ONO SOKKI

FP-213S

POSITIVE DISPLACEMENT TYPE FLOW DETECTOR

INSTRUCTION MANUAL

ONO SOKKI CO., LTD.

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FOREWARD

To make the most effective use of your FP-213S flow detector, please read this manual thoroughly before using the instrument.
The flow detector has been tested in a strict inspection process before shipment to verify that it operates normally. When you unpack the flow detector, make sure that it has not been damaged during shipping.
Should damage have occurred or the product not operate in accordance with specifications, contact your nearest representative.

Operating Precautions

- **Use the flow detector only with applicable fluids.**

  The FP-213S positive displacement type flow detector can be used for measurement of the following fluids:
  - Gasoline (unleaded and leaded)
  - Light oil
  - Fuel oil A
  - Kerosene
  - Petroleum general hydraulic oil

  The use of other fluids can cause corrosion and damage inside the detector. Never use the detector for measurement of fluids other than those listed above.

- **Use the detector in the specified operating temperature range.**

  The ambient temperature and fluid temperature range of the FP-213S flow detector is 0°C to +60°C (without freezing).

- **Avoid using the detector in locations subject to excessive vibration.**

  Since the FP-213S flow detector is a precision instrument, do not use it in locations subject to excessive vibration.
  Dropping the detector, applying excessive shock, or handling it roughly can cause damage and result in failure of the detector.

- **Never allow fluid in the detector to volatilize.**

  The FP-213S positive displacement type flow detector uses the fluid to be measured to lubricate its moving parts.
  If a volatile fluid evaporates between measurements, the detector will not be lubricated sufficiently. Therefore, never allow fluid in the detector to volatilize.
  See section 6, "MAINTENANCE AND STORAGE" for details on storage.

- **Never disassemble the detector.**

  Never disassemble the FP-213S flow detector. If disassembly is necessary, contact your sales representative or the nearest Ono Sokki sales office.

- **Be sure to use the accessory line filter.**

  The FP-213S positive displacement type flow detector incorporates an accessory line filter. Do not remove the line filter from the detector.

- **Flush light oil from the detector before piping.**

  The detector is filled with light oil at the time of shipment. To flush the light oil completely, be sure to supply a sufficient amount of the test fluid into the detector before proceeding.

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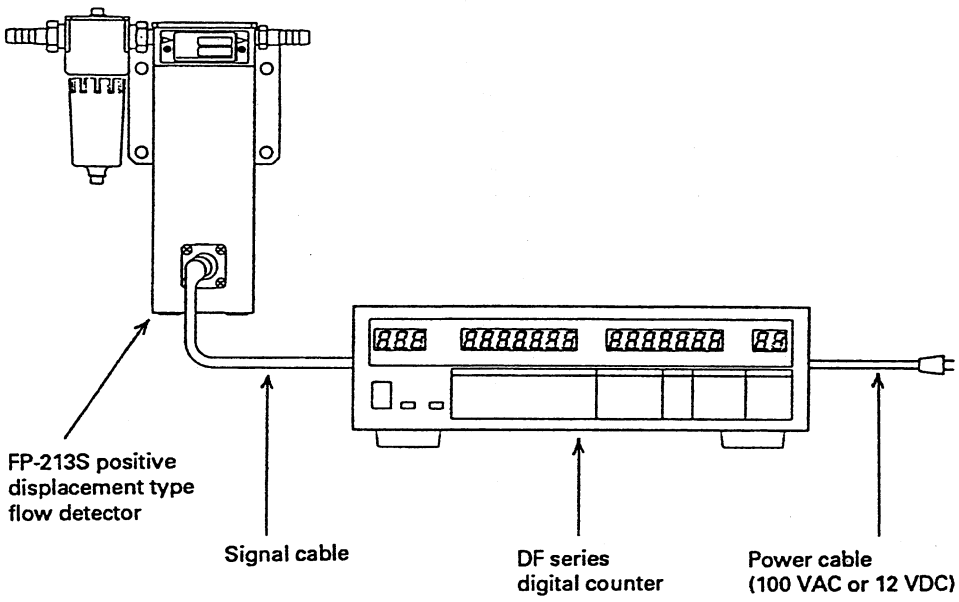
Section 1
OVERVIEW

1.1 Overview
1.2 System Configuration

1.1 Overview

The FP-213S is positive displacement type flow detector that employs pressure-loss compensation to measure instantaneous and integrated flow rates of fluids, in combination with the DF series digital counters.
The detector consists of four major sections: a flow rate/rotation converter that converts flow rates into crankshaft rotation through reciprocating motion of four pistons; a rotation pulse generator that transmits crankshaft rotation to an optical slit disk, converting it into pulse signals; a pressure difference detector that detects the difference in pressure at IN (fluid inlet) and OUT (fluid outlet) positions; and a servo-motor that is used to compensate for pressure loss.
Pulse signals are detected by two sets of optical photo detectors having a phase difference of 90°, so the direction of rotation can be discriminated and the flow rate accurately measured unaffected by reversed or pulsating flow.

1.2 System Configuration

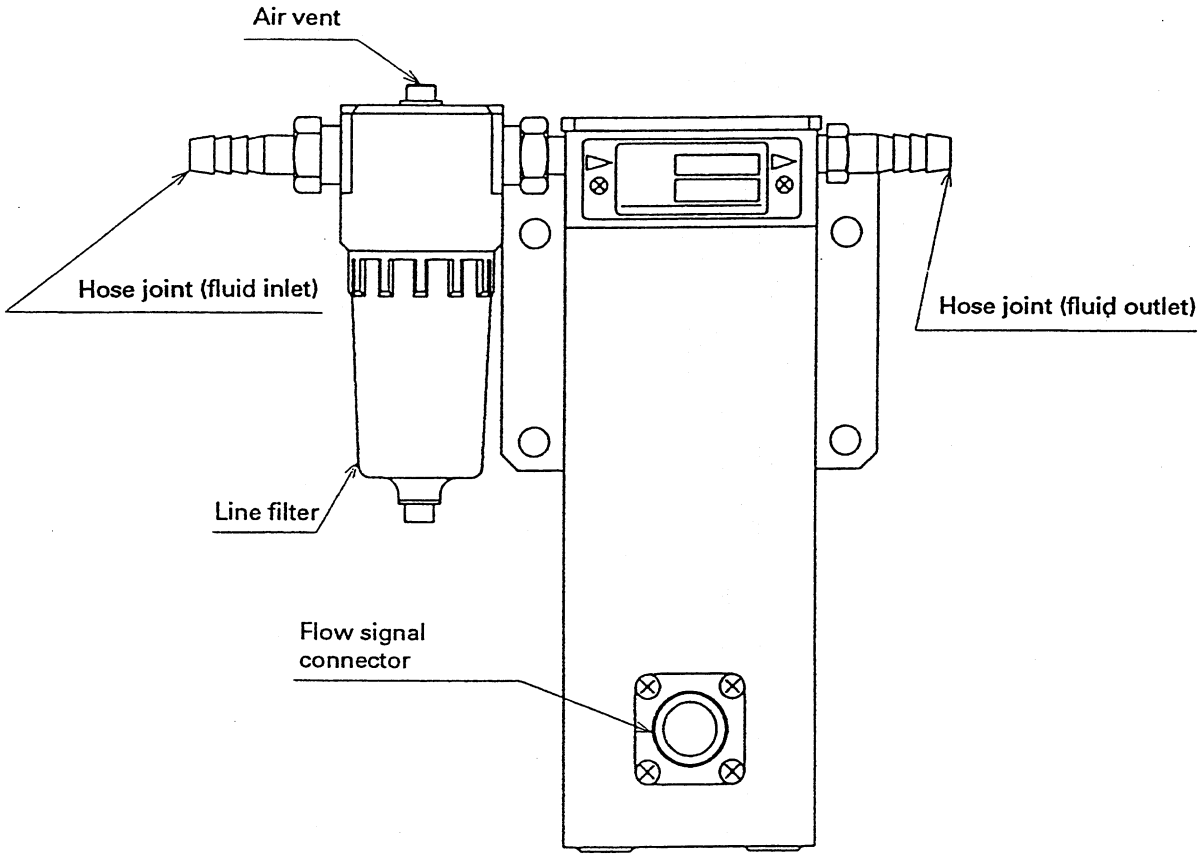


Detector type	Flow rate signal cable	Counter	Items to be measured	Output signal
FP-213S	FP-0011 (5 m) FP-0012 (10 m) FP-0014 (20 m)	DF-2410	Instantaneous and integrated flow rates and elapsed time	Analog and pulse signals GP-IB BCD (option) RS-232C (option)
		DF-210	Instantaneous and integrated flow rates	Analog and pulse signals
		DF-250	Instantaneous and integrated flow rates and elapsed time	Analog and pulse signals
		DF-311	Instantaneous and integrated flow rates	Analog and pulse signals BCD (option)
		DF-312	Instantaneous and integrated flow rates and elapsed time	Analog and pulse signals BCD (option)
		DF-2420	Instantaneous and integrated flow rates, elapsed time, temperature, and pressure	Analog and pulse signals GP-IB RS-232C (option)
		DF-313	Instantaneous and integrated flow rates, elapsed time, temperature, and pressure	Analog and pulse signals BCD (option)
		DF-315	Instantaneous and integrated flow rates, elapsed time, distance, rotation, speed, temperature, pressure, fuel efficiency, and cylinder injection rate	Analog and pulse signals BCD
		DF-320	Instantaneous and integrated flow rates, elapsed time, distance, rotation, speed, temperature, pressure, fuel efficiency, cylinder injection rate, torque, and horse power	Analog and pulse signals GP-IB and RGB
		DF-321	Instantaneous and integrated flow rates, elapsed time, distance, rotation, speed, temperature, pressure, fuel efficiency, cylinder injection rate, torque, and horse power	Analog and pulse signals GP-IB and RGB
		DF-210 + DF211	Instantaneous and integrated flow rates, elapsed time, temperature, and pressure	Analog and pulse signals

Notes:
- For measurement of some items, sensors other than the FP-213S are required.
- When using the FP-213S together with the DF-311, DF-312, DF-313, or DF-315, modification is required. Consult our sales office.

Section 2
NOMENCLATURE

Nomenclature



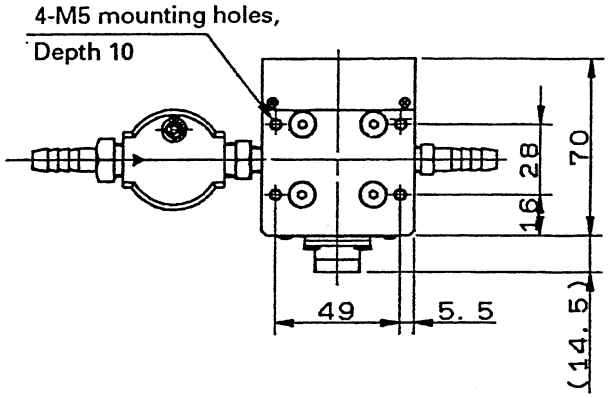
Section 3
INSTALLATION AND MOUNTING

3.1 Notes on Installation
3.2 Mounting

3.1 Notes on Installation

① Install the detector so that it is perpendicular to the ground (plumb), with an allowable angle range of ±15°.

② When fastening the detector, use the accompanying fittings. Even if other fittings are to be used, use the four M5 threaded holes at top of the detector to secure it.



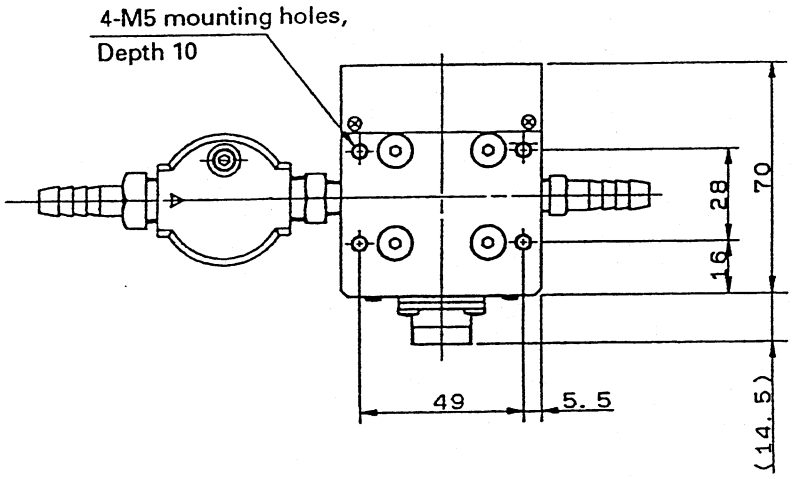
③ Since the detector is a precision instrument, install it in a location where the ambient temperature is within the rated ambient temperature range (0°C to 60°C) and where it will be subject to minimum vibration.

④ When using the detector with the gravity-drop method, in which the fuel supply pressure is provided by gravity, install it in a location lower than the fuel tank, so that neither dead air nor negative pressure can develop.

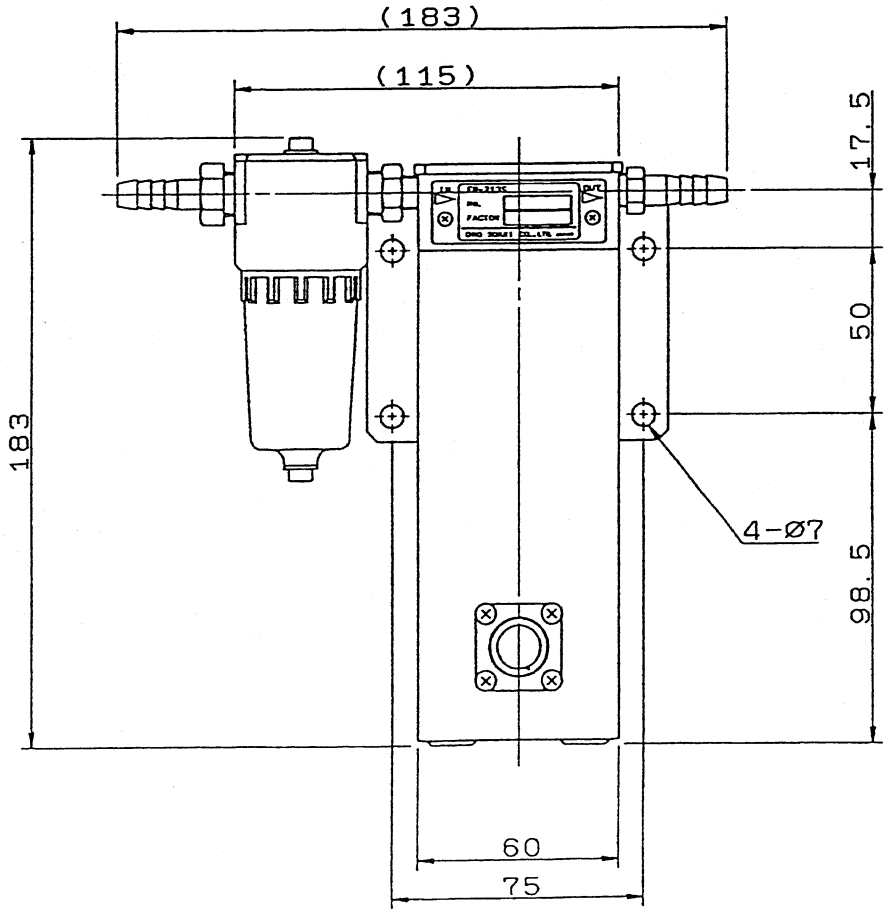
⑤ The detector incorporates an accessory line filter. Do not remove the line filter from the detector.

3.2 Mounting

Mounting fittings



Mounting dimensions



Section 4
PIPING

4.1 Piping Precautions
4.2 Piping Examples

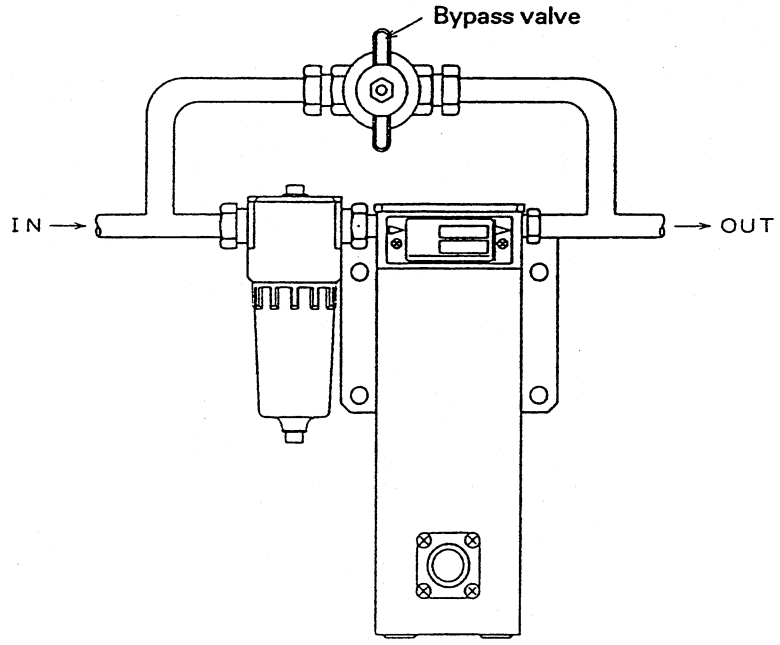
4.1 Piping Precautions

① Never remove the accessory line filter from the detector.

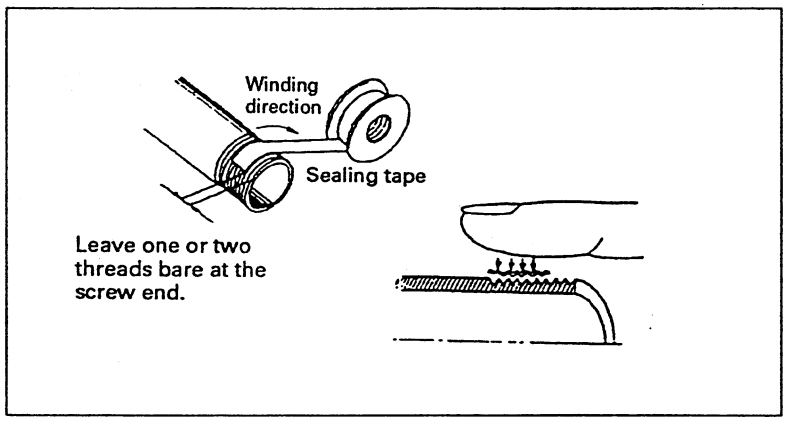
② Before piping work, make sure that IN (fluid inlet) and OUT (fluid outlet) connections are not reversed.

③ Power must not supplied during the piping work. When the signal cable is connected, if the power switch of the DF series digital counter is turned on, power is supplied to the detector.
During piping work, make sure that the power switch of the digital counter remains turned off and no signal cables are connected.

④ If power is not supplied to the detector, the pressure loss compensation function will not work, resulting in a large pressure loss. For this reason, it is recommended that a bypass valve be provided in the flow path, as shown below, to accommodate the maintenance of systems to be measured (engines, etc.), the purging of air from pipes, thus avoiding conditions that can cause detector malfunction (such as scuffing).



⑤ Care is required when using wound sealants such as sealing tape.
When replacing a joint, securely wind teflon sealing tape once or twice around the threads, leaving one or two threads bare at the screw end. When using fluid sealant, be careful not to get any sealant inside the pipe.



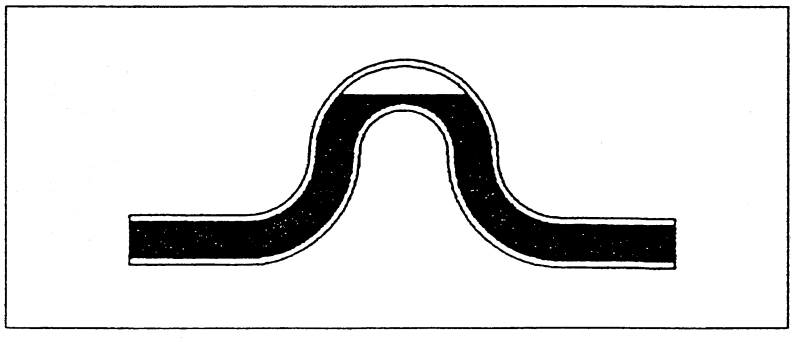
The standard tightening torque for joint is as follows:

Type	Screw size	Tightening torque
FP-213S	R1/8	40 kgf•cm
FP-213S	R1/4	50 kgf•cm

⑥ Before connecting the detector to the pipes, thoroughly flush fluid from the front and rear pipes.

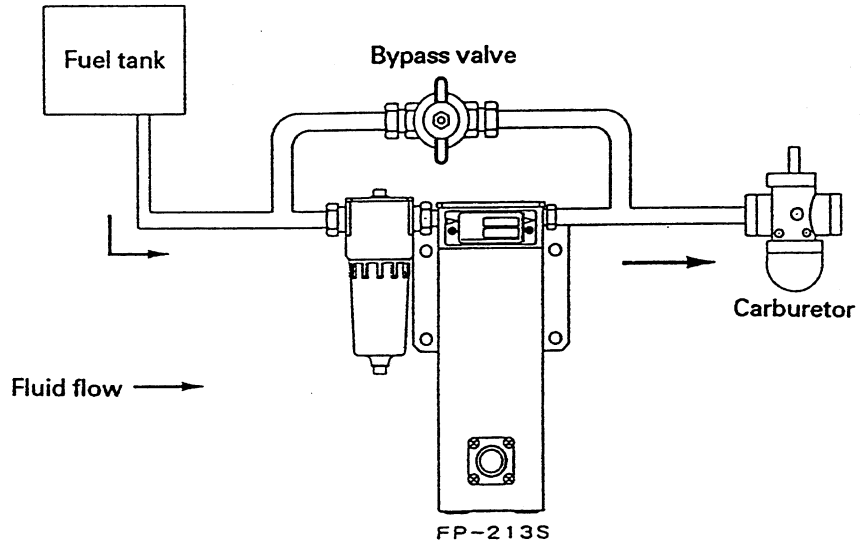
⑦ When using rubber hose for piping, *be sure to fix it with hose bands so that it cannot come off the hose joints*.
Inspect the rubber hose periodically and check that there is no deterioration. If there is any, replace the hose with a new one.

⑧ Avoid making the pipe arrangement shown below. If there is a hump in the pipe arrangement, air is likely to be trapped at the top of the pipe, from where it is hard to remove. Trapped air prevents accurate measurements.

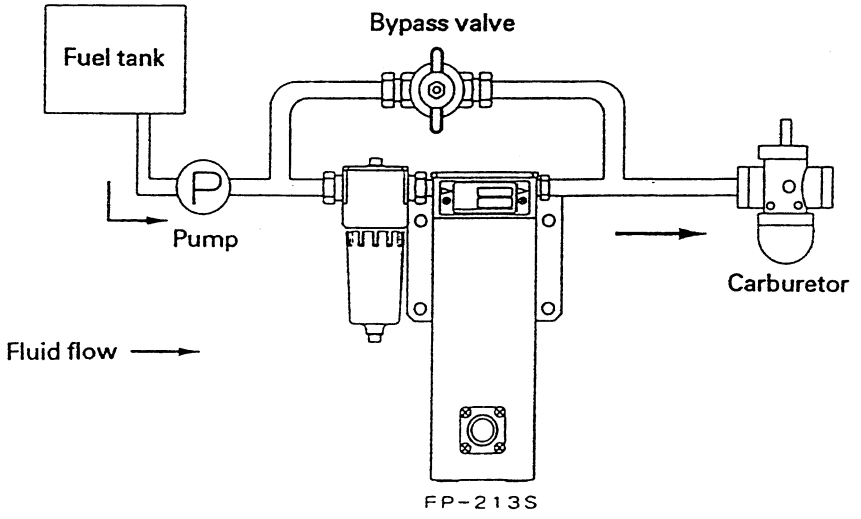


4.2 Piping Examples

For carburetors without fuel return equipment (with gravity-drop):

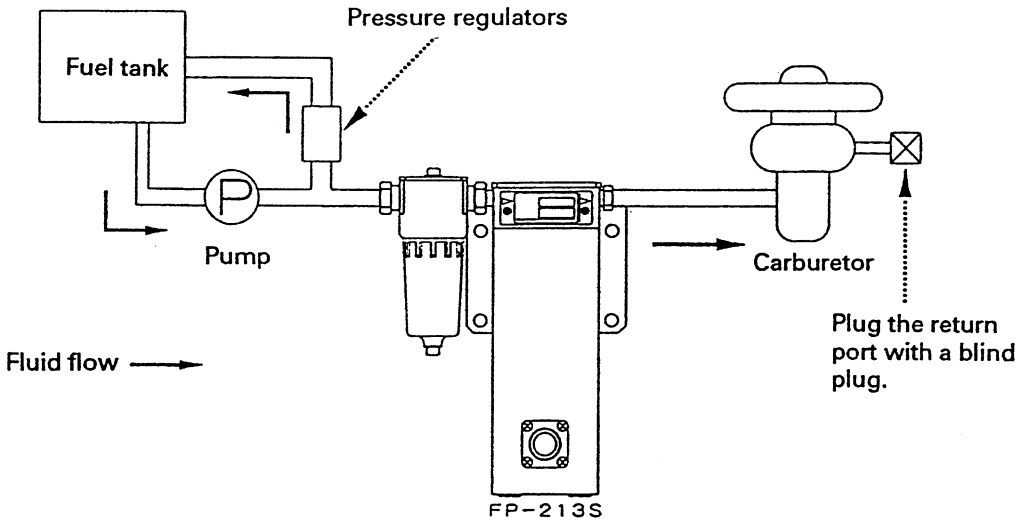


For carburetors with a fuel pump:



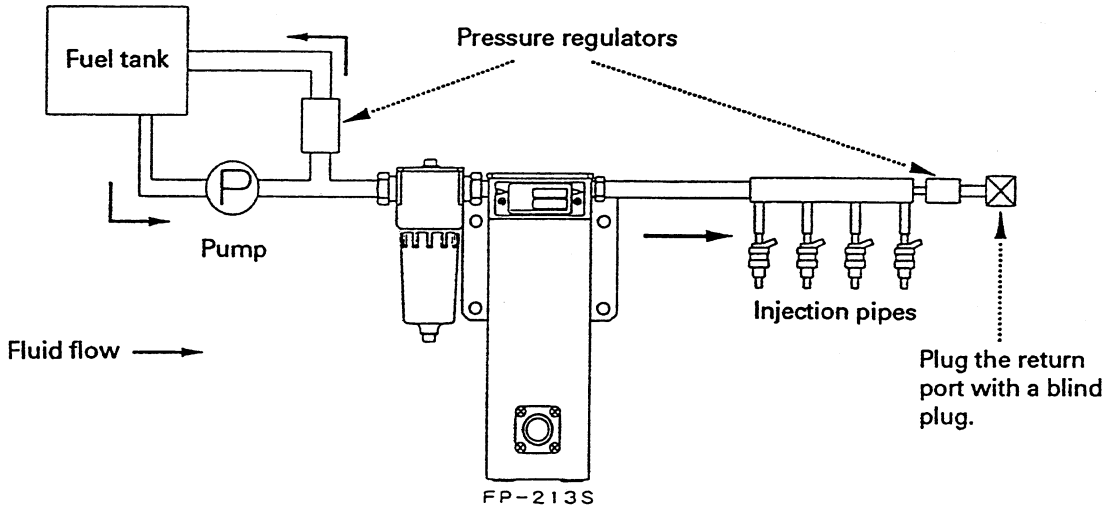
For cab-return systems:

Fuel pressure is regulated by the carburetor, and fuel is returned from the carburetor to the fuel tank.



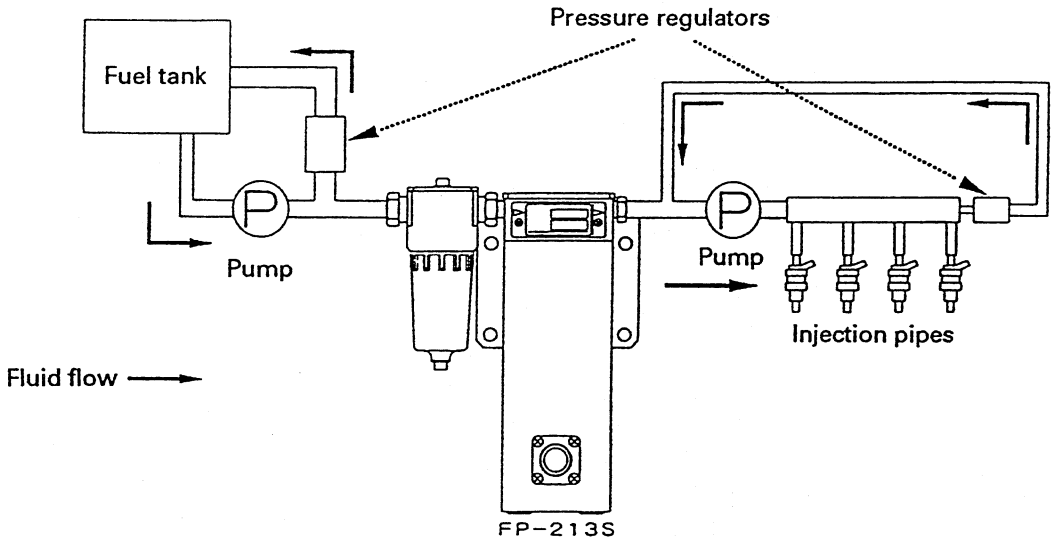
For electronic fuel injection systems:

When the FP-213S is used at the high pressure side



For electronic fuel injection systems:

When the FP-213S is used at the low pressure side



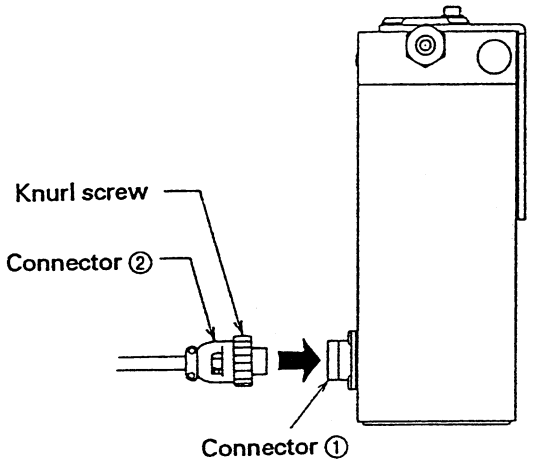
Section 5
MEASUREMENTS

5.1 Preparing for Measurement
5.2 Setting the FACTOR Value
5.3 Checking the Piping
5.4 Supplying Fluid
5.5 Purging of Air

5.1 Preparing for Measurement

■ **Connecting the flow rate signal cable**

Connect one end of the signal cable to the detector as shown below, then connect the other end to the SIG IN FLOW connector of the DF series digital counter.

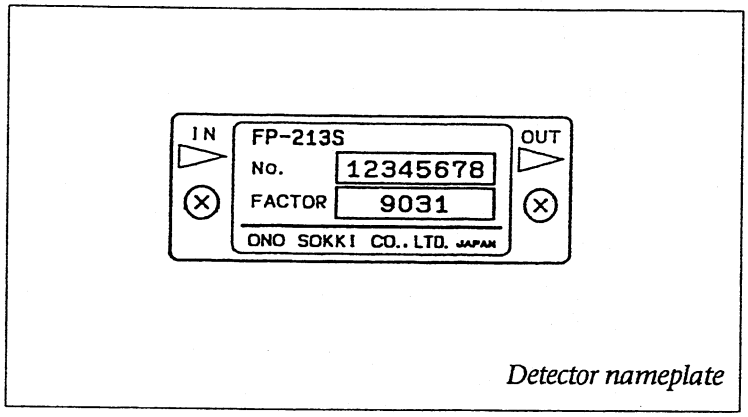


Aligning the notches of connectors ① and ②, insert connector ② into connector ① and then turn the Knurl screw clockwise to secure connector ②.

Detector type	Flow rate signal cable (option)		
FP-213S	FP-0011 (5 m) FP-0012 (10 m) FP-0014 (20 m)	[FP side connector] JMSP-1305F	[DP side connector] RM12BPG-5S

5.2 Setting the FACTOR Value

Before starting measurement, set the FACTOR value of the detector on the DF series digital counter. For details on how to set the FACTOR value, see the digital counter's manual.
Each detector has its own FACTOR value, which is inscribed on its nameplate in form of a four-digit number. Before measurement, check that the FACTOR value of the detector to be used has been set on the counter.



Detector nameplate

5.3 Checking the Piping

① Before supplying fluid, check that piping has been made correctly.
② Make sure that rubber hose joints are fixed securely with hose bands.
③ Carefully check that no fluid is leaking or oozing from any section of pipe.

5.4 Supplying Fluid

① Turn on the power switch of the DF series digital counter.
If piping for the detector is not complete, do not turn on the power of the counter.

② First, make a small fluid flow (with a flow rate of no more than 5 ℓ/h).

③ After the detector has been filled with the fluid, gradually increase the flow rate.

Note: The flow rate/rotation converter of the detector is lubricated with the fluid to be measured. Therefore, supplying a large amount of fluid to the detector before it is filled with the fluid can cause scuffing of the moving parts and malfunction of the detector .

5.5 Purging of Air

Before starting measurement, completely purge air from the detector and pipes. Incomplete purging of air can cause measurement errors and an unstable instantaneous flow rate.

■ **When a bypass valve is provided**

① Fully open the bypass valve to start supplying the fluid.

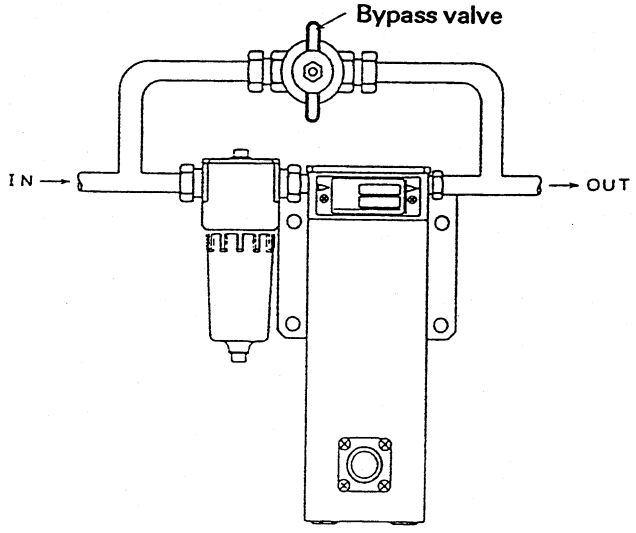
② Leaving the bypass valve open, maintain the fluid flow so that the air in the front and rear pipes is purged completely.

③ After air has been purged from the pipes, slowly close the bypass valve to purge air from the detector. At the same time, to prevent excessive instantaneous fluid flow, adjust the bypass valve opening while monitoring the indicated value of the instantaneous flow rate on the digital counter.

④ Close the bypass valve all the way to complete the purging of air from the detector and pipes.

⑤ Turn the AIR VENT valve at the top of the filter with a wrench to purge air from the detector. When loosening the AIR VENT valve, cover it with a cloth to prevent fluid blowout.
Be sure to close the AIR VENT valve before starting any measurement.

⑥ Turn the digital counter's power switch on and off several times.



Note: If the indicated value of the instantaneous flow rate fluctuates largely while fluid is flowing, there has been insufficient purging of air.

■ **When a bypass valve is not provided**

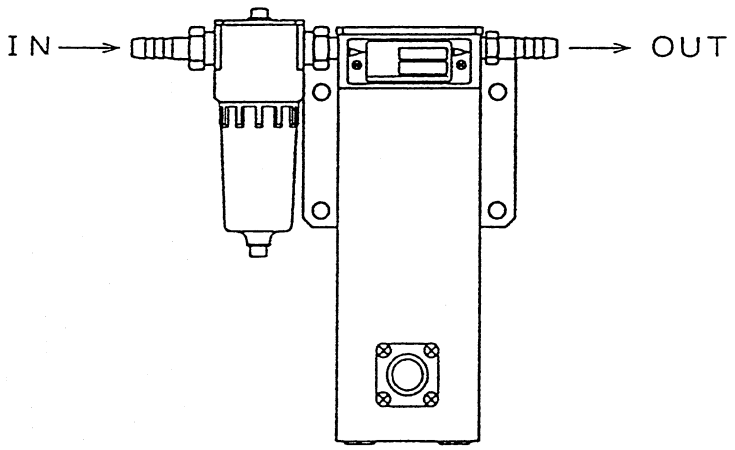
① Choose a detector setting that avoids excessive fluid flow. Then start supplying the fluid.

② Gradually increase the flow rate while monitoring the indicated value of the instantaneous flow rate on the digital counter, avoiding excessive fluid flow.

③ Maintain a high flow rate for the period of time necessary to purge air from the detector and pipes.

④ Turn the AIR VENT valve at the top of the filter with a wrench to purge air from the detector. When loosening the AIR VENT valve, cover it with a cloth to prevent fluid blowout.
Be sure to close the AIR VENT valve before starting any measurement.

⑤ Turn the digital counter's power switch on and off several times.



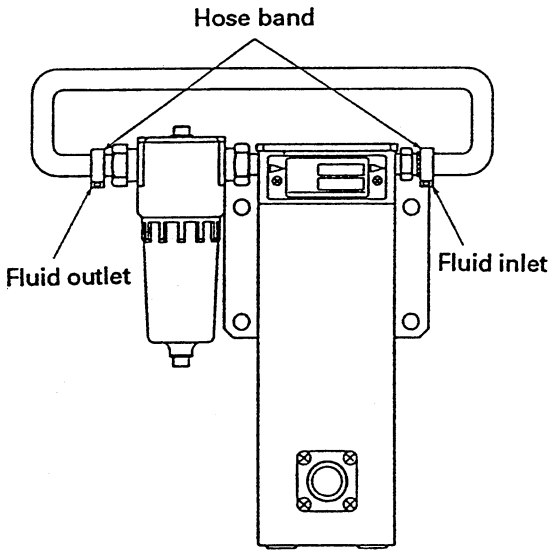
Note: If the indicated value of the instantaneous flow rate fluctuates largely when fluid is flowing, there has been insufficient purging of air.

Section 6
MAINTENANCE AND STORAGE

6.1 Storing the Detector
6.2 Inspection and Cleaning the Filter and Filter Element
6.3 Routine Inspection and Calibration

6.1 Storing the Detector

After measurement is completed and piping has been disassembled, connect the fluid inlet and the fluid outlet to hose fixed by hose bands, as shown at right, so that it cannot come off the hose joints.



Caution:

When storing the detector for a long period after measuring a volatile fluid like gasoline, fill the detector with non-volatile fluid such as light oil. Then make the above arrangement for storage.

Reasons for the Arrangement

- To prevent foreign matter from entering from the fluid inlet or output of the detector.
- To prevent leakage of fluid.
- To prevent fluid in the detector from evaporating or hardening, maintaining sufficient lubrication of the detector internal parts.

6.2 Inspection and Cleaning the Filter and Filter Element

The filter element is made of stainless steel micro mesh that can be used repeatedly. Inspect the filter element periodically and, if necessary, clean it.
When attaching a filter element in the filter and when reassembling the filter case, be careful not to allow dust or dirt to enter inside. Also be sure to set the O-ring correctly. If you perceive any flaw in the sealing O-ring, replace it with a new one.
The specified filter type is as follows:

Filter **EH-106**

6.3 Routine Inspection and Calibration

To ensure the best performance and operating conditions of the detector, conduct routine inspection and calibration. Contact your sales representative for details.

Section 7
TROUBLESHOOTING

Phenomenon	Cause	Possible Solution
The indicated value of the instantaneous flow rate is unstable.	Air remains in the detector and pipes.	Purge air completely. (See subsection 5.5, "Purging of Air".)
	The fluid supply pressure is insufficient with respect to the flow rate.	Raise the fluid supply pressure and check piping again.
	The fluid inside pipes or the detector has vaporized.	Move the detector and pipes away from any heat source. Raise the fluid supply pressure. Cool down the fluid using an oil cooler.
	The ripple or servo adjustment of the detector is out of proper range.	**Request for repair.**
The fluid does not flow smoothly.	Piping is partly blocked.	Remove the blocked section.
	The filter element is clogged with dust.	Clean the filter element.
	Power is not supplied to the detector.	Turn on power to the detector.
	Air is trapped in the piping (for gravity-drop).	Purge the air.
The fluid is flowing, but the digital counter stays at zero indication.	The signal cable is not connected.	Connect the signal cable.
	IN (fluid inlet) and OUT (fluid outlet) connections are reversed.	Connect IN (fluid inlet) and OUT (fluid outlet) correctly.
	The FACTOR value on the digital counter is set to 0000.	Set the FACTOR value of the counter correctly.
	The bypass valve is open (when it is provided).	Close the bypass valve.
The fluid does not flow.	The fluid supply pressure falls to zero.	Raise the fluid supply pressure.
	The detector has stuck.	**Request for repair.**
	Air is trapped in the piping (for gravity-drop).	Purge the air.

Phenomenon	Cause	Possible Solution
At low flow rates, the counter indicates zero; at high flow rates, it indicates a low value.	The bypass valve is open.	Close the bypass valve.
At low flow rates, the indicated value is unstable.	The detector does not move smoothly.	**Request for repair.**
The measured flow rate is different from the actual value.	The FACTOR value of the counter is not set correctly.	Set the FACTOR value of the counter correctly.
	Because of improper piping, return flow rate is also measured.	Configure the piping properly. (See subsection 4.2, "Piping Examples".)

Section 8
SPECIFICATIONS

Item to be measured : Flow rate

Detecting method : Positive displacement type (positive type)

Applicable fluids : Gasoline (unleaded and leaded), light oil, fuel oil A, kerosene, and general petroleum hydraulic oil

Material of wetted part :

Flow rate detecting section:

Parts	Material
Body, side plate, connecting rod, bearing case, pin, crankshaft, and top plate	SUS303
Piston	SUS303 + Hard chromium plating
Bearing, crank pin	SUS440C
Magnetic coupling	MAP-100
E-ring	SUS304
O-ring	FPM

Pressure difference detector :

Parts	Material
Bypass valve	Pyrex glass
O-ring	FPM
Others	PEEK, Polyacetal resins, NBR, Carbon

Filter section :

Parts	Material
Case	ZDC2, ADC12, SS41, FPM, SUS304
O-ring	FPM
Element	SUS303, SUS304, Nickel plating

Measuring range	:	0.06 to 60 ℓ/h
Measurement accuracy	:	Within ±0.5% of the reading value (over the entire measurement range)
Number of pulses	:	120 pulses/approx. 1.1 mℓ
Pressure loss	:	1 mmH_2O or less (excluding the pressure loss of the filter section)
Resolution	:	0.01 mℓ
Line filter (standard)	:	Filtering capacity : 5 µm (Type EH-106), Filter element : Incorporated in the filter.
Applicable counter	:	DF series digital counters DF-2410, DF-210, DF-311, DF-312, etc.

Output signal (flow rate) :

Cable (option)	:	For connection of the FP-231 and DF series digital counters FP-0011 (5 m), FP-0012 (10 m), FP-0014 (20 m)
Connector	:	Detector side : JMR-1305M Cable side : JMSP-1305F
Pin assignment	:	

1 SIG1
2 SIG2
3 COMMON
4 Shield COMMON
5 Power supply (12 VDC)

Detector side

Inlet and outlet joints :

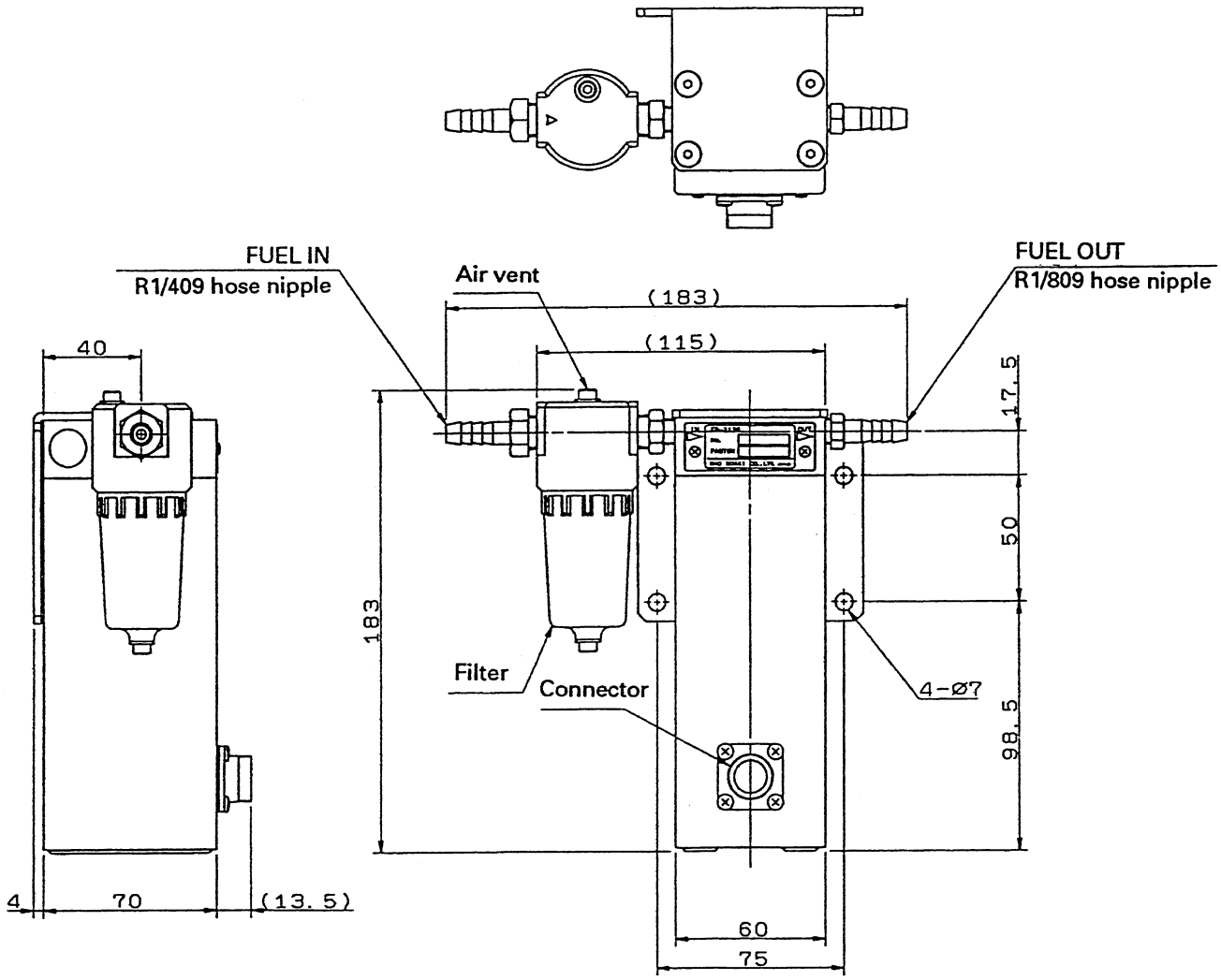
Fluid inlet	:	R1/4 ø9 (outer) x ø6 (inner) (hose joint)
Fluid outlet	:	R1/8 ø9 (outer) x ø6 (inner) (hose joint)

General specifications

Maximum operating pressure	:	Detector : 980 kPa Line filter : 980 kPa
Operating temperature	:	0°C to 60°C
Power supply	:	12 VDC (8 to 15 V) supplied from DF series digital counters
Power consumption	:	8.5 VA maximum (12 VDC)
Weight	:	Approx. 2.5 kg (including the line filter)
Accessory	:	Line filter (incorporated in the detector) Operating manual

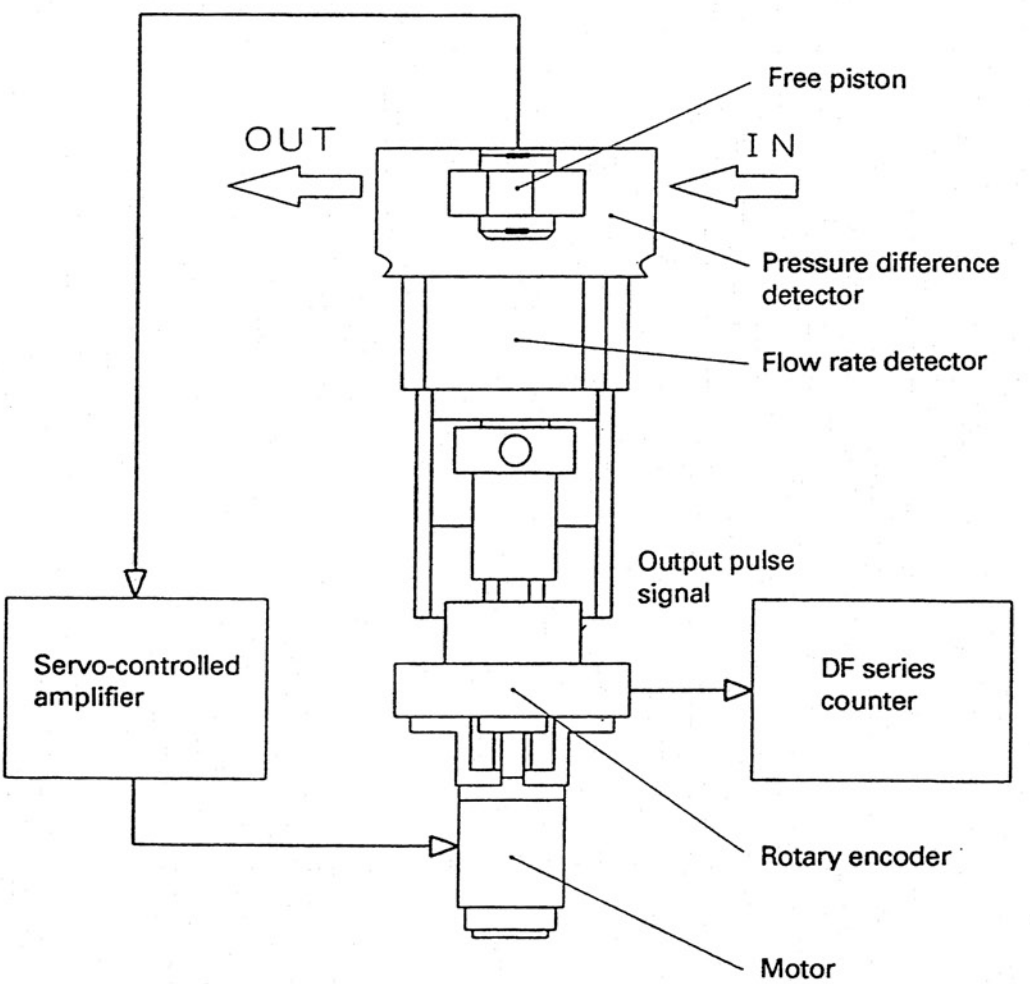
Outside Dimension

PF-213F



Mechanism and Operating Principle

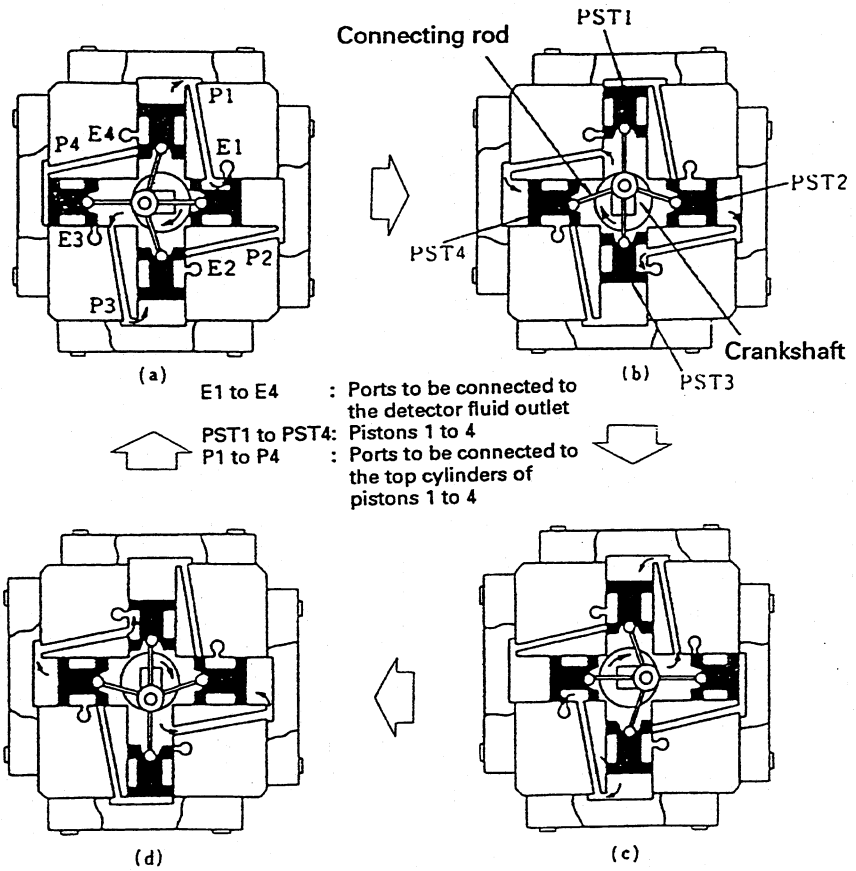
Mechanism



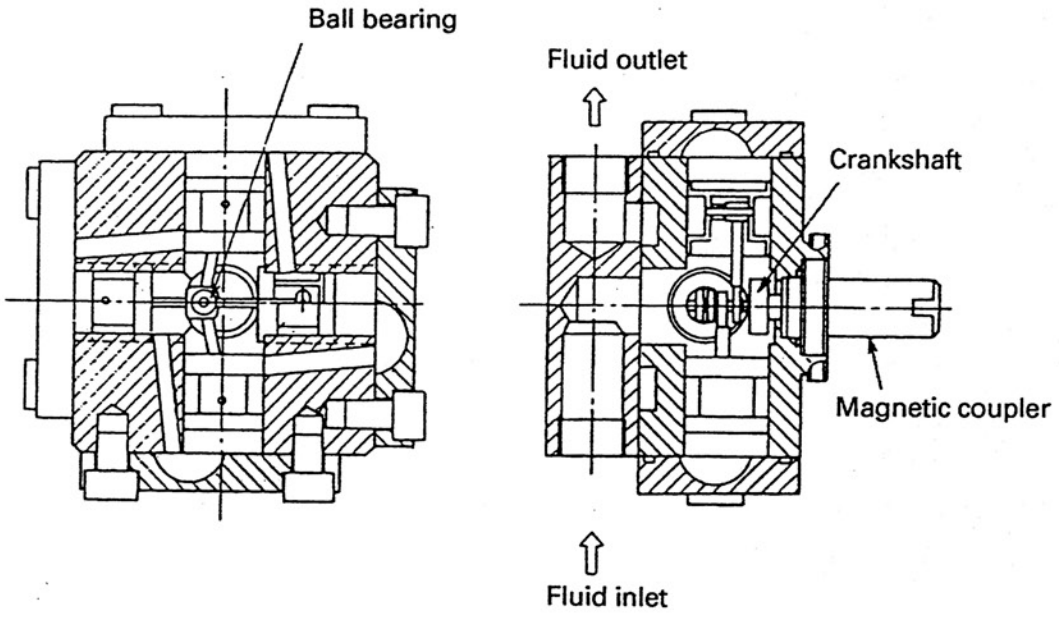
Detection of Flow Rates

The reciprocating motion of four pistons arranged in a radial pattern inside the detector is converted into rotating motion by the crankshaft. The cylinder section is mechanically isolated from the rotary encoder, whereas the crankshaft and the rotary encoder are connected by a magnetic coupler.
The rotary encoder generates a pulse signal that corresponds to the displacement of the pistons or flow rate. The DF series digital counter measures instantaneous and integrated flow rates based on the pulse signal and displays these values.

Operating Principle of Flow Rate/Rotation Converter (1)



Operating Principle of Flow Rate/Rotation Converter (2)



Pressure Loss Compensation

The free piston inserted into the bypass valve connecting the fluid inlet and outlet of the detector is moved by a minute pressure difference of 1 mmH_2O or less. When the pressure at the inlet is higher than that at the outlet, the free piston moves toward the outlet; when the pressure at the inlet is lower than that at the outlet, it moves toward the inlet.

The position of the free piston is detected by an eddy-current sensor, and a motor coupled with the rotary encoder is servo-controlled so that it is positioned at the neutral position (with zero pressure difference), thus compensating for pressure loss.

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*Outer appearance and specifications are subject to change without prior notice.
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WORLDWIDE
ONO SOKKI CO., LTD.
3-9-3 Shin-Yokohama, Kohoku-ku,
Yokohama 222-8507, Japan
Phone : +81-45-476-9712
Fax : +81-45-470-7244
E-mail : overseas@onosokki.co.jp

B00000747/IM93100101(1) 09Y(MS)010