CRYO-TORR® 8 HIGH-VACUUM PUMP (with SC/SCW Compressor)

Installation, Operation and Servicing Instructions

CTI-CRYOGENICS

HELIX TECHNOLOGY CORPORATION

CTI-CRYOGENICS
HELIX TECHNOLOGY CORPORATION

Compressor Model SC
Part #: 8032224
Serial #: 55I916588

Cryotorr 8 High Vacuum Pump
Part #: 8033289
Serial #: 46I917490

June 1989

ERRATA PAGE

This errata applies to all Installation, Operation and Servicing Instructions for Cryo-Torr® High-Vacuum Pumps and Cryodyne® Refrigeration Systems (Utilizing a Model SC Air-Cooled Compressor).

In the manuals listed below,

Rich
508-337-5143

MODEL SC COMPRESSOR MANUAL APPLICATION

CRYOPUMP/ REFRIGERATOR	MANUAL NO.	PAGE NO.
CT-7	M8040129	9
CT-8	M8040138	9
CT-8F	M8040136	9
CT-100	M8040110	9
Model 22	M8040125	11
Model 350	M8040012	9

Add the following "For Your Information" note, proceeding step 1 of Section 3.2B "Both SC and SCW Compressors". (Refer to Table for page location).

For Your Information --

If your application requires the use of multiple compressors on a single gas manifold, you must install an external check valve on the gas-return connector of each compressor. Contact the Applications Engineering Department for installation guidance on manifolding compressors.

February 1989

ERRATA PAGE

This errata as authorized by DEO 2768 (2/89) applies to all Installation, Operation and Servicing Instructions for Cryo-Torr(R) High-Vacuum Pumps and Cryodyne(R) Refrigeration Systems (Utilizing a Model SC Air-Cooled Compressor).

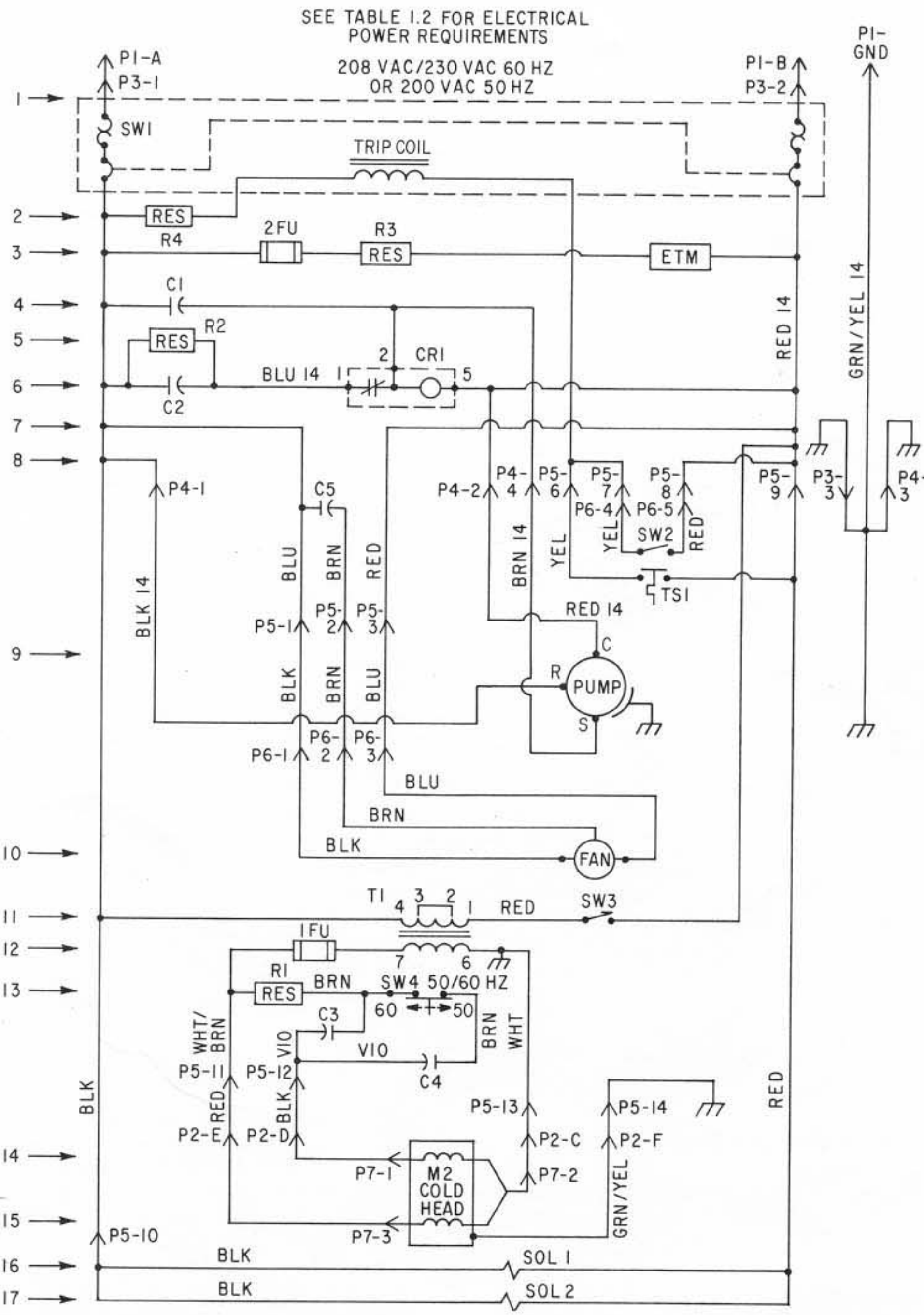
Replace the existing Figure B.1, "Electrical schematic for Model SC Compressor," page number (see Table below), in your cryopump/refrigerator manual with the revised schematic included with this errata.

MODEL SC COMPRESSOR SCHEMATIC LOCATION

CRYOPUMP/ REFRIGERATOR	MANUAL NO.	PAGE NO.
CT-7	M8040129	40
CT-8	M8040138	40
CT-8F	M8040136	40
CT-100	M8040110	40
Model 22	M8040125	36
Model 350	M8040012	34

Appendix B

Electrical Schematic and Location Information



(Revised 2/89)

Figure B.1 Electrical schematic for Model SC Compressor

CTI-CRYOGENICS
HELIX TECHNOLOGY CORPORATION

M8040138

CRYO-TORR® 8 HIGH-VACUUM PUMP
(UTILIZING A MODEL SC/SCW COMPRESSOR)

Installation, Operation, and Servicing Instructions

Revised September 1988

NOTICE

This Manual (with white covers) applies to *all* Model SCW (water-cooled) compressors; it *only* applies to SC (air-cooled) compressors having a serial number* prefix code "55".

Example:

5 5 - - - - - -

PREFIX CODE — NUMERICAL CODE — ALPHABETICAL CODE

*Serial number is embossed on rear-panel nameplate.

---

266 SECOND AVENUE   POST OFFICE BOX 9171   WALTHAM, MA 02254-9171   (617) 622-5000

Returning Equipment

Before returning any equipment to CTI-CRYOGENICS contact the Product Service Department in your area for instructions.

East Coast Service Center:
CTI-CRYOGENICS
Kelvin Park, 266 Second Avenue
P.O. Box 9171
Waltham, Massachusetts 02254-9171, USA
Telephone (617) 622-5000
TELEX 92-3442
Telecopier/Fax (617) 622-5222

West Coast Service Center:
CTI-CRYOGENICS
3350 Scott Boulevard #13
Santa Clara, California 95054, USA
Telephone (408) 727-8077
TELEX 17-2480
Telecopier/Fax (408) 988-6630

Obtain a Return Goods Authorization (RGA) number from the Product Service Department and indicate the number on all shipping cartons and correspondence.

For each item returned, preferably in its original shipping carton, include with the shipment:

Equipment type________________________________

Purchase date_________________________________

Compressor serial No.__________________________

Cryopump serial No.____________________________

CTI-CRYOGENICS sales order No.________________

CTI suggests that you record this information when you first receive your equipment.

Warning --

If the cryopump has been used to pump toxic or dangerous materials, clearly indicate on the shipping carton the identification of such materials when returning the equipment to CTI-CRYOGENICS.

Drain and purge cooling water from water-cooled compressors before shipment.

Technical Inquiries

Direct your technical inquiries concerning installation, operation, or maintenance to the Product Service Department of CTI-CRYOGENICS.

Guaranteed Up-Time Support (GUTS)

For rapid response service (24 hours a day), dial 1-800-FOR-GUTS.

December 1988

ERRATA PAGE

This errata applies to all Installation, Operation and Servicing Instructions for Cryo-Torr(R) High-Vacuum Pumps and Cryodyne(R) Refrigeration Systems (Utilizing a Model SC/SCW Compressor).

Correct step 2 and Caution note in Section 3.2B to read:

2. Your compressor is factory preset to operate at 60 Hz. If your operating frequency is 60 Hz, no action is required. For 50 Hz operation, refer to the Table below for proper slide switch position.

MODEL SC/SCW COMPRESSOR SLIDE SWITCH POSITIONS

CRYOPUMP/ REFRIGERATOR	MANUAL NO.	SLIDE SWITCH POSITION FOR 50 Hz APPLICATION
CT-7	M8040129	60
CT-8	M8040138	50
CT-8F	M8040136	50
CT-100	M8040110	60
Model 22	M8040125	60
Model 350	M8040012	50

If the slide switch requires repositioning to 50 Hz proceed as follows:

a. Remove the compressor cover.

b. Set the 50/60 Hz slide switch (7, Figure B.3 or 2, Figure B.4) to the 50 Hz frequency position.

> **Caution --**
>
> Failure to reset the slide switch to the 50 Hz position when operating at that frequency may cause improper cold head operation.

SAFETY CONSIDERATIONS

Your Cryo-Torr® High Vacuum Pump has been engineered to provide extremely safe and dependable operation when properly used. Certain safety considerations need to be observed during the normal use of your vacuum pump equipment. Warning blocks within the Manual text pinpoint these specific safety considerations. Warnings are defined as hazards or unsafe practices which could result in severe injury or loss of life.

⚠ WARNING


TOXIC, CORROSIVE OR DANGEROUS GASES present in a cryopump could cause severe injury upon contact.

1. Always vent such gases to a safe location, using an inert purge gas.
2. Clearly identify such gases on containers used to store or ship equipment after such exposure.


FLAMMABLE OR EXPLOSIVE GASES present in a cryopump could cause severe injury if ignited.

1. Always vent such gases to a safe location, using an inert purge gas.
2. Do not install a hot-filament type vacuum gauge on the cryopump side of the roughing valve; it could be an ignition source of flammable gases in the pump.
3. Cryopumping oxygen/ozone requires special precautions and frequent regeneration. Ozone may be present as a by-product of oxygen processes.

HIGH VOLTAGE is present within the system and can cause severe injury from electric shock.

1. Disconnect the system from all power sources before making electrical connections between system components and also before performing Troubleshooting and Maintenance procedures.

HIGH GAS PRESSURE is present within the system and can cause severe injury from propelled particles or parts.

1. Do not modify or remove the pressure relief valves, either on the cryopump or within the helium compressor.
2. Always depressurize the adsorber to atmospheric pressure before disposing of it.
3. Always bleed the helium charge down to atmospheric pressure before servicing or disassembling the self-sealing gas half-couplings.

BEFORE INSTALLING, OPERATING OR SERVICING EQUIPMENT, READ THIS MANUAL WHICH CONTAINS IMPORTANT SAFETY INFORMATION.

CRYOPUMP OXYGEN PROCEDURES

⚠WARNING

COMBUSTION SUPPORTED BY OXYGEN IN THE PUMP COULD CAUSE SEVERE INJURY. WHEN OXYGEN IS USED AS A PROCESS GAS, SPECIAL PRECAUTIONS DESCRIBED IN THE TEXT BELOW SHOULD BE TAKEN.

When oxygen is used as a process gas, the following precautions should be taken.

1. Follow all cryopump operating instructions including:
   - Insure that there are no sources of ignition (e.g., hot filament vacuum gauges) on the cryopump side of the high vac valve operating during the warming or venting of the pump.
   - Perform inert gas purge regenerations at flow rates recommended for cryopumps.
2. Regenerate as frequently as practical to minimize the amount of oxidizer present in the cryopump.
3. It is standard practice in the vacuum industry that any system exposed to richer-than-air oxygen levels should be prepared for oxygen service per the manufacturer's recommendations, including use of oxygen service lubricating oils in roughing pumps.

⚠WARNING

EXPLOSION OCCURING FROM OZONE IN THE PUMP COULD CAUSE SEVERE INJURY. OZONE CAN BE PRESENT AS A BY-PRODUCT OF OXYGEN PROCESSES. IF OZONE IS PRESENT, SPECIAL PRECAUTIONS DESCRIBED IN THE TEXT BELOW MUST BE TAKEN.

Ozone may be unknowingly produced in an ionizing process (e.g., sputtering, etching, glow discharge). Explosive conditions may exist if ozone is present, especially during warming of the cryopump. Signs of ozone's presence are:

1. Crackling/popping sounds (as in electrical arcing) occurring within the first few minutes of regeneration.
2. Gas venting from the cryopump during regeneration may have a pungent smell, similar to that present in an arc welding operation or after an electrical storm.

NOTE: A change in process may increase the amount of ozone present.

If ozone is present, the following precautions must be taken.

1. All of the above oxygen precautions must be followed. The required regeneration frequency is dependent upon flow and process conditions. Daily regeneration may be required. Call CTI-CRYOGENICS for assistance.
2. Reduce the oxygen mixture to the lowest level the process will allow.

NEW SAFETY INFORMATION

These Cryopump Oxygen Procedures have recently been made part of CTI-CRYOGENICS' safety instructions and will be included in the appropriate text section of future printings of cryopump manuals.

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2. Inspection
3. Installation
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C. Equipment List for the Cryo-Torr 8 High-Vacuum Pump
D. Principles of Operation
E. Cryopump Monitor, REGEN™, and Temperature Indicator
F. Conversion of Hydrogen-Vapor-Pressure Gauge Readings to Temperature
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H. Cryopump Installation/ Interface Drawings

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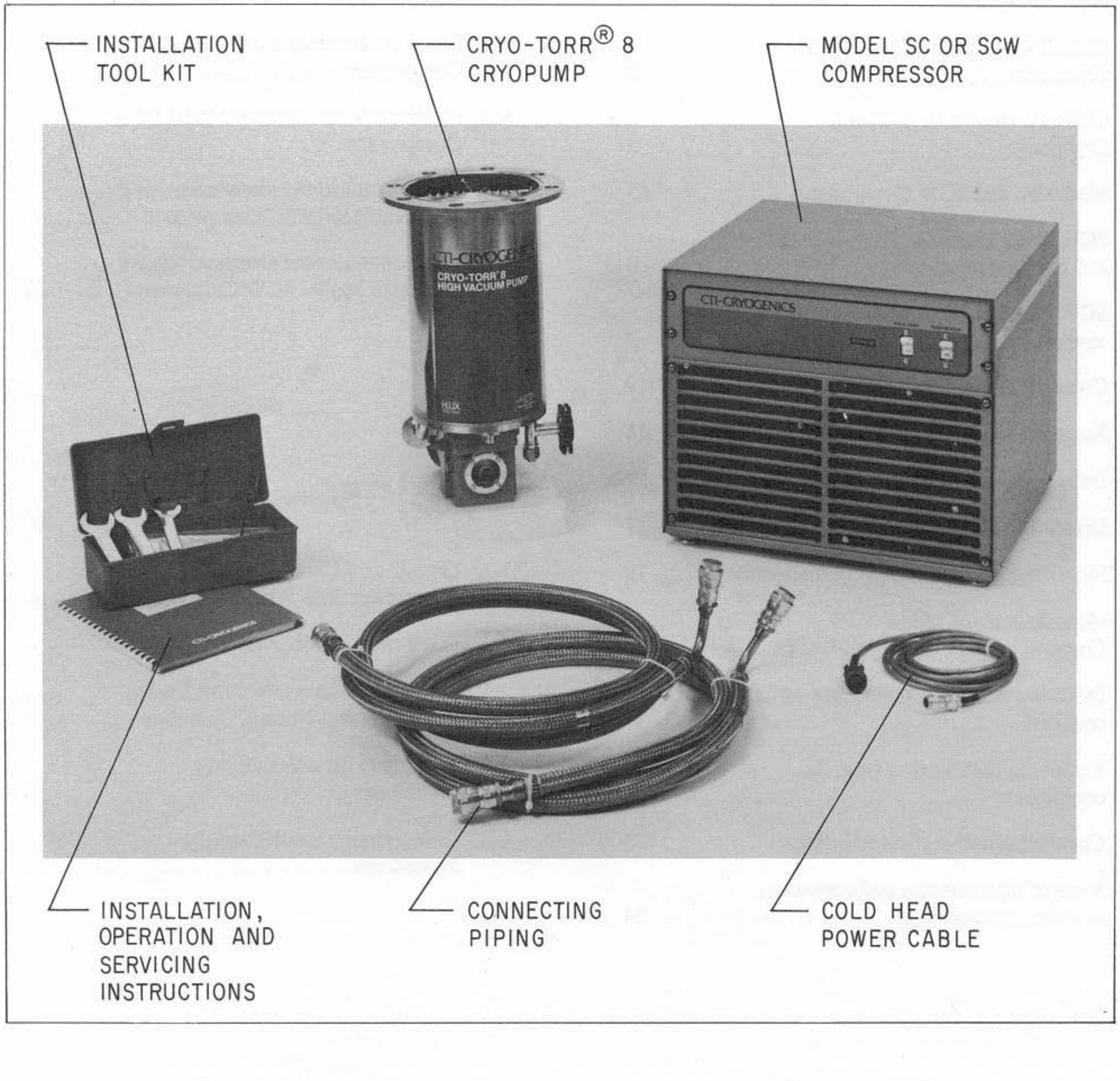

Figure 1.1 Cryo-Torr(R) 8 High-Vacuum Pumping System

Section 1: Introduction

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1.1 General

The Cryo-Torr(R) 8 High-Vacuum Pump, shown in Figure 1.1, provides fast, clean pumping of all gases in the 10^{-3} to 10^{-10} torr range. It operates on the principle that gases can be condensed and held at extremely low vapor pressures, achieving high speeds and throughputs.

Your pump is a highly-reliable and rugged unit that requires a minimum of servicing. Since the cryopump exposes no moving parts, operating fluids, or backing pumps to the vacuum, the possibility of contamination from the cryopump itself is eliminated.

1.2 Installation, Operation and Servicing Instructions

Installation, Operation and Servicing Instructions for your Cryo-Torr 8 vacuum pump provide complete and easily accessible information. All personnel with installation, operation, and servicing responsibilities should become familiar with the contents of these instructions to ensure safe, reliable, and high cryopump performance.

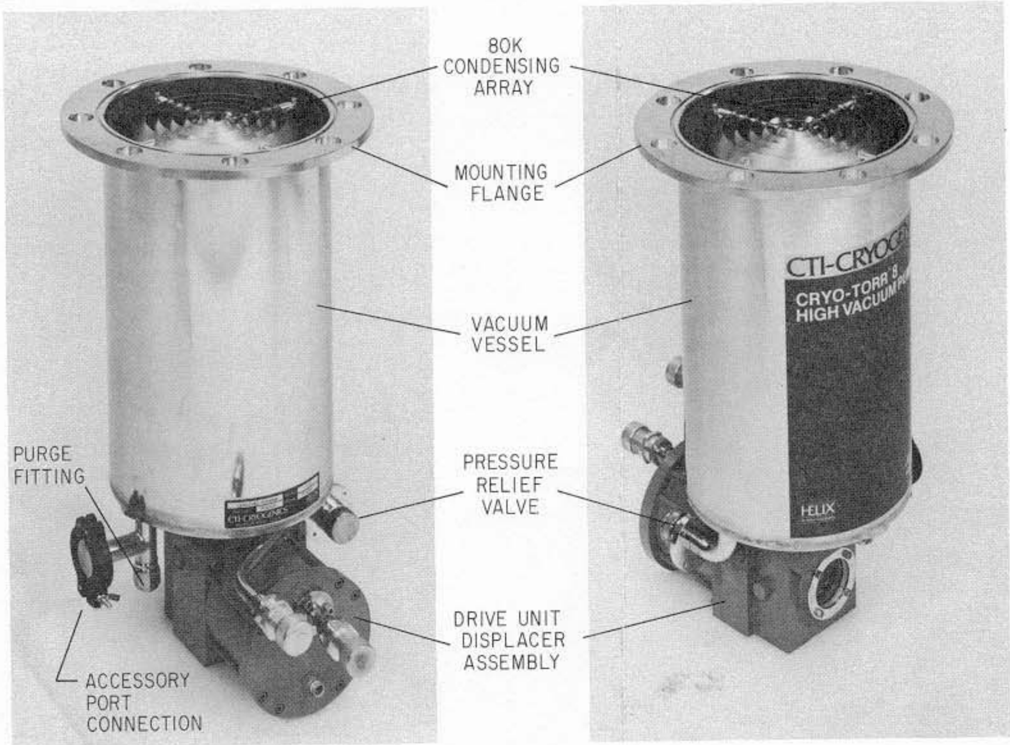

Figure 1.2 Overall views of the Cryo-Torr 8 Cryopump

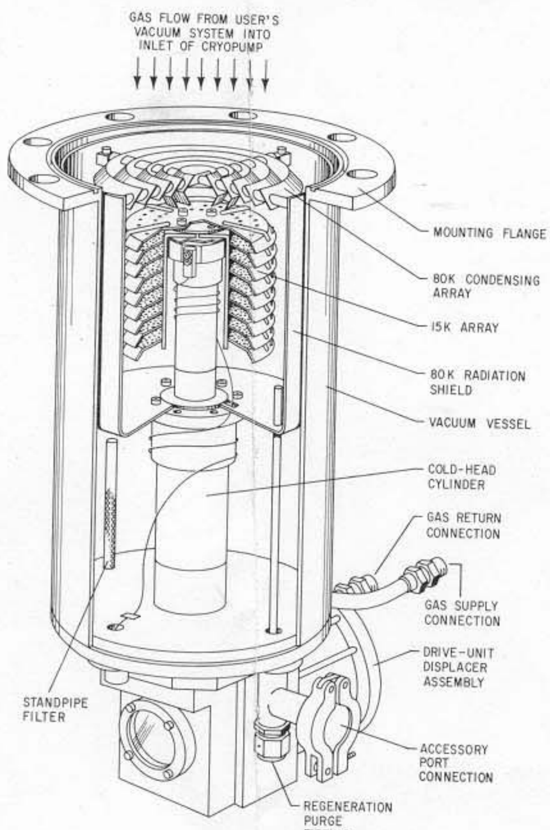

Figure 1.3 Cutaway view of Cryo-Torr 8 Cryopump

Table 1.1 Cryo-Torr 8 Cryopump and Interconnections Specifications

Weight
45 lb. (20 kg) approximate

Weight (Shipping)
50 lb. (23 kg)

Power requirement
Supplied from compressor

Instrumentation
Temperature sensor or optional hydrogen-vapor-pressure gauge

Interface data
Gas-supply connector: 1/2-inch self-sealing coupling
Gas-return connector: 1/2-inch self-sealing coupling

Pumping speed
Water: 4,000 liters/second
Air: 1,500 liters/second
Hydrogen: 2,500 liters/second
Argon: 1,200 liters/second

Crossover (Maximum gas burst)
150 torr-liters

Capacity
Condensable gases (argon, nitrogen, oxygen, etc.): 1,000 standard liters; 760,000 torr liters
Hydrogen gas: 6 standard liters (4,560 torr-liters) at 5×10^{-8} torr hydrogen partial pressure
12 standard liters (9,120 torr-liters) at a hydrogen partial pressure greater than 5×10^{-6} torr

Argon throughput
700 scc/min., 8.9 torr-liters/sec. maximum

Orientation
The cryopump may be operated in any position.

Interconnections

Helium supply and return piping
10 ft. (3 m) each with 1/2-inch self-sealing couplings at each termination. Longer lengths available

Cold-head power cable
10 ft. (3 m). Longer lengths available

Regeneration purge fitting
Supplied by CTI
Parker CPI ULTRASEAL SIZE 6
(with plug and nut)

Temperature sensor connection
Supplied with all temperature sensor accessories
Temperature sensor connection mates with Amphenol P/N 48-16R-10-55/48-23-41

Accessory port connection
Supplied by CTI
NW-25 ISO-KF flange
(with clamp and blank flange)

Table 1.2 Compressor Specifications

Model SC (air cooled) and Model SCW (water cooled) Compressors

Dimensions
19.6 inches (498 mm) Length
19.5 inches (495 mm) Width
16.8 inches (426 mm) Height

Weight
140 lbs (63.5 kg), approximate

Weight (Shipping)
155 lbs (70.5 kg), approximate

Power requirements (steady-state conditions)

For both air cooled SC and water cooled SCW compressors

VOLTS	Hz	PHASE	NOMINAL OPERATING CURRENT (AMPS)		OPERATING VOLTAGE RANGE (VOLTS)	MINIMUM RECOMMENDED ELECTRICAL SERVICE (AMPS)
			SCW	SC		
208/230	60	1Ø	8.5	10	198-253	15
200	50	1Ø	8.5	10	180-220	15

Power consumption
1.5 kw, nominal operating (SCW); 2.1 kw, nominal operating (SC)

Compressor input-power cable (customer supplied)
Recommended type SO-3 conductor, 600V, neoprene jacket and 14 gauge wire
Install per Figure B.1 or B2, page 40 and 42, Electrical Schematic, ensuring compliance with all national, state and local standards.

Helium pressure
Static: 245-250 psig (1690-1725 kPa) at 70 to 80°F (21 to 27°C)
Supply, nominal operation: 270-290 psig (1860-2000 kPa) at operating temperature

Ambient operating temperature range
60 to 100°F (16 to 38°C)

Interface
Cold-head power receptacle: Mates with plug on cold-head power cable
Compressor input-power receptacle: Mates with Hubbel twist lock plug No. 4579C, supplied with compressor
Gas-supply connector: 1/2-inch self-sealing coupling
Gas-return connector: 1/2-inch self-sealing coupling

Adsorber service schedule
Replace at increments of 10,000 hours as displayed on elapsed time meter

Cooling water requirements (Model SCW only)
100°F (38°C) maximum discharge temperature
Refer to Figure 3.1 and 3.2, pages 8 and 9, for parameters.

Section 2: Inspection

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2.3 Connecting the Piping and Cold Head Cable 6

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2.1 General

For Your Information --

These instructions have been produced to allow you to fold out cryopump and compressor photographs and drawings while using the following sections. Foldouts are Figures 1.2 and 1.3 on page 2 and Figure 1.4 on page 65.

On receipt, remove the Cryo-Torr high-vacuum pump system components from their shipping cartons and inspect them for evidence of damage as described in the following Sections. The air-cooled Model SC Compressor has a shipping bolt installed through the compressor bottom shipping cushion to support the compressor pump from vibration and shock during shipment. To remove the shipping bolt and bottom shipping cushion, proceed as follows.

1. Carefully tilt and set the compressor on its front grille so the shipping bolt is accessible.
2. Loosen and remove the shipping bolt from the underside of the bottom shipping cushion and remove the cushion from the compressor. Retain the shipping bolt and cushion for use during future compressor shipment.

Caution --

Always place the compressor back on its bottom shipping cushion and install the shipping bolt (wrench-tight) whenever you ship the compressor by common carrier. This will prevent damaging the compressor pump during transportation.

- Report damage to the shipper at once.
- Retain shipping cartons for storage or return shipment.

2.2 The Cryopump

Inspect the cryopump for damage by examining

1. Overall exterior.
2. Temperature sensor connection.
3. Mounting flange and its sealing surfaces after removing the protective cover.
4. Louver assembly of the 80K condensing array. Replace the protective cover.

2

2.3 Connecting Piping and Cold Head Cable

Inspect the piping and cable for damage by examining the overall exterior.

Caution --

Do not bend the flexible connecting piping to less than a 6-inch radius.

2.4 The Compressor

Inspect the compressor overall exterior for damage.

Inspect the compressor interior for damage and major oil loss by removing the rear grille on Model SC Compressors or the rear plate on Model SCW Compressors. Visually inspect to insure that oil leakage resulting from oil line damage has not occurred. Replace the grille or plate unless installation is to immediately follow.

Check the helium supply pressure pressure gauge. The gauge should indicate 250 psig (1725 kPa) minimum at 70°F. If the gauge reads less than 250 psig contact the Product Service Department.

2.5 Installation and Scheduled Maintenance Tool Kit

As part of your Cryo-Torr 8 system, you will find one each of the items below (unless otherwise indicated) included in the Installation and Scheduled Maintenance Tool Kit, P/N 8032040G004.

1. 1 inch, 1 1/8-inch, and 1 3/16-inch Armstrong open-end wrenches for self-sealing coupling.
2. 7/64-inch Hex ball-end speed wrench.
3. Four gasket seals, Aeroquip 22008-8, for the self-sealing couplings.
4. Fuse, 250 volts, 1 ampere, Buss MDL-1.
5. 3 inch square by 0.005-inch thick sheet of indium gasket material, P/N 3543738P001.
6. Adsorber depressurization fitting, P/N 3592444.

2.6 Additional Supplied Equipment

Included with your Cryo-Torr system are the following supplied equipment.

1. Compressor input-power receptacle.
2. Barbed fittings (2).

Section 3: Installation

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3.2B Both SC and SCW Compressors 9

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3.1 Compressor Installation

Installation of your compressor is an easy task requiring no special tools other than those supplied in the Installation and Scheduled Maintenance Kit.

Installation requirements for Model SC (air cooled) and Model SCW (water cooled) vary in some aspects. These instructions therefore break down installation procedures into

3.2A Model SCW compressor only
3.2B Both SC and SCW compressors

3.2A Model SCW (Water Cooled) Compressor Only

If flexible water hose connections are used, install the barbed fittings supplied with the compressor on the input and output connections:

1. Apply a light coating of standard plumbing thread sealant on the barbed fitting threads.
2. Tighten fittings onto 1/4-inch FPT input connection and 1/2-inch FPT output connection. DO NOT OVERTIGHTEN.
3. Connect flexible hoses to the fittings and secure with hose clamps.

If hard piping is desired, install the water lines directly onto the compressor 1/4-inch FPT input and 1/2-inch FPT output connections. DO NOT OVERTIGHTEN.

> **Caution --**
>
> Make sure that all water connections are tight.

Cooling Water: General Considerations

> **For Your Information --**
>
> Adjust your water flow to maintain an optimum discharge water temperature of 85°F with a minimum input pressure of 2 psig. For detailed water requirements, see below.

1. Cooling water must meet flow and pressure requirements as indicated in the following subsections.
2. Cooling water having a pH value of 6.0 to 8.0 and a calcium-carbonate concentration of less than 75 ppm, the quality of typical municipal drinking water, is acceptable. If the cooling water has a pH value lower than 6.0 or a calcium-carbonate concentration higher than 75 ppm, water conditioning may be required.
3. To conserve water, the cooling water should be shut off when the compressor is not running.

> **Caution --**
>
> If cooling water below 45°F (7°C) is allowed to run through the compressor while the compressor is not operating, the compressor oil will change viscosity and thicken, and may cause the compressor to overheat and shut off at startup. In this event, repeatedly restart the compressor and allow it to run until it has shut off several times. The oil temperature will rise and thereby allow continuous compressor operation.

3

4. Drain and purge water from the compressor before shipping it back to the factory or subjecting it to freezing conditions. Purge water from the compressor by blowing compressed air, regulated to 30 to 40 psig (200 to 275 kPa), into the compressor output connection and allowing water to exit from the water input connection.

Cooling Water: Flow and Pressure Requirements

> **Caution --**
>
> If your water supply pressure falls below 2 psig due to back pressure, the compressor will overheat and shut down.

Use the two graphs in Figure 3.1 to determine the minimum acceptable cooling water supply pressure at different flow rates and temperatures. Find the minimum pressure:

1. Determine the temperature variation of the cooling water. Allow ± 10°F to the present water temperature if a variation cannot be ascertained. Plot the high and low temperatures on the vertical axis of the lower graph.

   The example describes cooling water that varies between 40 and 70°F.

2. Determine the optimum water flow rate by drawing a horizontal line from the upper temperature variation figure on the lower graph to the upper curve of the allowable operating range indicated by cross hatching. Draw a line from this intersecting point straight down to the horizontal axis to find the optimal flow rate.

   The example shows a solid arrow extending from 70°F and intersecting the allowable operating range. Dashed arrows pointing downward indicate a water flow rate of 0.5 gallons per minute.

3. Determine the minimum cooling water supply pressure by drawing a line straight up from the flow rate in the lower graph to the upper graph. At the point at which this line intersects the upper graph, draw a line leftward to the vertical axis and find the minimum required water supply pressure.

   The example shows dashed arrows extending from the lower to the upper graph. On the upper graph the dashed arrows intersect the graph curve at approximately 2.5 psig.

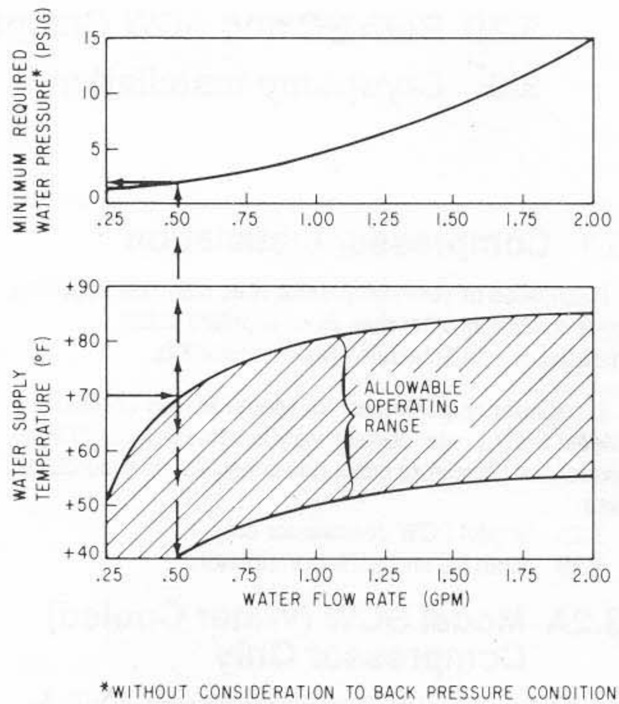

Figure 3.1 SCW Compressor cooling water flow and pressure requirements.

Cooling Water: Temperature Rise

> **Caution --**
>
> The temperature of the cooling water as it leaves the compressor should not exceed 100°F.

Use the graph in Figure 3.2 to determine the rise in cooling water temperature as it passes through the compressor. This information is used by plant engineering personnel to determine cooling water requirements.

Find the temperature rise:

1. Draw a vertical line upward from the horizontal axis of the graph at the water flow rate determined from the previous section, until it hits the graph curve.

   The example shows dashed arrows pointing upward to the graph curve from 0.50 gpm on the water flow rate axis.

2. At the point which the dashed arrows intersect the graph curve, draw a straight line to the left to obtain the increase in output water temperature.

   The example shows a temperature increase of 20°F.

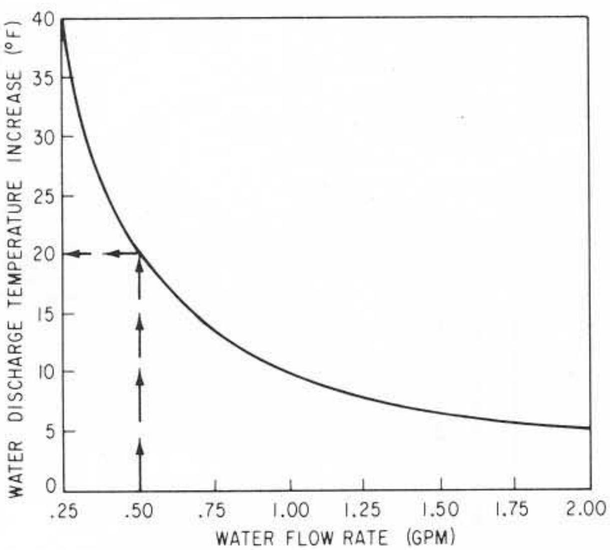

Figure 3.2 SCW Compressor water discharge temperature increase (°F)

3.2B Both SC and SCW Compressors

To install both model SC (air cooled) and SCW (water cooled) compressors:

1. Assemble the compressor input-power cable using the CTI-supplied compressor receptacle plug and a 600-volt power cable that has SO-3 conductor, 600 volt rating neoprene jacket, and 14-gauge wire.

   Follow Figure B.1 or B.2, pages 40 or 42, Electrical Schematic in Appendix B, being sure to comply with all national, state, and local standards.

2. After removing the compressor cover, set the 50/60 Hz slide switch (7, Figure B.3, or 2, Figure B.4, pages 44 or 45) to 50 Hz or 60 Hz frequency position as appropriate.

> **Caution --**
>
> Failure to set the switch to the appropriate frequency may cause improper cryopump operation.

3. Ensure that water is turned on.

4. With both switches on the compressor in the OFF position, connect the input-power cable to the power source. Refer to Table 1.2, page 3, for electrical power requirements.

5. Turn the compressor switch to the ON position and allow the compressor to run for 15 minutes to stabilize the oil circuit. Make sure that the compressor fan operates freely.

6. If your compressor is a Model SCW, confirm that the oil level is visible in the sight glass on the compressor pump. If no oil is visible, first, suspect that the oil level is overfilled and therefore not readily visible in the sight-glass. Carefully tip the compressor first toward and then away from you, while rechecking the oil level in the sight glass. If no oil is visible due to a level below the sight glass, contact the Product Service Department before proceeding.

7. Switch off the compressor and disconnect the input-power cable.

8. Replace the compressor cover.

9. Install the compressor in its permanent location on a level surface. Air cooled units must have a minimum clearance of 12 inches at the front and back for adequate airflow.

3

3.3 Cryopump Installation

Installing your Cryo-Torr 8 involves:

1. Mounting the cryopump to the vacuum system.
2. Connecting the cryopump to a roughing pump system.
3. Connecting the cryopump to the compressor.
4. Connecting the purge gas system (optional). Refer to Section 5.4 Assisted Regeneration, page 24.
5. Connecting a vent pipe to the cryopump relief valve (optional).

Refer to the Component Interconnection Diagram, Figure 3.3, for proper system connections.

Refer to Appendix H, page 57, for overall dimensions necessary for installation and interface for the various types of cryopumps that are available.

Mounting the Cryopump to the Vacuum System

The cryopump may be installed in any orientation without affecting its performance.

Before mounting the cryopump to the vacuum system, a high-vacuum isolation valve (Hi-Vac valve) should be installed between the cryopump and vacuum chamber to isolate the cryopump from the chamber during rough pumping, cooldown, and regeneration.

The Cryo-Torr 8 mates with a Hi-Vac valve or vacuum chamber with a six-inch ANSI, a 200 mm ISO multi-fastener or 10 inch OD metal seal mounting flanges. Other mating connections with an inside diameter of 8.0 inches or less may be used.

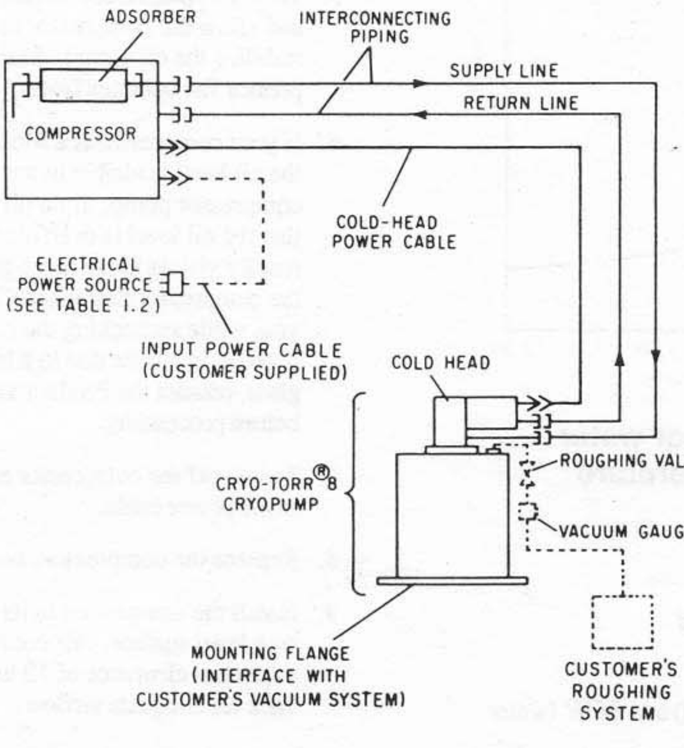

Figure 3.3 Component interconnection diagram

Installing the Cryopump

1. Remove the protective cover from the Hi-Vac valve or vacuum chamber, venting the relief valve to remove the partial vacuum if necessary.
2. After cleaning all sealing surfaces, install the O-ring or metal seal gasket as appropriate.
3. Mount the cryopump to the flange following the mounting-flange manufacturer's instructions. Be sure all mounting bolts are torqued to specified values.

Connecting a Vent Pipe

The cryopump pressure relief valve can be vented directly into the room or can be connected to an exhaust system.

> **Warning --**
>
> If toxic, corrosive, or flammable gases are pumped, a vent pipe must be connected to the cryopump relief valve and directed to a safe location.

In connecting a vent pipe to your cryopump, the 1.30 inch diameter x 1.38 inch long volume around the relief valve must remain open. Refer to installation and interface drawings in Appendix H, page 57, for details.

Vent pipe adapters are available from CTI-CRYOGENICS. Consult the Product Service Department or your sales representative.

Connecting a Roughing Pump System

The first step in connecting your Cryo-Torr 8 to a roughing pump system is to select a roughing line with the largest inside diameter possible to minimize the roughing time required during startup procedures prior to normal operation (see Figure 4.2, page 15).

The roughing pump system connects to the Cryo-Torr 8 through the cryopump accessory port. The port cover can be modified to accept 3/4-inch maximum OD tubing for use as a roughing pump connection. If larger than 3/4-inch roughing pump line is used, install the reduction fittings as conveniently close to the cryopump as possible.

> **Warning --**
>
> Do not install a hot-filament-type vacuum gauge on the cryopump side of the roughing valve; it could be an ignition source of flammable gases.

Install a roughing valve and vacuum gauge between the cryopump and roughing pump system, as close as possible to the cryopump. Both valve and gauge should be installed a maximum distance of 4 to 6 inches from the cryopump accessory port.

A device to minimize oil backstreaming from your roughing pump system is recommended and should be installed in the roughing pump line near the roughing pump.

Connecting the Cryopump to the Compressor

> **Warning --**
>
> Do not connect the compressor to its power source until all connections have been made between the components of the high-vacuum pump system.

Make the connections between the cryopump and compressor:

1. Remove all dust plugs and caps from the supply and return lines, compressor, and cryopump cold head. Check all fittings.
2. Connect the helium return line from the gas-return connector on the rear of the compressor to the gas-return connector on the drive-unit displacer assembly on the cryopump cold head.
3. Connect the helium supply line from the gas-supply connector on the rear of the compressor to the gas-supply connector on the drive-unit displacer assembly on the cryopump cold head.
4. Attach the supply and return line identification decals (CTI supplied) to their respective connecting piping ends.

Verify proper helium supply static pressure by confirming that the helium pressure gauge reads 245-250 psig (1690-1725 kPa) in an ambient temperature range of 60 to 100°F (16 to 38°C).

If the indicated pressure is higher than 250 psig (1725 kPa), reduce the pressure as follows:

1. Remove the flare cap from the gas charge fitting located on the rear of the compressor.
2. Open the gas charge valve very slowly. Allow a slight amount of helium gas to escape until the helium pressure gauge reads 250 psig (1725 kPa).
3. Close the gas charge valve and reinstall the flare cap.

If the indicated pressure is lower than 245 psig (1690 kPa), add helium gas as described in Section 7.2, page 33.

The last step required for installation is making electrical connections:

Warning --

Both switches on the front of the compressor must be in the OFF position before making any and all electrical connections.

1. Connect the cold head power cable to the rear panel of the compressor and the other end to the electrical power connector on the cryopump cold head.
2. Plug the compressor input power cable into the power source.
3. Your Cryo-Torr system is now ready for operation.

Section 4: Operation

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Caution --

Do not begin Cryo-Torr 8 system operation until all steps in the inspection and installation procedures have been completed and confirmed.

4.1 Before Startup

Operating Log

It is highly advisable to create and maintain a detailed operating log. The record will assist in troubleshooting should problems arise. Figure 4.1, page 14, is a sample operating log included for your use. You may make photocopies of this sample log as necessary.

Temperature Indication

While the Cryo-Torr 8 vacuum system can be operated without temperature indication, it is advisable to install either the temperature indicator or the cryopump monitor to facilitate accurate operating characteristics. Refer to Appendix E, pages 49 and 51, for detailed descriptions of both temperature indicating devices. Data is given in Appendix F, page 52, to convert a reading of the optional hydrogen-vapor pressure gauge to temperature in Kelvin. Note that this method of temperature measurement is only accurate at temperatures below 26K.

4.2 Rough Pumping (Preliminary Vacuum Pumping)

Determine the roughing pressure required before starting your cryopump by using Figure 4.2, page 15, and known factors of roughing line length and diameter and roughing pump speed (cfm).

Caution --

Do not rough pump your cryopump longer than necessary; otherwise mechanical pump oil backstreaming may occur and contaminate the cryopump.

Determine the roughing pump pressure required before cryopump startup and cooldown.

Caution --

Proper measurement of the roughing pressure (P) requires the use of a vacuum gauge described under "Connecting a Roughing Pump System," page 11.

4

Page ______________

Operating Log
Cryo-Torr 8 High-Vacuum Pump System

Cryopump serial number____________________ Installation date______________

Compressor serial number____________________

__________Avg. time to cooldown to operating temperature

__________Avg. time to achieve operating vacuum

Take readings at least once during each operating shift

DATE	TIME	CRYOPUMP TEMPERATURE	HELIUM SUPPLY PRESSURE GAUGE	COMPRESSOR ELAPSED TIME METER	NOTES ON REGENERATION SERVICING, ETC.

Scheduled maintenance service schedule:

1. Replace compressor adsorber after every 10,000 hours of operation.

Figure 4.1 Sample operating log

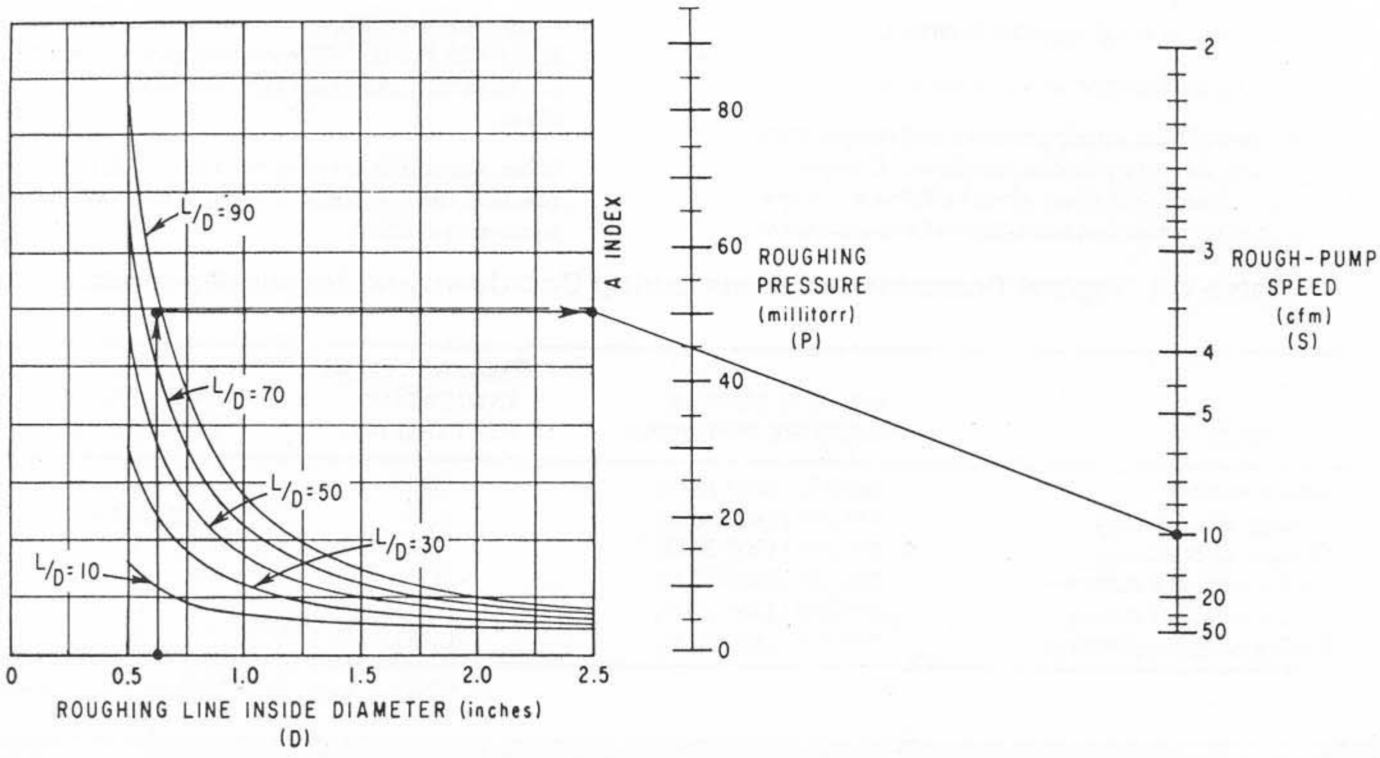


Figure 4.2 Determining roughing pressure

1. Calculate $\frac{L}{D} = \frac{\textit{Roughing line length (L)}}{\textit{Roughing line inside diameter (D)}}$

2. Locate D on the graph and draw a vertical line to the appropriate L/D curve.

3. At this intersection draw a horizontal line to the A INDEX line and mark the point.

4. Locate and mark the rough pump speed on the right-hand scale S.

> **Caution --**
>
> If a molecular sieve trap or equivalent is installed in the roughing line, use a rough pump speed S equal to one-half the actual rough pump speed.

5. Draw a straight line between your marks on the A INDEX line and the right hand scale S.

6. Where the straight line intersects the roughing pressure scale P, read the value that must be achieved during rough pumping before cryopump startup and cooldown.

Example:
a. D (roughing line inside diameter) = 0.625 inches nominal
b. 3/4-inch OD tube
c. L (roughing line length) = 54 inches
d. S (rough pump speed) = 10 cfm

Solution:
a. $\frac{L}{D} = \frac{54}{0.625}$ = *85, approximately.*
b. Locate D (0.625) on graph and draw line to L/D curve (85).
c. Draw line to a A INDEX line.
d. Locate and mark rough pump speed on right-hand scale S.
e. Draw line between A INDEX line and right-hand scale S.
f. Read value of P = 45 millitorr on the roughing pressure scale.

4.3 Startup and Cooldown

1. Confirm that roughing valve is closed.
2. Turn on compressor and cold head switches.
3. Record helium supply pressure and temperature reading during the initial cooldown. Compare these figures with those given in Table 4.1 below. If the cryopump has not achieved a second stage temperature of 20K or less in approximately 1 1/2 hours with the Hi-Vac valve closed, refer to Table 6.1, page 28, Cryopump Troubleshooting Procedures.
4. When the cooldown temperature of 20K or less is reached, the cryopump is ready for normal vacuum operation.

Table 4.1 Typical Pressure Variations During Cooldown and Normal Operation

TIME	HELIUM SUPPLY PRESSURE PSIG (kPa)	TEMPERATURE INDICATOR READING (k)	CRYOPUMP MONITOR INDICATOR*
Before startup	245-250 (1690-1725)	300	R
15 mins. after startup	270-290 (1860-2000)	270	R and Y
50 mins. after startup	270-290 (1860-2000)	170	Y
1 1/4 hours after startup	270-290 (1860-2000)	135	Y
1 1/2 hours after startup	270-290 (1860-2000)	10-20	G
During normal operation	270-290 (1860-2000)	10-20	G

*Red = Red, Y = Yellow, G = Green

For Your Information --

How the Cryopump Operates

Refer to Figures 1.2 and 1.3, page 2, while reviewing this subsection.

Your Cryo-Torr 8 cryopump basically consists of a cold head and a vacuum vessel. An 80K condensing array, a 15K array, and an 80K radiation shield are located in the vacuum vessel. The 15K array is secured to the cold head, which is welded to the vacuum vessel. The cold head provides cooling to the three arrays. Gases are removed from your vacuum chamber, thereby creating a vacuum when they are condensed or adsorbed on the cryogenically-cooled arrays.

Cold Head

The cold head, consists of a two-stage cold-head cylinder (part of the vacuum vessel) and drive unit displacer assembly, Figure 4.3 that together produce closed-cycle refrigeration at temperatures that range from 60 to 120K for the first stage cold station to 10 to 20K for the second-stage cold station, depending on operating conditions. Within the drive unit displacer assembly, the drive unit actuates the displacer-regenerator assembly located in the cold head cylinder and thereby controls the flow of helium into the cold head. Within the drive unit are located the crankcase (2) and drive motor (3), which is a direct-drive constant-speed motor operating at 72 rpm on 60 Hz power and 60 rpm on 50 Hz power.

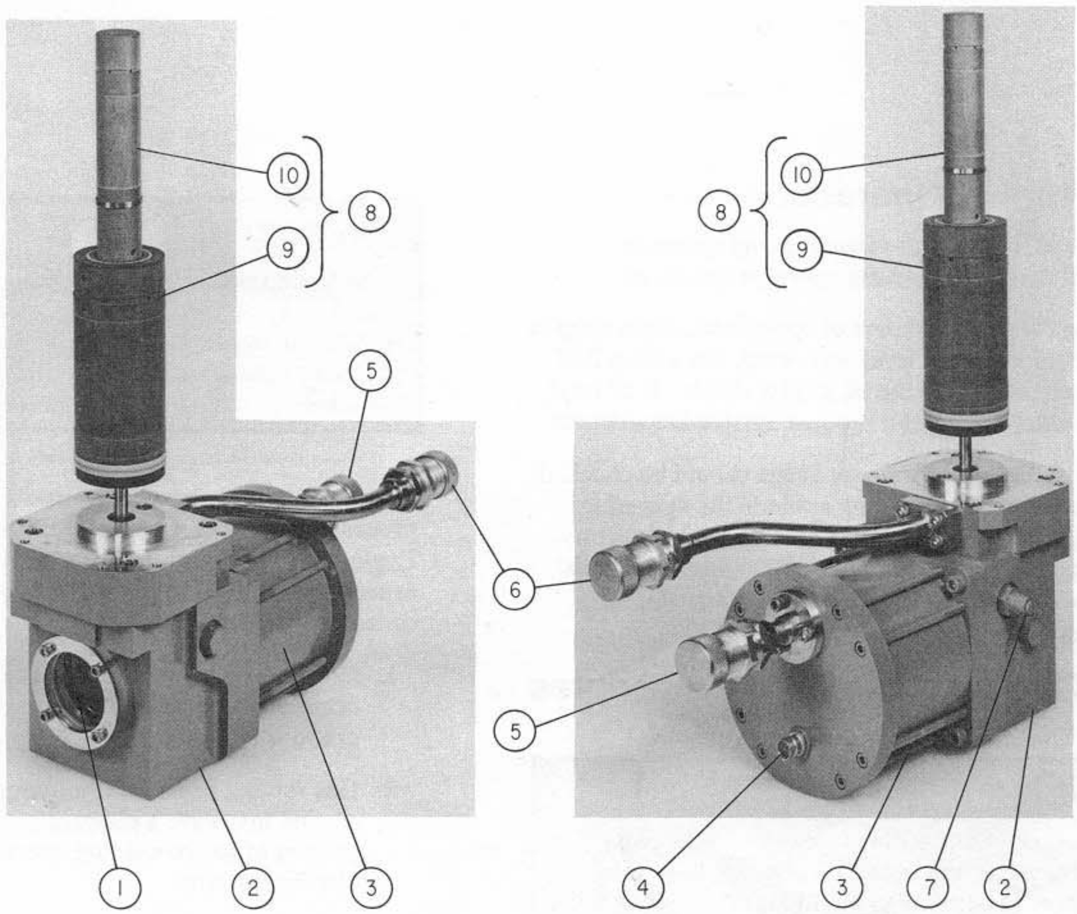
During operation, high pressure helium from the compressor enters the cold head at the helium supply connector (6), and flows through the displacer-regenerator assembly, crankcase, and motor housing before exiting through the helium gas return connector (5) and returning to the compressor. Helium expansion in the displacer-regenerator assembly provides cooling at the first and second stage cold stations.

Refer to Appendix D, page 47, for detailed information on the principles of operation.

Vacuum Vessel and Arrays

The 80K array condenses water and hydrocarbon vapors. The 15K array condenses nitrogen, oxygen, and argon while the specially processed charcoal of this array traps helium, hydrogen, and neon.

The temperature of the cold-head station to which the 15K array is attached is measured by a temperature sensor and transmitted to a temperature indicator, monitor or vapor pressure gauge.



A. FRONT VIEW

1. Sight Glass
2. Crankcase (Houses the Drive Mechanism)
3. Drive Motor
4. Power Connector
5. Gas Return Connector

B. REAR VIEW

6. Gas Supply Connector
7. Pressure Relief Valve
8. Displacer-Regenerator Assembly
9. First-Stage Displacer-Regenerator
10. Second-Stage Displacer-Regenerator

Figure 4.3 Drive-unit displacer

For Your Information (Continued) --

Compressor Gas and Oil Flows

Refer to Figures 4.3, and 4.4 or 4.5, pages 19 or 20, while reviewing this subsection.

Helium returning from the cryopump cold head enters the compressor, and a small quantity of oil is injected into the gas stream, thereby overcoming helium low specific heat and inability to carry heat produced during compression. Helium is then compressed and passed through a heat exchanger for removal of compression-caused heat. The helium flows through a bulk oil separator, oil-mist separator, and charcoal filter adsorber, where oil and contaminants are removed.

A differential pressure relief valve in the compressor limits the operating pressure differential between the helium supply and return lines, thereby allowing compressor operation without cold head operation. When cryocooler operation reaches a steady-stage condition, further pressure regulation is unnecessary.

4

4.4 Normal Operation

The Cryo-Torr 8 high-vacuum pump system is designed to operate without operator assistance.

During the first 100 hours of operation a slight drop in compressor pump oil level may occur, but a drop is of no concern as long as the oil level is visible. If oil level is not visible, contact the Product Service Department.

The helium supply pressure gauge should be checked once a week and the reading noted in the operating log. If the gauge reading falls outside the satisfactory operating range between 270 and 290 psig (1860-2000 kPa) on the gauge, refer to Section 6, page 27, Troubleshooting Procedures.

4.5 Cryopump Oxygen Procedures

> **Warning --**
>
> Combustion supported by oxygen in the pump could cause severe injury. When oxygen is used as a process gas, special precautions described in the text should be taken.

When oxygen is used as a process gas; the following precautions should be taken.

1. Follow all cryopump operating instructions including:
   - Insure that there are no sources of ignition (e.g., hot filament vacuum gauges) on the cryopump side of the high-vac valve operating during the warming or venting of the pump.
   - Perform inert gas purge regenerations at flow rates recommended for cryopumps.
2. Regenerate as frequently as practical to minimize the amount of oxidizer present in the cryopump.
3. It is standard practice in the vacuum industry that any system exposed to richer-than-air oxygen levels should be prepared for oxygen service per the manufacturer's recommendations, including use of oxygen service lubricating oils in roughing pumps.

> **Warning --**
>
> Explosion occurring from ozone in the pump could cause severe injury. Ozone can be present as a by-product of oxygen processes. If ozone is present, special precautions described in the text below must be taken.

Ozone may be unknowingly produced in an ionizing process (e.g., sputtering, etching, glow discharge). Explosive conditions may exist if ozone is present, especially during warming of the cryopump. Signs of ozone's presence are:

1. Crackling/popping sounds (as in electrical arcing) occurring within the first few minutes of regeneration.
2. Gas venting from the cryopump during regeneration may have a pungent smell, similar to that present in an arc welding operation or after an electrical storm.

   Note: A change in process may increase the amount of ozone present.

If ozone is present, the following precautions must be taken.

1. All of the above oxygen precautions must be followed. The required regeneration frequency is dependent upon flow and process conditions. Daily regeneration may be required. Call CTI-CRYOGENICS for assistance.
2. Reduce the oxygen mixture to the lowest level the process will allow.

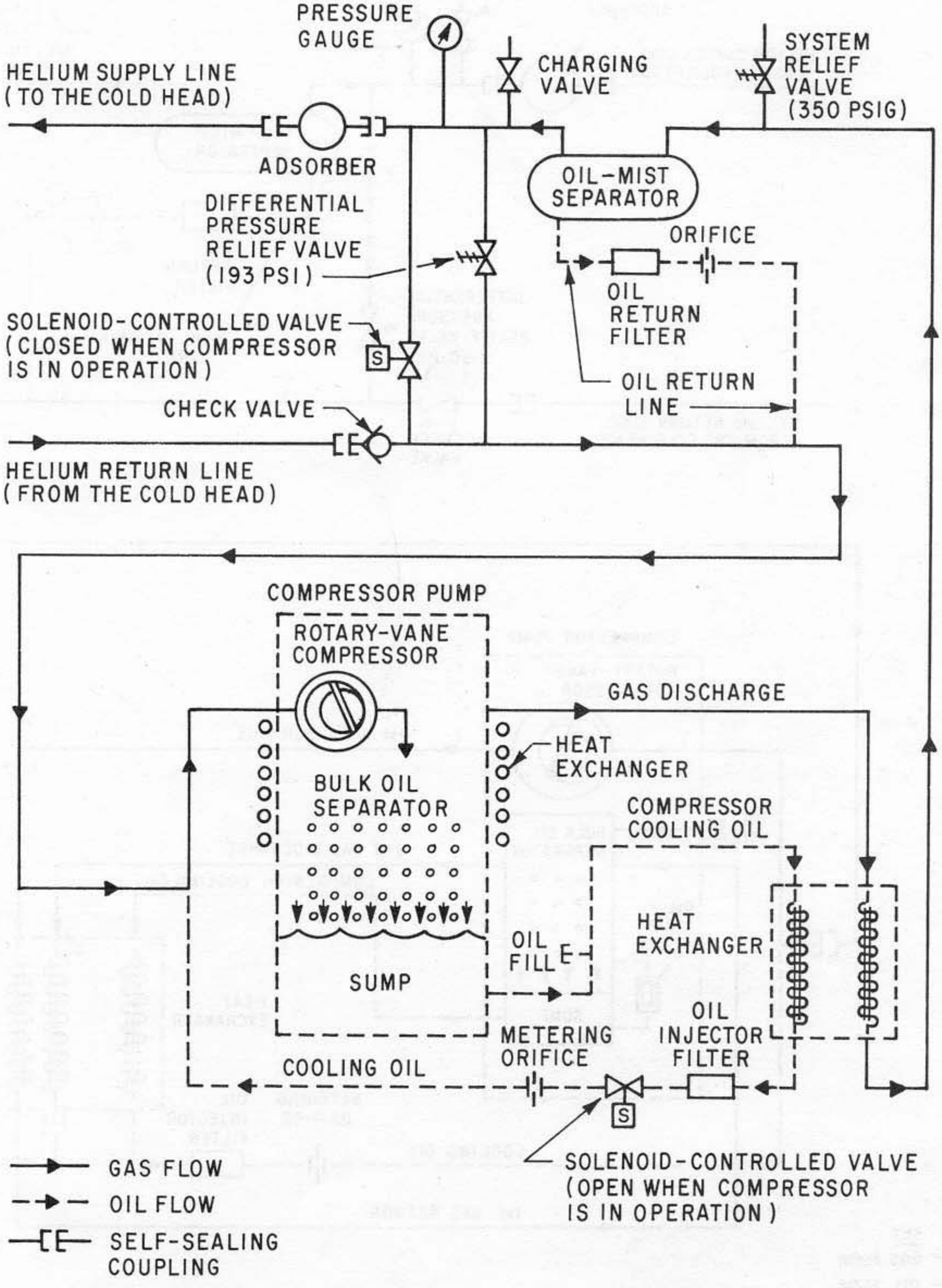


Figure 4.4 Flow diagram of Model SC Compressor

4

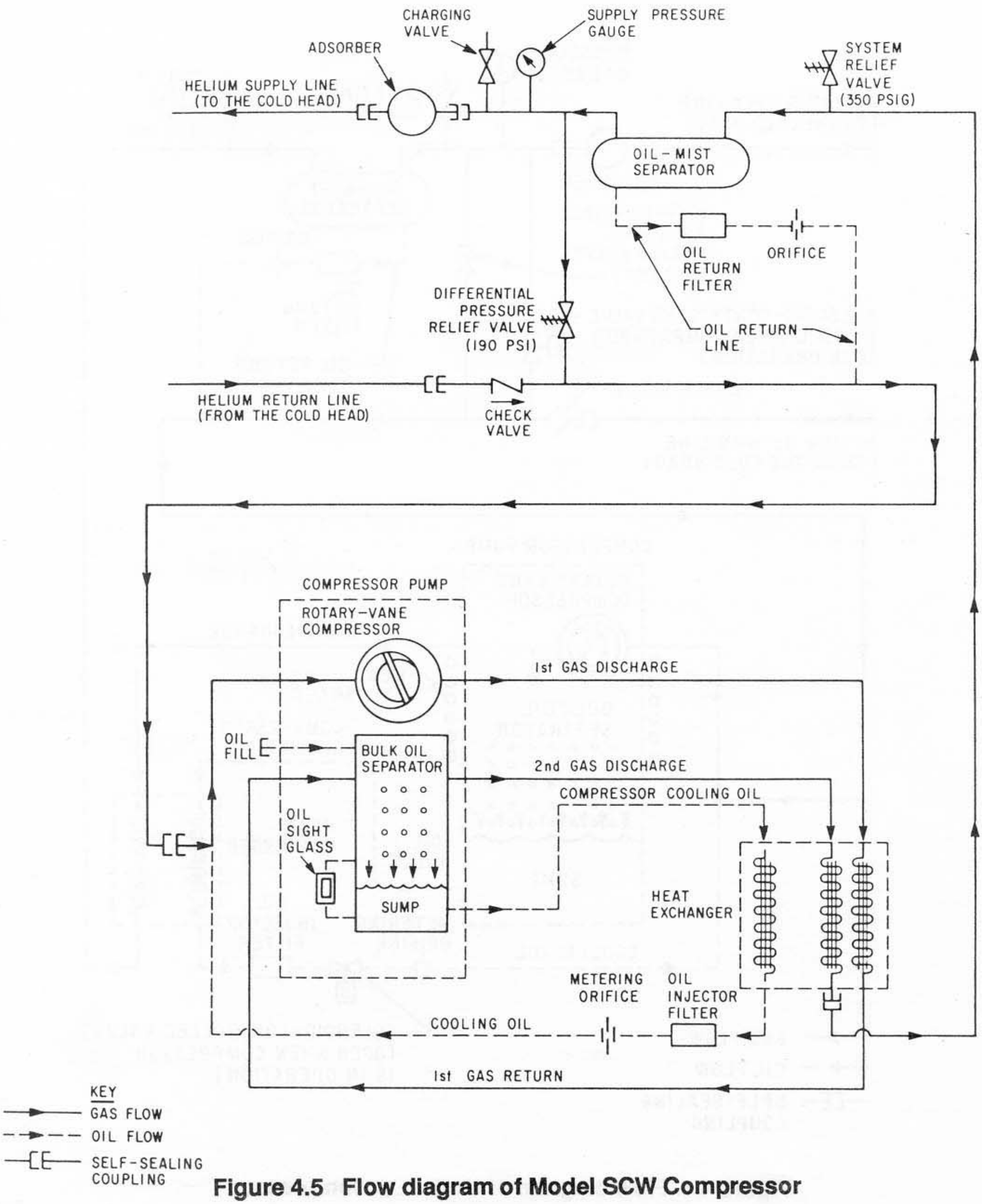


Figure 4.5 Flow diagram of Model SCW Compressor

4.6 Determining Crossover Pressure

Crossover pressure is the pressure in a vacuum chamber at which, as the Hi-Vac valve is opened, the cryopump high-vacuum pumping starts.

To determine the maximum permissible crossover pressure solve:

Maximum Crossover Pressure (MCP) =

$$\frac{\text{Maximum gas burst rating of cryopump (torr-liters)}}{\text{Vacuum chamber volume (liters)}}$$

Example:

Cryo-Torr 8 maximum gas burst rating: 150 torr-liters

Vacuum chamber: 18 by 30 inch bell jar = 100 liters (cubic inches x 0.01639 = liters)

$$MCP = \frac{\text{150 torr-liters}}{\text{100 liters}}$$

1.5 torr = 1500 militorr

Note: 1 ft.^{3} ≅ 28 liters

4.7 Determining Cryopump Capacity for Condensable Gases

The number of hours between regeneration cycles can be easily calculated in the case of a continuous gas flow of a known gas species:

A = *Duration of operation with a continuous gas flow (hours)*

B = *Gas Flow (scc/min.)*

C = *Cryo-Torr 8 capacity for the particular gas species being flowed (std liters); refer to Table 1.1, page 2.*

$$A = \frac{16.6 \times C}{B}$$

Example:

For a sputtering application of continuously flowing argon gas at 70 scc/min., the duration of continuous operation with this gas flow (between regenerations) would be:

$$A = \frac{16.6 \times 1000 \text{ (std liters)}}{70 \text{ (scc/min.)}} = 237 \text{ hours}$$

The number of crossover cycles between regenerations can also be easily calculated when the crossover pressure and vacuum chamber volume are known:

N = *Number of crossover cycles*

V = *Volume of vacuum chamber (liters)*

P = *Pressure of vacuum chamber prior to crossover (torr)*

$$N = \frac{\text{760,000 torr liters}}{P \times V}$$

Example:

For a vacuum chamber of 20 liters and a roughing pressure of 1 torr, the number of crossover cycles between regenerations would be:

$$N = \frac{\text{760,000 torr liters}}{1 \text{ (torr)} \times 20 \text{ (liters)}} = 38{,}000 \text{ cycles}$$

4.8 Cryopump Shutdown Procedures

1. Close the Hi-Vac valve in your vacuum system.
2. Turn off the compressor power and cold-head ON/OFF switches on the compressor.
3. Immediately start purge gas flow.
4. Allow the cryopump to warm up to ambient temperature without exposing it to the atmosphere. Warmup may take as long as 2 1/2 hours if no heat load is present. Refer to Section 5.4, page 24, Assisted Regeneration, for procedures to accelerate warmup time.

Caution --

Exposing the cryopump to atmosphere during warmup will cause excessive water vapor adsorption by the charcoal of the 15K array.

4.9 Cryopump Storage

If the cryopump is stored while still attached to your vacuum system, the cryopump vacuum vessel should be (1) maintained under vacuum of (2) kept at atmospheric pressure with dry nitrogen or argon.

If the cryopump is removed from your vacuum system, install the protective cover on the mounting flange on the cryopump vacuum vessel inlet before storage.

The remaining components of your Cryo-Torr 8 high-vacuum pump systems are fully protected during storage if kept under positive helium pressure and all component connections left connected. Periodically check the helium supply pressure gauge on the compressor. If the gauge reads below 245 psig (1690 kPa), add helium as described in Section 7.2, page 33.

4.10 Hazardous Materials

Warning --

If the cryopump has been used to pump toxic or dangerous materials, you must take adequate precautions to safeguard personnel.

If such a cryopump is shipped to a Product Service Department, clearly mark on all storage cartons the identity of the toxic or dangerous materials to which the cryopump has been subjected. Hazardous/toxic materials when offered for shipment must conform to all DOT regulations.

Section 5: Regeneration

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5.1 Introduction

Your Cryo-Torr 8 High-Vacuum Pump periodically requires regeneration to return it to its original operating capabiities.

Gases captured from a vacuum chamber and trapped in the cryopump through condensation and cryo-adsorption are held primarily in an ice-like form. Regeneration removes trapped gases through a process similar to defrosting a refrigerator freezer compartment.

During regeneration the cryopump warms to room temperature or higher, thereby allowing trapped gases to change from a solid state to a gaseous state. Liberated gases are released from the cryopump through the pressure relief valve to the atmosphere.

Warning --

Toxic, corrosive, or flammable gases must be safely vented to prevent harm to personnel and to avoid equipment damage. If a large amount of oxygen has been cryopumped, refer to Section 4.5, page 18.

The cryopump includes a standpipe filter designed to prevent particulate contamination from entering the relief valve. Contamination may cause the relief valve to seat improperly after a regeneration, affecting system pumpdown. Failure of this valve to reseat will affect unattended regeneration. The filter, made of stainless steel mesh, is attached to the relief port and it mounted inside the vacuum vessel. In general use, the standpipe filter requires neither maintenance nor User service for the life of your cryopump.

5.2 When to Regenerate

It is recommended that your cryopump be regenerated on a regular schedule coinciding with system maintenance, weekend system shutdown, etc. A suitable time interval between regenerations can be determined by experience.

The need to regenerate the Cryo-Torr high-vacuum pump as a result of saturation is a function of the cryopump capacity and the process gas throughput.

If the cryopump becomes incapable of maintaining a high-vacuum (typically an increase in your vacuum chamber base pressure by a factor greater than 10, even though the cold head and compressor unit are operating satisfactorily), the cryopump requires regeneration.

Data aiding calculation of gas saturation levels may be obtained in Section 4.7, page 21, Determining Cryo-pump Capacity for Condensable Gases.

Extended loss of electrical power (10 minutes or longer), system vacuum failure, such as venting with a partially open vacuum isolation valve, and operator error may necessitate cryopump regeneration. Short term electrical outages of up to 10 minutes should not result in the need to regenerate your cryopump.

Regeneration may be accomplished three ways:

1. Unassisted
2. Assisted } with optional equipment
3. Automatically } with optional equipment

5.3 Unassisted Regeneration

Unassisted regeneration may be performed by following the steps below.

> **Caution --**
>
> Each step in the regeneration process must be performed completely and in the indicated sequence.

1. Close the high-vacuum isolation valve between the cryopump and its vacuum chamber.
2. Shut off the cryopump using the compressor ON/OFF switch.
3. Allow the cryopump condensing arrays to warm to ambient temperature.

   It is essential that the water present on the condensing arrays reaches a temperature high enough to return the water to its liquid or vapor phase. Excess water will significantly increase the required roughing time.
4. When the condensing arrays reach ambient temperature, rough the cryopump to an an initial starting pressure, usually between 50 and 100 microns. Refer to Figure 4.2, page 15, for your specific roughing pressure. If adequate roughing is not performed, the charcoal adsorbent capacity for noncondensable gases will be reduced, thereby shortening the time required between regeneration cycles. At this point, you can perform a simple check (1) to ensure that your cryopump regeneration has been thorough, and (2) to ensure that no air-to-vacuum leaks are present, caused by regeneration. The check is called a rate of rise (ROR).

   Upon completion of your roughing cycle (to 50 or 100 microns), close the roughing valve and observe the rate of pressure rise (ROR). If your cryopump is clean and no leaks are present, the ROR should be less than 10 microns/minute over a five-minute period (total: 50 microns). If the ROR is greater than 50 microns, repurge the cryopump, check the cyropump relief valve for evidence of leaks, and repeat your roughing cycle and ROR.
5. Close the cryopump roughing valve and restart the cryopump.
6. When the second-stage array reaches a temperature of 20K or lower, regeneration is complete and the cryopump is ready for use.

> **Caution --**
>
> Techincal difficulties of unassisted regeneration are:
> 1. 2-4 hours may be required to bring the cryopump up to room temperature, depending on the quantity of frozen gases.
> 2. A relatively large amount of water vapor can remain in the cryopump, especially in the cryo-adsorbing array, causing extended rough pumping time requirements.
> 3. The cryopump is not purged of toxic, corrosive, or flammable gases.

5.4 Assisted Regeneration

Regeneration aided by incorporating the use of heated dry inert purge gas (nitrogen/argon) will overcome the unassisted regeneration technical difficulties by:

1. Minimizing the required time to bring the condensing and cryo-adsorbing arrays to room temperature.
2. Reducing the time required to rough the cryopump because the dry inert purge gas will minimize the amount of residual water vapor in the 15K array.
3. Diluting hazardous gases and ensuring their removal from the cryopump housing.

Note: Required optional accessories allowing assisted regeneration are:

DESCRIPTION	PART NUMBER
Purge gas heater	8080250K020
Purge gas solenoid valve	8080250K023
Relief valve exhaust adapter kit	8080250K008
Silicon diode temperature sensor	8080250K009

To accomplish assisted regeneration with heated dry purge gas:

1. Close the high-vacuum isolation valve.
2. Shut off the cryopump using the compressor ON/OFF switch.
3. Immediately introduce heated dry purge gas to the vacuum vessel purge fitting at approximately 150°F (66°C) and at a flow rate of 1-2 cfm. Allow the purge gas to vent.
4. Halt the gas purge when the condensing arrays reach 80°F (26°C).
5. Complete steps 4 through 6 of the unassisted regeneration cycle procedures.

5.5 Automatic Regeneration

Completely automatic and rapid regeneration of your cryopump is possible by adding the REGEN from CTI-CRYOGENICS to your system; refer to Appendix E, page 50. The REGEN can easily be installed on your system; all the valves, cables and other components are available to complete your installation. The REGEN components and the various options available for automatic regeneration are as follows:

For Your Information --

Estimating Frequency of Required Cryopump Regeneration

While periodic scheduled regeneration of the cryopump is recommended, regeneration may also be necessary due to the cryopump reaching the limit of its ability to capture and hold gases.

The frequency of regeneration depends on the individual application, ranging from a few hundred hours for very high gas-flow sputtering or bell jar evaporation systems, to many thousands of hours when operated at low pressures (below 10^{-5} torr).

Refer to Section 4.7, page 21, for estimating frequency of required cryopump regeneration.

DESCRIPTION	PART NUMBER
REGEN System. Includes controller, purge gas heater kit, purge gas valve kit, purge gas valve kit, roughing valve kit, 15 ft. diode cable assembly, (3) 15 ft. thermocouple cable assemblies, 15 ft. purge-cryopump isolation - rough valve cable assembly with 3 circuit receptacle connector kit, 15 ft. cryopump cable assembly, 15 ft. roughing valve cable assembly, (3) DV-6M thermocouple gauges, relief valve filter. Power contactor accessory kit optional.	8044070G001
Options	
Setpoint. Four user adjustable, uncommitted setpoints with variable hysteresis. Are totally independent of the regeneration process and can be used for any function.	8080250K021
RS232 computer interface. Permits REGEN to be programmed and controlled from a system computer.	8080250K019
Power contactor accessory kit.	8080250K032
Power contactor accessory kit. For 3HP maximum roughing pump.	8080250K034

Section 6: Troubleshooting Procedures

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6.2 Troubleshooting the Compressor. 27
6.3 Contacting the Product Service Department. 27

6.1 Troubleshooting the Cryopump

The primary indication of trouble in a vacuum pumping system is a rise in pressure in the vacuum chamber. This is referred to as the base pressure. A rise in the base pressure may be caused by a leak in your vacuum system or by a fault in the cryopump or saturation of your adsorbing charcoal array. (Regeneration may be necessary).

If you suspect a leak in your vacuum system, isolate the cryopump by closing the high-vacuum valve and leak check your vacuum chamber. If no signs of leakage are disclosed, a leak may be present below the high-vacuum valve. Helium leak checking below the high-vacuum valve should be performed with the cryopump shut off and at room temperature. Leak checking while the cryopump is operating may mask leaks that are present (due to the ability of the cryopump to pump helium). If no leak is found, refer to the cryopump troubleshooting procedures summarized in Table 6.1, page 28.

Most of the problems in the Troubleshooting Tables are followed by several possible causes and corrective actions. The causes and corresponding actions are listed in their order of probability of occurrence. 1) is most likely, 2) is next most likely, etc.

Maintaining a log of the readings (see Figure 4.1, page 14) of the temperature indicator during normal operation is a valuable tool in troubleshooting the cryopump. Values higher than 20K indicate that the second-stage cold station is too warm, thereby impairing the ability of the cryopump to pump hydrogen. A temperature below 20K means the cryopump is cold enough to pump and therefore the problem may be elsewhere.

6.2 Troubleshooting the Compressor

The compressor troubleshooting procedures are summarized in Table 6.2, page 29.

6.3 Contacting the Product Service Department

Should your Cryo-Torr 8 vacuum system develop problems not corrected by following the troubleshooting procedures summarized in Tables 6.1 and 6.2, pages 28 and 29, contact the nearest Product Service Department by calling the service hot line.

East Coast Service Center
266 Second Avenue
P.O. Box 9171
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Table 6.1 Cryopump Troubleshooting Procedures

Problem	Possible Cause	Corrective Action
1) High base pressure of vacuum system, and a cryopump temperature below 20K.	1) Air-to-vacuum leak in vacuum system or in cryopump.	1) a. Check cryopump relief valve for proper seating. b. Check cryopump for leaks. c. Check vacuum chamber and Hi-Vac valve for leaks.
	2) High partial pressure of noncondensables (helium, hydrogen, or neon) within the cryopump because the 15K array has reached full capacity.	2) Regenerate the cryopump per Section 5, page 23.
	3). One of the arrays is loose, thereby preventing good thermal contact with its cold station on the cold head.	3) Warm the cryopump to ambient temperature, and re-tighten the arrays to 15-20 inch-pounds.
2) High base pressure of vacuum system, and a cryopump temperature *above* 20K.	1) Decrease in cryopump cold head performance.	1) If the helium supply pressure gauge reads below the normal-operating supply pressure of 270-290 psig (1860-2000 kPa), add gas as described in Section 7.2, page 33.
	2) High partial pressure of noncondensables (helium, hydrogen, or neon) within the cryopump because the 15K array has reached full capacity.	2) Regenerate the cryopump per Section 5, page 23.
	3) Excessive thermal load on frontal array.	3) Reduce the thermal radiation load by (1) shielding the cryopump or (2) lowering the temperature of the radiating surface.

Problem	Possible Cause	Corrective Action
3) Cryopump fails to cool down to the required operating temperature or takes too long to reach that temperature (20K).	1) Low helium supply pressure.	1) Add gas as described in Section 7.2, page 33.
	2) Compressor problem.	2) Refer to Table 6.2, page 29.
	3) Vacuum leak in vacuum system or cryopump.	3) a. Check the cryopump relief valve for proper seating. b. Check cryopump for leaks. c. Check vacuum system for leaks.
	4) Incomplete regeneration may not have fully cleaned the adsorbing array. Partial pressures of noncondensables (hydrogen, neon or helium) may remain.	4) Regenerate the cryopump as described in Section 5, page 23.

Table 6.2 Compressor Troubleshooting Procedures

Warnings --

1. Disconnect the compressor from its power source before performing any troubleshooting procedures.
2. The compressor pump is hot after operating. Wait for the pump to cool down before working on the inside of the compressor.

Problem	Possible Cause	Corrective Action
1) Compressor ON/OFF switch (SW1) will not remain in the ON position. Refer to Figures B1 or B2, pages 40 and 42, for identification of all electrical components.	1) The safety interlock switch (SW2) or the thermal protective switches (TS1 and TS3 in the water cooled compressor) are closed, activating the relay-trip coil in the ON/OFF switch (SW1).	1) Securing the compressor cover may correct the problem. If not, allow the compressor to cool down and test switches (TS1) and (TS3) (on water cooled compressors) and (SW2). When you depress the plunger on the interlock switch located on the side of the heat exchanger, all switches should be open, allowing you to test any switch for continuity. If continuity is found, contact the Product Service Department.
	2) Excessive current drain has activated the series trip in the compressor ON/OFF switch.	2) Measure and record the current and contact the Product Service Department.
2) Compressor ON/OFF switch (SW1) remains in the ON position when switched to ON, but the compressor will not run.	1) No power coming from the power source.	1) Check service fuses, circuit breakers, and wiring associated with power source, and repair as needed.
	2) Incorrect or disconnected wiring within the compressor.	2) Check the compressor against its electrical schematic, Figure B.1 or B.2, pages 40 and 42.
	3) Overload protective switch (TS2) is open (water cooled compressor only).	3) If the contact points of switch (TS2) are open when excessive current is not being drawn, the switch is defective. Use an ohmmeter and refer to the schematic to determine whether the switch is open or closed. When switch (TS2) opens because of excessive current draw, the cause may be determined by referring to Problem 4.

Problem	Possible Cause	Corrective Action
3) Compressor stops after several minutes of operation and remains off.	1) High temperature of the compressor is caused by insufficient cooling water, resulting in the opening of thermal protective switch (water cooled compressor only).	1) Confirm that cooling water to the compressor is flowing. Confirm that proper cooling water flow rate and pressure exist by referring to Figure 3.1, page 8.
	2) Ambient temperature is unusually high (air cooled compressor only).	2) Provide a free flow of air to the compressor. Confirm a 12 inch (30 cm) clearance at the front and back of the compressor. Confirm unobstructed and clean heat exchanger filter element surfaces.
	3) After turn-off, very cold cooling water was left running through the compressor. The resulting low oil temperature has caused a restriction of oil flow through the metering orifice during startup.	3) Turn on the compressor and allow it to run until it has stopped several times, allowing the oil temperature to rise and the compressor to operate continuously for one hour minimum.
	4) Insufficient helium supply pressure as indicated by the supply pressure gauge.	4) Add helium per Section 7.2, page 33, Unscheduled Maintenance.
	5) Very cold cooling water is circulating through the compressor. The resulting low oil temperature causes a restriction of oil flow through the metering orifice during startup.	5) Recheck for proper cooling water temperature per Section 3.2A, page 7.
	6) High temperature of the compressed helium in the discharge line from the compressor pump has tripped the thermal protective switch (TS1).	6) Confirm that oil is visible in the compressor sight glass (water cooled compressor only).
	7) Clogged or restricted heat exchanger filter element (air cooled compressor only).	7) Confirm filter element is clean and unobstructed, clean contaminated filter element per Section 7.2, page 38.
	8) Mechanical seizure.	8) Contact the Product Service Department.

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Table 6.2 Compressor Troubleshooting Procedures (Cont.)

Problem	Possible Cause	Corrective Action
4) Compressor pump stops after several minutes of operation and then re-cycles ON and OFF at short intervals.	1) Low power source voltage.	1) Confirm power source voltage between 180 and 253 volts and restore if necessary.
	2) High temperature of compressor pump causes thermal protective switch (TS2) to open, and reset after compressor pump cools (water cooled compressor only).	2) Measure the current and take temperature readings of the compressor at a location adjacent to the electrical connections; then contact the Product Service Department.

Section 7: Maintenance Procedures

7.1 Scheduled Maintenance. 31
7.2 Unscheduled Maintenance 33

Warning --

1. Always disconnect the cryopump from all sources of electrical power before performing any maintenance procedures.
2. If the cryopump has been used to pump toxic or dangerous materials, you must take adequate precautions to safeguard personnel.

7.1 Scheduled Maintenance

The only scheduled maintenance required on the Cryo-Torr 8 system is replacement of the compressor adsorber (P/N 8080255K001) after every 10,000 hours of operation as indicated on the compressor elapsed time meter. The actual time indicated on the meters of systems operating at 50 Hz is slightly longer. To remove and replace the compressor adsorber proceed as follows:

1. Shut down the compressor.
2. Disconnect the compressor input power cable from its electrical power source.
3. Disconnect the flex lines from the gas-return and gas-supply connectors at the rear of the compressor (Figure 1.4 foldout, page 65).
   a. Use the two wrenches supplied in the Installation and Scheduled Maintenance Tool Kit to avoid loosening the body of the coupling from its adapter. Hold one wrench fast on the coupling half attached to the rear side of the compressor. Use the other wrench to loosen the coupling to the helium supply or return line.
   b. Unscrew the two self-sealing coupling halves quickly to minimize minor gas leakage.
4. Remove the screws holding the compressor rear grille/plate, front grille, and cover (Figure 1.4). Front and rear panels remain in place.
5. Remove the adsorber from the compressor according to Figures 7.1 and 7.2, page 32. Save all nuts, bolts, and washers for installing the replacement adsorber.

Warning --

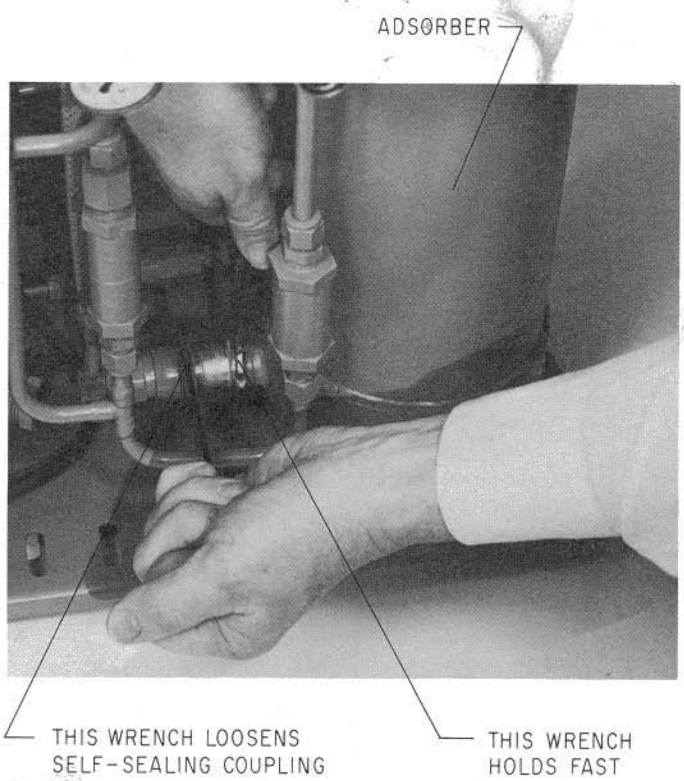
Depressurize the adsorber before disposing of it. Attach the depressurization fitting (included in the Installation Tool Kit) to the couplng half at either end of the adsorber and tighten it slowly.

6. Install the replacement adsorber as follows:
   a. Remove the dust caps from the self-sealing coupling halves at each end of the replacement adsorber.
   b. Install the replacement adsorber following the steps in Figure 7.2, page 32, in reverse order. Use the hardware saved in step 5 above.
7. Connect the adsorber to the compressor internal piping. Refer to Figure 7.3, page 33, and
   a. Check the self-sealing connector flat rubber gasket to make sure that it is clean and properly positioned.
   b. Using the two wrenches supplied in the Installation and Scheduled Maintenance Tool Kit, make the connection quickly to minimize minor gas leakage.

Caution --

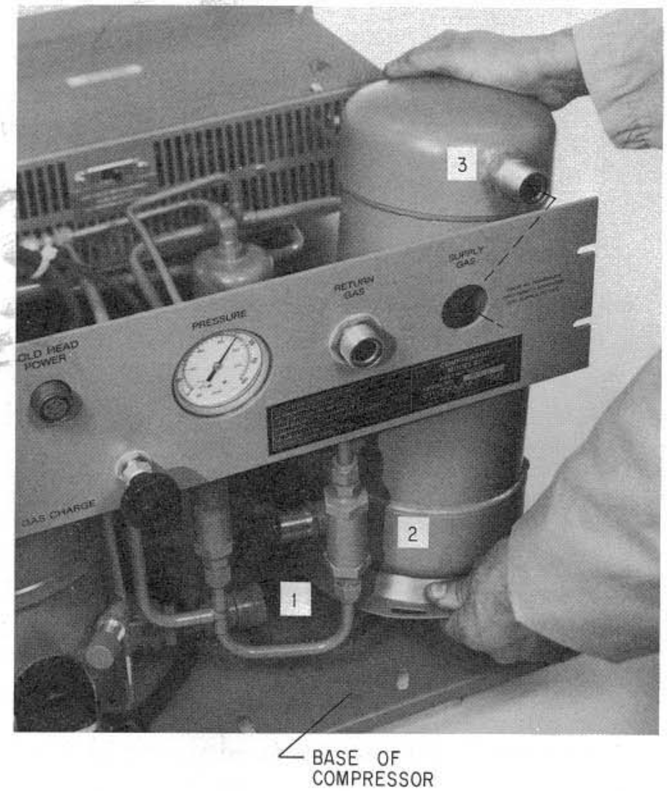
Make sure to hold fast on the left coupling nut while tightening the right coupling nut, as shown in Figure 7.3, page 33.

7



1. Use two wrenches (supplied) to avoid loosening the body of the coupling from its adapter.
2. Unscrew the two self-sealing coupling halves quickly to minimize gas leakage.

Figure 7.1 Disconnecting the adsorber self-sealing coupling



1. Disconnect the adsorber-inlet self-sealing coupling. See also Figure 7.1.
2. Remove the bolts, nuts, and washers that secure the adsorber to the base of the compressor.
3. Carefully slide the adsorber inward until the outlet self-sealing coupling clears the rear panel and remove the adsorber.

Figure 7.2 Removing the adsorber from the compressor

c. Make the first turns by hand and then firmly seal the connection using the two wrenches until the fittings "bottom". Refer to Figure 7.4, page 34, for proper coupling of the self-sealing connection.

8. Replace the cover and the front and rear grilles and secure them with their screws. *Make sure that the cover is installed so that the inside metal tab depresses the safety interlock switch.* The compressor cannot be started unless this switch is depressed.

9. Ensure that the supply pressure gauge reads 245-250 psig (1690-1725 kPa). If additional gas pressure is required, follow the instructions in Section 7.2, under Adding Helium Gas.

10. Add 10,000 to the reading on the elapsed time meter, and write this total on the decal provided with the replacement adsorber. This decal can be affixed to the front of the compressor.

11. Reconnect the return and supply flex lines to the compressor.

12. Connect the compressor input power cable to the electrical power source.

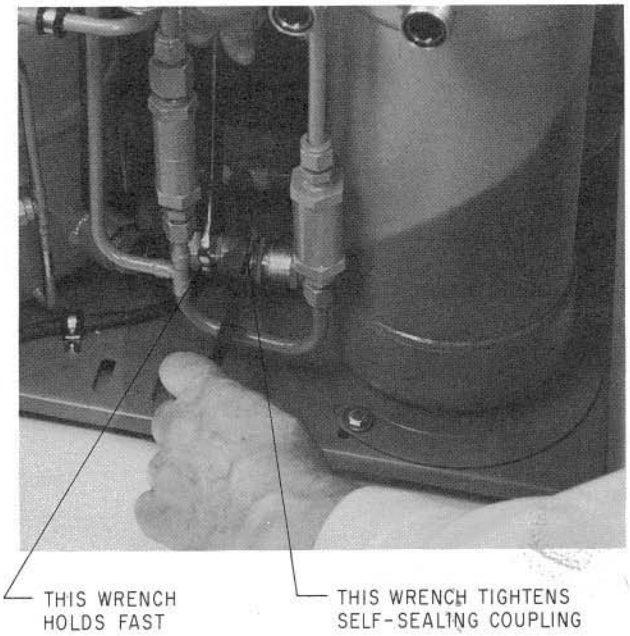


Figure 7.3 Connecting self-sealing couplings

7.2 Unscheduled Maintenance

Suggested Unscheduled Maintenance Equipment

It is advisable to keep on hand the unscheduled maintenance equipment and disposable supplies listed below.

1. Lint-free gloves and cloth.
2. Denatured alcohol.
3. Freon TF.
4. Helium, 99.999% pure.
5. Oakite or equivalent detergent soap.
6. Indium gasket 0.005-inch thick, 3" x 3" sheet, P/N 3543738P001.
7. Apiezon™ vacuum grease, P/N 579847*.
8. Pressure regulator (0-3000/0-400 psig).
9. Maintenance manifold, P/N 8080250K003*.
10. Torque wrench, 0 to 30 inch-pounds.
11. Installation Tool Kit, P/N 8032040G004. Supplied with Cryo-Torr 8 High-Vacuum Pump.
12. Helium charging line terminating in a 1/4-inch female flare fitting.

*Available from stock; consult the factory or your sales representative.

Adding Helium Gas

Caution --

If the compressor helium pressure gauge reads 0, decontamination is required. Refer to decontamination procedures on page 36 or contact the Product Service Department.

There are two conditions that require the addition of helium gas:

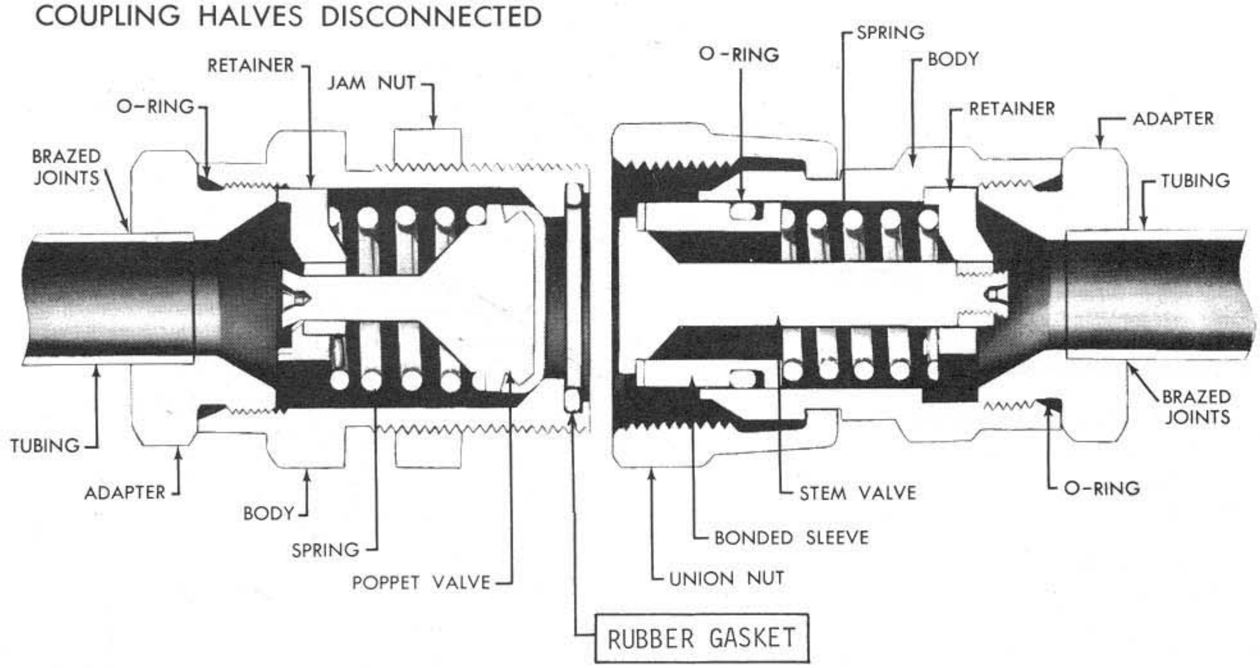
1. Compressor not operating; helium pressure gauge reads 245 psig, or below.

2. Compressor operating; helium pressure reads 270 psig, or below.

If you need to add helium more than once every several months, check for leaks caused by improperly connected self-sealing connections or any mechanical joint within the compressor.

Use only 99.999% pure helium gas.

COUPLING HALVES DISCONNECTED



COUPLING HALVES CONNECTED

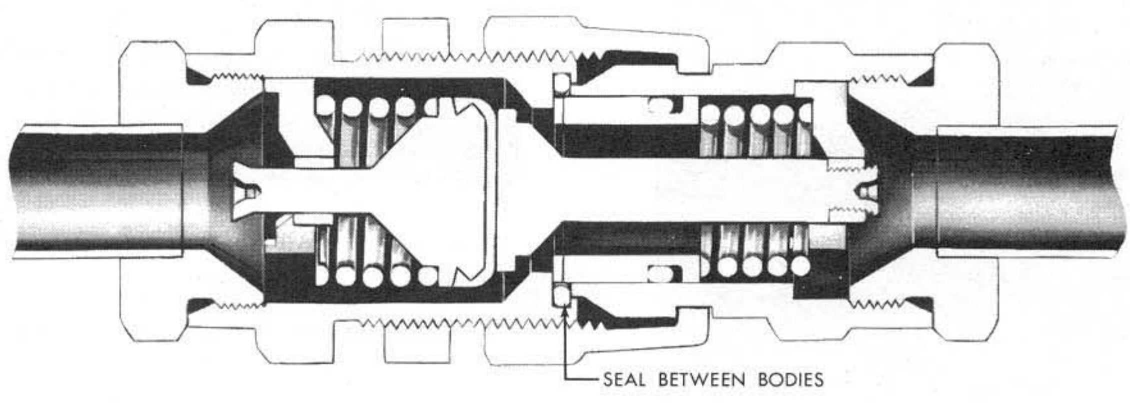


Figure 7.4 View of disconnected and connected self-sealing couplings

To add helium gas:

1. Remove the flare cap of the gas charge fitting on the rear of the compressor.
2. Loosely attach a charging line from the helium pressure regulator on the helium bottle to the 1/4-inch male flare fitting installed on the helium charge valve.

   A User-supplied helium charging line terminating in a 1/4-inch female flare fitting, and a two-stage pressure regulator rated at 10 to 400 psig (70-2755 kPa) is required for this operation.
3. Set the helium pressure regulator to 10 to 25 psig (70-175 kPa). Allow helium gas to flow through the charging line and around the loosened flare fitting for 30 seconds to purge the charging line of air. Then tighten the flare nut at the end of the charge line.
4. Reset the helium pressure regulator to 300 psig (2070 kPA). Depending on the compressor operating state, add helium gas:
   a. If the compressor is running under normal operating conditions, slowly open the helium charge valve on the rear of the compressor. When the helium pressure gauge rises to 270-290 psig (1860-2000 kPa) tightly close the charge valve.
   b. If the compressor is not running and is at an ambient temperature range of 70 to 80°F (21 to 27°C) slowly open the helium charge valve. When the helium pressure gauge rises to 245-250 psig (1690-1725 kPa) tightly close the charge valve.
5. Ensure that the helium charge valve on the compressor is tightly closed. Then shut off the helium pressure regulator on the helium bottle. Remove the charging line from the male flare fitting and reinstall the flare cap.

Helium Circuit Decontamination

Contamination of the helium-gas circuit is indicated by sluggish or intermittent operation (ratchetting) of the cold head drive mechanism. With severe contamination the cold head drive may seize and fail to operate. One of the major sources of contamination is using helium gas of less than the required purity. When performing the decontamination process, use only 99.999% pure-helium gas, and the regulator and charging line must be properly connected and purged.

This decontamination procedure will remove contaminants from the cold head and/or compressor, thereby restoring system performance. The cold-trapping of contaminants inside the cold head during this procedure will also decontaminate the compressor if the contamination of the system is not severe. Separate decontamination of the compressor is required whenever the compressor has been opened to atmosphere, or the pressure dropped to zero.

Cryopump Decontamination Procedures

1. Cool down the cryopump and operate it for one to three hours. If the system will not cool down, proceed to step 2. Operating the cryopump will isolate the contaminants by "freezing" them in the cold head. The contaminants in the helium-gas circuit of the cryopump tend to become frozen inside the cold head. The longer the cryopump is operated beyond the one-hour period, the greater is the amount of contamination that becomes isolated inside the cold head.
2. Shut down the cryopump per Section 4.8, page 22.
3. *Immediately* disconnect the helium supply and return lines from the gas-supply and gas-return connectors at the rear of the compressor. Leave them attached to the cold head.
4. Attach the maintenance manifold to the disconnected ends of the helium return and supply lines.
5. Reduce the pressure in the cold head to a level of 30 psig by using the maintenance manifold. Reducing the pressure in the cold head below 30 psig (200 kPa) may introduce more contaminants into the helium circuit.

6. Allow the second stage of the cold head to warm up to room temperature. The warmup time can be decreased by backfilling the vacuum chamber to one atmosphere with dry argon or nitrogen gas. Using the gas heater, CTI P/N 8080250K020, will reduce the warm-up time about 50 percent, and will maintain the gas temperature below the 150° F (66°C) limit.

7. Once the cryopump has reached room temperature, attach a two-stage regulator (0-3000/0-400 psig) and charging line to a helium bottle (99.999% pure). DO NOT OPEN THE BOTTLE AT THIS TIME. Purge the regulator and charging lines as instructed in steps a through d below. Do *not* use helium gas that is *less than 99.999% pure*.

   a. Open the regulator a small amount by turning the adjusting knob clockwise until it contacts the diaphragm, then turn approximately 1/8 to 1/4 turn more, so that the regulator is barely open.

   b. Slowly open the bottle valve, and purge the regulator and line for 10 to 15 seconds. Turn the regulator knob counter-clockwise until the helium stops flowing.

   c. Loosely connect the charge line to the 1/8-inch Hoke valve on the maintenance manifold.

   d. Purge the charge line again, as in step a, for 30 seconds, and tighten the charge line flare fitting onto the Hoke valve while the helium is flowing.

This procedure is required to ensure that both the regulator and the charging line will be purged of air and that the air trapped in the air trapped in the regulator will not diffuse back into the helium bottle. For best results, CTI suggests a dedicated helium bottle, regulator, and line, which are never separated, for adding helium.

8. Perform in sequence:

   a. Backfill the cold head with helium to a static charge pressure of 245-250 psig (1690-1725 kPa) by adjusting the regulator to the required pressure, and opening the Hoke valve on the manifold. Close the Hoke valve when the pressure is correct.

   b. Depressurize the cold head to between 30 and 50 psig (200 and 330 kPa) by slowly opening the ball valve and allowing the helium to bleed out slowly. Do *not* reduce the pressure to *less than* 30 psig or the cold head may be further contaminated.

   c. Perform flushing steps a and b four more times.

   d. Pressurize the cold head to the static charge pressure of 245-250 psig (1690-1725 kPa) and run the cold head drive motor for 10 to 30 seconds by actuating the cold head ON/OFF switch to on.

   e. Perform steps b through d four more times for a total of 25 flushes and a total of 5 drive-motor runs.

9. Verify that the cold head is pressurized to the static charge pressure of 245-250 psig (1690-1725 kPa).

10. Disconnect the maintenance manifold from the helium return and supply lines.

11. Reconnect the helium return and supply lines to the return and supply connectors at the rear of the compressor. The cryopump is now ready for operation.

Compressor Decontamination Procedures

The procedure to decontaminate a compressor is similar to the above procedure with certain exceptions.

- There is no need to operate the cryopump before decontaminating the compressor.
- The maintenance manifold and flex lines will be connected to the supply and return fittings on the compressor.

1. Depressurize the compressor (if pressurized) SLOWLY to 30 psig using the maintenance manifold.

2. Charge the compressor to approximately 250 psig (1725 kPa) by opening the Hoke valve on the maintenance manifold.

3. Run the compressor for about 30 seconds.
4. Repeat steps 1, 2, and 3 one time.

For Your Information --

After connecting the compressor to the cryopump, and operating the system for a period of time, it may be necessary to decontaminate the cryopump as some residual contamination from the compressor may become trapped in the cold head. If the entire system was reduced to zero psig (a broken flex line for example), then the cryopump will have to be decontaminated according to the cryopump decontamination section, page 35, and the compressor according to the compressor decontamination procedures.

Cleaning the Cryopump

Warning --

If the cryopump has been used to pump toxic or dangerous materials, you must take adequate precautions to safeguard personnel.

Cleaning the arrays or other interior surfaces of the cryopump vacuum vessel is seldom required because dust buildup does not affect performance, and the special alloy copper cryocondensing arrays are nickel plated for corrosion resistance.

If you wish to clean the arrays and other interior surfaces, follow the procedures below. Refer to Appendix A, page 39, Illustrated Parts Breakdown while performing these disassembly and reassembly procedures.

1. Confirm that an adequate supply of indium gasket material, P/N 3543738P001, is available to replace gaskets inadvertantly damaged during disassembly.
2. Carefully disassemble the components in the vacuum vessel, including the arrays and radiation shield, to avoid damage to the indium gaskets.
3. Clean the interior surface of the vacuum vessel, the 80K condensing array, and the 80K radiation shield as follows:
   a. Wash each item in strong soap or detergent solution and hot water.
   b. Rinse the items in clean hot water.
   c. Air or oven dry at 150°F (66°C) maximum.
   d. Wash with Freon TF using a clean lint-free cloth. Do not wash the radiation shield inside painted surface with any solvent that will dissolve or damage the paint.
   e. Air or oven dry all items at 150°F (66°C) maximum before reinstalling into the cryopump.

Caution --

Do not clean the 15K array, because you may severely contaminate the adsorbent in the cleaning process. Discard the array if it is severely contaminated.

4. Wearing lint-free gloves, reassemble the cryopump. Replace any indium gasket damaged during disassembly with a gasket cut from indium gasket material.
5. Torque all screws that compress indium gaskets for a minimum of 5 seconds to allow proper gasket seating.

SCREW THREAD	TORQUE (INCH-POUNDS)
No. 4-40	11
No. 6-32	20
No. 10-32	30

7

Cleaning the Air-Cooled Compressor Heat Exchanger Filter Element

Air cooled compressors have a filter element installed on the heat exchanger inlet to prevent dust and dirt from contaminating the exchanger and causing a loss of compressor efficiency. The filter element should be inspected for contamination every six months if the compressor is operated under normal conditions. You should establish more frequent filter inspection intervals as you gain experience, if your compressor operates under adverse conditions. In cases of severe heat exchanger element contamination a shutdown of your high-vacuum system may occur. The filter may be easily removed from the compressor for periodic inspection and cleaning by performing the following.

1. Shut down the compressor.
2. Remove the four screws securing the front grille shown in Figure 1.4, page 65, and remove the grille from the compressor.
3. Remove the filter element from the heat exchanger inlet.
4. Clean the filter element if contaminated using a mild detergent solution. In case of slight contamination, lightly tap the element to remove any loose dust and dirt from the element surfaces.
5. Allow the filter element to air-dry or use clean compressed air (set at 20-30 psi) to aid in drying.
6. Reinstall the element and front grille on the compressor and secure with four screws.

Servicing the Self-Sealing Couplings

Aeroquip Type 5400 self-sealing couplings are used in the Cryo-Torr high-vacuum pump system and have been designed to last the life of your cryopump. If a leak should occur at a self-sealing coupling, retighten the coupling as shown in Figure 7.3, page 33. If the leak persists, call CTI-CRYOGENICS, Product Service Department.

Appendix A
Illustrated Parts Breakdown

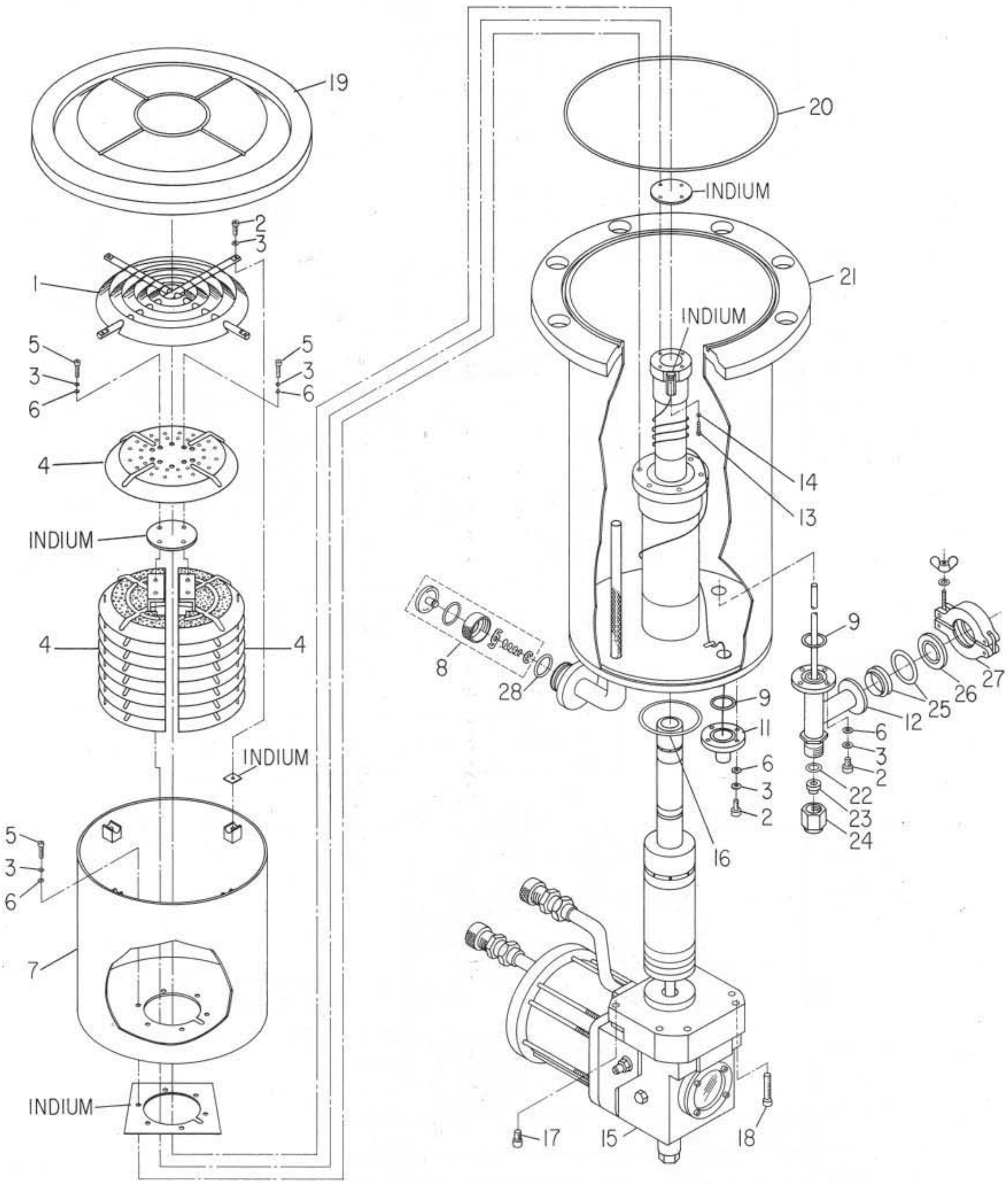


Figure A.1 Exploded view of Cryo-Torr 8 Cryopump

Item Number	Part Number	Description	No. Req'd.
--	---	Cryo-Torr 8 Cryopump	1
1	8080002K001	80K Condensing Array	1
2	---	Cap Screw, Hexagon Socket Type, SSTL, #6-32 × 1/2″ Lg.	12
3	---	Lockwasher, Split Type, SSTL, #6	22
4	8080002K010	15K Array Assembly	1
5	---	Cap Screw, Hexagon Socket Type, SSTL, #6-32 × 3/8″ Lg.	10
6	---	Washer, Flat, SSTL, #6	18
7	8080002K004	80K Radiation Shield	1
8	8080250K005	Pressure Relief Valve	1
9	---	O-Ring, #2-20, Viton, Parker, V377-9	2
10*	8080250K006	Hydrogen-Vapor-Pressure Gauge (Optional)	1
11	8080250K009	Diode Temperature Sensor	1
12	8044043G002	Regeneration Purge Fitting	1
13	--- ---	Cap Screw, Hexagon Socket Type, SSTL, #2-56 × 1/2″ Lg.	2
14	---	Lockwasher, Split Type, SSTL, #2	2
15	8080002K005	Drive-Unit—Displacer Assembly	1
16	---	O-Ring, #2-140, Buna-N, Parker N219-7	1
17	---	Cap Screw, Hexagon Socket Type, SSTL, #10-32 × 1/2″ Lg.	2
18	---	Cap Screw, Hexagon Socket Type, SSTL, #10-32 × 1-1/4″ Lg.	4
19	---	Protective Cover	1
20	---	O-Ring, #2-172, Viton, Parker V377-9	1
21	---	Vacuum Housing	1
22	---	O-Ring, #600-V1, Viton, Parker	1
23	---	Plug	1
24	---	Nut	1
25	---	Centering Ring W/O-Ring (Alcatel)	1
26	---	Flange, Blank	1
27	---	Clamp	1
28	---	O-Ring, #2V1-84-8A116, Cryolab	1
--	---	Indium Sheet, 3″ × 6″ × 0.005″ Thick	1

Appendix B
Electrical Schematic and Location Information

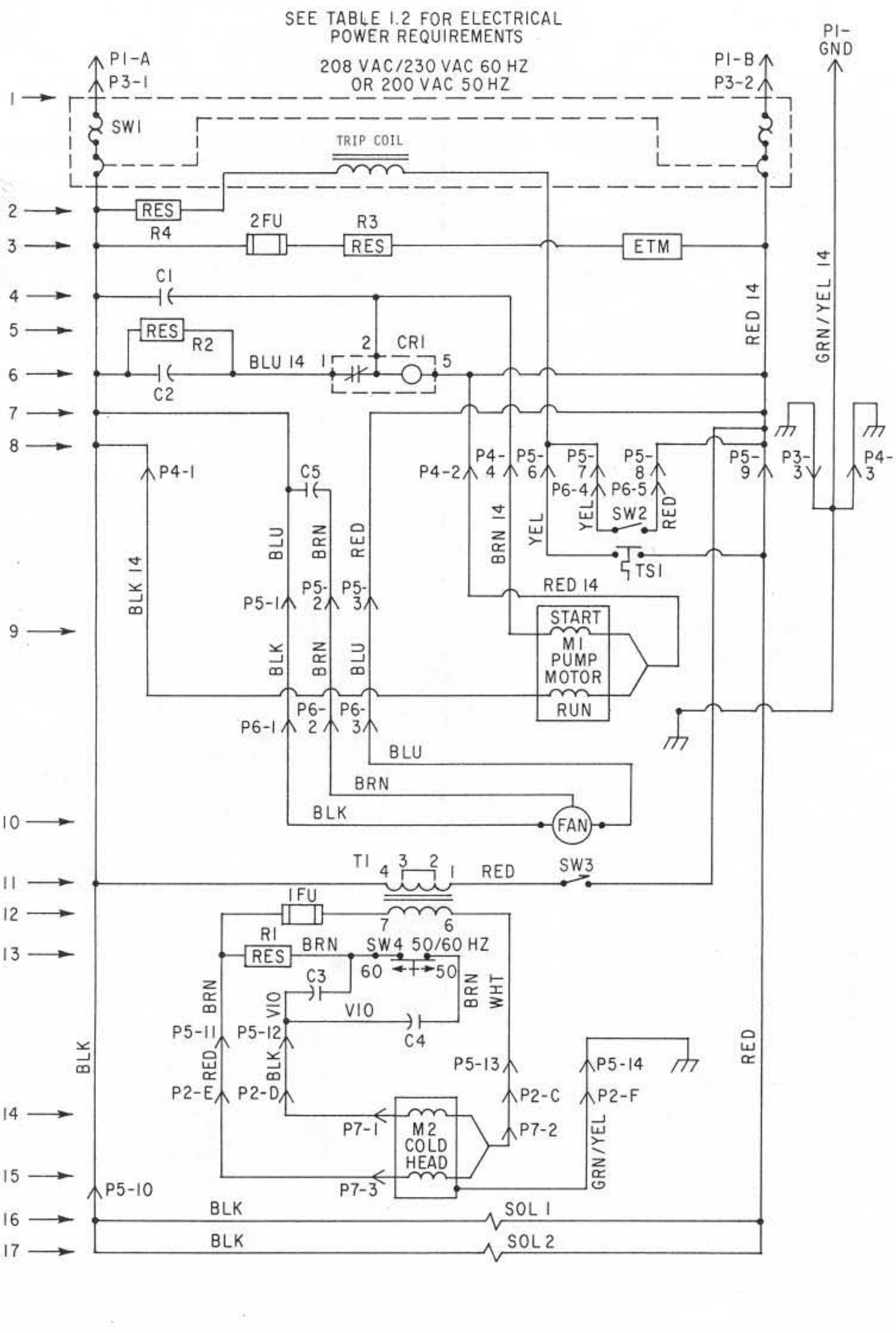


Figure B.1 Electrical schematic for Model SC Compressor

LEGEND FOR FIGURE B.1

C1 - COMPRESSOR-RUN PHASE-SHIFTING CAPACITOR, 35 MICROFARADS, 370 VAC
C2 - COMPRESSOR START CAPACITOR, 108-130 MICROFARADS, 330 VAC
C3 - COLD-HEAD-DRIVE-MOTOR PHASE-SHIFTING CAPACITOR, 6 MICROFARADS, 330 VAC
C4 - COLD-HEAD-DRIVE-MOTOR PHASE-SHIFTING CAPACITOR, 2 MICROFARADS, 330 VAC
C5 - BLOWER RUN CAPACITOR, 6 MICROFARADS, 400 VAC
CR1 - COMPRESSOR STARTING RELAY
ETM- ELAPSED-TIME METER
FAN - COOLING FAN
1FU - COLD-HEAD CIRCUIT FUSE, 1 AMP
2FU - ETM CIRCUIT FUSE, 1 AMP
M1- COMPRESSOR PUMP MOTOR
M2- COLD-HEAD DRIVE MOTOR
P1 - INPUT POWER CONNECTOR
P2 - COLD-HEAD CABLE CONNECTOR, 6 PIN
P3 - ELECTRICAL CONTROL, CHASSIS POWER CONNECTOR, 6 PIN
P4 - PUMP POWER CONNECTOR, 6 PIN
P5 - CHASSIS CONNECTOR, 15 PIN
P6 - FAN POWER CONNECTOR, 6 PIN
P7 - COLD-HEAD CABLE CONNECTOR, 6 PIN
R1 - COLD-HEAD-DRIVE-MOTOR PHASE-SHIFTING RESISTOR, 150 OHMS
R2 - COMPRESSOR START CAPACITOR "BLEED" RESISTOR, 15 KILOHMS
R3 - BALLAST RESISTOR FOR ELAPSED TIME METER, 13 KILOHMS
R4 - VOLTAGE DROPPING RESISTOR FOR PULLOUT COIL, 330 OHMS
SOL1 - SOLENOID VALVE, PRESSURE "DUMP"
SOL2 - SOLENOID VALVE, OIL SHUT OFF
SW1 - COMPRESSOR "ON/OFF" SWITCH
SW2 - SAFETY INTERLOCK SWITCH
SW3 - COLD-HEAD "ON/OFF" SWITCH
SW4 - 50-60 HZ SELECTOR SLIDE SWITCH
T1 - COLD-HEAD ISOLATION TRANSFORMER, 140-168 VAC OUTPUT
TS1 - THERMAL PROTECTIVE SWITCH - AIR FLOW

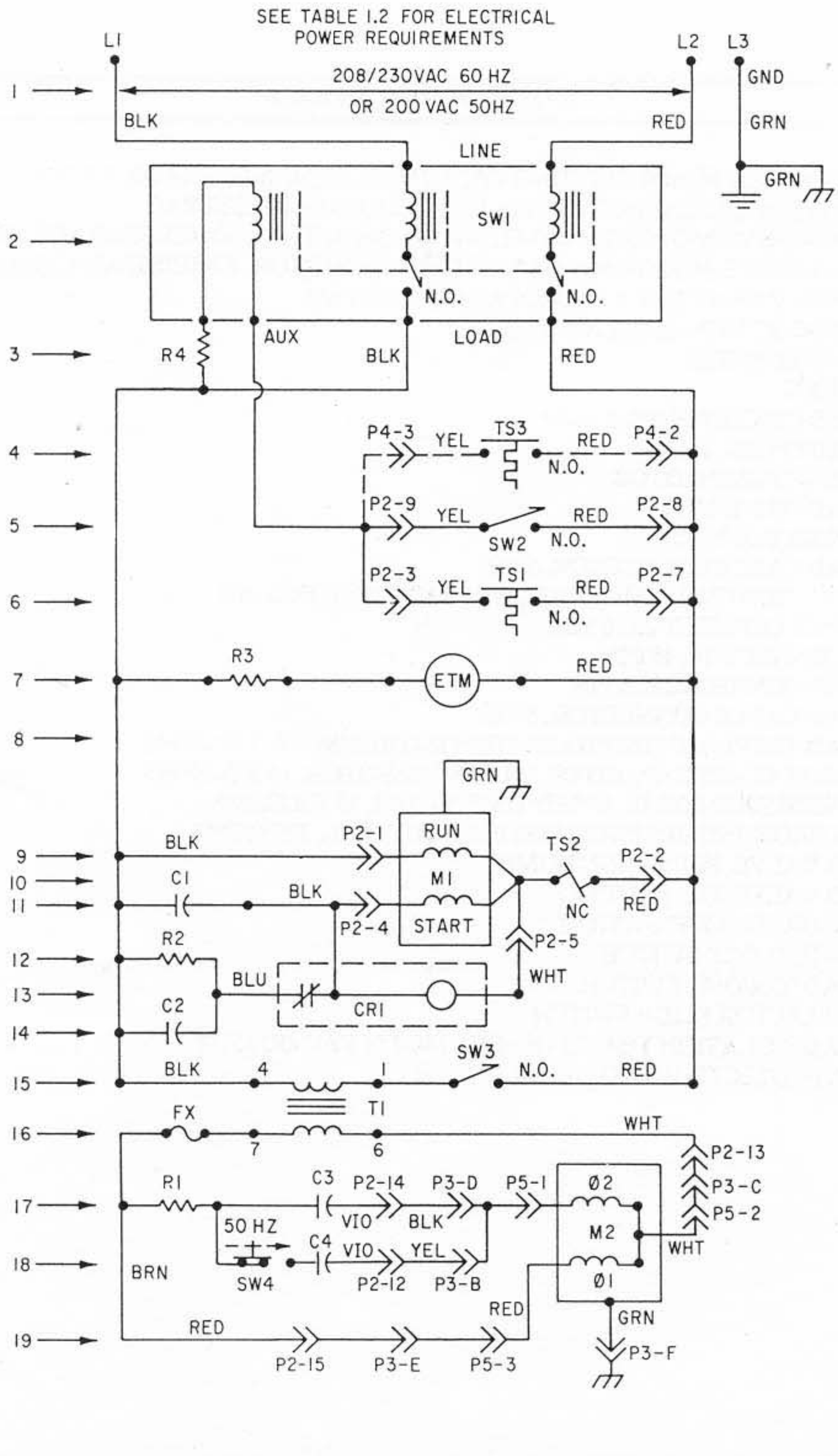
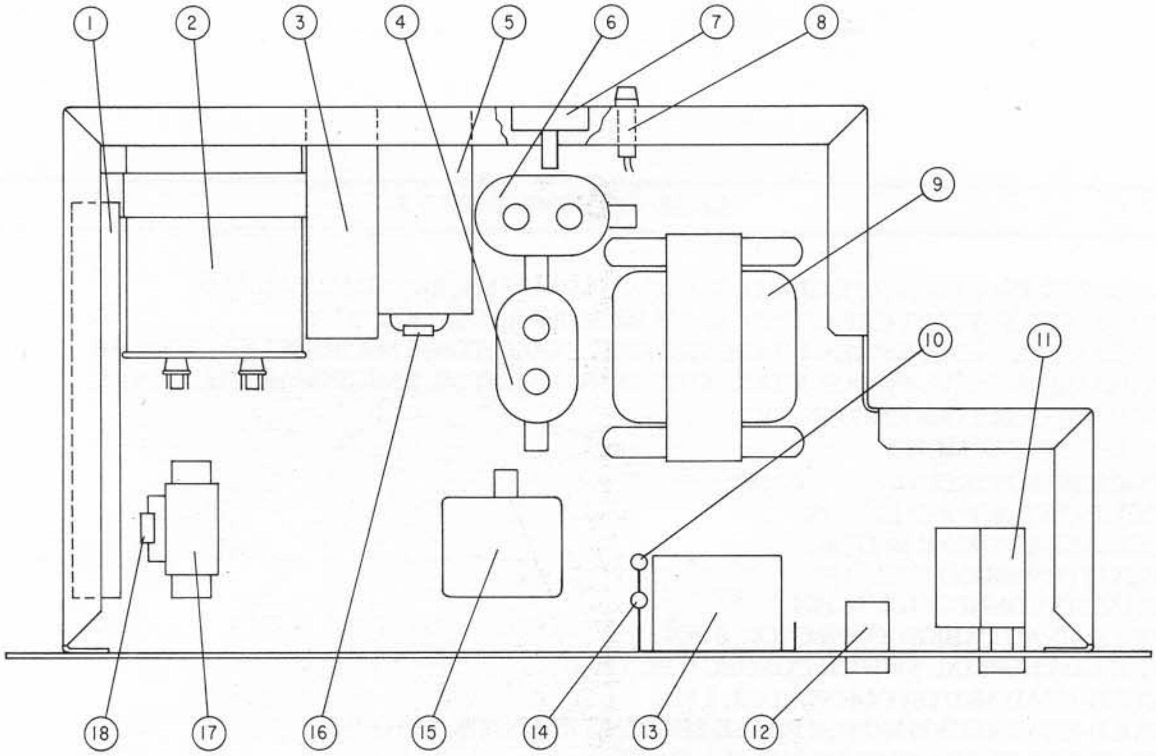


Figure B.2 Electrical schematic for Model SCW Compressor

LEGEND FOR FIGURE B.2

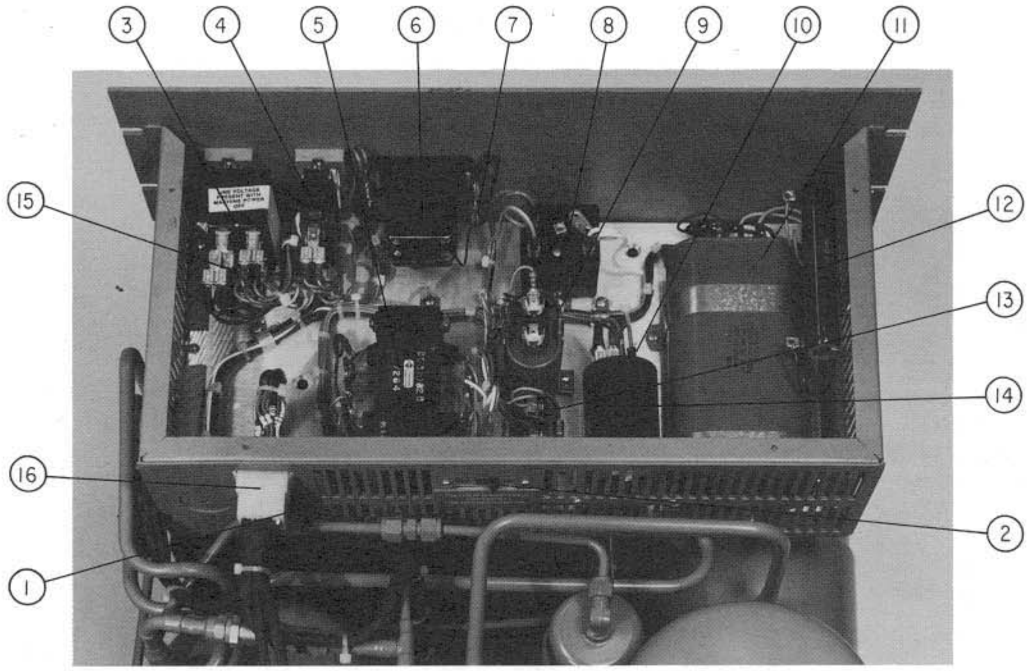
C1 - COMPRESSOR-RUN PHASE-SHIFTING CAPACITOR, 25 MICROFARADS, 440 VAC
C2 - COMPRESSOR START CAPACITOR, 48 ± 5 MICROFARADS, 330 VAC
C3 - COLD-HEAD-DRIVE-MOTOR PHASE-SHIFTING CAPACITOR, 6 MICROFARADS, 330 VAC
C4 - COLD-HEAD-DRIVE-MOTOR PHASE-SHIFTING CAPACITOR, 2 MICROFARADS, 330 VAC
CR1 - COMPRESSOR STARTING RELAY
ETM - ELAPSED-TIME METER
FX - COLD-HEAD CIRCUIT FUSE, 1 AMP
M1 - COMPRESSOR PUMP MOTOR
M2 - COLD-HEAD DRIVE MOTOR
P1 - INPUT POWER CONNECTOR
P2 - CHASSIS CONNECTOR, 15 PIN
P3 - COLD-HEAD CABLE CONNECTOR, 6 PIN
P4 - FAN OR THERMAL SWITCH CONNECTOR, 3 PIN
P5 - COLD-HEAD MOTOR CONNECTOR, 3 PIN
R1 - COLD-HEAD-DRIVE-MOTOR PHASE-SHIFTING RESISTOR, 150 OHMS
R2 - COMPRESSOR START RESISTOR, 18 KILOHMS
R3 - BALLAST RESISTOR FOR ELAPSED TIME METER, 13 KILOHMS
R4 - VOLTAGE DROPPING RESISTOR FOR PULLOUT COIL, 330 OHMS
SW1 - COMPRESSOR "ON/OFF" SWITCH
SW2 - SAFETY INTERLOCK SWITCH
SW3 - COLD-HEAD "ON/OFF" SWITCH
SW4 - 50-60 HZ SELECTOR SLIDE SWITCH
T1 - COLD-HEAD ISOLATION TRANSFORMER 140-168 VAC OUTPUT
TS1 - THERMAL PROTECTIVE SWITCH-OIL FLOW
TS2 - OVERCURRENT PROTECTIVE SWITCH
TS3 - THERMAL PROTECTIVE SWITCH-WATER FLOW



B

ITEM NUMBER	DESCRIPTION	SYMBOL DESIGNATION
1	Cold-Head-Drive-Motor Phase-Shifting Resistor, 150 Ohms	R1
2	Compressor-Run Phase-Shifting Capacitor, 35 Microfarads, 370 VAC	C1
3	Blower Run Capacitor, 6 Microfarads, 400 VAC	C5
4	Cold-Head-Drive-Motor Phase-Shifting Capacitor, 6 Microfarads, 330 VAC	C3
5	Compressor-Start Capacitor, 108-130 Microfarads, 330 VAC	C2
6	Cold-Head-Drive-Motor Phase-Shifting Capacitor, 2 Microfarads, 330 VAC	C4
7	50-60 Hz Selector Slide Switch	SW4
8	Cold-Head Circuit Fuse, 1 Ampere	1FU
9	Cold-Head Isolation Transformer, 140-168 VAC	T1
10	ETM Circuit Fuse, 1 Ampere	2FU
11	Compressor "ON/OFF" Switch	SW1
12	Cold-Head "ON/OFF" Switch	SW3
13	Elapsed-Time Meter	ETM
14	Ballast Resistor for Elapsed Time Meter, 13 Kilohms	R3
15	Compressor Starting Relay	CR1
16	Compressor Start Capacitor "Bleed" Resistor, 15 Kilohms	R2
17	Terminal Board	TB
18	Voltage Dropping Resistor for Pullout Coil, 330 Ohms	R4

Figure B.3 Components in the electrical control chassis of Model SC Compressor



B

ITEM NUMBER	DESCRIPTION	SYMBOL DESIGNATION
1	Cold-Head Circuit Fuse, 1 Ampere	FX
2	50-60 Hz Selector Slide Switch	SW4
3	Compressor ON/OFF Switch	SW1
4	Cold-Head ON/OFF Switch	SW3
5	Cold-Head Isolation Transformer	T1
6	Elapsed-Time Meter	ETM
7	Ballast Resistor For Elapsed-Time Meter, 13 Kilohms	R3
8	Compressor Starting Relay	CR1
9	Cold-Head-Drive-Motor-Phase-Shifting Capacitor, 6 Microfarads, 330 VAC	C3
10	Compressor Start Resistor, 18 Kilohms, 2 Watts	R2
11	Compressor-Run Phase-Shifting Capacitor 25 Microfarads, 440 VAC	C1
12	Cold-Head-Drive-Motor Phase-Shifting Resistor, 150 Ohms, 50 Watts	R1
13	Cold-Head-Drive-Motor Phase-Shifting Capacitor, 2 Microfarads, 330 VAC	C4
14	Compressor Start Capacitor, 48 ± 5 Microfarads, 330 VAC	C2
15	Voltage Dropping Resistor For Pullout Coil, 330 Ohms, 1 Watt	R4
16	Chassis Connector, 15 Pins	P2

Figure B.4 Components in the electrical control chassis of Model SCW Compressor

Appendix C
Equipment List for the Cryo-Torr 8 High-Vacuum Pump

ITEM NUMBER	QUANTITY	PART NUMBER	DESCRIPTION
1	1	*	Cryo-Torr 8 Cryopump
2	1	**	Model SC Compressor
3	2	8081271P002	Flexible Interconnecting Piping
4	1	8032040G004	Installation Tool Kit (see Section 2.5, page 6)
5	1	M8040138	Installation, Operation, and Servicing Instructions for the Cryo-Torr 8 High-Vacuum Pump
6	1	8032222G001	Cold-Head Power Cable
		*8033165	Cryo-Torr Crypump with Temperature Sensor-ANSI Flange
		8033166	Cryo-Torr 8 Cryopump with Vapor-Pressure Gauge-ANSI Flange
		8033167	Cryo-Torr 8 Cryopump with Temperature Sensor-ANSI Flange
		8033168	Cryo-Torr 8 Cryopump with Vapor-Pressure Gauge-ANSI Flange
		8033169	Cryo-Torr 8 Cryopump with Vapor-Pressure Gauge-Metal Seal Flange
		8033170	Cryo-Torr 8 Cryopump with Temperature Sensor-Metal Seal Flange
		8033171	Cryo-Torr 8 Cryopump with Vapor-Pressure Gauge-ISO Flange
		8033179	Cryo-Torr 8 Cryopump with Vapor-Pressure Gauge-ISO Flange
		**8032224	Model SC Compressor (Air Cooled)
		8032211	Model SCW Compressor (Water Cooled)
		OPTIONAL ITEM	
1		8080250K001	Maintenance Manifold

C

Appendix D
Principles of Operation

TECHNICAL DATA CRYODYNE® CLOSED CYCLE HELIUM REFRIGERATORS

The cooling process (cycle) of CRYODYNE Helium Refrigerators is analogous to that of common household refrigerators. In the latter, a working fluid (freon gas) is compressed, the heat of compression removed by air-cooled heat exchangers, and the gas is then expanded to produce cooling below the ambient temperature. This simple compression-expansion process will suffice for the household refrigerator, where temperatures in the sub-zero fahrenheit range are required. However, CRYODYNE systems must operate effectively and routinely at temperatures down to 6K (-449°F). Attainment of such extreme low levels requires highly efficient heat exchangers, and the use of a working fluid (helium gas) that remains fluid at temperatures approaching absolute zero (-459.6°F, -273.1°C, 0K).

All CRYODYNE systems comprise an air-cooled or water-cooled, oil-lubricated compressor unit with oil separation system (carry-over oil vapors would solidify at cryogenic temperatures and plug the heat exchangers of the refrigerator); and a refrigerator unit (remotely located from the compressor), which operates at slow speeds, has ample clearances, and has room-temperature valves and seals.

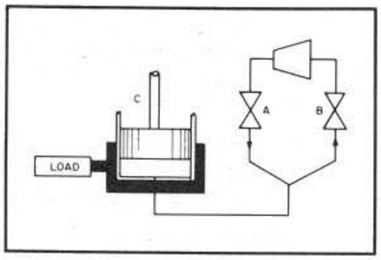


Figure 1 Elementary Cooling Circuit

The flow of helium in the refrigerator is cyclic. The sequence of operations can be illustrated by a single cylinder and piston (Figure 1).

A source of compressed gas is connected to the bottom of cylinder C through inlet valve A. Valve B is in the exhaust line leading to the low-pressure side of the compressor. With the piston at the bottom of the cylinder, and with valve B (exhaust) closed and valve A (inlet) open, the piston is caused to move upward and the cylinder fills with compressed gas. When valve A is closed and valve B is opened, the gas expands into the low-pressure discharge line and cools. The resulting temperature gradient across the cylinder wall causes heat to flow from the load into the cylinder. As a result, the gas warms to its original temperature. With valve B opened, and valve A closed, the piston is then lowered, displacing the remaining gas into the exhaust line, and the cycle is completed.

This elementary system, while workable, would not produce the extreme low temperatures required for uses to which the CRYODYNE refrigerators are applied. Thus the incoming gas must be cooled with the exhaust gas before the former reaches the cylinder. This is accomplished in the CRYODYNE refrigerator by a regenerator, which extracts heat from the incoming gas, stores it, and then releases it to the exhaust stream (Figure 2).

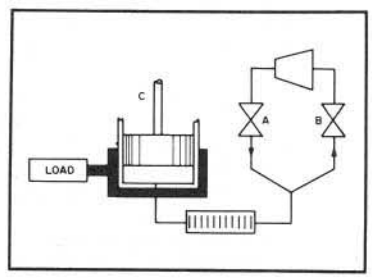


Figure 2 Cooling Circuit with Regenerator

D

A regenerator is a reversing-flow heat exchanger through which the helium passes alternatively in either direction. It is packed with a material of high surface area, high specific heat, and low thermal conductivity, that will readily accept heat from the helium (if the helium's temperature is higher) and give up this heat to the helium (if the helium's temperature is lower).

In steady-state operation, a system of this type exhibits the characteristic temperature profile of Figure 3. The steps of the cycle are as follows:

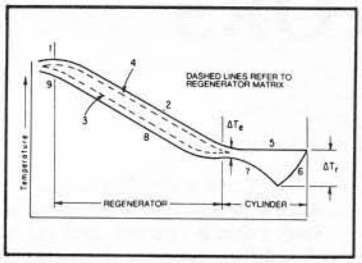


Figure 3 Temperature Profile of a Single-Stage Cryodyne Refrigerator

a. With the piston at the bottom of its stroke, compressed gas enters through valve A at room temperature (1).
b. As the piston rises, the gas passes through the regenerator. The matrix absorbs heat from the gas (warming from 3 to 4), and the gas cools.
c. Still at inlet pressure, the cooled gas fills the space beneath the piston. The gas temperature at this point (5) is about the same as that of the load.
d. Valve A closes and exhaust valve B opens, allowing the gas to expand and cool further as it does so (6). The temperature drop (ΔT_r) is responsible for the refrigerating effect.
e. Heat flows from the load through the cylinder walls, warming the gas to a temperature slightly (ΔT_e) below that at which it entered the cylinder (7).
f. As the gas passes through the regenerator, it warms up (8) as it receives heat from the matrix, and the matrix is cooled (4) to (3).
g. The piston descends, pushing the remaining cold gas out of the cylinder and through the regenerator. However, because the regenerator is not 100 percent efficient, there is always a temperature difference between the gas and the matrix; thus, at any point shown in the diagram, the exhaust gas remains slightly cooler than the inlet gas.
h. The low-pressure gas leaves through valve B at approximately room temperature (9).

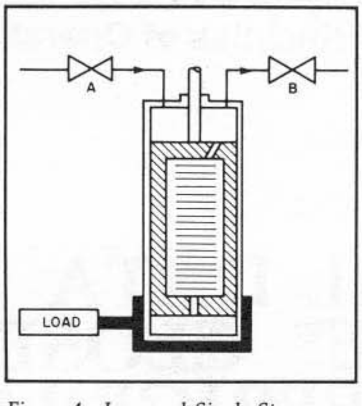


Figure 4 Improved Single Stage Refrigerator

In the system of Figure 2, the piston would require a pressure seal and would have to be designed to withstand unbalanced forces. A more practical version of this cycle is shown in Figure 4. This system uses a double-ended cylinder and an elongated piston made from a material of low thermal conductivity.

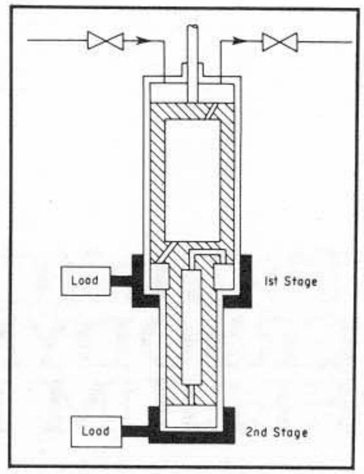


Figure 5 Two-Stage Cryodyne Refrigerator

Since the pressures above and below the piston are substantially equal, the piston needs no pressure seal. The piston is now more correctly called a "displacer," because it merely moves gas from one end of the cylinder to the other; no mechanical work is introduced, and thus the system is said to use a "no-work" cycle. The regenerator is placed inside the displacer to avoid unnecessary piping and to minimize heat losses.

The refrigerator shown in Figure 4 can achieve temperatures in the 30-77 K range. Since many of the applications of the CRYODYNE refrigerator are below that temperature, we can add a second, and even a third stage to produce temperatures below 10K.

The addition of a second stage (Figure 5) permits useful refrigeration down to 6 K.

CTI-CRYOGENICS

266 Second Avenue, P.O. Box 9171,
Waltham, MA 02254-9171
Telephone: (617) 890-9400 | Telex 92-3442

Appendix E
Cryopump Monitor, REGEN™, and Temperature Indicator

CRYOPUMP MONITOR

E

Description:
- Displays cryopump operating temperature range for cryopumps equipped with a silicon diode temperature sensor.
- Mounts directly on the cryopump in any orientation, or may be mounted remotely.
- Small, permanently mounted power pack may be plugged into any 117 VAC outlet.

Features:
- 3 light emitting diodes - Green, Yellow and Red

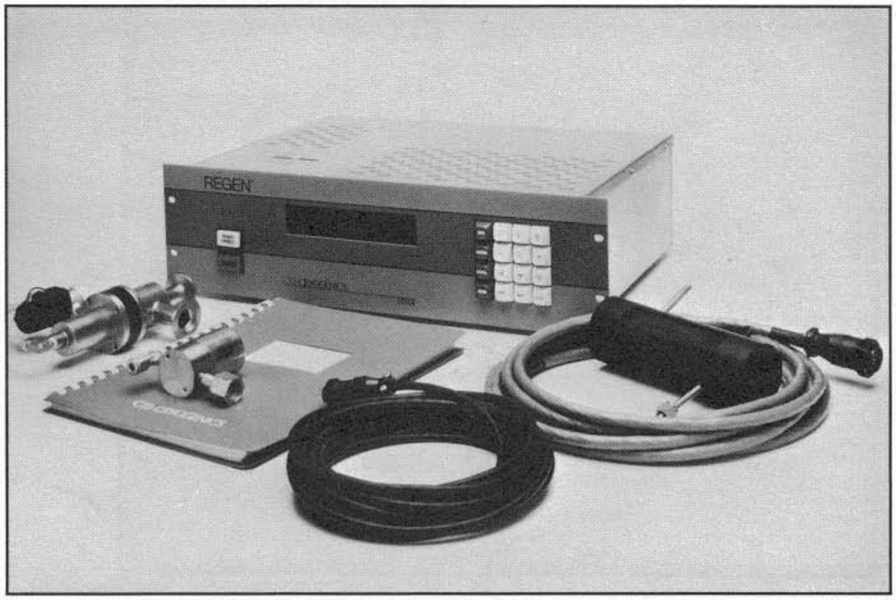
LED Condition	Pump Condition
Green on	Pump is cold (<20K) and operating.
Yellow on	Pump is cooling down or warming up.
Red on	Pump is warmed up sufficiently (regenerated) to be rough pumped and turned on again.

- Temperature range − 8 to 308 Kelvin

Specifications:
- Electrical Requirements:
  117 VAC (±20%), 1Ø, 50/60 Hz
  10 ft. power cord
- Weight: 15 oz. (423 g)
- Dimensions: 3.35 × 1.5 × 2.25 inches (85 × 38 × 57mm)

Cryo-Torr(R) cryopump accessories

REGEN™
Part No. 8044070



E

Description

- Microprocessor based with menu driven simple programming
- Auto regeneration based on cryopump performance, periodic regeneration based on time (weekend, night, etc.)
- A pre-programmed regeneration needs no operator input or control
- Fits into a standard 5¼ in. high × 19 in. rack
- Can use inputs from a silicon diode and thermocouples for optimal regeneration

Features

INPUTS
Silicon diode temperature sensor
Thermocouple temperature sensors
Remote Control Logic: start, stop, inhibit, 3 failsafe interlocks
Computer interface (RS-232) (optional)

OUTPUTS
115 vac control power for:
Roughing pump
Purge gas heater
Roughing valves
High vac isolation valve
Purge gas valve
Power contactors
Remote Control Logic: operate, system fault, regenerate
Setpoints (optional)

Specifications

- Electrical Requirements
  115 VAC ± 15%, 1Ø, 50/60 Hz
- 3-wire detachable power cord
- 6 amp fuse
- Output relays
  2, 3 amp max. @ 115 volts
- Weight: 11 lbs
- Dimensions: 19 × 5.25 × 12.5 inches (48.3 × 13.3 × 31.7 cm)

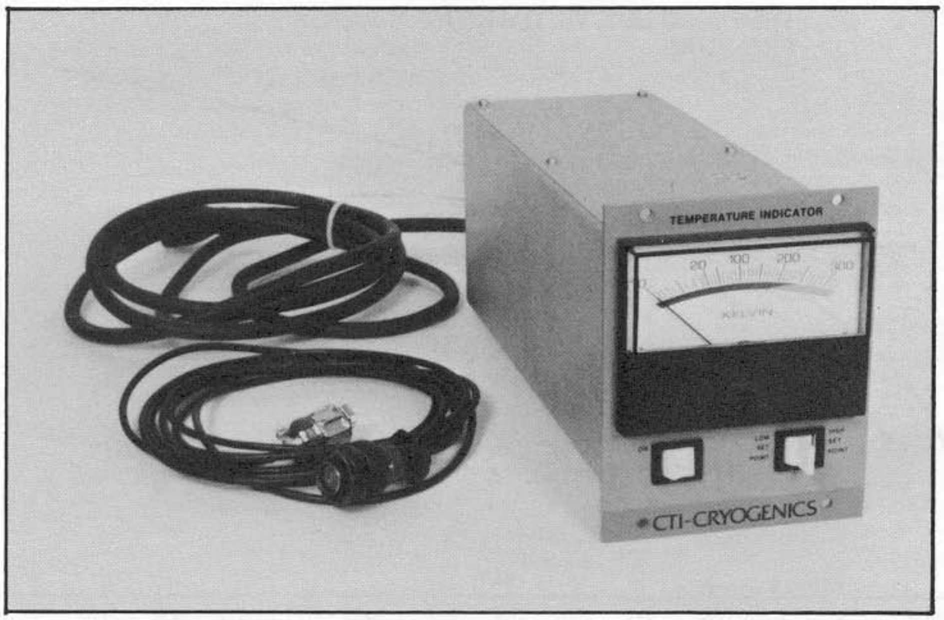
Accessory Components Available From CTI

- **Roughing valve, P/N 8080250K022**
- **Purge gas valve, P/N 8080250K023**
- **Purge gas heater, P/N 8080250K020**
- **Thermocouple pressure sensors, P/N 540126**
- **Power contactors, P/N 8080250K032**
  P/N 8080250K033
  P/N 8080250K034
  P/N 8080250K035

Cryo-Torr$^{(R)}$ cryopump accessories

TEMPERATURE INDICATOR

Part No. 8042001



Description

- Provides remote temperature reading of cryopump operating temperature for cryopumps equipped with a silicon diode sensor.
- Fits into a standard $5\frac{1}{4}$ in. high, 19 in. rack, one quarter panel.

Specifications

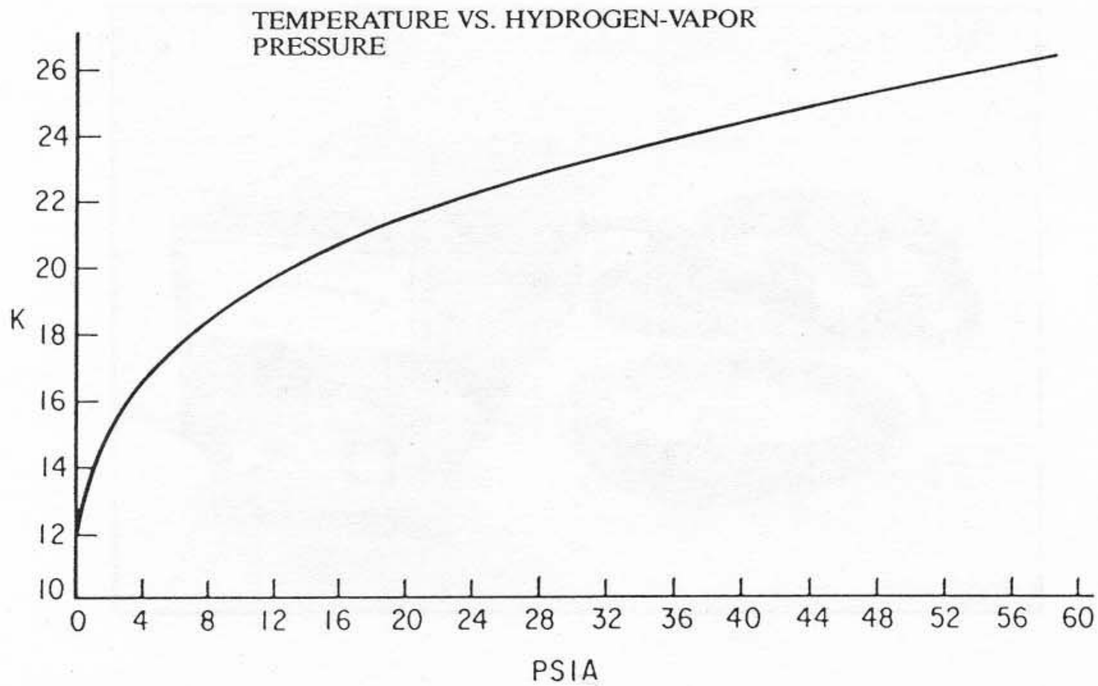
- Electrical Requirements:
  115 VAC or 208/230 VAC, 1Ø, 60 Hz 200/220 VAC, 1Ø, 50 Hz
  6 ft. power cord
  $^{1}/_{10}$ amp fuse
- Weight: 5 lbs.
- Dimensions: 5-$^{7}/_{32}$ × 4$^{1}/_{8}$ × 10-$^{7}/_{16}$ inches (132.5 × 104.7 × 265mm)

Features

- Analog panel meter with readout in Kelvin.
  Range 10 to 320 Kelvin.
  Accuracy: ± (2.5K + 2.5% of meter reading).
- High and low temperature set points, adjustable range from 10 to 320 Kelvin.
- One temperature indicator can serve multiple Cryo-Torr cryopumps with a customer supplied selector switch.

Appendix F
Conversion of Hydrogen-Vapor-Pressure-Gauge Readings to Temperature

Use the data given below to convert a reading of the optional hydrogen-vapor-pressure gauge (in psia) to the temperature of the second-stage cold station in degrees (Kelvin). The hydrogen-vapor-pressure gauge should not be used to measure temperatures higher than 26K.

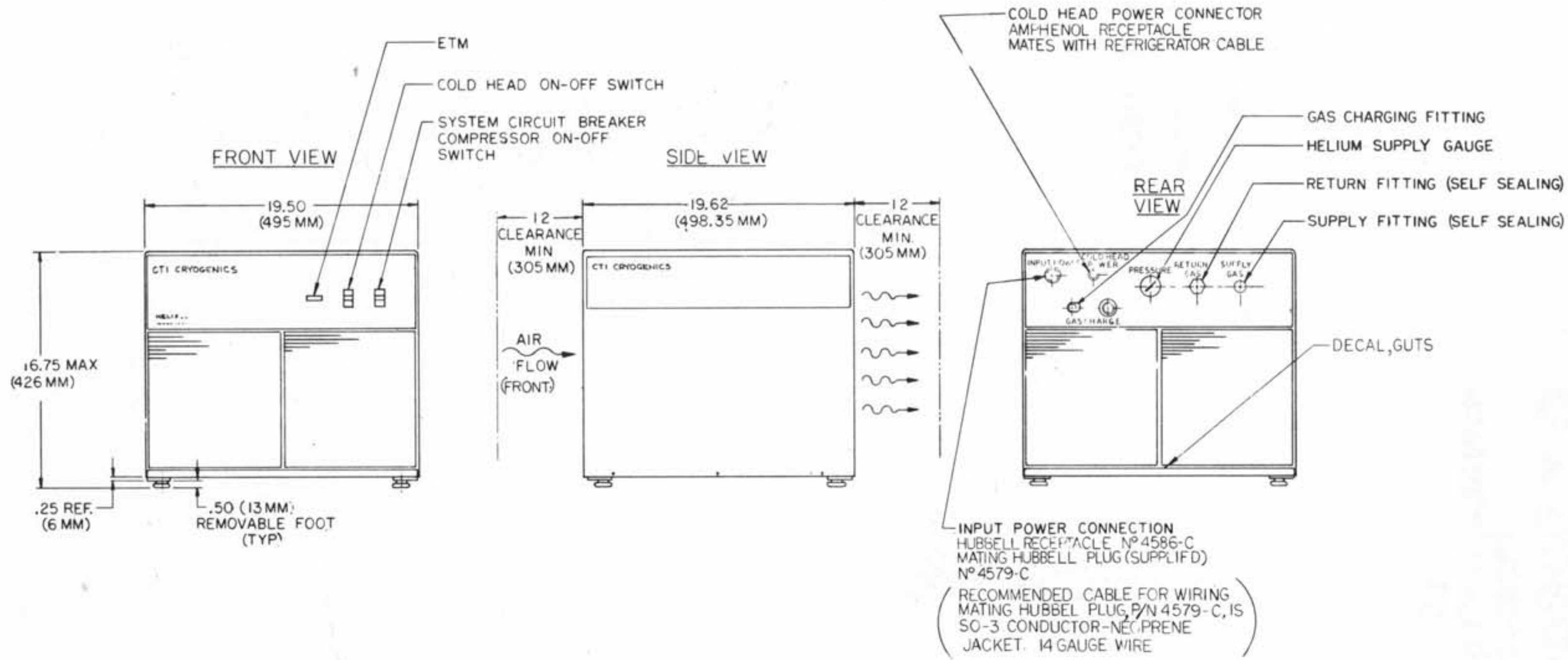


PSIA	K	PSIA	K
0	Less than 12	15	20.5
1	13.9	18	21.1
2	15.2	21	21.7
3	16.0	24	22.2
4	16.7	27	22.6
5	17.2	30	23.1
6	17.7	35	23.7
7	18.1	40	24.3
8	18.5	45	24.8
10	19.2	50	25.3
12	19.7	55	25.8

F

Appendix G
Compressor Installation/Interface Drawings

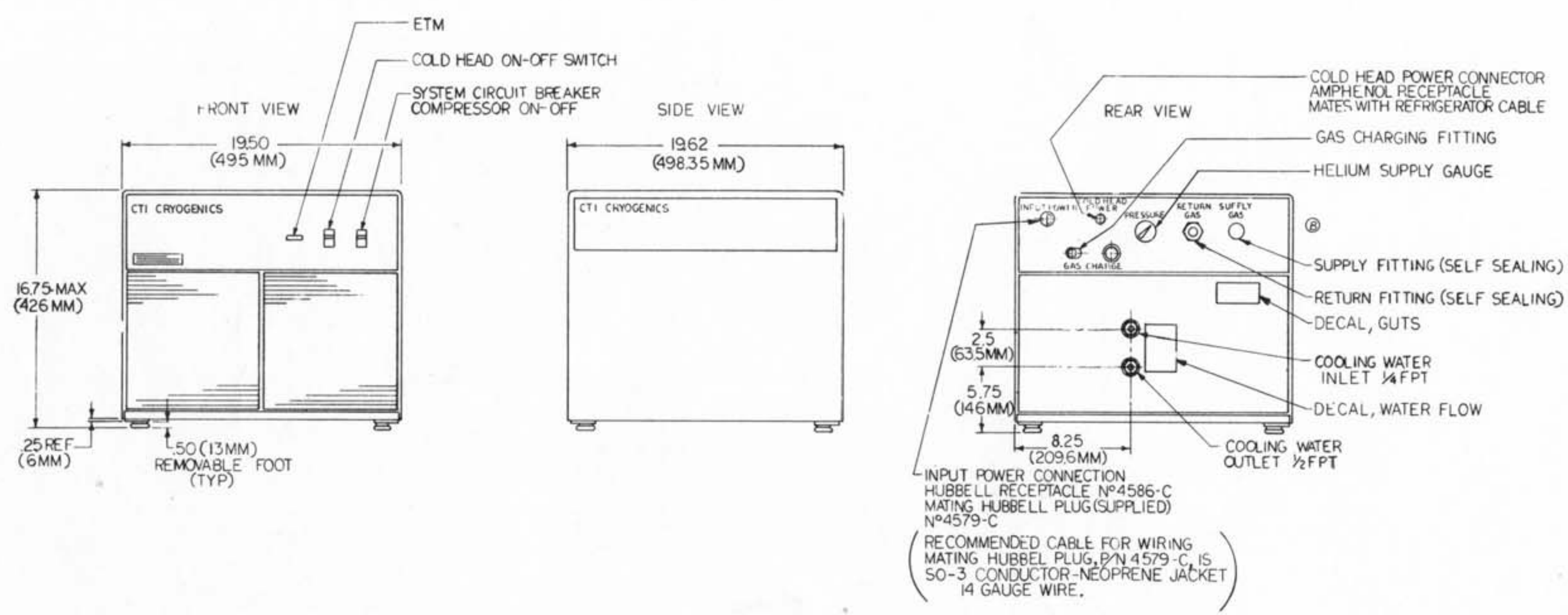
Title	Drawing/Rev.		Page
STANDARD COMPRESSOR - AIR COOLED	8032224	E	54
STANDARD COMPRESSOR - WATER COOLED	8032211	D	55



NOTES:

1. WEIGHT = APPROX. 140 LBS. 63.5 KG.
2. ELEC. PWR. RQMTS = 208/230V, 1ø, 60 HZ, 12.5 AMPS MAX. RUNNING; 2.1 KW NOM.
   RECOMMENDED OPERATING VOLTAGE RANGE IS 198 VOLTS (MIN.) TO 253 VOLTS (MAX).
   200/220V, 1ø, 50 HZ 12.5 AMPS MAX. RUNNING; 2.1 KW NOM.
   RECOMMENDED OPERATING VOLTAGE RANGE IS 180 VOLTS (MIN.) TO 220 VOLTS (MAX).
3. AMBIENT TEMP. 50° TO 100°F (10°C to 38°C).

INSTALLATION/INTERFACE
STANDARD COMPRESSOR
AIR COOLED
Drawing 8032224 Rev. E



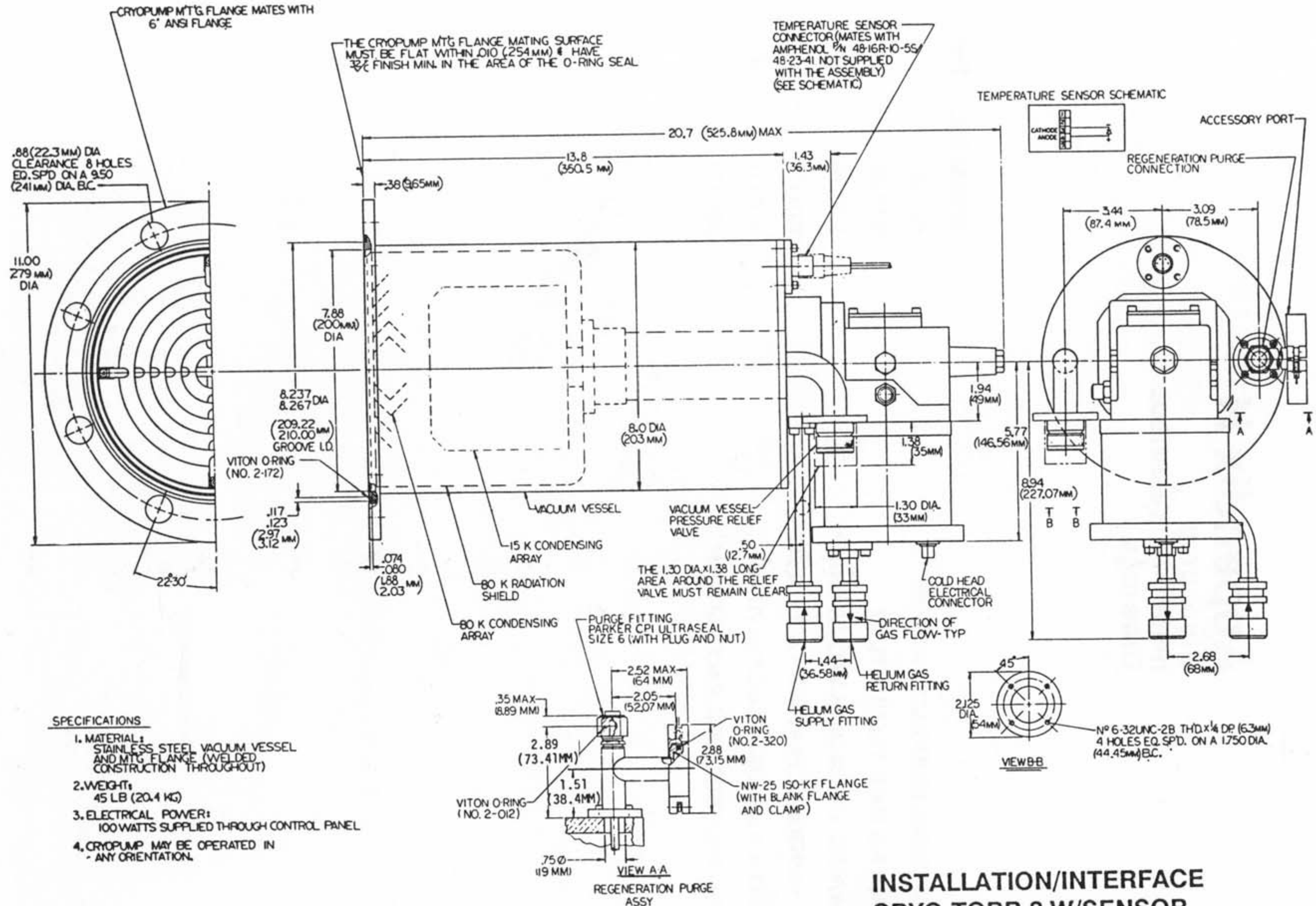
NOTES:
1. WEIGHT = APPROX. 140 LBS. (63.5 KG).
2. ELEC. POWER REQ'TS: 208/230V, 1ø, 60 HZ, 11 AMPS, MAX. RUNNING, 1.5 KW NOM. RECOMMENDED OPERATING VOLTAGE RANGE IS 198V (MIN.) TO 253V (MAX.): 200/220V, 1ø, 50 HZ, 11 AMPS MAX. RUNNING 1.5 KW NOM. RECOMMENDED OPERATING VOLTAGE RANGE IS 180V (MIN.) TO 220V (MAX).
3. AMBIENT TEMPERATURE 50°F to 100°F (10°C to 38°C).
4. THIS COMPRESSOR HAS BEEN DESIGNED TO OPERATE WITH WATER HAVING A P_H VALUE OF 6.0 TO 8.0 AND A CALCIUM CARBONATE CONCENTRATION OF LESS THAN 75 PARTS PER MILLION (TYPICAL MUNICIPAL DRINKING WATER QUALITY). FOR APPLICATIONS OF LOWER P_H OR GREATER HARDNESS, WATER CONDITIONING MAY BE NECESSARY.
5. MAXIMUM WATER PRESSURE IS 100 PSIG. MINIMUM WATER PRESSURE IS DEPENDANT ON WATER FLOW REQUIREMENT BUT SHOULD NOT BE LESS THAN 10 PSIG.

INSTALLATION/INTERFACE STANDARD COMPRESSOR WATER COOLED
Drawing 8032211 Rev. D

Appendix H
Cryopump Installation/Interface Drawings

Title	Drawing/Rev.		Page
CRYO-TORR 8 W/SENSOR HIGH-VACUUM PUMP	8033167	-	58
CRYO-TORR 8 W/V.P.G. HIGH-VACUUM PUMP	8033168	-	59
CRYO-TORR 8 W/V.P.G. ULTRA HIGH-VACUUM PUMP	8033169	-	60
CRYO-TORR 8 W/SENSOR ULTRA HIGH-VACUUM PUMP	8033170	-	61
CRYO-TORR 8-ISO W/V.P.G. HIGH-VACUUM PUMP	8033171	A	62
CRYO-TORR 8-ISO W/SENSOR HIGH-VACUUM PUMP	8033179	A	63

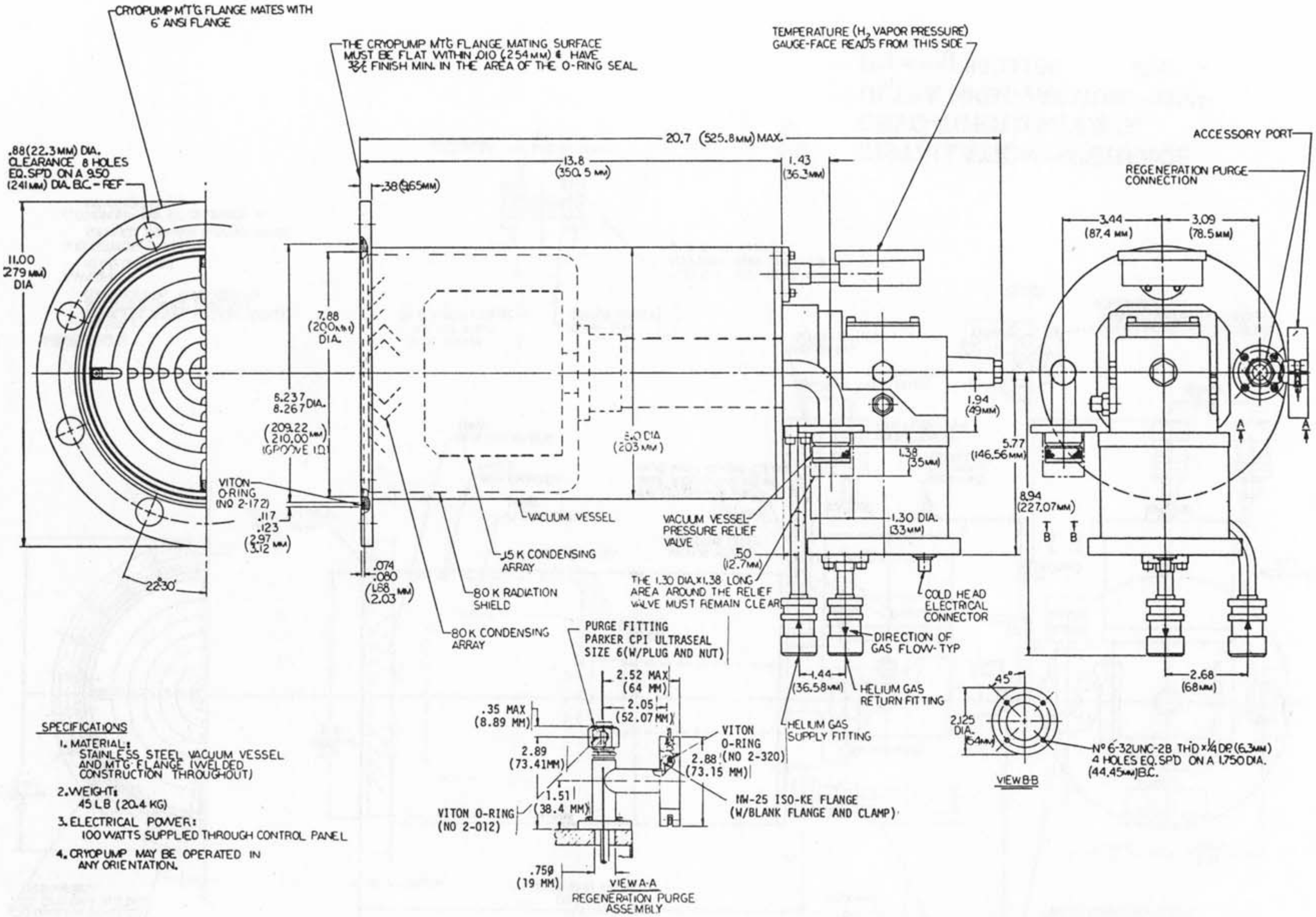
H



SPECIFICATIONS

1. MATERIAL: STAINLESS STEEL VACUUM VESSEL AND MTG FLANGE (WELDED CONSTRUCTION THROUGHOUT)
2. WEIGHT: 45 LB (20.4 KG)
3. ELECTRICAL POWER: 100 WATTS SUPPLIED THROUGH CONTROL PANEL
4. CRYOPUMP MAY BE OPERATED IN ANY ORIENTATION.

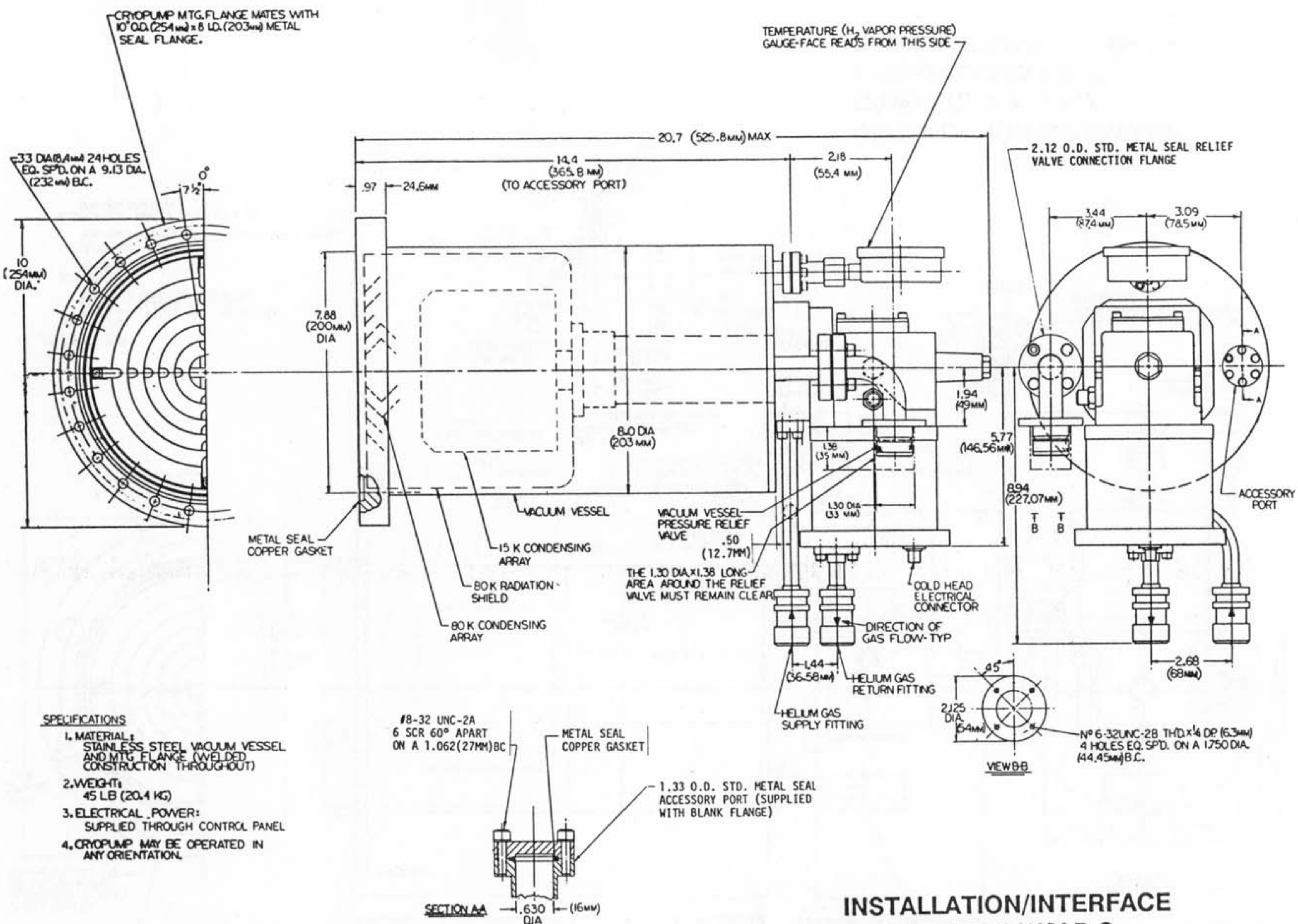
INSTALLATION/INTERFACE
CRYO-TORR 8 W/SENSOR
HIGH-VACUUM PUMP
Drawing 8033167 Rev. -



SPECIFICATIONS

1. MATERIAL: STAINLESS STEEL VACUUM VESSEL AND MTG FLANGE (WELDED CONSTRUCTION THROUGHOUT)
2. WEIGHT: 45 LB (20.4 KG)
3. ELECTRICAL POWER: 100 WATTS SUPPLIED THROUGH CONTROL PANEL
4. CRYOPUMP MAY BE OPERATED IN ANY ORIENTATION.

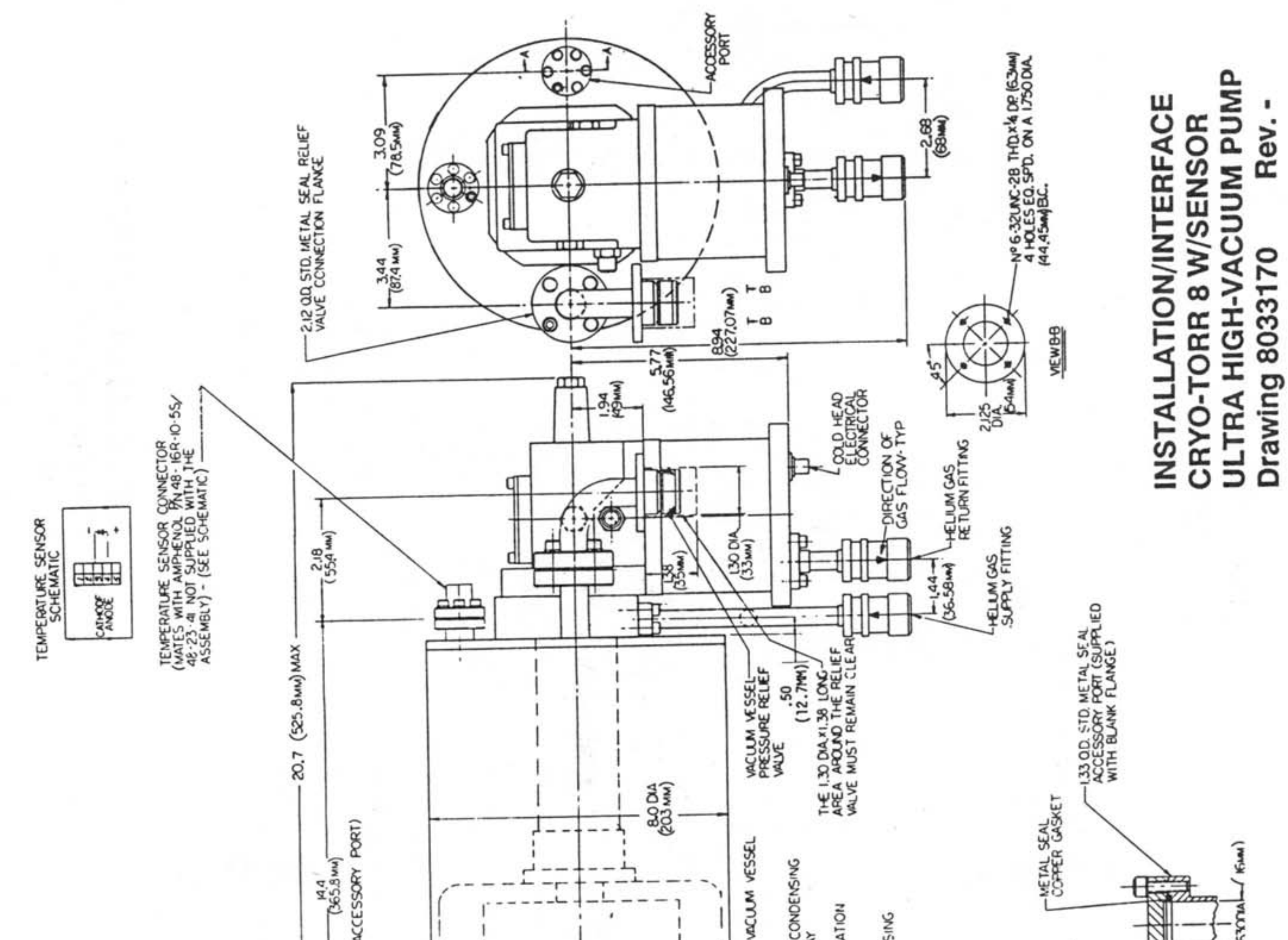
INSTALLATION/INTERFACE
CRYO-TORR 8 W/V.P.G.
HIGH-VACUUM PUMP
Drawing 8033168 Rev. -

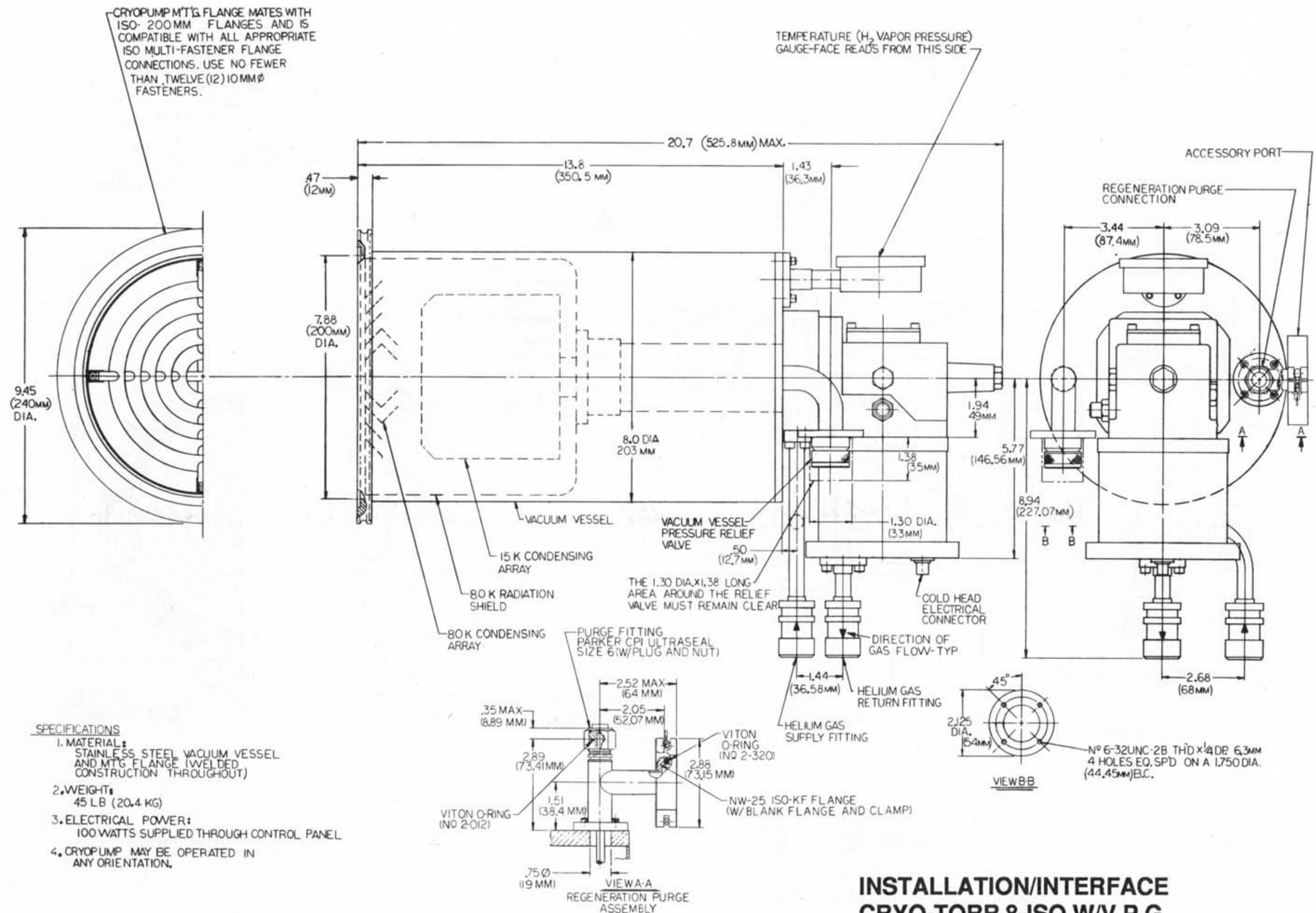


SPECIFICATIONS

1. MATERIAL: STAINLESS STEEL VACUUM VESSEL AND MTG. FLANGE (WELDED CONSTRUCTION THROUGHOUT)
2. WEIGHT: 45 LB (20.4 KG)
3. ELECTRICAL POWER: SUPPLIED THROUGH CONTROL PANEL
4. CRYOPUMP MAY BE OPERATED IN ANY ORIENTATION.

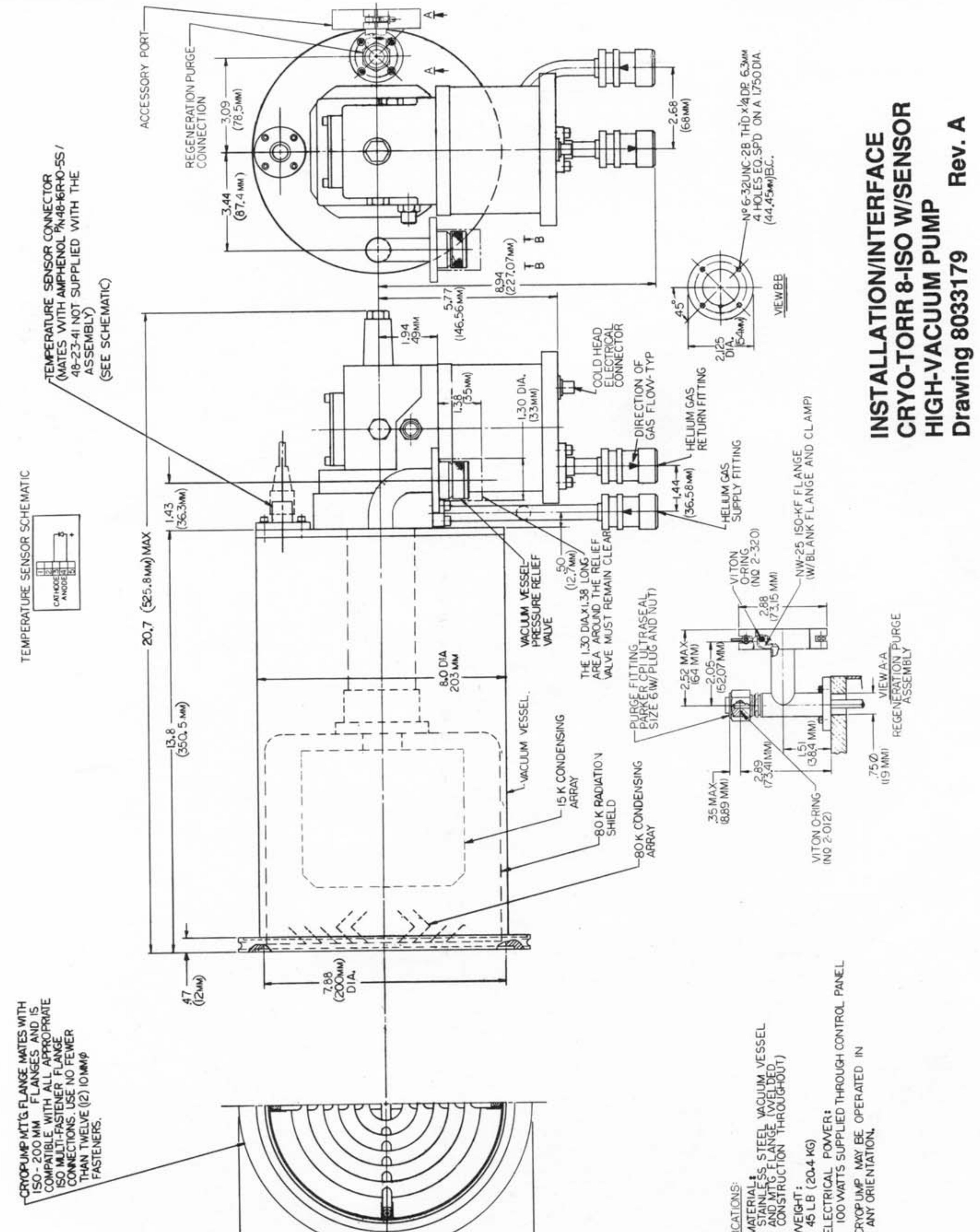
INSTALLATION/INTERFACE
CRYO-TORR 8 W/V.P.G.
ULTRA HIGH-VACUUM PUMP
Drawing 8033169 Rev. -


INSTALLATION/INTERFACE
CRYO-TORR 8 W/SENSOR
ULTRA HIGH-VACUUM PUMP
Drawing 8033170 Rev. -
TEMPERATURE SENSOR SCHEMATIC
CATHODE
ANODE
TEMPERATURE SENSOR CONNECTOR (MATES WITH AMPHENOL P/N 48-16R-10-5S/48-23-41 NOT SUPPLIED WITH THE ASSEMBLY) - (SEE SCHEMATIC)
2.12 O.D. STD. METAL SEAL RELIEF VALVE CONNECTION FLANGE
ACCESSORY PORT
3.09 (78.5MM)
3.44 (87.4MM)
2.68 (68MM)
5.77 (146.56MM)
8.94 (227.07MM)
1.94 (49MM)
2.18 (55.4MM)
1.30 DIA (33MM)
1.38 (35MM)
1.44 (36.58MM)
COLD HEAD ELECTRICAL CONNECTOR
DIRECTION OF GAS FLOW-TYP
HELIUM GAS RETURN FITTING
HELIUM GAS SUPPLY FITTING
Nº 6-32UNC-2B THD x 1/4 DP (6.3MM) 4 HOLES EQ. SPD. ON A 1.750 DIA. (44.45MM) B.C.
2.125 DIA. (54MM)
45°
VIEW B-B
20.7 (525.8MM) MAX
14.4 (365.8MM) (TO ACCESSORY PORT)
8.0 DIA (203 MM)
VACUUM VESSEL PRESSURE RELIEF VALVE
.50 (12.7MM)
THE 1.30 DIA x 1.38 LONG AREA AROUND THE RELIEF VALVE MUST REMAIN CLEAR
133 O.D. STD. METAL SEAL ACCESSORY PORT (SUPPLIED WITH BLANK FLANGE)
METAL SEAL COPPER GASKET
VACUUM VESSEL
15 K CONDENSING ARRAY
80 K RADIATION SHIELD
80 K CONDENSING ARRAY
8-32UNC-2A 6 SCR 60° APART ON A 1.062 (27MM) BC
SECTION A-A
.97
24.6MM
7.88 (200MM) DIA
METAL SEAL COPPER GASKET
CRYOPUMP MTG. FLANGE MATES WITH 10" O.D. (254MM) x 8 I.D. (203MM) METAL SEAL FLANGE.
.33 DIA (8.4MM) 24 HOLES EQ. SPD. ON A 9.13 DIA. (232MM) B.C.
10 (254MM) DIA.
7 1/2°
0°
SPECIFICATIONS
1. MATERIAL: STAINLESS STEEL VACUUM VESSEL AND MTG. FLANGE (WELDED CONSTRUCTION THROUGHOUT)
2. WEIGHT: 45 LB (20.4 KG)
3. ELECTRICAL POWER: SUPPLIED THROUGH CONTROL PANEL
4. CRYOPUMP MAY BE OPERATED IN ANY ORIENTATION.



SPECIFICATIONS
1. MATERIAL: STAINLESS STEEL VACUUM VESSEL AND MTG FLANGE (WELDED CONSTRUCTION THROUGHOUT)
2. WEIGHT: 45 LB (20.4 KG)
3. ELECTRICAL POWER: 100 WATTS SUPPLIED THROUGH CONTROL PANEL
4. CRYOPUMP MAY BE OPERATED IN ANY ORIENTATION.

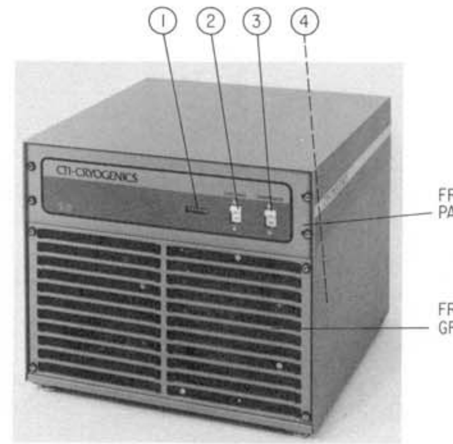
INSTALLATION/INTERFACE
CRYO-TORR 8-ISO W/V.P.G.
HIGH-VACUUM PUMP
Drawing 8033171 Rev. A


INSTALLATION/INTERFACE
CRYO-TORR 8-ISO W/SENSOR
HIGH-VACUUM PUMP
Drawing 8033179 Rev. A
ACCESSORY PORT
REGENERATION PURGE CONNECTION
3.09 (78.5MM)
3.44 (87.4 MM)
2.68 (68MM)
8.94 (227.07MM)
5.77 (146.56MM)
1.94 49MM
Nº 6-32UNC-2B THD x 1/4 DP. 6.3MM 4 HOLES EQ. SP'D ON A 1.750 DIA. (44.45MM) B.C.
45°
2.125 DIA. (54MM)
VIEW B-B
TEMPERATURE SENSOR CONNECTOR (MATES WITH AMPHENOL P/N 48-16R-10-5S / 48-23-41 NOT SUPPLIED WITH THE ASSEMBLY) (SEE SCHEMATIC)
TEMPERATURE SENSOR SCHEMATIC
CATHODE
ANODE
COLD HEAD ELECTRICAL CONNECTOR
DIRECTION OF GAS FLOW-TYP
HELIUM GAS RETURN FITTING
HELIUM GAS SUPPLY FITTING
1.38 (35MM)
1.30 DIA. (33MM)
1.44 (36.58MM)
1.43 (36.3MM)
20.7 (525.8MM) MAX
.50 (12.7MM)
THE 1.30 DIA x 1.38 LONG AREA AROUND THE RELIEF VALVE MUST REMAIN CLEAR
VACUUM VESSEL PRESSURE RELIEF VALVE
8.0 DIA 203 MM
VACUUM VESSEL
15 K CONDENSING ARRAY
80 K RADIATION SHIELD
80 K CONDENSING ARRAY
13.8 (350.5 MM)
.47 (12MM)
7.88 (200MM) DIA.
9.45 (240MM) DIA.
CRYOPUMP MT'G. FLANGE MATES WITH ISO-200 MM FLANGES AND IS COMPATIBLE WITH ALL APPROPRIATE ISO MULTI-FASTENER FLANGE CONNECTIONS. USE NO FEWER THAN TWELVE (12) 10 MM ϕ FASTENERS.
PURGE FITTING PARKER CPI ULTRASEAL SIZE 6 (W/ PLUG AND NUT)
VITON O-RING (NO 2-320)
NW-25 ISO-KF FLANGE (W/BLANK FLANGE AND CLAMP)
2.52 MAX (64 MM)
2.05 (52.07 MM)
2.88 (73.15 MM)
2.89 (73.41 MM)
1.51 (38.4 MM)
.35 MAX (8.89 MM)
.75 Ø (19 MM)
VITON O-RING (NO 2-012)
VIEW A-A REGENERATION PURGE ASSEMBLY
SPECIFICATIONS:
1. MATERIAL: STAINLESS STEEL VACUUM VESSEL AND MT'G FLANGE (WELDED CONSTRUCTION THROUGHOUT)
2. WEIGHT: 45 LB (20.4 KG)
3. ELECTRICAL POWER: 100 WATTS SUPPLIED THROUGH CONTROL PANEL
4. CRYOPUMP MAY BE OPERATED IN ANY ORIENTATION.

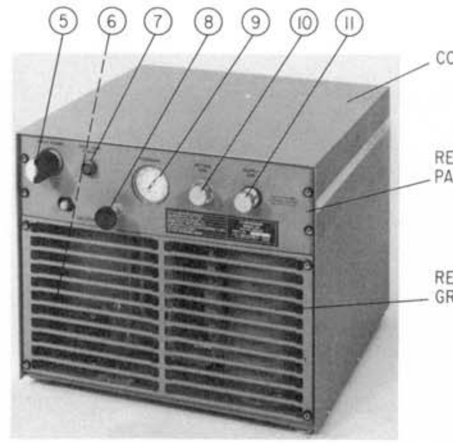
Legend

1. Elapsed time meter (ETM), in hours
2. Cold-head ON/OFF switch (SW3)
   Starts and stops the cold head.
   SW3 switch is interlocked to SW1, which must be on to operate.
3. Compressor ON/OFF switch (SW1*)
   Starts and stops the compressor and cooling fan.
   Switch contains a circuit breaker.
4. Safety interlock switch (SW2)
5. Input power cable plug
6. Oil sight glass (water-cooled compressor only)
7. Cold-head power cable receptacle
8. Helium gas charge fitting and valve
9. Helium supply pressure gauge
10. Helium gas-return connector-self-sealing coupling
11. Helium gas-supply connector-self-sealing coupling
12. Cooling water input } (water-cooled compressor only)
13. Cooling water output }

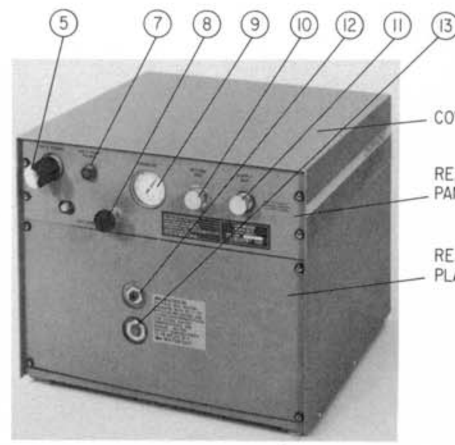
*Refer to Figure B.1 or B2, pages 40 or 42, for the electrical schematic and associated reference designators.



FRONT VIEW – BOTH COMPRESSOR TYPES



REAR VIEW – AIR COOLED



REAR VIEW – WATER COOLED

Figure 1.4 Model SC and SCW Compressors