2202M4JE-MY-iS2-N_2015.06.

MYCOM

i-Series Screw Compressor Instruction Manual

i125S / i125L
i160S / i160M / i160L

This manual is applied to each compressor after the serial number shown below.

i125S: 8750303 i125L: 8770301
i160S: 8710055 i160M: 8720018 i160L: 8730030

CAUTION

Before operating, servicing, or inspecting this product, read this manual thoroughly to fully understand the contents.
Keep this instruction manual in a safe, designated place for future reference whenever the manual is needed.
Specifications of this product and contents of this manual are subject to change without prior notice due to technical improvements, and the like.

MYCOM MAYEKAWA MFG. CO., LTD.

Preface

Thank you for purchasing our MYCOM i-series screw compressor (hereinafter referred to as "this product").
This instruction manual (hereinafter referred to as "this manual") provides safety information and operation and maintenance procedures, so that users correctly understand how to handle this product and, as a result, can use it safely and efficiently.

Before installing or using this product, make sure you read this manual.
Keep this manual in a safe place near this product for quick reference.

Revision History

Title	Document No.	First edition issue date
i-Series Screw Compressor Instruction manual	**2202M4JE-MY-iS2-N_2015.06.**	**April 28, 2014**

Revision No.	Issue Date	Major contents of revisions	Created / approved by:
00	April 28, 2014	Newly issued as applicable to the product after May 2014, due to modification of the i-series specifications.	Muta / Ikeda, Hirao
01	Sep. 24, 2014	Added models for IEC motor flange specifications.	Amanuma, Kato / Ikeda, Hirao
02	**June 01, 2015**	**Modified the constitution of Chapter 4 and Chapter 5. Added the basic multi-packaging points using plural i-sereis compressors.**	**Kitahara, Fujimoto / Ikeda**

Warranty and Disclaimer

Warranty Clauses

MAYEKAWA shall repair or replace parts of this product for no charge if any failure resulting from defects in design or manufacture occurs, under normal use with the purpose and method that are in accordance with the specifications of this product and this manual, within the warranty period.

The warranty period is "12 months from factory shipment of this product". If there is a separate agreement, that agreement shall prevail in principle.

MAYEKAWA is not liable for production or man-made disaster compensation due to malfunction or damage of this product.

Disclaimer of Warranty

Although MAYEKAWA warrants the clauses mentioned above, the following clauses are exempted.

- Malfunction or damage of this product caused by natural disaster, or other accidental forces (such as fire, thunderbolt, windstorm, intense rainfall, flood, tidal wave, earthquake, land subsidence, etc.).
- Malfunction or damage caused by misusage described below.
  - Malfunctions, damage, or deterioration of this product due to abnormal or improper use (including improperly storing this product outdoors or under too hot/humid conditions, unexpected inspections, tests, operations, too frequent liquid flow-back operation*, and too frequent start-stop cycles, etc.).
  - Malfunction or damage caused by devices or equipments not provided by MAYEKAWA including operation control methods of those devices.
  - Malfunction or damage caused by refrigerants, gases, or refrigerant oils, and operating conditions (design conditions) not approved for this product.
  - Malfunction or damage caused by maintenance or inspection not recommended by MAYEKAWA.
  - Malfunction or damage caused by parts that are not MYCOM genuine.
  - Malfunction or damage caused by remodeling the product without approval of MAYEKAWA.
  - Malfunction or damage caused by unexpected misusage

"Liquid flow-back operation" is ・・・

Normally, while the compressor sucks in the refrigerant liquid only after vaporizing it in the evaporator, it may directly sucks it in because of the faulty adjustment or failure of the expansion valve. We call this state of compressor operation "liquid flow-back operation".

No compressor can compress a liquid. The compressor may be damaged should the liquid be sucked in.

Important Information

Intended Use of this Product

This product is a general-purpose screw compressor for refrigeration and cold storage. Do not use this product for any other purposes that are not intended for or which depart from the specifications. For specifications of this product, refer to "2.3 Compressor Specifications".
Please perform the maintenance items described in this manual by using safe and assured procedures.

Important Information for Safe Use of this Product

Although MAYEKAWA has paid a lot of attention to safety measures for this product, all hazards including potential hazards caused by human errors, or due to environmental conditions can not be anticipated.
As there are too many items to be strictly observed or prohibited when using this product, it is impossible to inform all of them through this manual or warning labels. Therefore, when operating this product, pay extreme caution on personnel safety as well as on items described in this manual.
Important rules for safety work with this product that apply to all workers including managers and supervisors are listed below.
Please read this manual before using this product. Fully understand the instructions provided there, and be sure to perform the safety procedures described in this manual.

- Operation, maintenance, and inspection of this product should be performed by qualified personnel educated about the fundamentals of this product and trained about hazards involved and measures to avoid danger.
- Do not allow any person other than those educated on the fundamental expertise of this product and trained about hazards involved and measures to avoid dangers to approach this product while it is operating or during maintenance.
- Observe all related federal/national and local codes and regulations.
- To prevent accidents, do not carry out any operation or maintenance other than those described in this manual. Do not use this product for any purpose other than intended.
- Replace the parts with the MYCOM genuine parts.
- Not only workers but also managers should actively participate safety and health activities in the workplace to prevent accidents.
- When closing or opening a valve during work, make sure to apply lockout/tagout to prevent the valve from being accidentally closed or opened during the work.

[Lockout] To lock with a key in order to keep people, except the workers involved, from operating the product.

“Lockout” means disconnecting or keeping disconnected machines and devices by locking their energy (power) sources. Lockout is not just simply turning off the power switches to stop the supply of power, but includes immobilizing them with a key or similar device to keep any blocked switches from being operated.
Lockout devices are devices such as keys, covers, and latches, to immobilize switches, valves, opening and closing levers, etc., with a state of being locked.

[Tagout] To prevent any inappropriate work by hanging tag plates indicating "work in progress".

“Tagout” means to clearly indicate, by hanging tag plates, that a device is in lockout and that operation of the device is prohibited. Tag plates forbidding operation, starting, opening, etc. are warnings clearly stating to not operate energy (power) sources, and are not for stopping blocking devices.

Observe the following precautions when performing maintenance work on electrical control.

- Electrical maintenance of the product must be performed by certified/qualified personnel and only those educated about the electrical control of the product.
- Before servicing or inspecting the electrical equipment or devices, turn "OFF" the motor main power and control power, and perform lockout/tagout to prevent the power from being turned on during work.

Even when the motor main power and control power are turned "OFF", this product may be turned on if the power is supplied from outside the package unit in which this product is used. Make sure the power supply on the power source side is shut off, and perform lockout/tagout to prevent the product from being turned on during work.

About This Manual

- This product may be modified without prior notice. Therefore, the appearance of actual machine may differ from the descriptions in this manual. If you have any questions, contact our sales offices or service centers. For each sight of MAYEKAWA, refer to "Contact Information" in this manual or following URL. http://www.mayekawa.com/about/network/
- This manual is in English. If any other language is required, it is the customers’ responsibility to prepare a manual for safety education and operation instructions.
- This manual is copyrighted. Drawings and technical references including this manual shall not, in whole or part, be copied, photocopied, or reproduced into any electronic medium or machine-readable form without prior permission from MAYEKAWA.
- Photographs or drawings included in this manual may differ from the appearance of actual product.
- If this manual is lost or damaged, immediately request to one of our local sales offices or service centers for a new manual. Using this product without the manual may result in safety issues.
- When you resell this product, be sure to transfer this manual to the next owner.

Structure of This Manual

Chapter/Section Title	Description
Preface	Describes the outline of this manual and how to read this manual.
Warranty and Disclaimer	Describes what MAYEKAWA warrants and what are covered by the warranties. Warranty exemption is stated as disclaimer.
Important Information	Describes important information related to this product and this manual.
1. Safety	Describes safety information for the worker, safety rules for this product, and management details regarding the work safety that is required for handling this product.
2. Compressor Specifications and Configuration	Describes the main components of this product, functional information, specification, operating limits, drawings, and parts list.
3. Installation	Describes the installation procedure of this product.
4. Compressor and Package Unit Operation	Describes the precautions for operating this product and the package unit..
5. Maintenance and Inspection	Describes sections and period for inspecting, and assembly and disassembly of this product.
6. Troubleshooting	Describes troubleshooting methods for this product in case problems occur during operation of this product.
7. Related Documents	List of disassembly tools for i-series compressor, and other information
Appendix 1 : Packaging Points 1	Describes basic points for the design and manufacture of a i-series compressor package unit.
Appendix 2: Packaging Points 2	Describes basic multi-packaging points using plural i-sereis compressors.
Contact Information	Describes contact information for our local sales offices or service centers, which are for ordering MYCOM genuine parts.

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Appendix 1: Basic Points for Design and Manufacturing for the Compressor Package

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Contact Information

Chapter 1 Safety

1.1 Strict Requirements and Prohibitions

1.1.1 Strict Requirements (Do's)

1.1.1.1 Do's on Operation

- Make sure to attach safety and protective devices to the package unit.
- The safety devices and protection systems must be regularly checked for their normal operation.
- If any safety device or protection system does not function normally or this product operates in an abnormal manner, immediately stop the work and contact your supervisor. When the system is to be restarted, you must observe the decision and instruction of the supervisor.
- If this product has stopped operation due to an unknown cause, immediately contact your supervisor. Before restarting the system, you must seek the decision and instruction of the supervisor.
- Depending on the type of refrigerant used, its leakage may generate a bad smell or poisonous gas. Be sure to sufficiently ventilate the room while the machine is operated.
- Regarding the characteristics of the refrigerant and lubricating oil, e.g., corrosiveness, degradability, and toxicity, be sure to obtain the Safety Data Sheet (SDS) of them and follow the instructions given.
- When this product is not to be used for some period of time, close the suction (side) and discharge (side) stop valves and shut off the motor power source, heater power, and control power.

1.1.1.2 Do's on Maintenance

- Prepare work procedures based on a work plan. Be sure to perform danger forecasting before starting the work.
- If two or more people are to work together, be sure to mutually check the work details and procedures before the work. During the work, always keep track of the other workers' actions.
- Before working on any troubleshooting during operation, before setting up this product, before cleaning work, and before conducting maintenance or inspection work, be sure to shut off the motor power source, control power, and power to other equipment, perform lock-out and tag-out procedures, and take effective measures to prevent any accidental power-on during the work.
- Before working on any troubleshooting during operation, before setting up this product, before cleaning work, and before conducting maintenance or inspection work, be sure to check that the internal pressure of this product and the refrigeration/cold storage unit is at the atmospheric pressure.
- Depending on the type of refrigerant used, it may generate a bad smell or poisonous gas or could cause an oxygen deficient atmosphere. Before starting the work, measure the oxygen content in the work area, as appropriate, and provide sufficient ventilation. The ventilation must be continued steadily until the work is completed.
- For the properties of refrigerant and lubricating oil (corrosiveness, decomposability or toxicity), be sure to obtain the Safety Data Sheet (SDS) and follow the relevant information.
- After work, the tools used must be returned to the predefined location. Be sure not to leave them inside the package unit.

1.1.1.3 Do's on Lockout/Tagout after Shutting Off the Power

- A lock-out/tag-out mechanism must be installed for the main circuit breakers that supply power to the motor and power to the control system. The lock-out/tag-out after power down is a very effective means to ensure the safety when two or more workers are working on the system at the same time, as it can prevent possible injury of workers that may be caused by accidental power-on of the driving source by one of the workers.
- If there is a risk of danger, especially during cleaning, maintenance/inspection, or troubleshooting work, be sure to let the workers perform the lock-out/tag-out procedures after the motor main power and control power has been shut off.
- Because the workers may neglect to perform the lock-out/tag-out procedures or cut-off the power in the following situations, be sure to instruct them to strictly follow the correct procedure by clearly identifying the work that require lock-out/tag-out and the reasons why it is needed.
  - As it is a cumbersome task for the workers to cut off the motor main power and control power and use lock-out/tag-out devices before starting the work, they might neglect to do it.
  - The workers might determine by themselves that it should be OK just to cut off the motor main power and control power, and not use any lock-out/tag-out devices.

1.1.1.4 Do's about Personal Protective Gear

- Prepare and use protective gear complying with the safety standards of the regulations.
- Check the function of each protective gear before using.
- Wear designated clothes such as work outfits, with their cuffs tightly closed.
- Do not wear any neckties or jewelry as there is a risk of being entangled by a movable part or rotating part. Put on a helmet as your hair may get entangled.
- Do not have anything in your pocket to prevent objects from falling into the machine.

1.1.1.5 Do's about Handling of Hazardous and Toxic Substances

- Obtain Safety Data Sheet (SDS) from manufacturers of hazardous and toxic substances. Check the MSDS and follow the handling instructions recommended by the manufacturers to handle and store those substances.

1.1.1.6 Do's about Handling Emergency Situations

- Formulate an emergency action plan complying with the regulations, and post it on a safe place.

1.1.1.7 Do's about Waste Oil, Fluid, and Materials

- Disposing of refrigerant and oil used for this product are subject to a number of regulations for the environmental protection purposes. Follow the local, state, federal acts and regulations and your company's rules when disposing of such waste oil, fluid and materials.

1.1.1.8 Other Do's

- Keep clean the floor around the entire package unit. Provide a safety passage.
- Walk only on the areas set up as a work floor. Also, do not leave tools and cleaning solutions in that area.
- If water or oil is spilled on this product or the floor, immediately wipe it off to prevent workers from slipping and getting injured.

1.1.2 Prohibitions (Don’ts)

- Do not remove or relocate any safety device, including electrical interfaces.
- Do not disable any safety device by short-circuiting or bypassing without any permission.
- Do not leave this product unsafe and unattended, by removing a safety cover or some other measures.
- Do not touch, clean or lubricate any part of this product which is moving.
- Do not touch relays or electric systems such as terminal block with bare hands when turning on the power.

1.2 Warnings

The warning messages described in this manual warn dangerous situations that may arise during work by using the following four categories.

Neglecting such warnings may cause accidents, resulting in personal injury or even death.

Also, this product or its auxiliary equipment may be heavily damaged. Therefore, be sure to always observe the instructions of the warnings.

Table 1-1 Types and Meanings of Warnings

Symbol	Meaning
DANGER	Indicates that there is a high risk of death or severe injury if it is not avoided.
WARNING	Indicates that there is a potential risk of death or severe injury if it is not avoided.
CAUTION	Indicates that there is a risk of light or medium injury if it is not avoided.
CAUTION	Indicates that there is a potential risk of property damage if it is not avoided.

1.3 Residual Risks

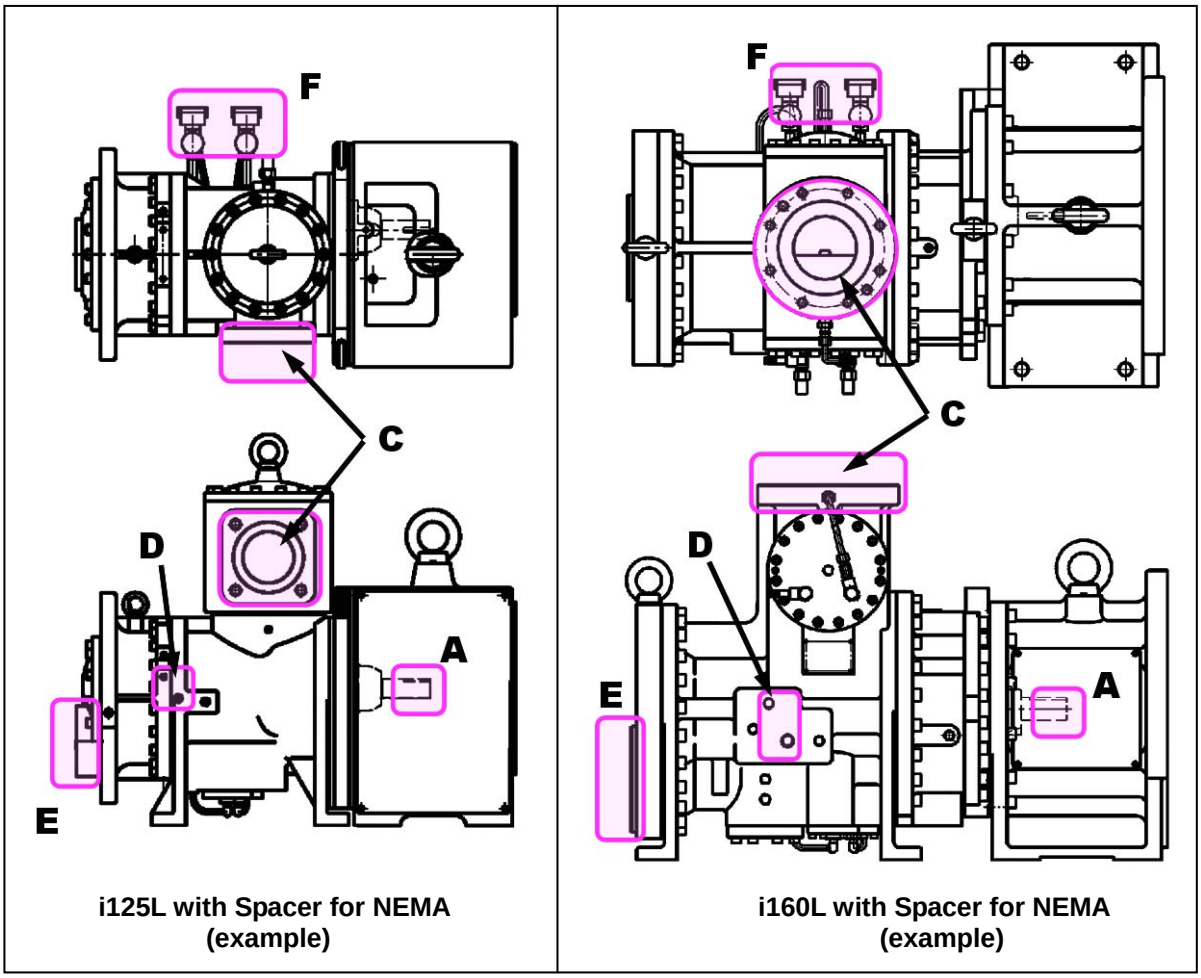
The following information assumes that this product is operated or inspected/maintained as part of a general package unit for refrigeration/cold storage. It is impossible to predict all the risk sources involved in actual use of the package unit.

Devise appropriate countermeasures for hazardous sources in your systems.

Table 1-2 Hazardous Sources

	Hazardous sources	Predicted hazard	Measures to be taken in operation	Countermeasures in cleaning, inspection, and parts replacement
A	Motor and compressor coupling	• Caught in or entangled in due to contact	• Install cover on the opening of coupling, or prohibit opening. • Keep away.	• Turn off motor main power and control power, and conduct lockout/tagout.
B	Motor terminals	• Electric shock caused by contact with live wires or electrical leakage	• Keep away. • Do not open terminal boxes. • Do not touch terminal boxes.	• Turn off motor main power and control power, and conduct lockout/tagout.
C	Compressor suction casing	• Frostbite due to contact • Contact with or inhalation of hazardous substances generated by leakage of refrigerant or the like	• Keep away and do not touch. • Wear protective gear. • Detect gas leakage.	• Wear protective gear. • Work under room temperature.
D	Compressor economizer and/or liquid injection port around and piping	• Burn injury due to contact Contact with or inhalation of hazardous substances generated by leakage or spout of refrigerant or the like	• Keep away and do not touch. • Wear protective gear. • Detect gas leakage.	• Wear protective gear. • Work at a temperature of not higher than 40°C.
E	Compressor discharge casing and discharge piping	• Burn injury due to contact Contact with or inhalation of hazardous substances generated by leakage or spout of refrigerant or the like	• Keep away and do not touch. • Wear protective gear. • Detect gas leakage.	• Wear protective gear. • Work at a temperature of not higher than 40°C.
F	Solenoid valve for controlling compressor capacity	• Electric shock caused by contact with live wires or electrical leakage	• Install protective cover on terminals, and prohibit opening. • Keep away and do not touch. • Wear protective gear.	• Turn off each breaker and the control power, and conduct lockout/tagout. • Wear protective gear.
G	Package Unit Check valve, service valve and joint in each section	• Contact with or inhalation of hazardous substances generated by mishandling or leakage • Frostbite or burn due to contact	• Sufficient ventilation • Indicate valve open/close state. • Keep away and do not touch. • Wear protective gear.	• Sufficient ventilation • Wear protective gear. • Tagout for controlled valve
H	Package Unit Solenoid valve or motor operated valve	• Electric shock caused by contact with live wires or electrical leakage • Pinched due to contact with driving part	• Install protective cover on terminals, and prohibit opening. • Keep away and do not touch. • Wear protective gear.	• Turn off each breaker and the control power, and conduct lockout/tagout. • Wear protective gear.

	Hazardous sources	Predicted hazard	Measures to be taken in operation	Countermeasures in cleaning, inspection, and parts replacement
I	Package Unit Electric components in each part (oil heater, protective device, etc.)	• Electric shock caused by contact with live wires or electrical leakage • Pinched due to contact with driving part	• Install protective cover on terminals, and prohibit opening. • Keep away and do not touch. • Wear protective gear.	• Turn off each breaker and the control power, and conduct lockout/tagout. • Wear protective gear.
J	Package Unit Oil drain	• Contact with hazardous substances generated by leakage or spout • Burn caused by contact with high-temperature fluid	• Sufficient ventilation • Keep away and do not touch. • Wear protective gear.	• Sufficient ventilation • Wear protective gear. • Work at a temperature of not higher than 40°C.
K	Noises	• Damage caused by noise	• Wear protective gear.	—



i125L with Spacer for NEMA (example)

i160L with Spacer for NEMA (example)

Figure 1-1 Locations of Hazardous sources (Compressor)

1.4 Safety Devices

For safe use and protection of this product, make sure to attach safety devices to this product in accordance with the regulations and the following instructions.

Safety devices cannot be kept in normal condition unless inspected and maintained at regular intervals. Their maintenance and inspection need to be performed as an important part of the maintenance/inspection work project. Provide users of this product with necessary information on the safety devices, for example, types of the safety devices, installation position, function, and inspection method of safety related devices.

WARNING

- **Check the safety devices after turning on the power and before operation of this product. If they do not operate normally, immediately take countermeasures.**

1.4.1 Emergency Stop Button

■ Overview/Function/Purpose

The emergency stop buttons are used for emergency shutdown of this product when an emergency situation arises.

■ Installation Positions

On the control board and in the operation control room

■ Stop/Restoration Methods

The operating procedures for the emergency stop button, i.e., how to stop the operation and restore the normal operating condition, must be clearly defined and the information provided to the user of this product.

■ Inspection Method/Interval

The emergency stop buttons must be tested before commissioning and must also be periodically re-tested after that.

The inspection procedures and the inspection interval for the emergency stop button must be clearly defined and the information provided to the user of this product

1.4.2 Circuit Breakers of Motor Main Power and Control Power (with Lockout/Tagout Mechanism)

■ Overview/Function/Purpose

Turn off the main motor and control power, and if there is any possibility of danger during work (especially during cleaning, maintenance, inspection, or troubleshooting), lockout/tagout devices must be used on the breakers of the main motor and control powers to prevent injuries to workers in case the power is turned on accidentally during work.

■ Methods of Performing and Releasing Lockout/Tagout

Make sure to clearly notify methods of performing and releasing lockout/tagout referring to the regulations created by Occupational Safety & Health Administration (OSHA) or local governing body.

■ Inspection Method/Interval

The inspection procedures and the inspection interval for the lockout/tagout devices must be clearly defined and the information provided to the user of this product.

1.4.3 Compressor Protective Devices

WARNING

- **Be sure to adjust the set values and check operation of the protective devices before the commissioning.**

Install necessary protection devices shown in section 2.3.3 "Alarm Set Values" in this manual chapter 2. Also, install the following protection devices that are not indicate in section 2.3.3, as occasion demands.

- **Protection from motor over current (OCR)**

  This device activates and applies appropriate control when the current equal to or higher than the set level flows. In some cases, this device stops the compressor operation.

  For more information about setting and installation of this device, please refer to the instruction manual of the motor.

- **Protection from oil level decrease**

  In case of the oil supply by differential pressure, install a protection device to the oil separator for protect form oil level decrease. Since there is a possibility that alarm for protection from lubricating differential pressure decrease does not activate even if the amount of lubricating oil is insufficient.

- **No Water Alarm**

  If you use water cooling oil cooler and/or water cooling condenser, a suspension of water supply protection is necessary.

  For more information about setting and installation of this protection device, please refer to the instruction manual of the motor or the like used in the cooling water system.

■ Connection Positions and Settings

Specify the connection position and setting for each compressor protective device, and make sure to provide users of this product with them.

■ Inspection Method/Interval

Compressor protective devices require operation tests and confirmation of the settings calibration before commissioning as well as at regular intervals.

Specify the inspection methods/intervals of the compressor protection devices, and make sure to provide users of this product with such information.

CAUTION

- **In the operation test, check that alarms and switches operate normally by using devices such as pressure tester. Do not operate the compressor with all the valves closed, or in any other dangerous conditions.**
- **If the protection from oil pressure (OP) or high pressure (HP) activates, do not restart operation until the cause of activation is removed.**

Chapter 2 Compressor Specifications and Configuration

2.1 Features of MYCOM i-series Compressor

MYCOM i-series compressor enables designers to design highly reliable and most compact refrigerating unit. It has a lot of features.

- **Centering is made unnecessary by mounting the motor using a flange.**

  By mounting the motor using a flange eliminates the need of the troublesome motor centering before starting the equipment.

- **Suction strainer and check valve built-in compressor**

  This compressor has built-in suction strainer and check valve which enable easy maintenance.

- **No oil pump required in differential pressure oil supply system**

  This compressor employs roller bearings which let lubrication oil reserved in part even when the machine is stopped. Accordingly, no lubrication failure will occur even with differential pressure oil supply system which has no oil pump installed.

- **3-step (100%, 75%, 50%) unloader**

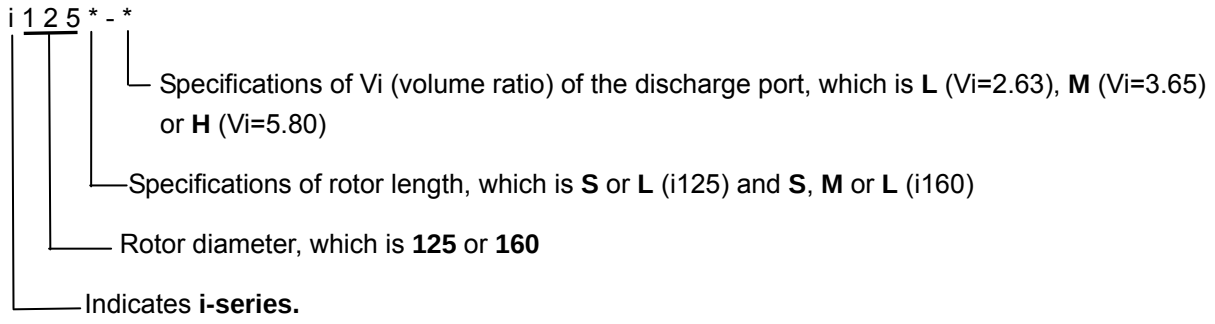
  As it has a 3-step (100%, 75%, 50%) unloader built-in, flow adjustment can be done easily.
  In addition, inverter-controlled speed control is available.

- **High efficiency, and low vibration and noise**

  Use of MYCOM original screw rotor profile attains high efficiency, and low vibration and noise.

2.2 Model Designation of the Compressor

This manual describes i125*-* and i160*-* models.
The meaning of the type designation, which is engraved on the MODEL column of the compressor nameplate, is as follows.



2.3 Compressor Specifications

2.3.1 Standard Specifications

Table 2-1 Specifications of i-series Compressor

Items				Model				
				i125S	i125L	i160S	i160M	i160L
Flange motor connection		NEMA	—	3**C, 40*C		3**D, 4**D		
		IEC	—	FF400	FF500	FF500 / FF600		
Product mass (Compressor only)			kg	330	350	520	560	600
Mass of compressor with motor spacer	for NEMA		kg	490	510	670	710	750
	for IEC	FF400	kg	440	—	—	—	—
		FF500	kg	—	480	630	670	710
		FF600	kg	—	—	660	700	740
Standard speed 50Hz/60Hz			min^{-1}	2950/3550				
Rotation direction			—	Clockwise as viewed from motor				
Swept volume 50Hz/60Hz			m^3/h	197/237	296/356	415/499	519/624	622/749
			CFM	116/139	174/210	244/294	305/367	366/441
Refrigerant			—	R717 / R404A / R507A / R134a				
Design pressure ***Note**			MPa	2.6 (Applies to i-series compressors manufactured and shipped in May 2014 or after.)				
Capacity control			—	3-step (100%, 75%, 50%) unloader				
Connected pipe size	Suction flange		—	MYCOM 100A (4")		ANSI ＃300 5"		
	Discharge flange		—	MYCOM 65A (2-1/2")		ANSI ＃300 3"		
	Oil inlet port		—	Rc1/2		Rc1		
	Economizer		—	Rc3/8		Rc3/4		
	Aquamizer (Liquid injection)		—	Rc1/4		Rc1/2		

- Unless otherwise noted, the pressure unit MPa represents the gauge pressure in this manual.
- For limits of working temperature and pressure, see Section 2.3.2 "Operation Limits" in this Chapter.

***Note:** The design pressure varies according to each area, laws and ordinances of the country. The design pressure of this list is the maximum value of the compressor. Therefore, the real design pressure may become less than this value according to the law. Please confirm real pressure on a name plate and individual specifications.

2.3.2 Operation Limits

Table 2-2 Operation Limits of i-series Compressor

Item		Normal operation range *Note 1	Permissible limit
Speed	min^{-1}	2950 @50 Hz 3550 @60 Hz	125S, 160S: Max. 4500 ***Note 2*** 125L, 160M, 160L : Max. 3550
Discharge pressure	MPa	1.0 to 1.9	Max. 1.9
Suction pressure	MPa	0.02 to 0.35	Max. 0.6 Min. -0.05
Differential pressure for lubrication (Po - Ps) ***Note3***	MPa	≥ 0.5	Min. 0.5 ****Note 4***
Discharge gas temperature	°C	Condensing temperature + 15 to 90	Max. 90
Superheating degree of suction gas	°C	5 to 20	—
Oil supply temperature	°C	30 to 60	Max. 80 BBSE ****Note 2*** Min. 30
Supply oil viscosity (kinematic viscosity)	mm^2/s	13 to 40	Min. 13 Max. 300 (At start-up time)
Vibration standard value at shipment	μm	(Half amplitude) 20	—
Noise standard value at shipment	dB (A)	125S, L, 160S, M: 84 160L: 85	—

■ Unless otherwise noted, the pressure unit MPa represents the gauge pressure in this manual.

Note 1: For operations outside the normal operation ranges, consult our compressor manufacturing division.

Note 2: When performing a speed-increasing operation by inverter at 70 °C or above oil temperature, contact our compressor manufacturing division to confirm the temperature on the mechanical seal sliding surface.

Note 3: Po = Oil supply pressure, Ps = Suction pressure

Note 4: This value excludes the start-up of the compressor. Refer to **Note 2** in the next section.

CAUTION

- **Repeated startup and stop in a short period is harmful not for the startup devices and electric machinery but also for the compressor itself. For information on the start/stop limitations, refer to each instruction manual.**
  Wait at least 15 minutes after stopping the compressor before restarting it.

2.3.3 Alarm Set Values

To protect the compressor, please set the alarm shown in the table below.

Table 2-3 Application Limits of i-series Compressor *Note 1

Item	Unit		Alarm	Stop
Rotation speed	min^{-1}	High	—	i125S, i160S: 4550 (0 sec.) i125L, i160M, i160L: 3650 (0 sec.)
		Low	—	1450 (0 sec.)
Discharge pressure	MPa	High	1.9 (0 sec.)	2.0 (0 sec.)
		Low	—	—
Suction pressure	MPa	High	0.6 (30 sec.)	0.6 (60 sec.)
		Low	-0.05 (30 sec.)	-0.05 (60 sec.)
Differential pressure for lubrication (Po - Ps) ***Note 2**	MPa	High	—	—
		Low	0.6 (30 sec.)	0.5 (30 sec.) ***Note 3**
Discharge temperature	°C	High	90 (5 sec.)	95 (0 sec.)
		Low	—	—
Suction temperature	°C	High	60 (60 sec.)	—
		Low	-58 (30 sec.)	-60 (30 sec.)
Discharge superheat	°C	High	—	—
		Low	15 (60 sec.)	10 (60 sec.)
Suction superheat	°C	High	—	—
		Low	0 (30 sec.)	0 (60 sec.)
Lubrication temperature	°C	High	80 (60 sec.)	85 (60 sec.)
		Low	30 (60 sec.)	25 (60 sec.)

■ Unless otherwise noted, the pressure unit MPa represents the gauge pressure in this manual.

***Note 1:** The values in the parentheses are the maximum operation delay times.
The values have been set to protect the compressor.

***Note 2:** Po = Oil supply pressure, Ps = Suction pressure

***Note 3:** This alarm stop is set for normal operation. At the time of the start-up of the compressor, it is not necessary to perform this alarm monitoring after start until 300 seconds.

2.3.4 Outer Dimensions

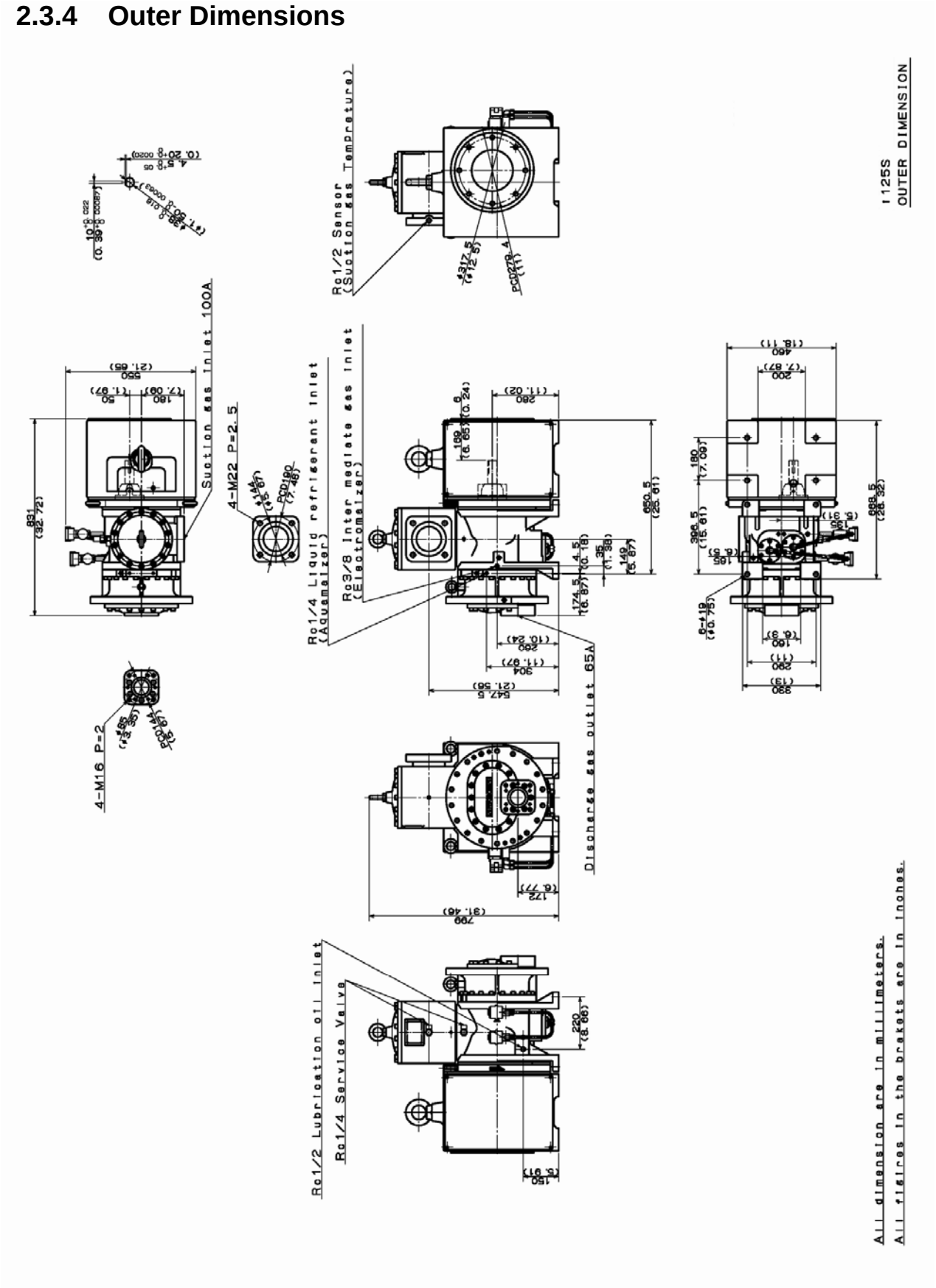


Figure 2-1 i125S Outer Dimensions with a Spacer for Flange Motor (NEMA)

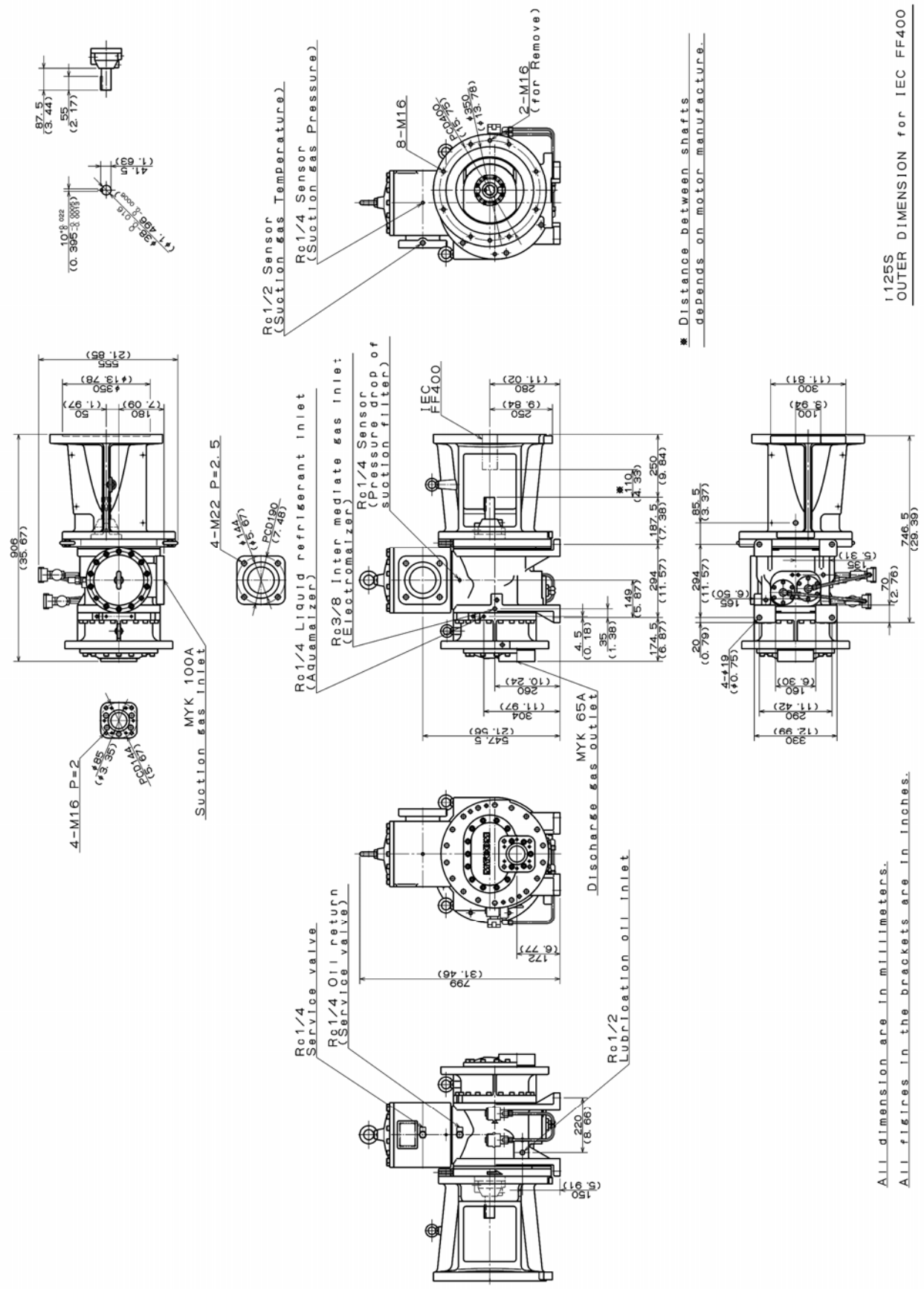


Figure 2-2 i125S Outer Dimensions with a Spacer for Flange Motor (IEC FF400)

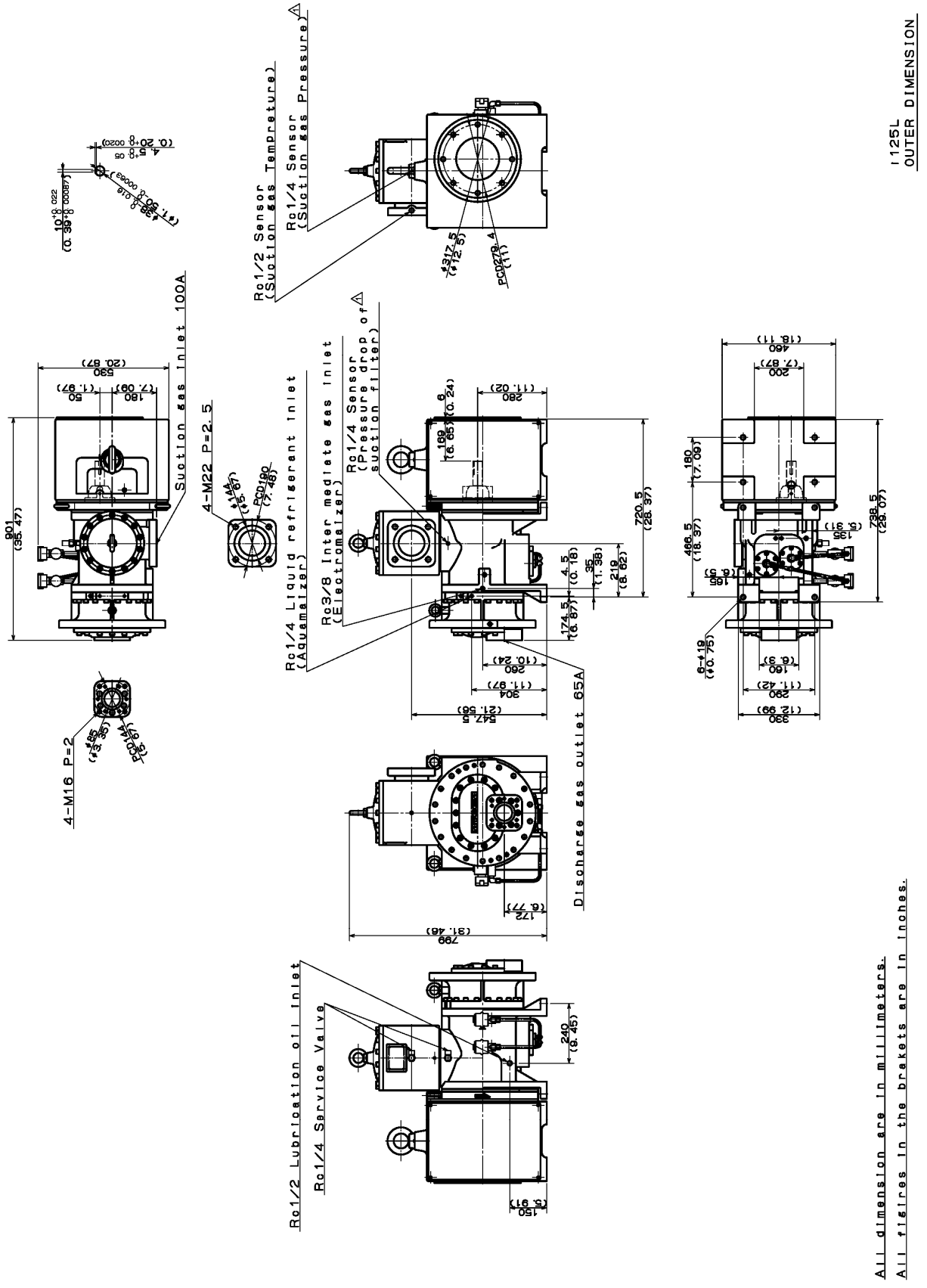


Figure 2-3 i125L Outer Dimensions with a Spacer for Flange Motor (NEMA)

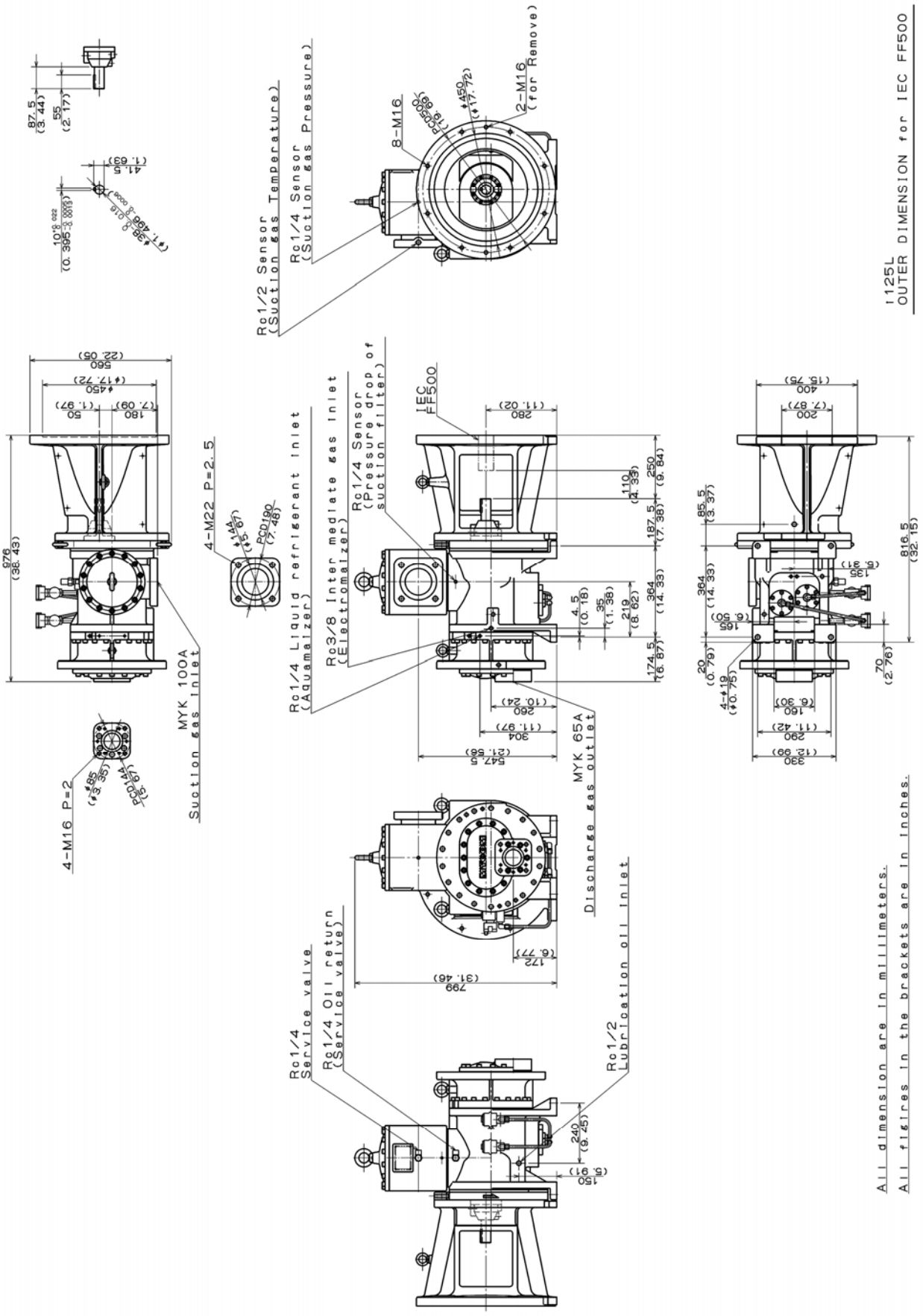


Figure 2-4 i125L Outer Dimensions with a Spacer for Flange Motor (IEC FF500)

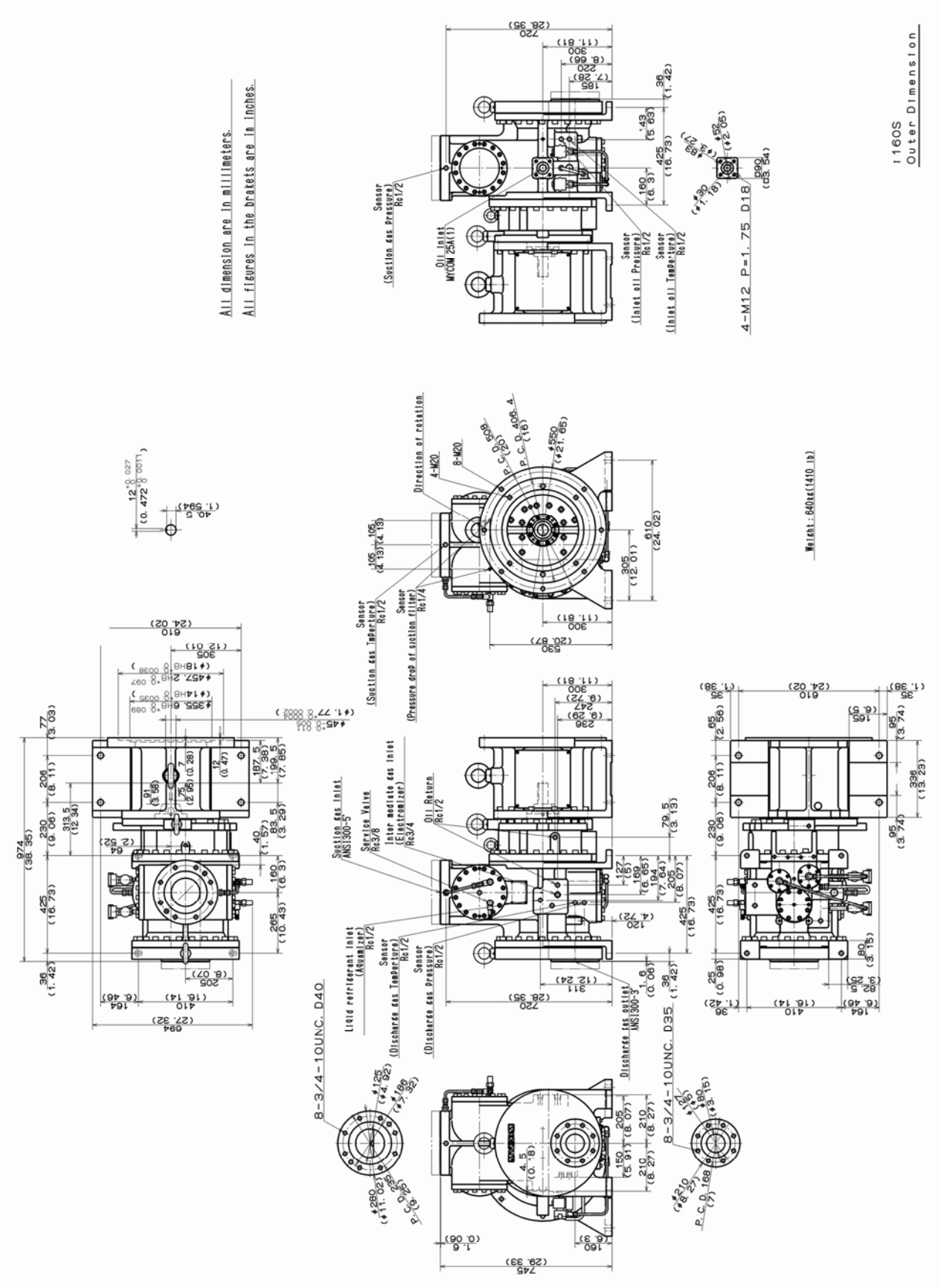


Figure 2-5 i160S Outer Dimensions with a Spacer for Flange Motor (NEMA)

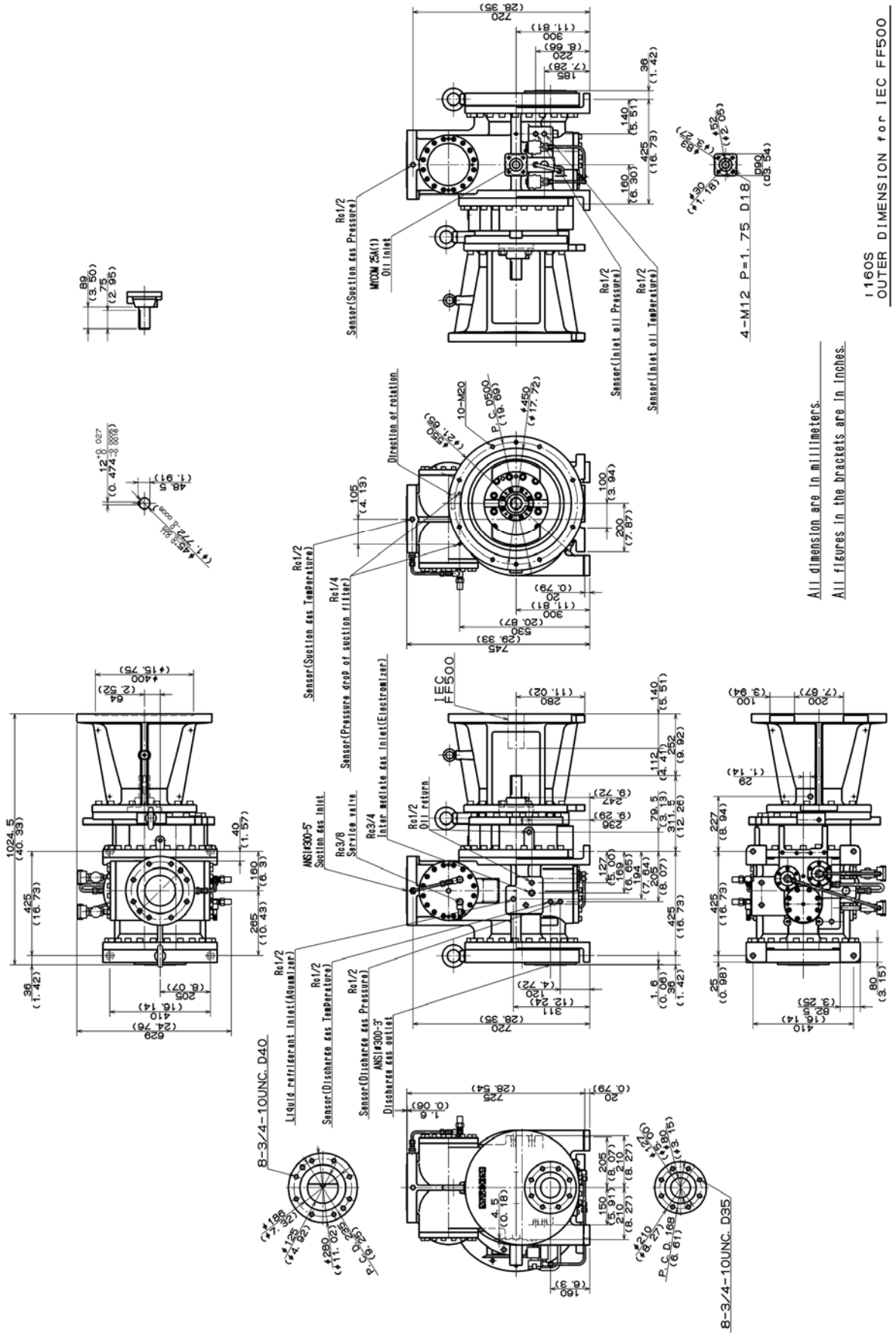


Figure 2-6 i160S Outer Dimensions with a Spacer for Motor Flange (IEC FF500)

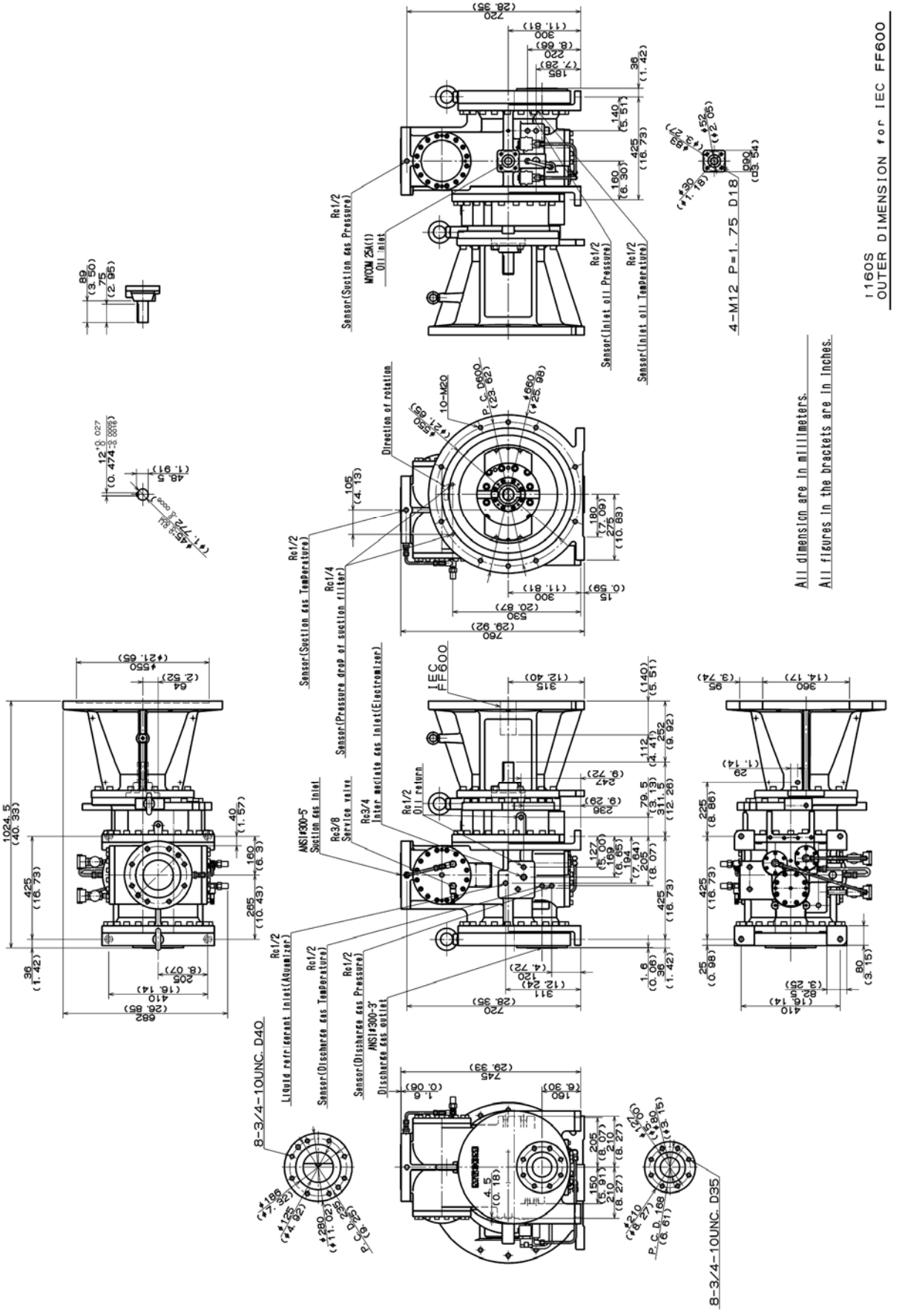


Figure 2-7 i160S Outer Dimensions with a Spacer for Flange Motor (IEC FF600)

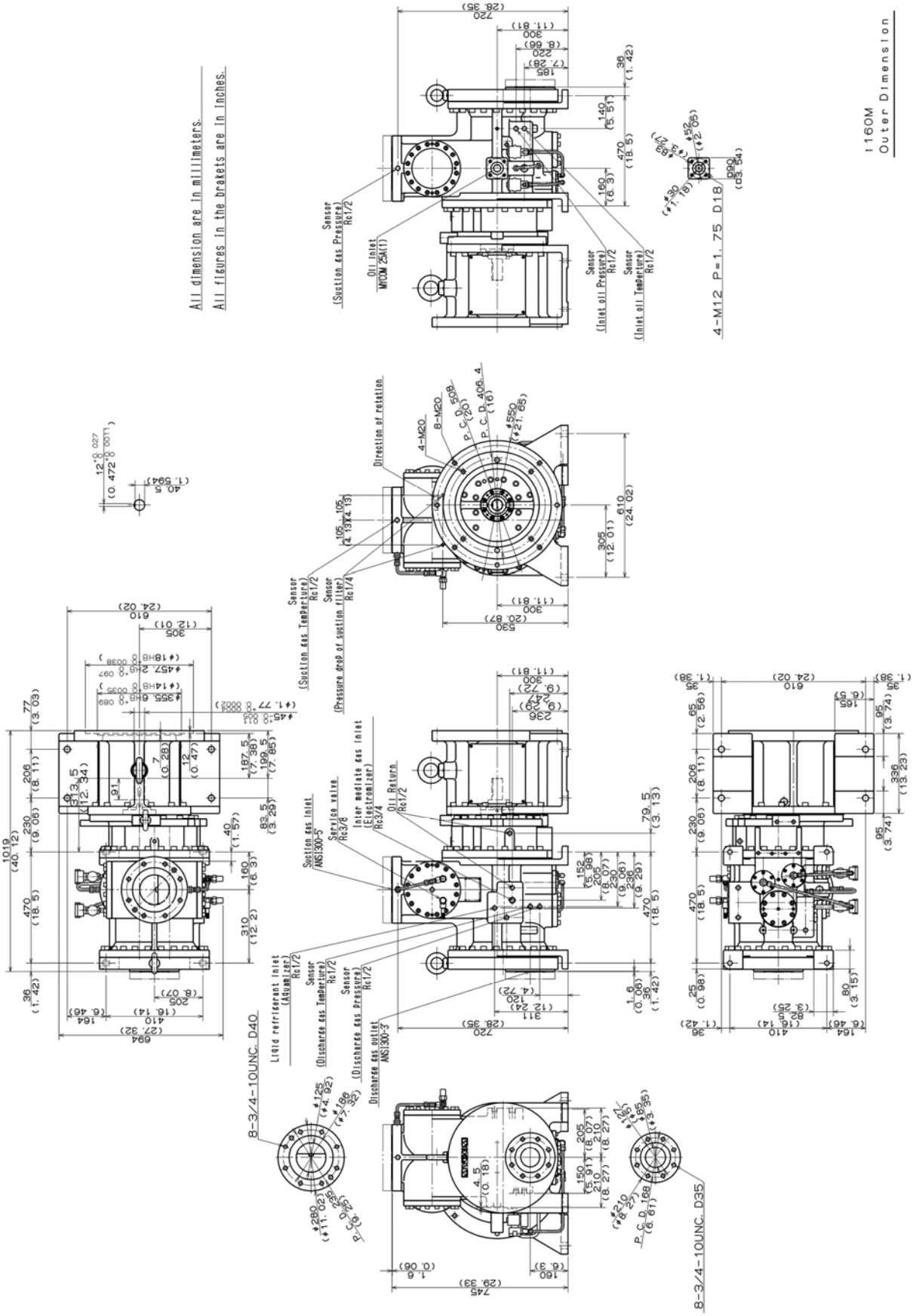


Figure 2-8 i160M Outer Dimensions with a Spacer for Flange Motor (NEMA)

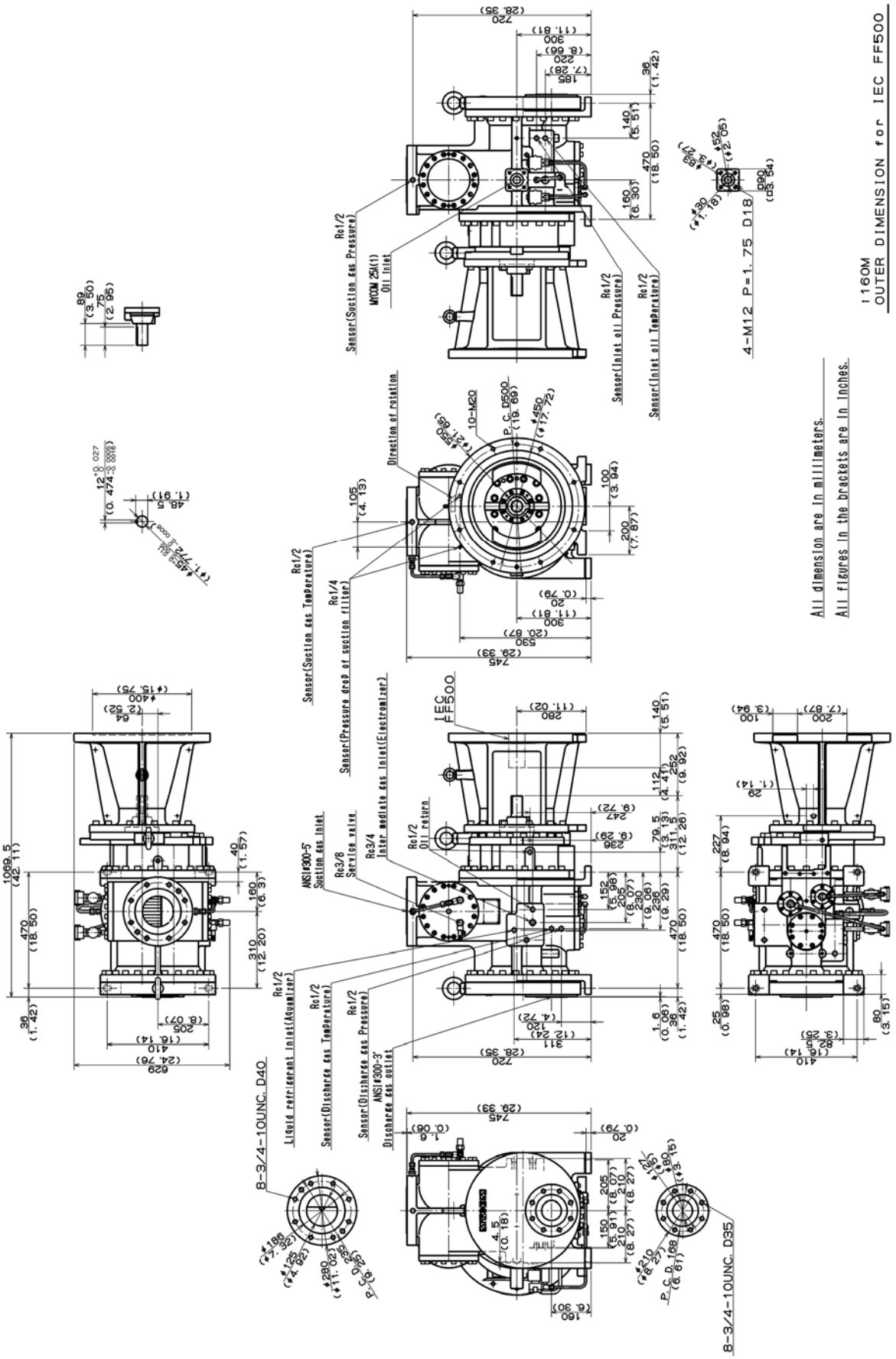


Figure 2-9 i160M Outer Dimensions with a Spacer for Motor Flange (IEC FF500)

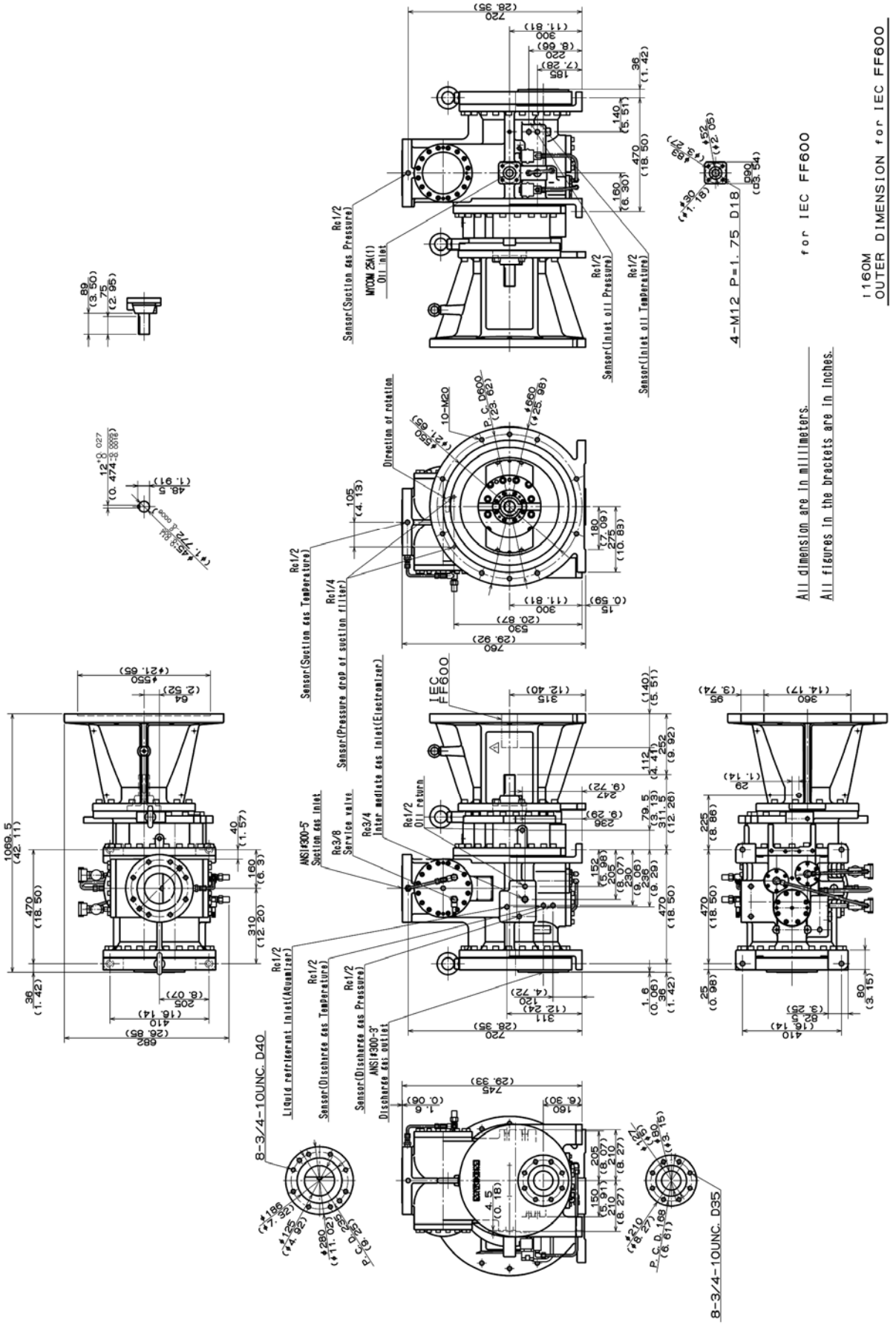


Figure 2-10 i160M Outer Dimensions with a Spacer for Flange Motor (IEC FF600)

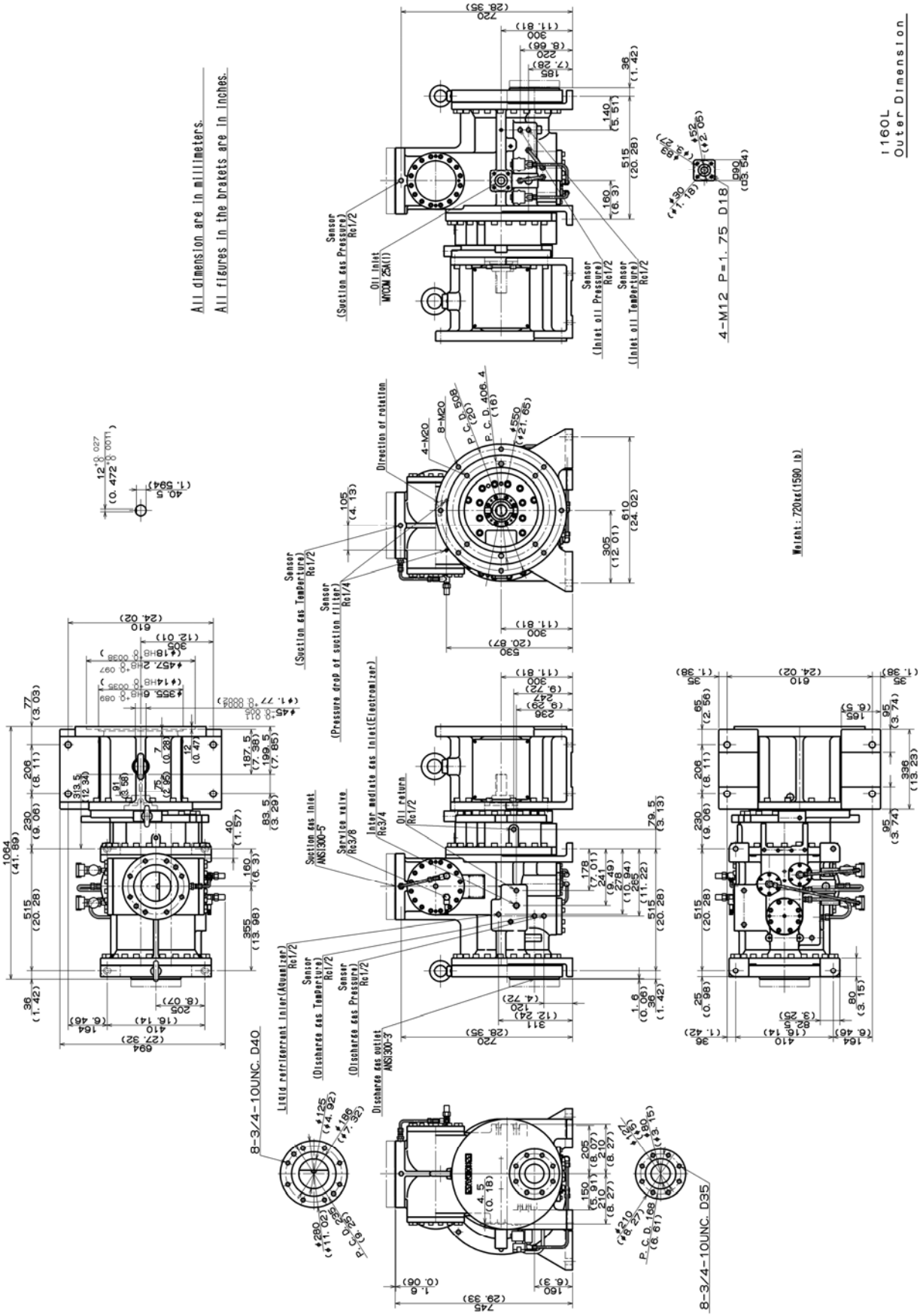


Figure 2-11 i160L Outer Dimensions with a Spacer for Flange Motor (NEMA)

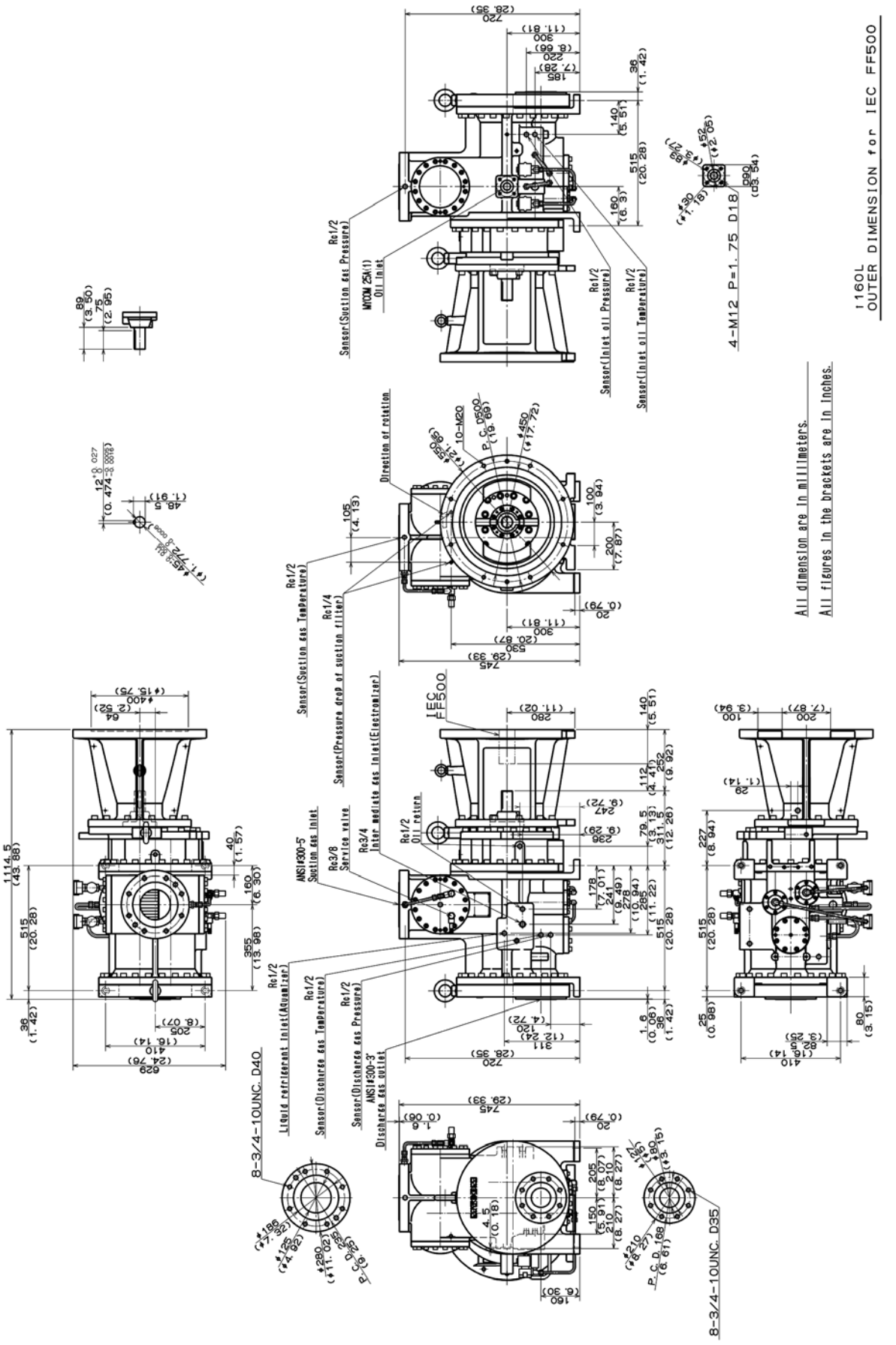


Figure 2-12 i160L Outer Dimensions with a Spacer for Flange Motor (IEC FF500)

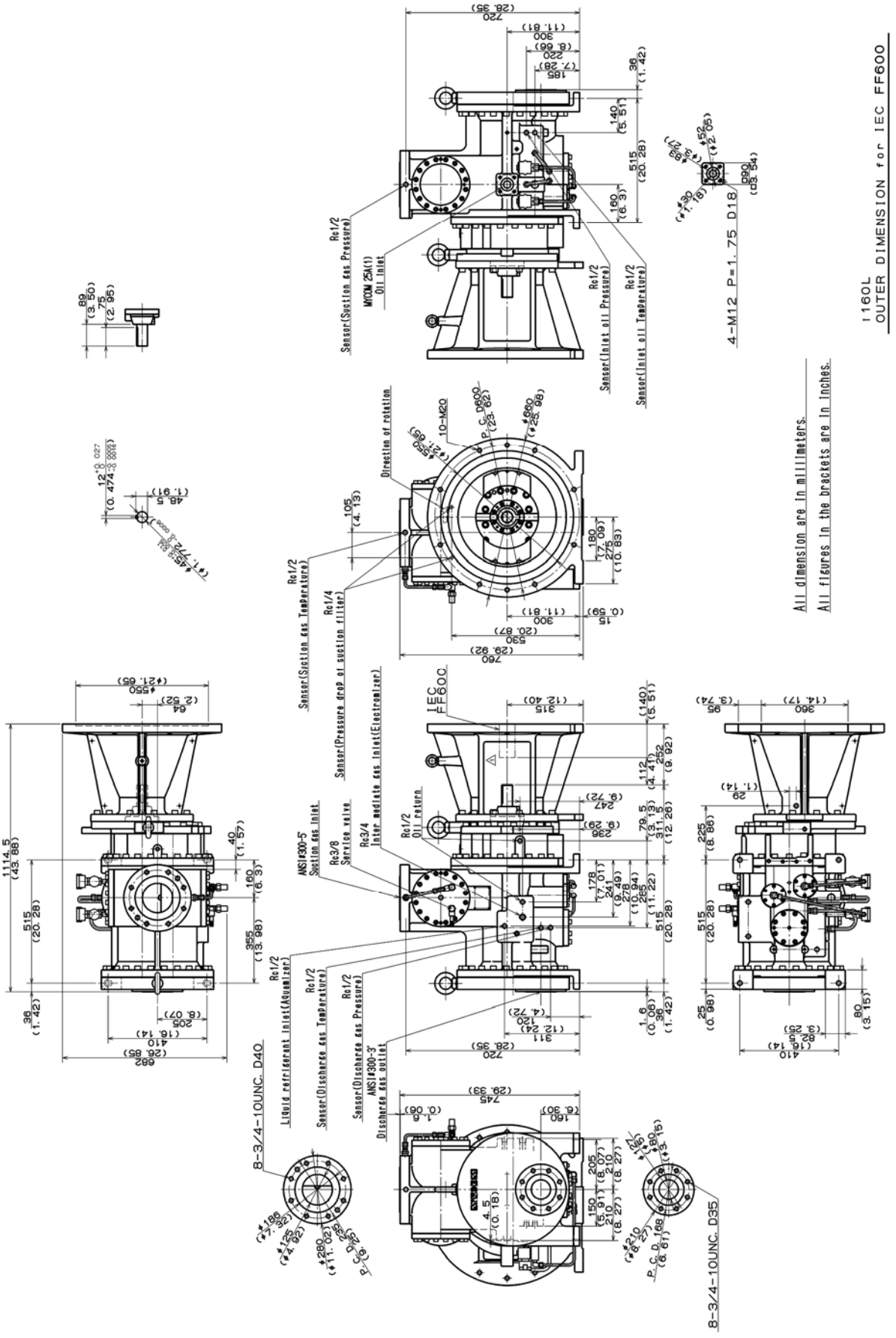


Figure 2-13 i160L Outer Dimensions with a Spacer for Flange Motor (IEC FF600)

2.4 Configuration of Compressor

2.4.1 Sectional Views

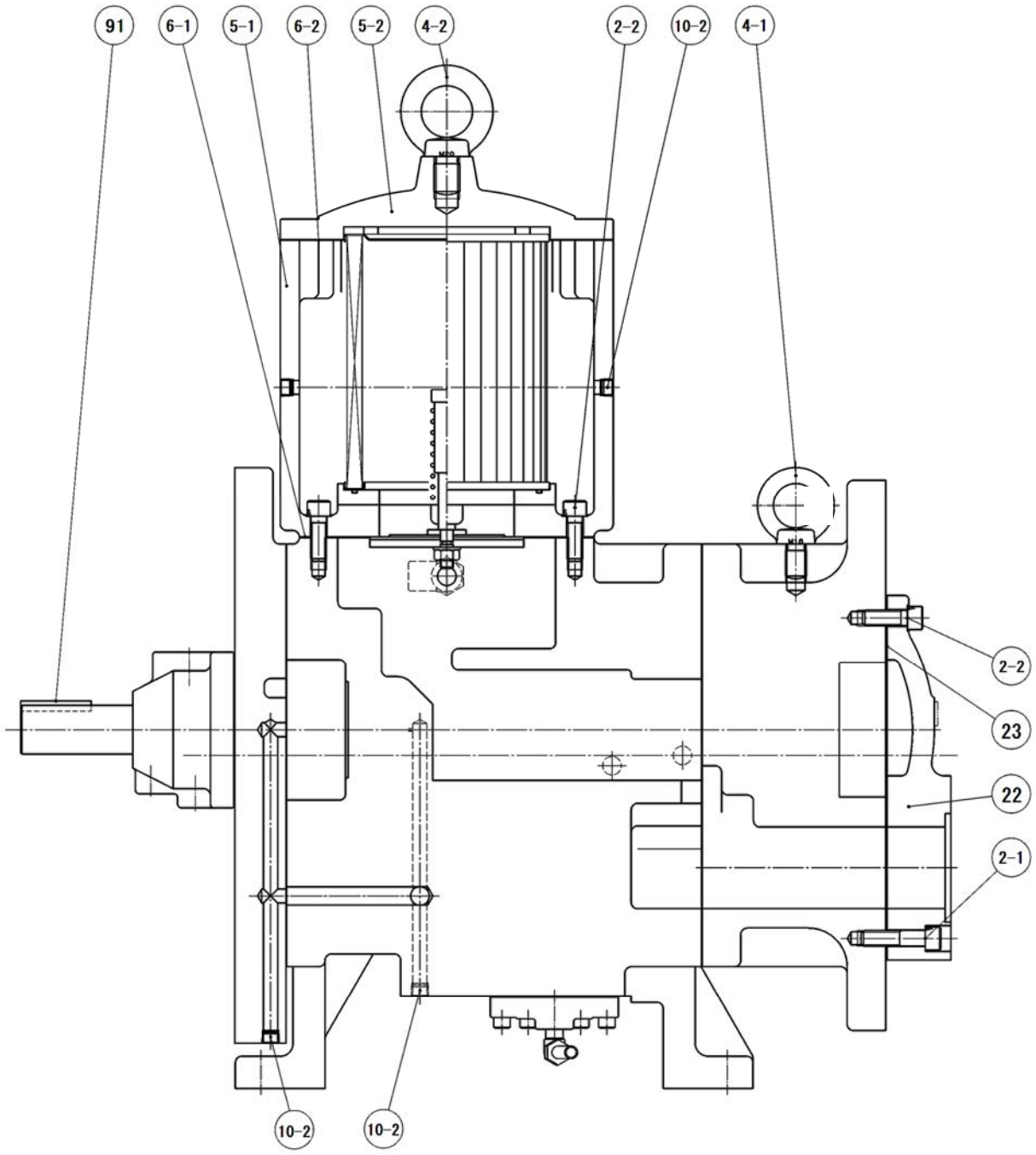


Figure 2-14 i125L Longitudinal Sectional View

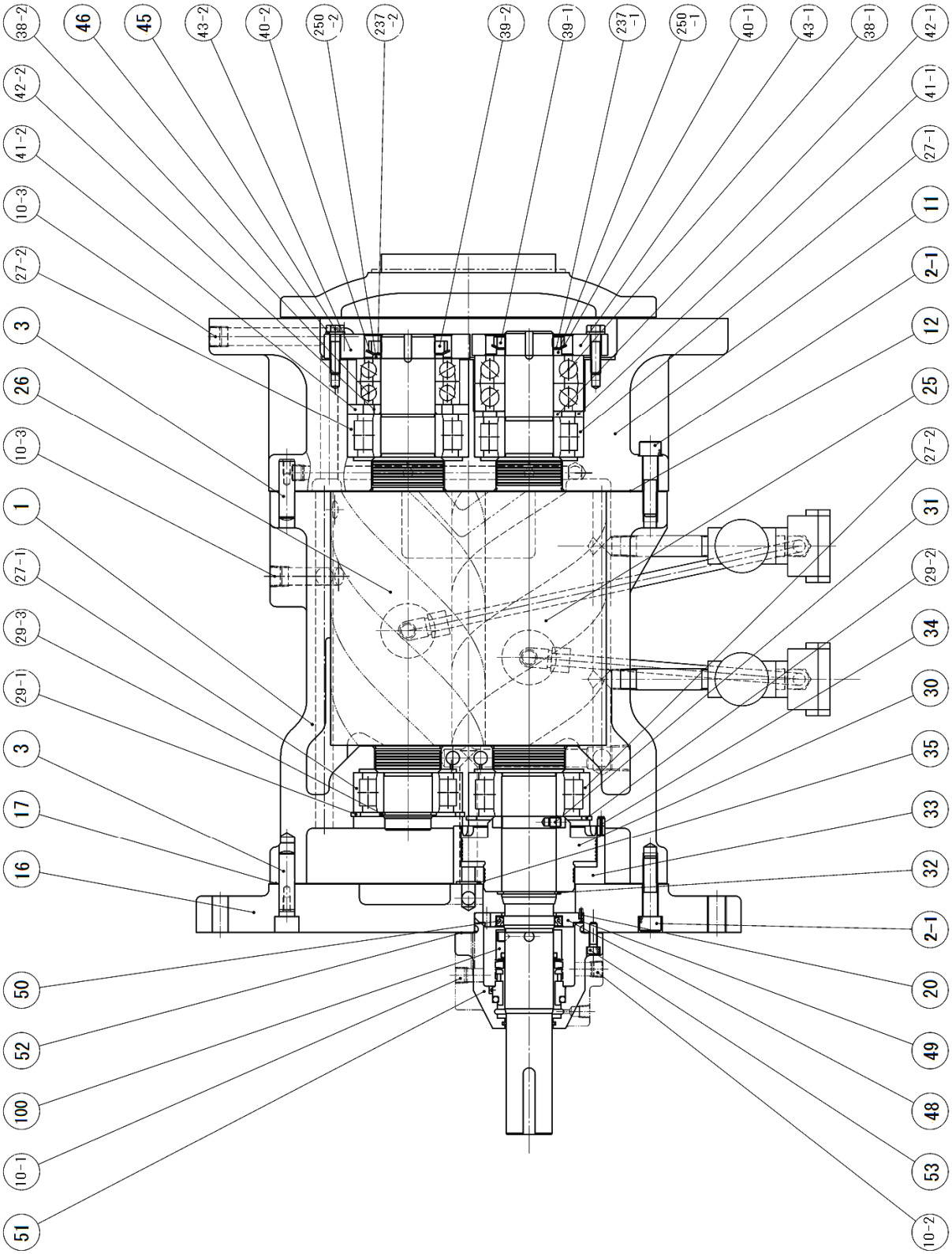


Figure 2-15 i125L Cross-Sectional View

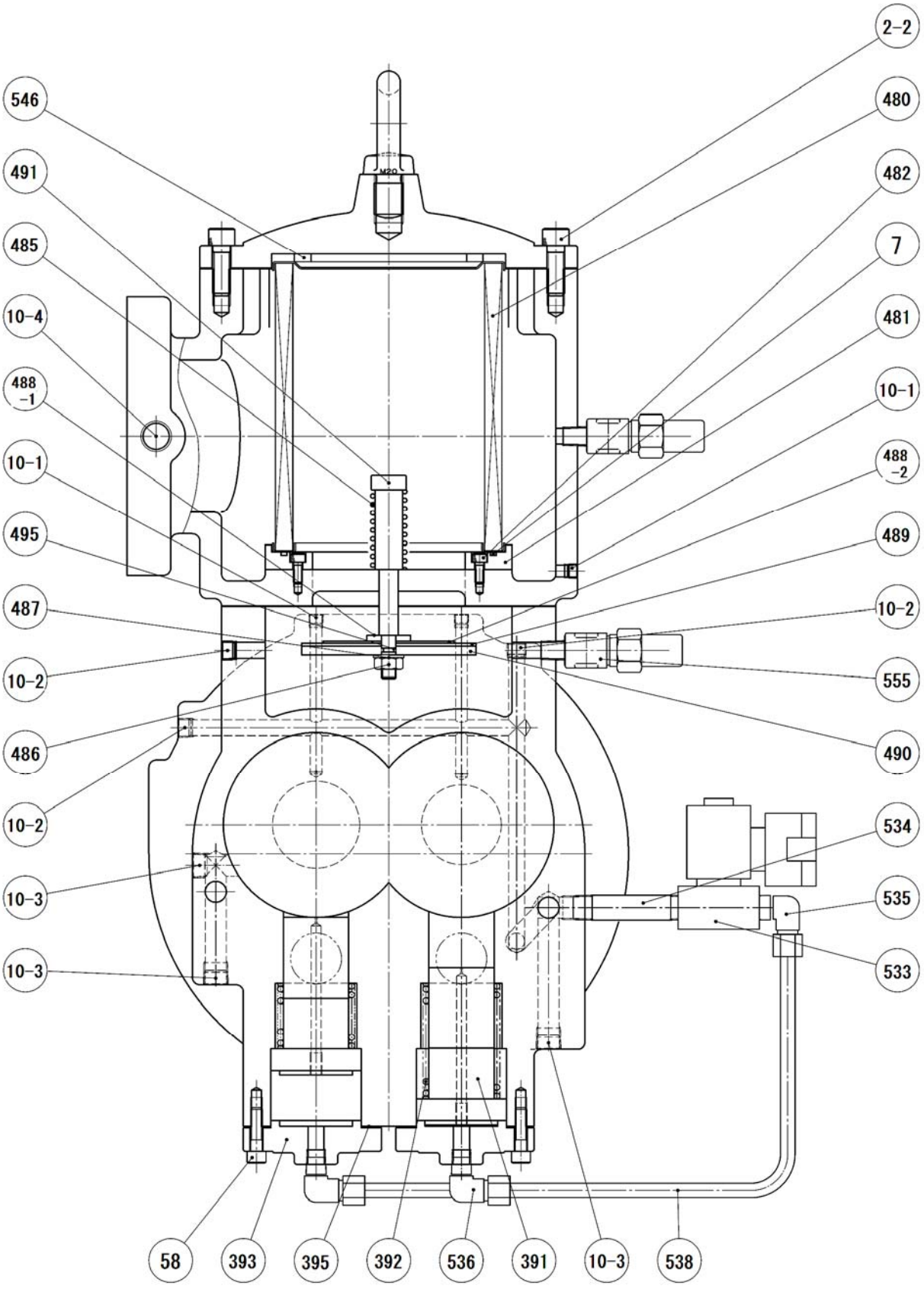


Figure 2-16 i125* Longitudinal Sectional View of Suction/Capacity Control Section

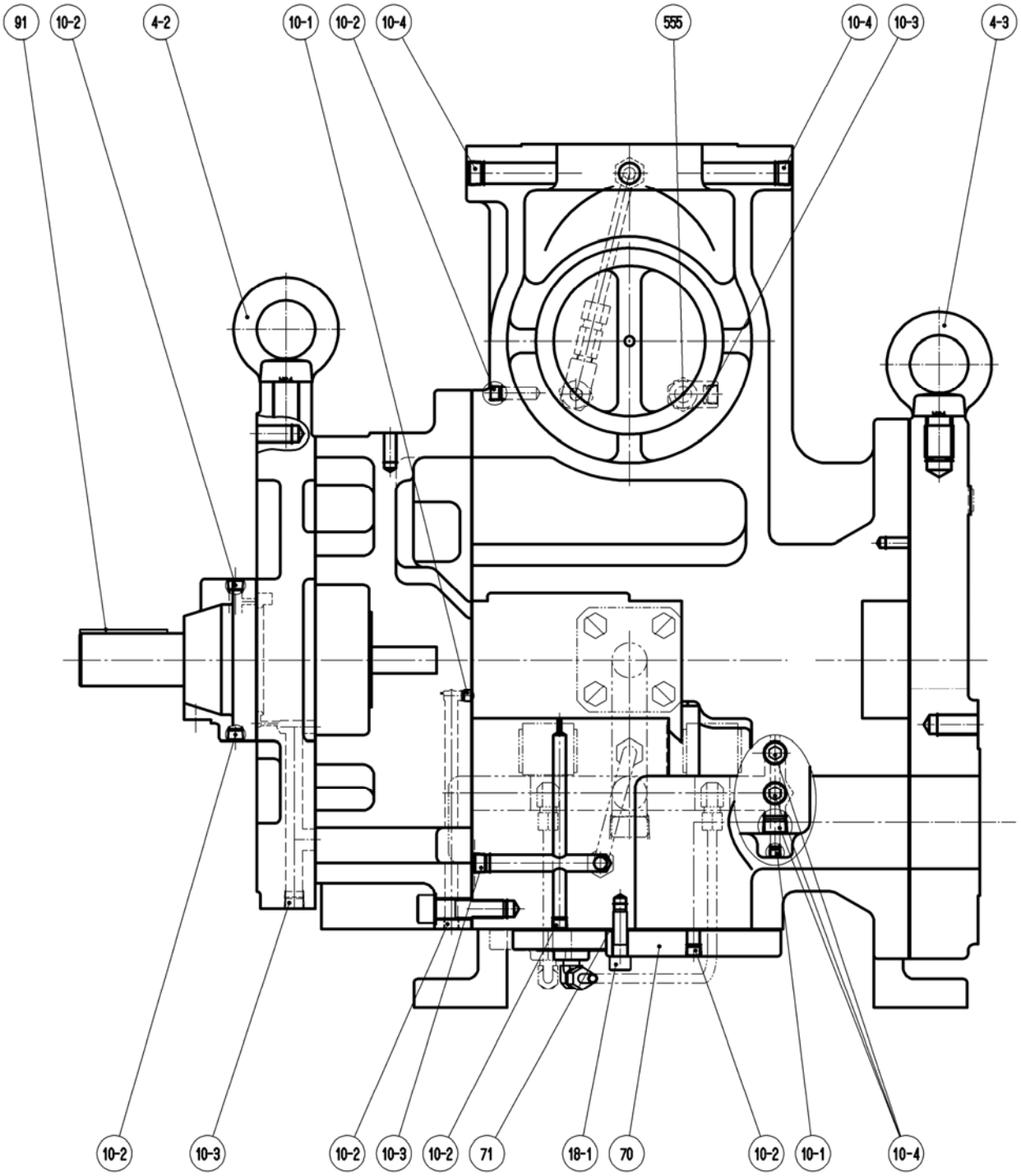


Figure 2-17 i160S Longitudinal Sectional View

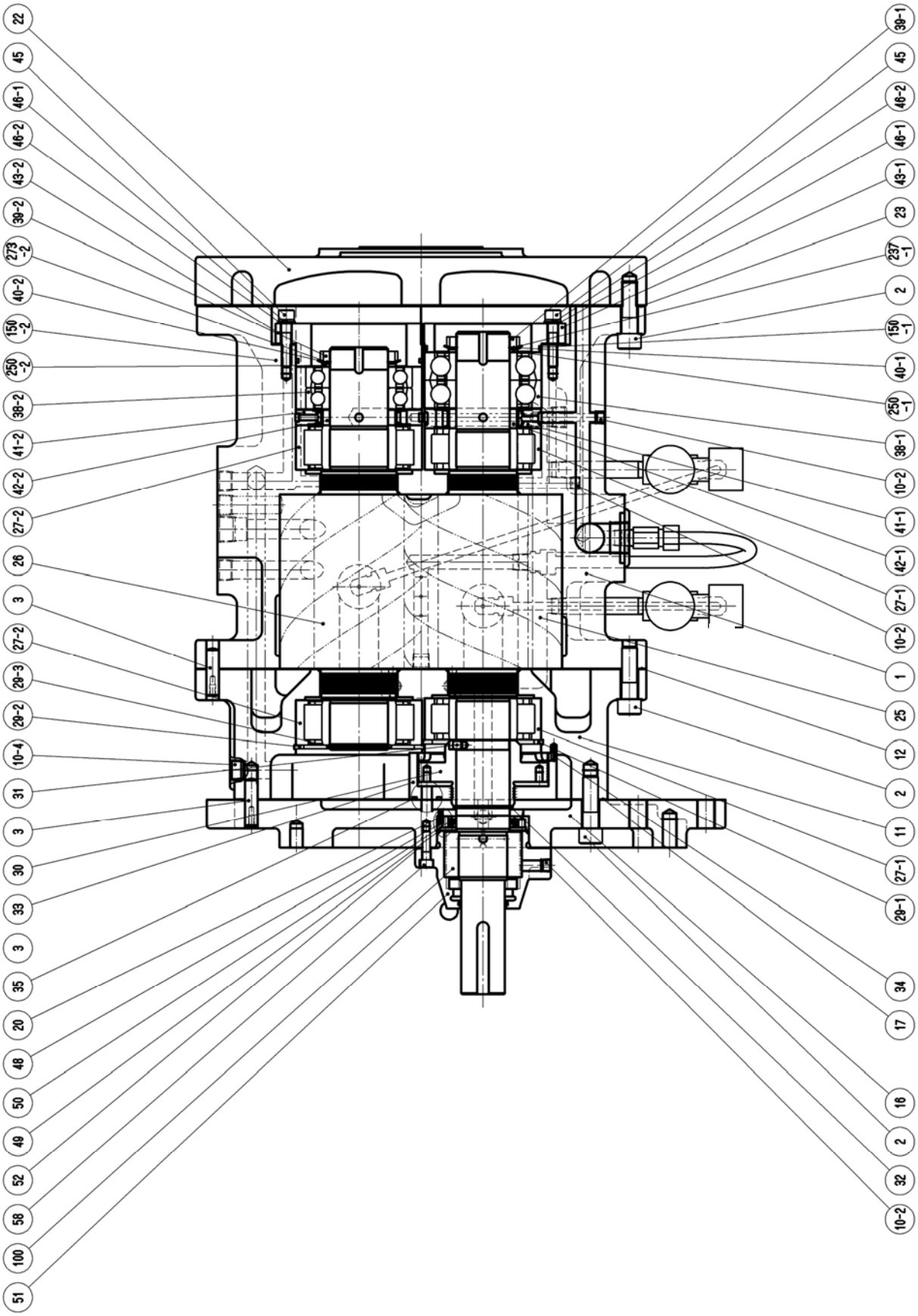


Figure 2-18 i160S Cross-Sectional View

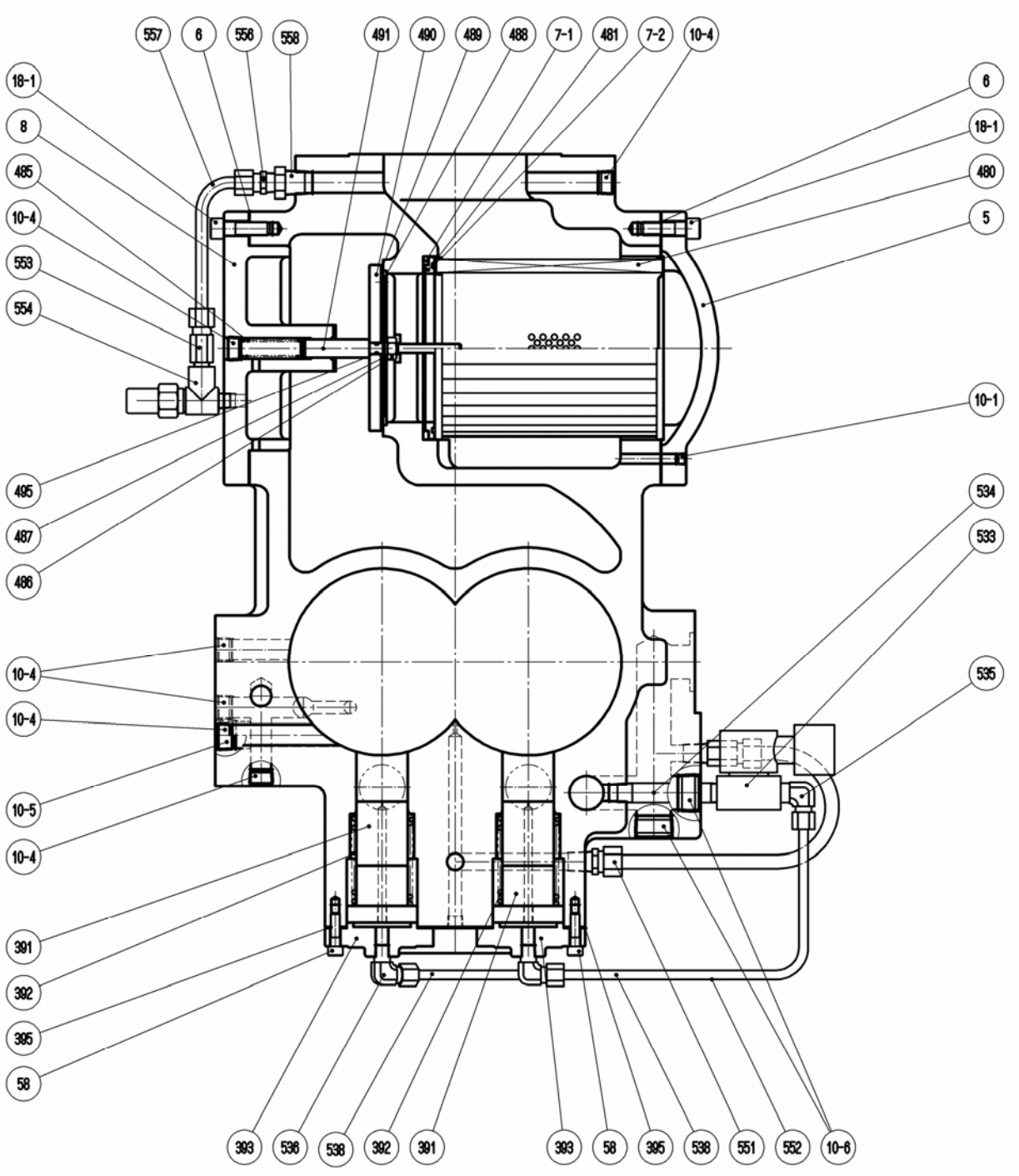


Figure 2-19 i160* Longitudinal Sectional View of Suction/Capacity Control Section

2.4.2 Development Views

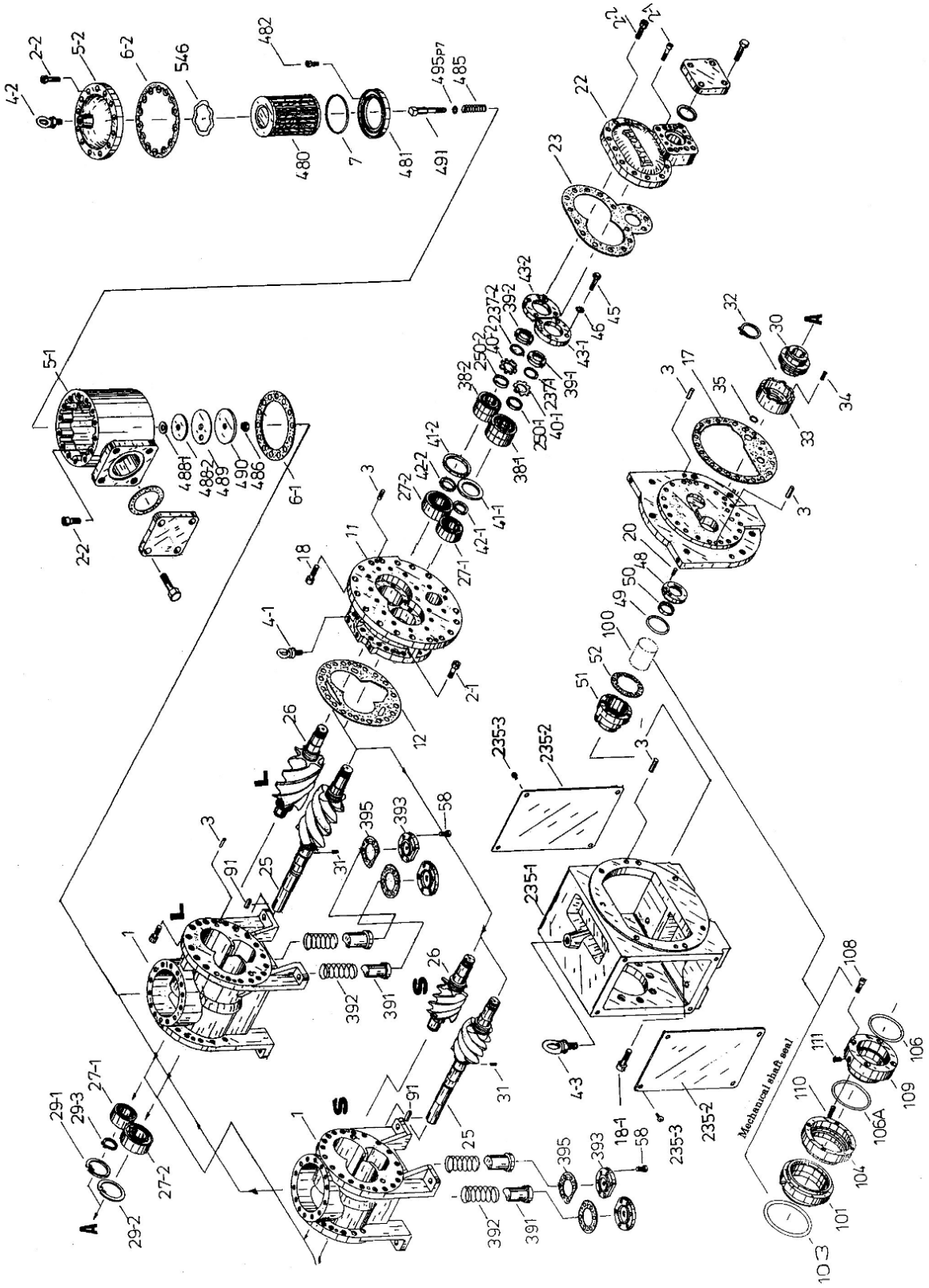


Figure 2-20 Development View of i125S/L Parts with Motor Spacer

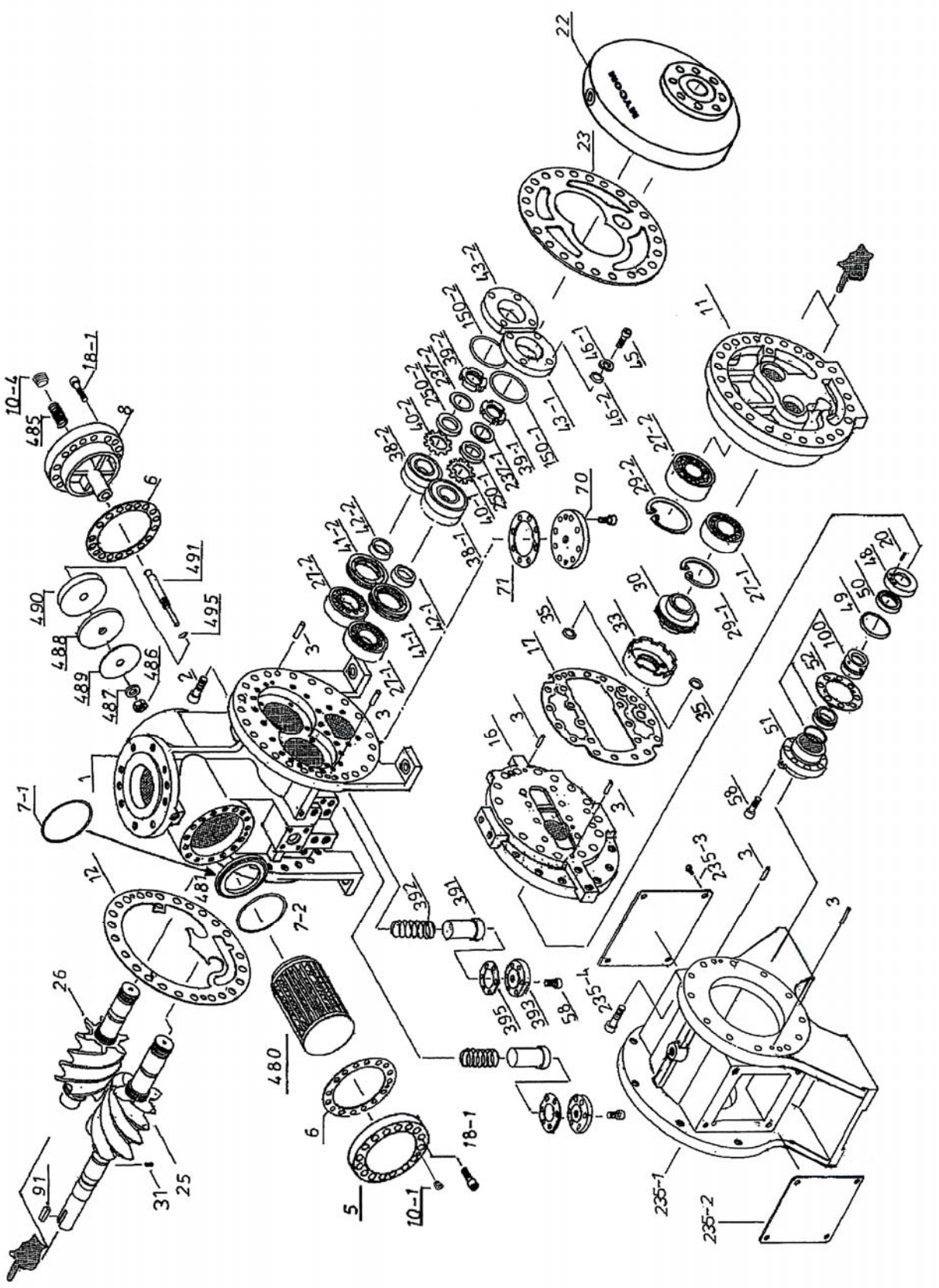


Figure 2-21 Development View of i160S/L Parts with Motor Spacer

2.4.3 Parts Configuration Table

Table 2-4 i125S/L Parts Configuration Table

P/N	Part name	Code No.	Remarks	Qty
1	Main Rotor Casing	CS00102-I125S*	i125S-* port	S:1
1	Main Rotor Casing	CS00102-I125L*	i125L-* port	L:1
2-1	Hexagon Socket Head Cap Screw	NB35412-050	M12×50 SCM435	45
2-2	Hexagon Socket Head Cap Screw	NB35412-035	M12×35 SCM435	39
3	Alignment Pin	NE242A13-050A	Φ13×50 with internal thread and slot	6
4-1	Eye Bolt	NB600-16	M16	3
4-2	Eye Bolt	NB600-20	M20	1
4-3	Eye Bolt	NB600-30	M30	1
5-1	Suction Adapter	CS00502-I125	i125	1
5-2	Strainer Cover	CS00510-I125	i125	1
6-1	Gasket, Suction Adapter	CS00600-I125	i125 t=0.5	1
6-2	Gasket, Strainer Cover	CS00900-I125	i125 t=0.5	1
7	O-ring	PA12-140	JIS B 2401 G140	1
10-1	Hexagon Socket Head Cap Plug	NF06-004	R1/8 S45C	5
10-2	Hexagon Socket Head Cap Plug	NF06-008	R1/4 S45C	10
10-3	Hexagon Socket Head Cap Plug	NF06-010	R3/8 S45C	S:6 L:5
10-4	Hexagon Socket Head Cap Plug	NF06-015	R1/2 S45C	1
11	Bearing Head	CS01102-I125	i125	1
12	Gasket, Bearing Head	CS01200-I125	i125 t=0.5	1
16	Bearing Cover	CS01602-I125	i125	1
17	Gasket, Bearing Cover	CS01700-I125	i125 t=0.5	1
18-1	Hexagon Socket Head Cap Screw	NB35416-055	M16×55 SCM435	7
20	Spring Pin	NE3203-008	Φ3×8	1
22	End Cover	CS02202-I125	i125	1
23	Gasket, End Cover	CS02300-I125	i125 t=1.0	1
25	Male Rotor	CS02600-I125SM	i125SM/SF FCD	S:1set
26	Female Rotor	CS02600-I125SF		
25	Male Rotor	CS02600-I125LM	i125LM/LF FCD	L:1set
26	Female Rotor	CS02600-I125LF		
27-1	Radial Bearing	CS02800-FM125M	FM125M	2
27-2	Radial Bearing	CS02800-FM125F	FM125F	2
29-1	Snap Ring	NG11-090	H90 C type-Internal	1
29-2	Snap Ring	NG11-100	H100 C type-Internal	1
29-3	Snap Ring	NG12-040	S40 C type-External	1
30	Balance Piston	CS03000-I125	i125	1
31	Slotted Set Screw	NA83608-016	FM160 (M8×16) with hexagon socket	1
32	Snap Ring	NG12-045	S45 C type-External	1
33	Sleeve, Balance Piston	CS03300-I125	i125	1
34	Spring pin	NE3206-015	FM160 (Φ6×15)	1

P/N	Part name	Code No.	Remarks	Qty
35	O-ring	PA11-016	JIS B 2401 P16	1
38-1	Thrust Bearing M	CS03800-I125M	i125M	1
38-2	Thrust Bearing F	CS03800-I125F	i125F	1
39-1	Lock Nut	NG31-008	AN8	1
39-2	Lock Nut	NG31-009	AN9	1
40-1	Lock Washer	NG32-008	AW8	1
40-2	Lock Washer	NG32-009	AW9	1
41-1	Spacer, Thrust Bearing Outer Race M	CS25000-FM11S	FM11S Thrust Washer	1
41-2	Spacer, Thrust Bearing Outer Race F	CS04100-I125F	i125F	1
42-1	Spacer, Thrust Bearing Alignment M	CS04200-I125M	i125M	1
42-2	Spacer, Thrust Bearing Alignment F	CS04200-125	125***	1
43-1	Thrust Bearing Gland M	CS04300-I125M	i125M	1
43-2	Thrust Bearing Gland F	CS04300-I125F	i125F	1
45	Hexagon Head Bolt	NB35408-035	M8×35 SCM435	8
46	Spring Washer	ND320-008	M8	8
48	Retainer, Oil Seal	CS04800-125	125***	1
49	O-ring	PA12-085	JIS B 2401 G85	1
50	Oil Seal	CS05000-125D	125*** Rareflon	1
51	Seal Cover	CS05102-125	125***	1
52	Gasket, Seal Cover	CS05200-125N	125***	1
53	Hexagon Socket Head Cap Screw	NB35406-020	M6×20 SCM435	8
58	Hexagon Socket Head Cap Screw	NB35408-030	M8X30 SCM435	12
91	Coupling Key	CS09100-125	125L**	1
92	Suction Flange with hole	CS71400-100MK	MYK 100A (Male)	1
93	Gasket, Suction Flange	CR72000-100N	MYK 100A	1
94	Hexagon Head Bolt, Suction Flange	NB12022-060	M22×60 SCM435	S:4 L:8
95	Discharge Flange with hole	CS71400-065CDMK	MYK 65CD (Male)	1
96	Gasket, Discharge Flange	CS23600-125N	MYK 65CD	1
97	Hexagon Head Bolt, Discharge Flange	NB12016-045	M16×45 SCM435	S:4 L:8
100	Mechanical Seal Assembly	CS10002-125EBS	BBSE 125***	1set
235-1	Motor Spacer	CS23502-I125N	for NEMA Motor Flange	1
			for IEC FF400	
			for IEC FF500	
235-2	Plate, Motor Spacer	CS23510-I125	i125	2
			for IEC FF400 (1), (2)	2
			for IEC FF500 (1), (2)	2
235-3	Hexagon Socket Head Cap Screw	NB35406-010	M6×10 SCM435	8
237-1	Torsional Slip Washer M	CS23700-F125M	FM125 M	1
237-2	Torsional Slip Washer F	CS23700-125	125L**	1
250-1	Thrust Washer M	CS04200-I125M	i125M Spacer, thrust bearing alignment	1
250-2	Thrust Washer F	CS25000-125	125***	1
391	Unloader Piston	CS39100-I160	i160*	2
392	Spring	CS39200-F125	FM125	2

P/N	Part name	Code No.	Remarks	Qty
393	Unloader Cover	CS39300-I160	i160*	2
395	Gasket, Unloader Cover	CS39500-I160	i160*	2
480	Strainer Element	CS48000-I160	i160*	1
481	Retainer, Strainer Element	CS48100-I125	i125	1
482	Hexagon Socket Head Cap Screw	NB35406-015	M6×15 SCM3	2
485	Check Valve Spring	CS48500-F125	FM125	1
486	Hexagon Nut	NC622-10	U-NUT M10	1
487	Plain Washer	ND193-10	JISB1256 small-sized, round-shaped 10-22H	1
488-1	Seat Stopper (1)	CS48800-F125	FM125	1
488-2	Seat Stopper (2)	CS48800-F1252	FM125	1
489	Valve Seat	CS48900-I125	i125	1
490	Valve Plate	CS49000-I125	i125	1
491	Check Valve Shaft	CS49100-I125	i125	1
495	O-ring	PA11-007	JIS B 2401 P7	1
533	Solenoid Valve	KF711-XOF1	SPOLAN XOF-120V	2
		KF711-XOF2	SPOLAN XOF-240V	
534	Nipple (High Pressure)	NN410-080	R3/8 Sch40 80L	2
535	Connection (L-type)	NJ3-0803NE	L-Φ8-R3/8 JO4060	2
536	Connection (L-type)	NJ3-0802NE	L-Φ8-R1/4 JO4050	2
538	Piping	QA11-08	Φ8	2
546	Wave Washer	ND91-016	FM125 BW16	1
555	Angle Valve	NF042-0302N	JO5820 R1/4×Rc1/4	2
795	Cover Plate, Discharge Flange	CS71500-I1251	i125 4.5x84D	1
795	Cover Plate, Suction Flange	CS71500-I1252	i125 4.5x123D	1

CAUTION

- **The part code of the O-ring is the one assigned to NBR-70-1 which is standard material. When the material of the O-ring is other than NBR, a different part code is used for each material.**
  If you are using O-rings made from other than the standard material, please contact MAYEKAWA when placing an order.

Table 2-5 i160* Parts Configuration Table

P/N	Part name	Code No.	Remarks	Qty
1	Main Rotor Casing	CS00102-I160S*	i160S-* port (L, M, H)	S:1
1	Main Rotor Casing	CS00102-I160M*	i160M-* port (L, M, H)	M:1
1	Main Rotor Casing	CS00102-I160L*	i160L-* port (L, M, H)	L:1
2	Hexagon Socket Head Cap Screw	NB35416-055	M16×55 SCM435	71
3	Alignment Pin	NE242A13-050A	13×50L With internal thread and slot	6
4-1	Eye Bolt	NB600-12	M12	3
4-2	Eye Bolt	NB600-24	M24	1
4-3	Eye Bolt	NB600-24	M24	1
5	Strainer Cover	CS00502-I160	i160	1
6	Gasket, Strainer Cover	CS00900-I160	i160 t=0.5	2
7-1	O-ring	PA12-150	JIS B 2401 G150	1
7-2	O-ring	PA12-140	JIS B 2401 G140	1
8	Check Valve Cover	CS00800-I160	i160	1
10-1	Hexagon Socket Head Cap Plug	NF06-004	R1/8 S45C	5
10-2	Hexagon Socket Head Cap Plug	NF06-008	R1/4 S45C	9
10-3	Hexagon Socket Head Cap Plug	NF06-010	R3/8 S45C	S,L:3 M:4
10-4	Hexagon Socket Head Cap Plug	NF06-015	R1/2 S45C	S, L:15 M:14
10-5	Hexagon Socket Head Cap Plug	NF06-020	R3/4 S45C	1
10-6	Hexagon Socket Head Cap Plug	NF06-025	R1 S25C	2
11	Bearing Head	CS01102-I160	i160	1
12	Gasket, Bearing Head	CS01200-I160	i160 t=0.5	1
16	Bearing Cover	CS01602-I160	i160	1
17	Gasket, Bearing Cover	CS01700-I160	i160 t=0.5	1
18-1	Hexagon Socket Head Cap Screw	NB35412-040	M12×40 SCM435	40
20	Spring Pin	NE3203-010	3×10L	1
22	End Cover	CS02202-I160N	i160	1
23	Gasket, End Cover	CS02300-I160N	i160 t=1.0	1
25	Male Rotor	CS02600-I160SM	i160SM/SF FCD	S:1set
26	Female Rotor	CS02600-I160SF		
25	Male Rotor	CS02600-I160MM	i160MM/MF FCD	M:1set
26	Female Rotor	CS02600-I160MF		
25	Male Rotor	CS02600-I160LM	i160LM/LF FCD	L:1set
26	Female Rotor	CS02600-I160LF		
27-1	Radial Bearing M	CS02800-FM160M	FM160	2
27-2	Radial Bearing F	CS02800-FM160F	FM160	2
29-1	Snap Ring	NG11-120	H120 C type-Internal	1
29-2	Snap Ring	NG11-130	H130 C-type-Internal	1
29-3	Snap Ring	NG12-060	S60 C type-External	1
30	Balance Piston	CS03000-I160	i160	1
30	Balance Piston (LT)		Special part for FM160 For H-port	1
31	Slotted Set Screw	NA83608-016	FM160 (M8×16)	1

P/N	Part name	Code No.	Remarks	Qty
32	Snap Ring	NG12-055	S55 C type-External	1
33	Sleeve, Balance Piston	CS03300-I160	i160	1
33	Sleeve, Balance Piston (LT)		Special part for FM160 For H-port	1
34	Spring pin	NE3206-015	FM160 (6×15L)	1
35	O-ring	PA11-024	JIS B2401 P24	2
38-1	Thrust Bearing M	CS03800-I160M	7311B	1
38-2	Thrust Bearing F	CS03800-I160F	7312B	1
39-1	Lock Nut	NG31-011	AN11	1
39-2	Lock Nut	NG31-012	AN12	1
40-1	Lock Washer	NG32-011	AW11	1
40-2	Lock Washer	NG32-012	AW12	1
41-1	Spacer, Thrust Bearing Outer Race M	CS04100-I160M	i160 M	1
41-2	Spacer, Thrust Bearing Outer Race F	CS04100-I160F	i160 F	1
42-1	Spacer, Thrust Bearing Alignment M	CS04200-I160M	i160 M	1
42-2	Spacer, Thrust Bearing Alignment F	CS04200-I160F	i160 F	1
43-1	Thrust Bearing Gland M	CS04300-I160M	i160 M	1
43-2	Thrust Bearing Gland F	CS04300-I160F	i160 F	1
45	Hexagon Socket Head Cap Screw	NB35410-050	M10×50 SCM435	8
46-1	Spring Washer	ND330-10	For hexagon socket head cap screw M10	8
46-2	Plain Washer	ND193-10	JIS B 1256 Small-sized, round-type 10-22H	8
48	Retainer, Oil Seal	CS04800-160	160***	1
49	O-ring	PA12-090	JIS B 2401 G90	1
50	Oil Seal Rareflon	CS05000-160VD	160*** (S55×70×9)	1
51	Seal cover	CS05102-160	160***	1
52	Gasket, Seal Cover	CS05200-160N	160*** t=0.5	1
58	Hexagon Socket Head Cap Screw	NB35408-030	M8×30 SCM435	8
91	Coupling Key	CS09100-160	160*** single round12×8×75	1
92	Suction Flange with hole	CZA01-300C05BMK	ANSI #300 5"	1
93	Gasket, Suction Flange	PL300-125	ANSI #300 5"	1
94-1	Stud Bolt	NBU703/4-103	3/4-10UNC ×65(103L)	8
94-2	Hex Nut	NCU1503/4-10UNC	3/4-10UNC ×65	8
95	Discharge Flange with hole	CZA01-300C03BMK	ANSI #300 3"	1
96	Gasket, Discharge Flange	PL300-080	ANSI #300 3"	1
100	Mechanical Seal Assembly	CS10002-160EBS	160V BBSE	1set
150-1	O-ring, Thrust Bearing Gland M	PA12-110	JIS B 2401 G110	1
150-2	O-ring, Thrust Bearing Gland F	PA12-115	JIS B 2401 G115	1
216-1	Flange with hole , Oil Inlet Port	CR74000-025	MYCOM 25A	1
216-2	Flange Gasket, Oil Inlet Port	CR72000-025N	MYCOM 25A	1
216-3	Hexagon Head Bolt	NB35412-035	M12×35 SCM435	4
216-4	Cover Plate (for Airtight/Pressure Test)	CS71500-025	MYCOM 25A Attached at shipment.	1

P/N	Part name	Code No.	Remarks	Qty
235-1	Motor Spacer	CS23500-I160N	for NEMA Motor Flange	1
			for IEC FF500	
			for IEC FF600	
235-2	Plate, Motor Spacer	CS23510-FM160	NEMA Motor Flange Spacer	2
			FF500 Motor Flange Spacer	
			FF600 Motor Flange Spacer	
235-3	Hexagon Socket Head Cap Screw	NB35406-010	M6×10 SCM435	8
235-4	Hexagon Socket Head Cap Screw	NB35416-055	M16×55 SCM435	12
237-1	Torsional Slip Washer M	CS23700-FM160M	FM160	1
237-2	Torsional Slip Washer F	CS23700-160	160***	1
250-1	Thrust Washer M	CS25000-FM160M	FM160	1
250-2	Thrust Washer F	CS25000-160	160*** Thrust washer	1
391	Unloader Piston	CS39100-I160	i160	2
392	Spring	CS39200-F125	FM125	2
393	Unloader Cover	CS39300-I160	i160	2
395	Gasket, Unloader Cover	CS39500-I160	i160 t=1.0	2
-	Hexagon Socket Head Cap Screw (common to No.58)	NB35408-030	M8×30 SCM435	12
480	Strainer Element	CS48000-I160	i160 #150 Φ160×200	1
481	Retainer, Strainer Element	CS48100-I160	i160	1
485	Check Valve Spring	CS48500-I160	i160	1
486	Hexagon Nut	NC622-10	FM160(U-NUT M10 Type 2)	1
487	Plain Washer	ND193-10	Small-sized SPCC1 M10	1
488	Seat Stopper	CS48800-I160	i160	1
489	Valve Seat	CS48900-I160	i160	1
490	Valve Plate	CS49000-I160	i160	1
491	Check Valve Shaft	CS49100-I160	i160	1
495	O-ring	PA11-007	JIS B 2401 P7	1
533	Solenoid Valve	KF711-XOF1	SPORLAN XOF-120V	2
		KF711-XOF2	SPORLAN XOF-240V	
534	Nipple (High Pressure)	NN410-100	Rc3/8×100L Sch40	2
535	Connection (L-type)	NJ3-0803NE	L-Φ8-R3/8 JO4060	2
536	Connection (L-type)	NJ3-0802NE	L-Φ8-R1/4 JO4050	2
538	Piping	QA11-08	Φ8	2
550	Check Union	KD122-12E	I-Φ12-R3/8	L: 2 S, M: 1
551	Connection (I-type)	NJ2-1203NE	I-Φ12-R3/8 JO4570	L: 2 S, M: 1
552	Piping	QA11-12	Φ12	1
553	Connection (I-type)	NJ2-1002NE	I-Φ10-R1/4	1
554	Angle Valve	NF067-02	TC-1 R1/4×Rc1/4	1
555	Angle Valve	NF067-03	TC-1 R3/8×Rc1/4	1
556	Connection (I-type)	NJ2-1003NE	I-Φ10-R3/8	1
557	Piping	QA11-10	Φ10	1

P/N	Part name	Code No.	Remarks	Qty
558	Hexagon Bushing	NF031-0403	JO5007 R1/2×Rc3/8	1
559	Hose Nipple	NN5102-050	8A×50	1
795	Cover Plate, Discharge Flange	CS71500-I1601	i160 4.5x146D	1
794	Cover Plate, Suction Flange	CS71500-I1602	i160 4.5x213D	1

CAUTION

- **The part code of the O-ring is the one assigned to NBR-70-1 which is standard material. When the material of the O-ring is other than NBR, a different part code is used for each material.**
  If you are using O-rings made from other than the standard material, please contact MAYEKAWA when placing an order.

2.5 Mechanisms

2.5.1 Basics of the Screw Compressor

The screw compressor is categorized as a positive displacement rotary compressor.
As shown in Figure 2-22, the refrigerant (gas) is continuously compressed by the 3-dimensional spaces that are formed by a pair of male and female screw rotors (with different sectional profiles) and the casing, as the spaces change continuously.
The rotor having 4 protruding lobe profiles is called a male or M rotor, and the rotor having 6 concave profiles is called a female or F rotor. In this manual, they are referred to as M rotor and F rotor.
The compressor is driven by the motor connected to the shaft of the M rotor.

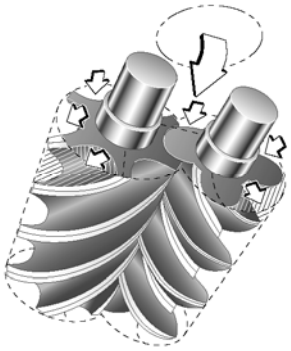


Figure 2-22 Compressor Mechanism

2.5.2 Suction Process

As shown in Figure 2-23, the rotors with different lobe profiles are engaged. As the rotors turn, the volume between the M and F rotor lobe profiles and the compressor casing gradually increases starting from the suction side.
As the rotation continues, at a certain point when the volume reaches its maximum, the rotors isolate the gas (volume), which is enclosed by the rotors and the compressor casing, from the suction port and then continues rotation.

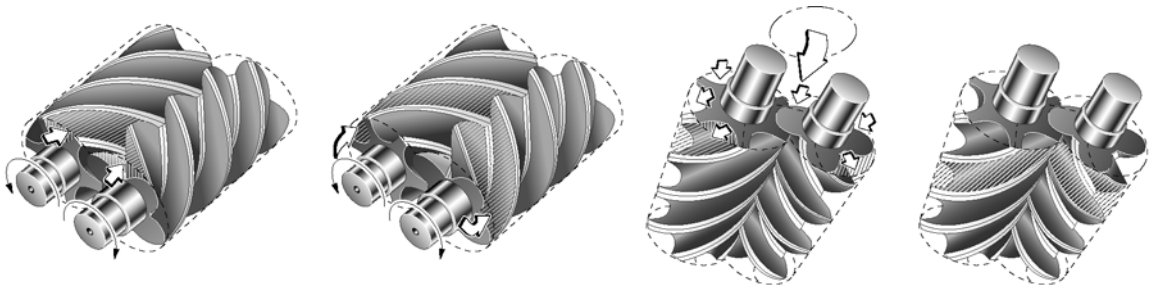


Figure 2-23 Suction Process

2.5.3 Compression Process

As the rotors rotate further, the volume between the rotor lobes decreases while the sealing line moves toward the discharge side, which compresses the trapped refrigerant gas.

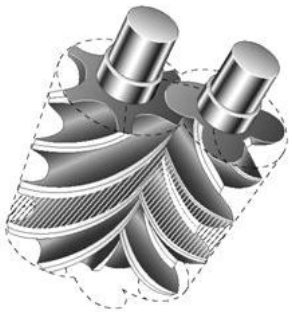


Figure 2-24 Compression Process

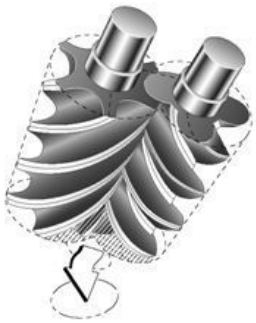


Figure 2-25 Discharge Process

2.5.4 Discharge Process

The volume between the rotor lobes decreases to a level predetermined by the discharge port. With the rotations of the rotors, the compressed refrigerant gas is pushed out to the discharge port.

2.5.5 About Volume Ratio (Vi)

Volume ratios (Vi) are indicated in property tables or catalogs by using port symbols L, M and H.
The volume ratio represented by each symbol (MYCOM screw compressor) is as follows:
L=2.63, M=3.65, H=5.80.

$$Vi = \frac{\text{Volume of suctioned refrigerant gas immediately before the start of compression}}{\text{Volume of refrigerant gas just before pushed out to discharge port}}$$

Decide which volume ratio (L, M or H) should be used according to operating conditions. If the compressor is used with a volume ratio that does not match operating conditions, operation will go inefficiently wasting the power.
The relationship between volume ratios and generally used compression ratios is as follows:

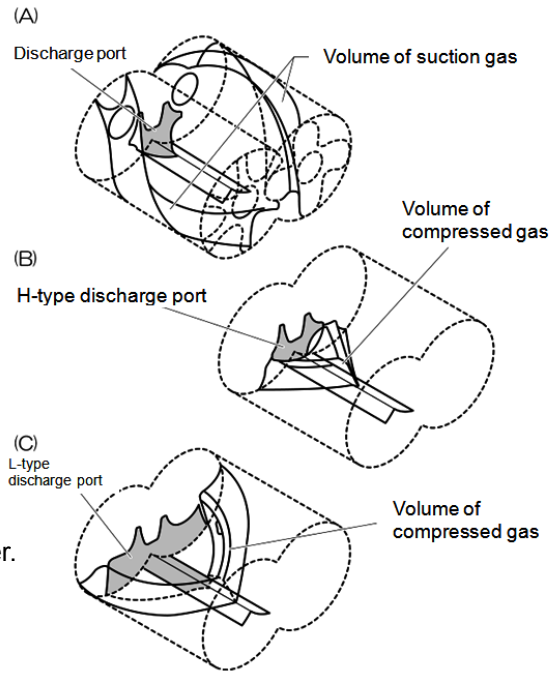


Figure 2-26 Volume Ratio

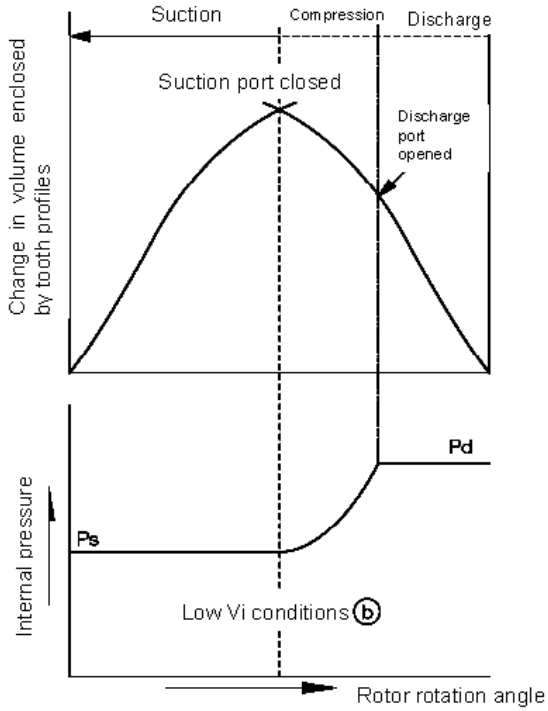
$$Vi = \left(\frac{Pd}{Ps}\right)^{\frac{1}{\kappa}} \quad \text{or} \quad Vi^{\kappa} = \frac{Pd}{Ps}$$

$(Vi)^{\kappa} = \pi i = Pd/Ps$ κ = Cp/Cv of refrigerant gas
Vi = Design volume ratio πi = Design compression ratio

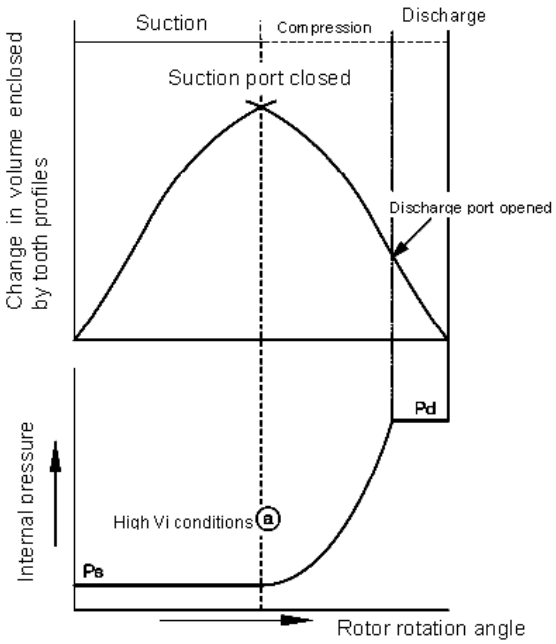
Vi is related to the specific heat ratio (κ) and therefore its value relative to the compression ratio varies depending on the type of refrigerant gas.

(A) Properly adapted Vi to load condition

Both the required compression ratio and Vi are low.

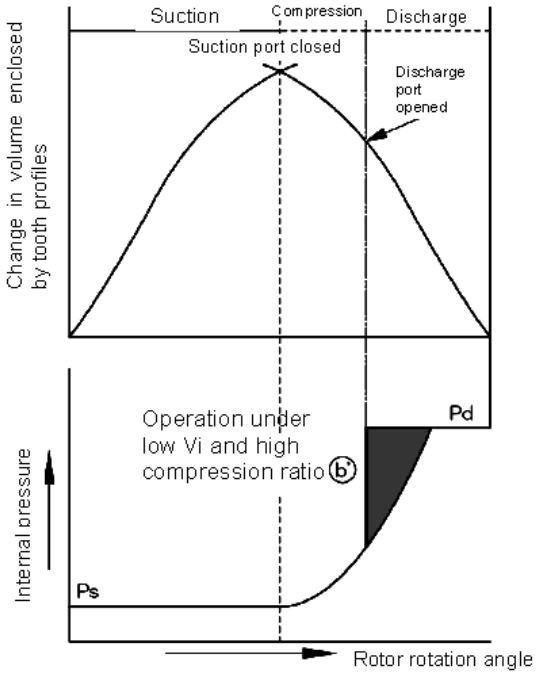


Both the required compression ratio and Vi are high.



(B) Improperly adapted Vi to load condition

Too low Vi compared with necessary compression ratio.



Too high Vi compared with necessary compression ratio

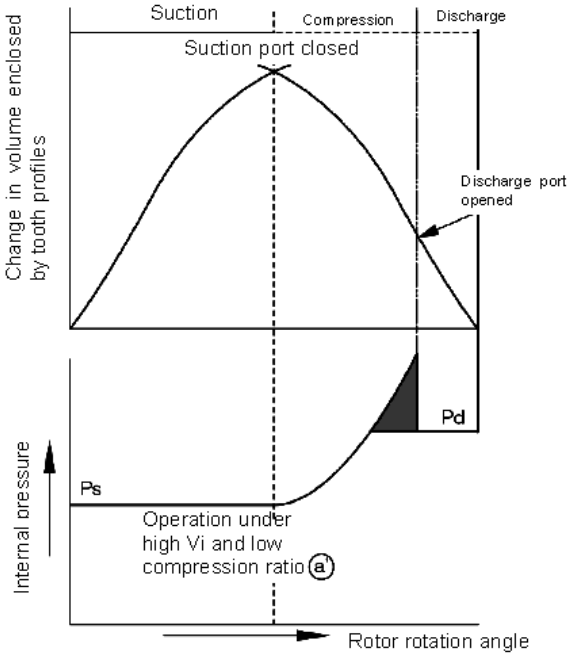
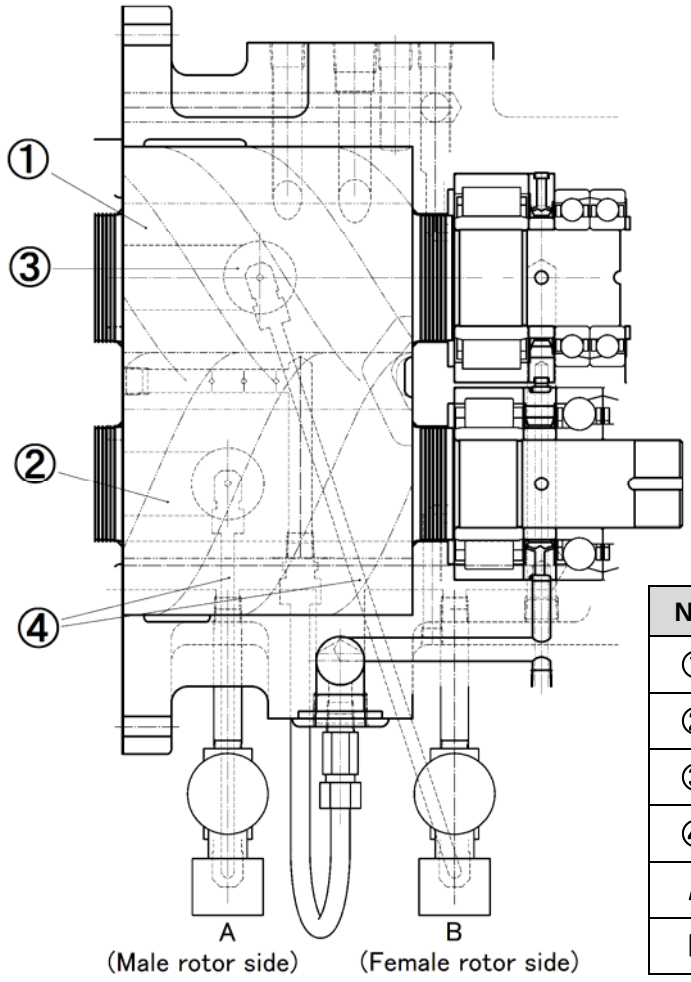


Figure 2-27 Relationship between Volume ratio (Vi) and Operation Conditions

2.5.6 Capacity Control Mechanism

The capacity control of i-series compressor can be controlled in three steps of 50%, 75% and 100% via the unloader piston installed at each male rotor side and female rotor side in the main rotor casing.

Each unloader piston controlled by solenoid valve.



No.	Description
①	Female Rotor
②	Male Rotor
③	Unloader Piston
④	Piping
A	Solenoid Valve
B	Solenoid Valve

Figure 2-28 Capacity Control Mechanism

Table 2-6 Control of Solenoid Valves for Capacity Control

	A	B
100%	ON (Opened)	ON (Opened)
75%	OFF (Closed)	ON (Closed)
50%	OFF (Closed)	OFF (Closed)
Standstill (50%)	OFF (Closed)	OFF (Closed)

■ Solenoid Valve for Capacity Control

Table 2-7 Specifications of the Solenoid Valves

Item			Solenoid Valve	
			SX07-03GN (Japan domestic)	SPORLAN XOF (Foreign)
Coil ratings	Volts	AC V	100, 200	120, 208 to 240
		DC V	—	24
	Watts	W	11/10	10
	Cycles	Hz	50/60	50/60
Piping joint		—	Rc3/8	3/8 NPT Female
Port size		mm	3	2.8
Maximum Operating pressure differential required		Mpa	2	1.7

Note: The pressure value represents the gauge pressure.

CAUTION

- **Solenoid valves for capacity control are indoor specifications. Make sure not to drop dew condensation water onto the solenoid valves by installing appropriate thermal protection on the suction piping to the compressor.**

Chapter 3 Installation

3.1 General Precautions for Installation

【POINT】

- The description in Chapter 3 “Installation” assumes that the compressor is installed to a package unit intended for standard type refrigeration/cold storage.
  If the package unit you are actually using is not the one for standard type refrigeration/cold storage, prepare a proper installation manual by referring to the description in this chapter and paying due consideration to safety, before installing the compressor.
  If there are any questions, please contact one of our local sales offices or service centers.

- In some cases, it may be required that installation is performed by qualified personnel. Make sure that the work is performed by qualified personnel in compliance with local laws, ordinances and other regulations/requirements.
- Read this chapter and related documents, and fully understand their contents before performing installation.
- Electrical works should be performed only by electrical engineers.

3.2 Installation Works

3.2.1 Unpacking

Check that there are no abnormalities such as damage on the compressor.

【POINT】

- If there are abnormalities or deficient parts on the compressor, please contact one of our local sales offices or service centers immediately.
- Unnecessary packing materials should be discarded according to the laws and ordinances, or your company's rules.

3.2.2 Storage

Perform the followings to store the compressor before installation.

- Store it indoors.
- Infuse nitrogen gas into the compressor and seal it. (Pressure: approximately 0.15 MPa)

3.2.3 Transportation

DANGER

- **Dropping of the lifted compressor may cause death or serious injury to the worker.**
  Do not allow anyone to be under the lifted compressor.

1. For lifting the compressor within the safety limit, use lifting equipment and tools appropriate for the mass of the compressor.
2. Secure sufficient space for safe lifting.
3. Always check the wire ropes before using them. Thoroughly check the wire ropes for problems such as kinks, knots and broken strands. Do not perform lifting work before confirming the safety of the wire ropes. If you cannot make a correct evaluation or judgment, entrust an expert to check.

4. To lift the compressor, attach the wire ropes to the appended eye bolts by using appropriate shackles and hooks. Use the eye bolts only for lifting the compressor.

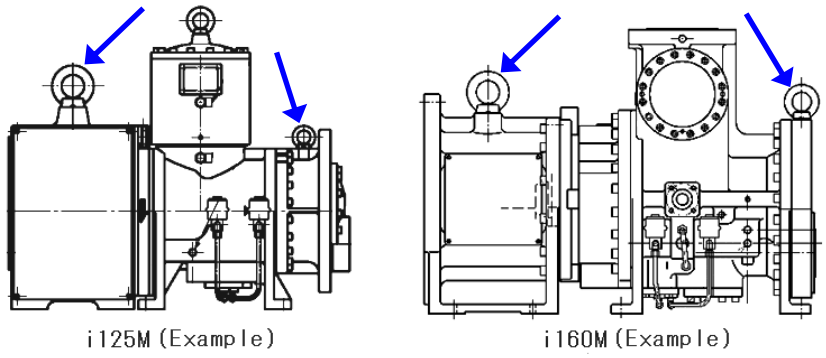


Figure 3-1 Eye bolts for lifting the compressor (Arrows)

CAUTION
● **The compressor eye bolts must not be used for lifting the package unit. To lift the package unit, use the lifting chains provided around the base or other lifting means provided on the base.**

5. Check path of compressor installation to make sure it is free of obstacles in consideration of the compressor size.

6. Before lifting, check that the hook is located above the gravity center of the compressor.

7. Before starting to lift up the compressor, instruct all the workers to be sufficiently away from the lifting area.

8. Just before starting to lift up, provide the coworkers with a sign (such as a call, hand signal, etc.) of starting the lifting action. Do not start to lift up unless the sign (such as a call, hand signal, etc.) has been fully acknowledged.

9. Slowly reel up the wire ropes until immediately before the compressor leaves the ground.

10. Then, reel up the wire ropes a little further until the compressor is slightly up away from the ground. Check that the compressor is not tilted. If the compressor is tilted, return the compressor to the ground and correct the tilt by adjusting the wire ropes. After that, restart the lifting operation.

11. Be sure to lift up the compressor slowly. If it is lifted rapidly, it may damage the lifting tools such as wire ropes or a part of the compressor.

12. When the lifting work starts, observe to see if wire ropes and lifting tools are normal. Be sure that the compressor is not tilted.

13. When moving the lifted compressor, always use guiding ropes.

14. When moving the compressor, turn away workers from the movement direction and check safety.

15. Do not lift the compressor above the safety passage unless absolutely necessary.

16. Do not lower the compressor on the safety passage. Always keep the safety passage free of obstacles.

17. Remove any obstacles before lowering the compressor onto the ground. The compressor should not be tilted or unstable.

18. Before lowering the compressor, announce to the workers around the working area in advance.

19. When lowering the compressor onto two or more blocks, align the tops of blocks so that the compressor becomes stable horizontally on them.

20. Slowly lower the lifted compressor so that it is not damaged by shock.

3.2.4 Preparation for Installation

■ Installation Space

Secure sufficient working space for easy operation, cleaning, maintenance, and inspection.

■ Lighting

Provide sufficient lighting to allow easy operation, cleaning, maintenance, and inspection.

■ Ventilation

If natural ventilation is insufficient, install ventilation fans according to the relevant regulations.

3.2.5 Installation

Check that the surface of the package unit, where the compressor is to be installed, is even and horizontal. If it is uneven and non-horizontal, tightening the bolts may lead to compressor deformation, which may prevent normal operation.

3.2.5.1 Piping Connection

■ Refrigerant Piping

The size of the connection piping, refer to Section 2.3.4 "Outer Dimensions" in this manual.

Observe the following when connecting the refrigerant piping.

- The compressor is one of the few devices installed within the refrigerating/cold storage unit that have moving components. These moving components are adversely affected by foreign substances within the system (scale, dust, spatter, etc.). Therefore, when connecting the piping, do not allow any of such foreign substances to enter inside.
- Some compressors (mainly those for export) are charged with nitrogen gas to prevent rust. Be sure to release the pressure before starting piping work.
- Be sure not to allow moisture to enter the piping. There is a high probability that it will cause trouble after the start of operation. Be sure to assemble piping when it is dry.
- Improper piping may cause operating problems such as oil not returning to the compressor or liquid flow-backs.
- When connecting the piping to the compressor, use piping that is the same size as the compressor connection port. If the pipe size of the piping is smaller than the compressor connection port, the flow of lubricating oil or refrigerant will be obstructed leading to problems.
- Do not let the mass of the piping connected to the compressor applied onto flanges or joints. Be sure to prepare proper supports for piping.

■ Oil Supply Piping

When constructing the multi-package unit with i-series compressors, in order to prevent backflow from the compressor, we recommend the installation of a solenoid valve of PARKER or an electric motor ball valve in the lubricating oil supply system.

Also, make sure to provide a check valve between the compressor and the valve described above.

3.2.5.2 Equipment and Devices for Protection of the Compressor

■ **Oil Filter**

According to the requirements of the use of the package unit or the standard to apply, install an oil filter of appropriate filtration precision in the lubrication system of the compressor.

In the case of general applications such as closed-cycle refrigeration systems, we recommend to use an oil filter with beta ratio in the range of $\beta_{20} \geq 150$ that conforms to requirements of NAS 1638 class 8 or ISO 4406 17/15/13.

The oil filter may be clogged just after the commissioning. We recommend installing two oil filters in parallel. This will enable replacement of either filter during operation.

■ **Oil Heater for Oil Separator**

To preserve the temperature of the lubricating oil before starting the compressor operation, install an oil heater on the oil separator. In cold districts, install a band heater to the oil supply piping. Make sure to install a protection function (thermostat, etc.) to the heater to prevent overheating.

■ **Suction Strainer**

The i-series compressor has built-in suction strainer. The same strainer elements are used for both models of the i125* and i160*. The mesh size of strainer element is 150 meshes.

During commissioning, small particles and scale may come from the system. We recommend to install a finer filter temporarily.

■ **Line Filter for Economizer/Aquamizer (Liquid injection)**

When using an economizer or/and aquamizer (liquid injection), install a filter with filtration accuracy of not higher than 100μm within the line.

■ **Compressor Protective Devices (Safety Devices)**

Install the necessary protective devices, referring to Section 1.4.3 "Compressor Protective Devices" and Section 2.3.3 "Alarm Setting Values", in this manual.

3.2.6 Airtightness Test

Before commissioning, perform an airtightness test on the refrigerating/cold storage package unit.

Use the design pressure of the refrigerating unit as the test pressure. Keep that pressure for at least 30 minutes, and perform a leak test on the connecting/jointing parts like flanges by using leakage detection liquid (soapy water, etc.).

3.2.7 Lubricating Oil Charge

CAUTION
● **In the packaging of the refrigerating unit, install two valves at the front and the rear of an oil filter. Install an oil charge port between the oil filter and the upstream side valve.** ● **When refilling lubricating oil, ensure that it is clean and does not contain foreign matters.** ● **Be careful that air and water are not mixed in when refilling.** ● **To ensure that the lubricating oil does not absorb air moisture, keep it indoors in an airtight container until use.**

3.2.7.1 Initial Charge of Lubricating oil

At initial commissioning or after periodical inspection, the compressor's moving parts such as bearings and mechanical seals may not be sufficiently lubricated. So, charge the compressor with lubricating oil according to the following procedure.

1. Thoroughly evacuate the compressor and oil separator (approximately 40 Torr).
2. Open the downstream side valve of the oil filter, and charge 10 liters of lubricating oil from the oil supply port.
3. Turn the compressor's rotor shaft.
4. Close the downstream side valve of the oil filter.
5. Open the upstream side valve of the oil filter, and charge lubricating oil to the oil separator until it reaches the specified level.

【POINT】

- Be sure to conduct the initial charge of lubricating oil in such a way that the oil cooler and oil filter are filled with lubricating oil.
- For details about lubricating oil to be used, refer to Section 4.1 "Lubricating Oil (Refrigerant Oil)" in this manual.
- Depending on the equipment configuration of your package unit, define the amount of initial charge of lubricating oil, and make sure to provide users of this product with the information.

3.2.7.2 Additional Charge of Lubricating Oil

Define the procedure of the additional filling of lubricating oil based on the configuration of the package unit, and make sure to provide users of this product with the information.

3.2.8 Charge of Refrigerant

Depending on the use working fluid and equipment configuration of your package unit, specify the work procedure that considered safety enough, and conduct the refrigerant filling work accordingly.

In addition, specify the procedure of the additional filling of refrigerant, make sure to provide users of this product with the information.

3.2.9 Check after Installation

Depending on the package unit to which this product is installed, formulate the necessary confirmation items and methods for package unit after installation and conduct them accordingly before the commissioning. Also, make sure to record and keep the results of your confirmation.

In addition, in case of i160*, make sure to confirm the following point. Do not forget it.

CAUTION

- **The angle valve (P/N: 554) shown in Figure 3-2 should be always closed during operation. Confirm that the valve is closed at the check work after installation before the commissioning.**

  Note that i125* models don't have this valve.

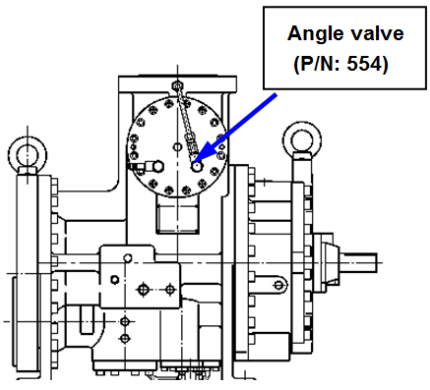


Figure 3-2 Location of P/N 554 Valve (i160*)

Chapter 4 Compressor and Package Unit Operation

4.1 Lubricating Oil (Refrigerant Oil)

Lubrication management is very significant to keep the compressor in a good operating condition.
Take the following notes when managing lubricating oil.

4.1.1 Precautions for Selecting the Lubricating Oil

- Selection of the lubricating oil should depend on the type of the refrigerant, the type of the evaporator used with the compressor, and the conditions under which the compressor is operated. Also to be considered when selecting lubricating oil are the properties of the oil that include not only the viscosity but also such characteristics as compatibility in refrigerant, separability from refrigerant, low temperature fluidity, high temperature thermal stability, etc.

  We therefore recommend contacting our sales offices or service centers for choice of a specified brand for your system.

- Lubricating oil used for compressors must have a viscosity appropriate for lubricating the bearings and other components in the compressors. The viscosity to be considered in this case should be the viscosity the oil shows at the oil inlet of the compressor. The viscosity of the lubricating oil significantly changes depending on the type of the refrigerant used in combination with the lubricating oil. If the refrigerant dissolves in the lubricating oil (or the lubricating oil and refrigerant are compatible), the viscosity of the lubricating oil drops to a level remarkably below the level required for operation of the compressor under some operating conditions. On the contrary, if the refrigerant does not dissolve in the lubricating oil (or the lubricating oil and refrigerant are incompatible), the viscosity may become too high when the supply oil temperature is low. For this reason, the lubricating oil must be selected such that it is supplied to the compressor with an appropriate viscosity (kinematic viscosity of 13 to 40 mm^2/s) in the operating state.

- The circulation of the lubricating oil for the entire system must be considered. After lubricating and cooling each part of the compressor, the lubricating oil is discharged with refrigerant gas. Most of the oil which is discharged from this compressor is trapped by the oil separator and is cycled to the compressor. A small quantity of refrigerant oil goes to the condenser and the evaporator. The lubricating oil is required to have sufficient fluidity and stability inside each part in the refrigerating cycle where temperatures differ.

- Note that some lubricating oils cannot be used depending on the combination with the refrigerant. The following caution is an example case that is required especially attention.

CAUTION
● **Be careful since polyolester synthetic oil (POE) cannot be used with ammonia refrigerant.**

4.1.2 Recommended Lubricating Oils

When selecting lubricating oil, not only compatibility with refrigerant but also effects on O-rings must be considered. To prevent compressor malfunctions, we recommend the lubricating oil described below.

4.1.2.1 Recommended Lubricating Oils for Ammonia Refrigerant

■ **Mineral Oils (incompatible oils)**

Brand	Kinematic viscosity (40°C) mm^2/s	Manufacturer	Type
SUNISO 3GS	30	Sun Oil	Naphthene base
SUNISO 4GS	55	Sun Oil	
REFOIL NS 3GS	30	Nippon Oil	
GARGOYLE ARCTIC C HEAVY	46	Exxon Mobil	
GARGOYLE ARCTIC 300	68	Exxon Mobil	
CAPELLA WF46	46	Texaco	
CAPELLA WF68	64	Texaco	
CP-1009-32	34	CPI	Hydrotreated paraffinic base
CP-1009-68	69	CPI	
REFLO 46A	46	Petro Canada	
REFLO 68A	58	Petro Canada	
CAPELLA PREMIUM	67	Texaco	
RHT-68	68	Kluber	
REFLO XL	59	Petro Canada	

■ **Synthetic Oils (incompatible oils)**

Brand	Kinematic viscosity (40°C) mm^2/s	Manufacturer	Type
Acemire 300	59	Acemire	AB
Mycold AB68	53	BVA	
ZERICE S46	46	Exxon Mobil	
ZERICE S68	68	Exxon Mobil	
BERREL FREEZE 46S	46	Matsumura Oil Co., Ltd.	
CP-4700-32	31	CPI	
CP-4700-68	56	CPI	
Gold - Cold 300	53	Golden West	
GARGOYLE ARCTIC NH68	64	Exxon Mobil	PAO+AB
REFLO SYNTHETIC 68A	62	Petro Canada	
Gargoyle arctic SHC 224 **Note**	30	Exxon Mobil	PAO
Gargoyle arctic SHC 226 (E) **Note**	68	Exxon Mobil	

Note: Use only the standard BBSE-type mechanical seal assembly.

4.1.2.2 Oils for Systems Using Hydrofluorocarbon (HFC) Refrigerants

■ **Polyolester Synthetic Oil (POE) for R404A and R507A: Compatible Synthetic Oil**

Brand	Kinematic viscosity (40°C) mm^2/s	Manufacturer	Type
SUNISO SL-68S	67	Sun Oil	POE
EMKARATE RL68H	72	Lubrizol	

■ **Polyolester Synthetic Oil (POE) for R134a: Incompatible Synthetic Oil**

Brand	Kinematic viscosity (40°C) mm^2/s	Manufacturer	Type
JOMO Freol α100	107	JX Nippon Oil and Energy Corporation	POE

CAUTION

- **When using lubricating oil of a brand not described in this section, or when using**
- **Lubricating oil along with refrigerants or gases not described in this section, please contact us.**

4.1.3 Change of Lubricating Oil Brand

When changing the lubricating oil brand in currently use for some reason, attention must be paid to the following points.

CAUTION

- **The change of lubricating oil brand may cause problems in operating conditions and the compressor. When changing the lubricating oil brand in use, make sure to contact us because appropriate steps must be surely followed.**
- **Package unit composition differs depending on the characteristics of lubricating oil (compatible/incompatible with refrigerant). As a general rule, changing compatible oil to incompatible oil or vice versa is not allowed.**

- Lubricating oil contains various additives to fulfill necessary lubricating conditions. Types of additives and their mixing ratio depend on each oil brand. We, therefore, recommend to avoid mixed use of different brands of lubricating oil. If mixed brands of lubricating oil are used, the different additives in the lubricating oil may react with each other and produce foreign substances like slurry.
- If it is necessary to change the brand of lubricating oil, collect as much as oil as possible from the compressor as well as from the condenser, evaporator, and all other refrigerating unit components before charging the new lubricating oil. After 100 to 200 hours of operation, replace the oil again.
- If lubricating oil manufacturers differ, contact both of them and inquire whether the changing is appropriate. The same confirmation is required for changing the brand even if it is of the same manufacturer.
- There is no problem in changing the viscosity level within the same brand. However, make sure that the viscosity grade will not cause problems during operation. (Example: SUNISO 3GS→SUNISO 4GS)

4.1.4 Precautions for Handling Lubricating Oil

- When refilling lubricating oil, ensure that it is clean and does not contain foreign matters.
- Be careful that air and water are not mixed in when refilling.
- To ensure that the lubricating oil does not absorb air moisture, keep it indoors in an airtight container until use.
- Always charge all oil from the oil container. We recommend that even if some oil remains, do not use it subsequently.

4.1.5 Lubricating Oil Management Criteria

Lubricating oils that are managed by the criteria are classified into the following categories:

(1) Mineral oils: Naphthenic base oils and paraffinic base oils
(2) Synthetic oils: Alkylbenzene (AB) and Polyalphaolefine (PAO)
(3) Synthetic oils: Polyolesters (POE)

- **Oil sampling and analysis is recommended every six months.**
- **If the following control criteria are not satisfied, replace the oil.**

The analysis items and the criteria are shown in the following tables. Please note that these management criteria may be changed without notice.

●Table 4-1 Mineral Oil and Synthetic Oil (AB, PAO)

Item	Criteria
(a) Color phase	ASTM color scale: 6.0 or less
(b) Total acid number (TAN)	0.3 mg KOH/g or less
(c) Kinematic viscosity	Within ±15 % from that of fresh oil
(d) Water content	100 mass ppm or less
(e) Degree of contamination	Degree of contamination measured by mass method (Millipore value) shall be 15 mg/100 mL or less

●Table 4-2 Synthetic Oil (POE)

Item	Criteria
(a) Color phase	ASTM color scale: 4.0 or less
(b) Total acid number (TAN)	0.2 mg KOH/g or less
(c) Kinematic viscosity	Within ±10 % from that of fresh oil
(d) Water content	200 mass ppm or less
(e) Degree of contamination	Degree of contamination measured by mass method (Millipore value) shall be 15 mg/100 mL or less

4.1.6 Lubricating Oil Replacement Timing

4.1.6.1 After Starting the Initial Operation

As the oil can easily be contaminated and degraded relatively quickly during the initial operation due to scales and deposits remaining in piping and vessels, be sure to sample and analyze the oil after 500 hours of operation.

If it is found as a result of the analysis that the criteria given in Tables 4-1 to 4-2 are not satisfied, the oil must be replaced.

4.1.6.2 During Normal Operation

Lubricating oils will degrade gradually as the system is operated over time.

The rate of degradation depends on the operating condition, type of oil and amount of foreign matters and moisture contained in the oil.

The lubricating oil must be sampled and analyzed every six months. If it is found as a result of the analysis that the control criteria given in Tables 4-1 to 4-2 are not satisfied, the oil must be replaced.

If the oil filters are frequently clogged or the oil color quickly becomes darker and unclear, replace the oil after removing the cause of the problem.

4.2 Precautions for Operation

4.2.1 Prevention of Liquid Flow-back

Liquid flow-back is a phenomenon where refrigerant that did not completely evaporate with the gas reaches the compressor. Liquid flow-back may cause insufficient lubrication of the compressor, abnormal vibrations and noises, and abnormal foaming of lubricating oil (too much oil loss). To prevent liquid flow-back, properly adjust the expansion valve of each liquid cooler.

For details, refer to "Troubleshooting" in this manual C.

4.2.2 Purging of Non-Condensable Gases

WARNING

- **Some types of refrigerants emit bad smells or toxic gases. Make sure to ventilate the air during work.**

If there is a leak on the low-pressure side of the refrigeration cycle, air may enter the package unit.

If non-condensable gas like air enters the unit, the condensing pressure rises and the energy consumption increases. This leads to uneconomical operation.

Follow the procedure below to check for non-condensable gases.

1. When the compressor is stopped, allow the cooling water to flow to the condenser for at least 15 minutes. Check the condensing pressure by using the pressure gauge of the compressor.

2. Check the cooling water temperature.

3. Compare the condensing pressure checked in step 1 above with the refrigerant saturation pressure that depends on the cooling water temperature (as shown in Table 4-3).

4. When the pressure inside the condenser and the refrigerant saturation pressure that depends on the cooling water temperature are approximately equivalent, non-condensable gases do not exist. When the pressure inside the condenser is 0.05 MPa or more higher than the refrigerant saturation pressure that depends on the cooling water temperature, there is a possibility of non-condensable gases entering the unit. In that case, purge the non-condensable gases from the condenser.

Table 4-3 Typical Refrigerant Temperature and Saturation Pressure

Temperature °C	Pressure MPa *1			
	Ammonia	R404A	R507A	R134a
0	0.328	0.509	0.523	0.192
4	0.396	0.590	0.606	0.237
8	0.472	0.678	0.696	0.287
12	0.557	0.775	0.795	0.342
16	0.652	0.881	0.903	0.403
20	0.756	0.996	1.021	0.471
24	0.871	1.121	1.148	0.545
28	0.998	1.256	1.286	0.626
32	1.137	1.401	1.435	0.714
36	1.289	1.559	1.595	0.811
40	1.454	1.728	1.768	0.916

*1: Unless otherwise noted, the pressure unit MPa represents the gauge pressure in this manual.

4.3 When Stopping the Compressor for a Long Time

When stopping the compressor for a long period of time, make sure to perform the following steps:

- Turn off the motor main power.
- Turn off the heater power and control panel power.
- Close the suction and discharge side shut-off valves.
- If an economizer or liquid injection is used, close the stop valve located at the compressor inlet.

When the compressor is stopped for more than a month, perform the following steps once a month:

- Turn the compressor shaft by removing the motor spacer plate (P/N: 235-2).
- Measure the unit pressure.
- Check for refrigerant leakage.

When restarting the compressor which has been stopped for more than a year, perform the following steps.

- Check the motor insulation resistance.
- In addition, conduct the items instructed in the motor instruction manual.
- Replace or analyze the lubricating oil. When analyzing, if it is found as a result of the analysis that the control criteria given in this Chapter, Section 4.1.5 Tables 4-1 to 4-2 are not satisfied, the oil must be replaced.
- Check for refrigerant leakage.
- Supply power to the oil heater at least half a day before staring operation..
- Before starting the operation, confirm that the refrigerant is not condensed in the package unit by checking the package temperature and pressure.

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Chapter 5 Maintenance and Inspection

5.1 Precautions for Maintenance and Inspection

When reading this Section, also refer to Section 1.1 in this manual Chapter 1.

DANGER

- **When entering the machine room for maintenance services, ensure that sufficient ventilation has been started and measure the oxygen concentration so that there is no risk of oxygen deficiency. The ventilation must be continued steadily until the work is completed.**
- **For performing the inspection work, be sure to prepare safety shoes, protective glasses, gas mask and other proper protective equipment and do not fail to use them whenever they are required.**
- **After stopping the machine and before working on a regular inspection or overhaul, be sure to shut off the main motor power, control power, and other power to each equipment and valve. After they are shut off, be sure to make the switches inoperable by others. Also, be sure to attach notification tags to prohibit operation (lock-out/tag-out).**
- **When any manual stop valve has been closed, be sure to make the valve inoperable by others and put a notification tag to prohibit the operation (tag-out).**
- **When the compressor is to be overhauled, check that the internal pressure of this product is at the atmospheric pressure before starting the work.**
- **When using lifting devices, e.g. a crane, etc. and/or lifting tools, ensure that they can sufficiently withstand the load.**
- **When lifting a heavy load object, do not allow anyone's body to put under it.**
- **The work to turn each power supply ON/OFF or operate a lifting unit must be exclusively performed by qualified personnel.**
- **When using electric tools, ensure that they are properly managed in accordance with each instruction manual. Especially before using and while using, be sure to follow the care instructions on the safety of each instruction manual.**

WARNING

- **Be sure to use only MYCOM genuine parts for replacement. Using parts that are not genuine can cause damage to this product or other devices during operation.**
- **Do not convert or modify this product or its components without prior permission from MAYEKAWA. Otherwise, it can lead to an unexpected accident.**
- **Exercise sufficient care for handling a heavy load, and use such a lifting device as a crane or work with an adequate number of personnel commensurate with the magnitude of the weight. Also, be sure to use stud bolts (safety retention bolts) and other support tools for the work. Neglecting the above warning can lead to low back pain of the worker or injury due to dropping of the parts.**
- **If two or more people are to work together, be sure to clearly define the work procedures to share a common understanding among all workers before performing the work.**
- **Not only the work to turn each power supply ON/OFF or operate a lifting device, but also any type of work requiring qualification must be exclusively performed by qualified personnel.**

CAUTION

- **When checking the operation data of units and executing other daily maintenance services, pay particular attention to avoid touching the area heated to a high temperature causing skin burns or inadvertently moving the handle of a valve leading to an erroneous operation.**
- **In the disassembly/inspection workplace, secure a sufficient space for temporary storage of the removed parts and tools, replacement parts, and for the disassembling work as well as safety passages, and then put up necessary off-limit signs.**
- **In the workplace, secure a sufficient space and refrain from putting tools directly on the floor or from haphazardly laying wires.**
- **Keep the floor clean all the time. Leaving the floor smeared with oil and the like causes it to be slippery and may result in the fall and injury of personnel. Thus, do not leave it but wipe it off right away.**
- **Make sure that the temperature of the high temperature sections such as head covers and discharge lines has been cooled down to normal ambient temperature, before working on them.**
- **When disassembling and reassembling the compressor, use the specified tools properly. Before starting to use those tools, gain the full understanding of their characteristics and the method for use.**
- **During the maintenance service, keep the tools clean all the time. Using those tools smeared with oil increases the risk of slip and fall, leading to an injury. Also during the service, there is a risk of foreign matters intruding inside the compressor to cause its damage.**
- **Parts are slippery with oil. Fully watch out for the risk of any object falling down. Pay attention to any parts falling down, which could lead to personal injury.**

CAUTION

- **Before disassembly, inspections, and handling of the compressor, sufficiently understand the disassembly and assembly procedures.**
  This manual is not intended to provide complete disassembly and assembly procedures for the compressor. Instead, it describes only the important points in relation to the maintenance service of the compressor.
- **If complete disassembly and assembly of the compressor are required, please contact your nearest sales office or service center of MAYEKAWA.**
- **When removing a part, be careful not to damage it.**
- **Place the removed parts on a clean workbench in an orderly manner.**
- **For cleaning parts, use kerosene and/or machine parts cleaner.**
- **Washed parts shall be dried by compressed air or wiped up using clean cloth. Do not use synthetic textiles or woolen textiles to prevent fibers from attaching the parts.**
- **When separating the assembled compressor casings, sometimes it is difficult to separate them due to the gasket stuck. In such a case, never hammer in a screw driver or flat chisel into the gap. Screw jack bolts using the screw holes to separate the casing each other. When some gap is observed between them, use a scraper to remove one side of the gasket from the surface.**
- **Removed bolts from each part should be classified into each used section to prevent confusion.**

5.2 Maintenance and Inspection List

5.2.1 Daily Management

As daily management, check the items listed in Table 5-1 "Daily Inspection Items" and record the results.

By regularly recording the daily operational data in an operation log, it should be able to detect any significant change in the system. This is significantly effective in preventing compressor failures.

It is particularly important to check whether the temperature/pressure correlations related to the refrigerant evaporation and condensation is proper. This makes it possible to quickly find out problems in the compressor or the system.

If a failure or accident should occur in the compressor or the system, the operation logbook will help determine the cause and take prompt and proper actions.

Table 5-1 Daily Inspection Items

Inspection Item		Inspection Details	Check Points and Actions
■ Compressor			
Operating hours	hour	Total operating hours	• Judgment of periodic maintenance interval
Suction pressure	Mpa	Difference from the set value of evaporation temperature equivalent pressure	• Contamination on the cooling pipe surface • Temperature, flow rate, etc. of the object to be cooled
Discharge pressure	MPa	Difference from cooling water temperature equivalent condensing pressure	• Contamination on condenser cooling pipes • Non-condensable gases mixed into the system • Quantity, temperature, etc. of cooling water
Oil supply pressure	MPa	Difference from discharge pressure	• Whether differential pressure is decreasing • Operation with liquid flow-back • Whether compressor parts are worn
Oil filter pressure loss	MPa	Pressure difference between oil filter inlet and outlet	• Contamination of lubricating oil • Clogging of oil filter element
Suction temperature	℃	Whether within upper and lower limits	• Temperature, flow rate, etc. of the object to be cooled
Degree of superheat for suction	℃	Whether degree of superheat is proper	• Adjust expansion valve • Insufficient refrigerant flow
Discharge temperature	℃	Whether within upper limit	• Non-condensable gases mixed into the system • Oil supply temperature, insufficient oil supply • Compressor failure
Oil supply temperature	℃	Whether within upper and lower limits	• Contamination on cooling pipes of oil cooler
Capacity control Specified load	%	Whether operation is normal	• Damage to solenoid valve coil • Improper adjustment of manual control valve of electromagnetic assembly
Leak from mechanical seal	mL	Leak per hour	• Mechanical seal failure

Inspection Item		Inspection Details	Check Points and Actions
Noise and vibration	-	Abnormal noise/vibration	• Compressor failure
■ Others			
Motor current	A	Whether it is higher than at test run	• Compressor failure
Oil level of oil separator	-	Oil level	• Oil loss • Replenish oil
Fluid level in the receiver	-	Fluid level	• Check for refrigerant leak • Replenish refrigerant
Refrigerant leak check	-	Leak or not	• The machine room and load side facilities

■ Unless otherwise noted, the pressure unit MPa represents the gauge pressure in this manual.

■ Daily Maintenance Items

1. Lubrication oil level

When the oil level in the oil separator reaches the lower limit, charge lubricating oil.

2. Replacing oil filter element

When the pressure difference between the inlet and out let ports of the oil filter exceeds 0.1 MPa, replace the oil filter element.
At the beginning of the operation, the differential pressure of the oil filter may increase quickly.

3. Cleaning of suction strainer

When the compressor operating hours exceeds 500 hours, check the suction strainer. If a temporary filter is installed for the initial stage of operation, remove it.

At the beginning of the operation or after periodical check, the pressure difference between the front and back of the suction strainer may increase quickly. If the differential pressure becomes large, check and clean the suction strainer.

4. Lubricating oil leak rate from mechanical seal

If much oil leaks from the mechanical seal, determine the leak rate per hour. The following table shows guidelines for allowable leak rate and the rate at which inspection must be done.

If any problem (damage, etc.) is found in mechanical seal, replace the mechanical seal assembly.

Table 5-2 Guideline for Leak from Mechanical Seal Section

Condition		i125* / i160*
Allowable leak rate	mL/hr	≤ 3
Rate at which inspection must be done	mL/hr	≥ 9

Note: The specifications above are just guidelines. They are not guaranteed values.

5. Contamination on the cooling water side of the cooling pipes of condenser and oil cooler

Clogging and contamination of the cooling pipe is largely affected by the quality of cooling water. When the oil temperature and discharge pressure gradually rise during the initial stage of operation, inspect and clean the cooling water side of oil cooler and condenser even when the time has not yet come at which inspection must be done.

5.2.2 Periodic Inspection

Check the following items at specified intervals.

In addition, observe relevant laws and regulations on the inspections and recording of the results that are provided for other related items such as any safety devices (e.g. gas leak detectors), or other utility (gas/electricity) protection devices that constitute the cooling package unit together with the compressor.

Table 5-3 Periodical Inspection Items

Item	Inspection Interval	Remarks
Pressure gauge/ pressure sensor	Once per year	
Temperature/ temperature sensor	Once per year	
Protection devices and Safety valves	Operation test and clean once per year	
Suction strainer	Check after 500 hours from the initial operation. Check and clean once per year.	If the pressure difference between the front and back of the suction strainer increases, check and clean the suction strainer.
Lubricating oil	Analyze oil after 500 hours from the initial operation. Analyze oil every 6 months.	When the analysis results do not satisfy the management criteria provided in Chapter 4 Section 4.1.5, replace oil.
Oil filter element	Replace once per year.	Replace oil filter element if the differential pressure between the inlet and outlet ports of the oil filter exceeds 0.1 MPa.
Cooling water side of oil cooler	Once per year	Clean if excessively contaminated.
Cooling water side of condenser	Once per year	Clean if excessively contaminated.
Mechanical seal section	Check once per year or per 8,000 operating hours.	To be replaced if any abnormality is found. If it is difficult to stop the compressor operation except for scheduled inspections, replace the mechanical seal assembly at each inspection.

■ Inspection frequency is the specified period after delivery or operating hours, whichever comes first.

5.2.3 Guidelines for Compressor Overhaul Interval

The compressor overhaul interval is largely affected by the compressor operating conditions, type and status of refrigerant and oil, and the system/equipment in which the compressor is operated.

The table below lists overhaul intervals recommended by MAYEKAWA which are categorized based on the compressor operating conditions.

Table 5-4 Standard Package Operation Conditions and Overhaul Interval Guidelines

Category of operating condition	Application example	Recommended Overhaul Interval
Relatively stable operating condition	Refrigeration and cold storage	Every 5 years or 40,000 operating hours
Relatively changing operating condition	Ice maker/chiller	Every 4 years or 30,000 operating hours
Frequently started/stopped, and relatively changing operating condition	Heat pump	Every 3 years or 20,000 operating hours

Note 1: The above guidelines are only applicable when the compressor is operated within the operation limits specified separately.
(Refer to Section 2.3.2 "Operation Limits" in this manual.)

Note 2: The above guidelines are only applicable when the compressor undergoes daily and periodic inspections Specified separately.
(Refer to Section 5.2.1 "Daily Management" in this manual.)

Note 3: Inspect the compressor at the intervals of specified period or operating hours, whichever comes first.

Note 4: The above guidelines do not constitute any warranty.

5.3 Compressor Disassembly Preparation

Screw compressors are very reliable compressors. However, it is necessary to disassemble and inspect parts after a certain period of operation.

This chapter 5 describes the essential points of disassembly methods, where to inspect on parts, and reassembly procedure of the i-series compressor.

As a general rule, overhauling of the screw compressor that require complete disassembly should be done at the maintenance factory.

At the installation location of the compressor, it is only possible to inspect/replace mechanical seals and suction strainers.

Read this manual thoroughly and fully understand the compressor structure as well as the work procedure before starting work.

Numbers denoted by [ ] that follow part names refer to the part numbers (P/N) used in assembly sectional views or parts configuration table.

5.3.1 Disassembly Tools and Work Place

Prepare special hand tools required for disassembly. Refer to Section 7.2 "Disassembly Tools" in this manual Chapter 7.

In addition, prepare standard hand tools, green carbonite grinding stone, #80- to #100-grit sandpapers, # about #400 to #800 sandpapers, parts cleaner, lubrication oil, a squirt can, a can for oil sump, and a waste cloth.

A work bench with a large surface plate is useful to perform work accurately and with ease.

If the surface plate cannot be prepared, use a commercially available steel plate. The steel plate should be approximately 1000 mm × 1500 mm in size and have a thickness of approximately 1.5 mm if the work location is flat.

Perform the work in a dry place with as little sand and dust as possible, with a sufficiently wide space around there. In addition it is necessary a temporary storage place for disassembled parts.

5.3.2 Replacement Parts

Prepare MYCOM genuine replacement parts.
Table 5-7 and table 5-8 are lists of standard parts to be replaced when i-series compressor overhauled.
When purchasing any part, inform its (a) model, (b) serial number, (c) part name, (d) part code and (e) required number to our sales offices or service centers.
The serial number (b) is especially required among them. Unless serial number is informed, it is difficult to identify design and production specification details that are needed to identify the part you want to purchase.

Table 5-7 Replacement parts of i125*

P/N	Part name	Code No.	Remarks	Qty
6-1	Gasket, Suction Adapter	CS00600-I125	i125	1
6-2	Gasket, Strainer Cover	CS00900-I125	i125	1
7	O-ring **see Note 1**	PA12-140	JIS B 2401 G140	1
12	Gasket, Bearing Head	CS01200-I125	i125	1
17	Gasket, Bearing Cover	CS01700-I125	i125	1
23	Gasket, End Cover	CS02300-I125	i125 t=1.0	1
27-1	Radial Bearing	CS02800-FM125M	FM125M	2
27-2	Radial Bearing	CS02800-FM125F	FM125F	2
30	Balance Piston **see Note 2**	CS03000-I125	i125	1
33	Sleeve, Balance Piston **see Note 2**	CS03300-I125	i125	1
35	O-ring **see Note 1**	PA11-016	JIS B 2401 P16	1
38-1	Thrust Bearing M	CS03800-I125M	i125M	1
38-2	Thrust Bearing F	CS03800-I125F	i125F	1
40-1	Lock Washer	NG32-008	AW8	1
40-2	Lock Washer	NG32-009	AW9	1
49	O-ring **see Note 1**	PA12-085	JIS B 2401 G85	1
50	Oil Seal **see Note 2**	CS05000-125D	125*** Rareflon	1
52	Gasket, Seal Cover	CS05200-125N	125***	1
100	Mechanical Seal Assembly **see Note 3**	CS10002-125EBS	BBSE 125***	1set
237-1	Torsional Slip Washer M	CS23700-F125M	FM125 M	1
237-2	Torsional Slip Washer F	CS23700-125	125L**	1
395	Gasket, Unloader Cover	CS39500-I160	i160*	2
480	Strainer Element **see Note 2**	CS48000-I160	i160*	1
489	Valve Seat	CS48900-I125	i125	1
491	Check Valve Shaft **see Note 2**	CS49100-I125	i125	1
495	O-ring **see Note 1**	PA11-007	JIS B 2401 P7	1

Table 5-8 Replacement parts of i160*

P/N	Part name	Code No.	Remarks	Qty
6	Gasket, Strainer Cover	CS00900-I160	i160 t=0.5	2
7-1	O-ring **see Note 1**	PA12-150	JIS B 2401 G150	1
7-2	O-ring **see Note 1**	PA12-140	JIS B 2401 G140	1
12	Gasket, Bearing Head	CS01200-I160	i160 t=0.5	1
17	Gasket, Bearing Cover	CS01700-I160	i160 t=0.5	1
23	Gasket, End Cover	CS02300-I160N	i160 t=1.0	1
27-1	Radial Bearing M	CS02800-FM160M	FM160	2
27-2	Radial Bearing F	CS02800-FM160F	FM160	2
30	Balance Piston **see Note 2**	CS03000-I160	i160	1
33	Sleeve, Balance Piston **see Note 2**	CS03300-I160	i160	1
35	O-ring **see Note 1**	PA11-024	JIS B2401 P24	2
38-1	Thrust Bearing M	CS03800-I160M	7311B	1
38-2	Thrust Bearing F	CS03800-I160F	7312B	1
40-1	Lock Washer	NG32-011	AW11	1
40-2	Lock Washer	NG32-012	AW12	1
49	O-ring **see Note 1**	PA12-090	JIS B 2401 G90	1
50	Oil Seal **see Note 2**	CS05000-160VD	160*** (S55×70×9)	1
52	Gasket, Seal Cover	CS05200-160N	160*** t=0.5	1
93	Gasket, Suction Flange	PL300-125	ANSI 300 # 5"	1
96	Gasket, Discharge Flange	PL300-080	ANSI 300 # 3"	1
100	Mechanical Seal Assembly **see Note 3**	CS10002-160EBS	160V BBSE	1set
150-1	O-ring **see Note 1**	PA12-110	JIS B 2401 G110	1
150-2	O-ring **see Note 1**	PA12-115	JIS B 2401 G115	1
216-2	Flange Gasket, Oil Inlet Port	CR72000-025N	MYCOM 25A	1
237-1	Torsional Slip Washer M	CS23700-FM160M	FM160	1
237-2	Torsional Slip Washer F	CS23700-160	160***	1
395	Gasket, Unloader Cover	CS39500-I160	i160 t=1.0	2
480	Strainer Element **see Note 2**	CS48000-I160	i160 #150 Φ160×200	1
489	Valve Seat	CS48900-I160	i160	1
491	Check Valve Shaft **see Note 2**	CS49100-I160	i160	1
495	O-ring **see Note 1**	PA11-007	JIS B 2401 P7	1

Note 1: The part code of the O-ring is the one assigned to NBR-70-1 which is standard material.

Note 2: When checking each part (No.30, 33, 50, 480, 491) and in case of malfunction's being a little seen, that it is possible to replace, prepare beforehand. If a special malfunction is not seen, it is possible to use in the continuation.

Note 3: Mechanical seal assembly (No.100) should be replaced if any defect is found during inspection. Actually, however, it is sometimes difficult to find out defects on the sliding surface only through visual inspection. In such circumstances, MAYEKAWA recommends to replace it with a new one.
Also, if it is difficult to stop the compressor operation except for scheduled inspections, MAYEKAWA recommends replacing No.100 in the same way.

5.3.3 Refrigerant Gas Treatment

5.3.3.1 Valves Used

Before removing the compressor or when performing air tightness test or evacuation, refrigerant gas is recovered and charged.
As the i-series compressor has a built-in check valve, care should be taken.
Work procedures differ between the i125* and i160*.

<i125*>

Two service valves are mounted to the check valve, one at the top and the other at the bottom. When removing gas from the compressor, the valve at the bottom is used. The valve on the top side is used when charging gas into the compressor.

<i160*>

Check that the valve attached to the startup pressure equalizer line is open, and remove or charge gas by using the service valve (one location).

5.3.3.2 Refrigerant Gas Recovery

After stopping the package unit operation, internal pressure of the compressor remains high.
Before disassembling the compressor, it is necessary to lower the internal pressure to atmospheric pressure. To do this, there are the following methods for example. Perform your recovery work in an appropriate manner considering site conditions, requirements of regulatory laws and regulations.

- By using the bypass valve, release the high pressure gas in the package unit to the low pressure side.
- If there is another refrigerating unit connected by existing bypasses piping, operate the other compressor and lower the pressure.
- Operate the refrigerating unit, close the refrigerant fluid supply master valve, and collect the liquefied gas in the receiver.
- By using a refrigerant recovery machine, recover the liquefied refrigerant in the receiver.

For any of the above methods, prepare a flow sheet describing the operations of the work. Verify valve operations that are necessary for each method, according to the flow sheet and on the actual unit.
Specify operation valves as well as connected devices and tubes on the flow sheet.
Prepare one flow sheet for the foreman and another one for display at the work area.
In addition, prepare a refrigerant collection procedure with the workplace situation considered. Be sure that all the personnel related to the work will read it together for confirmation, before starting the work.
The gas mask and other protective gears required at each stage of refrigerant recovery work must be prepared before starting the work.

WARNING

- **Be sure to confirm and make known the work contents and procedures described in the work procedure, and inform the estimated risks to the related personnel, before the work. Neglecting these efforts will increase the industrial accident occurrence rate to a level that cannot be ignored.**
- **After closing (opening) a valve for work, conduct lockout/tagout to prevent it from being handled accidentally during work.**

5.3.4 Removing Parts Connected to the Unit

DANGER

- **If refrigerant gas or a mixture of refrigerant and oil remains in the compressor, refrigerant gas may blow off when the closed circuit is opened. This may result in injury such as frostbite or loss of vision. Be sure to confirm that there is no residual pressure before opening any pipe connections.**

CAUTION

- **If the compressor is removed when the temperature around the suction flange is extremely lower than the ambient temperature, dew condensation may occur inside the system. After stopping the refrigerating unit, leave it as it is for some time.**

When removing the compressor from the unit frame, disconnect the following parts.

(1) Flange motor (and motor wiring if necessary)
(2) The compressor's suction piping and discharge piping
(3) Compressor's lubrication piping
(4) Compressor's economizer piping and aquamizer (liquid injection) piping
(5) Electrical wiring for capacity control solenoid valves
(6) Motor spacer
(7) Bolts for installing compressor (leg bolts)

【POINT】
Since remaining oil may leak out when disconnecting the oil piping from the compressor, slightly loosen the piping and observe the oil flow to decide whether to disconnect the piping right now or extract oil first from the oil temperature gauge on the lubrication header.
When disconnecting electrical wiring, put markings so that it can be reconnected easily.
Unless reconnected correctly, the compressor may not start up or the capacity control system may not operate.

5.3.5 Removing and Lifting the Compressor

When performing this section's work, also refer to Section 3.2.3 "Transportation" in this manual Chapter 3.

DANGER

- **The work to lift up or move the compressor must be performed by a qualified operator.**
- **Make sure that the lifting equipment and wires have sufficient load capacity for the compressor before starting the compressor lifting work.**
- **Never try to perform disassembly or assembly while the compressor is lifted in the air.**

5.3.6 Removing Oil from Compressor

Disconnection of the capacity control Φ8 piping [538] from the compressor will cause the oil remaining inside to be drained by approx. 1 liter (i125*) or by 2 liters (i160*).

Prepare a container to receive oil and an empty can for storage before starting the work.

5.4 Disassembly and Inspection

Be careful with handling of the parts during disassembly and inspection. Since the compressor rotates at a very high speed, even the slightest handling error could cause a situation that requires replacement of the rotor and all other important parts. Such errors can also cause problems or performance deterioration after the compressor is reassembled. Be sure to fully understand the following before starting the work.

5.4.1 Shaft Seal Block

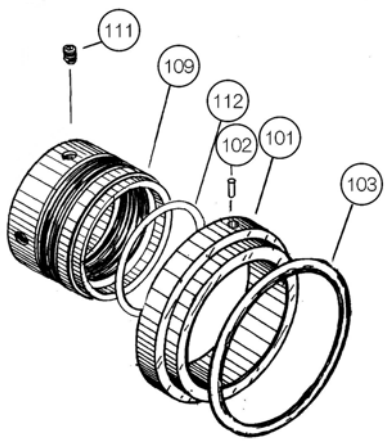
To prevent refrigerant gas and oil leakage, a reliable mechanical seal assembly is used for the shaft seal of the M rotor.

Mechanical seal assembly is mainly composed of "rotating ring" installed on the rotor shaft and "stationary ring" installed in the seal cover. Rotating ring rotates with the shaft, and slides each other with the stationary ring while maintaining a micron class gap. The sliding each other place is called as the sliding surface.

Mechanical seals have a precisely machined sliding surface and are made of fragile material.

Handle them with special care since leakage may occur if damaged.

Photo 001



P/N	Part Name (Rotating rings)	P/N	Part Name (Stationary rings)
109	Seal collar	101	Mating ring
111	Seal collar set screw	102	Insert lock pin
112	O-ring	103	O-ring

Figure 5-1 Details of BBSE Type Mechanical Seal Assembly

5.4.1.1 Disassembly

a) Of the eight hexagon socket head cap screws securing the seal cover [51], remove six and leave the two on the opposing sides.

b) Loosen the remaining two screws alternately and evenly, a little at a time. After a certain amount of loosening, the seal cover of the mechanical seal will be pushed by the repulsion force of the bellows and a gap will appear. A gap will not appear if the gasket is stuck. In that case, remove the seal cover; push the seal cover by screwing M8 eye bolts into the jacking threaded holes.

c) Use a container to catch the oil that will leak from the gap in the seal.

d) Pull out the seal cover, while keeping it parallel with the shaft (rotor shaft). The mating ring is attached inside the seal cover by using an O-ring [103]. Be careful not to let the mating ring [101] and the shaft damaged by contact.

e) Remove the O-ring [49] from between the seal cover and seal retainer [48].

Photo 002 Removing Seal Cover

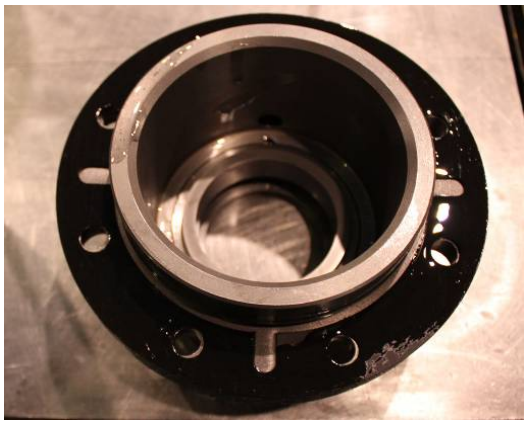


Photo 003 Seal Cover and Mating Ring

f) After removing the seal cover, wipe clean and inspect the shaft surface. If there are scratches, use fine sandpaper to smooth them over. This is done to prevent damage to the internal O-ring when pulling out the mechanical seal.

g) Loosen the set screws [111] of the seal collar [109] by turning them approximately three times (Photo 004). Do not remove the set screws completely, but leave them so that their ends are below the surface of the seal collar. These screws are located in two places 90 degrees apart from each other.

Photo 004 Loosening the Seal Collar Set Screws

Photo 005 Seal Retainer

h) Pull out the seal collar with your fingers. While pulling out, make sure that the ends of the set screws do not touch the shaft surface. Axial-direction scratches on the shaft can cause leaks.

i) Screw two M8 eye bolts into the jacking threaded holes. Then pull out the seal retainer while maintaining a right angle to the rotor shaft.

j) Remove the mating ring from the seal cover. At this time, be careful not to damage the mating ring.

5.4.1.2 Inspection

Mechanical seal should be replaced if any defect is found during inspection. Actually, however, it is sometimes difficult to find out defects on the sliding surface only through visual inspection. In such circumstances, MAYEKAWA recommends to replace it with a new one in the same manner as with O-rings or gaskets.

The contact between the sliding surfaces of the mating ring and seal collar must be checked even when replacing the seal. If there are obvious traces of uneven contact or damage, find out the cause (degradation over time, problems such as heating operation, etc.) and take necessary actions.

5.4.2 Bearing Cover

5.4.2.1 Disassembly

a) Remove two threaded alignment pins [3] by using a slide hammer (Photo 006).
b) Attach lifting tools, and remove all of the hexagon socket head cap screws. If the bearing cover gasket [17] is stuck, use a jack bolt to remove.
   At this moment, lubricating oil remaining inside the bearing cover will flow out. Prepare a container to catch oil.
c) Remove the bearing cover [16]. Exercise care not to let it hit against the shaft and cause damage.

Photo 006 Removing Alignment Pin

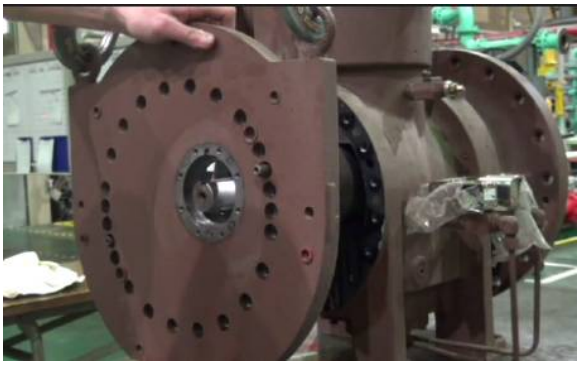


Photo 007 Removing Bearing Cover

5.4.2.2 Inspection

a) If the alignment pin is bent or worn, replace it with a new one.
b) The bearing cover gasket must be replaced with a new one.

5.4.3 Balance Piston

5.4.3.1 Disassembly

The balance piston sleeve [33] and the balance piston [30] can be removed just by removing the snap ring [32].

Photo 008 Removing the Snap Ring

Photo 009 Removing the Balance Piston Sleeve

Photo 010
Removing the Balance Piston

5.4.3.2 Inspection

a) If there are defects such as extreme wear, galling or chipping on the outer circumference of the balance piston or on the inner circumference of the balance piston sleeve, replace the defective component with a new one.

b) Measure the large and small outer diameters of the balance piston at four locations each.

   If either of the maximum values indicates that the part is worn down to or beyond the replacement criteria shown in Table 5-9, the part should be replaced with a new one.

   When replacing with new ones replace the balance piston and balance piston sleeve in a set.

Table 5-9 Balance Piston Replacement Criteria

measurement point		i125*	i160*
Balance Piston diameter (mm)	Large diameter	112.89	134.85
	Small diameter	74.91	64.85

5.4.4 End Cover

a) Remove two hexagon socket head cap screws (i125* [2-2], i160* [2]) symmetrically, and insert stud bolts. In the case of i160* , attach lifting tools to the end cover before proceeding to the next step.

b) Pull out remaining bolts, and remove the end cover [22]. At this moment, lubricating oil remaining inside the end cover will flow out. Prepare a container to catch oil.

5.4.5 Thrust Bearing Block

The thrust bearings [38-1] [38-2] are face-to-face angular contact ball bearings.

This bearing only receives thrust load and does not receive the radial load perpendicular to the shaft because there is a gap between the outer ring of the thrust bearing and the bearing head. Apart from receiving the thrust load, the bearing has the important role of securing the position of the gap between the rotor and the discharge side of the bearing head. This gap (end clearance) is significantly linked with performance.

5.4.5.1 Disassembly

Though part sizes differ between the M rotor side and F rotor side, the same work procedure is applied to both.

a) Remove hexagon head bolts [45] holding thrust bearing glands [43-1] [43-2], and remove the thrust bearing glands. A spring washer [46] is attached to the hexagon head bolt. Be careful not to lose the washer.
   As O-rings [150-1] [150-2] are mounted to the thrust bearing glands used for the i160-series, they are slightly tight.
b) Extend the bent claw of lock washers [40-1] [40-2].
c) Loosen lock nuts [39-1] [39-2] by using a dedicated lock nut socket. If, at this moment, the rotor shaft rotates, attach dedicated rotation stoppers 1 and 2 (refer to Section 7.2 in this manual) during work.
d) Remove lock nuts, torsional slip washers [237-1] [237-2] and thrust washers [250-1] [250-2].
e) Take out thrust bearings [38-1] [38-2]. Since the inner race of the bearing is slide fit on the rotor shaft, bend the tip of a aluminum wire with diameter of 1 to 2 mm, insert it between the outer ring and the ball retainer, and hook it onto the thrust bearing to pull it out.
f) Remove thrust bearing outer race spacers [41-1] [41-2] and thrust bearing alignment spacers [42-1] [42-2].

Photo 011 Extending the Claw of Lock Washer

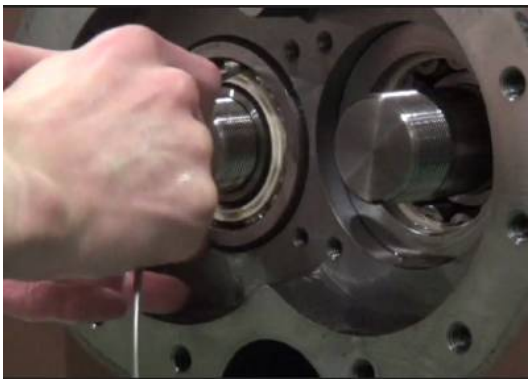


Photo 012 Removing the Thrust Bearing

5.4.5.2 Inspection

a) Replace the thrust bearing with a new one during regular inspection, regardless of whether or not it is defective. If there is an extreme problem, find the cause and review the operating state or periodic inspection interval to prevent recurrence of such problem.
b) If there is a problem such as extreme deformation in the notch of the lock nut, replace the part with a new one.
c) Be sure to replace lock washers and torsional slip washers with new ones.
d) O-rings [150-1] [150-2] attached to the i160-series compressor must be replaced with new ones.

5.4.6 Bearing Head

Though the case dividing method differs between i125* and i160*, the work flow is the same.

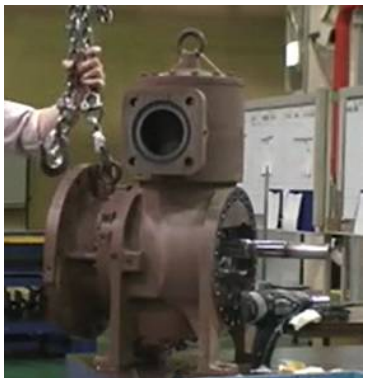


Photo 013 Attach Lifting Tool

5.4.6.1 Disassembly

a) Attach lifting tools, remove all bolts [2-1] that hold the part to the main rotor casing, and separate the part from the main rotor casing. If bearing head gasket [12] is stuck, use a jack bolt to remove it.
b) Remove bearing head [11] while taking care not to let it be hit and damaged by the rotor shaft. Also take care not to let the rotor fall off the main rotor casing.

5.4.6.2 Inspection

a) If the alignment pin is bent or worn, replace it with a new one.
b) The bearing head gasket must be replaced with a new one.

5.4.7 Rotors

Rotors [25] [26] are heavy, precisely machined components, which are the heart of the compressor.
Care must be taken not to get them damaged by dropping or in other ways. Using damaged rotors may lead to deterioration in performance or damage to the compressor.

Photo 014 Pulling Out the Rotor

5.4.7.1 Disassembly

a) When using the i125*, remove snap ring [29-3] from the F rotor.
b) As it is heavy in weight, be careful when handling. As the i160* rotor weighs more than 30 kg, use lifting tools such as chain blocks and nylon belts. Pull out about two thirds of the rotor, attach a belt around its outer circumference, and then pull out the remaining part of the rotor.
c) After pulling out the rotor, place it on V-blocks or the like to prevent damage to the outer circumference.
d) Remove slotted set screw [31].

5.4.7.2 Inspection

Check that the rotor is not extremely worn or damaged. Rotors stay almost free from wear during normal operation. If the rotor is found worn, check the cause and review the operating state to prevent recurrence of the problem.

Table 5-10 Rotor Replacement Standards

measurement point	i125*	i160*
Rotor's outer diameter (mm)	127.475	163.175

If the part wears beyond the replacement standard shown in Table 5-10, performance will be deteriorated. Replacement of the rotor is recommended.

5.4.8 Radial Bearings

Two pairs of large and small radial bearings are used. Put the disassembled parts in order to distinguish which bearing has been used where.

5.4.8.1 Disassembly

a) Put the radial bearing with the side containing the bearing for bearing head [11] faced upward.
b) Remove stop rings [29-1] [29-2], and pull out the outer rings of radial bearings [27-1] [27-2].

   * For the i125*, the snap ring is attached to the main rotor casing side.

c) Pull out the outer ring of the radial bearing from the main rotor casing.
d) Remove the inner ring of the radial bearing from the rotor after inspection. As the inner ring is shrink-fitted to the rotor, pull it out by heating it with a tool like a burner.

   Beforehand, remove oil such as lubricating oil sufficiently. Set the rotor with its inner ring (which is to be pulled out) faced downward and heat the inner ring only. Then the inner ring will come off.

5.4.8.2 Inspection

Replace the radial bearing with a new one during regular inspection, regardless of whether or not it is found defective.
However, if there is an extreme problem, find the cause and review the operating state or periodic inspection interval to prevent recurrence of such problem.

5.4.9 Suction Strainer and Check Valve

The structure of the suction strainer and check valve differ between i125 and i160.

5.4.9.1a Disassembly (i125*)

a) Remove strainer cover [5-2]. Remove wave washer [546], strainer element [480] and O-ring [7].
b) Check that the main body of the check valve moves smoothly.
c) Of the bolts securing suction adapter [5-1], remove all but the two on the opposing sides. Attach two M12 eye bolts and lifting to the suction adapter, remove the remaining bolts, and remove the suction adapter.

Photo 015
Removing i125-series Suction Adapter

d) Lay the suction adapter on the work bench. Remove hexagon nut [486], plain washer [46-2], valve plate [490], valve seat [489], seat stopper (1) [488-1], seat stopper (2) [488-2] and O-ring [495]. Pull out the check valve shaft [491] and check valve spring [485].

5.4.9.1b Disassembly (i160*)

a) Remove the R1/8 plug from strainer cover [5]. At this moment, lubricating oil remaining inside may flow out. Prepare a container to catch oil.
b) Remove the strainer cover. If gasket [6] is stuck, use a jack bolt to remove it.
c) Remove strainer element [480] and strainer mounting seat [481]. Remove O-rings [7-1] [7-2] from the strainer cover and the strainer mounting seat.
d) Observe the main body of the check valve from the strainer cover side. Check that it moves smoothly.

e) Remove Φ10 piping [557].

f) Remove the R1/2 plug from check valve cover [8], and pull out check valve spring [485].

g) Remove the check valve cover. Be sure to use a jack bolt for this removal. Be careful not to let the check valve main body fall at the inside.

h) Remove the check valve main body.

i) Remove hexagon nut [486] from check valve shaft [491]. Remove plain washer [46-2], seat stopper [488], valve seat [489], valve plate [490] and O-ring [495].

5.4.9.2 Inspection

a) If the main body of the check valve does not move smoothly, the check valve shaft may be worn or bent. Replace it with a new one.

b) Strainer element, check valve spring and hexagon nut must be replaced if there are problems such as extreme deformation or chipping.
   * With i160*, the inner cylinder of the strainer element may be deformed, but this is normal.

c) The gasket, O-ring and valve seat must be replaced with new ones.

5.4.10 Unloader

5.4.10.1 Disassembly

a) Attach lifting tools to the motor-side end face of the main rotor casing, and lay down the unloader horizontally.

b) Remove Φ8 piping [538].

c) Of the bolts securing unloader cover [393], remove all but the two on the opposing sides. Loosen the remaining two bolts alternately, and remove the unloader cover.
   At this moment, the unloader cover is being pushed from inside by spring. Remove the bolts carefully.

d) Pull out unloader piston [391]and spring [392] (Photo 016).

Photo 016 Removing Unloader Piston and Spring

5.4.10.2 Inspection

a) Mount an M8 bolt of the maximum allowed length to the unloader piston, insert it in the main rotor casing, and check the operation. If it does not move smoothly, the piston or casing may be worn or damaged, or have burr formed. If removal of the burrs and damages cannot improve the movement, replace the unloader piston with a new one.

b) If the spring is extremely worn or deformed, replace it with a new one.

c) Unloader cover gasket [395] must be replaced with a new one.

5.5 Reassembly

CAUTION

- **When reassembling, ensure that the replaced O-rings are of the correct standard (size, material, use for fixed portion or sliding portion, etc.). Incorrect replacement can lead to defects such as oil leakage.**
- **Some gaskets are asymmetrical. In that case, ensure that the assembly direction is correct. If the assembly direction is not correct, problems such as blocking of oil passages machined in the casing may occur, resulting in serious defects.**

After completing the disassembly and inspection procedures, start the assembly process.

First, read again Section 5.1 "Precautions for Maintenance and Inspection" in this Chapter 5.

Before starting the assembly, check the replacement parts once again.

Like gaskets, all O-rings that have been removed during the compressor disassembly must be replaced with new ones.

The reassembly sequence is mostly the reverse of the disassembly sequence. First of all, clean the work bench and the tools to be used.

Immediately prior to the assembly, use washing agent (e.g., kerosene, parts cleaner) ~~oil~~ to clean the parts to be assembled, dry them with compressed air, and sufficiently apply lubricating oil, etc. For this, prepare a sufficient amount of clean lubricating oil for the reassembly. Also, apply oil on both sides of the gasket.

Table 5-11 Tightening Torques for Hexagon Socket Head Cap Screws

Unit	M6	M8	M10	M12	M14	M16
N·m	10	25	50	90	140	240
kgf·cm	100	250	500	900	1400	2400

Tighten each hexagon socke head cap screw by referring to the torque shown in the above table.

5.5.1 Unloader

a) In the same way as for disassembly, lay main rotor casing [1] on its side (horizontally).
b) Set unloader cover gasket [395], unloader piston [391] and spring [392] to unloader cover [393].
You can install the unloader piston and spring first.
c) Insert this into the main rotor casing, and tighten the unloader cover.
d) Screw an M8 bolt of the maximum allowed length through the Rc1/4 hole of the unloader cover and screw it to the unloader piston.
Check that the piston moves properly.
e) Remove the M8 bolt, and install Φ8 piping [538].
f) Raise (set vertical) the main rotor casing.

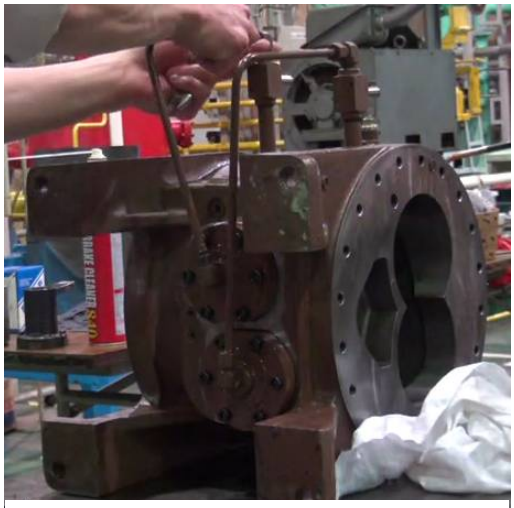


Photo 017 Installing Φ8 Pipe

5.5.2 Rotor and Inner Race of Radial Bearing

Make the rotor sufficiently adjusted. By using fine emery paper, remove over any damage on the shaft surface of the bearing and seal.

Both the M and F rotors have a certain engagement positions which are indicated by stamp marks.

Photo 018 M Rotor Mating Mark

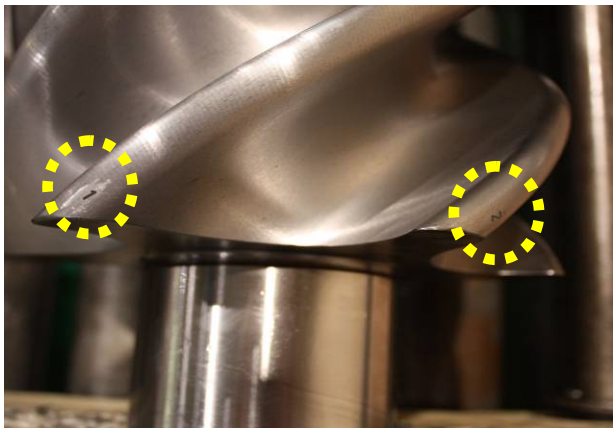


Photo 019 F Rotor Mating Marks

a) Shrink-fit the inner race of radial bearings [27-1] [27-2] to both the M and F rotors.
The inner race may move upward as it cools down and gets tightened. Hold it in position until it cools down completely. Make the combination of the inner and outer races, which have been packaged together, recognizable.
b) Screw the slotted set screw [31] fully into the M rotor.
c) Insert the M rotor into the main rotor casing. As it is heavy, be careful when handling.
As the i160* rotor weighs more than 30 kg, use lifting tools such as chain blocks and nylon belts. After pushing about half of the rotor into the main rotor casing, remove the lifting tools and push in the remaining portion of the rotor.
d) By following the same procedure as for the M rotor, push the F rotor into the main rotor casing. At this moment, engage the M rotor tooth, which has stamped mark 1, between the F rotor teeth having stamped marks 1 and 2.

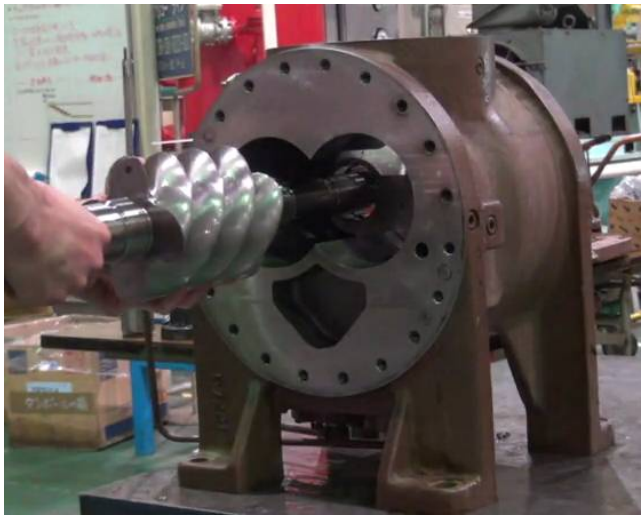


Photo 020 M Rotor Assembly

Photo 021 F Rotor Assembly

5.5.3 Bearing Head

a) Screw two stud bolts symmetrically. Affix the bearing head gasket [31] to the flange surface of the main rotor casing, and apply sufficient oil. (Photo 022)

b) While lifting bearing head [11] with lifting tools, temporarily tighten it with the 4 bolts.

c) After driving the alignment pin in position, tighten the bolts and remove the lifting tools.

Photo 022 Affixing Gasket

Photo 023 Installing Bearing Head

5.5.4 Outer Race of Radial Bearing

a) Attach the outer race of the radial bearing to the main rotor casing and bearing head, in such a way that the inner and outer races are combined in the same manner as when they have been packaged.

b) To secure the outer race of the bearing, mount snap rings [29-1] [29-2] to the bearing head (i160*) or main rotor casing (i125*).

c) Install snap ring [29-3] to the F rotor.

5.5.5 Suction Strainer and Check Valve

The structure differs between the i125 series and i160 series.

5.5.5.1 i 125*

a) Set O-ring [495] and check valve spring [485] to check valve shaft [491], and insert it to suction adapter [5-1].
b) While holding the check valve shaft with a hand to prevent it from coming off, insert seat stoppers [488-1] [488-2], valve seat [489], valve plate [490] and plain washer [46-2] in this order. Tighten hexagon nut [486].
c) Install suction adapter gasket [6-1] and suction adapter to main rotor casing. Check that the check valve functions properly.
d) Assemble O-ring [7], strainer element [480] and wave washer [546]. Install strainer cover gasket [6-2] and the strainer cover [5-2].

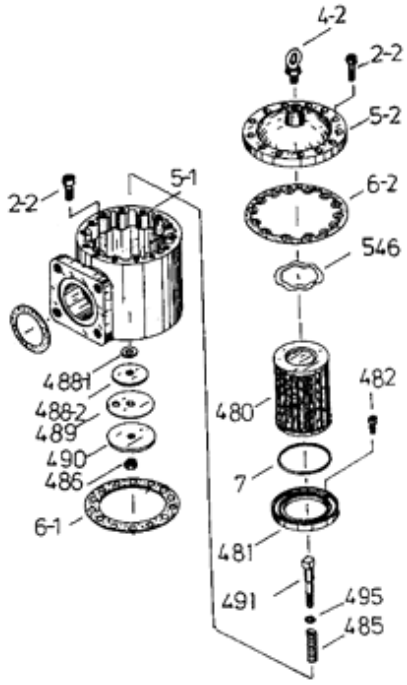


Figure 5-2 Suction Adapter part (i125*)

5.5.5.2 i 160*

a) Install O-ring [495], valve plate [490], valve seat [489], seat stopper [488] and plain washer [487] to check valve shaft [491]. Tighten hexagon nut [486].
b) Insert the check valve shaft to the side of main rotor casing. Install strainer cover gasket [6] and check valve cover [8].
c) Insert check valve spring [485], and attach a plug [10-4] to secure it.
d) From the strainer cover [5] side, confirm that the check valve operates properly.
e) Install O-rings [7-1] [7-2] to stainer element retainer [481].
f) Assemble stainer element retainer [481] and strainer element [480]. Install strainer cover gasket [6] and strainer cover [5].
g) Install R1/8 plug [10-1] to the plug hole in the 6 o'clock position of the strainer cover.

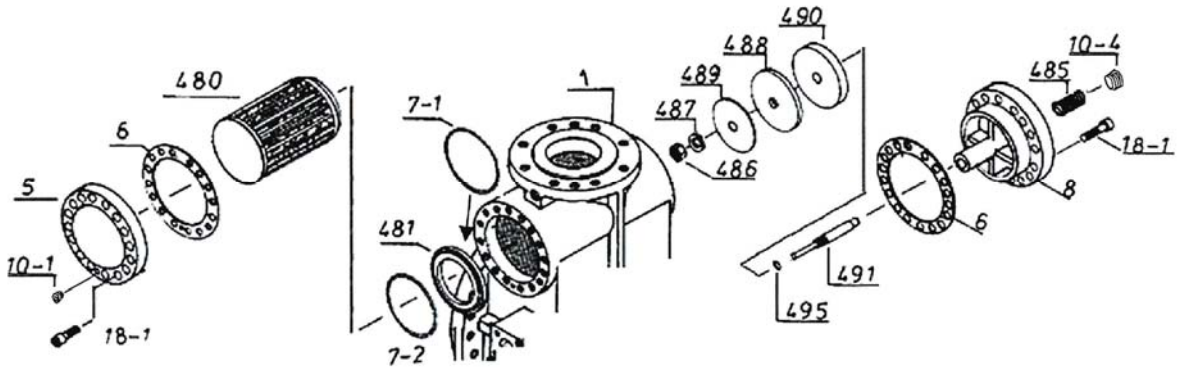


Figure 5-3 Suction Strainer and Check Valve (i160*)

5.5.6 Adjustment of Thrust Bearing and End Clearance

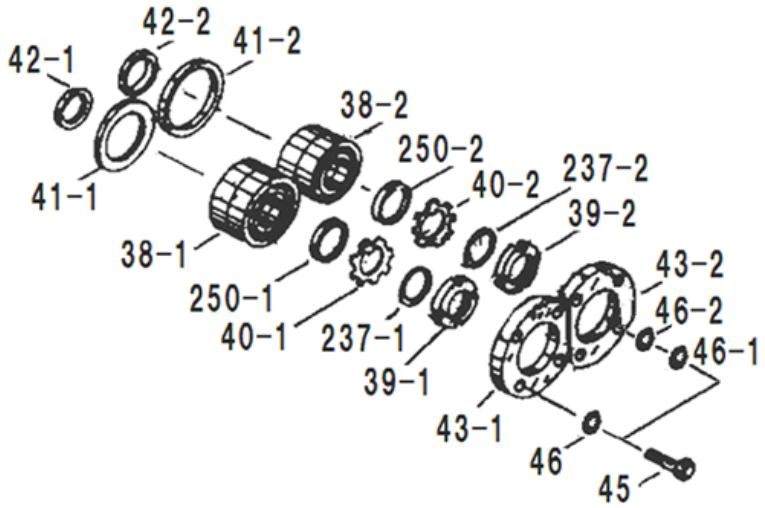


Figure 5-4 Thrust Bearings Block

Table 5-12 Thrust Bearing Components

P/N	Part name	i125*	i160*	P/N	Part name	i125*	i160*
38-1	Thrust Bearing M	1 set	1 set	43-1	Thrust Bearing Gland M	1	1
38-2	Thrust Bearing F	1 set	1 set	43-2	Thrust Bearing Gland F	1	1
39-1	Lock Nut	1	1	45	Hexagon Head Bolt	8	8
39-2	Lock Nut	1	1	46	Spring Washer	8	-
40-1	Lock Washer	1	1	46-1	Spring Washer	-	8
40-2	Lock Washer	1	1	46-2	Plain Washer	-	8
41-1	Spacer, Thrust Bearing Outer Race M	1	1	237-1	Torsional Slip Washer M	1	1
41-2	Spacer, Thrust Bearing Outer Race F	1	1	237-2	Torsional Slip Washer F	1	1
42-1	Spacer, Thrust Bearing Alignment M	1	1	250-1	Thrust Washer M	1	1
42-2	Spacer, Thrust Bearing Alignment F	1	1	250-2	Thrust Washer F	1	1

CAUTION

- **When assembling the disassembled thrust bearing without replacing any parts, check the M and F stamp marks on the thrust bearing outer race spacer and thrust bearing alignment spacer, and reassemble them in the same way as before disassembly. This is essential to control the end clearance of the rotor discharge side.**
- **Even when assembling the same bearing, dimensions may become incorrect if flakes of paint or dirt are caught between outer race spacers and alignment spacers.**
- **Regarding the direction of thrust bearing assembly, there may or may not be a V-shaped mark for assembly on the outer side of the bearing. Follow the instructions below for each case of assembling.**

a) The procedure for assembling this block is described in Figure 5-4.
The important points are explained below.

If there is a V-shaped mark for assembly on the outer side of the thrust bearing, assemble with the pointed end of the mark on the inner side of the machine, as there is a slight directional difference that affects end clearance adjustment.
If there is no V-shaped mark, assembly direction does not affect end clearance adjustment. However, to clarify the difference between the inner side and outer side of the machine, assemble the thrust bearing with the bearing number engravings on the outer side and then put down a V-shaped mark on the machine's inner side by using blue sharpening stone.

b) After assembling the thrust bearing, install thrust washers [41-1] [41-2], lock washers [40-1][40-2] and torsional slip washers [237-1] [237-2].

c) Attach dedicated shaft rotation stoppers 1 and 2. Tighten lock nuts [39-1] [39-2] to the specified torque shown in Table 5-13 or to the specified tightening angle shown in Table 5-14 (refer to Section 7.1 "Tightening Angles for Lock Nuts" in this manual for details), to fix the inner race of the thrust bearing to the rotor shaft. Be sure to use a new lock washer.

【POINT】

Tightening the lock nut while keeping the setting position between the lock nut wrench hooks and the lock nut grooves may cause to make the rotor run-out to enlarge due to uneven tightening forces.
Change the setting position between the lock nut wrench hooks and lock nut grooves about four times when fastening the lock nut.

d) Turn the M rotor shaft by hand, to make sure that rotation of rotors is smooth.

Table 5-13 Tightening Torques for Lock Nuts

		i125*		i160*	
		M rotor	F rotor	M rotor	F rotor
Tightening torque	N·m	116	166	306	400
	kgf·cm	1160	1660	3060	4000

Table 5-14 Tightening Angles for Lock Nuts

	Model	Angle range
First turn of tightening	For both M and F rotors (i125* / i160*)	30° to 40°
Second turn of tightening	For both M and F rotors (i125* / i160*)	20° to 30°

CAUTION

- **Since the inner race of the thrust bearing is loose fit and is secured by the tightening force of the nut alone, the tightening work is very important.**
- **If the thrust bearing has been replaced, the difference between the bearing inner race and outer race surfaces will be different even when the parts are manufactured within standard values. Therefore, fully tightening the nut from the initial use may lead to a noticeable reduction in the life of bearing, due to a lack of end clearance between the rotor and the bearing head discharge end face, and also due to indentations on the contact surface formed by ball pressure. To avoid this, check for end clearance while tightening.**

5.5.6.1 End Clearance Measurement

At this point (i.e., after the thrust bearing block has been fully assembled), measure the clearance between the bearing head end face and the rotor end face on the discharge side. This clearance is called as the end clearance.

In particular, this measurement must be made when the thrust bearing has been replaced. Even if the same bearing is used, the measurement should be made for verification.

If the measured clearance does not satisfy the range specified in Table 5-15, proper adjustment must be made.

Table 5-15 End Clearance

	i125*	i160*
End clearance mm	0.03 to 0.05	0.07 to 0.13

Photo 024 Attaching Dial Gauge to Rotor Shaft End

Photo 025 Tightening Thrust Bearing Gland

a) Push the rotor from the suction side (bearing cover side) to the discharge side while the thrust bearing inner race is secured to the rotor shaft, by using a tool (such as the handle edge of a soft hammer).

   Alternatively, by using a chamfered part of the lock nut, pull out the rotor with the edge of a flat blade screwdriver.

b) When the rotor has been pushed to the discharge side, prepare to install the thrust bearing gland. Attach a dial gauge on the bearing cover side axial end of the rotor, and match the needle to 0 (Photo 024).

c) Secure bearing glands [43-1] [43-2] by tightening the four bolts [45] evenly and gradually to the specified torque as shown in Table 5-15. Tightening each bolt to the specified torque at once will lead to uneven tightening. Tighten bolts in turn and in several steps.

d) Then, read the dial gauge measurement. This value is the actual end clearance.

   If the end clearance is outside the specified value, perform the adjustment work described in the next section. If the end clearance is within the specified value, turn the M rotor shaft by hand and confirm the smooth turning without uneven tightening. And then perform the measurement of the run-out of the rotor shaft described in next section (3).

Table 5-16 Tightening Torques for Thrust Bearing Glands

		i125*	i160*
Tightening torque	N·m	30	40
	kgf·cm	300	390

5.5.6.2 End Clearance Adjustment

(1) When end clearance is smaller than the specified value

To deal with this, insert shim material (thrust adjustment liner) of required thickness (difference in thickness from the specified value) between the thrust bearing alignment spacer [42] and thrust bearing inner race.

* The thrust adjustment liner is not shown in the development view, but available from us. Place an order together with a model name.

Or using a highly accurate surface grinding machine or asking professional service vendors to grind, grind the surface of thrust bearing outer race spacer [41] by the difference from the specified value. After grinding the flat surface, measure the whole circumference of the thrust bearing outer race spacer by using a micrometer, and check that the thickness is even.

(2) When end clearance is larger than the specified value

As the end clearance is excessive, remove shim material (thrust adjustment liner) of a thickness equal to the difference between the measured value and the specified value if the shim material is used between thrust bearing alignment spacer and thrust bearing inner race.
Or if the shim material is not used between thrust bearing alignment spacer and thrust bearing inner race, or even if used but insufficient thickness, grind the surface of thrust bearing alignment spacer[42] by the difference between the measured value and the specified value or ask professional vendors to do so.
After grinding the flat surface, measure the whole circumference of the spacer by using a micrometer, and check that the thickness is even.

(3) Rotor runout measurement

When the end clearance has been adjusted to within the specified range, place a dial gauge on the seal attachment portion of the M rotor shaft (FIgure 5-5) . Measure runout by turning the rotor shaft. The tolerance for runout is 0.03 mm or less for all models.
Runout occurs when the thrust bearing alignment spacer and outer race spacer are not parallel or when the thrust bearing mark is not at the correct side. And it occurs if fastening the lock nut performed without changing the position of the lock nut wrench (i.e., the uneven fastening of the lock nut).

Moreover small particles of dirt trapped between parts may cause excessive runout.
If the rotor runout is over the tolerance, even if the end clearance is within the specified range, disassemble and adjust the relative positions of the thrust bearing outer race spacer, alignment spacer and thrust bearing.
This is important because it affects the life of the mechanical seal and its performance. If axial runout still exceeds the tolerance even when no such assembly problems exist, contact us. The rotor shaft may be bent.

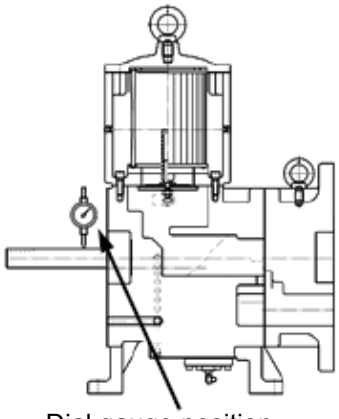


Figure 5-5 Runout Measurement

5.5.6.3 Tightening after End Clearance Adjustment

a) Bend the lock washer claw to the notch of the lock nut which is tightening the thrust bearing inner race,to prevent rotation.
b) Remove the hexagon head bolts that are tightening thrust bearing gland [43] one bye one.
Insert spring washer [46] as rotation stopper, and tighten to the specified torque again.
In case of i160*, use a flat washer [46-2] and spring washer [46-1], and tighten to the specified torque.

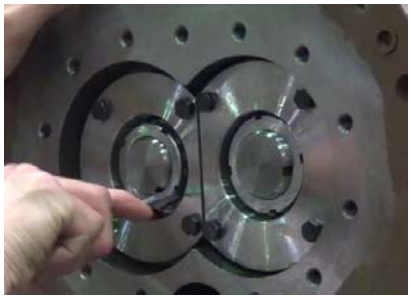


Photo 026

5.5.7 Balance Piston

a) With the notch of balance piston [30] aligned with the slotted set screw of M rotor shaft [31], install the balance piston.

b) With the notch of the balance piston sleeve [33] aligned with the spring pin, install the balance piston sleeve.

c) Install snap ring [32] and O-ring [35].

Photo 027 Installing Balance Piston

Photo 028 Installing Balance Piston Sleeve

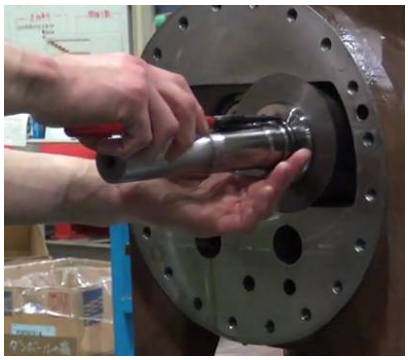


Photo 029 Installing Snap Ring

5.5.8 Bearing Cover

a) Screw two stud bolts symmetrically to the flange surface of the main rotor casing. Apply sufficient oil to the flange surface (Photo 030), and then place bearing cover gasket [17] (Photo 031).
Take note that the gasket has right/left difference.

b) While using lifting tools, temporarily tighten bearing cover [16] with 4 bolts.

c) After driving the alignment pin in position (Photo 032), tighten the bolts and remove the lifting tools.

Photo 030 Applying Oil with Brush

Photo 031 Gasket

Photo 032 alignment pin

Photo 033 Temporarily Tightening Bolts

Photo 034 Final Tightening with Torque Wrench

5.5.9 Shaft seal Block

The standard mechanical seal assemblies used in the current shaft seal of standard MYCOM screw compressors are of the BBSE (balance bellows single) type.

a) Before assembly, clean the portion where the mechanical seal will be installed.
b) In particular, recheck immediately before assembly that the stepped portion where the axial seal will be mounted is free of damage.
c) Assemble oil seal [50] to seal retainer [48].
Since the design modification in November 2002, the oil seal attachment direction has been changed from "facing the atmosphere side" to "facing the opposite side". The purpose of this change is to improve oil flow from inside the seal box so that the pressure will not rise too high.

Place a Teflon or other kind of resin block on the oil seal and tap on the block to push the oil seal into the retainer evenly until it bottoms. When it gets fully pushed in, you will know by the change in the tapping sound and feel.

After assembly, check that the step formed at the boundary between the oil seal and the retainer is even. See from the opposite side, and confirm that they are evenly assembled.
d) Using two eye bolts (M8), install the seal retainer with the oil seal along the rotor shaft.
At this time, ensure that the retainer's oil hole is on the upper side of the rotor shaft, and accurately align the rotation stop spring pin [20], which has been screwed to the bearing cover, with the notch of the oil seal retainer.

After assembly, try to turn the retainer's eye bolts to check that they are secure.
If they are properly aligned, the retainer will not rotate.
e) Then, insert the O-ring [49] for the seal retainer.

CAUTION
● **Take special care, because users frequently omit to insert this O-ring [49].**

Photo 035 Assembling Seal Retainer

Photo 036 Inserting O-ring [49]

f) Install the seal collar [109], which has the O-ring [112] attached to its inner periphery, to the rotor shaft. Before assembly, apply sufficient lubricating oil onto the rotor shaft and wash away dirts.
Push in the seal collar, carefully not to damage the O-ring [112] by the step on the rotor shaft. After installing the seal collar, push it by hand and check it's normal movement in the axial direction.

g) By using two seal collar set screws [111], tighten the seal collar against the countersunk holes in the rotor shaft. Tightening the seal collar at other places than the countersunk holes can cause damage to the rotor shaft which can lead to leakage.

h) Attach the O-ring [103] for mating ring and mating ring [101] to seal cover [51].

Photo 037 Tightening Seal Collar Set Screw

Photo 038 After Assembly of Mating Ring

i) Apply oil to seal cover gasket [52], align the gasket oil hole with the bearing cover oil hole, and affix gasket to the flange.

* The i-series compressors employ the standard internal oil supply type. With this type, the bearing cover and the seal cover are connected by drilled oil supply holes. Oil flows through the notch in seal cover to upper side of seal cover, and then goes through the drilled oil supply holes to the sliding surfaces of mechanical seal assembly.

j) Install the seal cover with the gasket, so that the oil removal piping of the seal cover is on the bottom side. At this time, assemble it carefully, either at a right angle or by delaying the upper side slightly, while paying attention not to cause the mating ring inside the seal cover hit against the rotor shaft.

The seal collar and mating ring sliding surface will come into contact midway through attachment. At this moment, check the dimensions between the seal cover gasket and the bearing cover flange surface by using a taper gauge. This value is called " fastening margin" for seal.
It is used when checking the sliding surface pressure between the rotating ring and stationary ring of the seal. If this value is not within the range shown in Table 5-17, measures should be taken, such as replacement of mechanical seal assembly or addition of another gasket.
With i-series compressor, the thickness of the seal cover gasket is 0.5 mm.

In case of BBSE-type seal of the i-series compressor, make sure that this value is in the range of 2 to 3 mm.

Photo 039
Checking Tightening Allowance

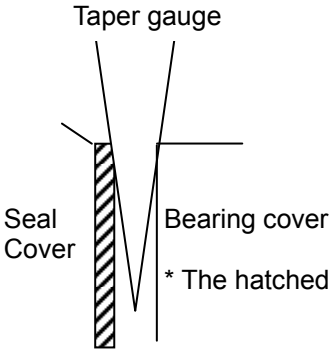


Figure 5-6 Checking Fastening Margin

Table 5-17 Fastening Margin for Seal

Model	BBSE seal
i125*	2.0 to 3.0 mm
i160*	2.0 to 3.0 mm

k) When the seal fastening margin is proper, push the seal cover firmly into the bearing cover.
Since there is repulsion force of the seal bellows, keep it pushed firmly and tighten the two hexagon socket head cap screws (for tightening the seal cover) evenly at positions 180 degrees apart.

When the gasket surface gets free of gap, tighten all of the remaining screws.

m) When tightening of the seal cover is finished, supply oil to the seal cover while rotating the shaft.

This oil refilling work is very important to maintain the airtightness in the shaft seal block when vacuuming after compressor overhauling.

n) After supplying oil, be sure to screw in the removed plug on the seal cover.

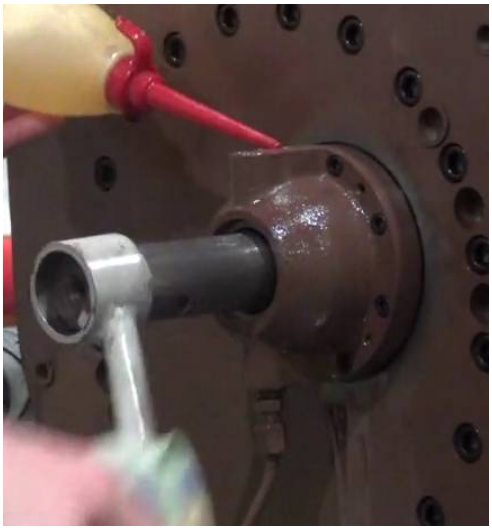


Photo 040 Supplying Oil

5.5.10 End Cover

a) Screw two stud bolts (i125*:M12/i160*:M16) symmetrically, and then place end cover gasket [23].

b) Install end cover [22].
In case of i160*, use lifting tools for safety assembly because the mass of end cover is 47 kg.

Chapter 6 Troubleshooting

Table 6-1 describes typical trouble symptoms of compressors, their causes and actions to be taken. The explanations of this Chapter are assumed that the compressor is used in the general refrigeration cycle.

Table 6-1 Troubleshooting

	Symptom	Direct cause	Root cause	Action
01	Compressor does not start up.	Power source is off.	Mostly caused by forgetting to turn on after inspection.	Use a check sheet for post-inspection actions and implement finger pointing and call check to prevent forgetting.
		Main motor failure	Mostly caused by activation of overload protection circuit.	Refer to the instruction manual of the motor for details including other causes and actions.
		Cooling water circulation is not confirmed.	Failure of devices such as cooling water pump and related circuits	Identify defective devices, investigate causes of failure and take necessary actions. Then, replace failed device(s).
			Circulation route is clogged.	Remove the clogging.
		Failure of magnet, relay, etc. in compressor startup circuit	Aging degradation	Identify defective devices, and replace with a new one.
			Poor installation environment	Replace ventilation fans, etc. if defective. Improve temperature, humidity and ventilation at the installation site.
02	Compressor stops immediately after startup.	Low pressure protection circuit activates.	Insufficient refrigerant flow ・ Insufficient refrigerant ・ Insufficient liquid supply ・ Heat exchange failure in heat exchanger	To correct insufficient refrigerant, check leak, stop leak and then add refrigerant. * Also pay attention to moisture entering into the system.
				To correct insufficient liquid supply, inspect expansion valve and liquid supply strainer. Take necessary actions. In addition, inspect devices and parameters (set values) of the expansion valve aperture adjusting mechanism, and take necessary actions.
				If there are any problem (insufficiency) in heat exchange, such as malfunction of defrosting, investigate the cause and take necessary actions.
				In case of malfunction of pressure adjustment valve, replace the valve or remove the cause.
			Failure of low pressure protection switch, pressure sensor, relay, etc.	Identify defective devices, investigate causes of failure and take necessary actions. Then, replace failed device(s).

	Symptom	Direct cause	Root cause	Action
02	Compressor stops immediately after startup.	Motor overload	Motor overload that occurs just after startup is mostly caused not by the refrigeration cycle but by the motor. Refer to the instruction manual of the motor.	
03	Abnormally low pressure (Low suction pressure)	Refer to direct cause, "Low pressure protection circuit activates", in Item 02 above.	Same as left	Same as left
04	Low oil pressure (Low oil supply pressure)	Oil filter element is clogged. * Pressure difference between outlet and inlet ports is large.	Contamination of lubricating oil	Remove clogging, and check oil for contamination/replace oil.
			Internal defects of compressor	Check for oil contamination and conduct vibration/noise diagnosis. Overhaul compressor if necessary.
		Insufficient oil in oil separator.	Oil heater is not functioning, refrigerant dissolves excessively when the machine is stopped, and oil loss occurs at startup.	Inspect oil heater alone, inspect relays, etc. on related circuits, and replace parts as necessary.
			Insufficient oil return due to insufficient refrigerant circulation	Correct insufficient refrigerant circulation, and return oil from load-side heat exchanger. * Supply lubricating oil temporarily.
			Troubles such as clogging in oil return passage	Remove causes of the trouble, and restore the system.
			Extensive oil leak	Inspect machine room and around the compressor, and take necessary actions. Check if there is oil floating in cooling water system. →If there is, check for oil leak from heat transmission tube of oil cooler and take necessary actions.
				If oil line piping is damaged due to excessive vibration, take measures to reduce vibration (including measures for resonance vibration).
		Oil pressure detection function is defective.	Failure of oil pressure protection switch, pressure sensor, relay, etc.	Identify defective device(s), investigate causes of failure and take necessary actions. Then, replace failed device(s).
			Pressure pipe is clogged.	Remove clogging, and check oil for contamination/replace oil.

	Symptom	Direct cause	Root cause	Action
05	Abnormally high pressure (Abnormal discharge pressure)	Heat exchange failure in condenser (heat exchanger)	Heat transmission tubes and/or fins are contaminated or blocked.	Clean and wash. Depending on the contamination level, use chemical cleaning.
			Failure or water dripping in fan motor, thermo switch, water spraying pipes, cooling water pumps, etc.	Identify defective device(s), investigate causes of failure and take necessary actions. Then, replace failed device(s).
			Faulty adjustment of cooling water/brine flow	In case of manually adjusted valve, readjust the valve. When an automatic control valve (including wax valve) is used, investigate the cause and take necessary actions.
			Other causes of insufficient flow of cooling water, etc.	Inspect filters installed on the circulation route for clogging and contamination, and take necessary actions. Inspect for leaks in circulation routes, and take necessary actions. Inspect water supply routes/mechanisms, and take necessary actions. If frozen, take measures such as improvement of heat insulation or increase of temperature.
			Deficiency in heat exchanger performance	If the symptom is caused by change in operating conditions, re-examine the conditions for improvement. If the symptom is caused by change in installation environment, improve the environment if possible. In either case, if improvement measure is difficult to be made, add more heat exchangers or increase their sizes.
		Non-condensable gases mixed into the system	Leak on low pressure side * There are also cases where the symptom was caused by corrosion in suction temperature gauge protection tube of the compressor.	Perform a leak check, and take necessary measures. Air-purge the heat exchanger.

	Symptom	Direct cause	Root cause	Action
05	Abnormally high pressure (Abnormal discharge pressure)	Refrigerant is excessive.	In some cases, insufficient cooling is judged as caused by insufficient refrigerant and, as a result, refrigerant is charged repeatedly.	Properly adjust the refrigerant charge.
			Capacity of heat changer is insufficient.	If the symptom is caused by change in operating conditions, re-examine the conditions for improvement. If improvement is difficult, add heat exchangers or increase their sizes.
		Discharge oil pressure detection function is defective.	Failure of high pressure protection switch, pressure sensor, relay, etc.	Identify defective device(s), investigate causes of failure and take necessary actions. Then, replace failed device(s).
			Clogging of pressure pipe	Remove clogging, and check oil for contamination/replace oil.
		Outlet shut-off valve of oil separator is closed.	Operator forgot to restore after shut down operation. Human error	Open the valve or perform emergent stop. Be sure to conduct tagout while handling valves. Be sure to check valves before starting the compressor.
06	Discharge temperature is abnormally high.	Overheated during operation	Insufficient refrigerant flow	See the causes listed in item 02 above.
			Heat load on load side is higher than design value.	Inspect the conditions on load side (warehousing volume, opening/closing of doors, etc.), and take necessary measures.
			Failure of low pressure protection switch, pressure sensor, relay, etc.	Identify defective device(s), investigate causes of failure and take necessary actions. Then, replace failed device(s).
		Non-condensable gases mixed into the system	Leak on low pressure side	Perform a leak check, and take necessary measures. Air-purge the heat exchanger.
		Oil supply temperature is high.	Heat exchange failure in oil cooler	For water-cooling system, see "Heat exchange failure in heat exchanger" in item 05 above. For liquid cooling system, check liquid supply expansion valve, temperature sensor and related relays/wiring/terminals, and take necessary actions.
			Oil temperature rise protection feature does not function.	Check temperature protection switch, temperature sensor and related relays/wiring/terminals, and take necessary actions.

	Symptom	Direct cause	Root cause	Action
06	Discharge temperature is abnormally high.	Defective discharge temperature detection/protection feature.	Failure of temperature protection switch, pressure sensor, relay, etc.	Identify defective device(s), investigate causes of failure and take necessary actions. Then, replace failed device(s).
		Insufficient oil supply	See "Low oil pressure" in Item 04 above.	Same as left
07	Leak from mechanical seal	Initial leak after replacement until sliding surfaces settle	In some cases, immediately after replacement, the compressor-specific operating conditions and the pressure receiving conditions of machined sliding surface is unstable.	In case of initial leak, although leak amount might increase temporarily, it will decrease gradually. Check that leak does not increase continuously. Duration of initial leak depends on design/operating conditions. It is approximately 200 hours, as a rough indication.
		Sliding surface is roughened due to overheating.	Started and stopped too many times. * In case of standard equipment, "four or more times per hour" is considered "too many".	If heat load is less than the level set by the equipment's design conditions, review the operating conditions and set control such that equipment is started/stopped less frequently.
				In case of capacity control malfunction, see "Capacity control malfunction" in item 09.
			The amount of lubricating oil contained in refrigerant gets smaller, resulting in decreased viscosity.	In case of liquid flow-back, remove the cause(s). If oil heater or devices on its control circuit are defective, replace the defective part.
			Overheated operation	See the causes in item 02, "Insufficient refrigerant flow".
			Oil supply temperature is high.	See the causes in item 06, "Oil supply temperature is high".
		Machine is stopped for a long time. (No oil film on sliding surfaces)	User-specific conditions, such as intermittent heat load	If machine is sometimes stopped longer than a week, take either of the following measures: (i) Conduct the compressor shaft turning by removing the motor spacer plate (P/N: 235-2) once per month. (ii) Attach an oil pot to other than sealed areas
		Deteriorated part(s)	Hardened O-ring	If deteriorated over time, replace. For other specific causes, see the causes/action for symptom "Overheating of sliding surface".

	Symptom	Direct cause	Root cause	Action
07	Leak from mechanical seal	Deteriorated part(s)	Swelled O-ring * This occurs when the lubricating oil of refrigerating machine contains large amount of refrigerant.	In case of liquid flow-back, remove the cause(s). If oil heater or devices on its control circuit are defective, replace the defective part.
			Deteriorated seal ring/mating ring	If deteriorated over time, replace. For other specific causes, see the causes/action for symptom "Overheating of sliding surface".
		Incompatibility of lubricating oil and operating conditions (such as working temperature range or refrigerant)	Unsuitable lubricating oil was selected, or operating conditions have changed after installation of the package unit.	If possible, review the operating conditions. If not, see Section 4.1"Lubricating Oil (Refrigerant Oil)" to select suitable lubricating oil and replace the whole quantity.
		Poor contact of sliding surfaces	Foreign matters attached to sliding surfaces, due to contaminated lubricating oil.	Replace the whole quantity of lubricating oil. Install bypass filter to oil supply line.
			Faulty assembly of parts Human error	Disassemble, replace parts and reassemble. Use assembly check sheet to ensure confirmation.
08	Squeaking sound from mechanical seal part	During initial period after exchange for new product, squeaks may be heard from sliding surfaces until they fit together.	As the sliding surfaces are very hard and dense, they need time to fit together.	Squeaking itself does not cause leak from seal or deterioration in sealing function. Normally, squeaking is heard for several dozens of hours, however, it may last longer in rare cases. →In this case, contact one of our service centers.
09	Capacity control malfunction	Failure of capacity control solenoid valve, related relays, or the like	Mostly caused by coil burnout.	If deteriorated over time, replace. If the symptom is caused by water leakage, etc., remove the cause(s) and then replace defective part(s). For details, refer to the instruction manual of solenoid valve.
		Internal leakage of capacity control solenoid valve	Aging degradation	Replace.
		Capacity control oil supply line is defective.	Leak/clogging in solenoid valve gland or oil supply piping	Remove cause, and check oil for contamination, replace oil if necessary.
10	Compressor generates abnormal vibration and/or sound.	M rotor shaft runout is excessive.	Lock nut(s) and/or thrust bearing gland(s) are tightened unevenly.	If lock nuts are not loose and parts such as thrust bearings are free of defects, tighten the lock nuts and/or thrust bearing glands evenly.

	Symptom	Direct cause	Root cause	Action
10	Compressor generates abnormal vibration and/or sound.	M rotor shaft runout is excessive.	Thrust bearing glands get loosened.	Lock washer tooth not bended, or thrust bearing rolling elements (balls) are worn. → Check the thrust bearing. If any defect is found, replace it, and then reassemble it after adjusting end clearance and checking shaft runout.
			Rotor dynamic balance is disturbed.	If no other causes are found for abnormal vibration, or if on-site overhaul only has been repeatedly performed for a long time, this may be the cause. → Overhaul the compressor at a place where a dynamic balance measurement/adjustment system is available, such as the MAYEKAWA Moriya Plant.
		Liquid flow-back during startup * Loud abnormal noise at startup. * If this is heard, the compressor may get damaged instantaneously.	Refrigerant liquefies and stays inside upstream piping when package unit is stopped.	There are many probable causes, such as a leak inside liquid supply solenoid valve on the load side, insufficient heat exchange (refrigerant evaporation) in heat exchanger, or trapping due to miss-piping in the piping line. → Identify the cause(s) and take necessary measures. Then overhaul and inspect the compressor.
		Liquid flow-back during operation * Notable frosting on the suction side. * In many cases, flow-back of mist (steam) rather than liquid occurs. * Sometimes, gas-liquid separator (accumulator) is attached to prevent this symptom. * See also the causes in item 02, "Insufficient refrigerant flow".	Aperture of liquid supply expansion valve is large.	In case of temperature-type expansion valve, check the condition of temperature sensitive cylinder and capillary tube. If any defect is found, take necessary actions. If orifice gets unsuitable due to the change in operating conditions, replace the orifice with proper size one(s).
				In case of electronic expansion valve, check devices attached on the expansion valve aperture control mechanism (circuit) such as temperature sensor, converter, controller (overheating regulator). If any of them is found defective, replace it. In the same way as with temperature-type expansion valve, if orifice gets unsuitable due to the change in operating conditions, replace the orifice with proper size one(s).

	Symptom	Direct cause	Root cause	Action
10	Compressor generates abnormal vibration and/or sound.	Liquid flow-back during operation * Notable frosting on the suction side. * In many cases, flow-back of mist (steam) rather than liquid occurs. * Sometimes, gas-liquid separator (accumulator) is attached to prevent this symptom. * See also the causes in item 02, "Insufficient refrigerant flow".	Expansion valve aperture control cannot keep up with rapid change in heat load on the load side.	Avoid rapid change in heat load that exceeds the set value of follow-up range of "heat exchanger on load side (evaporator)" + "expansion valve". For details, refer to the instruction manuals related to devices/control on load side.
			Heat exchange failure in heat exchanger on load side ・Related to defrosting	In case of frosting (icing), conduct manual defrosting. Set defrosting interval shorter. If a device which is specific to the defrosting type fails, remove the cause(s) and replace the device(s). If a piping route which is specific to the defrosting type gets blocked, remove the cause(s) and take necessary actions. * Especially when handling hot gas defrosting systems, thoroughly read and understand the contents of the instruction manuals for the units associated with devices/control on the load side.
			Heat exchange failure in heat exchanger on load side ・Load side conditions	If ventilation around the heat exchanger is obstructed for any reason such as piled up load, improve the conditions. * Ensure the flow of heating medium through the heat exchanger on the load side.
			Heat exchange failure in heat exchanger on load side ・Heat exchanger conditions	Check for any blocked heat transmission tubes or fan failure. If any problem is found, take necessary actions.
		Foreign substances entering the compressor	Welding spatter, etc. flowing from upstream side	Check suction strainer and/or oil filters. Replace element if defective. Overhaul the compressor. Collect foreign substances and identify their sources. Then take necessary measures.
			Tools and/or waste cloth left uncollected after overhauling	
		Damaged thrust bearings.	Deterioration over time (operated beyond recommended time of replacement)	The time for replacement depends largely on operating conditions (low pressure or high intermediate pressure will make the life shorter, etc.) and/or oil management conditions. In case of a typical refrigeration application which basically operates in a stable continuous mode, inspect and replace them every 40,000 hours or 5 years, whichever comes first. For details, refer to Section 5.2.3.

	Symptom	Direct cause	Root cause	Action
10	Compressor generates abnormal vibration and/or sound.	Damaged thrust bearings.	Operation with liquid flow-back	Refer to causes of "Liquid flow-back during startup" and "Liquid flow-back during operation" in item 10.
			Contamination by foreign substances	Refer to causes of "Foreign substances entering the compressor" above.
			Excessive thrust stress other than above ・High suction pressure exceeding the level set by operating conditions	Re-examine operating conditions, and improve if possible. If difficult to improve, review maintenance interval management.
			Faulty assembly * Lock nuts tightened insufficiently, lock washer tooth not bended, rotation stopper not set to thrust bearing gland or spring washer not assembled, etc.	Tighten lock nuts to the specified torque or torque angle (see "7.1 Tightening Angles for Lock Nuts" in this manual). Be sure to record data on the assembly check sheet to prevent omission of work steps.
		Resonance vibration	This occurs when the frequency of vibration comes close to the natural frequency of any component in the entire vibrating system, including pipes and supports.	In many cases, this symptom is caused by change in installation environment (such as change in piping routes or additive installation of devices within machine room, oil level change, etc.) →If occurrence of resonance vibration is a suspected, contact one of our service centers.

Chapter 7 Related Documents

7.1 Tightening Angles for Lock Nuts

When tightening a lock nut, if it is difficult to use a torque wrench, manage the tightening torque of the lock nut controlling the tightening angle range as explained below.

■ Tightening Angle Range of Lock Nuts for Rotor

a) After tightening the lock nut by hand, further tighten the lock nut by using a lock nut wrench until the rotor starts to turn. Take care not to over-tighten.

b) Put a mark on the lock nut at the right side edge of the rotor groove where the stopper tongue of the lock washer fits in, as shown in Figure 7-1.

c) From this marking position, tighten the lock nut in such a way that rotation can be stopped within the tightening angle range shown in Table 7-1 (i125*/i160*: 30° to 40°(first time tightening), 20° to 30°(second time tightening) for both [39-1] and [39-2]). When measuring the angle, use an angle gauge which is set to the diameter of rotor shaft.

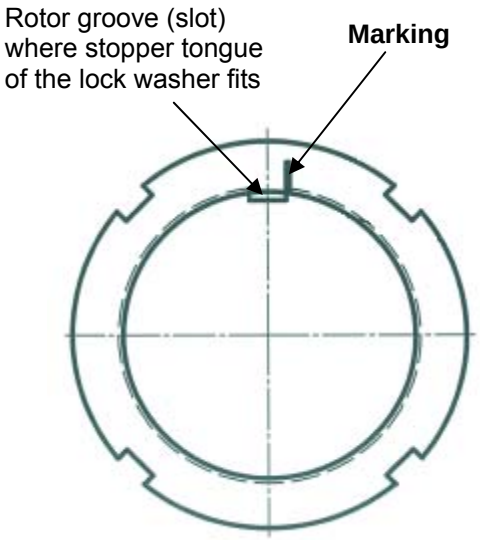


Figure 7-1 Position where Mark is Put

Table 7-1 Tightening Angles Specified for Lock Nuts of Rotor

	Model	Angle range
First time tightening	i125*, i160*	30° to 40°
Second time tightening	i125*, i160*	20° to 30°

* When tightening lock nut, tightening start position differs between the first time tightening and the tightening for the second time or after. Therefore, angle ranges are specified also for the second time tightening.

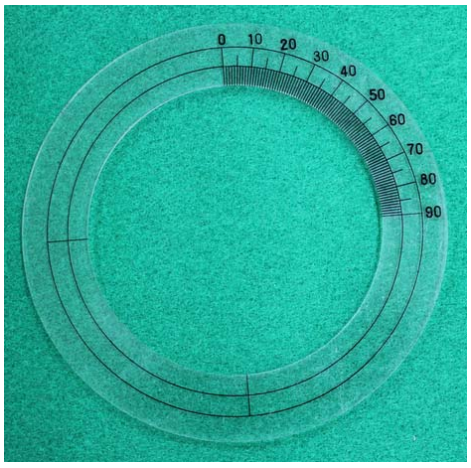
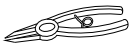
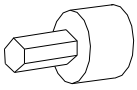
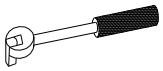
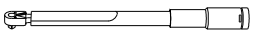
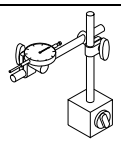


Photo 041 Angle Gauge (example)

7.2 Disassembly Tools

Table 7-2 List of Tools

Tool		i125*	i160*
Ratchet wrench		1/4”	
Adjustable wrench		250 mm	
Screwdriver		(Phillips)	
Screwdriver		(flat blade)	
Handle for hexagonal wrench key		Φ20 × L 300 (mm)	
Vinyl hose		Φ15 × L 720 (mm)	
Sponge		160 mm x 160 mm x 20 mm	
Double ended wrench		17 mm × 19 mm	
Box end wrench		30 mm × 32 mm	
Retaining ring pliers (Snap ring pliers)	 (external)	205 mm, tip size: Φ2.3 mm	
	 (internal)	300 mm, tip size: Φ3.0 mm	
Lock nut socket (Nut dimensions)		AN-8	AN-11
		AN-9	AN-12
Eye Bolt		M8 (two-piece set)	
Hexagon socket		width across flat 8 mm 10 mm 14 mm	5 mm 8 mm 10 mm 14 mm
Socket for socket wrench		13 mm	–
Socket adapter		19.5 female × 12.7 male	
Socket wrench handle		12.7 male × L 300 mm	
Extension bar		12.7 male × L 250 or 300 mm	
Preset torque wrench		200 N·m 420 N·m –	200 N·m 420 N·m 550 N·m
Hexagonal wrench key set		(width across flat) 2, 3, 4, 5, 6, 7, 10, 12, 14 mm	
Slide hammer		For M6	
Rotor shaft stopper 1		Hole Dia. 38.3 mm	Hole Dia. 45.3 mm
Rotor shaft stopper 2		Φ30 × L 340 mm	Φ35 × L 400 mm
Dial gauge & magnet stand			

7.3 Flange Motor and Connection Flange Size

Table 7-3 Flange Motor and Connection Flange Size

Motor	Output in HP	Flame Size	Connection Flange NEMA
USA (NEMA)	40	324	NEMA C-face (3**C/40*C) for i125*
	50	326	
	60	364	
	75	364	
	100	404	
	40	324	NEMA D-face (3**D/4**D) for i160*
	50	326	
	60	364	
	75	364	
	100	404	
	125	444	
	150	445	
	200	445	
	250	447	

Motor	Output in kW	Flame Size	Connection Flange IEC
ABB IE2(IP55) Cast-iron motors 3000 min^{-1}	37	200MLB	FF350
	45	225SMA	FF400
	55	250SMA	FF500
	75	280SMA	FF500
	90	280SMB	FF500
	110	315SMA	FF600
	132	315SMB	FF600
	160	315SMC	FF600
	200	315MLA	FF600
ABB IE3(IP55) Cast-iron motors 3000 min^{-1}	37	200MLB	FF350
	45	225SMA	FF400
	55	250SMA	FF500
	75	280SMB	FF500
	90	280SMC	FF500
	110	315SMB	FF600
	132	315SMC	FF600
	160	315MLA	FF600
	200	315MLB	FF600

Motor	Output in kW	Flame Size	Connection Flange IEC
Leroy-Somer FLSES (IP55)	37	200LU	FF350
	45	225MR	FF400
	55	250M	FF500
	75	280S	FF500
	90	280M	FF500
	110	315S	FF600
	132	315M	FF600
	160	315LA	FF600
	200	315B	FF600
Leroy-Somer Gamme 3000 LSRPM (IP55)	37	160MP	FF300
	44	160LR	FF300
	50	200L	FF350
	65	200L1	FF350
	85	200L1	FF350
	110	225ST2	FF400
	145	250SE	FF500
	170	250ME1	FF500
Leroy-Somer Gamme 3600 LSRPM (IP55)	34	160MP	FF300
	41	160MP	FF300
	49	160LR	FF300
	50	200L	FF350
	70	200L1	FF350
	85	200L1	FF350
	115	200LU2	FF350
	132	225SG	FF400
	165	250SE1	FF500
	190	250SE1	FF500
Luroy-Somer PLSES (IP23)	37	180LG	FF350
	45	200M	FF400
	55	200LU	FF400
	75	225MG	FF500
	90	250SP	FF600
	110	250MP	FF600
	132	280MD	FF600
	160	315S	FF740

Motor	Output in kW	Flame Size	Connection Flange IEC
Siemens (IE3, IE2) Cast-iron Series 2982 min^{-1}	37	200L	FF350
	45	225M	FF400
	55	250M	FF500
	75	280S	FF500
	90	280M	FF500
	110	315S	FF600
	132	315M	FF600
	150	315L	FF600
WEG (IE3) 3600/3000 min^{-1}	37	200L	FF350
	45	225S/M	FF400
	55	250S/M	FF500
	75	280S/M	FF500
	90	280S/M	FF500
	110	315S/M	FF600
	132	315S/M	FF600
	150	315S/M	FF600
	185	315S/M	FF600
	220	315L	FF600

Motor	Output in kW	Flame Size	Connection Flange IEC
TECO AEUVUK 2955 ～ 2970 min^{-1}	37	200L	FF350
	45	225M-2	FF400
	55	250M-2	FF500
	75	280S-2	FF500
	90	280M-2	FF500
	110	315S-2	FF600
	132	315M-2	FF600
	160	315L-S	FF600
	200	315L-2	FF600
	250	355M-2	FF740
TECO AEEVUK 2955 ～ 2970 min^{-1}	37	200L	FF350
	45	225M-2	FF400
	55	250M-2	FF500
	75	280S-2	FF500
	90	280M-2	FF500
	110	315S-2	FF600
	132	315M-2	FF600
	160	315L-S	FF600
	200	315L-2	FF600
	250	355M-2	FF740

Appendix 1: Basic Points of Design and Manufacturing for the Compressor Package

This appendix 1 describes the basic points of design and manufacturing for the packaging work using i-series compressor. In what is described here, there are overlapping explanations in chapter 1 to chapter 4 of this manual, but please refer to it as explanation to supplement them.

1-1 Basic Flow of the Package Unit

Figure app.1-1 is the reference flow of the package unit using i-series compressor.

Circulation of the lubricating oil (refrigerating oil) is necessary for the compressor for lubrication of the sliding surface parts such as bearings, mechanical seal assembly, the rotors, etc. and discharge temperature adjustment

Generally, oil separator, oil cooler, oil filter(s), protection switches or sensors and valves become the basic component.

The i-series compressor can use the flange type motor by using an exclusive motor spacer.

Oil pump is not necessary for the i-series compressor for differential pressure oil supply system.

Therefore it is necessary to secure the lowest oil supply pressure (high and low differential pressure) to prevent damage by the poor lubrication of bearings and the mechanical seal assembly.

Install the oil filter(s) less than 20 μm ($\beta_{20} \geqq 150$) filtration precision in the oil line to the compressor to prevent the entry of foreign matter such as dust. For details, refer to Section 3.2.5.2 in this manual Chapter 3.

The gas suction side inside of the i-series compressor has a suction filter and a check valve.

The compressed refrigerant gases separate lubricating oil with passing the coalescer inside the oil separator.

In order to ensure the minimum differential pressure (oil supply pressure - suction pressure) at the compressor start-up, MAYEKAWA recommends that you install a pressure regulating valve in the oil separator outlet piping.

In order to ensure the minimum differential pressure (oil supply pressure - suction pressure) at the time of the compressor start-up, MAYEKAWA recommends that you install a pressure regulating valve in the oil separator outlet piping.

Because regulations of the refrigerating system vary according to the use area, at the time of packaging, make sure that equipment configuration and operation control flow conform to the regulations in your area.

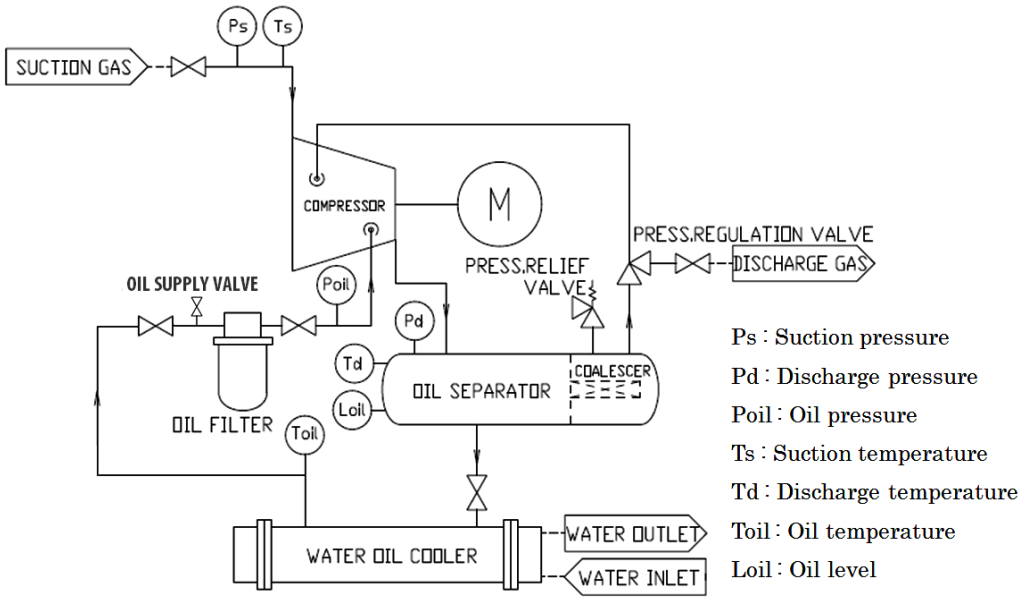


Figure app.1-1

1-2 Basic Flow of the Oil Cooler

The supply of oil to the compressor must be in the range of 30 °C to 60 °C. Therefore, a cooler for lubricating oil cooling is necessary after an oil separator.

Figure app.1-2 is the reference flow of the water cooled oil cooler.

The heat exchanger can be chosen with shell and tube type, plate-type, shell and plate-type and the air cooled type.

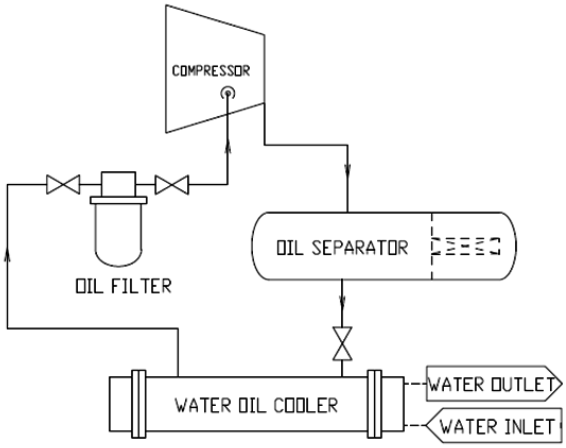


Figure app.1-2

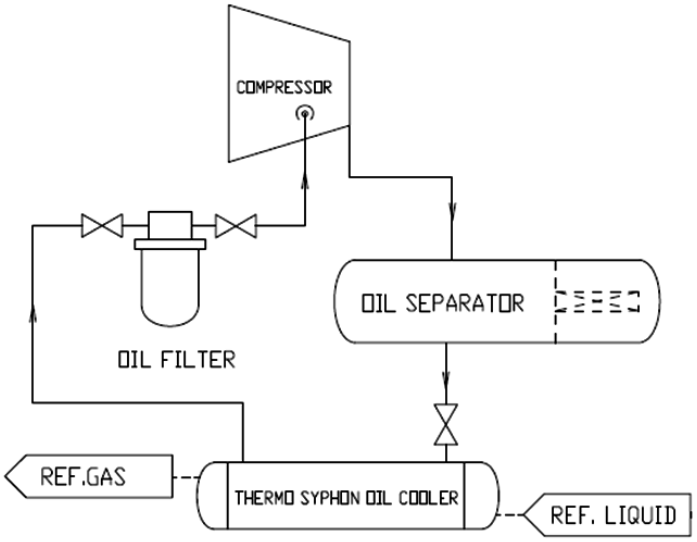


Figure app.1-3

Figure app.1-3 is the reference flow of the thermo-siphon oil cooler.

Shell and tube type or plate-type are general.

Even in the oil cooler of either method, install the oil cooler of adequate capacity to cover the oil radiation amount of the compressor.

Also, design considering a piping pressure-loss and a refrigerant liquid water head.

Figure app.1-4 is the oil cooling system of liquid injection. In this case, the heat exchanger is not required. The oil is cooled by letting the liquid injection port of the compressor breathe in refrigerant liquid after decompression.

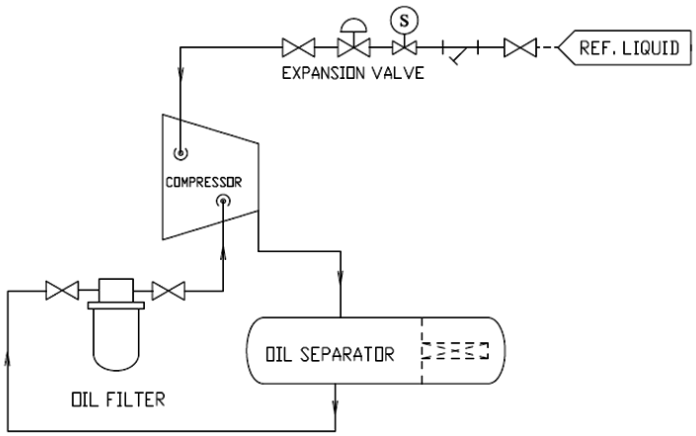


Figure app.1- 4

1-3 Oil Temperature Control

Generally, in order to keep the lubricating oil temperature in the oil separator, install the oil heater at the bottom of the oil separator.

In the cold district, the viscosity of lubricating oil at the compressor start-up is decreased; lubricating oil is hard to flow, so there are cases that package unit cannot secure the necessary oil supply pressure.

When you need to secure the oil supply temperature to the compressor, install an oil temperature control valve.

Figure app.1-5 is a reference flow in oil temperature control valve use. The mixing -type three-way valve is general.

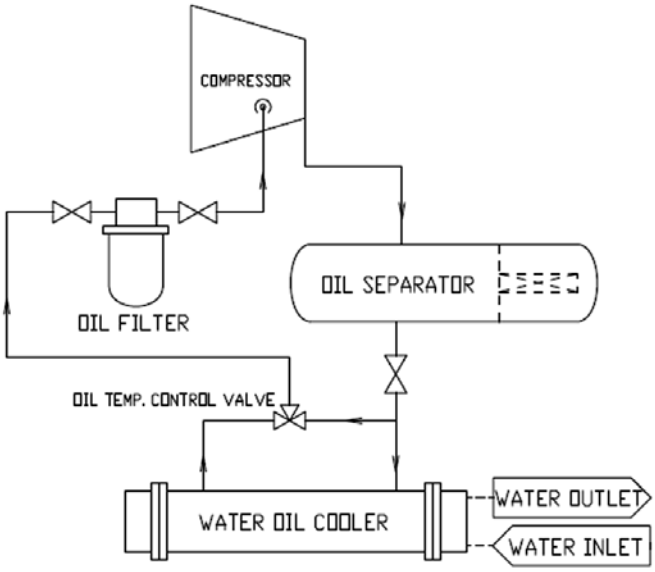


Figure app.1-5

1-4 Economizer

i-series compressor has a economizer port for improvement of refrigerating effect.

Figure app.1-6 is a use example of the general economizer system with the i-series compressor package unit.

DX type composed by a expansion valve and a heat exchanger, and flash tank type inhaling from common flash tank are general.

Install a filter with the ability for filtration less than 100μm in the economizer line.

In the case of DX type economizer, type of the heat exchanger can choose with shell and tube type, plate type, etc. Use it properly by the system of refrigerator.

I In addition, the economizer port can also be used as a side load gas inlet port, but since the diameter is small compared to general port for side load port, please contact us for the details.

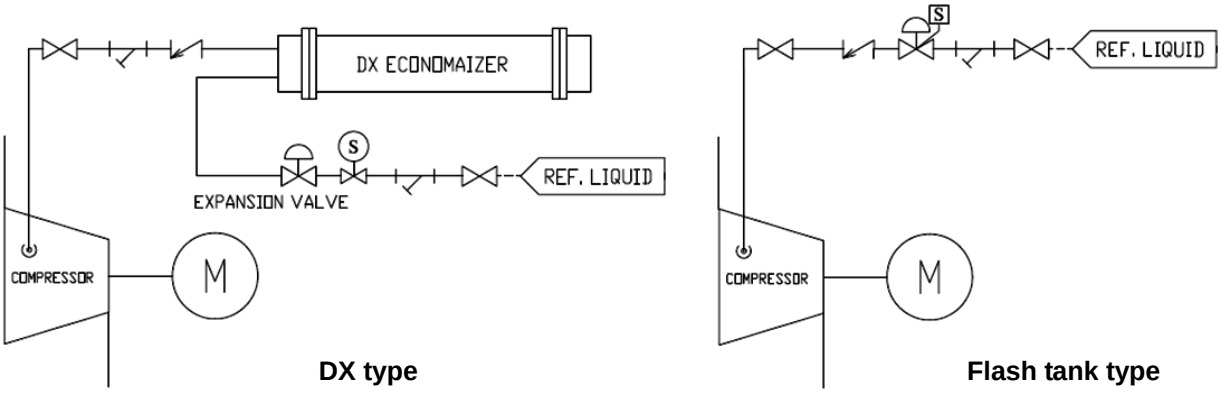


Figure app.1-6

1-5 Oil Separator

Oil separator has important two roles in the refrigeration system. One is to separate the lubricating oil from discharge gas of the compressor, and the other is to hold the oil. When you design a oil separator for the package unit using i-series compressor, take sufficient attention to the following points.

1) Installation of oil level gauge

   To manage the lubricating oil level, an oil level gauge that shows both the upper and lower level limit must be provided.

2) Installation of protection device from oil level decrease

   In case of the oil supply by differential pressure, install a protection device from oil level decrease. Since there is a possibility that alarm for protection from lubricating differential pressure decrease may not activate even if the amount of lubricating oil is insufficient.

3) Sufficient stiffness

   If a horizontal type of oil separator with the compressor and motor mounted on top is adopted, the oil separator must be sufficiently rigidly designed considering the transformation and the thermal strain of a separator casing.

Figure app.1-7 is an example flow with oil separator. Choose an appropriate oil separation method (coalescer / demister / cyclone system) according to your refrigeration system conditions.

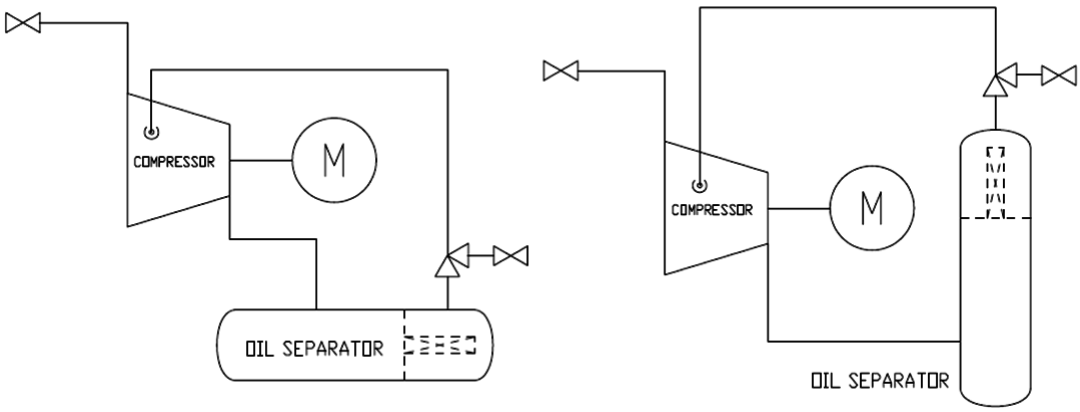


Figure app.1-7

1-6 Protection Devices

Package unit of the compressor requires protective devices to prevent damage to the components. Install the necessary protective devices in accordance with applicable law.

Generally, as shown in Figure app.1-1, monitoring and control of pressure and temperature of refrigerant, / oil, are required.

In addition, the range of operation, in accordance with applicable law, the installation of safety valve(s) is also required.

Please refer also to Section 1.4 and Section 2.3.3 in this manual.

1-7 Power Supply and Control Devices

An example of a standard power control circuit diagram (star-delta starting) is shown in Figure app.1-8a and Figure app.1-8b.

In the package unit using i-series compressor, you can choose a variety of motor starting method such as direct on-line starting, using a frequency inverter, star-delta starting, using a soft starter, etc. according to the type of motor.

When selecting wires, electromagnetic contactors and fuses, ask their information to the motor manufactures and adopt proper ones to the motor specifications.

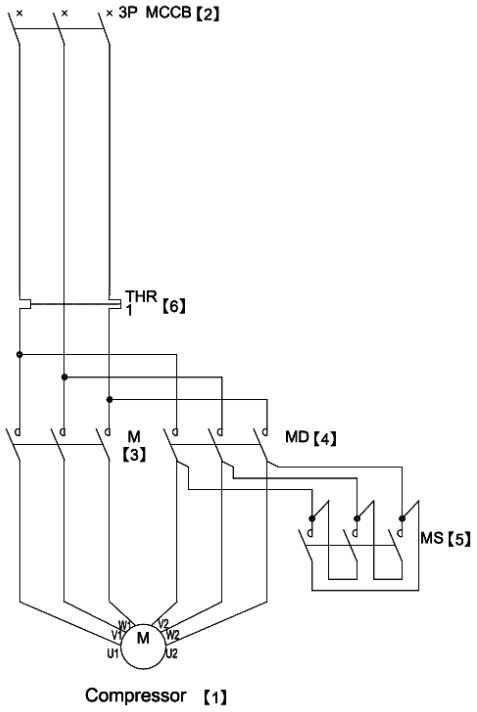
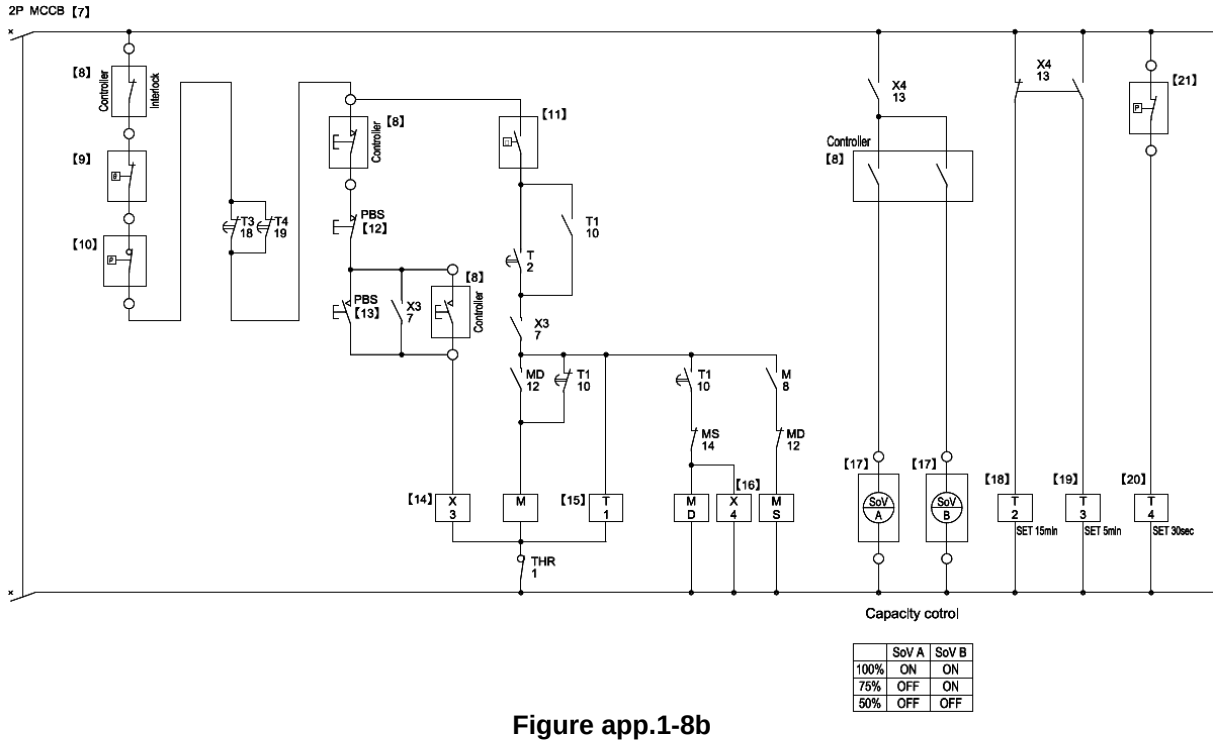


Figure app.1-8a

Reference:

[1**]**: Main Motor **[**2**]**: Main Power Source Switch
[3]: Electromagnetic Contactor (main)
[4]: Electromagnetic Contactor (delta)
[5]: Electromagnetic Contactor (star)
[6]: Thermal Switch [7]: Control Power Source Switch
[8]: Various Control Contact (other control circuit)

Note: [9] , [10], [11] and [21] are Contacts of Protection
[9]: Protection from abnormally High Discharge Temperature
[10]: Protection from abnormally High Discharge Pressure
[11]: Protection from abnormally High Suction Pressure
[12]: Switch for Operation Stop [13]: Switch for Operation Start
[14]: Relay for Operation Start/Stop [15]: Star-Delta Timer
[16]: Relay for Confirmation of Compressor Start-up [17]: Solenoid Valve for Capacity Control
[18]: Timer for Protection from Motor Re-starting
[19]: Timer for Protection from Low Oil Supply Pressure at the Compressor Start-up
[20]: Timer for Protection from Low Oil Supply Pressure
[21]: Contact of Protection from Low Oil Supply Pressure



	SoV A	SoV B
100%	ON	ON
75%	OFF	ON
50%	OFF	OFF

Figure app.1-8b

■ Exclusive Controller [MYPRO-IP]

If you will use the exclusive controller "MYPRO-IP" (sold separately), it becomes possible to further advanced control.

The main features of [MYPRO-IP] are as follows.

1. Various automatic control functions (capacity control and alarm operation)
2. Various state monitoring functions (pressure and temperature)
3. Setting change prohibition function
4. Communication function

For details, refer to dedicated booklet "MYPRO-IP Instruction Manual".

Appendix 2: Basic Points of Design and Manufacturing for the Compressors Multi- package

2-1 Preface

In previous Chapter Appendix 1 "Basic Points of Design and Manufacturing for the Compressor Package", we have introduced the basic packaging instructions using i-series compressor.

Our i-series compressor models have achieved simplification of the package by adopting the fully differential pressure oil supply method that does not require the oil pump for lubrication of the compressor. In addition, i-series compressor models can be used for various package types by adopting different systems and applications.

As major package types, it has been widely adopted that there are general basic packages of the monocoque type with the compressor mounted on the horizontal oil separator, and the large scale system packages such as multiple operation, chiller packages or the like.

In addition, according to the requests for adopting systems and/or applications, multi-packaging is also available that shares the oil separator and the oil cooler.

In this Chapter Appendix 2, we will introduce the basic points of design and manufacturing for the multiple packaged unit. When you need to increase the refrigeration capacity by using plural compressors, or to design the refrigeration package for the applications that require capacity control by controlling the number of compressors, you can refer to the instructions here.

In the same way as the single compressor packages require, refrigerators also change according to the local regulatory and customer's specifications. Comply with the required regulations and specification when designing the package.

2-2 Reference Flow and Configuration Components for Multi-package

2-2-1 Representative Flow of Multi-package

Figure app.2-1 indicates the reference flow of the package with three parallel compressors.

As a representative example, the package in Figure app.2-1 is adopting the shell and tube type water cooled oil cooler and vertical coalesce type oil separator. It has also set the prerequisites that the capacity control by limiting the number of compressors is required, which means some compressors are not in use during the operation.

The multi-package flow changes depending on the requested system and applications.

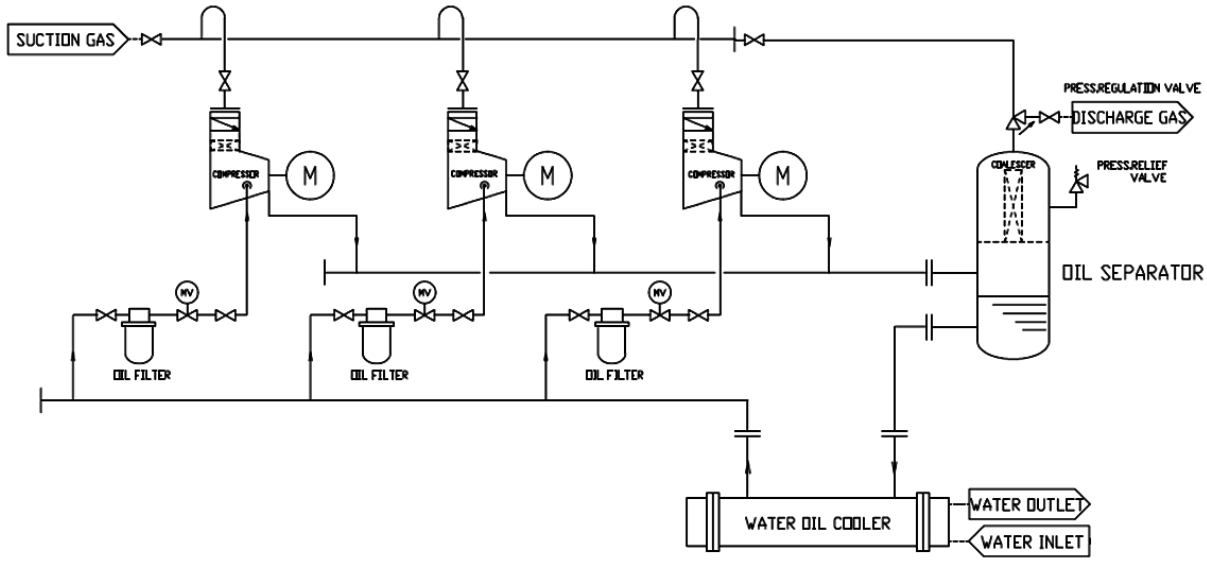


Figure app.2-1

2-2-2 Oil Separator

Similarly to the case of single package, the oil separator type can be selected according to the system and the application.

When the common separator is used, it is necessary to consider the separator size and adding of secondary separator depending on the swept volume of the compressor and the target oil carry amount. Therefore, selecting is possible from either one of cyclone type, demister type, and coalescer type. In case of horizontal type oil separator, of which oil accumulates inside, it is also possible to return oil to the suction side at the upstream side of the compressor.

2-2-3 Pressure Regulator for Differential Oil Supply Pressure

Because i-series compressor is the fully differential pressure oil supply type, it is necessary to secure the minimum oil supply pressure (oil supply pressure – suction pressure).

Similarly to the case of single packages, install the pressure regulator at the outlet side of the oil separator.

In case of Figure app.2-1 multi-package, instrument piping is attached from the suction side. When the number of compressors to be controlled, connect the instrument piping for the pressure regulator to the suction gas common header. If the instrument piping is connected to the suction side of each compressor, the pressure condition becomes instable when the compressor is stopped.

2-2-4 Oil Cooler

Similarly to the case of single package, selecting either one from the water cooled type, high-pressure liquid type, and liquid injection type is possible for the oil cooler of multi-package.

When the water cooled type or the high pressure liquid type is used, the oil cooler can be shared. However, if the liquid infection type is used, place the oil cooler at locations, at which each supplying oil to the compressor can be cooled.

In cold districts, where the minimum temperature of supplying oil cannot be kept, install the oil heater to the oil separator and mount the oil temperature control valve to the oil supply line (Refer to Appendix 1 Section 1-3 "Oil Temperature Control").

2-2-5 Oil Filter and Oil Line

Be sure to install the oil filter less than 20 μm (β20≥150) filtration precision to each compressor in order to protect the compressors (refer to Section 3.2.5.2 in this manual Chapter 3).

For the multi-package, each oil supply piping to the oil filter after oil cooler should be connected from common oil header so as to be uniform lubrication.

The flow in Figure app.2-1 has drawn in prerequisite that number of compressors is to be controlled. Therefore, the motor valve is provided after the oil filter, so the oil does not flow back when the compressor is stopped. Do not select a valve that can be operated in a back pressure.

2-2-6 Stop Valve and Safety Valves

The flow in Figure app.2-1 is an example of multi-package. Install the stop valves for the maintenance purpose according to the applicable regulations and as necessary. At that time, install the safety valves appropriately to the piping, heat exchanger, and the tanks carefully according to the applicable regulations.

Methods to select the appropriate safety valves are different depending on the local applicable laws and design guidelines.

2-3 Economizer

As introduced in Appendix 1 Section 1-4, DX type and flash tank type economizers are available depending on the system and application.

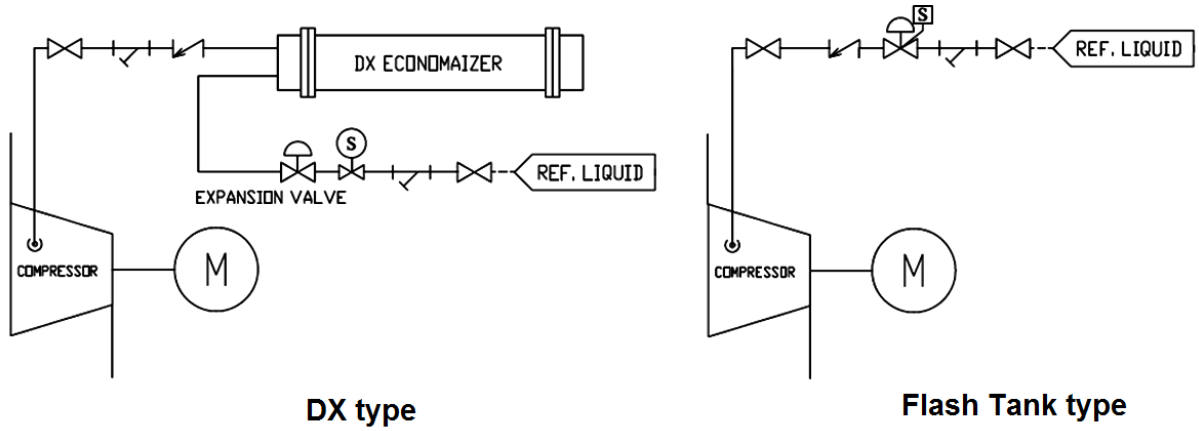


Figure app.2-2

The DX type economizer in Figure app.2-2 is indicating the shell and tube type as a representative example. However, it is also possible to select the plate type heat exchanger and electronic type expansion valve according to the system and application.

2-4 Protection Devices and Control Devices

The protection devices and the control devices, e.g. various sensors are required for the multi-package unit as well as the single-package unit.

Install the protection devices by considering the applicable regulations, applications, and maintenance.

Please refer also to Chapter 1, Section 1.4 and Chapter 2, Section 2.3.3 in this manual.

Contact Information

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MAYEKAWA (TAIWAN) CO., LTD. (TAIPEI HEAD OFFICE)	8F, NO, 421, SUNG-SHAN ROAD, TAIPEI, TAIWAN 11083, REP. OF CHINA	TEL: (886) 2-2727-9711 FAX: (886) 2-2759-8484
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MAYEKAWA (THAILAND) CO., LTD. (TRANG BRANCH)	1/7 TRANG-PALIAN RD., MUANG, TRANG 92000, THALAND	TEL: (66) 75-224-784 FAX: (66) 75-224-351
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