APD MODEL HC - 2D - 1 HELIUM COMPRESSOR

TECHNICAL MANUAL

APD CRYOGENICS INC
1833 Vultee Street
Allentown, PA 18103

Revision B: September 1997

263924A

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SAFETY

GENERAL

THE HC - 2D - 1 HELIUM COMPRESSOR IS DESIGNED TO OPERATE SAFELY WHEN THE INSTALLATION, OPERATION AND SERVICING ARE PERFORMED IN ACCORDANCE WITH THE INSTRUCTIONS IN THIS TECHNICAL MANUAL. CONSULT THE NEAREST APD CRYOGENICS SERVICE CENTER WITH ANY QUESTIONS YOU MAY HAVE CONCERNING THE USE OR MAINTENANCE OF THIS COMPRESSOR. FOR SERVICE CENTER LOCATIONS, SEE THE SERVICE SECTION OF THE GENERAL TECHNICAL MANUAL.

SPECIAL NOTICES

THREE TYPES OF SPECIAL NOTICES -- WARNINGS, CAUTIONS AND NOTES -- ARE USED IN THIS TECHNICAL MANUAL. THEY APPEAR AS FOLLOWS AND SERVE THE PURPOSES STATED.

WARNING

WARNINGS CALL ATTENTION TO ACTIONS OR CONDITIONS WHICH CAN RESULT IN INJURY OR DEATH TO PERSONNEL.

CAUTION

CAUTIONS CALL ATTENTION TO ACTIONS OR CONDITIONS WHICH CAN RESULT IN DAMAGE TO THE EQUIPMENT OR IN ABNORMAL PERFORMANCE.

NOTE

Notes give important, additional information, explanations or recommendations related to the procedure or discussion presented.

WARNINGS and **CAUTIONS**, like other safety instructions, appear in the text where they are especially applicable. Because of their importance, they are summarized in the General technical manual, which should be read first.

Definition of symbols used in this manual and on equipment:

I	Mains Disconnect ON		Refer to Manual
○	Mains Disconnect OFF		Protective Earth (Ground)
	OFF for Part of Equipment		DANGEROUS Voltage
	ON for Part of Equipment	V~	VOLTS, AC

INTRODUCTION

Helium Compressor Model HC - 2D - 1

The HC - 2D - 1 Compressor is a single-stage, water-cooled, rotary compressor designed to deliver high-pressure, oil-free helium gas to cryogenic refrigerators. The compressor is capable of operating a DE-202 Expander (refrigerator). An expander cable 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.

The model HC - 2D - 1 Compressor designation represents a family of compressors. Each member of the family has a different part number (P/N) because electrical components are customized to match the compressor to a specific expander model and to the customer's electrical service. The nameplate attached to the compressor's rear panel identifies the part number. See Electrical Characteristics in the Specifications section of this manual.

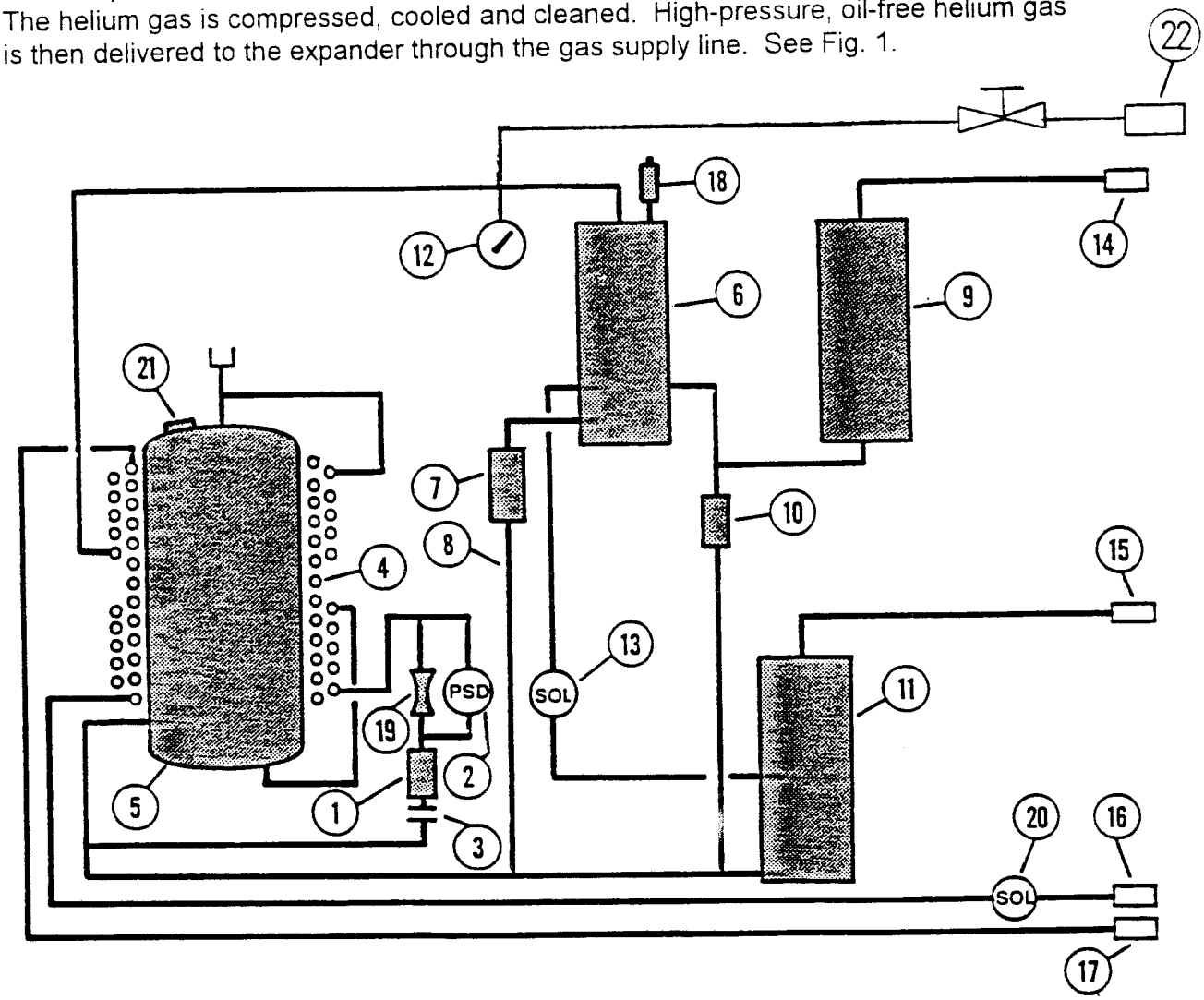
The information in this manual pertains only to the HC - 2D - 1 Compressor. Other components used with it to form an operating system are described in separate technical manuals.

Pressures are stated as gauge, not absolute. Psig is pounds per square inch gauge and kPa is Kilopascals gauge.

$$kPa = 6.895 \times Psig$$

PRINCIPLES OF OPERATION

The compressor continuously draws low-pressure helium from the system return line. The helium gas is compressed, cooled and cleaned. High-pressure, oil-free helium gas is then delivered to the expander through the gas supply line. See Fig. 1.



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

Fig. 1 HC - 2D - 1 Flow Diagram

When gas leaves the compressor, the gas 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 it 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 supplied to the expander through gas lines.

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

A gas line containing an internal by-pass valve connects the high-pressure line to the low-pressure line. The by-pass 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 in the oil separator whose element collects oil mist from the gas; oil is agglomerated and returned 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.

DESCRIPTION

The components of the HC - 2D - 1 Compressor are identified schematically in Fig. 1. Figures 2 and 3 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, size 8, male, Aeroquip, bulkhead couplings and are the points of connection on the rear panel for the rest of the system.

Gas Charge/ Vent Fitting -- A valved Swagelock fitting located on the front of the compressor is used for charging and venting helium gas refrigerant.

Water Supply and Return Fittings -- Both fittings are compression-type bulkhead fittings mounted on the rear panel.

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 digital display, elapsed time meter shows the compressor's cumulative running time in hours up to a total of 99,999 hours.

WARNING

THE COMPRESSOR'S 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. CONTACT LOCAL ENVIRONMENTAL AUTHORITIES FOR PROPER DISPOSAL OF THE LITHIUM BATTERY.

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 Receptacle and Optional Cable -- A 28-socket receptacle mounted on the rear panel and an expander cable supply electrical power from the compressor to the expander. The compressor can be supplied with a cable for operating a DE-202 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 capability. 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 0.63 ampere fuses in the expander circuit and two 0.4 ampere fuses in the primary of the control transformer are accessible in the electrical chassis box. Two 5.0 ampere fuses in the auxilliary power (accessory receptacle) circuit are accessible in the rear panel.

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.

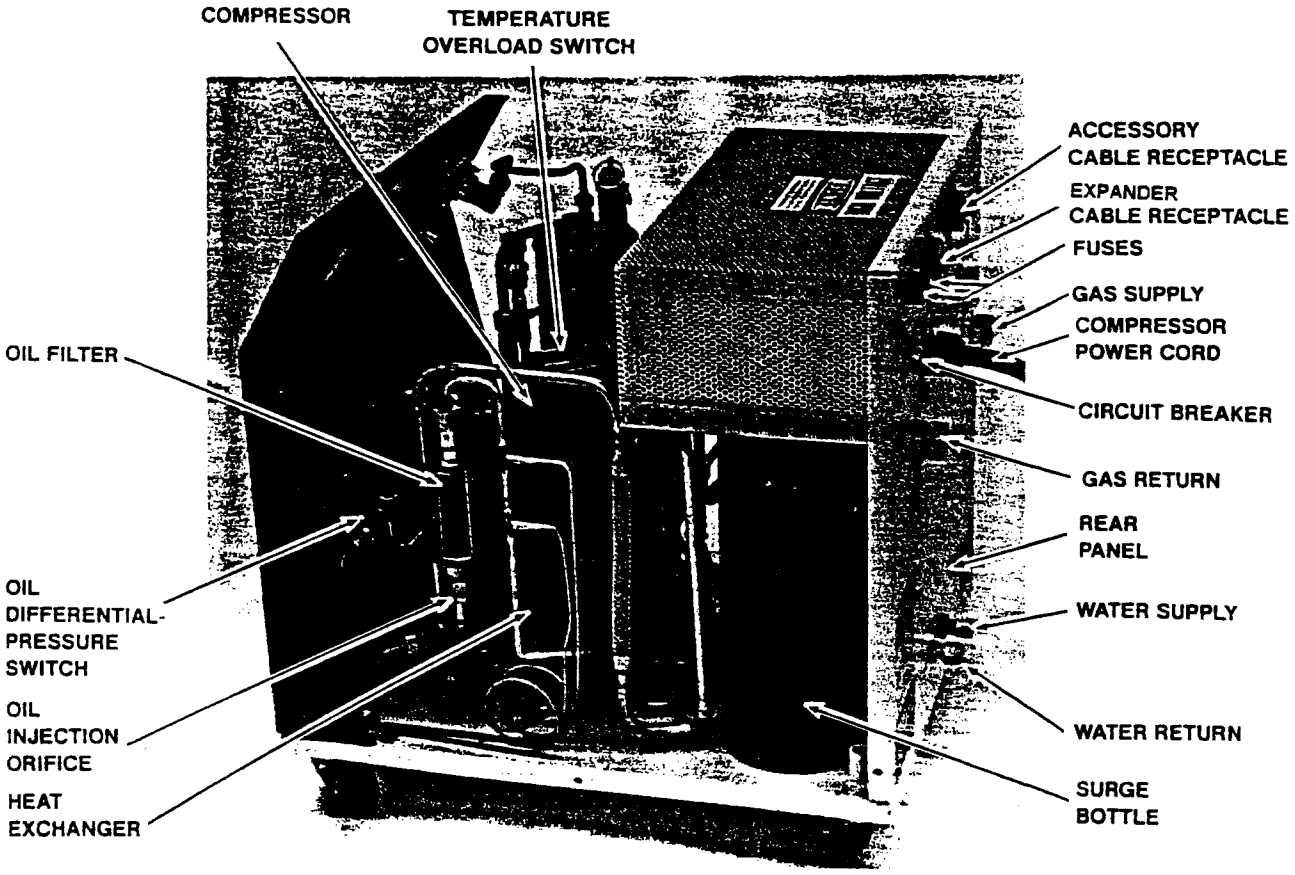


Fig. 2 Parts Identification

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.

If oil needs to be added to the compressor, an oil charging vessel (with oil) P/N 263775A1, is available as an accessory from APD.

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.

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

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.

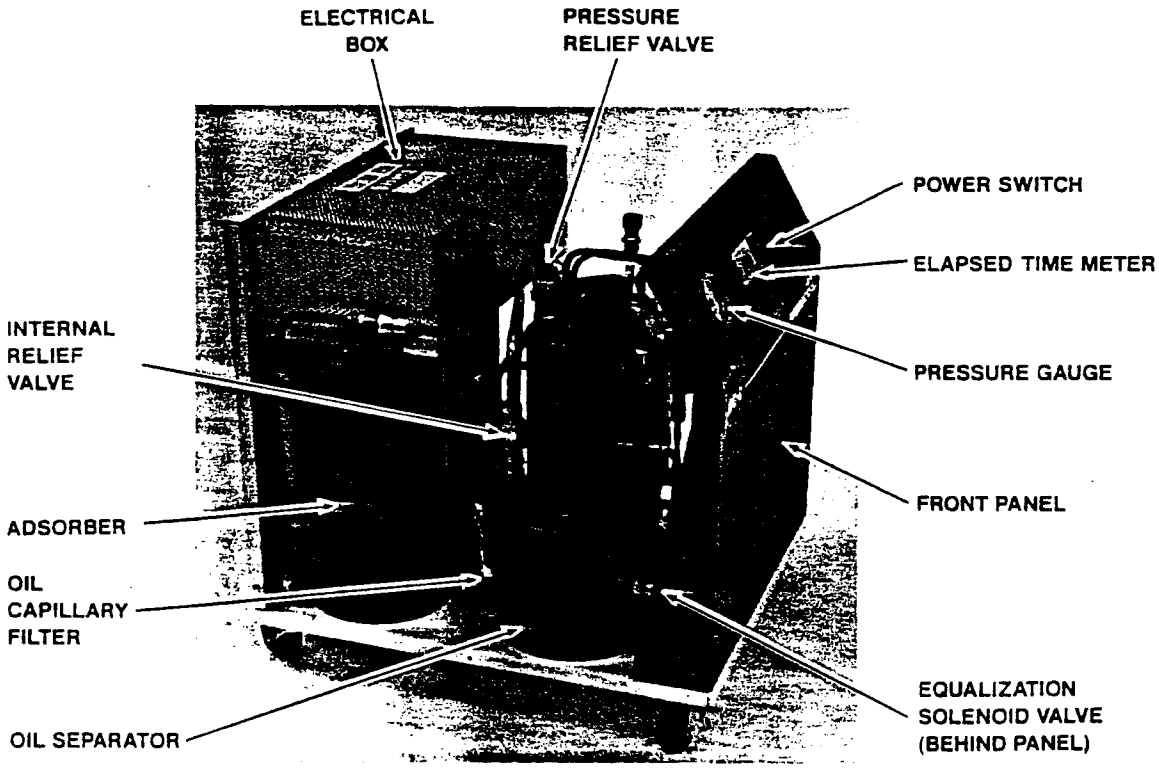


Fig. 3 Parts Identification

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

Internal By-Pass (Relief) Valve -- The internal by-pass 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.

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SPECIFICATIONS

Electrical Characteristics

Compressor P/N	Customer's Electrical Service	Compressor Transformer Requirement
262853E18G	208/ 230 V~ (± 5%) 60 Hz, 15 A	None
262853E18G	200 V~ (± 5%) 50 Hz, 15 A	None
262853E15G	220 V~ (± 5%) 50 Hz, 15 A	Transformer included, wired for step down to 200 V~
262853E16G	230/ 240 V~ (± 5%) 50 Hz, 15 A	Transformer included, wired for step down to 200/ 208 V~

Power Required: 1.7 kW, 8.5 amps full load at 208 V~; 32 amps locked rotor.

Power Cord Connector: NEMA L6-15P (2 pole, 3 wire, 15 A, 250 V~) male plug to connect to customer's receptacle.

Power should be provided through a separately-fused safety switch equipped with 15 A fuses or through a 15 A circuit breaker. The switch or circuit breaker should be located near the equipment.

Cooling Requirements

Cooling Water Inlet Temperature:	4° C to 27° C (40° F to 80° F)
Cooling Water Outlet Temperature:	41° C (105° F) maximum
Cooling Water Pressure:	210 kPa (30 psig) minimum 690 kPa (100 psig) maximum
Cooling Water Flow:	2.3 liters/ minute (0.6 gpm) minimum
Pressure Drop at Minimum Flow:	80 kPa (12 psi)
Water Chiller Cooling Capacity:	1.8 kW (6,000 BTU/ hour)

Helium Gas Pressures

	Compressor Only	With DE - 202 Expander
Equalization Pressure at 68° F	260 - 265 psig (1790 - 1830 kPa)	260 - 265 psig (1790 - 1830 kPa)
Operating Supply Pressure	330 - 350 psig (2270 - 2410 kPa)	320 - 340 psig (2200 - 2340 kPa)

Equalization pressures at different ambient temperatures:

T° C	P kPa	T° F	P psig
4	1700 - 1730	40	246 - 251
10	1730 - 1765	50	251 - 256
15.6	1765 - 1800	60	256 - 261
20.0	1790 - 1830	68	260 - 265
26.7	1830 - 1870	80	266 - 271
37.8	1900 - 1940	100	276 - 281
40	1915 - 1950	104	278 - 283

The Pressure-Relief Valve is set at 2760 kPa (400 psig).

Refrigerant Quality

Refrigerant is 99.995% pure helium gas with a dew point less than -50° C (-58° F) at 2070 kPa (300 psig).

Compressor Lubricant LB-300X, specially processed by APD.

Compressor Weight 80 kg (175 pounds)

Mounting Position Compressor must be mounted base down and level within 5 degrees.

Adapter Fittings and Cables Available from APD. See the Parts section of this manual.

Expander Receptacle

A 28-socket receptacle on the compressor rear panel accommodates the expander cable which furnishes power from the compressor to the expander's valve motor. Power to the valve motor is rated at 220 V~ and is fused at 0.63 amperes.

INSTALLATION

The HC - 2D - 1 Compressor is shipped in an operable condition. Installation consists of:

- Unpacking
- Examining for damage
- Placing the compressor at its point of use
- Connecting utilities
- Checking compressor operation
- Connecting other system components.

Unpacking, Inspection and Pressure Check

1. Open the shipping container, loosen the shipping restraints, and remove the contents. The container also includes the compressor technical manual and the installation kit. Optional items such as adapter fittings also will be included, if ordered.

NOTE

Retain the shipping container if it is in reusable condition for returning the compressor to the factory when reconditioning is required.

2. Check the Tip-N-Tell sensor mounted on the compressor.

If the Tip-N-Tell sensor shows no mishandling and there is no apparent physical damage, proceed to the sections Compressor Positioning and Compressor Checkout.

If the Tip-N-Tell sensor indicates mishandling (arrow point is blue), read the equalization pressure. Proceed to either Step **2.1** or **2.2**.

2.1 -- The equalization pressure is within specifications.

WARNING

ALL ELECTRICAL SUPPLY EQUIPMENT MUST MEET APPLICABLE CODES AND BE INSTALLED BY QUALIFIED PERSONNEL.

WARNING

PERMIT ONLY QUALIFIED ELECTRICAL TECHNICIANS TO OPEN ELECTRICAL ENCLOSURES, TO PERFORM ELECTRICAL CHECKS OR 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.

WARNING

WHEN CHECKING THE COMPRESSOR FOR SHIPPING DAMAGE, DO NOT CONNECT GAS LINES AND EXPANDER. THE COMPONENTS MAY BECOME CONTAMINATED WITH COMPRESSOR OIL.

Connect power and coolant to the compressor. See the next sections Compressor Positioning and Compressor Checkout. Test run the compressor for two (2) hours minimum. If there are no problems during this time period, stop the compressor and proceed to assemble the system.

If the compressor shuts down during the two- (2) hour test, contact the nearest APD Service Center.

2.2 -- The equalization pressure is outside the specified range or there is physical damage to the compressor housing.

Contact the nearest APD Service Center.

Compressor Positioning

Place the compressor in a location that is protected from the elements and where the ambient temperature will always be within the range of 4° C to 40° C (40° F to 104° F).

CAUTION

ALWAYS THOROUGHLY DRAIN THE COOLANT FROM THE COOLING CIRCUIT IF THE COMPRESSOR IS TO BE SHIPPED OR STORED.

CAUTION

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

The compressor must be installed base down, within 5 degrees of level, and preferably at a height convenient for making connections and reading the gauges. Be sure the compressor cannot inadvertently roll from its location, particularly if it is elevated.

Allow at least 600 mm (24") clearance from the back and from both sides of the compressor for maintenance.

Compressor Checkout

WARNING

ALL ELECTRICAL SUPPLY EQUIPMENT MUST MEET APPLICABLE CODES AND BE INSTALLED BY QUALIFIED PERSONNEL.

The compressor should be operated before being connected to the system.

1. Using 3/8" O.D. polyethylene tubing, nuts and ferrules from the installation kit, connect coolant supply and return lines to the compression fittings on the rear of the compressor. Connect the supply line to the supply valve furnished and installed by customer. Turn on the coolant.

Accessory Receptacle

A 14-socket receptacle on the compressor rear panel provides auxilliary power rated at 220 V~, 4.0 amperes to power APD or customer-provided accessories. The receptacle also provides for remote control of the compressor. See the Installation section for a description of the remote on/ off cable and operation.

Fuse Ratings:

Fuse 1: 250 V~, 5 AT	Fuse 4: 250 V~, 0.4 AT
Fuse 2: 250 V~, 5 AT	Fuse 5: 250 V~, 0.63 AT
Fuse 3: 250 V~, 0.4 AT	Fuse 6: 250 V~, 0.63 AT

Environmental Requirements

	Operating	Storage
Ambient Temperature	4° C to 40° C (40° F to 100° F)	-23° C to 65° C (-10° F to 149 ° F)
Relative Humidity	30% to 70%	10% to 90%
Atmospheric Pressure	52 kPa to 110 kPa 7.5 psia to 16.0 psia	52 kPa to 110 kPa (7.5 psia to 16.0 psia)

CAUTION

EQUIPMENT IS DESIGNED FOR INDOOR USE ONLY.

Pollution Degree II (except compressor motor is I)
(per EN61010-1, Clause 3.7.3)

Installation Category II (per EN61010-1, Clause 3.7.1)

Protective Earth Terminal Compressor Chassis 

Classification Class I

Dimensions Dimensions are in inches and (millimeters). See Fig. 4.

Space Requirements

Allow 600 mm (24") space in back of compressor for access to electrical, water and gas connections. Allow 600 mm (24") space on both sides of the compressor for maintenance of the adsorber.

Maintenance Interval Compressor adsorber: 10,000 hours.

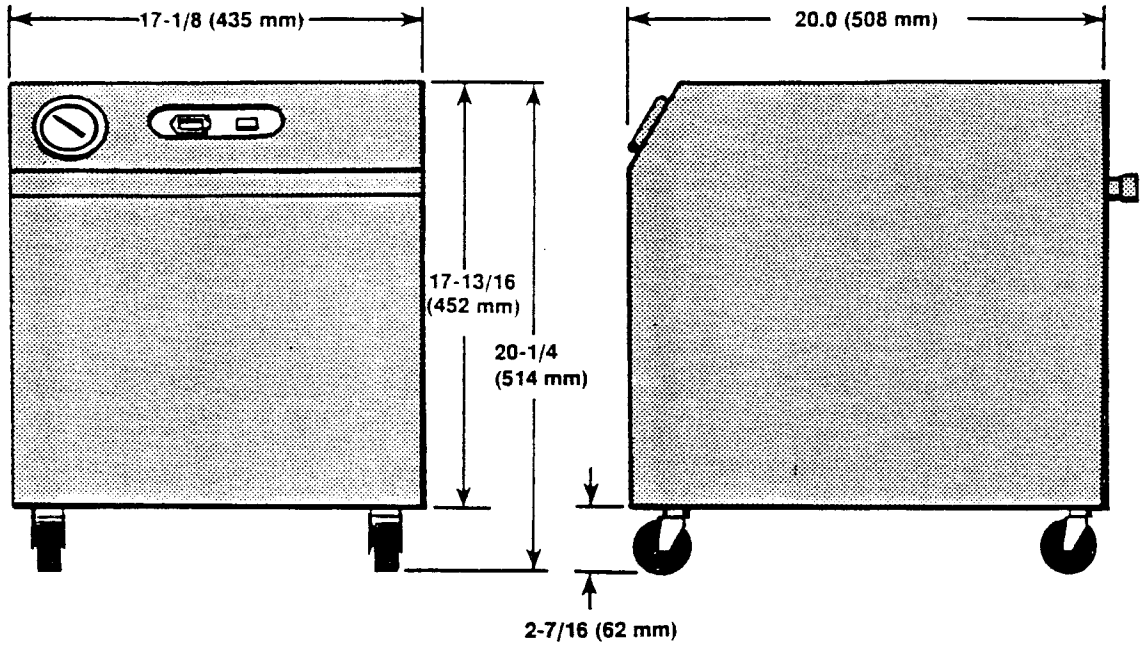

Fig. 4 HC - 2D - 1 Outline Dimensions

Supplier Name and Address

APD Cryogenics, Inc.
1833 Vultee Street
Allentown, PA 18103 - 4783
(610) 791 - 6700.

Supplier will make available on request circuit diagrams, component parts list, description, calibration instructions, or other information which will assist the user's appropriately-qualified technical personnel to repair those parts of the equipment which are designated by the manufacturer as being repairable.

2. Be sure the power switch on the compressor is off. Plug the power cable into customer's electrical receptacle after checking that the customer's electric service agrees with the Specifications. Switch on the power supply to the compressor. Check that the circuit breaker on the rear panel of the compressor is closed (handle is up).

3. To start the compressor, press the power switch on the front of the compressor. ⊙ Power switch indicator will light and the compressor will start. The water solenoid valve will open. Check water lines for leaks. Tighten the fittings if necessary. See Specifications for cooling requirements.

NOTE

An internal by-pass valve will open to prevent overloading the motor when the system gas lines are not connected to the compressor.

4. When the pressures stabilize, read the pressure gauge. The pressure should match the operating supply pressures (compressor only) in the Specifications.

5. Run the compressor for 10 minutes, then stop it by pressing the power switch. ○

This completes the checkout of the compressor.

Interconnections

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

DO NOT CRIMP THE GAS LINES. SUBSEQUENT ATTEMPTS TO BEND THE GAS LINES MAY DAMAGE THEM.

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

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.

NOTE

Retain the threaded protective caps and plugs to re-cover the couplings when they are not in use. They protect the couplings from damage and prevent entry of contaminants.

1. Arrange the system components so that the interconnecting gas lines will be protected from stress and traffic. Observe the minimum bend radius. Routing of gas lines should consider the need for gas line supports.
2. Remove the dust caps from the compressor supply and return gas couplings.
3. Remove the dust plugs from the couplings on one end of each of the supply and return gas lines.
4. Connect the supply gas line to the supply coupling on the compressor. Use two wrenches to tighten the coupling to 4.87 ± 0.7 kgf m (35 ± 5 ft. lbs.). See Fig. 5.

   Tighten each coupling before proceeding to the next one.

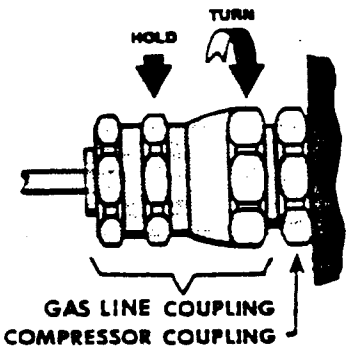

Fig. 5 Connect Gas Line to Compressor

5. Connect the return gas line to the return coupling on the compressor. Tighten the coupling to 4.87 ± 0.7 kgf m (35 ± 5 ft. lbs.).
6. Leak check all Aeroquip couplings. See the Leak Checking procedure in the Maintenance section.

7. Read the equalization pressure. Compare it to the equalization pressure stated in the Specifications section of the system manual.

8. Connect the other system components according to the instructions supplied for them. Connect the expander cable to the expander receptacle.

After the installation procedures for all system components have been completed, startup can begin.

Remote On/ Off Cable (Optional Accessory)

A remote on/ off cable, P/N 263887B, can be furnished as an accessory.

1. Disconnect the power to the compressor.
2. Remove the heat-shrink cap from one end of the remote on/ off cable. Connect the cable to customer's remote switch. Use the green/ yellow conductor to ground the switch box. Switch voltage will be 24 V~. See Fig. 8, Electrical Schematic.
3. Connect the other end of the cable to the accessory receptacle on the compressor.
4. Reconnect the compressor to its power source.

   The system can now be operated from the compressor or from customer's remote switch. When using the remote switch, the power switch on the compressor must be in the stop position.

5. To verify that the cable installation is correct, close customer's remote switch. Run the system for one minute, then stop.

NOTE

When the compressor is started by the remote on/ off switch, it cannot be stopped by the compressor's switch. Open the compressor's circuit breaker to stop it locally. When the compressor is started at the compressor power switch, it cannot be stopped at the remote on/ off switch.

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OPERATION

Operation

Starting and stopping are the only operating procedures performed at the compressor.

Prestart Check

Before starting the compressor, be sure that all other system components to be used are properly connected and ready for operation. Refer to the instructions supplied with the other components.

When the compressor is at room temperature, 20° C (68° F), the pressure gauge should indicate 1790 - 1830 kPa (260 - 265 psig). Higher or lower temperatures will result in correspondingly higher or lower pressures, but these pressure changes are normal. Abnormally lower readings indicate that some of the gas charge has been lost. Refer to the Maintenance section for instructions on recharging, cleaning and leak checking.

Starting

At the compressor, press the power switch. ⊙

The indicator in the switch will light. The compressor will start. Any items drawing power from the compressor will start.

Stopping

At the compressor, press the power switch. ○

The indicator light in the switch will go out. The compressor will stop. Any items drawing power from the compressor will stop.

Restarting After a Power Failure

If the compressor stops due to a power interruption, it is designed to restart immediately after power has been restored. If the compressor stops for other reasons, refer to the Troubleshooting section of this manual.

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MAINTENANCE

WARNING

DISCONNECT GAS LINES ONLY WHEN THE COMPRESSOR IS STOPPED AND THE EXPANDER HAS WARMED TO ROOM TEMPERATURE. 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 HELIUM GAS FROM A CYLINDER WITHOUT A PROPER REGULATOR. OVERPRESSURIZING 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 CAN 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

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 from 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 base on the compressor base to help locate the proper position for the new adsorber.

4. Disconnect the self-sealing coupling on the inlet side of the adsorber. Use two wrenches.

5. Elevate the compressor to gain access underneath the bottom panel. Remove the 3/8" bolt holding the adsorber to the base. Use a 9/16" wrench.

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 the 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 outline 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 bolt used to secure the adsorber to the base. Install and tighten this bolt and lock washer. Torque the bolt 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 4.87 $\pm$ 0.7 kgf m (35 $\pm$ 5 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 between 1.4 to 2.1 kgf m (10 to 15 ft. lbs.).

6. Reconnect the supply gas line to the supply coupling on the compressor. Torque the coupling to 4.87 $\pm$ 0.7 kgf m (35 $\pm$ 5 ft. lbs.).

7. Leak check all Aeroquip couplings just completed.
8. Check the equalization pressure. See Specifications.
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 venting adapter fitting.

Charging and Venting

Charging or venting is required whenever the operating or equalization pressure of the system is outside the range as stated in the Specifications. See Specifications for equalization pressures at different ambient temperatures.

See also the section Gas Cleanup.

Venting is required if leaking, self-sealing couplings need to be disassembled for repairs.

CAUTION

DO NOT CHARGE THROUGH THE SUPPLY COUPLING. DO NOT VENT THROUGH THE RETURN COUPLING.

Charging Procedure

Tools required: (2) 9/16" open-end wrenches.

This procedure may be performed with the compressor running. Use the gas charge/ vent fitting on the front panel.

1. Remove the dust plug, Swagelock P/N B-400-P (APD P/N 17505), from the charge/ vent fitting.

CAUTION

USE ONE WRENCH TO SUPPORT THE BODY OF THE CHARGE/ VENT FITTING WHILE REMOVING OR INSTALLING THE DUST PLUG OR THE CHARGE LINE NUT WITH THE OTHER WRENCH. DO NOT OVER-TORQUE.

2. Connect a 1/4" O. D. charge line to the pressure regulator of a helium gas cylinder containing 99.995% pure helium with a dew point less than -50° C (-58° F) at 2070 kPa (300 psig). Use brass Swagelock nut and ferrules (P/N's B-402-1, B-403-1 and B-404-1; APD P/N's 12301, 12302 and 12303, respectively.) Adjust the pressure regulator to 35 kPa (5 psig).

3. While connecting the charge line to the adapter fitting, thoroughly purge the charge line from the regulator. It is important to remove all air contaminants to prevent them from entering the system.

4. Adjust the pressure regulator to the desired operating or equalization pressure. See Specifications. **Slowly** open the charge/ vent valve. Charge the system with helium gas until the desired pressure is indicated on the compressor gauge. If the compressor is running, wait at least 30 seconds for the pressure to reach equilibrium.

5. Close the charge/ vent valve and the gas cylinder valve.

6. Disconnect the charge line from the charge/ vent fitting. Observe the above CAUTION.

7. Reinstall the dust plug on the charge/ vent fitting. Observe the above CAUTION.

This completes the charging procedure.

Venting Procedure to Adjust Operating or Equalization Pressure

Tools required: (2) 9/16" open-end wrenches.

This procedure may be performed with the compressor running. Use the gas charge/ vent fitting on the front panel.

1. Remove the dust plug, Swagelock P/N B-400-P (APD P/N 17505) from the charge/ vent fitting.

CAUTION

USE ONE WRENCH TO SUPPORT THE BODY OF THE CHARGE/ VENT FITTING WHILE REMOVING OR INSTALLING THE DUST PLUG WITH THE OTHER WRENCH. DO NOT OVER-TORQUE.

2. **Slowly** open the charge/ vent valve less than 2 turns. Vent the system until the desired pressure is indicated on the compressor gauge. See Specifications. If the compressor is running, wait at least 30 seconds for the pressure to reach equilibrium.

3. Close the charge/ vent valve.

4. Reinstall the dust plug on the charge/ vent fitting. Observe the above CAUTION.

This completes the procedure for venting to adjust the operating or equalization pressure.

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 from 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 two 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.

5. Remove the dust plug, Swagelock P/N B-400-P (APD P/N 17505) from the charge/ vent fitting.

CAUTION

USE ONE WRENCH TO SUPPORT THE BODY OF THE CHARGE/ VENT FITTING WHILE REMOVING OR INSTALLING THE DUST PLUG WITH THE OTHER WRENCH. DO NOT OVER-TORQUE.

6. **Slowly** open the charge/ vent valve. Vent the system to atmospheric pressure. Close the charge/ vent valve.

7. 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. 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 the adapter fitting P/N 262557B to the supply line from the oil separator, for venting 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 2070 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 1830 kPa (265 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 gas cylinder valve to increase the pressure 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. 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 has been disconnected prior to gas cleanup. Torque the Aeroquip coupling to 1.4 to 2.1 kgf m (10 to 15 ft. lbs.).

20. If other components need cleaning, refer to the procedures in their technical manuals. Otherwise, reconnect the supply and return gas lines to the compressor. Torque the gas line couplings to 4.85 ± 0.7 kgf m (35 ± 5 ft. lbs.).

21. Leak check the Aeroquip couplings. See the Leak Checking procedure in this section.

This completes the gas cleanup procedure for the compressor.

Leak Checking

In addition to identifying suspected leaks, check the compressor for helium leaks each time it has undergone any amount of disassembly. Use a helium mass spectrometer leak detector if available. Follow its manufacturer's instructions.

If a leak detector is not available, use a commercial leak detection solution. However, small leaks may not be detected. Also, it is important to:

- fully coat the joint being tested;
- allow time for bubbles to form at a small leak;
- look carefully for the smallest bubble formations.

After solution testing is completed, use water to wash all residue from joints and couplings.

In either method of testing, do not assume that one leak is the only one. Check all joints.

Leak detection by instruments can be misleading. Leaking gas can form patterns that indicate leaks at sound joints. Large leaks or a high gas concentration can make isolation difficult.

Leaks occur most frequently at threaded joints. However, they can occur also at brazed and welded joints.

The flat gasket in the face of the Aeroquip 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.

Leak Repair

Leaks in flexible 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 an APD Service Center.

Leaks at the self-sealing couplings can be repaired by replacing worn or damaged parts. Vent the compressor before beginning to disassemble it.

Leaks at threaded joints are frequently stopped by tightening the coupling. Continued leakage after tightening requires coupling repair. Install new O-rings or Teflon tape as required.

To repair a compressor coupling:

1. Stop the compressor and disconnect the power to the compressor.
2. Disconnect the gas line from the compressor coupling to be repaired.
3. Install dust caps on all disconnected gas couplings except the one to be repaired.
4. Remove the compressor's cover.
5. Use the Venting Procedure to Vent to Atmospheric Pressure to discharge all gas from the compressor. This procedure includes disconnecting the adsorber to prevent venting it.
6. At the coupling to be repaired, hold the stationary part with one wrench. Use a second wrench to disassemble the coupling.
7. Remove the old O-ring.
8. Wipe the O-ring groove to be sure it is clean. Lightly coat a new O-ring with vacuum grease. Install the new O-ring.
9. For a threaded joint sealed with Teflon tape, remove all old tape and apply new tape.
10. Reassemble the coupling using two wrenches.
11. Perform the Gas Cleanup procedure.

CAUTION

A LEAKING COUPLING ON AN ADSORBER SHOULD NOT BE REPAIRED IN THE FIELD. CONSULT AN APD SERVICE CENTER. VENTING THE ADSORBER WILL INTRODUCE CONTAMINANTS TO THE SYSTEM WHICH CANNOT BE REMOVED IN THE FIELD.

Replace Temperature Overload Switch

The overload switch fits in a depression on top of the compressor housing under the terminal box cover.

1. Disconnect the power to the compressor.
2. Remove the compressor module's cover.
3. Lift off the cover of the terminal box on top of the compressor. See Fig. 6.
4. Disconnect wires 48 and 49 from the temperature switch terminals. Remove the retainer containing the temperature switch. Discard the temperature overload switch and its retainer.
5. Place a new temperature overload switch with retainer into the terminal box on top of the compressor housing by engaging the retainer clips.
6. Connect wires 48 and 49 to the terminals of the temperature switch.
7. Replace the terminal box cover.

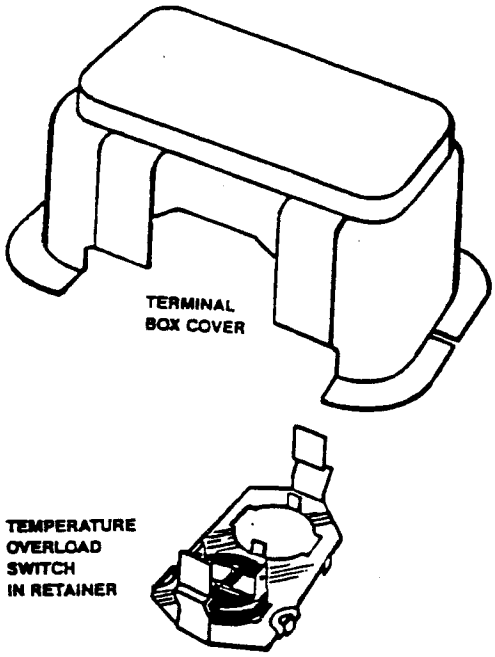

Fig. 6 Temperature Overload Switch

Automatic Shutdown

The compressor will not start or 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 shutdown was caused by the oil differential pressure switch, allow time for the pressure gauge to indicate 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 shutdown 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 re-start procedure. Check cooling water temperature and flow. Compare with Specifications.

The motor over-current relay must be manually reset after the compressor shuts down and the relay cools. To restart the compressor, disconnect power from the compressor. Remove the top cover and the electrical chassis cover. Press the red reset button on the over-current relay. The white indicator dot should move from the trip position. Install the chassis cover and the compressor cover. Reconnect the power and restart the compressor.

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

If a fuse is open, disconnect power to the compressor, replace the fuse, then restart the compressor. Fuses located in the electrical chassis box are in the expander valve motor and control circuits. Fuses mounted in the rear panel are in the accessory receptacle circuit.

The Troubleshooting Guide that follows lists problems that can occur in the compressor and suggests causes and corrective actions.

WARNING

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

WARNING

PERMIT ONLY QUALIFIED ELECTRICAL TECHNICIANS TO OPEN ELECTRICAL ENCLOSURES, TO PERFORM ELECTRICAL CHECKS OR 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.

CAUTION

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

Troubleshooting Guide

Problem	Possible Cause	Corrective Action
Compressor and items powered from it do not start when start switch on compressor is closed. Run light is not on.	No electrical power.	Check that power source is on and power cord is connected.
	Tripped circuit breaker in the compressor.	Check voltage. Reset circuit breaker. Consult an APD Service Center if the problem persists.
	Open fuse in the control circuit.	Check for a short circuit. Replace fuse. Consult an APD Service Center if the problem persists.
	Faulty control circuit transformer.	Measure resistances in primary and secondary. Compare with values in chart in this section. Replace transformer if defective.

Problem	Possible Cause	Corrective Action
Run light comes on for 30 seconds, then goes off, but the compressor does not start.	Defective motor contactor or open circuit to motor contactor.	Measure motor relay coil resistance. Check for an open circuit. Replace if defective.
	Low voltage in the primary or secondary circuit of control circuit transformer.	Measure resistances in primary and secondary. Replace transformer if defective.
Compressor starts but shuts down after approximately 30 seconds of operation.	Wrong equalization or operating pressure.	Refer to Specifications and section on Charging and Venting. Leak check the system if pressure is low.
	Gas equalization solenoid valve has failed.	Replace the solenoid valve.
	Low oil flow.	Look for oil leaks in the compressor module. Consult an APD Service Center.
	Orifice or the oil-cooling line filter is blocked.	Replace the orifice and the filter.
	Oil-differential pressure switch has failed.	Replace the switch.
Compressor starts but shuts down sometime later.	Insufficient coolant for the compressor.	Check coolant flow and temperature. Refer to Specifications.
	Circuit breaker or fuse is open.	Reset circuit breaker or replace fuse. Compare electric service with system specifications. Consult an APD Service Center if the problem persists.
	Component failure in the power circuit.	Check for an open circuit breaker or fuse. Reset or replace if necessary. Check for a faulty component.

Problem	Possible Cause	Corrective Action
Compressor starts but shuts down sometime later. (Continued)	Oil differential pressure switch is open.	Recheck corrective actions for the problem "Compressor starts, but shuts down after approximately 30 seconds of operation."
	Incorrect current draw.	Measure current. Check motor winding resistances. If check reveals failed motor windings or locked rotor, consult an APD Service Center.
	Compressor overload relay opens.	If water and power checks indicate utilities are within specifications, interlocks may be faulty. Consult an APD Service Center.
	Water solenoid valve is closed.	With power on, check water flow. If no water is flowing, turn off power. Disconnect wires 31 and 32 from terminals 5 and 3, respectively, on the terminal strip in the electrical chassis box. Measure the resistance of the solenoid valve coil. Compare with value on the chart in this section. If coil is open, replace it or install a new valve.
System starts but gas pressures are abnormally high or low.	Wrong equalization pressure.	Refer to Specifications and section on Charging and Venting. Leak check the system if pressure is low.
	Gas line couplings are not fully engaged.	Be sure that all Aeroquip couplings are fully engaged and torqued.
	Gas lines are connected wrong.	Reconnect. See the Installation section.

Problem	Possible Cause	Corrective Action
Gradual loss of helium gas pressure.	Gas is leaking from the compressor.	Leak check the compressor and repair.
Compressor runs, but elapsed time meter does not.	Defective elapsed time meter or motor contactor.	Replace the defective component.

WARNING

THE COMPRESSOR'S 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. CONTACT LOCAL ENVIRONMENTAL AUTHORITIES FOR PROPER DISPOSAL OF THE LITHIUM BATTERY.

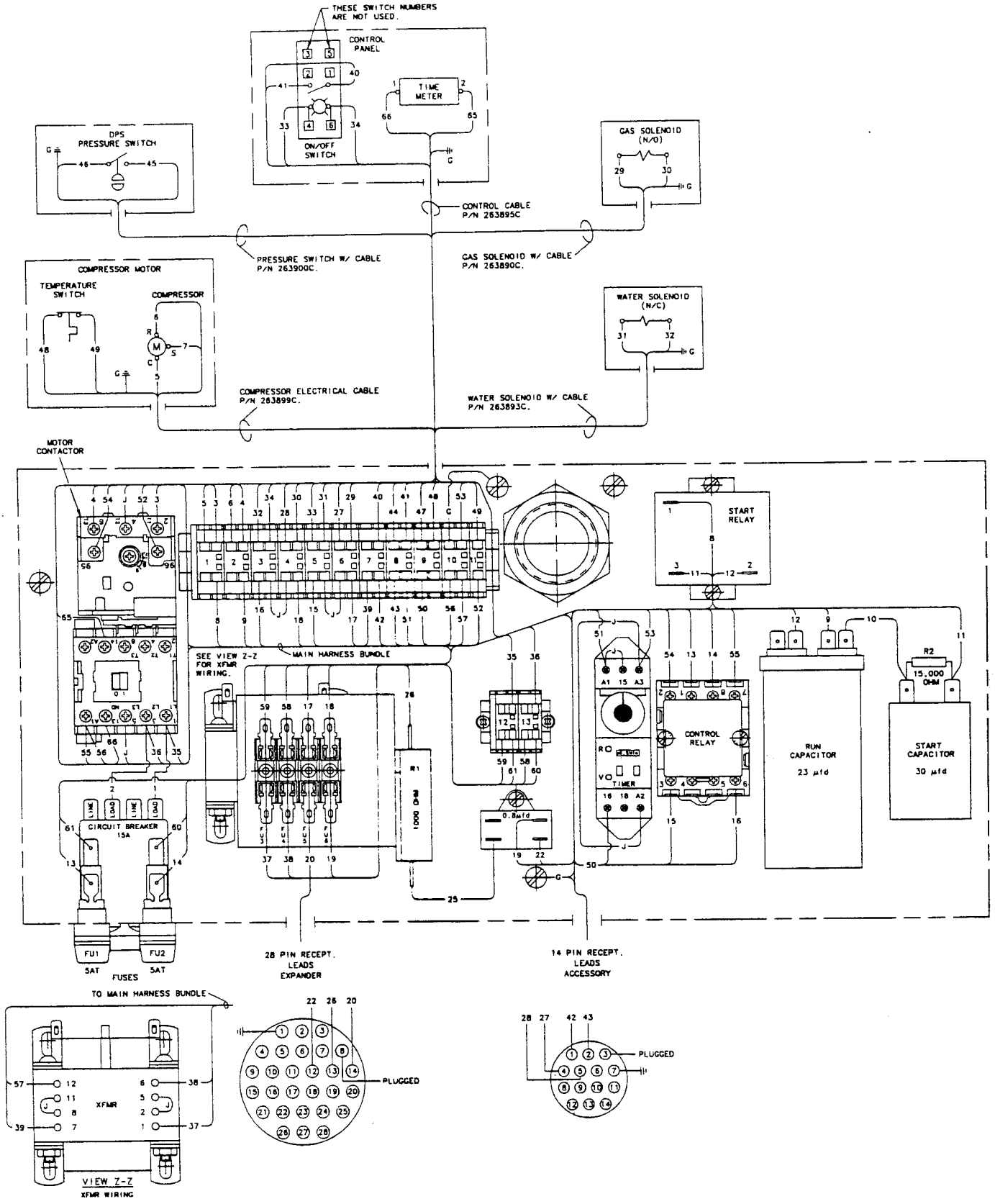

Fig. 7 HC - 2D - 1 Wiring Diagram

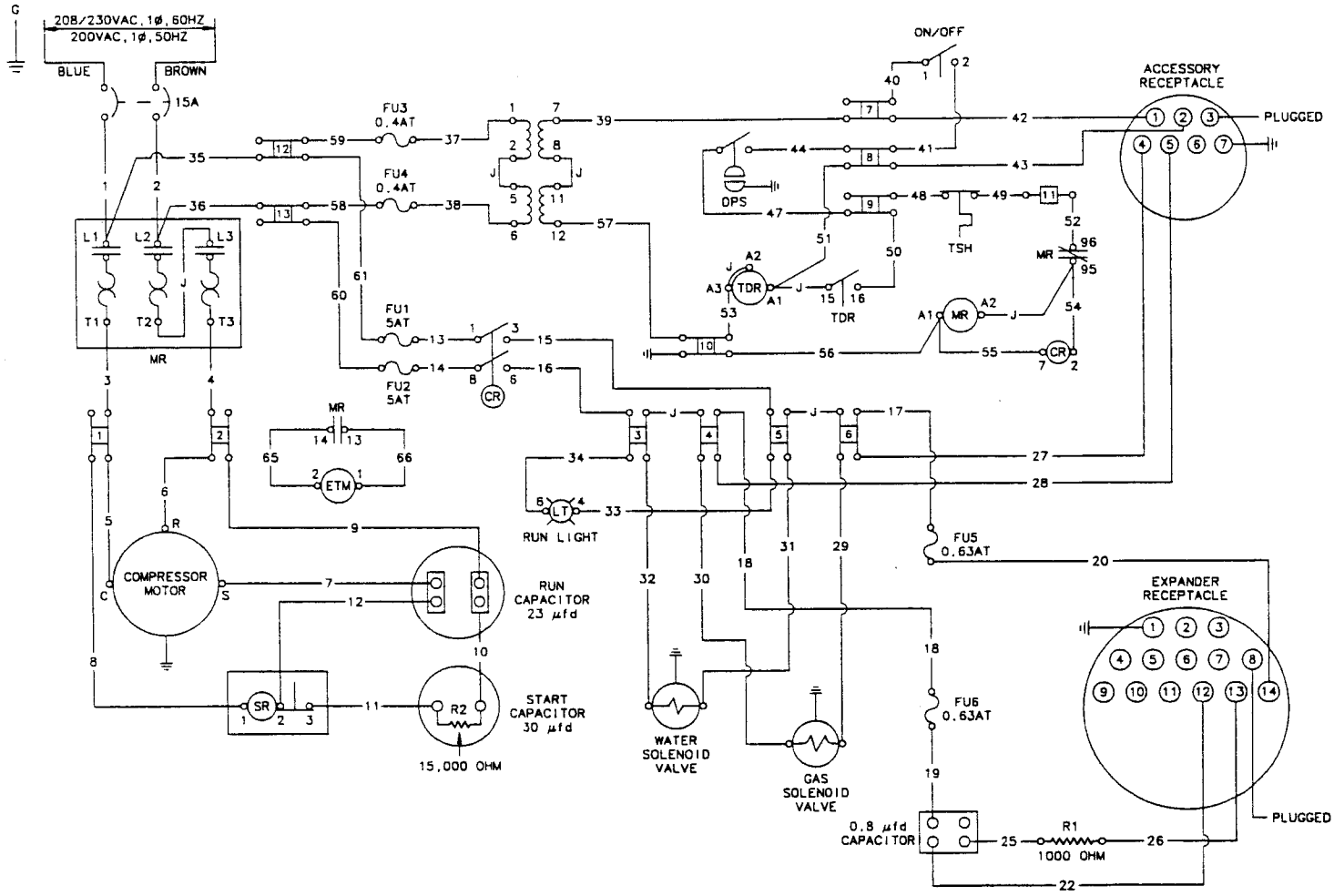

Fig. 8 HC - 2D - 1 Electrical Schematic

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.

Component	Resistance
Control Circuit Transformer Primary	21 ohms
Control Circuit Transformer Secondary	0.4 ohms
Control Relay Coil	64 ohms
Motor Relay Coil	22 ohms
Gas Equalization Solenoid Valve Coil	380 ohms
Start Relay Coil	6,100 ohms
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 OR 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 cover of the compressor module.

3. Remove the terminal box cover from the top of the compressor motor to expose the three terminals R, S and C. See Fig. 9. Disconnect wires 5, 6 and 7 from terminals C, R and S, respectively.

4. With an ohmmeter, check the resistance across compressor terminals C and R. Resistance should be about 1.6 to 2.0 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 the ohmmeter, check the resistance across compressor terminals C and S. Resistance should be 5.5 to 5.9 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 the 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 5, 6 and 7 to compressor terminals C, R and S, respectively.

8. Replace the terminal box cover and the cover of the compressor module, unless current measurement is to be performed.

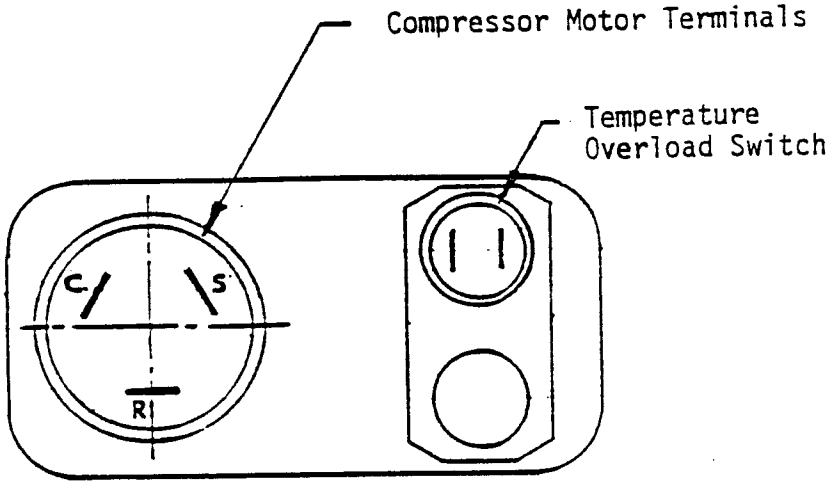

Fig. 9 Terminal Box on Compressor

Current Measurement

1. Disconnect the power to the compressor.
2. Remove the compressor 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 30 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 6 to 10 amps is normal at steady-state operating conditions.
    - A reading of 10 to 20 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 about 32 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 cover of the electrical chassis box cover and the compressor module cover.

PARTS

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.

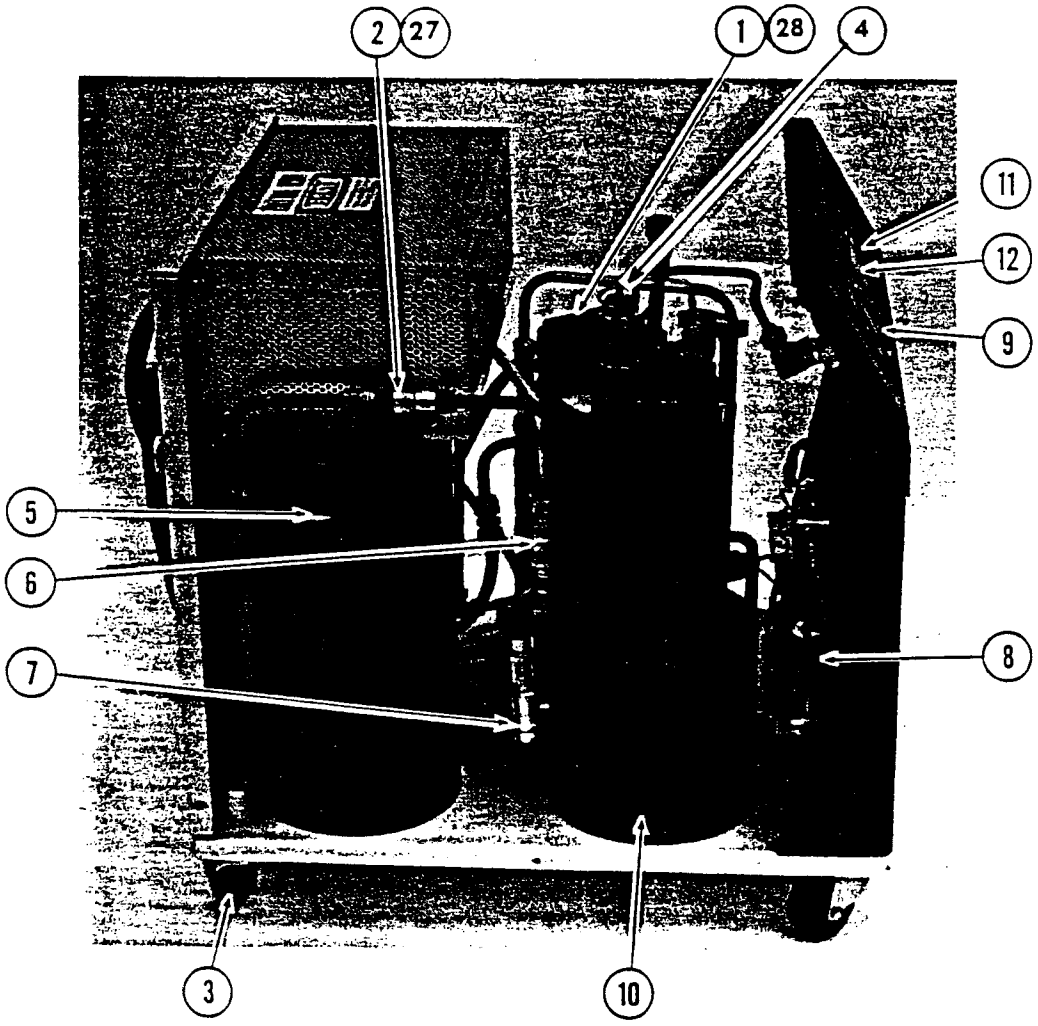

Fig. 10 Parts Identification

Parts Identification and Numbers (See Figs. 10, 11 and 12)

Item	Part Name	Part Number
1	Compressor Assembly	256581D
2	O-Ring (2), size 4 Aeroquip Coupling	77005
3	Caster (4)	49137
4	Pressure Relief Valve	53028
5	Adsorber Assembly	F256390A
6	Internal By-Pass Valve	270095A
7	Oil-Capillary Filter	50315
8	Gas Equalization Solenoid Valve	263890C
9	Pressure Gauge, Panel Mount, 2 Inch Dial	50532
10	Oil Separator Assembly	F263933A
11	Power Switch	262755A
12	Elapsed Time Meter	35008

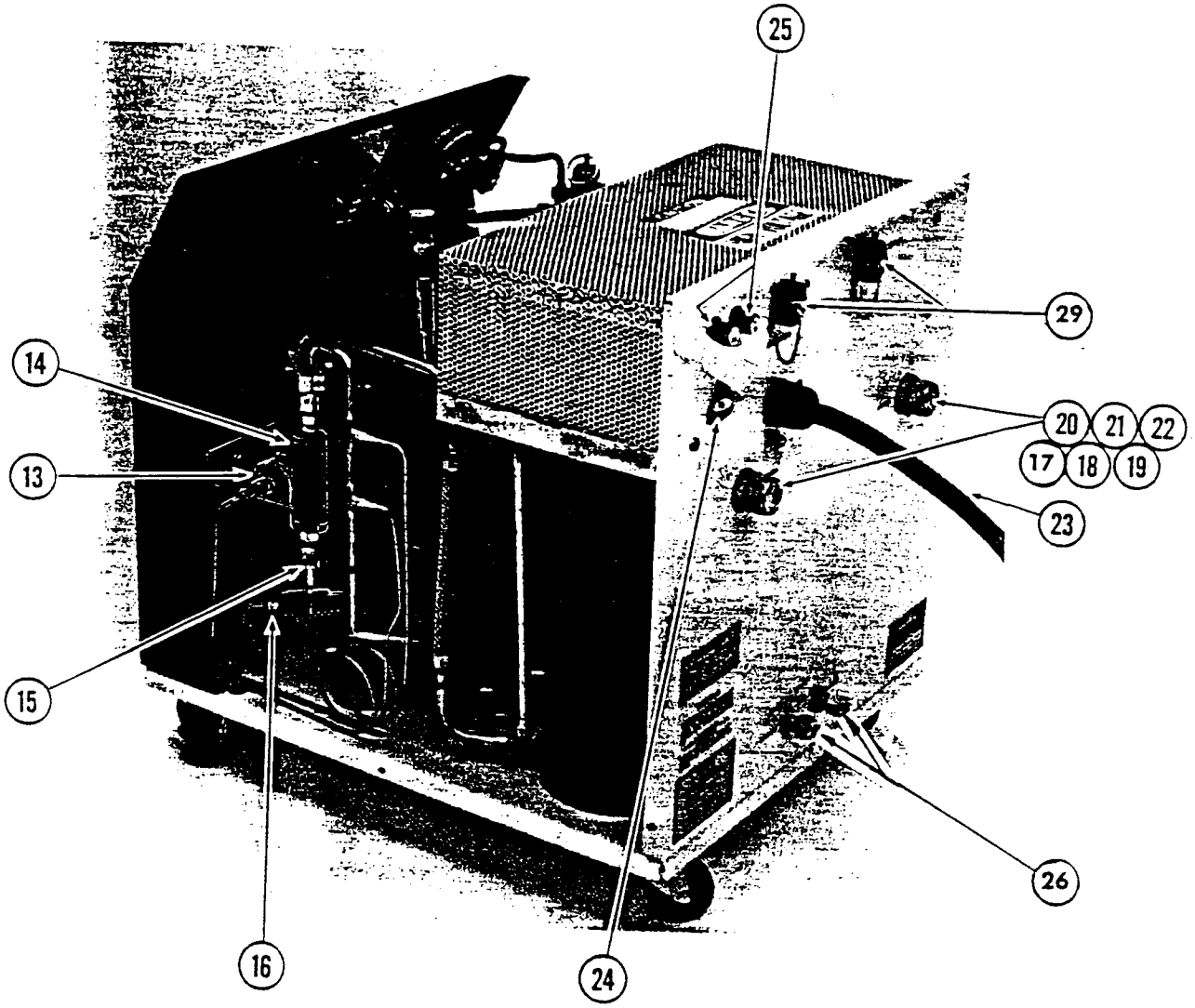

Fig. 11 Parts Identification

Parts Identification and Numbers (See Figs. 10, 11 and 12)

Item	Part Name	Part Number
13	Oil Differential Pressure Switch Assembly	263900C1
14	Oil Injection Filter Assembly	F255008A
15	Oil Injection Orifice	256638B
16	Oil Capillary Assembly	256301C
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	263892B
24	Circuit Breaker, 15A/ 250 V~ 2 Pole	38887
25	Fuse (2), 5.0 AT	34688
26	Fitting (2), Water	14505
27	Gasket Seal, size 4 Aeroquip Coupling	77003
28	Temperature Overload Switch in Retainer	256309A16P
29	Receptacle Cap (2)	34489
30	Fuse (2), 0.63 AT	34687
31	Fuse (2), 0.4 AT	34691

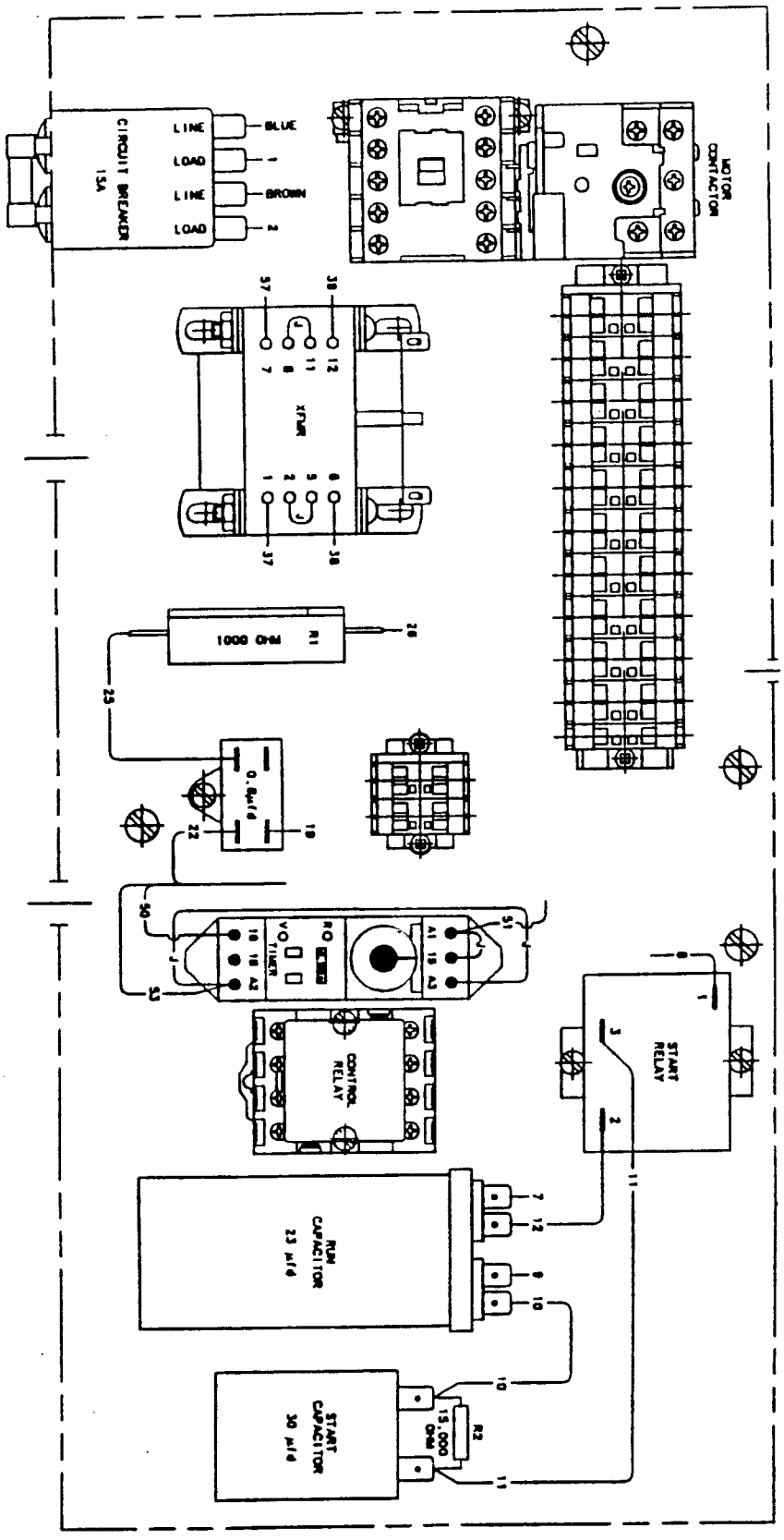

Fig. 12 Electrical Chassis Parts Identification

Parts Identification and Numbers (See Figs. 10, 11 and 12)

Item	Part Name	Part Number
32	Transformer, Control Circuit	39433
33	Time Delay Relay	37454
34	Resistor R1, 1,000 ohms	37526
35	Capacitor, Start, 30 µfd	256309A10P
36	Resistor R2, 15,000 ohms	37501
37	Capacitor, Expander Circuit, 0.8 µfd	32517
38	Capacitor, Run, 23 µfd	256309A11P
39	Start Relay	256309A13P
40	Motor Contactor and Overload Relay	79018
41*	Transformer for 220 V~, 50 Hz Electrical Service or Transformer for 230/ 240 V~, 50 Hz Electrical Service	39402 39416
42*	Adapter, 4 pin to 3 pin, for expander cable. (Furnished when required by customer's 3-pin expander receptacle.)	255605B
43	Water Solenoid Valve	263893C

***Part is not shown.**

Adapter Fittings

The following adapter fittings, required for servicing the HC - 2D - 1 Compressor, are available as accessories. 8F denotes a size 8, female Aeroquip coupling. Figure 13 shows a typical adapter fitting.

Item	Quantity	Part Name	Part Number
1	2	Adapter Fitting, 8F with Valve	255919B2
2	1	Adapter Fitting, 4M with Valve	262557B

Cables

The following cables for use with the HC - 2D - 1 Compressor are available as accessories from APD. Only one of the accessory cables can be used at the same time.

Item	Quantity	Description	Part Number
1	1	Expander Cable for DE - 202 Expander, 3.3 m (11 Ft.)	263941B11
2	1	Accessory Cable for Remote On/ Off, 6 m (20 Ft.)	263887B20
3	1	Accessory Cable for Power to a Cool Pak Air - to - Water Heat Exchanger	T B D
4	1	Accessory Cable for Auxiliary 220 V~ Power, 3 m (10 Ft.)	263888B10

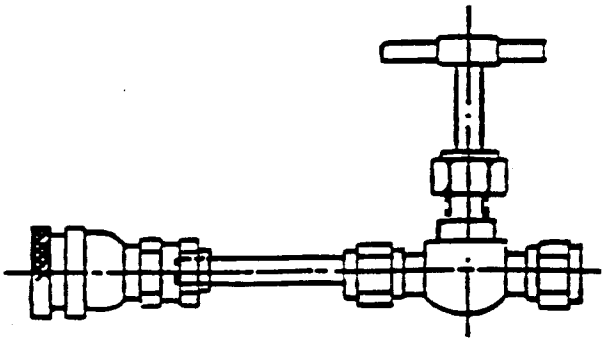

Fig. 13 Typical Adapter Fitting