeveränderung zuführt, wird regelt. Dieser Motor arbeitet mit einem für alle Drehzahl ausgelegten Regler, der die durch die Drehung der Kraftstoff-Nockenwelle (9) erzeugte Fliehkraft des stahlkugelgewichts (13) steurt. Die Reglerfeder 1 (2) und 2 (3) wird gleichmäßig beansprucht.

(1) Anlaßfeder
(2) Reglerfeder 1
(3) Reglerfeder 2
(4) Gabelhebel 1
(5) Gabelhebel 2
(6) Gabelhebelachse
(7) Gabelhebelhalterung
(8) Reglerhebel
(9) Kraftstoff-Nockenwelle
(10) Reglerkugelgehäuse
(11) Stahlkugel
(12) Reglerbüchse
(13) Stahlkugel

### ■ Beim Start

Da die Stahlkugeln (13) keiner Fliehkraft unterstehen, wird der Gabelhebel 1 (4) nach rechts von der Anlasserfeder (1) angezogen. Dementsprechend bewegt sich die Regelstange (14) in die maximale Einspritzposition und gewährleistet ein müheloses Starten.

(14) Regelstange

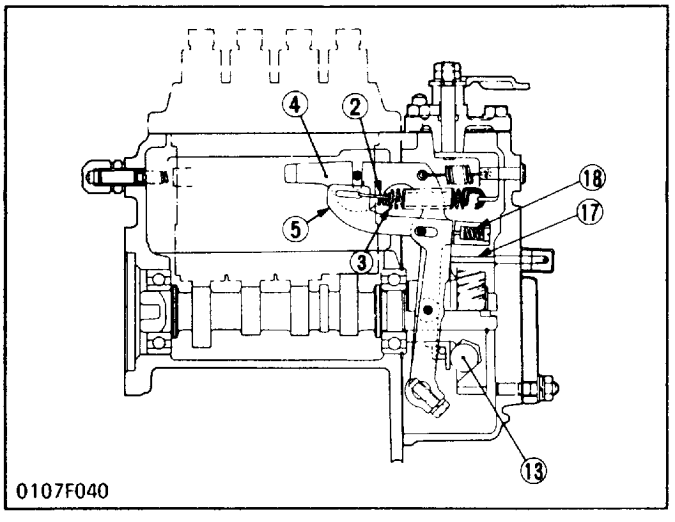
### ■ Bei Leerlauf

Wenn nach Anlassen des Motors der Geschwindigkeitsreglerhebel (15) in Leerlaufposition gebracht wird, ist keine Funktion der Reglerfeder 1 (2) und nur eine geringe Funktion der Reglerfeder 2 (3) gegeben. Die Reglermanschette (12) wird durch die Fliekraft der Stahlkugeln (13) nach links geschoben.

Der Gabellhebel 1 (4) und die Regelstange (14) werden somit durch die Reglermanschette nach links bewegt, während die Leerlaufbegrenzungsfeder (16) durch die Regelstange zusammengedrückt wird. Die Regelstange wird sodann in einer Position gehalten, in der eine Fliehkraft der Stahlkugeln und eine Betätigung der Anlasserfeder (1) gegeben ist, wobei die Reglerfeder 2 und die Leerlaufbegrenzungsfeder ausgeglichen sind und einen ruhigen und beständigen Leerlauf gewährleisten.

(15) Geschwindigkeitsreglerhebel
(16) Leerlaufbegrenzungsfeder

## ■ At high speed running with overload



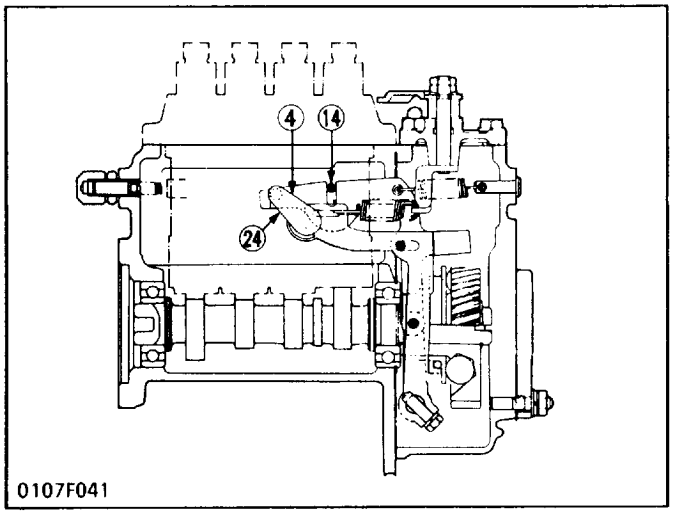
0107F040

When an overload is applied to the engine running at a high speed, the centrifugal force of steel ball (13) becomes small as the engine speed is dropped, and fork lever 2 (5) is pulled to the right by the governor springs 1 (2) and 2 (3), increasing fuel injection. Though, fork lever 2 becomes ineffective in increasing fuel injection when it is stopped by the adjusting bolt (17).

After that, when the force of torque spring (18) becomes greater than the centrifugal force of the steel ball, fork lever 1 (4) moves rightward to increase fuel injection, causing the engine to run continuously at a high torque.

(17) Adjusting Bolt
(18) Torque Spring

## ■ To stop engine



0107F041

When the stop lever (19) is moved to STOP position, fork lever 1 (4) is moved leftward and the control rack (14) is moved to the non-injection position, stopping the engine.

(19) Stop Lever

### ■ Marche à régime élevée avec surcharge

Lorsqu'un moteur tournant à grande vitesse, subit une surcharge, la force centrifuge des billes (13) devient moindre en raison de la chute du régime moteur; le levier à chape 2 (5) est alors tiré vers la droite par les ressorts 1 (2) et 2 (3) du régulateur, ce qui augmente l'injection de carburant. Ce pendant, le levier à chape 2 n'agit pas pour augmenter l'injection du carburant s'il est arrêté par la vis de réglage (17).

Après cela, lorsque la force du ressort (18) devient supérieure à la force centrifuge des billes, le levier à chape 1 (4) se déplace vers la droite pour augmenter l'injection de carburant, faisant tourner le moteur en continu avec un couple élevé.

(17) Vis de réglage
(18) Ressort

### ■ Pour arrêter le moteur

Lorsque le levier d'arrêt (19) est placé en position STOP, le levier à chape 1 (4) est déplacé vers la gauche et la crémaillère de pilotage (14) vient se placer en position d'arrêt d'injection, ce qui met le moteur à l'arrêt.

(19) Levier d'arrêt

### ■ Bei hoher Drehzahl mit Überlast

Wenn der Motor bei hoher Drehzahl einer Überlast ausgesetzt wird, vermindert sich die Fliehkraft der Stahlkugeln (13) entsprechend dem Abfall der Motorendrehzahl. Der Gabelhebel 2 (5) wird durch die Reglerfedern 1 (2) und 2 (3) nach rechts gezogen und die Kraftstoffeinspritzung erhöht. Der Gabelhebel 2 bewirkt keine erhöhte Kraftstoffeinspritzung, wenn er durch die Stellschraube (17) in Anschlagposition gebracht wird.

Wenn die Kraft der Feder (18) größer wird als die Fliehkraft der Stahlkugeln, bewegt sich der Gabelhebel 1 (4) nach rechts und bewirkt eine erhöhte Kraftstoffeinspritzung, während der Motor gleichmäßig bei hohem Drehmoment läuft.

(17) Stellschraube
(18) Feder

### ■ Ausschalten des Motors

Wenn der Anschlaghebel (19) in Anschlagstellung gebracht wird, bewegt sich der Gabelhebel 1 (4) nach links, während sich die Regelstange (14) in die Nicht-Einspritz-Position bewegt und so den Motor ausschaltet.

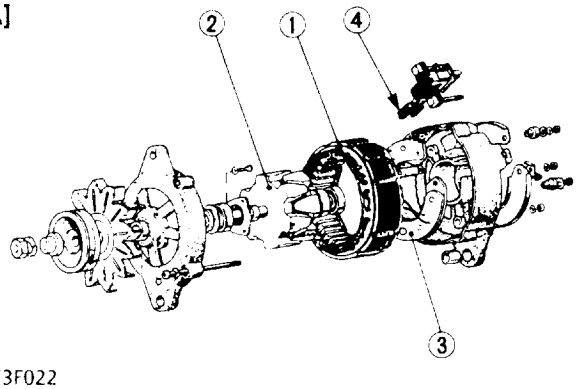
(19) Anschlaghebel

# 6 ELECTRICAL SYSTEM

## [1] CHARGING SYSTEM

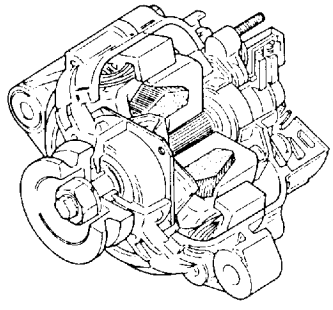
### (1) Alternator

[A]




0073F022

[B]



0087F032

The alternator generates 3-phase current at a fixed coil by the rotation of a rotor which is then emitted as full-wave rectified current by a diode. The alternator can generate power at all speeds from low to high.

(D1403-B, D1703-B, V1903-B, F2803-B)

A compact alternator with an IC regulator is used, having the following characteristics:

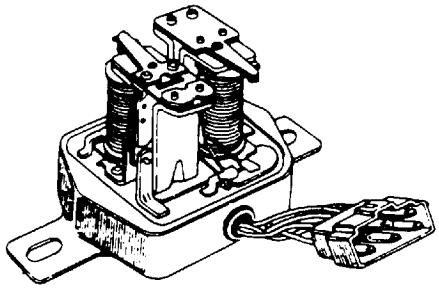
- Approximately 26% lighter and 17% smaller than a standard alternator.
- Cooling performance and safety have been improved by combining the cooling fan with the rotor and incorporating the fan / rotor unit inside the alternator.
- IC regulator is fitted inside the alternator.
- The rectifier, IC regulator and similar components are easy to remove, making it easier to service the alternator.

(1) Armature
(2) York
(3) Rectifier
(4) Brush

**[A] Standard**

**[B] Compact type (equipped with IC regulator)**

### (2) Regulator (Contact type)



C042F089

The regulator regulates the charging voltage. Since the alternator speed is varied by engine speed variation, the output voltage from alternator varies. However, constant voltage (12 V) must be supplied to the battery. That is the regulator which works to keep the charging voltage at 12 V.

# 6 SYSTEME ELECTRIQUE

## [1] CIRCUIT DE CHARGE

### (1) Alternateur

L'alternateur entraîne un courant triphasé à hauteur d'un bobinage fixe, par la rotation d'un rotor. Ce courant est alors réctifié par une diode. L'alternateur peut engendrer des puissances à tous les régimes.

(D1403-B, D1703-B, V1903-B, F2803-B)

L'alternateur utilisé est un alternateur compact avec un régulateur à CI intégré, qui a les caractéristiques suivantes:

- Il est de 26% plus léger et de 17% plus compact par rapport à l'alternateur standard.
- L'efficacité de refroidissement et la sécurité sont améliorées en incorporant dans l'alternateur, le ventilateur de refroidissement et le rotor aui sont véunis en un ensemble.
- Le régulateur à CI est intégré dans l'alternateur.
- Le redresseur, le régulateur à CI et les composants similaires sont faciles à déposer, ce qui facilite l'entretien de l'alternateur.

(1) Induit
(2) Carcasse
(3) Redresseur
(4) Balai

**[A] Standard**
**[B] Type Compact (avec un régulateur a Circuit Intégré)**

### (2) Régulateur (Type Contact)

Le régulateur change courant alternatif au courant continu, et aussi régle le voltage de charge. Car la vitesse d'alternateur est varié avec la vitesse du moteur, le voltage du débit par l'alternateur se varie. Mais, un voltage constant (12 V) soit être envoyé pour charger la batterie. C'est le régulateur qui fonctionne pour obtenir le voltage de débit en 12 V.

# 6 ELEKTRISCHES-SYSTEM

## [1] LADESYSTEM

### (1) Wechselstromdynamo

Durch der Alternator wird an einer feststehenden Spule durch die Drehung des Rotors ein Drehstrom erzeugt, der sodann als gleichgerichteter Vollwegstrom durch eine Diode übertragen wird. Die von dem Alternator erzeugte Leistung erstreckt sich auf alle Geschwindigkeiten von niedriger bis zu hoher Geschwindigkeit.

(D1403-B, D1703-B, V1903-B, F2803-B)

Eine kompakte Lichtmaschine mit einer integrierten Reglerschaltung verwendet, die die folgenden Merkmale besitzt:

- Ungefähr 26% leichter und 17% kleiner als eine herkömmliche Lichtmaschine.
- Durch die Verbindung des Lüfters mit dem Läufer und dem Einbau der Lüfter / Läufer-Einheit in die Lichtmaschine wurde die Kühlleistung und Sicherheit verbessert.
- Die integrierte Reglerschaltung ist in der Lichtmaschine untergebracht.
- Gleichrichter, integrierte Reglerschaltung und ähnliche Komponenten können leicht ausgebaut werden und erleichtern somit die Instandhaltung der Lichtmaschine.

(1) Anker
(2) Magnetjoch
(3) Gleichrichter
(4) Bürste

**[A] Genormtes**
**[B] Kompakte Typ (mit einer integrierten Reglerschaltung)**

### (2) Regulers (Kontakt Typ)

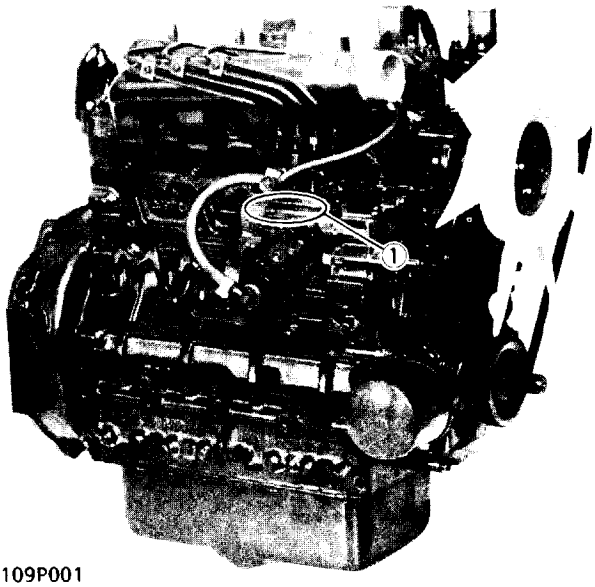
Der Regulator wandelt Wechselstrom in Gleichstrom um und kontrolliert gleichzeitig die Ladespannung. Da die Umdrehungsgeschwindigkeit des Dynamos von der Umdrehungszahl des Motors abhängig ist, ist auch seine Ausgangsspannung unterschiedlich. Die Batterie muß jedoch mit einer konstanten Spannung von (12 V) gespeist werden. Der Regulator hält die Ladespannung konstant auf 12 V.

# S. DISASSEMBLING AND SERVICING
# DEMONTAGE ET ENTRETIEN
# AUSBAU UND WARTUNG

# G GENERAL

## [1] ENGINE IDENTIFICATION

### Model Name and Engine Serial Number

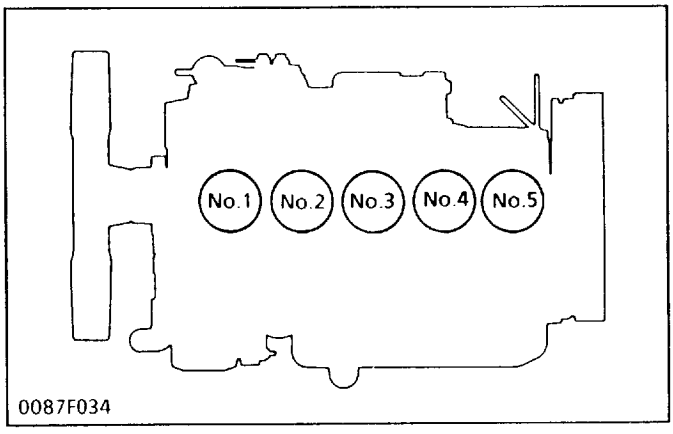



A109P001

When contacting the manufacturer, always specify your engine model name and serial number.

(1) Engine Model and Serial Number

### Cylinder Number




0087F034

The cylinder numbers of 92.4 mm STROKE SERIES diesel engine are designated as shown in the figure.

The sequence of cylinder numbers is given as No.1, No.2, No.3, No.4 and No.5 starting from the gear case side.

# G GENERALITES

## [1] IDENTIFICATION DU MOTEUR

### Modèle et numéro de fabrication du moteur

Si l'on consulte le constructeur, ne pas manquer d'indiquer le modèle et le numéro de fabrication du moteur.

(1) Modèle moteur et numéro de série

### Numéros des cylindres

Les numéros des cylindres des moteurs diesel moteur de série à 92,4 mm de course sont indiqués comme le montre la figure. L'ordre des numéros des cylindres est le suivant: N°1, N°2, N°3, N°4, N°5, en commençant du côté du carter de distribution.

# G ALLGEMEINES

## [1] MOTOR KENNZEICHNUNG

### Modellbezeichnung und Motor-Seriennummer

Wenn Sie sich mit dem Hersteller in Verbindung setzen, geben Sie stets die Modellbezeichnung und Seriennummer Ihres Motors an.

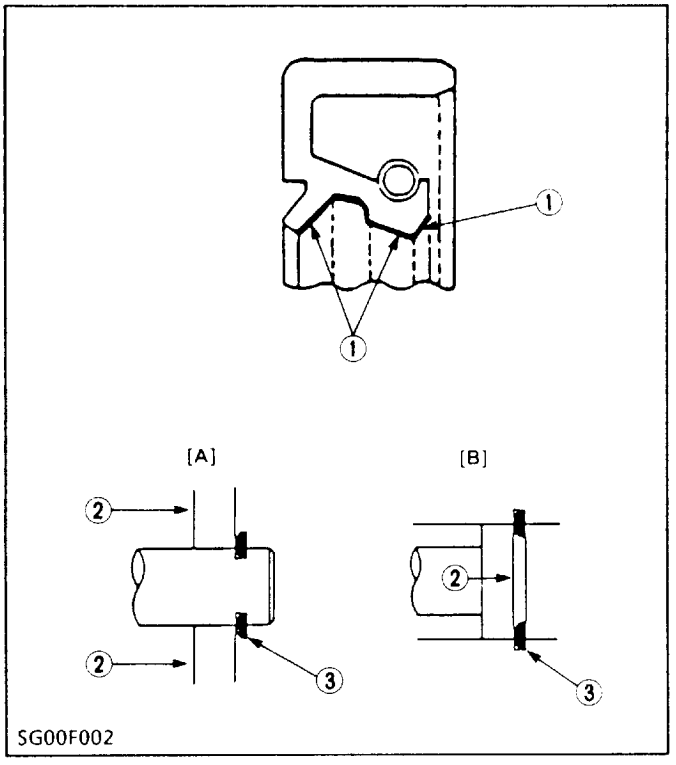
(1) Motormodell und Seriennummer

### Zylinderzahl

Die Zylinderzahl der Dieselmotoren Serienmotor mit 92,4 mm Mub sind wie in der Abbildung gezeigt.

Die Reihenfolge der Zylinderzahl ist mit Nr.1, Nr.2, Nr.3, Nr.4 und Nr.5 von der Getriebegehäuseseite aus angegeben.

# [2] GENERAL PRECAUTION




- During disassembly, carefully arrange removed parts in a clean area to prevent confusion later. Screws, bolts and nuts should be replaced in their original position to prevent reassembly errors.
- When special tools are required, use Kubota's genuine special tools. Special tools which are not frequently used should be made according to the drawings provided.
- Before disassembling or servicing live wires, make sure to always disconnect the grounding cable from the battery first.
- Remove oil and dirt from parts before measuring.
- Use only KUBOTA genuine parts for parts replacement to maintain engine performance and to ensure safety.
- Gaskets and O-rings must be replaced during reassembly. Apply grease to new O-rings or oil seals before assembling.
- When reassembling external or internal snap rings, position them so that the sharp edge faces against the direction from which force is applied.
- Be sure to perform run-in the serviced or reassembled engine. Do not attempt to give heavy load at once, or serious damage may result to the engine.

**CAUTION**

- **Certain components used in this engine (cylinder head-gasket, exhaust gasket, etc.) contain asbestos. Handle with care according to safety regulation.**

(1) Grease
(2) Force
(3) Place the Sharp Edge against the Direction of Force

**[A] External Snap Ring**
**[B] Internal Snap Ring**

## [2] PRECAUTIONS GENERALITES

- Pendant le démontage, ranger avec soin les pièces démontées dans un endroit propre, pour éviter toute confusion ultérieure. Les vis, les boulons et les écrous doivent être replacés dans leur position initiale pour éviter les erreurs au remontage.
- Utiliser des outils spéciaux Kubota d'origine. Les outils spéciaux peu utilisés peuvent être fabriqués d'après les plans fournis.
- Avant le démontage et avant tout travail sur des faisceaux sous-tension, s'assurer que l'on a décoonnecté d'abord le câble de masse de la batterie.
- Avant de prendre une mesure, enlever l'huile et la poussière pouvant se trouver sur les pièces.
- Pour les pièces de rechange, utiliser toujours les pièces KUBOTA d'origine, afin de conserver le rendement du moteur et assurer une sécurité totale de fonctionnement.
- Les joints plats et les joints toriques doivent être changés lors du remontage. Mettre de la graisse sur les joints toriques ou sur les joints d'huile neufs avant de les remonter.
- Pour remonter des circlips externe ou interne, les placer de manière que l'arête vive soit dirigée dans le sens d'où provient la force appliquée.
- Pour être sûr de réussir la mise en marche du moteur révisé ou remonté, évitez d'appliquer directement une lourde charge, car sinon des dégâts au moteur pourraient en résulter.

**⚠ ATTENTION**

- **Certains composants utilisés dans ce moteur (joint de culasse, joint d'échappement, etc.) contiennent de l'amiante. Manipuler avec soin selon la norme de sécurité.**

(1) Graisse
(2) Force
(3) Placer le côté à l'opposé de la direction d'où la force est appliquée

**[A] Circlip externe**
**[B] Circlip interne**

## [2] ALLGEMEINE VORKEHRUNGEN

- Beim Ausbau sind die entfernten Teile ordentlich abzulegen, um eine spätere Verwechslung zu vermeiden. Schrauben, Bolzen und Muttern sollten in ihrer ursprünglichen Position ausgetauscht werden, um Irrtümerr beim Wiederzusammenbau auszuschließen.
- Wenn Spezialwerkzeuge erforderlich sind, sollten Originalwerkzeuge von KUBOTA benutzt werden. Nicht häufig benutzte Spezialwerkzeuge sollten anhand der vorliegenden Zeichnungen hergestellt werden.
- Vor dem Ausbau oder vor einer Reparatur von stromführenden Drähten ist darauf zu achten, daß das Erdkabel zuerst von der Batterie getrennt wird.
- Vor der Furchführung von Messungen ist sämtliches Öl und Schmutz von den Teilen zu entfernen.
- Für den Austausch von Teilen sind nur Originalteile von KUBOTA zu verwenden, um eine einwandfreie Leistung des Motors zu gewährleisten.
- Dichtungen und O-ringe sind beim Wiederzusammenbau auszutauschen. Vor dem Einbau sind die neuen O-ringe oder Wellendichtungen mit Fett einzureiben.
- Beim Wiedereinbau äußere oder innere Sicherungsring ist darauf zu achten, daß diese derart eingesetzt werden, daß die scharfe Kante in die Richtung zeigt, aus welcher die Kraft aufgetragen wird.
- Die gewartete oder wiederzusammengesetzte Maschine muß unbedingt zunächst eingefahren werden. Die Maschine darf in keinem Fall von Anfang an vol belastet werden. Beachten Sie dies unbedingt, da die Maschine sonst schweren Schaden nehmen könnte.

**⚠ ACHTUNG**

- **Engine am Motor verwendete Dichtungen enthalten Asbest (Zylinderkopfdichtung, Auspuffdichtung usw.). Bitte beachten Sie bei der Reparatur die einschlägigen Sicherheitsvorschriften.**

(1) Schmierung
(2) Kraft
(3) Die scharfe Kante der Belastungskraft entgegen einsetzen.

**[A] Äußere-Sicherungsring**
**[B] Innere-Sicherungsring**

# [3] TIGHTENING TORQUES

Screws, bolts and nuts must be tightened to the specified torque using a torque wrench, Several screws, bolts and nuts such as those used on the cylinder head must be tightened in proper sequence and at the proper torque.

## (1) Tightening torques for special use screws, bolts and nuts

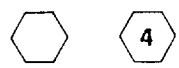
■ **NOTE**

- **For "*" marked screws, bolts and nuts on the table, apply engine oil to their threads and seats before tightening.**
- **After well cleaning its thread and bearing surface, fit a new head bolt (rust-preventive oil applied) without applying engine oil to it.**
- **When reusing the head bolt, apply engine oil to its thread and bearing surface before fitting it. After installing the engine, let it run for 30 minutes, and retighten the head bolt. (Before retightening it, loosen it by 30 to 90°.)**

| | Item | Size x Pitch | N·m | kgf·m | ft-lbs |
|---|---|---|---|---|---|
| | Head cover cap nut | M8 x 1.25 | 6.9 to 8.8 | 0.7 to 0.9 | 5.1 to 6.5 |
| * | Head bolt | M11 x 1.25 | 93.1 to 98.0 | 9.5 to 10.0 | 68.7 to 72.3 |
| * | Bearing case bolt 1 | M9 x 1.25 | 46.1 to 50.9 | 4.7 to 5.2 | 34.0 to 37.6 |
| * | Bearing case bolt 2 | M10 x 1.25 | 68.6 to 73.5 | 7.0 to 7.5 | 50.6 to 54.2 |
| * | Flywheel bolt | M12 x 1.25 | 98.0 to 107.8 | 10.0 to 11.0 | 72.3 to 79.5 |
| * | Connecting rod bolt | | | | |
| | (Non-flange bolt) | M8 x 1.0 | 36.3 to 41.2 | 3.7 to 4.2 | 26.6 to 30.4 |
| | (flange bolt) | M8 x 1.0 | 44.1 to 49.0 | 4.5 to 5.0 | 32.5 to 36.2 |
| * | Rocker arm bracket nut | M8 x 1.25 | 22.5 to 27.5 | 2.4 to 2.8 | 17.4 to 20.3 |
| * | Idle gear shaft bolt | M8 x 1.25 | 22.5 to 27.5 | 2.4 to 2.8 | 17.4 to 20.3 |
| * | Crankshaft end nut | M30 x 1.5 | 137.3 to 156.9 | 14.0 to 16.0 | 101.2 to 115.7 |
| | Crankshaft end bolt (F2803-B(E)) | M16 x 1.5 | 313.8 to 333.4 | 32.0 to 34.0 | 231.4 to 245.9 |
| | Glow plug | M10 x 1.25 | 19.6 to 24.5 | 2.0 to 2.5 | 14.5 to 18.1 |
| | Nozzle holder assembly | M20 x 1.5 | 49.0 to 68.6 | 5.0 to 7.0 | 36.2 to 50.6 |
| | Oil switch taper screw | PT 1/8 | 14.7 to 19.6 | 1.5 to 2.0 | 10.8 to 14.5 |
| | Injection pipe retaining nut | M12 x 1.5 | 24.5 to 34.3 | 2.5 to 3.5 | 18.1 to 25.3 |

## (2) Tightening torques for general use screws, bolts and nuts

When the tightening torques are not specified, tighten the screws, bolts and nuts according to the table below.

| Grade / Nominal Diameter / Unit | Standard Screw and Bolt  SG00F004 | | | Special Screw and Bolt  | | |
|---|---|---|---|---|---|---|
| | N·m | kgf·m | ft-lbs | N·m | kgf·m | ft-lbs |
| M 6 | 7.9 to 9.3 | 0.80 to 0.95 | 5.8 to 6.9 | 9.8 to 11.3 | 1.00 to 1.15 | 7.23 to 8.32 |
| M 8 | 17.7 to 20.6 | 1.8 to 2.1 | 13.0 to 15.2 | 23.5 to 27.5 | 2.4 to 2.8 | 17.4 to 20.3 |
| M10 | 39.2 to 45.1 | 4.0 to 4.6 | 28.9 to 33.3 | 48.1 to 55.9 | 4.9 to 5.7 | 35.4 to 41.2 |
| M12 | 62.8 to 72.6 | 6.4 to 7.4 | 46.3 to 53.5 | 77.5 to 90.2 | 7.9 to 9.2 | 57.1 to 66.5 |

Screw and bolt material grades are shown by numbers punched on the screw and bolt heads. Prior to tightening, be sure to check out the numbers as shown below.

| Punched Number | Screw and Bolt Material Grade |
|---|---|
| None or **4** | Standard Screw and Bolt SS41, S20C |
| **7** | Special Screw and Bolt S43C, S48C (Refined) |

# [3] COUPLES DE SERRAGE

Les vis, les boulons et les écrous doivent être serrés au couple spécifié à l'aide d'une clef dynamométrique. Plusieurs des vis, des boulons et des écrous, comme ceux de la culasse, doivent être serrés dans un ordre déterminé et à un couple spécifié.

## (1) Couples de serrage pour vis, boulons et écrous d'une utilisation particulière

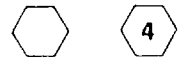
■ **NOTA**

- **Pour les vis, les boulons et les écrous marqués "*" dans le tableau, enduire d'huile moteur le filetage et les sièges avant d'effective serrage.**
- **Après avoir bien nettoyé son filetage et sa surface d'appui, adapter un nouveau boulon à tête (avec application d'huile antirouille) sans appliquer dessus d'huile pour moteurs.**
- **Après installation du moteur, le laisser tourner pendant 30 minutes, et resserrer le boulon à tête. (Avant de le resserrer, le desserrer de 30 à 90°.)**

| | Elément | Dimension x pas | N·m | kgf·m |
|---|---|---|---|---|
| | Ecrous de couvercle de culasse | M8 x 1,25 | 6,9 à 8,8 | 0,7 à 0,9 |
| * | Vis de culasse | M11 x 1,25 | 93,1 à 98,0 | 9,5 à 10,0 |
| * | Vis 1 de fixation de palier | M9 x 1.25 | 46,1 à 50,9 | 4,7 à 5,2 |
| * | Vis 2 de fixation de palier | M10 x 1.25 | 68,6 à 73,5 | 7,0 à 7,5 |
| * | Vis de volant | M12 x 1,25 | 98,0 à 107,8 | 10,0 à 11,0 |
| * | Boulon de tête de bielle | | | |
| | (Boulon sans collerette) | M8 x 1,0 | 36,3 à 41,2 | 3,7 à 4,2 |
| | (Boulon à collerette) | M8 x 1,0 | 44,1 à 49,0 | 4,5 à 5,0 |
| * | Ecrous de support de culbuteur | M8 x 1,25 | 22,5 à 27,5 | 2,4 à 2,8 |
| * | Vis l'axe du pignon | M8 x 1,25 | 22,5 à 27,5 | 2,4 à 2,8 |
| * | Ecrou d'extrémité de vilebrequin | M30 x 1,5 | 137,3 à 156,9 | 14,0 à 16,0 |
| | Boulon d'extrémité de vilebrequin (F2803-B(E)) | M16 x 1,5 | 313,8 à 333,4 | 32,0 à 34,0 |
| | Bougies de préchauffage | M10 x 1,25 | 19,6 à 24,5 | 2,0 à 2,5 |
| | Porte-injecteur | M20 x 1,5 | 49,0 à 68,6 | 5,0 à 7,0 |
| | Vis conique de manocontact de pression d'huile | PT 1/8 | 14,7 à 19,6 | 1,5 à 2,0 |
| | Ecrous de fixation de conduit d'injection | M12 x 1,5 | 24,5 à 34,3 | 2,5 à 3,5 |

## (2) Couples de serrage pour vis, boulons et écrous d'utilisation générale

Lorsque les couples de serrage ne sont pas spécifiés, serrer les vis, les boulons et les écrous aux valeurs du tableau ci-dessous.

| Grade / Diametètre Nominal / Unité | Vis et boulon standard  SG00F004 | | Vis et boulon spéciale  | |
|---|---|---|---|---|
| | N·m | kgf·m | N·m | kgf·m |
| M 6 | 7,9 à 9,3 | 0,80 à 0,95 | 9,8 à 11,3 | 1,00 à 1,15 |
| M 8 | 17,7 à 20,6 | 1,8 à 2,1 | 23,5 à 27,5 | 2,4 à 2,8 |
| M10 | 39,2 à 45,1 | 4,0 à 4,6 | 48,1 à 55,9 | 4,9 à 5,7 |
| M12 | 62,8 à 72,6 | 6,4 à 7,4 | 77,5 à 90,2 | 7,9 à 9,2 |

La qualité du matériau des vis est indiquée par des nombres gravés sur les têtes des vis et des boulons. Avant le serrage, bien vérifier les nombres indiqués ci-dessous.

| Numéro gravé | Qualité du matériau de la vis et de la boulon |
|---|---|
| Aucun ou **4** | Vis et boulon spéciale SS41, S20C |
| **7** | Vis et boulon spéciale S43C, S48C (raffiné) |

# [3] ANZUGSDREHMOMENTE

Die Schrauben, Bolzen und Muttern müssen mit dem vorgeschriebenen Anzugsdrehmoment unter Verwendung eines Drehmomentschlüssels angezogen werden. Verschiedene Schrauben, Bolzen und Muttern, wie sie beispielsweise am Zylinderkopf benutzt werden, sind in der richtigen Reihenfolge, sowie mit dem vorgeschriebenen Drehmoment anzuziehen.

## (1) Anzugsdrehmomente für spezielle Schrauben, Bolzen und Muttern

**■ ANMERKUNG**

- **Die Gewinde und Sitze der in der Tabelle mit "*" gekennzeichneten Schrauben, Bolzen und Muttern sind vor dem Anziehen mit Motoröl zu beschichten.**
- **Nachdem das Gewinde und die Auflagefläche gut gereinigt wurden, ist eine neue Zylinderkopfschraube (mit etwas Rostschutzöl versehen) einzusetzen. Kein Motoröl auf die Schraube auftragen.**
- **Bei einer Wiederverwendung der Zylinderkopfschraube ist das Gewinde und die Auflagefläche vor dem Einbau mit Motoröl zu versehen. Nach dem Einbau des Motors ihn etwa 30 Minuten laufenlassen, dann die Zylinderkopfschrauben noch einmal nachziehen. (Vor dem endgültigen Festziehen die Schrauben um 30 bis 90° lösen.)**

| | Teil | Größe x Steigung | N·m | kp·m |
|---|---|---|---|---|
| | Hutmutter der Zylinderkopfdeckel | M8 x 1,25 | 6,9 bis 8,8 | 0,7 bis 0,9 |
| * | Zylinderkopfschrauben | M11 x 1,25 | 93,1 bis 98,0 | 9,5 bis 10,0 |
| * | Lagergehäuseschrauben 1 | M9 x 1,25 | 46,1 bis 50,9 | 4,7 bis 5,2 |
| * | Lagergehäuseschrauben 2 | M10 x 1,25 | 68,6 bis 73,5 | 7,0 bis 7,5 |
| * | Schwungradschrauben | M12 x 1,25 | 98,0 bis 107,8 | 10,0 bis 11,0 |
| * | Schrauben an der Pleuelstange | | | |
| | (Schraube ohne Flansch) | M8 x 1,0 | 36,3 bis 41,2 | 3,7 bis 4,2 |
| | (Flansch-Schraube) | M8 x 1,0 | 44,1 bis 49,0 | 4,5 bis 5,0 |
| * | Kipphebelbockmuttern | M8 x 1,25 | 22,5 bis 27,5 | 2,4 bis 2,8 |
| * | Leerlaufgetriebeachsschrauben | M8 x 1,25 | 22,5 bis 27,5 | 2,4 bis 2,8 |
| * | Kurbelwellenmutter | M30 x 1,5 | 137,3 bis 156,9 | 14,0 bis 16,0 |
| | Kurbelwellenschraube (F2803-B(E)) | M16 x 1,5 | 313,8 bis 333,4 | 32,0 bis 34,0 |
| | Glühkerzen | M10 x 1,25 | 19,6 bis 24,5 | 2,0 bis 2,5 |
| | Düsenhalter | M20 x 1,5 | 49,0 bis 68,6 | 5,0 bis 7,0 |
| | Ölschalterkegelschraube | PT 1/8 | 14,7 bis 19,6 | 1,5 bis 2,0 |
| | Sicherungsmuttern Einspritzleitung | M12 x 1,5 | 24,5 bis 34,3 | 2,5 bis 3,5 |

## (2) Anzugsdrehmomente für allgemeine Schrauben, Bolzen und Muttern

Wenn die Anzugsdrehmomente nicht angegeben sind, so werden die Schrauben, Bolzen und Muttern gemäß der nachstehenden Tabelle angezogen:

| Klassifikation / Nenndurchmesser / Einheit | Standard-Schraube und -Bolzen 4 | | Spezial-Schraube und -Bolzen 7 | |
|---|---|---|---|---|
| | N·m | kp·m | N·m | kp·m |
| M 6 | 7,9 bis 9,3 | 0,80 bis 0,95 | 9,8 bis 11,3 | 1,00 bis 1,15 |
| M 8 | 17,7 bis 20,6 | 1,8 bis 2,1 | 23,5 bis 27,5 | 2,4 bis 2,8 |
| M10 | 39,2 bis 45,1 | 4,0 bis 4,6 | 48,1 bis 55,9 | 4,9 bis 5,7 |
| M12 | 62,8 bis 72,6 | 6,4 bis 7,4 | 77,5 bis 90,2 | 7,9 bis 9,2 |

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Das Material die Schraube und der Bolzen ist durch auf dem Schraubekopf und dem Bolzenkopf eingestanzte Nummern angegeben. Vor dem Anziehen sind die Nummern, wie nachstehend gezeigt, zu prüfen.

| Eingestanzte Nummern | Schraube und Boizenmaterial |
|---|---|
| Keine oder **4** | Standardschraube und -bolzen SS41, S20C |
| 7 | Spezialschraube und -bolzen S43C, S48C (vergütet) |

# [4] TROUBLESHOOTING

| Symptom | Probable Cause | Solution | Reference Page |
|---|---|---|---|
| Engine does not start | • No fuel | Replenish fuel | |
| | • Air in the fuel system | Vent air | |
| | • Water in the fuel system | Change fuel and repair or replace fuel system | |
| | • Fuel pipe clogged | Clean | |
| | • Fuel filter clogged | Clean or change | S-41 |
| | • Excessively high viscosity of fuel or engine oil at low temperature | Use the specified fuel or engine oil | S-39 |
| | • Fuel with low cetane number | Use the specified fuel | |
| | • Fuel leak due to loose injection pipe retaining nut | Tighten nut | |
| | • Incorrect injection timing | Adjust | S-105 |
| | • Fuel cam shaft worn | Replace | |
| | • Injection nozzle clogged | Clean | |
| | • Injection pump malfunctioning | Repair or replace | |
| | • Seizure of crankshaft, camshaft, piston, cylinder liner or bearing | Repair or replace | |
| | • Compression leak from cylinder | Replace head gasket, tighten cylinder head bolt, glow plug and nozzle holder | S-53 |
| | • Improper valve timing | Correct or replace timing gear | |
| | • Piston ring and liner worn | Replace | S-87, 19 |
| | • Excessive valve clearance | Adjust | S-43 |
| Starter does not run | • Battery discharged | Charge | |
| | • Starter malfunctioning | Repair or replace | |
| | • Key switch malfunctioning | Repair or replace | |
| | • Wiring disconnected | Connect | |
| Engine revolution is not smooth | • Fuel filter clogged or dirty | Clean or change | S-41 |
| | • Air cleaner clogged | Clean or change | S-41 |
| | • Fuel leak due to loose injection pipe retaining nut | Tighten nut | |
| | • Injection pump malfunctioning | Repair or replace | |
| | • Incorrect nozzle opening pressure | Adjust | S-107 |
| | • Injection nozzle stuck or clogged | Repair or replace | |
| | • Fuel over flow pipe clogged | Clean | |
| | • Governor malfunctioning | Repair | |
| Either white or blue exhaust gas is observed | • Excessive engine oil | Reduce to the specified level | |
| | • Piston ring and liner worn or stuck | Repair or replace | S-87, 19 |
| | • Incorrect injection timing | Adjust | S-105 |
| | • Deficient compression | Adjust top clearance | S-53 |
| Either black or dark gray exhaust gas is observed | • Overload | Lessen the load | |
| | • Low grade fuel used | Use the specified fuel | |
| | • Fuel filter clogged | Clean or change | |
| | • Air cleaner clogged | Clean or change | |
| | • Deficient nozzle injection | Repair or replace the nozzle | |
| Deficient output | • Incorrect injection timing | Adjust | S-105 |
| | • Engine's moving parts seem to be seizing | Repair or replace | |
| | • Uneven fuel injection | Repair or replace the injection pump | |
| | • Deficient nozzle injection | Repair or replace the nozzle | S-107 |
| | • Compression leak | Replace head gasket, tighten cylinder head bolt, glow plug and nozzle holder | |

| Symptom | Probable Cause | Solution | Reference Page |
|---|---|---|---|
| **Excessive lubricant oil consumption** | • Piston ring's gap facing the same direction | Shift ring gap direction | S-67 |
| | • Oil ring worn or stuck | Replace | |
| | • Piston ring groove worn | Replace the piston | S-87 |
| | • Valve stem and guide worn | Replace | |
| | • Oil leaking due to defective seals or packing | Replace | |
| **Fuel mixed into lubricant oil** | • Injection pump's plunger worn | Replace pump element or pump | S-107 |
| | • Deficient nozzle injection | Repair or replace the nozzle | |
| | • Injection pump broken | Replace | |
| **Water mixed into lubricant oil** | • Head gasket defective | Replace | |
| | • Cylinder block or cylinder head flawed | Replace | |
| **Low oil pressure** | • Engine oil insufficient | Replenish | |
| | • Oil strainer clogged | Clean | S-67 |
| | • Relief valve stuck with dirt | Clean | |
| | • Relief valve spring weaken or broken | Replace | |
| | • Excessive oil clearance of crankshaft bearing | Replace | |
| | • Excessive oil clearance of crank pin bearing | Replace | |
| | • Excessive oil clearance of rocker arm bearing | Replace | |
| | • Oil passage clogged | Clean | |
| | • Different type of oil | Use the specified type of oil | S-39 |
| | • Oil pump defective | Repair or replace | |
| **High oil pressure** | • Different type of oil | Use the specified type of oil | S-39 |
| | • Relief valve defective | Replace | |
| **Engine overheated** | • Engine oil insufficient | Replenish | |
| | • Fan belt broken or elongated | Change or adjust | S-39 |
| | • Cooling water insufficient | Replenish | |
| | • Radiator net and radiator fin clogged with dust | Clean | |
| | • Inside of radiator corroded | Clean or replace | |
| | • Cooling water flow route corroded | Clean or replace | |
| | • Radiator cap defective | Replace | |
| | • Overload running | Loosen the load | |
| | • Head gasket defective | Replace | |
| | • Incorrect injection timing | Adjust | |
| | • Unsuitable fuel used | Use the specified fuel | |
| **Battery quickly discharge** | • Battery electrolyte insufficient | Replenish distilled water and charge | |
| | • Fan belt slips | Adjust belt tension or change | |
| | • Wiring disconnected | Connect | |
| | • Rectifier defective | Replace | |
| | • Alternator defective | Replace | |
| | • Battery defective | Change | |

# [4] DEPANNAGE

| Anomalie | Cause possible | Solution | Page de ref. |
|---|---|---|---|
| Le moteur ne démarre pas | • Pas de carburant | Refaire le plein | |
| | • Air dans le circuit d'alimentation | Purger l'air | |
| | • Eau dans le circuit d'alimentation | Changer le carburant et réparer ou remplacer le système d'alimentation | |
| | • Conduit d'alimentation colmaté | Nettoyer | |
| | • Filtre à carburant colmaté | Nettoyer ou changer | S-42 |
| | • Trop forte viscosité du carburant ou de l'huile moteur à basse température | Utiliser le carburant ou l'huile moteur spécifiés | S-40 |
| | • Carburant à faible indice de cétane | Utiliser le carburant spécifié | |
| | • Fuite de carburant due au mauvais serrage d'un écrou de fixation du conduit d'injection | Serrer l'écrou | |
| | • Mauvais calage de l'injection | Régler | S-106 |
| | • Usure de l'arbre à cames | Remplacer | |
| | • Injecteur colmaté | Nettoyer | |
| | • Mauvais fonctionnement de la pompe d'injection | Réparer ou remplacer | |
| | • Grippage du vilebrequin, de l'arbre à cames, de piston, de chemise de cylindres ou de paliers | Réparer uo remplacer | |
| | • Manque de compression dans le cylindre | Remplacer le joint de culasse, serrer la vis de culasse, remplacer la bougie de préchauffage et le porte-injecteur | S-54 |
| | • Mauvais calage des distribution | Rectifier ou remplacer le pignon de distribution | |
| | • Usure de segment et de chemise | Remplacer | S-88, 20 |
| | • Excés de jeu des distribusion | Régler | S-44 |
| Le démarreur ne marche pas | • Batterie déchargée | Charger | |
| | • Mauvais fonctionnement du démarreur | Réparer ou remplacer | |
| | • Mauvais fonctionnement du interrupteur à clé | Réparer ou remplacer | |
| | • Câblage débranché | Brancher | |

| Anomalie | Cause possible | Solution | Page de ref. |
|---|---|---|---|
| **Le moteur ne tourne pas régulièrement** | • Filtre à carburant colmaté ou sale<br>• Filtre à air colmaté<br>• Fuite de carburant due au mauvais serrage d'un écrou de fixation du conduit d'injecteur<br>• Mauvais fonctionnement de la pompe d'injection<br>• Mauvais pression d'ouverture d'injecteur<br>• Injecteur colle ou colmaté<br>• Tuyau de trop-plain de carburant<br>• Mauvais fonctionnement du régulateur | Nettoyer ou changer<br>Nettoyer ou changer<br>Resserrer l'écrou<br>Réparer ou remplacer<br>Régler<br>Réparer ou remplacer<br>Nettoyer<br>Réparer | S-42<br>S-42<br>S-108 |
| **Les gaz d'échappement sont soit blancs, soit bleus** | • Excès d'huile moteur<br>• Usure ou collage d'un segment et d'une chemiseè<br>• Mauvais calage de l'injection<br>• Mauvais compression | Réduire au niveau spécifié<br>Réparer ou remplacer<br>Régler<br>Régler les l'espace neutre | S-88, 20<br>S-106<br>S-54 |
| **Les gaz d'échappement sont soit noirs, soit gris sombre** | • Surcharge<br>• Mauvaise qualité de carburant<br>• Filtre à carburant colmaté<br>• Filtre à air colmaté<br>• Injecteur défectueux | Diminuer la charge<br>Utiliser le carburant spécifié<br>Nettoyer ou changer<br>Nettoyer ou changer<br>Réparer ou remplacer l'injecteur | |
| **Puissance insuffisante** | • Mauvais calage de l'injection<br>• Les pièces mobiles du moteur semblent grippées<br>• Injection irrégulière de carburant<br>• Injecteur défectueux<br>• Manque de compression | Régler<br>Réparer ou remplacer<br>Réparer ou remplacer la pompe d'injection<br>Réparer ou remplacer l'injecteur<br>Remplacer le joint de culasse, sèrrer la vis de culasse, la bougie de préchauffage et le porte-injecteur | S-106<br>S-108 |
| **Consommation d'huile excessive** | • Le jeu de coupe est mis dans le même sens pour tous les segments de piston<br>• Segment racleur usé ou colle<br>• Rainure de segment usée<br>• Usure de la queue de soupape et du guide<br>• Fuite d'huile provoquée par une garniture ou une étanchéité défectueuse. | Modifier l'emplacement du jeu de coupe<br>Remplacer<br>Remplacer le piston<br>Remplacer | S-68<br>S-88 |
| **Carburant mélangé à l'huile de graissage** | • Usure du plongeur de pompe d'injection<br>• Injecteur défectueux<br>• Pompe d'injection | Remplacer l'élément de pompe ou la pompe<br>Réparer ou remplacer l'injecteur<br>Remplacer | S-108 |

| Anomalie | Cause possible | Solution | Page de ref. |
|---|---|---|---|
| Eau mélangée à l'huile de graissage | • Joint de culasse défectueux<br>• Carter ou culasse pailleux | Remplacer<br>Remplacer | |
| Faible pression d'huile | • Manque d'huile moteur<br>• Crépine colmatée<br>• Clapet de d'écharge collée par la saleté<br>• Ressort de clapet de d'écharge fatigué ou cassé<br>• Trop de jeu de marche d'un palier de villebrequin<br>• Trop de jeu de marche d'un palier de tête de bielle<br>• Trop de jeu de marche d'une coussinet de culbuteur<br>• Passage d'huile colmaté<br>• Type d'huile ne convenant pas<br>• Pompe à huile défectueuse | Faire l'appoint<br>Nettoyer<br>Nettoyer<br>Remplacer<br>Remplacer<br>Remplacer<br>Remplacer<br>Nettoyer<br>Utiliser le type d'huile spécifié<br>Réparer ou remplacer | S-68<br>S-40 |
| Pression d'huile élevée | • Type d'huile ne convenant pas<br>• Clapet de décharge défectueux | Utiliser le type d'huile spécifié<br>Remplacer | S-40 |
| Moteur surchauffé | • Manque d'huile moteur<br>• Courroie de ventilateur cassée ou détendue<br>• Manque de liquide de refroidissement<br>• Nids d'abeilles ou ailettes de radiateur colmatés par la saleté<br>• Intérieur du radiateur corrodé<br>• Circuit de liquide de refoidissement corroddé<br>• Bouchon de radiateur défectueux<br>• Marche avec surcharge<br>• Joint de culasse défectueux<br>• Mauvais calage de l'injection<br>• Type de carburant ne convenant pas | Faire l'appoint<br>Changer ou régler<br>Faire l'appoint<br>Nettoyer<br>Nettoyer ou remplacer<br>Nettoyer ou remplacer<br>Remplacer<br>Diminuer la charge<br>Remplacer<br>Régler<br>Utiliser le carburant spécifié | S-40 |
| La batterie se décharge trop rapidement | • Manque d'électrolyte<br>• Patinage de la courroie de ventilateur<br>• Câblage débranché<br>• Redresseur défectueux<br>• Dynamo de ventilateur défectueux<br>• Batterie défectueuse | Remettre de l'eau distillée et charger la batterie<br>Régler la tension de la courroie ou la changer<br>Rebrancher<br>Remplacer<br>Remplacer<br>Changer | |

# [4] STÖRUNGSSUCHE

| Störung | Mögliche Ursache | Abhilfe | Referenz Seite |
|---|---|---|---|
| Motor springt nicht an | • Kein Kraftstoft | Kraftstoff auffüllen | |
| | • Luft im Kraftstoffsystem | Entlüften | |
| | • Wasser im Kraftstoffsystem | Kraftstoff austauschen und Kraftstoffsystem reparieren oder erneuen | |
| | • Kraftstoffleitung verstopft | Reinigen | |
| | • Kraftstoff-Filter verstopft | Reinigen oder austauschen | S-42 |
| | • Zu hole Viskosität des Kraftstoffs oder des Motoröls bei niedriger Temperatur | Vorgeschriebenen Kraftstoff oder Motoröl verwenden | S-40 |
| | • Kraftstoff mit niedriger Ceten-Zahl | Vorgeschriebenen Kraftstoff verwenden | |
| | • Kraftstoffverlust infolge gelockerter Sicherrungsmutter der Einspritzleitung | Mutter anziehen | |
| | • Unkorrekte Einstellung der Einspritzung | Einstellen | S-106 |
| | • Kraftstoffnockenwelle abgenutzt | Austauschen | |
| | • Einspritzdüse verstopft | Reinigen | |
| | • Fehlerhafte Funktion der Einspritzpumpe | Reparieren oder austauschen | |
| | • Kurbelwelle, Nockenwelle, Kolben, Zylinderbuchse oder Lager festgefressen | Reparieren oder austauschen | |
| | • Kompressionsverlust am Zylinder | Kopfdichtung austauschen, Zylinderkopfschrauben, Glühkerze und Düsenhalter anziehen | S-54 |
| | • Unzulängliche Ventilsteuerung | Einstellen oder Steuerung austauschen | |
| | • Kolbenring und Buchse abgenutzt | Austauschen | S-88, 20 |
| | • Übermäßiges Ventilspiel | Einstellen | S-44 |
| Anlasser funktioniert nicht | • Batterie entladen | Aufladen | |
| | • Fehlerhafte Funktion des Anlassers | Reparieren oder austauschen | |
| | • Fehlerhafte Funktion des Kippschalters | Reparieren oder austauschen | |
| | • Verdrahtung gelöst | Anschließen | |

| Störung | Mögliche Ursache | Abhilfe | Referenz Seite |
|---|---|---|---|
| Motor dreht nicht gleichmäßig | • Kraftstoff-Filter verstopft oder verschmutzt | Reinigen oder austauschen | S-42 |
| | • Luftfilter verstopft | Säubern oder austauschen | S-42 |
| | • Kraftstoffverlust infolge gelockerter Einspritzleitungsmutter | Mutter anziehen | |
| | • Fehlerhafte Funktion der Einspritzpumpe | Reparieren oder austauschen | |
| | • Falscher Öffmungsdruck der Düse | Einstellen | S-108 |
| | • Einspritzdüse gesteckt oder verstopft | Reparieren oder austauschen | |
| | • Kraftstoffüberlaufrohr verstopft | Reinigen | |
| | • Fehlerhafte Funktion des Reglers | Reparieren | |
| Austritt von weißem oder blauem Abgas | • Zuviel Motoröl | Auf vorgeschriebenen Stand vermindern | |
| | • Kolbenring und Buchse abgenutzt oder gesteckt | Reparieren oder austauschen | S-88, 20 |
| | • Unkorrekte Spritzeinstellung | Einstellen | S-106 |
| | • Unzureichende Verdichtung | Kopfspiel einstellen | S-54 |
| Austritt von schwarzem oder dunkelgrauem Abgas | • Überlast | Last vermindern | – |
| | • Kraftstoff schlechter Qualität | Vorgeschriebenen Kraftstoff verwenden | |
| | • Kraftstoff-Filter verstopft | Reinigen oder austauschen | |
| | • Luftfilter verstopft | Reinigen oder austauschen | |
| | • Unzureichende Düseneinspritzung | Reparieren oder Düse austauschen | |
| Unzulängliche Leistung | • Unkorrekte Spritzeinstellung | Einstellen | S-106 |
| | • Bewegliche Motorteile möglicherweise fastgefressen | Reparieren oder austauschen | |
| | • Ungleichmäßige Kraftstoffeinspritzung | Reparieren oder Einspritz-pumpe austauschen | |
| | • Unzureichende Düseneinspritzung | Reparieren oder Düse austauschen | S-108 |
| | • Kompressionsverlust | Kopfdichtung austauschen, Zylinderkopfschrauben, Glühkerze und Düsenhalter anziehen | |
| Übermäßiger Schmierölver-brauch | • Kolbenringspalt zeigt in gleiche Richtung | Richtung des Kolben-ringspalt verschieben | S-68 |
| | • Ölabstreifring abgenutzt oder gesteckt | Austauschen | |
| | • Kolbenringnut abgenutzt | Kolben austauschen | S-88 |
| | • Ventilschaft und -führung abgenutzt | Austauschen | |
| | • Ölundichtigkeiten wegen beschädigter Dichtung oder Packung. | | |
| Kraftstoff in Schmieröl vermischt | • Tauchkolben der Einspritzpumpe abgenutzt | Pumpenelemente oder Pumpe austauschen | S-108 |
| | • Einspritzpumpe defekt | Austauschen | |
| | • Unzureichende Düseneinspritzung | Reparieren oder Düse austauschen | |

| Störung | Mögliche Ursache | Abhilfe | Referenz Seite |
|---|---|---|---|
| **Wasser in Schmieröl vermischt** | • Kopfdichtung defekt<br>• Risse im Kurbelgehäuse oder Zylinderkopf | Austauschen<br>Austauschen | |
| **Niedriger Öldruck** | • Zu wenig Motoröl<br>• Ölfilter verstopft<br>• Überdruckventil ist mit Staub verstopft<br>• Überdruckventilfeder ermüdet oder gebrochen<br>• Übermäßiges Ölspiel des Kurbelwellenlagers<br>• Übermäßiges Ölspiel des Pleuellagerschales<br>• Übermäßiges Ölspiel der Kipphebellager<br>• Öldurchgang verstopft<br>• Andere Ölsorte<br>• Ölpumpe defekt | Auffüllen<br>Reinigen<br>Reinigen<br>Austauschen<br>Austauschen<br>Austauschen<br>Austauschen<br>Reinigen<br>Vorgeschriebenen Ölsorte verwenden<br>Reparieren oder Austauschen | S-68<br>S-40 |
| **Höher Öldruck** | • Andere Ölsorte<br>• Überdruckventil defekt | Vorgeschriebenen Ölsorte verwenden<br>Austauschen | S-40 |
| **Motor überhitzt** | • Zu wenig Motoröl<br>• Lüfterriemen gebrochen oder nicht richtig gaspannt<br>• Zu wenig Kühlwasser<br>• Kühler und Kühlerrippe durch Staub verstopft<br>• Kühler innen verrostet<br>• Kühlwasserleitung verrostet<br>• Kuhlerverschlußkappe defekt<br>• Überlast<br>• Kopfdichtung defekt<br>• Unkorrekte Spritzeinstellung<br>• Ungeeigneter Kraftstoff | Auffüllen<br>Austauschen oder einstellen<br>Auffüllen<br>Reinigen<br>Reinigen oder austauschen<br>Reinigen oder austauschen<br>Austauschen<br>Last vermindern<br>Austauschen<br>Einstellen<br>Vorgeschriebenen Kraftstoff verwenden | S-40 |
| **Schnelle Entladung der Batterie** | • Zu wenig Elektrolyt<br>• Lüfterriemen rutscht<br>• Verdrahtung gelöst<br>• Gleichrichter defekt<br>• Lichtmachine mit Ventilator defekt<br>• Batterie defekt | Destilliertes Wasser auffüllen und aufladen<br>Spannung einstellen oder Riemen austauschen<br>Anschließen<br>Austauschen<br>Austauschen<br>Austauschen | |

# [5] SERVICING SPECIFICATIONS

## (1) ENGINE BODY

### Cylinder Head

| Item | | Factory Specification | Allowable Limit |
|---|---|---|---|
| Cylinder head surface flatness | | – | 0.05 mm/500 mm<br>0.0019 in./19.69 in. |
| Top clearance | | 0.55 to 0.70 mm<br>0.0217 to 0.0276 in. | – |
| Thickness of gasket | Free | 1.30 to 1.40 mm<br>0.0512 to 0.0551 in. | – |
| | Tightened | 1.15 to 1.25 mm<br>0.0453 to 0.0492 in. | – |
| Compression pressure | | 36 to 38 kgf/cm²/250 rpm<br>35.3 to 37.2 MPa/250 rpm<br>512 to 540 psi/250 rpm | 26 kgf/cm²/250 rpm<br>25.5 MPa/250 rpm<br>370 psi/250 rpm |
| Variance among cylinders | | | 10% or less |

### Valve

| | | | |
|---|---|---|---|
| Valve clearance (Cold) | | 0.18 to 0.22 mm<br>0.0071 to 0.0087 in. | – |
| Valve seat width | IN. | 2.12 mm<br>0.0835 in. | – |
| | EX. | 2.12 mm<br>0.0835 in. | – |
| Valve seat angle | IN. | 60°<br>1.047 rad. | – |
| | EX. | 45°<br>0.785 rad. | – |
| Valve face angle | IN. | 60°<br>1.047 rad. | – |
| | EX. | 45°<br>0.785 rad. | – |
| Valve recessing | Protrusion | 0.05 mm (0.0020 in.)<br>to | |
| | Recess | 0.15 mm (0.0059 in.) | 0.4 mm (0.0157 in.) |
| Clearance between valve stem and valve guide | | 0.040 to 0.070 mm<br>0.0016 to 0.0028 in. | 0.1 mm<br>0.0039 in. |
| Valve stem O.D. | | 7.960 to 7.975 mm<br>0.3134 to 0.3140 in. | – |
| Valve guide I.D. | | 8.015 to 8.030 mm<br>0.3156 to 0.3161 in. | – |

## Valve Timing

| Item | | | Factory Specification | Allowable Limit |
|---|---|---|---|---|
| Intake valve | D1403-B(E) | Open | 0.14 rad. (8°) before T.D.C. | – |
| | | Close | 0.35 rad. (20°) after B.D.C. | – |
| | D1703-B(E) V1903-B(E) V2203-B(E) F2803-B(E) | Open | 0.21 rad. (12°) before T.D.C. | – |
| | | Close | 0.63 rad. (36°) after B.D.C. | – |
| Exhaust valve | | Open | 1.05 rad. (60°) before B.D.C. | – |
| | | Close | 0.21 rad. (12°) after T.D.C. | – |

## Valve Spring

| | | |
|---|---|---|
| Free length | 41.7 to 42.2 mm<br>1.6417 to 1.6614 in. | 41.2 mm<br>1.6220 in. |
| Setting load / setting length | 117.6 N/35.0 mm<br>12.0 kgf/35.0 mm<br>26.4 lbs/1.3780 in. | 100.0 N/35.0 mm<br>10.2 kgf/35.0 mm<br>22.5 lbs/1.3780 in. |
| Tilt | – | 1.0 mm<br>0.039 in. |

## Rocker Arm

| | | |
|---|---|---|
| (V2203-B), serial number: ~3422<br>Clearance between rocker arm shaft and rocker arm | 0.018 to 0.070 mm<br>0.0007 to 0.0026 in. | 0.15 mm<br>0.0059 in. |
| Rocker arm shaft O.D. | 13.973 to 13.984 mm<br>0.5501 to 0.5506 in. | – |
| Rocker arm bush I.D. | 14.002 to 14.043 mm<br>0.5513 to 0.5529 in. | – |
| (V2203-B(E), serial number: 3423~ and D1403-B(E), D1703-B(E), V1903-B(E), F2803(E), all)<br>Clearance between rocker arm shaft and rocker arm | 0.016 to 0.045 mm<br>0.0006 to 0.0018 in. | 0.15 mm<br>0.0059 in. |
| Rocker arm shaft O.D. | 13.973 to 13.984 mm<br>0.5501 to 0.5506 in. | – |
| Rocker arm I.D. for shaft | 14.000 to 14.018 mm<br>0.5512 to 0.5519 in. | – |

## Tappet

| | | |
|---|---|---|
| Clearance between tappet and guide | 0.020 to 0.062 mm<br>0.0008 to 0.0024 in. | 0.07 mm<br>0.0028 in. |
| Tappet O.D. | 23.959 to 23.980 mm<br>0.9433 to 0.9441 in. | – |
| Tappet guide I.D. | 24.000 to 24.021 mm<br>0.9449 to 0.9457 in. | – |

## Camshaft

| Item | | Factory Specification | Allowable Limit |
|---|---|---|---|
| Camshaft side clearance | | 0.07 to 0.22 mm<br>0.0028 to 0.0087 in. | 0.3 mm<br>0.0118 in. |
| Camshaft alignment | | – | 0.01 mm<br>0.00039 in. |
| Cam height | IN, EX. | 33.47 mm<br>1.3177 in. | 33.42 mm<br>1.3157 in. |
| Oil clearance of camshaft | | 0.050 to 0.091 mm<br>0.0020 to 0.0036 in. | 0.15 mm<br>0.0059 in. |
| Camshaft journal O.D. | | 39.934 to 39.950 mm<br>1.5722 to 1.5728 in. | |
| Camshaft bearing I.D. | | 40.000 to 40.025 mm<br>1.5748 to 1.5758 in. | |

## Timing Gear

| | | | |
|---|---|---|---|
| Timing gear backlash | | | |
| Crank gear – Idle gear | | 0.0415 to 0.1122 mm<br>0.0016 to 0.0044 in. | 0.15 mm<br>0.0059in. |
| Idle gear – Cam gear | | 0.0415 to 0.1154 mm<br>0.0016 to 0.0045 in. | 0.15 mm<br>0.0059in. |
| Idle gear – Injection pump gear | | 0.0415 to 0.1154 mm<br>0.0016 to 0.0045 in. | 0.15 mm<br>0.0059in. |
| Crank gear – Oil pump gear | | 0.0415 to 0.1090 mm<br>0.0016 to 0.0043 in. | 0.15 mm<br>0.0059in. |
| Clearance between idle gear shaft and idle gear bushing | | 0.025 to 0.066 mm<br>0.0010 to 0.0026 in. | 0.10 mm<br>0.0039 in. |
| V2203-B(E) | Idle gear bushing I.D. | 32.000 to 32.025 mm<br>1.2598 to 1.2608 in. | – |
| | Idle gear shaft O.D. | 31.959 to 31.975 mm<br>1.2582 to 1.2589 in. | – |
| D1403-B(E)<br>D1703-B(E)<br>V1903-B(E)<br>F2803-B(E) | Idle gear bushing I.D. | 38.000 to 38.025 mm<br>1.4961 to 1.4970 in. | – |
| | Idle gear shaft O.D. | 37.959 to 37.975 mm<br>1.4944 to 1.4951 in. | – |
| Idle gear side clearance<br>Idle gear | | 0.20 to 0.51 mm<br>0.0079 to 0.0200 in. | 0.9 mm<br>0.0354 in. |

## Piston·Piston Ring

| Item | Factory Specification | Allowable Limit |
|---|---|---|
| Piston Pin Bore | 25.000 to 25.013 mm<br>0.9843 to 0.9848 in. | 25.05 mm<br>0.9862 in. |
| Clearance between compression ring 2 and ring groove | 0.093 to 0.120 mm<br>0.0037 to 0.0047 in. | 0.20 mm<br>0.0079 in. |
| Clearance between oil ring and ring groove | 0.020 to 0.052 mm<br>0.0008 to 0.0020 in. | 0.15 mm<br>0.0059 in. |
| Ring gap | | |
| Compression ring 1 | 0.30 to 0.45 mm<br>0.0118 to 0.0177 in. | 1.25 mm<br>0.0492 in. |
| Compression ring 2 | 0.30 to 0.45 mm<br>0.0118 to 0.0177 in. | 1.25 mm<br>0.0492 in. |
| Oil ring | 0.25 to 0.45 mm<br>0.0098 to 0.0177 in. | 1.25 mm<br>0.0492 in. |

## Connecting Rod

| | | |
|---|---|---|
| Connecting rod alignment | – | 0.05 mm<br>0.0020 in. |
| Clearance between piston pin and small end bushing | 0.014 to 0.038 mm<br>0.0006 to 0.0015 in. | 0.15 mm<br>0.0059 in. |
| Piston pin O.D. | 25.002 to 25.011 mm<br>0.9843 to 0.9847 in. | – |
| Small end bushing I.D. | 25.025 to 25.040 mm<br>0.9852 to 0.9858 in. | – |

## Crankshaft

| | | |
|---|---|---|
| Crankshaft alignment | – | 0.02 mm<br>0.00079 in. |
| Oil clearance between crankshaft journal and crankshaft bearing 1 | 0.04 to 0.118 mm<br>0.0016 to 0.0046 in. | 0.2 mm<br>0.0079 in. |
| Crankshaft journal O.D. | 51.921 to 51.940 mm<br>2.0441 to 2.0449 in. | – |
| Crankshaft bearing 1 I.D. | 51.980 to 52.039 mm<br>2.0465 to 2.0488 in. | – |
| Oil clearance between crankshaft journal and crankshaft bearing 2 | 0.04 to 0.104 mm<br>0.0016 to 0.0041 in. | 0.2 mm<br>0.0079 in. |
| Crankshaft O.D. | 51.921 to 51.940 mm<br>2.0441 to 2.0449 in. | – |
| Crankshaft bearing 2 I.D. | 51.980 to 52.025 mm<br>2.0465 to 2.0482 in. | – |
| Oil clearance between crank pin and crank pin bearing | 0.025 to 0.087 mm<br>0.0009 to 0.0034 in. | 0.2 mm<br>0.0079 in. |
| Crank pin O.D. | 46.959 to 46.975 mm<br>1.8488 to 1.8494 in. | – |
| Crank pin bearing I.D. | 47.000 to 47.046 mm<br>1.8504 to 1.8522 in. | – |
| Crankshaft side clearance | 0.15 to 0.31 mm<br>0.0059 to 0.0122 in. | 0.5 mm<br>0.0197 in. |

## Cylinder Bore

| | | | |
|---|---|---|---|
| Cylinder bore I.D. | D1703-B(E), V2203-B(E), F2803-B(E) | 87.000 to 87.022 mm<br>3.4252 to 3.4261 in. | + 0.15 mm<br>0.0059 in. |
| | D1403-B(E)<br>V1903-B(E) | 80.000 to 80.019 mm<br>3.1496 to 3.1504 in. | |

## (2) LUBRICATING SYSTEM

### Oil Pump

| Item | | Factory Specification | Allowable Limit |
|---|---|---|---|
| Engine oil pressure | At idle speed | 1.0 kgf/cm$^2$<br>98 kPa, 14 psi or more | 0.5 kgf/cm$^2$<br>49 kPa, 7 psi |
| | At rated speed | 3.0 to 4.5 kgf/cm$^2$<br>294.2 to 441 kPa<br>42.7 to 64 psi | 2.5 kgf/cm$^2$<br>245 kPa<br>36 psi |
| Engine oil pressure switch working pressure | | 0.5 kgf/cm$^2$, 49 kPa, 7 psi | |
| Clearance between inner rotor and outer rotor | | 0.10 to 0.16 mm<br>0.0039 to 0.0063 in. | – |
| Clearance between outer rotor and pump body | | 0.11 to 0.19 mm<br>0.0043 to 0.0075 in. | – |
| End clearance between inner rotor and cover | | 0.105 to 0.150 mm<br>0.0041 to 0.0059 in. | – |

## (3) COOLING SYSTEM

### Thermostat

| | | |
|---|---|---|
| Thermostat's valve opening temperature | 69.5 to 72.5°C<br>157.1 to 162.5°F | – |
| Temperature at which thermostat completely opens | 85°C<br>185°F | – |

### Radiator

| | | |
|---|---|---|
| Radiator water tightness | Water tightness at specified pressure<br>1.4 kgf/cm$^2$<br>137 kPa, 20 psi | – |
| Radiator cap air leakage | 10 seconds or more<br>0.9 → 0.6 kgf/cm$^2$<br>88 → 59 kPa, 13 → 9 psi | – |
| Fan belt tension | 10 to 12 mm/10 kgf<br>0.394 to 0.472 in./22.1 lbs. | – |

## (4) FUEL SYSTEM

### Injection Pump

| Item | | Factory Specification | Allowable Limit |
|---|---|---|---|
| Injection timing | D1403-B(E), D1703-B(E), V1903-B(E), V2203-B(E) | 0.30 to 0.33 rad. T.D.C. (17° to 19° before) | – |
| | F2803-B(E) | 0.31 to 0.35 rad. T.D.C. (18° to 20° before) | |
| Fuel tightness of pump element | | – | 14.7 MPa 150 kgf/cm$^2$, 2133 psi |
| Fuel tightness of delivery valve | | More 10 seconds 14.7 → 13.7 MPa 150 → 140 kgf/cm$^2$ 2133 → 1990 psi | 5 seconds 14.7 → 13.7 MPa 150 → 140 kgf/cm$^2$ 2133 → 1990 psi |

### Injection Nozzle

| | | |
|---|---|---|
| Fuel injection pressure | 13.73 to 14.71 MPa 140 to 150 kgf/cm$^2$ 1991 to 2133 psi | – |
| Fuel tightness of nozzle valve seat | When the pressure is 12.75 MPa (130 kgf/cm$^2$, 1849 psi), the valve seat must be fuel tightness. | – |

## (5) ELECTRICAL SYSTEM

### Starter

| | | |
|---|---|---|
| Commutator O.D. | 30.0 mm 1.1811 in. | 29.0 mm 1.1417 in. |
| Mica undercut | 0.5 to 0.8 mm 0.0197 to 0.0315 in. | 0.2 mm 0.0079 in. |
| Brush length | 15.0 mm 0.591 in. | 10.0 mm 0.394 in. |

### Alternator

| | | | |
|---|---|---|---|
| Output current | | 14 V, 35 A/4000 rpm | – |
| Rotor coil resistance (F – E) | V2203-B(E) | 4 Ω | – |
| | D1403-B(E), D1703-B(E), V1903-B(E), F2803-B(E) | 2.9 Ω | |
| Slip Ring O.D. | V2203-B(E) | 32.5 mm 1.2795 in. | 32.1 mm 1.2638 in. |
| | D1403-B(E), D1703-B(E), V1903-B(E), F2803-B(E) | 14.4 mm 0.567 in. | 14.0 mm 0.551 in. |
| Brush length | V2203-B(E) | 12.5 mm 0.4921 in. | 5.5 mm 0.2165 in. |
| | D1403-B(E), D1703-B(E), V1903-B(E), F2803-B(E) | 10.5 mm 0.413 in. | 4.5 mm 0.177 in. |

### Glow Plug

| | | |
|---|---|---|
| Glow plug resistance | 0.8 Ω | – |

# [5] CARACTERISTIQUES D'ENTRETIEN

## (1) MOTEUR

### Culasse

| Elément | | Valeur de référence | Limite de service |
|---|---|---|---|
| Planéité de la surface de la culasse | | – | 0,05 mm/500 mm |
| Jeu supérieur | | 0,55 à 0,70 mm | – |
| Epaisseur de joint | Avec de jeu | 1,30 à 1,40 mm | – |
| | Serré | 1,15 à 1,25 mm | – |
| Pression de compression | | 35,3 à 37,2 MPa/250 tr/mn<br>36 à 38 kgf/cm²/250 tr/mn | 24,5 MPa/250tr/mn<br>26 kgf/cm²/250tr/mn |
| Différence entre les cylindres | | | 10% ou moins |

### Soupapes

| | | | |
|---|---|---|---|
| Jeu des soupapes (à froid) | | 0,18 à 0,22 mm | – |
| Largeur de siège de soupape | ADM. | 2,12 mm | – |
| | ECH. | 2,12 mm | |
| Angle de siège de soupape | ADM. | 1,047 rad.<br>60° | – |
| | ECH. | 0,785 rad.<br>45° | – |
| Angle de surface de soupape | ADM. | 1,047 rad.<br>60° | – |
| | ECH. | 0,785 rad.<br>45° | – |
| Retrait des soupapes | Saillie | 0,05 mm<br>à | – |
| | Retrait | 0,15 mm | 0,4 mm |
| Jeu entre la queue de soupape et le guide de soupape | | 0,040 à 0,070 mm | 0,1 mm |
| Diamètre ext. de queue de soupape | | 7,960 à 7,975 mm | – |
| Diamètre int. de guide de soupape | | 8,015 à 8,030 mm | – |

### Calage des soupapes

| | | | | |
|---|---|---|---|---|
| Soupape d'admission | D1403-B(E) | Ouverte | 0,14 rad. (8°)<br>avant P.M.H. | – |
| | | Fermée | 0,35 rad. (20°)<br>après P.M.B. | – |
| | D1703-B(E)<br>V1903-B(E)<br>V2203-B(E)<br>F2803-B(E) | Ouverte | 0,21 rad. (12°)<br>avant P.M.H. | – |
| | | Fermée | 0,63 rad. (36°)<br>après P.M.B. | – |
| Soupape d'échappement | | Ouverte | 1,05 rad. (60°)<br>avant P.M.B. | – |
| | | Fermée | 0,21 rad. (12°)<br>après P.M.H. | – |

### Ressort de soupape

| | | |
|---|---|---|
| Longueur libre | 41,7 à 42,2 mm | 41,2 mm |
| Force sous charge / longueur sous charge | 117,6 N/35,0 mm<br>12,0 kgf/35,0 mm | 100,0 N/35,0 mm<br>10,2 kgf/35,0 mm |
| Rectangularité | – | 1,0 mm |

## Culbuteurs

| Elément | Valeur de référence | Limite de service |
|---|---|---|
| (V2203-B Numéro de série moteur: ~3422<br>Jeu entre l'axe de culbuteur et de culbuteur | 0,018 à 0,070 mm | 0,15 mm |
| Diamètre extérieur de l'axe de culbuteur | 13,973 à 13,984 mm | – |
| Diamètre intérieur de culbuteur | 14,002 à 14,043 mm | – |
| (V2203-B(E) Numéro de série moteur: 3423~ et D1403-B(E), D1703-B(E), D1903-B(E), F2803(E))<br>Jeu entre l'axe de culbuteur et de culbuteur | 0,016 à 0,045 mm | 0,15 mm |
| Diamètre extérieur de l'axe de culbuteur | 13,973 à 13,984 mm | – |
| Diamètre intérieur de culbuteur | 14,000 à 14,018 mm | – |

## Poussoirs

| | | |
|---|---|---|
| Jeu entre le poussoir et le guide | 0,020 à 0,062 mm | 0,07 mm |
| Diamètre extérieur du poussoir | 23,959 à 23,980 mm | – |
| Diamètre intérieur du guide de poussoir | 24,000 à 24,021 mm | – |

## Arbre à cames

| | | | |
|---|---|---|---|
| Jeu latéral d'arbre à cames | | 0,07 à 0,22 mm | 0,3 mm |
| Alignement d'arbre à cames | | – | 0,01 mm |
| Hauteur de cames | ADM, ECH | 33,47 mm | 33,42 mm |
| Jeu de lubrification de l'arbre à cames | | 0,050 à 0,091 mm | 0,15 mm |
| Diamètre extérieur du tourillon d'arbre à cames | | 39,934 à 39,950 mm | – |
| Diamètre intérieur du coussinet d'arbre à cames | | 40,000 à 40,025 mm | – |

## Pignon de distribution

| | | | |
|---|---|---|---|
| Jeu de pignon de distribution | | | |
| Pignon de lancement – Pignon de renvoi | | 0,0415 à 0,1122 mm | 0,15 mm |
| Pignon de renvoi – Pignon de cames | | 0,0415 à 0,1154 mm | 0,15 mm |
| Pignon de renvoi – Pignon de pompe d'injection | | 0,0415 à 0,1154 mm | 0,15 mm |
| Pignon de lancement – Pignon de pompe à huile | | 0,0415 à 0,1090 mm | 0,15 mm |
| Jeu latéral l'axe de pignon de renvoi et la bague de pignon de renvoi | | 0,025 à 0,066 mm | 0,10 mm |
| V2203-B(E) | Diamètre intérieur de la bague de pignon de renvoi | 32,000 à 32,025 mm | – |
| | Diamètre extérieur de l'axe de pignon de renvoi | 31,959 à 31,975 mm | – |
| D1403-B(E)<br>D1703-B(E)<br>V1903-B(E)<br>F2803-B(E) | Diamètre intérieur de la bague de pignon de renvoi | 38,000 à 38,025 mm | – |
| | Diamètre extérieur de l'axe de pignon de renvoi | 37,959 à 37,975 mm | – |
| Jeu latéral de pignon de renvoi<br>Pignon de renvoi | | 0,20 à 0,51 mm | 0,9 mm |

## Piston et segment

| Elément | Valeur de référence | Limite de service |
|---|---|---|
| Diamètre intérieur du alésage d'axe de piston | 25,000 à 25,013 mm | 25,05 mm |
| Jeu entre le segment de compression 2 et la rainure de segment | 0,093 à 0,120 mm | 0,20 mm |
| Jeu entre le segment racleur et la rainure de segment | 0,020 à 0,052 mm | 0,15 mm |
| Jeu de segments | | |
| Segment 1 de compression | 0,30 à 0,45 mm | 1,25 mm |
| Segment 2 de compression | 0,30 à 0,45 mm | 1,25 mm |
| Segment racleur | 0,25 à 0,45 mm | 1,25 mm |

## Bielles

| | | |
|---|---|---|
| Alignement des bielles | – | 0,05 mm |
| Jeu entre l'axe de piston et le coussinet de pied de bielle | 0,014 à 0,038 mm | 0,15 mm |
| Diamètre extérieur de l'axe de piston | 25,002 à 25,011 mm | – |
| Diamètre intérieur du coussinet de pied de bielle | 25,025 à 25,040 mm | – |

## Vilebrequin

| | | |
|---|---|---|
| Alignement du vilebrequin | – | 0,02 mm |
| Jeu de lubrification entre le vilebrequin et le coussinet 1 de vilebrequin | 0,04 à 0,118 mm | 0,2 mm |
| Diamètre extérieur du vilebrequin | 51,921 à 51,940 mm | – |
| Diamètre intérieur du coussinet 1 du vilebrequin | 51,980 à 52,039 mm | – |
| Jeu de lubrification entre le vilebrequin et le coussinet 2 de vilebrequin | 0,04 à 0,104 mm | 0,20 mm |
| Diamètre extérieur du vilebrequin | 51,921 à 51,940 mm | – |
| Diamètre intérieur du coussinet 2 du vilebrequin | 51,980 à 52,025 mm | – |
| Jeu de lubrification entre le maneton et le coussinet de tête de bielle | 0,025 à 0,087 mm | 0,2 mm |
| Diamètre extérieur du maneton | 46,959 à 46,975 mm | – |
| Diamètre intérieur du coussinet de tête de bielle | 47,000 à 47,046 mm | – |
| Jeu latéral du vilebrequin | 0,15 à 0,31 mm | 0,5 mm |

## Chemises de cylindres

| | | | |
|---|---|---|---|
| Diamètre intérieur de la chemise de cylindre | D1703-B(E), V2203-B(E), F2803-B(E) | 87,000 à 87,022 mm | + 0,15 mm |
| | D1403-B(E) V1903-B(E) | 80,000 à 80,019 mm | |

## (2) SYSTEME DE LUBRIFICATION

### Pompe à huile

| Elément | | Valeur de référence | Limite de service |
|---|---|---|---|
| Pression d'huile moteur | Au ralenti | 1,0 kgf/cm² 98 kPa ou plus | 0,5 kgf/cm² 49 kPa |
| | A vitesse nominal | 3,0 à 4,5 kgf/cm² 294,2 à 441 kPa | 2,5 kgf/cm² 245 kPa |
| Jeu entre le rotor intérieur et le rotor extérieur | | 0,10 à 0,16 mm | – |
| Jeu entre le rotor extérieur et le corps de pompe | | 0,11 à 0,19 mm | – |
| Jeu latéral entre le rotor intérieur et le couvercle | | 0,105 à 0,150 mm | – |

## (3) SYSTEME DE REFROIDISSEMENT

### Thermostat

| | | |
|---|---|---|
| Température d'ouverture du clapet de thermostat | 69,5 à 72,5°C | – |
| Température d'ouverture complète du thermostat | 85°C | – |

### Radiateur

| | | |
|---|---|---|
| Etanchéité à l'eau du radiateur | Etanchéité à l'eau à la pression spécifiée 1,4 kgf/cm² 137 kPa | – |
| Fuite d'air au bouchon de radiateur | 10 secondes ou plus 0,9 → 0,6 kgf/cm² 88 → 59 kPa | – |
| Tension de la courroie de ventilateur | 10 à 12 mm/10 kgf | – |

## (4) SYSTEME DE REFROIDISSEMENT

### Pompe d'injection

| Item | | Factory Specification | Allowable Limit |
|---|---|---|---|
| Calage de l'injection | D1403-B(E), D1703-B(E), V1903-B(E), V2203-B(E) | 0,24 à 0,27 rad. (17° à 19°) avant P.M.H. | – |
| | F2803-B(E) | 0,30 à 0,33 rad. (18° to 20°) avant P.M.H. | – |
| Etanchéité au carburant de l'élément de pompe | | – | 150 kgf/cm$^2$ |
| Etanchéité au carburant du clapet d'alimentation | | 10 seconds<br>14,7 → 13,7 MPa<br>150 → 140 kgf/cm$^2$ | 5 seconds<br>14,7 → 13,7 MPa<br>150 → 140 kgf/cm$^2$ |

### Injecteur

| | | |
|---|---|---|
| Pression d'injection | 13,73 à 14,71 MPa<br>140 à 150 kgf/cm$^2$ | – |
| Etanchéité au carburant du siège du clapet d'injecteur | Lorsque la pression est de 12,75 MPa (130 kgf/cm$^2$), le siège de clapet doit être étanche au carburant | – |

## (5) SYSTEME ELECTRIQUE

### Démarreur

| | | |
|---|---|---|
| Diamètre extérieur du contacteur | 30,0 mm | 29,0 mm |
| Profondeur d'entaille du mica | 0,5 à 0,8 mm | 0,2 mm |
| Longueur des balais | 15,0 mm | 10,0 mm |

### Alternateur

| | | | |
|---|---|---|---|
| Tension à vide | | 14 V, 35 A / 4000 tr/mn | – |
| Resistance de la rotor | V2203-B(E) | 4 Ω | – |
| | D1403-B(E), D1703-B(E), V1903-B(E), F2803-B(E) | 2,9 Ω | |
| Diamétre ext de bague collectrice | V2203-B(E) | 32,5 mm | 32,1 mm |
| | D1403-B(E), D1703-B(E), V1903-B(E), F2803-B(E) | 14,4 mm | 14,0 mm |
| Longueur des balais | V2203-B(E) | 12,5 mm | 5,5 mm |
| | D1403-B(E), D1703-B(E), V1903-B(E), F2803-B(E) | 10,5 mm | 4,5 mm |

### Bougie de préchauffage

| | | |
|---|---|---|
| Résistance de la bougie de préchauffage | 0,8 ohm | – |

# [5] WARTUNGSDATEN

## (1) MOTORKÖRPER

### Zylinderkopf

| Teil | | Werkdaten | Zulässiger Grenzwert |
|---|---|---|---|
| Abflachung der Zylinderkopffläche | | – | 0,05 mm/500 mm |
| Kopfspiel | | 0,55 bis 0,70 mm | – |
| Stärke der Zylinderkopfdichtungsscheibe | | 0,2 mm | – |
| Stärke der Dichtung | Frei | 1,30 bis 1,40 mm | – |
| | Gespannt | 1,15 bis 1,25 mm | – |
| Verdichtungsdruck | | 36 bis 38 kp/cm²/250u/Min | 26 kp/cm²/250u/Min |
| Unterschiedlichkeit der Zylinder | | | 10% oder weniger |

### Ventile

| | | | |
|---|---|---|---|
| Ventilspiel (kalt) | | 0,18 bis 0,22 mm | – |
| Ventilsitzbreite | Einlaß | 2,12 mm | – |
| | Auslaß | 2,12 mm | |
| Ventilsitzwinkel | Einlaß | 1,047 rad. 60° | – |
| | Auslaß | 0,785 rad. 45° | |
| Ventilellerwinkel | Einlaß | 1,047 rad. 60° | – |
| | Auslaß | 0,785 rad. 45° | |
| Ventilvertiefung | Vorsprung | 0,05 mm bis | – |
| | Ventilvertiefung | 0,15 mm | 0,4 mm |
| Spiel zwischen Ventilschaft und Ventilführung | | 0,040 bis 0,070 mm | 0,1 mm |
| Ventilschaft Außendurchmesser | | 7,960 bis 7,975 mm | – |
| Ventilführung Innendurchmesser | | 8,015 bis 8,030 mm | – |

### Ventilsteuerung

| | | | | |
|---|---|---|---|---|
| Einlaßventil | D1403-B(E) | Offen | 0,14 rad. (8°) Vor O.T. | – |
| | | Geschlossen | 0,35 rad. (20°) Nach U.T. | – |
| | D1703-B(E) V1903-B(E) V2203-B(E) F2803-B(E) | Offen | 0,21 rad. (12°) Vor O.T. | – |
| | | Geschlossen | 0,63 rad. (36°) Nach U.T. | – |
| Auslaßventil | | Ouverte | 1,05 rad. (60°) Vor O.T. | – |
| | | Fermée | 0,21 rad. (12°) Nach U.T. | – |

## Ventilfeder

| Teil | Werkdaten | Zulässiger Grenzwert |
|---|---|---|
| Freie Länge | 41,7 bis 42,2 mm | 41,2 mm |
| Einstellast / Einstellänge | 117,6 N/35,0 mm<br>12,0 kp/35,0 mm | 100,0 N/35,0 mm<br>10,2 kp/35,0 mm |
| Neigung | – | 1,0 mm |

## Kipphebel

| | | |
|---|---|---|
| (V2203-B Seriennumer des Motors: ~3422<br>Spiel zwischen Kipphebelachse und Kipphebel | 0,018 bis 0,070 mm | 0,15 mm |
| Kipphebelachse Außendurchmesser | 13,973 bis 13,984 mm | – |
| Kipphebel Innendurchmesser | 14,002 bis 14,043 mm | – |
| (V2203-B(E) Seriennumer des Motors: 3423~ und höher D1403-B(E), D1703-B(E), V1903-B(E), F2803(E))<br>Spiel zwischen Kipphebelachse und Kipphebel | 0,016 bis 0,045 mm | 0,15 mm |
| Kipphebelachse Außendurchmesser | 13,973 bis 13,984 mm | – |
| Kipphebel Innendurchmesser | 14,000 bis 14,018 mm | – |

## Stößel

| | | |
|---|---|---|
| Spiel zwischen Stößel und Führung | 0,020 bis 0,062 mm | 0,07 mm |
| Stößel Außendurchmesser | 23,959 bis 23,980 mm | – |
| Stößelführung Innendurchmesser | 24,000 bis 24,021 mm | – |

## Nockenwelle

| | | | |
|---|---|---|---|
| Seitenspiel der Nockenwelle | | 0,07 bis 0,22 mm | 0,3 mm |
| Nockenwellenausrichtung | | – | 0,01 mm |
| Nockenhöhe | einlaß | 33,47 mm | 33,42 mm |
| | auslaß | 33,47 mm | 33,42 mm |
| Ölspiel der Nockenwelle | | 0,050 bis 0,091 mm | 0,15 mm |
| Nockenwellenzapfen Außendurchmesser | | 39,934 bis 39,950 mm | – |
| Nockenwellenlager Innendurchmesser | | 40,000 bis 40,025 mm | – |

## Steuerung

| Teil | | Werkdaten | Zulässiger Grenzwert |
|---|---|---|---|
| Spiel der Steuerung | | | |
| Kurbelgetriebe – Leerlaufgetriebe | | 0,0415 bis 0,1122 mm | 0,15 mm |
| Leerlaufgetriebe – Nockengetriebe | | 0,0415 bis 0,1154 mm | 0,15 mm |
| Leerlaufgetriebe –Einspritzpumpengetriebe | | 0,0415 bis 0,1154 mm | 0,15 mm |
| Kurbelgetriebe – Ölpumpetrieb | | 0,0415 bis 0,1090 mm | 0,15 mm |
| Spiel zwischen Leerlaufachse und Leerlaufbuchse | | 0,025 bis 0,066 mm | 0,10 mm |
| V2203-B(E) | Leerlaufbuchse Innendurchmesser | 32,000 bis 32,025 mm | – |
| | Leerlaufachse Außendurohmesser | 31,959 bis 31,975 mm | – |
| D1403-B(E) D1703-B(E) V1903-B(E) F2803-B(E) | Leerlaufbuchse Innendurchmesser | 38,000 bis 38,025 mm | – |
| | Leerlaufachse Außendurohmesser | 37,959 bis 37,975 mm | – |
| Leerlauf – Seitenspiel Leerlaufgetriebe | | 0,20 bis 0,51 mm | 0,9 mm |

## Kolben·Kolbenring

| | | |
|---|---|---|
| Innendurchmesser des Kolbenbolzenbohrloch | 25,000 bis 25,013 mm | 25,05 mm |
| Spiel zwischen Verdichterring 2 und Ringnut | 0,093 bis 0,120 mm | 0,20 mm |
| Spiel zwischen Ölabstreifrin und Ringnut | 0,020 bis 0,052 mm | 0,15 mm |
| Kolben-ringspalt | | |
| Verdichter-ring 1 | 0,30 bis 0,45 mm | 1,25 mm |
| Verdichter-ring 2 | 0,30 bis 0,45 mm | 1,25 mm |
| Ölabstreifrin | 0,25 bis 0,45 mm | 1,25 mm |

## Pleuelstange

| | | |
|---|---|---|
| Pleuelstangenausrichtung | – | 0,05 mm |
| Spiel zwischen Kolbenbolzen und Pleuelbuchse | 0,014 bis 0,038 mm | 0,15 mm |
| Kolbenbolzen Außendurchmesser | 25,002 bis 25,011 mm | – |
| Pleuelbuchse Innendurchmesser | 25,025 bis 25,040 mm | – |

## Kurbelwelle

| | | |
|---|---|---|
| Kurbelwellenausrichtung | – | 0,02 mm |
| Ölspiel zwischen Kurbelwelle und Kurbelwellenlager 1 | 0,04 bis 0,118 mm | 0,2 mm |
| Kurbellwelle Außendurchmesser | 51,921 bis 51,940 mm | – |
| Kurbelwellenlager 1 Innendurchmesser | 51,980 bis 52,039 mm | – |
| Ölspiel zwischen Kurbelwelle und Kurbelwellenlager 2 | 0,04 bis 0,104 mm | 0,2 mm |
| Kurbelwelle Außendurchmesser | 51,921 bis 51,940 mm | – |
| Kurbelwellenlager 2 Innendurchmesser | 51,980 bis 52,025 mm | – |
| Ölpspiel zwischen Kurbelzapfen und Pleuellagerschale | 0,025 bis 0,087 mm | 0,2 mm |
| Kurbelzapfen Außendurchmesser | 46,959 bis 46,975 mm | – |
| Pleuellagerschale Innendurchmesser | 47,000 bis 47,046 mm | – |
| Seitenspiel der Kurbelwelle | 0,15 bis 0,31 mm | 0,5 mm |

## Zylinderlaufbuchse

| Teil | | Werkdaten | Zulässiger Grenzwert |
|---|---|---|---|
| Zylinderlaufbuchse Innendurchmesser | D1703-B(E), V2203-B(E), F2803-B(E) | 87,000 bis 87,022 mm | + 0,15 mm |
| | D1403-B(E) V1903-B(E) | 80,000 bis 80,019 mm | |

## (2) SCHMIERUNGSSYSTEM

### Ölpumpe

| | | | |
|---|---|---|---|
| Motoröldruck | Bei Leerlaufdrehzahl | 98 kPa<br>1,0 kp/cm² Oder mehr | 49 kPa<br>0,5 kp/cm² |
| | Bei Nenndrehzahl | 294,2 bis 441 kPa<br>3,0 bis 4,5 kp/cm² | 245 kPa<br>2,5 kp/cm² |
| Spiel zwischen innerem und äußerem Flügelrad | | 0,10 bis 0,16 mm | – |
| Spiel zwischen äußerem Flügelrad und Pumpengehäuse | | 0,11 bis 0,19 mm | – |
| Endspiel zwischen innerem Flügelrad und Abdeckung | | 0,105 bis 0,150 mm | – |

## (3) KÜHLUNGSSYSTEM

### Thermostat

| | | |
|---|---|---|
| Öffnungstemperatur des Thermostatventils | 69,5 bis 72,5°C | – |
| Temperatur für vollständige Öffnung des Thermostats | 85°C | – |

### Kühler

| | | |
|---|---|---|
| Wasserdichtigkeit des Kühlers | Wasserdichtigkeit bei vorgeschriebenem Druck<br>137 kPa<br>1,4 kp/cm² | – |
| Entlüftung durch Kühlerverschlubkappe | 10 Sekunden oder mehr<br>88 → 59 kPa<br>0,9 → 0,6 kp/cm² | – |
| Spannung des Lüfterriemens | 10 bis 12 mm/10 kp | – |

## (4) KRAFTSTOFFSYSTEM

### Einspritzpumpe

| Teil | | Werkdaten | Zulässiger Grenzwert |
|---|---|---|---|
| Spritzeinstellung | D1403-B(E), D1703-B(E), V1903-B(E), V2203-B(E) | 0,24 bis 0,27 rad. (17° bis 19°) vor O.T. | – |
| | F2803-B(E) | 0,30 bis 0,33 rad (18° bis 20°) vor O.T. | – |
| Kraftstoffdichtigkeit des Pumpenelementes | | – | 150 kp/cm$^2$ |
| Kraftstoffdichtigkeit des Druckventils | | 10 Sekunden 14,7 → 13,7 MPa 150 → 140 kp/cm$^2$ | 5 Sekunden 14,7 → 13,7 MPa 150 → 140 kp/cm$^2$ |

### Einspritzdüse

| | | |
|---|---|---|
| Kraftstoff-Einspritzdruck | 13,73 bis 14,71 MPa 140 bis 150 kp/cm$^2$ | – |
| Kraftstoffdichtigkeit des Düsenventilsitzes | Bei einem Druck von 12,75 MPa (130 kp/cm$^2$), darf kein Kraftstoff am Ventilsitz austreten. | – |

## (5) ELEKTRISCHES SYSTEM

### Anlasser

| | | |
|---|---|---|
| Kommutator Außendurchmesser | 30,0 mm | 29,0 mm |
| Glimmer-Unterschneidung | 0,5 bis 0,8 mm | 0,2 mm |
| Bürstenlänge | 15,0 mm | 10,0 mm |

### Wechselstromdynamo

| | | | |
|---|---|---|---|
| Leerlaufspannung | | 14 V, 35 A / 4000 U/Min. | – |
| Widerstand Rotor | V2203-B(E) | 4 Ω | – |
| | D1403-B(E), D1703-B(E), V1903-B(E), F2803-B(E) | 2,9 Ω | |
| Schleifring Außendurchmesser | V2203-B(E) | 32,5 mm | 32,1 mm |
| | D1403-B(E), D1703-B(E), V1903-B(E), F2803-B(E) | 14,4 mm | 14,0 mm |
| Bürstenlänge | V2203-B(E) | 12,5 mm | 5,5 mm |
| | D1403-B(E), D1703-B(E), V1903-B(E), F2803-B(E) | 10,5 mm | 4,5 mm |

### Glühkerze

| | | |
|---|---|---|
| Widerstand Glühkerze | 0,8 Ω | – |

# [6] MAINTENANCE CHECK LIST

To maintain long-lasting and safe engine performance, make it a rule to carry out regular inspections by following the table below.

| Item | | Service Interval | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Every 50 hrs | Every 75 hrs | Every 100 hrs | Every 150 hrs | Every 200 hrs | Every 300 hrs | Every 400 hrs | Every 500 hrs | Every 800 hrs | Every one year | Every two years |
| Checking fuel pipes and clamps | | ○ | | | | | | | | | | |
| * Changing engine oil | (1) Oil pan depth (90 mm) | | ○ | | | | | | | | | |
| | (2) Oil pan depth (124 mm) | | | ○ | | | | | | | | |
| | (3) Oil pan depth (90 mm) | | | | ○ | | | | | | | |
| | (4) Oil pan depth (124 mm) | | | | | ○ | | | | | | |
| Cleaning air filter element | | | | ○ | | | | | | | | |
| Cleaning fuel filter element | | | | ○ | | | | | | | | |
| Checking fan belt tension and damage | | | | ○ | | | | | | | | |
| Checking water pipes and clamps | | | | | | ○ | | | | | | |
| * Changing oil filter cartridge | (5) Oil pan depth (90 mm) | | | | ○ | | | | | | | |
| | (6) Oil pan depth (124 mm) | | | | | ○ | | | | | | |
| | ,(7) Oil pan depth (90 mm) | | | | | | ○ | | | | | |
| | (8) Oil pan depth (124 mm) | | | | | | | ○ | | | | |
| Changing fuel filter cartridge | | | | | | | | ○ | | | | |
| Cleaning radiator interior | | | | | | | | | ○ | | | |
| Changing radiator cleaner and coolant | | | | | | | | | | | | ○ |
| Changing air filter element | | | | | | | | | | | ○ | |
| Checking valve clearance | | | | | | | | | | ○ | | |
| Changing water pipes and clamps | | | | | | | | | | | | ○ |
| Changing fuel pipes and clamps | | | | | | | | | | | | ○ |

(1), (2) For generators (3000 / 3600 rpm)
(3), (4) For generators (1800 / 1500 rpm) and general construction / industrial machinery and farm equipment
(5), (6) For generators (3000 / 3600 rpm) and general construction / industrial machinery and farm equipment
(7), (8) For generators (1800 / 1500 rpm)

* Change engine oil and oil cartridge after the first 50 hours of operation.

**⚠ CAUTION**

- **When changing or inspecting, be sure to level and stop the engine.**

# [6] LISTE DES VERIFICATION D'ENTRETIEN

Pour conserver longtemps la fiabilité et la sécurité du moteur, procéder aux inspections periodiques cuivantes.

| Elément | | Périodes d'entretien | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Toutes les 50 hrs | Toutes les 75 hrs | Toutes les 100 hrs | Toutes les 150 hrs | Toutes les 200 hrs | Toutes les 300 hrs | Toutes les 400 hrs | Toutes les 500 hrs | Toutes les 800 hrs | Une fois par an | Une fois tous les 2 ans |
| Vérification des conduits d'alimentqation et des étriers | | ○ | | | | | | | | | | |
| * Changer de l'huile moteur | (1) Profondeur du carter d'huile 90 mm | | ○ | | | | | | | | | |
| | (2) Profondeur du carter d'huile 124 mm | | | ○ | | | | | | | | |
| | (3) Profondeur du carter d'huile 90 mm | | | | ○ | | | | | | | |
| | (4) Profondeur du carter d'huile 124 mm | | | | | ○ | | | | | | |
| Nettoyage de l'élément de filtre à air | | | | ○ | | | | | | | | |
| Nettoyage du élément filtre à carburant | | | | ○ | | | | | | | | |
| Vérification de la tension de la courroie de ventilateur et de son état | | | | ○ | | | | | | | | |
| Vérification des conduits d'eau et des étriers | | | | | | ○ | | | | | | |
| * Renouvellement de la cartouche du filtro à huile | (5) Profondeur du carter d'huile 90 mm | | | | ○ | | | | | | | |
| | (6) Profondeur du carter d'huile 124 mm | | | | | ○ | | | | | | |
| | (7) Profondeur du carter d'huile 90 mm | | | | | | ○ | | | | | |
| | (8) Profondeur du carter d'huile 124 mm | | | | | | | ○ | | | | |
| Renouvellement de la cartouche du filtro à carburant | | | | | | | | ○ | | | | |
| Nettoyage de l'intérieur du radiateur | | | | | | | | | ○ | | | |
| Renouvellement du filtre de radiateur et du liquide de refroidissement | | | | | | | | | | | | ○ |
| Renouvellement de l'élément de filtre à air | | | | | | | | | | | ○ | |
| Vérification du jeu des soupapes | | | | | | | | | | ○ | | |
| Renouvellement des conduits d'eau et de étriers | | | | | | | | | | | | ○ |
| Renouvellement des conduits d'alimentation et des étriers | | | | | | | | | | | | ○ |

(1), (2) Générateurs (3000 / 3600 tr/min)
(3), (4) Générateurs (1800 / 1500 tr/min) et les applications générales industrielles, agricoles et travaux publics
(5), (6) Générateurs (3000 / 3600 tr/min) et les applications générales industrielles agricoles et travaux publics
(7), (8) Générateurs (1800 / 1500 tr/min)

* Changer l'huile moteur et la cartouche du filtre à huile après les premières 50 heures de service.

**⚠ ATTENTION**

- **Pour toute opération de remplacement ou de vérification, veiller à ce que le moteur soit placé de niveau et mis à l'arrêt.**

# [6] WARTUNGS-CHECKLISTE

Zur Gewährieistung einer dauerhaften und sicheren Funktion de Motors sollten regelmäßige Inspektionen entsprechend der nachstehenden Tabelle durchgeführt werden.

| Teil | | Zeitabstände der Wartung | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Alle 50 Stunden | Alle 75 Stunden | Alle 100 Stunden | Alle 150 Stunden | Alle 200 Stunden | Alle 300 Stunden | Alle 400 Stunden | Alle 500 Stunden | Alle 800 Stunden | Jedes Jahr | Alle 2 Jahre |
| Überprüfung der Kraftstoffleitungen und Klemmen | | ○ | | | | | | | | | | |
| * Motoröl-wechsel | (1) 90 mm Tiefölwanne | | ○ | | | | | | | | | |
| | (2) 124 mm Tiefölwanne | | | ○ | | | | | | | | |
| | (3) 90 mm Tiefölwanne | | | | ○ | | | | | | | |
| | (4) 124 mm Tiefölwanne | | | | | ○ | | | | | | |
| Reinigung des Luftfiltereinsatzes | | | | ○ | | | | | | | | |
| Reinigung des Kraftstoff-Filtereinsatzes | | | | ○ | | | | | | | | |
| Überprüfung der Lüfterriemenspannung und Feststellung von Beschädigungen | | | | ○ | | | | | | | | |
| Überprüfung der Wasserleitungen und Klemmen | | | | | | ○ | | | | | | |
| * Austausch der Ölfilter-patrone | (5) 90 mm Tiefölwanne | | | | ○ | | | | | | | |
| | (6) 124 mm Tiefölwanne | | | | | ○ | | | | | | |
| | (7) 90 mm Tiefölwanne | | | | | | ○ | | | | | |
| | (8) 124 mm Tiefölwanne | | | | | | | ○ | | | | |
| Austausch der Treibstoff-Filterkeze | | | | | | | | ○ | | | | |
| Reinigung des Kühlerinnenraumes | | | | | | | | | ○ | | | |
| Austausch des Kühlerreinigungsmittels und des Kühlmittels | | | | | | | | | | | | ○ |
| Austausch des Luftfiltereinsatzes | | | | | | | | | | | ○ | |
| Überprüfung des Ventilspiels | | | | | | | | | | ○ | | |
| Austausch der Wasserleitungen und Klemmen | | | | | | | | | | | | ○ |
| Austausch der Kraftstoffleitungen und Klemmen | | | | | | | | | | | | ○ |

(1), (2) Für Generatoren (3000 / 3600 U/min)
(3), (4) Für Generatoren (1800 / 1500 U/min) und für allgemeine Bau- / Industriemaschinen und landwirtschaftliche Geräte
(5), (6) Für Generatoren (3000 / 3600 U/min) und für allgemeine Bau- / Industriemaschinen und landwirtschaftliche Geräte
(7), (8) Für Generatoren (1800 / 1500 U/min)

* Tauschen Sie das Motoröl und Ölfilterpatrone nach den ersten 50 Betriebsstunden aus.

**⚠ ATTENTION**

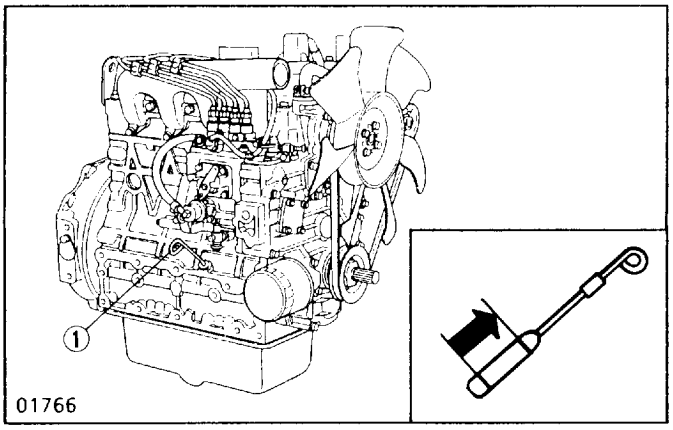
- **Bei Austausch oder Inspektion mu– der Motor ausgeschaltet werden.**

# [7] CHECK AND MAINTENANCE

■ NOTE

- Some types of gearcases are provided with an oil filler port. When the cylinder head has been reassembled or when the valve clearance has been readjusted, apply an enough amount of oil to the intake and exhaust valves, push rod and rocker arm just before fitting the head cover in position.

## (1) Daily Check Points

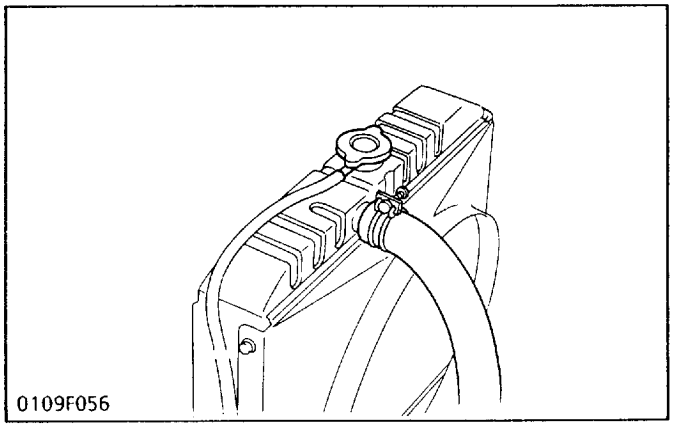



Checking Engine Oil Level

1. Level the engine.
2. To check the oil level, draw out the dipstick, wipe it clean, reinsert it, and draw it out again. Check to see that the oil level lies between the two notches.
3. If the level is too low, add new oil to the specified level.

■ IMPORTANT

- When using an oil of different maker or viscosity from the previous one, drain old oil. Never mix two different types of oil.




Checking and Replenish Cooling Water

1. Remove the radiator cap and check to see that the cooling water level is just bellow the port.
2. If low, add clean water and antifreeze.

⚠ CAUTION

- Do not remove the radiator cap until cooling water temperature is below its boiling point. Then loosen the cap slightly to relieve any excess pressure before removing the cap completely.

■ IMPORTANT

- Be sure to close the radiator cap securely. If the cap is loose or improperly closed, water may leak out and the engine could overheat.
- Do not use an antifreeze and scale inhibitor at the same time.

# [7] VERIFICATION ET ENTRETIEN

■ NOTA
- Certains types de boîtes d'engrenages sont fournis avec un orifice de remplissage pour huile. Lorsque la culasse de cylindre a été remontée ou lorsque le jeu de soupapes a éte réajusté, appliquer une quantité suffisante d'huile aux soupapes d'admission et d'échappement, à la tige de poussoir et au basculeur avant d'installer le couvercle de culasse en position.

## (1) Points de verification journalier

Verification du niveau d'huile moteur

1. Niveler le moteur.
2. Pour vérifier le niveau d'huile, retirer la jauge, l'essuyer, la remettre et la retirer de nouveau. Vérifier que le niveau d'huile se trouve entre les deux répères.
3. S'il manque de l'huile, ajouter de l'huile au niveau spécifié.

■ IMPORTANT
- Si l'on utilise une huile de marque ou de viscosité différente de l'huile se trouvant dans le carter, vidanger d'abord toute l'huile usagée. Ne jamais mélanger deux types d'huiles différents.

Vérification et remplissage du liquide de refroidissement

1. Déposer le bouchon de radiateur et vérifier si le niveau de liquide de rofroidissement se trouve juste au-dessous de l'orifice.
2. S'il est inférieur, faire l'appcint d'eau propre et antigel.

⚠ ATTENTION
- Ne pas enlever le bouchon du radiateur tant que la température de le liquide de refroidissement n'est pas descendue en-dessous du point d'ébullition. Ensuite, desserrer légèrement le bouchon jusqu'à la butée pour laisser s'échapper toute pression excessive avant d'ôter complètement le bouchon.

■ IMPORTANT
- Ne pas manquer de serrer fermement le bouchon de radiateur. Si le bouchon de radiateur est desserré ou mal fermé, la fuite d'eau pourrait se présenter, ce qui se traduit par une surchauffe éventuelle du moteur.
- Ne pas utiliser l'antigel et l'inhibiteur d'incrustation en même temps.

# [7] ÜBERPRÜFUNG UND WARTUNG

■ ANMERKUNG
- Einige Getriebegehäusetypen sind mit einer Öleinfüllöffnung versehen. Wenn der Zylinderkopf angebrcht wird, oder wenn das Ventilspiel erneut eingestellt wurde, ausreichend Öl auf Einlaß-und Auslaßventil sowie Kolbenstange und Kipphebel auftragen, bevor der Zylinderkopf festgesohraubt wird.

## (1) Tägliche Überprüfungspunkte

Überprüfung des Motorölstandes

1. Motor in horizontale Position bringen.
2. Zur Überprüfung des Ölstandes, den Ölmeßstab herausziehen, abwischen, wieder einstecken und nochmals herausziehen. Der Ölstand sollte zwischen den zwei Einkerbungen liegen.
3. Bei zu niedrigem Ölstand ist neues Öl bis zur vorgeschriebenen Höhe aufzufüllen.

■ WICHTIG
- Bei Verwendung einer anderen Ölsorte order eines Öls mit unterschielicher Viskosität, muß das gesamte alte Öl entfernt werden. Es dürfen niemals zwei unterschiedliche Ölsorten miteinander vermischt werden.

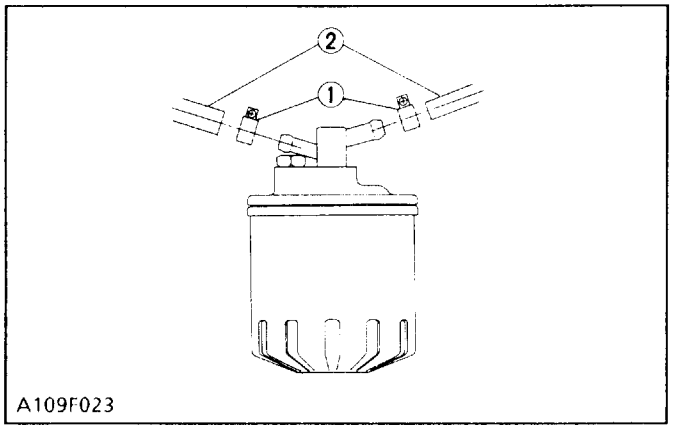
Überprüfung und Auffüllung des kühlwassers

1. Die kühlerverschlußkappe abschrauben und überprüfen, ob sich der Kühlwasserspiegel gerade unterhalb der Öffnung befindet.
2. Wenn er zu niedreg ist, reines Wasser und Frostchutzmittel nachfüllen.

⚠ ACHTUNG
- Die Kühlerverschlußkappe erst dann entfernen, wenn die Kühlwassertemperatur unter den Siedepunkt abgesunken ist. Dann die Verschlußkappe leicht bis zum Anschlag lösen, um vor dem vollständigen Entfernen den übermäßigen Druck abzulassen.

■ WICHTIG
- Darauf achten, daß die Kühlerverschraubung fest verschlossen wird. Wenn die Verschraubung lose oder unrichtig verschlossen ist, könnte Wasser auslaufen und der Motor überhitzt werden.
- Ein Frostschutzmittel und ein Kesselsteinverhütungsmittel nicht zur selben Zeit verwenden.

## (2) Check Point of Every 50 hours



A109F023

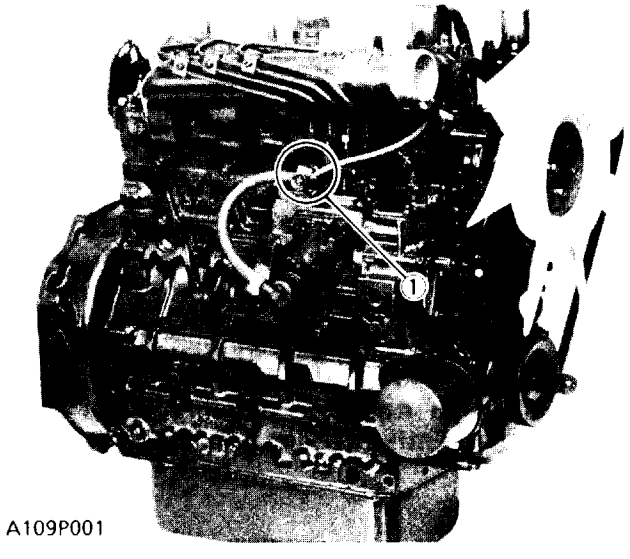
### Checking Fuel Pipe

1. If the clamp (1) is loose, apply oil to the threads and securely retighten it.
2. The fuel pipe (2) is made of rubber and ages regardless of the period of service.
   Change the fuel pipe together with the clamp every two years.
3. However, if the fuel pipe and clamp are found to be damaged or deteriorate earlier than two years, then change or remedy.
4. After the fuel pipe and the clamp have been changed, bleed the fuel system.

**⚠ CAUTION**

- **Stop the engine when attempting the check and change prescribed above.**

(1) Clamp
(2) Fuel Pipe



A109P001

**(When bleeding fuel system)**

1. Fill the fuel tank with fuel, and open the fuel cock.
2. Open the air vent plug on the fuel injection pump.
3. Pull the engine stop knob back completely to prevent the engine from starting while turning the key to rotate the engiine for about 10 seconds.
4. Close the air vent plug.

**■ NOTE**

- **Always keep the air vent plug on the fuel injection pump closed except when air is vented, or it may cause the engine to stop.**

(1) Air Vent Plug

## (2) Point de verification de toutes les 50 heures

### Vérification des tuyaux de carburant

1. Si l'étrier (1) est desserré, enduire d'huile les flletages et bien le resserrer.
2. Le tuyaux de carburant (2) est en caoutchouc, il vieillit quelque soit la durée d'utilisation.
   Changer le tuyaux de carburant ainsi que l'étrier tous les deux ans.
3. Cependant, si l'on constate que le tuyaux de carburant et son étrier sont endommagés ou détériorés avant ces deux années, les changer ou les réparer.
4. Après le changement du tuyaux de carburant et de l'étrier, purger l'air du circuit d'alimentation.

**⚠ ATTENTION**

- **Mettre le moteur à l'arrêt pour effectuer les vérifications et changements prescrits ci-dessus.**

(1) Etrier
(2) Tuyaux de carburant

**(Lors de la purge du circuit de carburant)**

1. Remplissez le réservoir de combustible et ouvrez le robinet d'arrivée.
2. Desserez le bouchon de purge de la pompe d'injection.
3. Tirez le bouton d'arrêt du moteur complètement pour empêcher le moteur de démarrer pendant que l'on tourne la clef à tourner le moteur pour 10 secondes environ.
4. Fermez le bouchon de purge.

**■ NOTA**

- **Le robinet de purge d'air se trouvant sur la pompe d'injection doit toujours rester fermé, sauf pour la purge de l'air, sans quoi cela provoquerait l'arrêt du moteur.**

(1) Bouchon de purge.

## (2) Überprüfungspunkt nach allen 50 Stunden

### Überprüfung der Kraftstoffleitung

1. Wenn sich die Klemme (1) gelöst hat, die Gewinde mit Öl eeinstreichen und die Klemme sorgfältig festziehen.
2. Die Kraftstoffleitung (2) besteht aus Gummi und unterliegt der Alterung, ungeachtet der Betriebsdauer.
   Die Kraftstoffleitung, gemeinsam mit der Klemme, alle 2 Jahre austauschen.
3. Wenn vor Ablauf von zwei Jahren eine Beschädigung oder Abnutzung der Kraftstoffleitung und der Klemmen festgestellt wird, müssen diese ausgetauscht oder repariert werden.
4. Nach erfolgtem Austausch der Kraftstoffleitung und der Klemme, muß das Kraftstoffsystem entlüftet werden.

**⚠ ACHTUNG**

- **Bei Durchführung der vorgeschriebenen Überprüfung und des Austauschs ist der Motor auszuschalten.**

(1) Klemme
(2) Kraftstoffleitung

**(Beim Entlüften des Kraftstoffsystems)**

1. Füllen Sie den Kraftstofftank mit Kraftstoff und öffnen Sie den Kraftstoffhahn.
2. Öffnen Sie den Entlüftungsstopfen an der Kraftstoffeinspritzpumpe.
3. Ziehen Sie den Motorhalterknopf, um den Motor anzuhalten, und betätigen Sie den Anlasser etwa 10 Sekunden Lang.
4. Schließen Sie den Entlüftungsstopfen, wenn in dem ausfließenden Kraftstoff keine Luftblasen mehr zu sehen Sind.

**■ ANMERKUNG**

- **Außer bei einer Entlüftung, den Entlüftungshahn an der Kraftstoffeinspritzpumpe stets geschlossen halten. Anderenfalls besteht die Gefahr, daß der Motor ausgeschaltet wird.**

(1) Entlüftungsschraube

## (3) Check Point of Every 75, 100, 150, 200 hours (For details, refer to page S-32)

| Models | Oil pan depth | |
|---|---|---|
| | 124 mm (4.88 in.) | * 90 mm (3.54 in.) |
| D1403-B(E)<br>D1703-B(E) | 7.0 ℓ<br>(1.85 U.S.gal.)<br>(1.54 Imp.gal.) | 5.6 ℓ<br>(1.48 U.S.gal.)<br>(1.23 Imp.gal.) |
| V1903-B(E)<br>V2203-B(E) | 9.5 ℓ<br>(2.51 U.S.gal.)<br>(2.09 Imp.gal.) | 7.6 ℓ<br>(2.01 U.S.gal.)<br>(1.672 Imp.gal.) |
| F2803-B(E) | 12.0 ℓ<br>(3.17 U.S.gal.)<br>(0.64 Imp.gal.) | — |

* 90 mm (3.54 in.) oil pan depth is optional.

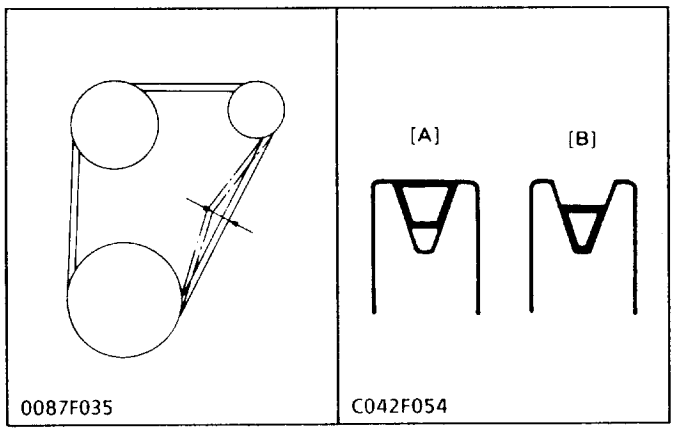
### Changing Engine Oil

1. After warming up, stop the engine.
2. To change the used oil, remove the drain plug at the bottom of the engine and drain off the oil completely.
3. Reinstall the drain plug.
4. Fill the new oil up to the upper notch on the dipstick.

**■ IMPORTANT**

- **Engine oil should be MIL-L-2104C or have properties of API classification CD/CE grades.**
- **Change the type of engine oil according to the ambient temperature.**
  **Above 25°C (77°F)---------- SAE 30 or 10W-30**
  **0°C to 25°C (32°F to 77°F)------ SAE 20 or 10W-30**
  **Below 0°C (32°F)---------- SAE 10 W or 10W-30**

## (4) Check Point of Every 100 hours



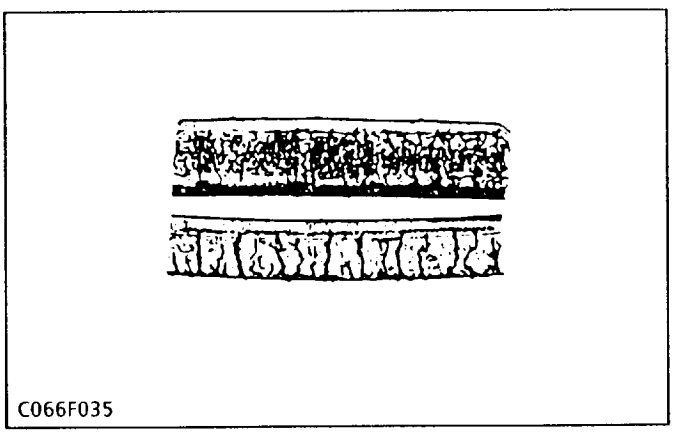




### Checking Fan Belt Tension

1. Press the fan belt between fan pulley and pulley at force of 98 N (10 kgf, 22 lbs).
   Check if the fan belt deflection is 10 to 12 mm (0.394 to 0.472 in.)
2. If the deflection is not within the factory specifications, loosen the bolt and nuts, and relocate the alternator to adjust,

**[A] Good**
**[B] Bad**




### Checking Fan Belt Damage

1. Check the fan belt for damage.
2. Check if the fan belt is worn and sunk in the pulley groove.
3. Replace the fan belt if the belt is damaged or nearly worn out and deeply sunk in the pulley groove.

## (3) Points de verification de toutes les 75, 100, 150, 200 heures (Pour les détails, se référer à la page S-33)

### Change d'huile moteur

1. Après avoir fait porté le moteur à température, le mettre à l'arrêt.
2. Pour vidanger l'huile usagée, enlever le bouchon de vidange se trouvant au bas du moteur et laisser l'huile s'écouler complètement.
3. Remettre le bouchon de vidange.
4. Remplir de l'huile neuve jusqu'à ce qu'elle atteint le trait supérieur de la jauge.

**■ IMPORTANT**

- **L'huile moteur doit être MIL-L-2104C ou a des propriétés conformes aux degrés CD/CE API.**
- **Changer le type d'huile moteur en fonction de la température ambiante.**
  **Plus de 25°C ---------- SAE 30 ou 10W-30**
  **0°C à 25°C ---------- SAE 20 ou 10W-30**
  **Moins de 0°C ---------- SAE 10W ou 10W-30**

| Modeles | Profondeur de carter d'huile | |
|---|---|---|
| | 124 mm | * 90 mm |
| D1403-B(E), D1703-B(E) | 7,0 ℓ | 5,6 ℓ |
| V1903-B(E), V2203-B(E) | 9,5 ℓ | 7,6 ℓ |
| F2803-B(E) | 12,0 ℓ | — |

* La profondeur du carter d'huile de 90 mm est optionnelle.

## (4) Points de verification de toutes les 100 heures

### Verification la tension de courroie de ventilateur

1. Appuyer sur la courroie de ventilateur entre la poulie de ventilateur et la poulie avec une force de 98 N (10 kgf).
   Vérifier si la tension de la courroie de ventilateur est de 10 à 12 mm.
2. Si la flexion n'est pas comprises dans la valeur de référence, desserrer les boulons et ecrous et ammener l'alternateur en place.

**[A] Correct** **[B] Incorrect**

### Verification l'état de la courroie de ventilateur

1. Vérifier si la courroie de ventilateur est endommagée.
2. Vérifier si la courroie de ventilateur est usée et enfoncée dans la gorge de la poulie.
3. Remplacer la courroie de ventilateur si elle est endommagée, ou sérieusement usée et enfoncée profondément dans la gorge de la poulie.

## (3) Überprüfungspunkte nach allen 75, 100, 150, 200 Stunden (Für die Einzelheiten siehe Seite S-34)

### Austaush des Motoröls

1. Motor warm laufen lassen und dann ausschalten.
2. Um das alte Öl zu wechseln, die Ablaßschraube am Motorboden entfernen und das Öl vollständig ablassen.
3. Die Ablaßschraube wieder einsetzen.
4. Neues Öl bis zur oberen Einkerbung des Ölmeßstabes einfüllen.

**■ WICHTIG**

- **MIL-L-2104C oder ein Motoröl die der API-Klasse CD/CE Güte entspricht ist zu ver-wenden.**
  **Die Motorölsorte gemäß der Umgebung-stemperatur wechseln.**
  **Über 25°C ----------SAE 30 oder 10W-30**
  **0°C bis 25°C ---------- SAE 20 oder 10W-30**
  **Unterhalb von 0°C ---------- SAE 10W oder 10W-30**

| Modelle | Tiefe der Ölwanne | |
|---|---|---|
| | 124 mm | * 90 mm |
| D1403-B(E), D1703-B(E) | 7,0 ℓ | 5,6 ℓ |
| V1903-B(E), V2203-B(E) | 9,5 ℓ | 7,6 ℓ |
| F2803-B(E) | 12,0 ℓ | — |

* Die Ölwanne (T = 90 mm) ist optional.

## (4) Überprüfungspunkte nach allen 100 Stunden

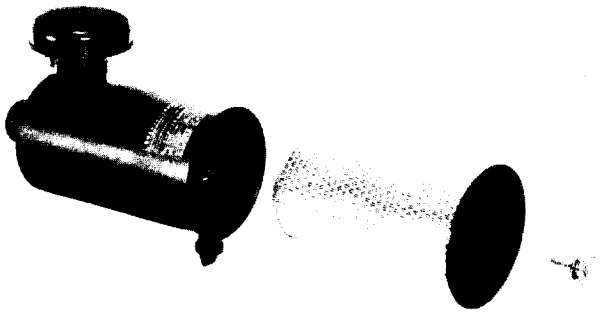
### Überprüfung der Lüfterriemenspannung

1. Auf den Lüfterriemen zwischen der Lüfter-riemenscheibe und Spannrolle mit dem einer Kraft von 98 N (10 kp) drücken.
   Überprüfen, ob die Durchsenkung des Lüfter-riemens zwischen 10 bis 12 mm beträgt.
2. Wenn sich die Biegung nicht innerhalb der Sollwerte befindet, die Bolzen und Muttern lösen und den Alternator in Stellung bringen.

**[A] Gut** **[B] Schlecht**

### Überprüfung auf Beschädigung des Lüfterriemens

1. Den Lüfterriemen auf Beschädigung überprüfen.
2. Überprüfen, ob der Lüfterriemen abgenutzt und in die Scheibenrille versenkt ist.
3. Den Lüfterriemen auswechseln wenn der Riemen beschädigt, bzw. stark abgetragen und in die Scheibenrille tief versenkt ist.



A109P002

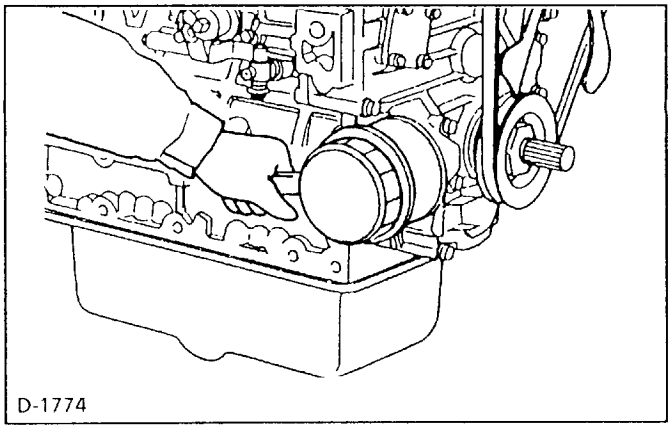
### Cleaning Air Cleaner

1. Remove the air cleaner element.
2. Use clean dry compressed air on the inside of the element.
   Air pressure at the nozzle must not exceed 690 kPa (7 kgf/cm$^2$, 100 psi).
   Maintain reasonable distance between the nozzle and the filter.

■ **NOTE**

- **Change the element once a year or every 6th cleaning.**
- **The air cleaner uses a dry element. Never apply oil to it.**

## (4) Check Point of Every 200 hours



D-1774

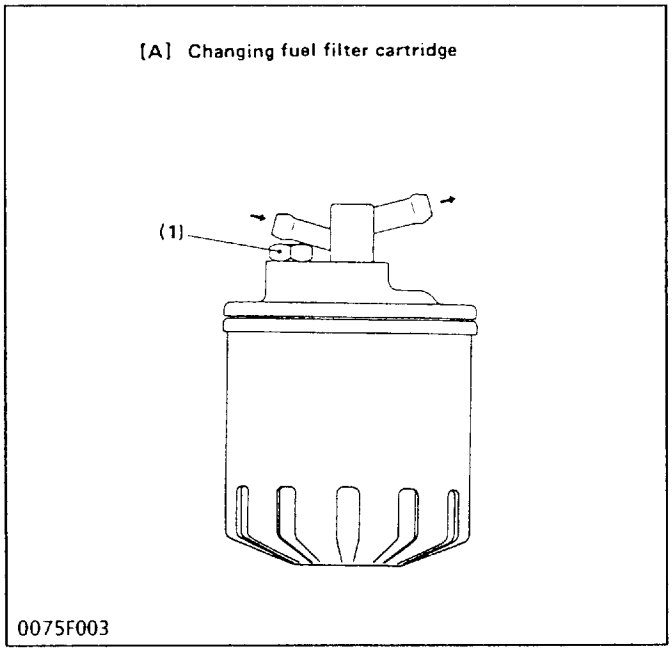
### Changing Engine Oil Filter Cartridge

1. Remove the oil filter cartridge with a filter wrench.
2. Apply engine oil to the rubber gasket on the new cart ridge.
3. Screw the new cartridge in by hand.

■ **NOTE**

- **Over-tightening may cause deformation of rubber gasket.**
- **After cartridge has been replaced, engine oil normally decreases a little.**
  **Check the oil level and add new oil to the specified level.**

## (5) Check Point of Every 150, 200, 300, 400 hours (For details, refer to page S-32)




0075F003

### Changing Fuel Filter Cartridge

Water and dust in fuel are collected in the filter cartridge. So, change the filter cartridge every 400 hours service.

1. Remove the used filter cartridge with filter wrench.
2. Apply a thin film of fuel to the surface of new filter cartridge gasket before screwing on.
3. Then tighten enough by hand.
4. Loosen the air vent plug to let the air out.
5. Start engine and check for fuel leakage.

(1) Air Vent Plug

### Nettoyage du filtre à air

1. Déposer l'élément de filtre à air.
2. Insuffler de l'air comprimé sec et propre vers l'intérieur de l'élément.
   La pression d'air à la buse ne doit pas excéder 690 kPa (7 kgf/cm$^2$, 6,9 bar).
   Maintenir une distance adéquate entre la buse et le filtre.

**■ NOTA**

- **Changer l'élément tous les ans ou tous les 6 nettoyages.**
- **Le filtre à air utilise un élément sec. Ne jamais l'enduire d'huile.**

## (4) Points de verification de toutes les 200 heures

### Renouvellement de la cartouch du filtre à huile moteur

1. Enlever la cartouche de filtre à huile à l'aide d'une clef pour filtre.
2. Enduire d'huile moteur le joint en dcaoutchouc de la cartouche neuve.
3. A la main, visser la cartouche neuve en place.

**■ NOTA**

- Un excés de serrage peut déformer le joint en caoutchouc.
- Après le remplacement de la cartouche, il est normal d'avoir une légère baisse de l'huile moteur. Vérifier le niveau d'huile et faire l'appoint jusqu'au niveau spécifié.

## (5) Points de verification de toutes les 150, 200, 300, 400 heures (Pour les détails, se référer à la page S-33)

### Changement de la cartouche du filtre à combustibel

L'eau et la poussière contenues dans le combustible s'accumulent dans la cartouche du filtre. Il est donc nécessaire de changer cette cartouche toutes les 400 heures d'emploi.

1. Retirer la cartouche usée à l'aide d'une clé à filtre.
2. Enduire la surface du nouveau joint de cartouche d'une fine couche de combustibel avant de la visser.
3. Bien serrer ensuite à la main.
4. Desserrer le bouchon de purge d'air afin d'évacuer l'air.
5. Mettre le moteur en marche et vérifier s'il n'y a pas de fuite de combustible.

(1) Valve du filtre

### Reinigung des Luftfilters

1. Den Luftfilter-Einsatz entfernen.
2. Den Einsatz aus der Innenseite mit reiner Druckluft durchblasen.
   Der Luftdruck an der Düse darf 690 kPa (7 kp/cm$^2$, 6,9 bar) nicht überschreiten.
   Einen angemessenen Abstand zwischen der Düse und dem Filter aufrechterhalten.

**■ ANMERKUNG**

- **Den Einsatz einmal im Jahr oder nach jeder 6. Reinigung austauschen.**
- **Der Luftfilter verwendet einen trockenen Einsatz. Niemals Öl auf ihn auftragen.**

## (4) Überprüfungspunkte nach allen 200 Stunden

### Austausch der Motorölfilterpatrone

1. Die Ölfilterpatrone mit einem Filterschlüssel entfernen.
2. Motoröl auf die Gummidichtung der neuen Patrone auftragen.
3. Die neue Patrone von Hand einschrauben.

**■ ANMERKUNG**

- Durch übermäßiges Anziehen kann die Gummidichtung beschädigt werden.
- Nach Austausch der Patrone sinkt das Motoröl normalerweise ein wenig ab.
  Ölstand prüfen und neues Öl bis zur vorgeschriebenen Höhe einfüllen.

## (5) Überprüfungspunkte nach allen 150, 200, 300, 400 Stunden (Für die Einzelheiten siehe Seite S-34)

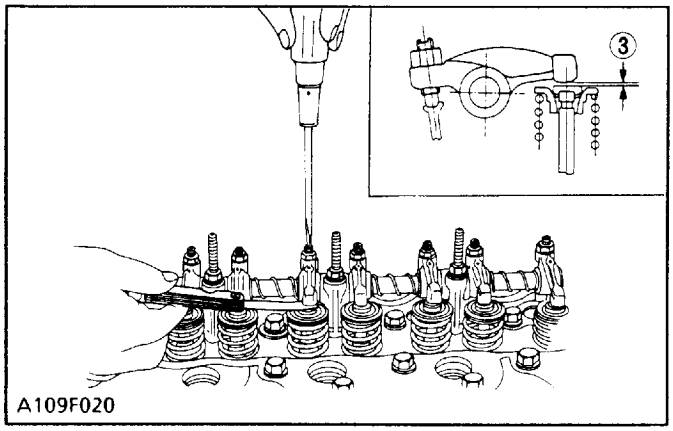
### Wechsel der Treibstoff-Filterkerze

Wasser und Staub in dem Treibstoff werden in der Filterkerze gesammelt, daher muß die Filterkerze nach je 400 Stunden Betrieb gewechselt werden.

1. Die gebrauchte Filterkerze mit einer Filterklemme entfernen.
2. Vor Anschrauben auf die Oberfläche der neuen FilterkerzeAbdichtung eine dünne Schicht Treibstoff auftragen.
3. Anschließ end manuell festziehen.
4. Den Luftventilverschluß lösen, damit die Luft entweicht.
5. Motor anlassen und auf Treibstoffaustritt prufen.

(1) Entlüfterstutzen

## (5) Check Point of Every 800 hours





(1) Projection
(2) TC Mark Line
(3) Valve Clearance

### Checking Valve Clearance

**■ IMPORTANT**

- **Valve clearance must be checked and adjusted when engine is cold.**

1. Remove the head cover.
2. Align the "1TC" mark on the flywheel and projection (1) on the housing so that the No.1 piston comes to the compression or overlap top dead center.
3. Check the following valve clearance marked with "o" using a feeler gauge.
4. If the clearance is not within the factory specifications, adjust with the adjusting screw.

| | | |
|---|---|---|
| Valve clearance | Factory spec. | 0.18 to 0.22 mm<br>0.0071 to 0.0087 in. |

**■ NOTE**

- **The "TC" making on the flywheel is just for No.1 cylinder. There is no "TC" marking for the other cylinders.**
- **No.1 piston comes to the T.D.C. position when the "TC" marking is aligned with the projection in the window on flywheel-housing. Turn the flywheel 0.26 rad. (15°) clockwise and counter-clockwise to see if the piston is at the compression top dead center or the overlap position. Now referring to the table below, readjust the valve clearance. (The piston is at the top dead center when both the In. and EX valves do not move; it is at the overlap position when both the valves move.**
- **Finally turn the flywheel 6.28 rad. (360°) and aligne the "TC" marking and the projection perfectly. Adjust all the other valve clearance as required.**
- **After turning the flywheel counterclockwise twice or three times, recheck the valve clearance.**
- **After adjusting the valve clearance, firmly tighten the lock nut of the adjusting screw.**

| Engine Model<br>Valve arrengement<br>Adjustable cylinder Location of piston | | D1403-B(E)<br>D1703-B(E) | | V1903-B(E)<br>V2203-B(E) | | F2803-B(E) | |
|---|---|---|---|---|---|---|---|
| | | IN. | EX. | IN. | EX. | IN. | EX. |
| When No.1 piston is compression top dead center | 1 st | o | o | o | o | o | o |
| | 2 nd | | o | o | | o | |
| | 3 rd | o | | | o | | o |
| | 4 th | | | | | | |
| When No.1 piston is overlap position | 1 st | | | | | | |
| | 2 nd | o | | | o | | o |
| | 3 rd | | o | o | | o | |
| | 4 th | | | o | o | o | o |
| | 5 th | | | | | o | o |

## (5) Point de verification de toutes les 800 heures

### Verification du jeu des soupapes

■ **IMPORTANT**

- **Le jeu des soupape doit être et réglé suivant les besoins avec le moteur froid.**

1. Déposer le couvre-culasse.
2. Aligner le repère "1 TC" du volant et le coin du carter de volant pour que le piston N° 1 arrive au point mort haut de compression.
3. Vérifier le jeu aux soupapes suivant marqup par "o" en utilisant un calibre d'épaisseur.
4. Si le jeu n'est pas compris dans la gamme de valeurs de référence, régler à l'aide de la vis de réglage.

| Jeu des soupapes (à froid) | Valeur de référence | 0,18 à 0,22 mm |
|---|---|---|

■ **NOTA**

- **Le marquage "TC" sur le volant n'est que pour le cylindre No.1 il n'y a pas de marquage "TC" pour les autres cylindres.**
- **Le piston No. 1 passe à la position P.M.H. (point mort haut) lorsque la marquage "TC" est aligné avec le repère poinçconné de la plaque de fond arrière. Tourner le volant de 15° (0,26 rad) dans le sens des aiguilles d'une montre, puis dans le sens inverse pour vérifier si le pisston est au point mort haut de la compression ou à la position de juxtaposition. En se référent maintenant au tableau ci-dessous, refaire le réglage du jeu des soupapes. (Le piston est au point mort haut lorsque les deux soupapes "ADM." et "ECH." ne bougent pas, il est à la position de juxtaposition lorsque les deux soupapes se déplacent.)**
- **Enfin, tourner le volant de 360° (6,28 rad) pour s'assurer que le marquage "TC" et le repère poinçonné sonnt parfaitement alignés. Régler tous les autres jeux de soupapes dans la mesure des nécessités.**
- **Après avoir tourné le volant dans le sens inverse des aiguilles d'une montre à deux ou trois reprises, vérifier à nouveau le jeu de soupape.**
- **Après avoir réglé le jeu de soupape, serrer fermement le contre-écrou de vis de réglage.**

| Nodèle de moteur Disposition des soupapes Cylinder ajustable Emplacement du piston | | D1403-B(E) D1703-B(E) | | V1903-B(E) V2203-B(E) | | F2803-B(E) | |
|---|---|---|---|---|---|---|---|
| | | ADM. | ECH. | ADM. | ECH. | ADM. | ECH. |
| Lorsque le piston N° 1 est au point mort haut de compression | 1 èmè | o | o | o | o | o | o |
| | 2 èmè | | o | o | | o | |
| | 3 èmè | o | | | o | | o |
| | 4 èmè | | | | | | |
| Lorsue le piston N° 1 et à la position de juxtaposition | 1 st | | | | | | |
| | 2 nd | o | | | o | | o |
| | 3 rd | | o | o | | o | |
| | 4 th | | | o | o | o | o |
| | 5 th | | | | | o | o |

(1) Partie entaillée
(2) Repère TC
(3) Jeu aux soupapes

## (5) Überprüfungspunkte nach allen 800 Stunden

### Überprüfung des Ventilspieles

■ **WICHTIG**

- **Das Ventilspiel bei kaltem Motor gemessen und eingestellt werden.**

1. Entfernen Sie die Zylinderkopfverkleidung.
2. Die "1 TC" -Marke auf dem Schwungrad und die Kante am Schwungradgehäuse so ausrichten, daß der Kolben Nr.1 in den oberen Totpunkt der Kompression gelangt.
3. Das mit "o" gekennzeichnete Ventilspiel mit Hilfe einer Fühlerlehre messen.
4. Das Spiel mit der Stellschraube berichtigen wenn es nicht innerhalb der vorgeschriebenen Werkdaten ist.

| Ventilspiel (Kalt) | Werkdaten | 0,18 bis 0,22 mm |
|---|---|---|

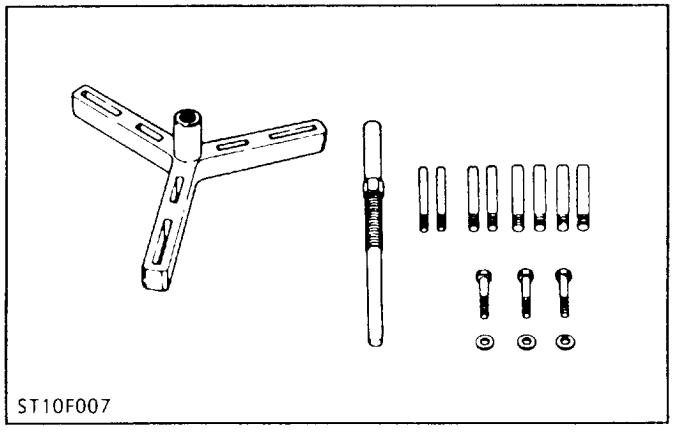
■ **ANMERKUNG**

- **Die "TC"-Marke auf der Schwungscheibe gilt nur für den Zylinder Nr. 1. Für die anderen Zylinder gibt es keint "TC"-Markierung.**
- **Wenn die "TC"-Marke mit der Stanzmarkierung der hinteren Scheibe ausgerichtet ist, befindet sich der Kolben Nr. 1 im OT. Nun die Schwungscheibe um 15° (0,26 rad) nach rechts bzw. nach links drehen, um zu prüfen, ob sich der Kolben i m OT (Kompressionsposition) oder in der Überlappungsposition befindet. (Der Kolben befindet sich im OT, wenn sich die Einlaü-und Auslaüventile nicht bewegen. Wenn sich beide Ventile bewegen, ist der Kolben in der Überlappungsposition.)**
- **Die Schwungscheibe schließlich um 360° (6,28 rad) drehen, um sicherzustellen, daß die "TC"-Marke und die Stanbzmerke präzise miteinander ausgerichtet sind. Sämtliche Ventilspiele müssen auf den Sollwert eingestellt werdern.**
- **Das Schwungrad zweimal oder dreimal entgegen dem Uhrzeigerlauf drehen und das Ventilspiel nachprüfen.**
- **Nach Einstellung des Ventilspiels, die Sicherungsmutter der Stellschraube festziehen.**

| Motor-Modell Ventilanordnung Einstellbarer Zylinder Kolbenposition | | D1403-B(E) D1703-B(E) | | V1903-B(E) V2203-B(E) | | F2803-B(E) | |
|---|---|---|---|---|---|---|---|
| | | EIN | AUS | EIN | AUS | EIN | AUS |
| Bei oberer Totpumkt der Kompression des Kolben Nr.1 | 1. | o | o | o | o | o | o |
| | 2. | | o | o | | o | |
| | 3. | o | | | o | | o |
| | 4. | | | | | | |
| Venn sich der Kolben Nr. 1 in der Überlappungsposition befindet | 1. | | | | | | |
| | 2. | o | | | o | | o |
| | 3. | | o | o | | o | |
| | 4. | | | o | o | o | o |
| | 5. | | | | | o | o |

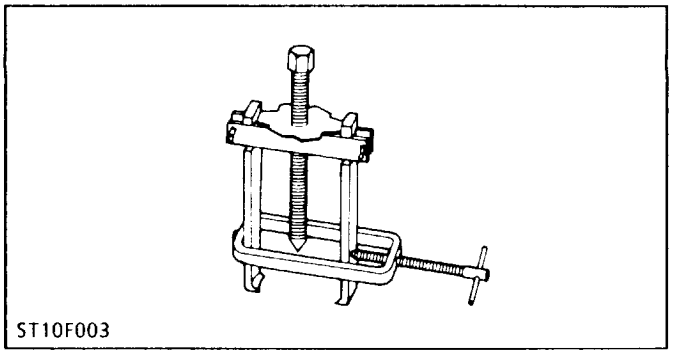
(1) Eingekerbten Teil
(2) TC-Markierung
(3) Vantilspiel

# [8] SPECIAL TOOLS


ST10F007

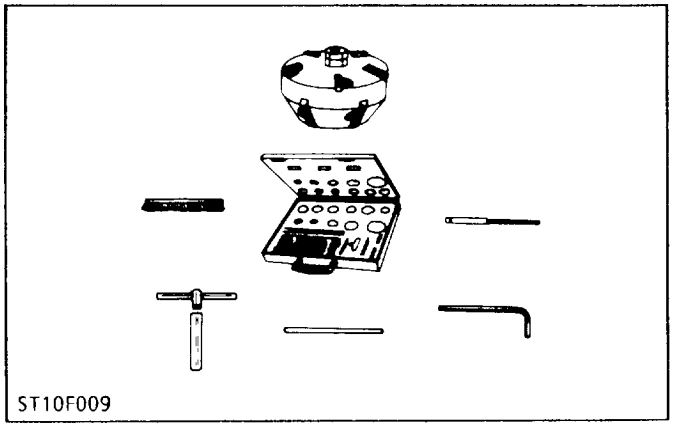
**Flywheel Puller**

Code No: 07916-32011
Application: Use to remove the flywheel.


ST10F003

**Special-use Puller Set**

Code No: 07916-09032
Application: Use for pulling out bearings, gears and other parts.


ST10F009

**Valve Seat Cutter Set**

Code No: 07909-33102
Application: Use for correcting valve seats.

# [8] OUTILS SPECIAUX

**Extracteur de volant**

Référence: 07916-32011
Utilisation: Sert à la depose du volant.

**Extracteur à usage spécial**

Référence: 07916-09032
Utilisation: Sert à l'extraction des roulements, des pignons et d'autres pièces.

**Fraiseuse**

Référence: 07909-33102
Utilisation: Sert pour rectifier les sièges de soupape.

# [8] SPEZIALWERKZEUGE

**Schwungradabziehwerkzeug**

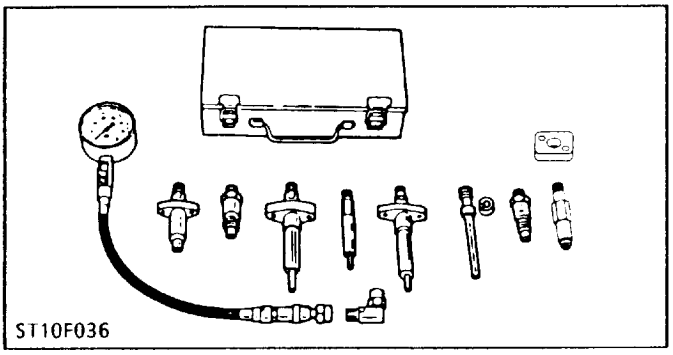
Code Nr: 07916-32011
Benutzung: Zum Schwungradausbau.

**Special-Abziehvorrichtung**

Code Nr: 07916-09032
Benutzung: Zum Abziehen von Lagern, Zahnrädern und anderen Teilen.

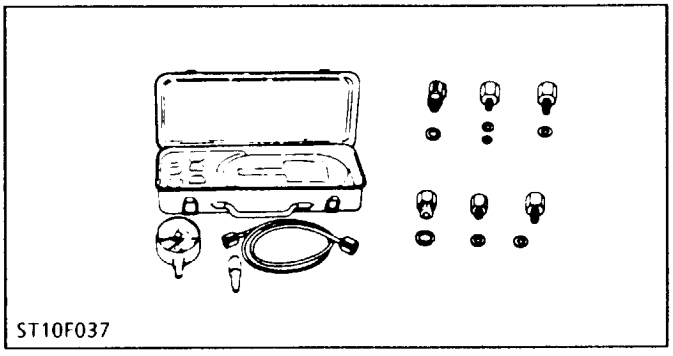
**Ventilsitzschneider**

Code Nr: 07909-33102
Benutzung: Zum Ausfräsen von Ventilen.


ST10F036

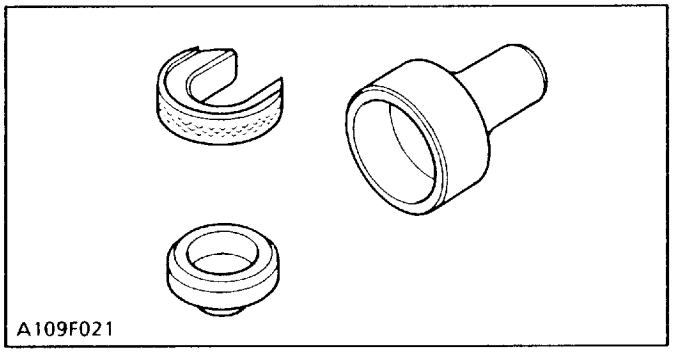
**Diesel Engine Compression Tester**

Code No: 07909-30207
Application: Use for measuring diesel engine compression pressure.


ST10F037

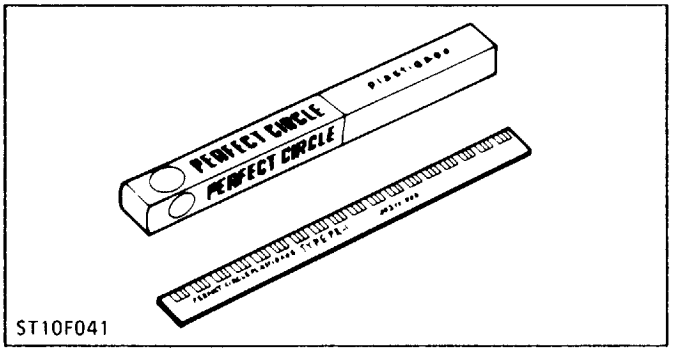
**Oil Pressure Tester**

Code No: 07916-32031
Application: Use for measuring lubricating oil pressure.


A109F021

**Auxiliary Socket For Fixing Crankshaft Sleeve**

Code No: 07916-32091
Application: Use to fix the crankshaft sleeve of the diesel engine.



ST10F041

**Plastigage**

Code No: 07909-30241
Application: Use for checking the oil clearance between crankshaft and bearing, etc.
Measuring range:
Green — 0.025 to 0.076 mm (0.001 to 0.003 in.)
Red — 0.051 to 0.152 mm (0.002 to 0.006 in.)
Blue — 0.102 to 0.229 mm (0.004 to 0.009 in.)

**Compressiomètre pour moteur diesel**

Référence: 07909-30207
Utilisation: Sert à mesurer la compression de moteurs diesel.

**Kompressionsprüfgerät für Dieselmotoren**

Code Nr: 07909-30207
Benutzung: Zum Messen der Kompression von Dieselmotors.

**Manomêtre de pression d'huile**

Référence: 07916-32031
Utilisation: Sert à mesurer la pression d'huile de lubrification.

**Öldruckprüfgerät**

Code Nr: 07916-32031
Benutzung: Zum Messen des schmieröldruckes.

**Outil pour la fixation de la coupelle de vilebrequin**

Référence: 07916-32091
Utilisation: Sert uniquement à fixer la coupelle de vilebrquin de moteurs diesel.

**Hilfsmuffe zur Befestigung der Kurbelwellenbuchse**

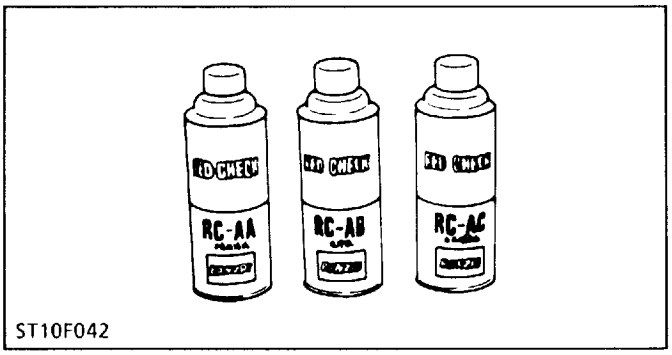
Code Nr: 07916-32091
Benetzung: Zum Befestigen der Kurbelwellenbuchse des Dieselmotors.

**Jauge plastique**

Référence: 07909-30241
Utilisation: Sert à vérifier le jeu de marche entre le villebrequin et le palier, etc.
Plage de mesure: Vert ——— 0,025 à 0,076 mm
Rouge ——— 0,051 à 0,152 mm
Bleu ——— 0,102 à 0,229 mm

**Preßmeßgerät**

Code Nr: 07909-30241
Benetzung: Zur Überprufung des Ölspiels zwischen kurbelwelle und Lager usw.
Meßbereich: Grün ——— 0,025 bis 0,076 mm
Reot ——— 0,051 bis 0,152 mm
Bluau ——— 0,102 bis 0,229 mm



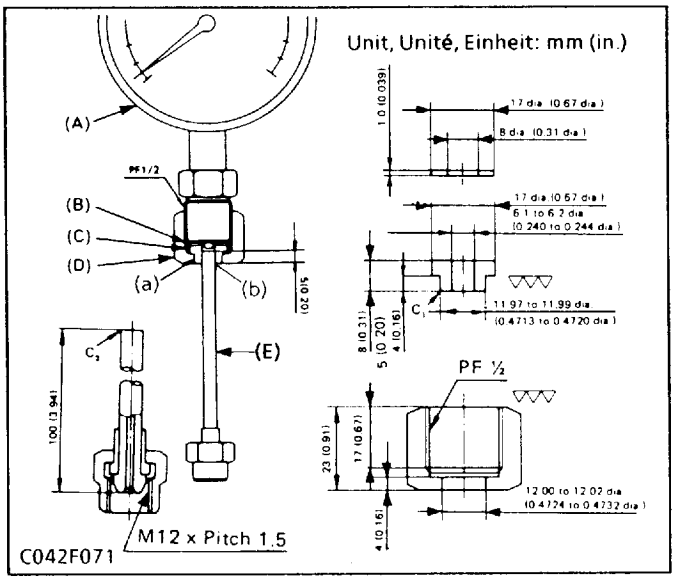
ST10F042

## Red Check (Crack check liquid)

Code No: 07909-31371
Application: Use for checking cracks on cylinder head, cylinder block, etc.

**■ NOTE**

- **The following special tools are not provided, so make them refering to the figures.**



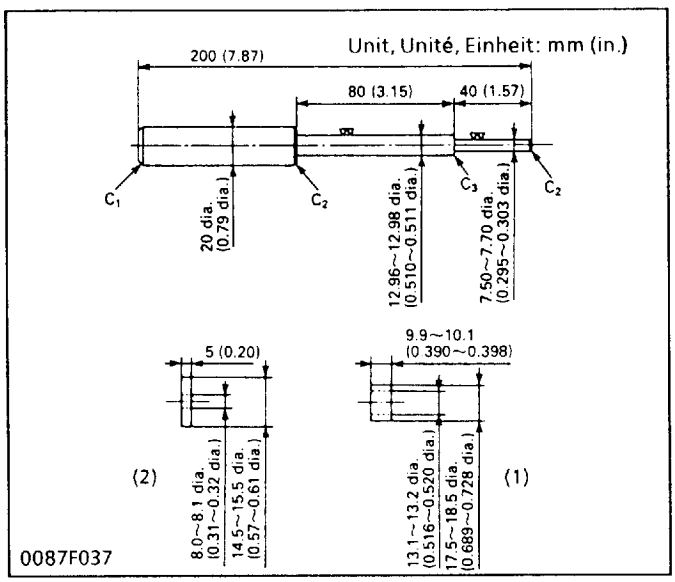
C042F071

## Injection Pump Pressure Tester

Application: Use for checking fuel tightness of the injection pump.

| | |
|---|---|
| A | Pressure gauge<br>Full scale: More than 29.4 MPa (300 kgf/cm², 4267 psi) |
| B | Copper gasket |
| C | Flange (Material: Steel) |
| D | Hex. nut 27 mm (1.06 in.) across the flat (Material: Steel) |
| E | Injection Pipe |

(a) Adhesive application
(b) Fillet welding on the enter circumference



0087F037

## Valve Guide Replacing Tool

Application: Use to press out and to press fit the valve guide.

(1) Spacer
(2) Stopper

| *Chamfer | mm | in. |
|---|---|---|
| $C_1$ | 2.0 | 0.079 |
| $C_2$ | 1.0 | 0.039 |
| $C_3$ | 0.3 | 0.012 |

**Unit : mm (in.)

## Liquide de vérification de fissure (Vérification en rouge)

Référence: 07909-31371
Utilisation: Sert à rechercher les fissures de la culasse, du bloc-moteur, etc.

■ **NOTA**
- **Les outils speciaux suivants ne sont pas fournis, aussi faut-il les fabriquer à l'aide des figures.**

## Manomètre de pression de la pompe d'injection

Utilisation: Sert à vérifier l'étanchéité au carburant des pompes d'injection.

| | |
|---|---|
| A | Jauge de pression<br>Echelle complète: Plus de 29,4 MPa (300 kgf/cm², 294 bar) |
| B | Joint en cuivre |
| C | Bride (Matériau: Acier) |
| D | Ecrou hexagonal, enfoncé à 27 mm (Matériau: Acier) |
| E | Conduit d'injection |

(a) Adhésif
(b) Soudure à la circonférence d'entrée

## Outil de remplacement de guides de soupape

Utilisation: Sert à extraire et à monter à pression le guide de soupape.

(1) Entretoise
(2) Butée

*Champfrein

## Flüssigkeit zur Ermittlung von Rissen

Code Nr: 07909-31371
Benetzung: Zur Ermittlung von Rissen an Zylinderköpf, Zylinderblock usw.

■ **ANMERKUNG**
- **Die folgenden Spezialwerkzeug werden nicht mitgeliefert. Diese sind anhand der Abbildungen anzufertigen.**

## Druckmesser für Einspritzpumpe

Benutzung: Zur Überprüfung der Kraftstoffdichtigkeit von Einspritzpumpen.

| | |
|---|---|
| A | Druckanzeige<br>Natürliche Größe: Über 29,4 MPa (300 kp/cm², 294 bar) |
| B | Kupferdichtung |
| C | Flansch (Material: Stahl) |
| D | 27 mm Sechskantmutter (Material: Stahl) |
| E | Einspritzleitung |

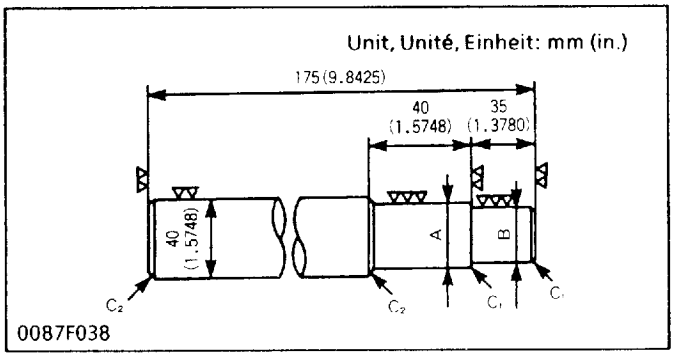
(a) Anhaftend
(b) Hohlkehischweiße am Eintrittsumkreis

## Werkzeug für den Austausch von Ventilführungen

Benutzung: Zum Herausdrücken und Einpassen der Ventilführung.

(1) Abstandsstück
(2) Begrenzer

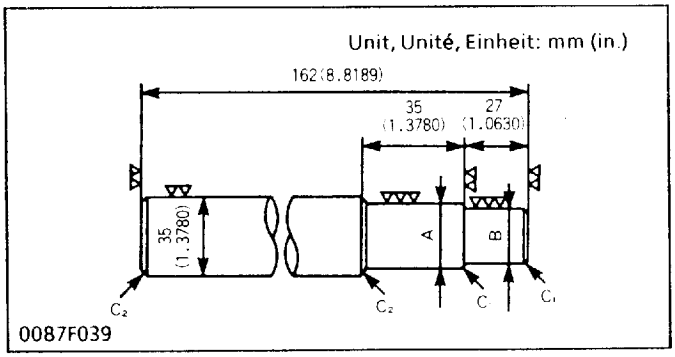
*Abfasung




## Idle gear Bushing Replacing Tool

Application: Use to press out and to press fit the idle gear bushing.

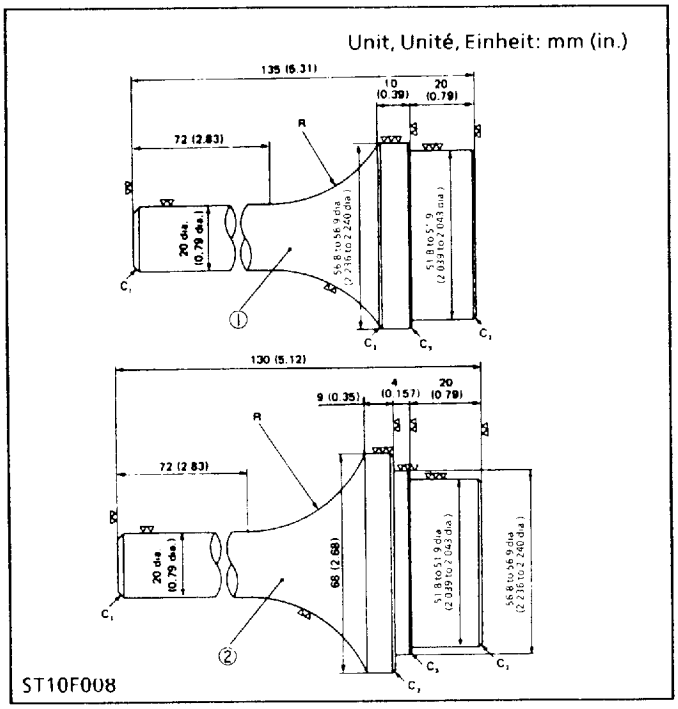
| | | |
|---|---|---|
| V2203-B(E) | A | 35.90 to 35.95 mm<br>1.4134 to 1.4154 in. |
| | B | 31.959 to 31.975 mm<br>1.2582 to 1.2589 in. |
| D1403-B(E)<br>D1703-B(E)<br>V1903-B(E)<br>F2803-B(E) | A | 41.90 to 41.95 mm<br>1.6496 to 1.6516 in. |
| | B | 37.959 to 37.975 mm<br>1.4950 to 1.4951 in. |




## Small End Bushing Replacing Tool

Application: Use to press out and to press fit the small end bushing.

| | |
|---|---|
| A | 27.90 to 27.95 mm<br>1.0984 to 1.1004 in. |
| B | 25.002 to 25.011 mm<br>0.9843 to 0.9847 in. |

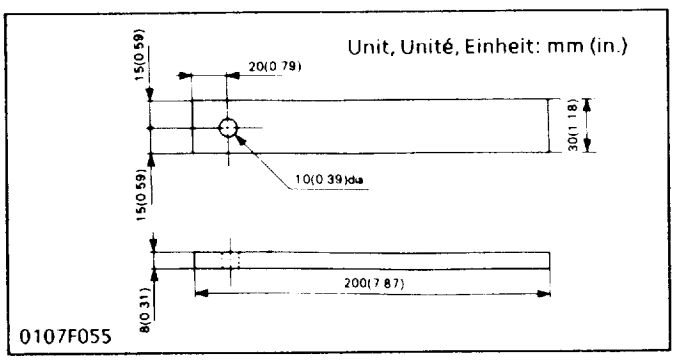



## Crankshaft Bearing 1 Replacing Tool

Application: Use to press out and to press fit the crankshaft bearing 1.

| *Chamfer | mm | in. |
|---|---|---|
| $C_1$ | 2.0 | 0.079 |
| $C_2$ | 1.0 | 0.039 |
| $C_3$ | 0.3 | 0.012 |

| **Radius | mm | in. |
|---|---|---|
| R | 240 | 1.57 |




## Flywheel Stopper

Application: Use to loosen and tighten the flywheel screw.

**Outil de remplacement de bague de pignon de renvoi**

Utilisation: Sert à extraire et à monter à pression le bague de pignon de renvoi.

| | | |
|---|---|---|
| V2203-B(E) | A | 35,90 à 35,95 mm |
| | B | 31,959 à 31,975 mm |
| D1403-B(E) D1703-B(E) V1903-B(E) F2803-B(E) | A | 41,90 à 41,95 mm |
| | B | 37,959 à 37,975 mm |

**Outil de remplacement de coussinet de pied de bielle**

Utilisation: Sert à extraire et à monter à pression le coussinet de pied de bielle.

| | |
|---|---|
| A | 27,90 à 27,95 mm |
| B | 25,002 à 25,011 mm |

**Outil de remplacement de coussinet 1 de bilebrequin**

Utilisation: Sert à extraire et à monter à pression le coussinet 1 de vilebrequin.

* Champfrein
** Rayon

**Werkzeug für den Austausch der Leerlaufbuchse**

Benutzung: Zum Herausdrücken und Einpassen der Leerlaufbuchse.

| | | |
|---|---|---|
| V2203-B(E) | A | 35,90 bis 35,95 mm |
| | B | 31,959 bis 31,975 mm |
| D1403-B(E) D1703-B(E) V1903-B(E) F2803-B(E) | A | 41,90 bis 41,95 mm |
| | B | 37,959 bis 37,975 mm |

**Werkzeug für den Austausch der Pleuelbuchse**

Benutzung: Zum Herausdrücken und Einpassen der Pleuelbuchse.

| | |
|---|---|
| A | 27,90 bis 27,95 mm |
| B | 25,002 bis 25,011 mm |

**Werkzeug für den Austausch der Kurbelwellenlagers 1**

Benutzung: Zum Herausdrücken und Einpassen der Kurbelwellenlagers 1.

* Abfasung
** Radius

**Betée de volant**

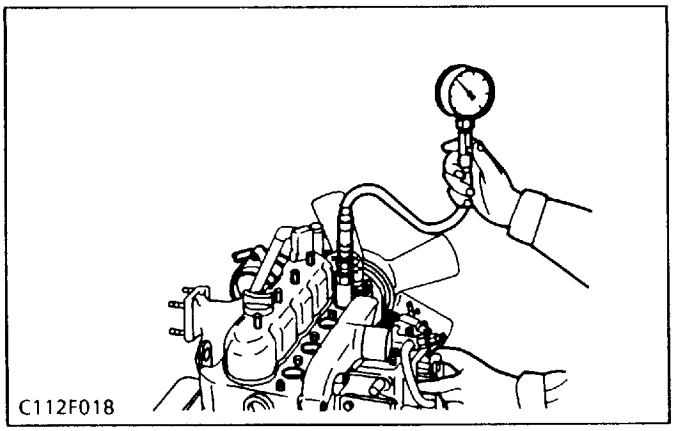
Utilisation: Pour desserrer et serrer le vis de volant.

**Schwungrad-Bremsvorrichtung**

Benutzung: Zum Lösen und Befestigen des Schwungradschraubes.

# 1 ENGINE BODY

## CHECKING AND ADJUSTING

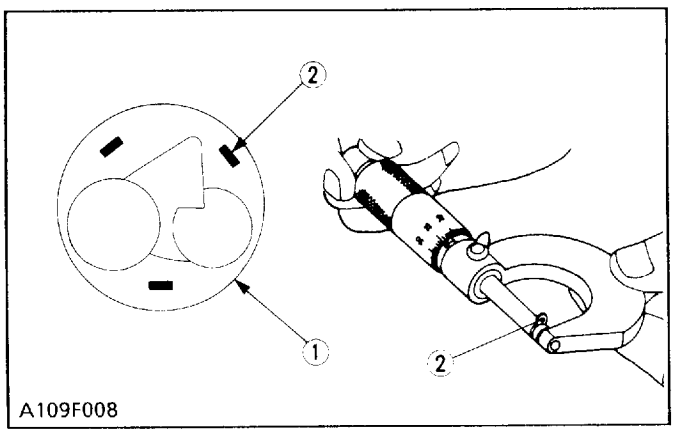



### Compression Pressure

1. After warming up the engine, stop it and remove the air cleaner, the muffler and all nozzle holders.
2. Install a compression tester (Code No: 07909-30207) for diesel engines to nozzle holder hole.
3. After making sure that the speed control lever is set at the stop position (Non-injection), run the engine at 200 to 300 rpm with the starter.
4. Read the maximum pressure. Measure the pressure more than twice.
5. If the measurement is below the allowable limit, check the cylinder, piston ring, top clearance, valve and cylinder head.

■ **NOTE**

- **Variances among cylinders compression values should be under 10 %.**




(1) Piston (2) Fuse (1.5 mm dia.)

### Top Clearance

1. Remove the cylinder head (then don't attempt to remove the cylinder head gasket).
2. Bring the piston to its top dead center, fasten 1.5 mm dia. 5 to 7 mm long fuse wires to 3 to 4 spots on the piston top with grease so as to avoid the recess for intake and exhaust valves and the combustion chamber ports.
3. Bring the piston to its bottom dead center, install the cylinder head, and tighten the cylinder head bolts to specified torque.
4. Turn the crank shaft until the piston exceeds its top dead center.
5. Remove the cylinder head, and measure squeezed fuse wires for thickness.
6. If the measurement is not within the specified value, check the oil clearance of the crankpin journal and the piston pin.

| | | |
|---|---|---|
| Top clearance | Factory spec. | 0.55 to 0.70 mm<br>0.0217 to 0.0276 in. |
| Tightening torque | Cylinder head bolts | 93.1 to 98.0 N·m<br>9.5 to 10.0 kgf·m<br>68.7 to 72.3 ft-lbs |

# 1 CORPS DU MOTEUR

## VERIFICATION ET REGLAGE

### Pression de compression

1. Après avoir chauffé le moteur, arrêter celui-ci et déposer le filtre à air, le pot d'échappement et tous les porte-injecteur.
2. Mettre en place un appareil d'essai à la compression (Référence: 07909-30207) pour moteurs diesel sur un trou de porte-injecteur.
3. Après avoir vérifié que le levier de contrôle de vitesse est mis sur la position d'arrêt (aucune injection), faire marcher le moteur à 200 à 300 tr/mn avec le démarreur.
4. Lire la pression maximum. Mesurer la pression par plus de trois fois.
5. Si la valeur mesurée est inférieure à la limite de service, vérifier le cylindre, le segment de piston, l'espace neutre, la soupape et la culasse.

■ **NOTA**

- **La différence de compression entre les cylindres ne doit pas dépasser 10%.**

### Jeu d'extremité

1. Déposer la culasse (ne pas tenter de déposer le joint de culasse).
2. Amener le piston à son point mort haut, fixer les fils fusibles de 5 à 7 mm de longs et d'un diamètre de 1,5 mm sur 3 à 4 points du fond de piston avec de la graisse, en évitant les soupapes d'admission et d'échappement et les orifices de chambre de combustion.
3. Amener le piston à son point mort bas, remettre en place la culasse et serrer les écrous de culasse à un couple spécifié.
4. Faire tourner le vilebrequin jusqu'à ce que le piston excède son point mort haut.
5. Déposer la culasse, et mesurer l'épaisseur des fils fusibles pressés.
6. Si la valeur mesurée n'est pas comprise dans la valeur de référence, vérifier le jeu de fonctionnement du tourillon de maneton de vilebrequin et de l'axe de piston.

| | | |
|---|---|---|
| Espace Neutre | Valeur de référence | 0,55 à 0,70 mm |
| Couple de serrage | Ecrou de culasse | 93,1 à 98,0 N·m<br>9,5 à 10,0 kgf·m |

(1) Piston
(2) Fusible (diamètre 1,5 mm)

# 1 MOTORKÖRPER

## ÜBERPRÜFUNG UND EINSTELLUNG

### Verdichtungsdruck

1. Den Motor warmlaufen lassen und dann abstellen und den Luftfilter, Auspufftopf and alle Düsenhälter entfernen.
2. Ein Kompressionsprüfgerät (Code Nr: 07909-30207) für Dieselmotore an die Düsenhälteröffnugn anbringen.
3. Nachdem sichergestellt wurde, daß der Geschwindigkeitsreglerhebel in der obersten Position gesetzt ist (keine Einspritzung), den Motor mit dem Anlasser bei einer Drehzahl von 200 vis 300 u/min laufen lassen.
4. Den maximalen Druck ablesen. Den Druck wenigstens zweimal ablesen.
5. Ist die Messung unterhalb des zulässigen Grenzwerts, den Zylinder, Kolben, das obere Spiel, das Ventil und den Zylinderkopf überprüfen.

■ **ANMERKUNG**

- **Der Unterschied des Verdichtungsdruckes zwischen den Zylindern sollte innerhalb 10% liegen.**

### Abstand zwischen Kolben und Zylinderkopf im O.T.

1. Den Zylinderkopf ausbauen (jedoch nicht versuchen die Zylinderkopfdichtung abzunehmen).
2. Denn Kolben auf seinen oberen Totpunkt setzen, Sicherungsdraht von 1,5 mm Durchm. und 5 bis 7 mm Länge auf 3 bis 4 Stellen am Kolbenboden mit Fett befestigen, um die Einlaß- und Auslaßventile sowohl als die Brennraummündungen zu vermeiden.
3. Den Kolben auf seinen unteren Totpunkt setzen, den Zylinderkopf einbauen und die Zylinderkopfmuttern wir vorgeschrieben anziehen.
4. Die Kurbelwelle drehen, bis der Kolben den oberen Totpunkt überschreitet.
5. Den Zylinderkopf ausbauen und die Dicke der zusammengedrückten Sicherungsdrähte messen.
6. Wenn sich die Messungen nicht innerhalb der Sollwerte befinden, das Ölspiel des Kurbel- und Kolbenzapfens überprüfen.

| | | |
|---|---|---|
| Zylinderkopfspiel | Werkdaten | 0,55 bis 0,70 mm |
| Anzugsdrehmoment | Zylinderkopfbolzen | 93,1 bis 98,0 N·m<br>9,5 bis 10,0 kgf·m |

(1) Kolben
(2) Sicherung (1,5 mm Durchmesser)

# DISASSEMBLING AND ASSEMBLING

## [1] DRAINING WATER AND OIL

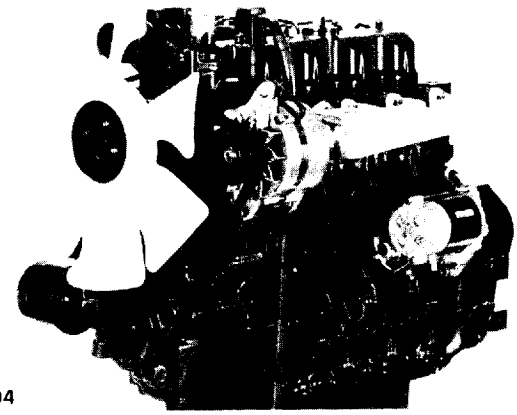
■ NOTE
- Some types of gearcases are provided with an oil filter port. When the cylinder head has been reassembled or when the valve clearance has been readjusted, apply an enough amount of oil to the intake and exhaust valves, push rod and rocker arm just before fitting the head cover in position.

Draining Cooling Water and Engine Oil

⚠ CAUTION
- Never remove radiator cap until cooling water temperature is below its boiling point. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.

1. Prepare a bucket. Open the drain cock to drain cooling water.
2. Prepare an oil pan. Remove the drain plug to drain engine oil in the pan.

## [2] EXTERNAL COMPONENTS



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Air Cleaner, Muffler and others

1. Remove the air cleaner and muffler.
2. Remove the fan, fan belt, alternator and starter.

(When reassembling)
- Install the muffler gasket so that its steel side face the muffler.
- Check to see that there are no cracks on the belt surface.

■ IMPORTANT
- After reassembling the fan belt, be sure to adjust the fan belt tension.

# DEMONTAGE ET MONTAGE

■ NOTA
- Certains types de boîtes d'engrenages sont fournis avec un orifice de remplissage pour huile. Lorsque la culasse de cylindre a été remontée ou lorsque le jeu de soupapes à éte réajusté, appliquer une quantité suffisante d'huile aux soupapes d'admission et d'échappement, à la tige de poussoir et au basculeur avant d'installer le couvercle de culasse en position.

## [1] VIDANGE D'EAU ET D'HUILE

Vidange d'eau de refroidissement et d'huile moteur

⚠ ATTENTION
- Ne jamais déposer le bouchon de radiateur avant que la température d'eau de refroidissement ne soit inférieure à son point d'ébullition. Desserrer légèrement le bouchon de manière à dégager toute pression excédentaire avant le déposer finalement.

1. Préparer un récipient pour récupération. Ouvrir le robinet de vidange pour vider l'eau de refroidissement.
2. Préparer un carter d'huile. Déposer la bouchon de vidange pour vider l'huile moteur dans le carter.

## [2] COMPOSANTES EXTERNES

Filtre à air et pot d'échappement

1. Déposer le filtre à air et pot d'échappement.
2. Déposer la courroie de ventilateur, l'alternateur et démarreur.

(Au remontage)
- Mettre en place le joint de pot d'échappement, sa partie en acier vers le pot d'échappement.
- Vérifier qu'il n'y a pas de fissures à la surface de la courroie.

■ IMPORTANT
- Après avoir remonté la courroie de ventilateur, bien en régler la tension.

# AUSBAU UND EINBAU

■ ANMERKUNG
- Einige Getriebegehäusetypen sind mit einer Öleinfüllöffnung versehen. Wenn der Zylinderkopf angebracht wird, oder wenn das Ventilspiel erneut eingestellt wurde, ausreichend Öl auf Einlaß-und Auslaßventil sowie Kolbenstange und Kipphebel auftragen, bevor der Zylinderkopf festgesohraubt wird.

## [1] ABLASSEN VON WASSER UND ÖL

Ablassen von Kühlwasser und Motoröl

⚠ ACHTUNG
- Die Kühlerverschlußkappe sollte niemals entfernt werden bis die Temperatur des Kühlwassers unterhalb des Siedepunktes liegt. Die Kappe zuerst bis zum Anschlag lösen, um den Überdruck zu entlasten, bevor sie vollkommen abgenommen wird.

1. Einen Kübel bereitstellen. Den Kühlerablaßhahn öffnen und das Kühlwasser ablassen.
2. Eine Ölwanne bereitstellen. Den Ablaßschraube entfernen, und das Motoröl in die Ölwanne ablassen.

## [2] ÄUSSERE BAUTEILE

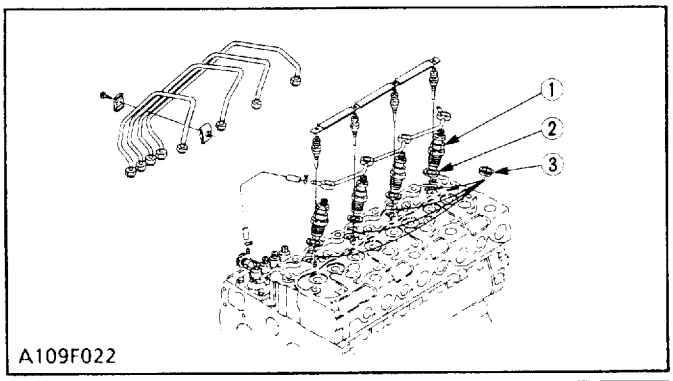
Luftfilter und Schalldämpfer

1. Den Luftfilter entfernen und Schallclämpfer.
2. Den Lüfterriemen, Lichtmaschine und Anlasser.

(Beim Wiedereinbau)
- Die Auspufftopfdichtung so einbauen, daß die Stahlseite zum Auspufftopf ausgerichtet ist.
- Prüfen, ob auf der Riemenfläche keine Risse vorhanden sind.

■ WICHTIG
- Nach erfolgtem Wiedereinbau des Lüfterriemens muß die Lüfterriemenspannung eingestellt werden.

# [3] CYLINDER HEAD AND VALVES



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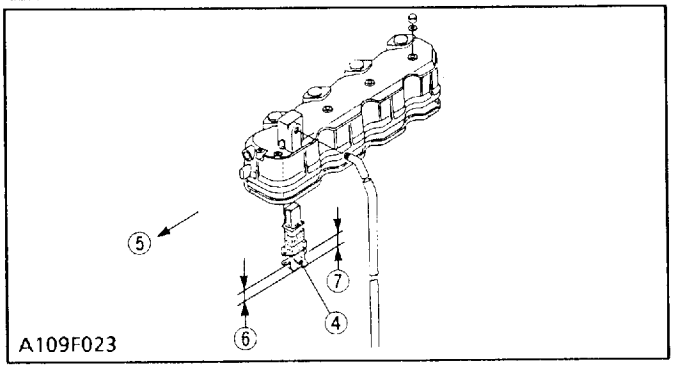

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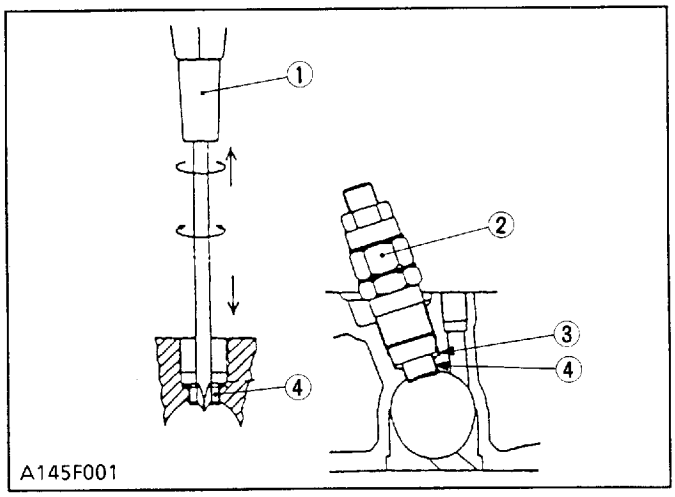
## Cylinder Head Cover and Nozzle Holder

1. Remove the injection pipes and overflow pipes.
2. Remove the glow plugs.
3. Remove the nozzle holder and copper gaskets.
4. Remove the heat seal.
5. Remove the head cover.

**(When reassembling)**

- Check to see that the cylinder head cover gasket is not defective.
- Be sure to place the heat seal (3) and breather oil shield (4) (See Fig).

(1) Nozzle Holder
(2) Copper Gasket
(3) Heat Seal
(4) Breather Oil Shield
(5) Gear Case Side
(6) Short Plate
(7) Long Plate



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## Nozzle Heat Seal Service Removal Procedure

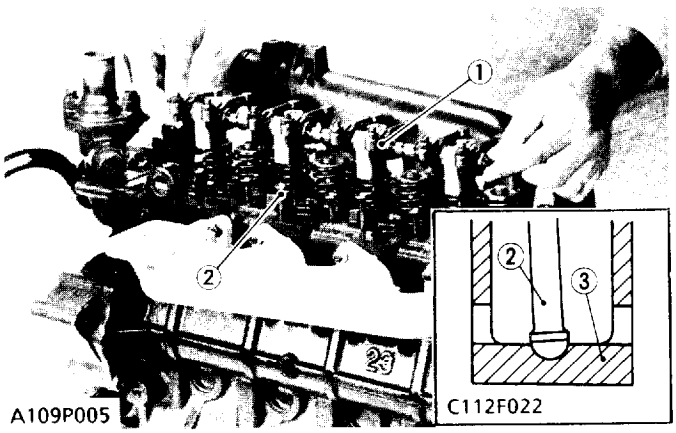
**■ IMPORTANT**

- **Use a plus (phillips head) screw driver that has a Dia. which is bigger than the heat seal hole (Approx. 6 mm) 1/4 in..**

1. Drive screw driver lightly into the heat seal hole.
2. Turn screw driver three or four times each way.
3. While turning the screw driver, slowly pull the heat seal out together with the injection nozzle gasket.

   If the heat seal drops, repeat the above procedure. Heat seal and injection nozzle gasket must be changed when the injection nozzle is removed for cleaning or for service.

(1) Plus Screw Driver
(2) Injection Nozzle
(3) Injection Nozzle Packin
(4) Heat Seal



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## Rocker Arm, Push Rod and In./Ex. Manifold

1. Remove the rocker arm as a unit.
2. Remove the push rods.
3. Remove the In./Ex. manifold.

**(When reassembling)**

- When putting the push rods onto the tappets, check to see if their ends are properly engaged with the grooves.

**■ IMPORTANT**

- **After reassembling the rocker arm, be sure to adjust the valve clearance.**

(1) Rocker Arm
(2) Push Rod
(3) Tappet

# [3] CULASSE ET SOUPAPES

## Couvercle de culasse et porte-injecteur

1. Détacher les conduits d'injection et le tuyau de trop-plein.
2. Détacher le cordon de bougie de préchauffage et la bougie de préchauffage.
3. Détacher le porte-injecteur et le joint en cuivre.
4. Enlever le joint thermique.
5. Déposer le couvercle de culasse.

**(Au remontage)**

- Vérifier que le joint de couvercle de culasse n'est pas d'efectueux.
- S'assurer de bien mettre en place le joint thermique (3) et huile de bouclier (4) (Voir figure).

(1) Porte-injecteur
(2) Joint en cuivre
(3) Joint thermique
(4) Huile de bouclier
(5) Côte engrenage
(6) Plaque court
(7) Plaque long

## Procédure d'enlèvement du joint thermique de l'injecteur

**■ IMPORTANT**

- **Utiliser un tournevis pour vis cruciforme (phillips) ayant un diamètre supérieur à celui du trou de joint thermique de 1/4 pouce (6 mm environ).**

1. Introduire le tournevis légèrement dans le trou de joint thermique.
2. Tourner le tournevis trois ou quatre fois dans chaque sens.
3. Tout en tournant le tournevis, retirer lentement le joint thermique avec le joint d'injecteur.

   Si le joint thermique tombe, répéter la procédure décrite ci-dessuss. Le joint therjmique et le joint d'injecteur doivent être remplacés lorsque l'injecteur est détaché en vue du nettoyage ou de l'entretien.

(1) Tournevis cruciforme
(2) Injectur
(3) Joint d'injecteur
(4) Joint thermique

## Culbuteurs, tiges de poussoirs et collecteurs

1. Déposer le culbuteur comme une seule pièce.
2. Déposer les poussoirs.
3. Détacher les collecteurs d'admission et d'échappement.

**(Au remontage)**

- En plaçant les tiges de poussoirs sur les poussoirs, vérifier que les extrémités sont bien engagées dans les rainures.

**■ IMPORTANT**

- **Après le remontage du culbuteur, veiller à régler le jeu des soupapes.**

(1) Culbuteur
(2) Tige de poussoir
(3) Poussoir

# [3] ZYLINDERKOPF UND VENTILE

## Zylinderkopfdeckel und Düsenhalter

1. Die Einspritzrohre und das Überlaufsrohr ausbauen.
2. Das Glühkerzenkabel und die Glühkerze ausbauen.
3. Den Düsenhalter und die Kupferscheibe ausbauen.
4. Die Wärmedichtung ausbauen.
5. Den Kopfdeckel ausbeuen.

**(Beim Wiedereinbau)**

- Die Dichtung der Zylinderkopfdeckel auf evtl ßeschädiqungen prüfen.
- Sehen Sie nach, ob Sie die Wärmedichtung eingesetzt haben (3) und Entluefter Oelschild (4) (Siehe Zeichung).

(1) Düsenhalter
(2) Kupferscheibe
(3) Wärmedichtung
(4) Entluefter Oelschild
(5) Getriebegehäuse
(6) Kurz platte
(7) Lang platte

## Ausbauanweisungen für den Einspritzdüsen-Isoletordichtring

**■ WICHTIG**

- **Einen Kreuzschlitzschraubendreher verwenden, dessen Durchmesser größer als die Montageöffnung des Isolatordichtrings ist. (ca. 6 mm).**

1. Den Schraubendreher vorsichtig in die Montageöffnung des Isolatordichtrings einführen.
2. Den Schraubendreher etwa drei bis viermal in beiden Richtungen drehen.
3. Während der Schraubendreher gedreht wird, den Isolatordichtring zusammen mit der Einspritzdüsen-Dichtung vorsichtig herausziehen.

   Wenn der Isolatordichtring herunterfällt, muß der obige Vorgang wiederholt werden. Der Isolatordichtring und die Einspritzdüsen-Dichtung müssen ersetzt werden, wenn die Einspritzdüse zu Reinigungs und Wartungszwecken ausgebaut wird.

(1) Kreuzshlitzshraubendreher
(2) Düsenhalter
(3) Kupferscheibe
(4) Wärmedichtung

## Kipphebel Stößelstange und Krümmer

1. Den Kipphebel als Einheit entfernen.
2. Die Stößelstangen entfernen.
3. Den Ausaug-und Auspuffkrümmer ausbauen.

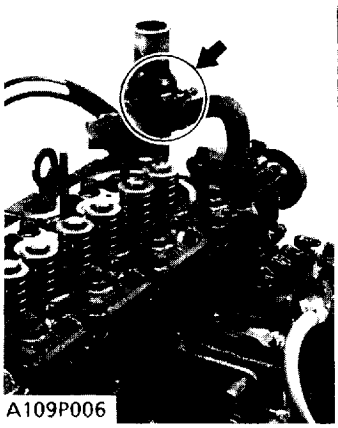
**(Beim Wiedereinbau)**

- Bei Anbringung der Stößelstangen auf den Ventilstößeln ist darauf zu achten, daß ihre Enden richtig in die Nuten eingreifen.

**■ WICHTIG**

- **Nach erfolgtem Wiedereinbau des Kipphebels muß das Ventilspiel eingestellt werden.**

(1) Kipphebel
(2) Stößelstange
(3) Stößel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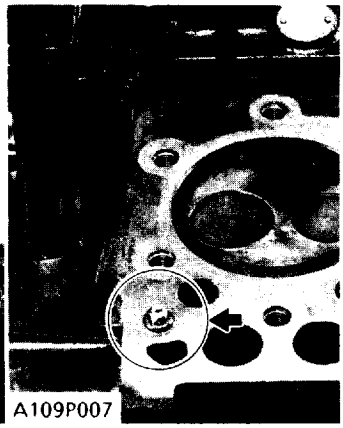
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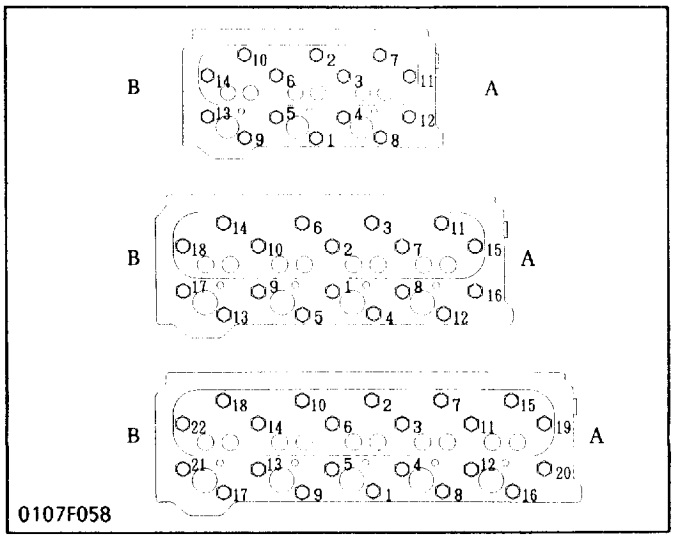

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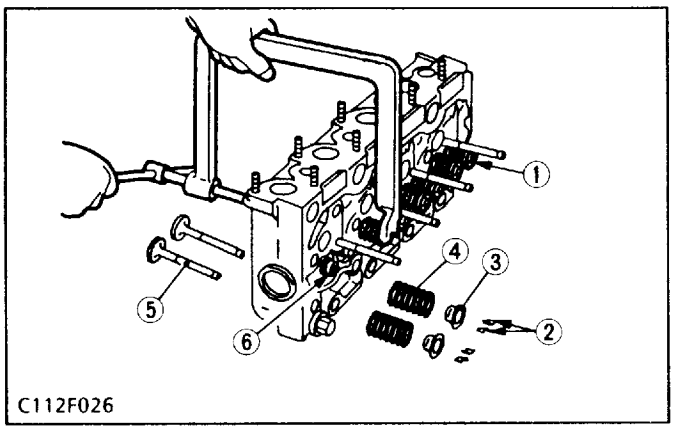

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## Cylinder Head and Tappet

1. Loosen the pipe band, and remove the water return pipe.
2. Remove the cylinder head bolts in the order of (22) to (1), and remove the cylinder head.
3. Remove the cylinder head gasket and O-ring.
4. Remove the tappets from the crank case.

**(When reassembling)**

- Replace the head gasket with a new one.
- Before installing the tappets, apply engine oil thinly around them.
- Install the cylinder head, using care not to damage the O-ring.
- Tighten the cylinder head bolt gradually in the order of (1) to (14·18·22) after applying engine oil.
- Retighten the cylinder head bolt after running the engine for 30 minutes.

**■ NOTE**

- **Mark the cylinder number to the tappets to prevent interchanging.**

**[A] Gear case side**
**[B] Flywheel side**

| | | |
|---|---|---|
| Tightening torque | Cylinder head bolts | 93.1 to 98.0 N·m<br>9.5 to 10.0 kgf·m<br>68.7 to 72.3 ft-lbs |

## Valve

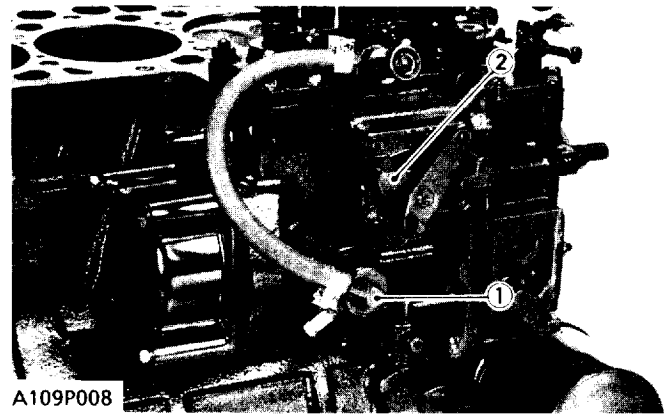
1. Remove the valve cap (1).
2. Remove the valve spring collet (2) with a valve lifter.
3. Remove the valve spring retainers (3), valve spring (4) and valve (5).

**(When reassembling)**

- Wash the valve stem and valve guide hole, and apply engine oil sufficiently.
- After installing the valve spring collets, lightly tap the stem to assure proper fit with a plastic hammer.

(1) Valve Cap
(2) Valve Spring Collet
(3) Valve Spring Retainer
(4) Valve Spring
(5) Valve
(6) Valve Stem Seal

# [4] GEAR CASE



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## Fuel Feed Pump and Pump Cover

1. Loosen the pipe clamp and remove the fuel pipe from the injection pump side.
2. Remove the fuel feed pump (1).
3. Remove the injection pump cover (2).

**(When reassembling)**

- Apply a liquid gasket (Three Bond 1215 or equivalent) to the both sides of fuel feed pump gasket.

(1) Fuel Feed Pump
(2) Injection Pump Cover

### Culasse et poussoirs

1. Desserrer le collier et enlever le conduit de retour d'eau.
2. Enlever les vis de culasse, dans l'ordre de (22) à (1), puis enlever la culasse.
3. Enlever le joint plat et le joint torique de culasse.
4. Enlever les de poussoirs du carter.

**(Au remontage)**

- Avant de remettre les poussoirs, les enduire d'une légère couche d'huile moteur.
- Remplacer le joint plat de culasse par un joint neuf.
- Monter la culasse en veillant à ne pas abimer le joint torique.
- Serrer progressivement les boulons de culasse dans l'ordre de (1) à (14·18·22) après les avoir enduits d'huile moteur.
- Resserrer les vis de culasse après avoir fait tourner le moteur pendant 30 minutes.

**■ NOTA**

- **Consigner le numéro de cylindre sur les poussoirs afin d'éviter un intervertissement.**

**[A] Côté engrenage**
**[B] Côté volant**

| | | |
|---|---|---|
| Couple de serrage | Ecrou de culasse | 93,1 à 98,0 N·m<br>9,5 à 10,0 kgf·m |

### Zylinderkopf und Stößel

1. Das Leitungsband lösen und die Wasserrücklaufleitung entfernen.
2. Die Zylinderkopfschrauben in der Reinhenfolge von (22) nach (1) entfernen und den Zylinderkopf herausnehmen.
3. Die Zylinderkopfdichtung und den O-Ring entfernen.
4. Die Stößel vom Kurbelgehäuse entfernen.

**(Beim Wiedereinbau)**

- Vor dem Einbau der Stößel diese mit einer dünnen Schicht Motoröl versehen.
- Die Zylinderkopfdichtung gegen eine neue austauschen.
- Die Zylinderkopf einsetzen und darauf achten, daß der O-Ring nicht beschädigt wird.
- Die Zylinderkopfbolzen nach und nach in der Reihenfolge von (1) nach (14·18·22) anziehen. Zuvor Motoröl auftragen.
- Die Zylinderkopfschrauben nochmals anziehen, nachdem der Motor 30 Minuten lang gelaufen ist.

**■ ANMERKUNG**

- **Die Zylindernummer auf die Stoßel markieren, um eine Verwechslung zu verhindern.**

**[A] Getriebegehäuseseite**
**[B] Schwungradseite**

| | | |
|---|---|---|
| Anzugsdrehmoment | Zylinderkopfbolzen | 93,1 bis 98,0 N·m<br>9,5 bis 10,0 kgf·m |

### Soupapes

1. Déposer les chapeaux de soupape (1).
2. Déposer les douilles de ressort de soupape (2) solidaires du lève-soupape.
3. Déposer les retenues de ressort de soupape (3), les ressorts de soupape (4) et les soupapes (5).

**(Au remontage)**

- Laver les queues de soupape et les orifices de guide de soupape, puis passer de l'huile moteur en quantité suffisante.
- Une fois les douilles de ressort de soupape installées, tapoter légèrement la queue de soupape avec un maillet en plastique pour s'assurer du bon ajustement.

(1) Capuchon de soupape
(2) Coupelle
(3) Cuvette
(4) Ressort de soupape
(5) Soupape
(6) Joint de tige de soupape

### Ventile

1. Die Ventilkappe (1) entfernen.
2. Die Federhalteringe (2) mit Hilfe einer Ventilfederzange abnehmen.
3. Die Ventilfederteller (3), Ventilfedern (4) und Ventile (5) herausnehmen.

**(Beim Wiedereinbau)**

- Ventilstange und Ventilführung waschen und mit ausreichend Motoröl versehen.
- Nach dem Einbau der Ventilfederhalteringe, leicht auf die Ventilstange mit einem Plastikhammer klopfen, um richtigen Sitz zu bewirken.

(1) Ventilkappe
(2) Konus
(3) Ventilfederteller
(4) Ventilfeder
(5) Ventil
(6) Ventilführungs-Verschluß

## [4] CARTER DE DISTRIBUTION

### Pompe d'alimentation et couvercle de pompe

1. Desserrer l'étrier et enlever le conduit d'alimentation du côté de la pompe à injection.
2. Enlever la pompe d'alimentation (1).
3. Enlever le couvercle de pompe d'injection (2).

**(Au remontage)**

- Appliquer un joint liquide (Three Bond 1215 ou équivalent) des deux côtés du joint de pompe d'alimentation.

(1) Pompe d'alimentation
(2) Couvercle de pompe d'injection

## [4] GETRIEBEGEHÄUSE

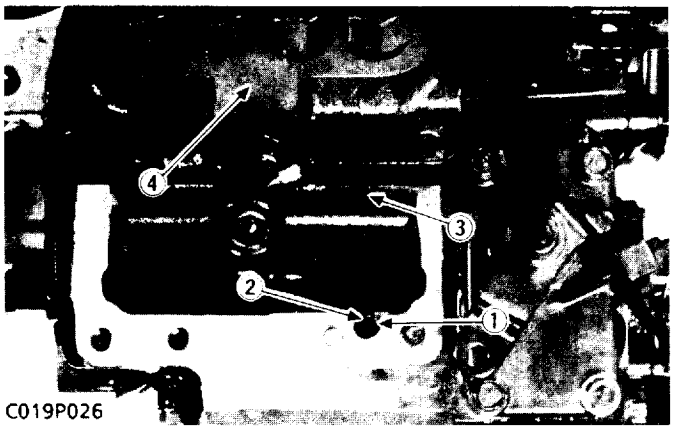
### Kraftstoff-Förderpumpe und Pumpendeckel

1. Die Leitungsklemme lösen und die Kraftstoffleitung der Seite der Einspritzpumpe entfernen.
2. Die Kraftstoff-Förderpumpe (1) entfernen.
3. Den Einspritzpumpendeckel (2) entfernen.

**(Beim Wiedereinbau)**

- Beide Seiten der Dichtung der Kraftstoff-Förderpumpe mit einer flüssigen Dichtung (Three Bond 1215 oder ähnlich) versehen.

(1) Kraftstoff-Förderpumpe
(2) Einspritzpumpendeckel




C019P026

(1) Notch
(2) Groove
(3) Control Rack Pin
(4) Injection Pump

## Injection Pump

1. Align the control rack pin (3) with the notch (1) on the crankcase, and remove the injection pump (4).
2. Remove the injection pump shims.
3. In principle, the injection pump should not be disassembled.

**(When reassembling)**

- When installing the injection pump, insert the control rack pin (3) firmly into the groove (2) of the fork lever and thrust lever.

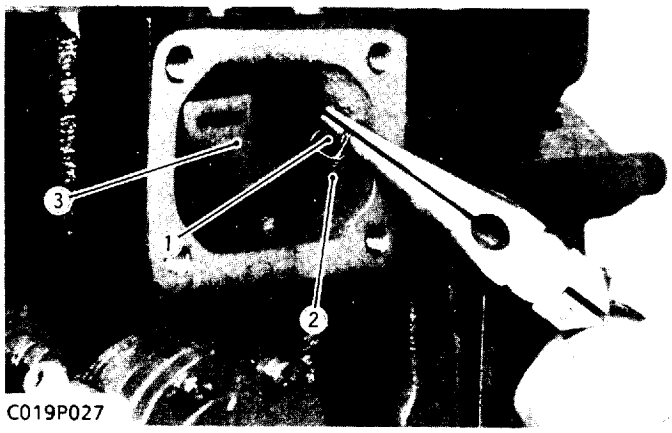
**■ NOTE**

**Engine serial number :D1403;~12211/D1703;~4253 /V1903;~1562/V2203;~60896 /F2803;~105567**

- **Insert the same number of shims as used before between crank case and pump.**
- **Addition or reduction of shim (0.15 mm, 0.0059 in.) delays or advances the injection timing by approx. 0.026 rad (1.5°).**
- **Apply liquid-type gasket (Three Bond 1215 or its equivalent) to both sides of the injection pump shim before reassembling.**

**Engine serial number :D1403;12212~/ D1703; 4254~ /V1903;1563~/ V2203;60897~ /F2803;105568~**

- **The sealant is applied to both sides of the soft metal gasket shim. the liquid gasket is not required for assembling.**
- **Addition or reduction of shim (0.05 mm, 0.0020 in.) delays or advances the injection timing by approx. 0.0087 rad (0.5°).**
- **In disassembling and replacing, be sure to use the same number of new gasket shims with the same thickness.**




C019P027

## Governor Spring

1. Remove the governor springs 1 (2) and 2 (1) from the fork lever 2 (3).

**(When reassembling)**

- Fix the governor springs 1 and 2 to the governor lever, and pull the springs through the window of the injection pump, and springs will be able to be hooked on to the governor fork lever 2 with ease.

(1) Governor Spring 2
(2) Governor Spring 1
(3) Fork Lever 2

## Pompe d'injecjtion

1. Aligner l'axe (3) de la crémaillère de pilotage et la encoche (1) ménagée sur le carter, puis enlever la pompe d'injection (4).
2. Déposer les cales d'épaisseur de la pompe d'injection.
3. En principe, il ne faut pas démonter la pompe d'injection.

(Au remontage)

- Lors du remontage de la pompe d'injection, insérer l'axe de la crémaillère de pilotage (3) dans la rainure (2) du levier à chape et du levier à butée, en l'adaptant bien.

■ NOTA

Numéro de serie moteur :

D1403;~12211 / D1703;~4253 / V1903;~1562 / V2203;~60896 / F2803;~105567

- Insérer le même nombre de cales que celui utilisé avant entre le carter de distribution et la pompe.
- En ajoutant ou en supprimant cale (0,15 mm) d'épaisseur, on retarde ou on avance le calage du l'injection d'environ de 1,5° (0,026 rad.).
- Appliquer un joint liquide (Three Bond 1215 ou équivalent) aux deux côtés des cales avant de les remonter.

Numéro de serie moteur :

D1403;12212~ / D1703; 4254~ / V1903;1563~ / V2203;60897~ / F2803;105568~

- Les soudures étant faites d'un métal tendre enduit de chaque côté d'un matériau étanche, il n'est pas nécessaire d'utiliser un joint liquide lors du montage de ces moteurs.
- En ajoutant ou en supprimant une cale (0,05 mm) d'épaisseur, on retarde ou on avance le calage du l'injection de 0,0087 rad (0,5°).
- Lors du démontage et du remplacement, toujoujours utiliser le même nombre de cales de joint neuves avec la même épaisseur.

(1) Encoche
(2) Rainure
(3) Axe de crémaillère de pilotage
(4) Pompe d'injection

## Ressort de régulateur

1. Enlever les ressorts 1 (2) et 2 (1) de régulateur du levieir à chape 2 (3).

(Au remontage)

- Fixer les ressorts 1 et 2 de régulateur sur le levier de régulateur et retirer les ressorts par la fenêtre de la pompe d'injection; on doit pouvoir accrocher facilement les ressorts au levier à chape 2 du régulateur.

(1) Ressort 2 de régulateur
(2) Ressort 1 de régulateur
(3) Levier à chape 2

## Einspritzpumpe

1. Den Regelstangenbolzen (3) mit der Gashebel (1) auf dem Kurbelgehäuse ausrichten und die Einspritzpumpe (4) entfernen.
2. Die Blechbeilagen der Einspritzpumpe entfernen.
3. Prinzipiell sollte die Einspritzpumpe nicht zerlegt werden.

(Beim Wiedereinbau)

- Beim Einbau der Einspritzpumpe den Regelstangenbolzen (3) fest in die Nut (2) des Gabelhebels und der Schubstange einschieben.

■ ANMERKUNG

Seriennummer des motors :

D1403;~12211 / D1703;~4253 / V1903;~1562 / V2203;~60896 / F2803;~105567

- Die vorher verwendete Anzahl von Beilagscheiben zwischen dem Getriebegehäuse und Pumpe einfügen.
- Durch die Zugabe oder Verminderug Blechbeilage (0,15 mm) wird die Spritzeinstellung um 1,5° (0,026 rad.) verzögert oder vorgerückt.
- Eine Dichtungsmasse (THREE BOND 1215 oder Äquivalent) an beiden Seiten des Einspritzpumpen-Beilagscheibe aufgetragen.

Seriennummer des motors :

D1403;12212~ / D1703; 4254~ / V1903;1563~ / V2203;60897~ / F2803;105568~

- Das Dichtmittel wird an beide Seiten der weichen Metalldichtungs-Beilagscheibe aufgetragen. Für den Zusammenbau ist eine Flüssigkeitsdichtung nicht benötigt.
- Durch die Zugabe odre Verminderung Blechbeilage (0,05 mm) wird die Spritzeinstellung un 0,0087 rad (0,5°) verzögert oder vorgerückt.
- Beim Zerlegen bzw. Auswechseln der Einspritzpumpe deshalb immer sicherstellen, daß die gleiche Anzahl von Dichtscheiben der gleichen Stärke verwendet werden.

(1) Gashebel
(2) Nut
(3) Regelstangenbolzen
(4) Einspritzpumpe

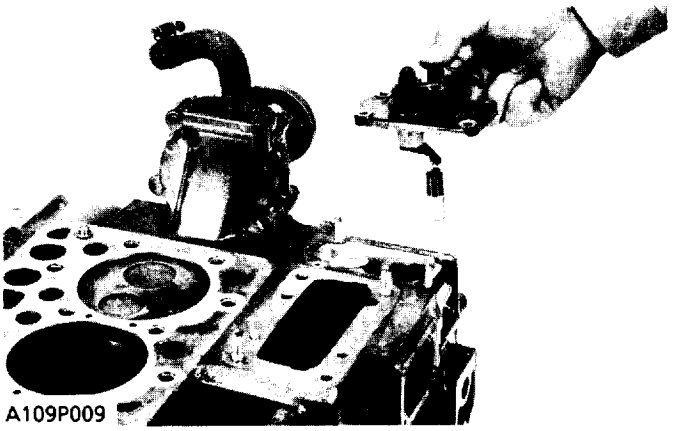
## Reglerfeder

1. Die Reglerfedern 1 (2) und 2 (1) von dem Gabelhebel 2 (3) entfernen.

(Beim Wiedereinbau)

- Die Reglerfedern 1 und 2 am Reglerhebel befestigen und die Federn durch die Öffnung der Einspritzpumpe ziehen, so daß diese mühelos am Gabelhebel 2 des Reglers eingehakt werden können.

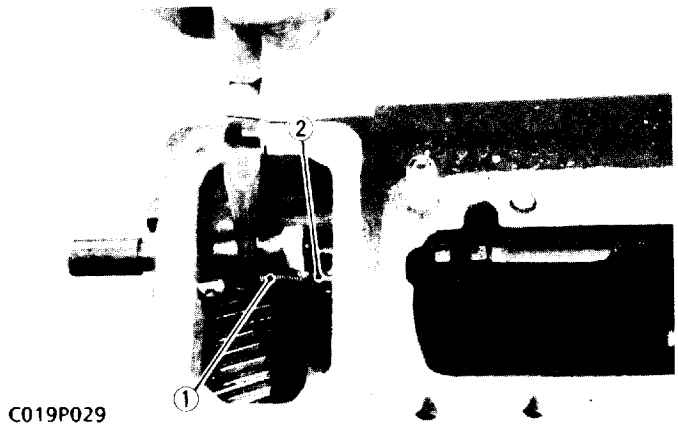
(1) Reglerfeder 2
(2) Reglerfeder 1
(3) Gabelhebel 2


A109P009

## Speed Control Plate

1. Remove the speed control plate with the governor springs 1 and 2.

**(When reassembling)**
- Be careful not to drop the governor springs 1 and 2 into the gear case.
- Apply a liquid gasket (Three Bond 1215 or equivalent) to both sides of the speed control plate gasket.



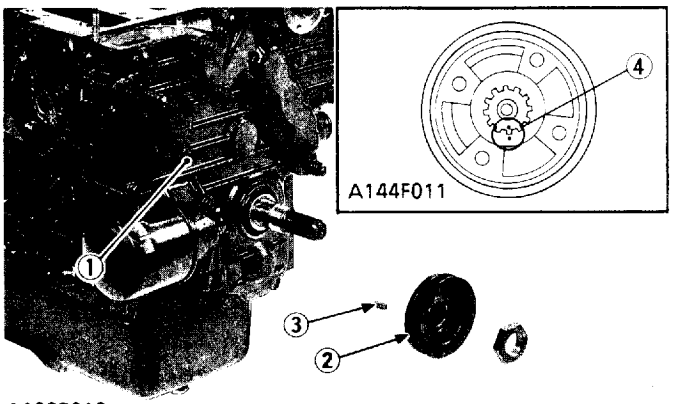
C019P029

## Start Spring

1. Remove the start spring (1) from the fork lever 1 (2).

**(When reassembling)**
- Be careful not to drop the start spring into the gear case.
- Hook the start spring so that the longer hook is on the fork lever side.

(1) Start Spring
(2) Fork Lever 1

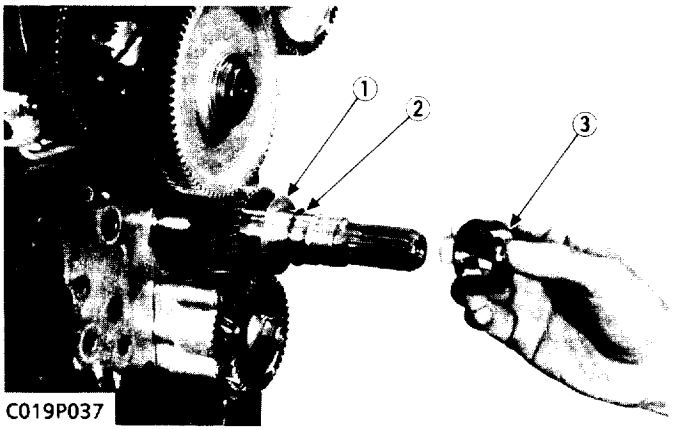


A109P010

## Gear Case

1. Pull out the fan drive pulley (2) with a puller.
2. Remove the feather key (3).
3. Remove the gear case (1).

**(When reassembling)**
- Apply a liquid gasket (Three Bond 1215 or equivalent) to both sides of the gear case gasket.
- Grease thinly to the oil seal, and install it, ensuring the lip does not come off.
- Install the pulley (F2803) to the crankshaft, aligning the marks (4) on them.



C019P037

## Crankshaft Oil Slinger

1. Remove the crankshaft collar (3).
2. Remove the O-ring (2).
3. Remove the crankshaft oil slinger (1).

(1) Crankshaft Oil Slinger
(2) O-ring
(3) Crankshaft Collar

### Levier de réglage de régime

1. Enlever le levier de réglage de régime avec les ressorts 1 et 2 de régulateur.

**(Au remontage)**
- Veiller à ne pas faire tomber les ressorts de régulateur dans le carter de distribution.
- Appliquer un joint liquide (Three Bond 1215 ou équivalent) des deux côtés du joint du levier de réglage de régime.

### Geschwindigkeitssteuerplatte

1. Die Geschwindigkeitssteuerplatte mit den Reglerfedern 1 und 2 entfernen.

**(Beim Wiedereinbau)**
- Darauf achten, daß die Reglerfedern 1 und 2 nicht in das Getriebegehäuse fallen.
- Beide Seiten der Dichtung der Geschwindigkeitssteuerplatte mit einer flüssigen Dichtung (Three Bond 1215 oder ähnlich) versehen.

### Ressort de démarreur

1. Retirer le ressort de démarreur (1) du levier à chape 1 (2).

**(Au remontage)**
- Veiller à ne pas faire tomber le ressort de démarreur dans le carter réducteur.
- Pour la mise en place du ressort de démarrage, orienter l'extrémité à crochet plus long que l'autre vers le côté levier de fourche.

(1) Ressort de démarreur (2) Levier à chape 1

### Anlaßfeder

1. Die Anlaßfeder (1) am Gabelhebel 1 (2) entfernen.

**(Beim Wiedereinbau)**
- Es ist darauf zu achten, daß die Anlaßfeder nicht in das Getriebegehäuse fällt.
- Eine Hakenfeder so ansetzen, daß der längere Haken auf der Hakenhebelseite liege.

(1) Anlaßfeder (2) Gabelhebel 1

### Carter de distribution

1. Avec un extracteur, retirer la poulie d'entraînement de ventilateur (2).
2. Enlever la clavette (3).
3. Enlever le carter de distribution (1).

**(Au remontage)**
- Appliquer un joint liquide (Three Bond 1215 ou équivalent) des deux côtés du joint de carter de distribution.
- Graisser légèrement le joint spy et le mettre en place en veillant à ce que la lèvre ne ressorte pas.
- Vèrifier si la poulie d'entraînement du ventilateur est alignée sur le repère (4) d'alignement. (F2803)

### Getriebegehäuse

1. Die Lüfterantriebsriemenscheibe (2) mit Hilfe eine Abziehvorrichtung abziehen.
2. Den Federkeil (3) entfernen.
3. Das Getriebegehäuse (1) entfernen.

**(Beim Wiedereinbau)**
- Beide Seiten der Getriebegehäusedichtung mit einer flüssigen Dichtung (Three Bond 1215 oder ähnlich) versehen.
- Die Wellendichtung dünn mit Schmiere bestreichen und einsetzen. Hierbei ist darauf zu achten, daß sich die Lippe nicht löst.
- Sich vergewissem, daß die vetilatorriemenscheibe mit der Markierung (4) ausgerichtet ist. (F2803)

### Bague d'étanchéité du vilebrequin

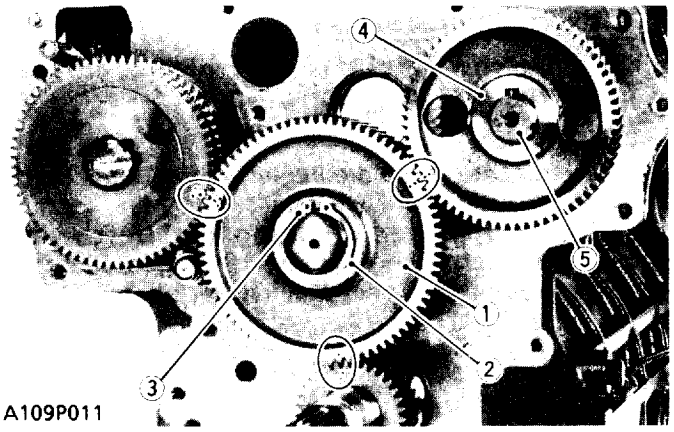
1. Enlever le collier du vilebrequin (3).
2. Enlever le joint torique (2).
3. Enlever la bague d'étanchéité du vilebrequin (1).

(1) Bague d'étanchéité du vilebrquin (3) Collier de vilebrequin
(2) Joint torique

### Kurbelwellen-Ölschleuderring

1. Die Kurbelwellenmanschette (3) entfernen.
2. Den O-Ring entfernen (2).
3. Den Kurbelwellen-Ölschleuderring (1) entfernen.

(1) Kurbelwellen-Ölschleuderring (3) Kurbelwellenmanschette
(2) O-Ring



A109P011

## Idle Gear and Camshaft

1. Remove the idle gear (1).
2. Align the round hole on the cam gear with the camshaft stopper mounting screw position and remove the bolts.
3. Remove the cam gear (4) with camshaft (5).

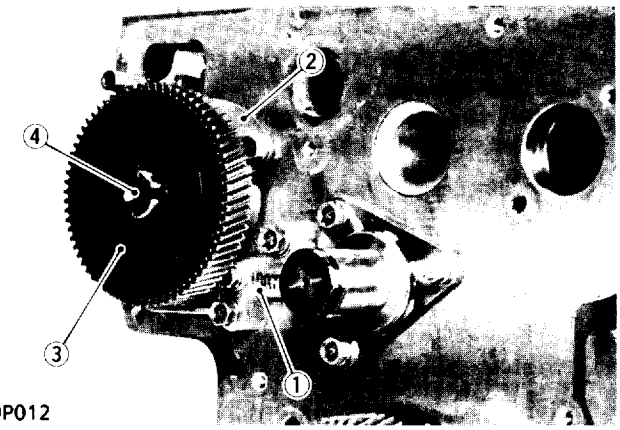
**(When reassembling)**

- Apply engine oil thinly to the camshaft and idle gear bushing before installation.

**■ IMPORTANT**

- **When installing the idle gear, be sure to align the alignment marks on gears.**

(1) Idle Gear
(2) Idle Collar 2
(3) External Snap Ring
(4) Cam Gear
(5) Camshaft

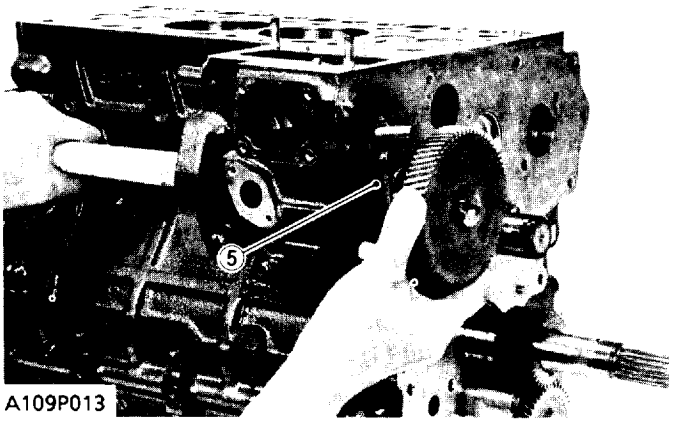


A109P012

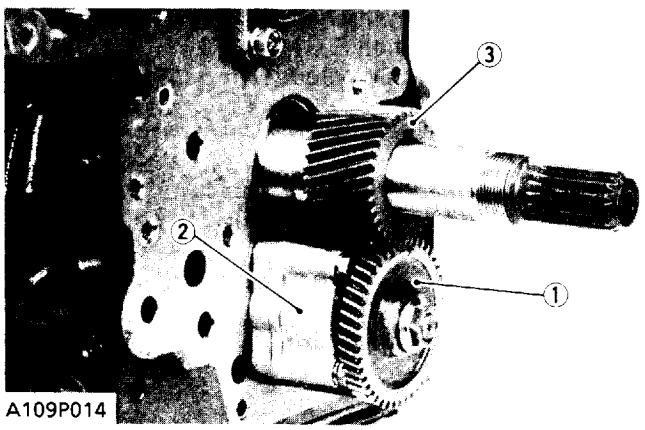
## Fuel Camshaft and Fork Lever Assembly

1. Remove the fuel camshaft cover.
2. Remove the fork lever holder mounting bolt.
3. Remove the fuel camshaft stopper.
4. Remove the fuel camshaft and fork lever shaft at the same time.

(1) Fork Lever Holder
(2) Fuel Camshaft Stopper
(3) Injection Pump Gear
(4) Fuel Camshaft
(5) Fork Lever Assembly



A109P013



A109P014

## Oil Pump and Crank Gear

1. Pull out the oil pump drive gear (1) with a puller.
2. Remove the oil pump mounting bolts.
3. Remove the oil pump (2).
4. Remove the crank gear with a special-use puller set (Code No: 07916-09032).
5. Remove the feather key on the crankshaft.

**(When reassembling)**

- Check to see that the feather key is on the crankshaft.
  Heat the crank gear to approx. 80 °C (176 °F), and fit on the crankshaft.

(1) Oil Pump Drive Gear
(2) Oil Pump
(3) Crank Gear

### Pignon de renvoi et arbre à cames

1. Enlever le pignon de renvoi (1).
2. Aligner le trou rond du pignon de came et la vis de fixation de butée d'arbre à cames.
3. Enlever le pignon de came (4) et l'arbre à cames (5).

**(Au remontage)**

- Enduire l'arbre à cames et les bagues du pignon de renvoi d'une légère couche d'huile moteur avant de le remonter.

**■ IMPORTANT**

- **Pour la mise en place du pignon de renvoi, bien s'assurer que l'on ligne les repères d'alignement des pignons.**

(1) Pignon de renvoi
(2) Collier 2 de pignon de renvoi
(3) Circlip extérieur
(4) Pignon de came
(5) Arbre à cames

### Arbre à came d'alimentation et Ens. levier à chape

1. Enlever le couvercle d'arbre à came.
2. Enlever les boulons de fixation du porte-levier à chape.
3. Enlever la butée d'arbre à came d'alimentation.
4. Enlever l'arbre à came, et arbre de levier de fourche en même temps.

(1) Porte-levier à chape
(2) Butée d'arbre à came d'alimentation
(3) Pignon de pompe d'injection
(4) Arbre à came d'alimentation
(5) Ensemble levier à chape

### Leerlaufgetriebe und Nockenwelle

1. Die das Leerlaufgetriebe (1) entfernen.
2. Die runde Öffnung am Nockengetriebe mit der Befestigungsschraube des Nockenwellenbegrenzers ausrichten.
3. Das Nockengetriebe (4) und die Nockenwelle (5) entfernen.

**(Beim Wiedereinbau)**

- Vor dem Einbau die Nockenwelle und Leerlaufbuchse mit einer dünnen Schicht Motoröl versehen.

**■ WICHTIG**

- **Beim Einbau des Leerlaufgetriebes darauf achten, daß die Markierungen auf den Zahnrädern zueinander ausgerichtet sind.**

(1) Leerlaufgetriebe
(2) Leerlaufmanschette 2
(3) Äußere Klemme
(4) Nockengetriebe
(5) Nockenwelle

### Kraftstoff-Nockenwelle und Gabelhebel

1. Den Kraftstoff-Nockenwellendeckel entfernen.
2. Die Befestigungsbolzen der Gabelhebel halterung entfernen.
3. Den Kraftstoff-Nockenwellen begrenzer entfernen.
4. Den Kraftstoff-Nockenwelle mit den Gabelhebel entfernen.

(1) Gabelhebel haltenung
(2) Kraftstoff-Nockenwellenbegrenzer
(3) Einspritzpumpengetriebe
(3) Einspritzpumpengetriebe
(4) Kraftstoff-Nockenwelle
(5) Gabelhebel

### Pompe à huile et Pignon de lancement

1. Retirer le pignon d'entraînement (1) de la pompe à huile avec un extracteur.
2. Enlever les vis de fixation de la pompe à huile.
3. Enlever la pompe à huile (2).
4. Enlever le pignon de lancement avec le jeu d'extraction spécial (Référence 07916-09032).
5. Enlever la clavette du vilebrequin.

**(Au remontage)**

- Vérifier que la clavette se trouve sur le vilebrequin.
- Chauffer le pignon de lancement à environ 80 °C et le monter sur le vilebrequin.

(1) Pignon d'entraînement de la pompe à huile
(2) Pompe à huile
(3) Pignon de lancement

### Ölpumpe und Kurbelgetriebe

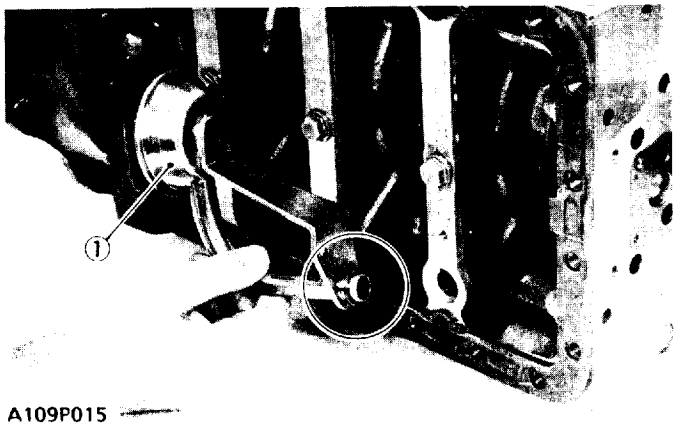
1. Den Ölpumpenantrieb (1) mit Hilfe einer Abziehvorrichtung entfernen.
2. Die Befestigungsschrauben der Ölpumpe entfernen.
3. Die Ölpumpe (2) herausnehmen.
4. Das Kurbelgetriebe mit Hilfe einer Spezial-Abziehvorrichtung (Code Nr. 07916-09032) entfernen.
5. Den Federkeil auf der Kurbelwelle entfernen.

**(Beim Wiedeereinbau)**

- Prüfen, ob der Federkeil auf der Kurbelwelle aufsitzt.
- Das Kurbelgetriebe auf etwa 80 °C erwärmen und auf der Kurbelwelle einsetzen.

(1) Ölpumpenantrieb (2) Ölpumpe (3) Kurbelgetriebe

# [5] PISTON AND CONNECTING ROD




A109P015

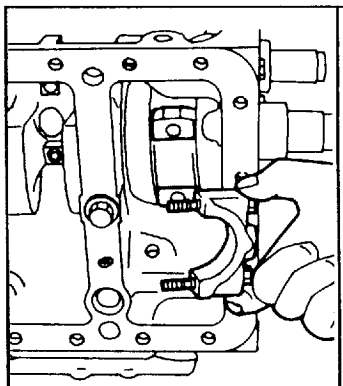
### Oil Pan and Oil Strainer

1. Remove the oil pan and strainer (1).

**(When reassembling)**

- After cleaning the oil strainer, install it.
- Install the oil strainer (1), being careful not to damage the O-ring.
- Apply a liquid gasket (Three Bond 1215 or equivalent) to both sides of the oil pan gasket.
- To avoid uneven tightening, tighten mounting bolts in diagonal order from the center.

(1) Oil Strainer



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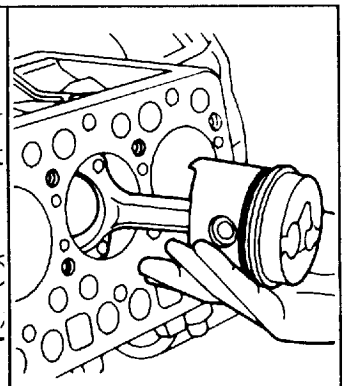

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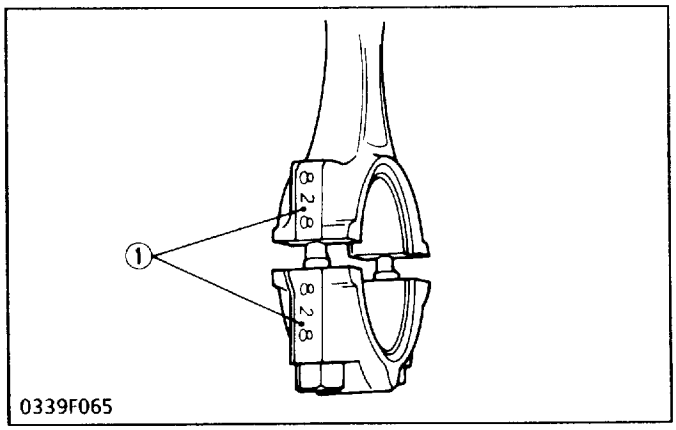
### Piston

1. Turn the flywheel, and bring the piston to the bottom dead center.
2. Remove the connecting rod bolt and take off the connecting rod cap.
3. Turn the flywheel, and bring the piston to the top dead center.
4. Pull out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.

**(When reassembling)**

- Apply engine oil to the piston, piston ring and cylinder bore.
- When inserting the piston into the cylinder, face the number (1) on the connecting rod to the injection pump.
- Align the number (1) on the connecting rod and connecting rod cap.
- Apply engine oil to the crank pin bearings and bolts.

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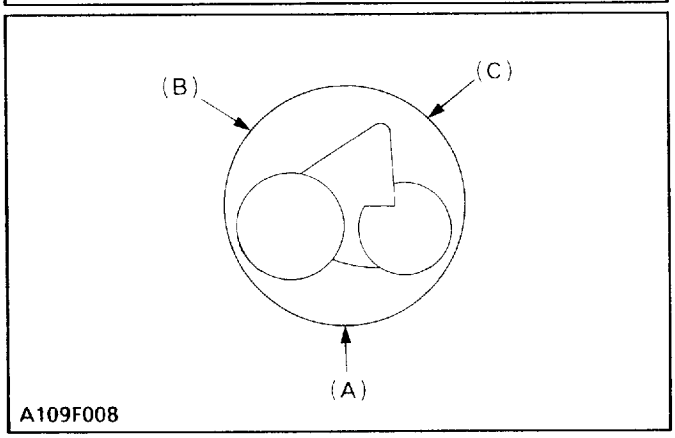
| | | | |
|---|---|---|---|
| Tightening torque | Connecting rod bolt | Non-Flange bolt | 36.3 to 41.2 N·m<br>3.7 to 4.2 kgf·m<br>26.6 to 30.4 ft-lbs |
| | | Flange bolt | 44.1 to 49.0 N·m<br>4.5 to 5.0 kgf·m<br>32.5 to 36.2 ft-lbs |

**■ IMPORTANT**

- **Do not change the combination of cylinder and piston. Make sure of the position of each piston by marking.**
- **The oil ring's edge is hard-chromium plated; and when inserting the piston into the cylinder, make certain the piston ring compressor is tight so that the oil ring is not caught by the cylinder, peeling off the plating.**
- **Place the piston rings so that there are gaps every 120° (2.09 rad.) with no gap facing the piston pin in the cylinder. (See Fig.)**

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(1) Align the mark

**(A) Top Ring Gap**
**(B) Second Ring Gap**
**(C) Oil Ring Gap**

# [5] PISTONS ET BIELLES

## Carter d'huile et crépine d'huile

1. Enlever les carter d'huile et la crépine (1).

**(Au remontage)**
- Après avoir nettoyé la crépine, la remonter.
- Monter la crépine d'huile (1), en veillant à ne pas abîner le joint torique.
- Appliquer un joint liquide (Three Bond 1215 ou équivalent) des deux côtés du joint de carter.
- Pour éviter un serrage inégal, serrer les boulon de fixation du carter d'huile en diagonal, en commençant par le centre.

(1) Crépine d'huile

## Pistons

1. Appliquer de l'huile moteur sur le piston, les segments et l'alésage de cylindre.
2. Tpourner le volant et amener le piston au point mort bas.
3. Enlever le boulon de bielle et ôter le chapeau de bielle.
4. Tourner le volant à nouveau et amener le piston au point mort haut.

**(Au remontage)**
- Enduire d'huile moteur les piston, les segment et cylindre.
- Pour introduire le piston dans le cylindre, mettre en regard le repère (1) de la bielle et la pompe à injection.
- Aligner les repères (1) de la bielle et du chapeau de bielle.
- Enduire d'huile moteur le coussinet de tête de bielle et boulon.

| | | | |
|---|---|---|---|
| Couple de serrage | Boulon de tête de bielle | Boulon sans collerette | 36,3 à 41,2 N·m<br>3,7 à 4,2 kgf·m |
| | | Boulon à collerette | 44,1 à 49,0 N·m<br>4,5 à 5,0 kgf·m |

**■ IMPORTANT**
- **Ne pas changer les combinaisons de cylindre et de piston. Assurer la position de chaque piston, par un repérage.**
- **Le bord du segment racleur est plaqué en chrome dur. Lorsqu'on introduit le piston dans le cylindre, s'assurer que le serreur des segments du piston est serré de telle façon que le segment racleur ne soit pas arrêté par le cylindre en risquant d'érafler le revêtement.**
- **Les intervals des segments se trouvent à 120° (2,09 rad.) de difference avec les autres sans être facés vers l'axe de piston. (Voir figure)**

(1) Aligner les repères

**(A) Coupe du premier segment**
**(B) Coupe du deuxième segment**
**(C) Coupe du segment racleur**

# [5] KOLBEN UND PLEUELSTANGE

## Ölwanne und Ölfilter

1. Die Ölwanne entfernen und Ölfilter (1).

**(Beim Wiedereinbau)**
- Den Ölfilter reinigen und wieder einsetzen.
- Beim Einbau des Ölfilters (1) darauf achten, daß der O-Ring nicht beschädigt wird.
- Beide Seiten der Ölwannendichtung mit einer flüssigen Dichtung (Three Bond 1215 oder ähnlich) versehen.
- Um ein ungleichmäßiges Anziehen zu vermeiden, werden die Befestigungsschrauben in diagonaler Reihenfolge von der Mitte aus augezogen.

(1) Ölfilter

## Kolben

1. Motoröl auf den Kolben, Kolbenring und den Zylinder auftragen.
2. Das Schwungrad drehen bis der Kolben zum unteren Totpunkt gelangt.
3. Die Pleuelstangenschraube und den Pleuelstangendeckel entfernen.
4. Das Schwungrad wiieder drehen bis der Kolben zum oberen Totpunkt kommt.

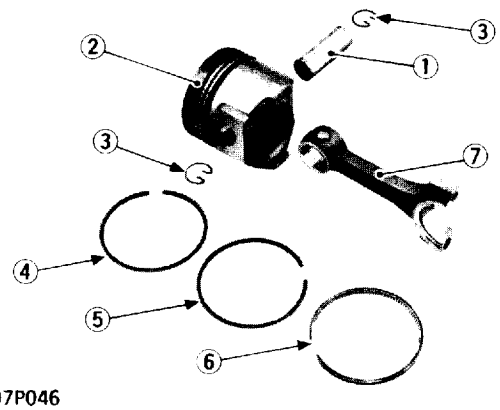
**(Beim Wiedereinbau)**
- Den Kolben, Kolbenring und Zylinderblock mit einer Schicht Motoröl versehen.
- Beim Einsetzen des Kolbens in den Zylinder auf die Markierung (1) der Peluelstange zur Einspritzpumpe hin achten.
- Die Markierungen (1) auf der Pleuelstange und dem Pleuelstangendeckel ausrichten.
- Auf die Pleuellagerschale dine Schicht Motoröl auftragen und Bolzen.

| | | | |
|---|---|---|---|
| Anzugsdr-ehmoment | Schraubeu an der Pleuel-stange | Schraube ohne flansch | 36,3 bis 41,2 N·m<br>3,7 bis 4,2 kgf·m |
| | | Flansch Schraube | 44,1 bis 49,0 N·m<br>4,5 bis 5,0 kgf·m |

**■ WICHTIG**
- **Die Kombination vom Zylinder und Kolben darf nicht verwechselt werden. Die Position eines jeden Kolbens ist zu markieren.**
- **Die Kante des Ölrings ist hartchrombeschichtet. deshalb muß beim Einsetzen des Kolbens in den Zylinder darauf geachtet werden, daß der Kolbenringkompressor fest anliegt und der Ölring nicht gegen den Zylinder kratzen kann, wodurch die Beschichtung abgeschält würde.**
- **Legen Sie die Kolbenringe so ein, daß all 120° (2,09 rad.) eine Öffnung verbleibt, jedoch keine dieser Öffnungen dem Kolbenstift im Zylinder zugewendet ist. (Siehe Zeichung)**

(1) Die Markierungen

**(A) Obererringspalt**
**(B) Zweiterringspalt**
**(C) Ölabstreifringspalt**

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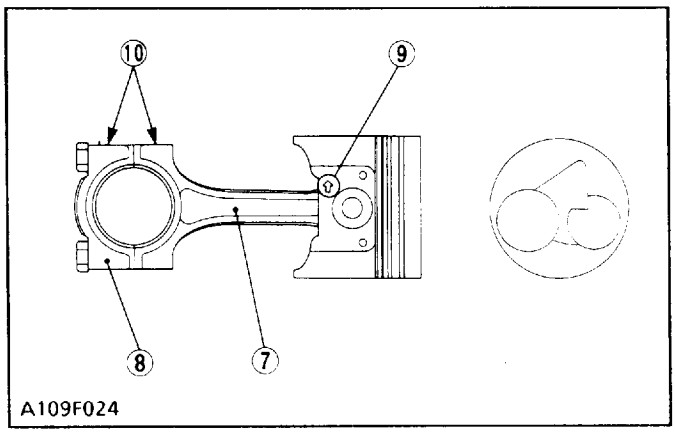


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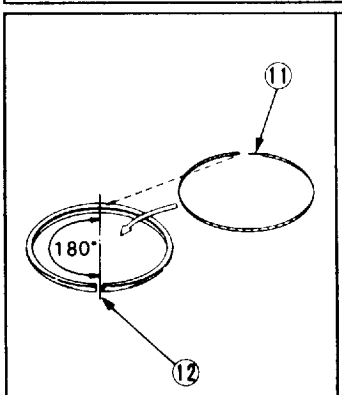


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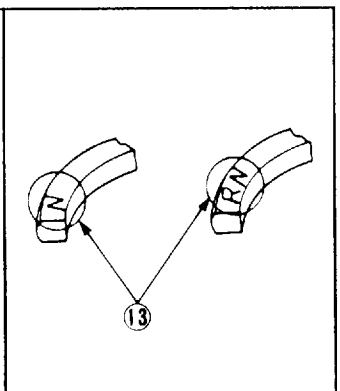


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## Piston Ring and Connecting Rod

1. Remove the piston rings using a piston ring tool.
2. Remove the piston pin (1), and separate the connecting rod (7) from the piston (2).

**(When reassembling)**

- When installing the ring, assemble the rings so that the manufacturer's mark (13) near the gap faces the top of the piston.
- When installing the oil ring onto the piston, place the expander joint (11) on the opposite side of the oil ring gap (12).
- Apply engine oil to the piston pin.
- When installing the connecting rod to the piston, immerse the piston in 80°C (176°F) oil for 10 to 15 minutes and insert the piston pin to the piston.

**■ NOTE**

- When installing the connecting rod to the piston, align the mark (10) on the connecting rod to the arrow's direction of casting mark on the piston.

**■ IMPORTANT**

- **Mark the same number on the connecting rod and the piston so as not to change the combination.**

(1) Piston Pin
(2) Piston
(3) Piston Pin Snap Ring
(4) Compression Ring 1
(5) Compression Ring 2
(6) Oil Ring
(7) Connecting Rod
(8) Connecting Rod Cap
(9) Casting Mark
(10) Mark
(11) Expander Joint
(12) Oil Ring Gap
(13) Manufacturer's Mark

## Segments et bielles

1. Enlever les segments à l'aide de l'outil de serrage de segments.
2. Enlever l'axe du piston (1) et séparer la bielle (7) du piston (2).

**(Au remontage)**

- Lors de la mise en place des segments, monter ces derniers de manière à ce que le repère du fabricant (13) à proximité du jeu de coupe soit orienté vers le sommet du piston.
- Pour monter le segment racleur sur le piston, placer le joint de dilatation (11) du côté opposé à la coupe du segment racleur (12).
- Enduire d'huile moteur l'axe du piston.
- Lors de la mise en place de l'axe de piston, immerger ce dernier pendant 10 à 15 minutes dans de l'huile à 80°C, puis introduire l'axe dans le piston.

**■ NOTA**

- **Lorsque la bielle est montée au piston, aligner la marquage (10) de la bielle avec la flèche du repère en fonte sur le piston.**

**■ IMPORTANT**

- **Marquer le même numéro sur la bielle et sur la piston pour retrouver la même combinaison.**

(1) Axe de piston
(2) Piston
(3) Circlip d'axe de piston
(4) Segment 1 de compression
(5) Segment 2 de compression
(6) Segment racleur
(7) Bielle
(8) Chapeau de bielle
(9) Repère moulé
(10) Repère
(11) Joint de dilatation
(12) Coupe du segment racleur
(13) Repère du fabricant

## Kolbenring und Pleuelstange

1. Die Kolbenringe mit Hilfe eines Kolbenringwerkzeuges entfernen.
2. Den Kolbenbolzen (1) entfernen und die Pleuelstange (7) vom Kolben (2) trennen.

**(Beim Wiedereinbau)**

- Beim Einbau der Ringe müssen diese so angeordnet werden, daß die Markierung (13) des Herstellers nahe dem Spalt zur Spitze des Kolbens hin zeigt.
- Bei der Anbringung des Ölabstreifringes auf dem Kolben, das Spreizrohr (11) an der entgegengesetzten Seite des Ölabstreifringspalts (12) ansetzen.
- Den Kolbenbolzen mit einer Schicht Motoröl versehen.
- Beim Einbau des Kolbenbolzens, den Kolben 10 bis 15 Minuten in Öl (80°C) eintauchen und dann den Kolbenbolzen in dem Kolben einsetzen.

**■ ANMERKUNG**

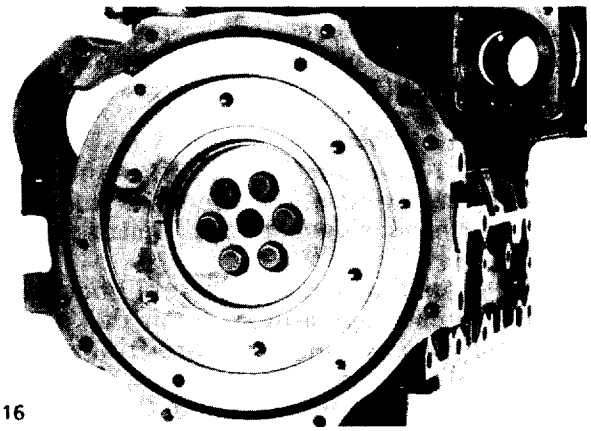
- **Wenn die Kurbelstange auf dem Kolben eingerichtet wird, die Marke (10) der Kurbelstange mit dem auf dem Kolben abgegossenen Pfeil ausrichten.**

**■ WICHTIG**

- **Die Pleuelstange und den Kolben mit der gleichen Nummer versehen, um eine Verwechslung zu vermeiden.**

(1) Kolbenbolzen
(2) Kolben
(3) Kolbenbolzen-Sicherungsring
(4) Verdichterring 1
(5) Verdichterring 2
(6) Ölabstreifring
(7) Pleuelstange
(8) Pleuelstangendeckel
(9) Gußmarkierung
(10) Markierung
(11) Spreizrohr
(12) Ölabstreifringspalt
(13) Markierung

# [6] FLYWHEEL AND CRANKSHAFT



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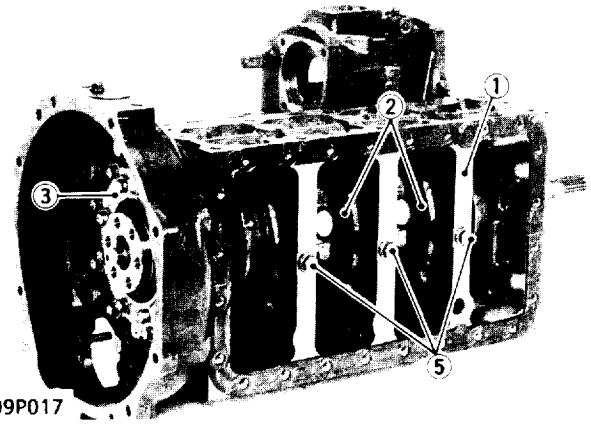
## Flywheel

1. Lock the flywheel not to turn using the flywheel stopper.
2. Remove the flywheel screws, except for two which must be loosened and left as they are.
3. Set a flywheel puller (Code No: 07916-32011), and remove the flywheel.

**(When reassembling)**

- Apply engine oil to the flywheel bolt.

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## Bearing Case Cover and Crankshaft

**■ NOTE**

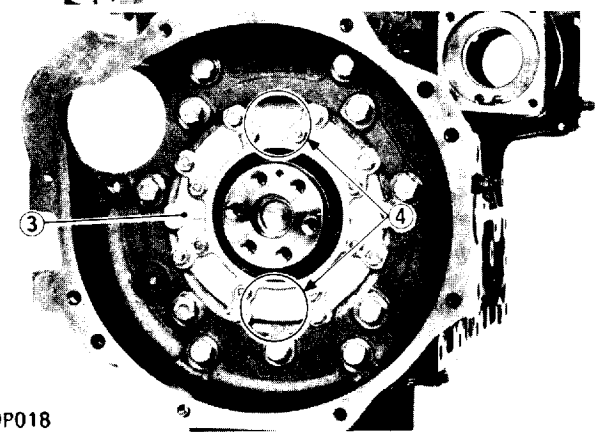
- **Before disassembling, check the side clearance of crankshaft. Also check it during reassembly.**

1. Remove the bearing case cover (3).
2. Remove the bearing case screw 2 (5).
3. Pull out the crankshaft.

**(When reassembling)**

**■ IMPORTANT**

- **Install the crankshaft sub assembly, aligning the screw hole of main bearing case 2 (2) with the screw hole of cylinder block (1).**
- **Apply engine oil to the seat and thread of bearing case screw 2 (5) and tightening it.**
- **Install the bearing case cover (3) to position the casting mark " 下 " (4) on it downward or the casting mark "up" (4) on it upward.**
- **Tighten the bearing case cover mounting screws with even force on the diagonal line.**

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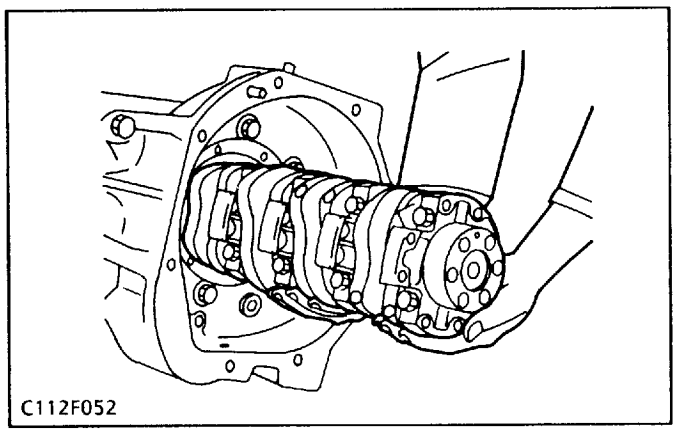
(1) Cylinder Block
(2) Main Bearing Case 2
(3) Bearing Case Cover
(4) Casting Mark " 下 " or "up"
(5) Bearing Case Screw 2



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# [6] VOLANT ET VILEBREQUIN

## Volant

1. Bloquer le volant de sorte qu'il ne tourne pas avec la butée de volant.
2. Enlever les vis du volant, à l'exception des deux qui doivent étre simplement desserrées et laisser où elles sont.
3. Monter l'extracteur de volant (Référence 07916-32011), puis enlever le volant.

**(Au remontage)**

- Enduire d'huile moteur les boulon du volant.

## Couvercle de palier et vilebrequin

**■ NOTA**

- **Avant la dépose, vérifier le jeu latéral du vilebrequin. Vérifier également cet jeu lors de la repose.**

1. Déposer de couvercle de palier (3).
2. Déposer la vis de palier 2 (5).
3. Retirer le vilebrequin.

**(Au remontage)**

**■ IMPORTANT**

- **Mettre en place le sous-ensemble de vilebrequin, en alignant le trou de vis du palier principal 2 (2) sur celui du bloc-moteur (1).**
- **Enduire d'huile moteur le siège et le filet de la vis de palier 2 (5) et l'avoir serrée.**
- **Mettre en place le couvercle de palier (3) en orientant le repère " 下 " (4) vers le bas ou en orientant le repère "up" (4) vers le haut.**
- **Serrer les vis de montage de couvercle de palier à un couple uniforme sur la diagonale.**

(1) Bloc-moteur
(2) Palier principal 2
(3) Couvercle de Palier
(4) Orientaut le repère " 下 " ou "up"
(5) Vis de palier 2

# [6] SCHWUNGRAD UND KURBELWELLE

## Schwungrad

1. Das Schwungrad mit der Schwungrad-Bremsvorrichtung sichern, so daß es nicht drehen kann.
2. Die Schwungradschrauben entfernen, außer zwei Schrauben, die gelost und so belassen werden.
3. Eine Schwungrad-Abziehvorrichtung (Code Nr. 07916-32011) ansetzen und das Schwungrad entfernen.

**(Beim Wiedeereinbau)**

- Auf die Schwungradbolzen eine Schicht Motoröl auftragen.

## Lagerschalendeckel und Kurbelwelle

**■ ANMERKUNG**

- **Vor dem Zerlegen das Seitenspiel der Kurbelwelle überprüfen. Dasselbe auch während des Zusammenbaus vornehmen.**

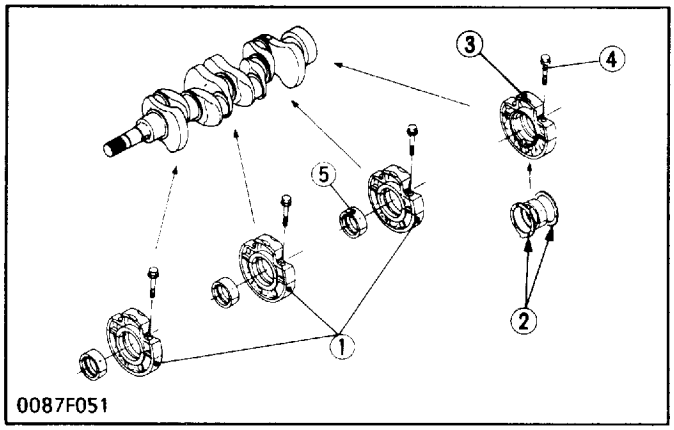
1. Die Lagerschalendeckel (3) entfernen.
2. Die Lageschalenschraube 2 (5) entfernen.
3. Die Kurbelwelle herausziehen.

**(Beim Wiedereinbau)**

**■ WICHTIG**

- **Die Kurbelwelle-Unterbaugruppe einbauen und dabei das Schraubenloch der Hauptlagerschale 2 (2) mit dem Schraubenloch des Zylinderblock (1) ausrichten.**
- **Motoröl auf den Sitz und das Gewinde der Lagerschalenschraube 2 (5) auftragen und dem Anziehen.**
- **Den Lagerschalendeckel (3) mit der " 下 " Marke (4) nach unten ausgerichtet einbauen oder "up" Marle (4) nach unten ausgerichtet einbuen.**
- **Die Befestigungsschrauben für den Lagerschalendeckel in Kreuzmuster mit gleicher Kraft anziehen.**

(1) Zylinderblock
(2) Hauptlagerschale 2
(3) Lagerschalendeckel
(4) Markierung " 下 " oder "up"
(5) Lageschalenschraube 2



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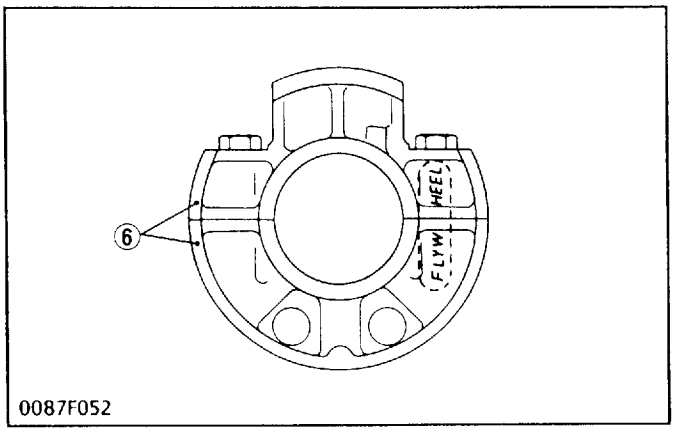

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**Main Bearing Case Assembly**

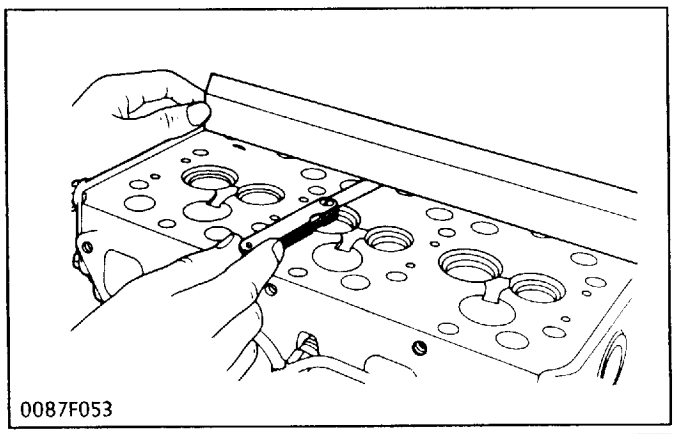
1. Remove the two bearing case screws 1 (4), and remove the main bearing case assembly 1 (3), being careful with the thrust bearing (2) and crankshaft bearing 2 (5).
2. Remove the main bearing case 1, 2 and 3 (1) as above.

**(When reassembling)**

- Clean the oil passage in the main bearing case.
- Apply clean engine oil on the crankshaft bearing 2 and thrust bearings.
- Install the main bearing case assemblies in the original positions. Since diameters of main bearing cases vary, install them in order of makings (A, B, C) from the gear case side.
- Match the alignment numberts (6) on the main bearing case.
- When installing the main bearing case 1, 2 and 3, face the mark " **FLYWHEEL**" to the flywheel.
- Be sure to install the thrust bearing with its oil groove facing outward.
- Confirm that the main bearing case moves smoothly and holizontally after tightening the bearing case screw 1 to the specified torque.

# SERVICING

## [1] CYLINDER HEAD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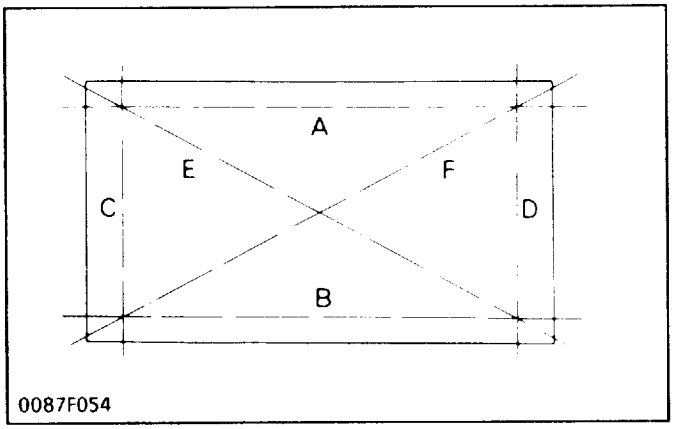

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**Cylinder Head Surface Flatness**

1. Thoroughly clean the cylinder head surface.
2. Place a straightedge on the cylinder head's four sides and two diagonal as shown in the figure. Measure the clearance with a feeler gauge.
3. If the measurement exceeds the allowable limit, replace the cylinder head.

■ **NOTE**

- **Do not place the straight edge on the combustion chamber.**

### Ensemble de palier principal

1. Enlever les deux vis 1 (4) de palier, et enlever l'ensemble de palier principal 1 (3) en faisant attention au palier de butée (2) et au palier 2 (5) de vilebrequin.
2. Enlever de palier principal 1, 2 et 3 (1), comme ci-dessus.

**(Au remontage)**

- Nettoyer le passage d'huile de palier principal.
- Enduire d'huile moteur propre le palier 2 du vilebrequin et les paliers de butée.
- Monter les ensembles de palier principal dans leur position d'orgine. Les diamètres des carters de palier principal variant, les reposer dans l'ordre des marques (A, B, C) à partir du côté boîtier d'engrenage.
- Faire correspondre les numéros d'alignement (6) sur le carter de palier principal.
- Au montage de palier principal 1, 2 et 3, de boîte principale, le repère "**FLYWHEEL**" doit regarder vers le volant.
- Veiller à ce que la rainure à huile du palier de butée regarde vers l'extérieur.
- Vérifier que le carter de palier principal se déplace régulièremehnt et horizontalement après avoir serré la vis de carter de palier 1 au couple spécifié.

### Hauptlagergehäuse

1. Die zwei Lagergehäuseschrauben 1 (4) und das Hauptlagergehäuse 1 (3) entfernen. Hierbei das Drucklager (2) und das Kurbelwellenlager 2 (5) vorsichting behandeln.
2. Die Hauptlagergehäuseanordnungen 1, 2 und 3 (1), wie oben, entfernen.

**(Beim Wiedereinbau)**

- Den Öldurchgang im Hauptlagergehäuse reinigen.
- Auf die Kurbelwellenlage 2 und die Drucklager eine Schicht sauberes Motoröl auftragen.
- Die Hauptlagergehäuse in der ursprünglichen Position einsetzen. Weil sich die Durchmesser der Hauptlagergehäuse verändern, die Gehäuse in der Ordnung der Markierungen (A, B, C) von der Getriebekosten-Seite installieren.
- Die Ausrichtnummer (6) auf das Hauptlagergehäuse anpassen.
- Beim Einbau der Hauptlagergehäuse 1, 2 und 3, darauf achten, daß die Markierung "**FLYWHEEL**" in Richtung Schwungrad zeigt.
- Darauf achten, daß beim Einbau des Drucklagers die Ölnut nach außen zeigt.
- Die Lagergehäuseschroube 1 auf das vorgeschriebene Auszugmoment festziehen und feststellen, daß sich das Hauptlagergehäuse stoßfrei und horizontal bewegt.

# ENTRETIEN

## [1] CULASSE

### Planéité de la surface de la culasse

1. Nettoyer complètement la surface de la culasse.
2. Placer une règle sur les quatre coins et deux diagonales de la culasse comme indiqué sur la figure.
   Mesurer le jeu à l'aide d'une jauge d'épaisseur.
3. Si la valeur mesurée excède la limite de service, remplacer la culasse.

**■ NOTA**

- **Ne pas présenter la règle droite sur la chamber de combustion.**

# WARTUNG

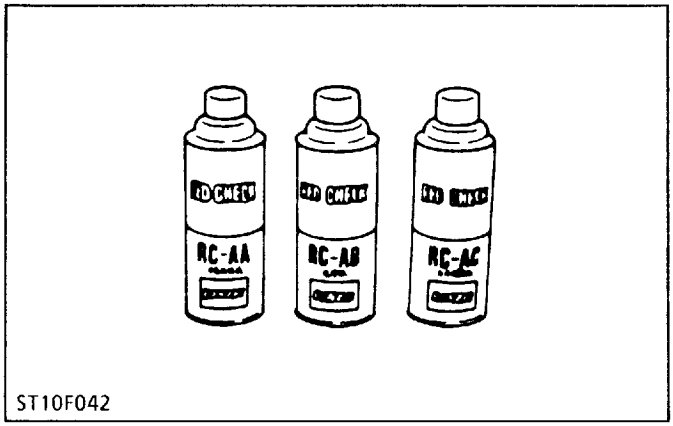
## [1] ZYLINDERKOPF

### Abflachung der Zylinderkopffläche

1. Die Zylinderkopffläche gründlich reinigen.
2. Ein Abrichtlineal auf die vier Seiten des Zylinderkopfes legen und zwei Diagonale zeichnen wie in der Abbildung gezeigt.
   Das Spiel mit einer Fühlerlehre messen.
3. Überschreitet die Abmessung den zulässigen Grenzwert, den Zylinderkopfauswechseln.

**■ ANMERKUNG**

- **Das Abrichtlineal nicht auf die Verbrnnung-skammer legen.**



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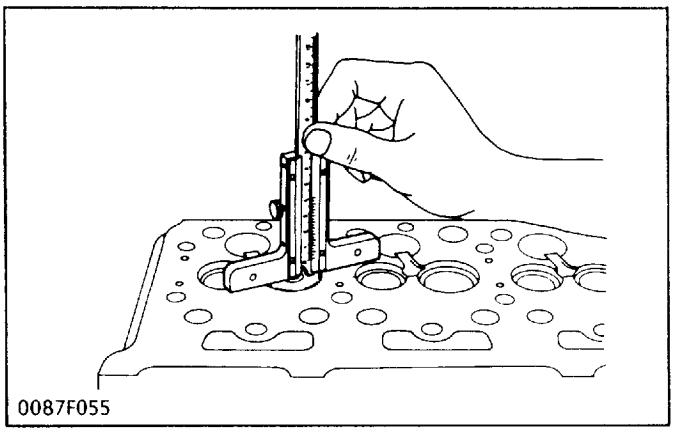
## Cylinder Head Flaw

1. Prepare an air spray red check (Code No: 07909-31371).
2. Clean the surface of the cylinder head with detergent.
3. Spray the cylinder head surface with the red permeative liquid.
   Leave it five to ten minutes after spraying.
4. Wash away the red permeative liquid on the cylinder head surface with the detergent.
5. Spray the cylinder head surface with white developer. If flawed, it can be identified as red marks.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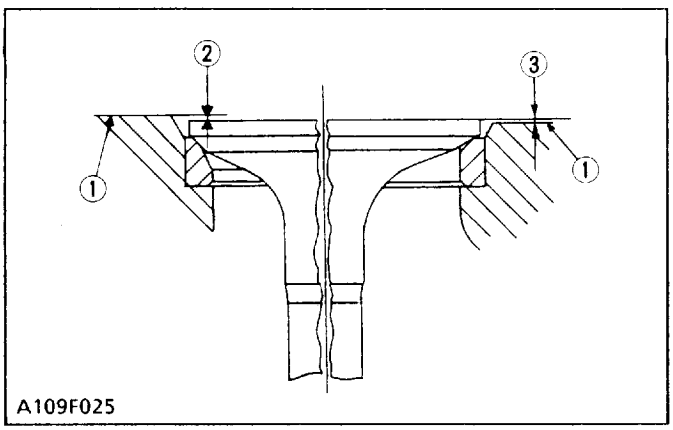
## Valve Recessing

1. Clean the cylinder head, the valve face and seat.
2. Insert the valve into guide.
3. Measure the valve recessing or protrusion with a depth gauge or dial gauge.
4. If the measurement exceeds the allowable limit, replace the valve or cylinder head.

| | | |
|---|---|---|
| Valve recessing | Factory spec. | (Protrusion) 0.05 mm (0.0020 in.) to (recessing) 0.15 mm (0.0059 in.) |
| | Allowable limit | (recessing) 0.4 mm (0.0157 in.) |



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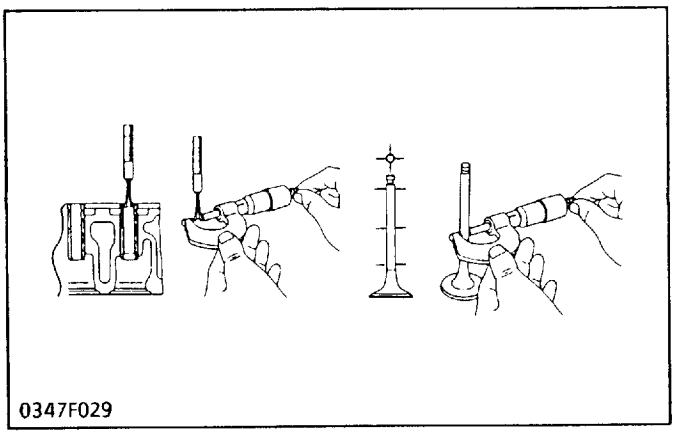
(1) Cylinder Head Surface
(2) Recessing
(3) Protrusion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## Clearance between Valve Stem and guide

1. Remove carbon from the valve guide section.
2. Measure the valve stem O.D. with an outside micrometer.
3. Measure the valve guide I.D. of the cylinder head at the most wear part as shown in the figure below with a small hole gauge. And calculate the clearance.
4. If the clearance exceeds the allowable limit, replace the valves. If it still exceeds the allowable limit, replace the valve guide.

| | | |
|---|---|---|
| Clearance between valve sem and guide | Factory spec. | 0.040 to 0.070 mm 0.0016 to 0.0028 in. |
| | Allowable limit | 0.1 mm 0.0039 in. |

| | | |
|---|---|---|
| Valve guide I.D. | Factory spec. | 8.015 to 8.030 mm 0.3156 to 0.3161 in. |

| | | |
|---|---|---|
| Valve stem O.D. | Factory spec. | 7.960 to 7.975 mm 0.3134 to 0.3140 in. |

## Defaut de surface de culasse

1. Prépare un liquide de vérification de fissure (Référence: 07909-31371).
2. Nettoyer la surface de culasse avec un détersif.
3. Pulvériser du liquide imprégnant rouge sur la surface de la culasse et la laisser reposer pendant cing à dix minutes.
4. Laver la surface de la culasse avec le dérsif pour éliminer le liquide imprégnant rouge.
5. Pulvériser du produit révélateur blanc sur la surface de la culasse.
   S'il y a des fissures, on peut les voir apparaître sous forme de marque rouge.

## Retrait des soupapes

1. Nettoyer la culasse, la soupape et le siège.
2. Insérer la soupape dans le guide.
3. Mesurer le retrait de soupape à l'aide d'un calibre de profondeur.
4. Si la valeur mesurée excède la limite de service, remplacer la soupape. Si elle est supérieure à la limite de service même après remplacement du soupape, rectifier la surface du siège de soupape de la culasse à l'aide d'un coupe-siège (Référence: 07909-33102) ou d'une rectifieuse de siège. Ensuite, rectifier la surface de la culasse à l'aide d'une rectifieuse plane, remplacer la culasse.

| | | |
|---|---|---|
| Retrait des soupapes | Valeur de référence | (Saillie) 0,05 mm à (retrait) 0,15 mm |
| | Limite de service | (retrait) 0,4 mm |

(1) Surface de la culasse
(2) Retrait
(3) Saillie

## Sprung in der Zylindekopffläche

1. Eine Flüssigkeit zur Ermittlung von Rissen (CodeNr.: 07909-31371) vorbereiten.
2. Die Zylinderkopffläche mit einem Reinigungsmittel säubern..
3. Die Zylinderkopffläche mit der roten Flüssigkeit einsprühen.
   Nach dem spritzen 10 Minuten lang stehen lassen.
4. Mit einem Reingungsmittel die rote Flüssigkeit auf der Zylinderkopffläche abwaschen.
5. Die Zylinderkopffläche mit der weißem Entwicklerflüssigkeit einsprühen.
   Eventuelle Fehler können als rote Markierungen identifiziert werden.

## Ventilvertiefung

1. Den Zylinderkopf, die Ventilsitzfläche und den Ventilsitz renigen.
2. Das Ventil in die Ventilführung einschieben.
3. Die Ventilvertiefung mit Hilfe einer Tiefenlehre messen.
4. Überschreitet die Messung die zulässige Grenze das Ventil auswechseln.
   Wird die zulässige Grenze nach Auswechslung des Ventils noch immer überschritten, die Ventilvertiefung des Zylinderkopfes mit einem Ventilsitzschneider (CodeNr. 07909-33102) oder mit einer Ventilsitzschleifmaschine berichtigen. Danach die Zylinderkopffläche mit einer Planschleifmachine berichtigen, oder den Zylinderkopf auswechseln.

| | | |
|---|---|---|
| Ventilvertiefung | Werkdaten | (Vorsprung) 0,05 mm bis (Vertiefung) 0,15 mm |
| | Zulässiger Grenzwert | (Vertiefung) 0,4 mm |

(1) Zylinderkopffläche
(2) Vertiefung
(3) Vorsprung

## Jeu entre la queue de soupape et le guide de soupape

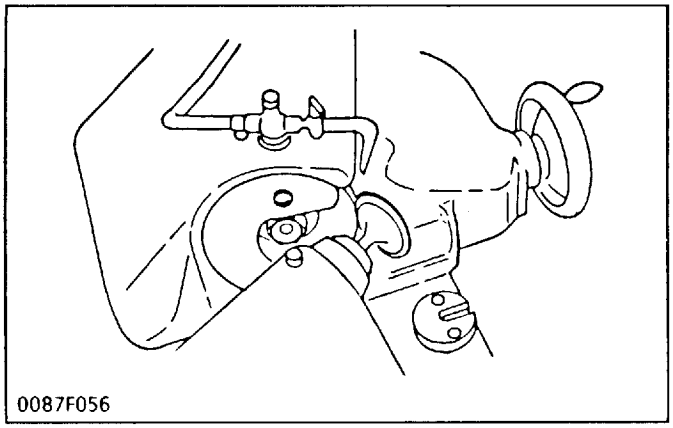
1. Eliminer la calamine du guide de soupape.
2. Mesurer le diamètre extérieur de la queue de soupape au moyen d'un micromètre d'extérieur.
3. Mesurer le diamètre intérieur du guide de soupape de la culasse sur la partie la plus usée comme indiqué sur la figure ci-dessous à l'aide d'un calibre pour trous. Et, calculer le jeu.
4. Si le jeu dépasse la limite de service, remplacer les soupapes. S'il excède toujours la limite de service, remplacer la culasse.

| | | |
|---|---|---|
| Jeu entre la queue de soupape et le guide de soupape | Valeur de référence | 0,040 à 0,070 mm |
| | Limite de service | 0,1 mm |
| Diamètre ext. de queue de soupape | Valeur de référence | 7,960 à 7,975 mm |
| Diamètre int. de guide de soupape | Valeur de référence | 8,015 à 8,030 mm |

## Spiel zwischen Ventilschaft und Ventilführung

1. Ölkohle vom Ventilführungsteil entfernen.
2. Mit einem Außenmikrometer den Ventilschaft-Außendurchmessee messen.
3. Mit einer kleinen Bohrungslehre den Ventilführungs-Innendurchmesser am meist verschlissenen Teil messen wie in der Abbildung unten dargestellt. Das Spiel berechnen.
4. Überschreitet das Spiel den zulässigen Grenzwert ist das Ventil auszuwechseln. Wird der zulässigen Grenzwert noch immer überschritten ist der Zylinderkopf austauschen.

| | | |
|---|---|---|
| Spiel zwischen ventilschaft und ventilführung | Werkdaten | 0,040 bis 0,070 mm |
| | Zulässiger Grenzwert | 0,1 mm |
| Ventilschaft Außendurchmesser | Werkdaten | 7,960 bis 7,975 mm |
| Ventilführung Innendurchmesser | Werkdaten | 8,015 bis 8,030 mm |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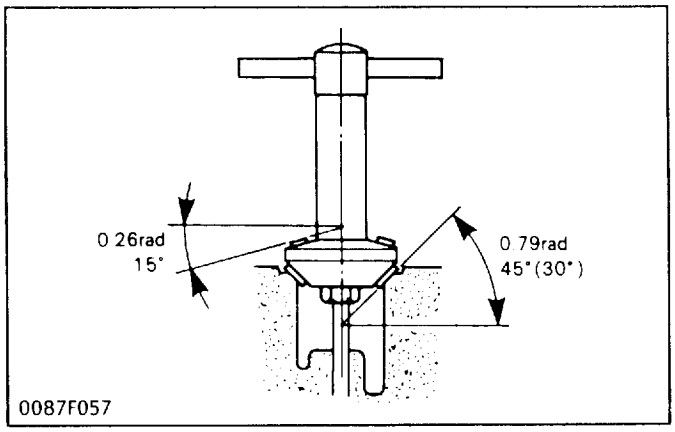
## Correcting Valve and Valve Seat

■ **NOTE**
- **Before correcting the valve and seat, check the valve stem and the I.D. of the valve guide section, and repair them if necessary.**
- **After correcting the valve seat, be sure to check the valve recessing.**

**1) Correcting Valve**

1. Correct the valve with a valve refacer.



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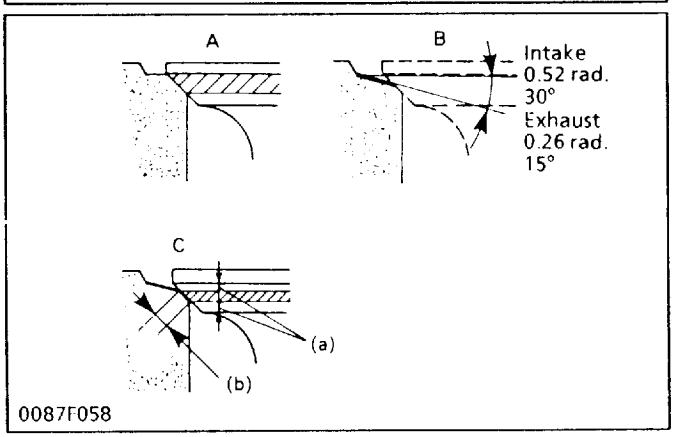
**2) Correcting Valve Seat**

1. Slightly correct the seat surface with a 60° (Intake valve) or 45° (Exhaust valve) seat cutter (1) (Code No: 07909-33102).
2. Resurface the seat surface with 30° valve seat cutter to intake valve seat and with 15° valve seat cutter to exhaust valve seat so that the width is close to specified valve seat width. (2.12 mm 0.0835 in.)
3. After resurfacing the seat, inspect for even valve seating, apply a thin film of compund between the valve face and the valve seat, and fit them with valve lapping tool.
4. Check valve sealing with prussian blue, the valve seating surface should show good contact all the way around.



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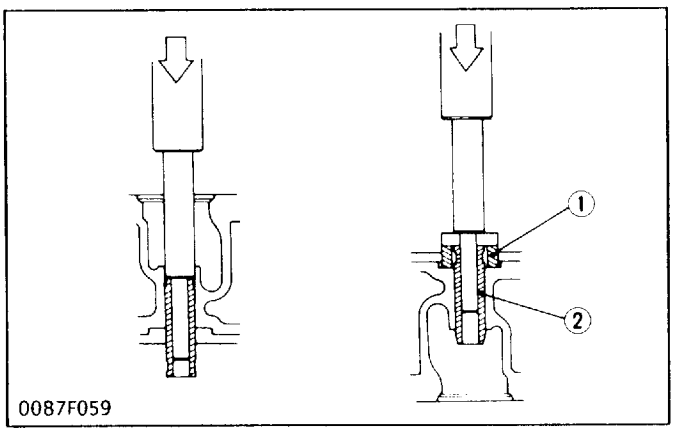
**[A] Check Contact**
**[B] Correct Seat Width**
**[C] Check Contact**

(a) Identical Dimensions
(b) Valve Seat Width



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**(When removing)**

1. Using a valve guide replacing tool, press out the used valve guide.

**(When installing)**

1. Clean a new valve guide, and apply engine oil to it.
2. Using a valve guide replacing tool, press in a new valve guide until it is flush with the cylinder head as shown in the figure.
3. Ream precisely the I.D. of the valve guide to the specified dimension. (See page S-16)

■ **NOTE**
- **Be careful not to strike valve guide with a hammer, etc. during replacement.**

(1) Spacer
(2) Valve Guide

## Rectification de soupape et du siège de soupape

■ **NOTA**
- **Avant de rectifier la soupape et le siège, vérifier la queue de soupape et le diamètre intérieur de la partie de guide de soupape, et les réparer si nécessaire.**
- **Après correction du siège de soupape, ne pas manquer de vérifier le retrait de soupape.**

**1) Rectification de la soupape**
1. Rectifier la soupape à l'aide d'un rectifieuse de soupape.

**2) Rectification du siège de soupape**
1. Corriger légèrement la surface du siège avec un outil de coupe pour siège de soupape (1) (No de code: 07909-33102) à 60° (pour la soupape d'admission) ou à 45° (pour la soupape d'échappement).
2. Resurfacer la surface du siège avec un outil de coupe pour siège de soupape à 30° (pour la soupape d'admission) ou à 15° (pour la soupape d'échappement) de telle sorte que la largeur soit proche de la valeur spécifiée. (2,12 mm)
3. Puis, vérifier si le siège de soupape pent être installé de façon uniforme. Appliquer une mince couche de composé entre la surface de la soupape et le siège de soupape, et les ajuster ensemble avec un outil de rodage pour soupape.
4. Vérifier l'étanchéité de la soupape avec du bleu de Prusse. La surface d'assise de la soupape devra pouvoir montrer un bon contact sur tout le pourtour.

**[A] Vérification du contact**
**[B] Rectification de largeur du siège**
**[C] Vérification du contact**

(a) Dimensions identiques
(b) Largeur du siège de soupape

## Berichtigung von Ventil und Ventilsitz

■ **ANMERKUNG**
- **Vor der Korrektur des Ventils und Ventilsitzes, den Ventilschaft und den I.D. des Ventilführungsteiles messen und ggf. berichtigen**
- **Nach der Berichtigung des Ventilsitzes ist die Ventilaussparung zu überprüfen.**

**1) Berichtigung des Ventils**
1. Das Ventil mit einem Ventileinschleifer berichtigen.

**2) Korrigieren des Ventilsitzes**
1. Die Ventilsitzoberfläche mit einem 60°- (für Einlaßventil) oder 45°- (für Auslaßventil) Ventilsitzfräser (1) (Code-Nr. 07909-33102) nacharbeiten.
2. Die Ventilsitzoberfläche mit einem 30°- (für Einlaßventil) oder 15°- (für Auslaßventil) Ventilsitzfräser nacharbeiten, so daß die ventilsitzbreite nahezu den spezifischen Wert aufweist. (2,12 mm)
3. Danach Überprüfen, ob der Ventilsitz gleichmäßig abgetragen wurde. Hierfür einen dünnen Film Schleifmittel zwischen Ventilsitzfläche und Ventilsitz auftragen und mit einem Ventilläpper behandeln.
4. Den Ventilabsohluß mit Preußisch-Blau feststellen. Die Ventilsitzfläche muß rundherum guten Kontakt aufweisen.

**[A] Den Kontact prüfen**
**[B] Die Sitzbreite berichtigen**
**[C] Den Kontakt prüfen**

(a) Identische Abmessungen
(b) Ventilsitzbreite

**(A la dépose)**
1. En utilisant l'outil de remplacement de guide de soupape, chasser le guide de soupape.

**(A la pose)**
1. Nettoyer l'alésage du guide de soupape, et appliquer de l'huile moteur sur l'alésage.
2. En utilisant l'outil de remplacement de guide de soupape, enfoncer un nouveau guide de soupape jusqu'à ce qu'il soit de niveau avec la culasse de la manière indiquée dans la figure.
3. Roder précisément le D.I. du guide de soupape à la dimension spécifiée. (Voir page S-22)

■ **NOTA**
- **Veiller à ne pas heurter le guide de soupape avec un marteau ou un autre objet pendant le remplacement.**

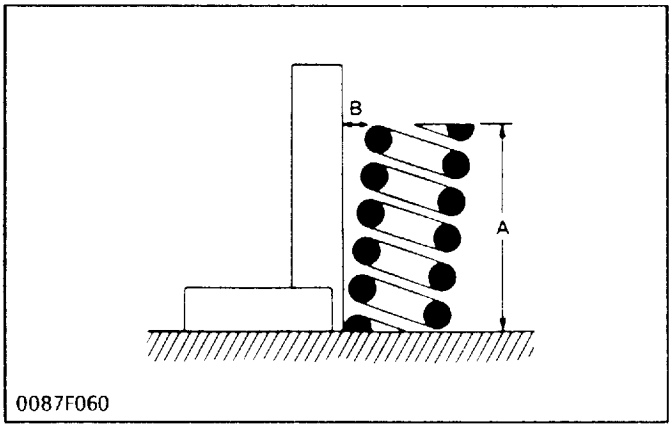
(1) Entretoise
(2) Guide de soupape

**(Beim Ausbauen)**
1. Mit einem Werkzeug für den Austausch von Ventilführungen (siehe Seite S-54) die alte Ventilführung herausdrücken.

**(Beim Einbauen)**
1. Eine neue Ventilführung reinigen und Motoröl auftragen.
2. Mit einem Werkzeug für den Austausch von Ventilführungen eine neue Ventilführung eindrücken, bis sie mit dem Zylinderkopf angeglichen ist wie in der Abbildung gezeigt.
3. Den I.D. der Ventilführung genau auf die richtige Abmessung reiben. (Seite S-27)

■ **ANMERKUNG**
- **Während des Austauschs darf die Ventilführung nicht mit einem Hammer oder einem anderen Werkzeug eingeschlagen werden.**

(1) Abstandsstück
(2) Ventilführung



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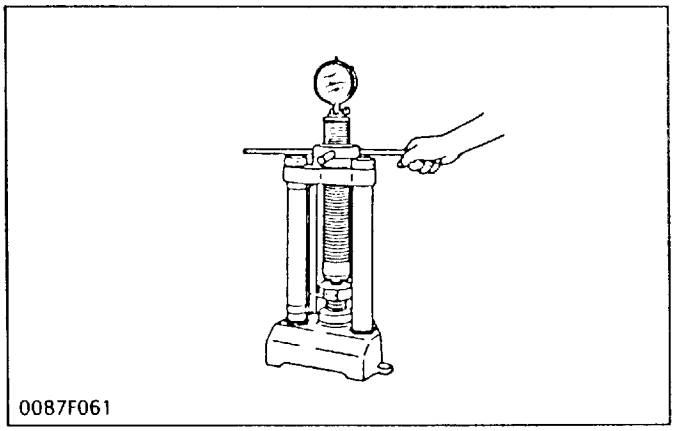
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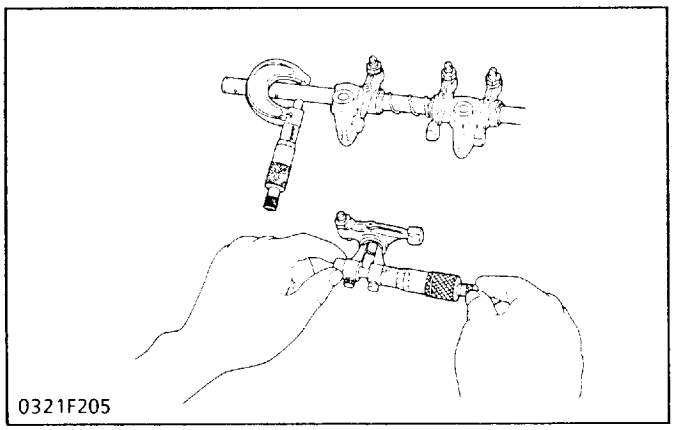
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## Valve Spring

1. Measure the length **A** with vernier calipers. If the measurement is less than the allowable limit, replace.
2. Put the spring on a surface plate, place a square on the side of the spring, and check to see if the entire side is in contact with the square. Rotate the spring and measure the maximum **B**.
   If the measurement exceeds the allowable limit, replace.
3. Check the entire surface of the spring for scratches. Replace it, if any.
4. Place the spring on a tester and compress it to the same length it is actually compressed in the engine.
   Read the compression load on the gauge.
   If the measurement exceeds the allowable limit, replace it.

| | | |
|---|---|---|
| Free length | Factory spec. | 41.7 to 42.2 mm<br>1.6417 to 1.6614 in. |
| | Allowable limit | 41.2 mm<br>1.6220 in. |
| Tilt | Factory spec. | 1.0 mm<br>0.039 in. |
| Setting load / Setting length | Factory spec. | 12.0 kgf / 35.0 mm<br>117.6 N / 35.0 mm<br>26.4 lbs. / 1.3780 in. |
| | Allowable limit | 10.2 kgf / 35.0 mm<br>100.0 N / 35.0 mm<br>22.5 lbs. / 1.3780 in. |

## Oil Clearance of Rocker Arm Shaft and Bearing

1. Measure the rocker arm bearing I.D. with an inside micrometer.
2. Measure the rocker arm shaft O.D. with an outside micrometer.
3. If the clearance exceeds the allowable limit, replace the bushing.
4. If the clearance still exceeds the allowable limit after replacing the bushing, replace the rocker arm shaft.

**[With bushing]**

| | | |
|---|---|---|
| Oil clearance of rocker arm shaft and bush | Factory spec. | 0.018 to 0.070 mm<br>0.0007 to 0.0026 in. |
| | Allowable limit | 0.15 mm<br>0.0059 in. |
| Rocker arm shaft O.D. | Factory spec. | 13.973 to 13.984 mm<br>0.5501 to 0.5506 in. |
| Rocker arm bush I.D. | Factory spec. | 14.002 to 14.043 mm<br>0.5513 to 0.5529 in. |

**[Bushless type]**

| | | |
|---|---|---|
| Oil clearance of rocker arm shaft and bearing | Factory spec. | 0.016 to 0.045 mm<br>0.0006 to 0.0015 in. |
| | Allowable limit | 0.15 mm<br>0.0059 in. |
| Rocker arm shaft O.D. | Factory spec. | 13.973 to 13.984 mm<br>0.5501 to 0.5506 in. |
| Rocker arm bush I.D. | Factory spec. | 14.000 to 14.018 mm<br>0.5512 to 0.5517 in. |

## Ressort de soupape

1. Mesurer la longueur **A** à l'aide d'un pièd à coulisse. Si la valeur mesurée est inférieure à la limite de service, remplacer.
2. Placer un ressort sur un plateau de dressage, mettre une équerre sur le côté du ressort et vérifier si le côté entier entre en contact avec l'équerre. Tourner le ressort et mesurer la valeur maximum **B**.
   Si la valeur mesurée dépasse la limite de service, remplacer.
3. Vérifier la surface entière du ressort pour constater l'absence ou la présence de rayures. S'il en existe, remplacer le ressort.
4. Placer le ressort sur un appareil d'essai et le bander à la même longueur que celui bandé réellement dans le moteur.
   Lire la force de compression sur l'indicateur.
   Si la valeur lue excède la limite de service, remplacer le ressort.

| | | |
|---|---|---|
| Longueur libre | Valeur de référence | 41,7 à 42,2 mm |
| | Limite de service | 41,2 mm |
| Rectangularité | Limite de service | 1,0 mm |
| Force sous charge / Longueur sous charge | Valeur de référence | 12,0 kgf / 35,0 mm<br>117,6 N / 35,0 mm |
| | Limite de service | 10,2 kgf / 35,0 mm<br>100,0 N / 35,0 mm |

## Jeu de marche entre l'axe de culbuteur et la coussinet

1. Mesurer le D.I. de la bague de cultuteur au moyen d'un micromètre intérieur.
2. Mesurer le D.E. de la bague de culbuteur au moyen d'un micromètre extérieur.
3. Si la valeur du jeu dépasse la limite autorisée, remplacer la bague.
4. Si, après avoir remplacer la bague, la valeur du jeu dépasse toujours la limite de service, remplacer l'axe de culbuteur.

**[Avec la coussinet]**

| | | |
|---|---|---|
| Jeu de marche entre l'axe de culbuteur et la coussinet | Valeur de référence | 0,018 à 0,070 mm |
| | Limite de service | 0,15 mm |
| Diamètre extérieur de l'axe de culbuteur | Valeur de référence | 13,973 à 13,984 mm |
| Diamètre intérieur de culbuteur | Valeur de référence | 14,002 à 14,043 mm |

**[Entre sans la coussinet]**

| | | |
|---|---|---|
| Jeu de marche entre l'axe de culbuteur et la coussinet | Valeur de référence | 0,016 à 0,045 mm |
| | Limite de service | 0,15 mm |
| Diamètre extérieur de l'axe de culbuteur | Valeur de référence | 13,973 à 13,984 mm |
| Diamètre intérieur de culbuteur | Valeur de référence | 14,000 à 14,018 mm |

## Ventilfeder

1. Länge **A** mit einer Noniusschublehre messen. Unterschreitet die Messung den zulässigen Grenzwert, auswechseln.
2. Die Feder auf eine Prüfplatte legen, ein Dreieck entlang der Federseite legen und überprüfen, ob die ganze Seite mit dem Dreieck in Berührung ist. Die Feder drehen und den maximalen **B**-Wert messen.
   Überschreitet die Messung den zulässigen Grenzwert, auswechseln.
3. Die ganze Federoberfläche auf Kratzer überprüfen. Sind welche vorhanden, austauschen.
4. Die Feder auf ein Testgerät legen und auf die selbe Länge zusammenpressen wie sich tatsächlich im Motor zusammengepreßt wird.
   Die Kompressionslast auf dem Prüfgerät ablesen.
   Überschreitet die Messung den zulässigen Grenzwert, die Feder austauschen.

| | | |
|---|---|---|
| Freie länge | Werkdaten | 41,7 bis 42,2 mm |
| | Zulässiger Grenzwert | 41,2 mm |
| Neigung | Zulässiger Grenzwert | 1,0 mm |
| Einstellast / Einstellänge | Werkdaten | 12,0 kgf / 35,0 mm<br>117,6 N / 35,0 mm |
| | Zulässiger Grenzwert | 10,2 kgf / 35,0 mm<br>100,0 N / 35,0 mm |

## Ölspiel zwischen Kipphebelweelle und Lager

1. Messen Sie den inneren Durchmesser der Kipphebelbuchse mit einem Stichmaß.
2. Messen Sie den äußeren Durchmesser des Kipphebelschaftes mit einem Außen-Mikrometermaß.
3. Wenn das Spiel die angegebenen Werte übertrifft, ersetzen Sie die Buchse.
4. Sollte nach Auswechseln der Buchse das Spiel immer noch die Toleranzgrenze überschreiten, muß der Kipphebelschaft ausgewechselt werden.

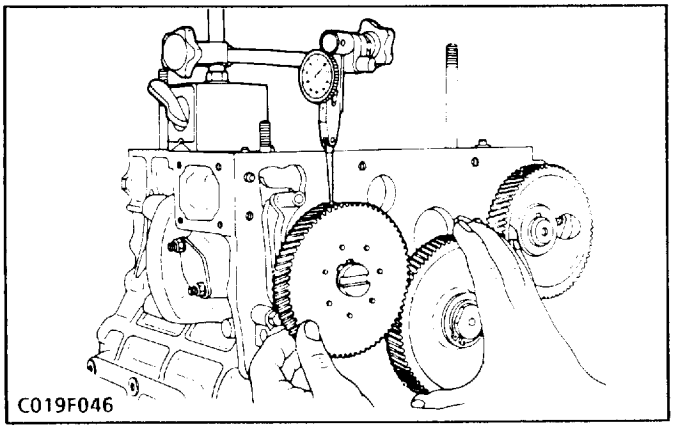
**[Mit Lager]**

| | | |
|---|---|---|
| Ölspiel zwischen Kipphebelwelle und Lager | Werkdaten | 0,018 bis 0,070 mm |
| | Zulässiger Grenzwert | 0,15 mm |
| Kipphebelachse Außendurchmesser | Werkdaten | 13,973 bis 13,984 mm |
| Kipphebel Innendurchmesser | Werkdaten | 14,002 bis 14,043 mm |

**[Ohne Lager]**

| | | |
|---|---|---|
| Ölspiel zwischen Kipphebelwelle und Lager | Werkdaten | 0,016 bis 0,045 mm |
| | Zulässiger Grenzwert | 0,15 mm |
| Kipphebelachse Außendurchmesser | Werkdaten | 13,973 bis 13,984 mm |
| Kipphebel Innendurchmesser | Werkdaten | 14,000 bis 14,018 mm |

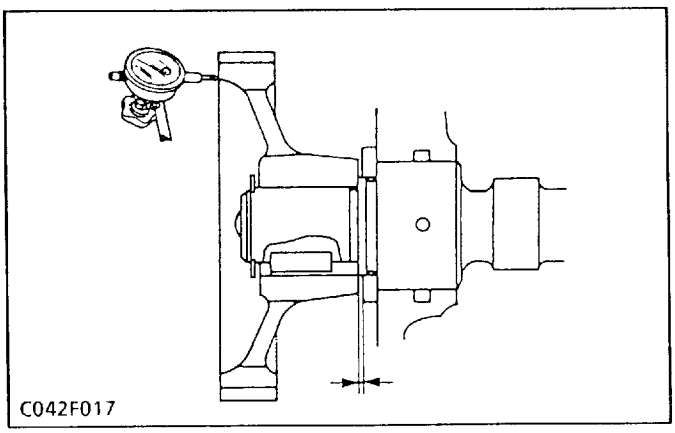
# [2] TIMING GEAR AND CAMSHAFT


C019F046

### Timing Gear Backlash

1. Set a dial indicator (lever type) with its tip on the gear tooth.
2. Move the gear to measure the backlash, holding its mating gear.
3. If the backlash exceeds the allowable limit, check the oil clearance of the shafts and gear.
4. If the oil clearance is proper, replace the gear.

| | | |
|---|---|---|
| Crank gear – Idle gear | Factory spec. | 0.0415 to 0.1122 mm<br>0.0016 to 0.0044 in. |
| | Allowable limit | 0.15 mm<br>0.0059 in. |
| Idle gear – Cam gear | Factory spec. | 0.0415 to 0.1154 mm<br>0.0016 to 0.0045 in. |
| | Allowable limit | 0.15 mm<br>0.0059 in. |
| Idle gear – Injection pump gear | Factory spec. | 0.0415 to 0.1154 mm<br>0.0016 to 0.0045 in. |
| | Allowable limit | 0.15 mm<br>0.0059 in. |
| Crank gear – Oil pump gear | Factory spec. | 0.0415 to 0.1090 mm<br>0.0016 to 0.0043 in. |
| | Allowable limit | 0.15 mm<br>0.0059 in. |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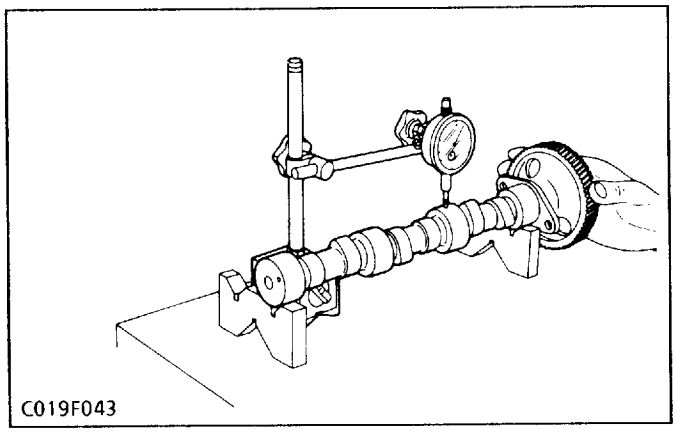
### End Play of Camshaft

1. Move the camshaft to the flywheel side.
2. Set a dial indicator to the cam gear face.
3. Pull the cam gear with the camshaft to its end.
4. Measure the clearance between the cam gear and camshaft stopper.
5. If the clearance exceeds the allowable limit, replace the camshaft stopper.

| | | |
|---|---|---|
| End play of camshaft | Factory spec. | 0.07 to 0.22 mm<br>0.0027 to 0.0087 in. |
| | Allowable limit | 0.3 mm<br>0.0118 in. |


C019F043

### Camshaft Alignment

1. Support the camshaft with V-blocks on the surface plate and set a dial indicator with its tip on the intermediate journal at right angle.
2. Rotate the camshaft on the V-blocks and get the misalignment (half of the measurement).
3. If the misalignment exceeds the allowable limit, replace the camshaft.

| | | |
|---|---|---|
| Camshaft alignment | Allowable limit | 0.01 mm<br>0.00039 in. |

# [2] PIGNON DE DISTRIBUTION ET ARBRE A CAMES

## Jeu d'engrènement de pignon de distribution

1. Disposer un comparateur à cadran (modèle à levier) et sa lèvre sur la dent de pignon.
2. Faire tourner le pignon pour mesurer le battement tout en immobilisant le pignon correspondant.
3. Vérifier le jeu de gaissage des arbres et du pignon si le battement excède la tolérance.
4. Remplacer le pignon si le jeu de graissage est correct.

| | | |
|---|---|---|
| Pignon de lancement / Pignon de renvoi | Valeur de référence | 0,0415 à 0,1122 mm |
| | Limite de service | 0,15 mm |
| Pignon de renvoi / Pignon de cames | Valeur de référence | 0,0415 à 0,1154 mm |
| | Limite de service | 0,15 mm |
| Pignon de renvoi / Pignon de pompe d'injection | Valeur de référence | 0,0415 à 0,1154 mm |
| | Limite de service | 0,15 mm |
| Pignon de lancement / Pignon de pompe à huile | Valeur de référence | 0,0415 à 0,1090 mm |
| | Limite de service | 0,15 mm |

## Jeu latéral de l'arbre à cames

1. Pousser le l'arbre à cames vers le volant.
2. Fixer un comparateur à cadran sur le pignon de cames.
3. Tirer la commande de cames solidaire de l'arbre à cames jusqu'à son extrémité.
4. Mesurer le jeu entre commande de cames et butée d'arbre à cames.
5. Remplacer la butée d'arbre à cames si le jeu excède la tolérance.

| | | |
|---|---|---|
| Jeu latéral de l'arbre à cames | Valeur de référence | 0,07 à 0,22 mm |
| | Limite de service | 0,3 mm |

## Alignement de l'arbre à cames

1. Supporter l'arbre à cames avec des blocs trapézoïdaux sur le plateau de dressage et mettre un comparateur à cadran de telle façon que son extrémité soit perpendiculaire au tourillon intermédiaire.
2. Tourner l'arbre à cames sur les blocs trapézoïdaux et obtenir le désalignement (moitié de la valeur mesurée).
3. Si le désalignement excède la limite de service, remplacer l'arbre à cames.

| | | |
|---|---|---|
| Alignement de l'arbre à cames | Limite de service | 0,01 mm |

# [2] STEUERUNG UND NOCKENWELLE

## Spiel der Steuerung

1. Eine Meßuhr (Hebeltyp) mit der Spitze an einem Zahn ansetzen.
2. Das Zahnrad bewegen, während die daran sitzenden Zahnräder festgehalten werden.
3. Falls der zulässige Grenzwert überstiegen wird, die Ölabstände der Wellen und Zahnräder messen.
4. Falls der Ölabstand korrekt ist, das Zahnrad austauschen.

| | | |
|---|---|---|
| Kurbelgetriebe / Leerlaufgetriebe | Werkdaten | 0,0415 bis 0,1122 mm |
| | Zulässiger Grenzwert | 0,15 mm |
| Leerlaufgetriebe / Nockengetriebe | Werkdaten | 0,0415 bis 0,1154 mm |
| | Zulässiger Grenzwert | 0,15 mm |
| Leerlaufgetriebe / Einspritzpumpengetriebe | Werkdaten | 0,0415 bis 0,1154 mm |
| | Zulässiger Grenzwert | 0,15 mm |
| Kurbelgetriebe / Ölpumpetrieb | Werkdaten | 0,0415 bis 0,1090 mm |
| | Zulässiger Grenzwert | 0,15 mm |

## Endspiel der Nockenwelle

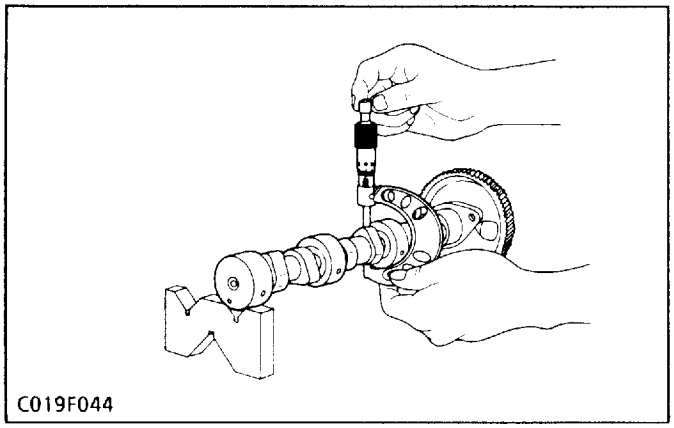
1. Die Nockenwelle in Richtung Schwungrad ziehen.
2. Ein Meßuhr an der Nockenwelle anbringen.
3. Das Nockenwellenrad mit der Nockenwelle bis zum Anschlag herausziehen.
4. Den Abstand zwischen Nockenwellenrad und Nockenwellenanschlag messen.
5. Falls der Abstand den zulässigen Grenzwert übersteigt, den Nockenwellenanschlag austauschen.

| | | |
|---|---|---|
| Endspiel der Nockenwelle | Werkdaten | 0,07 bis 0,22 mm |
| | Zulässiger Grenzwert | 0,3 mm |

## Nockenwellenausrichtung

1. Die Nockenwelle mit V-Blöcken auf der Richtplatte abstützen und eine Meßuhr mit der Spitze lotrecht auf den Zwischenzapfen ansetzen.
2. Die Nockenwelle auf den V-Blöcken drehen, um eine Versetzung (Hälfte des Messungswertes) zu erhalten.
3. Überschreitet die Versetzung den zulässigen Grenzwert die Nockenwelle auswechseln.

| | | |
|---|---|---|
| Nockenwellen-ausrichtung | Zulässiger Grenzwert | 0,01 mm |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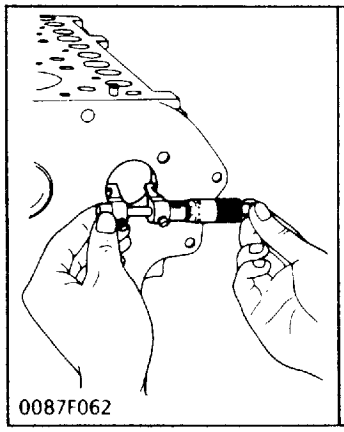
### Intake and Exhaust Cam Height

1. Measure the height of the cam at its highest point with an outside micrometer.
2. If the measurement is less than the allowable limit, replace it.

| | | |
|---|---|---|
| Intake and exhaust camheight | Factory spec. | 33.47 mm 1.3177 in. |
| | Allowable limit | 33.42 mm 1.3157 in. |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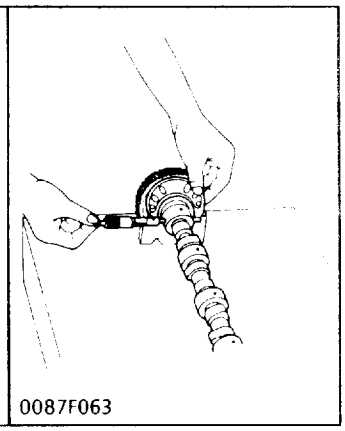
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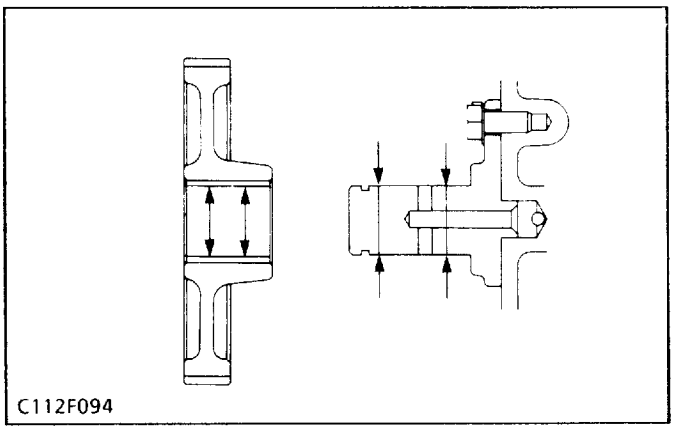
### Oil Clearance of Camshaft Journal

1. Measure the camshaft journal O.D. with an outside micrometer.
2. Measure the cylinder block bore I.D. for camshaft with an inside micrometer. Calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the camshaft.

| | | |
|---|---|---|
| Oil clearance of camshaft journal | Factory spec. | 0.050 to 0.091 mm 0.0020 to 0.0036 in. |
| | Allowable limit | 0.15 mm 0.0059 in. |
| Camshaft journal O.D. | Factory spec. | 39.934 to 39.950 mm 1.5722 to 1.5728 in. |
| Camshaft bearing I.D. | Factory spec. | 40.000 to 40.025 mm 1.5748 to 1.5758 in. |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### Clearance between Idle Gear Shaft and Idle Gear Bushing

1. Measure the idle gear shaft O.D. with an outside micrometer.
2. Measure the idle gear bushing I.D. with an inside micrometer, and calculate the clearance.
3. If the clearance exceeds the allowable limit, replace the bushing.

| | | |
|---|---|---|
| Clearance between idle gear shaft and idle gear bushing | Factory spec. | 0.025 to 0.066 mm 0.0010 to 0.0026 in. |
| | Allowable limit | 0.1 mm 0.0039 in. |

**[V2203-B(E)]**

| | | |
|---|---|---|
| Idle gear bushing I.D. | Factory spec. | 32.000 to 32.025 mm 1.2598 to 1.2608 in. |
| Idle gear shaft O.D. | Factory spec. | 31.959 to 31.975 mm 1.2582 to 1.2589 in. |

**[D1403-B(E), D1703-B(E), V1903-B(E), F2803-B(E)]**

| | | |
|---|---|---|
| Idle gear bushing I.D. | Factory spec. | 38.000 to 38.025 mm 1.4961 to 1.4970 in. |
| Idle gear shaft O.D. | Factory spec. | 37.959 to 37.975 mm 1.4944 to 1.4951 in. |

## Hauteurs de cames d'admission et d'échappement

1. Mesurer la hauteur de la cames à son point le plus haut à l'aide d'un micromètre d'extérieur.
2. Si la mesure est inférieure à la limite de service, remplacer l'arbre à cames.

| | | |
|---|---|---|
| Hauteus de cames d'admission et d'échappement | Valeur de référence | 33,47 mm |
| | Limite de service | 33,42 mm |

## Nockenhöhe am Ein-und Auslaß

1. Mit einem Außenmikrometer die Höhe des Nockens an seinem höchsten Punkt messen.
2. Liegt der Meßwert unter dem zulässigen Grenzwert, die Nockenwelle austauschen.

| | | |
|---|---|---|
| Nockenhöhe am Ein- und Auslaß | Werkdaten | 33,47 mm |
| | Zulässiger Grenzwert | 33,42 mm |

## Jeu de marche de l'arbre à cames

1. Mesurer le diamètre extérieur du tourillon d'arbre à came à l'aide d'un micromètre d'extérieur.
2. Mesurer le diamètre intérieur du bloc-moteur pour l'arbre à came à l'aide d'un micromètre d'intérieur. Calculer le jeu de marche.
3. Si le jeu de marche dépasse la limite de service, remplacer l'arbre à cames.

| | | |
|---|---|---|
| Jeu de marche de l'arbre à cames | Valeur de référence | 0,050 à 0,091 mm |
| | Limite de service | 0,15 mm |
| Diamètre extérieur du tourillon d'arbre à cames | Valeur de référence | 39,934 à 39,950 mm |
| Diamètre intérieur du coussinet d'arbre à cames | Valeur de référence | 40,000 à 40,025 mm |

## Ölspiel der Nockenwelle

1. Mit einem Außenmikrometer den Außendurchmesser des Nockenwellenzapfens messen.
2. Mit einem Innenmikrometer den Innendurchmesser der Zylinderblockbohrungen für die Nockenwelle messen. Ölspiel berechnen.
3. Überschreitet der Ölspiel den zulässigen Grenzwert, die Nockenwelle austauschen.

| | | |
|---|---|---|
| Ölspiel der Nockenwelle | Werkdaten | 0,050 bis 0,091 mm |
| | Zulässiger Grenzwert | 0,15 mm |
| Nockenwellenzapfen Außendurchmesser | Werkdaten | 39,934 bis 39,950 mm |
| Nockenwellenlager Innendurchmesser | Werkdaten | 40,000 bis 40,025 mm |

## Jeu entre l'axe du pignon de renvoi et les bagues du pignon de renvoi

1. Mesurer le diamètre extérieur de l'axe du pignon de renvoi à l'aide d'un micromètre extérieur.
2. Mesurer le diamètre inférieur des bagues des pignons de renvoi avec un micromètre intérieur et calculer le jeu.
3. Si le jeu dépasse la limite de service, remplacer les bagues.

| | | |
|---|---|---|
| Jeu latéral l'axe de pignon de renvoi et bague de pignon de renvoi | Valeur de référence | 0,025 à 0,066 mm |
| | Limite de service | 0,1 mm |

**[V2203-B(E)]**

| | | |
|---|---|---|
| Diamètre intérieur de la bague de pignon de renvoi | Valeur de référence | 32,000 à 32,025 mm |
| Diamètre extérieur de l'axe de pignon de renvoi | Valeur de référence | 31,959 à 31,975 mm |

**[D1403-B(E), D1703-B(E), V1903-B(E), F2803-B(E)]**

| | | |
|---|---|---|
| Diamètre intérieur de la bague de pignon de renvoi | Valeur de référence | 38,000 à 38,025 mm |
| Diamètre extérieur de l'axe de pignon de renvoi | Valeur de référence | 37,959 à 37,975 mm |

## Spiel zwischen Leerlaufachse und Leerlaufbuchse

1. Den Außendurchmesser der Leerlaufachse mit Hilfe eines Außenmikrometers messen.
2. Den Innendurchmesser der Leerlaufbuchsen mit Hilfe eines Innenmikrometers messen und das Spiel berechnen.
3. Wenn das Spiel den zulässigen Grenzwert überschreitet, die Buchse austauschen.

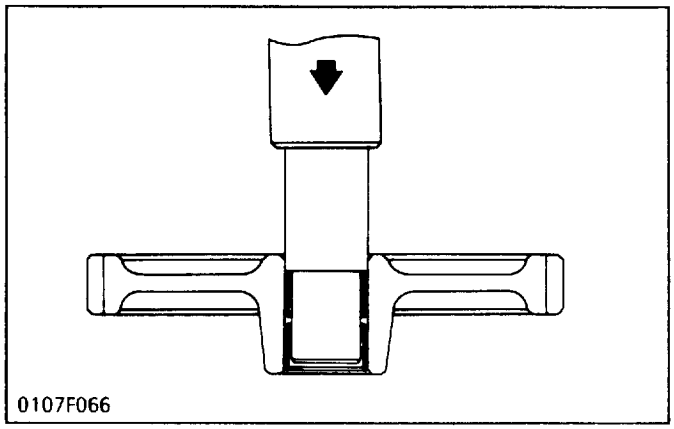
| | | |
|---|---|---|
| Spiel zwischen Leerlaufachse und Leerlaufbuchse | Werkdaten | 0,025 bis 0,066 mm |
| | Zulässiger Grenzwert | 0,1 mm |

**[V2203-B(E)]**

| | | |
|---|---|---|
| Leerlaufbuchse Innendurchmesser | Werkdaten | 32,000 bis 32,025 mm |
| Leerlaufachse Außendurchmesser | Werkdaten | 31,959 bis 31,975 mm |

**[D1403-B(E), D1703-B(E), V1903-B(E), F2803-B(E)]**

| | | |
|---|---|---|
| Leerlaufbuchse Innendurchmesser | Werkdaten | 38,000 bis 38,025 mm |
| Leerlaufachse Außendurchmesser | Werkdaten | 37,959 bis 37,975 mm |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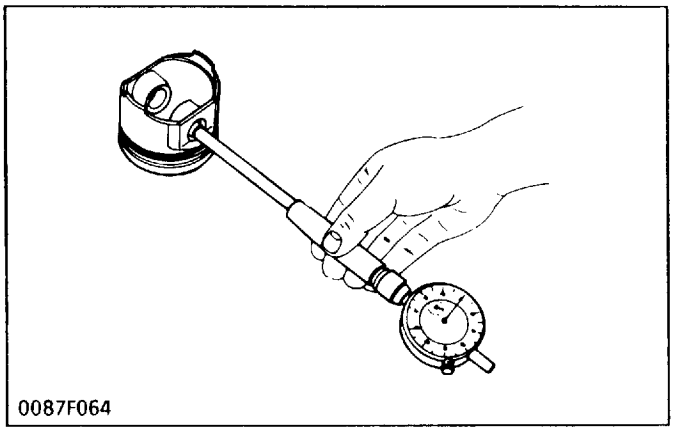
### Replacing Idle Gear Bushing

1. Press the used bushing out using a idle gear bushing replacing tool.
2. Press fit new bushing.

## [3] PISTON AND CONNECTING ROD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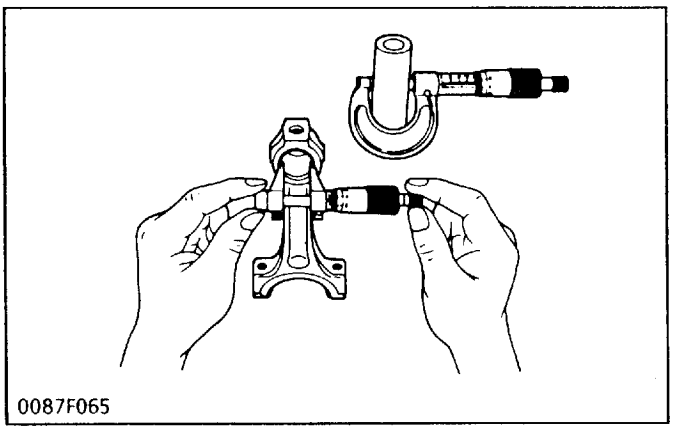
### Piston Pin-Bore I.D.

1. Measure the I.D. of the piston pin-bore in both the horizontal and vertical directions with a cylinder gauge.
2. If the measurement exceeds the allowable limit, replace the piston.

| | | |
|---|---|---|
| Piston pin bore I.D. | Factory spec. | 25.000 to 25.013 mm<br>0.9843 to 0.9848 in. |
| | Allowable limit | 25.05 mm<br>0.9862 in. |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### Oil Clearance between Piston Pin and Small End Bushing

1. Measure the O.D. of the piston pin where it contacts the bushing with an outside micrometer.
2. Measure the I.D. of the piston pin bushing at the connecting rod small end with a cylinder gauge. Calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the bushing. If it still exceeds the allowable limit, replace the piston pin.

| | | |
|---|---|---|
| Oil clearance between piston pin and small end bushing | Factory spec. | 0.014 to 0.038 mm<br>0.0006 to 0.0015 in. |
| | Allowable limit | 0.15 mm<br>0.0059 in. |
| Piston pin O.D. | Factory spec. | 25.002 to 25.011 mm<br>0.9843 to 0.9847 in. |
| Small end bushing I.D. | Factory spec. | 25.025 to 25.040 mm<br>0.9852 to 0.9858 in. |

### Remplacement des bagues de pignon de renvoi

1. A la presse, chasser les bagues anciennes en utilisant l'outil de remplacement de coussinets de pignon de renvoi.
2. A la presse, monter les bagues neuves.

### Austausch der Leerlaufbuchsen

1. Die alten Buchsen mit Hilfe eines für den Austausch der Leerlaufbuchsen vorgesehenen Werkzeuges herausdrücken.
2. Die neuen Buchsen einsetzen.

## [3] PISTON ET BIELLE

### D.I. de logement d'axe de piston

1. Mesurer le diamètre intérieur de logement d'axe de piston dans les sens vertical et horizontal à l'aide d'un comparateur.
2. Si la mesure excède la limite de service, remplace le piston.

| | | |
|---|---|---|
| Diamètre intérieur du alésage d'axe de piston | Valeur de référence | 25,000 à 25,013 mm |
| | Limite de service | 25,05 mm |

### Jeu entre l'axe de piston et le coussinet de pied de bielle

1. Mesurer le diamètre extérieur de l'axe de piston au niveau où celui-ci vient en contact avec la bague de pied de bielle au moyen d'un micromètre d'extérieur.
2. Mesurer le diamètre intérieur de la bague de pied de bielle à l'aide d'un comparateur. Calculer le jeu de marche.
3. Si le jeu excède la limite de service, remplacer la bague. Si le jeu est encore supérieur à la limite de service, remplacer l'axe de piston.

| | | |
|---|---|---|
| Jeu entre l'axe de piston et le coussinet de pied de bielle | Valeur de référence | 0,014 à 0,038 mm |
| | Limite de service | 0,15 mm |
| Diamètre extérieur de l'axe de piston | Valeur de référence | 25,002 à 25,011 mm |
| Diamètre intérieur du coussinet de pied de bielle | Valeur de référence | 25,025 à 25,040mm |

## [3] KOLBEN UND PLEUELSTANGE

### Innendurchmesser der Kolbenbolzenbohrung

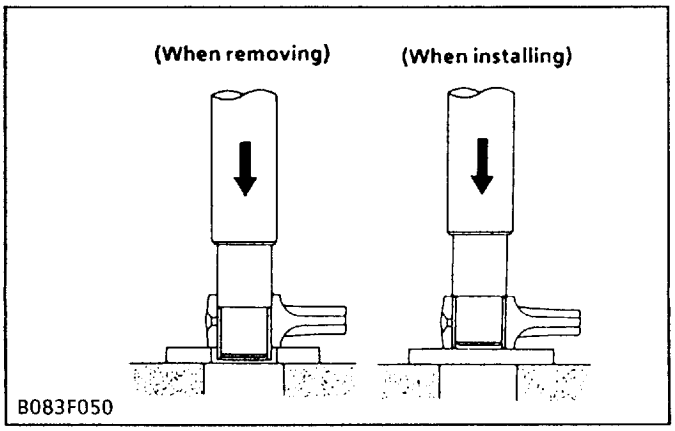
1. Mit einem Lehrdorn den Innen der Kolbenbolzenbohrung in horizontaler wie auch vertikaler Richtung messen.
2. Überschreitet die Messung den zulässigen Grenzwert, den Kolben austauschen.

| | | |
|---|---|---|
| Innendurchmesser des Kolbenbolzen-bohlach | Werkdaten | 25,000 bis 25,013 mm |
| | Zulässiger Grenzwert | 25,05 mm |

### Ölspiel zwischen Kolbenbolzen und Buchse

1. Mit einem Außenmikrometer den Außendurchmesser des Kolbenbolzens an der Stelle messen, wo er die Buchse berührt.
2. Mit einem Lehrdorn den Innendurchmesser der Kolbenbolzenbuchse am Pleuelstangenkopf messen. Den Ölspiel berechnen.
3. Überschreitet der Spiel den zulässigen Grenzwert, die Buchse auswechseln. Wird der zulässige Grenzwert noch immer überschritten, den Kolbenbolzen auswechseln.

| | | |
|---|---|---|
| Spielzwischen Kolbenbolzen und Pleuelbuchse | Werkdaten | 0,014 bis 0,038 mm |
| | Zulässiger Grenzwert | 0,15 mm |
| Kolbenbolzen Außendurchmesser | Werkdaten | 25,002 bis 25,011 mm |
| Pleuelbuchse Innendurchmesser | Werkdaten | 25,025 bis 25,040 mm |



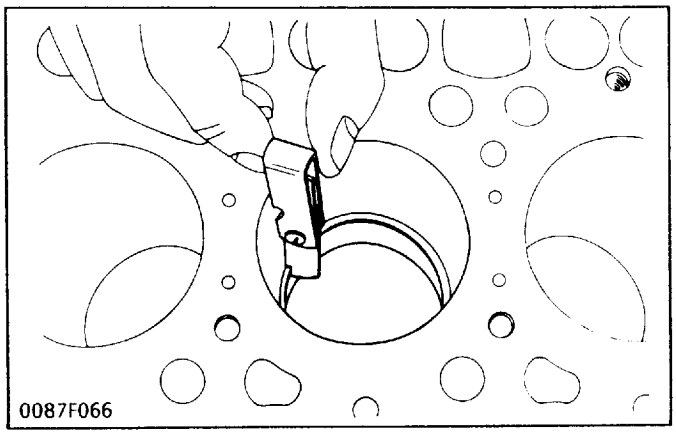

## Replacing Connecting Rod Small End Bushing

**(When removing)**

1. Press out the small end bushing with a connecting rod small end bushing replacing tool.

**(When installing)**

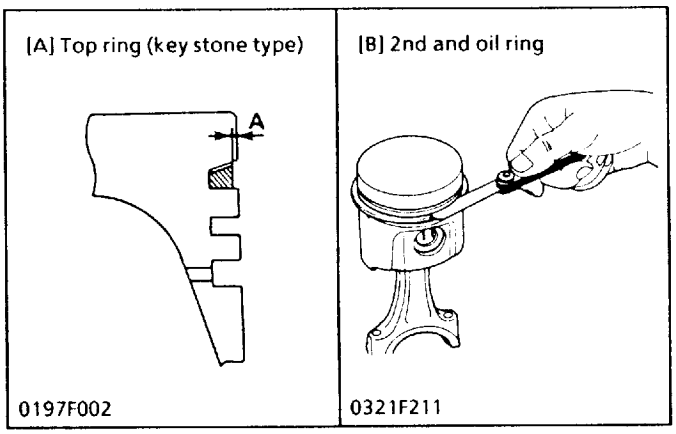
1. Clean a new small end bushing and bore, and apply engine oil to them.
2. Press fit a new bushing, taking due care to see that the connecting rod hole matches the bushing hole.




## Piston Ring Gap

1. Insert the piston ring into the lower part of the liner (the least worn out part) with the piston.
2. Measure the ring gap with a feeler gauge.
3. If the gap exceeds the allowable limit, replace the ring.

| | | |
|---|---|---|
| Compression ring 1, 2 | Factory spec. | 0.30 to 0.45 mm<br>0.0118 to 0.0177 in. |
| | Allowable limit | 1.25 mm<br>0.0492 in. |
| Oil ring | Factory spec. | 0.25 to 0.45 mm<br>0.0098 to 0.0177 in. |
| | Allowable limit | 1.25 mm<br>0.0492 in. |




## Clearance between Piston Ring and Groove

1. Remove carbon from the ring grooves.
2. Measure the clearance between the ring and the groove with a feeler gauge or depth gauge.
3. If the clearance exceeds allowable limit, replace the ring since compression leak and oil shortage result.
4. If the clearance still exceeds the allowable limit after replacing the ring, replace the piston.

| | | |
|---|---|---|
| Factory spec. | 2nd ring | 0.093 to 0.12 mm<br>0.0037 top 0.0047 in. |
| | Oil ring | 0.020 to 0.052 mm<br>0.00079 to 0.0020 in. |
| Allowable limit [B] | 2nd ring | 0.2 mm<br>0.0079 in. |
| | Oil ring | 0.15 mm<br>0.0059 in. |
| Factory specification: A | | More than 0.2 mm<br>0.079 in. |

## Remplacement de la bague de pied de bielle

**(Au retrait)**
1. Pousser dehors la bague de pied de bielle à l'aide d'un outil de remplacement de bague de pied de bielle.

**(Lors de la repose)**
1. Nettoyer une bague neuve de pied de bielle et l'alésage, et les enduire d'huile moteur.
2. A la presse, monter un coussinet neuf, en veillant à ce que le trou de la bielle corresponde bien au trou du coussinet.

## Austausch der Pleuelbuchse

**(Beim Ausbau)**
1. Die Pleuelbuchse mit einem Pleuelbuchsen-Ausbauwerkzeug heraustreiben.

**(Beim Einbau)**
1. Die neue Pleuelbuchse und -Bohrung reinigen und mit Motoröl beschichten.
2. Eine neue Buchse einsetzen. Hierbei darauf achten, daß die Öffnung der Pleuelstange mit der Buchsenöffnung übereinstimmt.

## Jeu de coupe segment de piston

1. Introduire le segment de piston dans la partie inférieure de la chemise (partie le moins usée) avec le piston.
2. Mesurer le jeu du segment avec une jauge d'épaisseur.
3. Si le jeu dépasse la limite de service, remplacer le segment.

| | | |
|---|---|---|
| Segment 1, 2 de compression | Valeur de référence | 0,30 à 0,45 mm |
| | Limite de service | 1,25 mm |
| Segment racleur | Valeur de référence | 0,25 à 0,45 mm |
| | Limite de service | 1,25 mm |

## Kolbenringspalt

1. Mit dem Kolben den Kolbenring in den unteren (am wenigsten abgenutzten) Teil der Laufbüchse eintreiben.
2. Den Ringsplat mit Hilfe einer Fühlerlehremessen.
3. Überschreitet der splat den zulässigen Grenzwert, den Kolbenring austauschen.

| | | |
|---|---|---|
| Verdichterring 1, 2 | Werkdaten | 0,30 bis 0,45 mm |
| | Zulässiger Grenzwert | 1,25 mm |
| Ölabstreifrin | Werkdaten | 0,25 bis 0,45 mm |
| | Zulässiger Grenzwert | 1,25 mm |

## Jeu entre le segment et la rainure de segment

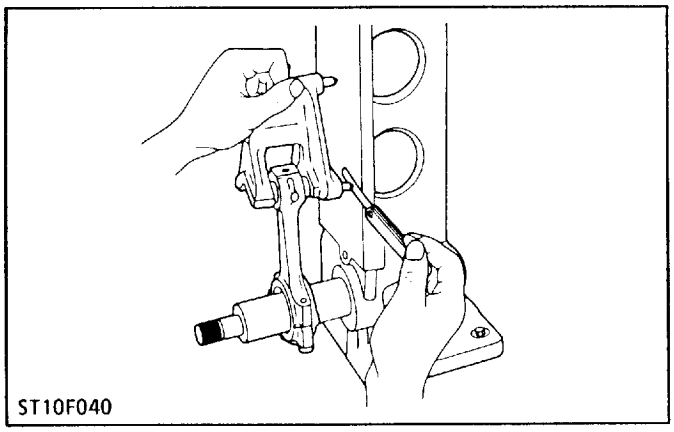
1. Eliminer la calamine des gorges de segment.
2. Mesurer la jeu entre le segment et la gorge à l'aide d'une jauge d'épaisseur ou d'un calibre de profondeur.
3. Si le jeu excède la limite de service, remplacer le segment pour éviter la fuite de compression et le manque d'huile en résultant.
4. Si le jeu reste toujours supérieur à la limite de service même après remplacement du segment, remplacer le piston.

| | | |
|---|---|---|
| Valeur de référence | Segment 2 de compression | 0,093 à 0,12 mm |
| | Segment racleur | 0,020 à 0,052 mm |
| Limite de service [B] | Segment 2 de compression | 0,2 mm |
| | Segment racleur | 0,15 mm |
| Valeur de référence: A | | Plus de 0,2 mm |

## Spiel zwischen Kolbenring und Ringnut

1. Ölkohlenablagerungen aus den Ringnuten.
2. Das Spiel zwischen Ring und Nut mit einer Fühlerlehre bzw. einem Tiefenmaß messen.
3. Überschreitet das Spiel den zulässigen Grenzwert den Ring auswechseln, da sonst eine Kompressionsleckage und ein Ölverlust erfolgen könnte.
4. Überschreitet nach der Auswechslung der Ringes das Spiel noch immer den zulässigen Grenzwert den Kolben auswechseln.

| | | |
|---|---|---|
| Werkdaten | Verdichter-ring 2 | 0,093 bis 0,12 mm |
| | Ölabstreifrin | 0,020 bis 0,052 mm |
| Zulässiger Grenzwert [B] | Verdichter-ring 2 | 0,2 mm |
| | Ölabstreifrin | 0,15 mm |
| Werksvorschrift: A | | Mehr als 0,2 mm |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### Connecting Rod Alignment

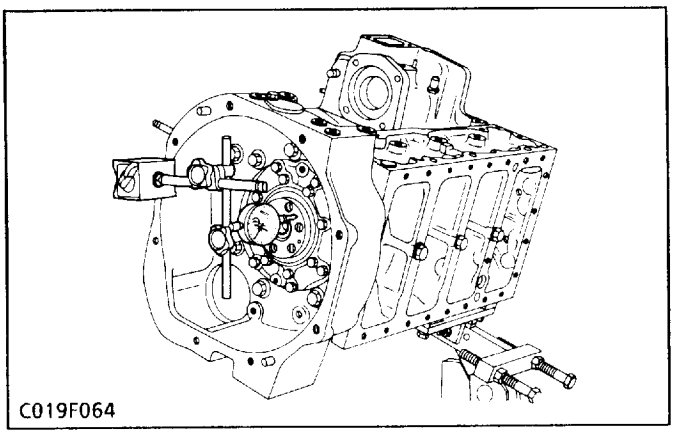
■ **NOTE**

- **Since the I.D. of the connecting rod small end bushing is the basis of this check, check the bushing for wear beforehand.**

1. Install the piston pin into the connecting rod.
2. Install the connecting rod on the connecting rod alignment tool.
3. Put a gauge over the piston pin and move it against the face plate.
4. If the gauge does not fit squarely against the face plate, measure the space between the pin of the gauge and the face plate.
5. If the measurement exceeds the allowable limit, replace the connecting rod.

| | | |
|---|---|---|
| Connecting rod alignment | Allowable limit | 0.05 mm 0.0020 in. |

## [4] CRANKSHAFT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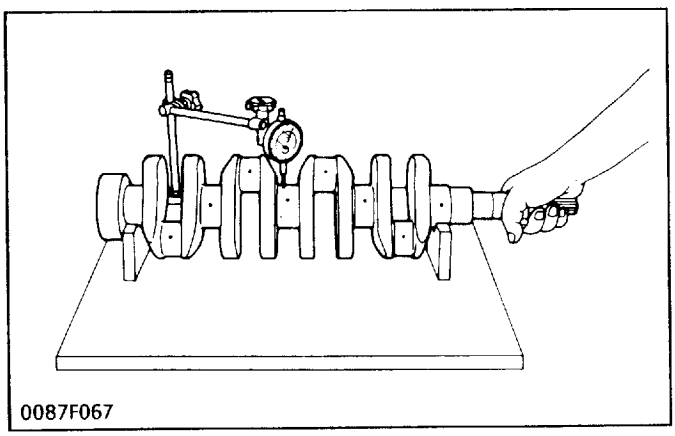
### Side Clearance of Crankshaft

1. Move the crankshaft to the flywheel side.
2. Set a dial indicator to the crankshaft.
3. Measure the end play by pulling the crankshaft toward the crank gear.
4. If the measurement exceeds the allowable limit, replace the thrust bearing 1 and 2.

| | | |
|---|---|---|
| Crankshaft side clearance | Factory spec. | 0.15 to 0.31 mm 0.0059 to 0.0122 in. |
| | Allowable limit | 0.5 mm 0.0197 in. |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### Crankshaft Alignment

1. Support the crankshaft with V-blocks on the surface plate and set a dial indicator with its tip on the intermediate journal at right angle.
2. Rotate the crankshaft on the V-blocks and get the misalignment (half of the measurement).
3. If the misalignment exceeds the allowable limit, replace the crankshaft.

| | | |
|---|---|---|
| Crankshaft Alignment | Allowable limit | 0.02 mm 0.00079 in. |

### Alignement de bielle

■ **NOTA**

- **Etant donné le diamètre intérieur de la bague de pied de bielle est la base de cette vérifcation, vérifier d'avance si la bague est usée.**

1. Mettre l'axe de piston en place dans la bielle.
2. Poser la bielle à l'aide de l'outil d'alignement de bielle.
3. Disposer un calibre sur l'axe de piston et le déplacer sur la paroi.
4. Si le calibre ne peut être disposé à angle droit sur la paroi, mesurer l'espace entre l'axe du calibre et la paroi.
5. Si la mesure excède la limite de service, remplacer la bielle.

| | | |
|---|---|---|
| Alignement de bielle | Limite de service | 0,05 mm |

## [4] VILEBREQUIN

### Jeu latéral de vilebrequin

1. Pousser le vilebrequin vers le volant.
2. Fixer un comparateur à cadran sur le vilebrequin.
3. Mesurer le jeu latéral de vilebrequin en poussant le vilebrequin vers son pignon.
4. Si la mesure excède la limite de service, remplacer la demi-coussinet de butée 1 et 2.

| | | |
|---|---|---|
| Jeu latéral de vilebrequin | Valeur de référence | 0,15 à 0,31 mm |
| | Limite de service | 0,5 mm |

### Alignement du vilebrequin

1. Supporter le vilebrequin avec des blocs trapézoïdaux sur le plateau de dressage et mettre un comparateur à cadran de telle façon que son extrémité soit perpendiculaire au tourillon intermédiaire.
2. Tourner le vilebrequin sur les blocs trapézoïdaux et obtenir le désalignement (moitié de la valeur mesurée).
3. Si le désalignement excède la limite de serviice, remplacer le vilebrequin.

| | | |
|---|---|---|
| Alignement du vilebrequin | Limite de service | 0,02 mm |

### Pleuelstangenausrichtung

■ **ANMERKUNG**

- **Da diese Kontrolle auf den Innendurchmesser der Pleuelstangenkopfbuchse basiert, die Buchse vorher auf Verschleiß überprüfen.**

1. Kolbenbolzen in die Pleuelstange einsetzen.
2. Die Pleuelstange an der Pleuelstangen-Krümmungsmeßlehre anbringen.
3. Die Lehre über den Kolbenbolzen schieben und diesen gegen die Lehrenplatte bewegen.
4. Falls die Lehre nicht flach auf der Lehrenplatte aufliegt, den Abstand zwischen Stift der Lehre und der Lehrenplatte messen.
5. Überschreitet die Messung den zulässigen Grenzwert, die pleuelstange austauchen.

| | | |
|---|---|---|
| Pleuelstange-nausrichtung | Zulässiger Grenzwert | 0,05 mm |

## [4] KURBELWELLE

### Axialspiel der Kurbelwelle

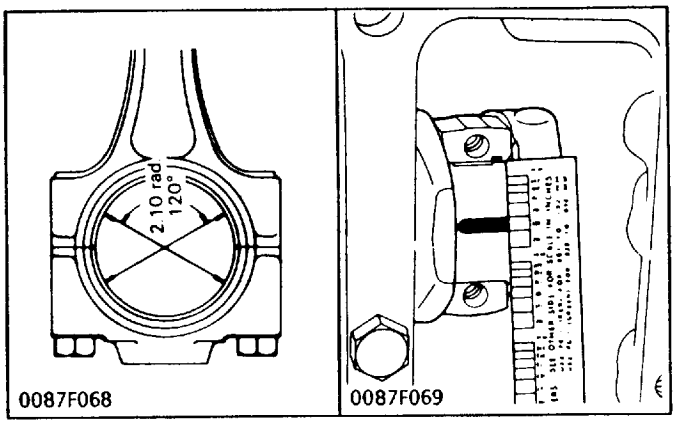
1. Die Kurbelwelle in Richtung Schwungrad ziehen.
2. Ein Meßuhr an der Kurbelwelle anbringen.
3. Das Axialspiel durch Schieben der Kurbelwelle in Richtung des Kurbelwellenrades messen.
4. Überschreitet die Messung den Zulässigen Grenzwert, die Drucklager 1 und 2 austauschen.

| | | |
|---|---|---|
| Axialspiel der Kurbelwelle | Werkdaten | 0,15 bis 0,31 mm |
| | Zulässiger Grenzwert | 0,5 mm |

### Kurbelwellenausrichtung

1. Die Kurbelwelle mit V-Blöcken auf der Richtplatte abstützen und eine Meßuhr mit der Spitze lotrecht auf den Zwischenzapfen ansetzen.
2. Die Kurbelwelle auf den V-Blöcken drehen, um eine (Hälfte des Messungswertes) zu erhalten.
3. Überschreitet die Versetzung den zulässigen Grenzwert, die Kurbelwelle auswechseln.

| | | |
|---|---|---|
| Kurbelwellenau-srichtung | Zulässiger Grenzwert | 0,02 mm |



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## Oil Clearance between Crank Pin and Crank Pin Bearing

1. Clean the crank pin and crank pin bearing.
2. Put a strip of plastigage (Code No: 07909-30241) on the center of the crank pin in each direction as shown in the figure.

■ **IMPORTANT**
- **Never insert the press gauge into the crank pin oil hole.**

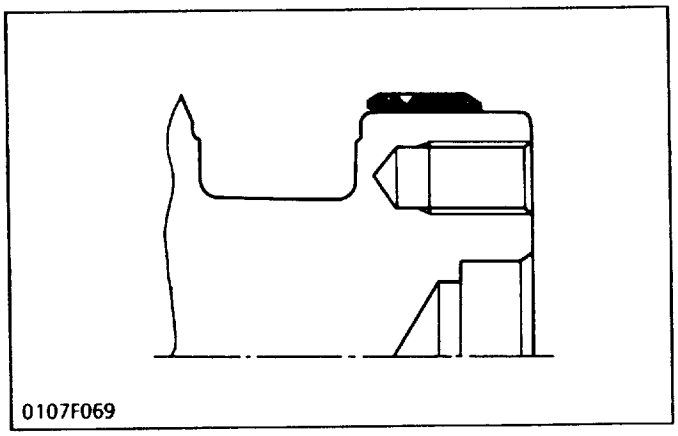
3. Install the connecting rod cap and tighten the screws to the specified torque, and remove the cap again.

■ **NOTE**
- **Fasten the crankshaft so that it does not turn.**

4. Measure the amount of the flattening with the scale and get the oil clearance.
5. If the clearance exceeds the allowable limit, replace the bearing.

**(Reference)**
- When the oil clearance is to be measured by removing the crankshaft, tighten the connecting rod cap with the specified torque, then measure the crank pin bearing I.D. with a cylinder gauge or an inside micrometer. And measure the crank pin O.D. with an outside micrometer. Calculate the oil clearance.

| | | |
|---|---|---|
| Oil clearance between crank pin and crank pin bearing | Factory spec. | 0.025 to 0.087 mm<br>0.0009 to 0.0034 in. |
| | Allowable limit | 0.2 mm<br>0.0079 in. |
| Crank pin O.D. | Factory spec. | 46.959 to 46.975 mm<br>1.8488 to 1.8494 in. |
| Crank pin bearing I.D. | Factory spec. | 47.000 to 47.046 mm<br>1.8504 to 1.8522 in. |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## Crankshaft Sleeve Wear

1. Check the wear on the crankshaft sleeve.
2. If the wear exceeds the allowable limit or when the engine oil leaks, replace the crankshaft sleeve.

| | | |
|---|---|---|
| Wear of sleeve | Allowable limit | 0.1 mm<br>0.004 in. |

## Jeu de marche entre le maneton et le coussinet de tête de bielle

1. Nettoyer le maneton et le coussinet de tête de bielle.
2. Disposer une jauge plastique (Référence: 07909-30241) au centre du maneton daus chaque direction montrée sur la figure.

■ **IMPORTANT**
- **Ne pas introduire la jauge plastique dans le trou de lubrification du maneton.**

3. Poser le chapeau de bielle et serrer les vis au couple spécifié puis retirer le chapeau de bielle.

■ **NOTA**
- **Immobiliser le vilebrequin pour l'empêcher de tourner.**

4. Mesurer l'aplatissement à l'aide d'une échelle et en déduire le jeu de marche.
5. Si le jeu excède la limite de service, remplacer le coussinet de tête de bielle.

**(Référence)**
- Lorsque le jeu de marche doit être mesuré en déposant le vilebrequin, serrer le chapeau de tête de bielle à un couple spécifié, ensuite mesurer le diamètre intérieur du coussinet de tête de bielle à l'aide d'un comparateur ou d'un micromètre d'intérieur. Et, mesurer le diamètre extérieur du maneton à l'aide d'un micromètre d'extérieur. Calculer le jeu de marche.

| | | |
|---|---|---|
| Jeu de lubrification entre le maneton et le coussinet de tête de bielle | Valeur de référence | 0,025 à 0,087 mm |
| | Limite de service | 0,2 mm |
| Diamètre extérieur de maneton | Valeur de référence | 46,959 à 46,975 mm |
| Diamètre intérieur du coussinet de tête de bielle | Valeur de référence | 47,000 à 47,046 mm |

## Usure de la coupelle de vilebrequin

1. Vérifier l'usure du manchon de vilebrequin.
2. Si l'usure dépasse la limite de service ou le moteur fuit, remplacer le manchon de vilebrequin.

| | | |
|---|---|---|
| Usure de manchon | Limite de service | 0,1 mm |

## Ölspiel zwischen Kurbelzapfen und Pleuellagerschale

1. Den Kurbelzapfen und das Pleuellagerschale reinigen.
2. Einen Streifen der Preßmeßgerät (CodeNr. 07909-30241) auf die Mitte des Kurbelzapfens in alle Richtungen legen.

■ **WICHTIG**
- **Das Preßmeßgerät nicht in die Ölöffnung des Kurbelzapfens einsetzen.**

3. Die Pleuelstangendeckel anbringen und die Schrauben mit dem vorgeschriebenen Drehmoment anziehen und dann den Pleuelstangendeckel wieder abschrauben.

■ **ANMERKUNG**
- **Die Kurbelwelle so befestigen, daß sie nicht drehen kann.**

4. Die Stärke der Preßmeßgerät messen und den Ölspiel errechnen.
5. Überschreitet der Ölspiel den zulässigen Grenzwert, die Pleuellagerschale austauschen.

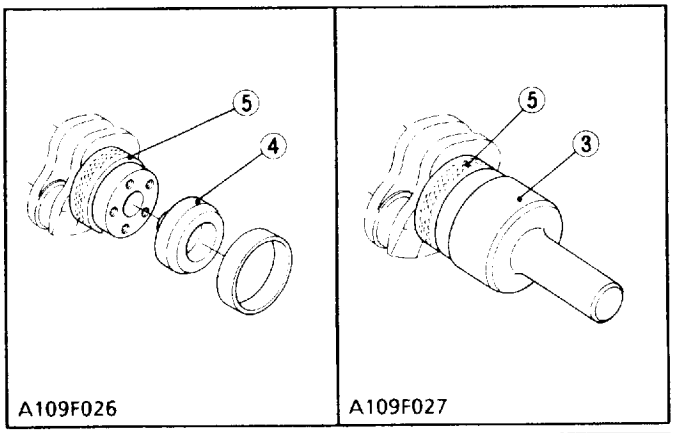
**(Referenz)**
- Ist der Ölspiel durch den Ausbau der Kurbelwelle zu messen, den Pleuelstangendeckel auf das vorgeschriebenen Drehmoment anziehen und dann mit einem Lehrdorn oder einem Innenmikrometer den Innendurchmesser der Pleuellagerschale messen. Mit einem Außenmikrometer den Außendurchmesser der Kurbelzapfen messen. Den Ölspiel berechnen.

| | | |
|---|---|---|
| Ölspiel zwischen Kurbelzapfen und Pleuellagerschale | Werkdaten | 0,025 bis 0,087 mm |
| | Zulässiger Grenzwert | 0,2 mm |
| Karbelzapfen Außendurchmesser | Werkdaten | 46,959 bis 46,975 mm |
| Pleuellagerschale Innendurchmesser | Werkdaten | 47,000 bis 47,046 mm |

## Abnutzung der Kurbelwellenbuchse

1. Prüfen Sie den Verschleiß der Kurbelwellenlaufbuchse.
2. Ist der Verschleiß größer als die zulässige Grenze, oder wenn die Maschine Öl leckt, ersetzen Sie die Wellenlaufbuchse.

| | | |
|---|---|---|
| Verschleiß der Laufbuchse | Zulässiger Grenzwert | 0,1 mm |



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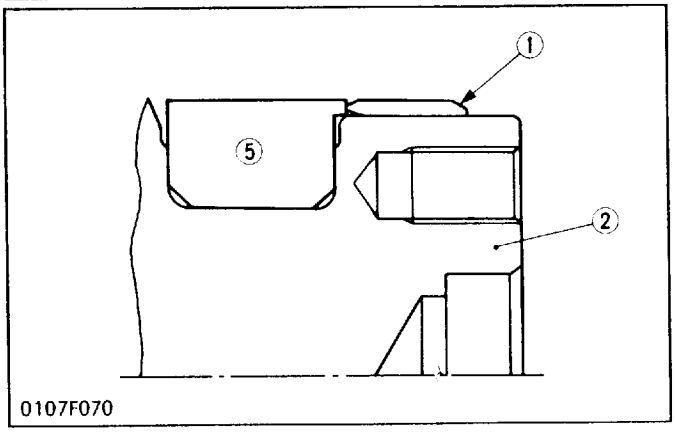

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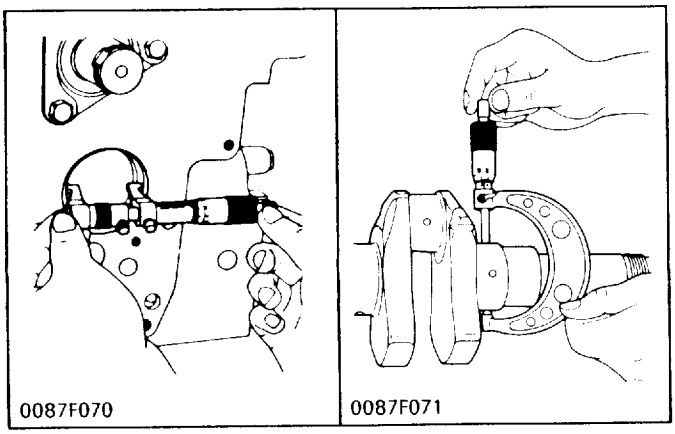
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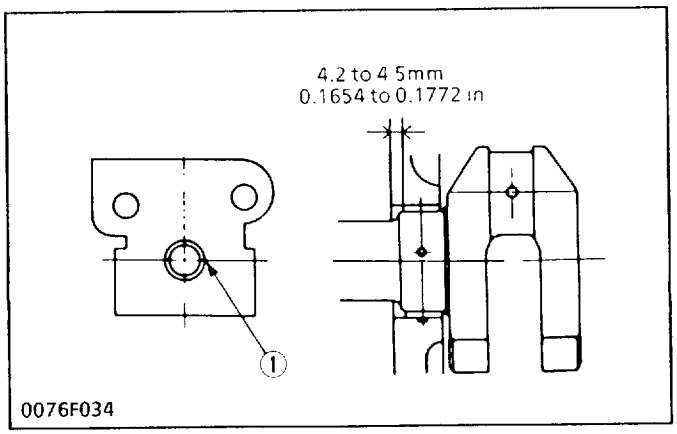

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## Replacing Crankshaft Sleeve

1. Remove the used crankshaft sleeve using a special-use puller set (Code No:07916-32091).
2. Set the sleeve guide (4) to the crankshaft.
3. Set the stopper (5) to the crankshaft as shown in figure.
4. Heat a new sleeve to a temperature between 150 and 200°C (302 and 392°F), and fix the sleeve to the crankshaft as shown in figure.
5. Press fit the sleeve using the auxiliary socket for pushing (3).

■ **NOTE**

- **Mount the sleeve with its largely chamfered surface facing outward.**

(1) Crankshaft Sleeve
(2) Crankshaft
(3) Auxiliary Socket for Pushing
(4) Sleeve Guide
(5) Stopper

## Oil Clearance between Crankshaft Journal and Crankshaft Bearing 1

1. Measure the O.D. of the crankshaft journal with an outside micrometer.
2. Measure the I.D. of the crankshaft bearing 1 with an inside micrometer. Calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the crankshaft bearing 1.

| | | |
|---|---|---|
| Oil clearance between crankshaft journal and crankshaft bearing 1 | Factory spec. | 0.04 to 0.118 mm<br>0.0016 to 0.0046 in. |
| | Allowable limit | 0.2 mm<br>0.0079 in. |
| Crankshaft journal 1 O.D. | Factory spec. | 51.921 to 51.940 mm<br>2.0441 to 2.0449 in. |
| Crankshaft bearing 1 I.D. | Factory spec. | 51.980 to 52.039 mm<br>2.0466 to 2.0488 in. |

## Replacing Crankshaft Bearing 1

**(When removing)**

1. Press out the bearing 1 with crankshaft bearing 1 replacing tool.

**(When installing)**

1. Clean a new bearing 1 and bore, and apply engine oil to them.
2. Press fit a new bearing 1 using a inserting tool, taking due care to see that the seam of bearing 1 faces the exhaust manifold side.

(1) Seam

## Remplacement de la coupelle de vilebrequin

1. Enlever la coupelle de vilebrequin usé à l'aide du jeu d'extraction spécial (Référence 07916-32091).
2. Placer le guide de coupelle (4) sur le vilebrequin.
3. Mettre la butée (5) sur le vilebrequin, comme indiqué dans la figure.
4. Chauffer une coupelle neuve à une température comprise entre 150 et 200°C puis fixer la coupelle sur le vilebrequin, comme indiqué dans la figure.
5. Ajuster à la presse la coupelle en utilisant la prise lumière pour le repousser (3).

**■ NOTA**

- **Monter le manchon avec sa surface largement chanfreinée orientée vers le haut.**

(1) Coupelle de vilebrequin
(2) Vilebrequin
(3) Prise de lumière
(4) Guide de coupelle
(5) Butée

## Austausch der Kurbelwellenbuchse

1. Die alte Kurbelwellenbuchse mit Hilfe einer speziellen Abziehvorrichtung (Code Nr. 07916-32091) entfernen.
2. Die Buchsenführung (4) an die Kurbelwelle ansetzen.
3. Den Begrenzer (5) an die Kurbelwelle ansetzen, wie in der Abbildung gezeigt.
4. Eine neue Buchse bei einer Temperatur zwischen 150 und 200°C erhitzen und, wie in der Abbildung gezeigt, an der Kurbelwelle einsetzen.
5. Die Buchse mit Hilfe der Hilfsmuffe (3) einpressen.

**■ ANMERKUNG**

- **Die Hülse so montieren, daß die Seite mit der größeren Abschrägung nach außen zeigt.**

(1) Kurbelwellenbuchse
(2) Kurbelwelle
(3) Hilfsmuffe für den Einsatz
(4) Buchsenführung
(5) Begrenzer

## Jeu de marche entre le tourillon de vilebrequin et coussinet 1 de vilebrequin

1. Mesurer le diamètre extérieur du tourillon de vilebrequin avec un micromètre extérieur.
2. Mesurer le diamètre intérieur du coussinet 1 du vilebrequin avec un micromètre intérieur. Calculer le jeu de marche.
3. Si ce jeu de marche dépasse la limite de service, remplacer le coussinet 1 de vilebrequin.

| | | |
|---|---|---|
| Jeu de lubrification entre le vilebrequin et le coussinet 1 de vilebrequin | Valeur de référence | 0,04 à 0,118 mm |
| | Limite de service | 0,2 mm |
| Diamètre extérieur du vilebrequin | Valeur de référence | 51,921 à 51,940 mm |
| Diamètre intérieur du coussinet 1 du vilebrequin | Valeur de référence | 51,980 à 52,039 mm |

## Remplacement du coussinet 1 du vilebrequin

**(Au retrait)**

1. Chasser le coussinet 1 de vilebrequin au moyen de l'outil de remplacement de coussinet 1 de vilebrequin.

**(Lors de la repose)**

1. Nettoyer un coussinet 1 neuf et alésage et les enduire d'huile moteur.
2. Monter à la presse un coussinet 1 neuf en utilisant un outil de mise en place, en veillant à ce que la jointure du coussinet 1 soit en regard du côté du collecteur d'échappement.

(1) Jointure

## Ölspiel Zwischen Kurebelwelle und Kurebelwellenlager 1

1. Den Außendurchmesser der Kurbelwelle mit einem Außenmikrometer messen.
2. Den Innendurchmesser des Kurbelwellenlagers 1 mit einem Innenmikrometer messen und das Ölspiel berechnen.
3. Überschreitet der Ölspiel den zulässigen Grenzwert, die Kurebelwellenlager 1.

| | | |
|---|---|---|
| Ölspiel zwischen Kurbelwelle und Kurbelwellenlager 1 | Werkdaten | 0,04 bis 0,118 mm |
| | Zulässiger Grenzwert | 0,2 mm |
| Kurbelwelle Außendurchmesser | Werkdaten | 51,921 bis 51,940 mm |
| Kurbelwellenlager 1 Innendurchmesser | Werkdaten | 51,980 bis 52,039 mm |

## Austausch des Kurbelwellenlager 1

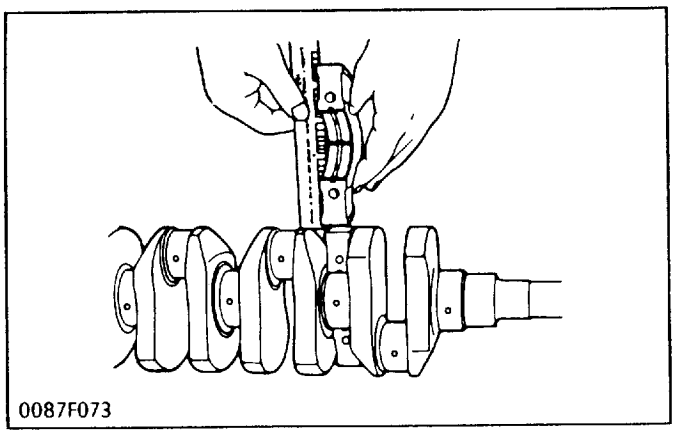
**(Beim Ausbau)**

1. Das lager 1 mit den werkzeug für den Austausch des Kurbelwellenlager herausdrücken.

**(Beim Einbau)**

1. Das neue Lager 1 und die Bohrung reinigen und Öl auf sie auftragen.
2. Ein neues Lager 1 mit Hilfe eines Einsatzwerkzeuges einpassen. Hierbei darauf achten, daß die Naht des Lagers 1 der Auspuffkrümmerseite gegenüberliegt.

(1) Naht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## Oil Clearance between Crankshaft Journal and Crankshaft Bearing 2

1. Clean the crankshaft journal and crankshaft bearing.
2. Put a strip of plastigage (Code No: 07909-30241) on the center of the journal.

**■ IMPORTANT**

- **Never insert the plastigage into the oil hole of the journal.**

3. Install the main bearing case and tighten the screws to the specified torque, and remove the cases again.
4. Measure the amount of the flattening with the scale and get the oil clearance.
5. If the clearance exceeds the allowable limit, replace the crankshaft bearing.

| | | |
|---|---|---|
| Oil clearance between crankshaft and crankshaft bearing 2 | Factory spec. | 0.04 to 0.104 mm<br>0.0016 to 0.0041 in. |
| | Allowable limit | 0.2 mm<br>0.0079 in. |

| | | |
|---|---|---|
| Crankshaft O.D. | Factory spec. | 51.921 to 51.940 mm<br>2.0441 to 2.0449 in. |
| Crankshaft bearing 2 I.D. | Factory spec. | 51.980 to 52.025 mm<br>2.0466 to 2.0482 in. |

## Jeu de marche entre le tourillon de vilebrequin et coussinet 2 de vilebrequin

1. Nettoyer le tourillon de vilebrequin et coussinet de vilebrequin.
2. Disposer une jauge plastique (Référence: 07909-30241) au centre de tourillon de vilebrequin.

**■ IMPORTANT**

- **Ne pas introduire la jauge plastique dans le trou de lubrification de tourillon.**

3. Poser le palier principal et serrer les vis au couple spécifié puis retirer le palier principal.
4. Mesurer l'aplatissement à l'aid d'une échelle et en déduire le jeu de marche.
5. Si le jeu excède la limite de service, remplace le coussinet.

| | | |
|---|---|---|
| Oil clearance between crankshaft and crankshaft bearing 2 | Valeur de référence | 0,04 à 0,104 mm |
| | Limite de service | 0,2 mm |
| Diamètre extérieur du vilebrequin | Valeur de référence | 51,921 à 51,940 mm |
| Diamètre intérieur du coussinet 2 du vilebrquin | Valeur de référence | 51,980 à 52,025 mm |

## Ölspiel zwischen Kurebelwelle und Kurebelwellenlager 2

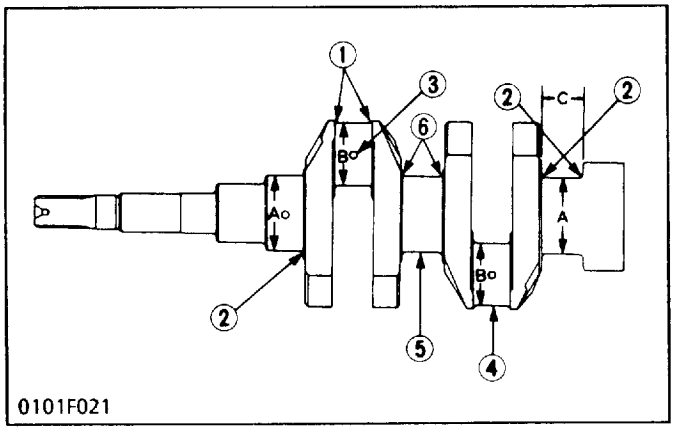
1. Den Kurebelwelle und das Kurebelwellenlager reinigen.
2. Einen Streifen der Preßmeßgerät (CodeNr. 07909-30241) auf die Mitte des Kurebelwelle legen.

**■ WICHTIG**

- **Das Preßmeßgerät nicht in die Ölöffnung des Kurebedwelle einsetzen.**

3. Die Hauptlagerschale anbringen und die Schrauben mit dem vorgeschriebenen Drehmoment anziehn und dann den Hauptlagerschale abschrauben.
4. Die Stärke der Preßmeßgerätmessen und den Ölspiel errechnen.
5. Überschreitet der Ölspiel den zulässigen Grenzwert, die Kurebelwellenlager austauschen.

| | | |
|---|---|---|
| Ölspiel zwischen Kurbelwelle und Kurbellenlager 2 | Werkdaten | 0,04 bis 0,104 mm |
| | Zulässiger Grenzwert | 0,2 mm |
| Kurbelwelle Außendurchmesser | Werkdaten | 51,921 bis 51,940 mm |
| Kurbelwellenlager 2 Innendurchmesser | Werkdaten | 51,980 bis 52,025 mm |




### Undersized and Oversized Bearing

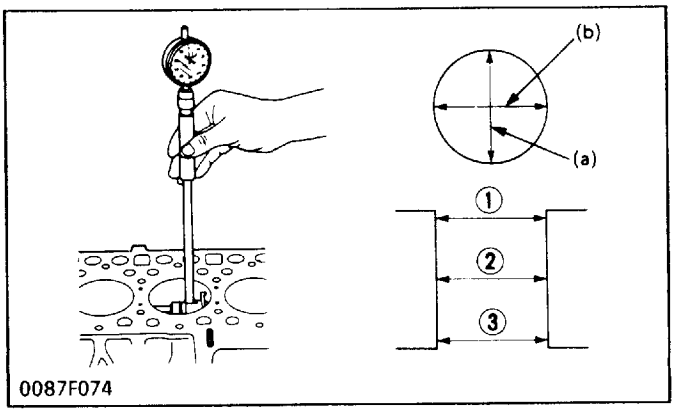
If the standard-size bearing cannot be employed due to excessive wear of the crank pin and crank journal, employ under-size or over-size bearings.

For under size or oversize bearing use, take the precautions noted below.

1. The crank pin (4), crank journal (5) and crank journal side surface (6) must be fine-finished to higher than $\frac{0.4\text{-}S}{\nabla\nabla\nabla\nabla}$ (0.000016 in.-S)
2. Grind the crankpin (4) and journal (5) with a wheel which has specified round corner and width without shoulder.
3. Be sure to chamfer the oil hole circumference (3) with an oil stone.
   (1) 3.3 to 3.7 mm radius (0.1299 to 0.1457 in. radius)
   (2) 2.8 to 3.2 mm radius (0.1102 to 0.1260 in. Radius)
   (3) Oil hole must be 1.0 to 1.5 mm Radius (0.0394 to 0.0591 in. Radius)

| Size | Code No. | Name of bearing | Bearing mark | Crankshaft processing dimension | |
|---|---|---|---|---|---|
| **–0.2 mm** –0.008 in. | 17331-2391-1 | Crankshaft bearing 1 (0.2 minus) | 020 US | A | **51.721 to 51.740 mm** 2.0363 to 2.0370 in. |
| **–0.2 mm** –0.008 in. | 17331-2393-1 | Crankshaft bearing 2 (0.2 minus) | 020 US | | |
| **–0.4 mm** –0.016 in. | 17331-2392-1 | Crankshaft bearing 1 (0.4 minus) | 040 US | | **51.521 to 51.540 mm** 2.0284 to 2.0291 in. |
| **–0.4 mm** –0.016 in. | 17331-2394-1 | Crankshaft bearing 2 (0.4 minus) | 040 US | | |
| **–0.2 mm** –0.008 in. | 17331-2297-1 | Crank pin bearing (0.2 minus) | 020 US | B | **46.759 to 46.775 mm** 1.8409 to 1.8415 in. |
| **–0.4 mm** –0.016 in. | 17331-2298-1 | Crank pin bearing (0.4 minus) | 040 US | | **46.559 to 46.575 mm** 1.8330 to 1.8337 in. |
| **+0.2 mm** +0.008 in. | 15221-2395-1 | Thrust bearing 1 (0.2 plus) | 020 OS | C | **26.20 to 26.25 mm** 1.0315 to 1.0335 in. |
| | 19202-2397-1 | Thrust bearing 2 (0.2 plus) | | | |
| **+0.4 mm** +0.016 in. | 15221-2396-1 | Thrust bearing 1 (0.4 plus) | 040 OS | | **26.40 to 26.45 mm** 1.0394 to 1.0413 in. |
| | 19202-2398-1 | Thrust bearing 2 (0.4 plus) | | | |

## [5] CYLINDER BORE




### Cylinder Bore I.D.

1. Measure the six points shown in the figure with a cylinder gauge to find out the maximum wear. Generally, position (1) in the (a, b) direction (at about 20 mm (0.79 in.) from the top) shows the maximum wear. Since position (3) at the lower part of the bore will show the minimum wear, find these difference. (See page S-19)

### Coussinet sous-dimensionnés et sur-dimensionnés

Si l'on ne peut utiliser des coussinets de dimension standard à cause d'une usure essive du maneton ou du tourillon de vilebrequin utiliser des coussinets sous-dimensionnés ou sur-dijmkensionnés. Pour utiliser des coussinets sous-dimensionnés ou sur-dimensionnés, observer les précautions suivantes:

1. Le maneton (4), le tourillon du vilebrequin (5) et la surface latérale du tourillon (6) doivent être surfacés avec un degré soupérieur à 0.4-S ▽▽▽▽
2. Recitifier le maneton (4) et le tourillon (5) de vilebrequin à l'aide d'une meule sans épaulement ayant un coin arrondi et une largeur spécifiés.
3. Veiller à repasser le tour du perçage de lubrification (3) avec une pierre abrasive à huile.
   (1) 3,3 à 3,7 mm Rayon
   (2) 2,8 à 3,2 mm Rayon
   (3) Le perçage de lubrification doit avoir de 1,0 à 1,5 mm Rayon

### Lager in Übergröße und unter Normalgröße

Wenn aufgrund einer übermäßigen Abnutzung des Kurbelzapfens kein Lager in Normalgröße benutzt werden kann, müssen Lager in Übergröße oder unter Normalgröße eingesetzt werden. Hierbei sind die folgenden Vorkehrungen zu beachten:

1. Der Kurbelzapfen (4), sowie der Kurbelwellezapfen (5) und die Sietenfläche des Kurbelwellezapfens (6) müssen auf mehr als 0.4-S ▽▽▽▽ feingeschlichtet werden.
2. Den Zapfen (4) und das Ende (5) der Kurbelwelle mit einem Schleifrad schleifen, das die vorgeschriebene Rundung und Breite hat und keine Abstufungen.
3. Darauf achten, daß die Ölöffnung an ihrem Umfang (3) mit einem Ölstein abgeschrägt wird.
   (1) 3,3 bis 3,7 mm Radius
   (2) 2,8 bis 3,2 mm Radius
   (3) Die Ölöffnung muß 1,0 bis 1,5 mm Radius betragen.

| Dimension<br>Größe | Référence<br>Code Nr. | Nom du coussinet<br>Lagername | Marque du coussinet<br>Lager-markierung | Dimension du vilebrequin<br>Bearbeitungsabmessung des Kurbelwelles | |
|---|---|---|---|---|---|
| –0,2 mm | 17331-2391-1 | Coussinet 1 de vilebrequin (0,2 moins)<br>Kurbelwellenlager 1 (0,2 minus) | 020 US | A | 51,721 à 51,740 mm<br>51,721 bis 51,740 mm |
| –0,2 mm | 17331-2393-1 | Coussinet 2 de vilebrequin (0,2 moins)<br>Kurbelwellenlager 2 (0,2 minus) | 020 US | | |
| –0,4 mm | 17331-2392-1 | Coussinet 1 de vilebrequin (0,4 moins)<br>Kurbelwellenlager 1 (0,4 minus) | 040 US | | 51,521 à 51,540 mm<br>51,521 bis 51,540 mm |
| –0,4 mm | 17331-2394-1 | Coussinet 2 de vilebrequin (0,4 moins)<br>Kurbelwellenlager 2 (0,4 minus) | 040 US | | |
| –0,2 mm | 17331-2297-1 | Coussinet de maneton (0,2 moins)<br>Pleuellagerschale (0,2 minus) | 020 US | B | 46,759 à 46,775 mm<br>46,759 bis 46,775 mm |
| –0,4 mm | 17331-2298-1 | Coussinet de maneton (0,4 moins)<br>Pleuellagerschale (0,4 minus) | 040 US | | 46,559 à 46,575 mm<br>46,559 bis 46,575 mm |
| + 0,2 mm | 15221-2395-1 | Coussinet 1 de butée (0,2 plus)<br>Drucklager 1 (0,2 plus) | 0,20 OS | C | 26,20 à 26,25 mm<br>26,20 bis 26,25 mm |
| | 19202-2397-1 | Coussinet 2 de butée (0,2 plus)<br>Drucklager 2 (0,2 plus) | | | |
| + 0,4 mm | 15221-2396-1 | Coussinet 1 de butée (0,4 plus)<br>Drucklager 1 (0,4 plus) | 0,40 OS | | 26,40 à 26,45 mm<br>26,40 bis 26,45 mm |
| | 19202-2398-1 | Coussinet 2 de butée (0,4 plus)<br>Drucklager 2 (0,4 plus) | | | |

## [5] CHEMISE DE CYLINDRE

### D.I. de logment de cylindre

1. Mesurer aux six points indiqués sur la figure à l'aide d'un comparateur afin de déterminer l'usure maximum.
   Normalement, la position (1) dans la direction (a, b) (environ 20 mm du haut) indique l'usure maximale. L'emplacement (3), au bas de la logment, présentant l'usure minimum, déterminer la différence. (Voir page S-24)

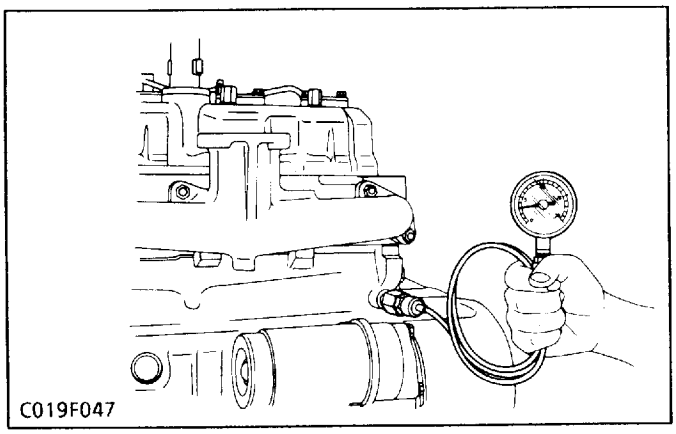
## [5] ZYLINDERLAUFBUCHSE

### Innendurchmesser der Zylinderbohrung

1. An den sechs inder Abbildung gezeigten Punkten den Innendurchmesser mit einer Zylinderlehre messen, um die maximale Abnutzung zu ermitteln. Im Allgemeinen zeigt Punkt (1) in Richtung (a, b) (ungefähr 20 mm von oben) die größte Abnutzung. Position (3) im unteren Teil der Zylinderbohrung zeigt die geringste Abnutzung. Der Unterschied in der Abnutzung in den beiden Positionen gibt den Abnutzungsgrad an. (Siehe Seite S-29)

# 2 LUBRICATING SYSTEM

## CHECKING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### Engine Oil Pressure

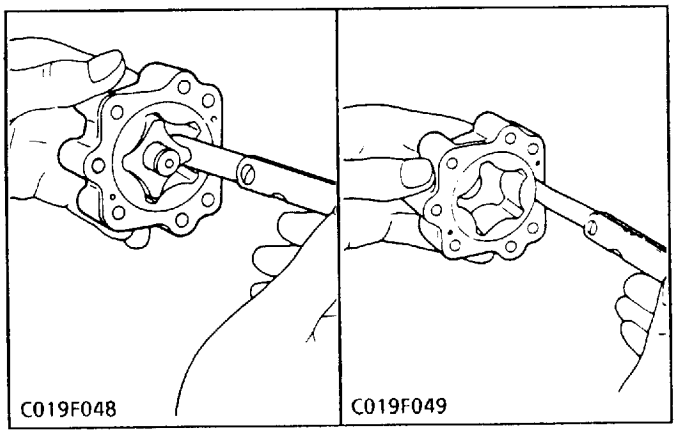
1. Remove the oil switch and set a pressure tester (Code No: 07916-32031).
2. Start the engine. After warming up, measure the oil pressure of both idling and rated speeds.
3. If the oil pressure is less than the allowable limit, check the following.

- Engine oil insufficient
- Oil pump defective
- Oil strainer clogged
- Oil gallery clogged
- Excessive oil clearance of bearing
- Foreign matter in the relief valve

| | | |
|---|---|---|
| At idle speed | Allowable limit | 0.5 kgf/cm² 49 kPa, 7 psi |
| At rated speed | Factory spec. | 3.0 to 4.5 kgf/cm² 294.2 to 441 kPa 42.7 to 64 psi |
| | Allowable limit | 2.5 kgf/cm² 245 kPa 36 psi |

## SERVICING

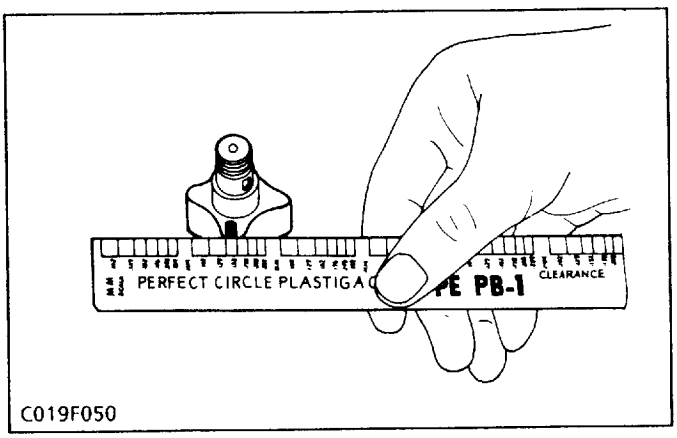
### [1] OIL PUMP


C019F048 C019F049

### Rotor and Lobe Clearance

1. Measure the clearance between lobes of the inner rotor and the outer rotor with a feeler gauge.
2. Measure the clearance between the outer rotor and the pump body with a feeler gauge.
3. If the clearance exceeds the factory spec. replace the oil pump rotor assembly.

| | | |
|---|---|---|
| Clearance between inner rotor and outer rotor | Factory spec. | 0.03 to 0.14 mm 0.0012 to 0.0055 in. |
| Clearance between outer rotor and pump body | Factory spec. | 0.11 to 0.19 mm 0.0043 to 0.0075 in. |



C019F050

### Clearance between Rotor and Cover

1. Put a strip of plastigage (Code No: 07909-30241) onto the rotor face with grease.
2. Install the cover and tighten the screws.
3. Remove the cover carefully, and measure the width of the press gauge with a sheet of gauge.
4. If the clearance exceeds the factory spec. replace oil pump rotor assembly.

| | | |
|---|---|---|
| End clearance between inner rotor and cover | Factory spec. | 0.105 to 0.150 mm 0.0041 to 0.0059 in. |

# 2 SYSTEME DE LUBRIFICATION

## VERIFICATION

### Pression d'huile moteur

1. Enlever le manocontact de pression d'huile et brancher un manomètre (Référence 07916-32031).
2. Démarrer le moteur. Mesurer la pression d'huile au régime ralenti et au régime nominale quand le moteur est chaud.
3. Vérifier les éléments suivants si la pression d'huile est inférieure à la limite de service.

- Quantité insuffisante d'huile-moteur
- Pompe à huile défectueuse
- Crépine encrassé
- Jeu de marche de coussinet excessif
- Saletés dans la soupape de décharge
- Passage d'huile obstrué

| | | |
|---|---|---|
| Au ralenti | Limite de service | 0,5 kgf/cm² 49 kPa |
| A vitesse nominal | Valeur de référence | 3,0 à 4,5 kgf/cm² 294,2 à 441 kPa |
| | Limite de service | 2,5 kgf/cm² 245 kPa |

## ENTRETIEN

### [1] POMPE A HUILE

#### Jeu de lobe et rotor

1. Mesurer le jeu entre les lobes des rotors intérieur et extérieur, avec une jauge d'épaisseur.
2. Mesurer le jeu entre le rotor extérieur et le corps de pompe avec une jauge d'épaisseur.
3. Si le jeu dépasse la valeur de référence remplacer l'ensemble de rotor de pompe à huile.

| | | |
|---|---|---|
| Jeu entre le rotor intérieur et le rotor extérieur | Valeur de référence | 0,03 à 0,14 mm |
| Jeu entre le rotor extérieur et le corps de pompe | Valeur de référence | 0,11 à 0,19 mm |

#### Jeu entre le rotor et le couvercle

1. Disposer une jauge plastique (Référence: 07909-30241) sur la paroi graissée du rotor.
2. Poser le couvercle et serrer les vis.
3. Déposer le couvercle avec précaution et mesurer la dépression du manomètre à l'aide d'un tableau d'équivalence.
4. Si le jeu excède la valeur de référence, remplacer l'ensemble de rotor de pompe à huile.

| | | |
|---|---|---|
| Jeu latéral entre le rotor intérieur et le couvercle | Valeur de référence | 0,105 à 0,150 mm |

# 2 SCHMIERUNGS SYSTEM

## ÜBERPRÜFUNG

### Motoröldruck

1. Den Ölschalter entfernen und ein Öldruckprüfer (Code Nr.07916-32031) ansetzen.
2. Den Motor anlassen. Nachdem er warm gelaufen ist, den Öldruck im Leerlauf und bei unten angegebener Drehzahl messen.
3. Falls der Öldruck unter dem zulässigen Grenzwert, folgende Punkte überprüfen:

- Ungenügend Motoröl
- Ölpumpe defekt
- Ölfilter verstopft
- Übermäßiger Ölspiel an den Lagern
- Fremdkörper im Überdruckventil
- Ölkanal verstopft

| | | |
|---|---|---|
| Bei Leerlaufdrehzahl | Zulässiger Grenzwert | 0,5 kp/cm² 49 kPa |
| Bei Nenndrehzahl | Werkdaten | 3,0 bis 4,5 kp/cm² 294,2 bis 441 kPa |
| | Zulässiger Grenzwert | 2,5 kp/cm² 245 kPa |

## WARTUNG

### [1] ÖLPUMPE

#### Spiel zwischen innerem und äußerem Flügelrad

1. Das Spiel zwischen dem inneren und äußeren Flügelrad mit Hilfe ainer Fühlerlehre messen.
2. Das Spiel zwischen dem äußeren Flügelrad und dem Pumpengehäuse mit Hilfe einer Fühlerlehre messen.
3. Whenn das Spiel den Werkdaten überschreitet, den Flügelradsatz austauschen.

| | | |
|---|---|---|
| Clearance between valve housing and spool | Werkdaten | 0,03 bis 0,14 mm |
| Clearance between valve housing and spool | Werkdaten | 0,11 bis 0,19 mm |

#### Spiel zwischen Flügelrad und Abdeckung

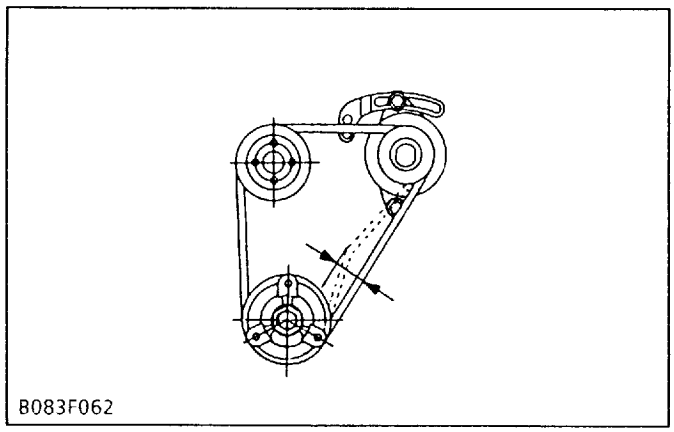
1. Einen Streifen der Preßmeßgerät (Code Nr. 07909-30241) mit etwas Fett auf die Flügelrades setzen.
2. Deckel aufschrauben.
3. Die deckel vorsichtig entfernen und das Meßplättchen mit einer Blattlehre messen.
4. Wenn das Spiel den Werkdaten überschreitet, den Flügelraasatz austauschen.

| | | |
|---|---|---|
| Endspiel zwischen innerem Flügelrad und Abdeckung | Werkdaten | 0,105 bis 0,150 mm |

# 3 COOLING SYSTEM

## CHECKING

### [1] FAN BELT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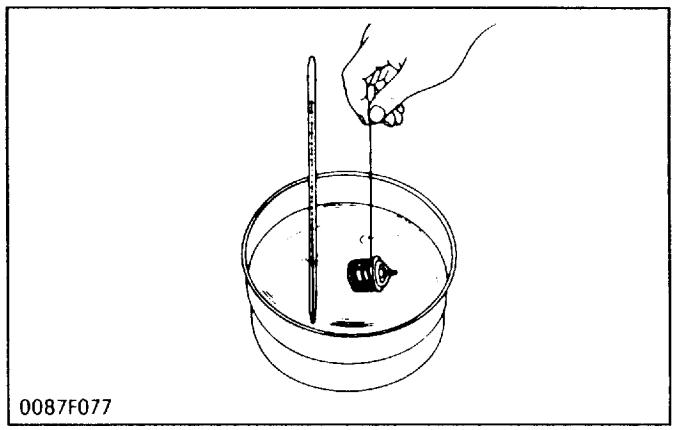
**Fan Belt Tension**

1. Press the fan belt between fan pulley and pulley at force of 10 kgf (98N, 22 lbs).
   Check if the fan belt deflection is 10 to 12 mm (0.394 to 0.472 in.)
2. If the deflection is not within the factory specifications, loosen the bolt and nuts, and relocate the alternator to adjust.

### [2] RADIATOR

**⚠ CAUTION**

- **When removing the radiator cap, wait at least ten minutes after the engine has stopped and cooled down. Otherwise, hot water may gush out, scalding nearby people.**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**Thermostat's Valve Opening Temperature**

1. Push down the thermostat valve and insert a string between the valve and the valve seat.
2. Place the thermostat and a thermometer in a container with water and gradually heat the water.
3. Hold the string to suspend the thermostat in the water. When the water temperature rises, the thermostat valve will open, allowing it to fall down from the string.
   Read the temperature at this moment on the thermometer.
4. Continue heating the water and read the temperature when the valve has risen by about 8 mm (0.315 in.).
5. If the measurement is not acceptable, replace the thermostat.

| | | |
|---|---|---|
| Thermostat's valve opening temperature | Factory spec. | 69.5 to 72.5°C<br>157.1 to 162.5°F |
| Temperature at which thermostat completely opens | Factory spec. | 85°C<br>185.5°F |

# 3 SYSTEM DE REFROIDISSEMENT

## VERIFICATION

### [1] COURROIE DE VENTILATEUR

**Tension de courroie de ventilateur**

1. Appuyer sur la courroie de ventilateur entre la poulie de ventilateur et la poulie avec une force de 10 kgf (98N).
   Vérifier si la tension de la courroie de ventilateur est de 10 à 12 mm.
2. Si la flexion n'est pas comprises dans la valeur de référence, desserrer les boulons et ecrous et ammener l'alternateur en place.

### [2] RADIATEUR

**ATTENTION**

- **Lors de l'enlèvement du bouchon de radiateur, attendre au moins 10 minutes après l'arrêt et le refroidissement du moteur. Autrement, l'eau chaude peut jaillir, échaudant le personnel.**

**Température d'ouverture de vanne de thermostat**

1. Appuyer sur la vanne de thermostat et introduire une corde entre la vanne et le siège de vanne.
2. Mettre le thermostat et un thermomètre dans un récipient d'eau puis chauffer l'eau progressivement.
3. Tenir la corde pour suspendre le thermostat dans l'eau. Lorsque la température de l'eau augmente, le clapet du thermostat doit s'ouvrir, ce qui la fera tomber de la corde. Sur le thermomètre, relever la température indiquée à ce moment.
4. Continuer de chauffer l'eau et mesurer la température lorsque le clapet s'est soulevé d'environ 8 mm.
5. Si la mesure est inacceptable, remplacer le thermostat.

| | | |
|---|---|---|
| Température d'ouverture du clapet thermostat | Valeur de référence | 69,5 à 72,5°C |
| Température d'ouverture complète du thermostat | Valeur de référence | 85°C |

# 3 KÜHLUNGSSYSTEM

## ÜBERPRÜFUNG

### [1] LÜFTERRIEMEN

**Spannung des Lüfterriemens**

1. Auf den Lüfterriemen zwischen der Lüfterriemenscheibe und Spannrolle mit einer Kraft von 10 kp (98N) drücken.
   Überprüfen, ob die Durchsenkung des Lüfterriemens zwischen 10 bis 12 mm beträgt.
2. Wenn sich die Biegung nicht innerhalb der Sollwerte befindet, die Bolzen und Muttern lösen und den Alternator in Stellung bringen.

### [2] KÜHLER

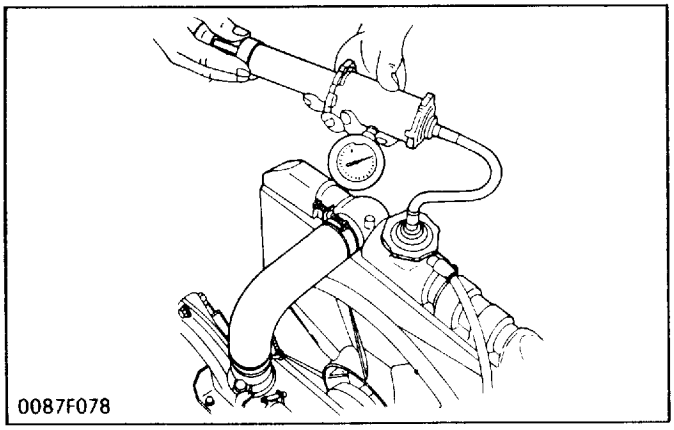
**ACHTUNG**

- **Beim Entfernen der Kühlerverschlußkappe wenigstens zehn Minuten lang nach dem Abstellen des Motors warten, bis der Motor abgekühlt ist. Sonst könnte heißes Wasser hervorsprudeln und Personen in der Umgebung verletzen.**

**Öffnungstemperatur des Thermostatventils**

1. Den Thermostatventil herunterdrücken und eine Schnur zwischen das Ventil und den Ventilsitz einfügen.
2. Den thermostat und ein Thermometer in einen mit Wasser gefüllten Behälter legen und das Wasser allmählich erhitzen.
3. Die Schnur so halten, daß der Thermostat im Wasser aufgehängt ist. Wenn die Wassertemperatur ansteigt, öffnet das Thermostatventil und es fällt von der Schnur herunter.
   Sodann ist die Temperatur am Thermomenter abzulesen.
4. Das Wasser weiter erhitzen und die Temperatur ablesen, wenn das Ventil um etwa 8 mm angehoben hat.
5. Wenn die Messung nicht akzeptabel ist, den Thermostat austauschen.

| | | |
|---|---|---|
| Öffnungstemperatur des Thermostatventils | Werkdaten | 69,5 bis 72,5°C |
| Temperatur, für vollständige Öffnung des Thermostats | Werkdaten | 85°C |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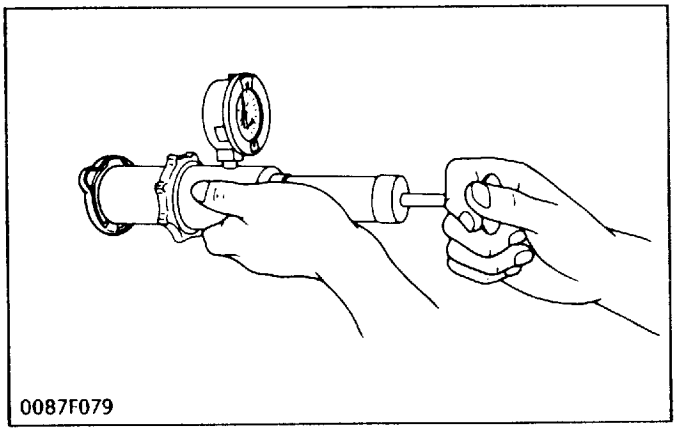
### Radiator Water Leakage

1. Pour a specified amount of water into the radiator.
2. Set a radiator tester (Code No: 07909-31551). Increase water pressure to the specified pressure of 1.4 kgf/cm$^2$ (137 kPa, 20 psi).
3. Check each section for water leakage.
4. When water leakage is excessive, replace the radiator. If water leakage is caused by a small pinhole, correct the radiator with radiator cement.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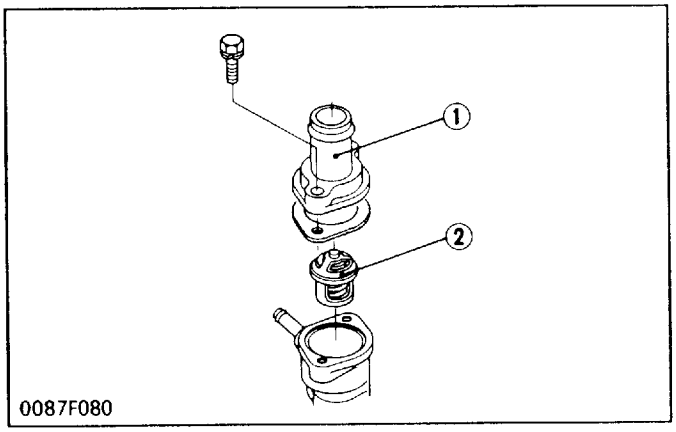
### Radiator Cap Air Leakage

1. Set a radiator tester (Code No: 07909-31551) to the radiator cap.
2. Apply the specified pressure of 0.9 kgf/cm$^2$ (98.1 kPa, 12.8 psi).
3. Check if the pressure drop to less than 0.6 kgf/cm$^2$ (59 kPa, 9 psi) in 10 seconds.
4. If the pressure is less than the factory specification, replace it.

# DISASSEMBLING AND ASSEMBLING



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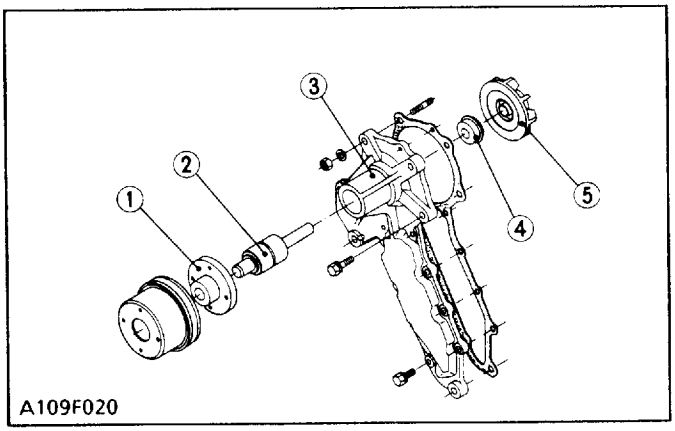
### Thermostat

1. Remove the thermostat cover (1).
2. Remove the thermostat (2).

**(When reassembling)**

- Apply a liquid gasket (Three Bond 1215 or equivalent) only at the thermostat cover side of the gasket.

(1) Thermostat Cover
(2) Thermostat



A109F020

### Water Pump

1. Remove the fan and fan pulley.
2. Remove the water pump from gear case cover.
3. Remove the water pump flange (1).
4. Press out the water pump shaft (2) with the impeller (5) on it.
5. Remove the impeller from the water pump shaft.
6. Remove the mechanical seal (4).

**(When reassembling)**

- Replace the mechanical seal with new one.

(1) Water Pump Flange
(2) Water Pump Shaft
(3) Water Pump Body
(4) Mechanical Seal
(5) Impeller

### Fuite d'eau sur le radiateur

1. Verser un volume spécifié d'eau dans le radiateur.
2. Installer un appareil d'essai de radiateur (Référence: 07909-31551). Augmenter la pression d'eau jusqu'à la valeur spécifiée, soit 1,4 kgf/cm² (137 kPa, 1,37 bar).
3. Vérifier chaque partie pour s'assurer de l'absence de fuite d'eau.
4. Lorsque la fuite d'eau est excessive, remplacer le radiateur. Si la fuite d'eau provient d'une petite piqûre, réparer le radiateur avec du ciment.

### Wasserverlust im Kühler

1. Eine spezifizierte Menge von Wasser in den Kühler einfüllen.
2. Ein Kühler-Testgerät (CodeNr. 07909-31551) anbringen. Den Wasserdruck auf den spezifizierten Druck von 1,4 kp/cm² (137 kPa, 1,37 bar) erhöhen.
3. Jeden Teil auf Wasserverlust überprüfen.
4. Wird ein übermäßiger Wasserverlust festgestellt den Kühler auswechseln. Wird der Wasserverlust durch ein feines Loch verursacht, den Kühler mit Kühlerzement ausbessern.

### Fuite d'air au niveau du bouchon de radiateur

1. Monter un appareil d'essai de radiateur (Référence: 07909-31551) sur le bouchon du radiateur.
2. Appliquer la pression spécifiée de 0,9 kgf/cm² (98,1 kPa, 0,88 bar).
3. Vérifier si la perte de charge en 10 secondes est inférieure à 0,6 kgf/cm² (59 kPa, 0,59 bar).
4. Si la pression est inférieure à la valeur de référence, remplacer le bouchon de radiateur.

### Entlüftung durch Kühlerverschlußkappe

1. Ein Kühler- Testgerät (CodeNr. 07909-31551) an der Kühlerverschlußkappe ansetzen.
2. Den vorgeschriebenen Druck von 0,9 kp/cm² (98,1 kPa, 0,88 bar) aufbringen.
3. Überprüfen, ob der Druck innerhalb von 10 Sekunden bis auf weniger als 0,6 kp/cm² (59 kPa, 0,59 bar) abfällt.
4. Unterschreitet der Druck die Werkdaten, die Kappe auuswechseln.

# DEMONTAGE ET MONTAGE

### Thermostat

1. Enlever le couvercle de thermostat (1).
2. Enlever le thermostat (2).

**(Au remontage)**

- Appliquer un joint liquide (Three Bond 1215 ou équivalent) mais seulement sur le côté du joint faisant face au couvercle de thermostat.

(1) Couvercle de thermostat
(2) Thermostat

### Pompe à eau

1. Enlever le ventilateur et la poulie de ventilateur.
2. Enlever la pompe à eau du couvercle de carter de distribution.
3. Enlever la bride de la pompe à eau (1).
4. Chasser à la presse l'arbre de pompe à eau (2) avec la turbine (5).
5. Enlever la turbine de l'arbre de pompe à eau.
6. Enlever le joint mécanique (4).

**(Au remontage)**

- Remplacer le joint mécanique par un joint mécanique neuf.

(1) Bride de pompe à eau
(2) Arbre de pompe à eau
(3) Corps de pompe à eau
(4) Joint mécanique
(5) Turbine

# AUSBAU UND EINBAU

### Thermostat

1. Die Thermostatabdeckung (1) entfernen.
2. Den Thermostat (2) entfernen.

**(Beim Wiedereinbau)**

- Nur auf die Thermostatabdeckungsseite der Dichtung eine flüssige Dichtung (Three Bond 1215 oder ähnlich) versehen.

(1) Thermostatabdeckung
(2) Thermostat

### Wasserpumpe

1. Den Lüfter und die Lüfterriemenscheibe entfernen.
2. Die Wasserpumpe vom Getriebegehäusedeckel entfernen.
3. Den Wasserpumpenflansch (1) entfernen.
4. Den Wasserpumpenschaft (2) mit dem Flügelrad (5) herausdrücken.
5. Das Flügelrad vom Wasserpumpenschaft abnehmen.
6. Die mechanische Dichtung (4) entfernen.

**(Beim Wiedereinbau)**

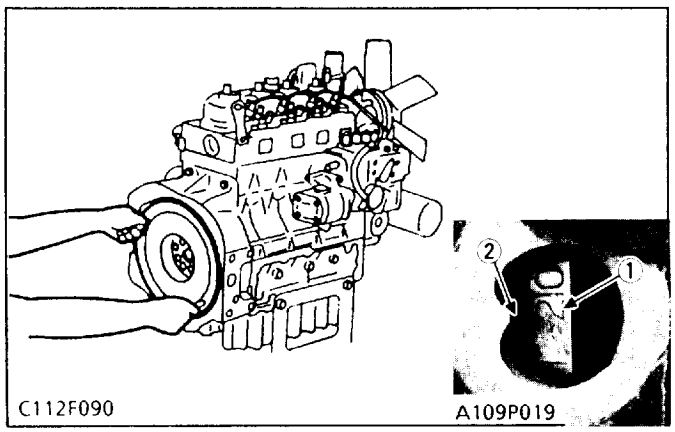
- Die mechanische Dichtung gegen eine neue austauschen.

(1) Wasserpumpenflansch
(2) Wasserpumpenschaft
(3) Wasserpumpengehäuse
(4) Mechanische Dichtung
(5) Flügelrad

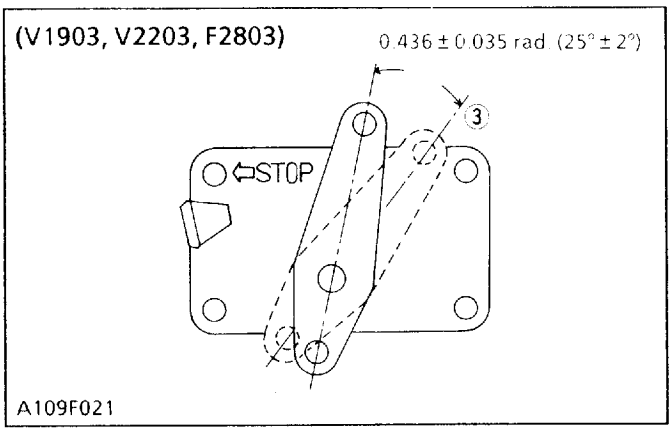
# 4 FUEL SYSTEM

## CHECKING AND ADJUSTING

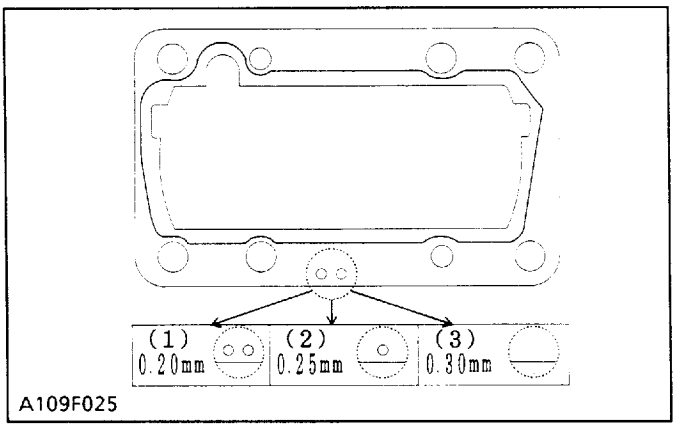
### [1] INJECTION PUMP




(1) Timing Mark
(2) Projection




(3) Stop Lever in Free Position




(5) 2-holes : 0.20 mm
(6) 1-hole : 0.25 mm
(7) Without hole : 0.30 mm

**Injection Timing**

1. Remove the injection pipes.
2. Set the speed control lever to maximum fuel discharge position.

**■ NOTE**

- **The F2803, V2203 and V1903 pumps have a displacement angle. In adjusting the injection timing, pull the stop lever from its free position by 0.436 ± 0.035 rad. (25° ± 2°) toward the stop position.**

3. Turn the flywheel counterclockwise (facing the flywheel) until the fuel fills up to the hole of the delivery valve holder for 1st cylinder.
4. Turn the flywheel further and stop turning when the fuel begins to flow over, to get the present injection timing.
5. (The flywheel has mark 1TC and four lines indicating every 0.087 rad. (5°) of crank angle from 0.175 rad. (10°) to 0.436 rad. (25°) before mark 1TC) Calculate the angle which the projection of the window points out. If the calculation differs from specified injection timing, add or remove the shim to adjust.

**(Injection Timing)**

D1403 / D1703 0.14 to 0.27 rad.
V1903 / V2203 : (17° to 19°) B.T.D.C.
F2803 : 0.314 to 0.349 rad. (18° to 20°) B.T.D.C.

**■ NOTE**

**(Engine serial number : D1403-12211, D1703-4253, V1903-1562, V2203-60896, F2803-105567 or lower)**

- **Shims are available in thickness of 0.15 mm, 0.30 mm. Combine these shims for adjustments.**
- **Addition or reduction of shim (0.15 mm, 0.0059 in.) delays or advances the injection timing by approx. 0.026 rad (1.5°).**
- **After adjusting the injection timing, apply liquid-type gasket (Three Bond 1215 or its equivalent) to both sides of the injection pump shim before reassembling.**

**(Engine serial number : D1403-12212, D1703-4254, V1903-1563, V2203-60897, F2803-105568 or higher)**

- **The sealant is applied to both sides of the soft metal gasket shim. The liquid gasket is not required for assembling.**
- **Shims are available in thickness of 0.20 mm, 0.25 mm and 0.30 mm. Combine these shims for adjustments.**
- **Addition or reduction of shim (0.05 mm, 0.0020 in.) delays or advances the injection timing by approx. 0.0087 rad (0.5°).**
- **In disassembling and replacing, be sure to use the same number of new gasket shims with the same thickness.**

# 4 SYSTEM D'ALIMENTATION

## VERIFICATION ET REGLAGE

### [1] POMPE D'INJECTION

Calage de l'injection

1. Retirer les tuyaux d'injection.
2. Placer le levier de contrôle de vitesse sur la position de décharge d'essence maximum.

■ NOTA

- **Les pompes F2803, V2203 et V1903 présentent un angle de déplacement. Dans le réglage du calage de l'injection, tirer le levier d'arrêt de sa position libre de 0,436 ± 0,035 rad. (25° ± 2°) vers la position d'arrêt.**

3. Tourner le volant dans le sens inverse des aiguilles d'une montre (vers le volant) jusqu'à ce que l'essence se remplisse jusqu'à l'orifice du support de soupape de refoulement pour le 1er cylindre.
4. Tourner davantage le volant et arrêter de le tourner lorsque l'essence commence à s'écouler, pour obtenir le calage d'injection actuel.
5. (Il y a sur le volant une marque 1TC et quatre lignes indiquant chaque 0,087 rad. (5°) d'angle du vilebrequin de 0,175 rad. (10°) à 0,436 rad. (25°) avant la amarque 1TC sur le volant.) Calculer l'angle sur lequel est dirigée la marque du regard. Si le calcul diffère du calage d'injection spécifié, ajouter ou retirer une cale pour effectuer le réglage.

(Calage de l'injection)
D1403 / D1703 0,14 à 0,27 rad.
V1903 / V2203 : (17° à 19°) B.T.D.C.
F2803 : 0,314 à 0,349 rad. (18° à 20°) B.T.D.C.

■ NOTA

**(Numéro de serie moteur : antérieur à D1403-12211, D1703-4253, V1903-1562, V2203-60896, F2803-105567)**

- **En ajoutant ou en supprimant cale (0,15 mm) d'épaisseur, on retarde ou on avance le calage de l'injection d'environ de 1,5° (0,026 rad.).**
- **Des cales d'une épaisseur de 0,15 mm et 0,30 mm sont disponibles. Combiner ces cales adéquatement pour les ajustements.**
- **Après réglage du calage de l'injection, appliquer un joint liquide (Three Bond 1215 ou équivalent) aux deux côtés des cales avant de les remonter.**

**(Numéro de serie moteur : postérieur à D1403-12212, D1703-4254, V1903-1563, V2203-60897, F2803-105568)**

- **Les soudures étant faites d'un métal tendre enduit de chaque côte d'un matériau étanche, il n'est pas nécessaire d'utiliser un joint liquide lors du montage de ces moteurs.**
- **Des cales d'une épaisseur de 0,20 mm, 0,25 mm et 0,30 mm sont disponibles. Combiner ces cales adéquatement pour les ajustements.**
- **En ajoutant ou en supprimant une cale (0,05 mm) d'épaisseur, on retarde ou on avance le calage de l'injection de4 0,0087 rad (0,5°).**
- **Lors du démontage et du remplacement, toujours utiliser le même nombre de cales de joint neuves avec la même épaisseur.**

(1) Calage le repère
(2) Repère gravé
(3) Levier d'arrêt à la position libre
(5) 2-trou : 0,20 mm
(6) 1-trou : 0,25 mm
(7) Sans trou : 0,30 mm

# 4 KRAFTSSTOFF-SYSTEM

## ÜBERPRÜFUNG UND EINSTELLUNG

### [1] EINSPRITZPUMPE

Einspritzverstellung

1. Die Einspritzleitungen ausbauen.
2. Den Beschleunigungshebel auf die maximale Kraftstoffförderungsposition stellen.

■ ANMERKUNG

- **Die Pumpen (F2803, V2203 und V1903) besitzen einen Hubraumwinkel. Beim Einstellen der Einspritzzeit ist der Stopphebel von seiner Freigabeposition um 0,436 ± 0,035 rad. (25° ± 2°) in Richtung Stopp-Position zu ziehen.**

3. Das Schwungrad entgegen dem Uhrzeigersinn drehen, bis Kraftstoff bis zum Loch des Förderventilhalters zum 1. Zylinder aufgefüllt wird.
4. Das Schwungrad weiter drehen und aufhören, sobald Kraftstoff überläuft, um die gegenwärtige Verstellung zu ermitteln.
5. (Das Schwungrad besitzt die 1TC-Marke und vier Linien, die jeweils 0,087 rad (5°) des Kurbelwinkels von 0,175 rad (10°) bis zu 0,436 rad (25°) vor der 1TC-Marke anzeigen). Den Winkel berechnen, den die Marke am Fenster anzeigt. Falls die Berechnung von der vorgeschriebenen Einspritzverstellung abweicht, durch Zugabe bzw. Abnohme einer Beilagscheibe nachstellen.

(Einspritzverstellung)
D1403 / D1703 0,14 bis 0,27 rad.
V1903 / V2203 : (17° bis 19°) B.T.D.C.
F2803 : 0,314 bis 0,349 rad. (18° bis 20°) B.T.D.C.

■ ANMERKUNG

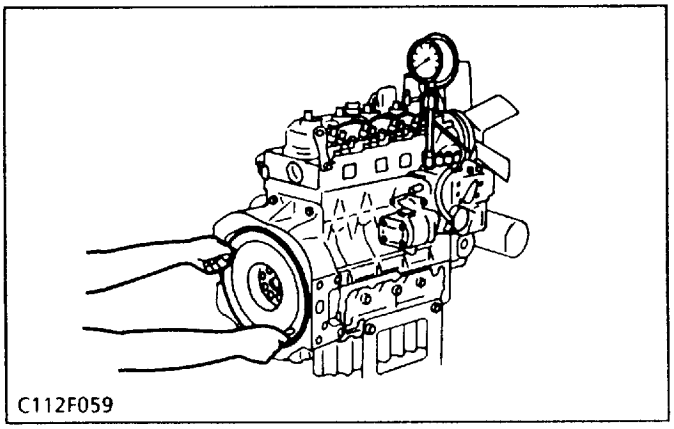
**(Seriennummer des Motors : D1403-12211, D1703-4253, V1903-1562, V2203-60896, F2803-105567 und davor)**

- **Durch die Zugabe oder Verminderung Blechbeilage (0,15 mm) wird die Spritzeinstewllung um 1,5° (0,026 rad.) verzögert oder vorgerückt.**
- **Beilagscheiben mit einer Dicke von 0,15 mm und 0,3 mm sind erhältlich. Kombinieren Sie diese Beilagscheiben für die Einstellungen.**
- **Nach der Einstellung der Spritzeinstellung (vor dem Zusammenbauen) Dichtflüssigkeit (THREE BOND 1215 oder Aquivalent) an beiden Seiten des Einspritzpumpen-Blechbeilage auftragen.**

**(Seriennummer des Motors : D1403-12212, D1703-4254, V1903-1563, V2203-60897, F2803-105568 und danach)**

- **Das Dichtmittel wird an beide Seiten der weichen Metalldichtungs-Beilagscheibe aufgetragen. Für den Zusammenbau ist eine Flüssigkeitsdichtung nicht benötigt.**
- **Beilagscheiben mit einer Dicke von 0,20 mm, 0,25 mm und 0,30 mm sind erhältlich, Kombinieren Sie diese Beilagscheiben für die Einstellungen.**
- **Durch die Zugabe odre Verminderung Blechbeilage (0,05 mm) wird die Spritzeinstellung un 0,0087 rad (0,5°) verzögert oder vorgerückt.**
- **Beim Zerlegen bzw. Auswechseln der Einspritzpumpe deshalb immer sicherstellen, daß die gleiche Anzahl von Dichtscheiben der gleichen Stärke verwendet werden.**

(1) Markierung
(2) Markierung übereinstimmt
(3) Stopphebel in freier Stellung
(5) 2-Löcher : 0,20 mm
(6) 1-Loch : 0,25 mm
(7) kain Loch : 0,30 mm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### Fuel Tightness of Pump Element

1. Remove the injection pipe.
2. Install the injection pump pressure tester (1) to the injection pump.
3. Set the speed control lever to the maximum speed position.
4. Turn the flywheel ten times or more to increase the pressure.
5. If the pressure can not reach the allowable limit, replace the pump element or injection pump assembly.

| | | |
|---|---|---|
| Fuel tightness of pump element | Allowable limit | 150 kgf/cm² 14.7 MPa, 2133 psi |

(1) Injection Pump Pressure Tester

### Fuel Tightness of Delivery Valve

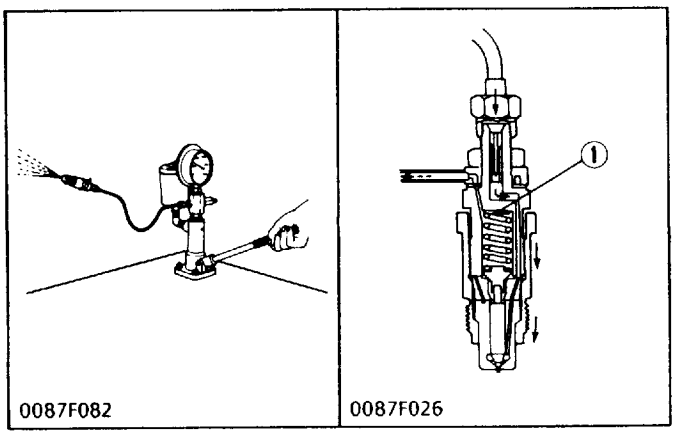
1. Set a pressure tester to the fuel injection pump.
2. Rotate the flywheel and raise the pressure to 155-160 kg/cm².
3. Now turn the flywheel back about half a turn (to keep the plunger free). Maintain the flywheel at this position and clock the time taken for the pressure to drop from the 150 kg/cm² down to 140 kg/cm².
4. Measure the time needed to decrease the pressure from 150 to 140 kgf/cm² (14.7 to 13.7 MPa, 2133 to 1990 psi).
5. If the measurement is less than allowable limit, replace the delivery valve.

| | | |
|---|---|---|
| Fuel tightness of delivery valve | Allowable limit | 5 seconds 150 → 140 kgf/cm² 14.7 → 13.7 MPa 2133 → 1900 psi |

## [2] INJECTION NOZZLE

**CAUTION**

- **Check the nozzle injection pressure and condition after confirming that there is nobody standing in the direction the fume goes. If the fume from the nozzle directly contacts the human body, cells may be destroyed and blood poisoning may be caused.**



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(1) Adjusting Washer

### Nozzle Injection Pressure

1. Set the injection nozzle to the nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, disassemble the injection nozzle, and change adjusting washer (1) until the proper injection pressure is obtained.

**(Reference)**

- Pressure variation with 0.025 mm (0.00098 in.) difference of adjusting washer thickness. Approx. 6 kgf/cm² (588.6 kPa, 85.32 psi)

| | | |
|---|---|---|
| Fuel injection pressure | Factory spec. | 140 to 150 kgf/cm² 13.73 to 14.71 MPa 1991 to 2133 psi |

### Etanchéité au carburant de l'élément de pompe

1. Déposer le tuyau d'injection.
2. Disposer un manomètre de pression (1) de la pompe d'injection sur la pompe d'injection.
3. Positionner le levier de commande de vitesse sur la position de vitesse maximum.
4. Faire tourner le moteur au moins dix fois afin d'accroître la pression.
5. Si la pression ne peut atteindre la limite de service, remplace l'élément de pompe oul'ensemble de pompe d'injection.

| | | |
|---|---|---|
| Etanchéité au carburant de l'élément de pompe | Limite de service | 150 kgf/cm² 14,7 MPa |

(1) Manomètre de pression de la pompe d'injection

### Etanchéité au carburant du clapet de refoulement

1. Mettre un manomètre sur la pompe d'injection.
2. Faire tourner la volant pour augmenter la pression jusqu' 15,2 à 15,7 MPa (155 à 160 kgf/cm²).
3. Relâcher la pression dans la cahmbre de refoulement en abaissant le piston (pompe d'injection) au point mort bas.
4. Mesurer le temps nécessaire pour faire tomber la pression de 150 à 140 kgf/cm² (14,7 à 13,7 MPa).
5. Si la mesure est inférieure à la limite de service, remplacer le clapet de refoulement.

| | | |
|---|---|---|
| Etanchéité au carburant du clapet d'alimentation | Limite de service | 5 seconds 150 → 140 kgf/cm² 14,7 → 13,7 MPa |

## [2] INJECTEURS

**ATTENTION**

- **Vérifier la pression et l'état d'injecteur après s'être assuré que personne ne se trouve dans la direction de pulvérisation de carburant. Si le carburant pulvérisé en provenance de l'injecteur vient directement en contact avec le corps humain, les cellules risquent d'être dêtruites, provoquant une intoxication de sang.**

### Tarage d'injection

1. Fixer l'injecteur sur la pompe à tarer.
2. Déplacer la manette de la pompe à tarer pour mesurer la pression à laquelle le carburant commence à gicler de l'injecteur.
3. Si la valeur mesurée n'est pas comprise dans la gamme de valeurs de référence, démonter l'injecteur et remplacer la rondelle de réglage (1) jusqu'à obtenir le tarage d'injection appropriée.

**(Référence)**

- Variation de pression avec 0,025 mm de différence d'épaisseur de rondelle de réglage.
  Environ 6 kgf/cm² (588,6 kPa)

| | | |
|---|---|---|
| Pression d'injection | Valeur de référence | 140 à 150 kgf/cm² 13,73 à 14,71 MPa |

(1) Rondelle de réglage

### Kraftstoffdichtigkeit des Pumpenelementes

1. Die Einspritzleitung abnehmen.
2. Das Druckmesser für Einspritzpumpe (1) an der Einspritzpumpe anbringen.
3. Den Gashebel in die Vollgasstellung schieben.
4. Den Motor mit Hilfe der Anlasserkurbel 10 Mal umdrehen, damit sich Druck in der Einspritzpumpe aufbaut.
5. Erreicht der Druck nicht der Zulässigen Grenzwert, das pumpenelement oder die Einspritzpumpen-Baugruppe auswechseln.

| | | |
|---|---|---|
| Kraftstoffdichtigkeit des Pumpenelementes | Zulässiger Grenzwert | 150 kp/cm² 14,7 MPa |

(1) Druckmesser für Einspritzpumpe

### Kraftstoffdichtigkeit des Druckventils

1. Einen Druckmesser an der Kraftstoffeinspritz-pumpe anschließen.
2. Das Schwungrad drehen, umden Druck auf 15,2 bis 15,7 MPa (155 bis 160 kgf/cm2) zu erhöhen.
3. Den Druck aus der Förderkammer ablassen, indem der Tauchkolben an den unteren Totpunkt gebracht wird.
4. Die Zeit messen, die erforderlich ist, damit der Druck von 150 auf 140 kp/cm² (14,7 auf 13,7 MPa) abfällt.
5. Wenn die Messung unter dem zulässigen Grenzwert liegt, das Druckventil austauschen.

| | | |
|---|---|---|
| Kraftstoffdichtigkeit des Druckventils | Zulässiger Grenzwert | 5 sekunden 150 → 140 kp/cm² 14,7 → 13,7 MPa |

## [2] EINSPRITZDÜSE

**ACHTUNG**

- **Zuerst sicherstellen, daß sich keine Personen in der Spritzstrahlrichtung befinden und dann den Düseneinspritzdruck und -Zustand überprüfen. Kommt ein Spritzstrahl aus der Düse mit einem Menschenkörper in Berührung, könnte eine Zellenzerstörung oder eine Blutvergiftung verursacht werden.**

### Kraftstoff-Einspritzdruck

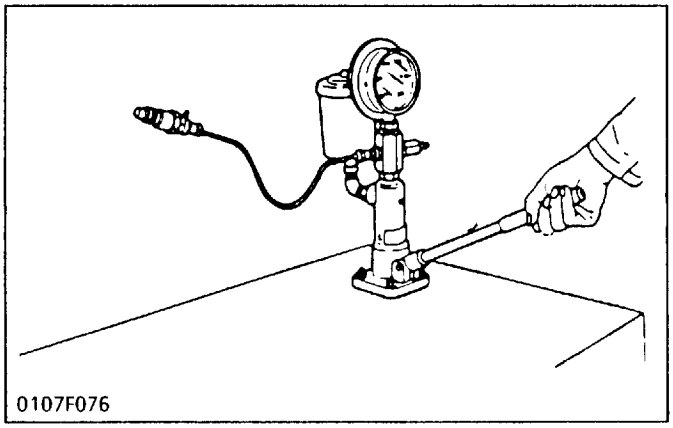
1. Die Einspritzdüse an das Düsenprüfgerät anschließen.
2. Den Testgeräthandgriff langsam bewegen, um den Druck messen bei welchem Kraftstoff aus der Düse herauszuspritzen beginnt.
3. Liegt die Messung nicht innerhalb die Werkdaten-liegt, die Einspritzdüse zerlegen und die Einstellscheibe (1) wechseln, bis der richtige Druck erhalten wird.

**(Referenz)**

- Druckänderung mit einem Unterschied von 0,025 mm in der Einstellscheibendicke.
  Ca. 6 kp/cm² (588,6 kPa)

| | | |
|---|---|---|
| Kraftstoff-Einspritzdruck | Werkdaten | 140 bis 150 kgf/cm² 13,73 bis 14,71 MPa |

(1) Einstellscheibe

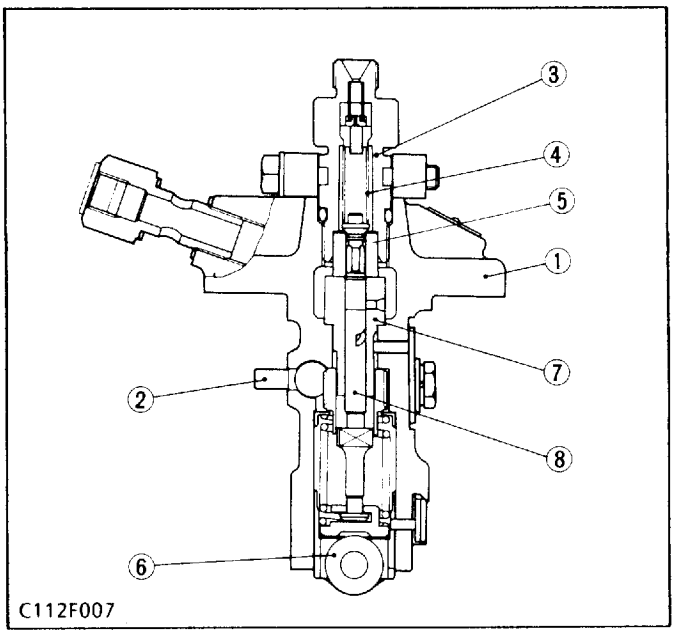

0107F076

**Fuel Tightness of Needle Valve Seat**

1. Set the injection nozzle to a nozzle tester. Apply a pressure 130kgf/cm$^2$ (12.75 MPa, 1849 psi).
2. After keeping the nozzle under this pressure for 10 seconds, check to see if fuel leaks from the nozzle.
3. If fuel should leak, replace the nozzle piece.

# DISASSEMBLING AND ASSEMBLING

## [1] INJECTION PUMP



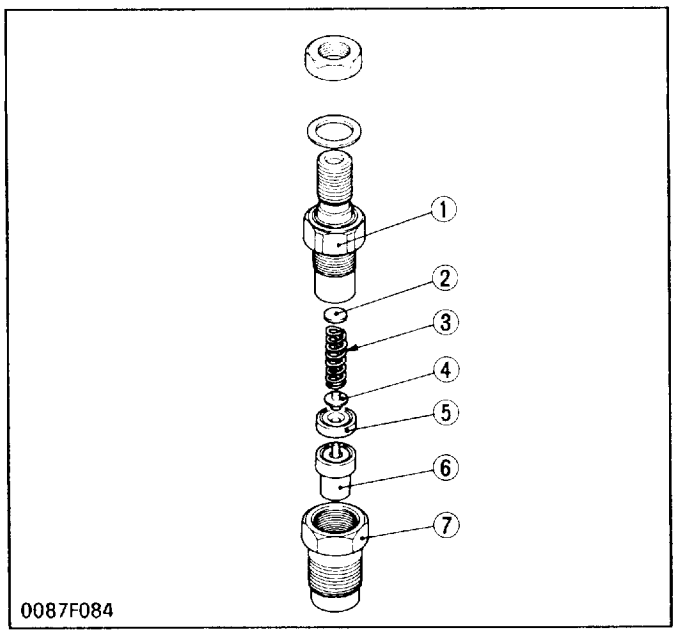
C112F007

■ **IMPORTANT**

- **If replacing the pump element, the amount of fuel injection should be adjusted on a specified bench.**

(1) Pump Body
(2) Control Rack
(3) Delivery Valve Holder
(4) Delivery Valve Spring
(5) Delivery Valve
(6) Tappet Roller
(7) Cylinder
(8) Plunger

## [2] INJECTION NOZZLE



0087F084

**Nozzle Holder**

1. Secure the nozzle retaining nut (7) with a vise.
2. Remove the nozzle holder (1), and take out parts inside.

**(When reassembling)**

- Assemble the nozzle in clean fuel oil.
- Install the push rod (4), noting its direction.
- After assembling the nozzle, be sure to adjust the fuel injection pressure.

(1) Nozzle Holder
(2) Adjusting Washer
(3) Nozzle Spring
(4) Push Rod
(5) Distance Piece
(6) Nozzle Piece
(7) Nozzle Retaining Nut

### Etanchéité au carburant du siège d'aiguille

1. Fixer l'injecteur sur la pompe à tarer.
   Appliquer une pression de 130 kgf/cm² (12,75 MPa, 127,5 bar).
2. Après avoir gardé l'injecteur sous cette pression pendant 10 secondes, vérifier s'il y a des fuites du trou d'injecteur.
3. S'il y a une fuite de carburant, remplacer l'injecteur.

### Kraftstoffdichtigkeit des Düsenventilsitzes

1. Die Einspritzdüse an das Düsenprüfgerät anschließen.
   Einen Druck von 130 kp/cm² (12,75 MPa, 127,5 bar) aufbringen.
2. Die Düse 10 Sekunden unter diesem Druck halten und prüfen, ob Kraftstoff am Düsenventilsitz austritt.
3. Ist dies der Fall, das Düsenteil austauschen.

# DEMONTAGE ET MONTAGE

## [1] POMPE D'INJECTION

**■ IMPORTANT**

- **Lors du remplacement de l'élément de pompe, la quantité d'injection de carburant doit être ajustée sur un banc spécifié.**

(1) Corps de pompe
(2) Tige de réglage
(3) Tubulure de refoulement
(4) Ressort de clapet de refoulement
(5) Clapet de refoulement
(6) Galet de poussoir
(7) Cylindre
(8) Piston

# AUS- UND EINBAU

## [1] EINSPRITZPUMPE

**■ WICHTIG**

- **Bei dem Auswechseln des Pumpenelementes sollte die Kraftstoffeinspritzmenge auf eiinem vorgeschriiebenen Prüfstand eingestellt werden.**

(1) Pumpengehäuse
(2) Regelstange
(3) Druckventilhälter
(4) Druckventilfeder
(5) Druckventil
(6) Stößelrolle
(7) Zylinder
(8) Kolben

## [2] INJECTEURS

### Porte-injecteur

1. Fixer l'écrou de retenue de l'injecteur (7) dans un étau.
2. Enlever le porte-injecteur (1) et retirer les pièces intrieures.

**(Pour le remontage)**

- Monter l'injecteur dans de l'huile fluide propre.
- Noter le sens de la tige de poussoir (4), avant de l'installer.
- Après le montage de l'injecteur, veiller à régler la pression d'injection.

(1) Porte-injecteur
(2) Rondelle de réglage
(3) Ressort d'injecteur
(4) Tige de poussoir
(5) Pièce d'écartement
(6) Pièce de l'injecteur
(7) Ecrou de retenue d'injecteur

## [2] EINSPRITZÜSE

### Düsenhalter

1. Die Düsen-Sicherungsmutter (7) mit einen Schraubstock sichern.
2. Den Düsenhalter (1) entfernen und die Innenteile herausnehmen.

**(Beim Wiedereinbau)**

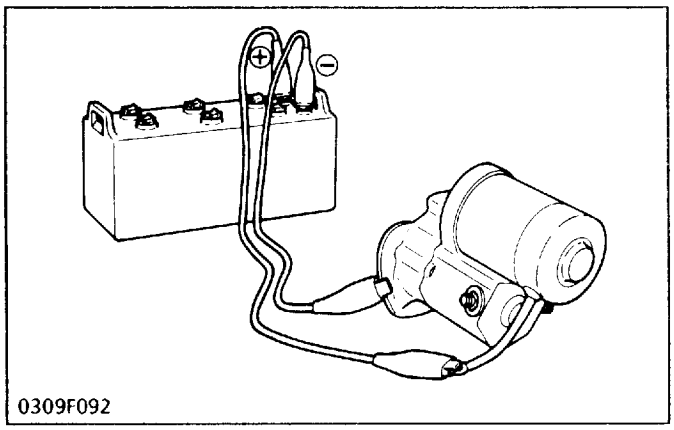
- Die Düse in sauberem Leichtöl zusammensetzen.
- Die Stößelstange (4) unter Beachtung der Richtung montieren.
- Nach erfolgtem Einbau der Düsu muß der Kraftstoff- Einspritzdruck eingestellt werden.

(1) Düsenhalter
(2) Regulierscheibe
(3) Düsenfeder
(4) Stößelstange
(5) Abstandstück
(6) Düsenteil
(7) Düsen-Sicherungsmutter

# 5 ELECTRICAL SYSTEM

## CHECKING

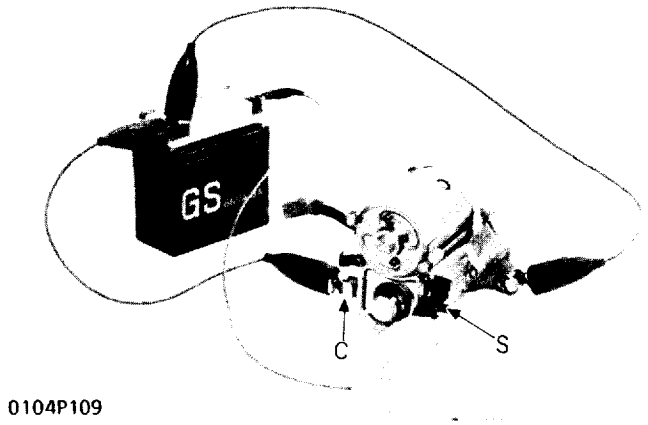
### [1] STARTER



0309F092

**Motor Test**

1. Disconnect the connecting lead from the "C" terminal of the starter and connect a jumper lead from the connecting lead to the positive battery terminal.
2. Connect a jumper lead momentarily between the starter body and the negative battery terminal.
3. If the motor does not run, check the motor.



0104P109

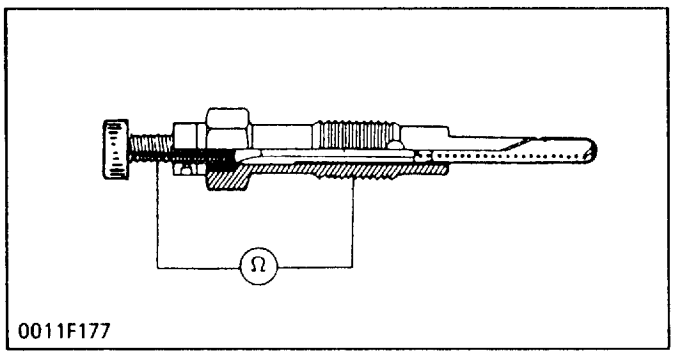
**Magnet Switch**

1. Disconnect the connecting lead from the "C" terminal of the starter.
2. Connect jumper leads from the negative terminal of 6 V battery to the body and "C" terminal of the magnet switch.
3. The pinion gear should pop out, when a jumper lead is connected between the positive terminal of the battery to the "S" terminal of the magnet switch.
4. The pinion gear should stay out without the jumper from the negative terminal to the "C" terminal.

■ **NOTE**

- **Each test should be carried out for a short time, about 3 to 5 seconds.**

### [2] GLOW PLUG



0011F177

**Glow Plug**

1. Disconnect the leads from the glow plugs.
2. Measure the resistance with an circuit tester across the glow plug terminal and the housing.
3. If 0 ohm is indicated, the screw at the tip of the glow plug and the housing are short-circuited.
   If the reference value is not indicated, the glow plug is faulty, replace the glow plug.

| | | |
|---|---|---|
| Glow plug resistance | Factory spec. | 0.8 Ω |

# 5 SYSTEME ELECTRIQUE

## VERIFICATION

### [1] DEMARREUR

**Essai de moteur**

1. Débrancher le câble de la borne "C" du démarreur et connecter un fil volant entre le câble et la borne positive de la batterie.
2. Connecter provisoirement un fil volant entre le corps du démarreur et la borne négative de la batterie.
3. Si le moteur ne tourne pas, le vérifier.

**Commutateur magnétique**

1. Débrancher le câble de la borne "C" du démarreur.
2. Brancher des fils volants entre la borne négative de la batterie de 6 V et le corps du démarreur et la borne "C" du commutateur magnétique.
3. Le pignon d'attaque doit saillir en-dehors lorsque l'on branche un fil volant entre la borne positive de la batterie et la borne "S" du commutateur magnétique.
4. Le pignon d'attaque doit rester sorti sans le fil volant venant de la borne négative et sorti allant à la borne "C".

■ **NOTA**

- **Chaque essai doit être effectué rapidement : ne pas dépasser de 3 à 5 secondes.**

### [2] BOUGIE DE PRECHAUFFAGE

**Bougie de préchauffage**

1. Déconnecter les conducteurs des bougies de préchauffage.
2. Mesurer la résistance en branchant un ohmmètre à la borne de la bougie de préchauffage et au corps.
3. Si l'ohmmètre indique 0 ohm, la vis à l'extrémité de la bougie de préchauffage et le corps sont court-circuités.

| | | |
|---|---|---|
| Résistance de la bougie de préchauffage | Valeur de référence | 0,8 Ω |

# 5 ELEKTRISCHES-SYSTEM

## ÜBERPRÜFUNG

### [1] ANLASSER

**Motorprüfung**

1. Die Verbindungleitung an der Klemme "C" des Anlassers lösen und einen Schaltdraht zwischen der Verbindungsleitung und der Plus-Klemme der Batterie anschließen.
2. Für kurze Zeit einen Schaltdraht zwischen dem Anlassergehäuse und der Minus-Klemme der Batterie anschließen.
3. Wenn der Motor nicht läuft, überprüfun.

**Magnetschalter**

1. Die Verbindungsleitung an der Klemme "C" des Anlassers lösen.
2. Die Schaltdrähte zwischen der Minus-Klemme der Batterie 6 V und dem Gehäuse und der Klemme "C" des Magnetschalters anschließen.
3. Das Zahngetriebe sollte ausgerückt sein, wenn einen Schaltdraht zwischen der Plus-Klemme der Batterie und der Klemme "S" des Magnetschalters angeschlossen wird.
4. Das Schaltgetriebe sollte ohne den Schaltdraht zwischen der Minus-Klemme und der Klemme "C" ausgelassen werden.

■ **ANMERKUNG**

- **Jede Prüfung sollte über eine kurze Zeitdauer von 3 bis 5 Sekunden durchgeführt werden.**

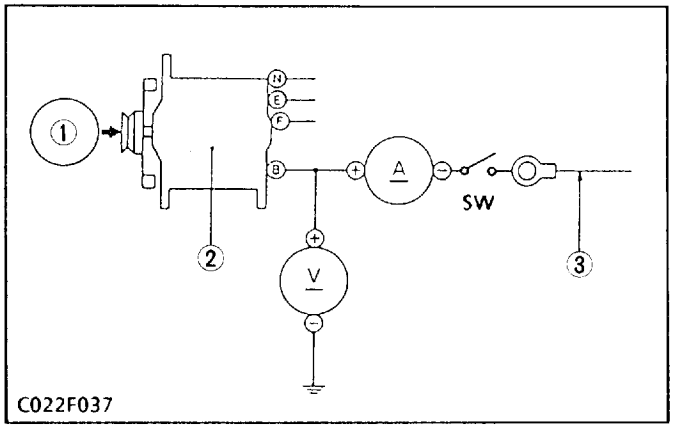
### [2] GLÜHKERZE

**Glühkerze**

1. Die Leitungen von den Glühkerzen trennen.
2. Mit einem Ohmmeter den Widerstand über der Glühkerzen-Anschlußklemme und dem Gehäuse messen.
3. Wird 0 Ohm angezeigt bedeutet es, daß die Schraube auf der Glühkerzenspitze mit dem Gehäuse kurzgeschlossen ist.

| | | |
|---|---|---|
| Widerstand Glühkerze | Werkdaten | 0,8 Ω |

# [3] STANDARD-ALTERNATOR AND REGULATOR



C022F037

(1) Revolution Counter
(2) Alternator
(3) B terminal Lead

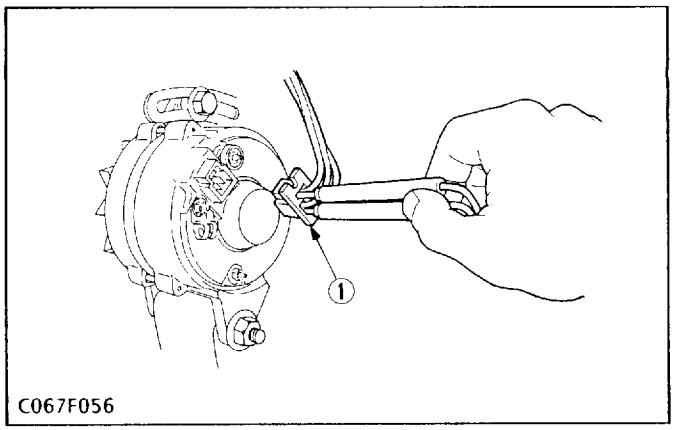
## Output Current

1. Disconnect the cable from the alternator's **B** terminal and connect an ammeter and voltmeter to **B** terminal. Then switch on all electrical loads (such as lights and battery) and read the meters.

| | |
|---|---|
| Output current | 35 A |
| Voltage | 14 V |
| Rotational speed | 4000 rpm |

**■ NOTE**

- **Be sure to disconnect the battery's negative cable before setting the ammeter and voltmeter.**
- **When the electrical load is considerably low or the battery is fully charged, the specified reading cannot be obtained.**



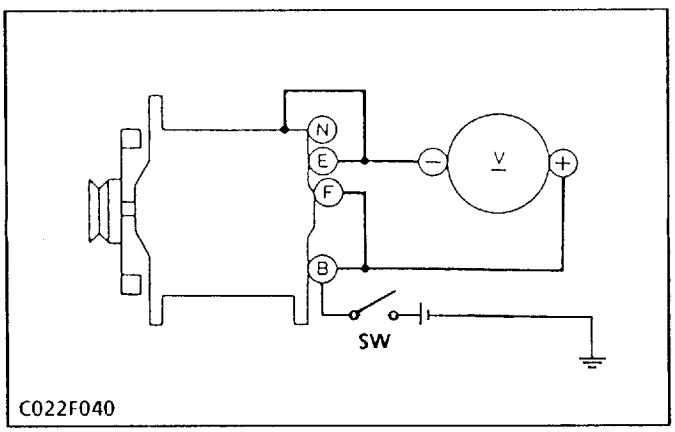
C067F056

## Connector Voltage

1. Disconnect the connector from the alternator.
2. Turn the main switch on and then measure the voltage across the alternator connector's **F** and **E** terminals.

| | | |
|---|---|---|
| Connector voltage (**F** -**E**) | Factory spec. | 12 V |

(1) Coupler



C022F040

## No-Load Testing

1. Disconnect the alternator's connector, connect the alternator's **F** terminal to **B** terminal, and ground **E** terminal to the body. (Do not remove the B terminal lead to battery.)
2. Start the engine and speed up the alternator to the specified rpm. (1050 to 1350). Next, turn the key-switch off of battery circuit or disconnect the battery's negative cable.
3. Connect a voltmeter across **B** terminal and **E** terminal and measure the voltage.

| | |
|---|---|
| Voltage | 14 V |
| Rotational speed | 1050 to 1350 rpm |

# [3] ALTERNATEUR-STANDARD ET REGULATEUR

## Courant de sortie

1. Déconnecter le câble provenent de la borne B de l'alternateur et connecter un ampèremètre et un voltmètre à la borne B. Ensuite, mettre en marche toutes les charges électriques (telles que les lampes et batterie) et lire les valeurs indiquée.

| | |
|---|---|
| Courant de sortie | 35 A |
| Tension | 14 V |
| Vitesse de rotation | 4000 tr/mn |

**■ NOTA**

- **Déconnecter le câble négatif de batterie avant de monter l'ampéremètre et le voltmètre.**
- **Lorsque la charge électrique est considérablement faible ou que la batterie est pleinement chargée, les indications spécifiées ne peuvent pas être obtenues.**

(1) Compte-tours
(2) Altornatour
(3) Conducteur de borne B

## Tension de connecteur

1. Débrancher le connecteur de l'alternateur.
2. Mettre l'interrupteur principal en marche, puis mesurer la tension aux bornes F et E du connecteur d'alternateur.

| | | |
|---|---|---|
| Tension de connecteur (F -E) | Valeur de référence | 12 V |

(1) Connecteur

## Essai à vide

1. Débrancher le connecteur d'alternateur, brancher la borne F de l'alternateur à la borne B, et la borne de terre E au corps. (Ne pas debrancher le câble entre la borne B et la batterie.)
2. Faire démarrer le moteur et augmenter la vitesse de l'alternateur jusqu'à 1050 à 1350 tr/mn. Ensuite, couper l'interrupteur principal du circuit de la batterie, déconnecter le câble négatif de batterie et mesurer la tension.
3. Connecteûr un voltmètre à la borne B et à la borne de terre ou E, et Mesure la tension

| | |
|---|---|
| Tension | 14 V |
| Vitesse de rotation | 1050 à 1350 tr/mn |

# [3] GENORMTES-LICHTMASCHINE UND REGLER

## Ausgangsstrom

1. Das Kabel von der Klemme B der Lichtmaschine trennen und ein Ampere- und Voltmeter an Klemme B verbinden. Anschließend alle elektrischen Verbraucher (wie z.b. Scheinwerfer und batterie) einschalten und die Meßwerte ablesen.

| | |
|---|---|
| Ausgangsstrom | 35 A |
| Spannung | 14 V |
| Drehzahl | 4000 U/min |

**■ ANMERKUNG**

- **Darauf achten, vor Einstellung des Ampere- und Voltmessers das Minukabel abzuklemnen.**
- **Falls die elektrische Ladung wesentlich niedriger oder die Batterie voll aufgeladen ist, kann der vorgeschriebene Wert nicht erreicht werden.**

(1) Drehzahlmesser
(2) Lichtmaschine
(3) Anschlaußklemme B

## Verbindungsstückspannung

1. Das Verbindungsstück von der Lichtmaschine trennen.
2. Den Hauptschalter aufdrehen und die Spannung über die Klemmen F und E der Lichtmaschine messen.

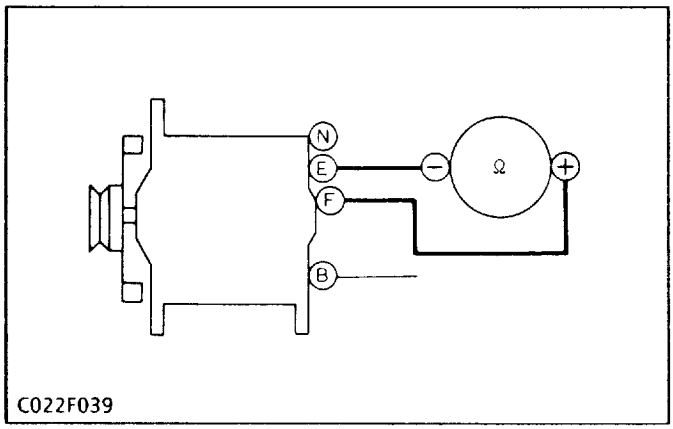
| | | |
|---|---|---|
| Verbindungsstück-spannung (F -E) | Werkdaten | 12 V |

(1) Verbindungsstück

## Leerlaufprüfung

1. Das Verbindungsstück von der Lichtmaschine entfernen und Lichtmaschinen-Klemme F an Klemme B und Klemme E and Masse anschließen. (Das kabel zwischen der Klemme B und der Masse nicht trennen.)
2. Den Motor anlassen und die Lichtmaschine bis zur vorgeschriebenen Drehzahl (1050 bis 1350 U/min) beschleunigen. Dann den Hauptschalter des batteriekreises ausschalten, und das Minuskabel abklemmen und die Spannung messen.
3. Das Voltmeter an Klemme B und Masse oder Klemme E anschließen, und die spannung wessen.

| | |
|---|---|
| Spannung | 14 V |
| Drehzahl | 1050 bis 1350 U/min |

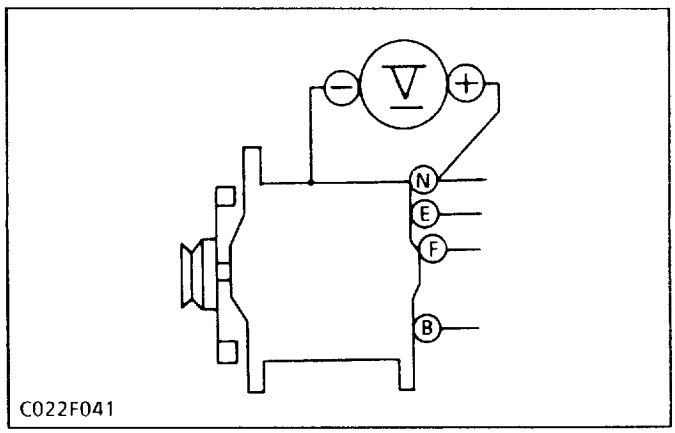


C022F039

## Rotor Coil Resistance

1. Disconnect the alternator connector and then measure the resistance across the alternator's **F** and **E** terminals.

| | | |
|---|---|---|
| Terminal resistance (F - E) | Factory spec. | 4 ohms |



C022F041

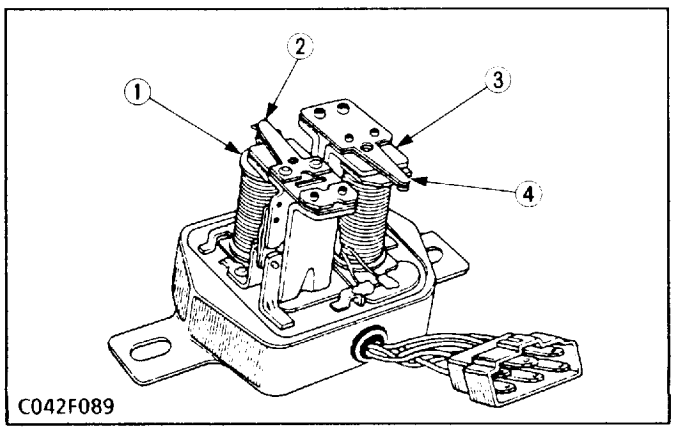
## Cut-In Voltage

1. Connect a voltmeter across the alternator's **N** terminal and the body.
2. Remove the fuse shown in below and connect a bulb (30W) in its place.
3. Speed up the alternator until the charge warning lamp goes off or dims, then read the voltmeter.

| | | |
|---|---|---|
| Cut-in voltage | Factory spec. | 4.5 to 5.8 V |

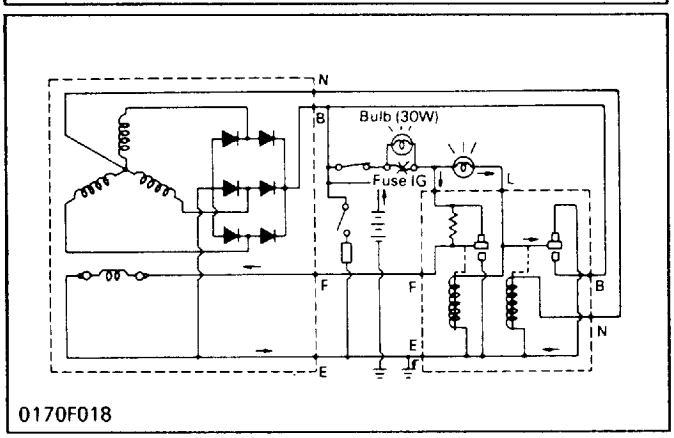
■ **NOTE**

- **When the cut-in voltage is high, bend the adjusting arm (4) of voltage relay close to the pressure coil, and when low, bend it away from.**



C042F089

(1) Voltage Regulator
(2) Adjusting Arm
(3) Voltage Relay
(4) Adjusting Arm



0170F018

## Bobinage de rotor resistance

1. Débrancher le connecteur d'alternateur, puis mesurer la résistance entre les bornes F et E de l'alternateur.

| | | |
|---|---|---|
| Résistance aux bornes (F - E) | Valeur de référence | 4 ohms |

## Tension de mise en circuit

1. Connecter un voltmètre à la borne N de l'alternateur et au corps.
2. Enlever le fusible indiqué ci-dessous et connecter une ampoule (30 W) à sa place.
3. Augmenter la vitesse de l'alternateur jusqu'à ce que le voyant de charge s'eéteigne ou baisse, puis relever le voltmètre.

| | | |
|---|---|---|
| Tension de mise en circuit | Valeur de référence | 4,5 à 5,8 V |

■ **NOTA**

- **Lorsque la tension de mise en circuit est haute, fléchir le bras de réglage (4) du relais d'induction vers le bobinage d'induction et lorsqu'elle est basse, le fléchir à l'écart du bobinage d'induction.**

(1) Régulateur de tension
(2) Bras de réglage
(3) Relais d'induction
(4) Bras de réglage

## Widerstand Läuferspule

1. Das Verbindungsstück von der Lichtmaschine entfernen und den Widerstand zwischen der Lichtmaschinen-Klemmen F und E messen.

| | | |
|---|---|---|
| Klemmenwiderstand (F - E) | Werkdaten | 4 ohms |

## Einschaltsspannung

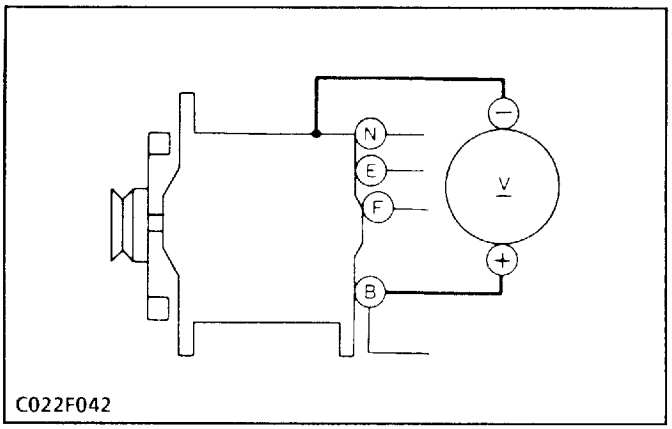
1. Ein Voltmeter zwischen Klemme N der Lichtmaschine und Masse verbinden.
2. Die unten gezeigte Sicherung herausnehmen und eine Lampe (30 W) an ihre Stelle verbinden.
3. Die Lichtmaschine beschleunigen, bis die Warnlampe für die Lichtmaschine erlischt oder abgeschwächt wird und dann den Meßwert ablesen.

| | | |
|---|---|---|
| Einschaltsspannung | Werkdaten | 4,5 bis 5,8 V |

■ **ANMERKUNG**

- **Falls die Einschaltsspannung zu hoch ist, den Einstellhebel (4) des Spannungsrelais zur Druckspule hin biegen und wenn sie zu niedrig ist von der Druckspule weg biegen.**

(1) Spannungsregler
(2) Einstellhebel
(3) Spannungsrelais
(4) Einstellhebel



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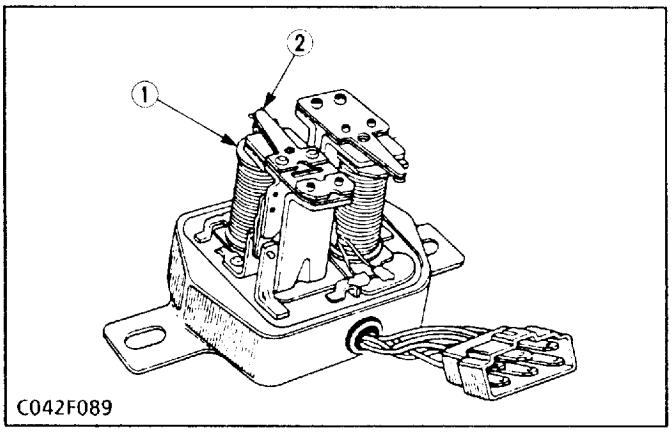


C042F089

## No-Load Regulating Voltage

1. Connect a voltmeter across the alternator's **B** terminal and the ground.
2. Start the engine, speed up to a rate(approx.1300 rpm) where the alternator is self-excited, and disconnect the battery's negative cable.
3. Read the voltmeter while gradually accelerating the engine.

| | | |
|---|---|---|
| Regulating voltage | Factory spec. | 13.8 to 14.8 V |

**■ NOTE**

- **Be sure to gradually accelerate the engine while reading the voltmeter. Never obtain the specified engine speed by decelerating the engine from maximum speed.**
- **When the regulating voltage is high, bend the adjusting arm (2) of voltage regulator (1) close to the voltage coil, and when low, bend it away from.**

(1) Voltage Regulator
(2) Adjusting Arm

## Tension de réglage à vide

1. Connecter un voltmètre à la borne B de l'alternateur et à la borne de terre.
2. Faire démarrer le moteur, augmenter son régime jusqu'à une valeur (1300 tr/mn env.) où l'alternateur est autoexcité, et déconnecter le câble négatif de batterie.
3. Relever le voltmètre tout en accélérant graduellement le moteur.

| | | |
|---|---|---|
| Tension de réglage | Valeur de référence | 13,8 à 14,8 V |

### ■ NOTA

- Accelerer graduellement le moteur en relevant le voltmètre. Ne pas obtenir la vitesse de moteur spécifiée en décélérant le moteur à partir du régime maximum.
- Lorsque la tension de réglage est haute, fléchir le bras de réglage (2) du régulateur de tension (1) vers la bobinage de tension et lorsqu'elle est basse, le fléchir à l'écart du bobinage de tension.

(1) Régulateur de tension
(2) Bras de réglage

## Leeerlauf-Reglerspannung

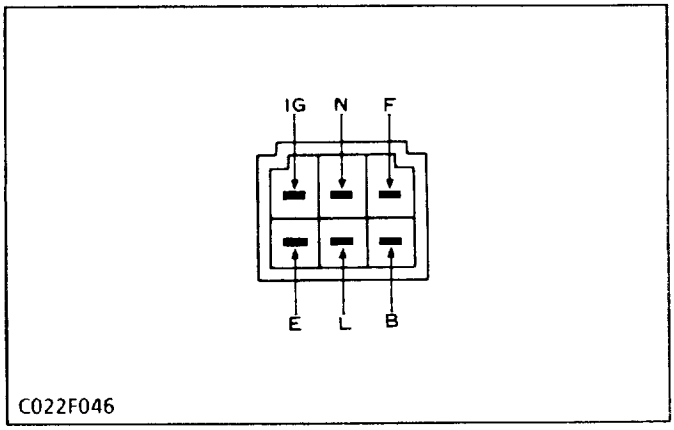
1. Ein Voltmeter zwischen Klemme B der Lichtmaschine und Masse verbinden.
2. Den Motor anlassen und auf eine Drehzahl beschleunigen (ca. 1300 U/min) bei der die Lichtmaschine selbsterregt wird und das Minuskabel von der Batterie abklemmen.
3. Das Voltmeter während der stufenweisen Beschleunigung des Motors ablesen.

| | | |
|---|---|---|
| Reglerspannung | Werkdaten | 13,8 bis 14,8 V |

### ■ ANMERKUNG

- Darauf achten, daß beim Ablesen des Voltmeters der Motor stufenweise beschleunigt wird. Niemals die vorgeschriebene Motordrehzahl durch Geschwindigkeitsabnahme der Höchstgeschwindigkeit erreichen.
- Falls die Reglerspannung zu hoch ist, den Einstellhebel (2) des Spannungsreglers (1) zur Spannungsspule hin biegen und wenn sie zo niedrig ist von der Spannungsspule weg biegen.

(1) Spannungsregler
(2) Einstellhebel



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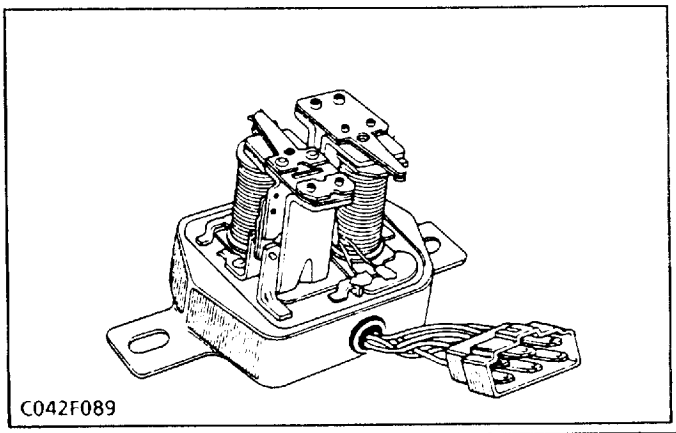
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## Regulator Relay

**Test terminals IG-F, F-E, N-E, L-E, B-E and B-L.**

1. Check the continuity across the each terminals. (The nominal resistances between terminals are given below for reference.)
2. Press the adjusting arm (2) of the voltage regulator (1) or press the adjusting arm (4) of voltage relay (3) and check the continuity. (The nominal resistances between terminals are given below for reference.)

**■ NOTE**

- **"Pull" means the condition where the armature point is contacting the high-speed side point with finger pressure only.**
- **"Stationary" means the condition where the armature point is in contact the low-speed side point.**

(1) Voltage Regulator
(2) Adjusting Arm
(3) Voltage Relay
(4) Adjusting Arm

| Terminals | Voltage relay | Voltage regulator | Normal resistance Ω | Failure and Probable Causes |
|---|---|---|---|---|
| IG ——— F (Black/white) (White/green) | — | Stationary | 0 | If the reading is over 0, bad contact on low-speed side point of voltage regulator. |
| | — | Pull | Approx. 11 | If the reading is not normal res., the control resister is faulty. |
| F ——— E (White/Green) (Black) | — | Stationary | ∞ | If the reading is not ∞, bad contact on low-speed side point of voltage regulator. |
| | — | Pull | 0 | If the reading is not 0, bad contact on high-speed side point of voltage regulator. |
| I ——— E (White/Red) (Black) | Stationary state | — | 0 | If reading is over 0, bad contact on voltage relay point P1. |
| | Pull | — | Approx. 100 | If reading is 0, deposition occurs on voltage relay point P1.<br>If reading is ∞, voltage coil is cut. |
| N ——— E (White/Black) (Black) | — | — | Approx. 23 | If reading is 0, relay coil is shorted.<br>If reading is ∞, pressure coil is cut |
| B ——— E (White) (Black) | Stationary | — | ∞ | If reading is ∞, voltage relay point 2 is melted and burned. |
| B ——— L (White) (White/Red) | Pull | — | 0 | If reading is over 0, bad contact on voltage relay point P2. |

## Relais de régulateur

**Bornes d'essai IG-F, F-E, N-E, L-E, B-E et B-L**

1. Vérifier la continuité entre bornes.
   (Les résistances nominales entre bornes sont données ci-dessous à titre de référence.)
2. Appuyer sur le bras de réglage (2) du régulateur de tension (1) ou sur le bras de réglage (4) du relais d'induction (3) et vérifier la continuité.
   (Les résistances nominales entre bornes sont données ci-dessous à titre de référence.)

**■ NOTA**

- **"Tiré" signifie l'état où le point d'induit est en contact avec le point du côté grande vitesse par la pression du doigt seulement.**
- **"Fixe" signifie l'état où le point d'induit est en contact avec le point du côté petite vitesse.**

(1) Régulateur de tension
(2) Bras de réglage
(3) Relais d'induction
(4) Bras de réglage

## Reglerrelais

**Probeklemmen IG-F, F-E, N-E, L-E, B-E und B-L**

1. Auf Durchgang zwischen den jeweiligen Klemmen prüfen.
   (Der Nennwiderstand zwischen den Klemmen ist für Bezugnahme angeführt.)
2. Den Einstellhebel (2) des Spannungsreglers (1) oder den Einstellhebel (4) des Spannungsreglers (3) drücken und auf Durchgang überprüfen.

**■ ANMERKUNG**

- **"Ziehen" bedeutet der Zustand, bei dem die Läuferspitze nur bei Fingedruck den Punkt auf der Schnellgeschwindigkeitsseite berührt.**
- **"Unbeweglich" bedeutet der Zustand, bei dem die Läuferspitze den Punkt auf der Niedergeschwindigkeitsseite berührt.**

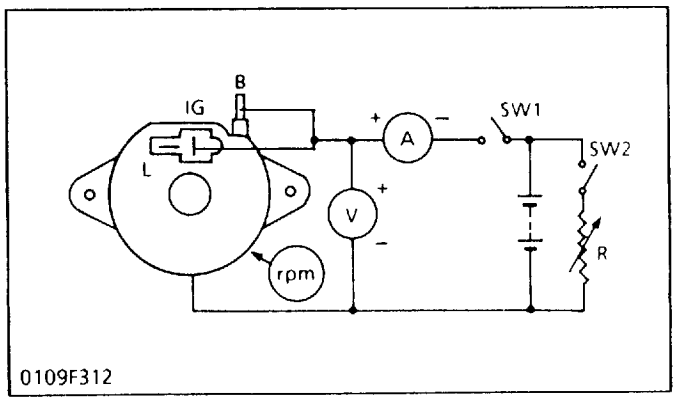
(1) Spannungsregler
(2) Einstellhebel
(3) Spannungsrelais
(4) Einstellhebel

| Bornes<br>*Klemme* | Relais d'induction<br>*Spannungs-relais* | Régulateur de tension<br>*Spannungs-regler* | Résistance normale (ohms)<br>*Nennwiderstand (ohm)* | Défaut et causes probables<br>*Störung und mögliche Ursache* |
|---|---|---|---|---|
| IG ——— F<br>(Noir/blanc)<br>*(Schwarz/weiß)*<br>(Blanc/vert)<br>*(Weiß/Grün)* | — | Fixe<br>*Unbeweglich* | 0 | Si la valeur indiquée est supérieure à 0, un mauvais contact du point du côté petite vitesse du régulateur de tension est supposé.<br>*Wenn der Meßwert mehr als 0 beträgt, schlechter Kontakt am niedergeschwindigkeitsseitigen Punkt des Spannungsreglers.* |
| | — | Tiré<br>*Ziehen* | Env. 11<br>*Ca. 11* | Si la valeur indiquée est inférieure à la résistance normale, la résistance de réglage est défectueuse.<br>*Wenn der Meßwert einen anomalen Widerstand zeigt ist der Steuerdierstand fehlerhaft.* |
| F ——— E<br>(Blanc/vert)<br>*(Weiß/Grün)*<br>(Noir)<br>*(Schwarz)* | — | Fixe<br>*Unbeweglich* | ∞ | Si la valeur indiquée n'est pas infinie, un mauvais contact du point du côté petite vitesse du régulateur de tension est supposée.<br>*Wenn der Meßwert nicht ∞ beträgt, schlechter Kontakt am niedergeschwindigkeitsseitigen Punkt des Spannungsreglers* |
| | — | Tiré<br>*Ziehen* | 0 | Si la valeur indiquée est de 0, un mauvais contact du côté grande vitesse du régulateur de tension est supposé.<br>*Wenn der Meßwert nicht 0 beträgt, schlechter Konkakt am hochgeschwindigkeitssetigen Punkt des Spannungsreglers* |
| I ——— E<br>(Blanc/Rouge)<br>*(Weiß/Rot)* | Fixe<br>*Unbeweglic* | — | 0 | Si la valeur indiquée est supérieure à 0, un mauvais contact du point de relais d'induction P1 est supposé.<br>*Wenn der Meßwert mehr als 0 beträgt, schlechter Konkakt am Spannungsrelaispunkt P1.* |
| (Noir)<br>*(Schwarz)* | Tiré<br>*Ziehen* | — | Env. 100<br>*Ca. 100* | Si la valeur indiquée est de 0, les dépôts sont présents au point de relais d'induction P1.<br>Si elle est infinie, le bobinage de tension est rompu.<br>*Wenn der Meßwert 0 beträgt sind Ablagerungen am Spannungsrelaispunkt P1 vorhanden.*<br>*Wenn der Meßwert ∞ beträgt ist die Spannungsspule gebrochen.* |
| N ——— E<br>(Blanc/Noir)<br>*(Weiß/Schwarz)*<br>(Noir)<br>*(Schwarz)* | — | — | Env. 23<br>*Ca. 23* | Si la valeur indiquée est de 0, le bobinage de relais est court-circuité.<br>Si elle est infinie, le bobinage d'induction est romkpu.<br>*Wenn der Meßwert 0 beträgt, ist die Relaisspule kurzgeschlossen. Wenn der Meßwert ∞beträgt ist die Druckspule gebrochen.* |
| B ——— E<br>(Blanc) (Noir)<br>*(Weiß) (Schwarz)* | Fixe<br>*Unbeweglic* | — | ∞ | Si la valeur indiquée est infinie, le point de relais d'éinduction 2 est fondu et grillé.<br>*Wenn der Meßwert ∞ beträgt ist der Spannungs-relaispunkt 2 geschmolzen und durchgebrannt.* |
| B ——— L<br>(Blanc) (Blanc/Rouge)<br>*(Weiß) (Weiß/Rot)* | Tiré<br>*Ziehen* | — | 0 | Si la valeur indiquée est supérieure à 0, un mauvais contact du point de relais d'induction P2 est supposé.<br>*Wenn der Meßwert mehr als 0 beträgt, besteht schlechter Kontakt am Spannungsrelaispunkt P2.* |

# [4] COMPACT TYPE (EQUIPPED WITH IC REGULATOR)

(precaution when checking)

- Do not directory connect the terminal "**L**" with the terminal "**B**". Otherwise, the three exciting diodes may be damaged. When connecting the terminal "**L**", insert a 3.4 W lamp between the terminals "**L**" and "**B**".
- Always use a fully charged battery.
- Be careful to observe the proper polarity of the battery. Never install the battery in the wrong direction.
- Never disconnect the battery while the alternator is operating.



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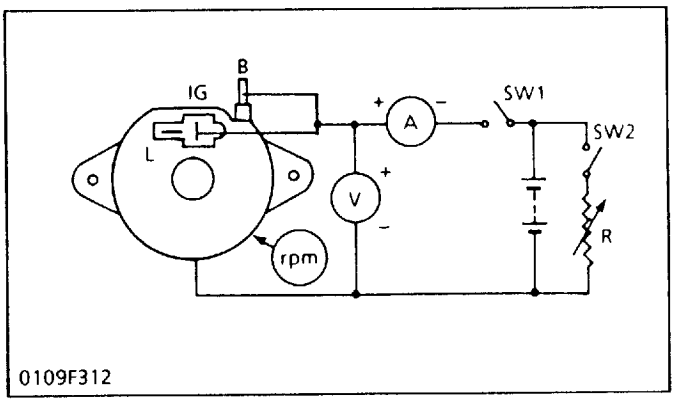

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## Regulating Voltage

1. Make the connections as shown in the figure, and turn on switch "**SW1**".
2. Increase the alternator speed to 5000 rpm.
3. Turn on switch "**SW2**". Adjust load resistance "**R**" so that the ammeter shows 10A.
4. Check that the voltage reading on the voltmeter is within the factory specifications.

| | | |
|---|---|---|
| Regulating voltage | Factory spec. | 14.2 to 14.8 V |

## No-Load Characteristics

1. Make the connections as shown in the figure, and turn on switch "**SW1**".
2. Increase the alternator speed so that the pointer of the ammeter swings to the plus side.
3. Turn off switch "**SW1**" to decrease the speed, and read the speed at which the voltage is equal to the factory specification.
4. The speed must be below the factory specification.

| | | |
|---|---|---|
| No-load characteristics | Factory spec. | 1400 rpm or less"at 13.5 V |

## Output Characteristics

1. Make the connections as shown in the figure above, and turn on switch "**SW1**" and "**SW2**".
2. Increase the alternator speed while adjusting the load resistance so that the voltage complies with the factory specification.
3. Read the speed at which the current is equal to the factory specification.
4. The speed must be below the factory specification.
5. Decrease the speed so that the current approaches zero, the turn off switches "**SW1**" and "**SW2**".

| | | |
|---|---|---|
| Output characteristics | Factory spec. | 43 A or more at 13.5 V, 5000 rpm |

# [4] TYPE COMPACT (AVEC UN REGULATEUR A CIRCUIT INTEGRE

(Précaution lors de la vérification)
- Ne pas connecter directement la borne "L" à la borne "B", faute de quoi les trois diodes d'excitation peuvent être endommagées. Lors de la connexion de la borne "L", insérer une lampe de 3,4 W entre les bornes "L" et "B".
- Toujours utiliser une batterie complètement chargée.
- Faire attention à observer la polarité correcte de la batterie. Ne jamais installer la batterie dans le mauvais sens.
- Ne jamais déconnecter la batterie pendant que l'alternateur fonctionne.

## Tension de régulation

1. Effectuer les connecxions comme indiqué dans la figure et enclencher le contacteur "SW1".
2. Augmenter la vitesse de l'alternateur à 5000 tr/mn.
3. Enclencher le contacteur "SW2". Ajuster la résistance de charge "R" de sorte que l'ampèremètre indique 10 A.
4. Vérifier que l'indication de tension sur le voltmètre est dans les limites des caractéristiques d'usine.

| | | |
|---|---|---|
| Tension de régulation | Valeur de référence | 14,2 à 14,8 V |

## Caractéristiques à vide

1. Effectuer les connexions comme indiqué dans la figure et enclencher le contacteur "SW1".
2. Augmenter la vitesse de l'alternateur de sorte que l'aiguille de l'ampèremètre oscille vers le côté plus.
3. Désenclencher le contacteur "SW1" pour réduire la vitesse et lire la vitesse à laquelle la tension est égale aux caractéristiques d'usine.
4. La vitesse doit être inférieure aux caractéristiques d'usine.

| | | |
|---|---|---|
| Caractéristiques à vide | Valeur de référence | 1,400 tr/mn ou moins à 13,5 V |

## Caractéristiques de sortie

1. Effectuer les connexions comme indiqué dans la figure ci-dessus et enclencher les contacteurs "SW1" et "SW2".
2. Augmenter la vitesse de l'alternateur tout en ajustant la résistance de charge de sorte que la tension soit conforme avec les caractéristiques d'usine.
3. Lire la vitesse à laquelle le courant est égal aux caractéristiques d'usine.
4. La vitesse doit être inférieure aux caractéristiques d'usine.
5. Réduire la vitesse de sorte que le courant s'approche de zéro, puis désenclencher les contacteurs "SW1"et "SW2".

| | | |
|---|---|---|
| Caractéristiques de sortie | Valeur de référence | 43 A ou plus à 13,5 V, 5,000 tr/mn |

# [4] KOMPAKTE TYP (MIT EINER INTER GRIERTEN REGLERSCHALTUNG)

(Vorsichtsmaßnahme bei der Prüfung)
- Niemals die Klemme "L" direkt mit der Klemme "B" verbinden. Anderenfalls können die drei Erreger-Dioden beschädigt werden. Wenn die Klemme "L" angeschlossen wird, eine 3,4 W Lampe zwischen die Klemmen "L" und "B" schalten.
- Immer eine voll aufgeladene Batterie verwenden.
- Auf richtige Polung der Batterie achten. Niemals die Batteire in der falschen Richtung einsetzen.
- Niemals die Batterie abtrennen während die Lichtmaschine arbeitet.

## Regelspannung

1. Die in der Abbildung gezeigten Anschlüsse vornehmen und den Schalter **"SW1"** einschalten.
2. Die Lichtmaschinen-Drehzahl auf 5,000 l/min. erhöhen.
3. Den Schalter **"SW2"** einschalten. Den Lastwiderstand **"R"** so einstellen, daß das Amperemeter 10 A anzeigt.
4. Darauf achten, daß die spannungsanzeige an dem Voltmeter innerhalb der Werks-Spezfikations liegt.

| | | |
|---|---|---|
| Regelspannung | Werks-Spezifikation | 14,2 bis 14,8 V |

## Kennwerte ohne Last

1. Die in der Abbildung gezeigten Anschlüsse vornehmen und den Schalter **"SW1"** einschalten.
2. Die Lichtmaschinen-Drehzahl erhöhen, so daß der zeiger des Amperemeters auf die Plus-Seite ausschlägt.
3. Den Schalter **"SW1"** ausschalten, um die Drehzahl zu vermindern, und die Drehzahl ablesen, bei der die Spannung gleich der Werks-Spezifikation ist.
4. Die Drehzahl muß unter der Werks-Spezifikation liegen.

| | | |
|---|---|---|
| Kennwert ohne Last | Werks-Spezifikation | 1,400 U/min. oder weniger bei 13,5V |

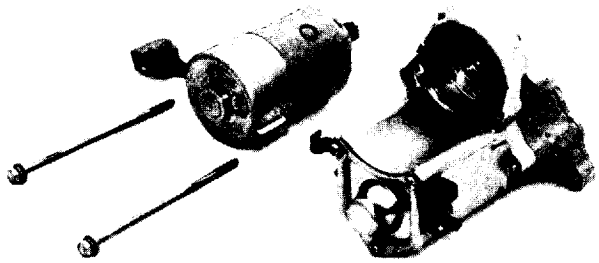
## Ausgangs-Kennwerte

1. Die in der obigen Abbildung dargestellten Anschlüsse vornehmen und die Schalter "SW1" und "SW2" einschalten.
2. Die Lichtmaschinen-Drehzahl erhöhen, während der Last-widerstand eingestellt wird, so daß die Spannung der Werks-Spezifikation entspricht.
3. Die Drehzahl ablesen, bei der die Stromastärke gleich der Werks-Spezifikation ist.
4. Die Drehzahl muß unter der Werks-Spezifikation liegen.
5. Die Drehzahl vermindern, so daß die Stromstärke an Null angenähert wird, und die Schalter "SW1" und "SW2" ausschalten.

| | | |
|---|---|---|
| Ausgangs-Kennwert | Werks-Spezifikation | 43 A oder nehr bei 13,5 V, 5,000 U/min. |

# DISASSEMBLING AND ASSEMBLING

## [1] STARTER



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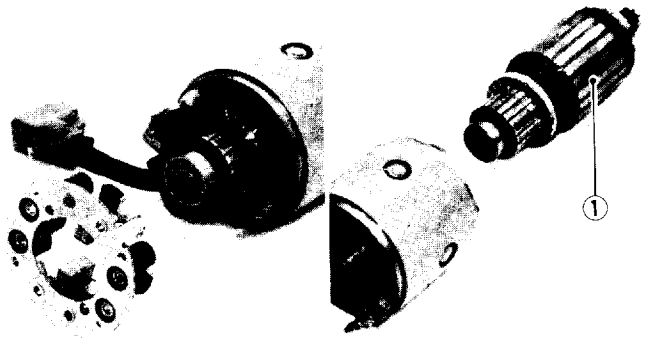
### Starter Motor

1. Disconnect the connecting lead.
2. Remove the mounting nuts.
3. Remove the magnet switch by sliding it up so that it is disconnected from the drive lever.

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0107P087

### Brush Holder

1. Draw out the brush from the holder while holding the spring up.
2. Remove the brush holder.

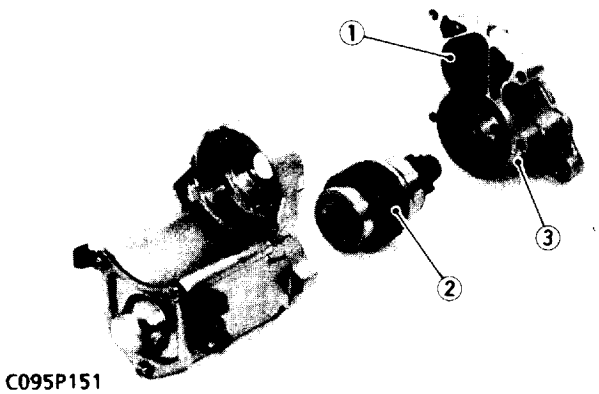
**(When reassembling)**

- Do not damage the brush, commutator and bearing.

### Armature

1. Draw out the armature (1).

(1) Armature

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### Housing, Idle Gear and Overrunning Clutch

1. Remove the housing (3).
2. Remove the idle gear (1) and the overrunning clutch (2).

**■ NOTE**

- **Do not damage the clutch bearing and do not let the dust adhere to it.**
- **Do not lose the steel ball in the overrunning clutch.**

(1) Idle Gear
(2) Overrunning Clutch
(3) Housing

# DEMONTAGE ET MONTAGE

## [1] DEMARREUR

### Contacteur magnétique

1. Débrancher le fil de connexion.
2. Retirer l'écrou de montage.
3. Déposer le contacteur magnétique en le faisant glisser vers le haut de manière à le désaccoupler du levier d'entrainement.

### Porte-balais

1. Extraire le balai du porte-balais en soulevant le ressort.
2. Déposer le porte-balais.

**(Au remontage)**

- Ne pas endommager le balais, le collecteur et le roulement.

### Induit

1. Extraire l'induit (1) solidaire.

(1) Induit

### Carter , pignon de renvoi et roue libre

1. Enlever le carter (3).
2. Enlever le pignon de renvoi (1) et la roue libre (2).

**■ NOTA**

- **Ne pas endommager le palier de roue libre et ne pas laisser la poussière y adhérer.**
- **Ne pas perdre la bille en acier de la roue libre.**

(1) Pignon de renvoi
(2) Roue libre
(3) Carter

# AUS- UND EINBAU

## [1] ANLASSER

### Magnetschalter

1. Das Anschlußkabel abklemmen.
2. Die Haltemutter abschrauben.
3. Den Magnetschalter nach oben hin abziehen, so daß er aus dem Ausrückhebel gleitet.

### Bürstenhalter

1. Die Feder nach oben ziehen und die Bürste vom Halter ziehen.
2. Den Bürstenhalter abnehmen.

**(Beim Wiedereinbau)**

- Darauf achten, daß die Bürste, kommutator und Lager nicht beschädigt werden.

### Anker

1. Den Anker (1) mit dem herausziehen.

(1) Anker

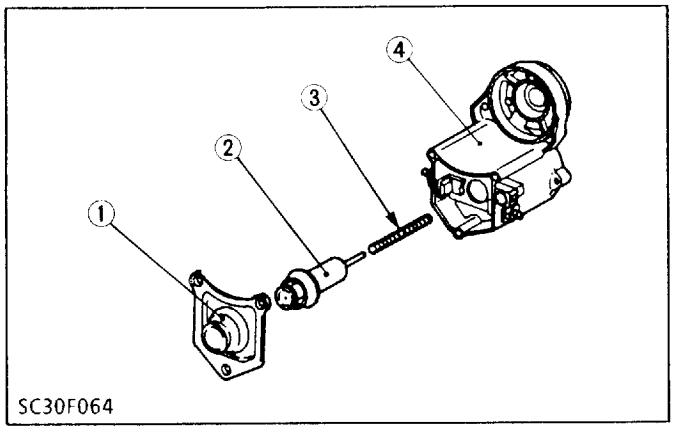
### Gehäuse, Leerlaugetriebe und Freilaufkupplung

1. Das Gehäuse (3) entfernen.
2. Das Leerlaufgetriebe (1) und die Freilaufkupplung (2) entferrnen.

**■ ANMERKUNG**

- **Das Kupplungslager darf nicht beschädigt und muß von anhaftendem Staub freigehalten werden.**
- **Darauf achten, daß die Stahlkugel in der Freilaufkupplung nicht verlorengeht.**

(1) Leerlaufgetriebe
(2) Freilaufkupplung
(3) Gehäuse



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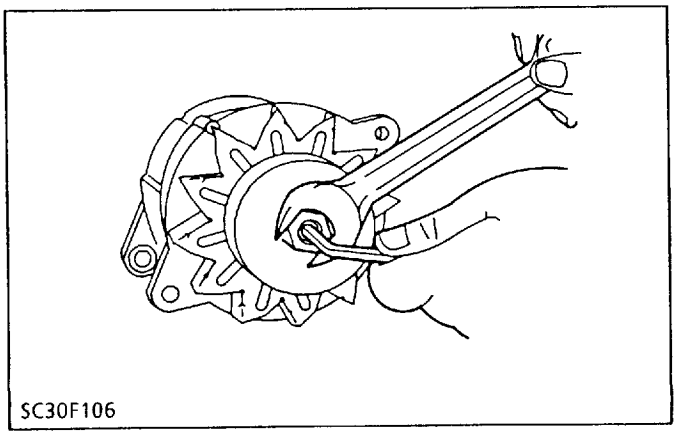
### Plunger

1. Remove the end cover (1) of solenoid switch (4).
2. Remove the plunger (2) and spring (3).

(1) End Cover
(2) Plunger
(3) Spring
(4) Solenoid Switch

## [2] ALTERNATOR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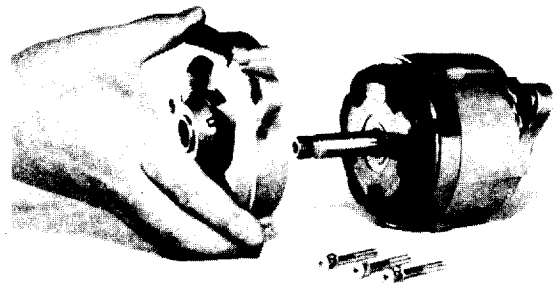
### Pulley

1. Hold the shaft with an Allen wrench and remove the nut.
2. Remove the pulley.
3. Remove the fan.


C022P019

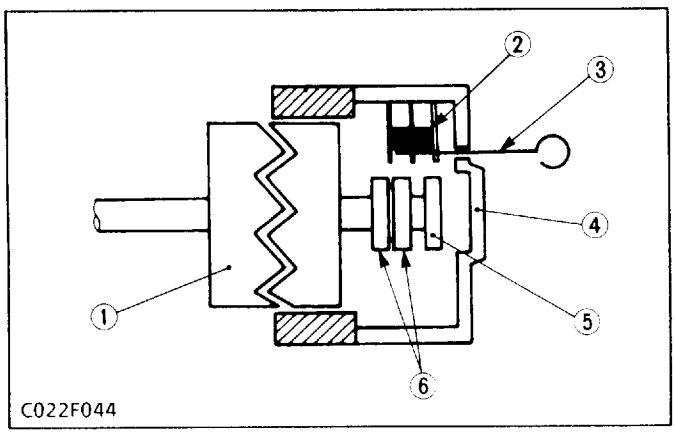
### Drive Side End Frame and Rotor

1. Remove the through bolts.
2. Remove the drive end frame.
3. Draw out the rotor.

**(When reassembling)**

- Install the rotor, lifting up the brushes with a wire through the access hole.

(1) Rotor
(2) Brush
(3) Wire
(4) End Frame
(5) Bearing
(6) Slip Ring



C022F044

### Plongeur

1. Enlever le couvercle d'extrémité (1) de l'interrupteur du solénoïde (4).
2. Enlever le plongeur (2) et le ressort (3).

(1) Couvercle d'extrémité
(2) Plongeur
(3) Ressort
(4) Interrupteur du solénoïde

### Stößel

1. Die Endabdeckung (1) des Solenoidschalters (4) entfernen.
2. Den Stößel (2) und die Feder (3) entfernen.

(1) Endabdeckung
(2) Stößel
(3) Feder
(4) Solenoidschalter

## [2] ALTERNATEUR

### Poulie

1. Maintenir l'arbre avec une clé à six pans creux et enlever l'écrou.
2. Détacher la poulie.
3. Déposer le ventilateur.

## [2] LICHTMASCHINE

### Riemenscheibe

1. Die Welle mit einem Innensechskantschlüssel halten und die Mutter entfernen.
2. Die Riemenscheibe abnehmen.
3. Den Lüfter entfernen.

### Bâti d'extrémité du côté entraînement

1. Enlever les boulons traversants.
2. Détacher le bâti d'extrémité du côté entraînement.
3. Retirer le rotor.

**(Au remontage)**

- Poser le rotor, soulever les balais avec un fil à travers le trou d'accès.

(1) Rotor
(2) Balai
(3) Fil
(4) Bâti d'extrémité
(5) Roulement
(6) Bague collectrice

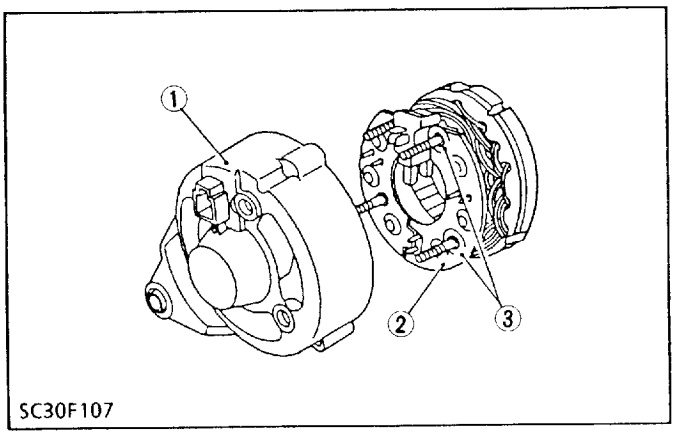
### Antriebsseitiger Endrahmen und Läufer

1. Die Durchgangsschrauben entfernen.
2. Den Antrieb und den Endrahmen entfernen.
3. Den Läufer herausziehen.

**(Beim Wiedereinbau)**

- Den Läufer einbauen und dabei die Bürsten mit einem Draht durch das Zugangsloch führen.

(1) Läufer
(2) Bürste
(3) Draht
(4) Endrahmen
(5) Lager
(6) Schleifring



SC30F107

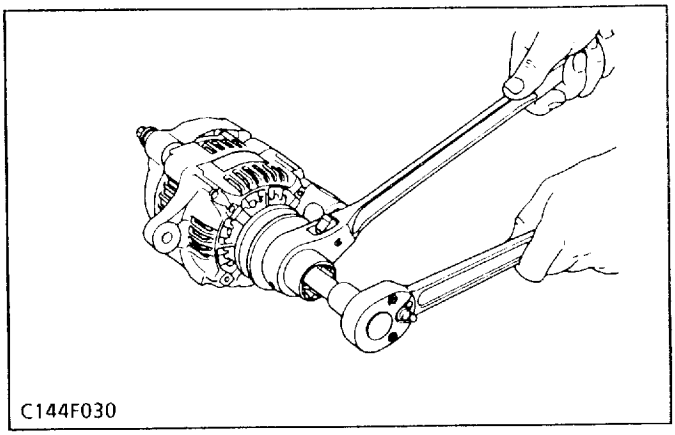
**Rectifier**

1. Remove the nuts.
2. Remove the end cover (1).
3. Remove the rectifier (2).

**(When reassembling)**

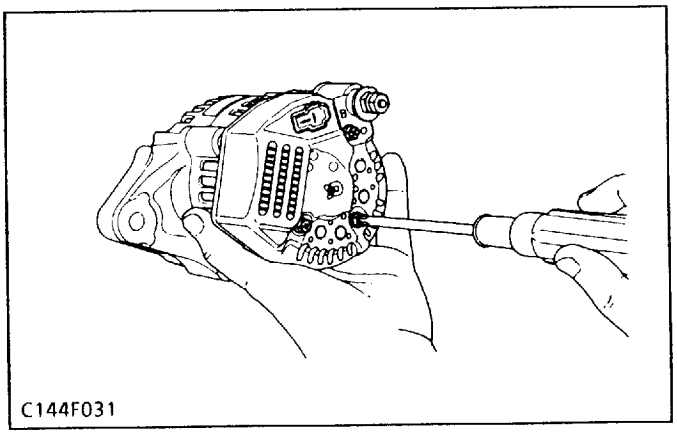
- Be sure to install the insulation washer (3) on the bolt at the positive diode side.

## [2] ALTERNATOR (D1403-B, D1703-B, V1903-B, F2803-B)


C144F030

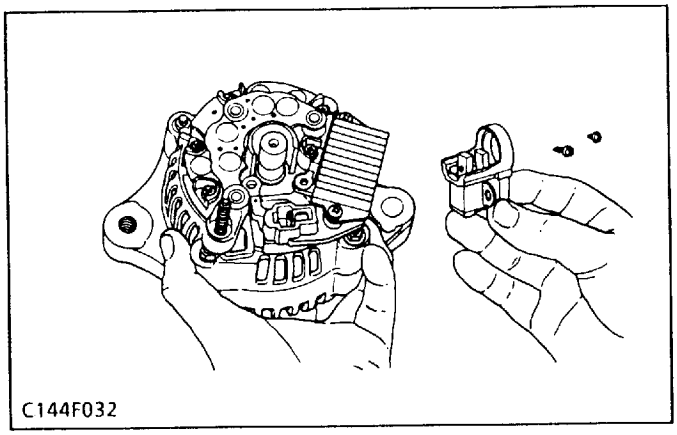
**Pulley**

1. With the hexagonal end of the pulley shaft secured with a double-ended ratchet wrench as shown in the photo, loosen the pulley nut with a socket wrench and remove it.


C144F031

**Rear End Cover**

1. Unscrew the three rear end cover screws and the terminal "B" nut and remove the rear end cover.


C144F032

**Brush Holder**

1. Unscrew the two screws holding the brush holder and remove the brush holder.

**Redresseur**

1. Enlever les écrous.
2. Détacher le couvercle d'extrémité (1).
3. Déposer le redresseur (2).

**(Au remontage)**

- Ne pas oublier de mettre la rondelle isolante (3) sur le boulon du côté diode positive.

**Gleichrichter**

1. Die Muttern ausbauen.
2. Den Enddeckel (1) entfernen.
3. Den Gleichrichter (2) entfernen.

**(Beim Wiedereinbau)**

- Darauf achten, daß die Isolierscheibe (3) an die Schraube auf der positiven Diodenseite angebracht wird.

## [2] ALTERNATEUR (D1403-B, D1703-B, V1903-B, F2803-B)

**Poulie**

1. Maintenez l'extrémité hexagonale de la tige de la poulie avec une clef à cliquet à deux têtes commes sur le photo et dévissez l'écrou de la poulie avec une clef à tube pour le retirer.

**Couvercle arrière**

1. Démontez les trois vis du couvercle arrière et l'écrou de la borne "B" pour retirer le couvercle arrière.

**Porte-balai**

1. Dévissez les deux vis retenant le porte-balai retirer le porte balai.

## [2] WECHSELSTROM-LICHTMASCHINE (D1403-B, D1703-B, V1903-B, F2803-B)

**Riemenscheibe**

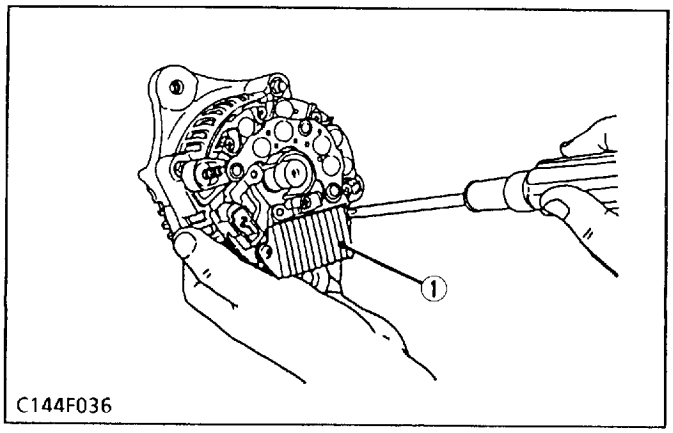
1. Das Sechskantende der Welle wird, wie in der photographie dargestellt, mit einem doppelendigen Ratschenhebel gesichert. Dann lösen Sie die Mutter der Riemenscheibe mit einem Steckschlüssel und enfternen sie.

**Hinteren Abdeckung**

1. Lösen Sie die drei Schrauaben der hinteren Abdeckung, sowie die Mutter von Klemme "B". Entfernen Sie dann die hintere Abdeckung.

**Bürstenhalter**

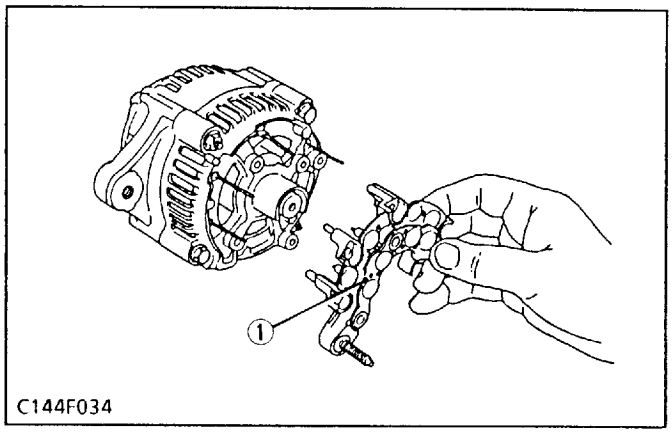
1. Lösen Sie die beiden Schrauben, die den Bürstenhalter. Entfernen Sie dann den Bürstenhalter.




## IC Regulator

1. Unscrew the three screws holding the IC regulator (1) and remove the regulator.

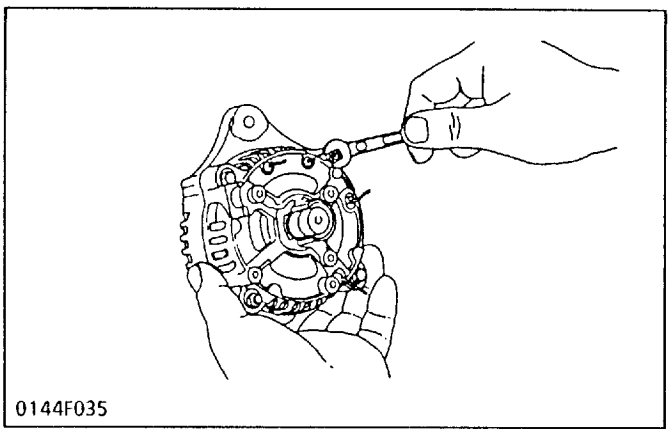
(1) IC Regulator




## Rectifier

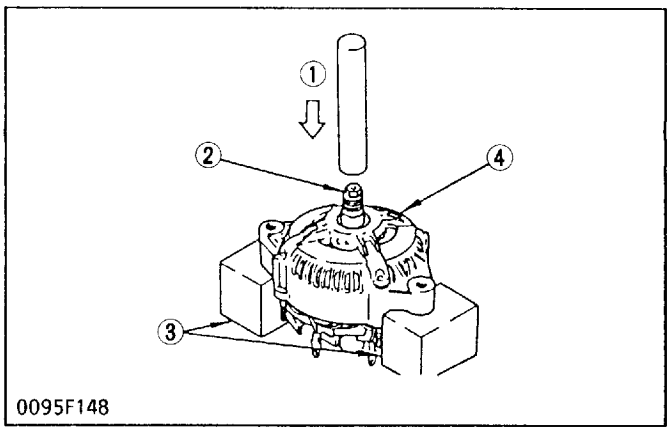
1. Remove the four screws holding the rectifier (1) and the stator lead wires.

(1) Rectifier




## Rear End Frame

1. Remove the two nuts and two screws holding the drive end frame and the rear end frame.
2. Remove the rear end frame.




## Rotor

1. With the drive end frame held level on the blocks as illustrated, press out the rotor.

**■ IMPORTANT**

- **Take special care not to drop the rotor and damage the slip ring or fan, etc.**

(1) Press
(2) Rotor
(3) Block
(4) Drive End Frame

### Regulateur à circuit intégré

1. Dévisser les trois vis retenant le régulateur à circuit intégré (1) pour le retirer.

(1) Regulateur à circuit intégré

### IC-Reglers

1. Lösen Sie die drei Schrauben, mit denen der IC-Regler (1) befestigt ist und entfernen Sie den Regler.

(1) IC-Reglers

### Redresseur

1. Retirer les quatre vis retenant le redresseur (1) et les câbles conducteurs du stator.

(1) Redresseur

### Gleichrichters

1. Entfernen Sie die vier Schrauben, mit denen der Gleichrichter (1) und die Zuleitungen des Stators befestigt sind.

(1) Gleichrichters

### Support de palier arrière

1. Retirer les deux écrous et deux vis retenant le support de palier côté entraînement et le support de palier arrière.
2. Retirer le support de palier arrière.

### Rahmen des hinteren Endes

1. Entfernen Sie die zwei Muttern und die zwei Schrauben, die den Rahmen des Antriebsendes und den Rahmen des hinteren Endes halten.
2. Entfernen Sie den Rahmen des hinteren Endes.

### Rotor

1. Maintenir le support de palier côté entraînement à un niveau fixe sur les blocs de retenue comme sur la figure et retirer le rotor avec une presse.

**■ IMPORTANT**

- **Veiller à ne pas laisser tomber le rotor et à ne pas endommager la bague collectrice ou le ventilateur, etc.**

(1) Presse
(2) Rotor
(3) Bloc
(4) Support de palier côté entrainement

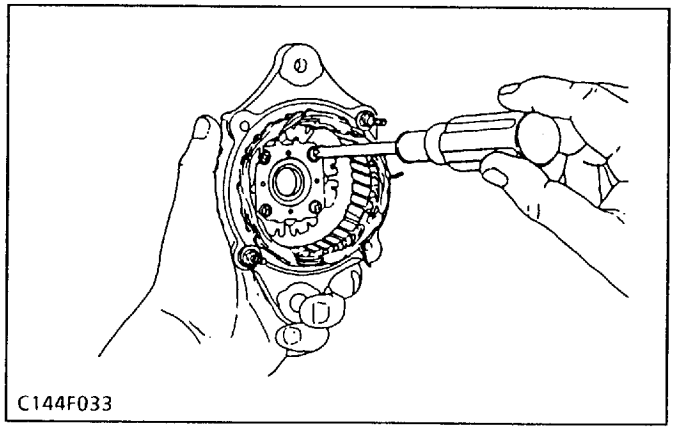
### Rotor

1. Entfernen Sie den Rotor mit Hilfe einer Presse wie auf der Abbildung dargestellt.

**■ WICHTIG**

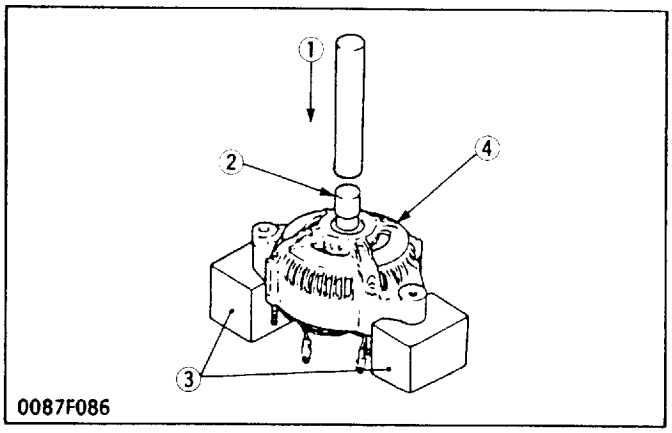
- **Achten Sie darauf, daß der Rotor nicht herunterfallen kann und der Lüfter oder andere Teile beschädigt werden.**

(1) Presse
(2) Rotor
(3) Block
(4) Rahmen des Antriebsendes


C144F033

### Retainer Plate

1. Remove the screws holding the retainer plate and remove the retainer plate.

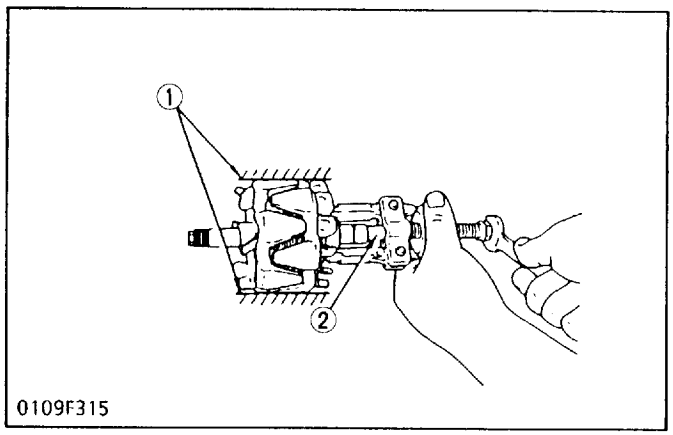


0087F086

### Bearing on the Drive End Side

1. With the drive end frame held level on blocks as illustrated extract the bearing with a press and jig.

(1) Press
(2) Jig
(3) Block
(4) Drive End Frame



0109F315

### Bearing at the Slip Ring Side

1. Using a puller, extract the bearing in the manner shown in the figure.

(1) Lightly secure with a vise to prevent damage
(2) Press at the center

## Plaque de retenue

1. Retirer les vis retenant la plaque de retenue et extrayer celle-ci.

## Halteplatte

1. Entfernen Sie die Schrauben mit denen die Halteplatte befestigt ist undd entfernen Sie dann die Halteplatte.

## Roulement sur le côté avant

1. Maintenier le carter d'embout avant, bien droit, sur les blocs de retenue comme sur la figure et retirer les roulement avec une presse et un démonteur.

(1) Presse
(2) Démonteur
(3) Bloc
(4) Support de palier côté entraînement

## Lager auf der Antriebsseite

1. Entfernen Sie die Lager wie in der Abbildung dargestellt mit Hilfe einer Presse und einer Einspannvorrichtung.

(1) Presse
(2) Einspannvorrichtrung
(3) Block
(4) Rahmen des Antriebsendes

## Roulement sur le côté de la bague collectrice

1. En vous servant d'un extracteur, retirer le roulement comme indiqué sur la figure.

(1) Bloquer légèrement avec un étau pour éviter des degâts
(2) Presser au centre

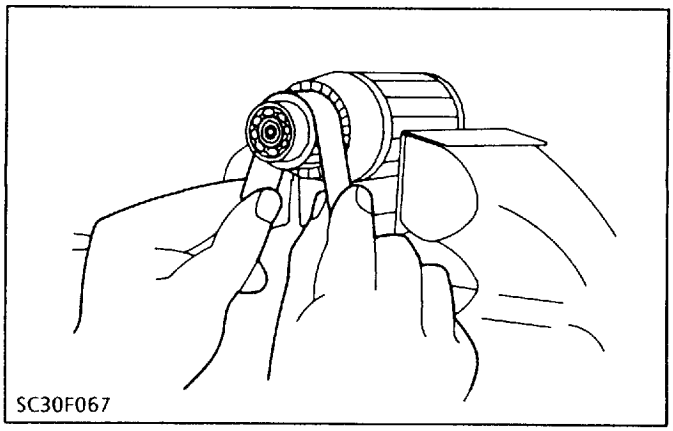
## Lager an der Schleifringseite

1. Entfernen Sie das Lager mit Hilfe eines Ziehers wie in Abbildung gezeigt.

(1) Vorsichtig in einer Zwinge sichern, um Schäden zu vermeiden
(2) In der Mitte drücken

# SERVICING

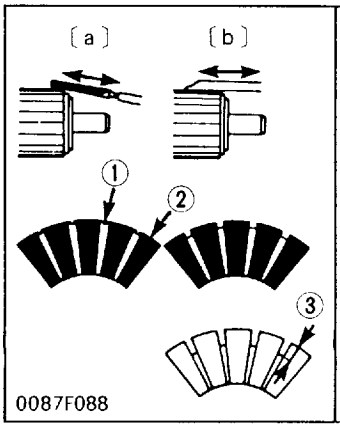
## [1] STARTER


SC30F067

### Commutator and Mica

1. Check the contact face of the commutator for wear, and grind the commutator with sand paper if it is slightly worn.
2. Measure the commutator O.D. at several points.
3. If the difference of the O.D.'s exceeds the allowable limit, correct the commutator on a lathe to the factory specification.
4. If the minimum O.D. is less than the allowable limit, replace the armature.
5. Measure the mica undercut.
6. If the undercut is less than the allowable limit, correct with a saw blade and chamfer the segment edges.

| | | |
|---|---|---|
| Commutator O.D. | Factory spec. | 30 mm 1.1811 in. |
| | Allowable limit | 29 mm 1.1417 in. |
| Mica under cut | Factory spec. | 0.5 to 0.8 mm 0.0197 to 0.0315 in. |
| | Allowable limit | 0.2 mm 0.0079 in. |



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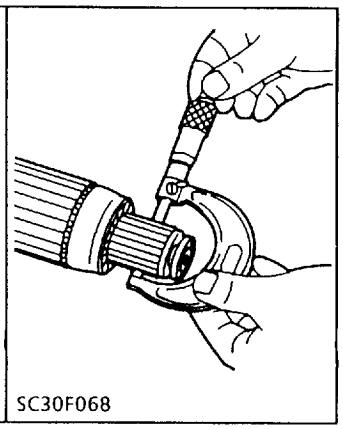
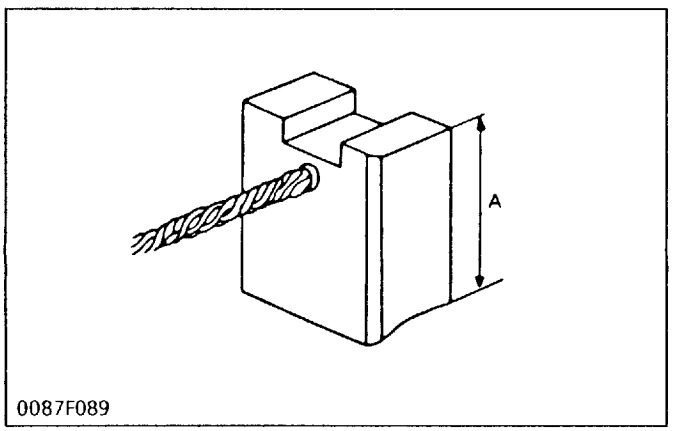

SC30F068

(1) Mica
(2) Segment
(3) Depth of Mica

**[a] Bad**
**[b] Good**

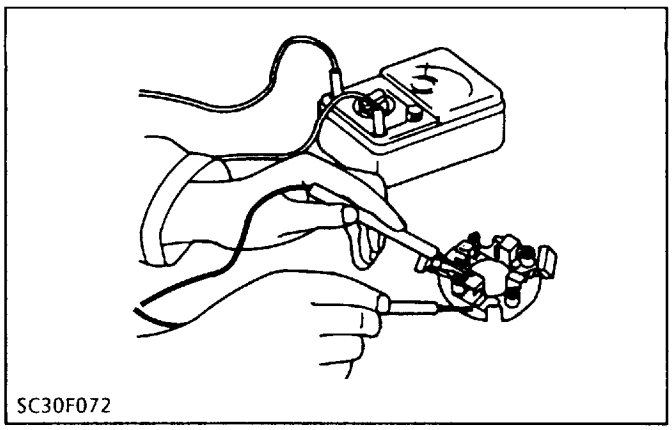


0087F089

### Brush Wear

1. Measure the brush length **A**.
2. If the length is less than the allowable limit, replace the brush.

| | | |
|---|---|---|
| Brush length | Factory spec. | 15 mm 0.59 in. |
| | Allowable limit | 10.0 mm 0.394 in. |


SC30F072

### Brush Holder

1. Check the continuity across the brush holder and holder support with an ohmmeter.
2. If it conducts, replace it.

# ENTRETIEN

## [1] DEMARREUR

### Commutateur

1. Vérifier la surface de contact du commutateur qui peur être usée; rectifier le commutateur avec de la toile émeri s'il est légèrement usé.
2. Mesurer en plusieurs points le diamètre extérieur du commutateur.
3. Si les différences de diamètre extérieur dépassent la tolérance, rectifier le commutateur au tour pour le mettre à la valeur de référence.
4. Si le diamètre extérieur minimum est inférieur à la limite de service, remplacer le commutateur.
5. Mesurer la profondeur d'entaille du mica.
6. Si la profondeur d'entaille est inférieure à la limite de service, rectifier avec une lame de scie et chanfreiner les bords des segments.

| | | |
|---|---|---|
| Diamètre extérieur du contacteur | Valeur de référence | 30 mm |
| | Limite de service | 29,0 mm |
| Profondeur d'entaille du mica | Valeur de référence | 0,5 à 0,8 mm |
| | Limite de service | 0,2 mm |

**[a] Mauvais**
**[b] Bon**

(1) Mica
(2) Segment
(3) Profondeur de mica

### Usure des balais

1. Mesurer la longueur **A** des balais.
2. Si la longueur est inférieure à la limite de servicee, remplacer les balais.

| | | |
|---|---|---|
| Longueur des balais | Valeur de référence | 15 mm |
| | Limite de service | 10,0 mm |

### Porte-balais

1. Avec un ohmmètre, vérifier la continuité aux bornes du porte-balais et au support du porte-balais.
2. S'il y a continuité, remplacer le porte-balai.

# WARTUNG

## [1] ANLASSER

### Kommutator und Glimmer

1. Die Berührungsfläche des Kommutators auf Abnutzung prüfen und bei geringer Abnutzung den Kommutator mit Sandpapier abschleifen.
2. Den Außendurchmesser des Kommutators an mehreren punkten messen.
3. Wenn der Unterschied der Außendurchmesser den zulässigen Grenzwert überschreitet, den Kommutator auf einer Drehbank entsprechend den Werkdaten nachbessern.
4. Wenn der Mindestaußendurchmesser niedriger als der zulässige Grenzwert ist, den Kommutator austauschen.
5. Die Glimmer-Unterschneidung messen.
6. Wenn die Unterschneidung unter dem zulässigen Grenzwert liegt, mit einem Sägeblatt nachbessern und die abschnittkanten abschrägen.

| | | |
|---|---|---|
| Kommutator Außendurchmesser | Werkdaten | 30 mm |
| | Zulässiger Grenzwert | 29,0 mm |
| Glimmer-Unterschneidung | Werkdaten | 0,5 bis 0,8 mm |
| | Zulässiger Grenzwert | 0,2 mm |

**[a] Schlecht**
**[b] Gut**

(1) Glimmer
(2) Abschnitt
(3) Glimmertiefe

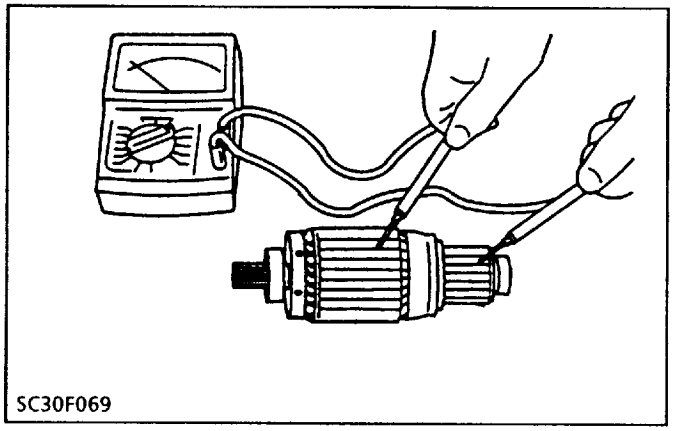
### Abnutzung der Bürsten

1. Die Bürstenlänge **A** messen.
2. Wenn die Länge unter dem zulässigen Grenzwert liegt, die Bürste austauschen.

| | | |
|---|---|---|
| Bürstenlänge | Werkdaten | 15 mm |
| | Zulässiger Grenzwert | 10,0 mm |

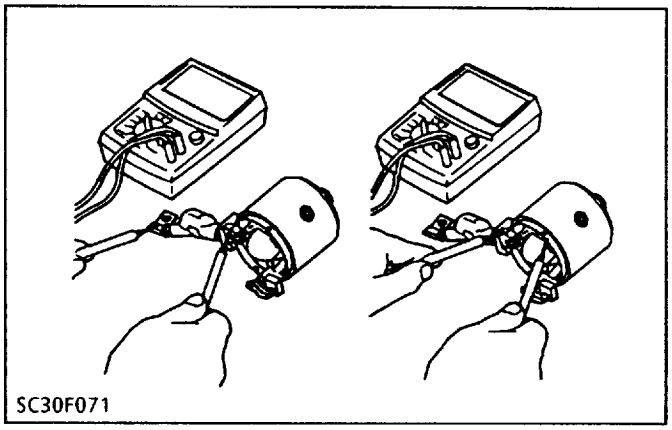
### Bürstenhalter

1. Den Bürstenhalter und den Halterträger mit Hilfe eines Widerstandsmessers auf Stromfluß prüfen.
2. Falls ein Stromfluß vorliegt, austauschen.


SC30F069

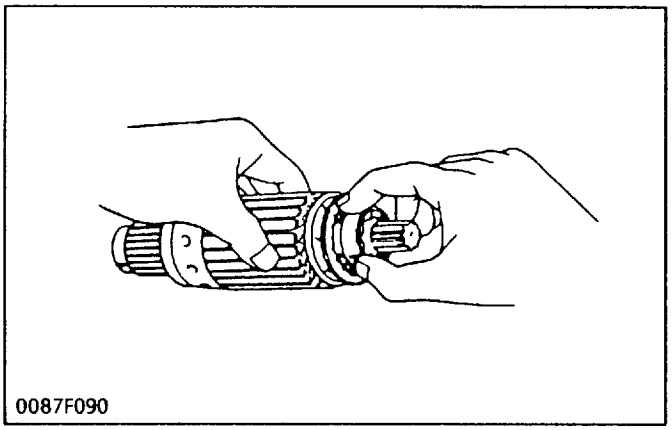
### Armature Coil

1. Check the continuity across the commutator and armature core with an ohmmeter.
2. If it conducts, replace it.


SC30F071

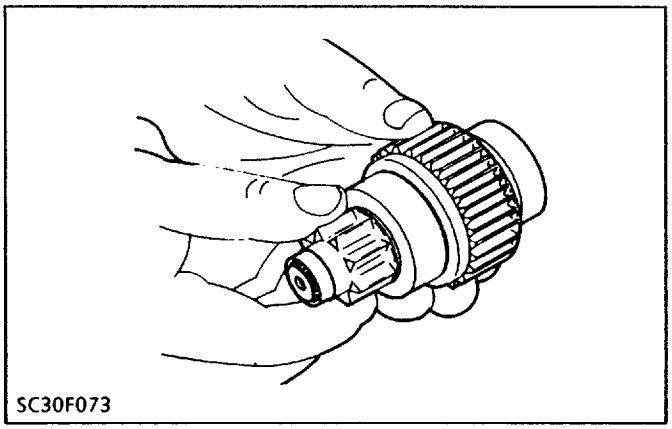
### Yoke

1. Check the continuity across the lead and brush with an ohmmeter.
2. If it does not conduct, replace the yoke.
3. Check the continuity across the brush and yoke with an ohmmeter.
4. If it conducts, replace the yoke.


0087F090

### Armature Bearing

1. Check the bearing for smooth rotation.
2. If it does not smooth rotation, replace it.


SC30F073

### Overrunning Clutch

1. Check the clutch for smooth rotation.
2. The overrunning clutch should engage and rotate with the pinion shaft in driving direction and disengage in reverse.

**Bobine d'induit**

1. Avec un ohmmètre, vérifier la continuité aux bornes du collecteur et de l'arbre d'induit.
2. S'il y a continuité, remplacer l'induit.

**Ankerspule**

1. Den Commutator und die Ankerwelle mit Hilfe eines Widerstandsmessers auf Stromfluß prüfen.
2. Falls ein Stromfluß vorliegt, austauschen.

**Ectrier**

1. Avec un ohmmètre, vérifier la continuité entre le câble et les balais.
2. S'il y a solution de continuité, remplacer l'éctrier.
3. Avec un ohmmètre, vérifier la continuité entre les balais et l'étrier.
4. S'il y a continuité, remplacer l'étrier.

**Bügel**

1. Die Verbindungsleitung und die Bürste mit Hilfe eines Widerstandsmessers auf Stromfluß prüfen.
2. Falls kein Stromfluß vorliegt, den Bügel austauschen.
3. Die Bürste und de Bügel mit Hilfe eines Widerstandsmessers auf Stromfluß prüfen.
4. Falls kein Stromfluß vorliegt, den Bügel austauschen.

**Roulement à induit**

1. Vérifier que le roulement tourne facilement.
2. S'il ne tourne pas facilement, le remplacer.

**Ankerkugellager**

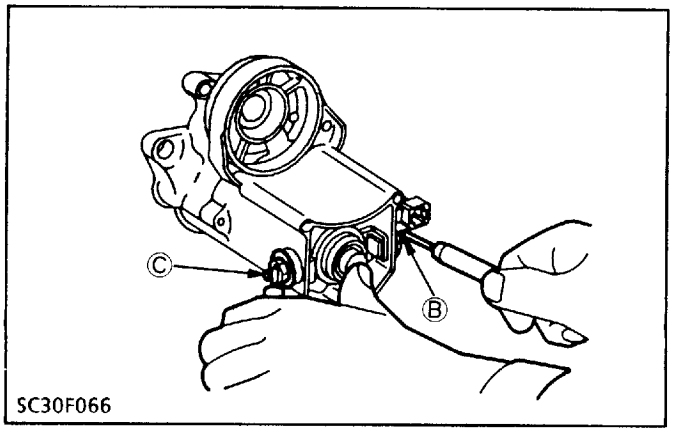
1. Darauf achten, daß die Stahlkugeln der Kupplung nicht verloren gehen.
2. Überprüfen, ob sich das Lager einwandfrei dreht.

**Roue libre**

1. Vérifier la rotation régulière de roue libre.
2. Le roue libre doit s'embrayer et tourner avec l'axe du pignon dans le sens d'entraînement et doit se dégager dans le sens inverse.

**Freilaufkupplung**

1. Das die Freilaufkupplung auf leichtgängige Drehung prüfen.
2. Die Freilaufkupplung solle eingreifen und mit der Ritzelwelle in Antriebsrichtung drehen und in umgekehrter Richtung auskuppeln.

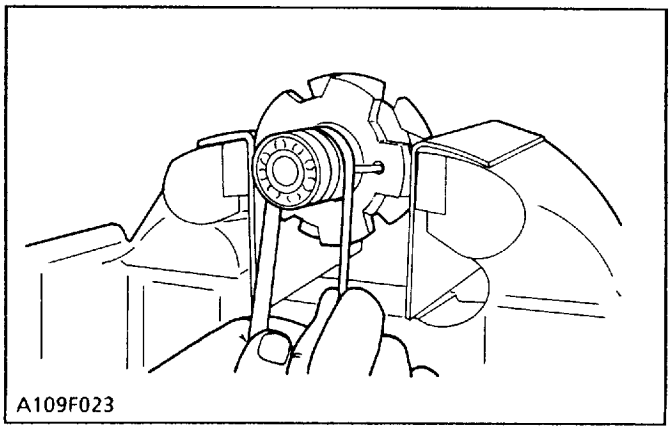


SC30F066

### Magnet Switch

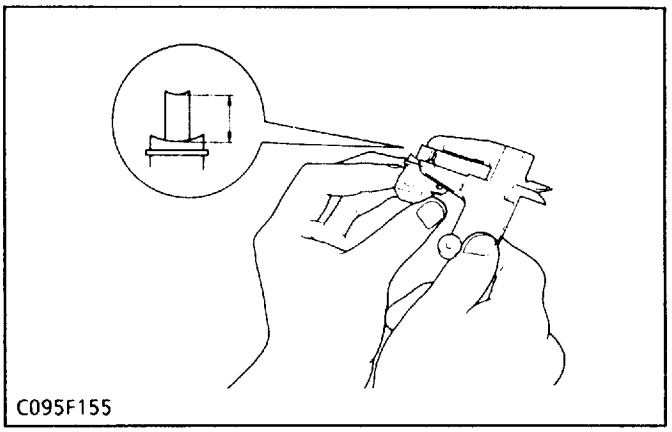
1. Check the continuity across the "C" terminal and the "B" terminal with an ohmmeter pushing the plunger.
2. If it does not conduct, check the contacts.

## [2] ALTERNATOR


A109F023

### Slip Ring

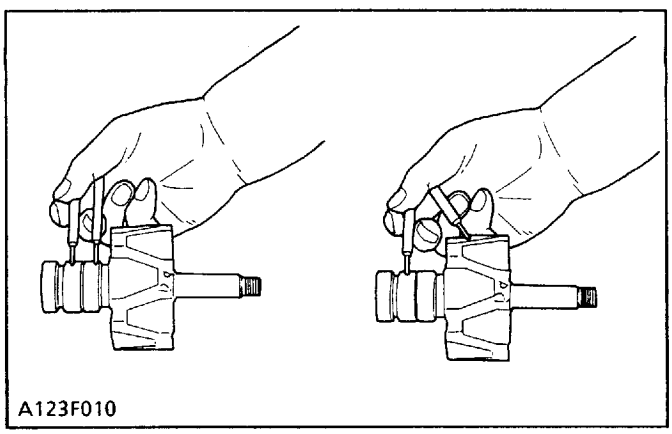
1. Check the slip ring for score.
2. If scored, correct with a sand paper or on a lathe. (Slip Ring O.D. See page S-21)


C095F155

### Brush Wear

1. Check the length of the brush, if the length is shorter than the allowable limit, replace.
2. Make sure that the brush moves smoothly.
3. If the brush is defective, replace.

| | | | |
|---|---|---|---|
| Brush length | Factory spec. | V2203-B | 12.5 mm 0.4921 in. |
| | | D1403-B, V1703-B, V1903-B, F2803-B | 10.5 mm 0.413 in. |
| | Allowable limit | V2203-B | 5.5 mm 0.2165 in. |
| | | D1403-B, V1703-B, V1903-B, F2803-B | 4.5 mm 0.177 in. |


A123F010

### Rotor Coil

1. Check the continuity across the slip ring and core with an ohmmeter.
2. If conduct, replace.
3. Measure the resistance across the slip rings.
4. If the resistance is 0Ω, replace. (Rotor coil resistance See Page S-21)

### Contacteur magnétique

1. Avec un ohmmètre repoussant le plongeur, vérifier la continuité entre la borne "**C**" et la borne "**B**".
2. S'il n'y a pas de continuité, vérifier les contacts.

### Magnetschalter

1. Mit Hilfe einer Widerstandsmessers prüfen, ob zwischen der Klemme "**C**" und der Klemme "**B**" ein Stromfluß besteht. Hierzu den Tauchkolben herunterdrücken.
2. Falls kein Stromfluß vorliegt, die Kontakte überprüfen.

## [2] ALTERNATEUR

### Bague collectrice

1. Vérifier que la bague collectrice est exempte de rayure.
2. Si la bague est rayée, la rectifier à l'aide d'un papier d'émeri ou d'un tour.
   (Diamétre ext. de bague collectrice Voir page S-26)

## [2] LICHTMASCHINE

### Schleifring

1. Den Schleifring auf Riefen überprüfen.
2. Wenn Riefen vorhanden sind, mit Sandpapier oder auf einer Drehbank glätten.
   (Schleifring Außendurchmesser Siehe Seite S-31)

### Usure des balais

1. Vérifier la longueur du balais. Si elle est inférieure à la limite admissible, remplacer le balais.
2. Vérifier le mouvement du balais.
3. Si le balais est défectueux, le remplacer.

| | | | |
|---|---|---|---|
| Longueur des balais | Valeur de référence | V2203-B | 12,5 mm |
| | | D1403-B, V1703-B, V1903-B, F2803-B | 10,5 mm |
| | Limite de service | V2203-B | 5,5 mm |
| | | D1403-B, V1703-B, V1903-B, F2803-B | 4,5 mm |

### Abnutzung der Bürsten

1. Die Länge der jeweiligen Bürsten überprüfen. Auswechseln, wenn die zulässige Toleranz der Länge unterschritten wird.
2. Sichergehen, daß sich die Bürste einwandfrei bewegt.
3. Die Bürste auswechseln, wenn sie fehlerhaft ist.

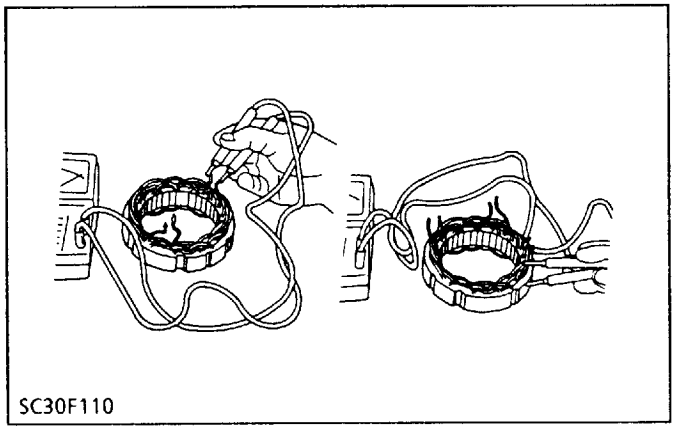
| | | | |
|---|---|---|---|
| Bürstenlänge | Werkdaten | V2203-B | 12,5 mm |
| | | D1403-B, V1703-B, V1903-B, F2803-B | 10,5 mm |
| | Zulässiger Grenzwert | V2203-B | 5,5 mm |
| | | D1403-B, V1703-B, V1903-B, F2803-B | 4,5 mm |

### Bobinage de rotor

1. Vérifier la continuité entre la bague collectrice et le noyau en utilisant un ohmmètre.
2. Si la continuijté est constatée, remplacer le bobinage.
3. Mesurer la résistance entre bagues collectrices.
4. Si la résistance est de 0 ohm, remplacer le bobinage.
   (Resistance de la rotor Voir Page S-26)

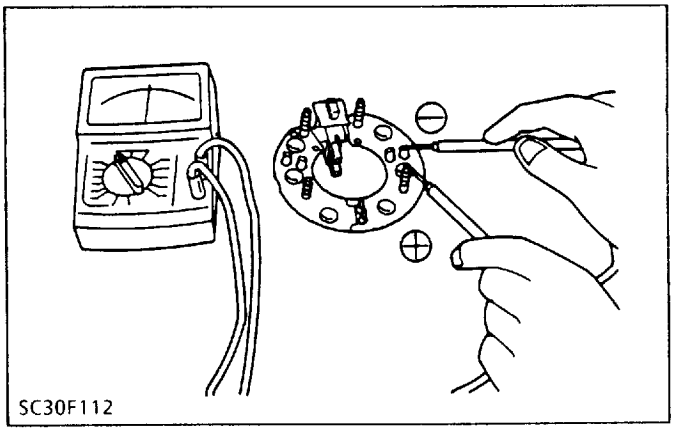
### Läuferspule

1. Mit einem Ohmmeter auf Durchgang zwischen Schleifring und Läufereisen überprüfen.
2. Falls Durchgang besteht, auswechseln.
3. Den Widerstand zwischen den Schleifringen messen.
4. Falls der Widerstand 0 Ohm beträgt, auswechseln.
   (Widerstand Rotor Siehe Seite S-31)


SC30F110

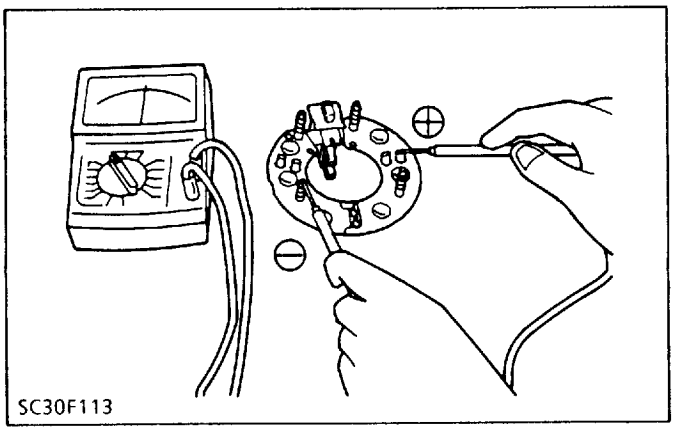
### Stator Coil

1. Check the continuity across each lead of the stator coil with an ohmmeter.
2. If it does not conduct, replace.
3. Check the continuity across each stator coil lead and core with an ohmmeter.
4. If it conducts, replace.


SC30F112

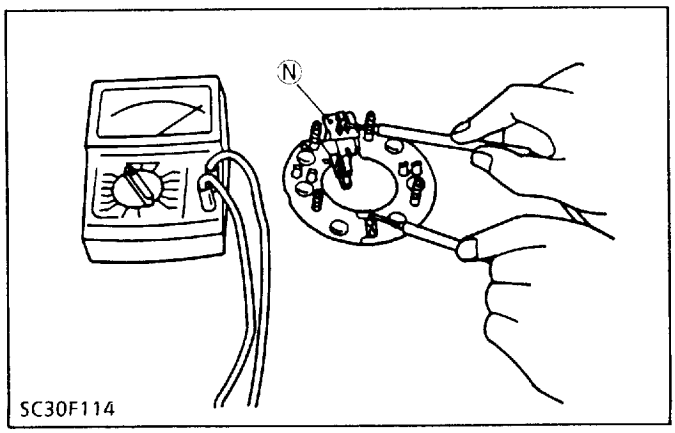
### Positive Diodes

1. Connect the positive lead of the ohmmeter to the M6 screw and the negative lead to each coil connecting terminal, and check the continuity.
2. If a certain value is not indicated, replace the diode assembly.
3. Interchange the connection of the leads and check the continuity.
4. If any value is indicated, replace the diode assembly.


SC30F113

### Negative Diodes

1. Connect the positive lead of the ohmmeter to each coil connecting terminal and the negative lead to the M5 screw, and check the continuity.
2. If a certain value is not indicated, replace the diode assembly.
3. Interchange the connection of the leads and check the continuity.
4. If any valve is indicated, replace the diode assembly.



SC30F114

### "N" Terminal and Coil Connection

1. Check the continuity across "N" terminal and coil connecting terminals (inside) with an ohmmeter.
2. If it does not conduct, replace.

**Bobinage de stator**

1. Vérifier la continuité entre conducjteurs du bobinage de stator à l'aide d'un ohmmètre.
2. Si la continuité n'est pas constatée, remplacer le bobinage.
3. Vérifier la continuité entre chaque conducteur du bobinage de stator et la couronne de tôle à l'aide d'un ohmmètre.
4. Si la continuité est constatée, remplacer le bobinage.

**Ständerspule**

1. Mit einem Ohmmeter auf Durchgang zwischen den jeweiligen Leitungen der Ständerspule überprüfen.
2. Falls Durchgang besteht, auswechseln.
3. Mit einem Ohmmeter auf Durchgang zwischen den jeweiligen Leitungen und dem Eisen ü;berprüfen.
4. Falls Durchgang besteht, auswechseln.

**Diodes positives**

1. Connecter le conducteur positif de l'ohmmètre à la vis M6 et le conducteur négatif à chaque borne de connexion de bobinage, et vérifier la contuinuité.
2. Si aucune valeur n'est pas indiquée, remplacer l'ensemble de diodes.
3. Permuter les conducteurs et vérifier la continuité.
4. Si une valeur quelconque est indiquée, remplacer l'ensemble de diodes.

**Positive Dioden**

1. Den positiven Leiter des Ohmmeters an die M6-Schraube und die negative Leitung an jeweilige Spulenanschlußklemme anschließen und auf Durchgang überprüfen.
2. Wenn der vorgeschriebene Meßwert nicht angezeigt wird die Dioden-Baugruppe auswechseln.
3. Den Anschluß der Verbinder miteinander austauschen und auf Durchgang überprüfen.
4. Falls ein Wert angezeigt wird die Dioden-Baugruppe auswechseln.

**Diodes négatives**

1. Connecter le conducteur positif de l'ohmmètre à chaque borne de connexion de bobinage et le conducteur négatif à la vis M5, et vérifier la continuité.
2. Si aucune valeur n'est indiquée, remplacer l'ensemble de diodes.
3. Permuter les conducteurs et vérifier la continuité.
4. Si une valeur quelconque est indiquée, remplacer l'ensemble de diodes.

**Negative Dioden**

1. Den positiven Leiter des Ohmmeters an die jeweilige Spulenanschlußklemme und den negativen Leiter an die M5-Schraube anschließen und auf Durchgang überprüfen.
2. Wenn der vorgeschriebene Meßwert nicht angezeigt wird die Dioden-Baugruppe auswechseln.
3. Den Anschluß der Verbinder miteinander austauschen und auf Durchgang überprüfen.
4. Falls ein Wert angezeigt wird die Dioden-Baugruppe auswechseln.

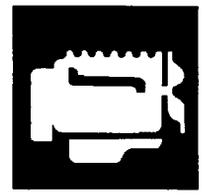
**Borne N et bornes de connexion de bobinage**

1. Vérifier la continuité entre la borne N et les bornes de connexion de bobinage (intérieures) en utilisant un ohmmètre.
2. Si l'absence de continuité est constatée, remplacer l'ensemble.

**"N"-Klemme und Spulenanschluß**

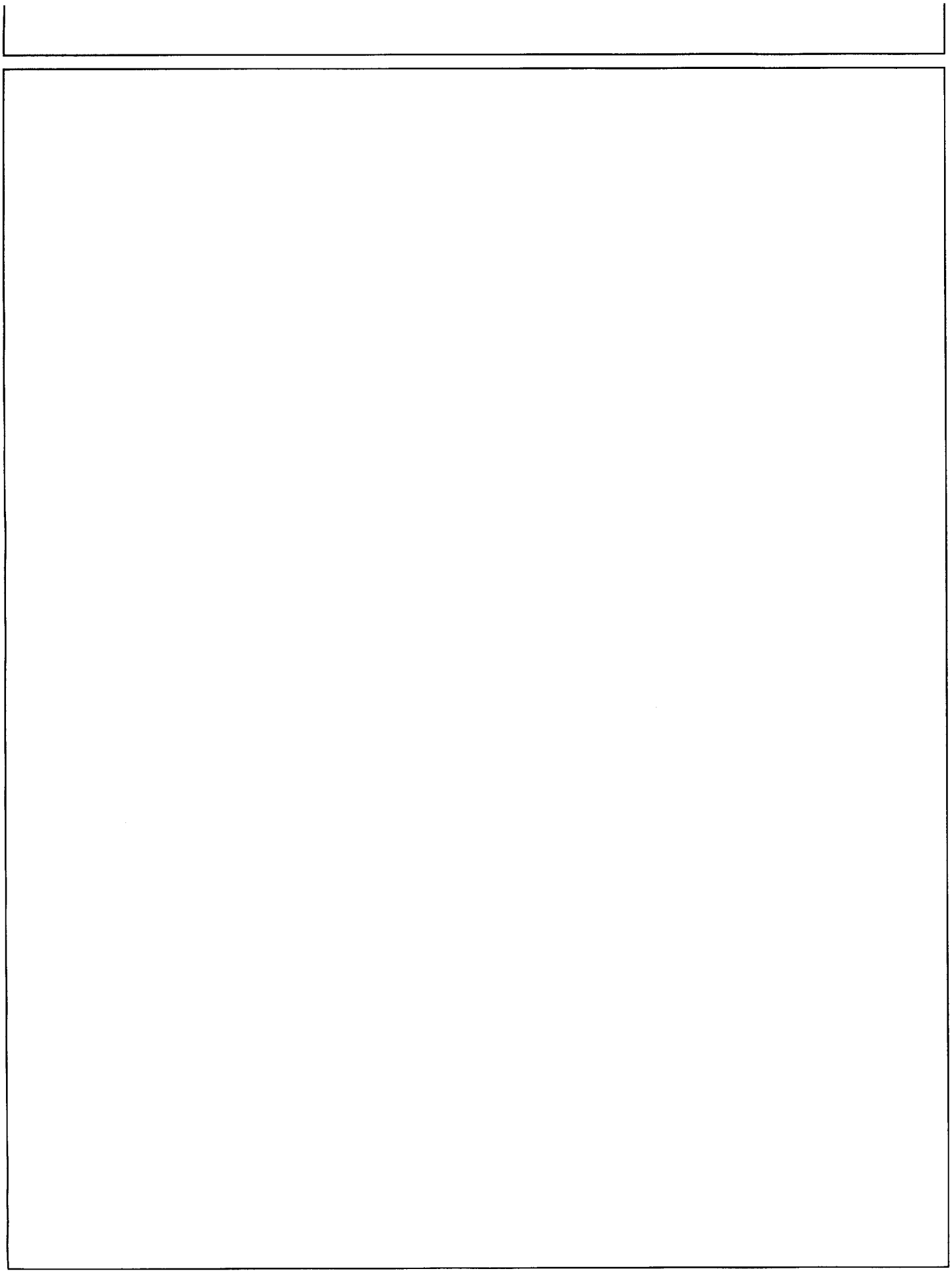
1. Mit einem Ohmmeter auf Durchgang zwischen der "N"-Klemme und den Spulen-Verbindungsklemmen (innen) Überprüfen.
2. Wenn kein Durchgang besteht, auswechseln.

# SECTION 06
# ENGINE



58Mu

## CONTENTS



## SECTION 1

# GENERAL INFORMATION

### TABLE OF CONTENTS

# 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.
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 dismounting the engine or disconnecting pipes and hoses.
11. Always check and recheck your 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 3LA1, 3LB1, 3LD1 family 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 3LB1 and 3LD1 engines.

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.
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.

**(Example)**

Major components

Figures in parentheses "( )" show the order of disassembling or reassembling.

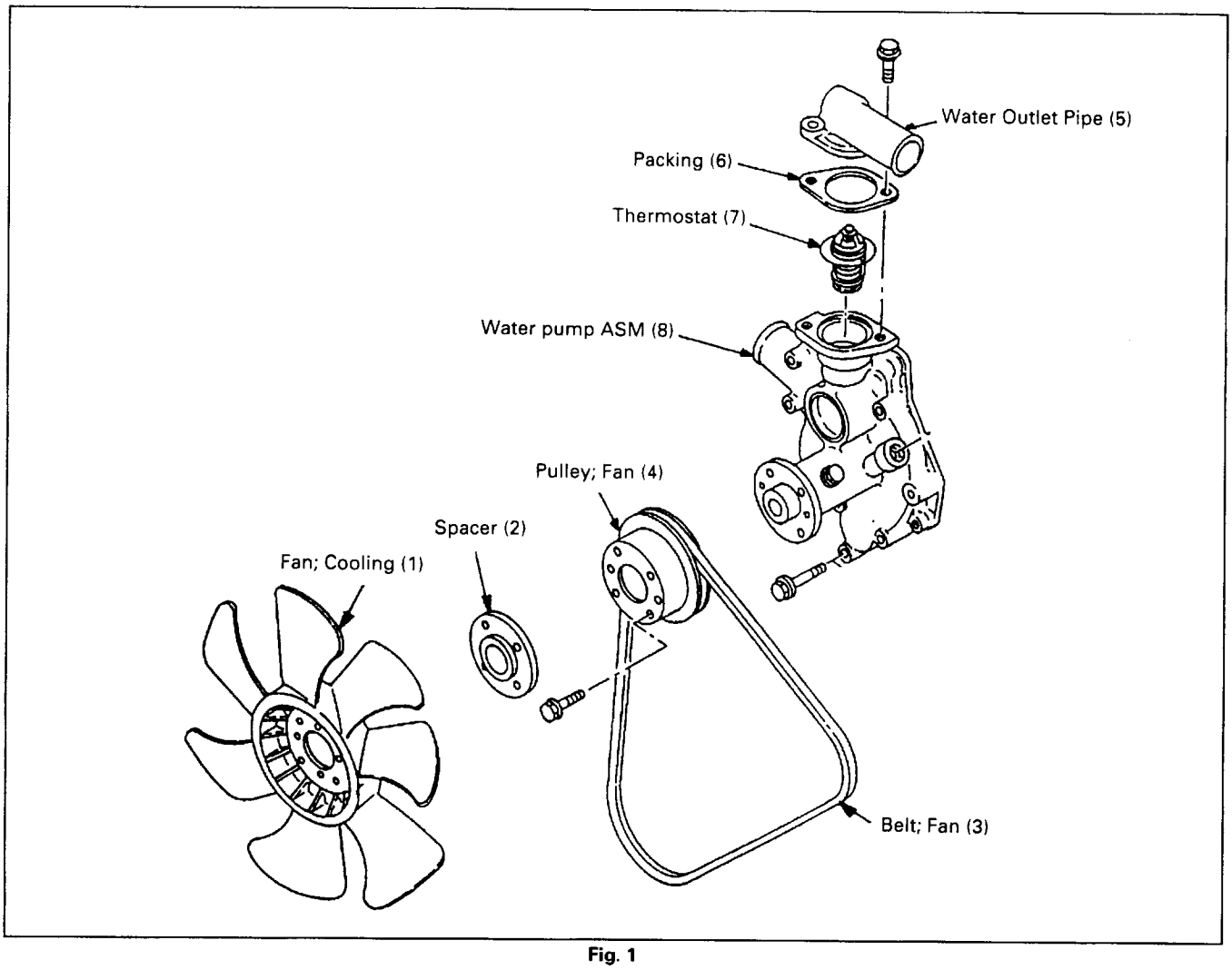



**Fig. 1**

7. 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.

8. Components and parts are listed in the singular form throughout the Manual.

9. The following symbols appear throughout this Worshop Manual. They tell you the type of service operation or step to perform.

 ... Remove

 ... Adjustment

 ... Installation

 ... Cleaning

 ... Disassembly

 ... Important Operation Requiring Extra Care

 ... Reassembly

 ... Specified Torque (Tighten)

 ... Alignment (Marks)

 ... Special Tool Use Required for Recommended (Isuzu Tool or Tools)

 ... Directional Indication

 ... Commercially Available Tool Use Required or Recommended

 ... Inspection

 ... Lubrication (Oil)

 ... Measurement

 ... Lubrication (Grease)

 ... Liquid Gasket Application

10. Direction 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.

The engine's direction of rotation is counterclockwise viewed from the flywheel.

# APPEARANCE

## 1. MODELS 4LC1 AND 4LB1 AND 4LE1

### (1) Left side view

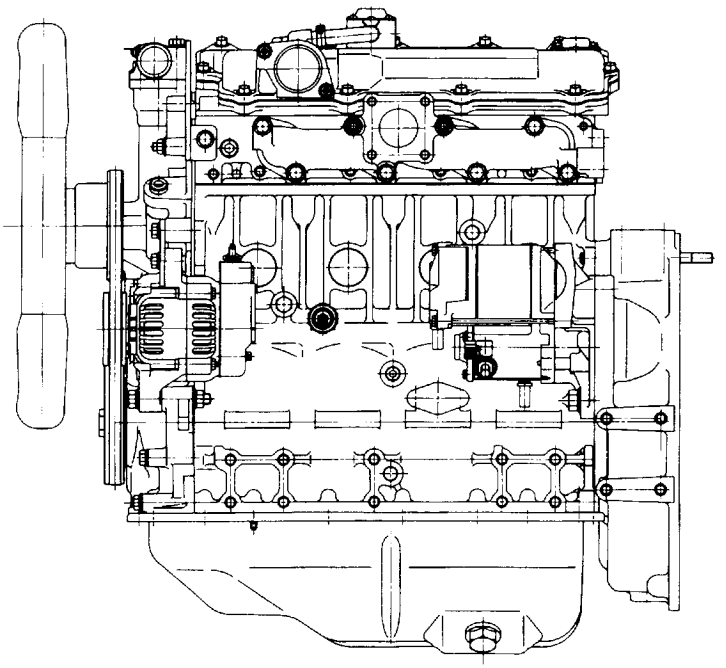


Fig. 2

### (2) Right side view

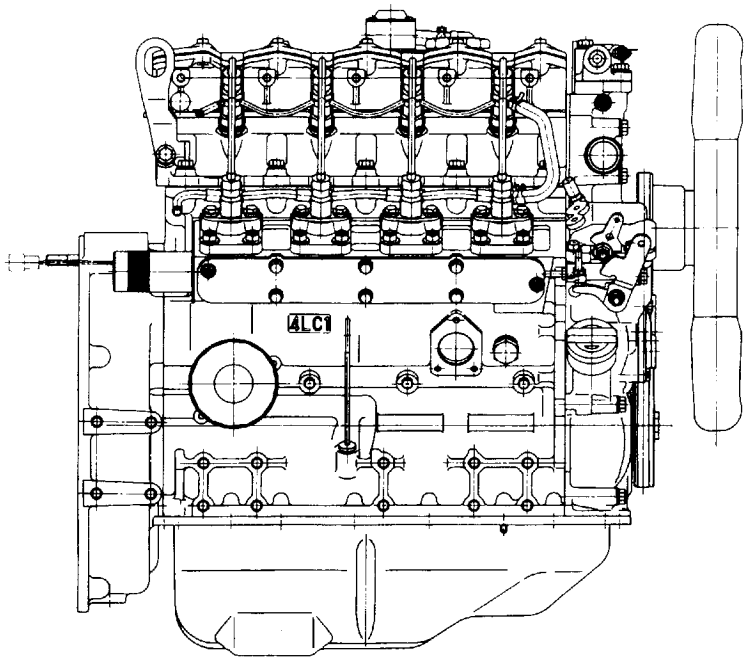



Fig. 3

## 2. MODEL 4LB1T (with turbocharger)

### (1) Left side view

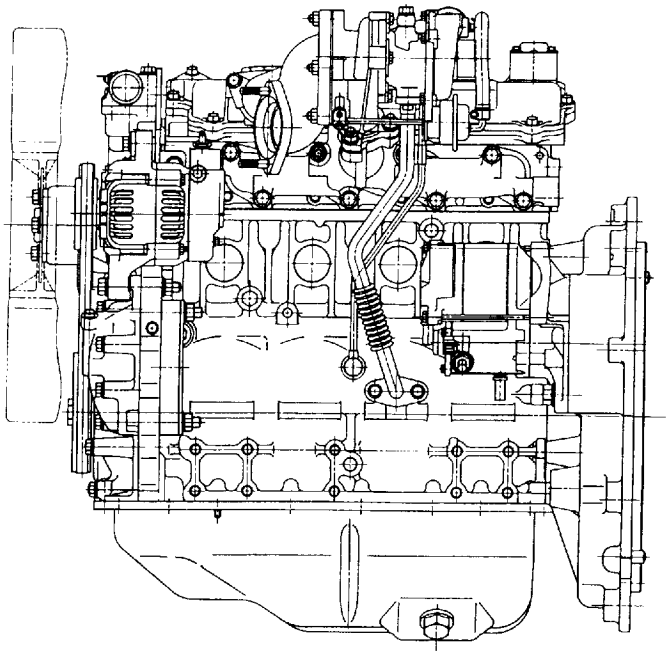


Fig. 4

### (2) Right side view

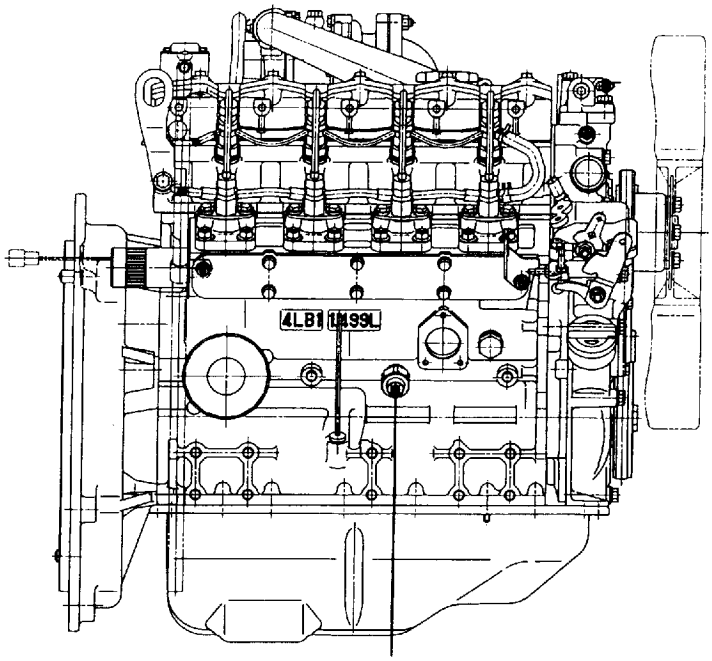



Fig. 5

# MAIN DATA AND SPECIFICATIONS

## 1. MODELS 4LB1 AND 4LB1T

| Item \ Engine model(s) | | | 4LB1 | 4LB1T |
|---|---|---|---|---|
| Type | | | In-line water cooled 4-cycle type, OHV: diesel engine | |
| Timing drive system | | | Gear drive | |
| Number of piston rings | | | Compression rings 2, and oil ring 1 | |
| No. of cylinders - bore × stroke mm | | | 4 – 77.4 × 79.7 | |
| Displacement cc (cid) | | | 1499 (92) | |
| Compression ratio | | | 22 : 1 | |
| Type of combustion chamber | | | Swirl chamber | |
| Overall length × width × height mm | | | * 554 × 436 × 579 | 554 × 466 × 611 |
| Dry weight kg (lb) | | | * 130 (287) | 137 (302) |
| Fuel injection timing (BTDC) (when at stop) | | | * 16° | |
| Firing order | | | 1 – 3 – 4 – 2 | |
| Fuel | | | Highspeed diesel fuel (SAE No.2) | |
| Idling speed r.p.m | | | * 850 | |
| Compression pressure kg/cm² (psi/MPa) | | | 31 (441/3) or more/250 r.p.m. | |
| Valve clearance (cold) mm (in) | | Intake | 0.4 (0.0157) | |
| | | Exhaust | 0.4 (0.0157) | |
| Valve operating timing | Intake valve | Open (BTDC) | 15° | |
| | | Close (ABDC) | 29° | |
| | Exhaust valve | Open (BBDC) | 40° | |
| | | Close (ATDC) | 16° | |
| Injection pump | | | Bosch type | |
| Governor | | | Mechanical type | |
| Nozzle | | | Throttle type | |
| Injection pressure kg/cm² (psi/MPa) | | | * 135 (1920/13.2) | |
| Oil pump | | | Trochoid type | |
| Oil filter | | | Cartridge type | |
| Lubricant capacity: In total lit (qts) | | | * About 7.3 (7.7) | |
| Generator output (V – A) | | | * 12 – 20 | |
| Starter output (V – KW) | | | * 12 – 1.0 | |

**(Note)** These specifications may be subject to change without notice.
Figures in the column with an asterisk (*) are different for each machine. Refer to the specifications provided by machine manufacturers.

## 2. MODELS 4LC1 AND 4LE1

| Item \ Engine model(s) | | | 4LC1 | 4LE1 |
|---|---|---|---|---|
| Type | | | In-line water cooled 4-cycle type, OHV: diesel engine | |
| Timing drive system | | | Gear drive | |
| Number of piston rings | | | Compression rings 2, and oil ring 1 | |
| No. of cylinders - bore × stroke mm | | | 4 – 77.4 × 92 | 4 – 85 × 92 |
| Displacement cc (cid) | | | 1731 (106) | 2179 (133) |
| Compression ratio | | | 22 : 1 | 21.5 : 1 |
| Type of combustion chamber | | | Swirl chamber | |
| Overall length × width × height mm | | | * 554 × 436 × 606 | 691 × 449 × 616 |
| Dry weight kg (lb) | | | * 143 (315) | 155 (342) |
| Fuel injection timing (BTDC) (when at stop) | | | * 16° | |
| Firing order | | | 1 – 3 – 4 – 2 | |
| Fuel | | | Highspeed diesel fuel (SAE No.2) | |
| Idling speed r.p.m | | | * 850 | |
| Compression pressure kg/cm$^2$ (psi/MPa) | | | 31 (441/3) or more/250 r.p.m. | |
| Valve clearance (cold) mm (in) | | Intake | 0.4 (0.0157) | |
| | | Exhaust | 0.4 (0.0157) | |
| Valve operating timing | Intake valve | Open (BTDC) | 15° | |
| | | Close (ABDC) | 29° | |
| | Exhaust valve | Open (BBDC) | 40° | |
| | | Close (ATDC) | 16° | |
| Injection pump | | | Bosch type | |
| Governor | | | Mechanical type | |
| Nozzle | | | Throttle type | |
| Injection pressure kg/cm$^2$ (psi/MPa) | | | * 135 (1920/13.2) | |
| Oil pump | | | Trochoid type | |
| Oil filter | | | Cartridge type | |
| Lubricant capacity: In total lit (qts) | | | * About 7.3 (7.7) | About 8.7 (9.2) |
| Generator output (V – A) | | | * 12 – 20 | |
| Starter output (V – KW) | | | * 12 – 1.0 | |

**(Note)** These specifications may be subject to change without notice.
Figures in the column with an asterisk (*) are different for each machine. Refer to the specifications provided by machine manufacturers.

# TIGHTENING TORQUE SPECIFICATIONS

The tightening torque values given in the table below are applicable to the bolts unless otherwise specified.

## STANDARD BOLT

kg·m (lb.ft/N·m)

| Strength Class / Bolt Identification / Bolt Diameter × pitch (mm) | 4.8 (4T) | (7T) | 8.8 | | 9.8 (9T) |
|---|---|---|---|---|---|
| | | | Refined | Non-Refined | |
| |  |  |  |  |  |
| |  No mark | —— |  |  |  |
| M 6 × 1.0 | 0.4 ~ 0.8 (2.9 ~ 5.8/3.9 ~ 7.8) | 0.5 ~ 1.0 (3.6 ~ 7.2/4.9 ~ 9.8) | | | —— |
| M 8 × 1.25 | 0.8 ~ 1.8 (5.8 ~ 13.0/7.8 ~ 17.7) | 1.2 ~ 2.3 (8.7 ~ 16.6/11.8 ~ 22.6) | | | 1.7 ~ 3.1 (12.3 ~ 22.4/16.7 ~ 30.4) |
| M10 × 1.25 | 2.1 ~ 3.5 (15.2 ~ 25.3/20.6 ~ 34.3) | 2.8 ~ 4.7 (20.3 ~ 34.0/27.5 ~ 46.1) | | | 3.8 ~ 6.4 (27.5 ~ 46.3/37.3 ~ 62.8) |
| M12 × 1.25 | 5.0 ~ 7.5 (36.2 ~ 54.2/49.0 ~ 73.6) | 6.2 ~ 9.3 (44.8 ~ 67.3/60.8 ~ 91.2) | | | 7.7 ~ 11.6 (55.7 ~ 83.9/75.5 ~ 113.8) |
| M14 × 1.5 | 7.8 ~ 11.7 (56.4 ~ 84.6/78.5 ~ 114.7) | 9.5 ~ 14.2 (68.7 ~ 102.7/93.2 ~ 139.3) | | | 11.6 ~ 17.4 (83.9 ~ 125.6/113.8 ~ 170.6) |
| M16 × 1.5 | 10.6 ~ 16.0 (76.7 ~ 115.7/103.0 ~ 156.9) | 13.8 ~ 20.8 (99.8 ~ 150.4/135.3 ~ 204.0) | | | 16.3 ~ 24.5 (118.9 ~ 177.2/159.9 ~ 240.3) |
| M18 × 1.5 | 15.4 ~ 23.0 (111.1 ~ 166.4/151.0 ~ 225.6) | 19.9 ~ 29.9 (143.9 ~ 216.3/195.2 ~ 391.3) | | | 23.4 ~ 35.2 (169.3 ~ 254.6/229.5 ~ 345.2) |
| M20 × 1.5 | 21.0 ~ 31.6 (151.9 ~ 228.6/205.9 ~ 307.9) | 27.5 ~ 41.3 (198.9 ~ 298.7/269.7 ~ 405.0) | | | 32.3 ~ 48.5 (233.6 ~ 350.8/316.8 ~ 475.6) |
| M22 × 1.5 | 25.6 ~ 42.2 (185.2 ~ 305.2/251.1 ~ 413.8) | 37.0 ~ 55.5 (267.6 ~ 401.4/362.9 ~ 544.3) | | | 43.3 ~ 64.9 (313.2 ~ 469.4/424.6 ~ 636.5) |
| M24 × 2.0 | 36.6 ~ 55.0 (264.7 ~ 397.8/358.9 ~ 539.4) | 43.9 ~ 72.5 (317.5 ~ 523.9/430.5 ~ 711.0) | | | 56.5 ~ 84.7 (408.7 ~ 612.6/554.1 ~ 830.6) |
| *M10 × 1.5 | 2.0 ~ 3.4 (14.5 ~ 24.6/19.6 ~ 32.4) | 2.8 ~ 4.6 (20.3 ~ 33.3/27.5 ~ 45.1) | | | 3.7 ~ 6.1 (26.8 ~ 44.1/36.3 ~ 59.8) |
| *M12 × 1.5 | 4.6 ~ 7.0 (33.3 ~ 50.6/45.1 ~ 68.7) | 5.8 ~ 8.6 (42.0 ~ 62.2/56.9 ~ 84.3) | | | 7.3 ~ 10.9 (52.8 ~ 78.8/71.6 ~ 106.9) |
| *M14 × 2.0 | 7.3 ~ 10.9 (52.8 ~ 78.8/71.6 ~ 106.9) | 9.0 ~ 13.4 (65.1 ~ 96.9/88.3 ~ 131.4) | | | 10.9 ~ 16.3 (78.8 ~ 118.9/106.9 ~ 159.9) |
| *M16 × 2.0 | 10.2 ~ 15.2 (73.8 ~ 110.0/100.0 ~ 149.1) | 13.2 ~ 19.8 (95.5 ~ 143.2/129.5 ~ 194.2) | | | 15.6 ~ 23.4 (112.8 ~ 169.3/162.8 ~ 229.5) |

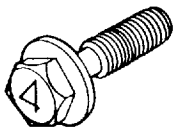
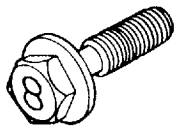
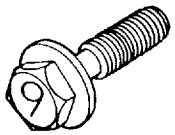
**An asterisk (*) indicates that the bolts are used for female threaded parts that are made of soft materials such as casting. Those shown in parentheses in the strength class indicate the classification by the old standard.**

# TIGHTENING TORQUE SPECIFICATIONS

The tightening torque values given in the table below are applicable to the bolts unless otherwise specified.

## FLANGED HEAD BOLT

kg·m (lb.ft/N·m)

| Bolt head marking / Nominal size (dia. x pitch) |  |  |  |
|---|---|---|---|
| M 6 × 1 | 0.5 ~ 0.9<br>(3.61 ~ 6.50/4.6 ~ 8.5) | 0.6 ~ 1.2<br>(4.33 ~ 8.67/5.88 ~ 11.76) | ——— |
| M 8 × 1.25 | 1.1 ~ 2.0<br>(7.95 ~ 14.46/10.78 ~ 19.61) | 1.4 ~ 2.9<br>(4.33 ~ 8.67/5.88 ~ 11.76) | 1.9 ~ 3.4<br>(13.74 ~ 24.59/18.63 ~ 33.34) |
| M10 × 1.25 | 2.3 ~ 3.9<br>(17.35 ~ 28.20/23.53 ~ 38.24) | 3.6 ~ 6.4<br>(26.03 ~ 44.12/35.30 ~ 59.82) | 4.3 ~ 7.2<br>(31.10 ~ 52.07/42.16 ~ 70.60) |
| *M10 × 1.5 | 2.3 ~ 3.8<br>(16.63 ~ 27.48/22.55 ~ 37.26) | 3.5 ~ 5.8<br>(25.31 ~ 41.95/34.32 ~ 56.87) | 4.1 ~ 6.8<br>(29.65 ~ 49.18/40.20 ~ 66.68) |
| M12 × 1.25 | 5.6 ~ 8.4<br>(40.50 ~ 60.75/54.91 ~ 82.37) | 7.9 ~ 11.9<br>(57.14 ~ 86.07/77.47 ~ 116.69) | 8.7 ~ 13.0<br>(62.92 ~ 94.02/85.31 ~ 127.48) |
| *M12 × 1.75 | 3.5 ~ 9.5<br>(37.61 ~ 56.41/50.99 ~ 76.49) | 7.3 ~ 10.9<br>(52.80 ~ 78.83/71.58 ~ 106.89) | 8.1 ~ 12.2<br>(58.58 ~ 88.24/79.43 ~ 119.64) |
| M14 × 1.5 | 8.5 ~ 12.7<br>(61.48 ~ 91.85/83.35 ~ 124.54) | 11.7 ~ 17.6<br>(84.62 ~ 127.30/114.73 ~ 172.59) | 12.6 ~ 18.9<br>(91.13 ~ 136.70/123.56 ~ 185.34) |
| *M14 × 2 | 7.6 ~ 11.5<br>(57.14 ~ 85.34/77.47 ~ 115.71) | 11.1 ~ 16.6<br>(80.28 ~ 120.06/108.85 ~ 162.79) | 11.8 ~ 17.7<br>(85.34 ~ 128.02/115.71 ~ 173.57) |
| M16 × 1.5 | 11.8 ~ 17.7<br>(85.34 ~ 128.02/115.71 ~ 173.57) | 17.1 ~ 26.5<br>(125.85 ~ 189.50/170.63 ~ 256.93) | 18.0 ~ 27.1<br>(130.19 ~ 196.01/176.52 ~ 265.76) |
| *M16 × 2 | 11.2 ~ 16.7<br>(81.00 ~ 120.79/109.83 ~ 163.77) | 16.6 ~ 24.9<br>(120.06 ~ 180.10/162.79 ~ 244.18) | 17.2 ~ 25.7<br>(124.40 ~ 186.61/168.67 ~ 253.01) |

**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.

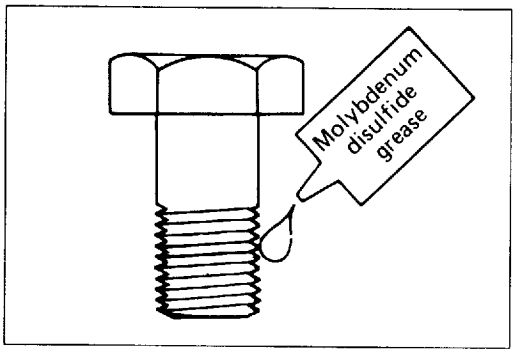



Fig. 6

2. Apply a coat of molybdenum disulfide grease to the threads and setting faces of the nuts and bolts.

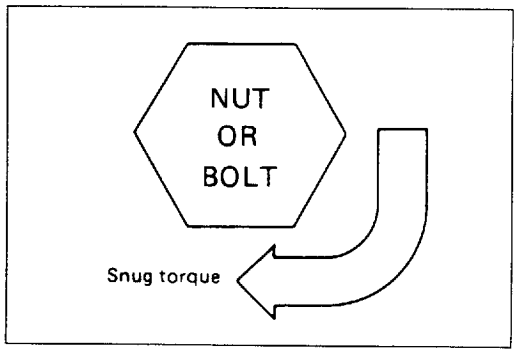



Fig. 7

3. Tighten the nuts and bolts to the specified torque (snug torque) with a torque wrench.

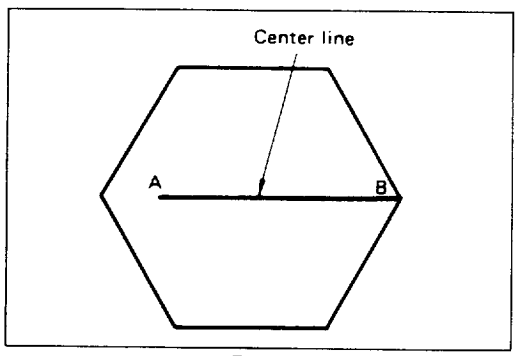



Fig. 8

4. Draw a line [A-B] across the center of each bolt.

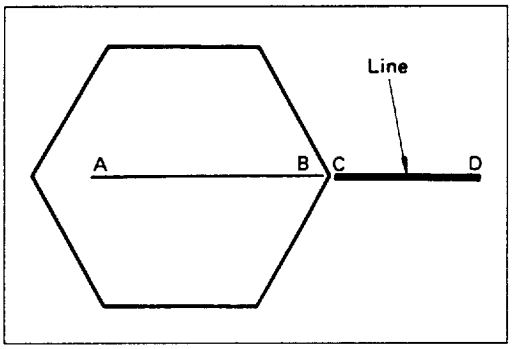



Fig. 9

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].

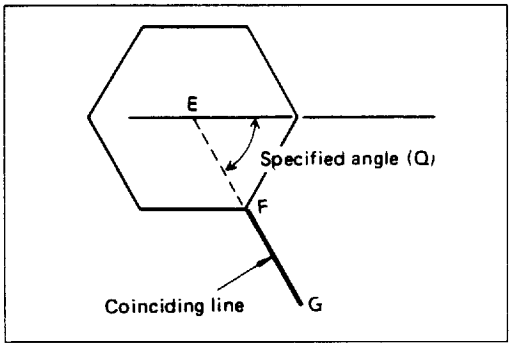



Fig. 10

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.

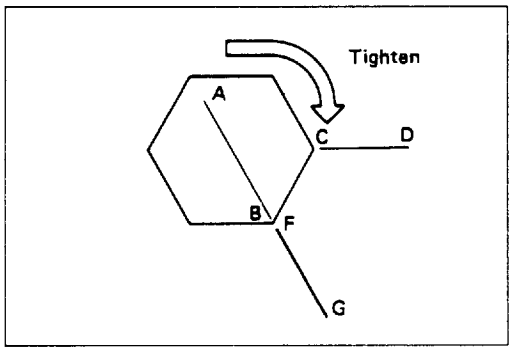



Fig. 11

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].

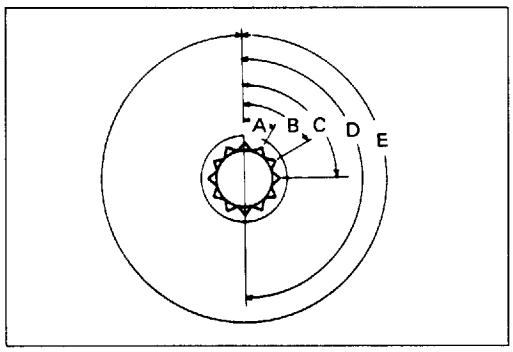



Fig. 12

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 |

# TIGHTENING TORQUE ON MAJOR COMPONENTS

## 1. COOLING FAN AND WATER PUMP

kg·m (ft. lbs.)

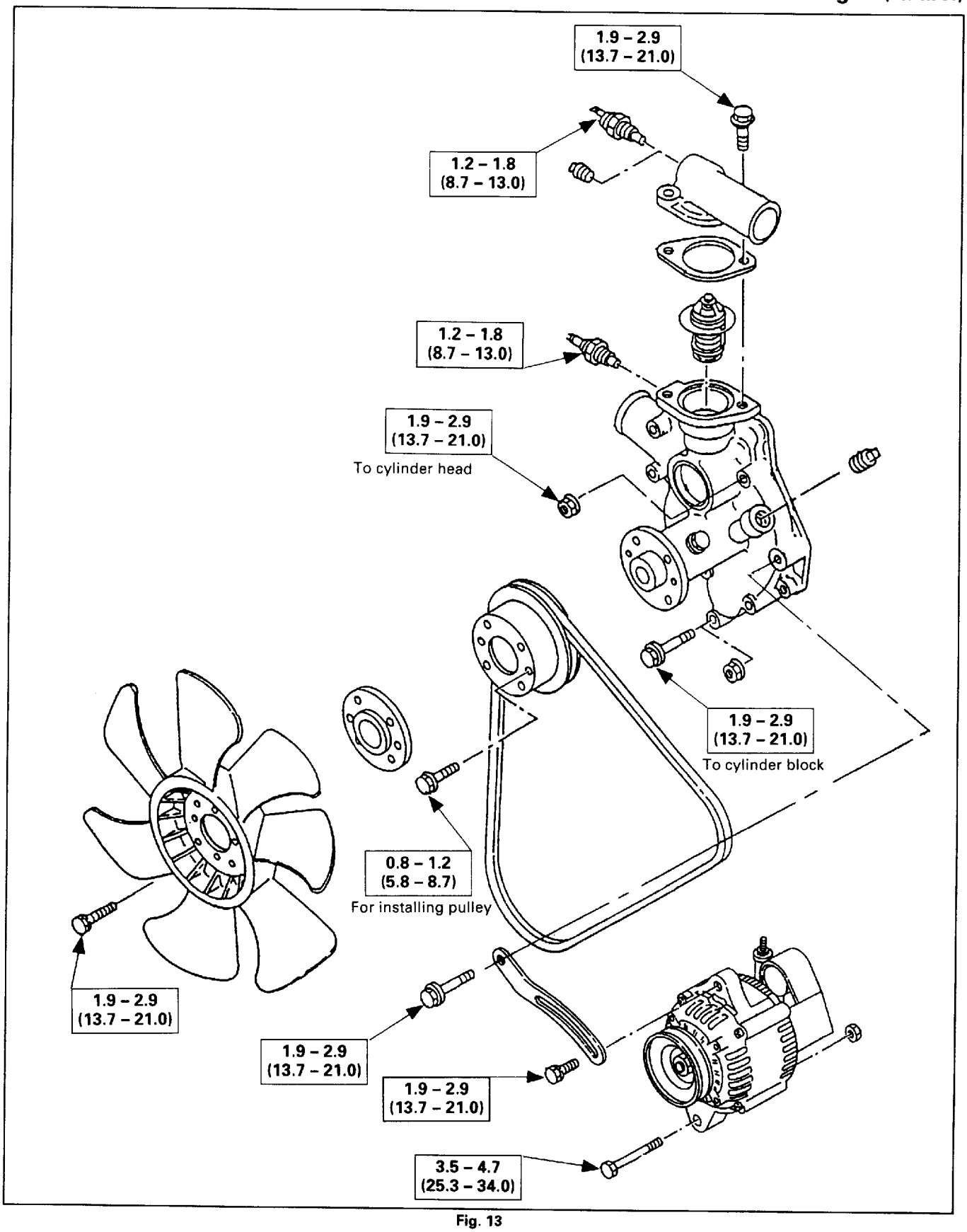



Fig. 13

## 2. CYLINDER HEAD AND CYLINDER HEAD COVER

**kg·m (ft. lbs.)**

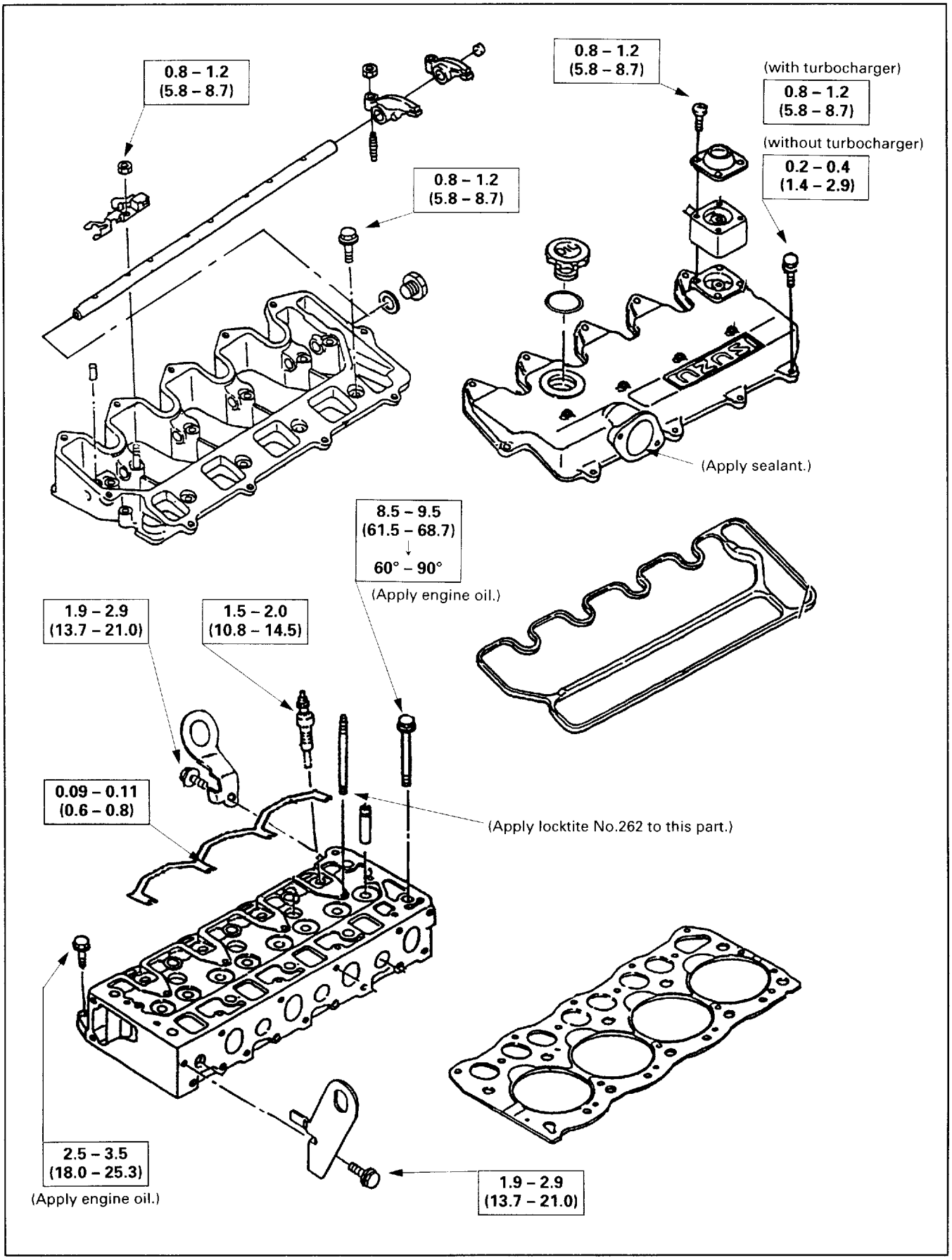



Fig. 14

## 3. CYLINDER BLOCK AND OTHER COMPONENTS (1)

kg·m (ft. lbs.)

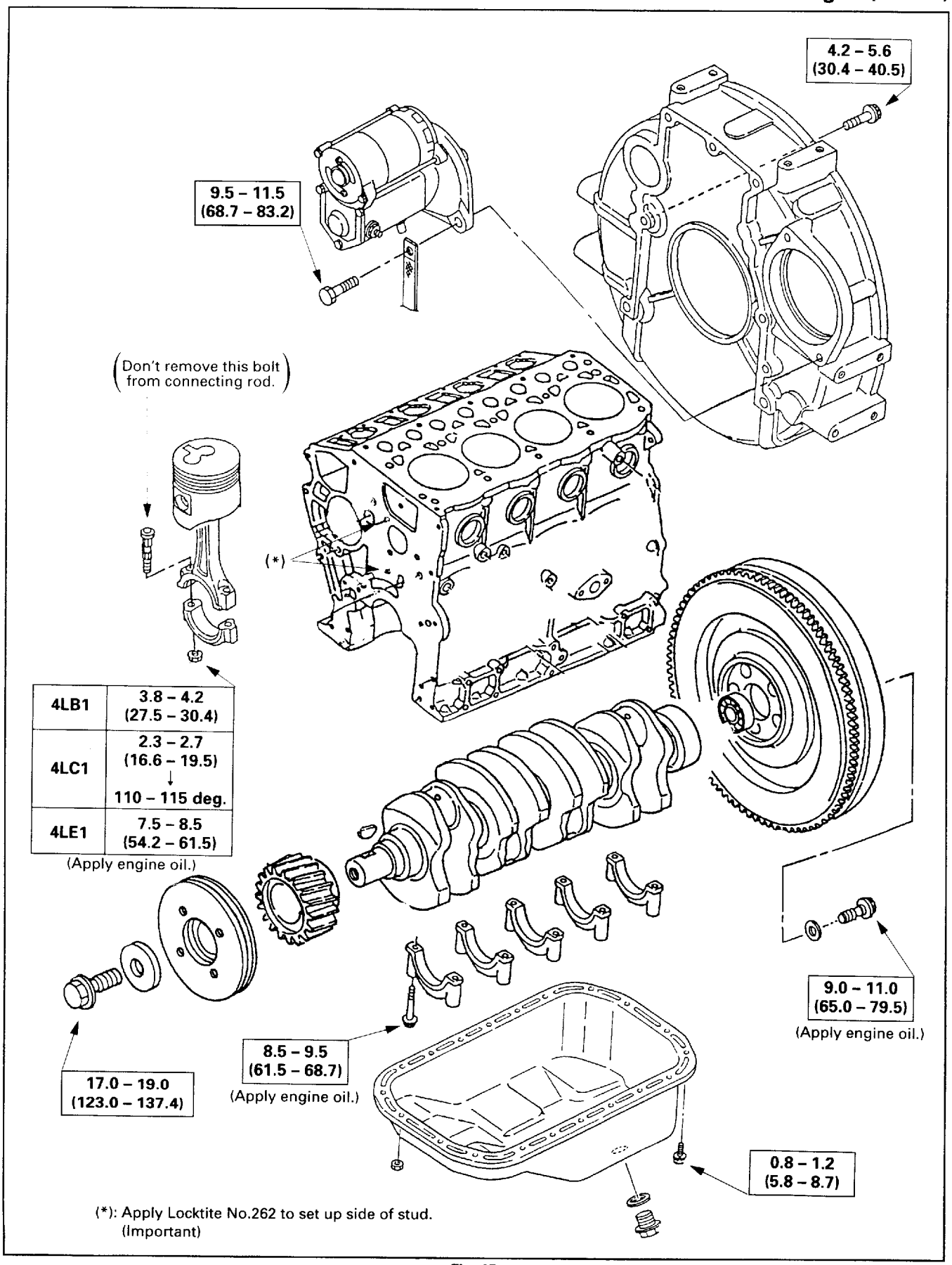



Fig. 15

## 4. CYLINDER BLOCK AND OTHER COMPONENTS (2)

kg·m (ft. lbs.)

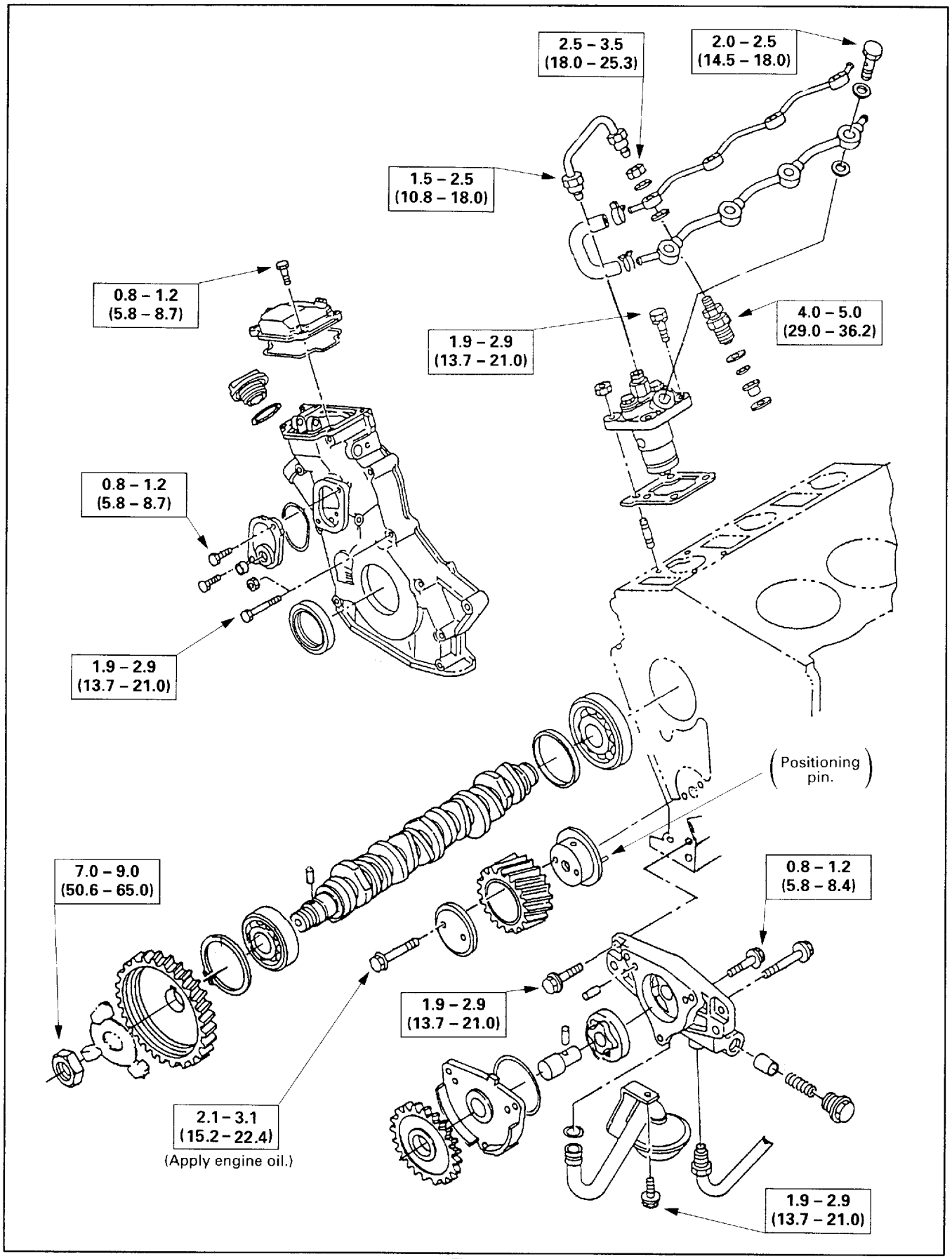



Fig. 16

## 5. CYLINDER BLOCK AND OTHER COMPONENTS (3)

**kg·m (ft. lbs.)**

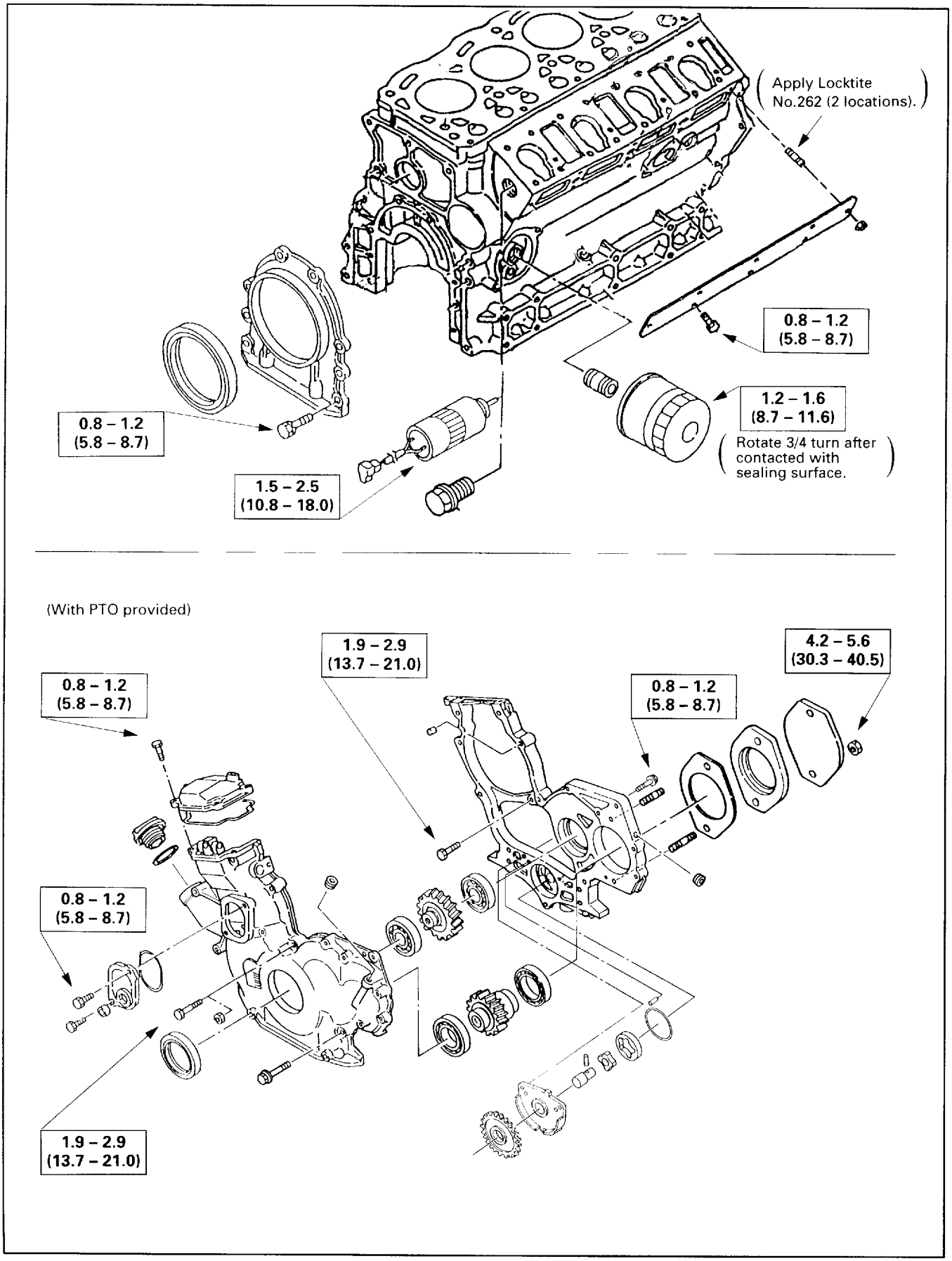



Fig. 17

## 6. TURBOCHARGER

kg·m (ft. lbs.)

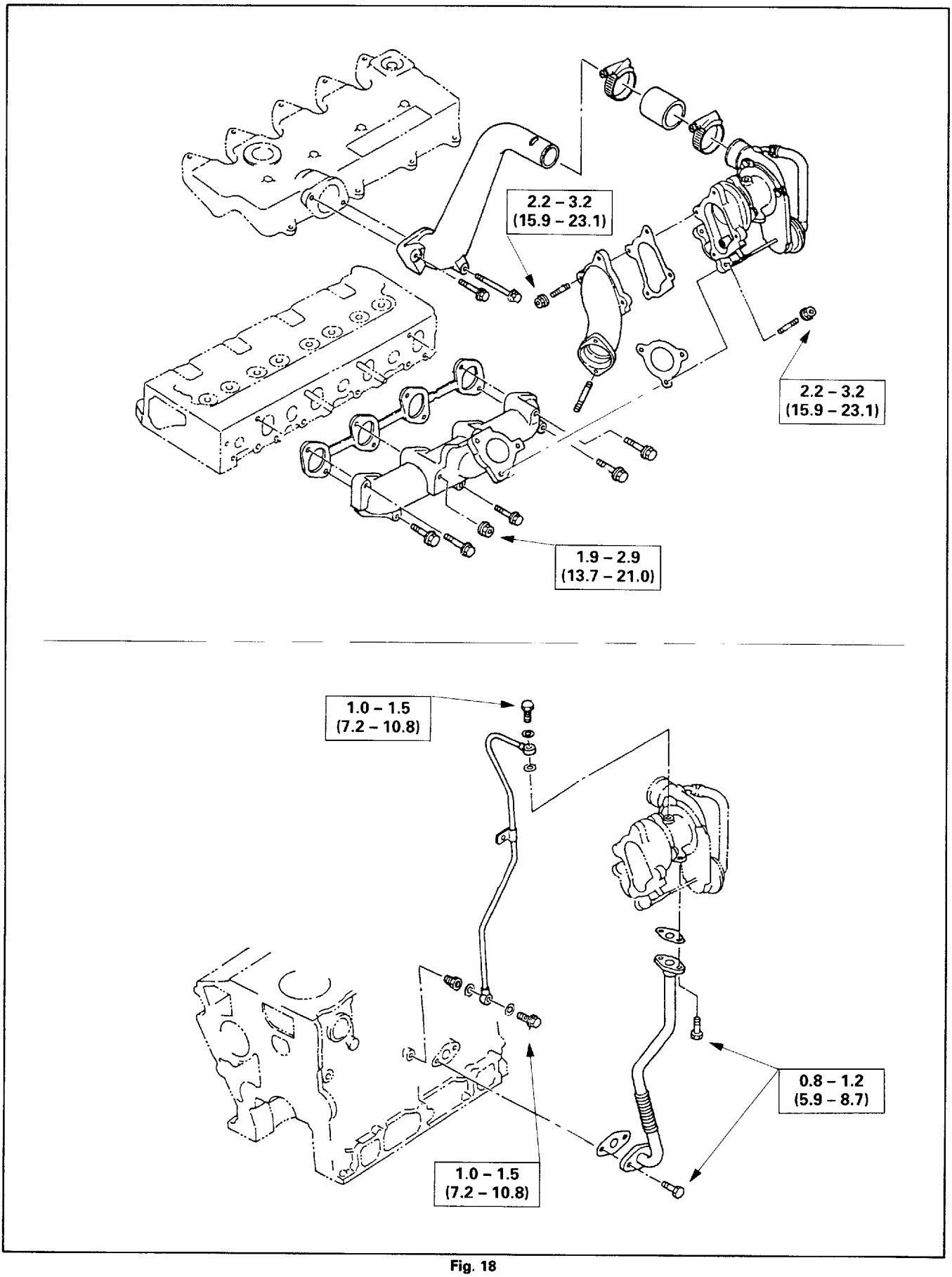



Fig. 18

# GASKET LOCATION

## 1. LOCATIONS WHERE GASKETS ARE USED

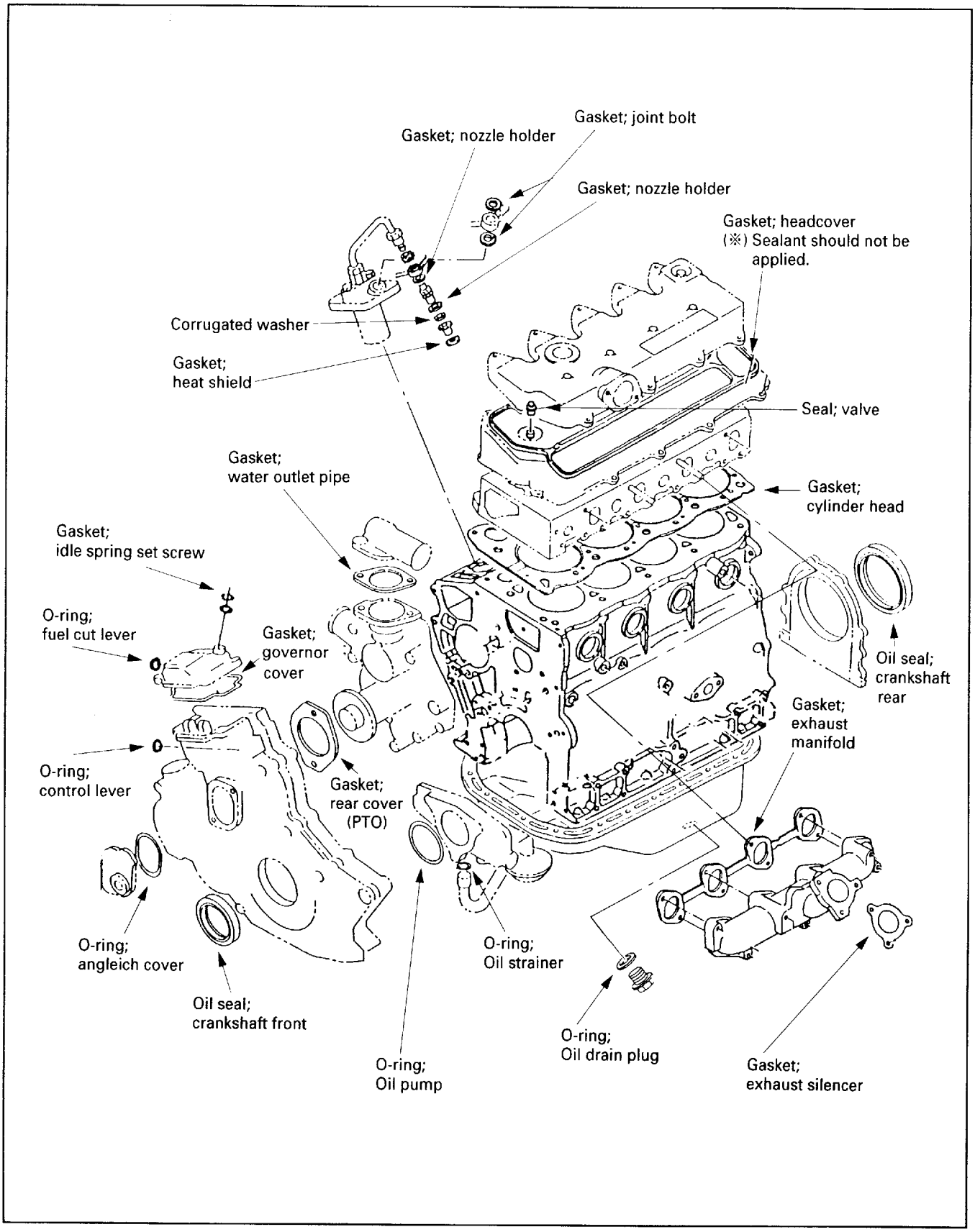



Fig. 19

## 2. LOCATIONS WHERE SEALANT IS APPLIED

| | Location | | Condition for use | | Name of sealant |
|---|---|---|---|---|---|
| | Name of part | Name of mating part | Object to be sealed | Groove to be applied | |
| 1 | Oil pan | Cylinder block | Engine oil (10W-30) | Not provided | TB1207C |
| 2 | Rocker bracket | Cylinder head | Engine oil (10W-30) | Provided | TB1207C |
| 3 | Air inlet pipe | Cylinder head cover | Air | Provided | TB1207C |
| 4 | Front plate (with PTO provided) | Cylinder block | Engine oil (10W-30) | Provided | TB1207C |
| 5 | Timing case (with PTO provided) | Front plate | Engine oil (10W-30) | Provided | TB1207C |
| 6 | Timing case (with no PTO provided) | Cylinder block | Engine oil (10W-30) | Provided | TB1207C |
| 7 | Water pump ASM | Cylinder block | Cooling water | Not provided | TB1207C |
| 8 | Rear cover; water pump | Body; water pump | Cooling water | Provided | TB1207B |
| 9 | Housing cover; injection pump | Cylinder block | Engine oil (10W-30) | Provided | TB1207C |
| 10 | Solenoid; fuel cut | Cylinder block | Engine oil (10W-30) | Provided | TB1207C |
| 11 | Retainer; oil seal | Cylinder block | Engine oil (10W-30) | Provided | TB1207C |
| 12 | Indicator; air cleaner | Air cleaner | Air | Not provided | (Sealing tape) |

Fig. 20

# MAINTENANCE

## 1. VALVE CLEARANCE AND ADJUSTMENT

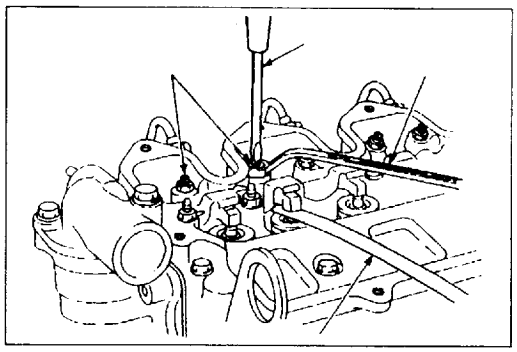


Fig. 21

**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.

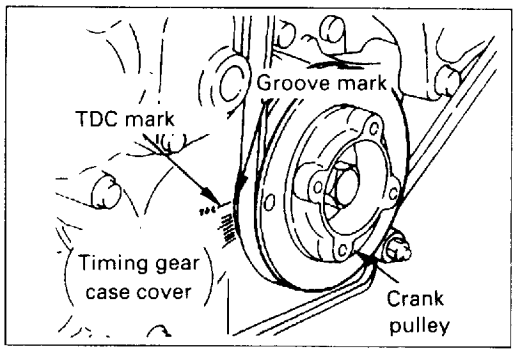



Fig. 22

1. Bring the piston in either the No. 1 cylinder or the No. 3 cylinder to Top Dead Center on the compression stroke by turning the crankshaft until the TDC mark on the front cover aligns with the groove mark on the crankshaft pulley.
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. 4 piston is at TDC on the compression stroke.

   Adjust the circle or double circle marked valves as shown in Fig. 24, while the No. 1 or the No.4 cylinder is at TDC on compression stroke.

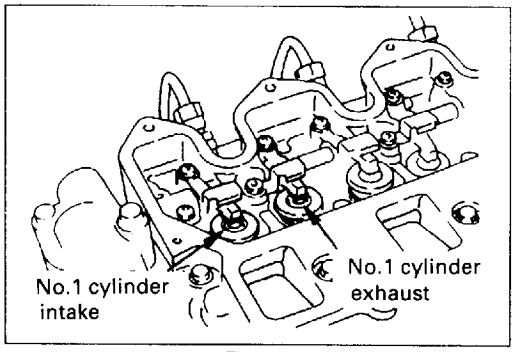
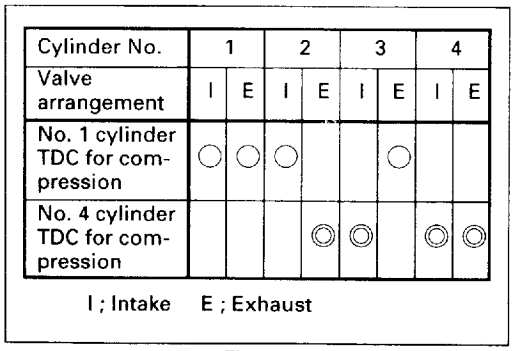



Fig. 23

mm (in.)

| | |
|---|---|
| Intake and Exhaust Valve Clearance (cold) | 0.40 ± 0.05 (0.015 ± 0.002) |



| Cylinder No. | 1 | | 2 | | 3 | | 4 | |
|---|---|---|---|---|---|---|---|---|
| Valve arrangement | I | E | I | E | I | E | I | E |
| No. 1 cylinder TDC for compression | ○ | ○ | ○ | | | ○ | | |
| No. 4 cylinder TDC for compression | | | | ◎ | ◎ | | ◎ | ◎ |

I ; Intake E ; Exhaust

Fig. 24

3. Loosen each valve clearance adjusting screw as shown in the illustration.
4. Insert a 0.40 mm (0.015 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 belt on the feeler gauge.
6. Tighten the lock nut securely.
7. Rotate the crankshaft 360°.

   Realign the crankshaft pulley.
8. Adjust the clearances for the remaining valves as shown in the illustration.

## 2. LUBRICATIN SYSTEM

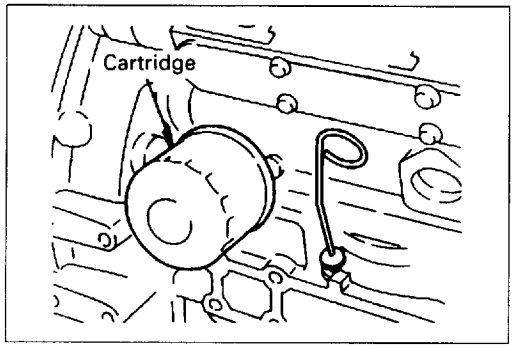



Fig. 25

### Cartridge (Spin-On) Type

#### Removal

Remover 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 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.

## 3. COOLING SYSTEM

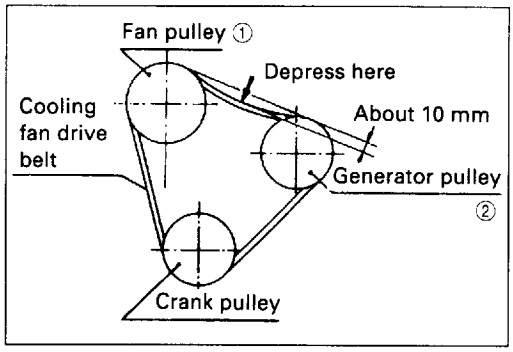



Fig. 26

### 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 (22 lb) midway between the Fan pulley ① and the Generator pulley ②.
3. Adjust the belt tension by loosening the Generator 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 | 8.0 – 12.0 (0.3 – 0.5) |

## 4. INJECTION TIMING

**Note:**

**Take care to avoid entry of dust or foreign particles into the pump interior when the timing adjustment is made.**

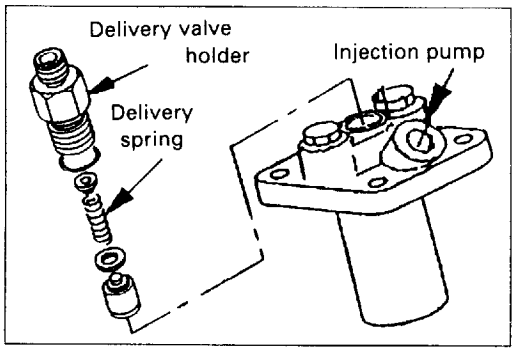



Fig. 27

1. Remove the injection pipe of the No. 1 cylinder.
2. Remove the delivery valve holder of the injection pump of the No. 1 cylinder, and then pull out the delivery spring.
3. With the spring left removed, install the delivery valve holder.
4. Slowly turn the crankshaft pulley clockwise, at the same time, continue to feed the fuel.

   When the fuel stop flowing out from the No. 1 delivery valve holder, stop turning the crankshaft.

   This crank angle position is the starting point of injection.

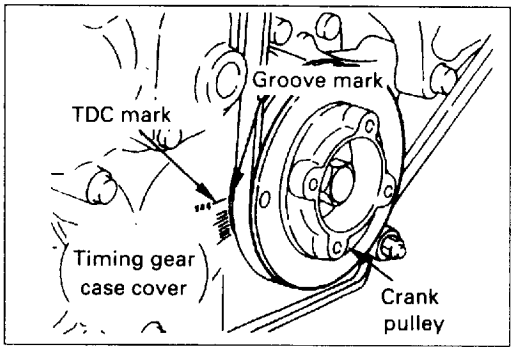



Fig. 28

5. In the condition at Step (4) above, confirm what degree the "groove mark" of the crank pulley is at, when seen by the "timing mark", provided in the timing gear case.

   When the value is out of the range of the normal injection timing, adjust it accordingly.

| | | |
|---|---|---|
| * Injection timing | 4LB1, 4LC1, 4LE1 | BTDC 16° |

**Note:**

**The injection timing varies according to the specifications of the machine.**

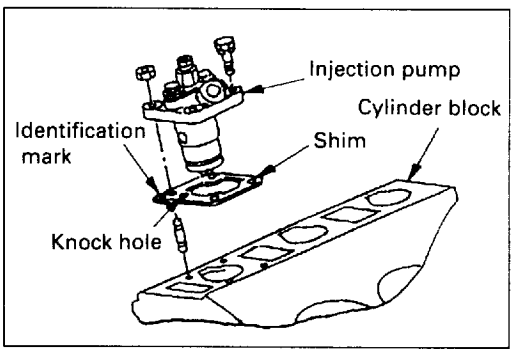



Fig. 29

6. Adjust the injection timing with a shim between the injection pump and the cylinder block.

   Shim is available in the following 9 types, and "identification mark" is stamped (or imprinted) on the top face.

Identification mark of shim and its thickness (mm)

| Mark | Thickness | Mark | Thickness | Mark | Thickness |
|---|---|---|---|---|---|
| 2 | 0.2 | 5 | 0.5 | 8 | 0.8 |
| 3 | 0.3 | 6 | 0.6 | 10 | 1.0 |
| 4 | 0.4 | 7 | 0.7 | 12 | 1.2 |

**Note:**

**For each of the injection pumps of three cylinders, the shim adjustment is made at the same time.**

**When a shim is missing while overhauling the engine and the shim thickness is unknown, assemble the engine with provisional shim inserted. After assembling the engine, check the injection timing and adjust the shim until the normal injection timing is obtained.**

**Reference:**

To add the 0.1 mm shim thickness corresponds to the 1 degree of crankshaft angle advance.

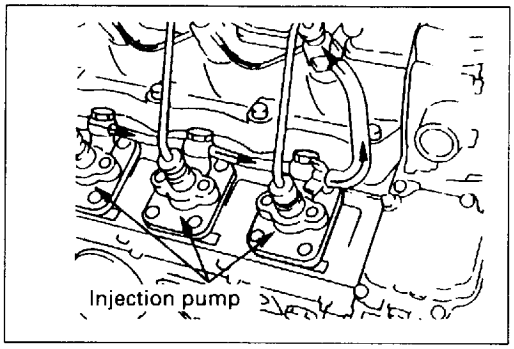



Fig. 30

**Air bleeding from fuel** (automatic air-bleeding system)

1. **For the automatic air-bleeding system**

   When the starter switch is set to "OPERATION", the electromagnetic pump is activated to force-feed fuel to the fuel pipe and the leak-off pipe, and air in the fuel system is automatically bled.

2. **For non-automatic air-bleeding system**

   While sending fuel by means of the force of the electromagnetic pump, the fall from the fuel tank or the feed pump lever, bleed air out of the fuel pipe eye bolt of the No. 1 cylinder injection pump, the leak-off pipe eye bolt of the injection nozzle and the air-bleeder plug of the fuel filter, starting with the one installed the lower most and upward.

## 5. COMPRESSION PRESSURE MEASUREMENT

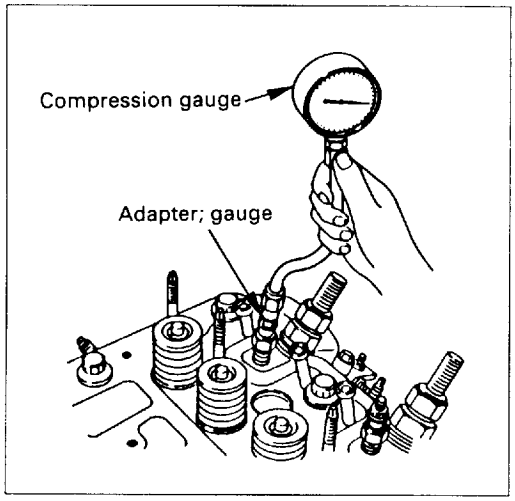



Fig. 31

1. Operate the engine to warm-up until the coolant temperature reachs 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 508840-2008-0

Compression Gauge Adapter 508840-2009-0

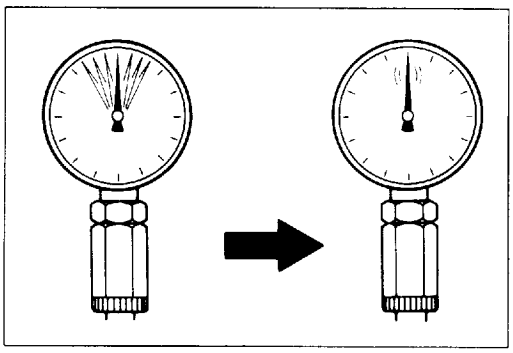


Fig. 32

4. Crank the engine with the starter motor and take the compression gauge reading.

kg/cm² (psi) at 250 rpm

| Standard | Limit |
|---|---|
| 31.0 (441) | 26.0 (370) |

5. Repeat the procedure (Steps 3 and 4) for the remaining cylinders.

   Compression pressure should be approximately the same for each cylinder. A variation exceeding 2.0 kg/cm² (28 psi) is unacceptable.

   If the measured value exceeds the specified limit, the related parts must be checked.

## 6. FUEL SYSTEM

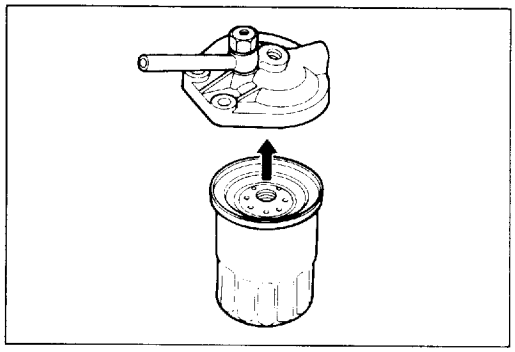


Fig. 33

### 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 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.

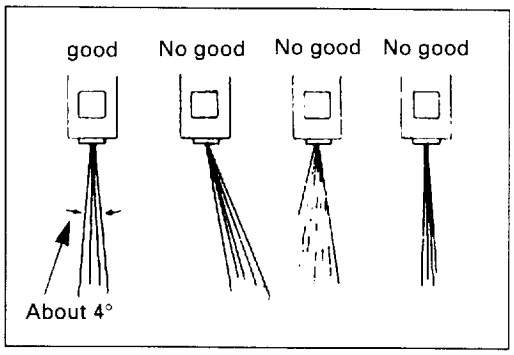



Fig. 34

#### Injection nozzle

Check to see if the spray condition and the injection pressure are normal. Adjust them to the specified value respectively when they don't meet the standard valve.

kg/cm² (psi)

| | | |
|---|---|---|
| Injection pressure | 4LB1 | 135 (1920) |
| | 4LC1 | |
| | 4LE1 | |

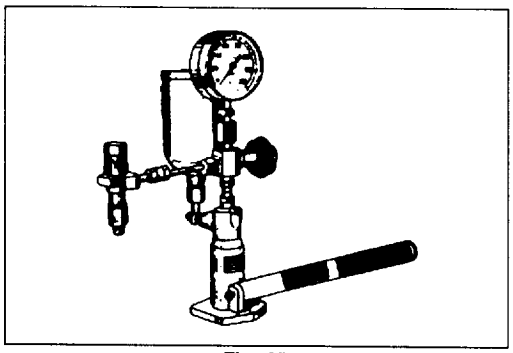


Fig. 35

Using a nozzle tester, adjust the injection pressure with a shim.

Special tool: Nozzle tester

# RECOMMENDED LUBRICATING OIL

| TYPE OF LUBRICANTS (API) | DIESEL ENGINE OIL; CC OR CD GRADE |
|---|---|

## ENGINE OIL VISCOSITY CHART

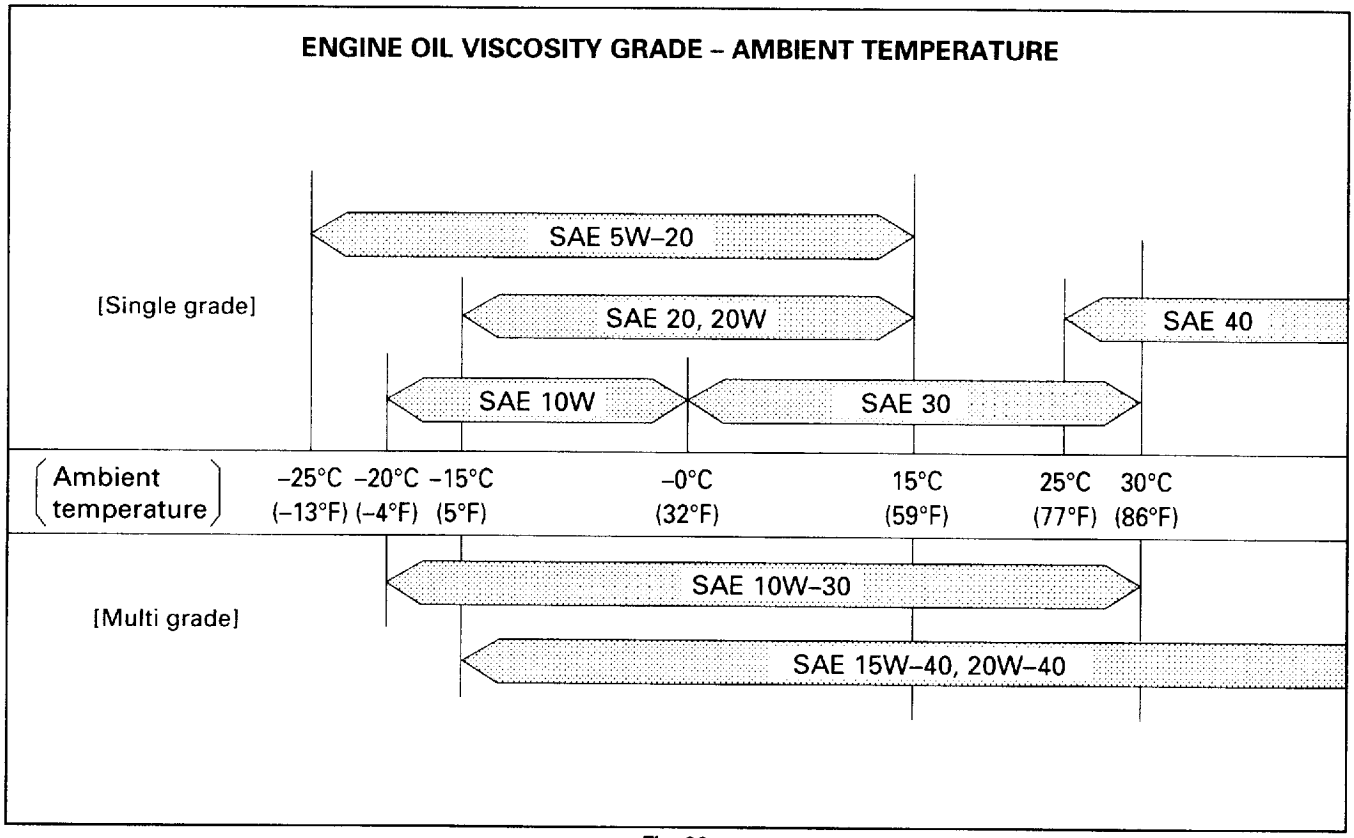



Fig. 36

## SECTION 2

# ENGINE

### TABLE OF CONTENTS

# DISASSEMBLY

## 1. EXTERNAL PARTS (Left-hand side)

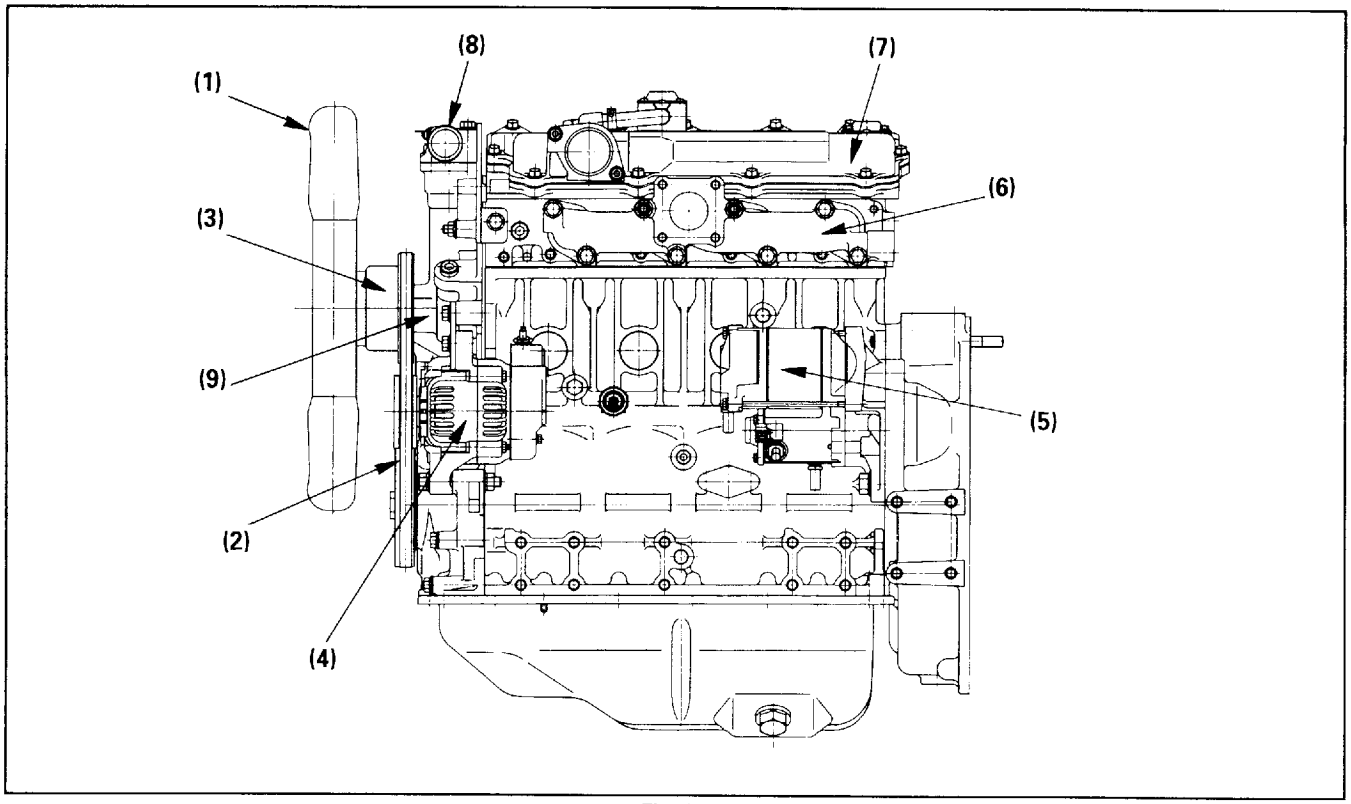



Fig. 37

(1) Cooling fan and spacer
(2) Fan belt
(3) Fan pulley
(4) Generator
(5) Starter
(6) Exhaust manifold and gasket
(7) Cylinder head cover and air intake pipe
(8) Water outlet pipe and thermostat
(9) Water pump assembly

## 2. EXTERNAL PARTS (Right-hand side)

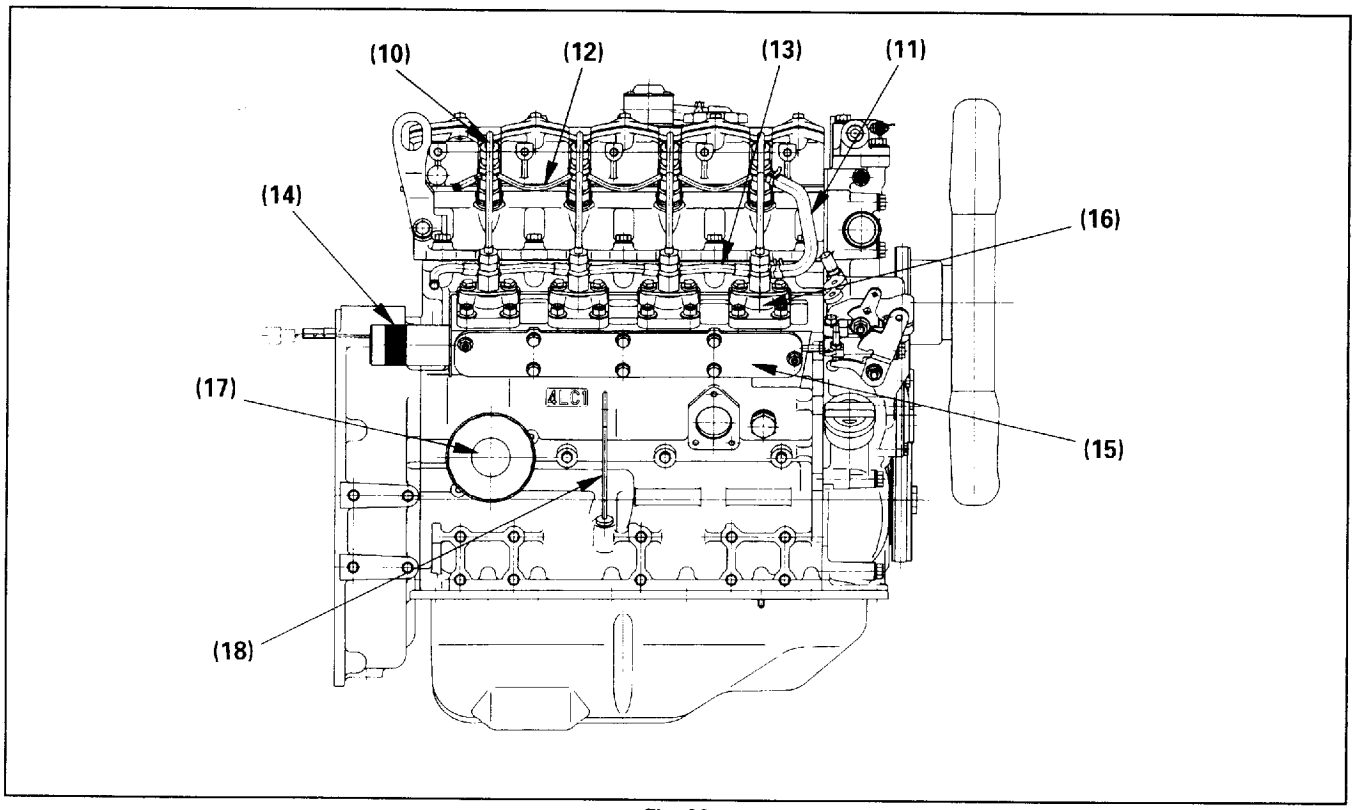



Fig. 38

(10) Injection pipe . . . . . 4 pcs.
(11) Fuel hose
(12) Fuel leak off pipe
(13) Fuel pipe
(14) Engine stop solenoid
(15) Injection pump housing cover
(16) Injection pump and shim . . . . . 4 set
(17) Oil filter
(18) Oil level gauge

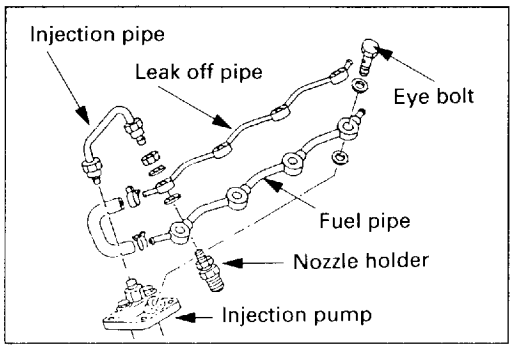



Fig. 39

**Injection pipe**

**Leak off pipe**

**Fuel pipe**

1. Loosen the sleeve nuts on the nozzle holder side and on the injection pump side, and then disconnect the injection pipes.
2. Disconnect the leak off pipe together with gaskets.
3. Remove the eye bolt, and then disconnect the fuel pipe.

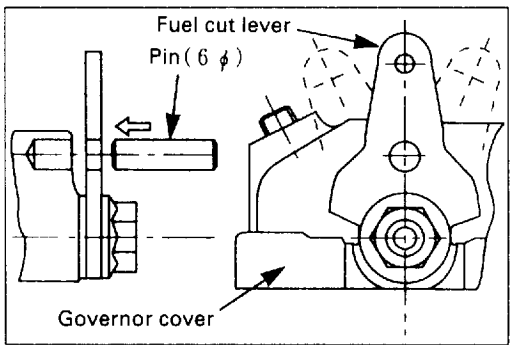



Fig. 40

**Injection pump**

1. Align the hole of the fuel cut lever with the hole of the governor cover, and then insert a pin (6ø) into this hole to hold the fuel cut lever.
2. Check to see if the pin groove of the control link is at the center of the injection pump.
3. Remove the injection pump, and then take out the shim.

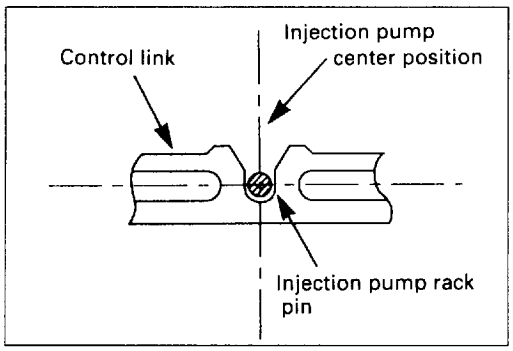



Fig. 41

NOTE:

1. **Mark each injection pump as to which cylinder it was removed from.**
2. **Do not reuse the shim, replace it with the same thickness that was removed.**

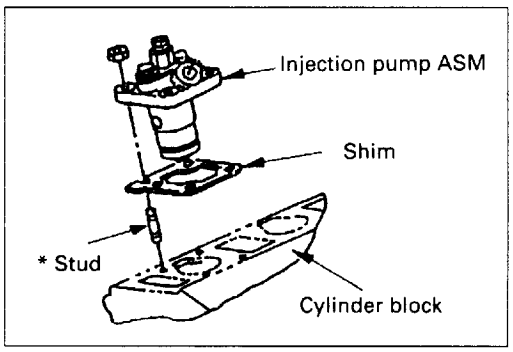



Fig. 42

**Backlash of timing gear**

mm (in.)

| | STANDARD | LIMIT |
|---|---|---|
| CRANK GEAR/ IDLER GEAR | 0.04 (0.0017) | 0.2 (0.0079) |
| CAM GEAR/ IDLER GEAR | 0.03 (0.0012) | 0.2 (0.0079) |

**IDLER GEAR END PLAY**

mm (in.)

| STANDARD | LIMIT |
|---|---|
| 0.058 – 0.115 (0.0023 – 0.0045) | 0.2 (0.0079) |

**CRANKSHAFT END PLAY**

mm (in.)

| STANDARD | LIMIT |
|---|---|
| 0.058 – 0.208 (0.0023 – 0.0082) | 0.3 (0.0118) |

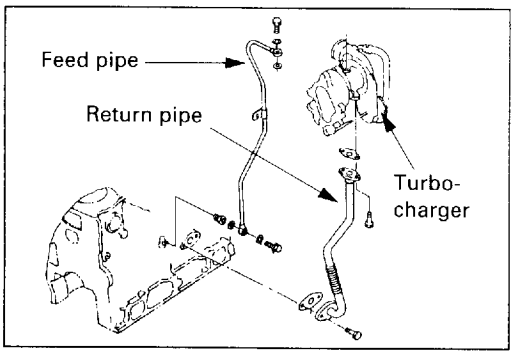



Fig. 43

**Return pipe**

**Feed pipe**

Remove the return pipe and the feed pipe.

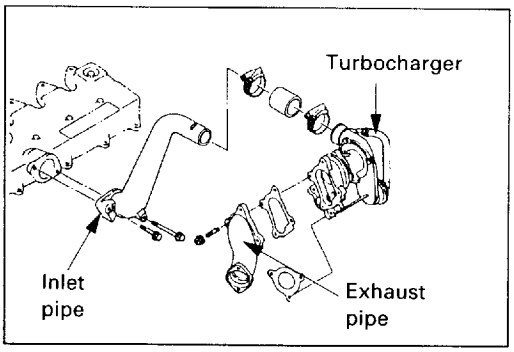



Fig. 44

**Exhaust pipe**

**Inlet pipe**

**Turbocharger**

Remove the exhaust pipe, the inlet pipe and turbocharger.

## 3. INTERNAL PARTS

### Disassembly Steps

(1) Rocker Bracket Assembly
(2) Push Rods
(3) Rear Hanger
(4) Front Hanger
(5) Cylinder Head Assembly
(6) Cylinder Head Gasket
(7) Tappets
(8) Oil Pan
(9) Oil Strainer
(10) Oil Pipe
(11) Crank Pulley
(12) Flywheel
(13) Flywheel Housing
(14) Timing Gear Case (without PTO)
(15) Oil Pump Assembly
(16) Idler Gear and Shaft
(17) Cam Gear
(18) Camshaft
(19) Rear Seal Retainer
(20) Piston Assemblies
(21) Crankshaft

## Internal Parts (1/3)

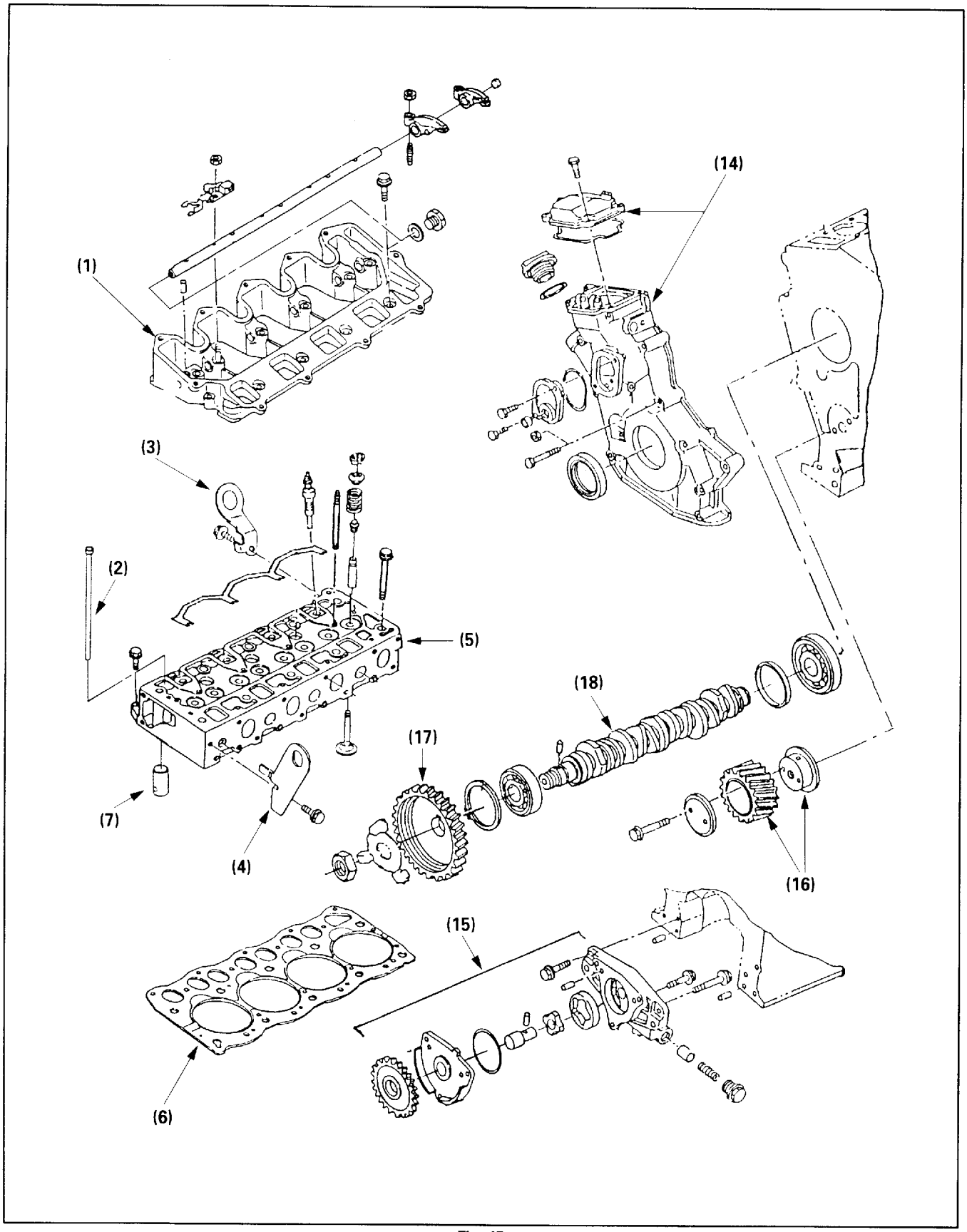



Fig. 45

## Internal Parts (2/3)

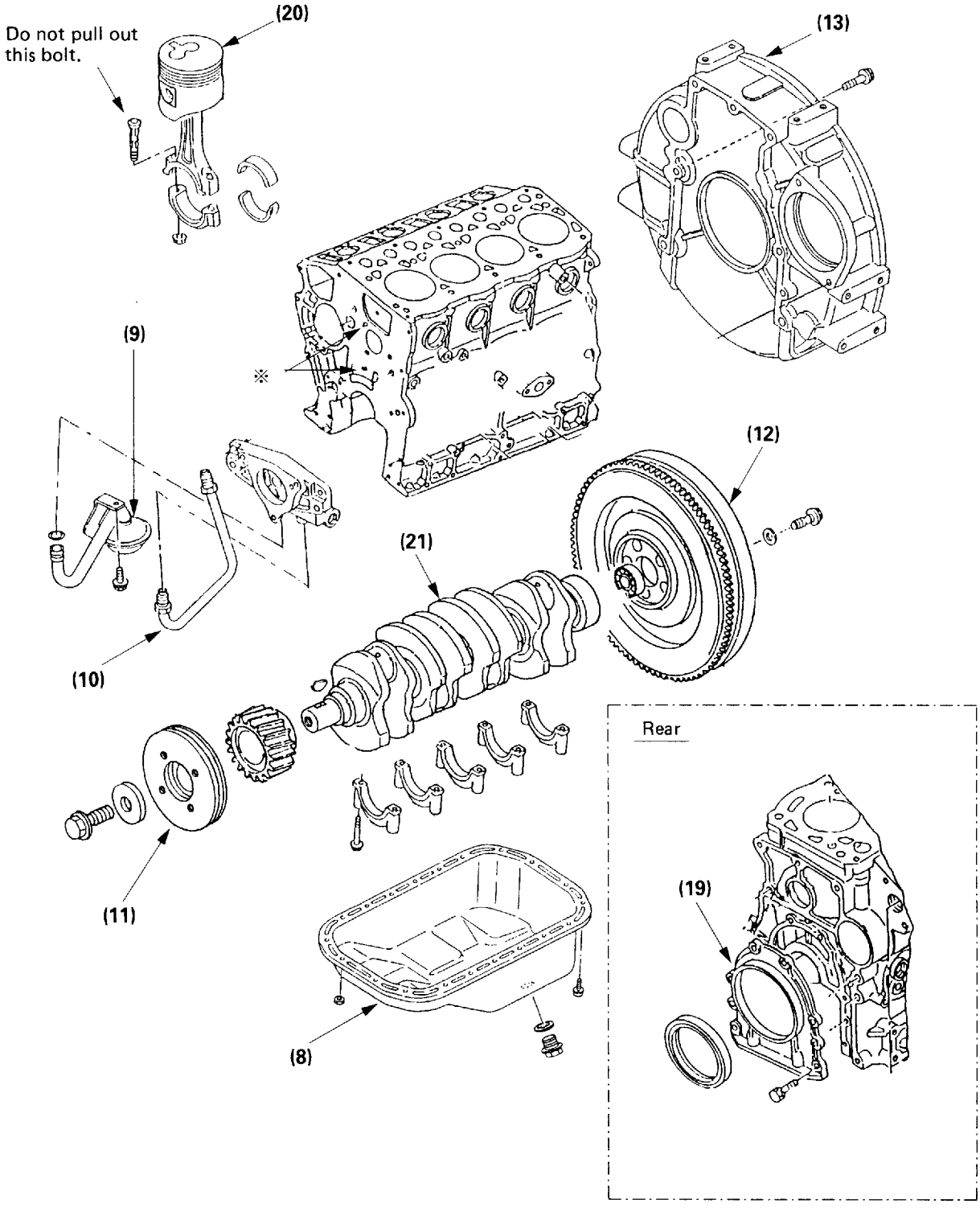



Fig. 46

## Internal Parts (3/3)

### When provided with PTO

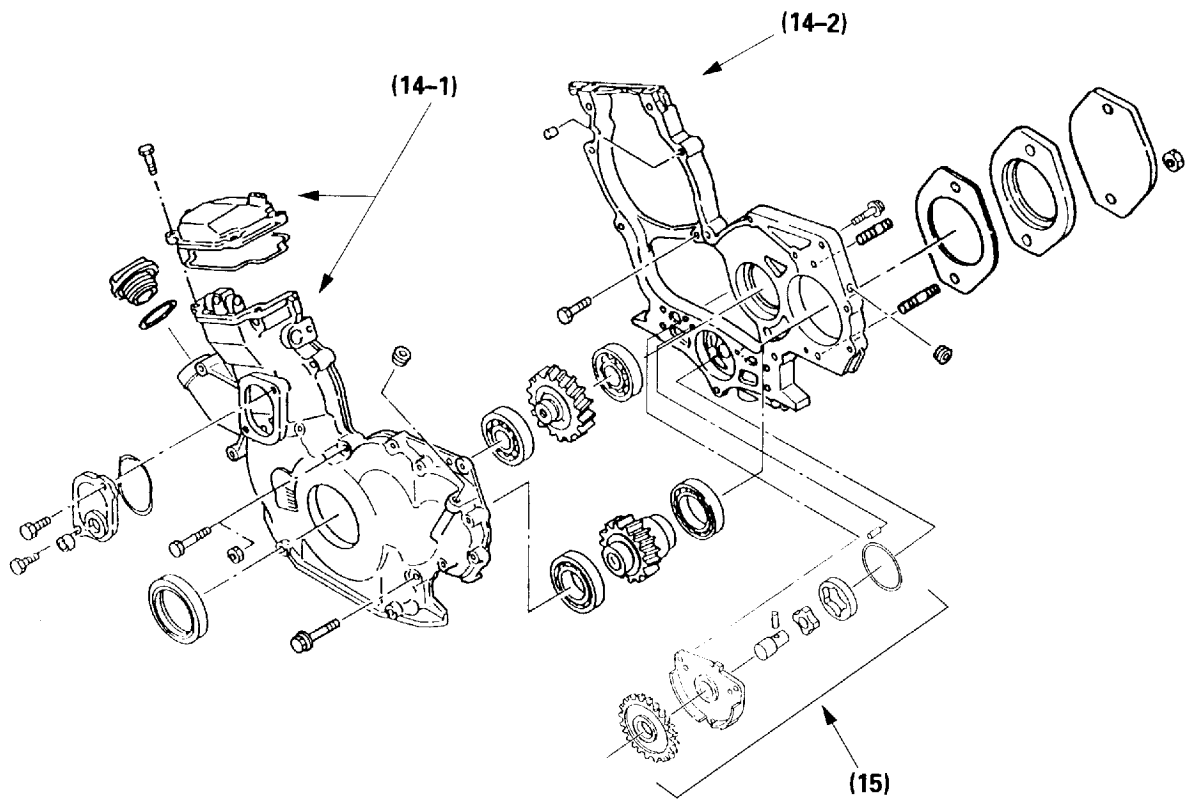



Fig. 47

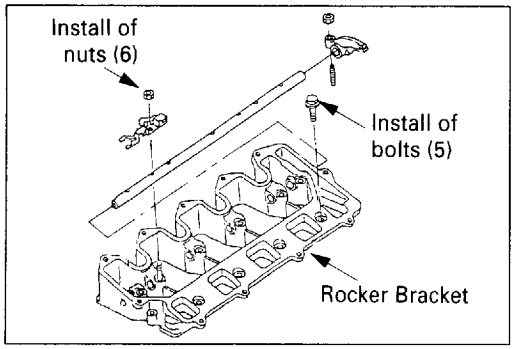



Fig. 48

**Rocker bracket**

**Push rod**

1. Remove the rocker bracket assembly. (M6 × 1 . . . . . 5 bolts and 6 nuts)
2. Pull out the push rods (8 pcs.).

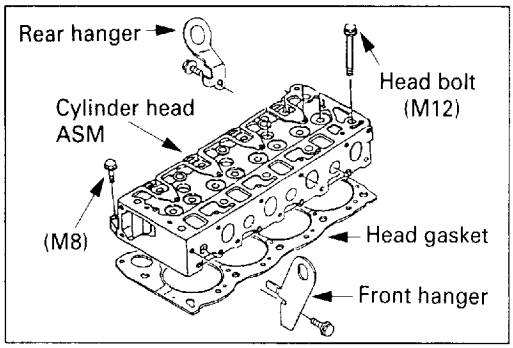



Fig. 49

**Cylinder head assembly**

1. Remove the rear and front hangers.
2. When removing the cylinder head bolts, loosen them slowly, a little at a time, starting with the outside, working in a circular pattern inward.
3. Remove the cylinder head assembly and the head gasket.
4. Pull out the tappet from the cylinder body.

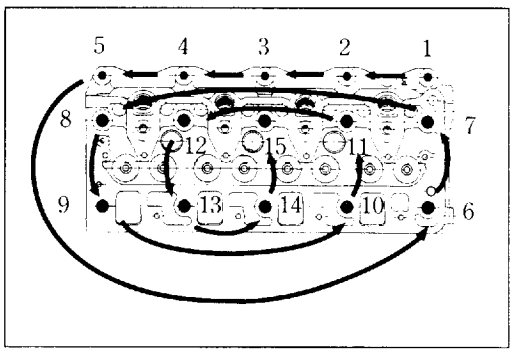



Fig. 50

## Cylinder Head Assembly

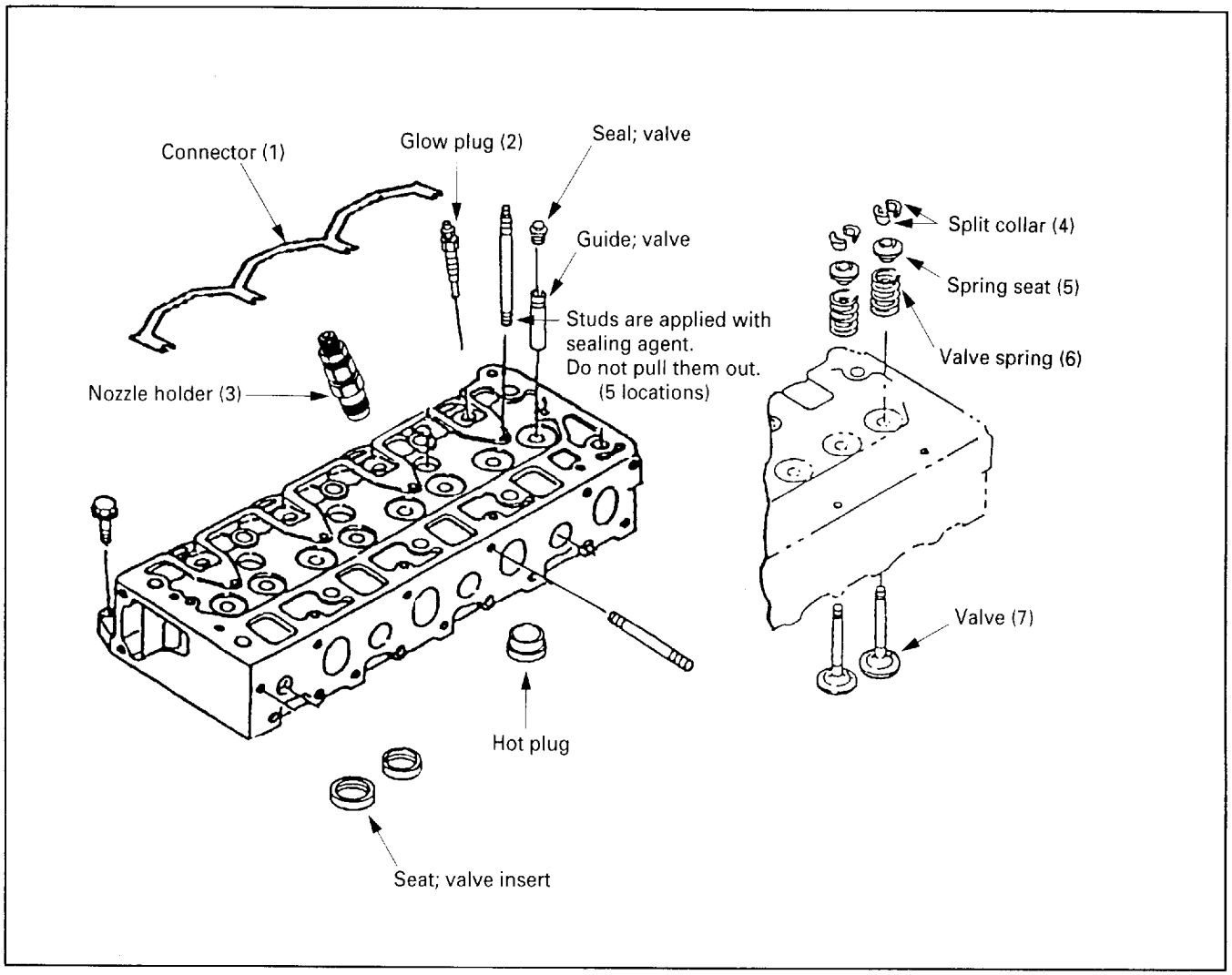



Fig. 51

### Valve mechanism

1. Before disassembling the valve mechanism, remove the connector, glow plug and nozzle holder assembly.
2. Compressing the valve spring, remove the split collar, spring seat, valve spring and valve.

## Timing Gear

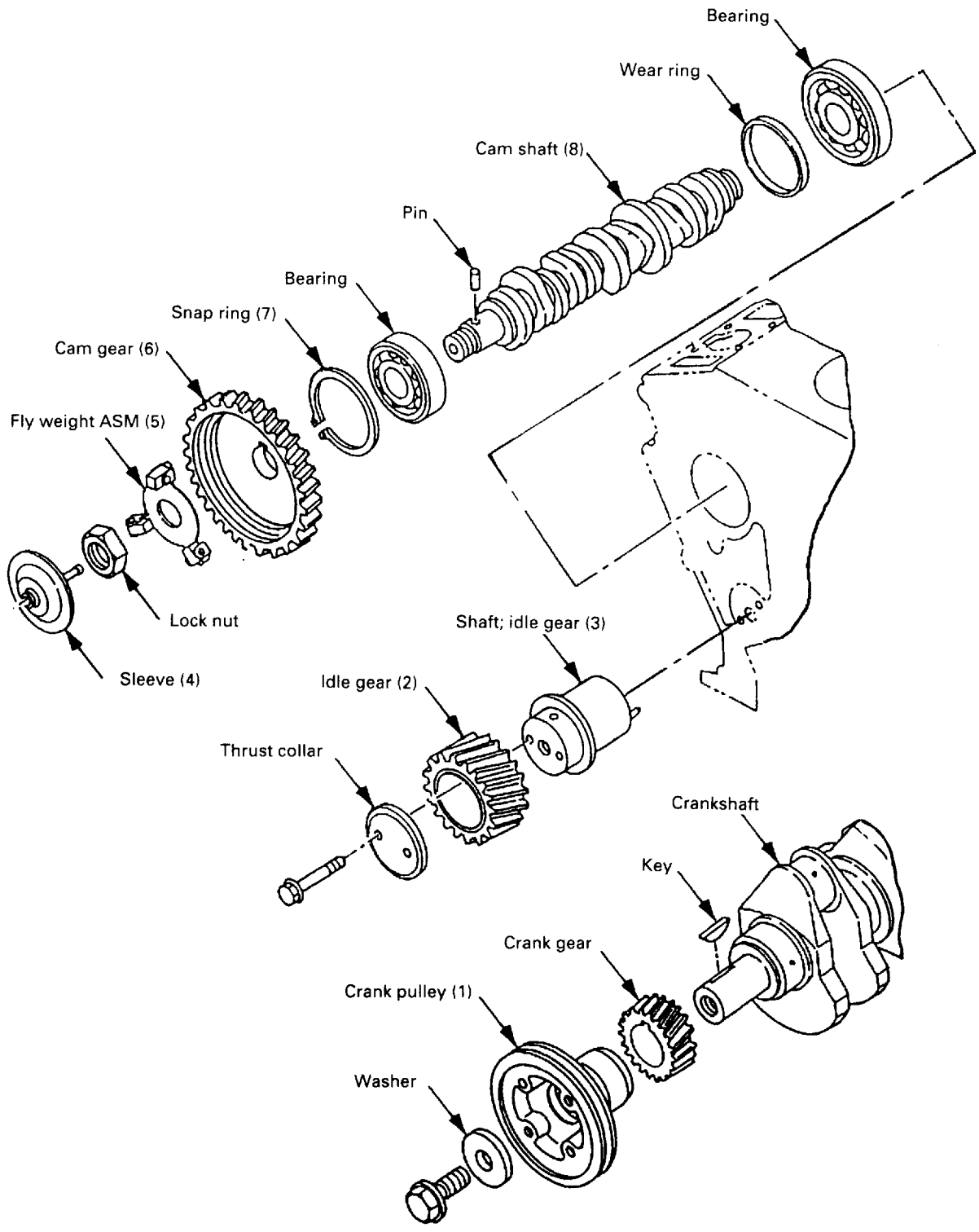



Fig. 52

**Timing gear**

1. Remove the idle gear and the idle gear shaft.
2. Pull out the sleeve from the tip end of the cam shaft.
3. Remove the lock nut of the cam shaft gear, and then remove the flyweight assembly and the cam gear.

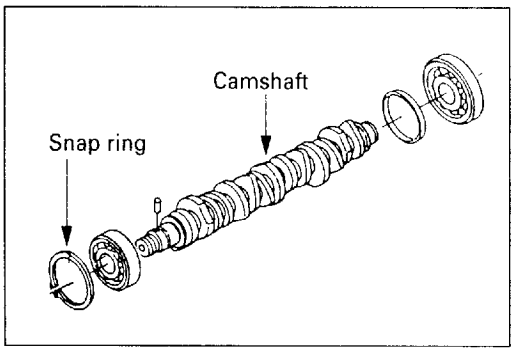



Fig. 53

**Camshaft**

1. Remove the snap ring which holds down the front bearing of the cam shaft from the ring groove of the cylinder block.
2. Pull out the cam shaft from the cylinder block, together with the bearing.

## Piston and Connecting Rod

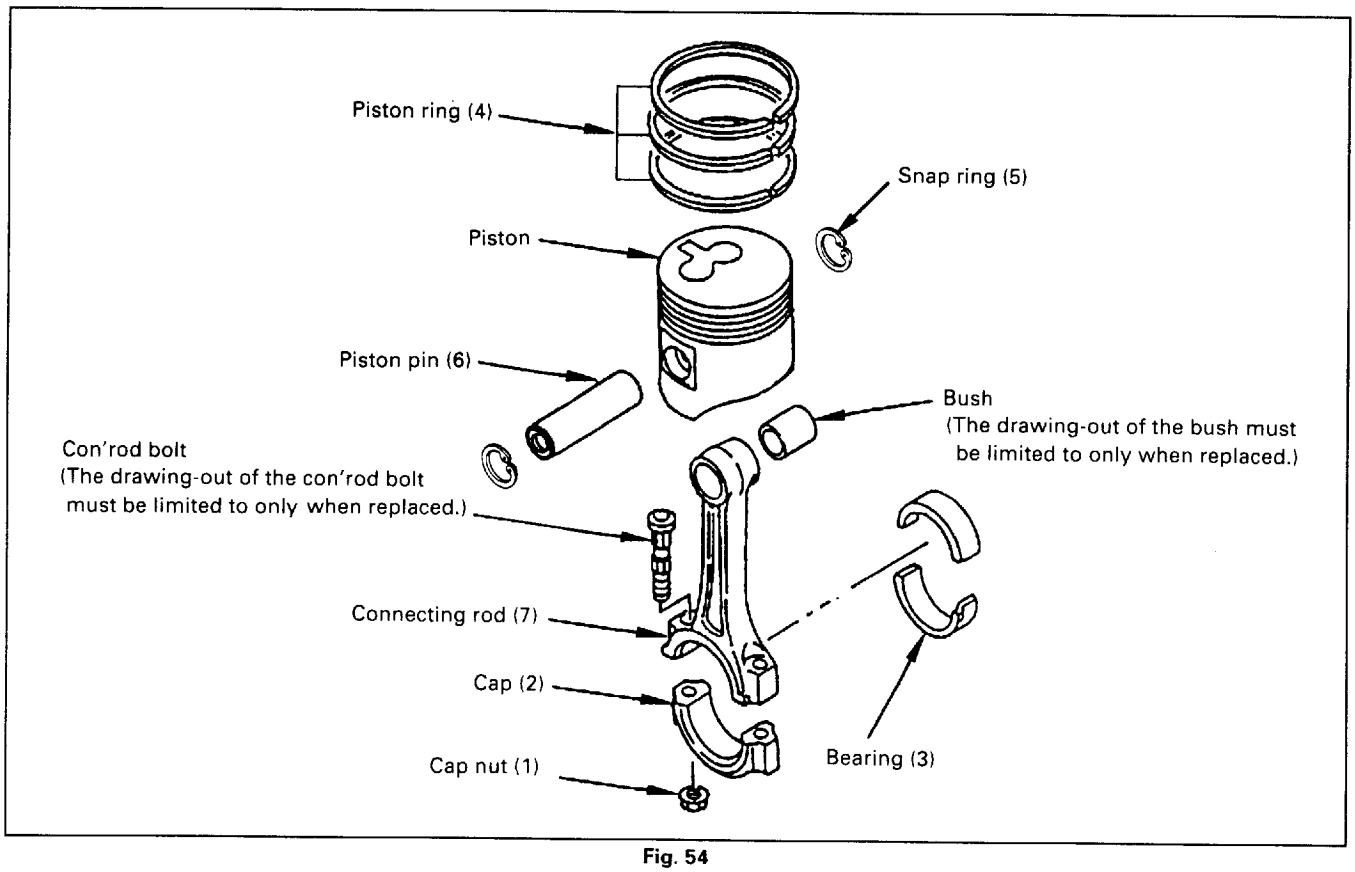



Fig. 54

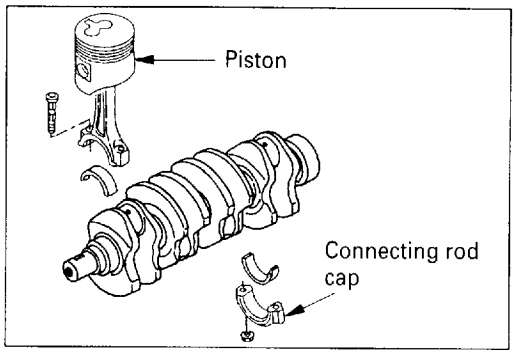



Fig. 55

### Piston and connecting rod

1. Turning the crankshaft, position the piston to be removed at the bottom dead center.
2. Loosen the cap nut of the connecting rod, and then remove it.
3. Give another rotation to the crankshaft to position the piston at the top dead center.
4. With the handle of a hammer placed at the bottom of the connecting rod, push the piston assembly upward out of the cylinder block.

**Notes:**

1. **Before removing the piston, scrape the carbon deposit off the cylinder wall.**
2. **When pushing out the piston assembly, care should be taken not to damage the cylinder wall.**
3. **Attach a tag with a cylinder number to the removed caps and bearings to keep them in order.**

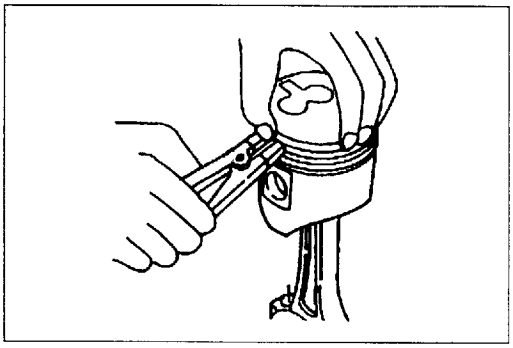


Fig. 56

**Piston ring**

Remove the piston ring with a ring pliers.

Pliers: piston ring 1-85221-029-0

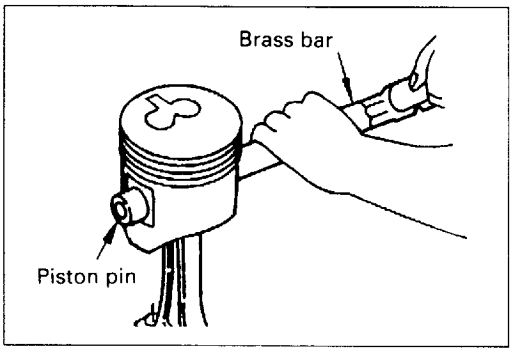



Fig. 57

**Piston pin**

1. Remove the snap rings with a commercially available tool.
2. With a brass bar attached to the piston pin, push it out by hammering it lightly.

**Note:**

**Keep the pistons, piston pins and connecting rods in order for each cylinder.**

# INSPECTION AND REPAIR

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

## 1. CYLINDER BLOCK

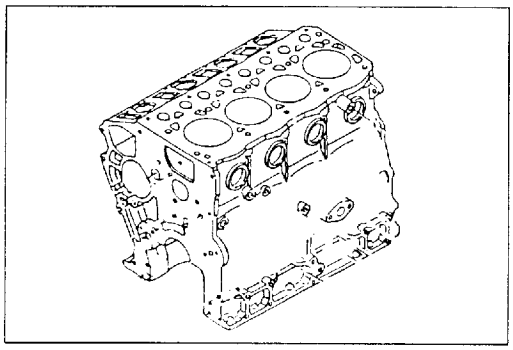


Fig. 58

**Cylinder block**

Check the cylinder block for wear, damage or any other defects.

Use the hydraulic gauge to check the water jacket water pressure.

Apply water pressure to the water jacket at 5 kg/cm$^2$ (71.1 psi) for three minutes.

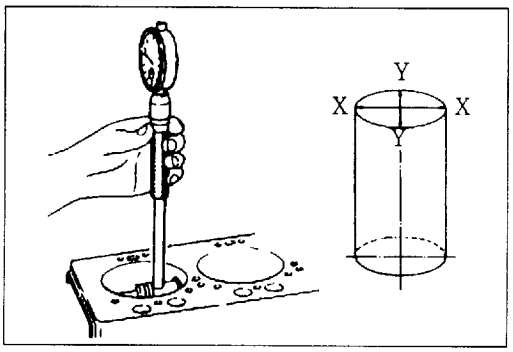



Fig. 59

**Cylinder bore**

Measurement position: 13mm below the top (Measure in X-X and Y-Y directions.) (Near the No. 1 compression ring)

mm (in.)

| Engine | Limit | Repair method |
|---|---|---|
| 4LB1<br>4LC1<br>4LE1 | 0.2 (0.0079) | Perform boring and honing of the inner diameter. |

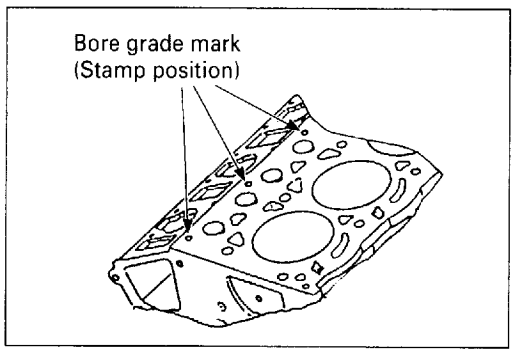



Fig. 60

**Cylinder bore diameter and grade mark**

The grade mark is stamped on the top surface of the cylinder block (on the mating face with the cylinder head).

mm (in.)

| Engine | Bore Diameter | Grade |
|---|---|---|
| 4LB1<br>4LC1 | 77.400 – 77.410<br>(3.0472 – 3.0476) | A |
| | 77.411 – 77.420<br>(3.0476 – 3.0480) | B |
| | 77.421 – 77.430<br>(3.0480 – 3.0484) | C |
| 4LE1 | 85.000 – 85.010<br>(3.3464 – 3.3468) | A |
| | 85.011 – 85.020<br>(3.3468 – 3.3472) | B |
| | 85.021 – 85.030<br>(3.3472 – 3.3476) | C |

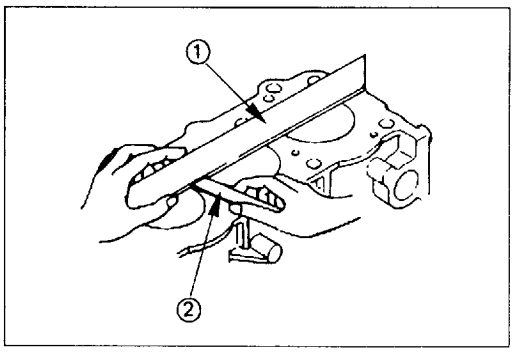



Fig. 61

## Cylinder Body Upper Face Warpage

Use a straight edge ① and a feeler gauge ② to measure the four sides and the two diagonals of the cylinder body upper face.

Regrind the cylinder body upper face if the measured values are greater than the specified limit but less than the maximum grinding allowance.

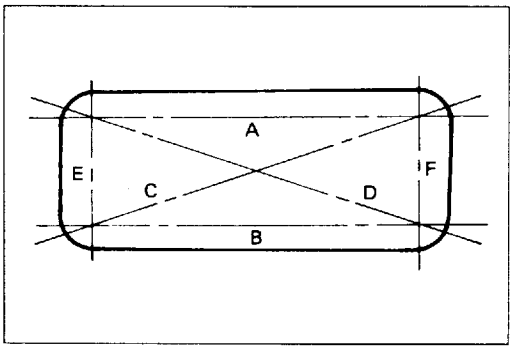



Fig. 62

If the measured values exceed the maximum grinding allowance, the cylinder body must be replaced.

Cylinder Body Upper Face Warpage mm (in.)

| Standard | Limit | Maximum Grinding Allowance |
|---|---|---|
| 0.075 (0.0029) | 0.15 (0.0059) | 0.3 (0.0118) |

If the measured value is less than the limit, the cylinder body may be reground.

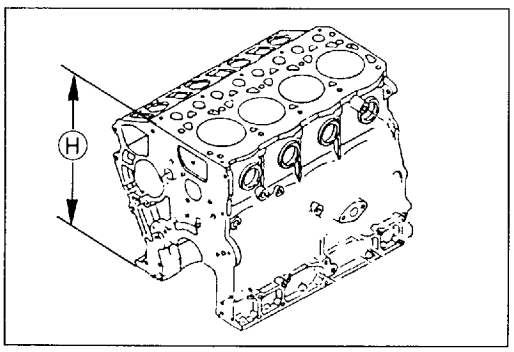



Fig. 63

Cylinder Body Height Ⓗ (Reference) mm (in.)

| Engine | Standard |
|---|---|
| 4LB1 | 280.94 – 281.06<br>(11.060 – 11.065) |
| 4LC1<br>4LE1 | 307.94 – 308.06<br>(12.123 – 12.128) |

## 2. CYLINDER HEAD

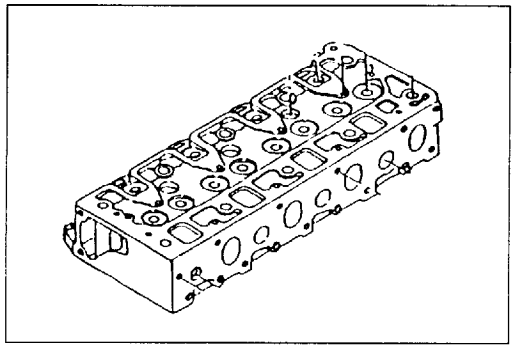


Fig. 64

### Cylinder head inspection

Remove carbon deposit on the bottom surface of the head with care not to damage the valve seat.

Leakage: Water pressure test 5kg/cm² (for 3 minutes)

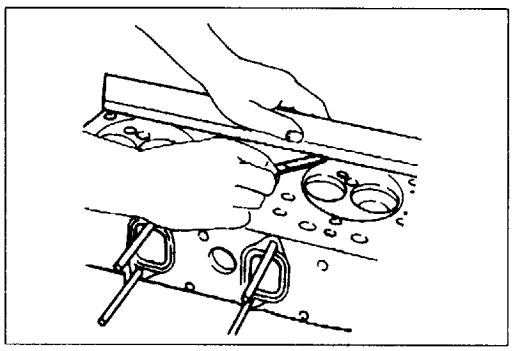


Fig. 65

### 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.

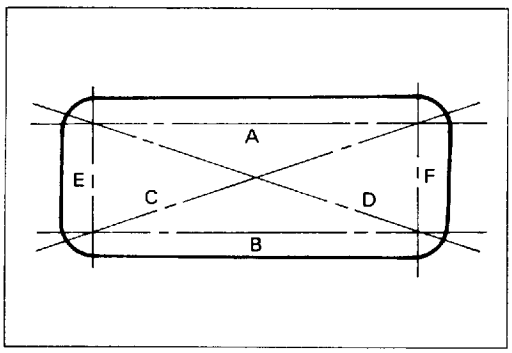



Fig. 66

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 Allwance |
|---|---|---|
| 0.075 (0.0029) | 0.15 (0.0059) | 0.3 (0.0118) |

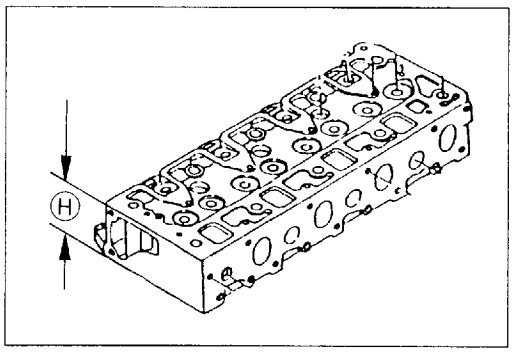



Fig. 67

Cylinder Head Height Ⓗ (Reference) mm (in.)

| Engine | Standard |
|---|---|
| 4LB1<br>4LC1<br>4LE1 | 63.90 – 64.10<br>(2.515 – 2.523) |

**Note:**

**If the cylinder head lower face is reground, valve depression must be checked.**

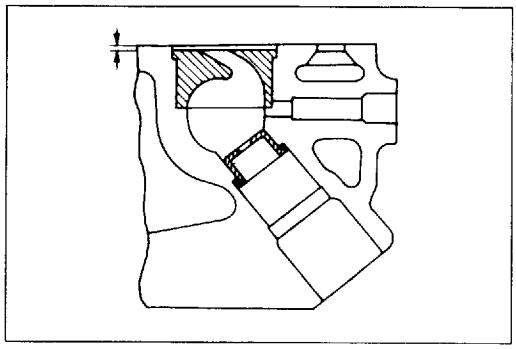


Fig. 68

## HOT PLUG

### Hot Plug Depression

1. Clean the cylinder head lower face, taking care not to damage the hot plug surfaces.
2. Use a straight edge and a feeler gauge to measure the hot plug depression in a straight line from the No. 1 hot plug to the No. 3 hot plug.

   If the measured value exceeds the specified limit, the hot plugs must be replaced.

Hot Plug Depression mm (in.)

| Limit |
|---|
| 0.05 (0.002) |

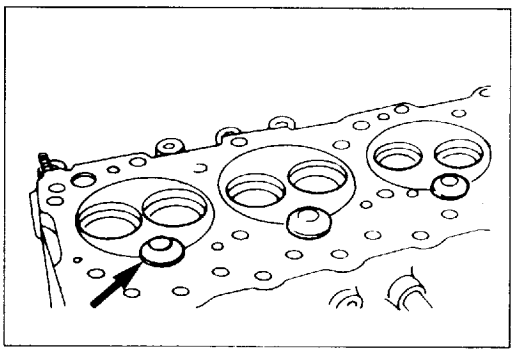


Fig. 69

### Combustion Chamber Inspection

1. Remove the carbon adhering to the inside of the combustion chamber. Take care not to damage the hot plug fitting positions.
2. Inspect the combustion chamber, the hot plug hole, and the hot plug machined faces for cracking and other damage.

   If cracking or damage is present, the cylinder head must be replaced.

**Note:**

**Be absolutely certain that there are no scratches or protuberances on the combustion chamber surfaces which will be in contact with the hot plug after it is installed. These flaws will prevent the hot plug from seating correctly.**

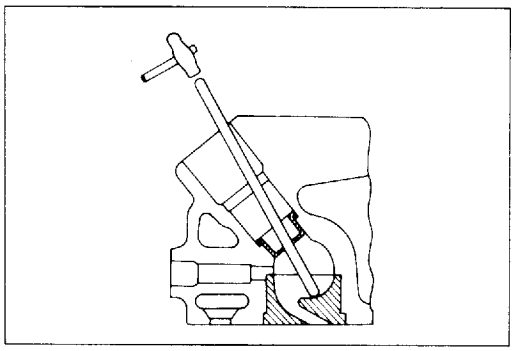


Fig. 70

### Hot Plug Replacement

### Hot Plug Removal

1. Insert a 3.0 – 5.0 mm (0.12 – 0.20 in) diameter brass bar into the nozzle holder fitting hole until it makes contact with the hot plug.
2. Lightly tap the bar with a hammer to drive the hot plug free.

### Hot Plug Inspection

Inspect the hot plugs for excessive wear and other damage. Replace the hot plugs if either of these conditions are discovered.

Refer to "Hot Plug Installation".

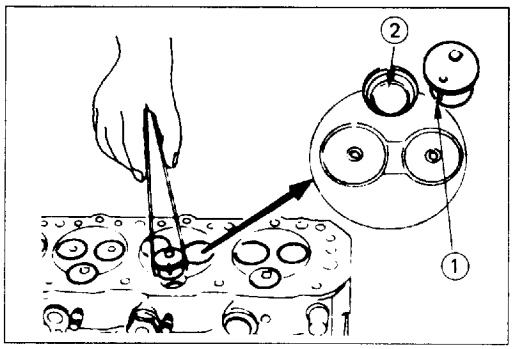



Fig. 71

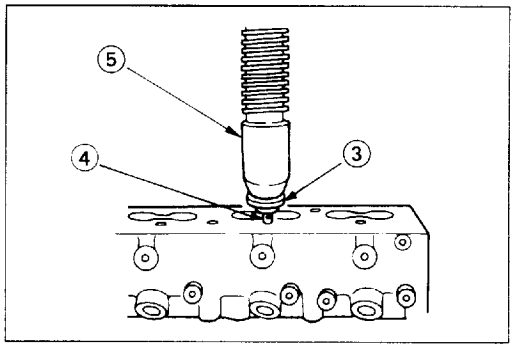



Fig. 72

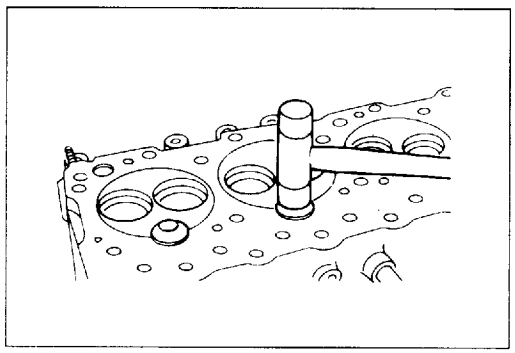


Fig. 73

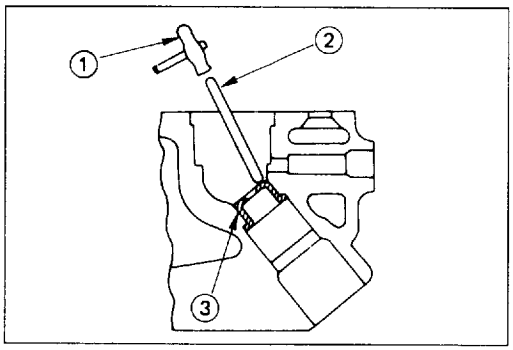



Fig. 74

### Hot Plug Installation

1. Align the hot plug knock ball ① with the cylinder head groove ② and tap it temporarily into position with a plastic hammer.
2. Place a metal plate ③ approximately 25 mm (1 in) thick over the hot plug upper surface ④.
3. Use a bench press ⑤ to exert a pressure of 4,000 – 5,000 kg (8,819 – 11,023 lb/39,227 – 49,033 N) on the metal plate covering the hot plug upper surface. This will drive the hot plug into position.
4. Lightly tap the hot plug head to make sure that it is firmly seated.
5. Repeat the procedure (Steps 1 – 4) for the remaining hot plugs.

**Note:**

**Do not apply pressure greater than that specified. Damage to the cylinder head will result.**

6. Use a surface grinder to grind off any hot plug surface protuberances.

   The hot plug surfaces must be perfectly flush with the cylinder head lower face.

7. After grinding, make sure that the hot plug surfaces are completely free of protuberances.

   The hot plug surfaces must also be free of depressions.

   Once again, lightly tap the hot plug heads to make sure that they are firmly seated.

### Heat Shield Replacement

### Heat Shield Removal

After removing the hot plugs, use a hammer ① and a brass bar ② to lightly tap the lower side of the heat shield ③ and drive it free.

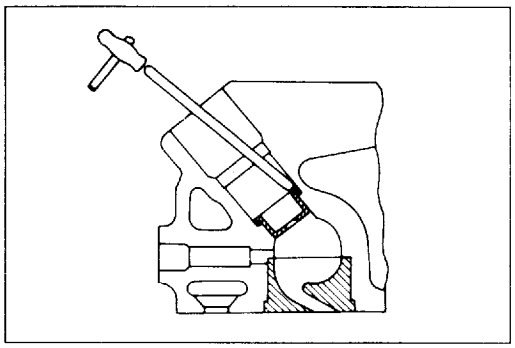


Fig. 75

**Heat Shield Installation**

Install the heat shield to the cylinder head from the nozzle holder installation hole side. Lightly tap the heat shield flange into place with a hammer and a brass bar.

The heat shield flange side must be facing up.

**Note:**

**Always install a new heat shield. Never reuse the old heat shield.**

## 3. VALVE, VALVE SEAT INSERT AND VALVE SEAL

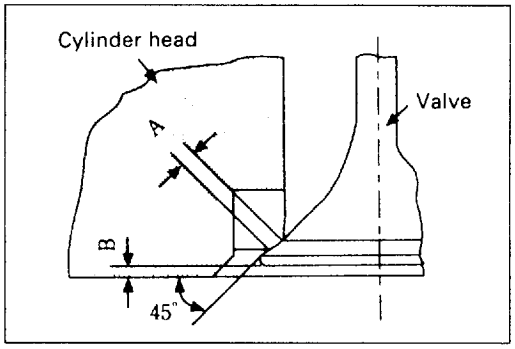



Fig. 76

**Inspection of valve seat**

1. A – Contact width
2. B – Valve depression

mm (in.)

| | Standard | Limit |
|---|---|---|
| Contact width | 2.0 (0.0787) | 2.5 (0.0984) |
| Valve depression | 0.7 (0.0276) | 1.2 (0.0427) |

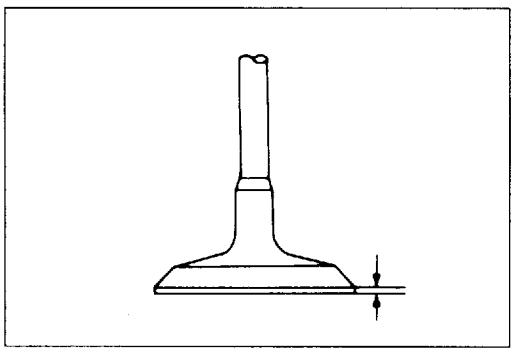


Fig. 77

**Valve thickness**

| Nominal | Limit | Repair method |
|---|---|---|
| 1.0 (0.03937) | 0.7 (0.0276) | Replace |

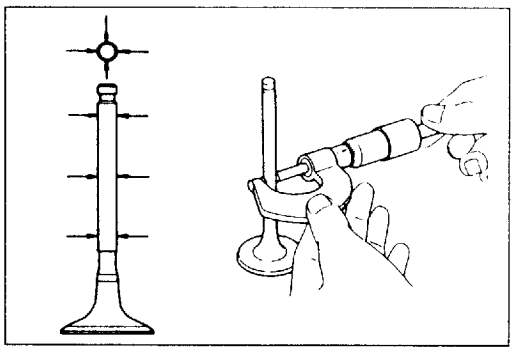


Fig. 78

**Valve Stem Outside Diameter**

Measure the valve stem diameter at three points.

If the measured value is less than the specified limit, the valve must be replaced.

Valve Stem Outside Diameter mm (in.)

| | Standard | Limit |
|---|---|---|
| Intake Valve | 7.0 (0.2756) | 6.85 (0.2697) |
| Exhaust Valve | 7.0 (0.2756) | 6.80 (0.2677) |

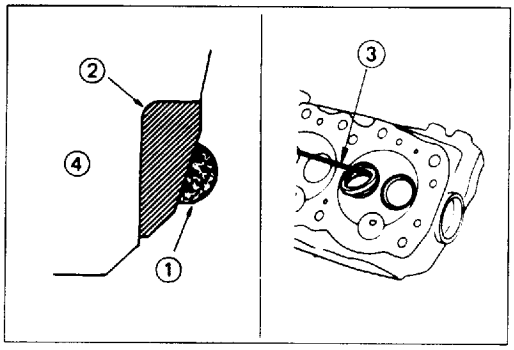


Fig. 79

### 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.

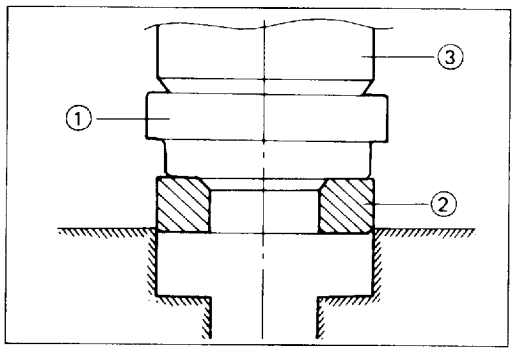


Fig. 80

### Valve Seat Insert Installation

1. Carefully place the attachment ① (having a 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 gradually apply pressure to the attachment and press the valve seat insert into place. 4,000 kg (8,819 lbs.)

**Note:**

**Do not apply an excessive amount of pressure with the bench press. Damage to the valve seat insert will result.**

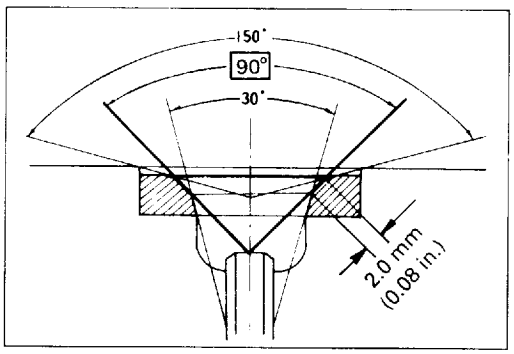


Fig. 81

### Valve Seat Insert Correction

1. Remove the carbon from the valve seat insert surface.
2. Use a valve cutter (15°, 45°, and 75° blades) to minimize scratches and other rough areas. This will bring the contact width back to the standard value.

   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 surface.

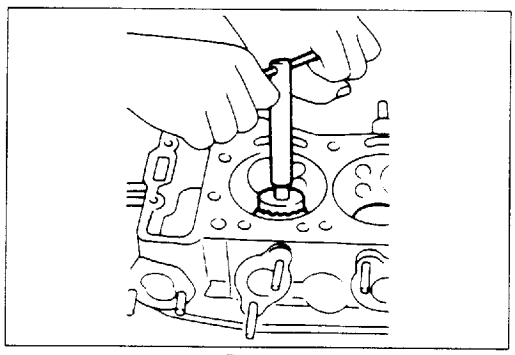


Fig. 82

| Valve Seat Angle | degree |
|---|---|
| 45 | |

**Note:**

**Use an adjustable valve cutter pilot.**

**Do not allow the valve cutter pilot to wobble inside the valve guide.**

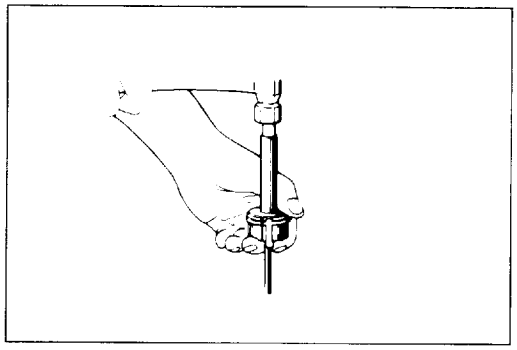


Fig. 83

3. Apply abrasive compound to the valve seat insert surface.
4. Insert the valve into the valve guide.
5. Apply light pressure to the valve while turning it to fit the valve seat insert.
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.
8. Clean the head and valves to remove the abrasive compound and metal particles.

## 4. VALVE SPRING

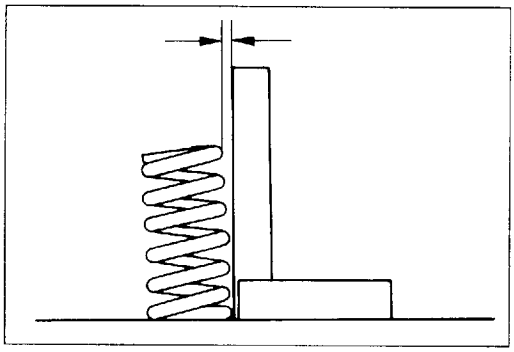


Fig. 84

### 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 | 1.8 (0.0709) | 2.5 (0.0984) |

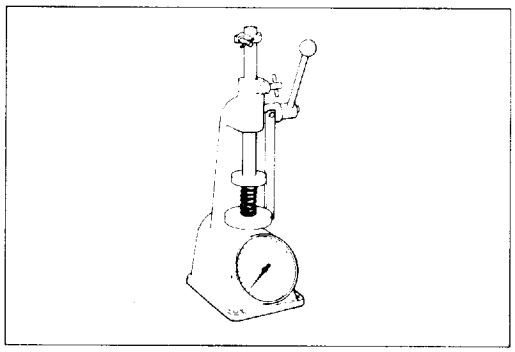


Fig. 85

### 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.

mm (in.)

| | Standard | Limit |
|---|---|---|
| Valve Spring Tension at 29.9 mm Set Length | 17.0 (37.479) | 15.0 (33.069) |

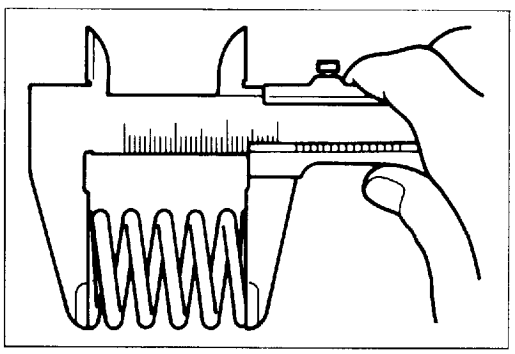


Fig. 86

### 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.)

| | Standard | Limit |
|---|---|---|
| Exhaust and Intake Valve Spring Free Length | 42.1 (1.6575) | 40.0 (1.5748) |

## 5. TAPPET (Cam Follower or Valve Lifter) AND PUSH ROD

### TAPPET

Inspect the tappets for excessive wear, damage and any abnormalities.

Use a micrometer to measure the tappet diameter.

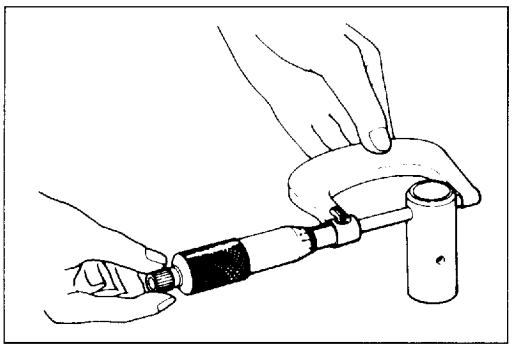


Fig. 87

mm (in.)

| | Standard |
|---|---|
| Tappet Diameter | 20.967 – 20.980<br>(0.82547 – 0.82598) |

Use a dial indicator to measure the clearance between the tappet and cylinder body tappet travelling bore.

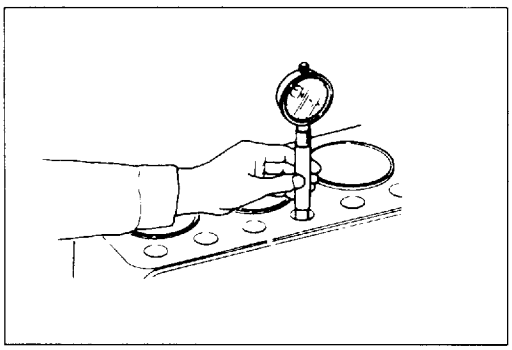


Fig. 88

mm (in.)

| | Standard | Limit |
|---|---|---|
| Tappet and Tappet Travelling Bore Clearance | 0.020 – 0.054<br>(0.00079 – 0.00213) | 0.08<br>(0.00315) |

### PUSH ROD

Use a filler gauge to measure the valve push rod runout.

Roll the push rod along a smooth flat surface (illustration).

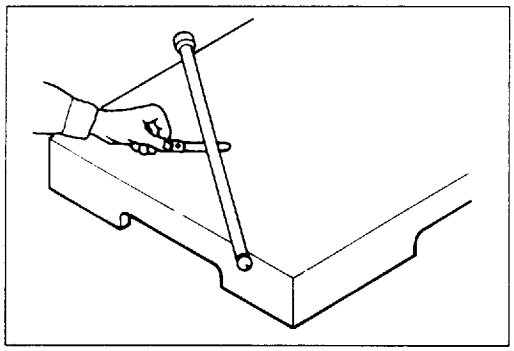


Fig. 89

mm (in.)

| | Limit |
|---|---|
| Push Rod Run-Out | 0.3 (0.0118) |

## 6. CAM SHAFT

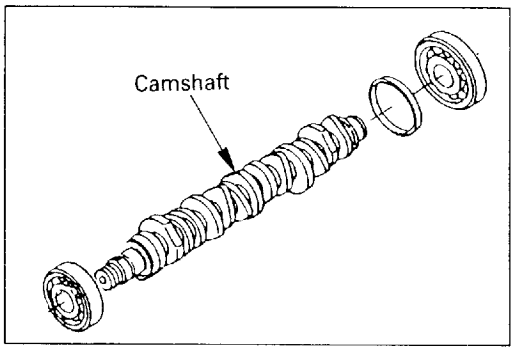



Fig. 90

**Inspection of cam shaft**

Check the journal and the cam for evidence of wear, damage or any other defect.

**Note:**

**With the front and rear parts of camshaft pressed in with ball bearings, and with the cylinder block pressed in with roller bearings as the center bearing, check to see if the camshaft rotates smoothly with no play at each bearing.**

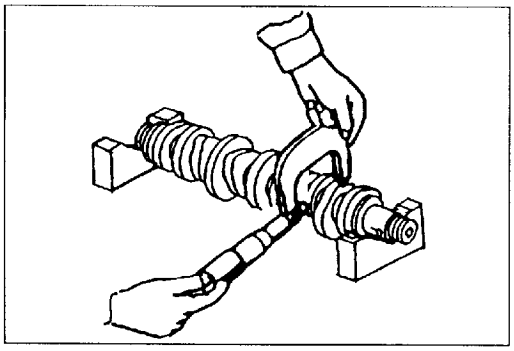


Fig. 91

**Measurement of journal and cam**

1. Cam height (A – B) mm (in.)

| | Standard | Limit | Repair method |
|---|---|---|---|
| Intake | 6.13 (0.2413) | 5.83 (0.2295) | Replace |
| Exhaust | 6.43 (0.2531) | 6.13 (0.2413) | Replace |

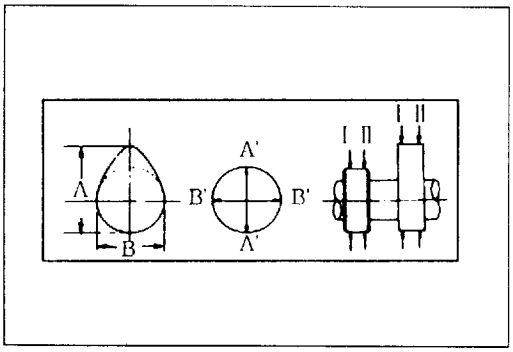



Fig. 92

2. Center journal diameter mm (in.)

| Nominal | Limit | Repair method |
|---|---|---|
| 52 ø (2.0472) | 51.92 ø (2.0441) | Replace |

3. Uneven wear of journal mm (in.)

| Nominal | Limit | Repair method |
|---|---|---|
| 52 ø (2.0472) | 0.05 (0.002) | Replace |

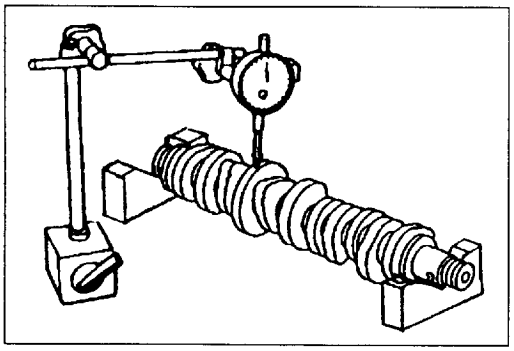


Fig. 93

4. Runout of cam shaft mm (in.)

| Nominal | Limit | Repair method |
|---|---|---|
| 0.02 (0.008) | 0.1 (0.004) | Replace |

## 7. ROCKER ARM SHAFT AND ROCKER ARM

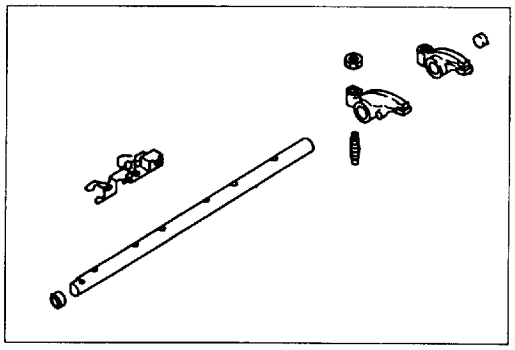


Fig. 94

Inspect all disassembled parts for wear, damage and any abnormalities.

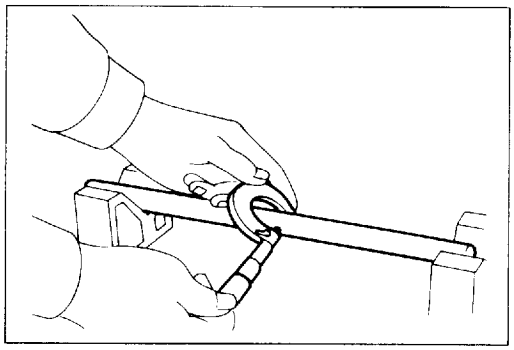


Fig. 95

### 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 |
|---|---|
| Rocker Arm Shaft Diameter | 11.935 – 11.955 (0.4699 – 0.4707) |

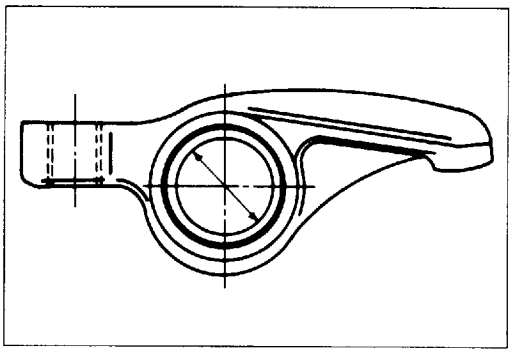


Fig. 96

### Rocker Arm Shaft and Rocker Arm Clearance

1. Use a vernier caliper to measure the rocker arm bushing inside diameter.

mm (in.)

| | Standard |
|---|---|
| Rocker Arm Bushing Inside Diameter | 11.960 – 11.980 (0.4709 – 0.4717) |

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.

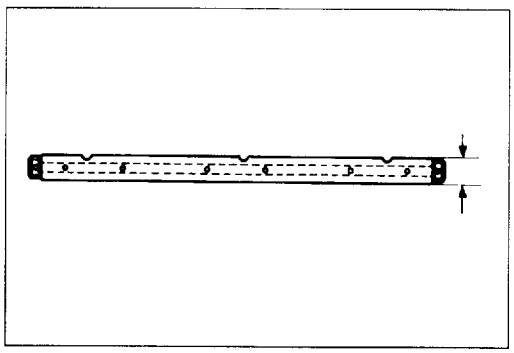


Fig. 97

mm (in.)

| | Standard | Limit |
|---|---|---|
| Rocker Arm Bushing and Rocker Arm Shaft Clearance | 0.005 – 0.045 (0.0002 – 0.0018) | 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.

## 8. PISTON, PISTON PIN AND PISTON RING

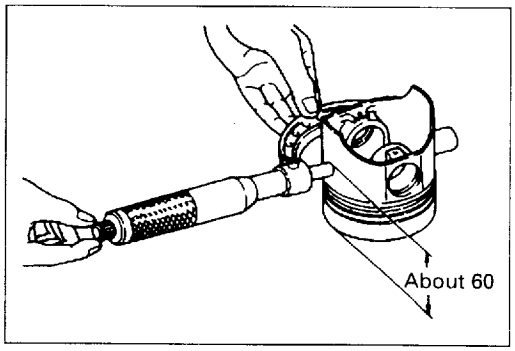



Fig. 98

### Clearance between piston and cylinder bore

1. Measure the outside diameter of the piston at about 60 mm from the top in a right angle to the piston pin (in the unit of 1/1,000 mm).
2. Calculate the clearance based on the measurements of the cylinder bore and the outside diameter of the piston.

mm (in.)

| | |
|---|---|
| Clearance | 0.015 – 0.035 (0.0006 – 0.0014) |

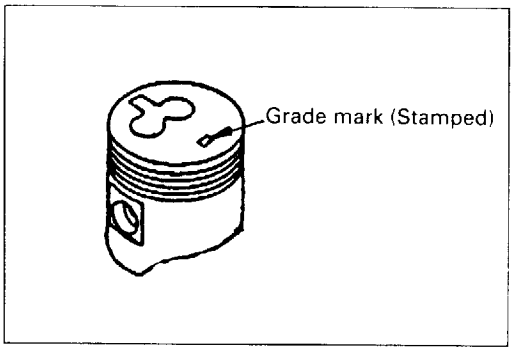



Fig. 99

### Outside diameter of piston and grade mark

The grade mark is stamped on the top surface of the piston.

mm (in.)

| Model | Outside diameter of piston | Grade |
|---|---|---|
| 4LB1<br>4LC1 | 77.375 – 77.385<br>(3.0462 – 3.0466) | A |
| | 77.386 – 77.395<br>(3.0467 – 3.0470) | B |
| | 77.396 – 77.405<br>(3.470 – 3.0474) | C |
| 4LE1 | 84.975 – 84.985<br>(3.3454 – 3.3458) | A |
| | 84.986 – 84.995<br>(3.3459 – 3.3462) | B |
| | 84.996 – 85.005<br>(3.3463– 3.3466) | C |

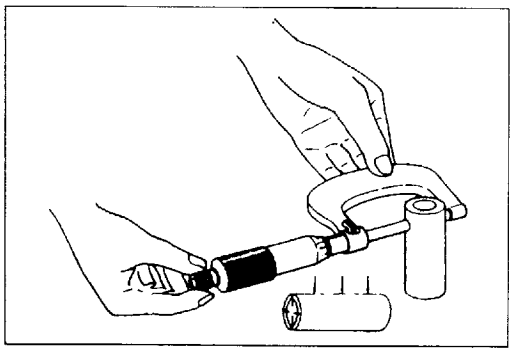


Fig. 100

### Wear of piston pin (outside diameter)

mm (in.)

| Model | Nominal | Limit | Remarks |
|---|---|---|---|
| 4LB1 | 21.0<br>(0.8268) | 20.97<br>(0.8256) | Replace if worn beyond limit |
| 4LB1T<br>4LC1<br>4LE1 | 25.0<br>(0.9843) | 24.97<br>(0.9831) | |

### Clearance between piston pin and piston pin hole

mm (in.)

| | Standard |
|---|---|
| 4LB1, 4LC1, 4LE1 | 0.002 – 0.012<br>(0.00008 – 0.00047) |

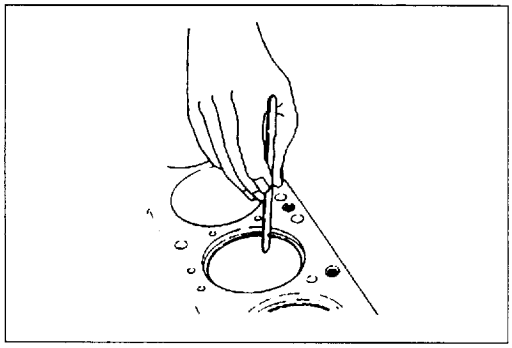


Fig. 101

### Piston ring gap

With the ring inserted into the cylinder bore, push it in with the piston head so that it becomes a right angle to the cylinder, and then measure the gap of the piston ring.

If worn beyond the limit, replace the rings.

mm (in.)

| | | Standard | Limit |
|---|---|---|---|
| 1st compression ring | | 0.2 – 0.35<br>(0.0079 – 0.0138) | 1.5<br>(0.0590) |
| 2nd compression ring | 4LB1<br>4LC1 | 0.2 – 0.4<br>(0.0079 – 0.0157) | |
| | 4LE1 | 0.35 – 0.5<br>(0.0138 – 0.0197) | |
| Oil ring | | 0.2 – 0.4<br>(0.0079 – 0.0157) | 1.0<br>(0.03937) |

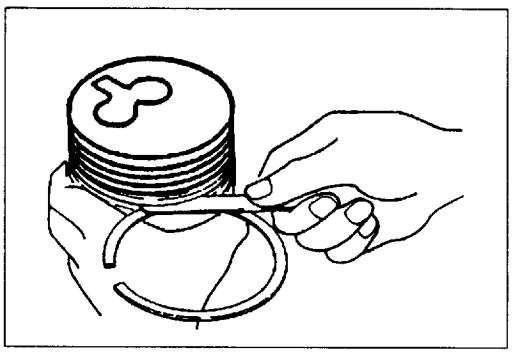


Fig. 102

### Clearance between piston ring groove and ring

Measure clearance at several places on the circumference.

If worn beyond the limit, replace the rings or piston.

4LB1

mm (in.)

| | Standard | Limit |
|---|---|---|
| 1st compression ring | 0.065 – 0.100<br>(0.0026 – 0.0039) | 0.2<br>(0.0078) |
| 2nd compression ring | 0.03 – 0.070<br>(0.0012 – 0.0027) | 0.15<br>(0.0059) |
| Oil ring | 0.02 – 0.06<br>(0.0008 – 0.0024) | |

4LB1T, 4LC1

mm (in.)

| | Standard | Limit |
|---|---|---|
| 1st compression ring | 0.075 – 0.110<br>(0.0029 – 0.0043) | 0.2<br>0.0078) |
| 2nd compression ring | 0.030 – 0.070<br>(0.0011 – 0.0027) | 0.15<br>(0.0059) |
| Oil ring | 0.020 – 0.060<br>(0.0007 – 0.0024) | |

4LE1

mm (in.)

| | Standard | Limit |
|---|---|---|
| 1st compression ring | 0.085 – 0.105 (0.0033 – 0.0041) | 0.2 (0.0078) |
| 2nd compression ring | 0.050 – 0.085 (0.0020 – 0.0033) | 0.15 (0.0059) |
| Oil ring | 0.030 – 0.070 (0.0011 – 0.0027) | |

## 9. CONNECTING ROD AND CONNECTING ROD BEARING

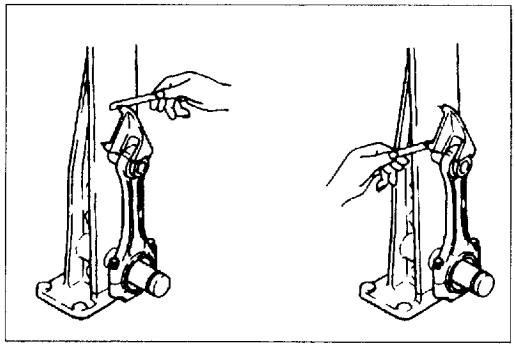


Fig. 103

**Torsion and parallelism of connecting rod**

If worn beyond the limit-repair or replace.

mm (in.)

| Per 100 mm (3.94) | Standard | Limit |
|---|---|---|
| Torsion | 0.05 (0.002) | 0.2 (0.0079) |
| Parallelism | 0.05 (0.002) | 0.15 (0.0059) |

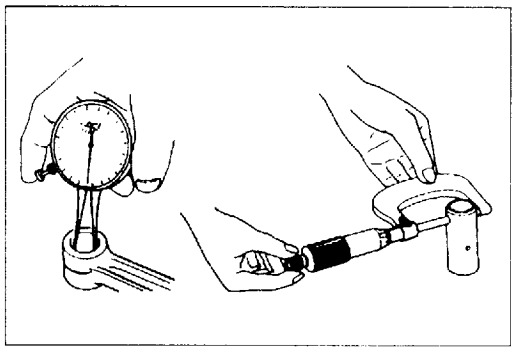


Fig. 104

**Clearance between small end pin hole of connecting rod and piston pin, inside diameter of bushing**

mm (in.)

| | | Standard | Limit |
|---|---|---|---|
| Clearance | | 0.008 – 0.020 (0.0003 – 0.0008) | 0.05 (0.0020) |
| Inside diameter | 4LB1 | 21 (0.8268) | — |
| | 4LB1T 4LC1 4LE1 | 25 (0.9843) | — |

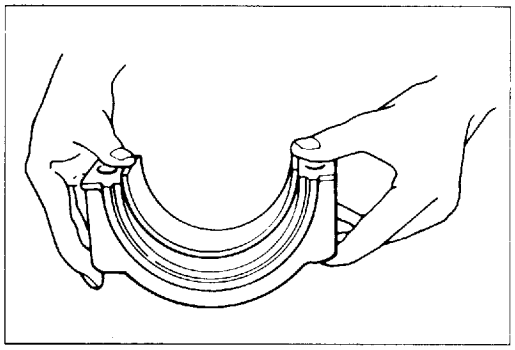


Fig. 105

### 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.

kg·m (ft. lbs.)

| | | |
|---|---|---|
| Tightening torque | 4LB1, 4LB1T | 3.8 – 4.2 (27 – 30) |
| | 4LC1 | 2.3 – 2.7 (17 – 20) ↓ 100 – 115 deg. |
| | 4LE1 | 7.5 – 8.5 (54 – 61) |

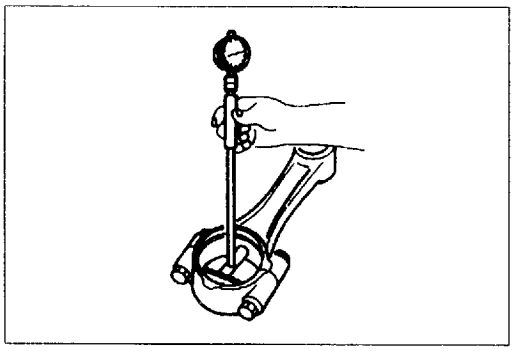


Fig. 106

**Clearance between bearing and crank pin, inside diameter with bearing installed and without.**

mm (in.)

| | Standard | Limit |
|---|---|---|
| Clearance | 0.035 – 0.073 (0.0014 – 0.0029) | 0.10 (0.0039) |

## 10.CRANKSHAFT AND CRANKSHAFT BEARING

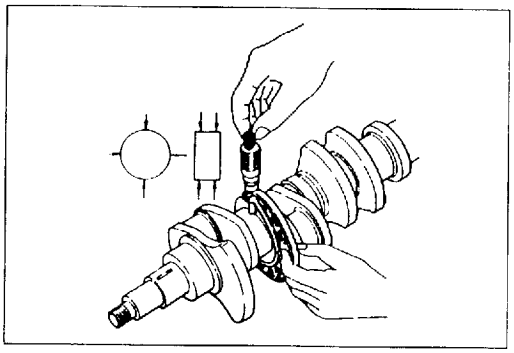


Fig. 107

**Outside diameters of journal and pin**

If worn beyond the limits-replace

Crank journal

mm (in.)

| | Standard | Limit |
|---|---|---|
| 4LB1<br>4LC1 | 56.0 (2.2047) | 55.86 (2.1992) |
| 4LE1 | 60.0 (2.3622) | 59.86 (2.3567) |

Crank pin

mm (in.)

| | Standard | Limit |
|---|---|---|
| 4LB1 | 43.0 (1.6929) | 41.87 (1.6484) |
| 4LC1 | 46.0 (1.8110) | 45.87 (1.8059) |
| 4LE1 | 49.0 (1.9291) | 48.87 (1.9240) |

**Note:**

**When there occurs an uneven wear to the crankshaft, replace it with a new one without grinding it for reuse.**

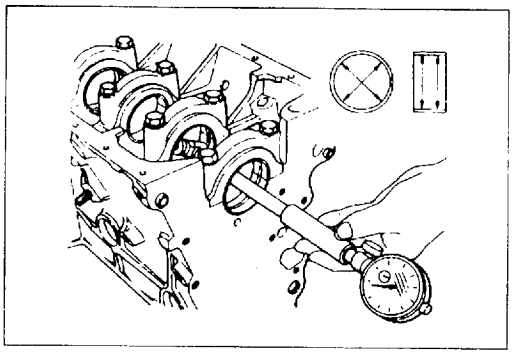


Fig. 108

**Clearance between journal and bearing inside diameter with bearing installed and without**

mm (in.)

| | Standard | Limit |
|---|---|---|
| Clearance | 0.029 – 0.072<br>(0.0011 – 0.0028) | 0.11<br>(0.0043) |

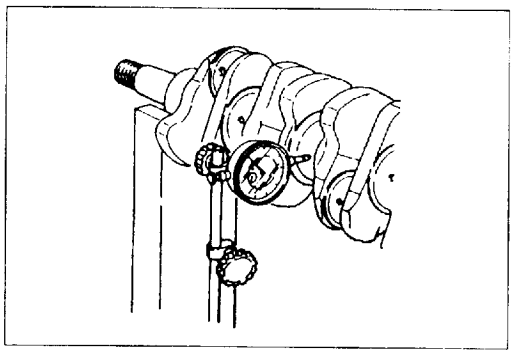


Fig. 109

**Runout of crankshaft**

Replace if beyond limit

mm (in.)

| Standard | Limit |
|---|---|
| 0.025 (0.001) | 0.05 (0.002) |

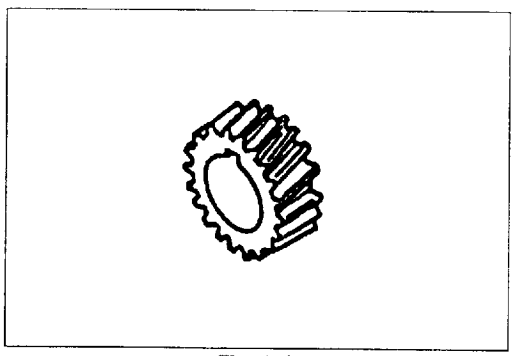


Fig. 110

**Crankshaft gear**

Check the crankshaft gear visually for damage and any other defects.

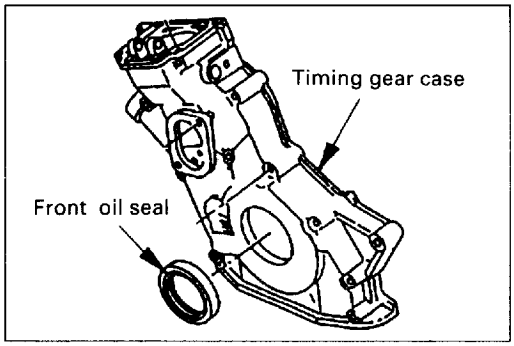



Fig. 111

**Oil seal**

When the lip of an oil seal is found defective, replace it with a new one.

**Installation**

Use the crankshaft front oil seal installer to install the crankshaft front oil seal.

## 11.FLYWHEEL AND RING GEAR

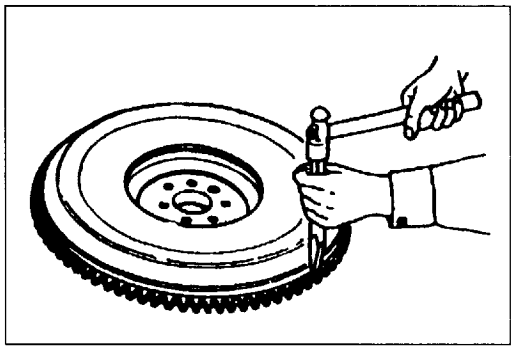


Fig. 112

**Ring Gear Replacement**

**Ring Gear**

Inspect the ring gear.

If the ring gear teeth are broken or excessively worn, the ring gear must be replaced.

**Ring Gear Removal**

Strike around the edges of the ring gear with a hammer and chisel to remove it.

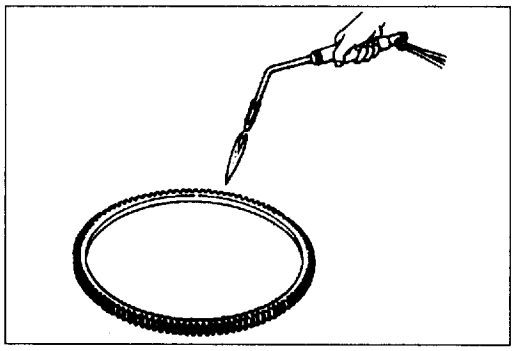


Fig. 113

**Ring Gear Installation**

1. Heat the ring gear evenly with a gas burner to invite thermal expansion.

   Do not allow the temperature of the gas burner to exceed 200°C (390°F).
2. Use a hammer to install the ring gear when it is sufficiently heated.

## 12.TIMING GEAR

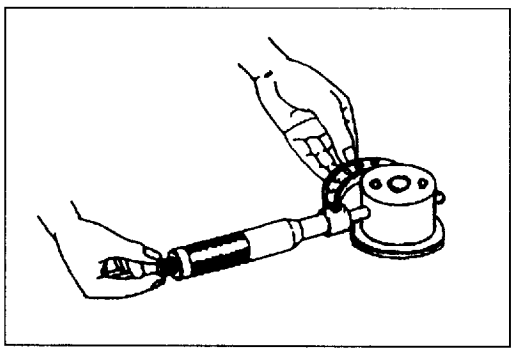


Fig. 114

**Uneven wear of idle gear shaft**

mm (in.)

| Nominal | Limit |
|---|---|
| 45.0 (1.7717) | 0.1 (0.0039) |

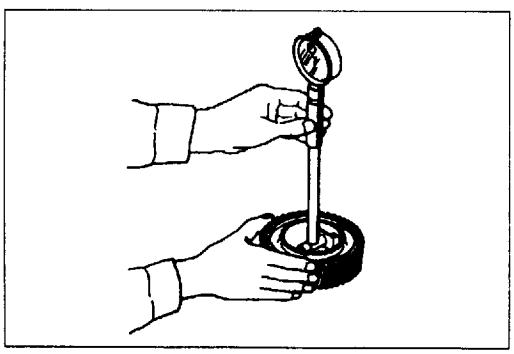


Fig. 115

**Clearance between idle gear bushing and shaft**

mm (in.)

| Standard | Limit |
|---|---|
| 0.025 – 0.085 (0.001 – 0.0033) | 0.2 (0.0079) |

# REASSEMBLY

## 1. CYLINDER HEAD ASSEMBLY

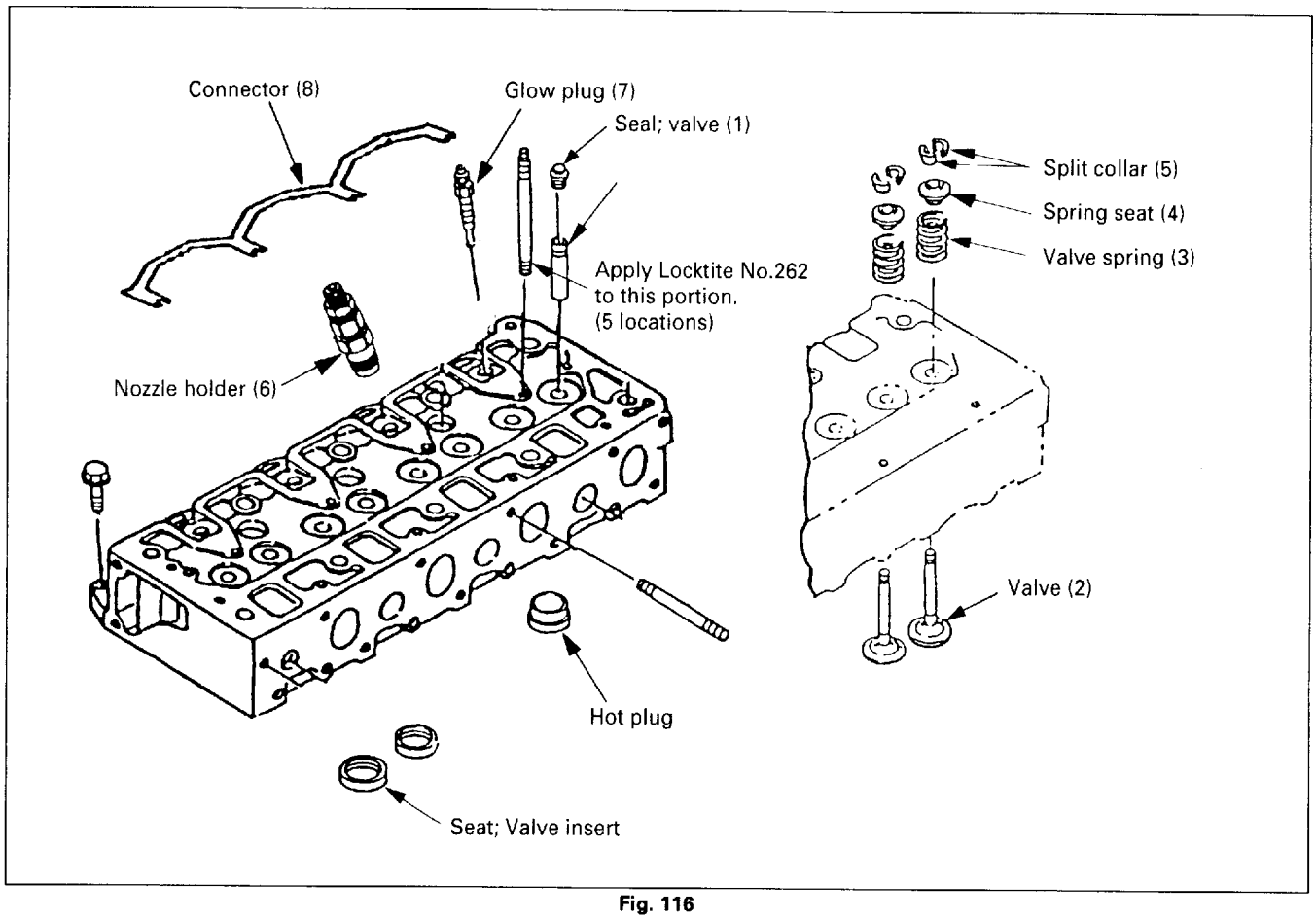



Fig. 116

### Important Operations

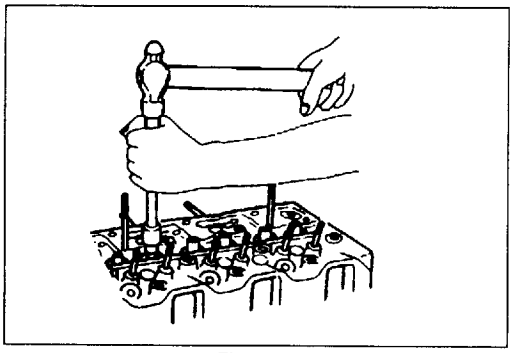


Fig. 117

**Valve Stem Oil Seal**

1. Lubricate the oil seals and valve stem sealing area with engine oil.
2. Use a valve stem oil seal installer to install the oil seal.

   Valve Stem Oil Seal Installer: 5-8840-9007-0

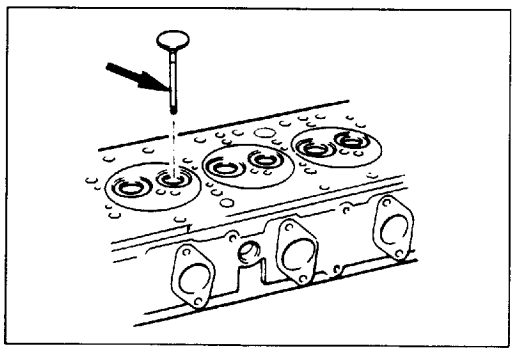


Fig. 118

**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.

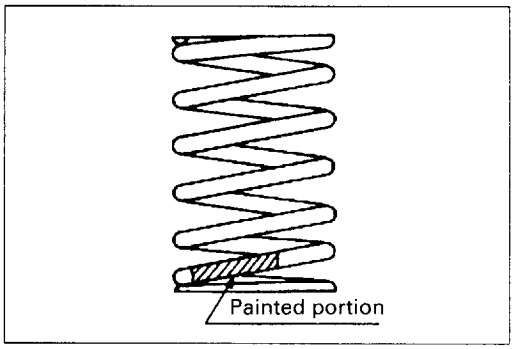



Fig. 119

### Intake and Exhaust Valve Springs

Install the valve springs with their painted end (the close pitched end) facing down.

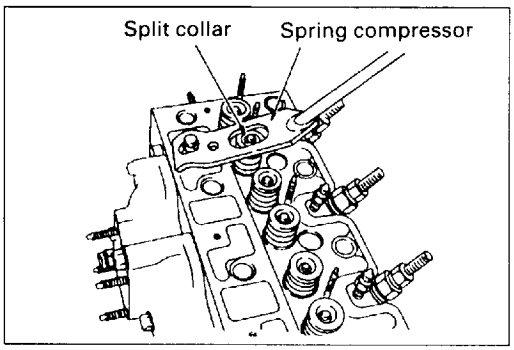



Fig. 120

### 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:

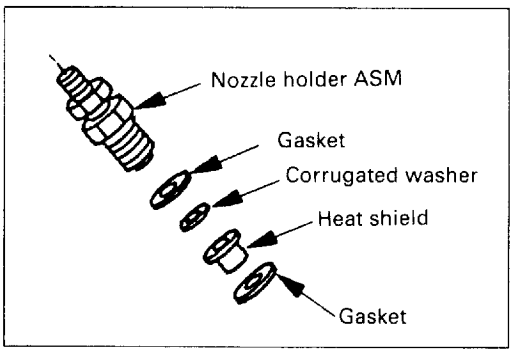



Fig. 121

### Nozzle holder assembly

Before assembling the nozzle holder assembly, check to see if the spray condition and the spray pressure of the injection nozzle are appropriate, (Refer to "INSPECTION AND SERVICE.")

Assemble to the cylinder head the gasket (heat shield), heat shield, corrugated washer and gasket (nozzle holder) in this order.

Install the nozzle holder assembly, and then tighten it to the specified torque.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 4.0 – 5.0 (29.0 – 36.0) |

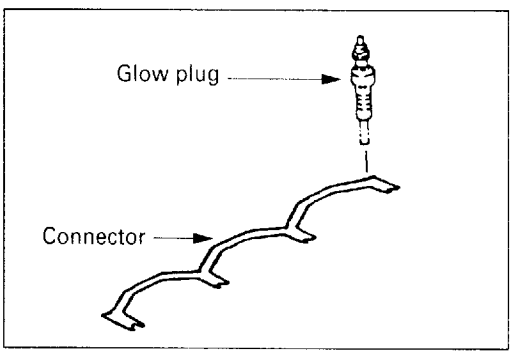



Fig. 122

### Glow plug and connector

Assemble the glow plug to the cylinder head, and then tighten it to the specified torque.

Install the connector to the glow plug, and then tighten until snug.

kg·m (ft. lbs.)

| Parts | Tightening torque |
|---|---|
| Glow plug | 1.5 – 2.0 (11.0 – 14.0) |

## 2. PISTON AND CONNECTING ROD

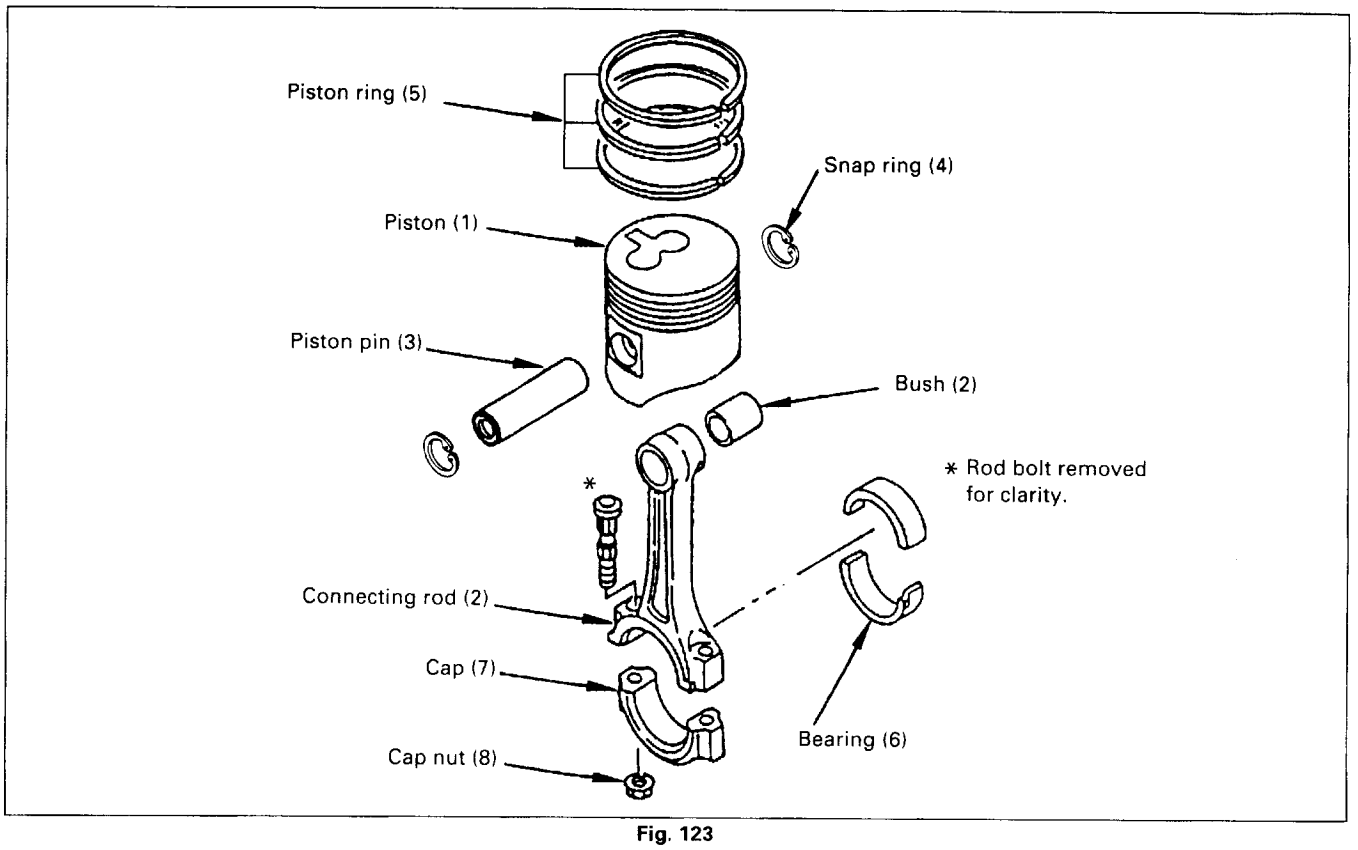



Fig. 123

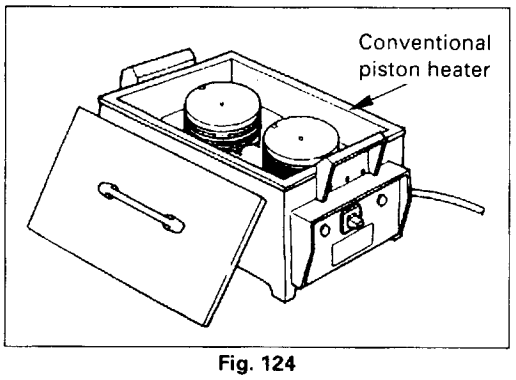



Fig. 124

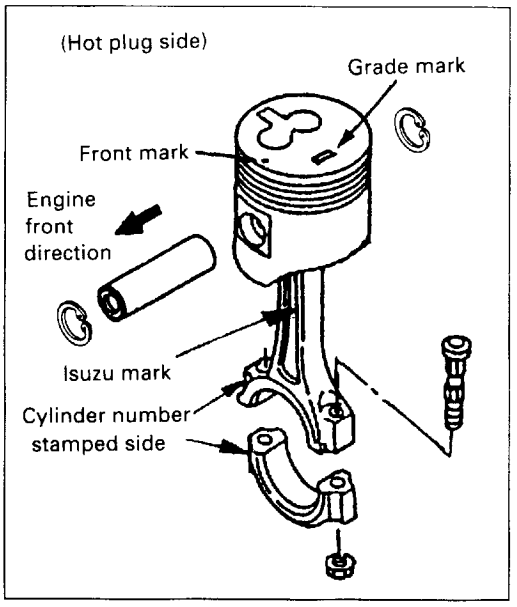



Fig. 125

### Important Operations

**Piston**

Use a piston heater to heat the pistons to approximately 100°C (212°F).

**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.

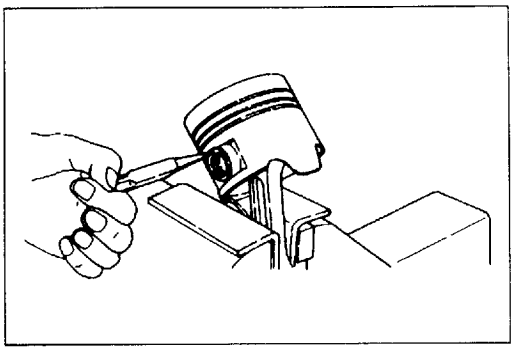


Fig. 126

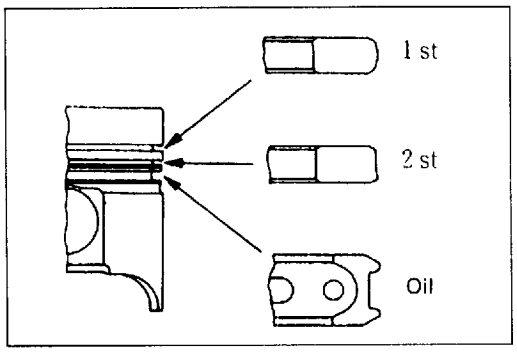



Fig. 127

**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.

**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) 2nd compression ring

   (3) 1st compression ring

   The marked side of the two compression rings must be facing up.

   The undercut side of the second 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.

## 3. INTERNAL PARTS

### Reassembly Steps

(1) Crankshaft
(2) Piston Assembly
(3) Rear Seal Retainer
(4) Camshaft
(5) Cam Gear
(6) Idler gear and Shaft
(7) Oil Pump Assembly
(8) Timing Gear Case (Without PTO)
(9) Flywheel Housing
(10) Flywheel
(11) Crank Pulley
(12) Oil Pipe
(13) Oil Strainer
(14) Oil Pan
(15) Tappets
(16) Cylinder Head Gasket
(17) Cylinder Head Assembly
(18) Push Rods
(19) Rocker Bracket Assembly
(20) Engine Hangers

## Internal Parts (1/3)

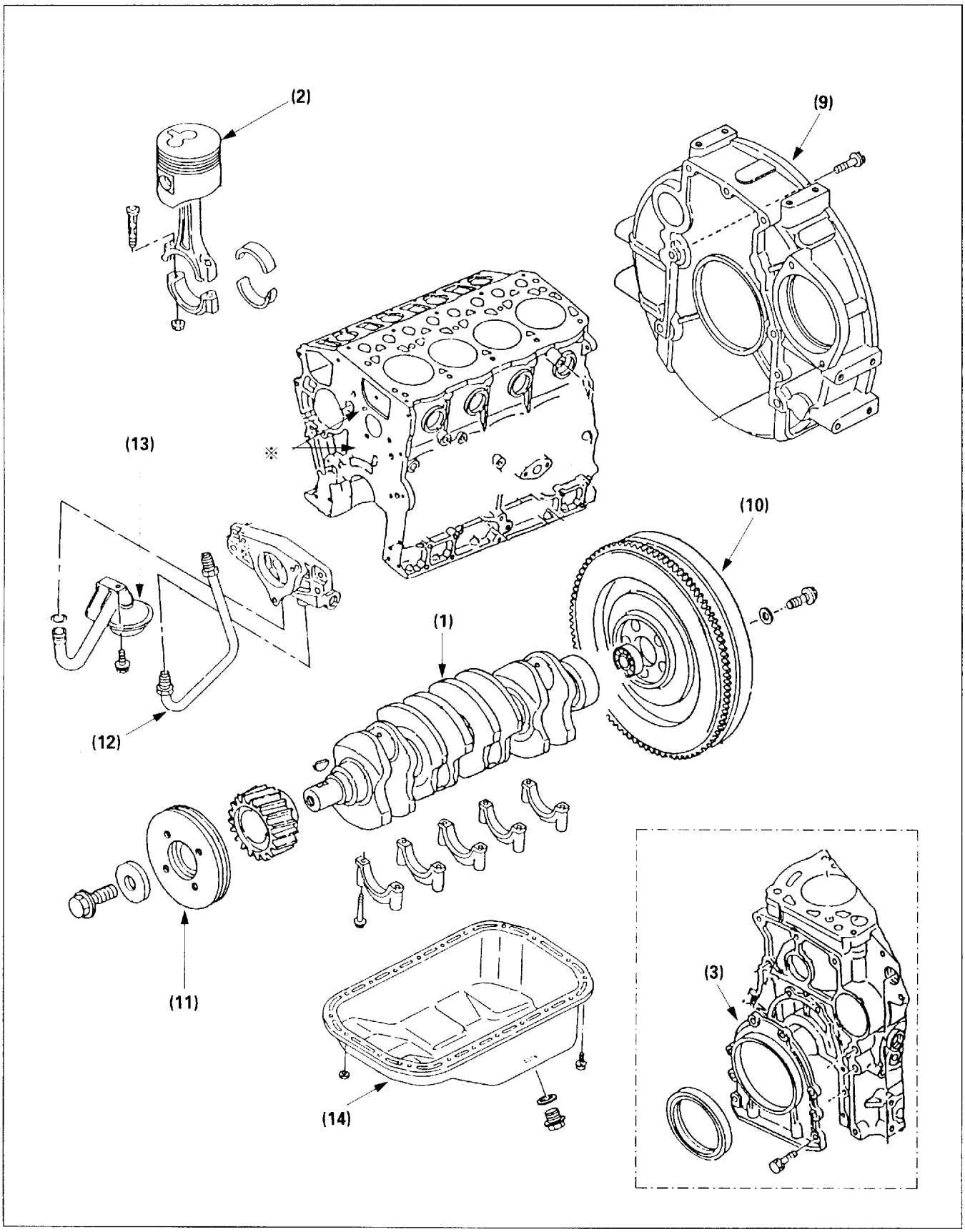



Fig. 128

## Internal Parts (2/3)

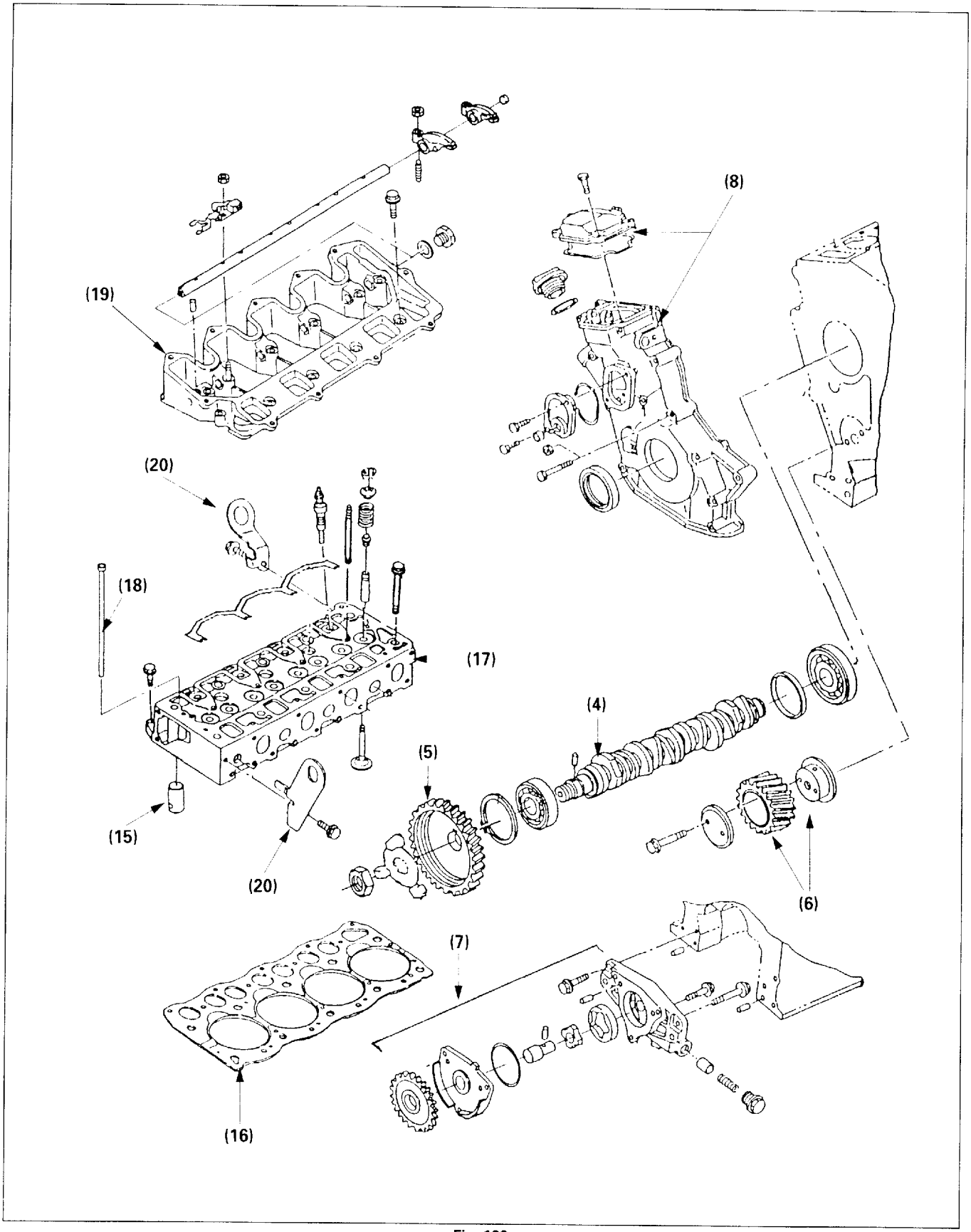



Fig. 129

## Internal Parts (3/3)

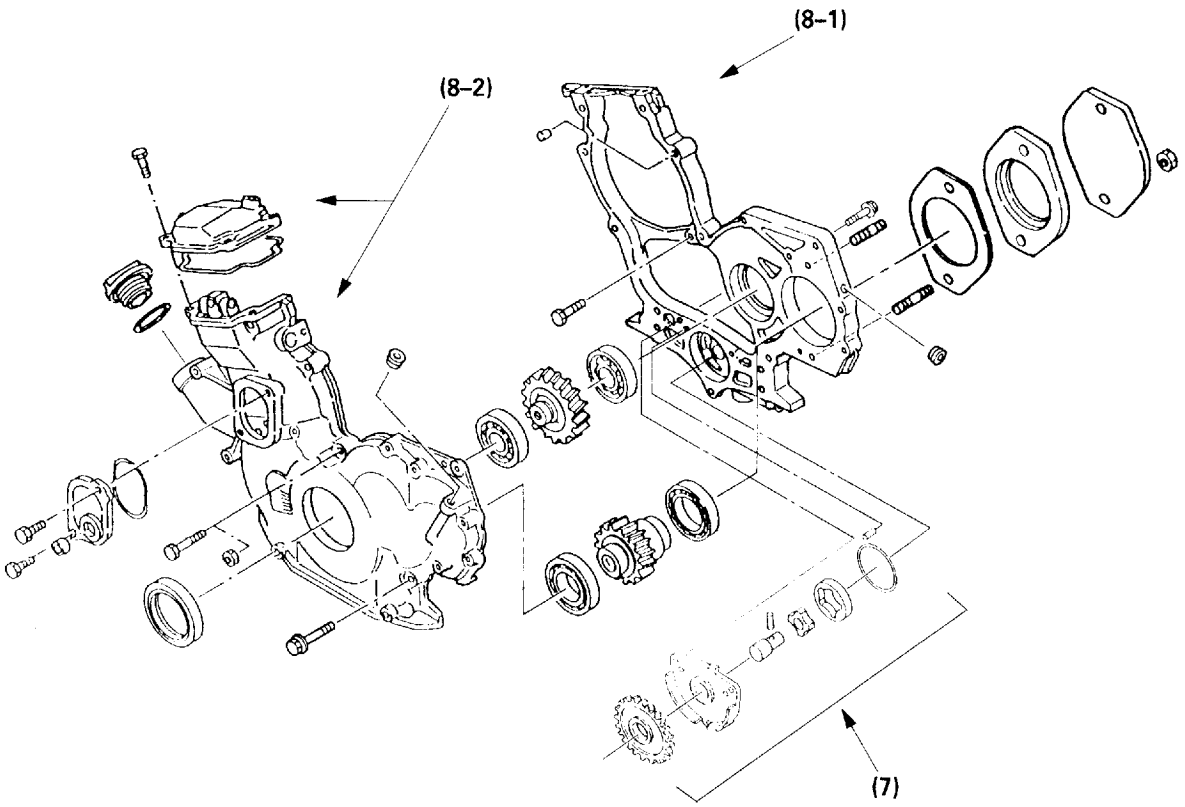



Fig. 130

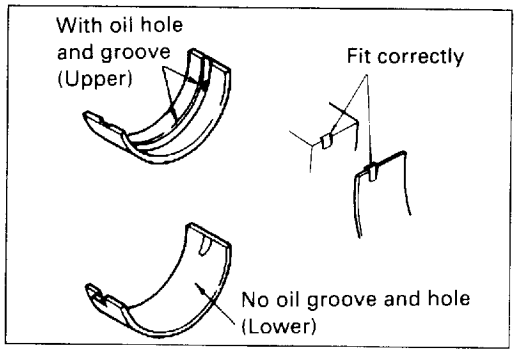



Fig. 131

### Crankshaft bearing

Note that there is an oil hole and an oil groove in the upper bearing (on the block side), but not in the lower bearing (on the bearing cap side).

Fit the bearing tang firmly into the slot machined on the cylinder body bearing arches.

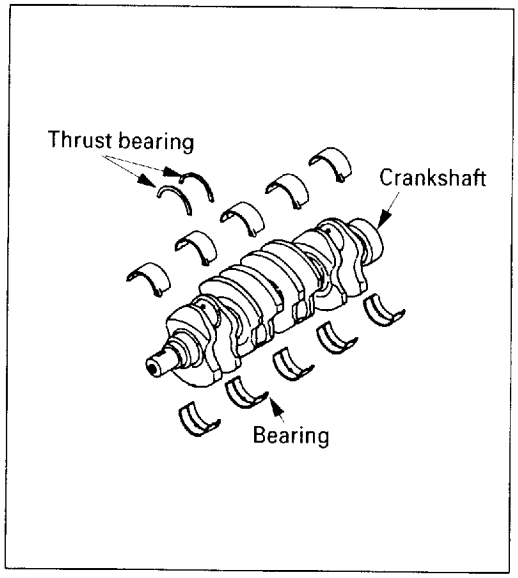



Fig. 132

### Crankshaft and bearing

Lubricate the bearings with engine oil, install the crankshaft, install the thrust bearings with the groove facing the crankshaft.

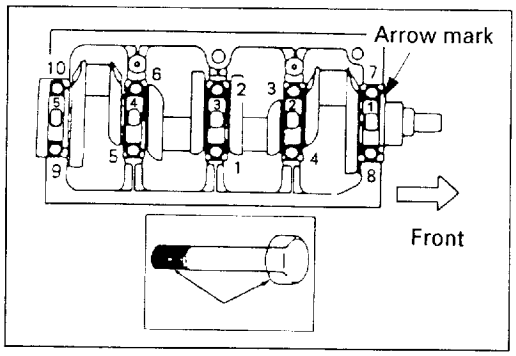



Fig. 133

### 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.

kg·m (ft. lbs.)

| | |
|---|---|
| Crankshaft Bearing Cap Bolt Torque | 8.5 – 9.5 (61.0 – 69.0) |

4. Check that the crankshaft turns smoothly by manually rotating it.

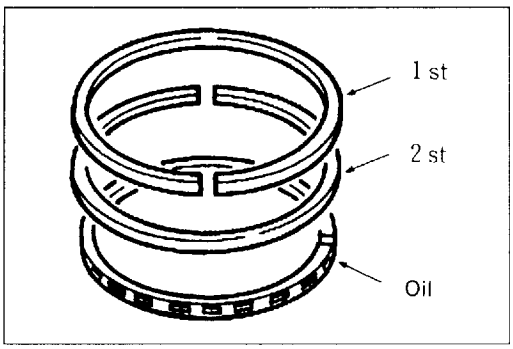



Fig. 134

Position the rings as shown making sure the ring gaps are away from the thrust side.

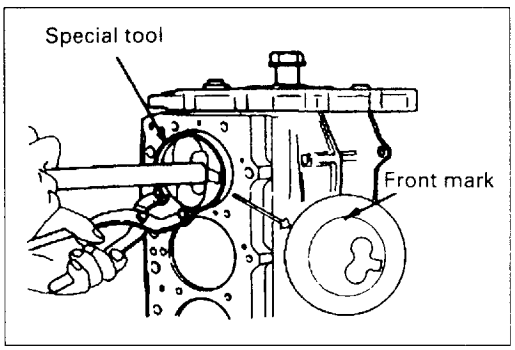



Fig. 135

**Piston and Connecting Rod**

Lubricate the piston, the piston rings, and the connecting rod bearings with engine oil.

Position the piston front mark towards the front of the engine.

Use the piston ring compressor to compress the piston rings.

Use a hammer grip to push the piston in until it makes contact with the crank pin.

At the same time, rotate the crankshaft until the crankpin reaches its highest point.

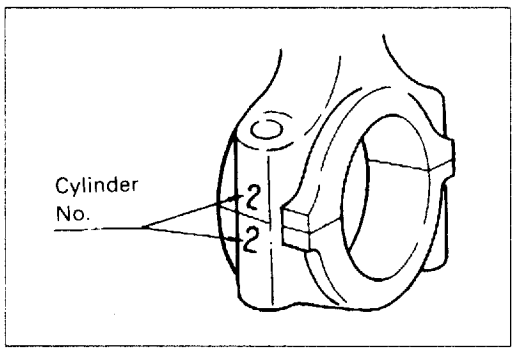



Fig. 136

Set the bearing cap cylinder number marks and the connecting rod cylinder number marks.

The marks must be facing the injection pump side.

kg·m (ft. lbs.)

| | | |
|---|---|---|
| Tightening torque | 4LB1 | 3.8 – 4.2 (27 – 30) |
| | 4LC1 | 2.3 – 2.7 (17 – 20) ↓ 100 – 115 deg. |
| | 4LE1 | 7.5 – 8.5 (54 – 61) |

**Note:**

**After installation, confirm that the crankshaft rotates smoothly.**

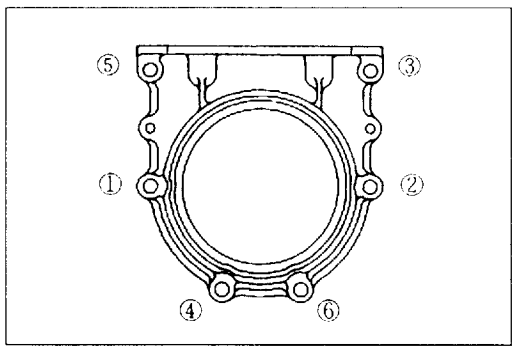



Fig. 137

**Installation of retainer**

After applying engine oil to the lip of the oil seal, install the retainer. Apply sealant.

Tighten bolts on the retainer to the specified torque in the order as shown in the figure left.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 0.8 – 1.2 (6.0 – 9.0) |

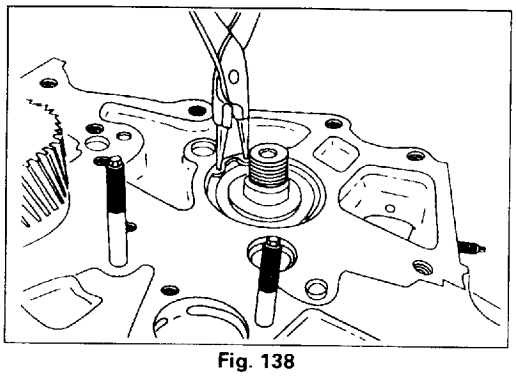


Fig. 138

### Camshaft assembly

1. Apply engine oil to the inside of the bearing of the cylinder block, and then install the camshaft assembly.

**Note:**

**When installing the assembly, care should be taken not to damage the bearing.**

2. After installation of the snap ring to the outside of the front bearing, check to see if the camshaft rotates smoothly.

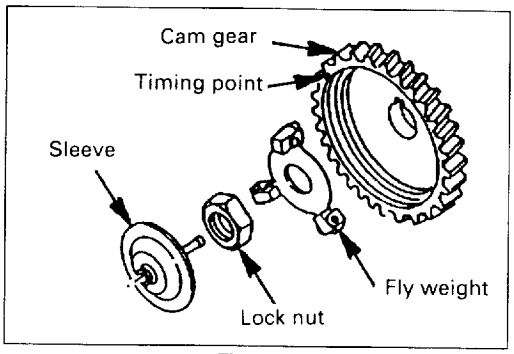



Fig. 139

### Cam gear and sleeve

1. Install the cam gear to the camshaft so that the timing point (a dot mark "•") comes to the front side.
2. With the flyweight installed, tighten the cam gear with a lock nut.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 7.0 – 9.0 (51.0 – 65.0) |

3. Apply engine oil to the shaft of the sleeve and the slide of the flyweight.
4. With the lip of the sleeve placed in the cavity of the flyweight, insert the shaft of the sleeve into the tip end of the camshaft.

**Note:**

**Check to see if the sleeve moves smoothly.**

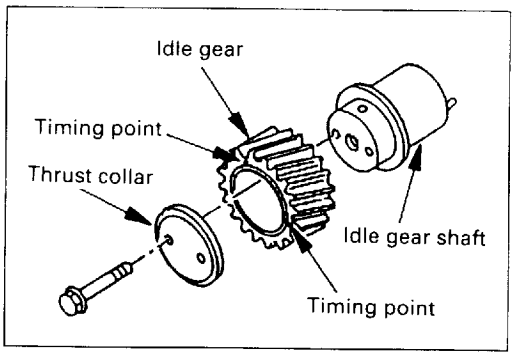



Fig. 140

### Idle Gear

Install the idler gear shaft with the oil hole facing upward.

Lubricate the shaft with oil.

Install the idler gear.

Align the timing marks as shown in the illustration.

Install the thrust collar and tighten the bolts to the specified torque.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 2.1 – 3.1 (15.2 – 22.4) |

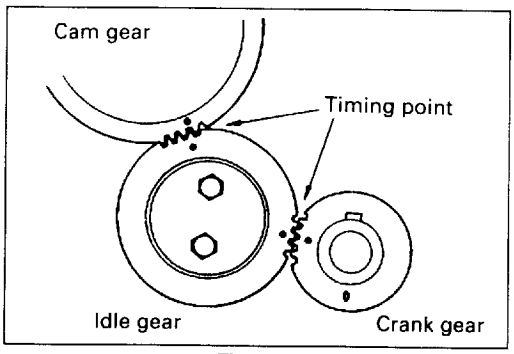



Fig. 141

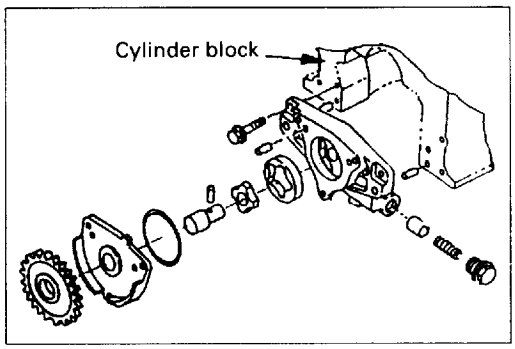



Fig. 142

**Oil pump assembly**

1. When PTO is not provided, install the oil pump assembly to the cylinder block.

PTO not provided — kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |

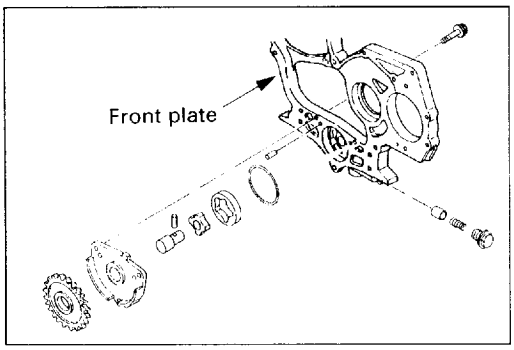



Fig. 143

2. When PTO is provided, install the oil pump to the front plate.

PTO provided — kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 0.8 – 1.2 (6.0 – 9.0) |

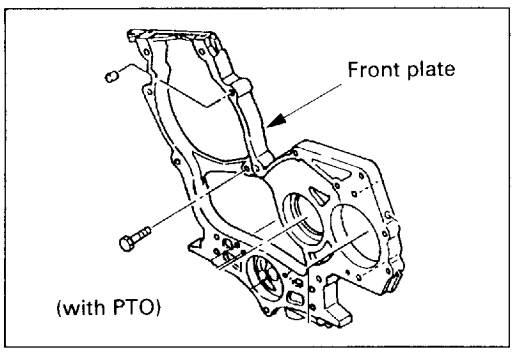



Fig. 144

**Front plate (only for those provided with PTO)**

Apply liquid gasket to the front plate incorporated with the oil pump before installing it to the cylinder block.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |

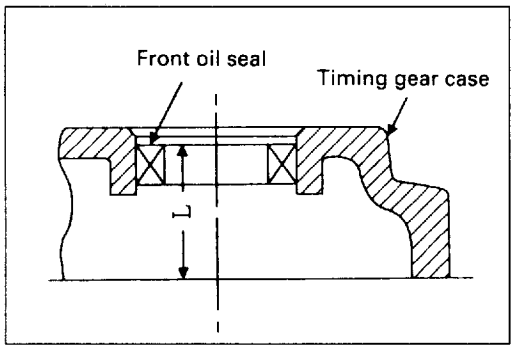



Fig. 145

**Front oil seal**

Install the front oil seal to the timing gear case.

Installation is made according to the "L" dimension shown in the figure.

mm (in.)

| | L dimension |
|---|---|
| PTO not provided | 60.2 – 60.8 (2.370 – 2.384) |
| PTO provided | 40.2 – 40.8 (1.582 – 1.606) |

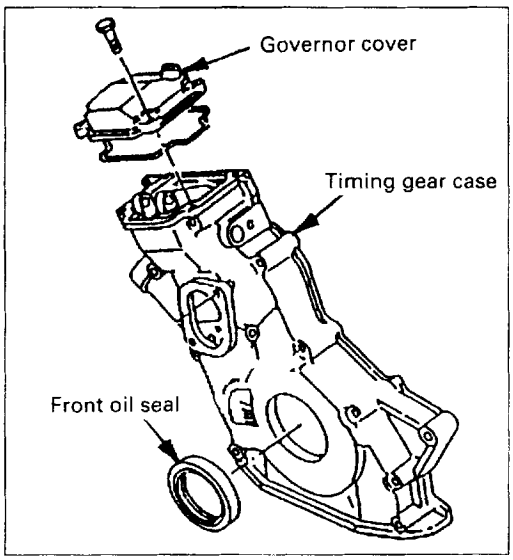



Fig. 146

**Timing gear case (with governor)**

When not provided with PTO, install the timing gear case to the cylinder block. When provided with PTO, install it to the front plate.

1. Put the link plate of the governor incorporated in the gear case through the connecting hole of the injection pump in advance.
2. Apply engine oil to the bushes provided on both ends of the main spring lever of the governor.
3. Apply sealant to the gear case, and then install it to the cylinder block or the front plate.

kg·m (ft. lbs.)

| | |
|---|---|
| Case tightening torque | 1.9 – 2.9 (14.0 – 21.0) |

4. Assemble the gasket and the governor cover to the top of the gear case, and then tighten them to the specified torque.

kg·m (ft. lbs.)

| | |
|---|---|
| Cover tightening torque | 0.8 – 1.2 (6.0 – 9.0) |

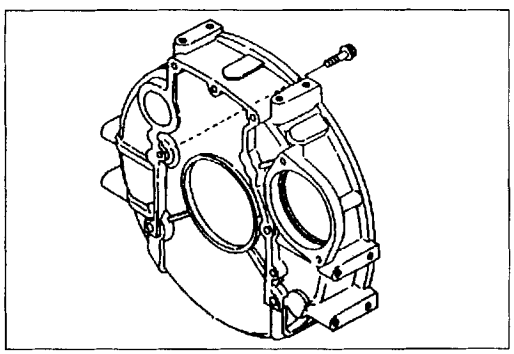


Fig. 147

**Flywheel housing**

Install the flywheel housing to the cylinder body.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 4.2 – 5.6 (30.0 – 40.0) |

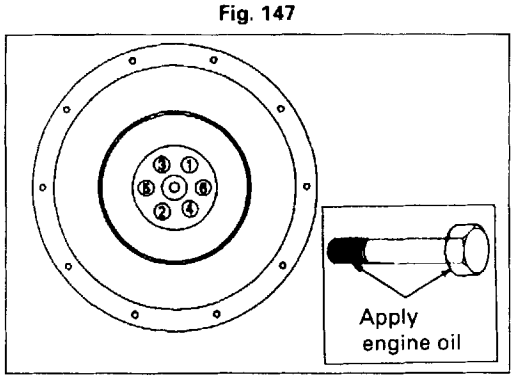



Fig. 148

**Flywheel**

Lubricate bolts with engine oil.

Tighten a little at a time in the sequence shown in the illustration.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 9.0 – 11.0 (65.0 – 80.0) |

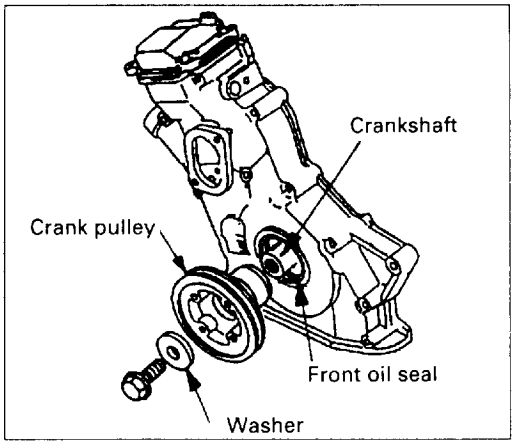


Fig. 149

**Crank pulley**

Lubricate the lip of the front, seal with oil

Install the crank pulley, lock the crankshaft and tighten the front bolt.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 17.0 – 19.0 (123.0 – 137.0) |

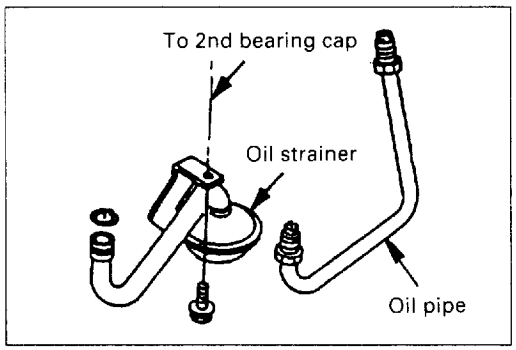


Fig. 150

**Oil pipe and oil strainer**

1. Install the oil pipe from the oil pump assembly to the cylinder block and tighten the sleeve nuts.
2. Install the oil strainer to the oil pump, and then tighten the bracket of the strainer to the No. 2 bearing cap.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |

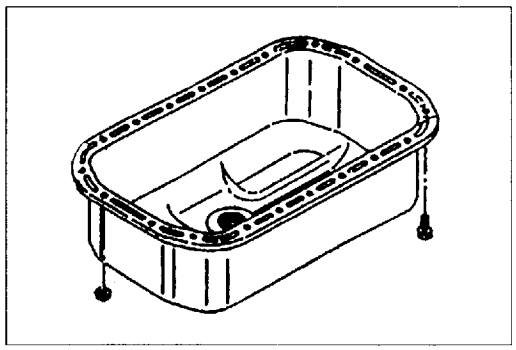


Fig. 151

**Oil pan**

1. Apply sealant to the oil pan.
2. Install the oil pan to the cylinder block and tighten fixing bolts evenly.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 0.8 – 1.2 (6.0 – 9.0) |

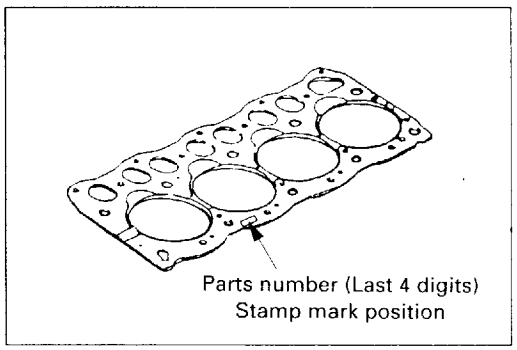


Fig. 152

**Tappet and head gasket**

1. Install the tappet to the cylinder block.
2. When installing the head gasket, turn up the stamp mark of the parts number (last 4 digits) which is between the No. 2 and No. 3 cylinders of the gasket.

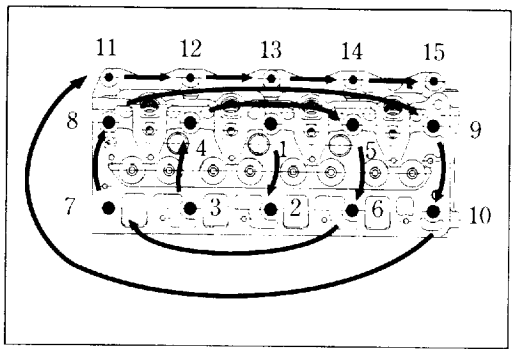



Fig. 153

### Cylinder head assembly

Lubricate the bolts with oil.

Tighten the bolts in the sequence shown in the illustration to the specified torque.

kg·m (ft. lbs.)

| Bolt size | Tightening torque |
|---|---|
| M12 × 1.5 (8 each) | 8.5 – 9.5 (61 – 69) → 60°~90° |
| M8 × 1.25 (4 each) | 2.5 – 3.5 (18 – 25) |

### Push rod

Install the push rods.

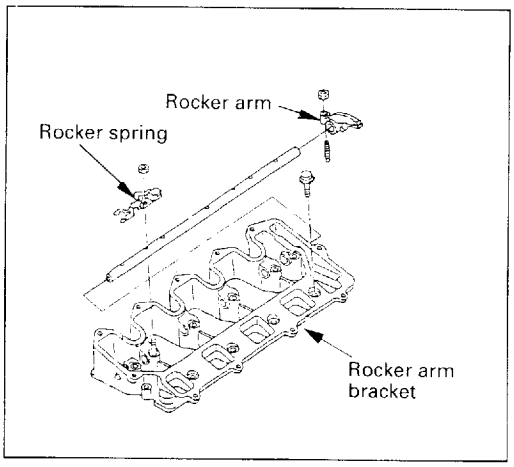



Fig. 154

### Rocker arm bracket assembly

Apply liquid gasket to the the bottom of the rocker arm bracket assembly, being careful not to get any in the groove around the oil galley as shown in the illustration.

Install the rocker arm bracket assembly making sure the push rods align with the rocker arms and tighten to the specified torque.

kg·m (ft. lbs.)

| Tightening torque | 0.8 – 1.2 (6.0 – 9.0) |
|---|---|

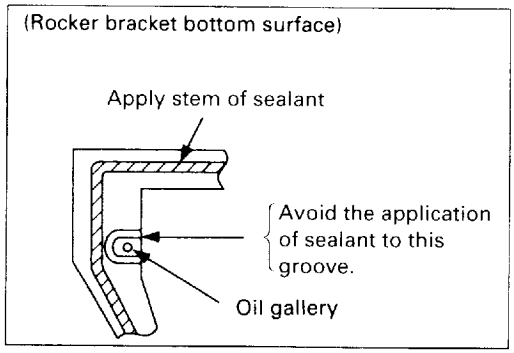



Fig. 155

Refer to Section "General Information – Maintenance" (on page 21).

**Adjustment of valve clearance**

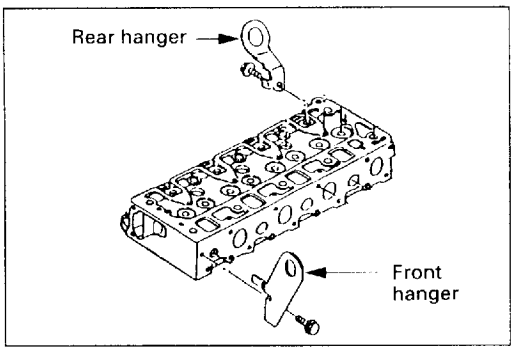



Fig. 156

**Front hanger and rear hanger**

Tighten them to the specified torque shown below.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |

## 4. EXTERNAL PARTS (Right-hand Side)

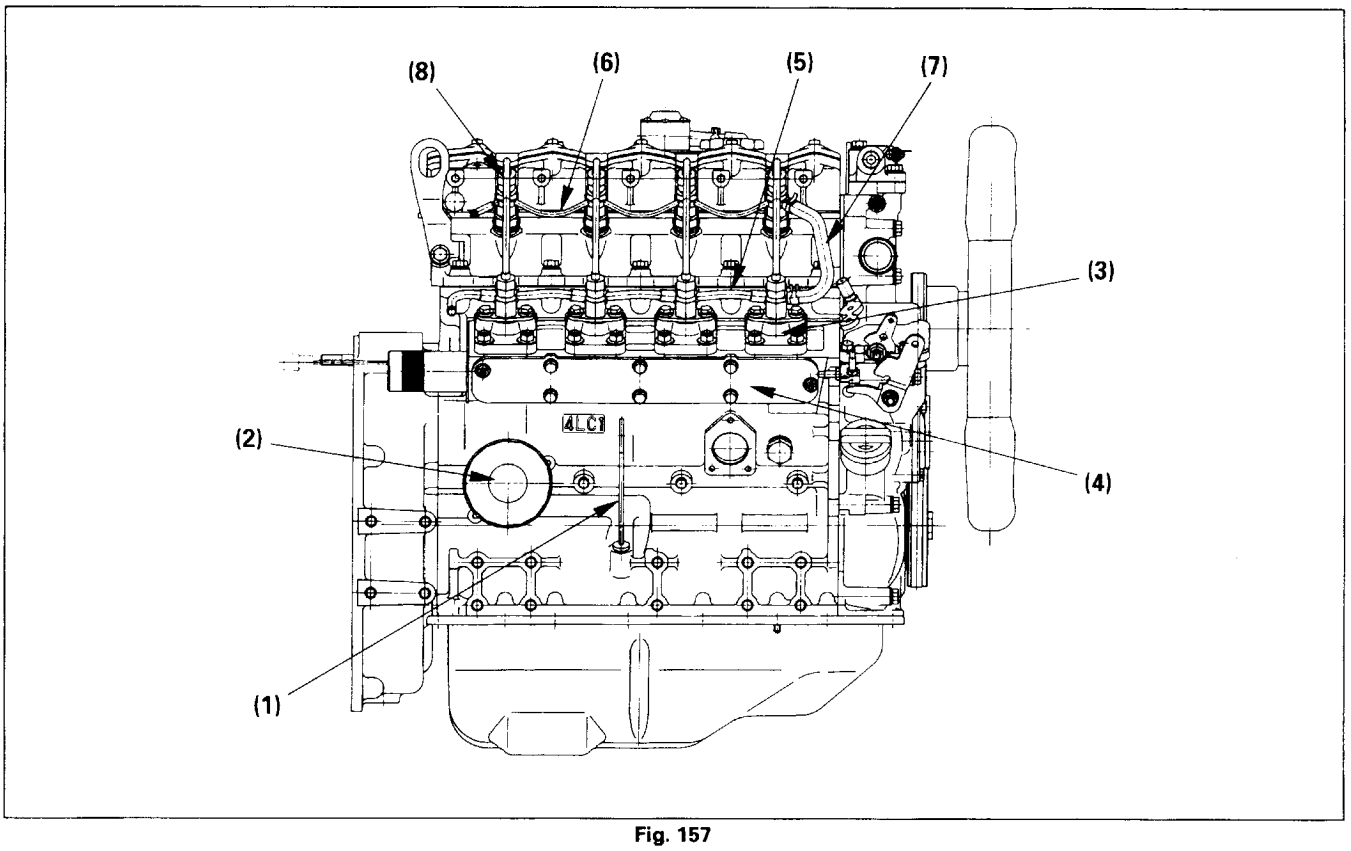



Fig. 157

(1) Dipstick
(2) Oil Filter
(3) Injection Pump
(4) Injection Pump Housing Cover
(5) Fuel Pipe
(6) Leak Off Pipe
(7) Fuel Hose
(8) Injection Pipe

## 5. EXTERNAL PARTS (Left-hand Side)

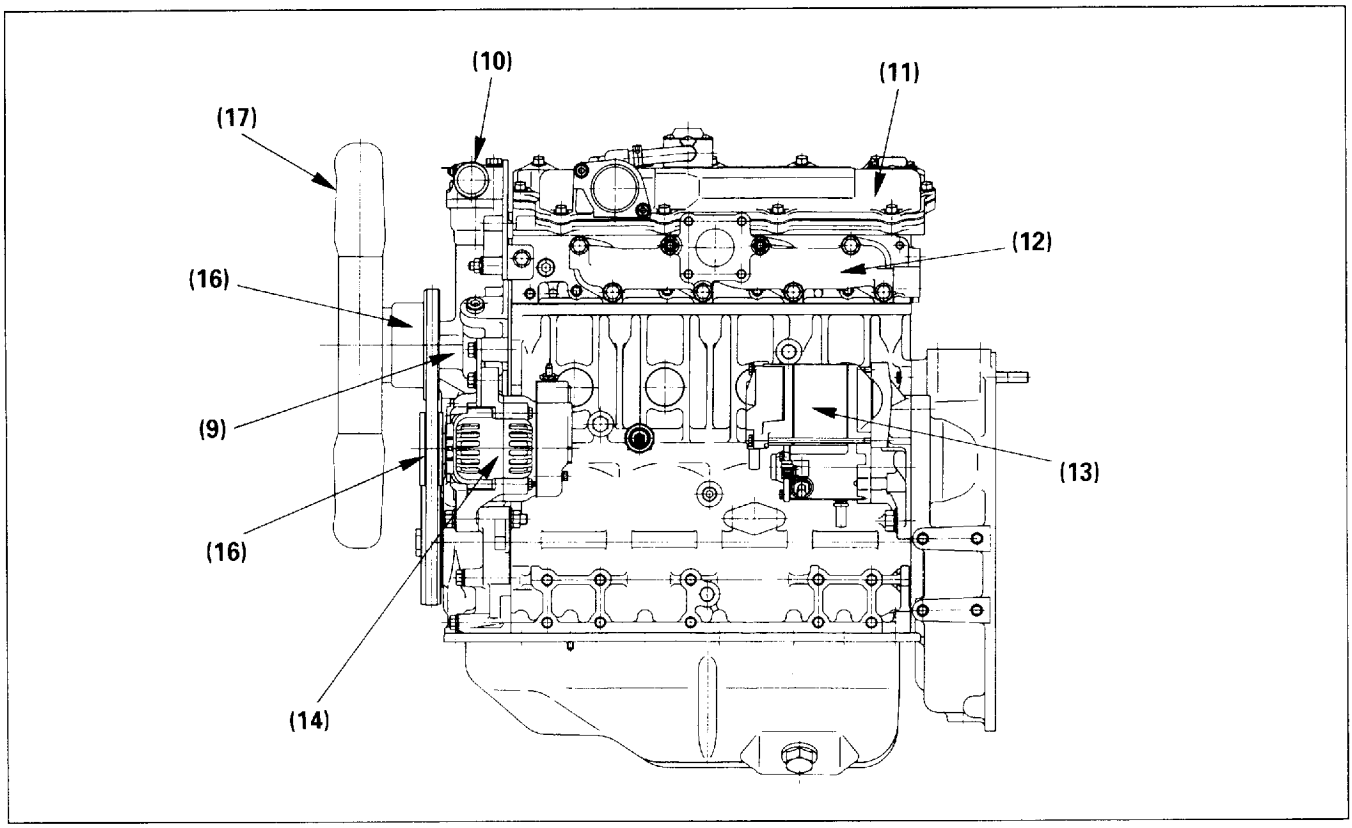



Fig. 158

(9) Water Pump
(10) Thermostat and Water Outlet Pipe
(11) Cylinder Head Cover
(12) Exhaust Manifold
(13) Starter
(14) Generator
(15) Fan Pulley
(16) Fan Belt
(17) Cooling Fan

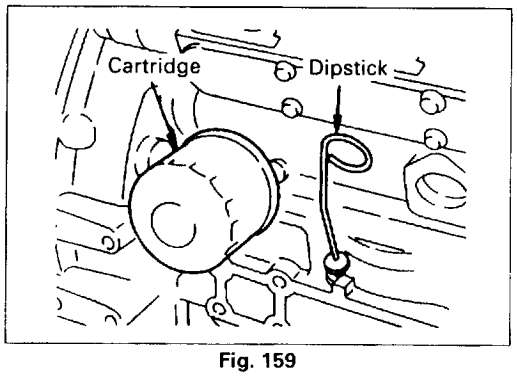



Fig. 159

**Dipstick**

**Oil filter** (cartridge)

1. Insert the dipstick.
2. Install the cartridge with a filter wrench (commercially available).

(1) Apply engine oil thinly to the gasket of the cartridge.

(2) Screw in the cartridge until the gasket comes into contact with the seal, and then tighten it by giving it about 3/4 turns.

(Reference: Tightening torque 1.2 to 1.6 kg·m (8.6 – 11.6 ft. lbs.))

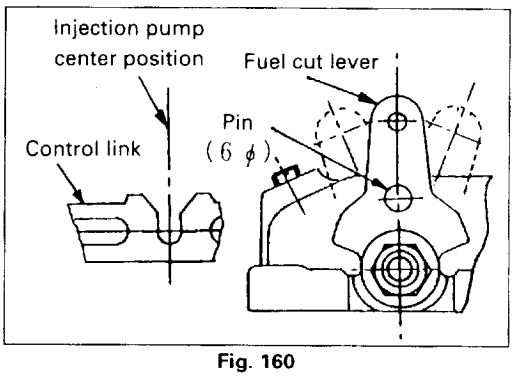



Fig. 160

**Injection pump**

Align the two (2) holes in the fuel cut lever and the governor and lock into place with a pin.

This will center and hold the control link for the installation of the injection pumps.

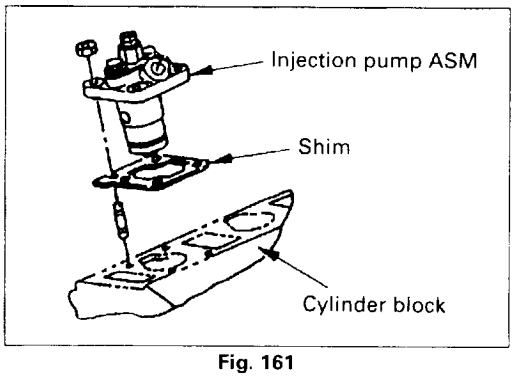



Fig. 161

Install a new shim with the same thickness as the one that was removed. (Refer to the maintenance section on shim selection).

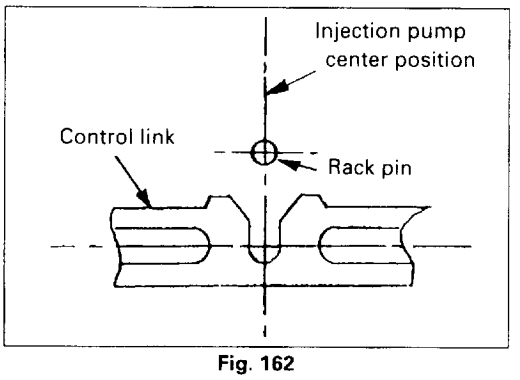



Fig. 162

Install the injection pump making sure the rack pin is in the groove of the control rack before tightening the injection pump to the specified torque.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |

Remove the rack pin (6ø) which is inserted into the fuel cut lever, and then confirm that the fuel cut lever moves smoothly.

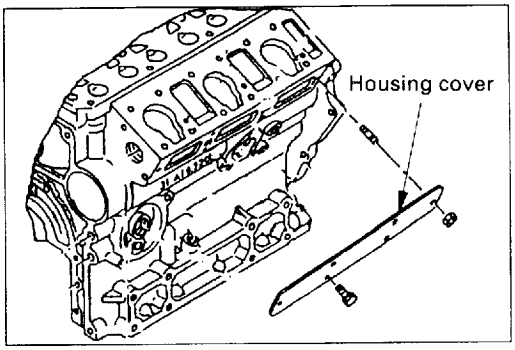



Fig. 163

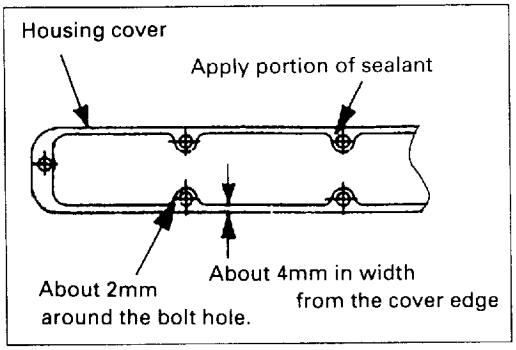



Fig. 164

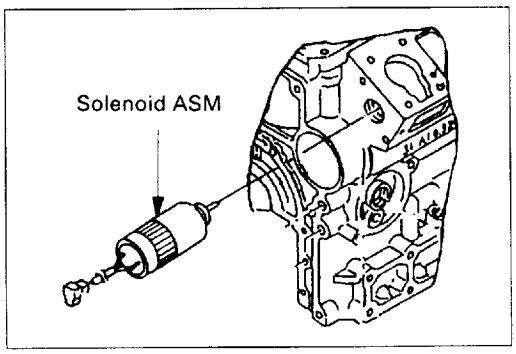



Fig. 165

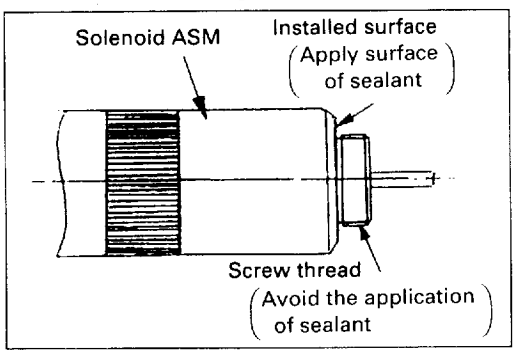



Fig. 166

**Injection pump housing cover**

After applying sealant (TB1207C) to the housing cover, install it to the cylinder block by the side of the injection pump.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 0.8 – 1.2 (6.0 – 9.0) |

**Note:**

**The areas of the housing cover to which liquid gasket is applied are about 4 mm in width from the cover edge and about 2 mm around the bolts.**

**Solenoid assembly**

1. Apply sealant (TB1207C) to the surface (bite groove) in which the solenoid is installed.

**Note:**

**Avoid the application of sealant to the screw thread.**

2. Screw in the solenoid from the rear of the cylinder block (the rear of the No. 3 injection pump rack), and then tighten it to the specified torque.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 1.5 – 2.5 (11.0 – 18.0) |

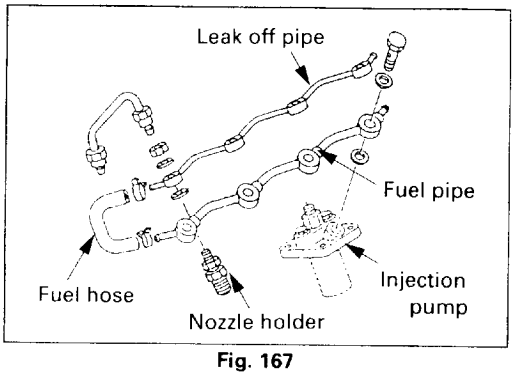



Fig. 167

**Fuel pipe**

**Leak off pipe**

1. Install the fuel pipe to the injection pump and then tighten it to the specified torque.
2. Install the leak off pipe to the nozzle holder and then tighten it to the specified torque.

kg·m (ft. lbs.)

| Tightening torque | |
|---|---|
| Fuel pipe | 2.0 – 2.5 (14.0 – 18.0) |
| Leak off pipe | 2.5 – 3.5 (18.0 – 25.0) |

**Note:**

**When tightening it, hold the pipe securely by hand so that it will not rotate.**

3. Connect the fuel pipe and the leak off pipe with the fuel hose and fix them with clips.

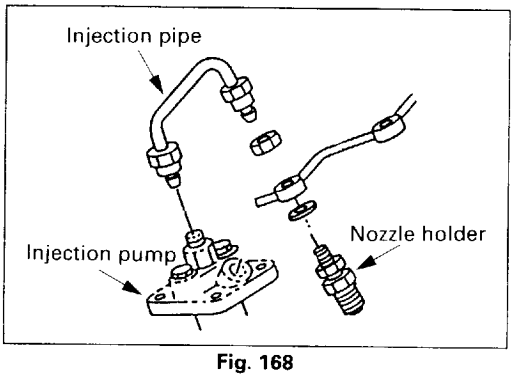



Fig. 168

**Injection pipe**

Install the injection pipe to the injection pump and the nozzle holder and tighten them up with sleeve nuts.

kg·m (ft. lbs.)

| Tightening torque | 1.5 – 2.5 (11.0 – 18.0) |
|---|---|

**Note:**

**Set the thread of the sleeve nut securely before tightening it up.**

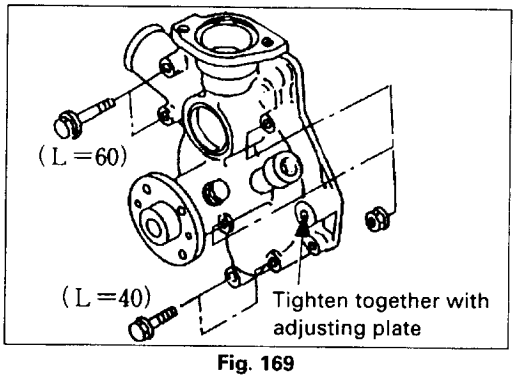



Fig. 169

**Water pump assembly**

1. Put sealant on the water pump where it contacts the block and head.
2. Tighten to the specified torque.

kg·m (ft. lbs.)

| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |
|---|---|

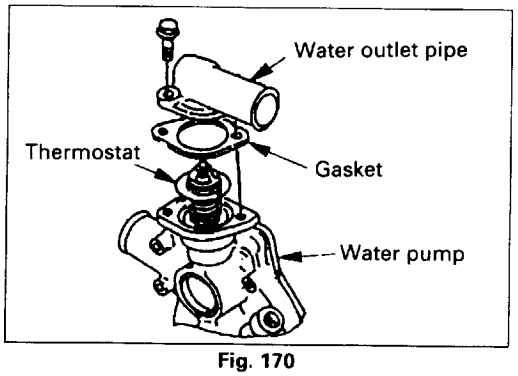



Fig. 170

**Thermostat**

**Water outlet pipe**

Assemble the thermostat, install the gasket and the water outlet pipe, and then tighten it to the specified torque.

kg·m (ft. lbs.)

| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |
|---|---|

### Adjustment of valve clearance

(Refer to Section "GENERAL INFORMATION – MAINTENANCE.")

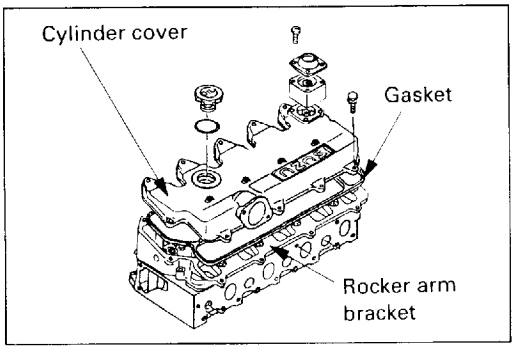



Fig. 171

### Cylinder head cover

1. Install the gasket to the cylinder head cover.

**Notes:**

1. **Much care should be taken for the gasket not to get dislocated or twisted when installing the head cover.**
2. **Avoid the application of sealant to the rubber gasket.**

2. Install the cylinder head cover to the rocker arm bracket, and tighten it to the specified torque.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 0.2 – 0.4 (1.4 – 2.9) |

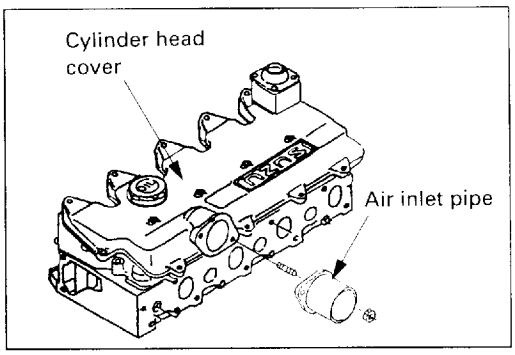



Fig. 172

### Air inlet pipe

1. Apply sealant (TB1207C) to the surface in which the air inlet pipe is installed.
2. Install the air inlet pipe to the cylinder head cover, and tighten it to the specified torque.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 0.8 – 1.2 (6.0 – 9.0) |

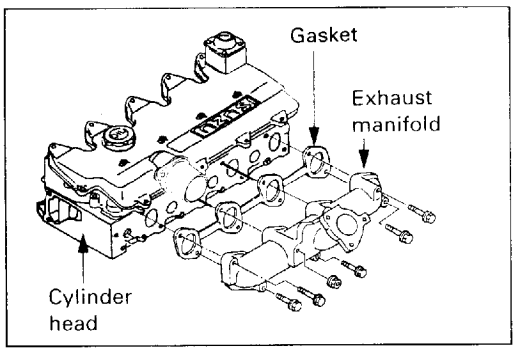



Fig. 173

### Exhaust manifold

Assemble the gasket to the cylinder head, install the exhaust manifold along the stud bolts and tighten it to the specified torque.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |

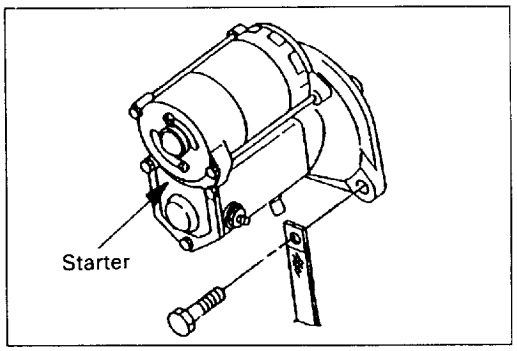



Fig. 174

### Starter

Install the starter to the flywheel housing, and tighten it to the specified torque.

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 9.5 – 11.5 (68.7 – 83.2) |

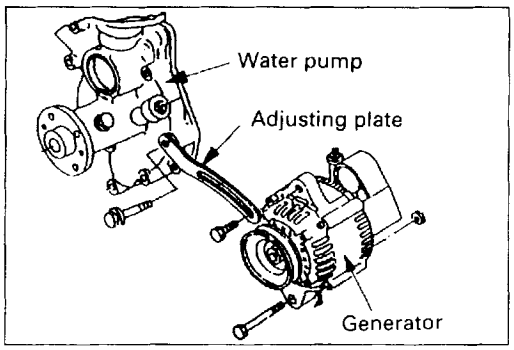



Fig. 175

### Generator

1. Tighten the adjust plate together with the water pump, and then install them temporarily.
2. Install the bottom of the generator to the timing gear case, and then tighten it temporarily with bolts and nuts.
3. Install the fixing bolts onto the top of the generator through the adjusting plate. (Temporary tightening)

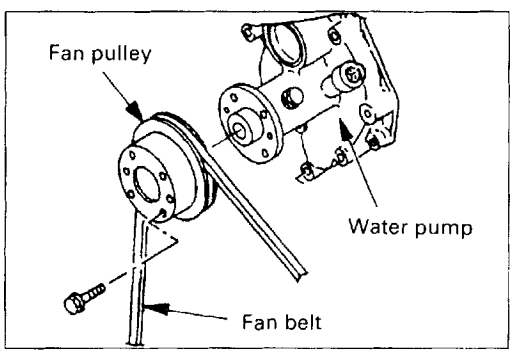



Fig. 176

### Fan pulley and fan belt

1. Install the fan pulley to the water pump and then tighten it up. (2 locations)

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 0.8 – 1.2 (6.0 – 9.0) |

2. Set the fan belt to each pulley.

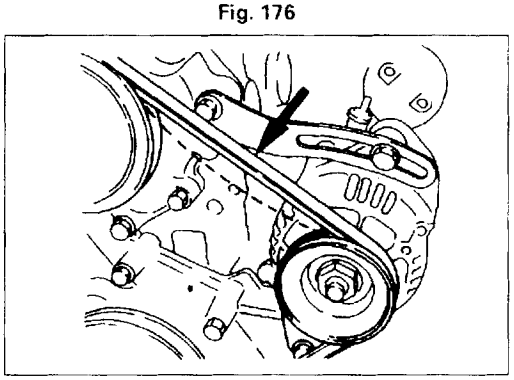


Fig. 177

### Fan belt tension

Adjust the alternator as specified and tighten to the specified torque.

mm (in.)

| | |
|---|---|
| Deflection amount (Press the belt at its center between the pulleys with 10kg (22 lbs.) force.) | 8 to 10 (0.315 – 0.3937) |

mm (in.)

| | |
|---|---|
| Generator upper | 1.9 – 2.9 (14.0 – 21.0) |
| Generator lower | 3.5 – 4.7 (25.0 – 34.0) |
| Adjust plate | 1.9 – 2.9 (14.0 – 21.0) |

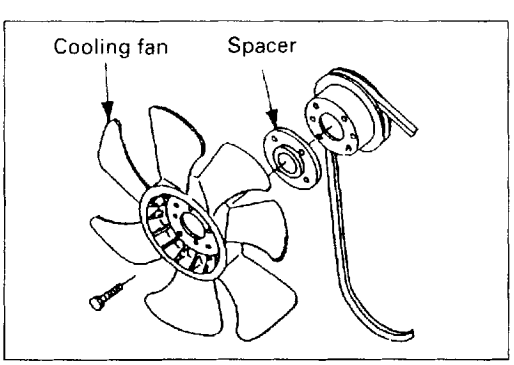



Fig. 178

### Cooling fan

1. Assemble the spacer before tightening the cooling fan.
2. Tighten it to the specified torque. (4 locations)

kg·m (ft. lbs.)

| | |
|---|---|
| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |

## MEMO

SECTION 3

# LUBRICATING SYSTEM

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# LUBRICATING OIL CIRCULATION DIAGRAM

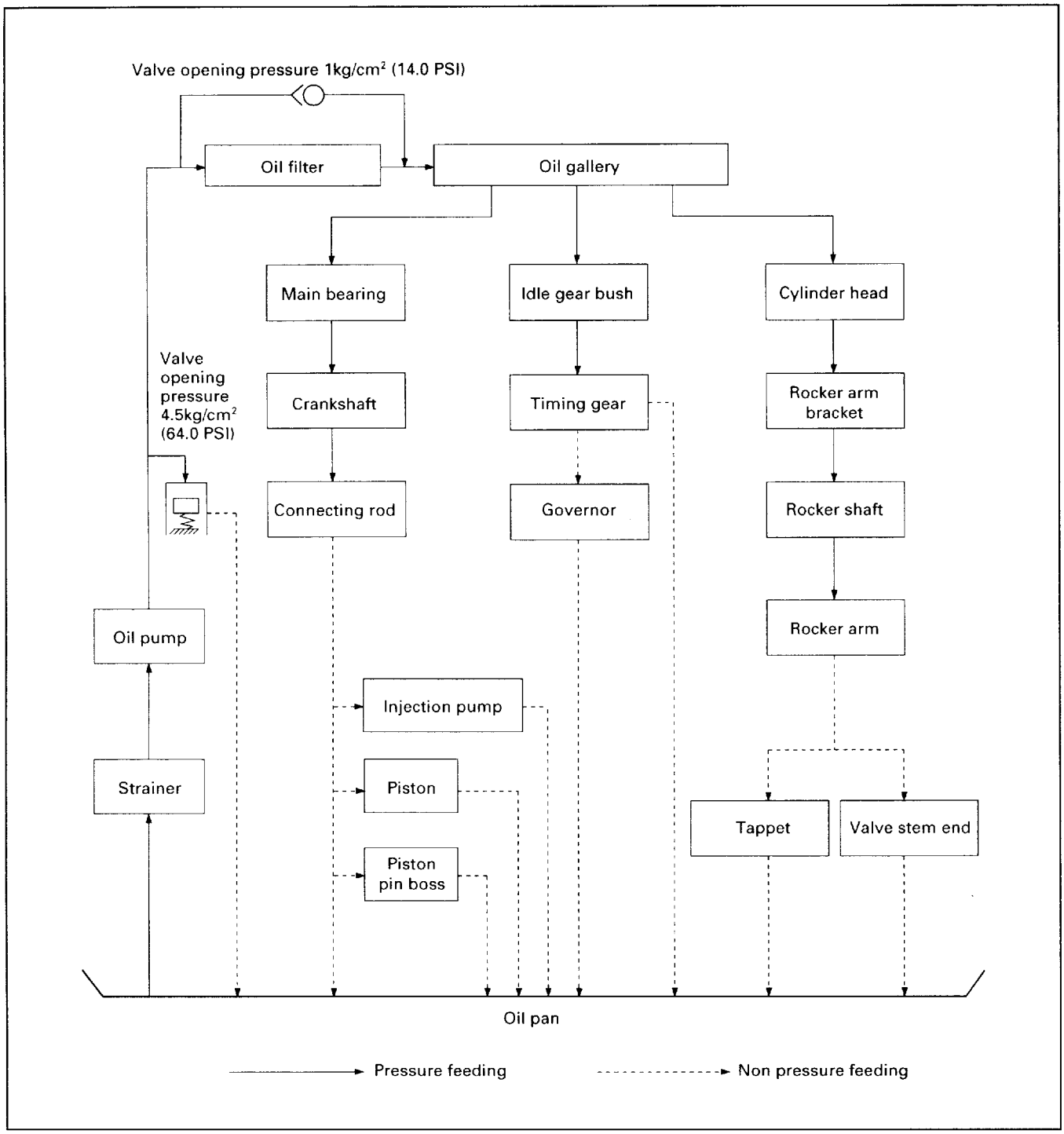


Fig. 179

# OIL PUMP

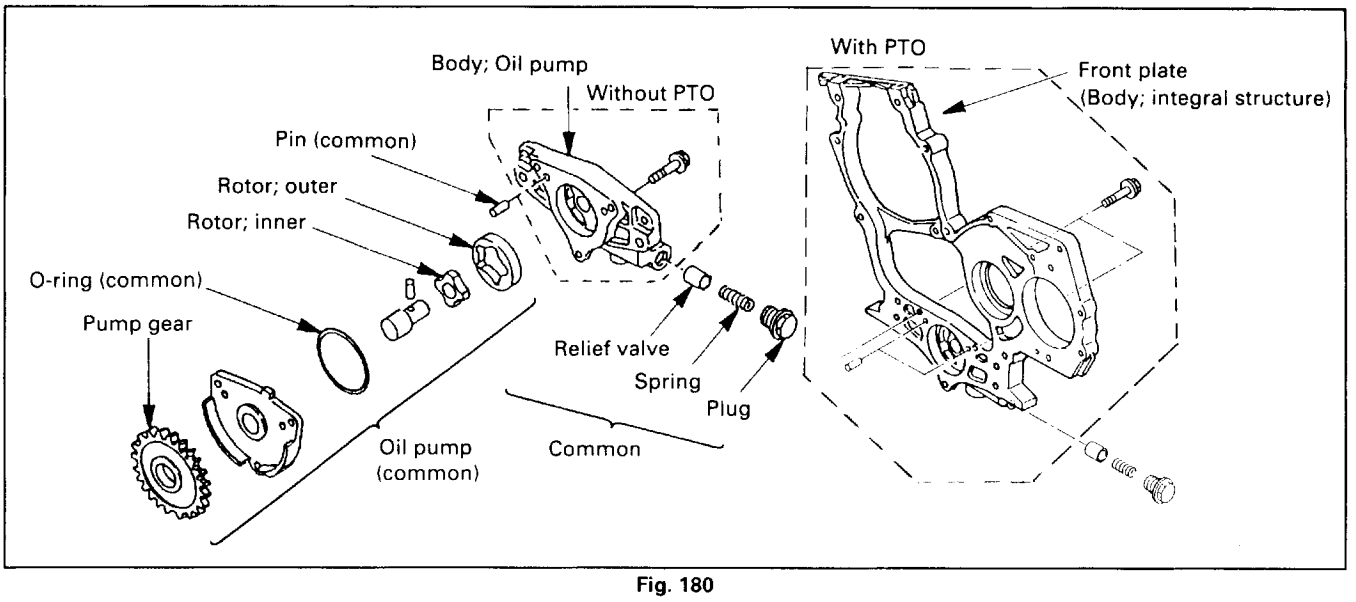


Fig. 180

**Inspection and replacement**

When there is wear, damages or any other defects found, repair or replace the rotor.

**Clearance between the outer rotor or inner rotor and the pump cover**

mm (in.)

| Standard | Limit |
|---|---|
| 0.040 – 0.085 (0.0016 – 0.0033) | 0.15 (0.0059) |

**Clearance between the periphery of the outer rotor and the pump body**

mm (in.)

| Standard | Limit |
|---|---|
| 0.10 – 0.185 (0.0039 – 0.0073) | 0.4 (0.0157) |

**Clearance between the inner rotor and the outer rotor**

mm (in.)

| Standard | Limit |
|---|---|
| 0.17 (0.0067) | 0.2 (0.0079) |

## MEMO

## SECTION 4

# COOLING SYSTEM

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# COOLING WATER CIRCULATION SYSTEM DIAGRAM

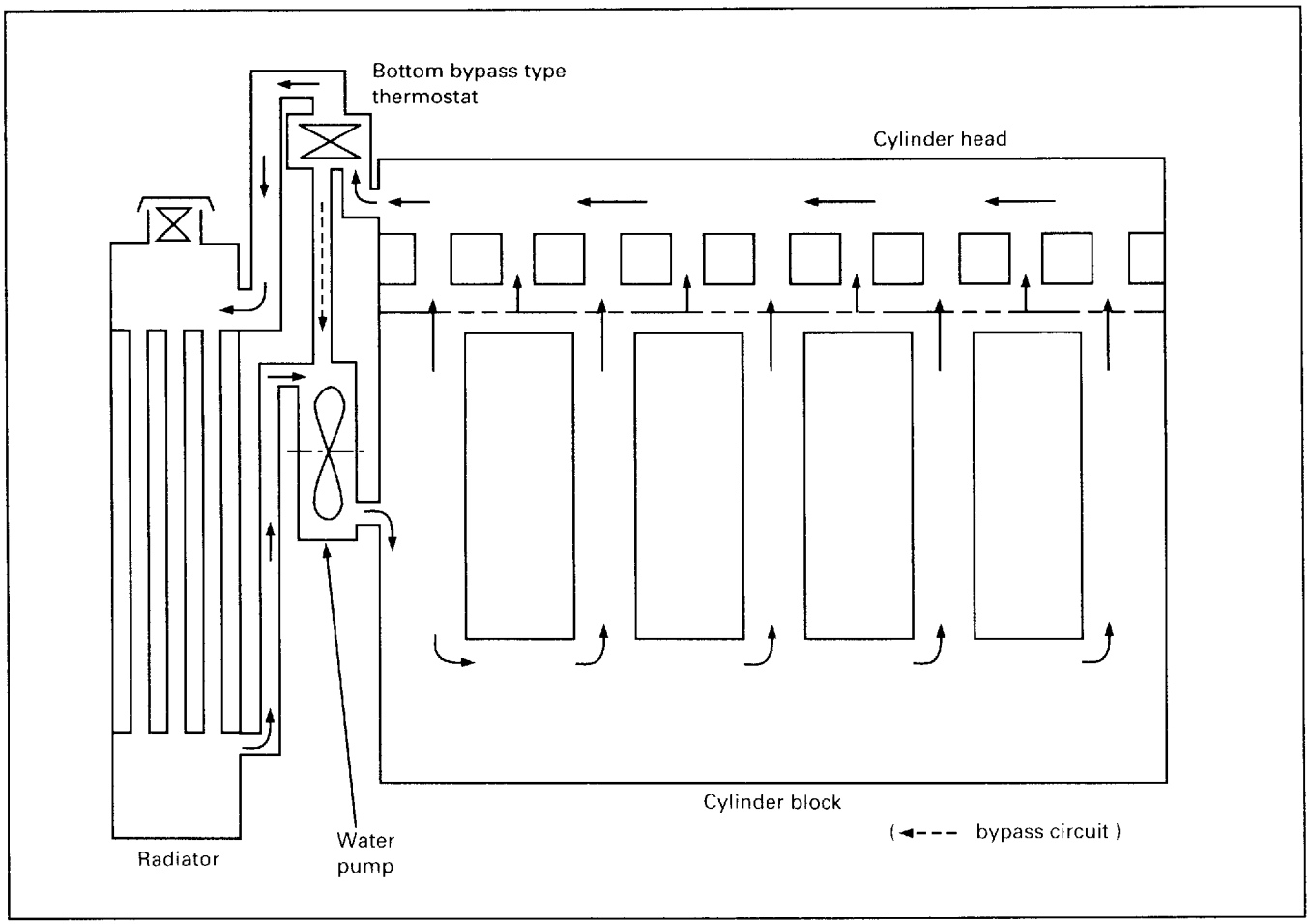


Fig. 181

# WATER PUMP

## DISASSEMBLY

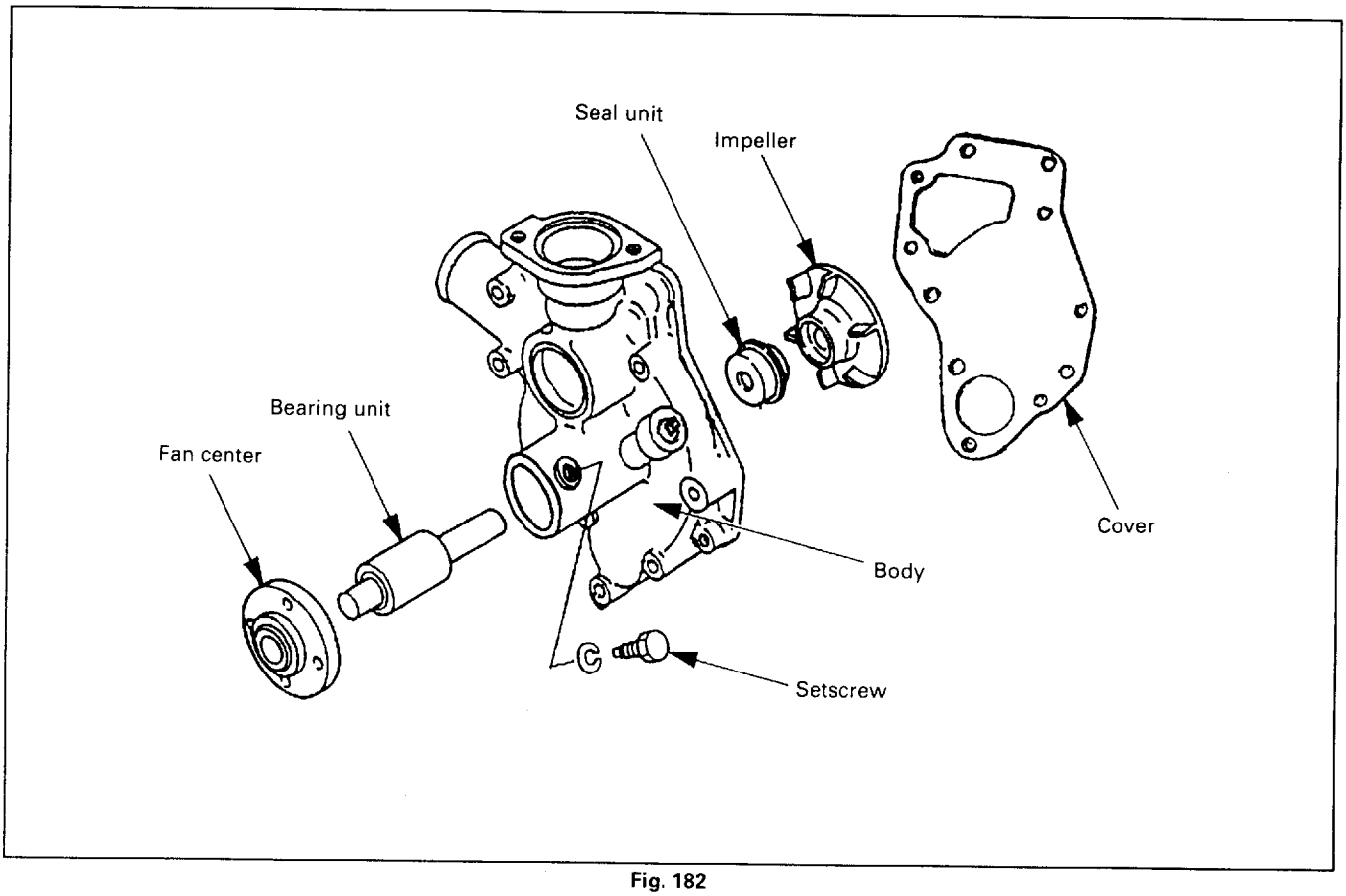


Fig. 182

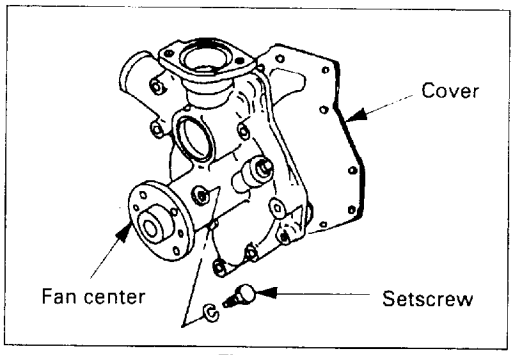


Fig. 183

**Fan center**

**Cover**

1. Loosen the set screw.
2. Remove the cover.

**Note:**

**The cover is applied with sealant (TB1207B). When removing the cover, much care should be taken not to deform it by applying an excessive force to it.**

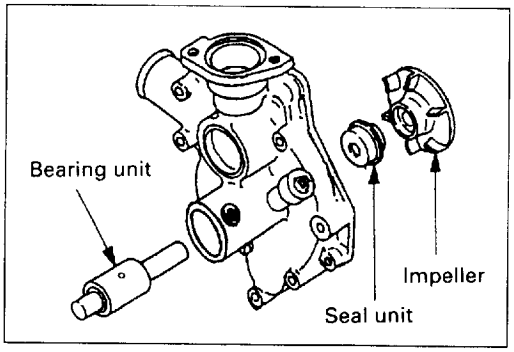


Fig. 184

**Impeller**

**Seal unit**

**Bearing unit**

## REASSEMBLY

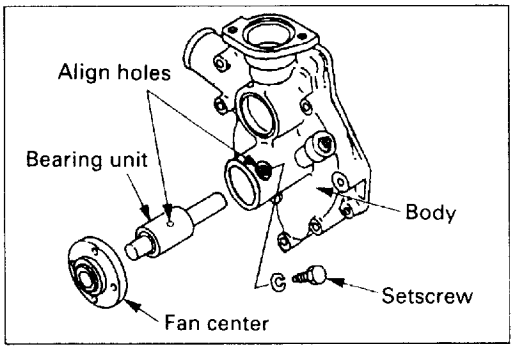


Fig. 185

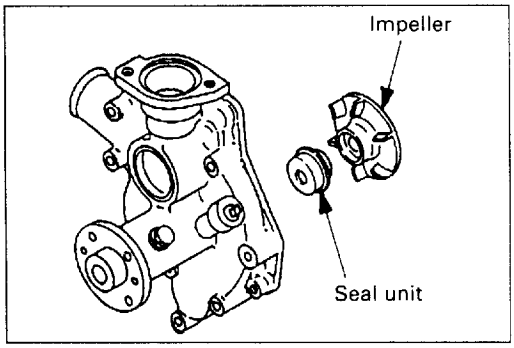


Fig. 186

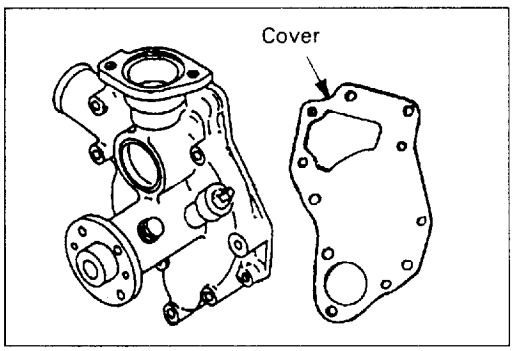


Fig. 187

### Bearing unit

With a hole in the bearing unit set in line with one in the body, lock the bearing unit with a setscrew.

kg·m (ft. lbs.)

| | |
|---|---|
| Set screw tightening torque | 0.8 – 1.2 (6.0 – 9.0) |

### Seal unit

### Impeller

1. Apply BELCO bond No. 4 to the surface where the seal unit comes into contact with the body, and then assemble the seal unit.
2. Press in the impeller with a press until the clearance between the pump impeller and the body gets to the specified value.

### Cover

1. Apply liquid gasket to the surface to which the cover is installed, and then install the cover.
2. Apply Screw-lock to the cover installation screws, and then tighten them.

### Clearance, play and tightening allowance between parts

1. Clearance between the pump impeller and the body

mm (in.)

| | |
|---|---|
| Standard | 0.53 – 2.17 (0.0209 – 0.0854) |

2. Play in the water pump ball bearing

mm (in.)

| Standard | Limit |
|---|---|
| 0.008 – 0.010 (0.0003 – 0.0004) | 0.2 (0.0079) |

3. Tightening allowance between the fan center and the bearing shaft

mm (in.)

| | |
|---|---|
| Standard | 0.026 – 0.061 (0.001 – 0.0024) |

# THERMOSTAT

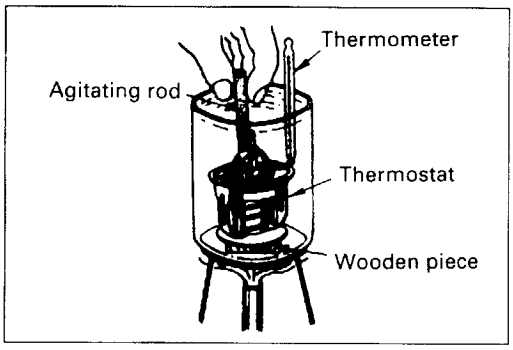


Fig. 188

**Inspection and replacement**

Replace the thermostat when there is wear, damages or any other defects found.

| | |
|---|---|
| Opening temp. | 74.5 – 78.5°C (166 – 174°F) |
| Valve lift mm (in.) | 8mm or more at 90°C<br>(0.315 inch or more at 194°F) |

## MEMO

## SECTION 5

# FUEL SYSTEM

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# FUEL CIRCULATION SYSTEM DIAGRAM

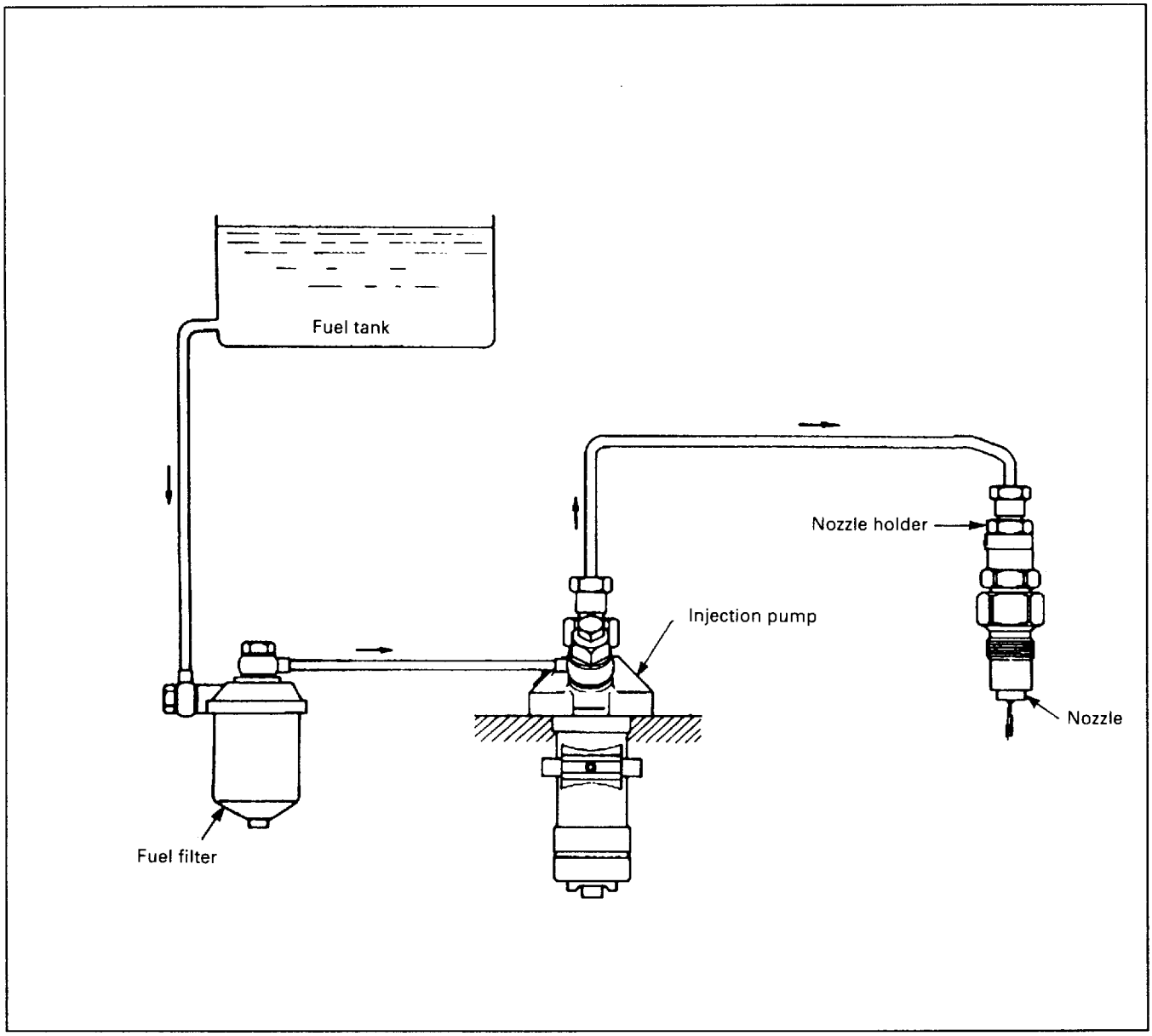



Fig. 189

# GOVERNOR

1. The adjustments of the governor-related parts require the engine performance test.
2. Before disassembling the governor, measure the dimensions "A" and "B" given in the structural drawing to ensure the same dimensions in reassembly.
3. Do not disassemble the governor when the performance test cannot be conducted after reassembly.

## 1. STRUCTURAL DRAWING OF GOVERNOR (1)

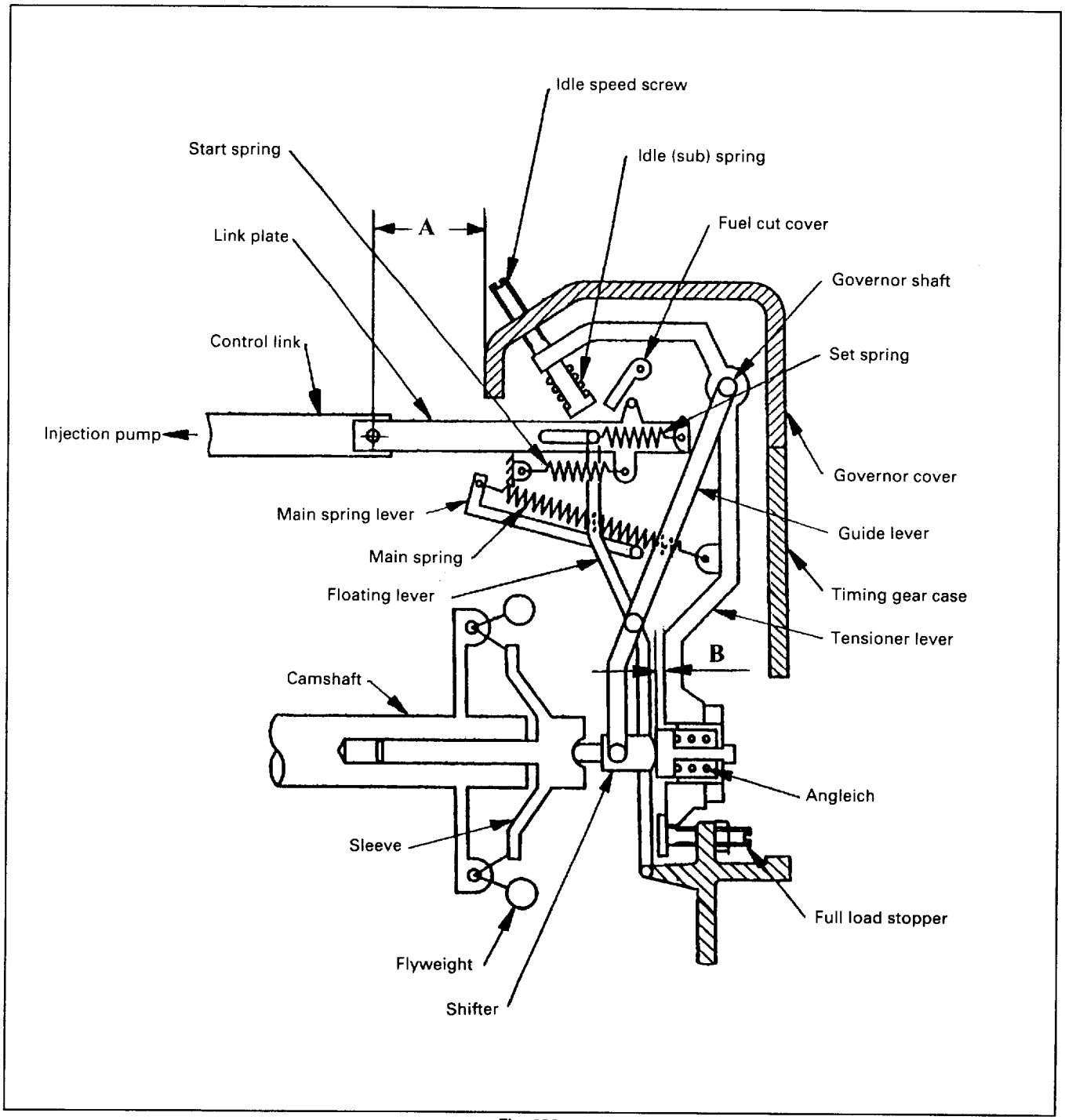



Fig. 190

## 2. STRUCTURAL DRAWING OF GOVERNOR (2)

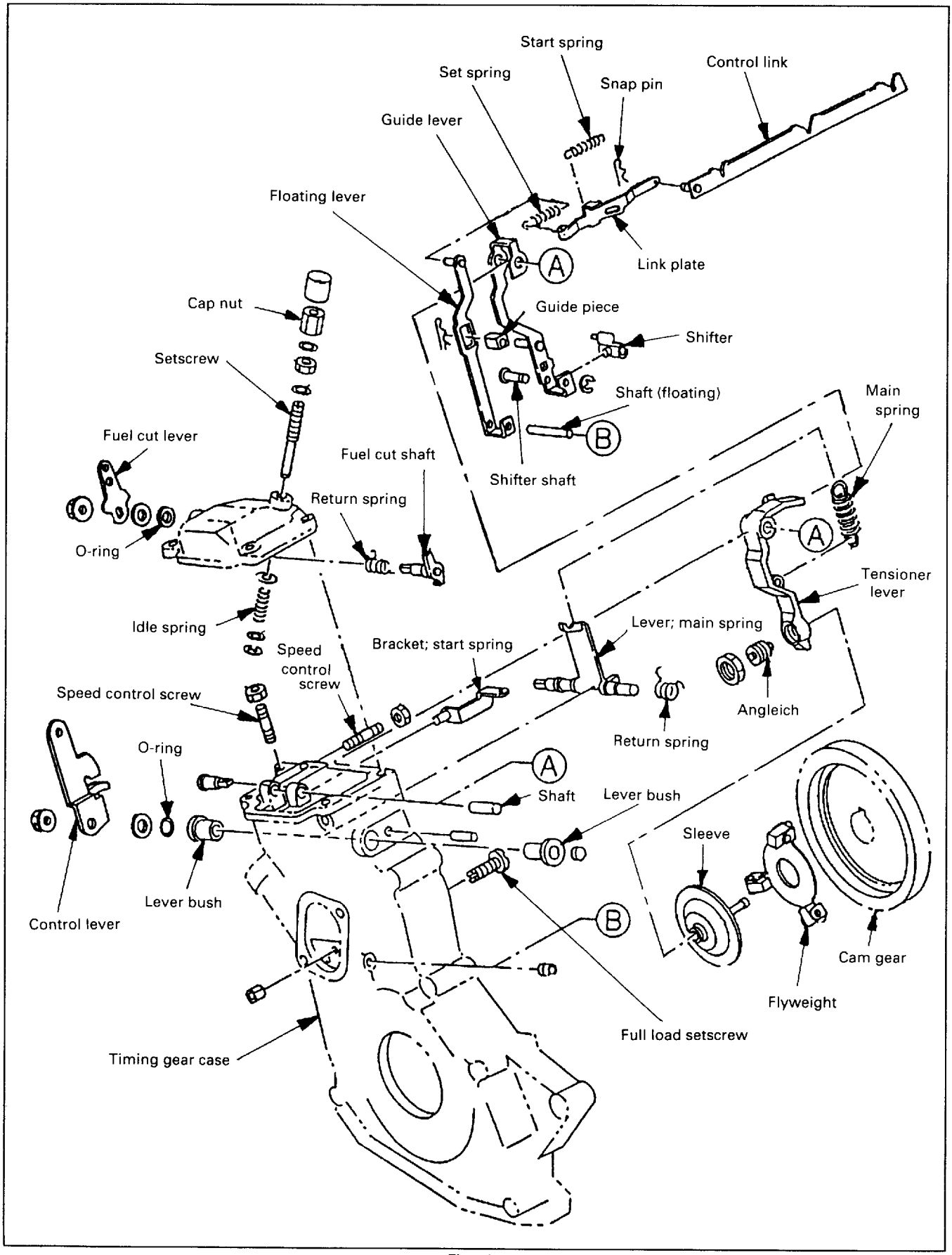



Fig. 191

## 3. REASSEMBLY OF CONTROL LEVER RELATED PARTS

(1) Put the lever (main spring) through the hole of the timing gear case lever.

**Note:**

**Before hammering in the bushes, put both shafts of the lever through the holes of the timing gear case lever respectively.**

(2) Put the return spring of the control lever through the shaft of the lever (main spring).

(3) Assemble the bushes.
Assemble the bush of the lever (main spring) first, and then the control lever bush.

**Note:**

**When assembling the bushes, apply Loctite (#601) to the periphery of the bushes.**

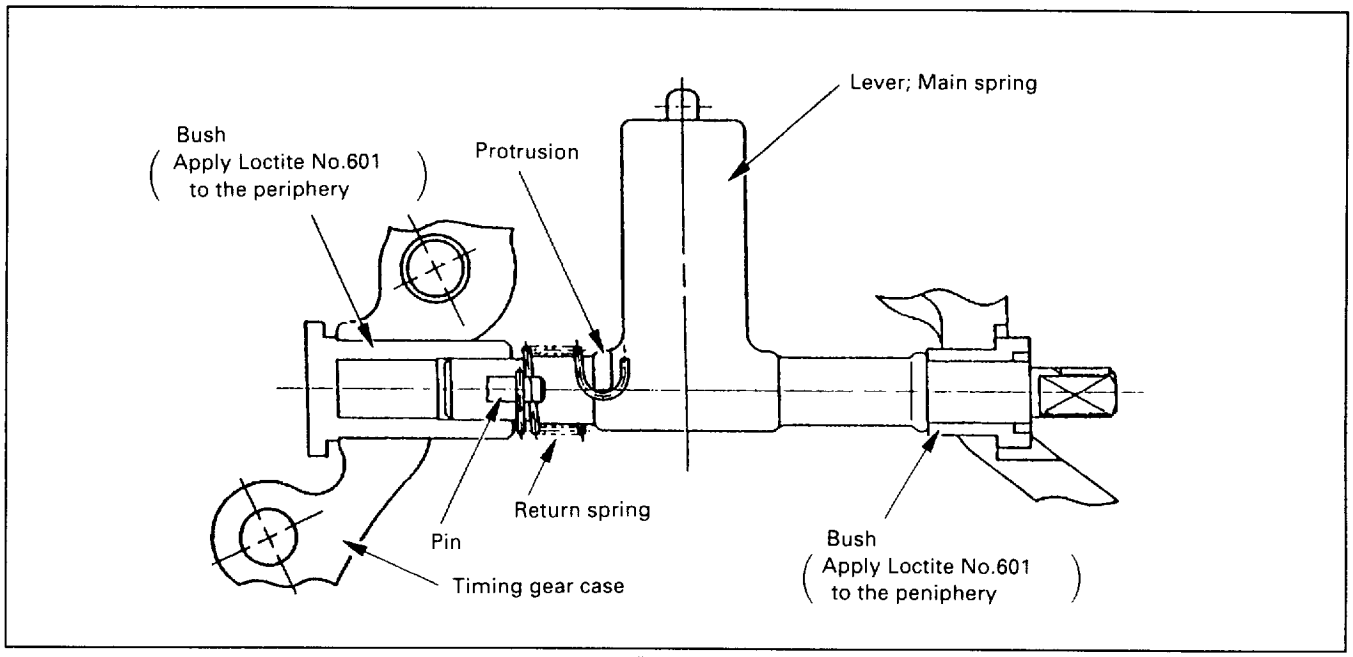



Fig. 192

(4) Hook both ends of the return spring (control lever) securely to the protrusion and the pin of the lever (main spring) respectively.

(6) Assemble the control lever.
Assemble the O-ring to the groove of the bushes (control lever) first, and then assemble the washers and the control lever before tightening up the control lever with a nut.

kg·m (ft. lbs.)

| | |
|---|---|
| Control lever tightening torque | 1.2 – 1.8 (9.0 – 13.0) |

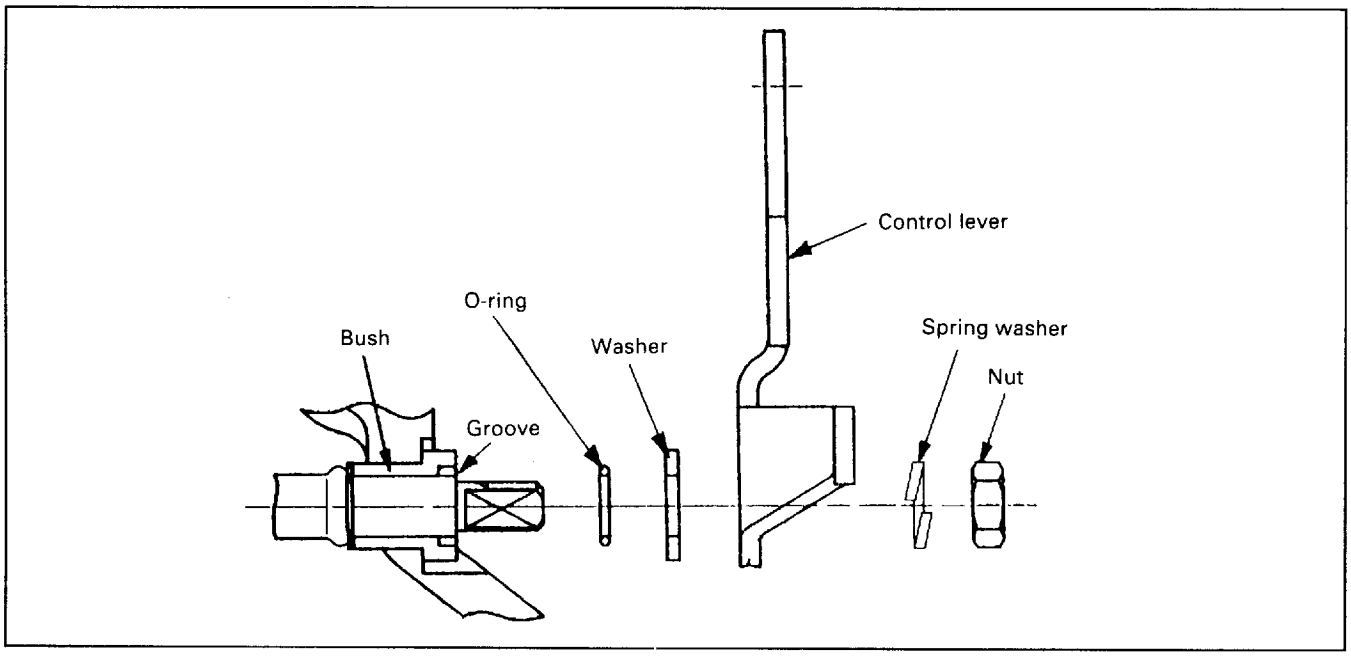



Fig. 193

**Notes:**

1. **Tighten the control lever after locking the control lever firmly.**
   **(Do not tighten the control lever after locking the main spring lever.)**
2. **After assembly, confirm that the control lever moves smoothly.**

## 4. Reassembly of shifter

(1) Assemble the shifter to the guide lever, put the shaft through it, and then assemble the snap ring.

(2) After assembly, confirm that the shaft moves smoothly.

(3) Also, confirm that the shifter shakes smoothly.

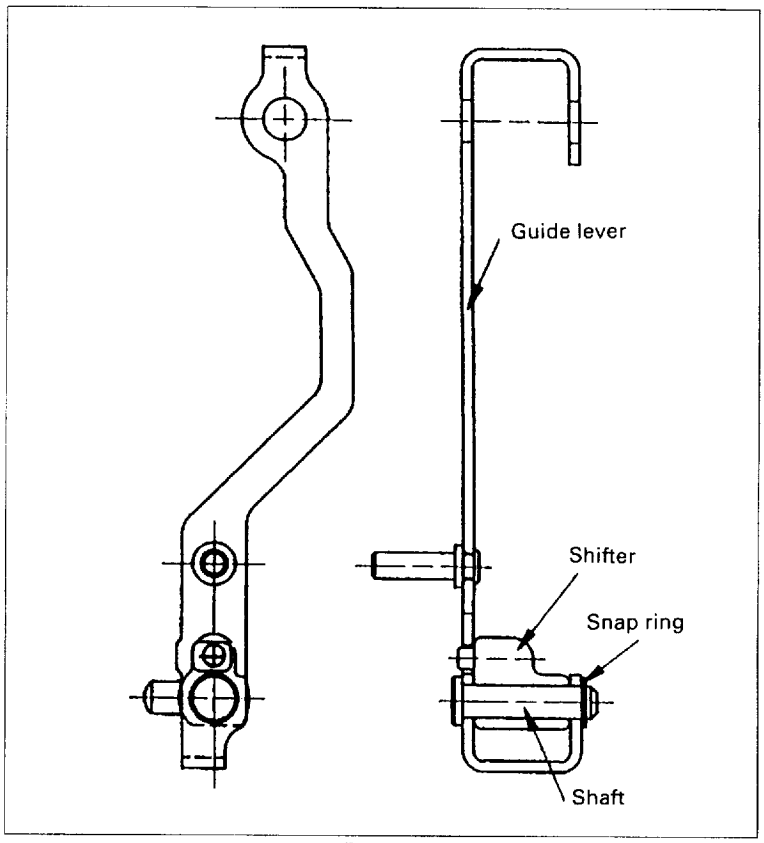



Fig. 194

## 5. Reassembly of governor cover

Assemble the related parts such as the fuel cut lever and the idle spring to the governor cover.

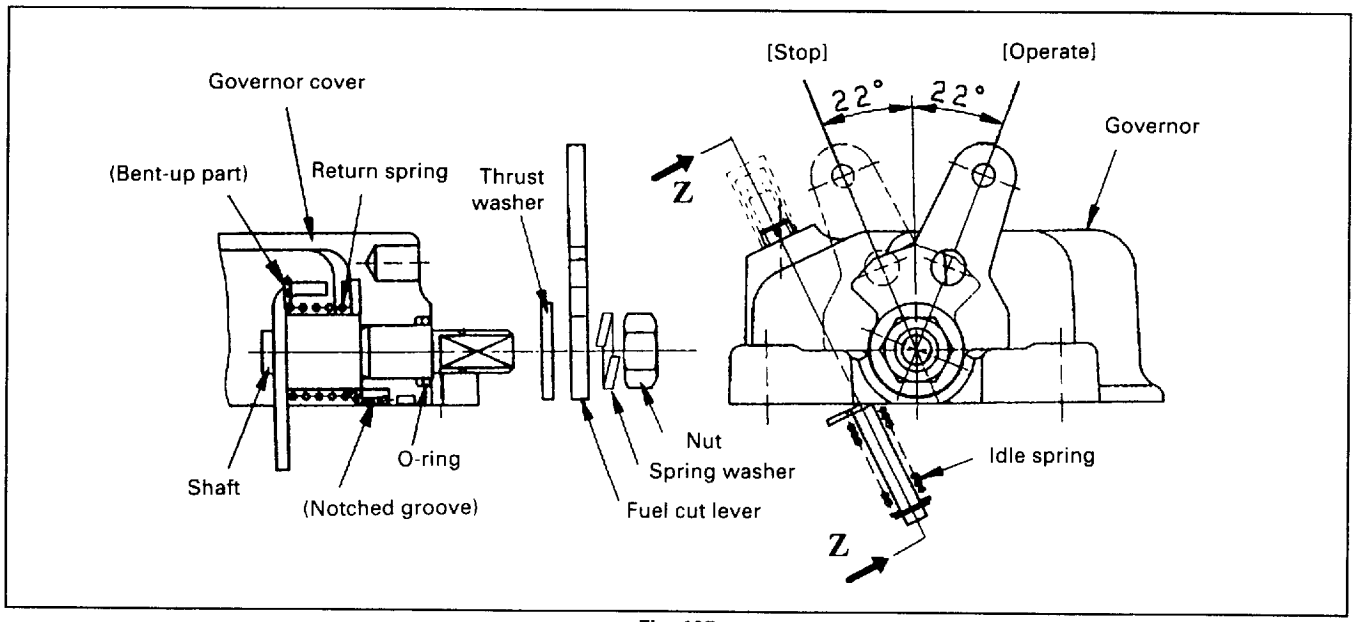



Fig. 195

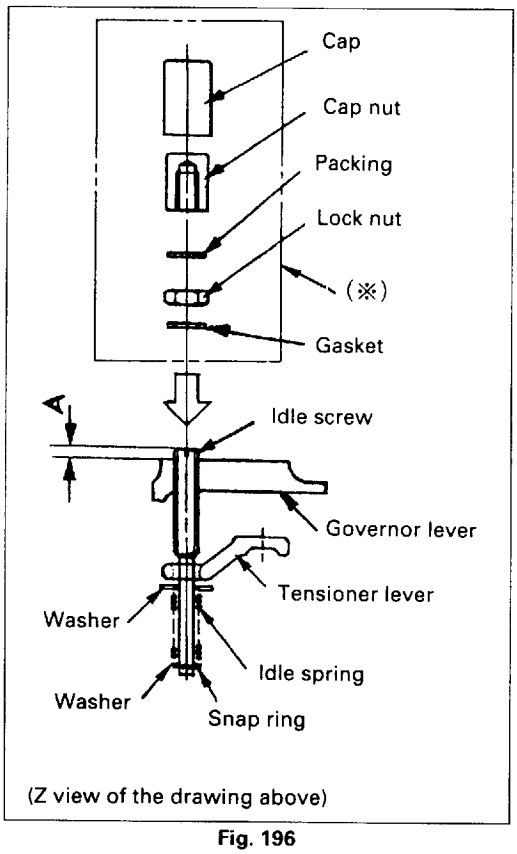



Fig. 196

(1) When assembling the shaft, apply engine oil to the sliding portion with the governor cover.

(2) Set both ends of the return spring securely to the notched groove at the bottom of the cover and the bent-up arm of the lever respectively.

(3) After reassembling the governor cover, confirm that the governor moves smoothly.

(4) When assembling the timing gear case to the governor cover, tighten the "A" dimension shown in the illustration to 2 – 3 mm temporarily.

The parts given in the square indicated by (*) are assembled after performance test.

mm (in.)

| | |
|---|---|
| "A" dimension | (When assembling temporarily)<br>2 – 3 (0.0787 – 0.0118) |

## 6. Reassembly of full-load stopper

Install the full-load stopper to the timing gear case, and then tighten it with a nut temporarily.

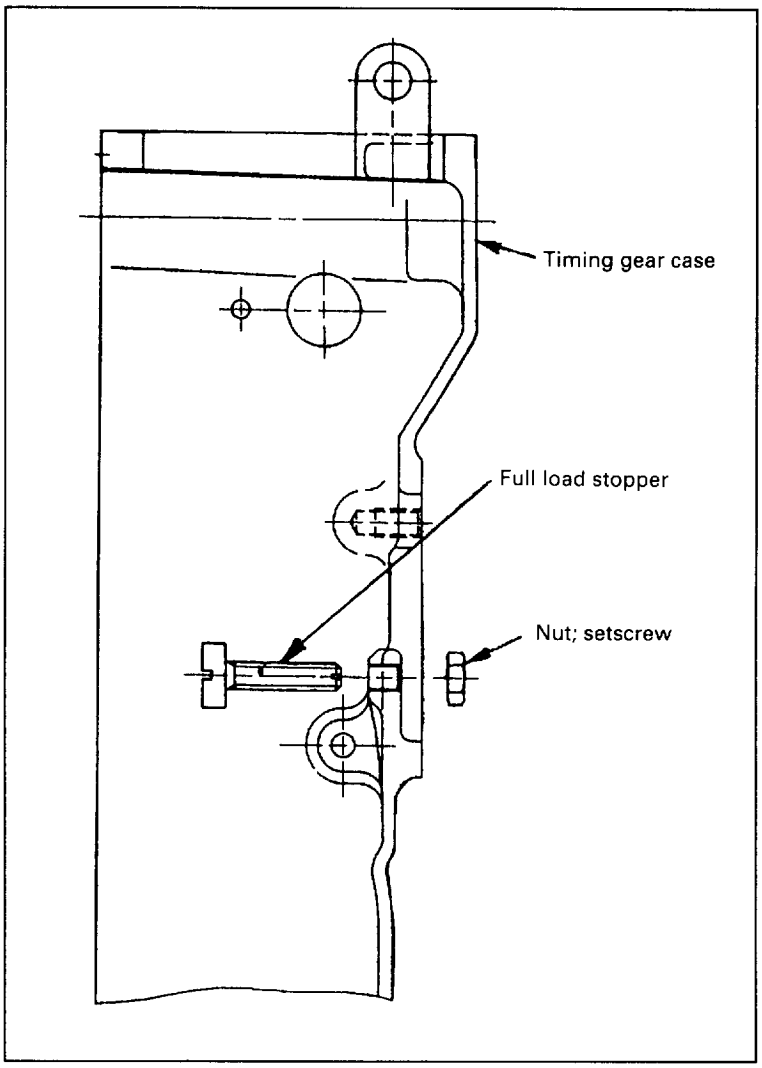



Fig. 197

## 7. Reassembly of governor lever related components

Assemble each lever and spring to the timing gear case.

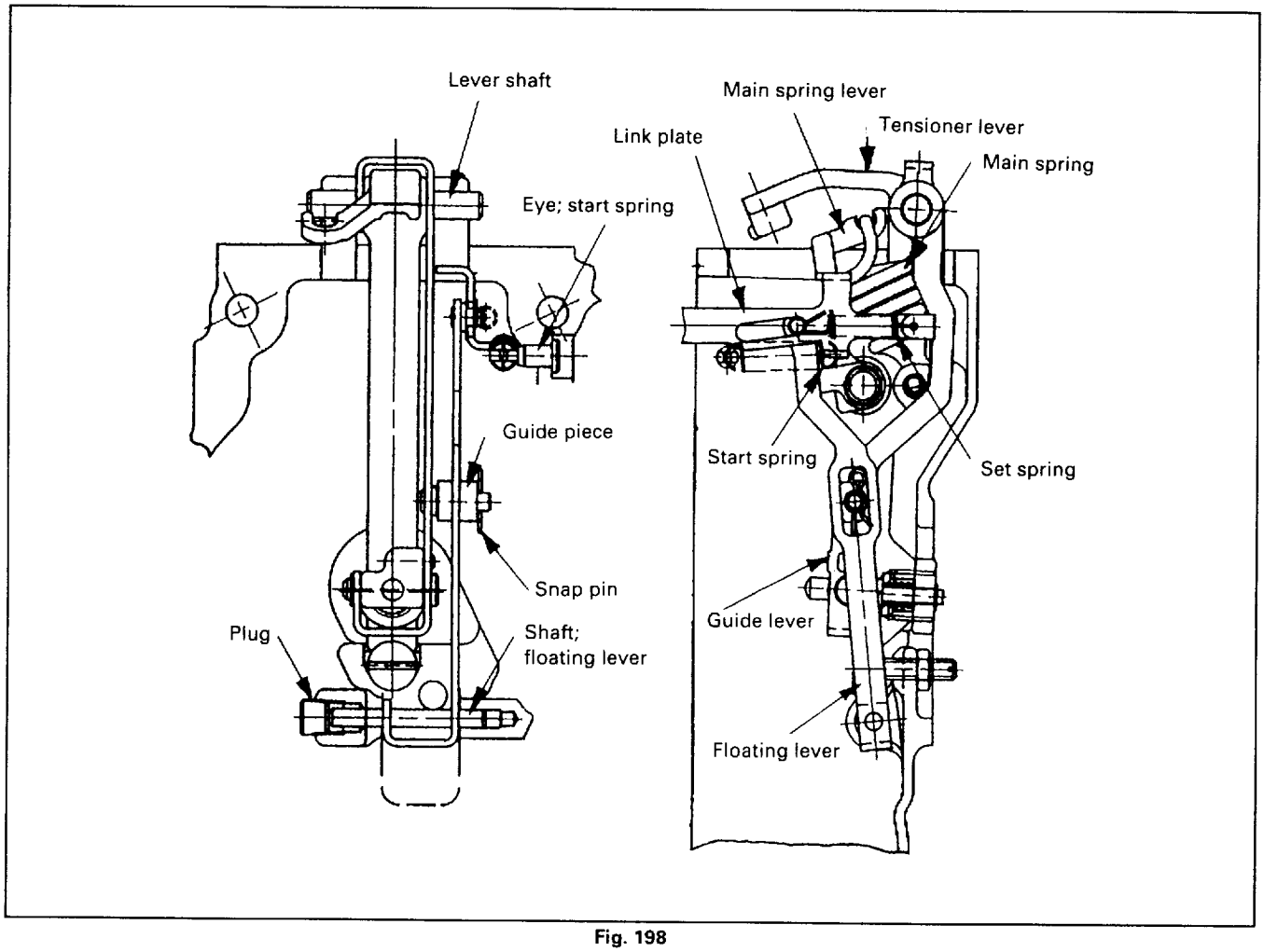



Fig. 198

## 8. Notes when assembling governor related components

(1) When assembling components, apply engine oil to each slide (such as the end face of the lever, the hole in the shaft, and the periphery of the shaft).

(2) Install the set spring securely to the groove of the pin connecting the floating lever, with much care to its assembling direction.

(3) Confirm that each lever moves by its dead weight before installing the start spring.

(4) After assembly, confirm that each lever moves smoothly.
And also confirm that each spring operates properly.

# NOZZLE HOLDER ASSEMBLY

## DISASSEMBLY

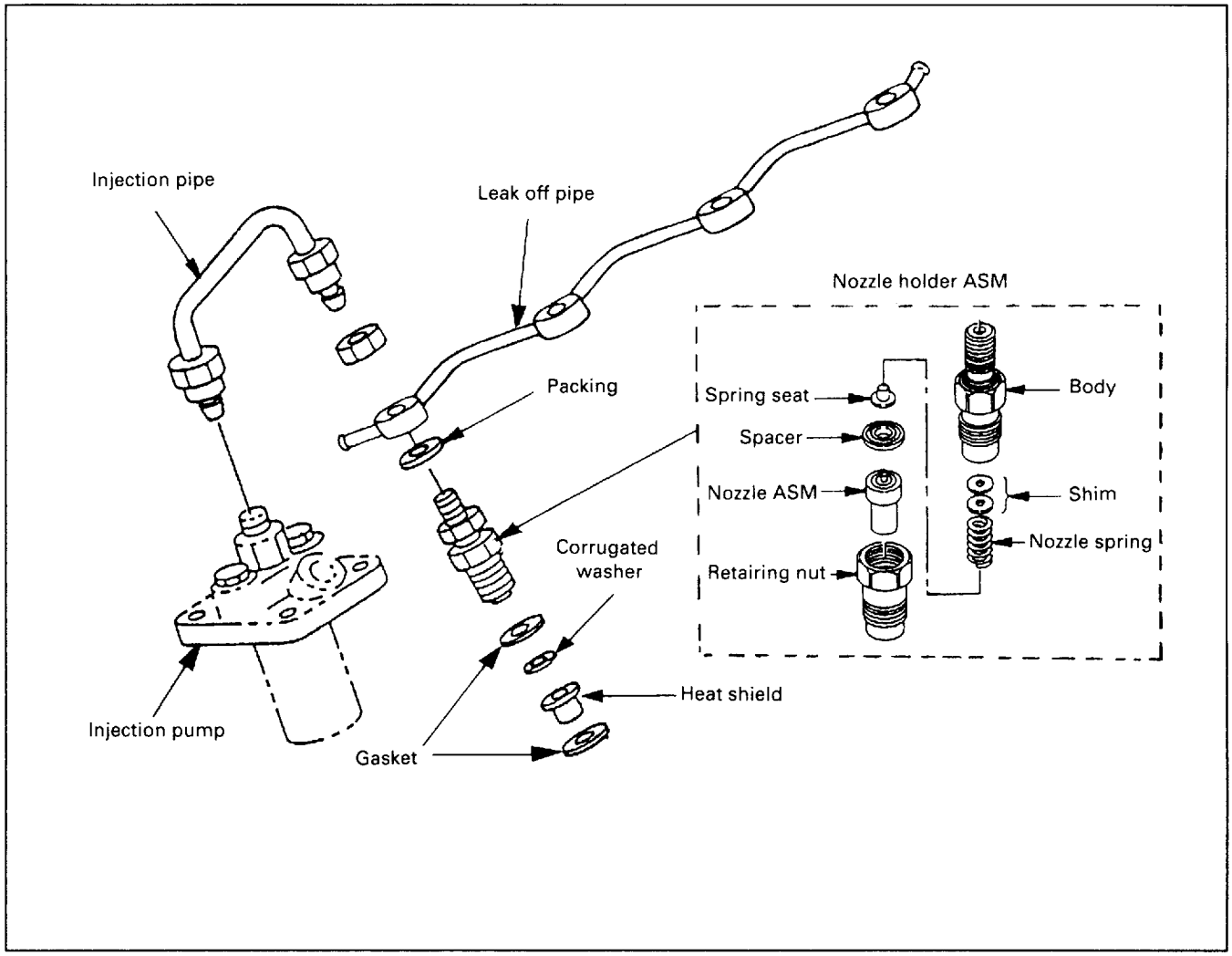



Fig. 199

## NOZZLE ASSEMBLY

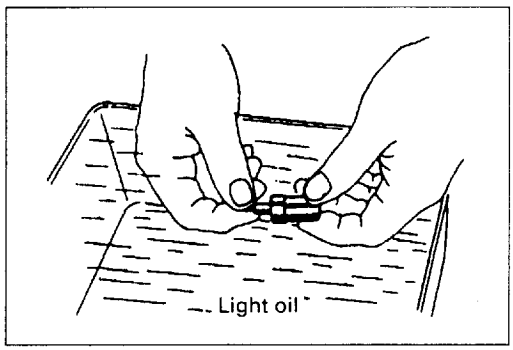



Fig. 200

### Inspection and replacement

Place the removed nozzle in the clean light oil, disassemble it into the nozzle body and the needle valve and clean them thoroughly. Then check to see if the valve moves smoothly in the body.

When it does not move smoothly, repair or replace the nozzle.

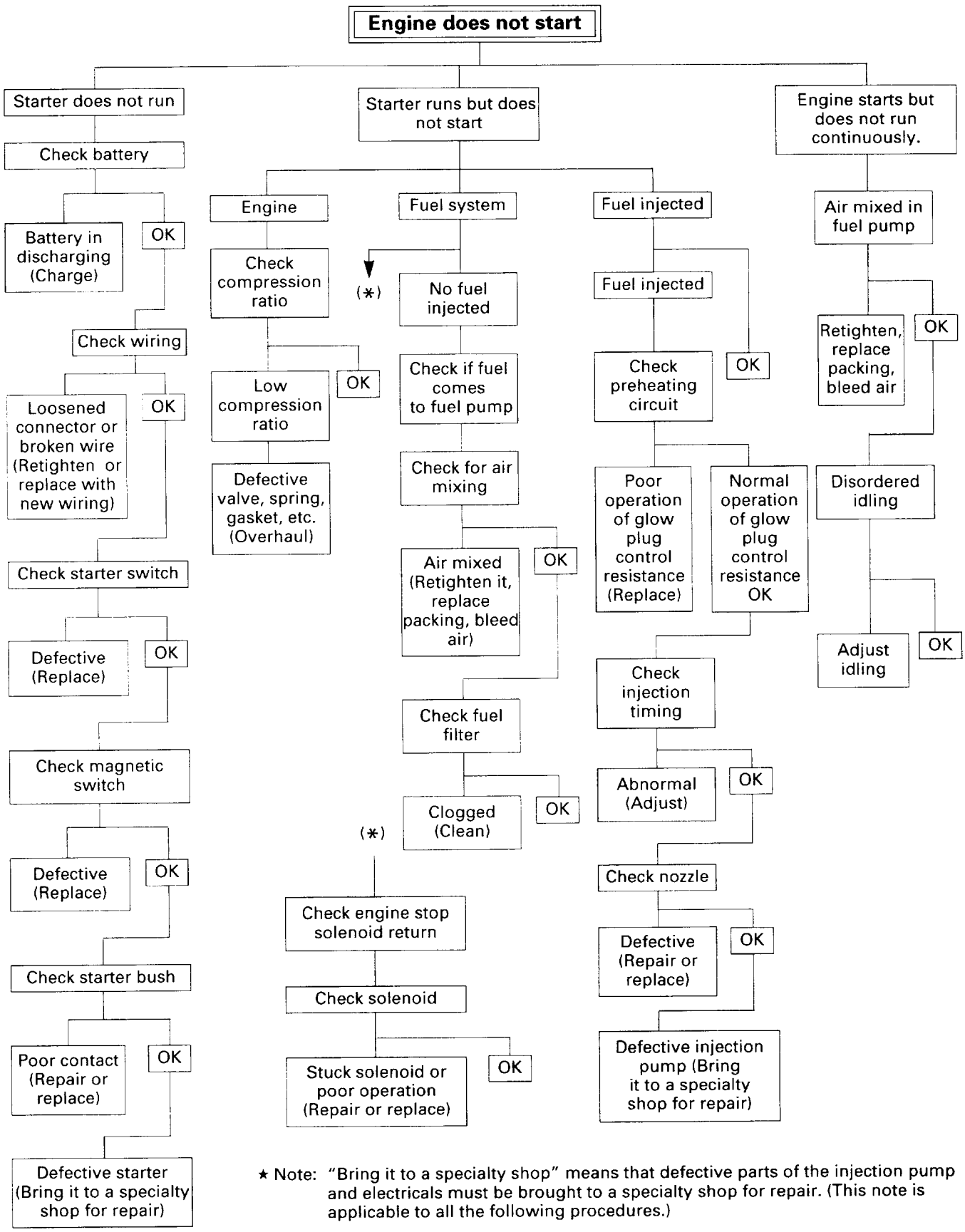
### Adjustment

For the adjustment of the injection pressure and the spray condition of fuel, refer to Section 1 "INSPECTION AND SERVICE."

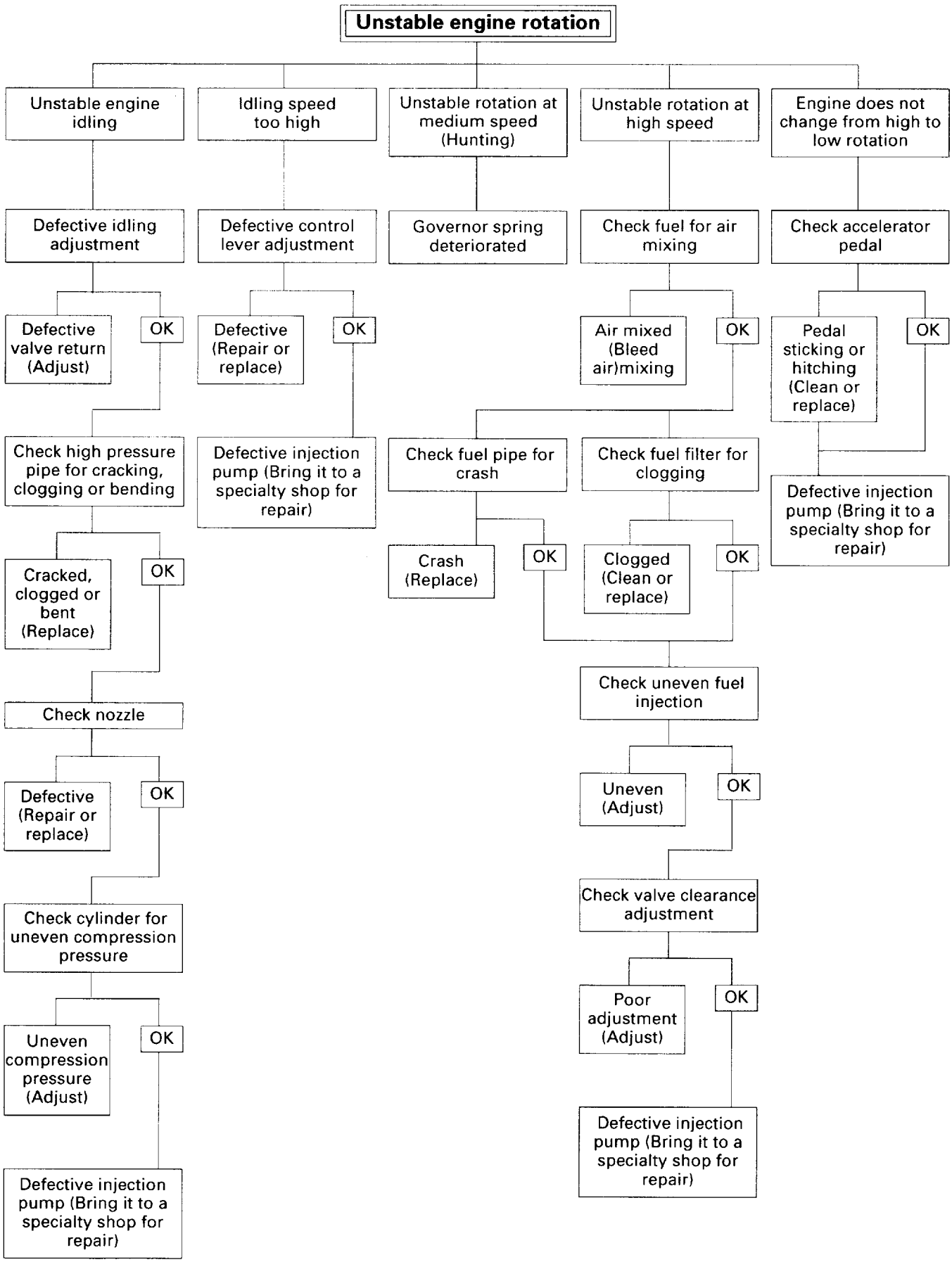
## MEMO

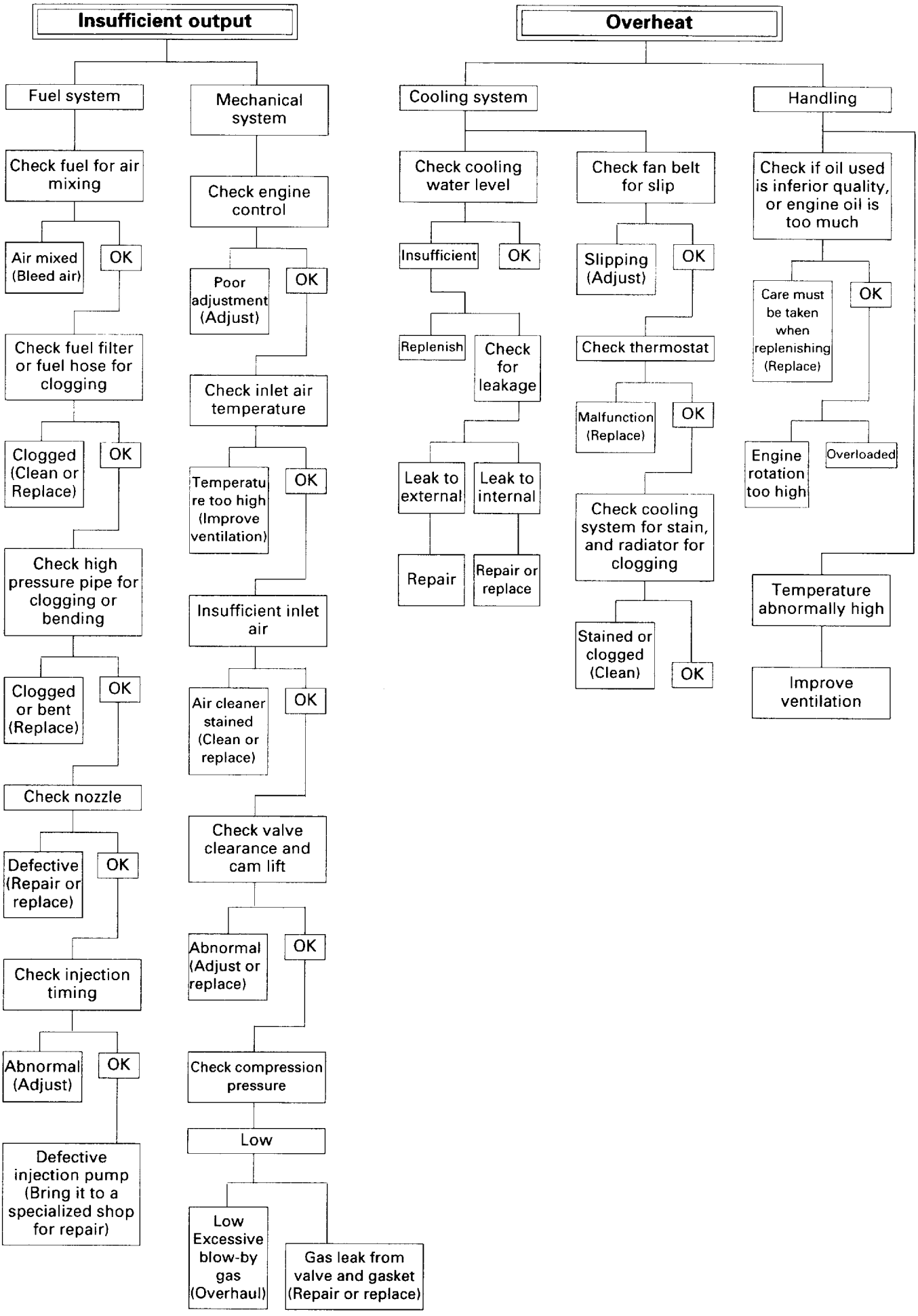
# SECTION 6

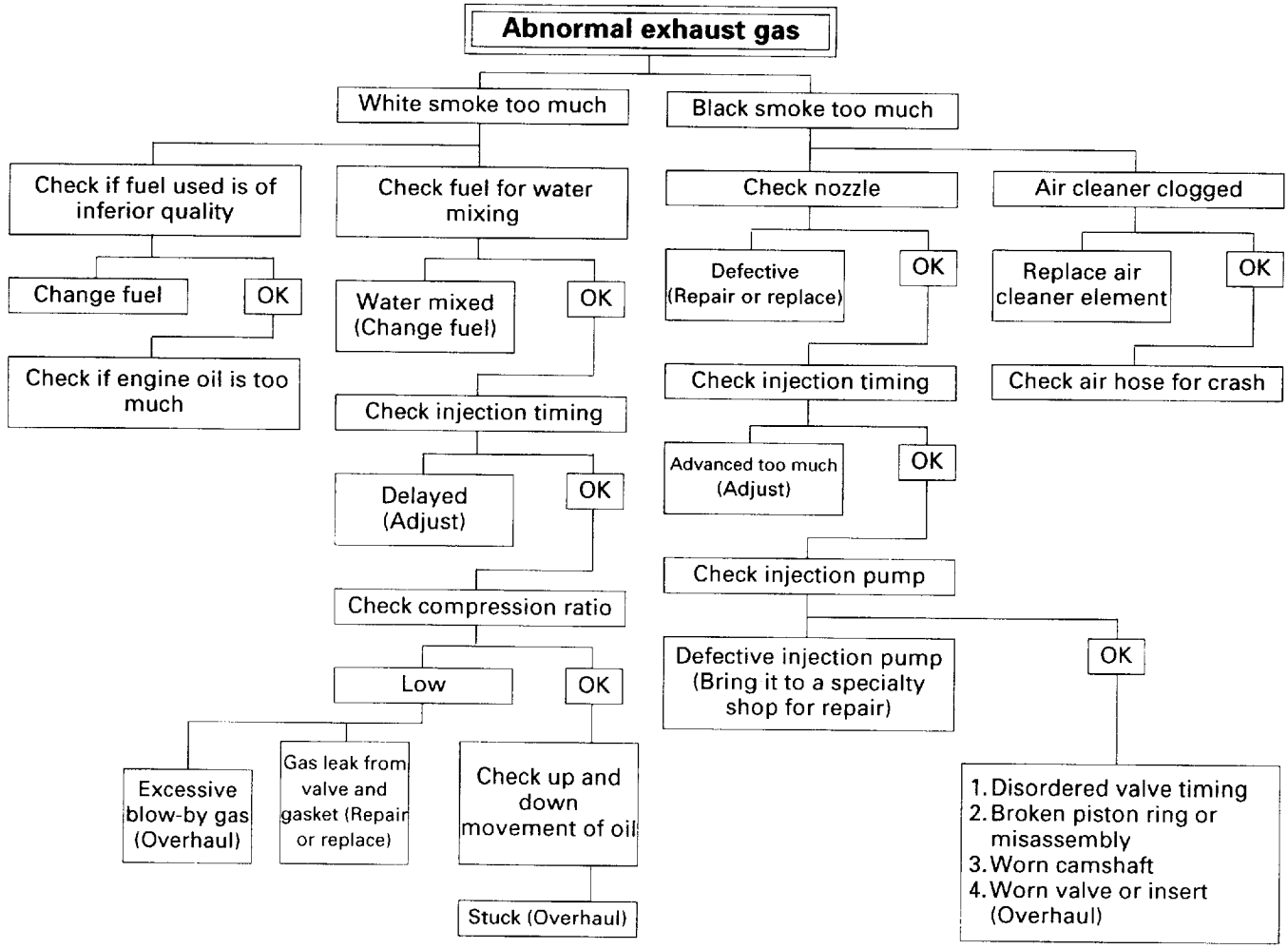
# TROUBLESHOOTING

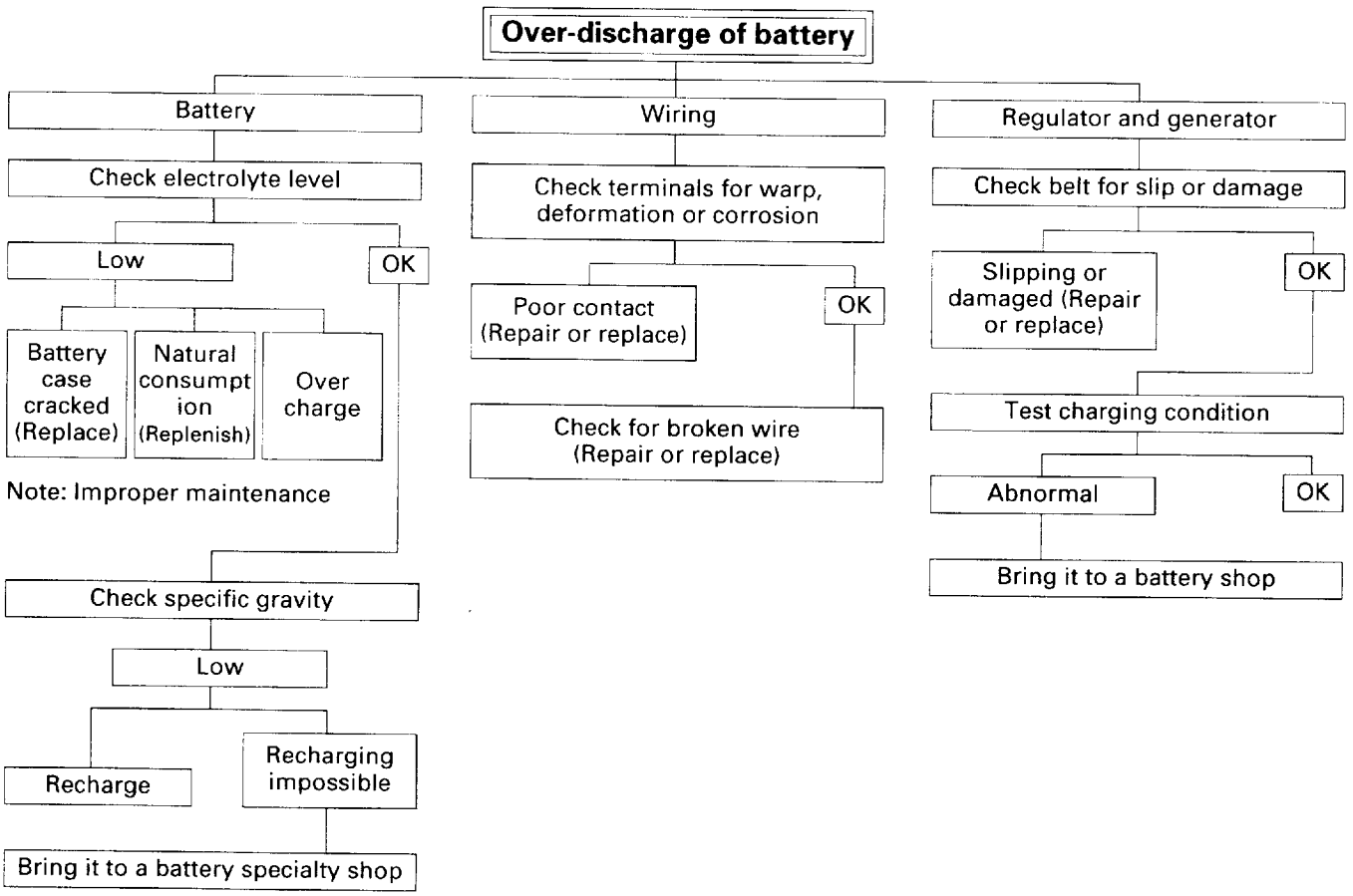


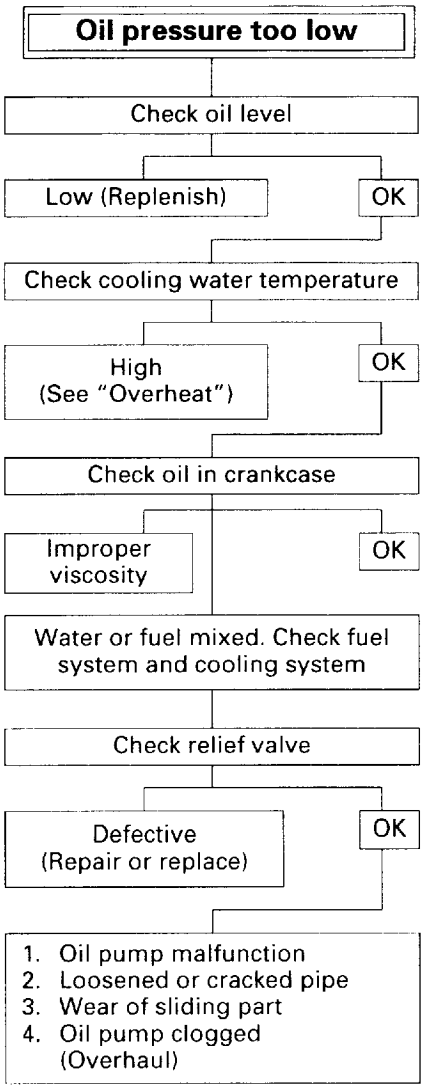

★ Note: "Bring it to a specialty shop" means that defective parts of the injection pump and electricals must be brought to a specialty shop for repair. (This note is applicable to all the following procedures.)

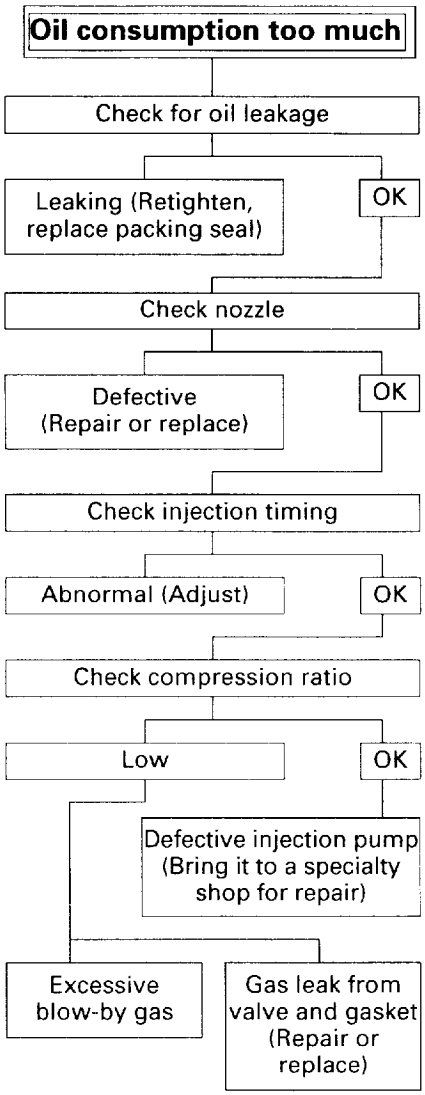

Unstable engine rotation
Unstable engine idling
Idling speed too high
Unstable rotation at medium speed (Hunting)
Unstable rotation at high speed
Engine does not change from high to low rotation
Defective idling adjustment
Defective control lever adjustment
Governor spring deteriorated
Check fuel for air mixing
Check accelerator pedal
Defective valve return (Adjust)
OK
Defective (Repair or replace)
OK
Air mixed (Bleed air)mixing
OK
Pedal sticking or hitching (Clean or replace)
OK
Check high pressure pipe for cracking, clogging or bending
Defective injection pump (Bring it to a specialty shop for repair)
Check fuel pipe for crash
Check fuel filter for clogging
Defective injection pump (Bring it to a specialty shop for repair)
Cracked, clogged or bent (Replace)
OK
Crash (Replace)
OK
Clogged (Clean or replace)
OK
Check nozzle
Check uneven fuel injection
Defective (Repair or replace)
OK
Uneven (Adjust)
OK
Check cylinder for uneven compression pressure
Check valve clearance adjustment
Uneven compression pressure (Adjust)
OK
Poor adjustment (Adjust)
OK
Defective injection pump (Bring it to a specialty shop for repair)
Defective injection pump (Bring it to a specialty shop for repair)

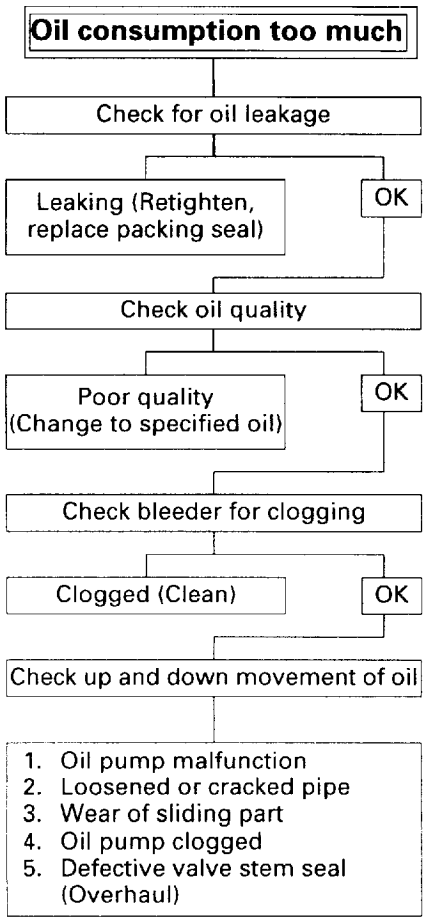

Insufficient output
Fuel system
Check fuel for air mixing
Air mixed (Bleed air)
OK
Check fuel filter or fuel hose for clogging
Clogged (Clean or Replace)
OK
Check high pressure pipe for clogging or bending
Clogged or bent (Replace)
OK
Check nozzle
Defective (Repair or replace)
OK
Check injection timing
Abnormal (Adjust)
OK
Defective injection pump (Bring it to a specialized shop for repair)
Mechanical system
Check engine control
Poor adjustment (Adjust)
OK
Check inlet air temperature
Temperatu re too high (Improve ventilation)
OK
Insufficient inlet air
Air cleaner stained (Clean or replace)
OK
Check valve clearance and cam lift
Abnormal (Adjust or replace)
OK
Check compression pressure
Low
Low Excessive blow-by gas (Overhaul)
Gas leak from valve and gasket (Repair or replace)
Overheat
Cooling system
Check cooling water level
Insufficient
OK
Replenish
Check for leakage
Leak to external
Leak to internal
Repair
Repair or replace
Check fan belt for slip
Slipping (Adjust)
OK
Check thermostat
Malfunction (Replace)
OK
Check cooling system for stain, and radiator for clogging
Stained or clogged (Clean)
OK
Handling
Check if oil used is inferior quality, or engine oil is too much
Care must be taken when replenishing (Replace)
OK
Engine rotation too high
Overloaded
Temperature abnormally high
Improve ventilation


Abnormal exhaust gas
White smoke too much
Black smoke too much
Check if fuel used is of inferior quality
Check fuel for water mixing
Check nozzle
Air cleaner clogged
Change fuel
OK
Water mixed (Change fuel)
OK
Defective (Repair or replace)
OK
Replace air cleaner element
OK
Check if engine oil is too much
Check injection timing
Check injection timing
Check air hose for crash
Delayed (Adjust)
OK
Advanced too much (Adjust)
OK
Check compression ratio
Check injection pump
Low
OK
Defective injection pump (Bring it to a specialty shop for repair)
OK
Excessive blow-by gas (Overhaul)
Gas leak from valve and gasket (Repair or replace)
Check up and down movement of oil
1. Disordered valve timing
2. Broken piston ring or misassembly
3. Worn camshaft
4. Worn valve or insert (Overhaul)
Stuck (Overhaul)

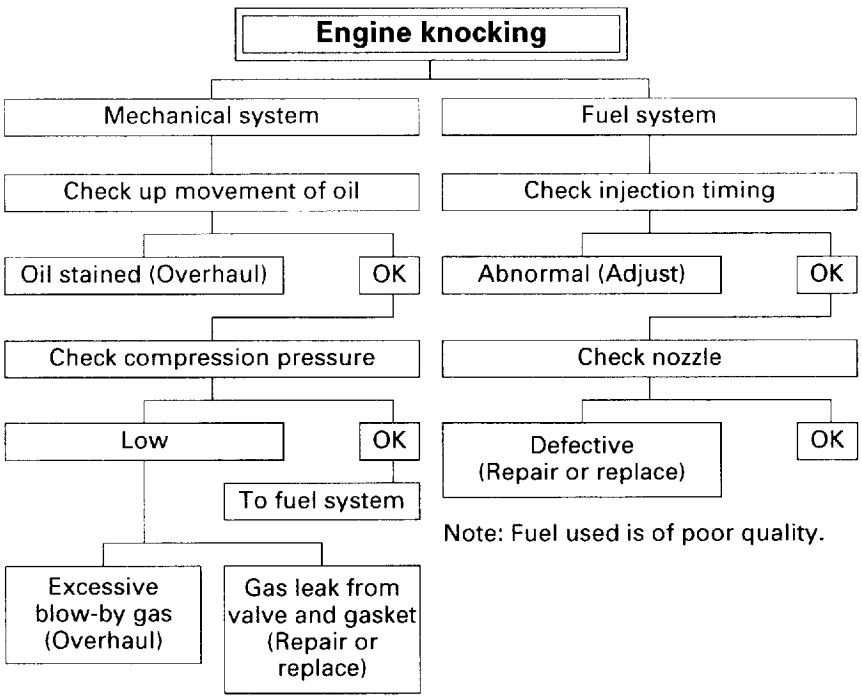

Over-discharge of battery
Battery
Wiring
Regulator and generator
Check electrolyte level
Check terminals for warp, deformation or corrosion
Check belt for slip or damage
Low
OK
Poor contact (Repair or replace)
OK
Slipping or damaged (Repair or replace)
OK
Battery case cracked (Replace)
Natural consumption (Replenish)
Over charge
Check for broken wire (Repair or replace)
Test charging condition
Note: Improper maintenance
Abnormal
OK
Check specific gravity
Bring it to a battery shop
Low
Recharge
Recharging impossible
Bring it to a battery specialty shop




(*) Worn bore,and worn or broken ring (Measure compression pressure, and check entrance of dust)



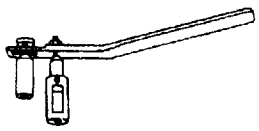
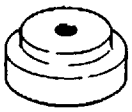
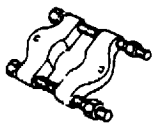
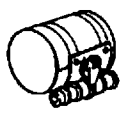

Note: Fuel used is of poor quality.

## MEMO

## SECTION 7

# SPECIAL TOOLS

The alphanumeric codes in parentheses "( )" are part numbers assigned by special tool manufacturers.

| No. | Illustration | Part Number | Part Name | Page |
|---|---|---|---|---|
| 1. |  | | Valve spring compressor | — |
| 2. |  | 5-8840-2061-0 | Setting: Oil seal front | — |
| 3. |  | 5-8840-9004-0 (JKM-1006) | Setting: Oil seal rear | — |
| 4. |  | 5-8840-0007-0 (J-8092) | Drive handle | — |
| 5. |  | 5-8840-9007-0 (JKM-1009) | Setting: Valve guide seal | — |
| 6. |  | 5-8840-0015-0 (J-22912-01) | Remover bearing | — |
| 7. |  | 5-8840-2008-0 (J-29762) | Compression gauge | |
| 8. |  | 5-8840-2009-0 (J-26999-20) | Adapter: Compression gauge | |
| 9. |  | 5-8840-9015-0 (JKM-9004) | Oil filter wrench | |
| 10. |  | 5-8840-9016-0 (J-28829) | Tester: Nozzle | |
| 11. |  | 5-8840-9018-0 (J-8037) | Piston ring compressor | |

## MEMO

## SECTION 8

# CONVERSION TABLE

### TABLE OF CONTENTS



## 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 |

## 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 |

## 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 |

## PRESSURE

### POUNDS PER SQUARE INCHES TO KILOGRAMS PER SQUARE CENTIMETERS

| lb/in² | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | lb/in² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (psi) | kg/cm² | kg/cm² | kg/cm² | kg/cm² | kg/cm² | kg/cm² | kg/cm² | kg/cm² | kg/cm² | kg/cm² | (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/cm² | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | kg/cm² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | lb/in²(psi) | lb/in²(psi) | lb/in²(psi) | lb/in²(psi) | lb/in²(psi) | lb/in²(psi) | lb/in²(psi) | lb/in²(psi) | lb/in²(psi) | lb/in²(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/cm² | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | kg/cm² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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/cm² | kg/cm² | kg/cm² | kg/cm² | kg/cm² | kg/cm² | kg/cm² | kg/cm² | kg/cm² | kg/cm² | |
| — | — | 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 |

## 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 |