2202M1JE-DA-C4_N_2014.01.

MYCOM

Compound 2-stage Screw Compressor

1612**C Instruction Manual

1612LSC／1612LLC／1612MSC／1612SSC

CAUTION

Before operating, maintaining, or inspecting this product, read the manual thoroughly and fully understand the contents.
Keep the instruction manual in a safe, designated place for future reference whenever the need arises.
Specifications of this product are subject to change without prior notice.

MYCOM MAYEKAWA MFG. CO., LTD.

Preface

Thank you for purchasing this MYCOM compound two-stage screw compressor 1612C (hereinafter indicated as “this product”).

This instruction manual (hereinafter indicated as “this manual”) describes safety information, operational and maintenance procedures in detail for safe and effective use of this product, and applies to the following types.

1612LSC-***-51/61, 1612LLC-***-51/61, 1612MSC-***-51/61, 1612SSC-***-51/61

Before installing or using this product, make sure you read this manual.

Keep this manual in a safe place near the product for quick reference.

Revision History

Instruction manual name		Document No.	First edition issue date
1612C Instruction manual		2202M1JE-DA-C4-N_2014.01.	2013.05.30
Revision No.	**Issuance Date**	**Contents of revisions**	**Created/ approved by:**
—	1974.06.30	Issuance of 1612C first edition	Sumio Yamamoto
—	1983.10.01	New issuance as 1612C/2016C edition	Sumio Yamamoto
—	1993.06.30	Revision of 1612C/2016C (correcting editing errors, etc.)	Sumio Yamamoto
—	1996.06.30	1994.07 Re-examination by constitution of Product Liability Act	Ikehara / Shozu
00	2013.05.30	Overall re-examination by reissuance as an electronic edition, its document No. change	Ikehara / Hirao
01	2013.12.26	1.1.1「MSDS」change to「SDS」, etc.	Ikehara / Hirao
02	**2014.01.15**	**5.7.14「Unloader Indicator」 (correcting editing errors, etc.)**	**Ikehara / Hirao**

Warranty and Disclaimer

Warranty Clauses

If malfunctions or damages occur under proper usage and conditions following documents such as specifications or instruction manual of this product, or, if MAYEKAWA judges that malfunctions or damages are related to design or manufacture of the product, and if the malfunctions or damages are within the warranty period, we will repair or replace the product without any charges.

The warranty period is “12 months from factory shipment of this product”. If use of this product is governed by any other contracts, they will be given priority.

Disclaimer Clauses (Exclusion of Warranty Clauses)

Please note that we disclaim any responsibility for damage or malfunction to this product, as described in the following items.

- Malfunction or damage of this product caused by natural disaster, or other accidental forces (such as windstorm, intense rainfall, flood, tidal wave, earthquake, land subsidence, thunderbolt, fire, etc.).
- Malfunction, damage, or defect to this product due to abnormal or improper use (such as storing this product outdoors or in locations subject to high temperatures and high humidity, unexpected inspections, tests, operations, and excessive repetition of start-up/stoppage of the product.).
- Malfunction or damage caused by devices or equipment not provided by MAYEKAWA including operation control methods of those devices.
- Malfunction or damage caused by refrigerants, gases, or lubricants 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 MAYEKAWA genuine.
- Malfunction or damage caused by remodeling the product without the approval of MAYEKAWA.
- Direct or indirect production warranty or all other related warranties that arose due to malfunction or damage of this product.

Important Information

Intended Use of This Product

This product is a general-purpose screw compressor intended for refrigeration and cold storage.

Do not use the product for any purposes for which it was not intended or which depart from the specifications. For specifications of this product, refer to “2.3 Compressor Specifications”.

The maintenance items described in this manual should be performed safely and closely following procedures.

Important Information for Safe Use of This Product

Although MAYEKAWA has thoroughly considered the safety measures for this product, all hazards, including potential hazards caused by human error or environmental conditions, cannot be anticipated.

There are many guidelines that must be observed for operating this product. However, the warnings in this manual and the safety labels on the product are not all inclusive. When operating this product, always pay extreme attention to general safety precautions as well as on items described in this manual.

Important rules for safe operation that apply to all workers including managers and supervisors are listed below.

Before using this product, carefully read and fully understand the contents written in this manual and pay attention to safety.

- Operation, maintenance, and inspection of this product should be performed by qualified personnel educated about the fundamentals of the product and trained about the hazards involved and measures to avoid danger.
- Do not allow anyone other than those educated about the fundamental expertise of the product and trained about hazards involved and measures to avoid dangers to approach the 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, or use the product for any unapproved purpose.
- Replace parts with MYCOM genuine parts.
- Not only workers but also managers should actively participate in safety and health activities in the workplace to prevent accidents.
- When closing or opening valves during work, apply lockout/tagout without failure, to prevent the valves from closing or opening accidentally 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 by 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, the product may be turned on if power is supplied from outside the refrigeration system or cold storage. 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 in your area, refer to chapter 8 in this manual.
- This manual is in English. If any other language is required it is the customer's 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 in 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 the actual product.
- If this manual is lost or damaged, immediately place a purchase order to our local sales offices or service centers for a new manual. Using the product without the manual may result in safety issues.
- If you resell the product, never fail to include this manual with the product.

Construction of This Manual

Title of section and chapter	Description details
Preface	Describes the outline of this manual and how to read the manual.
Warranty and Disclaimer	Describes clauses and coverage of warranty. Exemption of warranty clauses is described as disclaimer.
Important Information	Describes important information related to the product and this manual.
1. Safety	Describes safety information for workers, safety rules for this product, and management details regarding work safety required for handling the product.
2. Structure and Specifications of the Compressor	Describes the main components of the product, functional information, specifications, and operating limits.
3. Installation	Describes installation procedure of the product.
4. Compressor and Unit Operation	Describes precautions for operating the product.
5. Maintenance and Inspection	Describes sections and period for inspecting, disassembly and assembly of the product.
6. Troubleshooting	Describes troubleshooting methods for the product in case problems occur during operation of the product.
7. Related Documents	Describes documents such as development views and configuration tables for parts.
Contact Information	Describes contact information for our local sales offices or service centers, which are for ordering MYCOM genuine parts.

Table of Contents

5 Maintenance and Inspection

6 Troubleshooting

7 Related Documents

Contact Information

How to Order MYCOM Genuine Parts

Sales Offices/Service Centers)

1 Safety

1.1 Observation/Prevention

1.1.1 Observances (Do's)

1.1.1.1 Do's on Operation

- Always install the safety devices and the protective devices to the refrigerator or cold storage unit.
- Regularly inspect the safety devices and the protective devices. Ensure that they operate properly.
- If the safety devices and the protective devices do not work properly or the machine operates abnormally, stop operation immediately and report the incident to your supervisor. Do not restart the machine until the supervisor determines the machine safety and provides proper instructions for restart.
- If the machine stops due to unknown reasons, immediately inform your supervisor. Do not restart the machine until the supervisor determines the machine safety and provides the proper instructions for restart.
- Some types of refrigerants generate bad smells or toxic gases because of leakage, etc. Make sure to ventilate the working area.
- Some refrigerants and refrigerant oils may be corrosive, decomposable, or toxic. Make sure to obtain the Safety Data Sheets (SDS) of the refrigerants and refrigerant oils and follow their instructions.
- When stopping the compressor for a long time, turn "OFF" the main motor, heater, and control power. Close the suction and discharge shut-off valves.

1.1.1.2 Do's on Maintenance

- Create a work procedure based on the work plan and always perform accident prediction training before starting work.
- When performing work with at least two or more persons, thoroughly confirm each other's work and work procedures, and understand other workers' actions before commencement.
- Always turn off and lockout/tagout the main motor power, control power, and power to other devices before troubleshooting, setup, cleaning, maintenance, or inspection of the compressor. Also, make sure that power to these items is NOT turned on accidentally during work.
- Always confirm that the pressure inside the refrigerating or cold storage unit is atmospheric before troubleshooting, setup, cleaning, maintenance or inspection of the compressor.
- Some types of refrigerants generate bad smells or toxic gases and cause oxygen deficiency. Before working, measure oxygen concentration in the working area as necessary, and maintain sufficient ventilation. Make sure to continue maintaining sufficient ventilation until the work is completed.
- Some refrigerants and refrigerant oils may be corrosive, decomposable, or toxic. Make sure to obtain the Safety Data Sheets (SDS) of the refrigerants and refrigerant oils and follow their instructions.
- After working on the machine, always store the tools used in their specified places and make sure that no tools are left in or around the machine.

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

- Set up lockout/tagout devices for the main breakers of the main motor and control power. The lockout/tagout after shutting off the power is a very effective way to secure workers' safety and can prevent injury to workers caused by a number of workers accidentally turning the power source on.
- If there are any possibilities of danger during work (especially during cleaning, maintenance, inspection, or troubleshooting), turn "OFF" the main motor and control power, and perform lockout/tagout.
- In the following situations, workers may neglect to perform power source shutoff or lockout/tagout. Clearly notify the workers of the necessity of lockout/tagout.
  - It is assumed that workers do not perform lockout/tagout before starting work because it is troublesome, and only turn "OFF" the main motor and control power.
  - It is assumed that workers only turn off main motor and control power and do not lockout/tagout the main motor and control power, because they judge that there is no danger.

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 piece of protective gear before use.
- Wear work clothing, and tighten cuffs.
- Do not wear any neckties or jewelry that can get entangled in moving or rotating parts.
  A helmet is recommended to protect your head and hair.
- Do not have anything in your pocket to prevent objects from falling into the machine.

1.1.1.5 Do's about the Handling of Hazardous and Toxic Substances

- Obtain Safety Data Sheets (SDS) from manufacturers of hazardous and toxic substances.
- Check the SDS 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

- Develop an emergency action procedure in accordance with the legal regulations and post it in a safe place.

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

- Disposal of refrigerant and waste oil from the compressor is subject to a number of regulations for environmental protection purposes. Follow the local, state or federal acts and regulations as well as your company's rules, when disposing of such waste oil, fluid and materials.

1.1.1.8 Other Do's

- Keep the floor around the refrigerating and cold storage units clean and provide a safety aisle.
- Use only the safety aisle to move around the equipment. Keep the safety aisle free from any tools and cleaning fluid.
- If water or oil is spilled on the compressor or the floor, immediately wipe it off to prevent workers from injury caused by slipping.

1.1.2 Don’ts

- Do not remove or relocate any safety devices, including electrical interfaces.
- Do not disable any safety devices by short-circuiting or bypassing without any permission.
- Do not leave the compressor unattended in an unsafe condition, such as by removing the safety cover or some other safety measures.
- Do not touch, clean, or lubricate any moving part of the compressor during operation.
- Do not touch electrical systems such as relays and terminal blocks with bare hands when turning on the power.

1.2 Warnings

To alert workers about dangers, the following two measures are always provided with the compressor.

- Warnings described in this manual
- Safety labels affixed on the individual devices
  * There is no safety label attached to the compressor itself to which this manual targeted. For details about the safety labels attached to devices, refer to the refrigerating unit’s instruction manual.

1.2.1 Types and Meanings of Warnings

This manual includes the following four types of warnings to be used for hazards during operation or maintenance of the compressor.

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

Also, the compressor 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

DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in serious injury or death.
WARNING	Indicates a potential hazardous situation which, if not avoided, could result in serious injury or death.
CAUTION	Indicates a potential hazardous situation which, if not avoided, may result in minor or moderate injury.
CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in property damage.

1.3 Residual Risks

The following information is provided on the assumption that this product is operated, inspected, and maintained while being used in general refrigerating, cold storage package units. Note that all hazardous sources cannot be predicted for the applications mentioned.

Devise appropriate countermeasures for hazardous sources in your systems.

Table 1-2 Hazardous Sources

	Danger source	Predicted hazard	Measures to be taken in operation	Measures to be taken when cleaning, inspecting, and replacing parts
A	Motor and compressor coupling Refer to Figure 1-1.	• Entanglement caused by contact	• Install coupling covers and prohibit opening • Keep away	• Shut off and lockout/tagout of motor's main power and control power
B	Motor terminals	• Electric shock caused by live wiring contact and electrical leakage	• Keep away • Do not open terminal boxes • Do not touch terminal boxes	• Shut off and lockout/tagout of motor's main power and control power
C	Compressor low-stage side suction casing Refer to Figure 1-1	• Frostbite caused by contact • Contact with or inhalation of hazardous substances caused by leaking refrigerant, etc.	• Keep away and do not touch • Wear protective gear • Gas leakage detection	• Wear protective gear • Work under normal temperature
D	Compressor high-stage side discharge casing and discharge piping Refer to Figure 1-1	• Burn caused by contact • Contact with or inhalation of hazardous substances caused by leaking and blowing off refrigerant, etc.	• Keep away and do not touch • Wear protective gear • Gas leakage detection	• Wear protective gear • Work in temperatures below 40 °C
E	Refrigeration unit Stop valves/service valves and joints on each part	• Contact with or inhalation of hazardous substances caused by misoperation and leakage. • Frostbite or burns caused by contact	• Sufficient ventilation • Display of valve switching state • Keep away and do not touch • Wear protective gear	• Sufficient ventilation • Wear protective gear • Tagout of operation valves
F	Refrigeration unit Solenoid valves/motorized valves on each part	• Electric shock caused by live wiring contact and electrical leakage • Trapping caused by contact with a drive part	• Install terminal protective cover and prohibit opening • Keep away and do not touch • Wear protective gear	• Shut off each breaker, and shut off and lockout/tagout the control power • Wear protective gear

	Danger source	Predicted hazard	Measures to be taken in operation	Measures to be taken when cleaning, inspecting, and replacing parts
G	Refrigeration unit Electric components of each part (oil heater, protective switch, etc.)	• Electric shock caused by live wiring contact and electrical leakage • Trapping caused by contact with a drive part	• Install terminal protective cover and prohibit opening • Keep away and do not touch • Wear protective gear	• Shut off each breaker, and shut off and lockout/tagout the control power • Wear protective gear
H	Refrigeration unit Oil drains	• Contact with hazardous substances caused by leakage and blowoff • Burn caused by contacting with high temperature fluid	• Sufficient ventilation • Keep away and do not touch • Wear protective gear	• Sufficient ventilation • Wear protective gear • Work in temperatures below 40 °C
I	Noises	• Hearing disabilities caused by noises	• Wear protective gear	—

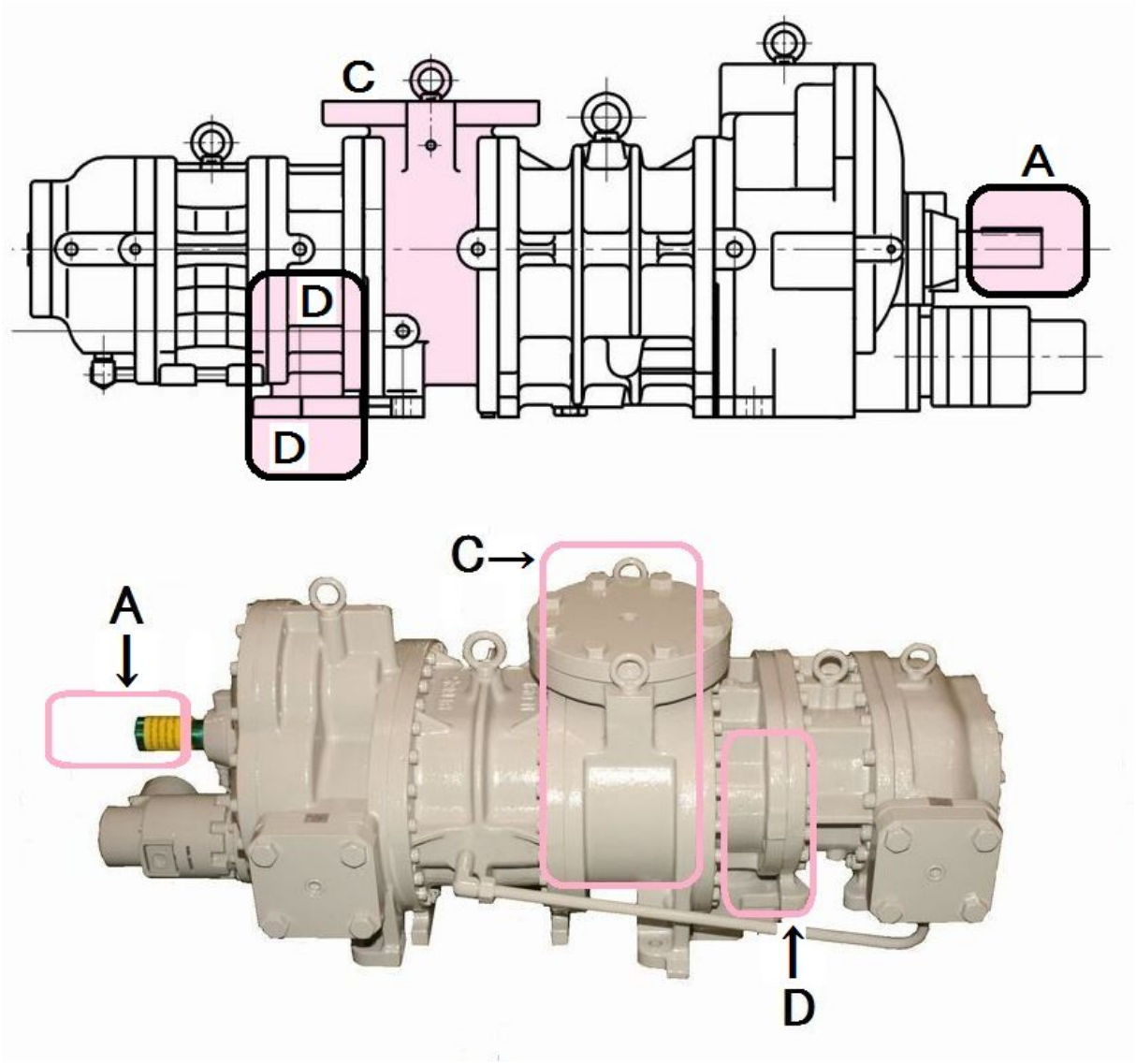


Figure 1-1 Hazardous Source Positions (Compressor)

1.4 Safety Devices

For safe use and protection of the compressor, make sure to attach safety devices to the compressor that comply with the regulations and the following descriptions.

Safety devices must be properly and periodically maintained and inspected. To keep safety devices functioning normally, it is important to include maintenance and inspection of safety devices in the periodical maintenance/inspection schedule. Make sure to provide users of the compressor with necessary information on types, attachment positions, functions, inspection method of the safety devices.

WARNING

- **Check the safety devices after turning on the power and before operating the compressor. If they do not operate normally, immediately take necessary measures.**

1.4.1 Emergency Stop Button

Overview/Function/Purpose

The emergency stop buttons are used to stop the compressor operation immediately if an emergency occurs to the compressor.

Installation Locations

The emergency stop buttons should be installed in the controller on the compressor and in the operating control room

Stop/Reset Methods

To activate and reset the emergency stop buttons, refer to the unit instruction manual.

Inspection Method/Cycle

The emergency stop buttons must be tested before a test run as well as periodically. For details about the inspection procedure and inspection cycle of the emergency stop buttons, refer to the unit instruction manual.

1.4.2 Breakers for the Main Motor Power and Control Power (with Lockout/Tagout Devices)

Overview/Function/Purpose

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

Methods of Performing and Releasing Lockout/Tagout

In accordance with the regulations created by Occupational Safety & Health Administration (OSHA) and other authorities, make sure to clearly indicate methods of performing and releasing lockout/tagout and provide users of this compressor with the necessary information.

Inspection Method/Cycle

For inspection procedures and the inspection cycle of the lockout/tagout devices, refer to the unit instruction manual.

1.4.3 Compressor Protection Devices

WARNING

- **Adjust the set values and check operation of the protective devices during a test run.**

■ Overview/Function/Purpose

Use the compressor protection devices to protect the compressor

- Discharge temperature increase protection (DT)

  This device stops the compressor operation when the discharge temperature of the compressor exceeds the set value.

  Install a temperature output port in the discharge piping.

- Oil temperature increase protection (OT)

  This device stops the compressor operation when the oil temperature of the compressor exceeds the set value.

  Install a temperature output port in the unit lubrication piping after the oil cooler.

- Abnormal high pressure protection (HP)

  This device stops the compressor operation when the discharge pressure abnormally rises due to compressor misoperations or stoppage of cooling water supply to the condenser.

  This device prevents explosion of the equipment and components.

  Install a pressure output port in discharge piping.

- Abnormal intermediate pressure protection (IP)

  This device controls the compressor appropriately when the intermediate pressure exceeds the set value. In some cases, this device stops the compressor operation.

  Install a pressure output port in the unit intermediate gas piping (or compressor intermediate gas pressure output port).

- Suction pressure decrease protection (LP)

  This device stops the compressor operation when the suction pressure becomes below the set value.

  Install a pressure output port in suction piping.

- Low oil pressure failure protection (OP)

  This device stops the compressor operation when refrigerant oil supply is not sufficient, the oil filter is clogged, the refrigerant is mixed into the lubricant, and oil supply pressure difference (from discharge pressure) becomes below the set value.

  This device is to protect the compressor from wear and burnout.

  Install pressure output ports in the unit lubrication piping after the oil filter and in the unit intermediate gas piping (or compressor intermediate gas pressure output port).

- Motor overcurrent protection (OCR)

  This device controls the compressor appropriately when the current exceeds the set value. In some cases, this device stops the compressor operation.

  This device is normally installed in the compressor operation controller.

■ Connection Positions/Settings

For details about the connection positions and settings for each compressor protection devices, refer to the unit instruction manual.

Make sure that the set values do not exceed the operating limits indicated in section 2.3.2 and Table 2-2 of this manual.

■ Inspection Method/Cycle

Each compressor's protection devices require operation tests, confirmation of the settings and calibration before starting or operating the compressor and must be periodically re-tested after that.

For details about the inspection procedure and inspection cycle of the compressor's protection devices, refer to the unit instruction manual.

⚠ CAUTION

- **Use devices such as a pressure tester to check that alarms and switches operate normally. Do not operate the compressor with all the valves closed, or in any other dangerous conditions.**
- **If low oil pressure failure protection (OP) or high pressure protection (HP) shutdown the system, make sure to eliminate the cause of it before resetting the compressor.**

2 Structure and Specifications of the Compressor

2.1 Features of the MYCOM 1612**C Compound 2-stage Screw Compressor

This compressor is one of our most popular models, with over 1000 units sold worldwide since its introduction in 1973.

This compound 2-stage screw compressor combines two standard-type screw compressor units into one unit that uses a 2-stage compression method.

Generally, screw compressors use oil injection to keep discharge temperature low during operation without loss of volumetric efficiency even at high compression ratios, with singles-stage usage possible even at evaporative temperatures near −40 °C.

However, for low-temperature regular usage, to improve KW/RT (the ratio of power consumption versus cooling ability), a 2-stage compression method is used. To use standard-type screw compressors in a 2-stage compression method, at least two screw compressors must be combined so that there is a upper side and a lower side, which requires multiple sets of machinery, power, and utilities, etc. to be installed.

This 2-stage screw compressor combines these two units into one compound machine.

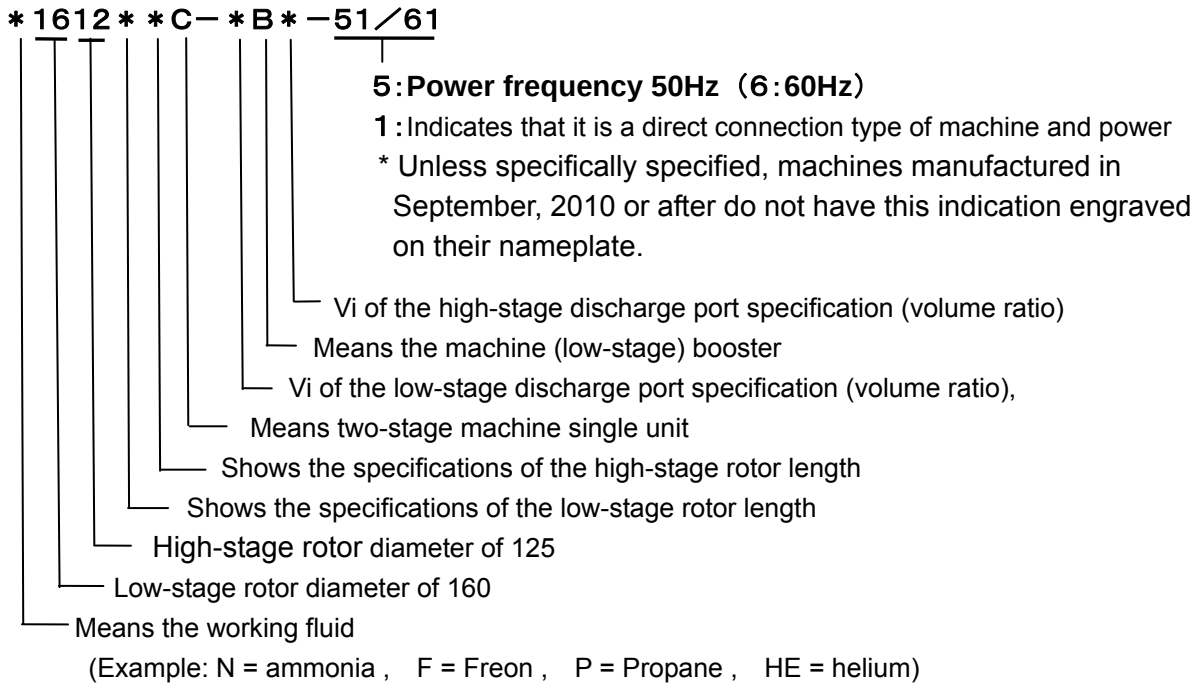
This manual describes the 1612**C - *** - 51 and 1612**C - *** - 61 models.

The 1612**C model has a capacity control mechanism on the low- stage only, and not for the high-stage.

There are various combinations of methods for machine control and capacity control, but as they have no direct relation to compressor inspection, they are omitted here.

2.2 Model Designation of the Compressor

This manual describes the 1612**C - *** - 51 and 1612**C - *** - 61 models.
The meaning of the type designation stamped on the nameplate of the compressor MODEL column is as follows.



2.3 Compressor Specifications

2.3.1 Specifications

Table 2-1 1612C Screw Compressor Specifications**

Item			1612			
			LLC	LSC	MSC	SSC
Weight		kg	520	500	460	420
Low-stage theoretical displacement @3550 rpm /2950 rpm		m³/h	749/622	749/622	624/519	499/415
High-stage theoretical displacement @3550 rpm /2950 rpm		m³/h	356/295	237/197	237/197	237/197
Refrigerant		—	NH_3, HFC, etc.			
Design pressure		MPa	2.6			
Capacity control (Actual load)		—	10 to 100%			
Rotation direction		—	Counter-clockwise viewed from motor			
Connection pipe size	Suction flange low-stage	—	MYCOM 125A (5″)			
	Discharge flange low-stage	—	MYCOM 80A (3″)			
	Suction flange high-stage	—	MYCOM 80A (3″)			
	Discharge flange high-stage	—	MYCOM 65A (2½″)			
	Journal lubrication supply (low-stage)	—	Rc1/2			
	Journal lubrication supply (high-stage)	—	Rc3/8			
	Oil injection lubrication supply	—	Rc3/8			
	Capacity control	—	Load: Rc1/4, Unload: Rc3/8			

- **In this manual unless otherwise noted, pressure units MPa represents the gauge pressure.**
- **For usage temperature ranges and pressure ranges, refer to "2.3.2 Operation Limits".**

2.3.2 Operation Limits

Table 2-1 Operation Limits of 1612C**

Item	Operation Limits	Remarks
Maximum discharge pressure	1.96 MPa	Casing design pressure: 2.6 MPa
Minimum suction pressure	−0.080 MPa	Shaft seal, performance
Maximum intermediate pressure	0.588 MPa	Bearing
Minimum intermediate pressure	> Suction pressure	Recommended condition: > suction pressure +0.1 MPa
Lubrication supply pressure	Ps: suction pressure, Pd: discharge pressure	
1) Journal lubrication pressure	Pd +0.049 to 0.39 MPa	Balance piston lubrication (pressurized lubrication)
2) Axis bearing and oil injection minimum lubrication pressure	Ps +0.49 MPa *Note 1	Check valve must be installed
3) Balance piston minimum lubrication pressure	Pd +0.049 MPa	
Suction temperature	max 85 °C min −60 °C	Clearance allowed between rotor and casing Casing design
Maximum discharge temperature	Low-stage: 90 °C High-stage: 100 °C	Clearance allowed between rotor and casing
Maximum lubrication temperature	60 °C	Viscosity should be 13 mm²/s or greater. (Optimally, viscosity should be between 13 and 40 mm²/s)
Minimum lubrication temperature	30 °C	Viscosity should be 60 mm²/s or less.
Maximum M rotor rotation speed	4500 rpm	Bearing, performance, shaft seal
Minimum M rotor rotation speed	1450 rpm	Bearing

Note 1: For the condition that the differences between Pd and Ps must be less than 0.49 MPa, an oil pump must be installed.
Also, in the case of "NH_3 + Compatible lubricant (PN46)", an oil pump must be installed.

CAUTION

- **If operation at partial load, which is not greater than 30% of the indicated load, is continued for a long time except when starting up the machine, abnormal noises or vibration may be generated. So avoid such operation.**
- **Repeating startup or shutdown operations in a short period of time is detrimental for the starter and the motor as well as for the compressor itself. Refer to the documentation of each device for the starting and stopping limitations of the starter and the motor. After stopping the compressor, wait 15 minutes or more before performing the next startup procedure.**

2.3.3 Outer Dimensions

■ 1612LLC Outer Dimensions

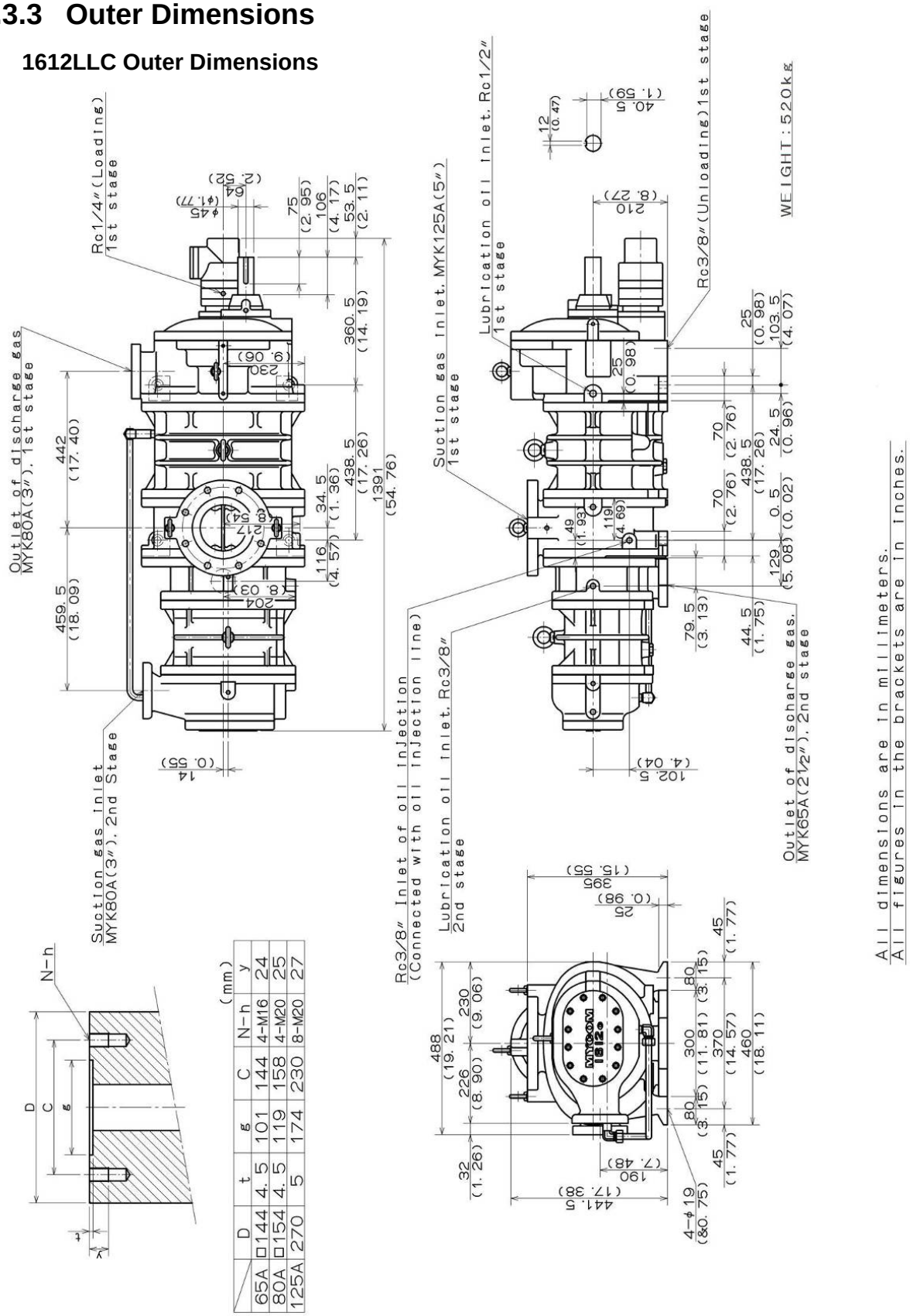
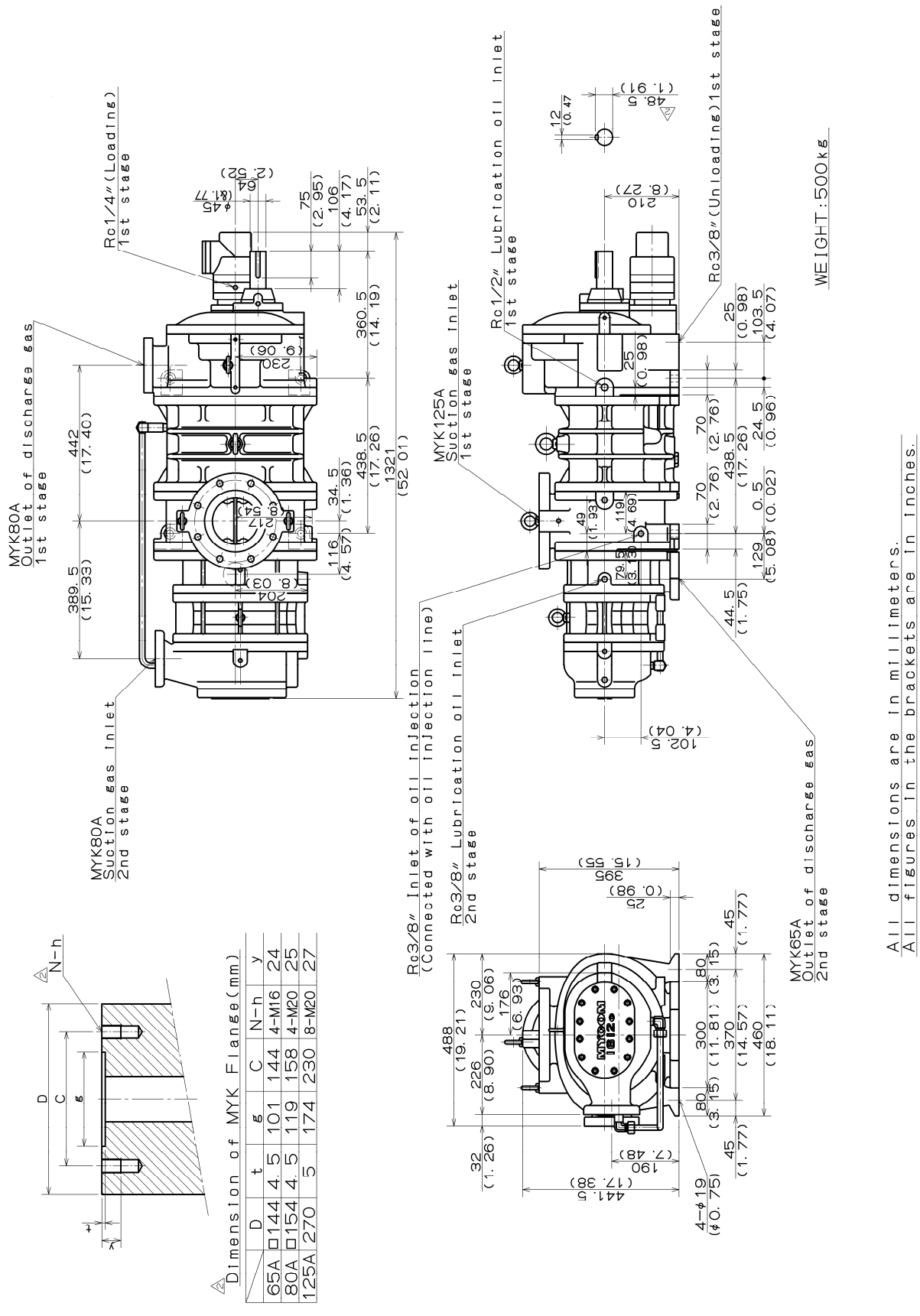


Figure 2-1 1612LLC Outer Dimensions Diagram

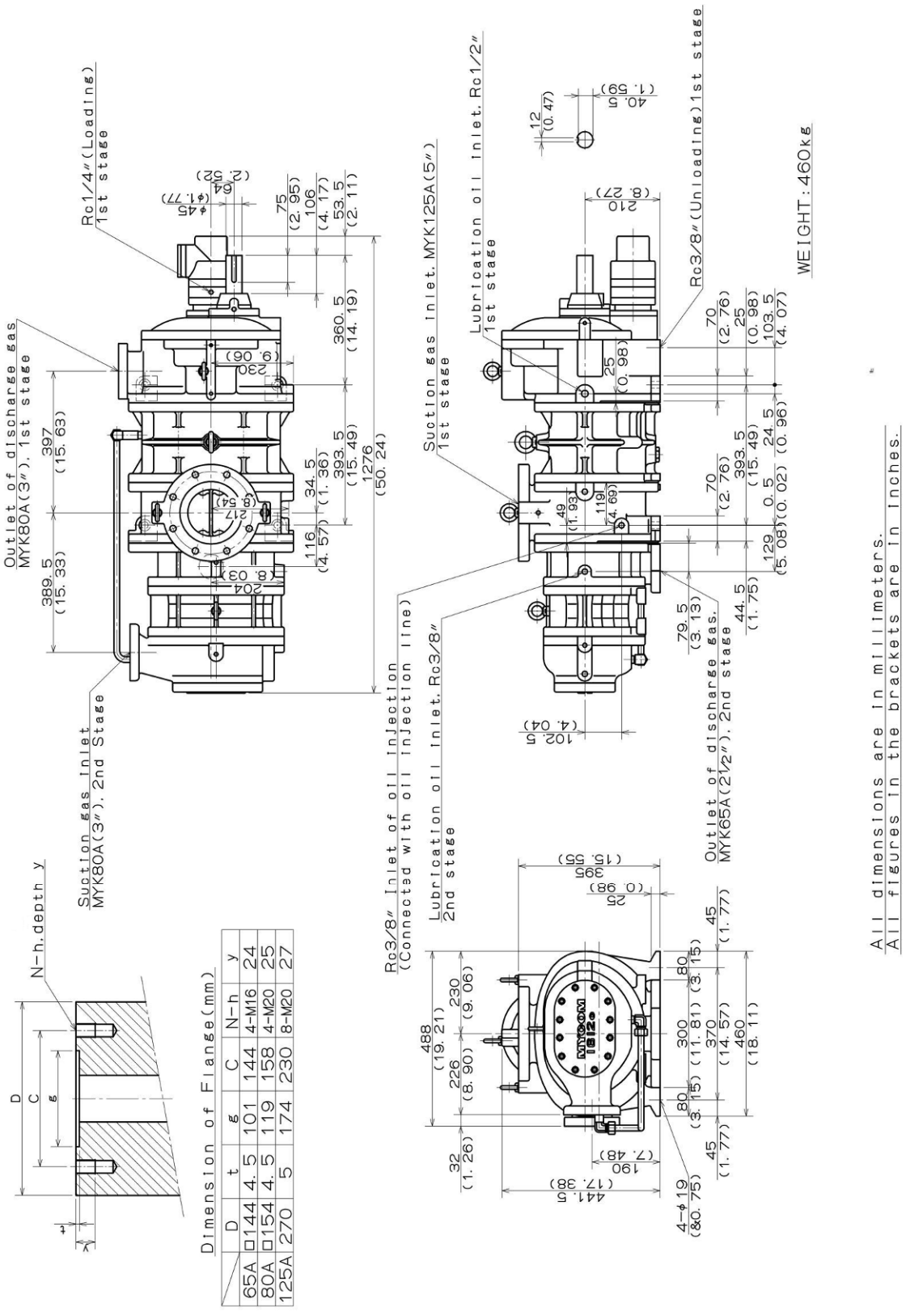
■ 1612LSC Outer Dimensions



	D	t	g	C	N-h	y
65A	□144	4.5	101	144	4-M16	24
80A	□154	4.5	119	158	4-M20	25
125A	270	5	174	230	8-M20	27

Figure 2-2 1612LSC Outer Dimensions Diagram

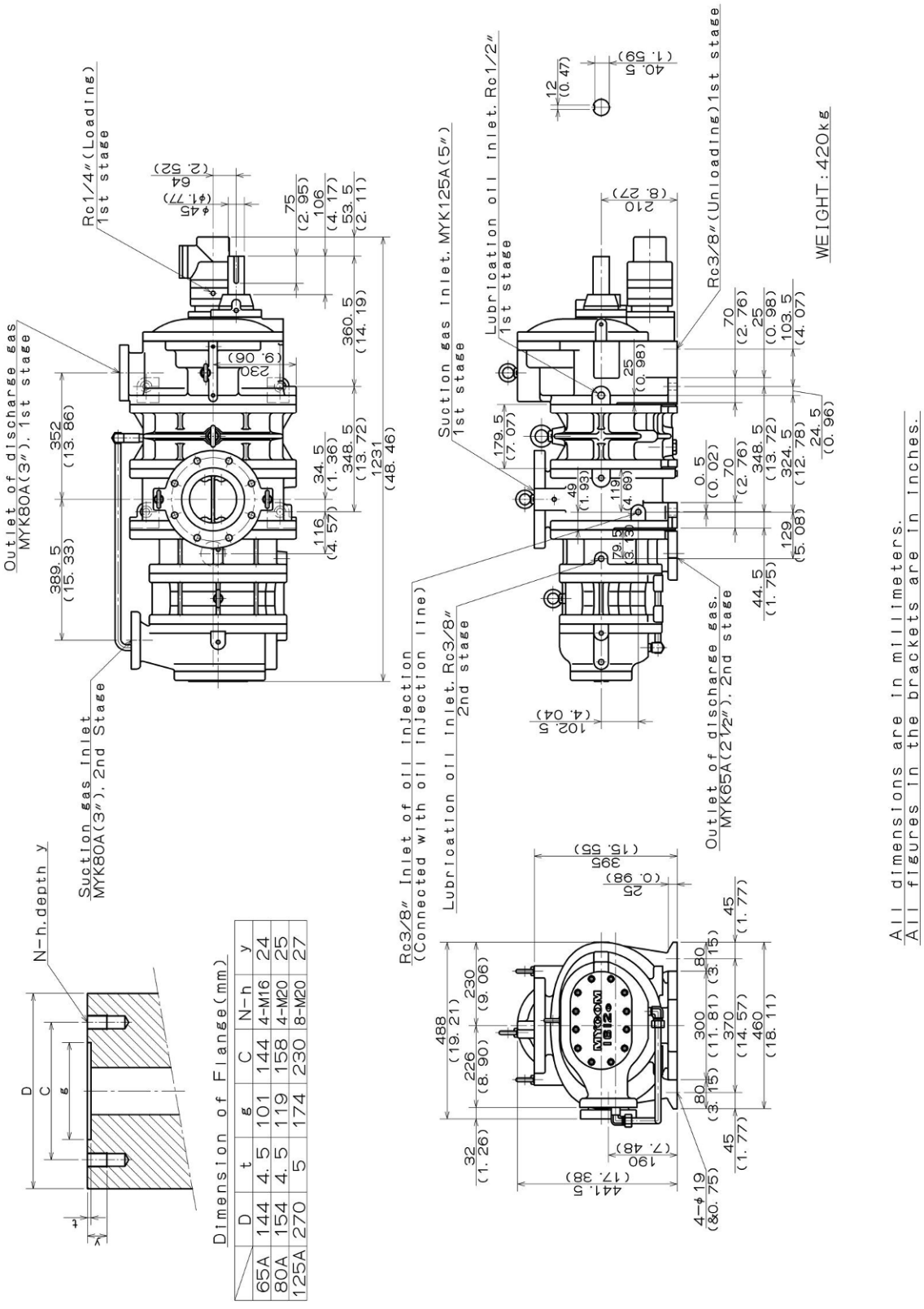
■ 1612MSC Outer Dimensions



	D	t	g	C	N-h	y
65A	□144	4.5	101	144	4-M16	24
80A	□154	4.5	119	158	4-M20	25
125A	270	5	174	230	8-M20	27

Figure 2-3 1612MSC Outer Dimensions Diagram

■ 1612SSC Outer Dimensions



Dimension of Flange(mm)

	D	t	g	C	N-h	y
65A	144	4.5	101	144	4-M16	24
80A	154	4.5	119	158	4-M20	25
125A	270	5	174	230	8-M20	27

Figure 2-4 1612SSC Outer Dimensions Diagram

2.4 Structure of the Compressor

【POINT】

- For names of each part of the compressor, refer to "7.1 Development Views, Assembly Sectional Views ", and "7.2 Parts Configuration Table".

2.4.1 Sectional View

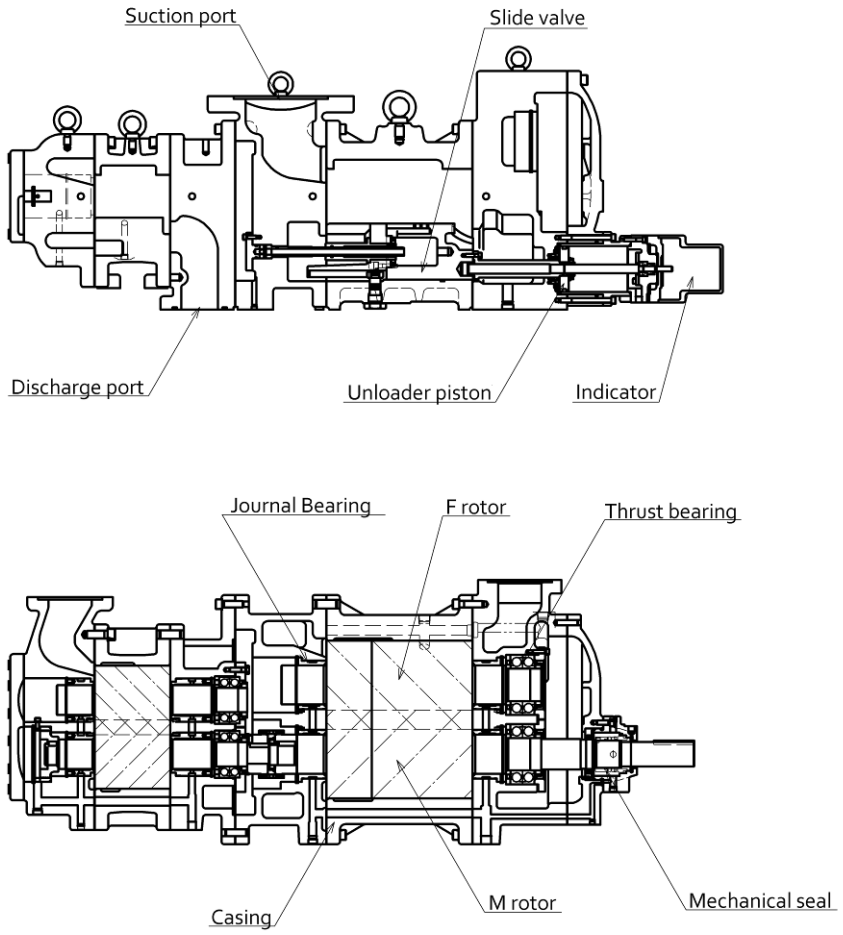


Figure 2-5 1612C Screw Compressor Sectional View**

As shown in Figure 2-5, in the casing are two screw rotors with long leads supported on either end by axle bearings. They are meshed with each other in a joint assembly. The key parts of the screw compressor are rotors with protruding lobes called the M (male) rotor, and the rotor with depressions for those lobes, called the F (female) rotor. The M rotor has 4 lobe sections, and the F rotor has 6 lobe sections.

The standard compressor's M rotor is driven by a 2-pole motor, which operates at 3000 rpm (50 Hz), or 3600 rpm (60 Hz), and the F rotor operates at 2000 rpm (50 Hz) or 2400 rpm (60 Hz), according to the M rotor.

* For these rpm (synchronized speed) calculations, during operation the motor rotator will slip, resulting in slightly slower actual speeds.

This latest type of screw mesh is asymmetric in shape, and has been designed for maximum compression efficiency. The mesh surfaces are thoroughly lubricated with oil, and mechanically the casing does not contact with the screw lobe edges, so there is almost no abrasion.

2.5 Mechanisms

2.5.1 Basics of the Screw Compressor

The screw compressor is a positive displacement rotary compressor. It has the features of both the reciprocating and centrifugal compressors.

As shown in Figure 2-6 Compressor Mechanism, the refrigerant (gas) is continuously compressed by changing the volume between the casing and the male and female meshed screw rotors, which have different profiles.

The rotor with 4 protruding lobe sections is called the M rotor (male rotor), and the rotor with 6 lobe depressions is called the F rotor (female rotor). Throughout this manual they are referred to as the M rotor and F rotor.

The compressor is driven by the motor connected to the M rotor.

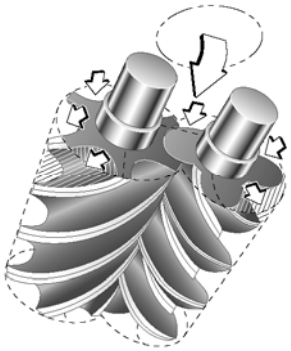


Figure 2-6 Compressor Mechanism

2.5.2 Suction Process

As shown in Figure 2-7 Suction Process, the rotors' different profiles mesh together. Also the volume enclosed between the M and F rotor lobes and compressor casing increases from the suction side as the rotors turn.

As rotations continue, at a certain point the volume reaches its maximum, the rotors start to trap the gas between the lobes and compressor casing thereby isolating the gas from the suction port.

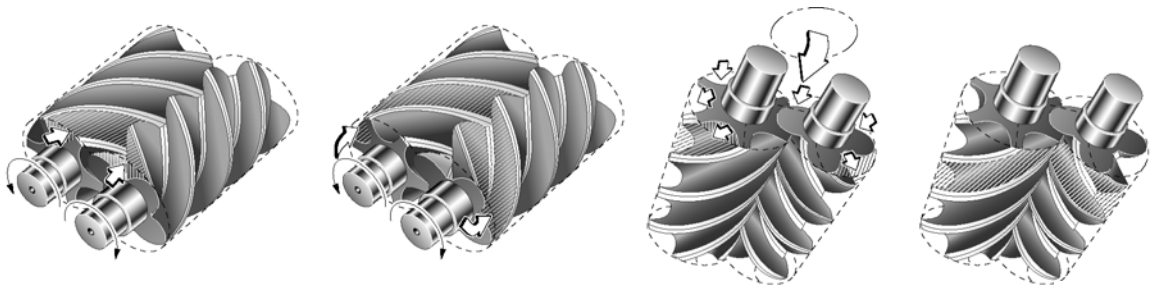


Figure 2-7 Suction Process

2.5.3 Compression Process

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

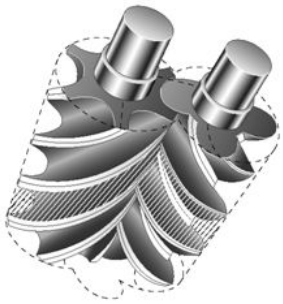


Figure 2-8 Compression Process

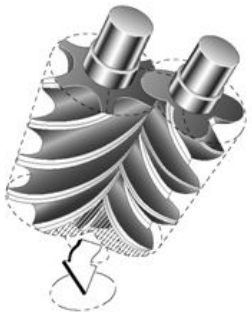


Figure 2-9 Discharge Process

2.5.4 Discharge Process

Through the compression process, the volume between rotor lobes decreases to a predetermined value at the discharge port.

Following rotor rotation, the compressed refrigerant gas is pushed out of the discharge port.

2.5.5 About Volume Ratio (Vi)

Volume ratios (Vi) are indicated in performance tables and catalogs with the port symbols L, M, and H.
The volume ratios for each symbol (for MYCOM screw compressors) are as follows: L=2.63, M=3.65, H=5.80.

$$Vi = \frac{\text{Volume of refrigerant gas suctioned in immediately before compression begins}}{\text{Volume of refrigerant gas just before discharge port}}$$

Volume ratios L, M, or H are to be used according to operation conditions. If a compressor is used with a volume ratio that does not match operation conditions, unnecessary power is expended, resulting in inefficient operation.
Their relationships with compression ratios that are

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

generally used are shown below.

$(Vi)^K = \pi i = Pd/Ps$ K = Cp/Cv of refrigerant gas
Vi = designed volume ratio
πi = designed compression ratio

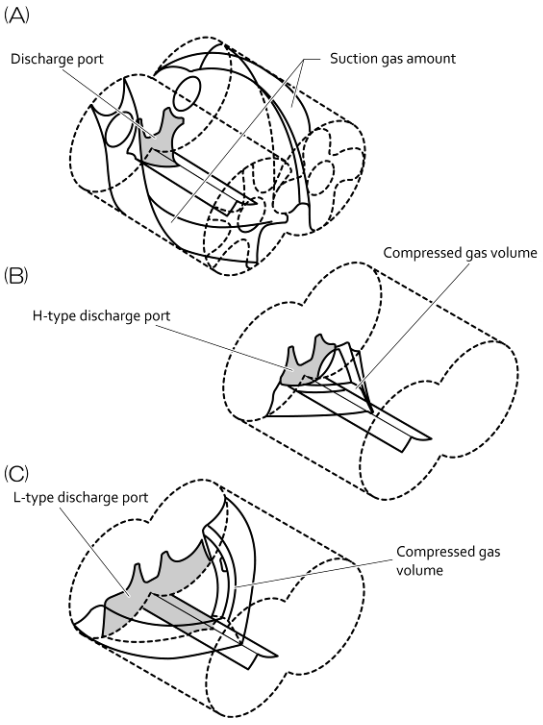
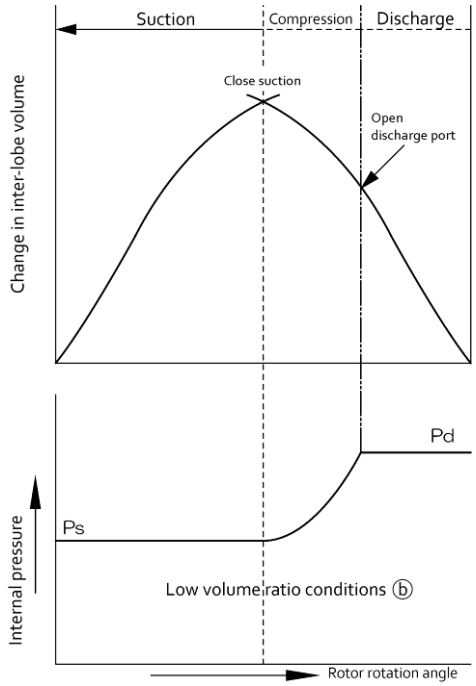


Figure 2-10 Volume Ratio Explanation

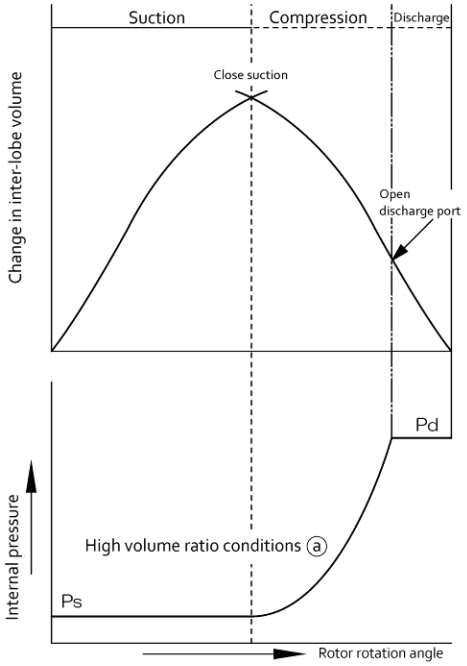
The constant of the refrigerant gas also a factor, and the Vi value for the compression ratio will change according to the refrigerant gas used.

(A) When Vi matches operation conditions

The required compression ratio and Vi are both low

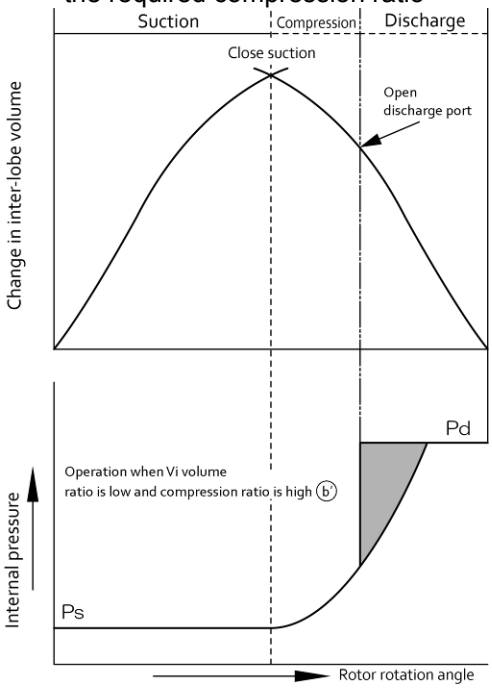


The required compression ratio and Vi are both high



(B) When Vi does not match operation conditions

Vi is too low compared to the required compression ratio



Vi is too high compared to the required compression ratio

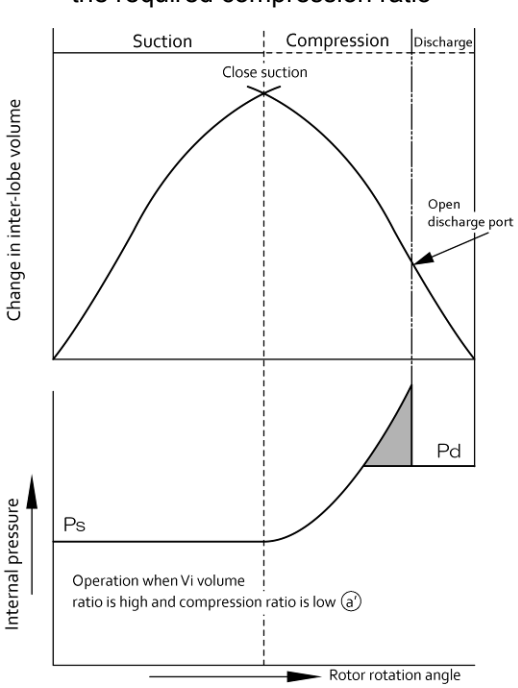


Figure 2-11 Relationship between volume ratio (Vi) and operation conditions

2.5.6 Capacity Control Mechanism

The capacity control structure involves the moving of a slide valve, bypassing suction gas just before compression on the suction side, which shortens the portion of the rotor used for compression. The slide valve is at the bottom of the casing where the rotors mesh together, and is constructed to move parallel to the rotor's axis. This movement is changed by a cam mechanism into rotation movement, and as the position (capacity control ratio) is indicated externally, the electrical resistance value changes to provide feedback to the automatic control circuit.

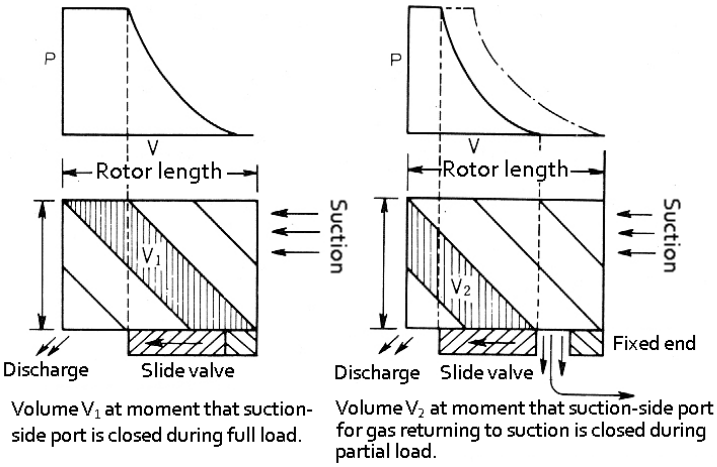


Figure 2-12 Capacity Control Mechanism

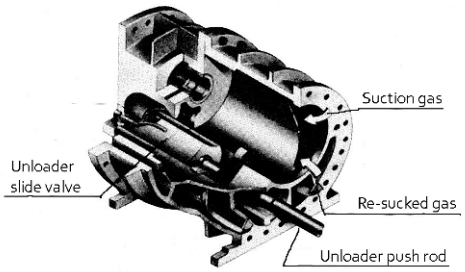


Figure 2-13 Slide Valve in the Rotor Casing

The 1612**C has capacity control on the low-stage part only, and when it operates, the displacement ratio changes, which in turn naturally tends to balance intermediate pressure.

When the capacity control is applied at the same displacement ratio, compared to when the total displacement amount is controlled at the low-stage part only, there is a slight difference in efficiency, but in practice there is no difference performance-wise for the screw compressor when VL/VH is between 2 and 4. As this is proportional to VH+VL, with the method used, the difference when capacity control is at the same ratio presents no problems.

2.5.7 Bearings

For the load created on the rotor perpendicular to the axle, a white metal-lined sleeve-type bearing is used. The bearing uses surface fitted ball bearings with angular contact for loads along the axis direction.

In particular, axial load for the M rotor, which has one type of helical gear, is comparatively larger than that of the F rotor because of the thrust from discharge pressure. This load for the M rotor is reduced by the use of a thrust bearing, along with a balance piston providing opposing hydraulic pressure.

2.5.8 Sealing Devices

A general mechanical seal is used. The mechanical seal area is fully immersed in oil and rotates, providing a complete seal and cooling efficiency.

As an example, for the BBSE (Balanced Bellows Single Seal)-type, which is a standard seal currently in use, the fixed ring (mating ring) is cast metal, and the rotating ring is carbon, with an O-ring for the packing.

Also, for operation with high suction pressure, or when helium gas is used, a balance-type specially-constructed mechanical seal is used.

2.6 Gas and Oil Flow

The screw compressor's compression process is described earlier in this manual.

Gas for the compound 1612**C compressor passes from the evaporator and through the suction strainer and check valve, and is sucked into the center part of the compressor ①, and it is compressed at the low-stage close to the driving axis ②. Then the compressed gas is discharged at ③.

③ and ④ are connected by piping through which gas used for super cooling is mixed in from the liquid cooler.

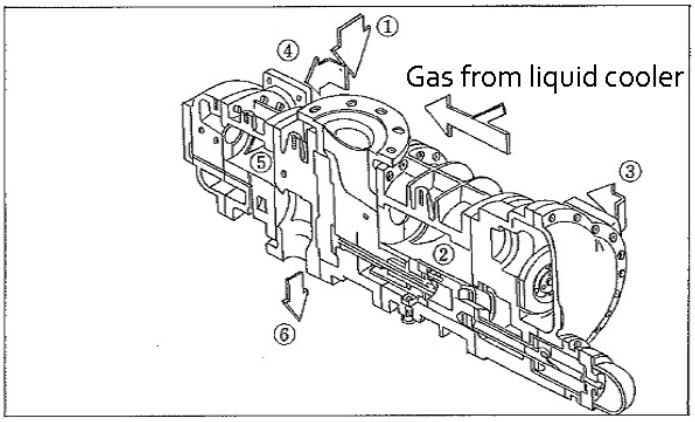


Figure 2-14 Gas Flow

Lubrication oil injected in the low-stage is mixed with the gas and sucked into the high-stage at ④, compressed at ⑤, and discharged at ⑥ to the oil separator, and then sent to the condenser.

The oil is cooled even without intermediate gas cooling, so the high-stage discharge temperature can be maintained at below 90 °C.

■ Lubrication Mechanism

Lubrication oil is split into 4 flows as shown in Figure 2-15, and after providing lubrication, it is mixed with discharge gas and leaves the compressor. In standard configurations, oil injection is not performed at the high-stage.

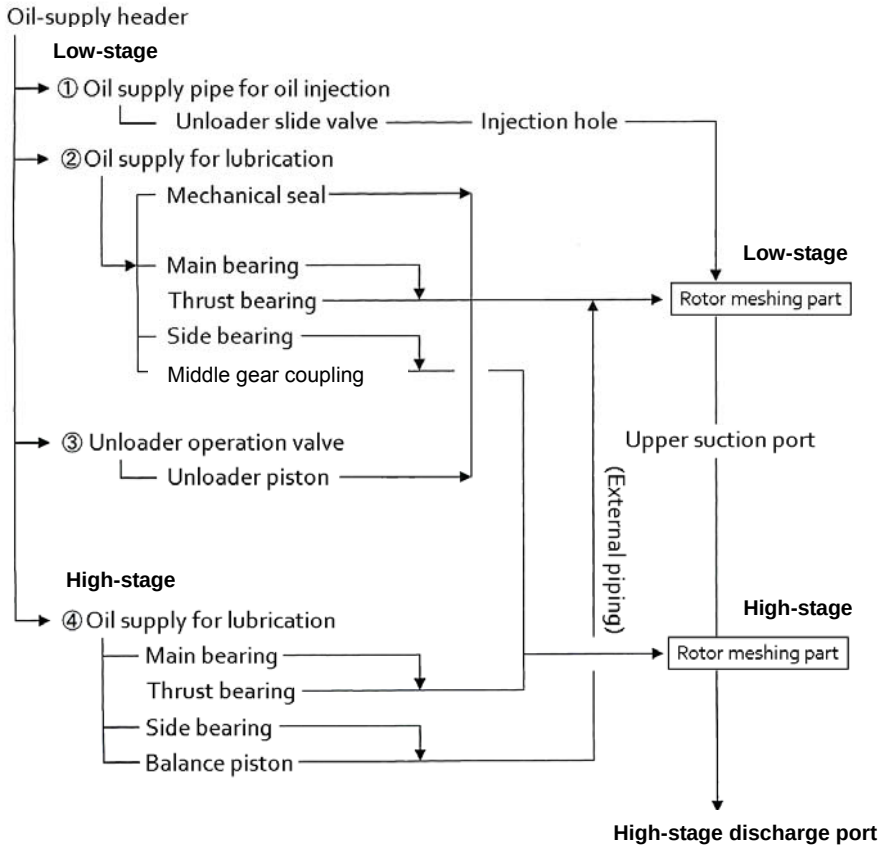


Figure 2-15 1612C Lubrication Flow**

3 Installation

3.1 General Precautions for Installation

【POINT】

- This chapter is based on the assumption that the compressor is installed to a standard refrigeration/cold storage unit.
  If the unit is not a standard refrigeration/cold storage unit, prepare an installation procedure manual referring to this chapter and considering safety precautions, before installing the compressor.
  If there are any questions, please contact our local sales offices or service centers.

- In some cases, it may be required that installation is performed by qualified personnel or a contracting company.
  Make sure that the work is performed by qualified personnel or a contracting company in compliance with local laws and ordinances.
- Read this chapter and related documents, and fully understand their contents before performing installation.
- Electrical work must be performed only by a qualified worker.

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 our local sales office or service centers.
- Unnecessary packaging materials should be discarded according to the laws and ordinances, or your company's rules.

3.2.2 Storage

To store the compressor before installation;

- Store it indoors.
- Seal nitrogen gas in the compressor. (Pressure: approximately 0.15 MPa)

3.2.3 Transfer

⚠ 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. To lift the compressor, use lifting equipment with sufficient load capacity for the weight of the compressor and appropriate lifting slings having proof load of more than the weight of compressor.
2. Secure sufficient space for safe lifting.
3. Check the wire ropes before use. Thoroughly check the wire ropes for problems such as kinks, knots, and broken strands. Do not start lifting unless the wire ropes have been verified and have no problems. If you cannot make a correct evaluation or judgment, entrust an expert to inspect.

4. To lift the compressor, attach the wire ropes to the attached eyebolts using appropriate shackles and hooks. The eyebolts are only used for lifting the compressor. Do not use the eyebolts to lift the compressor with any attached apparatus.

CAUTION

- **The compressor eyebolts must not be used to lift the unit. To lift the unit, use the lifting chains on the compressor unit base periphery or other lifting devices provided on the compressor unit base.**

5. Check the transportation route for any obstacles in consideration of the compressor size.

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

7. Instruct all workers to move from near the work site before lifting.

8. Before lifting the compressor, alert all workers on the site of possible dangers of the lifting process by signal (such as calling at the beginning of the work or making a signal by hand). Do not lift the compressor unless the signals are completely understood by all personnel working together.

9. Slowly windup the wire ropes until shortly before the compressor leaves the ground.

10. Then, wind up the wire ropes a little further until the compressor is slightly away from the ground and check that the compressor is balanced. If the compressor is inclined, return the compressor to the ground and correct the inclination by adjusting the wire ropes. Then, restart the lifting operation.

11. Make sure to wind up the compressor slowly. Lifting it too quickly may damage the lifting equipment including the wire ropes or part of the compressor.

12. When lifting the compressor, check the state of the wire ropes and lifting equipment. Check that the compressor is not inclined.

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 any safety aisles unless absolutely necessary.

16. Do not put the compressor in a safety aisle. Always keep the safety aisle free of obstacles.

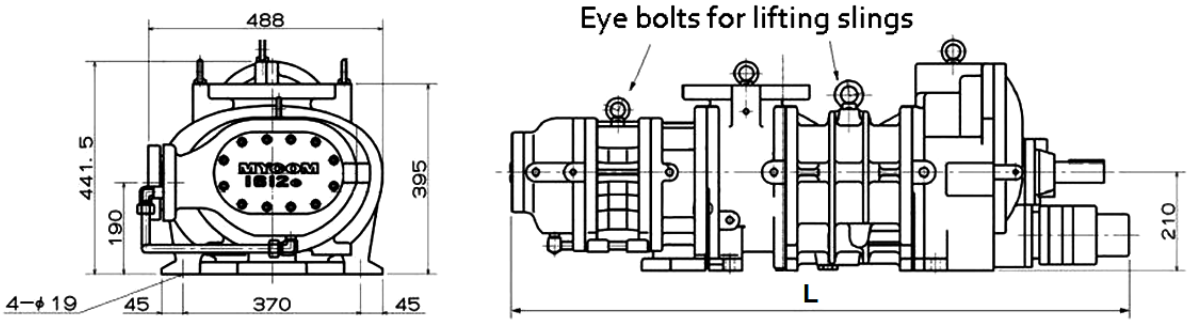
17. Remove any obstacles before putting down the compressor on the ground. The compressor should not be inclined or unstable.

18. Before putting down the compressor on the ground, announce to the workers around the working area.

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. Lower the compressor slowly so that it does not get damaged due to impact.

■ Outer Dimensions, Weight and Lifting Position



	1612LLC	1612LSC	1612MSC	1612SSC
Weight (kg)	520	500	460	420
L (mm)	1391	1321	1276	1231

Figure 3-1 Outer Dimensions, Weight and Lifting Position of Compressor

Figure 3-2 Lifted View

3.2.4 Preparation for Installation

■ Installation Space

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

■ Illumination

Prepare lighting for easy operation, cleaning, maintenance, and inspection.

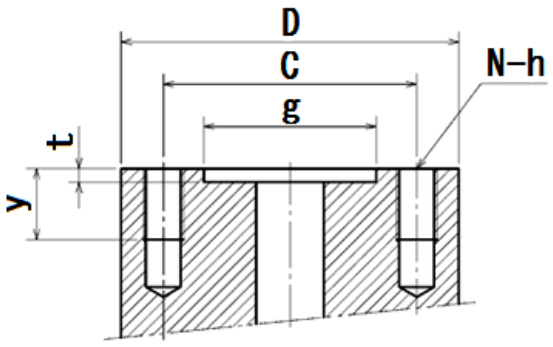
■ Ventilation

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

■ Piping

Table 3-1 Connected Piping List (Compressor)

Item	Dimensions	Remarks
Suction gas inlet	MYCOM 125A (5″)	See figure 3-3.
Low-stage gas outlet	MYCOM 80A (3″)	See figure 3-3.
High-stage gas inlet	MYCOM 80A (3″)	See figure 3-3.
High-stage discharge gas outlet	MYCOM 65A (2½″)	See figure 3-3.
Low-stage bearing (journal) oil inlet	Rc1/2	
Low-stage capacity control oil inlet (increase side)	Rc1/4	
Low-stage capacity control oil inlet (decrease side)	Rc3/8	
Oil injection inlet	Rc3/8	
High-stage bearing (journal) oil inlet	Rc3/8	



	D	t	g	C	N–h	y
65A	□144	4.5	101	144	4–M16	24
80A	□154	4.5	119	158	4–M20	25
125A	270	5	174	230	8–M20	27

Figure 3-3 MYCOM Flange Dimensions

* In external dimensions figures 2-1, 2-2, 2-3 and 2-4 in “2.2.2 Outer Dimensions” in chapter 2 of this manual, these MYCOM flange dimensions are noted as MYK**A.

3.2.5 Installation

3.2.5.1 Installation

Check that the surface of the refrigeration/cold storage unit for compressor installation is even and horizontal. If it is not flat and horizontal, tightening the bolts may lead to compressor deformation, and operation may be affected.

3.2.5.2 Piping Connection

■ Refrigerant Piping

When connecting the refrigerant piping, follow the instructions below.

- The compressor is one of the few devices with moving components in refrigerating/cold storage units. The moving components are adversely affected by foreign substances within the system (scale, dust, spatter, etc.). Therefore when connecting the piping, make sure that no such foreign substances enter the piping.
- In some compressors, in particular those shipped overseas, nitrogen gas is enclosed to prevent rust. Release the pressure before starting piping work.
- Do not allow moisture to enter the piping because it can cause trouble after starting operation. Assemble piping when it is dry.
- Cover flanges are attached to the low-stage gas outlet and the high-stage gas inlet of the compressor, but after installation attach piping (intermediate piping) to both connection ports.
- Inappropriate piping may cause operating problems such as oil not returning to the compressor or liquid flowing back to the compressor.
- When connecting piping to the compressor, as a general rule, use piping that is the same size as the compressor connection port. If the size of the piping is smaller than the compressor connection port, the flow of lubricant or refrigerant will be obstructed leading to problems.
- Do not block flange or fittings with the weight of the piping connected to the compressor. Prepare the appropriate support for piping.

3.2.5.3 Equipment and Devices for Protection of the Compressor

■ Oil Filter

Use an oil filter with “nominal filtration rating: 15 μm or less” and install it in front of the oil inlet of the compressor.

The oil filter may clog just after test operation. 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 lubricant before starting the compressor, install an oil heater on the oil separator. Make sure to install a protection function (thermostat, etc.) to prevent overheating.

■ Suction Strainer

When miscible oil is used, the mesh size of suction strainer should be 200 meshes or more, and when non-miscible oil is used, the mesh size of suction strainer should be 100 meshes or more.

For details about miscible oil and non-miscible oil, refer to “4.1 Lubricant (Refrigerant Oil)”.

During test operation, small particles and scale may come from the system. We recommend installing a fine temporary filter during test operation.

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

To protect the compressor, install the protective devices as indicated in "1.4.3 Compressor Protective Devices" in this manual.

3.2.6 Leak Test

Perform the leak test on the refrigerating/cold storage unit.

3.2.7 Lubrication Oil Charge

CAUTION

- **When refilling lubricant, ensure that it is clean and does not contain foreign matter.**
- **Be careful that air and water are not mixed in the lubrication oil when refilling.**
- **To ensure that the lubricant does not absorb air moisture, keep it indoors in an airtight container until use.**

3.2.7.1 Lubricant Initial Charge

At the initial test operation or after periodical inspections, the compressor's moving parts such as bearings and seals may not have sufficient lubrication. Therefore, charge the compressor with lubricant according to the following procedure.

1. Thoroughly vacuum the compressor and oil separator to approximately 40 Torr. Make sure that the unloader solenoid valves are opened to vacuum the unloader cylinders.
2. Close the oil separator outlet valve in the oil supply line. Also close the oil injection regulating valve.
3. Charge lubricant from the drain valve on the oil cooler (or on the oil filter).
4. When the oil level reaches to the lower limit of the oil level gauge in the oil separator, stop the charging from the oil supply line. (The minimum amount of lubricant charge is the combined capacity of the oil cooler and oil filter plus at least approximately 20 liters.)
5. Then, charge lubricant to the specified level from the charging valve on the oil separator.
6. Start the oil pump and check the oil pump discharge pressure to confirm that the lubricant flows. Check if the oil level on the oil separator lowers.
7. Adjust the differential pressure (oil supply pressure minus discharge pressure) of oil pump discharge. (Specified differential pressure: 0.2 ± 0.05 MPa)
8. After adjusting the differential pressure, run the oil pump for 2 minutes. After checking that the motor main power is off, turn the compressor driving shaft. (About 10 turns using a coupling)
9. If lubricant flows through the oil supply line normally after performing the above, the initial lubricant charge is completed.

【POINT】

- After the initial charge of lubricant, make sure that the oil cooler and oil filter are filled with lubricant.
- For the lubricant to be used, refer to "4.1 Lubricant (Refrigerant Oil)" in this manual.
- For the amount of initial charge of lubricant, refer to the refrigerating unit instruction manual.

3.2.7.2 Additional Charge of Lubricant Procedure

For additional charge of lubricant during operation the procedures of charging defer depending on the systems and operating conditions therefore follow the procedures described in the instruction manual of the unit.

3.2.8 Charging of Refrigerant

Charge refrigerant, referring to the refrigerating/cold storage unit instruction manual.

3.2.9 Check after Installation

Perform the checks after compressor installation according to the refrigerating/cold storage unit check list.

4 Compressor and Unit Operation

4.1 Lubricant (Refrigerant Oil)

The management of lubricant (refrigerant oil) is a significant point in order to keep the compressor in a good operating condition.

When managing lubricant, follow the instructions below.

4.1.1 Precautions for Selecting the Lubricant

- Lubricant must be selected considering the refrigerant in use, type of evaporator, and operation conditions. Various properties of lubricant must be considered such as solubility with the refrigerant, separability, fluidity at low temperature and thermal stability at high temperature as well as viscosity. We therefore recommend consulting our sales offices or Mayekawa agencies for choice of a specified brand for your system.
- The lubricant supplied to the compressor must have an appropriate viscosity which is necessary to lubricate bearings and other mechanical components. The refrigerant oil viscosity must be measured at the oil supply port of the compressor. The viscosity of lubricant is significantly affected by the type of refrigerant and oil. If the refrigerant dissolves in oil (the oil is miscible), the actual viscosity may be substantially lower than the required viscosity for the compressor depending on the operation conditions. If the refrigerant does not dissolve in the oil (the oil is not miscible) and the oil temperature is low, the viscosity may become excessively high. The lubricant must be selected such that it is supplied to the compressor with an appropriate viscosity (13–40 mm²/s) in the operating conditions.
- The cycle of lubricant for the compressor must be considered. After lubricating and cooling each part of the compressor, the lubricant 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 the refrigerant oil goes to the condenser and the evaporator. The lubricant is required to have sufficient fluidity and stability inside each part of the compressor where temperatures differ.

CAUTION
● **Be careful since the use of polyolester synthetic oil (POE) for ammonia refrigerant is banned.**

4.1.2 Recommended Lubricant

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

4.1.2.1 Recommended Lubricant for Ammonia Refrigerant

■ **Polyalkylene Glycol Synthetic Oil (PAG)**

Brand	Kinematic viscosity (40 °C) mm²/s	Manufacturer	Type
JOMO Freol PN46	46	JX Nippon Oil and Energy Corporation	PAG

The only miscible oil for ammonia refrigerant is JOMO Freol PN46.

■ Mineral Oil: Non-miscible Oil

Brand	Kinematic viscosity (40 °C) mm²/s	Manufacturer	Type
SUNISO 3GS	30	Sun Oil	Naphthen
SUNISO 4GS	55	Sun Oil	
REFOIL NS 3GS	30	Nippon Oil Corporation	
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 paraffin
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 Oil: Non-miscible Oil

Brand	Kinematic viscosity (40 °C) mm²/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	
CP-4700-32	31	CPI	
CP-4700-68	56	CPI	
Gold-Cold 300	53	Goiden West	
GARGOYLE ARCTIC NH68	64	Exxon Mobil	PAO+AB
REFLO SYNTHETIC 68A	62	Petro Canada	
Gargoyle arctic SHC 224*	30	Exxon Mobil	PAO
Gargoyle arctic SHC 226(E)*	68	Exxon Mobil	

NOTE: Make sure to use the standard BBSE-type seal assembly.

4.1.2.2 Lubricant for HFC-type Refrigerant

■ **Polyolester Synthetic Oil (POE) for R404A, R507A, R410A: Miscible Synthetic Oil**

Brand	Kinematic viscosity (40 °C) mm²/s	Manufacturer	Type
SUNISO SL-68S	67	Sun Oil	POE
EMKARATE RL68H	72	Lubrizol	

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

Brand	Kinematic viscosity (40 °C) mm²/s	Manufacturer	Type
JOMO Freol α100	107	JX Nippon Oil and Energy Corporation	POE

CAUTION

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

4.1.3 Change of Lubricant Brand

- Lubricant contains various additives for the purpose of fulfilling necessary lubricating conditions. Types of additives and their mixing ratio differ among oil brands. Therefore, we recommend avoiding the mixed use of different brands of lubricant. If mixed brands of lubricant are used, the different additives in the lubricant may react with each other and cause problems such as creating slurry of foreign substances.
- If it is necessary to change the brand of lubricant, collect as much oil as possible from the compressor as well as from the condenser, evaporator, and other unit and plant components before charging to the new lubricant. After 100 to 200 hours of operation, change the oil again.
- If lubricant manufacturers differ, contact both the manufacturers and inquire whether the change is appropriate. Even for the lubricant from the same manufacturer, inquiry is also necessary for the change.
- When only changing the viscosity grate for the lubricant of the same brand, no inquiry is necessary. However, make sure that the viscosity grade will not cause problems during operation. (Example: SUNISO 3GS → SUNISO 4GS)

CAUTION

- **Unit components differ depending on the characteristics of lubricant (ammonia miscible or non-miscible oil). As a general rule, do not change miscible oil to non-miscible oil. Only use recommended miscible oil JOMO Freol PN46. Changing brands is not allowed.**

4.1.4 Precautions for Handling Lubricant

- When refilling lubricant, ensure that it is clean and does not contain foreign matter.
- Be careful that air and water are not mixed in when refilling.
- To ensure that the lubricant does not absorb air moisture, keep it indoors in an airtight container until use.

4.1.5 Precautions for Handling JOMO Freol PN46 (Ammonia Miscible Oil)

PN46 is much more hygroscopic than mineral oils and any moisture mixed in the oil may lead to rust, corrosion and wear. Therefore, attention must be paid to the following points.

CAUTION

- **Charge oil as quickly as possible after opening the pail can (within 15 minutes is advisable).**
- **Do not perform oil charging in rainy weather or at a place with high humidity to prevent absorbing moisture.**
- **Even if some oil remains, do not use it subsequently.**
- **If JOMO Freol PN46 drops on a painted surface, wipe it away as soon as possible. Otherwise the paint may come off.**

For details about managing lubricant, refer to chapter "5.3 Management of Lubricant" in this manual.

4.2 Precautions for Operation

4.2.1 Prevention of Liquid Return (Liquid Backflow)

Liquid return is a phenomenon where refrigerant that did not completely evaporate with the gas reaches the compressor. Liquid return may cause insufficient lubrication of the compressor, abnormal vibrations and noises, and abnormal foaming of lubricant (too much entry of oil). To prevent liquid return, appropriately adjust the expansion valve of each evaporator and liquid cooler. For details, refer to "Troubleshooting" in chapter 6.

4.2.2 Purging of Non-condensable Gases

WARNING

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

If there is a leak on the low-pressure side of the refrigerating/cold storage unit, air may get mixed into the unit.

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

Follow the procedures below to inspect non-condensable gases.

1. While the compressor is stopped, keep the cooling water flow to the condenser of the unit for at least 15 minutes. Check the condensing pressure in the pressure gauge of the compressor.
2. Check the cooling water temperature.
3. Compare the condensing pressure checked in step 1 with the refrigerant saturation pressure that depends on the cooling water temperature as shown in the table below.
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 4-1 Typical Refrigerant Temperature and Saturation Pressure

Temperature °C	Pressure MPa				
	Ammonia	R404A	R507A	R410A	R134a
0	0.328	0.509	0.523	0.699	0.192
4	0.396	0.590	0.606	0.807	0.237
8	0.472	0.678	0.696	0.924	0.287
12	0.557	0.775	0.795	1.053	0.342
16	0.652	0.881	0.903	1.193	0.403
20	0.756	0.996	1.021	1.346	0.471
24	0.871	1.121	1.148	1.513	0.545
28	0.998	1.256	1.286	1.693	0.626
32	1.137	1.401	1.435	1.887	0.714
36	1.289	1.559	1.595	2.098	0.811
40	1.454	1.728	1.768	2.324	0.916

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

4.2.3 Actions for Long Term Shut-down of the Compressor

Before stopping the compressor for a long time, make sure to perform the following steps.

- Turn off the motor main power.
- Turn off the oil heater power and the control power.
- Close the suction stop valve and discharge stop valve.

If the operation stop period is 1 month or longer, perform the following checks once per month.

- Measure the system pressure.
- Check for refrigerant leak.
- Operate the oil pump for 5 minutes. After that, rotate the compressor shaft (10 rotations or more).

When restarting the compressor after an operation stop period of 1 year or longer, check the system for refrigerant leak and replace the refrigerant oil. Also check the motor insulation resistance.

Supply power to the oil heater at least 1 hour before operation start. Before starting the operation, confirm that the refrigerant is not condensed in the package by checking the package temperature and pressure.

5 Maintenance and Inspection

5.1 Precautions for Maintenance and Inspection

- Before starting maintenance/inspection work after completely removing the refrigerant from the unit, make sure that the main motor, control and power for instruments and valves are turned off and the power off switches are protected from any unauthorized access. In addition, attach a tag to each power off switch informing other workers that the switch must not be turned on (lockout/tagout).
- Also when a manual valve is closed, apply appropriate measures so that it cannot be operated by other workers and attach a tag stating that the device must not be opened (tagout).
- Before disassembling, inspecting or handling the compressor, fully understand the disassembly/assembly procedure of the compressor. This manual does not provide the complete procedures of compressor disassembly and assembly but just instructs the main points in compressor service.
- If you need to perform complete compressor disassembly/assembly work, consult with our local sales offices or service centers.
- When replacing any parts on the compressor, always use MYCOM genuine parts. If any unauthentic parts are used, unexpected problems may occur.
- Do not modify the compressor or any of its parts without prior permission of Mayekawa. It may cause the compressor to be damaged or disabled from maintaining its normal functions.
- To disassemble the compressor, it must be removed from the installed unit frame and placed on a work bench. Before removing the compressor from the unit, make sure to remove the refrigerant in the unit and confirm that the pressure inside the compressor is atmospheric.
- Prior to removing the compressor from the unit frame, check that the high temperature side (discharge side) is cooled down to 40 °C or less.
- Perform the compressor disassembly on a rigid and flat work bench.
- When removing the compressor from the unit frame and placing it on the work bench, follow the instructions in Chapter 3, “3.1 General Precautions for Installation” and “3.2.3 Transfer”.
- Lifting and carrying works for the compressor and package must be performed by a qualified person.
- For compressor disassembly/assembly, use specified tools that are properly functioning.
- When handling heavy parts, exercise extreme caution and use safe auxiliary tools such as safety bolts.
- When carrying a heavy part, use lifting equipment such as a crane, or work using two or more workers.
- Before working with other workers, make sure that all workers clearly understand the work procedure.
- Turning on and off each power supply must be done by a qualified person, taking care to avoid any electric shock hazards.
- Any other electric or manufacturing work requiring some expert qualifications must be performed by a qualified person.

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.

Logging these operation data on a daily basis aid in finding out any abnormal conditions of the compressor. 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.

In addition to the items listed in Table 5-1, it is necessary to record and manage refrigerating unit components and load side conditions on a daily basis. For their details, refer to the instruction manual of the refrigerating unit.

Table 5-1 Daily Inspection Items

Inspection Items			Inspection Contents	Check Items/Actions
Compressor	Operating hours	h	Total operating hours	• Judgment of periodic maintenance timing
	Suction pressure	MPa Note 1	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
	Intermediate pressure	MPa	Pressure difference from rated operation (normal value)	• If it is too large, check high-stage. If it is too small, check low-stage.
	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 lubricant • Clogging of oil filter
	Suction temperature	°C	Whether within upper and lower limits	• Temperature, flow rate, etc. of the object to be cooled
	Degree of superheat for suction	°C	Whether degree of superheat is proper	• Adjust expansion valve • Insufficient refrigerant flow
	Intermediate temperature	°C	Whether within upper and lower limits	• Adjust intermediate expansion valve
	Discharge temperature	°C	Whether within upper limit	• Non-condensable gases mixed into the system • Oil supply temperature, insufficient oil supply • Compressor failure

Inspection Items			Inspection Contents	Check Items/Actions
Compressor	Oil supply temperature	°C	Whether within upper and lower limits	• Contamination on cooling pipes of oil cooler
	Capacity control Indicated 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
	Noise and vibration		Abnormal noise/vibration	• Compressor failure
Others	Motor current	A	Whether it is higher than the current at test run	• Compressor failure
	Oil level of oil separator	-	Oil level	• Oil entry • Replenish oil
	Fluid level in the receiver	-	Fluid level	• Replenish refrigerant
	Check for refrigerant leak	-	leak or not	• The machine room and the load side facilities

Note 1 : 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 lubricant by referring to the instruction manual of the unit.

2. Replacing oil filter
When the differential pressure between the lubrication oil supply pressure and the discharge pressure is 0.15 MPa or higher, replace the oil filter. 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, 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 differential pressure 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. Lubricant 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.

Table 5-2 Guideline for Leak from Mechanical Seal

	1612**C
Allowable leak rate	≤ 3 ml/h
Rate at which inspection must be done	≥ 9 ml/h

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 Periodical Inspection

Check the following items at specified intervals.

Table 5-3 Periodical Inspection Items

Item	Frequency of inspections	Remarks
Pressure gauges /pressure sensors	Check once per year.	
Thermometers /temperature sensors	Check once per year.	
Protective devices and safety valves	Check once per year.	
Suction strainer	Check after 500 hours from the start of operation.	If the differential pressure between the front and back of the suction strainer increases, check and clean the suction strainer.
	Check and clean once per year.	
Lubricant	Replace lubricant after 500 hours from the start of operation.	
	Analyze oil every 6 months.	When the analysis results do not meet the management criteria provided in "5.3 Management of Lubricant" of this manual, replace oil.
Oil filter	Replace once per year.	Replace oil filter when the differential pressure between the discharge pressure and oil supply pressure exceeds 0.15 MPa.
Cooling water side of oil cooler	Check once per year.	Clean if excessively contaminated.
Cooling water side of condenser	Check once per year.	Clean if excessively contaminated.
Mechanical seal	Check once per year or per 8,000 operating hours. Note*	To be replaced if any abnormality is found However, in the case that it is difficult to stop the operation not at regular inspection, replace the mechanical seal assembly at every inspection.
Coupling	Check once per year or per 8,000 operating hours. Note*	

Note*: Inspect the machine per period or operating hours, whichever is shorter.

5.2.3 Guidelines for Compressor Overhaul Frequency

When servicing or overhauling the compressor, follow the instructions and guidelines described below.

The compressor overhaul frequency 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 frequencies recommended by Mayekawa which are categorized based on the compressor operating conditions.

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

Category of operating condition	Application example	Recommended Overhaul Frequency
Relatively stable operating condition	Cold storage and refrigeration	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 conditions	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.
(See "2.3.2 Operation Limits" in this manual.)

Note 2: The above guidelines are only applicable when the compressor undergoes daily and periodical inspections specified separately.
(See "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 Management of Lubricant

5.3.1 Lubricants Management Criteria

Lubricants, to which the management criteria applies, are classified as follows.

1. Synthetic oils : Polyalkylene glycols (PAG)
2. Mineral oils : Naphthenic base and paraffinic base
3. Synthetic oils : Alkyl benzene (AB) and Polyalphaolefine (PAO)
4. Synthetic oils : Polyolesters (POE)

- **We recommend performing sampling oil analysis every six months.**
- **If the oil does not satisfy the management criteria below, replace the oil.**

  * This does not apply to water contents in PAG oil. See Note 1 of the table below.

Items and criteria are as follows. The management criteria may be changed without notice.

Table 5-5 Synthetic Oil (PAG)

Item	Management Criteria
(a) Color	ASTM color standard: 4.0 or less
(b) Total acid number (TAN)	Max. 0.1 mg·KOH/g
(c) Kinematic viscosity	Within ±10% in variation when compared with fresh oil
(d) Water content	Max. 2000 ppm Note 1
(e) Contamination level	Max. 15 mg/100 ml as measured by gravimetric (Millipore filter) method Note2

Table 5-6 Mineral Oils and Synthetic Oils (AB, PAO)

Item	Management Criteria
(a) Color	ASTM color standard: 6.0 or less
(b) Total acid number (TAN)	Max. 0.3 mg·KOH/g
(c) Kinematic viscosity	Within ±15% in variation when compared with fresh oil
(d) Water content	Max. 100 ppm Note 1
(e) Contamination level	Max. 15 mg/100 ml as measured by gravimetric (Millipore filter) method Note2

Table 5-7 Synthetic Oil (POE)

Item	Management Criteria
(a) Color	ASTM color standard: 4.0 or less
(b) Total acid number	Max. 0.2 mg·KOH/g
(c) Kinematic viscosity	Within ±10% in variation when compared with fresh oil
(d) Water content	Max. 200 ppm
(e) Contamination level	Max. 15 mg/100 ml as measured by gravimetric (Millipore filter) method Note2

Note 1: Synthetic oils (inter-soluble with ammonia) are so highly hygroscopic that they can absorb moisture at the time of sampling. In addition, the ammonia content they have absorbed may be detected as the water content at the time of the analysis, making it difficult to precisely measure the water content. Therefore, use the criterion value only as a reference.

Note 2: This assumes the use of an oil filter with nominal mesh size at 15 μm or finer.

5.3.2 Replacement Interval for Lubricant

5.3.2.1 The initial startup

When the system is started up for the first time, since the lubricant may get contaminated or deteriorated due to scale inside the piping and vessels, sample and analyze the lubricant 500 hours after starting operation.

If the results do not meet the management criteria for each oil type detailed in Tables 5-5 through 5-7, replace the lubricant.

5.3.2.2 During normal operation

Lubricant deteriorates gradually as the system is operated over time.

The deterioration rate depends on the operating conditions, oil type, and any foreign substances or water in the oil. Sample and analyze the lubricant every 6 months and if the results do not meet the management criteria for each oil type detailed in tables 5-5 through 5-7, replace the lubricant.

If oil filters frequently clog or the oil has turned dark and unclear, replace oil after removing the cause of problem.

5.4 Compressor Disassembly Preparation

Screw compressors are, as described in Chapter 2, extremely dependable compressors. However, it is necessary to disassemble and inspect parts after a fixed period of operation. This chapter describes the order and method of disassembly, and locations and method of inspecting parts.
As a general rule, periodic inspections where the compressor is disassembled should be done at the manufacturing factory. However, in unavoidable circumstances where work must be done at the installed location, follow the procedures below.
For most disassembly and inspection work, the compressor must be removed from its frame.
(It is possible to perform some disassembly without needing to remove the compressor from its frame.)

Performing work without following the instructions in this chapter could cause damage to parts or incorrect assembly, and lead to unforeseen problems when the compressor is restarted.
Read carefully and understand the instructions before starting work.
In addition, numbers denoted by【 】that follow part names refer to the numbers in assembly cross-section views or development views.

⚠ DANGER

- **Before performing inspection/maintenance work ensure that the main motor power and control power are turned off. Do not turn the power on during inspection/maintenance work.**
- **If the power is turned on during inspection/maintenance work, the compressor and oil valve will move and parts may get caught in the rotation axis or become damaged. Also, there is a danger of electric shock.**

⚠ WARNING

- **After turning off the motor main power, control power, and power for the other equipment, always perform lockout/tagout to prevent any inadvertent operation to turn on the equipment.**
- **After closing the suction stop valve, discharge stop valve, and liquid supply stop valve, always perform lockout/tagout to prevent any inadvertent opening of these valves.**
- **Lockout/tagout must always be performed by the person working on the equipment.**
- **After confirming that all work is complete, the person who applied lockout/tagout must be the one to release them.**
- **If there is residual high-pressure refrigerant gas or oil dissolved in the refrigerant, the gas and oil may blow off when closed valves (components) are opened. This may result in injury such as frostbite and loss of vision. Always check and confirm the pressure in the compressor, before opening any pipe connections and valves.**

5.4.1 Tools for Disassembly and Work Place

CAUTION

- **For compressor disassembly/assembly, use specified tools that are properly functioning. Using tools that are worn or damaged or that are unsuitable for the work can result in injury.**

Prepare tools to be required for the work referring to “7.5 Tools for Disassembly.” It is also recommended to prepare general hand tools, green silicon carbide grinding stone, emery paper(#80-#100), emery paper(over #800), parts cleaning oil, lubrication oil, a lubricator, an oil can for oil sump, waste cloth and so on.

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 1200 mm × 2400 mm in size and have a thickness of approximately 1.5 mm if the work location is flat.

To safely perform bolts and plugs removal used in the lower side of the compressor, an exclusive frame for placing the compressor is required. Refer to the article 5.4.5 in this chapter.

Perform the work in a dry place with as little sand and dust as possible, with a sufficiently wide space around there.

5.4.2 Replacement Parts

Prepare MYCOM genuine replacement parts based on the table 7-1 " Parts Configuration Table " in this manual Chapter 7.

Because O-rings and gaskets which are removed for the inspection are easy to be damaged, replace all with new ones.

When purchasing any part, inform its (a) model, (b) serial number, (c) part name, (d) code No. and (e) necessary number to our sales office or service center. Especially when the (b) serial number of the compressor is not identified, it will be difficult to decide the required parts because we can not specify the design and manufacturing specifications.

5.4.3 Recovering the Refrigerant

After stopping the compressor unit, internal pressure of the compressor is high. Before disassembling the compressor, it is necessary to lower the internal pressure to atmospheric pressure. The following methods are available.

- By using the bypass valve, release the high pressure gas in the unit to the low pressure side.
- If there is another compressor unit connected by bypass piping (or which can be temporarily installed), operate the other compressor and lower the pressure through the bypass piping.
- Operate the refrigerating unit, close the 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 control 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.

⚠ WARNING

- **Make sure that all risk assessment checks, including checking the work contents and procedure, are implemented before starting work. Neglecting these checks will lead to an increase in industrial accidents to a level that cannot be ignored.**
- **Perform lockout/tagout on all valves opened/closed for this work to prevent mistaken operation during the work.**

5.4.4 Removing Parts Connected to the Unit

⚠ DANGER

- **If there is residual high-pressure refrigerant gas or oil dissolved in the refrigerant, the gas and oil may blow off when closed valves (components) are opened. This may result in injury such as frostbite and loss of vision. Always check and confirm the pressure in the compressor, before opening any pipe connections and valves.**

When removing the compressor from the frame, separate it from the following parts.

(1) The coupling joining the compressor and electric motor

(2) The compressor's suction piping flange and discharge piping flange (if the suction strainer is connected directly to the compressor, remove the strainer too), and the intermediate piping connecting the low-stage discharge port to the high-stage suction port

(3) Compressor lubrication piping (journal lubrication: 2 places, oil injection: 1 place, capacity control increase/decrease: 1 place each)

(4) Capacity control operation electric wiring
(Depending on the situation of the workplace, unloader indicator assembly may be separated, with the wiring left as it is. See "5.7.14 Unloader Indicator" in this manual.)

(5) Bolts for attaching compressor (leg bolts)

(6) Oil escape piping at the bottom of the low-stage bearing head

【POINT】

When disconnecting the intermediate piping connecting the low-stage discharge port to the high-stage suction port, extract all oil from the oil escape piping on the low-stage bearing head beforehand.
Since remaining oils may leak out when disconnecting the oil piping from the compressor, warm the piping slightly and disconnect it while checking for oil flow, or disconnect it after removing the oil beforehand from the oil temperature gauge of the lubrication header.
Since the unloader cylinder is full of oil, prepare a tray for overflowing oil when disconnecting the piping. The container should hold approximately 4 liters.
When disconnecting the electric wiring, attach markings for ease of rewiring. If rewiring is not performed correctly, the compressor may not start up or the capacity control system may not operate.

5.4.5 Compressor Removing and Lifting

WARNING

- **All compressor lifting and moving work must be performed by a qualified person. Allowing an unqualified person to perform this work may result in an accident due to dropping the compressor.**
- **Do not assemble/disassemble the compressor while it is being lifted. Doing so may cause the compressor or parts to drop.**

【POINT】

Since the suction piping is located immediately above the compressor, hold it up or partially remove it before lifting the compressor. When lifting the compressor, use the eyebolts 【4】 attached to the middle of the compressor rotor casing.
If steps 5 and onwards (apart from 10 and 11) in Figure 5-1 Disassembly Order Description in 5.5 of this chapter will be performed, ***do not disassembling while lifting the compressor***, put place the compressor on a work bench as in the lower right photograph, and remove approximately 8 bolts from the lower side of the necessary flange parts. These cannot be removed after lowering the compressor onto the table.

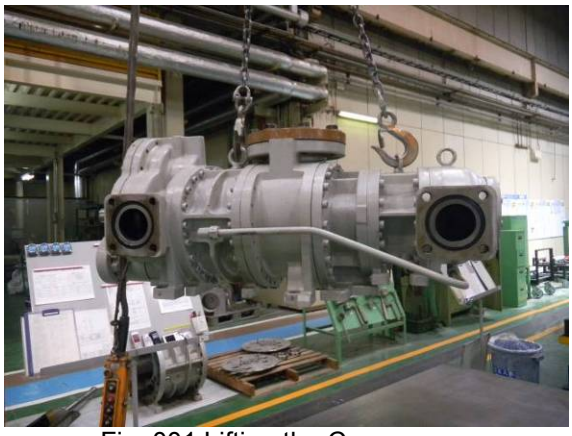


Fig. 001 Lifting the Compressor

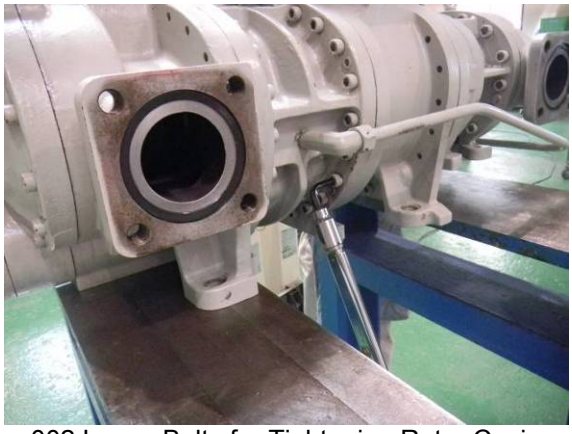


Fig. 002 Lower Bolts for Tightening Rotor Casing

5.4.6 Removing Oil from Inside the Compressor

Since there is a large quantity of oil inside the compressor, remove it beforehand.
There is a plug【10】under the suction cover【5-1】and a plug【15】under the bearing head【11-1】..
Most of the oil will flow from these plug holes. The remaining oil will flow onto the work bench during disassembly.
Main locations remaining oil are a) inside the unloader cylinder, b) inside the balance piston cover, c) inside the seal cover【51】, and d) inside the suction cover【5-1】. Prepare a tray and cloth for oil that spills during disassembly.

5.5 Order of Disassembly

Generally compressors are disassembled in the order shown in Figure 5-1 Illustrated Disassembly Sequence but the order in the figure is just an example and the actual order may differ according to individual situations.
For instance when overhauling it is no problem to start separation of high-stage part from low-stage part after removing the compressor from the unit frame and putting it on the work bench prepared beforehand.
In addition it is often the case that the disassembly of unloader cover/unloader cylinder part from mechanical seal part is performed in the reverse order of shown in the Figure 5-1.

Shown in the steps in the Figure 5-1, ① through ⑤ ,⑩ and ⑪, you can disassemble the compressor with the compressor attached on its frame.
When conducting steps ⑦ through ⑳, perform each step after removing the compressor and placing it on the work bench.

When conducting steps ⑦ through ⑳, the compressor should be removed from its frame and placed on a work bench prepared in advance.
When disassembling high-stage or low-stage side only, start from step ⑦ and disassemble necessary parts only.
Parts which have no problem should be left as they are. Do not disassemble such parts unless during periodical inspection.
Since it is difficult to completely eliminate the risks of performing inaccurate work at the field, disassemble the minimum required parts only.

Table 5-8 Compressor Disassembly Sequence Examles

	Part for Disassembly	Disassembly Order
(1)	Mechanical seal	① - ②
(2)	Unloader indicator	③
(3)	Unloader cylinder cover	③ - ④
(4)	Unloader piston and unloader cylinder	④
(5)	Bearing cover	⑤
(6)	Speed increaser gear casing (speed increaser type)	⑥
(7)	Separating high-stage and low-stage	⑦
High-stage		
(8)	Gear coupling	⑦ - ⑧
(9)	Thrust bearing	⑦ - ⑧ - ⑨
(10)	Balance piston cover	⑩ - ⑪
(11)	Balance piston	⑩ - ⑪
(12)	Suction cover and side bearing	⑩ - ⑪ - ⑫
(13)	Rotor and main rotor casing	⑬ - ⑭
(14)	Bearing head and main bearing	⑭
Low-stage		
(15)	Thrust bearing	⑮
(16)	Gear coupling	⑯
(17)	Suction cover casing and side bearing	⑰
(18)	Rotor and rotor casing	⑱ - ⑲
(19)	Bearing head and main bearing	⑲
(20)	Unloader slide valve and guide block	⑲

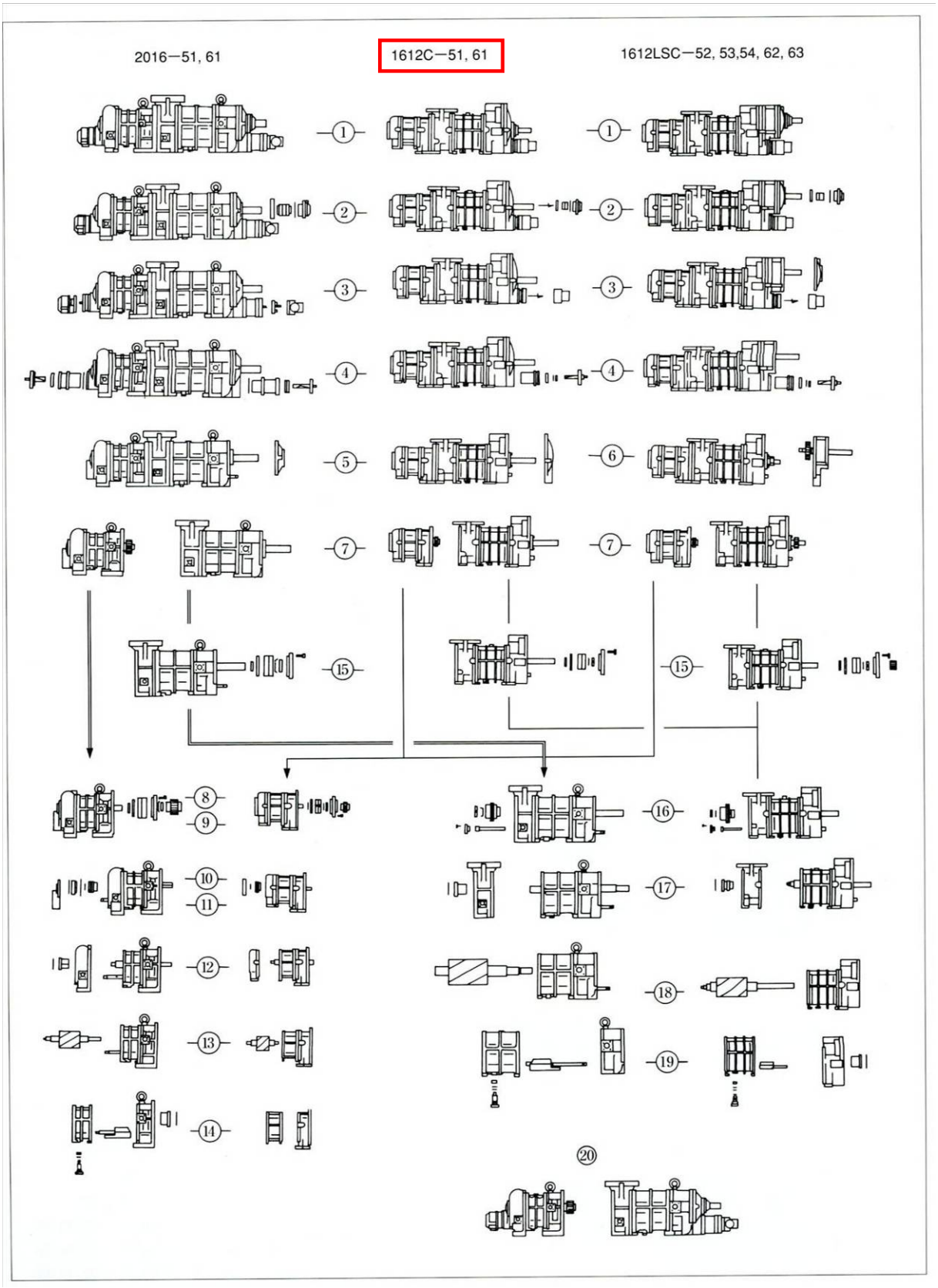


Figure 5-1 Disassembly Order Description

5.6 Disassembly Inspection

DANGER

- **Before performing overhaul work ensure that the main motor power and control power are turned off. Do not turn the power on during inspection/maintenance work. If the power is turned on during inspection/maintenance work, the compressor and oil valve will move and parts may get caught in the rotation axis or become damaged. Also, there is a danger of electric shock.**

WARNING

- **When turning power supplies on or off, take care to avoid electric shocks.**
- **Take care when handling heavy objects and use a crane etc., if necessary. There is a danger of the compressor or parts dropping.**
- **When using a crane, it must be operated by a qualified person. Allowing an unqualified person to perform this work may result in an accident due to dropping the compressor.**
- **Replace the parts with the MYCOM genuine parts. Using parts that are not genuine can cause damage to the compressor or other devices during operation.**

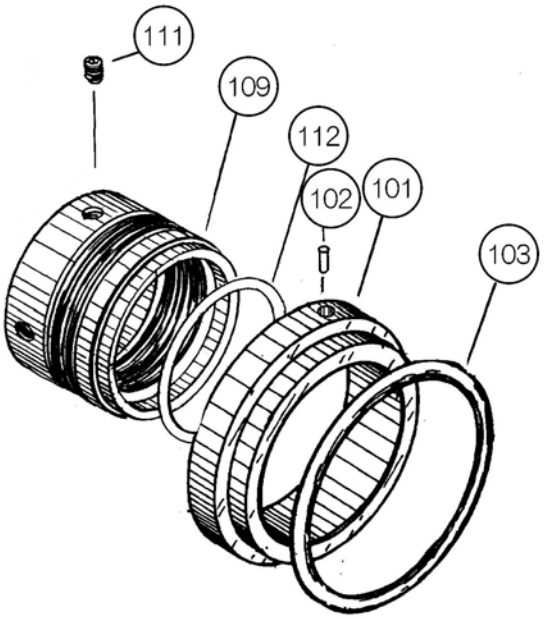
CAUTION

- **For compressor disassembly/assembly work, use specified tools that are properly functioning. Using tools that are worn or damaged, or that are inappropriate for the work, can result in injury.**

Take care when handling parts during overhaul work. Since the compressor rotates at a particularly high speed, even the slightest error when handling parts could cause a situation that requires replacing the rotor or other important parts. Another result could be an accident or deterioration in performance after reassembling the compressor.
Read carefully and understand the points below before starting work.

5.6.1 Mechanical Seal

Fig. 003



No.	Part name	
101	Mating ring	Stationary ring
102	Insert lock pin	
103	O-ring	
109	Seal collar	Rotating ring
111	Seal collar locking screw	
112	O-ring	

Figure 5-2 Detais of BBSE type Mechanical Seal

5.6.1.1 Disassembly

a) Of the eight hexagon socket head cap screws 【53】on the seal cover 【51】, remove six and leave the two on the opposing sides.

b) Slowly loosen the remaining two screws by turns so that they stay even. After a certain amount of loosening, the seal cover of the mechanical seal will be pushed by the spring and a gap will appear. A gap will not appear if the gasket is stuck. In that case, push the seal cover by screwing the 8 mm eyebolts into the seal cover's service holes.

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

d) Pull out the seal cover keeping it parallel with the shaft (rotor axis). The mating ring inside the seal cover is attached with an O-ring 【103】. Ensure that the mating ring and shaft do not come into contact causing damage.

e) Remove the O-ring 【49】. between the seal cover and the seal retainer.

f) After removing the seal cover, wipe clean and inspect the axis 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 locking screws 【111】 of the seal collar 【109】 by turning them three times.
For 1612**C type compressors, remove the bearing cover plug and loosen the locking screws through the hole with a wrench (Fig.005). Do not remove the locking screws, but leave them so that the tips are below the surface of the seal collar. There are two screws separated by 90 degrees.

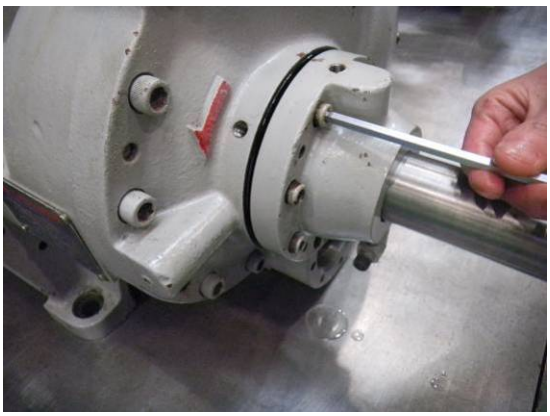


Fig. 004 Removing Seal Cover

Fig. 005 Seal Cover and Mating Ring

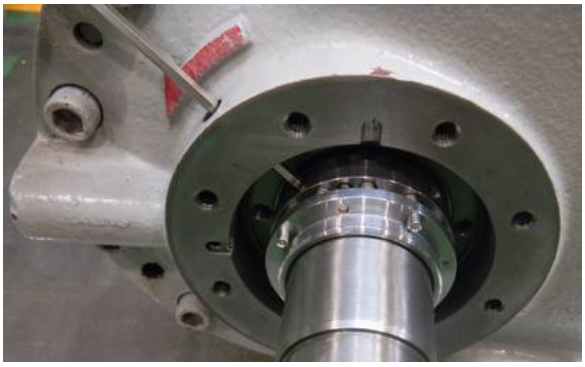


Fig. 006 Loosening the Seal Collar Locking Screws

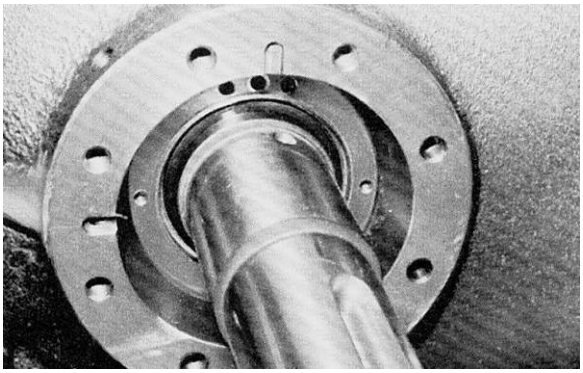


Fig. 007 Seal Retainer

h) Pull out the seal collar part with your fingers. When pulling out, ensure that the tips of the locking screws do not hit the shaft. Axial direction damage to the shaft can cause leaks.

i) Remove the two eyebolts for removing the seal retainer and screw them into the bolt holes, and then pull out the seal retainer at a right angle to the axis.

5.6.1.2 Inspection

a) Inspect the sliding surface of the mating ring and seal ring. If there is an even sheen on the surface, it can continue to be used. Since leaks can occur if there are bumps or scratches on the surface, a replacement is necessary.

b) Since swelling or deformation can occur easily on O-rings, replace them each time the mechanical seals are inspected.
There are 3 seal O-rings: the O-ring【49】between the seal cover and seal retainer, the O-ring【103】. between the mating ring and seal cover, and the O-ring【112】between the seal collar and shaft. For BOS models, there is another O-ring 【106-2】on the main body of the mechanical seal, bringing the total to four O-rings.

c) Oil seals use a special material. Use genuine replacement parts.

d) Replace the seal cover gasket with a new one.

5.6.2 Unloader Indicator

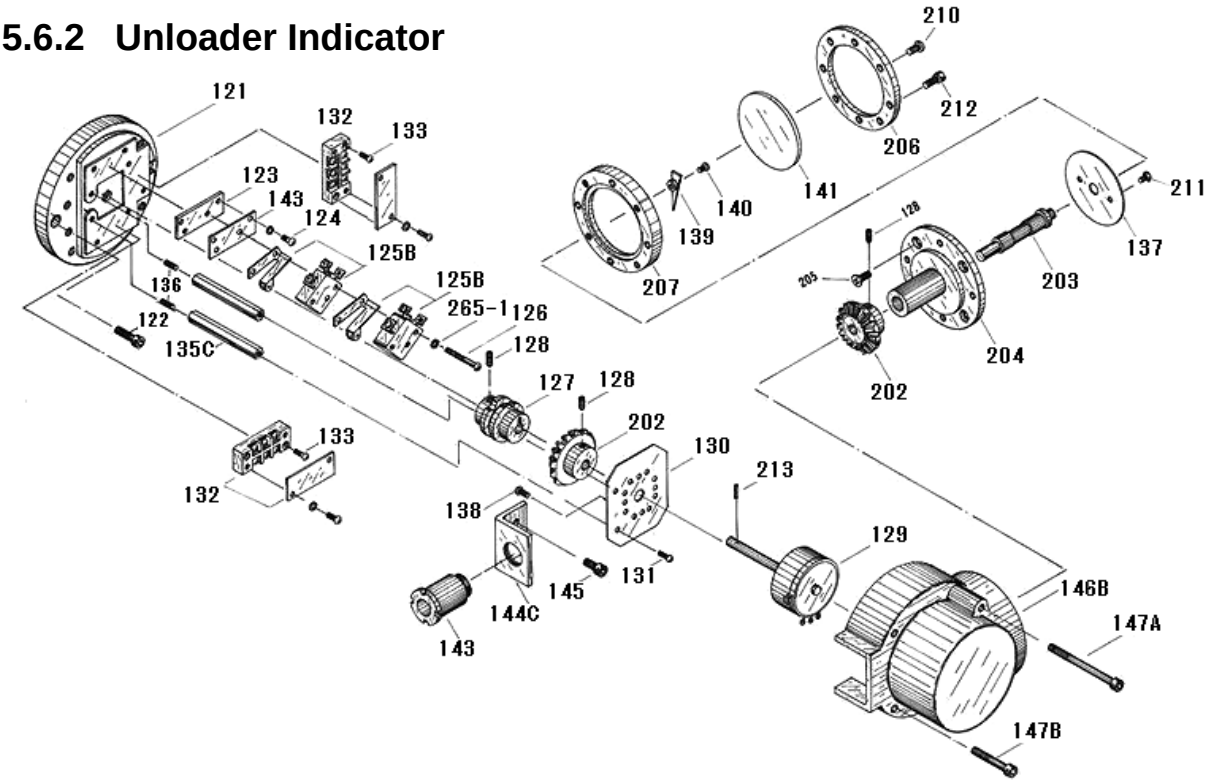


Figure 5-3 Development View of the 1612C Standard-type Low-stage Indicator**

Table 5-9 Unloader Indicator Components

No.	Part Name	Qty	Remarks	No.	Part Name	Qty	Remarks
120	Indicator assembly	1		141	Indicator glass	1	141
121	Micro-switch base plate	1	125L**	143	Electric wiring connector	1	
122	Hexagon socket head cap screw	2	M6 x 25	144	Connector support	1	125L**
123	Micro-switch set-plate	1	125L**	145	Hexagon socket head cap screw	2	M6x15
124	Phillips screw	2	M3 x 10	146	Indicator cover (2)	1	1612LSC
125	Micro-switch	2		147A	Hexagon socket head cap screw	2	M6x95
126	Phillips screw	2	M2.5 x 25	147B		2	M6x60
127	Micro-switch cam	1	125L**	149	Micro-switch Insulation plate	1	125L**
128	Set screw	2	M4 x 8	202	Bevel gear (2)	2	φ6
129	Potentiometer	1		203	Indicator shaft	1	
130	Potentiometer set-plate	1	200L**	204	Indicator shaft bearing	1	
131	Phillips screw	3	M3x5	205	Flat head screw	4	M5x14
132	Terminal block	2	LK-3P	206	Indicator glass gland	1	
133	Phillips screw	4	M3 x 20	207	Indicator glass support	1	
134	Potentiometer support arm	2		210	Phillips screw	4	M5x15
136	Potentiometer mounting screw	4	M3 x 14	211	Flat head screw	2	M3x5
137	Indicator dial	1		212	Hexagon socket head cap screw	4	M5x30
138	Indicator dial screw	2	M3x5	213	Spring pin	1	φ2x8
139	Indicator needle	1	200L**	265-1	Spring washer	2	M2.5
140	Indicator needle screw	1	M3x10	265-2	Spring washer	2	M3

5.6.2.1 Disassembly

Remove the indicator cover before pulling out the unloader indicator wiring because the indicator has a terminal board for wiring. Perform the work as described below and after removing the wiring reattach the cover for protection.

a) Loosen the hexagon socket head cap screws 【212】holding the indicator glass. Do not mistakenly loosen the phillips screws【210】on the same surface. Remove assembly parts【141】, 【202 – 207】, 【210】, and 【211】.

b) The cover can be removed by unscrewing the four hexagon socket head cap screws 【147】 attached to indicator cover.

c) Since there is a terminal block, remove wiring after removing the surface plastic sheet and loosening the screws.

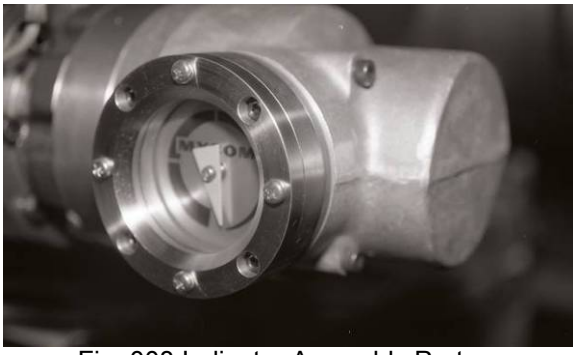


Fig. 008 Indicator Assembly Part

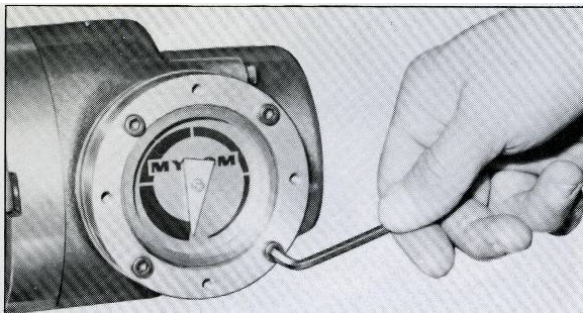


Fig. 009 Removing Indicator Glass and Gland

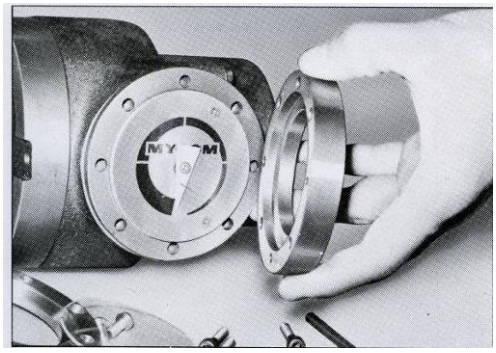


Fig. 010 Removing Indicator Glass and Gland

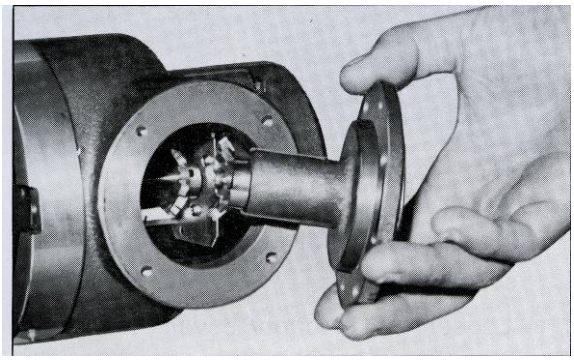


Fig.011 Removing Indicator Shaft Assembly

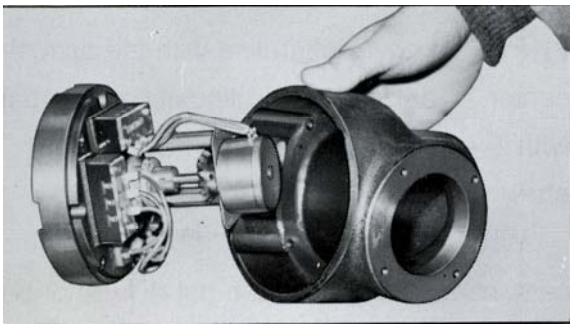


Fig. 012 Removing Indicator Cover

■ If further disassembly is necessary

Since the indicator is an assembled part, unless disassembly is necessary, remove it wholly and do not disassemble it further.

a) After the previous disassembly, the internal potentiometer, micros-witch, and micro-switch attaching board with micro-switch cam attached can be removed.

b) Remove the hexagon socket head cap screws 【122】.

c) Loosen the micro-switch cam set screw 【128】.

d) Then it is possible to remove the assembly as is by pulling in the axial direction.

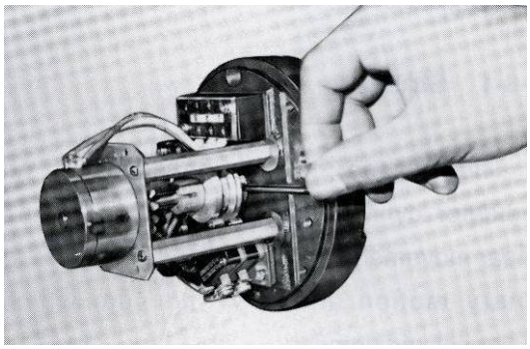


Fig. 013 Loosening Micro-switch Cam Set Screw

5.6.2.2 Inspection

Since the unloader indicator part is removed as assembly and its inspection and adjustment is often performed after reassembling and recovering the compressor, the inspection is described in 5.7 Reassembly in this chapter.
Refer to 5.7.14 " Unloader Indicator "

5.6.3 Unloader Cylinder Cover

The unloader cylinder cover【74】contains the indicator cam【77】, which converts the line position of the unloader slide valve into a rotation angle, and its attachment parts.

This part does not need to be disassembled unless there was an abnormality during operation. Disassemble and inspect this part if there is a leak in the shaft seal part of the cam or when instructions are not accurate.

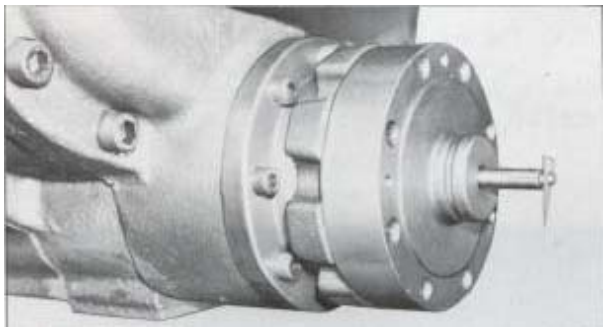


Fig. 014 Unloader Cylinder Cover Part

5.6.3.1 Disassembly

Fig. 015 Unloader Cylinder Cover

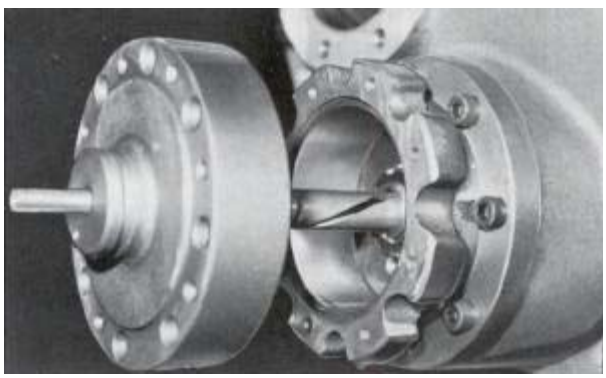


Fig. 016 Mating of Indicator Cam and Push Rod

a) Remove the hexagon socket head cap screws 【76】for attaching the unloader cylinder cover.

b) The unloader cylinder cover can be pulled straight out as is because the indicator cam 【77】 attached to the unloader cylinder cover is stuck to the inner side of the unloader push rod 【67】 in the unloader cylinder, and the grooved pin (guide pin) 【68】is in the groove of the indicator cam. Ensure that the unloader cylinder cover is not bent because the axis part of the indicator cam will also become bent.

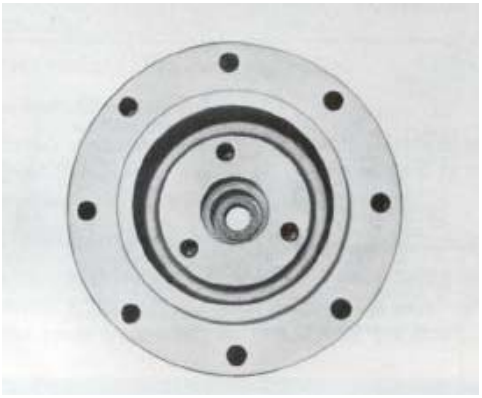


Fig. 017 Unloader Cylinder Cover Main Body

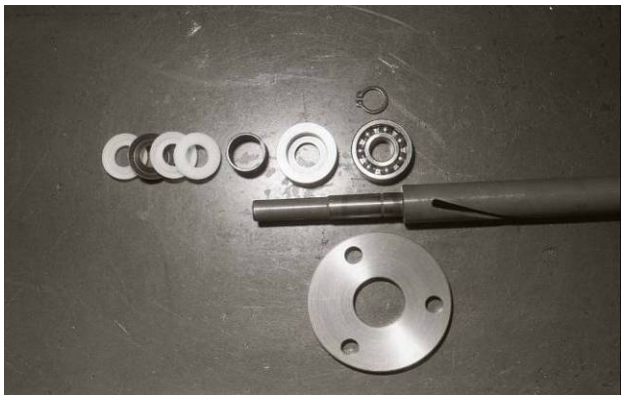


Fig. 018 Sealing Parts of Indicator Cam Axis

c) If the indicator cam does not work properly, inspect the groove, bearings, and guide pin of the indicator cam.

If there is a leak from the packing part, replace the packing. The order of disassembly is as follows.

c-1) Remove the three hexagon socket head cap screws 【81】securing the bearing gland 【80】 that holds the indicator cam on the cylinder side of the unloader cylinder cover.

c-2) Now it is possible to pull out the indicator cam with the ball bearing 【78】and stop ring 【79】 securing the bearing attached to the axis.

c-3) Attach the spring retainer 【84】, spring 【83】, and Teflon V-rings 【82】, in that order, to the inside of the unloader cylinder cover. Since Teflon V-rings are attached tightly to the outer diameter of unloader cylinder cover holes, they cannot be reused once they are removed, because the tongue part becomes damaged. Do not remove them unless for replacement.

Fig. 019 Teflon V-rings

5.6.3.2 Inspection

a) Inspect the packing part of the indicator cam axis for damage. If refrigerant leaks without any damage to this part, the V-rings are defective. Replace the V-rings.

b) Inspect the indicator cam groove part and replace it if damage or wear is found.

5.6.4 Unloader Piston and Unloader Cylinder

5.6.4.1 Disassembly

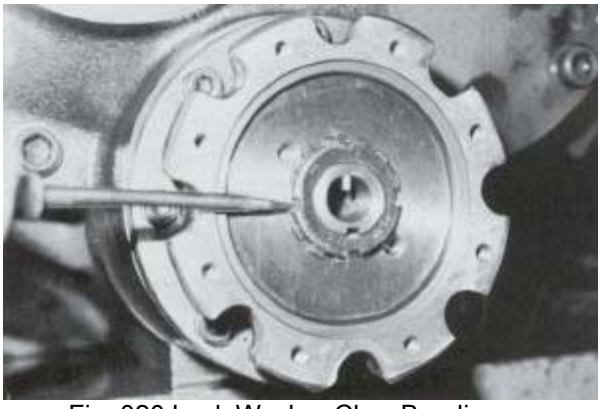


Fig. 020 Lock Washer Claw Bending

a) Pull out the unloader piston to the no-load position. Next, bend back the rotation stopper claw around the lock washer 【70】 that secures the piston to the push rod, ensure that the lock nut 【69】rotates, and loosen the nut using the lock nut wrench.
Remove the unloader piston by screwing eyebolts into the two screw holes.

b) The low-stage unloader cylinder【60】is attached to the low-stage bearing head【11-1】along with the bearing cover 【16】by eight long bolts 【61】.
Remove【61】and then pull out the unloader cylinder.


Fig. 021 Removing Lock Nut

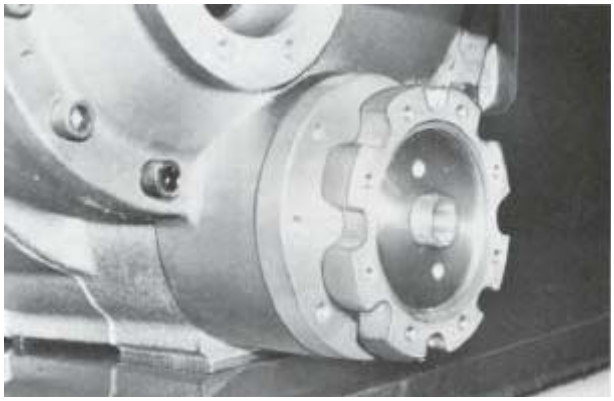


Fig. 022 After Lock Nut Removal

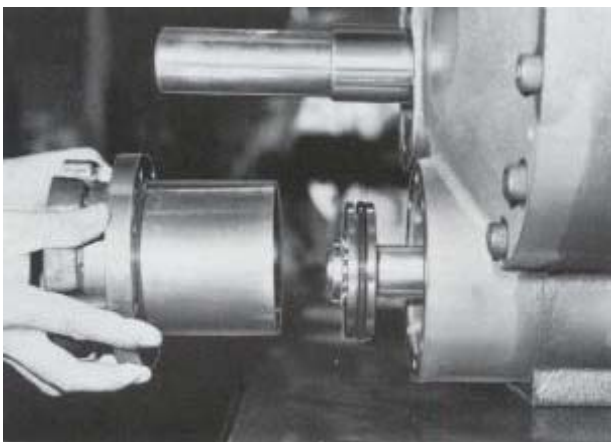


Fig. 023 Removing Unloader Cylinder

5.6.4.2 Inspection

a) Be sure to replace the cap seal 【66】, witch is attached to the outer circumference of the unloader piston 【64】, as well as the O-ring 【65】.

b) Since the unloader cylinder often has damage or oil refuse stuck to the inner surface, clean thoroughly and use fine emery paper to smoothen it.

Fig. 023 Removing the Cap Seal

5.6.5 Bearing Cover

Remove the bearing cover 【16】when pulling out the low-stage thrust bearing part or the rotor for inspection.

5.6.5.1 Disassembly

a) Remove all of the hexagon socket head cap screws 【18-1】. The bearing cover remains attached to the bearing head with alignment pins 【19-1】.

b) Screw holes are located in symmetric positions. By screwing the two removed bolts 【18-1】into the right and left holes, the bearing cover will separate from the bearing head. When a gap has opened, use a thin knife or spatula-shaped object to peel up one side of the cover.

c) Screw the bolts further, until the cover comes off the alignment pins.

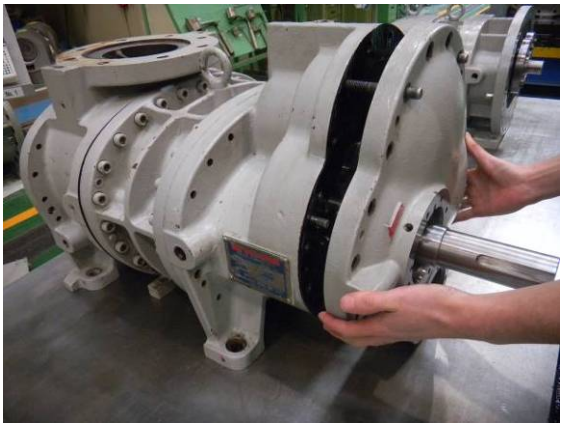


Fig. 025 Removing Bearing Cover

Fig. 026 After Bearing Cover Removal

CAUTION
● **At this time, ensure that the bearing cover is supported to avoid it toppling or dropping onto the shaft (rotor axis). Protect the shaft with a cloth beforehand.**

5.6.6 Speed Increase Gear Casing

This section does not apply to the 1612**C-51 / 61 (direct connection) models.

5.6.7 Separating High-stage and Low-stage

Separate the high-stage and low-stage when pulling out the high-stage thrust bearing part or each rotor is required. It is also structurally possible to separate at the first step of disassembly.

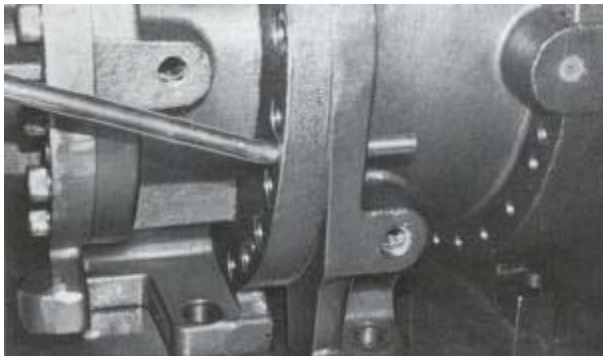


Fig. 027 Separating High-stage and Low-stage

5.6.7.1 Disassembly

a) As explained under【POINT】at 5.4.5 in this manual , put the compressor on a special table and remove the bolts from the lower side. Then, remove the remaining hexagon socket head cap screws【18-2】. At this moment, the upper side of the compressor is spaced apart the surface plate.

   Brace the upper side with a rectangular piece of wood or the like to prevent it from falling when disassembled.

b) Drive alignment pins 【19-2】into suction cover 【5-1】.

c) Since the bearing head 【11-2】 and suction cover are stuck together with the gasket 【17】, gently tap the suction cover leg part with a shockless hammer or screw the removed bolts【18-2】into the holes on the bearing head to push out the suction cover evenly.
   Do not insert a screwdriver or chisel into the gap.

d) On the male rotor axis there are power transmission gear couplings 【151 – 157】.
   Move the casing in parallel with the axis to separate the driving side and the moved side in the axial direction.

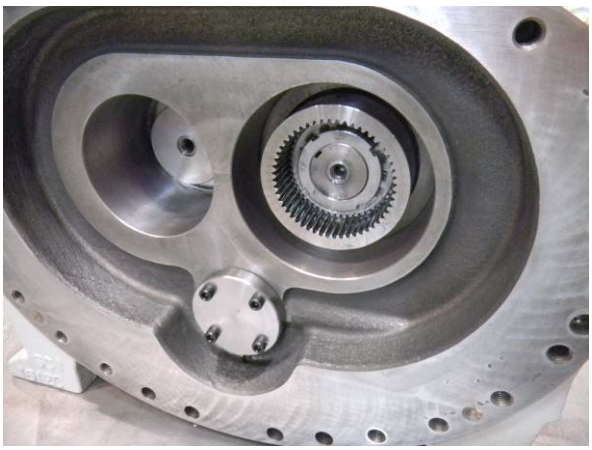


Fig. 028 Low-stage After Separation

Fig. 029 Removing the Driven Hub

* Fig.028 and 029 are gear coupling before the design modification of February, 2011.

5.6.8 High-stage Gear Coupling

As shown in the separated parts in the previous section, the coupling for transmitting power can be separated into the high-stage and low-stage, and each is fixed to a shaft (rotor axis).

【POINT】

Until the design modification in July 2004 for only 1612LLC type compressor two keys were incorporated to fix driven hub and drive hub of M rotors both low and high stages. According to this design modification M rotor on low stage has become one key specification which is common to LSC type compressors and M rotor on high stage was newly manufactured.
In addition the gear coupling part of 1612**C type compressors was changed according to the design modification issued in February 2011.
More detailed information about the design modification of the gear coupling refer to 5.6.16 Low-stage Gear Coupling in this chapter.

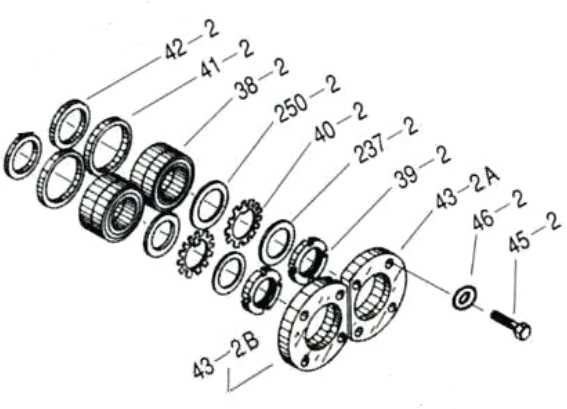
5.6.8.1 Disassembly

Remove the driven hub【153】after loosening the locking screw【159】of the key on the driven hub. It can be removed easily because it is fitted loosely.

5.6.8.2 Inspection

Inspect whether there is abnormal deformation or wear on the teeth or surfaces, and if there is any fault investigate the cause and replace the damaged parts.

5.6.9 High-stage Thrust Bearings



No.	Part Name	Qty
38-2	Thrust bearing (2)	2
39-2	Lock nut (2)	2
40-2	Lock washer (2)	2
41-2	Thrust bearing outer race spacer (2)	2
42-2	Thrust bearing alignment spacer (2)	2
43-2A	Thrust bearing gland (2) A for female rotor	1
43-2B	Thrust bearing gland (2) B for male rotor	1
45-2	Hexagon head screw (M8 x 30)	8
46-2	Spring washer (for M8)	8
237-2	Torsional slip washer (for 125***)	2
250-2	Thrust washer (for 125***)	2

Figure 5-4 High-stage Thrust Bearing Part

Thrust bearings play the most important role in a screw compressor.
Take sufficient care during the assembly and adjustment of these parts because it can affect the performance of the compressor or cause it to break.

The thrust bearing【38-2】uses front assembly angular contact ball bearings.
The thrust bearing only receives thrust load and does not receive the radial load perpendicular to the axis because there is a gap between the outer race of the thrust bearing and the bearing head.
In addition to 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 linked significantly with performance.

Fig.030 Thrust Bearing

5.6.9.1 Disassembly

a) Remove the lock nut 【39-2】 after extending the lock washer 【40-2】locking claw securing the thrust bearing inner race to the rotor axis.

b) Remove the thrust bearing glands 【43-2A, 43-2B】after removing the spring washer【46-2】and the hexagon head bolts 【45-2】.
If an older model with a rotation stopper fitting is used instead of a spring washer, extend the claw of the rotation stopper【46-2】of the hexagon head bolt【45-2】, remove the screw, and remove the gland.

c) There is a gap between the outer race of the thrust bearing and the bearing head. Since the inner race of the bearing slides on to the rotor axis, bend the tip of a 2-3 mm diameter wire, insert it between the outer race and the ball retainer, and hook it onto the thrust bearing to pull it out.

d) There is a thrust bearing outer race spacer 【41-2】 for the bearing head side outer race and a thrust bearing alignment spacer 【42-2】 for the rotor axis side inner race inside the thrust bearing.
To identify where to set, the thrust bearing outer race spacers and thrust bearing alignment spacers have a stamped mark of "M" or "F" which means "for M rotor" or "for F rotor".

The bearing glands, thrust bearing outer race spacers and thrust bearing alignment spacers, which have been removed, should be divided into two groups (M rotor group and F rotor group). Reassembling incorrectly can lead to a difference in the dimensions of the end clearance (the gap between the rotor tip and the bearing head) causing a decline in performance or a galling accident due to hardening and over-heating. Make sure to reassemble using the correct parts.

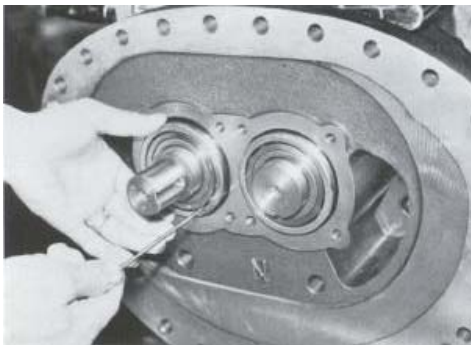


Fig. 031 Pulling Out Thrust Bearing

Fig. 032 Spacer and Alignment Spacer

5.6.9.2 Inspection

a) After cleaning the thrust bearing thoroughly, if the balls in the ball bearings are shiny, there is no problem.
If the surface of the ball bearings is dull, contact us just in case.
Next, inspect the gap between the retainer and the balls. If there is burr where the balls are held in the retainer, or if the gap between the balls and retainer is too big, there is a problem.

b) Rotate the outer race while supporting the inner race with your hand. If you feel an abnormal vibration, inspect thoroughly for abnormalities on the ball contact surface of the inner and outer races or on the balls themselves. Even small pieces of dirt that entered during removal can feel like an abnormality. In this case, use high pressure to clear away dirt after washing. If abnormalities persist, replace the part.

c) Moving the cleaned bearing with your hand will make a rattling sound. This is due to the gap between the balls and the retainer. If the bearing is placed flat, this sound should disappear.
Also, this sound should disappear after applying lubricant. If the sound persists, a more detailed investigation is necessary.

d) Even if an abnormality is not identified by the above-mentioned check in the case of thrust bearings with more than 20,000 hours compressor operation, the thrust bearings should be replaced with new ones, in consideration of security of the continuation operation until the next overhaul.

CAUTION

- **Since a bearing is a combination of specifically designed parts, even if a bearing with the same number is found in a bearing manufacturer's catalog, the accuracy or material may not be the same. Use genuine MYCOM parts when replacing parts. Parts that are not genuine shall not be included in the warranty.**

5.6.10 Balance Piston Cover

Disassemble when pulling out the rotor or inspecting the side bearing【28-2】or balance piston【30】.

a) Loosen all hexagon socket head cap screws 【24】 3 or 4 rotations, lightly tap the side of the cover with a shockless hammer, and peel off the touching balance piston cover gasket 【23】.

b) In this state, drain the oil from the balance piston and side bearings inside the suction cover. When the oil has been drained, remove all screws apart from the one on the upper side. While holding down the balance piston cover, remove the remaining screw and remove the balance piston cover without damaging the gasket.

5.6.11 Balance Piston

When the screw compressor is operated, the thrust load on the M rotor is large and the rotation compared to the F rotor is fast. Therefore, the life of a thrust bearing on the M rotor would normally be much shorter than the life of a thrust bearing on the F rotor . To reduce the load on the M rotor bearing, a hydraulic piston is used to negate the load to the end of the rotor drive axis.

* A balance piston is not required on the low-stage because, due to low-pressure conditions, the difference in life is not as big as the high-stage.

Fig. 033 Balance Piston and Balance Piston Sleeve

5.6.11.1 Disassembly

<Change in Shape of the 1612**C Suction Cover【5-2】.>

Due to the modification in shape design of the high-stage suction cover【5-2】in February 1975, the attachment of a balance piston sleeve【33】became necessary. Accordingly, the balance piston 【30】. and the balance piston cover 【22】 were newly created.

a) Using stop ring pliers, remove the stop ring【32】that secures the balance piston【30】to the axis. Screw in eyebolts to remove the balance piston. It is not necessary to remove the balance piston key 【31】 embedded in the rotor axis.

b) Since the 1612**C model has a balance piston sleeve attached to the high-stage, remove the hexagon socket head cap screw【34】for stopping the balance piston sleeve【33】from rotating. Make sure not to lose the attached special spring washer 【335】.

   * Special spring washer means a spring washer for a hexagon head cap screw.

c) Remove the stop ring 【37】 for securing the balance piston sleeve. Since the stop ring is pushed out by the inner O-ring, it can be removed easily by pushing gently.

d) Pull out the balance piston sleeve. The sleeve can be removed easily because the gap between its outer diameter and the suction cover is loose.

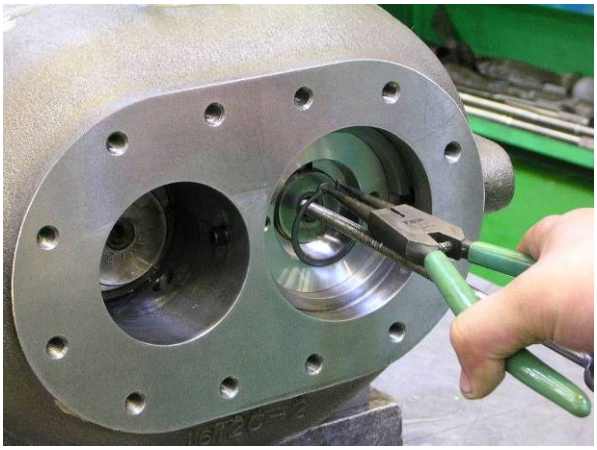


Fig. 034 Removing the Stop Ring

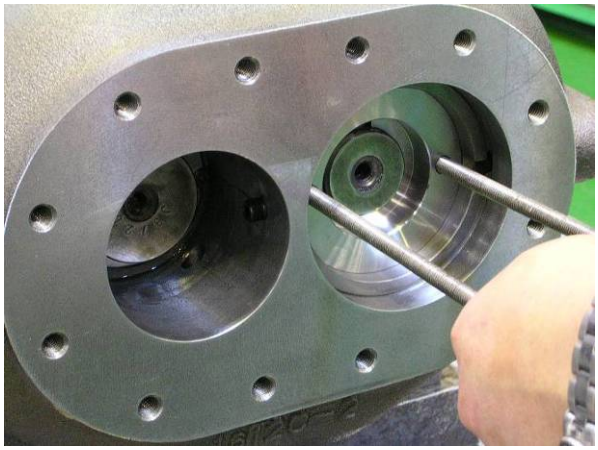


Fig. 035 Pulling Out the Balance Piston

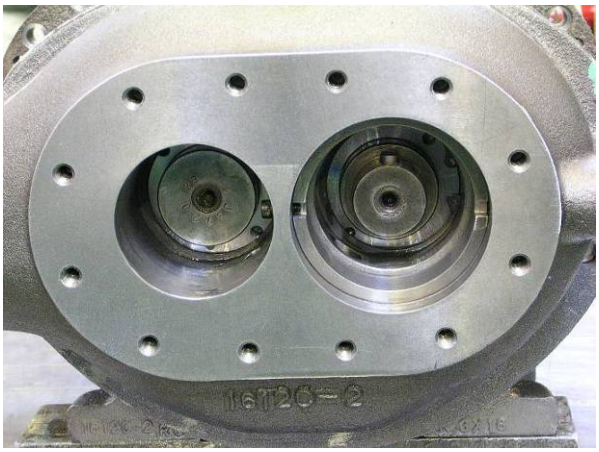


Fig. 036 Balance Piston Sleeve Rotation Stopper Part

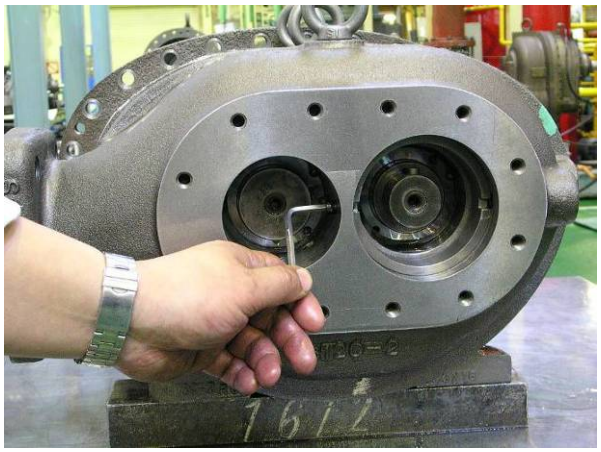


Fig. 037 Loosening Rotation Stopper Screw

5.6.11.2 Inspection

Signs of wear can be seen on the inner side of the balance piston sleeve. However, this is due to the fact that the gap between the balance piston and the piston sleeve is smaller than the gap between the rotor axis and the bearings, and is not a problem.
Wear will not get worse because there is a large gap around the outside of the balance piston sleeve to prevent the balance piston from receiving the bearing load.

5.6.12 High-stage Suction Cover and Side Bearings

The high-stage suction cover with the intermediate pressure gas port is an important part because it has the seal function for suction side casing and the side bearing for holding the rotor.

5.6.12.1 Disassembly

a) Loosen and remove the hexagon socket head cap screws 【2-2】. that hold the high-stage suction cover 【5-2】. and the high-stage rotor casing 【1-2】. The alignment pins 【3-2】and rotor axis are secured so they will not fall.

b) Since the suction cover gasket 【6-2】is stuck to the surface, either gently tap the suction cover surface, or evenly push the suction cover by screwing two of the removed hexagon socket head cap screws【2-2】into the holes in the flange part of the rotor casing. When a gap has opened, use a thin knife or spatula-shaped object to peel up to one direction. (Do not insert a screwdriver or chisel into the gap.)

c) At the position where the alignment pins can be taken out, remove the suction cover parallel to the axis with a single pulling motion. The thrust bearings are disconnected so the rotors will also be removed. Ensure that the rotors stay in its casing.

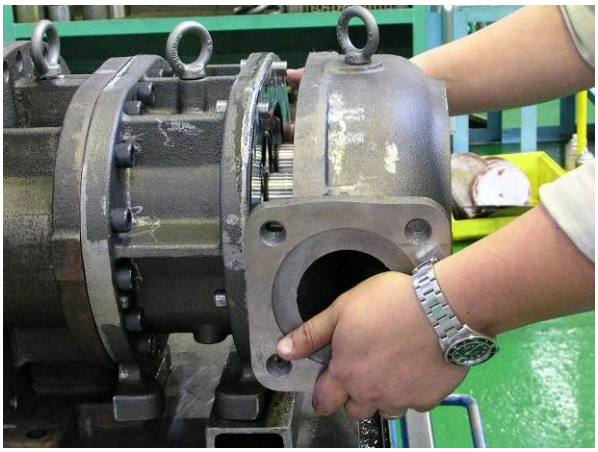


Fig. 038 Pulling Out Suction Cover

d) The side bearing 【28-2】is press-fit from the balance piston cover side of the suction cover. Remove the stop ring 【29-2】and push it out from the rotor side.
Only disassemble during replacement.

5.6.12.2 Inspection

a) The suction cover itself does not cause abnormalities. Inspect the metal surface because the side bearing is a moving part. Replace it if there is an abnormality or foreign matter is embedded. The inner diameter of the side bearing is interrelated with the rotor axis and should be judged based on the gap between the two.

b) The inner surface of the rotor casing side has a gap and should not cause any problems. However, if the inner surface of the rotor casing shows signs of wear etc., thrust bearings may be damaged.

c) In standard specifications, oil is not injection into the high-stage. Even if there are oil holes, they are plugged and plugs should not be removed.

5.6.13 Pulling Out the High-stage Rotors

For 1612**C models, the 125SU or 125LU type rotor assembly is used for the high-stage.

5.6.13.1 Disassembly

a) The high-stage rotor comes loose when disassembling the suction cover and can be removed easily. Either the M or F rotor can be removed first, but the M rotor is longer so it is easier to remove that first.
Hold the axis up slightly, pull out the rotor while rotating it clockwise, and after two thirds of the rotor has been pulled out, pull the rest out slowly with one hand on the outer side of the rotor.

CAUTION

- **If the M rotor is pulled out without rotating it, the F rotor will be pulled out also.**

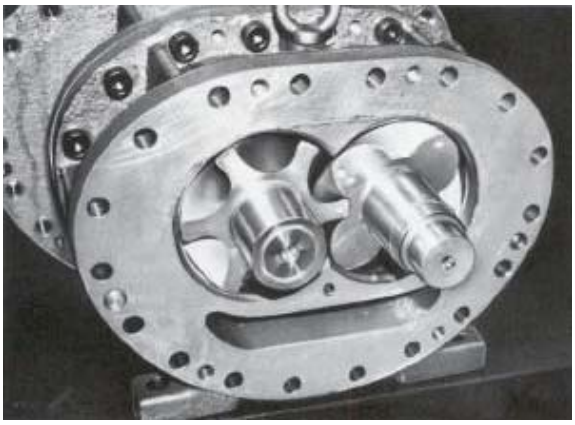


Fig. 039 Before Pulling Out M Rotor

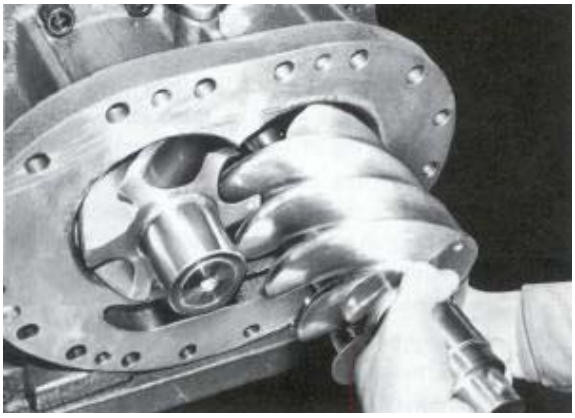


Fig. 040 Pulling Out M Rotor

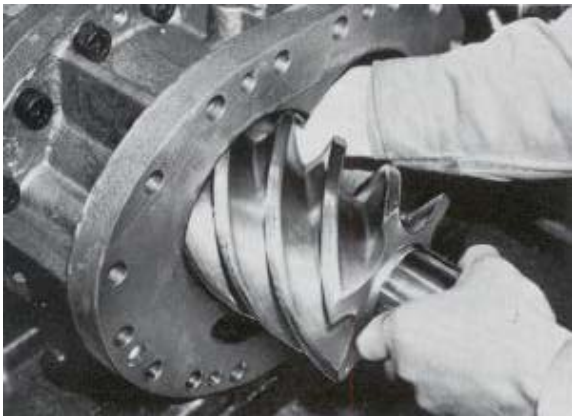


Fig. 041 Pulling Out F Rotor

b) Do not place the removed rotor directly on the floor. Use a cushion made of wood, etc., an I-block or a V-block to suspend the bearing part of the rotor.

c) Pull out the female rotor in the same way. Take care not to damage the main bearing with the end of the rotor axis when removing.

5.6.13.2 Inspection

a) During normal use the teeth of the rotor should not get damaged at all. The parts of the teeth that hit each other (near the base on the M motor and the ends on the F rotor) are shiny black.
Apart from this, there may be some perpendicular linear damage due to small pieces of dirt in the oil or gas. However, this is not the same as galling, so smooth over the damaged parts with a grinding stone or fine emery paper.
When disassembling after stopping operation for a long time and if ammonia refrigerant is used, the teeth surface of the rotors may rust. Clean it off gently with emery paper.

b) Inspect the bearings. This part is subject to high-frequency hardening (in standard machines).
There should be almost no wear unless the oil used is particularly dirty or hard pieces of dirt are embedded in the metal (due to a broken filter, etc.).

c) Inspect whether there are signs of inner race rotation in the thrust bearing assembly part of the rotor.
If any signs can be seen, read the warnings related to assembly carefully.

Fig. 042 Rotor Casing

d) Inspect inside the rotor casing. There is a small gap between the outer side of the rotor and the rotor casing. Slight damage to the ends of the rotor teeth and inner surface of the rotor casing caused by dirt etc., is not a problem.
However, damage caused by the ends of the rotor teeth hitting against the surface of the rotor casing is an abnormality.
Measure the bearing inner diameter and the axis diameter. If left alone, this could cause an accident such as seizure.

5.6.14 High-stage Bearing Head and Main Bearings

There is a gas discharge port, based on the compressor's operating conditions, on the surface that has the rotor of the bearing head【11-2】assembled on it.
This discharge port affects the performance of the compressor.
On the bearing head there is also the main bearing which supports one end of the rotor.

5.6.14.1 Disassembly

a) Remove all hexagon socket head cap screws 【2-2】 that hold the casing and bearing head and hit alignment pins into the rotor casing side.

b) Tap the leg part of the bearing head gently with a shockless hammer to peel off the bearing head gasket 【12-2】.
If the gasket is stuck fast, screw removed screws【2-2】into the holes in the casing side to push it (same method as with the suction cover). The rotor has been removed so this work should be easy.

c) Since the main bearing【27-2】is gently press-fit to the bearing head, remove the stop ring and tap the rotor side to remove the main bearing.

Fig. 043 After Removing Main Bearings

5.6.14.2 Inspection

a) Inspect the bearing surface of main bearing 【27-2】 inside the bearing head. Replace it if there are signs of hard dirt embedded on the inner surface.

b) Inspect the surface with the discharge port of the rotor. Smooth over any damage. If there is a lot of heavy damage on the surface, the thrust bearing may have defect or the end clearance adjustment is not appropriate. Damage can also be caused by dirt in the piping. Inspect while referring to the assembly instructions.

5.6.15 Low-stage Thrust Bearings

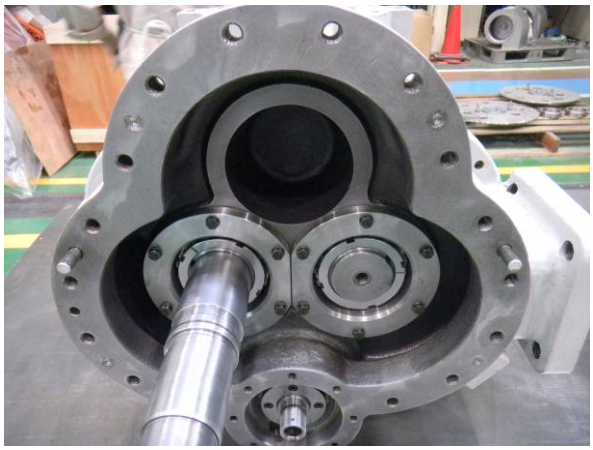


Fig. 044 Thrust Bearing Part

5.6.15.1 Disassembly

a) Remove the hexagon socket head cap screws 【45-1】 holding the thrust bearing gland 【43-1】. Make sure not to lose the attached spring washers 【46-1】.

b) Remove the axis side lock nut【39-1】and washer【40-1】as in the same manner of the high-stage.

c) Remove the thrust bearing 【38-1】as in the same manner of the high-stage.

<About the 1612**C Low-stage Thrust Bearing Gland and Tightening Bolts>

It also might be a too old episode, due to the design modification in April 1988;

1. The low-stage thrust bearing gland changed from a size 7 hole with a seated depth of 6 for a diameter 13 head, to a *size 7 through-hole*.
2. The tightening bolts changed from M6x25 hexagon socket head cap screws to *M6x30 hexagon head screws*.

* For old parts, use 1612LSC old model speed-increaser parts.
However, for changed parts, do not use 1612LSC old model speed-increaser parts.

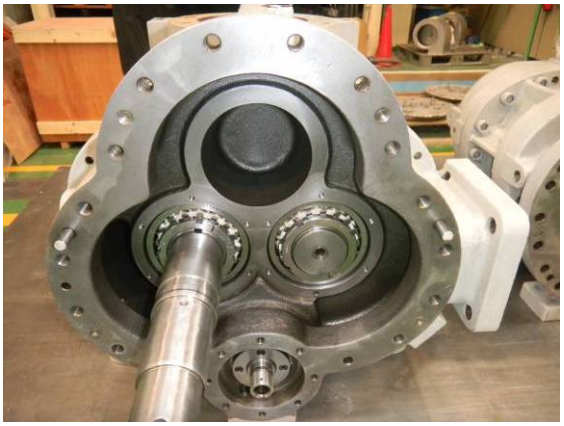


Fig. 045 After Removing Thrust Bearing Gland

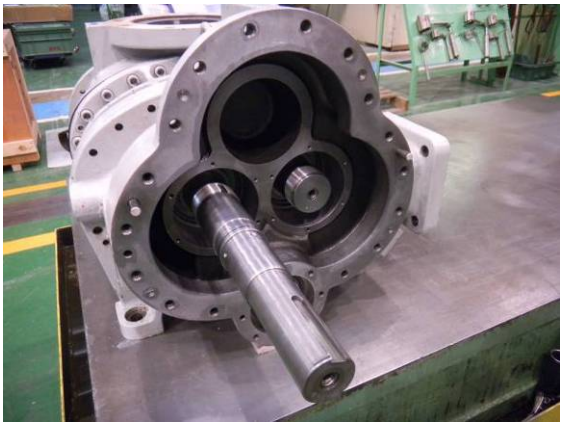


Fig. 046 After Removing Bearing

5.6.15.2 Inspection

Inspect the low-stage thrust bearing as in the same manner of the high-stage thrust bearing referred in the section 5.6.9.2.

5.6.16 Low-stage Gear Coupling

The driving side of the gear coupling is attached to the M rotor low-stage, in order to transmit power from the low-stage to the high-stage.

<About the 1612**C Gear Coupling Method History>

In January 1979, after exchanging approval drawings with the manufacturer, the coupling method was changed from the hexagon head screw direct connection to the method using a sleeve to connect to the coupling hub.
This method was used for a long time but in February 2011, due to a design modification notification, a method using a stopper inside the sleeve was introduced (compatible with the former method).

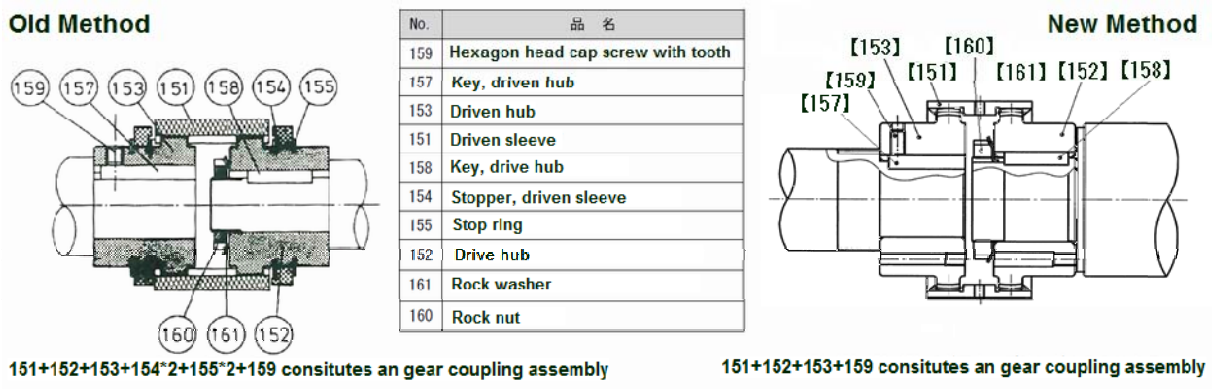


Figure 5-5 Gear Coupling Assembly Drawing
(before and after Design Modification in February, 2011)

5.6.16.1 Disassembly

a) It is possible to remove the driven sleeve 【151】 with your hands. Remove the drive hub 【152】. Extend the lock washer【161】claw and loosen the lock nut【160】.

b) There are two screw holes in the drive hub. Pull it out by screwing in two eyebolts (Tools for standard disassembly). It can be removed easily because it is fitted loosely.

c) Leave the embedded key of the rotor axis as it is.

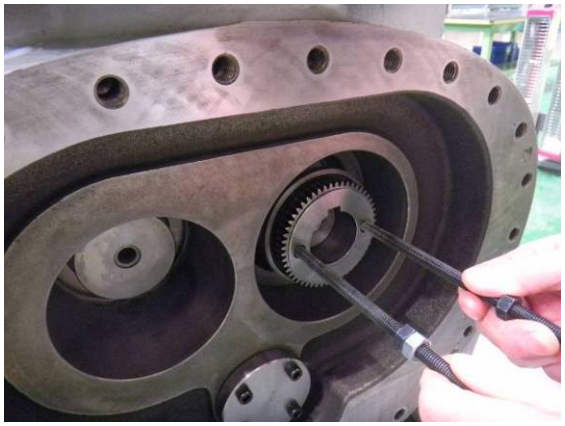


Fig. 047 Removing Drive Hub

5.6.16.2 Inspection

Inspect for deformation or teeth surface wear in both the hub and the sleeve.
Also, inspect the gap between them and the high-stage driven gear. If there is an abnormality, replace the pair.
Also, investigate the cause of the abnormality at the same time.

5.6.17 Low-stage Suction Cover and Side Bearings

5.6.17.1 Disassembly

a) Before disassembly, remove the 6–8 hexagon head cap screws 【2-1】on the bottom side while the compressor is lifted (refer to section 5.4.5 in this Chapter).

b) In order to pull out the oil injection pipe 【85】. that supplies injection oil to the unloader slide valve, remove the tightening bolts 【166】of the oil injection pipe retainer 【164】at the bottom of the high-stage.

c) Remove the oil injection pipe retainer.

Fig. 048 Removing Oil Injection Pipe Retainer

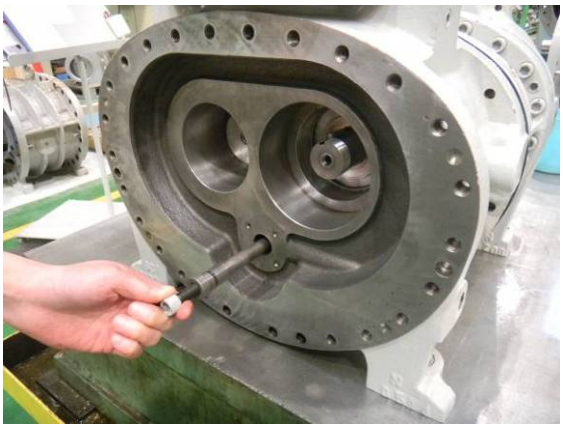


Fig. 049 Pulling Out Oil Injection Pipe

d) There is a screw in the hole of the oil injection pipe. Remove it after screwing in the screws 【2-1】.

e) Remove all of the hexagon socket head cap screws 【2-1】. Next, hit alignment pins 【3-1】into the rotor casing 【1-1】.

f) Screw in screws【2-1】into the two holes in the rotor casing flange, and then push the suction cover flange evenly.

g) When a gap has opened, use a thin knife or spatula-shaped object to peel it up and attach it to the suction cover.

h) When a gap has opened to the length of the screw, pull out the rotor axis and side bearing combination by sliding it on the surface plate parallel with the axis. Take care not to remove the rotor as well.

i) It is possible to remove the side bearing 【28-1】by removing the stop ring【29-1】and gently tapping the rotor side. Damage to the bearing can be avoided by screwing a screw into the hole at the end of the bearing before removal.

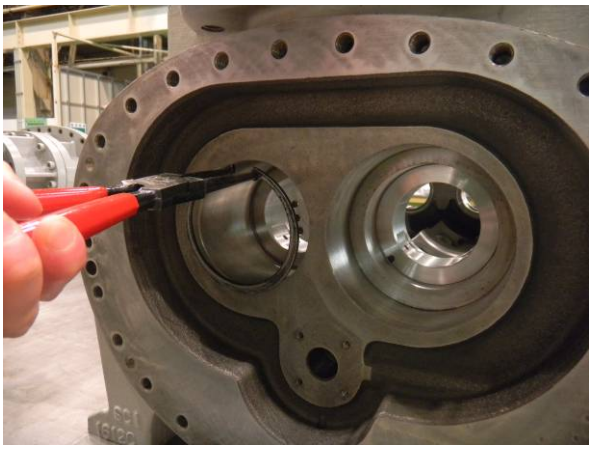


Fig. 050 Removing Stop Ring

5.6.17.2 Inspection

Inspect for wear or embedded foreign matter on the sliding surface inside the side bearing.
If the opposite rotor axis side is worn, even if the side bearing inner diameter dimensions are correct, hard foreign matter is embedded. Replace the side bearing with a new one.

5.6.18 Low-stage Rotors and Rotor Casing

The rotors can be removed easily as in the same manner of high-stage. Care must be taken because the low-stage rotors are heavy.

Inspect the ends of the rotor teeth and rotor casing in the same way as the high-stage, but be aware that there is an unloader slide valve on the low-stage which may hit against the ends of the rotor teeth. If the contact is particularly hard, scrape off the contacting parts with a scraper or file. Finally, make the surface smooth with emery paper. After making the surface smooth, wash thoroughly with wash oil and make sure that no iron powder is left inside.

Fig. 051 Rotor Casing

5.6.19 Low-stage Bearing Head and Main Bearings

Apart from when disassembling and inspecting the unloader slide valve, it is not necessary to separate the low-stage bearing head【11-1】and the rotor casing【1-1】.

However, according to the design modification in July 1986, of the low-stage bearing head the part where the unloader push rod is set has been changed. Compressors manufactured before this change need to be separated into lower-stage bearing head and rotor casing to replace O-ring attached to this part.

5.6.19.1 Disassembly

a) Remove all of the hexagon socket head cap screws 【2-1】.
b) Hit a alignment pins 【3-1】into the rotor casing flange side.
c) Separate the bearing head and rotor casing using two screw holes in the bearing head flange part.
d) Separate the embedded unloader push rod 【67】parallel to the axis.
e) Remove the main bearings 【27-1】by removing the stop rings 【29-1】and gently tapping the rotor side.
f) The slide valve should be dealt with in the same manner as the high-stage.

5.6.19.2 Inspection

a) Inspect the bearing surface of the rotor discharge side. Heavy damage on this surface could affect performance. In that case, contact us.
b) Inspect inside the main bearing for wear or embedded foreign matter.
c) Inspect in the same way as the upper side slide valve.

5.6.20 Low-stage Unloader Slide Valve and Guide Block

When the bearing head and the rotor casing are separated, the slide valve is attached to the bottom of the rotor casing and moves in parallel with the axis whose position is controlled by the inside guide block【87】and the outside perimeter (of the rotor casing).

The slide valve consists of slide valve 1【54】, slide valve 2【55】, hexagon socket head cap screw【58】, push rod【67】, and oil injection pipe guide【168】, etc.

5.6.20.1 Disassembly

a) The push rod can be pulled out easily in the discharge direction.

b) When replacing the push rod, remove the hexagon socket head cap screws 【162】.

c) Since the oil injection pipe guide 【168】is secured internally by a lock nut, remove the hexagon socket head cap screws 【58】and disassemble and remove the slide valve assembly.

Fig. 052 Unloader Slide Valve

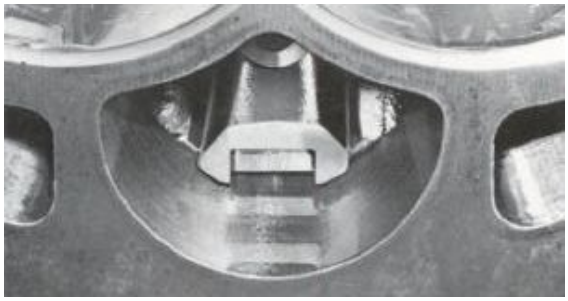


Fig. 053 Unloader Slide Valve and Guide Block

5.6.20.2 Inspection

a) Inspect the gap between the guide block and the sliding surface of the slide valve guiding part.

b) Inspect for abnormalities in the guide pin (dowel pin) 【68】 which mates with the indicator cam 【77】 of the unloader push rod.

c) Inspect for looseness in the assembled state.

d) Thoroughly inspect the hole for the oil injection pipe.

5.7 Reassembly

⚠ WARNING

- **When turning electric tools etc. on or off, take care to avoid electric shocks.**
- **Take care when handling heavy objects and use a crane etc. if necessary. There is a danger of the compressor or parts dropping.**
- **When using a crane, it must be operated by a qualified person. Allowing an unqualified person to perform this work may result in an accident due to dropping the compressor.**
- **Replace the parts with the MYCOM genuine parts. Using parts that are not genuine can cause damage to the compressor or other devices during operation.**

⚠ CAUTION

- **For compressor reassembly work, use specified tools that are properly functioning. Using tools that are worn or damaged, or that are inappropriate for the work, can result in injury.**
- **Before using electric tools, check that there is no problem with insulation resistance. Otherwise, use double insulation tools.**

CAUTION

- **When reassembling, ensure that the replaced O-rings are of the correct standard (size, material, for secure/moving parts 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, a major defect could be caused by the oil route inside the casing being blocked.**

Start reassembly after disassembly and inspection has finished.
Recheck the purchased replacement parts before assembly.
Replace all O-rings as well as gaskets with new ones which were removed by overhauling the compressor.
Reassembly procedure is basically the disassembly procedure in reverse. First, clean the work bench and tools to be used.
Assembly parts should be cleaned with wash oil (kerosene etc.) immediately before assembly, then dried with a compressed air drier, and then covered with lubricant. Prepare sufficient clean lubricant for use during reassembly.
Also, apply lubricant to both sides of the gasket.
The assembly work has many factors in common with both the high-stage part and the low-stage part, so the explanation is common to both parts.
Read and understand the instructions before performing assembly work.

Table 5-10 Standard Tightening Torque for Hexagon Socket Head Cap Screws

Screw Size	M6	M8	M10	M12	M14	M16	M20	M24
N·m	10	25	50	90	140	240	450	750
kgf·cm	100	250	500	900	1400	2400	4500	7500

Tighten each bolt referring to the torque shown in the table above.

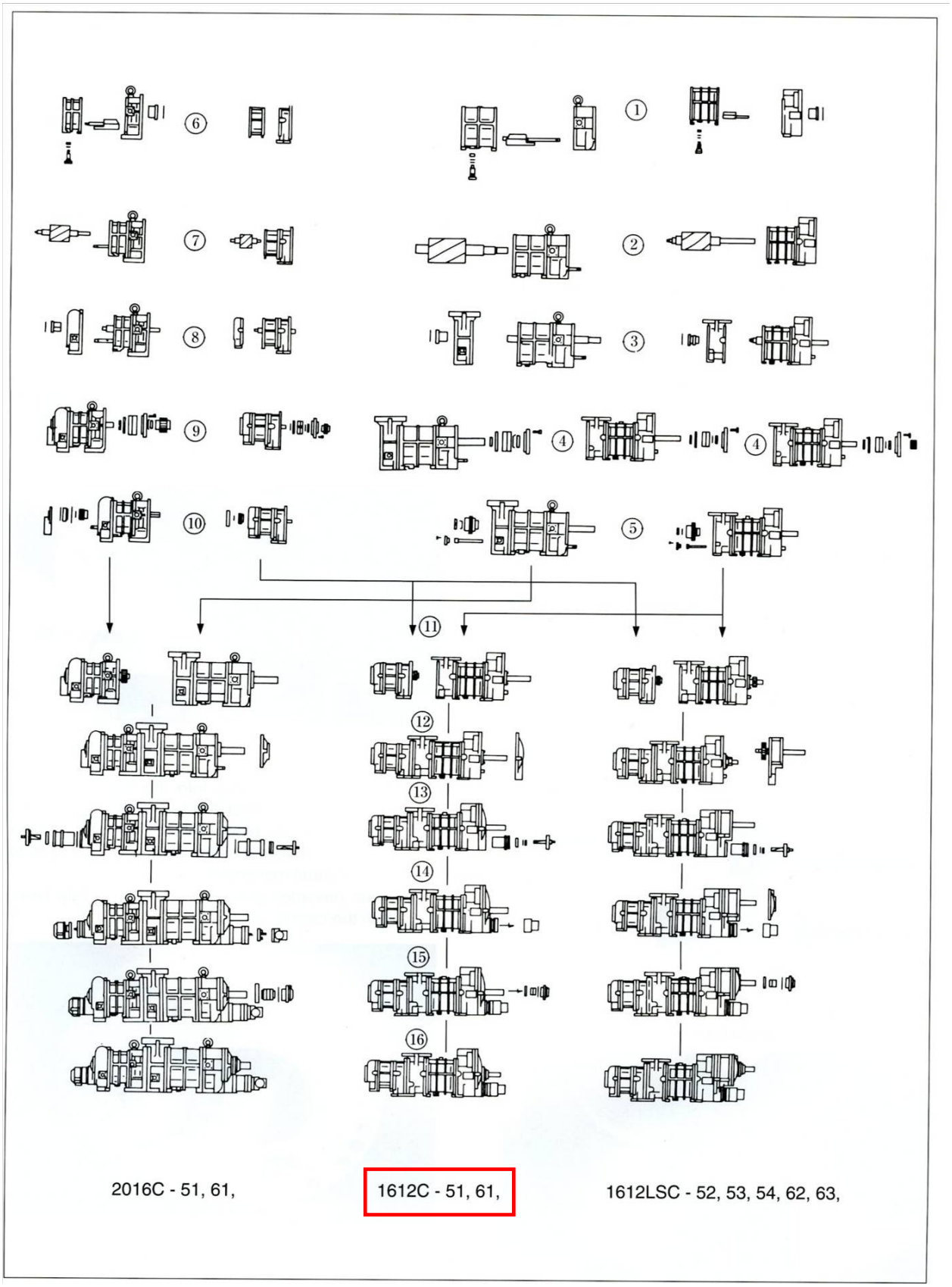


Figure 5-6 Assembly Order Explanation

* The circled numbers in the figure do not correspond to the steps below.

5.7.1 Low-stage Unloader Slide Valve and Guide Block

a) First, tightly screw the guide block stem【88】to the bottom of the casing, and then attach the guide block【87】inside the casing.

b) If the slide valve assembly parts are disassembled, retighten them securely using hexagon socket head cap screws so that they match accurately.

c) Gently smooth the outer surface of each part with a grindstone or emery paper before attaching it to the casing. Next, match the slide valve groove with the guide block and push gently.

d) After assembly, hold and move the unloader push rod, and inspect its movement. Also, inspect the seam between the part and the casing to ensure that it is even.
If it is not even, the part has not been assembled correctly and reassembly is necessary. Using it in that state can lead to an unforeseen accident due to the outer surface of the rotor hitting the slide valve.
* It is not a problem if the unloader slide valve is slightly lower than the casing.

CAUTION

- **There is a problem with assembly if the unloader slide valve is higher than the rotor casing. In that case, reassembly is essential. Using it in that state can lead to heavy damage or an accident due to the outer surface of the rotor coming into contact with the slide valve.**

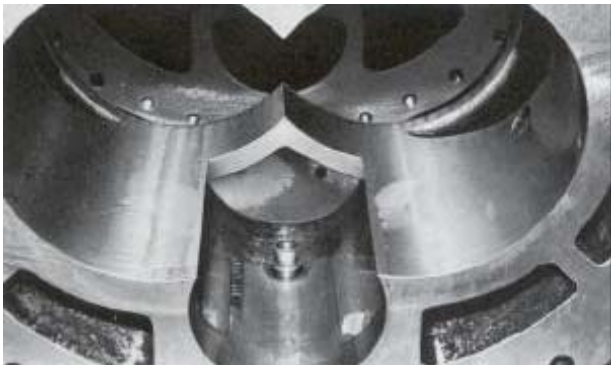


Fig. 054 Guide Block Stem Inside Casing

5.7.2 High-stage Rotor Casing

There are no parts to be reassembled. Clean each part thoroughly.

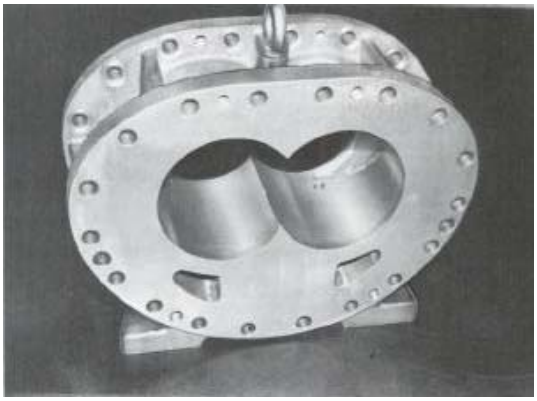


Fig. 055 High-stage Rotor Casing

5.7.3 Bearing Head and Rotor Casing (High/Low-stage)

CAUTION

- **Since the bearing head gasket is asymmetrical, pay attention to the direction when attaching it. If assembly is performed incorrectly, the oil route in the casing may be blocked.**

Fig. 056 Assembled High-stage

a) First, put the unloader push rod into the bearing head hole, and then slide the bearing head or the rotor casing to assemble.

b) Loosely tighten the two screws, secure the alignment pins【3-1】in position, and then tighten the screws in turn evenly.

c) After tightening the screws, check that the bearing head gasket is not protruding inside the casing. New gaskets will always protrude inside the casing so cut the protruding part off with a sharp knife.

d) Assemble the high-stage bearing head and rotor casing in the same manner.

CAUTION

- **Make sure to check for protrusion of the bearing head gasket after assembling the bearing head and rotor casing. If this work is not performed, measurements may be incorrect due to the gasket becoming stuck between the end of the rotor and the surface of the bearing head when adjusting end clearance. Also, performance may deteriorate by operating the compressor after confirming the incorrect end clearance.**

5.7.4 Bearing Head and Main Bearings (High /Low-stage)

It is no problem which assembly work is fast, bearing head and rotor casing described in previous section or bearing head and main bearings in this section.

a) The main bearing (O-ring type) is attached by a gentle press-fitting method.
Position the notch of the main bearing so that it is aligned with the spring pin【14】in the bearing head (using a fixture such as a guide rod is helpful), then, using padding, hit in the notch.

b) After positioning spring pin, high stage main bearings are pushed into bearing head using 8mm eyebolts shown in Fig.057.
If the position is not aligned, pull out the notch and hit it in again.

Fig.057 Attaching Main Bearing High-stage

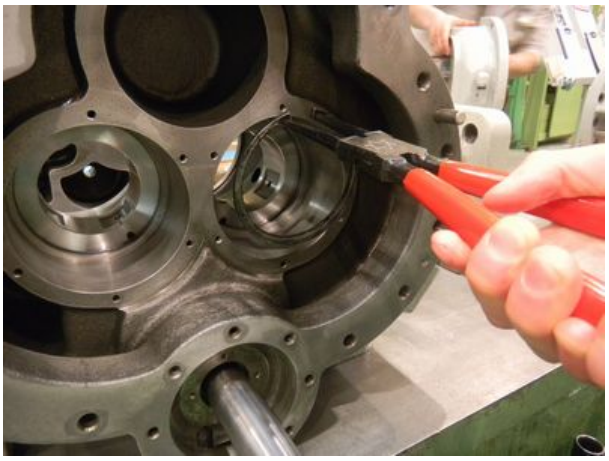


Fig.058 Attaching Stop Ring

c) Make sure to attach O-ring【197】and O-ring gland【326】to the part where the unloader push rod goes through low-stage bearing head.

However, this O-ring gland【326】is applied after the design modification in July 1986. For the compressors manufactured before this change O-ring【197】should be attached in the groove on bearing head.

Fig.059 O-ring【197】

Fig.060 Attaching O-ring Gland【326】

5.7.5 Attaching Rotors (High/Low-stage)

<1612**C Rotor Profile>

The profile was changed from A Profile to O Profile in July 1994.
The biggest difference is the tooth tip edges. Profile A has the tooth tip edges while profile O does not have them

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 certain engagement positions which are indicated by stamp marks.

To facilitate the alignment when attaching to the rotor casing, numbers are stamped on the discharge-side tooth peak of the M rotor and the suction-side tooth peak of the F rotor, respectively.

Fig. 061 M Rotor Mating Mark

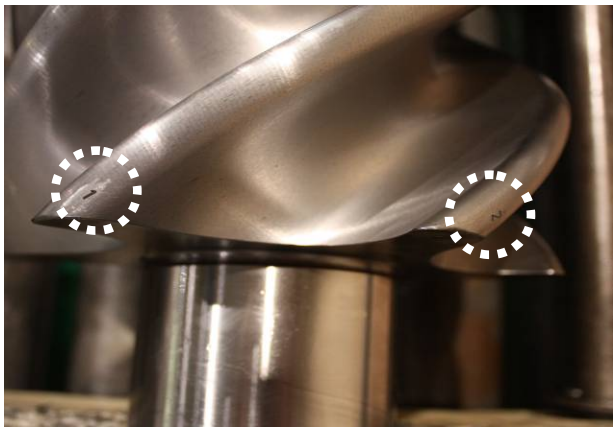


Fig. 062 F Rotor Mating Mark

a) Sufficiently lubricate the main bearing inside the bearing head as well as the bearing portion of the rotor shaft.

b) In assembly, attach the F rotor first to the casing.

c) Insert the M rotor tooth peak (1) between the F rotor tooth peaks (1) and (2). To avoid problems related to engagement and balance, etc., be sure to mate as shown above.
As the M rotor has a stamped mark on the discharge side, it can be easily aligned for assembly.

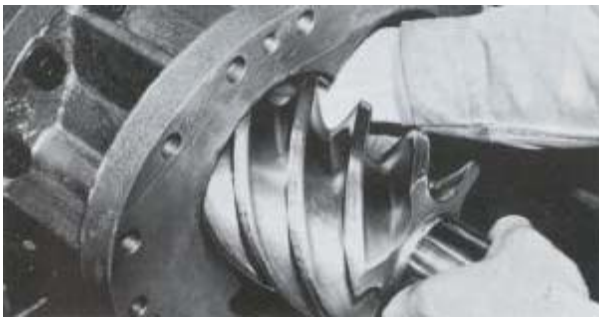


Fig. 063 Attaching F Rotor

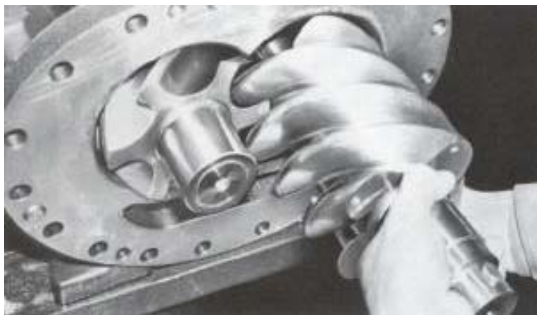


Fig. 064 Attaching M Rotor

CAUTION
● **Since the outer side of the rotor touches the rotor casing in this state, do not rotate too much. Rotating may cause the rotor teeth to wear.**

5.7.6 Suction Cover and Side Bearings (High/Low-stage)

a) The side bearing (O-ring type) is dimensioned in such a way that it is gentle press-fit to the suction cover.
Press it onto the bearing positioning pin【8】in the suction cover aligning it with the bearing notch. Check the alignment of the pin and notch while pressing. If they become misaligned, remove the bearing and try again. After assembly is complete, secure with a stop ring.

b) The suction cover gasket is asymmetrical. Check the position of the oil supply hole.
Lubricate the side bearing thoroughly.

Fig. 065 Side Bearing Rotation Stopper (Low-stage)

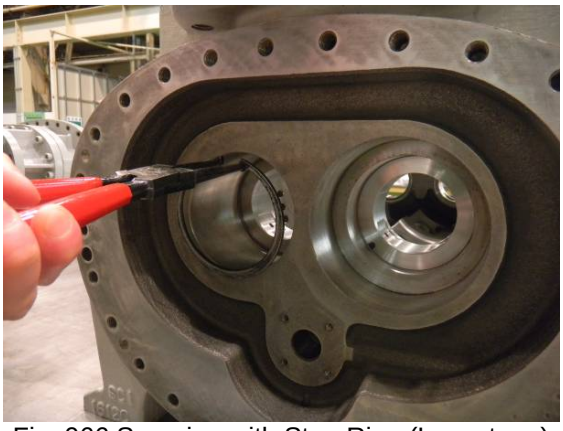


Fig. 066 Securing with Stop Ring (Low-stage)

【POINT】

When press-fitting, using a weight jig and a plastic spacer indicated in the Figure 5-8 makes attaching bearing works easier. The plastic spacer should be just the right size of the bearing inner diameter and hit the spacer inside with the weight jig.

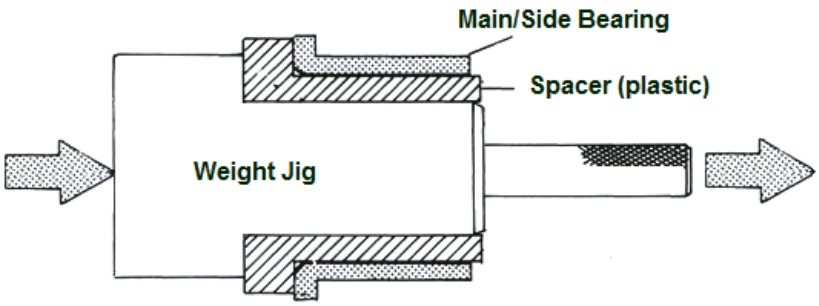


Figure 5-7 Spacer and Weight Jig for press-fitting a Bearing

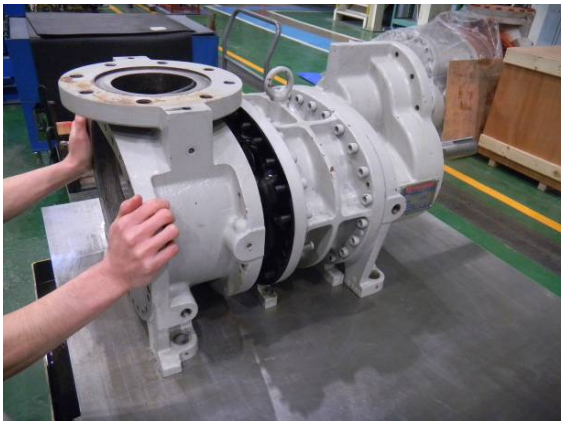


Fig. 067 Low-stage Suction Cover Assembly

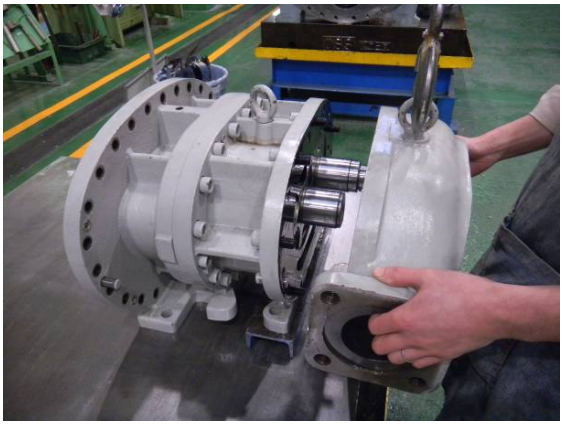


Fig. 068 High-stage Suction Cover Assembly

c) When assembling the low-stage side, slide the suction cover on the work bench to move it to the assembly location. When assembling the high-stage side, use a lifting tool shown in Fig.068 or put a stand witch adjusted height.
When fitting the side bearing and the rotor shaft, be careful not to let the end of the rotor shaft damage the metal on the inner surface of the side bearing.

d) When the rotor axis has entered the side bearing, slide the suction cover parallel with the axis to assemble.

e) First, hit in alignment pins for positioning. Then, tighten the screws evenly.
The six screws on the lower side should be tightened during *final assembly on the special stand* used at disassembling.

f) Rotate the male rotor axis with your hand and check the meshing of the rotors.

g) For the low-stage, assemble the oil injection pipe, and then tighten using the oil injection pipe retainer.

h) Move the push rod with your hand and check the movement of the unloader slide valve.

i) While holding the male rotor axis move it in the axis direction and check that there is allowance.

j) For the high-stage, assemble the balance piston and secure with a stop ring. Check that it is in the groove.

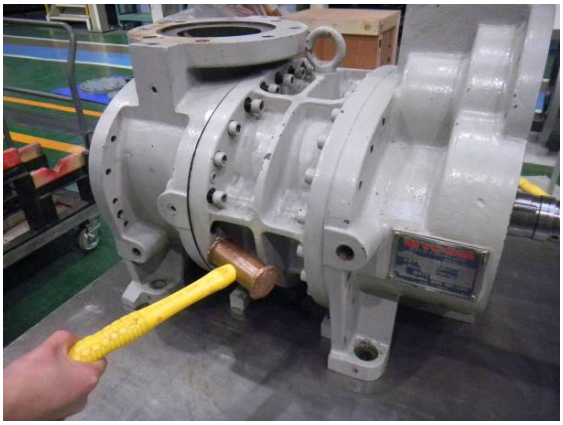


Fig. 069 Hitting Alignment Pin

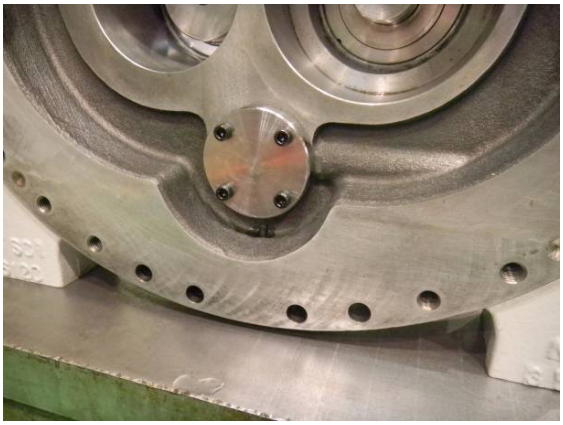
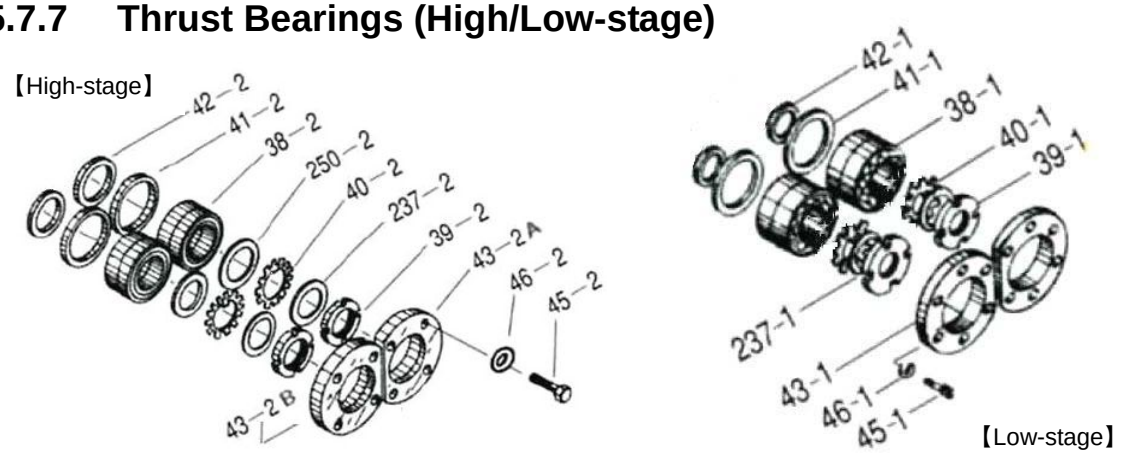


Fig. 070 Oil Injection Pipe Retainer

5.7.7 Thrust Bearings (High/Low-stage)



No.	Part Name	Q'ty
42-1, 42-2	Thrust bearing alignment spacer (1), (2)	2 each
41-1, 41-2	Thrust bearing outer race spacer (1), (2)	2 each
38-1, 38-2	Thrust bearing (1), (2)	2 sets each
250-2	Thrust washer (for 125***) *High-stage only	2
40-1, 40-2	Lock washer (1), (2)	2 each
237-1, 237-2	Torsional slip washer (1), (2)	2 each
39-1, 39-2	Lock nut (1), (2)	2 each
43-2A	Thrust bearing gland (2) A for high-stage F rotor	1
43-2B	Thrust bearing gland (2) B for low-stage M rotor	1
43-1	Thrust bearing gland (1)	2
46-1	Spring washer (1)	12
46-2	Spring washer (2)	8
45-1	Hexagon head bolt	12
45-2	Hexagon head bolt	8

Figure 5-8 Development View of Thrust Bearing Section

CAUTION

- **When installing the disassembled thrust bearing as is, check the male/female engravings on the thrust bearing outer race spacers and thrust bearing alignment spacers, and reassemble them in the same way as before disassembly. This is essential to control the end clearance of the rotor discharge side.**
- **Even if the same bearing is reassembled, small pieces of paint or dirt between the spacers and washers can cause dimensions to become incorrect.**
- **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 accordingly.**

The procedure for assembling this part is described in Figure 5-8. The important points are explained below.

a) 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 due to 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, after assembling with the bearing number engravings on the outer side, make a V-shaped mark using blue whetstone on the machine's inner side of the bearing.

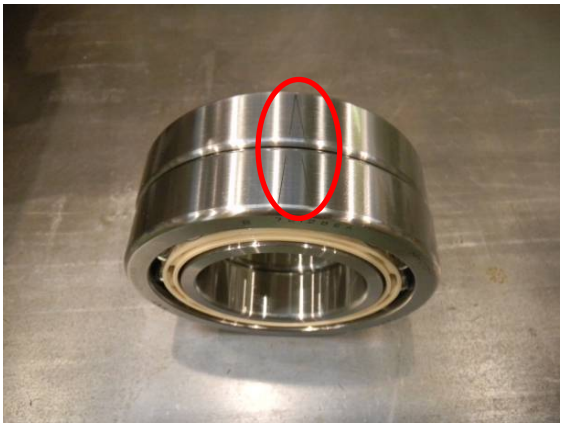


Fig. 071 Thrust Bearing Assembly Mark

Fig. 072 Assembling Thrust Bearing

b) After assembling the thrust bearing, attach the lock washer, tighten the lock nut, and secure the inner race of the thrust bearing to the rotor axis. Be sure to use a new lock washer.

CAUTION

- **Since the inner race of the thrust bearing is lodged for ease of access at the assembly site 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 is different even if within standard values. Therefore, fully tightening the nut from the start may lead to a noticeable reduction in the life of the bearing due to a lack of end clearance between the rotor and bearing head discharge side edge, and indentations on the contact surface from ball pressure. To avoid this, check for end clearance while tightening.**

5.7.7.1 End Clearance Measurement

At this point, measure the end clearance of the fully assembled rotor discharge side. In particular, when the thrust bearing has been replaced, measurement is essential. When using the same bearing, measure just in case.
If the clearance is not within the specified range shown in Table 5-11, adjustment is required.
The measurement method and adjustment method are explained below.

Table 5-11 End Clearance (Unit: mm)

Compressor Model	Rotor Profile	High-stage	Low-stage		
			S	M	L
1612**C	A	0.04–0.06	0.20–0.22	0.22–0.24	0.24–0.26
	O	0.03–0.06			

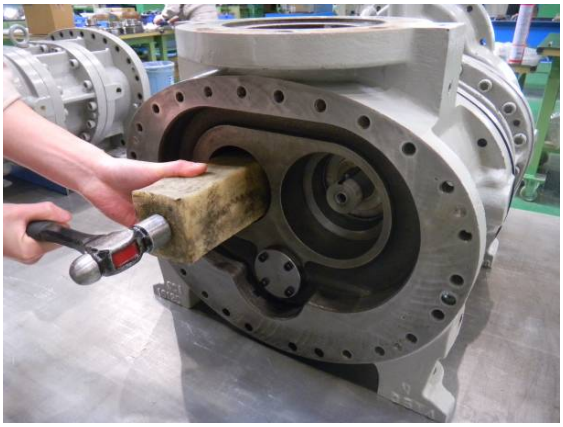


Fig. 073 Pushing Rotor from Suction Side to Discharge Side

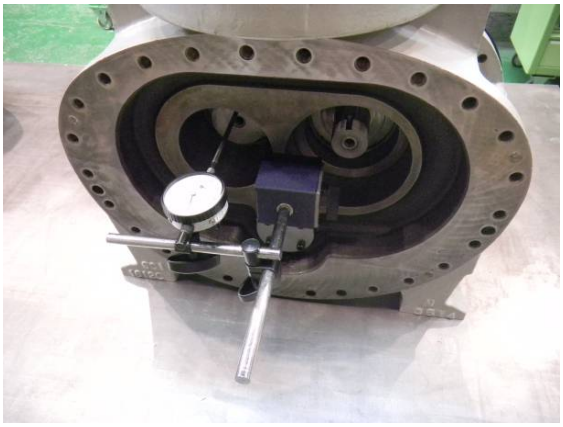


Fig. 074 End Clearance Measurement

a) Push the rotor to the discharge side while the thrust bearing inner race is secured to the rotor axis. As shown in Fig. 073, push the rotor from the suction side using a fixture (Teflon).
Alternatively, as shown in Figure 5-9, using the chamfered part of the lock nut, pull out the rotor with the edge of a flat screwdriver.

b) When the rotor has been pushed to the discharge side, prepare to attach the thrust bearing gland, then attach a dial gauge to the end of the axis and match the indicating needle to 0.
Dial gauge measurement should be done from the side bearing, as shown in Fig. 074, in order to make the bearing gland tightening work easier and more precise.

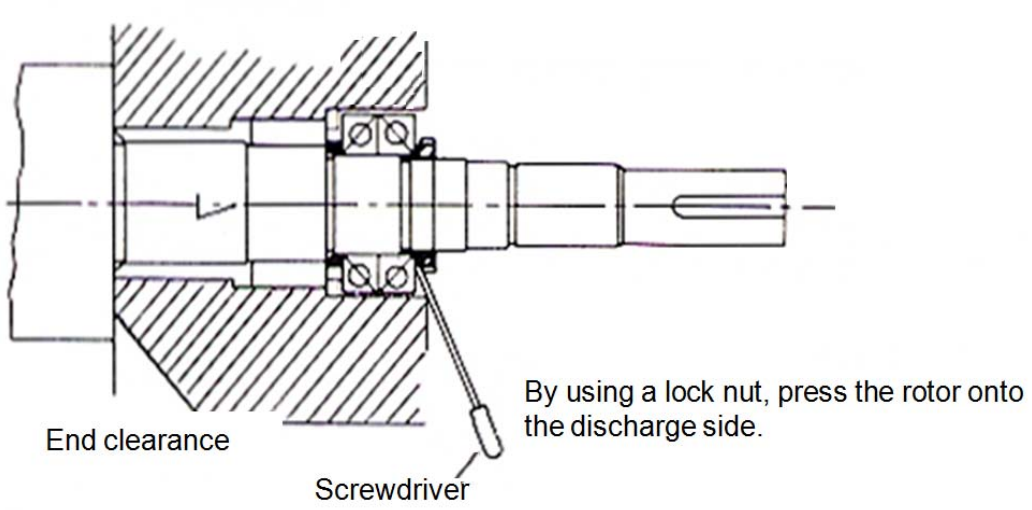


Figure 5-9 End Clearance Adjustment【1】

c) Secure the bearing gland by tightening the four screws evenly to the specified tightening torque gradually.
Tightening each screw to the specified torque at once will lead to uneven tightening so tighten each screw little by little. Then, read the dial gauge measurement. This value is the actual end clearance.

Table 5-12 Thrust Bearing Gland Tightening Torque

Compressor Model		Tightening Torque	
		N·m	kgf·cm
1612**C	Low-stage	13	130
	High-stage	30	300

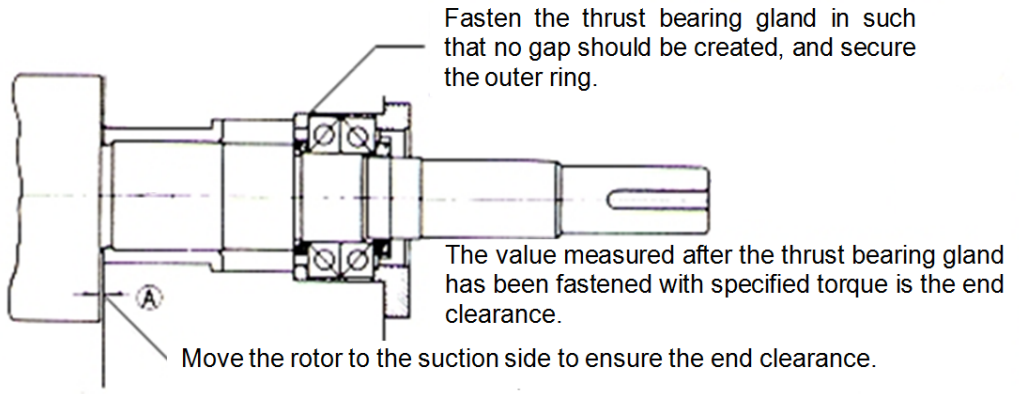


Figure 5-10 End Clearance Adjustment【2】

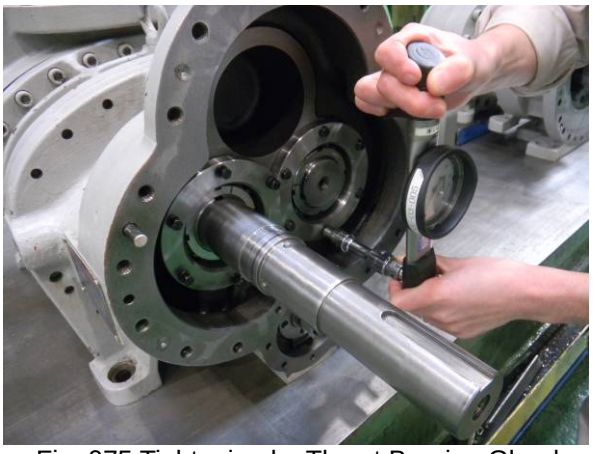


Fig. 075 Tightening by Thrust Bearing Gland

5.7.7.2 End Clearance Adjustment Method

(1) When the 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 saucer by using a micrometer, and check that the thickness is even.

(2) When the 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 service 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 axial runout measurement

If the end clearance has been adjusted to within the specified range, place a dial gauge probe on the male rotor axis seal attachment part and measure axial runout by rotating the rotor axis.
The tolerance for axial runout is 0.03 mm or less for all models.
Runout occurs when the thrust bearing alignment spacer and thrust bearing outer race spacer are not parallel or when the thrust bearing mark is not aligned. In particular, runout is obvious when dirt exists between parts.
If axial runout exceeds the tolerance level, even if the end clearance is within the specified range, disassemble and adjust the relative positions of the outer race spacer, alignment spacer and thrust bearing. This is important because it affects the life of the mechanical seal and performance.

5.7.7.3 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 by one. Insert spring washers【46】as rotation stoppers, and tighten to the specified torque again.

5.7.8 Bearing Cover

a) Before attaching the bearing cover【16】, confirm once again that the lock washer claw of the thrust bearing bended as a rotating stopper and that all the hexagon head bolts for holding the thrust bearing gland have spring washer inserted.

b) Screw the stud bolts into two of the upper holes provided in the flange surface of the bearing head (1)【11-1】.

c) Apply oil to the bearing head flange surface and the both surfaces of the bearing cover gasket (1)【17-1】. Hang the gasket on those stud bolts in such that it is put on the flange surface.

d) While holding down the bearing cover with your hand, align the alignment pins and holes, and gently hit the flange part with a shockless hammer alternately to assemble.
When the gap has closed sufficiently, screw in 2-3 screws to close the gap evenly, and then screw in the remaining screws to tighten.

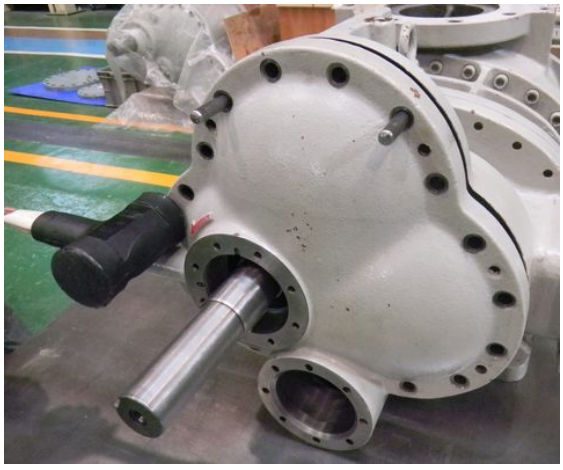
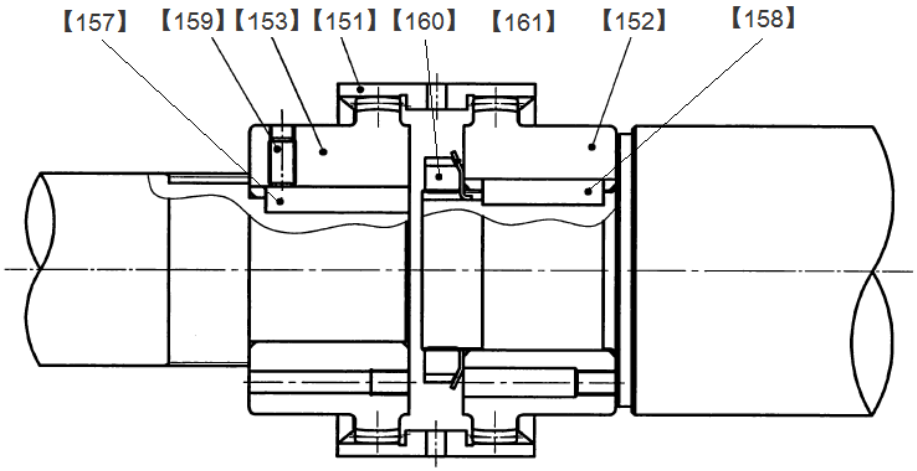


Fig. 076 Bearing Cover

5.7.9 Combining High-stage and Low-stage



【157】	Key, driven hub	【160】	Lock nut
【159】	Set screw	【161】	Lock washer
【153】	Driven hub	【152】	Drive hub
【151】	Driven sleeve	【158】	Key, Drive hub

Figure 5-11 Assembly Drawing of Gear Coupling

a) On the high-stage, attach the driven hub【153】of the gear coupling, and fasten the M8 set screw【159】for securing the driven hub key【157】. This set screw is knurled and provided with anti-loosening.

b) On the low-stage, attach the drive hub【152】, lock washer【161】and lock nut【160】in this order. Fasten the lock nut with the specified torque or tightening angle range (see Chapter 7 "7.3 Tightening Torques for Bolts and Nuts" in this manual).
Align the lock washer claw with the notch of the lock nut, and bend it.

c) Set the driven sleeve onto the low-stage drive hub.

Fig.077 The Present Gear Coupling Parts

Fig.078 Low-stage Gear Coupling Part

d) Screw stud bolts into two of the upper holes provided in the low-stage flange surface which is to be attached to the high-stage.

e) Apply oil to the both surfaces of the bearing cover gasket (2)【17-2】. Attach the gasket on the flange surface over the stud bolts.

f) Lift the high-stage by using lifting tools until it is slightly off the surface plate, and move it toward the low-stage.
At this moment, on the low-stage, slightly move the M rotor shaft in both directions, so that the gear coupling assembly will fit smoothly.

g) After the gear coupling is assembled, press the high-stage parallel with the rotor shaft. For both upper and lower sides, gradually and evenly tighten, temporarily, the hexagon socket head cap screws【18-2】that are set in the bolt holes, each hole located one or two holes apart from the left or right alignment pin, until the high-stage and low-stage flange surfaces come into contact.

h) After the flange surfaces come into contact, slightly loosen the four hexagon socket head cap screws, which have been temporarily tightened, and then drive in the left and right alignment pins.

i) Tighten the hexagon socket head cap screws to the specified torque (90 N·m). The lower bolts should be tightened on the special table, which was used during disassembly.

j) Turn the low-stage M rotor (use of a jig for rotating the rotor is helpful), and check that it rotates properly.

Fig. 079 Combining High and Low-stage

5.7.10 High-stage Balance Piston Cover

Assemble in the correct direction paying attention to the oil hole of the gasket.

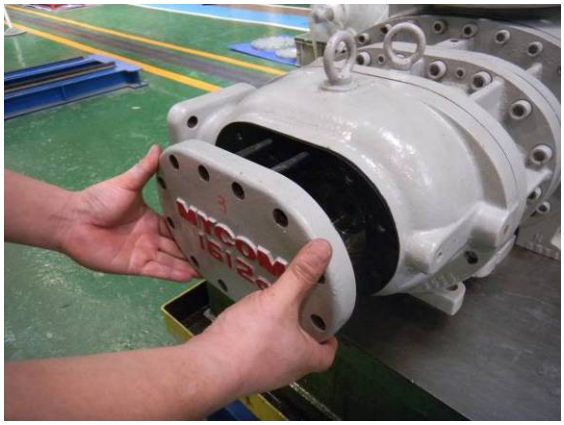
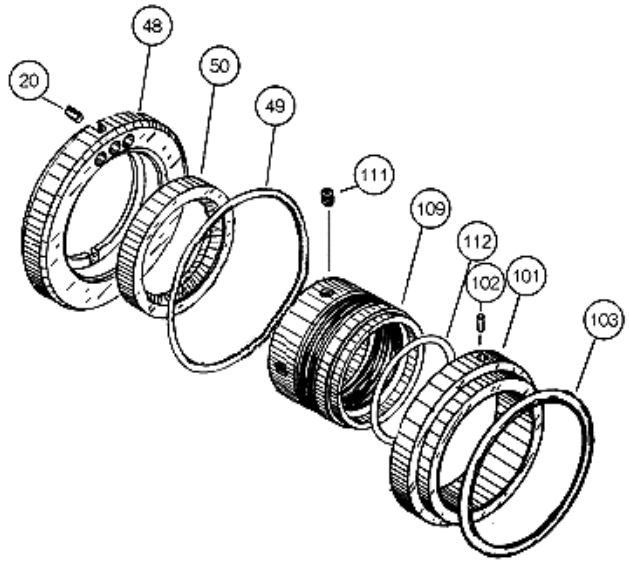


Fig.080 Assembling Balance Piston Cover

5.7.11 Mechanical Seal

The BBSE (balance bellows single) type of the mechanical seal assemblies used in current standard MYCOM screw compressors as standard specification.
In addition, the BOS (balance O-rings single) type may be used by the specification of the customer.



No.		Part Name	
100	101	Mating ring	Stationary ring
	102	Insert lock pin	
	103	O-ring	
	109	Seal collar	Rotating ring
	111	Seal collar set screw	
	112	O-ring	
20		Spring pin	
48		Oil seal retainer	
49		O-ring	
50		Oil seal	

Figure 5-12 BBSE Type Mechanical Seal

a) Before assembly, clean the part of the rotor axis where the seal will be attached.

b) In particular, immediately before assembly, recheck the step part for mounting the axial seal for damage.

c) Attach the oil seal【50】to the oil seal retainer【48】.
Since the design modification notification in November 2002, the oil seal attachment direction has changed from the oil seal lip facing the atmosphere side to it facing the opposite side. This was in order to improve oil flow from inside the seal box and ensure that pressure is not excessive. However, if attaching the oil seal retainer in the following work may become difficult, attach it according to the previous attachment direction.
Using a resinous material such as Teflon as the batten, gently hit the oil seal while pushing it evenly and fully to assemble. When it has been pushed in fully, the sound and feedback will change.
After assembly, check that the seal is aligned with the retainer and that they are even from the other side.

d) Attach the oil seal retainer with the oil seal attached to the rotor axis using 2 standard 8mm eyebolts as shown in Fig. 081. At this time, ensure that the retainer's oil hole is on the upper side of the rotor axis, and accurately align the spring pin【20】for stopping rotation on the bearing cover with the retainer notch part.
After assembly, rotate the retainer's eyebolts to check that they are secure. If they are secure, the retainer will not rotate.

e) Next, insert the O-ring【49】for the oil seal retainer (Fig.082).

CAUTION

- **Take special care because users frequently omit to insert the O-ring【49】for oil seal retainer.**

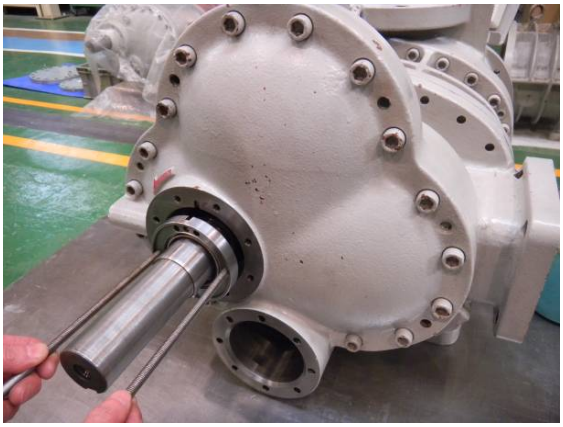


Fig. 081 Oil Seal Retainer and Oil Seal

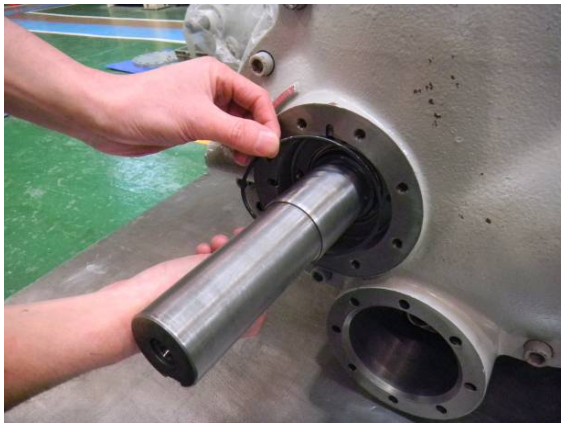


Fig. 082 Attaching O-ring【49】

f) Attach the mechanical seal assembly to the rotor axis. Before assembly, apply sufficient assembly lubrication oil to the rotor axis and seal in order to wash away any dirt.
After assembly, check movement by pushing the seal ring with your hand in the direction of the axis. Take care not to damage the O-ring【112】on the rotor axis steps while doing so.

g) Tighten the seal collar into the securing countersinking holes on the rotor axis using 2 seal collar locking screws【111】. Tightening the seal collar into holes other than the countersinking holes can cause damage to the rotor axis which can lead to leakage.

h) Attach the mating ring O-ring【103】and the mating ring【101】to the seal cover【51】.

i) Apply oil to the seal cover gasket【52】, align the gasket oil hole with the bearing cover oil hole, and affix the gasket to the attachment (flange) side.
* With the standard internal oil supply type, the bearing cover and the seal cover are connected by an oil supply hole, and oil is supplied to the upper sliding surface of mechanical seal assembly from that oil supply hole via the seal cover notch part and the upper side of the seal cover.

j) Attach the gasket so that the oil removal piping of the attached seal cover is on the bottom side.
At this time, attach it carefully, either at a right angle or by delaying the upper side slightly, to ensure that the mating ring inside the seal cover does not hit the rotor axis.

k) The seal ring and the 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 (Fig.083). This value is called tightening allowance for seal. It is used when checking the sliding face pressure between the rotating ring and stationary ring of the seal.
In case of BBSE-type seal of the 1612**C, if this value is not within the range between 2 and 3 mm, measures should be taken, such as replacement of mechanical seal assembly or addition of another gasket.
With the 1612**C compressor, the thickness of the seal cover gasket is 0.5 mm.

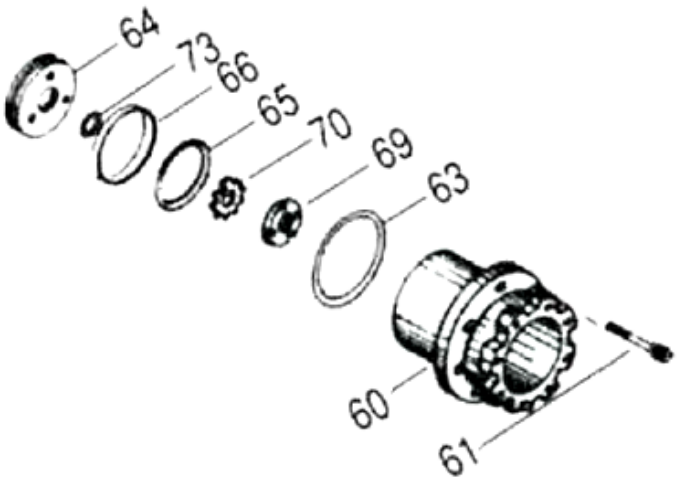
Fig.083

m) When the seal tightening allowance 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【53】(for tightening the seal cover) evenly at positions 180 degrees apart. When there is no gap between the flange surface and the gasket, tighten all of the remaining bolts to the specified torque (25 N·m).

n) The hole for tightening the seal collar set screw on 1612C models is on the bearing cover, so do not forget to plug it after attaching the seal cover.

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

5.7.12 Unloader Cylinder and Piston



No.	Part Name	Q'ty
60	Unloader Cylinder	1
61	Hexagon Socket Head Cap Screw M8X95	8
63	O-ring JISB2401 G95	1
64	Unloader Piston	1
65	O-ring JISB2401 P75	1
66	Cap Seal BE75	1
69	Lock Nut AN05	1
70	Lock Washer AW05	1
73	O-ring JISB2401 P21	1

Figure 5-13 Unloader Cylinder Part

a) Attach the O-ring【73】to the O-ring groove at the end of the unloader push rod【67】where the unloader piston is to be attached.

b) Attach the O-ring【65】to the unloader piston【64】using sufficient assembly lubricant, and then attach the cap seal【66】on that. Inserting an outer side fold in the circumferential direction of the cap seal makes attachment smooth.
Also, using a small smooth spatula-shaped object makes attachment easier.

c) From the side of the unloader cylinder【60】where the inner surface is chamfered for ease of assembly (inner machine side), attach the unloader piston with the screw holes for eyebolts on the unloader cylinder cover side.
After assembly, check that the cap seal is not broken or pinched.

d) Attach the O-ring【63】to the O-ring groove at the bearing cover【16】where the unloader cylinder is to be attached.
* According to a design modification notification on October 1996, the place O-ring【63】is attached has been changed from the opening with chamfered to the current position indicated in Figure 5-13.
This modification was applied first to assembly (serial No.1622548) in Dec. 13. 1996.

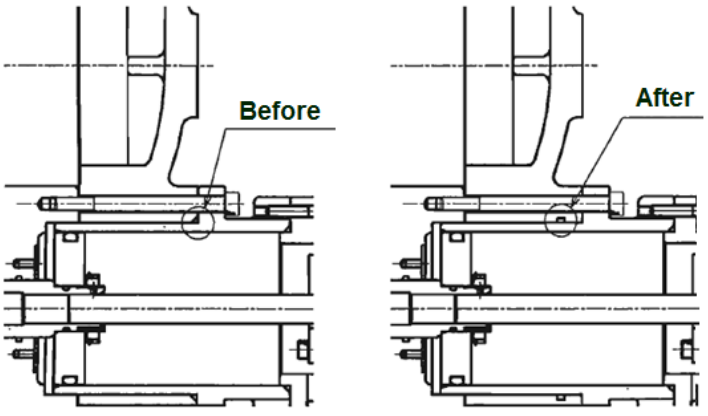


Figure 5-14 Before/After Design Modification

e) Attach the unloader cylinder to the bearing cover, and fasten the eight hexagon socket head cap screws【61】to the specified torque (25 N·m).

f) Attach the lock washer【70】and lock nut【69】to the unloader push rod, and fasten the lock nut to the specified torque of 80 N·m (Photo 114).
To stop rotation, align the lock washer claw with the notch of the lock nut in the tightening direction, and bend the claw (Photo 115). Lastly, check the movement of the unloader piston by using eye bolts.

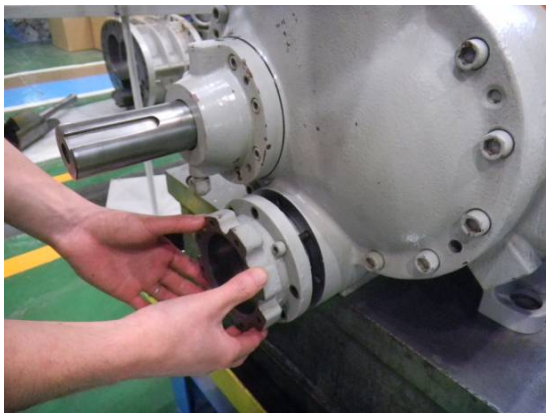


Fig.084 Attaching Unloader Cylinder

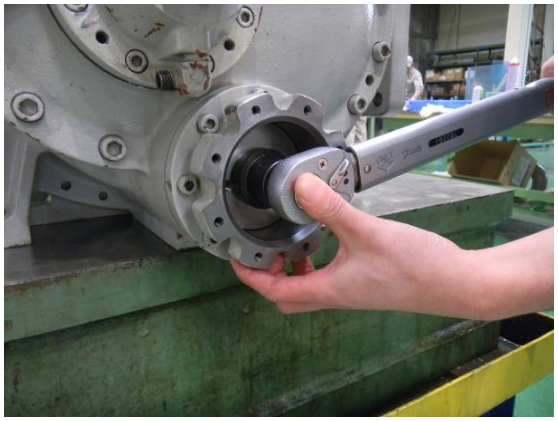


Fig.085 Fasten Lock Nut

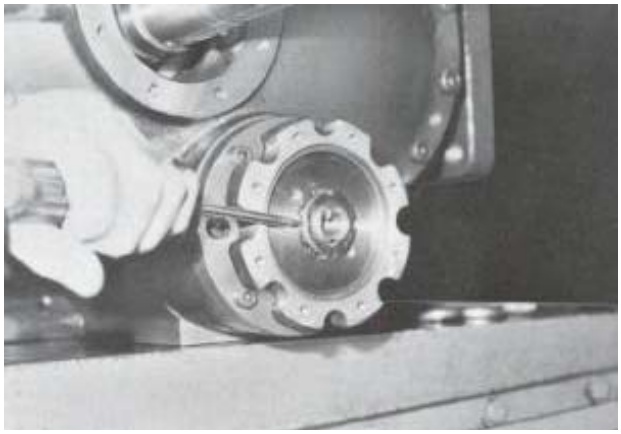


Fig. 086 Bending the Lock Washer Claw

Fig.087 Check motion of Unloader Piston

g) After tightening the unloader piston, screw eyebolts into the unloader piston again, and move the piston 2-3 times to check it's motion.

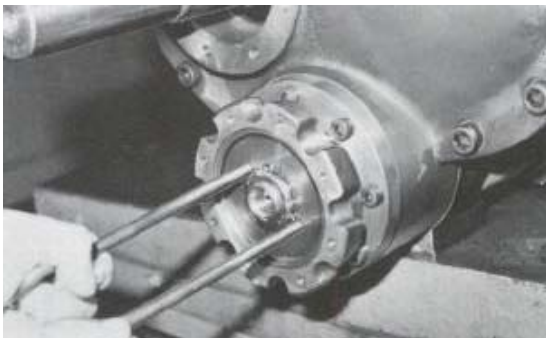


Fig. 088 Lastly, Pulling to Front
(All No-load Position)

CAUTION

- **For the 1612SSC model, do not forget to attach the unloader piston spacer【423】.**

5.7.13 Unloader Cylinder Cover

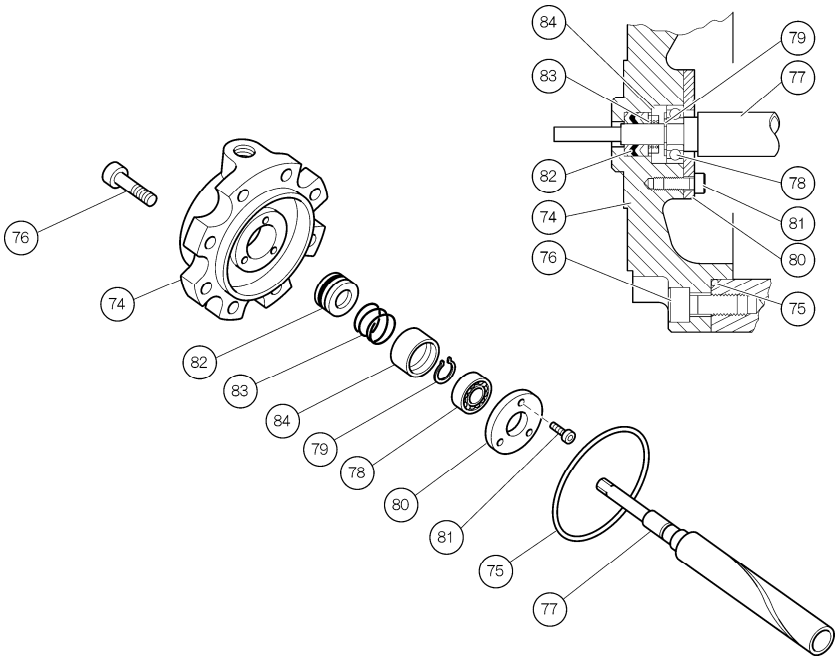


Figure 5-15 Unloader Cylinder Cover Development View

a) Before proceeding to the next procedure, make sure to pull the unloader piston to the no-load position (front).

b) Attach the ball bearing【78】to the axial part of the indicator cam【77】. When pushing in, push the inner race of the bearing. Pushing the outer race may cause damage to the bearing.
Push up to the indicator cam step and use a stop ring to hold.

c) Attach the V-ring set【82】applying sufficient oil to the unloader cylinder cover【74】. One of the V-rings in a set is made of rubber (dark color) to improve sealing performance. As shown in Figure 5-14, it is set at the second position viewed from the outer side of the machine.
Make sure that the V protrusion of the V-ring faces the outer side and the lip faces the inner side of the machine.

d) Attach the spring【83】and spring retainer【84】, insert the axis of the indicator cam assembled in b) into the V-ring, and tighten the bearing to the unloader cylinder cover using the bearing gland【80】.

e) Check that the indicator cam rotates smoothly, and then attach the O-ring【75】to the unloader cylinder cover.

f) Attach the unloader cylinder cover to the unloader cylinder【60】. Push the unloader cylinder cover in such a way that the guide pin (groove pin)【68】of the unloader push rod【67】just fits to the spiral groove of the indicator cam. Secure the unloader cylinder cover with the hexagon socket head cap screws【76】, with its hole for supplying unloader working oil facing upward.

5.7.14 Unloader Indicator

The unloader indicator contains micro-switches, a micro-switch cam and a potentiometer. Either of them detects the rotational volume change of the shaft of the indicator cam, which converts the axial positional change of the unloader slide valve into circumferential positional change, and sends it as electric signals to the control side of the package unit or refrigerating system.

For confirmation after inspection/adjustment or parts replacement, they need to be linked with the control side. So, even during an overhaul which is conducted with the compressor carried out of the installation site, this portion is often removed from the compressor as an indicator assembly so that inspection/adjustment can be conducted at the site.

WARNING

- **When testing/adjusting or replacing parts on the indicator, make sure to turn off and lockout/tagout the control power. Failure to do so could cause an electric shock.**

The 1612**C model has, on its low-stage, an indicator designed for the low-stage of 2-stage compressor, which, additively, has a bevel gear for changing the indicator needle and dial from axial direction to lateral direction.

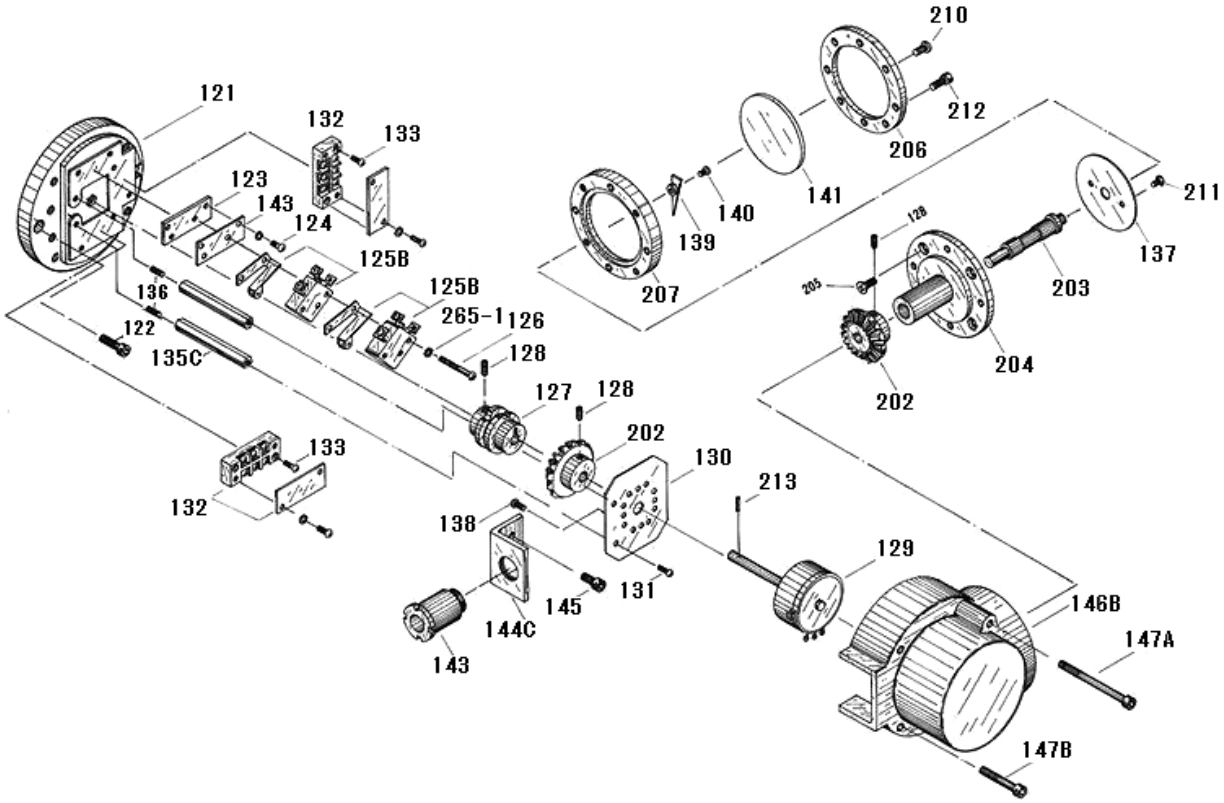


Figure 5-16 Development View of the 1612C Unloader Indicator**

5.7.14.1 Potentiometer

The potentiometer of the 1612**C indicator is of the full rotation type. It senses the continuously variable position (indicated load of 0% to 100%) of the unloader slide valve, and feeds the sensed position as electric signals to the control side of the package unit or refrigerating system. Life expectancy of the potentiometer varies significantly depending on the compressor's installation environment (with corrosive gas atmosphere or much moisture) or operating state (frequently operated with partial load, frequently started/stopped, subject to much vibration, etc.). It is a consumable part, and needs to be replaced periodically depending on the situation.

■ Disassembly

a) Remove the hexagon head cap screws securing indicator glass【141】, indicator glass gland【206】 and indicator glass support【205】. At this time, do not mistakenly loosen the phillips screws【210】 on the same surface.
   It become possible to remove the indicator shaft assembly with【141】,【202～207】,【210】, and 【211】.

b) When remove two hexagon head cap screws【147A】【147B】for each which are securing the indicator cover【146B】, it becomes possible to remove the indicator cover.

c) Remove the electric wiring of the potentiometer. To avoid future assembly errors, put markings to indicate positional relationship of wiring by using different colors of tape or the like, and take a note.

d) Remove the phillips screws【131】of the potentiometer set-plate【130】. This allows the potentiometer set-plate with the potentiometer [129] attached to be removed.
   The potentiometer axis is removed with the micro-switch cam [127] and bevel gear [202] attached.

e) The micro-switch cam moves freely in the direction of the axis can be easily removed because only the rotation direction is secured by a spring pin [213] in the potentiometer axis and a notch.

f) The bevel gear [202] is secured to the potentiometer axis by the set screw [128].
   Loosen the set screw, and then pull out the potentiometer spring pin using pliers to remove.

d) Loosening two phillips screws [138] allows the potentiometer and potentiometer set-plate to be separated.

■ Inspection

a) On the terminal block, check whether or not the lead wires of the potentiometer are loose.

b) Check for defects such as cracks in the welded portion of the potentiometer lead wires.

c) Rotate the axis of the potentiometer with hand, and check with a tester whether the resistance value changes smoothly.

5.7.14.2 Micro-switch

The unloader indicator has two micro-switches and one micro-switch cam, for sensing that the unloader slide valve is at the 0% position or the 100% position of capacity control (indicated load).
If, for any reason, their assembly gets loose or the micro-switch(es) gets faulty, proper sensing will be disabled, which will cause trouble in operation control of the compressor.

■ Disassembly

a) Same work as disassembly procedure of the potentiometer a) to d).

b) Remove the electric wiring of the micro-switch. To avoid future assembly errors, put markings to indicate positional relationship of wiring by using different colors of tape or the like, and take a note.

c) The micro-switch【125】is secured with two long phillips screws【126】. The micro-switch can be removed by loosening these screws. Do not remove these screws except when the micro-switch needs to be replaced. Leave them as they are when conducting inspections or positional adjustments.

■ Inspection

a) Check that the wiring of the micro-switch has been removed. After that, turn the switch on and off and check whether it works properly by using a tester.

b) When the compressor's capacity control oil pressure pipe is opened due to overhaul or the like, pull the unloader piston to the no-load position/full-load position by using nitrogen gas or compressed air pressure, in order to check whether the micro-switch senses the 0%/100% position of the micro-switch cam.

c) In addition, conduct appearance check to find out any traces of water entry inside the indicator, defects in the switch terminal such as corrosion, wear in the switch roller or micro-switch cam, etc.

5.7.14.3 Assembly and Adjustment

a) Attach the micro switches. In theory, the switches will work on the cam irrelevant of the position of the attachment holes. However, attach switches as close as possible to the cam.

b) Secure the potentiometer to the attaching board, attach the bevel gear, and secure with locking screws.

c) Press a spring pin into the potentiometer axis hole.

d) Align the micro switch cam notch with the pin and attach to the potentiometer axis.

e) Secure the potentiometer part to the support post [134].

f) Attach the assembled part to the unloader cover using hexagon socket head cap screws [122].
Match the indicator cylindrical cam axis of the unloader cover with the micro switch cam.
Rotate the micro switch cam with your hand to check micro switch operation. (Make sure to use a tester etc.)

g) Align the countersinking holes of the axis with the locking screws of the micro switch cam and secure them. This fixes the positions of the unloader slide valve, micro switch cam, and potentiometer.

h) Attach the indicator cover. Electric wiring should be placed considering ease of operation.

i) Attach the indicator. If the needle is not set to 0 due to the alignment of the gears, remove the indicator glass part, loosen the needle locking screw, and set the needle to 0. Assembly is now complete.

■ When the position of the unloader piston is unknown

When the position of the unloader piston is unknown, position the indicator needle correctly by following the procedure below.

a) When the compressor's capacity control oil pressure pipe is opened due to overhaul or the like, pull the unloader piston to the no-load position by using nitrogen gas or compressed air pressure. Then, align the indicator needle to the start point of the semicircular range drawn on the dial face, and fix it. Next, move the unloader piston to the full-load position, and check that the indicator needle points at the end point of the range drawn on the dial face.

b) In a normal state where the capacity control oil pressure pipe is not opened, move the unloader piston by using a manual capacity control circuit. When the control power is turned on, keep the indicator cover attached to avoid electrical shock. After the position of the piston is determined, turn off the control power and conduct lockout/tagout. After that, remove the indicator cover and fix the indicator needle.

6 Troubleshooting

Table 6-1 describes typical troubles of compressors, their causes, and actions to be taken. For details about troubleshooting for the unit and refrigeration cycle, refer to the unit instruction manual.

Table 6-1 Troubleshooting

	Trouble	Direct causes	Factors	Actions
01	Compressor not starting	Power source is off.	Most cases are due to neglect to turn power source on after inspection.	Prevent by checking using a check sheet, and by pointing and calling.
		Main motor malfunction	Most cases are due to overload protection circuit.	Refer to the motor instruction manual as well for other causes and actions.
		Capacity control of 0% undetected by indicator micro-switch and micro-switch cam	Malfunction of micro-switch	Replace micro-switch.
			Loosening of micro-switch or micro-switch cam set screw due to vibration.	Adjust position for cam and switch and tighten them. Use screw glue as necessary. If vibration of compressor is abnormally high, refer to item 12, “Abnormal vibration and/or noise of compressor”.
		Capacity control hydraulic circuit defect	Maladjustment of oil controller valve (decreased too much)	Readjust.
			Leak or clogging in pipes and solenoid valves	Remove factors. Check oil contamination level and replace pipes and solenoid valves.
		Unconfirmed hydraulic pressure	Malfunction in hydraulic pressure protection device, pressure sensor, relays, etc.	Identify malfunctioning devices, examine their causes, and take measures. Then, replace malfunctioning devices.
			Clogging in connecting pipes	Remove clogging. Check oil contamination level and replace oil as necessary.
		Unconfirmed cooling water circulation	Malfunction in devices such as cooling water pumps and related circuits	Identify malfunctioning devices, examine their causes, and take measures. Then, replace malfunctioning devices.
			Clogging in circulation routes	Remove clogging.
		Malfunction in magnets, relays, etc., in compressor start circuit	Aging degradation	Replace with new devices.
			Bad installation environment	Replace ventilation fans, etc, if malfunctioning. Improve temperature, humidity, and ventilation for installation site.

	Trouble	Direct causes	Factors	Actions
02	Compressor stops immediately after startup.	Low pressure protection circuit activated	Insufficient refrigerant circulation volume • Insufficient refrigerant amount • Insufficient refrigerant supply • Heat exchange failure at heat exchanger	For insufficient refrigerant amount, check for and stop leak, and then replenish refrigerant. * Be aware of moisture contamination in the system.
				For insufficient supply, inspect expansion valves and supplying strainers, and then take necessary measures. Also, inspect devices and parameters (setting values) for expansion value aperture adjustment device, and then take necessary measures.
				If any heat exchange failures as typified by poor defrost performance, investigate the cause and take measures.
				For malfunction in pressure adjustment valve operation, replace pressure adjustment valve, or remove the cause.
			Malfunction of low pressure protection device, pressure sensor, relays, etc.	Identify malfunctioning devices, examine their causes, and take measures. Then, replace malfunctioning devices.
		Motor overload	In many cases, motor overload that occurs just after startup is caused by the motor, not by the refrigeration cycle. Refer to the motor instruction manual.	
03	Abnormally low pressure (low suction pressure)	Refer to the direct cause “Low pressure protection circuit activated” in item 2.	Same as on the left	Same as on the left
04	Low oil-supply pressure	Clogging in oil filter element * Big difference in outlet/inlet pressures	Contamination of lubricant	Remove clogging. Check oil contamination level and replace pipes and solenoid valves.
			Defect inside compressor	Check oil contamination level. After vibration noise diagnosis, overhaul compressor as necessary.
		Insufficient oil amount in oil separator	Malfunctioning oil heater, excessive refrigerant dissolution during stoppage, and oil carried away during startup.	Inspect oil heater. Inspect relays, etc., on related circuits. Replace parts as necessary.
			Insufficient oil return caused by insufficient refrigerant circulation	Resolve insufficient refrigerant circulation, and then return oil from load side heat exchanger. * Replenish lubricant temporarily.
			Troubles such as clogging in oil return circuit	Remove any causes of trouble to restore.

	Trouble	Direct causes	Factors	Actions
04	Low oil-supply pressure	Insufficient oil amount in oil separator	Extensive oil leak	Inspect machine room and around compressor and take measures. Inspect for presence of oil floating in cooling water system. If there is any oil floating, check for oil leak in oil cooler heat transmission tube, and take measures.
				For damage in pipes, etc., caused by excessive vibration, take vibration reduction measures (including sympathetic vibration measures).
		Defect in hydraulic pressure detection feature.	Malfunction in hydraulic pressure protection device, pressure sensor, relays, etc.	Identify malfunctioning devices, examine their causes, and take measures. Then, replace malfunctioning devices.
			Clogging in connecting pipes	Remove clogging. Check oil contamination level and replace oil as necessary.
05	Abnormally high inter-mediate pressure	High suction pressure	Heat load on load side is higher than design value.	Inspect the situation on load side (loading volume, opening and closing of doors, etc.), and take necessary measures.
			Malfunction in suction pressure adjustment device	For pressure detection fault, replace pressure sensor. * If there is a problem in pressure output position, change the position.
				For device fault in control circuit, change problematic device.
				For inappropriate parameters (setting values) for control circuits, optimize them.
				For malfunction in pressure adjustment valve operation, replace pressure adjustment valve, or remove the cause.
			Malfunction in compressor capacity control	Refer to item 11, “Capacity control malfunction”.
		Liquid backflow from intermediate liquid cooler	Malfunction of and leak inside intermediate supply expansion valve	Repair or replace intermediate supply expansion valve.

	Trouble	Direct causes	Factors	Actions
05	Abnormally high inter-mediate pressure	Defect in high-stage side of compressor	Malfunction in compressor high-stage capacity control (capacity does not increase)	Refer to item 11, “Capacity control malfunction”.
			Abnormal wear and damage to parts on high-stage of compressor	Overhaul compressor and replace parts. Replace all lubricant.
06	Abnormally high pressure (abnormal discharge pressure)	Heat exchange failure at condenser (heat exchanger)	Contaminated and blocked heat trans-mission tubes, fins, etc.	Clean and wash them. Use solvent to clean depending on contamination.
			Malfunction of fan motor, thermoswitch, water spray bars, cooling water pumps, etc. (including overfall)	Identify malfunctioning devices, examine their causes, and take measures. Then, replace malfunctioning devices.
			Flow volume adjustment fault for cooling water, brine, etc.	If valve is manually adjusted, readjust it. If an automatic control valve (including wax valve) is used, examine its cause and take measures.
			Other insufficient circulation volume problems of cooling water, etc.	Inspect for clogging and contamination of circulation route filters, and take measures. Inspect for leak in circulation routes, and take measures. Inspect water supply routes and construction, and take measures. If frozen, improve by insulation or heating.
			Poor performance in heat exchanger	If the trouble is caused by change in operating conditions, re-examine the conditions to improve. If the trouble is caused by change in installation environment, improve the environment if possible. For both cases, if it is difficult to improve, add more heat exchangers or increase their sizes.
		Uncondensed gas in the system	Leak on low pressure side * Cases of erosion of compressor’s suction thermometer protection pipe have also been confirmed.	Inspect for leak, and take necessary measures. Then, air purge the heat exchanger.

	Trouble	Direct causes	Factors	Actions
06	Abnormally high pressure (abnormal discharge pressure)	Excessive refrigerant charge	In some cases, without enough investigation of other causes for insufficient cooling, insufficient refrig-erant amount was considered to be the cause, and refrigerant was charged repeatedly.	Adjust refrigerant to proper amount.
			Insufficient capacity of heat exchanger	If the trouble is caused by change in operating conditions, re-examine the conditions to improve. If it is difficult to improve, add more heat exchangers or increase their sizes.
		Defect in discharge pressure detection feature	Malfunction in abnormal high pressure protection device, pressure sensor, relays, etc.	Identify malfunctioning devices, examine their causes, and take measures. Then, replace malfunctioning devices.
			Liquid stoppage, etc., by clogging in connecting pipes	Remove clogging. Check oil contamination level and replace oil as necessary.
		Closed outlet stop valve for oil separator	Neglected to restore after closing. Human error	Open valve or stop immediately. Make sure to perform tagout during valve operation. Make sure to perform a valve check before starting compressor.
07	Abnormally high discharge temperature	Overheating during operation	Insufficient refriger-ant circulation	Refer to Factors of item 2.
			Heat load on load side is higher than design value.	Inspect the situation on load side (loading volume, opening and closing of doors, etc.), and take necessary measures.
			Malfunction in low pressure protection device, pressure sensor, relays, etc.	Identify malfunctioning devices, examine their causes, and take measures. Then, replace malfunctioning devices.
		Non-condensable gases in the system	Leak on low pressure side	Inspect for leak, and take necessary measures. Then, air purge the heat exchanger.

	Trouble	Direct causes	Factors	Actions
07	Abnormally high discharge temperature	High supply oil temperature	Heat exchange fault in oil cooler	For water-cooling types, refer to "Heat exchange failure at condenser (heat exchanger)" in item 6. For liquid cooling type, inspect liquid supply expansion valve, temperature sensor, related relays, wiring, terminals, etc., and take measures.
			Failure in oil temperature increase protection feature	Inspect temperature protection device, temperature sensor, related relays, wiring, terminals, etc., and take measures.
		Defect in discharge temperature detection and protection features	Malfunction in temperature protection device, temperature sensor, relays, etc.	Identify malfunctioning devices, examine their causes, and take measures. Then, replace malfunctioning devices.
		Insufficient supply oil	Refer to item 4, "Low hydraulic pressure (low supply pressure)".	Same as on the left
08	Leak from mechanical seal	Initial leak after replacement until sliding surfaces fit together	This happens because of the specific operating conditions of the compressor and unsteadiness in bearing pressure condition of processed sliding surfaces following replacement.	For initial leak, amount of leak might increase temporarily. However, it will gradually decrease, so check that the amount of leak does not increase continuously. Period of initial leak might differ according to design and operating conditions. 200 hours can be a rough guide.
		Damaged sliding surfaces due to excessive heat of sliding surfaces	Most cases are due to excessive repetition of startup/stoppage. * For a standard device, more than 4 times per hour is considered too many.	If heat load is below the device's design conditions, re-examine operating conditions. Set the control settings to fewer startup/stoppage times.
				For capacity control malfunctions, see item 11, "Capacity control malfunction".
			Lubricant became steeped with refrigerant, resulting in decreased viscosity	For liquid backflow operation, remove the causes. For malfunction of oil heater and other devices on control circuit, replace them.
			Overheat operation	Refer to Factor "Insufficient refrigerant circulation volume" in item 2.
			High supply oil temperature	Refer to the Direct cause "High supply oil temperature" in item 7.

	Trouble	Direct causes	Factors	Actions
08	Leak from mechanical seal	Long stoppage period (no oil film on sliding surfaces)	Due to user's specific conditions, such as heat load being intermittent.	If stoppage period becomes more than one week, manually operate oil pump as well as turn rotor axis of compressor, or equip external seal portion with oil pot.
		Deteriorated parts	Hardened O-ring	For aging degradation, replace O-ring. For other unique causes, the same factors and actions described in "Damaged sliding surfaces due to excessive heat of sliding surfaces" can be applied.
			Swelled O-ring * Occurs in excessive refrigerant dissolution oil	For liquid backflow operation, remove the causes. For malfunction of oil heater and other devices on control circuit, replace them.
			Deteriorated seal ring or mating ring	For aging degradation, replace parts. For other unique causes, the same factors and actions described in "Damaged sliding surfaces due to excessive heat of sliding surfaces" can be applied.
		Incompatibility between operating conditions (working temperature ranges, refrigerant, etc.) and lubricant	Inappropriate lubricant or change in operating conditions since installation of device	Re-examine operating conditions if possible. If not, refer to Chapter 4.1, "Lubricant (Refrigerant Oil)", and select lubricant again and replace all amount of current lubricant with new type.
		Bad contact condition of sliding surfaces	Foreign matter attached to sliding surfaces due to contamination of lubricant	Exchange all lubricant. Equip oil supply line with bypass filters.
			Faulty parts attachment Human error	Overhaul compressor to replace parts, and reassemble it. Check using assembly check sheet.
09	Squeaking sound from mechanical seal part	During initial period after replacement until sliding surfaces fit together, squeaking sound caused by contact of sliding surfaces might be heard.	Sliding surfaces are high in hardness as well as in density, so it takes a while for them to fit together.	Squeaking itself does not cause leak from or functional deterioration of seal. Squeaking normally subsides after few dozens of hours, but it could continue in rare cases. →In this case, contact our service centers.

	Trouble	Direct causes	Factors	Actions
10	Faulty indication of capacity control position	Imprecision in compressor indicator	Loose screws for indicator	Manually tighten screws to the 0% indication position of compressor capacity control.
			Worn bevel gear for indicator	For aging degradation, replace parts. If cased by excessive vibration of compressor, take vibration reduction measures, and then replace parts.
		Imprecision in controller capacity control indicator	Worn groove of compressor indicator cam	Most cases are due to prolonged partial load operation. In this case, replace indicator cam. * Indicator cam that is currently manufactured has reinforced groove.
			Worn guide pin (dowel pin) of compressor push rod	Guide pin of compressor push rod is currently reinforced as well. However, if only indicator cam has reinforced groove, wear of guide pin might occur. Replace push rod.
			Malfunction in potentiometer	If cased by aging degradation or prolonged partial load operation, replace potentiometer. If cased by excessive vibration of compressor, take vibration reduction measures, and then replace parts.
			Maladjustment of zero and span adjustment for E/E positioner	Readjust it.
			Malfunction of E/E positioner or its indicator	For aging degradation, replace E/E positioner. For unique causes such as surge current, remove the causes or take measures.
			Loose terminals or faulty wiring	For loose terminals, tighten them. For faulty wiring, replace it.
11	Capacity control malfunction	Refer to each factor in “Imprecision in controller capacity control indicator” above.	Same as on the left	Same as on the left
		Undetected 100% or 0% by indicator micro-switch and micro-switch cam	Malfunction of micro-switch	Replace micro-switch.
			Loose screws for micro-switch and cam from vibration	Adjust position for cam and switch and tighten them. Use screw glue as necessary. If vibration of compressor is abnormally great, refer to item 12, “Abnormal vibration and/or noise of compressor”.

	Trouble	Direct causes	Factors	Actions
11	Capacity control malfunction	Malfunction of solenoid (modular) valves or related relays, etc. for capacity control	Most cases are due to coil burnout.	For aging degradation, replace parts. For water leakage, etc., remove the cause and replace parts. Refer to the solenoid valve instruction manual for details.
		Internal leakage of solenoid (modular) valves for capacity control	Liquid trapped, etc. inside unloader cylinder due to temperature increases	If caused by prolonged low load operation, improve by re-examining the operation method. Install a capacity control hydraulic line with an in-line check valve (internal reversal-stoppage valve) and an oil bypass line.
		Capacity control hydraulic line defect	Maladjustment of oil controller valve	Readjust it.
			Leak and clogging in solenoid valve gland and oil pipes	Remove factors. Check oil contamination level and replace oil as necessary.
		Unloader piston not moving (This is one factor of a defect of the capacity control hydraulic line, but described separately.)	Damaged cap seal for piston	Check oil contamination level and replace oil as necessary. Replace O-ring, cap seal, etc.
			Pinched cap seal	Can be considered as a factor, but almost no such cases exist. Replace O-ring, cap seal, etc.
			Worn cap seal	Check oil contamination level and replace oil as necessary. Replace O-ring, cap seal, etc.
			Refrigerant gas retention in unloader cylinder	Stop compressor. Operate oil pump and repeat loading and unloading to purge refrigerant gas from cylinder. For liquid backflow operation, remove the causes. For malfunction of oil heater and other devices on control circuit, replace them.
12	Abnormal vibration and/or noise of compressor	Insufficient axis adjustment with motor side	If vibration value is greater in the axial direction, this might be the cause.	Readjust axis. If abnormal vibration and noise frequently occur in monocock unit, hot alignment (perform rated operation of compressor once to increase its temperature and readjust before the temperature decreases) is recommended.

	Trouble	Direct causes	Factors	Actions
12	Abnormal vibration and/or noise of compressor	Large vibration in Male rotor axis	Uneven tightening for thrust bearing glands	If loose locknuts exist and no other fault is found in parts such as thrust bearing, tighten locknuts evenly.
			Loose thrust bearing	Forgetting to bend lock washer claw (rare, but due to human error) or wear of thrust bearing rolling element (ball) can be considered. →Check for any defects in thrust bearing. If there are any defects, replace it. Then perform end clearance adjustment as well as axis contact check, and reassemble it.
			Imprecision in dynamic balance of rotors	Inspection only at site is impossible. However, if no other causes for abnormal vibration are found, and if on-site overhaul has been repeatedly performed, this might be the factor. Overhaul compressor at an institution such at MAYEKAWA Moriya Factory with dynamic balance measurement/ adjustment equipment.
		Oil hammer	Continuous low load operation at below 30% of capacity control	During low load operation, lubricant is poorly discharged. Because of this, the amount of oil that remains inside rotor mesh increases and oil becomes condensed. →Avoid continuous low load operation. * Especially for light gas liquids (such for He and NH_3),10 minutes low load operation has a negative effect. For liquid types such as fluorocarbons, operations of more than 30 minutes are not recommended.
		Liquid backflow during startup * Initial abnormal noises are conspicuous.	When compressor is stopped, refrigerant is liquefied and remains in upstream piping.	This is due to various factors such as a leak inside the liquid supply solenoid valve on load side, insufficient heat exchange (refrigerant evaporation) in heat exchanger, or trapping caused by mis-piping in piping route. →If this phenomenon happens, in many cases, compressor (stack and thrust bearing for rotor and casing) gets instantly damaged. This phenomenon may also have an impact on continued operation. →Identify the causes (more than one may exist), and take measures. Then, perform an overhaul of the compressor.

	Trouble	Direct causes	Factors	Actions
12	Abnormal vibration and/or noise of compressor	Liquid backflow during operation * Frosting on suction side is conspicuous. * In many cases, the phenomenon is often “mist-back” (suction of moist steam) rather than liquid backflow. * To prevent this phenomenon, gas-liquid separator (accumulator) can be installed. * Refer to Factor “Insufficient refrigerant circulation volume” in item 2 as well.	Opening for liquid supply expansion valve is too large.	For temperature type expansion valve, inspect temperature sensitive cylinder and capillary tube. Take measures if any defects are found. For incompatible orifice due to the change in operating conditions, replace orifice.
				For electronic expansion valve, inspect devices on expansion valve opening control devices (circuit) such as temperature sensor, converter, controller (over-heating regulator). If any defects are found, replace the faulty devices. As with temperature type expansion valve, for incompatible orifice due to the change in operating conditions, replace orifice.
			Rapid change from unloaded operation to full load operation	Set control parameters so that rapid change will not occur. Or, re-adjust opening of oil controller valve on capacity control increase side towards the decrease side.
			Expansion valve opening control cannot keep up with rapid changes in heat load on load side.	Avoid rapid changes in heat load that exceed set response ranges of the heat exchanger (evaporator) on load side and expansion valve. For details, refer to the instruction manual related to devices/control on load side.
			Heat exchange failure (insufficient exchange) of heat exchanger on load side: defrost-related	For frosting (icing), defrost manually. Reduce defrost interval setting. For malfunction of devices specific to defrosting methods, remove the cause and replace them. For blocked piping routing specific to defrosting methods, remove the cause and take measures. Especially for hot gas defrost type, fully understand the unit operation manual related to devices/control on load side.

	Trouble	Direct causes	Factors	Actions
12	Abnormal vibration and/or noise of compressor	Liquid backflow during operation	Heat exchange failure (insufficient exchange) of heat exchanger on load side: load side conditions	Improve the environment if heat exchanger is excessively loaded and impacts ventilation. * Make sure that the flow of heating medium for heat exchanger on load side is stable.
			Heat exchange failure (insufficient exchange) of heat exchanger on load side: heat exchanger conditions	Inspect for blockade around heat transmission tube and malfunctioning fans. If any, take measures.
		Foreign substances contaminating compressor	Contamination of welding spatter, etc., from upstream side	Inspect suction strainer and oil filter. If any problems to element, replace it. Overhaul compressor. Collect foreign substances and objects. Identify the source and take measures.
			Neglect of collecting tools and rags during overhaul	
		Damage to thrust bearing	Aging degradation (exceeded appropriate time for replacement)	Appropriate time for replacement will differ due to operating conditions (if low pressure or intermediate pressure is high, life of thrust bearing becomes shorter) and oil management conditions. However, if used under standard refrigerating usage based on steady continuous operation, inspect and replace it after 40000 hours or within 5 years. For details, refer to chapter 5.2.3 in this manual.
			Liquid backflow operation	Refer to the Direct causes “Liquid backflow during startup” and “Liquid backflow during operation” above in this item.
			Contamination of foreign substances	Refer to the Direct cause “Foreign substances contaminating compressor” above.
			Excessive thrust stress other than above • High suction/ intermediate pressure exceeding operating conditions	Re-examine operating conditions and improve them if possible. If it is difficult to improve, re-examine maintenance interval management.

	Trouble	Direct causes	Factors	Actions
12	Abnormal vibration and/or noise of compressor	Damage to thrust bearing	Faulty assembly * Lock nuts tightened insufficiently, lock washer tab not bended, rotation stopper not set to thrust bearing gland, gland not assembled, etc.	Tighten lock nuts by using specified torque or torque angle (see Chapter 7, "7.3 Tightening Torques for Bolts and Nuts" in this manual). Be sure to record data on the assembly check sheet to prevent omission of work steps.
		Sympathetic vibration	This phenomenon occurs when vibration approaches the natural frequency of the whole vibration system for the machinery, including piping and support.	In many cases, this occurs due to change in installation environment such as change in piping circuit or additional installation of devices in the machine room, and changes in oil levels. →If sympathetic vibration is suspected, contact our sales offices or service centers.

7 Related Documents

7.1 Development Views of the Parts Assembly /Cross-section Views

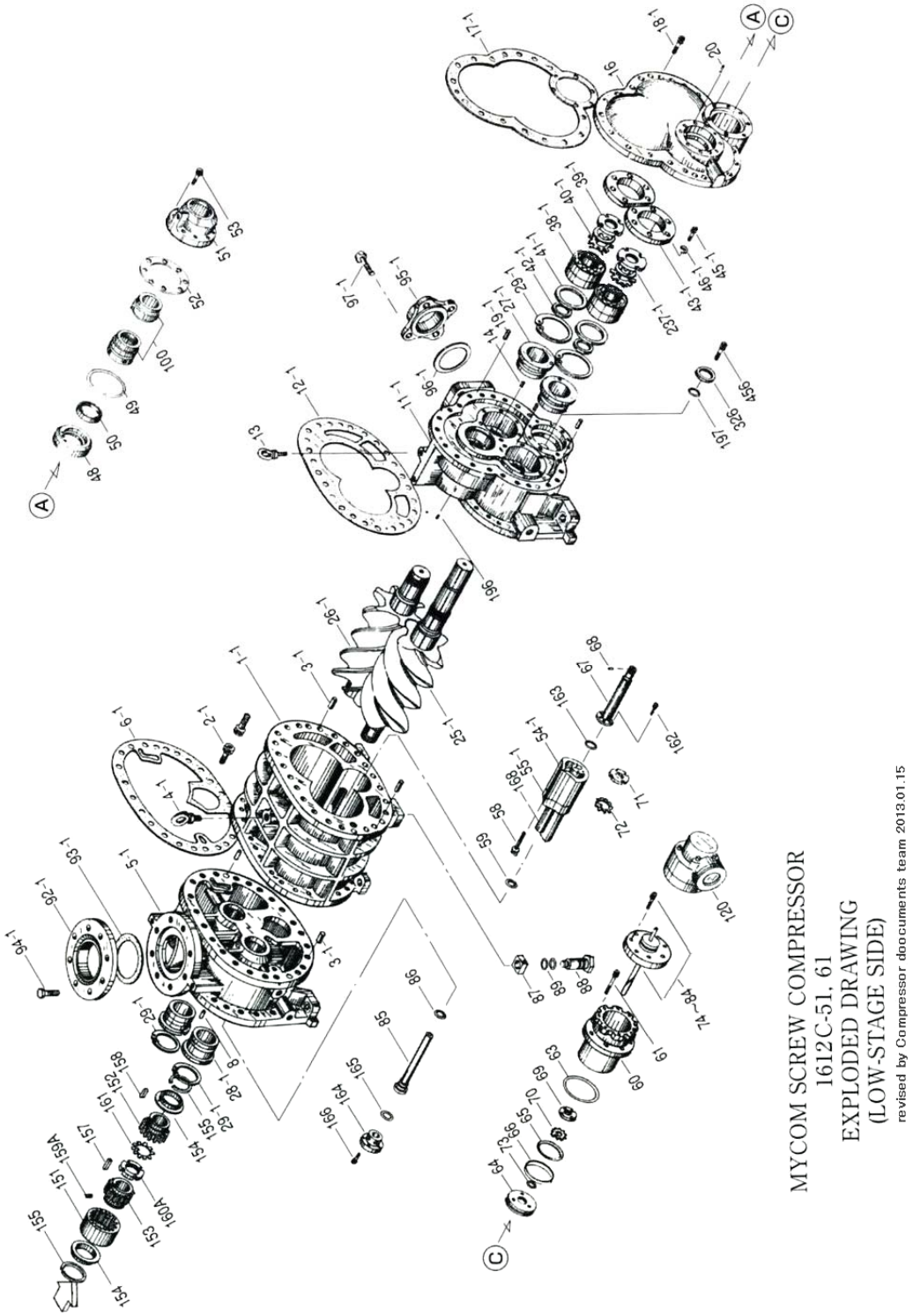


Figure 7-1 Development View of the Parts Assembly (Low-stage)

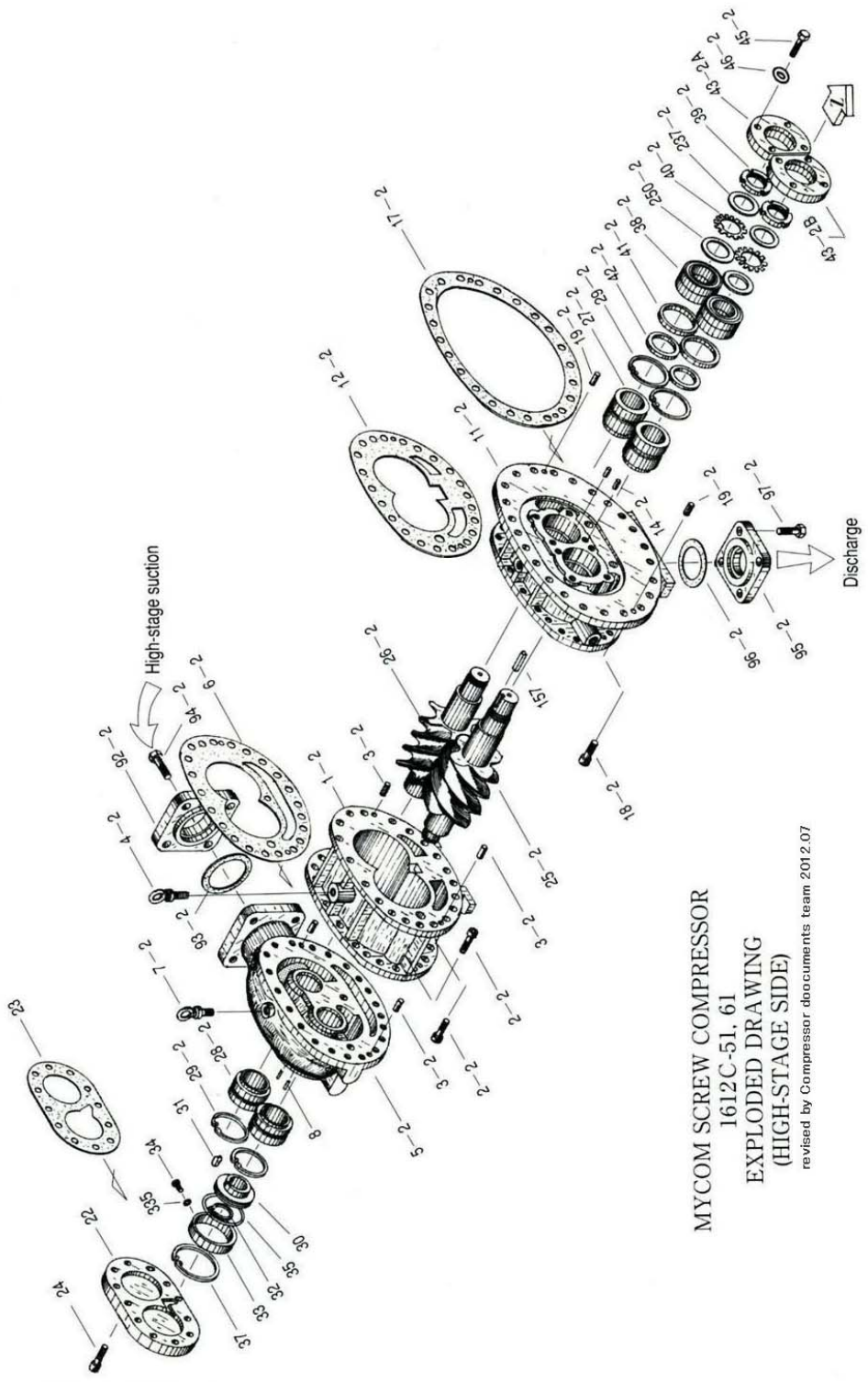


Figure 7-2 Development View of the Parts Assembly (High-stage)

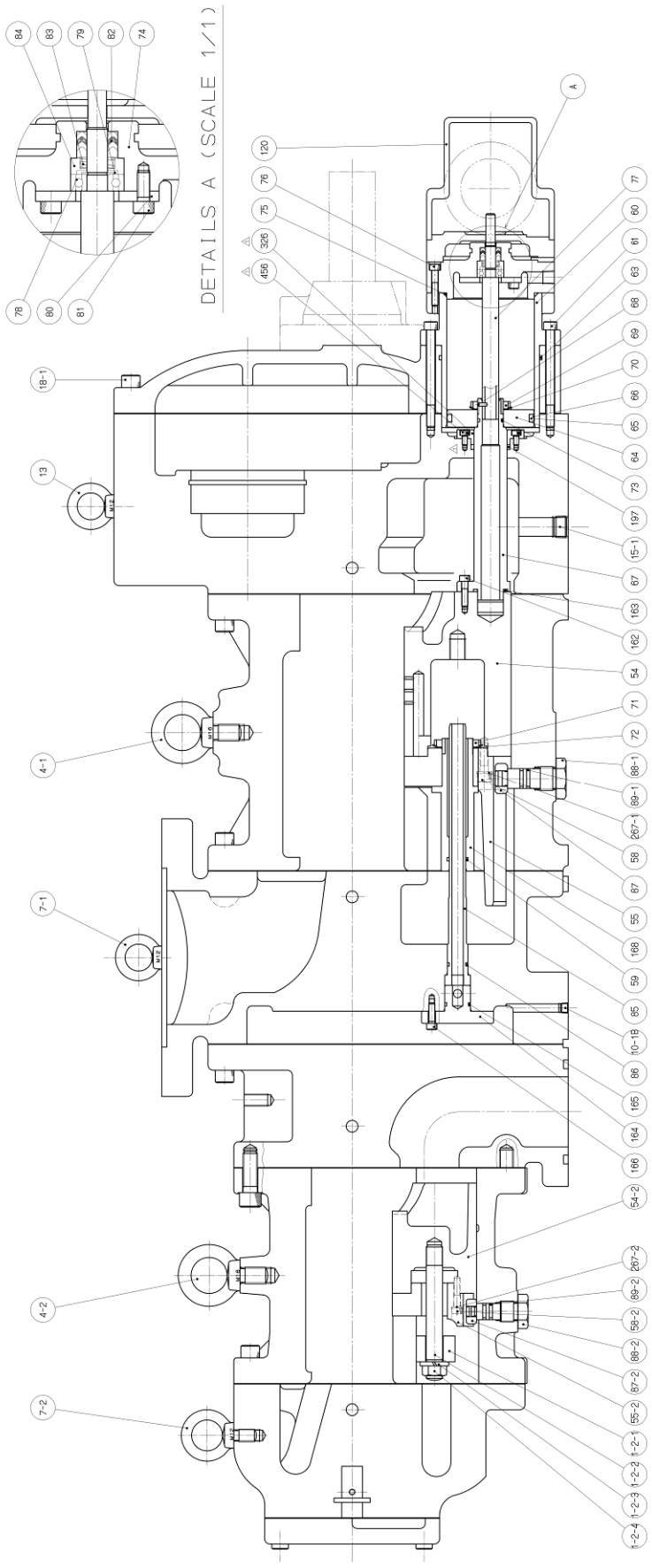


Figure 7-3 1612LLC Cross-section View (Vertical)

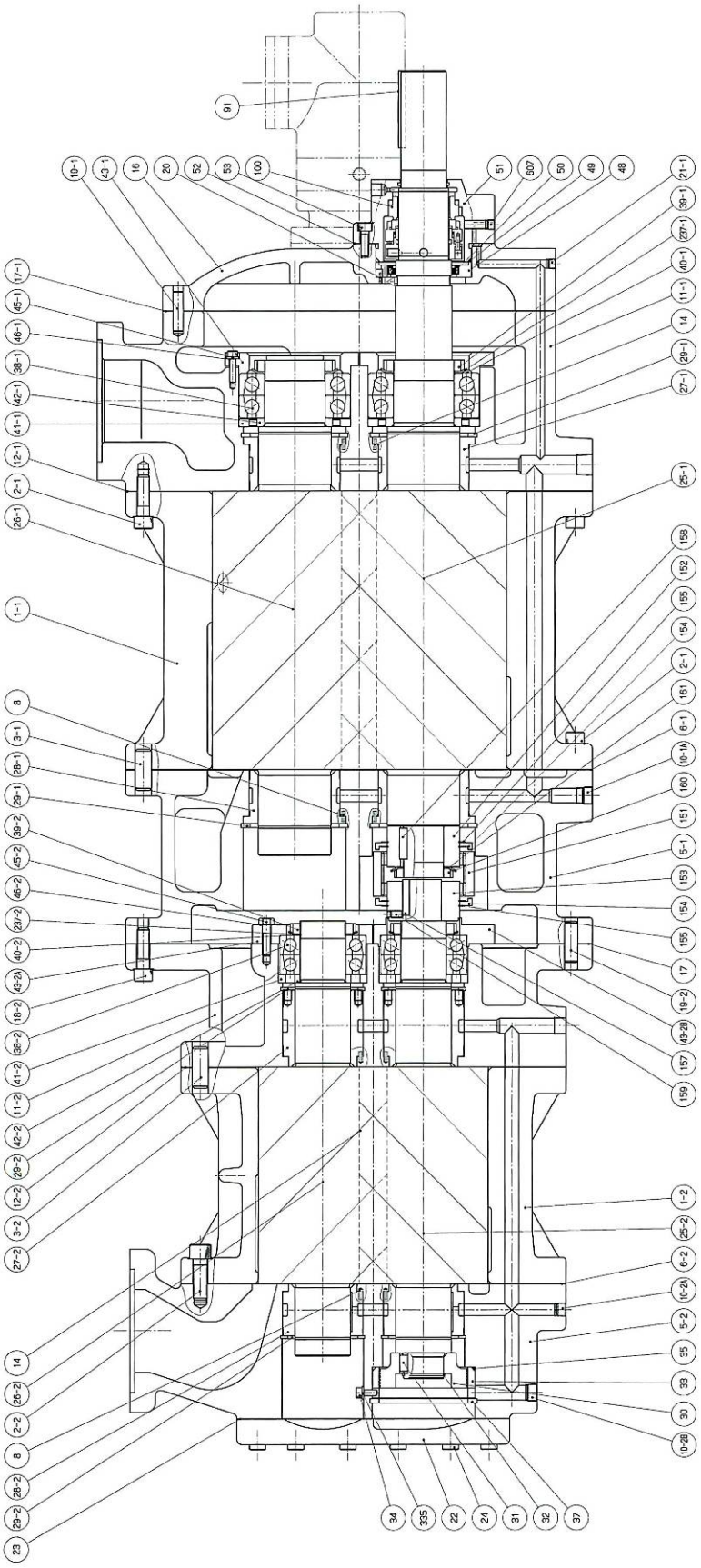


Figure 7-4 1612LLC Cross-section View (Horizontal)

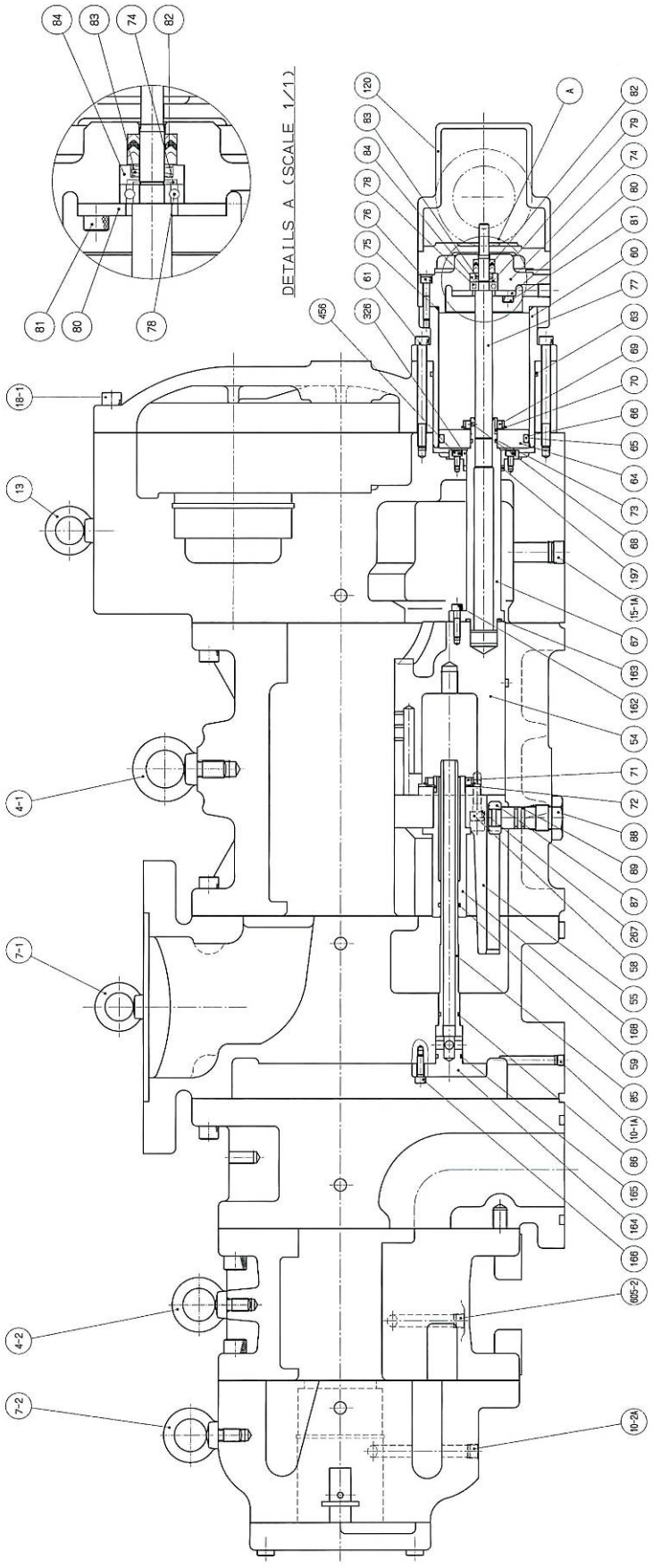


Figure 7-5 1612LSC Cross-section View (Vertical)

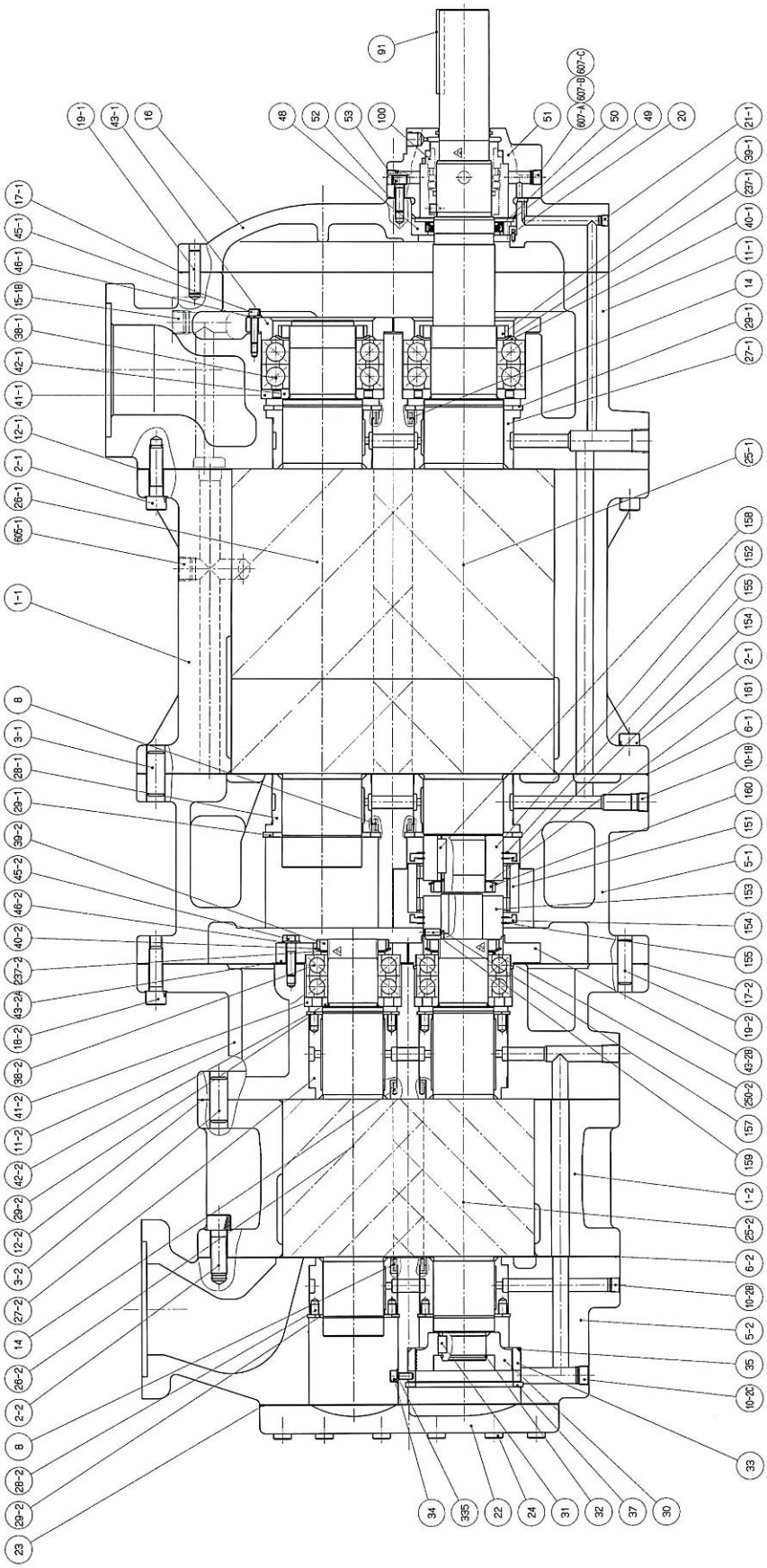


Figure 7-6 1612LSC Cross-section View (Horizontal)

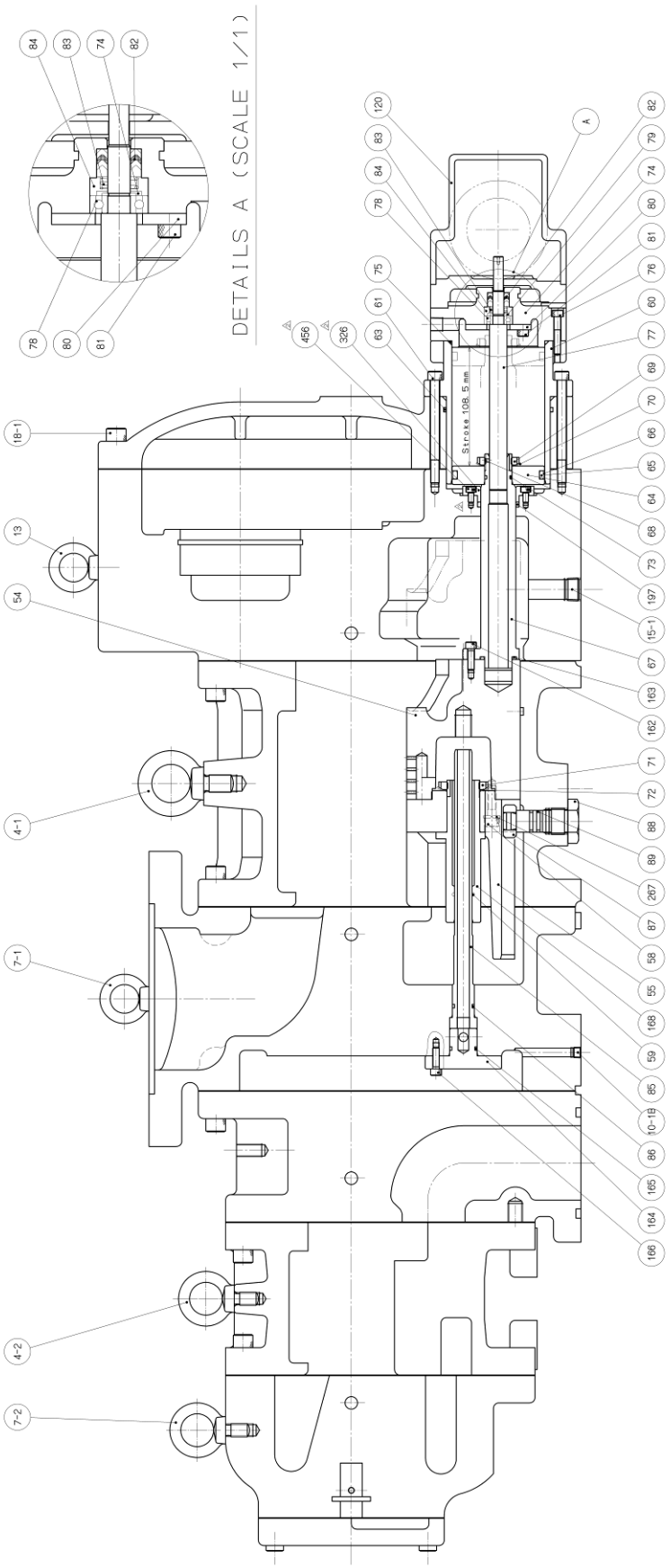


Figure 7-7 1612MSC Cross-section View (Vertical)

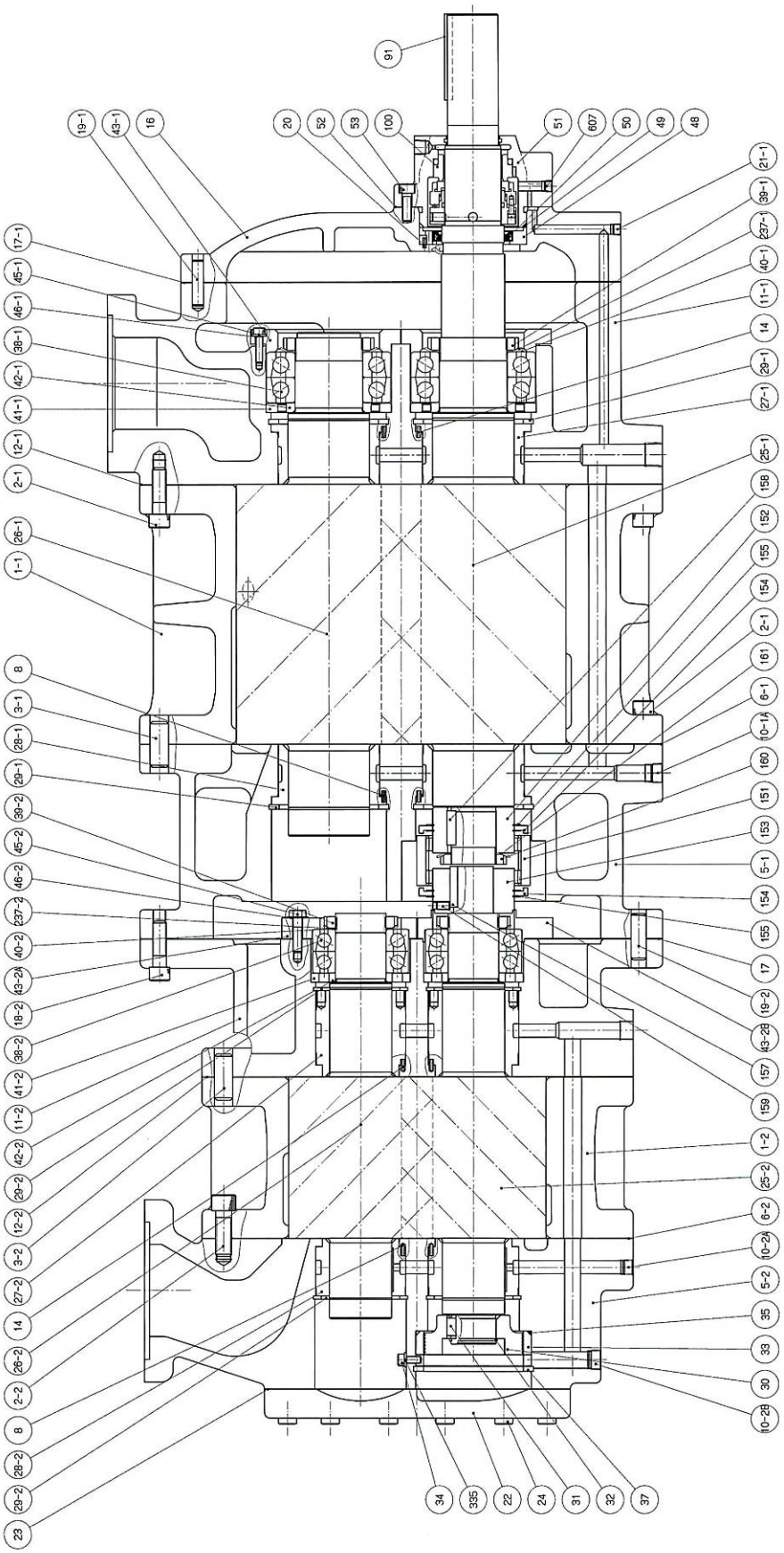


Figure 7-8 1612MSC Cross-section View (Horizontal)

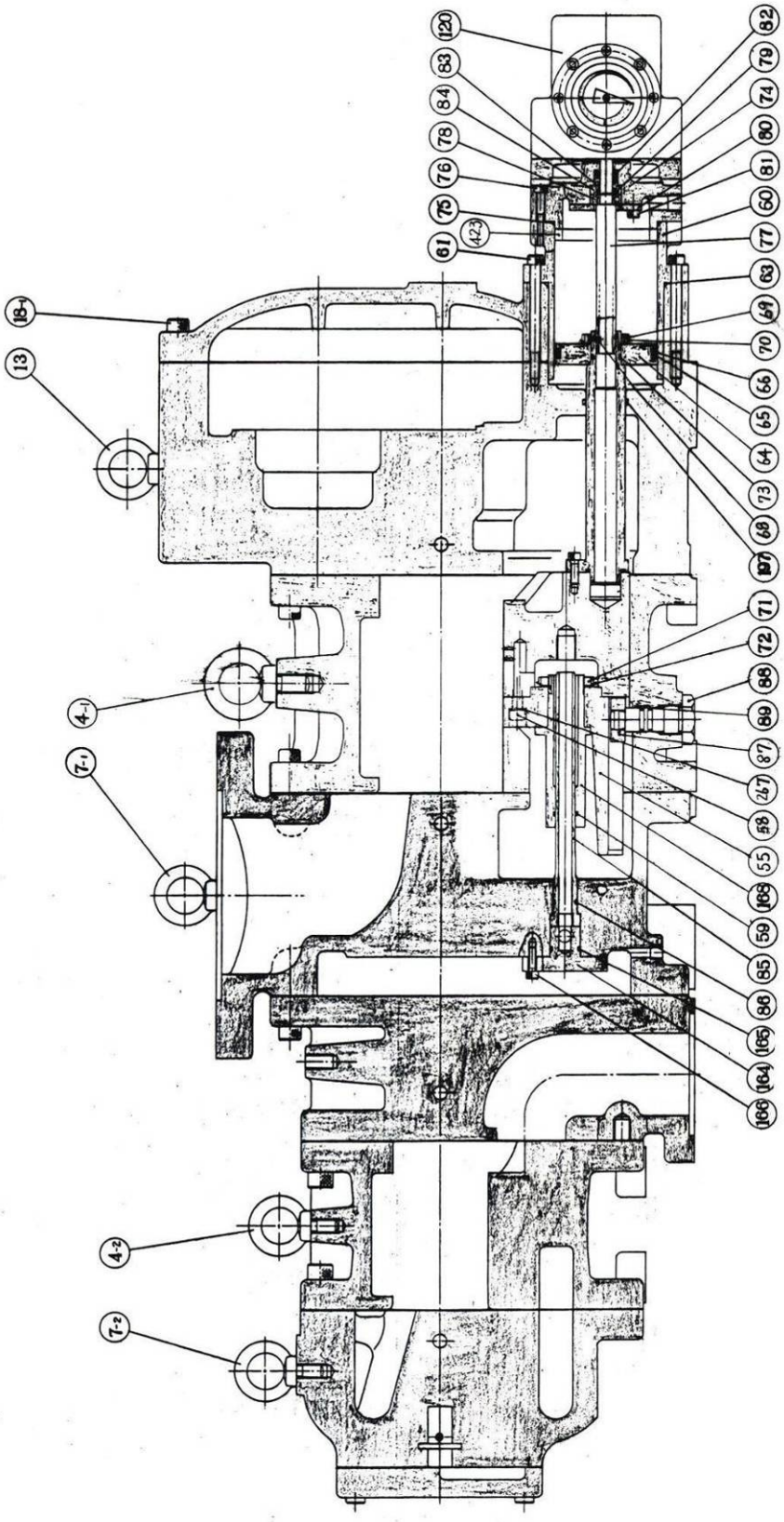


Figure 7-9 1612SSC Cross-section View (Vertical)

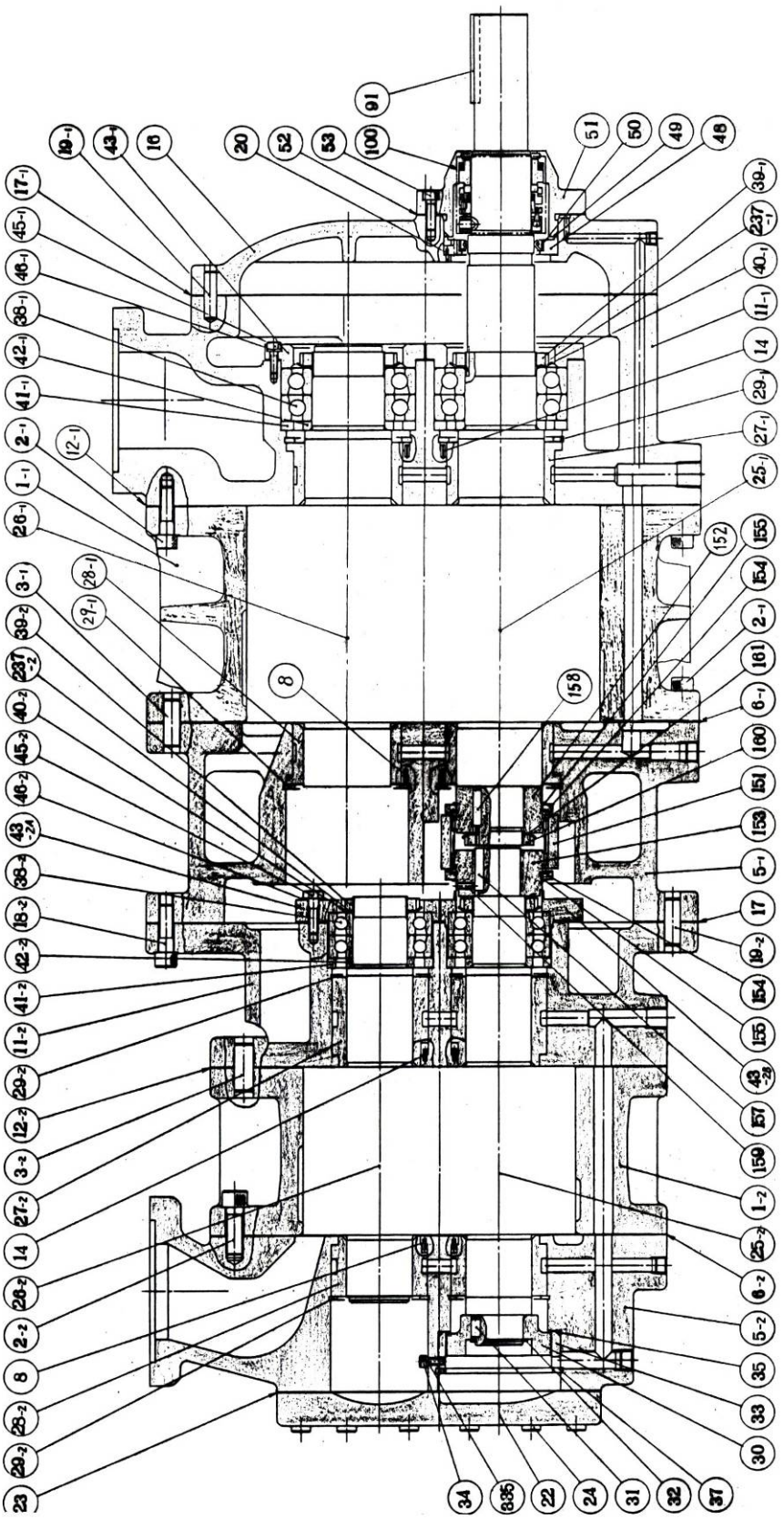


Figure 7-10 1612SSC Cross-section View (Horizontal)

7.2 Configuration Table of the Parts

Table 7-1 Configuration table of the parts of 1612C**

No.	Part Name	Code No.	Remarks	Quantity			
				LLC	LSC	MSC	SSC
1-1	Main Rotor Casing (1)	CS00100-160L	160L**	1	1	-	-
1-1	Main Rotor Casing (1)	CS00100-160M	160M**	-	-	1	-
1-1	Main Rotor Casing (1)	CS00100-160S	160S**	-	-	-	1
1-2	Main Rotor Casing (2)	CS00100-1612C2L	1612LLC	1	-	-	-
1-2	Main Rotor Casing (2)	CS00100-1612C	1612*SC	-	1	1	1
1-2-1	Unloader Slide Valve Gland	CS81210-1612LLC		1	-	-	-
1-2-2	Stud Bolt	NB56516-110N2	M16X110	1	-	-	-
1-2-3	Spring Washer	ND320-016	M16	1	-	-	-
1-2-4	Hexagon Nut	NC140-16	M16	1	-	-	-
2-1	Hexagon Socket Head Cap Screw	NB35412-040	M12X40	46	46	46	46
2-2	Hexagon Socket Head Cap Screw	NB35414-040	M14X40	36	36	36	36
3-1	Alignment Pin	NE2013-040	φ13X40	4	4	4	4
3-2	Alignment Pin	NE2016-040	φ16X40	4	4	4	4
4-1	Eye Bolt (Hanger Bolt)	NB600-16	M16	1	1	1	1
4-2	Eye Bolt (Hanger Bolt)	NB600-12	M12	1	1	1	1
4-2	Eye Bolt (Hanger Bolt)	NB600-16	M16	1	-	-	-
5-1	Suction Cover (1)	CS00500-1612C1	1612**C	1	1	1	1
5-2	Suction Cover (2)	CS00500-1612C2	1612**C	1	1	1	1
6-1	Gasket, Suction Cover (1)	CS00600-160N	160***	1	1	1	1
6-2	Gasket, Suction Cover (2)	CS00600-1612CN	1612**C	1	1	1	1
7	Eye Bolt (Hanger Bolt)	NB600-12	M12	1	1	1	1
8	Spring Pin	NE3204-010	φ4X10	4	4	4	4
10-1A	Plug	NF06-010	R3/8	1	1	1	1
10-2A	Plug	NF06-008	R1/4	1	1	1	1
10-2B	Plug	NF06-010	R3/8	1	1	1	1
11-1	Bearing Head (1)	CS01100-1612C1	1612**C	1	1	1	1
11-2	Bearing Head (2)	CS01100-1612C2	1612**C	1	1	1	1
12-1	Gasket, Bearing Head (1)	CS01200-160N	160***	1	1	1	1
12-2	Gasket, Bearing Head (2)	CS01200-1612CN	1612**C	1	1	1	1
13	Eye Bolt (Hanger Bolt)	NB600-12	M12	1	1	1	1
14	Spring Pin	NE3204-010	φ4X10	4	4	4	4
15-1	Plug	NF06-015	R1/2	1	1	1	1
16	Bearing Cover	CS01600-1612C	1612**C	1	1	1	1
17-1	Gasket, Bearing Cover (1)	CS17000-1612CN	1612**C	1	1	1	1
17-2	Gasket, Bearing Cover (2)	CS01700-1612CN	1612**C	1	1	1	1
18-1	Hexagon Socket Head Cap Screw	NB35412-040	M12X40	16	16	16	16
18-2	Hexagon Socket Head Cap Screw	NB35412-040	M12X40	23	23	23	23
19-1	Alignment Pin	NE2010-040	φ10x40	2	2	2	2
19-2	Alignment Pin	NE2013-040	φ13X40	2	2	2	2
20	Spring Pin	NE3203-010	φ3X10	1	1	1	1
21	Plug	NF06-004	R1/8	1	1	1	1
22	Balance Piston Cover	CS02200-1612C	1612**C	1	1	1	1
23	Gasket, Balance Piston Cover	CS02300-1612CN	1612**C	1	1	1	1
24	Hexagon Socket Head Cap Screw	NB35410-035	M10X35	12	12	12	12
25-1	Male Rotor (1)	CS02520-1612C1	1612LSC (1)	-	1	-	-
26-1	Female Rotor (1)						

No.	Part Name	Code No.	Remarks	Quantity			
				LLC	LSC	MSC	SSC
25-1	Male Rotor (1)	CS02520-1612LL1	1612LLC (1)	1	-	-	-
26-1	Female Rotor (1)						
25-1	Male Rotor (1)	-	1612MSC	-	-	1	-
26-1	Female Rotor (1)						
25-1	Male Rotor (1)	-	1612SSC	-	-	-	1
26-1	Female Rotor (1)						
25-2	Male Rotor (2)	CS02520-1612C2	1612LSC (2)	-	1	-	-
26-2	Female Rotor (2)						
25-2	Male Rotor (2)	CS02520-1612LL2	1612LLC (2)	1	-	-	-
26-2	Female Rotor (2)						
27-1	Main Bearing (1)	CS02800-1610C1	1610SLC/1612**C	2	2	2	2
27-2	Main Bearing (2)	CS02700-125	125***	2	2	2	2
28-1	Side Bearing (1)	CS02800-1610C1	1610SLC/1612**C	2	2	2	2
28-2	Side Bearing (2)	CS02800-125	125***	2	2	2	2
29-1	Stop Ring (1)	NG11-102	H102	4	4	4	4
29-2	Stop Ring (2)	NG11-080	H80	4	4	4	4
30	Balance Piston	CS03000-1612C	1612**C	1	1	1	1
31	Key, Balance Piston	CS03100-125	125***	1	1	1	1
32	Stop Ring	NG12-040	S40	1	1	1	1
33	Sleeve, Balance Piston	CS03300-160	160***	1	1	1	1
34	Hexagon Socket Head Cap Screw	NB35406-015	M6X15	1	1	1	1
35	O-ring	PA12-095	JISB2401 1A G95	1	1	1	1
37	Stop Ring	NG11-102	H102	1	1	1	1
38-1	Thrust Bearing (1)	CS03800-160P	7212B PPS	2	2	2	2
38-2	Thrust Bearing (2)	CS03800-125P	7209B PPS	2	2	2	2
39-1	Lock Nut (1)	NG31-012	AN12	2	2	2	2
39-2	Lock Nut (2)	NG31-009	AN09	2	2	2	2
40-1	Lock Washer (1)	NG32-012	AW12	2	2	2	2
40-2	Lock Washer (2)	NG32-009	AW09	2	2	2	2
41-1	Spacer, Thrust Bearing Outer Race (1)	CS04100-160	160***	2	2	2	2
41-2	Spacer, Thrust Bearing Outer Race (2)	CS04100-125	125***	2	2	2	2
42-1	Spacer, Thrust Bearing Alignment (1)	CS04200-B160	160***	2	2	2	2
42-2	Spacer, Thrust Bearing Alignment (2)	CS04200-125	125***	2	2	2	2
43-1	Thrust Bearing Gland (1)	CS04300-1612C1	1610**C&1612**C	2	2	2	2
43-2A	Thrust Bearing Gland (2) A	CS04300-1612C2F	1612**C	2	2	2	2
43-2B	Thrust Bearing Gland (2) B	CS04300-1612C2M	1612**C	2	2	2	2
45-1	Hexagon Socket Head Cap Screw	NB35406-025	M6X25	12	12	12	12
45-1	Hexagon Head Bolt	NB15506-030	M6X30	12	12	12	12
45-2	Hexagon Head Bolt	NB111008-030	M8X30	8	8	8	8
46-1	Spring Washer	ND320-006	M6	12	12	12	12
46-2	Lock Washer (2)	ND320-008	M8	8	8	8	8
48	Retainer, Oil Seal	CS04800-160	160***	1	1	1	1
49	O-ring	PA12-090	JISB2401 1A G90	1	1	1	1
50	Oil Seal	CS05000-160VD	SA1J55X70X9	1	1	1	1
51	Seal Cover	CS05102-160	160***	1	1	1	1
51	Seal Cover	CS05100-160HE	160*** (HE 用)	1	1	1	1
52	Gasket, Seal Cover	CS05200-160N	160***	1	1	1	1
53	Hexagon Socket Head Cap Screw	NB35408-025	M8X25	8	8	8	8
54-1	Unloader Slide Valve (L Port)	CS05400-1612C	1612LSC	1	1	-	-

No.	Part Name	Code No.	Remarks	Quantity			
				LLC	LSC	MSC	SSC
54-1	Unloader Slide Valve (M Port)	CS05400-1612C	1612LSC	1	1	-	-
54-1	Unloader Slide Valve (L Port)	-	1612MSC	-	-	1	-
54-1	Unloader Slide Valve (M Port)	-	1612MSC	-	-	1	-
54-1	Unloader Slide Valve (L Port)	-	1610SLC	-	-	-	1
54-1	Unloader Slide Valve (M Port)	-	1610SLC	-	-	-	1
54-1	Unloader Slide Valve (M Port)	-	1612L*C for Freon	-	-	-	-
54-1	Unloader Slide Valve (M Port)	-	1610SLC for Freon	-	-	-	-
54-2	Unloader Slide Valve (1-2) (L Port)	-	1612LLC	1	-	-	-
54-2	Unloader Slide Valve (1-2) (M Port)	-	1612LLC	1	-	-	-
55-1	Unloader Slide Valve (2)	CS05400-1612C	1612L*C	1	1	-	-
55-1	Unloader Slide Valve (2)	-	1610SLC	-	-	1	1
55-2	Unloader Slide Valve (2-2)	-	1612LLC	1	-	-	-
58	Hexagon Socket Head Cap Screw	NB35408-030	M8X30	4	4	4	4
58-2	Hexagon Socket Head Cap Screw	NB35406-025	M6X25	4	-	-	-
59	O-ring	PA11-016	JISB2401 1A P16	1	1	1	1
60	Unloader Cylinder	CS06000-1612C	1612**C	1	1	1	1
61	Hexagon Socket Head Cap Screw	NB35408-095	M8X95	8	8	8	8
63	O-ring	PA12-095	JISB2401 1A G95	1	1	1	1
64	Unloader Piston	CS06400-1612C	1612**C	1	1	1	1
65	O-ring	PA11-075	JISB2401 1A P75	1	1	1	1
66	Cap Seal	CS06600-125	CAP-1BE75	1	1	1	1
67	Push Rod, Unloader Slide Valve	CS06700-1612C	1612**C	1	1	1	1
68	Guide Pin	CS06809-03	φ3X8	1	1	1	1
69	Lock Nut	NG31-005	AN05	1	1	1	1
70	Lock Washer	NG32-005	AW05	1	1	1	1
71	Lock Nut	NG31-006	AN06	1	1	1	1
72	Lock Washer	NG32-006	AW06	1	1	1	1
73	O-ring	PA11-021	JISB2401 1A P21	1	1	1	1
74	Unloader Cylinder Cover	CS07402-125	125***	1	1	1	1
74	Unloader Cylinder Cover (Explosion-Proof Type)	CS07460-125	125***	1	1	1	1
75	O-ring	PA12-085	JISB2401 1A G85	1	1	1	1
76	Hexagon Socket Head Cap Screw	NB35406-035	M6X35	8	8	8	8
77	Indicator Cam	CS07700-1612C	1612LSC	1	1	1	-
77	Indicator Cam	CS07700-1612SSC	1612SSC	-	-	-	1
78	Ball Bearing	CS07800-200	#6000	1	1	1	1
79	Stop Ring	NG12-010	S10	1	1	1	1
80	Bearing Gland	CS08000-200	200***	1	1	1	1
81	Hexagon Socket Head Cap Screw	NB35406-015	M6X15	3	3	3	3
82	V-ring (set)	CS08200-200B	VH10 NBR	1	1	1	1
83	Spring	CS08300-200	200***	1	1	1	1
84	Retainer, Indicator Cam Spring	CS08400-200	200***	1	1	1	1
85	Oil Injection Pipe	CS08500-160SUK	125L**/160S**	1	1	1	-
85	Oil Injection Pipe	CS08500-1610CK	1610SLC	-	-	-	1
86	O-ring	PA11-016	JISB2401 1A P16	1	1	1	1
87	Guide Block	CS08700-160	160***	1	1	1	1
88	Stem, Guide Block			1	1	1	1
87-2	Guide Block (2)	CS08700-125	125***	1	-	-	-
88-2	Stem, Guide Block (2)			1	-	-	-

No.	Part Name	Code No.	Remarks	Quantity			
				LLC	LSC	MSC	SSC
89	O-ring	PA11-016	JISB2401 1A P16	2	2	2	2
89-2	O-ring	PA11-012	JISB2401 1A P12	2	-	-	-
91	Shaft Key	CS09100-160	160***	1	1	1	1
92-1	Suction Flange (1) (with hole)	CS71400-125MK	MYK125A(5")	1	1	1	1
92-1	Suction Flange (1) (without hole)	CS71400-P125	MYK125A(5")	1	1	1	1
92-2	Suction Flange (2) (with hole)	CS71400-080MK	MYK80A(3")	1	1	1	1
92-2	Suction Flange (2) (without hole)	CS71400-080	MYK80A(3")	1	1	1	1
93-1	Gasket, Suction Flange (1)	CR72000-125N	MYK125A(5")	1	1	1	1
93-2	Gasket, Suction Flange (2)	CR72000-080N	MYK80A(3")	1	1	1	1
94-1	Hexagon Head Bolt	NB12020-055	M20X55	8	8	8	8
94-2	Hexagon Head Bolt	NB12020-055	M20X55	4	4	4	4
95-1	Discharge Flange (1) (without hole)	CS71400-080	MYK80A(3")	1	1	1	1
95-2	Discharge Flange (2) (without hole)	CS71400-065	MYK65A(2"1/2)	1	1	1	1
96-1	Gasket, Discharge Flange (1)	CR72000-080N	MYK80A(3")	1	1	1	1
96-2	Gasket, Discharge Flange (2)	CR72000-065N	MYK65A(2"1/2)	1	1	1	1
97-1	Hexagon Head Bolt	NB12020-055	M20X55	4	4	4	4
97-2	Hexagon Head Bolt	NB12010-055	M16X55	4	4	4	4
100	Mechanical Seal Assembly	CS10000-160BT	BOS-T1 160V**	1	1	1	1
100	Mechanical Seal Assembly	CS10002-160EBS	BBS-E 160	1	1	1	1
120	Unloader Indicator Assembly	CS12000-1612F	1612LSC 0-100	1	1	1	1
125	Micro-switch Set	CS1259-C	125L**	1	1	1	1
127	Micro-switch Cam	CS12700-125F	125L** 0-100%	1	1	1	1
127	Micro-switch Cam	CS12700-125H	125L** 0-50%	1	1	1	1
129	Potentiometer (with lead wire)	CS1299-J	1612 1k	-	-	-	-
129	Conductive Potentiometer (with lead wire)	CS12919-J	1612 1k	1	1	1	1
202	Bevel Gear	CS20100-1612C6	1612 ID 6mm	2	2	2	2
-	Gear Coupling Assembly (New Type)	CS1519-J	151+152+153+159	1	1	1	1
-	Gear Coupling Assembly (Old Type)	CS1519-J	151+152+153+159 +154+155	-	-	-	-
151	Driven Sleeve	CS15100-1612C	1610**C	1	1	1	1
152	Drive Hub		1610**C	1	1	1	1
153	Driven Hub		1612**C	1	1	1	1
154	Stopper, Drive Sleeve	CS15400-1610C	1610**C	2	2	2	2
155	Stop Ring	CS154001-1612C	RR-293(#10 用)	4	4	4	4
157	Key, Driven Hub	CS15700-1612CH	1612C S45C-H	2	1	1	1
158	Key, Drive Hub	CS15800-1612CH	1612C S45C-H	2	1	1	1
159	Set Screw (with looseness stop)	NA83606-015	M6X15	1	1	1	1
160	Lock Nut	NG31-008	AN08	1	1	1	1
161	Lock Washer	NG32-008	AW08	1	1	1	1
162	Hexagon Socket Head Cap Screw	NB35406-020	M6X20	5	5	5	5
163	O-ring	PA12-025	JISB2401 1A G25	1	1	1	1
164	Retainer, Oil Injection Pipe	CS16400-1612C		1	1	1	1
165	O-ring	PA11-021	JISB2401 1A P21	1	1	1	1
166	Hexagon Socket Head Cap Screw	NB35406-020	M6X20	4	4	4	4
167	Plug	NF06-008	R1/4	1	1	1	1
168	Pipe Guide, Oil Injection	CS16800-1612C	1612LSC	1	1	1	-
168	Pipe Guide, Oil Injection	CS16800-1610C	1610SLC	-	-	-	1
197	O-ring	PA11-032	JISB2401 1A P32	1	1	1	1
237-1	Torsional Slip Washer (1)	CS23700-160	160***	2	2	2	2

No.	Part Name	Code No.	Remarks	Quantity			
				LLC	LSC	MSC	SSC
237-2	Torsional Slip Washer (2)	CS23700-125	125***	2	2	2	2
250-2	Thrust Washer (2)	CS25000-125	125***	2	2	2	2
267	Special Spring Washer for Hex. socket head cap screw	ND330-08	M8 f	4	4	4	4
267-2	Special Spring Washer for Hex. socket head cap screw	ND330-06	M6	4	-	-	-
326	Gland, O-ring	CS32600-1612C		1	1	1	1
335	Special Spring Washer for Hex. socket head cap screw	ND330-06	M6	1	1	1	1
423	Unloader Piston Spacer	CS42300-1612SSC	1612SSC	-	-	-	1
456	Hexagon Socket Head Cap Screw	NB35405-010	M5X10	4	4	4	4
605-1	Plug	NF06-015	R1/2	1	1	1	1
605-2	Plug	NF06-008	R1/4	1	1	1	1
607	Plug	NF06-004	R1/8	1	1	1	1

CAUTION

- **The part code of the O-ring is the one assigned to NBR 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.

7.3 List of Bolt/Nut Tightening Torques

Table 7-2 List of Tightening Torques

■ **Hexagon socket head cap screw**

No.	Tightening point	Tightening torque		Qty.	Size
		N·m	kgf·cm		
2-1	Main Rotor Casing (1) to Suction Cover (1) and Bearing Head (1)	90	900	52	M12×40
2-2	Main Rotor Casing (2) to Suction Cover (2) and Bearing Head (2)	140	1400	36	M14×40
18-1	Bearing cover to Bearing Head (1)	90	900	16	M12×40
18-2	Bearing Head (2) to Suction cover (1)	90	900	23	M12×40
24	Balance piston cover to Suction Cover (2)	50	500	12	M10×35
34	Balance piston sleeve	10	100	1	M6×15
53	Seal cover to Bearing Cover	25	250	8	M8×25
58	Unloader Slide Valve	25	250	4	M8×30
58-2	Special specification only for the LLC type for securing slide valve	10	100	4	M6×25
61	Unloader cylinder to Bearing Cover and Bearing Head	25	250	8	M8×95
76	Unloader Cylinder Cover to Unloader Cylinder	10	100	8	M6×35
81	Bearing gland	10	100	3	M6×15
162	Push rod, Unloader Slide Valve	10	100	5	M6×20
166	Oil Injection Pipe Gland	10	100	4	M6×20
456	O-ring Gland to Bearing Head (1)	6	60	4	M5×10

■ **Hexagon head screw**

No.	Tightening point	Tightening torque		Qty.	Size
		N·m	kgf·cm		
45-1	Thrust bearing gland (1) * specified torque	13	130	12	M6×30
45-2	Thrust bearing gland (2) * specified torque	30	300	8	M8×30
94-1	Suction cover flange (1) MYK125A	140	1400	8	M20×55
94-2	Suction cover (intermediate piping) flange (2) MYK80A	140	1400	4	M20×55
97-1	Discharge cover (intermediate piping) flange (1) MYK80A	140	1400	4	M20×55
97-2	Discharge cover flange (2) MYK65A	110	1100	4	M16×55

■ Locknut

No.	Tightening point	Tightening torque N·m		Qty.	Size
		Regular use	Maximum		
39-1	Thrust bearing (1) Note1	408	510	2	AN12
39-2	Thrust bearing (2) Note1	206	258	2	AN09
69	Unloader piston * specified torque	80	—	1	AN05
71	Unloader slide valve	49	61	1	AN06
160	Gear coupling, drive hub Note1	90	113	1	AN08

Note 1: On June 14, 2010, the "Lock Nut Tightening Angle Range Control Standard" has been introduced to our compressor manufacturing division, to control the specified tightening torque for rotor shaft lock nuts (【39-1】【39-2】【160】 in tables above) as follows. Accordingly, the tightening angle range is now added to the rotor shaft lock nut tightening procedure in this manual.

■ Tightening Angle Range of Lock Nuts for Rotors

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 7-9.

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 7-3 (2016**C【39-1】,【39-2】and【160】: 30° to 40°(first time tightening), 20° to 30°(second time tightening). When measuring the angle, use an angle gauge which is set to the diameter of rotor shaft.

Table 7-3 Tightening Angles Specified for Lock Nuts of Rotor

	Model	Angle range
First time tightening	125 to 250	30°to 40°
	320/400	25°to 35°
Second time tightening	125 to 250	20°to 30°
	320/400	15°to 25°

* 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.

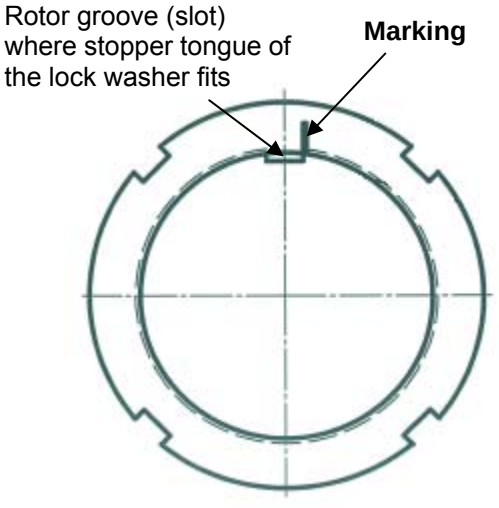


Figure 7-11 Position where mark is put

7.4 O-rings for Use

7.4.1 List of O-rings for Use

Table 7-4 List of O-rings for Use

No.	Used locations		JIS-B2401 (mm type)
	attached place	description in functional aspect	
35	Balance Piston Sleeve	same as left	G95
49	Oil Seal Retainer	same as left	G90
59	Oil Injection Pipe Guide	Oil Injection Pipe	P16
63	Bearing Cover	Unloader Cylinder	G95
65	Unloader piston	same as left	P75
73	Unloader Push Rod	Unloader Piston	P21
75	Unloader cylinder cover	same as left	G85
86	Oil injection pipe	same as left	P16
89	Guide block stem	same as left	P16
89-2	Special specification only for the LLC type, guide block stem	same as left	P12
163	Unloader slide valve (1)	same as left	G25
165	Oil injection pipe gland	same as left	P21
197	Bearing Head (1)	Unloader Push Rod	P32

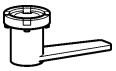
7.4.2 List of O-ring Materials for Screw Compressor

Table 7-5 List of O-ring Materials for Screw Compressor (except for mechanical seal)

Operation fluid	O-ring materials
Ammonia	NBR
HFC	
CO_2	FKM
	HNBR
R23	FKM
Propane	
Propylene	
Natural gas	
City gas	
Helium	

7.5 Tools for Disassembly

Table 7-6 List of Tools for Standard Disassembly

Tool name		size, etc.;
Ratchet wrench		1/4”
Adjustable wrench		250mm
Screwdriver		Phillips
Screwdriver		Flat blade
Stop ring pliers		for shaft
Stop ring pliers		for groove
Eye bolt		M8 two-peace-set
Allen wrench key		Across flats 2mm 3mm 4mm 5mm 6mm 8mm 10mm 12mm
Lock nut wrench		AN-05
		AN-06
		AN-8
		AN-9
		AN-12
Torque wrench for assembly		5-25N·m
		20-100N·m
		40-280N·m

Contact Information

How to Order MYCOM Genuine Parts

Confirm the target parts by referring to 7.1 "Development Views, Cross-section Views" and 7.2 " Configuration Tables of the Parts" in Chapter 7 "Related Documents" of this manual.
Please inform the Model Name and Serial Number, Part Name, Cord No., and required quantity to our local sales offices or service centers.
When you need more information about the compressor or have questions, apart from the ordering of parts, please contact our sales offices or service centers.

Sales Offices/Service Centers

■ Sales Offices in Japan (as of January 01, 2014)

Description	Location	Phone/Fax
Head Office	3–14–15 BOTAN KOTO-KU, TOKYO 135-8482	TEL: 03-3642-8181 FAX: 03-3643-7094
Hokkaido Branch	2-5-1, 3-JYO NIJYUUYONKEN NISHI-KU, SAPPORO-CITY, HOKKAIDO 063-0803	TEL: 011-631-2052 FAX: 011-631-2053
Tohoku Branch	8-72, ROKUTYONO-MEMINAMI-MACHI, WAKABAYASHI-KU, SENDAI-CITY, MIYAGI 984-0013	TEL: 022-288-5001 FAX: 022-288-5155
Kanto Branch	3–14–15 BOTAN, KOTO-KU, TOKYO 135-8482	TEL: 03-3642-8968 FAX: 03-3641-8468
Chubu Branch	2-9-6, MARUNOUCHI, NAKA-KU, NAGOYA CITY, AICHI 460-0002	TEL: 052-218-3307 FAX: 052-218-3308
Kansai Branch	1-4-27, EBIE, FUKUSHIMA-KU, OSAKA CITY, OSAKA 553-0001	TEL: 06-4795-6000 FAX: 06-4795-6033
Chushikoku Branch	2-3-40, TAKAYADAI, HIGASHIHIROSHIMA CITY, HIROSHIMA 739-2117	TEL: 082-491-1830 FAX: 082-491-1838
Kyushu Branch	FUKUOKA-FUJILAND-BUILD. 10F, 2-3, NAKASHIMA-MACHI, NAKASU, HAKATA-KU, FUKUOKA CITY, FUKUOKA 810-0802	TEL: 092-262-0016 FAX: 092-262-0115

■ Manufacturing Bases in Japan (as of January 01, 2014)

Description	Location	Phone/Fax
Moriya Plant	2000, TATSUZAWA MORIYA-CITY, IBARAKI 302-0118	TEL: 0297-48-1361 FAX: 0297-48-5269
Higashi-Hiroshima Plant	2-3-40, TAKAYADAI, HIGASHIHIROSHIMA CITY, HIROSHIMA 739-2117	TEL: 082-491-1828 FAX: 082-491-1838

■ Global Network (as of January 01, 2014)

Description	Location	Telephone and facsimile No.
NORTH AMERICA		
MAYEKAWA CANADA INC. (VANCOUVER OFFICE)	12180 RIVERSIDE WAY, RICHMOND, B.C., V6W 1K5, CANADA	TEL: (1) 604-270-1544 FAX: (1) 604-270-9870
MAYEKAWA CANADA INC. (TORONTO OFFICE)	1745 BONHILL ROAD, UNIT #6&7 MISSISSAUGA, ONTARIO, L5T 1C1, CANADA	TEL: (1) 905-564-0664 FAX: (1) 905-564-7614
MAYEKAWA CANADA INC. (CALGARY OFFICE)	4525 6A STREET N.E., CALGARY, ALBERTA, T2E 4B2, CANADA	TEL: (1) 403-250-1554 FAX: (1) 403-250-1504
MAYEKAWA U.S.A. INC. (CHICAGO OFFICE)	1850 JARVICE AVENUE, ELK GROVE VILLAGE, IL 60007, U.S.A.	TEL: (1) 773-516-5070 FAX: (1) 773-516-5071
MAYEKAWA U.S.A. INC. (NEW YORK OFFICE)	250 WEST NYACK ROAD,SUITE 230,WEST NYACK, NY 10994, U.S.A.	TEL: (1) 914-301-9770 FAX: (1) 914-332-0400
MAYEKAWA U.S.A. INC. (HEAD QUARTERS) (NASHVILLE PLANT)	130 SMART PARK DRIVE, LEBANON, TN 37090, U.S.A.	TEL: (1) 615-773-2859 FAX: (1) 615-444-1995
MAYEKAWA U.S.A. INC. (LA OFFICE)	19475 GRAMERCY PLACE, TORRANCE, CA 90501, U.S.A.	TEL: (1) 310-328-1362 FAX: (1) 310-782-6759
MAYEKAWA U.S.A. INC. (SEATTLE OFFICE)	2615 W CASINO ROAD, UNIT-3D, EVERETT, WA 98204, U.S.A.	TEL: (1) 425-645-9400 FAX: (1) 425-353-3344
MAYEKAWA U.S.A. INC. (PORTLAND OFFICE)	4700 SW MACADAM AVENUE, SUITE 201 PORTLAND, OREGON 97239, U.S.A.	TEL: (1) 971-230-1795 FAX: (1) 503-224-9259
MAYEKAWA U.S.A. INC. (COVINA OFFICE)	1272 CENTER COURT DR, SUITE 106, COVINA, CA 91724, U.S.A.	TEL: (1) 626-598-5030 FAX: (1) -
MAYEKAWA U.S.A.INC. (SAN ANTONIO OFFICE)	1219 SAFARI, SAN ANTONIO, TX 78216, U.S.A.	TEL: (1) 210-599-4536 FAX: (1) 210-599-4538
MAYEKAWA U.S.A. INC. (YORK OFFICE)	3395 FARMTRAIL ROAD YORK, PA 17406, U.S.A.	TEL: (1) 717-779-0138 FAX: (1) 717-779-0109
MAYEKAWA U.S.A. INC. CHEMICAL PROCESS DIVISION (LA OFFICE & MANUFACTURING)	19475 GRAMERCY PLACE, TORRANCE, CA 90501, U.S.A.	TEL: (1) 310-328-6279 FAX: (1) 310-328-8487
MAYEKAWA U.S.A. INC. CHEMICAL PROCESS DIVISION (HUSTON SERVICE OFFICE)	3222 PASADENA FREEWAY PASADENA, TX 77503, U.S.A.	TEL: (1) 281-447-2599 FAX: (1) 281-447-6623
EUROPE		
N.V.MAYEKAWA EUROPE S.A. (HEAD OFFICE, FACTORY)	LEUVENSESTEENWEG 605, 1930 ZAVENTEM, BELGIUM	TEL: (32) 2-757-9075 FAX: (32) 2-757-9023
MAYEKAWA DEUTSCHLAND GMBH	UNTER-BOHNHOF-STRASSE 38A, D-82110 GERMERING, DEUTSCHLAND	TEL:(49) 89-5527-989-0 FAX:(49)89-5527-989-19

Description	Location	Telephone and facsimile No.
MAYEKAWA DEUTSCHLAND GMBH (HUMBURG OFFICE)	WEIDESTRASSE 122A, 22083 HAMBURG DEUTSCHLAND	TEL:(49)40-2788-9149-0 FAX:(49)40-2788-9149-9
N.V.MAYEKAWA EUROPE S.A.(UK)	16 OAKHURST GARDENS, BEXLEYHEATH, KENT DA7 5JP, UNITED KINGDOM	TEL: (44) 1322-433558 FAX: (44) 1322-433164
MAYEKAWA. S.L.	CALLE MONTEVIDEO 5, NAVE 13 POL. INDUSTRIAL CAMPORROSO 28806 ALCALA DE HENARES, MADRID, SPAIN	TEL: (34) 91-830-0392 FAX: (34) 91-830-0397
MAYEKAWA FRANCAISE SARL	9, RUE MICHAEL FARADAY, 78180 MONTIGNY-LE-BRETONNEUX, FARNCE	TEL: (33) 1-30-58-26-00 FAX: (33) 1-30-58-19-37
MAYEKAWA MFG. CO., LTD. MOSCOW LIAISON OFFICE	KOROVY VAL ST., 7, OFFICE 228, 119049, MOSCOW,RUSSIA	TEL: (7) 499-230-01-76 FAX: (7) 499-230-21-12
MAYEKAWA INTERTEC AG	ROSENBERGSTRASSE 31, CH-6300 ZUG, SWITZERLAND	TEL: (41) 41-726-8626 FAX: (41) 41-726-8620
MAYEKAWA MIDDLE EAST FZCO	P.O.BOX 61349, PBU: RA08-UC05, JEBEL ALI FREE ZONE, DUBAI, U.A.E.	TEL: (971) 4-888-6363 FAX: (971) 4-888-6373
MAYEKAWA TURKEY SOGUTMA SANAYI VE TICARET LIMITED SIRKETI	ISTANBUL DUNYA TICARET MERKEZI A-2 BLOK KAT 10 No:325 YESILKOY 34149, ISTANBUL, TURKEY	TEL: (90) 212-4653631 FAX: (90) 212-4653635
N.V. MAYEKAWA EUROPE S.A.（BULGARIA）	24,KAMEN ANDREEV STR. 1303, SOFIA, BULGARIA	TEL: (359) 2-8910130 FAX: (359) 2-8910131
MAYEKAWA ITALIA S.R.L.（MILANO OFFICE）	VIA RICCARDO LOMBARDI 19/12, 20153 MILANO, ITALY	TEL: (39) 02-4892-9159 FAX: (39) 02-453-1728
MAYEKAWA ITALIA S.R.L.（BOLOGNA OFFICE）	VIA PRADAZZO 7,40012 CALDERARA DI RENO,, BOLOGNA, ITALY	TEL: (39) 051-726-364 FAX: (39) 051-726-804
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MAYEKAWA AUSTRALIA PTY.LTD.	UNIT 2, 44 MCCAULEY STREET MATRAVILLE NSW 2036, AUSTRALIA	TEL: (61) 2-9695-7000 FAX: (61) 2-9695-7001
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MAYEKAWA INDIA PVT.LTD. (CHENNAI FACTORY)	RS No.225/226/238,NAYAPAKKAM VILLAGE, PUDDUVALLUR PANCHAYAT, VALARPURAM POST THIRUVALLUR DISTRICT, TAMIL NADU 602105, INDIA	TEL: (91) 92-8258-2508 FAX: -
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Description	Location	Telephone and facsimile No.
MAYEKAWA INDIA PVT. LTD. (JALANDHAR OFFICE)	SHOP NO. 3, OPP. TV TOWER, NIKODAR ROAD, JALANDHAR, PUNJAB 144201, INDIA	TEL: (91) 9711303865 FAX: —
MAYEKAWA INDIA PVT. LTD. (AGRA OFFICE)	CS-9 SECOND FLOOR, RASHMI PALACE, SULTAN GANJ KI PULIA, KAMLA NAGAR, AGRA, U.P. 282005, INDIA	TEL: (91) 89-5450-2937 FAX: (91) 97-1130-3865
P.T.MAYEKAWA INDONESIA	GRAHA PRATAMA BUILDING, 9TH FLOOR JL. M.T. HARYONO KAV.15 JAKARTA 12810, INDONESIA	TEL: (62) 21-8370-9484 FAX: (62) 21-8370-9483
P.T.MAYEKAWA INDONESIA (MEDAN OFFICE)	JL. SUTRISNO No.274 MEDAN-20215, INDONESIA	TEL: (62) 61-7323627 FAX: (62) 61-7358848
P.T.MAYEKAWA INDONESIA (SURABAYA OFFICE)	BUMI MANDIARI BUILDING, 7TH FLOOR SUITE 702B, JL. JEND. BASUKI RACHMAT No. 129-137, SURABAYA-INDONESIA	TEL: (62) 31-531-6613 FAX: (62) 31-532-4341
MAYEKAWA (M) SDN. BHD.	No.3, JALAN PJU 3/50, SUNWAY DAMANSARA TECHNOLOGY PARK, 47810 PETALING JAYA, SELANGOR, MALAYSIA	TEL: (60) 3-78051406 FAX: (60) 3-78051409
MAYEKAWA PHILIPPINES CORP.	4/F UNIT A AND B SUNTREE TOWER, 13 MERALCO AVENUE, SAN ANTONIO, ORTIGAS CENTER, PASIG CITY 1605, PHILIPPINES	TEL: (63) 2-706-0473 FAX: (63) 2-706-0475
MAYEKAWA PHILIPPINES CORP. (GENARAL SANTOS OFFICE)	ROOM 4, LEAH DAPROZA BUILDING FISCAL DAPROZA AVENUE GENERAL SANTOS CITY 9500, PHILIPPINES	TEL: (63) 83-552-3282 FAX: (63) 83-301-2698
MAYEKAWA SINGAPORE PTE.LTD.	6 TAGORE LANE SINGAPORE 787470	TEL: (65) 6451-1565 FAX: (65) 6451-4932
MAYEKAWA (TAIWAN) CO., LTD.	No.2-1,XINZHAN RD.,QIANZHEN DIST., KAOHSIUNG CITY,80672 TAIWAN , REP.OF CHINA	TEL: (886) 7-821-0886 FAX: (886) 7-821-4688
MAYEKAWA (TAIWAN) CO., LTD. (CHEMICAL DEPARTMENT)	1F., NO.2, SHIN JANN ROAD, CHIEN CHEN DIST., KAOHSIUNG, TAIWAN 80672, REP.OF CHINA	TEL: (886) 7-812-7709 FAX: (886) 7-812-9019
MAYEKAWA (TAIWAN) CO., LTD. (TAIPEI BRANCH)	8F, NO, 421, SUNG-SHAN ROAD, TAIPEI, TAIWAN 11083, REP. OF CHINA	TEL: (886) 2-2727-9711 FAX: (886) 2-2759-8484
MAYEKAWA (TAIWAN) CO., LTD. (TAICHUNG BRANCH)	NO. 19, SEC.3, HUANJUNG RD., TAICHUNG, TAIWAN, REP. OF CHINA	TEL: (886) 4-2251-4128 FAX: (886) 4-2251-4129
MAYEKAWA CHINA INDUSTRIES CO., LTD. (SHANGHAI BRANCH)	ROOM 3001, NANZHENG BUILDING, NO.580 WEST NANJING RD., 200041 SHANGHAI, P.R. CHINA	TEL: (86) 21-5234-1988 FAX: (86) 21-5234-1788
MAYEKAWA CHINA MFG.CO., LTD.	201700 PLANT 1, NO.39, WEST XIQING ROAD, QINGPU, SHANHAI, P.R. CHINA	TEL: (86) 21-6920-7718 FAX: (86) 21-6920-7719

Description	Location	Telephone and facsimile No.
MAYEKAWA CHINA MFG.CO., LTD. (GUANGZHOU BRANCH)	266701 RM.1205, BUILDING H, R&F TIANHE PROSPEROUS PLACE, EAST LINHE ROAD, TIANHE DISTRICT, GUANGZHOU, P.R., CHINA	TEL: (86) 20-8527-6161 FAX: (86) 20-8527-6165
MAYEKAWA CHINA MFG. CO., LTD. (QINGDAO BRANCH)	ROOM 601, FULIN BUILDING NO.87 SOUTH FUZHOU ROAD, SOUTH DISTRICT, QINGDAO CITY, 266071, CHINA	TEL: (86) 532-8602-6169 FAX: (86) 532-8602-6269
MAYEKAWA MFG. CO., LTD (BEIJING LIAISON OFFICE)	NO.643 HANWEI PLAZA, NO.7 GUANGHUA ROAD, CHAOYANG DISTRICT, BEIJING 100004, P.R. CHINA	TEL: (86) 10-6561-7811 FAX: (86) 10-6561-1997
MAYEKAWA CHINA MFG. CO., LTD. (DALIAN BRANCH)	RM.A13-5, No.1 BUILDING, AREA A , WUCAI CITY, DALIAN ECO-TECH DEVELOPMENT ZONE, DALIAN 116100, CHINA	TEL: (86) 411-8753-9620 FAX: (86)411-8757-9620
MAYEKAWA (THAILAND) CO., LTD.	2/3 MOO 14, 3RD FLOOR BANGNA TOWER BLDG., TOWER A, BANGNA-TRAD RD, K.M.6.5, BANGKAEW BANGPLEE, SAMUTPRAKARN 10540, THAILAND	TEL: (66) 2-751-9610 FAX: (66) 2-751-9565
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
MAYEKAWA VIETNAM ONE MEMBER CO., LTD.	ROOM 305, 3FL, TUOI TRE TOWER, 60A HOANG VAN THU, WARD 9, PHU NHUAN DIST., HO CHI MINH CITY, VIETNAM	TEL: (84) 8-3997-5284 FAX: (84) 8-3997-5287
MYCOM KOREA CO., LTD. (HEAD OFFICE)	JUYEON BUILDING 2F, SEOGYE-DONG 209, YONGSAN-KU, SEOUL, 140-710, REP.OF KOREA	TEL: (82) 2-796-1766 FAX: (82) 2-798-7715
MYCOM KOREA CO., LTD. CHANGWON FACTORY	PALYONG DONG 24-20, UICHANG-KU, CHANGWON, KYUNGSANGNAM-DO 641-847, REP.OF KOREA	TEL: (82) 55-294-8678 FAX: (82) 55-299-7678
MYCOM KOREA CO., LTD. (PUSAN BRANCH)	5F GUKJE BLDG., JUNGANG-DONG 6-GA, JUNG-GU, PUSAN 600-714, REP.OF KOREA	TEL: (82) 51-242-3737 FAX: (82) 51-243-8542
MYCOM KOREA CO., LTD. (GWANGJU BRANCH)	970-6 WOLCHUL-DONG PUK-KU GWANGJU 500-460, REP. OF KOREA	TEL: (82) 62-973-8471 FAX: (82) 62-973-8475
LATIN AMERICA		
MAYEKAWA ARGENTINA S.A. (BUENOS AIRES OFFICE)	AV. VELEZ SARSFIELD 670/74 C1282 AFT-CAPITAL FEDERAL BUENOS AIRES, REPUBLICA ARGENTINA	TEL: (54) 11-4302-2791 FAX: (54) 11-4304-3015

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MAYEKAWA ARGENTINA S.A. (PUERTO MADRYN OFFICE)	OFICINA PTO. MADRYN LEOPOLDO LUGONES 45 (U9129KDA)-PUERTO MADRYN PCIA DE CHUBUT REPUBLICA ARGENTINA	TEL: (54) 2965-475414 FAX: (54) 2965-475414
MYCOM PERU S.A.C.	CALLE LUIS PASTEUR 1490, LINCE, LIMA, PERU	TEL: (51) 1-205-5400 FAX: (51) 1-222-1543
MAYEKAWA CHILE S.A.C.el. (SANTIAGO OFFICE)	CORDILLERA No.331, MODULO D14, FLEX CENTER, PUERTO VESPUCIO, QUILICURA, SANTIAGO, CHILE	TEL: (56) 2-739-0202 FAX: (56) 2-739-2700
MAYEKAWA CHILE S.A.C.el. (CONCEPCION OFFICE)	ANIBAL PINTO No.215, OFICINA 403, CONCEPCION, CHILE	TEL: (56) 41-223547 FAX: (56) 41-212443
MAYEKAWA CHILE S.A.C.el. (PUERTO MONTT OFFICE)	BERNARDINO 1057 MODULO 6, PARQUE INDUSTRIAL SAN ANDRES PUERTO MONTT, CHILE	TEL: (56) 65-257570 FAX: (56) 65-288073
MAYEKAWA ECUADOR S.A.	CALLE 15B Y AV. GUILLERMO PAREJA C.C.STEFANY LOCAL #4, CALLA.LA GARZOTA 1 MZ.28 SOLOR 13, GUAYAQUIL, ECUADOR	TEL: (593)4-262-9108 FAX: -
MAYEKAWA COLOMBIA S.A.S	TRANSVERSAL 93 NO.53-48 INTERIOR 37, PAQUE INDUSTRIAL EL DORADO, BOGOTA, COLOMBIA	TEL: (57) 1-430-9980 FAX: (57) 1-437-0988
MAYEKAWA COLOMBIA S.A.S. (MEDELLIN OFFICE)	DIRECCION CR 43B No. 8 SUR 10 OFICINA 404 EDF. OVIEDO MEDELLIN, COLOMBIA	TEL: (57) 4-313-4343 FAX: (57) 4-313-4343
MAYEKAWA DO BRASIL EQIPAMENTOS INDUSTRIAIS LTDA.	RUA LICATEM 250, BLOCO B/C, JARDIM PEROVA-ARUJA-SP CEP:07428-280, BRASIL	TEL: (55) 11-4654-8000 FAX: (55) 11-4654-8002
MAYEKAWA DO BRASIL LTDA. (BAHIA BRANCH)	RUA DR. JOSE PEROBA, 275 - SALA 902 EDIFICIO METROPOLIS - BAIRRO STIEPE, SALVADOR – BA,CEP:41770-235, BRASIL	TEL: (55) 71-3341-0737 FAX: —
MAYEKAWA DO BRASIL EQIPAMENTOS INDUSTRIAIS LTDA. (CHAPECO BRANCH)	AV. NEREU RAMOS, 75D, SALA 503A, EDIFICIO CENTRO PROFISSIONAL CEP:89801-023 C.P.:177 CHAPECO-SC, BRASIL	TEL: (55) 49-3324-0681 FAX: (55) 49-3322-4241
MAYEKAWA DO BRASIL EQIPAMENTOS INDUSTRIAIS LTDA. (CUIABA BRANCH)	AVENIDA ISSAC POVOAS, 586 – SALA 405 EDIFICIO WALL STREET - CENTRO CUIABA-MT, CEP 78055-560, BRASIL	TEL: (55) 65-3023-7559 FAX: —
MAYEKAWA DO BRASIL EQIPAMENTOS INDUSTRIAIS LTDA. (CURITIBA BRANCH)	RUA XV DE NOVEMBRO, 2175 6 ANDAR SALA 30 SHOPPING CELLI CEP:83005-000 SAO JOSE DOS PINHAIS-PR, BRASIL	TEL: (55) 41-3383-1518 FAX: (55) 41-3383-1987
MAYEKAWA DO BRASIL EQIPAMENTOS INDUSTRIAIS LTDA. (GOIANIA BRANCH)	RUA C, 255 – QUADRA 588 – LOTE 4/8 SALA 104 – CENTRO EMPRESARIAL SEBBA GOIANIA-GO, CEP 74280-010, BRASIL	TEL: (55) 62-3093-5062 FAX: —

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MAYEKAWA DO BRASIL EQIPAMENTOS INDUSTRIAIS LTDA. (OESTE PAULISTA BRANCH)	AV. FRANCISCO DE CHAGAS OLIVEIRA, 344 JARDIM PINHEIRO SAO JOSE DO RIO PRETO-SP, CEP 15091-330, BRASIL	TEL: (55) 17-3227-0235 FAX: (55) 17-3227-3120
MAYEKAWA DO BRASIL EQIPAMENTOS INDUSTRIAIS LTDA. (RECIFE BRANCH)	RUA AGENOR LOPES, 292 SALA 305 CEP:51021-110 BOA VIAGEM RECIFE-PE, BRASIL	TEL: (55) 81-3342-7670 FAX: -
MAYEKAWA DO BRASIL EQIPAMENTOS INDUSTRIAIS LTDA. (RIO GRANDE DO SUL BRANCH)	RUA MUCK, 298 – SALA 601 EDIFICIO SANTA HELENA CEP:92010-250 CANOAS-RS, BRASIL	TEL: (55) 51-3429-1860 FAX: —
MAYEKAWA DO BRASIL EQIPAMENTOS INDUSTRIAIS LTDA. (LINHARES BRANCH)	AV. GOVERNADOR CARLOS LINDENBERG, 873/107 CENTRO CEP:29900-020 LINHARES-ES, BRASIL	
MAYEKAWA DO BRASIL EQIPAMENTOS INDUSTRIAIS LTDA. (MACAE)	RUA PROFESSOR MARIETA PEIXOTO, 62 CENTRO - MACAE – RJ, CEP 27910-250, BRASIL	TEL: (55) 22-2772-6069 FAX: (55) 22-2759-3112
MAYEKAWA DO BRASIL EQIPAMENTOS INDUSTRIAIS LTDA. (RIO DE JANEIRO BRANCH)	AV.LUIZ CARLOS PRESTES, 350-SALA 313-EDIFICIO BARRA TRADE II, BARRA DA TIJUCA, RIO DE JANEIRO-RJ CEP:22775-055, BRASIL	TEL: (55) 21-2431-3600 FAX: (55) 21-2430-8882
MYCOM CENTROAMERICA S.A	BODEGA #63, CONDOMINIO COMERCIAL TIERRA DOS, EL CACIQUE DE RIO SEGUNDO, ALAJUELA, COSTA RICA	TEL: (506) 2441-4464 FAX: (506) 2441-4465
MYCOM VENEZUELA SALES & SERVICES,C.A. (CARACAS OFFICE)	CALLE LOS MANGOS, EDIFICIO SELEMAR, PISO 8, SABANA GRANDE, CARACAS, VENEZUELA	TEL: (58) 212-216-6026 FAX: (58) 212-216-0608
MYCOM VENEZUELA SALES & SERVICE, C.A. (MARACAY OFFICE)	AV.INTERCOMUNAL TURMERO, EDF.TECHOMAT METROPOLITANO, PISO 1, OFICINA 3, MARACAY, EDO.ARAGUA, VENEZUELA	TEL: (58) 243-269-4913 FAX: (58) 243-269-3952
MYCOM VENEZUELA SALES & SERVICE, C.A. (MARACAIBO OFFICE)	CALLE 148,CENTRO EMPRESARIAL SAN FRANCISCO NIVEL 1 LOCAL 5 Y 6, ZONA INDUSTRIAL IIETAPA,SAN FRANCISCO EDO.ZUILIA, VENEZUELA	TEL: (58) 261-418-1760 FAX: -
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MYCOM CHEMICAL PROCESS CORP. DE VENEZUELA S.A.	CALLE 148,CENTRO EMPRESARIAL SAN FRANCISCO NIVEL 1 LOCAL 5 Y 6, ZONA INDUSTRIAL IIETAPA,SAN FRANCISCO EDO.ZUILIA, VENEZUELA	TEL: (58) 261-418-1760 FAX: -

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MAYEKAWA DE MEXICO, S.A. DE C.V. (CUERNAVACA OFFICE)	AV.DE LOS 50MTS.NO.381, CIVAC. JIUTEPEC MORELOS, C.P.62578, MEXICO	TEL: (52) 77-73-19-0925 FAX: (52) 77-73-20-5762
MAYEKAWA DE MEXICO, S.A. DE C.V. (MEXICO CITY OFFICE)	AV.COYOACAN #945 COL .DEL VALLE DEL. BENITO JUAREZ C.P.03100, MEXICO, D.F. MEXICO	TEL: (52) 55-5062-0870 FAX: (52) 55-5062-0898
MAYEKAWA DE MEXICO, S.A. DE C.V. (GUADALAJARA OFFICE)	SANTA MARIA No.3086, COL. VALLARTA SAN LUCAS GUADALAJARA, JALISCO, C.P.44690, MEXICO	TEL: (52) 3336-15-5765 FAX: (52) 3336-15-1307
MAYEKAWA DE MEXICO, S.A. DE C.V. (MONTERREY OFFICE)	AV.CHAPULTEPEC NO.2233 OTE. FRACC, BUENOS AIRES MONTERREY N.L. C.P.64800, MEXICO	TEL: (52) 81-8347-3085 FAX: (52) 81-8347-5830
MAYEKAWA DE MEXICO, S.A. DE C.V. (HERMOSILLO OFFICE)	CALLE FRAY TORIBIO DE BENAVENTE #38 COL. LOS ARCOS CD. HERMOSILLO, SONORA, C.P.83250, MEXICO	TEL: (52) 662-216-2047 FAX: (52) 662-216-2047
MAYEKAWA DE MEXICO, S.A. DE C.V. (IRAPUATO OFFICE)	CALLE AGUSTIN ZARAGOZA NO.219 LOCAL-2 COL.DEPORTIVA, C.P.36612, IRAPUATO, GTO. MEXICO	TEL: (52) 462-624-9353 FAX: (52) 462-624-9264
MAYEKAWA DE MEXICO, S.A. DE C.V. (CULIACAN OFFICE)	AV. NICOLAS BRAVO 1572, LOCAL 1 COL.MORELOS CULIACAN, SINALOA, C.P.80170, MEXICO	TEL: (52) 66-7715-4199 FAX: (52) 66-7715-4150

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