



Sumitomo Heavy Industries, Ltd.

MANUAL NUMBER: CD32ZZ-070K

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# **TECHNICAL INSTRUCTION**

## ***RDK-415D 4K COLD HEAD***

***For Service Personnel Only***

***Sumitomo Heavy Industries, Ltd.  
Cryogenics Division***

***2-1-1 Yato-cho, Nishitokyo-City,  
Tokyo 188-8585, Japan***

**E-mail: [cryo@shi.co.jp](mailto:cryo@shi.co.jp)  
URL: <http://www.shicryogenics.com>**



## EC DECLARATION OF CONFORMITY

We, Sumitomo Heavy Industries, Ltd., declare herewith that the Cold Head (component of Closed Cycle Cryogenic Refrigeration System) listed below, on the basis of its design and engineering as well as in the embodiment which we have placed on the market, comply with the applicable safety and health requirements set forth in EC directives.

This declaration becomes invalid if modifications are made to the product without consultation with us.

Designation of the Cold Head model;

RDK-4XXyz, -3XXyz, -2XXyz

XX stands for any numbers.

y stands for with or without a letter.

z stands for with or without a number.

The products comply with the following council directives;

> Machinery Directive (2006/42/EC)

> EMC Directive (2004/108/EC)

Applicable standards;

> EN 60204-1: 2006

> EN 55011: 2007, +A2:2007

> EN 61000-3-2: 2006

> EN 61000-3-3: 1995, +A1 :2001,  
+A2 :2005

> EN 61000-6-2: 2005

Tokyo, 20 May / 2011

Tosiharu Tanaka,

General Manager, Cryogenics Division

*Sumitomo Heavy Industries, Ltd.*

*Cryogenics Division*

*Precision Equipment Group*

2-1-1, YATO-CHO, NISHITOKYO-CITY, TOKYO 188-8585, JAPAN

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## **CROSS REFERENCE**

Thoroughly read this manual and following manuals before using this equipment.

<b>MANUAL NAME</b>	<b>MANUAL No.</b>
OPERATION MANUAL SRDK Series CRYOCOOLER*	CD32ZZ-063
TECHNICAL INSTRUCTION CSA-71A COMPRESSOR UNIT*	CD32ZZ-067
TECHNICAL INSTRUCTION CSW-71C COMPRESSOR UNIT*	CD32ZZ-068
TECHNICAL INSTRUCTION CSW-71D COMPRESSOR UNIT*	CD32ZZ-069
OPERATION MANUAL SRDK Series CRYOCOOLER* (for Outdoor used Compressor Unit)	CD32ZZ-076
TECHNICAL INSTRUCTION CNA-61C OUTDOOR USED COMPRESSOR UNIT*	CD32ZZ-077
TECHNICAL INSTRUCTION CNA-61D OUTDOOR USED COMPRESSOR UNIT*	CD32ZZ-078
OPERATION MANUAL SRDK Series CRYOCOOLER* (for F-50 Series Compressor Unit)	CD32ZZ-225
TECHNICAL INSTRUCTION F-50L COMPRESSOR UNIT*	CD32ZZ-227
TECHNICAL INSTRUCTION F-50H COMPRESSOR UNIT*	CD32ZZ-226
TECHNICAL INSTRUCTION F-50HC COMPRESSOR UNIT*	CD32ZZ-224

\* See TECHNICAL INSTRUCTION of Compressor Unit used.

## **1 GENERAL INFORMATION**

The RDK-415D Cold Head is a two-stage GM cycle cryo-refrigerator. The function of the Cold Head is to produce continuous closed-cycle refrigeration at temperatures, depending upon the heat load imposed, in the range of 25 K to 40 K for the first-stage cold station and in the range of 3.5 K to 4.2 K for the second-stage cold station.

The Cold Head has three major components: the drive unit; the cylinder; and the displacer-regenerator assembly, which is located inside the cylinder.

With newly developed rare earth regenerator material and with very unique structure, the model RDK-415D Cold Head has its 2nd stage refrigeration capacity of 1.5W at 4.2K.

Functionally, the high-pressure helium gas from the Compressor Unit will be supplied to the Cold Head through the helium gas supply connector. The supply gas will be passed into the displacer-regenerator assembly, come out through the displacer-regenerator assembly to the crankcase through the motor housing, and finally will be returned to the Compressor Unit through the helium gas return connector. The helium gas expansion in the displacer-regenerator assembly will be provided cooling condition for the first and second-stage cold stations.

## 1-1 SPECIFICATIONS

The specifications of the RDK-415D Cold Head are summarized in **Table 1.1**

**Figure 1.1** shows the outline view of Cold Head.

**Table 1.1 RDK-415D COLD HEAD SPECIFICATION**

<b>Refrigeration Capacity*</b> First Stage Second Stage	35 / 45 W at 50 K (50 / 60 Hz) 1.5 W at 4.2 K (50 / 60 Hz)
<b>Orientation</b>	Any (Capacity Loss: Max. 15%)
<b>Ambient Temperature Range</b>	5 to 35 deg.C (28 to 35 deg.C with 5% Capacity Loss)
<b>Humidity Range</b>	25 to 85 %RH (without dew)
<b>Helium Gas Pressure</b> for Indoor Used Compressor Unit Static Operating (High Side)** (for Reference) for Outdoor Used Compressor Unit Static Operating (High Side)** (for Reference)	1.60 - 1.65 MPa at 20 deg.C 2.00 - 2.20 MPa --- approx.  1.60 - 1.70 MPa at 20 deg.C 1.90 - 2.10 MPa --- approx.
<b>Pressure Relief Valve Setting</b>	1.86 - 1.96 MPa
<b>Gas Supply Connector</b> <b>Gas Return Connector</b>	1/2-inch Coupling 1/2-inch Coupling
<b>Dimension</b> Width Length Height	180 mm 294 mm 557 mm
<b>Mass</b>	18.5 kg --- approx.

\* If the Compressor Unit used is the indoor type, use the 20A x 20m flex line or 20A x 6m + Buffer Tank to get the specified cooling capacity.

\*\* The operating pressure varies according to the heat load of cold head and temperature around the equipment.

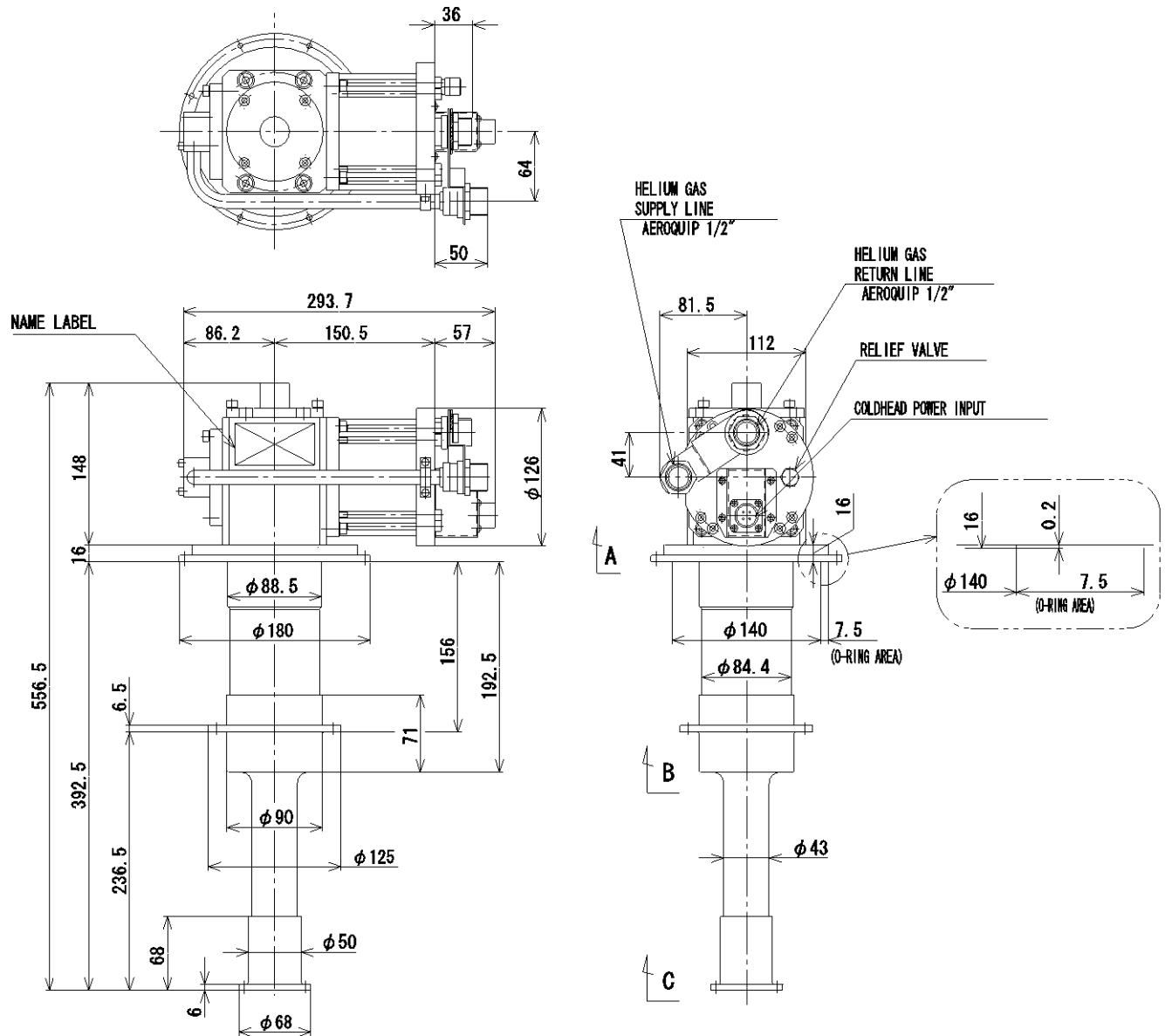


Figure 1.1 OUTLINE VIEW OF COLD HEAD MODEL RDK-415D

## 1-2 CONSTRUCTION

The cross section of the RDK-415D Cold Head is shown in **Figure 1.2**. It consists of a Cylinder, No. 1 Displacer, No. 2 Displacer, drive mechanism, and Cold Head Drive Motor. No. 1 Displacer is connected to the Scotch Yoke which can be driven by the Cold Head Drive Motor through the Crank with Bush so that the rotation of the Cold Head Drive Motor can be varied to reciprocating motion of Scotch Yoke and Displacers.

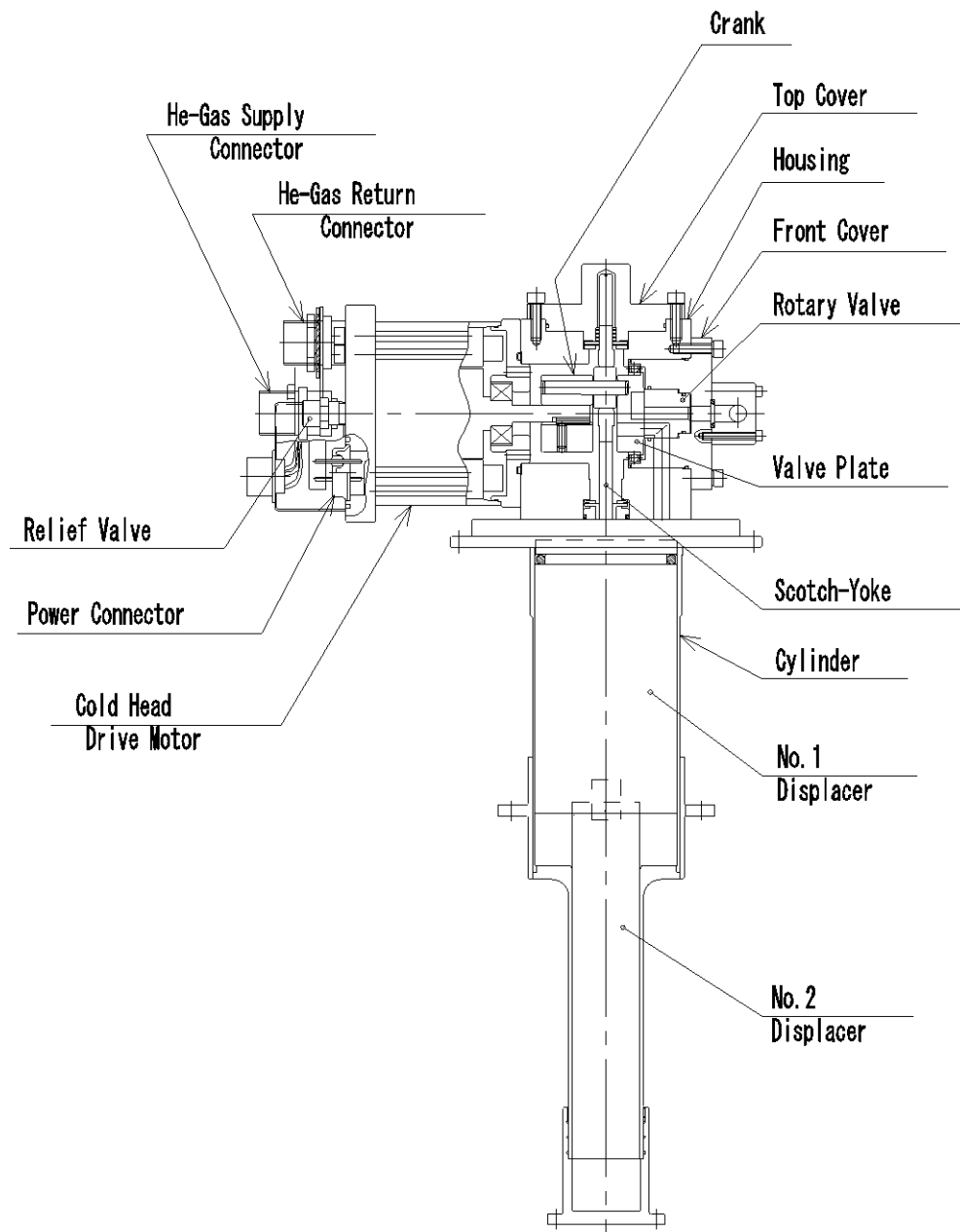
The Rotary Valve system is furnished to control the helium gas intake and exhaust timing. The Rotary Valve is also coupled to the Cold Head Drive Motor through Crank, so intake and exhaust operation is synchronized with the position of the Displacer.

The Displacer is a loose fit in the Cylinder except at the top and where it is equipped with a dynamic(sliding) seal to prevent leakage passed through the clearance between the Displacer and Cylinder.

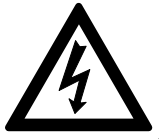
The Displacers consist of regenerator material which cool the gas when passing downwards to the cold space and heats the gas when passing upwards from the cold space. Rear earth regenerator material is used in the 2nd stage Displacer to produce the cooling capacity at the temperature of 4.2K.

The pressure above and below the Displacer is the same except for small pressure drops across the regenerator when gas is flowing through it. Virtually no physical work is required to move the Displacer in the Cylinder. No work is done on the gas and the gas does no work on the Displacer. The pressure in the system is increased or decreased by operation of the inlet or outlet valves.





**Figure 1.2 CROSS SECTION OF THE RDK-415D COLD HEAD**

**2 MAINTENANCE****WARNING****<Warning about electric shock>**

This cryocooler includes a high-voltage section. Touching it may result in electric shock. Handle it with extreme care.

**WARNING****<Warning about explosion, escape of gas>**

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) contains a high-pressure (about 1.62 MPa helium gas sealed in. Hitting the equipment with a sharp edge or touching it with a pointed object may cause explosion or escape of gas. Handle the equipment with extreme care.

Do not disassemble the equipment for purposes other than maintenance specified in this service manual under any circumstances. Disassembling the equipment may result in electric shock, explosion or escape of gas.

The cold head, compressor unit, compressor adsorber and flex lines are pressurized with helium gas. Purge the helium gas from all pressurized components before disposing. Open the purging valve gradually or it may result in serious injury.

Install the cryocooler in the ventilated area, otherwise it may result in asphyxiation in case the helium gas is purged or leaked.

When scrapping the CryoCooler, handle it as Industrial Waste and pass it over to legally qualified disposer.

When removing the cold head from the vacuum chamber, do not break the vacuum with the low temperature of cold head second stage. Breaking the vacuum may result in serious damage, explosion or escape of gas. Keep the Flex Lines connected and maintain the high vacuum of the chamber and wait until the cold head second stage temperature rises up to 100K to Room Temperature before removing the cold head.

When removing the cold head from the customer's equipment and removing the Flex Lines from the cold head, do not remove with the low temperature of cold head second stage. Removing the Flex Lines and cold head may result in serious damage, explosion or escape of gas. When removing the cold head and Flex Lines, wait until the cold head second stage temperature rises up to 100K to Room Temperature.

**CAUTION****<Caution against misoperation>**

The cold head drive switch provided with the compressor unit is only used for maintenance. Be sure to turn it OFF in normal operation. Using the compressor unit with the cold head drive switch turned ON may result in misoperation or malfunction.

The RDK-415D Cold Head is to be required to replace the sliding parts inside every 10,000 Hrs.

The maintenance work is not a User's maintenance. Replace the Cold Head completely at site and return it to Sumitomo Heavy Industries, Ltd. for refurbishment.

**APPENDIX****DRAWINGS**

No.	PART NAME
1	RDK-415D COLD HEAD



## REVISION CONTROL

Manual No.	Revision	Remarks	Date
CD32ZZ-070	-A	Publication of first edition.	DEC. 10 / 1999
	-B	Add the CNA-61C, D Compressor Unit	OCT. 2 / 2000
	-C	Change the SHI address.	JAN. 25 / 2001
	-D	Add the description of using flex line.	MAR. 21 / 2001
	-E	Correct the dimension of 1 <sup>st</sup> Cylinder.	MAR. 14 / 2003
	-F	Change the division name.	JUN. 9 / 2003
	-G	The information of the SHI inquiries and typographical error was corrected.	JAN. 12 / 2006
	-H	The description about F-50 Series Compressor Unit was added.	DEC. 14 / 2007
	-J	The Humidity Range was added.	DEC. 1 / 2009
	-K	CE declaration was added.	SEPT. 25 / 2013