MT 345 Rx RLB.

CTI-CRYOGENICS

M8040012

# INSTALLATION, OPERATION, AND SERVICING INSTRUCTIONS

## MODEL 350C CRYODYNE(R) CRYOCOOLER

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## RETURNING EQUIPMENT

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

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CTI-CRYOGENICS
Product Service Department
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P.O. Box 9171
Waltham, Massachusetts 02254-9171, U.S.A.
Telephone (617) 890-9400 or (617) 895-1659 - TELEX 92-3442
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Toll Free Telephone 1-800-232-4300.

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Obtain a Return Goods Authorization (RGA) number from 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_____Date of Purchase_____
Compressor Serial No._____
Cold Head Serial No._____
CTI-CRYOGENICS Sales Order No._____

## TECHNICAL INQUIRIES

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

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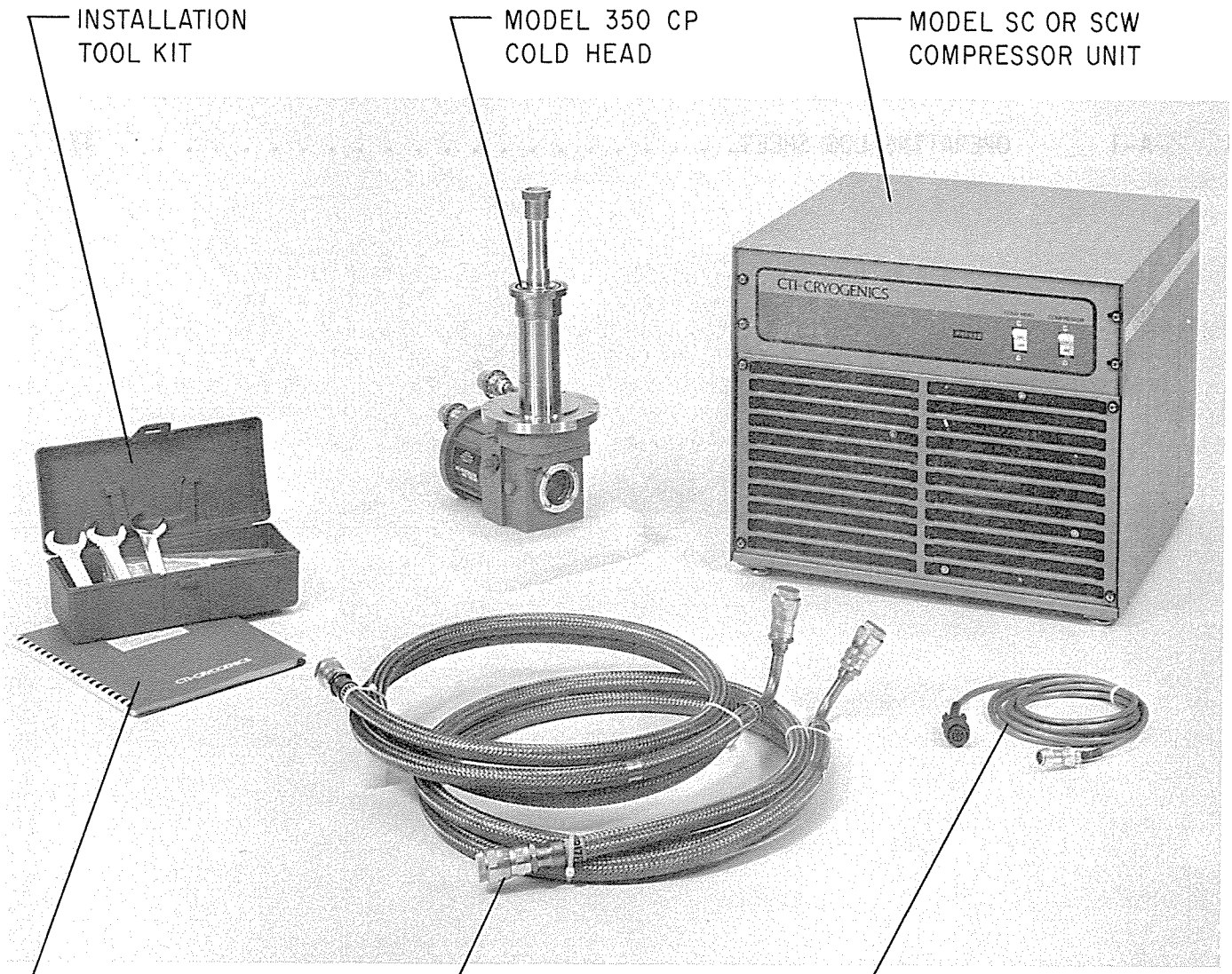



FIGURE 1-1. THE MODEL 350C CRYODYNE(R) CRYOCOOLER

# SECTION 1
# INTRODUCTION

## 1.1 GENERAL

The Model 350C CRYODYNE(R) Cryocooler provides reliable refrigeration at cryogenic temperatures for long, continuous periods. This cryocooler (see Figure 1-1) consists of the Model 350CP Cold Head, the Model SC or SCW Compressor Unit, interconnecting piping, and an installation tool kit.

The Model 350C CRYODYNE(R) Cryocooler, which uses helium as the refrigerant, is designed to interface with many kinds of apparatus that require cryogenic temperatures. The use of a CRYODYNE(R) Cryocooler as a source of cryogenic temperatures offers a degree of freedom in the design of such interfacing apparatus (in particular, size and operational flexibility) that is generally unobtainable when a liquid refrigerant is employed. One immediate advantage of a CRYODYNE(R) Cryocooler is that the cold head can be operated in any orientation without loss of performance. After the end of an operating period of the cryocooler, the cold-head cold stations can be raised to ambient temperature in a relatively short time.

This manual provides instructions for initial inspection and installation, operation, and servicing of the Model 350C CRYODYNE(R) Cryocooler. Your cryocooler is a highly-reliable and rugged unit that requires a minimum of servicing. Functional descriptions of the major assemblies that comprise the cryocooler are detailed in Section 4. Servicing instructions are covered in Sections 5, and 6. Section 5 covers troubleshooting in simplified tabular format; and Section 6 presents both scheduled and unscheduled maintenance instructions.

## 1.2 DESCRIPTION OF COMPONENTS

As shown in Figure 1-1, your Model 350C CRYODYNE(R) Cryocooler consists of a Model 350CP Cold Head, a Model SC or SCW Compressor Unit, interconnecting piping, a cold-head power cable, and an installation tool kit.

### 1.2.1 350CP Cold Head

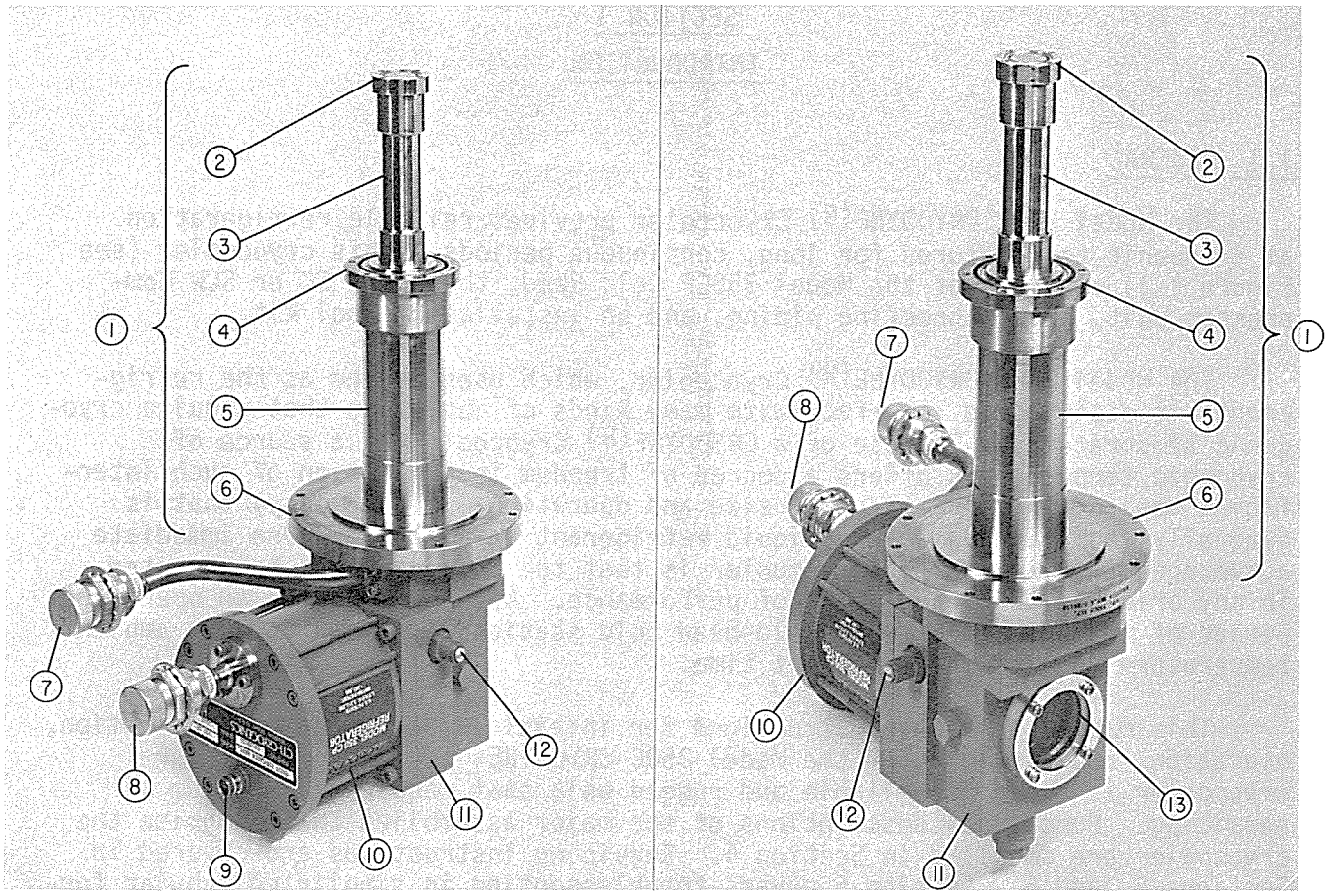
Figure 1-2 shows front and rear overall views of the cold head, with identification of the major external components.

### 1.2.2 Model SC and SCW Compressor Units

Figure 1-3 shows overall views of both the air-cooled (SC) and water cooled (SCW) versions of the compressor unit. The controls, indicators, and principal external components are also identified; the legend includes brief functional descriptions of most of the identified items shown.

## 1.3 SPECIFICATIONS

Table 1-1 is a summary of specifications for the Model 350C CRYODYNE(R) Cryocooler.




A. REAR VIEW

B. FRONT VIEW

1. Cylinder
2. Second-Stage Cold Station
3. Second-Stage Cylinder
4. First-Stage Cold Station
5. First-Stage Cylinder
6. Top Flange
7. Helium-Gas Supply Connector (with dust cap)
8. Helium-Gas Return Connector (with dust cap)
9. Electrical Power Connector
10. Drive Motor
11. Crankcase (houses the drive mechanism)
12. Pressure Relief Valve
13. Sight Glass

FIGURE 1-2. THE MODEL 350CP COLD HEAD

TABLE 1-1. SPECIFICATIONS FOR THE MODEL 350C CRYODYNE(R) CRYOCOOLER (Cont.)

MODEL 350CP COLD HEAD

| | |
|---|---|
| Dimensions (approximate): | |
| Length | 11.9 inches (302 mm) |
| Width | 6 inches (152 mm). |
| Height | 18.50 inches (470 mm) |
| Weight (approximate) | 33 lb (15 kg) |
| Power requirement | Supplied from the Compressor Unit |
| Ambient-Temperature Operating Range | 60°F to 100°F (16°C to 38°C) |
| Interface Data: | |
| Gas-supply connector | 1/2-inch self-sealing coupling |
| Gas-return connector | 1/2-inch self-sealing coupling |
| Orientation | The cold head may be operated in any orientation. |

Refrigeration Capacity:

Figures 1-4 and 1-5 are graphs showing typical refrigeration capacities (at 60 Hz and 50 Hz respectively) of the Model 350C CRYODYNE(R) Cryocooler.

| | |
|---|---|
| Temperature Stability under Constant Load: (At the Second-Stage Cold Station) | ± 1.0K |
| No-load Cooldown Time to 20K: | 40 minutes; 60-Hz power<br>50 minutes; 50-Hz power |

INTERCONNECTIONS

| | | |
|---|---|---|
| Helium Supply Piping | 10 ft (3m) | Longer lengths can be used. |
| Helium Return Piping | 10 ft (3m) | |
| | 1/2-inch self-sealing coupling at each termination. | |
| Cold-Head Power Cable | 10 ft (3m) | Longer lengths are available. |
| Compressor Input-Power Cable | Recommend cable type SO-3 conductor, 600V, neoprene jacket, 14-gauge wire. Cable to be supplied by User. Install per Figure B-1, Electrical Schematic, ensuring compliance with all National, State, and local standards. | |

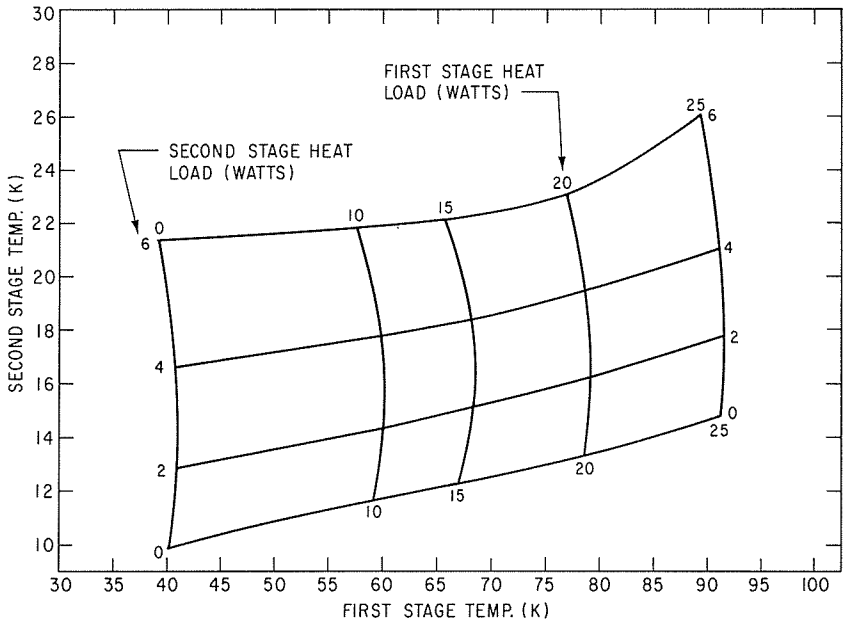



FIGURE 1-4. TYPICAL REFRIGERATION CAPACITY OF THE MODEL 350C CRYODYNE(R) CRYOCOOLER (60 HERTZ)

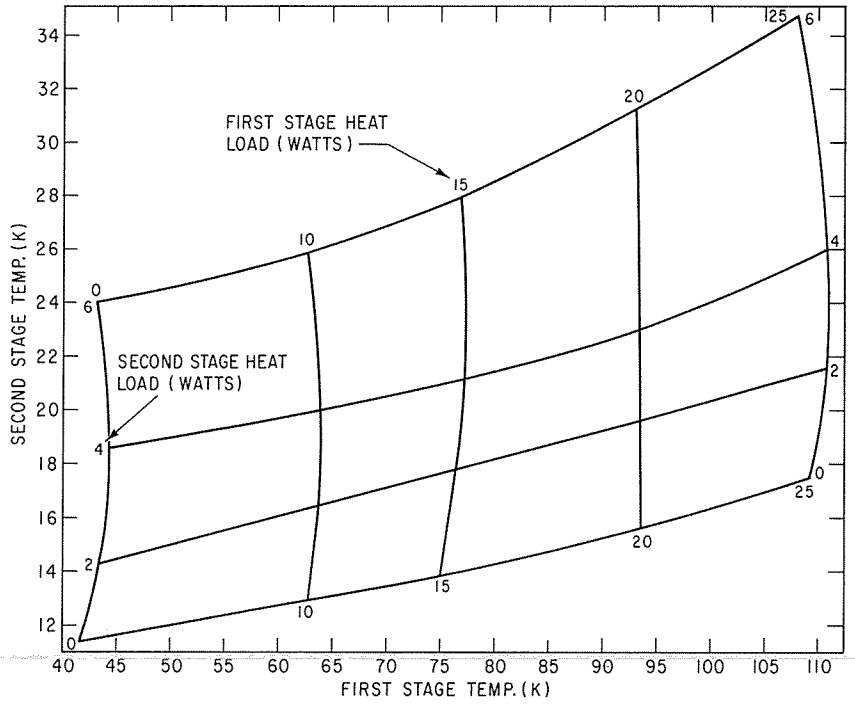



FIGURE 1-5. TYPICAL REFRIGERATION CAPACITY OF THE MODEL 350C CRYODYNE(R) CRYOCOOLER (50 HERTZ)

## SECTION 2
## INSPECTION AND INSTALLATION

### 2.1 INSPECTION

The Model 350C CRYODYNE(R) Cryocooler should be thoroughly inspected for evidence of damage upon receipt from CTI-CRYOGENICS. Follow the procedures below. If evidence of damage is found, notify the shipper at once. Retain all original shipping carton(s) for use during equipment storage or shipment.

#### 2.1.1 Cold Head (See Figure 1-2)

Inspect the exterior of the cold head for evidence of damage. Examples of such evidence are a bent cold-station and a dented cylinder.

#### 2.1.2 Interconnecting Piping and Wiring (See Figure 1-1)

(1) Inspect the interconnecting piping for evidence of damage. Do not bend the flexible interconnecting piping to less than a six-inch radius or damage may occur. Also, avoid twisting the piping when making final connections.

(2) Do not remove the self-sealing coupling caps and plugs until the cryocooler components are to be connected.

(3) Inspect the cold-head power cable for evidence of damage.

#### 2.1.3 Compressor Unit (See Figure 1-3)

(1) Inspect the exterior of the compressor unit for shipping damage.

(2) Check the compressor-unit pressure gauge (7). It should indicate 260 ± 10 psig (1790 ± 70 kPa), or slightly higher if the compressor unit has been stored in a warm location. If the pressure gauge indicates 0, contact the Product Service Department of CTI-CRYOGENICS.

(3) Remove the rear grille (12) or rear plate (13).

(4) Inspect the interior of the compressor unit for evidence of damage or major oil loss.

(5) Replace rear grille, unless compressor is to be installed immediately.

## 2.2 INSTALLATION

### 2.2.1 Connecting and Disconnecting Self-Sealing Couplings

Refer to Figures 2-1, 2-2, and 2-3 for the procedures to connect and disconnect self-sealing couplings.

### 2.2.2 Compressor Unit

The following procedures must be followed prior to making any system connections, and apply to both air-cooled and water-cooled compressor units, except where noted otherwise.

(1) If flexible water hose connections are to be used with a water-cooled compressor unit, install the water connection barbed fittings (supplied with compressor) as shown in Figure 2-4.

(2) Connect water-cooled compressor units to a supply of cooling water having a flow rate and temperature that will insure a 90°F (32°C) maximum output temperature. A minimum supply pressure of 5 psig (35 kPa) is required. For further information, refer to paragraph 2.2.3, Cooling Water Considerations.

(3) Assemble the compressor input-power cable. Use the CTI-supplied compressor-receptacle plug and a 600-volt power cable. Recommended cable type is SO-3 conductor, 600V, neoprene jacket, 14-gauge wire. Follow Figure B-1, Electrical Schematic, ensuring compliance with all National, State, and Local standards.

(4) With the rear grille removed, locate the 50/60 Hz slide switch, as shown in Figure 2-1 on the rear of the control panel. Set the switch to the applicable frequency.

CAUTION

FAILURE TO SET THE 50/60 HZ SLIDE SWITCH TO THE APPLICABLE FREQUENCY MAY CAUSE IMPROPER OPERATION OF THE COLD HEAD.

(5) Ensure that both front switches on the compressor unit are off before connecting the input power cable to the power source. Refer to Table 1-1 for power requirements.

(6) Switch the compressor unit on to stabilize the compressor oil circuit. Ensure that the fan is operating freely. Leave the unit on for 15 minutes.

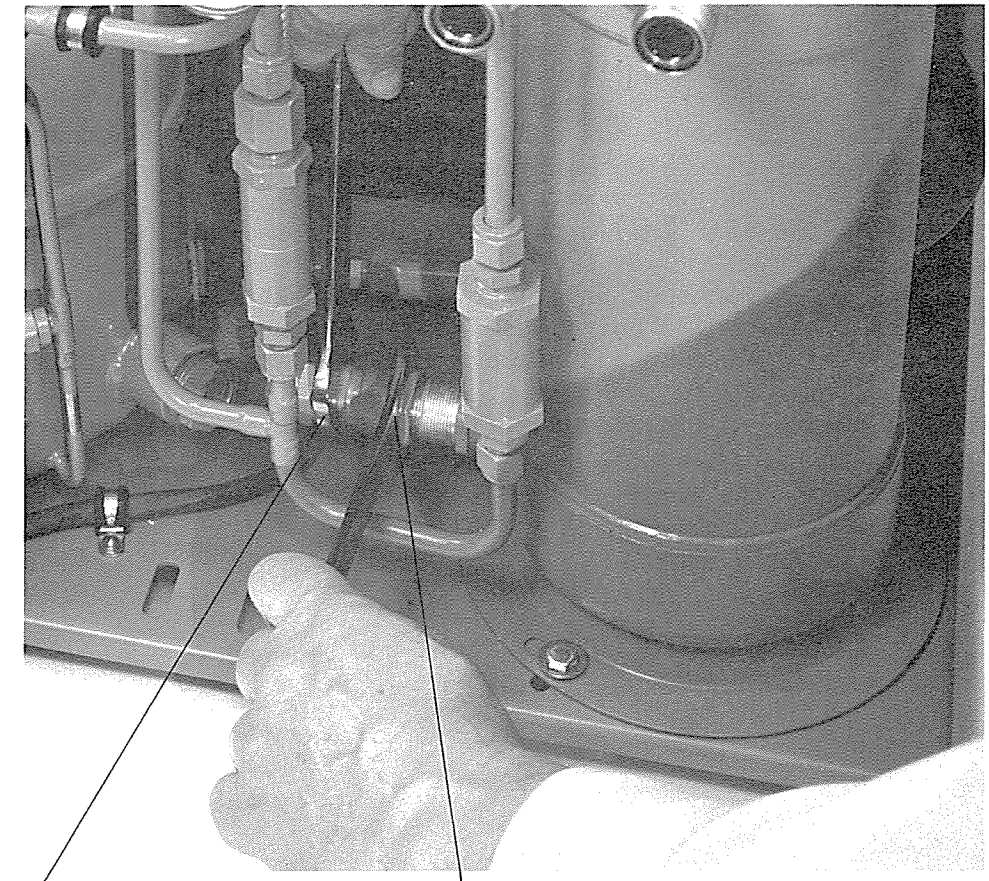
(7) Switch off the compressor unit, and disconnect the input power cable.

(8) Remove the rear grille or rear plate of the compressor unit and check that the oil level is visible in the sight glass on the compressor pump and note that the adsorber is connected. If no oil is visible or if the adsorber is not connected, contact the Product Service Department of CTI-CRYOGENICS before proceeding.

(9) Reinstall the rear grille or rear plate on the compressor unit.

(10) Install the compressor unit into its permanent location on a level surface. Air-cooled units must have a minimum clearance of 12 inches (30 cm) at the front and back to ensure adequate airflow.

(11) For water-cooled compressor units, make sure that all water connections are tight.



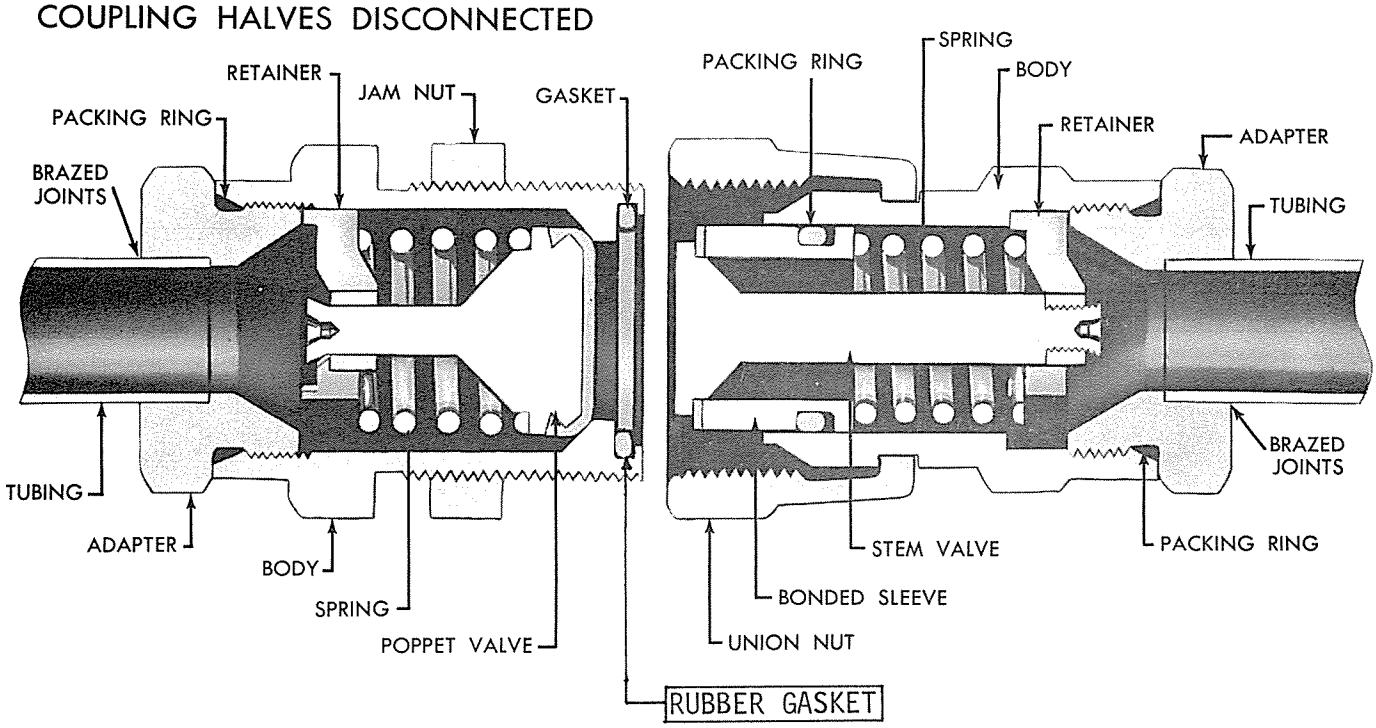

1. Ensure that the flat rubber gasket is clean and in place before connecting a self-sealing coupling. (See Figure 2-2, COUPLING HALVES DISCONNECTED).

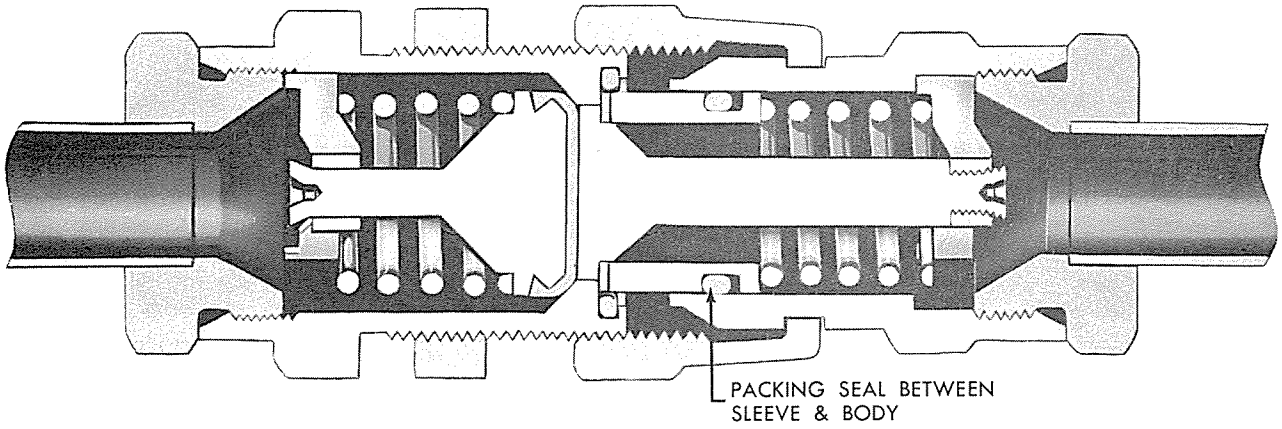
2. Use two wrenches (supplied) to avoid loosening the body of the coupling from its adapter.

3. Screw the two self-sealing coupling halves together (make the first few turns by hand). Minor gas leakage may occur while turning the connection half. Complete the connection quickly to minimize gas loss.

4. Be sure the coupling is firmly seated; do not apply more than 35 foot-pounds of torque.

FIGURE 2-1. PROCEDURE FOR CONNECTING A SELF-SEALING COUPLING



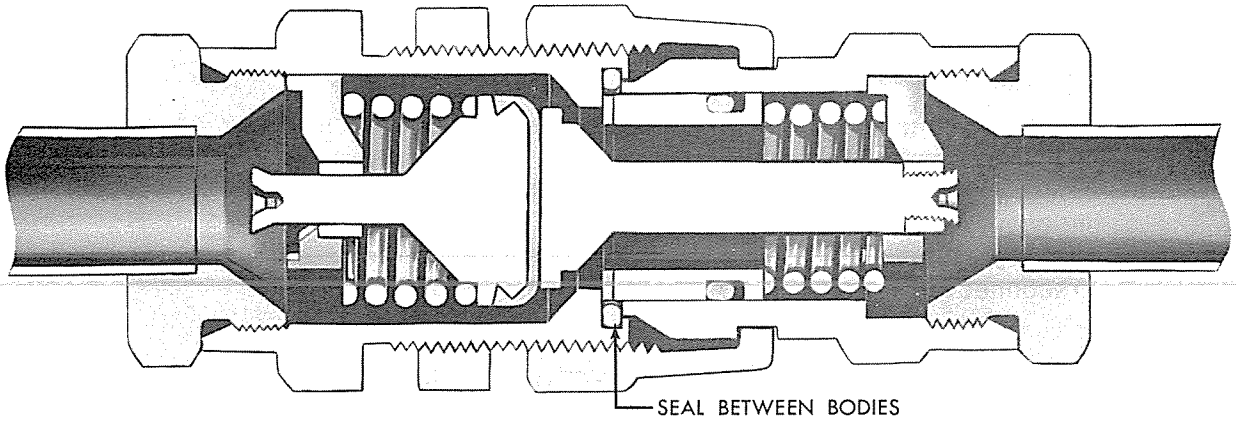
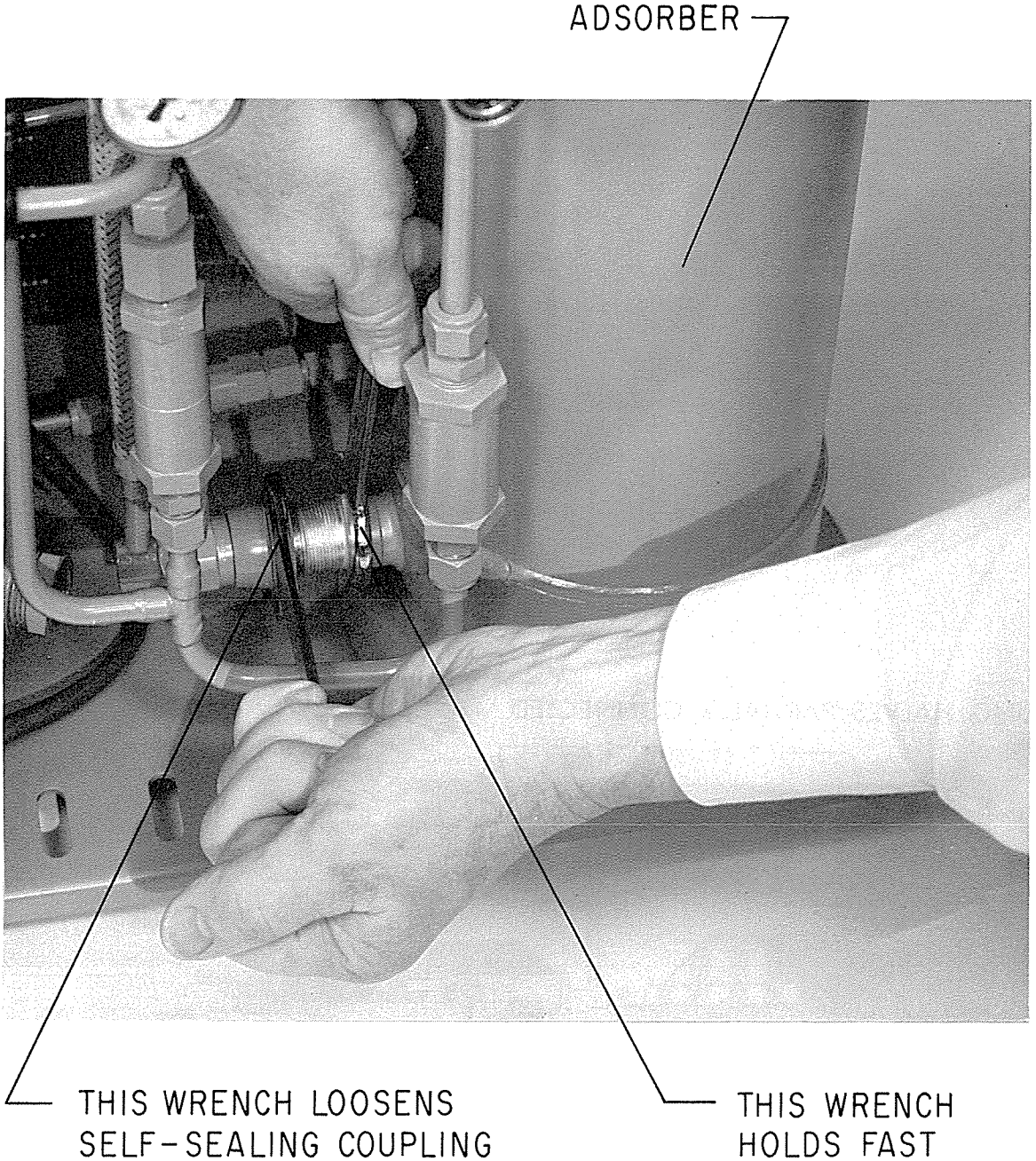




FIGURE 2-2. CUTAWAY VIEWS OF A SELF-SEALING COUPLING (AEROQUIP)




1. Use two wrenches (supplied) to avoid loosening the body of the coupling from its adapter.

2. Unscrew the two self-sealing coupling halves. Minor gas leakage may occur while turning the connecting half. Complete the disconnection quickly to minimize gas loss.

FIGURE 2-3. PROCEDURE FOR DISCONNECTING A SELF-SEALING COUPLING

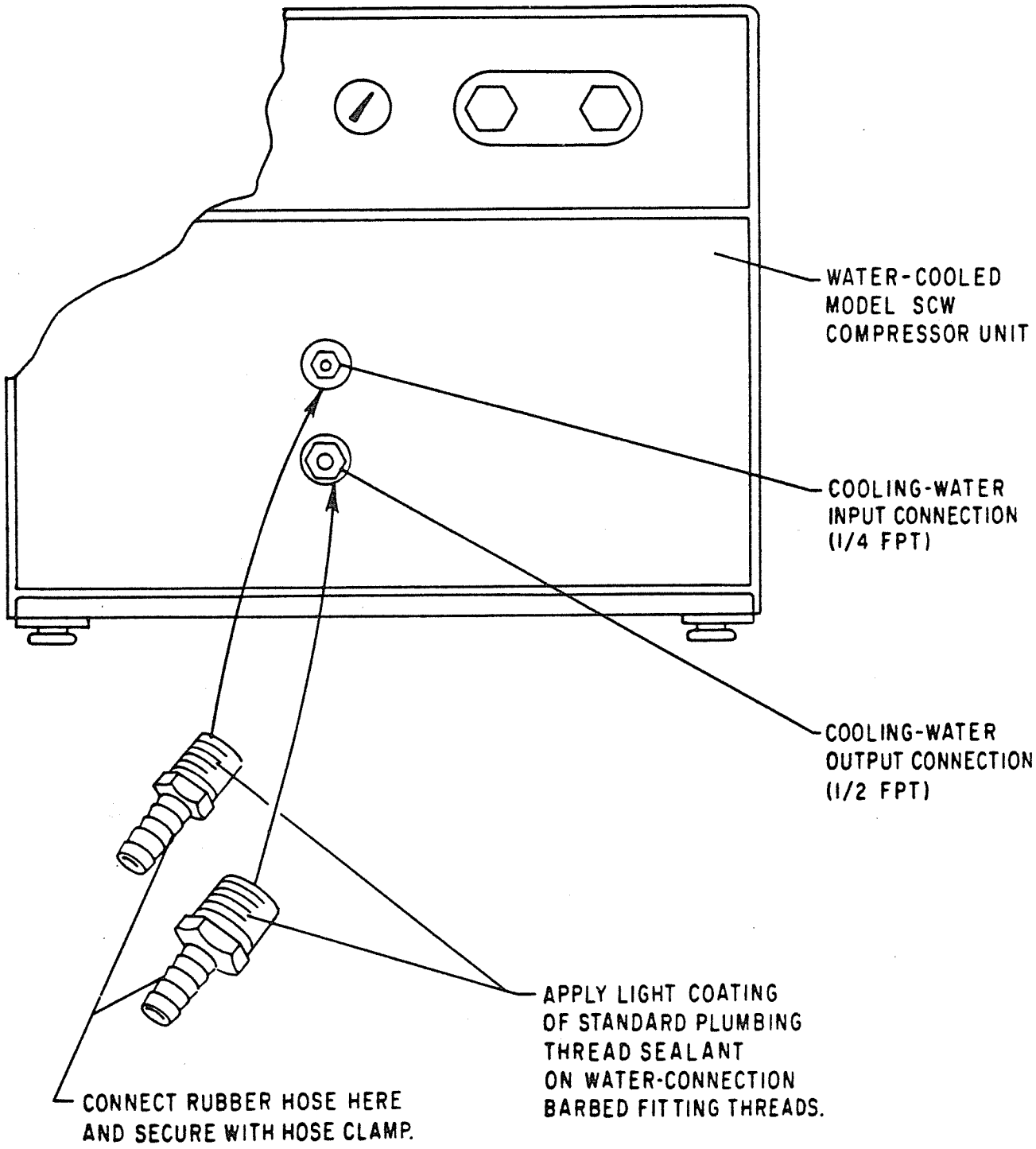



FIGURE 2-4. WATER-CONNECTION BARBED FITTINGS USED ON WATER-COOLED COMPRESSOR UNITS

### 2.2.3 Cooling Water Considerations

The following cooling water considerations apply to water-cooled compressor units only.

(1) Incoming cooling water with a temperature below the allowable operating range shown in Figure G-1 of Appendix G should not be used with the compressor unit. This will lower the oil temperature, thereby causing a restriction of oil flow through the oil-injection orifice during startup. This will cause the compressor unit to overheat and shut down. Before starting the compressor unit, select the proper cooling water requirements in accordance with Table 1-1 or Appendix G.

(2) The water-cooled Model SCW Compressor Unit has been designed to operate with water having a pH value of 6.0 to 8.0 and a calcium-carbonate concentration of less than 75 parts per million. (This is the quality of typical municipal drinking water.) When the water supplied has a pH value lower than 6.0 or a calcium-carbonate concentration in excess of 75 parts per million, contact the Product Service Department of CTI-CRYOGENICS; water conditioning may be necessary.

(3) To conserve water, CTI-CRYOGENICS recommends that the cooling water supply be shut off when the compressor unit is not running. If cooling water colder than 50°F (10°C) is left running while the compressor unit is shut off, the compressor oil may sufficiently change in viscosity (i.e., thicken) to cause the compressor unit to overheat and shut down upon restart. If this occurs, turn on the compressor unit and allow it to run until it stops. Repeat this procedure a number of times until the oil temperature rises and the compressor unit is able to operate continuously.

(4) Before shipping a compressor unit back to CTI-CRYOGENICS, or whenever the compressor unit may be subjected to freezing conditions, drain the compressor unit. Purge it of all remaining water by blowing compressed air, regulated to 30-40 psig (200-275 kPa), through the cooling water output connection (Figure 2-4). Allow the compressed air to exit from the cooling water input connection.

### 2.2.4 Cold Head

Proceed as follows to install the cold head in the User's vacuum system. See Figure 2-5 for the major interface dimensions of the Model 350CP Cold Head.

(1) Using a clean, lint-free cloth moistened with solvent such as acetone, carefully clean the groove for the O-ring in the mounting flange of your vacuum system.

(2) Using a clean, dry cloth, sparingly lubricate the O-ring with low-vapor-pressure grease; for example, Apiezon "L" grease. Do not clean the O-ring with solvent.

(3) Install the O-ring in the O-ring groove.

(4) Carefully install the cold head on the mounting flange of your vacuum chamber.

The cold head and related components must have adequate vacuum integrity for proper operation in your vacuum system. Inadequate vacuum will result in an unwanted gas-conduction heat load from the room-temperature vacuum housing to the cold surfaces of the cold-head cold stations. A small vacuum leak will cause higher-than-normal cold-station operating temperatures, combined with a gradual temperature increase; a large vacuum leak may prevent satisfactory cooldown. The rough-pumping system should be isolated from your vacuum system, once cooldown has started, by closing the roughing valve shown in Figure 2-6.

CTI-CRYOGENICS recommends that a suitable pressure relief valve be installed in your vacuum system to prevent any possible positive pressure rise during warmup.

### 2.2.5 Component Interconnections

A component interconnection diagram for the Model 350C CRYODYNE(R) Cryocooler is shown in Figure 2-6. Refer also to Figures 1-2 and 1-3 for the location of components discussed below. Refer to section 3.2 for details of rough-pumping valving and gaging requirements.

WARNING

DO NOT CONNECT THE COMPRESSOR UNIT TO ITS POWER SOURCE UNTIL ALL INTERCONNECTIONS HAVE BEEN MADE BETWEEN THE COMPONENTS OF THE CRYOCOOLER.

(1) Remove all dust plugs/caps from both interconnecting helium lines, and from the gas-supply and gas-return connectors on the cold head and on the rear of the compressor unit.

(2) Connect the interconnecting piping between the compressor unit and the cold head in the order listed below.

(a) Connect the helium return line to the gas-return connector on the rear of the compressor unit.

(b) Connect the helium supply line to the gas-supply connector on the rear of the compressor unit.

(c) Connect the helium supply line to the gas-supply connector on the drive-unit displacer assembly.

(d) Connect the helium return line to the gas-return connector on the drive-unit displacer assembly.

Note

Read the pressure on the compressor-unit pressure gauge. The required static pressure is 250 + 0, -5 psig (1725 +0, -35 kPa), in an ambient-temperature range of 60°F to 100°F (16°C to 38°C).

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

(a) Remove the flare cap from the gas charge fitting on the rear of the compressor unit.

(b) While observing the pressure gauge, very slowly (and only slightly) open the gas charge valve and reduce the gauge indication to 250 psig (1725 kPa).

(c) Close the gas charge valve after the correct charge pressure has been obtained, and reinstall the flare cap.

(4) If the indicated pressure is lower than 245 psig (1690 kPa), add helium gas as described in Section 6.2.1.

(5) Make electrical connections as follows:

WARNINGS

(1) NEVER CONNECT THE COLD-HEAD POWER CABLE TO THE COLD HEAD WHILE THE COMPRESSOR UNIT IS RUNNING.

(2) ENSURE THAT BOTH OF THE SWITCHES ON THE FRONT OF THE COMPRESSOR UNIT ARE OFF BEFORE CONNECTING THE COMPRESSOR UNIT TO ITS POWER SOURCE.

(a) Connect one end of the cold-head power cable to the rear panel of the compressor unit and the other end to the electrical power connector of the cold head.

(b) Plug the input power cable into the power source.

# SECTION 3
# OPERATION

Do not begin any of the procedures described in this Section until all of the inspection and installation procedures described in Section 2 have been completed and confirmed.

## 3.1 OPERATING LOG

It is important to maintain an operating log when utilizing the Model 350C CRYODYNE(R) Cryocooler. Various system parameters should be recorded during cooldown, and also while the cryocooler is operating under normal load conditions. These records may be extremely useful later, both in recognizing degradation of performance and in troubleshooting. An operating log sheet is included in Appendix A and may be reproduced by each customer for use in recording the data indicated therein.

## 3.2 INSTALLING THE LOAD

The load can be either attached directly to the cold station concerned or coupled to it with heat wicks (braided copper straps). Indium foil that is 0.002 to 0.005 inch thick should be used between the mating surfaces to improve thermal conduction.

When the installation of the load has been completed, rough-pump the User's vacuum chamber down to 1 x $10^{-2}$ torr or better. Then close the roughing valve prior to starting the cooldown of the cryocooler. Upon cooldown, the refrigerator will cryopump residual gases in the chamber and an insulating vacuum between $10^{-4}$ and $10^{-5}$ torr will be achieved.

## 3.3 START-UP AND COOLDOWN PROCEDURES

(1) Turn the compressor unit and cold head "ON-OFF" switches to "ON" (1 and 2, Figure 1-3). Note the reading on the compressor-unit gauge.

(2) During cooldown, record the operating-log data at 10-minute intervals. To insure minimum cooldown time, do not apply electrical power to any load during the cooldown.

The cooldown time associated with a normal cooldown with no load attached to the second-stage cold head is specified in Table 1-1. The cooldown time will increase approximately 15 minutes for each pound-of-mass increase of the attached load.

Pressure regulation during a cooldown is automatic. The compressor-unit pressures will vary during cooldown but will usually attain steady values nominally within 30 minutes after start-up.

## 3.4 NORMAL OPERATION

The components of the Model 350C CRYODYNE(R) Cryocooler are designed to operate unattended under normal conditions. Helium supply pressure should have a mean value between 270-290 psig (1860-2000 kPa). If there is a variation from this range, refer to Section 5, TROUBLESHOOTING.

During normal operation, the operating log sheet should be filled out at least once a day.

During the first 100 hours of cryocooler operation, a slight drop in the oil level of the compressor pump may occur. Such a drop should cause no concern, as long as the oil level is visible. However, if the oil level continues to drop, so that it is no longer visible, contact the Product Service Department of CTI-CRYOGENICS.

## 3.5 SHUTDOWN PROCEDURES

Shut down the Model 350C CRYODYNE(R) Cryocooler by means of the compressor-unit and cold head "ON-OFF" switches, which are located on the front panel of the compressor unit.

It will take many hours to warm the cold-head cylinder to ambient temperature with no heat load present. If a rapid warm-up is desired, break the vacuum with a clean, dry gas, such as nitrogen or argon. If this method is used, leave the valve open to allow the expanding gas to escape as the cylinder warms.

## 3.6 STORAGE

The cryocooler is fully protected in storage if kept under positive helium pressure. Keep all components completely connected for best results. Periodically check the helium-supply pressure gauge on the compressor rear panel to ensure a constant static pressure of above 245 psig (1690 kPa).

If the cold head is removed from your vacuum system, be careful not to damage the cold-head cylinder and sealing surfaces.

# SECTION 4

# FUNCTIONAL DESCRIPTION

This Section presents additional detail description of the cold head and the compressor units. Knowledge of the content of this Section is not required in order to operate your cryocooler. The information is included in this Manual for the benefit of those readers who desire a more comprehensive understanding of the functional operation of the Model 350C CRYODYNE(R) Cryocooler.

## 4.1 MODEL 350CP COLD HEAD (See Figure 1-2)

The function of the cold head is to produce continuous closed-cycle refrigeration at temperatures that, depending upon the heat load imposed, are in the range of 40K to 100K for the first-stage cold station (4) and in the range of 10K to 20K for the second-stage cold station (2). Refer to Appendix E for an explanation of the principles of operation.

The cold head has three major components: the drive unit; the cylinder (1); and the displacer-regenerator assembly, which is located inside the cylinder.

The drive unit consists of the following subassemblies: the drive motor (10); the crankcase (11); and the drive mechanism, which is located inside the crankcase. The drive unit actuates the displacer-regenerator assembly and controls the flow of helium into and out of the cold head.

The motor employed is a direct-drive, constant-speed motor that operates at 72 rpm on 60-Hz power and at 60 rpm on 50-Hz power. The motor housing has two connectors: one is the electrical power connector (9), through which power is supplied; the other is the helium-gas return connector (8).

Functionally, the incoming high-pressure helium gas from the compressor unit enters the cold head through the helium-gas supply connector (7). The gas then passes into the displacer-regenerator assembly, flows out through the displacer-regenerator assembly, into the crankcase, through the motor housing, and finally through the helium-gas return connector (8) to the compressor unit. The helium gas expansion in the displacer-regenerator assembly provides cooling at the first and second-stage cold stations, each at different temperatures.

## 4.2 THE COMPRESSOR UNIT (See Figure 1-3)

The compressor unit is designed to operate unattended while providing a constant supply of clean helium to the cold head at the proper operating pressure. It consists of a compressor pump, a cooling system, an oil-injection system, an oil separation system, and an adsorber. In addition, the compressor unit is equipped with a pressure gauge and an electrical-control-chassis. See Table 1-1 for the electrical power specifications. Refer to Appendix B for information relating to the electrical circuits of the compressor unit.

### 4.2.1 Gas and Oil Flows in the Compressor Unit (See Figure 4-1)

Since helium has a low specific heat, it is unable to adequately carry the heat produced during compression out of the compressor, unless a small quantity of oil is injected into the gas stream to keep the compression chamber cool and assist in removing this heat. Most of this oil comes from the bulk oil separator.

Helium returning from the cold head at suction (i.e., low) pressure goes to the compressor pump where it is compressed to supply (i.e., high) pressure. When the helium gas is compressed, it heats; it must then pass through a heat exchanger to remove the heat of compression. Since the compressor is oil-lubricated (and oil is added to the helium flow), a bulk oil separator is used to remove most of the oil from the helium. The helium gas then goes through a second separator (oil-mist) where the remaining oil is removed. Finally, a charcoal filter (adsorber) is used to remove any remaining contaminants.

### 4.2.2 Pressure Regulation in the Compressor Unit (See Figure 4-1)

A 190-psi (1310 kPa) differential-pressure relief valve is incorporated in the compressor unit that limits the operating pressure differential between the helium supply and return lines. This function allows the compressor unit to be run without operating the cold head. As soon as cryocooler operation reaches a steady-state condition, further pressure regulation is unnecessary.

# SECTION 5
# TROUBLESHOOTING

This section covers difficulties that may occur in day-to-day operation of the Model 350C CRYODYNE(R) Cryocooler. The operator must be familiar with the mechanical and electrical details of the equipment.

Tables 5-1 and 5-2 present the troubleshooting procedures for the cold head and compressor unit. The procedures are in quick-reference tabular form, with possible causes and corrective actions specified for each type of fault. The operating log (Appendix A) can be useful when troubleshooting; it reveals changes in operating conditions that occur over a period of time.

A reduction in cold head performance is often due to a degradation in insulating vacuum.

In the event of a vacuum failure, first check for a leak in the User's vacuum system.

TABLE 5-1. COLD-HEAD TROUBLESHOOTING PROCEDURES

| FAULT | POSSIBLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| #1 The cold head fails to cool down to the required operating temperature, or takes too long to reach that temperature. | 1. Low charge pressure.<br>2. Vacuum leak in User's vacuum system.<br>3. Excessive heat load.<br>4. Contamination of the helium gas.<br>5. Compressor unit problem.<br>6. Internal malfunction in the cold head. | 1. Add gas per Section 6.2.1.<br>2. Check User's vacuum system for leaks.<br>3. Eliminate excessive heat load.<br>4. Decontaminate per Section 6.2.2.<br>5. See Table 5-2.<br>6. Contact the Product Service Department of CTI-CRYOGENICS. |
| #2 The cold-head drive unit fails to run, even though the compressor unit is operating. | 1. Lack of power from the compressor unit. | 1.a. Ensure that the cold-head "ON-OFF" switch is "ON".<br>b. Ensure that the cold-head power cable is properly attached to the electrical power connectors of the cold-head drive unit and the compressor unit.<br>c. Ensure the integrity of the 1-ampere cold-head circuit fuse in the electrical-control chassis of the compressor unit. (See Figure B-2 for fuse location.)<br>d. Contact the Product Service Department of CTI-CRYOGENICS if the preceding steps have failed to correct the fault. |

TABLE 5-1. COLD-HEAD TROUBLESHOOTING PROCEDURES (Cont.)

| FAULT | POSSIBLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| #2 The cold-head drive unit fails to run, even though the compressor unit is operating. (Cont.) | 2. An internal malfunction. | 2. Contact the Product Service Department of CTI-CRYOGENICS for assistance. |
| #3 The cold-head drive unit operates erratically, usually accompanied by considerable noise. | 1. Contamination of the helium gas.<br><br>2. Internal malfunction of the cold head. | 1. Decontaminate per Section 6.2.2.<br><br>2. Contact the Product Service Department of CTI-CRYOGENICS for assistance. |
| #4 The cold-head drive unit makes a growling noise. | 1. The 50/60 Hz slide switch (Figure 2-1) is in the wrong position. | 1. Set the slide switch to the correct position. |

TABLE 5-2. COMPRESSOR-UNIT TROUBLESHOOTING PROCEDURES

WARNINGS

(1) DISCONNECT THE COMPRESSOR UNIT FROM ITS POWER SOURCE BEFORE MAKING ANY CONTINUITY CHECKS.

(2) THE COMPRESSOR PUMP IS HOT AFTER THE COMPRESSOR UNIT HAS BEEN OPERATING! USE CAUTION IF IT IS NOT POSSIBLE TO WAIT FOR THE PUMP TO COOL DOWN BEFORE WORKING INSIDE THE COMPRESSOR UNIT.

Note

Refer to Figure B-1 for identification of electrical components.

| FAULT | POSSIBLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| #1 The compressor-unit "ON-OFF" switch (SW1) will not remain in the "ON" position. | 1) Either the safety interlock switch (SW2) is closed, or the thermal protective switches TS1 and TS3 (water-cooled only) are closed. Either condition activates the relay-trip coil in the compressor-unit "ON-OFF" switch (SW1). | 1) Check that the compressor-unit cover is securely in place. If this does not correct the fault, allow the compressor to cool, remove the compressor-unit cover, and then test switches TS1, TS3 (water-cooled only) and SW2, as follows. Depress the plunger on the interlock switch (located on the side of the heat exchanger). All switches should now be open. Test any switch for continuity. If continuity is found, contact the Product Service Department of CTI-CRYOGENICS for assistance. |
| | 2) Excessive current drain has activated the series trip in the compressor-unit "ON-OFF" switch (SW1). | 2) Measure and record the current and contact the Product Service Department of CTI-CRYOGENICS for assistance. |

TABLE 5-2. COMPRESSOR-UNIT TROUBLESHOOTING PROCEDURES (Cont.)

| FAULT | POSSIBLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| #2 The compressor-unit "ON-OFF" switch (SW1) remains in the "ON" position when switched on but the compressor pump will not run. | 1) No power at the User's power source. | 1) Check the service fuses, circuit breakers, and wiring associated with the User's power source and fix as required. |
| | 2) Incorrect or disconnected wiring is present within the compressor. | 2) Check the compressor-unit wiring (see Figure B-1.) |
| | 3) The overload protective switch (TS2) is open. (In air-cooled units the cooling fan will run but the compressor pump will not.) | 3) If the contact points of this switch are open when excess current is <u>not</u> being drawn, the switch is defective. Use the schematic of Figure B-1 and an ohmmeter to check whether the switch is open or closed. (When switch TS2 opens because of excessive current draw, the cause must be ascertained; see Fault #4.) |
| #3 The compressor unit stops after several minutes of operation and remains "OFF". | 1) Excessively high temperature of the compressor unit due to inadequate cooling water has resulted in the opening of thermal protective switch TS1 or TS2. See Figure G-1. | 1) Check that cooling water to the compressor-unit is turned on. Check the cooling water for proper pressure and water flow rate per requirements in Appendix G.1 and in Figure G-1. |

TABLE 5-2. COMPRESSOR-UNIT TROUBLESHOOTING PROCEDURES (Cont.)

| FAULT | POSSIBLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| #3 The compressor unit stops after several minutes of operation and remains "OFF". (Cont.) | 2) The ambient temperature is unusually high (air-cooled compressors only). | 2) Ensure that a free flow of air is provided to the compressor unit. Check that there is a minimum clearance of 12 inches (30 cm) at the front and back of the compressor unit. Also, check that the heat-exchanger surfaces are unobstructed and clean. |
| | 3) The very cold cooling water was left circulating through the compressor unit after the unit was turned off, lowering the oil temperature and causing a restriction of oil flow through the metering orifice during startup. | 3) Turn on the compressor unit and allow it to run until it stops. Repeat this turn-on procedure a number of times until the oil temperature rises and the compressor unit is able to operate continuously for a minimum of one hour without shutting down. |
| | 4) There is insufficient helium charge pressure. | 4) Check the supply pressure gauge. If it reads less than as specified in Table 1-1, follow the procedure given in Section 6.2.1 for adding helium. |
| | 5) Excessively cold cooling water supply has lowered the oil temperature, causing a restriction of oil flow through the oil injection orifice during startup. | 5) Recheck for proper cooling-water temperature in accordance with procedures in Section G.1. |

TABLE 5-2. COMPRESSOR-UNIT TROUBLESHOOTING PROCEDURES (Cont.)

| FAULT | POSSIBLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| #3 The compressor unit stops after several minutes of operation and remains "OFF". (Cont.) | 6) Excessively high temperature of the compressed helium in the discharge line from the compressor pump, has caused thermal protective switch TS1 to open. | 6) Check the oil level in the compressor pump. The oil level should be visible in the sight glass. |
| | 7) Mechanical seizure. | 7) Contact the Product Service Department of CTI-CRYOGENICS. |
| #4 The compressor pump stops after several minutes of operation and then recycles "ON" and "OFF" at short intervals. | 1) The voltage from the User's power source is too low. | 1) Check for too low a voltage being supplied to the compressor unit. Normal voltage must be restored before the compressor unit can operate properly. (See Table 1-1.) |
| | 2) Excessively high temperature of the compressor pump has caused TS2 to open and reset upon cooling down. | 2. Measure the current and take temperature readings of the compressor pump housing (adjacent to electrical connections). Contact the Product Service Department of CTI-CRYOGENICS for assistance. |

# SECTION 6
# MAINTENANCE

The only scheduled maintenance required for the Model 350C CRYODYNE(R) Cryocooler is the replacement of the compressor-unit adsorber after 10,000 hours of operation.

**WARNING**

**ALWAYS DISCONNECT THE CRYOCOOLER FROM ALL SOURCES OF ELECTRICAL POWER BEFORE PERFORMING ANY MAINTENANCE.**

## 6.1 SCHEDULED MAINTENANCE - REPLACING THE ADSORBER (PART NO. 8080-255-K-001)

Replace the adsorber in increments of 10,000 hours, as displayed on the elapsed time meter. (The actual elapsed time will be slightly longer on 50 Hz power.)

(1) Disconnect the input power cable of the compressor unit from its electrical power source.

(2) Disconnect the self-sealing couplings (Figure 2-3) from the gas-return and gas-supply connectors at the rear of the compressor unit.

(3) Remove the rear grille (12 or 13, Figure 1-3), the front grille (5), and the cover (10) by removing the 22 screws that secure these items to the compressor unit. Front panel (4) and rear panel (11) remain in place.

(4) Remove the adsorber from the compressor unit, following the procedural steps presented in Figure 6-1. Save all nuts, bolts, and washers for use when installing the replacement adsorber. (Rear panel (11) removed for clarity).

**WARNING**

**DEPRESSURIZE THE ADSORBER BEFORE DISPOSING OF IT. TO ACCOMPLISH THIS, ATTACH THE DEPRESSURIZATION FITTING, CTI-CRYOGENICS PART NO. C3592444, TO THE COUPLING HALF AT EITHER END OF THE ADSORBER AND TIGHTEN IT SLOWLY.**

(5) 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 by performing the steps in Figure 6-1 in the reverse order. Use the hardware saved in step 4 above. Reconnect the self-sealing couplings per Figure 2-1.