

# **IWAKI**

## **Pneumatic Drive Bellows Pump**

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### **FS Series**

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## **Instruction Manual**

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⚠ Read this manual before use of product

Thank you for having selected IWAKI's Pneumatic Drive Bellows Pump FS Series. This instruction manual, which is divided into 5 sections, namely "Safety Section," "Outline Section," "Installation Section," "Operation Section" and "Maintenance Section," deals with the correct handling and operation procedures for the pump. To make maximum use of the pump and to ensure safe and long operation of the pump, please read this manual thoroughly and carefully prior to operating the pump.

## Contents

<b>IMPORTANT INSTRUCTIONS .....</b>	<b>1</b>
Safety Section (Instructions to prevent accidents) .....	2
<b>OUTLINE OF PRODUCT .....</b>	<b>6</b>
1. Unpacking and Inspection .....	7
2. Operation Principle .....	7
3. Identification Codes .....	8
4. Specifications .....	8
5. Outer Dimensions/Mass .....	9
6. Names of Parts and Structure of Pump .....	11
7. Description on Body and Label .....	13
<b>INSTALLATION SECTION .....</b>	<b>14</b>
1. Before Use .....	15
2. Installation, Piping, and Wiring .....	18
<b>OPERATION SECTION .....</b>	<b>32</b>
1. Preparation .....	33
2. Pump Operation .....	33
3. Points to Be Observed in Operation .....	34
<b>MAINTENANCE SECTION .....</b>	<b>35</b>
1. Causes of Trouble and Troubleshooting .....	36
2. Maintenance and Inspection .....	38
3. Consumable Parts .....	39



This instruction manual should be kept on hand by the end user for quick reference. It is recommended that each user, after reading the instruction manual thoroughly, place it in a position close to the pump system and where it may be easily accessed by any user at any time whenever necessary.

# ***Important Instruction***




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## **For the Safe and Correct Handling of the Pump**

- Read the "Safety Instructions" sections carefully to prevent accidents involving your customers or other personnel and to avoid damage or loss of other assets. Always follow the instructions and advice found in these sections.
- Observe and abide by the instructions described in this manual. These instructions are very important for protecting pump users from potentially dangerous conditions and situations related with the use of the pump system.
- The symbols relate to the following meanings described below:

 <b>Warning</b>	<b>Nonobservance or misapplication of the contents of the "Warning" section could lead to a serious accident, including death or injury.</b>
 <b>Caution</b>	<b>Nonobservance or misapplication of the contents of the "Caution" section could lead to serious physical injury to the user or serious damage to the product.</b>

### **Types of Symbols**

-  Indicates that "Warning" or "Caution" must be exercised. Inside this triangle, a concrete and practical image provided as a warning or caution message is depicted.
-  Indicates a prohibited action or procedure. Inside or near this circle, a concrete and practical image of the activity to be avoided is depicted.
-  Indicates an important action or procedure which must be performed or carried out without fail. Failure to follow the instructions herein can lead to malfunction or damage to the pump.

# Safety Section

## **WARNING**

- **Look around**

Make sure there is no one around the pump when connecting the power cable. The power supply switch is not provided on the pump. Connecting the power cable and supply air to the pump starts pump operation.



- **Do not remodel pump**

Never try to remodel the pump. Remodeling may be a cause of serious accident or damage. Iwaki takes no responsibility for accidents or damages that may result due to any remodeling without first obtaining permission from Iwaki.



- **For specified application only**

The use of a pump in any application other than those clearly specified may result in injury or damage to the pump. Use the pump strictly in accordance with the pump specifications and application range.



- **Do not drain**

Never discharge hazardous liquid, including but not limited to chemical liquid, over the ground or floor in the plant directly.  
Abide by local regulations when disposing of hazardous substances.



- **Do not touch**

Touching the pump or piping which is extremely hot due to the circulation of a hot liquid may cause severe burns. Arrange adequate hand-protective measures when feeding a liquid at temperatures higher than 50 °C.



## **CAUTION**

- **Do not exceed the specified voltage**

Do not supply power voltage in excess of the level specified. Otherwise, a fire or electric shock may result.



- **Wear protectors**

Never fail to wear protective gear (protective goggles, cap, mask, acid-resistant gloves) when disassembling, assembling, or maintaining the pump. In addition, clean the pump carefully with pure water before working on the pump.



- **Qualified operator only**

The pump must be operated only by operator(s) who have been trained in the safe operation of the pump.



# Safety Section

## CAUTION

- **Lifting pump**

If a lifting rope or chain breaks or is cut when lifting the pump, a fatal or serious injury to person may result from the accident. Select a lifting rope or chain which is strong enough for the load of the pump. Furthermore, no person should be allowed to get under the pump while it is being lifted.



- **Power OFF**

Make sure no one turns on the power switch while work is being done on the pump. Be sure to turn off the power switch before you start any maintenance/repair work concerning the pump. If the working site is noisy or under conditions of low visibility, you should display a notice which clearly states "POWER Off(Maintenance)," near the power switch in order to inform other personnel about the situation. Power ON executed by any other person than the operator/service personnel may result in a serious accident. The operator must take special precautions to avoid accidents.



Power off

- **Storage limit**

Do not store the pump in places where an explosive atmosphere is located, dust is generated, or corrosive gas (such as chlorine gas) is present. Otherwise, a fire may be caused or the health of personnel may be jeopardized.



Prohibited

- **Ventilate site**

When handling a toxic liquid or odorant, ventilate the working site well. In addition, wear protective gear (protective mask, goggles, gloves, etc.).



- **Disposal of used pump**

Disposal of used or damaged pumps must be done in accordance with local laws and regulations. (Consult a licensed industrial waste products disposing company.)



Caution

- **Send-back to Iwaki**

When sending the pump back to Iwaki, drain the liquid out of the pump and clean thoroughly with water to prevent any accidents during transportation.



Caution

- **Pump stroke speed**

Do not run the pump at a stroke speed higher than the max. stroke speed which is shown on the item 4. Specifications on page 8. A stroke speed higher than Max. stroke speed shortens the life of the bellows.



Caution

# Safety Section

## CAUTION

- **Supply air pressure**

Supply air pressure must be maintained within specified supply air pressure range. Otherwise, the bellows may be deformed.



Pump type	Liquid temperature range	Supply air pressure range
FS-15-30-60	5-50 deg.C	0.147-0.490 (MPa)
	51-100 deg.C	0.147-0.294 (MPa)
	101-180 deg.C	0.147-0.196 (MPa)

- **Liquid temperature range**

Pumped liquid temperature should be 5-180 deg.C.



- **Prohibited liquids**

Do not operate the pump with the following liquids.

- Liquid easily crystallized
- Liquid containing slurry
- Solvent naphtha



- **Liquids to be handled with care**

Stripper, solvent-type liquid, hydrazine or fuming sulfuric acid should be handled carefully.



- **Air exhaust port**

Do not narrow the air exhaust port (for example by reducing the tube diameter). Otherwise the bellows may be deformed due to the residual pressure.



- **During pump operation**

- Make sure to open both the suction and discharge-side valves fully. In addition, confirm that the piping is fully supplied with liquid.



# Safety Section

## CAUTION

- **Stopping pump operation**

- When stopping pump operation, release the pressure on the discharge side first. Otherwise, the bellows may be deformed due to the residual pressure on the pump discharge side.
- If a valve is provided on the discharge side, do not close the valve upon stopping the pump. The resulting impactive pressure may deform the bellows or connecting plate.



- **Pump at halt**

Do not supply air to both the right and left air-supply ports at the same time, to prevent the bellows from becoming deformed.



- **Note for electrode**

There is a case which electrode could not detect leakages. This comes from operating condition (supply air pressure etc) and size of crakes on the bellows. please contact IWAKI for detail.



- **Static electricity**

When low electric conductivity liquids such as ultra-pure water and fluor inactive liquid (e.g. Fluorinert™) are handled, the static electricity may be generated in the pump, which may cause static discharge and pump break down. Take countermeasures to avoid and remove the static electricity.



# ***OUTLINE OF PRODUCT***

This section deals with operating principle, type and specifications of the pump as an introduction of the pneumatic drive bellows pump.

1. <i>Unpacking and Inspection</i> .....	7
2. <i>Operating Principle</i> .....	7
3. <i>Identification Codes</i> .....	8
4. <i>Specifications</i> .....	8
5. <i>Outer Dimensions/Mass</i> .....	9
6. <i>Names of Parts and Structure of Pump</i> .....	11
7. <i>Description on Body and Label</i> .....	13



# 1. Unpacking and Inspection



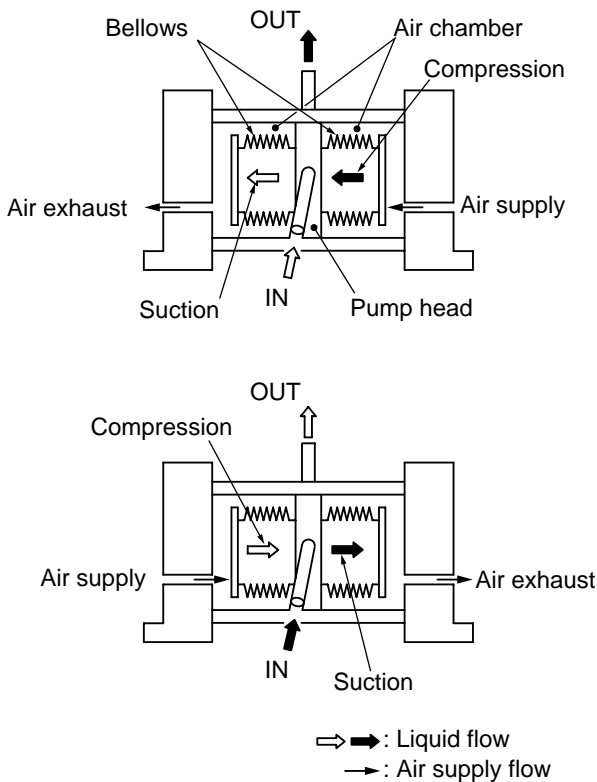
MODEL  
MFG. NO.

After unpacking the product, check the following points to ascertain that the product is exactly as you ordered. If you find anything wrong, please contact your dealer.

- [1] Does the model indicated on the nameplate represent what you ordered?
- [2] Has the pump or any part of it been damaged as the result of an accident or mishandling in transit?
- [3] Have all the special accessories, if ordered, been delivered with the pump? e.g.:
  - 1 Controller  
(AC-1 type, FD type, SC type, FDC-1 type)
  - 2 Quick exhaust valve

Wiring depends on type of controller.

# 2. Operation Principle



Suction/compression: Created by bellows stroke

Iwaki's air-driven bellows pumps are made entirely of fluororesin and designed for semiconductor manufacturing processes.

The pump unit consists of two air chambers and a pair of bellows. These bellows move reciprocally in the air chambers for suction and discharge, by which the liquid is pumped continuously.

- [1] Liquid is sucked into the pump head through the suction port by the expansion (suction motion) of the bellows.
- [2] The liquid is then forced out of the pump head through the discharge port by the compression (discharge motion) of the bellows.

### 3. Identification Codes

#### **FS - 15 H T 1 - 01**

(1) (2) (3) (4) (5) (6)

- (1) Series code  
FS: Pump for medium & high temperature liquid and low to high-pressure applications.
- (2) Maximum discharge volume  
FS-15 : 15 L/min.  
FS-30 : 30 L/min.  
FS-60 : 55 L/min.
- (3) Liquid temp. H : 5-180 deg.C
- (4) Pump connection port (discharge port/suction port)  
T: Tube type connection (standard)
- (5) Connection between pumphead and bellows  
1: Mechanical connection type  
2: Weld type
- (6) Special specifications  
No symbol : Standard  
01 : Special specifications (01, 02……)

### 4. Specifications

	Item	FS-15HT1/T2			FS-30HT1/T2			FS-60HT1/T2		
General Specification	Max. discharge volume (Note 1)	15 L/min			30 L/min			55 L/min		
	Max. stroke speed (Note 2)	240 spm			220 spm			200 spm		
	Self-priming ability (Note 3)	1 m			2 m			2 m		
	Liquid temp. range (deg.C)	5-50	51-100	101-180	5-50	51-100	101-180	5-50	51-100	101-180
	Supply air pressure range (MPa)	0.147-0.490	0.147-0.294	0.147-0.196	0.147-0.490	0.147-0.294	0.147-0.196	0.147-0.490	0.147-0.294	0.147-0.196
	Liquid-contacting material	PFA, PTFE								
	Pump connection port	PFA 1/2" tube (O.D. 12.7×I.D. 9.52 mm)			PFA tube (O.D. 19×I.D. 16 mm)			PFA tube (O.D. 25×I.D. 22 mm)		
	Supply air connection port	Rc 1/4"			Rc 1/4"			Rc 3/8"		
	Max. air consumption (at max. discharge volume, max. supply air pressure)	200 NI/min	160 NI/min	110 NI/min	370 NI/min	280 NI/min	170 NI/min	670 NI/min	440 NI/min	300 NI/min
	Ambient temp.	0~40 deg.C								
	Driving method	External forced switching of driving air								
Proximity switch arrangement	Type	High-frequency type proximity switch								
	Output type	NPN DC open/close output								
	Source voltage	DC10V~DC30V								

Note 1. The maximum discharge volume value is based on pure water at room temperature.

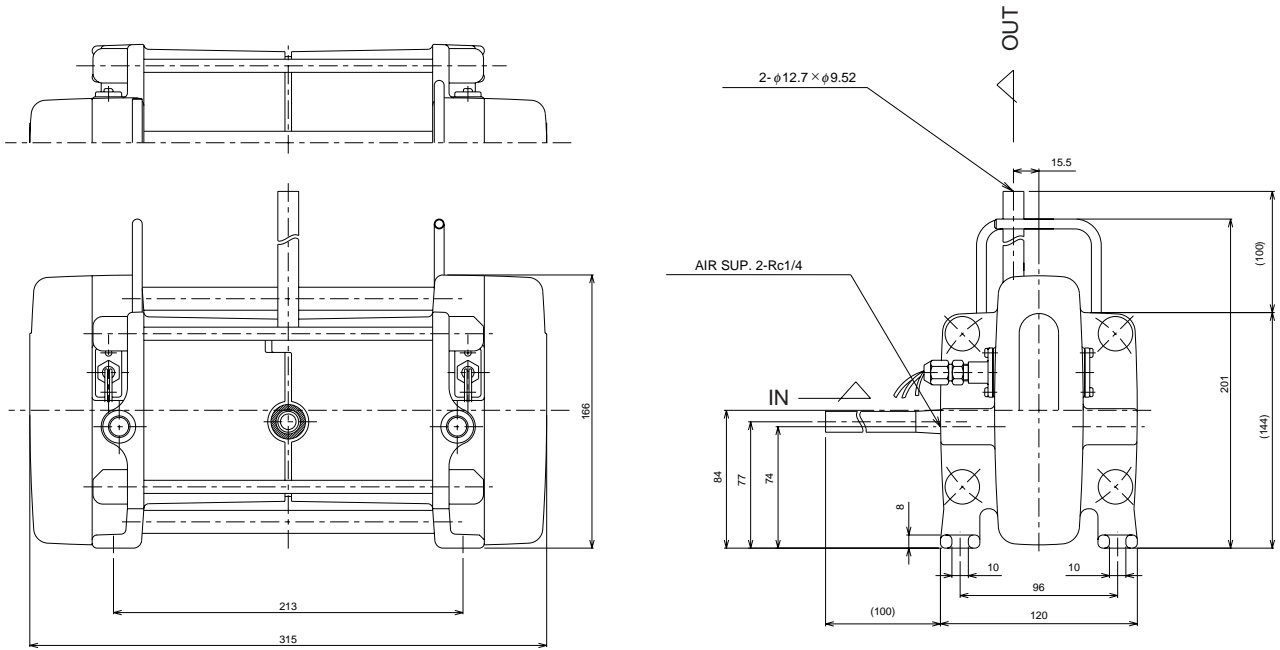
Note 2. Supply air pressure must be limited to 0.147-0.294MPa to get the max. stroke speed. Max. stroke speed must be 180 spm or less if supply air pressure exceeds 0.295MPa and below 0.490MPa.

Note 3. The self-priming value is based on the maximum stroke speed with pure water at room temperature.

# 5. Outer Dimensions/Mass

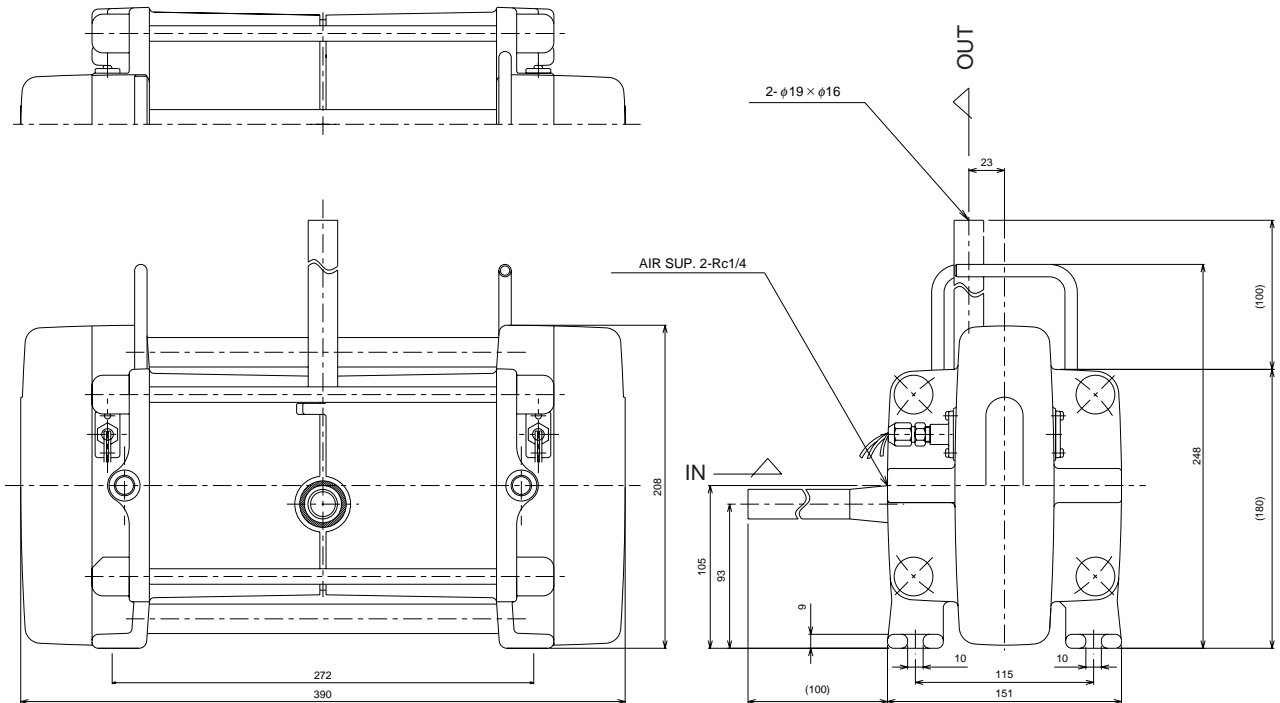
**FS-15HT Mass : 6.3kg**

Unit : mm



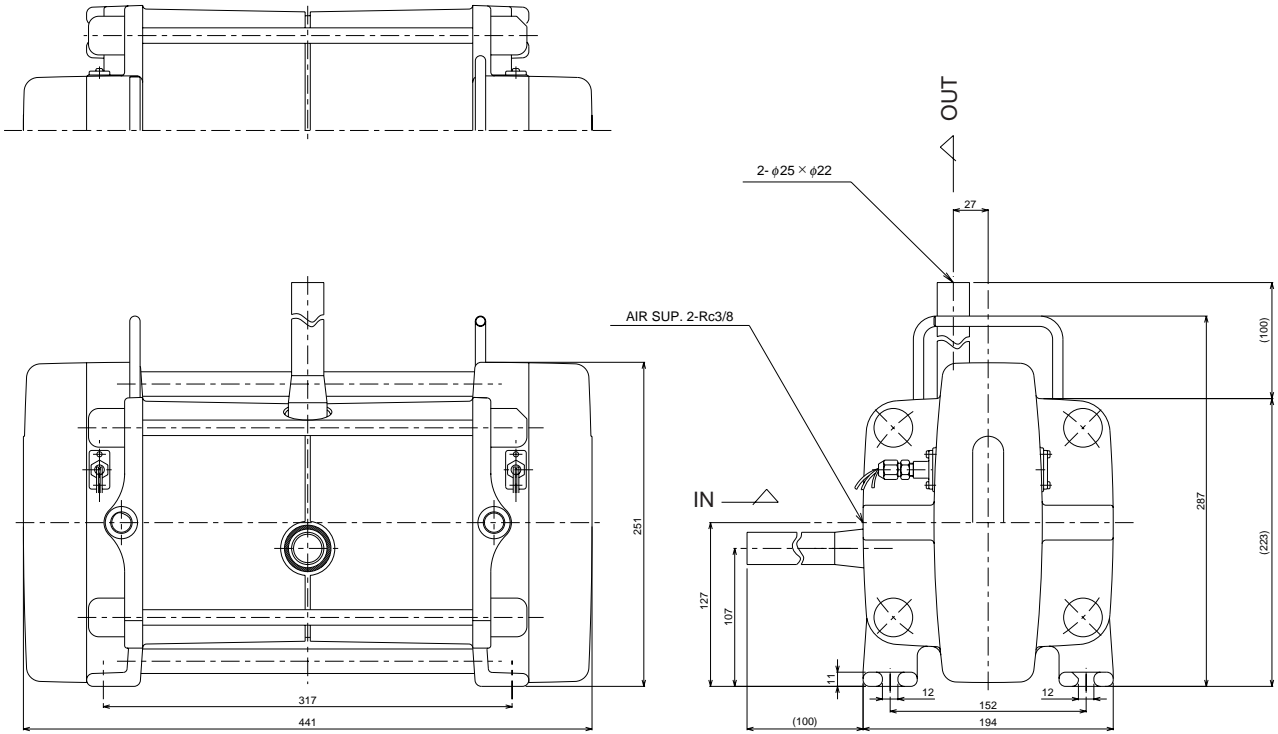
**FS-30HT Mass : 11.7kg**

Unit : mm



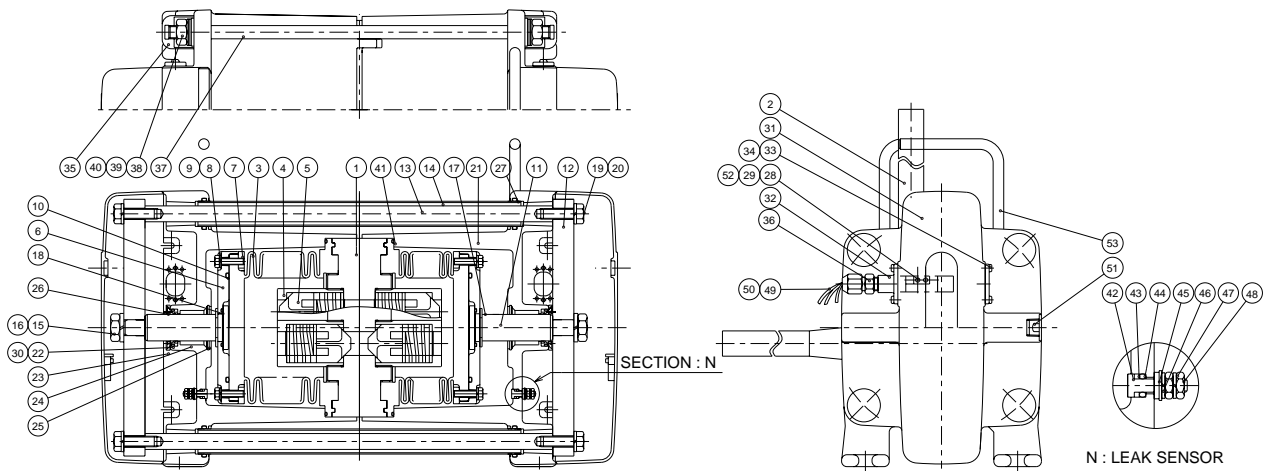
**FS-60HT Mass : 21.5kg**

Unit : mm



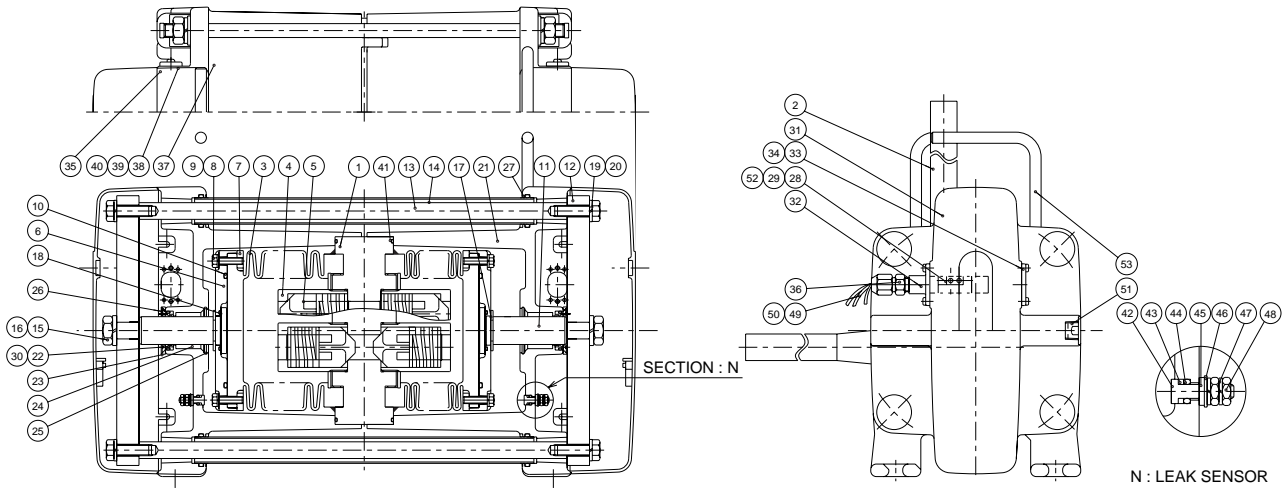
## 6. Names of Parts and Structure of Pump

FS-15·30·60HT1



No.	Parts Name	Q'ty	Material	Remarks	No.	Parts Name	Q'ty	Material	Remarks
1	Pump head	1	PTFE		28	Proximity switch	2		
2	Tube	2	PFA		29	Pan head screw	4	Stainless steel	
3	Bellows	2	PTFE		30	O ring	2	FKM	
4	Valve case	4	PFA		31	Cylinder head cover	2	PPE	
5	Valve	4	PFA		32	Switch holder A	2	PPE	
6	Bellows plate	2	ADC12	4F coating	33	Switch holder B	2	PPE	
7	Split flange	4	SUS304		34	Pan head screw	8	PPS	
8	Hex. bolt	12	Stainless steel		35	Cap	8	PP	
9	Spring washer	12	Stainless steel		36	Joint	2	PP	CP-C6-R1/8
10	O ring	2	FKM		37	Stud bolt	4	SUS304	PTFE coated
11	Pump shaft	2	SUS304	Hard chrome plated	38	Hex. nut	8	Stainless steel	
12	Connecting plate	2	SUS304		39	Plate washer	8	Stainless steel	
13	Connecting shaft	2	SUS304		40	Conical spring washer	24	Stainless steel	
14	Shaft cover	2	SUS304	4F coating	41	O ring	2	FKM	
15	Hex. nut	2	Stainless steel		42	Leak sensor	4	SUS304	
16	Spring washer	2	Stainless steel		43	Gasket	4	PTFE	
17	E shape stop ring	2	Stainless steel		44	O ring	4	FKM	
18	O ring	2	FKM		45	Gasket C	4	PTFE	
19	Hex. bolt	4	Stainless steel		46	Plate washer	4	Stainless steel	
20	Spring washer	4	Stainless steel		47	Spring washer	8	Stainless steel	
21	Cylinder head	2	ADC12	4F coating	48	Hex. nut	8	Stainless steel	
22	Lip seal	2	Filler charged PTFE		49	FF cord (black)	2		AWG26 1.3 dia.
23	Packing stopper	2	SUS304		50	FF cord (white)	2		AWG26 1.3 dia.
24	Bearing	2	Filler charged PTFE		51	Cap. plug	2	Stainless steel	4F coating
25	Stop ring	2	Stainless steel		52	Hex. nut	4	Stainless steel	
26	Screw	8	Stainless steel		53	Handle	2	Stainless steel	4F coating
27	O ring	4	FKM						


**FS-15·30·60HT2**

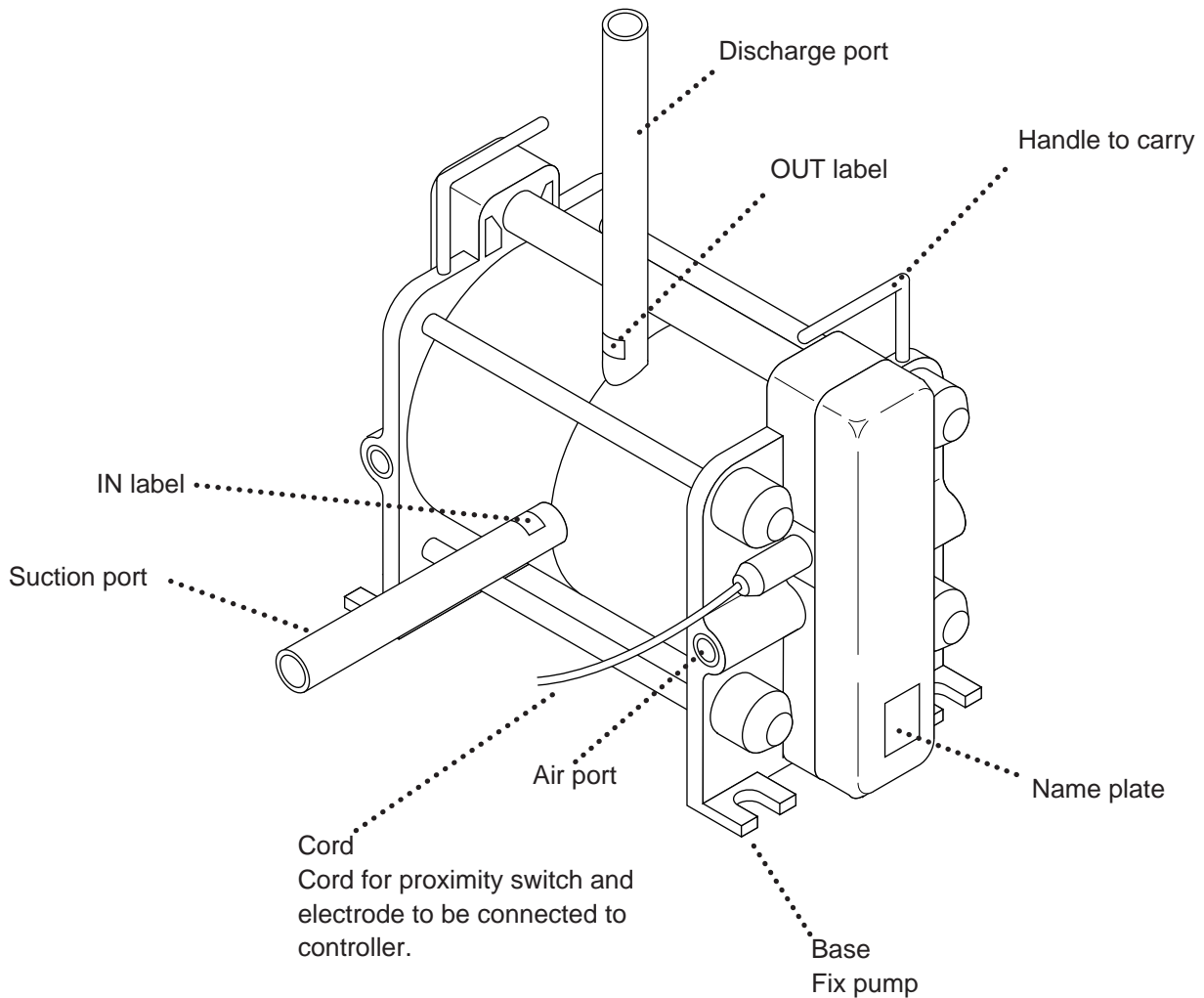


No.	Parts Name	Q'ty	Material	Remarks	No.	Parts Name	Q'ty	Material	Remarks
1	Pump head	1	PTFE		28	Proximity switch	2		
2	Tube	2	PFA		29	Pan head screw	4	Stainless steel	
3	Bellows	2	PTFE		30	O ring	2	FKM	
4	Valve case	4	PFA		31	Cylinder head cover	2	PPE	
5	Valve	4	PFA		32	Switch holder A	2	PPE	
6	Bellows plate	2	ADC12	4F coating	33	Switch holder B	2	PPE	
7	Split flange	4	SUS304		34	Pan head screw	8	PPS	
8	Hex. bolt	12	Stainless steel		35	Cap	8	PP	
9	Spring washer	12	Stainless steel		36	Joint	2	PP	CP-C6-R1/8
10	O ring	2	FKM		37	Stud bolt	4	SUS304	PTFE coated
11	Pump shaft	2	SUS304	Hard chrome plated	38	Hex. nut	8	Stainless steel	
12	Connecting plate	2	SUS304		39	Plate washer	8	Stainless steel	
13	Connecting shaft	2	SUS304		40	Conical spring washer	24	Stainless steel	
14	Shaft cover	2	SUS304	4F coating	41	O ring	2	FKM	
15	Hex. nut	2	Stainless steel		42	Leak sensor	4	SUS304	
16	Spring washer	2	Stainless steel		43	Gasket	4	PTFE	
17	E shape stop ring	2	Stainless steel		44	O ring	4	FKM	
18	O ring	2	FKM		45	Gasket C	4	PTFE	
19	Hex. bolt	4	Stainless steel		46	Plate washer	4	Stainless steel	
20	Spring washer	4	Stainless steel		47	Spring washer	8	Stainless steel	
21	Cylinder head	2	ADC12	4F coating	48	Hex. nut	8	Stainless steel	
22	Lip seal	2	Filler charged PTFE		49	FF cord (black)	2		AWG26 1.3 dia.
23	Packing stopper	2	SUS304		50	FF cord (white)	2		AWG26 1.3 dia.
24	Bearing	2	Filler charged PTFE		51	Cap. plug	2	Stainless steel	4F coating
25	Stop ring	2	Stainless steel		52	Hex. nut	4	Stainless steel	
26	Screw	8	Stainless steel		53	Handle	2	Stainless steel	4F coating
27	O ring	4	FKM						

## 7. Description on Body and Label

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 **Caution** When cleaning the pump be careful not to wipe the labels or the pump body with solvent.



# ***INSTALLATION SECTION***

This "Installation Section" must be thoroughly understood by the user before actually installing the pump. Do not start your installation work unless you confirm your understanding of the entire set of descriptions in this section.

1. <i>Before Use</i> .....	15
2. <i>Installation, Piping, and Wiring</i> .....	18
2.1 <i>Installation</i> .....	18
2.2 <i>Liquid Tubing</i> .....	19
2.3 <i>Air Piping</i> .....	22
2.4 <i>Wiring</i> .....	28








# 1. Before Use

For reliable pump performance to suit your application purposes, full safety measures should be taken for the pump unit and the entire system. The following information, including the points to be observed in the handling of the pump, deals with the measures to ensure the safe operation of the system. Please read the description carefully.

To operate this pump, a 5-port solenoid valve and a controller (AC-1 type, FD type, SC type or FDC-1 type) are required.

In addition, to enhance system safety, a quick exhaust valve must be installed.

No.	Points to be Observed	Description										
1	<ul style="list-style-type: none"> <li>○ Pump stroke speed: Do not run pump exceeding the max. stroke speed which is shown on the item 4. Specifications on page 8.</li> </ul>	<ul style="list-style-type: none"> <li>● If many air bubbles are sucked through pump suction port, pump is put into state of air locked operation and stroke rate will rise to abnormal levels. Safety measure should be taken so that pump does not run at speeds above max. stroke speed. With FD, SC or FDC-1 controller, the upper limit of stroke speed can be set.</li> </ul>										
2	<ul style="list-style-type: none"> <li>○ Supply air pressure must be maintained within specified pressure range.</li> </ul>	<ul style="list-style-type: none"> <li>● In view of pressure resistance of filter at medium temperature, provide air under as low pressure as possible, for protection of bellows &amp; to ensure safety.</li> <li>● Any fluctuation in pressure of supplied air causes change in discharge. Attach reducing valve to stabilize pressure.</li> </ul> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Pump type</th> <th>Liquid temperature range</th> <th>Supply air pressure range</th> </tr> </thead> <tbody> <tr> <td rowspan="3" style="text-align: center;">FS-15-30-60</td> <td style="text-align: center;">5-50 deg.C</td> <td style="text-align: center;">0.147-0.490 (MPa)</td> </tr> <tr> <td style="text-align: center;">51-100 deg.C</td> <td style="text-align: center;">0.147-0.294 (MPa)</td> </tr> <tr> <td style="text-align: center;">101-180 deg.C</td> <td style="text-align: center;">0.147-0.196 (MPa)</td> </tr> </tbody> </table>	Pump type	Liquid temperature range	Supply air pressure range	FS-15-30-60	5-50 deg.C	0.147-0.490 (MPa)	51-100 deg.C	0.147-0.294 (MPa)	101-180 deg.C	0.147-0.196 (MPa)
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	101-180 deg.C	0.147-0.196 (MPa)										
3	<ul style="list-style-type: none"> <li>○ Liquid temp. range</li> </ul>	<ul style="list-style-type: none"> <li>● Temp. of pumped liquid must be within the range of 5-180 deg.C.</li> </ul>										
4	<ul style="list-style-type: none"> <li>○ Prohibited liquids</li> <li>⚠ <b>Caution</b> Following liquids must not be used.</li> <li>● Liquids that are easily crystallized</li> <li>● Liquids containing slurry</li> <li>● Low conductivity carbon hydrate liquid</li> </ul>	<ul style="list-style-type: none"> <li>● Service life of valve &amp; bellows is shortened with use of liquid that is easily crystallized or contains slurry. Use of such liquids is not recommended.</li> <li>● If solvent naphtha is used, electrostatic destruction may be generated between fluororesin &amp; liquid, finally producing pinholes.</li> </ul>										

No.	Points to be Observed	Description
5	<ul style="list-style-type: none"> <li>○ Liquids to be handled with care               <ul style="list-style-type: none"> <li>· Stripper</li> <li>· Hydrazine</li> <li>· Fuming sulfuric acid</li> <li>· Solvent type liquids</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>● Some types of strippers may cause cracks in bellows or piping (PFA) at an early stage. (Contact Iwaki for a different warranty period applied for such liquids.)</li> <li>● Explosion-proof specifications are required to use solvent type liquid. (Contact Iwaki for details.)</li> </ul>
6	<ul style="list-style-type: none"> <li>○ When stopping pump operation, do not close discharge valve before releasing all pressure from bellows.</li> </ul>	<p> <b>Caution</b></p> <p>Stopping pump without releasing pressure on pump discharge side may result in deformed bellows due to force of pressure remaining on pump discharge side.</p>
7	<ul style="list-style-type: none"> <li>○ Do not suspend pump operation for a prolonged period without first removing the liquid from the pump chamber.</li> </ul>	<p> <b>Caution</b></p> <p>Suspending pump operation for a prolonged period without removing liquid inside the pump chamber may cause corrosion of the electrode or other parts due to permeation of the liquid's gas content.</p> <p>(Example: Pump operated once a day for a minimum period of 10 minutes.)</p> <p>In such a case, contact Iwaki for special instructions.</p>
8	<ul style="list-style-type: none"> <li>○ Do not narrow air exhaust port. (Do not use tubing of smaller diameter than specified.)</li> </ul>	<p> <b>Caution</b></p> <p>If exhaust port piping of 5-port solenoid valve is extended longer to position other than specification, &amp; air exhaust port is narrowed, bellows may be deformed by force of supply air resulting from imbalance between discharge side pressure &amp; supply air pressure.</p>
9	<ul style="list-style-type: none"> <li>○ Do not supply air to both right &amp; left air supply ports when pump operation is suspended.</li> </ul>	<p> <b>Caution</b></p> <ul style="list-style-type: none"> <li>● If air is supplied simultaneously to two air chambers on right &amp; left sides while pump operation is suspended, bellows are pressurized &amp; will finally deform.</li> <li>● Be especially careful when using double solenoid electromagnetic valve, because some types of valve cause simultaneous pressurization of two air chambers between valve stops.</li> </ul>
10	<ul style="list-style-type: none"> <li>○ Do not close the secondary-side air valve upon stopping the pump.</li> </ul>	<p> <b>Caution</b></p> <ul style="list-style-type: none"> <li>● If the secondary-side air valve on the liquid line is closed upon stopping the pump, the resulting residual pressure in the bellows may cause a deformation of the bellows or connecting plate.</li> <li>● Note that the secondary-side air valve is kept open except for the purpose of drainage.</li> </ul>

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## ■ Other precautions to be taken

### [1] Surface temperature of pump

#### **Warning**

Touching the pump or piping whose surface temperature is extremely high due to the circulation of a hot liquid is very dangerous. Always arrange adequate hand-protective measures when engaged in feeding a hot liquid into the pump. The max. pump surface temperature is shown in the table.

Model	Liquid temp.	Max. cylinder surface temp.	Room temp.
FS-15	180 deg.C	59 deg.C	23 deg.C
FS-30	180 deg.C	63 deg.C	23 deg.C
FS-60	180 deg.C	56 deg.C	23 deg.C

### [2] Noise from pump

Noises are generated from air exhaust or the like during pump operation. Apply sound damping measures as necessary. The Level of sound generated by pump is shown in the table.

Model	Supply air pressure	Stroke speed	Sound level
FS-15	0.490MPa	180 spm	64.2 dB(A)
	0.294	240	67.5
FS-30	0.490MPa	180 spm	70.5 dB(A)
	0.294	220	70.5
FS-60	0.490MPa	180 spm	72.0 dB(A)
	0.294	200	73.0

## 2. Installation, Piping, and Wiring

When you feel or notice any danger or abnormal condition during installation and other set-up work, stop the work and go back to the very first step.



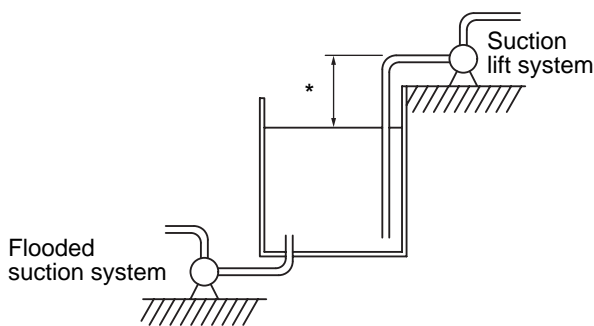
### WARNING

Make sure no one turns on the power switch while work is being done on the pump. Be sure to turn off the power switch before you start any maintenance/repair work concerning the pump. If the working site is noisy or under conditions of low visibility, you should display a notice which clearly states "POWER OFF(MAINTENANCE)," near the power switch in order to inform other personnel about the situation. Power ON executed by any other person than the operator/service personnel may result in a serious accident. The operator must take special precautions to avoid accidents.

Only the operators/service staff who are adequately trained in safe handling procedures should be in charge of the related electric arrangement and control of the power source. Iwaki takes no responsibility for injury to person or damage to assets which results from a failure to observe this instruction. Consult Iwaki, an Iwaki branch office, or an Iwaki distributor as necessary.

### 2.1 Installation

[1] Pump installation position



- **Flooded suction system**

Set the pump as close to the liquid supply tank as possible.

- ▲ **Caution**

Employ a flooded suction system for feeding a liquid at higher temperatures than room temperature or for a liquid circulation system.

- **Suction lift system**

Set the suction side piping in accordance with the self-priming capacity and as close to the liquid supply tank as possible.

\* Self-priming capacity :

FS-15 : 1m

FS-30 : 2m

FS-60 : 2m

- ▲ **Caution**

The self-priming capacity above is based on a pump operation at the max. stroke speed using pure water at room temperature. The suction height differs with the liquid's characteristics, temperature, and suction pipe length. For detailed information, contact Iwaki.

[2] Installation foundation

Select a flat and rigid foundation (such as a chassis) for installation, to avoid twisting motion or vibration.

[3] Direction of pump

Direct the discharge port upward and the suction port horizontally. Use anchor bolts to fasten the pump firmly in position.

[4] Bolt tightening

Tighten the bolts on the housing upon installation by applying the following fastening torque.

Fastening torque for FS-15HT1: 9.8N·m

FS-15HT2: 4.9N·m

FS-30HT1: 15.7N·m

FS-30HT2: 5.9N·m

FS-60HT1: 21.6N·m

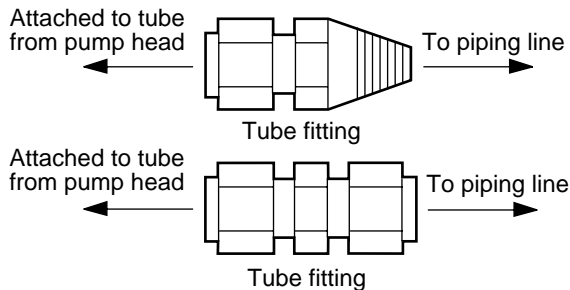
FS-60HT2: 6.9N·m

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## 2.2 Liquid Tubing

The standard tubes for both the discharge and suction ports are PFA tubes. Connect the tubes as described below



### [1] Pump port diameters and materials

The standard material of the pump discharge port and suction port is PFA tubing. The applicable tubing diameters are as follows.

\* Tubing diameters

FS-15.....1/2"(O.D. 12.7 × I.D. 9.52 mm)

FS-30.....O.D. 19 × I.D. 16 mm

FS-60.....O.D. 25 × I.D. 22 mm

Use tube fittings with diameters corresponding to those of the tubes. (See the figure on the left.)

- The diameter of the piping side tubing should be larger than those of the discharge and suction ports.

[2] Air blow or flush tubing to get rid of foreign matter, prior to connecting with the pump.

[3] Tubing connection should be done such that extra piping load is not applied to the pump. Use pipe supports as necessary to prevent vibration and heat generated along the piping from reaching the pump.

[4] Pipe joints should be assembled carefully, to prevent liquid leakage, air leakage, and air suction.

[5] Standard couplings may be used in the piping. However, they must be designed to be reliable against leakage in such operations as high-temperature feeding or heat cycle operation.

### 2.2.1 Points to be observed in suction pipe arrangement

[1] Basically the suction pipe should be large in diameter, short in length, and in a flooded suction condition. In the case of a suction lift system, determine the height according to the self-priming capacity of the pump.

\* The suction height differs with the liquid's characteristics, temperature, and suction pipe length. For detailed information, contact Iwaki.

[2] To block the entrance into the bellows of solid particles such as wafer fragments or the like, install a filter or strainer on the suction pipe. Select a filter or strainer which has low piping resistance.

#### Caution

Fragments of damaged wafer chips inside the pump may get stuck in the bellows and eventually cause damage. If solid matter clogs the pump valve, the discharge volume may be affected with the normal checking function disabled.

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- 
- [3] When installing a valve on the suction pipe, select a valve with an orifice larger than the inner diameter of the said pipe. A smaller orifice may result in a larger suction piping resistance or an increased chance for the valve to be clogged with a crystallized substance. Make sure to keep the valve open during pump operation.

 **Caution**

Operating the pump with the valve on the suction pipe increases the pressure inside the bellows to deform the bellows inwardly.

## 2.2.2 Points to be observed in discharge pipe arrangement

- [1] The pump discharge load increases with the length of the discharge pipe or the number of bends along the pipe. In order to decrease the load install a dampener which minimizes pulsation.

- [2] When installing a valve in the discharge pipe, select a valve with an orifice whose diameter is larger than that of the inner diameter of the pipe. A valve with a smaller diameter may increase the discharge piping resistance or easily be clogged with crystallized substance. Keep the valve open when the pump is in operation. Do not close the valve until the discharge pressure reaches "0" after the pump is stopped.

 **Caution**

Do not close the valve before stopping the pump. The resulting impactive pressure may deform the bellows.

- [3] A filter must be selected to meet the pump type.

Filtering area, grain-removing performance, and flow characteristics should be taken into consideration in selecting the filter. Desired flow rate may not be achieved if the selection is wrong.

 **Caution**

The filter should be dampened well before running operation liquid. A desired flow rate may not be achieved if the filter is not dampened well.

The filter dries out if the operation liquid is not supplied for a long time. Make sure to dampen the filter prior to pump operation. Read the instruction manual of the filter for the details.

- [4] The piping should be designed in a manner that no residual pressure results on the discharge side upon stopping the pump.

(For example, filter air elimination shall be set full open or a return circuit shall be employed to remove residual pressure.)

 **Caution**

Residual pressure on the discharge side upon stopping the pump may deform the bellows.

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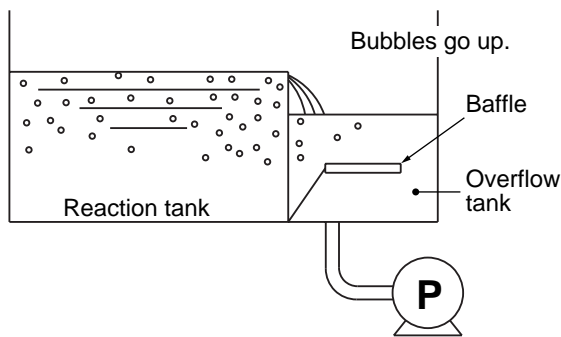
### 2.2.3 Air elimination measures

When strong acid liquid is fed into the reaction tank or such liquid is circulated through narrow tubing, bubbles are generated. If such bubbles are mingled in the liquid that is sent to the bellows, the system is put into a state of air locked operation. As a result, the stroke speed increases and smooth liquid feeding is impacted.

For safe and efficient circulation and feeding of liquid, it is necessary to carry out air elimination and take proper safety measures.

When air enters the bellows and the pump is air locked, the pump stroke speed increases. If the increase is excessive, that is, higher than the specified pump stroke speed, stop the pump or carry out air elimination.

- **Plan "A"(Flooded suction system)**

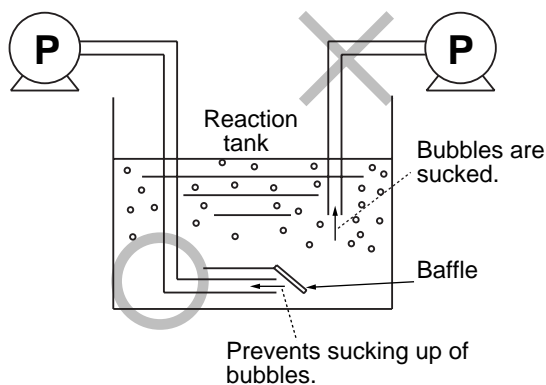


[1] Plan A (Bubbles are blocked by means of baffle-board)

- 1 Flooded suction system:

A baffle is set in the overflow tank to separate the bubbles from the liquid, thus eliminating the air content.

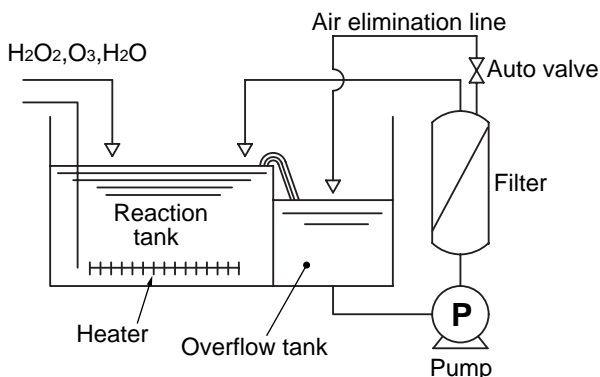
- **Plan "A" (Suction lift system)**



- 2 Suction lift system:

A baffle is set in the lower level in the reaction tank. The top of the suction port tube is positioned under the baffle so that bubbles are not sucked in together with the liquid.

• **Plan B (using auto valve)**



[2] Plan B (Automatic air elimination with auto valve installed)

1 Regardless of the occurrence of air locking, continuous automatic air elimination is executed in the entire system. For example, the air elimination process is activated every 2 minutes after the start-up of the pump by opening the auto valve for 10 seconds.

Note 1: Some filters have diameters too small for air elimination. Take the diameter into consideration when selecting a filter.

Note 2: Determine the open period of the auto valve on the basis of the system performance.

2 If the conditions under which bubbles are mingled remain the same, an air elimination technique which fits well with such conditions may be applicable. For example, if bubbles are generated only when feeding H<sub>2</sub>O<sub>2</sub>, open the auto valve to carry out air elimination only when H<sub>2</sub>O<sub>2</sub> is fed.

3 Another technique is to install an air detection sensor in the suction port area, so that the auto valve is automatically opened by a signal sent out from the sensor and the air elimination operation is executed.

- Installing another air detection sensor on the discharge side is effective in preventing air from entering in the event of bellows damage.

## 2.3 Air Piping



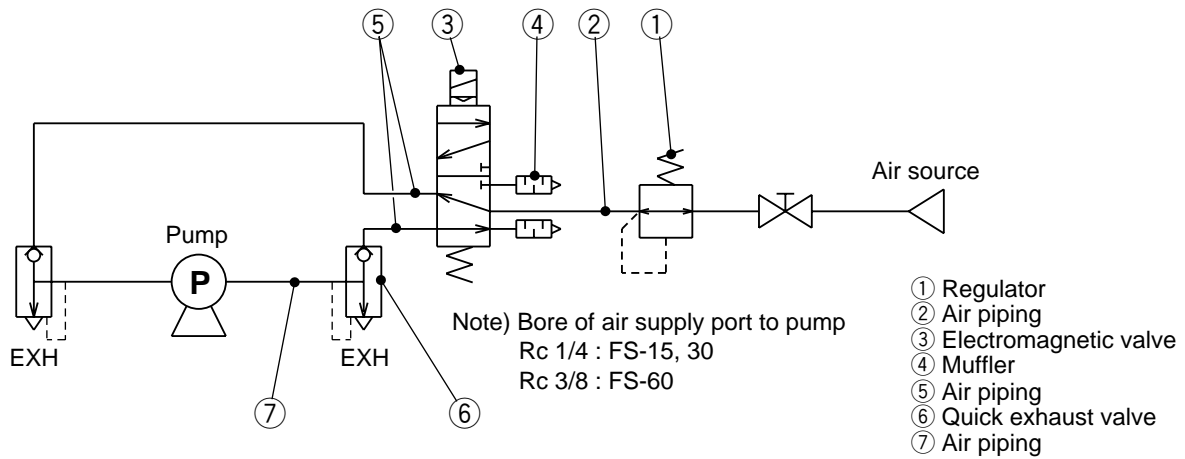
### CAUTION

- Any supplied air must be instrumentation air which is clean and free from moisture and dust. Water, oil, or dust in the supplied air may lower the performance of the pump.
- The following troubles may occur with FS type pumps if the air supply piping is long and narrow.
  - a. The bellows may be deformed inwardly due to remaining compressed air that is not efficiently released out of the pump air chamber.
  - b. Discharge may be reduced due to pump stroke speed slowdown.

**Complete air piping in accordance with the sample arrangement shown on the next page.**



### 2.3.1 Sample air piping



#### [1] Regulator

Select a regulator on a basis of the air consumption rate of the pump. (Pressure drop should be less than 20KPa.)

#### ⚠ Caution

Set the supply air pressure within supply air pressure range.

Each pump should be provided with an independent regulator.

Pump type	Liquid temperature range	Supply air pressure range
FS-15-30-60	5-50 deg.C	0.147-0.490 (MPa)
	51-100 deg.C	0.147-0.294 (MPa)
	101-180 deg.C	0.147-0.196 (MPa)

#### ⚠ Caution

With a single regulator provided to cover two or more electromagnetic valves, the valve located farthest from the regulator may malfunction due to insufficient delivery of pressure.

#### [2] Air piping

1) When the pump is used at supply air pressure of 0.490MPa or below :

The air pipe inner diameter between the regulator and the electromagnetic valve should be 6.5mm or more for FS-15 and 8mm or more for FS-30 and FS-60.

2) When the pump is used at supply air pressure of 0.294MPa or below :

The air pipe inner diameter between the regulator and the electromagnetic valve should be 6.5mm or more for FS-15 and FS-30 and 8mm or more for FS-60.

[3] Electromagnetic valve

Use table below to select your 5-port electromagnetic valve.

Air pressure to pump is 0.49MPa or below.

Model	Necessary effective cross-sectional area	Diameter of port
FS-15	14mm <sup>2</sup> or larger	Rc 1/4" or larger
FS-30	25mm <sup>2</sup> or larger	Rc 1/4" or larger
FS-60	66mm <sup>2</sup> or larger	Rc 3/8" or larger

Air pressure to pump is 0.29MPa or below.

Model	Necessary effective cross-sectional area	Diameter of port
FS-15	10mm <sup>2</sup> or larger	Rc 1/4" or larger
FS-30	23mm <sup>2</sup> or larger	Rc 1/4" or larger
FS-60	34mm <sup>2</sup> or larger	Rc 3/8" or larger

 **Caution**

When a double-solenoid type electromagnetic valve is to be used, select a 2-position type. Use of a 3-position type may deform the bellows, since the air on both sides is pressured or released simultaneously upon stopping the pump with some 3-position type electromagnetic valve.

[4] Muffler

A muffler is installed on the exhaust port of the electromagnetic valve and quick exhaust valve.

FS-15, 30 : Select a muffler with an effective cross-section area of 35mm<sup>2</sup> or larger.

FS-60 : Select a muffler with an effective cross-section area of 60mm<sup>2</sup> or larger.

[5] Air piping

Select air pipes between the electromagnetic valve and pump or quick exhaust valve as specified in the following table.

Air pressure to pump is 0.49MPa or below

	FS-15	FS-30	FS-60
Pipe length shorter than 1m	Inner diameter larger than 6.5mm	Inner diameter larger than 8mm	Inner diameter larger than 8mm
Pipe length 1 to 3m	Inner diameter larger than 7.5mm or the use of quick exhaust valve	Inner diameter larger than 9mm or the use of quick exhaust valve	Inner diameter larger than 9mm or the use of quick exhaust valve
Pipe length longer than 3m	Contact Iwaki		

Air pressure to pump is 0.294MPa or below

	FS-15	FS-30	FS-60
Pipe length shorter than 1m	Inner diameter larger than 6.5mm	Inner diameter larger than 6.5mm	Inner diameter larger than 8mm
Pipe length 1 to 3m	Inner diameter larger than 7.5mm or the use of quick exhaust valve	Inner diameter larger than 7.5mm or the use of quick exhaust valve	Inner diameter larger than 9mm or the use of quick exhaust valve
Pipe length longer than 3m	Contact Iwaki		

Note: Both of right and left pipes length must be the same. Different length causes larger pulsation of liquid.

[6] Quick exhaust valve

As shown in Figure 1, the air exhausted out of the pump flows out of the system via the exhaust port of the electromagnetic valve. (Fig. 1)

Depending upon the type of liquid applied, some permeated gas may mix with the exhaust air. (The inside of the electromagnetic valve may be corroded by such permeated gas, becoming useless to the system.) In such a case, install a quick exhaust valve between the pump and the electromagnetic valve. The air will be exhausted through the exhaust port of the quick exhaust valve, as shown in Figure 2. (A limited amount of air will be exhausted through the electromagnetic valve.) The quick exhaust valve must be installed in a position close to the pump (within a distance of 1m). (Fig. 2)

• Direction of air exhaust

Fig.1 Air Exhaust Without Quick Exhaust Valve

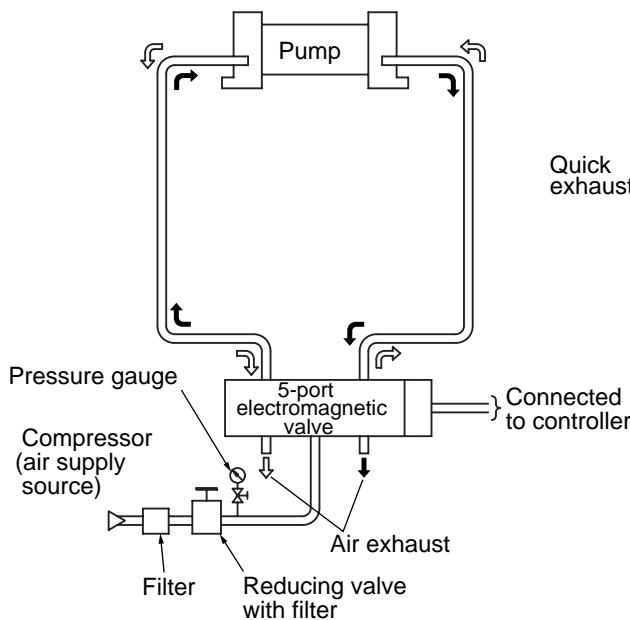
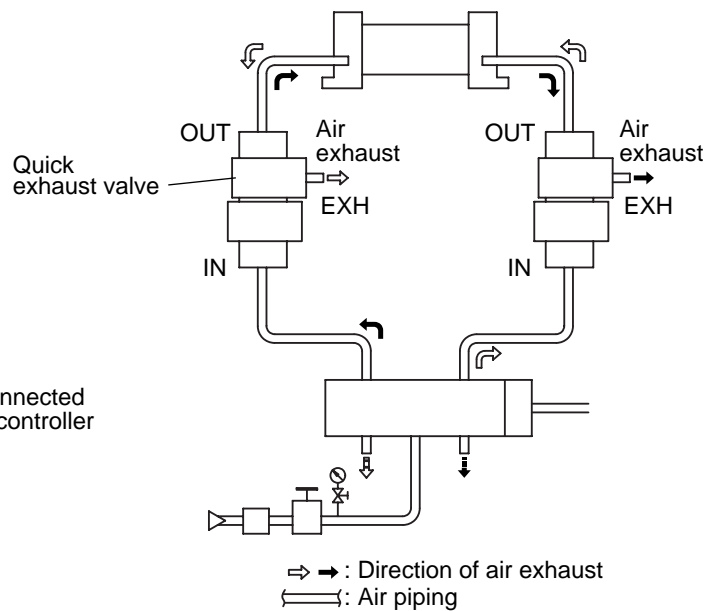


Fig. 2 Air Exhaust With Quick Exhaust Valve



**5-port electromagnetic valve : 2 positions, single solenoid**

\* The quick exhaust valve has the directions of IN, OUT, and EXH. (The direction symbols are stamped on the valve.) The piping should be made as shown in Fig. 2.

[7] Air piping

The air piping between the quick exhaust valve and the pump should be decided according to the following table.

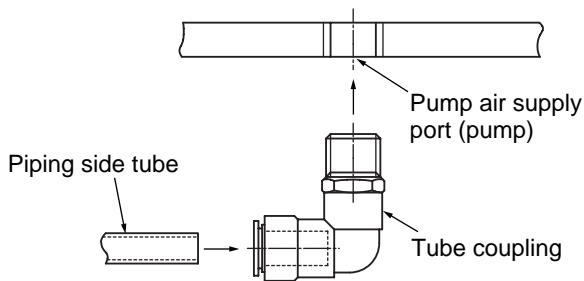
In case pump air pressure is 0.49MPa or below

	FS-15	FS-30	FS-60
Piping length	Less than 4 m	Less than 2 m	Less than 2 m
Pipe inner diameter	More than 6.5 m	More than 8 m	More than 12 m

In case pump air pressure is 0.294MPa or below

	FS-15	FS-30	FS-60
Piping length	Less than 7 m	Less than 1.5 m	Less than 2 m
Pipe inner diameter	More than 6.5 m	More than 6.5 m	More than 9 m

## 2.3.2 Points to be observed in air piping



### [1] Diameter of pump connection port

The diameter of the connection port on the air supply side is as follows.

- \* Connection port diameter
- FS-15, 30 : Rc 1/4"
- FS-60 : Rc 3/8"

### [2] Install a relief type reducing valve.

Fluctuation of supply air pressure results in fluctuation of the pump stroke rate as well as discharge volume. Install a reducing valve to maintain the air pressure at a fixed level.

### [3] Install a safety valve.

Install a safety valve to prevent the supply air pressure from exceeding supply air pressure range.

Pump type	Liquid temperature range	Supply air pressure range
FS-15-30-60	5-50 deg.C	0.147-0.490 (MPa)
	51-100 deg.C	0.147-0.294 (MPa)
	101-180 deg.C	0.147-0.196 (MPa)

### [4] Installation of air exhaust port

The exhaust ports of the air circulation system and the electromagnetic valve must be installed in correct positions so that the exhaust air is released into the open air.

#### **Caution**

Narrowing the air exhaust port may block the air exhaust out of the pump. As a result the bellows may be deformed inwardly. Determine the necessary air devices with reference to the sample air piping described in 2.3.1. on page 23.

### [5] Measure to minimize air exhaust

To minimize the noise of air exhaust, connect the exhaust port with a duct or attach a silencer on the exhaust port.

### [6] Installation of multiple pumps

The air consumption of pumps (the total consumption by all pumps installed) increases in relation to the compressor capacity. The diameter of the pipe must be determined taking into consideration the total number of pumps.

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### 2.3.3 Effective cross-sectional area

#### [1] Effective cross-sectional area

In the field of pneumatic devices, the term “Effective cross-sectional area” is used to indicate the capacity to allow air to flow freely. When air is sent through a pipe, the air cannot run totally through the actual cross-sectional area of the pipe due to the negative effect of the piping resistance. The defacto cross-sectional area which serves the air flow is called the effective cross-sectional area. (The value increases with the capacity which allows air or fluid to flow freely.)

\* For each effective cross-sectional area value of a pneumatic device, refer to the catalog of each device issued by the manufacturer.

#### [2] Determination of composite effective cross-sectional area

Air devices are connected in series with the pump. It is necessary to determine the composite effective cross-sectional area of the entire system from each effective cross-sectional area of each device. (Determination of the effective cross-sectional area on the air exhaust side.)

Composite effective cross-sectional area is determined from the following formula.

$$\frac{1}{S^2} = \frac{1}{S_1^2} + \frac{1}{S_2^2} + \dots + \frac{1}{S_n^2}$$

S: Composite effective cross-section area

Si: Effective cross-sectional area of each part

Effective cross-sectional area of air device/air pipe: See the catalog issued by each manufacturer.

Quick exhaust valve (QEV-8V : FS-15, 30): Effective cross-sectional area on the exhaust side (OUT→EXH) is 33mm<sup>2</sup>.

Quick exhaust valve (QEV-10V : FS-60): Effective cross-sectional area on the exhaust side (OUT→EXH) is 33mm<sup>2</sup>.

\* **Required composite effective cross-sectional area (Air pressure to pump is 0.490MPa or below)**

**FS-15 type S=10.7mm<sup>2</sup> or larger**

**FS-30 type S=17.4mm<sup>2</sup> or larger**

**FS-60 type S=26.2mm<sup>2</sup> or larger**

\* **Required composite effective cross-sectional area (Air pressure to pump is 0.294MPa or below)**

**FS-15 type S=9mm<sup>2</sup> or larger**

**FS-30 type S=14mm<sup>2</sup> or larger**

**FS-60 type S=22mm<sup>2</sup> or larger**

Confirm that the composite effective cross-sectional area of the actual air piping is the above mentioned or larger.

### 2.3.4 Preventive measures against condensation

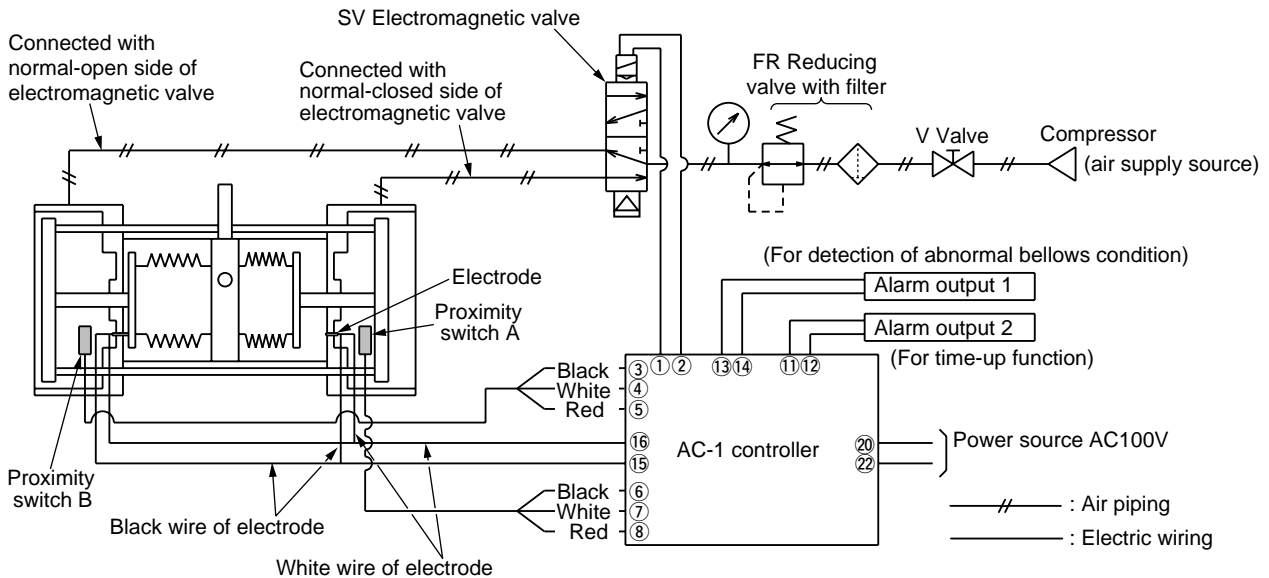
If condensation is likely to occur in the pipe between the pump and electromagnetic valve, take the following preventive measures.

- Enlarge the diameter of the pipe.
- Arrange a heater system over the piping.
- Feed heated compressed air to the pump. Observe the temperature limits of the pipe joints, electromagnetic valve, and other component parts when heating the pipe or compressed air.

## 2.4 Wiring with controller

A 5-port electromagnetic valve and controller of AC-1, FD type, SC type or FDC-1 type are required for the operation of this pump. For wiring, refer to the instruction manual of each controller.

### 2.4.1 Wiring with AC-1 controller



#### [1] Wiring for proximity switch

##### ⚠ Caution

The proximity switches of the FS series pump have three wires: black, white, and red. Improper wiring may cause the proximity switch to burn. Carry out the wiring carefully and accurately.

- ▶ Connect the wires (black, white, and red) of proximity switch A with terminals no. ⑥, ⑦, and ⑧, respectively, of the controller.
- ▶ Connect the wires (black, white, and red) of proximity switch B with terminals no. ③, ④, and ⑤, respectively, of the controller.

\* Symbols A and B are arbitrary. A and B may be interchanged.

##### ⚠ Warning

A standard proximity switch cannot be used when a flammable liquid such as a solvent is used. An explosion-proof proximity switch must be used in the case of a flammable liquid.

#### [2] Wiring for electrode

Connect the tow wires (white and black, approximately 1.8m), which extend from both the right and left sides of the pump, with terminals no. ⑮ and ⑯ of the controller.

- ▶ Join the right and left white wires and connect it with terminal no. ⑯.
- ▶ Join the right and left black wires and connect it with terminal no. ⑮.

\* Never connect the white and black wires. This will result in electrical conduction between the tow lines.

\* The terminal numbers to be connected with the wires may be interchanged.

##### ⚠ Warning

The use of an electrode is prohibited when a flammable liquid such as solvent is pumped. Sparking of the electrode in a solvent application may cause a fire. Pumping of flammable liquid must employ explosion-proof specifications which may be obtained through consultation with Iwaki or your dealer.

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[3] Wiring for 5-port electromagnetic valve

Connect the two wires to terminals no. ① (+) and ② (-) of the controller. Terminals no. ① and ② of the AC-1 type controller have polarity. The electromagnetic valve has no polarity. Some types with a built-in surge killer have polarity, which requires special attention in the connection process.

 **Caution**

As a rule, the 5-port electromagnetic valve has no polarity, though there are exceptions. If a 5-port electromagnetic valve with polarity is used, be careful about the +/- polarity in wiring. Note that improper polarity selection may result in the burning of the valve.

**Note:**

The air piping of the 5-port electromagnetic valve is divided into the 'normal-open' side pipe and 'normal-closed' side pipe. The 'normal-open' side should be installed on the proximity switch B side and 'normal-closed' on the proximity switch A side. The pump does not run if this connection is incorrect. To run the pump, interchange the air piping of the 5-port electromagnetic valve or interchange the wires of proximity switches A and B.

[4] Wiring for alarm output 1

Connect with terminals no. ⑬ and ⑭ for the use of the detection of damaged bellows.

\* Please refer to the "AC-1 Controller Instruction Manual" for details.

• Operating mechanism

If the bellows are damaged while the power switch is on, and the leaked liquid causes the black and white electrode lead wires on the either the left or right side to conduct electrically, the controller will be activated to turn the 5-port electromagnetic valve off (and stop the pump). Then, the red LED (bellows abnormality indicator lamp) on the controller will turn on. Simultaneously, the alarm will be generated externally.

[5] Wiring for alarm output 2

Connect with terminals no. ⑪ and ⑫ for use of the time-up function.

\* Please refer to the AC-1 Controller Instruction Manual for details.

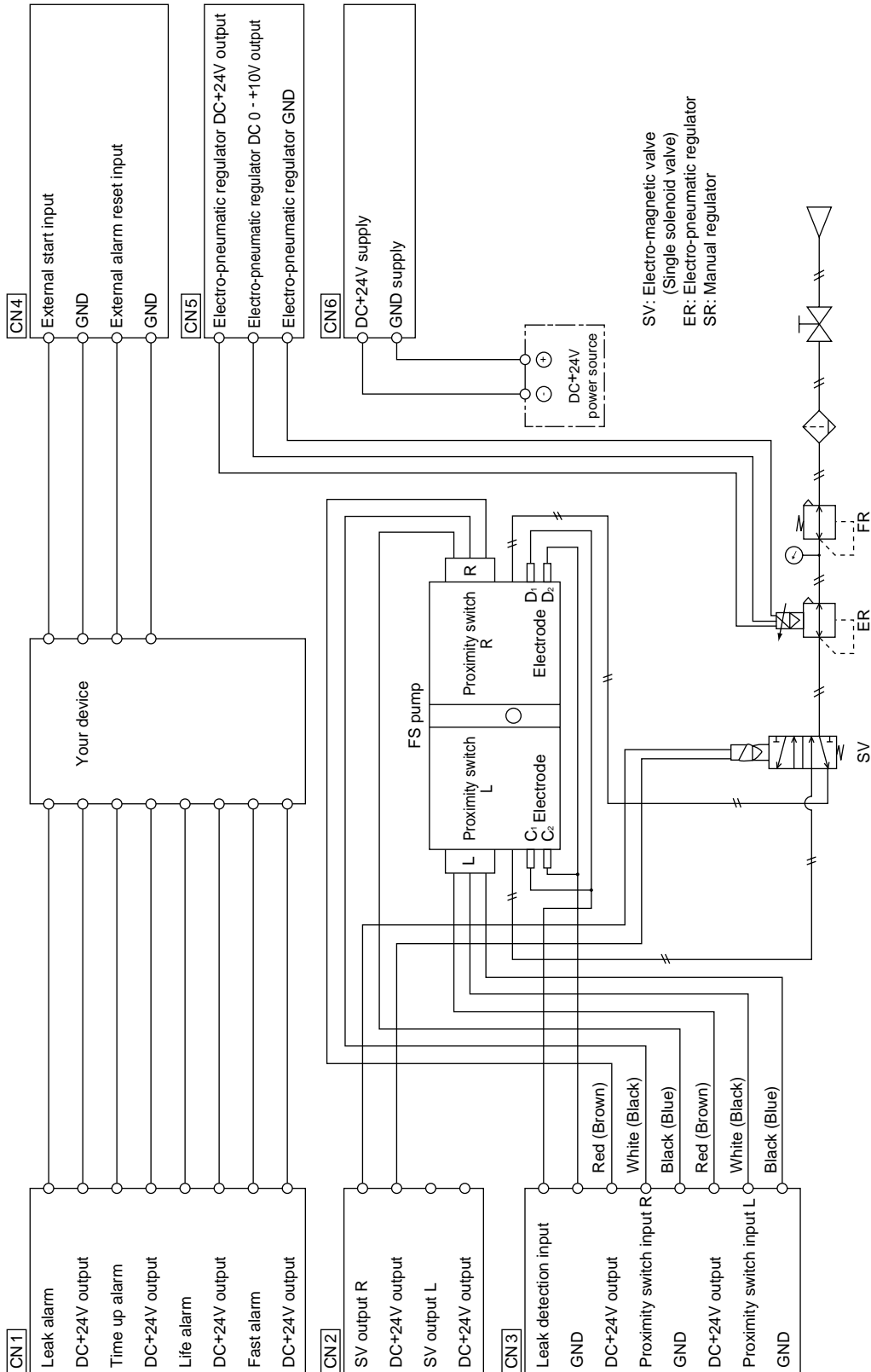
• Operating mechanism

Alarm output 2 (Time-up function with AC-1 type controller)

If the time set in the timer is exceeded due to suspended operation or reduced stroke number of the pump, the time-up indicator [Time Up] (yellow) will turn on. Simultaneously, the alarm will be generated externally.

## 2.4.2 Wiring with FDC-1 controller

The FDC-1 controller should be arranged as shown below. For details, refer to the instruction manual of the FDC-1 controller.





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### 2.4.3 Wiring instructions

#### [1] Wires

Wires (approximately 1m) of the proximity switch and lead wires (approximately 1.8m) of the electrode are provided with the pump. However, no other connection wires are attached with the product. Obtain the wires required for wiring the controller and 5-port electromagnetic valve in accordance with the following table.

Wire Application	Power Specification
For controller power	115V, 0.24A or above
For connecting 5-port electromagnetic valve & controller	24V, 0.24A or above

#### [2] Extension of electrode wire

Control the resistance value to 5k  $\Omega$  or lower, including the attached lead wire (about 1.8m in length).

Any resistance larger than 5k  $\Omega$  may result in inability to stop the pump. (Because detection by the auto-stop alarm will not be available due to the valve in excess of the detection range of the controller when the bellows is damaged.)

#### [3] Wiring of proximity switch

Separate the wires of the proximity switch from the power line or other high-voltage cable. They should not be installed in the same duct or in the same cable tube, otherwise the switch may malfunction. When extending the wire, if it is not extended beyond 30m, use a wire of 0.3mm<sup>2</sup> or above. If the extension is for more than 30m, use wire with a conductive resistance of 100  $\Omega$ /km or less.

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# ***OPERATION SECTION***

Pump operation shall be limited to the range covered by and described in this instruction manual. Use of the pump in a different method or procedure that is not described in this instruction manual is prohibited. Iwaki takes no responsibility for injury to person or damage to assets which results from a failure to observe this instruction. Contact Iwaki, an Iwaki branch office, or an Iwaki distributor as necessary.

1. <i>Preparation</i> .....	33
2. <i>Pump Operation</i> .....	33
2.1 <i>Starting pump</i> .....	33
2.2 <i>Stopping pump</i> .....	34
2.3 <i>Adjustment of         discharge amount</i> .....	34
3. <i>Points to Be Observed     in Operation</i> .....	34

# 1. Preparation

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Carry out the following preparatory steps when starting the pump operation for the first time after installation or after a long-time suspension of the pump operation.

[1] Confirm that the electric wiring has been conducted correctly. (Wiring for proximity switch and electromagnetic valve.)

 **Caution**

Improper wiring may cause burned proximity switch.

[2] Confirm that the air piping has been connected correctly. Check for loose couplings.

[3] Confirm that the pump has been fixed firmly in place.

[4] Confirm that there is no loose coupling along the liquid piping.

[5] Confirm the valves on the suction and discharge piping are fully opened.

[6] Confirm that the tank or bath has been filled with liquid.

 **Caution**

Never fail to conduct a trial run with pure water. Confirm that the trial run indicates no abnormal condition before starting the practical operation of the pump.

[7] Confirm that the filter has been well dampened.

 **Caution**

Follow the description in the instruction manual of the filter.

# 2. Pump Operation

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During the trial run of the pump, flush the unit and piping at the same time. Following is a description of the operation and adjustment of the pump using the AC-1 controller.  
(For pump operation using the FD, SC or FDC-1 controller, refer to the instruction manual of respective controller.)

## 2.1 Starting pump

[1] Supply air to the pump.

- Set the regulator to a specified supply air pressure.

 **Caution**

Set the supply air pressure within supply air pressure range.

Pump type	Liquid temperature range	Supply air pressure range
FS-15-30-60	5-50 deg.C	0.147-0.490 (MPa)
	51-100 deg.C	0.147-0.294 (MPa)
	101-180 deg.C	0.147-0.196 (MPa)

- Open the air supply valve.

 **Caution**

Adjust the supply air valve so that the pump can not run at the speed exceeding the specified max. stroke rate.

[2] Turn on the power switch of the controller. The pump will start operation and the "Operation indicator" LED (blue) on the controller will start flashing.

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## 2.2 Stopping pump

[1] Turn off the power switch of the controller.

The pump will stop operation and the 'Operation indicator' LED will go out.

[2] Make sure the discharge-side valve is open upon stopping the pump.

 **Caution**

Do not close the discharge-side valve upon stopping the pump.

[3] Make sure the system does not allow residual pressure on the discharge side upon the stopping of the pump.

## 2.3 Adjustment of discharge amount(Output)

[1] The discharge amount of the pump shall be adjusted by changing the degree of opening the air supply valve as well as the air flow rate.

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# 3. Points to Be Observed in Operation

Pay attention to the following points during operation.

Upon detecting any abnormal condition, stop the pump immediately and refer to "Causes of Trouble and Troubleshooting."

No.	Inspection Point	Remarks
1	Is pump stroke speed at specified level?	Stroke speed must be within specified one. (Note 1)
2	Is air pressure kept Normal?	Supplied air must be maintained within specified one. (Note 2)
3	Is air volume enough?	
4	Is there any leakage in sealed section of air piping or liquid piping?	
5	Is supply air clean?	

Note 1. Allowable max. stroke rate depends on pump type.

(See Outline of product 4. Specifications on page 8.)

Note 2. Supply air pressure range differs according to liquid temp.

(See Outline of product 4. Specifications on page 8.)

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# ***MAINTENANCE SECTION***

Handling, maintenance and inspection of the pump shall be limited to the range covered by and described in this instruction manual. Handling of the pump beyond the range covered by this instruction manual is prohibited. Iwaki takes no responsibility for injury to person or damage to assets caused from a failure to observe this instruction. Contact Iwaki, an Iwaki branch office, or an Iwaki distributor as necessary.

1. <i>Causes of Troubles and Troubleshooting</i> .....	36
2. <i>Maintenance and Inspection</i> .....	38
3. <i>Consumable Parts</i> .....	39

# 1. Causes of Trouble and Troubleshooting

Trouble	Causes	Countermeasures	Inspection and check points
Pump does not operate.	Faulty selection of electromagnetic valve	① Inspect and repair or replace.	a Use a quick exhaust valve if corrosive gas influences.
	Improper wiring or disconnection in proximity switch	① Inspect and correct wiring. ② Replace if burned.*	a Check if the three wires are arranged as described in the manual. b Check air piping and wiring.
	Bellows are damaged.	① Replace pump head.*	a Check if supply air pressure is lower than the specification. b Check if pump stroke speed is lower than the specification. c Check if liquid temperature is lower than the specification. d Check if residual pressure is removed upon pump stop. e Check if air pipe is too narrow/ long. f Check if suction pipe is narrowed.
	Increased discharge pressure in liquid feeling pipe	① Inspect the filter and replace it. ② Discharge-side valve is closed.	a Check filter for clogging or dry-up. b Check if filter is well dampened. a Open discharge-side valve.
	Supply air pressure or air volume is too low.	① Set back to initial set value. (Reset)	a Set pressure higher than min. operation pressure for electromagnetic valve. b Secure a diameter and air flow rate in consideration of the number of pumps installed.a.
	Malfunction of electrode	① Remove the water content from the wet surface of the pump and the air.	a. Take measures to protect the pump from liquid. b. Only completely dehumidified air should be used for the air supply
Pump operates but no liquid is discharged.	Valve is clogged with foreign matter (such as fragments of wafer, etc.).	① Replace pump head.* ② Suction-side valve is closed.	a Install pump guard filter or the like on pump suction pipe. a Open suction-side valve. Check if valve route is blocked with crystallized substance
	Wear of valve or valve seat.	① Replace pump head.*	

(Note) Repair works marked by \* are conducted by Iwaki.

Trouble	Causes	Countermeasures	Inspection and check points
Discharge volume is reduced.	Supply air pressure or air volume is reduced.  Increased discharge pressure  Valve is clogged with foreign matter. Wear of valve or valve seat  Insufficient NPSHa (Netpositive suction head available)	① Set back to initial set value or review air flow rate.  ② Review discharge conditions.  ① Replace pump head.*  ① Check suction conditions.	a Secure a diameter and air flow rate in consideration of the number of pumps installed.  a Check filter for clogging or dry-up. b Check if air is removed from the filter well. c Check if discharge-side valve is open.  a Install pump guard filter or the like on pump suction pipe.  a Check if suction pipe is too narrow long.
Liquid leaks.	Stud bolt is insufficiently clamped.  Bellows are damaged.	① Replace pump head.*	Tight stud bolt with rated torque. (Keep record of tightening torque for next periodical inspection.)  a Check if supply air pressure is lower than the specification. b Check if pump stroke speed is lower than the specification. c Check if liquid temperature is lower than the specification. d Check if residual pressure is removed upon pump stop. e Check if air pipe is narrow and long. f Check if suction pipe is narrowed.
Excessive air consumption	Wear of shaft packing	Replace packing.*	
Pump function is not balanced.	Wear of valve or valve seat  Faulty selection of electromagnetic valve	① Replace pump head.*  ① Inspect and repair or replace.	a Set pressure higher than min. operation pressure for electromagnetic valve.
Excessive vibration or noise	Pump is not fixed on the equipment properly. Tighten anchor bolt.  Pump stroke speed is excessively high.	① Set pump stroke speed lower than the specification.	a Lower supply air pressure or reduce air flow.

**(Note) Repair works marked by \* are conducted by Iwaki.**

## 2. Maintenance and Inspection

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 **WARNING**

- **Wear protectors**  
Make sure to wear protective gear (protective goggles, cap, mask, etc.) when carrying out maintenance and inspection work.
- **Release pressure out of piping**  
Residual pressure in the piping may force the liquid and cause an unexpected accident. Release the residual pressure before starting the work.
- **Power OFF**  
Make sure no one turns on the power switch while work is being done on the pump. Be sure to turn off the power switch before you start any maintenance/repair work concerning the pump. If the working site is noisy or under conditions of low visibility, you should display a notice which clearly states "Power OFF (Maintenance) " near the power switch in order to inform other personnel about the situation. Power ON executed by any other person than the operator/service personnel may result in a serious accident. The operator must take special precautions to avoid accidents.

### 2.1 Periodic inspection

- [1] Check to ensure stroke speed is not lowered. (This should be done at least once a month.)  
The stroke speed may be lowered due to air leakage causing an air consumption increase. Such a condition may be attributed to the wear of the lip seal. Replace the lip seal as necessary.  
\* This repair work shall be conducted by Iwaki.
- [2] Check if bolts on the housing are loose. (This should be done at least once a month.)  
Release the discharge-side pressure first. Then stop the pump and wait until the pump temperature is lowered to room temperature to tighten the bolt slowly and carefully.  
Fastening torque for FS-15HT1: 9.8N·m  
FS-30HT1: 15.7N·m  
FS-60HT1: 21.6N·m
- [3] Operation of the pump after a long suspension  
Supply air to the pump (approx. 0.196MPa) and confirm there is no air leakage from the pump discharge port before restarting the pump.



### **3. Consumable Parts**

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The consumable parts shown below must be replaced when the time comes as shown on table below. The replacement must be done by IWAKI.

FS-15, 30, 60HT1

Nos. of dwg. on page 11	Parts name	Q'ty	Time to be replaced
1, 2, 4, 5	Pump head unit	1	Two years of actual running time
3	Bellows	2	
22	Lip seal	2	

FS-15, 30, 60HT2

Nos. of dwg. on page 12	Parts name	Q'ty	Time to be replaced
1, 2, 3, 4, 5	Pump head & bellows unit	1	Two years of actual running time
22	Lip seal	2	

Note : Quantity is per unit.



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