NIKKISO CO., LTD.

NIKKISO Metering Pumps
MX Series Diaphragm Type

■ Instruction Manual ■

Manual No. 2210 R1

ISO 14001 HIGASHIMURAYAMA PLANT

ISO 9001 HIGASHIMURAYAMA PLANT

PRECAUTIONS

1. Read this instruction manual prior to installation, piping and operation.
2. This manual must be kept where anyone who uses this equipment can read it easily.
3. If this equipment is used at any specifications other than the original specifications, the manufacturer can bear no responsibility for the result.

Revised: February, 2002

NIKKISO Metering Pumps
of MX Series
Diaphragm Type

CONTENTS

This operation manual consists of the following sections. Please read the manual thoroughly.

Preface

(1) This manual describes how to operate and maintain the NIKKISO metering pump with MX series diaphragm type. In order to secure safe operation, never access the pump until the operator completely understands the system. Read this manual thoroughly before installation, wiring, operation and maintenance. Furthermore, keep this manual at the specified place for a pump operator to refer it promptly.

(2) Items that require caution are marked ⚠ CAUTION

The meanings of the warnings are described in "**SAFETY PRECAUTIONS**" on the next page. Read and understand the precautions before operation.

(3) Note that NIKKISO is not responsible for the following:
- Any accident caused by usage other than original specification.
- Any accident caused by usage not specified in the operation manual.
- Any accident caused by usage not observed in the operation manual.
- Any accident caused by use of a maintenance part not manufactured by NIKKISO or not specified by NIKKISO.
- Corrosion of the pump by the handled liquid.

(4) Always consult NIKKISO before attempting any modifications.

(5) Perform periodic maintenance in accordance with the operation manual.

(6) Should any part of the manual be damaged or lost, or should you need to check the specifications of your equipment, contact our local agent listed on the back of this booklet. In such a case, note the serial number given in the equipment delivery specification or on the name plate.

(7) Product(s) (including parts, technical data or information thereto) described in this manual shall be subject to export control laws and regulations of Japan or the US. You need to obtain the approval from appropriate government(s) when you export if such laws and regulations require.

SAFETY PRECAUTIONS

Before installation, maintenance, and checkup, carefully read this manual and other documents supplied with the equipment. Use the equipment only after fully understanding the equipment, safety, and precautions.

<Definitions of safety alert Symbols>

The symbol ⚠ is used in this manual to alert you before starting any action or operation.

The symbol ⚠ is followed by a DANGER, WARNING or CAUTION warning, and a description of the warning. For the safety of personnel and the equipment, it is extremely important to follow the warning.

Warnings are classified into the following three types depending on the degree of potential hazard caused by misuse:

⚠ **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 hazardous situation which, if not avoided, could result in minor or moderate injury or damage to property.

NOTE: : indicates information given for reference.

⚠ WARNING

1. At the time of installation
   (1) Be sure to connect the motor to ground (with ground wire), otherwise there is a possibility of receiving an electric shock.

2. Before disassembly
   (1) Always turn off the power supply to the motor, otherwise there is a possibility of receiving an electric shock.
   (2) When the handled liquid is hazardous, remove or replace the hazardous liquid before attempting disassembly by flushing with safe liquid or other similar procedure. When disassembling a pump, wear appropriate personal protective equipment.

3. At the time of shipment to the manufacture
   (1) When a pump is returned to the manufacturer for periodical check or repair, remove handled liquid completely, and clean inside the pump.

⚠ CAUTION

1. At the time of installation of pump and piping
   (1) When conducting pressure test of piping, never apply the test pressure to the pump, this may damage the pump.

2. During operation
   (1) Avoid unnecessary shut-off operation, this may damage the pump.
   (2) Do not operate the pump while cavitation occurs, this may damage the pump.
   (3) When the safeguard or emergency signal system is activated, stop the pump immediately. Identify and solve the cause of the problem.
   (4) Do not touch rotating or reciprocating parts directly. They may cause injury.
   (5) The bearing housing of the pump, the stuffing box, and motor surface become hot. Do not touch them directly. They may cause a burn.

3. At the time of scrapping
   (1) When disposing of the pump unit, resin parts, packings, lubricating oil, etc., disposed procedure must be obeyed in accordance with the laws and regulations.

SAFETY ALERT LABELS

The following labels are indications to secure a safe environment when operating or maintain the pump system. If the label is torn, removed or lost, apply it to the same position again or replace it to a new one. When ordering a new label, contact our local agent listed on the back of this booklet.

[Applied positions of the safety alert labels]

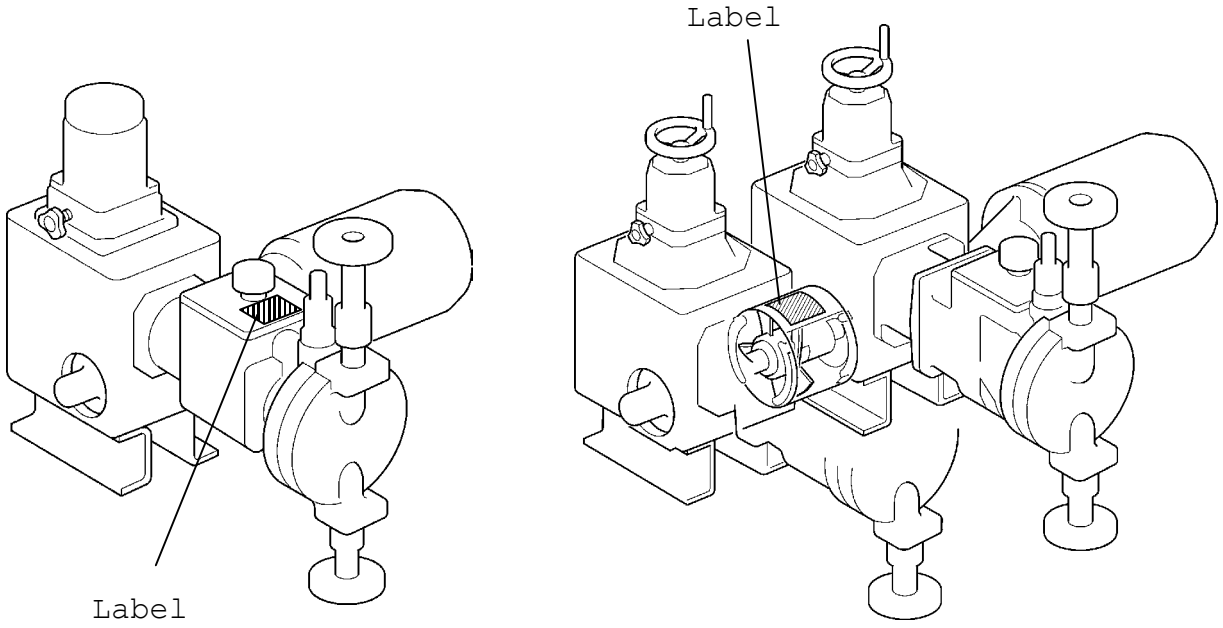


Fig. 1 Applied positions of the safety alert labels

[Indication of the safety alert labels]

Label

Label (When the pump is equipped with the cooling fan)

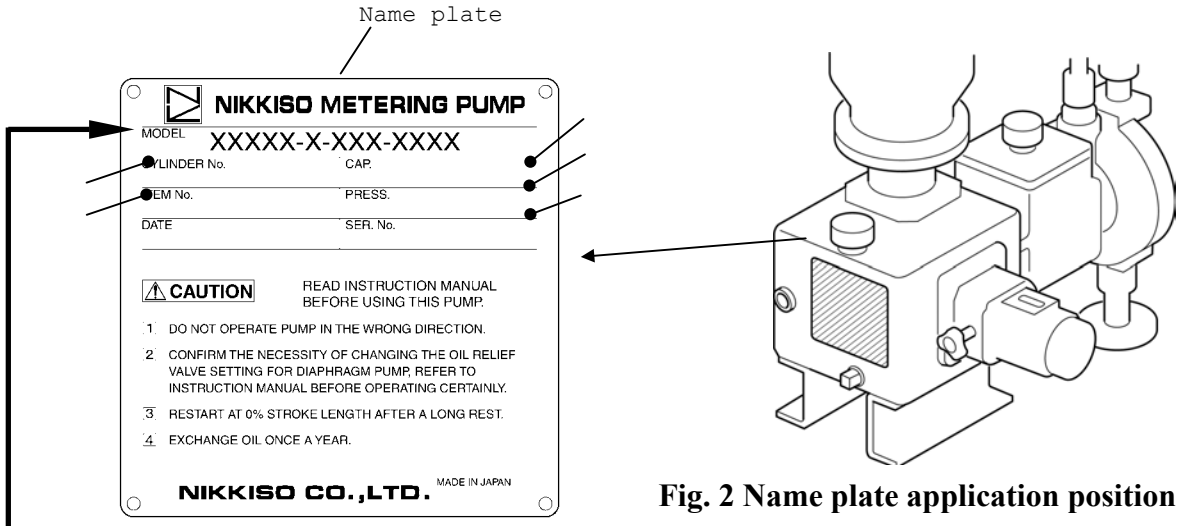


Fig. 2 Name plate application position

- Cylinder No.: Cylinder No. of the multiplex pumps
- Model No.: Type of the pump
- Capacity: Discharge flowrate
- Pressure: Discharge pressure
- Manufacturer's number: Serial number of the pump

Model No. Indication

Pump frame				
1	M	3	H	A
1	2	3	4	5

Stroke length adjusting unit
G
6

Power End		
V	0.8	F
7	8	9

Liquid end			
40	D1	P	SP
10	11	12	13

Pump model is abbreviated with , and . (Example: M3H)

Pump No..... Number of multiplexed pumps

Series..... M: MX series

Stroke Length .....

1	2	3	4	5
15 mm	22 mm	35 mm	55 mm	80 mm

Construction.....

L	Type L (low pressure type)
H	Type H (middle and high pressure type)

Reduction gear symbol.....

Indicates the reduction ration of the gear.

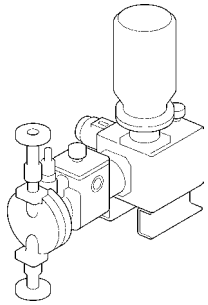
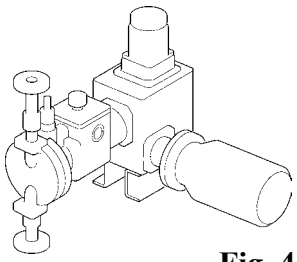
Reduction symbol	A	B	C	D	E	F
Reduction ratio	1/26	1/20	1/16	1/13	1/10	1/16
Pump speed (rpm) 50/60Hz	55.9 /67.1	72.7 /87.3	90.9 /109.1	111.9 /134.3	145.5 /174.6	181.8 /218.2

*A-E: 4-pole motor, F: 2-pole motor (Allowance of 3% motor slip)

Stroke length adjustment.....

No indication	Manual
E	Electric (totally enclosed type)
F	Electric (explosion-proof type, Exd BT5)
G	Electric (totally enclosed type) with controller built in
H	Electric (explosion-proof type, Exd BT5) with controller built in
A	Pneumatic air motor type (cylinder actuator type)

Motor Types.....

V	Vertical type (simplex and manual stroke length adjustment)  **Fig. 3 Vertical type (MV)**
H	Horizontal type (simplex with servo unit, multiplex type)  **Fig. 4 Horizontal type (MH)**

Power..... Motor output (kW) is indicated.
Example: 0.4 for 0.4 kW (raised 0.8 for 0.75 kW)

Speed alteration (speed is adjustable)

Variable speed	F	Inverter controlled motor
	G	Speed controllable motor other than inverter type
Fixed	No indication	4-pole motor
	T	8-pole motor
	P	6-pole motor
	K	2-pole motor

Plunger / piston diameter (mm)..... Disregarding fractions below the decimal point
Example: 3 for 3.2 mm

Material Indicates the material and the material code of the liquid end main body

Code	Material	Code	Material	Code	Material
A1	Cast iron	D2	SUS316L/SCS16	L2	Zirconium
B1	Cast steel	D5	SUS316J1L/SCS20	M1	Hard polyvinyl chloride
B3	Forged steel	E1	Carpenter 20	N2	PFA lining
C1	SUS304/SCS13	G1	Hastelloy B	-	PTFCE
C2	SUS304L/SCS19	G2	Hastelloy C	P1	Transparent acryl
C3	SUS321	G5	Monel	N5	PVDF
D1	SUS316/SCS14	L1	Titanium		

Any materials other than those above should be indicated by × × in principle.

Type of liquid end

P	Single diaphragm type
R	Diaphragm type with diaphragm failure detector
K	Packed plunger type
M	Metallic diaphragm type
L	Metallic diaphragm type with diaphragm failure detector
N	Exclusive use for Sodium hypochlorite
S	Exclusive use for Sodium hypochlorite

Special construction ..... SP for special specifications

NOTE:
For multiplex pumps, if the pump has three or more different kinds of liquid end types, plunger diameters, materials, etc., an abbreviation MUT is used in the column of Liquid end.
Example: 3 M 4 H E – H 7.5 – MUT

1 Installation and Piping

⚠ CAUTION

(1) There is the possibility of an unstable situation during removal from the temporary base because of its high and asymmetrical center of gravity. Furthermore, some types of the model have a small distance between the base surface and the lower portion of the suction flange. During moving or installation after unpacking, take adequate care to prevent the pump from being inverted.

(2) Do not put weight on the pump. That may cause deformation or damage to the coupling cover, resin parts, etc.

1.1 Unpacking and Storage

(1) When unpacking, take care to avoid shocks**.**

(2) Upon unpacking, check the pump for any damage. Also, check the accessories and spare parts.

(3) Report any damage, which seems to be caused by transportation, to Nikkiso promptly.

(4) If storage in excess of 6 months is necessary, anti-rust treatment is required. For the anti-rusting procedure, contact Nikkiso.

1.2 Foundation and Installation

(1) Provide space around the pump to facilitate safe operation and maintenance. Secure enough maintenance space to remove the installation bolts of the pump.

NOTE:

A maintenance space is required which satisfies the 90-degree rotation of the crankcase during the disassembly of the type-MV for periodical inspection. (Refer to sec.6-4 “disassembly”)

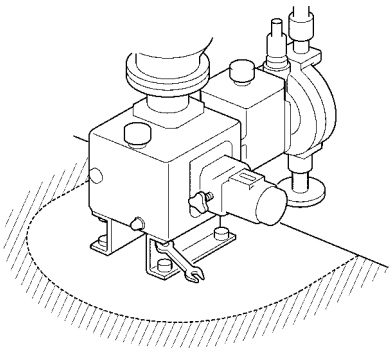


Fig.1-1 Maintenance space

(2) Do not grout or set the base plate directly into the foundation.

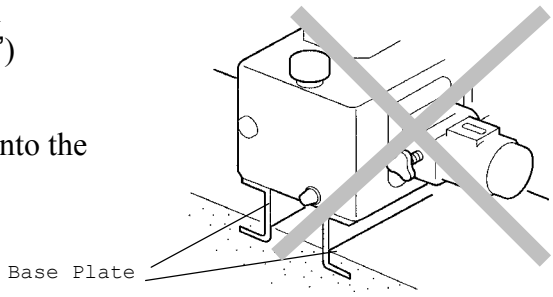


Fig.1-2 Do not grout

(3) Attach the pump firmly with anchor bolts. Use a leveling device to ensure the machine is level.

(4) The pump should not be more than 5 mm/1m out of level as measured on the base plate or on an horizontal surface of the pump frame.

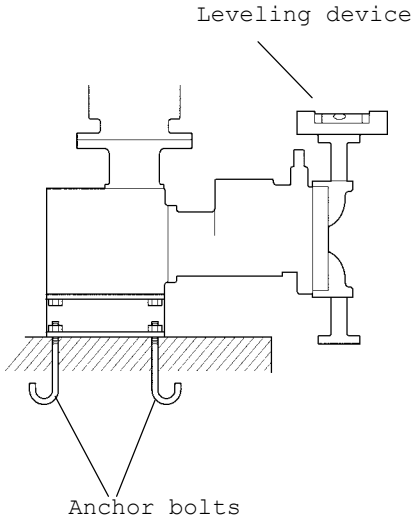


Fig.1-3 Fixing and leveling

(5) The motor, pumps, and worm shafts are connected through couplings. A centering adjustment between the motor output shaft and the worm shaft is required for a foot mount motor, or for the multiplex pump which has a fan. Likewise, centering between the worm shafts are required for the multiplex system after completion of the installation.

NOTE:
Normally, the centering is not required because centering is precisely set by the motor bracket or adapter.

1.2.1 Centering

(1) To check centering, mount a dial gauge to the coupling on measure the parallelism and concentricity by turning the motor shaft by hand.

(2) The tolerance on the centering is as follows.

Table 1-1 Table of Centering tolerance Unit: mm

Model	**A**: Parallelism tolerance	**B**: Concentricity tolerance
M1	0.82	0.40
M2	0.82	0.40
M3	0.85	0.44
M4	1.05	0.50
M5	1.35	0.56

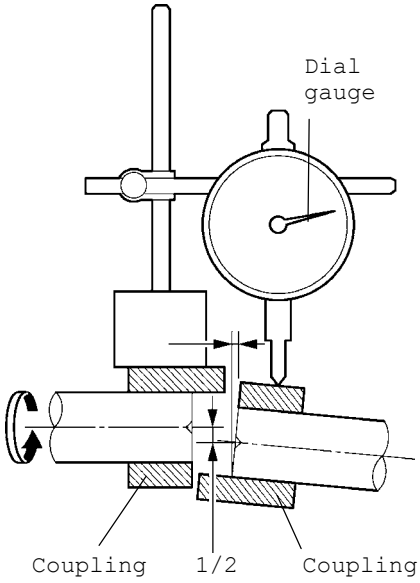


Fig.1-4 Centering of the coupling

1.3 Piping

⚠ CAUTION

(1) Support each pipe separately at points near the pump so that the pump body is not loaded.

(2) If a high temperature or low temperature liquid is to be handled, take measures so that the pump is not overloaded due to thermal distortions of the piping.

(3) It is necessary to have an external relief valve and a pressure gauge in the discharge piping.

(4) In the pressure test of piping, prevent the test pressure from being applied to the pump as it may deform or damage the diaphragm.

(1) The piping shall meet the piping conditions (NPSH and minimum required differential pressure). Especially when the pump operates at the speed of more than 130 rpm, it is necessary to investigate the piping by considering the acceleration head. For the piping conditions, etc., refer to NIKKISO technical data.

(2) Before connecting the piping to the pump, blow the air through the inside of the piping so that no welding debris, dust, etc., remain inside the piping.

NOTE:

If dust or foreign material remains in the piping, it may cause check valve clogging to result in discharge malfunction or cause damage to the check valve.

(3) In order to facilitate disassembly and reassembly of the liquid end, insert short pipes in the vicinity of the pump outlet and inlet flanges.

(4) The piping should be made as short and straight as practicable so that no air pockets form inside it.

(5) If the handling liquid is a gas forming liquid , such as sodium hypochlorite, or the handling liquid contains solid particles, special care is required.

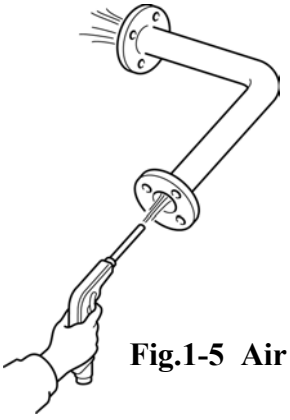


Fig.1-5 Air blow cleaning

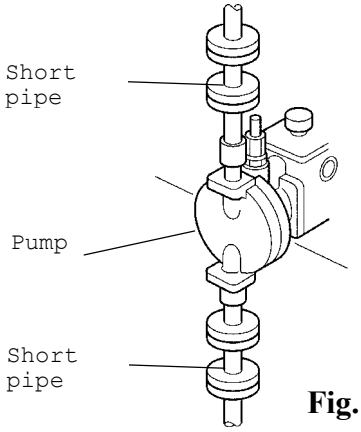


Fig.1-6 Short pipe

1.3.1 Suction Piping

(1) Normally, the pump should be used in a flooded condition.

(2) In case of priming, a foot valve and priming pipe shown in Fig.1-7 are necessary at the time of startup.

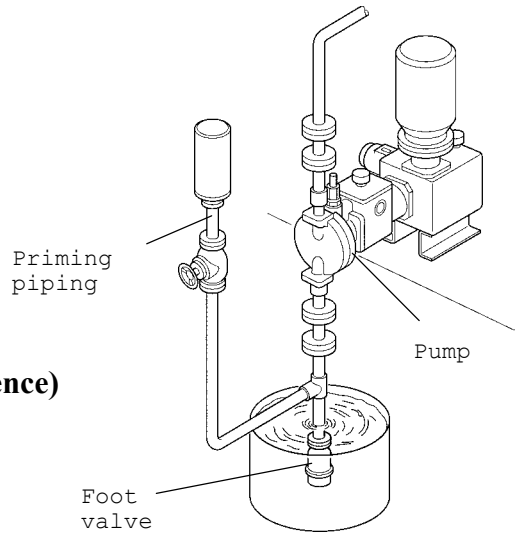


Fig.1-7 Priming piping (reference)

(3) When handling the gas forming liquid, provide a gas vent pipe in the inlet piping just near the pump.

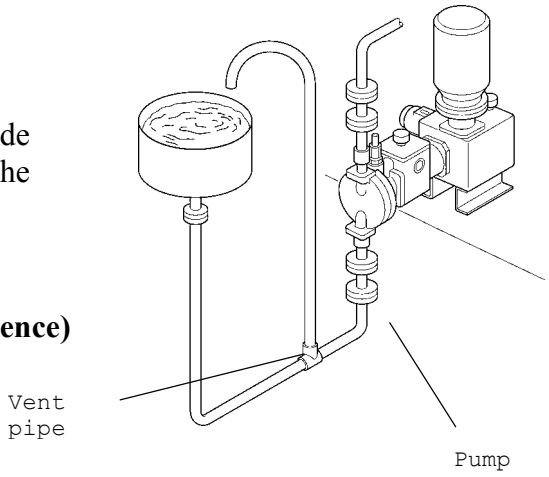


Fig.1-8 Gas vent pipe (reference)

(4) Take care to prevent the leakage of air into the suction piping.

(5) In order to facilitate maintenance, provide a block valve in the vicinity of the pump inlet.

(6) The block valve may clog and discharge become poor if foreign matter in the suction piping goes into the pump. To prevent this, take measures such as providing a strainer.

NOTE:

It is recommended to install the strainer.

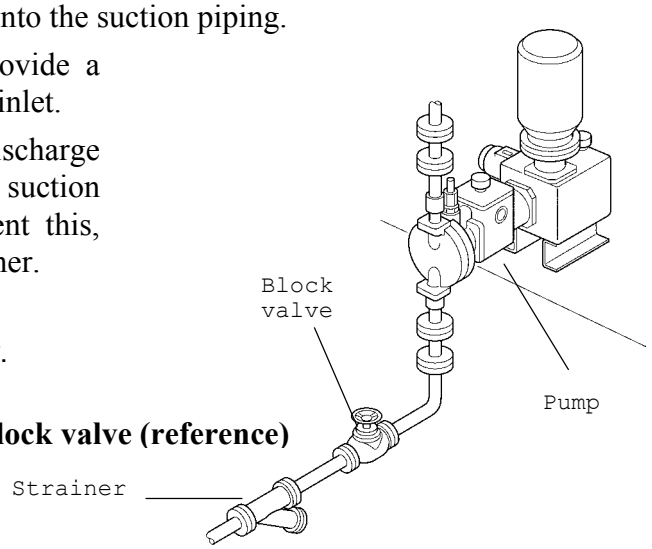


Fig.1-9 Strainer and block valve (reference)

1.3.2 Discharge Piping

(1) Relief valves

There are two relief valves.
One is a external relief valve which is installed in the discharge piping to protect the equipment in that piping. The other is the oil relief valve which is equipped with the pump to protect itself.

- The pump is originally equipped with the oil relief valve. In addition, the customer should install the external relief valve (optional) in the discharge piping system.
- The external relief valve should be installed between the pump and the block valve in the discharge piping.
- Do not apply pressure to the external relief valve outlet piping, and take care not to spray the liquid when it is operating.

NOTE:

Please adjust the set pressure of external relief valve in case its outlet piping is usually pressurized.

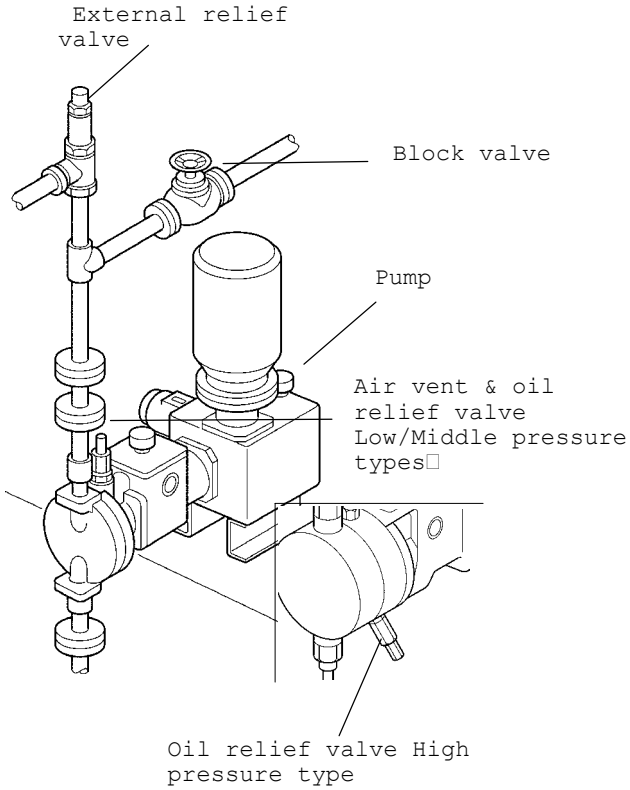


Fig.1-10 Relief valve and oil relief valve

- NIKKISO prepares the following external relief valves. It is an optional.

Relief Valve (Model : NV)

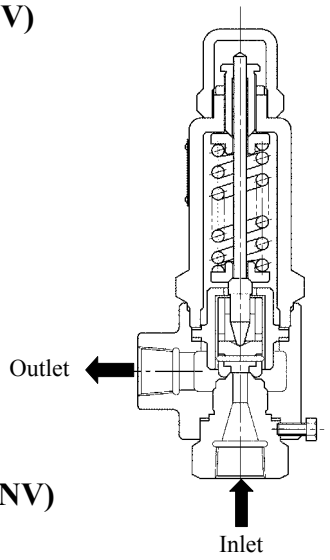


Fig.1-11 Relief valve (Model :NV)

Relief Valve (Model: SV Diaphragm Type)

NOTE:

It is most suited to a system which uses strongly corrosive liquid or hazardous liquid.

When this relief valve is used, do not return the relief valve outlet piping to the pump suction side, and do not apply pressure to the relief valve outlet side.

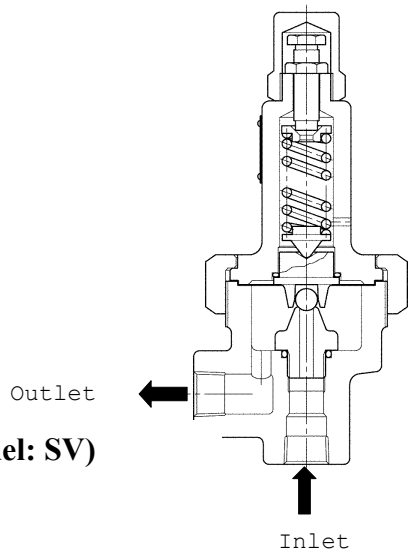


Fig.1-12 Relief valve (Model: SV)

(2) When the handling liquid is to be pumped into a high pressure vessel, install a check valve in the vicinity of the vessel inlet. This is for safety. The check valve prevents the flow reversal from the high pressure vessel when the pump is started.

When the pump is stopped, close the block valve in order to protect the pump from high pressure of the high pressure vessel.

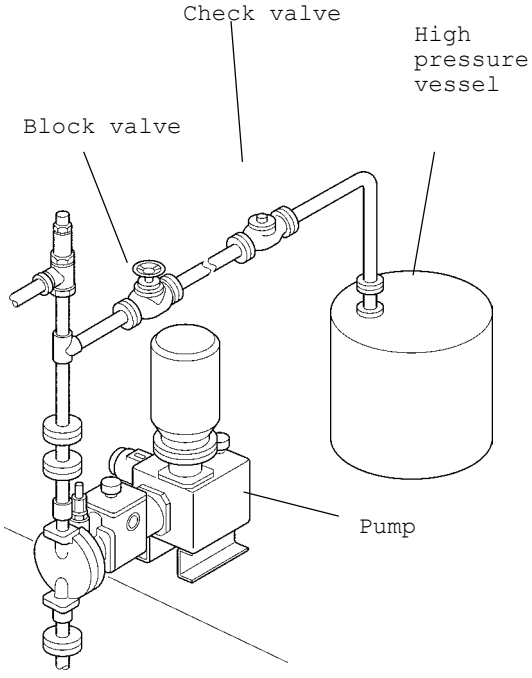


Fig.1-13 Prevention from flow reversal

1.4 Electrical Connections

⚠ WARNING

Connect an earth cable securely to the motor in order to prevent possible receiving an electric shock.

⚠ CAUTION

(1) Use a circuit breaker, and furthermore use an over current relay to positively protect the system.

(2) Electrical connections should be made so that the motor or the gearbox output shaft rotates in the direction specified at the side of the crankcase. Do not rotate the pump in the reverse direction as it may cause crank seizing. Check the rotation direction with the stroke length adjusted to 0% at no load.

(1) Normally, a horizontal/vertical flange type motor is mounted to the pump.

Some pumps are equipped with a foot-mount motor, gear box motor, variable speed controlled motor, etc.

(2) Use the power supply satisfying the specifications shown on the motor name plate.

(3) If a pressure type diaphragm failure detector electrical output (optional) is to be provided, make the necessary connections without fail.

NOTE:

Install an ammeter for monitoring the pump operation.

2 Starting

2.1 Descriptions

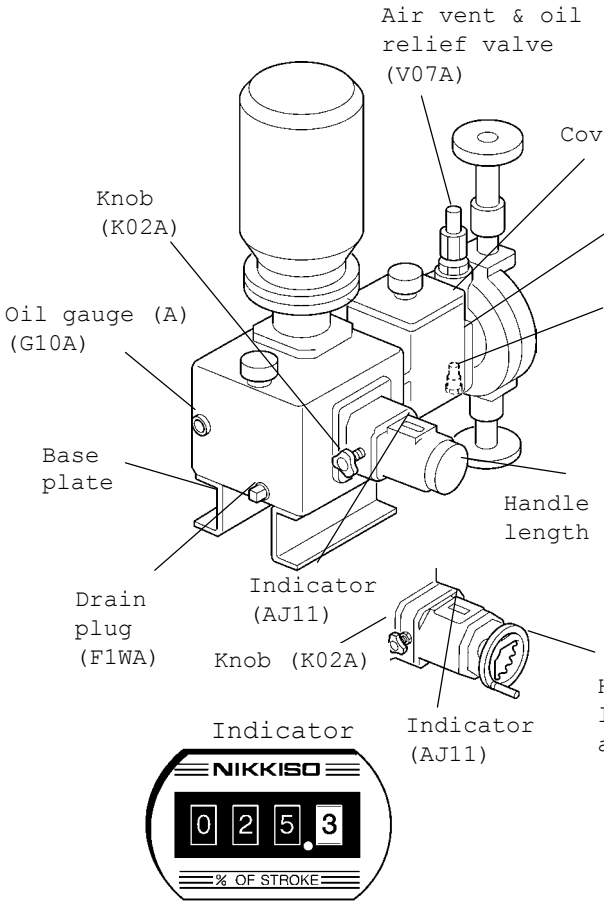


Fig. 2-1 Stroke length indication (indicating 25.3%)

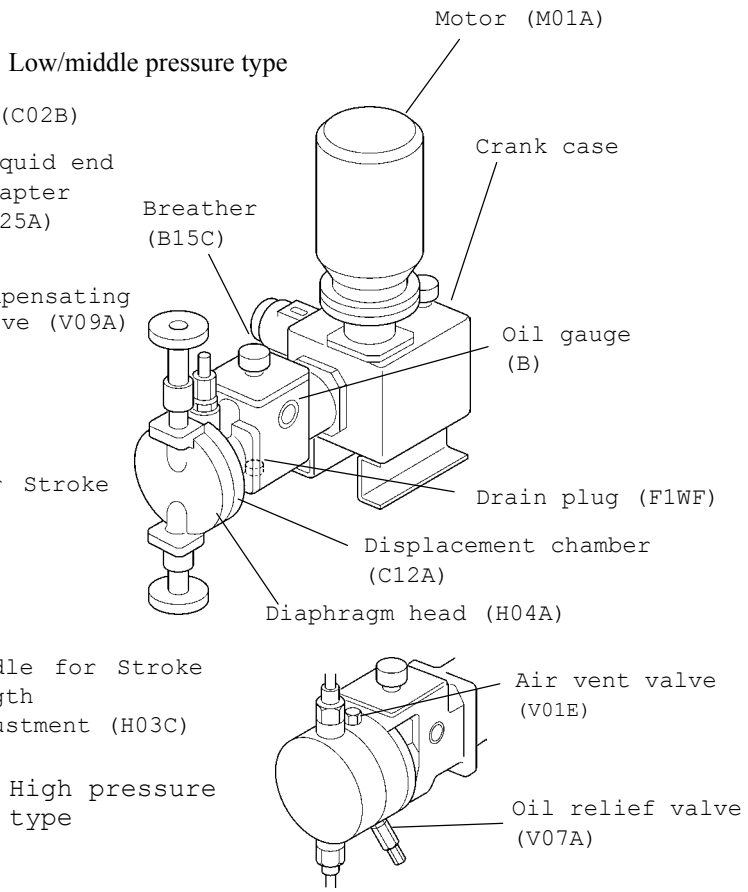


Fig.2-2 External view of Type MV

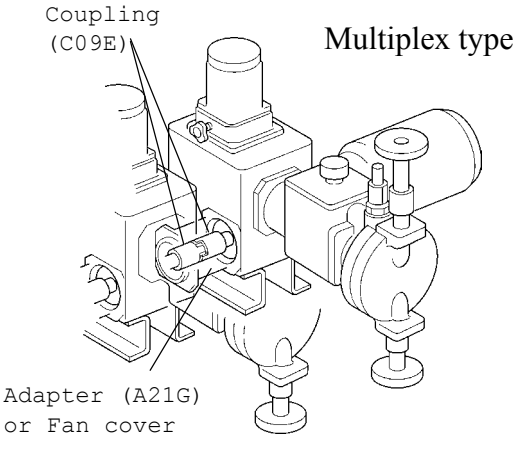


Fig.2-3 External view of Multiplex type

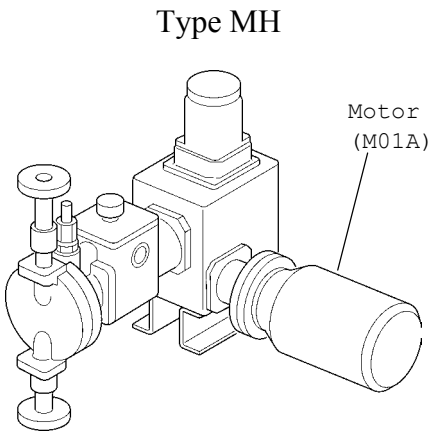


Fig.2-4 External view of Type MH

2.2 Precautions

⚠ CAUTION

(1) The diaphragm pump is selected, designed and adjusted in accordance with the customer's request and specifications. If the pump is used under different conditions from those in the specifications, it may not satisfy the required performance as a controlled volume pump, or may be damaged.

Do not operate the pump under different conditions from those in the pump specifications including discharging pressure, suction pressure, temperature, viscosity, handling liquid, presence of suspended solids, etc. Please contact Nikkiso when operating conditions are different than specified.

(2) When the pump is operating at a lower discharge pressure indicated in the specifications, it is necessary to adjust the set pressure of the oil relief valve and diaphragm failure detector (optional). (Refer to Section 3 for pressure setting of relief valve, Section 8 for pressure setting of the diaphragm failure detector.)

2.3 Check before Starting

⚠ CAUTION

(1) Use caution as liquid is transferred during run-in. Take the required measures that the liquid transfer will not cause any bad influence to the whole system by changing the valve positions.

(2) Confirm the diaphragm head securing bolts of the liquid end unit are tightened. Refer to Section 7 for the tightening torque of the diaphragm head bolts.

(3) Do not operate the pump with the discharge and suction piping closed. If the block valve is not opened, there is a possibility of diaphragm damage.

Confirm the following check items before starting operation.

2.3.1 Lubricating Oil of Power End

(1) Check that the crankcase contains specified level of lubricating oil through the oil being reached to the center of the oil gauge (A).

In case of the multiplex pump, check each crankcase individually. Normally, the pump is filled with the proper amount of oil on shipment from NIKKISO.

(2) If the oil is low, add the oil in accordance with 3.3 " Lubricating Oil Replacement in the Power End ."

The types and brands of lubricating oil are shown in Table 3-7, 8.

NOTE:
As the Type L crankcase has no oil gauge (A), check the oil level with the oil gauge (B) which is shown in Fig.2-6.

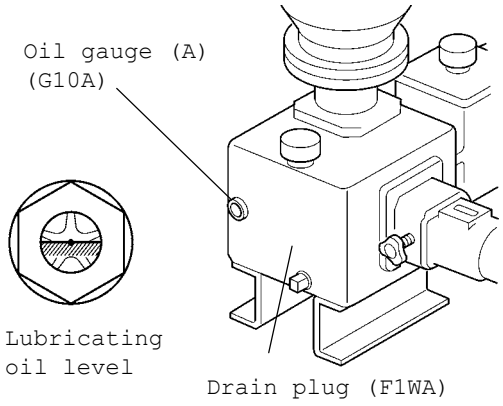


Fig.2-5 Check of lubricating Oil

2.3.1 Hydraulic Oil of Liquid End

(1) Check that the liquid end adapter contains specified level of hydraulic oil through the oil being reached to the center of the oil gauge (B). The lubricating oil of Type L uses the same as that of the power end.

(2) If the oil is low, add the oil in accordance with 3.4 " Hydraulic Oil Replenishing and Replacement in the Liquid End." In case of excessive oil, drain it to the specified level.

The types and brands of hydraulic oil are shown in Table 3-8. For Type L, refer to Table 3-8.

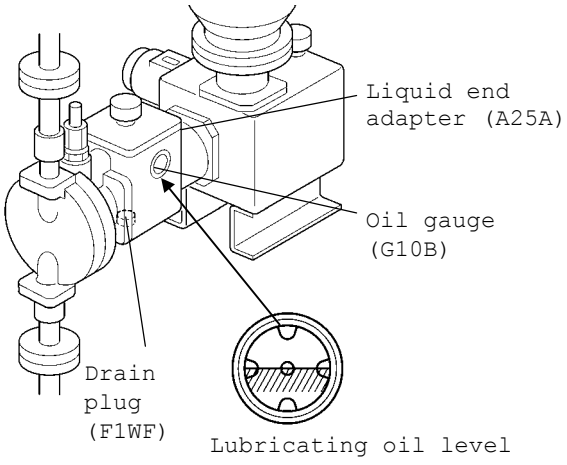


Fig.2-6 Check of hydraulic oil

2.3.3 Set pressure of Diaphragm Failure Detector (Optional)

When the pump is equipped with a pressure type diaphragm failure detector, it is impossible to detect the diaphragm failure if the actual operating pressure is lower than the set pressure. Check the set pressure. (Refer to 3.5.2 "Pressure Setting of Diaphragm Failure Detector.")

2.4 Starting and Run-in Operation

⚠ CAUTION

(1) Do not touch rotating or reciprocating parts directly. They may cause injury.

(2) The bearing housing of the pump, the stuffing box, and motor surface become hot. Do not touch them directly. They may cause injury.

(3) If the pump trips out, do not restart until the trip cause is remedied.

2.4.1 Stroke Length Adjustment

It is possible to adjust the stroke length of the pump by the handle for stroke length adjustment either during pumping operation or when stopped.

A. When the method of stroke length adjustment is manual.

(1) Loosen the knob.

When the pump is Type M4 or M5, loosen the lock nut, then loosen the knob.

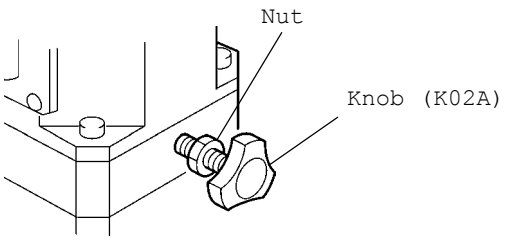


Fig.2-7 Securing/releasing stroke length

(2) Turn the handle located on the indicator head to adjust the stroke length.

Table 2-1 Table of stroke length adjustment

Handle rotating direction	Stroke length
Clockwise	Increase
Counter clockwise	Decrease

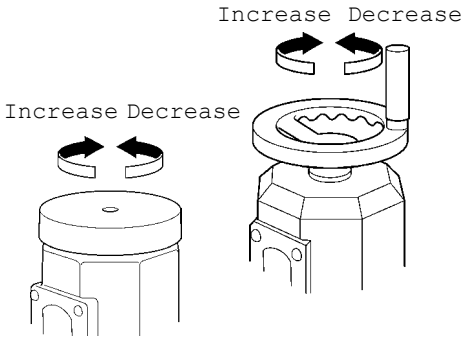


Fig.2-8 Increase/decrease of stroke length

(3) If the stroke length adjustment is not required during operation, tighten the knob tightly.

In case the Type M4 or M5, tighten the knob, then lock the knob with the lock nut.

B. When the method of stroke length adjustment is electric or pneumatic. refer to the instruction manual for servo unit.

2.4.2 Zero Point Confirmation

⚠ CAUTION

The reciprocating portion is dangerous. Do not touch it directly. They may cause injury.

Confirm the zero point of the stroke length and the indicator coincide completely before starting operation.

A. When the method of stroke length adjustment is manual or electric.

(1) Loosen the nut and knob, turn the handle, and set the indicator to 0%.

(When the method of stroke length adjustment is electric, the nut and knob are not attached.)

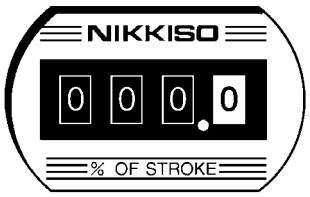


Fig.2-9 0% indication of the stroke length

(2) Remove the cover of the liquid end adapter.

(3) Turn ON the power of the motor to start the pump.

(4) Check conformity of the zero point of the indicator and the actual minimum point of the plunger/piston visually by turning the handle little by little.

NOTE:
Normally, the zero point adjustment is completed at shipment from NIKKISO. This is only for confirmation of the zero point being set properly.

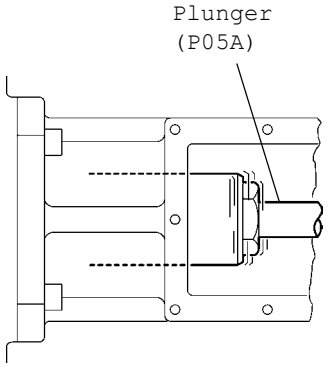


Fig.2-10 Check for the minimum point of plunger or piston

(5) If the zero point has deviated from the actual plunger/piston position, check and locate the minimum point of the plunger/piston and tighten the knob at its minimum point and fix the lead screw.

(6) Refer to Section 6 for the "zero adjustment" and reset the indicator.

B. When the method of stroke length adjustment is pneumatic.

Refer to the instruction manual for Air servo unit.

2.4.3 First Half of Run-in Operation (no load operation)

The first half of run-in operation must be followed in accordance with the following Fig.2-11 "Run-in operation mode."

NOTE:
Increase the stroke length without applying any pressure.

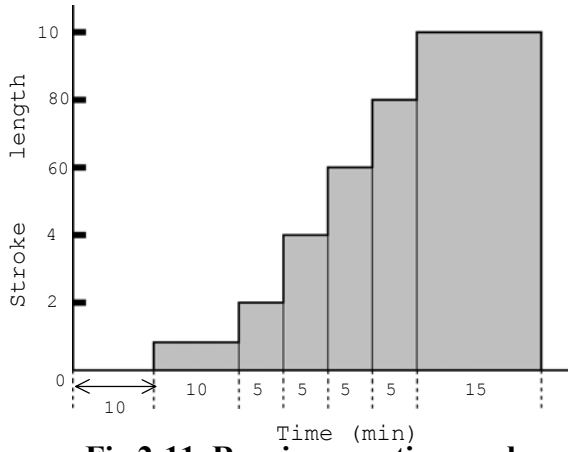


Fig.2-11 Run-in operation mode

(1) Turn the handle for stroke length adjustment to set the stroke length to 0%. (In case the multiplex pumps, set all cylinders to 0%.)

NOTE:
Open the block valves of the discharge and suction sides. When the pump is equipped with a jacket, after heating the jacket, wait until the liquid end unit reaches a specified temperature. Then supply the liquid.

(2) Turn on the power switch of the motor to start the pump. Check the direction of the motor rotation.

(3) Operate the pump for 10 minutes without pressure applied with keeping at 0% stroke length. If the suction pressure becomes negative, refer to Section 1.3.

⚠ CAUTION

Stop the pump when the transparent tube is attached to the hydraulic oil overflow nozzle.

After completion of confirmation, remove the transparent tube in order to prevent it falling off during operation.

NOTE:
It is much easier to check hydraulic oil issuing from the overflow nozzle by attaching a transparent tube.

(4) Increase the stroke to 10% without applying pressure, and operate the pump for 10 minutes. Confirm the hydraulic oil is ejected once in every stroke through the transparent tube which is attached on the hydraulic oil overflow nozzle. The ejected oil should be a very small amount. The oil ejecting interval should conform to the starting period of each discharge stroke.

NOTE:
If hydraulic oil is not ejected, implement the following steps of (8)-(12), then operate the pump in accordance with the above (4) paragraph.

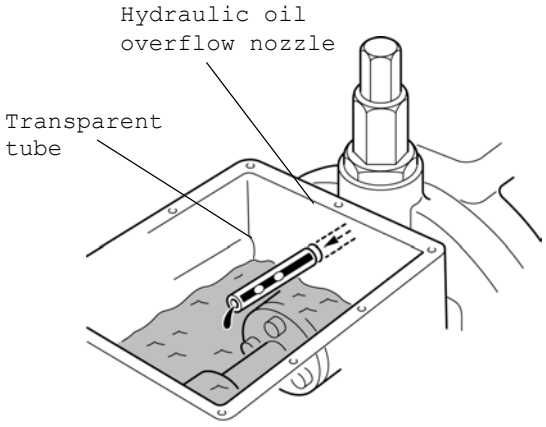


Fig. 2-12 Confirmation of oil issuing

(5) Increase the stroke length 20% at 5 minute intervals to 100%.

(6) Operate the pump 100% of stroke length for 15 minutes.

(7) During this period, confirm that there is no abnormal noise (85dBA, at 1m(3ft) distance from the pump) from the pump unit, no abnormal vibration (80 mP-P) from the crank case unit, and that smooth movement of the handle for stroke length adjustment is observed.

⚠ CAUTION

If any faults are observed, stop the pump immediately and solve the problem. The procedure returns to Section 2.4.3. In order to solve the fault, refer to Section 4.

(8) Set the stroke length to 0%, and stop the pump. Remove the air vent valve from the displacement chamber.

When the pump model is the low or middle pressure type, remove the air vent & oil relief valve. For the high pressure type, remove the air vent valve.

⚠ CAUTION

Be careful not to spill hydraulic oil.

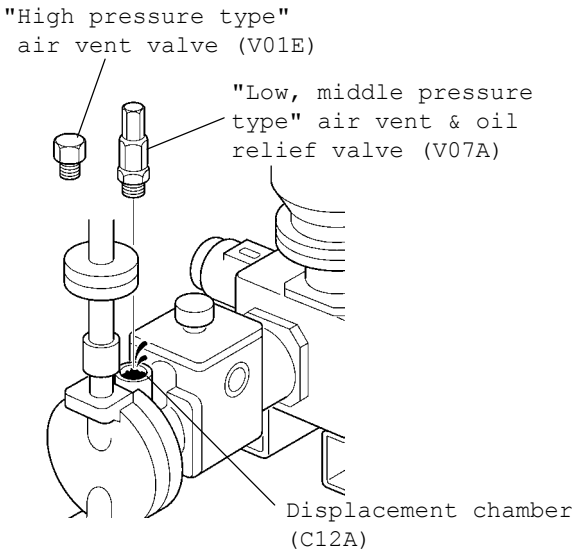


Fig. 2-13 Removal of Air vent valve

(9) Apply the suction pressure to the pump. Confirm the hydraulic oil is ejected due to the diaphragm pressurizing the displacement chamber.

- When the suction pressure is higher than the atmospheric pressure, use the pressure being applied on the suction side.
- When the suction pressure is lower than the atmospheric pressure, use compressed air or priming liquid pressure on the suction side.

(10) Turn on the power switch of the motor to start the pump. Set the stroke length to 5%. (For the multiplex system, start all cylinders.)

(11) If the hydraulic oil level does not come to the air vent valve or the air vent & oil relief valve, add hydraulic oil little by little. If air is included in the displacement chamber, bubbles come up to the oil surface. Add hydraulic oil little by little until the surface steadily rises with no bubbling.

(12) Set the stroke length to 0% and stop the pump. Attach the air vent valve or the air vent & oil relief valve and fix firmly. (For the multiplex pumps, follow this procedure on all cylinders.)

(13) Confirm the steps from (4) to (7) of 2.4.3 “First Half of Run-in Operation (no load operation).”

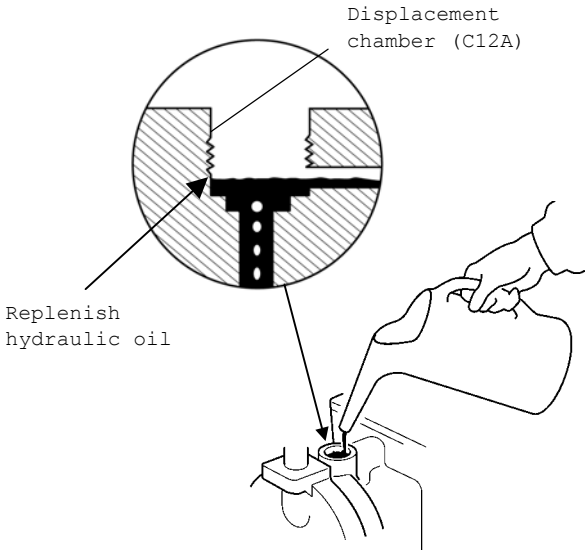


Fig. 2-14 Confirmation of oil level

2.4.4 Last Half of Run-in Operation (load operation)

⚠ CAUTION

(1) If the handling liquid leaks from the liquid end adapter, stop the pump immediately and solve the problem.

(2) The bearing housing of the pump, the stuffing box, and motor surface become hot. Do not touch them directly. They may cause a burn.

(3) If the pump stops abnormally, do not restart it until the trouble causes are removed.

The last half of run-in operation must be followed in accordance with the following Fig.2-15, 16 "Run-in operation mode."

(1) Confirm the block valves of the suction and discharge piping are opened.

(2) When the discharge pressure is below 2.0 Mpa; after applying the specified pressure, increase the stroke length from 20% gradually in 20% steps at 15 minutes intervals.

NOTE:
After reaching the specified pressure, increase the stroke length. Check the ammeter for the pump not being overloaded during the pressurizing period.

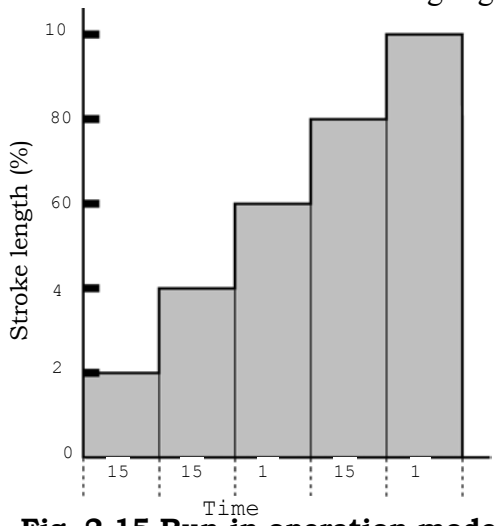


Fig. 2-15 Run-in operation mode-1

(3) When the discharging pressure is above 2.0 MPa; set the stroke length to 100%. Increase the discharge pressure gradually in steps of about 20% of the specified pressure at 15 minutes intervals.

If it is difficult to pressurize the pump, it is possible to load it using a back pressure valve or external relief valve.

If it is difficult to pressurize gradually, after pressurized with the specified pressure, increase the stroke length from 0% in 20% steps at 15 minutes intervals.

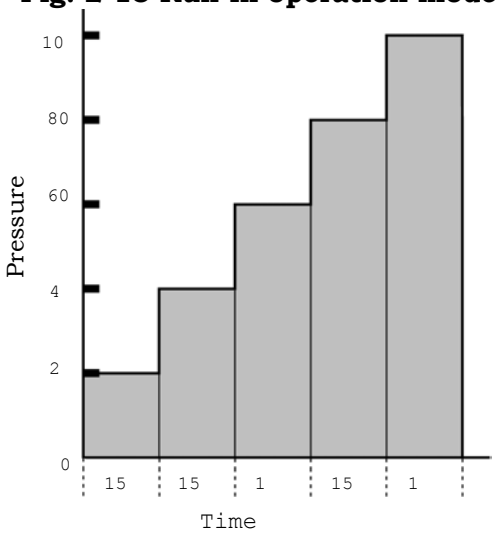


Fig. 2-16 run-in operation mode-2

NOTE:
After setting the stroke length to 100%, then increase the pressure. Check the ammeter not being overloaded during the pressurizing period.

2.4.5 Measurement of Discharge Capacity

After confirming no mechanical abnormalities, check the discharge capacity under the actual working conditions.

(1) Measure the each capacity at the point of 25%, 50%, 75% and 100% of stroke length.

(2) When it is possible to control the pump speed, measure the capacity by varying the pump speed.

(3) If there is no dispersion in the each measured capacity at the same conditions, the pump is normal.

(4) Draw a performance curve based on the measured results (with the stroke length or the pump speed along the x axis and y axis).

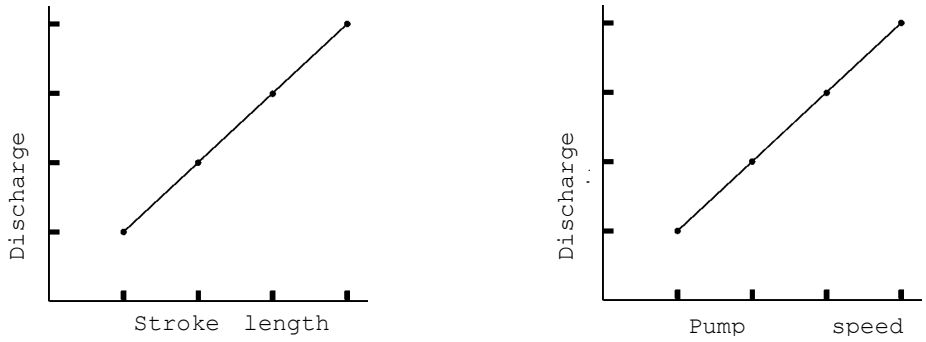


Fig. 2-17 Performance curve

(5) When the discharge curve has a linear relationship with the stroke length or the pump speed, the pump is normal.

After getting the actual performance curve, it is possible to estimate necessary stroke length or pump speed based on it.

(6) The measured results of discharge capacity may be slightly different from the manufacturer's test report. However, if there is no variability in the discharge capacity, and the performance curve keeps its linearity, it may be due to different measuring conditions and not indicate an abnormality.

(7) If any abnormalities are noticed including dispersed discharge capacity, lack of linearity, etc., resolve the abnormality referring to Section 4.

2.5 Restarting after Shutdown

(1) When the pump is to be restarted after a short term shutdown (less than 1 month), it may be operated immediately at any stroke length and under the working discharge pressure.

(2) If the pump is to be restarted after a long term shutdown (more than 1 month), operate it under no load condition with 0% of stroke length for several minutes, then increase the stroke length and set the discharge capacity to the required value.

(3) When the oil temperature is low in a cold area or in the winter season, the lubricating oil in the crank case has a higher viscosity. In such case, do not apply the load as it may overload the motor. Operate the motor with stroke length 0% for 30□60 minutes, and when the oil temperature rises, increase the stroke length.

⚠ CAUTION

If the amount of hydraulic oil in the displacement chamber is too much, there is a possibility of diaphragm damage.

(4) To operate the pump after liquid end disassembly and reassembly or hydraulic oil replacement, it is necessary to be conformed in accordance with 2.4.3.

3 Checks and Maintenance

⚠ WARNING

(1) Before disassembling the pump, turn off the power to the motor. Otherwise there is a possibility of receiving an electric shock.

(2) When the handling liquid is hazardous, remove or replace the hazardous liquid before disassembling by flushing with safe liquid or similar safety method.

⚠ CAUTION

(1) The rotating and the reciprocating portions are dangerous. Do not touch them directly. They may cause injury.

(2) The bearing housing of the pump, the stuffing box, and motor surface become hot. Do not touch them directly. They may cause injury.

(3) When the safeguard or emergency signal system is functioned, stop the pump immediately. Locate the trouble causes and solve the problems.

(4) If the handling liquid leaks from the liquid end, stop the pump immediately. Locate the trouble causes and solve the problems.

(5) When disposing of the pump unit, packings, lubricating oil, etc., proper disposal procedure must be obeyed in accordance with the laws and regulations.

3.1 Checks and Maintenance

The daily and periodical checks and maintenance which is explained in this section is necessary to maintain specified and constant performance. Furthermore, in order to maintain safe operation, check items and maintenance procedures, which is explained in the next page. They are to be understood completely and to be executed correctly.

NOTE:
When any abnormalities are observed before periodical inspection, be sure to check the system and solve the problems.

3.1.1 Daily Checks and Maintenance

(1) Execute daily checks and maintenance in accordance with the related sections.
Oil level check and replenish: Refer to page 5-7 of this section
Replacement of the oil seals and packings: Refer to Section 6
Diaphragm failure detector: Refer to Section 8

(2) Carry out daily checks and maintenance in accordance with Table 3-1.

Table 3-1 Daily Checks and Maintenance Items

No.	Positions	Check items	Check period	Checks and maintenance procedure	Action to be taken
1	Liquid End	Hydraulic oil level	Daily	It is normal that oil level is within the oil gauge (B).	Replenish oil if necessary.
2		Indication of diaphragm failure detector	Daily	Confirm the pressure indication not increased.	If the pressure is increased, stop the pump immediately and replace it with a new one.
3		Replacement of hydraulic oil	Annually	———	Replace oil completely.
4	Power End	Lubricating oil level in the crank case	Daily	It is normal that oil level is at the specified position of the oil gauge (A).	Replenish oil if necessary.
5		Leakage from oil seal	Daily	Confirm no leakage from the seal. (Guideline: within 1mℓ/day)	If leakage is observed more than guideline, replace.
6		Replacement of lubricating oil	500 hours after installation, and then annually	———	Replace oil completely.

3.1.2 Periodic Checks and Maintenance

(1) Carry out periodic checks and maintenance in accordance with the related sections.
Liquid end: Annually, refer to Section 7, 8 (Optional)
Power end: Once two years. Refer to Section 6
Replacement parts: Refer to Section 5.

(2) Carry out periodic checks and maintenance in accordance with Table 3-2.

Table 3-2 Periodic Checks and Maintenance items

No.	Positions	Check items	Check period	Checks and maintenance procedure	Action to be taken
1	Liquid End	Gland or plunger	Annually	At the time of packing replacement, check the plunger for surface wear and flaws.	If wear or flaws are observed, replace it.
2		Ball valve or wing valve, spring	Annually	Check the valve for stable discharge capacity, unusual noise, wear and corrosion.	If wear, flaws or corrosion are observed, replace them.
3		Valve seat	Annually	Same as the above.	Same as the above.
4		Diaphragm	Annually	———	Replace it at the time of disassembly.
5		Oil relief valve, oil compensating valve, air vent valve, position valve	2 years	Check the valve and valve seat for wear and flaws.	If wear or flaws are observed, replace them.
6		Oil gauge (B)	2 years	———	Replace when any stain exists inside the gauge.
7	Power End	Bearings and related parts	2 years	———	Replace them at the time of disassembly.
8		Coupling cushion	2 years	———	Same as above.
9		Collar	2 years	———	Same as above.
10		Oil gauge (A)	2 years	———	Replace when any stain exists inside the gauge.
11		Cross head pin	2 years	———	Replace them at the time of disassembly.
12		Oil seal and packing	2 years	———	Same as above.
13		Gasket (O-ring)	2 years	———	Same as above.

3.2 When Diaphragm Failure Detector (Optional) activated

Refer to Section 8 " Diaphragm Failure Detection."

3.3 Replacement of Lubricating Oil in Power End

Refer to Table 3-7, 8, 9 and 11 for the details.

(1) The type of lubricating oil used depends on the type of pump.

Type H: NIKKISO NKS OIL #6100 or equivalent

Type L: NIKKISO NKS OIL #1200 or equivalent

Type L uses lubricating oil also for the diaphragm hydraulic oil of the liquid end unit.

(2) After the initial 500 hours of operation from pump installation, replace the oil completely with new. Subsequently, change the lubricating oil completely annually. Even if the pump is not in operation, the lubricating oil may have deteriorated. Annual oil change is needed.

(3) Temperature rise and the upper limit of oil temperature:
When the pump is subjected direct to the sun in the summer season or if the ambient temperature is especially high, the oil temperature rises and its viscosity is decreased. The maximum oil temperature maintaining the oil performance in the crankcase is 80□ for NIKKISO NKS OIL #6100 and NIKKISO NKS OIL #1200. When the operating temperature exceeds this maximum temperature, consult NIKKISO.

3.3.1 Replacement of Lubricating Oil

(1) Drain

Remove the breather on the pump frame, then remove the drain plug which is positioned on the rear bottom of the crank case. After drain, attach the drain plug.

NOTE:
For Type L, remove the drain plug at the bottom of the liquid end adapter,too.

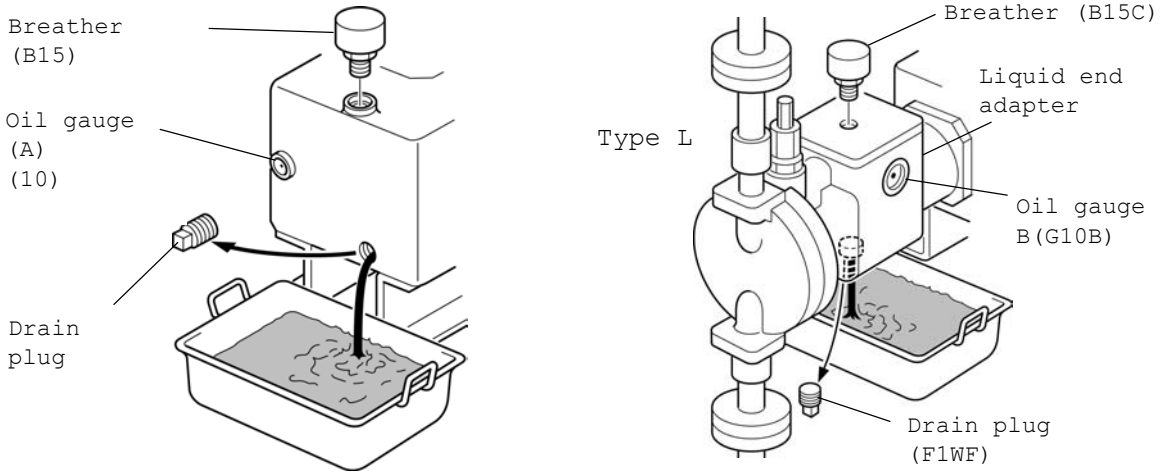


Fig.3-1 Lubricating oil replacement

(2) Lubrication

Supply lubricating oil up to the red point on the oil gauge (A) from the breather attachment hole with taking care not to drop foreign matter such as sand or dust into it. This is the oil level when the pump is at rest. During operation, maintain an oil level visible within the oil gauge (A). After lubricating, reattach the breather.

NOTE:

For Type L, replace lubricating oil both in the liquid end adapter and the crankcase. (Refer to step 3.4.1 "Replenishing the Hydraulic Oil".)

3.4 Hydraulic Oil Replenishing and Replacement in Liquid End

Refer to Table 3-8, 10, 11 and 12 for the details.

(1) The hydraulic oil for the displacement chamber and the liquid end adapter is different from the type in the pump.

Table 3-3 Oil designation for hydraulic oil

Type	Handling liquid temperature	Designated oil
Type H	0-80	NIKKISO NKS OIL #2000 or equivalent
	Outside the above range.	Refer to the oil list in the Delivery Specification.
Type L	0-80	NIKKISO NKS OIL #1200 or equivalent
	Outside the above range.	Can not designate the type of the oil.

(2) When the pump is equipped with the diaphragm failure detector, hydraulic oil replacement is only required with diaphragm replacement or disassembly of liquid end. The hydraulic oil inside the ring is the same as the above items in the Table 3-3. However, a different type of the lubricating oil may be used according to the customer's request. In that case, replace with the same oil.

(3) Change the hydraulic oil completely annually.

3.4.1 Replenishing the Hydraulic Oil

(1) Set the stroke length to 0%, and remove the breather on the top of the liquid end adapter.

(2) Supply lubricating oil up to the red point on the oil gauge (B) from the breather attachment hole taking care of not to drop foreign matters such as sand or dust into it. This is the oil level when the pump is at rest. During operation, maintain an oil level visible within the oil gauge (B). After lubricating, reattach the breather.

NOTE:

Hydraulic oil of Type L is also used as the lubricating oil for the power end. It takes a little time for the hydraulic oil to flow into the crankcase from the liquid end adapter. Confirm the oil level after one minute.

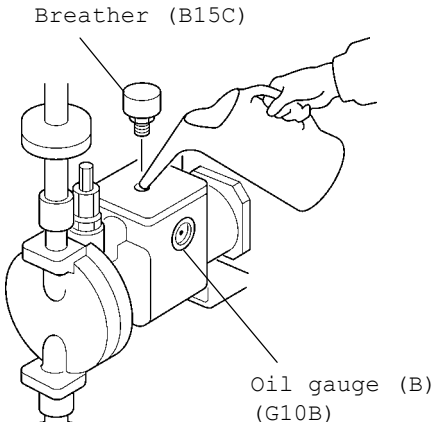


Fig.3-2 Replenishing hydraulic oil

3.4.2 Replacement of Hydraulic Oil

Refer to Section 7.

(1) Drain

Remove the breather on the top of the liquid end adapter, then remove the drain plug on the bottom of the liquid end adapter. After drain, attach the drain plug.

NOTE:

In the case of a the head size DV-50 and DV-800 for the low pressure type, or DV-400 and DV-1600 for middle pressure type, remove the drain plug of the displacement chamber and remove hydraulic oil inside the displacement chamber.

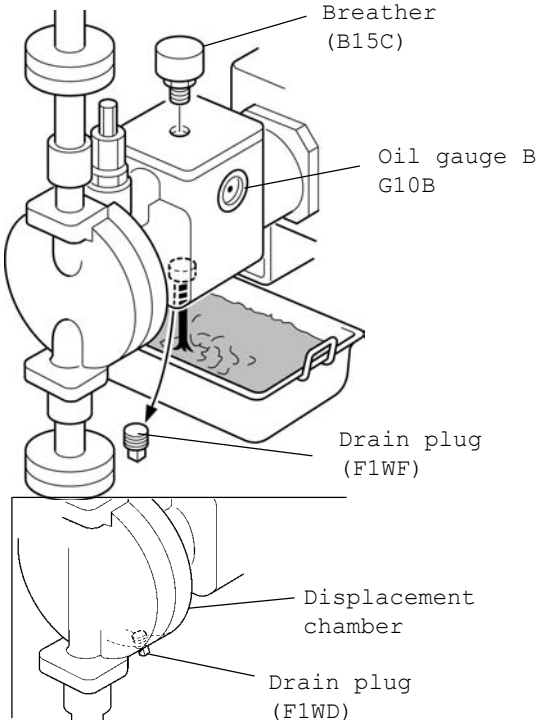


Fig.3-3 Hydraulic oil replacement

(2) Lubrication

Supply lubricating oil, up to the red point on the oil gauge (B), from the breather attachment hole.

NOTE:

Hydraulic oil of Type L is also used as the lubricating oil for the power end. It takes a little time for the hydraulic oil to flow into the crankcase from the liquid end adapter. Confirm the oil level after one minute.

(3) Air venting: Remove air inside the liquid end adapter referring to Section 7.

3.5 Pressure Setting

3.5.1 Pressure Setting of Oil Relief Valve

⚠ CAUTION

In order to prevent overload, follow the oil relief valve set pressure standard.

(1) The oil relief valve has been set in accordance with the oil relief valve set pressure standard shown in Table 3-4, unless otherwise specified.

Table 3-4 Oil relief valve set pressure standard

Discharge pressure P (MPa)	Set pressure (MPa)
2.0 P	P + 0.2
2.0 P	1.1P

(2) In any of the following cases, it is necessary to reset the set pressure of the oil relief valve.

Table 3-5 Oil relief valve set pressure standard

1	Oil relief valve disassembly	Reset the set pressure.
2	Used a lower pressure than the pump specifications and discharge pressure indicated on the nameplate.	It is recommended to reset the set pressure for safe operation.
3	Used a higher pressure than the pump specifications and discharge pressure indicated on the nameplate.	Inform the manufacturer. It is necessary to confirm that the pump (pressure durability of the liquid end, motor capacitance, piston force, etc.) can perform as satisfied.

(3) Pressure setting method

Set the stroke length of the pump as follows.

Table 3-6 Stroke length settings

Plunger or piston diameter	Setting stroke length
Less than φ20mm	100%
More than φ20mm	25%

- Remove the cap and loosen the lock nut, then loosen the hexagon head bolt fully.
- Throttle the block valve in the pump discharge piping gradually, and while watching the pump discharge side pressure gauge, tighten the hexagon head bolt so that the oil relief valve does not operate until the above set pressure shown in Table 3-4. Then, secure the bolt with the lock nut. This work should be done within a short time so as to prevent erosion of the oil relief valve seat.
- Finally, open the discharge side block valve fully and set the stroke length of the pump to the desired value.

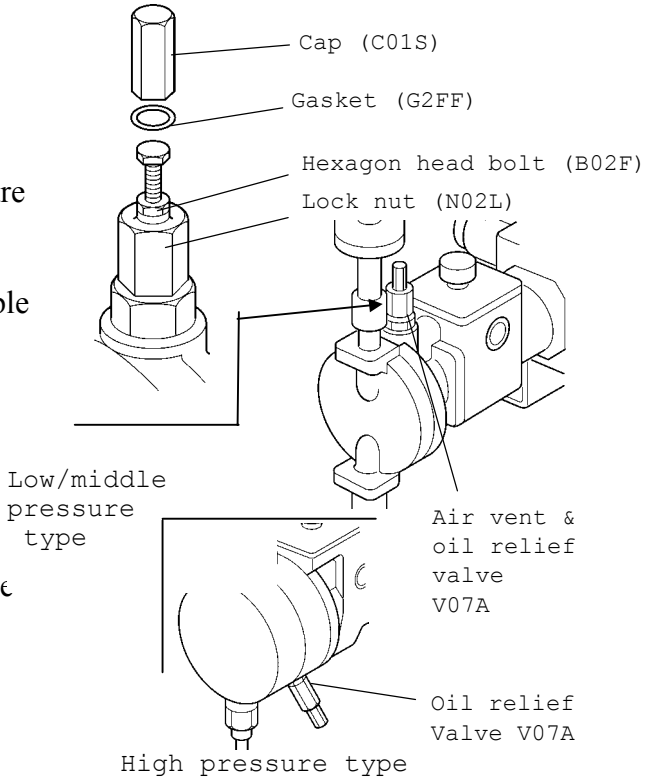


Fig.3-4 Pressure setting of oil relief valve

3.5.2 Pressure Setting of Diaphragm Failure Detector (Optional)

⚠ CAUTION

(1) If the discharge pressure is not within the pressure range of the indicator, it may fail to detect the diaphragm failure, or may frequently fail to detect correctly. Be sure to use the proper range indicator.

(2) If the diaphragm breaks, the indication rises up to the pump discharging pressure. Set the pressure gauge with electric contacts and the pressure switch to 50% of operating pressure.

(1) Pressure gauge, pressure gauge with electric contacts

When the discharge pressure is changed greatly, replace the gauges with those having the appropriate pressure range.

(2) Pressure switch

It is difficult to change the range of the pressure switch at the site. When changing of the pressure range is needed, contact us.

3.6 Table of Lubricating and Hydraulic Oil

3.6.1 Lubricating Oil for Power End

Table 3-7 Lubricant for Type H

Part	Crank case	
Specification	JIS K2219 Gear Oil, Industrial No.2 ISO VG150	
Manufacturer's specification	NKS Oil # 6100	
Lubrication system	Oil bath	
Changing interval	Annually (If necessary, replenish oil more often.)	
Kinematic viscosity	150.4 mm^2/s (40), 14.75 mm^2/s (100)	
Pour point	12.5	
Equivalent oils available on market	DAPHNE SUPER GEAR 150	IDEMITSU KOSAN CO., LTD.
	JOMO REDUCTUS 150	JAPAN ENERGY CORPORATION
	MOBIL GEAR 629	MOBIL OIL CORPORATION
	OMALA OIL 150	SHOWA SHELL OIL CO., LTD.
	BONNOC M150	NIPPON MITSUBISHI OIL CORPORATION
	COSMO GEAR SE150	COSMO OIL CO., LTD.
	SPARTAN EP150	ESSO STANDARD OIL CORPORATION

Table 3-8 Lubricant for Type L

Part	Crank case, displacement chamber and liquid end adapter	
Specification	ISO VG46	
Manufacturer's specification	NKS Oil # 1200	
Lubrication system	Oil bath	
Changing interval	Annually (If necessary, replenish oil more often.)	
Kinematic viscosity	44.59 mm^2/s (40), 6.846 mm^2/s (100)	
Pour point	27.5	
Equivalent oils available on market	DAPHNE SUPER HYDRO 46A	IDEMITSU KOSAN CO., LTD.
	HYDLUX ES 46	JAPAN ENERGY CORPORATION
	MOBIL DTE 25	MOBIL OIL CORPORATION
	TELLUS OIL ST46	SHOWA SHELL OIL CO., LTD.
	SUPER HYRANDO V46	NIPPON MITSUBISHI OIL CORPORATION
	SUPER EPOCH 46	COSMO OIL CO., LTD.
	UNIPOWER XL46	ESSO OIL CO., LTD.

3.6.2 Replacement of Lubricating Oil in Power End

Table 3-9 Lubricating oil replacement (liter /one cylinder)

Model	Oil volume
M1H	1.0
M2H	1.5
M3H	5.5
M4H	9.5
M5H	23.0

NOTE:
Refer to Table 3-11 for oil replacement of Type L.

3.6.3 Hydraulic Oil for Liquid End

NOTE:
Type L uses lubricating oil also for the diaphragm hydraulic oil of the liquid end unit. Refer to Table 3-8.

Table 3-10 Hydraulic oil for Type H

Part	Displacement chamber and liquid end adapter	Diaphragm failure detector (Optional)
Specification	——	
Manufacturer's specification	NKS Oil # 2000	
Lubrication system	Oil bath	
Changing interval	Annually (If necessary, replenish oil more often.)	
Kinematic viscosity	Approx. 10 mm^2/s (40), Approx. 3 mm^2/s (100)	
Pour point	40	
Equivalent oils available on market	DAPHNE TORQUE OIL A	IDEMITSU KOSAN CO., LTD.
	JOMO TORCON AW18	JAPAN ENERGY CORPORATION
	PEGASUS CONVERTER FLUID	MOBIL OIL CORPORATION
	TELLUS OIL C10	SHOWA SHELL OIL CO., LTD.
	NEW PANTORQUE B	NIPPON MITSUBISHI OIL CORPORATION
	COSMO TORQUE OIL 15	COSMO OIL CO., LTD.
	SPINESSO 10	ESSO OIL CO., LTD.

NOTE:
The above information is for temperature conditions of the handling liquid within the range of 0-80. If the handling liquid temperature is outside this range, refer to the delivery specification list.

3.6.4 Replacement of Hydraulic Oil in Liquid End

Table 3-11 Low and middle pressure pump hydraulic oil replacement

Model		Plunger/piston diameter (mm)	Head size	Oil volume (liter) *1	Oil volume inside the ring (milliliter) *2
Low pressure type	M1L	7,10	DV-1.8	1.5	5
		14, 20	DV-6	1.5	7
		30, 40	DV-25	2.0	10
		55, 65	DV-50	2.5	15
	M2L	30	DV-25	3.0	10
		40, 55	DV-50	3.5	15
		65	DV-100	3.5	20
		80, 90	DV-200	4.0	30
	M3L	40	DV-50	7.0	15
		55	DV-100	7.0	20
		65, 80	DV-200	8.0	30
		90, 110	DV-400	8.5	50
	M4L	80, 90	DV-400	21.0	50
		110, 130	DV-800	26.0	110
Middle pressure type	M1H	10	DV-1.8	1.0	5
		14, 20	DV-6	1.0	10
		28, 40	DV-25	1.4	15
	M2H	14	DV-6	1.0	10
		20, 28	DV-25	1.4	15
		40, 56	DV-100	2.6	20
	M3H	20, 28	DV-25	2.3	15
		40, 56	DV-100	4.8	20
		80, 112	DV-400	6.4	50
	M4H	28, 40	DV-100	5.0	20
		56, 80	DV-400	6.5	50
		112, 160	DV-1600	10.0	200
	M5H	28, 40	DV-100	5.0	20
		56, 80	DV-400	6.5	50
		112, 160	DV-1600	10.0	200

NOTE:

*1) For the low pressure type, oil volume shown is the total volume for the power end and the liquid end.

*2) Shows oil volume with pressure type diaphragm failure detector.

Table 3-12 High pressure pump hydraulic oil replacement

Model		Plunger diameter (mm)	Head size	Oil volume (liter)	Oil volume inside the ring (milliliter) *1
High pressure type	M1H	10	DV-1.8	1.0	5
		14	DV-6	1.0	10
	M2H	7, 10	DV-1.8	1.0	5
		14	DV-6	1.0	10
		20	DV-25	1.4	15
	M3H	10, 14	DV-6	2.1	10
		20, 28	DV-25	2.3	15
	M4H	14, 20	DV-25	4.5	15
		28, 40	DV-100	5.0	20
	M5H	14, 20	DV-25	4.5	15
		28, 40	DV-100	5.0	20

NOTE:
*1) Shows oil volume with pressure type diaphragm failure detector.

4 Troubleshooting

Pump malfunctions and their countermeasures are summarized in the following pages.
In general, actual trouble often has complex causes. Therefore, apply the following troubleshooting chart as a reference. If it is difficult to locate the trouble cause, contact our local agent.

NOTE:

When inquiring of us, fill out the trouble conditions on the form affixed on the last page of this section, and send it to us. It will help us to locate the trouble cause and make it easier for us to set up countermeasures.

4.1 Power End

NOTE:

(1) When customers are going to disassemble the pump by themselves, refer to Section 6 and fully understand the disassembly/reassembly procedures. If the customer considers it is too difficult to disassemble, contact our local agent.

(2) When a pump has a automatic stroke length adjustment, refer to the operation manual for information on the pneumatic servo unit or the electric servo unit.

4.1.1 Motor does not start or is overloaded

Table 4-1 Malfunction and countermeasures-1

Check items	Check result	Possible causes of malfunction	Countermeasures
Rotate the worm shaft or the motor fan manually without applying pressure.	Rotates smoothly.	The power supply circuit open.	Connect it.
		Power supply and motor ratings don't match.	Match the power supply and motor ratings.
	Does not rotate smoothly.	Excessive shim tightening.	Readjust shims. (Sect. 6)
		Coupling attachment failure.	Reattachment of coupling. (Sect. 6)
		Centering failure.	Centering readjustment. (Sect. 2)
	Does not rotate.	Freezing or solidification of handling liquid	Prevent freezing or solidification.
		Discharge piping is blocked or shut off.	Check discharge piping.
		Damaged power end.	Check and replace damaged parts.

4.1.2 Handle for stroke length adjustment is turned heavily or can not be turned

Table 4-2 Malfunction and countermeasures - 2

Check items	Check result	Possible causes of malfunction	Countermeasures
Check the stroke length fixing knob and lock nut.	Tightened.	The lead screw is locked.	Release the knob and the lock nut.
	Loosened.	Excessive thrust bearing tightening	Readjust tightening. (Sect. 6)
		The power end damaged.	Check and replace damaged part. (Sect. 6)

4.1.3 Vibration / Noise is excessive

NOTE:
The lead screw pushing noise and the worm gear back rush noise occur every one stroke due to the pump mechanism. They are not malfunctioning.

Table 4-3 Malfunction and countermeasures - 3

Possible causes of malfunction	Countermeasures
Defective coupling attachment. Centering defective.	Attach coupling correctly. (Sect. 6) Adjust centering again. (Sect. 6)
Wearing of crank, cam, cam ring, hollow shaft.	Replace crank assembly. (Sect. 6)
Bearings are loosened.	Readjust shims. (Sect. 6)
Wearing of bearings.	Replace bearings. (Sect.6)

4.1.4 Abnormal heating of crankcase oil

NOTE:
When the temperature increase of crankcase and the ambient or the handling liquid temperature increase are similar, it is not malfunctioning.

Table 4-4 Malfunction and countermeasures - 4

Check items	Check result	Possible causes of malfunction	Countermeasures
Check the pump discharge pressure.	Exceeds the rated discharge pressure.	Overloaded.	Adjust to the appropriate discharge pressure
Check lubricating oil inside the crank case.	Inappropriate viscosity or inadequate amount of oil.	Overloaded.	Change the lubricating oil for an appropriate one or adjust the oil level.
———		Excessive tightening of thrust bearings.	Readjust the tightening (Sect. 6)
		Excessive tightening of shims.	Readjust the shims (Sect. 6)

4.2 Liquid End

NOTES:

(1) When customers are going to disassemble the pump by themselves, refer to Section 7 and fully understand the disassembly/reassembly procedures. If the customer considers it is too difficult to disassemble, contact our local agent.

(2) For the function of the diaphragm failure detector (optional), refer to Section 8.

4.2.1 Failing to discharge

Table 4-5 Malfunction and countermeasures - 1

Check items	Check result	Possible causes of malfunction	Countermeasures
Check the movement of the plunger (piston).	Not moving	The power supply is not turned.	Turn on the power supply.
		The plunger adapter is removed. (Middle/high pressure type)	Tighten the plunger adapter. (Sect. 6)
	Moving.	The pump and suction piping are not filled with the handling liquid.	Fill the piping and liquid end with the handling liquid. (Sect. 1)
		Gas ingress into the suction piping and/or liquid end.	Fill the piping and liquid end with the handling liquid. If the gas ingess is continuously, fit the gas vent piping. (Sect. 1)
		The valve of the suction piping is closed.	Open the valve of the suction piping. (Sect. 1)
		The check valve was assembled the wrong way.	Disassemble, check and reassemble of check valve. (Sect.7)
		Check valve malfunctioning due to foreign matter sticking in the valve.	Disassemble, check and reassemble of check valve. (Sect.7)
			Fit a strainer in the suction piping. (Sect. 1)
		Insufficient air venting in the displacement chamber.	Replenish hydraulic oil to the displacement chamber, and remove the air inside the chamber. (Sect. 7)
		Set pressure of the oil relief valve is low, or foreign matter is inserted into the seal part and hydraulic oil is leaking.	Check the set pressure of the oil relief valve. (Sect. 3) Disassemble, check and reassemble the oil relief valve. (Sect.7)
		End of the tube of the oil compensating valve is positioned over the hydraulic oil surface. (*1)	Check the hydraulic oil level. Set the tube to the appropriate position. (Sect. 7)

(*1) Check the hydraulic oil level. Refer to step (1) of “4.2.9” for the details.

4.2.2 Pressure does not rise, or when the pressure is raised, the discharge capacity is decreased.

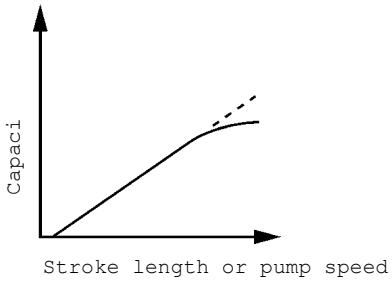
Table 4-6 Malfunction and countermeasures - 2

Check items	Check result	Possible causes of malfunction	Countermeasures
Check handling liquid condition	Compressibility of the handling liquid is high, or liquid contains a large amount of gas.	Discharge failure due to liquid compressibility.	Examine pump specifications. If inappropriate, replace the pump with an appropriate type.
Check hydraulic oil discharge from the air vent & oil relief valve (low/ middle pressure type) or the air vent valve (high pressure type). (*1)	Hydraulic oil is discharged.	Gas ingress into the liquid end and/or suction piping.	Fill with handling liquid. If the gas ingress is continuously, fit a gas vent piping. (Sect. 1)
		Hydraulic oil leakage due to wearing of packing.	Disassemble, check and replace packing. (Sect.7)
		The check valve is damaged and the handling liquid is leaking.	Disassemble, check and replace check valve. (Sect.7)
		Insufficient air venting in the displacement chamber.	Replenish the hydraulic oil to the displacement chamber, and remove the air inside the chamber. (Sect. 7)
		Set pressure of the oil relief valve is low, or the seal part is damaged and hydraulic oil is leaking.	Check the set pressure of the oil relief valve. (Sect. 3) Disassemble, check and reassemble of oil relief valve. (Sect.7)
		Hydraulic oil leakage from the seat of the air vent valve or the oil compensating valve.	Disassemble, check and reassemble each valve. (Sect.7)
	Not discharged.	Air inside the displacement chamber is not vented due to air vent valve malfunction. (*1)	Replace the air vent & oil relief valve (low/ middle pressure type) or the air vent valve (high pressure type). (Sect. 7)

(*1) Check to see hydraulic oil is discharged at each stroke from the air vent & oil relief valve (low/ middle pressure type) or the air vent valve (high pressure type). Refer to step (2) of “4.2.9 “ for the details.

4.2.3 Discharge capacity is too small

(1) The discharge capacity decreases as shown in Fig. 4-1.



Measure the pump discharge capacity, and draw a graph showing pump stroke length (or pump speed) against discharging capacity. Compare the obtained curve to the initial test data sheet.

——— shows measured curve

---------- shows initial test data

Fig.4-1 Capacity graph

Table 4-7 Malfunction and countermeasures - 3

Check items	Check result	Possible causes of malfunction	Countermeasures
Check handling liquid condition.	Viscosity of handling liquid is high.	The internal friction loss of the pump is too high. (NPSHR)	Change the pump specifications.
		The NPSH conditions are not satisfied due to increase of piping friction loss.	Examine the piping system.
Check suction piping condition.	Too long or too narrow piping.	The NPSH conditions are not satisfied due to increase of piping loss.	Examination the piping specifications: accumulator setting, level maintaining of suction, larger diameter of piping, etc.
Check suction piping.	The strainer is clogged.	The NPSH conditions are not satisfied due to increase of piping loss.	Clean the strainer.
	Suction piping blockage with foreign matter.	The NPSH conditions are not satisfied due to increase of piping loss.	Clean the piping.
Check inside the pump.	Diaphragm is deformed.	Diaphragm malfunctioning.	Replace. (Sect. 7)
Check flow gauge specifications.	Out of range.	Indication failure of the flow gauge.	Recalibrate gauge.

(2) The discharge capacity is small as shown in Fig. 4-2.

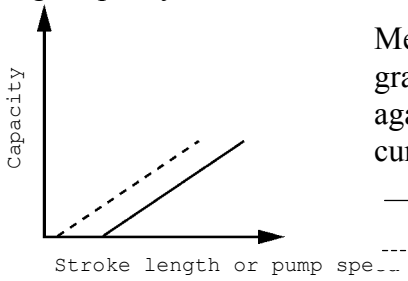


Fig.4-2 Capacity graph

Measure the pump discharge capacity, and draw a graph showing pump stroke length (or pump speed) against discharging capacity. Compare the obtained curve to the initial test data sheet.

——— shows measured curve

---------- shows initial test data

Table 4-8 Malfunction and countermeasures - 4

Check items	Check result	Possible causes of malfunction	Countermeasures
Check handling liquid condition	Compressibility of the handling liquid is high, or liquid contains a large amount of gas.	Discharge failure due to liquid compressibility.	Replace the pump, or examine pump specifications.
Check hydraulic oil discharge from the air vent & oil relief valve (low/ middle pressure type) or the air vent valve (high pressure type). (*1)	Hydraulic oil is discharged.	Gas ingress into the liquid end and/or suction piping.	Fill with handling liquid. If the gas ingress is continuously, fit a gas vent piping. (Sect. 1)
		Insufficient air venting in the displacement chamber.	Replenish the hydraulic oil to the displacement chamber, and remove the air inside the chamber. (Sect. 7)
		Air ingress into the ring (R03K). (*2)	Replenish the hydraulic oil to the diaphragm failure detector. (Sect. 8) Check handling liquid forms gas or not.
		Hydraulic oil leakage due to wearing of packing.	Disassemble, check and replace packing. (Sect.7)
		The check valve is damaged and the handling liquid is leaking.	Disassemble, check and replace check valve. (Sect.7)
		Hydraulic oil leakage from the seat of the oil relief valve, air vent valve or the oil compensating valve. (*3)	Disassemble, check and reassemble of each valve. (Sect.7)
	Not discharged.	Air inside the displacement chamber is not vented due to air vent valve malfunction.	Replace air vent & oil relief valve (low/ middle pressure type) or the air vent valve (high pressure type). (Sect. 7)

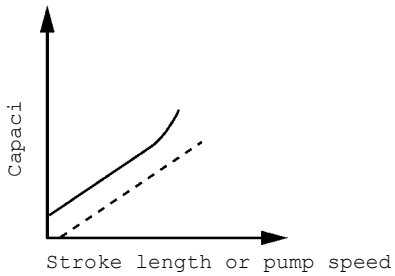
(*1) Check to see if hydraulic oil is discharged at each stroke from the air vent & oil relief valve (low/ middle pressure type) or the air vent valve (high pressure type). Refer to step (2) of “4.2.9” for the details.

(*2) In case the optional diaphragm failure detector is installed.

(*3) For checking the oil compensating valve condition, refer to step (3) of “4.2.9”.

4.2.4 Discharge capacity is excessive

(1) The discharge capacity is large as shown in Fig. 4-3.



Measure the pump discharge capacity, and draw a graph showing pump stroke length (or pump speed) against discharging capacity. Compare the obtained curve to the initial test data sheet.

——— shows measured curve

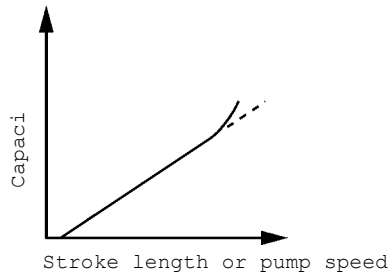
---------- shows initial test data

Fig.4-3 Capacity graph

Table 4-9 Malfunction and countermeasures - 5

Check items	Check result	Possible causes of malfunction	Countermeasures
Check piping condition.	Discharge level is lower than the suction level. Discharge pressure is lower than the suction pressure.	The handling liquid flows no matter how the pump works.	Fit a back pressure valve.

(2) The discharge capacity increased as shown in Fig. 4-4.



Measure the pump discharge capacity, and draw a graph showing pump stroke length (or pump speed) against discharging capacity. Compare the obtained curve to the initial test data sheet.

——— shows measured curve

---------- shows initial test data

Fig.4-4 Capacity graph

Table 4-10 Malfunction and countermeasures - 6

Check items	Check result	Possible causes of malfunction	Countermeasures
Check piping condition.	Insufficient differential pressure.	The handling liquid flows due to acceleration head no matter how the pump works. (Over feeding)	Fit a back pressure valve.
			Fit an accumulator.
			Enlarge the piping diameter.

4.2.5 Discharge capacity is not stable (Flowrate is changing in a intervals of a few minutes.)

Table 4-11 Malfunction and countermeasures – 7

Check items	Check result	Possible causes of malfunction	Countermeasures
Check flow gauge specifications.	Out of range.	Indication failure of the flow gauge.	Recalibrate the flow gauge.
	Not corresponding to the pulsating flow.	The flow gauge does not indicate correct value due to pulsation.	Change the flow gauge. Or reduce the pulsation by fitting an accumulator or other measures.
Check suction piping condition.	Too long or too narrow piping.	The NPSH conditions are not satisfied due to increase of piping loss.	Examination the piping specifications: accumulator fitting, level maintaining of suction, larger diameter of piping, etc.
Check suction piping.	The strainer is clogged.	The NPSH conditions are not satisfied due to increase of piping loss.	Clean the strainer.
	Suction piping blockage with foreign matter.	The NPSH conditions are not satisfied due to increase of piping loss.	Clean the piping.
Check oil compensating valve functioning. (*1)	Malfunction of compensating valve.	Impossible to control hydraulic oil flow	Replace. (Sect. 7)

(*1) For checking the oil compensating valve condition, refer to step (3) of “4.2.9”.

4.2.6 Discharge capacity decreases with time

Table 4-12 Malfunction and countermeasures – 8

Check items	Check result	Possible causes of malfunction	Countermeasures
Check hydraulic oil discharge from the air vent & oil relief valve (low/ middle pressure type) or the air vent valve (high pressure type). (*1)	Hydraulic oil is discharged.	Gas ingress into the liquid end and/or suction piping.	Fill with handling liquid. If the gas ingress is continuously, fit a gas vent piping. (Sect. 1)
		Hydraulic oil leakage due to wearing of packing.	Disassemble, check and replace packing. (Sect.7)
		The check valve is damaged and the handling liquid is leaking.	Disassemble, check and replace check valve. (Sect.7)
		Set pressure of the oil relief valve is low, or the seal part is damaged and hydraulic oil is leaking.	Check the set pressure of the oil relief valve. (Sect. 3) Disassemble, check and reassemble of oil relief valve. (Sect.7)
	Not discharged.	Air inside the displacement chamber is not vented due to air vent valve malfunction.	Replace air vent & oil relief valve (low/ middle pressure type) or the air vent valve (high pressure type). (Sect. 7)

(*1) Check to see if hydraulic oil is discharged at each stroke from the air vent & oil relief valve (low/ middle pressure type) or the air vent valve (high pressure type). Refer to step (2) of "4.2.9" for the details.

4.2.7 Excessive noise

Table 4-13 Malfunction and countermeasures – 9

Check items	Check result	Possible causes of malfunction	Countermeasures
Locate the noise source.	Noise from the check valve.	Check valve noise.	If there is no wear, there is no problem.(Sect. 7)
		Noise due to unsatisfaction of NPSH condition (Cavitation).	Raise the inner pressure of the suction tank.
			Raise the level of the liquid in the suction tank.
			Enlarge the diameter of the suction piping.
			Shorten the suction piping.
			Fit an accumulator to the suction side.
	Noise from oil relief valve.	The set pressure of the oil relief valve is lower than the discharge pressure.	Check the discharge pressure and the oil relief valve setting pressure. (Sect. 3)
		Noise due to unsatisfaction of NPSH condition..	Raise the inner pressure of the suction tank.
			Raise the level of the liquid in the suction tank.
			Enlarge the diameter of the suction piping.
			Shorten the suction piping.
			Fit an accumulator to the suction side.
	Noise from the liquid end and piping.	Unsatisfaction of NPSH condition.	Raise the inner pressure of the suction tank.
			Raise the level of the liquid in the suction tank.
			Enlarge the diameter of the suction piping.
			Shorten the suction piping.
			Fit an accumulator to the suction side.
		Water impact noise by the handling liquid inside the discharge piping.	Change the pump starting and stopping procedures. (Start with small capacity, stop with decreased.)
			Fit a check valve to the discharge piping.

4.2.8 Oil relief valve frequently works

Table 4-14 Malfunction and countermeasures – 10

Check items	Check result	Possible causes of malfunction	Countermeasures
Check the timing of the oil relief valve working.	In operation.	The discharge pressure is higher than the set pressure of the oil relief valve.	Check the discharge pressure and the oil relief valve setting pressure. (Sect. 3)
		Suction pressure is too low.	Raise the suction pressure.
			Raise the inner pressure of the suction tank.
			Raise the level of the liquid in the suction tank.
			Enlarge the diameter of the suction piping.
			Shorten the suction piping.
			Fit an accumulator to the suction side.
		Oil relief valve is working due to acceleration head of discharge piping.	Enlarge the diameter of the discharge piping.
			Shorten the discharge piping.
			Fit an accumulator to the discharge side.
	When starting or changing the handling liquid:	Water impact by the handling liquid inside the discharge piping.	Change the pump starting and stopping procedures. (Start with small capacity, stop with decreased capacity.)
			Fit a check valve to the discharge piping.

4.2.9 Function check of oil compensating valve and air vent valve

⚠ CAUTION

Before removing the cover of the liquid end adapter in order to confirm the plunger (piston) movement, always stop the pump. If the pump does not stop during check, it may cause injury by pinching fingers by the plunger or piston.

Furthermore, if any tools are inserted into the liquid end adapter, they may cause machine damage.

(1) Remove the cover of the liquid end adapter, and check the hydraulic oil level.

Confirm that the actual oil level is not correspond to the following position in the drawing.

Type L (Low pressure type)

The oil level is lower than the tube fitting.

Type H (Middle, high pressure type)

The end of the tube exceeds the oil level.

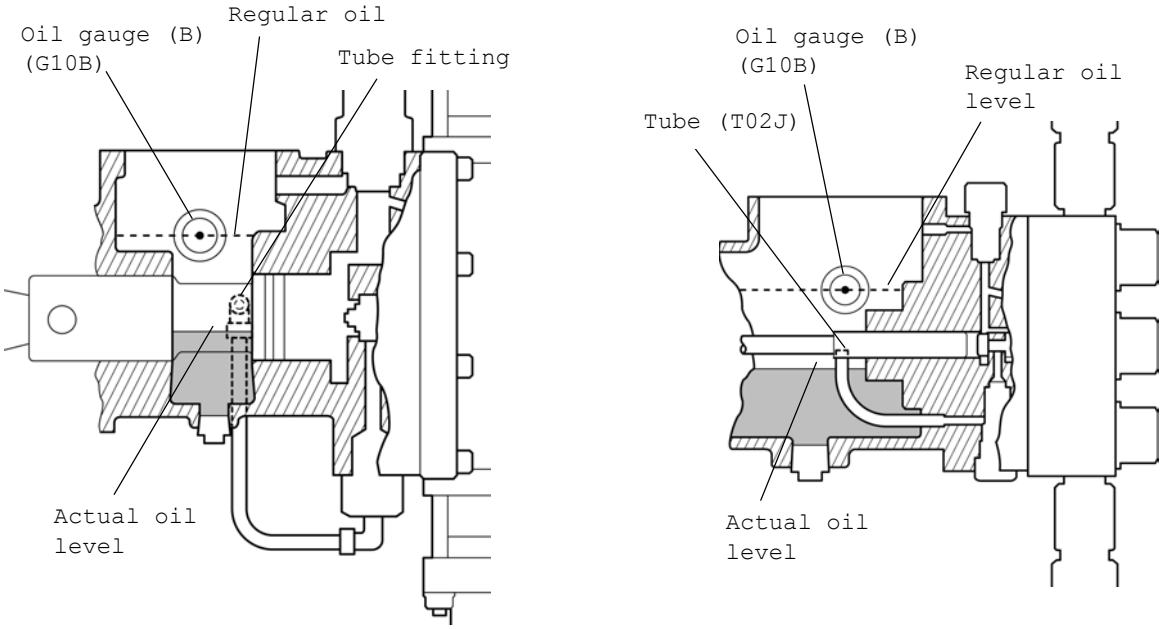


Fig.4-5 Check for the hydraulic oil level

⚠ CAUTION

Before removing the cover for attaching a transparent tube, or checking for the discharging of hydraulic oil from the air vent valve, always stop the pump.

If the pump does not stop during check, it may cause injury by pinching fingers by the plunger or piston. Furthermore, if any tools are inserted into the liquid end adapter, they may cause machine damage.

(2) Remove the cover of the liquid end adapter and attach a transparent tube to the overflow nozzle. Start the pump and confirm hydraulic oil is discharged from the overflow nozzle.

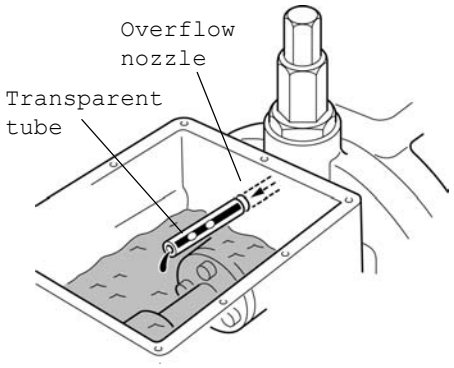


Fig.4-6 Confirmation of hydraulic oil discharge

⚠ CAUTION

Before removing the cover for attaching a transparent tube, or checking for the discharging of hydraulic oil from the air vent valve, always stop the pump.

If the pump does not stop during check, it may cause injury by pinching fingers by the plunger or piston. Furthermore, if any tools are inserted into the liquid end adapter, they may cause machine damage.

(3) Check the functioning of the oil compensating valve by the following procedure.

- Remove the cover of the liquid end adapter.
- Attach a transparent tube on the tube of the oil compensating valve.

  When the pump is Type L, remove the tube fitting from the tube. When removing the tube, hydraulic oil is spilled out from the tube fitting. Apply tape to stop the oil leakage.
- Fill the transparent tube with oil.
- Start the pump. When the oil level of the transparent tube descends a few millimeters at each stroke, it is normal.

NOTE:
Check the functioning of the oil compensating valve while hydraulic oil remains in the transparent tube. Otherwise the air comes into the displacement chamber.

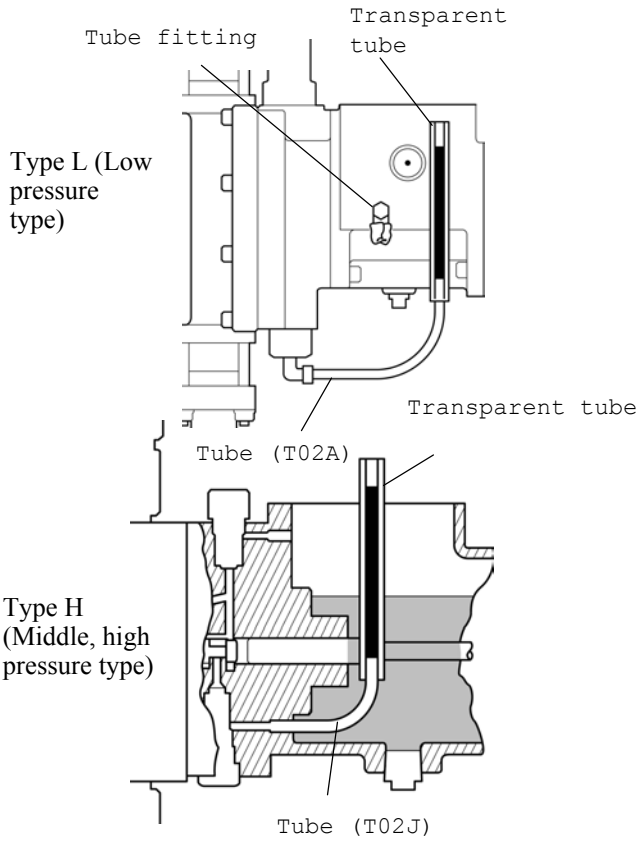


Fig.4-7 Check for the oil compensating valve

4.3 Trouble Information Sheet (#F21-A4-0025 R0)

When inquiring about machine trouble, contact our local agent, filling in the following form. It is helpful to us in providing correct and prompt countermeasures.

(1) Trouble condition:

(2) Pump condition (Immediately before the trouble occurrence)

Model and Serial number of the pump (Refer to the name plate on the pump) MODEL NUMBER-SERIAL NUMBER:				
Handling liquid:				
Temperature of the handling liquid:	T. at starting:	T. during operation:		
Specific gravity:	Viscosity: mPas	Specific heat:		
Saturated vapor pressure: Pa				
If the liquid includes solids;	No	Yes	Maximum particle diameter: μm	
			Density: mass%-True specific gravity:	
Is the handling liquid single component ?	If not, please note the mixture of components, especially explain details if an acid is included:			
Pump operation: Continuous / Intermittent	Operating conditions:			
Capacity:				
Suction pressure: Mpa (at capacity:)			Equipped with a pressure gauge	
Discharge pressure: Mpa (at capacity:)			Equipped with a pressure gauge	
NPSHA: Mpa (at capacity:)				
Suction strainer	No	Yes	Mesh density: Cleaning interval: per	
History:	Trial operation on Year Month | Normal operation on Year Month			
	Periodical maintenance Once a			

(3) Current pump performance:

When the pump is controlled by inverter, please draw both A and B curves.

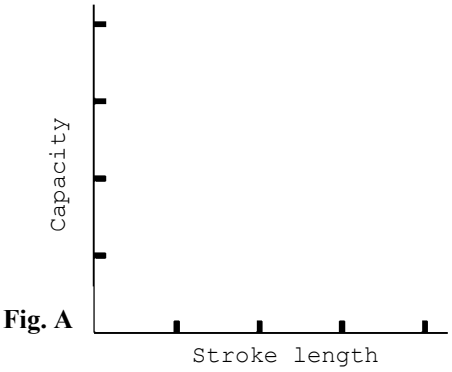


Fig. A

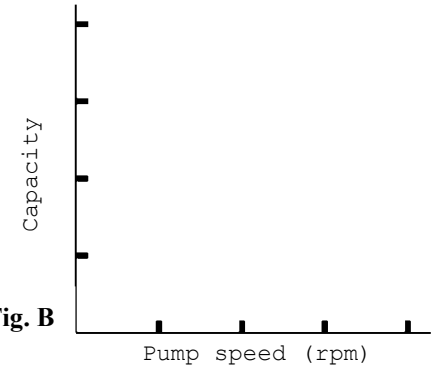


Fig. B

(4) Other information concerning to the trouble: (ex.: vibration, noise etc.)

(5) Please add the piping drawing(s).

5 Spare Parts

5.1 Recommended Spare Parts

⚠ CAUTION

It is recommended to use the following parts at all times. If a diaphragm, which is not designated as a recommended part, is used, it's performance can not be guaranteed.

It is recommended to prepare the following parts for periodical or urgent replacement.
The parts listed in the following table refer to one cylinder.

Table 5-1 Recommended Spare Parts for Liquid End-1

Type of Liquid End (*1)	**Part Name**	**Item**	**1 year operation**	**2 years operation**
Low pressure type [P.D.7-20]	Valve assembly	AV06, BV06	1 set	2 set
All types	Packing, Backup ring, O-ring for packing	P07A, P07E R03N, Y52M	1 set	2 set
All types (*2)	Gasket(O-ring)	G2DA, G2DG Y12N, Y12P	1 set	2 set
	Ball valve, Wing valve	V01A, V03A	1 set	2 set
	Valve seat	S05A, S05B	1 set	2 set
Low pressure type [P.D.7-10] High pressure type [All]	Plunger	P05A	1	2
All types	Diaphragm	D02A, D02B	1 set	2 set
	Spring for wing valve	S09C	1 set	2 set
Middle and high pressure types	Wear ring	R14A	1 set	2 set
Low pressure type [P.D.14] Middle pressure type [All]	Gland	G03B	1	2

(*1): P.D. represents the diameter of the plunger.

(*2): For the low pressure type [P.D.7-20] , these parts are not needed to prepare because this is included in the valve assembly.

Table 5-2 Recommended Spare Parts for Liquid End-2

Type of Liquid End	Part Name	Item	1 year operation	2 years operation
All types	Gasket for hydraulic unit	G2DB, G2DD Y12H, Y12J Y12R, Y62B Y62E, Y62F Y62G, Y62H Y72L, Y72N		1 set
	Oil compensating valve	V09A, S09M V01K, P06H	-	1 set
	Oil relief valve	V07A	-	1 set
High pressure type [All]	Air vent valve	V01E	-	1 set
All types	Gasket for valve attachment (O-ring)	G2FC, G2FD G2FE, Y62J Y62R	1 set	2 set
	Position valve assembly and gaskets (O-ring) for mounting	V01T, N02P W2AH, S09J Y72B	-	1 set
	Oil gauge (B)	G10B	-	1

Table 5-3 Recommended Spare Parts for Power End-1

Type of Power End	Part Name	Item	1 year operation	2 years operation
All types	Bearings and related parts including bushings	B01A, B01B B01C, B01D B01H, B01K B01R, B01S B08K, W05B W05D	-	1 set
	Coupling cushion	C08A, C08D	-	1 set
	Collar	C17B, C17E	-	1 set
Middle and High Pressure Type	Oil gauge (A)	G10A	-	1 set

Table 5-4 Recommended Spare Parts for Power End-2

Type of Power End	Part Name	Item	1 year operation	2 years operation
All Types	Cross head pin	P03B	-	1 set
	Oil seal	Y11A	1 set	2 set
	Packing	Y11B	1 set	2 set
	Gasket (O-ring)	Y12A, Y52K Y72A, Y72B Y72C, Y72D Y72E, Y72F Y72G, Y72P	-	1 set

5.2 Ordering Spare Parts

(1) When ordering spare parts, contact NIKKISO and indicate the following items.

- Specify the pump serial No. and the Model No. shown on the nameplate of the pump, and in the case of the multiplex pump, include the cylinder No.
- Specify the parts descriptions (including part's item no.) and quantity.

(2) The material of the parts may have been changed due to improvement and development. Before ordering parts, confirm the final specifications of the model.

6 Construction of Power End

The stroke length is adjustable manually or by means of an automatic controller (electric servo or air servo types). This manual describes the manual adjustment.
For adjustment by means of automatic controller, refer to "NIKKISO Metering Pump Electro Servo Unit Operation Manual" or "NIKKISO Metering Pump Air Servo Unit Operation Manual".

NOTE:

Disassembly and reassembly of the power end may require a crane, a press and/or electric furnace (for shrinkage fit) depending on the maintenance procedures.

6.1 Mechanism and Construction

The power end consists of a crankcase and a stroke length adjustment unit. Main parts are described in the figure shown below. Functions of each unit are explained in the following section. Understand the fundamental construction of the power end to ease operation and maintenance. (Illustration shows Model MV of M2)

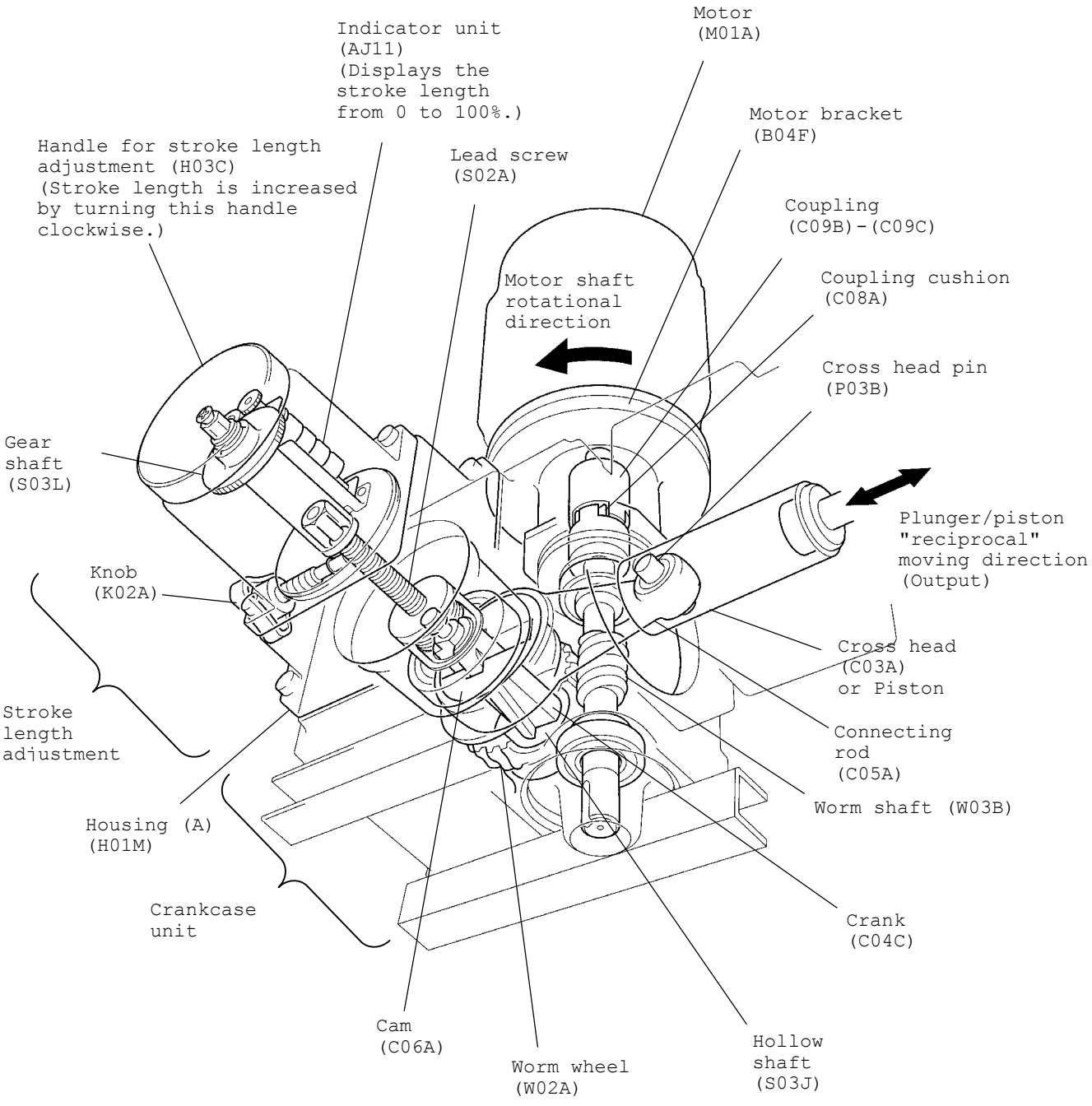


Fig. 6-1 Construction

6.1.1 Crankcase

(1) The worm shaft is directly connected through couplings to the motor output shaft. The rotation speed of the worm wheel is reduced by the worm gear.

(2) The cam is rotated by the hollow shaft which is directly connected to the worm wheel.

(3) The eccentric motion of the cam is converted into a reciprocating motion of the plunger / piston which is connected directly to the crosshead through the crosshead pin.

(4) The power from the piston is transmitted to the hollow shaft. The hollow shaft is supported at both ends by the crankcase and housing (A).

(5) The rotating unit is supported by roller bearings, and uses oil bath lubrication. The worm shaft upper bearing of Model MV and the crank bearing of the Model MH are positioned higher than the oil bath level, but do not require lubrication because they are sealed with grease.

(6) The needle bearing at the small end of the connecting rod and the bushes at the large end and the crosshead sliding unit use the oil bath lubrication.

6.1.2 Stroke Length Adjustment

(1) The stroke length is adjustable between 0 and 100% by changing the relative eccentricity of crank with respect to the cam. The relative eccentricity is controlled by moving the crank vertically by turning the handle.

(2) Loosen the knob, and turn the handle. The gear shaft, which is directly connect to the handle, rotates the lead screw and moves the crank vertically.

(3) When turning the handle clockwise, the stroke length is increased. The stroke length is displayed on the indicator unit.

(4) If there is no need to change the stroke length during operation, tighten the knob manually in order not to move the lead screw.

6.2 Drive Motor

(1) Normally, this pump uses a 4-polar vertical (or horizontal) flange mount motor, which is mounted to the motor bracket. The output shaft is directly connected through the coupling and the coupling cushion to the worm shaft.

(2) When a wider range of flow rate adjustment is required, it may be required to change the motor to a geared motor or a variable speed motor.

6.3 Multiplex Pump (Only applicable to Model MH)

(1) One power end per one liquid end. In the multiplex pump system, the construction of the power end and liquid end is as same as in the simplex pump.

(2) The stroke length adjustment units are independently attached to the power end.

(3) In the multiplex pump system, each crankcase is mounted on the same base plate. All worm shafts, are directly connected through couplings and coupling cushion.

(4) It is not necessary to adjust the centering of each pump unit because it is correctly determined by the positioning adapters for the multiplex pump system.

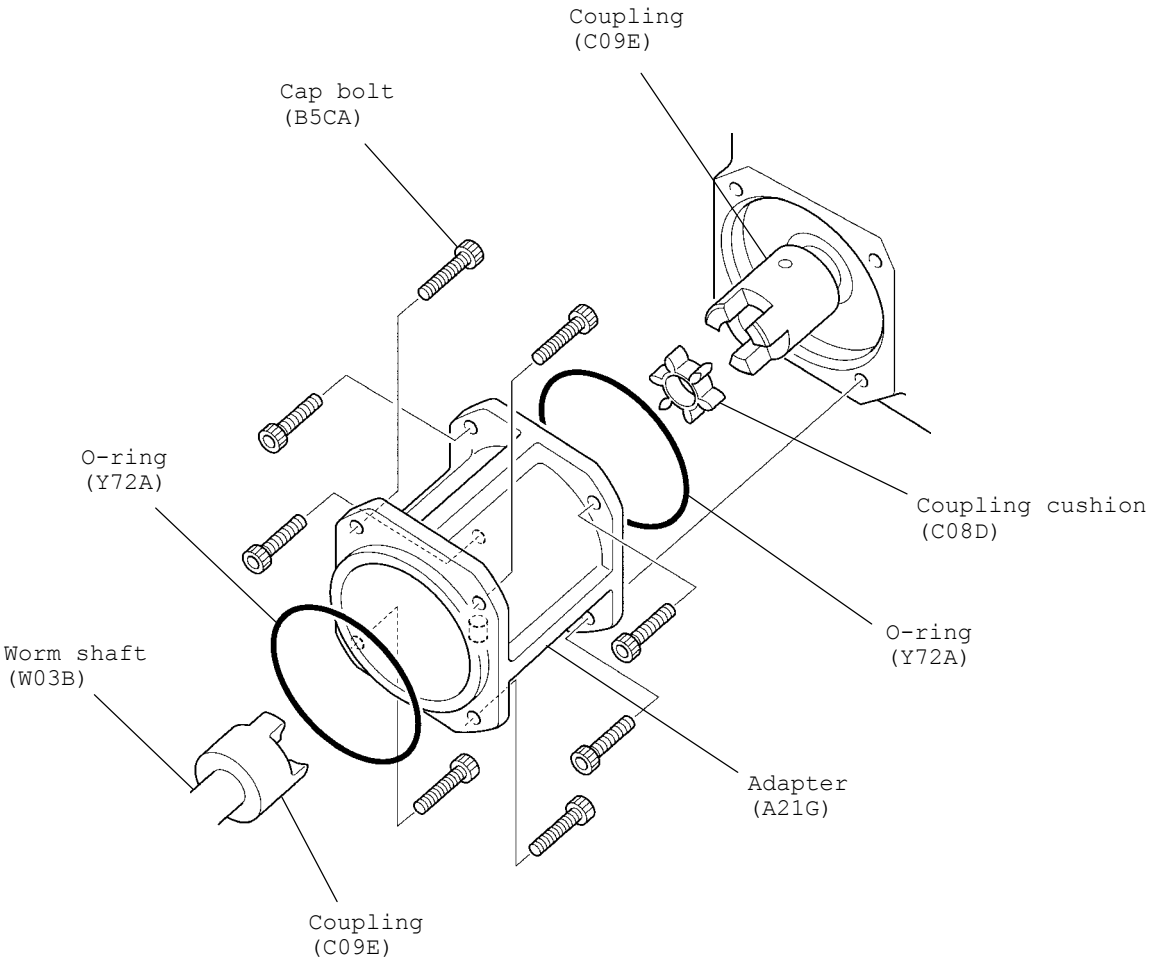


Fig. 6-2 Multiplex pump

6.4 Disassembly

⚠ WARNING

(1) Always turn off the power supply to the motor, otherwise there is a possibility of receiving an electric shock.

(2) When the handled liquid is hazardous, remove or replace the hazardous liquid before attempting disassembly by flushing with safe liquid or other similar procedure. When disassembling a pump, wear appropriate personal protective equipment.

⚠ CAUTION

Heavy parts such as a crank unit are included in the power end. When disassembling and reassembling them, be sure to take care of not drop them. Falling parts could cause injury. It is required to remove the liquid end unit for the low pressure type of pump.

NOTE:

Refer to section 7 Disassembly of Liquid End.

(1) Remove the breather, and then remove the drain plug to drain lubricating oil from the crankcase and the liquid end adapter.
Diaphragm Type: Refer to 3.3 and 3.4
Packed Plunger Type: Refer to 3.3
Exclusive use for Sodium Hypochlorite: Refer to 3.2

⚠ CAUTION

When a high output motor is required, it is possible to exceed the normal motor weight by more than 60 kgs. If necessary, use a crane for lifting the motor in order to prevent it from dropping. If inappropriate measures are adopted to move the motor, it may cause injury.

(2) Remove the four hexagon head bolts and remove the motor from the motor bracket. When removing the motor, as the motor is heavy, use appropriate measures to handle it.

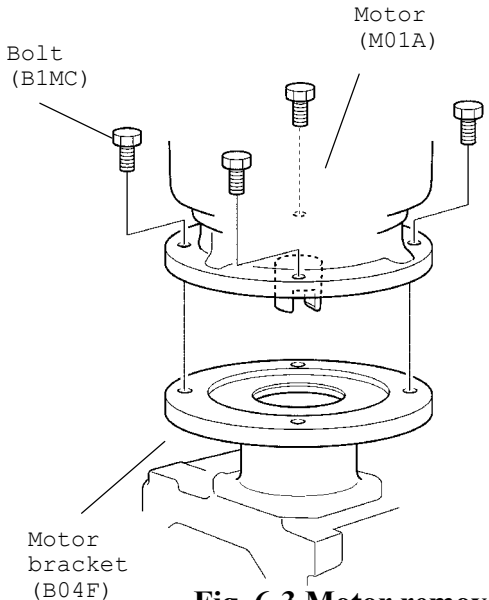


Fig. 6-3 Motor removal

(3) If necessary, remove the two set screws , then remove the coupling and the key from the motor shaft.
Before removing the coupling from the shaft, measure and record the setting position of the coupling using the slide calipers.

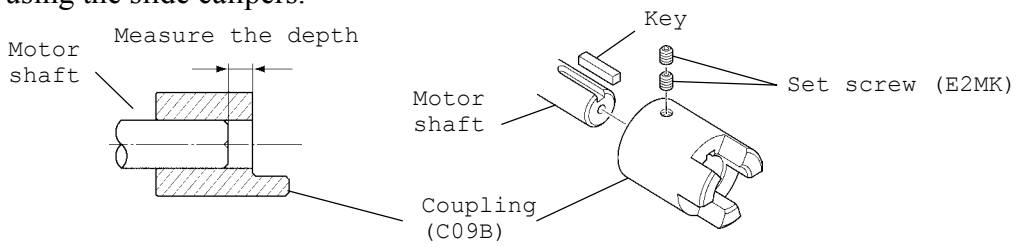


Fig. 6-4 Coupling removal

(4) Remove four cap bolts, and remove the motor bracket from the crankcase. Remove the coupling cushion from the coupling.

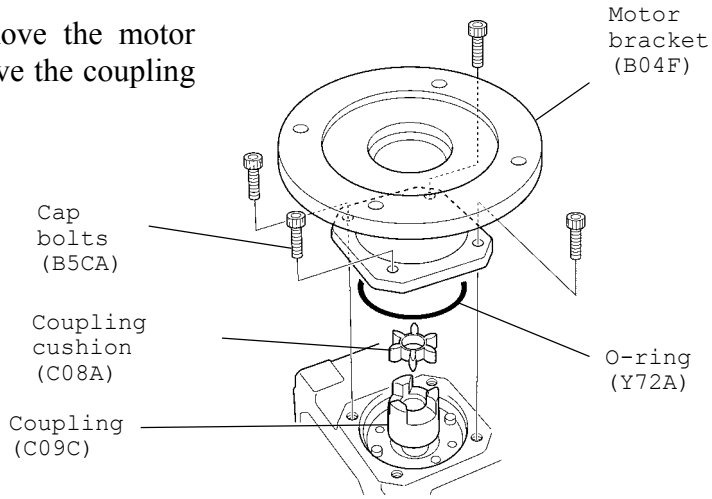


Fig. 6-5 Motor bracket removal

(5) Remove the liquid end adapter's cover.
Disconnect the crosshead and plunger adapter for Type H.
Use the accessory tool, which is shown in figure below, for removal of Type H of Model M3.
(Illustration shows Diaphragm Type)

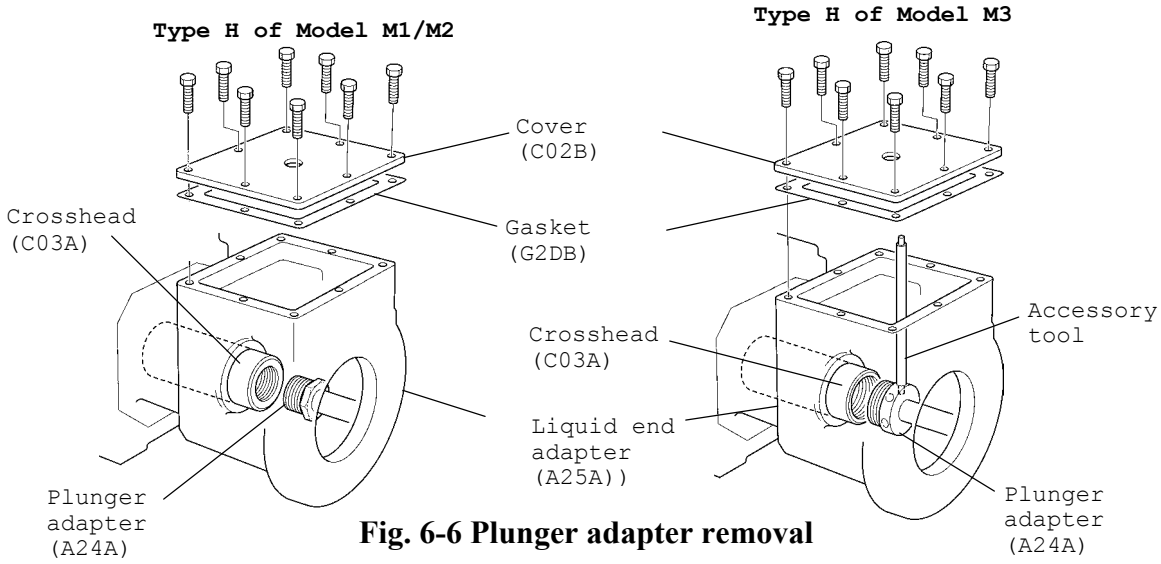


Fig. 6-6 Plunger adapter removal

(6) Remove the four cap bolts, then remove the liquid end adapter from the crankcase. Careful disassembly is required in order not to flaw the surface of the crosshead. When removing the crosshead, use a cloth to cover it.

NOTE:

Careful handling of the crosshead is required. If any flaws are applied to the surface of the crosshead, they may cause oil leakage, so the same part must not be reused.

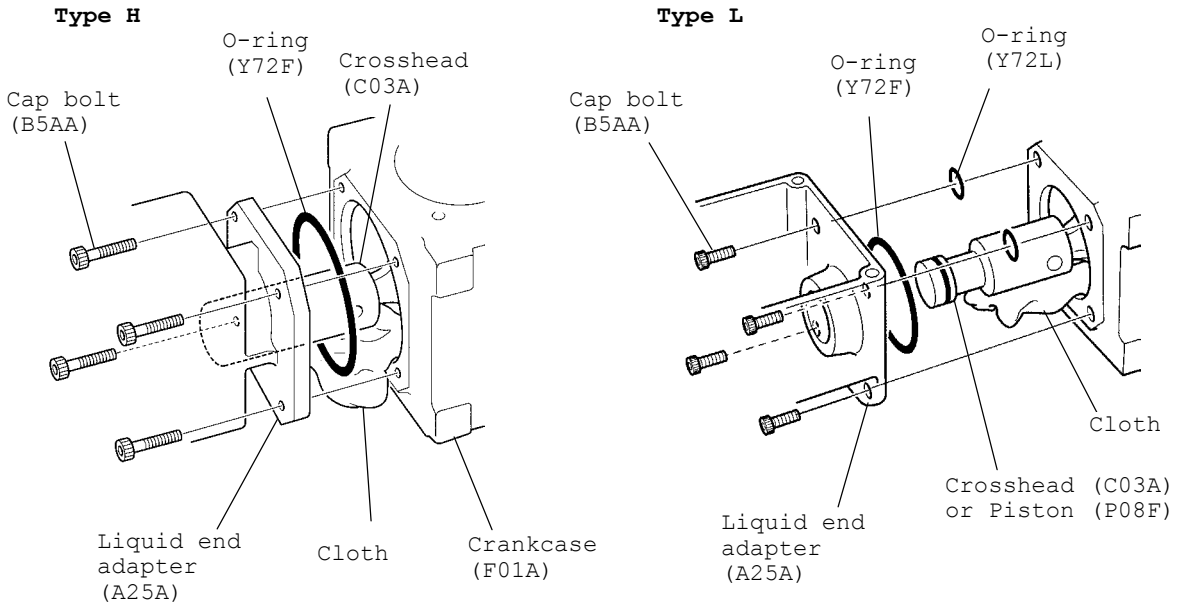


Fig. 6-7 Liquid end adapter removal

(7) When disassembling Type H, remove the liquid end adapter from the displacement chamber, then remove the packing positioned inside the liquid end adapter. (For Type L, this process is not applicable because a packing is not used inside the liquid end adapter.)

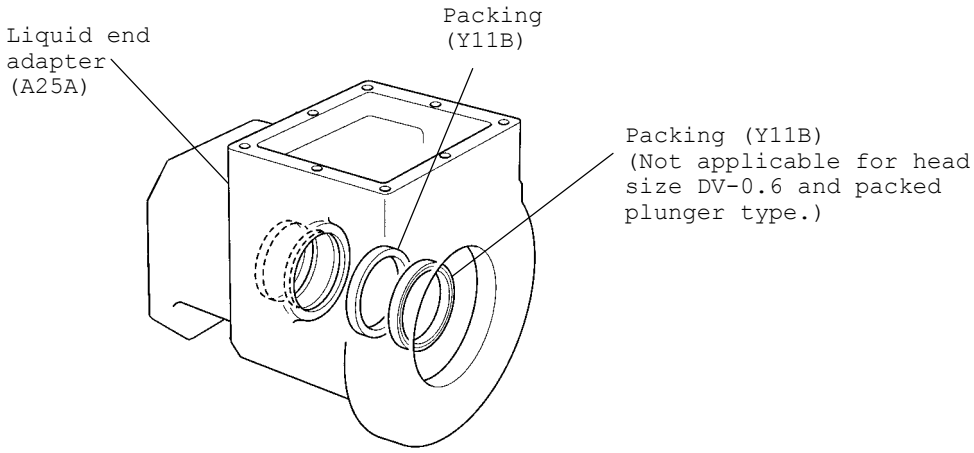


Fig. 6-8 Packing removal

⚠ CAUTION

When rotating the worm shaft manually, turn it with the coupling attached. Otherwise fingers may be cut by the edges of the key way.

(8) Remove the crosshead pin, and disconnect the crosshead from the connecting rod. Disconnection is only possible at the top dead center of 100% stroke.

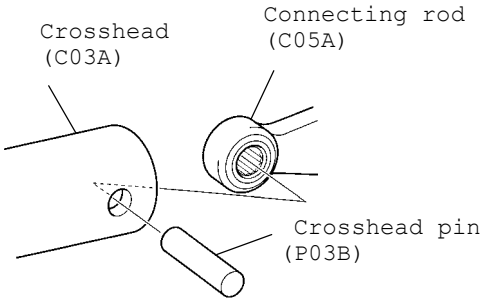


Fig. 6-9 Crosshead removal

⚠ CAUTION

When rotating the crankcase 90 degree, use the crane for lifting it in order to maintain balance. If inappropriate measures are adopted to rotate the crankcase, it may cause injury.

(9) Remove the crankcase from the base plate. When disassembling Model MV, rotate the crankcase 90 degree, and position the stroke length adjustment unit (Indicator head) to the top position.

NOTE:

There is no need to rotate the crankcase for Model MH.

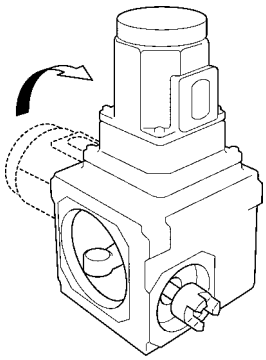


Fig. 6-10 Rotate of the crankcase

(10) Remove the handle, indicator cover and knob from the indicator head.

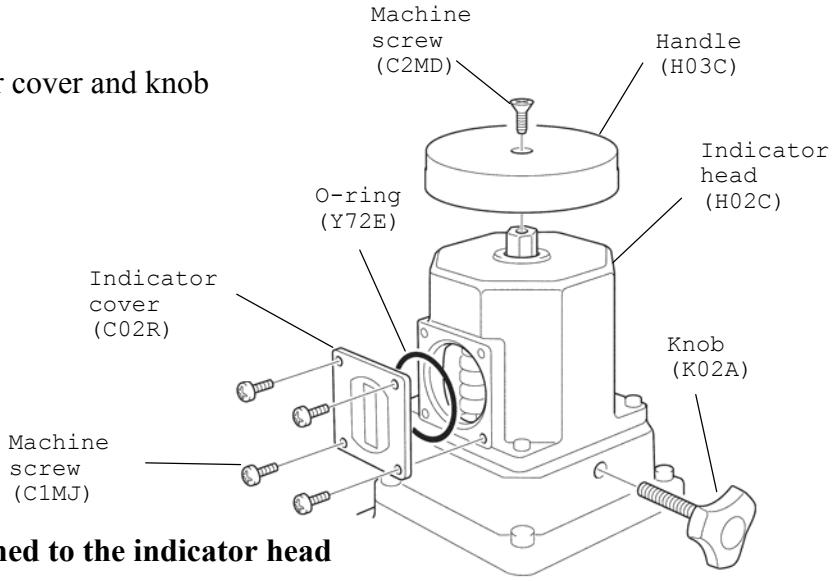


Fig. 6-11 Part removal attached to the indicator head

(11) Remove four cap bolts, then remove the indicator head from housing (A).
For Model M1, the indicator head and housing (A) are secured together.

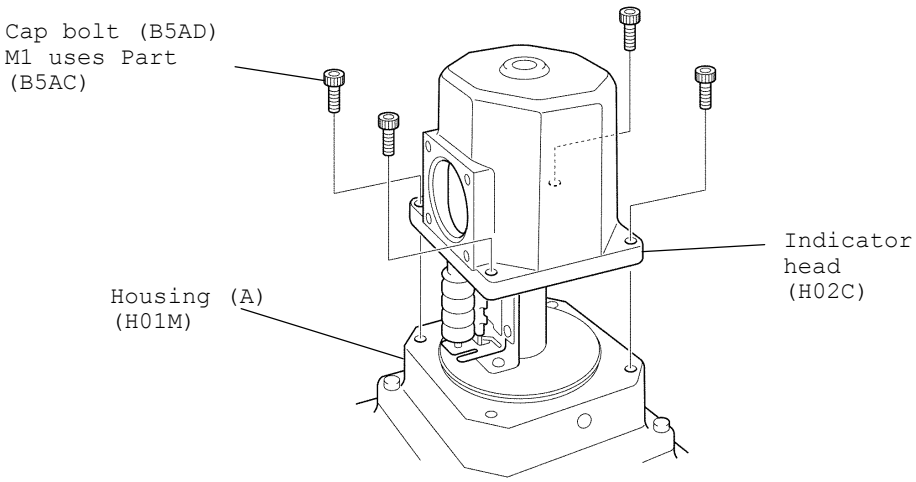


Fig. 6-12 Indicator head removal

(12) Remove the indicator unit and the gear shaft from housing (A).

(13) Removes set screws and remove the nut from the lead screw.

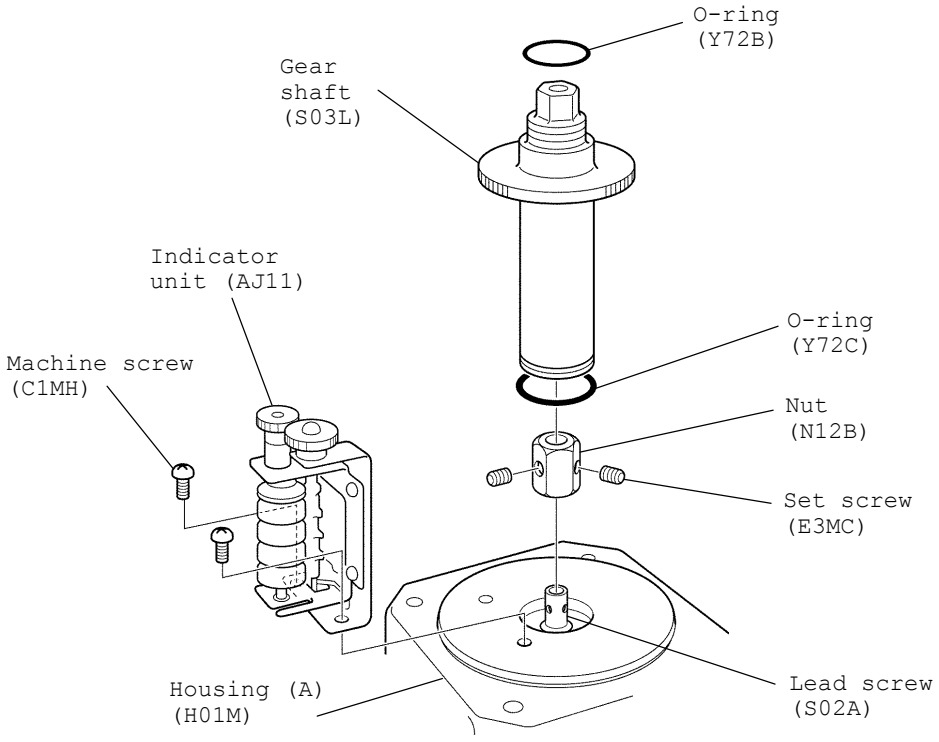


Fig. 6-13 Indicator unit and gear shaft removal

⚠ CAUTION

Be careful not to cut fingers with the shim.

(14) By rotating the lead screw clockwise, remove housing (A) upward. Remove the shim. Make a bended as shown in figure below. By using it, push the pin out from housing (A). (See the figure shown on the right.)

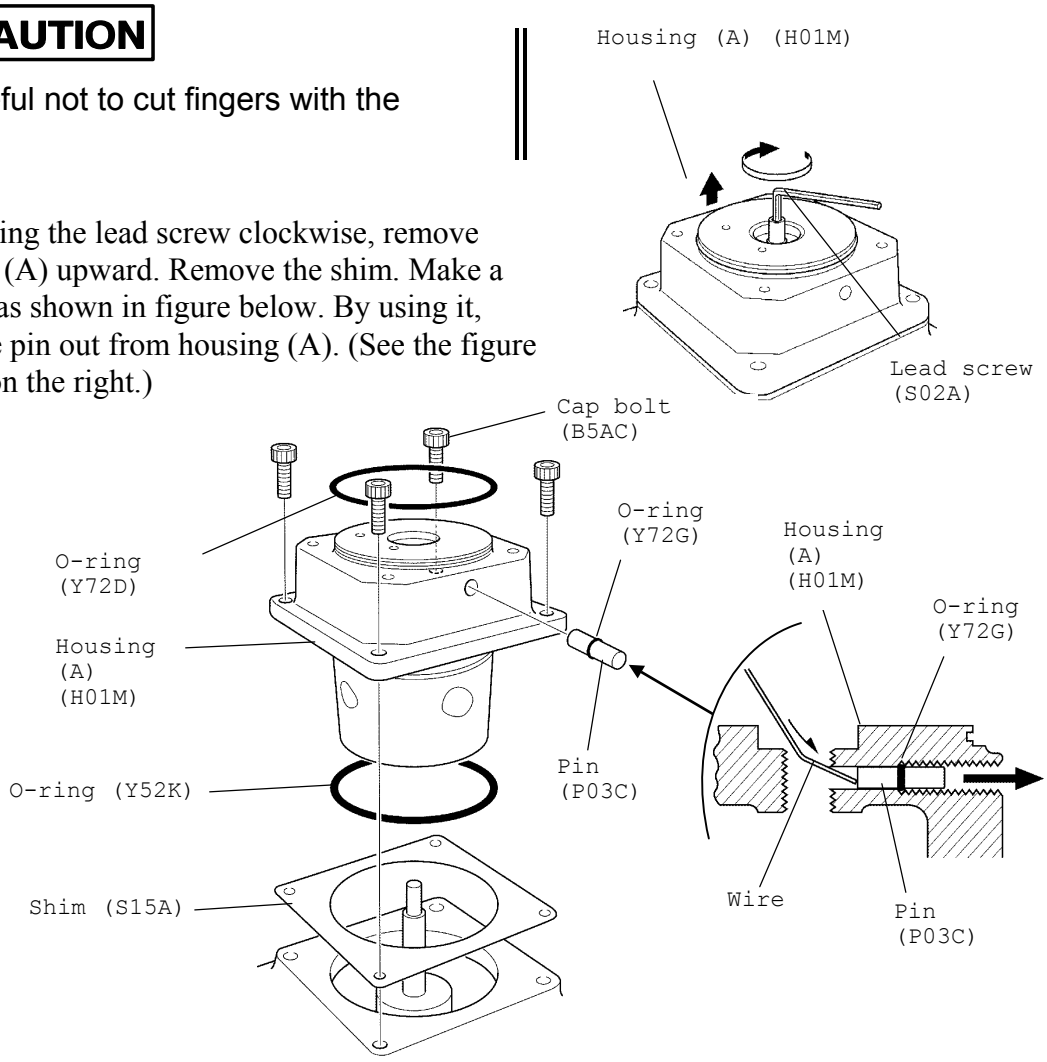


Fig. 6-14 Housing (A) removal

⚠ CAUTION

Be careful not to cut fingers with lead screw.

(15) Pull the lead screw up to the position where the stroke length is 0 %. Maintain the lead screw at the same position, and disconnect the connecting rod from the cam. Then remove it from the crankcase by tilting it as shown in the figure on the right.

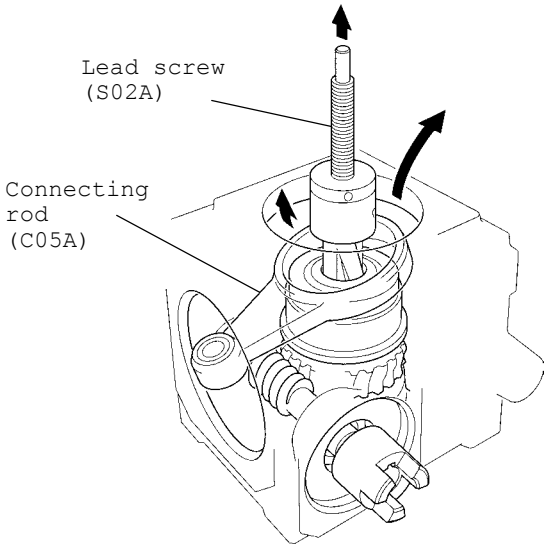


Fig. 6-15 Connecting rod removal

(16) Remove the needle bearing and bush from the connecting rod.

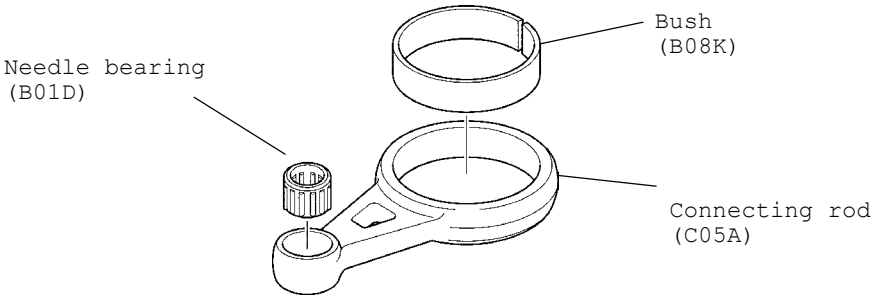


Fig. 6-16 Needle bearing and bush removal

(17) If necessary, remove two set screws, then remove the coupling and key from the worm shaft. Before removing the coupling, note the coupling depth by using the slide calipers.

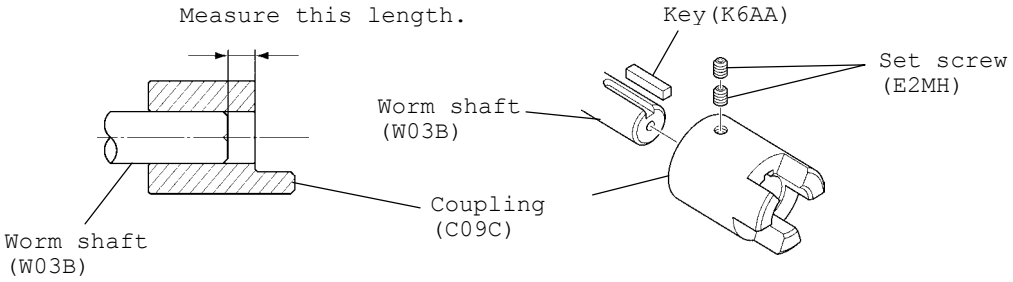


Fig. 6-17 Coupling removal

(18) Both ends of the worm shaft are covered with the caps. Remove all cap bolts, then remove the two caps from the crankcase. For the opposite side of the motor side, remove the shim.

NOTE:

Model M1; A snap ring is positioned on each end of the worm shaft.

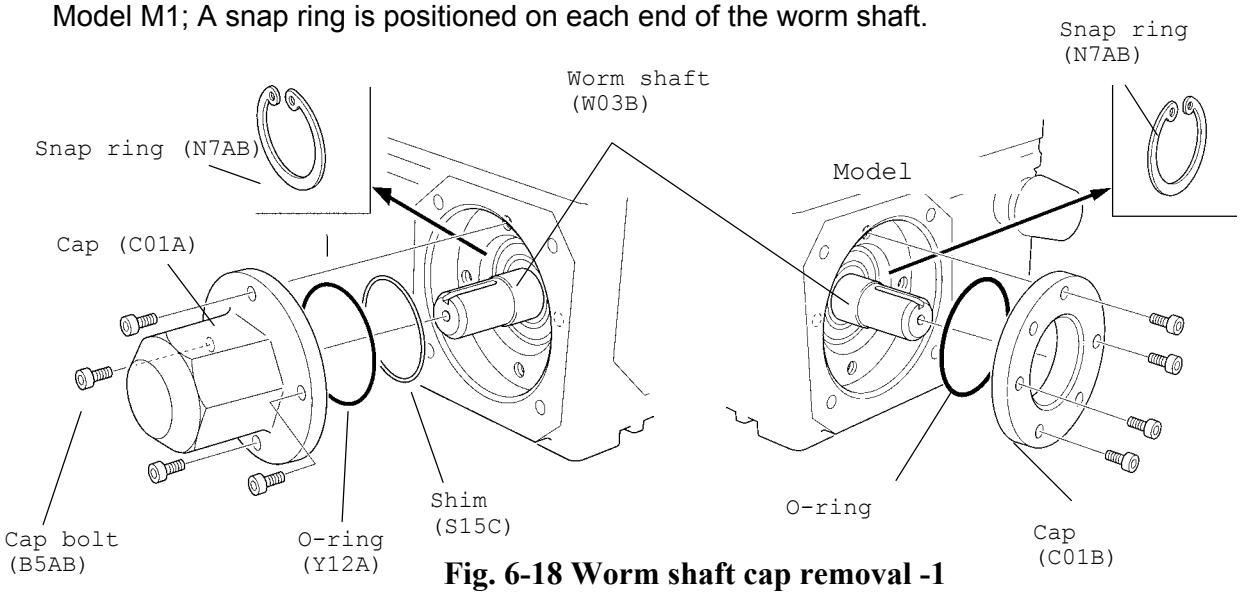


Fig. 6-18 Worm shaft cap removal -1

When removing caps of Model MH, the oil seal is also removed.

NOTE:

If it is difficult to remove the cap which is located on the motor side, set two bolts in the screw holes of the cap, and screw them. The cap is easily removed from the crankcase.

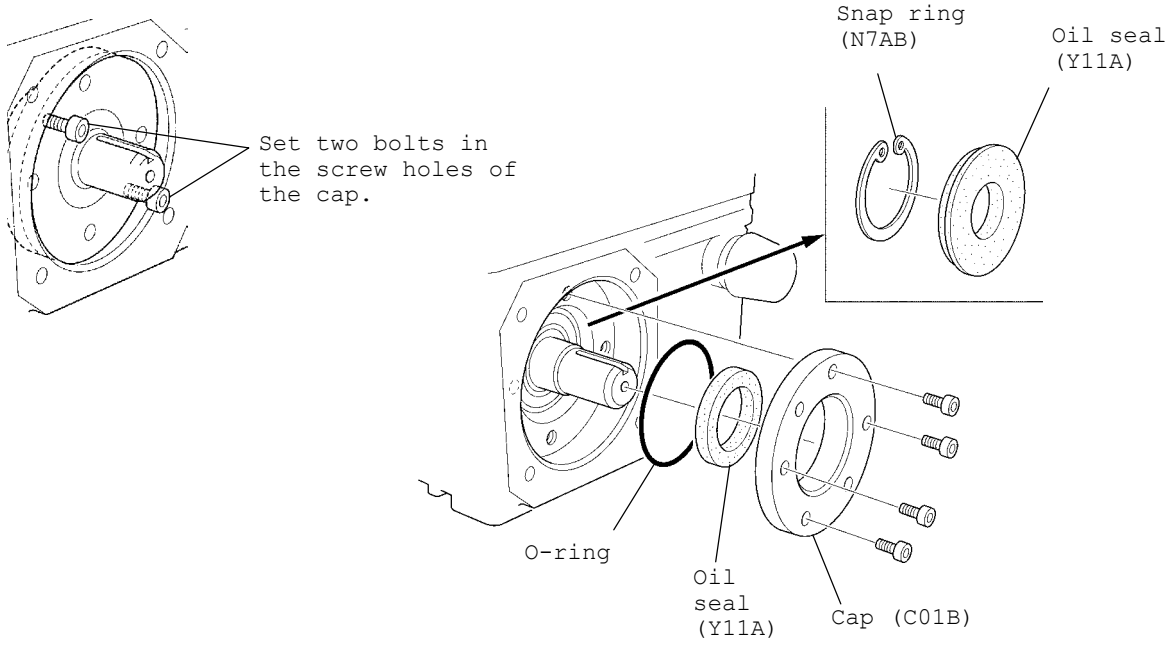


Fig. 6-19 Worm shaft cap removal -2

(19) Tap the worm shaft with a plastic hammer and disassemble it with the bearings from the crankcase.

(20) Remove the tapered roller bearings and the ball bearings from the worm shaft. When disassembling Model MH, remove collar with the bearing.

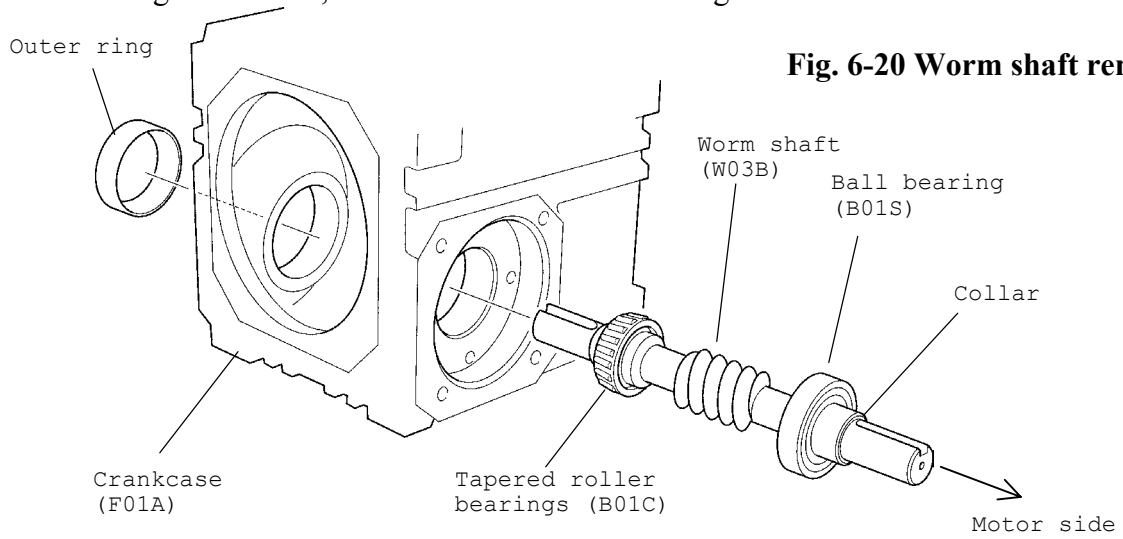


Fig. 6-20 Worm shaft removal

⚠ CAUTION

Be careful not to cut fingers with lead screw and shim.

(21) Remove the crank unit from the crankcase.
Remove the shim from the crankcase.

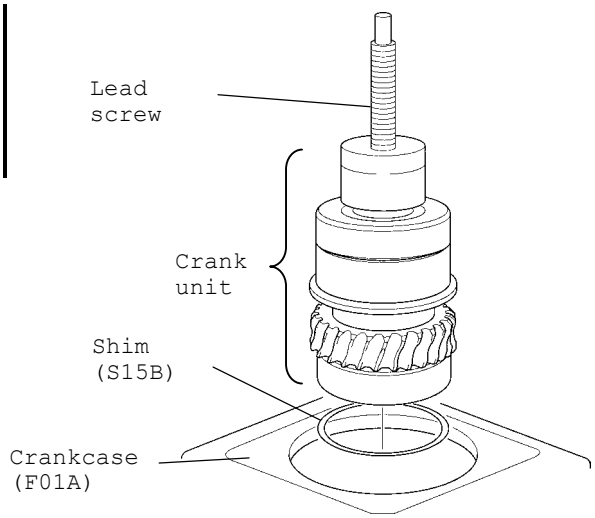


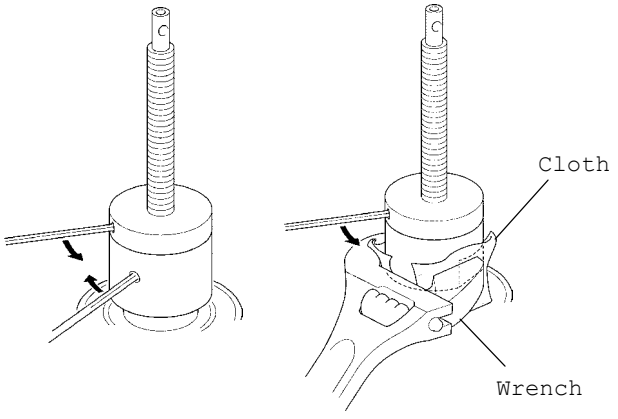
Fig. 6-21 Crank unit removal

⚠ CAUTION

Be careful not to cut fingers with lead screw.

(22) Remove set screws of housing (B), and remove the lead screw assembly.

(23) Remove the hexagon head bolt and disassemble the ball bearings and housing (B) from the crank.



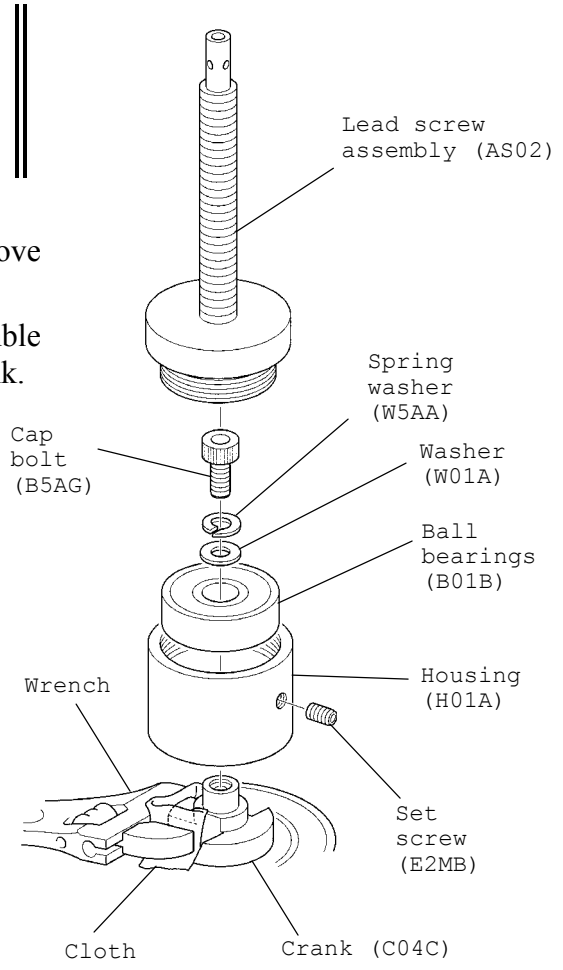


Fig. 6-22 Lead screw and housing (B) removal

(24) Remove the crank downward, then remove the cam from the hollow shaft.

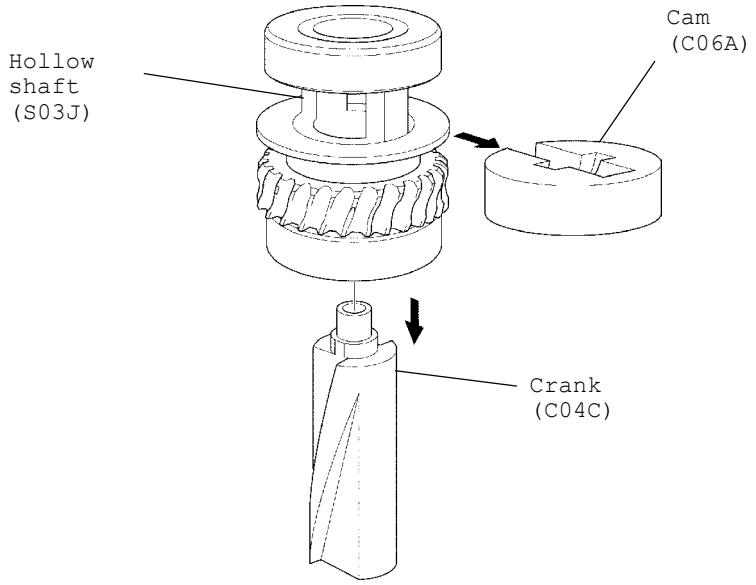


Fig. 6-23 Crank removal

(25) Disassemble the bearings, worm wheel, hollow shaft, etc.

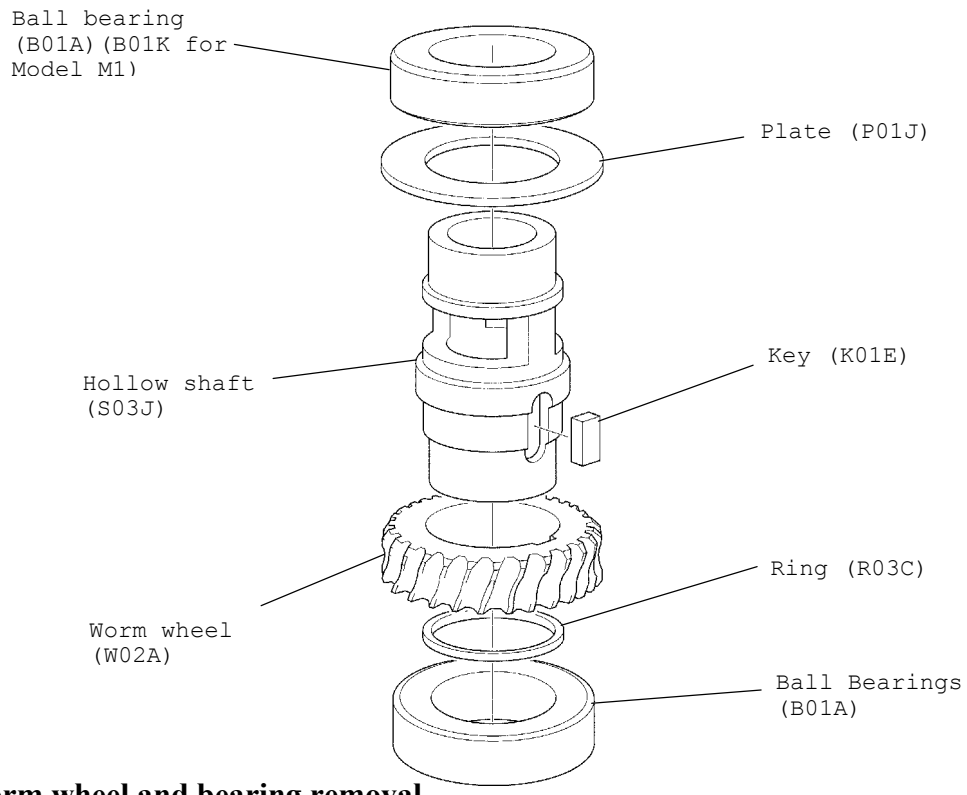


Fig. 6-24 Worm wheel and bearing removal

6.5 Reassembly

When reassembling the unit, the procedure is the reverse of disassembly.
Pay attention to the following items.

(1) Replace the following parts with new ones.
Coupling cushion-Oil seal-Bearings-Collar-Packing -O-ring-Crosshead pin-Bush -Oil gauge (A)

(2) When fitting O-ring, apply grease to O-ring and insert it without causing any damage.

(3) When assembling the ball bearing on the worm shaft, press fit them on the lathe mark side of the worm shaft. When assembling Model MH, after completion of the bearing assemblage, shrinkage fit the collar in order to obtain a firm connection.

Collar: Approx.150

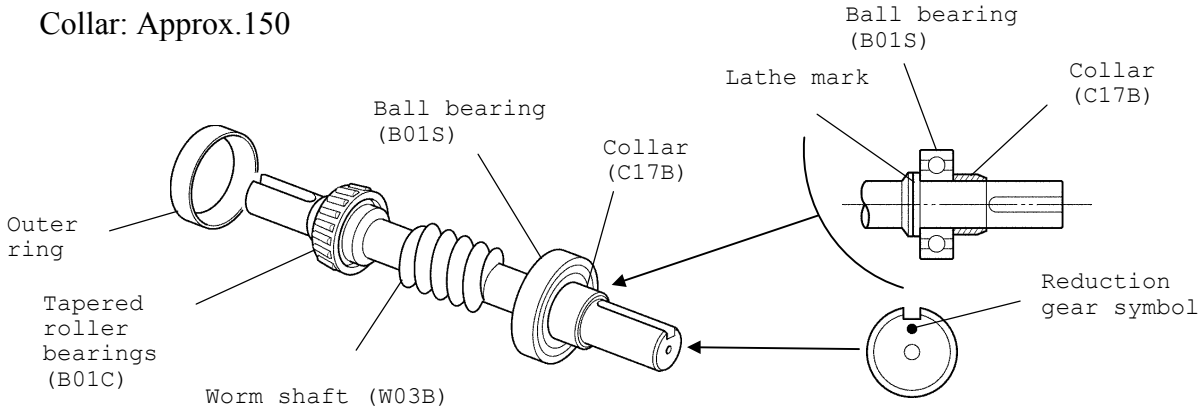


Fig. 6-25 Worm shaft reassembly

(4) The worm shaft and the worm wheel are replaceable as a pair. If only one part's replacement is necessary, contact us for details.

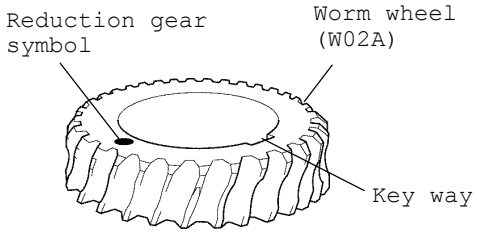


Fig. 6-26 Reduction gear symbol of worm wheel

(5) Set the worm wheel on the hollow shaft with UP mark side of the worm wheel coming to the lead screw side. Fit the worm wheel with shrinkage fitting measure to obtain a firm connection.

Worm wheel: Approx.80

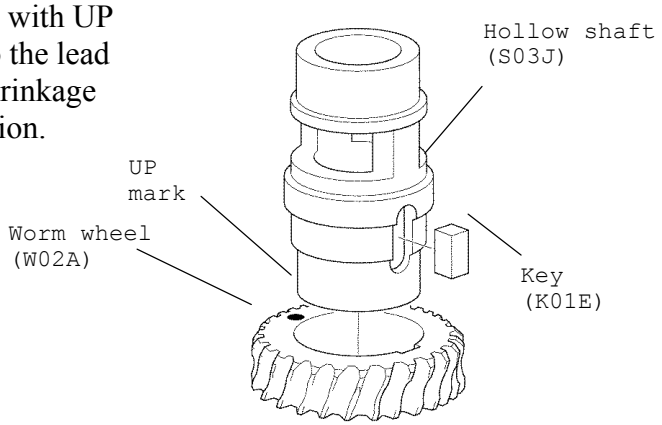


Fig. 6-27 Worm wheel reassembly

(6) When assembling the cam, after attaching the plate to the hollow shaft, keep the position of the hollow shaft and the crank as shown in the figure on the right. Set the UP mark of the cam to the lead screw side. Then assemble them.

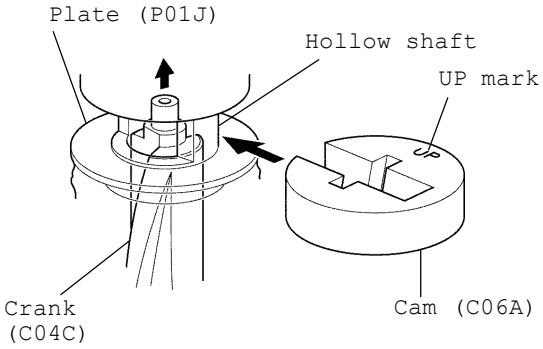


Fig. 6-28 Cam reassembly

(7) When press fitting the bush into the larger hole of the connecting rod, set the slit of the bush as shown in figure on the right. Furthermore, pay attention that the bush does not to protrude from the edge of the connecting rod.

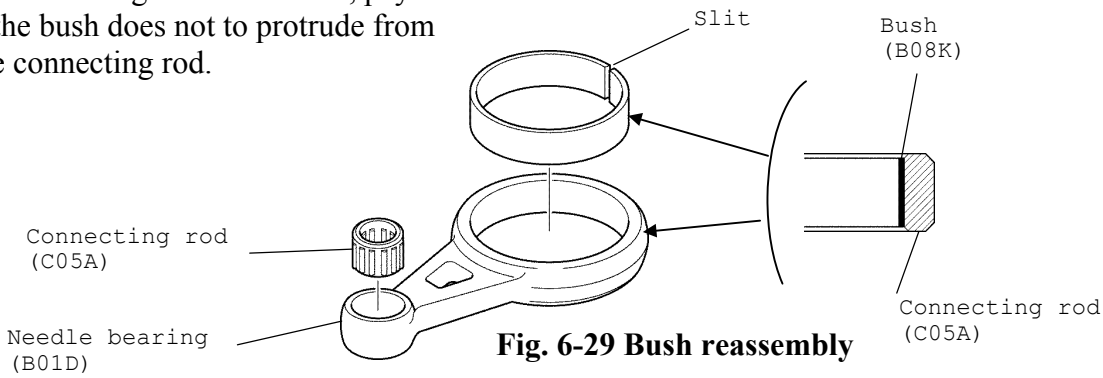


Fig. 6-29 Bush reassembly

(8) Protect the surface of the crank with a cloth, and secure it with a wrench. Tighten housing (B) and the bearing with the cap bolt firmly. In the same way, tighten housing (B) and the lead screw assembly. Apply molybdenum disulfide on the thread of the lead screw.

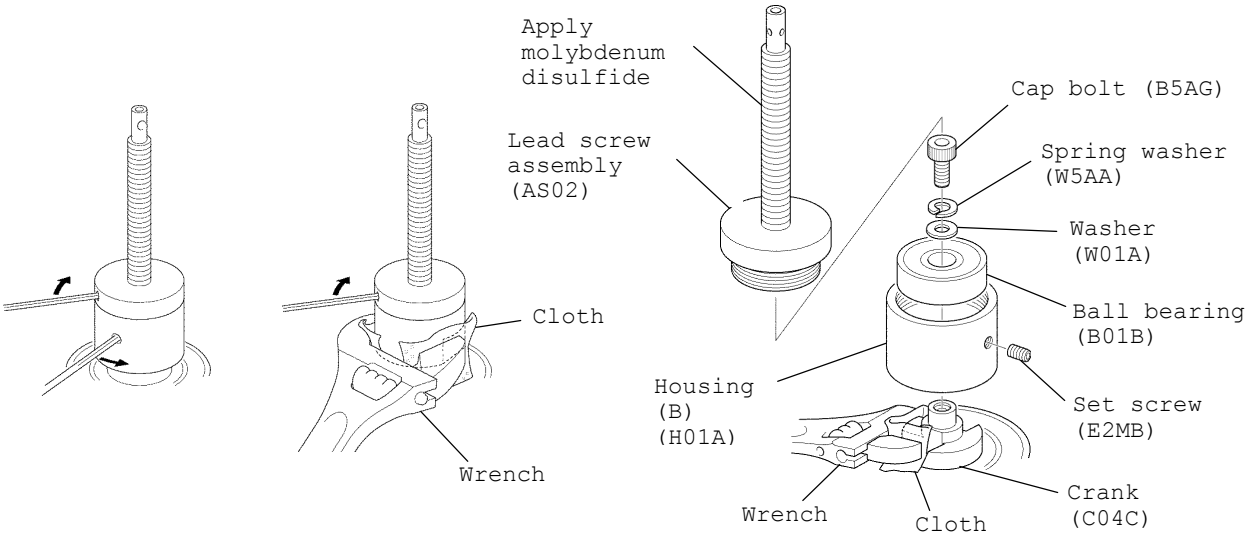


Fig. 6-30 Lead Screw Reassembly

(9) Three shim adjustments are required in this pump system.
- Gap adjustment of the worm shaft (Set the thermal expansion margin)
- Mesh adjustment between the worm wheel and worm shaft gear (Vertical adjustment)
- Tightening adjustment of the hollow shaft bearings (Minimize the bearing end play)

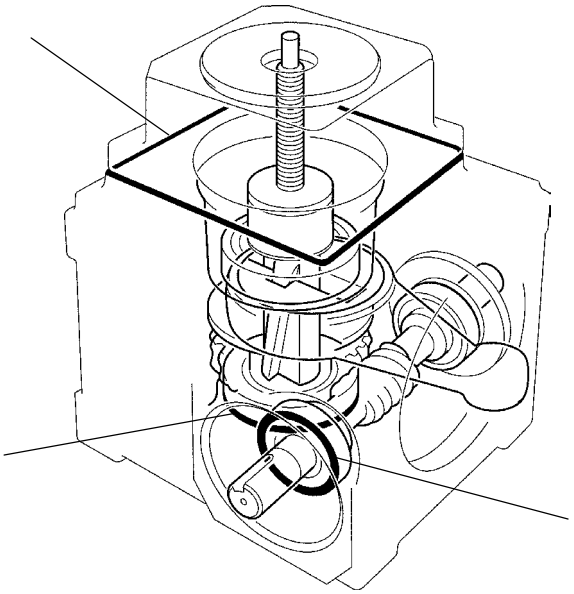


Fig. 6-31 Shim Positions

The shim adjustment procedures are shown below:

1- Assemble the worm shaft unit alone, and adjust gap of the worm shaft by adding / re-moving shims until obtaining an appropriate gap.

Gap: 0.02 - 0.05 mm

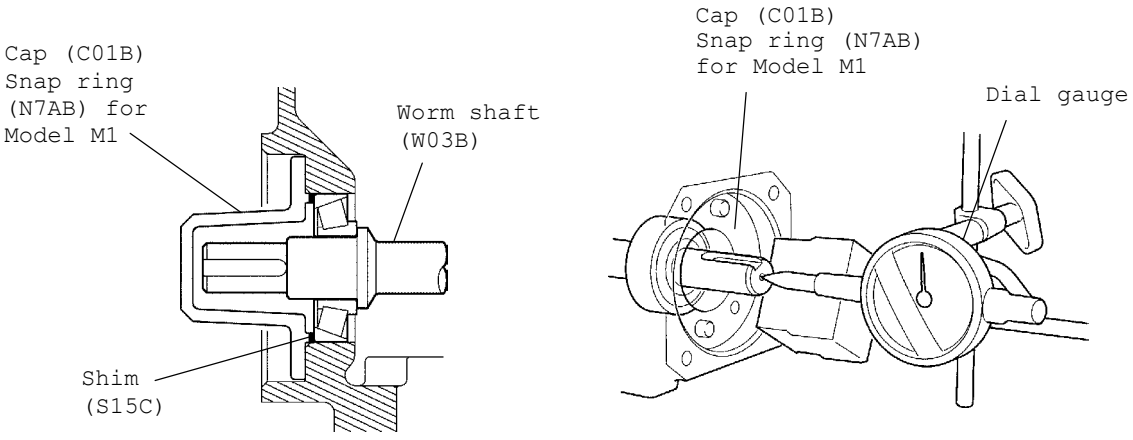


Fig. 6-32 Gap adjustment of the worm shaft

1- Apply a gear meshing marker to the worm shaft gear tooth, and assemble the worm shaft.

2- Insert the crank unit in the crank case.

3- Rotate the worm shaft, and mark the meshing point on the worm wheel.
Adjust the meshing being positioned a slight lower than the center of the gear.
By tightening the housing (A) in accordance with Step 1, the meshing mark moves upward a little.
So, meshing mark should be lower than the center of the gear.

NOTE:

When turning the worm shaft, fit the coupling temporarily.

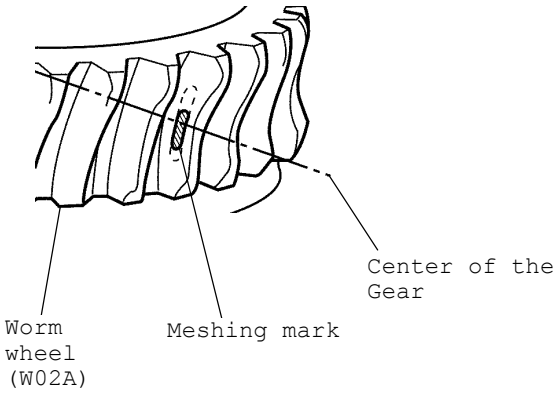


Fig. 6-33 Worm wheel vertical adjustment

1- Rotate the lead screw and assemble housing (A). Measure the gap between the crankcase and housing (A) by the thickness gauge. By adding / removing shims, adjust the gap until obtaining the appropriate thickness as shown on the table below.
After adjustment of the gap, tighten the housing (A) to the crankcase with the cap bolts.

NOTE:

Before tightening the housing (A), check that the connecting rod is already installed in the crankcase.

Table 6-1 Tightening adjustment of Housing (A)

Model	Gap (mm)
M1	0.05 - 0.15
M2	0.10 - 0.20
M3	0.15 - 0.25

NOTE:

Check the setting direction of the housing (A) by confirming the position of the indicator unit attachment hole.

Type MV: set the indicator unit attachment hole to the motor side.

Type MH: set the indicator unit attachment hole to the opposite side of the liquid end.

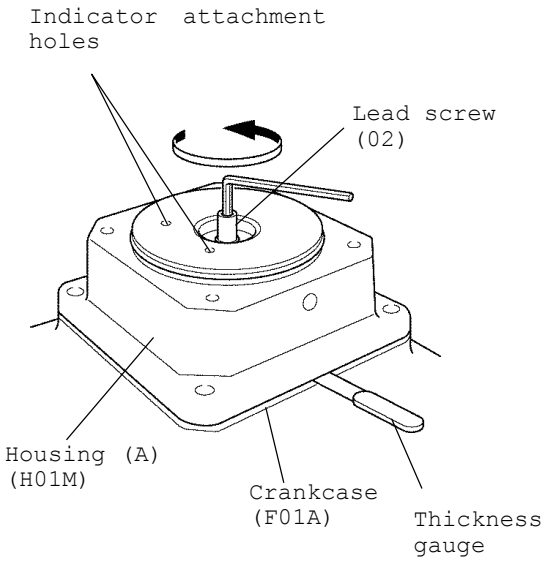


Fig. 6-34 Tightening adjustment of housing (A)

(10) When fitting the oil seal on the worm shaft, apply tape to the key way of the worm shaft to protect the lip of the oil seal.

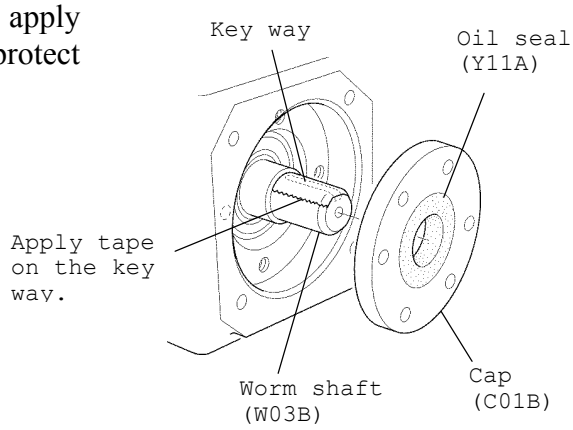


Fig. 6-35 Oil seal reassembly

(11) When assembling the coupling, secure it to the same relative position of motor and worm shafts, as was noted when disassembling them. Apply molybdenum disulfide on the end of the shaft.

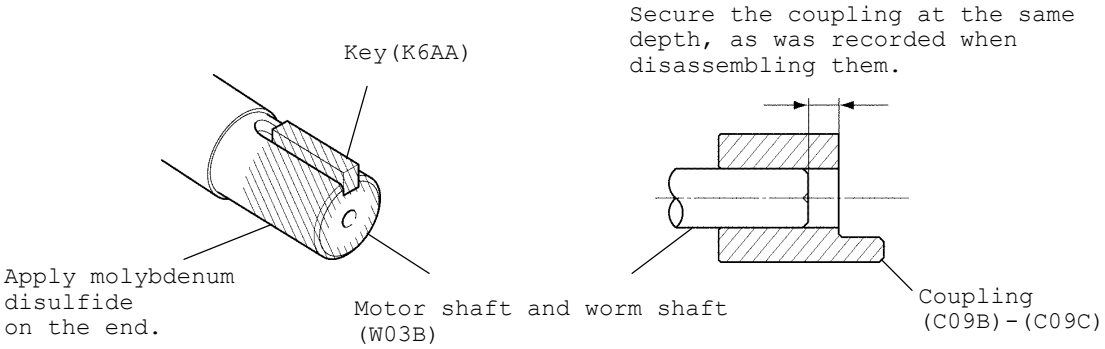


Fig. 6-36 Coupling reassembly

(12) When inserting the pin, pay attention that the oil seal does not touch the screw portion of housing (A).

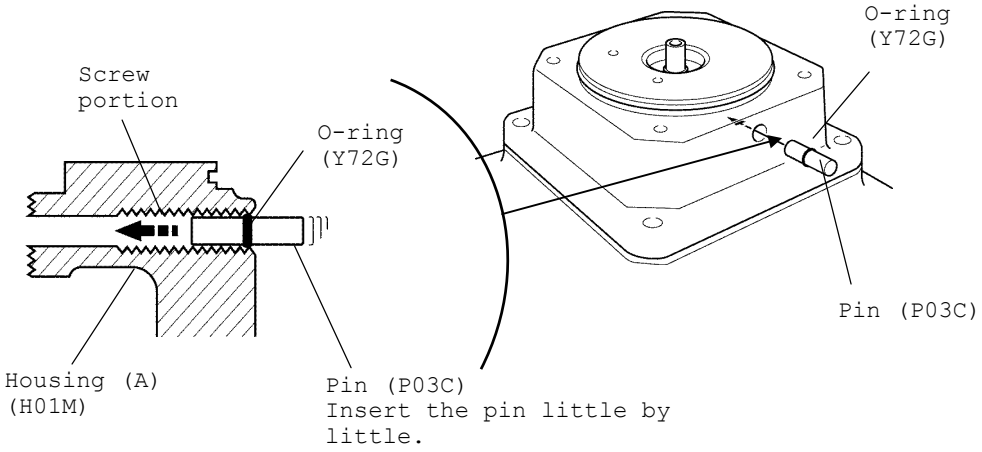


Fig. 6-37 Pin reassembly

(13) When assembling Type H, insert the packing carefully bending it into the liquid end adapter as shown in the figure below. Pay attention to the correct installation direction of the packing. In case of packed plunger type, the packing should be press fitted. (The packing is not applicable for Type L.)

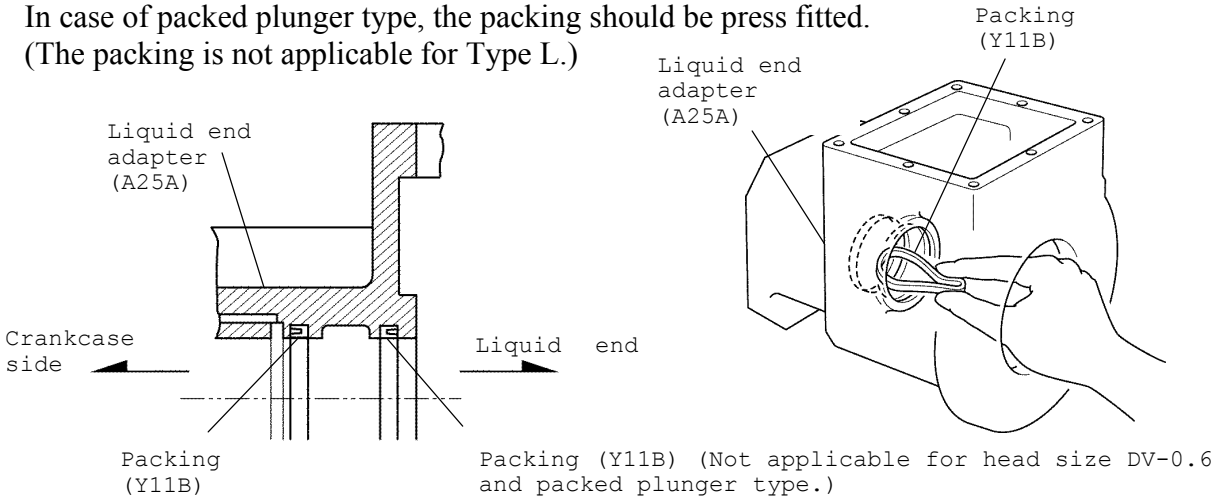


Fig. 6-38 Packing reassembly

6.5.1 Zero Adjustment

After completion of crosshead and liquid end adapter reassembly, set to the zero position.

(1) Loosen the knob, and set the dial gauge to the end of the crosshead.

(2) Rotate the coupling manually. The crosshead reciprocates.

(3) Turn the handle, and locate the minimum position of the stroke length. When finding the minimum position, tighten the knob.

(4) Reset the indicator and attach the indicator cover.

NOTE:

When resetting the indicator, pay attention not to drop tools into the indicator head.

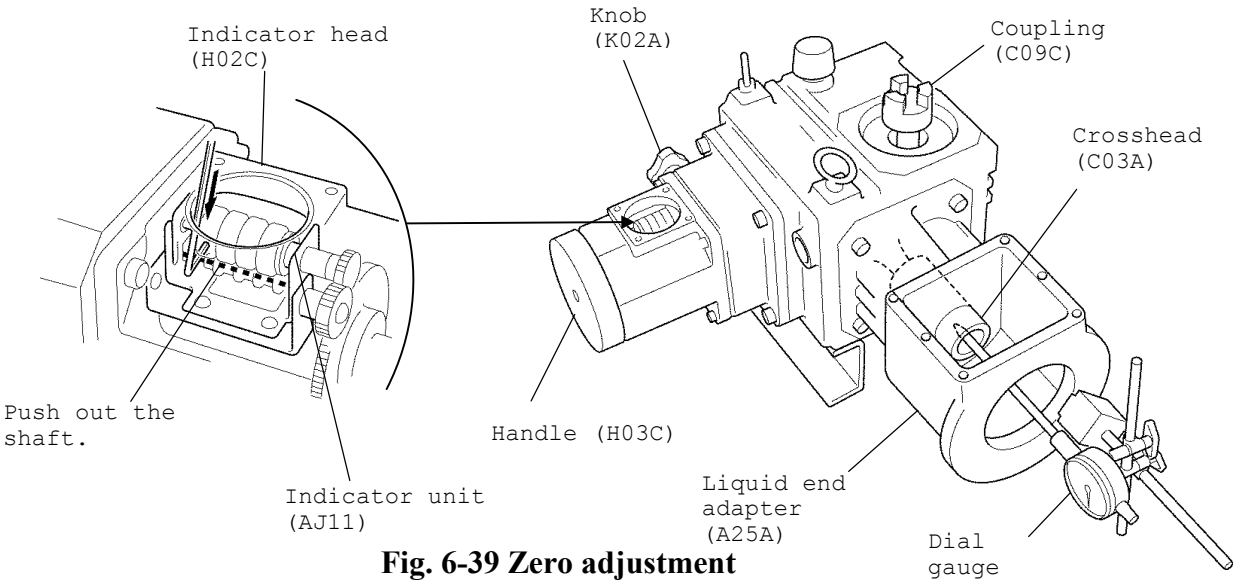


Fig. 6-39 Zero adjustment

6.5.2 Motor Reinstallation

Confirm that the gap between couplings is being maintained at between 2 and 3 mm before fixing the motor.

- Measure distance (A) between the motor installation surface of the motor bracket and the tip of the coupling of the motor bracket side.
- Measure distance (B) between the flange surface of the motor and the tip of the coupling.
- Confirm the value of (A) minus (B) is within the range of 2 to 3 mm.

After confirmation, fit the coupling cushion and attach the motor. If the model has outdoor specifications, apply a sealing chemical to the surface of the motor bracket flange to prevent invasion of moisture.

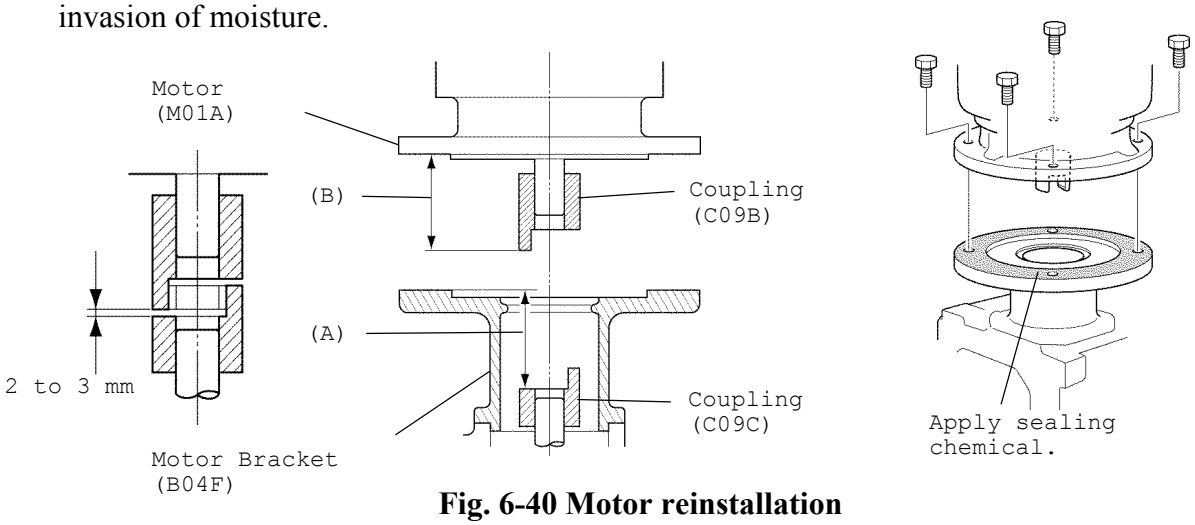


Fig. 6-40 Motor reinstallation

6.6 Multiplex Pump Connection Procedure (Only applicable to Model MH)

When connecting the worm shafts between crankcases, set each shaft by the following procedure.

(1) If each pump is equal in reduction ratio, then observe the following steps:
(For the reduction ratio, refer to the model descriptions in page.)

NOTE:

When the reduction gear symbol is F (2 polar motor), it is the same as the case of the symbol (C) 16 as shown in Table 6-2.

(Example) Triplex pump, reduction ration: 1/26

- Adjust the stroke length of each pump to 100%.
- Set the plunger at the end of the suction stroke. (Bottom dead center)
- Mark the motor side coupling of No.2 and No.3 pumps.

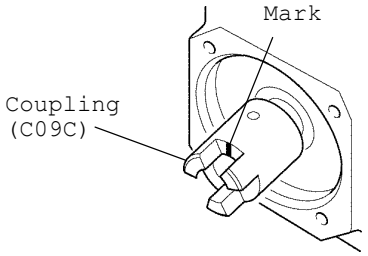


Fig. 6-41 Marking

- The worm shaft rotation (plunger position) is calculated by the following equations.

  G=H/N

  where, G = worm shaft rotation

  H = the inverse of the reduction ratio (26/1)

  N = number of pumps (triple)
  therefore, G = 26 / 3= 8 2/3 (rotation)

- Calculate the worm shaft rotation between No.2 and No.3 pumps.

  The applicable equation is:

  (n-1) × G = Z

  where, Z = rotation of corresponding worm shaft

  G = worm shaft rotation (8 2/3)

  n = pump No.

  therefore,

  (2-1) × 8 2/3 = 8 2/3 rotation (No. 2 pump)

  (3-1) × 8 2/3 = 17 1/3 rotation (No. 3 pump)

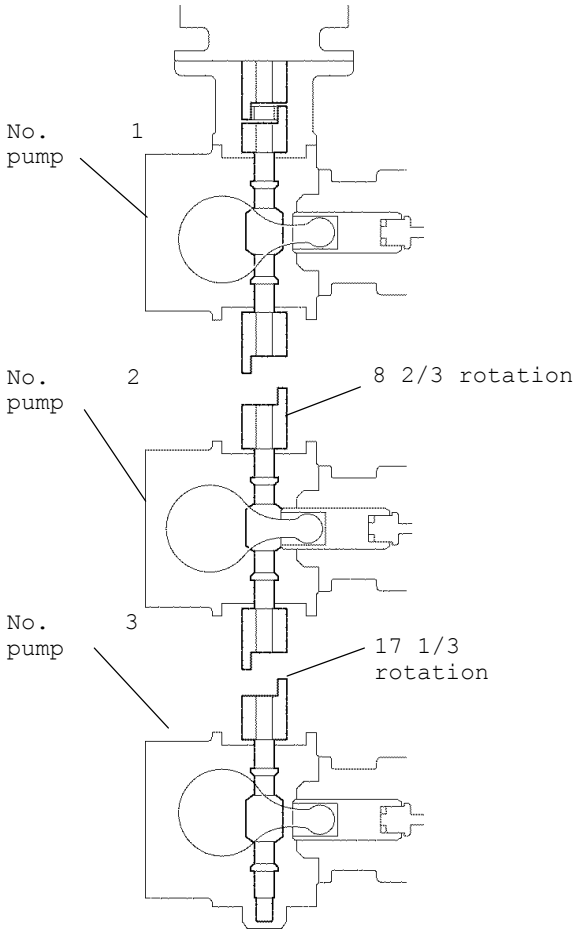


Fig. 6-42 Coupling rotation

- Rotate No.2 worm shaft by 8 2/3 turns and connect it to No.1 worm shaft. Then rotate No.3 worm shaft by 17 1/3 turns and connect it to No.2 worm shaft. Following is a table showing how to calculate the setting positions of the cranks.

Table 6-2 Worm Shaft Rotation (G)

Number of multiplex (N)	(Reduction gear symbol) Inverse number of the reduction ratio H					
	(A) 26	(B) 20	(C) 16	(D) 13	(E) 10	(F) 8
2	13	10	8	6 1/2	5	same as the(C)16
3	8 2/3	6 2/3	5 1/3	4 1/3	3 1/3	
4	6 1/2	5	4	3 1/4	2 1/2	
5	5 1/5	4	3 1/5	2 3/5	2	
6	4 1/3	3 1/3	2 2/3	2 1/6	1 2/3	

(2) If each pump has a different reduction ratio, connect the worm shafts at any positions.

6.7 Run-in Operation After Reassembly

⚠ CAUTION

The moving portions and bearing housing of the pump do not move as smoothly as before disassembly. After completion of reassembly, carry out the run-in operation sufficiently. Refer to “2.4.3 First half of Run-in Operation“ and ”2.4.4 Last half of Run-in Operation”. If run-in operation is neglected, it may cause of power end damage.

(1) Set the indicator to 0%, and tighten the knob manually to stop the lead screw.

(2) Confirm that the crankcase contains appropriate lubricating oil.

(3) For the run-in operation, refer to "2.4 Starting and Run-in Operation" in detail.
When run-in begins, the stroke length is to be set as explained in the above paragraph (1).

6.8 Parts Lists and Cross Sections of Power End

6.8.1 Parts List for Model M1

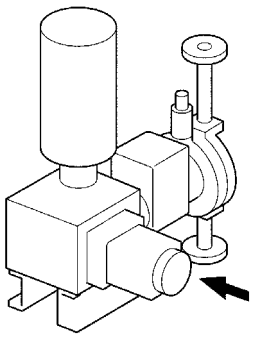
ITEM	Part Name	MV Q'TY	MH Q'TY
A21G	Adapter	0	0[1]
A24A	Plunger Adapter	1	1
A25A	Liquid End Adapter	1	1
AC04	Crank Assembly	1SET	1SET
C0C4	Crank	(1)	(1)
C06A	Cam	(1)	(1)
S03J	Hollow Shaft	(1)	(1)
AJ11	Indicator Unit	1SET	1SET
A1NB	Nut	(1)	(1)
B04R	Bracket	(1)	(1)
B08J	Bush	(1)	(1)
C1MG	Machine Screw	(4)	(4)
C1MK	Machine Screw	(1)	(1)
G01G	Gear (B)	(1)	(1)
G01H	Gear (C)	(1)	(1)
J11F	Indicator	(1)	(1)
W2AK	Washer	(2)	(2)
W5BC	Spring Washer	(1)	(1)
AS02	Lead Screw Assembly	1SET	1SET
C01D	Cap	(1)	(1)
N5AB	Spring Pin	(1)	(1)
S02A	Lead Screw	(1)	(1)
B01A	Ball Bearing	1	1
B01B	Ball Bearing	1	1
B01C	Tapered Roller Bearing	1	1
B01D	Needle Bearing	1	1
B01K	Ball Bearing	1	1
B01S	Ball Bearing	1	1
B04F	Motor Bracket	1	1
B08K	Bush	1	1
B15A	Breather	1	1
B1MC	Hexagon Head Bolt	4	4
B1NC	Hexagon Head Bolt	1	1
B5AA	Cap Bolt	4	4
B5AB	Cap Bolt	2	2
B5AC	Cap Bolt	4	4
B5AG	Cap Bolt	1	1
B5CA	Cap Bolt	4	4[8]
C01A	Cap	1	1
C02R	Indicator Cover	1	1
C03A	Crosshead	1	1
C05A	Connecting Rod	1	1
C08A	Coupling Cushion	1	1
C08D	Coupling Cushion	0	0[1]
C09B	Coupling (Motor side)	1	1
C09C	Coupling (Pump side)	1	1
C09E	Coupling	0	0[1]
C17B	Collar	0	1[2]
C1MH	Machine Screw	2	2
C1MJ	Machine Screw	4	4

ITEM	Part Name	MV Q'TY	MH Q'TY
C2MD	Machine Screw	1	1
E2MB	Set Screw	1	1
E2MH	Set Screw	2	2[4]
E2MK	Set Screw	2	2
E3MC	Set Screw	2	2
F01A	Crank Case (Pump Frame)	1	1
F1WA	Plug	1	1
G10A	Oil Gauge (A)	1	1
H01A	Housing (B)	1	1
H01M	Housing (A)	1	1
H02C	Indicator Head	1	1
H03C	Handle	1	1
K01E	Key	1	1
K02A	Knob	1	1
K6AA	Key	1	1[2]
L1WK	Plug	1	1
L1WQ	Plug	0	1
L1WR	Plug	1	0
M01A	Motor	1	1
N12B	Nut	1	1
N7AB	Snap Ring	2	2
P01J	Plate	1	1
P03B	Crosshead Pin	1	1
P03C	Pin	1	1
P13D	Name Plate	1	1
R02A	Rivet	4	4
R03C	Ring	1	1
S03L	Gear Shaft	1	1
S06A	Segment	1SET	1SET
S15A	Shim	1SET	1SET
S15B	Shim	1SET	1SET
S15C	Shim	1SET	1SET
W01A	Washer	1	1
W02A	Worm Wheel	1	1
W03B	Worm Shaft	1	1
W5AA	Spring Washer	1	1
Y11A	Oil Seal	0	1[2]
Y11B	Packing	2<1>	2<1>
Y12A	O-ring	1	1
Y52K	O-ring	1	1
Y72A	O-ring	1	1[2]
Y72B	O-ring	1	1
Y72C	O-ring	1	1
Y72D	O-ring	1	1
Y72E	O-ring	1	1
Y72F	O-ring	1	1
Y72G	O-ring	1	1

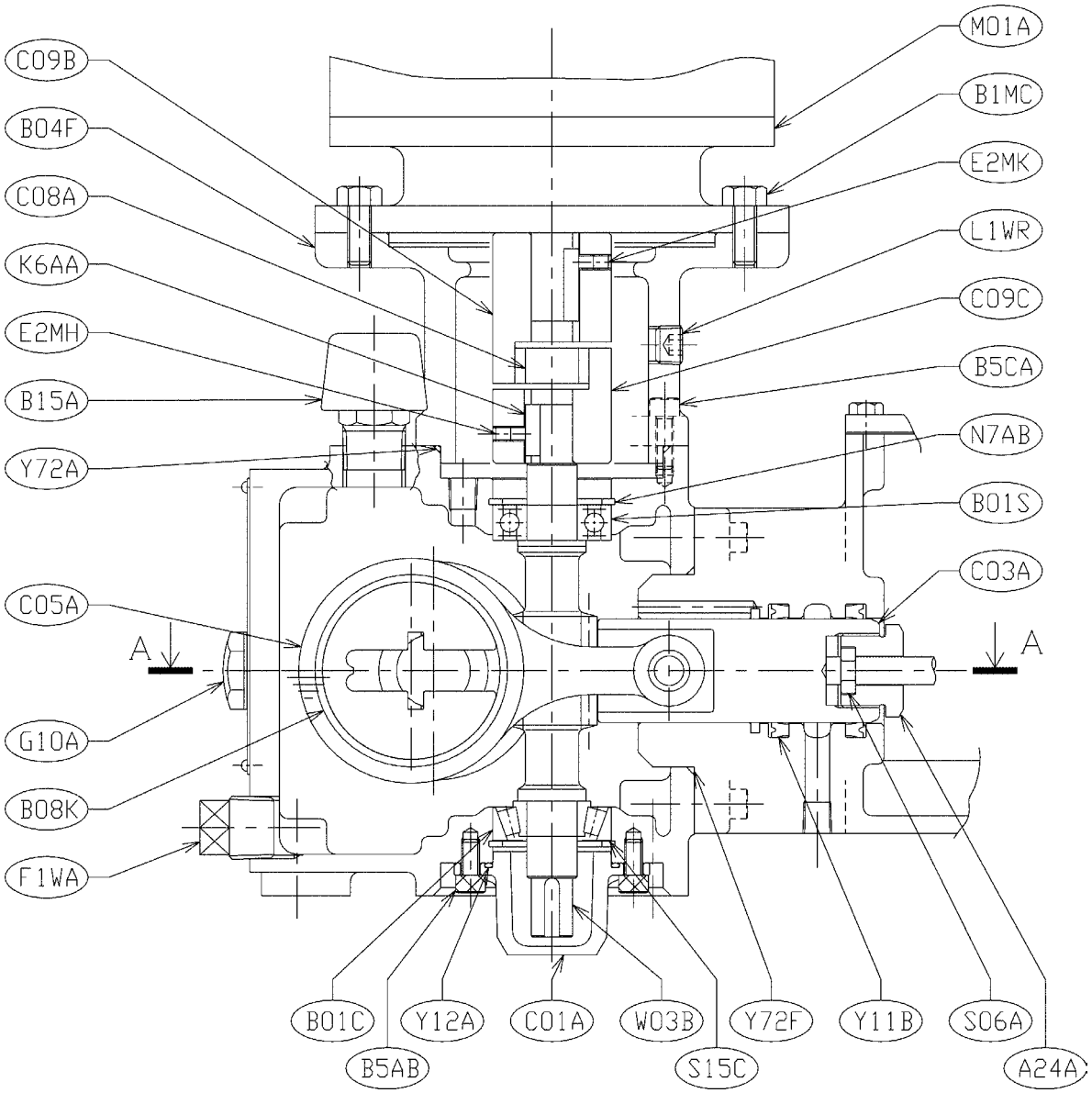
NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.
2. [ ] Q'TY are required for multiplex type.
3. **< >** Q'TY are required for head size DV-0.6 and packed plunger type.

6.8.2 Cross Section of Model M1

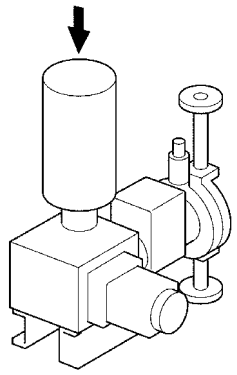
Model M1 (MV) -1/2



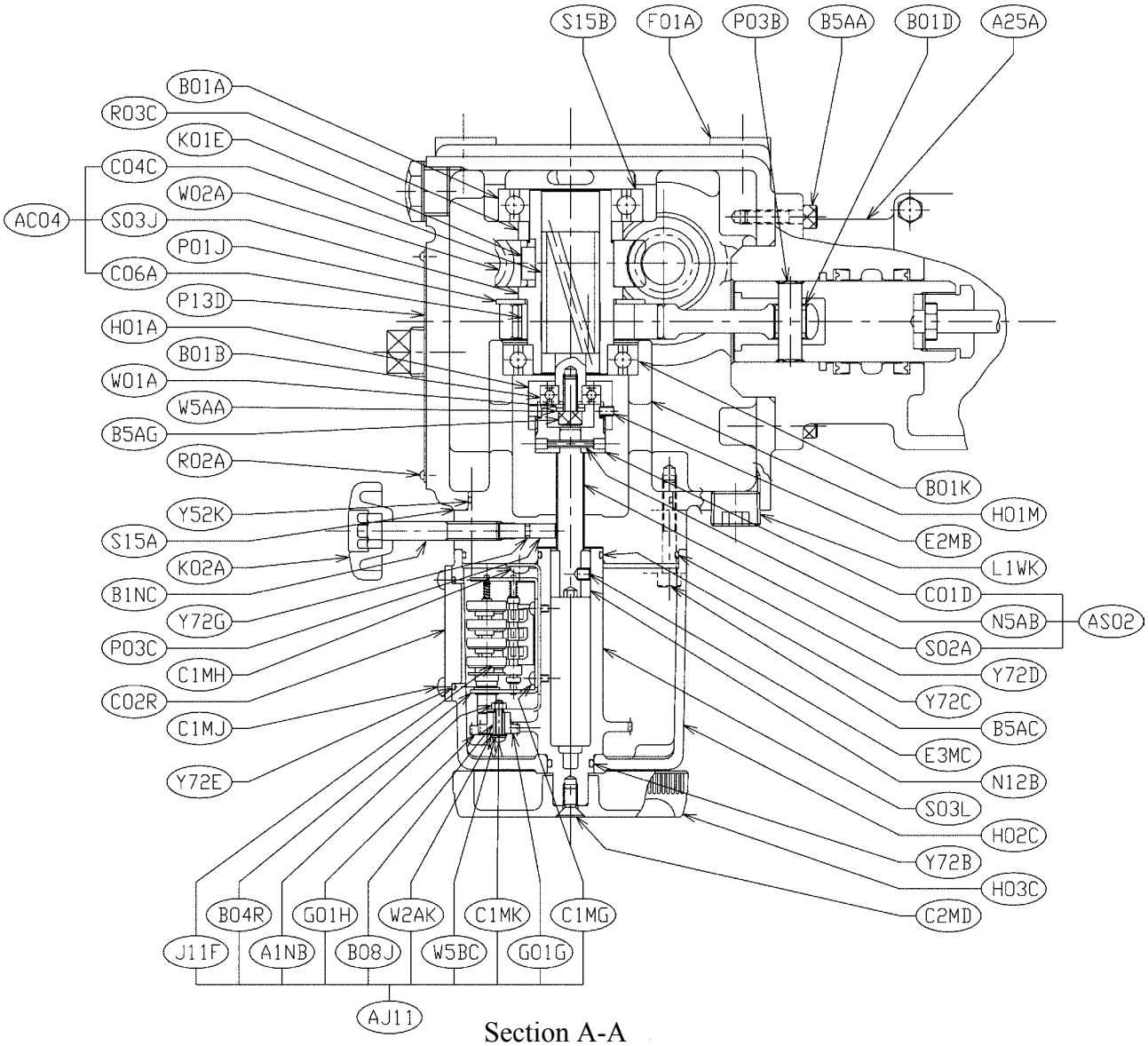
View Y



Model M1 (MV) -2/2

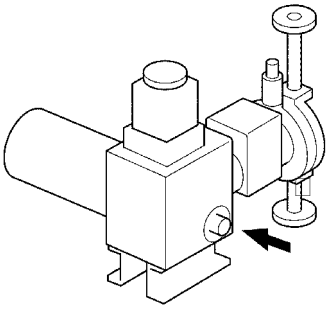


View Z

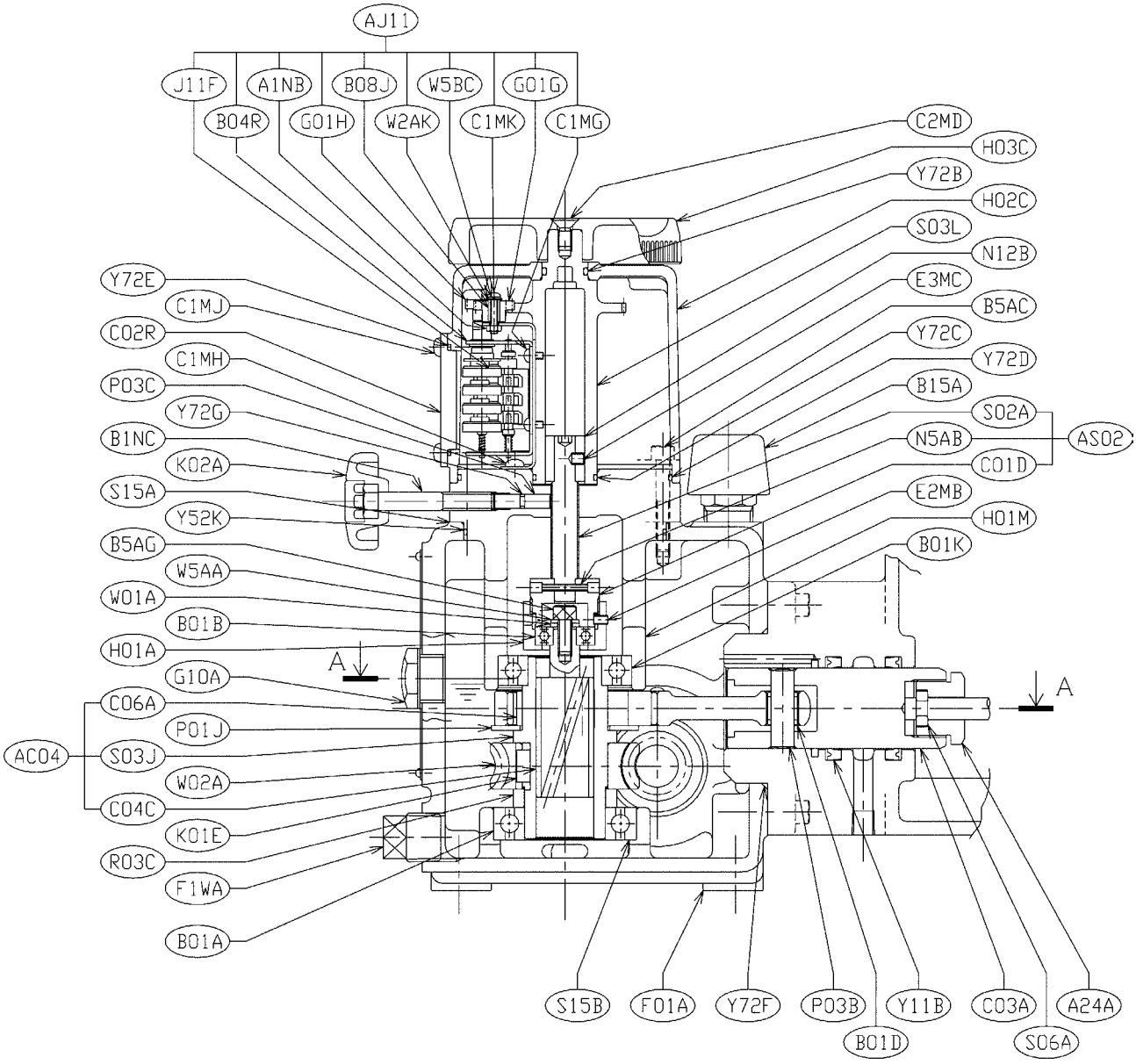


Section A-A

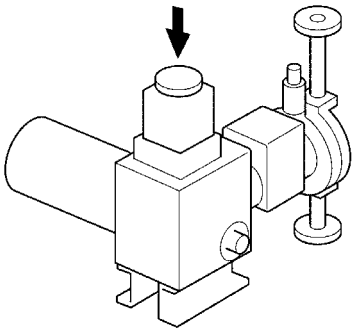
Model M1 (MH) -1/2



View Y



Model M1 (MH) -2/2



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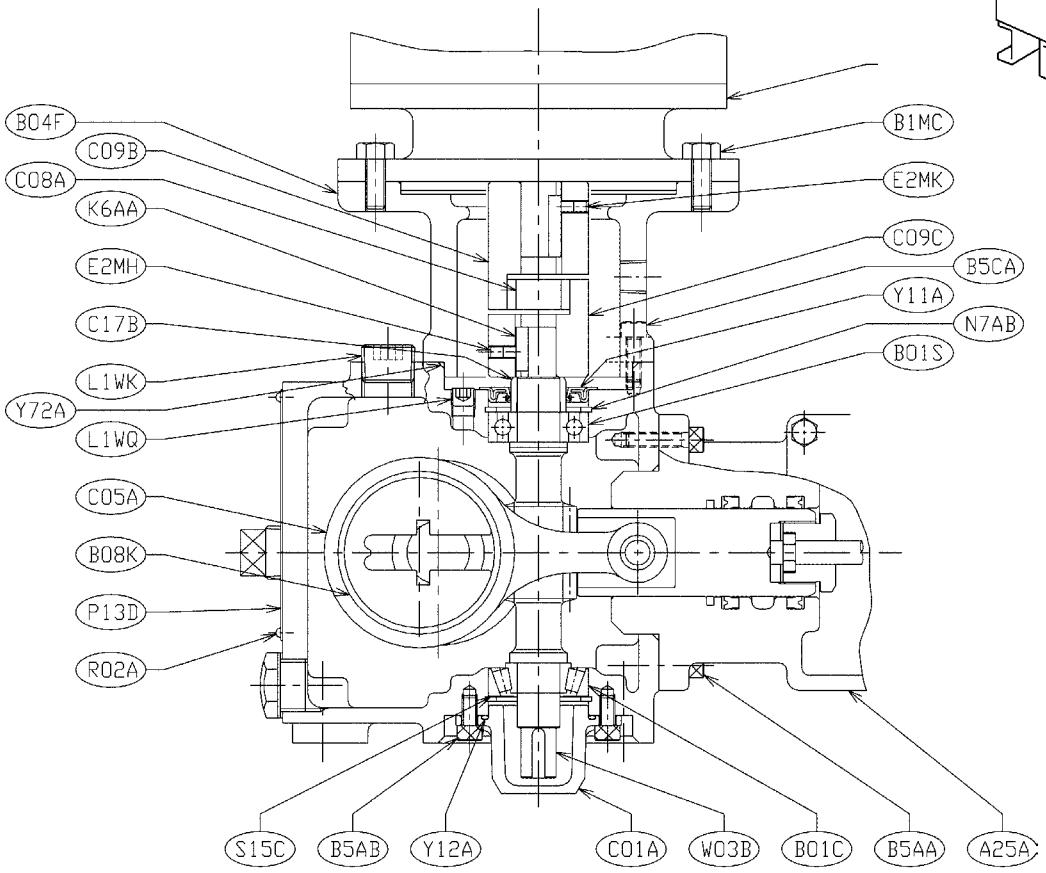
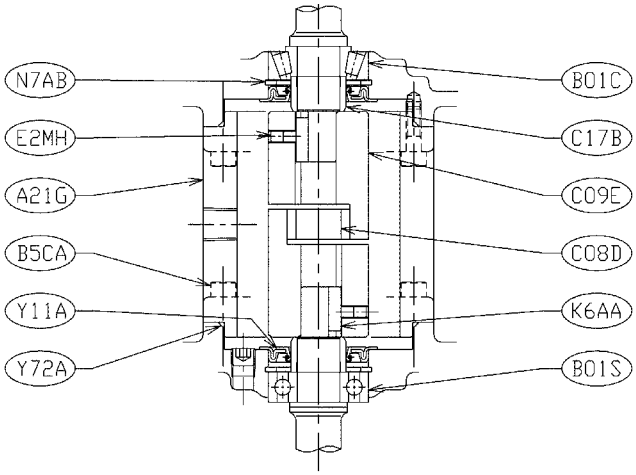


A − A

Section A-A



For Multiplex type.

6.8.3 Parts List for Model M2

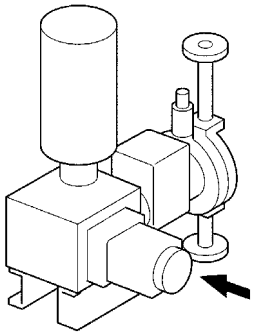
ITEM	Part Name	MV Q'TY	MH Q'TY
A21G	Adapter	0	0[1]
A24A	Plunger Adapter	1	1
A25A	Liquid End Adapter	1	1
AC04	Crank Assembly	1SET	1SET
C0C4	Crank	(1)	(1)
C06A	Cam	(1)	(1)
S03J	Hollow Shaft	(1)	(1)
AJ11	Indicator Unit	1SET	1SET
A1NB	Nut	(1)	(1)
B04R	Bracket	(1)	(1)
B08J	Bush	(1)	(1)
C1MG	Machine Screw	(4)	(4)
C1MK	Machine Screw	(1)	(1)
G01G	Gear (B)	(1)	(1)
G01H	Gear (C)	(1)	(1)
J11F	Indicator	(1)	(1)
W2AK	Washer	(2)	(2)
W5BC	Spring Washer	(1)	(1)
AS02	Lead Screw Assembly	1SET	1SET
C01D	Cap	(1)	(1)
N5AB	Spring Pin	(1)	(1)
S02A	Lead Screw	(1)	(1)
B01A	Ball Bearing	2	2
B01B	Ball Bearing	1	1
B01C	Tapered Roller Bearing	1	1
B01D	Needle Bearing	1	1
B01S	Ball Bearing	1	1
B04F	Motor Bracket	1	1
B08K	Bush	1	1
B15A	Breather	1	1
B1MC	Hexagon Head Bolt	4	4
B1NC	Hexagon Head Bolt	1	1
B5AA	Cap Bolt	4	4
B5AB	Cap Bolt	8	8
B5AC	Cap Bolt	4	4
B5AD	Cap Bolt	4	4
B5AG	Cap Bolt	1	1
B5CA	Cap Bolt	4	4[8]
C01A	Cap	1	1
C01B	Cap	1	1
C01J	Cap	0	0[1]
C02R	Indicator Cover	1	1
C03A	Crosshead	1	1
C05A	Connecting Rod	1	1
C08A	Coupling Cushion	1	1
C08D	Coupling Cushion	0	0[1]
C09B	Coupling (Motor side)	1	1
C09C	Coupling (Pump side)	1	1
C09E	Coupling	0	0[1]
C17B	Collar	0	1[2]
C1MH	Machine Screw	2	2

ITEM	Part Name	MV Q'TY	MH Q'TY
C1MJ	Machine Screw	4	4
C2MD	Machine Screw	1	1
E2MB	Set Screw	1	1
E2MH	Set Screw	2	2[4]
E2MK	Set Screw	2	2
E3MC	Set Screw	2	2
F01A	Crank Case (Pump Frame)	1	1
F1WA	Plug	1	1
G10A	Oil Gauge (A)	1	1
H01A	Housing (B)	1	1
H01M	Housing (A)	1	1
H02C	Indicator Head	1	1
H03C	Handle	1	1
K01E	Key	1	1
K02A	Knob	1	1
K6AA	Key	1	1[2]
L1WK	Plug	1	1
L1WQ	Plug	0	1
L1WR	Plug	1	0
M01A	Motor	1	1
N12B	Nut	1	1
P01J	Plate	1	1
P03B	Crosshead Pin	1	1
P03C	Pin	1	1
P13D	Name Plate	1	1
R02A	Rivet	4	4
R03C	Ring	1	1
S03L	Gear Shaft	1	1
S06A	Segment	1SET	1SET
S15A	Shim	1SET	1SET
S15B	Shim	1SET	1SET
S15C	Shim	1SET	1SET
W01A	Washer	1	1
W02A	Worm Wheel	1	1
W03B	Worm Shaft	1	1
W5AA	Spring Washer	1	1
Y11A	Oil Seal	0	1[2]
Y11B	Packing	2<1>	2<1>
Y12A	O-ring	2	2
Y52K	O-ring	1	1
Y72A	O-ring	1	1[2]
Y72B	O-ring	1	1
Y72C	O-ring	1	1
Y72D	O-ring	1	1
Y72E	O-ring	1	1
Y72F	O-ring	1	1
Y72G	O-ring	1	1

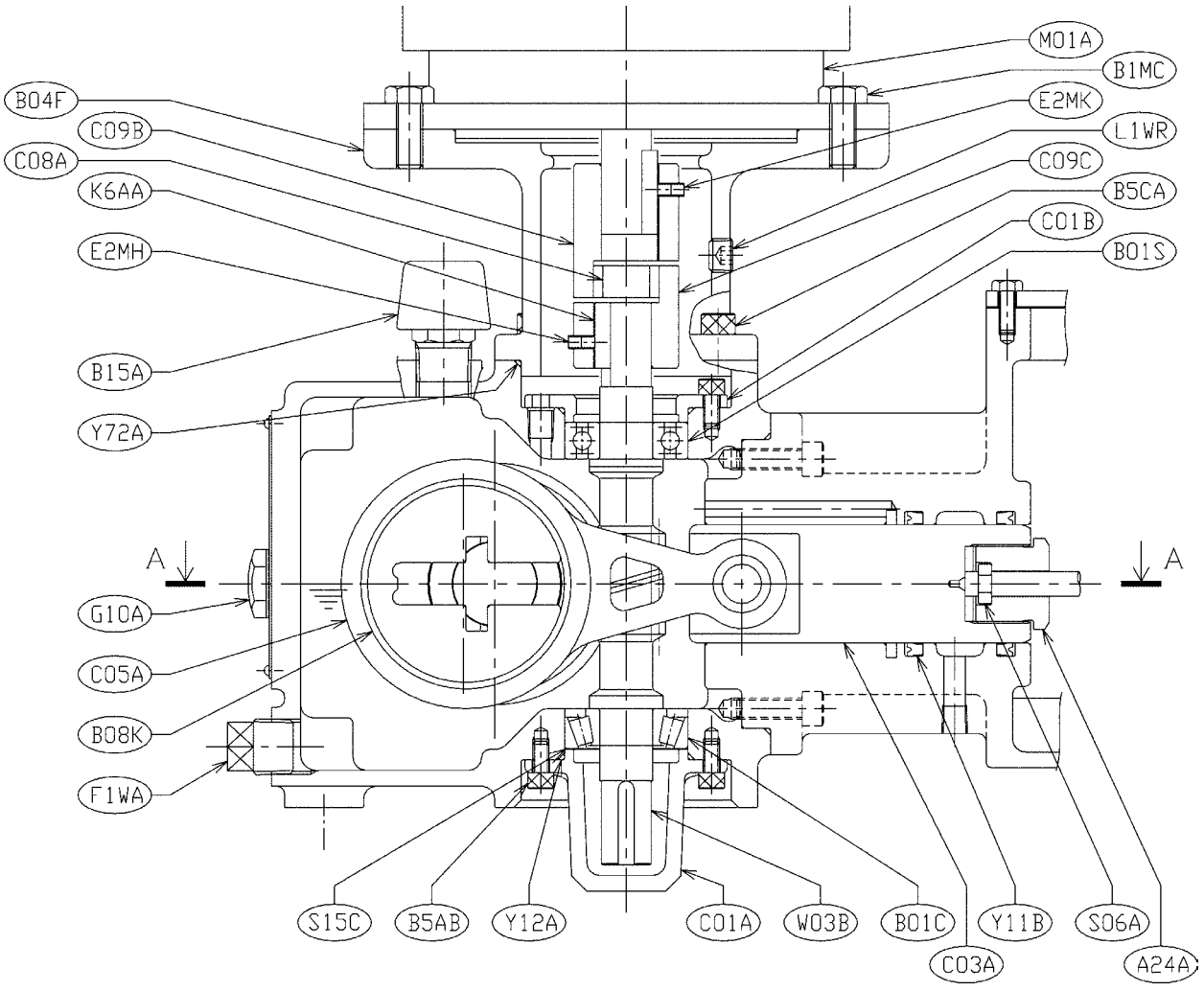
NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.
2. [ ] Q'TY are required for multiplex type.
3. **< >** Q'TY are required for packed plunger type.

6.8.4 Cross Section of Model M2

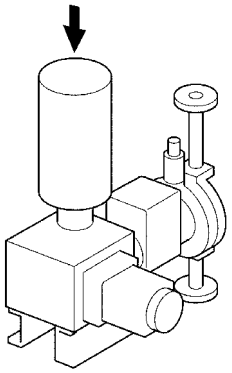
Model M2 (MV) -1/2



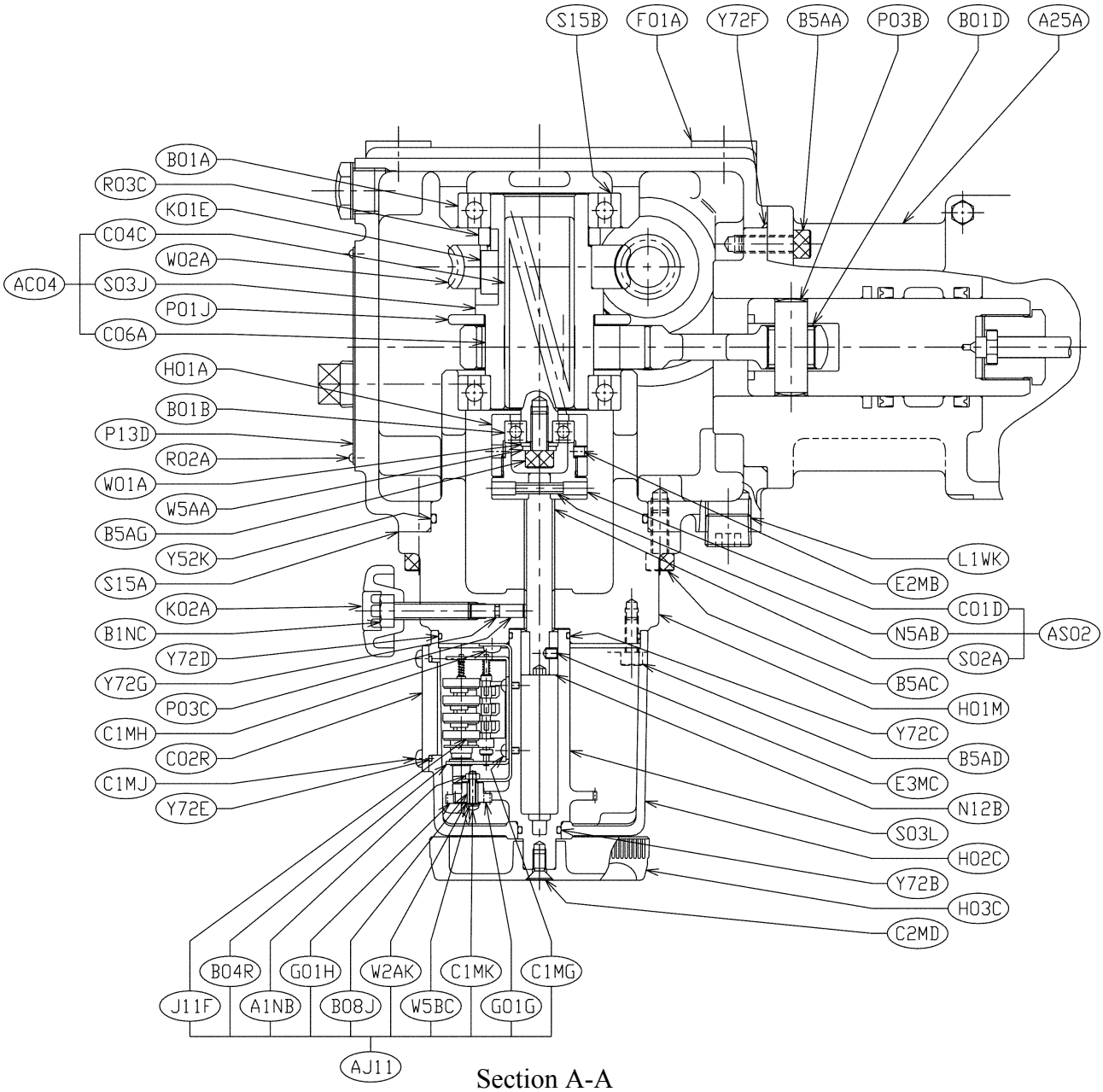
View Y



Model M2 (MV) -2/2

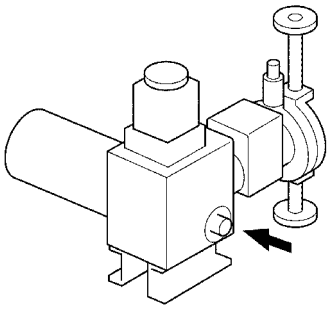


View Z

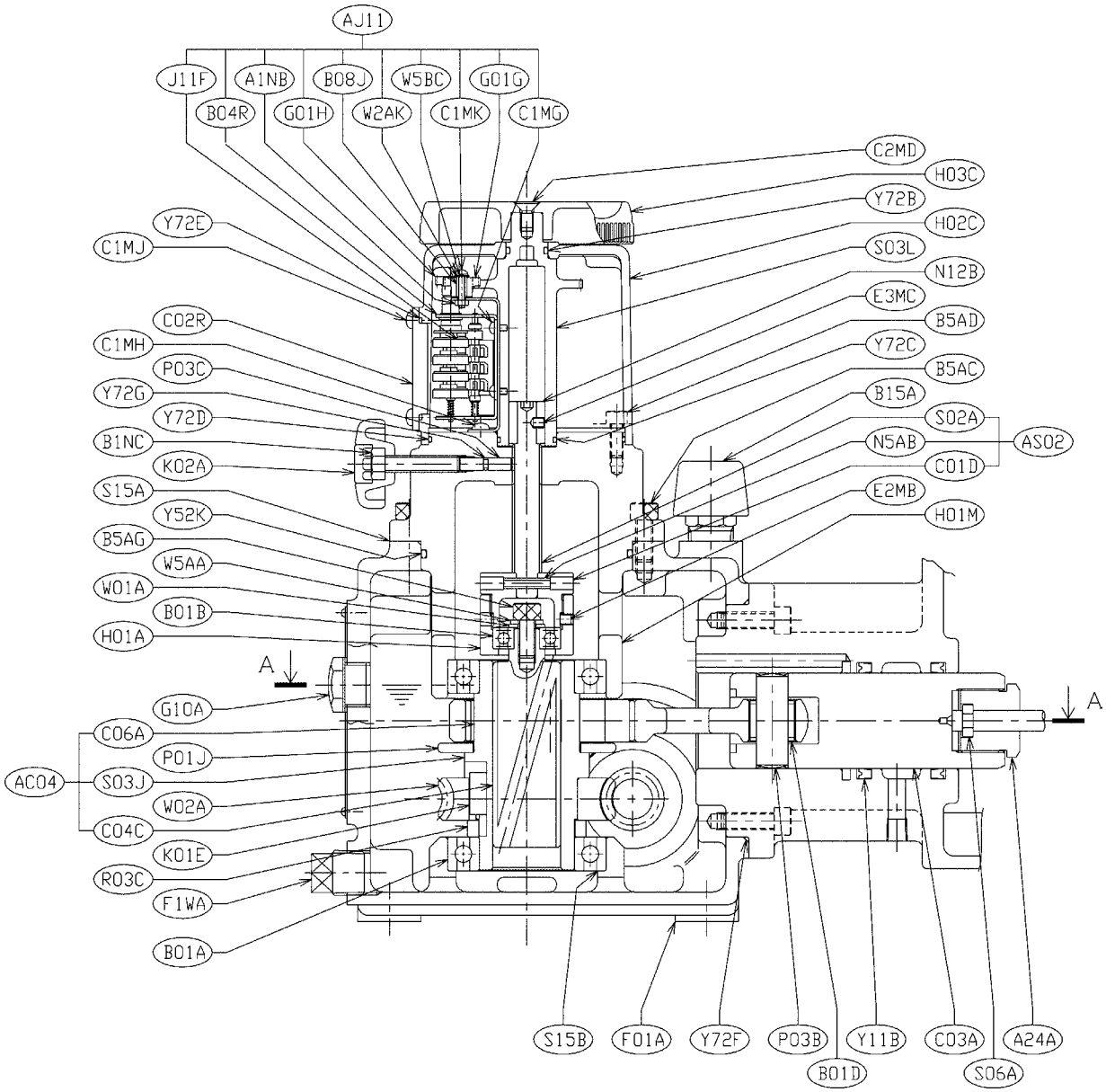


Section A-A

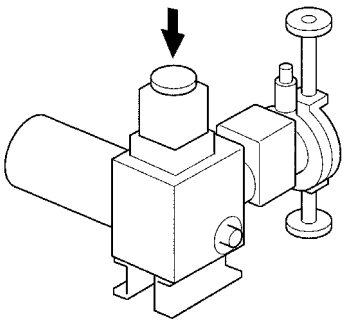
Model M2 (MH) -1/2



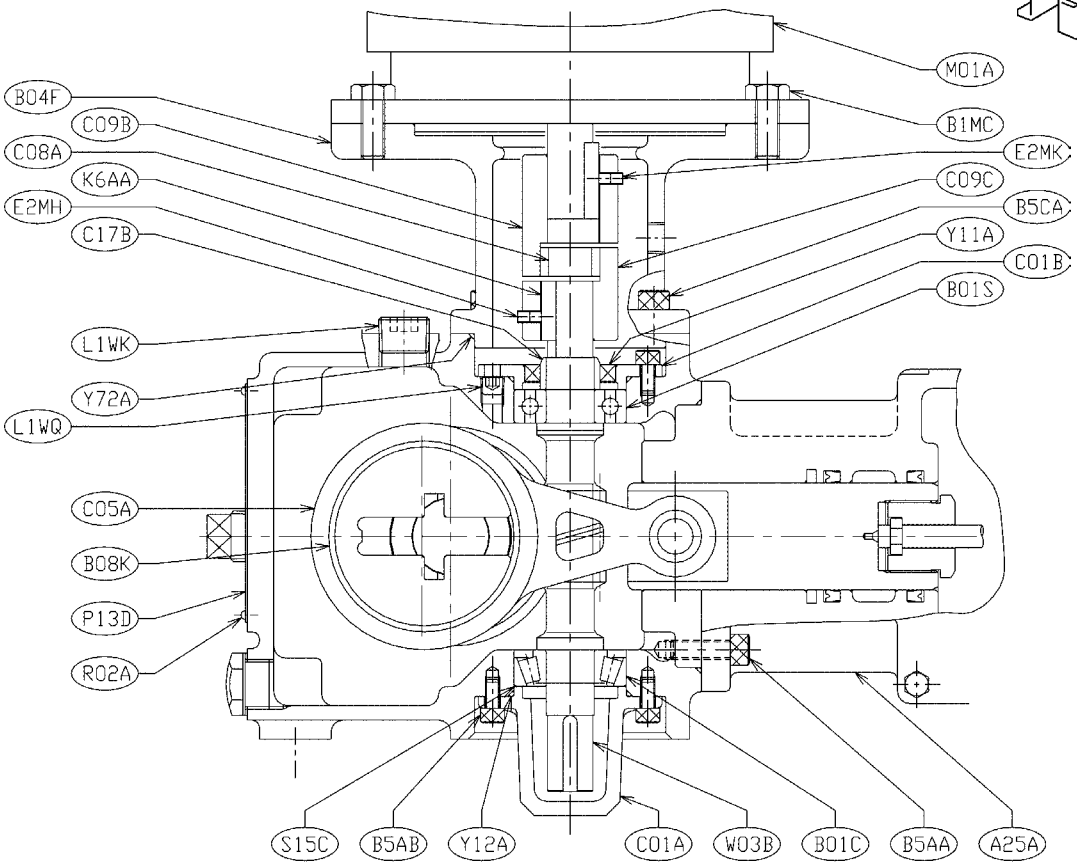
View Y



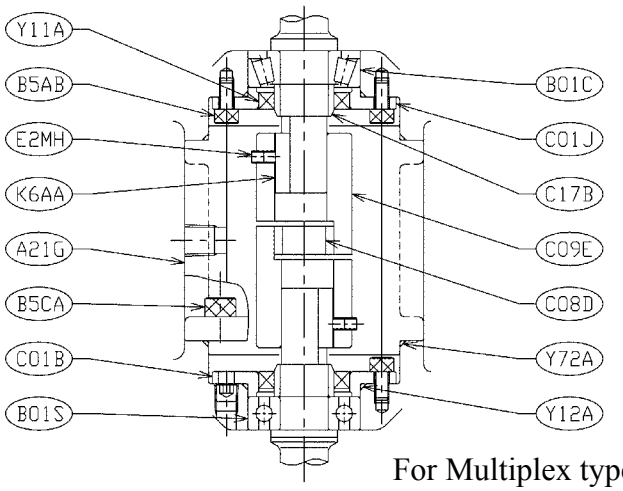
Model M2 (MH) -2/2



View Z



Section A-A



For Multiplex type.

6.8.5 Parts List for Model M3

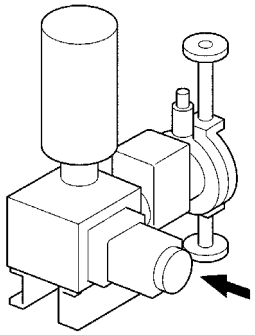
ITEM	Part Name	MV Q'TY	MH Q'TY
A21G	Adapter	0	0[1]
A24A	Plunger Adapter	1	1
A25A	Liquid End Adapter	1	1
AC04	Crank Assembly	1SET	1SET
C0C4	Crank	(1)	(1)
C06A	Cam	(1)	(1)
S03J	Hollow Shaft	(1)	(1)
AJ11	Indicator Unit	1SET	1SET
A1NB	Nut	(1)	(1)
B04R	Bracket	(1)	(1)
B08J	Bush	(1)	(1)
C1MG	Machine Screw	(4)	(4)
C1MK	Machine Screw	(1)	(1)
G01G	Gear (B)	(1)	(1)
G01H	Gear (C)	(1)	(1)
J11F	Indicator	(1)	(1)
W2AK	Washer	(2)	(2)
W5BC	Spring Washer	(1)	(1)
AS02	Lead Screw Assembly	1SET	1SET
C01D	Cap	(1)	(1)
N5AB	Spring Pin	(1)	(1)
S02A	Lead Screw	(1)	(1)
B01A	Ball Bearing	2	2
B01B	Ball Bearing	1	1
B01C	Tapered Roller Bearing	1	1
B01D	Needle Bearing	1	1
B01S	Ball Bearing	1	1
B04F	Motor Bracket	1	1
B08K	Bush	1	1
B15A	Breather	1	1
B1MC	Hexagon Head Bolt	4	4
B1NC	Hexagon Head Bolt	1	1
B5AA	Cap Bolt	4	4
B5AB	Cap Bolt	8	8
B5AC	Cap Bolt	4	4
B5AD	Cap Bolt	4	4
B5AG	Cap Bolt	1	1
B5CA	Cap Bolt	4	4[8]
C01A	Cap	1	1
C01B	Cap	1	1
C01J	Cap	0	0[1]
C02R	Indicator Cover	1	1
C03A	Crosshead	1	1
C05A	Connecting Rod	1	1
C08A	Coupling Cushion	1	1
C08D	Coupling Cushion	0	0[1]
C09B	Coupling (Motor side)	1	1
C09C	Coupling (Pump side)	1	1
C09E	Coupling	0	0[1]
C17B	Collar	0	1[2]
C1MH	Machine Screw	2	2

ITEM	Part Name	MV Q'TY	MH Q'TY
C1MJ	Machine Screw	4	4
C2MD	Machine Screw	1	1
E2MB	Set Screw	1	1
E2MH	Set Screw	2	2[4]
E2MK	Set Screw	2	2
E3MC	Set Screw	2	2
F01A	Crank Case (Pump Frame)	1	1
F1WA	Plug	1	1
G10A	Oil Gauge (A)	1	1
H01A	Housing (B)	1	1
H01M	Housing (A)	1	1
H02C	Indicator Head	1	1
H03C	Handle	1	1
K01E	Key	1	1
K02A	Knob	1	1
K6AA	Key	1	1[2]
L1WK	Plug	1	1
L1WQ	Plug	0	1
L1WR	Plug	1	0
M01A	Motor	1	1
N12B	Nut	1	1
P01J	Plate	1	1
P03B	Crosshead Pin	1	1
P03C	Pin	1	1
P13D	Name Plate	1	1
R02A	Rivet	4	4
R03C	Ring	1	1
S03L	Gear Shaft	1	1
S06A	Segment	1SET	1SET
S15A	Shim	1SET	1SET
S15B	Shim	1SET	1SET
S15C	Shim	1SET	1SET
W01A	Washer	1	1
W02A	Worm Wheel	1	1
W03B	Worm Shaft	1	1
W5AA	Spring Washer	1	1
Y11A	Oil Seal	0	1[2]
Y11B	Packing	2<1>	2<1>
Y12A	O-ring	2	2
Y52K	O-ring	1	1
Y72A	O-ring	1	1[2]
Y72B	O-ring	1	1
Y72C	O-ring	1	1
Y72D	O-ring	1	1
Y72E	O-ring	1	1
Y72F	O-ring	1	1
Y72G	O-ring	1	1

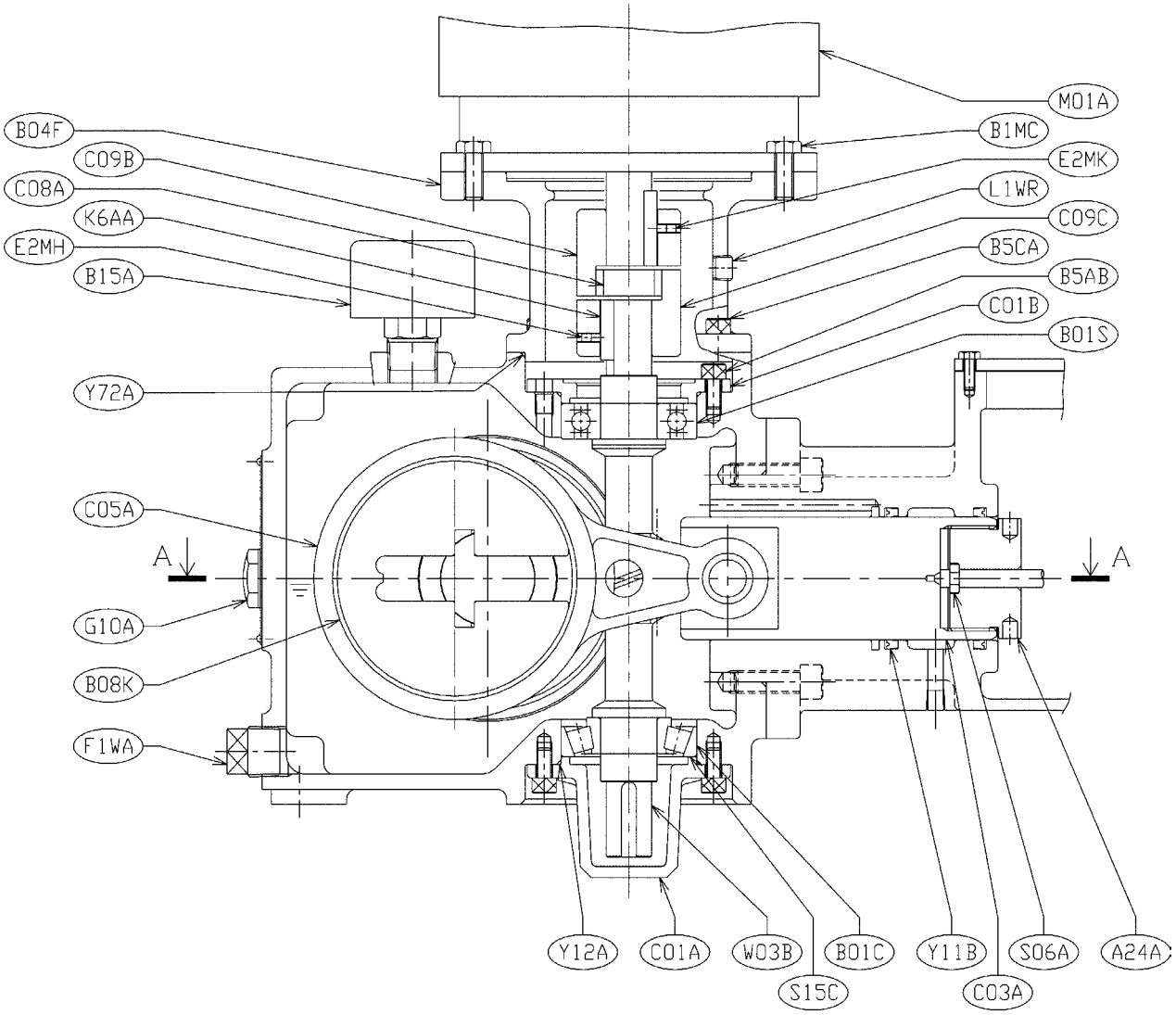
NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.
2. [ ] Q'TY are required for multiplex type.
3. **< >** Q'TY are required for packed plunger type.

6.8.6 Cross Section of Model M3

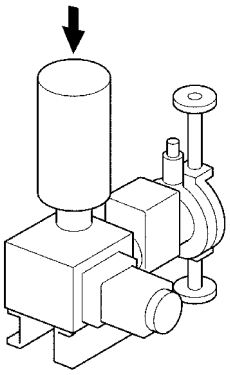
Model M3 (MV) -1/2



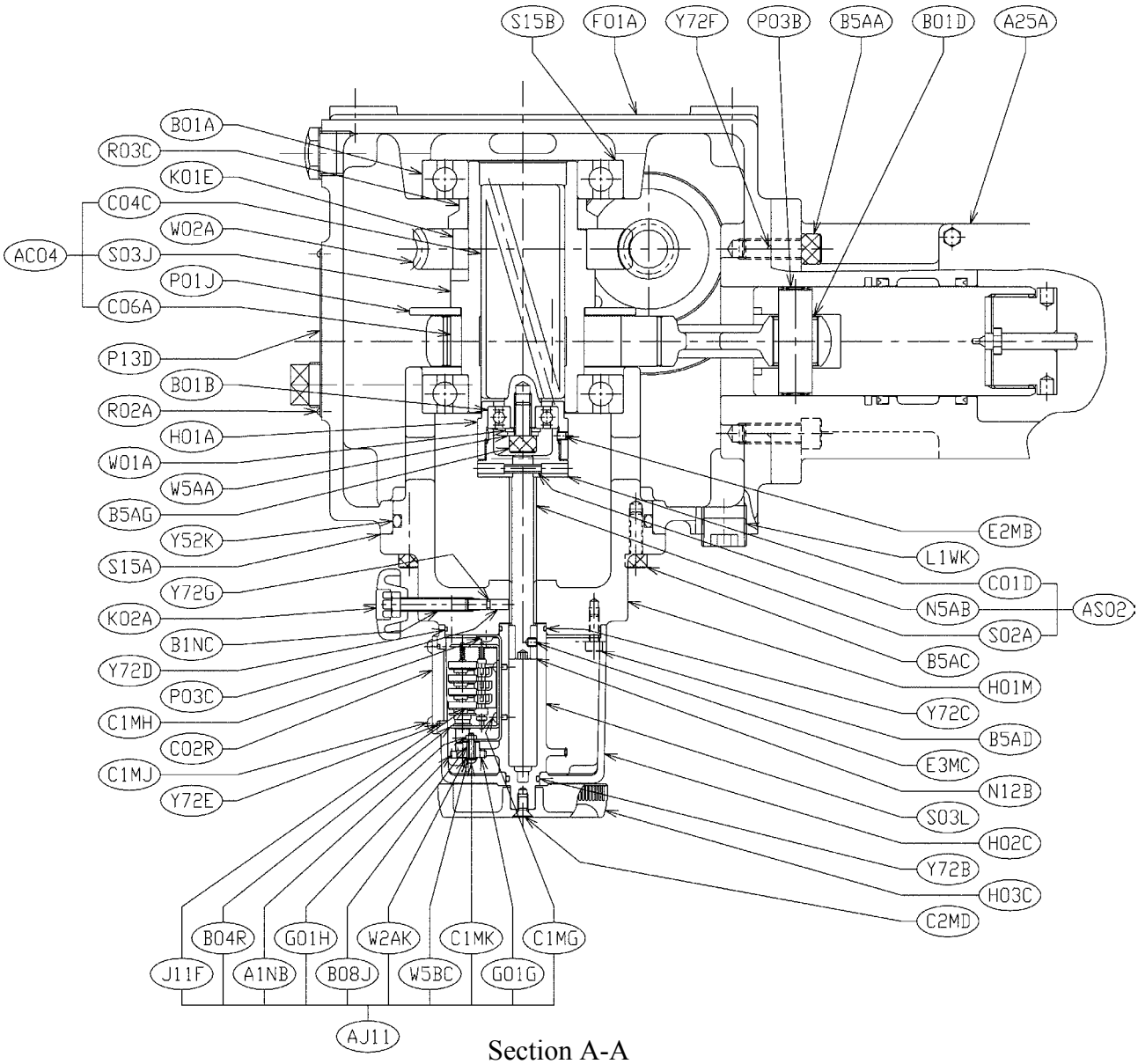
View Y



Model M3 (MV) -2/2

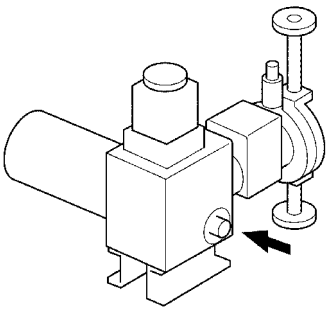


View Z

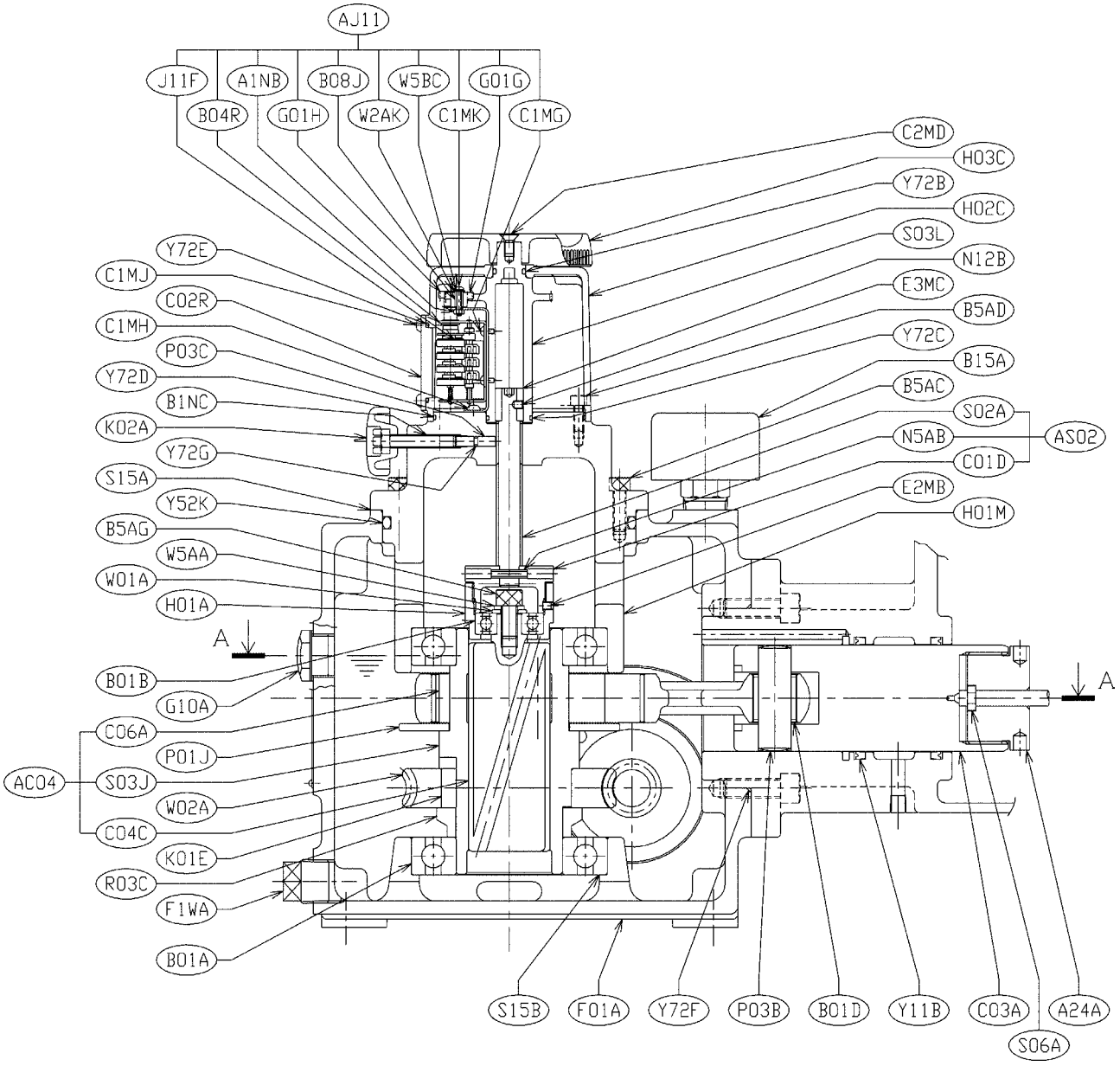


Section A-A

Model M3 (MH) -1/2

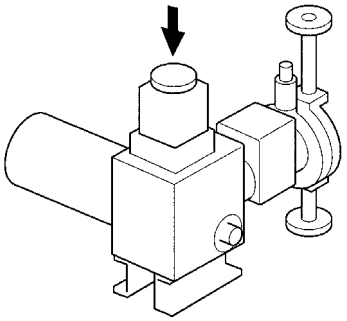


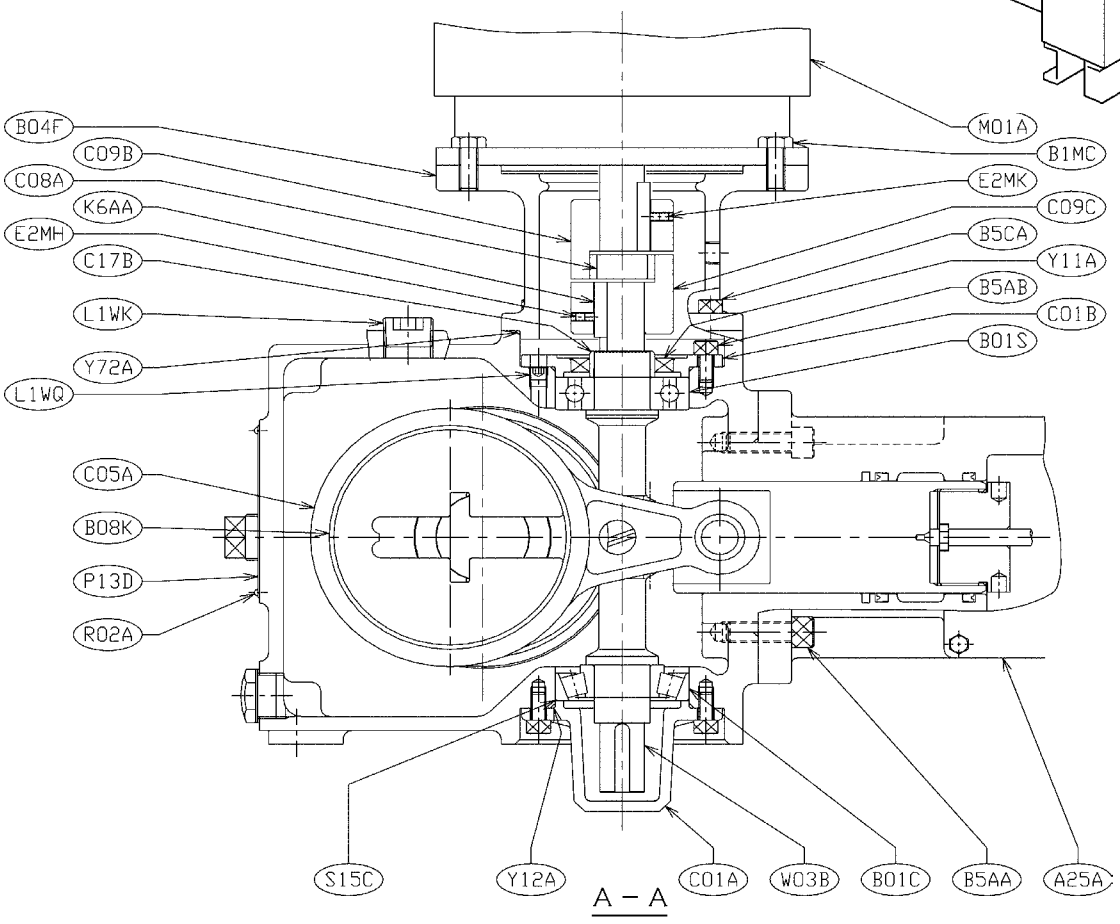
View Y



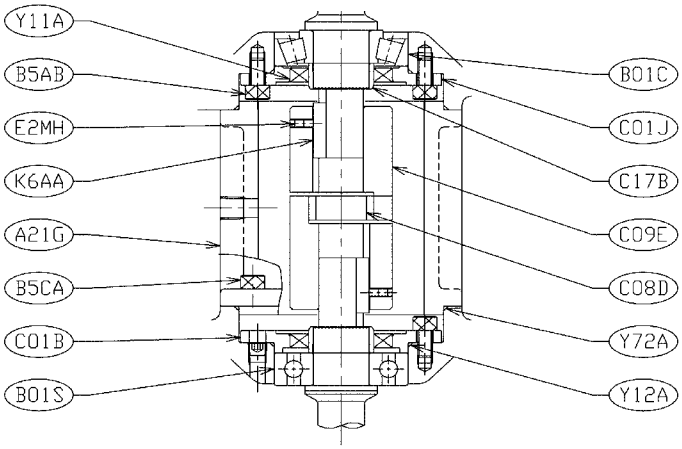
Model M3 (MH) -2/2

View Z





Section A-A



For Multiplex type.

7 Construction of Liquid End

NOTE:

Please check the model No. marked on the nameplate on the rear of crankcase, and confirm pump specification referring to page . The liquid end is equipped with the single type diaphragm. It is possible to fit with Diaphragm Type with Failure Detector (Optional). When the liquid end is equipped with failure detector, also refer to Section 8.

7.1 Outline

The liquid end consists of a pump unit and a hydraulic unit. The main parts are arranged as shown below. Function of each part is explained in the following section. Understand the fundamental construction of the liquid end to ease maintenance and operations.
(The illustration shows the single diaphragm type of the head size DV-200.)

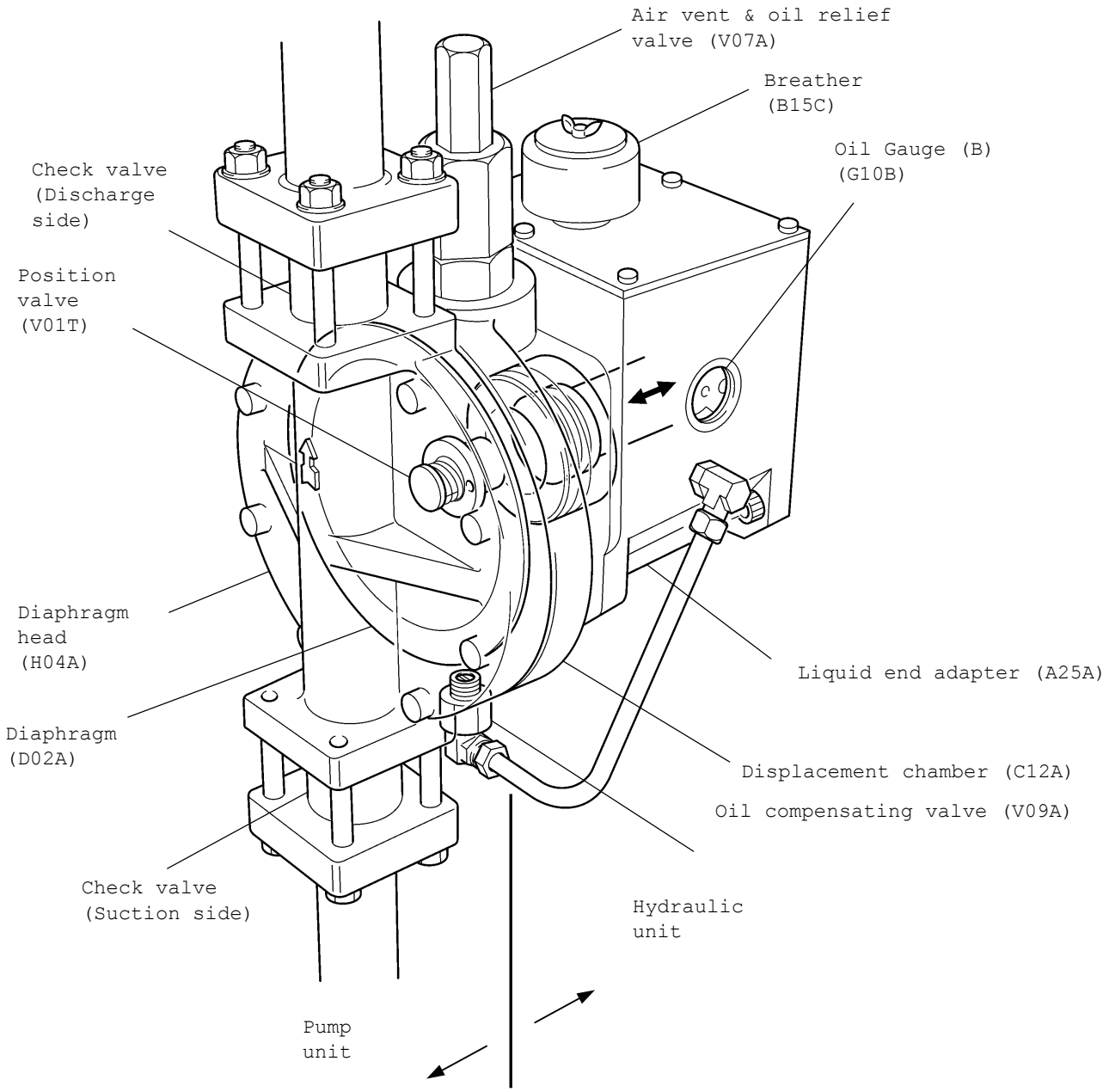


Fig. 7-1 Liquid end

7.1.1 Construction

(1) The pump unit consists of a PTFE diaphragm, a diaphragm head, and lower (suction) and upper (discharge) check valves.

(2) The hydraulic unit
The displacement chamber of the hydraulic unit is filled with hydraulic oil and is equipped with the following valves to control the oil pressure.

- The air vent valve of the air vent & oil relief valve is set at the highest position of the displacement chamber. This valve expels a small amount of hydraulic oil in every stroke and at the same time it discharges foam which is produced during pumping into the liquid end adapter.
- The air vent & oil relief valve prevents excessive pressure in the pump due to improper operation/handling, such as valve closing in the discharge piping while pumping.
- The position valve consists of disk and stem. It controls the switching of the oil path from the liquid end adapter by changing the position of the diaphragm.
- The oil compensating valve consists of the body, ball valve, spring, disk, and C-type retaining ring. When the inner pressure of the hydraulic unit is below the spring setting pressure, this unit supplies hydraulic oil. The displacement chamber is equipped with a gland and is sealed by the piston gasket. The displacement chamber is separated from the liquid end adapter.

(3) The liquid end adapter connects the liquid end with the power end. The inside of the adapter is filled with hydraulic oil.

7.1.2 Precision Keeping Mechanism

The reciprocating motion of the piston causes the diaphragm lateral movement via hydraulic oil pressure. The lateral movement of the diaphragm results in the delivery of the handled liquid via the suction and discharge check valves. The displacement volume of the diaphragm is slightly smaller than the displacement volume of the piston because of the discharge of hydraulic oil through the air vent valve into the liquid end adapter. For this reason, the diaphragm does not contact the diaphragm head. No protection plate is required. To make up for the oil loss, hydraulic oil is added through the oil compensating valve as follows.
Just before the completion of suction stroke, the diaphragm pushes the position valve. As a result, the oil path between the hydraulic unit and the oil compensating valve is opened. Only when the pressure of the hydraulic unit is lower than the set pressure of the oil compensating valve, oil is supplied. After making up for the oil loss, the diaphragm is detached from the position valve and the oil path is shut off, to prevent excess oil supply. By repetition of this procedure, the hydraulic oil in the hydraulic unit is kept at the proper level.

7.2 Replacement of Parts

⚠ WARNING

(1) During disassembly, the handled liquid remaining in the liquid end comes out. When the handled liquid is harmful, the harmful liquid in the liquid end should be replaced with a harmless liquid or fresh water by operating the pump for a time or by flushing from the suction flange side before attempting disassembly. Otherwise, there is a danger of handled liquid coming in contact with operators/maintenance personnel.

(2) Lower the pump pressure of the discharge side to atmospheric pressure before attempting disassembly. Otherwise, there is a danger of spouting of residual liquid.

⚠ CAUTION

Some of the parts of the liquid end, such as diaphragm head, displacement chamber, etc. are heavy. When disassembling/reassembling unit, special care is needed to handle them without dropping. Falling parts may be damaged and/or injure the operator.

⚠ CAUTION

(1) When disassembling/reassembling the liquid end, be careful not to add foreign substances and/or contaminants to the parts. They may cause mechanical trouble.

(2) When contaminated hydraulic oil is observed during reassemble of the liquid end, change the hydraulic oil and disassemble and clean the hydraulic unit to prevent malfunction of the air vent and position valves.

NOTES:

(1) When hard polyvinyl chloride (PVC), fluorocarbon resin (PTFE-GL), or other material is used in the liquid end, as it is easily broken, it needs special care in handling during disassembly/reassemble.

(2) As for the Type M2L liquid end adapter cover "attachment direction" is decided. The arrow mark LE that is attached to the cover please attach the cover toward the liquid end side.

(3) Refer to the following table concerning the head size of the liquid end.

Table 7-1 Head size list

Pump head size		DV-1.8	DV-6	DV-25	DV-50	DV-100	DV-200	DV-400	DV-800
Piston diameter (mm)	Type M1L	7,10(*1)	14,20	30,40	55,65	-	-	-	-
	Type M2L	-	-	30	40,55	65	80,90	-	-
	Type M3L	-	-	-	40	55	65,80	90,110	-
	Type M4L	-	-	-	-	-	-	80,90	110,130

(*1): Plunger diameter.

7.2.1 Check Valve Replacement

There are three types of check valve units: valve assembly type, cartridge type, and stacking type, in accordance with the specifications. Furthermore, there are the ball valve types (one stage, two stage) and the wing valve type. Confirm the installed valve type with the cross section of the liquid end and pump data sheet, and refer to the following Table 7-2.

Table 7-2 Type of Check Valve

Check valve type	Head size	Ball valve		Wing valve (*1)
		1 stage	2 stage	
Valve assembly type	DV-1.8	Option	Standard	-
	DV-6	Option	Standard	-
Cartridge type	DV-25	Standard	Option	Standard
Stacking type	DV-50	Standard	Option	Standard
	DV-100	Standard	Option	Standard
	DV-200	Standard	-	Standard
	DV-400	Standard	-	Standard
	DV-800	Standard	-	Standard

(*1): The wing valve is the standard when the discharging flow is considerably large.

A. Valve Assembly Type (DV-1.8 / DV-6) Check Valve Replacement

⚠ WARNING

During disassembly of the valve assembly, the handled liquid remaining in the liquid end comes out. Wear the protective clothing to prevent liquid contamination. If the handled liquid is poisonous, it may cause operator injury.

NOTES:

(1) A gasket is positioned between the valve assembly and the diaphragm head. As this is almost transparent, be careful not to lose it.

(2) The parts of the valve assembly type of check valve are all installed in a cartridge. It is difficult to repair the parts inside the cartridge. Therefore, when the check valve is configurated as the valve assembly type, replace it as an assembly.

[Disassembly]

(1) Drain all residual liquid in the suction and discharge piping of the pump.

(2) Remove the suction and discharge piping from the pump.

(3) Remove the suction and discharge flanges. When removing the suction flange, remove the elbow positioned on the suction side.

(4) Loosen the locknut, and remove the valve assembly.

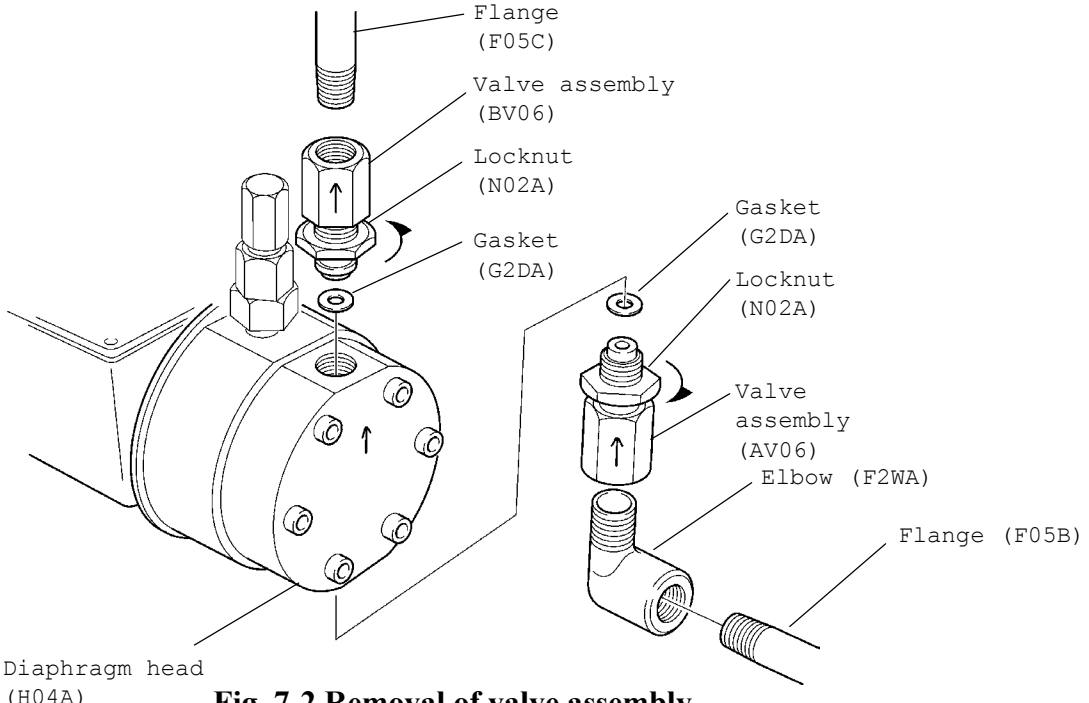


Fig. 7-2 Removal of valve assembly

(5) Check inside the valve assembly. Push the parts out from the cartridge slowly by using a slender stick (Outer diameter: 6mm) with flat end through the flange attaching hole of the cartridge. When pressing parts, pay attention not to damage parts of the cartridge, and not to lose them. When the check valve is one stage ball valve configuration, the cartridge contains one set of parts.

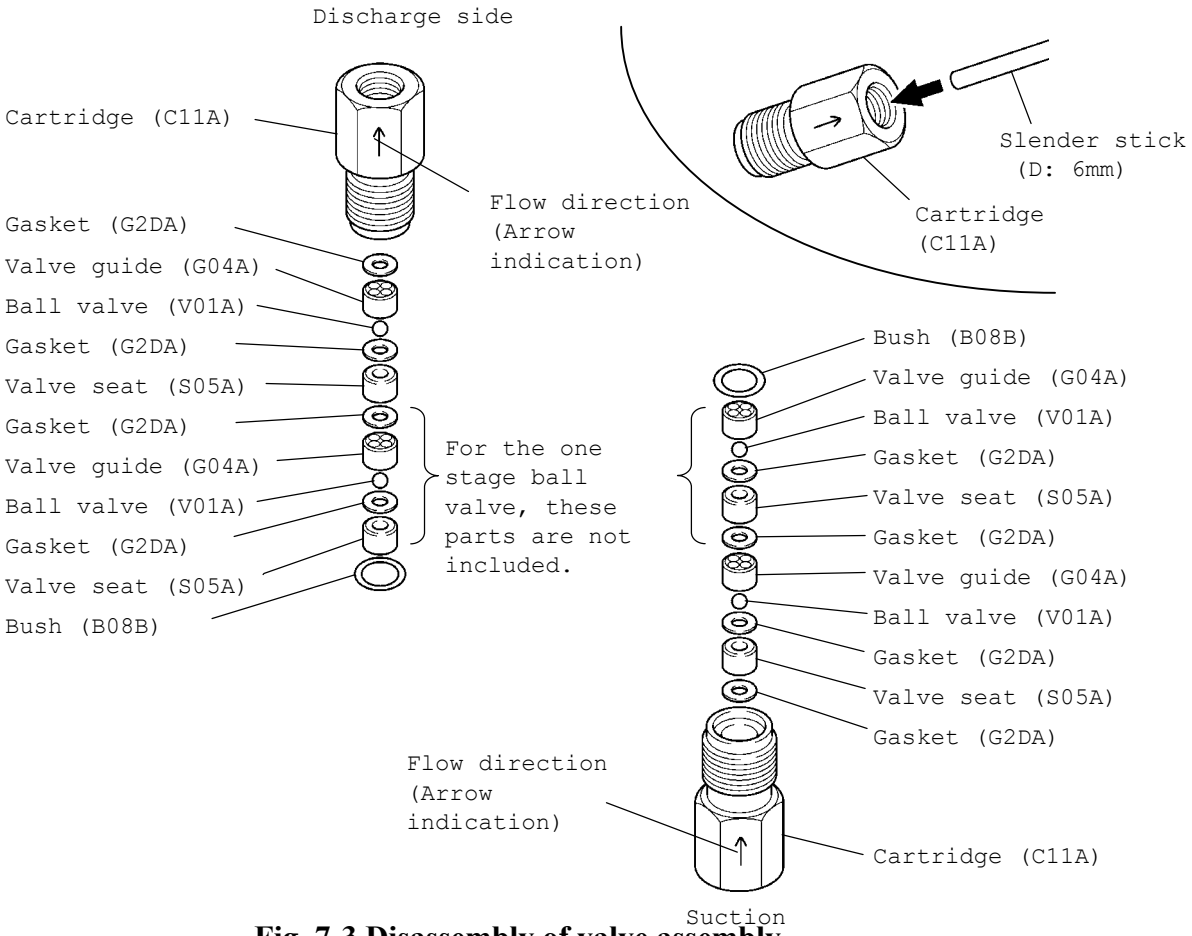


Fig. 7-3 Disassembly of valve assembly

[Reassembly]

When reassembling the unit, the procedure is the reverse of disassembly. Pay attention to the following items:

(1) When mounting parts of the cartridge, make sure that the position of each part and the direction of the valve seat correspond to those shown in Fig. 7-3 and in the cross section drawing.

(2) When mounting the cartridge on the diaphragm head, confirm that the arrow marks, which are marked on both units, are aligned. Be sure to insert the gasket between the diaphragm head and the cartridge. Refer to Fig. 7-2.

(3) After completion of the valve reassembly, be sure to tighten the lock nut. Refer to Fig. 7-2.

B. Cartridge Type (DV-25) Check Valve Replacement

⚠ WARNING

During disassembly of the cartridge, the handled liquid remaining in the diaphragm head comes out. Wear protective clothing for preventing liquid contamination.
If the handled liquid is poisonous, it may cause operator injury.

NOTE:

A gasket is positioned between the valve assembly and the diaphragm head. As this is almost transparent, be careful not to lose it.

[Disassembly]

(1) Drain all residual liquid in the suction and discharge piping of the pump.
(2) Remove the suction and discharge piping.
(3) Remove the flanges of the suction and discharge sides.

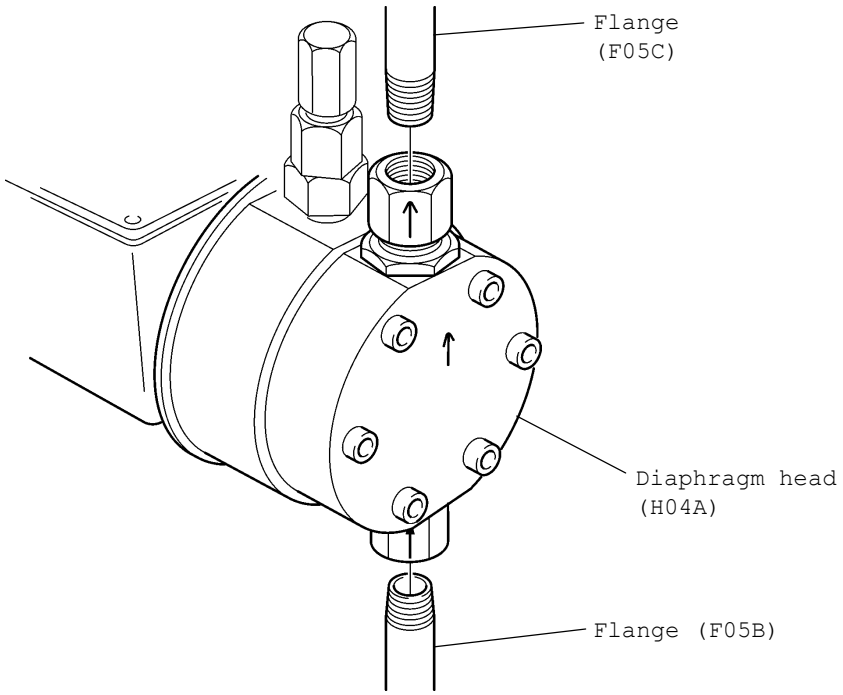


Fig. 7-4 Flange disassembly

(4) Loosen the locknut, remove the cartridge and pull out the parts from inside the cartridge. If the parts (such as valve guide) inside the cartridge are difficult to pull out, push the parts out from the cartridge slowly by using a slender stick (Outer diameter: 6mm) with flat end through the flange attaching hole of the cartridge. When pushing parts, pay attention not to damage parts of the cartridge, and not to lose them.

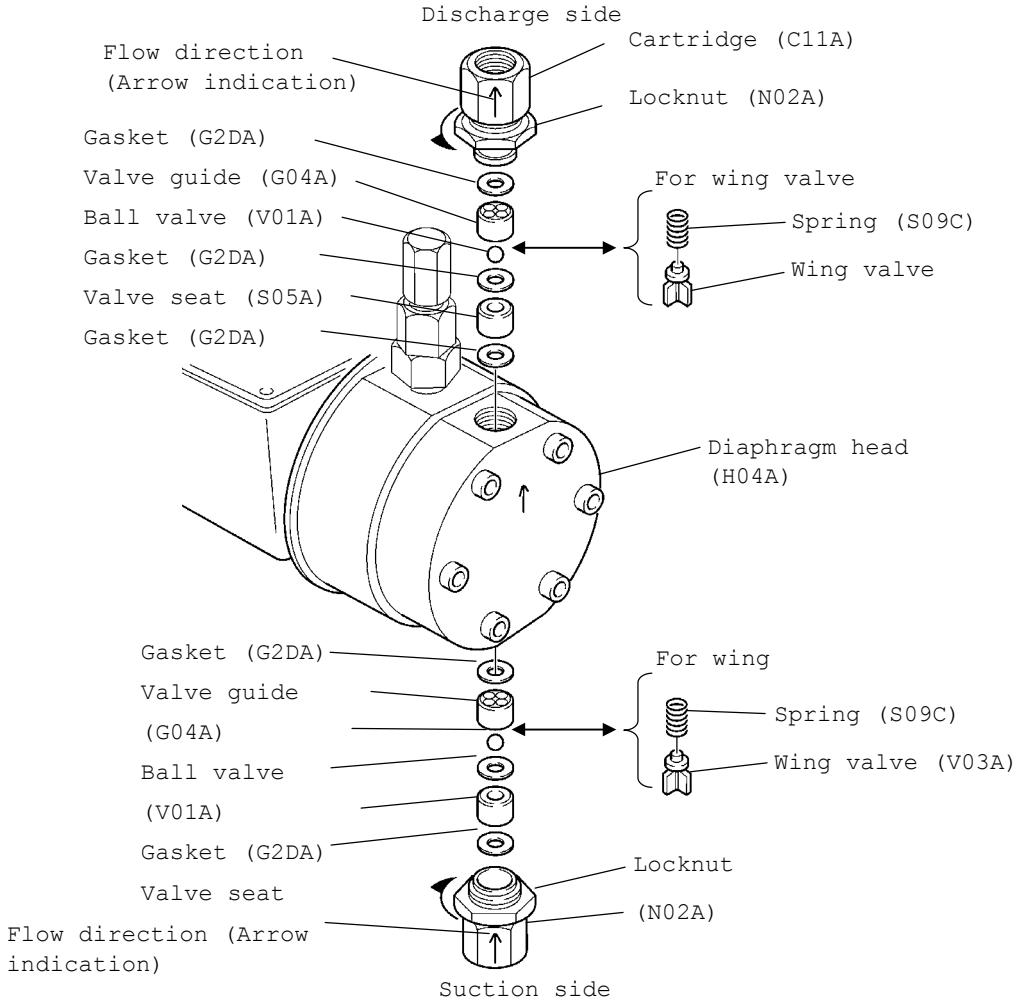


Fig. 7-5 Disassembly of cartridge assembly

[Reassembly]

When reassembling the unit, the procedure is the reverse of disassembly. Pay attention to the following items:

(1) When mounting parts of the cartridge, make sure that the position of each part and the direction of the valve seat correspond to those shown in Fig. 7-5 and in the cross section drawing.

(2) When mounting the cartridge on the diaphragm head, confirm that the arrow marks, which are marked on both units, are aligned. Be sure to insert the gasket between the diaphragm head and the cartridge. Refer to Fig. 7-5.

(3) After completion of valve reassembly, be sure to tighten the lock nut. Refer to Fig. 7-5.

C. Stacking Type (DV-50□800) Check Valve Replacement

⚠ WARNING

During disassembly of the flange, the handled liquid remaining in the diaphragm head comes out. Wear protective clothing for preventing liquid contamination. If the handled liquid is poisonous, it may cause operator's injury.

NOTE:

When removing the suction side, pay attention not to drop it or damage it.

[Disassembly]

(1) Drain all residual liquid in the suction and discharge piping of the pump.

(2) Remove the suction and discharge piping.

(3) Remove hexagon nuts of the flange and remove all parts of the check valve and flange.

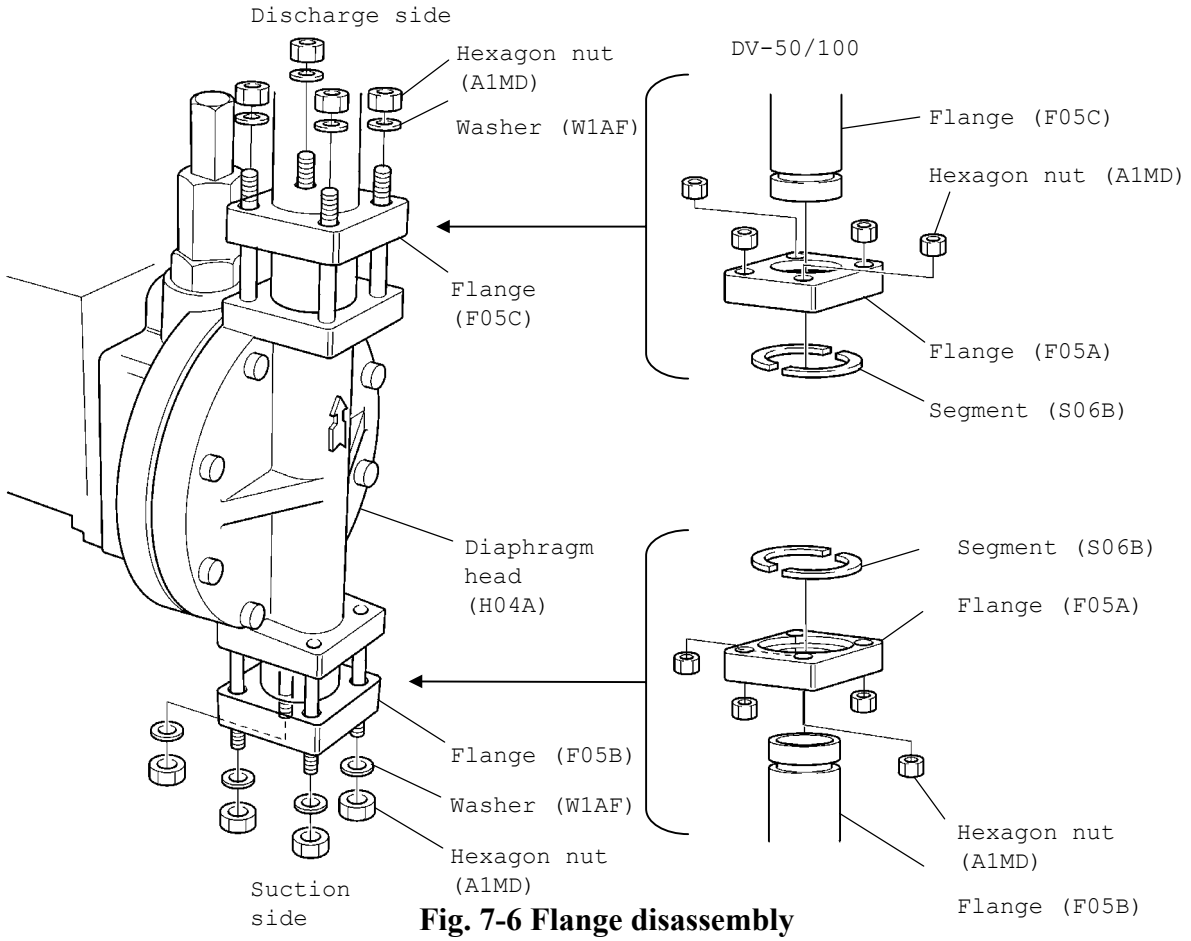


Fig. 7-6 Flange disassembly

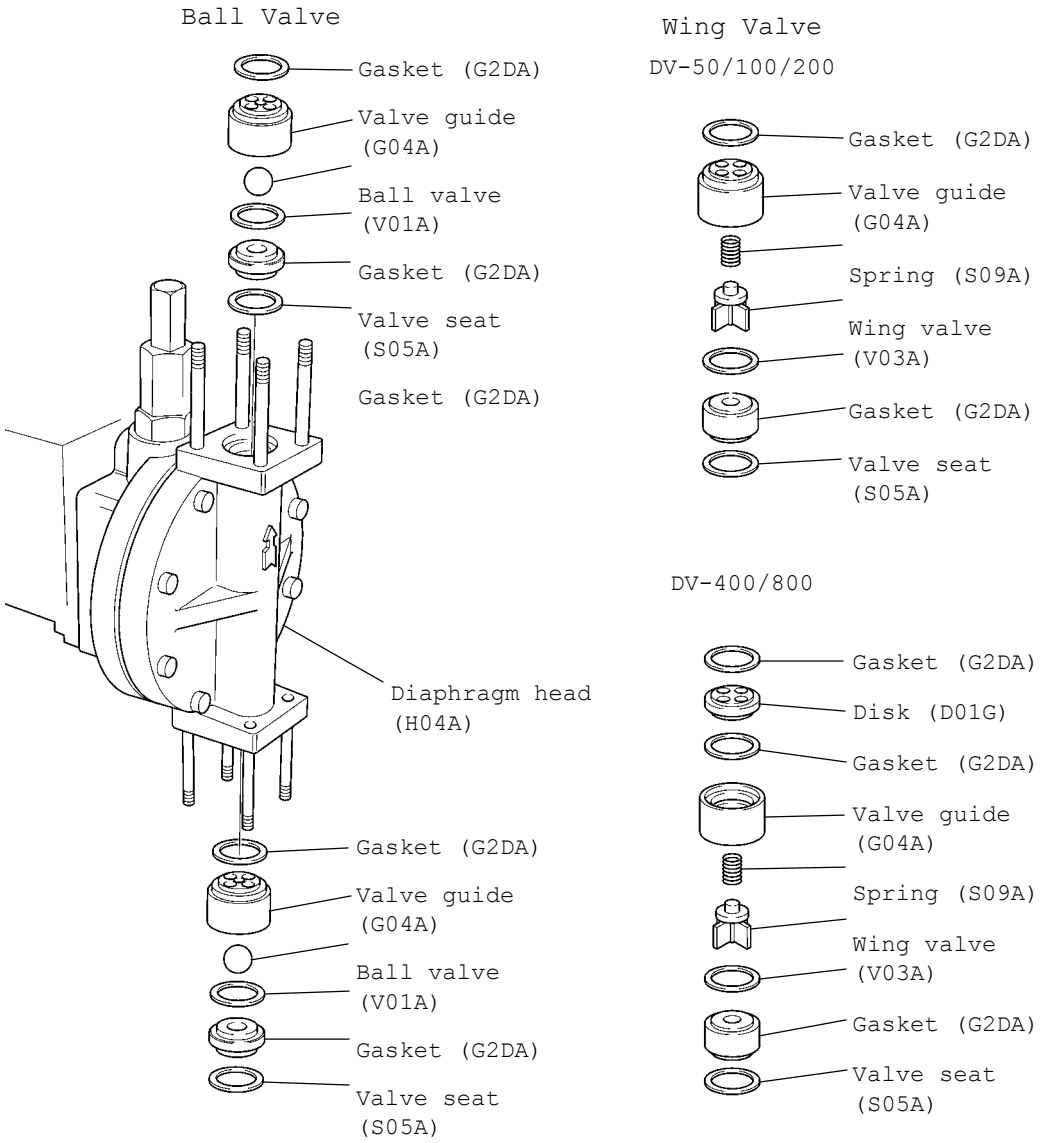


Fig. 7-7 Disassembly of check valve

[Reassembly]

When reassembling the unit, the procedure is the reverse of disassembly. Pay attention to the following items:

(1) When mounting parts of the valve to the diaphragm head, make sure that the position of each part and the direction of the valve seat correspond to those shown in Fig. 7-7 and in the cross section drawing.

(2) When securing the hexagon nuts, tighten them uniformly and sufficiently. If they are secured unevenly, gasket may fail to function normally and there is a possibility that the handled liquid will leak. Refer to Fig. 7-6.

(3) When the head size of DV-50/100 is applied, before tightening the hexagon nuts, align the bolt hole positions on the suction and discharge flanges to the bolt positions on the mating flanges.

7.2.2 Diaphragm Replacement

⚠ WARNING

During disassembly of the diaphragm head, the handled liquid remaining in the diaphragm head and hydraulic oil remaining in the displacement chamber come out. Wear protective clothing for preventing liquid contamination.
If the handled liquid is poisonous, it may cause operator's injury.

⚠ CAUTION

The weight of the diaphragm head of the head size DV-200 - 800 exceeds 10 kg. When removing the diaphragm head, use a crane or other lifting device. Pay attention not to drop it. Falling parts may be damaged and/or injure the operator.

[Disassembly]

(1) Drain all residual liquid in the suction and discharge piping of the pump.

(2) Remove the suction and discharge piping.

(3) Remove the air vent & oil relief valve. A gasket is positioned between the air vent & oil relief valve and displacement chamber. Pay attention not to lose it.

(4) In the case of a head size DV-50 - 800, remove the plug located on the bottom of the displacement chamber, and drain the hydraulic oil from the displacement chamber.

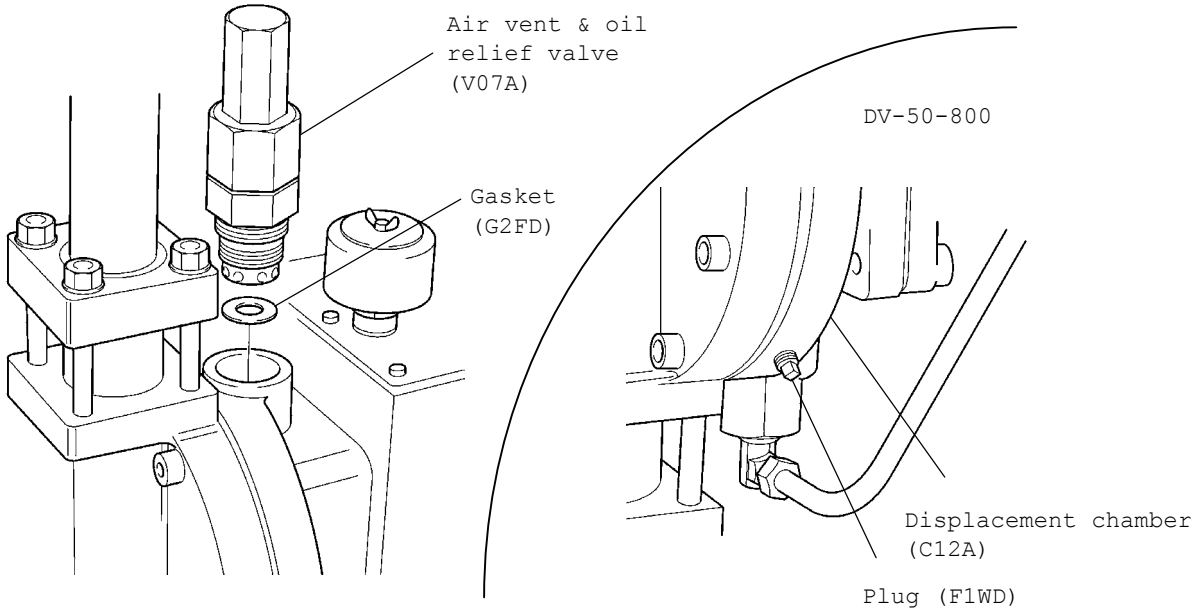


Fig. 7-8 Drain of hydraulic oil

(5) Remove the cap bolts and remove the diaphragm head.

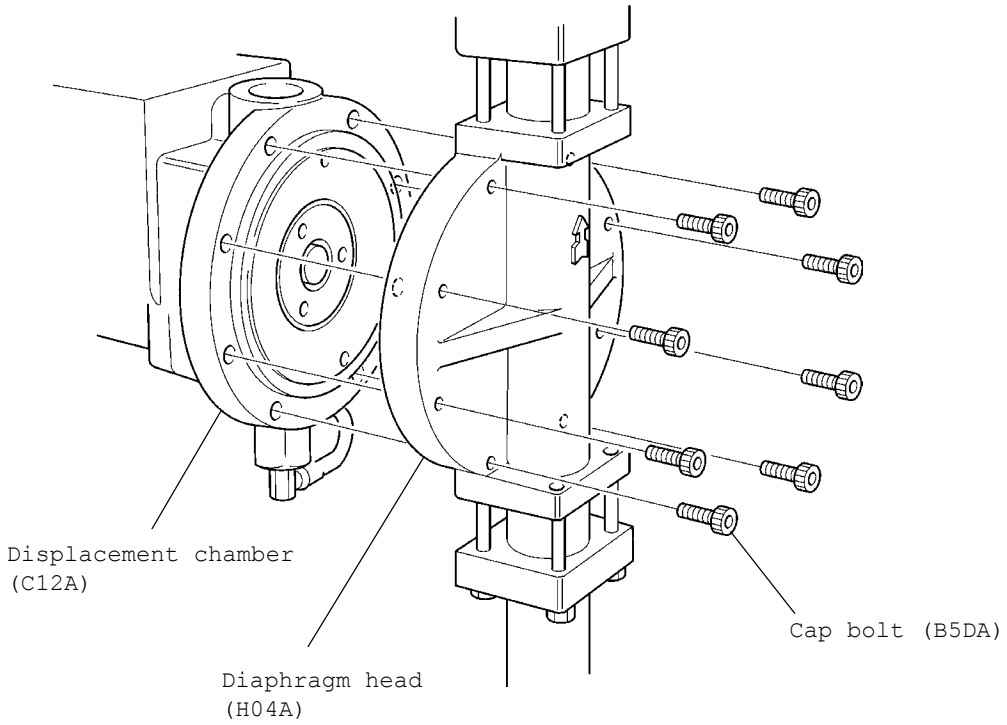


Fig. 7-9Removal of diaphragm head

(6) Remove the diaphragm from the groove of the diaphragm head.

A. Diaphragm Removal of Single Diaphragm

⚠ CAUTION

When removing the diaphragm, pay attention not to flaw the seal surface of the diaphragm head. If the seal is damaged, it may cause leakage of the handled liquid/hydraulic oil.

Stick the diaphragm with a sharp lever and remove it.

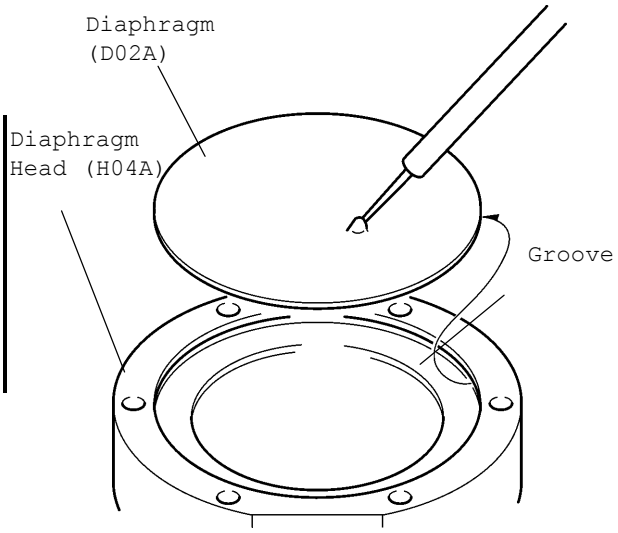


Fig. 7-10 Removal of single diaphragm

B. Removal of Diaphragm with Diaphragm Failure Detector (Optional)

⚠ CAUTION

(1) If the diaphragms of the hydraulic and pump units are removed together, there is a possibility of bending or breaking the ring. When the ring is broken, parts replacement is required. Therefore remove the diaphragms individually. If the ring is broken, it may result in hydraulic oil/handled liquid leakage.

(2) The ring is positioned with the spring pin. Therefore, pull the ring out manually to prevent ring damage.

(3) When removing the diaphragm, pay attention not to flaw the seal surface. If the seal is damaged, it may result in hydraulic oil/handled liquid leakage.

When removing the diaphragm, remove the parts in this order: diaphragm of the hydraulic unit side, ring, and the pump unit, along the recess of the diaphragm head. Stick the diaphragm with a sharp lever and remove it. Pull the ring upward manually.

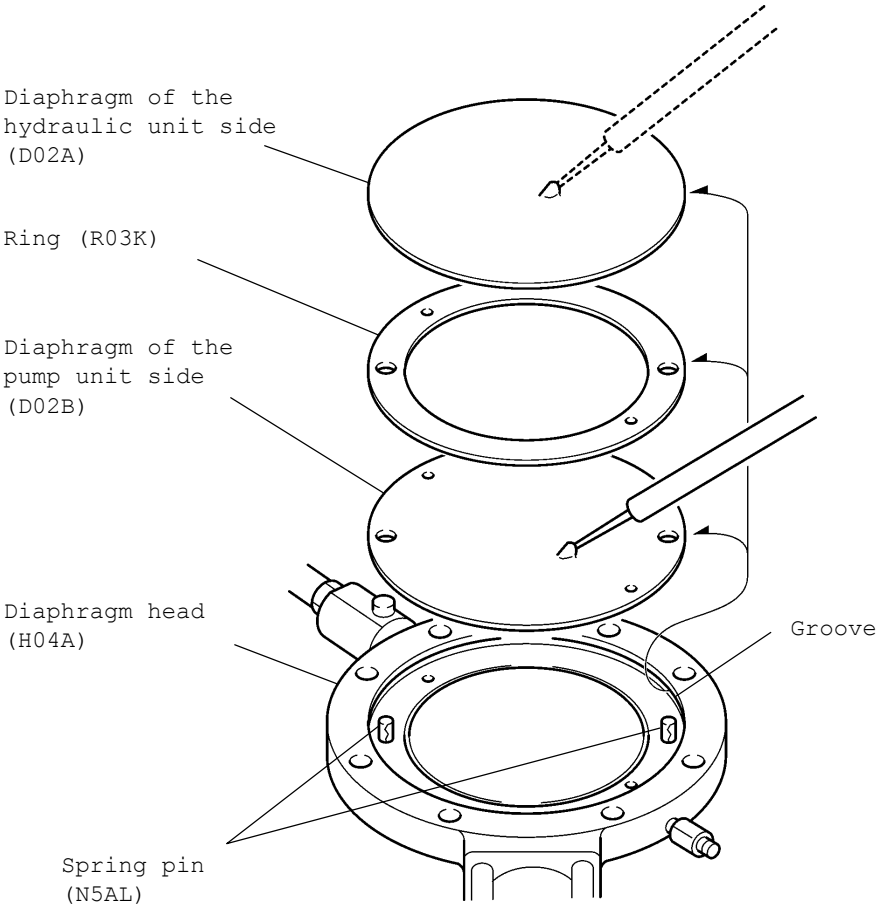


Fig. 7-11 Removal of diaphragm with diaphragm failure detector

[Reassembly]

When reassembling the unit, the procedure is the reverse of disassembly. Pay attention to the following items:

⚠ CAUTION

(1) Do not reuse the same diaphragm because it may start leaking.

(2) Tighten the cap bolts to the specified tightening torque shown in Table 7-3. If excessive torque is applied on the bolts, it may result in deformation of the diaphragm and/or leakage of hydraulic oil/handled liquid.

Table 7-3 Proper tightening torque for the cap bolt

Pump head size	Bolt size	Tightening torque (N-m)
DV-1.8	M8	15
DV-6	M8	15
DV-25	M8	18
DV-50	M10	35
DV-100	M10	35
DV-200	M12	50
DV-400	M12	50
DV-800	M16	90

A. Fitting of Single Diaphragm Type Diaphragm

(1) Properly install the diaphragm into the recess of the diaphragm head. Refer to Fig. 7-10.

(2) When mounting the diaphragm head, make sure that the flow direction of the handled liquid is upward and fit the diaphragm head to the displacement chamber with the specified torque. Refer to Fig. 7-9 and Table 7-3.

B. Fitting of Diaphragm with Diaphragm Failure Detector (Optional)

⚠ CAUTION

There are two types holes in the ring and the diaphragm of the pump unit side. One is the sensing hole for failure detection (small hole) and another is the positioning hole for the spring pin (comparably larger diameter). If the ring is installed up side down, the holes will not mate and this will not enable detection of diaphragm failure. When fitting the diaphragm and the ring, pay attention that these two holes come to the same position.

(1) Insert the diaphragm of the pump unit side into the recess of the diaphragm head, mating the hole of the diaphragm to the spring pin on the diaphragm seal.

(2) Attach the ring, mating the hole on the ring to the spring pin on the diaphragm seal.

(3) Insert the diaphragm of the hydraulic unit side into the recess of the diaphragm head. Pay attention that the parts don't slip out of position between the diaphragm of the pump unit side and the ring.

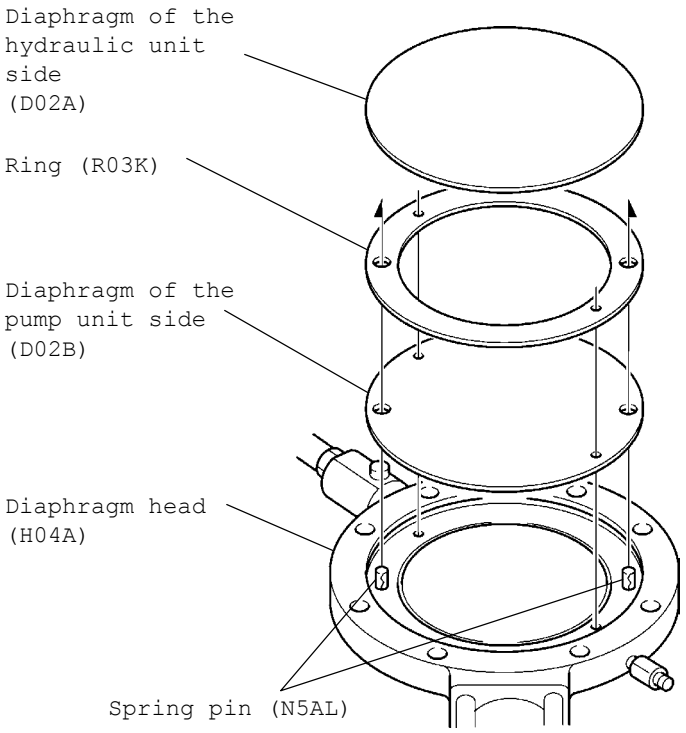


Fig. 7-12 Fitting of diaphragm with diaphragm failure detector

(4) When mounting the diaphragm head, make sure that the flow direction of the handled liquid is upward and attach the diaphragm head to the displacement chamber with the specified torque. Refer to Fig. 7-9 and Table 7-3.

7.2.3 Packing and Gland Replacement

NOTE:
Before disassembling the power end, the liquid end must be removed. Refer to the following required parts removal.
DV-1.8: To the extent of displacement chamber
DV-6.800: To the extent of displacement chamber, gland and piston

A. Packing and Gland Replacement of Head Size DV-1.8

⚠ CAUTION

When handling a heavy unit, use a crane or other lifting device. Pay attention not to drop it. Falling parts may be damaged and/or injure the operator.

⚠ CAUTION

When disassembling the unit, take special care that the plunger does not touch the ring or the gland. Furthermore, confirm there is no flaw or depression sensible by the nail or finger on the surface of the plunger. If any flaw is observed, part replacement is required. Contact us for details. If the packing is reused, reduced packing life and oil leakage may result in the deterioration of pump performance.

NOTE:
When removing the displacement chamber, a small amount of oil comes out from the chamber. Prepare a tray to catch it.

[Disassembly]

(1) Drain all residual liquid in the suction and discharge piping of the pump.
(2) Remove the suction and discharge piping.
(3) Remove the air vent & oil relief valve. Refer to Fig. 7-8.
(4) Drain oil from crankcase and the liquid end adapter. Refer to Section 3.3.

(5) Remove the tube from the fitting of oil compensation valve.
(6) Remove the cap bolts and remove the displacement chamber.

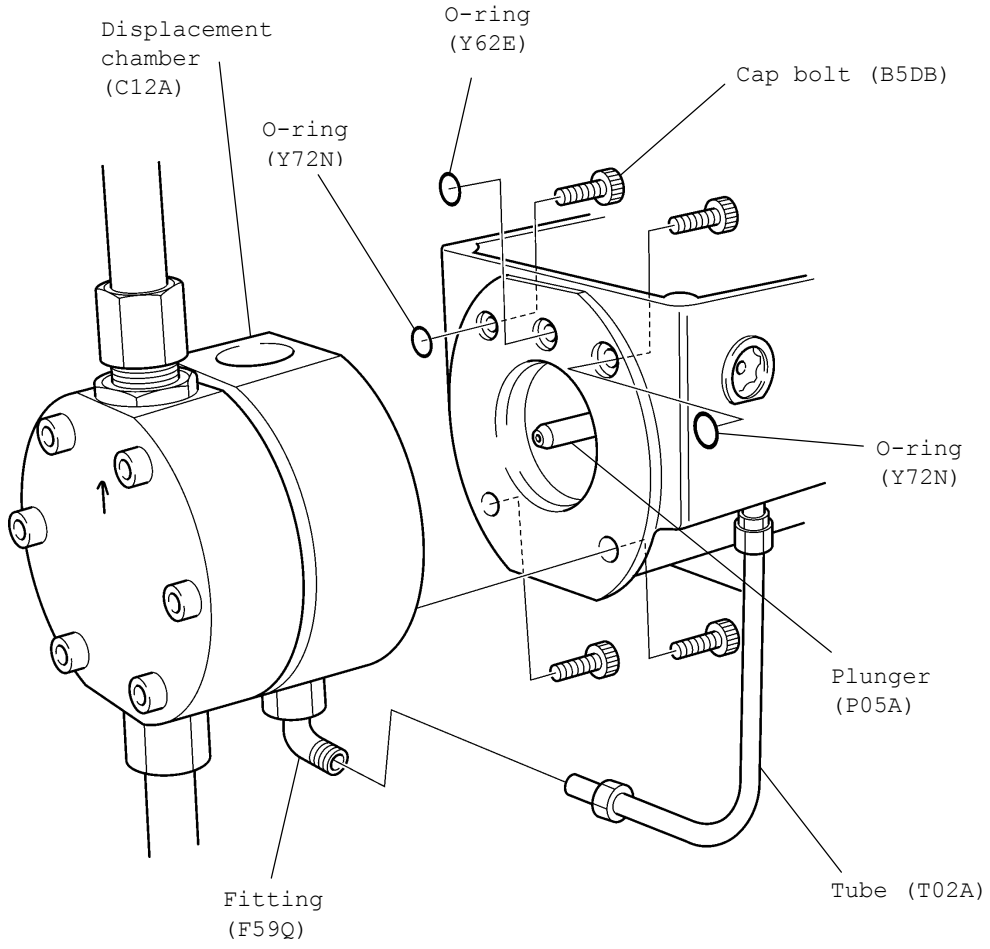


Fig. 7-13 Removal of displacement chamber (DV-1.8)

(7) Remove the cap bolts and remove the ring.

(8) Insert a flat tip lever (screw driver) into the groove of the gland and remove the gland and packing.

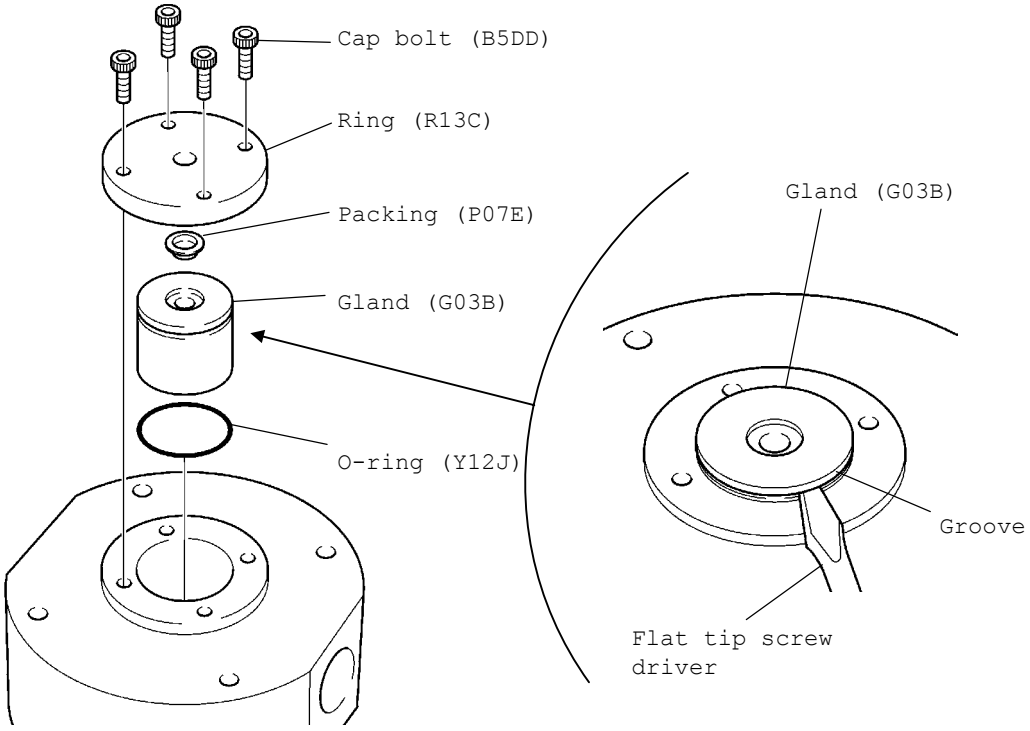


Fig. 7-14 Removal of packing and gland (DV-1.8)

[Reassembly]

When reassembling the unit, the procedure is the reverse of disassembly. Pay attention to the following items:

⚠ CAUTION

When disassembling the unit, take special care the plunger does not touch the ring or the gland. Furthermore, confirm there is no flaw or depression on the moving surface of the plunger packing.

(1) Replace the O-ring with a new one.

(2) Confirm the O-ring is installed, then mount the gland. Refer to Fig. 7-14.

(3) Confirm the O-ring is installed, then mount the displacement chamber. Refer to Fig. 7-13.

B. Packing and Gland Replacement of Head Size DV-6.800

⚠ CAUTION

When handling a heavy unit, use a crane or other lifting device. Pay attention not to drop it. Falling parts may be damaged and/or injure the operator.

⚠ CAUTION

(1) When replacing the packing or gland, pay attention not to flaw the gland and liquid end adapter. If the surface is damaged, it may cause leakage of the oil.

(2) Check for flaws and for sharp edges on the recess. When any flaw is observed, replace it with new one. If the gland is reused, it may reduce packing life and may result in the deterioration of pump performance.

NOTE:

When removing the displacement chamber, a small amount of oil comes out from the chamber. Prepare a tray to catch it.

[Disassembly]

(1) Drain all residual liquid in the suction and discharge piping of the pump.

(2) Remove the suction and discharge piping.

(3) Remove the air vent & oil relief valve. Refer to Fig.7-8.

(4) In a case of Head size DV-50.800: Remove the plug at the bottom of the displacement chamber, and drain the hydraulic oil.

(5) Drain hydraulic oil of the crankcase and the liquid end adapter. Refer to Section 3.3.

(6) Loosen the nut on the side of the oil compensation valve fitting, and remove the tube. When the head size is DV-800, also loosen the nut of the liquid end adapter fitting, and remove the tube.

(7) Remove the cap bolts and remove the displacement chamber.

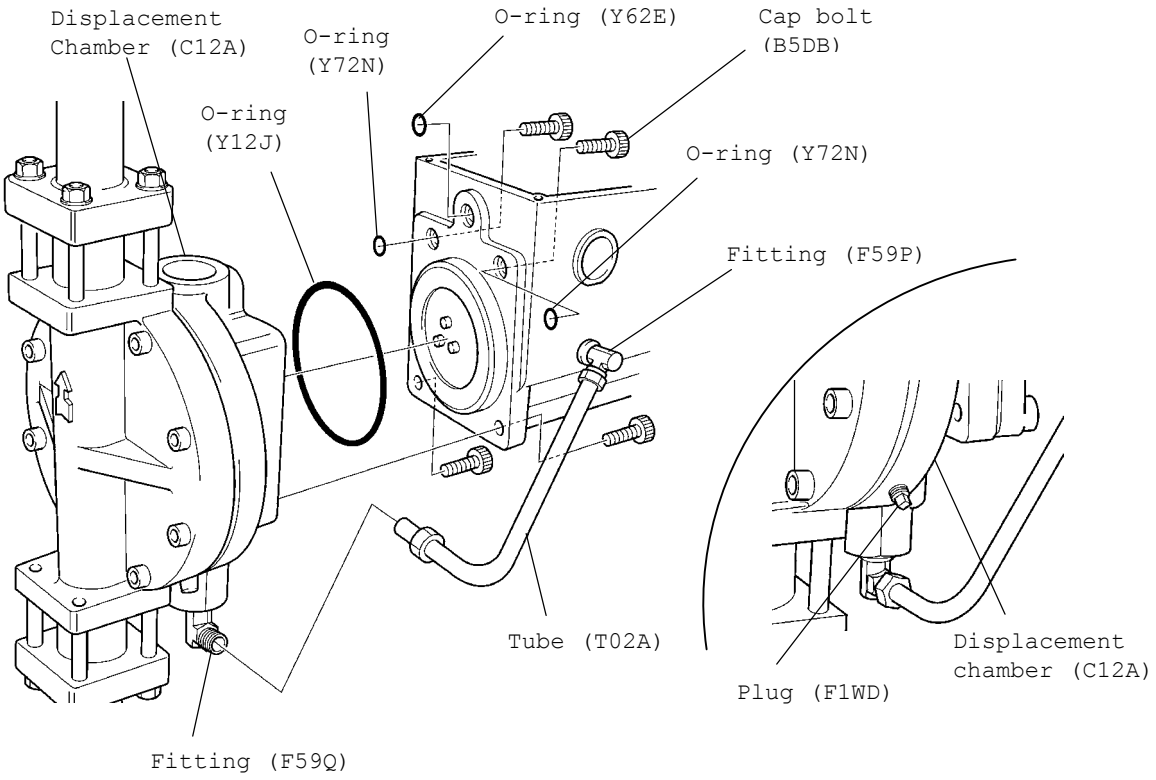


Fig. 7-15 Removal of displacement chamber (DV-6-800)

(8) Insert a flat tip screw driver covered with cloth between the gland and the liquid end adapter, and remove the gland slowly.

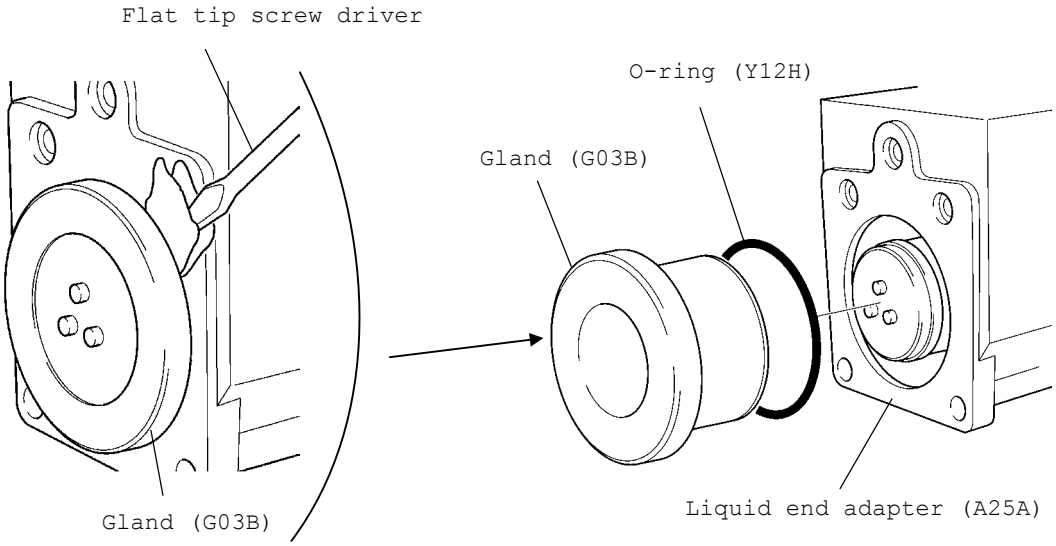


Fig. 7-16 Removal of gland (DV-6-800)

(9) Remove the piston. There are two types of piston, the one body type and the separate type. The removal procedure of each is different. Refer to the following table.

Table 7-4 Piston Type

Pump head size	Piston diameter (mm)							
	M1L		M2L		M3L		M4L	
	One body	Separated	One body	Separated	One body	Separated	One body	Separated
DV-6	14,20	-	-	-	-	-	-	-
DV-25	30	40	30	-	-	-	-	-
DV-50	-	55,65	40	55	40	-	-	-
DV-100	-	-	-	65	55	-	-	-
DV-200	-	-	-	80,90	65	80	-	-
DV-400	-	-	-	-	-	90,110	-	80,90
DV-800	-	-	-	-	-	-	-	110,130

- One body piston: Refer to 6.4. "Remove the liquid end adapter," then remove the piston.

- Separated piston: Remove the cap bolts, then remove the piston.

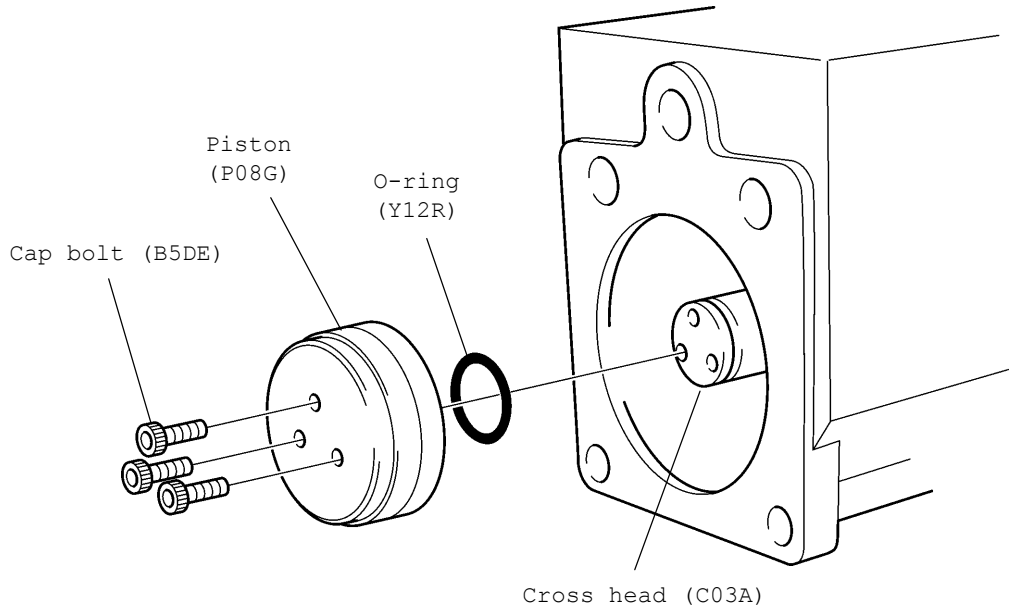


Fig. 7-17 Removal of piston (Separated type)

⚠ CAUTION

When removing the packing, special care is needed not to flaw the piston groove. If any flaw is made to the groove, it will result in the deterioration of pump performance.

(10) Pull out the packing using a thin metal blade, or cut and remove it.

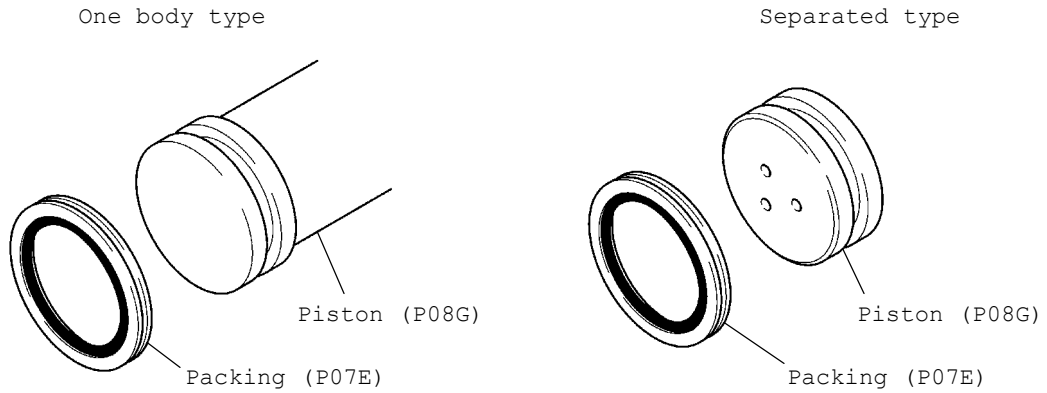


Fig. 7-18 Removal of packing

[Reassembly]

When reassembling the unit, the procedure is the reverse of disassembly. Pay attention to the following items:

(1) Replace the O-ring with a new one.

⚠ CAUTION

If packing is twisted when installed or any flaw exists on the surface of the packing, it becomes a cause of leakage, and it will result in the deterioration of pump performance.

(2) When DV-25.800 packing is installed:
The packing is constructed with two parts, the seal ring and O-ring. First, set O-ring without twisting, then set the seal ring using a soft string.

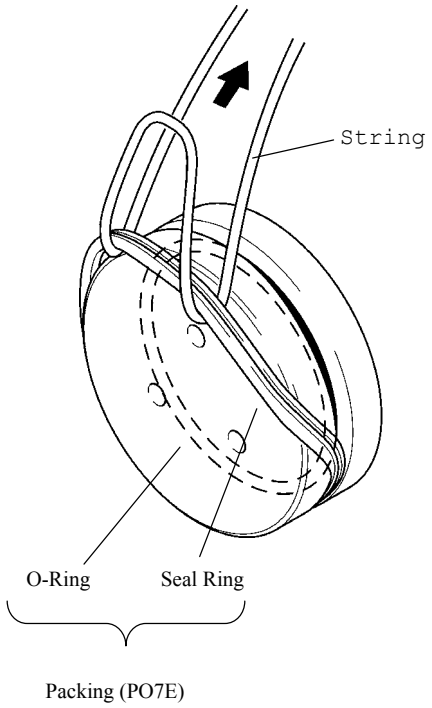


Fig. 7-19 Installation of packing

⚠ CAUTION

When inserting the packing, pay attention that the packing does not protrude from the groove, or is not twisted. If any defect is observed, the concerned packing can not be reused.

(3) When DV-6 packing is installed:
As the material of the DV-6 packing is PTFE, special care is required to get the packing to fit to the groove of the piston. Apply a small amount of grease to whole surface of packing, then slowly insert the piston into the gland.

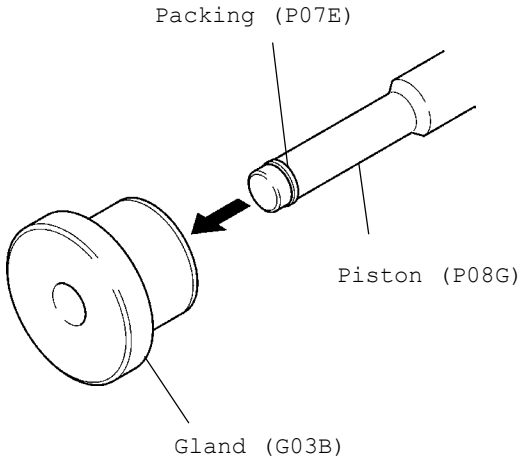


Fig. 7-20 Preparation of packing installation (DV-6)

(4) When one body type piston is installed:
After confirmation of O-ring installation, mount the liquid end adapter.
Refer to Section 6.4 and 6.5.

(5) When separated type piston is installed:

NOTE:

The cap bolt, which secures the plate, is pre-coated with an anti-loosening coating on the thread. When the number of times of disassembly/reassembly exceeds five, it is recommended to use a new one.

After confirmation of O-ring installation on the cross head, attach the piston.

Refer to Fig. 7-17.

⚠ CAUTION

When setting the gland on the piston, pay attention that the parts do not touch each other and apply any flaw to the surfaces. If the surfaces are damaged, it may result in shorter life of the packing or deterioration of pump performance.

(6) Confirm the fit of O-ring on the gland. Position the gland on the liquid end adapter and install it slowly by softly hitting it with a plastic hammer. Refer to Fig. 7-16.

(7) Confirm the fit of O-ring, attach the displacement chamber. Refer to Fig. 7-15.

(8) Connect the tube firmly to the fitting. Refer to Fig. 7-15.

7.2.4 Air Vent & Oil Relief Valve Replacement

⚠ CAUTION

(1) Loosen the pressure adjustment bolt completely. If removing the bonnet without loosening the adjustment bolt, the bonnet may be sprung out by the spring pressure inside the valve.

(2) When disassembling the air vent & oil relief valve , pay attention to not flawing the seal surface. If any defect is observed on the seal surface, replace it with a new one. Otherwise, it may result in a hydraulic oil leakage and insufficient discharge.

(3) If the C-type retaining ring is removed, it is possible to remove the valve and the spring. However, they are small parts and are easily lost. Do not remove the C-type retaining ring during normal disassembly procedure. When the C-type retaining ring is removed, as it is easily deformed, use a new ring.

NOTE:

When replacing the air vent & oil relief valve, replace it as an assembly part, not only the concerned part.

[Disassembly]

(1) Remove the air vent & oil relief valve from the displacement chamber. A gasket is positioned between the air vent & oil relief valve and the displacement chamber. Keep it and do not lose.

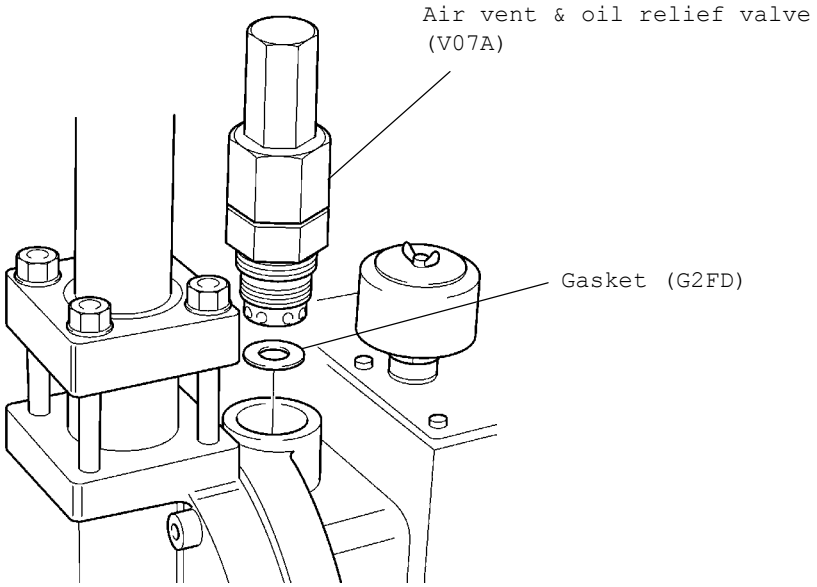


Fig. 7-21 Removal of air vent & oil relief valve

(2) Remove the cap.

(3) Loosen the lock nut, then loosen the pressure adjustment bolt completely.

(4) Remove the bonnet from the body, and remove the parts inside.

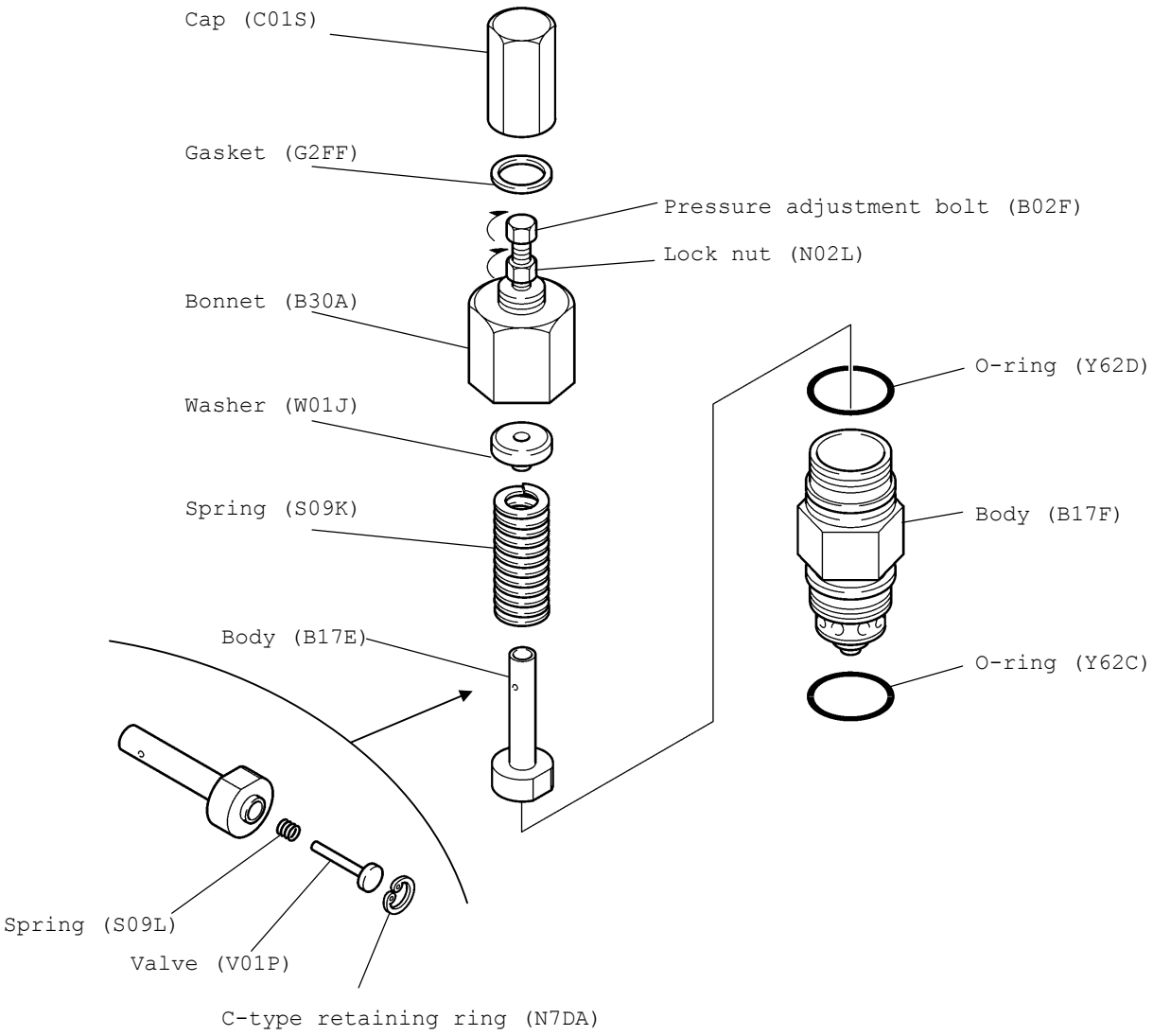


Fig. 7-22 Disassembly of air vent & oil relief valve

[Reassembly]

When reassembling the unit, the procedure is the reverse of disassembly. Pay attention to the following items:

(1) Be sure to clean and dry all parts before reassembly.

(2) After mounting the air vent & oil relief valve, reset the pressure adjustment bolt to the specified pressure. Refer to Section 3.5.

7.2.5 Oil Compensating Valve Replacement

NOTES:

(1) If the oil compensating valve is removed without draining hydraulic oil, oil comes out from the valve hole. Loosen the plug at the bottom of the liquid end adapter, and drain hydraulic oil before disassembly. As the upper portion of the pump frame and the liquid end adapter are internally connected, some oil inside the power end is also drained.

(2) When replacing the oil compensating valve, replace it as an assembly part, not only the concerned part.

[Disassembly]

(1) Loosen the nut of the fitting of the oil compensating valve side, and remove the tube. When the head size is DV-800, also loosen the nut of the fitting of the liquid end adapter side, and remove the tube.

(2) Remove the oil compensating valve by turning it. While removing the oil compensating valve, small amount of hydraulic oil comes out. Prepare a tray to catch oil.

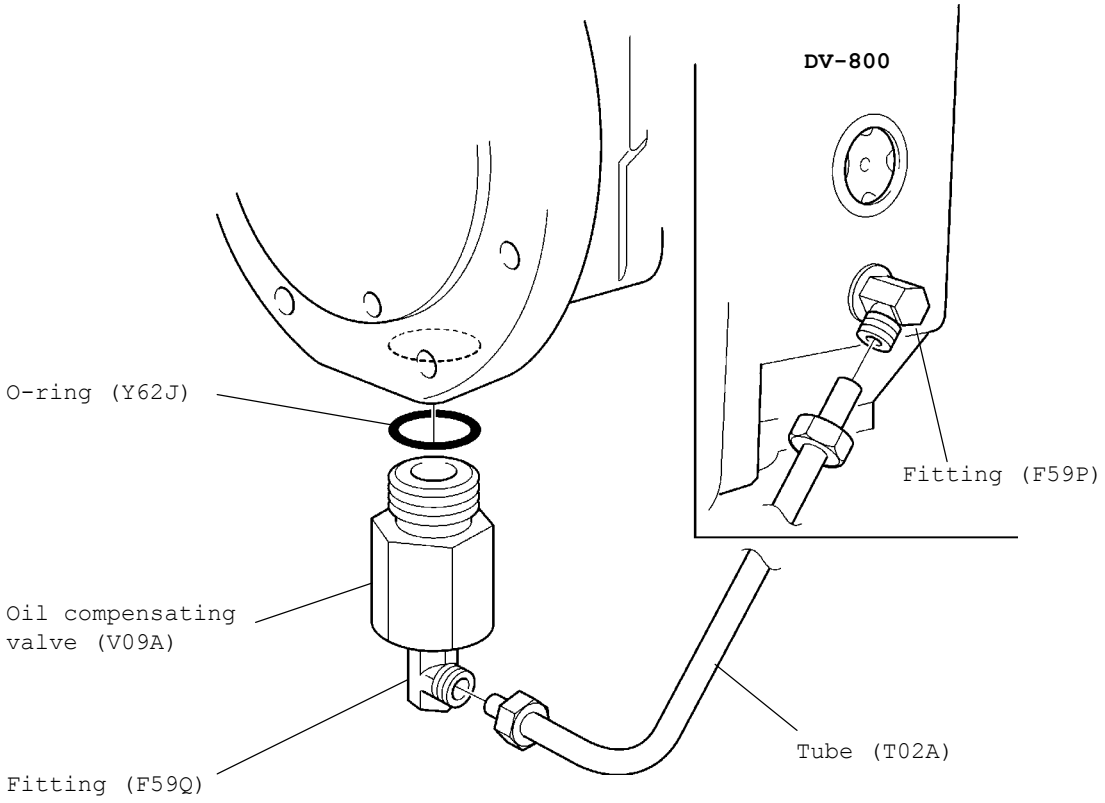


Fig. 7-23 Removal of oil compensating valve

⚠ CAUTION

If the C-type retaining ring is removed, it is possible to remove the ball valve, spring and disk. However, they are small parts and are easily lost. Do not remove the C-type retaining ring during normal disassembly procedure. When the C-type retaining ring is removed, as it is easily deformed, use a new ring.

(3) Remove the C-type retaining ring and remove the parts inside the oil compensating valve.

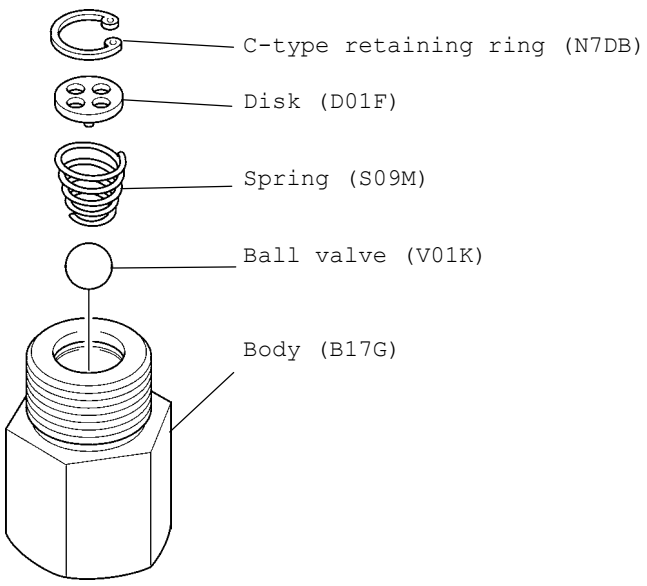


Fig.7-24 Disassembly of oil compensating valve

[Reassembly]

When reassembling the unit, the procedure is the reverse of disassembly.
Pay attention to the following items:

(1) Replace the O-ring with a new one.

(2) Be sure to clean and dry all parts before reassembly.

7.2.6 Position Valve Replacement

A. Position Valve Replacement of Head Size DV-1.8 - 100

⚠ CAUTION

When handling a heavy unit, use a crane or other lifting device. Pay attention not to drop it. Falling parts may be damaged and/or injure the operator.

⚠ CAUTION

(1) Do not reuse the seal washer. Before disassembling the unit, prepare a new washer. If an old washer is reused, it may break the diaphragm.

(2) When replacing the disk and stem of the position valve, replace as an assembly parts, not only the concerned part. If replaced only a concerned part, it is difficult to maintain sufficient sealing performance. This may result in breakage of the diaphragm.

NOTE:

When removing the position valve, use wrench and screw driver as shown in Fig. 7-25.

[Disassembly]

(1) Remove the displacement chamber. Refer to Section 7.2.2 and 7.2.3.

(2) Loosen the U-nut, which are positioned at the rear side of the displacement chamber. Secure the stem by supporting it with a screw driver, which is inserted through the wrench, and loosen the U-nut.

(3) When removing the seal washer, the disk and the stem come out by internal spring force.

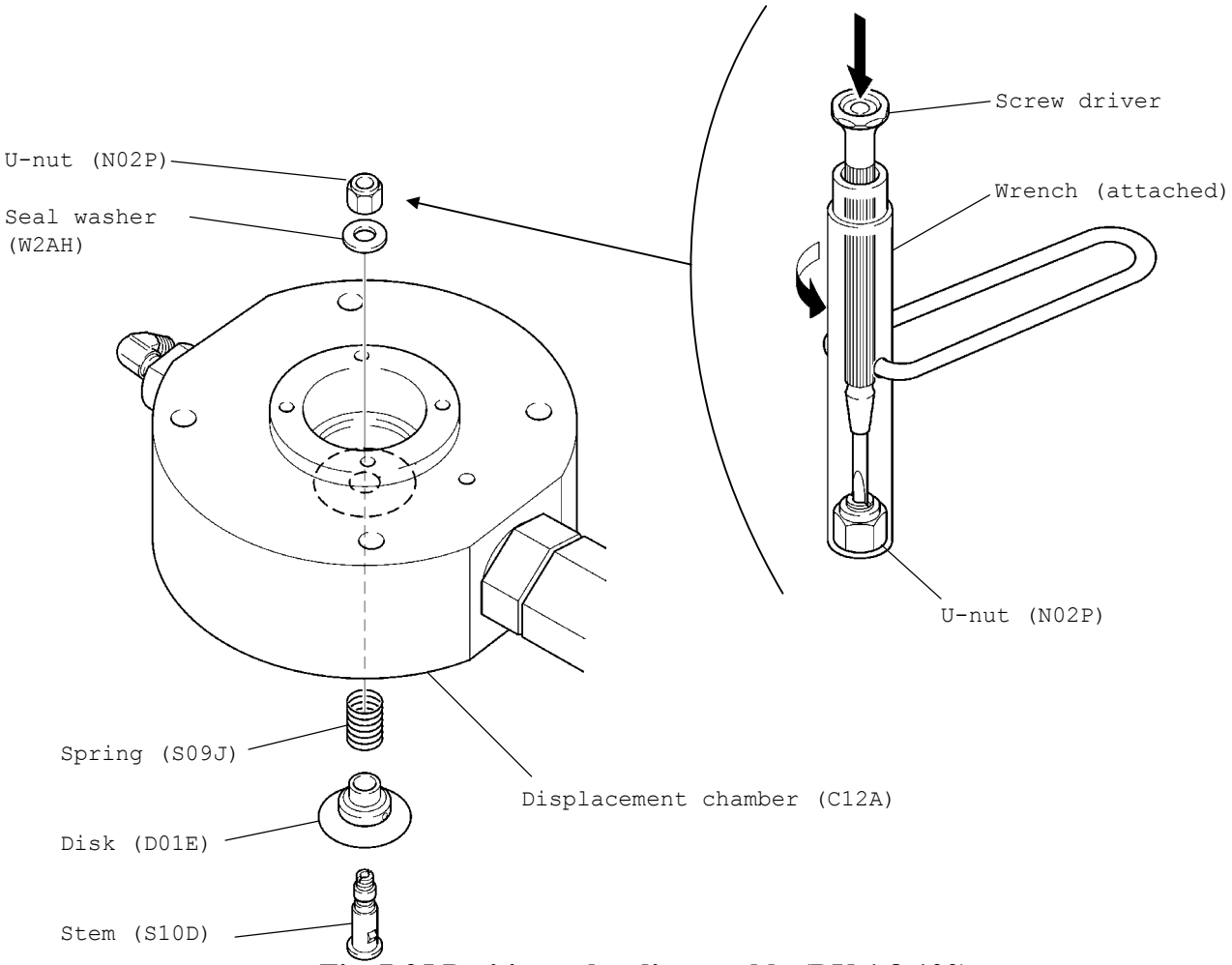


Fig. 7-25 Position valve disassembly (DV-1.8-100)

[Reassembly]

When reassembling the unit, the procedure is the reverse of disassembly. Pay attention to the following items:

(1) Be sure to clean and dry all parts before reassembly.

B. Position Valve Replacement of Head Size DV-200-800

⚠ CAUTION

When removing the plate, pay attention not to drop it. Falling parts may be damaged and/or injure the operator.

[Disassembly]

⚠ CAUTION

(1) When replacing the position valve, replace it as an assembly part, not only the concerned part. Otherwise it may break the diaphragm.

(2) O-rings are set in two positions. When reassembling the unit, be sure to refit them. If they are missed, it is difficult to maintain sufficient sealing performance and may result in breakage of the diaphragm.

(1) Remove the diaphragm head. Refer to Section 7.2.2.

(2) Remove the cap bolts and remove the plate.

(3) Insert the flat tip screw driver covered with cloth between the position valve and the displacement chamber, and remove the position valve. As the position valve is positioned by a positioning pin on the displacement chamber, pull it away vertically. If necessary, replace the O-ring with a new one.

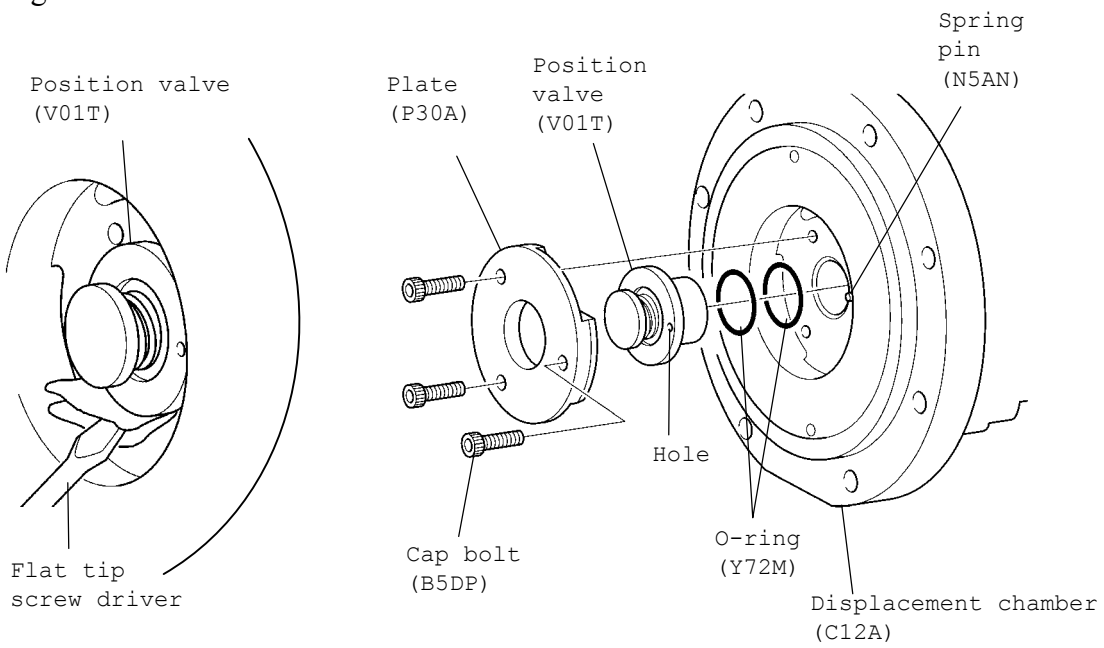


Fig. 7-26 Removal of position valve (DV-200-800)

[Reassembly]

⚠ CAUTION

Tighten the plate mounting cap bolt sufficiently. Otherwise, it may become loose during operation and may result in damage to the pump.

NOTE:

The cap bolt, which secures the plate, is pre-coated with an anti-loosening coating on the thread. When number of times of disassembly/reassembly exceeds five, it is recommended to use a new one.

When reassembling the unit, the procedure is the reverse of disassembly. Pay attention to the following items:

(1) Replace the O-ring with a new one.

(2) Be sure to clean and dry all parts before reassembly.

(3) Reassemble the position valve by mating the hole of its housing and the positioning spring pin of the displacement chamber. Refer to Fig. 7-26.

(4) Be sure to fit the two O-rings in the specified positions. When the O-rings are set, apply small amount of grease to their surfaces and insert them gently without damaging them. Refer to Fig. 7-26.

7.2.7 Supply Hydraulic Oil and Air Venting

After completion of parts replacement of the liquid end adapter, replenish the hydraulic oil. Concerning the type of hydraulic oil, refer to Section 3.4, and Table 3-8, 11. Concerning the run-in operation, refer to the paragraph on checking and maintenance in Section 2.

⚠ CAUTION

(1) When disassembling the liquid end, and when replenishing hydraulic oil, be sure to follow the instructions shown in this section. Otherwise, there is a possibility of insufficient liquid discharging.

(2) Do not drop any piece of seal tape from the plug or other foreign matter into the hydraulic unit. It may clog the valve of the hydraulic unit, and result in insufficient liquid discharge.

(3) For the pump with diaphragm failure detector (optional), oil replenishing to the failure detector, air bleeding and adjustments are required. Refer to Section 8.

(4) When the air vent & oil relief valve is reassembled, set the pressure adjustment bolt to the specified pressure. Otherwise, there is a possibility of damage to the pump. Refer to Section 3.5.

(1) Confirm that the drain plugs and tubes of the liquid end adapter and other concerned units are all tightened and secured.

(2) Set the stroke length to 0 %.

(3) Replenish hydraulic oil to the center level of the oil gauge of the liquid end adapter.

NOTE:

As the upper portions of the pump frame and the liquid end adapter are internally connected, some oil is also supplied to the power end. It takes a certain time (about one minute) to equalize the oil level because of its viscosity. After completion of oil replenishment, reconfirm the oil level.

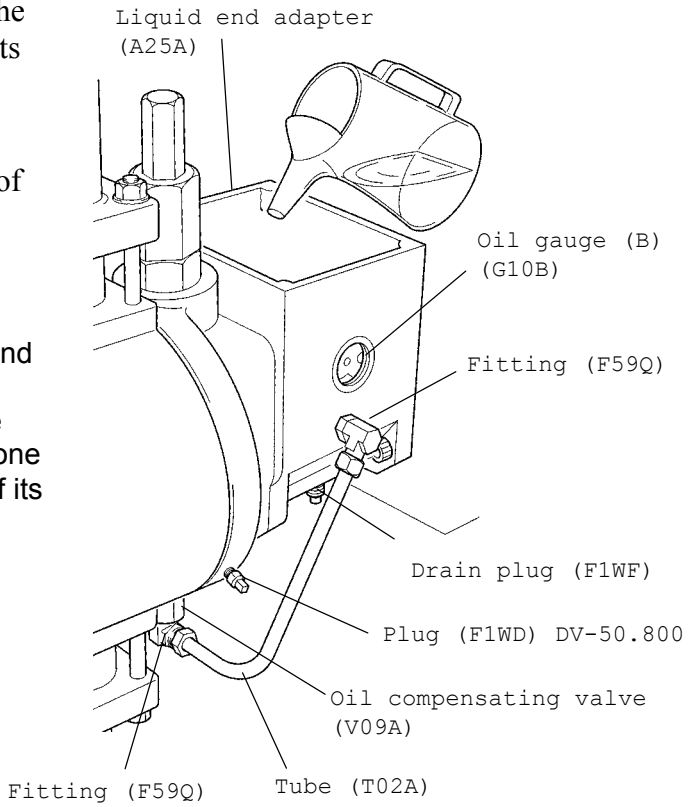


Fig. 7-27 Lubrication to liquid end adapter

(4) Remove the air vent & oil relief valve which is positioned at the top of the displacement chamber, and replenish hydraulic oil to the displacement chamber.

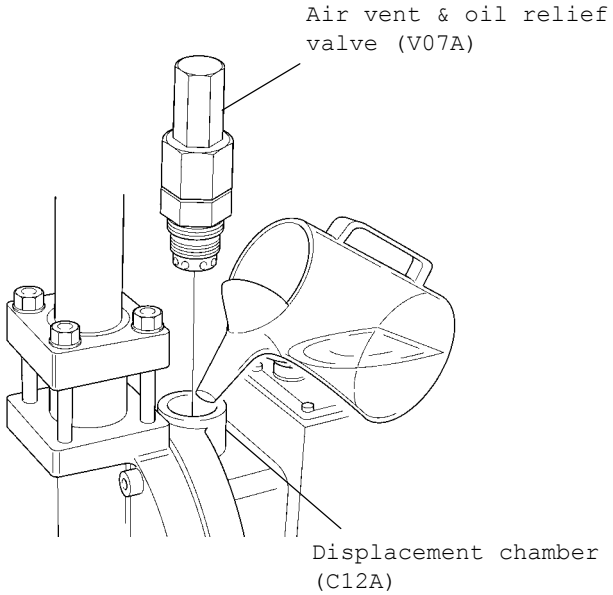


Fig. 7-28 Lubrication to displacement chamber

(5) In case of Head Size DV-1.8/DV-6:

⚠ CAUTION

Retaining the pump for lubrication. Otherwise, operator may be pinched his/her hand in the piston or the plunger resulting in injury.

Fill 10cc of hydraulic oil in a syringe and insert its tip into the hole of the fitting in the liquid end adapter and inject oil into the fitting.

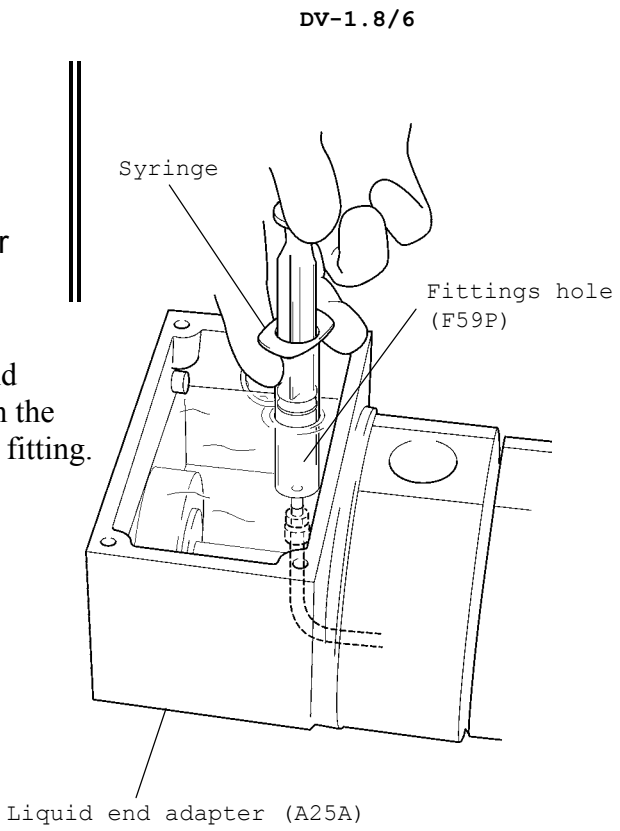


Fig. 7-29 Lubrication of fitting

(6) Turn on the power to the motor, and start the pump.

NOTE:

Be careful of the possibility of hydraulic oil splashing out of the thread hole of relief valve.

(7) Adjust the pump stroke length to 5%. (With multiplex pump configuration, adjust all stroke lengths to 5%.) If the oil level does not reach the hole of the air vent valve of the air vent & oil relief valve, replenish oil little by little until it reaches the hole level. While replenishing oil, air inside the displacement chamber comes out as bubbles. Replenish the oil observing bubbles and oil level until bubbles clear and the oil surface become steady.

(8) Adjust the pump stroke to 0% and mount the air vent & oil relief valve. The lubrication procedure is completed. (With the multiplex pump configuration, adjust all stroke lengths to 0%.) When the pump is equipped with failure detector, lubricate the failure detector referring to Section 8.

7.3 Parts Lists and Cross Section of Liquid End

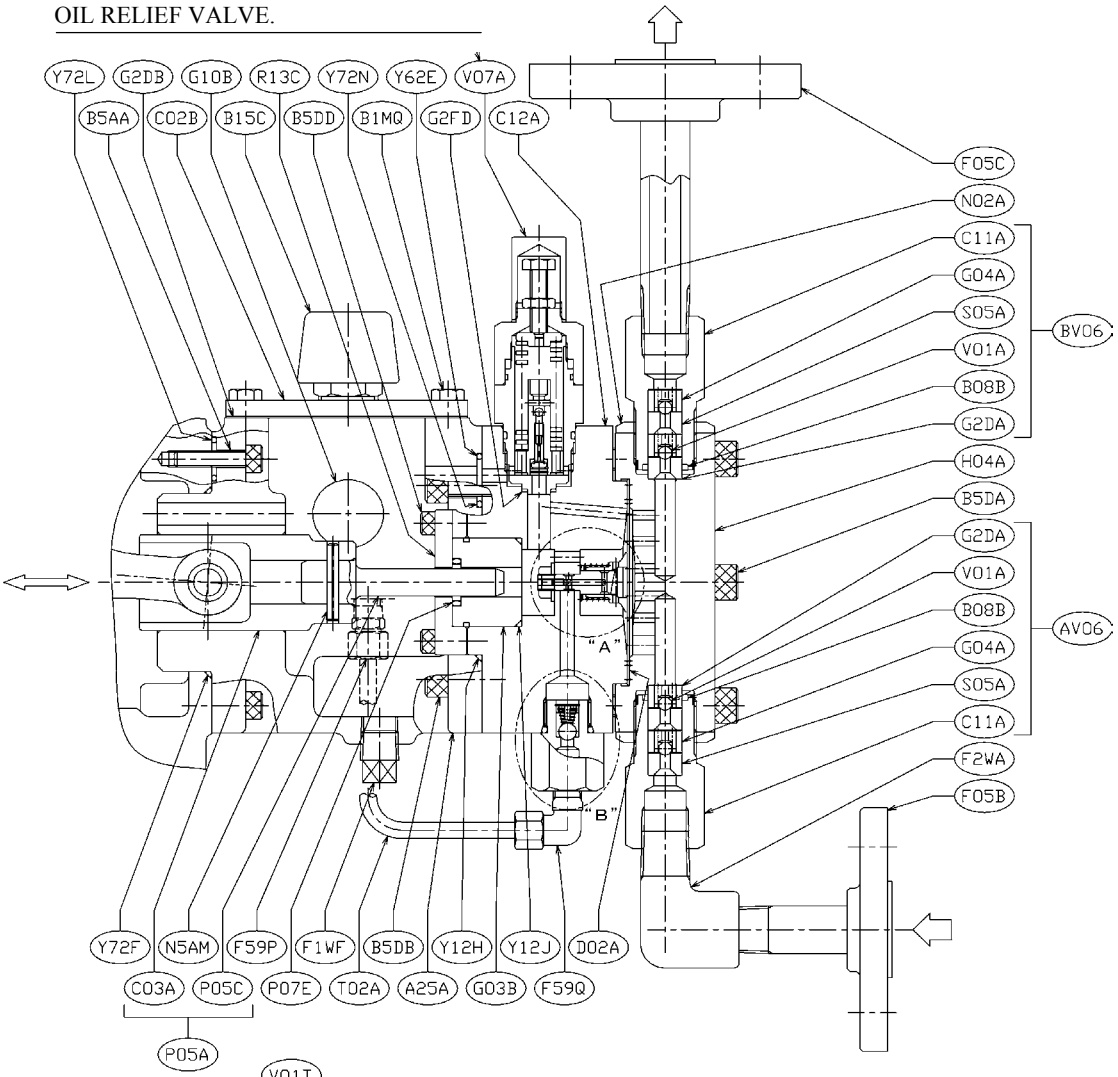
7.3.1 DV-1.8 (Single Diaphragm Type)

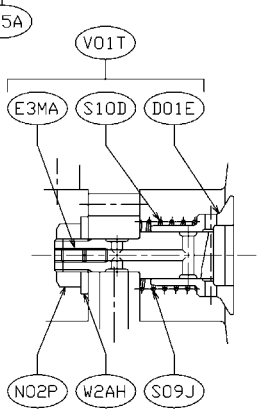
ITEM	PART NAME	Q'TY	REMARKS
A25A	Liquid end adapter	1	
AV06	Valve assembly	1SET	
B08B	Bushing	(1)	
C11A	Cartridge	(1)	
G04A	Valve guide	(2)	
G2DA	Gasket	(5)	
S05A	Valve seat	(2)	
V01A	Ball valve	(2)	
BV06	Valve assembly	1SET	
B08B	Bushing	(1)	
C11A	Cartridge	(1)	
G04A	Valve guide	(2)	
G2DA	Gasket	(5)	
S05A	Valve seat	(2)	
V01A	Ball valve	(2)	
B15C	Breather	1	
B1MQ	Hexagon head bolt	6	
B5AA	Cap bolt	4	
B5DA	Cap bolt	6	
B5DB	Cap bolt	4	
B5DD	Cap bolt	4	
C02B	Cover	1	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
F05B	Flange	1	
F05C	Flange	1	
F1WF	Plug	1	
F2WA	Elbow	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N02A	Lock nut	2	
N02P	U nut	1	
P05A	Plunger assembly	1SET	
C03A	Cross head	(1)	
N5AM	Spring pin	(1)	
P05C	Plunger	(1)	

ITEM	PART NAME	Q'TY	REMARKS
P07E	Packing	1	
R13C	Ring	1	
S09J	Spring	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	
W2AH	Seal washer	1	
Y12J	O-ring	1	
Y12H	O-ring	1	
Y62E	O-ring	1	
Y62J	O-ring	1	
Y72F	O-ring	1	
Y72L	O-ring	2	
Y72N	O-ring	2	
V01T	Position valve	1SET	
D01E	Disk	(1)	
E3MA	Set screw	(2)	
S10D	Stem	(1)	
V09A	Oil compensating valve	1SET	
B17G	Body	(1)	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

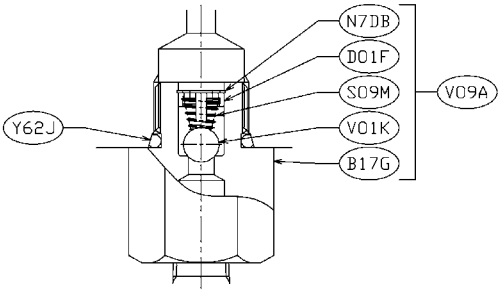
NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.

Refer to section 7.3.17 for AIR VENT & OIL RELIEF VALVE.





DETAIL "A"



DETAIL "B"

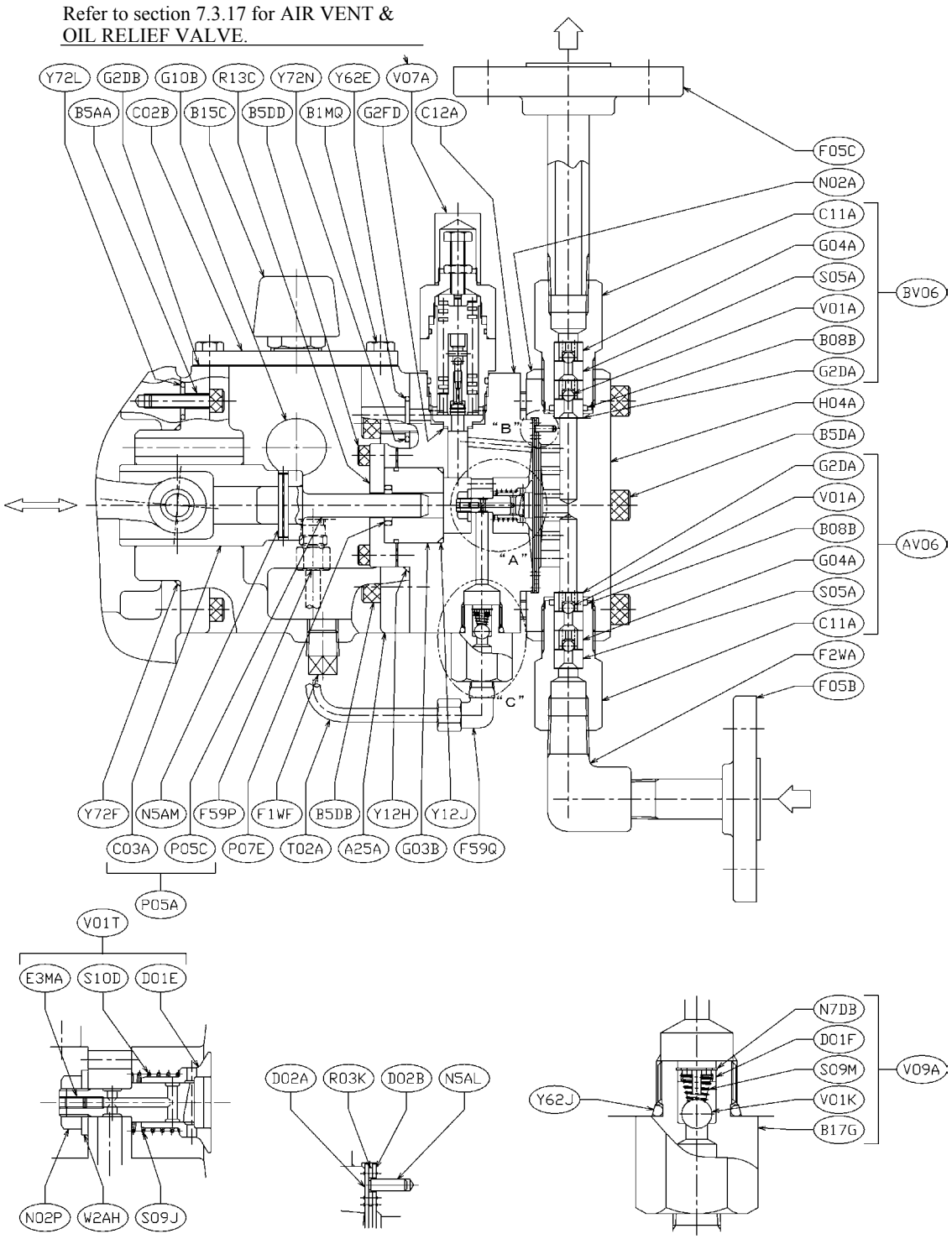
HEAD SIZE	MODEL/ TYPE	PLUNGER DIA. (mm)	VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
DV-1.8	M1L	7,10	2 STAGE BALL VALVE	STAINLESS STEEL	SINGLE DIAPHRAGM

7.3.2 DV-1.8 (Diaphragm Type with Failure Detector)

ITEM	PART NAME	Q'TY	REMARKS
A25A	Liquid end adapter	1	
AV06	Valve assembly	1SET	
B08B	Bushing	(1)	
C11A	Cartridge	(1)	
G04A	Valve guide	(2)	
G2DA	Gasket	(5)	
S05A	Valve seat	(2)	
V01A	Ball valve	(2)	
BV06	Valve assembly	1SET	
B08B	Bushing	(1)	
C11A	Cartridge	(1)	
G04A	Valve guide	(2)	
G2DA	Gasket	(5)	
S05A	Valve seat	(2)	
V01A	Ball valve	(2)	
B15C	Breather	1	
B1MQ	Hexagon head bolt	6	
B5AA	Cap bolt	4	
B5DA	Cap bolt	6	
B5DB	Cap bolt	4	
B5DD	Cap bolt	4	
C02B	Cover	1	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
D02B	Diaphragm	1	
F05B	Flange	1	
F05C	Flange	1	
F1WF	Plug	1	
F2WA	Elbow	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N02A	Lock nut	2	
N02P	U nut	1	
N5AL	Spring pin	2	
P05A	Plunger assembly	1SET	
C03A	Cross head	(1)	

ITEM	PART NAME	Q'TY	REMARKS
N5AM	Spring pin	(1)	
P05C	Plunger	(1)	
P07E	Packing	1	
R03K	Ring	1	
R13C	Ring	1	
S09J	Spring	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	
W2AH	Seal washer	1	
Y12J	O-ring	1	
Y12H	O-ring	1	
Y62E	O-ring	1	
Y62J	O-ring	1	
Y72F	O-ring	1	
Y72L	O-ring	2	
Y72N	O-ring	2	
V01T	Position valve	1SET	
D01E	Disk	(1)	
E3MA	Set screw	(2)	
S10D	Stem	(1)	
V09A	Oil compensating valve	1SET	
B17G	Body	(1)	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.



DETAIL

DETAIL "B"

DETAIL "C"

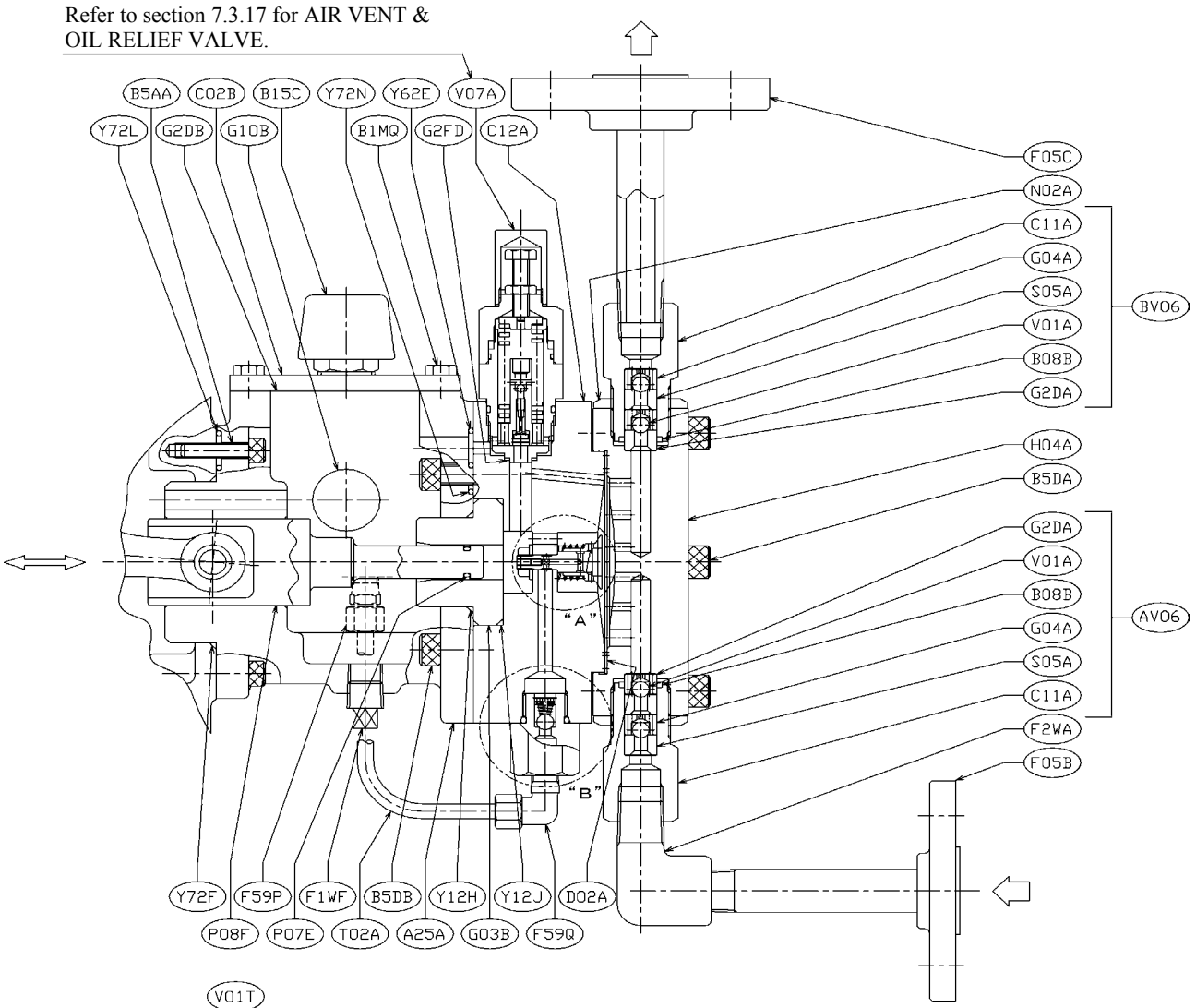
HEAD SIZE	MODEL/ TYPE	PLUNGER DIA. (mm)	VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
DV-1.8	M1L	7,10	2 STAGE BALL VALVE	STAINLESS STEEL	PRESSURE TYPE DIAPHRAGM FAILURE DETECTOR

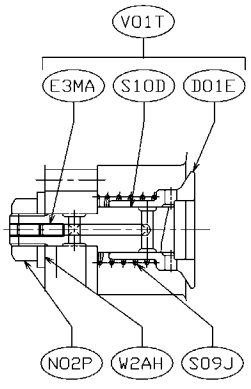
7.3.3 DV-6 (Single Diaphragm Type)

ITEM	PART NAME	Q'TY	REMARKS
A25A	Liquid end adapter	1	
AV06	Valve assembly	1SET	
B08B	Bushing	(1)	
C11A	Cartridge	(1)	
G04A	Valve guide	(2)	
G2DA	Gasket	(5)	
S05A	Valve seat	(2)	
V01A	Ball valve	(2)	
BV06	Valve assembly	1SET	
B08B	Bushing	(1)	
C11A	Cartridge	(1)	
G04A	Valve guide	(2)	
G2DA	Gasket	(5)	
S05A	Valve seat	(2)	
V01A	Ball valve	(2)	
B15C	Breather	1	
B1MQ	Hexagon head bolt	6	
B5AA	Cap bolt	4	
B5DA	Cap bolt	6	
B5DB	Cap bolt	4	
C02B	Cover	1	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
F05B	Flange	1	
F05C	Flange	1	
F1WF	Plug	1	
F2WA	Elbow	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N02A	Lock nut	2	
N02P	U nut	1	
P07E	Packing	1	
P08F	Piston	1	
S09J	Spring	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	

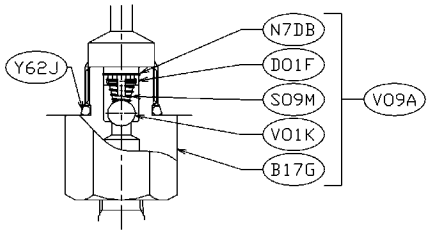
ITEM	PART NAME	Q'TY	REMARKS
W2AH	Seal washer	1	
Y12J	O-ring	1	
Y12H	O-ring	1	
Y62E	O-ring	1	
Y62J	O-ring	1	
Y72F	O-ring	1	
Y72L	O-ring	2	
Y72N	O-ring	2	
V01T	Position valve	1SET	
D01E	Disk	(1)	
E3MA	Set screw	(2)	
S10D	Stem	(1)	
V09A	Oil compensating valve	1SET	
B17G	Body	(1)	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.





DETAIL



DETAIL "B"

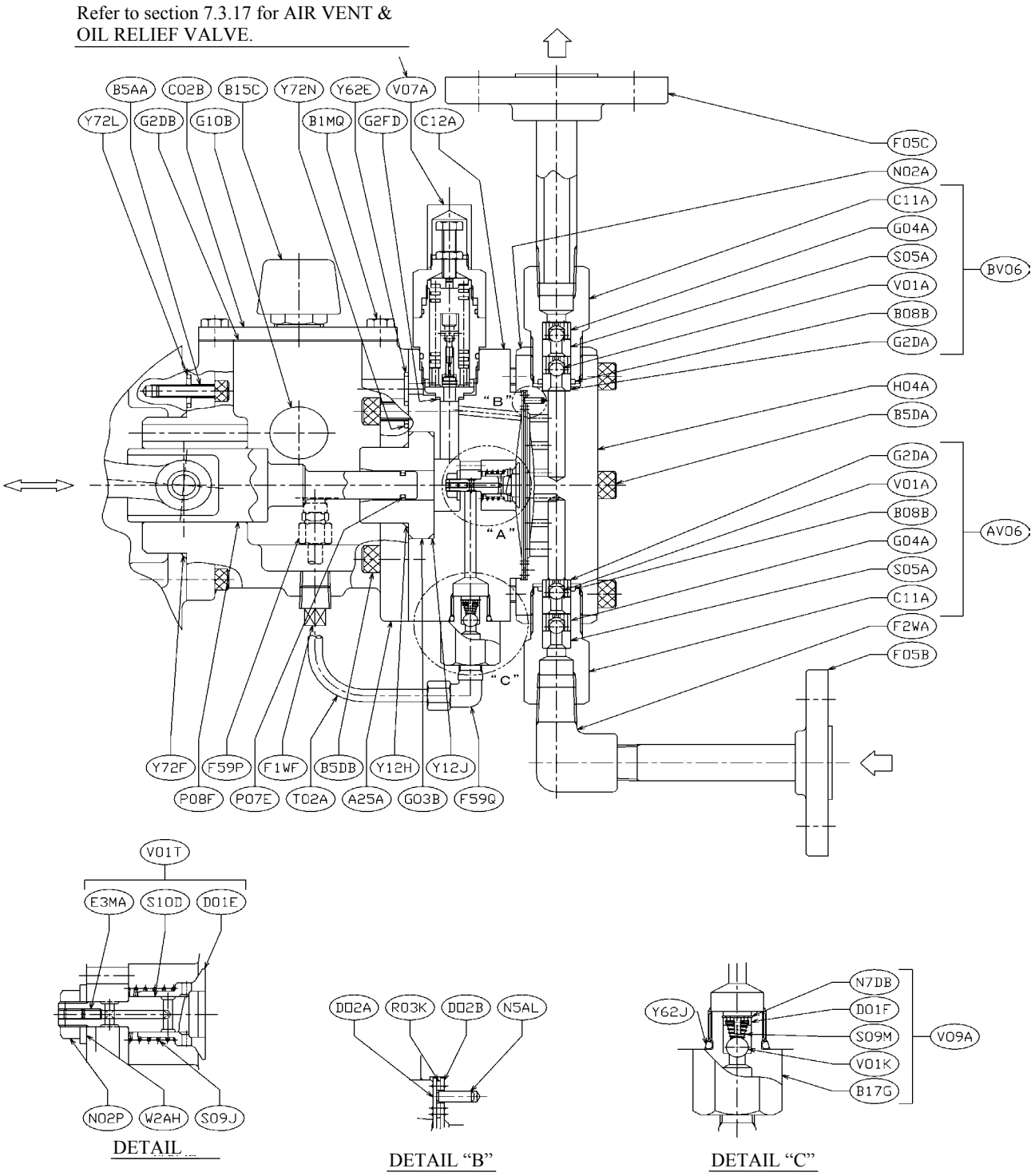
HEAD SIZE	MODEL/ TYPE	PISTON DIA.(mm)	VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
DV-6	M1L	14,20	2 STAGE BALL VALVE	STAINLESS STEEL	SINGLE DIAPHRAGM

7.3.4 DV-6 (Diaphragm Type with Failure Detector)

ITEM	PART NAME	Q'TY	REMARKS
A25A	Liquid end adapter	1	
AV06	Valve assembly	1SET	
B08B	Bushing	(1)	
C11A	Cartridge	(1)	
G04A	Valve guide	(2)	
G2DA	Gasket	(5)	
S05A	Valve seat	(2)	
V01A	Ball valve	(2)	
BV06	Valve assembly	1SET	
B08B	Bushing	(1)	
C11A	Cartridge	(1)	
G04A	Valve guide	(2)	
G2DA	Gasket	(5)	
S05A	Valve seat	(2)	
V01A	Ball valve	(2)	
B15C	Breather	1	
B1MQ	Hexagon head bolt	6	
B5AA	Cap bolt	4	
B5DA	Cap bolt	6	
B5DB	Cap bolt	4	
C02B	Cover	1	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
D02B	Diaphragm	1	
F05B	Flange	1	
F05C	Flange	1	
F1WF	Plug	1	
F2WA	Elbow	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N02A	Lock nut	2	
N02P	U nut	1	
N5AL	Spring pin	2	
P07E	Packing	1	
P08F	Piston	1	
R03K	Ring	1	

ITEM	PART NAME	Q'TY	REMARKS
S09J	Spring	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	
W2AH	Seal washer	1	
Y12J	O-ring	1	
Y12H	O-ring	1	
Y62E	O-ring	1	
Y62J	O-ring	1	
Y72F	O-ring	1	
Y72L	O-ring	2	
Y72N	O-ring	2	
V01T	Position valve	1SET	
D01E	Disk	(1)	
E3MA	Set screw	(2)	
S10D	Stem	(1)	
V09A	Oil compensating valve	1SET	
B17G	Body	(1)	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.



HEAD SIZE	MODEL/ TYPE	PISTON DIA. (mm)	VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
DV-6	M1L	14,20	2 STAGE BALL VALVE	STAINLESS STEEL	PRESSURE TYPE DIAPHRAGM FAILURE DETECTOR

7.3.5 DV-25 (Single Diaphragm Type)

ITEM	PART NAME	Q'TY	REMARKS
A25A	Liquid end adapter	1	
B15C	Breather	1	
B1MQ	Hexagon head bolt	6[8]	M1,[M2]
B5AA	Cap bolt	4	
B5DA	Cap bolt	6	
B5DB	Cap bolt	4	
C02B	Cover	1	
C11A	Cartridge	2	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
F05B	Flange	1	
F05C	Flange	1	
F1WF	Plug	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N02A	Lock nut	2	
N02P	U nut	1	
P07E	Packing	1	
S09J	Spring	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	
W2AH	Seal washer	1	
Y12H	O-ring	1	
Y12J	O-ring	1	
Y62E	O-ring	1	
Y62J	O-ring	1	
Y72F	O-ring	1	
Y72L	O-ring	2	
Y72N	O-ring	2	
V01T	Position valve	1SET	
D01E	Disk	(1)	
E3MA	Set screw	(2)	
S10D	Stem	(1)	
V09A	Oil compensating valve	1SET	
B17G	Body	(1)	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

PISTON TYPE

ONE BODY TYPE (P.D. 30)

P08F	Piston	1	

SEPARATED TYPE (P.D. 40)

B5DE	Nylok bolt	2	
C03A	Cross head	1	
P08G	Piston	1	
Y12R	O-ring	1	

VALVE TYPE

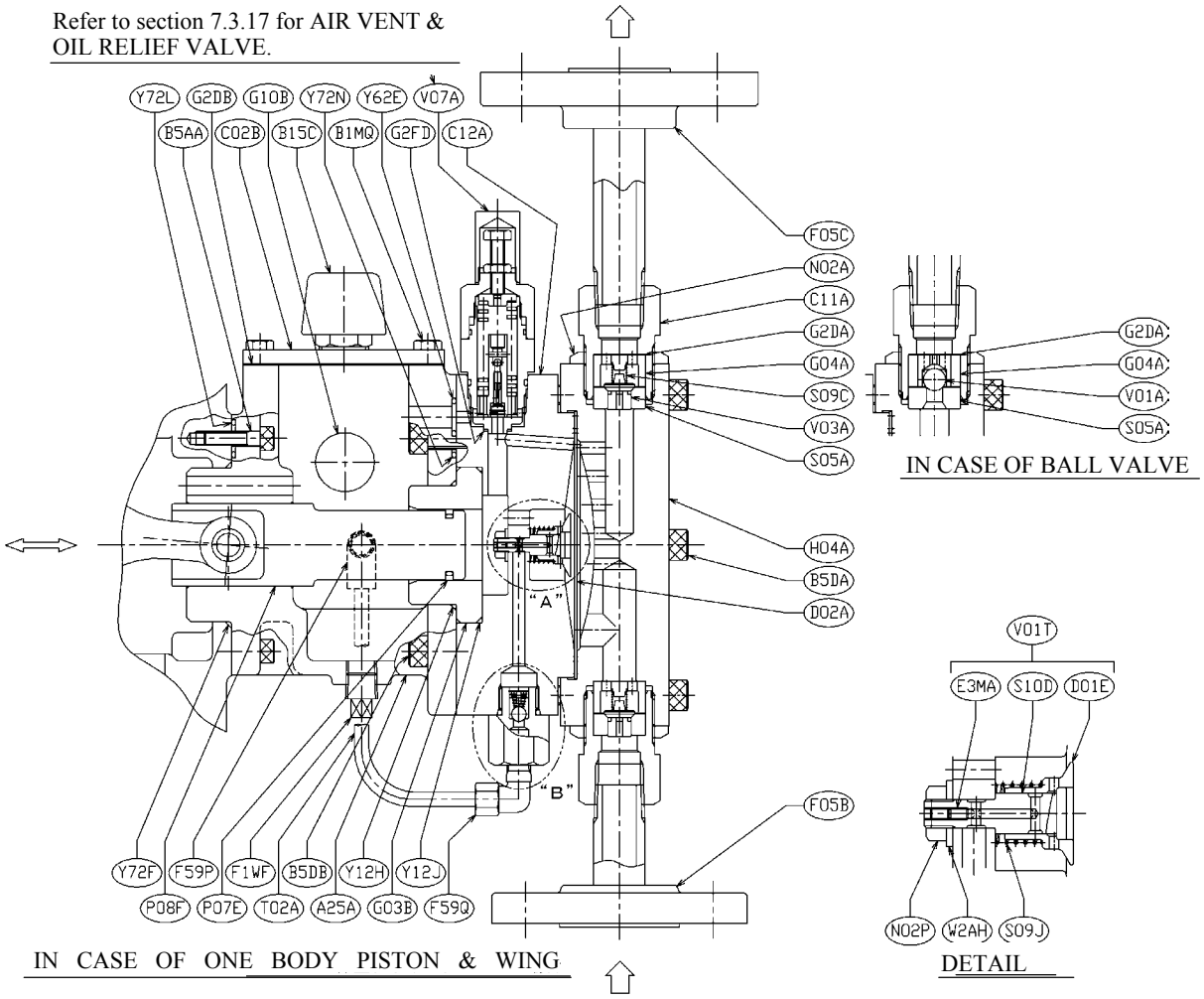
WING VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
S09C	Spring	2	
V03A	Wing valve	2	

BALL VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
V01A	Ball valve	2	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.



HEAD SIZE	MODEL/ TYPE	PISTON		VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
		TYPE	DIA. (mm)			
DV-25	M1L	ONE BODY	30	1 STAGE BALL VALVE or WING VALVE	STAINLESS STEEL	SINGLE DIAPHRAGM
		SEPARATED	40			
	M2L	ONE BODY	30			

7.3.6 DV-25 (Diaphragm Type with Failure Detector)

ITEM	PART NAME	Q'TY	REMARKS
A25A	Liquid end adapter	1	
B15C	Breather	1	
B1MQ	Hexagon head bolt	6[8]	M1,[M2]
B5AA	Cap bolt	4	
B5DA	Cap bolt	6	
B5DB	Cap bolt	4	
C02B	Cover	1	
C11A	Cartridge	2	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
D02B	Diaphragm	1	
F05B	Flange	1	
F05C	Flange	1	
F1WF	Plug	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N02A	Lock nut	2	
N02P	U nut	1	
N5AL	Spring pin	2	
P07E	Packing	1	
R03K	Ring	1	
S09J	Spring	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	
W2AH	Seal washer	1	
Y12H	O-ring	1	
Y12J	O-ring	1	
Y62E	O-ring	1	
Y62J	O-ring	1	
Y72F	O-ring	1	
Y72L	O-ring	2	
Y72N	O-ring	2	
V01T	Position valve	1SET	
D01E	Disk	(1)	
E3MA	Set screw	(2)	
S10D	Stem	(1)	

ITEM	PART NAME	Q'TY	REMARKS
V09A	Oil compensating valve	1SET	
B17G	Body	(1)	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

PISTON TYPE

ONE BODY TYPE (P.D. 30)

P08F	Piston	1	

SEPARATED TYPE (P.D. 40)

B5DE	Cap bolt	2	
C03A	Cross head	1	
P08G	Piston	1	
Y12R	O-ring	1	

VALVE TYPE

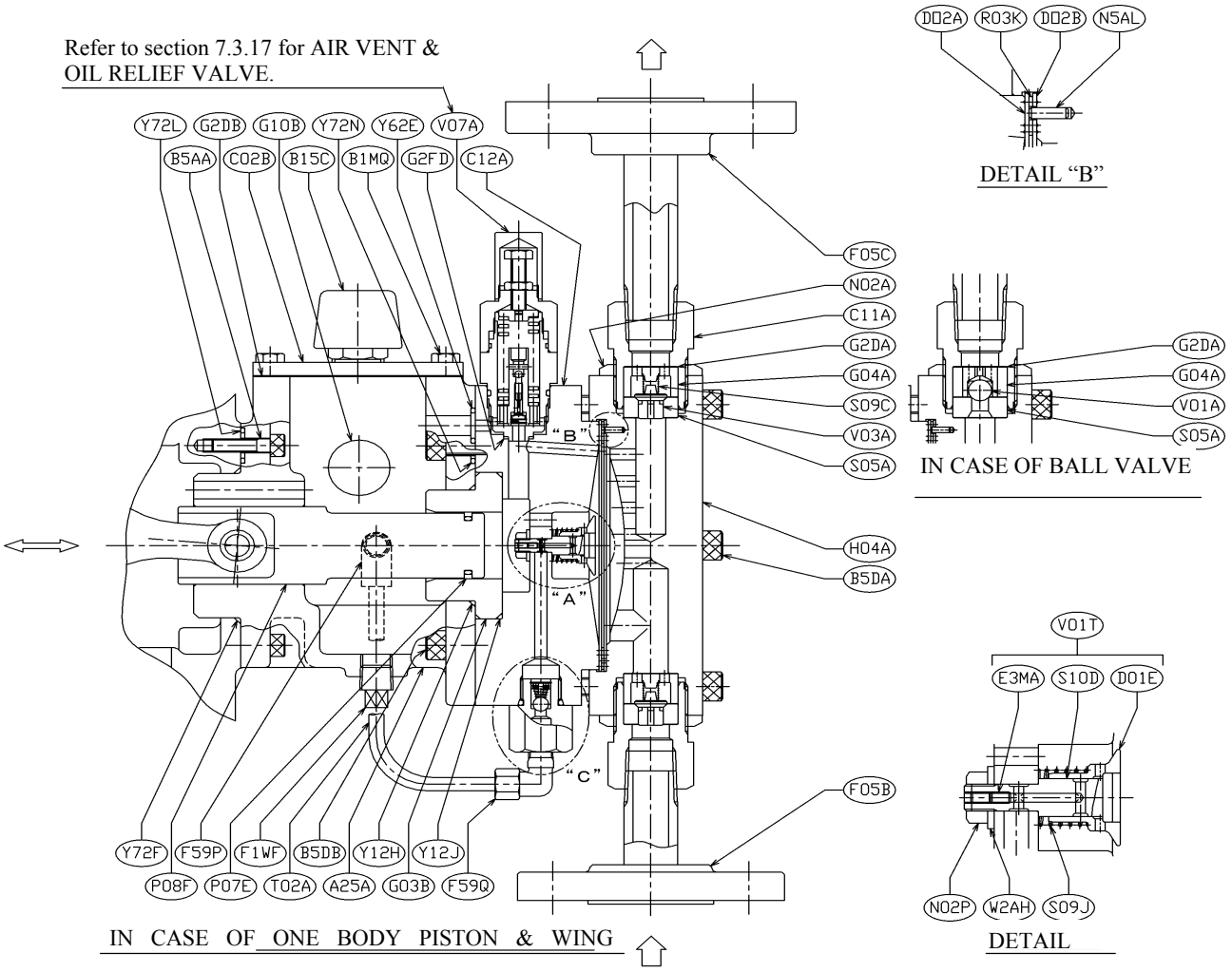
WING VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
S09C	Spring	2	
V03A	Wing valve	2	

BALL VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
V01A	Ball valve	2	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.



HEAD SIZE	MODEL/ TYPE	PISTON		VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
		TYPE	DIA. (mm)			
DV-25	M1L	ONE BODY	30	1 STAGE BALL VALVE or WING VALVE	STAINLESS STEEL	PRESSURE TYPE DIAPHRAGM FAILURE DETECTOR
		SEPARATED	40			
	M2L	ONE BODY	30			

7.3.7 DV-50 (Single Diaphragm Type)

ITEM	PART NAME	Q'TY	REMARKS
A1MD	Nut	8	
A25A	Liquid end adapter	1	
B15C	Breather	1	
B1MQ	Hexagon head bolt	6[8]	M1,[M2,M3]
B5AA	Cap bolt	4	
B5DA	Cap bolt	6	
B5DB	Cap bolt	4	
B6MB	Stud bolt	8	
C02B	Cover	1	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
F05A	Flange	2	
F05B	Flange	1	
F05C	Flange	1	
F1WD	Plug	1	
F1WF	Plug	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N02P	U nut	1	
P07E	Packing	1	
S06B	Segment	2	
S09J	Spring	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	
W2AH	Seal washer	1	
Y62E	O-ring	1	
Y62J	O-ring	1	
Y12J	O-ring	1	
Y12H	O-ring	1	
Y72N	O-ring	2	
Y72L	O-ring	2	
Y72F	O-ring	1	
V01T	Position valve	1SET	
D01E	Disk	(1)	
E3MA	Set screw	(2)	
S10D	Stem	(1)	

ITEM	PART NAME	Q'TY	REMARKS
V09A	Oil compensating valve	1SET	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
B17G	Body	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

PISTON TYPE

ONE BODY TYPE (P.D. 40)

P08F	Piston	1	

SEPARATED TYPE (P.D. 55,65)

B5DE	Cap bolt	2	
C03A	Cross head	1	
P08G	Piston	1	
Y12R	O-ring	1	

VALVE TYPE

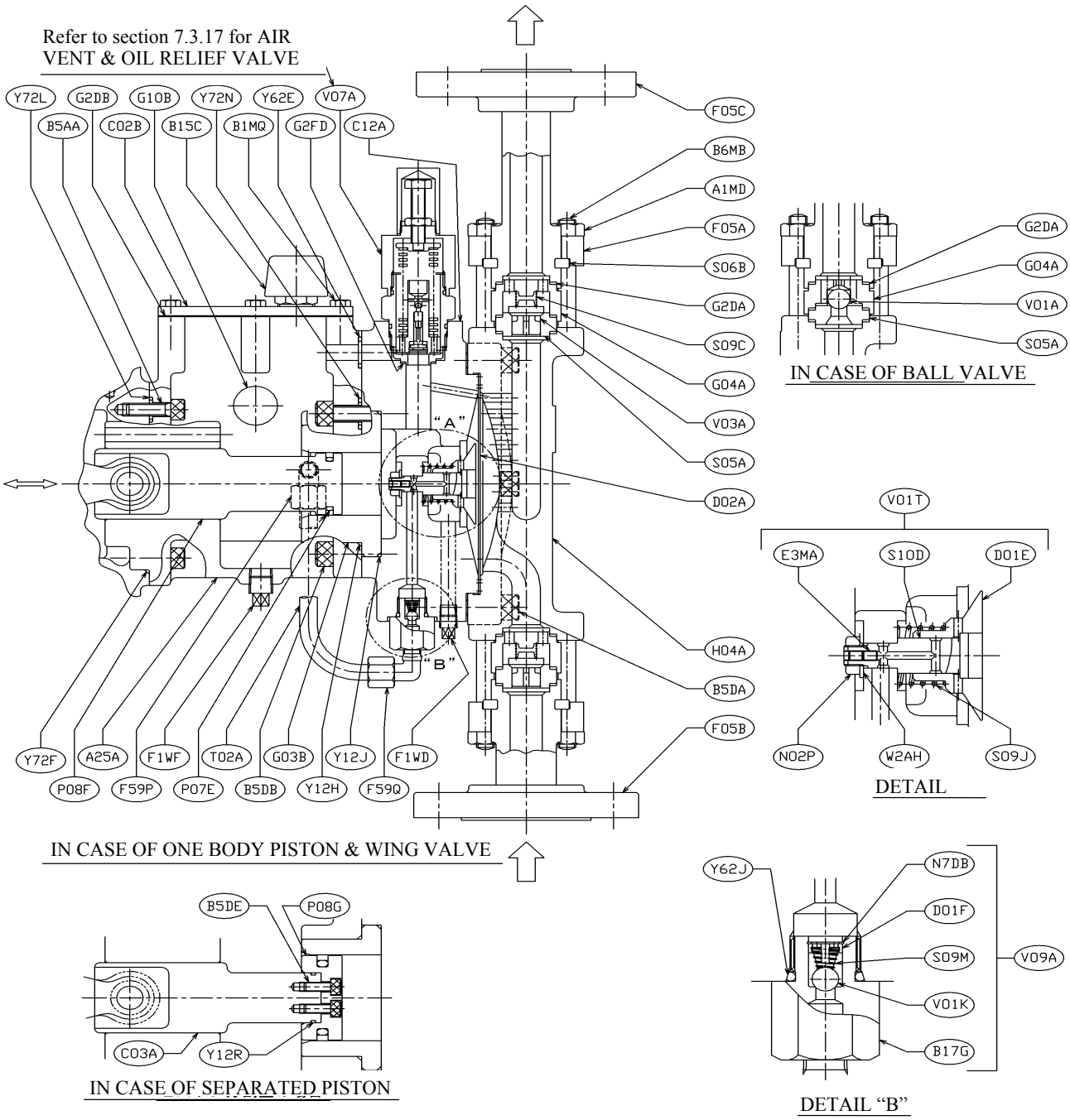
WING VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
S09C	Spring	2	
V03A	Wing valve	2	

BALL VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
V01A	Ball valve	2	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.



HEAD SIZE	MODEL/ TYPE	PISTON		VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
		TYPE	DIA. (mm)			
DV-50	M1L	SEPARATED	55,65	1 STAGE BALL VALVE or WING VALVE	STAINLESS STEEL	SINGLE DIAPHRAGM
	M2L	ONE BODY	40			
		SEPARATED	55			
	M3L	ONE BODY	40			

7.3.8 DV-50 (Diaphragm Type with Failure Detector)

ITEM	PART NAME	Q'TY	REMARKS
A1MD	Nut	8	
A25A	Liquid end adapter	1	
B15C	Breather	1	
B1MQ	Hexagon head bolt	6[8]	M1,[M2,M3]
B5AA	Cap bolt	4	
B5DA	Cap bolt	6	
B5DB	Cap bolt	4	
B6MB	Stud bolt	8	
C02B	Cover	1	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
D02B	Diaphragm	1	
F05A	Flange	2	
F05B	Flange	1	
F05C	Flange	1	
F1WD	Plug	1	
F1WF	Plug	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N02P	U nut	1	
N5AL	Spring pin	2	
P07E	Packing	1	
R03K	Ring	1	
S06B	Segment	2	
S09J	Spring	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	
W2AH	Seal washer	1	
Y62E	O-ring	1	
Y62J	O-ring	1	
Y12J	O-ring	1	
Y12H	O-ring	1	
Y72N	O-ring	2	
Y72L	O-ring	2	
Y72F	O-ring	1	
V01T	Position valve	1SET	

ITEM	PART NAME	Q'TY	REMARKS
D01E	Disk	(1)	
E3MA	Set screw	(2)	
S10D	Stem	(1)	
V09A	Oil compensating valve	1SET	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
B17G	Body	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

PISTON TYPE

ONE BODY TYPE (P.D. 40)

P08F	Piston	1	

SEPARATED TYPE (P.D. 55,65)

B5DE	Cap bolt	2	
C03A	Cross head	1	
P08G	Piston	1	
Y12R	O-ring	1	

VALVE TYPE

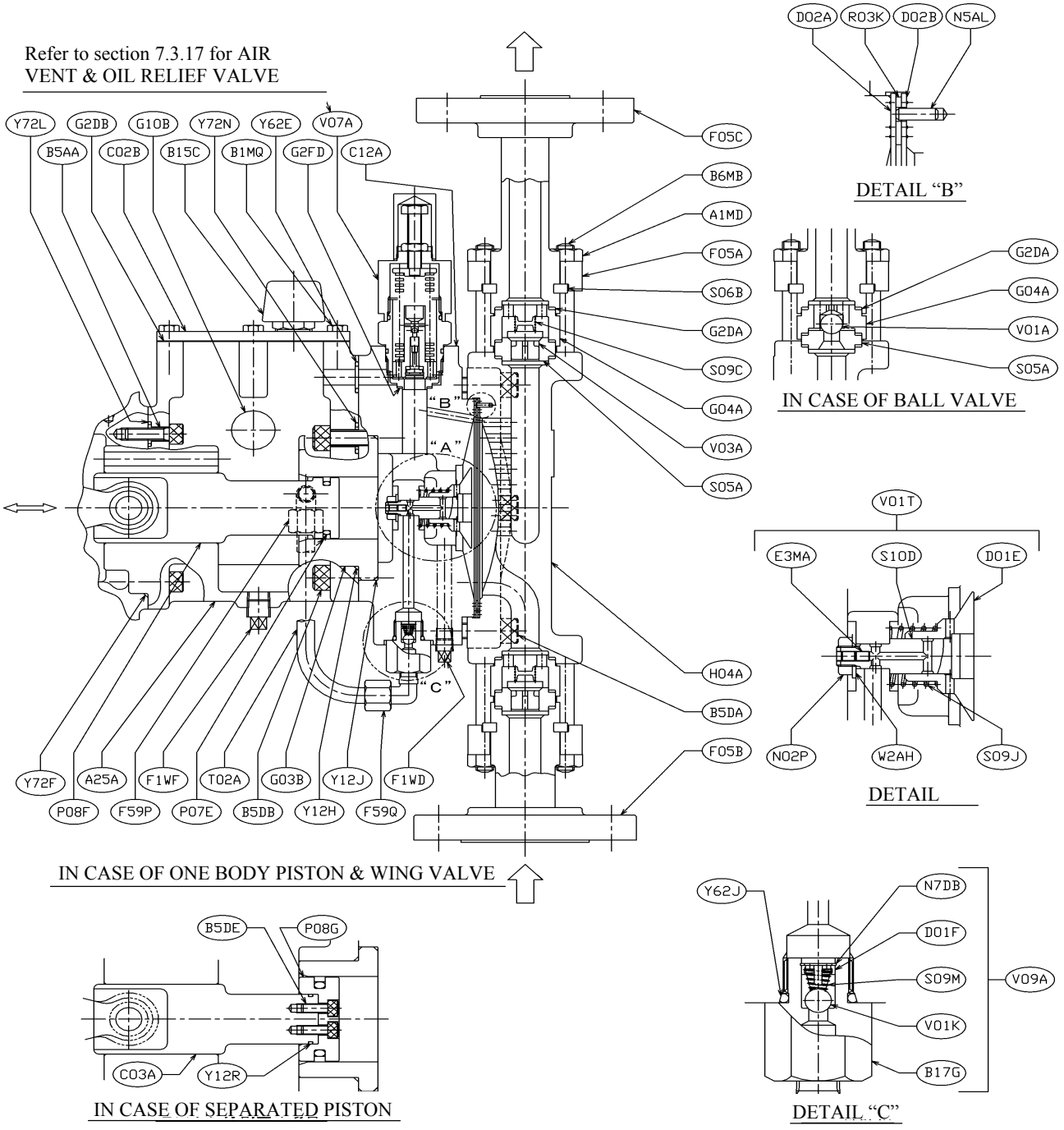
WING VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
S09C	Spring	2	
V03A	Wing valve	2	

BALL VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
V01A	Ball valve	2	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.



HEAD SIZE	MODEL/ TYPE	PISTON		VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
		TYPE	DIA. (mm)			
DV-50	M1L	SEPARATED	55,65	1 STAGE BALL VALVE or WING VALVE	STAINLESS STEEL	PRESSURE TYPE DIAPHRAGM FAILURE DETECTOR
	M2L	ONE BODY	40			
		SEPARATED	55			
	M3L	ONE BODY	40			

7.3.9 DV-100 (Single Diaphragm Type)

ITEM	PART NAME	Q'TY	REMARKS
A1MD	Nut	8	
A25A	Liquid end adapter	1	
B15C	Breather	1	
B1MQ	Hexagon head bolt	8	
B5AA	Cap bolt	4	
B5DA	Cap bolt	6	
B5DB	Cap bolt	4	
B6MB	Stud bolt	8	
C02B	Cover	1	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
F05A	Flange	2	
F05B	Flange	1	
F05C	Flange	1	
F1WD	Plug	1	
F1WF	Plug	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N02P	U nut	1	
P07E	Packing	1	
S06B	Segment	2	
S09J	Spring	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	
W2AH	Seal washer	1	
Y12H	O-ring	1	
Y12J	O-ring	1	
Y62E	O-ring	1	
Y62J	O-ring	1	
Y72F	O-ring	1	
Y72L	O-ring	2	
Y72N	O-ring	2	
V01T	Position valve	1SET	
D01E	Disk	(1)	
E3MA	Set screw	(2)	
S10D	Stem	(1)	

ITEM	PART NAME	Q'TY	REMARKS
V09A	Oil compensating valve	1SET	
B17G	Body	(1)	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

PISTON TYPE

ONE BODY TYPE (P.D. 55)

P08F	Piston	1	

SEPARATED TYPE (P.D. 65)

B5DE	Cap bolt	2	
C03A	Cross head	1	
P08G	Piston	1	
Y12R	O-ring	1	

VALVE TYPE

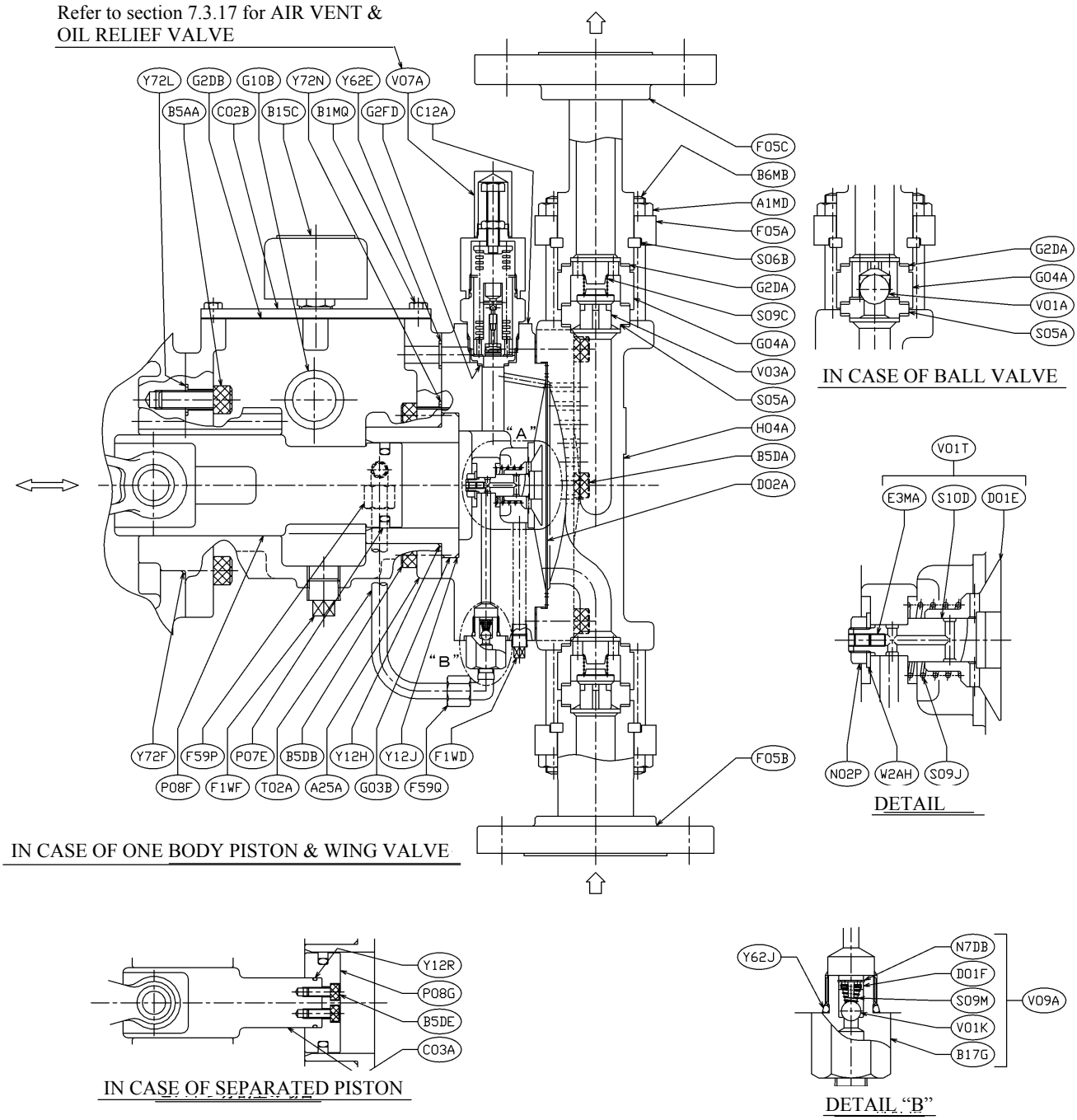
WING VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
S09C	Spring	2	
V03A	Wing valve	2	

BALL VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
V01A	Ball valve	2	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.



HEAD SIZE	MODEL/ TYPE	PISTON		VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
		TYPE	DIA. (mm)			
DV-100	M2L	SEPARATED	65	1 STAGE BALL VALVE or WING VALVE	STAINLESS STEEL	SINGLE DIAPHRAGM
	M3L	ONE BODY	55			

7.3.10 DV-100 (Diaphragm Type with Failure Detector)

ITEM	PART NAME	Q'TY	REMARKS
A1MD	Nut	8	
A25A	Liquid end adapter	1	
B15C	Breather	1	
B1MQ	Hexagon head bolt	8	
B5AA	Cap bolt	4	
B5DA	Cap bolt	6	
B5DB	Cap bolt	4	
B6MB	Stud bolt	8	
C02B	Cover	1	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
D02B	Diaphragm	1	
F05A	Flange	2	
F05B	Flange	1	
F05C	Flange	1	
F1WD	Plug	1	
F1WF	Plug	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N02P	U nut	1	
N5AL	Spring pin	2	
P07E	Packing	1	
R03K	Ring	1	
S06B	Segment	2	
S09J	Spring	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	
W2AH	Seal washer	1	
Y12H	O-ring	1	
Y12J	O-ring	1	
Y62E	O-ring	1	
Y62J	O-ring	1	
Y72F	O-ring	1	
Y72L	O-ring	2	
Y72N	O-ring	2	
V01T	Position valve	1SET	

ITEM	PART NAME	Q'TY	REMARKS
D01E	Disk	(1)	
E3MA	Set screw	(2)	
S10D	Stem	(1)	
V09A	Oil compensating valve	1SET	
B17G	Body	(1)	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

PISTON TYPE

ONE BODY TYPE (P.D. 55)

P08F	Piston	1	

SEPARATED TYPE (P.D. 65)

B5DE	Cap bolt	2	
C03A	Cross head	1	
P08G	Piston	1	
Y12R	O-ring	1	

VALVE TYPE

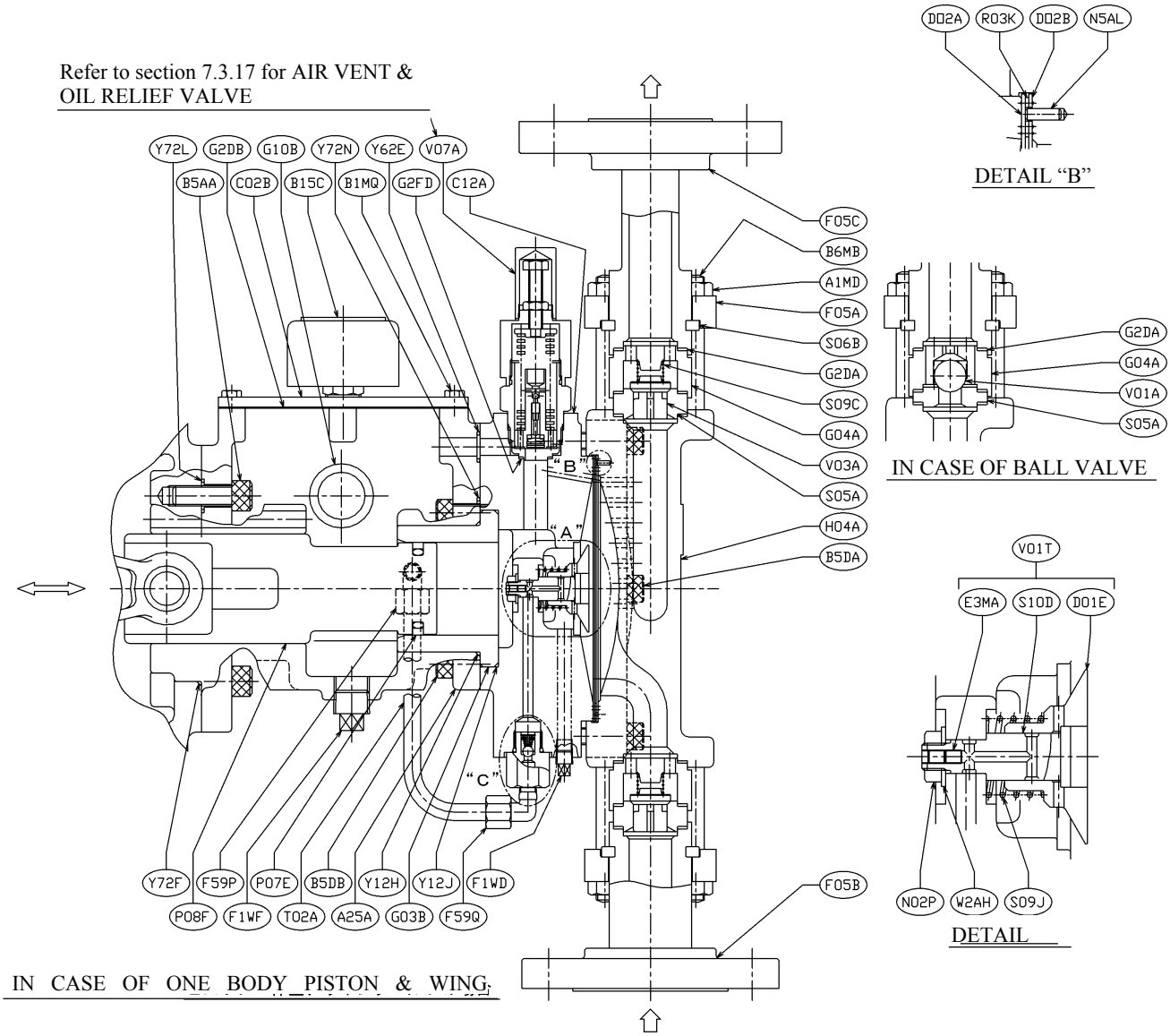
WING VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
S09C	Spring	2	
V03A	Wing valve	2	

BALL VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
V01A	Ball valve	2	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.



HEAD SIZE	MODEL/ TYPE	PISTON		VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
		TYPE	DIA. (mm)			
DV-100	M2L	SEPARATED	65	1 STAGE BALL VALVE or WING VALVE	STAINLESS STEEL	PRESSURE TYPE DIAPHRAGM FAILURE DETECTOR
	M3L	ONE BODY	55			

7.3.11 DV-200 (Single Diaphragm Type)

ITEM	PART NAME	Q'TY	REMARKS
A1MD	Nut	8	
A25A	Liquid end adapter	1	
B15C	Breather	1	
B1MQ	Hexagon head bolt	6[8]	M2,[M3]
B5AA	Cap bolt	4	
B5DA	Cap bolt	8	
B5DB	Cap bolt	4	
B5DP	Cap bolt	3	
B6MB	Stud bolt	8	
B8MB	Eye bolt	2	
C02B	Cover	1	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
F05B	Flange	1	
F05C	Flange	1	
F1WD	Plug	1	
F1WF	Plug	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N5AN	Spring pin	1	
P07E	Packing	1	
P30A	Backup plate	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	
W1AF	Washer	8	
Y12H	O-ring	1	
Y12J	O-ring	1	
Y62E	O-ring	1	
Y62J	O-ring	1	
Y72L	O-ring	2	
Y72N	O-ring	2	
Y72F	O-ring	1	
Y72M	O-ring	2	
V01T	Position valve	1SET	
D01E	Disk	(1)	
S09J	Spring	(1)	

ITEM	PART NAME	Q'TY	REMARKS
H01Q	Housing	(1)	
S10D	Stem	(1)	
N02P	U nut	(1)	
V09A	Oil compensating valve	1SET	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
B17G	Body	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

PISTON TYPE

ONE BODY TYPE (P.D. 65)

P08F	Piston	1	

SEPARATED TYPE (P.D. 80,90)

B5DE	Cap bolt	2[3]	M2[M3]
C03A	Cross head	1	
P08G	Piston	1	
Y12R	O-ring	1	

VALVE TYPE

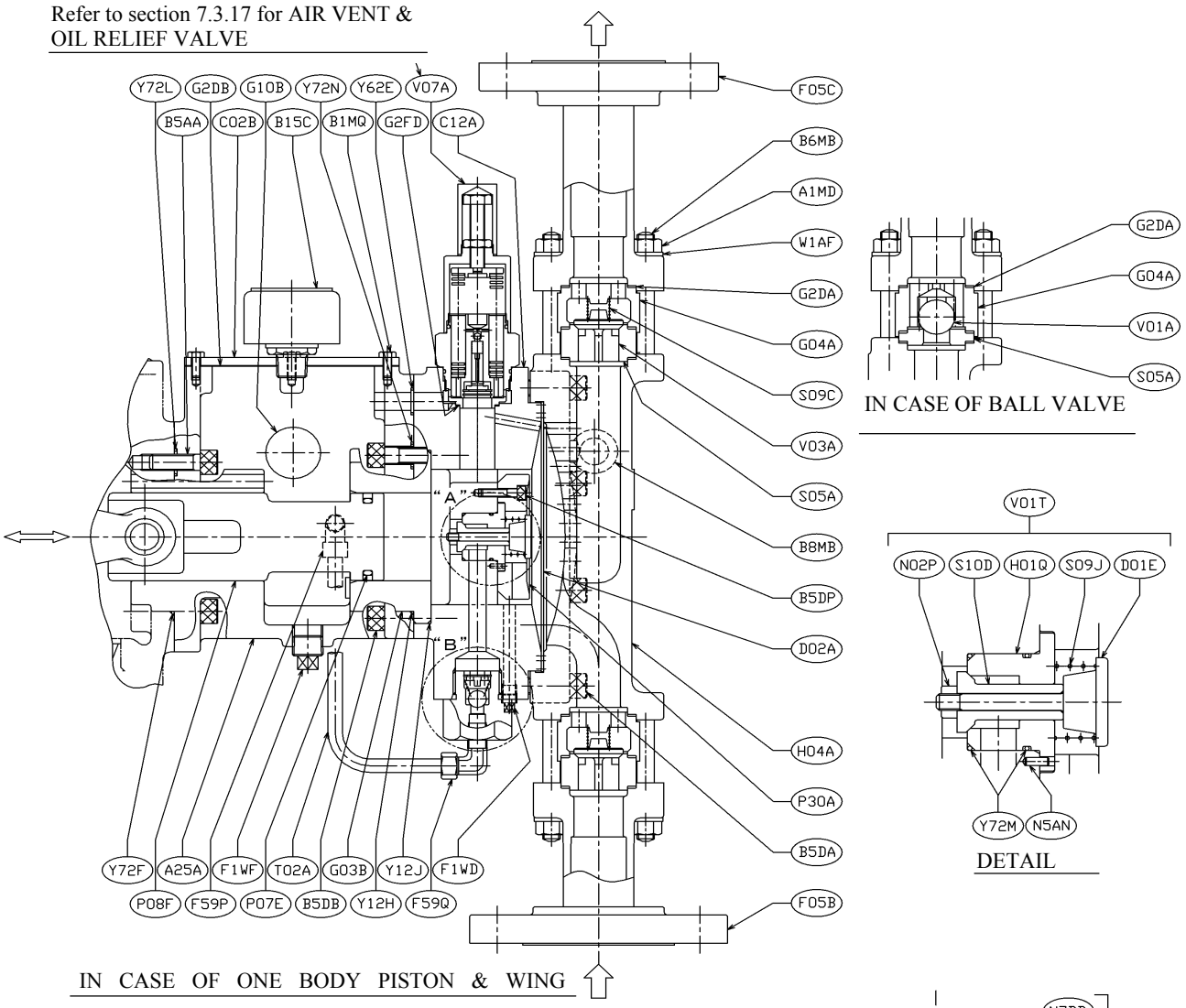
WING VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
S09C	Spring	2	
V03A	Wing valve	2	

BALL VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
V01A	Ball valve	2	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.



HEAD SIZE	MODEL/ TYPE	PISTON		VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
		TYPE	DIA. (mm)			
DV-200	M2L	SEPARATED	80,90	1 STAGE BALL VALVE or WING VALVE	STAINLESS STEEL	SINGLE DIAPHRAGM
	M3L	ONE BODY	65			
		SEPARATED	80			

7.3.12 DV-200 (Diaphragm Type with Failure Detector)

ITEM	PART NAME	Q'TY	REMARKS
A1MD	Nut	8	
A25A	Liquid end adapter	1	
B15C	Breather	1	
B1MQ	Hexagon head bolt	6[8]	M2,[M3]
B5AA	Cap bolt	4	
B5DA	Cap bolt	8	
B5DB	Cap bolt	4	
B5DP	Cap bolt	3	
B6MB	Stud bolt	8	
B8MB	Eye bolt	2	
C02B	Cover	1	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
D02B	Diaphragm	1	
F05B	Flange	1	
F05C	Flange	1	
F1WD	Plug	1	
F1WF	Plug	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N5AL	Spring pin	2	
N5AN	Spring pin	1	
P07E	Packing	1	
P30A	Backup plate	1	
R03K	Ring	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	
W1AF	Washer	8	
Y12H	O-ring	1	
Y12J	O-ring	1	
Y62E	O-ring	1	
Y62J	O-ring	1	
Y72L	O-ring	2	
Y72N	O-ring	2	
Y72F	O-ring	1	
Y72M	O-ring	2	

ITEM	PART NAME	Q'TY	REMARKS
V01T	Position valve	1SET	
D01E	Disk	(1)	
S09J	Spring	(1)	
H01Q	Housing	(1)	
S10D	Stem	(1)	
N02P	U nut	(1)	
V09A	Oil compensating valve	1SET	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
B17G	Body	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

PISTON TYPE

ONE BODY TYPE (P.D. 65)

P08F	Piston	1	

SEPARATED TYPE (P.D. 80,90)

B5DE	Cap bolt	2[3]	M2[M3]
C03A	Cross head	1	
P08G	Piston	1	
Y12R	O-ring	1	

VALVE TYPE

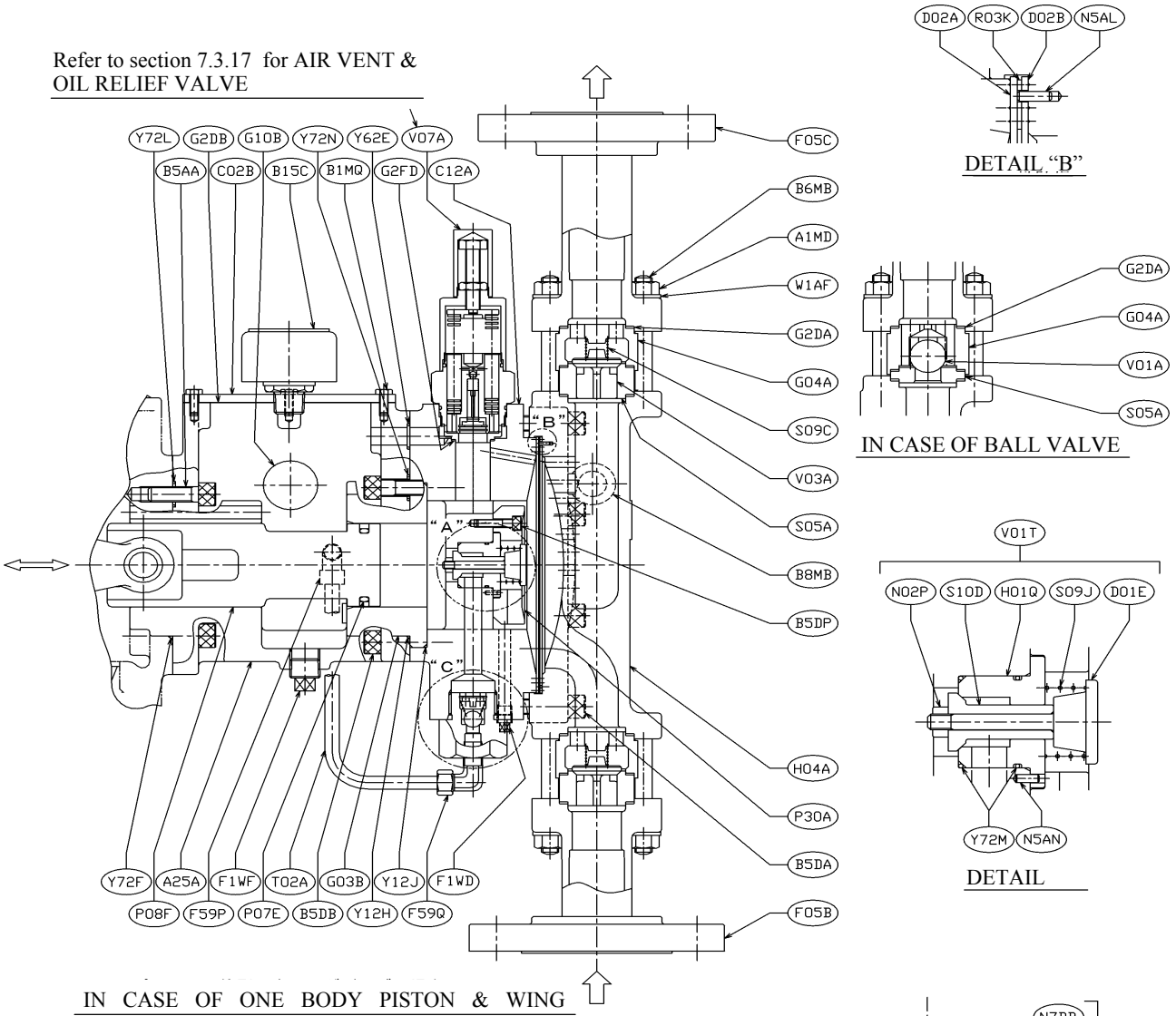
WING VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
S09C	Spring	2	
V03A	Wing valve	2	

BALL VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
V01A	Ball valve	2	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.



HEAD SIZE	MODEL/ TYPE	PISTON		VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
		TYPE	DIA. (mm)			
DV-200	M2L	SEPARATED	80,90	1 STAGE BALL VALVE or WING VALVE	STAINLESS STEEL	PRESSURE TYPE DIAPHRAGM FAILURE DETECTOR
	M3L	ONE BODY	65			
		SEPARATED	80			

7.3.13 DV-400 (Single Diaphragm Type)

ITEM	PART NAME	Q'TY	REMARKS
A1MD	Nut	8	
A25A	Liquid end adapter	1	
B15C	Breather	1	
B1MQ	Hexagon head bolt	8	
B5AA	Cap bolt	4	
B5DA	Cap bolt	10	
B5DB	Cap bolt	4	
B5DE	Cap bolt	3	
B5DP	Cap bolt	3	
B6MB	Stud bolt	8	
B8MB	Eye bolt	2	
C02B	Cover	1	
C03A	Cross head	1	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
F05B	Flange	1	
F05C	Flange	1	
F1WD	Plug	1	
F1WF	Plug	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N5AN	Spring pin	1	
P07E	Packing	1	
P08G	Piston	1	
P30A	Backup plate	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	
W1AF	Washer	8	
Y12H	O-ring	1	
Y12J	O-ring	1	
Y12R	O-ring	1	
Y62E	O-ring	1	
Y62J	O-ring	1	
Y72F	O-ring	1	
Y72L	O-ring	2	
Y72M	O-ring	2	
Y72N	O-ring	2	
V01T	Position valve	1SET	
D01E	Disk	(1)	
H01Q	Housing	(1)	
N02P	U nut	(1)	
S09J	Spring	(1)	
S10D	Stem	(1)	
V09A	Oil compensating valve	1SET	
B17G	Body	(1)	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

VALVE TYPE

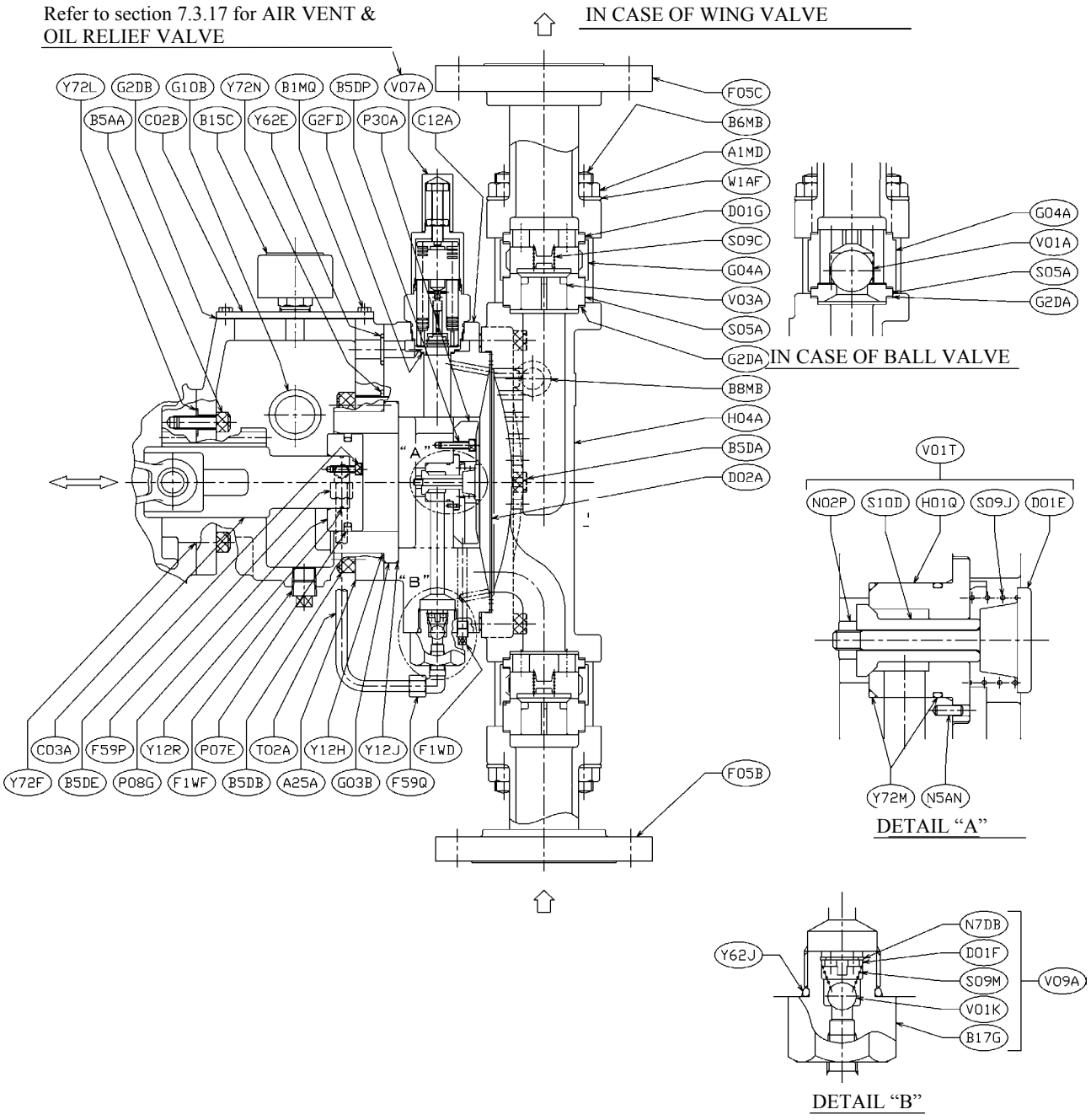
WING VALVE TYPE

D01G	Disk	2	
G04A	Valve guide	2	
G2DA	Gasket	8	
S05A	Valve seat	2	
S09C	Spring	2	
V03A	Wing valve	2	

BALL VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
V01A	Ball valve	2	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.



HEAD SIZE	MODEL/ TYPE	PISTON		VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
		TYPE	DIA. (mm)			
DV-400	M3L	SEPARATED	90,110	1 STAGE BALL VALVE or WING VALVE	STAINLESS STEEL	SINGLE DIAPHRAGM
	M4L		80,90			

7.3.14 DV-400 (Diaphragm Type with Failure Detector)

ITEM	PART NAME	Q'TY	REMARKS
A1MD	Nut	8	
A25A	Liquid end adapter	1	
B15C	Breather	1	
B1MQ	Hexagon head bolt	8	
B5AA	Cap bolt	4	
B5DA	Cap bolt	10	
B5DB	Cap bolt	4	
B5DE	Cap bolt	3	
B5DP	Cap bolt	3	
B6MB	Stud bolt	8	
B8MB	Eye bolt	2	
C02B	Cover	1	
C03A	Cross head	1	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
D02B	Diaphragm	1	
F05B	Flange	1	
F05C	Flange	1	
F1WD	Plug	1	
F1WF	Plug	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N5AL	Spring pin	2	
N5AN	Spring pin	1	
P07E	Packing	1	
P08G	Piston	1	
P30A	Backup plate	1	
R03K	Ring	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	
W1AF	Washer	8	
Y12H	O-ring	1	
Y12J	O-ring	1	
Y12R	O-ring	1	
Y62E	O-ring	1	
Y62J	O-ring	1	

ITEM	PART NAME	Q'TY	REMARKS
Y72F	O-ring	1	
Y72L	O-ring	2	
Y72M	O-ring	2	
Y72N	O-ring	2	
V01T	Position valve	1SET	
D01E	Disk	(1)	
H01Q	Housing	(1)	
N02P	U nut	(1)	
S09J	Spring	(1)	
S10D	Stem	(1)	
V09A	Oil compensating valve	1SET	
B17G	Body	(1)	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

VALVE TYPE

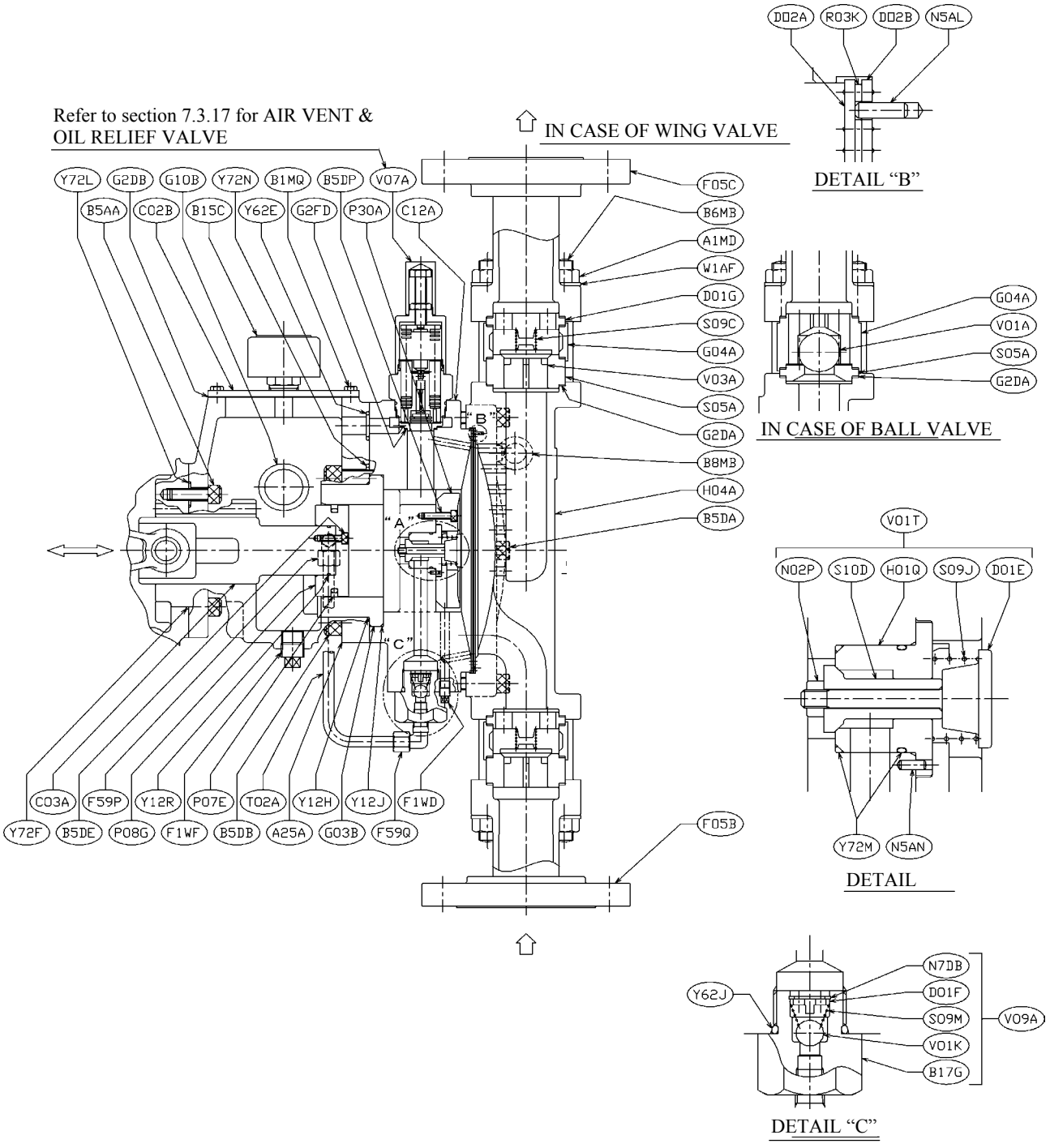
WING VALVE TYPE

D01G	Disk	2	
G04A	Valve guide	2	
G2DA	Gasket	8	
S05A	Valve seat	2	
S09C	Spring	2	
V03A	Wing valve	2	

BALL VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
V01A	Ball valve	2	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.



HEAD SIZE	MODEL/ TYPE	PISTON		VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
		TYPE	DIA. (mm)			
DV-400	M3L	SEPARATED	90,110	1 STAGE BALL VALVE or WING VALVE	STAINLESS STEEL	PRESSURE TYPE DIAPHRAGM FAILURE DETECTOR
	M4L		80,90			

7.3.15 DV-800 (Single Diaphragm Type)

ITEM	PART NAME	Q'TY	REMARKS
A1MD	Nut	8	
A25A	Liquid end adapter	1	
B15C	Breather	1	
B1MQ	Hexagon head bolt	8	
B5AA	Cap bolt	4	
B5DA	Cap bolt	10	
B5DB	Cap bolt	4	
B5DE	Cap bolt	3	
B5DP	Cap bolt	3	
B6MB	Stud bolt	8	
B8MB	Eye bolt	2	
C02B	Cover	1	
C03A	Cross head	1	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
F05B	Flange	1	
F05C	Flange	1	
F1WD	Plug	1	
F1WF	Plug	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N5AN	Spring pin	1	
P07E	Packing	1	
P08G	Piston	1	
P30A	Backup plate	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	
W1AF	Washer	8	
Y12H	O-ring	1	
Y12J	O-ring	1	
Y12R	O-ring	1	
Y62E	O-ring	1	
Y62J	O-ring	1	
Y72F	O-ring	1	
Y72L	O-ring	2	
Y72M	O-ring	2	
Y72N	O-ring	2	
V01T	Position valve	1SET	
D01E	Disk	(1)	
H01Q	Housing	(1)	
N02P	U nut	(1)	
S09J	Spring	(1)	
S10D	Stem	(1)	
V09A	Oil compensating valve	1SET	
B17G	Body	(1)	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

VALVE TYPE

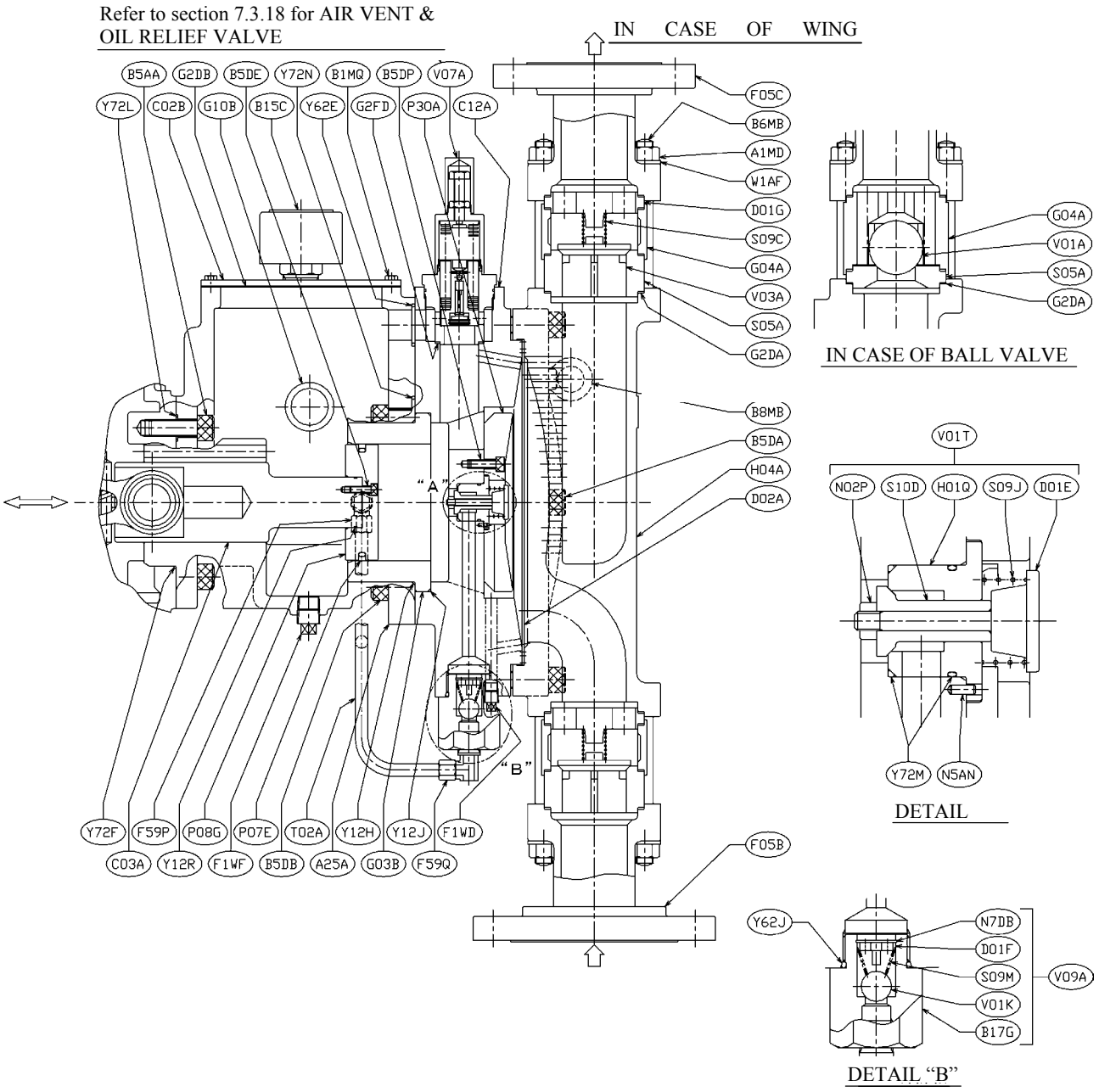
WING VALVE TYPE

D01G	Disk	2	
G04A	Valve guide	2	
G2DA	Gasket	8	
S05A	Valve seat	2	
S09C	Spring	2	
V03A	Wing valve	2	

BALL VALVE TYPE

G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
V01A	Ball valve	2	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.



HEAD SIZE	MODEL/ TYPE	PISTON		VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
		TYPE	DIA. (mm)			
DV-800	M4L	SEPARATED	110,130	1 STAGE BALL VALVE or WING VALVE	STAINLESS STEEL	SINGLE DIAPHRAGM

7.3.16 DV-800 (Diaphragm Type with Failure Detector)

ITEM	PART NAME	Q'TY	REMARKS
A1MD	Nut	8	
A25A	Liquid end adapter	1	
B15C	Breather	1	
B1MQ	Hexagon head bolt	8	
B5AA	Cap bolt	4	
B5DA	Cap bolt	10	
B5DB	Cap bolt	4	
B5DE	Cap bolt	3	
B5DP	Cap bolt	3	
B6MB	Stud bolt	8	
B8MB	Eye bolt	2	
C02B	Cover	1	
C03A	Cross head	1	
C12A	Displacement chamber	1	
D02A	Diaphragm	1	
D02B	Diaphragm	1	
F05B	Flange	1	
F05C	Flange	1	
F1WD	Plug	1	
F1WF	Plug	1	
F59P	Fitting	1	
F59Q	Fitting	1	
G03B	Gland	1	
G10B	Oil gauge (B)	1	
G2DB	Gasket	1	
G2FD	Gasket	1	
H04A	Diaphragm head	1	
N5AL	Spring pin	2	
N5AN	Spring pin	1	
P07E	Packing	1	
P08G	Piston	1	
P30A	Backup plate	1	
R03K	Ring	1	
T02A	Tube	1	
V07A	Air vent & oil relief valve	1SET	
W1AF	Washer	8	
Y12H	O-ring	1	
Y12J	O-ring	1	
Y12R	O-ring	1	
Y62E	O-ring	1	
Y62J	O-ring	1	

ITEM	PART NAME	Q'TY	REMARKS
Y72F	O-ring	1	
Y72L	O-ring	2	
Y72M	O-ring	2	
Y72N	O-ring	2	
V01T	Position valve	1SET	
D01E	Disk	(1)	
H01Q	Housing	(1)	
N02P	U nut	(1)	
S09J	Spring	(1)	
S10D	Stem	(1)	
V09A	Oil compensating valve	1SET	
B17G	Body	(1)	
D01F	Disk	(1)	
N7DB	Retaining ring	(1)	
S09M	Spring	(1)	
V01K	Ball valve	(1)	

VALVE TYPE

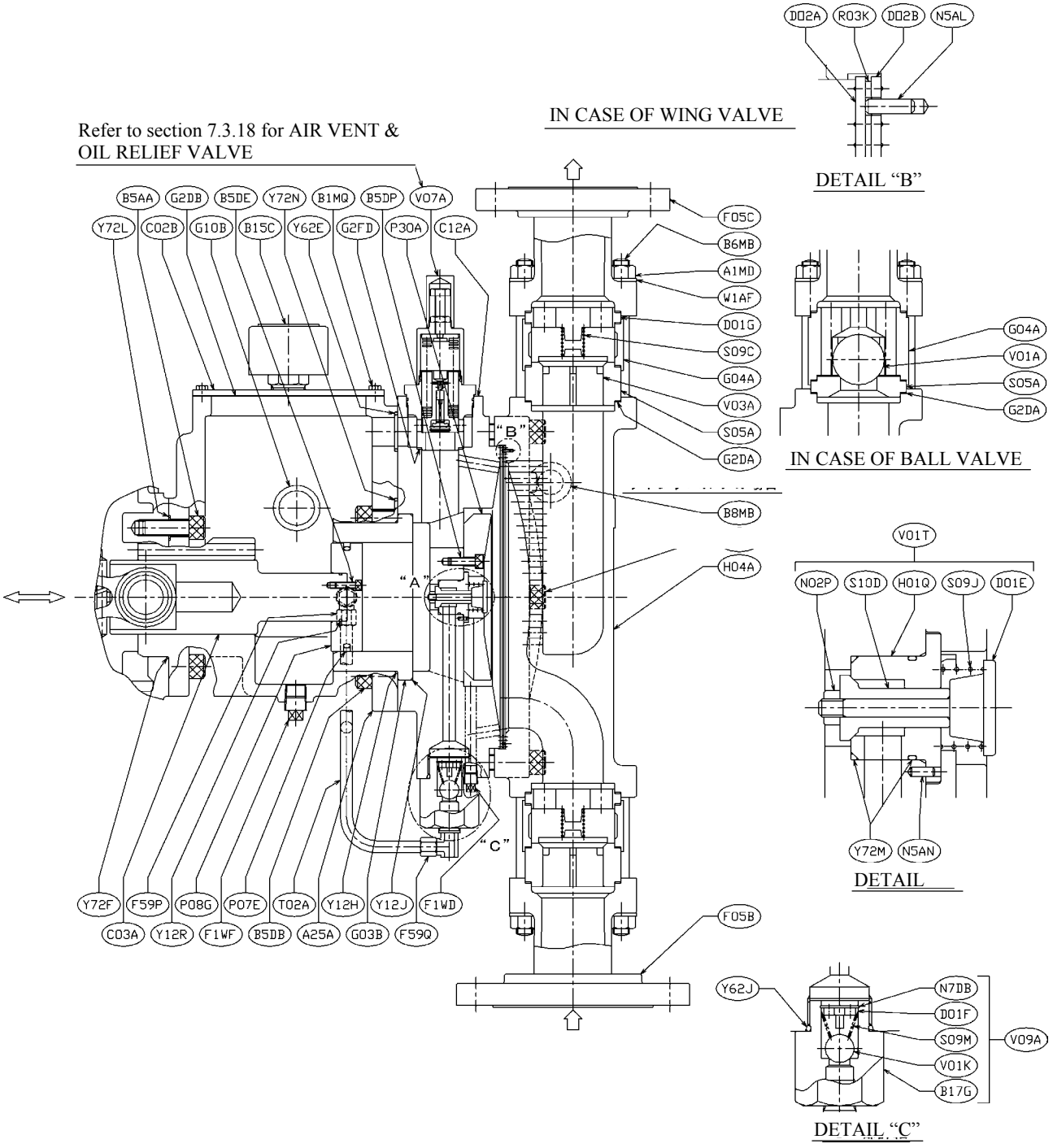
WING VALVE TYPE

D01G	Disk	2	
G04A	Valve guide	2	
G2DA	Gasket	8	
S05A	Valve seat	2	
S09C	Spring	2	
V03A	Wing valve	2	

BALL VALVE TYPE

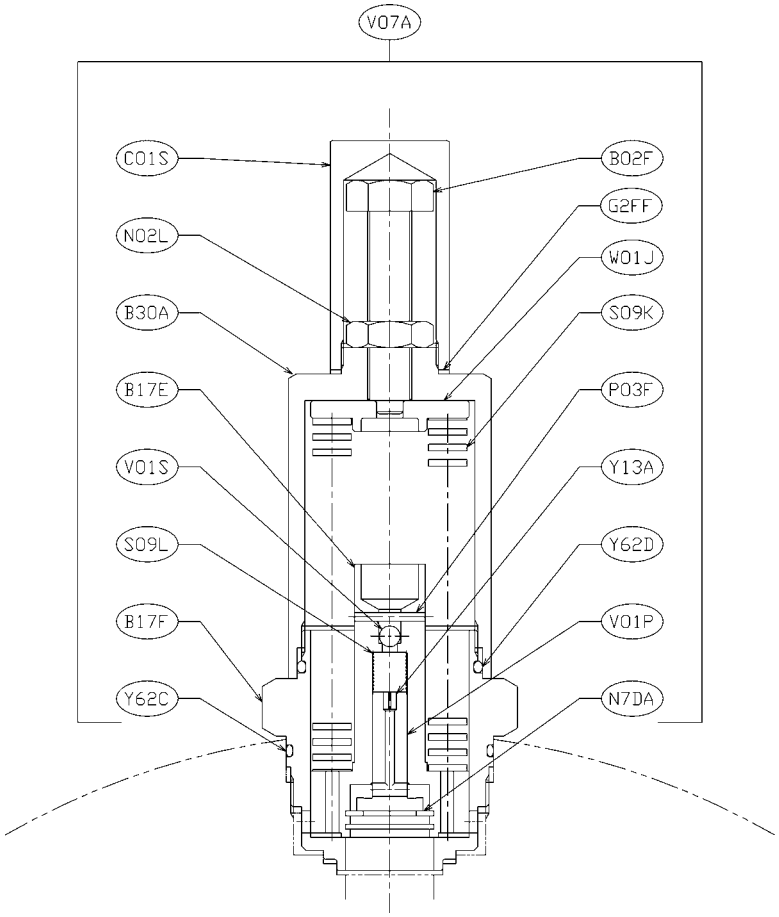
G04A	Valve guide	2	
G2DA	Gasket	6	
S05A	Valve seat	2	
V01A	Ball valve	2	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.



HEAD SIZE	MODEL/ TYPE	PISTON		VALVE TYPE	MATERIAL	DIAPHRAGM TYPE
		TYPE	DIA. (mm)			
DV-800	M4L	SEPARATED	110,130	1 STAGE BALL VALVE or WING VALVE	STAINLESS STEEL	PRESSURE TYPE DIAPHRAGM FAILURE DETECTOR

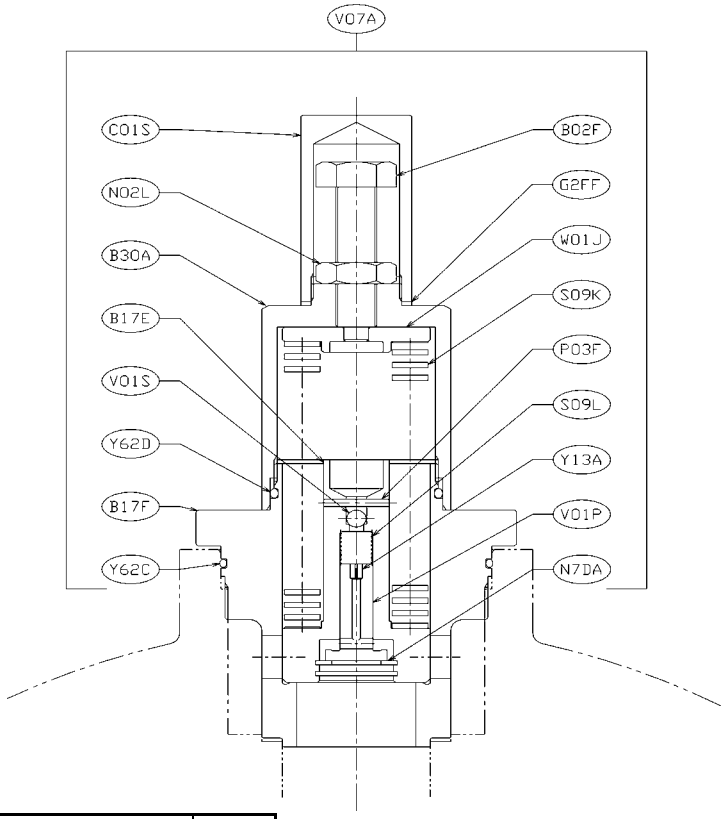
7.3.17 Air Vent & Oil Relief Valve (DV-1.8~400)



ITEM	PART NAME	Q'TY
V07A	Air vent & oil relief valve	1SET
B02F	Bolt	1
B17E	Body	1
B17F	Body	1
B30A	Bonnet	1
C01S	Cap	1
G2FF	Gasket	1
N02L	Lock nut	1
N7DA	Retaining ring	1
P03F	Pin	1
S09K	Spring	1
S09L	Spring	1
V01P	Valve	1
V01S	Ball valve	1
W01J	Washer	1
Y13A	Orifice	1
Y62C	O-ring	1
Y62D	O-ring	1

MODEL/ TYPE	HEADSIZE	PISTON DIA. (mm)
M1L	DV-1.8	7,10 (Plunger dia.)
	DV-6	14,20
	DV-25	30,40
	DV-50	55,65
M2L	DV-25	30
	DV-50	40,55
	DV-100	65
	DV-200	80,90
M3L	DV-50	40
	DV-100	55
	DV-200	65,80
	DV-400	90,110
M4L	DV-400	80,90

7.3.18 Air Vent & Oil Relief Valve (DV-800)



ITEM	PART NAME	Q'TY
V07A	Air vent & oil relief valve	1SET
B02F	Bolt	1
B17E	Body	1
B17F	Body	1
B30A	Bonnet	1
C01S	Cap	1
G2FF	Gasket	1
N02L	Lock nut	1
N7DA	Retaining ring	1
P03F	Pin	1
S09K	Spring	1
S09L	Spring	1
V01P	Valve	1
V01S	Ball valve	1
W01J	Washer	1
Y13A	Orifice	1
Y62C	O-ring	1
Y62D	O-ring	1

MODEL/ TYPE	HEADSIZE	PISTON DIA. (mm)
M4L	DV-800	110,130

8 Pressure Type Diaphragm Failure detector (Optional)

8.1 Outline

8.1.1 Construction

(1) There are two diaphragms in the pump unit, and the ring is inserted between them.

(2) The detecting unit including lubrication plug (P06D) and the drain plug (P06E) for hydraulic oil is attached to the diaphragm head.

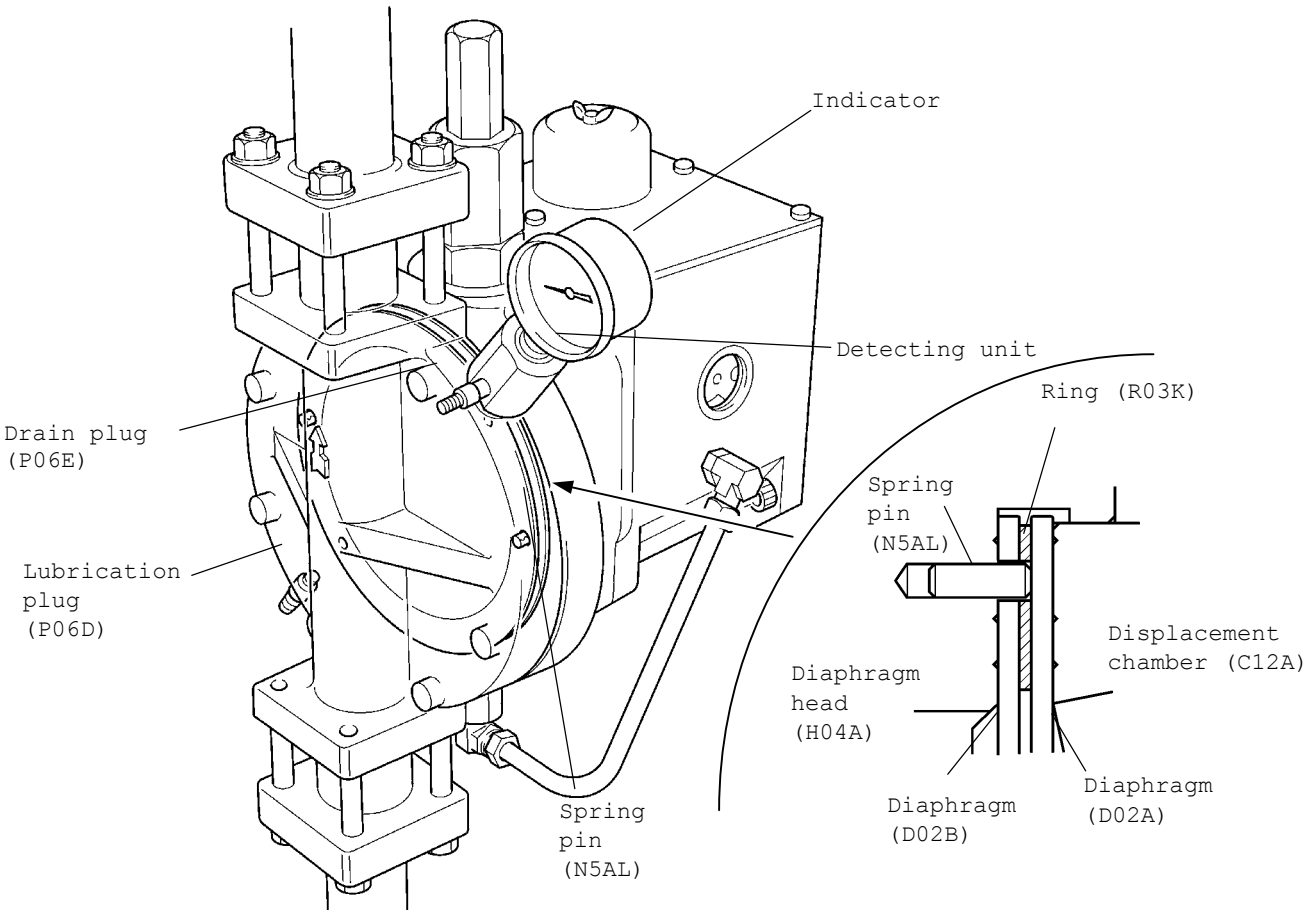


Fig. 8-1 Construction of pressure type diaphragm failure detector

8.1.2 Operation

The gap between two diaphragms is filled with hydraulic oil. Excessive oil is issued from the check valve of the detecting unit by the discharging pressure during the discharge stroke Issued oil is drained from the drain plug (P06E) of the detecting unit. Therefore, the pressure of the detecting unit is equal to atmospheric pressure. Normally, the two diaphragms move together because the check valve is functioning at the detecting unit, however, if one of the diaphragms is broken, the handled liquid or the hydraulic oil penetrates into the detecting unit during the discharge stroke, and the pressure between the diaphragms increases to the discharge pressure. This abnormal pressure is sensed by the detector and the damage to the diaphragm is displayed on the indicator.

8.2 Diaphragm Failure Detection

⚠ WARNING

When loosening the drain plug (P06E), handled liquid spouts from the tip of the plug. If the liquid is poisonous, wear protective clothing and fit the hose on the tip of the plug in order to prevent of liquid leakage. If not, liquid may stain on the operator's skin.

⚠ CAUTION

(1) When detecting damage to the diaphragm, immediately stop the pump and resolve the trouble. Do not restart the pump until the trouble cause is removed.

(2) The standard material of the failure detector is 316SS. If any corrosive liquid against 316SS invades the detector, rinse it carefully and reassemble it. If corrosion is advanced, replace it to prevent malfunction of the detector.

(3) When confirming the damage to the diaphragms, it is recommended to remove the normal piping and connect the test piping. Otherwise, there is a possibility of hydraulic oil mixing with the handled liquid.

8.2.1 Indication

There are three types of the indicator as shown in the table below. The pressure gauge is a standard specification.

Table 8-1 Types and Detecting System of Indicators

Type	Detection system
Pressure gauge (Standard equipment)	The pressure gauge is used as an indicator. It is possible to detect failure visually.
Pressure gauge with electric contact (Optional)	The Pressure gauge with electric contact is used as an indicator. It is possible to detect failure visually and electrically.
Pressure switch (Optional)	The pressure switch is used as an indicator. It detects failure electrically and controls the pump system automatically such as automatic stop. The explosion-proof specification is also optional.

8.2.2 Confirmation

When the failure of the diaphragm is detected, locate the diaphragm malfunction referring to the following table.

(1) Immediately after the pump starts, the diaphragm failure is indicated.

Table 8-2 Confirmation of Diaphragm Malfunction-1

Test	Test result	Assumption of causes	Countermeasures
Open the plug (P06E) for a while. (Drain Issued oil using a hose.)	A small amount of hydraulic oil and gas are discharged but stop immediately.	The pressure temporary rises due to gas expansion inside the detecting unit.	After bleeding pressure inside the detector unit, restart the pump.
	Hydraulic oil issues and it stops in two or three minutes.	Hydraulic oil remains between two diaphragms. The pressure rises due to remaining residual oil.	After bleeding pressure inside the detector unit, restart the pump.
	Oil and/or handled liquid issues and it does not stop.	The pressure rises due to leakage from the diaphragm seal.	Confirm the tightening torque of the Tightening bolt (B5DA). Tighten the bolt. Refer to Section 7.
		The diaphragm is broken.	Disassembly to confirm trouble causes. Refer to Section 7.

(2) The failure of the diaphragm is indicated during pump operation.

Table 8-3 Confirmation of Diaphragm Malfunction-2

Test	Test result	Assumption of causes	Countermeasures
Open the plug (P06E) for a while. (Drain Issued oil using a hose.)	A small amount of hydraulic oil and gas are discharged but stop immediately.	Gas produced from the handled liquid permeates the diaphragm.	Bleed the pressure inside the detector unit, and restart the pump. If this symptom often occurs, contact us.
	Hydraulic oil and/or handled liquid issues and it does not stop.	The diaphragm is broken.	Disassembly to confirm trouble causes. Refer to Section 7.

(1) Confirm the indicator.

(2) Open the drain plug (P06E). Confirm whether hydraulic oil or gas is issued or exhausted from the plug.

(3) Tighten the drain plug (P06E) and restart the pump immediately. After restarting the operation, if the failure indication is displayed soon, it shows the damage to the diaphragms. Stop the operation and replace the diaphragms with a new set. Refer to Section 7.2.2.

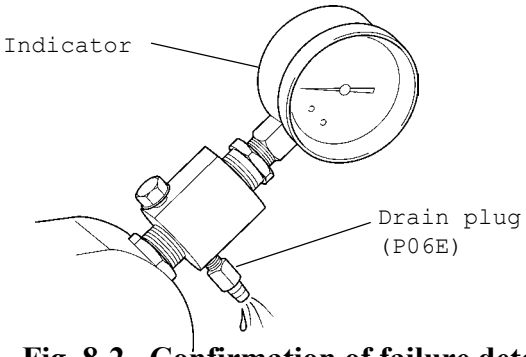


Fig. 8-2 Confirmation of failure detector

8.3 Lubrication for Failure Detector

8.3.1 Lubrication

⚠ CAUTION

(1) The syringe, which is attached with the pump, is only applicable to NKS Oil #1200 or equivalent. Do not use it with other oils.

(2) Do not point the tip of the syringe at people. There is a possibility of the liquid inside the syringe spouting and staining the skin and eye.

(3) If the oil can not be injected smoothly with the syringe, there is a possibility of deviation of the holes of the ring/diaphragm. Confirm the hole positions of the ring and the diaphragm referring to Section 7.2.2. If excessive stress is applied on the syringe, it may be broken.

NOTES:

(1) If the syringe does not move smoothly, move it in and out without liquid. If it still does not move smoothly, use a new one.

(2) When a syringe cannot be used, use an oiler, which has a sufficient performance to the handled liquid.

(1) Loosen the lubricating plug (P06D), then loosen the drain plug (P06E) of the detecting unit.

(2) Fill the syringe with hydraulic oil, position the tip of the syringe to the tapered hole of the lubrication plug (P06D), and inject the hydraulic oil. Inject specified amount of oil. Refer to Table 3-11 of Section 3.

(3) After injection, and tighten the lubricating plug (P06D). After air venting (Refer to Section 8.3.2) and tighten the drain plug (P06E).

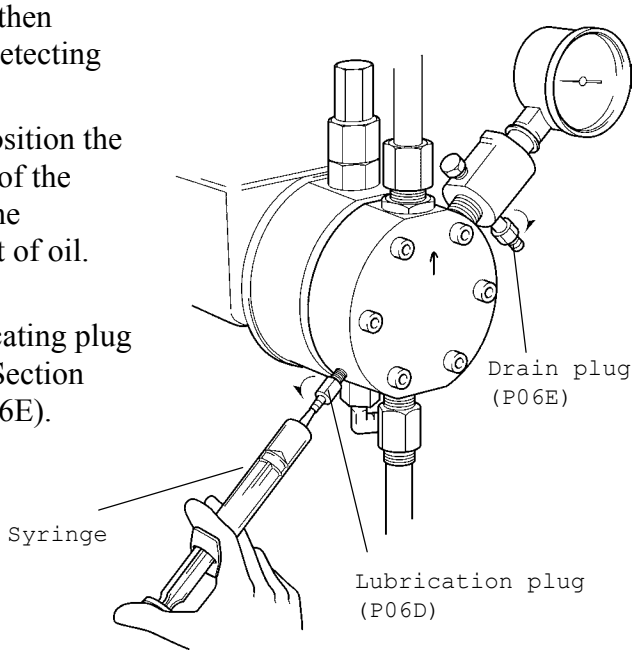


Fig. 8-3 Lubrication of failure detector

8.3.2 Air Venting

⚠ WARNING

When loosening the drain plug (P06E), handled liquid spouts from the tip of the plug. If the liquid is poisonous, wear protective clothing and fit the hose on the tip of the plug in order to prevent of liquid leakage. If not, liquid may stain on the operator's skin.

NOTES:

(1) When attaching the pressure gauge with electric contact or the pressure switch, if the actual operating pressure is lower than the specified pressure, which is noted on the nameplate, change of pressure setting is needed. For the Pressure gauge with electric contact, it is easily changed with the knob. However, for the pressure switch, it is difficult to change the setting pressure. When changing the set pressure, contact us.

(2) When setting the pressure, set the pressure to 50% of the operating pressure. The initial pressure when shipping is 50% of the pressure which is noted on the nameplate. If immediate stopping of the pump as soon trouble occurs is required, a lower setting pressure is recommended.

(3) Lubricate the power end and liquid end before air venting of inside the diaphragm failure detector.

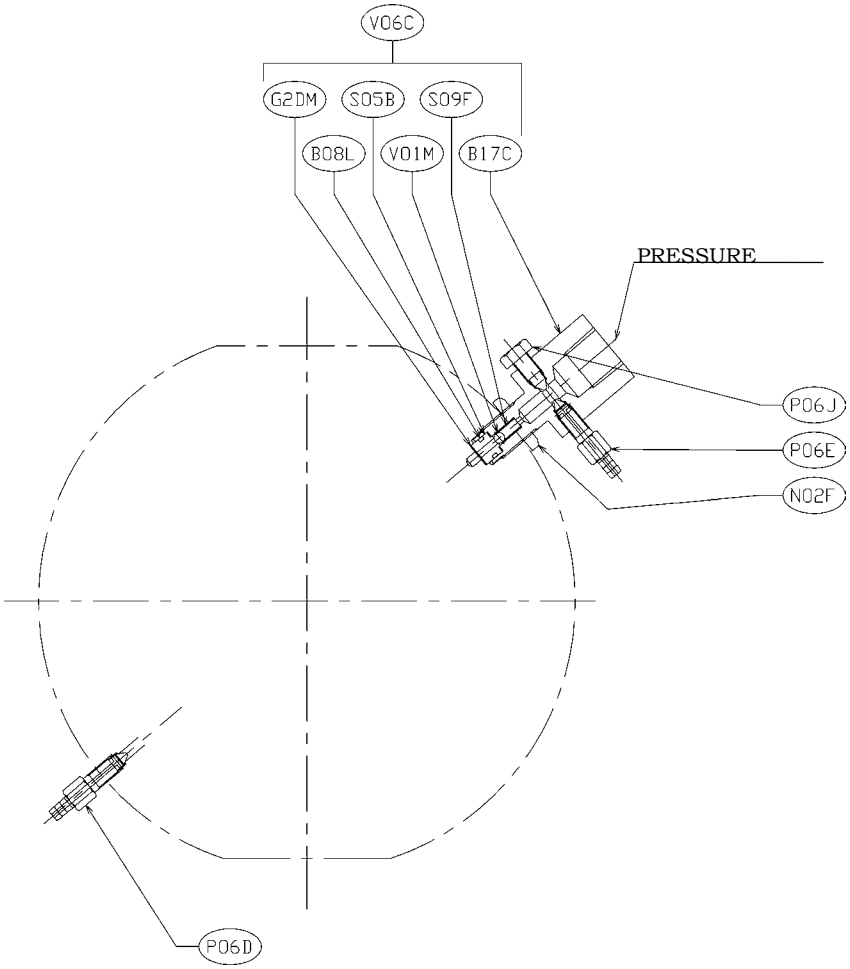
(1) Operate the pump applying pressure of about 0.1-0.2 MPa (stroke length: 10%, 2-3 minutes) with the drain plug (P06E) loosened.

(2) Tighten the drain plug (P06E), and start the pump in accordance with Section 2 "Starting."

(3) After running for one hour operation at rated specification, check the indicator of the diaphragm failure detector.

- If pressure is raised:
  Attach a hose onto the drain plug (P06E) to prevent an oil spill.
  Loosen the drain plug (P06E), then drain excessive hydraulic oil, which has overflowed due to diaphragm contacting-printing, under rated operation. After draining, tighten the drain plug (P06E) again.
- If pressure is not raised: It is possible to operate the pump without problems.

8.4 Parts Lists and Cross Section of Diaphragm Failure Detector



ITEM	PART NAME	Q'TY	REMARKS
N02F	Nut	1	
P06D	Plug	1	
P06E	Plug	1	
P06J	Plug	1	
V06C	Valve assembly	1SET	
B08L	O-ring	(1)	
B17C	Body	(1)	
G2DM	Gasket	(2)	
S05G	Valve seat	(1)	
S09F	Spring	(1)	
V01M	Ball valve	(1)	

NOTE:
1. ( ) Parenthesize Q'TY are required for one (1) set.

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Instruction Manual

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