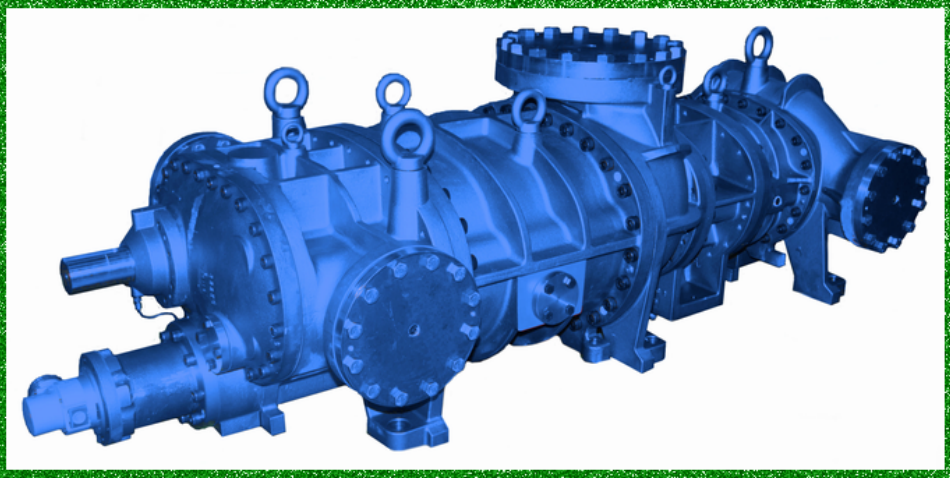
2201MYJE-MY-C8-N_2015.04.

MYCOM

Compound 2-stage Screw Compressor

# 3225**C Instruction Manual

**3225LLLC/3225LLMC/3225LLSC/3225LLC/3225LMC/3225LSC**
**3225MLC/3225MMC/3225MSC/3225SLC/3225SMC/3225SSC**



**CAUTION**

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

MYCOM MAYEKAWA MFG. CO., LTD.

# Preface

Thank you for purchasing the MYCOM C-series compound 2-stage screw compressor 3225**C (hereinafter referred to as "this product").

This Instruction Manual (hereinafter referred to as "this manual") provides safety information and operation and maintenance procedures, so that users correctly understand how to handle this product and, as a result, can use it safely and efficiently. This manual is applicable to the following models:

| | | | | | |
|---|---|---|---|---|---|
| 3225LLLC-*B*-51 | 3225LLLC-*B*-61 | 3225LLMC-*B*-51 | 3225LLMC-*B*-61 | 3225LLSC-*B*-51 | 3225LLSC-*B*-61 |
| 3225LLC-*B*-51 | 3225LLC-*B*-61 | 3225LMC-*B*-51 | 3225LMC-*B*-61 | 3225LSC-*B*-51 | 3225LSC-*B*-61 |
| 3225MLC-*B*-51 | 3225MLC-*B*-61 | 3225MMC-*B*-51 | 3225MMC-*B*-61 | 3225MSC-*B*-51 | 3225MSC-*B*-61 |
| 3225SLC-*B*-51 | 3225SLC-*B*-61 | 3225SMC-*B*-51 | 3225SMC-*B*-61 | 3225SSC-*B*-51 | 3225SSC-*B*-61 |

* -51 (-61) may not be written. For more information, see 2.2 "Model designation of the compressor" in this manual Chapter 2.

Make sure you read this manual before installing or using this product.

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

## Revision History

| Title | | Document No. | First edition issue date |
|---|---|---|---|
| **3225**C Instruction Manual** | | **2201MYJE-MY-C8-N_2015.04.** | **Nov. 14, 2014** |
| **Revision No.** | **Issue date** | **Major Contents of revisions** | **Created/approved by:** |
| 00 | Nov. 14, 2014 | Overall review associated with reissue as electronic document, document No. change | Ikehara / Hirao |
| **01** | **Apr. 30, 2015** | **Modified the constitution of Chapter 4 and Chapter 5. Correction of describing, etc.** | **Ikehara / Muta** |
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# Warranty and Disclaimer

## Warranty

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

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

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

## Disclaimer of Warranty

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

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

"Liquid flow-back operation" is ・・・

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

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

# Important Information

## Intended Use of This Product

This product is a general-purpose screw compressor for refrigeration, cold storage and various gases compression. Do not use this product for any other purposes that are not intended for or which depart from the specifications. For specifications of this product, refer to "2.3 Compressor Specifications".

Please perform the maintenance items described in this manual by using safe and assured procedures.

## For Safe Use of This Product

Although MAYEKAWA has paid a lot of attention to safety measures for this product, all hazards including potential hazards caused by human errors, or due to environmental conditions can not be anticipated.

As there are too many items to be strictly observed or prohibited when using this product, it is impossible to inform all of them through this manual. Therefore, when operating this product, pay extreme caution on personnel safety as well as on items described in this manual.

Important rules for safety work with this product that apply to all workers including managers and supervisors are listed below.

Please read this manual before using this product. Fully understand the instructions provided there, and be sure to perform the safety procedures described in this manual.

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

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

Lockout means disconnecting or keeping disconnected machines and devices by locking their energy (power) sources. Lockout is not just simply turning off the power switches to stop the supply of power, but includes immobilizing them with a key or similar device to keep any blocked switches from being operated.

Lockout devices are devices such as keys, covers, and latches, to immobilize switches, valves, opening and closing levers, etc., with a state of being locked.

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

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

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

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

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

# About This Manual

- This product may be modified without prior notice. Therefore, the appearance of actual machine may differ from the descriptions in this manual. If you have any questions, contact our sales offices or service centers. For each sight of MAYEKAWA, refer to "Contact Information" in this manual or following URL. http://www.mayekawa.com/about/network/
- This manual is in English. If any other language is required, it is the customers' responsibility to prepare a manual for safety education and operation instructions.
- This manual is copyrighted. Drawings and technical references including this manual shall not, in whole or part, be copied, photocopied, or reproduced into any electronic medium or machine-readable form without prior permission from MAYEKAWA.
- Photographs or drawings included in this manual may differ from the appearance of actual product.
- If this manual is lost or damaged, immediately request our local sales offices or service centers for a new manual. Using this product without the manual may result in safety issues.
- If you resell this product, never fail to attach this manual to this product.

# Construction of This Manual

| Title of section and chapter | Description details |
|---|---|
| Preface | Describes the outline of this manual and how to read this manual. |
| Warranty and Disclaimer | Describes what MAYEKAWA warrants and what are covered by the warranties. Warranty exemption is stated as disclaimer. |
| Important Information | Describes important information related to this product and this manual. |
| 1. Safety | Describes safety information for the worker, safety rules for this product, and management details regarding the work safety that is required for handling this product. |
| 2. Compressor Specifications and Structure | Describes the main components of this product, functional information, specification, and operating limits. |
| 3. Installation | Describes the installation procedure of this product. |
| 4. Compressor and Package Unit Operation | Describes the precautions for operating this product. |
| 5. Maintenance and Inspection | Describes sections and period for inspecting, and assembly and disassembly of this product. |
| 6. Troubleshooting | Describes troubleshooting methods for this product in case problems occur during operation of this product. |
| 7. Related Documents | Describes documents such as development views and parts list. |
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# Table of Contents

## Chapter 6 Troubleshooting



## Chapter 7 Related Documents



## Contact Information

# Chapter 1 Safety

## 1.1 Strict Requirements and Prohibitions

### 1.1.1 Strict Requirements (Do's)

#### 1.1.1.1 Do's on Operation

- Make sure to install safety and protective devices on the package unit.
- Regularly inspect the safety and protective devices if they function properly.
- If the safety or protective devices do not work properly or if this product operates abnormally, immediately stop the operation and report to the supervisor. Obtain his/her approval and direction before restarting the compressor.
- If this product stops for unknown reasons, immediately inform your supervisor of it. Obtain his/her approval before restarting the compressor.
- Some types of refrigerants emit bad smell or toxic gases when they leak. Make sure to ventilate the air during operation.
- For the properties of refrigerant and lubricating oil (corrosiveness, decomposability or toxicity), be sure to obtain the Safety Data Sheet (SDS) and follow the relevant information.
- When stopping the operation of this product, close the suction and discharge side shut-off valves and turn "OFF" the motor (main power), heater power, and control power.

#### 1.1.1.2 Do's on Maintenance

- Prepare work procedures based on a work schedule. Be sure to perform danger forecasting before starting the work.
- Before performing the work together with at least one other person, thoroughly confirm each other's work details and procedures to acknowledge the other worker's movement.
- When troubleshooting during operation or before performing setup, cleaning, maintenance, or inspection of this product, always turn OFF the main power to the motor and control power and other devices. Also, lock and tag out them to prevent the power from being supplied erroneously during operation.
- When troubleshooting during operation or before performing setup, cleaning, maintenance, or inspection of this product, confirm that the pressure inside this product and the package unit is at atmospheric pressure.
- Some refrigerants in use generate bad smell or toxic gases, or may cause deficiency of oxygen. Before starting work, measure oxygen concentration in the work area as necessary. Ventilate the area well. Be sure to keep the area well ventilated until the work is finished.
- For the properties of refrigerant and lubricating oil (corrosiveness, decomposability or toxicity), be sure to obtain the Safety Data Sheet (SDS) and follow the relevant information.
- After using tools always restore to designated place and never leave tools in the package unit

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

- Attach lockout/tagout mechanism to the main breakers of motor main power and control power. Lockout/tagout after power off is a very effective means to secure safety. It can prevent the power source from being turned on by accident by two or more workers which may cause injury to other worker(s).

- If there are any possibilities of danger during works (especially during cleaning, maintenance and inspection, and troubleshooting), turn "OFF" the motor main power 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 the 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 protective gear before using.
- Wear designated clothes such as work outfits, with their cuffs tightly closed.
- Do not wear any neckties or jewelry as there is a risk of being entangled by a movable part or rotating part. Put on a helmet as your hair may get entangled.
- Do not have anything in your pocket to prevent objects from falling into the machine.

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

- Obtain the Safety Data Sheet (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

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

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

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

#### 1.1.1.8 Other Do's

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

### 1.1.2 Prohibitions (Don’ts)

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

## 1.2 Warnings

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

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

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

**Table 1-1 Warning Symbols and their Meanings**

| Symbol | Meaning |
|---|---|
| DANGER | Indicates a hazardous situation which, if not avoided, could very likely cause serious injury or death. |
| WARNING | Indicates a potentially hazardous situation which, if not avoided, may cause serious injury or death. |
| CAUTION | Indicates a potentially hazardous situation which, if not avoided, may cause 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 assumes that this product is operated or inspected/maintained while being used in general refrigerating/cold storage/gas compression 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**

| | Hazardous sources | Predicted hazard | Countermeasures in operation | Countermeasures in cleaning, inspection, and parts exchange |
|---|---|---|---|---|
| A | Motor and compressor coupling Refer to Figure 1-1 | • Caught in due to contact | • Install coupling cover and prohibit opening.<br>• Keep away. | • Turn off motor main power and control power, and conduct lockout/tagout. |
| B | Motor terminals | • Electric shock caused by contact with live wires or electrical leakage | • Keep away.<br>• Do not open terminal boxes.<br>• Do not touch terminal boxes. | • Turn off motor main power and control power, and conduct lockout/tagout. |
| C | Compressor low-stage side suction casing Refer to Figure 1-1 | • Frostbite due to contact<br>• Contact with or inhalation of hazardous substances generated by leakage of refrigerant or the like | • Keep away and do not touch.<br>• Wear protective gear.<br>• Detect gas leakage. | • Wear protective gear.<br>• Work under room temperature. |
| D | Compressor intermediate piping (low-stage discharge port to high stage suction port) Refer to Figure 1-1 | • Burn injury due to contact<br>• Contact with or inhalation of hazardous substances generated by leakage or spout of refrigerant or the like | • Keep away and do not touch<br>• Wear protective gear<br>• Gas leakage detection | • Wear protective gear<br>• Work in temperatures below 40 °C |
| E | Compressor high-stage side discharge casing and discharge piping | • Burn injury due to contact<br>• Contact with or inhalation of hazardous substances generated by leakage or spout of refrigerant or the like | • Keep away and do not touch.<br>• Wear protective gear.<br>• Detect gas leakage. | • Wear protective gear.<br>• Work at a temperature of not higher than 40°C. |
| F | Check valves/service valves and joints on each section of the package unit | • Contact with or inhalation of hazardous substances generated by mishandling or leakage<br>• Frostbite or burn due to contact | • Sufficient ventilation<br>• Indicate valve open/close state.<br>• Keep away and do not touch.<br>• Wear protective gear. | • Sufficient ventilation<br>• Wear protective gear.<br>• Tagout for controlled valve |
| G | Solenoid valves/electric valves on each section of the package unit | • Electric shock caused by contact with live wires or electrical leakage<br>• Pinched due to contact with driving part | • Install protective cover on terminals, and prohibit opening.<br>• Keep away and do not touch.<br>• Wear protective gear. | • Turn off each breaker and the control power, and conduct lockout/tagout.<br>• Wear protective gear. |
| H | Electric components in each section of the package unit (oil heater, protective switch, etc.) | • Electric shock caused by contact with live wires or electrical leakage<br>• Pinched due to contact with driving part | • Install protective cover on terminals, and prohibit opening.<br>• Keep away and do not touch.<br>• Wear protective gear. | • Turn off each breaker and the control power, and conduct lockout/tagout.<br>• Wear protective gear. |
| I | Package unit oil drains | • Contact with hazardous substances generated by leakage or spout<br>• Burn caused by contact with high-temperature fluid | • Sufficient ventilation<br>• Keep away and do not touch.<br>• Wear protective gear. | • Sufficient ventilation<br>• Wear protective gear.<br>• Work at a temperature of not higher than 40°C. |
| J | Noises | • Damage caused by noise | • Wear protective gear. | — |

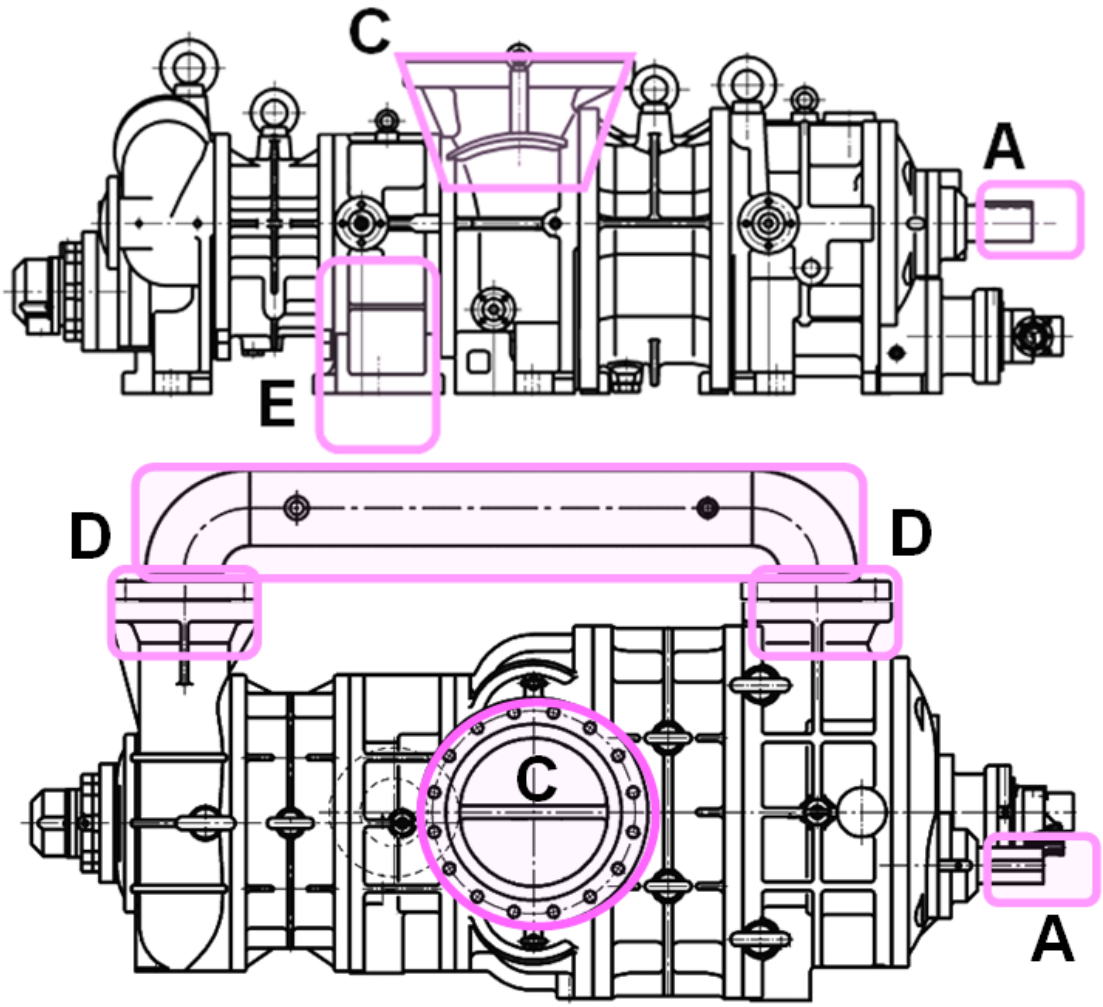



Figure 1-1 Locations of Hazardous Sources (compressor)

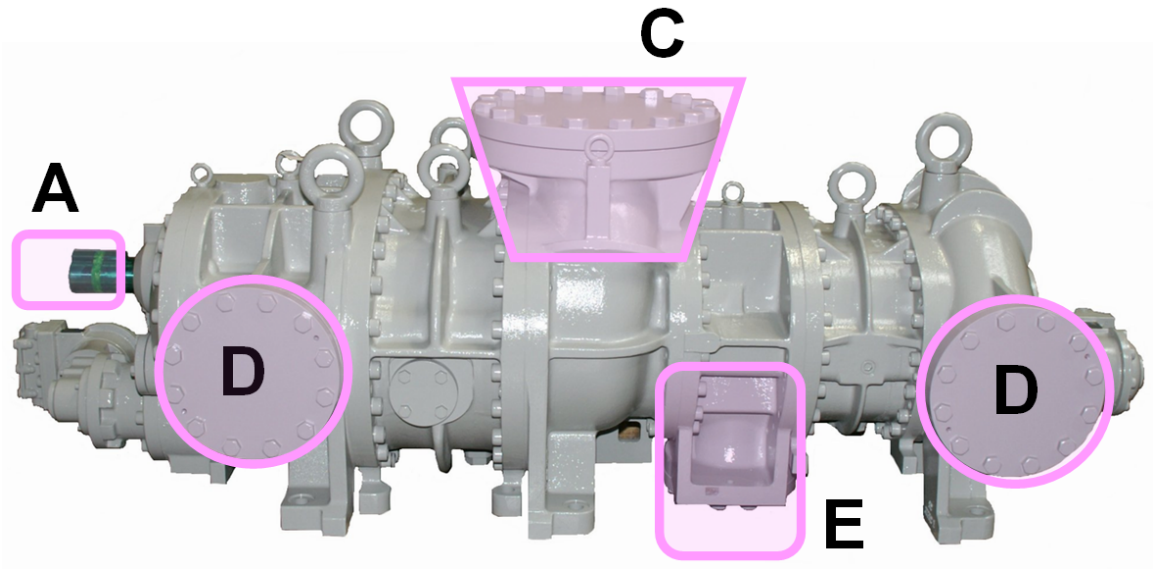



Photo 001 Locations of Hazardous Sources (compressor)

# 1.4 Safety Devices

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

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

**WARNING**

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

## 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 in this product.

### ■ Installation Positions

On the control board and in the operation control room

### ■ Stop/Restoration Methods

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

### ■ Inspection Method/Cycle

The emergency stop buttons must be tested before commissioning and must also be periodically re-tested after that. The inspection procedures and the inspection interval for the emergency stop button must be clearly defined and the information provided to the user of this product.

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

### ■ Overview/Function/Purpose

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

### ■ Methods of Performing and Releasing Lockout/Tagout

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

### ■ Inspection Method/Cycle

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

## 1.4.3 Compressor Protective Devices

**WARNING**

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

### ■ Overview/Function/Purpose

These protective devices are used to protect this product.

- **Protecting from discharge temperature rise (DT)**

  This device activates and stops the compressor operation when the compressor discharge temperature gets equal to or higher than the set value.
  Install a temperature sensing port to the discharge pipe.

- **Protecting from oil temperature rise (OT)**

  This device activates and stops the compressor operation when the compressor oil temperature gets equal to or higher than the set value.
  Install a temperature sensing port to the oil supply pipe of the package unit (after the oil cooler).

- **Protecting from high pressure (HP)**

  This device activates and stops the compressor operation when the compressor discharge pressure gets abnormally high due to mishandling of the compressor or suspension of water supply to the condenser. This device prevents explosion of the equipment and components.
  Install a pressure sensing port to the discharge pipe.

- **Protecting from intermediate pressure (IP)**

  This device activates when the intermediate pressure of the compressor gets equal to or higher than the set value and properly controls the compressor. In some cases, this device stops the compressor operation. Install a pressure output port to the package unit's intermediate gas pipe (or compressor's intermediate gas pressure output port).

- **Protecting from suction pressure drop (LP)**

  This device activates and stops the compressor operation when the compressor suction pressure gets equal to or lower than the set value.
  Install a pressure sensing port to the suction pipe.

- **Protecting from oil pressure (OP)**

  This device activates and stops the compressor operation when the differential pressure to supply oil to the compressor (= lubrication oil supply pipe pressure − compressor discharge pressure) gets equal to or lower than the set value, due to insufficient lubricating oil, clogged filter or mixture of refrigerant into the lubrication oil. This device prevents the sliding portion from being abnormally worn or seized.
  Install a pressure sensing port to the package unit's oil supply pump (after the oil pump) and the discharge pipe.

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

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

## ■ Connection Positions and Settings

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

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

## ■ Inspection Method/Cycle

Compressor protective devices require operation tests and confirmation of the settings calibration before commissioning as well as at regular intervals.
Specify the inspection methods/intervals of the compressor protection devices, and make sure to provide users of this product with such information.

**CAUTION**

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

# Chapter 2 Compressor Specifications and Structure

## 2.1 Overview of the MYCOM 3225**C

The 2-stage compression system, which has hitherto required two units of standard-type screw compressor for its embodiment, can now be realized by a single unit of compound 2-stage screw compressor.

Generally, screw compressors use oil injection to keep discharge temperature at a low level during operation without loss of volumetric efficiency even at high compression ratios. It can, therefore, be operated with a single-stage compression system even at evaporative temperatures near -40°C.

However, for normal use at low temperatures, a 2-stage compression system is applied in order to improve kW/RT (ratio of power consumption versus cooling ability). If the 2-stage compression system is configured with standard-type screw compressors, at least two screw compressor units need to be installed, one on the high-stage and the other on the low-stage, which inevitably requires double installation of the entire system including machinery, motors, utilities, etc.

This 2-stage screw compressor is produced to solve this problem. It is a single unit that has two single-stage compressor units combined into one.

The 3225**C model has a capacity control mechanism for startup load reduction on the high-stage, and a capacity control mechanism for coping with load change on the low-stage.

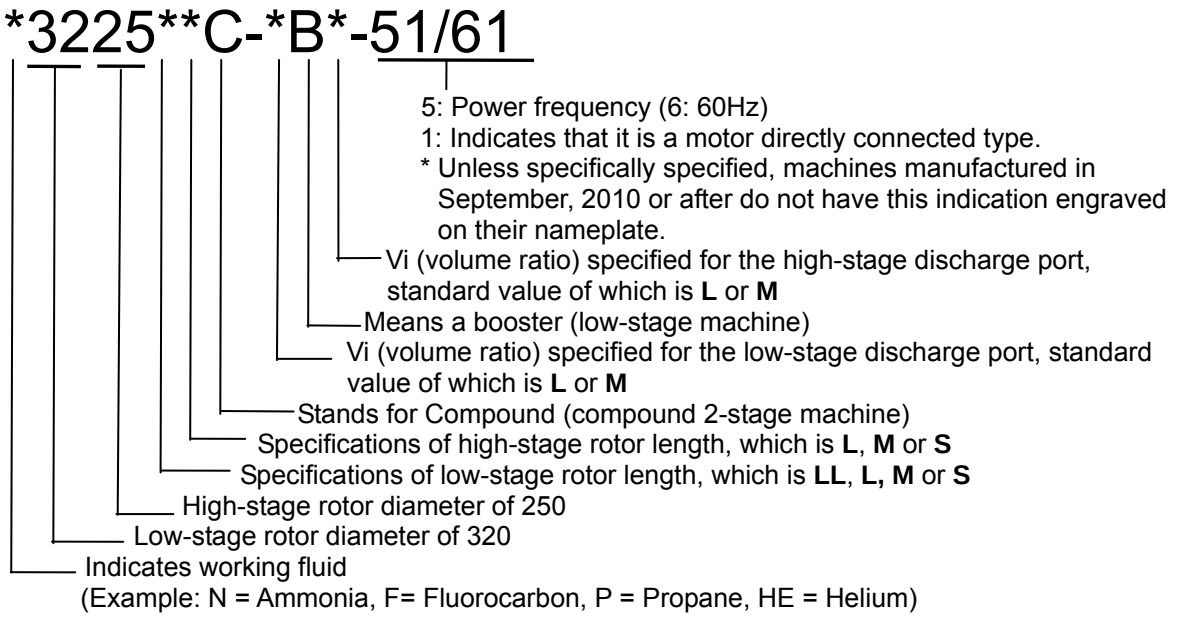
In addition, there are four rotor lengths for the low-stage and three rotor lengths for the high-stage.

Moreover, customer is able to select each low-stage and high-stage volume ratio from two specifications. Employing these combinations of each specification, 3225**C is providing a high versatility that can satisfy a wide range of operation conditions required by different applications at the load side. Therefore, the MYCOM 3225**C models are the long-selling products which last to more than 30 years since the developed in 1982 as the large sized compound 2-stage screw compressor.

## 2.2 Model Designation of the Compressor

This manual describes 3225**C-*B*-51 and 3225**C-*B*-61 models.

The meaning of the type designation, which is engraved on the MODEL column of the compressor nameplate, is as follows.



# 2.3 Compressor Specifications

## 2.3.1 Standard Specifications

**Table 2-1 3225**C Screw Compressor Specifications (1/2)**

| Items | | | Model | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | LLLC | LLMC | LLSC | LLC | LMC | LSC |
| Product mass | | kg | 4150 | 4100 | 4020 | 3440 | 3390 | 3310 |
| Low-stage swept volume @3550 $min^{-1}$ /2950 $min^{-1}$ | | $m^3/h$ | 6740 /5600 | 6740 /5600 | 6740 /5600 | 5700 /4740 | 5700 /4740 | 5700 /4740 |
| High-stage swept volume @3550 $min^{-1}$ /2950 $min^{-1}$ | | $m^3/h$ | 2840 /2360 | 2380 /1980 | 1900 /1580 | 2840 /2360 | 2380 /1980 | 1900 /1580 |
| Working fluid (Refrigerant) | | - | Ammonia, Hydrofluorocarbon, etc. | | | | | |
| Design pressure | | MPa | 2.6 | | | | | |
| Capacity control (Actual load) | | % | 10 to 100 | | | | | |
| Rotation direction | | - | Counterclockwise viewed from motor | | | | | |
| Connected pipe size | Low-stage suction flange | - | JIS 20K 350A (14”) | | | | | |
| | Low-stage discharge flange | - | JIS 20K 200A (8”) | | | | | |
| | High-stage suction flange | - | JIS 20K 200A (8”) | | | | | |
| | High-stage discharge flange | - | JIS 20K 150A (6”) | | | | | |
| | Journal lubrication (low-stage) | - | JIS 20K 40A (1-1/2”) | | | | | |
| | Journal lubrication (High-stage) | - | JIS 20K 25A (1”) | | | | | |
| | Oil injection lubrication | - | JIS 20K 20A (3/4”) | | | | | |
| | Oil return Inlet (Rotor casing) | - | JIS 20K 32A (1-1/4”) | | | | | |
| | Oil return outlet (Low-stage Bearing cover) | - | JIS 20K 32A (1-1/4”) | | | | | |
| | Oil return outlet (High-stage Suction cover) | - | JIS 20K 20A (3/4”) | | | | | |
| | Low-stage capacity control | - | Load: Rc3/8, Unload: Rc3/8 | | | | | |
| | High-stage capacity control | - | Load: Rc3/8, Unload: Rc3/8 | | | | | |

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

**Table 2-2 3225**C Screw Compressor Specifications (1/2)**

| Items | | | Model | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | MLC | MMC | MSC | SLC | SMC | SSC |
| Product mass | | kg | 3290 | 3240 | 3160 | 3150 | 3100 | 3020 |
| Low-stage swept volume @3550 $min^{-1}$ /2950 $min^{-1}$ | | $m^3/h$ | 4760 /3960 | 4760 /3960 | 4760 /3960 | 3820 /3170 | 3820 /3170 | 3820 /3170 |
| High-stage swept volume @3550 $min^{-1}$ /2950 $min^{-1}$ | | $m^3/h$ | 2840 /2360 | 2380 /1980 | 1900 /1580 | 2840 /2360 | 2380 /1980 | 1900 /1580 |
| Refrigerant | | - | Ammonia, Hydrofluorocarbon, etc. | | | | | |
| Design pressure | | MPa | 2.6 | | | | | |
| Capacity control (Actual load) | | % | 10 to 100 | | | | | |
| Rotation direction | | - | Counterclockwise viewed from motor | | | | | |
| Connected pipe size | Low-stage suction flange | - | JIS 20K 350A (14”) | | | | | |
| | Low-stage discharge flange | - | JIS 20K 200A (8”) | | | | | |
| | High-stage suction flange | - | JIS 20K 200A (8”) | | | | | |
| | High-stage discharge flange | - | JIS 20K 150A (6”) | | | | | |
| | Journal lubrication (low-stage) | - | JIS 20K 40A (1-1/2”) | | | | | |
| | Journal lubrication (High-stage) | - | JIS 20K 25A (1”) | | | | | |
| | Oil injection lubrication | - | JIS 20K 20A (3/4”) | | | | | |
| | Oil return Inlet (Rotor casing) | - | JIS 20K 32A (1-1/4”) | | | | | |
| | Oil return outlet (Low-stage Bearing cover) | - | JIS 20K 32A (1-1/4”) | | | | | |
| | Oil return outlet (High-stage Suction cover) | - | JIS 20K 20A (3/4”) | | | | | |
| | Low-stage capacity control | - | Load: Rc3/8, Unload: Rc3/8 | | | | | |
| | High-stage capacity control | - | Load: Rc3/8, Unload: Rc3/8 | | | | | |

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

## 2.3.2 Operation Limits

**Table 2-3 Operation Limits of 3225**C**

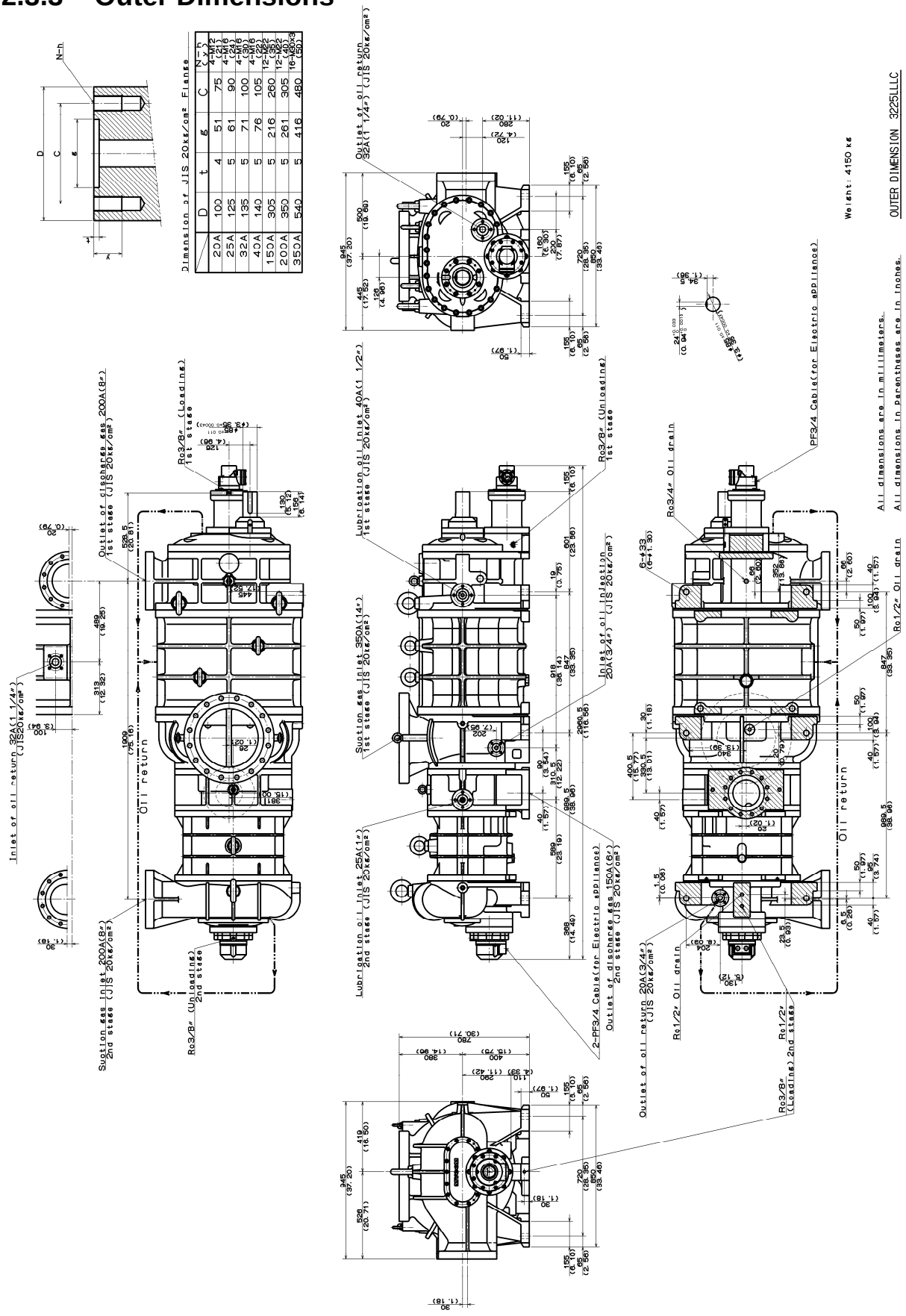
| Items | | Operation Limits |
|---|---|---|
| Maximum discharge pressure | MPa | 1.96 |
| Minimum suction pressure | MPa | −0.080 |
| Maximum intermediate pressure | MPa | 0.588 |
| Minimum intermediate pressure | - | > Suction pressure |
| Oil supply pressure | | |
| ・ Maximum journal lubrication pressure | MPa | Discharge pressure + 0.39 |
| ・ Minimum journal lubrication pressure | MPa | Discharge pressure +0.049 and Suction pressure +0.49 |
| ・ Minimum oil injection lubrication pressure | MPa | Suction pressure +0.49 |
| Maximum Suction temperature | °C | 85 |
| Minimum suction temperature | °C | −60 |
| Maximum low-stage discharge temperature | °C | 90 |
| Maximum high-stage discharge temperature | °C | 100 |
| Maximum oil supply temperature | °C | 60 |
| Minimum oil supply temperature | °C | 30 |
| Maximum male rotor rotation speed | $min^{-1}$ | 3600 |
| Minimum male rotor rotation speed | $min^{-1}$ | 1450 |

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

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

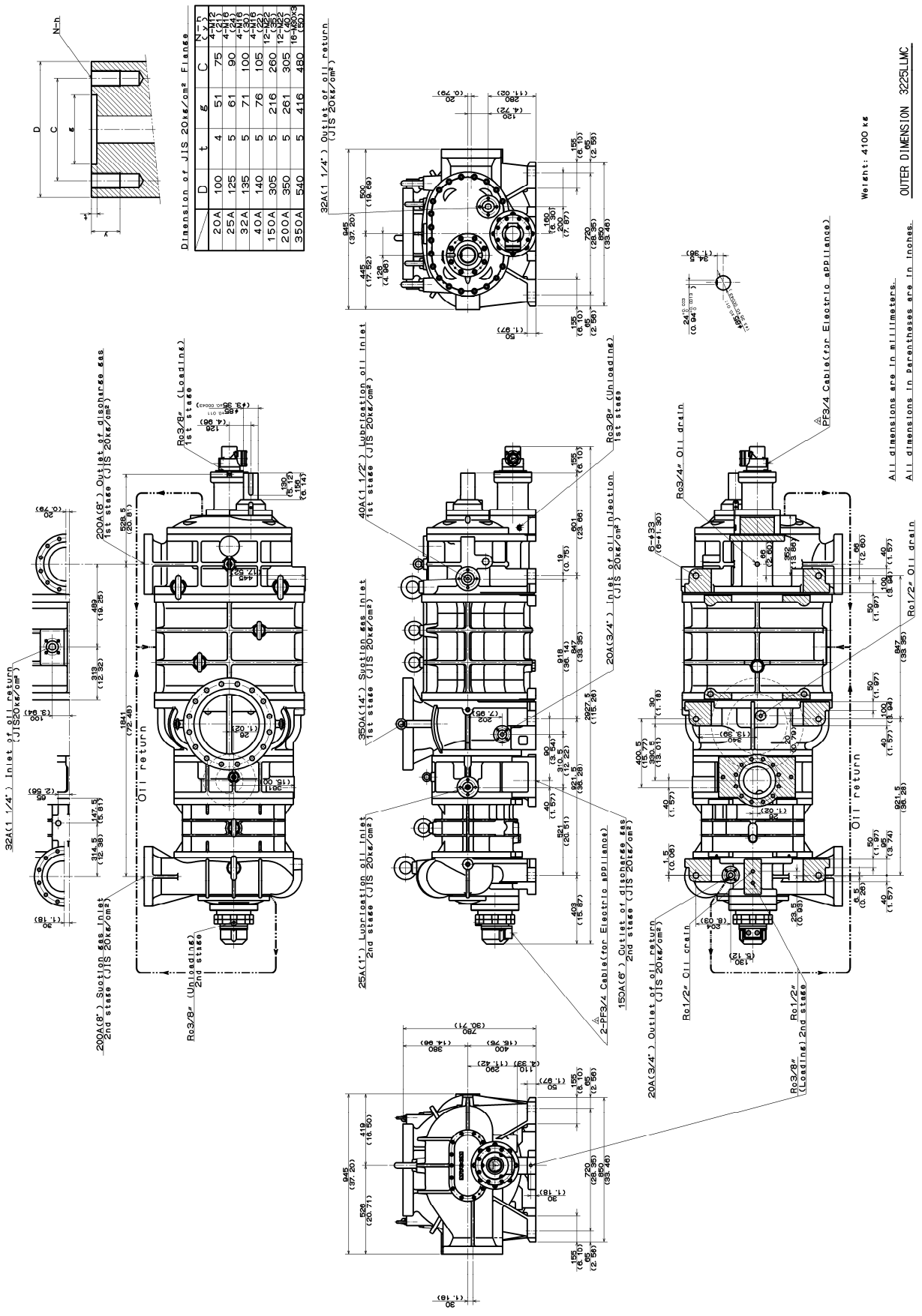
## 2.3.3 Outer Dimensions




Dimension of JIS 20kg/cm² Flange

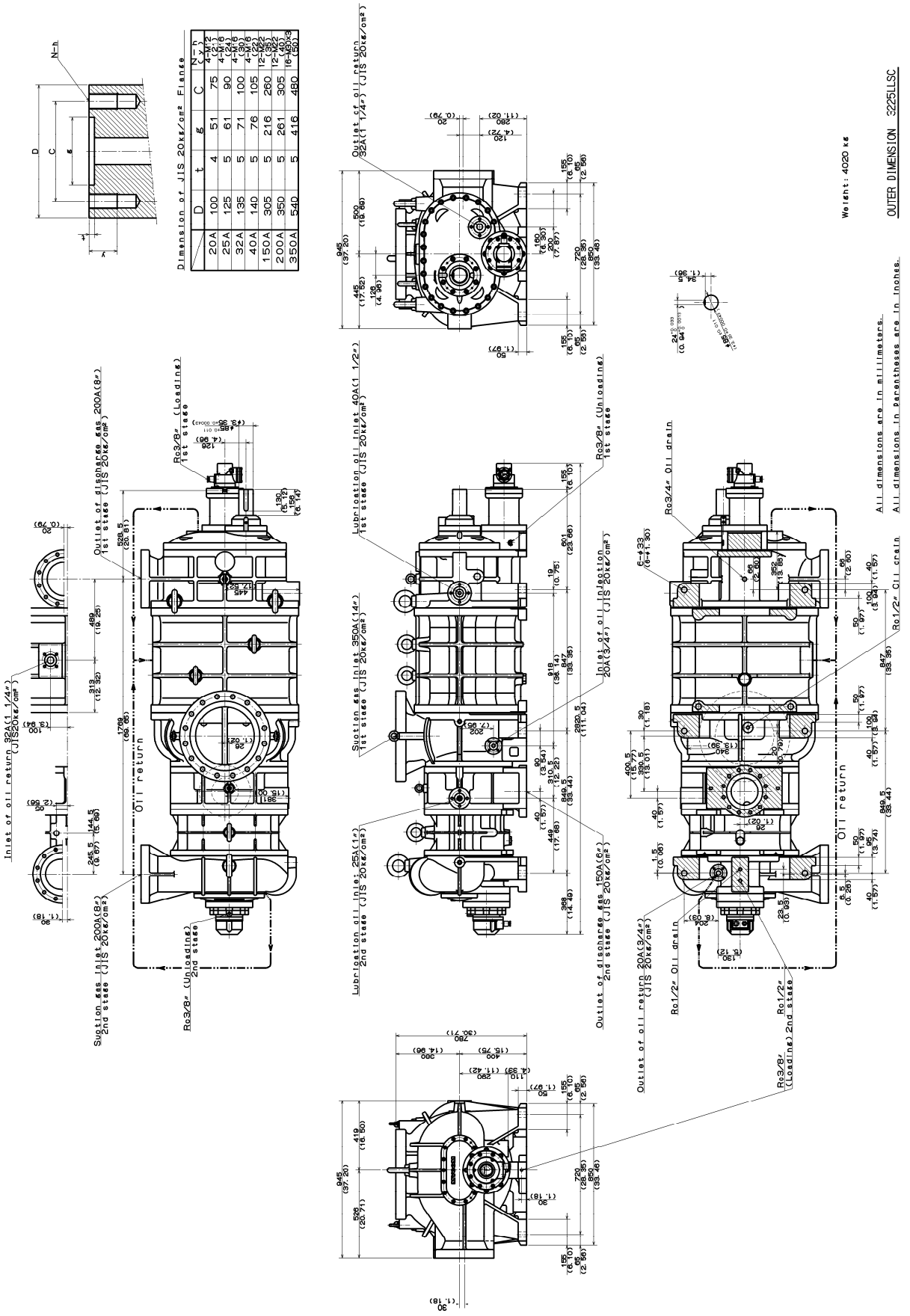
| | D | t | g | C | N-h |
|---|---|---|---|---|---|
| 20A | 100 | 4 | 51 | 75 | 4-M12 |
| 25A | 125 | 5 | 61 | 90 | 4-M16 |
| 32A | 135 | 5 | 71 | 100 | 4-M16 |
| 40A | 140 | 5 | 76 | 105 | 4-M16 |
| 150A | 305 | 5 | 216 | 260 | 12-M22 |
| 200A | 350 | 5 | 261 | 305 | 12-M22 |
| 350A | 540 | 5 | 416 | 480 | 16-M22 |

**Figure 2-1 Outer Dimension 3225LLLC**



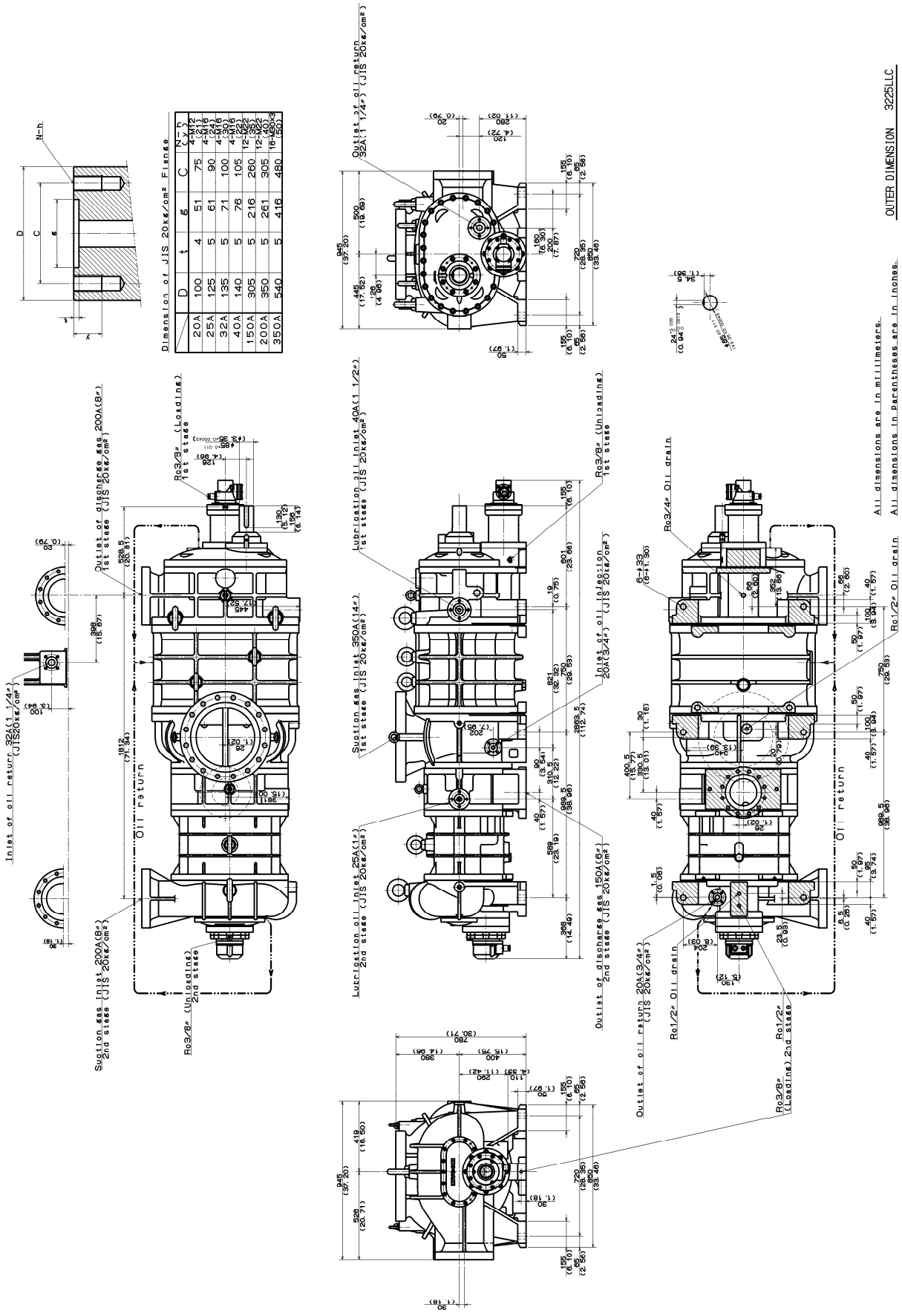

| | D | t | g | C | N-n |
|---|---|---|---|---|---|
| 20A | 100 | 4 | 51 | 75 | 4-M12 |
| 25A | 125 | 5 | 61 | 90 | 4-M16 (24) |
| 32A | 135 | 5 | 71 | 100 | 4-M16 (30) |
| 40A | 140 | 5 | 76 | 105 | 4-M16 12-M22 |
| 150A | 305 | 5 | 216 | 280 | 12-M22 12-M27 |
| 200A | 350 | 5 | 261 | 305 | 12-M27 16-M30×3 |
| 350A | 540 | 5 | 416 | 480 | (30) |

**Figure 2-2 Outer Dimension 3225LLMC**



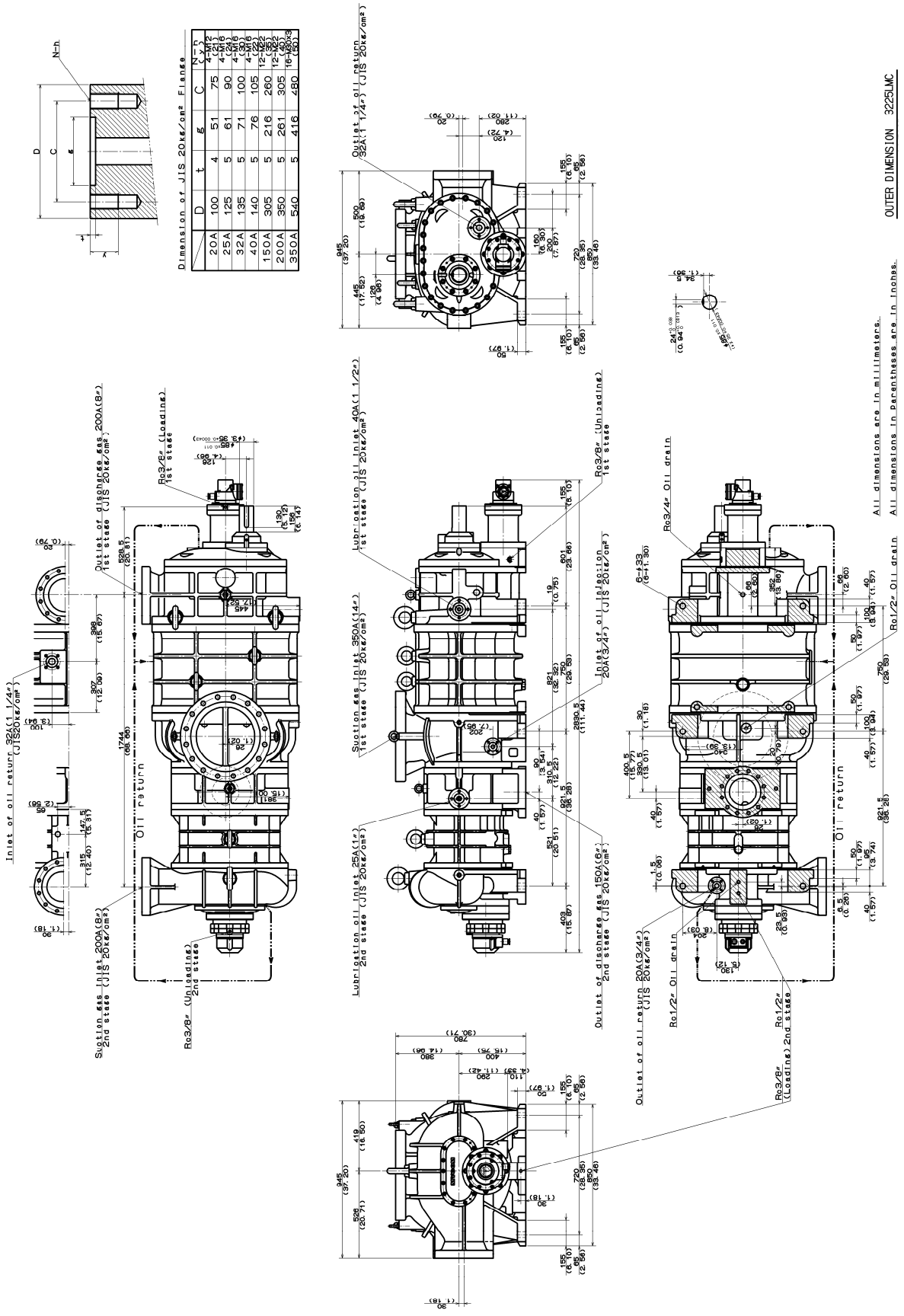

| | D | t | g | C | N-h |
|---|---|---|---|---|---|
| 20A | 100 | 4 | 51 | 75 | 4-M12 |
| 25A | 125 | 5 | 61 | 90 | 4-φ19 (3/4) |
| 32A | 135 | 5 | 71 | 100 | 4-φ19 (3/4) |
| 40A | 140 | 5 | 76 | 105 | 4-φ19 (3/4) |
| 150A | 305 | 5 | 216 | 260 | 12-φ22 (7/8) |
| 200A | 350 | 5 | 261 | 305 | 16-φ22 (7/8) |
| 350A | 540 | 5 | 416 | 480 | 20-φ26 (1") |

**Figure 2-3 Outer Dimension 3225LLSC**



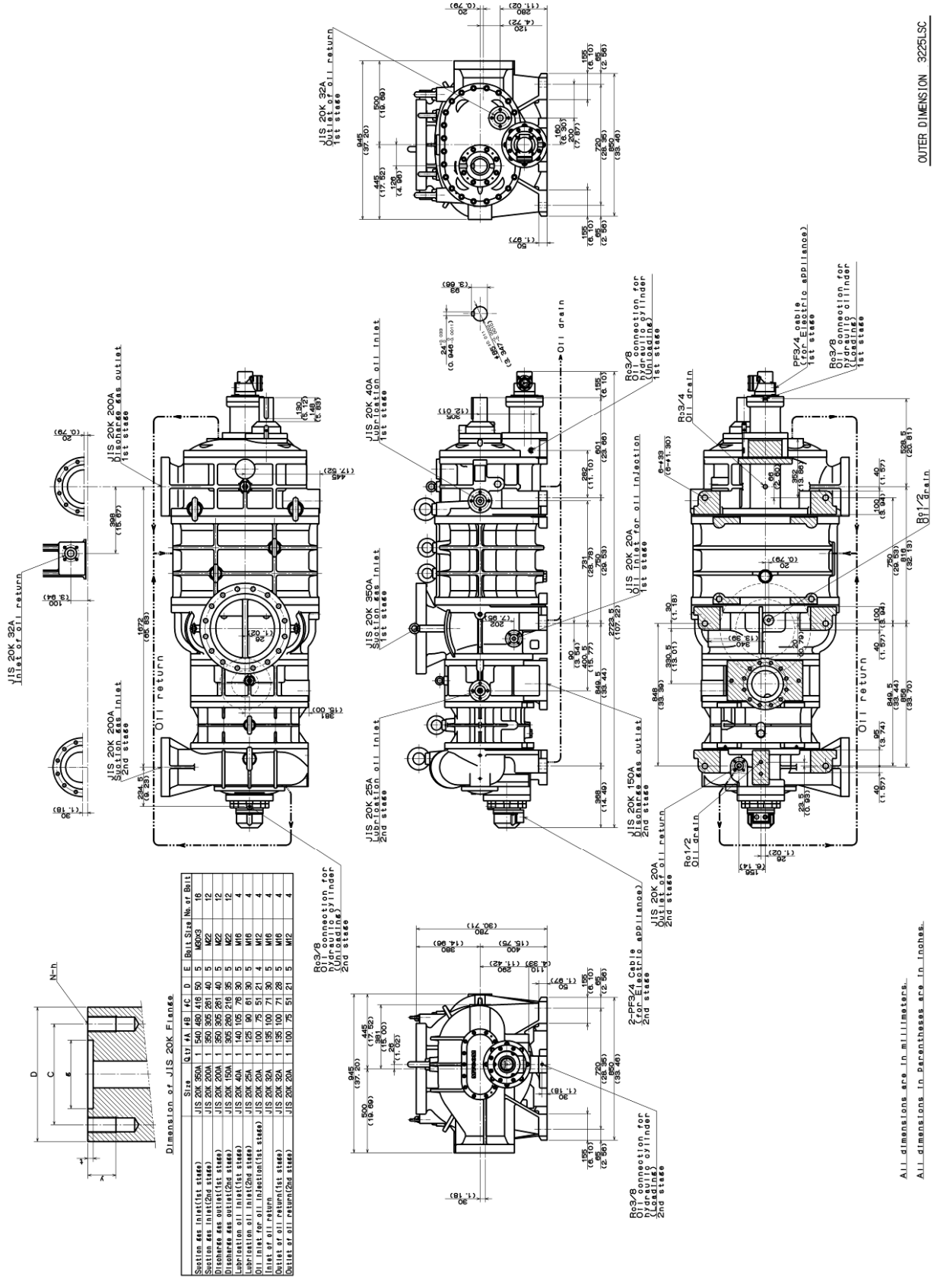

| | D | t | g | C | N - n |
|---|---|---|---|---|---|
| 20A | 100 | 4 | 51 | 75 | 4-M12 (G1/2) |
| 25A | 125 | 5 | 61 | 90 | 4-M16 (G3/4) |
| 32A | 135 | 5 | 71 | 100 | 4-M16 (G1) |
| 40A | 140 | 5 | 76 | 105 | 4-M16 (G1 1/2) |
| 150A | 305 | 5 | 216 | 260 | 12-M22 (G6) |
| 200A | 350 | 5 | 261 | 305 | 12-M22 (G8) |
| 350A | 540 | 5 | 416 | 480 | 16-M30x3 (G14) |

**Figure 2-4 Outer Dimension 3225LLC**




| Dimension of JIS 20kg/cm² Flange | D | t | g | C | N-n |
|---|---|---|---|---|---|
| 20A | 100 | 4 | 51 | 75 | 4-M12 (21) |
| 25A | 125 | 5 | 61 | 90 | 4-M16 (24) |
| 32A | 135 | 5 | 71 | 100 | 4-M16 (24) |
| 40A | 140 | 5 | 76 | 105 | 4-M16 (24) |
| 150A | 305 | 5 | 216 | 260 | 12-M20 (35) |
| 200A | 350 | 5 | 261 | 305 | 12-M20 (35) |
| 350A | 540 | 5 | 416 | 480 | 16-M20×3 (50) |

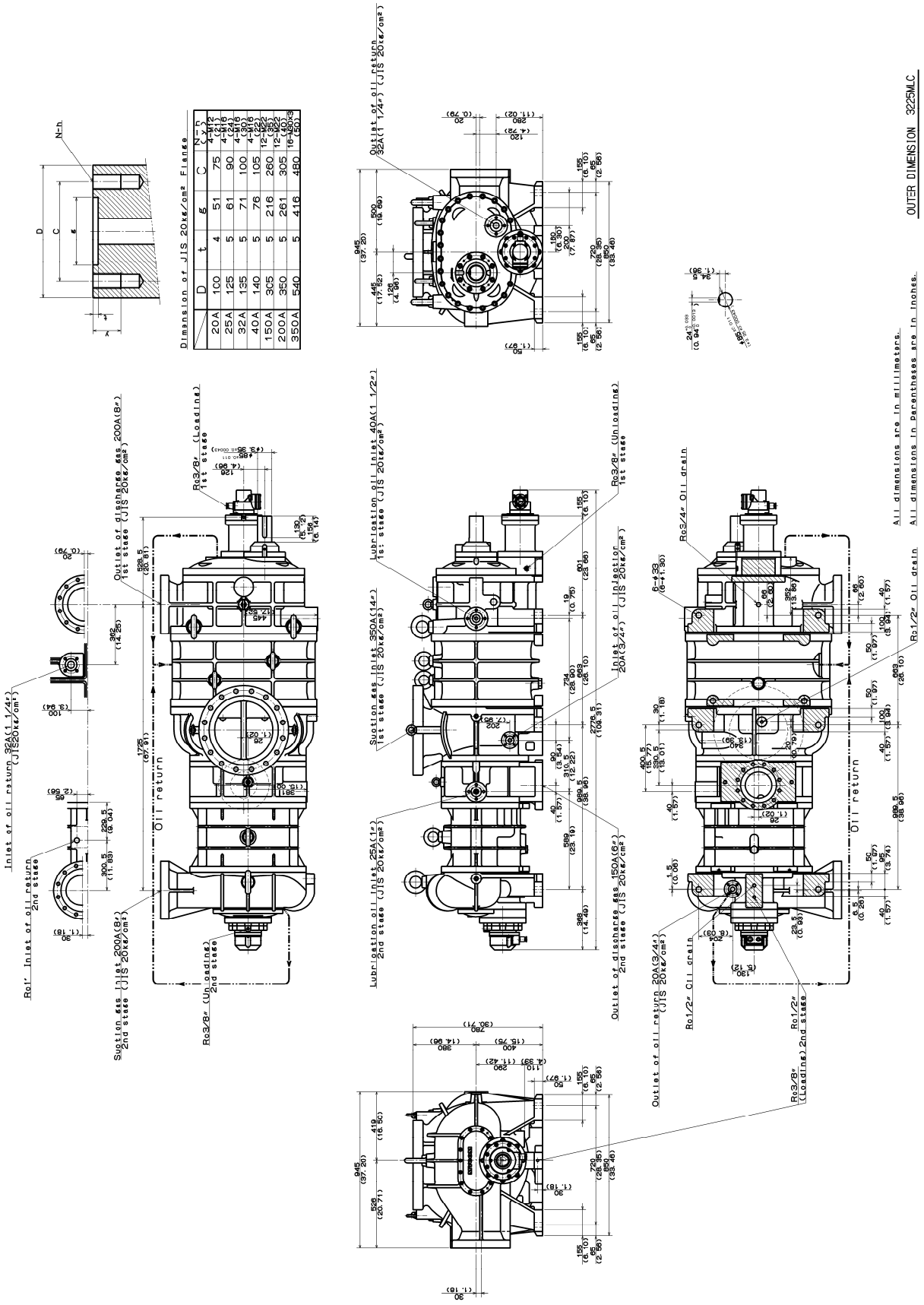
**Figure 2-5 Outer Dimension 3225LMC**




Dimension of JIS 20K Flange

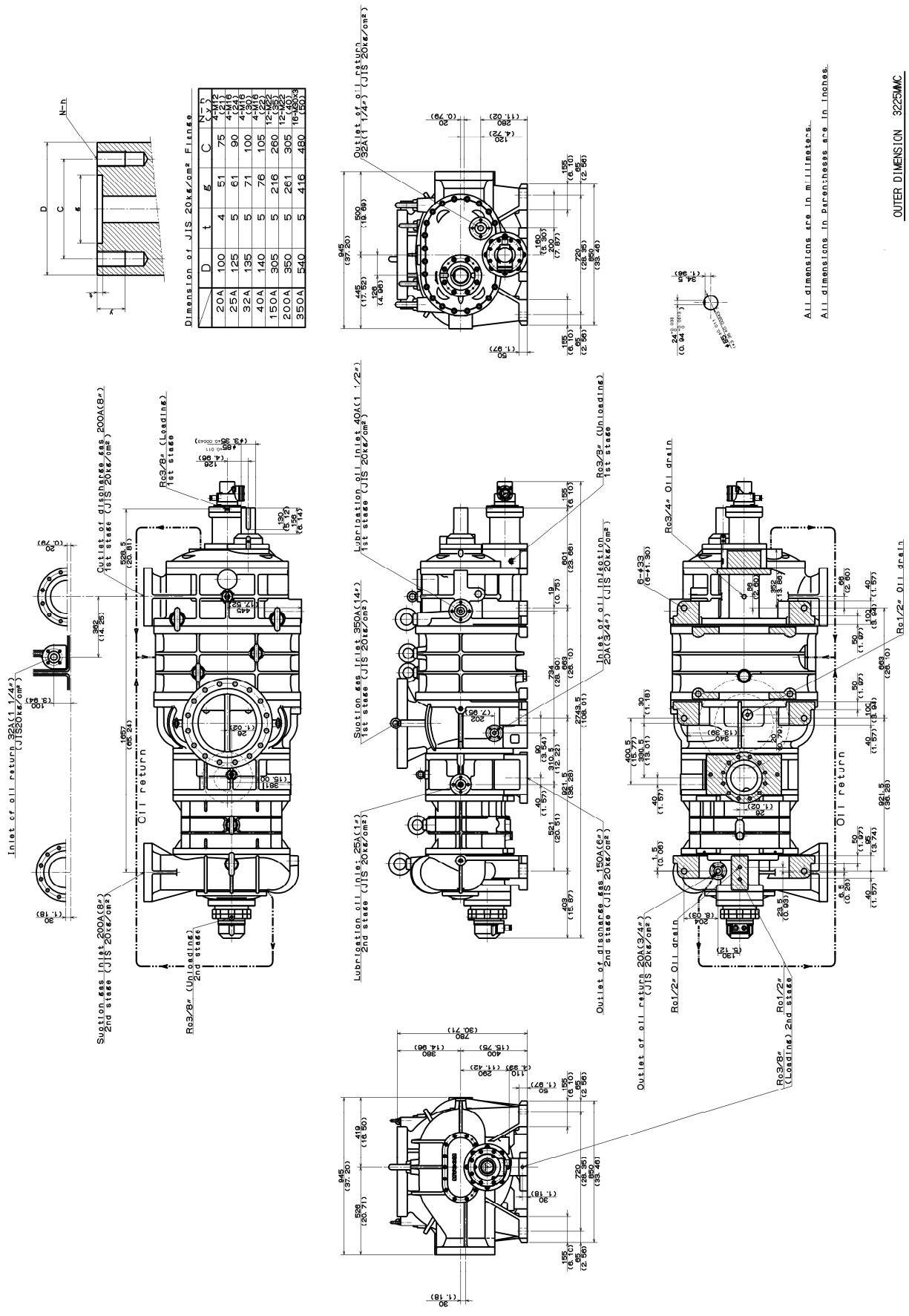
| | Size | Q'ty | A | B | C | D | E | Bolt Size | No. of Bolt |
|---|---|---|---|---|---|---|---|---|---|
| Suction gas inlet(1st stage) | JIS 20K 350A | 1 | 540 | 480 | 416 | 50 | 5 | M20X3 | 16 |
| Suction gas inlet(2nd stage) | JIS 20K 200A | 1 | 350 | 305 | 261 | 40 | 5 | M22 | 12 |
| Discharge gas outlet(1st stage) | JIS 20K 200A | 1 | 350 | 305 | 261 | 40 | 5 | M22 | 12 |
| Discharge gas outlet(2nd stage) | JIS 20K 150A | 1 | 305 | 260 | 216 | 35 | 5 | M22 | 12 |
| Lubrication oil inlet(1st stage) | JIS 20K 40A | 1 | 140 | 105 | 76 | 30 | 5 | M16 | 4 |
| Lubrication oil inlet(2nd stage) | JIS 20K 25A | 1 | 125 | 90 | 61 | 30 | 5 | M16 | 4 |
| Oil inlet for oil injection(1st stage) | JIS 20K 20A | 1 | 100 | 75 | 51 | 21 | 4 | M12 | 4 |
| Inlet of oil return | JIS 20K 32A | 1 | 135 | 100 | 71 | 30 | 5 | M16 | 4 |
| Outlet of oil return(1st stage) | JIS 20K 32A | 1 | 135 | 100 | 71 | 28 | 5 | M16 | 4 |
| Outlet of oil return(2nd stage) | JIS 20K 20A | 1 | 100 | 75 | 51 | 21 | 5 | M12 | 4 |

**Figure 2-6 Outer Dimension 3225LSC**



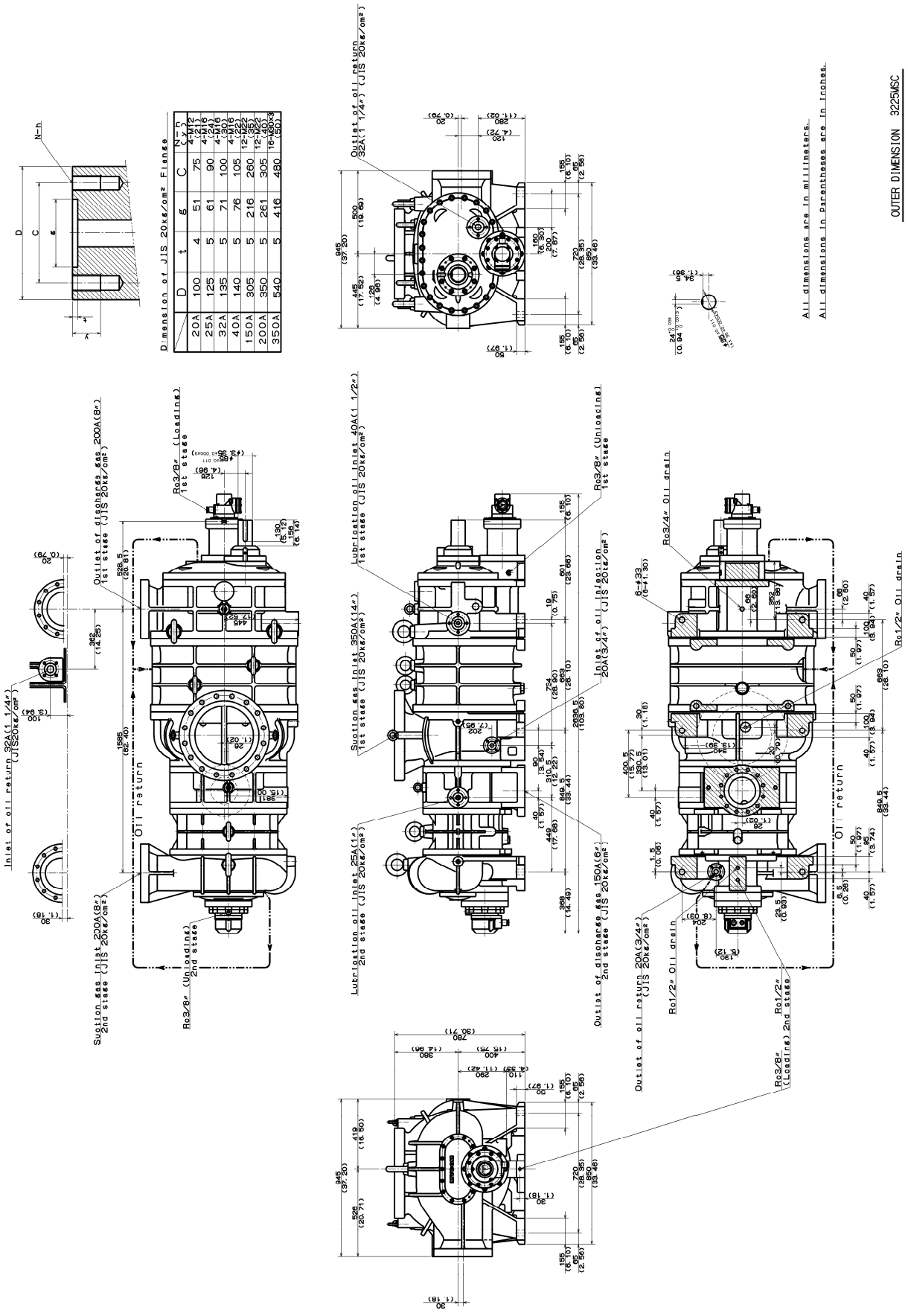

| | D | t | g | C | N-h |
|---|---|---|---|---|---|
| 20A | 100 | 4 | 51 | 75 | 4-M12 |
| 25A | 125 | 5 | 61 | 90 | 4-M16 |
| 32A | 135 | 5 | 71 | 100 | 4-M16 |
| 40A | 140 | 5 | 76 | 105 | 4-M16 |
| 150A | 305 | 5 | 216 | 260 | 12-M22 |
| 200A | 350 | 5 | 261 | 305 | 12-M22 |
| 350A | 540 | 5 | 416 | 480 | 16-M22 |

**Figure 2-7 Outer Dimension 3225MLC**



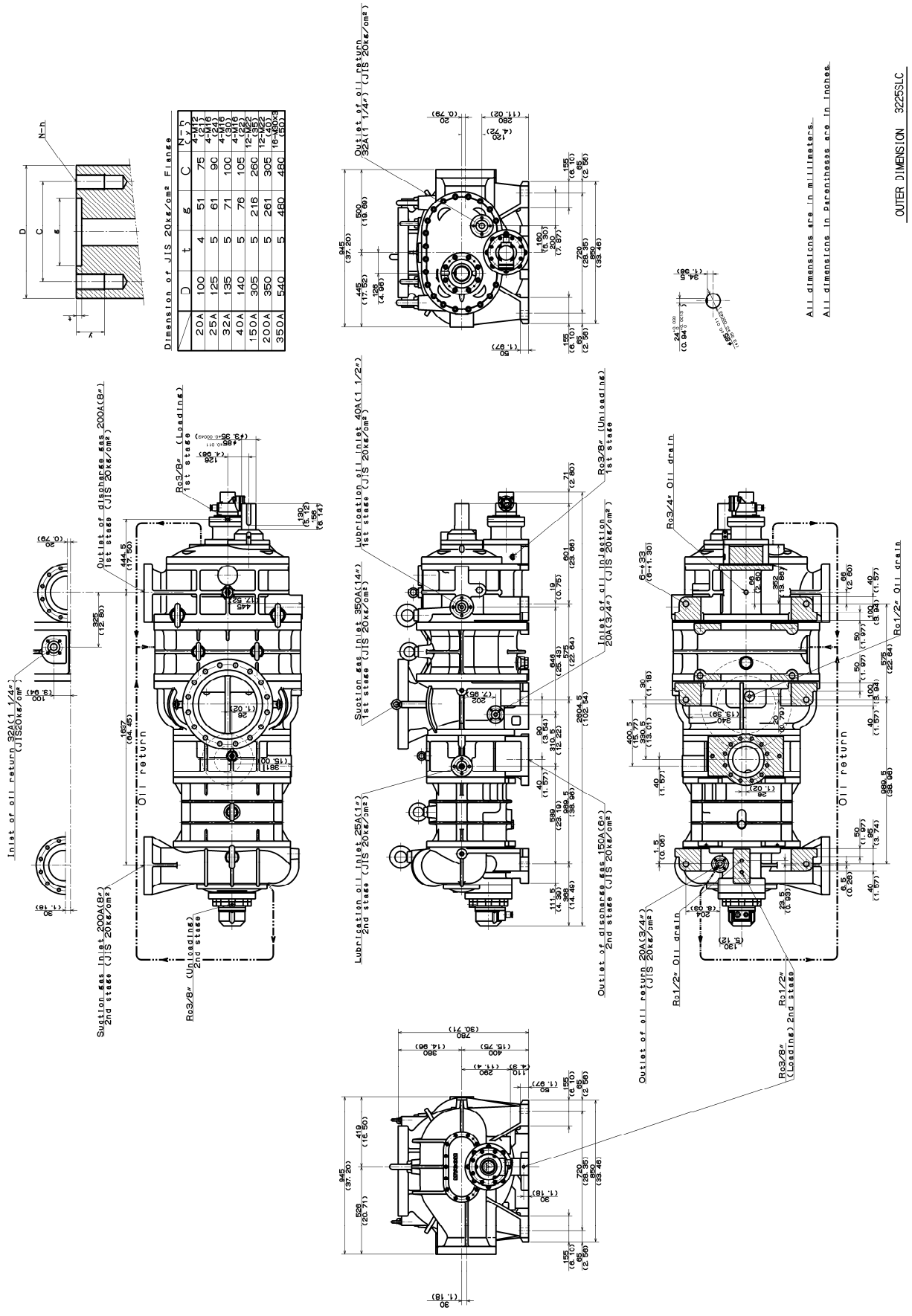

| | D | t | g | C | N-n |
|---|---|---|---|---|---|
| 20A | 100 | 4 | 51 | 75 | 4-12 |
| 25A | 125 | 5 | 61 | 90 | 4-M16 |
| 32A | 135 | 5 | 71 | 100 | 4-M16 |
| 40A | 140 | 5 | 76 | 105 | 4-M16 |
| 150A | 305 | 5 | 216 | 280 | 12-M22 |
| 200A | 350 | 5 | 261 | 305 | 12-M22 |
| 350A | 540 | 5 | 416 | 480 | 16-M20×3 |

**Figure 2-8 Outer Dimension 3225MMC**



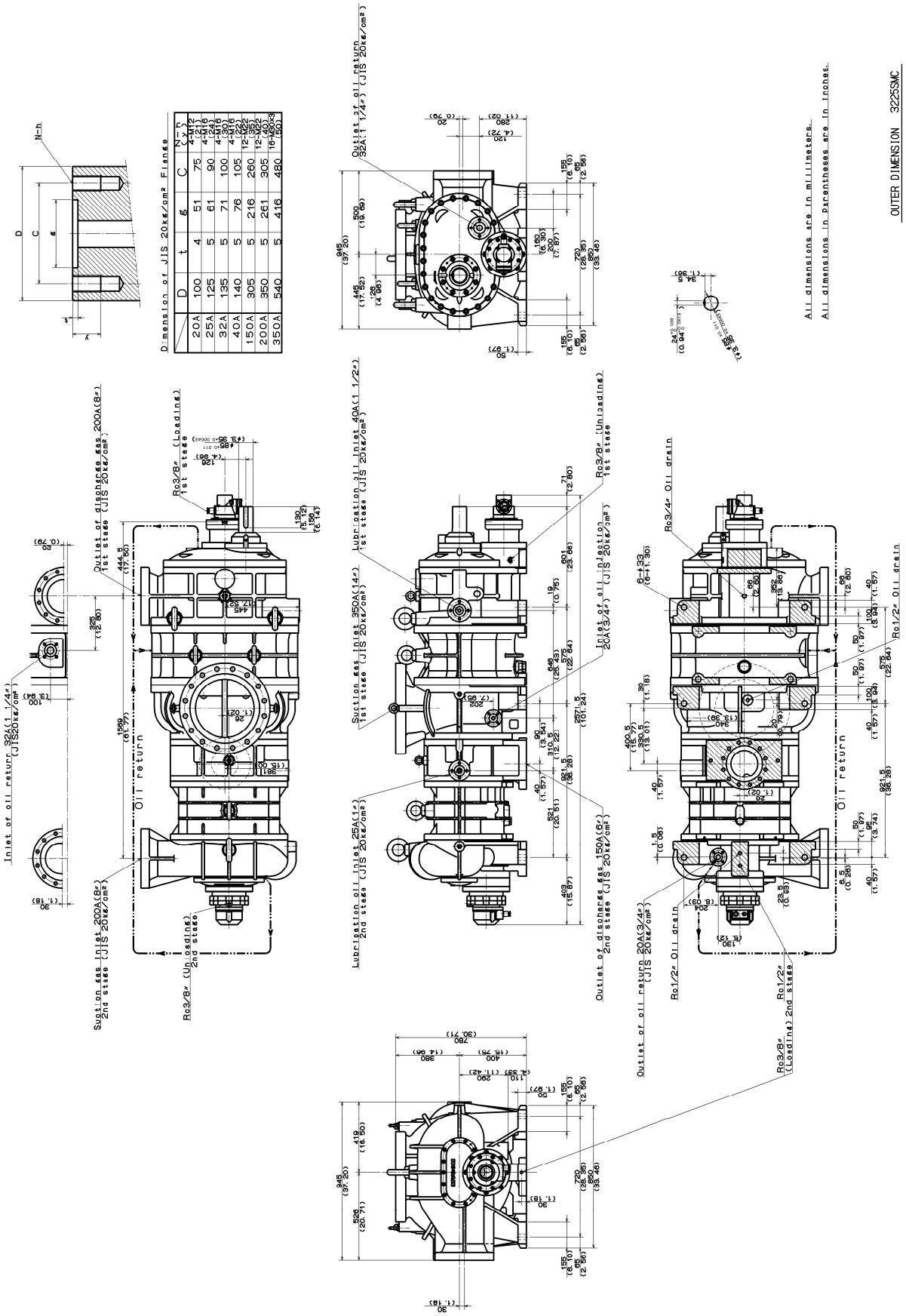

| | D | t | g | C | N-h |
|---|---|---|---|---|---|
| 20A | 100 | 4 | 51 | 75 | 4-M12 |
| 25A | 125 | 5 | 61 | 90 | 4-M16 |
| 32A | 135 | 5 | 71 | 100 | 4-M16 |
| 40A | 140 | 5 | 76 | 105 | 4-M16 |
| 150A | 305 | 5 | 216 | 260 | 12-M22 |
| 200A | 350 | 5 | 261 | 305 | 12-M22 |
| 350A | 540 | 5 | 416 | 480 | 16-M30×3 |

**Figure 2-9 Outer Dimension 3225MSC**



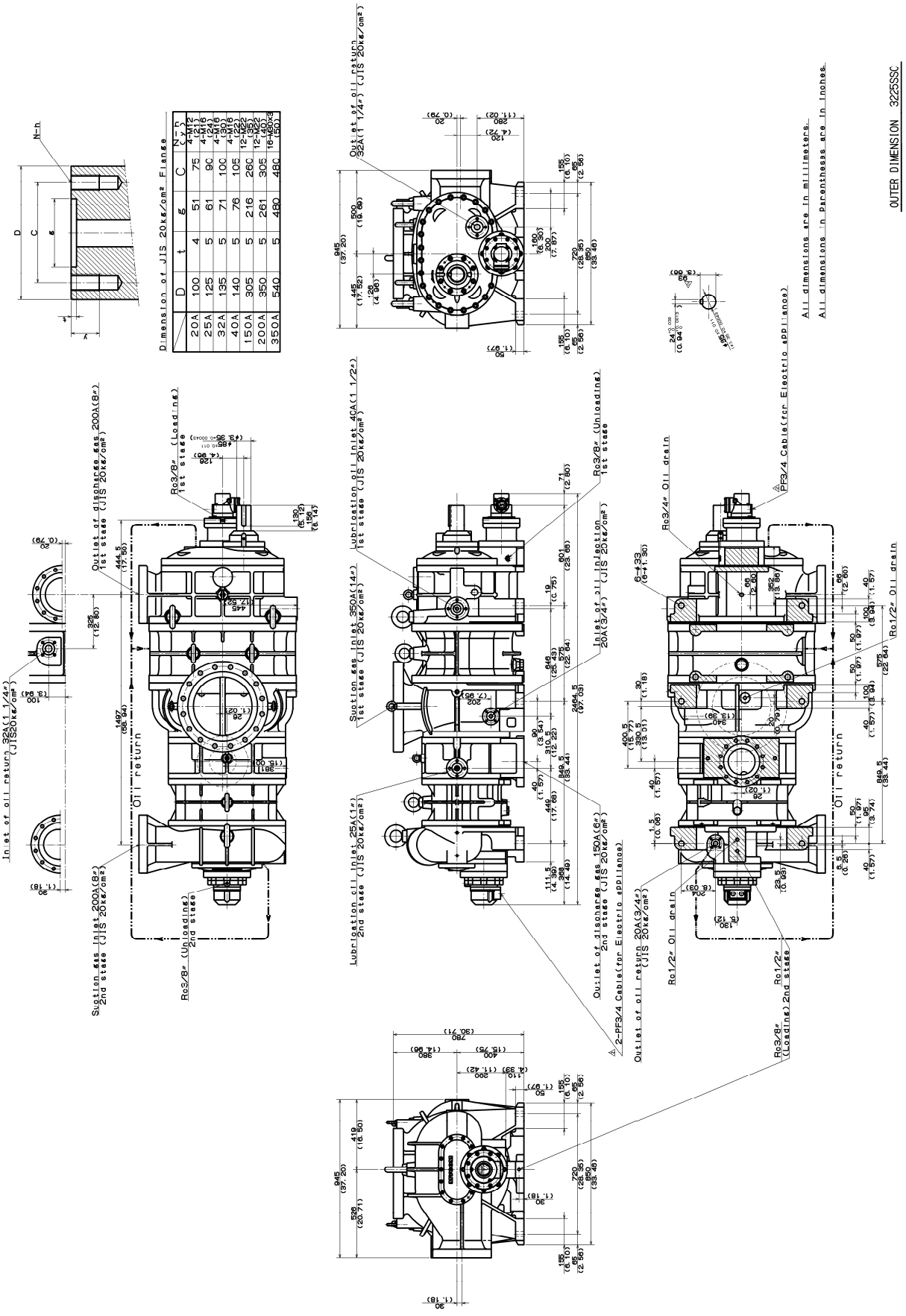

| | D | t | g | C | N-h |
|---|---|---|---|---|---|
| 20A | 100 | 4 | 51 | 75 | 4-φ12 (φ0.47) |
| 25A | 125 | 5 | 61 | 90 | 4-M16 (φ0.63) |
| 32A | 135 | 5 | 71 | 100 | 4-M16 (φ0.63) |
| 40A | 140 | 5 | 76 | 105 | 4-M16 (φ0.63) |
| 150A | 305 | 5 | 216 | 260 | 12-M22 (φ0.87) |
| 200A | 350 | 5 | 261 | 305 | 12-M22 (φ0.87) |
| 350A | 540 | 5 | 480 | 480 | 16-M20×3 (φ0.79) |

**Figure 2-10 Outer Dimension 3225SLC**




| | D | t | g | C | N-h |
|---|---|---|---|---|---|
| 20A | 100 | 4 | 51 | 75 | 4-M12 (-21) |
| 25A | 125 | 5 | 61 | 90 | 4-M16 (-21) |
| 32A | 135 | 5 | 71 | 100 | 4-M16 (-21) |
| 40A | 140 | 5 | 76 | 105 | 4-M16 (-21) |
| 150A | 305 | 5 | 216 | 260 | 12-M22 (-35) |
| 200A | 350 | 5 | 261 | 305 | 12-M22 (-35) |
| 350A | 540 | 5 | 416 | 480 | 16-M30x3 (-50) |

**Figure 2-11 Outer Dimension 3225SMC**




| | D | t | g | C | N-h |
|---|---|---|---|---|---|
| 20A | 100 | 4 | 51 | 75 | 4-M12 |
| 25A | 125 | 5 | 61 | 90 | 4-M16 |
| 32A | 135 | 5 | 71 | 100 | 4-(24) |
| 40A | 140 | 5 | 76 | 105 | 4-(30) |
| 150A | 305 | 5 | 216 | 260 | 12-M22 |
| 200A | 350 | 5 | 261 | 305 | 12-(40) |
| 350A | 540 | 5 | 480 | 480 | 16-(50) |

**Figure 2-12 Outer Dimension 3225SSC**

# 2.4 Structure of Compressor

【POINT】

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

## 2.4.1 Sectional View

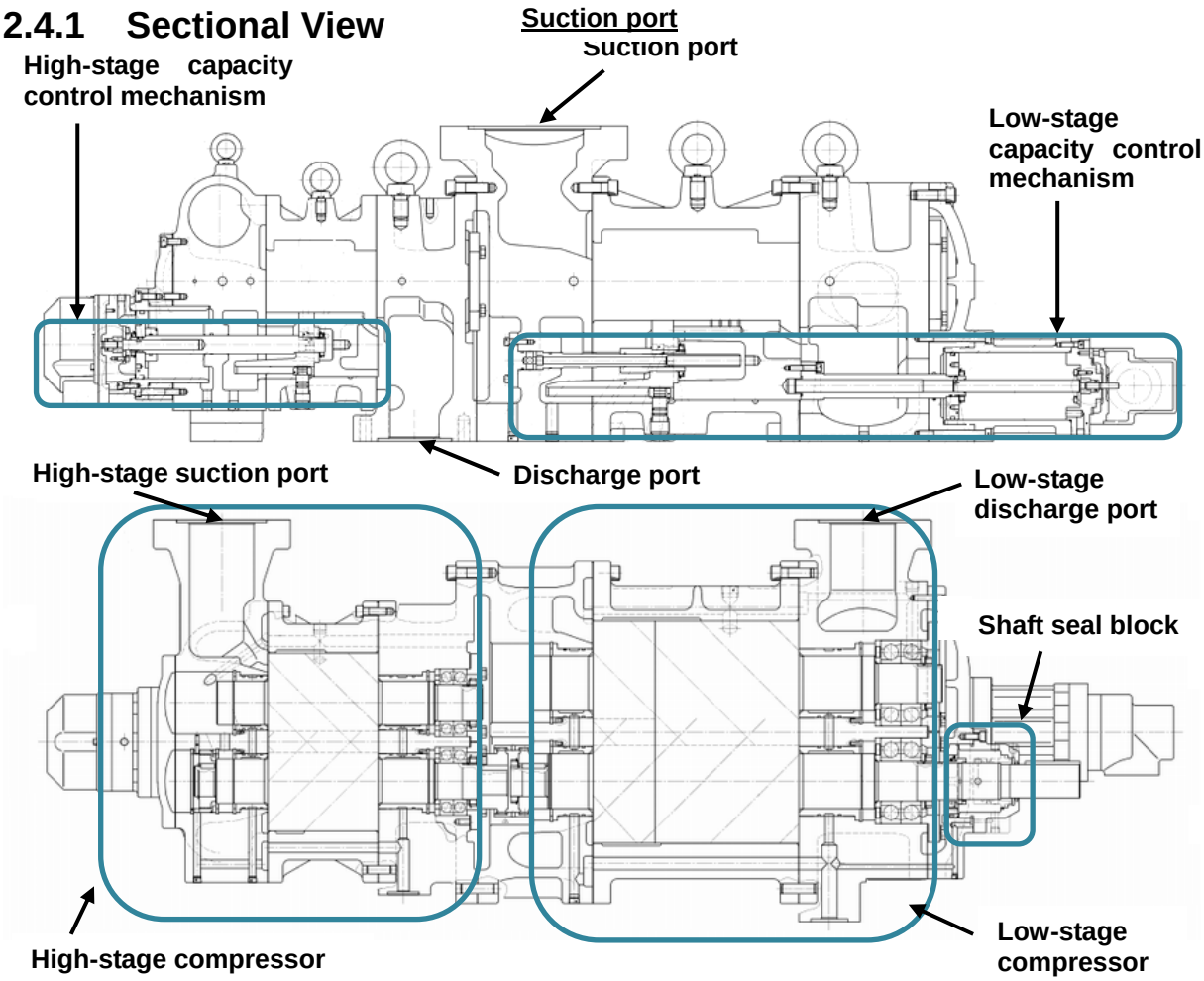



**Figure 2-13 3225**C Screw Compressor Sectional Views**

The 3225**C model, a compound 2-stage compressor, consists of two compressors, (i) a low-stage compressor which suctions gas, working fluid, from the refrigerating unit and compresses (pressure-raises) the gas and (ii) a high-stage compressor which furthermore compresses the gas that has been pressure-raised by the low-stage compressor and sends the resulting gas to the equipment side.

In each casing (low-stage, high-stage), two screw rotors are supported on both ends by bearings. They are meshed with each other in a joint assembly. These two screw rotors are a set of a male rotor having 4 protruding lobe profiles (M rotor) and a female rotor having 6 concave lobe profiles (F rotor). They conduct compressing according to the mechanism explained below.

The standard compressor's M rotor is driven by a 2-pole motor; it operates at 3000 $min^{-1}$ (50 Hz) or 3600 $min^{-1}$ (60 Hz). F rotor operates at 2000 $min^{-1}$ (50 Hz) or 2400 $min^{-1}$ (60 Hz), conforming to the operation of M rotor.

* The actual speed of a motor is less than its calculated speed (synchronous speed). This difference is caused by slipping of the motor rotor.

The shaft of the low-stage compressor's M rotor which is linked with the motor has a shaft seal block that keeps gas and lubricating oil from escaping from inside the compressor.

For high efficient operation, the 3225**C model has a capacity control mechanism for coping with load change on the low-stage, and a capacity control mechanism for reducing startup load on the high-stage.

# 2.5 Mechanisms

## 2.5.1 Basics of the Screw Compressor

The screw compressor is categorized as a positive displacement rotary compressor.

As shown in Figure 2-14, the refrigerant (gas) is continuously compressed by the 3-dimensional spaces that are formed by a pair of male and female screw rotors (with different sectional profiles) and the casing, as the spaces change continuously.

The rotor having 4 protruding lobe profiles is called a male or M rotor, and the rotor having 6 concave lobe profiles is called a female or F rotor. In this manual, they are referred to as M rotor and F rotor.

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

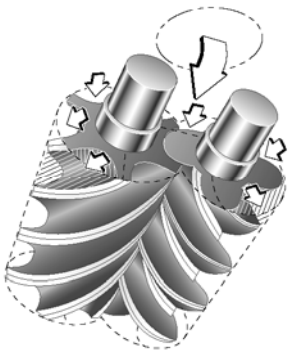


**Figure 2-14 Compressor Mechanism**

## 2.5.2 Suction Process

As shown in Figure 2-15, the rotors with different lobe profiles are engaged. As the rotors turn, the volume between the M and F rotor lobe profiles and the compressor casing gradually increases starting from the suction side.

As the rotation continues, at a certain point when the volume reaches its maximum, the rotors isolate the gas (volume), which is enclosed by the rotors and the compressor casing, from the suction port and then continues rotation.

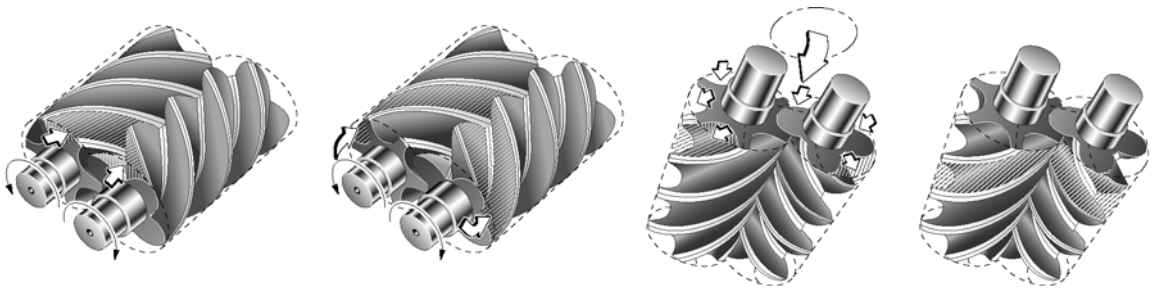


**Figure 2-15 Suction Process**

## 2.5.3 Compression Process

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

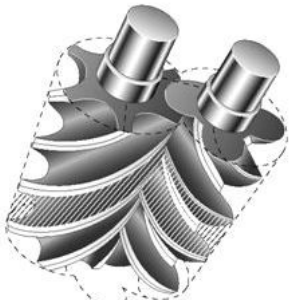


**Figure 2-16 Compression Process**

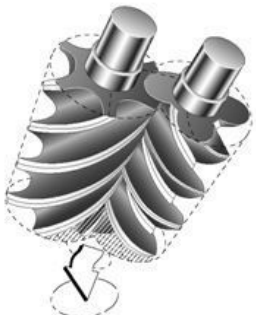


**Figure 2-17 Discharge Process**

## 2.5.4 Discharge Process

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

## 2.5.5 About Volume Ratio (Vi)

Volume ratios (Vi) of MYCOM C-series screw compressors are indicated in performance tables or catalogs by using port symbols L and M.

The volume ratio represented by each symbol is as follows:

L=2.63, M=3.65.

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

Which volume ratio (L or M) should be used is decided according to operating conditions. If the compressor is used with a volume ratio that does not match operating conditions, operation will go inefficiently wasting the power.

The relationship between volume ratios and generally used compression ratios is as follows:

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

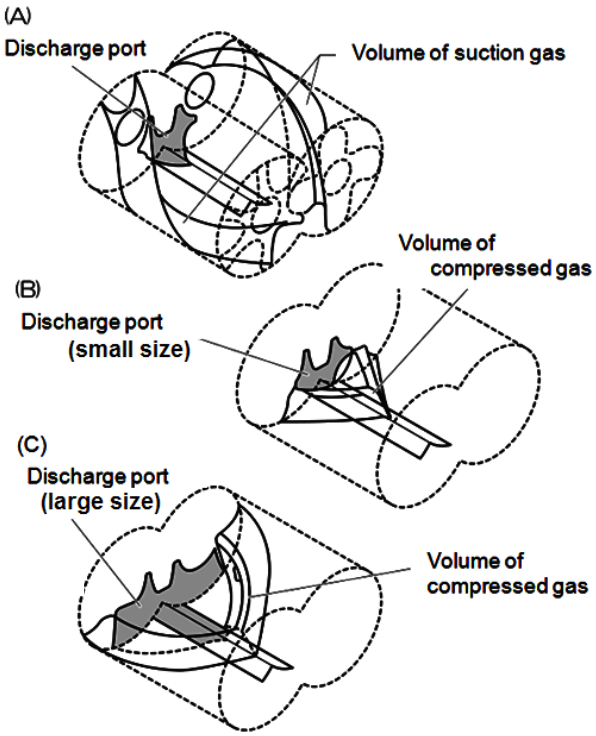


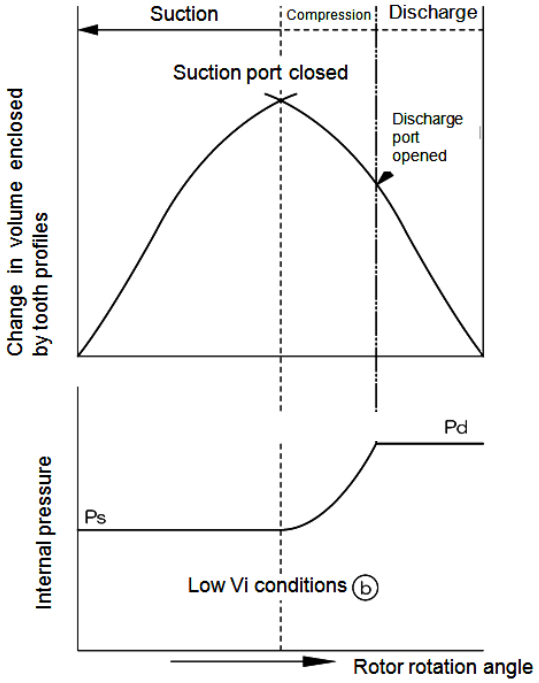

**Figure 2-18 Volume Ratio**

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

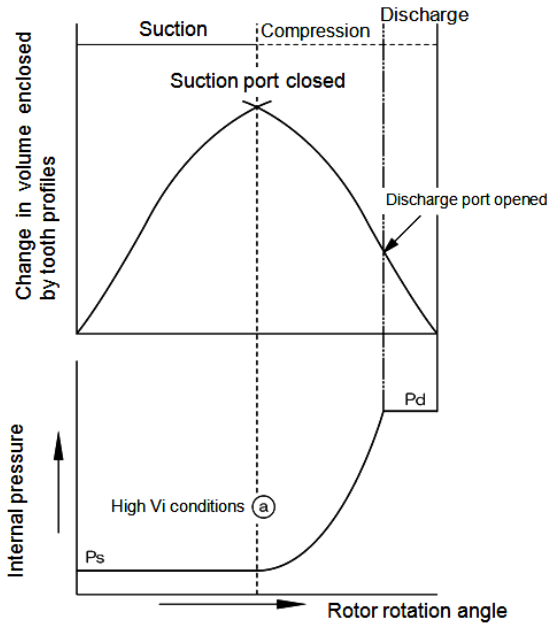
As Vi is affected by the constant of the refrigerant gas, its value that corresponds to the compression ratio will change depending on the refrigerant gas.

### (A) Properly adapted Vi to load condition

Both the required compression ratio and Vi are low.

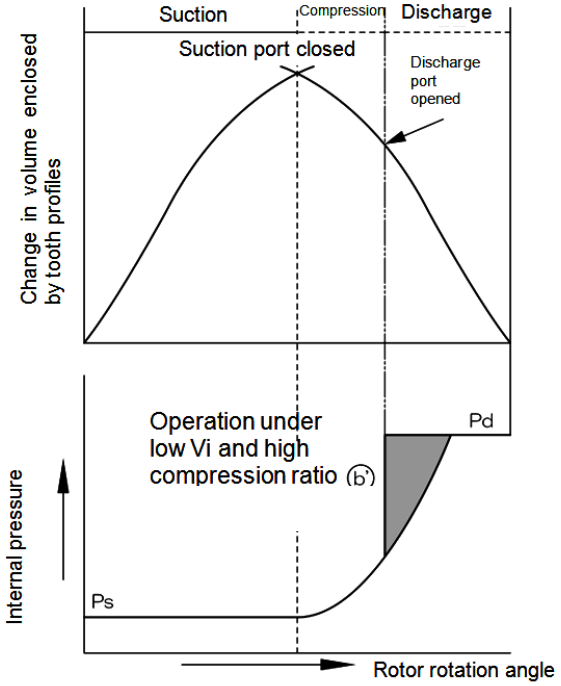



Both the required compression ratio and Vi are high.




### (B) Improperly adapted Vi to load condition

Vi is too low compared to the required compression ratio.




Vi is too high compared to the required compression ratio.

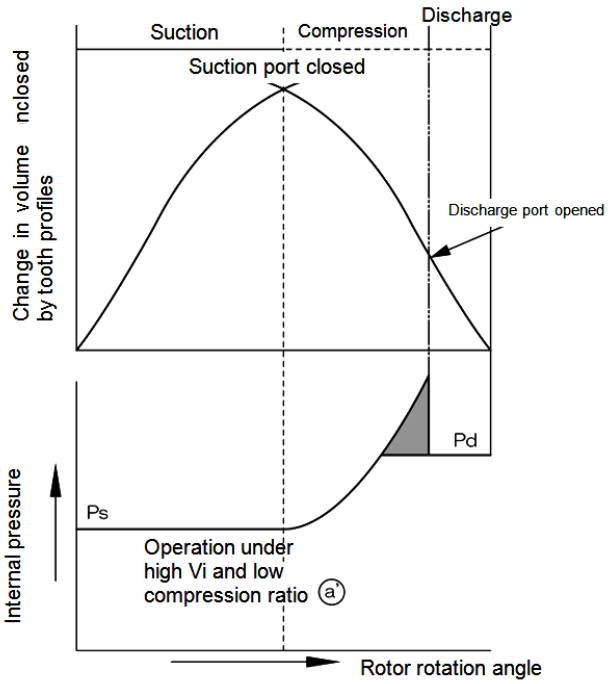



**Figure 2-19 Relationship between Volume ratio (Vi) and Operation Conditions**

## 2.5.6 Capacity Control Mechanism

The capacity control mechanism, by moving a slide valve, lets suction gas (immediately before compressed) bypass and advance to the suction side, to help shorten the rotor portion used for compression. The slide valve is located at the bottom of the casing in which the rotors mesh together, and is constructed to move parallel to the rotor shaft. This movement is changed by a cam mechanism into rotation movement. Its position (namely, capacity control ratio) is indicated externally and, at the same time, fed back to the automatic control circuit by changing the electric resistance.

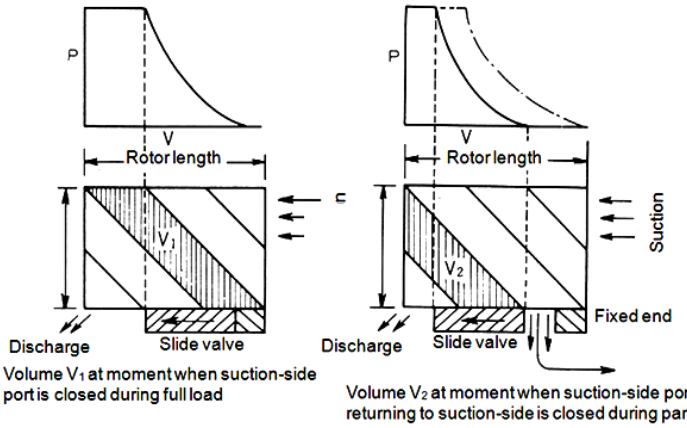



**Figure 2-20 Capacity Control Mechanism**

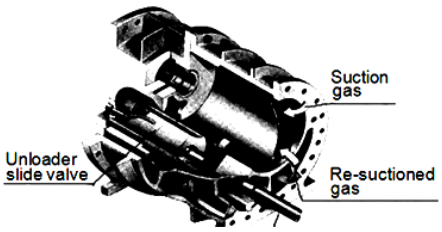



**Figure 2-21 Slide Valve in the Main Rotor Casing**

## 2.5.7 Bearings and Balance Piston

For the load acting on the rotor perpendicular to the shaft, sleeve-type white metal-lined bearing is used. For the load acting along the shaft direction, face-to-face combination type of angular contact ball bearings is used.

Special care is taken to cope with the load acting along the shaft direction. Because the M rotor is a kind of helical gear and also because the thrust force produced by discharge pressure is larger than that for F rotor, the load applied onto the M rotor is reduced by using not only a thrust bearing but also a balance piston that applies pressure from the opposing direction.

## 2.5.8 Shaft Seal Block

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

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

For example, the BBSE (Balance Bellow Single Seal) which is currently used as standard seal, employs a stationary ring (mating ring) made of special cast iron, a rotating ring made from carbon, and O-rings for the packing.

# 2.6 Gas and Oil Flow

The compression process of the screw compressor is as described in the preceding paragraphs.

Gas of the compound 2-stage screw compressor 3225**C is sent from the evaporator, and passes through the strainer and check valve. It is drawn in from the upper central area (1) of the compressor, compressed at the low-stage side (2), and then discharged at (3).

(3) and (4) are connected with a pipe. At the mid point of the pipe, that gas is mixed with the gas from liquid cooler which was used for super-cooling.

Lubricating oil injected at the low-stage is, while kept mixed with gas, suctioned from (4) into the high-stage.

After being compressed at (5), the gas mixed with lubricating oil is discharged from (6), and is sent from the oil separator to the condenser.

Even if without intermediate gas cooling, oil provides cooling effect.

So, the high-stage discharge temperature is maintained at a temperature not higher than 90°C.

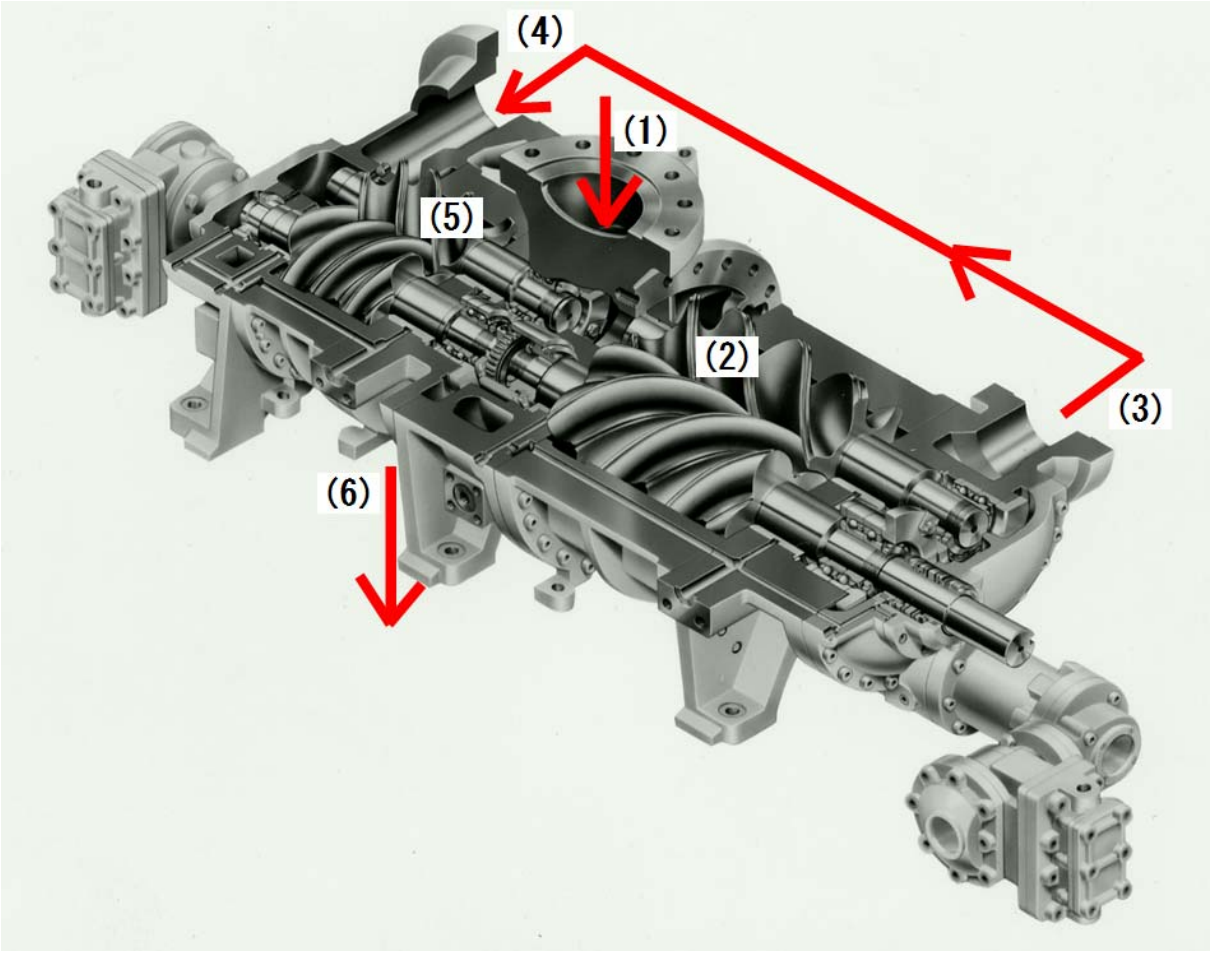



**Figure 2-22 Gas Flow**

## ■ Oil Supply Route

As shown in Figure 2-23, lubricating oil is split into five flows. After completing each role, the oil flows to the rotor messing part of the high-stage, and in addition to return to the low-stage rotor meshing part through the external piping. At last, both oil mixed with compressed gas and discharged from the compressor.

In standard configuration, oil injection is not performed at the high-stage.

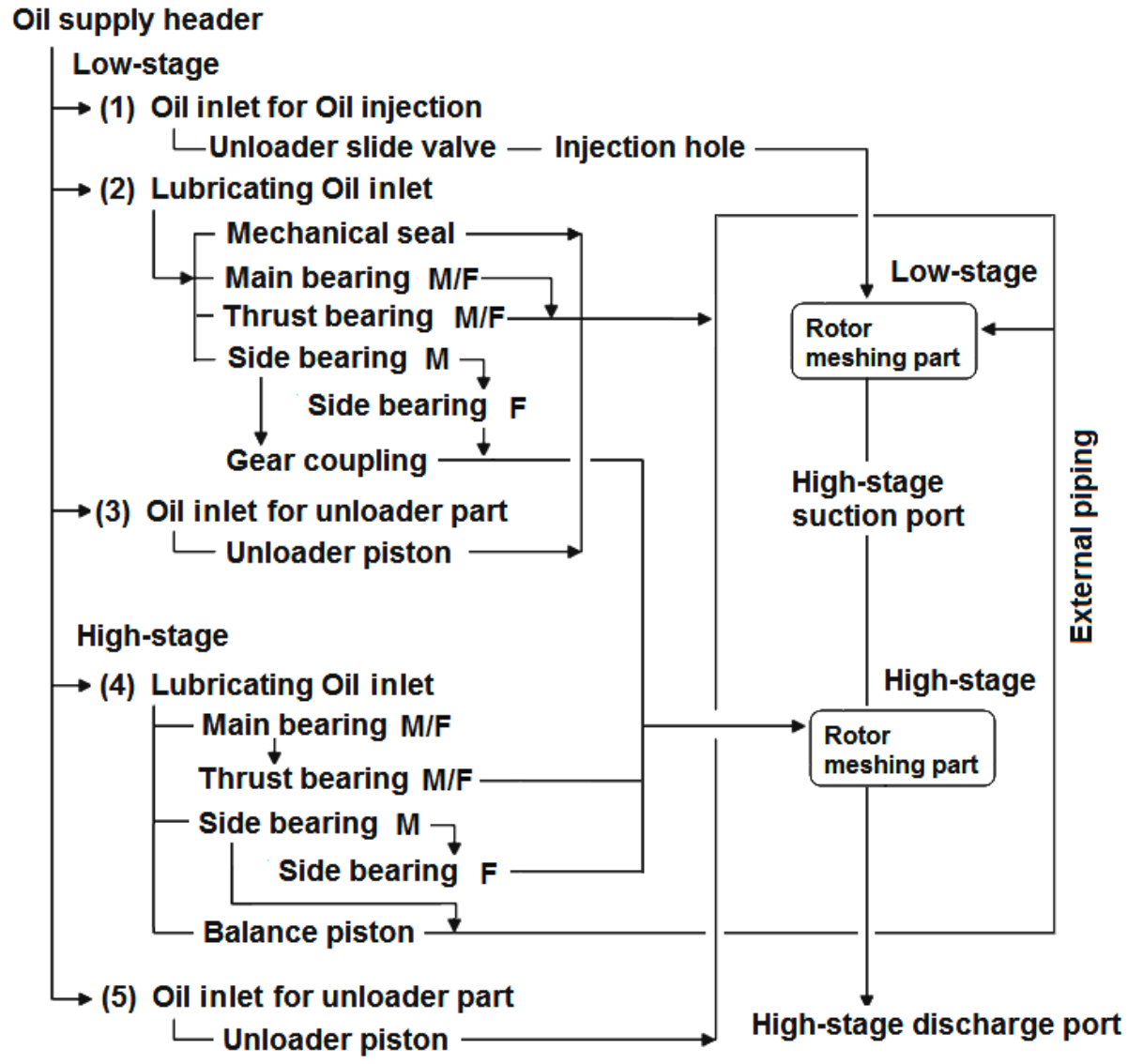



**Figure 2-23 3225**C Oil Supply Route**

# Chapter 3 Installation

## 3.1 General Precautions for Installation

【POINT】

- This chapter (Installation) assumes that the compressor is installed to a standard refrigeration / cold storage/gas compression package unit.
  If the package unit you are actually using is not the standard type refrigeration/cold storage/gas compression package unit, prepare a proper installation manual by referring to the description in this chapter and paying due consideration to safety, before installing the compressor.
  If there are any questions, please contact our local sales offices or service centers.

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

## 3.2 Installation Works

### 3.2.1 Unpacking

Confirm whether a compressor does not have abnormality including the damage.

【POINT】

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

### 3.2.2 Storage

If you need to store the compressor before installation, perform the followings:

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

### 3.2.3 Transportation

**DANGER**

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

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

***4.*** To lift the compressor, attach the wire ropes to the appended eye bolts by using appropriate shackles and hooks. Refer to Figure 3-1 and Photo 002 in next page.
Use the eye bolts only for lifting the compressor. Do not use the eye bolts when lifting the compressor together with additive equipment.

**CAUTION**

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

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

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

***7.*** Direct all the workers to stay clear of the work site before lifting.

***8.*** Before lifting the compressor, alert all workers in area of dangers during 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 (such as calling out or hand signals) are completely understood by the workers at site.

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

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

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

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

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

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

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

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

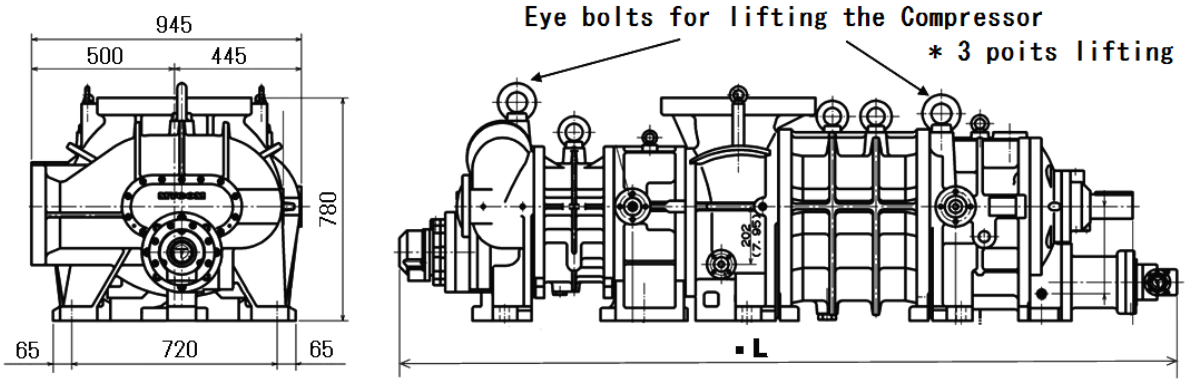
***17.*** Remove any obstacles before lowering the compressor onto the ground. The compressor should not be tilted or unstable.

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

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

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

## ■ Outer Dimensions, Mass and Lifting Position




| | 3225LLLC | 3225LLMC | 3225LLSC | 3225LLC | 3225LMC | 3225LSC |
|---|---|---|---|---|---|---|
| **Product mass** (kg) | 4150 | 4100 | 4020 | 3440 | 3390 | 3310 |
| L (mm) | 2960.5 | 2927.5 | 2820.5 | 2863.5 | 2830.5 | 2723.5 |
| | **3225MLC** | **3225MMC** | **3225MSC** | **322SLC** | **322SMC** | **3225SSC** |
| **Product mass** (kg) | 3290 | 3240 | 3160 | 3150 | 3100 | 3020 |
| L (mm) | 2776.5 | 2743.5 | 2636.5 | 2604.5 | 2571.5 | 2464.5 |

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

**Photo 002 Lifting Position**

## 3.2.4 Preparation for Installation

### ■ Installation Space

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

### ■ Illumination

Prepare illumination devices which allow easy operation, cleaning, maintenance, and inspection.

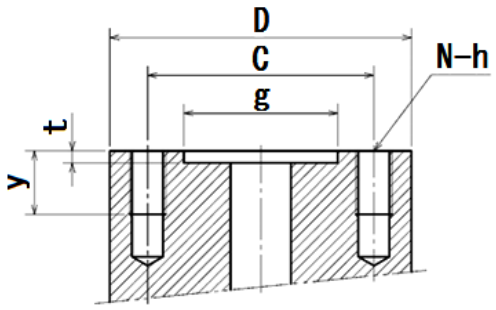
### ■ Ventilation

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

### ■ Piping

**Table 3-1 List of Connecting Pipes (Compressor)**

| Item | Dimensions | Remarks |
|---|---|---|
| Suction gas inlet | JIS 20K 350A (14") | See Figure 3-2. |
| Low-stage gas outlet | JIS 20K 200A (8") | |
| High-stage gas inlet | JIS 20K 200A (8") | |
| High-stage discharge gas outlet | JIS 20K 150A (6") | |
| Lubricating oil inlet for low-stage bearing (journal) | JIS 20K 40A (1-1/2") | |
| Lubricating oil inlet for High-stage bearing (journal) | JIS 20K 25A (1") | |
| Oil inlet for oil injection | JIS 20K 20A (3/4") | |
| Oil return inlet | JIS 20K 32A (1-1/4") | |
| Oil return outlet of low-stage | JIS 20K 32A (1-1/4") | |
| Oil return outlet of High-stage | JIS 20K 20A (3/4") | |
| Lubricating oil inlet for low-stage capacity control | Rc3/8 | same as loading and unloading |
| Lubrication oil inlet for high-stage capacity control | Rc3/8 | |




| | D | t | g | C | N-h | y |
|---|---|---|---|---|---|---|
| 20A | 100 | 4 | 51 | 75 | 4-M12×P1.75 | 21 |
| 25A | 125 | 5 | 61 | 90 | 4-M16×P2 | 24 |
| 32A | 135 | 5 | 71 | 100 | 4-M16×P2 | 30 |
| 40A | 140 | 5 | 76 | 105 | 4-M16×P2 | 22 |
| 150A | 305 | 5 | 216 | 260 | 12-M22×P2.5 | 35 |
| 200A | 350 | 5 | 261 | 305 | 12-M22×P2.5 | 40 |
| 350A | 540 | 5 | 480 | 480 | 16-M30×P3 (Special thread) | 50 |

**Figure 3-2 JIS20K Flange Dimensions of Compressor (mm)**

## 3.2.5 Installation

### 3.2.5.1 Installation

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

### 3.2.5.2 Shaft Alignment between the Compressor and Driving Machine

**DANGER**

- **Turn off the main power and control power of the driving machine before shaft alignment work between the compressor and the driving machine. Be careful so that the power of instruments does not turn on during shaft alignment work. If the power turns on during shaft alignment work, the driving machine starts moving and there is a risk of being entangled with the rotating shaft.**
- **At the time of turning ON/OFF each electric power breaker, make sure to prevent electric shock.**

**CAUTION**

- **For shaft alignment work between the compressor and driving machine, use designated tools in normal condition. If a worn or damaged tool or a tool unsuitable for the work is used, there is a risk of being injured.**

In the case shaft alignment between this product and the driving machine, be sure that the deviations within the range shown in the Table 3–2. However, if alignment tolerance of the driving machine side is more stringent than Table 3-2, please adjust to the request within the allowable value of the driving machine side.

**Table 3–2 Tolerance of Misalignment**

| | Tolerance |
|---|---|
| Offset | 6/100 mm |
| Angularity | 3/100 mm (reference: Φ100 mm) |

The Figure 3–3 and 3–4 show how to measure offset and angularity when performing the centering of the shafts of the driving machine and this product using a dedicated hub, a dial gauge and a magnet stand.

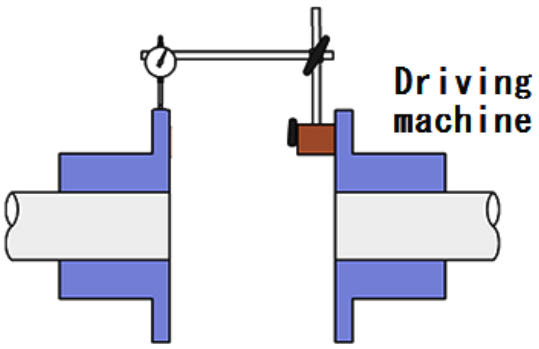



**Figure 3-3 Measurement of Offset**

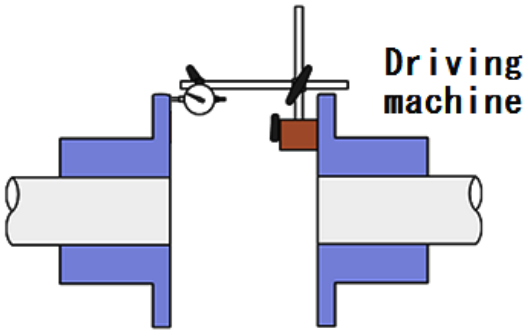



**Figure 3-4 Measurement of Angularity**

### 3.2.5.3 Piping Connection

#### ■ Refrigerant Piping

Observe the following when connecting the refrigerant piping to the compressor.

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

### 3.2.5.4 Equipment and Devices for Protection of the Compressor

#### ■ Oil Filter

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

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

When the package unit requires API 619 4th/5th edition conformity, use an oil filter with beta ratio in the range of $\beta_{10} \geq 200$.

The oil filter may be clogged 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 lubricating oil before starting the compressor, install an oil heater on the oil separator. Make sure to install a protection function (e.g., with thermostat, etc.) to the oil heater to prevent overheating.

#### ■ Suction Strainer

When compatible (inter-soluble) oil is used, the mesh size of suction strainer should be not less than 200 meshes. When incompatible (non- inter-soluble) oil is used, it should be not less than 100 meshes.

For details about compatible and incompatible oils, see Section 4.1 "Lubricating Oil (Refrigerant Oil)" in this manual Chapter 4.

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

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

To protect the compressor, install the necessary protective devices as described in Section 1.4.3 "Compressor Protective Devices" in this manual Chapter 1.

## 3.2.6 Airtightness Test

Perform an airtightness test on the package unit before starting commissioning. To prevent water entry in the package unit, use nitrogen gas or dry air for the airtightness test.

## 3.2.7 Lubricating Oil Charge

**CAUTION**

- **TO select the lubricating oil to be used, refer to Section 4.1 "Lubricating Oil (Refrigerant Oil)" in this manual.**
- **When refilling lubricating oil, ensure that it is clean and does not contain foreign matters.**
- **Be careful that air and water are not mixed in when refilling.**
- **To ensure that the lubricating oil does not absorb air moisture, keep it indoors in an airtight container until use.**

### 3.2.7.1 Initial Charge of Lubricating Oil

Depending on the package unit configuration and operating condition, specify the procedure, method and amount of the initial charge of lubricating oil, and make sure to provide users of this product with such information.

In determining the procedure and work procedure of the initial charge of lubricating oil, please care oil is to be filled in the oil filter and oil cooler always.

### 3.2.7.2 Additional Charge of Lubricating Oil

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

## 3.2.8 Charge of Refrigerant

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

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

## 3.2.9 Check after Installation

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

# Chapter 4 Compressor and Package Unit Operation

## 4.1 Lubricating Oil (Refrigerant Oil)

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

### 4.1.1 Precautions for Selecting the Lubricating Oil

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

  We therefore recommend contacting our sales offices or service centers for choice of a specified brand for your system.
- Lubricating oil used for compressors must have a viscosity appropriate for lubricating the bearings and other components in the compressors. The viscosity to be considered in this case should be the viscosity the oil shows at the oil inlet of the compressor. The viscosity of the lubricating oil significantly changes depending on the type of the refrigerant used in combination with the oil. If the refrigerant dissolves in the oil (or the oil and refrigerant are compatible), the viscosity of the oil drops to a level remarkably below the level required for operation of the compressor under some operating conditions. On the contrary, if the refrigerant does not dissolve in the oil (or the oil and refrigerant are incompatible), the viscosity may become too high when the supply oil temperature is low. For this reason, the lubricating oil must be selected such that it is supplied to the compressor with an appropriate viscosity (kinematic viscosity of 13 to 40 $mm^2/s$) in the operating state.
- The circulation of the lubricating oil for the entire system must be considered. After lubricating and cooling each part of the compressor, the lubricating oil is discharged with refrigerant gas. Most of the oil which is discharged from this compressor is trapped by the oil separator and is cycled to the compressor. A small quantity of refrigerant oil goes to the condenser and the evaporator. The lubricating oil is required to have sufficient fluidity and stability inside each part in the refrigerating cycle where temperatures differ.
- Note that some lubricating oils cannot be used depending on the combination with the refrigerant. The following caution is an example case that is required especially attention.

| CAUTION |
| --- |
| ● **Be careful since polyolester synthetic oil (POE) must not be used with ammonia refrigerant.** |

### 4.1.2 Recommended Lubricating Oils

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

#### 4.1.2.1 Recommended Lubricating oils for Ammonia Refrigerant

■ **Polyalkylene Glycols (PAG) Based Synthetic Oil (compatible oil)**

| Brand | Kinematic viscosity (40°C) $mm^2/s$ | Manufacturer | Type |
| --- | --- | --- | --- |
| JOMO Freol PN46 | 46 | JX Nippon Oil and Energy Corporation | PAG |

■ **Mineral Oils (incompatible oils)**

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

■ **Synthetic Oils (incompatible oils)**

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

Note: Use only a seal of the standard BBSE type.

### 4.1.2.2 Oils for Systems Using Hydrofluorocarbon (HFC) Refrigerants

■ **Polyolester synthetic oils (POE) for R404A, R507A and R410A: compatible synthetic oils**

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

■ **Polyolester Synthetic Oil (POE) for R134a: compatible synthetic oil**

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

CAUTION

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

## 4.1.3 Change of Lubricating Oil Brand

When changing the lubricating oil for another brand for some reason, pay attention to the following:

CAUTION

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

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

## 4.1.4 Precautions for Handling lubricating oil

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

### 4.1.4.1 Precautions for Handling Polyalkylene Glycol (PAG)

PAG oil is much more hygroscopic than mineral oils and any moisture mixed in the oil may lead to rust, corrosion and wear within the package. When handling PAG oil, pay special attention to the following points.

- Do not perform oil charging in rainy weather or at a place with high humidity to prevent absorbing moisture.
- Before charging, remove as much moisture as possible from the system by exhausting it with a vacuum pump for a sufficient length of time and leaving the system in vacuum condition overnight.
- Do not open the lid of pail (oil container) until just before charging. Once the can is opened, finish the oil charge as quickly as possible. (Finish the charge of a single can of oil within 15 minutes.)
- Cover any gaps between the pail opening and the charge hose so that foreign substances or moisture cannot enter. A more effective way is to substitute any space inside the pail with nitrogen gas .
- Always charge all oil from the pail. Even if some oil remains, do not use it subsequently.
- If any oil drops on a painted surface, wipe it away as soon as possible. Otherwise the paint may come off.

### 4.1.4.2 Precautions for Handling Polyolester (POE) Oil

This type of oil has high hygroscopicity as polyalkylene glycol, and also exhibits hydrolyzability under high temperature environments. Moisture entry must be avoided. Therefore, special attention must be paid as with PAG when handling POE.

- Finish the charging in as short a time as possible after opening the pail to minimize exposure to air.
- Make sure that all oil in a pail is used in a single charging. Any remaining oil must be stored indoors with the can lid closed tightly. Do not attempt to store it for a long time.
- Because POE can hydrolyze, make sure to perform an oil analysis regularly in the package to see if any abnormal conditions are present.

## 4.1.5 Lubricating Oil Management Criteria

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

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

- **Oil sampling and analysis is recommended every six months.**
- **If the following control criteria are not satisfied, replace the oil.**
  - ◆ Note that the water content of PAG shall be excluded from the above oil replacement criteria. Refer to the Note *1 in the following table.

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

**Table 4-1 Synthetic Oil (PAG)**

| Item | Criteria |
|---|---|
| (a) Color phase | ASTM color scale: 4.0 or less |
| (b) Total acid number (TAN) | 0.1 mg KOH/g or less |
| (c) Kinematic viscosity | Within ±10 % from that of fresh oil |
| (d) Water content | 2000 mass ppm or less **Note1** |
| (e) Degree of contamination | Degree of contamination measured by mass method (Millipore value) shall be 15 mg/100 mL or less |

**Table 4-2 Mineral Oil and Synthetic Oil (AB, PAO)**

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

**Table 4-3 Synthetic Oil (POE)**

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

Note 1: Synthetic oils (compatible 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. Thus, use the criterion value only as a reference.

## 4.1.6 Lubricating Oil Replacement Timing

### 4.1.6.1 After Starting the Initial Operation

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

If it is found as a result of the analysis that the criteria given in Tables 4-1 to 4-3 are not satisfied, the oil must be replaced.

### 4.1.6.2 During Normal Operation

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

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

The lubricating oil must be sampled and analyzed every six months. If it is found as a result of the analysis that the control criteria given in Tables 4-1 to 4-3 are not satisfied, the oil must be replaced.

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

# 4.2 Precautions for Operation

If the package unit is used in the refrigeration cycle, please keep in mind the contents of this section in particular.

## 4.2.1 Prevention of Liquid Flow-back Operation

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

For details, refer to Chapter 6 "Troubleshooting" in this manual Chapter 6.

## 4.2.2 Purging of Non-Condensable Gases

**WARNING**

- **Some types of refrigerants emit bad smells or toxic gases. Make sure to ventilate the air during work.**
- **When handling fluorocarbon refrigerants, remember that they are prohibited from being purged into air by law.**

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

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

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

1. When the compressor is stopped, allow the cooling water to flow to the unit's condenser for at least 15 minutes. Check the condensing pressure by using the pressure gauge of the compressor.
2. Check the cooling water temperature.
3. Compare the condensing pressure checked in step 1 above with the refrigerant saturation pressure that depends on the cooling water temperature (as shown in the table below).

**Table 4-4 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. 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.

# 4.3 When Stopping the Compressor for a Long Time

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

- Turn off the motor main power.
- Turn off the 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.

- Operate the oil pump for 10 seconds per week.
  After that, rotate the compressor shaft (10 rotations or more).
- Measure the package unit pressure once per month.
- Check for refrigerant leakage once per month.

When restarting the compressor after an operation stop period of 1 year or longer, check the system for refrigerant leak and analyze the lubricating oil. If it is found as a result of the analysis that the control criteria given in this Chapter, Section 4.1.5 Tables 4-1 to 4-3 are not satisfied, the oil must be replaced.

Also check the motor insulation resistance.

Supply power to the oil heater at least 1 day before operation start.

Before starting the operation, confirm that the refrigerant is not condensed in the package unit by checking the package unit temperature and pressure.

# Chapter 5 Maintenance and Inspection

## 5.1 Precautions for Maintenance and Inspection

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

**DANGER**

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

**WARNING**

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

**⚠ CAUTION**

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

**CAUTION**

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

# 5.2 Maintenance and Inspection List

## 5.2.1 Daily Management

For the purpose of daily maintenance, check the items listed in Table 5-1 "Daily Inspection Item" and record the results.

Regularly recording the daily operational data in an operation log makes it possible to detect any significant change in the system. This practice is particularly effective in preventing possible failures of the compressor.

It is particularly important to keep track of the records that indicate the relationship between the temperature and pressure, as it is closely related to the evaporation and condensation of the refrigerant, in quickly finding any abnormal condition of the compressor or the system.

Keeping an operation log in this way can facilitate the efforts to properly track down the cause of failure or accident that may occur in the compressor or the system, making it easier to quickly and accurately deal with the situation.

**Table 5-1 Daily Inspection Items**

| Inspection item | | | Inspection details | Checkpoints and actions |
|---|---|---|---|---|
| Compressor | Hours of operation | hour | Total hours of operation | • Used to determine the timing of regular maintenance and inspection |
| | Suction pressure | MPa | Difference from the pressure that corresponds to the specified evaporation temperature | • Cleanliness of the cooling pipe surface<br>• Temperature and flow of the items to be cooled |
| | Intermediate pressure | MPa | Difference from the normal pressure during rated operation | • If the pressure is too high (or too low), check the conditions of the high/low-stages. |
| | Discharge pressure | MPa | Difference from the condensation pressure for the specified cooling water temperature | • Cleanliness of the condenser cooling pipe<br>• Mixing of non-condensing gas<br>• Amount and temperature of the cooling water |
| | Oil supply pressure | MPa | Difference from the discharge pressure | • Whether the differential pressure is decreasing or not<br>• Liquid flow-back operation<br>• Wear of compressor parts |
| | Pressure loss of the oil filter | MPa | Pressure difference between the inlet and outlet ports of the oil filter | • Contamination of the lubricating oil<br>• Clogged oil filter |
| | Suction temperature | °C | Whether upper or lower limit temperature is not exceeded | • Temperature and flow of the items cooled |
| | Suction degree of superheat | °C | Whether the degree of superheat is appropriate or not | • Adjustment of expansion valve<br>• Insufficient refrigerant circulation |
| | Intermediate temperature | °C | Whether upper or lower limit temperature is not exceeded | • Adjustment of the intermediate expansion valve |
| | Discharge temperature | °C | Whether it is within the upper limit temperature | • Mixing of non-condensing gas<br>• Supply oil temperature, insufficient amount of oil supply<br>• Compressor failure |
| | Supply oil temperature | °C | Whether upper or lower limit temperature is not exceeded | • Cleanliness of the cooling pipe of the oil cooler |
| | Capacity control loading | % | Normally operation | • Damaged coil of the solenoid valve<br>• Improper manual valve adjustment of the solenoid assembly |
| | Leak at the mechanical seal | mL/hr | Amount of leak per hour | • Mechanical seal failure |
| | Noise and vibration | - | Abnormal noise and/or vibration | • Compressor failure |

**Table 5-1 Daily Inspection Item (continued)**

| Inspection item | | | Inspection details | Checkpoints and actions |
|---|---|---|---|---|
| Others | Motor current | A | Whether it is increased from the time of the commissioning | • Compressor/motor failure |
| | Oil level of the oil separator | - | Oil level height | • Oil loss<br>• Replenish oil |
| | Liquid level of the liquid receiver | - | Liquid level height | • Replenish refrigerant |
| | Refrigerant leak check | - | If any leak is found | • Inside the machine room and in the facility on the load side |

■ **Unless otherwise specified, the pressure unit "MPa" represents the gauge pressure in this manual.**

## ■ Daily Maintenance Items

***1.*** Oil level height of the lubricating oil
If the oil level of the oil separator has reached the lower limit, charge the lubricating oil.

***2.*** Oil filer element replacement
When the differential pressure between the inlet and outlet ports of the oil filter exceeds 0.1 MPa, replace the filter element. During the period of initial operation, the pressure difference between the inlet and outlet ports of the oil filter can quickly become large

***3.*** Cleaning of suction strainer
Inspect the suction strainer when the operating hours of the compressor from the initial operation starting has exceeded 500 hours.

If the filter used is a temporary filter for initial operation, remove the filter.

Also, as it is common that the differential pressure across the suction strainer can become large in a short period of time, inspect and clean the suction strainer if the differential pressure is large.

***4.*** Amount of oil leak from the mechanical seal
If the amount of oil leak from the mechanical seal is considered excessive, check the amount of oil leak per hour. The table below shows the guideline on the acceptable amount of oil leak and the amount that requires inspection.
If any damage is found on the mechanical seal in the inspection, be sure to replace it.

**Table 5-2 Criteria of the Leakage from the Mechanical Seal**

| | 3225**C |
|---|---|
| Acceptable leakage amount (mL/hr) | ≤ 6 |
| Inspection is required (mL/hr) | ≥ 18 |

Note: The values in the above table are only for guidance purposes, and no guarantee is provided.

***5.*** Contamination on the cooling water side of the condenser and oil cooler cooling pipe.
The degree of contamination and clogging of the cooling pipe can significantly vary depending on the quality of the cooling water. If any gradual increase in the oil temperature and/or the discharge pressure is observed during the initial period of operation, check and clean the cooling water side of the oil cooler and the condenser regardless of the inspection schedule.

## 5.2.2 Periodic Inspection

Conduct inspection for the following items according to the specified intervals.

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

**Table 5-3 Periodic Inspection Items**

| Item | Inspection interval and Content | Remarks |
|---|---|---|
| Pressure gauge/pressure sensor | Yearly inspection | |
| Thermometer/temperature sensor | Yearly inspection | |
| Protection devices and safety valves | Yearly inspection | |
| Suction strainer | Inspection after 500 hours of initial operation | Perform inspection and cleaning if the differential pressure across the suction strainer is high. |
| | Yearly inspection and cleaning | |
| Lubricating oil | Analyze the oil after 500 hours of initial operation | Replace the oil if the analysis result does not satisfy the control criteria given in Section 4.1.5 "Lubricating oil Management Criteria". |
| | Analyze the Oil every six months | |
| Oil filter element | Yearly replacement | When the differential pressure between the inlet and outlet ports of the oil filter exceeds 0.1 MPa, replace the filter element. |
| Cooling water side of the oil cooler | Yearly inspection | Clean it if it is heavily contaminated. |
| Cooling water side of the condenser | Yearly inspection | Clean it if it is heavily contaminated. |
| Mechanical seal | Inspection every year or every 8000 hours of operation **Note*** | To be replaced if any abnormality is found.<br>If it is difficult to stop equipment except for scheduled inspections, replace the part at each inspection. |
| Coupling | Inspection every year or every 8000 hours of operation **Note*** | |

**Note*:** The inspection shall be performed according to the operating period or operating hours, whichever comes first.

## 5.2.3 Guidelines for the Timing of Compressor Overhaul

While the overhaul interval for the compressor depends heavily on the conditions of use, type and condition of the refrigerant and oil, the package unit, and other factors, the table below shows the recommended interval of overhaul, as a guideline.

**Table 5-4 Guidelines for the Timing of Overhaul Based on the Conditions of Use (standard package)**

| Category of Operating Condition | Application Example | Guideline for the overhaul timing |
|---|---|---|
| Relatively stable operating condition | Cold storage and refrigeration | Every 5 years or 40,000 operating hours |
| Relatively variable 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 guideline is applicable only when the package unit is used under the standard operating conditions separately defined. (Refer to Chapter 2, Section 2.3.2 "Operation Limits" in this manual.)

Note 2: The above guideline is applicable only when the routine and regular inspection services that are separately defined are performed. (Refer to Section 5.2.1 "Daily Maintenance" of this chapter.)

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

Note 4: The above guideline is for reference only, and not a warranty period.

# 5.3 Compressor Disassembly Preparation

Although screw compressors are very reliable machines, it is still necessary to perform overhaul to inspect internal parts after a certain period of operation.
This chapter 5 explains the essential points of disassembly methods, where to inspect on parts, and reassembly procedure of the compound 2-stage screw compressor 3225**C.

In principle, overhauling of the screw compressor that require complete disassembly should be performed in the maintenance factory. If you must do the overhaul work at the installation site due to unavoidable reasons, use the methods described in the following paragraphs.

However, please note that regular overhaul work requires removal of the compressor from the base frame. And then, the compressor should be placed on a work bench which has properly size area to disassembling the compressor.

When moving the compressor from the unit base to the workbench, be sure to follow the instructions given in Chapter 3, Section 3.1 "General Installation Precautions" and Section 3.2.3 "Transportation" of this manual.

Note that some parts name given in the text of this manual is followed by a number enclosed in square brackets [ ], which indicates the part identification number given in assembly sectional views or development views.

## 5.3.1 Disassembly Tools and Workplace

Prepare necessary disassembly tools for the compressor by referring to Section 7.5 "Disassembly Tools" in this manual Chapter 7.

In addition, prepare other necessary tools and materials including general hand tools, GC (green carbonite) grinding stones, sandpapers of #80 to #100, about #400 to #800 sandpapers, parts cleaner, lubricating oil, oilcan, empty can to receive drain oil, waste, etc.

If the overhaul work is to be done with the compressor removed from the installation base, prepare the work bench whose size is at least around 1.5 times the length and the width of the compressor..

In addition, a special stand for the compressor is required in order to safely perform the removal/fastening of bolts and plugs on the bottom side of the compressor. Refer to Section 5.3.5 of this chapter.

To the extent possible, choose a dry and clean workplace free from sand or dust. Note that a sufficient space is required around the compressor. In addition, it is necessary a temporary storage place for disassembled parts.

## 5.3.2 Replacement Parts

Prepare the MYCOM genuine parts for replacement.

Parts listed in Table 5-5, we recommend to be replaced on the occasion of each compressor overhaul.

When ordering parts, be sure to inform the (a) model name, (b) serial number, (c) part name, (d) code No. and (e) quantity required, to our sales offices or service centers.

In particular, if the serial number (b) is unknown, the details of the applicable design and manufacturing specifications cannot be identified, and thus it becomes difficult to choose correct parts. So, make sure to inform the (b) serial number to us.

**Table 5-5 Replacement Parts of 3225**C Overhauling**

| P/N | Part Name | Code No. | Remarks | Q'ty. |
|---|---|---|---|---|
| 6-1 | Gasket, Suction Cover (1) | CS00600-320N | | 1 |
| 6-2 | Gasket, Suction Cover (2) | CS00600-3225CN | | 1 |
| 12-1 | Gasket, Bearing Head (1) | CS01200-320N | | 1 |
| 12-2 | Gasket, Bearing Head (2) | CS01200-250N | | 1 |
| 17-1 | Gasket, Bearing Cover (1) | CS01700-3225CN | | 1 |
| 17-2 | Gasket, Bearing Cover (2) | CS73300-3225CN | | 1 |
| 23 | Gasket, Balance Piston Cover | CS02300-250N | | 1 |
| 27-1 | Main Bearing (1) with O-ring | CS0270-GRT | | 2 |
| 27-2 | Main Bearing (2) with O-ring | CS0270-FRT | | 2 |
| 28-1 | Side Bearing (1) with O-ring | CS0280-GRT | | 2 |
| 28-2 | Side Bearing (2) with O-ring | CS0280-FRT | | 2 |
| 30 | Balance Piston | CS03000-250 | To be replaced if any abnormality is found. | 1 |
| 33 | Balance Piston Sleeve | CS03300-250 | | 1 |
| 35 | O-ring JIS B 2401 P150 | PA11-150 | | 1 |
| 38-1 | Thrust Bearing (1) | CS03800-320 | | 2 |
| 38-2 | Thrust Bearing (2) | CS03800-250P | | 2 |
| 39-1 | Lock Nut (1) AN21 | NG31-021 | To be replaced if any abnormality is found. | 2 |
| 39-2 | Lock Nut (2) AN17 | NG31-017 | | 2 |
| 40-1 | Lock Washer (1) AW21 | NG32-021 | | 2 |
| 40-2 | Lock Washer (2) AW17 | NG32-017 | | 2 |
| 49 | O-ring JIS B 2401 G160 | PA12-160 | | 1 |
| 50 | Oil Seal | CS05010-320VD | | 1 |
| 52 | Gasket, Seal Cover | CS05200-320N | | 1 |
| 59 | O-ring JIS B 2401 P32 | PA11-032 | | 1 |
| 63-1 | O-ring JIS B 2401 G170 | PA12-170 | | 1 |
| 63-2 | O-ring JIS B 2401 G190 | PA12-190 | | 1 |
| 65-1 | O-ring JIS B 2401 P140 | PA11-140 | | 1 |
| 65-2 | O-ring JIS B 2401 P155 | PA11-155 | | 1 |
| 66-1 | Cap Seal (1) BE-140 | CS06600-3225 | | 1 |
| 66-2 | Cap Seal (2) BE-155 | CS06600-250 | | 1 |
| 68-1 | Guide Pin (1) | NE2506-016 | To be replaced if any abnormality is found. | 1 |
| 68-2 | Guide Pin (2) | NE2506-012 | | 1 |
| 69-1 | Lock Nut (1) AN10, Unloader Piston | NG31-010 | To be replaced if any abnormality is found. | 1 |
| 69-2 | Lock Nut (2) AN08, Unloader Piston | NG31-008 | | 1 |
| 70-1 | Lock Washer (1), Unloader Piston AW10 | NG32-010 | | 1 |
| 70-2 | Lock Washer (2), Unloader Piston AW08 | NG32-008 | | 1 |

| P/N | Part Name | Code No. | Remarks | Q'ty. |
|---|---|---|---|---|
| 73-1 | O-ring JIS B 2401 P44 | PA11-044 | | 1 |
| 73-2 | O-ring JIS B 2401 G35 | PA12-035 | | 1 |
| 75-1 | O-ring JIS B 2401 G150 | PA12-150 | | 1 |
| 75-2 | O-ring JIS B 2401 G170 | PA12-170 | | 1 |
| 78 | Ball Bearing, Indicator Cam #6000 | CS07800-200 | | 2 |
| 79 | Snap ring C type External S10 | NG12-010 | | 2 |
| 82 | V-ring, Indicator Cam VH10 NBR | CS08200-200B | | 2 |
| 86 | O-ring JIS B 2401 G30 | PA12-030 | | 1 |
| 89-1 | O-ring JIS B 2401 P24 | PA11-024 | | 2 |
| 89-2 | O-ring JIS B 2401 P20 | PA11-020 | | 2 |
| 93-1 | Gasket, Suction Flange (1) | CS71200-350N | JIS 20K 350A(14") | 1 |
| 93-2 | Gasket, Suction Flange (2) | CS71200-200N | JIS 20K 200A(8") | 1 |
| 96-1 | Gasket, Discharge Flange (1) | CS71200-200N | JIS 20K 200A | 1 |
| 96-2 | Gasket, Discharge Flange (2) | CS71200-150N | JIS 20K 150A | 1 |
| 100 | Mechanical Seal Assembly BBS-E | CS10002-320EBS | | 1 |
| 125-1 | Set of Micro-switch (1) | CS1259-C | | 1 |
| 125-2 | Micro-switch (2) | CS12500-200 | | 2 |
| 129-1 | Potentiometer (1) 1612 1k with Wire | CS1299-J | To be replaced if any abnormality is found. | 1 |
| 129-2 | Potentiometer (2) 200-1K with Wire | CS1299-E10 | | 1 |
| 202-1 | Bevel Gear 1612D ID 6 mm | CS20100-1612C6 | To be replaced if any abnormality is found. | 2 |
| 150 | O-ring JIS B 2401 G220 | PA12-220 | | 2 |
| - | Gear Coupling Assembly (Current Type) | CS1519-M | To be replaced if any abnormality is found. | 1 |
| 159 | Knurled Cup Point Socket Set Screw | NA83610-025 | To be replaced if any abnormality is found. | 1 |
| 160 | Lock Nut AN15, Drive Hub | NG31-015 | To be replaced if any abnormality is found. | 1 |
| 161 | Lock Washer AW15 | NG32-015 | | 1 |
| 165 | O-ring JIS B 2401 P40 | PA11-040 | | 1 |
| 197 | O-ring JIS B 2401 P58 | PA11-058 | | 1 |
| 216-1 | Gasket, Lubricating Oil Inlet Flange (1) | CS71200-040N | JIS 20K 40A | 1 |
| 216-2 | Gasket, Lubricating Oil Inlet Flange (2) | CS71200-025N | JIS 20K 25A | 1 |
| 219 | Gasket, Oil Injection Inlet Flange | CS71200-020N | JIS 20K 20A | 1 |
| 237-1 | Tortional Slip Washer (1) | CS23700-320 | | 2 |
| 237-2 | Tortional Slip Washer (2) | CS23700-250 | | 2 |
| 328 | O-ring JIS B 2401 P46 | PA11-046 | | 1 |
| 351 | Gasket, Balance Piston Lubricating Oil Outlet Flange | CS71200-020N | JIS 20K 20A | 1 |
| 354 | Gasket, Bearing Cover Lubricating Oil Outlet Flange | CS71200-032N | JIS 20K 32A | 1 |
| 357 | Gasket, Main Rotor Casing Oil Return Flange | CS71200-032N | JIS 20K 32A | 1 |
| 421 | O-ring JIS B 2401 P46 | PA11-046 | | 2(*SC) (*MC) |
| 431 | O-ring JIS B 2401 P140 | PA11-140 | | 1 (M*C) |
| 432-1 | O-ring JIS B 2401 G165 | PA12-165 | | 4 |
| 432-2 | O-ring JIS B 2401 G130 | PA12-130 | | 4 |
| 433-1 | O-ring JIS B 2401 G165 | PA12-165 | | 4 |

| P/N | Part Name | Code No. | Remarks | Q'ty. |
|---|---|---|---|---|
| 433-2 | O-ring JIS B 2401 G130 | PA12-130 | | 4 |
| 528 | Oil Seal Sleeve with O-ring | CS52809-320VD | | 1 |
| 744 | O-ring, Oil Seal Sleeve JIS B 2401 G90 | PA12-090 | | 1 |
| - | Coupling Element | | To be replaced if any abnormality is found. | - |
| - | O-ring Set 3225C NBR | CS7109-0M | | - |
| - | Gasket Set 3225C | CS7118-0M | | - |

【POINT】

In case of replacing the main/side bearings of No.27 and No.28, it is not necessary to prepare the O-rings of No.432 and No.433 because the main/side bearings have the O-rings.

【POINT】

The sizes of O-ring No.432-2 and No.432-2 have been changed to G130 from G135 in October 2012 as a design modification.

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 us when placing an order.**

### 5.3.3 Refrigerant Gas Recovery

At the time the compressor operation is stopped, the pressure inside the compressor is still high. As such, it is necessary to lower the pressure down to the atmospheric pressure before starting the disassembly process. To do this, there are the following methods for example. Perform your recovery work in an appropriate manner considering site conditions, requirements of regulatory laws and regulations.

- Use the bypass valve to release the high pressure gas in the package unit into the low pressure side.
- If there is an adjacent compressor to which a permanent bypass line is connected from this compressor, operate the other compressor and lower the pressure through the bypass line.
- Operate the refrigerating system and close the supply source valve to turn the gas into liquid, and recover the liquid at the receiver.
- Use a refrigerant recovery machine to recover the liquid at the receiver.

In using either method, prepare a working flow sheet of the system beforehand. Check the valves to be controlled during the recovery work, according to the method to be used, by comparing them with the ones in the flow sheet, and clearly note the valves to be operated, other connected devices, and tubes on the flow sheet.

Two flow sheets must be prepared: one at the foreman and the other for posting in the workplace.

In addition, prepare a work procedure document for the refrigerant recovery work to reflect the actual conditions of the workplace, and sufficiently share the work details among all the coworkers through checking and confirmation before actually starting the work.

The gas mask and other protective gears required at each stage of refrigerant recovery work must be prepared before starting the work.

**WARNING**

- **Before the work, be sure to check and communicate the work details and procedure among all coworkers, and carry out hazard prediction activities based on the information shared. Neglecting to do this will increase the risk of on-the-job accidents and injuries to a considerable level.**
- **After closing (opening) a valve for work, conduct lockout/tagout to prevent it from being handled accidentally during the work.**

## 5.3.4 Removal of Connections to the Unit

**DANGER**

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

When removing the compressor from the mounting base frame, the following parts must be disconnected beforehand:

(1) Coupling to connect the compressor to the driving machine;

(2) Suction and discharge pipes of the compressor.
If the suction strainer is directly connected to the compressor, also remove the strainer;

(3) Oil supply lines to the compressor (Two journal oil inlet ports, one oil injection inlet port, and two ports for each of the capacity increase and decrease controls);

(4) Electric wiring for capacity control operation (In some cases, the unloader indicator assembly may be removed with the wiring left as it is. Refer to Section 5.4.1.1 in this chapter.);

(5) Compressor mounting bolts (foot bolts); and

(6) Intermediate connecting piping from the low-stage discharge port to high-stage suction port of the compressor (In some cases, this piping is not removed, and the compressor is removed with this piping attached.)

【POINT】

When removing oil lines from the compressor, there is possibility of gas and oil blowing out caused by residual pressure. And any residual oil in the pipe will flow out. To be prepared for this, either check the amount of oil outflow by slightly loosening the pipe joint or drain the oil from the oil temperature gauge at the supply header before removing the pipe.

Work carefully in particular when disassembling the unloader cylinder block since there is residual pressure and oil fills in the unloader cylinder. Moreover, prepare a larger volume container than the unloader cylinder volume to receive oil flowing out.

For easy reconnection, disconnected electric wires should be properly marked for identification. Any wrong reconnection may result in a startup failure or inability to operate the capacity control mechanism.

## 5.3.5 Removing and Lifting the Compressor

**DANGER**

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

【POINT】

As the suction pipe is located immediately above the compressor, lift up or partially remove the pipe such that it will not interfere with the lifting device.

For the lifting positions of the compressor, refer to Photo 002 or Figure 3-1 in page 3-3 of Chapter 3 in this manual.

If the planned overhaul work includes separation between low-stage and high-stage blocks of the compressor, place the compressor on a special stand as shown in Photo 003 and then remove eight or more hexagon head cap screws around the bottom flange part. Never try to remove these bolts while the compressor is lifted in the air. Note that these bolts cannot be removed once the compressor is placed on the work bench.

**Photo 003: Loosening Lower Flange Fastening Bolts**

## 5.3.6 Draining Oil from the Compressor

Because considerable amount of oil is in the compressor, it is necessary to drain the oil beforehand.

The drain plugs are located on the bottom of the suction covers [5-1], [5-2] and on the bottom of the bearing head [11-1].

The most part of the oil will be drained from these plug holes.

The remaining oil will be drained as appropriate in the disassembly process on the surface plate work bench.

The residual oil will mainly remain inside the a) unloader cylinder, b) balance piston cover [22], c) seal cover [51], and suction covers [5-1] and [5-2].


**Photo 004: Draining Oil from the Bearing Head**

Have oil pans and waste ready to receive oil to be drained during the disassembly process.

# 5.4 Disassembly and Inspection

During the overhaul work, be very careful in handling the parts. As the compressor is a delicate machine that is operated at very high speed, a minor handling error could result in a situation where the rotor and other major components must be entirely replaced. Another possibility is that it may cause a failure or performance degradation when the compressor is operated after the reassembly.

Please fully understand the following sections before starting the work.

In general, the disassembly sequence will follow the flow shown on the left side of Figure 5-1 "Illustration of the disassembly sequence". Note that the sequence shown is an example, and it may change depending on the situation. For example, it is allowed to separate the low-stage and high-stage blocks at first, as shown on the right side of the flow.

Also, in the case of the flow on the left side, the sequence of disassembly may be reversed between the unloader cover/unloader cylinder block and the mechanical seal block.

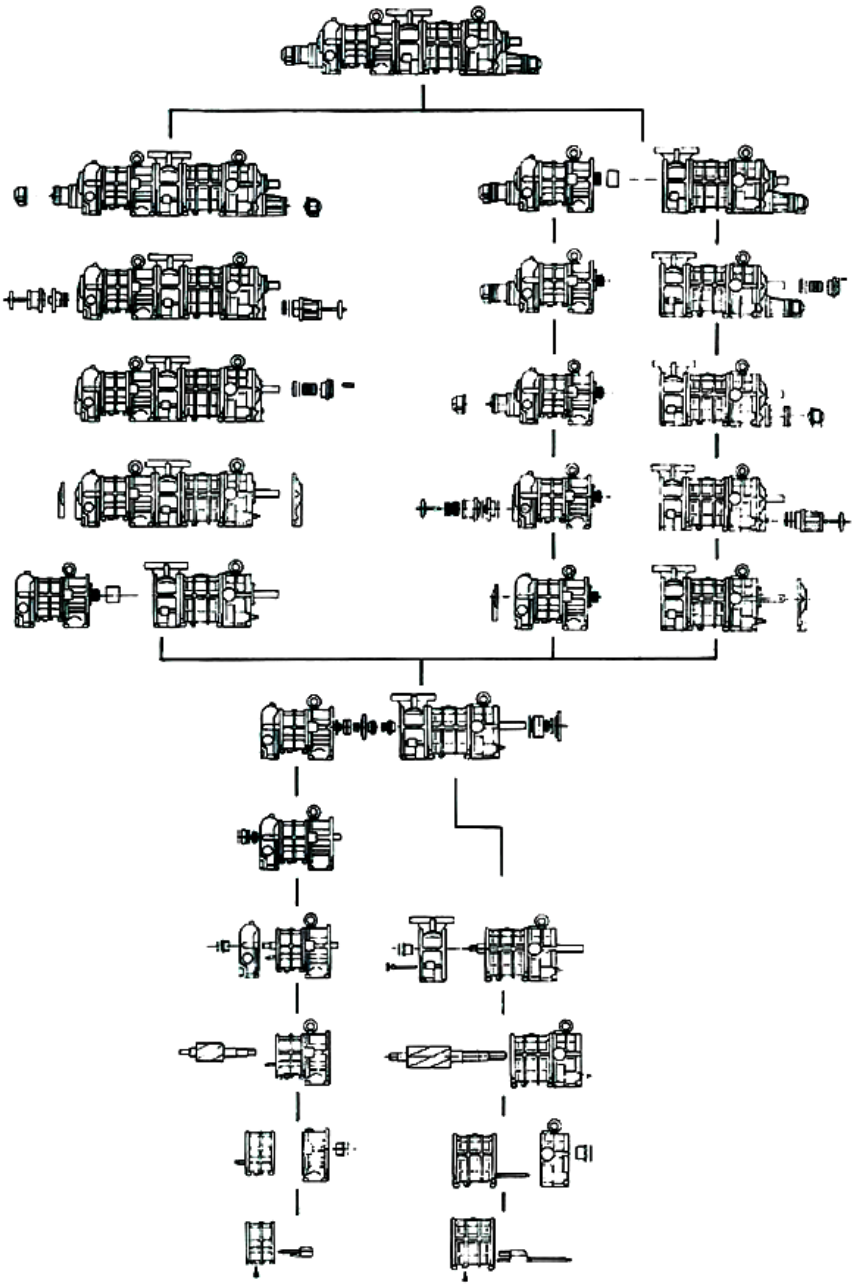


**Figure 5-1 Illustration of the Disassembly Sequence**

## 5.4.1 Unloader Indicator

Because the type 3225**C has a capacity control mechanism also on the high-stage, there are two unloader indicator locations. The standard operation method is such that the capacity control is used only on the low-stage during operation, and the capacity control on the high-stage is used to reduce the load during the startup phase.

As a different control method may be used depending on the system, refer to the separate electrical control schematic diagram for the plant.

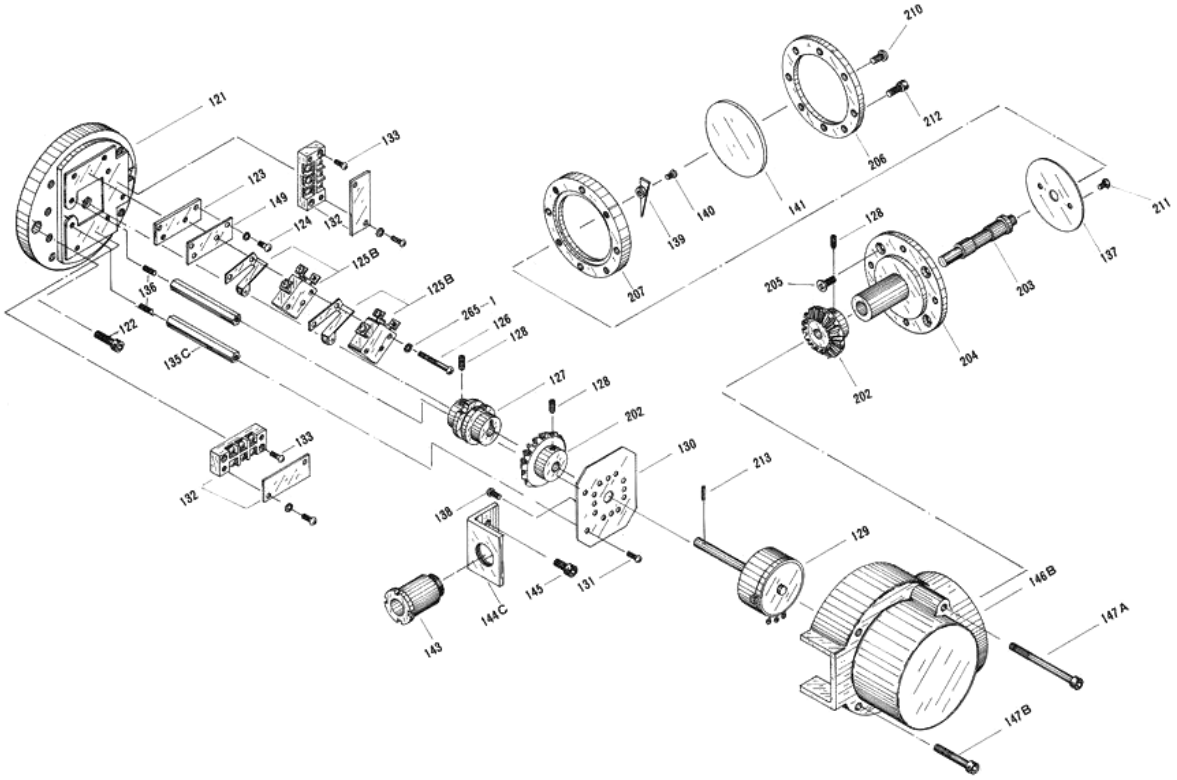



**Figure 5-2 Development View of the Standard Low-stage Indicator for 3225**C**

### 5.4.1.1 Disassembly

■ **In Case of Removing the Wiring only**

When removing the wiring of the unloader indicator upon removing the compressor, it is necessary to remove the cover as the indicator has a terminal block for the wiring. Perform the work according to the following procedure, and after removing the wires, attach the cover to them for protection.

○ Low-stage

a) Loosen the hexagon socket head cap screws [212] that are fastening the indicator glass [141]. In this, do not loosen the Phillips screws [210] on the same surface. In this way, the assembly consisting of the parts [141], [202 to 207], [210], and [211] can be removed.

b) By removing the two each hexagon socket head cap screws [147A] and [147B] that are used to fasten the indicator cover [146B], the cover can be removed.

c) As you can see the terminal block, remove the plastic cover on the block, and then remove the screws to disconnect the wires.

○ **High-stage**

Regarding the high-stage capacity control, the 3225*SC and 3225*LC types have the load indication of 30 to 100% while the model 3225*LC has the load indication 0 to 100%. Accordingly, the dial [137] and micro-switch cam [127] of the types *SC and *MC are for the indication of 30 to 100% while the type *LC has the standard dial and micro-switch cam for the 0 to 100% indication, according to the standard (200UD/G) specification. Otherwise, the mechanism of the indicator is the same between all types.

a) By removing the three hexagon socket head cap screws [147] that are used to fasten the indicator cover [146], the cover can be removed.
b) The indicator cover will be removed with the glass [141] and spacer [142] attached. While the glass and spacer are glued, be careful not to drop these as they may be separated from the cover.
c) Remove the wiring.

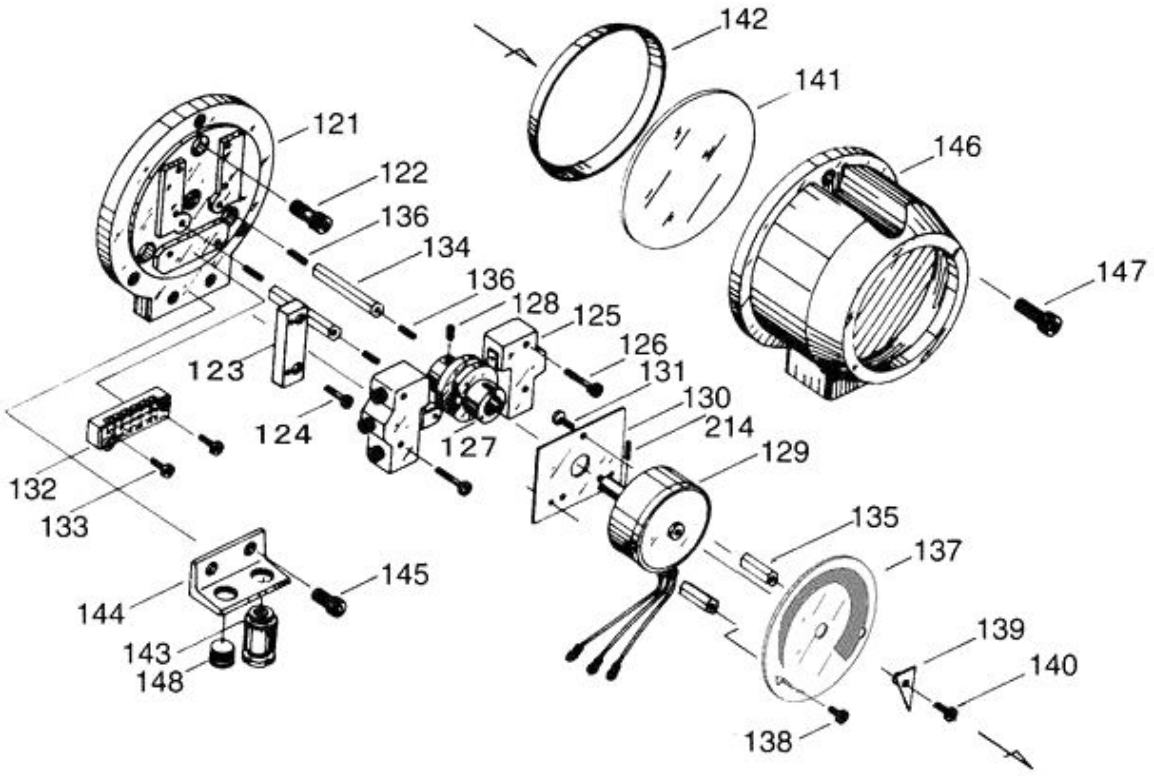



**Figure 5-3 Development View of the Standard High-stage Indicator for 3225**C**

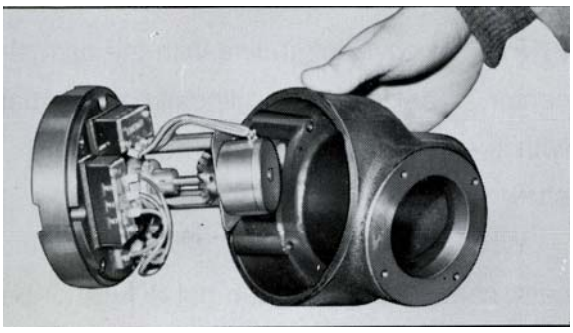


**Photo 005: Removing Low-stage Indicator Cover**

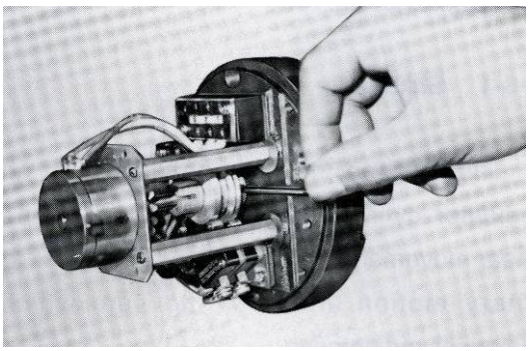


**Photo 006:Loosening Low-stage Micro-switch Cam Fixing Screw**

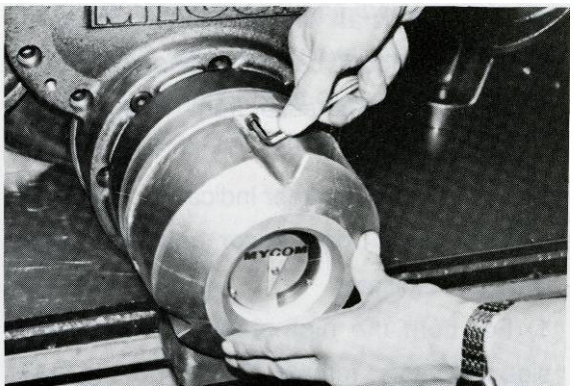


**Photo 007: Removing High-Stage Indicator Cover**

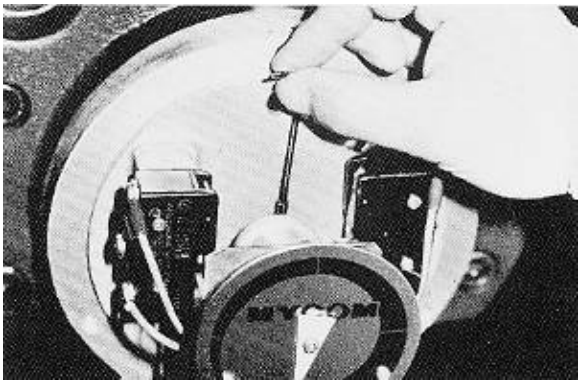


**Photo 008: Loosening High-stage Micro-switch Cam Fixing Screw**

■ **For Further Disassembly (In case of Removing as Unloader Indicator Assembly)**

As the indicator is an assembly to be removed as a whole, no further disassembly should be made unless the purpose of the disassembly is to disassemble this part.

○ **High and Low-stages**

a) As a result of the previous disassembly process, the micro-switch mounting plate [121], which is mounting the potentiometer, micro-switch, and micro-switch cam, can be removed.
b) Unscrew and remove the hexagon socket head cap screws [122].
c) Loosen the set screw [128] of the micro-switch cam.
d) After that, the assembly can be removed by pulling it in the axial direction.

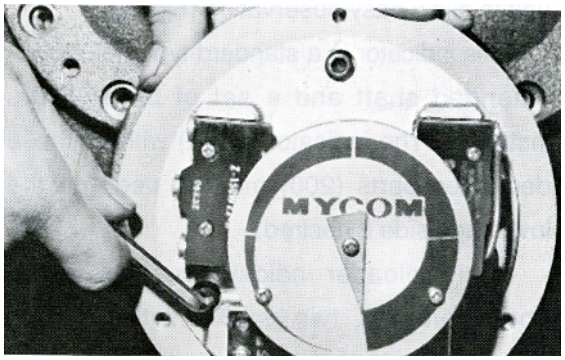



**Photo 009: Loosening high-stage micro-switch base plate fixing bolt**

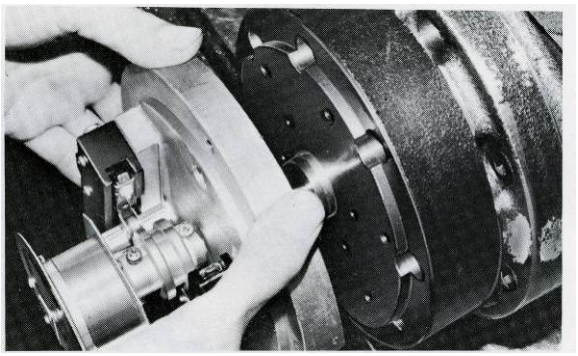


**Photo 010: Removing the high-stage indicator block**

### 5.4.1.2 Inspection

The inspection procedure is described in the "Reassembly" section of this chapter, as it is often the case that the unloader indicator block is removed as an assembly and later inspected and adjusted after the overhauled compressor is reassembled and installed on the mounting base. For details, refer to Section 5.5.15 "Unloader Indicator" in this chapter.

## 5.4.2 Unloader Cover

The unloader cover [74-1] [74-2] is mounted with the indicator cam [77-1] [77-2], which converts the linear motion of the unloader slide valve to a rotational motion, and their mounting parts.

The indicator cam is supported by the ball bearing [78] and fixed to the cover with a bearing gland [80].

To make it airtight, the V-ring [82], spring [83], and spring retainer [84] are also attached.

The indicator cam has a spiral groove of 340° to cover the moving range of the unloader slide valve. The indicator cam shaft is rotated being pushed by the guide pin [68-1] [68-2] on the top end of the unloader push rod [67-1] [67-2].

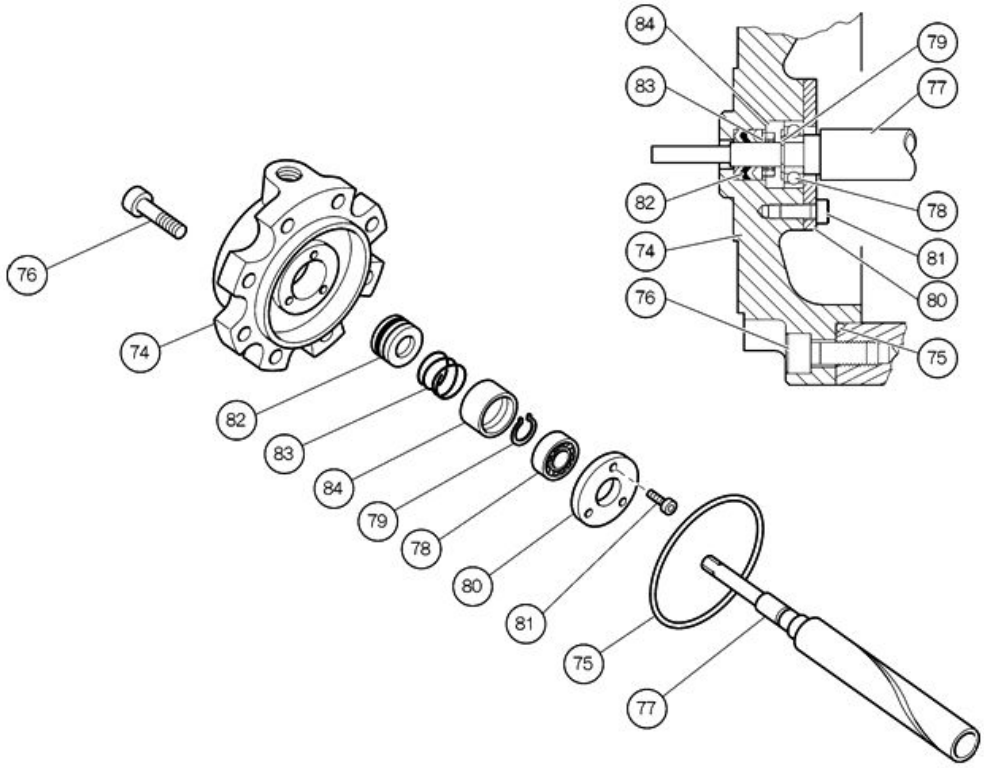



**Figure 5-4 Unloader Cover Block**

### 5.4.2.1 Disassembly

a) Unscrew and remove the unloader cover mounting hexagon socket head cap screws [76-1] and [76-2].

b) Pull the cover out in the direction parallel to the axis of the push rod in the unloader cylinder. Carefully pull it straight, because if the unloader cover is pulled sideways, the shaft of the indicator cam may be bent.

c) If the indicator cam will not move normally, check the spiral groove of the indicator cam, bearing, and guide pin. The disassembly sequence is as follows:

   c-1) As the bearing gland [80], which fixes the indicator cam in place, is secured by three hexagon socket head cap screws [81] on the cylinder side of the unloader cover, unscrew and remove these bolts.

   c-2) Then, the indicator cam can be pulled out with the ball bearing [78] and the snap ring (retaining ring) [79] attached to the shaft.

   c-3) Inside the unloader cover, the spring retainer [84], spring [83], and then V-ring [82] are assembled in this order. Because the V-ring is tightly engaged with the bore of the unloader cover, the lip of the V-ring will be damaged when it is once removed, making it unusable again. Therefore, be sure to replace it with a new one once it is disassembled.

**Photo 011: Removing the Unloader Cover**

**Photo 012: Ball Bearing for the Indicator Cam**

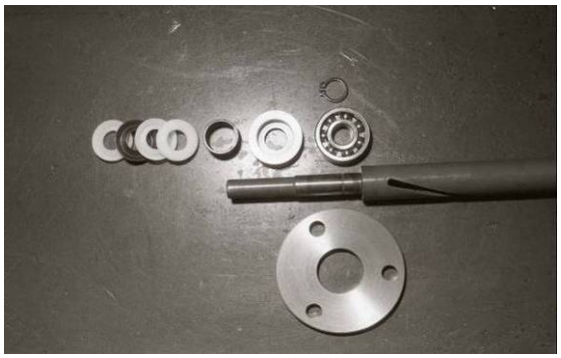


**Photo 013: Indicator Cam Mounting Parts**

**Photo 014: V-ring (Black part is NBR/FKM)**

### 5.4.2.2 Inspection

a) Check the packing portion of the indicator cam shaft for any flaw. If the refrigerant leaks without any flaw observed in this part, it should be due to a defect of the V-ring or installing the V-ring without sufficient oil.

   In this case, replace the V-ring.

b) Check the spiral groove of the indicator cam. If an abnormal flaw or wear is observed, replace it with a new one.

## 5.4.3 Unloader Piston and Unloader Cylinder

Inside the unloader cylinder [60-1] [60-2] is an unloader piston [64-1] [64-2] around which the cap seal [66-1] [66-2] and O-ring [65-1] [65-2] are fitted. The unloader piston is assembled to the unloader push rod [67-1] [67-2], which operates the unloader slide valve, with the lock nut [69-1] [69-2].

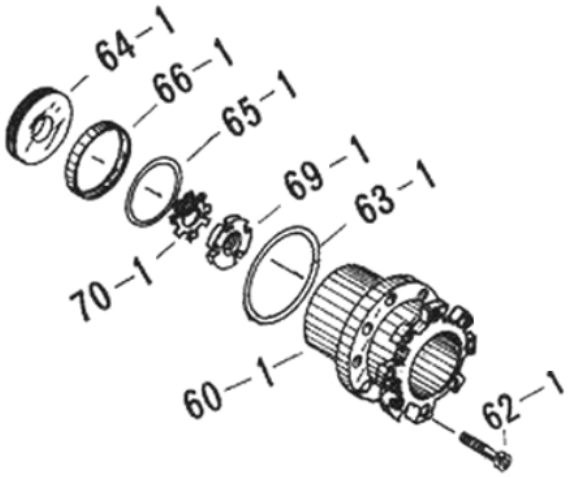



**Figure 5-5 Unloader Cylinder Block (Low-stage)**

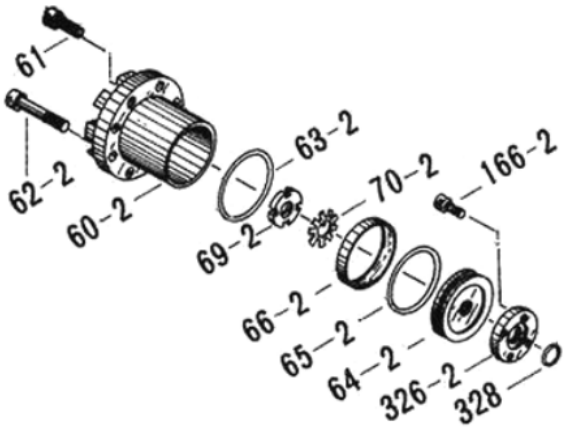



**Figure 5-6 Unloader Cylinder Block (High-stage)**

### 5.4.3.1 Disassembly

a) Screw two M8 eyebolts into the threaded holes of the unloader piston [64-1] [64-2], and pull it fully towards you.

b) Unbend the locking tooth of the lock washer [70-1] [70-2], which is used to fix the piston on the push rod, such that the lock nut [69-1] [69-2] can be turned. Then, loosen and remove the lock nut.

c) Now, you can remove the unloader piston.

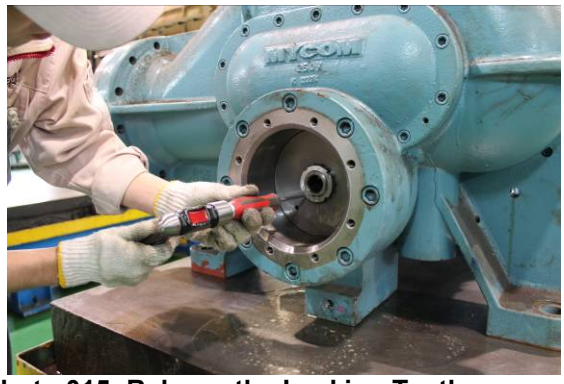


**Photo 015: Release the Locking Tooth of the Lock Washer (High-stage)**

**Photo 016: Use Lock Nut Wrench to Loosen the Lock Nut (High-stage)**

b) The low-stage unloader cylinder [60-1] is fastened by eight long hexagon socket head cap screws [62-1] to the low-stage bearing head [11-1] together with the bearing cover [16].
Even when all the hexagon socket head cap screws are removed, the unloader cylinder will not drop off as it is securely engaged with the bearing cover. Pull out the unloader cylinder by holding the flange or rib.

**Photo 017: Removing the Low-stage Unloader Cylinder**

c) The high-stage unloader cylinder [60-2] is also fastened by hexagon socket head cap screws [61] (× 2) and [62-2] (× 6). The high-stage unloader cylinder is to be pulled out similarly to Step b) for the case of low-stage cylinder. However, if the cylinder is to be further disassembled, leave the two bolts [61] fastened. Remove the bolts [24] and [62-2] fastening the balance piston cover [22] and remove the unloader cylinder together with the balance piston cover. In this, as oil remains in the balance piston and side bearing part, be careful of the oil that will come out when the balance piston cover is removed. If the gasket [23] is sticking and it does not come off, screw in two M8 eye bolts to the two forcing screw threads on the balance piston cover to separate the gasket.

**Photo 018: Removing the Balance Piston Cover and Unloader Cylinder together**

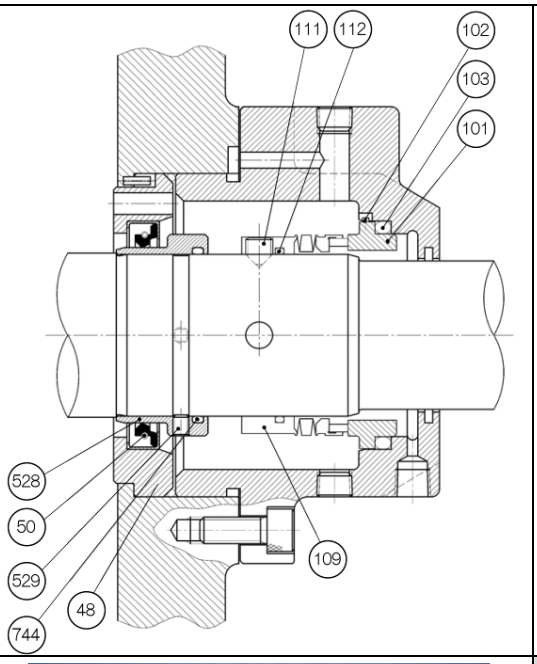
### 5.4.3.2 Inspection

a) Both the O-ring [65-1] [65-2] and cap seal [64-1] [64-2] that are on the periphery of the unloader piston [64-1] [64-2] must be replaced by new ones.

b) As it is often seen that the inside of the unloader cylinder has flaws or is contaminated by oil residue, thoroughly clean the area and use fine sandpapers to finish the surface.

**Photo 019: Removing the Cap Seal**

## 5.4.4 Shaft Seal Block



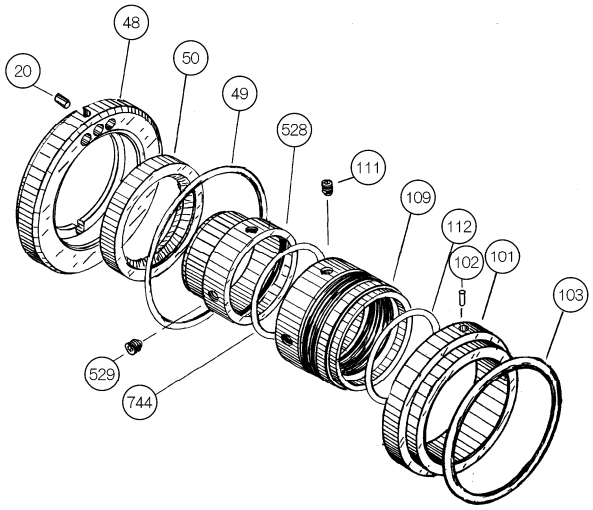




Photo 020: Seal assembly

| No. | | Part Name | |
|---|---|---|---|
| 101 | 100 | Mating ring | Stationary rings |
| 102 | | Insert lock pin | |
| 103 | | O-ring | |
| 109 | | Seal collar | Rotating rings |
| 111 | | Seal collar set screw | |
| 112 | | O-ring | |
| 528 | | Oil seal sleeve | |
| 529 | | Set screw for oil seal sleeve | |
| 744 | | O-ring | |
| 48 | | Retainer, oil seal | |
| 49 | | O-ring | |
| 50 | | Oil seal | |
| 20 | | Spring pin | |

**Figure 5-7 Development View of BBSE-type Mechanical Seal Assembly and Rerated Parts**

### 5.4.4.1 Disassembly

a) Of the eight hexagon socket head cap screws [53] securing the seal cover [51], remove six bolts leaving two diagonally opposite bolts.

b) Loosen the remaining two screws alternately and evenly, a little at a time. When the screws are loosened to some extent, the seal cover will be pushed by the spring force of the seal to create a gap under the cover. The gap will not be created if the gasket is sticking to both surfaces. In this case, free the cover by screwing M8 eye bolts into the jacking screw threads on the seal cover to separate it.

c) As the oil inside will flow out through the gap, be ready to receive the oil with a container.

d) Pull out the seal cover in the direction of the rotor shaft axis. Inside the cover, there is the mating ring fitted with the O-ring. In this, carefully remove the seal cover for the mating ring not to be damaged by touching the shaft.

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

f) After the seal cover has been removed, wipe clean the shaft and then check its surface. If any flaw is found, use a fine sandpaper to smoothen the surface. This correction is intended to prevent possible damage of the internal O-ring when the mechanical seal is pulled out.

g) Loosen the set screws [111] securing the seal collar [109] about three turns. Do not remove the set screws completely. Loosen them such that their ends are retracted from the surface of the seal collar. These two screws are located 90° apart from each other.

h) Pull out the mechanical seal assembly by holding the seal collar with your fingertips. While removing the assembly, make sure that the ends of the set screws do not touch the shaft surface. Any scratch on the shaft will cause leakage.

i) Pull out the oil seal sleeve [528] after removing the two set screws [529] .

j) Screw two M8 eye bolts into the screw holes in the seal retainer and pull out the seal retainer while keeping it in the right angle with the shaft.

k) Remove the oil seal [50] that is atacched into the oil seal retainer.

**Photo 021: Removing the Seal Cover**

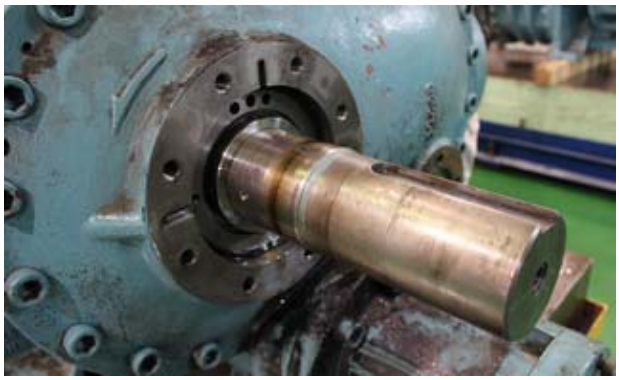


**Photo 022: After Removal of the Seal Assembly**

### 5.4.4.2 Inspection

a) Although it is instructed that the mechanical seal must be replaced after abnormality is found in the inspection, only visually checking the sliding surface may be insufficient in determining any abnormality. It is thus recommended to always replace it with a new one, similarly to the case of O-rings and gaskets, if the inspection is done in such a way.

   Also, if it is difficult to stop the compressor operation except for scheduled inspections, we recommend to replace the mechanical seal assembly with a new one at every inspection of this block.
   However, even if the assembly is to be replaced without exception, it is still necessary to visually check the condition of the sliding surface between the mating ring and the seal collar. If any unevenness or flaw is observed on the sliding surface, analyze the condition to determine whether it is due to aging, overheating, or other reasons in order to take necessary corrective actions.

b) Replace the O-rings every time the mechanical seal assembly is inspected because they normally swell and deform over time.

c) Check the wear of the oil seal sleeve in the area it rubs against the oil seal lip.

   If wear is evident, replace both the oil seal [50] and oil seal sleeve [528] with new parts. Since the oil seal is made of a special material, only genuine oil seals must be used for the replacement.

**Information on the O-ring [744] for the oil seal sleeve**

A design modification was made in March 2010 to insert an O-ring [744] in the oil seal sleeve.

## 5.4.5 Bearing Cover

The bearing cover [16] should be removed when the low-stage thrust bearing block is inspected or the rotor is pulled out for inspection.

### 5.4.5.1 Disassembly

a) Unscrew and remove all the hexagon socket head cap screws [18-1]. The bearing cover remains attached to the bearing head [11-1] with two alignment pins [19-1].
b) For safety, screw two stud bolts into appropriate top bolt holes.
c) There are two jacking screw holes in the opposite positions. By screwing in two left and right M8 eye bolts evenly, the bearing cover will be separated from the bearing head. When some gap is observed between them, use a scraper to remove one side of the gasket [17-1] from the body.
d) Further screwing in the eye bolts will disengage the bearing cover from the alignment pins.

**CAUTION**

- **At this point, if the bearing cover is not properly supported, it may fall or drop down onto the rotor shaft to cause damage on it. So, be sure to protect the shaft with a blanket or other protective covering before starting the work.**

**Photo 023: Removing the Bearing Cover**

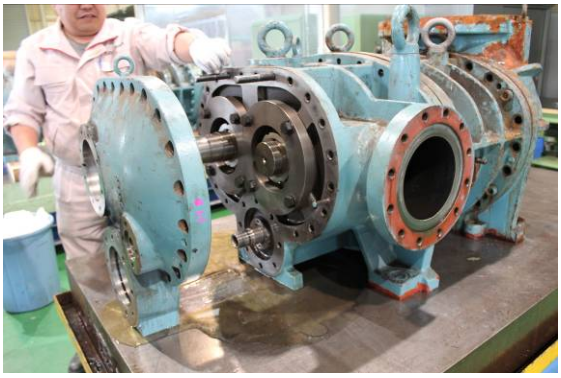


**Photo 024: Removing the Bearing Cover**

## 5.4.6 Separating High-stage and Low-stage Blocks

The high-stage and low-stage blocks should be separated before inspecting the gear coupling, high-stage thrust bearing, main bearing, pulled out rotors, etc.

As explained at the beginning of Section 5.4 of this chapter, the separation may be done at the initial step of the overhaul work.

### 5.4.6.1 Disassembly

a) As it is explained 【POINT】 in the Section 5.3.5, the bolts on the bottom side must be removed by placing the compressor on a special stand before starting the disassembly work.

b) Remove the hexagon socket head cap screws [18-2] that fasten the high-stage bearing head [11-2] to the low-stage suction cover [5-1].

c) As the gasket [17-2] is sticking to both surfaces of the high-stage bearing head and the low-stage suction cover, use the bolts [18-2] that have been removed to screw them into the jacking threads in the bearing head to evenly push the suction cover to separate the two blocks.

d) The gear coupling assembly [151 to 161] for power transmission is located inside, on the side of the M rotor shaft.
As the drive side and driven side of the coupling can be separated along the shaft axis, move the main body exactly along the shaft axis to separate them.

**Photo 025: Screwing in the Bolts to Push and Separate**

**Photo 026: Separating the High-stage and Low-stage Blocks**

## 5.4.7 Gear Coupling

The gear coupling, which is used as a power transmission means, is divided into the high-stage and the low-stage blocks, with each block attached to the corresponding M rotor shaft, and these two blocks are directly connected by a drive sleeve.

### 5.4.7.1 Disassembly

a) The drive sleeve [151] can be removed by hand after the high-stage and low-stage are separated.

b) On the high-stage (driven) side, first loosen the knurled cup point socket set screw [159] on the driven hub used for locking, and then pull out the driven hub. The driven hub can be easily pulled out, as clearance fit is used.

c) To remove the low-stage drive hub [152], release the locking teeth of the lock washer [161] and loosen the lock nut [160].

d) There are two screw holes in the drive hub.
Screw M8 eye bolts into these screw holes and pull out the drive hub. It can be easily pulled out, as clearance fit is used.

### 5.4.7.2 Inspection

Check the hub and sleeve for possible deformation of the gear teeth and wear on each tooth flank.

If it is found abnormal, replace the whole gear coupling assembly. At the same time, investigate the cause of the abnormality.

**Photo 027: Current Gear coupling parts**

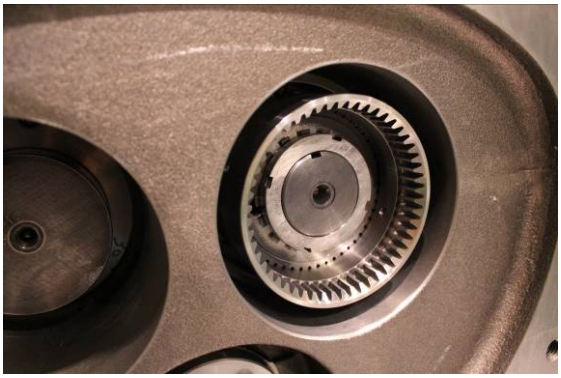
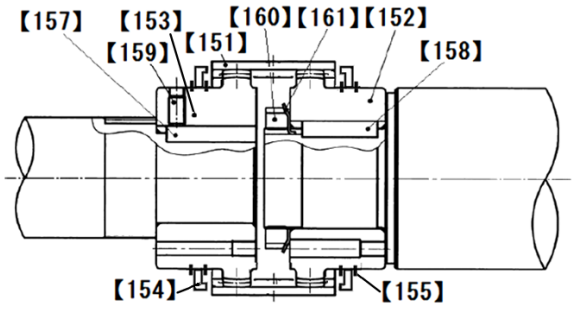


**Photo 028: Low-stage Gear Coupling**

**Gear coupling mechanism of 3225**C models**

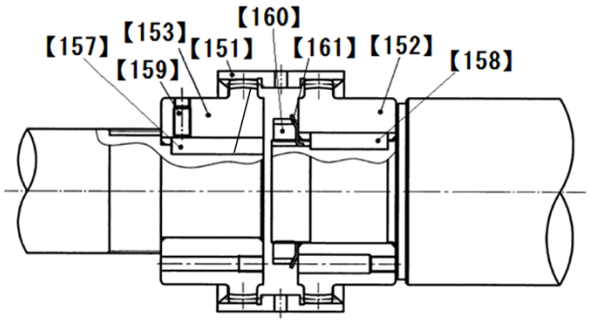
The gear coupling of 3225**C uses a coupling hub and drive sleeve. While the old couplings (before the design modification made in February 2011) have a stop on both outer ends of the sleeve to prevent the sleeve from dropping off, the stops are placed on the inside of the drive sleeve after the design modification (compatible with the old type).

After this design modification, the drive sleeve stopper [154] and stop ring [155] are no more used.




The gear coupling assembly consists of the items 151, 152, 153, 154*2, 155*4, and 159.

**Figure 5-8 Conventional Method (Before the Design modification in Feb. 2011)**




The gear coupling assembly consists of the items151, 152, 153, and 159.

**Figure 5-9 New Method (After the Design modification in Feb. 2011)**

## 5.4.8 Removing Oil Injection Pipe

The oil injection pipe [85] is located at the bottom of the low-stage suction cover [5-1].

### 5.4.8.1 Disassembly

Remove the oil injection pipe gland [164], and then hold a M20 bolt screwed into the screw hole on the head of the oil injection pipe to pull out the pipe.

**Photo 029 Removing Oil Injection Pipe**

**Photo 030 Removing Oil Injection Pipe**

## 5.4.9 Balance Piston

During the operation of a screw compressor, both the rotation rate and the thrust load of the M rotor are higher than those of the F rotor. Accordingly, the service life of the thrust bearing for the M rotor will be significantly shorter than that of the F rotor, if no special measures are taken. As such, in order to reduce the thrust bearing load on the M rotor side, a hydraulic piston is used on the shaft end of the rotor drive shaft to cancel the thrust load.

◆ Note that no balance piston is used on the low-stage. Because the low-stage pressure condition is lower than high-stage, the service life difference of the bearings is not so significant compared to the high-stage.

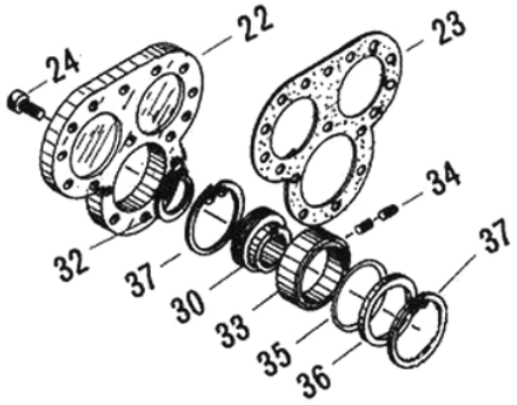



**Figure 5-10 Balance Piston Block**

### 5.4.9.1 Disassembly

a) Remove the snap ring [32] retaining the balance piston [30] on the shaft using external snap ring pliers.

b) Pull the balance piston straight out by screwing two eye bolts into the screw holes. While the rotor shaft has a balance piston key [31], it is unnecessary to remove the key.

**Photo 031**

**Photo 032**

c) To prevent rotation of the balance piston sleeve [33], there are hexagon socket head set screws [34] screwed from both the M rotor side (balance piston)and F rotor side. So, loosen the set screw on the F rotor side, and place the M rotor side screw under the suction cover as shown in Photo 032.

d) Remove the snap ring [37] securing the balance piston sleeve using the internal snap ring pliers. As the snap ring is pressed out by the internal O-ring [35], slightly pushing it can easily remove the snap ring.

e) Remove the balance piston sleeve and O-ring.
As clearance fit is used to engage the outside of the sleeve with the suction cover, you can easily pull it out.
As there is an O-ring spacer [36], also remove the spacer.

### 5.4.9.2 Inspection

While you will be able to find some trace of wear on the inside surface of the balance piston sleeve, such wear is not abnormal as it is caused because the clearance between the balance piston and the sleeve is narrower than the clearance between the rotor shaft and the bearing.

Because enough clearance is given to the outside of balance piston sleeve in order not to apply the bearing load to the balance piston, no further development of the wear is expected.

However, you should still carefully check the condition because when the side bearing is significantly worn, the balance piston may also be worn.

## 5.4.10 High-stage Suction Cover and Side Bearings

If the work sequence is such that the thrust bearing block is disassembled first and then the suction cover is removed, there is a risk that, when the suction cover is separated from the main rotor casing, the rotor may also be pull out and dropped. As such, in the procedure described in this manual, the suction cover is removed first, and then the thrust bearing is disassembled.

| CAUTION |
| --- |
| ● **In this procedure to remove the suction cover before disassembling the thrust bearing block, it is necessary to sufficiently loosen the lock nut that are securing the thrust bearing while the rotor is supported by both the main and side bearings, in order not to damage the rotor during the disassembly process.** |

### 5.4.10.1 Disassembly

a) Remove the hexagon head bolts [45-2] and the conical spring washers [46-2] that are used to fasten the thrust bearing gland [43-2], and then remove the gland.

   In case of a former model which uses a rotation stopper fitting instead of a conical spring washer, extend the bent plate of the rotation stopper and remove it from the hexagon head blot [46-2], and then remove the hexagon head bolt and the thrust bearing gland.

**Photo 033 Removal of Hexagon Head Bolts**

**Photo 034 Loosening the Lock Nut**

b) Unbend the rotation stopper tooth of the lock washer [40-2] holding the lock nut [39-2] which retains the inner race of thrust bearing [38-2] on the rotor shaft and loosen the lock nut using a lock nut wrench.

c) As the height of the high-stage main rotor casing is low, the casing is installed like a bridge to connect between the suction cover and the bearing head. As such, the main rotor casing will be supported only by one side (i.e., overhang)when the suction cover is removed. To avoid this, either place squared timbers or use a lifting device to properly support the main rotor casing.

d) Loosen and remove the hexagon socket head cap screws [2-2] securing the high-stage suction cover [5-2] to the high-stage main rotor casing [1-2].

e) As the gasket [6-2] of the suction cover is sticking to the surface of the flange, screw two hexagon socket head cap screws [2-2] that have been removed into the screw holes in the main rotor casing flange to evenly push the suction cover. When some gap is observed between them, use a scraper to remove one side of the gasket from the surface.

f) When it comes to the position the alignment pins are disengaged, pull out the suction cover at once along the rotor axis.

g) As the high-stage suction cover is installed with an O-ring [328] and O-ring gland [326-2] in the opening for the push rod to pass through, remove them. As the four bolts fastening the O-ring gland are small (M5), be careful not to lose them.

h) The side bearing [28-2] has been press fit from the balance piston cover side of the suction cover. Remove the snap ring [29-2] using internal snap ring pliers.

i) Either push out the side bearing from the main rotor casing side using some block or pull it out using a special tool such as shown in Photo 034. For the details of the special tool, refer to Section 5.5.2 in this chapter.

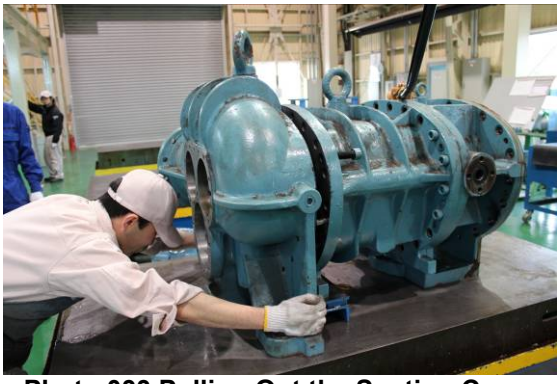


**Photo 033 Pulling Out the Suction Cover**

**Photo 034 Removing the Side Bearing**

### 5.4.10.2 Inspection

a) Check the oil inlet path to the balance piston part of the suction cover by spraying air or the like.

b) We recommend unconditional exchange of the side bearings on the occasion of the compressor overhaul, but for confirmation of the compressor condition and system operating condition, carefully check the sliding part metal surface of the side bearings.

If the metal surface is turned gray or any foreign matter is embedded, also carefully check the wear of the rotor shaft.

c) The inside surface of the main rotor casing should have no problems because sufficient clearance is provided. However, if any trace of scraping by the end of the rotor is found, it should be determined that the thrust bearing is defective. It is also necessary to check the operational condition, such as whether the system is operated for a long time with a high intermediate pressure.

## 5.4.11 Low-stage Suction Cover and Side Bearings

Similarly to the case of the high-stage, the lock nut fastening the thrust bearing should be loosened before removing the suction cover.

### 5.4.11.1 Disassembly

a) Remove the hexagon head bolts [45-1] fastening the thrust bearing gland [43-1] and O-ring [150]. As conical spring washers [46-1] are used together, be careful not to lose them.
b) Unbend the tooth of the lock washer [40-1], and loosen the lock nut [39-1].
c) Loosen and remove the hexagon socket head cap screws [2-1] securing the suction cover [5-1] to the main rotor casing [1-1].
d) Drive in the alignment pins [3-1] to the main rotor casing side as shown in Photo 35. If it is not feasible, screw in suitable bolts to the jacking screw holes on the flange to push the suction cover evenly.
e) At this time, the alignment pins will also be disengaged. Even after the alignment pins are disengaged, as the rotor shaft and side bearing are still engaged together, pull out the suction cover carefully along the shaft axis (Photo 36).
f) Remove the snap ring [29-1] holding the side bearing using internal snap ring pliers.
g) Either push out the side bearing from the main rotor casing side using some block or pull it out using a special tool such as shown in Photo 037. For the details of the special tool, refer to Section 5.5.2 in this chapter.

**Photo 035**

**Photo 036**

**Photo 037**

### 5.4.11.2 Inspection

Inspect the suction cover and side bearings in the same way as for the high-stage.

## 5.4.12 Thrust Bearing Block

### 5.4.12.1 Disassembly of High-stage Thrust Bearing Block

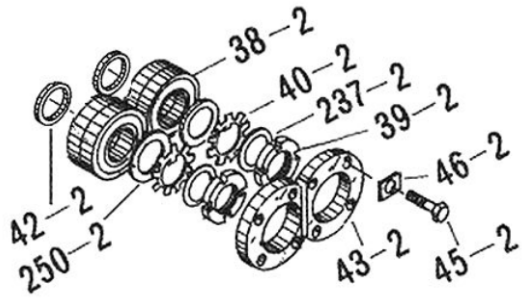



**Figure 5-11 High-stage Thrust Bearing Block**

**Table 5-6 Component Parts of the High-stage Thrust Bearing Block**

| P/N | Name | Q'ty |
|---|---|---|
| 38-2 | Thrust bearing (2) | 2 |
| 39-2 | Lock nut (2) | 2 |
| 40-2 | Lock washer (2) | 2 |
| 42-2 | Thrust bearing alignment spacer (2) | 2 |
| 43-2 | Thrust bearing gland (2) | 2 |
| 45-2 | Hexagon head bolt | 8 |
| 46-2 | Conical spring washer (2) | 8 |
| 237-2 | Torsional slip washer (2) | 2 |
| 250-2 | Thrust washer (2) | 2 |

【POINT】

The high-stage thrust bearing block of 3225**C has no spacer for the thrust bearing outer race. While the thrust bearing outer race spacer is used to support (i.e., ensure a sufficient support width for) the outer race of the thrust bearing, 250 or higher models use no spacer for the thrust bearing outer race because the case (bearing head) side has sufficient margin to the support it.

a) Remove the lock nut [39-2] that has been loosened. Then, remove the torsional slip washer [237-2], lock washer [40-2], and thrust washer [250-2].

b) The clearance fit is applied to two gaps between the outer race of the thrust bearing and the bearing head, between the inner race of the thrust bearing and the rotor shaft.

   Prepare a 1 or 2 mm diameter aluminum wire, make the tip of the wire flat by hammering, and slightly bend the tip to make a hook. Then, insert the tip of the wire between the outer race and the ball retainer of the thrust bearing [38-2] to hook and pull out the bearing. In this way, the bearing can be easily removed.

c) The whole thrust bearing will be removed helped by the surface tension of the oil on the side face. If you have failed to remove the whole bearing at once, put the components in the order of the removal.

d) Inside the thrust bearing is an alignment spacer [42-2] for the inner race on the rotor shaft side. The M rotor side has a marking of "M", and the F rotor side has a marking of "F".

   Neatly arrange the parts removed, i.e., the thrust bearing gland, thrust washer, thrust bearing, and thrust bearing alignment spacer, separately for the M rotor and F rotor as shown in Photo 040.
   You must be very careful because if an assembly error is made to result in a wrong combination of parts after failing to neatly arranging and separating the parts, it can lead to performance degradation and/or dragging accident due to overheating caused by being too narrow clearance, for example.

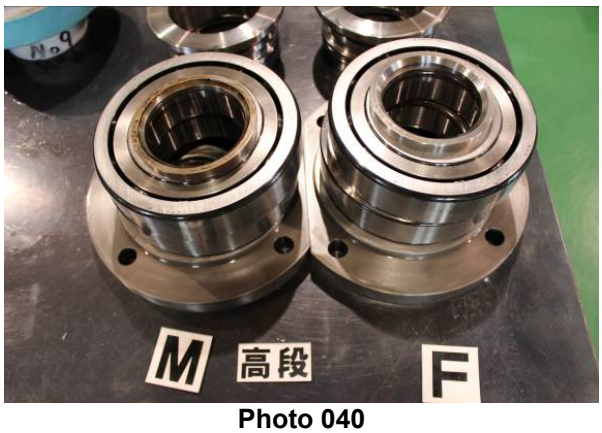



**Photo 040**

### 5.4.12.2 Disassembly of Low-stage Thrust Bearing Block

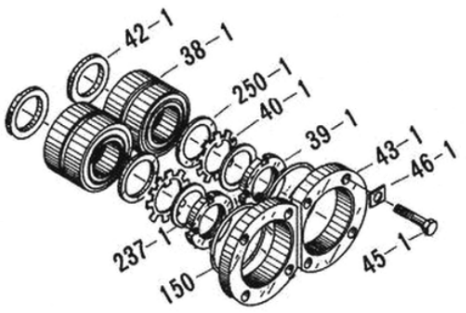



**Figure 5-12 Low-stage Thrust Bearing Block**

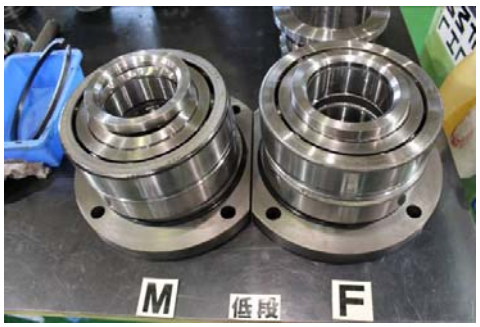



**Photo 041**

【POINT】

Unlike the high-stage, the low-stage thrust bearing block of 3225**C is using an oil supply spacer for the combined surface. This is to facilitate lubrication of the ball bearing because as the rotor diameter becomes larger, the rotor shaft diameter become larger. Thus, a larger thrust bearing is required and the ball rotation speed increases accordingly. Furthermore, as with the high-stage, the low-stage thrust bearing block of 3225**C has no spacer for the thrust bearing outer race.

a) Remove the lock nut [39-1] that has been loosened. Then, remove the torsional slip washer [237-1], lock washer [40-1], and thrust washer [250-1].
b) Similarly to the case of the high-stage, remove the thrust bearing [38-1] and the thrust bearing alignment spacer [42-1].

### 5.4.12.3 Inspection (High-stage and Low-stage)

a) The thrust bearing is normal if the bearing balls are found fully glossy after the thrust bearing has been fully washed and cleaned. It is abnormal if the ball surface has tarnish streaky pattern.
b) Support the inner race with your hand and rotate the outer race. If you feel abnormal vibration on the hand, the rolling contact surface of the inner or outer race or some balls may be in an abnormal condition. So, carefully check the conditions. You could feel some irregular click even with a small foreign matter that has entered during the removal process. In such a case, it should return to the normal condition when high pressure air is used to blow out the foreign matters after washing and cleaning the unit. If the bearing is determined to be defective, it must be replaced with new ones.
c) If the inner race and outer race can be easily separated, the wear is considered excessive. If so, you cannot reuse the bearing.
d) After washing the bearing, you should be able to hear a clattering sound when the bearing is rotated by hand. Such a sound is due to the motion of the ball within the backlash or play, or the gap between the retainer and the ball. Such a sound will not be heard if the bearing is held horizontal and turned. If some lubricating oil is applied after washing the bearing, the sound should not be heard when the bearing is turned. If you can still hear the sound, the bearing is abnormal.
e) If any abnormality is seen in the thrust bearing in the above inspection, replace with new ones.
In addition, carefully check the reason whether due to mere aging or any problem with the operating condition and/or lubricating mechanism.

f the compressor has been operated for more than 20,000 hours without replacing the thrust bearing, it is recommended to replace the bearing with a new one for safely continuing the operation until the next overhaul, even if no abnormality is found in the above described inspection.

**CAUTION**

- **As the bearing used for the compressor is a specially designed combined-type bearing, the accuracy and material are different from normal ones of the same part number that may be found in the catalogue of a bearing manufacturer. Be sure to use only MYCOM genuine parts for replacement. Otherwise, it will not be covered by the warranty.**

## 5.4.13 High-stage Rotors and Main Rotor Casing

### 5.4.13.1 Disassembly

a) While you can pull out the rotor either from the M or F side, you should be very careful in the work as either rotor is very heavy.

When pulling out the M rotor (or F rotor) first, pull out about 2/3 of the full length of the rotor by holding the shaft upward and turning it in the CW (or CCW) direction.

**CAUTION**

- **You should carefully note that the rotor must be rotated in the specified direction while pulling it out. If the M (F) rotor is not turned during the pulling out process, the F (M) rotor can also be pulled out together.**

b) As a preparation, use a nylon belt or other lifting belt that will not blemish the lifting surface to support the center of the rotor. Then, pull out the rotor while slightly lifting up the rotor using the belt.

**Photo 042 Pulling Out the F Rotor**

**Photo 043 Lifting Up the F Rotor**

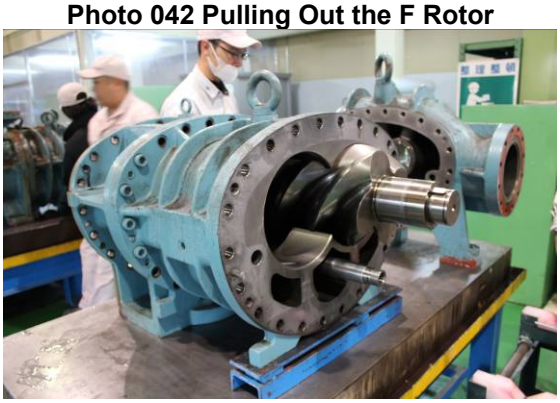


**Photo 044 Pulling Out the M Rotor**

**Photo 045 Lifting Up the M Rotor**

c) The pulled out rotor should not be directly placed on the floor. Use appropriate wood boards to support the rotor as a cushion to prevent blemishing or use V-blocks to support the shaft to prevent blemishing of the outer surface (See Photos 046 and 048.)

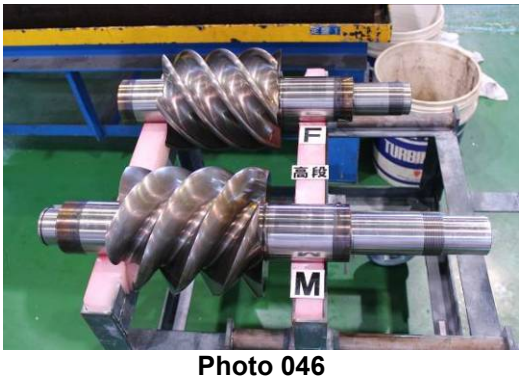



**Photo 046**

### 5.4.13.2 Inspection

a) No abnormality should be observed on the surface of the rotor lobes under normal operations. Regarding the contact surface of the teeth, black luster should be seen on the root area of the M rotor lobes and on the tip area of the F rotor lobes.

   In other cases, when the suction gas or oil is contaminated by fine dust, there may be fine linear scratches on the shaft surface, in the direction perpendicular to the shaft axis. If any such flaw is found, use a fine sandpaper or grindstone to smooth the surface.

b) In case of ammonia refrigerant or gas compressor, the non-contact surface of the rotor may be discolored by rust or deposits. Use sandpapers or others to finish the surface according to the degree of the problem.

c) Then, check the bearing areas of the rotor shaft. Two types of finishing are used: one is the induction hardening (polish finishing) for the standard specification, and the other is the hard chrome plating (polish finishing), as a special specification. The most suitable finish is selected according to the type of refrigerant and operation conditions.

   Very little wear will be present unless the compressor is operated for a long time using dirty oil or any hard matter is buried in the metal of the inner circumference of the bearing.

d) Check the portion of the shaft on which the thrust bearing is mounted for any trace to show that the inner race of the bearing has rotated.
   If the lock nut that fastens the inner race of the thrust bearing is loosened, or if the bearing is abnormally worn, the inner race will become rotate. If any trace of rotation is seen, correct the problem. Depending on the degree of the rotation trace, it might be necessary to replace the rotors with new ones.

e) Check the inner surface of the main rotor casing.
   There is a narrow clearance between the periphery of the rotor and the main rotor casing. Any slight flaw present on the tip of the rotor teeth or on the inner surface of the main rotor casing, due to small foreign matters, will not be a problem.
   If there is any trace to show that the tips of the rotor teeth have hit the inner surface of the main rotor casing, it is an abnormal condition. In such a case, the possible cause is that the main bearing and/or side bearing is worn out. Take proper actions by finding the cause of the problem, such as contamination of the lubricating oil or entrance of foreign matters.

## 5.4.14 Low-stage Rotors and Main Rotor Casing

Perform the work similarly to the case of the high-stage unit. The work should be very carefully performed as the low-stage rotors are heavier than the high-stage rotors.

Also perform the inspection work similarly to the case of the high-stage unit.

As the low-stage M rotor is installed with a mechanical seal, do the work very carefully not to damage the shaft. It is recommended to apply a protective tape on the shaft surface.

**Photo 047 Pulling Out the Low-stage M Rotor**

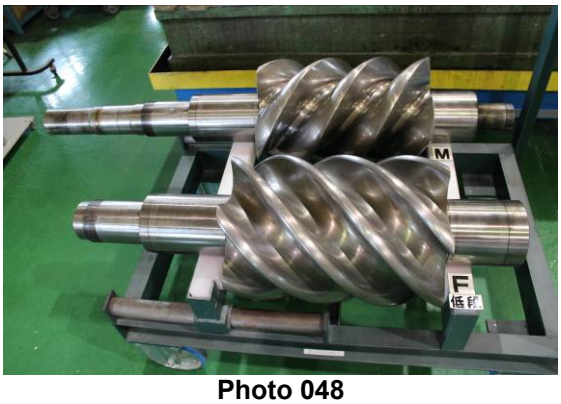



**Photo 048**

## 5.4.15 High-stage Bearing Head and Main Bearings

On the rotor mounting side of the bearing head [11-2], there is a gas discharge port as determined by the operating conditions of the compressor. This discharge port affects the performance of the compressor.
In addition, the bearing head has the main bearing that supports one end of the rotor.

### 5.4.15.1 Disassembly

a) Remove all the hexagon socket head cap screws [2-2] fastening the main rotor casing and the bearing head. Support the foot of the main rotor casing using squared timbers.

b) Use jacking bolts to evenly push the block. Once some gap is produced between the main rotor casing and the bearing head, use a scraper to detach the gasket from the bearing head and put it on to the main rotor casing side.
When the alignment pins are disengaged, the bearing head is separated from the main rotor casing.

**Photo 049 Loosening the Fastening Bolts**

c) The main bearing [27-2] is lightly press fit into the bearing head. When removing the main bearing, first use internal snap ring priers to remove the snap ring [29-2]. Then, either use a plastic block or other suitable element to push the bearing from the rotor side or use a special tool such as shown in Photo 051 to pull out the bearing. For the details of the special tool, refer to Section 5.5.2 in this manual.

**Photo 050 Removing the Snap Ring Internal**

**Photo 051 Removing the Main Bearing**

d) The unloader slide valve can be removed as an assembly by pulling it out from the bearing head side. If no specific abnormality is found, no further disassembly is required.

e) The guide block stem [88-2] is screwed in from the bottom of the main rotor casing, and the guide block [87-2] is engaged from the top. To replace the O-rings [89-2], remove the guide block stem.

### 5.4.15.2 Inspection

a) We recommend as well as the side bearings, unconditional exchange of the main bearings on the occasion of the compressor overhaul, but for confirmation of the compressor condition and system operating condition, carefully check the sliding part metal surface of the main bearings.

If the metal surface is gray or any foreign matter is buried, also carefully check the wear of the rotor shaft.

b) Check the condition of the surface of the bearing head on the rotor side, where the discharge port is. Properly mend the surface if any flaw is observed. If the entire surface has significant flaws, either the thrust bearing is defective or the end clearance adjustment is poor.

   If oil compression has been caused during the operation, carefully and thoroughly check the area of the discharge port in particular. If the continued use is in doubt at all, perform the penetrant testing (color check) to determine if it can be used or not.

c) With the unloader slide valve mounted in position, check the step height between the slide valve and the main rotor casing surfaces. Usually, the surface of the slide valve should be lower than the surface of the main rotor casing.

   If the top surface of the slide valve has a trace of hitting the rotor, the probable cause is that the slide valve is worn or the rotor shaft/bearing is worn. Please contact our sales offices or service centers.

d) Check the properness of the slotted guide pin [68-2] at the tip of the unloader push rod [67-2] that engages with the indicator cam [77-2].

## 5.4.16 Low-stage Bearing Head and Main Bearings

### 5.4.16.1 Disassembly

a) Unscrew and remove all the hexagon socket head cap screws [2-1].
b) Drive in the alignment pins [3-1] from the bearing head side to the main rotor casing side.
c) Use the jacking screw holes on the flange to separate the bearing head and the main rotor casing.
d) Separate them carefully along the shaft axis, as the unloader push rod [67-1] is engaged.
e) The main bearing [27-1] can be easily pulled out by removing the snap ring [29-1] and then lightly tapping it from the rotor side via a pad. Otherwise, use a special tool to pull it out.
f) Remove the slide valve as an assembly, using the same procedure as for the high-stage unit. Carefully perform the work, as you are handling a heavy object.

**Photo 052 Removing the Snap Ring Internal**

**Photo 053 Removing the Slide Valve Assembly**

### 5.4.16.2 Inspection

The inspection must be performed similarly to the case of the high-stage.

# 5.5 Reassembly

**CAUTION**

- **During the reassembly work, be very careful in selecting the correct replacement O-rings of the specified standard, not to make a mistake regarding the size, material, for fixed use, for sliding use, etc. Using a wrong O-ring can lead to oil leak or other problems.**
- **Some gaskets are not symmetrically shaped. In such a case, be careful not to misplace the gasket. If the gasket is misplaced, it can lead to a significant problem such as blocking any oil supply route on the casing.**

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

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

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

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

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

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

Because the assembly procedure is mostly similar between the high-stage and low-stage sides, the following sections provide explanations that are commonly used for both stages. For this purpose, the part number given in the common explanations will omit the distinction between high-stage and low-stage by means of a hyphenated suffix (the suffix of [**-1] for low-stage and [**-2] for high-stage part number will be omitted).

Please fully understand the details in this Section 5.5 for correct assembly work.

**Table 5-7 Tightening Torques for Hexagon Socket Head Cap Screws**

| Torque unit | 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 |

When fastening the hexagon socket head cap screws, use the tightening torque specified in the above table.

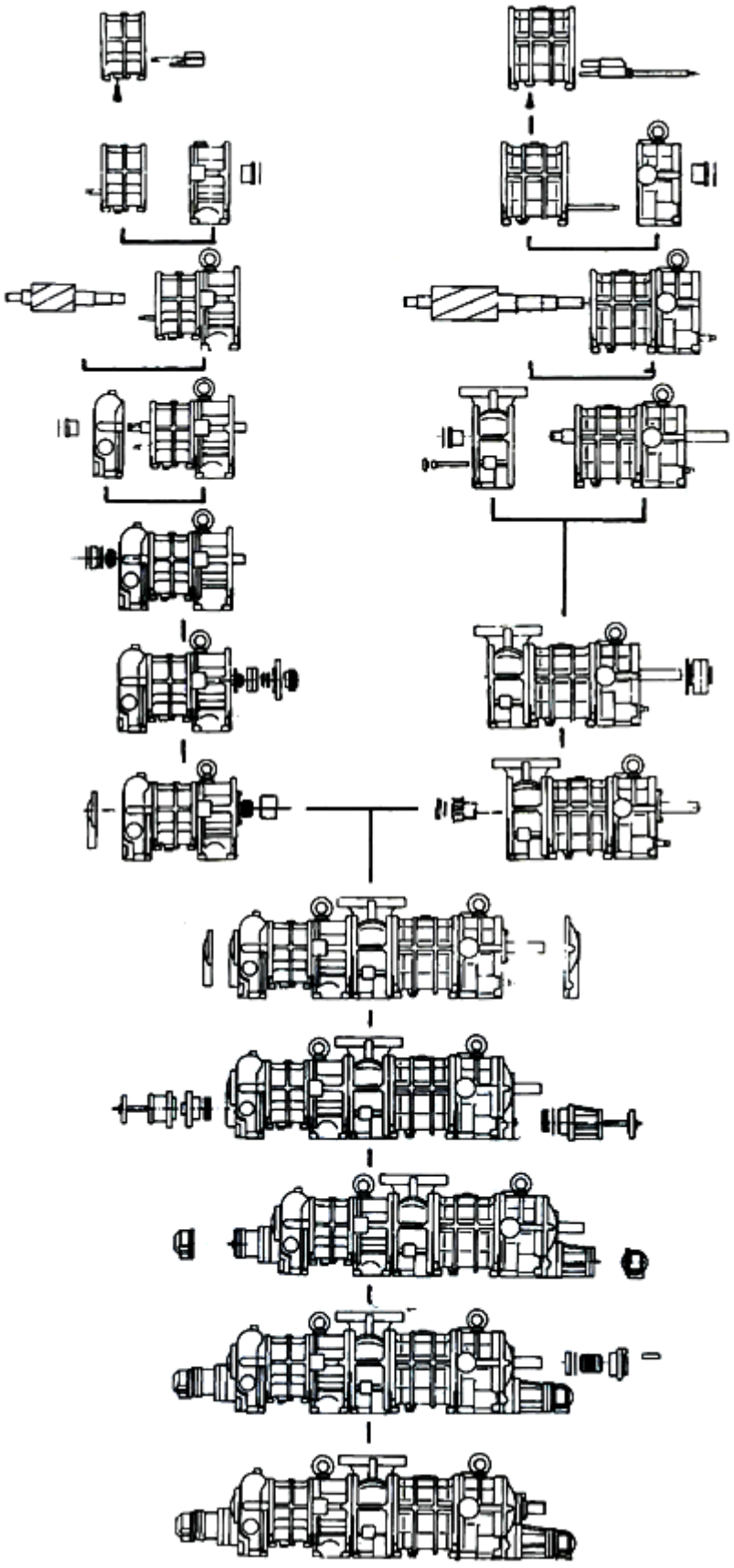


**Figure 5-13 Illustration of the Assembly Sequence (Example)**

## 5.5.1 Unloader Slide Valve and Guide Block

a) Attach two O-rings [89] on the guide block stem [88] and screw in the guide block stem securely from the bottom of the casing. Then, mount the guide block [87] in the casing.

b) If the slide valve assembly has been disassembled, first make sure that the alignment position between the slide valves [54] and [55] is accurately reproduced and then tighten the hexagon socket head cap screws [58] with spring washers [267] at the specified torque. The outer diameter of the spring washers used here is less than normal spring washers for hexagon socket head cap screws. So, be careful not to mix up with other washers.

c) After using a grind stone or fine sand paper to lightly finish the circumference of the assembly, mount the assembly in the main rotor casing. Then, slowly push-in the push rod while aligning the groove of the slide valve with the guide block.

d) After it is assembled, hold the unloader push rod and move it for several times to check that it moves smoothly. Then, carefully check the joint with the main rotor casing that there is no step between them.
If there is a step, check it by reversing the orientation of the guide block first. If the step is still present, it should be due to imperfect assembling, and it must be reassembled.

- ◆ A slight step between the surfaces of the unloader slide valve and the main rotor casing is allowed if the slide valve side is lower.

**CAUTION**

- **If the step is such that the surface of the unloader slide valve is higher than the surface of the main rotor casing, it is considered the problem of assembly. In such a case, it must not be left uncorrected. Be sure to reassemble it. Otherwise, the periphery of the rotor can make contact with the slide valve, resulting in a severe damage.**

e) The low-stage slide valve assembly has an oil injection pipe guide [168] on the opposite side of the push rod. Do not forget to install the O-ring [59] (Photo 055).

**Photo 054 Installing the Slide Valve (low-stage)**

**Photo 055 O-ring for the Oil Injection Pipe Guide**

## 5.5.2 Bearing Head and Main Bearings

The main bearing (O-ring type) [27] is installed by a light press fit.

a) Align the notch on the main bearing with the spring pin [14] that is driven in into the bearing head [11], and then push it in with a pad. For the alignment, it is convenient to use a tool such as a guide bar.

b) After the bearing has been inserted, install the snap ring [29] to retain the bearing in position (Photo 056). Securely install the snap ring to be fully seated in the ring groove, by pushing the snap ring with a guide bar or the like, or by lightly hitting the guide bar with a hammer while placing the guide bar on the snap ring.

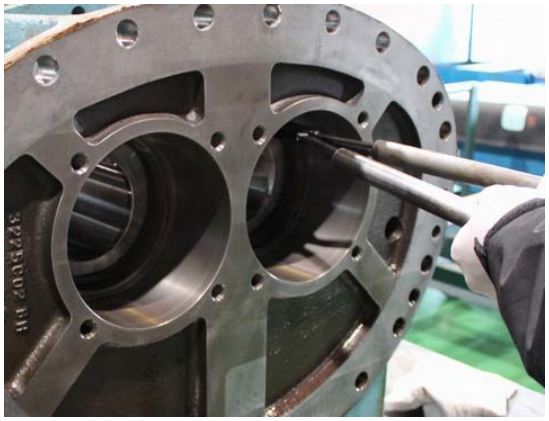


**Photo 056 High-stage Bearing Head**

**Photo 057 Low-stage Bearing Head**

c) On the low-stage bearing head [11-1], install the O-ring [197] in the part where the push rod passes through. Then, use hexagon socket head cap screws [166-1] to install the O-ring gland [326-1].

【POINT】

When press fitting the bearing, it is recommended to prepare a collared plastic cylinder (spacer) that exactly fits inside the inner diameter of the bearing and also a collared weight that fits inside the plastic cylinder as shown in Figure 5-14. Then, hit the top of the weight for easy press fitting of the bearing. Instead of the above, special tools are also available from us for the high-stage and low-stage main and side bearings. These tools are similar to the above described weight, and the surface finish of which is improved to eliminate the need of a plastic spacer (Refer to Chapter 7, Section 7.5). You are welcome to place an order if necessary.

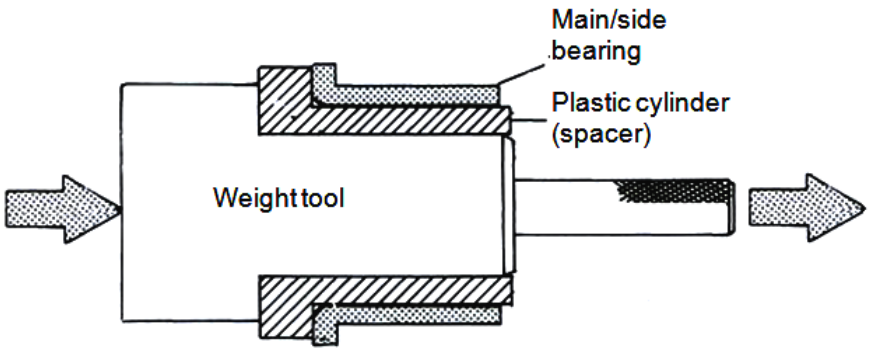



**Figure 5-14 Example Tool for Press Fitting the Bearing**

## 5.5.3 Bearing Head and Main Rotor Casing

**CAUTION**

- **Since the bearing head gasket [12] is not symmetrically shaped, carefully check the orientation when installing the gasket.**
- **If you place the bearing head gasket by just hanging it on the stud bolts, the gasket will protrude into the inside of the rotor casing when the casing is assembled. Apply sufficient amount of oil, etc. to the gasket to make it fully attached to the surface to prevent protruding upon the assembly.**

a) In case of the low-stage, after fitting the unloader push rod [67-1] into the hole of the bearing head [11-1], slide either the bearing head or the main rotor casing [1-1] to mate them together.

b) Lightly fastening two bolts [2] in symmetrical position. Next, drive in the alignment pins [3] to fix the position by using a copper or an aluminum hammer.

c) After tightening the bolts [2], check that the bearing head gasket is not protruding into the inside of the casing.

d) Also, move the slide valve back and forth to check that it works normally.

e) As the full height of the high-stage main rotor casing is lower than that of the bearing head, both centers will not be aligned when they are placed on the work bench. Therefore, either use a pedestal as used in the disassembly process or lift the rotor casing using a crane or other device to align the centers.

   The assembly procedure after mating the both casing flanges is same as the high-stage.

f) The bottom bolts that cannot be fastened on the work bench are to be fastened later on.

Photo 058 Low-stage Rotor Casing and Bearing Head

**CAUTION**

- **Be sure to check for possible protrusion of the gasket after the bearing head and rotor casing have been assembled together. If you forget to check it out, it may lead to a measurement error in the end clearance adjustment process, as the gasket may be placed in between the rotor end and the bearing head surface. Furthermore, if the compressor is operated after the end clearance is erroneously adjusted and fixed in this condition, it may compromise the performance.**

## 5.5.4 Installing the Rotors

**Note on the rotor profile of 3225**C**

The rotor profile has been changed from the A profile to O profile from the production in November 1993. The biggest difference is the existence of lobe tip edge, as the A profile with lobe tip edge has been changed to the O profile, which has no lobe tip edge.

The rotor must be sufficiently reworked. If any slight flaw is observed on the shaft surface in the area of attaching the bearing or seal, use a sand paper to correct and finish the surface. After finishing the surface to attach the seal, apply protective tape on the surface.

Both the M rotor and F rotor have a specific engagement position, and the position is marked by carving.
In order to make it easier to match the positions when the rotor is installed into the main rotor casing, a number is marked on the lobe tip: the M rotor has the marking on the discharge side, and the F rotor has the marking on the suction side.

**Photo 059 Mating Mark on the M Rotor**

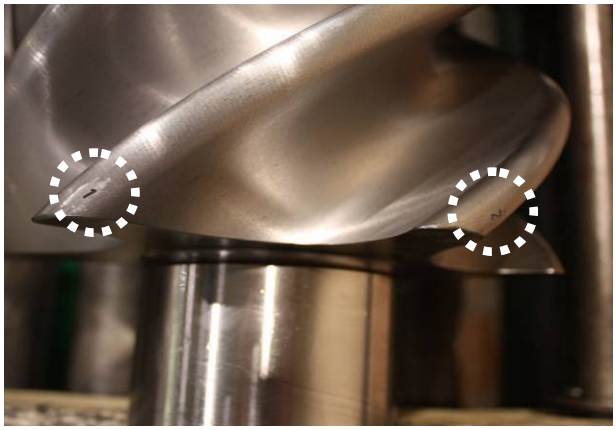


**Photo 060 Mating Mark on the F Rotor**

a) Apply sufficient amount of lubricating oil on the main bearing in the bearing head and on the bearing area of the rotor shaft.
b) While it is easier to mate the markings if the F rotor is first installed into the casing, it is not a mistake to install the M rotor first, as shown in the photo to the right.
c) Regardless of which rotor is installed first, the lobe of the M rotor with the carved marking of "1" must be set in between the F rotor's lobes that are marked "1" and "2". As it affects smooth engagement of the lobes as well as the balance, be sure to mate the markings as described above.

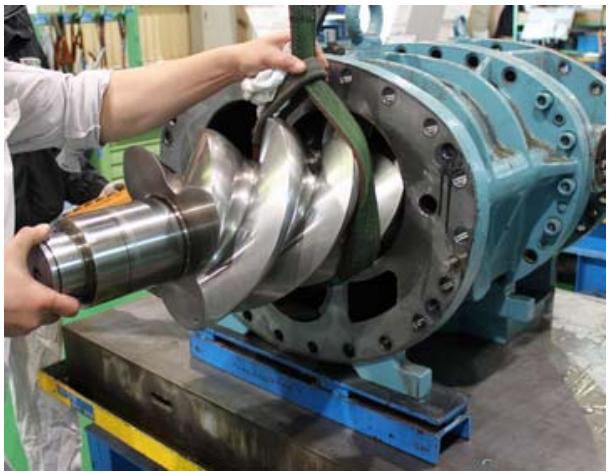


**Photo 061 Installing the M Rotor**

**CAUTION**

- **As the circumference of the rotor is touching the main rotor casing in this condition, any rotation of the rotor should be kept to the minimum required. Otherwise, the lobes tip of the rotor may be worn.**

## 5.5.5 Suction Cover and Side Bearings

a) Similarly to the main bearing, the side bearing (O-ring type) [28] is machined to the size that will allow light press fitting to the suction cover.
Press fit the bearing by aligning the notch position of the bearing with the spring pin [8] for positioning the bearing driven-in on the suction cover. During the press fitting process, check that the notch position of the bearing is at the pin position. If the position has been shifted, pull out the bearing and try the press fitting process again.

b) After the bearing has been installed, install the snap ring [29] to retain the bearing. Make sure that the snap ring is fully seated in the ring groove either by pushing the ring with a guide bar or tapping the head of the guide bar while applying the bar on the ring.

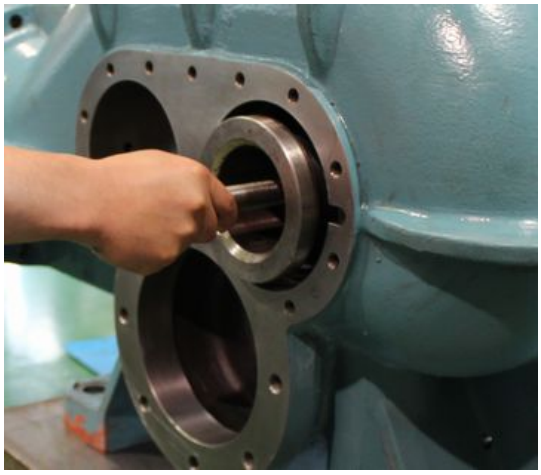


**Photo 062 Installing the High-stage Side Bearing**

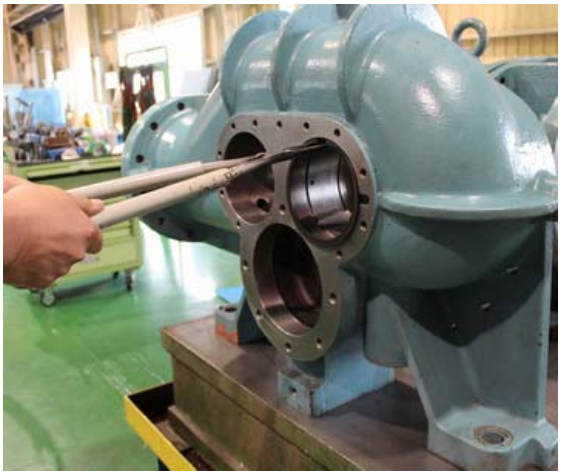


**Photo 063 Installing the High-stage Snap Ring**

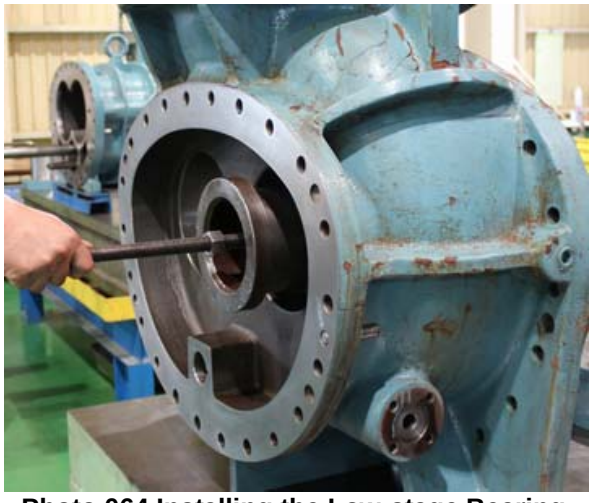


**Photo 064 Installing the Low-stage Bearing**

**Photo 065 Installing the Low-stage Snap Ring**

## 5.5.6 Balance Piston Sleeve

The high-stage suction cover shall be further installed with the balance piston sleeve.

a) First install the snap ring for the O-ring retainer [37], and then install the spacer [36].

b) After setting the O-ring [35] in position, install the balance piston sleeve [33].
Insert the chamfered side of the balance piston sleeve towards the O-ring already placed. Also, align the notch of the balance piston sleeve to the rotation stop/oil supply port.

**Photo 066 Installing the O-ring**

**Photo 067 Installing the Balance Piston Sleeve**

c) Attach the set screw [34] for the balance piston sleeve detent, and attach a remaining set screw from the opposite side (F rotor side) to secure the set screw which is attached earlier.

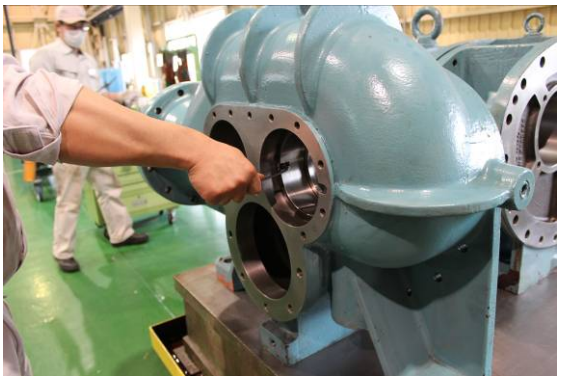


**Photo 068 The Balance Piston Sleeve Detent**

d) Insert the snap ring [37] to retain the balance piston sleeve. As it should be difficult to fit the snap ring into the groove due to the elastic force of the O-ring, either push the side of the ring by a guide bar or tap the head of the guide bar to fit the ring securely into the groove.

e) Install the O-ring [73] on the unloader push rod (Photo 069).

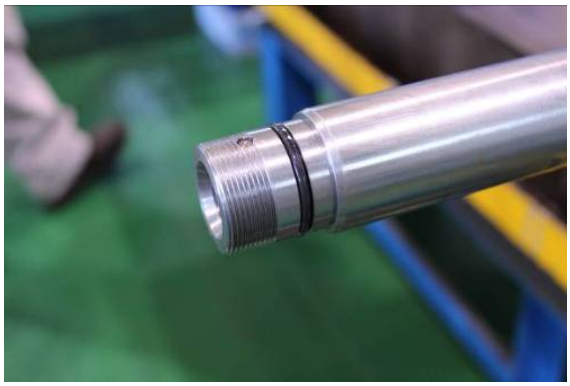


**Photo 069**

## 5.5.7 Installing the Suction Cover

a) The gasket of the suction cover [6] is not symmetrically shaped, both for the high-stage and low-stage.
Apply oil on both sides of the gasket, and attach it to the main rotor casing side while carefully checking the position of oil supply holes.

**Photo 070 (High-stage)**

**Photo 071 (Low-stage)**

b) On the high-stage side, pass the unloader push rod through the hole at the bottom of the suction cover.
Slide (or use a lifting device to move) the suction cover in parallel along the shaft axis to engage the rotor shafts with the side bearings. At this time, be careful not to damage the inside surface of the side bearing by the shaft end.
As the low-stage unloader push rod is out to the bearing head side, be careful only with the rotor shaft end in this work.

**Photo 072 (High-stage)**

**Photo 073 (Low-stage)**

c) After the suction cover has been pushed in up to the flange surface, lightly fasten some of the bolts [2].

d) Using a copper hammer or an aluminum hammer, drive in the alignment pins [3].

**Photo 074 (High-stage)**

**Photo 075 (Low-stage)**

e) Tighten the hexagon socket head cap screws evenly up to the specified tightening torque. The bolts on the bottom side (about 6 bolts) are to be tightened during the final assembly stage, on the special stand used in the disassembly process.

f) For both the high-stage and low-stage blocks, move the unloader push rod back and force by hand to check that it is working normally.

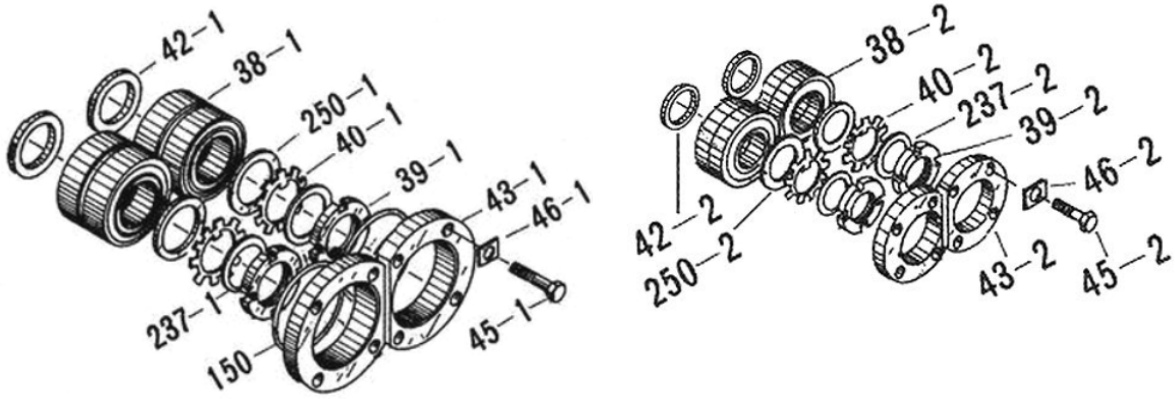
g) Hold and rotate the M rotor shaft to check if it works normally.
In addition, check that the rotor has an axial play (i.e., the rotor can move in the axial direction).

h) On the low-stage, push in the oil injection pipe [85] installed with the O-ring [86] to the suction cover (Photo 076). Then, install the oil injection pipe gland [164] installed with the O-ring [165].

**Photo 076**

**Photo 077**

## 5.5.8 Thrust Bearing Block




**(Low-stage)** **(High-stage)**

**Figure 5-15 Thrust Bearing Block**

**Table 5-8 Components of the thrust bearing block**

| P/N | Part Name | Q'ty | |
|---|---|---|---|
| | | Low-stage | High-stage |
| 42-1, 42-2 | Thrust bearing alignment spacer (1), (2) | 2 | 2 |
| 38-1, 38-2 | Thrust bearing (1), (2) | 2 | 2 |
| 250-1, 250-2 | Thrust washer (1), (2) | 2 | 2 |
| 40-1, 40-2 | Lock washer (1), (2) | 2 | 2 |
| 237-1, 237-2 | Torsional slip washer (1), (2) | 2 | 2 |
| 39-1, 39-2 | Lock nut (1), (2) | 2 | 2 |
| 150 | O-ring, JISB2401 G220 | 2 | - |
| 43-1, 43-2 | Thrust bearing gland (1), (2) | 2 | 2 |
| 46-1, 46-2 | Conical spring washer (1), (2) | 8 | 8 |
| 45-1, 45-2 | Hexagon head bolt (1), (2) | 8 | 8 |

**CAUTION**

- **The torsional slip washer [237] and lock washer [39] must be replaced with new ones.**
- **If the removed thrust bearing is to be installed as it is, check the marking of "M" or "F" on the thrust bearing alignment spacer and assemble it in the same combination as it was disassembled. This is important in controlling the end clearance on the discharge side of the rotor.**
- **Even if the same bearing is installed, the work must be very carefully done as the dimension can change if any foreign matter such as a chip of paint or dust is pinched by the alignment spacer.**
- **In determining the installation direction of the thrust bearing, there are two methods depending on the existence of an alignment "V" marking on the outer circumference of the bearing. Install the bearing according to the following procedure provided for each case.**

The assembly sequence for this block is as illustrated in Figure 5-15. The important points to be noted in the procedure are described below:

a) Check the marking of either "M" or "F" on the thrust bearing alignment spacer to ensure that the units are assembled in the same combination of parts.

   The front and back of the thrust alignment spacer must be distinguished when it is installed. The larger chamfering side is on the inner machine side, and the smaller chamfering side is on the thrust bearing side.

b) If thrust bearing has a "V" marking on the outer circumference, it means that the installation direction of the bearing will sensitively affect the end clearance adjustment. In this case, the bearing must be installed with the pointed end of the marking pointed toward the inside of the machine.
If there is no "V" marking, it means that the direction of the bearing installation will not affect the end clearance adjustment. However, in order to clearly determine the orientation (whether it is on the inside or outside of the machine), first combine both bearings with the bearing number carving facing the outside of the machine. Then, use a blue whetstone to write the above "V" marking on the bearing to show the inside direction of the machine. Then, install the bearing (Photo 078).

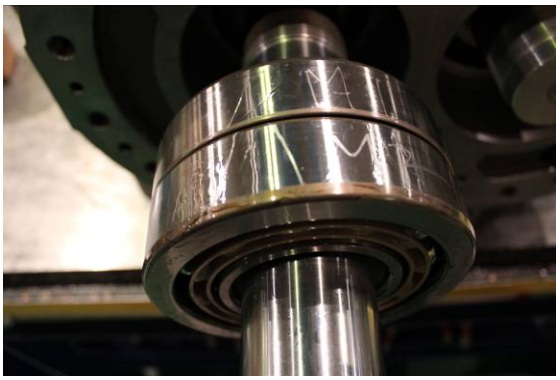


**Photo 078**

c) After the thrust bearing has been installed, attach the thrust washer, lock washer, and torsional slip washer. Then, tighten the lock nut at the specified torque or within the specified range of the tightening angle (refer to Chapter 7, Section 7.3 "Tightening Torques for Bolts and Nuts" in this manual) to secure the inner race of the thrust bearing on the rotor shaft.

**Photo 079 Tightening the High-stage Lock Nut**

**Photo 080 Tightening the Low-stage Lock Nut**

【POINT】

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

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

**CAUTION**

- **As clearance fit is used for the inner race of the thrust bearing, this tightening work is very important because the bearing is secured only by the tightening force of the lock nut.**

**CAUTION**

- **When the thrust bearing has been replaced, the dimensional difference between the sides of the inner race and outer race varies even if it is within the tolerance of the applicable standard specification.**
  **As such, if the thickness of the thrust bearing alignment spacer that has been used is insufficient, and if the lock nut is securely tightened from the first, the end clearance between the rotor shaft end and the end face of the discharge side bearing head will be lost. Furthermore, as the balls are pressed against the rolling contact surface to create impression on the surface, it will damage the bearing. To avoid this, gradually tighten the lock nut while rotating the rotor to make sure the outer race is free, until the lock nut is fully tightened. If it comes to require more force to turn the rotor while the lock nut is being tightened, the thickness of the spacer is considered insufficient.**

### 5.5.8.1 End Clearance Measurement

At this point (i.e., after the thrust bearing block has been fully assembled), measure the clearance between the bearing head end face and the rotor end face on the discharge side. This clearance is called as the end clearance.
In particular, this measurement must be made when the thrust bearing has been replaced. Even if the same bearing is used, the measurement should be made for verification.
If the measured clearance does not satisfy the range specified in Table 5-9, proper adjustment must be made.

**Table 5-9 Specified Range of End Clearance (unit: mm)**

| Model | Rotor profile | High-stage | Low-stage | | | |
|---|---|---|---|---|---|---|
| | | | S | M | L | LL |
| 3225**C | A | 0.06 to 0.08 | 0.70 to 0.76 | 0.73 to 0.79 | 0.77 to 0.83 | 0.81 to 0.87 |
| | O | 0.08 to 0.011 | | | | |

a) For pressing the rotor shaft on to the discharge side, hit the rotor shaft strongly from the suction side while putting a jig (Teflon block).

b) Prepare the thrust bearing gland to be readily mounted. Mount a dial gauge on the suction side axial end of the rotor, and set the indication needle to zero point while the rotor is fully pressed onto the discharge end face (Photos 081 and 082).

**Photo 081 (High-stage)**

**Photo 082 (Low-stage)**

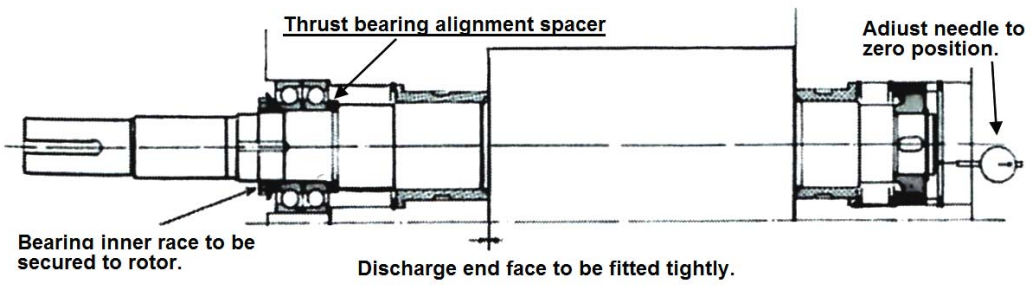



**Figure 5-16 End Clearance Measurement Preparation**

c) Without inserting the conical spring washer, tighten the four fastening bolts of the bearing gland sequentially and evenly up to the specified tightening torque (Photo 083). Tightening each bolt at once at the specified torque must be avoided because it will result in uneven tightening. So, repeat to sequentially tighten the bolts for several times.

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

**Table 5-10 Tightening Torques for the Thrust Bearing Gland**

| Compressor | | Tightening torque | |
|---|---|---|---|
| | | N·m | kgf cm |
| 3225**C | High-stage | 60 | 600 |
| | Low-stage | 120 | 1200 |

**Photo 083**

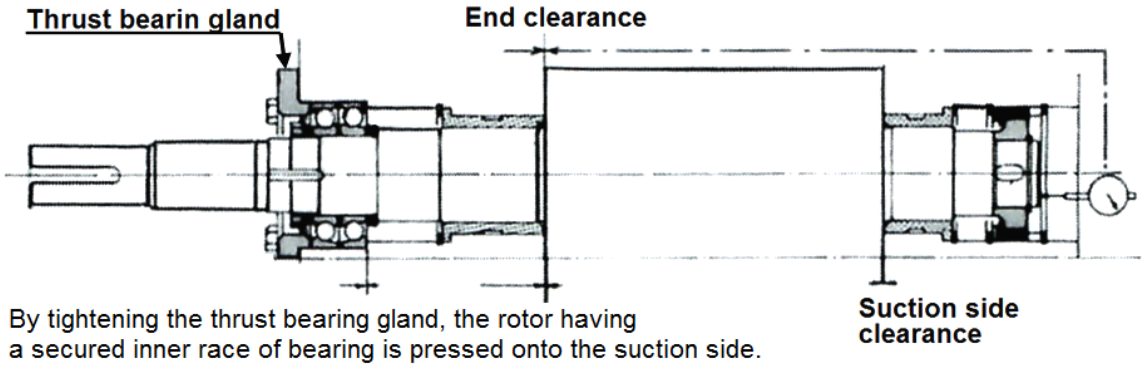



**Figure 5-17 Measurement of the End Clearance**

## 5.5.8.2 End Clearance Adjustment Procedure

(1) When the end clearance is less than the specified value
In this case, a shim (thrust adjustment liner) must be inserted between the thrust alignment spacer [42] and the inner race of the thrust bearing to increase the end clearance.
The thickness of the shim must be determined by the difference between the specified end clearance and the measured value.

◆ Although the thrust adjustment liner is not shown in the sectional view and development view, you can place an order to us indicating the model name.

(2) When the end clearance exceeds the specified value
If any shim (thrust adjustment liner) has been inserted between the thrust bearing alignment spacer and the inner race of the thrust bearing, and the thickness corresponds to the difference between the measured end clearance and the specified value, just remove the shim.

If no shim is used or the thickness of the shim is insufficient to compensate for the excess end clearance, use a surface-grinding machine (or ask a vendor) to make the thrust bearing alignment spacer [42] thinner by the amount of the end clearance difference between the measured and specified values. After the surface grinding is done, use a micrometer to measure the thickness of the spacer for the entire circumference to make sure the thickness is uniform.

(3) Measuring the run-out of the rotor shaft (low-stage M rotor)
If the end clearance adjustment has been successfully completed, then measure the run-out of the low-stage M rotor shaft using a dial gauge at the point of the mechanical seal attachment and turning the shaft by hand (Photo 084).


**Photo 084**

A run-out of up to 0.03 mm is acceptable for all models. The run-out occurs if the thickness of the thrust alignment spacer is not uniform or the marking on the thrust bearing is not properly positioned. And it occurs if fastening the lock nut performed without changing the position of the lock nut wrench (i.e., the uneven fastening of the lock nut). The run-out also becomes significant if any small foreign matter is present in between relevant parts.

If the run-out exceeds the allowable value, disassemble the unit again even if the end clearance is within the specified limits, and adjust the relative position of the alignment spacer and thrust bearing.

This adjustment is very important as any run-out affects the function and service life of the mechanical seal.

### 5.5.8.3 Tightening after Finishing the End Clearance Adjustment

a) Remove the thrust bearing glands [43-1] of the low-stage.

b) Attach the O-rings [150] to removed thrust bearing glands. Without inserting the conical spring washers in the same manner as in the case of the end clearance measurement/alignment, clearance, tighten the hexagon head bolts i n a diagonal sequence, a little at a time, and finally tighten them to the specified torque.

The procedures after this are same both low-stage and high-stage.

c) Remove one of the hexagon bolts fastening the thrust bearing gland [43], insert the conical spring washer [46], tighten the bolt at the specified torque, and repeat this procedure for all other hexagon head bolts.

d) Bend the tooth of the lock washer to set it in the notch of the lock nut fastening the inner race of the thrust bearing to prevent loosening (Photos 085 and 086). The these steps c) and d) may be performed in reverse order.

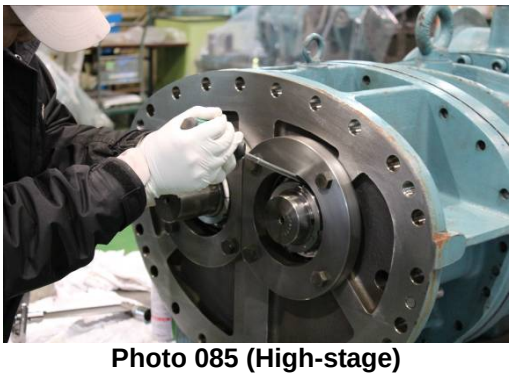


**Photo 085 (High-stage)**

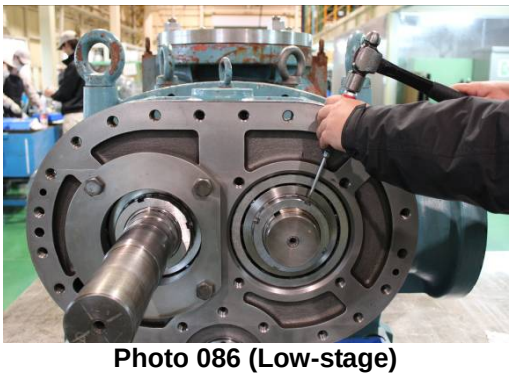


**Photo 086 (Low-stage)**

【POINT】

Conical spring washer has been adopted instead of the plate type lock washer from October, 2001. When using the conical spring washers for the compressors produced before this modification, the hexagon head bolt heads may interfere with the low-stage bearing cover inner face.
In case of overhauling the compressor produced before October, 2011, do not change the lock washer [46] to the conical spring washer.

### 5.5.8.4 Installing the Balance Piston

On the high-stage side, install the balance piston [30] (Photo 087).
Then, use the external snap ring pliers to install the snap ring [32], and fix it in position.
Check that the snap ring is fully seated in the groove.

**Photo 087**

## 5.5.9 Balance Piston Cover and High-stage Unloader Cylinder

a) Before installing the balance piston cover on the high-stage suction cover [5-2], install the O-ring [328] in the part of the high-stage suction cover where the push rod passes through. Then, use hexagon socket head cap screws [166-2] to install the O-ring gland [326-2].

b) Install the unload spacer (for 30% load) [420] on the high-stage push rod. In the case of 3225*LC, no unloader spacer is used (because the full length of the unloader cylinder has been reduced to make adjustment unnecessary).

**Photo 088 O-ring Gland**

c) In the case of 3225**C, as the high-stage side also has the unloader cylinder [60-2], the work will become easier if the unloader cylinder is first installed on the balance piston cover [22] and then the resulting assembly is installed on the high-stage suction cover [5-2].

d) Install the O-ring [63-2] in the O-ring groove on the machined surface of the balance piston cover along which the unloader cylinder is installed (Photo 089).

【POINT】

The mounting position of this O-ring has been changed in Oct. 1996 to the current position shown in Photo 089 from the previous chamfered part in the corner of the balance piston cover. The low-stage bearing cover was similarly changed at the same time.

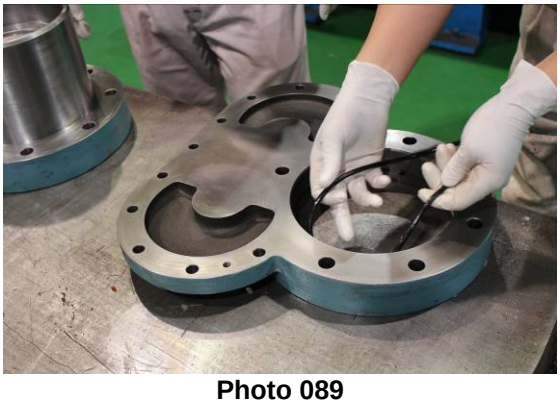


**Photo 089**

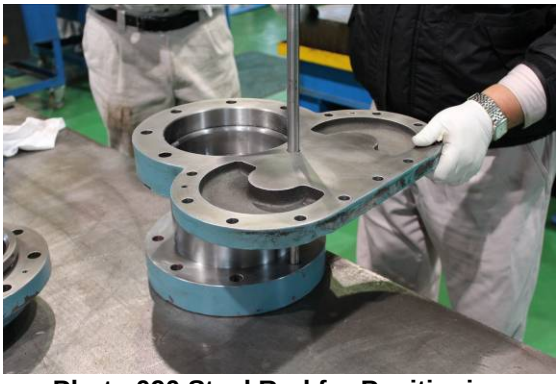


**Photo 090 Steel Rod for Positioning**

e) Align the position of the balance piston cover with the unloader cylinder. As shown in the above Photo 090, using a steel rod for positioning makes it easier to align the position of bolt holes.
As no gasket is used on the mating flange between the balance piston cover and unloader cylinder, evenly and thinly apply liquid gasket (made of special synthetic rubber) on the surface of the flange of the unloader cylinder inside from the center of the bolt holes.

f) As the O-ring of the balance piston cover is already installed, lightly tap the flange surface with a soft hammer to install it as shown in Photo 091.

g) When joining the flanges, also align the bolt hole positions if any positioning steel rod is not used. Then, insert two hexagon socket head cap screws [61] in the positions shown in Photos 092 and 093 to fasten the unloader cylinder to the balance piston cover.

**Photo 091**

**Photo 092**

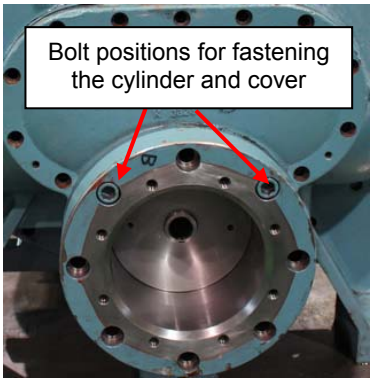



**Photo 093**

h) Install the O-ring [73-2] in the O-ring groove on the tip of the unloader push rod [67-2], at the position where the unloader piston is installed.

i) Attach the O-ring [65-2] without lubricating oil on the unloader piston [64-2], and then install the cap seal [66-2] on it. It can be smoothly installed by slightly folding the cap seal along the circumferential direction. Also, using a small and smooth spatula (Photo 094) will facilitate the assembling work.

j) Install the unloader piston fitted with the O-ring and cap seal in the unloader cylinder. One side of the unloader piston is with screw holes for eye bolts, while the other side does not have such holes. First, to make it easier to fit the cap seal on the unloader cylinder wall, lightly press one side of the piston onto the chamfered area of the unloader cylinder by hand, changing the side of the piston for several times. Finally, apply lubricating oil to the unloader cylinder, then, push and install the piston with the screw holes side of the piston facing the unloader cover. After the installation, check that the cap seal is not broken or pinched.

**Photo 094**

**Photo 095**

k) Push the unloader piston into the unloader cylinder and set it in the middle of the cylinder, pull the unloader push rod [67-2] toward you, and install the balance piston cover with the gasket fitted as shown in Photo 095 onto the high-stage suction cover (Photo 096). Pushing the piston into the push rod and temporarily fastening the lock nut [69-2] in the course of the work will make later work easier.

Photo 096

Photo 097

m) After joining the flanges together, tighten the hexagon socket head cap screws [24] of the balance piston cover at the specified torque of 90 N·m and tighten the hexagon socket head cap screws [62-2] of the unloader cylinder at the specified torque of 240 N·m.

n) Use the eye bolts to pull the piston toward you (Photo 098), once remove the temporarily fastened lock nut, install the lock washer [70-2] and lock nut [69-2], and then tighten the lock nut at the specified torque of 140 N·m. To prevent loosening, bend the tooth of the lock washer at the notch of the lock nut (Photo 100). Lastly, use the eye bolts to check the smooth movement of the piston (Photo 101).

Photo 098

Photo 099

Photo 100

Photo 101

## 5.5.10 Bearing Cover

a) Before installing the bearing cover [16], check that the teeth of the lock washer of the thrust bearing part have been properly bent to prevent rotation and that the hexagon head bolts fastening the thrust bearing gland are with conical spring washers.

b) For ensuring the safety, screw two stud bolts in the upper bolt holes on the flange of the low-stage bearing head [11-1].

c) After applying sufficient amount of oil, etc. on the flange surface of the bearing head as well as on both sides of the gasket (1) for the bearing cover [17-1], hang the gasket from the upper stud bolts and attach the gasket onto the flange surface (Photo 102).

**Photo 102**

**CAUTION**

- **The bearing cover gasket is not symmetric because there is a hole for lubricating oil line to the mechanical seal block in the left (seal) side.**
  **Be careful that do not mistake the direction of the gasket when attaching onto the bearing head flange surface. Mistaken the direction of the gasket causes the lubrication failure to the shaft seal block.**

**Photo 103**

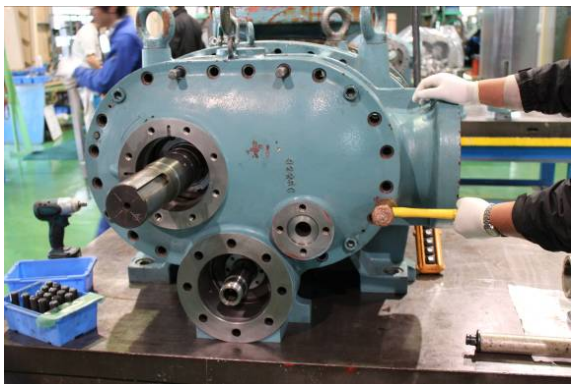


**Photo 104**

d) While lifting the bearing cover using a lifting hook on the eye bolt, install the bearing cover carefully not to make contact with the M rotor shaft or the push rod (Photo 103). Once the cover is on the stud bolts, the lifting hook may be removed.

e) After correctly setting the position of the alignment pins, lightly tap the flange at different places alternately using a copper hammer or soft hammer to install the cover in position (Photo 104).

f) When the cover has come to the position the bolts can be screwed in, screw in two or three hexagon socket head cap screws [18-1] and evenly tighten them to reduce the clearance and make the cover contact the body. Then, tighten all the bolts at the specified torque of 450 N·m.

## 5.5.11 Shaft Seal Block

The standard mechanical seal assemblies used in the current shaft seal of MYCOM standard screw compressors are of the BBSE (balance bellows single) type. There are other cases where the BOS (balance O-ring single) type seals are used, according to the specification by the customer.

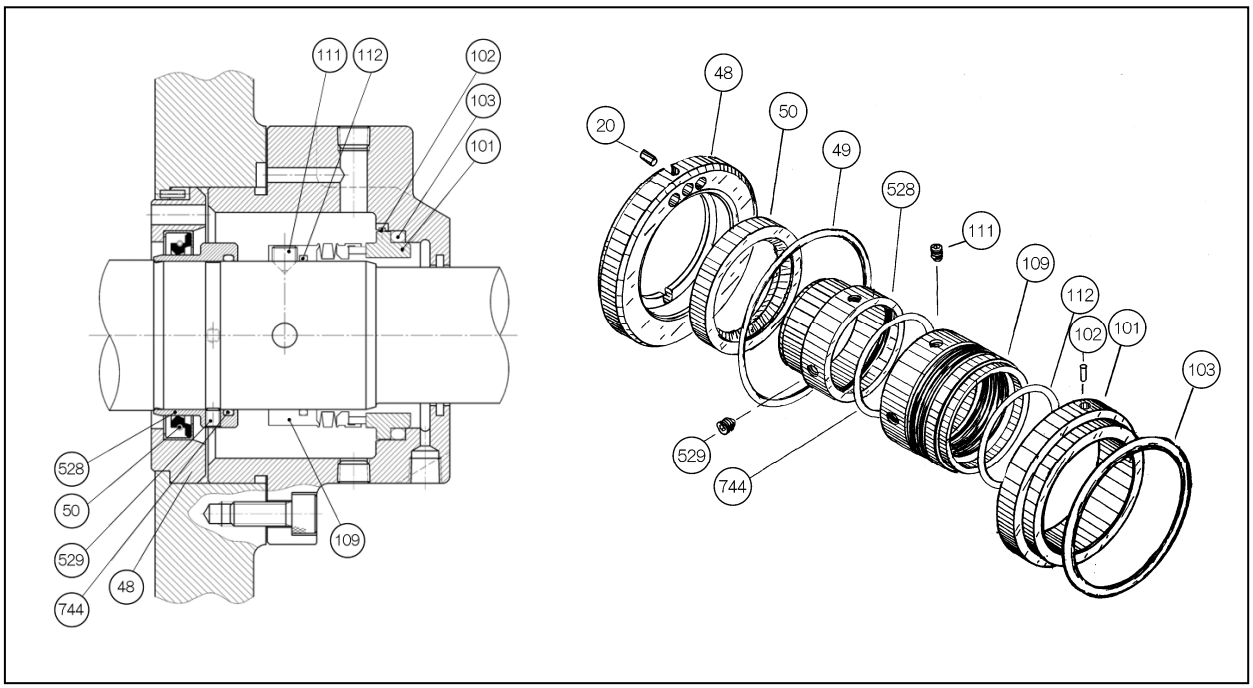



**Figure 5-18 BBSE-type Mechanical Seal**

a) Before installing the mechanical seal, clean the seal installation area on the rotor shaft. In particular, immediately prior to the assembly, check again that no flaw is present on the step area of the shaft where the seal is to be installed.

b) Install the oil seal [50] on the seal retainer [48]. The installation orientation of the oil seal has been reversed in November 2002 as a design change. While the oil seal had been installed with the oil seal lip facing the direction of the atmosphere, the direction was reversed. This is because excessively high pressure should be avoided by helping the escape of oil from the seal box.
Using a Teflon block or the like as a pad (Photo 105), lightly hit the pad to push the oil seal evenly into the retainer until it is fully seated. Once the oil seal is fully inserted, you can easily sense it as the hitting sound as well as the response will change.
After the installation, check that the level difference with the retainer is uniform and that the oil seal is evenly inserted by observing the condition from the opposite side.

c) Insert the O-ring [744] into the inner circumference of the oil seal sleeve [528], and install the sleeve into the oil seal retainer with an O-ring inserted as shown in Photo 106.

**Photo 105**

**Photo 106**

d) Install the oil seal retainer with the oil seal and sleeve along the rotor shaft using two M8 eye bolts as shown in Photo 107. At this time, position the oil escape hole of the retainer on the upper side of the rotor shaft, and accurately align the notch in the retainer with the position of the spring pin [20] that is driven in into the bearing cover to prevent its rotation.
After the installation, check the position by slightly turning the retainer to the left and the right using the eye bolts. If the position is correct, the retainer will not rotate.

e) Secure the oil seal sleeve using two set screws [529] on the rotor shaft (Photo 108).

**Photo 107**

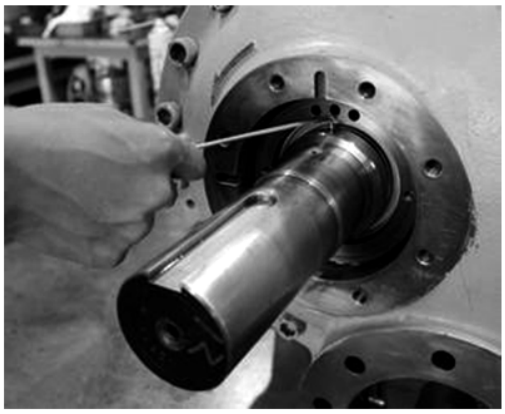


**Photo 108**

f) Then, insert the O-ring for the seal retainer [49] (Photo 109).

| CAUTION |
| --- |
| ● **You should be particularly careful on this point, as the O-ring for the oil seal retainer [49] is often forgotten to be installed.** |

g) Insert the O-ring [112] on the inner circumference of the seal collar [109], and install the seal collar on the rotor shaft. Before the assembly, apply sufficient lubricating oil onto the rotor shaft and wash out dust and stains. Push in the seal collar carefully not to damage the O-ring [112] by the step on the rotor shaft (Photo 110). After installing the seal collar, push it by hand and check it's normal movement in the axial direction.

h) Fasten the seal collar on the rotor shaft by screwing the two seal collar set screws [111] at the countersinks on the rotor shaft (Photo 111). Failing to fasten the screws at the countersink positions will damage the rotor shaft, and it can cause a leakage.

**Photo 109**

**Photo 110**

**Photo 111**

i) Install the O-ring [103] for the mating ring and the mating ring [101] on the seal cover [51]. (Photo 112)

j) Apply oil on the seal cover gasket [52] and attach it to the seal cover flange by carefully aligning the oil hole position on the gasket and the one on the flange.

- ◆ In the case of the standard internal oil supply system, oil is first sent from the bearing cover to the seal cover through the oil supply hole machined on them, then from the notch in the seal cover to the upper part of the seal cover through a groove, and lastly supplied from the oil supply hole in the seal cover to the upper part of the sliding surface of the mechanical seal.

k) Install the seal cover with the gasket such that the oil drop tube comes to the bottom side.
At this time, carefully install the seal cover not to hit the mating ring in the seal cover with the rotor shaft. For this, hold the seal cover at the right angle to the rotor shaft or only slightly incline it such that the top side follows the bottom side.

m) At a midway point, the sliding surface of the seal ring comes in contact with that of the mating ring. At this point, use a taper gauge (Photo 113) to check the clearance between the surfaces of the seal cover gasket and the bearing cover flange. This clearance is called "fastening margin" of the seal, and is used as a guideline in determining the sliding surface pressure between the rotating ring and stationary ring of the seal. In case of the BBSE type seals for 3225**C, make sure that this value is in the range of 3.5 to 4.5 mm.

**Photo 112**

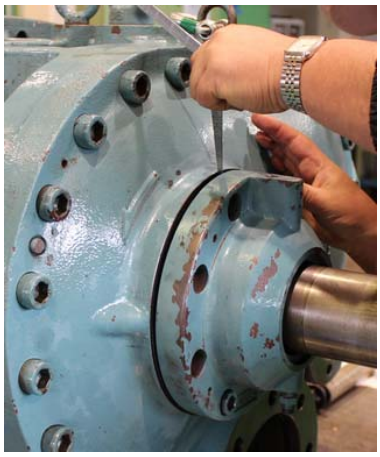


**Photo 113**

n) If it is confirmed that the fastening margin of the seal is appropriate, firmly press the seal cover onto the bearing cover. While you will feel the reaction of the seal bellows, keep pressing the cover and fasten two hexagon socket head cap screws [53] evenly to secure the seal cover at opposite positions separated by 180°. When there is no clearance between the surface of the flange and gasket, fasten all other bolts at the specified torque of 240 N·m.

o) After fastening the seal cover, remove the plug on the top of the seal cover, and supply oil approx. 600 mL into the seal cover while rotating the rotor shaft (Photo 114).

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

After the refilling work, make sure to attach the removed plug on the seal cover.

**Photo 114**

## 5.5.12 Low-stage Unloader Cylinder

The installation of the low-stage unloader cylinder may be done either after the bearing cover installation described in Section 5.5.10 or after the installation of the mechanical seal.

a) Check that the O-ring [73-1] is inserted in the O-ring groove on the tip of the unloader push rod [67-1], at the position where the unloader piston is installed.
b) Install the O-ring [65-1] and cap seal [66-1] on the unloader piston [64-1].
c) Install the unloader piston fitted with the O-ring and cap seal in the unloader cylinder [60-1]. The work procedure is the same as that for the high-stage side as described in Section 5.5.9, item j).
d) Insert the O-ring [63-1] in the O-ring groove on the part of the bearing cover [16] in which the unloader cylinder is installed (Photo 115).
   ◆ The assembly method of this O-ring [63-1] has been changed in the design change dated Oct. 29, 1996. While the O-ring is inserted to the triangular part on the flange surface of the bearing cover that makes contact with the unloader cylinder in the previous method, the O-ring is inserted in the O-ring groove in the current method.
e) Install the unloader cylinder in the bearing cover (Photo 116), and fasten the eight hexagon socket head cap screws [62-1] at the specified tightening torque of 450 N·m.

**Photo 115**

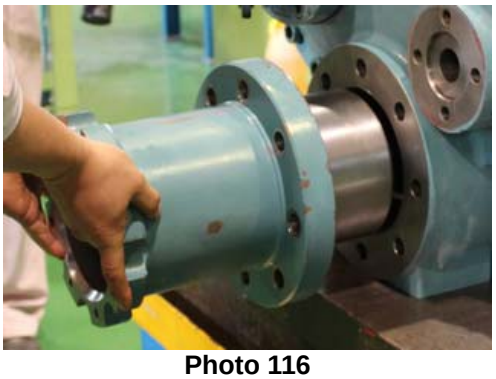


**Photo 116**

f) Set the lock washer [70-1] and lock nut [69-1] on the unloader push rod, and fasten the lock nut at the specified torque of 180 N·m.
   At this point, in the case of 3225M*C, be careful not to excessively pull the unloader piston toward you as it is explained in the caution in the next section.
   To prevent loosening, bend the tooth of the lock washer on the tightening side at the notch of the lock nut (Photo 117). Lastly, use the eye bolts to check the movement of the unloader piston (Photo 118).

**Photo 117**

**Photo 118**

## 5.5.13 Unloader Cover

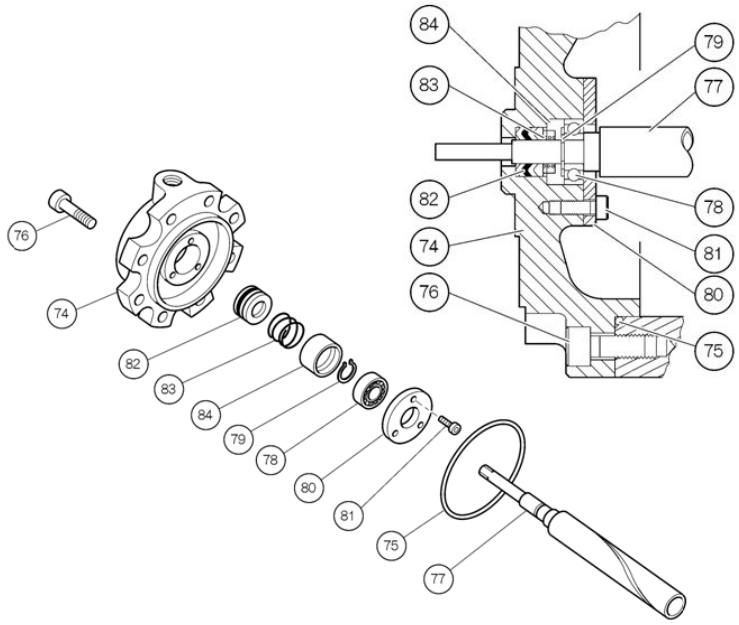



Figure 5-19 Unloader Cover Block

Photo 119 Installing High-stage Unloader Cover

Photo 120 Inserting Spacer

a) Use eye bolts to move the unloader piston back and forth to check the normal operation again. In doing this, be careful not to pull the unloader piston up to the extreme position.

**CAUTION**

- **You should be careful because if the low-stage unloader piston is pulled beyond a limit, the slide valve may be disengaged from the guide block in some models (3225M*C).**

b) To prevent disengagement of the slide valve from the guide block on the 3325M*C models, the spacer [423], of which outer circumference has O-ring [431] inserted, must be installed in the low-stage unloader cylinder beforehand. (Photo 120)

c) Assemble the ball bearing [78] on the shaft portion of the indicator cam [77]. When fitting the bearing onto the shaft, push the inner race of the bearing. Pushing the outer race may damage the bearing. Push the bearing to the stepped portion of the indicator cam and retain the bearing with the external snap ring.

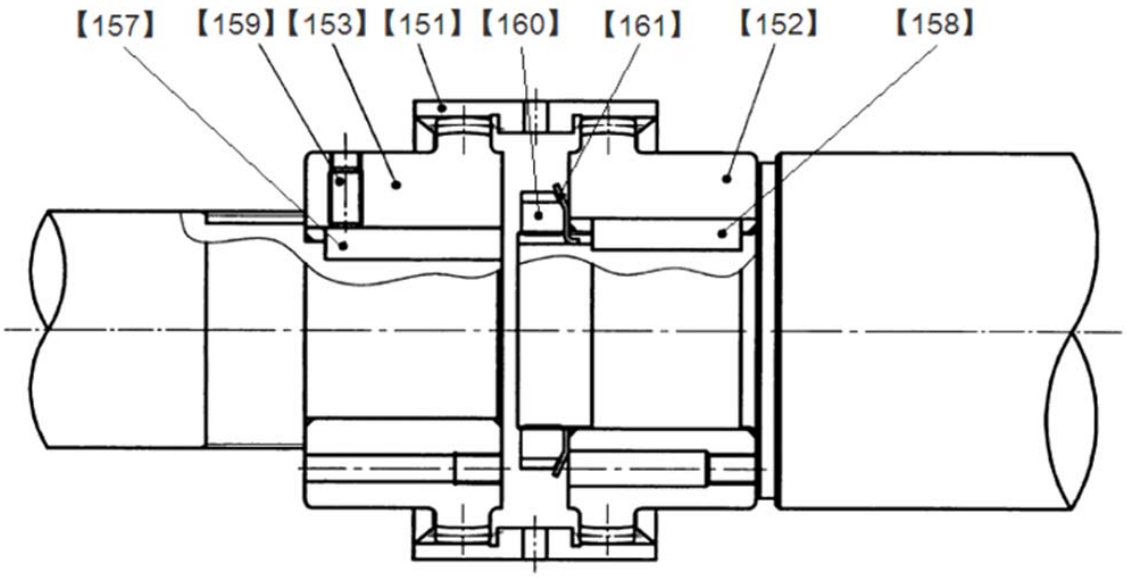
d) Sufficiently apply oil on the unloader cover [74], and install the V-ring set [82] in it. One of the rings of the V-ring set (i.e., dark colored one) is made of rubber to improve the sealing performance, and is placed as the second item from the outside as shown in Fig. 5-19. The orientation of the V-ring must be such that the apex of the V-shape faces the outside and the lips face inside.

e) Install the spring [83] and the spring retainer [84] into position. Then, insert the shaft of the indicator cam assembled in Step b) above into the V-ring. Lastly, fasten the bearing gland [80] onto the unloader cover to retain the bearing.

f) After making sure that the indicator cam rotates smoothly, attach the O-ring [75] to the unloader cover.

g) Install the unloader cover on the unloader cylinder [60]. Making sure that the guide pin [68] of the unloader push rod [67] is well engaged in the spiral groove of the indicator cylindrical cam, push-in the unloader cover. With the oil supply hole for the unloader operation up, secure the unloader cover by fastening the hexagon socket head cap screws [76] at the specified torque (90 N·m for both high-stage and low-stage).

## 5.5.14 Coupling the High-stage and Low-stage Blocks




| | | | |
|---|---|---|---|
| 【157】 | Driven hub key | 【160】 | Locknut |
| 【159】 | Self-locking knurled hexagon socket set screw | 【161】 | Lock washer |
| 【153】 | Driven hub | 【152】 | Drive hub |
| 【151】 | Drive sleeve | 【158】 | Drive hub key |

**Figure 5-20 Gear Coupling Block**

a) Attach the driven hub [153] of the gear coupling on the high-stage side, and fasten the M12 hexagon socket set screw [159] to hold the driven hub key [157].

   This hexagon socket 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. Tighten the lock nut at the specified torque or within the specified range of the tightening angle (refer to Chapter 7, Section 7.3 "Tightening Torques for Bolts and Nuts" in this manual). Then, bend the tooth of the lock washer at the notch of the lock nut.

c) Set the drive sleeve on the low-stage drive hub.

d) Screw in two stud bolts into two of the upper bolt holes in the low-stage flange.

e) After applying sufficient amount of oil, etc. on both sides of the bearing cover gasket (2) [17-2], hang the gasket from the upper stud bolts and correctly attach the gasket onto the flange surface.

f) After slightly lifting up the high-stage block from the surface table using a lifting device, slowly move the block to approach the low-stage side.

   At this time, the gear coupling can be engaged smoothly if the M rotor shaft on the low-stage side is rotated clockwise and counterclockwise alternately for a small amount (Photo 121).

**Photo 121**

g) Once the gear coupling has been successfully engaged, push the high-stage unit onto the low-stage unit along the rotor shaft axis. Then, insert 4 to 6 hexagon socket head cap screws [18-2] into the bolt holes, while avoiding the bolt holes that are adjacent to the left and right alignment pins, and temporarily fasten them evenly to eliminate the clearance between the low-stage and high-stage flanges.

h) After the flange surfaces have contacted, slightly loosen the bolts that have been temporarily fastened. Then, drive in the left and right alignment pins [19-2] (Photo 122).

i) Rotate the low-stage M rotor using a special tool or something to check that no abnormality is found.

**Photo 122**

**Photo 123**

j) Tighten the hexagon socket head cap screws at the specified torque of 450 N·m (Photo 123). The lower bolts must be tightened with the compressor placed on a special stand as in the case of disassembly (Photos 124 and 125). Do not forget to attach bottom drain plugs while the compressor is placed on the special stand.

**Photo 124**

**Photo 125**

## 5.5.15 Unloader Indicator

The unloader indicator contains micro-switches, a micro-switch cam, and a potentiometer. These parts are used to detect the change in the rotation angle of the indicator cam shaft, which converts the axial position change of the unloader slide valve into rotational position change, convert the change into an electric signal, and send the signal to the package unit and/or the controller of the refrigeration system.

To check the unloader indicator after inspection, adjustment, or parts replacement, coordination with the controller side will be required. Even in a case where the compressor is carried out of the installation site for overhaul, the indicator assembly is often removed from the compressor (to be kept at the site) and the inspection/adjustment and parts replacement are performed at the site. Thus, this section provides a detailed procedure, which may be helpful after the reassembly work.

**WARNING**

- **When removing the indicator block or performing inspection/adjustment or parts replacement, be sure to shut down the control power and use lock-out and tag-out procedures. If the power is not shut down, there is a risk of electric shock.**

The high-stage side of 3225**C is implemented with an indicator assembly that is identical to the one used in a standard single stage machine (except that the dial and micro-switch cam for the 3225*MC and the 3225*SC are special to the high-stage of the 3225*M/SC types, for the range of 30 to 100 %). The low-stage side of 3225**C is implemented with an indicator assembly that is identical to the one used in 1612**C, specially designed for the low-stage use, with the addition of a bevel gear to convert the axial direction to the lateral direction, for the indicator and dial.

### 5.5.15.1 Potentiometer

The potentiometer of the standard-type indicator is a rotary instrument for measurement over a full turn. 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.

While the expected service life of the potentiometer will significantly vary depending on the installation environment of the compressor (e.g. corrosive gas atmosphere, moisture, or the like.) and operational conditions (e.g. frequent partial load operations, frequent start/stop operation, vibration, etc.), the potentiometer is a consumable part that requires regular replacement according to the situation.

- **Disassembly**

  Refer to Section 5.4.1.1 in this manual for the disassembly procedure for the potentiometers on the low-stage and high-stage sides.

- **Inspection**

  a) Check at the terminal block that the lead wires of the potentiometer are not loosened.
  b) Check for any crack or other defects in the soldering of the lead wires of the potentiometer.
  c) Manually rotate the shaft of the potentiometer and measure the resistance value using a circuit tester to check that the resistance value changes smoothly.

### 5.5.15.2 Micro-switches and Micro-switch Cam

The unloader indicator uses two micro-switches and one micro-switch cam to detect the commanded 0 % (30 % for the high-stage of 3225*M/SC) and 100% capacity control positions of the unloader slide valve.
If the micro-switch fails or any of these connections becomes loose for some reason, correct position detection cannot be made, and it causes a problem in the operation control of the compressor.

■ **Disassembly**

Refer to Section 5.5.2.1 in this manual for the disassembly procedure for the potentiometers on the low-stage and high-stage sides.

■ **Inspection**

a) In the normal condition where the hydraulic line for the capacity control of the compressor is not opened, set the unloader piston to the no load and full load positions from the manual capacity control circuit and check the operation of the control circuit to see if the micro-switch can detect the 0 % (30 %) and 100 % positions of the micro-switch cam (i.e., by checking the operation of the relevant relays and contacts).

b) After shutting down the control power and carrying out the lock-out and tag-out procedures, remove the indicator glass and check that the micro-switch mounting screws [126] are not loosened.

c) Check that the hexagon socket set screw [128] securing the micro-switch cam [127] are not loosened.

d) After checking that the wiring for the micro-switch has been removed, turn on and off the switch to check the normal switching operation of the micro-switch using a circuit tester.

e) If the hydraulic line for the capacity control of the compressor is opened for overhaul or other work, use nitrogen gas or compressed air to set the unloader piston to the no-load and full load positions and check if the micro-switch can detect the 0 % (30 %) and 100 % positions of the micro-switch cam.

f) Carry out other visual inspection including any indication of water intrusion in the indicator, any rust on switch terminals, any wear of the switch roller or micro-switch cam, and so on.

### 5.5.15.3 Reassembly

To carry out the reassembly, follow the disassembly procedure in reverse. Lastly, correctly set the needle position according to the following procedure:

a) If the hydraulic line for the capacity control of the compressor is opened for the purpose of overhaul or other work, use nitrogen gas or compressed air to set the unloader piston to the no-load position. Then, set and fix the indicator dial needle to the origin of the figure to show the rotation on the dial. Next, set the piston to the full load position. Make sure the indicator dial needle points to the end point of the figure on the dial.

b) In the normal condition where the hydraulic line for the capacity control is not opened, use the manual capacity control circuit to move the piston. While the control power is turned on, the indicator cover must be mounted to prevent possible electric shock. Then, after the piston position is fixed, control power is turned off, and the lock-out and tag-out procedures are completed, remove the indicator cover and secure the indicator dial needle in position.

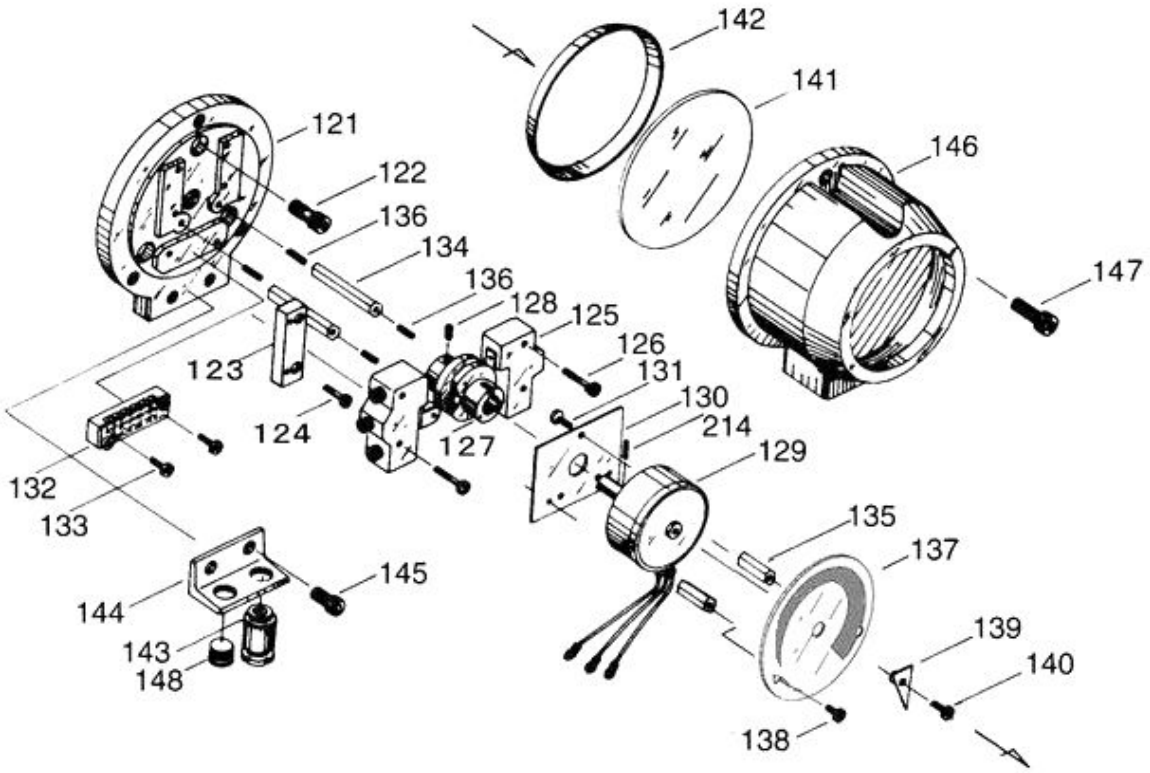



**Figure 5-21 The High-stage Unloader Indicator for 3225**C**

**Table 5-11 Component Parts of the High-stage Unloader Indicator for 3225**C**

| P/N | Part Name | Q'ty | P/N | Part Name | Q'ty |
|---|---|---|---|---|---|
| 121 | Micro-switch base plate | 1 | 136 | Hexagon socket set screw, M3 × 14 | 3 |
| 122 | Hexagon socket head cap screw, M6 × 20 | 3 | 137 | Dial, 30 to 100 % | 1 |
| 123 | Micro-switch base plate | 1 | 137 | Dial, 0 to 100 % | 1 |
| 124 | Philips Screw, M3 × 10 | 2 | 138 | Philips Screw, M3 × 5 | 2 |
| 125 | Micro-switch | 2 | 139 | Indicator dial needle | 1 |
| 126 | Philips Screw, M3 × 25 | 4 | 140 | Philips Screw, M3 × 10 | 1 |
| 127 | Micro-switch cam, 30 to 100 % | 1 | 141 | Indicator glass | 1 |
| 127 | Micro-switch cam, 0 to 100 % | 1 | 142 | Indicator glass spacer | 1 |
| 128 | Hexagon socket set screw, M4 × 8 | 1 | 143 | Electric cable gland | 1 |
| 129 | Potentiometer | 1 | 144 | Bracket, 125L | 1 |
| 130 | Potentiometer mounting plate | 1 | 145 | Hexagon socket head cap screw, M6 × 15 | 2 |
| 131 | Philips Screw, M3 × 5 | 3 | 146 | Unloader indicator cover (2) | 1 |
| 132 | Terminal block | 1 | 147 | Hexagon socket head cap screw, M6 × 15 | 3 |
| 133 | Philips Screw, M3 × 20 | 2 | 148 | Plug | 1 |
| 134 | Dial plate support [2] | 2 | 214 | Spring pin 2 dia. × 8 | 1 |
| 135 | Dial plate support [1] | 2 | 265-2 | Spring washer, M3 | 7 |

Note: For the items 127 and 137, the range of 30 to 100 % is specified for 3225*MC or 3225*SC and the range of 0 to 100 % is specified for 3225*LC.

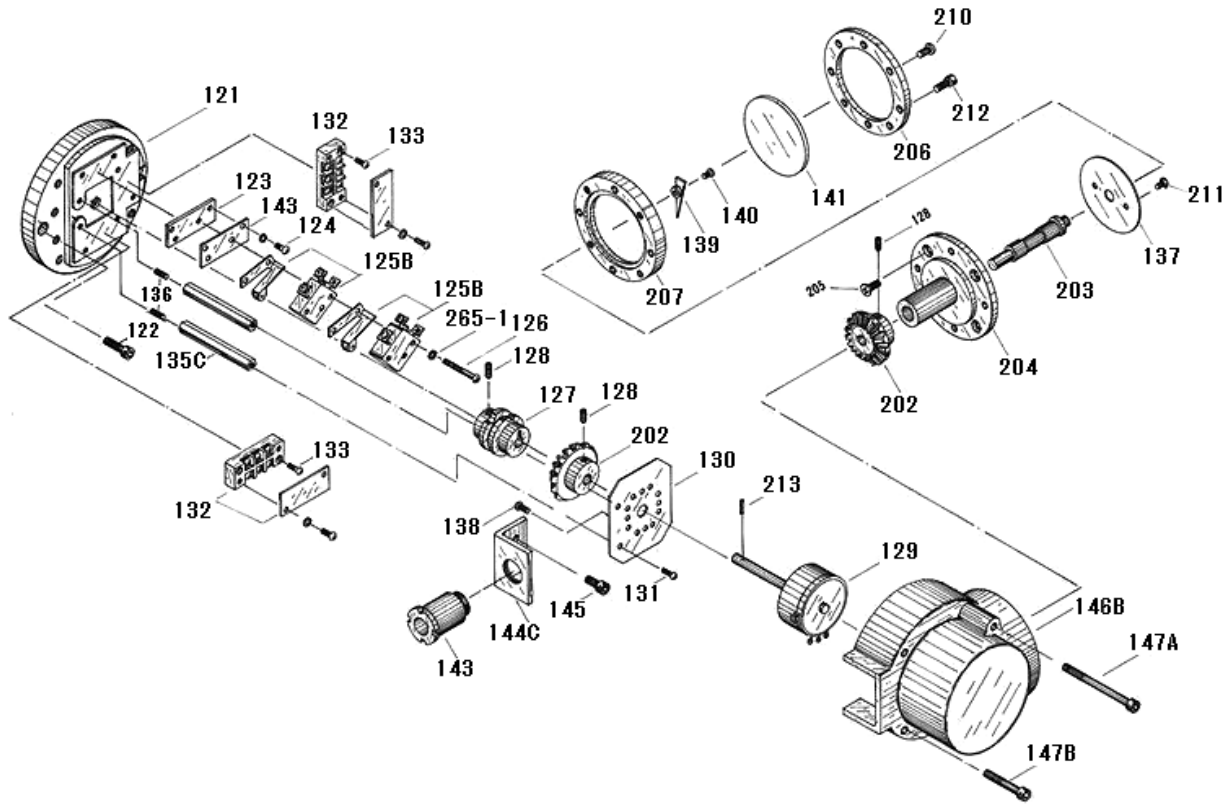



**Figure 5-22 The Low-stage Unloader Indicator of 3225**C (Type 1612C)**

**Table 5-12 Component Parts of the Low-stage Unloader Indicator for 3225**C**

| P/N | Part Name | Q'ty | P/N | Part Name | Q'ty |
|---|---|---|---|---|---|
| 121 | Micro-switch base plate | 1 | 143 | Electric cable gland | 1 |
| 122 | Hexagon socket head cap screw, M6 × 25 | 3 | 144 | Bracket, 125L | 1 |
| 123 | Micro-switch base plate, 125L | 1 | 145 | Hexagon socket head cap screw, M6 × 15 | 2 |
| 124 | Philips Screw, M3 × 10 | 2 | 146 | Unloader indicator cover [2], 1612LSC | 1 |
| 125 | Micro-switch | 2 | 147A | Hexagon socket head cap screw, M6 × 60 | 2 |
| 126 | Philips Screw, M2.5 × 25 | 4 | 147B | Hexagon socket head cap screw, M6 × 95 | 2 |
| 127 | Micro-switch cam, 0 to 100 % | 1 | 149 | Micro-switch insulating plate, 125L | 1 |
| 128 | Hexagon socket set screw, M4 × 8 | 1 | 202 | Bevel gear [2]. 6 dia. | 2 |
| 129 | Potentiometer | 1 | 203 | Indicator dial needle shaft | 1 |
| 130 | Potentiometer mounting plate | 1 | 204 | Indicator dial needle shaft holder | 1 |
| 131 | Philips Screw, M3 × 5 | 3 | 205 | Countersunk screw, M5 × 14 | 4 |
| 132 | Terminal block | 1 | 206 | Indicator glass spacer | 1 |
| 133 | Philips Screw, M3 × 20 | 2 | 207 | Indicator glass holder | 1 |
| 134 | Dial plate support [3] | 2 | 210 | Philips Screw, M5 × 15 | 4 |
| 136 | Hexagon socket set screw, M3 × 14 | 3 | 211 | Countersunk screw, M3 × 5 | 2 |
| 137 | Indicator dial [B], 0 to 100% | 1 | 212 | Hexagon socket head cap screw, M5 × 30 | 4 |
| 138 | Philips Screw, M3 × 5 | 2 | 213 | Spring pin 2 dia. × 8 | 1 |
| 139 | Indicator dial needle | 1 | 265-1 | Spring washer, M2.5 | 2 |
| 140 | Philips Screw, M3 × 10 | 1 | 265-2 | Spring washer, M3 | 2 |
| 141 | Indicator glass | 1 | - | - | - |

# Chapter 6 Troubleshooting

Table 6-1 describes typical trouble symptoms of compressors, their causes and actions to be taken.

The explanations of this Chapter are assumed that the compressor is used in the general refrigeration cycle.

**Table 6-1 Troubleshooting**

**01: Compressor does not start up**

| Direct cause | Root cause | Action |
|---|---|---|
| Power source is off. | Mostly caused by forgetting to turn on after inspection. | Use a check sheet for post-inspection actions and implement finger pointing and call check to prevent forgetting. |
| Main motor failure | Mostly caused by activation of overload protection circuit. | Refer to the operation manual of the motor for details including other causes and actions. |
| "Micro-switch and micro-switch cam" of the indicator do not sense capacity control of 0%. | Micro-switch failure | Replace. |
| | Loosening of micro-switch or micro-switch cam set screw due to vibration. | Adjust the position of the cam and switch, and tighten them.<br>Use thread locking agent when necessary.<br>When compressor's vibration is unusually high, see Item No. 12 "Compressor generates abnormal vibration and/or sound". |
| Defective capacity control oil supply line | Improper adjustment of oil flow control valve (throttled excessively). | Readjust. |
| | Leak/clogging in piping or solenoid valve | Remove cause, and check oil for contamination/replace oil. |
| Oil pressure not detected | Failure of oil pressure protection device, pressure sensor, relay, etc. | Identify defective devices, investigate causes of failure and take necessary actions.<br>Then, replace failed device(s). |
| | Pressure pipe is clogged. | Remove clogging, and check oil for contamination/replace oil. |
| Cooling water circulation is not confirmed. | Failure of devices such as cooling water pump and related circuits | Identify defective devices, investigate causes of failure and take necessary actions.<br>Then, replace failed device(s). |
| | Circulation route is clogged. | Remove the clogging. |
| Failure of magnet, relay, etc. in compressor startup circuit | Aging degradation | Replace with new one. |
| | Poor installation environment | Replace ventilation fans, etc. if defective.<br>Improve temperature, humidity and ventilation at the installation site. |

**02: Compressor stops immediately after startup**

| Direct cause | Root cause | Action |
|---|---|---|
| Low pressure protection circuit activates. | Insufficient refrigerant flow<br>• Insufficient refrigerant | To correct insufficient refrigerant, check leak, stop leak and then add refrigerant.<br>* Also pay attention to moisture entering into the system. |

**02: Compressor stops immediately after startup (continued)**

| Direct cause | Root cause | Action |
|---|---|---|
| Low pressure protection circuit activates. | Insufficient refrigerant flow<br>• Insufficient liquid supply | To correct insufficient liquid supply, inspect expansion valve and liquid supply strainer. Take necessary actions.<br>In addition, inspect devices and parameters (set values) of the expansion valve aperture adjusting mechanism, and take necessary actions. |
| | Heat exchange failure in heat exchanger | If there are any problem (insufficiency) in heat exchange, such as malfunction of defrosting, investigate the cause and take necessary actions. |
| | | In case of malfunction of pressure control valve, replace the valve or remove the cause. |
| | Failure of low pressure protection device, pressure sensor, relay, etc. | Identify defective devices, investigate causes of failure and take necessary actions.<br>Then, replace failed device(s). |
| Motor overload | Motor overload that occurs just after startup is mostly caused not by the refrigeration cycle but by the motor. Refer to the instruction manual of the motor. | |

**03: Unusually low pressure (decrease of suction pressure)**

| Direct cause | Root cause | Action |
|---|---|---|
| Refer to direct cause, "Low pressure protection circuit activates", in Item 02 above. | Same as left | Same as left |

**04: Low oil pressure (low lubricating oil supply pressure)**

| Direct cause | Root cause | Action |
|---|---|---|
| Oil filter element is clogged.<br>* Pressure difference between the outlet port and inlet port is large. | Contamination of lubricating oil | Remove clogging, and check oil for contamination/replace oil. |
| | Internal defects of compressor | Check for oil contamination and conduct vibration/noise diagnosis. Overhaul compressor if necessary. |
| Insufficient oil in oil separator. | Oil heater is not functioning, refrigerant dissolves excessively when the machine is stopped, and oil loss occurs at startup. | Inspect oil heater alone, inspect relays, etc. on related circuits, and replace parts as necessary. |
| | Insufficient oil return due to insufficient refrigerant circulation | Correct insufficient refrigerant circulation, and return oil from load-side heat exchanger.<br>* Supply lubricating oil temporarily. |
| | Troubles such as clogging in oil return passage | Remove causes of the trouble, and restore the system. |

**04: Low oil pressure (continued)**

| Direct cause | Root cause | Action |
|---|---|---|
| Insufficient oil in oil separator. | Extensive oil leak | Inspect machine room and around the compressor, and take necessary actions.<br>Check if there is oil floating in cooling water system.<br>→If there is, check for oil leak from heat transmission tube of oil cooler and take necessary actions. |
| | | If piping is damaged due to excessive vibration, take measures to reduce vibration (including measures for resonance vibration). |
| Oil pressure detection function is defective. | Failure of oil pressure protection device, pressure sensor, relay, etc. | Identify defective devices, investigate causes of failure and take necessary actions.<br>Then, replace failed device(s). |
| | Pressure pipe is clogged. | Remove clogging, and check oil for contamination/replace oil. |

**05: Intermediate pressure is unusually high.**

| Direct cause | Root cause | Action |
|---|---|---|
| High suction pressure | Heat load on load side is higher than design value. | Inspect the conditions on load side (warehousing volume, opening/closing of doors, etc.), and take necessary measures. |
| | Malfunction of suction pressure control mechanism | In case of pressure sensing failure, replace the pressure sensor.<br>* In some cases, pressure pick-up position is improper. → Change the position. |
| | | If there is a problem in device(s) on the control circuit, find the defective device(s) and replace it. |
| | | If parameter (set value) on the control circuit is improper, optimize it. |
| | | In case of malfunction of pressure control valve, replace the valve or remove the cause. |
| | Malfunction of compressor's capacity control | See Item No. 11 "Capacity control malfunction". |
| Liquid flow-back from intermediate liquid cooler. | Failure or internal leakage of intermediate liquid supply expansion valve | Repair or replace. |
| There is problem in compressor's high-stage. | Malfunction of capacity control on compressor's high- stage | See Item No. 11 "Capacity control malfunction". |
| | Excessive wear or sliding damage of the part(s) on compressor's high- stage | Overhaul compressor and replace parts.<br>Replace the whole quantity of lubricating oil. |

**06: Unusually high pressure (abnormal discharge pressure)**

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

**06: Unusually high pressure (continued)**

| Direct cause | Root cause | Action |
|---|---|---|
| Discharge pressure detection function is defective. | Failure of high pressure protection device, pressure sensor, relay, etc. | Identify defective devices, investigate causes of failure and take necessary actions.<br>Then, replace failed device(s). |
| | clogging of pressure pipe | Remove clogging, and check oil for contamination/replace oil. |
| Outlet shut-off valve of oil separator is closed. | Operator forgot to restore after shut down operation.<br>Human error | Open the valve or perform emergent stop.<br>Be sure to conduct tagout while handling valves.<br>Be sure to check valves before starting the compressor. |

**07: Discharge temperature is abnormally high.**

| Direct cause | Root cause | Action |
|---|---|---|
| Overheated during operation | Insufficient refrigerant flow | See the causes listed in item 02 above. |
| | Heat load on load side is higher than design value. | Inspect the conditions on load side (warehousing volume, opening/closing of doors, etc.), and take necessary measures. |
| | Failure of low pressure protection device, pressure sensor, relay, etc. | Identify defective devices, investigate causes of failure and take necessary actions.<br>Then, replace failed device(s). |
| Non-condensable gases mixed into the system | Leak on low pressure side | Perform a leak check, and take necessary measures.<br>Air-purge the heat exchanger. |
| Oil supply temperature is high. | Heat exchange failure in oil cooler | For water-cooling system, see "Heat exchange failure in heat exchanger" in 06 above.<br>For liquid cooling system, check liquid supply expansion valve, temperature sensor and related relays/wiring/terminals, and take necessary actions. |
| | Oil temperature rise protection feature does not function. | Check temperature protection device, temperature sensor and related relays/wiring/terminals, and take necessary actions. |
| Defective discharge temperature detection/protection feature. | Failure of temperature protection device, temperature sensor, relay, etc. | Identify defective devices, investigate causes of failure and take necessary actions.<br>Then, replace failed device(s). |
| Insufficient oil supply | See "Low oil pressure" in Item 04 above. | Same as left |

**08: Leak from mechanical seal**

| Direct cause | Root cause | Action |
|---|---|---|
| Initial leak after replacement until sliding surfaces settle | In some cases, immediately after replacement, the compressor-specific operating conditions and the pressure receiving conditions of machined sliding surface is unstable. | In case of initial leak, although leak amount might increase temporarily, it will decrease gradually. Check that leak does not increase continuously. Duration of initial leak depends on design/operating conditions. It is approximately 200 hours, as a rough indication. |
| Sliding surface is roughened due to overheating. | Started and stopped too many times.<br>* In case of standard equipment, "four or more times per hour" is considered "frequent/too many". | If heat load is less than the level set by the equipment's design conditions, review the operating conditions and set control such that equipment is started/stopped less frequently. |
| | | In case of capacity control malfunction, see "Capacity control malfunction" in item No. 11. |
| | Excessive refrigerant solved into the lubricating oil, resulting in decreased viscosity of oil. | In case of liquid flow-back, remove the cause(s).<br>If oil heater or devices on its control circuit are defective, replace the defective part. |
| | Overheated operation | See the causes in item 02, "Insufficient refrigerant flow". |
| | Oil supply temperature is high. | See the causes in item 07, "Oil supply temperature is high". |
| Machine is stopped for a long time.<br>(No oil film on sliding surfaces) | User-specific conditions, such as intermittent heat load | If machine is sometimes stopped longer than a week, take either of the following measures: (i) Manually operate oil pump alone and turn the rotor shaft of the compressor.<br>(ii) Attach an oil pot for supply oil to the seal cover. |
| Deteriorated part(s) | Hardened O-ring | If deteriorated over time, replace.<br>For other specific causes, see the causes/action for symptom "Overheating of sliding surface". |
| | Swelled O-ring<br>* This occurs when the lubricating oil of refrigerating machine contains large amount of refrigerant. | In case of liquid flow-back, remove the cause(s).<br>If oil heater or devices on its control circuit are defective, replace the defective part. |
| | Deteriorated seal ring/mating ring | If deteriorated over time, replace.<br>For other specific causes, see the causes/action for symptom "Overheating of sliding surface". |
| Incompatibility of lubricating oil and operating conditions (such as working temperature range or refrigerant) | Unsuitable lubricating oil was selected, or operating conditions have changed after installation of the equipment. | If possible, review the operating conditions.<br>If not, see "4-1 Lubricating Oil (Refrigerant Oil)" to select suitable lubricating oil and replace the whole quantity. |

**08: Leak from mechanical seal (continued)**

| Direct cause | Root cause | Action |
|---|---|---|
| Poor contact of sliding surfaces | Foreign matter attached to sliding surfaces, due to contaminated lubricating oil. | Replace the whole quantity of lubricating oil.<br>Install bypass filter to oil supply line. |
| | Faulty assembly of parts<br>Human error | Disassemble, replace parts and reassemble.<br>Use assembly check sheet to ensure confirmation. |

**09: Squeaking of mechanical seal**

| Direct cause | Root cause | Action |
|---|---|---|
| During initial period after exchange for new mechanical seal, squeaks may be heard from sliding surfaces until they fit together. | As the sliding surfaces are very hard and dense, they need time to fit together. | Squeaking itself does not cause leak from seal or deterioration in sealing function.<br>Normally, squeaking is heard for several dozens of hours, however, it may last longer in rare cases.<br>→In this case, contact our service center. |

**10: Capacity control position is indicated incorrectly**

| Direct cause | Root cause | Action |
|---|---|---|
| Inaccurate reading of compressor indicator gauge. | Screw for securing indicator needle is loose. | Manually operate the compressor's capacity control to indicate 0% position, and tighten the screw again. |
| | Indicator's bevel gears are worn. | If deteriorated over time, replace.<br>If the wear is caused by excessive vibration of the compressor, take measures to reduce vibration and then replace the bevel gears. |
| Inaccurate reading of capacity control indicator on the control panel. | The cam groove of compressor's indicator cam is worn. | Often caused by continued operation with load on a certain point.<br>→Replace the indicator cam.<br>* The currently shipped indicator cam has its grooved portion strengthened. |
| | The guide pin of the compressor push rod is worn. | Currently, this pin is also improved in resistivity against wear. If the indicator cam is replaced with the improved version, replace the pin with the countermeasure part. |
| | Failure of potentiometer | If the part is deteriorated over time or loaded at a certain point during operation for a long time, replace it.<br>If the wear is caused by excessive vibration of the compressor, take measures to reduce vibration and then replace the potentiometer. |
| | Improper zero span adjustment of E/E positioner | Readjust. |

**10: Capacity control position is indicated incorrectly (continued)**

| Direct cause | Root cause | Action |
|---|---|---|
| Inaccurate reading of capacity control indicator on the control panel. | E/E positioner or/and indicator is faulty. | If deteriorated over time, replace.<br>If there are specific causes such as surge current, remove the cause or take proper action. |
| | Loosened terminals or defective wires | Tighten the terminals if loosened.<br>Replace defective wires. |

**11: Capacity control malfunction**

| Direct cause | Root cause | Action |
|---|---|---|
| ↑ See the causes for "Inaccurate reading of capacity control indicator on the control panel". | Same as left | Same as left |
| "Micro-switches and micro-switch cam" of the indicator do not sense "100%" position and/or "0%" position. | Micro-switch failure | Replace. |
| | Loosening of micro-switch or micro-switch cam screw due to vibration. | Adjust the position of the cam and switch, and tighten them.<br>Use thread locking agent when necessary.<br>When compressor's vibration is unusually high, see Item No. 12 "Compressor generates abnormal vibration and/or sound". |
| Failure of capacity control solenoid valve or related relays | Mostly caused by coil burnout. | If deteriorated over time, replace.<br>If the symptom is caused by wet with water, etc., remove the cause(s) and then replace defective part(s).<br>For details, refer to the instruction manual of solenoid valve. |
| Internal leakage of capacity control solenoid valve | Oil compression due to temperature rise inside unloader cylinder | If the symptom is caused by long duration of low-load operation, review and improve the operating method.<br>Arrange inline check valve and oil bypass route on the capacity control oil supply line. |
| Defective capacity control oil supply line | Improper adjustment of oil flow control valve | Readjust. |
| | Leak/clogging in solenoid valve gland or oil supply piping | Remove cause, and check oil for contamination/replace oil. |
| Unloader piston does not move.<br>(Though this is one of the causes of "Defective capacity control oil supply line", it is listed separately here.) | Damage on the cap seal of the piston | Check oil for contamination/replace oil.<br>Replace O-ring, cap seal, etc. |
| | Cap seal is pinched. | Replace O-ring, cap seal, etc. |
| | Cap seal is worn. | Check oil for contamination/replace oil. Replace O-ring, cap seal, etc. |
| | There is residual refrigerant gas inside unloader cylinder. | Stop the compressor. By operating the oil pump, repeat load/unload operation to purge refrigerant gas from unloader cylinder.<br>In case of liquid flow-back, remove the cause(s).<br>If oil heater or devices on its control circuit are defective, replace the defective part. |

**12: Compressor generates abnormal vibration and/or sound.**

| Direct cause | Root cause | Action |
|---|---|---|
| Shaft poorly aligned with motor | If the shaft vibration value of axial direction is high, it may be caused by this. | Conduct shaft alignment again.<br>If this occurs frequently in monocoque unit, perform hot alignment (operate the compressor at rated speed to raise the temperature and make adjustment before it cools down). |
| M rotor shaft runout excessively. | Lock nuts and/or thrust bearing glands are tightened unevenly. | If lock nuts are not loose and parts such as thrust bearing are free of defects, tighten the glands evenly. |
| | Thrust bearing glands get loosened. | Lock washer tooth not bended, or thrust bearing rolling elements (balls) are worn.<br>→ Check the thrust bearing. If any defect is found, replace it, and then reassemble it after adjusting end clearance and checking shaft runout. |
| | Rotor dynamic balance is disturbed. | If no other causes are found for abnormal vibration, or if on-site overhaul only has been repeatedly performed for a long time, this may be the cause.<br>→ Overhaul the compressor at a place where a dynamic balance measurement/adjustment system is available, such as the MAYEKAWA Moriya Factory. |
| Oil compression | Continuous low-load operation with capacity control not greater than 30% | During low-load operation, lubricating oil is difficult to be discharged. As a result, oil that stays between the engaged rotors increases and gets compressed.<br>→ Avoid continuous low-load operation as far as possible.<br>* Especially when the fluid is light gas (He, NH3, etc.), continuous operation of merely 10 minutes can cause bad effect. The maximum limit should be 30 minutes even for fluorocarbon fluids. |
| Liquid flow-back during startup<br>* Loud abnormal noise at startup.<br>* If this is heard, the compressor may get damaged instantaneously. | Refrigerant liquefies and stays inside upstream piping when equipment is stopped. | There are many probable causes, such as a leak inside liquid supply solenoid valve on the load side, insufficient heat exchange (refrigerant evaporation) in heat exchanger, or trapping due to mis-piping in the piping line.<br>→ Identify the cause(s) and take necessary measures. Then overhaul and inspect the compressor. |

**12: Compressor generates abnormal vibration and/or sound (continued)**

| Direct cause | Root cause | Action |
|---|---|---|
| Liquid flow-back during operation<br>* Notable frosting on the suction side.<br>* In many cases, flow-back of mist (steam) rather than liquid occurs.<br>* Sometimes, gas-liquid separator (accumulator) is attached to prevent this symptom.<br><br>* See also the causes in item 02, "Insufficient refrigerant flow" | Aperture of liquid supply expansion valve is large | In case of temperature-type expansion valve, check the condition of temperature sensitive cylinder and capillary tube. If any defect is found, take necessary actions.<br>If orifice gets unsuitable due to the change in operating conditions, replace the orifice with proper size one(s). |
| | | In case of electronic expansion valve, check devices attached on the expansion valve aperture control mechanism (circuit) such as temperature sensor, converter, controller (overheating regulator). If any of them is found defective, replace it.<br>In the same way as with temperature-type expansion valve, if orifice gets unsuitable due to the change in operating conditions, replace the orifice with proper size one(s). |
| | Rapid change from no-load operation to full-load operation | Set control parameters so as to prevent rapid changes.<br>Otherwise, make adjustment by throttling the aperture of the capacity control increase-side oil quantity adjusting valve. |
| | Expansion valve aperture control cannot keep up with rapid change in heat load on the load side. | Avoid rapid change in heat load that exceeds the set value of follow-up range of "heat exchanger on load side (evaporator)" and "expansion valve".<br>For details, refer to the instruction manuals related to devices/control on load side. |
| | Heat exchange failure in heat exchanger on load side<br>・Related to defrosting | In case of frosting (icing), conduct manual defrosting.<br>Set defrosting interval shorter.<br>If a device which is specific to the defrosting type fails, remove the cause(s) and replace the device(s).<br>If a piping route which is specific to the defrosting type gets blocked, remove the cause(s) and take necessary actions.<br>* Especially when handling hot gas defrosting systems, thoroughly read and understand the contents of the instruction manuals for the units associated with devices/control on the load side. |
| | Heat exchange failure in heat exchanger on load side<br>・Load side conditions | If ventilation around the heat exchanger is obstructed for any reason such as piled up load, improve the conditions.<br>* Ensure the flow of heating medium through the heat exchanger on the load side. |
| | Heat exchange failure in heat exchanger on load side<br>・Heat exchanger conditions | Check for any blocked heat transmission tubes or fan motor(s) failure. If any problem is found, take necessary actions. |

**12: Compressor generates abnormal vibration and/or sound (continued)**

| Direct cause | Root cause | Action |
|---|---|---|
| Foreign substances entering the compressor | Welding spatter, etc. flowing from upstream side | Check suction strainer and/or oil filters. Replace element if defective.<br>Overhaul the compressor.<br>Collect foreign substances and identify their sources. Then take necessary actions. |
| | Tools and/or waste cloth left uncollected after overhauling | |
| Damaged thrust bearings. | Deterioration over time (operated beyond recommended time of replacement) | The time for replacement depends largely on operating conditions (low pressure or high intermediate pressure will make the life shorter, etc.) and/or oil management conditions. In case of a typical refrigeration application which basically operates in a stable continuous mode, inspect and replace them every 40,000 hours or 5 years, whichever comes first.<br>For details, see Chapter 5, Section 5.2.3 in this manual. |
| | Operation with liquid flow-back | Refer to causes of "Liquid flow-back during startup" and "Liquid flow-back during operation" in item 12. |
| | Entry of foreign substances | Refer to causes of "Foreign substances entering the compressor" above. |
| | Excessive thrust stress other than above<br>・High suction pressure/intermediate pressure exceeding the level set by operating conditions | Re-examine operating conditions, and improve if possible.<br>If difficult to improve, review maintenance interval. |
| | Faulty assembly<br>* Lock nuts tightened insufficiently, lock washer tooth 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).<br><br>Be sure to record data on the assembly check sheet to prevent omission of work steps. |
| Resonance vibration | This occurs when the frequency of vibration comes close to the natural frequency of any component in the entire vibrating system, including pipes and supports. | In many cases, this symptom is caused by change in installation environment (such as change in piping routes or additive installation of devices in the machine room, oil level change, etc.)<br>→If occurrence of resonance vibration is a suspected, contact our service centers. |

# Chapter 7 Related Documents

## 7.1 Development Views, Assembly Sectional Views

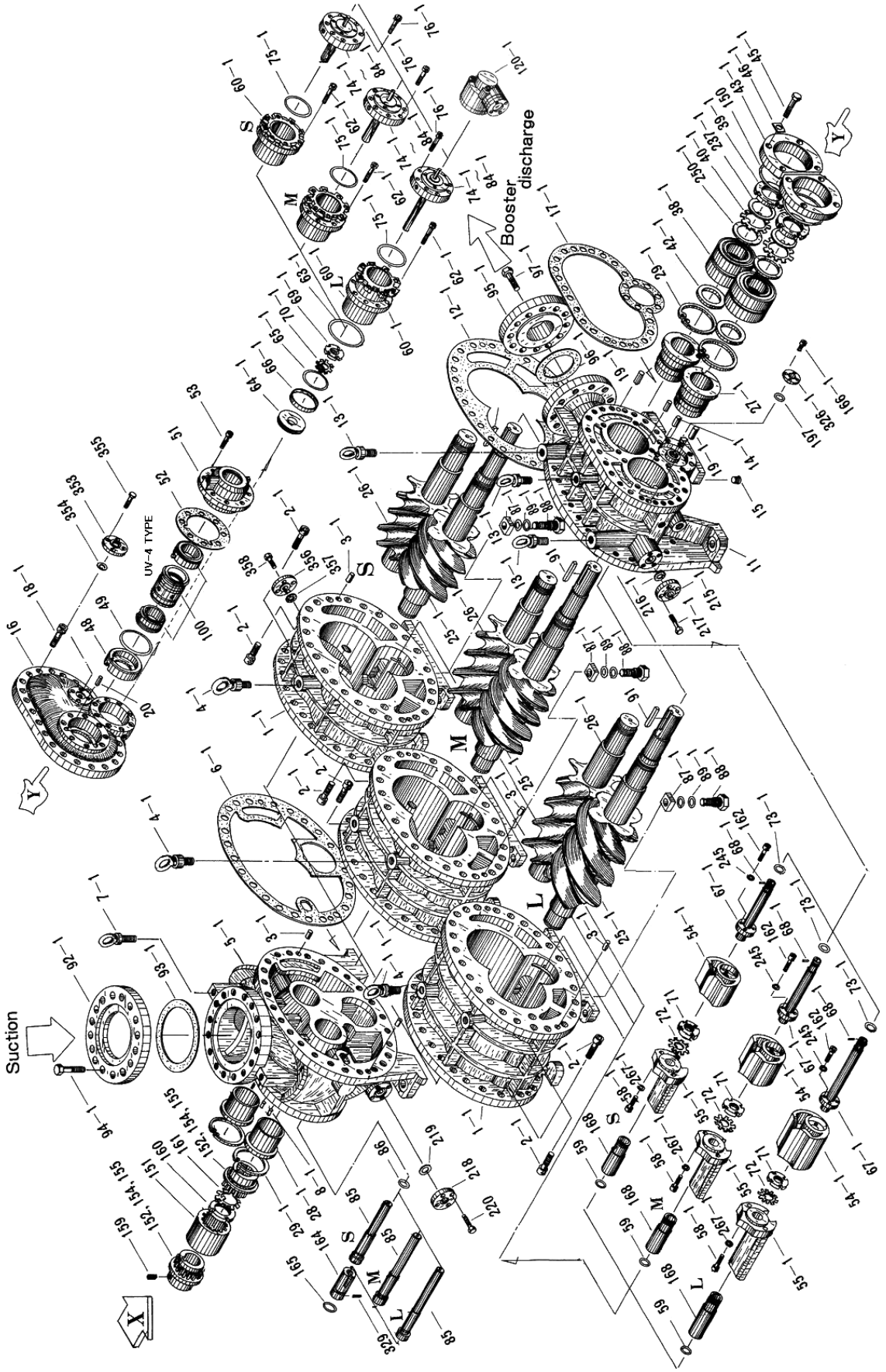



**Figure 7-1 3225**C Development View (Low-stage)**

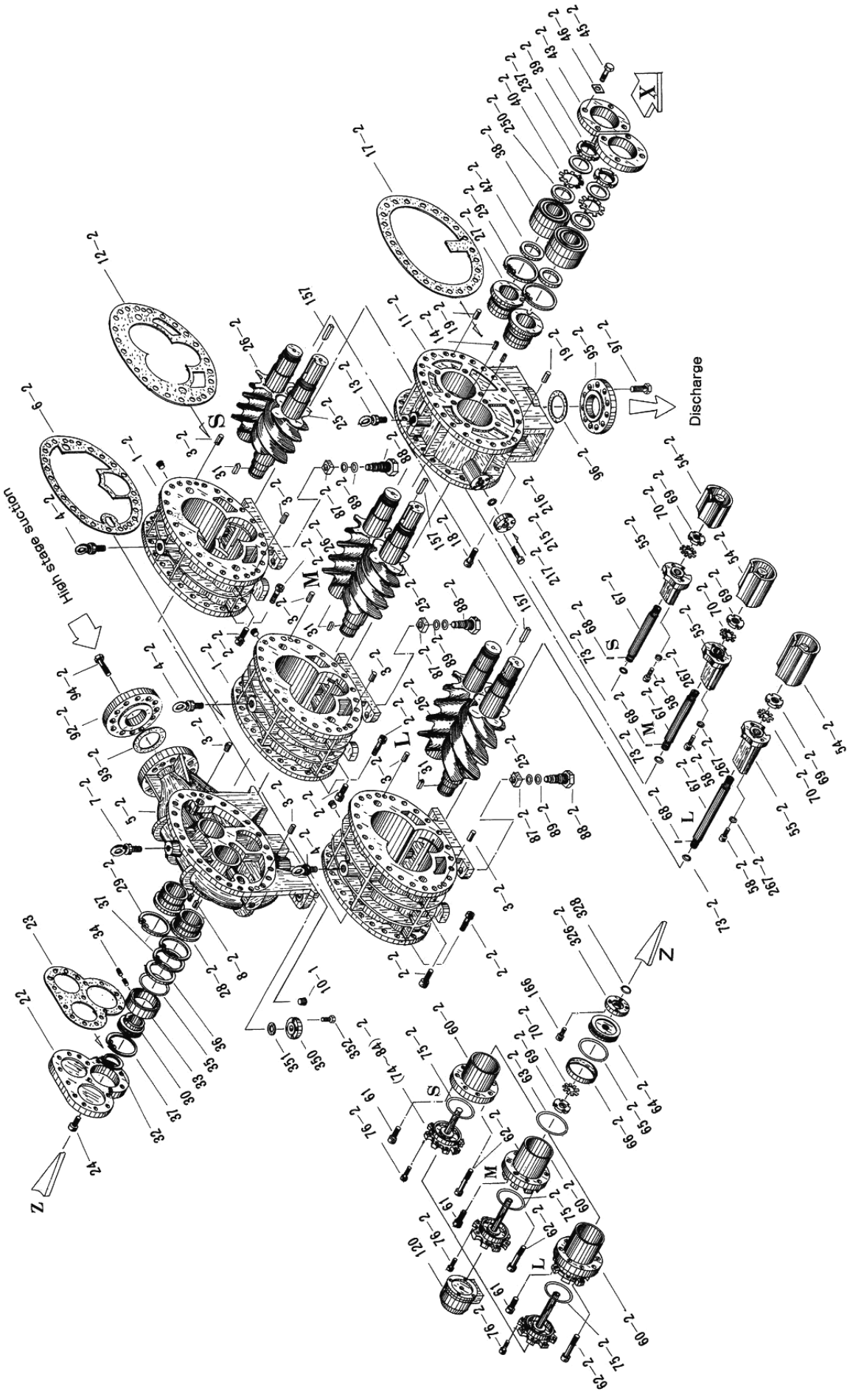



**Figure 7-2 3225**C Development View (High-stage)**

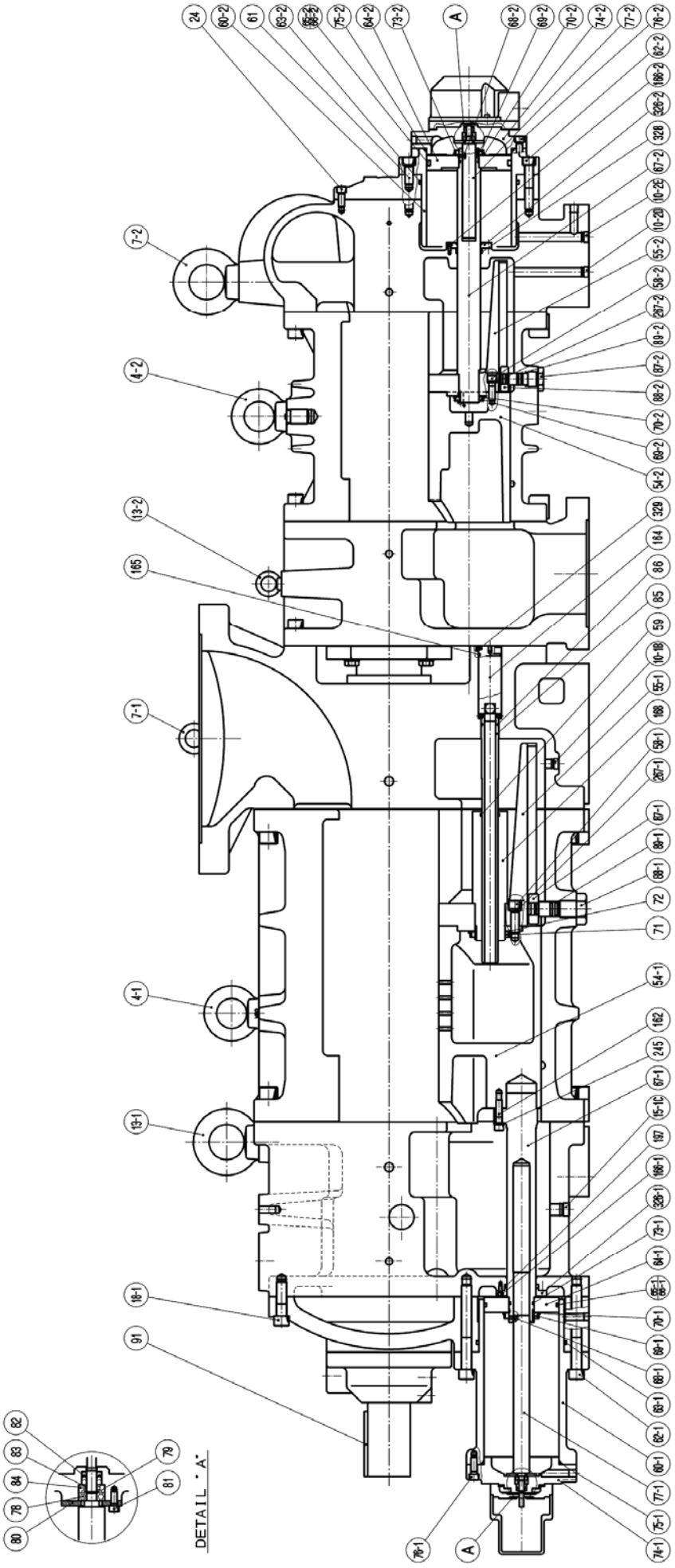



Figure 7-3 3225LLLC Assembly Sectional View (Vertical)

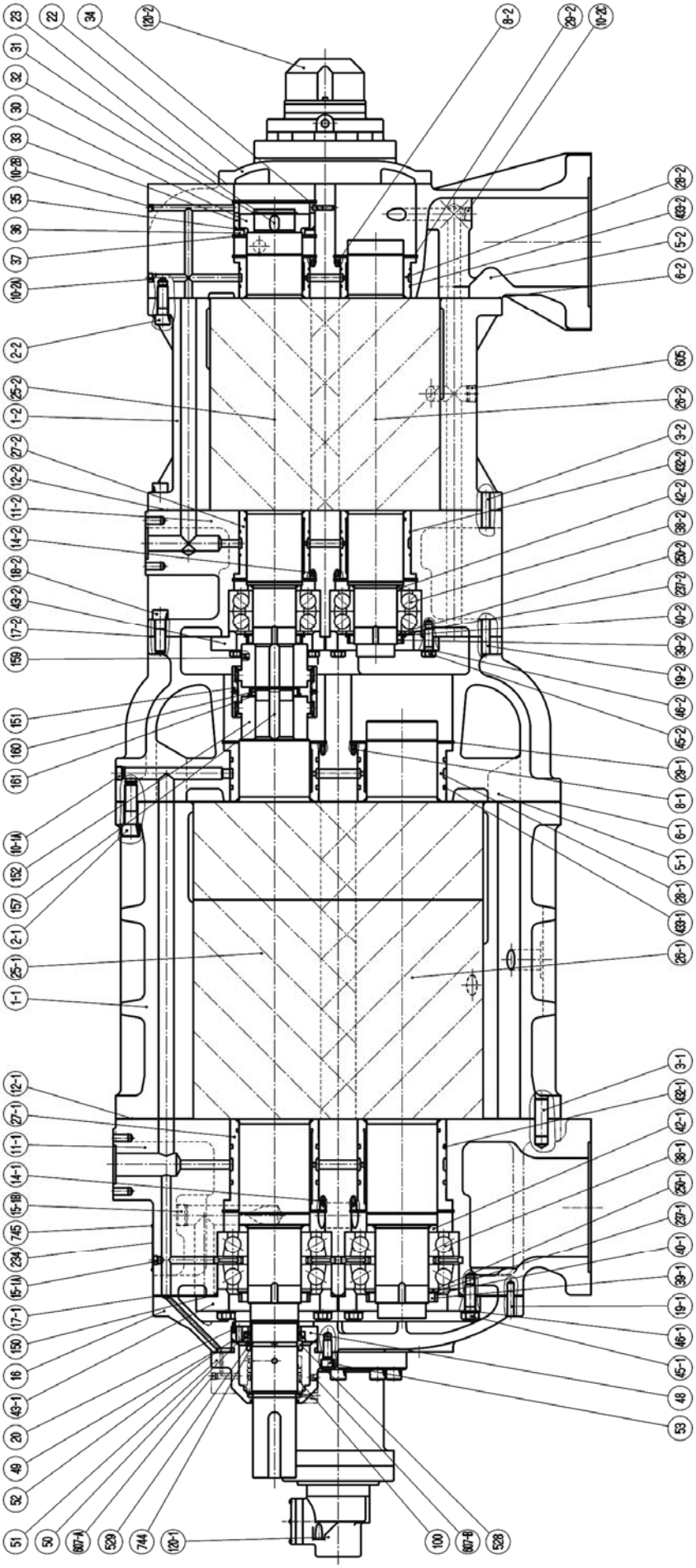



Figure 7-4 3225LLLC Assembly Sectional View (Horizontal)

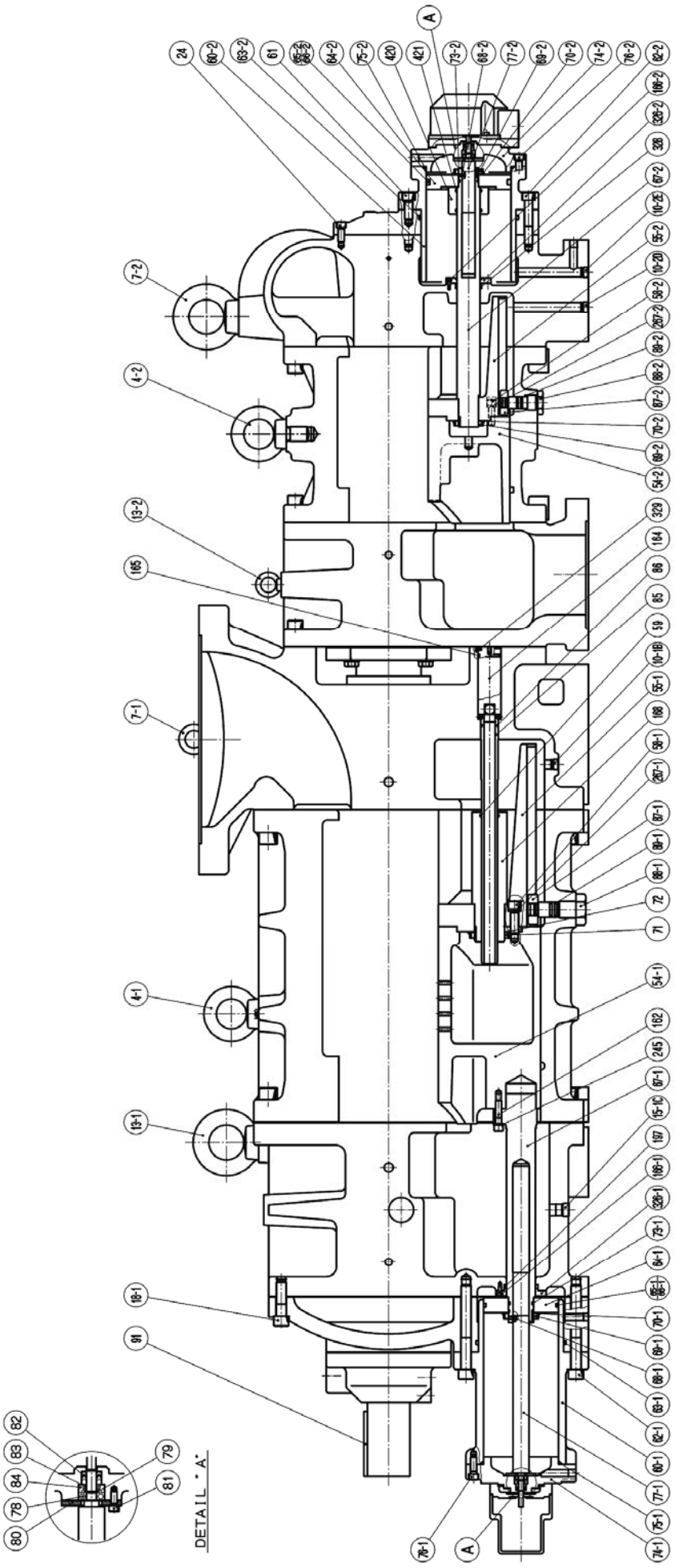



Figure 7-5 3225LLMC Assembly Sectional View (Vertical)

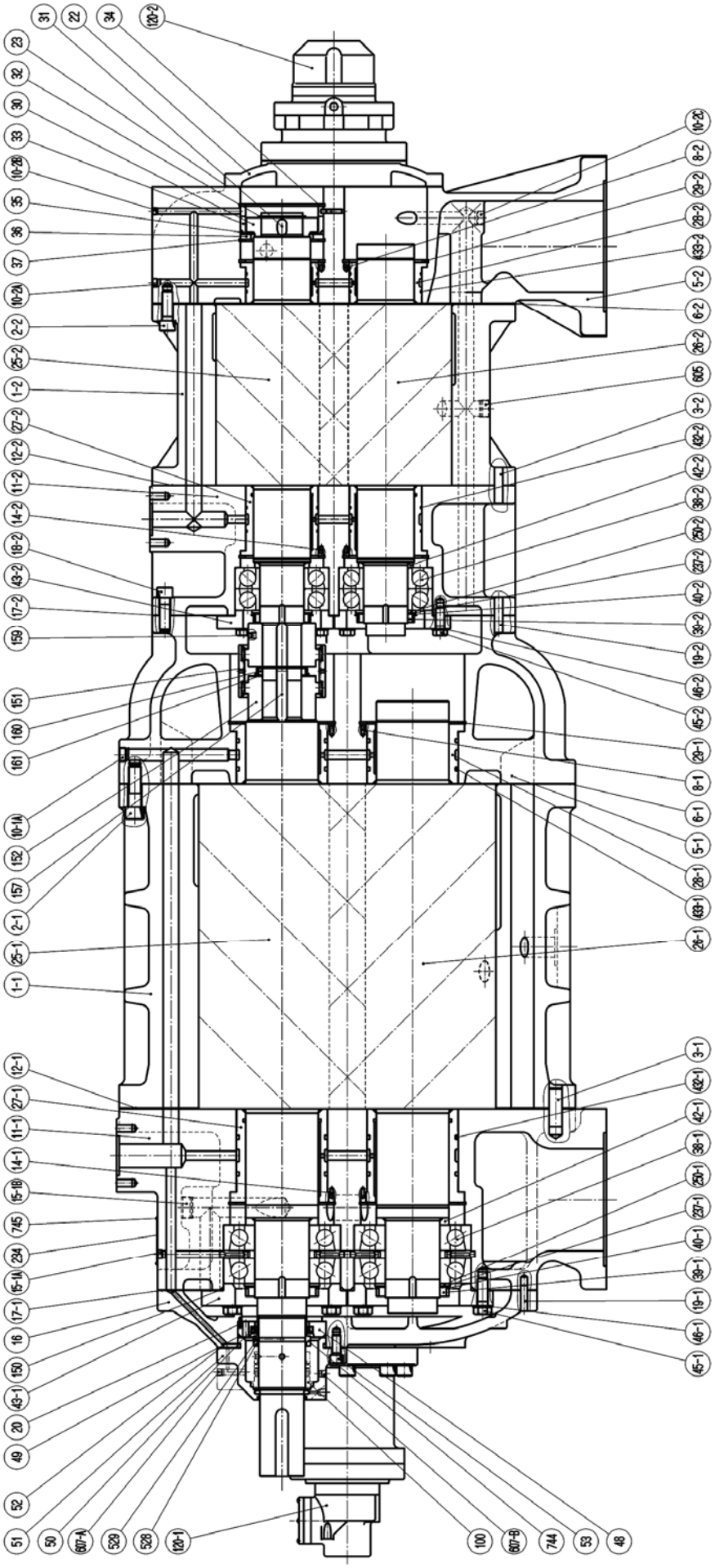



Figure 7-6 3225LLMC Assembly Sectional View (Horizontal)

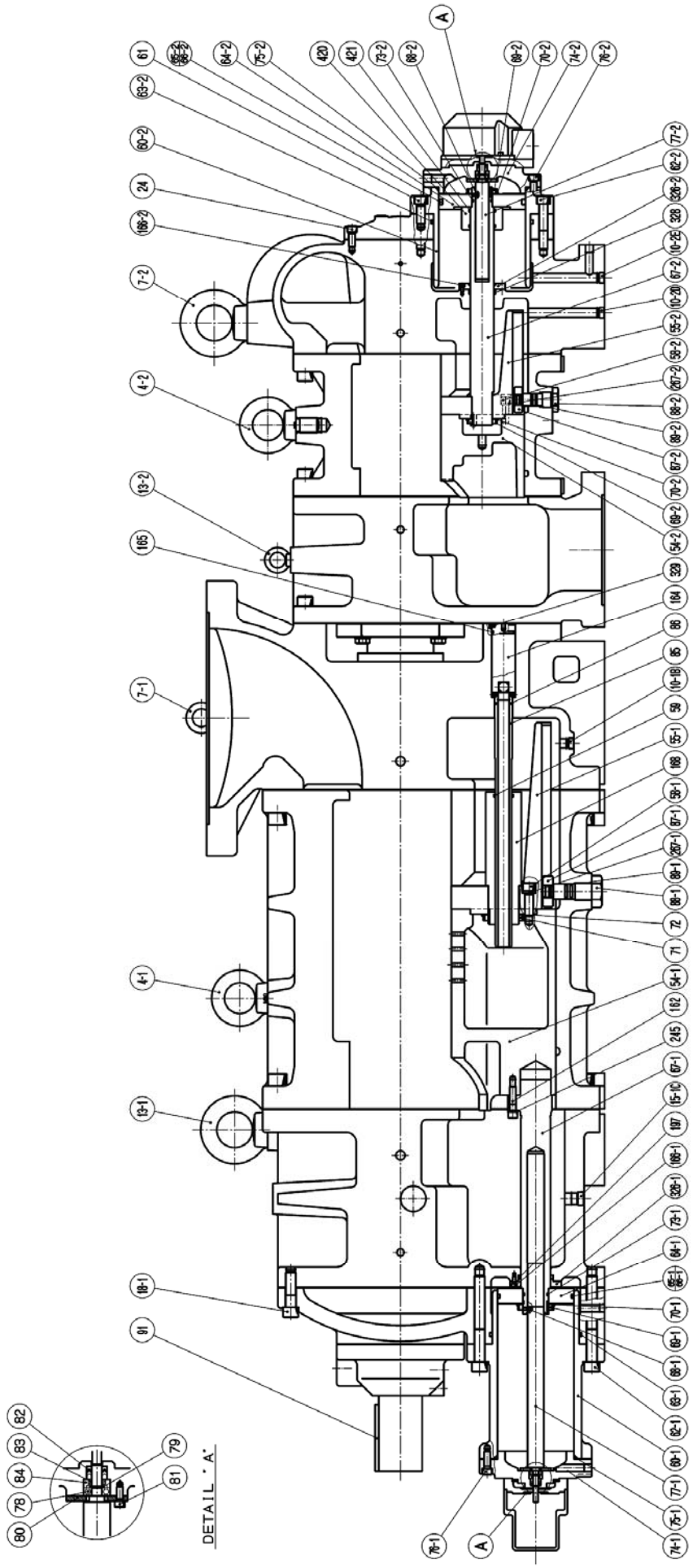



Figure 7-7 3225LLSC Assembly Sectional View (Vertical)

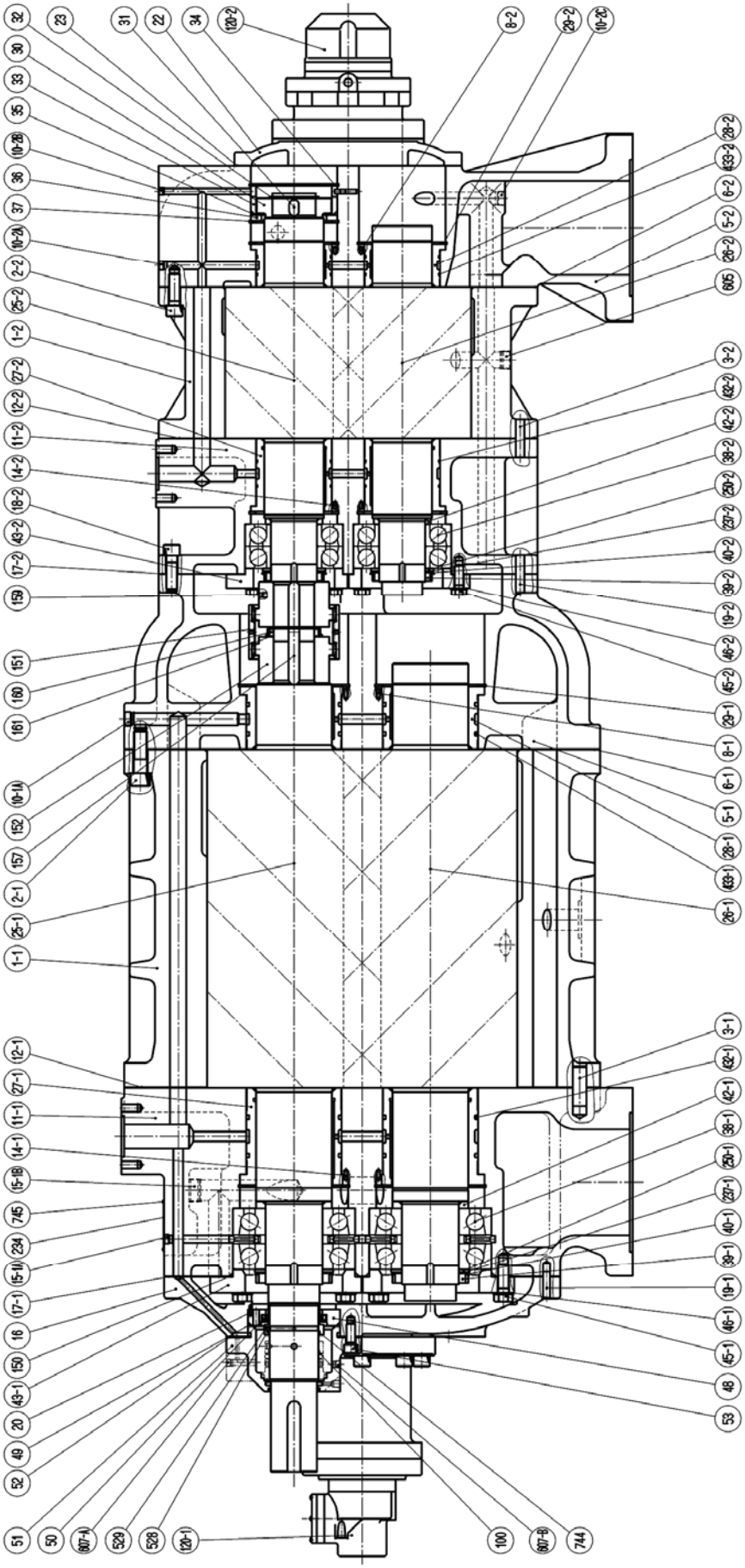



Figure 7-8 3225LLSC Assembly Sectional View (Horizontal)

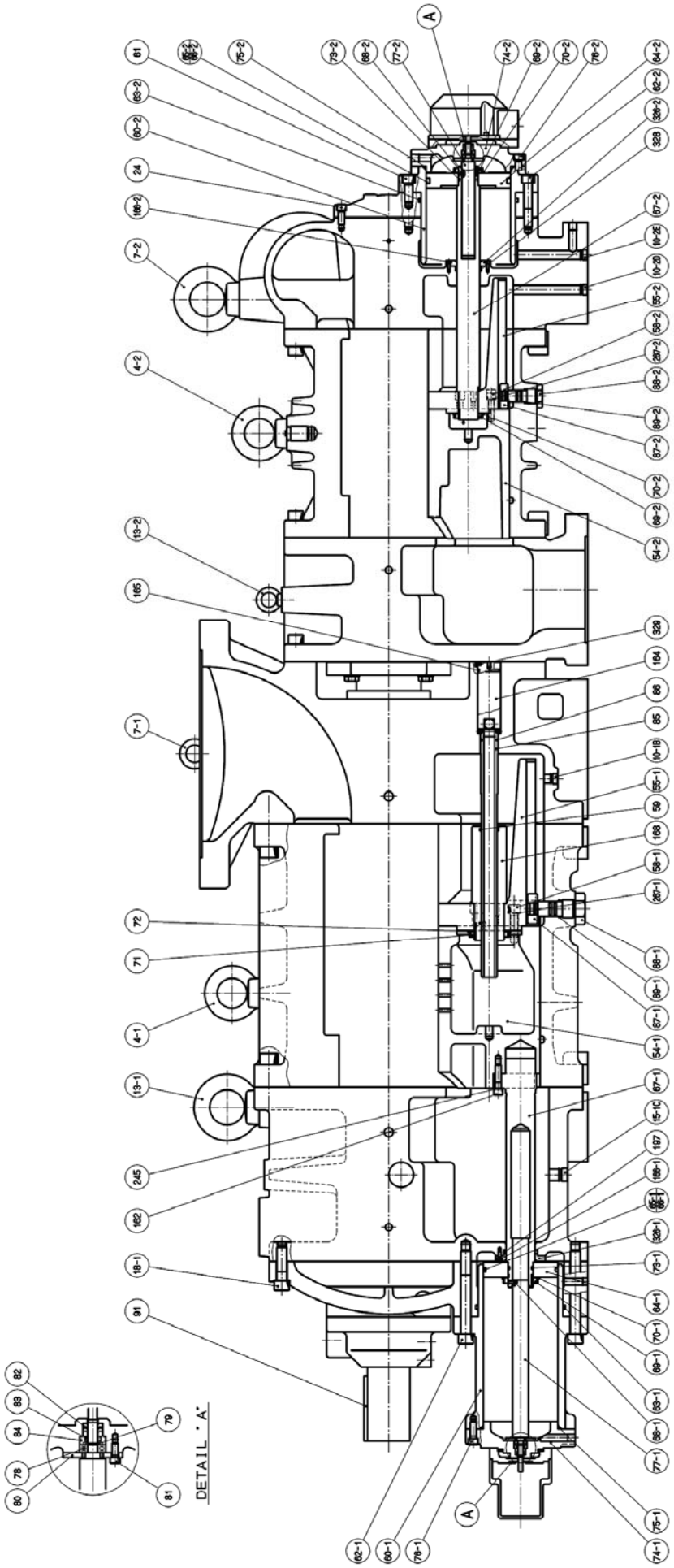



Figure 7-9 3225LLC Assembly Sectional View (Vertical)

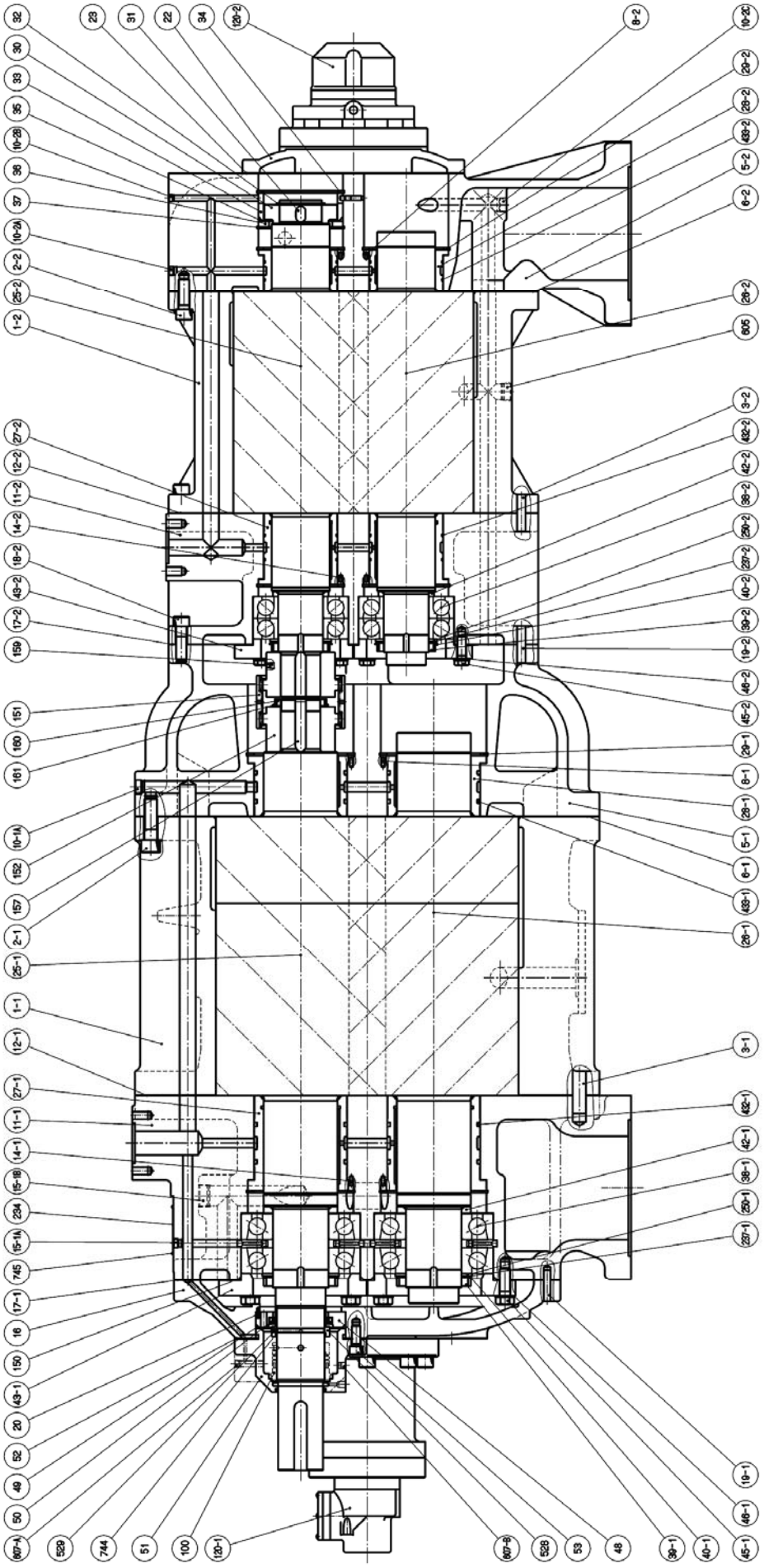



Figure 7-10 3225LLC Assembly Sectional View (Horizontal)

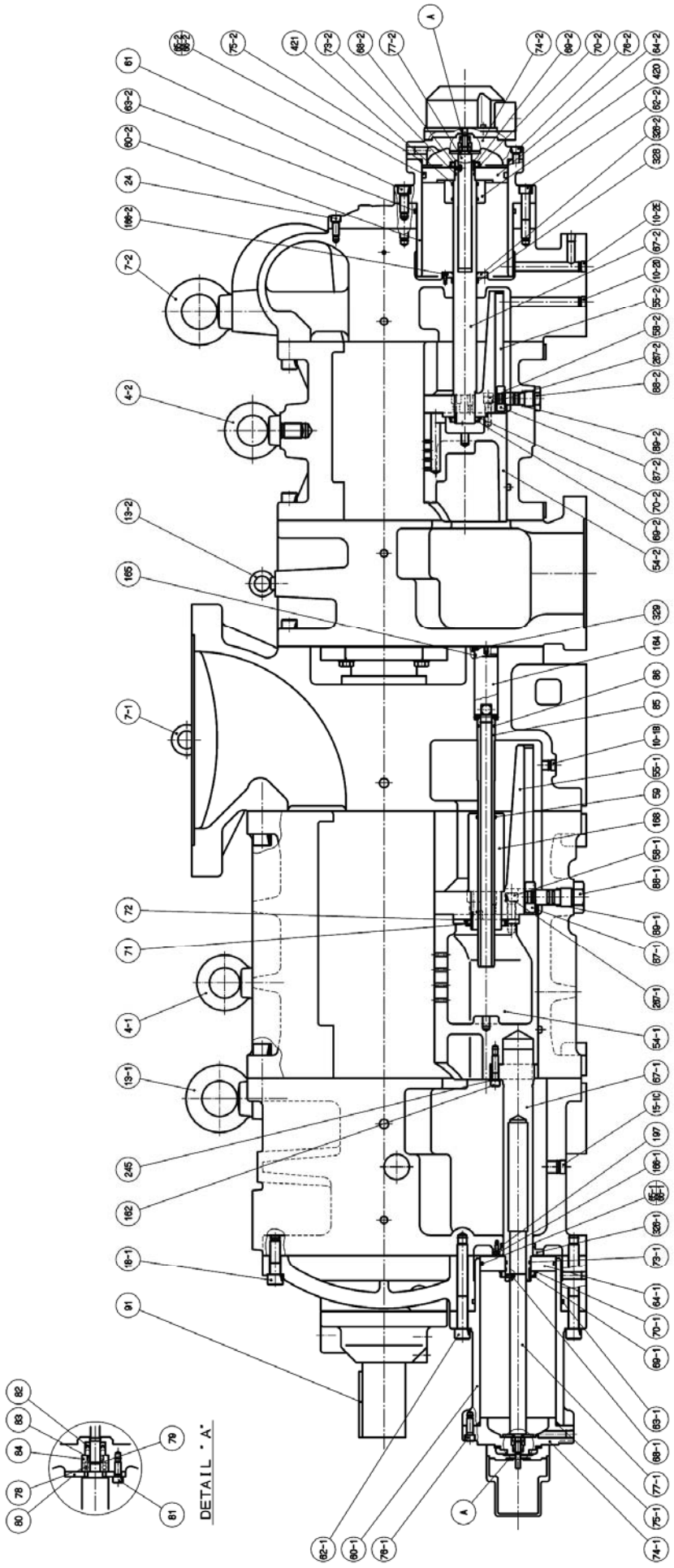



Figure 7-11 3225LMC Assembly Sectional View (Vertical)

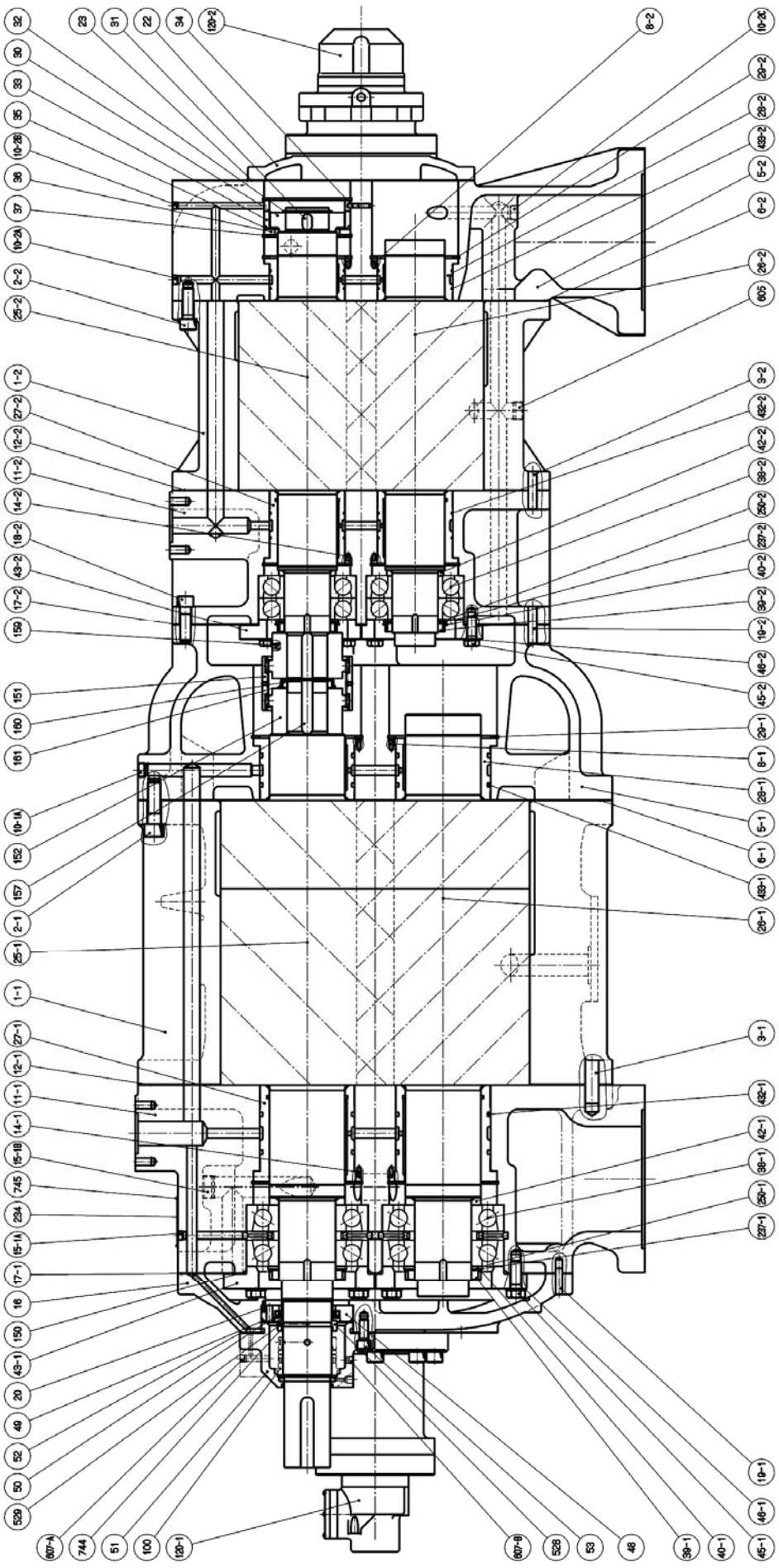



**Figure 7-12 3225LMC Assembly Sectional View (Horizontal)**

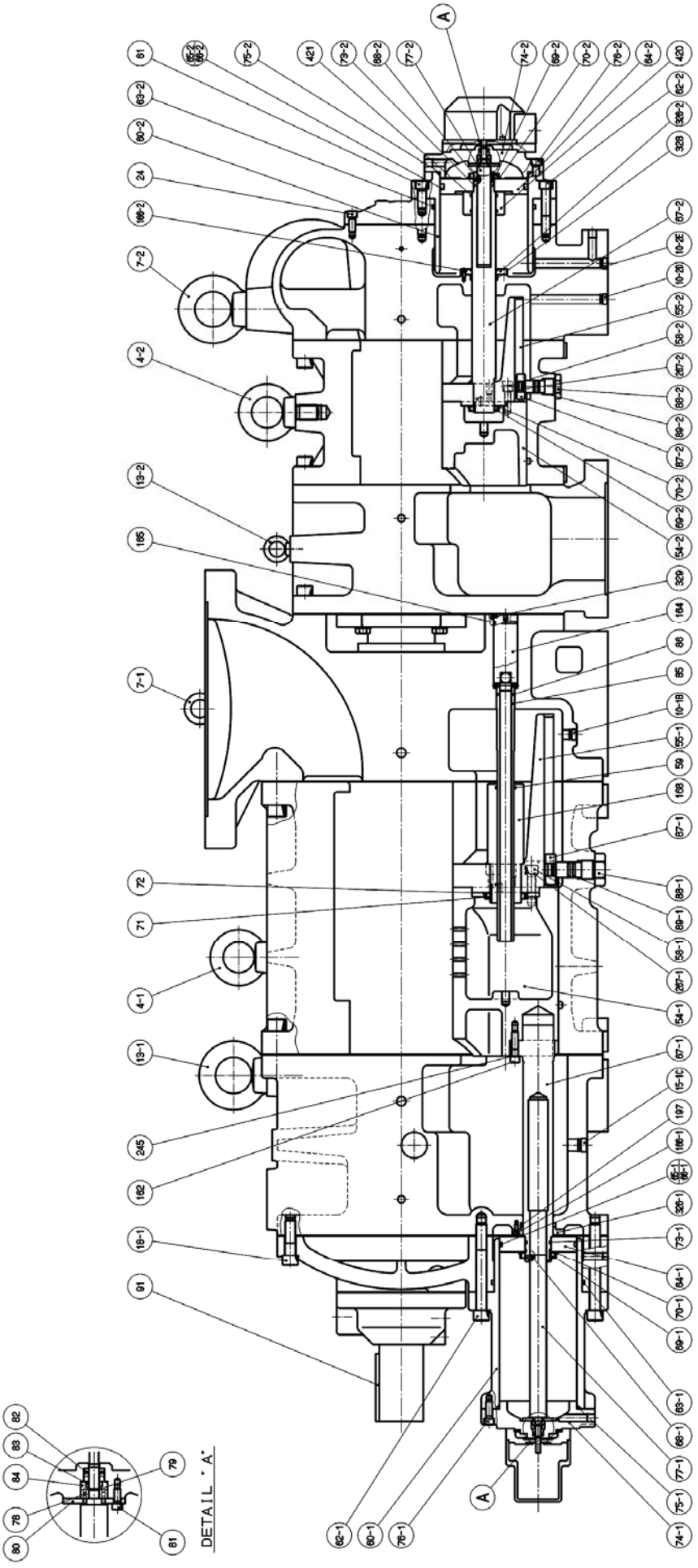



Figure 7-13 3225LSC Assembly Sectional View (Vertical)

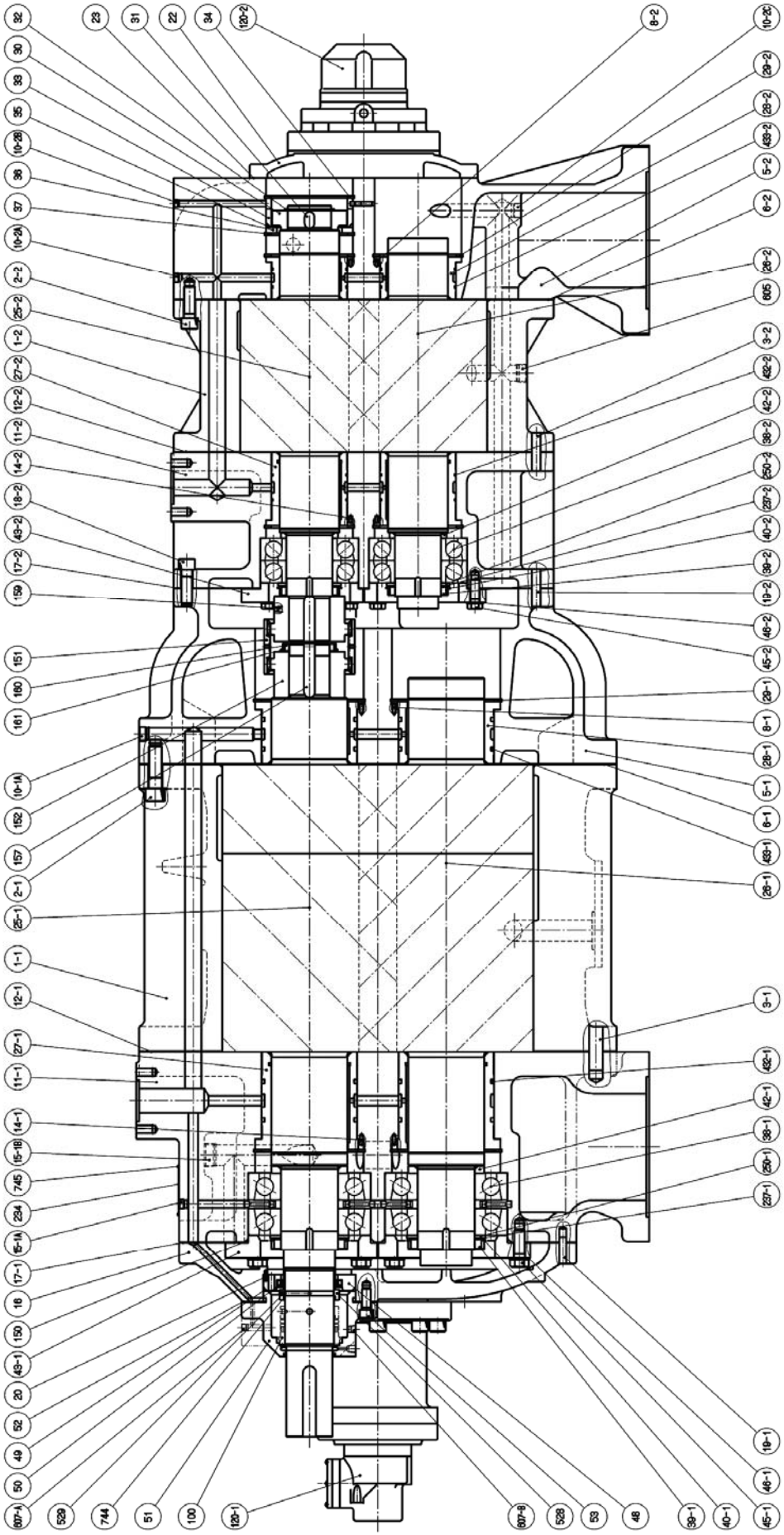



Figure 7-14 3225LSC Assembly Sectional View (Horizontal)

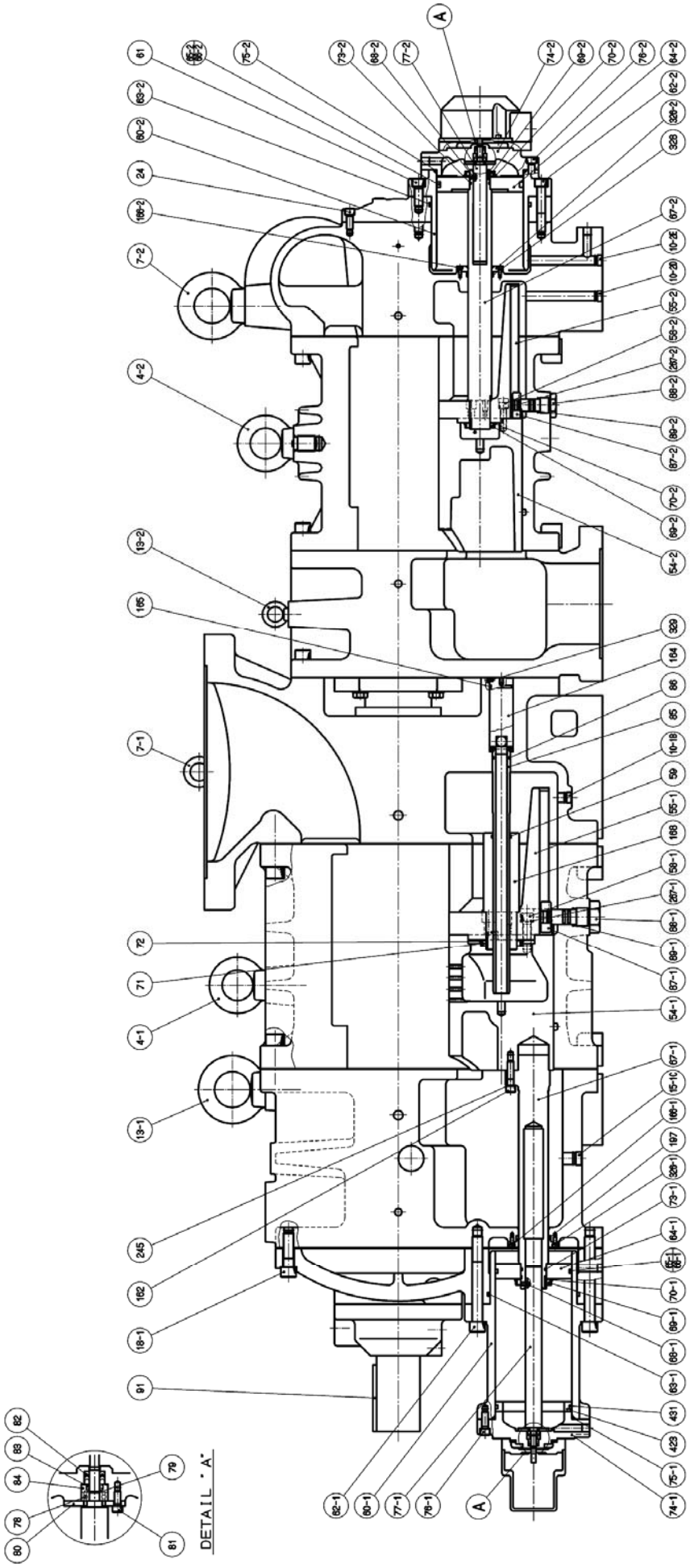



Figure 7-15 3225MLC Assembly Sectional View (Vertical)

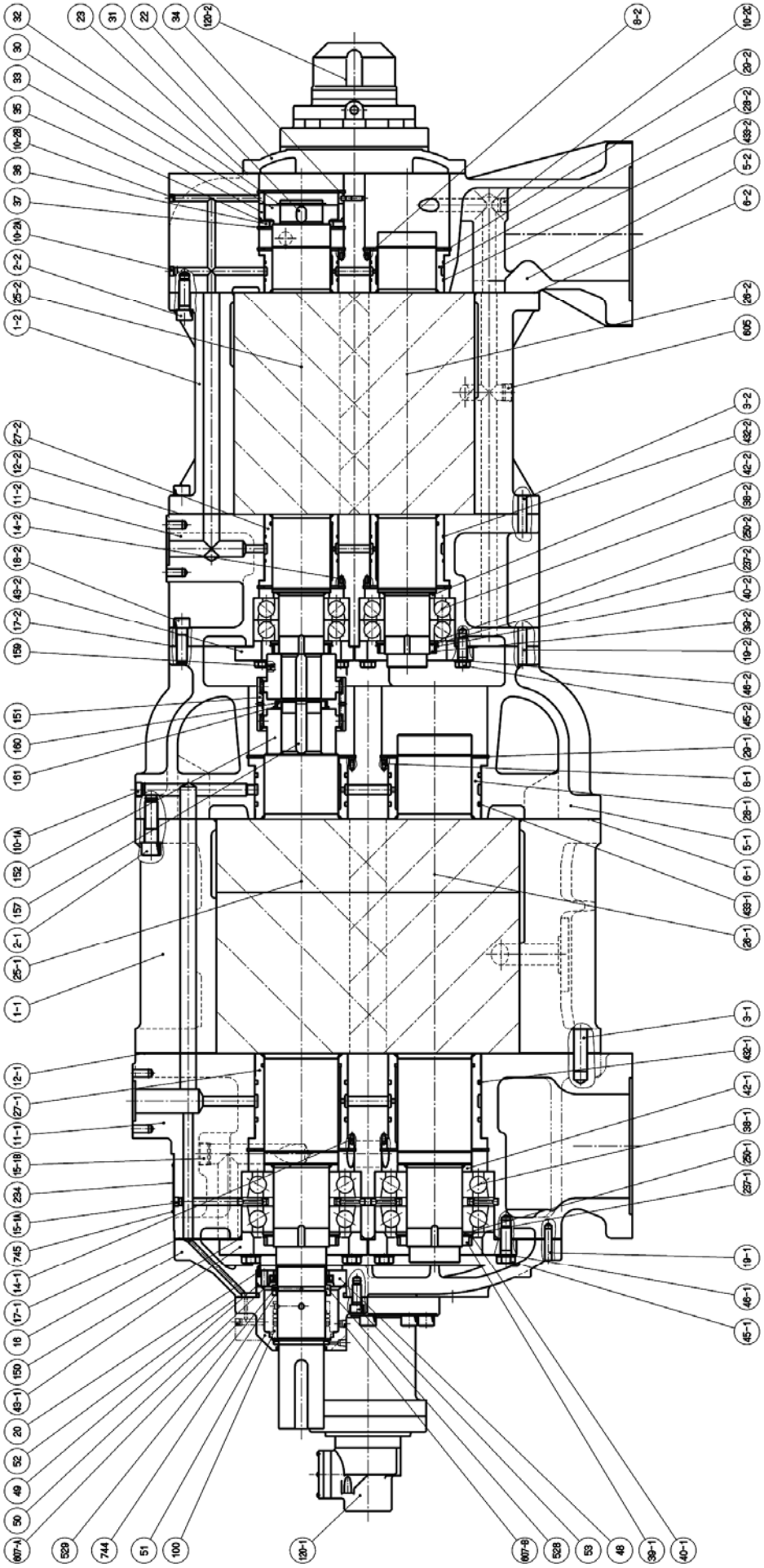



Figure 7-16 3225MLC Assembly Sectional View (Horizontal)

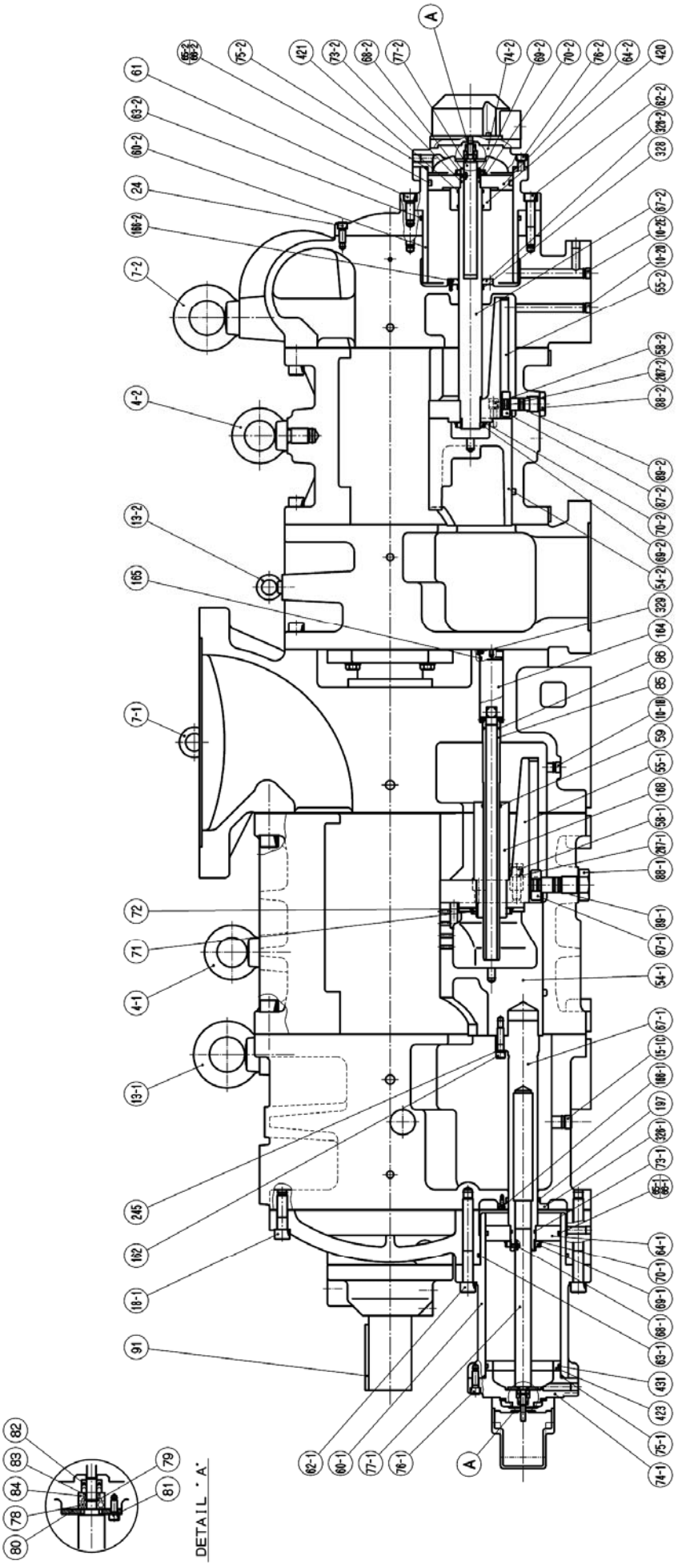



Figure 7-17 3225MMC Assembly Sectional View (Vertical)

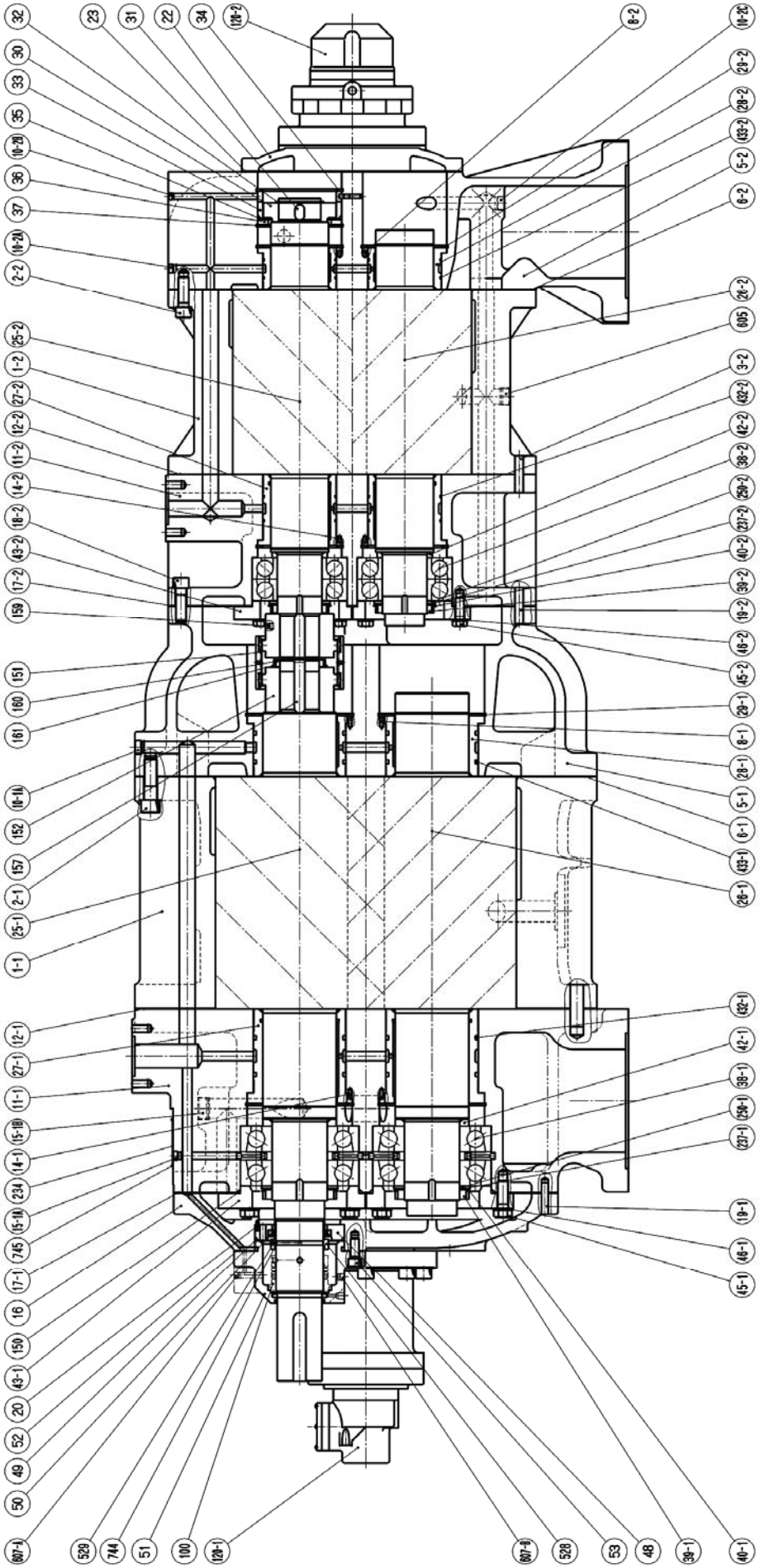



Figure 7-18 3225MMC Assembly Sectional View (Horizontal)

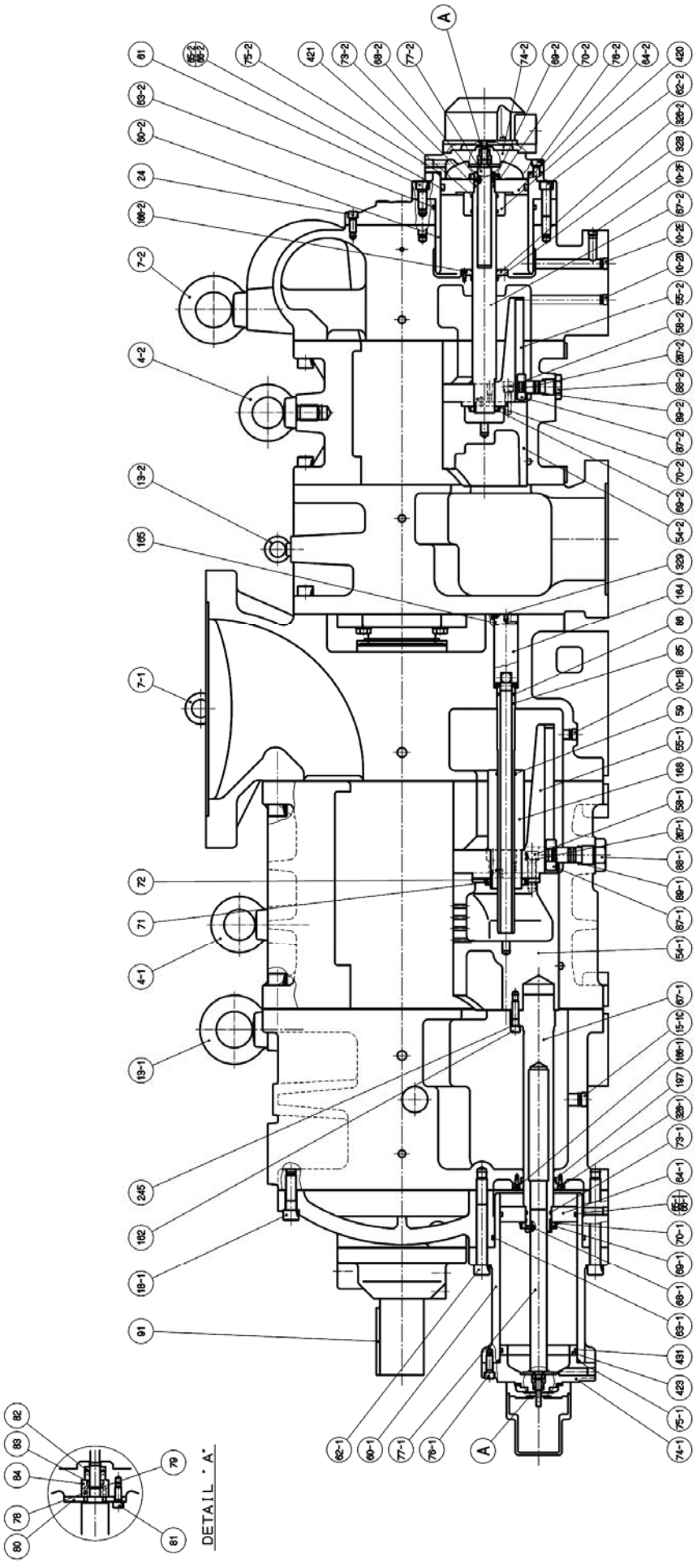



Figure 7-19 3225MSC Assembly Sectional View (Vertical)

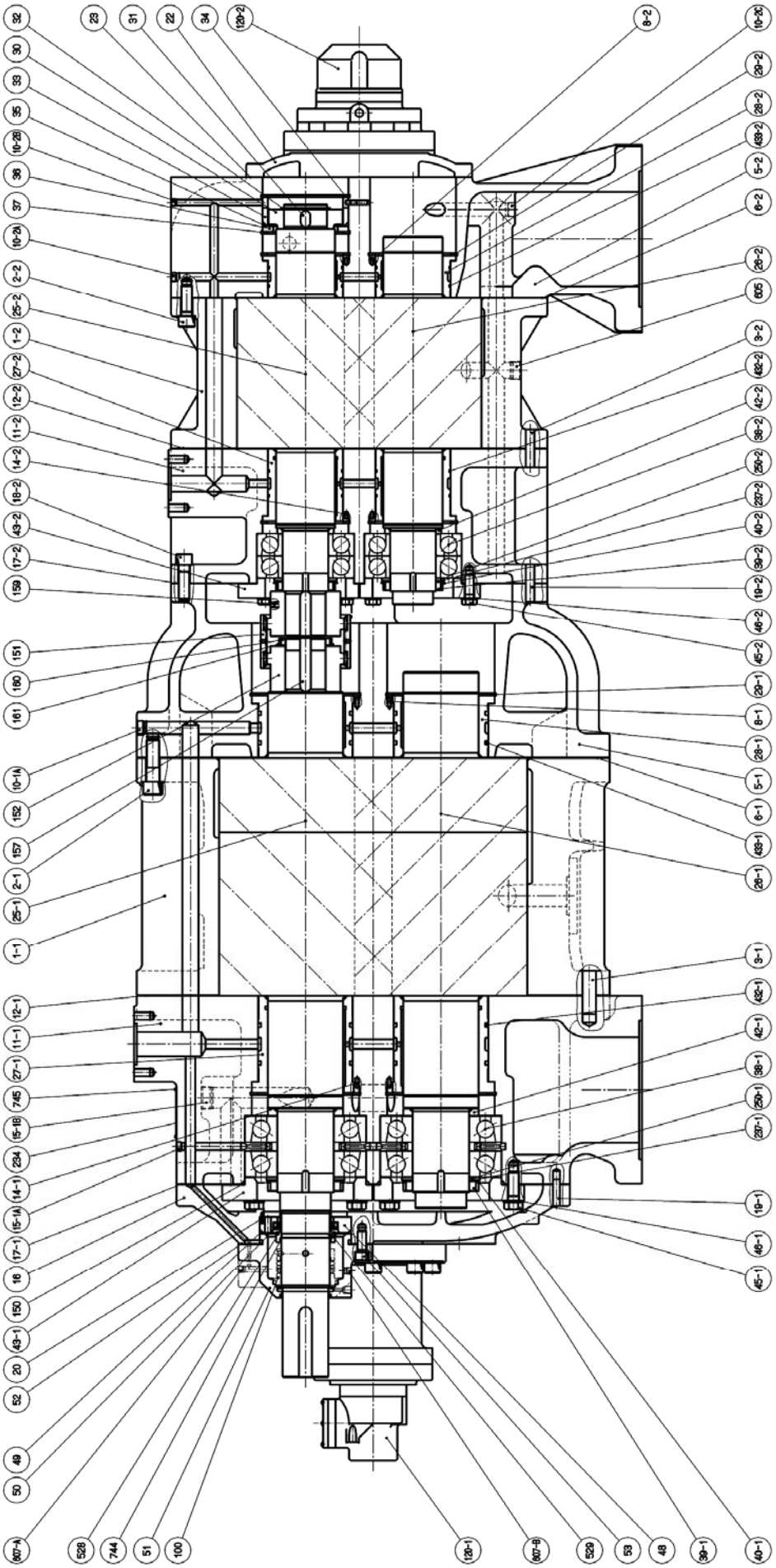



Figure 7-20 3225MSC Assembly Sectional View (Horizontal)

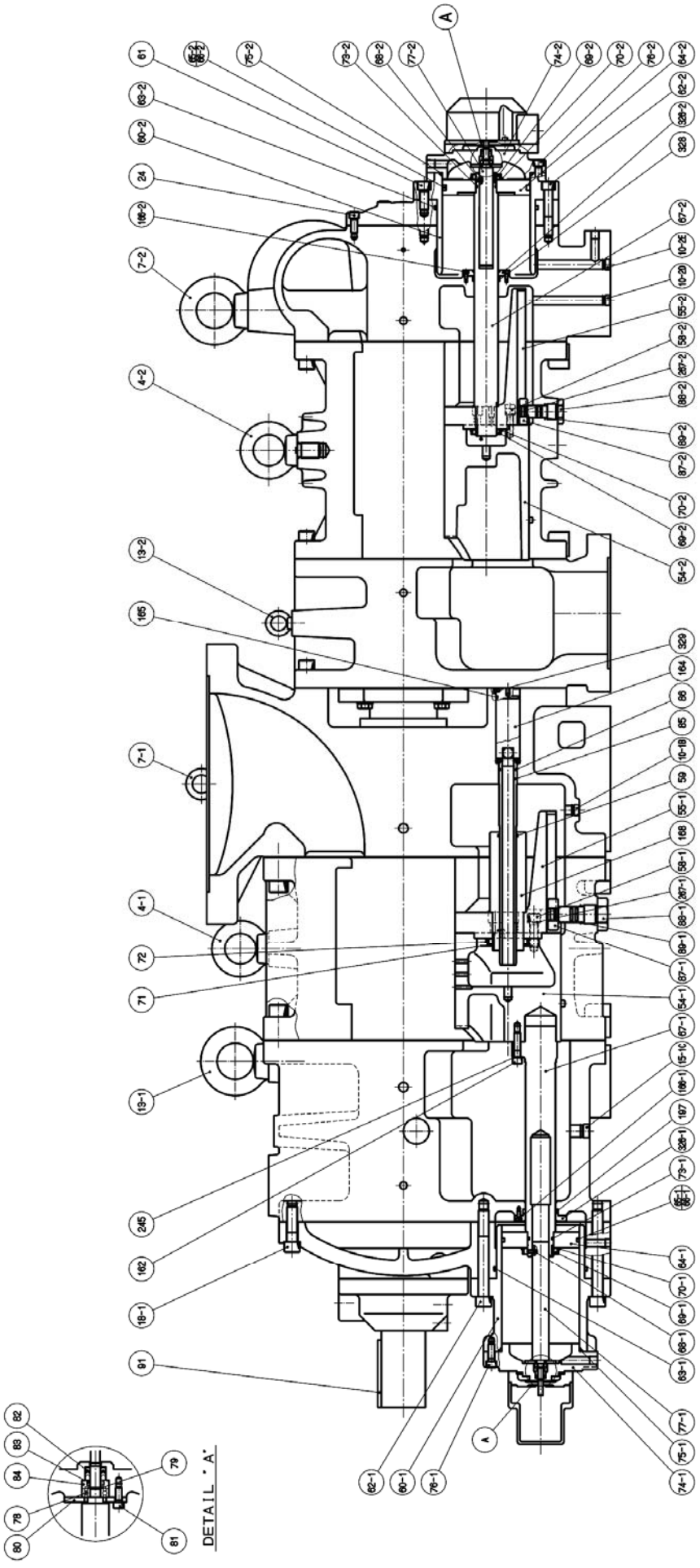



Figure 7-21 3225SLC Assembly Sectional View (Vertical)

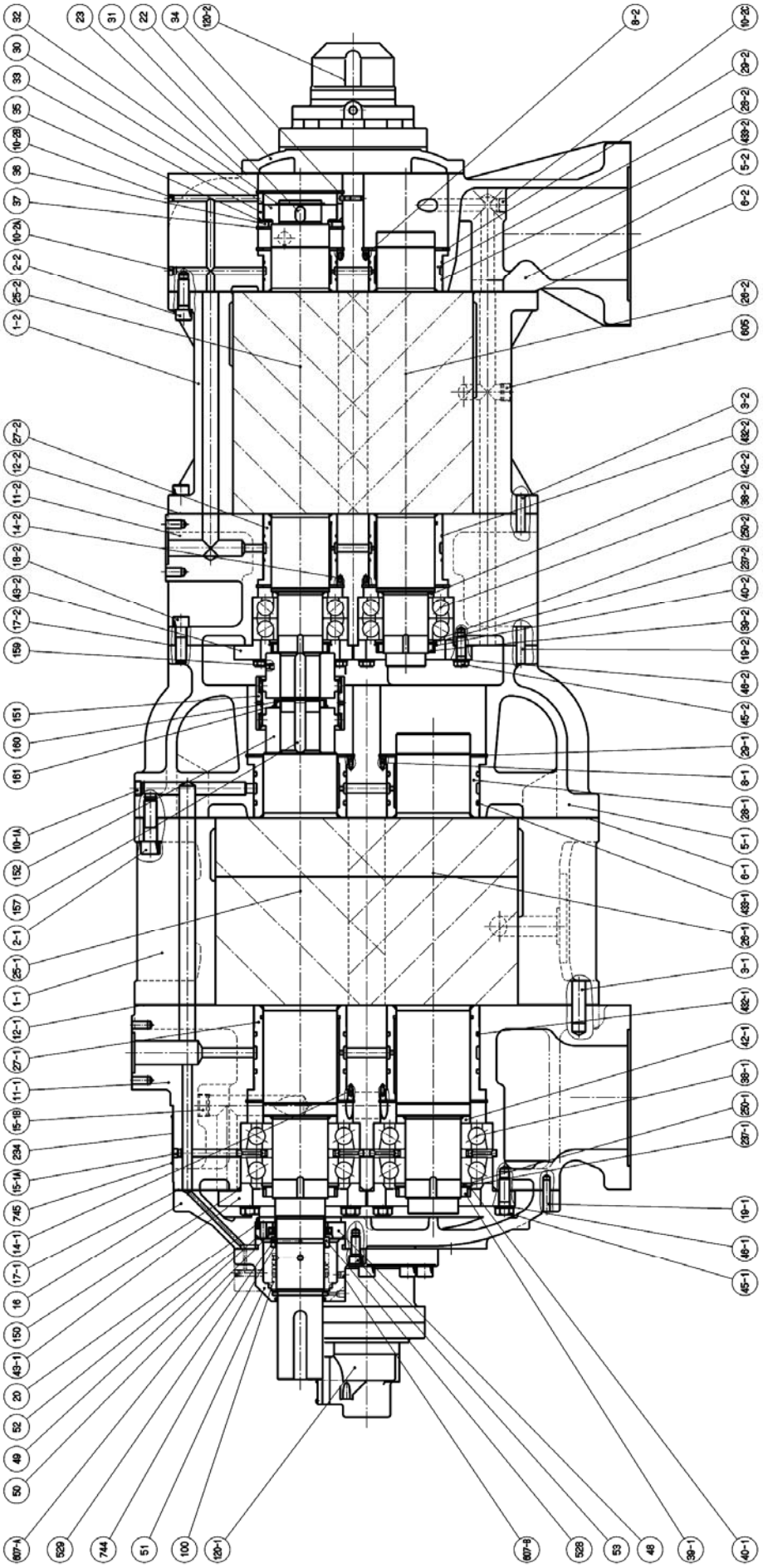



Figure 7-22 3225SLC Assembly Sectional View (Horizontal)

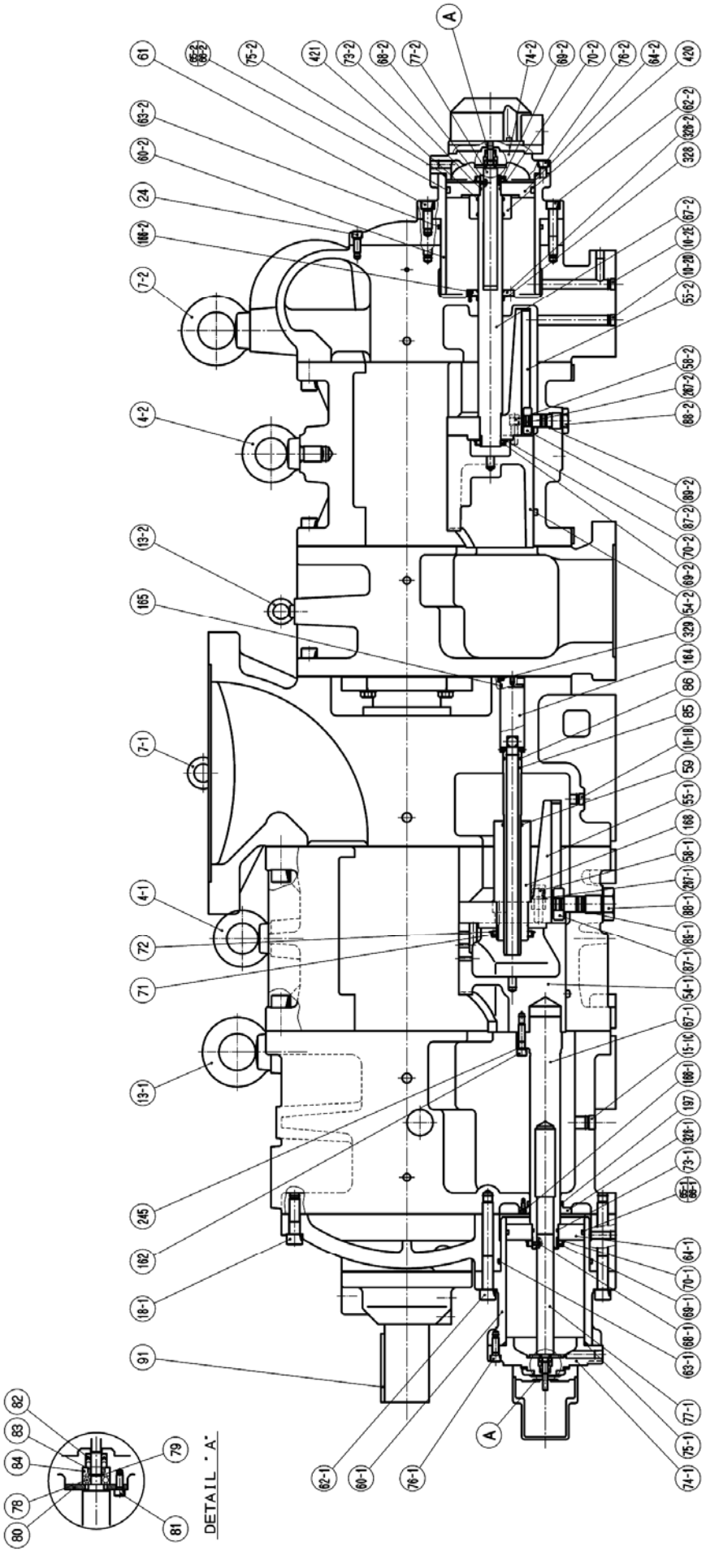



Figure 7-23 3225SMC Assembly Sectional View (Vertical)

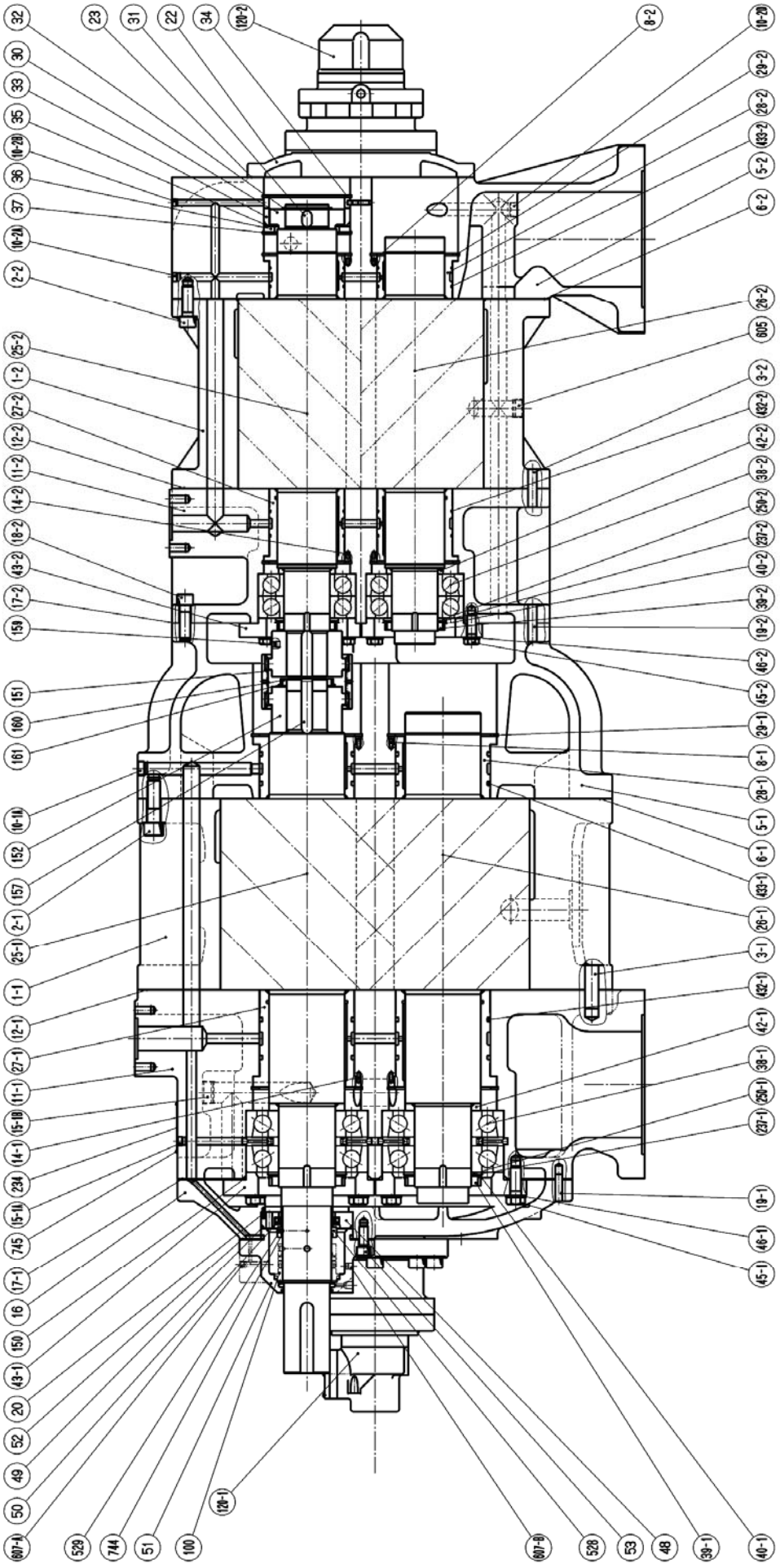



Figure 7-24 3225SMC Assembly Sectional View (Horizontal)

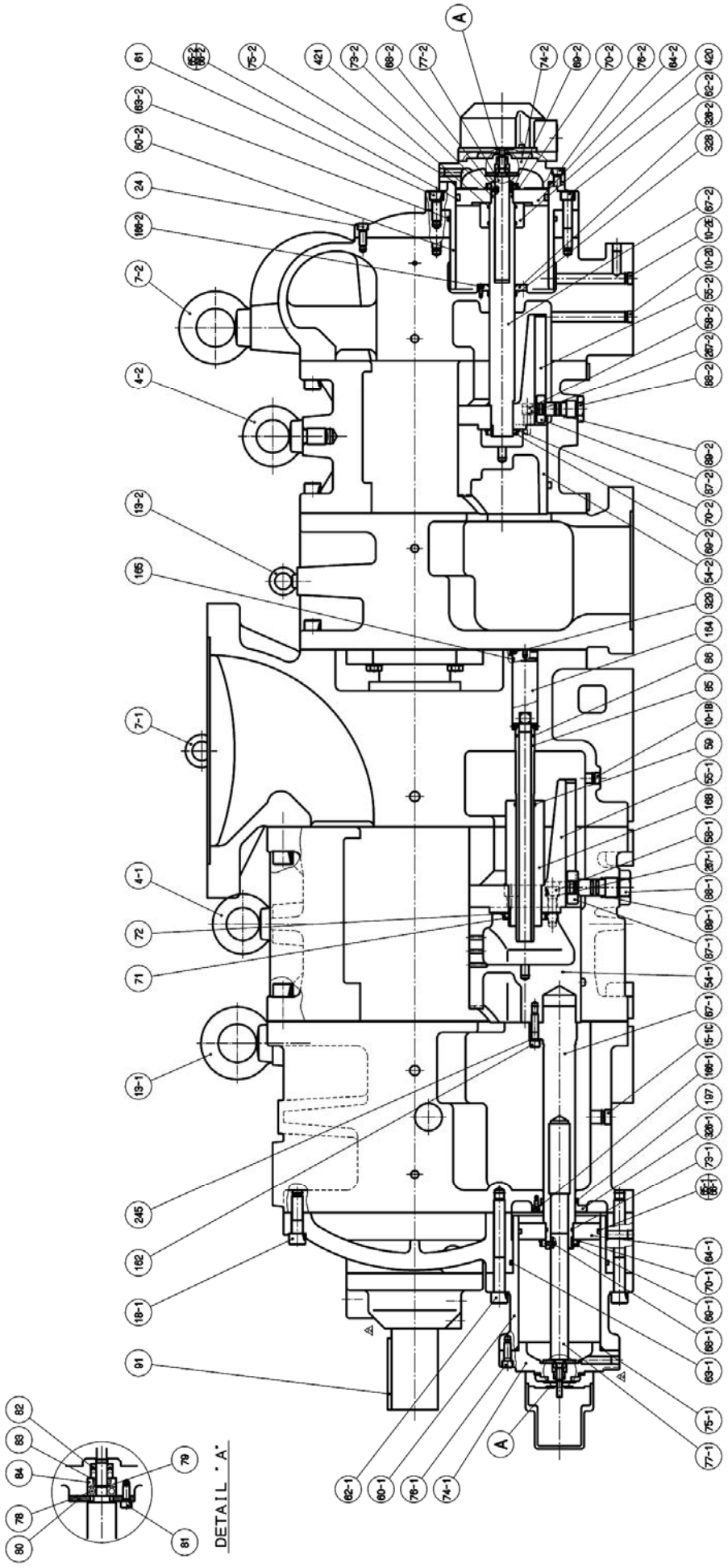



Figure 7-25 3225SSC Assembly Sectional View (Vertical)

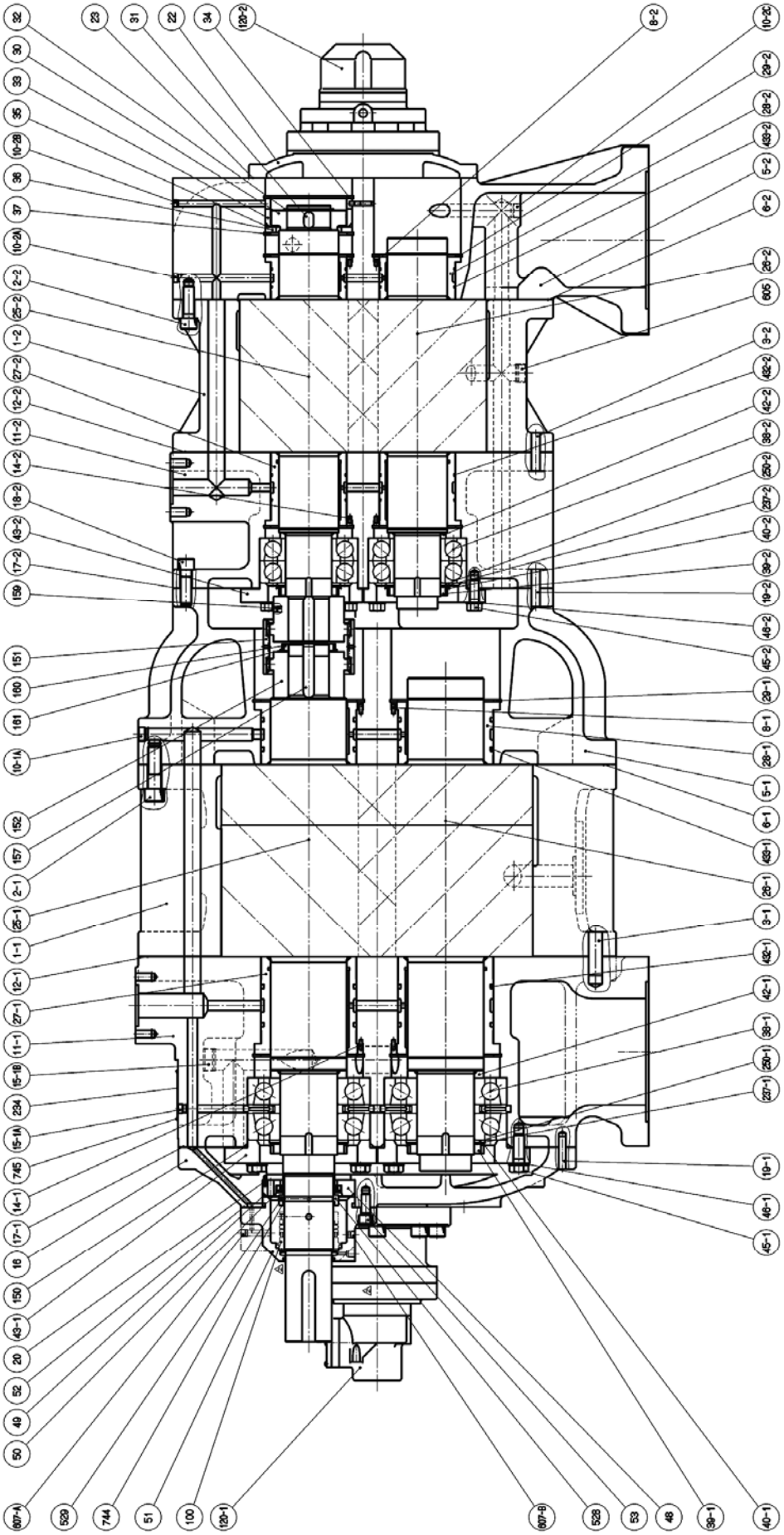



Figure 7-26 3225SSC Assembly Sectional View (Horizontal)

# 7.2 Parts Configuration Table

**Table 7-1 Parts Configuration Table**

| P/N | Part Name | Code No. | Remarks | Q'ty. |
|---|---|---|---|---|
| 1-1 | Main Rotor Casing (1) | CS00100-3225C1S | 3225S** | 1 (S*C) |
| 1-1 | Main Rotor Casing (1) | CS00100-3225C1M | 3225M* | 1 (M*C) |
| 1-1 | Main Rotor Casing (1) | CS00100-3225C1L | 3225L** | 1 (L*C) |
| 1-1 | Main Rotor Casing (1) | CS00100-3225C1LL | 3225LL* | 1(LL*C) |
| 1-2 | Main Rotor Casing (2) | CS00100-250S | 250S** | 1 (*SC) |
| 1-2 | Main Rotor Casing (2) | CS00100-250M | 250M** | 1 (*MC) |
| 1-2 | Main Rotor Casing (2) | CS00100-250L | 250L** | 1 (*LC) |
| 2-1 | Hexagon Socket Head Cap Screw | NB35424-080 | M24×80 | 52 |
| 2-2 | Hexagon Socket Head Cap Screw | NB35424-060 | M20×60 | 44 |
| 3-1 | Alignment Pin | NE2025-080 | Φ25×80 | 4 |
| 3-2 | Alignment Pin | NE2016-070 | Φ16×70 | 4 |
| 4-1 | Eye Bolt | NB600-30 | M30 | 2 |
| 4-2 | Eye Bolt | NB600-30 | M30 | 1 |
| 5-1 | Suction Cover (1) | CS00500-3225C1 | 3225**C | 1 |
| 5-2 | Suction Cover (2) | CS00500-3225C2 | 3225**C | 1 |
| 6-1 | Gasket, Suction Cover (1) | CS00600-320N | 320*** | 1 |
| 6-2 | Gasket, Suction Cover (2) | CS00600-3225CN | 3225**C | 1 |
| 7-1 | Eye Bolt | NB600-16 | M16 | 2 |
| 7-2 | Eye Bolt | NB600-36 | M36 | 1 |
| 8-1 | Spring Pin (1) | NE3206-018 | Φ6×18 | 2 |
| 8-2 | Spring Pin (2) | NE3206-012 | Φ6×12 | 2 |
| 10-1A | Plug | NF06-020 | R3/4 | 1 |
| 10-1B | Plug | NF06-015 | R1/2 | 1 |
| 10-2A | Plug | NF06-010 | R3/8 | 1 |
| 10-2B | Plug | NF06-032 | R1/4 | 1 |
| 10-2C | Plug | NF06-020 | R3/4 | 1 |
| 10-2D | Plug | NF06-015 | R1/2 | 1 |
| 10-2E | Plug | NF06-015 | R1/2 | 1 |
| 10-2F | Plug | NF06-015 | R1/2 | 1 |
| 11-1 | Bearing Head (1) | CS01100-3225C1 | 3225**C | 1 |
| 11-2 | Bearing Head (2) | CS01100-3225C2 | 3225**C | 1 |
| 12-1 | Gasket, Bearing Head (1) | CS01200-320N | 320*** | 1 |
| 12-2 | Gasket, Bearing Head (2) | CS01200-250N | 250*** | 1 |
| 13-1 | Eye Bolt | NB0600-036 | M36 | 2 |
| 13-2 | Eye Bolt | NB0600-012 | M12 | 1 |
| 14-1 | Spring Pin (1) | NE3206-018 | Φ6×18 | 2 |
| 14-2 | Spring Pin (2) | NE3206-012 | Φ6×12 | 2 |
| 15-1A | Plug | NF06-010 | R3/8 | 1 |
| 15-1B | Plug | NF06-032 | R1"1/4 | 1 |
| 15-1C | Plug | NF06-020 | R3/4 | 1 |
| 16 | Bearing Cover | CS01800-3225C | 3225**C | 1 |
| 17-1 | Gasket, Bearing Cover (1) | CS01700-3225CN | 3225**C | 1 |
| 17-2 | Gasket, Bearing Cover (2) | CS73300-3225CN | 3225**C | 1 |

| P/N | Part Name | Code No. | Remarks | Q'ty. |
|---|---|---|---|---|
| 18-1 | Hexagon Socket Head Cap Screw | NB35420-070 | M20×70 | 20 |
| 18-2 | Hexagon Socket Head Cap Screw | NB35420-065 | M20×65 | 24 |
| 19-1 | Alignment Pin | NE2013-060 | Φ13×60 | 2 |
| 19-2 | Alignment Pin | NE2016-070 | Φ16×70 | 2 |
| 20 | Spring Pin | NE3203-016 | Φ3×16 | 1 |
| 22 | Balance Piston Cover | CS02200-250 | 250V** | 1 |
| 23 | Gasket, Balance Piston Cover | CS02300-250N | 250*** | 1 |
| 24 | Hexagon Socket Head Cap Screw | NB35412-030 | M12×30 | 11 |
| 25-1 | Male Rotor (1) | CS02520-3225*** | 3225S*C O-profile, induction hardening | 1 (S*C) |
| 26-1 | Female Rotor (1) | | | |
| 25-1 | Male Rotor (1) | CS02520-3225*** | 3225M*C O-profile, induction hardening | 1 (M*C) |
| 26-1 | Female Rotor (1) | | | |
| 25-1 | Male Rotor (1) | CS02520-3225*** | 3225L*C O-profile, induction hardening | 1 (L*C) |
| 26-1 | Female Rotor (1) | | | |
| 25-1 | Male Rotor (1) | CS02520-3225*** | 3225LL* O-profile, induction hardening | 1(LL*C) |
| 26-1 | Female Rotor (1) | | | |
| 25-2 | Male Rotor (2) | CS02520-3225*** | 3225*SC O-profile, induction hardening | 1 (*SC) |
| 26-2 | Female Rotor (2) | | | |
| 25-2 | Male Rotor (2) | CS02520-3225*** | 3225*MC O-profile, induction hardening | 1 (*MC) |
| 26-2 | Female Rotor (2) | | | |
| 25-2 | Male Rotor (2) | CS02520-3225*** | 3225*LC O-profile, induction hardening | 1 (*LC) |
| 26-2 | Female Rotor (2) | | | |
| 27-1 | Main Bearing (1) O-ring type | CS0270-GRT | 320*** | 2 |
| 27-2 | Main Bearing (2) O-ring type | CS0270-FRT | 250*** | 2 |
| 28-1 | Side Bearing (1) O-ring type | CS0280-GRT | 320*** | 2 |
| 28-2 | Side Bearing (2) O-ring type | CS0280-FRT | 250*** | 2 |
| 29-1 | Snap Ring (1)　C type internal | NG11-200 | H200 | 4 |
| 29-2 | Snap Ring (2)　C type internal | NG11-160 | H160 | 4 |
| 30 | Balance Piston | CS03000-250 | 250*** | 1 |
| 31 | Key, Balance Piston | CS03100-250 | 250*** | 1 |
| 32 | Snap Ring　C type external | NG12-080 | S80 | 1 |
| 33 | Sleeve, Balance Piston | CS03300-250 | 250*** | 1 |
| 34 | Set Screw | NA83608-020 | M8×20 | 2 |
| 35 | O-ring | PA11-150 | JIS B 2401 P150 | 1 |
| 36 | Spacer | CS03600-250 | 250*** | 1 |
| 37 | Snap Ring　C type internal | NG11-160 | H160 | 2 |
| 38-1 | Thrust Bearing (1) | CS03800-320 | 320*** | 2 |
| 38-2 | Thrust Bearing (2) | CS03800-250P | 250*** PPS | 2 |
| 39-1 | Lock Nut (1) | NG31-021 | AN21 | 2 |
| 39-2 | Lock Nut (2) | NG31-017 | AN17 | 2 |
| 40-1 | Lock Washer (1) | NG32-021 | AW21 | 2 |
| 40-2 | Lock Washer (2) | NG32-017 | AW17 | 2 |
| 42-1 | Spacer, Thrust Bearing Alignment (1) | CS04200-B320 | 320*** | 2 |
| 42-2 | Spacer, Thrust Bearing Alignment (2) | CS04200-250 | 250*** | 2 |
| 43-1 | Thrust Bearing Gland (1) | CS04300-320S | 320*** | 2 |
| 43-2 | Thrust Bearing Gland (2) | CS04300-250S | 250*** | 2 |
| 45-1 | Hexagon Head Bolt | NB111020-055 | M20×55 | 8 |

| P/N | Part Name | Code No. | Remarks | Q'ty. |
|---|---|---|---|---|
| 45-2 | Hexagon Head Bolt | NB111016-045 | M16×45 | 8 |
| 46-1 | Conical Spring Washer | CS04600-320 | M20 | 8 |
| - | Lock Washer (1) Set (old, plate type) | CS0469-G | 320*** 8ps/set | - |
| 46-2 | Conical Spring Washer | CS04600-250 | M16 | 8 |
| - | Lock Washer (2) Set (old, plate type) | CS0469-F | 250*** 8ps/set | - |
| 48 | Retainer, Oil Seal | CS04800-320VDS | 320V** | 1 |
| 49 | O-ring | PA12-160 | JIS B 2401 G160 | 1 |
| 50 | Oil Seal | CS05010-320VD | SA1J 95×120×13 | 1 |
| 51 | Seal Cover | CS05100-320 | 320*** | 1 |
| 52 | Gasket, Seal Cover | CS05200-320N | 320*** | 1 |
| 53 | Hexagon Socket Head Cap Screw | NB35416-040 | M16×40 | 8 |
| 54-1 | Unloader Slide Valve (1-1) (L Port) | - | 3225S*C | 1 (S*C) |
| 54-1 | Unloader Slide Valve (1-1) (M Port) | - | 3225S*C | 1 (S*C) |
| 54-1 | Unloader Slide Valve (1-1) (L Port) | - | 3225M*C | 1 (M*C) |
| 54-1 | Unloader Slide Valve (1-1) (M Port) | - | 3225M*C | 1 (M*C) |
| 54-1 | Unloader Slide Valve (1-1) (L Port) | - | 3225L*C | 1 (L*C) |
| 54-1 | Unloader Slide Valve (1-1) (M Port) | - | 3225L*C | 1 (L*C) |
| 54-1 | Unloader Slide Valve (1-1) (L Port) | - | 3225LL*C | 1(LL*C) |
| 54-1 | Unloader Slide Valve (1-1) (M Port) | - | 3225LL*C | 1(LL*C) |
| 54-2 | Unloader Slide Valve (1-2) (L Port) | - | 3225*SC | 1 (*SC) |
| 54-2 | Unloader Slide Valve (1-2) (M Port) | - | 3225*SC | 1 (*SC) |
| 54-2 | Unloader Slide Valve (1-2) (L Port) | - | 3225*MC | 1 (*MC) |
| 54-2 | Unloader Slide Valve (1-2) (M Port) | - | 3225*MC | 1 (*MC) |
| 54-2 | Unloader Slide Valve (1-2) (L Port) | - | 3225*LC | 1 (*LC) |
| 54-2 | Unloader Slide Valve (1-2) (M Port) | - | 3225*LC | 1 (*LC) |
| 55-1 | Unloader Slide Valve (2-1) | - | 320S** | 1 (S*C) |
| 55-1 | Unloader Slide Valve (2-1) | - | 320M** | 1 (M*C) |
| 55-1 | Unloader Slide Valve (2-1) | - | 320L** | 1 (L*C) |
| 55-1 | Unloader Slide Valve (2-1) | - | 320LL* | 1(LL*C) |
| 55-2 | Unloader Slide Valve (2-2) | - | 250S** | 1 (*SC) |
| 55-2 | Unloader Slide Valve (2-2) | - | 250M** | 1 (*MC) |
| 55-2 | Unloader Slide Valve (2-2) | - | 250L** | 1 (*LC) |
| 58-1 | Hexagon Socket Head Cap Screw | NB35416-050 | M16×50 | 4 |
| 58-2 | Hexagon Socket Head Cap Screw | NB35412-040 | M12×40 | 4 |
| 59 | O-ring | PA11-032 | JIS B 2401 P32 | 1 |
| 60-1 | Unloader Cylinder (1) | - | 3225S*C | 1 (S*C) |
| 60-1 | Unloader Cylinder (1) | - | 3225L*C | 1(M*C)(L*C) |
| 60-2 | Unloader Cylinder (2) | - | 250S,250L | 1 (*SC)(*LC) |
| 60-2 | Unloader Cylinder (2) | - | 250M | 1 (*MC) |
| 61 | Hexagon Socket Head Cap Screw | NB35416-040 | M16×40 | 2 |
| 62-1 | Hexagon Socket Head Cap Screw | NB35420-070 | M20×170 | 8 |
| 62-2 | Hexagon Socket Head Cap Screw | NB35416-090 | M16×90 | 6 |
| 63-1 | O-ring | PA12-170 | JIS B 2401 G170 | 1 |
| 63-2 | O-ring | PA12-190 | JIS B 2401 G190 | 1 |
| 64-1 | Unloader Piston (1) | CS06400-3225CK | 3225**C | 1 |
| 64-2 | Unloader Piston (2) | CS06400-250T | 250*** | 1 |
| 65-1 | O-ring | PA11-140 | JIS B 2401 P140 | 1 |

| P/N | Part Name | Code No. | Remarks | Q'ty. |
|---|---|---|---|---|
| 65-2 | O-ring | PA11-155 | JIS B 2401 P155 | 1 |
| 66-1 | Teflon Cap Seal | CS06600-3225 | SUNR-BE-140(S4101) | 1 |
| 66-2 | Teflon Cap Seal | CS06600-250 | SUNR-BE-155(S4101) | 1 |
| 67-1 | Push Rod, Unloader Slide Valve (1) | CS06700-3225C | 3225S*C | 1 (S*C) |
| 67-1 | Push Rod, Unloader Slide Valve (1) | - | 3225L*C,M*C,LL*C | 1(M*C)(L*C) |
| 67-2 | Push Rod, Unloader Slide Valve (2) | - | 3225*SC | 1 (*SC) |
| 67-2 | Push Rod, Unloader Slide Valve (2) | - | 3225*MC | 1 (*MC) |
| 67-2 | Push Rod, Unloader Slide Valve (2) | - | 3225*LC | 1 (*LC) |
| 68-1 | Guide Pin (1) | NE2506-016 | Φ6×16 | 1 |
| 68-2 | Guide Pin (2) | NE2506-012 | Φ5×12 | 1 |
| 69-1 | Lock Nut (1) | NG31-010 | AN10 | 1 |
| 69-2 | Lock Nut (2) | NG31-008 | AN08 | 2 |
| 70-1 | Lock Washer (1) | NG32-010 | AW10 | 1 |
| 70-2 | Lock Washer (2) | NG32-008 | AW08 | 2 |
| 71 | Lock Nut | NG31-012 | AN12 | 1 |
| 72 | Lock Washer | NG32-012 | AW12 | 1 |
| 73-1 | O-ring | PA11-044 | JIS B 2401 P44 | 1 |
| 73-2 | O-ring | PA12-035 | JIS B 2401 G35 | 1 |
| 74-1 | Unloader Cover (1) | CS07400-3225C | 3225**C | 1 |
| 74-2 | Unloader Cover (2) | CS07400-250S | 250*** | 1 |
| 75-1 | O-ring | PA12-150 | JIS B 2401 G150 | 1 |
| 75-2 | O-ring | PA12-170 | JIS B 2401 G170 | 1 |
| 76-1 | Hexagon Socket Head Cap Screw | NB35412-035 | M12×35 | 8 |
| 76-2 | Hexagon Socket Head Cap Screw | NB35412-030 | M12×30 | 8 |
| 77-1 | Indicator Cam (1) | - | 3225S*C | 1 (S*C) |
| 77-1 | Indicator Cam (1) | - | 3225M*C | 1 (M*C) |
| 77-1 | Indicator Cam (1) | CS07700-3225C | 3225L*C | 1 (L*C) |
| 77-2 | Indicator Cam (2) | CS07700-250S | 250S** | 1 (*SC)(*LC) |
| 77-2 | Indicator Cam (2) | - | 250M** | 1 (*MC) |
| 78 | Ball Bearing | CS07800-200 | #6000 | 2 |
| 79 | Snap Ring C type external | NG12-010 | S10 | 2 |
| 80 | Bearing Gland | CS08000-200 | 200*** | 2 |
| 81 | Hexagon Socket Head Cap Screw | NB35406-015 | M6×15 | 6 |
| 82 | V-ring | CS08200-200B | VH10 NBR | 2 |
| 83 | Spring | CS08300-200 | 200*** | 2 |
| 84 | Retainer, Indicator Cam Spring | CS08400-200 | 200*** | 2 |
| 85 | Oil Injection Pipe | - | 3225S*C | 1 (S*C) |
| 85 | Oil Injection Pipe | - | 320M** | 1 (M*C) |
| 85 | Oil Injection Pipe | - | 320L** | 1 (L*C) |
| 86 | O-ring | PA12-030 | JIS B 2401 G30 | 1 |
| 87-1 | Guide Block (1) | CS08700-320 | 320*** | 1 |
| 88-1 | Stem, Guide Block (1) | | | |
| 87-2 | Guide Block (2) | CS08700-250 | 250*** | 1 |
| 88-2 | Stem, Guide Block (2) | | | |
| 89-1 | O-ring | PA11-024 | JIS B 2401 P24 | 2 |
| 89-2 | O-ring | PA11-020 | JIS B 2401 P20 | 2 |
| 91 | Shaft Key | CS09100-320 | 320*** | 1 |

| P/N | Part Name | Code No. | Remarks | Q'ty. |
|---|---|---|---|---|
| 92-1 | Suction Flange (1) with hole | CS71300-350 | JIS 20K 350A (14") | 1 |
| 92-1 | Suction Flange (1) without hole | CS71300-P350 | JIS 20K 350A (14") | 1 |
| 92-2 | Suction Flange (2) with hole | CS71300-200 | JIS 20K 200A (8") | 1 |
| 92-2 | Suction Flange (2) without hole | CS71300-P200 | JIS 20K 200A (8") | 1 |
| 93-1 | Gasket, Suction Flange (1) | CS71200-350N | JIS 20K 350A (14") | 1 |
| 93-2 | Gasket, Suction Flange (2) | CS71200-200N | JIS 20K 200A (8") | 1 |
| 94-1 | Hexagon Head Bolt | NB12030-080P3 | M30P3×80 | 16 |
| 94-2 | Hexagon Head Bolt | NB12022-055 | M22×55 | 12 |
| 95-1 | Discharge Flange (1) with hole | CS71300-200 | JIS 20K 200A (8") | 1 |
| 95-1 | Discharge Flange (1) without hole | CS71300-P200 | JIS 20K 200A (8") | 1 |
| 95-2 | Discharge Flange (2) with hole | CS71300-150 | JIS 20K 150A (6") | 1 |
| 95-2 | Discharge Flange (2) without hole | CS71300-P150 | JIS 20K 150A (6") | 1 |
| 96-1 | Gasket, Discharge Flange (1) | CS71200-200N | JIS 20K 200A | 1 |
| 96-2 | Gasket, Discharge Flange (2) | CS71200-150N | JIS 20K 150A | 1 |
| 97-1 | Hexagon Head Bolt | NB12022-055 | M22×55 | 12 |
| 97-2 | Hexagon Head Bolt | NB12022-055 | M22×55 | 12 |
| 100 | Mechanical Seal Assembly | CS10000-320BE | BOS-E1 | 1 |
| 100 | Mechanical Seal Assembly | CS10002-320EBS | BBS-E | 1 |
| 100 | Mechanical Seal Assembly | CS10001-320BBS | BBS3 | 1 |
| 120-1 | Unloader Indicator Assembly (1) | CS12000-1612F | 1612**C | 1 |
| 120-2 | Unloader Indicator Assembly (2) | CS12000-3225 | 3225C (2) 30-100% | 1 |
| 125-1 | Micro Switch Set (1) | CS1259-C | 125L** | 1 |
| 125-2 | Micro Switch (2) | CS12500-200 | 200*** Z15GW | 2 |
| 127-1 | Micro Switch Cam (1) | CS12700-125F | 125L** 0-100% | 1 |
| 127-2 | Micro Switch Cam (2) | CS12700-322530 | 3225*SC/*MC (2) | 1 |
| 127-2 | Micro Switch Cam (2) | CS12700-200F | 3225*LC (2) | 1 |
| 129-1 | Potentiometer (1) | CS1299-J | 1612 1k with lead wire | 1 |
| 129-2 | Potentiometer (2) 200-1k | CS1299-E10 | with lead wire | 1 |
| 137-1 | Indicator Dial (1) | CS13700-1612CA | 1612**C | 1 |
| 137-2 | Indicator Dial (2) | CS13700-3225C | 3225*SC/*MC (2) | 1 |
| 137-2 | Indicator Dial (2) | CS13700-200 | 3225*LC (2) | 1 |
| 202-1 | Bevel Gear | CS20100-1612C6 | 1612 ID 6mm | 2 |
| 150 | O-ring | PA12-220 | JIS B 2401 G220 | 2 |
| - | Gear Coupling Assembly (Current Type) | CS1519-M | 151+152+153+159 | 1 |
| - | Gear Coupling Assembly (Old Type) | CS1519-M | 151+152+153+159 +154+155 | - |
| 151 | Drive Sleeve | CS15100-3225C | 3225**C IUS-A-30 | 1 |
| 152 | Drive Hub | | 3225**C IUS-A-30 | 2 |
| 154 | Stopper, Drive Sleeve | | 3225**C IUS-A-30 | 2 |
| 155 | Stop Ring | - | FRS-130 | 4 |
| 157 | Key, Driven Hub & Drive Hub | CS15700-3225CH | 20×12×84 | 2 |
| 159 | Set Screw | NA83610-025 | M10×16 knurled, with anti-loosening | 1 |
| 160 | Lock Nut | NG31-015 | AN15 | 1 |
| 161 | Lock Washer | NG32-015 | AW15 | 1 |
| 162 | Hexagon Socket Head Cap Screw | NB35412-050 | M12×50 | 5 |
| 164 | Retainer, Oil Injection Pipe | CS16400-3225C | 3225**C | 1 |
| 165 | O-ring | PA11-040 | JIS B 2401 P40 | 1 |

| P/N | Part Name | Code No. | Remarks | Q'ty. |
|---|---|---|---|---|
| 166-1 | Hexagon Socket Head Cap Screw | NB35496-015 | M6×15 | 4 |
| 166-2 | Hexagon Socket Head Cap Screw | NB35405-012 | M5×12 | 4 |
| 168 | Pipe Guide, Oil Injection | CS16800-3225C | 3225L*C,M*C,S*C | 1 |
| 168 | Pipe Guide, Oil Injection | - | 3225LL*C | 1(LL*C) |
| 197 | O-ring | PA11-058 | JIS B 2401 P58 | 1 |
| 215-1 | Flange, Lubricating Oil Supply (1) with hole | CS71300-040MK | JIS 20K 40A (1"1/2) | 1 |
| 215-1 | Flange, Lubricating Oil Supply (1) without hole | CS71300-040 | JIS 20K 40A (1"1/2) | 1 |
| 215-2 | Flange, Lubrication Oil Supply (2) with hole | CS71300-025MK | JIS 20K 25A (1") | 1 |
| 215-2 | Flange, Lubricating Oil Supply (2) without hole | CS71300-025 | JIS 20K 25A (1") | 1 |
| 216-1 | Gasket, Lubricating Oil Supply Flange (1) | CS71200-040N | JIS 20K 40A | 1 |
| 216-2 | Gasket, Lubricating Oil Supply Flange (2) | CS71200-025N | JIS 20K 25A | 1 |
| 217-1 | Hexagon Head Bolt | NB12016-045 | M16×45 | 4 |
| 217-2 | Hexagon Head Bolt | NB12016-045 | M16×45 | 4 |
| 218 | Flange, Injection Oil Supply with hole | CS71300-020MK | JIS 20K 20A (3/4") | 1 |
| 218 | Flange, Injection Oil Supply without hole | CS71300-020 | JIS 20K 20A (3/4") | 1 |
| 219 | Gasket, Injection Oil Supply Flange | CS71200-020N | JIS 20K 20A | 1 |
| 220 | Hexagon Head Bolt | NB12012-035 | M12×35 | 4 |
| 237-1 | Torsional Slip Washer (1) | CS23700-320 | 320*** | 2 |
| 237-2 | Torsional Slip Washer (2) | CS23700-250 | 250*** | 2 |
| 245- | Spring Washer | ND330-12 | M12 | 5 |
| 250-1 | Thrust Washer (1) | CS25000-320 | 320*** | 2 |
| 250-2 | Thrust Washer (2) | CS25000-250 | 250*** | 2 |
| 267-1 | Special Spring Washer for Hexagon Socket Head Cap Screw | ND330-16 | M16 | 4 |
| 267-2 | Special Spring Washer for Hexagon Socket Head Cap Screw | ND330-12 | M12 | 4 |
| 326-1 | Gland, O-ring (1) | CS32600-3225C | 3225**C | 1 |
| 326-2 | Gland, O-ring (2) | CS32600-3225C2 | 3225**C | 1 |
| 328 | O-ring | PA11-046 | JIS B 2401 P46 | 1 |
| 329 | Spring Pin | NE3204-010 | Φ4×10 | 1 |
| 350 | Flange, Balance Piston Oil Return Piping with hole | CS71300-020MK | JIS 20K 20A (3/4") | 1 |
| 350 | Flange, Balance Piston Oil Return Piping without hole | CS71300-020 | JIS 20K 20A (3/4") | 1 |
| 351 | Gasket, Balance Piston | CS71200-020N | JIS 20K 20A | 1 |
| 352 | Hexagon Head Bolt | NB12012-035 | M12×35 | 4 |
| 353 | Flange, Bearing Cover Oil Return Piping with hole | CS71300-032MK | JIS 20K 32A( 1-1/4") | 1 |
| 353 | Flange, Bearing Cover Oil Return Piping without hole | CS71300-032 | JIS 20K 32A (1-1/4") | 1 |
| 354 | Gasket, Bearing Cover | CS71200-032N | JIS 20K 32A | 1 |
| 355 | Hexagon Head Bolt | NB12016-045 | M16×45 | 4 |
| 356 | Flange, Rotor Casing Oil Return Piping with hole | CS71300-032MK | JIS 20K 32A (1-1/4") | 1 |
| 356 | Flange, Rotor Casing Oil Return Piping without hole | CS71300-032 | JIS 20K 32A (1-1/4") | 1 |
| 357 | Gasket, Rotor Casing | CS71200-032N | JIS 20K 32A | 1 |
| 358 | Hexagon Head Bolt | NB12016-045 | M16×45 | 4 |
| 420 | Spacer, Unload Position (High-stage) | CS42000-250S30 | 250S** 30 % load | 1 (*SC) |
| 420 | Spacer, Unload Position (High-stage) | CS42000-250M30 | 250M** 30 % load | 1 (*MC) |

| P/N | Part Name | Code No. | Remarks | Q'ty. |
|---|---|---|---|---|
| 421 | O-ring | PA11-046 | JIS B 2401 P46 | 2(*SC)(*MC) |
| 423 | Spacer, Unload Position (Low-stage) | CS42300-3225MSC | 3225M*C | 1 (M*C) |
| 431 | O-ring | PA11-140 | JIS B 2401 P140 | 1 (M*C) |
| 432-1 | O-ring | PA12-165 | JIS B 2401 G165 | 4 |
| 432-2 | O-ring | PA12-130 | JIS B 2401 G130 | 4 |
| 433-1 | O-ring | PA12-165 | JIS B 2401 G165 | 4 |
| 433-2 | O-ring | PA12-130 | JIS B 2401 G130 | 4 |
| 528 | Sleeve with O-ring, Oil Seal | CS52809-320VD | 320V** | 1 |
| 529 | Set Screw | NA83606-008 | M6×8 | 2 |
| 605 | Plug | NF06-025 | R 1" | 1 |
| 607-A | Plug | NF06-008 | R 1/4 | 1 |
| 607-B | Plug | NF06-008 | R 1/4 | 1 |
| 744 | O-ring | PA12-090 | JIS B 2401 G90 | 1 |
| - | O-ring set | CS7109-0M | NBR 3225C | - |
| - | Gasket set | CS7118-0M | 3225C | - |

【POINT】

The sizes of O-ring No.432-2 and No.432-2 have been changed to G130 from G135 in October 2012 as a design change.

**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 Tightening Torques for Bolts and Nuts

**Table 7-2 List of Tightening Torques**

## ■ Hexagon socket head cap screw

| P/N | What is tightened | Torque | | Q'ty. | Size |
|---|---|---|---|---|---|
| | | N·m | kgf·cm | | |
| 2-1 | Main Rotor Casing (1) to Suction Cover (1) and Bearing Head (1) | 750 | 7500 | 52 | M24×80 |
| 2-2 | Main Rotor Casing (2) to Suction Cover (2) and Bearing Head (2) | 750 | 7500 | 44 | M24×60 |
| 18-1 | Bearing Cover to Bearing Head (1) | 450 | 4500 | 20 | M20×70 |
| 18-2 | Suction Cover (1) to Bearing Head (2) | 450 | 4500 | 24 | M20×65 |
| 24 | Balance Piston Cover to Suction Cover (2) | 90 | 900 | 11 | M12×30 |
| 53 | Seal Cover to Bearing Cover | 240 | 2400 | 8 | M16×40 |
| 58-1 | For Securing Unloader Slide Valve | 240 | 2400 | 4 | M16×50 |
| 58-2 | For Securing Unloader Slide Valve | 90 | 900 | 4 | M12×40 |
| 61 | Unloader Cylinder (2) to Balance Piston Cover | 240 | 2400 | 2 | M16×40 |
| 62-1 | Unloader Cylinder (1) to Bearing Cover and Bearing Head (1) | 450 | 4500 | 8 | M20×170 |
| 62-2 | Unloader Cylinder (2) to Balance Piston Cover and Suction Cover (2) | 240 | 2400 | 6 | M16×90 |
| 76-1 | Unloader Cover (1) to Unloader Cylinder (1) | 90 | 900 | 8 | M12×35 |
| 76-2 | Unloader Cover (2) to Unloader Cylinder (2) | 90 | 900 | 8 | M12×30 |
| 81 | Bearing Gland (1) (2) to Unloader Cover | 10 | 100 | 6 | M6×15 |
| 162 | Push Rod, Unloader Slide Valve (1) | 90 | 900 | 5 | M12×50 |
| 166-1 | O-ring Gland (1) to Bearing Head (1) | 10 | 100 | 4 | M6×15 |
| 166-2 | O-ring Gland (1) to Suction Cover (2) | 6 | 60 | 4 | M5×12 |

## ■ Hexagon Head Bolt

| P/N | What is tightened | Torque | | Q'ty. | Size |
|---|---|---|---|---|---|
| | | N·m | kgf·cm | | |
| 45-1 | Thrust Bearing Gland (1) | 120 | 1200 | 8 | M20×55 |
| 45-2 | Thrust Bearing Gland (2) | 60 | 600 | 8 | M16×45 |
| 94-1 | Suction Flange (1) JIS 20K 350A | 200 | 2000 | 12 | M30×80 |
| 94-2 | Suction Flange (intermediate pipe) (2) JIS 20K 200A | 140 | 1400 | 12 | M22×55 |
| 97-1 | Discharge Flange (intermediate pipe) (1) JIS 20K 200A | 140 | 1400 | 12 | M22×55 |
| 97-2 | Discharge Flange (2) JIS 20K 150A | 160 | 1600 | 8 | M22×55 |
| 217-1 | Journal Lubrication Flange (1) JIS 20K 40A | 40 | 400 | 4 | M16X45 |
| 217-2 | Journal Lubrication Flange (1) JIS 20K 250A | 40 | 400 | 4 | M16X45 |
| 220 | Oil Injection Flange JIS 20K 20A | 40 | 400 | 4 | M12X35 |
| 352 | Oil Return Outlet Flange on Suction Cover (2) JIS 20K 20A | 40 | 400 | 4 | M12X35 |
| 355 | Oil Return Outlet Flange on Bearing Cover JIS 20K 32A | 40 | 400 | 4 | M16X45 |
| 358 | Oil Return Inlet Flange on Main Rotor Casing (1) JIS 20K 32A | 40 | 400 | 4 | M16X45 |

## ■ Lock Nut

| P/N | What is tightened | Tightening torque (N·m) | | Q'ty. | Size |
|---|---|---|---|---|---|
| | | Standard | Maximum | | |
| 39-1 | Thrust Bearing (1) Note 1 | 2259 | 2824 | 2 | AN21 |
| 39-2 | Thrust Bearing (2) Note 1 | 1186 | 1483 | 2 | AN17 |
| 69-1 | Unloader Piston (1) | 180 | - | 1 | AN10 |
| 69-2 | Unloader Piston (2) | 140 | - | 1 | AN08 |
| 71-1 | Unloader Slide Valve (1-1) | 408 | 510 | 1 | AN12 |
| 160 | Gear Coupling Drive Hub Note 1 | 810 | 1012 | 1 | AN15 |

Note 1: When tightening a lock nut, if it is difficult to use a torque wrench, manage the tightening torque of the lock nut controlling the tightening angle range as explained below.

## ■ Tightening Angle Range of Lock Nuts for 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.
When measuring the angle, use an angle gauge which is set to the diameter of rotor shaft.

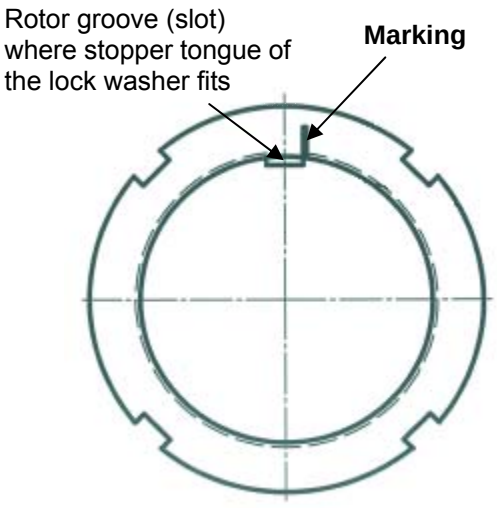



**Figure 7-9 Position where mark is put**

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

| | Model | Angle range |
|---|---|---|
| First time tightening | 250 (High-stage) | 30°to 40° |
| | 320 (Low-stage) | 25°to 35° |
| Second time tightening | 250 (High-stage) | 20°to 30° |
| | 320 (Low-stage) | 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.

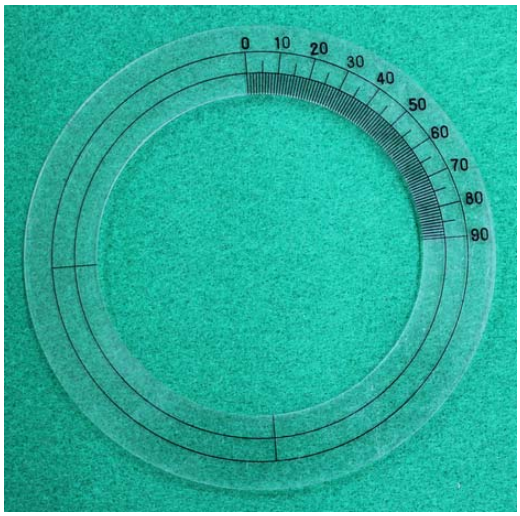



Photo 126 Angle gauge (example)

# 7.4 About the O-rings Used

## 7.4.1 List of O-rings Used

**Table 7-3 List of O-rings Used**

| P/N | Location | | JIS B 2401 Size |
|---|---|---|---|
| | attached place | description in functional aspect | |
| 35 | Sleeve, Balance Piston | same as left | P150 |
| 49 | Seal Retainer | same as left | G160 |
| 59 | Oil Injection Pipe Guide | Oil Injection Pipe | P32 |
| 63-1 | Bearing Cover | Unloader Cylinder (1) | G170 |
| 63-2 | Balance Piston Cover | Unloader Cylinder (2) | G190 |
| 65-1 | Unloader Piston (1) | same as left | P140 |
| 65-2 | Unloader Piston (2) | same as left | P155 |
| 73-1 | Unloader Push Rod (1) | Unloader Piston (1) | P44 |
| 73-2 | Unloader Push Rod (2) | Unloader Piston (2) | G35 |
| 75-1 | Unloader Cover (1) | same as left | G150 |
| 75-2 | Unloader Cover (2) | same as left | G170 |
| 86 | Oil Injection Pipe | same as left | G30 |
| 89-1 | Guide block Stem (1) | same as left | P24 |
| 89-2 | Guide block Stem (2) | same as left | P20 |
| 150 | Thrust Bearing Gland (1) | same as left | G220 |
| 165 | Oil Injection Pipe Gland | same as left | P40 |
| 197 | Bearing Head (1) | Unloader Push Rod (1) | P58 |
| 328 | Suction Cover (2) | Unloader Push Rod (2) | P46 |
| 421 | Unload Spacer (2) | same as left | P46 |
| 431 | Unload Spacer (1) | same as left | P140 |
| 432-1 | Main Bearing (1) | same as left | G165 |
| 432-2 | Main Bearing (2) | same as left | G130 |
| 433-1 | Side Bearing (1) | same as left | G165 |
| 433-2 | Side Bearing (2) | same as left | G130 |
| 744 | Oil Seal Sleeve | same as left | G90 |

■ Attached place means parts which they have grooves or with taper cutting for attaching O-ring.

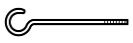
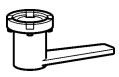
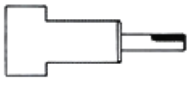
## 7.4.2 O-ring Materials Used for Screw Compressor

**Table 7-4 List of O-ring Materials Used for Screw Compressor (excluding mechanical seal)**

| Working fluid | O-ring material |
|---|---|
| Ammonia | NBR |
| Hydrofluorocarbon (HFC) | |
| $CO_2$ | FKM |
| | HNBR |
| Trifluoromethane (R23) | FKM |
| Propane | |
| Propylene | |
| Natural gas | |
| City gas | |
| Helium | |

# 7.5 Tools for Disassembly

**Table 7-5 List of Tools for Disassembly (example)**

| Tool name | Illustration | size, etc.; | | Parts Center Code No. |
|---|---|---|---|---|
| Ratchet wrench |  | 1/4” | | SG261-08 |
| Adjustable wrench |  | 250 mm | | SG231-250 |
| Screwdriver |  | Phillips | 75 mm | SG112-075 |
| | | | 125 mm | SG112-125 |
| Screwdriver |  | Flat blade | 75 mm | SG111-075 |
| | | | 125 mm | SG111-125 |
| Snap ring pliers |  | External | ST-1 | SG311-01 |
| | | | ST-3 | SG311-03 |
| Snap ring pliers |  | Internal | RT-4 | SG312-04 |
| Eye bolt |  | M8×200 two-peace-set | | UHT0016 |
| Allen wrench key |  | Across flats | 2 mm | SG241-02 |
| | | | 3 mm | SG241-03 |
| | | | 4 mm | SG241-04 |
| | | | 5 mm | SG241-05 |
| | | | 6 mm | SG241-06 |
| | | | 8 mm | SG241-08 |
| | | | 10 mm | SG241-10 |
| | | | 14 mm | SG241-14 |
| | | | 17 mm | SG241-17 |
| | | | 19 mm | SG241-19 |
| Lock nut wrench |  | AN-08 | | SAS111-08 |
| | | AN-10 | | SAS111-10 |
| | | AN-12 | | SAS111-12 |
| | | AN-15 (L) | | SAS112-15 |
| | | AN-17 | | SAS111-17 |
| | | AN-21 | | SAS111-21 |
| Torque wrench for assembly |  | 5-25 N·m | | - |
| | | 20-100 N·m | | SG132-0900 |
| | | 60-420 N·m | | SG132-4200 |
| Assembly and Disassembly Tool, Main/Side Bearing |  | 250S/L | | CS70300-250 |
| | | 320S/L | | CS70300-320 |

# Contact Information

## Sales Offices/Service Centers

### ■ Sales Offices in Japan (as of April 21, 2015)

| Description | Location | Phone/Fax |
|---|---|---|
| Head Office | 3–14–15 BOTAN KOTO-KU, TOKYO 135-8482 | TEL: 03-3642-8181<br>FAX: 03-3643-7094 |
| Hokkaido Branch | 2-5-1, 3-JYO NIJYUUYONKEN NISHI-KU,<br>SAPPORO-CITY, HOKKAIDO 063-0803 | TEL: 011-631-2052<br>FAX: 011-631-2053 |
| Tohoku Branch | 8-72, ROKUTYONO-MEMINAMI-MACHI,<br>WAKABAYASHI-KU, SENDAI-CITY, MIYAGI 984-0013 | TEL: 022-288-5001<br>FAX: 022-288-5155 |
| Kanto Branch | 3–14–15 BOTAN, KOTO-KU, TOKYO 135-8482 | TEL: 03-3642-8968<br>FAX: 03-3641-8468 |
| Chubu Branch | 2-9-6, MARUNOUCHI, NAKA-KU, NAGOYA CITY, AICHI 460-0002 | TEL: 052-218-3307<br>FAX: 052-218-3308 |
| Kansai Branch | 1-4-27, EBIE, FUKUSHIMA-KU, OSAKA CITY, OSAKA 553-0001 | TEL: 06-4795-6000<br>FAX: 06-4795-6033 |
| Chugoku Branch | 2-3-40, TAKAYADAI, HIGASHIHIROSHIMA CITY,<br>HIROSHIMA 739-2117 | TEL: 082-491-1830<br>FAX: 082-491-1838 |
| Shikoku Branch | 410-1, OTAKAMI-MACHI, TAKAMATSU-CITY, KAGAWA 761-2117 | TEL: 087-868-3400<br>FAX: 087-868-3399 |
| Kyushu Branch | FUKUOKA-FUJILAND-BUILD. 10F, 2-3, NAKASHIMA-MACHI,<br>NAKASU, HAKATA-KU, FUKUOKA CITY, FUKUOKA 810-0802 | TEL: 092-262-0016<br>FAX: 092-262-0115 |

### ■ Manufacturing Bases in Japan (as of April 21, 2015)

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

## ■ Global Network (as of April 21, 2015)

| 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. (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 & ANUFACTURING) | 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 |
| MAYEKAWA U.S.A. INC. CHEMICAL PROCESS DIVISION (HUSTON SALES & ENGINEERING OFFICE) | 1770 ST. JAMES PLACE, SUITE 408, HOUSTON, TX 77056, U.S.A. | TEL: (1) 832-547-2320 |
| **EUROPE and AFRICA** | | |
| 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 |
| 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 |

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| MAYEKAWA. S.L. | CALLE MONTEVIDEO 5, NAVE 13<br>POL. INDUSTRIAL CAMPORROSO<br>28806 ALCALA DE HENARES,<br>MADRID, SPAIN | TEL: (34) 91-830-0392<br>FAX: (34) 91-830-0397 |
| MAYEKAWA FRANCAISE SARL | 9, RUE MICHAEL FARADAY, 78180<br>MONTIGNY-LE-BRETONNEUX,<br>FRANCE | TEL: (33) 1-30-58-26-00<br>FAX: (33) 1-30-58-19-37 |
| N.V. MAYEKAWA EUROPE<br>MOSCOW REPRESENTATIVE<br>OFFICE | KOROVY VAL ST., 7, OFFICE 228,<br>119049, MOSCOW,RUSSIA | TEL: (7) 499-230-01-76<br>FAX: (7) 499-230-21-12 |
| MAYEKAWA-SVEDAN SP. Z 0.0.<br>(MPL) | UL. DRUSKIENNICKA 8/10, 60-476<br>POZNAN, POLAND | TEL: (48) 61-842-0738<br>FAX: (48) 61-848-5837 |
| MAYEKAWA INTERTEC AG | ROSENBERGSTRASSE 31, CH-6300<br>ZUG, SWITZERLAND | TEL: (41) 41-726-8626<br>FAX: (41) 41-726-8620 |
| MAYEKAWA INTERTEC AG<br>- EGYPT | P.O.BOX 341<br>NEW CAIRO - 5th SETTLEMENT,<br>NORTH 90th St. THE 47th BUILDING -<br>4th FLOOR, OFFICE 419, EGYPT | TEL: (20) 22-503-2925<br>FAX: (20) 22-503-2801 |
| MAYEKAWA INTERTECH AG<br>- ABU DHABI | ALI & SONS BUSINESS CENTER<br>OFFICE No.201<br>ALI KHALFAN RASHED AL MUTAWA<br>AL DHAHIRI BLDG. PLOT No.29, AL<br>AIN ROAD, UMM AL NAR, ABU DHABI<br>U.A.E. P.O. BOX 129865 | TEL: (971) 2-5102-451<br>FAX: (971) 2-5102-571 |
| MAYEKAWA MIDDLE EAST FZCO | P.O.BOX 61349, PBU: RA08-UC05,<br>JEBEL ALI FREE ZONE, DUBAI, U.A.E. | TEL: (971) 4-888-6363<br>FAX: (971) 4-888-6373 |
| MAYEKAWA TURKEY SOGUTMA<br>SANAYI VE TICARET LIMITED<br>SIRKETI | ISTANBUL DUNYA TICARET MERKEZI<br>A-2 BLOK KAT 10 No:325 YESILKOY<br>34149, ISTANBUL, TURKEY | TEL: (90) 212-4653631<br>FAX: (90) 212-4653635 |
| N.V. MAYEKAWA EUROPE S.A.<br>（BULGARIA） | 24,KAMEN ANDREEV STR. 1303,<br>SOFIA, BULGARIA | TEL: (359) 2-8910130<br>FAX: (359) 2-8910131 |
| MAYEKAWA ITALIA S.R.L.<br>（MILANO OFFICE） | VIA RICCARDO LOMBARDI 19/12,<br>20153 MILANO, ITALY | TEL: (39) 02-4892-9159<br>FAX: (39) 02-453-1728 |
| MAYEKAWA ITALIA S.R.L.<br>（BOLOGNA OFFICE） | VIA PRADAZZO 7,40012 CALDERARA<br>DI RENO,<br>BOLOGNA, ITALY | TEL: (39) 051-726-364<br>FAX: (39) 051-726-804 |
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| MAYEKAWA AUSTRALIA PTY.<br>LTD.(NEW ZEALAND OFFICE) | UNIT 2, 30 TUI STREET, OTAHUHU,<br>AUCKLAND 2024, NEW ZEALAND | TEL: (64) 9-276-2305<br>FAX: (64) 9-276-2306 |
| MAYEKAWA INDIA PVT.LTD.<br>(GURGAON OFFICE) | 545, 1st FLOOR, SECTOR-20,VILLAGE<br>DUNDAHERA<br>GURAGAON-122016, HARYANA,<br>INDIA | TEL: (91) 12-4651-0181<br>FAX: (91) 12-4651-0188 |

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| P.T.MAYEKAWA INDONESIA (MEDAN OFFICE) | JL. SUTRISNO No.274 MEDAN-20215, INDONESIA | TEL: (62) 61-7323627<br>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<br>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<br>FAX: (60) 3-78051409 |
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| MAYEKAWA PHILIPPINES CORP. (GENARAL SANTOS OFFICE) | ROOM 4, LEAH DAPROZA BUILDING FISCAL DAPROZA AVENUE GENERAL SANTOS CITY 9500, PHILIPPINES | TEL: (63) 83-552-3282<br>FAX: (63) 83-301-2698 |
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| MAYEKAWA (TAIWAN) CO., LTD. (KAOHSIUNG OFFICE) | No.2-1,XINZHAN RD.,QIANZHEN DIST.,<br>KAOHSIUNG CITY,80672<br>TAIWAN , ROC | TEL: (886) 7-821-0886<br>FAX: (886) 7-821-4688 |
| MAYEKAWA (TAIWAN) CO., LTD. (CHEMICAL DEPARTMENT) | 1F., NO.2, SHIN JANN ROAD, CHIEN CHEN DIST., KAOHSIUNG, TAIWAN 80672, ROC | TEL: (886) 7-812-7709<br>FAX: (886) 7-812-9019 |
| MAYEKAWA (TAIWAN) CO., LTD. (TAIPEI HEAD OFFICE) | 8F, NO, 421, SUNG-SHAN ROAD, TAIPEI, TAIWAN 11083, REP. OF CHINA | TEL: (886) 2-2727-9711<br>FAX: (886) 2-2759-8484 |
| MAYEKAWA (TAIWAN) CO., LTD. (TAICHUNG BRANCH) | NO. 80-2, SEC.3, HUANJUNG RD., TAICHUNG, TAIWAN, 40755,<br>REP. OF CHINA | TEL: (886) 4-2251-4128<br>FAX: (886) 4-2251-4129 |
| MAYEKAWA CHINA INDUSTRIES CO., LTD.<br>(SHANGHAI BRANCH) | ROOM 3001, NANZHENG BUILDING, NO.580 WEST NANJING RD.,<br>200041 SHANGHAI, P.R. CHINA | TEL: (86) 21-5234-1988<br>FAX: (86) 21-5234-1788 |
| MAYEKAWA CHINA MFG.CO., LTD. | 201700 PLANT 1, NO.39, WEST XIQING ROAD,<br>QINGPU, SHANHAI, P.R. CHINA | TEL: (86) 21-6920-7718<br>FAX: (86) 21-6920-7719 |
| MAYEKAWA CHINA MFG.CO., LTD. (GUANGZHOU BRANCH) | RM.1205, TIANLHEFULI BUSINESS MANSION, No.4, HUA TING RD, GUANGZHOU, 510610, CHINA | TEL: (86) 20-8527-6161<br>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<br>FAX: (86) 532-8602-6269 |

| Description | Location | Telephone and facsimile No. |
|---|---|---|
| MAYEKAWA CHINA MFG. CO., LTD. (DALIAN BRANCH) | RM.A13-5, No.1 BUILDING, AREA A , WUCAI CITY, DALIAN ECO-TECH DEVELOPMENT ZONE, 116100, DALIAN, P. R. CHINA | TEL: (86) 411-8753-9620<br>FAX: (86)411-8757-9620 |
| MAYEKAWA (THAILAND) CO., LTD.<br>MAYEKAWA HOLDING (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<br>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<br>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,<br>VIETNAM | TEL: (84) 8-3997-5284<br>FAX: (84) 8-3997-5287 |
| MYCOM KOREA CO., LTD. (HEAD OFFICE) | 2F, 345, CHEONGRA-RO , YONGSAN-KU,<br>SEOUL, 140-710, REP.OF KOREA | TEL: (82) 2-796-1766<br>FAX: (82) 2-798-7715 |
| MYCOM KOREA CO., LTD. CHANGWON FACTORY | 19, BANGYE-RO, UICHANG-KU, CHANGWON-SI,<br>GYEONGSANGNAM-DO 641-847, REP.OF KOREA | TEL: (82) 55-294-8678<br>FAX: (82) 55-299-7678 |
| MYCOM KOREA CO., LTD. (BUSAN BRANCH) | 5F, 26, JUNGANG-DAERO, JUNG-GU, BUSAN 600-714, REP.OF KOREA | TEL: (82) 51-242-3737<br>FAX: (82) 51-243-8542 |
| **LATIN AMERICA** | | |
| MAYEKAWA ARGENTINA S.A. (BUENOS AIRES OFFICE) | DR. JOSE VALENTIN GOMEZ 151, LOT42, HAEDO-PARTIDO DE MORON, BUENOS AIRES, CP B1706FMA, ARGENTINA | TEL: (54) 11-4627-6660<br>FAX: (54) 11-4628-1511 |
| 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<br>FAX: (54) 2965-475414 |
| MYCOM PERU S.A.C. | CALLE LUIS PASTEUR 1490,<br>LINCE, LIMA, PERU | TEL: (51) 1-205-5400<br>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<br>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<br>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<br>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<br>TEL: (593)4-262-6407<br>FAX: - |
| MAYEKAWA COLOMBIA S.A.S | TRANSVERSAL 93 NO.53-48 INTERIOR 37, PAQUE INDUSTRIAL EL DORADO, BOGOTA, COLOMBIA | TEL: (57) 1-430-9980<br>TEL: (57) 1-224-3028<br>FAX: (57) 1-437-0988 |

| Description | Location | Telephone and facsimile No. |
|---|---|---|
| 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<br>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<br>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<br>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<br>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<br>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<br>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<br>FAX: — |
| 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<br>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<br>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<br>FAX: (55) 51-3477-5212 |
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| MAYEKAWA DO BRASIL EQIPAMENTOS INDUSTRIAIS LTDA. (MACAE) | RUA PROFESSOR MARIETA PEIXOTO, 62 CENTRO - MACAE – RJ, CEP 27910-250, BRASIL | TEL: (55) 22-2772-6069<br>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<br>FAX: (55) 21-2430-8882 |
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