NEW HOLLAND

E16 - E18

WORKSHOP MANUAL
ENGLISH

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SYMBOLS AND INDICATIONS

In this service manual, symbols and indications are used to draw the attention on important points for safety and quality.

SAFETY

This safety symbol is used for important safety message. When you see this symbol, be alert to the potential for personal injury. Strictly follow the recommended precautions.

INDICATIONS

Reading this service manual you can find indications as **"IMPORTANT"** or **"NOTE"** that have the following meaning:

- **IMPORTANT**
  Indicates a situation which, if not avoided, could caused damages to the machine.

- **Note**
  Indicates supplementary technical information or know-how.

visibly connected to the ground.

- The Electric Power Company, if previously advised and involved in the work, as well as machine Operator, Owner and/or any natural person or legal entity having rent or leased the machine or being responsible at the time by contract or by law, are liable for the adoption of the necessary precautions.
- Decrease work speed. Reaction time could be too slow and distance evaluation wrong.
- Warn all ground personnel to keep clear of the machine and/or load at all times. If the load has to be guided down for laying, consult the Electric Power Company to know which precautions should be taken.
- Appoint a person in charge of signalling duties. This person will have the responsibility of observing the machine, any part of it and/or the load approaching the electric lines from a standpoint more favourable than the Operator's. This signal man (flag-man) must be in direct communication with the Operator and the Operator must pay undivided attention to the signals supplied.

When working in or near pits, in ditches or very high walls, check that the walls are sufficiently propped up to avoid cave-in hazards.

Pay the utmost attention when working near overhang walls or where landslides may take place. Make sure that the support surface is strong enough to prevent landslides.

When digging, there is the risk of cave-ins and landslides.

Always check ground conditions and conditions of the material to be removed.

Support everywhere it is required to prevent possible cave-ins or landslides when:

- digging near previous trenches filled with material,
- digging in bad ground conditions,
- digging trenches subject to vibration from railroads, working machines or highway traffic.

STOPPING

When the machine is to be stopped for whatever reason, always check that all controls are in the neutral position and that the safety lever is on the lock position to guarantee risk-free start-up.

Never leave the machine unattended with the engine running.

Prior to leaving the driver's seat, and after making sure that all people are clear of the machine, slowly lower the attachment until resting it safely to the ground.

Retract possible auxiliary tools to the closed safety position.

Check that all controls are in the neutral position.

Move engine controls to the shut-down position.

Switch off the key-start switch.

Consult the Operation and Maintenance Instruction Manual.

Park the machine in a non-operating and no-traffic area.

Park on firm level ground. If this is not possible, position the machine at a right angle to the slope, making sure there is no danger of uncontrolled sliding.

If parking in traffic lanes cannot be avoided, provide appropriate flags, barriers, flares and other signals as required to adequately warn the oncoming drivers.

Always switch off the key-start switch before cleaning, repairing or servicing, or parking the machine to prevent accidental unauthorised start-up.

Never lower the attachment or auxiliary tools other than from sitting in the operator's seat.

Sound the horn. Make sure that nobody is within the machine operating range. Lower the attachment slowly.

Securely block and lock the machine every time you leave it unattended. Return keys to the safe place previously agreed upon.

Perform all necessary operations for stopping as detailed in the Operation and Maintenance Instruction Manual.

Drive the machine far from pits, trenches, rocky hanging walls, areas with overhead electric lines, and slopes before stopping it at the end of the working day.

Align the upperstructure to the tracks in order to allow to easily get on and off the driver's compartment.

Move all controls to the position specified for machine stopping. Refer the Operation and Maintenance Instruction Manual.

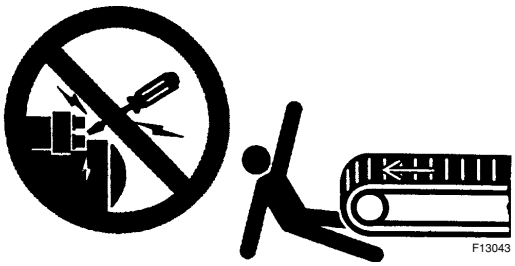
Never park on an incline without accurately blocking the machine to prevent unexpected movement.

Follow stopping instructions contained in the Operation and Maintenance Instruction Manual.

OPERATE ONLY FROM THE DRIVER'S SEAT

To start the motor with an unsuitable procedure may cause sudden movement of the machine with possibility to cause serious injuries or mortal incidents

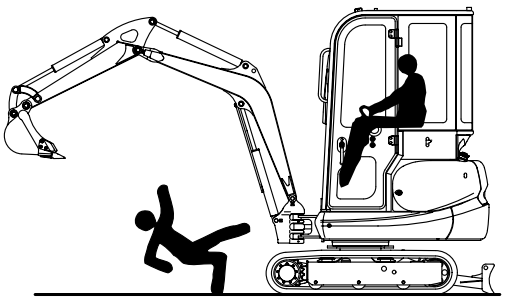
- start the engine only from the driver's seat.
- **NEVER** start the engine while standing on a shoe or on the ground.
- Do not start the engine by short circuiting between starter motor terminals.
- Before starting the engine, ensure that all control levers are in the neutral position.



DONT CARRY RIDERS ON THE MACHINE

Riders on the machine are subject to injuries such as being struck by foreign objects and being thrown off the machine.

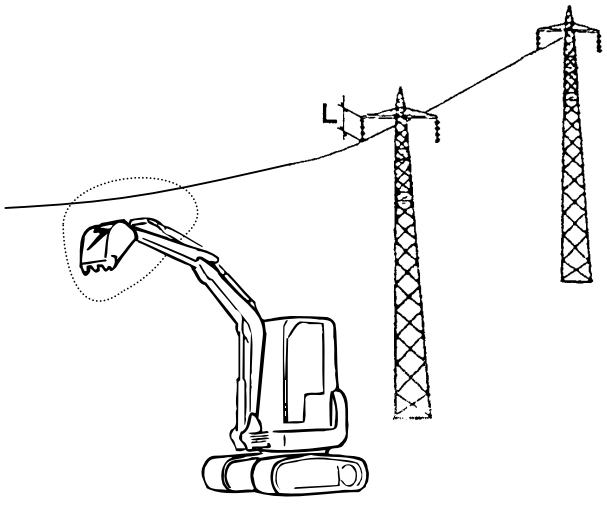
- Only machine operator is allowed on the machine. Keep riders off.
- Riders also obstruct the operator's visibility, resulting in the machine being operated unsafely.



AVOID ELECTRIC 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 plus twice the line insulator length (**L**).
- 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.



PRACTICE SAFE MAINTENANCE

Understand service procedures before doing work.

Keep work area clean and dry.

Never lubricate or service the machine while it is moving.
Keep hands, feet and clothing from power-driven parts.

Before servicing the machine, park the machine on a level surface.

If maintenance procedure must be performed with engine running, do not leave machine unattended.

If the machine must be raised, keep a 90 to 110° between 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.

Keep all parts in good condition and properly installed. Fix any damage immediately. Replace worn or broken parts.

Remove any building of grease, oil, or debris.
Disconnect the ground cable (-) from the batteries before servicing electrical systems or welding on the machine.

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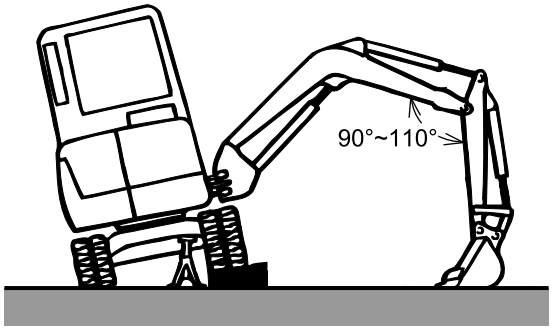

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SAFETY PRECAUTIONS

HANDLE FLUIDS - AVOID FIRES

Handle fuel with care; it is highly flammable.
Do not refuel the machine while smoking or near open flame or sparks.
Always stop engine before refueling machine. Fill fuel tank outdoors.

Store flammable fluids away from fire hazards.
Do not incinerate or puncture pressurized containers.

Make sure machine is clean of trash, grease, and debris.

Do not store oily rags; they can ignite and burn spontaneously.


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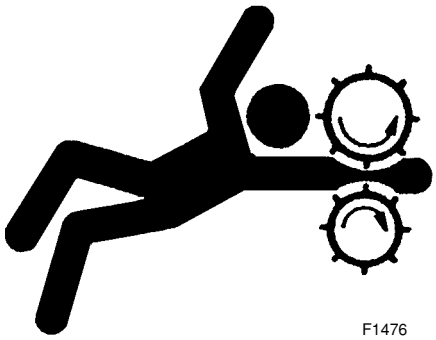
SERVICE MACHINE SAFELY

Tie long hair behing you head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.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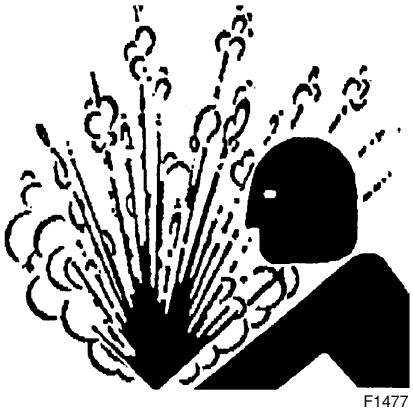
SERVICE COOLING SYSTEM SAFELY

Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands.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SECTION 3 PRELIMINARY REMARKS

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SECTION 4 SPECIFICATIONS

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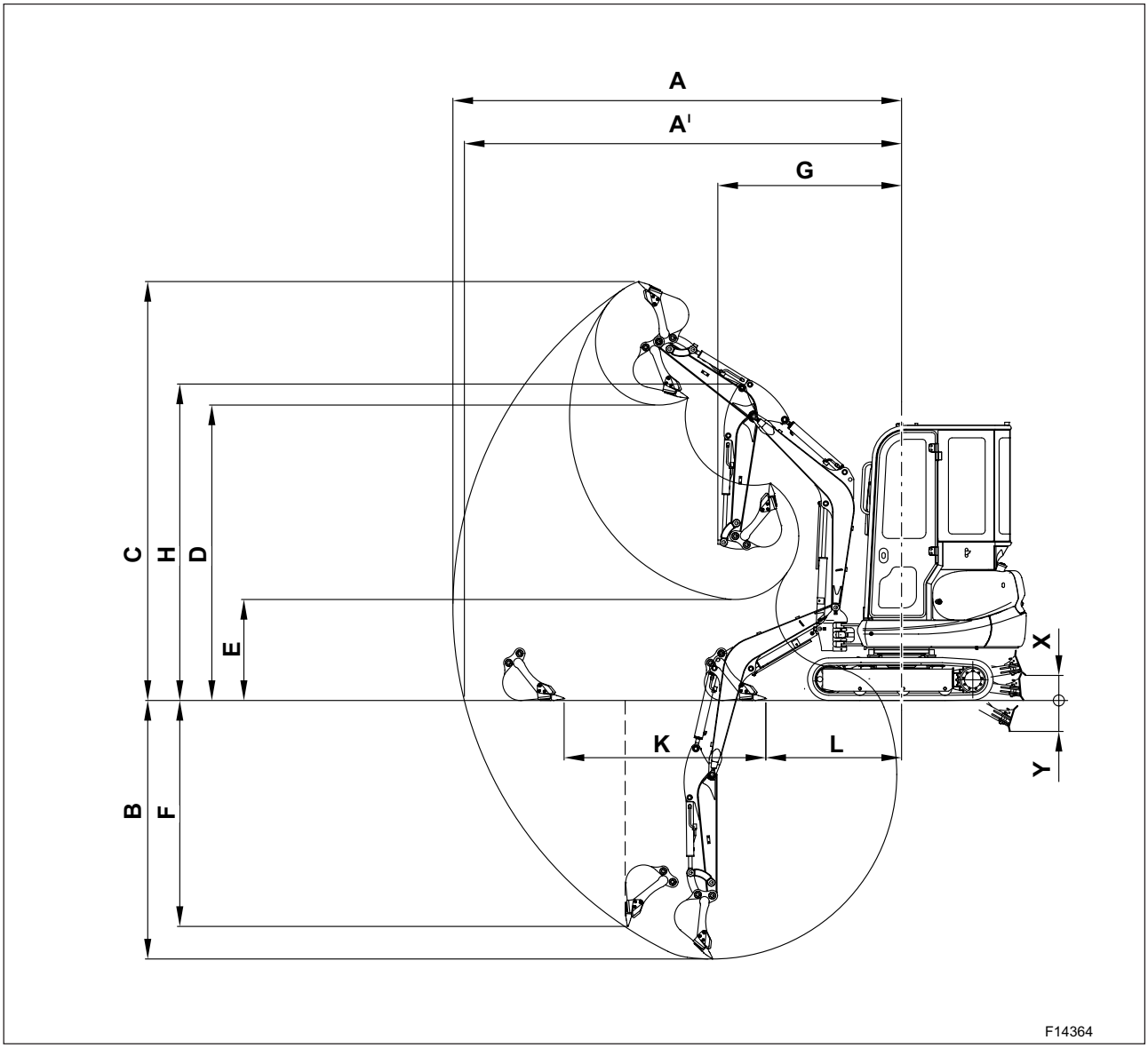
DIGGING PERFORMANCES (CAB)

With 0.044 m³ bucket



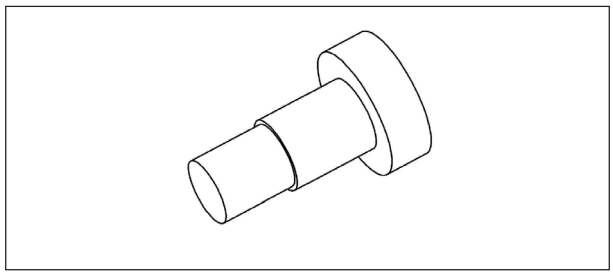
(Dimensions in mm)

ARM	1020	1220
A	3780	3970
A'	3683	3879
B	2178	2378
C	3530	3654
D	2490	2613
E	851	654
F	1904	2099
G	1548	1579
H	2667	2667
K	1699	1970
L	1143	1065
X	210	210
Y	270	270

TOOLS OF CYLINDERS

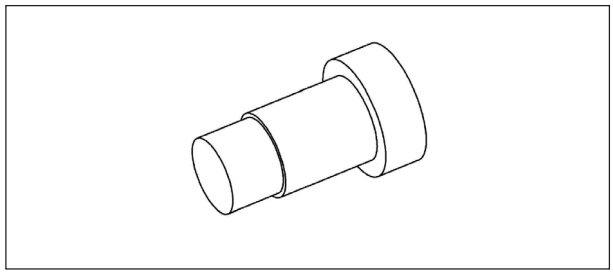
Head bushing installer (diam. 30 Boom, Bucket).
Part number 380001513

380001513



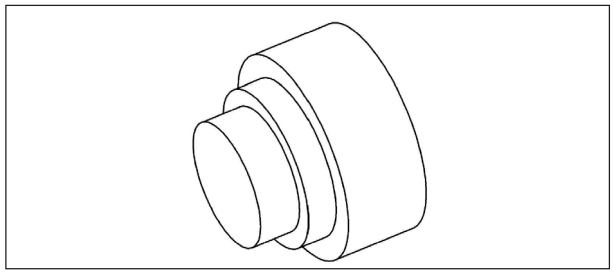
Head bushing installer (diam. 35, Arm, Dozer, Swing).
Part number 380001514

380001514



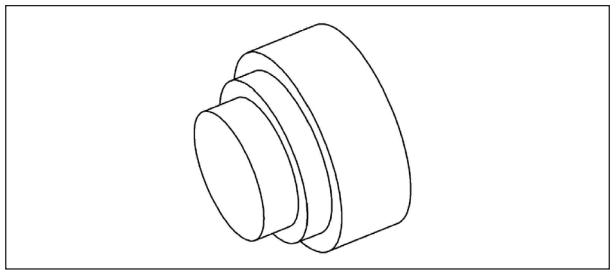
Pin bushing installer (diam. 30, Boom, Bucket).
Part number 380001515

380001515



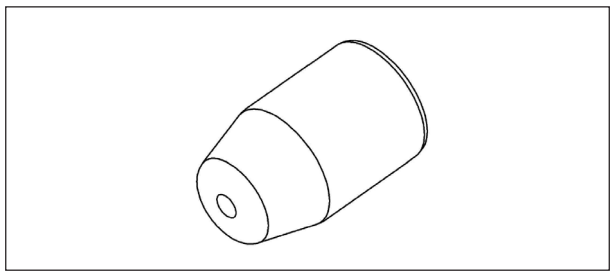
Pin bushing installer (diam. 35, Arm, Dozer, Swing).
Part number 380001516

380001516



Seal ring guide (Bucket).
Part number 380001517

380001517



PREFACE

Working Conditions

Technicians: One or more technicians qualified by Manufacturer as a first class service technician (with five years or more of field experience and having completed the training in the operation of vehicle type construction machinery) to be provided.

Facilities: General jigs, tools, apparatus, testers to be provided.
The maintenance workshop to be equipped with a good enough capacity of building with crane and inspection instruments necessary for specific self inspection activities.

Place: The workshop to be located on a flat land at which the work is able to perform and to which a service car or truck crane is accessible.

Applicable Range of Standard Maintenance Time

- Standard maintenance time: Direct maintenance time plus spare time.
- Direct maintenance time: Net time actually spent for maintenance.
- Spare time: Time for transportation of the machine for maintenance, preparation for safety work, meeting for the work and physiological time for the needs of body.

Excluded Time
(not included in the standard maintenance time)

Repairing time:
Time for machining, sheet metal processing, welding, gas cutting, removing broken screw, taking care of parts and painting.

Items excluded from maintenance time because of uncertainly in time:
Receiving the vehicle into shop,transportation, delivery, final inspection and investigation of causes for trouble, diagnosis and inspection.

Indirect time: Time for field work, preparation of required parts, etc., before starting work, going to and from the site, waiting due to user's convenience at the site and paper work for reports, bills, etc.

Special time: Working time at early morning, at mid night and on holidays shall be separately calculated.

Separate calculation:
The cost for service cars, trucks with crane and truck cranes shall be separately calculated.

Applicable Machine for Estimation of Standard Maintenance Time

- Standard machine.
- A well maintained machine combined with standard attachments which has operated in a normal circumstances.

HOW TO USE MAINTENANCE STANDARDS AND PRECUATIONS

Application

• For New Machine;
This manual is to be used to confirm the actual performance and functions of the machine compared with the PERFORMANCE STANDARDS.

• At Specific Self-Inspection (as per LOCAL RULES);
The maintenance standards are used to make them as the criteria to determine the time for reconditioning, adjustment and replacement.

• At Deterioration of Performance;
This manual is of the criteria of safe and economical judgment whether the deterioration of performance on the machine would be caused by any faults or normal deterioration due to machine operation for a long period.

• For Replacement of Major Components;
This manual is of the standard to determine the time for replacement to recover the performance of major components such as pump, etc.

Terminology

• Standard Values:
These are of the standard values to assemble and regulate a new machine. Where special notes are not given, these values are based on the machine with standard structure (the machine with standard attachments and shoes).

• Standard Values for Repair:
These are of the values at which the reconditioning is required.
In order to ensure the performance and safety, it is strictly prohibited to use the machine with the parts and components being over the standard values.

• Serviceability Limit:
This is of the service limit for each part and component at which the reconditioning is impossible and they must be replaced to new ones.
All the parts and components which are estimated to exceed the serviceability limit up to the next periodical inspection and maintenance, should be also replaced to new ones.
The machine operation with the parts and components which have exceeded the serviceability limit, causes increase of troubles and down-time of the machine, and also causes safety problems.

Precautions for Judgment:

• Evaluation for Measured Data:
It is inevitable some variation on the measured data due to differences between measuring conditions, peculiar variability on a new machine, old and new versions of the machine and measuring characteristics.
The judgment for the measured data should be comprehensively conducted based on the extent of level of the measured data, instead of mere comparison with the standard values.

• Determination for Reconditioning, Adjustment or Replacement:
There are two kinds of deterioration of machine performance; one is due to normal wear with time elapsing of operation, and the other is recoverable to the standard values with the adjustment for pressure, etc.
Therefore, the determination for reconditioning, adjustment or replacement should be conducted taking various factors into consideration such as operating hours, working conditions and maintenance conditions of the machine, so that the machine is able to be operated at the optimum performance level.

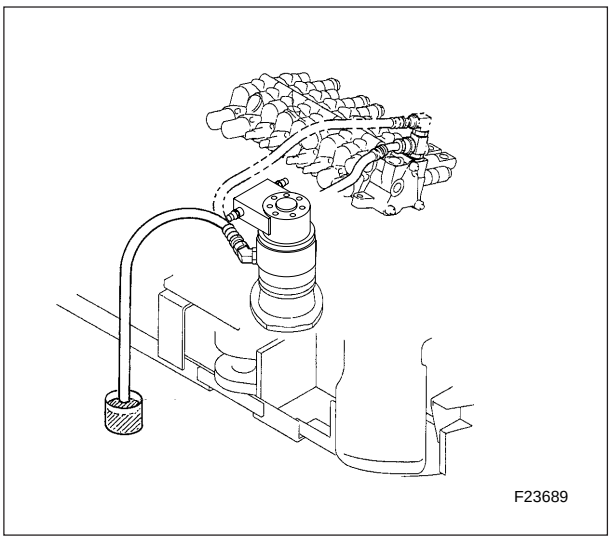
Other Precautions

• Parts with Aging Effect:
The rubber products such as hydraulic hoses, O-rings, oil seals, etc. are deteriorated with the aging effect. It is necessary to replace them to new ones at periodical intervals or at every overhaul.

• Parts required Periodical Replacement:
It is recommendable to designate the important hoses critical to secure the safety as Very Important Parts (V.I.P.),x!nd periodically replace with new ones.

• Inspection & Replacement of Lubricants:
It is necessary for the user of the machine to fully familiarize himself with the procedures and precautions to handle the machine in safe and carry out the maintenance, as well as the procedures for inspection and lubrication. Refer to the OPERATION & MAINTENANCE MANUAL as well.

DRAIN RATE OF TRAVEL MOTOR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- Preparation
  Stop the engine, and release air inside the hydraulic oil tank.
  Disconnect the slew motor drain hose at the return side to the hydraulic oil tank. Then receive the drain oil to a container. Install plug on bore of tank after removing drain hose.

- Measurement:
  Engine: At rated speed
  Hydraulic oil temp.: 50 ~ 60 °C
  Machine posture : Pushing a fixture with the side of bucket, operating the engine.
  Measure the drained volume of oil for 30 seconds relieving at full stroke of the slewing operation.

Unit : liter / 30 sec

DRAIN RATE OF TRAVEL MOTOR		
Standard value	Standard value for repair	Serviceability limit
0.15	0.23	0.30

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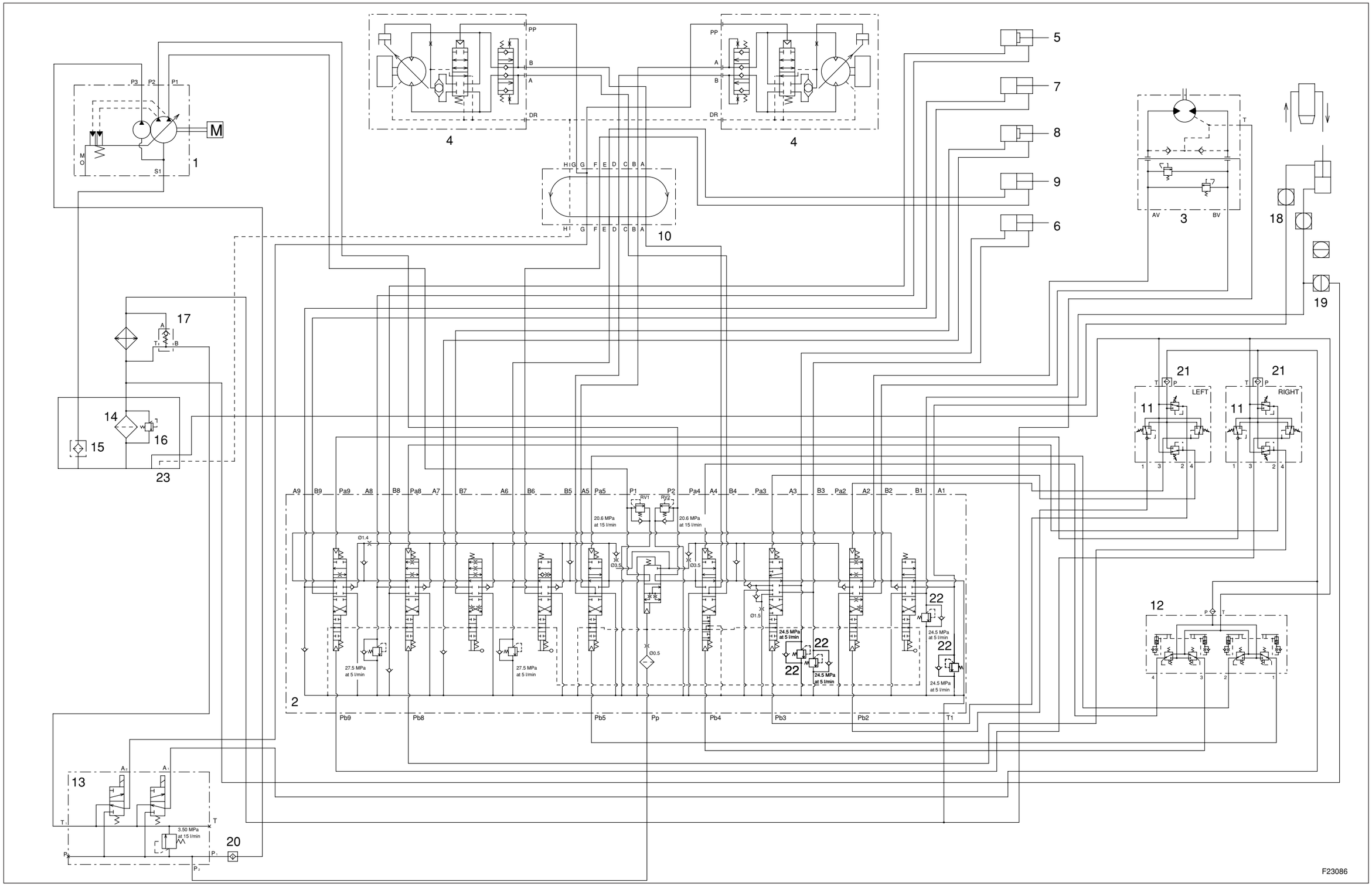
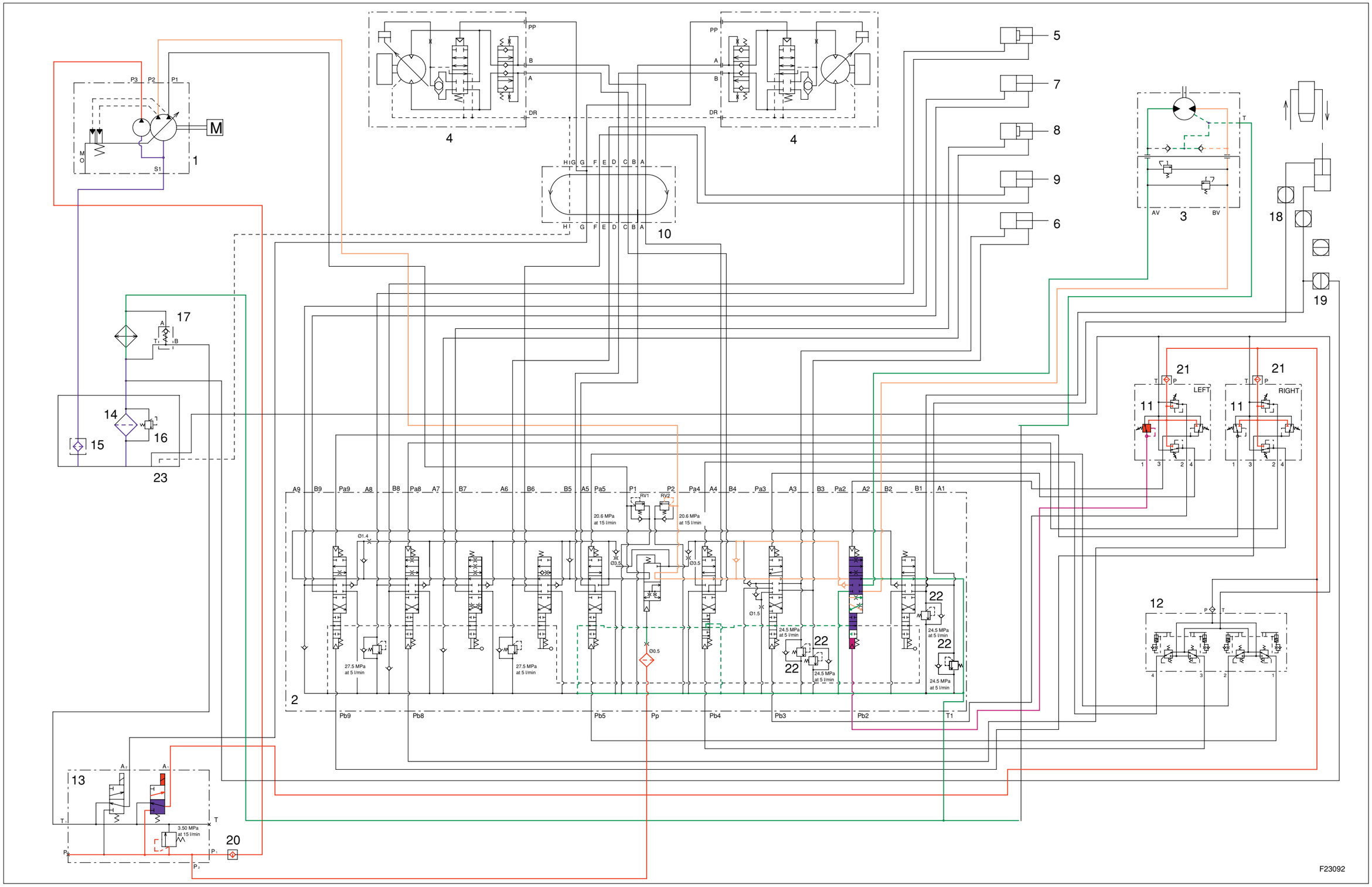
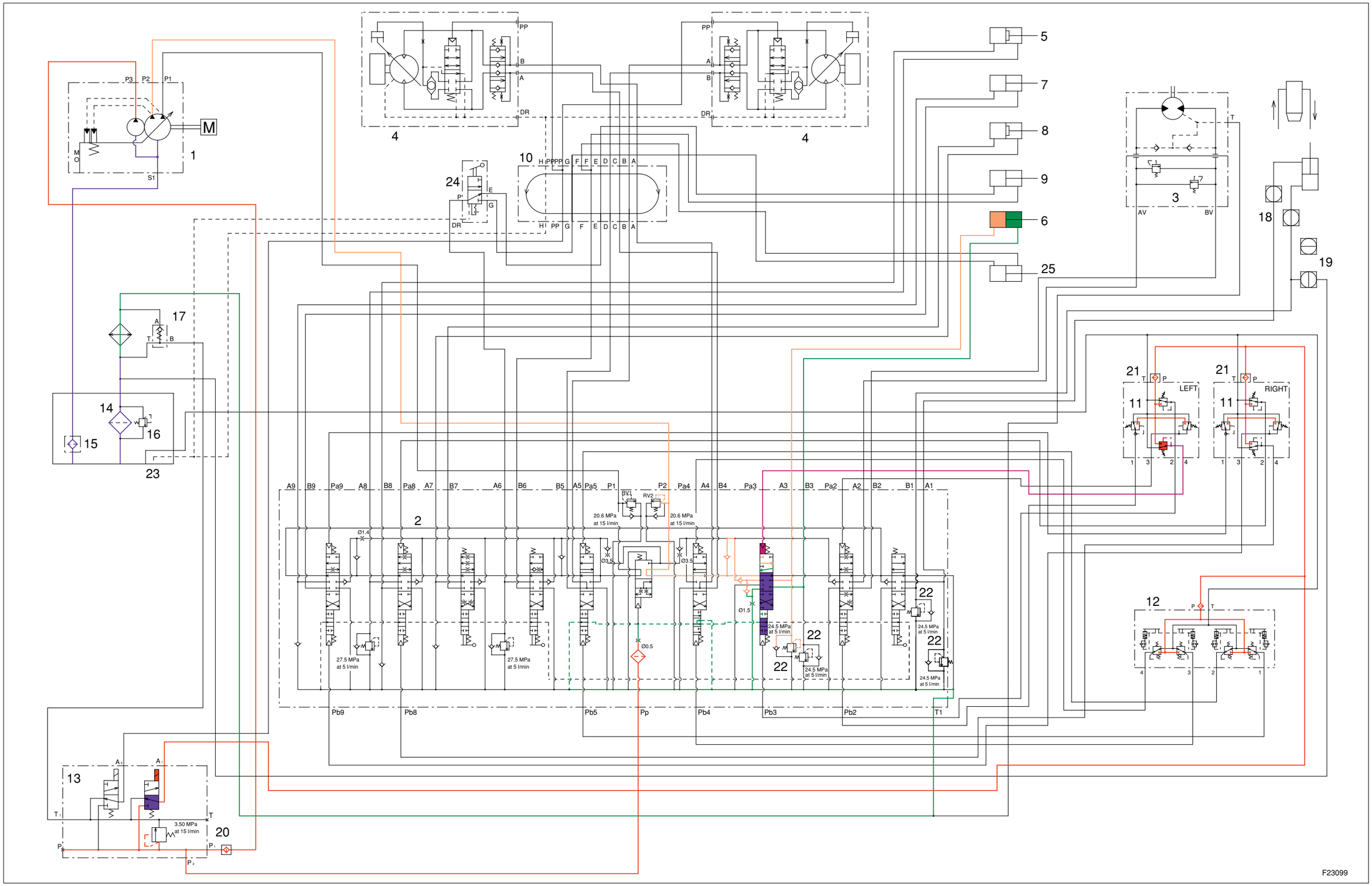
RIGID CRAWLER FRAME



SLEW LEFT OPERATING CIRCUIT (RIGID CRAWLER FRAME)



ARM OPERATING CIRCUIT (ADJUSTABLE CRAWLER FRAME WIDTH)



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NIBBLER / BREAKER OPERATING CIRCUIT

The operation is conducted by the operating pedal, which drives the cable to operate valve.

NIBBLER (CLOSE) OPERATING CIRCUIT

Nibbler Operation

Press the left side of the control pedal, and the cable is pulled and consequently the service (nibbler / breaker) valve spool of control valve (**2**) is Shifted. Since the pilot oil pressure is not utilized for it, as the same case as the dozer, it is activated regardless to the safety lock lever.

Main Circuit

- Supply Circuit for Nibbler Cylinder
  The discharged oils from P1 and P2 ports on the variable pump flow into P1 and P2 ports on the control valve (**2**), and join together at the point before the service valve. The pressurized oil discharged from B1 port through the service valve, is supplied to head side of the nibbler cylinder to close the nibbler.

BREAKER ON OPERATING CIRCUIT

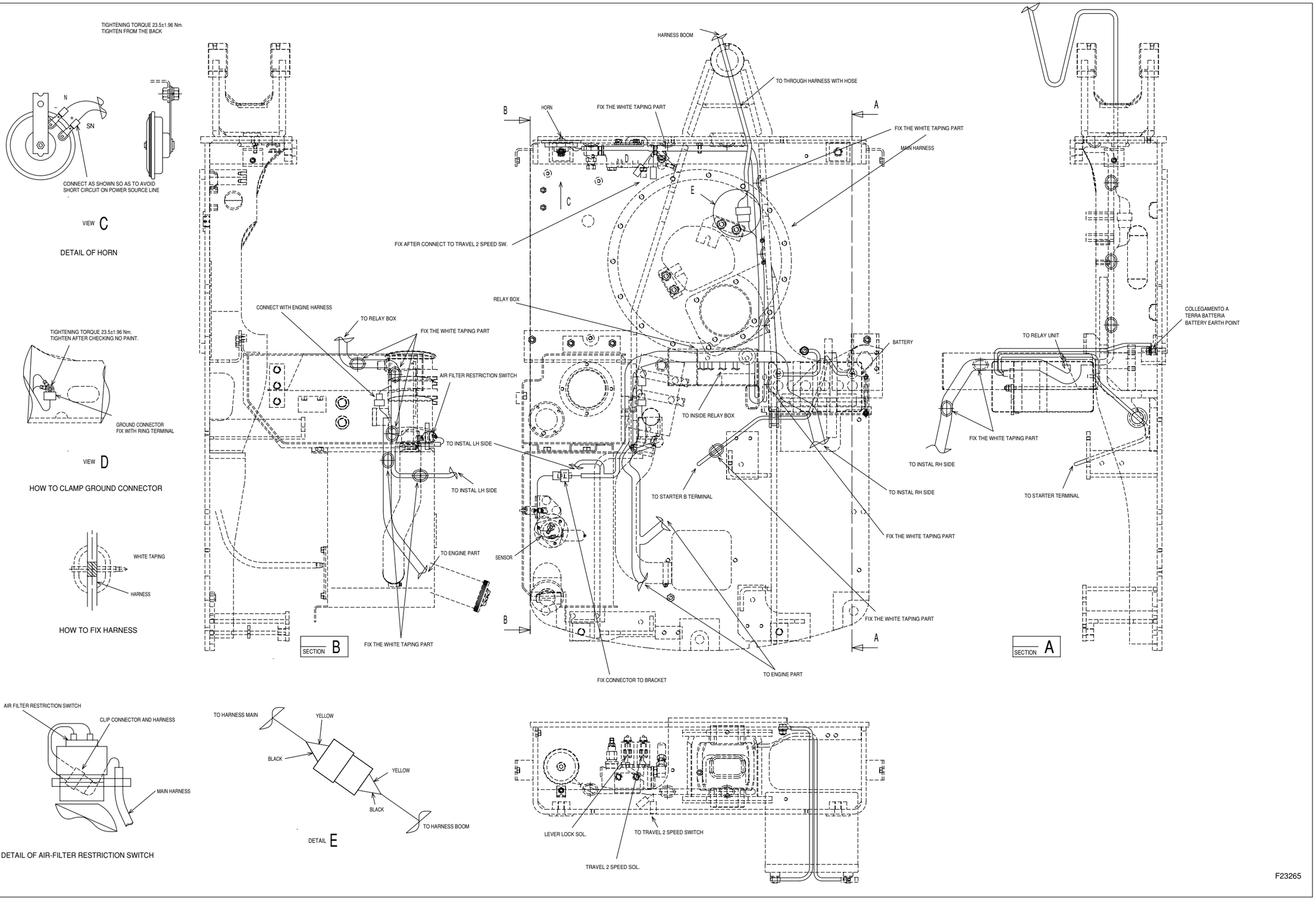
Breaker Operation

Press the right side of the control pedal, and the cable is pushed and consequently the service (nibbler / breaker) valve spool of control valve (**2**) is Shifted. Since the pilot oil pressure is not utilized for it, as the same case as the dozer, it is activated regardless to the safety lock lever.

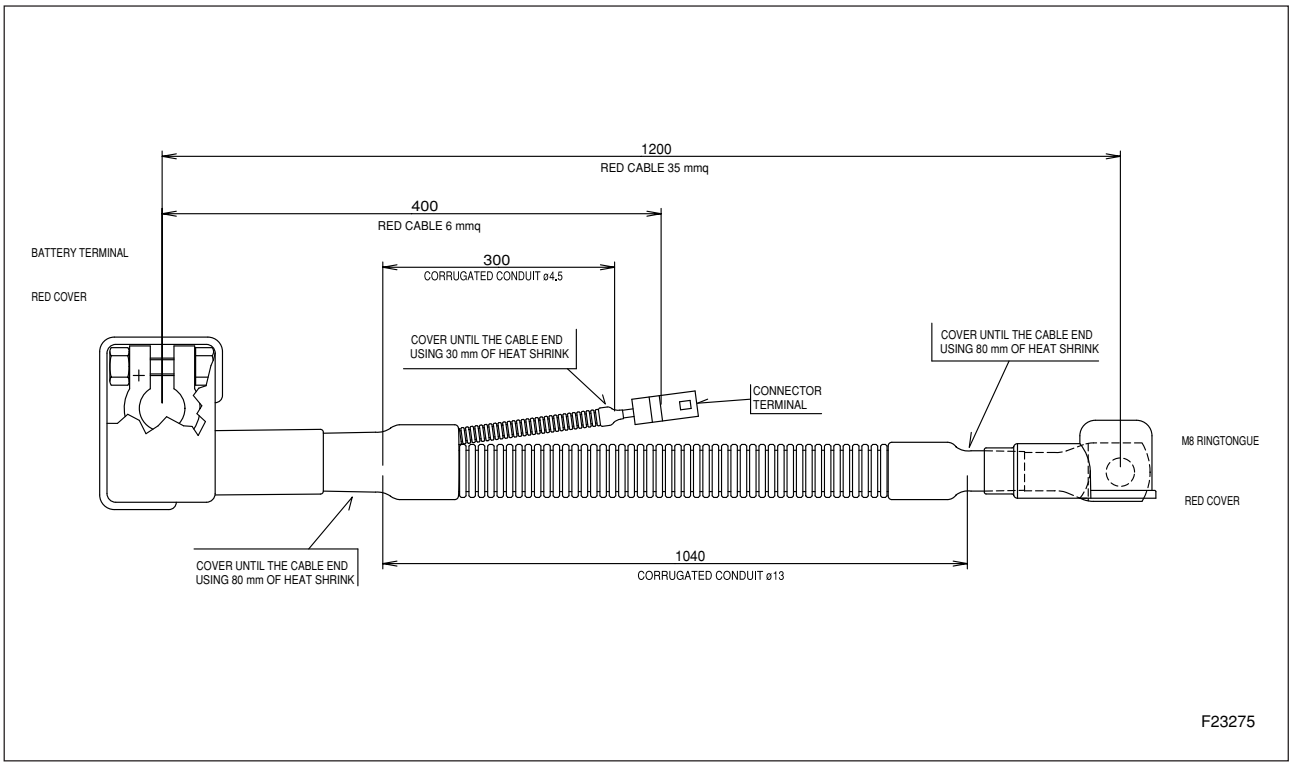
Main Circuit

The discharged oils from P1 and P2 join together in the control valve (**2**). The pressurized oil discharged from A1 port through the service valve enters into the breaker to operate it. The return oil returns to the hydraulic oil tank (**23**) through the stop valve (**18**) which is switched to the breaker side.

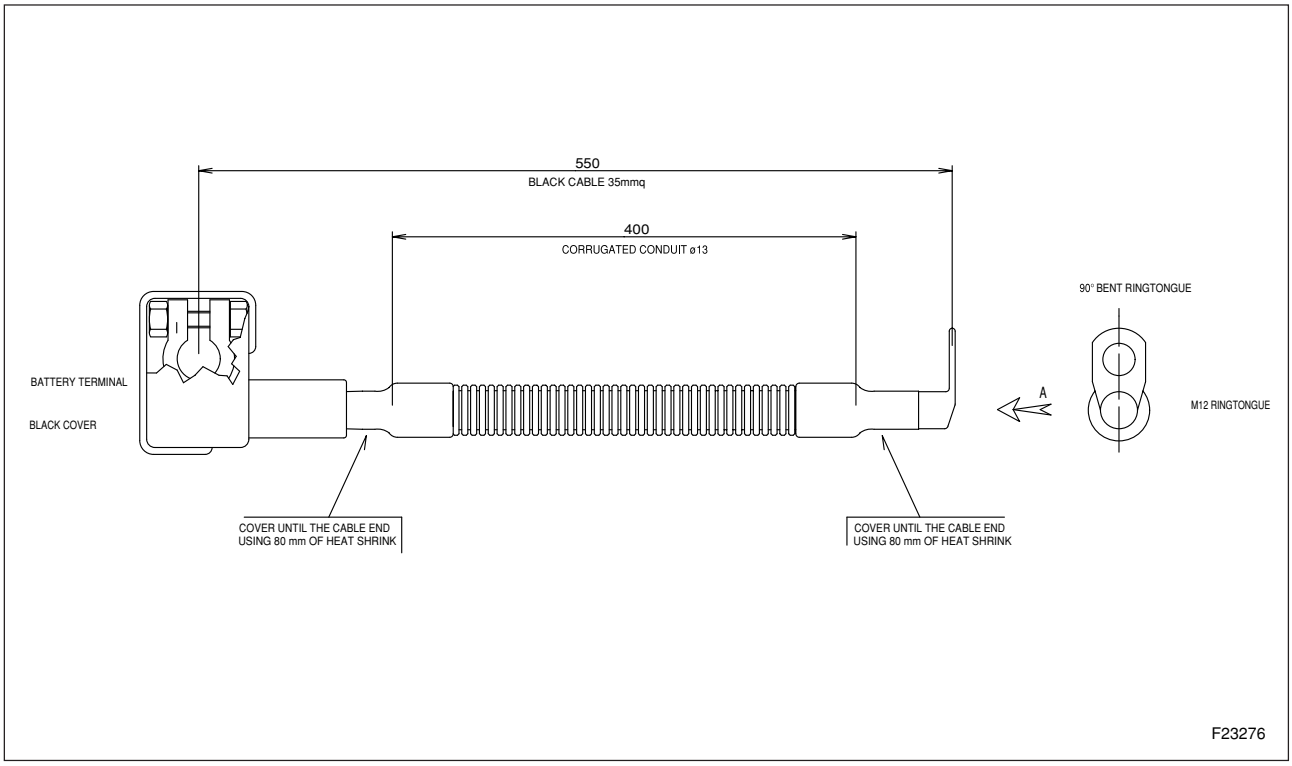
HARNESS ASSY, UPP



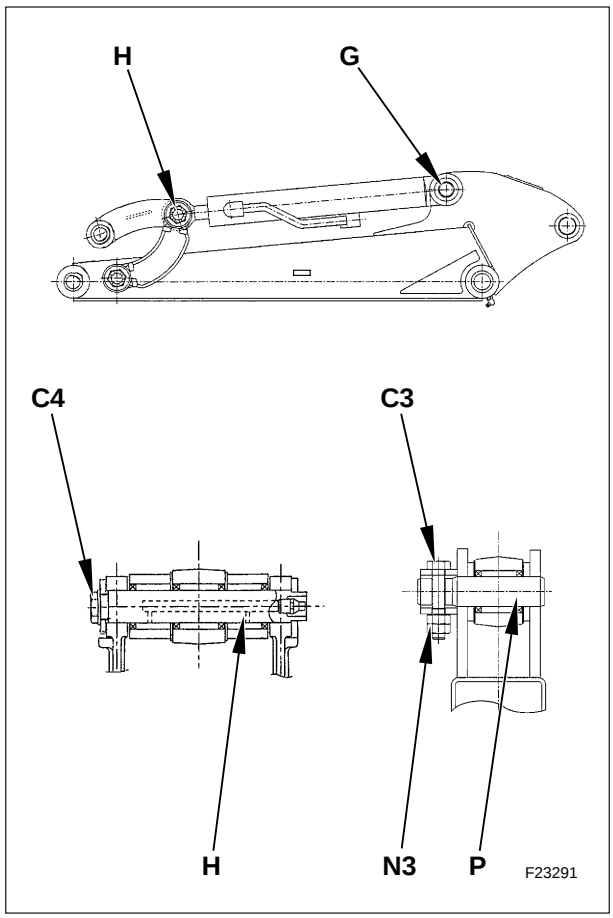
BATTERY CABLE (+)



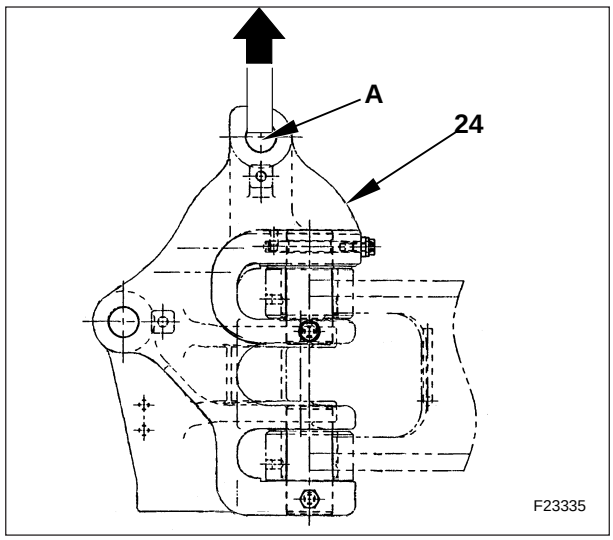
BATTERY CABLE (-)



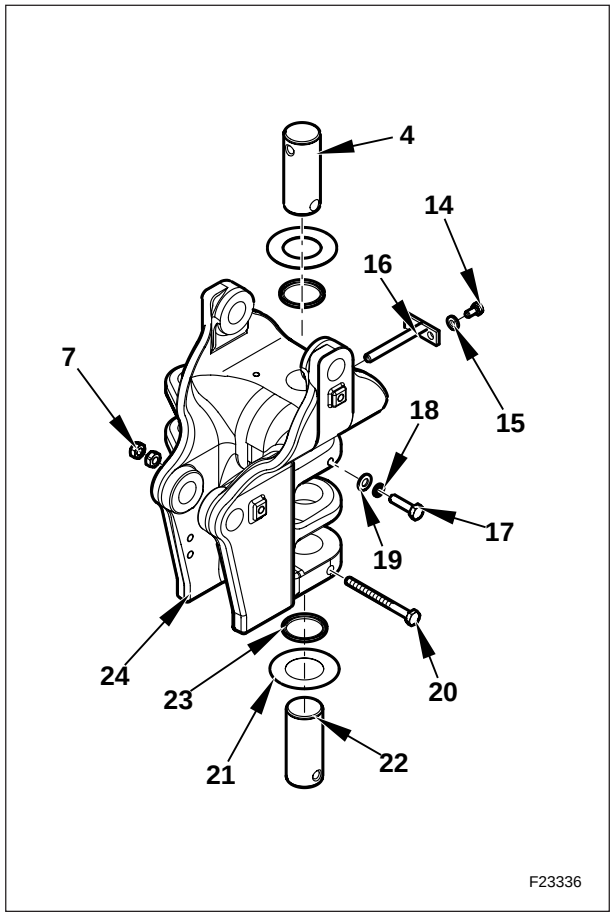
5. Removal of bucket cylinder
- Remove the capscrew (**C4**) that is preventing the rod pin (**H**) from coming out, then pull off the pin (**H**).
- Remove the capscrew (**C3**)and nuts (**N3**) that are preventing the head pin (**G**) from coming out, then pull off the pin (**G**).
- Apply a nylon sling to the tube of bucket cylinder, and remove the cylinder.
  Weight: 9 kg



3. Install the boom foot pin (**A**) to the original position on swing bracket (**24**), then temporarily lift it up.

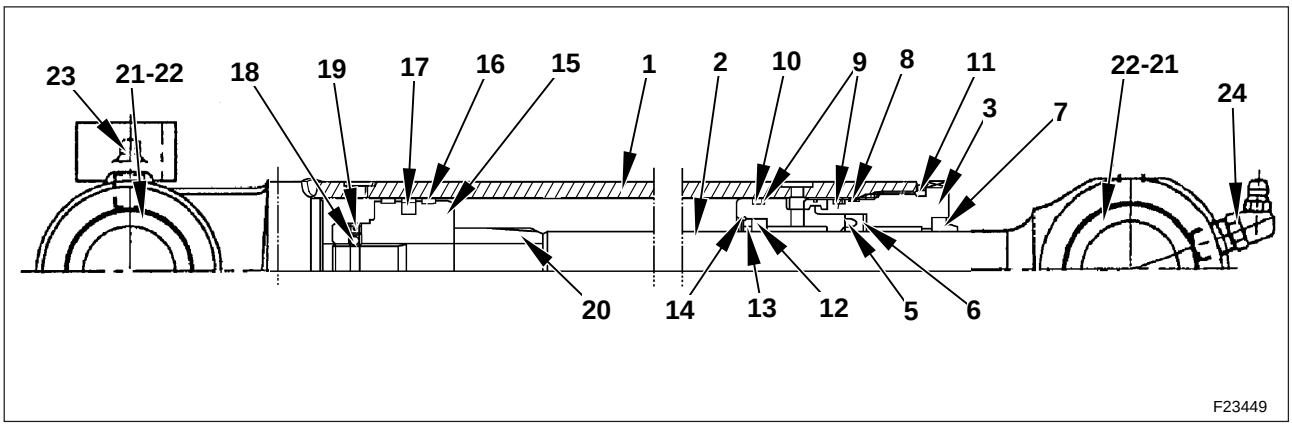


4. Remove capscrew (**17**) with washers (**18**) and (**19**).
Remove capscrew (**14**) and pin (**16**) to free the pin (**4**).
Remove capscrew (**20**) and nuts (**7**) to free the pin (**22**).
Take off pin (**4**) with its shim (**21**) and pin (**22**) with its shim (**21**).
Remove the swing bracket (**24**).
Weight of swing bracket: 31 Kg



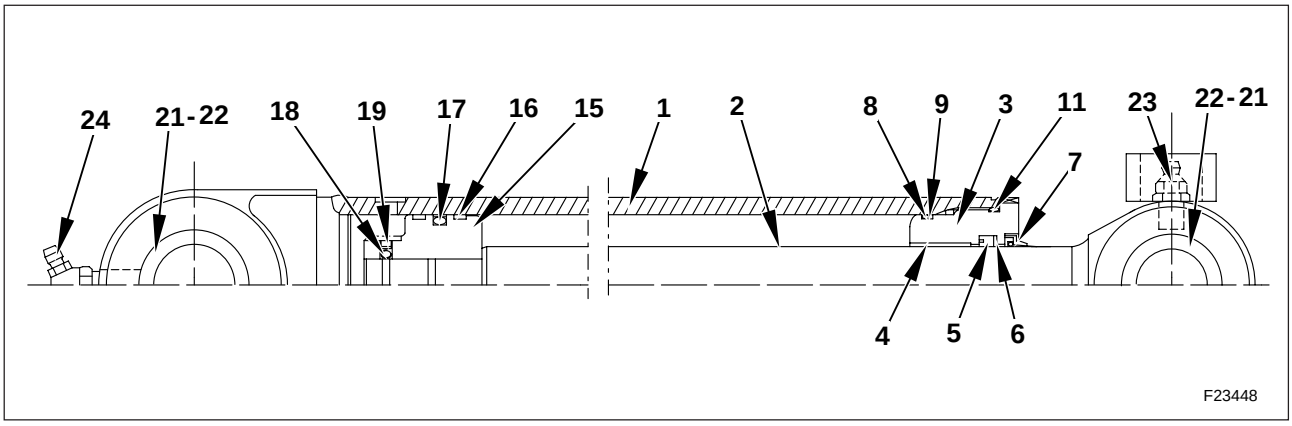
COMPONENTS

BOOM, ARM AND SWING CYLINDERS



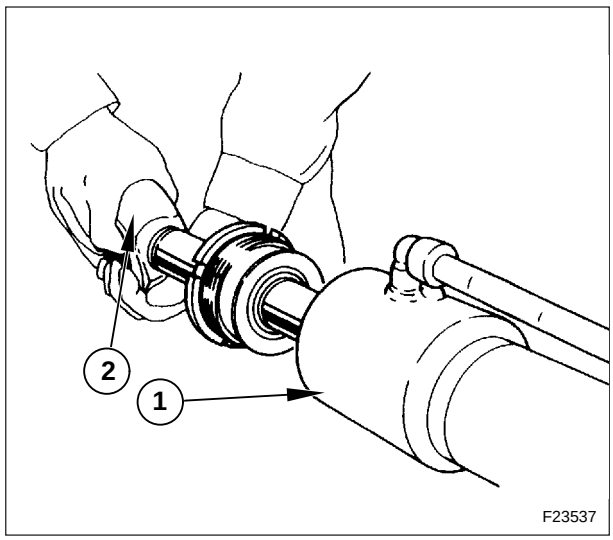
No.	NAME	Q'TY	No.	NAME	Q'TY	No.	NAME	Q'TY
1	CYLINDER TUBE ASSY	1	9	BACK-UP RING	2	17	SEAL RING ASSY	1
2	PISTON ROD ASSY	1	10	O-RING	1	18	STEEL BALL	1
3	CYLINDER HEAD	1	11	O-RING	1	19	SETSCREW	1
4	BUSHING	1	12	CUSHION RING	1	20	CUSHION BEARING	1
5	U-RING	1	13	SPACER	1	21	PIN BUSHING	2
6	BACK-UP RING	1	14	STOPPER	1	22	DUST SEAL	4
7	WIPER RING	1	15	PISTON	1	23	GREASE NIPPLE	1
8	O-RING	1	16	SLIDE RING	2	24	GREASE NIPPLE	1

DOZER, BUCKET AND CRAWLER WIDTH CYLINDERS

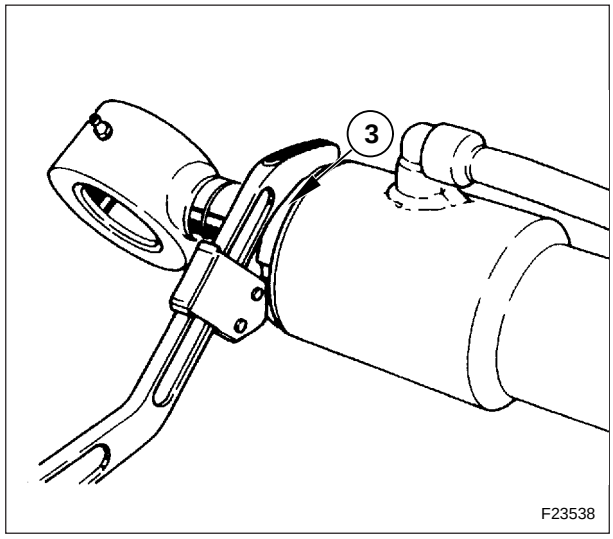


No.	NAME	Q'TY	No.	NAME	Q'TY	No.	NAME	Q'TY
1	CYLINDER TUBE ASSY	1	8	O-RING	1	19	SETSCREW	1
2	PISTON ROD ASSY	1	9	BACK-UP RING	2	21	PIN BUSHING	2
3	CYLINDER HEAD	1	11	O-RING	1	22	DUST SEAL	4
4	BUSHING	1	15	PISTON	1	23	GREASE NIPPLE	1
5	U-RING	1	16	SLIDE RING	2	24	GREASE NIPPLE	1
6	BACK-UP RING	1	17	SEAL RING ASSY	1			
7	WIPER RING	1	18	STEEL BALL	1			

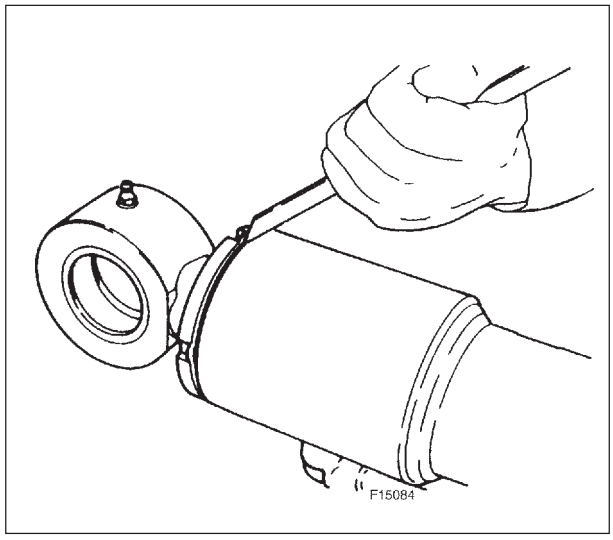
13. Fix the tube (**1**) in level, and install the piston rod assy (**2**) into it.
- At the installation, align the center of piston rod to the center of tube and install the piston rod in straight, paying attention not to damage seals.



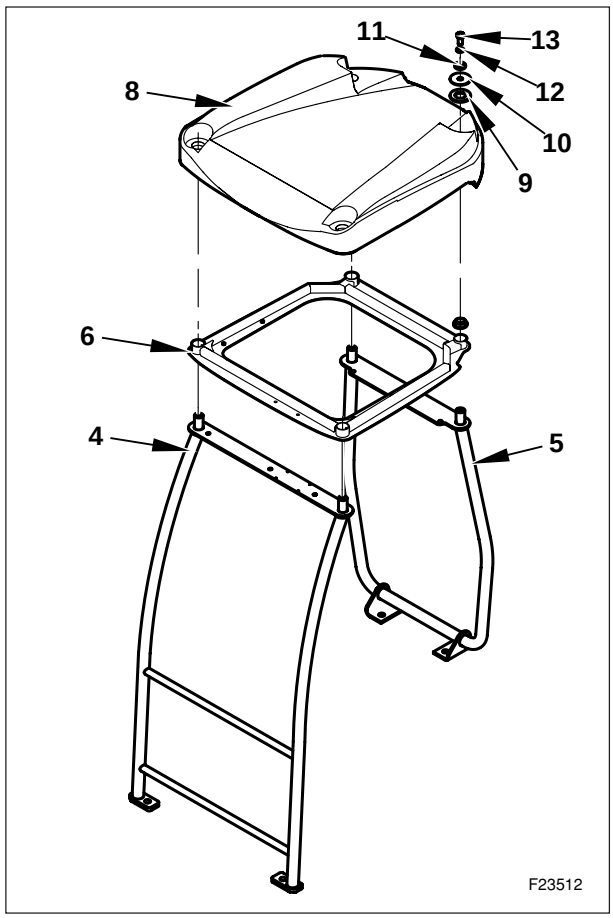
14. Install the cylinder head (**3**).
- Apply hydraulic oil on the packings (seals)prior to install.
- Tightening torque for cylinder head:



15. Bend the locking fin on the tube to lock the cylinder head.



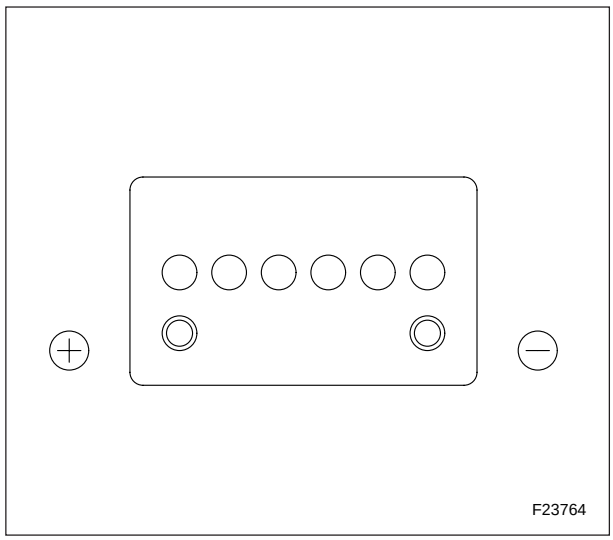
3. If necessary, disassembly the canopy assy:
- Loosen and remove the capscrews (**13**) with washers (**10**), (**11**), (**12**) and rubber (**9**).
- Dissassembly canopy (**8**), plate (**6**) and support (**4**) and (**5**).



INSTALLATION

Install the canopy by the procedure reverse of the removal following the tighten torque:
Torque of capscrews (**3**), (**13**): 191 ± 20 Nm

BATTERY

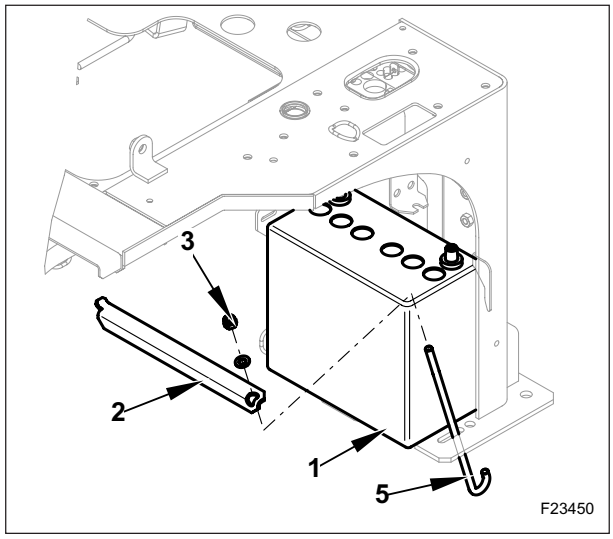


REMOVAL

- Open the right bonnet.
- Disconnect the cable terminal on the negative side.
- Next, disconnect the cable terminal on the positive side.

WARNING

Follow the specified battery cable disconnecting procedure. The disconnection of the battery cable should be carried out starting from the grounding side, and the connection should be carried out finally the grounding side.

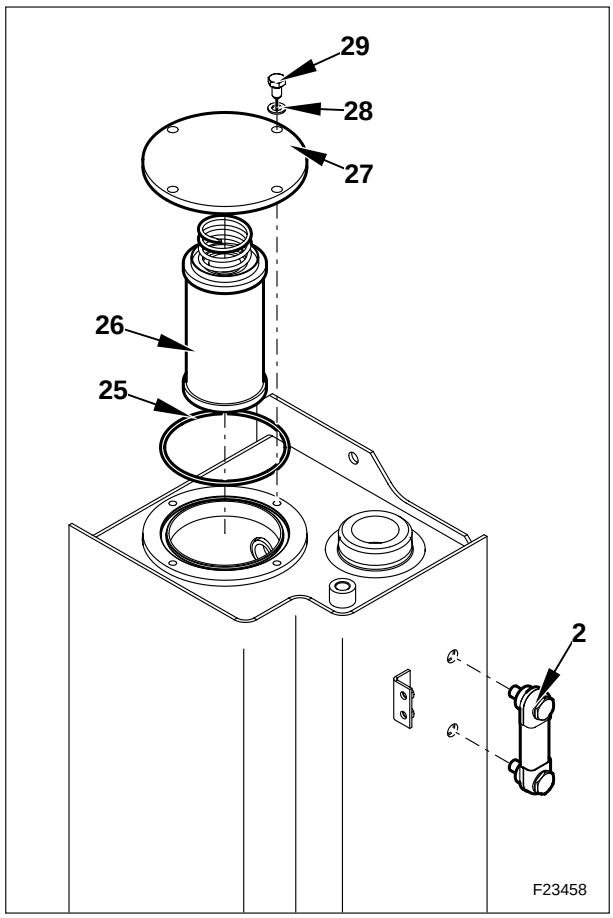


- Loosen nut (**3**) and remove bracket (**2**) and rod (**5**).
- Take out the battery (**1**) holding the strap auxiliary attached to the battery.

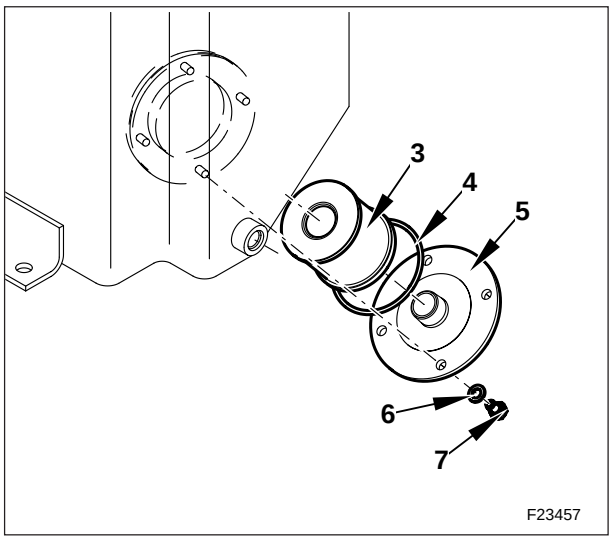
INSTALLATION

Install the battery by the procedure reverse of the removal.

6. Loosen and remove capscrews (**29**).
Remove cover (**27**) and filter (**26**). Controlled the O-ring (**25**) and eventually replaced it.
Loosen and remove (if necessary for replaced) the gauge level oil (**2**).



7. Loosen and remove capscrews (**7**).
Remove flange (**5**) and controlled the O-ring (**4**) (eventually replaced it).
Remove strainer suction (**3**).

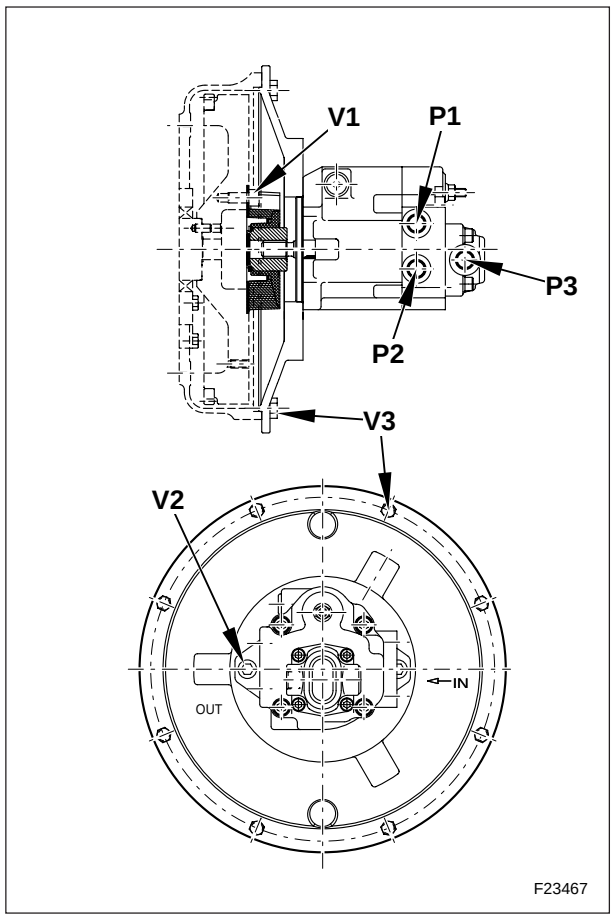


INSTALLATION

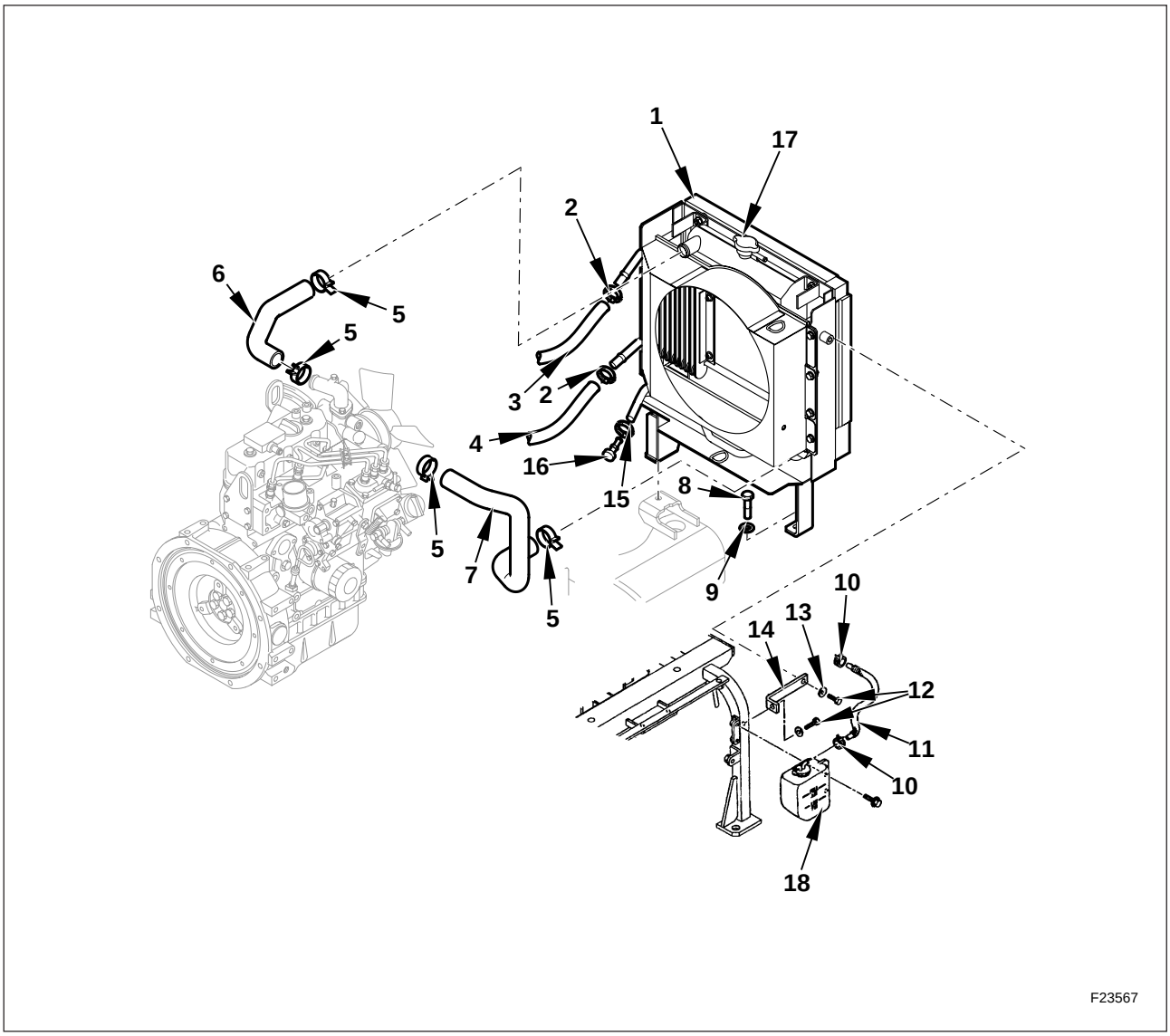
- Install the pump by the procedure reverse of the removal following the indication.
  - Apply grease on the spline coupling.
  - Grease: type 75 MD NH720.
  - Before pump starting, fill in oil the pump casing.

- Apply Loctite 262 on capscrews (**V1**), (**V2**) and (**V3**).

- Torque:
  - Torque of capscrews (**V1**): 52 ± 5.2 Nm
  - Torque of capscrews (**V2**): 103.9 ± 10.4 Nm
  - Torque of capscrews (**V3**): 63.7 ± 6.4 Nm



RADIATOR



1. Radiator assy
2. Clip
3. Hose of oil cooler
4. Hose of oil cooler
5. Clip
6. Hose radiator
7. Hose radiator
8. Capscrew
9. Washer
10. Clip
11. Tube
12. Capscrew
13. Washer
14. Bracket
15. Collar
16. Plug
17. Radiator cap
18. Water tank

SLEWING

- Torque:
  - Fastening torque of spool (**2a**): 3.92 ÷ 4.9 Nm.
  - Fastening torque of capscrew (**10**): 5.88 ÷ 6.86 Nm.

No.	NAME	Q'TY
1	Body	1
2a	Spool	1
2b	Spring seat	1
2c	Spring	1
2d	Spring seat	1
2e	Spool end	1
3	Load check valve	1
4	Spring(for check valve)	1
5	O-ring	1
6	Plug	1
7	O-ring	2
8	Pilot cover	1
9	Pilot cover	1
10	Capscrew M5X20	4

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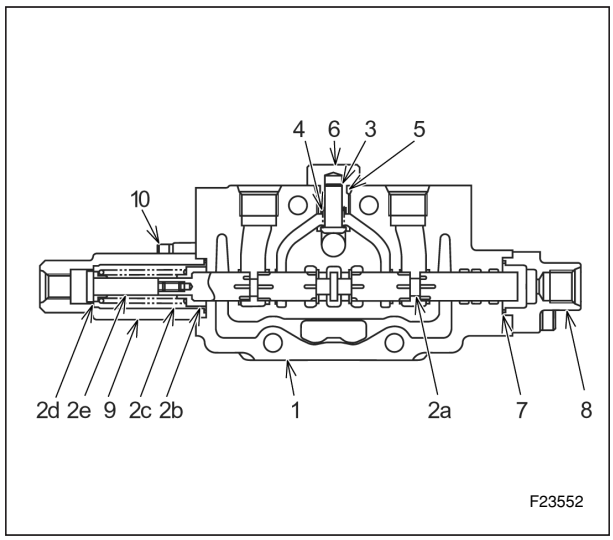


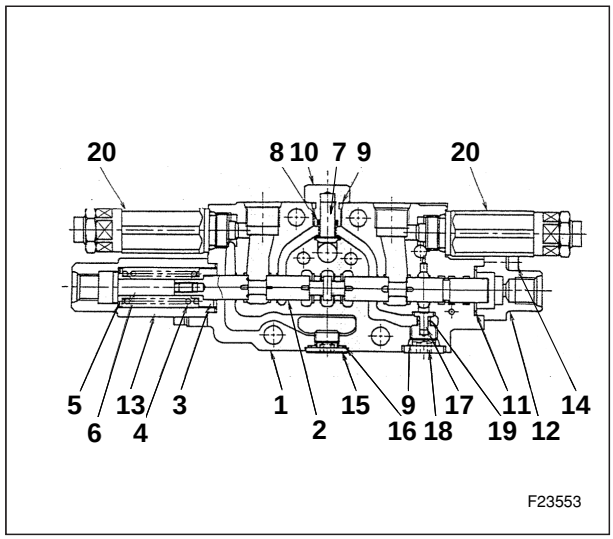
F23552

ARM

- Valve relief:
  - Set pressure: 24.5 $^{+0.5}_{-0}$ Mpa at 5 L/min.
  - Fastening torque: 39.2 Nm
- Torque:
  - Fastening torque of spool (**6**): 3.92 ÷ 4.9 Nm.
  - Fastening torque of capscrew (**14**): 5.88 ÷ 6.86 Nm.

No.	NAME	Q'TY
1	Body	1
2	Spool	1
3	Seat	1
4	Spring	1
5	Seat	1
6	Spool	1
7	Poppet	1
8	Spring	1
9	O-Ring	2
10	Plug	1
11	O-Ring	2
12	Cover	1
13	Cover	1
14	Capscrew	4
15	Plug	1
16	O-Ring	1
17	Poppet	1
18	Plug	1
19	Spring	1
20	Valve, relief	2

F23744

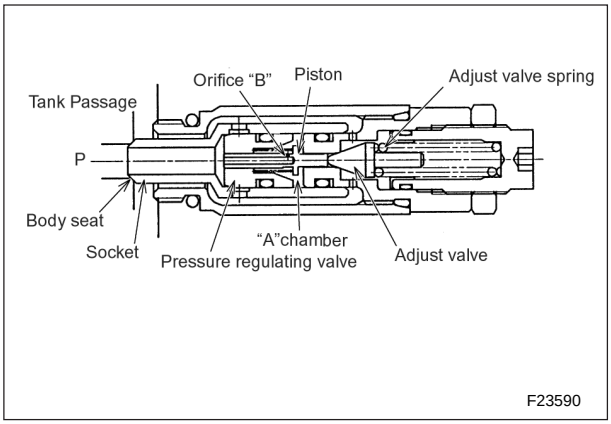


F23553

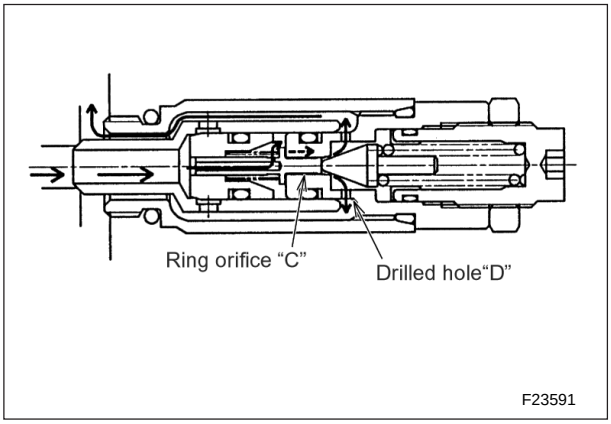
OPERATION OF RELIEF VALVE

Operation at relief condition

1. The pressure oil passes through the inside of the piston placed in the pressure regulating valve(main valve) and fills in (**A**) chamber inside of the piston through the orifice (**B**) to securely seat the pressure regulating valve and the socket, and the socket and the body seat.

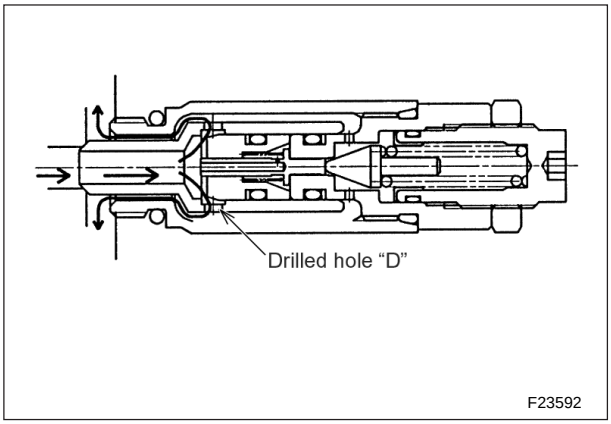


2. When the pressure of the oil in the (**P**) port reaches to the set pressure of the spring, the pressure oil acts on the adjust valve through the piston and opens the adjust valve.
Then, the pressure oil passes through the inside of the piston, orifice (**B**), (**A**) chamber, ring orifice, and drilled hole (**D**) in order, and flows out to the tank circuit around the socket.



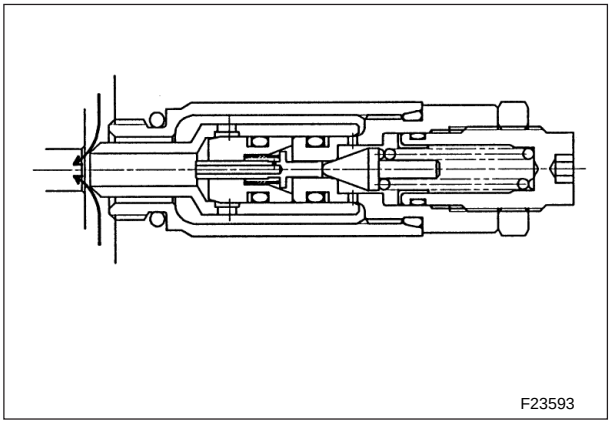
3. The pressure in (**A**) chamber drops because the adjust valve is open, consequently the pressure oil in the (**P**) port flows out to the tank circuit through the drilled hole (**E**).

4. When the pressure on the (**P**) port drops lower than the spring set pressure of the adjust valve, the adjust valve is pushed against the seat by the adjust valve spring force of the adjust valve and the pressure in (**A**) chamber is equal to the pressure in the (**P**) port, consequently the adjust valve is also pushed against the seat and returns to the former condition.

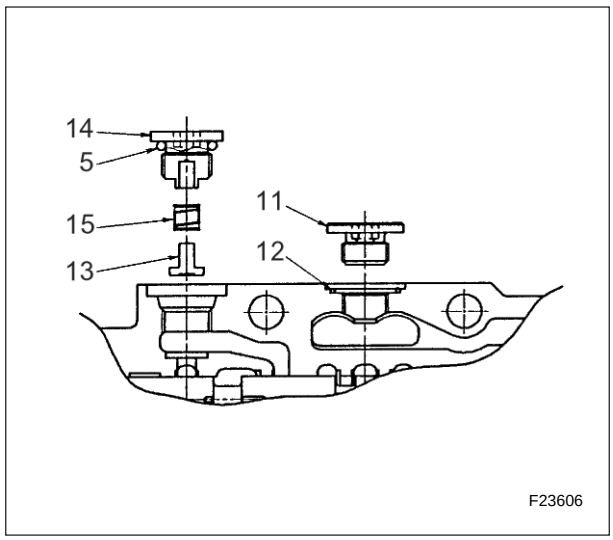


Suction operation:

When the negative pressure is generated in the (**P**) port, the oil is supplied through the tank circuit.
When the pressure of the tank circuit from the (**P**) port rises, the socket is pushed up.
Consequently, the space between the body seat and the socket opens, and the oil flows from the tank passage into the (**P**) port and the space fills with the oil.



3. Load check valve and plug for recirculation in arm section.
Put the valve on work bench directing the actuator port downward.
Remove plug (**11**) at the center of the bottom of the arm switching section with allen wrench of 6mm. And remove O-ring (**12**) also.
Then, loosen and remove one more plug (**14**) with allen wrench of 6mm. Take out spring (**15**) and load check valve (**13**) through the hole the plug was removed from with tweezers or magnet.



4. Disassembling main frame of switching section
Loosen and remove 4 nuts M8 for the main frame assembly of the switching section on the side of the valve with spanner of 13mm (socket wrench).
Draw 4 tie-bolts from the side and remove each main frame of the switching section. Then, care should be taken not to miss various O-rings fitted on the mating face of respective main frame.
The main frame of the switching section is equipped with many plugs screwed in. These plugs are for preliminary holes, so don't disassemble when not required.

5. Precautions for disassembly.

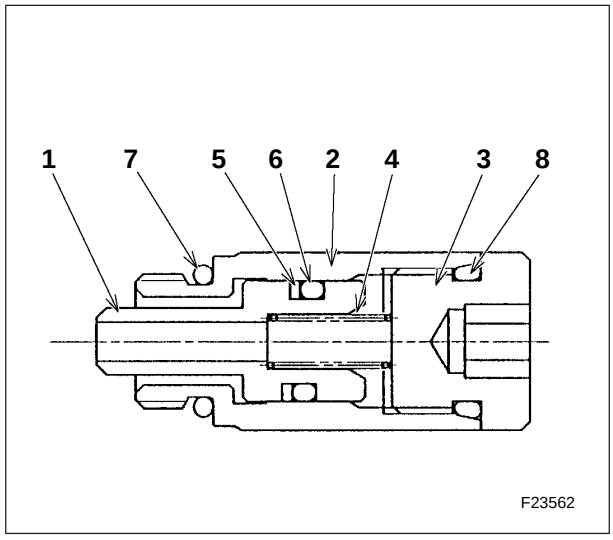
WARNING

The removed parts should be carried and stored carefully to prevent damage and contamination. And when the removed parts are applied, stored, or carried in the removed condition, fill up the holes after the removal of parts with cap, tape, etc. to protect it from entry of dust, dirt, etc.

6. Disassembling anticavitation valve.

WARNING

Since the anticavitation valve is essential for the performance, replace the assy if necessary.
For reference, how to disassemble for checking the abnormality is shown below.
*Hold body (**2**) with vice at the hexagonal section of the opposing flat.*
*Loosen and remove plug (**3**) with allen wrench of 8mm. After removing spring (**4**), push anticavitation valve (**1**) in from the seat side, taking care not to damage the seat, and draw O-ring (**6**) and back-up ring (**5**) from the side plug (**3**) is taken out taking care not to damage the thread around the body (**2**).*



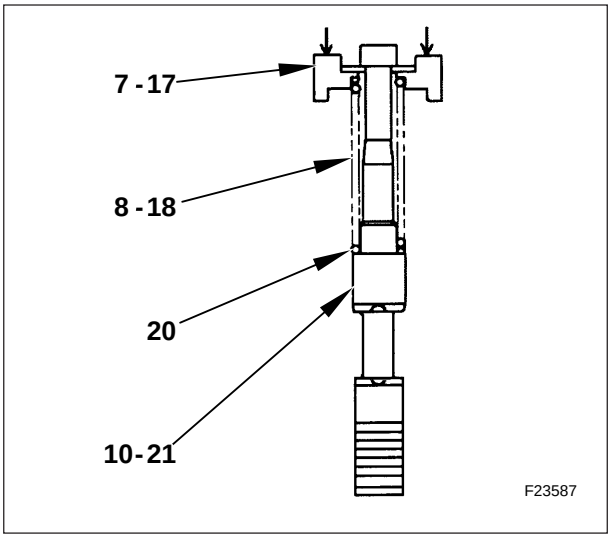
Relief valve

The relief valve is essential for the performance and the safety, and it is difficult to reset the pressure other if there is no facility in service shop, so when abnormality occurs, don't fail to replace the assy. The handling method is for reference, replace the assy as a rule.

Phenomenon	Cause	Corrective action
1. Pressure does not rise.	The pressure adjusting valve of each relief valve, poppet and piston are stuck, kept open, or got caught dust in the seat section of the valve.	• Check that the engagement valve of respective valve doesn't get matters caught in it. • Each part slides freely. • Clean all parts completely.
2. Relief pressure is unstable.	The adjusting valve of respective valve is damaged, or the piston is stuck to the poppet.	• Replace the damaged part. • Clean all parts completely. • Remove flaw on the surface.
3. The relief pressure is not within the limit of set values.	1) Wear due to dust 2) Lock nut and adjusting screw are loose. • Breakage and permanent set in fatigue of spring 3) Malfunction of RV and ORV	1) Disassemble and clean 2) Adjusting pressure • Replace spring. 3) Measure the pressure of RV and ORV.
4. Oil leakage	1) Damage on each seat section Wear of O-ring 2) Respective part is stuck due to dust entered.	1) Replace the worn or damaged part. Check that respective part move smoothly before installing. 2) Check that it is free from scratch, score and foreign matter before installing.

F23760

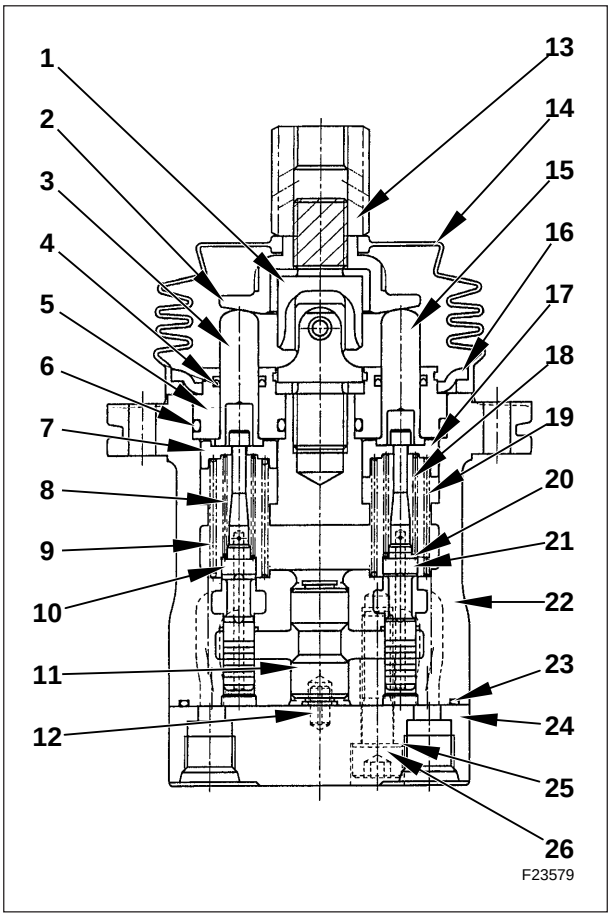
- Disassemble the spool (**10**), (**21**) spring seat (**7**), (**17**) spring (**8**), (**18**) and washer (**20**).
- These parts to be treated as assy until assembling.
- Loosen disk (**2**), adjusting nut (**13**) and lock nut on the handle operating parts, using spanner, and disassemble joint (**1**).



ASSEMBLY

- Before assembling, wash parts with washing oil and dry them with compressed air, Avoid using cloth if possible.
  - Before assembling correct all defects made during disassembling, clean parts, coat moving parts with oil and refit parts back in original place.

- Replace O-rings with new ones.
- Replace seal washers (**25**) with new ones, also.
- Fit O-rings (**23**) into valve body (**22**).
- Install port plate (**24**) to valve body (**22**).
- In that case, beware of the mounting position so that spring pin (**12**) can be set in the hole of valve body (**22**) side.
- Tighten slowly, with specified torque, two socket capscrews (**26**) with seal washers (**25**).
  Torque: 29.4±3 Nm



ASSEMBLY

1. Wash all the parts with cleaning oil before assembly and dry them as much as possible.
- Be sure to repair any damage caused by disassembly. clean the parts, apply grease to the movable parts, and assemble the same parts in the same portion.
- Exchange all the O-ring and packings with new ones as a rule.

2. Assemble the washer (**14**), the shim (**13**), the secondary pressure setting spring (**26**) and the spring seat (**12**) with the spool (**17**) in this order.

3. Pass the spool (**17**) through the larger hole of the spring seat (**12**), push in the seat and laterally shift the seat while deflecting the secondary spring.

4. Clamp the casing (**18**) with a vise, and install the return spring (**27**) in the casing (**18**).

5. Install the pressure reducing valve portion subassembly assembled in the above steps 2) and 3) into the casing (**18**).
- Assemble in the same position as before the disassembly.
- When installing the pressure reducing valve portion subassembly, be careful not to allow the lower end of the spool to hit the casing edge strongly.

6. Install the O-rings (**25**) and (**29**) in the casing (**18**).

7. Clamp the upper casing (**23**) with a vise and install the steel balls.

8. Install the spring seat (**11**) in the casing (**23**) with a pincette or the like.

9. Install the damping spring (**10**) in the casing (**23**).

10. Install the piston (**3**).

11. Install the O-ring (**8**) to the plug (**5**).

12. Install the packing (**4**) to the plug (**5**).
- Carefully install thee packing in the correct direction.
- Lightly apply grease before installing the packing.

13. Install the grease cup (**22**) in plug (**5**).

14. Install the push rod (**3**) on plug (**5**).

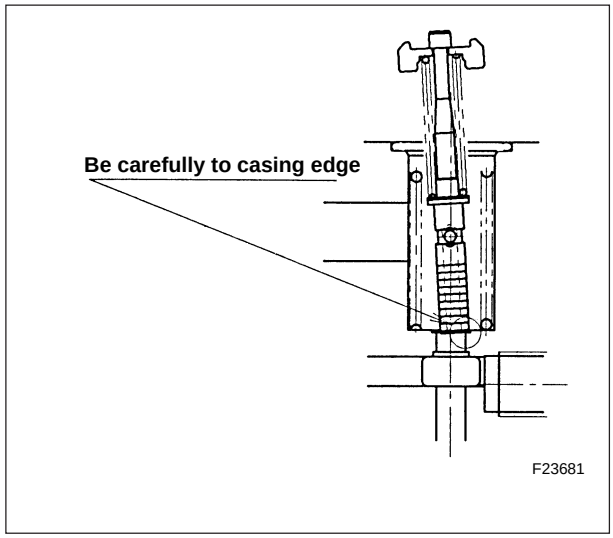
15. install the push rod subassembly assembled in the above steps (**11**) through (**14**) in the casing (**23**).

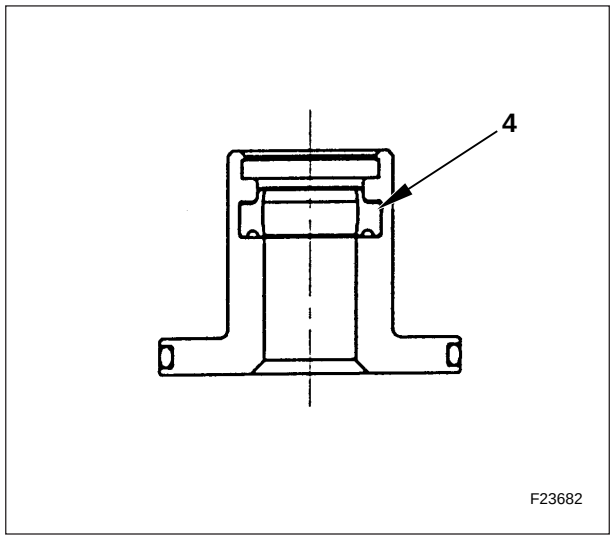
16. Lay the cover (**7**) on the flat table, and lightly hammer the special jig 1 applied on the bushing to press in the bushing (**28**).

17. Clamp the lower cover assembly assembled in the above steps (**2**) through (**6**) with a vise to install the upper cover assembly assembled in the above steps (**7**) through (**15**).

18. Install the cover (**7**) to the casing (**23**).

19. Tighten the hexagon socket capscrews (**6**) with the specified torque.





1. Pinion shaft
2. Bearing
3. O-ring
4. Circlip
5. Bush
6. Seal ring
7. O-ring
8. Bearing
9. Circlip
10. Gearbox housing
11. Backup ring
12. O-ring
13. O-ring
14. Backup ring
15. Steel disc
16. Sintered disc
17. Brake shaft
18. Circlip
19. Brake piston
20. Spring
21. O-ring
22. Hydraulic motor
23. Screw
24. Plug
25. Washer
26. Screw
27. Cover
28. Backup ring
29. O-ring
30. Bearing
31. O-ring
32. Plug
33. Housing+shaft
34. Cardan shaft
35. O-ring
36. Distributor plate
37. Gerotor
38. Cover
39. Washer
40. Screw
41. Valve
42. Screw
43. Screw

ASSEMBLY

The pieces that are subject to general wear and tear are the following.

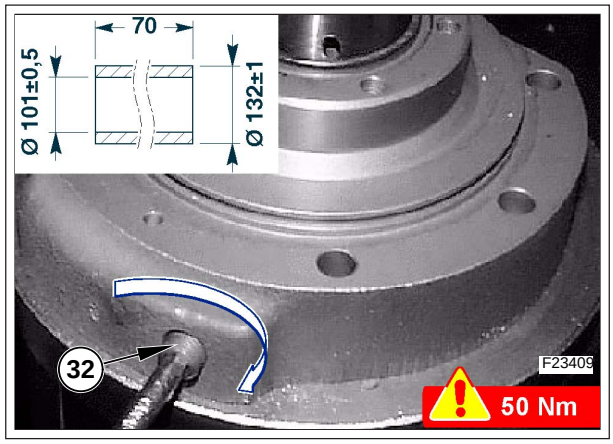
- Gears.
- Bearings.
- All the seals.

Replace the used or irregular parts respecting the following steps.

- Accurately remove dirt, and in particular properly clean the seals, bearings and locking rings seating.
- Lubricate the parts before connecting them.
- In the case of damaged gears, for example a planetary, do not proceed to replace the individual gear but the entire reduction assembly.
- When reassembling a part always replace all the seals involved.
- Replace all the damaged parts with original spare.

Hydraulic motor reassembly

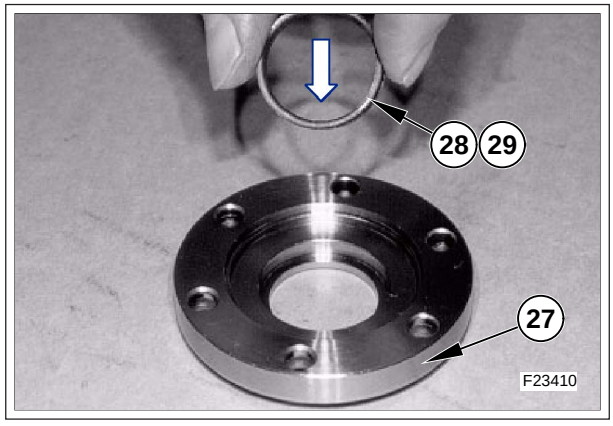
1. Place the motor housing (**33A**) on the support with the output side upwards. If removed, apply **Loctite 542** on the plug (**32**) and tighten, by a torque wrench, at 50 Nm torque.



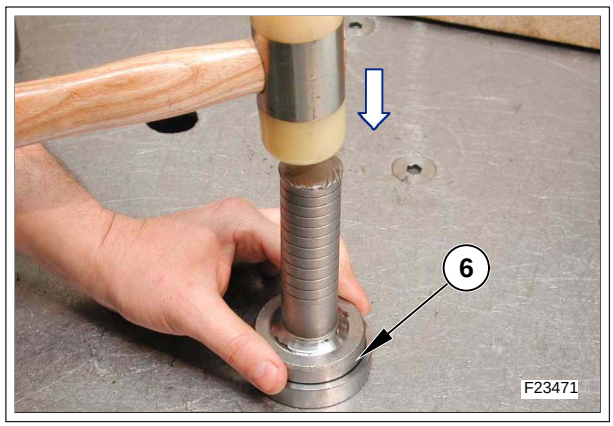
2. Place in the internal cover (**27**) the back-up ring (**28**) and the O-ring seal (**29**).

WARNING

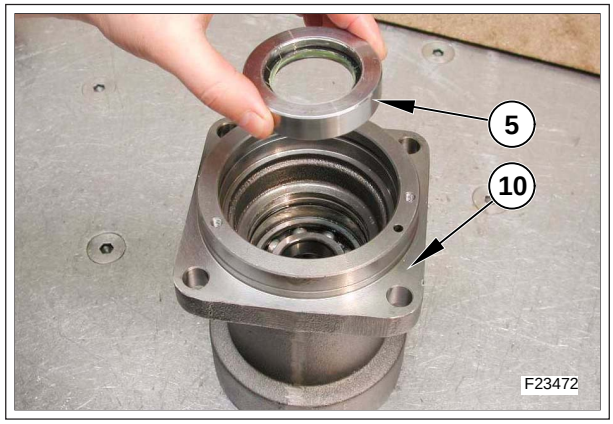
Be careful to the correct direction of assembly.



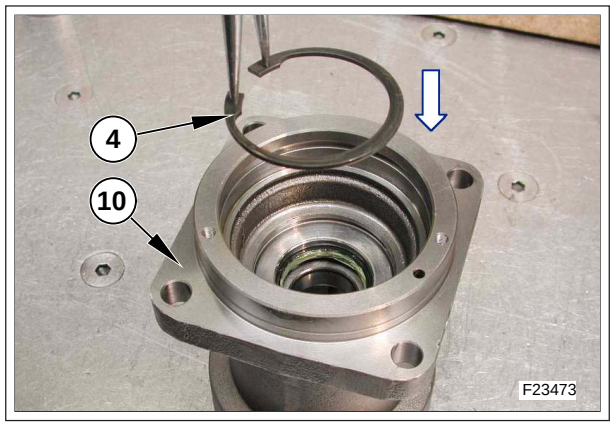
37. By using a rubber hammer push the seal ring (**6**) against the seat shoulder.



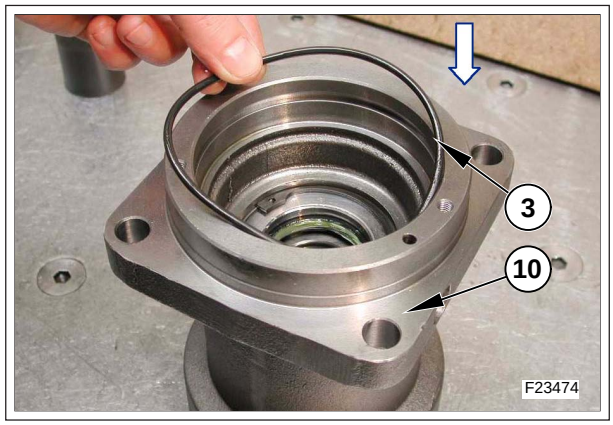
38. Place the bush (**5**) into its seat in the gearbox housing (**10**).



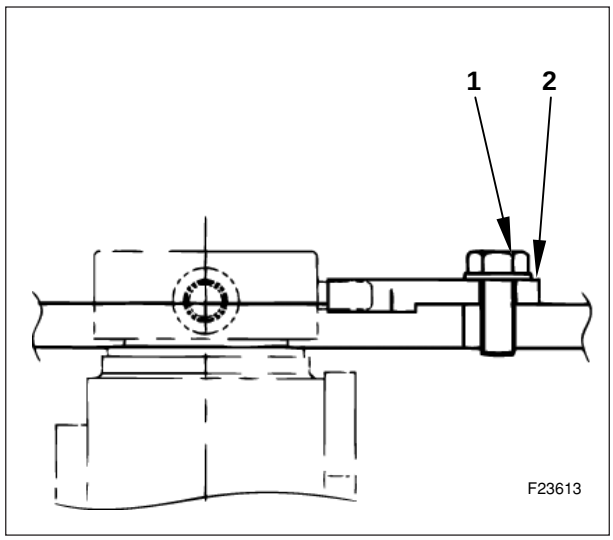
39. By using pliers, place the circlip (**4**) into its seat in the gearbox housing (**10**).



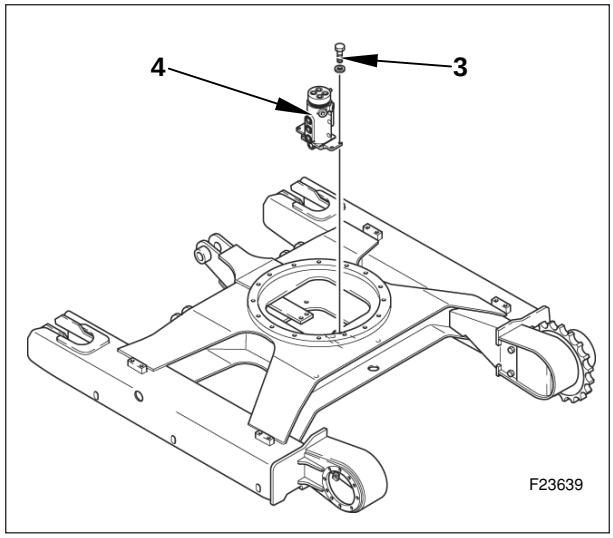
40. Fit the O-ring seal (**3**) into its seat in the gearbox housing (**10**).



- Removing stopper:
  loosen 2 capscrews (**1**) M12 and remove stopper (**2**).



- Removing swivel joint:
  loosen 4 capscrews (**3**) M8 from the lower side and remove swivel joint (**4**) from the lower side.
  Weight of sviwel joint: 11kg



TROUBLESHOOTING

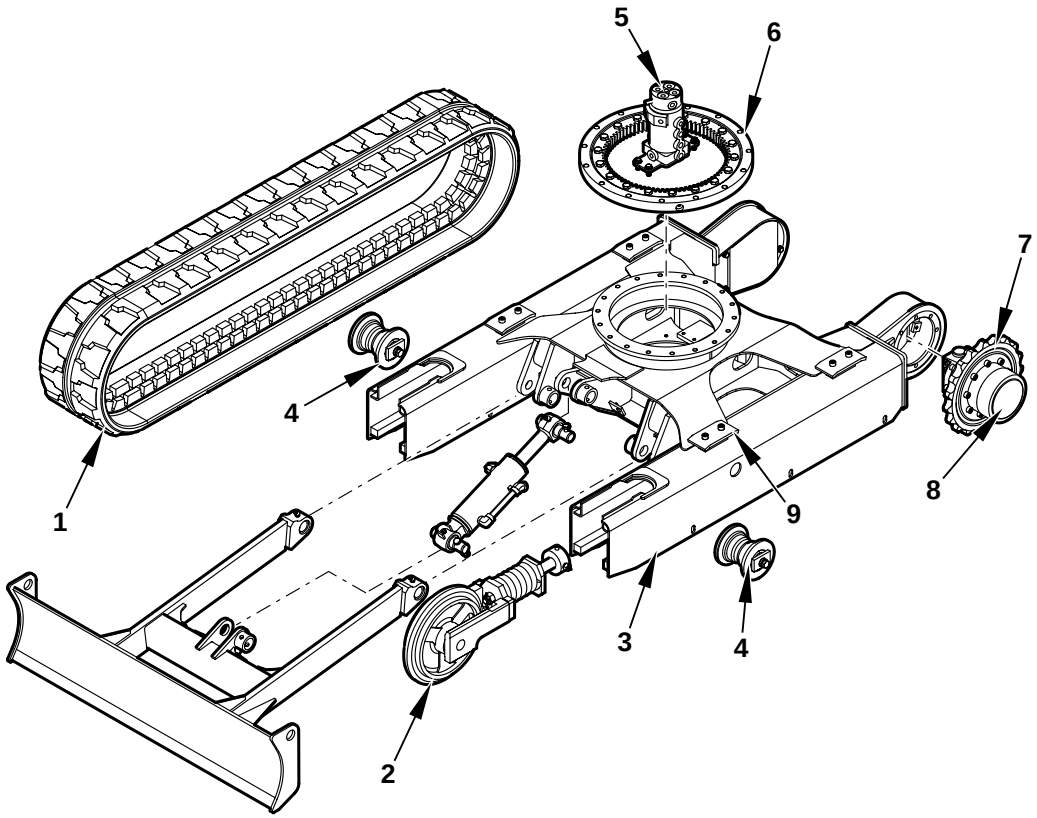
Troubles	Possible causes	Remedy
External oil leakage	• O-ring is defective.	• Replace all the seal parts.
Internal oil leakage	• Thrust ring is defective. • Excessive wear on sliding surfaces.	• Replace all the seal parts. • Replace the assembly.
Shaft sticks	• Shaft and body are stuck together.	• Carry out grinding and honing. If excessive looseness cause oil leakage, replace the assembly.
Flange looseness	• Capscrew tightening isinsufficient.	• Retighten with the specified torque.

F15354gb

LOW STRUCTURE

It is the lower part of a mini excavator and is the rigid structure. It mainly consists of:

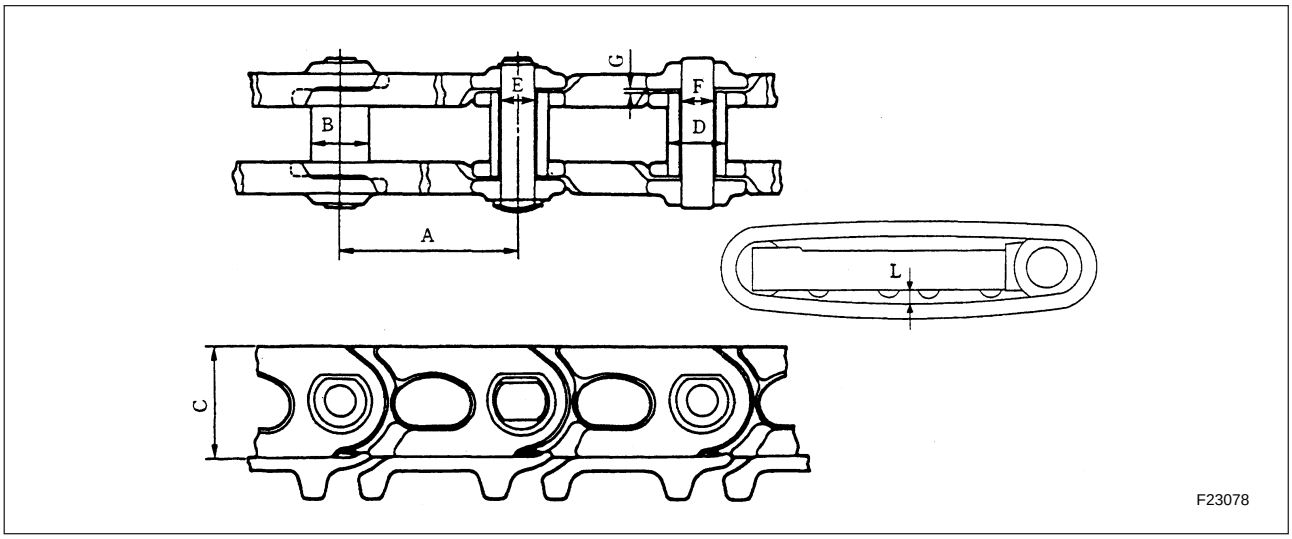
RIGID CRAWLER FRAME



F23065

1. Crawler
2. Idler
3. Lower frame
4. Roller track
5. Joint swivel
6. Slewing bearing
7. Sprocket
8. Travel motor
9. Slide plate

IRON CRAWLER

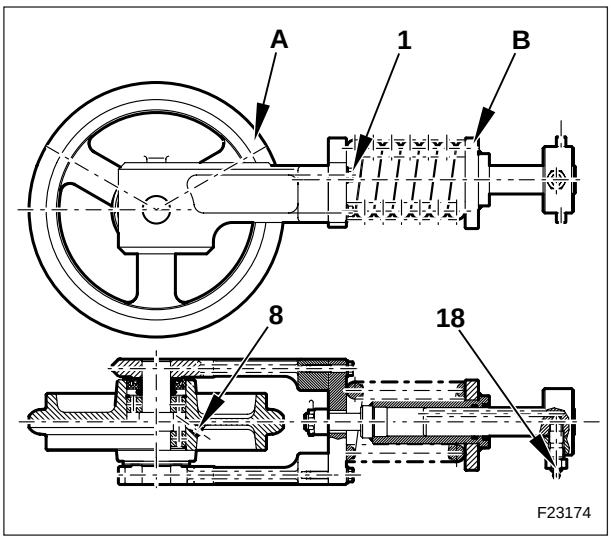


L: Distance between the bottom of frame and top of iron crawler.

No.	ITEM	STANDARD VALUE				STANDARD VALUE FOR REPAIR	SERVICE-ABILITY LIMIT	REMEDY
A	Link pitch	90 (3.54)				91.5 (3.60)	92 (3.62)	Replace
B	O.D. of bushing	$22.15^{+0.04}_{0}$ ($0.8720^{+0.0016}_{0}$)				20 (0.79)	20.5 (0.81)	
C	Height of link	46 (1.81)				42.5 (1.67)	41 (1.61)	Repair or Replace
D	Interference between bushing and link	ϕ22 (0.87)	Shaft	+0.19 (+0.0075) ~ +0.15 (+0.0059)	Interference 0.10 ~ 0.19 (0.0039~ 0.0075)	← 0.1 (0.0039)	← 0 (0)	Replace
			Bore	+0.05 (+0.0020) ~ 0 (0)				
E	Interference between regular pin and link	ϕ14 (0.55)	Shaft	+0.20 (+0.0079) ~ +0.15 (+0.0059)	Interference 0.10 ~ 0.20 (0.0039~ 0.0079)	← 0.1 (0.0039)	← 0 (0)	
			Bore	+0.05 (+0.0020) ~ 0 (0)				
F	Clearance between master pin and link	ϕ14 (0.55)	Shaft	-0.02 (-0.0008) ~ -0.05 (-0.0020)	Clearance 0.02 ~ 0.10 (0.0008~ 0.0039)	← 0.5 (0.020)	—	Replace link
			Bore	+0.05 (+0.0020) ~ 0 (0)				
G	Clearance between links	0.6 (0.24) One side				6 (0.24) Both sides	7 (0.28) Both sides	Replace
L	Slack of steel crawler	75 ~ 80 (2.95 ~ 3.15)				—	—	Adjustment

F23171

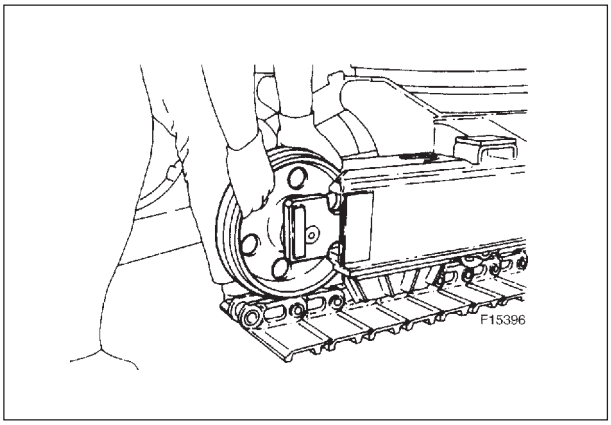
INSTALLATION OF IDLER ADJUSTER



1. Install idler shell (**A**) to the idler regulation (**B**) by means of capscrews (**1**) in the reverse order of removing the idler assy. Coat the threaded part of capscrews (**1**) with Loctite type 262 beforehand.

Torque: 33 ± 3 Nm

The assembly of the idler and idler adjuster is to be installed to the lower frame so that the grease feeding plug (**8**) is positioned to upside, and the valve (**18**) is facing to outside.



2. Install idler together with idler adjuster assy. Weight of idler adjuster: 22 kg

Install the crawler assy, and adjust the crawler tension.

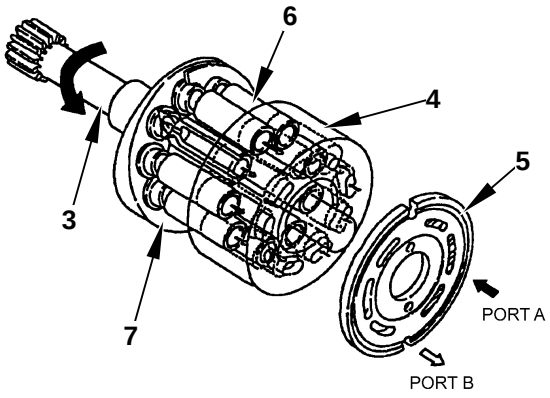
- On that occasion, confirm the lubrication through the grease nipple is proper and that grease is not leaking from the grease cylinder.

HYDRAULIC MOTOR

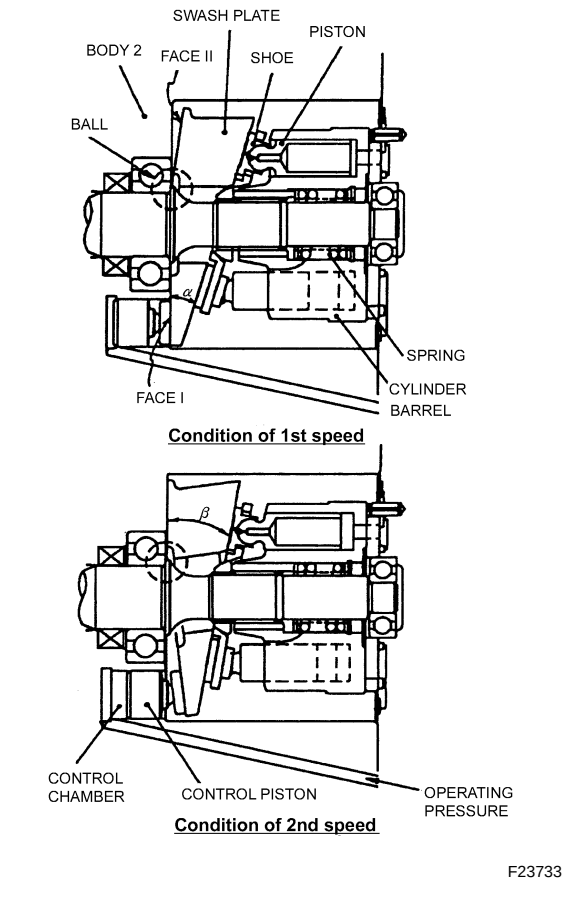
- Function of Motor
  This hydraulic motor of an axial piston (swash plate) type converts the hydraulic energy furnished by the pump into rotary motion.

- Construction and Operation Principle of Motor
  The pressurized oil supplied through the counter-balance valve is supplied to the valve plate (**5**). When pressurized oil is supplied to port A, it flows into the cylinder port on the cylinder barrel (**4**) of aligning with port (**A**), and pushes the piston (**6**). The force on the piston is converted through the swash plate (**7**) into rotary motion, which is transmitted to the shaft (**3**) through the spline provided on the cylinder barrel (**4**).
  The return oil from the cylinder port flows out through port (**B**) on the valve plate (**5**).
  In case of the reverse rotation, the oil flows into port (**B**), and the return oil flows out port (**A**).

- Operation Principle of two-Speed Motor
  The swash plate has two faces, I and II, on the opposite face on which the piston shoes are sliding, and is supported by two balls which are fixed to the body.
  Since the balls are eccentrically provided above the center line of the shaft, at the case of 1st speed, the combined force of the pressure oil exerted to the piston and the spring in the cylinder barrel pushes (**I**) face to the body, making the slant angle of the swash plate to causing a large displacement.
  When the switch for 2nd speed is set on, the pressurized oil is led into the control room through the solenoid valve and the 2nd speed spool. Then the control piston pushes the swash plate to move it up to getting contact of (**II**) face with the body, and fix the swash plate with the slant angle of fl causing a small displacement.
  While the engine is at a standstill, the control room is connected to the drain port through the 2nd speed spool. Then the swash plate is returned the 1st speed position by the spring force. Therefore, the travel motor is always set at 1st speed at every start-up of the engine.

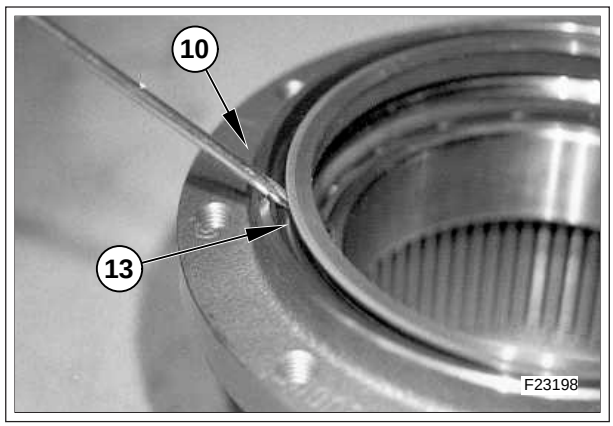


F23732

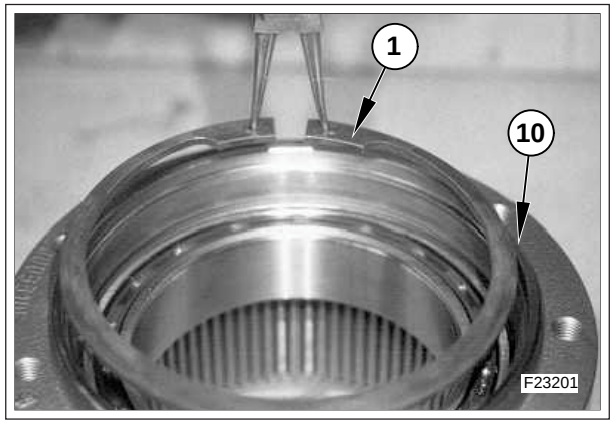


F23733

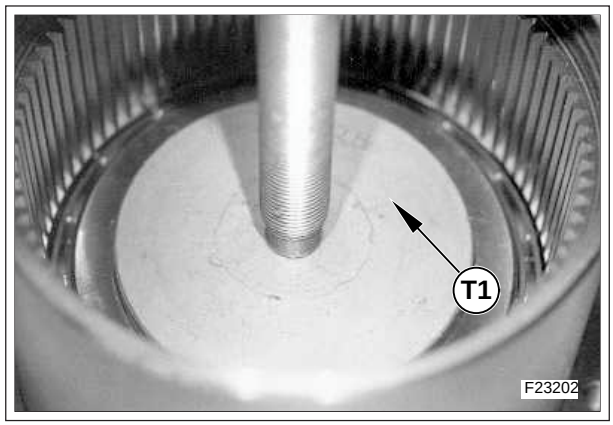
13. Use a screwdriver to remove the 2nd half-seal (**13**) from the gearbox housing (**10**).

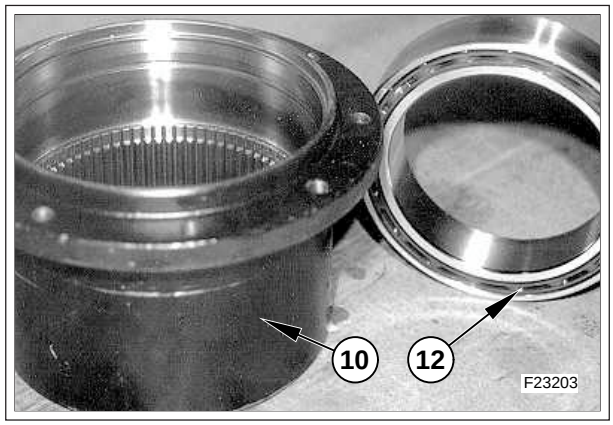


14. Using pliers remove the circlip (**1**) from its seat in the gearbox housing (**10**).

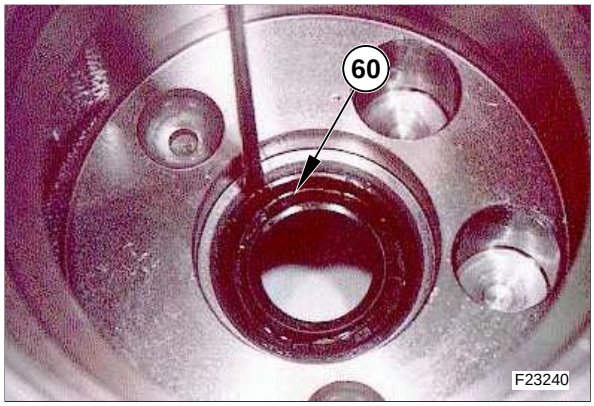


15. Using a puller (**T1**), push on metal stopper and remove the bearing (**12**) from the gearbox housing (**10**).





51. By using a screwdriver remove the seal ring (**60**) from its seat in the flanged hub.
Disassemble the seal ring only in case of replacement, because this will damage it.

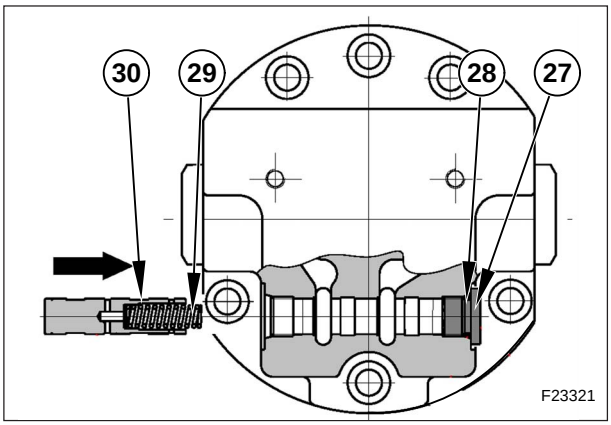


33. Insert the spring (**29**) in the two speed spool (**30**).

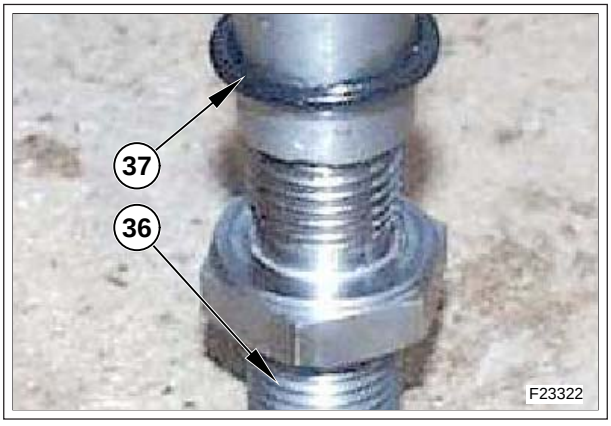
34. Insert the two speed spool (**30**) in the base plate as shown on the sketch.

WARNING

Two speed spool have to move smoothly inside its seat in the base plate.

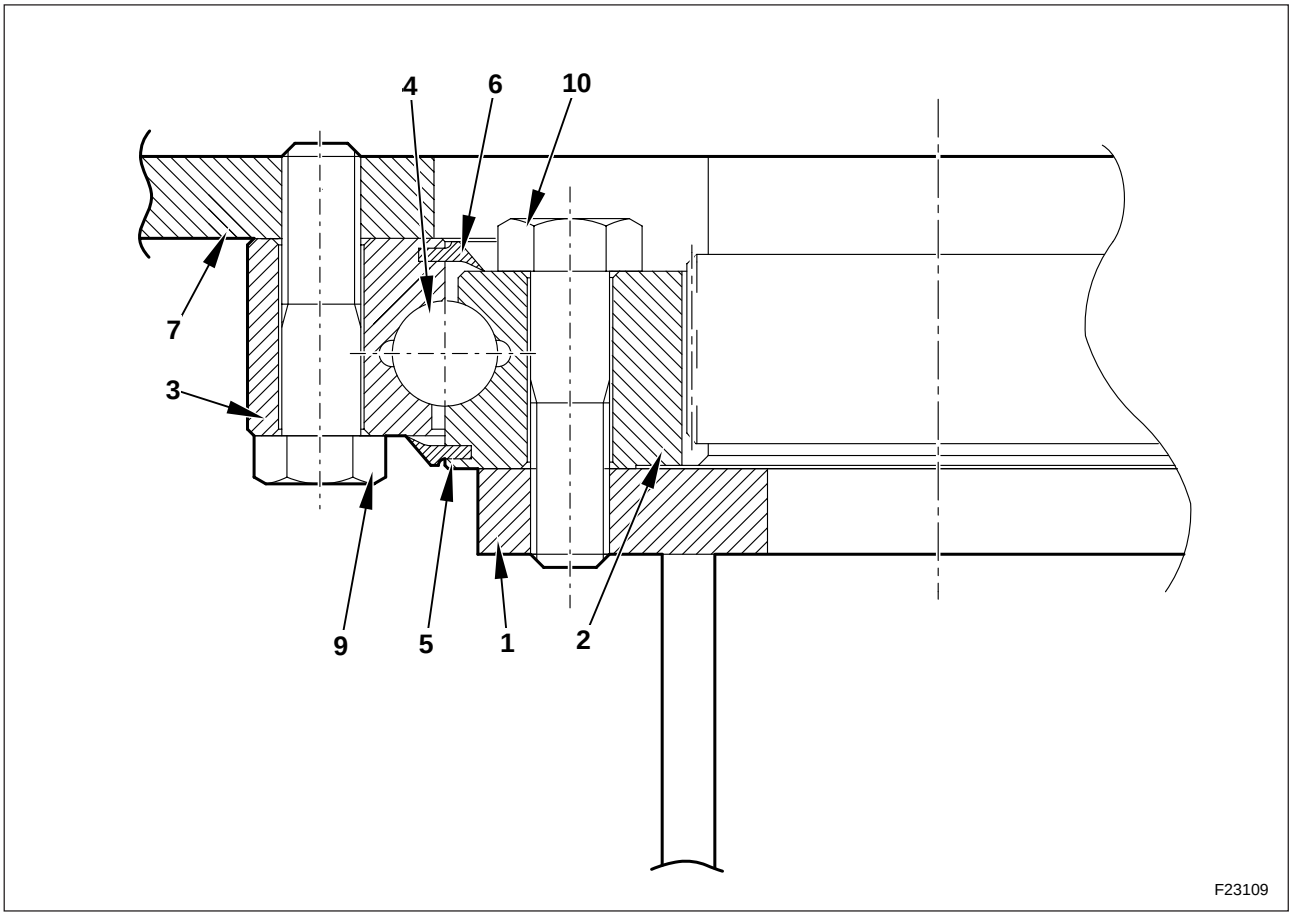


35. By using the stopper assemble the O-ring seal (**37**) in its seat in the plug (**36**).



SLEW BEARING

The Slew bearing is composed of outer race (**3**) bolted to the upper frame (**7**), an inner race (**2**) bolted to the lower frame and a double rows of balls (**4**).
The pinion of the slew motor (**8**), controled by swing motor through the swing reduction gears, rotates on its own axis and it also revolves round the centre of inner race of swing bearing, allowing the upper structure to swing independently of the lower frame.



1. Lower frame
2. Inner race
3. Outer race
4. Bearing ball
5. Inner seal
6. Outer seal
7. Upper frame
8. Pinion of the slew motor
9. Outer race screw
10. Inner race screw

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SECTION 13 TROUBLESHOOTING HYDRAULIC SYSTEM

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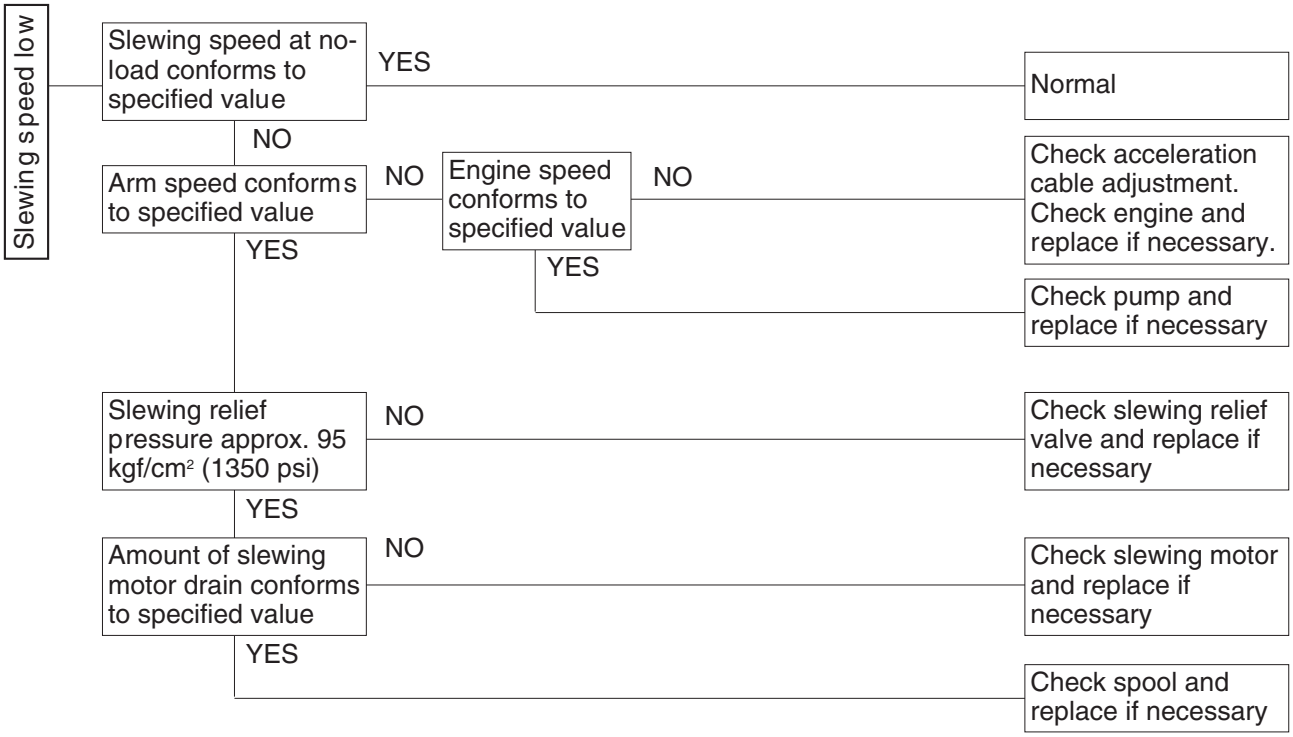
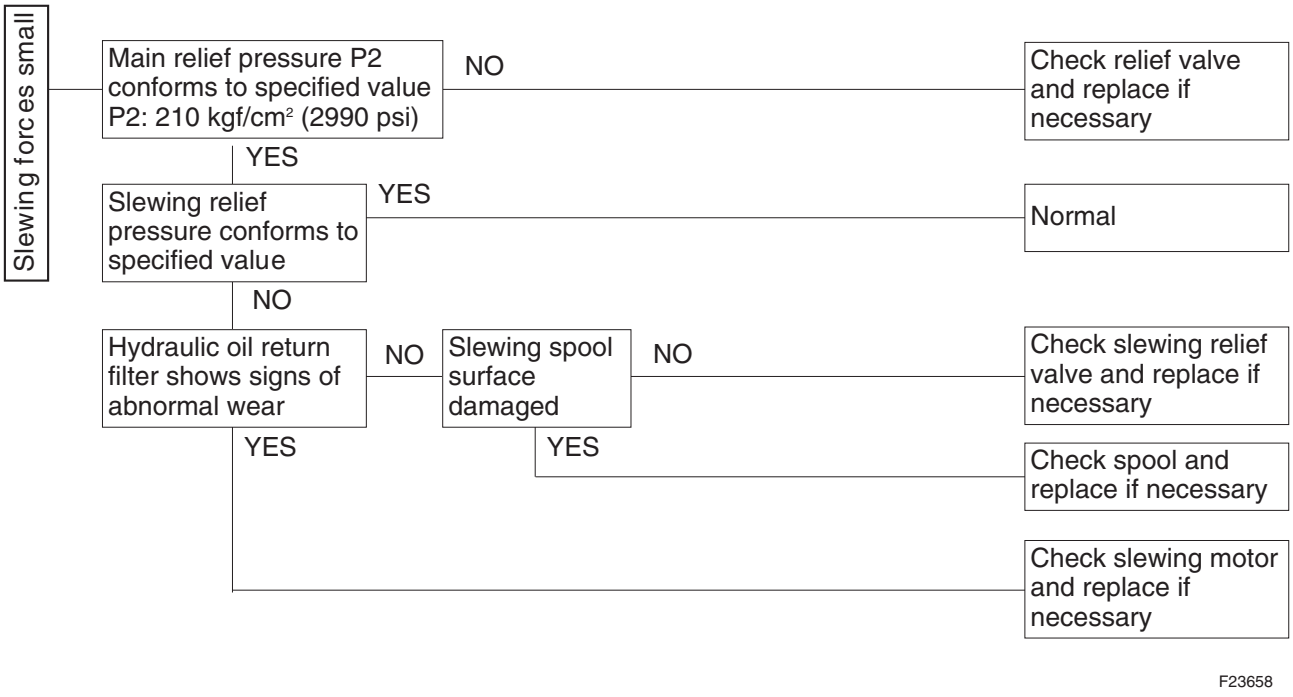

Slewing speed low
Slewing speed at no-load conforms to specified value
YES
Normal
NO
Arm speed conforms to specified value
NO
Engine speed conforms to specified value
NO
Check acceleration cable adjustment. Check engine and replace if necessary.
YES
YES
Check pump and replace if necessary
Slewing relief pressure approx. 95 kgf/cm² (1350 psi)
NO
Check slewing relief valve and replace if necessary
YES
Amount of slewing motor drain conforms to specified value
NO
Check slewing motor and replace if necessary
YES
Check spool and replace if necessary


Slewing forces small
Main relief pressure P2 conforms to specified value P2: 210 kgf/cm² (2990 psi)
NO
Check relief valve and replace if necessary
YES
Slewing relief pressure conforms to specified value
YES
Normal
NO
Hydraulic oil return filter shows signs of abnormal wear
NO
Slewing spool surface damaged
NO
Check slewing relief valve and replace if necessary
YES
YES
Check spool and replace if necessary
Check slewing motor and replace if necessary

F23658

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SECTION 15 TROUBLESHOOTING ENGINE

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E16 - E18

SECTION 16 ENGINE

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3TNE84

*Output conditions: Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤ 550 mmAq, other conditions complying with JIS D 1005–1986. After minimum 30 hour's run-in.

Item			Model / Unit	3TNE84												
SPECIFICATIONS	Application		—	CL		VM						CH		VH		
	Type		—	Vertical, 4-cycle water-cooled diesel engine												
	Combustion system		—	Direct injection system												
	No. of cylinders – Bore X Stroke		mm	3 – 84 X 90												
	Displacement		C˚	1.496												
	Firing order		—	1 – 3 – 2 – 1												
	Revolution speed		rpm	1500	1800	2000	2200	2400	2600	2800	3000	3000	3600	3200	3400	3600
	Output*	Continuous rating	kW(HP)	11.3 (15.2)	13.5 (18.1)	—	—	—	—	—	—	22.4 (30.0)	26.1 (35.0)	—	—	—
		Max. rating	kW(HP)	12.4 (16.6)	14.8 (19.8)	16.4 (22.0)	18.1 (24.3)	19.7 (26.4)	21.3 (28.6)	23.0 (30.8)	24.6 (33.0)	24.6 (33.0)	28.7 (38.5)	25.6 (34.3)	27.0 (36.2)	28.3 (38.0)
	Max. revolution speed at no load		rpm	1600^{+50}_{0}	1900^{+50}_{0}	2175^{+50}_{0}	2375^{+50}_{0}	2600^{+50}_{0}	2800^{+50}_{0}	3000^{+50}_{0}	3225^{+50}_{0}	3200^{+50}_{0}	3800^{+50}_{0}	3455^{+50}_{0}	3670^{+50}_{0}	3870^{+50}_{0}
	Min. revolution speed at no load			≤1200		≤800						≤1500		≤800		
	Direction of rotation		—	Counterclockwise (viewed from flywheel)												
	Power take off		—	Flywheel												
	Compression ratio		—	18.0												
	Fuel injection timing (FID, b.T.D.C.)		deg	10±1		12±1		14±1		16±1		24±1		18±1	20±1	24±1
	Compression pressure		MPa (kgf/cm²)	3.24 ± 0.1 (33 ± 1), at 250 rpm												
	Fuel injection pressure		MPa (kgf/cm²)	$19.6^{+1.0}_{0}$ (200^{+10}_{0})												
	Recommended diesel gas oil		—	ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.)												
	Lubrication system		—	Forced lubrication with trochoid pump												
	Lubricating oil capacity Max/Effective		C˚	4.7/1.8								6.9/2.1				
	Recommended lubricating oil		—	API grade CC class or higher												
	Cooling system		—	Liquid cooling/Radiator												
	Cooling water capacity		C˚	2.0 (for engine only)												
	Cooling fan No. of blade ¥ dia.		mm	Pusher type, 6 X Ø335												
	Crank V-pulley dia./ Fan V-pulley dia.		mm	Ø120/Ø90		Ø110/Ø110										
	Governor		—	Mechanical centrifugal governor (All speed type)												
	Starting system		—	Electrical												
	]1 Dimensions L X W X H		mm	589X486X623		556 ¥X 486 X 623 / 564 X 486 X 623						564 X 486 X 623		556 X 486 X 623/ 564 X 486 X 623		
	]1 Dry weight		kg	161		138/155						149		138 / 149		
PERFORMANCE	Governing perform-ance (full speed range)	Transient speed difference	%	≤10	≤8	≤12						≤10	≤8	≤12		
		Steady state speed band	%	≤5	≤4	≤9		≤8		≤7		≤5	≤4	≤8		
		Recovery time	sec	≤5		≤6						≤5		≤6		
		Fluctuation of revolution	rpm	≤15		≤25						≤30				
	L.O. press.	Rated operation	MPa (kgf/cm²)	0.29±0.05 (3.0±0.5)		0.34±0.05 (3.5±0.5)						0.39±0.05 (4.0±0.5)				
		Idling		≥0.06 (≥0.6)												

*1. Designation of engine dimension and dry weight in numerals.
CL/CH application: engine with flywheel housing
VM/VH application: engine with back plate/with flywheel hausing

COOLING WATER, LUBRICATING OIL AND FUEL OIL

COOLING WATER

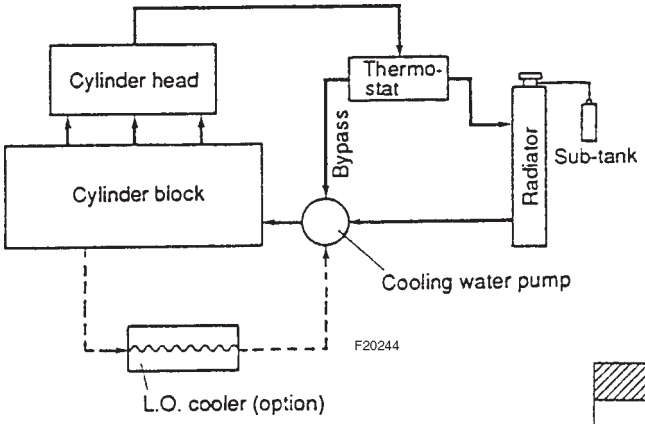
Proper use of cooling water

Impurities in cooling water are deposited in the engine and radiator in the form of scale and cause rusting. For this reason, heat conduction of the cooling system and cooling water flow are impaired, and cause cooling functions to reduce and the engine to overheat. Therefore, drain the cooling water at intervals of 400 hours or one year. Never use hard water as the cooling water.

In order to prevent the cooling water from freezing in cold weather, be sure to use an antifreeze agent. For further information on and proper usage and type of rust-preventive agents, antifreezes, and cleaning agents, contact your nearest dealer.

Cooling water system diagram

Indirect injection system and direct injection system.



LUBRICATING OIL

Proper use of lubricating oil

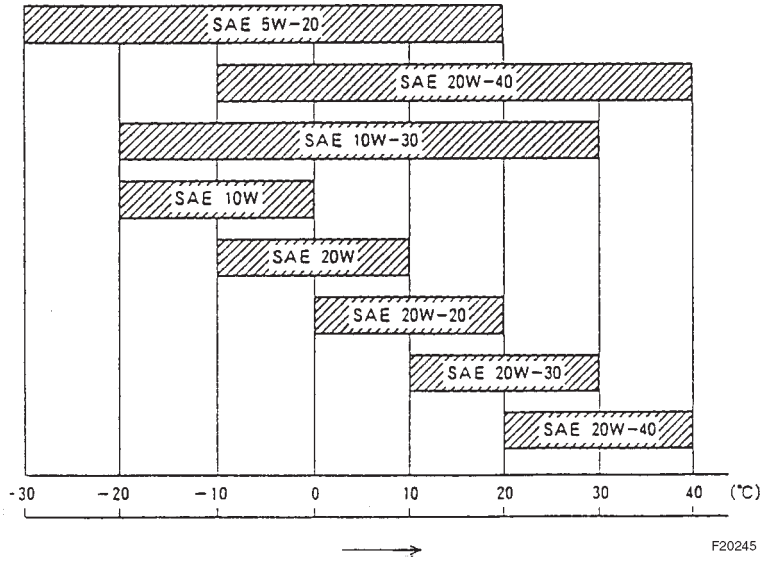
Use of proper lubricating oil brings about the following effects.

(1) The friction part of the engine is protected from friction and wear.
(2) The engine parts is protected from rusting and corrosion.
(3) The high temperature part of the engine is effectively cooled.
(4) The engine is protected from leakage of combustion gas.
(5) The engine parts are protected from sludge deposits.

For the above reasons, use lubricating oil API Service Classification Class CC or better. Instruct your customers to replace lubricating oil initially at 20-30 hours in a dusty place, 50 hours in a less dusty place, and at intervals of 250 hours (100 hours in a dusty place) thereafter.

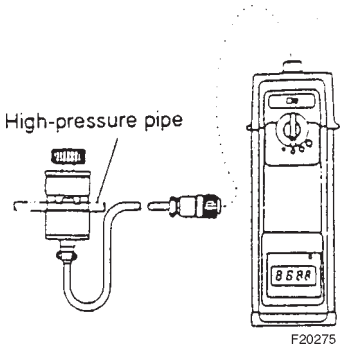
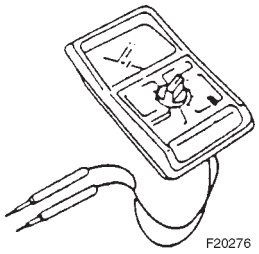
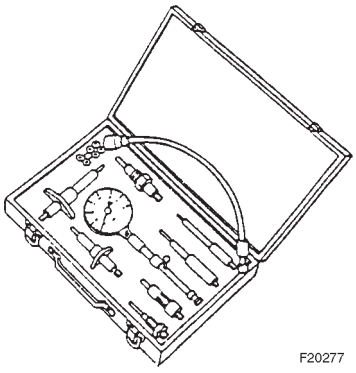
Reference: Lubricating oil to be used at ambient temperature

Select the viscosity of lubricating oil depending on ambient temperature at which the engine is used, according to SAE Service Grade shown below.



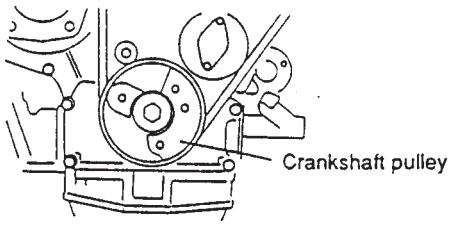
Ambient temperature at which the engine is used, °C

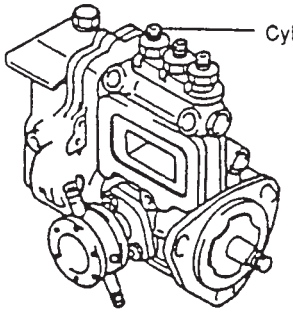
: Recommended SAE Service Grade

No.	Instrument name		Purpose of use	Illustration
16	Tachometer	High pressure fuel pipe clamping type	Measures engine RPM's using pulse system, irrelevantly to the center of the rotary shaft and the circumference of the rotary object.	
17	Circuit tester		Measures the resistance, voltage, and continuity of electric circuits.	
18	Compression gauge kit		Measures compression pressure. Yanmar Code No. TOL-97190080	

Direct injection system

(1) Using the crankshaft pulley, turn the engine in the specified direction. Check the injection timing at the delivery valve of the fuel injection pump for cylinder No.1. (Cylinders are numbered se-quentially from cylinder No. 1 from the flywheel side).

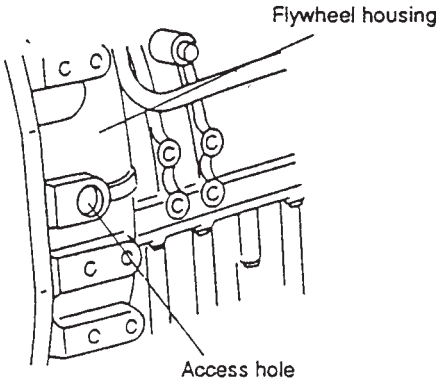


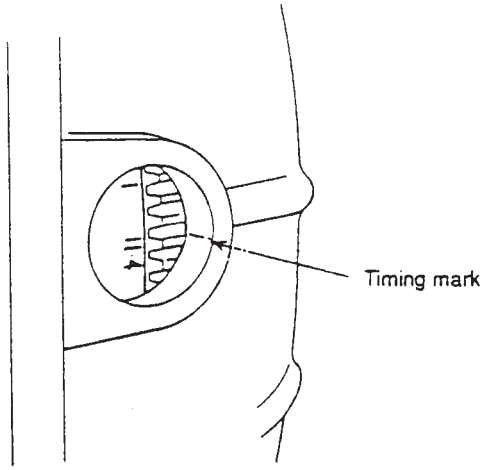


(2) When the crankshaft is turned in the specified direction, the oil level rises at the tip of the delivery valve spring holder. At that time, stop the crankshaft.

(3) Identify the timing mark stamped on the flywheel through the access hole of the flywheel housing.

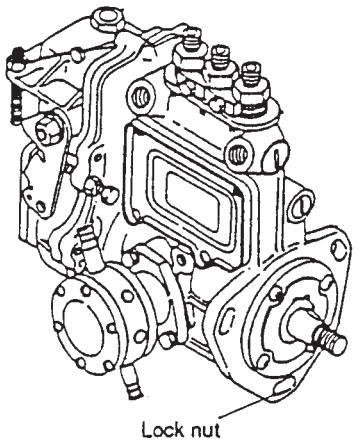
*: *For fuel injection timing for each engine model, refer to Chapter 1, Specifications and Performance.*



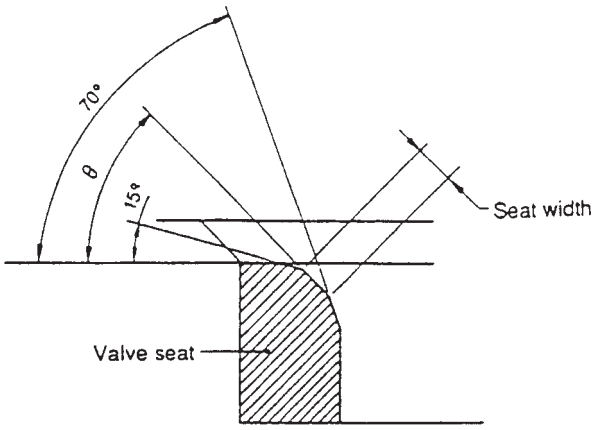


(4) If the measured injection timing differs from the specified timing, adjust the injection timing by turning down the fuel injection pump toward the engine or to the opposite side after loosening the lock nut of the fuel injection pump.

- If injection timing is late, turn down the fuel injection pump away from the engine.
- If the injection timing too early, turn the injection pump down toward the engine.



F20286



(Valve seat correction angle) F20298

(3) Knead valve compound with oil and finish the valve seat by lapping.

* *If any valve requires correction, be sure to measure the oil clearance between the valve stem outside dia. and valve guide inside dia. If the oil clearance exceeds the limit, replace the valve or valve guide before correcting the valve seat surface. (For oil clearance between the valve and valve guide, refer to section 3 in this chapter.)*

(4) Finally, lap the valve using only oil.

* *1. After the valve seat is corrected, thoroughly clean the valve and cylinder head using diesel oil or the like. Thoroughly remove the valve compound or grindstone powder.*

2. For slightly poor contact, take steps (3) and (4).

[Extraction of Valve seat]

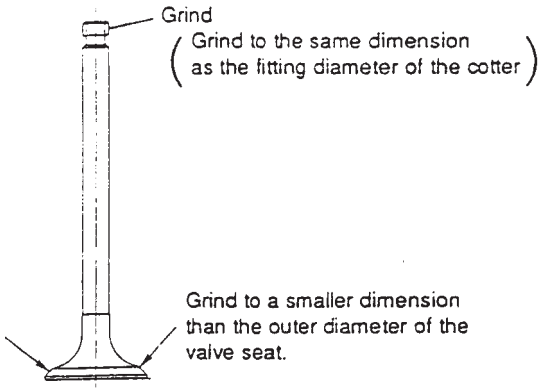
Without valve seat	2/3TNE68: 3 TNE74: Direct injection system:	All VM CL and VM
With valve seat	3TNE74 (IDI): Direct injection system: Turbocharged engine:	CH and VH CH and VH All

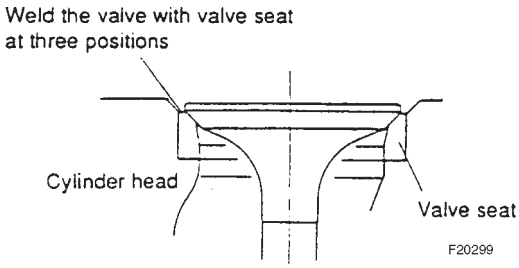
(1) Grind the circumference of the intake/exhaust valve head being or having been used to the dimension smaller than the valve seat outer diameter.

(2) Grind the circumference of the stem end of the valve to the same dimension as the fitting diameter of the cotter.

(3) Weld the intake/exhaust valve head with the valve seat at three positions.

(4) Hit the stem end of the intake/exhaust valve to extract the valve seat.





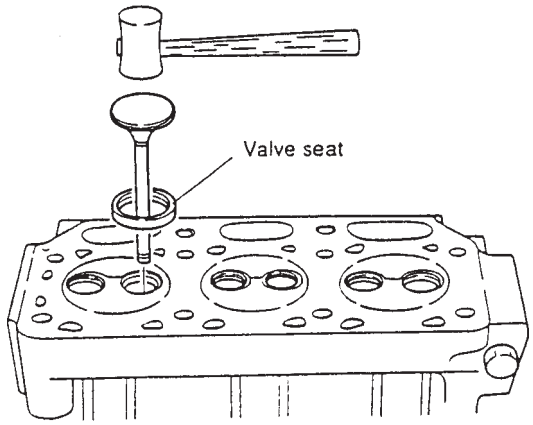
[Insertion of valve seat]

(1) Put the valve seat in a container which contains liquefied nitrogen, or ether or alcohol with dry ice to cool it sufficiently.

(2) Heat the cylinder head around the portion for valve seat insertion to 80~100˚C with a dryer.

(3) With the new intake/exhaust valve, securely insert the sufficiently cooled valve seat into the cylinder head by tapping the head of the intake/exhaust valve.

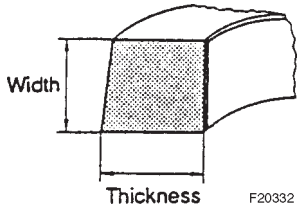
(4) Stand the cylinder head until the entire cylinder head is cooled to normal temperature.



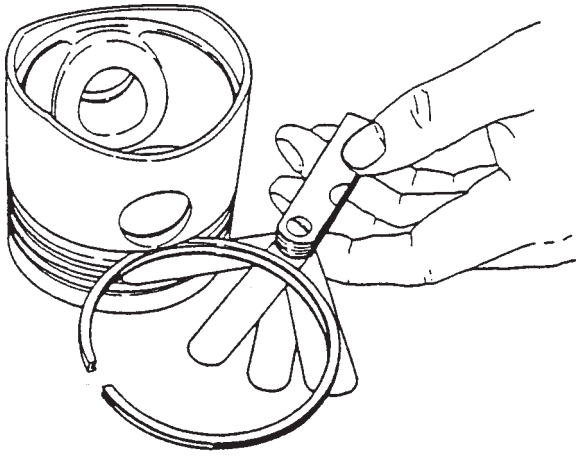
(Insertion of valve seat) F20300

Measuring the ring groove width, ring width, and end clearance

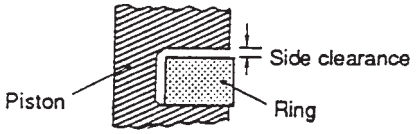
To measure the piston ring groove width, first measure the width of the piston ring. Then, insert the piston ring into the ring groove that has been carefully cleaned. Insert a thickness gauge in between the piston ring and groove to measure the gap between them. Obtain the ring groove width by adding ring width to the measured side clearance.

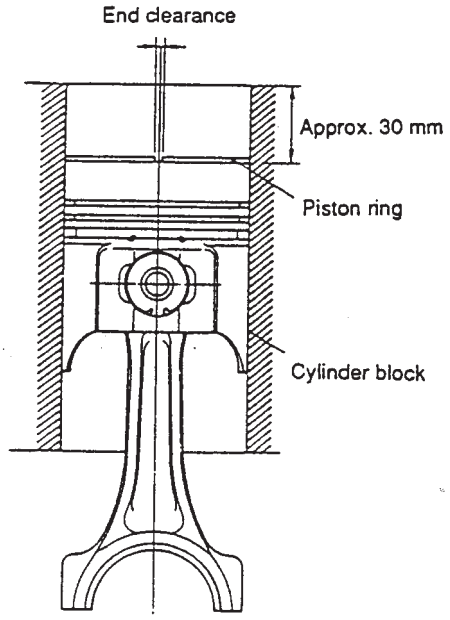


To measure the end clearance, push the piston ring into the sleeve using the piston head, insert a thickness gauge in end clearance to measure. If the sleeve is worn, measure the end clearance after pushing the piston ring to the portion of the sleeve which is less worn (approx. 30 mm from the lower end of the sleeve).



(Measuring the side clearance) F20333



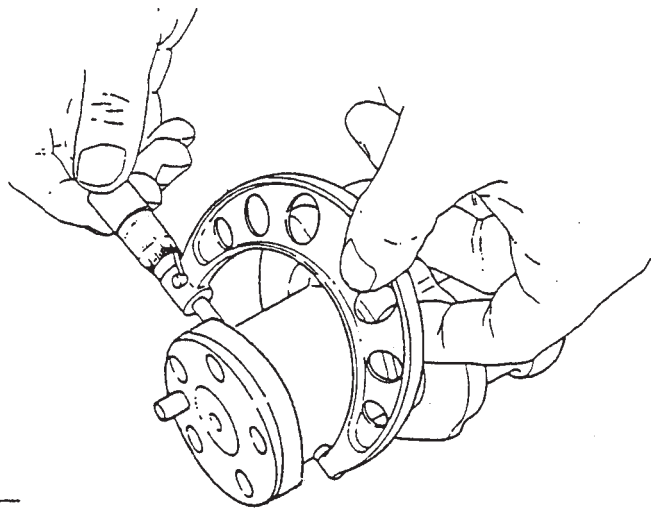


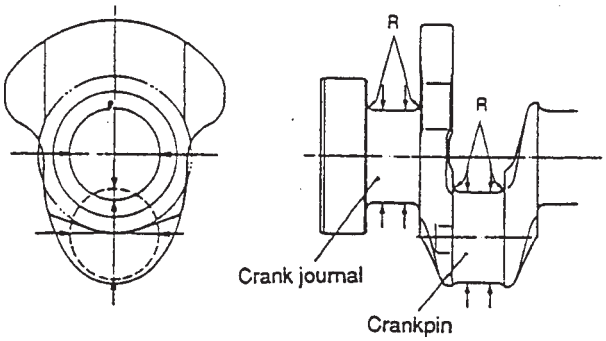
(Measuring the end clearance of piston ring) F20334

Measurement of crankpin and journal

Measure the outside diameter, roundness, taper angle of the crankpin and the journal. If uneven wear or roundness exceeds the wear limit but measured outside diameter is within the limit, use the crankpin and journal after correcting them by regrinding. Replace them with new ones, if any of the limit is exceeded.

An oversized crankpin metal by 0.25 mm is available.





(Measuring position of the crankpin and crankjournal)

F20354

(mm)

		2/3TNE68		3TNE74		3TNE78A 4TNE82A 3/4TNE88		3/4TNE82, 3/4TNE84(T),	
		Standard	Wear limit	Standard	Wear limit	Standard	Wear limit	Standard	Wear limit
Crankpin	Crankpin outside diameter	35.970 ~35.980	35.91	39.970 ~39.980	39.91	42.952 ~42.962	42.91	47.952 ~47.962	47.91
Crank journal	Crankshaft journal outside diameter	39.970 ~39.980	39.90	43.970 ~43.980	43.90	46.952 ~46.962	46.91	53.952 ~53.962	53.91
	Bearing metal thickness	1.487 ~1.500	—	1.987 ~2.000	—	1.987 ~2.000	—	1.995 ~2.010	—
	Crank journal and bushing oil clearance	0.033 ~0.059	0.15	0.033 ~0.059	0.15	0.038 ~0.093	0.25	0.038 ~0.068	0.15

<table>
<tr><th>Step</th><th>Removal Parts</th><th>Remarks</th></tr>
<tr><td></td><td></td><td>Apply a dial gauge to the end of crankshaft (65). Force the crankshaft on both sides in the axial direction to measure the thrust gap. Alternatively, insert a thickness gauge directly between the base thrust metal and the thrust surface of the crankshaft to measure the gap.
If the limit size is exceeded, replace the thrust metal with a new one.
(mm)<table><tr><td></td><td>All models</td></tr><tr><td>Thrust gap</td><td>0.090 ~ 0.271</td></tr></table>2. Notice on the removal of thrust metal 73
(1) When removing thrust metal (73), ascertain the position and direction where thrust metal is installed in relation to the cap.
(2) Make sure that the thrust metal groove is outward in relation to the cap.</td></tr>
<tr><td>24</td><td>1. Remove piston (66) and connecting rod (67) assembly.</td><td>1. To selectively remove a desired piston and connecting rod assembly without extracting crankshaft (65), take the steps itemized below:
(1) Remove carbon deposits from the upper wall of the cylinder using fine sandpaper, taking care not to damage the inner surface of the cylinder.
(2) While turning the crankshaft, with the crankpin side cap 64 removed, raise the piston up to the top dead center (TDC).
(3) Extract the piston/connecting rod assembly while tapping the connecting rod (67) at the large end with the handle of a plastic hammer or the like.</td></tr>
<tr><td>25</td><td>1. Remove tappet (59).</td><td></td></tr>
</table>

CONNECTING ROD

(Unit: mm)

Item \ Model		2/3TNE68		3TNE74		3TNE78A 3TNE82A		3/4TNE82, 3/4TNE84(T), 3/4TNE88	
		Standard	Wear limit	Standard	Wear limit	Standard	Wear limit	Standard	Wear limit
Crankpin side	Crankpin bushing inside dia.	39.000 ~39.016	—	43.000 ~43.016	—	46.000 ~46.016	—	51.000 ~51.010	—
	Crankpin metal thickness	1.487 ~1.500	—	1.487 ~1.500	—	1.487 ~1.500	—	1.492 ~1.500	—
	Crankpin outside dia.	35.970 ~35.980	35.91	39.970 ~39.980	39.91	42.952 ~42.962	42.91	47.952 ~47.962	47.91
	Oil clearance	0.033 ~0.059	0.15	0.033 ~0.059	0.15	0.038 ~0.090	0.16	0.038 ~0.074	0.16
Piston pin side	Piston pin bushing inside dia.	20.025 ~20.038	20.10	21.025 ~21.038	21.10	23.025 ~23.038	23.10	26.025 ~26.038	26.10
	Piston pin outside dia.	19.991 ~20.000	19.90	20.991 ~21.000	20.90	22.991 ~23.000	22.90	25.987 ~26.000	25.90
	Oil clearance	0.025 ~0.047	0.2	0.025 ~0.047	0.2	0.025 ~0.047	0.2	0.025 ~0.051	0.2
Twist and parallelism		Less than 0.03 per 100 mm	0.08	Less than 0.03 per 100 mm	0.08	Less than 0.03 per 100 mm	0.08	Less than 0.03 per 100 mm	0.08

CAMSHAFT

(Unit: mm)

Item \ Model		2/3TNE68		3TNE74		3TNE78A/82A, 3/4TNE82, 3/4TNE84(T), 3/4TNE88	
		Standard	Wear limit	Standard	Wear limit	Standard	Wear limit
Gear side	Camshaft journal outside dia.	35.940 ~35.960	35.85	39.940 ~39.960	39.85	44.925 ~44.950	44.85
	Oil clearance	0.040 ~0.085	—	0.040 ~0.085	—	0.040 ~0.130	—
Intermediate	Camshaft journal outside dia.	35.910 ~35.935	35.85	39.910 ~39.935	39.85	44.910 ~44.935	44.85
	Oil clearance	0.065 ~0.115	—	0.065 ~0.115	—	0.065 ~0.115	—
Flywheel side	Camshaft journal outside dia.	35.940 ~35.960	35.85	39.940 ~39.960	39.85	44.925 ~44.950	44.85
	Oil clearance	0.040 ~0.125	—	0.040 ~0.125	—	0.050 ~0.100	—

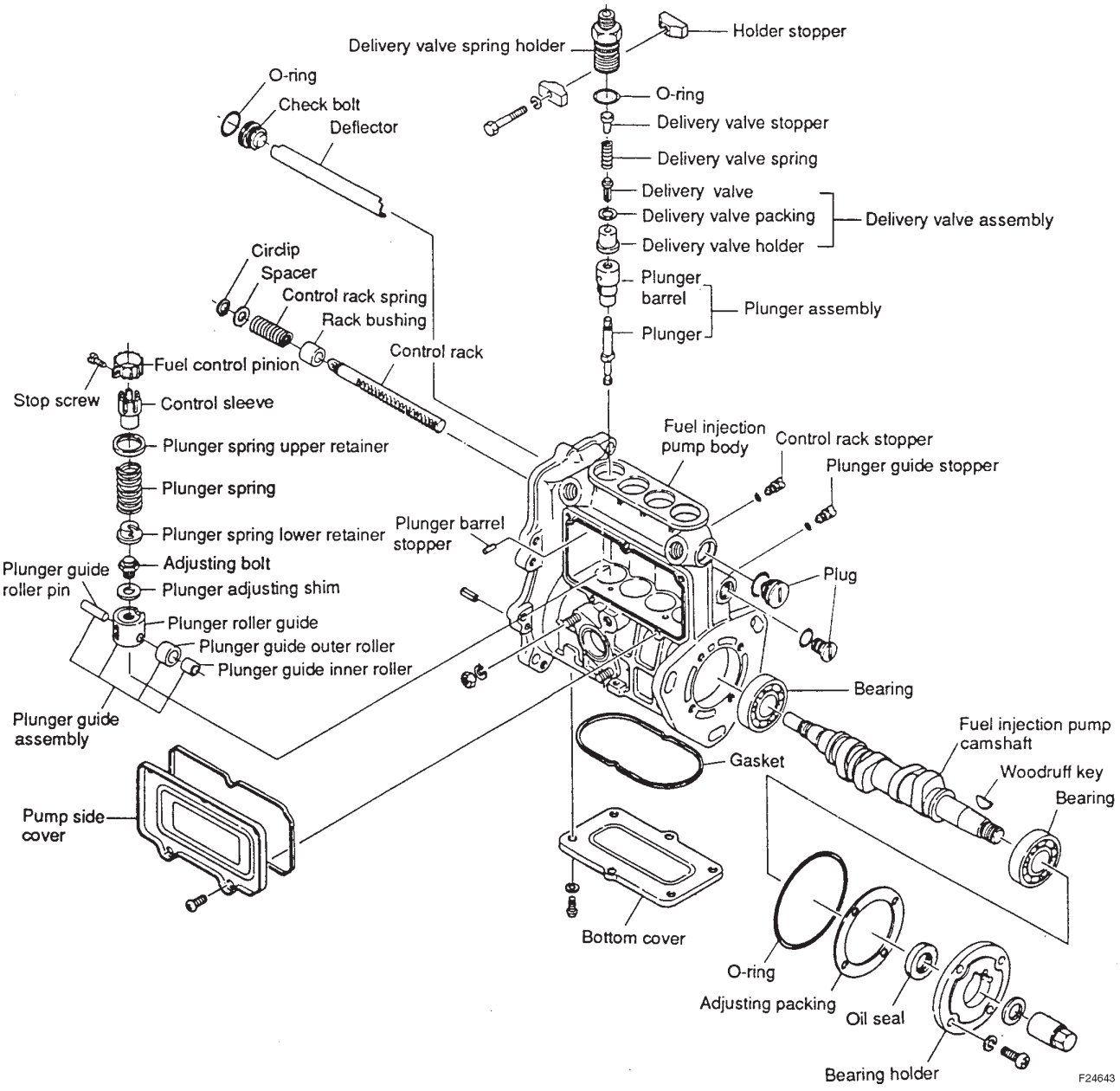
CRANKSHAFT

(Unit: mm)

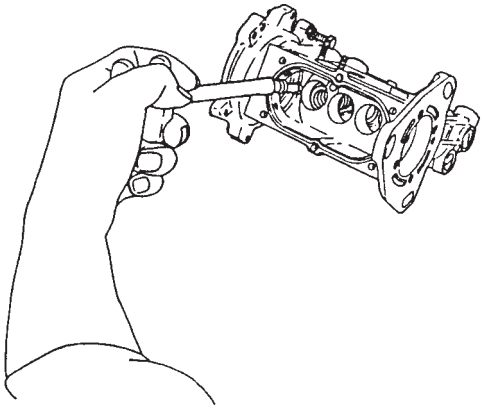
Item \ Model		2/3TNE68		3TNE74		3TNE78A 3TNE82A		3/4TNE82, 3/4TNE84(T), 3/4TNE88	
		Standard	Wear limit	Standard	Wear limit	Standard	Wear limit	Standard	Wear limit
Crank journal	Crankshaft journal outside dia.	39.970 ~39.980	39.90	43.970 ~43.980	43.90	46.952 ~46.962	46.91	53.952 ~53.962	53.91
	Bearing metal thickness	1.487 ~1.500	—	1.987 ~2.000	—	1.987 ~2.000	—	1.995 ~2.000	—
	Crank journal and bushing oil clearance	0.033 ~0.059	0.15	0.033 ~0.059	0.15	0.038 ~0.093	0.25	0.038 ~0.068	0.15
Bend		0.02 or less	—	0.02 or less	—	0.02 or less	—	0.02 or less	—

FUEL INJECTION PUMP FOR DIRECT INJECTION SYSTEM

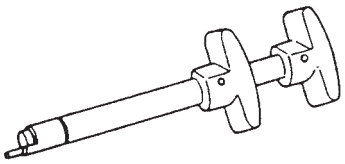
EXPLODED VIEW (YPES TYPE)



(9) Mount the plunger spring lower retainer on the top of the plunger. While aligning the match mark of the plunger flange with that of the control sleeve, reassemble the plunger from the bottom of the fuel injection pump using a plunger insertion tool (special service tool).



(Insertion of plunger with a special service tool: Plunger insertion tool)

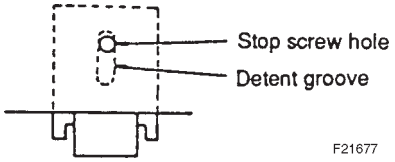


(Special service tool: Plunger insertion tool) F21673

* *Never reassemble the plunger in reverse. Otherwise, fuel injection volume increases excessively to the point where fuel injection volume becomes uncontrollable.*

(10) Insert the plunger guide assembly into the fuel injection pump from its bottom. Push up the plunger guide using the handle of a hammer, etc., and put a tappet holder (special service tool) in between the lower spring retainer and fuel injection pump body.

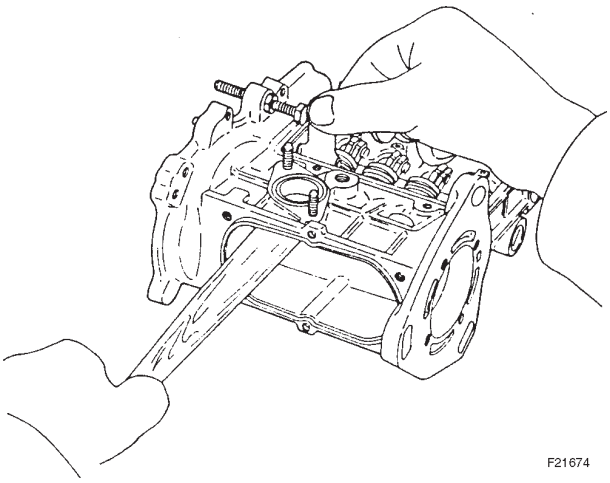
*1. *While keeping the plunger guide detent groove facing upward, align with the mating screw hole of the plunger guide stopper on the fuel injection pump body.*



F21677

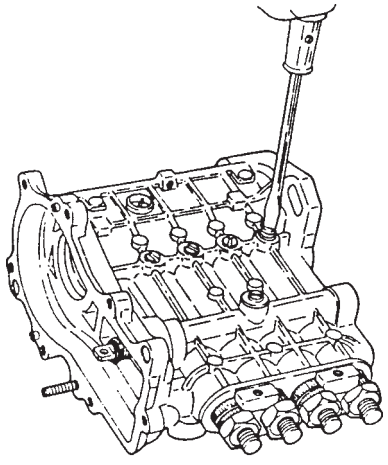
*2. *Check to see if the control rack moves freely. If not, the plunger spring interferes with something else. In this case, hold the plunger spring in position using a screwdriver.*

*3. *When replacing the plunger guide assembly with a new one, insert the standard shim, and temporarily tighten it.*

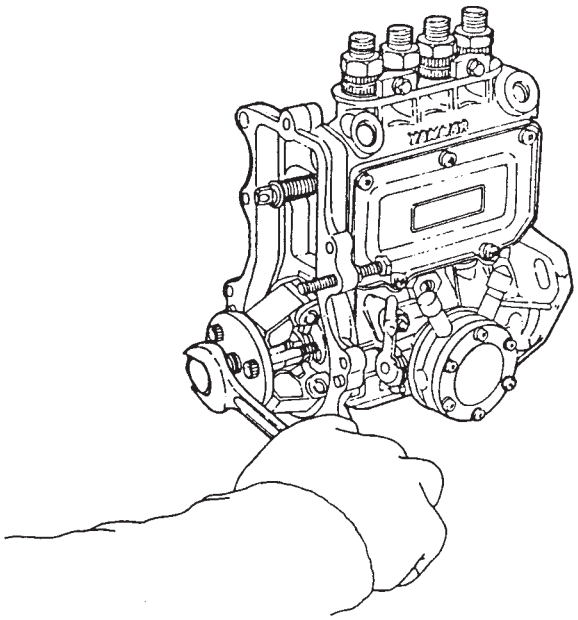


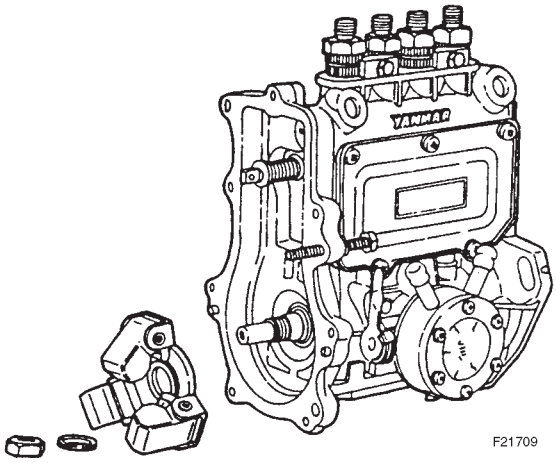
F21674

(11) Make sure that the plunger guide detent groove is in position. Tighten the plunger guide stopper.



F21676

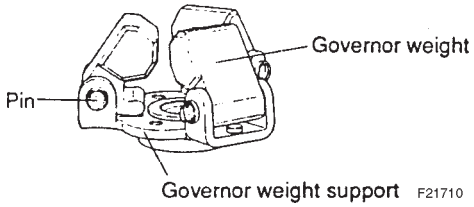




INSPECTION

Inspection of governor weight assembly

(1) Replace the governor weight if it does not open and close smoothly.



(2) Replace the governor weight assembly if the contact surface with governor sleeve is extremely worn.

(3) Replace if there is governor weight support and pin wear or the the caulking is loose.

(4) Replace if the governor weight support stopper is excessively worn.

Inspection of governor sleeve

(1) Replace the governor sleeve if the contact surface with governor weight is worn or there is pitching.

(2) Replace the governor sleeve if the contact surface with shifter is excessively worn or there is pitching.

(3) If the governor sleeve does not move smoothly on the fuel injection pump camshaft due to governor sleeve inner dia. wear or other reasons, replace.