

5

HC - 4 MK2 HELIUM COMPRESSOR

TECHNICAL MANUAL

APD CRYOGENICS INC
1833 Vultee Street
Allentown, PA 18103

291 6700
2
F

Model HC 4MK2-FF
P/N 260341E-186FF
Serial F0751NH
D.O.M. 8/96

Compressor HC-4

TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION	3-1
Helium Compressor Model HC-4 MK2	3-1
PRINCIPLES OF OPERATION	3-1
DESCRIPTION	3-3
Components	3-3
SPECIFICATIONS	3-8
Electrical Characteristics	3-8
Cooling Requirements	3-8
Helium Gas Pressures	3-9
Compressor Lubricant	3-9
Compressor Weight	3-9
Mounting Position	3-9
Installation Kit	3-9
Dimensions	3-10
MAINTENANCE	3-11
Adsorber Replacement	3-12
Adsorber Removal	3-12
Adsorber Installation	3-13
Used Adsorber Venting and Disposal	3-14
Venting Procedure to Vent to Atmospheric Pressure	3-14
Gas Cleanup	3-15
TROUBLESHOOTING	3-18
Automatic Shutdown	3-18
Measure Resistance Values of Components	3-21
Compressor Motor	3-21
Winding Continuity, Grounding and Resistance	3-22
Current Measurement	3-23
PARTS	3-25
Ordering	3-25
Parts Identification and Numbers	3-27

ILLUSTRATIONS LIST		<u>Page</u>
Fig. 3.1	HC-4MK2 Flow Diagram	3-2
Fig. 3.2	Parts Identification	3-4
Fig. 3.3	Parts Identification	3-6
Fig. 3.4	Electrical Chassis Parts Identification	3-7
Fig. 3.5	HC-4 MK2 Outline Dimensions	3-10
Fig. 3.6	HC-4 MK2 Wiring Diagram	3-19
Fig. 3.7	HC-4 MK2 Electrical Schematic	3-20
Fig. 3.8	Compressor Terminals.....	3-23
Fig. 3.9	Parts Identification	3-26
Fig. 3.10	Parts Identification	3-28

RLE/dmk
261803A.DOC

Helium Compressor Model HC-4 MK2

The HC-4 MK2 Compressor is a single-stage, water-cooled, rotary compressor designed to deliver high-pressure, oil-free, helium gas to cryogenic refrigerators. An expander cable connected to the compressor supplies electrical power to the expander. Self-sealing couplings allow for easy connection to and disconnection from the rest of the closed-cycle cryogenic refrigeration system.

PRINCIPLES OF OPERATION

The compressor continuously draws low-pressure helium from the system return line. It compresses, cools and cleans the gas, then delivers it through the system supply line to the expander. See Fig. 3.1.

When gas leaves the compressor, it contains heat and compressor lubricant. Both must be removed. From the compressor, the hot gas with its entrained oil flows over the motor winding, where the gas loses some of its suspended oil, then out of the shell and through one circuit of a three-circuit heat exchanger, where the gas is cooled. Next, the gas passes through the oil separator and the adsorber for oil and moisture removal. From the adsorber, the high pressure gas is piped to the expander.

Through the system gas return line, low-pressure gas from the expander flows into the compressor.

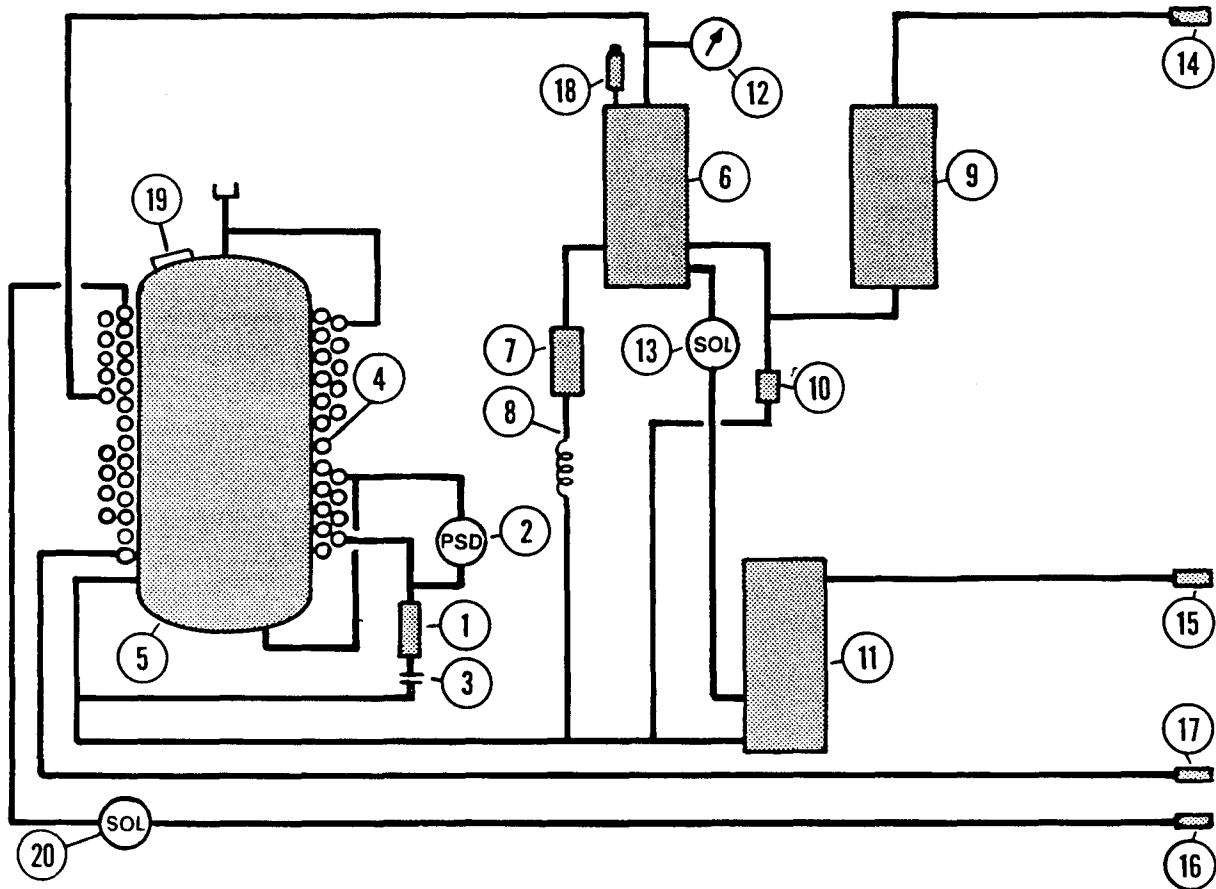
A gas line containing an internal bypass valve connects the high-pressure line to the low-pressure line. The bypass valve will open to prevent overloading the motor when the system gas lines are not connected to the compressor.

Oil is separated from the gas in three stages. The first stage is by precipitation when the gas passes over the motor windings. The second-stage is the oil separator whose element collects oil mist from the gas, agglomerates it and returns the oil to the compressor. The third stage is the adsorber which removes any remaining oil the gas is carrying.

Oil collected in the separator flows back to the compressor through a capillary tube. The differential gas pressure across the system is the moving force, and the capillary size limits the amount of gas bypassed. The small amount of oil collected in the adsorber remains there and is removed only by replacing the adsorber.

Oil in the compressor housing also collects heat. The shell-wrapped heat exchanger removes heat from the compressor motor and the warm oil by direct conduction through the compressor shell. Gas pressure pushes oil through the heat exchanger's outer tubes which cool the warm oil from the compressor. This cooled oil is then reinjected into the gas return line, which returns the oil to the compressor to reabsorb heat and lubricate the compressor.

PRINCIPLES OF OPERATION



- | | | | |
|-----|----------------------------------|-----|---------------------------------|
| 1. | Oil Line Filter | 11. | Surge Bottle |
| 2. | Oil Differential Pressure Switch | 12. | Pressure Gauge |
| 3. | Oil Injection Orifice | 13. | Gas Equalization Solenoid Valve |
| 4. | Heat Exchanger | 14. | Gas Supply Coupling |
| 5. | Compressor | 15. | Gas Return Coupling |
| 6. | Oil Separator | 16. | Water Supply Fitting |
| 7. | Oil Capillary Filter | 17. | Water Return Fitting |
| 8. | Oil Capillary | 18. | Pressure Relief Valve |
| 9. | Adsorber | 19. | Temperature Overload Switch |
| 10. | Internal Bypass Valve | 20. | Water Solenoid Valve |

Fig. 3.1 HC-4 MK2 Flow Diagram

The components of the HC-4 MK2 Compressor are identified schematically in Fig. 3.1. Figures 3.2, 3.3 and 3.4 identify the parts pictorially. Features and functions of individual components are described in the following paragraphs.

Components

Gas Supply and Return Couplings -- Both are self-sealing bulkhead couplings and are the points of connection on the rear panel for the rest of the system.

Water Supply and Return Fittings -- Both fittings are compression-type bulkhead fittings mounted on the rear panel, for 3/8" tubing.

Compressor Power Cord -- Terminating with a 3-prong plug, this power cord supplies electrical power to the compressor.

Elapsed Time Meter -- The battery-operated LCD elapsed time meter shows the compressor's cumulative running time in hours up to a total of 99,999 hours.

WARNING

THE ELAPSED TIME METER CONTAINS A LITHIUM BATTERY.
DO NOT REMOVE THE BATTERY. DO NOT RECHARGE,
DISASSEMBLE, MUTILATE, WET OR DISPOSE OF THE METER
IN FIRE.

Power Switch -- This on/ off switch starts and stops the compressor. The switch lights to indicate that power is on to the compressor.

Pressure Gauge -- A pressure gauge indicates gas supply pressure. When the compressor is not running, the gauge shows the equalization pressure.

Expander (Displacer) Receptacle and Expander Cable -- A 28-socket receptacle mounted on the rear panel and an expander cable supply electrical power from the compressor to the expander.

Accessory Receptacle and Optional Cables -- The accessory receptacle mounted on the rear panel is a 14-socket connector for supplying auxiliary power or remote on/ off control. The remote on/ off and auxiliary power cables are available as options.

Circuit Breaker -- A panel mounted circuit breaker in the main power supply protects the compressor module from electrical overload.

Fuses -- Two 0.6 ampere fuses in the expander circuit and one 0.6 ampere fuse in the primary of the control transformer are accessible in the rear panel. Two 5 ampere fuses in the auxiliary power circuit (from the accessory receptacle) are located in the electrical chassis.

DESCRIPTION

Electrical Chassis Box -- The electrical box contains electrical components and connections and distributes power to all system circuits. It is accessible by removing the top cover of the compressor.

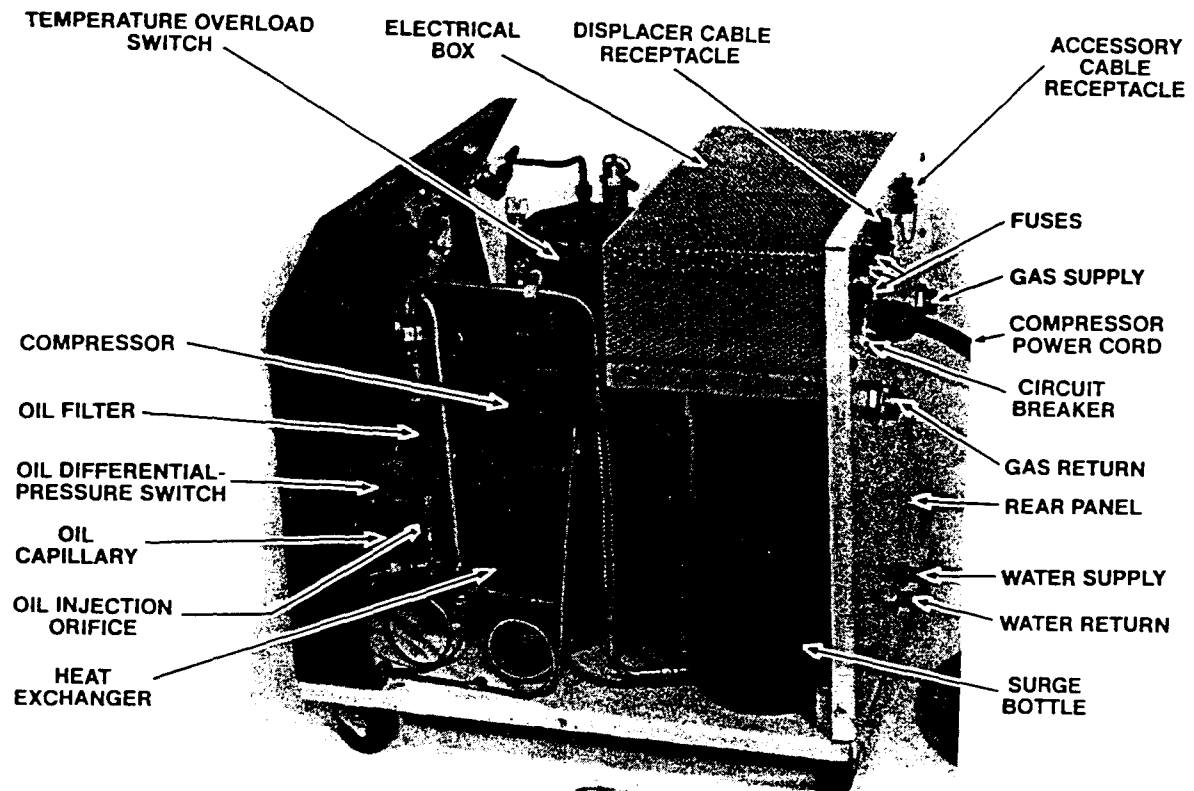


Fig. 3.2 Parts Identification

DESCRIPTION

Compressor -- The rotary, positive displacement compressor is hermetically sealed. Electrical connections to the motor are made at terminals under a protective cover on top of the housing.

The lubricant is a synthetic oil put in the compressor at the factory. Thereafter, oil is not changed or added. The oil fill fitting on the top of the compressor housing must not be opened.

Heat Exchanger -- The heat exchanger consists of three coils wrapped around the compressor. One cools helium, another cools the compressor shell and another cools oil in the oil injection circuit. This circuit cools oil that has absorbed heat from the compressor and reinjects the cooled oil, which continues to absorb heat from the compressor.

Temperature Overload Switch -- Installed under the electrical terminal box cover on top of the compressor, this switch senses compressor temperature through contact with the housing. The switch opens the control circuit at a predetermined temperature and resets automatically upon cooling.

Gas Equalization Solenoid Valve -- This solenoid valve opens when the compressor is stopped. The valve allows the helium gas pressure across the compressor to equalize, to prevent oil from being blown out of the compressor into the low-pressure gas line.

Oil Separator -- The bottom of the oil separator serves as a sump. A retainer plate above the sump supports fibrous material that acts as the separating agent. Entrained oil coalesces on it, forming large droplets which drain into the sump. This unit needs no servicing or replacement.

Oil Capillary -- The capillary returns oil collected in the separator sump to the low-pressure side of the compressor for recycling.

Adsorber -- The adsorber removes any oil and moisture the gas is carrying which did not drop out in the separator. This vessel contains activated charcoal for oil adsorption. The adsorber has a finite life and must be replaced every 10,000 operating hours.

Pressure Relief Valve -- The relief valve prevents the compressor from operating at an unsafe pressure.

Oil Filters -- There are two oil filters. One filter in the oil separator drain line protects the return oil capillary. The other filter in the oil injection circuit protects the compressor.

Oil Injection Orifice -- This orifice is installed downstream of the oil filter in the oil injection line and controls the flow rate of oil into the compressor's gas return line.

Surge Bottle -- The surge bottle located in the return gas line dampens the pressure pulsations.

DESCRIPTION

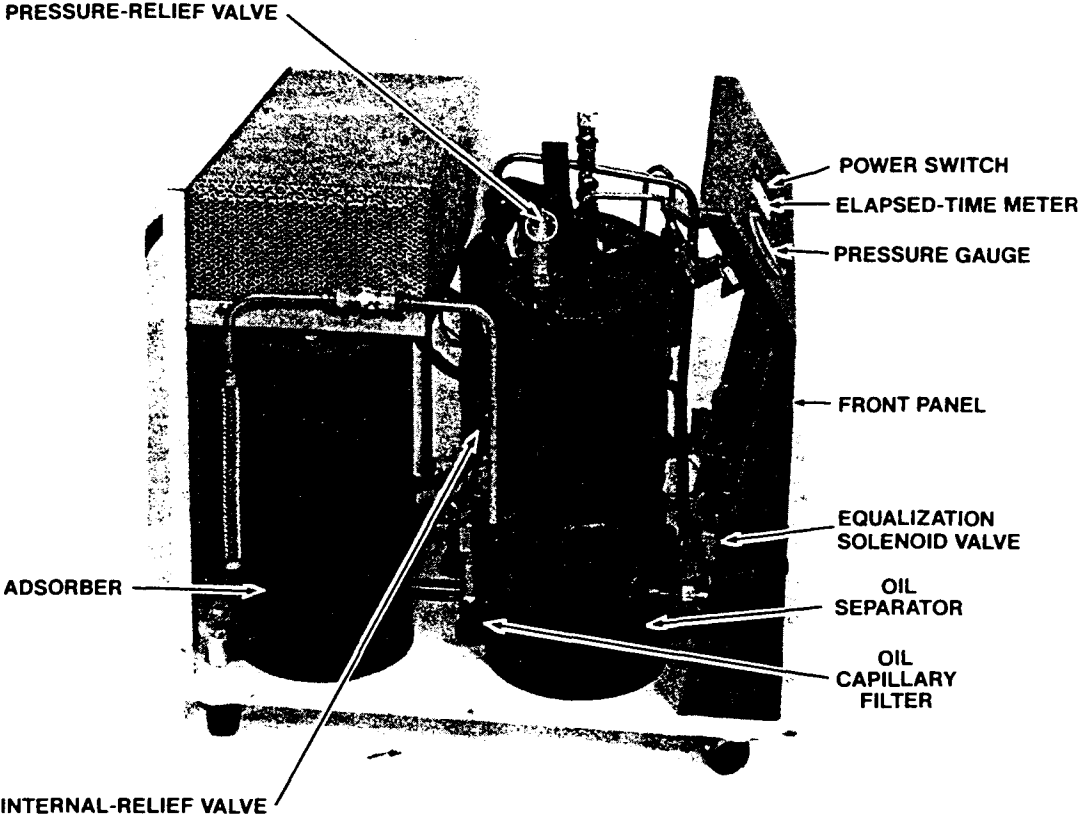


Fig. 3.3 Parts Identification

DESCRIPTION

Oil Differential Pressure Switch -- This switch shuts down the compressor if oil injection flow is too low or too warm for proper operation.

Internal Bypass (Relief) Valve -- The internal bypass valve opens to allow the compressor to be run when the system gas lines are disconnected, to avoid overloading the motor.

Transformer -- Some 50 Hz applications include an externally-mounted transformer on the rear panel of the compressor. See Specifications.

Water Solenoid Valve -- This normally closed solenoid valve opens when the compressor starts to allow cooling water to flow.

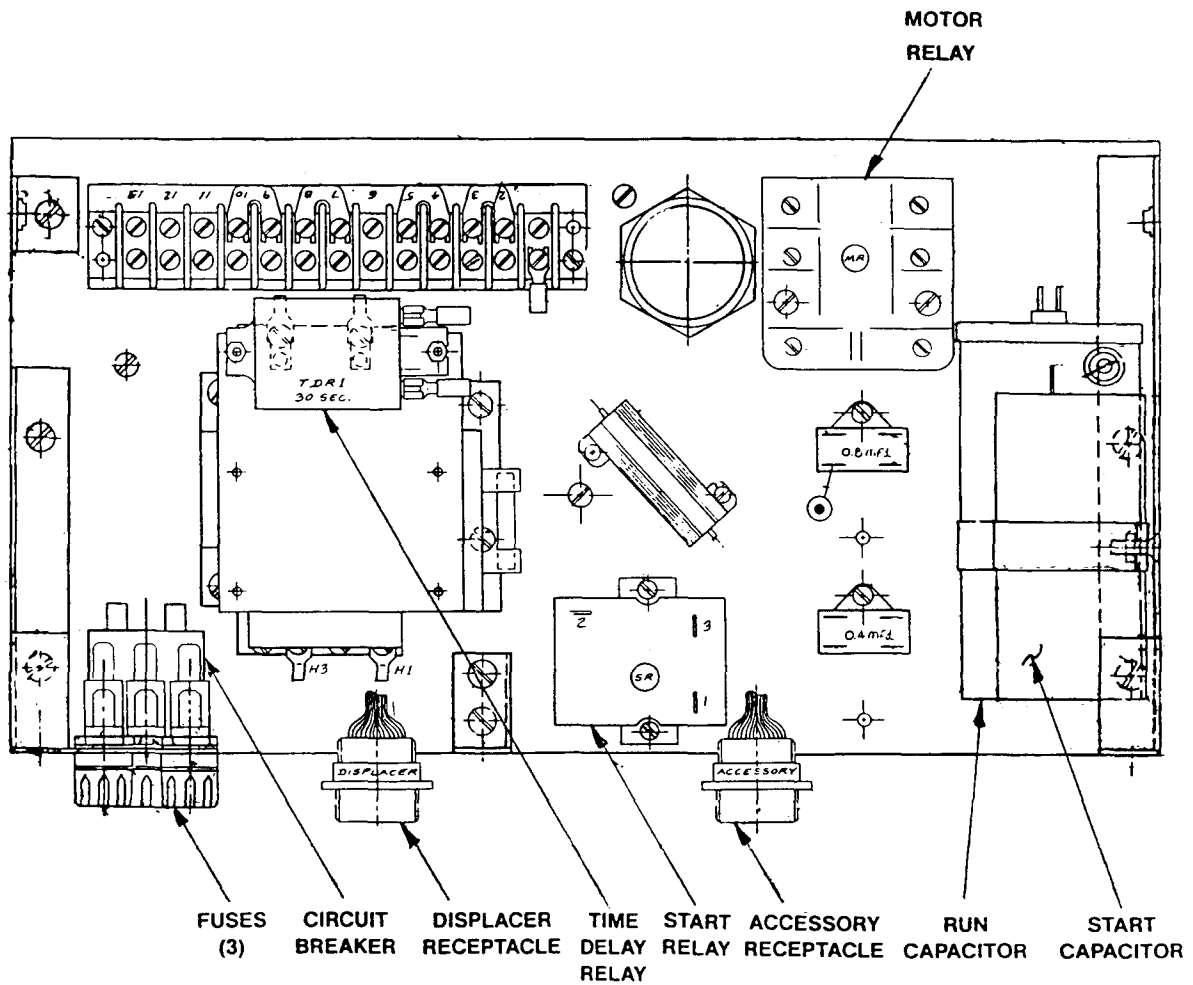


Fig. 3.4 Electrical Chassis Parts Identification

SPECIFICATIONS

Electrical Characteristics

<u>Compressor Part Number Suffix</u>	<u>Customer's Electrical Service</u>	<u>Compressor Transformer Requirement</u>
18G	208/ 230 VAC ($\pm 5\%$) 1 ph, 60 Hz	None
18G	200 VAC ($\pm 5\%$) 1 ph, 50 Hz	None
15G	220 VAC ($\pm 5\%$) 1 ph, 50 Hz	Transformer included, wired for step down to 200 VAC.
16G	230/ 240 VAC ($\pm 5\%$) 1 ph, 50 Hz	Transformer included, wired for step down to 200/ 208 VAC.

Power Required: 3.0 kW, 15.5 amps full load at 208 VAC; 68 amps locked rotor.

Power Cord Connector: NEMA L6-30P (2 Pole, 3 Wire, 30 A, 250 VAC) male plug to connect to customer's receptacle.

Cooling Requirements

Room Ambient Temperature:	10° C to 38° C (50° F to 100° F)	70
Cooling Water Inlet Temperature:	4° C to 27° C (40° F to 80° F)	40-44
Cooling Water Outlet Temperature:	41° C (105° F) maximum	110
Cooling Water Pressure:	210 kPa (30 psig) minimum 690 kPa (100 psig) maximum	1/2" - 1 1/2"
Cooling Water Flow:	2.7 liters/ min (0.7 gpm) minimum	
Pressure Drop at Minimum Flow :	85 kPa (12 psi)	
Water Chiller Cooling Capacity:	11,000 BTU/ hour	

NOTE

Operating the equipment out of specifications may void the warranty.

SPECIFICATIONS

Helium Gas Pressures

	<u>Compressor Only</u>	<u>With M204S Expander</u>
Equalization Pressure at 68°F:	240 - 245 psig (1650 - 1690 kPa)	240 - 245 psig (1650 - 1690 kPa)
Operating Supply Pressure:	300 - 320 psig (2070 - 2210 kPa)	280 - 300 psig (1930 - 2070 kPa)

Equalization Pressures at Different Ambient Temperatures:

<u>T° C</u>	<u>P kPa</u>	<u>T° F</u>	<u>P psig</u>
10	1600 - 1630	50	232 - 237
15.6	1630 - 1660	60	236 - 241
20	1650 - 1690	68	240 - 245
26.7	1690 - 1730	80	245 - 250
37.8	1750 - 1790	100	255 - 260

Pressure Relief Valve is set at 2750 kPa (400 psig).

Compressor Lubricant

UCON LB-300-X, specially processed by APD.

Compressor Weight 91 kg (200 pounds)

Mounting Position

Compressor must be mounted with its base down and level within 5 degrees.

Installation Kit

An installation kit, P/N 255437A, is furnished with the HC-4 MK2 Compressor. The kit contains:

<u>Item</u>	<u>Quantity</u>	<u>Description</u>	<u>Part Number</u>
1	12 m (40 Ft)	Polyethylene Tubing, 3/8" OD	60751
2	2 Sets	Swagelock Front and Rear Ferrules for 3/8" OD Tubing	17567
3	2	Swagelock Nuts for 3/8" OD Tubing	12341
4	1	Adapter Fitting, 8F with Valve	255919B2

SPECIFICATIONS

Dimensions

Dimensions are in millimeters and (inches).

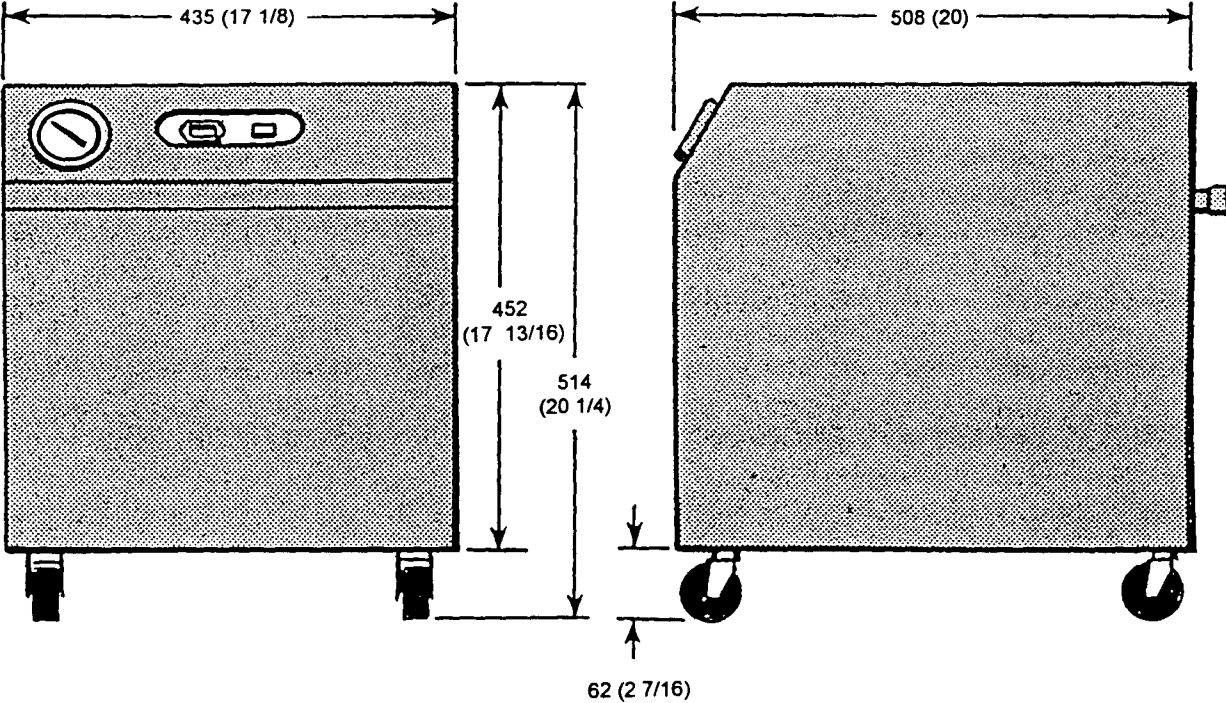


Fig. 3.5 HC-4 MK2 Outline Dimensions

WARNING

DISCONNECT GAS LINES ONLY WHEN THE COMPRESSOR IS STOPPED. DISCONNECTING THE EXPANDER WHILE IT IS COLD MAY CREATE EXCESSIVELY HIGH INTERNAL PRESSURE AS THE GAS WARMS. MATERIAL FAILURE AND UNCONTROLLED PRESSURE RELEASE CAN CAUSE INJURY TO PERSONNEL IN THE WORK AREA.

WARNING

THE COMPRESSOR IS CHARGED WITH HELIUM GAS. VENT THE COMPRESSOR TO ATMOSPHERIC PRESSURE BEFORE DISASSEMBLY, EXCEPT WHEN DISCONNECTING ADSORBER OR GAS LINES. UNCONTROLLED PRESSURE RELEASE CAN CAUSE INJURY TO PERSONNEL IN THE WORK AREA.

WARNING

NEVER USE COMPRESSED GAS FROM A CYLINDER WITHOUT A PROPER REGULATOR. OVERPRESSURIZATION CAN CAUSE PERSONAL INJURY IF THE SYSTEM EQUIPMENT RUPTURES.

WARNING

DURING OPERATION, SOME SURFACES UNDER THE COMPRESSOR'S COVER BECOME HOT. AVOID INJURY FROM BURNS BY ALLOWING THE COMPRESSOR TO COOL FOR 1/2 HOUR AFTER SHUTDOWN BEFORE REMOVING THE COVER FOR MAINTENANCE.

WARNING

WHEN HANDLING PRESSURIZED GAS LINES AND OTHER PRESSURIZED EQUIPMENT, ALWAYS WEAR EYE PROTECTION.

WARNING

NEVER APPLY HEAT TO A PRESSURIZED GAS LINE OR OTHER PRESSURIZED COMPONENTS.

CAUTION

MODIFICATION TO EQUIPMENT WITHOUT THE CONSENT OF THE MANUFACTURER WILL VOID THE WARRANTY.

CAUTION

FOLLOW CHARGING AND VENTING PROCEDURE TO PREVENT REVERSED FLOW OF SYSTEM GAS. REVERSED FLOW CAN RESULT IN CONTAMINATION OF THE SYSTEM WITH THE COMPRESSOR OIL.

CAUTION

REPEATEDLY CHARGING THE SYSTEM WITH HELIUM GAS RATHER THAN LOCATING AND REPAIRING GAS LEAKS MAY CAUSE A MALFUNCTION. IMPURITIES ARE INTRODUCED AT AN ABNORMAL RATE AND MAY FREEZE IN THE EXPANDER.

CAUTION

CHECK THE CONDITION OF THE GASKET SEAL ON THE MALE HALF OF EACH AEROQUIP COUPLING. BE SURE THE GASKET SEAL IS IN PLACE AND THE SEALING SURFACES ON BOTH THE MALE AND FEMALE HALVES ARE CLEAN BEFORE CONNECTING. REPLACE THE GASKET SEAL IF IT IS DAMAGED OR MISSING.

CAUTION

DO NOT ALLOW AIR TO GET INTO THE SYSTEM. MOISTURE FROM THE ATMOSPHERE CAN SERIOUSLY DEGRADE EXPANDER PERFORMANCE.

Adsorber Replacement

13 months

The adsorber must be replaced every 10,000 operating hours. The used adsorber has no salvage or repair value. Venting of the compressor is not required when replacing the adsorber, because the couplings are self-sealing.

Adsorber Removal

1. Stop the compressor and disconnect the power to the compressor.
2. Disconnect the supply gas line from the supply coupling on the compressor. Screw a dust plug into the disconnected gas line coupling.

NOTE

Always hold the stationary nut on the gas line coupling with one wrench while turning the moveable coupling nut with the other wrench.

3. Remove the compressor's cover.

NOTE

Trace the outline of the adsorber on the compressor base to help locate the proper position of the new adsorber.

4. Disconnect the self-sealing coupling on the tube from the oil separator to the inlet side of the adsorber.
5. Elevate the compressor to gain access underneath the bottom panel. Use a 9/16" wrench to remove the 3/8" cap screw and lock washer holding the adsorber to the base.

CAUTION

DO NOT TIP THE COMPRESSOR GREATER THAN 5 DEGREES, TO AVOID FLOWING OIL INTO UNWANTED PLACES AND CAUSING A NUISANCE SHUTDOWN.

6. Remove the lock nut and nylon washer on the supply coupling on the rear panel.
7. Pull the adsorber back until the supply coupling clears the rear panel. Remove the adsorber. Remove the lock washer from the Aeroquip supply coupling. Retain all hardware to use with the new adsorber.

WARNING

THE ADSORBER IS CHARGED WITH HELIUM GAS. FOLLOW THE ADSORBER VENTING PROCEDURE FOR SAFE DISPOSAL OF THE USED ADSORBER.

Adsorber Installation

1. Remove the caps from the gas lines of the new adsorber. **Do not vent the new adsorber.**
2. Position the adsorber on the base within the traced line and insert the supply coupling through the rear panel. Be sure the lock washer is installed on the coupling prior to inserting it through the rear panel.

3. Apply Loctite 242 to the threads of the cap screw used to fasten the adsorber to the base. Install and tighten this cap screw and lock washer. Torque the cap screw to 3.5 kgf m (25 ft. lbs.). Lower the elevated compressor to the floor.
4. Install the nylon washer and the locknut on the supply coupling. Torque the locknut to 5.5 kgf m (40 ft. lbs.).
5. Connect the adsorber's self-sealing coupling on its inlet side to the oil separator's outlet coupling. With wrenches, torque the size 4 Aeroquip coupling to 1.4 to 2 kgf m (10 to 15 ft. lbs.).
6. Reconnect the supply gas line to the supply coupling on the compressor. Torque the coupling to 4.85 ± 0.7 kgf m (35 ± 5 ft. lbs.).
7. Leak check all Aeroquip couplings just completed. See Leak Checking in the Maintenance section of the System Manual.
8. Check the equalization pressure. See Specifications in this manual.
9. Reinstall the compressor's cover.

This completes the procedure for replacing an adsorber.

Used Adsorber Venting and Disposal

For safe disposal of the used adsorber:

1. A venting adapter fitting is included with the new adsorber. Attach it to one of the self-sealing couplings on the **used** adsorber. Vent the **used** adsorber to atmospheric pressure.
2. Discard the used adsorber and the adapter fitting.

Venting Procedure to Vent to Atmospheric Pressure

This procedure includes disconnecting the adsorber to prevent venting it.

1. Stop the compressor and disconnect the power to the compressor.
2. Disconnect both the supply and return gas lines from the couplings on the compressor. Screw dust plugs into the disconnected gas line couplings.
3. Remove the compressor's cover.
4. With wrenches, disconnect the Aeroquip coupling in the supply line between the oil separator and the inlet side of the adsorber. This keeps the adsorber pressurized.

MAINTENANCE

5. Locate adapter fitting P/N 257246C2. Also locate adapter fitting P/N SK8217A2 and be sure its valve is closed. Move the part of the supply line fastened to the adsorber out of the way. Connect the adapter fittings to the female Aeroquip coupling on the supply line from the oil separator.
6. **Slowly** open the valve on the adapter fitting. Vent the system to atmospheric pressure. Close the valve on the adapter fitting.
7. Remove the adapter fittings.
8. Perform the required maintenance.

NOTE

Do not reconnect the adsorber if the compressor has been vented to atmospheric pressure.

This completes the procedure to vent the compressor to atmospheric pressure.

Gas Cleanup

Gas cleanup is required if the compressor's interior has been opened to the atmosphere or the equalization pressure is 140 kPa (20 psig) or lower. Gas cleanup is performed with the compressor disconnected from the other system components. The adsorber must be disconnected unless it also has been opened to the atmosphere or its charge pressure is less than 140 kPa (20 psig).

NOTE

If the compressor's interior has been exposed to the atmosphere for an extended period, gas cleanup may not suffice to guarantee system gas purity and adsorber replacement will be required.

1. Disconnect the gas lines from the compressor. Screw dust plugs into the disconnected gas line couplings.
2. Locate two adapter fittings P/N 255919B2. Be sure their valves are closed. Attach them to the supply and return Aeroquip couplings on the compressor.

NOTE

If the adsorber has been disconnected, connect adapter fittings P/N 257246C2 and P/N SK8217A2 to the supply line from the oil separator, for venting the compressor during this procedure.

3. Connect a charge line to the pressure regulator of a helium gas cylinder containing 99.995% pure helium gas with a dew point less than -50° C (-58° F) at 2065 kPa (300 psig). Adjust the gas cylinder pressure regulator to 35 kPa (5 psig).

4. While connecting the charge line to the adapter fitting on the compressor's return coupling, thoroughly purge the charge line from the regulator. It is important to remove all air contaminants to prevent them from entering the system.
5. Adjust the pressure regulator to 1520 kPa (220 psig). Open the valve on the adapter fitting and charge the compressor to 1520 kPa (220 psig). If the adsorber is connected, increase the charge pressure to 1690 kPa (245 psig).
6. Close the valve on the adapter fitting used for charging.
7. Run the compressor for at least 30 minutes to heat the oil to operating temperature. Stop the compressor.
8. Adjust the pressure regulator to 690 kPa (100 psig).
9. Open the vent valve on the supply coupling of the compressor. Watch the compressor's pressure gauge. When the pressure falls to 35 to 70 kPa (5 to 10 psig), close the vent valve. Open the charge valve to build the pressure back up to 690 kPa (100 psig). Close the charge valve.
10. Repeat Step 9 five (5) times.
11. Adjust the pressure regulator to the equalization pressure of the system. See Specifications.
12. Open the valve on the adapter fitting and charge the compressor to the equalization pressure. Close the charge valve on the adapter fitting. Start the compressor.
13. After running 30 to 45 seconds, stop the compressor. Open the vent valve and vent the compressor to 35 to 70 kPa (5 to 10 psig). Close the vent valve.
14. Repeat Steps 12 and 13 five (5) times; then go to Step 15.
15. Open the charge valve on the adapter fitting. Charge the compressor to the equalization pressure. See Specifications in this manual. Close the charge valve.
16. Allow the compressor to cool. Read the pressure gauge with the compressor at 20° C (68° F). Adjust the equalization pressure by charging or venting to conform to the Specifications.
17. Close the gas cylinder valve and adjust the pressure regulator to zero psig.
18. Disconnect the charge line from the adapter fitting. Store the charge line to keep it clean.
19. Remove both adapter fittings.

NOTE

Reconnect the adsorber if it was disconnected prior to gas cleanup.
Torque the Aeroquip coupling to 1.4 to 2 kgf m (10 to 15 ft. lbs.).

20. If other components need cleaning, refer to the procedure in their manuals. Otherwise, reconnect the supply and return gas lines. Torque the couplings to 4.85 ± 0.7 kgf m (35 ± 5 ft. lbs.).
21. Leak check the Aeroquip couplings. See Leak Checking in the System manual.

This completes the gas clean-up procedure for the compressor.

Automatic Shutdown

The compressor will shut down automatically if any of the following are open:

- the oil differential pressure switch
- the compressor temperature overload switch
- the motor over-current relay
- the circuit breaker or a control circuit fuse.

If the compressor has been shut down by one of these interlocks, do not restart until the problem has been found and corrected. Refer to the Troubleshooting Guide to identify the problem.

If the shut down was caused by the oil differential pressure switch, wait until the pressure gauge indicates the equalization pressure. The compressor should start by turning the power switch off, then on.

If the unit shuts down again, refer to the Troubleshooting section to determine the cause and corrective action.

When the shut down is caused by the temperature overload switch, the compressor will restart only after it has cooled enough for the switch to close. Press the power switch to off. After waiting for the compressor to cool, press the power switch to restart. Should the compressor fail to start, turn it off and allow more cooling time. Repeat the restart procedure.

The motor over-current relay, mounted inside the compressor motor, is temperature dependent. It will automatically reset after the relay has cooled. To restart the compressor, press the power switch to the on position. If the compressor fails to start, turn it off and allow more cooling time. Repeat the start procedure.

If the circuit breaker opens, reset the breaker by pushing its lever to the up position.

If a fuse is open, disconnect the compressor power cord, replace the fuse, then restart the compressor.

Refer to the Troubleshooting Guide in the System manual and the following procedures for checking the electrical components of the compressor.

TROUBLESHOOTING

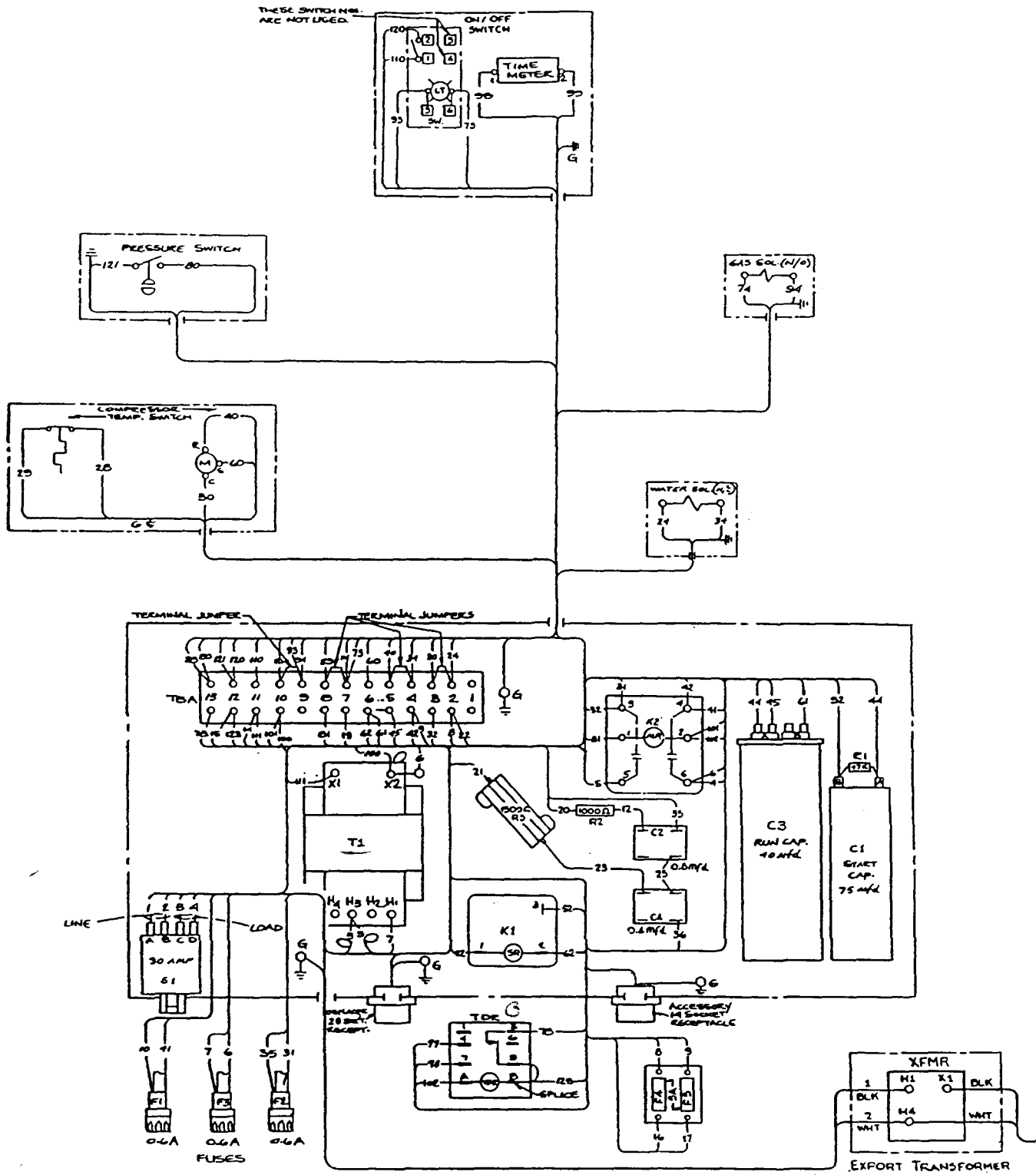


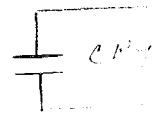
Fig. 3.6 HC-4 MK2 Compressor Wiring Diagram

Comp

TROUBLESHOOTING

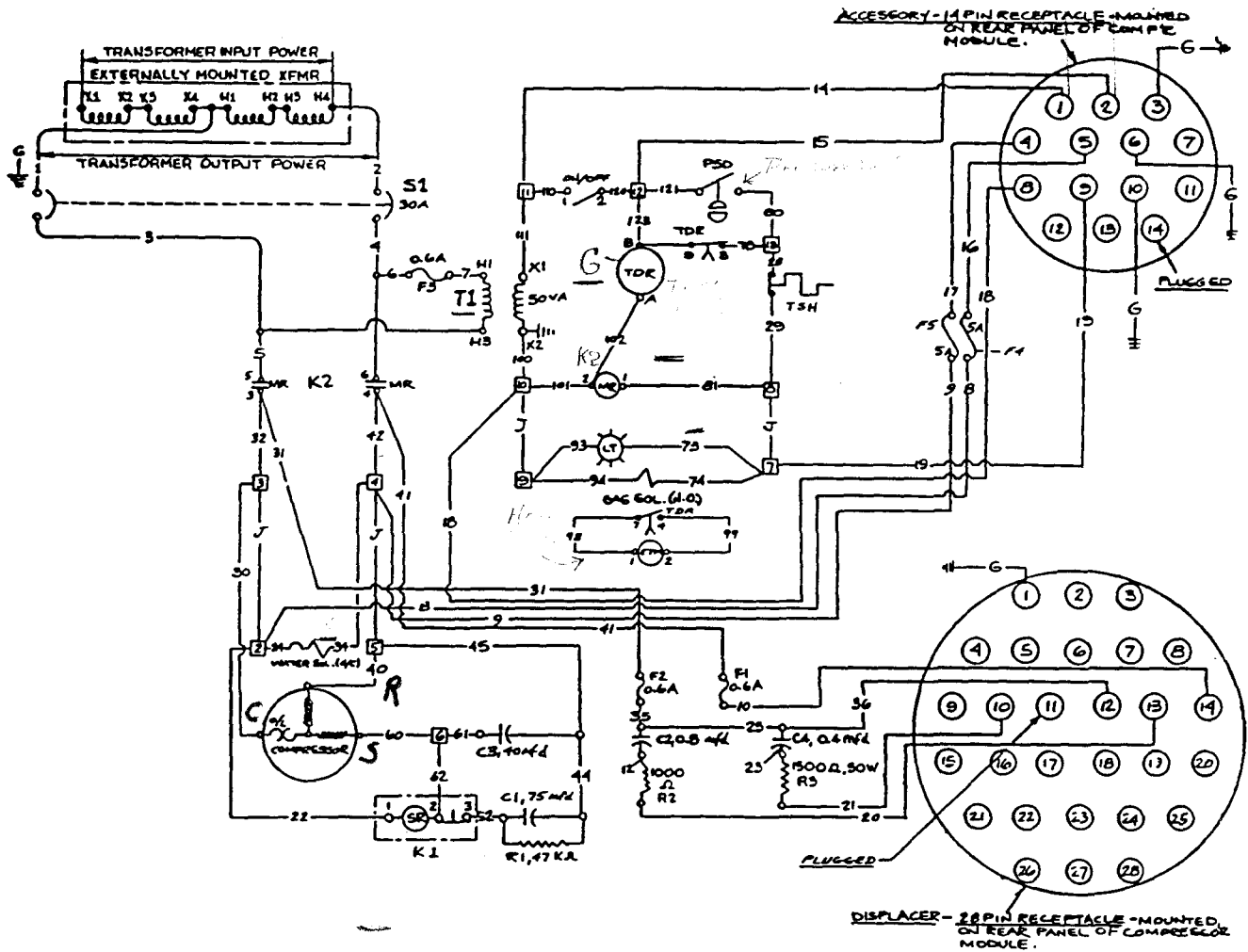
R / 15

C



console

compressor



TROUBLESHOOTING

Measure Resistance Values of Components

The values listed below are approximate and are intended to be used as guides. Disconnect any wires from the component to be checked or disconnect the component from the circuit before measuring its resistance.

<u>Component</u>	<u>Resistance</u>	
Control Circuit Transformer Primary	40 ohms	340 340
Control Circuit Transformer Secondary	12 ohms	150 to 111
Motor Relay Coil	300 Ohms	
Gas Equalization Solenoid Valve Coil	94 ohms	
Start Relay Coil	14,400 ohms	64-27
Water Solenoid Valve Coil	380 ohms	
Time Delay Relay Coil	Solid State, Normally Open Coil.	

Compressor Motor

Compressor motor checks for winding continuity, resistance and grounding will isolate most motor electrical problems. Current measurements will separate a locked rotor condition from other electrical problems. When the checks indicate a faulty compressor, a replacement is needed. Contact an APD Service Center.

WARNING

DISCONNECT THE POWER TO THE COMPRESSOR BEFORE TROUBLESHOOTING THE ELECTRICAL COMPONENTS.

WARNING

DURING OPERATION, SOME SURFACES UNDER THE COMPRESSOR'S COVER BECOME HOT. AVOID INJURY FROM BURNS BY ALLOWING THE COMPRESSOR TO COOL FOR 1/2 HOUR AFTER SHUTDOWN BEFORE REMOVING THE COVER FOR MAINTENANCE.

WARNING

PERMIT ONLY QUALIFIED ELECTRICAL TECHNICIANS TO OPEN ELECTRICAL ENCLOSURES, TO PERFORM ELECTRICAL CHECKS FOR TO PERFORM TESTS WITH THE POWER SUPPLY CONNECTED AND WIRING EXPOSED. FAILURE TO OBSERVE THIS WARNING CAN RESULT IN INJURY OR DEATH FROM ELECTRIC SHOCK.

Winding Continuity, Grounding and Resistance

1. Disconnect the power to the compressor.
2. Remove the compressor's cover.
3. Remove the terminal box cover from the top of the compressor motor to expose the three terminals R, S, and C. See Fig. 3.8. Disconnect wires 40, 60, and 30 from terminals R, S, and C respectively.
4. With an ohmmeter, check the resistance across compressor terminals C and R. Resistance should be 0.8 to 1.2 ohms. If the resistance is outside this range, consult an APD Service Center. If there is no continuity, the winding is open. Consult an APD Service Center.
5. With an ohmmeter, check the resistance across compressor terminals C and S. Resistance should be 1.8 to 2.2 ohms. If the resistance is outside this range, consult an APD Service Center. If there is no continuity, the winding is open. Consult an APD Service Center.
6. With an ohmmeter, check for continuity between compressor terminal C and one of the copper tubes entering the compressor housing. If there is continuity, the motor is grounded. Consult an APD Service Center.
7. If the motor passes these electrical checks, reconnect wires 40, 60, and 30 to compressor terminals R, S, and C respectively.
8. Replace the terminal box cover and the cover of the compressor module, unless current measurement is to be performed.

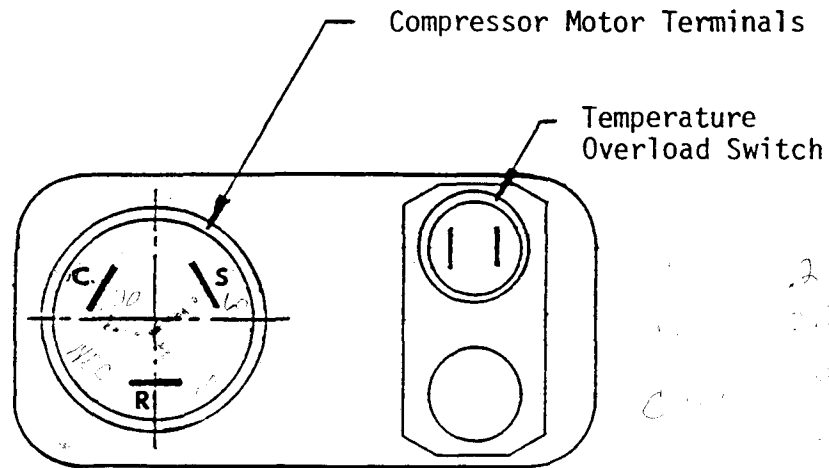


Fig. 3.8 Compressor Terminals

Current Measurement

1. Disconnect the power to the compressor.
2. Remove the compressor's top cover and the cover from the electrical chassis box.
3. Clamp the ammeter onto one of the power wires on the line side of the circuit breaker. The current can range up to 70 amperes. Use a suitable scale on a clamp-on ammeter.
4. Reconnect the power to the compressor.
5. Start the compressor.
6. Read the ammeter, then stop the compressor.
 - A reading of 0 amps indicates an open circuit.
 - A reading of 14 to 20 amps is normal at steady-state operating conditions.

TROUBLESHOOTING

- A reading of 20 to 40 amps indicates a defective relay, start-run capacitor, or bad motor windings. Check the resistance of each to detect the faulty component.
 - A reading of 68 amps indicates a locked rotor. Consult an APD Service Center.
 - A reading of full scale, along with a tripped circuit breaker or a blown control circuit fuse, indicates a short circuit in the chassis wiring or motor.
7. Remove the ammeter.
 8. Replace the electrical chassis box cover and the compressor's cover.

Ordering

The nameplate fastened to the rear panel of the compressor housing identifies the compressor as follows:

Model Number
Part Number
Serial Number.

Furnish this complete information when ordering parts. Also, order parts by part number and name. Refer to the next section for Parts Identification and Numbers.

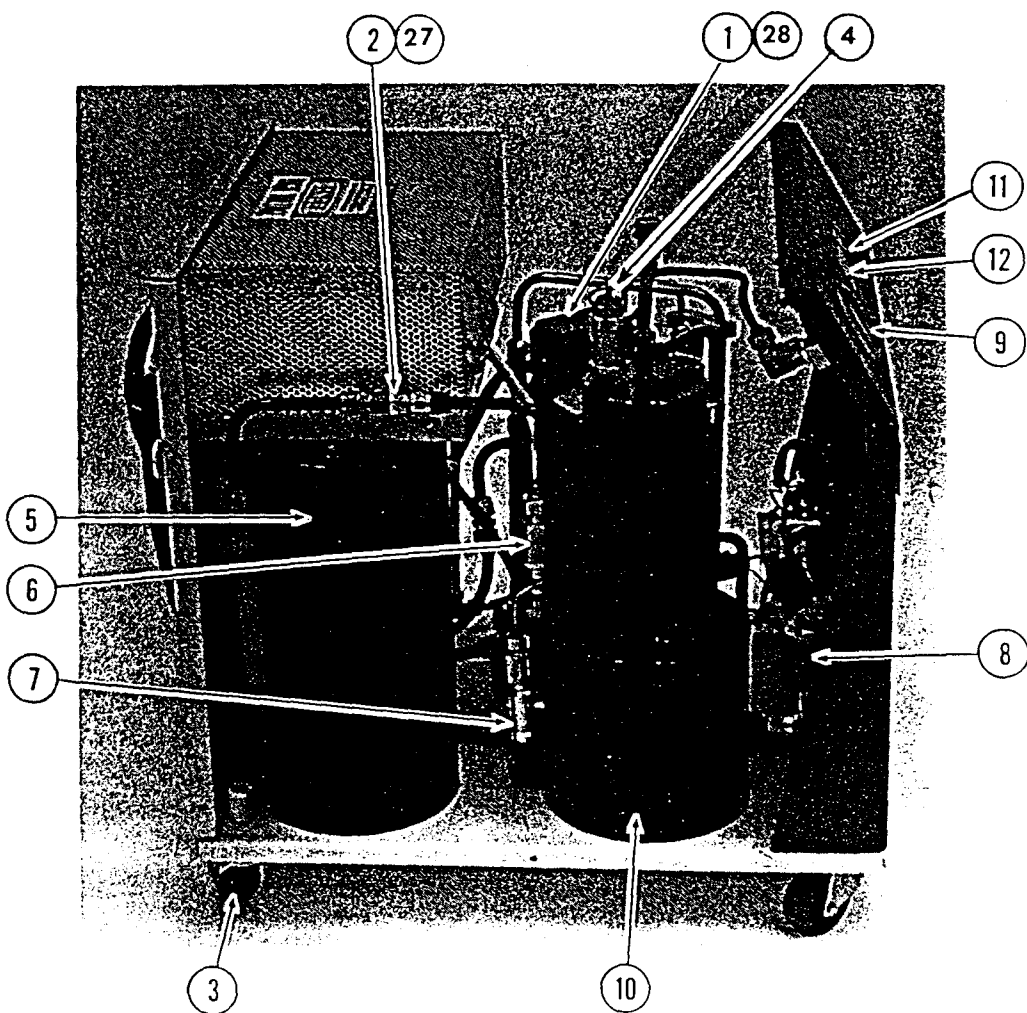


Fig. 3.9 Parts Identification

PARTS

Parts Identification and Numbers (See Fig. 3.9)

<u>Item</u>	<u>Part Name</u>	<u>Part Number</u>
1	Compressor Assembly	256035E
2	O-Ring (2), Size 4 Aeroquip Coupling	77183
3	Caster (4)	49133
4	Pressure Relief Valve	53028
5	Adsorber Assembly	F256390A
6	Internal By-Pass Valve	270067A
7	Oil Capillary Filter	50315
8	Gas Equalization Solenoid Valve	254990C
9	Pressure Gauge, Panel Mount, 2-Inch Dial	50532
10	Oil Separator Assembly	254732D
11	Power Switch	38850
12	Elapsed Time Meter	35008

PARTS

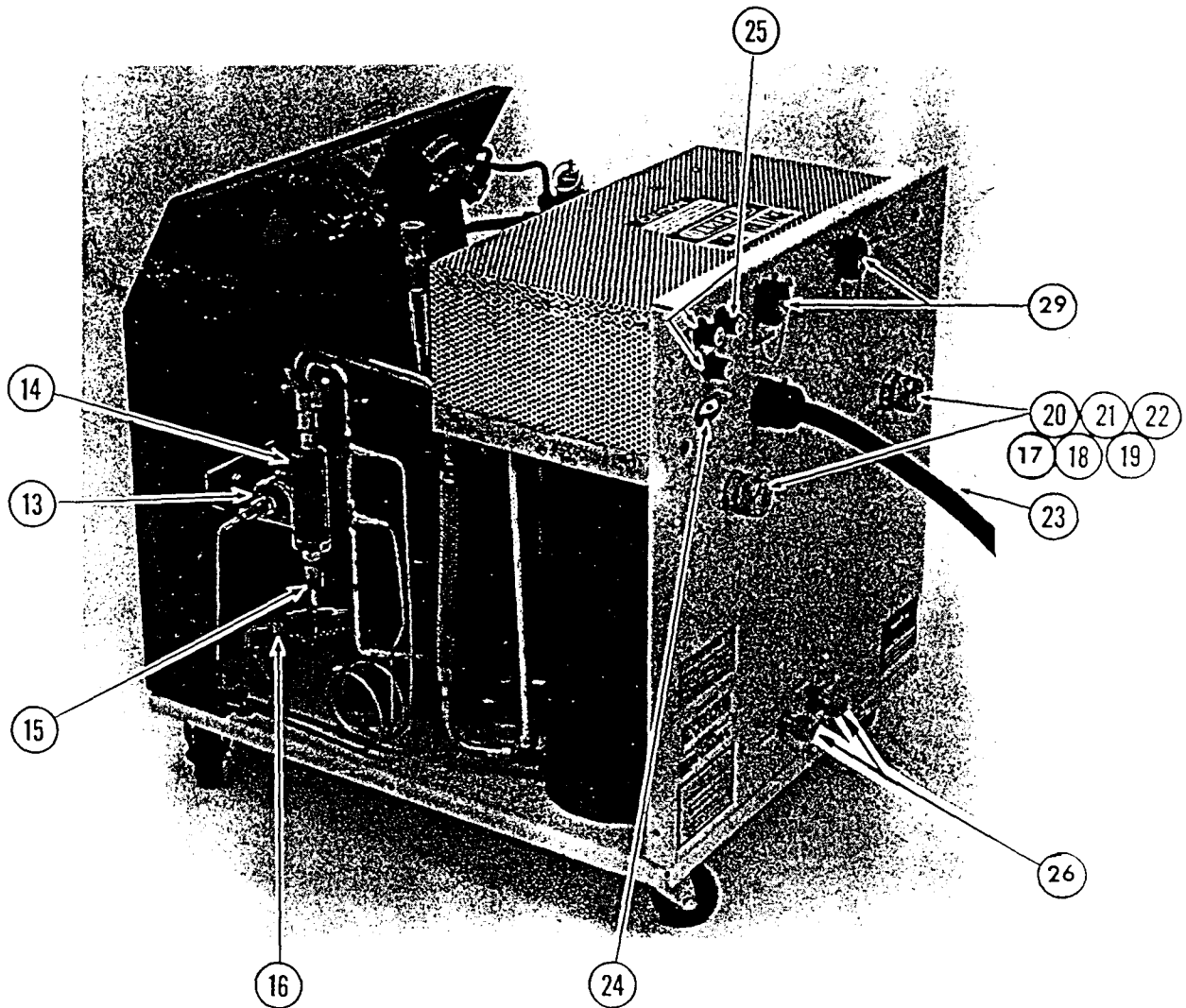


Fig. 3.10 Parts Identification

PARTS

Parts Identification and Numbers (See Figs. 3.9 and 3.10)

<u>Item</u>	<u>Part Name</u>	<u>Part Number</u>
13	Oil Differential Pressure Switch Assembly	256089C
14	Oil Injection Filter Assembly	255008B
15	Oil Injection Orifice	256066B
16	Oil Capillary Assembly	254763C
17	Gasket Seal (2), Aeroquip Coupling	77002
18	O-Ring (2), Aeroquip Coupling	47102
19	Nylon Washer (2), Aeroquip Coupling	72628
20	Lock Washer (2), Aeroquip Coupling	46401
21	Lock Nut (2), Aeroquip Coupling	46101
22	Dust Cap (2), Aeroquip coupling	45301
23	Power Cable	256507B
24	Circuit Breaker S1, 30A/ 250 VAC/ 2 Pole	34668
25	Fuse F1, F2, F3, 0.6 amp	34653
26	Fitting (2), Water	14505
27	Gasket Seal, Size 4 Aeroquip Coupling	77003
28	Temperature Overload Switch in Retainer	256034A2
29	Receptacle Cap (2)	34489

Parts Identification and Numbers (See Fig. 3.7)

<u>Item</u>	<u>Part Name</u>	<u>Part Number</u>
30	Transformer T1, Control Circuit	39409
31	Time Delay Relay	37414
32	Resistor R2; 1,000 ohms	37904
33	Resistor R3; 1,500 ohms	37520
34	Capacitor C1, Start, 75 mfd	256034A10
35	Resistor R1; 47,000 ohms	256034A14
36	Capacitor C2, Expander Circuit, 0.8 mfd	32517
37	Capacitor C3, Run, 40 mfd	256034A11
38	Start Relay K1	256034A13
39	Motor Contactor K2	37104
40	Transformer for 220 VAC, 1 ph, 50 Hz Electrical Service	39417
	or	
	Transformer for 230/ 240 VAC, 1 ph, 50 Hz Electrical Service	39401
41	Water Solenoid Valve	256415C
42	Fuse F4, F5, 5 amp	34665
43	Capacitor C4, 0.4 mfd	32522

OIL CHARGING VESSEL

TECHNICAL MANUAL

**APD CRYOGENICS INC
1833 Vultee Street
Allentown, PA 18103**

READ THESE INSTRUCTIONS BEFORE USING THE OIL CHARGING VESSEL

NOTE

File this manual in the Accessory section of your technical manual.

1.0 SCOPE

The following instructions define the proper use of the oil charging vessels P/N 263775A1, - A2 and - A3 for helium compressors.

WARNINGS

THE OIL CHARGING VESSEL IS PRESSURIZED WITH 210 kPa (30 psig) HELIUM GAS AS RECEIVED. AFTER USE IT WILL CONTAIN SYSTEM PRESSURES OF ~ 2070 kPa (300 psig). UNCONTROLLED PRESSURE RELEASE CAN CAUSE INJURY TO PERSONNEL IN THE WORK AREA.

WHEN HANDLING PRESSURIZED COMPONENTS, ALWAYS WEAR EYE PROTECTION.

USE TWO WRENCHES WHEN DISCONNECTING THE OIL CHARGING VESSEL FROM THE COMPRESSOR TO AVOID LOOSENING THE COMPRESSOR OIL FILL COUPLING.

NEVER APPLY HEAT TO A PRESSURIZED COMPONENT.

WHEN VENTING THE USED OIL CHARGING VESSEL, AIM THE EXHAUST FROM THE VENTING ADAPTER AWAY FROM PERSONNEL TO PREVENT INJURY DUE TO THE RELEASE OF HELIUM GAS AND REMNANT OIL.

CAUTIONS

BE SURE THE GASKET SEAL IS IN PLACE AND CLEAN ON THE MALE AEROQUIP OIL FILL COUPLING ON THE TOP OF THE COMPRESSOR MOTOR.

DO NOT ALLOW AIR TO GET INTO THE COMPRESSOR. KEEP THE COUPLINGS ALIGNED WHEN CONNECTING THE OIL CHARGING VESSEL TO THE COMPRESSOR OIL FILL COUPLING.

VENT THE USED OIL CHARGING VESSEL PER THE PROCEDURE FOR SAFE DISPOSAL IN SECTION 3.0.

MODIFICATION TO EQUIPMENT WITHOUT THE CONSENT OF THE MANUFACTURER WILL VOID THE WARRANTY.

2.0 PROCEDURE FOR ADDING OIL TO A COMPRESSOR

2.1 Turn off the compressor.

2.2 Disconnect the electrical power to the compressor.

2.3 Remove the top cover from the compressor.

READ THESE INSTRUCTIONS BEFORE USING THE OIL CHARGING VESSEL

- 2.4 Locate the size 4, male Aeroquip coupling on top of the compressor motor. This is the oil fill connection. Refer to the schematic diagram, Figure 1, in this manual.
- 2.5 Remove the dust cap from the compressor oil fill coupling and retain the cap.
- 2.6 Unpack a new oil charging vessel. Verify that you have the correct vessel for the compressor to be charged. Read these instructions. Set aside the separate male Aeroquip venting adapter.

<u>PART NUMBER</u>	<u>OIL QUANTITY</u>	<u>COMPRESSOR</u>
263775A1	100 mL	HC - 2D Series
263775A2	150 mL	HC - 4 Series
263775A3	200 mL	HC - 8 Series

- 2.7 Remove the dust cap from the oil charging vessel female Aeroquip coupling.
- 2.8 Check that the mating surfaces of both couplings are clean and that the gasket seal is in place on the male Aeroquip oil fill coupling.
- 2.9 Align and thread the oil charging vessel coupling onto the oil fill coupling.
- 2.10 Use two 3/4" (19 mm) wrenches: one to hold the compressor oil fill coupling stationary, and one to tighten the oil charging vessel coupling onto it. Tighten to 1.4 - 1.6 kgf m (10 - 12 lb ft).
- 2.11 Allow the oil in the charging vessel to drain into the compressor for 3 hours.
- 2.12 After 3 hours, remove the oil charging vessel. Use two wrenches to avoid loosening the compressor oil fill coupling.
- 2.13 Re-install the dust cap on the compressor oil fill coupling.
- 2.14 Re-install the compressor top cover.
- 2.15 Re-connect the electrical power to the compressor. The compressor can now be returned to normal operation.

3.0 PROCEDURE FOR VENTING A USED OIL CHARGING VESSEL

- 3.1 The oil charging vessel is supplied with a separate venting adapter, consisting of a male Aeroquip coupling attached to a fitting that contains a small orifice. The orifice prevents the pressurized helium and remnant oil from venting too rapidly.
- 3.2 After using the oil charging vessel to add oil to a compressor, align the venting adapter male Aeroquip coupling with the oil charging vessel female Aeroquip coupling.

READ THESE INSTRUCTIONS BEFORE USING THE OIL CHARGING VESSEL

- 3.3 DO NOT TIGHTEN THE COUPLINGS TOGETHER UNTIL AFTER YOU AIM THE EXHAUST FROM THE VENTING ADAPTER AWAY FROM PERSONNEL TO PREVENT INJURY DUE TO THE RELEASE OF HELIUM GAS AND REMNANT OIL. Aim the exhaust into a receptacle to catch any oil that may stream out.
- 3.4 Tighten the couplings together and vent all the pressure.
- 3.5 After safely venting, dispose of the empty, depressurized oil charging vessel in accordance with your local ordinances.

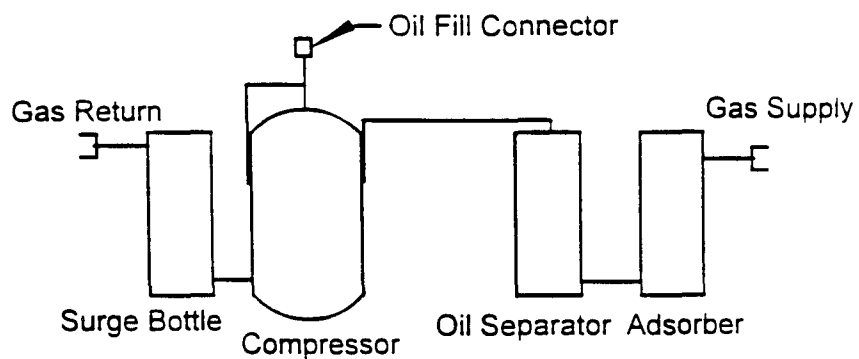


Figure 1 Compressor Schematic Diagram

CHAPTER 5

GAS LINES

APD CRYOGENICS INC
1833 Vultee Street
Allentown, PA 18103

CHAPTER 5 - GAS LINES

	Page
DESCRIPTION	5.1
SPECIFICATIONS	5.2
Minimum Bend Radius	5.2
Pressure and Temperature Ratings.	5.2
Identification Labels	5.2
Installation Tools.	5.2
MAINTENANCE	5.3
Disconnecting Gas Lines	5.3
From the Compressor.	5.3
From the Expander.	5.4
Leak Checking	5.4
Gas Line Repair	5.5
Venting	5.5
Repair Self-Sealing Couplings	5.6
Replace the Gasket Seal.	5.6
Repair or Replace the Coupling	5.7
Gas Cleanup and Recharging.	5.8
Gas Cleanup and Recharging (Systems Using Nycoil Gas Lines)	5.9
PARTS	5.11
Ordering.	5.11
Parts Identification and Numbers.	5.11
 ILLUSTRATIONS LIST	
Fig. 5.1 Typical Gas Line Construction	5.1
Fig. 5.2 Disconnect Gas Line from Compressor	5.3
Fig. 5.3 Break Gas Line Connection from Expander	5.4
Fig. 5.4 Disconnect Gas Line from Expander	5.4
Fig. 5.5 Aeroquip Male Coupling Parts.	5.6
Fig. 5.6 Remove Coupling from Gas Line	5.7
Fig. 5.7 Aeroquip Female Coupling Parts	5.7
Fig. 5.8 Parts Identification	5.11

RLE/dmk
PL410EN2/48

DESCRIPTION

Gas lines are needed to connect compressors to expanders to complete the system. Gas lines are constructed from convoluted stainless steel tubing covered with metal braid or from soft copper tubing or Nycoil tubing. All gas lines are equipped with Aeroquip self-sealing couplings and are furnished cleaned, charged with helium gas and leak checked.

Nycoil gas lines are permeable. Gas can diffuse through the nylon tubing wall. System equalization pressure may decrease in as little time as two (2) months. Also, air may diffuse into the gas line and contaminate the system helium gas with other gases and water vapor.

System performance and adsorber life will be less than that of a system using stainless steel or copper gas lines.

See special procedures for Gas Cleanup and Recharging in the Maintenance section.

Each cryogenic system includes interconnecting gas lines to carry helium gas refrigerant to and from the components. A gas line carries high pressure gas from the compressor to the expander and another gas line returns lower pressure gas to the compressor.

Flexible gas lines simplify installation. The self-sealing couplings maintain the gas charge and purity by minimizing gas loss when connections are being made or broken and by preventing the entrance of contaminants. Dust plugs protect the coupling threads from damage and also help to maintain cleanliness.

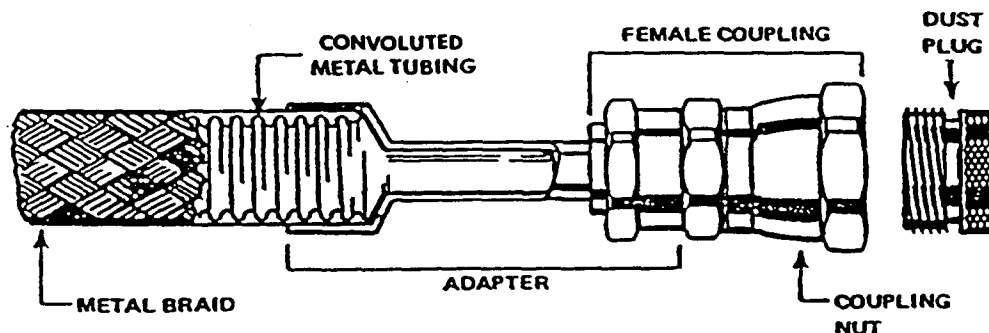


Fig. 5.1 Flexible Gas Line Construction

SPECIFICATIONS

Minimum Bend Radius

<u>Gas Line Type</u>	<u>Diameter mm (inches)</u>	<u>Minimum Bend Radius mm (inches)</u>
Convoluted Stainless Steel	13 (1/2) I.D.	230 (9)
Copper Tubing, using a tube bender	17 (5/8) O.D.	57 (2 1/4)
Copper Tubing, without a tube bender	17 (5/8) O.D.	457 (18)

NOTE

Working length of a Nycoil gas line is two (2) times its coiled length.

<u>Pressure and Temperature Ratings</u>	<u>Stainless Steel and Copper</u>	<u>Nycoil</u>
Design pressure, max.	2760 kPa (400 psig)	2760 kPa (400 psig)
Operating pressure, max.	2410 kPa (350 psig)	1930 kPa (280 psig)
Charge pressure, max.	1860 kPa (270 psig)	1380 kPa (200 psig)
Operating temperature, max.	49°C (120°F)	49°C (120°F)
Operating temperature, min.	4°C (40°F)	4°C (40°F)

Identification Labels

Labels on the gas lines identify their function in the system as follows:

SUPPLY (color coded red) - helium gas supply to the expander from the compressor.

RETURN (color coded green) - helium gas return from the expander to the compressor.

Separate labels are furnished with standard gas lines for the customer to attach the labels. See the Installation section in the System chapter.

Installation Tools

Properly sized open end wrenches are needed to install and remove gas lines.

For installation, gas lines with size 8 Aeroquip couplings require one each of these open end wrenches, contained in wrench kit P/N 255438A:

1" P/N 43800; 1 1/8" P/N 43413; 1 3/16" P/N 43802

For MRI systems with an RF shield, gas feedthroughs may be furnished for installation through the shield. Wrench kit P/N 260454A contains the above three wrenches plus a 1 7/8" open end wrench, P/N 43447, to fit the nut on the magnet side of the gas feedthroughs.

Disconnecting Gas Lines

WARNING

EXTREME COLD CAN CAUSE FROSTBITE. WHEN HANDLING SYSTEM COMPONENTS, BE CAREFUL NOT TO TOUCH ANY FROSTED PARTS.

WARNING

DISCONNECT GAS LINES ONLY WHEN THE COMPRESSOR IS STOPPED. DISCONNECTING THE EXPANDER WHILE IT IS COLD CAN CREATE EXCESSIVELY HIGH INTERNAL PRESSURE AS THE GAS WARMS. MATERIAL FAILURE AND UNCONTROLLED PRESSURE RELEASE CAN CAUSE INJURY TO PERSONNEL IN THE WORK AREA.

WARNING

USE TWO WRENCHES WHEN DISCONNECTING A GAS LINE COUPLING TO AVOID LOOSENING THE MATING COUPLING. GAS PRESSURE CAN PROJECT THE COUPLING WITH ENOUGH FORCE TO CAUSE INJURIES.

CAUTION

KEEP THE GAS LINE COUPLINGS ALIGNED WHEN MAKING OR BREAKING A COUPLING CONNECTION. LEAKAGE CAN OCCUR DUE TO THE WEIGHT OF THE GAS LINE OR DUE TO A SHARP BEND NEAR THE CONNECTION.

From the Compressor

1. Always use two wrenches. Use one wrench to hold the coupling adapter. Use the second wrench to turn the gas line coupling nut from the compressor coupling. See Fig. 5.2.
2. Screw a dust cap finger tight on to the compressor coupling.

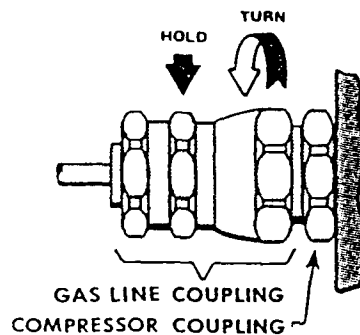


Fig. 5.2 Disconnect Gas Line from Compressor

From the Expander

1. Always use two wrenches. Use one wrench to hold the expander coupling. Use the second wrench on the gas line coupling nut to break the connection. See Fig. 5.3.
2. After breaking the connection, hold the coupling adapter with one wrench.

Remove the gas line coupling from the expander coupling with the second wrench. See Fig. 5.4.

3. Screw a dust cap finger tight on to the expander coupling.

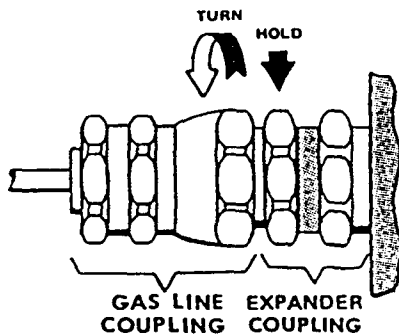


Fig. 5.3 Break Gas Line Connection from Expander

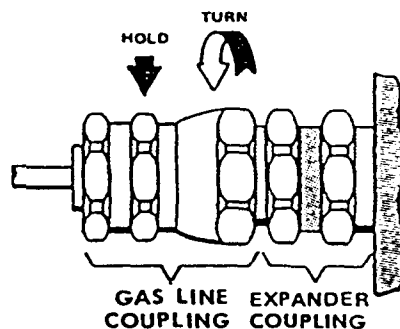


Fig. 5.4 Disconnect Gas Line from Expander

Leak Checking

Leakage of helium gas is the only likely problem to originate on a gas line. Use of a helium mass spectrometer leak detector is recommended. If no mass spectrometer is available, a liquid leak detector solution may be used on the coupling joints.

With the gas lines connected to the compressor and to the expander, leak check the connected coupling joints.

The flat gasket in the face of the male coupling seals the joint. A leak at this gasket seal can be detected only when a gas line is connected. A leak here can be caused by:

- * the coupling not fully tightened.
- * a worn, damaged or missing gasket seal.
- * dirt on or under the gasket seal.
- * dirt on the female coupling's mating surface.
- * damaged parts on either coupling which prevent proper mating or sealing.

Gas Line Repair

Leaks in the convoluted metal tubing cannot be repaired. Discard the damaged gas line and install a new one.

Leaks at welded joints require special skills to repair. Consult the APD Service Department.

Leaks at the self-sealing couplings can be repaired by replacing worn or damaged parts. Vent the gas line before beginning to disassemble it, except when replacing a gasket seal.

When couplings are frequently disconnected and reconnected, it is important to wipe the mating parts (threads and faces) with a clean, lint-free tissue or cloth.

Venting

1. Disconnect the gas line from the system. Install a dust cap on each of the male couplings of the compressor and expander, or on the RF gas feedthroughs, if used in the system.

NOTE

Adapter fittings are available as optional accessories from APD.

2. Be sure the valve on adapter fitting P/N SK8217A2 is closed. If only one coupling on the gas line assembly is to be repaired, install the adapter fitting on the good coupling. Use two wrenches.
3. Slowly open the valve on the adapter fitting to vent the entire charge of helium gas.
4. Close the valve on the adapter fitting. Do not remove the adapter fitting. It will be used for gas cleanup and recharging.

NOTE

Gas cleanup and recharging of the gas line are always required if a coupling has been repaired. Instead of venting the gas line to atmospheric pressure, some operators prefer to connect an adapter fitting and a charge line to the coupling not being repaired, to purge the gas line with helium during repair. Set the helium gas regulator at 5 psig or less to prevent air from entering the gas line and contaminating it.

Repair Self-Sealing Couplings

WARNING

ALWAYS VENT A GAS CHARGED COMPONENT BEFORE BEGINNING TO DISASSEMBLE ITS COUPLINGS. GAS PRESSURE CAN LAUNCH A LOOSE COUPLING WITH ENOUGH FORCE TO CAUSE PERSONAL INJURY.

CAUTION

MODIFICATION TO EQUIPMENT WITHOUT THE CONSENT OF THE MANUFACTURER WILL VOID THE WARRANTY.

Damaged threads, leaking seals or a leaking valve assembly may require replacement of coupling parts or replacement of the complete coupling half.

Replace the Gasket Seal

From repeated connecting and disconnecting the coupling, the gasket seal just inside the face of a male coupling may begin to leak and require replacement.

The gasket seal is replaced while the gas line is disconnected. See Fig. 5.5.

1. Carefully pry the old gasket seal from its recessed ring in the body.
2. Lightly coat the new gasket seal with vacuum grease and press it into the ring.

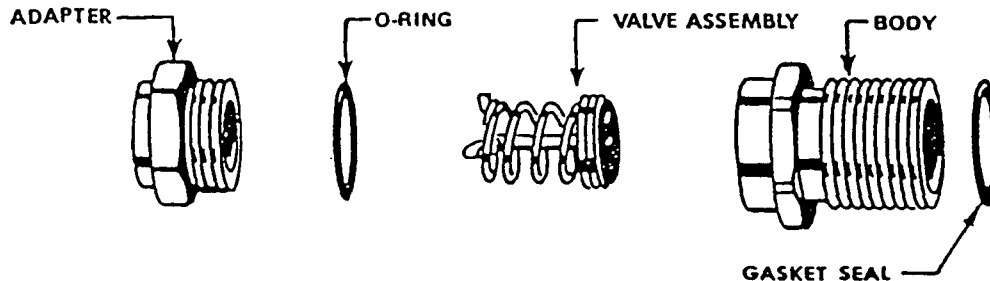


Fig. 5.5 Aeroquip Male Coupling Parts

Repair or Replace the Coupling

This procedure applies to both male and female couplings on gas lines, compressor and expander.

1. Vent the charged component using the venting procedure in the Maintenance section of the appropriate chapter.
2. If the coupling to be repaired has the venting adapter fitting attached, remove the adapter fitting.
3. Use two wrenches to disconnect the coupling body from the adapter. Hold the adapter with one wrench. Remove the coupling body with the other wrench. See Fig. 5.6.

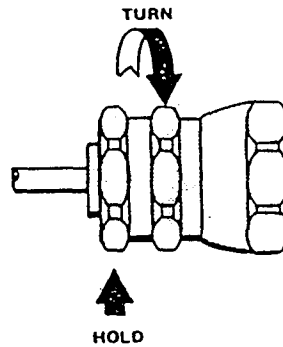


Fig. 5.6 Remove Coupling from Gas Line

4. Push the valve assembly from the coupling body. It is not fastened. Examine all parts and replace any that are damaged or replace the entire coupling half. See Figures 5.5 or 5.7.

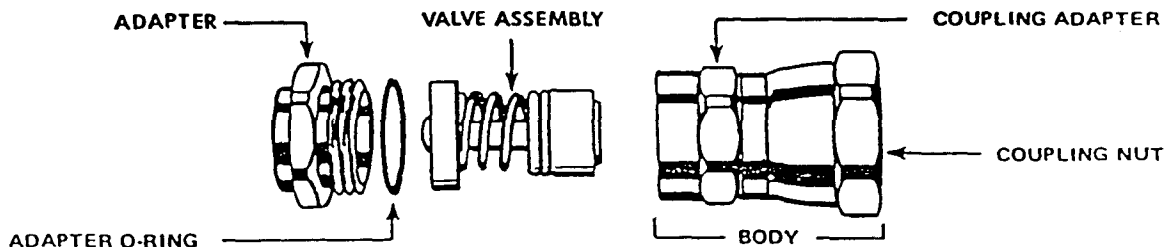


Fig. 5.7 Aeroquip Female Coupling Parts

MAINTENANCE

5. Remove the O-ring from the gas line adapter.
6. Wipe the O-ring groove to be sure it is clean. Lightly coat a new O-ring with vacuum grease. Install the O-ring in the gas line adapter.
7. Wipe the valve assembly with a clean, lint-free cloth. Insert the valve assembly into the coupling body from the rear.
8. Thoroughly degrease or apply Locquic Primer T (a degreasing agent) to the threads of the adapter and to the internal threads of the coupling body. Do not get Primer T on the O-ring or any of its seating surfaces.
9. Allow about 5 minutes for the primer to dry. Apply Loctite 242 to one full thread in the coupling adapter. Use a needle applicator. Start at the second thread from the lead thread and work toward the hexagon. Shake the Loctite before use.
10. Assemble the coupling body to the adapter. Use two wrenches. Hold the adapter with one wrench and screw the two parts together. Tighten the size 8 Aeroquip coupling parts to 4.85 to 6.25 kg_f m (35 to 45 ft. lbs.).
11. Allow at least a 6-hour curing period before applying gas pressure.

This completes the procedure for repairing or replacing a self-sealing coupling.

Gas Cleanup and Recharging

Cleaning and recharging are always required when a gas line has been vented and repaired or if the gas pressure has dropped to less than 140 kPa (20 psig). Each gas line is cleaned and charged individually using adapter fittings.

1. Locate and connect adapter fitting P/N SK8217A2 to one gas line coupling. Connect adapter fittings P/N 255919B2 and 257246C5 to the other coupling. Be sure the valve on each adapter fitting is closed before it is connected.

NOTE

Adapter fittings are available as optional accessories from APD.

2. Connect a charge line to the pressure regulator of a helium gas cylinder containing 99.995% pure helium gas with a dew point less than -50°C (-58°F) at 2065 kPa (300 psig).

WARNING

NEVER USE COMPRESSED GAS FROM A CYLINDER WITHOUT A PROPER REGULATOR. OVERPRESSURIZING CAN CAUSE PERSONAL INJURY IF THE SYSTEM EQUIPMENT RUPTURES.

3. Open the gas cylinder valve. While connecting the charge line to the valve on one of the adapter fittings, thoroughly purge the charge line from the regulator. It is important to remove all air contaminants to prevent them from entering the gas line.
4. Adjust the gas cylinder regulator to 690 kPa (100 psig). Open the valve on the adapter fitting and charge the gas line to 690 kPa (100 psig).
5. Close the valve on the helium gas cylinder (not on the regulator).
6. Open the vent valve. Watch the regulator pressure gauge. When the pressure falls to 35 to 70 kPa (5 to 10 psig), close the vent valve. Open the gas cylinder valve to increase the pressure to 690 kPa (100 psig). Close the gas cylinder valve.
7. Repeat step 6 five times.
8. Close the valve on the adapter fitting used for charging. Open the gas cylinder valve. Adjust the pressure regulator to the equalization pressure of the system. Refer to the Specification section in the System chapter.
9. Open the valve on the adapter fitting and charge the gas line to the equalization pressure.
10. Close the valve on the adapter fitting. Close the gas cylinder valve. Disconnect the charge line from the adapter fitting. Store the charge line to keep it clean.
11. Remove the adapter fittings.

This completes the procedure for gas cleanup of a gas line.

Gas Cleanup and Recharging (Systems Using Nycoil Gas Lines)

Because Nycoil gas lines are permeable, frequent, scheduled maintenance is required on the system every 60 or 90 days, depending on the system components.

For system using compressor models HC-4 (series), 1R04WSL or 1R04WOI, perform Gas Cleanup and Recharging every 90 days -- even if the system has not operated.

For systems using compressor models HC-2 (series), 1R02W, 1R02A, 1R02WOI, 1L02W or 1L02A, perform Gas Cleanup and Recharging every 60 days -- even if the system has not operated.

MAINTENANCE

This schedule is based on a system equalization pressure loss of 70 kPa (10 psig). If the equalization pressure drops 70 kPa (10 psig) or more during the 60- or 90-day period, perform Gas Cleanup and Recharging procedure as soon as the pressure loss is detected. Do not wait for the expiration of the 60 or 90 days.

1. Using two wrenches, disconnect the gas lines from the compressor and from the expander.
2. For gas cleanup of Nycoil gas lines, follow the same procedure for Gas Cleanup and Recharging (Stainless Steel and Copper Gas Lines) in this section.
3. For gas cleanup of the compressor and expander, see the Gas Cleanup procedures in the compressor and Expander sections.
4. Using two wrenches, reconnect the components. Check the equalization pressure of the system after completing the reinstallation.

This completes the procedure for gas cleanup of components used in a system containing Nycoil gas lines.

Ordering

Order parts by part number and name. See Fig. 5.8.

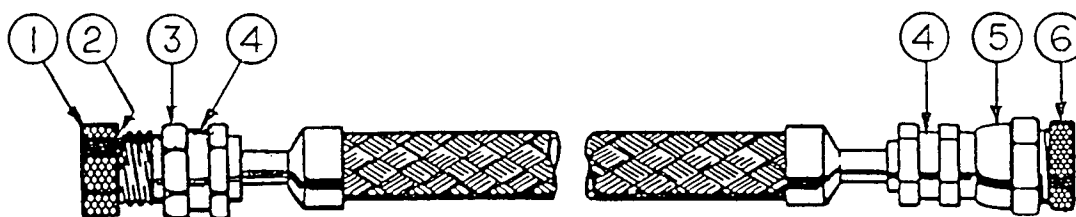
Parts Identification and Number

Fig. 5.8 Parts Identification

<u>Item</u>	<u>Part Name</u>	<u>Part Number</u>		
		<u>Size 4</u>	<u>Size 8</u>	<u>Size 12</u>
1	Dust Cap	N/A	45301	45401
2	Gasket Seal	N/A	77002	77046
3	Coupling Half	N/A	44701	44801
4	O-Ring	77183	77196	77113
5	Coupling Half	44901	45001	45101
6	Dust Plug	45501	45601	45701

**Addendum To Helium Compressor Technical Manuals
For a Compressor With a Gas Fill Port**

**APD CRYOGENICS INC.
1833 Vultee Street
Allentown, PA 18103**

NOTE

Place this Addendum in the Compressor section of your technical manual, ahead of the Compressor technical manual.

This Addendum applies to the following compressors which have a gas fill and vent port on the compressor's front panel:

<u>Compressor Model Number</u>	<u>Compressor Part Number</u>
HC - 2D - FF	256639E 18G - FF
	256639E 15G - FF
	256639E 16G - FF
HC - 4MK2 - FF	260341E 18G - FF
	260341E 15G - FF
	260341E 16G - FF
HC - 8C1 - FF	258492E 20J - FF
HC - 8C5 - FF	261200E 20J - FF

1.0 Scope

This addendum to the compressor technical manual describes the charging and venting procedures for a compressor with the gas fill port.

2.0 Tools and Materials Required

WARNING

NEVER USE COMPRESSED HELIUM GAS FROM A CYLINDER WITHOUT A PROPER REGULATOR. OVER PRESSURIZATION CAN CAUSE PERSONAL INJURY IF THE SYSTEM EQUIPMENT RUPTURES

WARNING

WHEN HANDLING PRESSURIZED GAS LINES AND OTHER PRESSURIZED EQUIPMENT, ALWAYS WEAR EYE PROTECTION

- Gas Supply -- A regulated helium gas cylinder containing 99.995% pure helium with a dew point less than -50° C (-58° F) at 2070 kPa (300 psig).
- 1/4" O.D. tube charge line from helium supply to compressor.
- Swagelok® nut and ferrules (P/N's B-402-1, B-403-1 and B-404-1; reference APD P/N's 12301, 12302 and 12303, respectively).
- Two 9/16" open-end wrenches.

3.0 Charging Procedure (with or without the compressor operating)

WARNING

BE SURE THE GAS FILL VALVE IS COMPLETELY CLOSED BEFORE REMOVING THE SWAGELOK[®] NUT AND PLUG. GAS PRESSURE CAN PROJECT THE PARTS WITH ENOUGH FORCE TO CAUSE INJURIES.

CAUTION

USE ONE WRENCH TO SUPPORT THE BODY OF THE GAS FILL PORT FITTING WHILE REMOVING OR INSTALLING THE DUST CAP OR CHARGE LINE NUT WITH THE OTHER WRENCH. DO NOT OVER-TORQUE.

1. Remove the dust plug (Swagelok[®] P/N B-400-P; reference APD P/N 17505) from the gas fill port.
2. Adjust the helium gas supply regulator to 5 psig. Thoroughly purge the charge line while connecting the charge line to the gas fill port. It is important to remove all air contaminants to prevent them from entering the system.
3. Adjust the helium gas supply regulator to the desired pressure. See the Specifications section of the compressor technical manual for proper operating or equalization pressure. *290-245 psi*
4. Slowly open the gas fill valve. Charge the system until the desired pressure is indicated on the compressor gauge. If the compressor is operating, wait at least 30 seconds for the system pressure to reach equilibrium.
5. Close the gas fill valve and the helium gas supply valve.
6. Disconnect the charge line from the gas fill port. See CAUTION above.
7. Install the dust plug on the gas fill port. See CAUTION above.

4.0 Venting Procedure (with or without the compressor operating)

WARNING

BE SURE THE GAS FILL VALVE IS COMPLETELY CLOSED BEFORE REMOVING THE SWAGELOK[®] NUT AND PLUG. GAS PRESSURE CAN PROJECT THE PARTS WITH ENOUGH FORCE TO CAUSE INJURIES.

CAUTION

USE ONE WRENCH TO SUPPORT THE BODY OF THE GAS FILL PORT FITTING WHILE REMOVING OR INSTALLING THE DUST CAP WITH THE OTHER WRENCH. DO NOT OVER-TORQUE.

1. Remove the dust plug (Swagelok® P/N B-400-P; reference APD P/N 17505) from the gas fill port.
2. Slowly open the gas fill valve, less than 2 turns. Vent the system until the desired pressure is indicated on the compressor gauge. See the Specifications section of the compressor technical manual for proper operating or equalization pressure. If the compressor is operating, wait at least 30 seconds for the system pressure to reach equilibrium.
3. Close the gas fill valve.
4. Install the dust plug on the gas fill port. See CAUTION above.

Compressor Front Panel

