Flow Cell Flowmeter

Instruction Manual

FLT, FLY and FLG Series

CAUTION

- **Be sure to read this operation manual and "Cautions for Operation" and follow the instructions.**
- A glass tapered tube is used for this flowmeter. If the glass tapered tube is hit with a tool and such, it may be damaged.
- Be sure to observe the specified maximum operation temperature and pressure.
- If the valve is suddenly opened and closed by a magnetic valve and such, the impact by the float may damage the tapered tube leading to a dangerous situation.
- Freezing may damage the flowmeter. Extract water from the flowmeter.
- Strong alkaline fluid such as NaOH and KOH and fluid containing fluorinated acid cannot be used.

NIPPON FLOW CELL CO., LTD.

1. Introduction

Thank you for purchasing the Flow Cell Flowmeter. Be sure to read this instruction manual and "Handling Precautions Manual" before use and follow the instructions to correctly and safely use this product.

2. Overview

2-1 Overview

The FL series flow cell flowmeter has been developed combining the features of differential pressure (orifice) and area flowmeters. This compact flowmeter integrates the base socket into which the orifice plate is embedded and the flow rate indicator of area flowmeter. The easy-to-handle flowmeter of simple structure can be freely mounted on the piping both vertically and horizontally.

2-2 Measuring principle and composition

The pressure differs according to the flow velocity between the upstream and downstream sides of the orifice plate. By measuring the bypass flow rate obtained from this pressure difference, total flow rate can be found. Based on this principle, the flow cell flowmeter consists of the base socket and the flow-rate indicator.

Differential pressure is generated by the orifice plate installed within the base socket, and split flow generated by the differential pressure is introduced to the flow-rate indicator. The fluid that has passed through the strainer flows into the tapered tube and lift the float.

The scale displaying the total flow within the main pipe according to the change of the float position is indicated on the outer surface of the tapered tube.

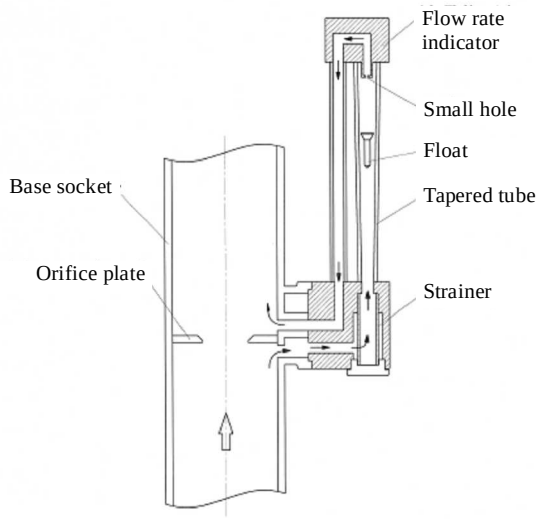


Fig. 1 Measuring principle

2-3 Specifications

Table 1

Item \ Model	FLT	FLY	FLG
Measurement fluid	Liquids (water, etc.) and gas (air, etc.)		
Accuracy	Water: ±2.0%FS Other fluids: ±2.5%FS		
Connection and nominal diameter	Screw connection Rc3/8 to Rc4	Wafer connection JIS 10K flange 40 to 500 A	Flange connection JIS 10K flange 15 to 500 A
Maximum operating pressure The special specification is indicated in the parentheses.	0.8 MPa (2.0 MPa)	0.8 MPa (1.4 MPa)	
Operating temperature range *1	Material No. 5: 0ºC to 90ºC (0ºC to 120ºC in the case of fluoro-rubber O-ring) Materials Nos. 6 and 7: 0ºC to 90ºC (0ºC to 120ºC in the case of fluororesin or fluoro-rubber O-ring) Note: 0ºC to 50ºC if the float is made of PVC		

Item \ Model	FLT	FLY	FLG
Standard accessories	Washing brush	Flange connection bolts, nuts, washers, gaskets and washing brush	Washing brush

*1 The fluid shall not be frozen.
*2 Materials of bolts, nuts and washers
Body material No. 5: SS400
Body material Nos. 6 and 7: SUS304

Note: The following materials are used for the respective material numbers in the flow cell flowmeters.
No. 5: FCD, SS and brass are used for the wetted parts.
No. 6: SUS304 or corrosion-resistant material equivalent to SCS13 or higher is used for the wetted parts.
No. 7: SUS316 or corrosion-resistant material equivalent to SCS14 is used for the wetted parts.

2-4 Model

FL□		—	□	□	□	□	□	□	□	
Connection method	T									Screw connection (Female screw for JIS pipes)
	Y									Wafer connection (Insertion for JIS 10K flange)
	G									Flange connection (JIS 10K FF)
Option		H								With H-type cock piece
			C							With connector
				D						With D piece (when thermal insulation material is used for the piping)
					F					With flange for FLY type (JIS 10K FF, 2 pieces of flange/set)
						P				Float material PVC (weighted) *Only for liquid (Note 1)
							S			O-ring materials other than NBR S: Fluoro rubber or EPDM U: Fluororesin
								U		
									AB	Photoelectric switch (for liquid and gas)
									AM	Magnetic switch 1-output alarm (for liquid) (Note 2)
									AMM	Magnetic switch 2-output alarm (for liquid) (Note 2)

Note 1: Standard float materials: SUS316, titanium, glass and ruby (Material cannot be specified by customer.)
Note 2: In the case of the magnetic switch, the float material is PVC and the float material code “P” is used for the model.
Note 3: If the “U: Fluororesin” is selected for the O-ring material, the used material becomes Nos. 6 or 7.

2-5 Parts composition

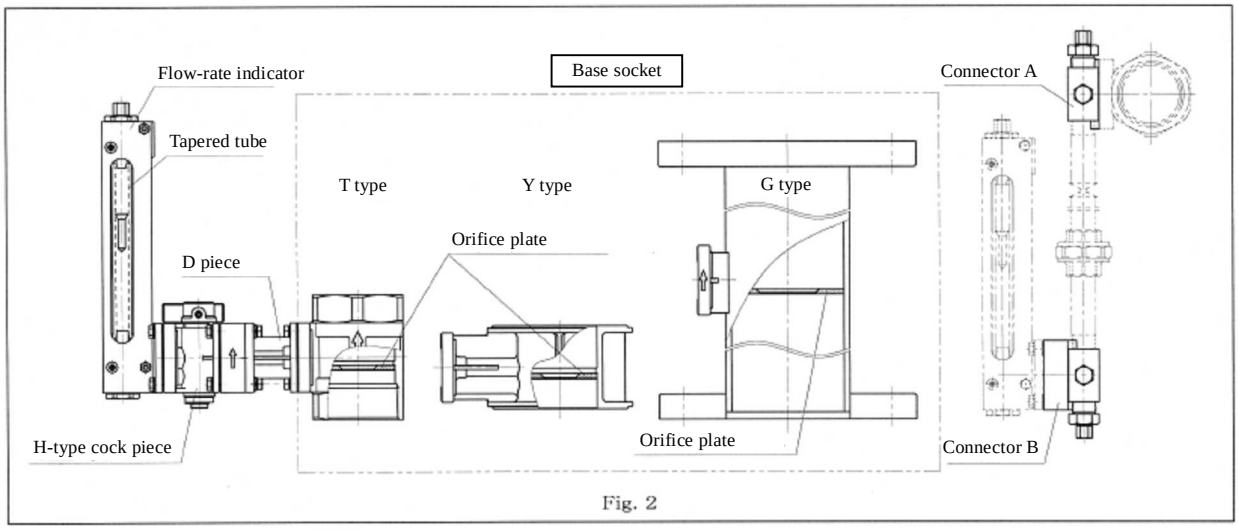


Fig. 2

2-6 Standard used materials

Table 3

Part name	Model	Nominal diameter	No. 5	No. 6	No. 7
Base socket	FLT	10 to 20 A	—	SCS14	
		25 to 100 A	FCD450		
	FLY	40 to 300 A	FCD450	—	
		350 to 500 A	SS400		
		40 to 200 A	—	SCS14	
		250 to 500 A		SUS304	SUS316
	FLG	15 to 50 A	SS400, SCS14	SUS304, SCS14	—
		65 to 500 A	SS400	SUS304	
Flow-rate indicator	All models / Nominal diameters		C3604, SCS14	SUS304, SCS14, SUS316	SUS316, SCS14
Tapered tube			Heat-resistant glass		
O-ring			NBR		
Orifice plate			SUS304		SUS316
H-type cock piece			C3604, SCS14, NBR, fluoro rubber	SUS316, SCS14, NBR, fluoro rubber	
D piece			SUS316, SCS14		
Connectors A and B					

3. Mounting

3-1 Mounting environment

(1) Secure sufficient space around the flow cell flowmeter for cleaning and replacing the parts such as the strainer and tapered tube.
(2) If the flowmeter is mounted on piping subjected to high vibration, its performance and durability may be affected. Avoid mounting the flowmeter on such piping or firmly fix the piping so that vibration is not conveyed to the flowmeter.
(3) When liquid flow rate is measured by the flow cell flowmeter, an error may result if air bubbles are contained in the liquid. Therefore, install an air removal device upstream of the flowmeter to precisely measure flow rate.

3-2 Use of H-type cock piece

Set the cock piece handle to the SHUT (S) position, and then the following operations can be performed even if fluid is flowing in the main pipe.

- Flashing inside the piping
- Cleaning of the flow-rate indicator unit
- Replacement f parts such as the tapered tube
- Prevention of damage due to freezing

To prevent damage due to freezing, set the cock piece handle to the SHUT (S) position and completely drain the liquid from the flow-rate indicator. Remove the strainer cap on the flow-rate indicator bottom and loosen the air vent plug on the top to drain the liquid.

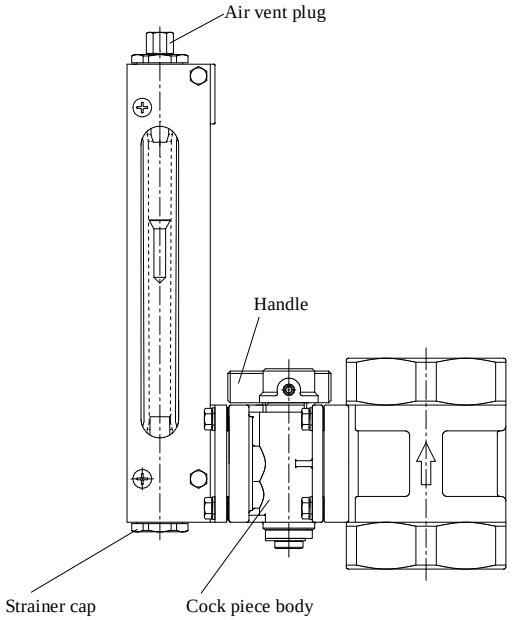


Fig. 3 FLT-H model
(with H-type cock piece)

(1) Parts for mounting: 4 pieces of mounting bolts (supplied with the flowmeter)
(2) Tool used: spanner (8 opposite sides)
(3) Mounting method
Firmly fasten the attached cock piece on the base socket with the attached mounting bolts. The cock piece can be mounted vertically or horizontally.
(4) Maximum operating pressure/temperature
Standard 0.8 MPa 90ºC
(In the case of the fluororesin or fluoro rubber O-ring, the maximum operating temperature is 120ºC.)

3-3 Use of connector (optional)

If the flow cell flowmeter cannot be installed in the place readily visible due to the piping, the flow-rate indicator can be extended using the connector to install it in the readily visible place.

(1) Parts necessary for mounting the connector

Table 4

Connectors A and B	Connection Rc3/8 1 piece each
Attached mounting bolts	For mounting connector A 4 pieces/set
Union	Connection Rc3/8 2 pieces
Bypass valve	Nominal diameter 10A Connection R3/8

Sealing materials	Sealing tape, etc.

*1: Customer is requested to prepare the union, bypass pipe and sealing materials.

*2: The bypass-pipe installation status may affect the accuracy. Therefore, the pipe length for connector connection must be 5m or less.

*3: It is recommended to install valves upstream and downstream of the cock piece or the bypass valve, respectively, for maintenance work of the flow-rate indicator.

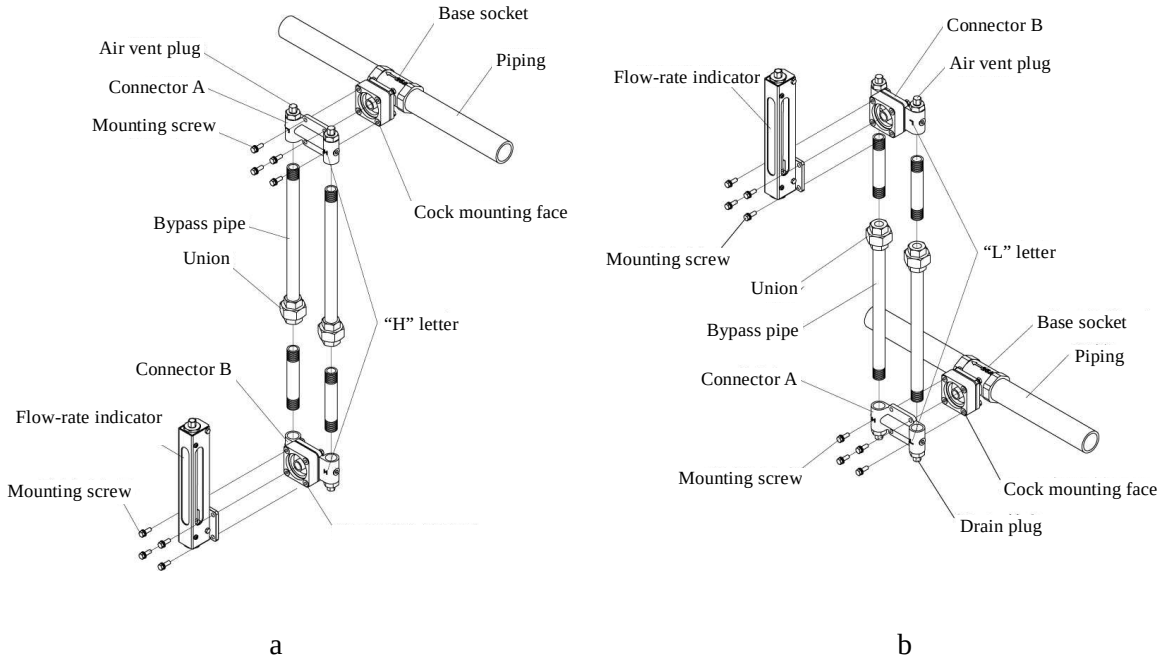
(2) Tools

- Pipe wrench for piping
- Phillips screwdriver
- Spanner (opposite sides: 8 and 10)

(3) Mounting method

[1] Basically the connectors can be mounted in the two methods as shown in Fig. 4 a and b.

[2] Connect the connectors A and B using the bypass pipes as shown in Fig. 4. Be sure to connect the “H” side of the connector A to the “H” side of the connector B, and the “L” side of the connector A to the “L” side of the connector B.



a b

Fig. 4

Note 1: If the bypass pipe is too long and the flowmeter becomes instable due to vibraton, support the area near the flowmeter.

Note 2: Even if an elbow or gate valve is set in the bypass pipe, the accuracy is affected only slightly. However set it in the position where an operator can easily remove air within the piping.

Note 3: When measurement is taken with the flowmeter mounted, sufficiently remove air using the air vent plugs of the connectors A and B. Do not remove the air vent plugs but loosen them. If air is not sufficiently removed, measurement may not be correctly taken. If gas is to be measured, drain liquid before using the flowmeter.

3-4 Straight pipe before and after the flow cell flowmeter

The flow cell flow meter is the restriction flowmeter utilizing the orifice plate. Therefore, it is necessary to install the straight pipes, the diameter of which is same as that of the flow cell flowmeter, upstream and downstream of the orifice plate. Install the straight pipe, the length of which from the orifice plate must be at least the pipe diameter multiplied by the magnification ratio shown in Table 5.

Table 5

	Elbow, cheese or shrinkage pipe	Valve or expanding pipe
Upstream side	6	8
Downstream side	3	3

3-5 Cautions for mounting

(1) Before mounting the flowmeter, be sure to ensure that the serial number of the base socket is the same as that of the flow-rate indicator. Also ensure that the flow cell flowmeter specifications (used fluid, scale range, temperature, pressure, etc.) match the actual use conditions.

(2) When mounting the flowmeter of flange (FLG type) or wafer (FLY type) connection, be careful so that the gasket does not protrude into the piping interior.

Note: If the gasket is protruded into the piping interior, the measurement accuracy is adversely affected. If a commercially available gasket is used, its core part may protrude into the pipe interior. Be sure to cut the protruded part before use.

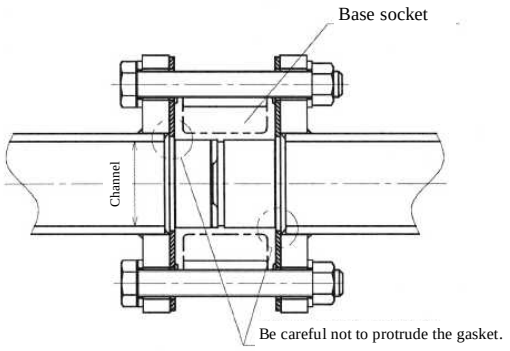


Fig. 5 FLY-type example

(3) Mount the base socket while aligning its arrow mark with the flow direction. The flow cell flowmeter can be mounted on the piping in the direction of the bottom to top, top to bottom, right to left, and left to right as shown in Fig. 6 and 7. Note, however, that the accuracy is affected if the pipe is not filled fully with water.

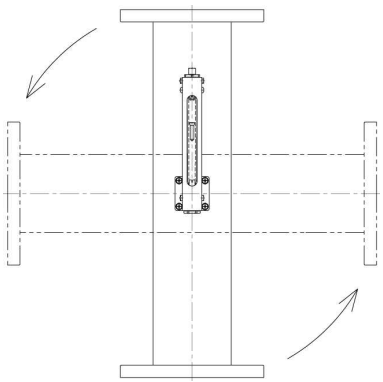


Fig. 6

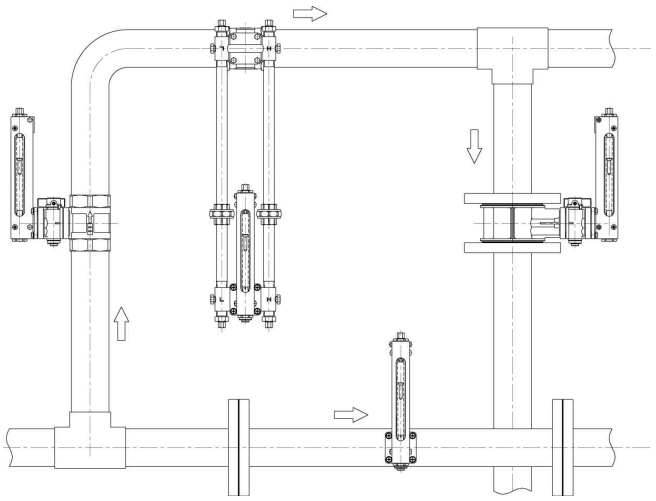


Fig. 7 Example of piping

(4) The orifice dimensions and inner diameter of the base socket are designed based on the SGP pipe. Use the pipe that has the same inner diameter as the SGP pipe. For 80A more of the FLG type (material No. 6), use the piping equivalent to Sch20S of stainless steel piping pipe.

Note: Never use PVC or lining pipe because it adversely affects the accuracy.

(5) Chamfer the pipe cut ends and remove the burrs. Be careful not to apply too much force to the pipe when cutting it so that its inner diameter is not narrowed even slightly (See Fig. 8).

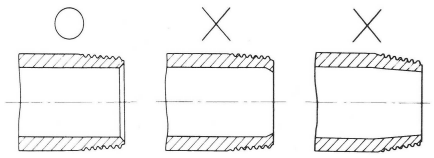


Fig. 8

4. Operation

4-1 Operation procedures

(1) Flush the piping to remove the scales, etc. within the piping (If the cock piece is provided, fully close it).

(2) If the cock piece is provided, slowly turn it in the OPEN direction (in the direction where the handle becomes parallel to the cock piece body) until it cannot be turned any further to fully open it.

Note: Be sure to fully open the cock piece when measuring the flow rate.

(3) In the case of liquid, after starting feeding it, gradually open the air vent plug on the top of the flow-rate indicator to remove the inside air. Be careful because the air vent plug may drop and the liquid may be spewed out if the air vent plug is opened at once.

If the connector is provided, also open its air vent plug and completely remove the air within the bypass pipe. If an elbow or valve is installed in the pipe, carefully remove the air.

4-2 Cautions for operation

(1) In the case that the flowmeter is used for gas, hunting of the float may occur if the valve is opened or closed suddenly, causing damage to the parts such as the tapered tube, float and stopper and adversely affecting the performance.
(2) If operation is stopped in the place subjected to freezing, completely drain the liquid within the flow-rate indicator to prevent damage to the tapered tube, etc. due to freezing of the liquid (See Section 3-2 “Use of H-type Cock Piece”).
(3) Be careful because the tapered tube may be broken if sudden temperature change is applied to it.

4-3 How to read flow rate

The correct flow-rate reading position of the float is shown in Fig. 9. To prevent reading error, keep your line of sight horizontal when reading the scale.

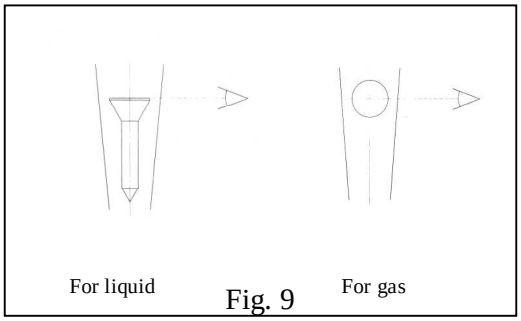


Fig. 9

5. Correction of flow rate

- Conversion method for liquids having different densities

$$Q_1 = Q_0\sqrt{\frac{\rho_0(\rho_f - \rho_1)}{\rho_1(\rho_f - \rho_0)}}$$

Q_1: actual flow rate (m^3/h, etc.)
Q_0: reading of the flowmeter (m^3/h, etc.)
ρ_1: density of used liquid (g/cm^3)
ρ_0: density of liquid listed on the flowmeter (g/cm^3)
ρ_f: density of float (g/cm^3)

- Conversion method for gas

$$Q_1 = Q_0\sqrt{\frac{\rho_0}{\rho_1}}\sqrt{\frac{(101.3 + p_1)(273.2 + t_0)}{(101.3 + p_0)(273.2 + t_1)}}$$

Q_1: actual flow rate [m^3/h (ntp), etc.]
Q_0: reading of the flowmeter [m^3/h (ntp), etc.]
ρ_1: density [kg/m^3 (ntp)] of used gas (0ºC, 1 atm)
ρ_0: density [kg/m^3 (ntp)] of gas listed on the flowmeter (0ºC, 1 atm)
P_1: used pressure (kPa)
P_0: pressure listed on the flowmeter (kPa)
t_1: used temperature (ºC)
t_0: temperature listed on the flowmeter (ºC)

6. Maintenance

6-1 Inspection items for maintenance

The inspection items are as follows:

(1) Contamination of the tapered tube
(2) Clogging of the small hole in the upper stopper
(3) Clogging of the strainer
(4) Corrosion of the wetted surface
(5) Corrosion and deformation of the float
(6) Leakage from the sealing of the joints between the parts
(7) Change of use conditions such as fluid density, viscosity, temperature and pressure
(8) Corrosion or wear of the orifice plate

Note: Especially if the small hole in the upper stopper (2) or the strainer (3) is clogged, an indication error may result. Check them occasionally.

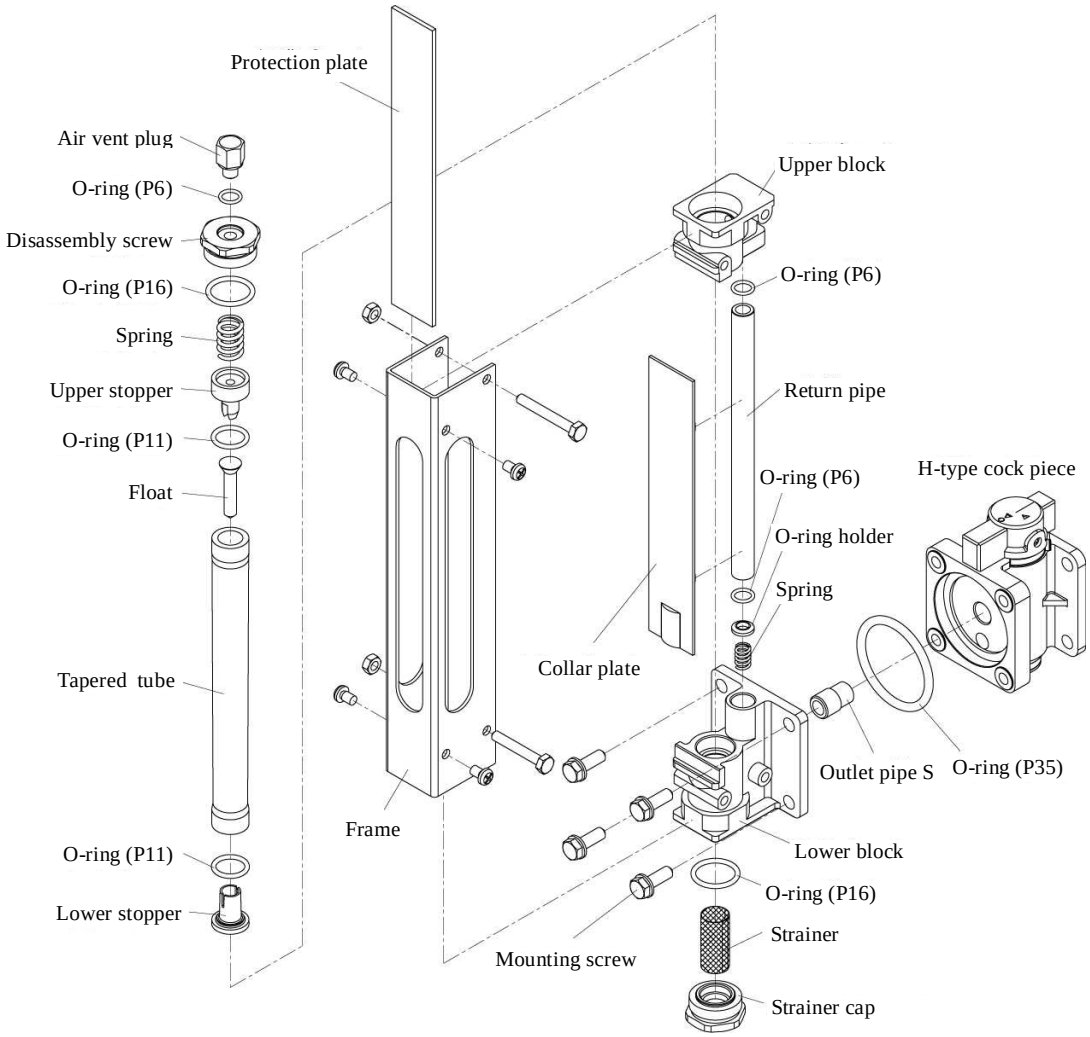


Fig. 10

6-2 Disassembly and washing

(1) Washing of the strainer

Remove the strainer cap in the lower block, and then the strainer can be removed. After washing the strainer with water or neutral detergent, set it on the strainer cap and screw it into the lower block. When reassembling the strainer, be sufficiently careful not to damage the O-ring. Slightly wet the O-ring with water, and then the strainer can be smoothly reassembled (See Fig. 11).

(2) Washing the tapered tube and the small hole of the upper stopper

Since accuracy is adversely affected if the area around the small hole of the upper stopper is deformed, carefully wash the parts. Disassemble the parts in the following order (See Fig. 11).

Standard type (See Fig. 11.)

(1) Disassembly screw
(2) Upper stopper spring
(3) Upper stopper
(4) Float
(5) O-ring (P11)
(6) Tapered tube
(7) O-ring (P11)
(8) Lower stopper

Note: If the O-ring (P11) (5) is adhered to the part and cannot be removed, slightly wet it with water and then it may be removed easily.

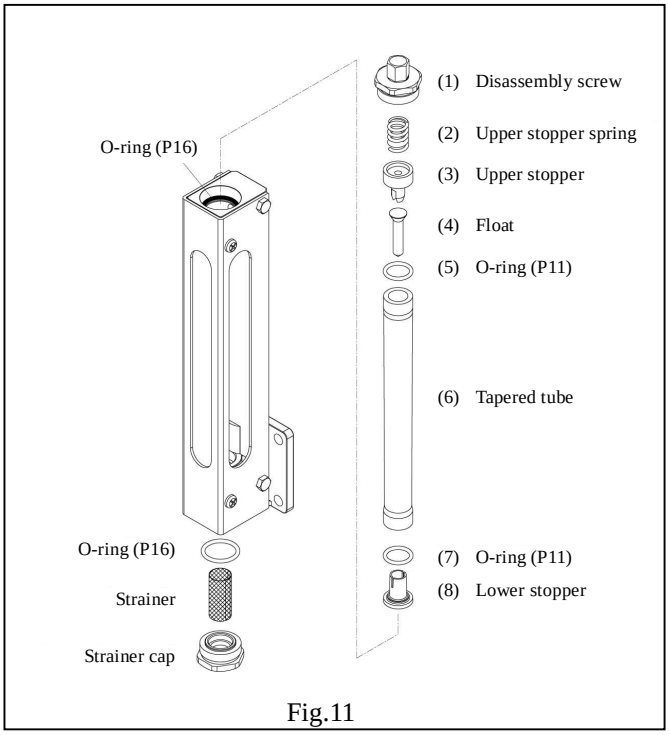


Fig.11

When the O-ring of fluororesin is used (See Fig. 12.)

(1) Clamping bolt
(2) Disassembly screw
(3) O-ring (P8)
(4) Stopper holder
(5) Upper stopper
(6) Float
(7) O-ring (P11)
(8) Tapered tube
(9) O-ring (P11)
(10) Lower stopper

(2)→(4)→(3) when assembling the parts

Note 1: If the liquid leaks from the top or bottom of the tapered tube, gradually tighten the clamping bolt (1). Ensure that the disassembly bolt (2) is firmly tightened before tightening the clamping bolt (1).

Note 2: If the tapered tube (8) was removed, sufficiently tighten the disassembly screw (2), and then gradually tighten the clamping bolt (1) until liquid leakage is stopped.
For removing the air within the indicator, loosen the clamping bolt (1).

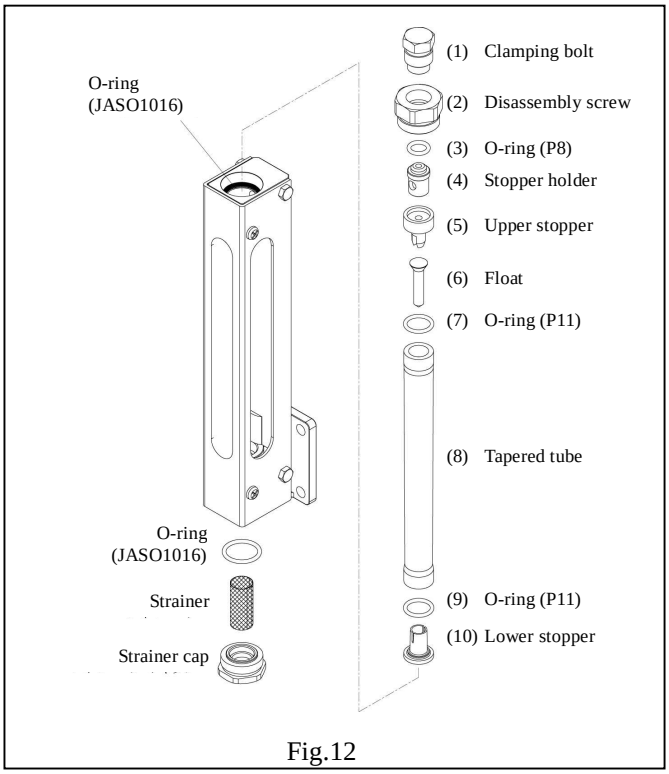


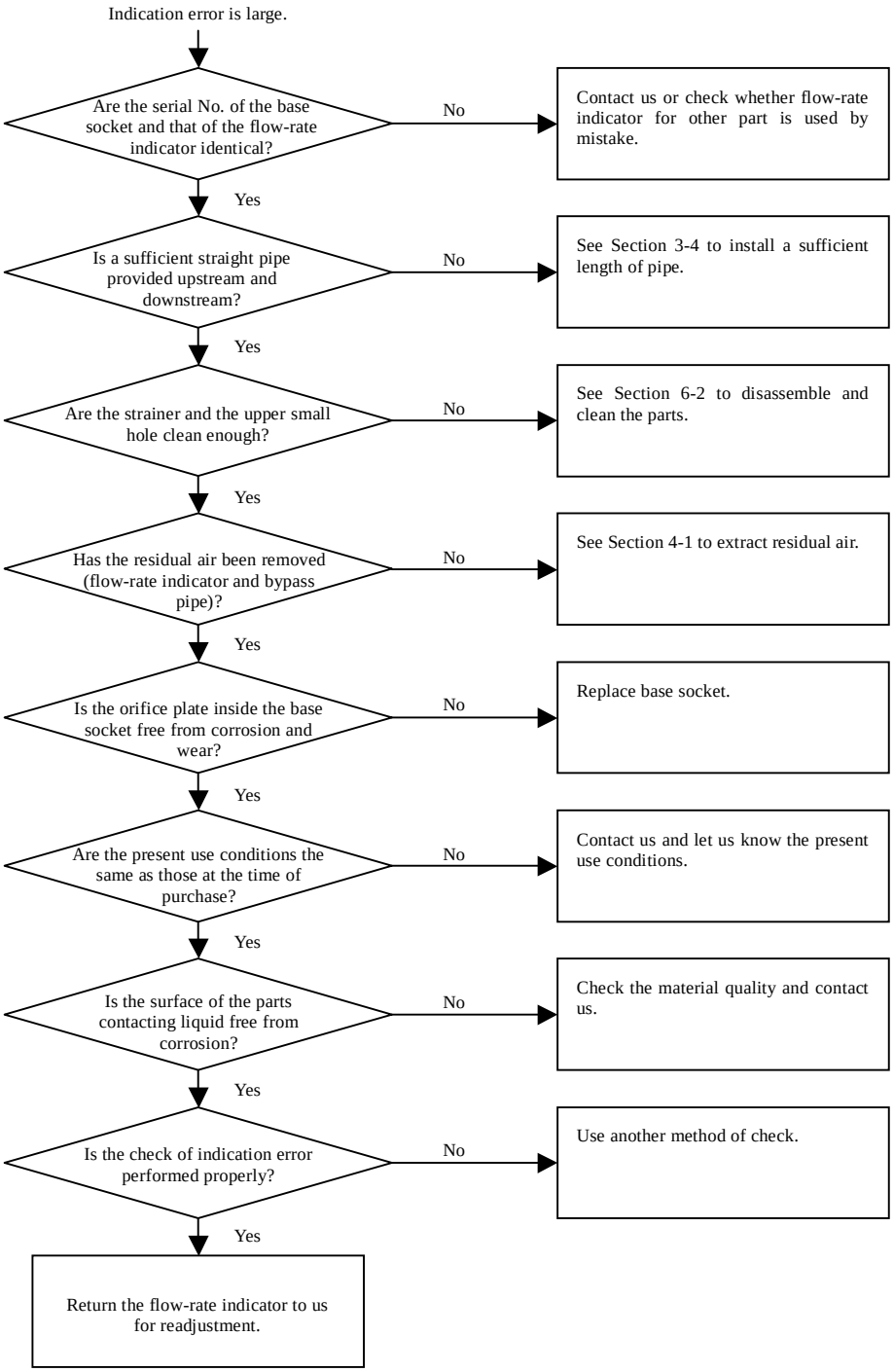
Fig.12

6-3 Troubleshooting

(1) When the tapered tube or the float needs to be replaced

In the flow cell flowmeter, the instrumental error is determined based on the combination of the tapered tube, float and upper stopper (with a small hole). It is therefore necessary to replace the entire set of the three parts even if only one of them needs to be replaced.

(2) Countermeasures for an error of the flow-rate indicator



(3) Request when you contact us

If you contact us for repair and inquiry, let us know the **serial No.** displayed on the product as well as the **name of used fluid** and **scale range** displayed on the tapered tube.

【MEMO】

FLOW CELL

NIPPON FLOW CELL CO., LTD.

Head Office
Shinbashi 2-chome MT Bldg.,
2-5-5, Shinbashi, Minato-ku, Tokyo 105-0004, Japan
TEL : 03-3500-2171
FAX : 03-3500-1071

Branch Office :
Sendai
Saitama
Yokohama
Nagoya
Osaka
Okayama
Hiroshima
Fukuoka

Plant :
Itabashi
kawaguchi
Maebashi