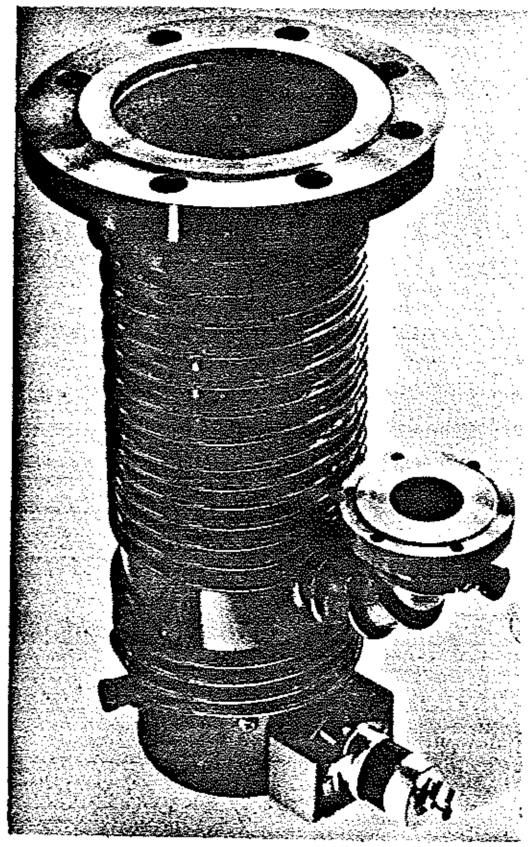
CVC Instruction Manual
No. 6-70-B
Revision No. 1



Consolidated Vacuum Corporation

ROCHESTER CVC Products, Inc. NEW YORK

DIFFUSION PUMPS, TYPES PMC-PMCS
MODELS B & C - 2C, 4B, 6B, 10C

TABLE OF CONTENTS

1.0 INTRODUCTION

This instruction manual is designed to aid you not only in the installation of this equipment but throughout its working life. How well it aids you depends upon how thoroughly you read and make reference to it. Since your warranty does not cover damage resulting from abuse and from errors in installation, it is to your advantage to read this manual as comprehensively as possible. Further assistance is available if necessary. (See Assistance from CVC).

The Table of Contents reveals the plan and scope of this manual.

Description of PMC-PMCS-2C, 4B, 6B, and 10C Diffusion Pumps

Basically the PMC pump you have purchased consists of an inlet flange, casing and forearm (enclosed in cooling coils), outlet flange, heater and nozzle assembly. Pump fluid is not included in the purchase price of the pump and must be ordered as a separate item (see the attached literature).

The PMC is constructed of carbon steel, and the PMCS of stainless steel. The flanges (inlet and outlet), each have raised step seal areas for sealing with the elastomer Con-O-Ring gaskets supplied with the pump.

The pump size is indicated by the particular model number; for example, the 2C model pump is of nominal 2" size, the 4B of nominal 4" size, etc.

"B & C" Model PMC pumps feature cooling coils around the boiler area of the pump casing to provide rapid cooling of the fluid during shut down. A Dri-Cap® Shield is also supplied (except in the PMCS-2C where it would unduly restrict the plateau speed of the pump); as an integral part of the nozzle assembly. Its purpose is to minimize backstreaming of fluid vapor from the pumping area. This shield cap may be easily removed should higher pumping speeds be desired.

230 volt cartridge heaters are available for converting these pumps to operation with electrical service other than the standard anticipated for them. This conversion is discussed in Section 4.5 of this manual.

2.0 INSTALLATION

2.1 Specifications

Specifications	Pump Sizes			
	2"	4"	6"	10"
Inlet Connection	Flange	Flange	Flange	Flange
O.D.	4"	9"	11"	16"
I.D.	2-1/4"	5-1/4"	7"	12"
Thickness	5/8"	15/16"	1"	1-3/16"
Bolt Circle	3-5/16"	7-1/2"	9-1/2"	14-1/4"
No. of Holes	6	8	8	12
Hole Diameter	11/32"	3/4"	7/8"	1"
Outlet Connection	Tubing	Flange	Flange	Flange
O.D.	3/4"	4"	7-1/2"	7-1/2"
I.D.	---	1-5/8"	2-13/16"	2-13/16"
Thickness	---	9/16"	15/16"	15/16"
Bolt Circle	---	3-5/16"	6"	6"
No. of Holes	---	6	4	4
Hole Diameter	---	11/32"	3/4"	3/4"
Cooling Connections	1/8" FPT	1/4" FPT	1/4 FPT	1/4 FPT
Nozzle Material	Aluminum	Aluminum	Aluminum	Aluminum
Casing Material	Stainless Steel	*	*	*
Heater Voltage (Rated)	115 V.	115 V.	115 V.	230 V.
Heater Wattage (Rated)	300 W	1200 W	1800 W	4500 W
Pump Fluid (Quantity)	80 cc	400 cc	800 cc	1500 cc
Net Weight	5 lbs.	28 lbs.	46 lbs.	146 lbs.
Water Flow (Nominal Rate)	1/20 gpm	1/6 gpm	1/4 gpm	3/5 gpm
Over-all Height	11-3/16"	16-5/8"	20-1/2"	28"
Flange to Flange Height	3-1/2"	7-1/2"	7-1/2"	15-1/4"
Flange Center to Flange Center	3"	5-1/2"	8-1/2"	11-3/4"

* Type PMC - Carbon Steel
* Type PMCS - Stainless Steel

2.2 Unpacking and Preparation (Refer to Figure I)

Equipment is normally shipped F. O. B. Rochester, New York. Directly after receipt, this equipment should be unpacked and inspected for shipping damage. Damage in transit is the responsibility of the transportation company and should be reported to them.

Each pump is packed so that it may be stored as received (after initial inspection) if its use is not immediately required.

The following steps should be completed to prepare the pump for set-up:

1. Remove the protective coverings from the pump inlet and outlet and the plastic Caplugs from the connections for the cooling and Quench coils.

2. Remove any packing materials from the inside of the pump.

3. Lift the nozzle assembly out of the casing.

4. Rinse the nozzle assembly, the inside of the casing, and the hollow cylindrical sleeves with petroleum ether* or benzene*.

5. Rinse the same items first with acetone*, then with isopropyl* alcohol

6. Remove all traces of alcohol with oil-free compressed air.

7. Place one sleeve over each of the finned heater housings which extend upward from the bottom of the pump casing.

8. Replace the nozzle assembly in the casing making sure it is seated firmly on the bottom of the casing.

9. Wipe the inlet and outlet flanges to remove all foreign particles.

10. It is desirable that the Con-O-Ring gasket be lubricated with a very light coat of Celvacene® vacuum grease.

*CAUTION: Solvents recommended in this manual may be toxic and/or flammable. Suitable precautions should be observed in using them.

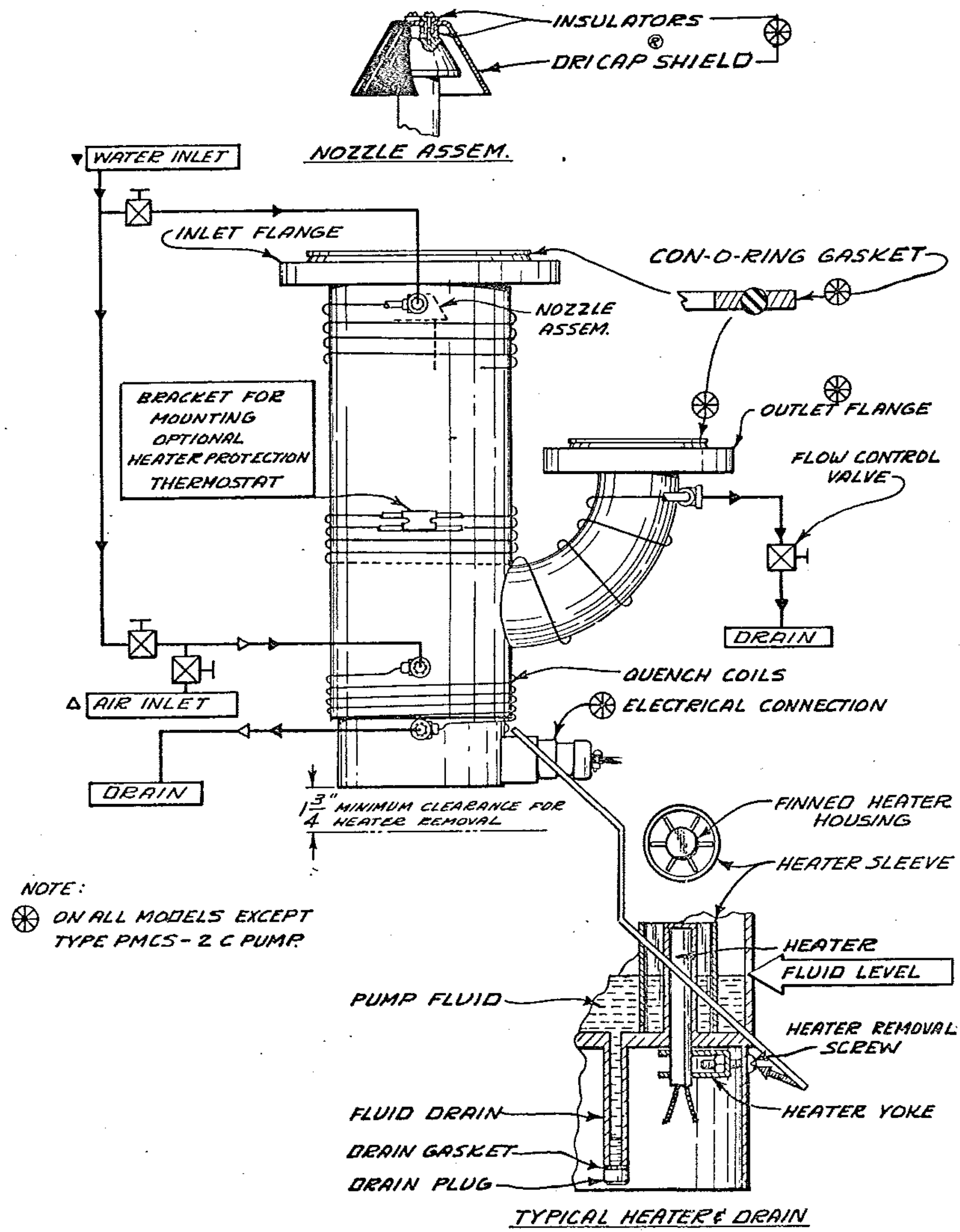


FIG. 1 TYPICAL DIFFUSION PUMP & COOLING SCHEMATIC TYPE PMC

2.3 Connections: (Refer to Figure I).

2.3.1 Vacuum Line Connections

Install the pump so the casing is in a vertical position. Bolt the inlet flange, with the Con-O-Ring gasket positioned, to an ungrooved mating flange attached to the vacuum line. Tighten all bolts to finger tightness then use a wrench to successively tighten pairs of bolts which are opposite each other on the flange. This produces even compression over the entire contact surface of the sealing gasket. The pump is designed so it can be safely suspended by the flange without providing additional support.

Use the same procedure for the outlet.

For further information and recommendations on vacuum piping, connections, and gauging, See Appendix I.

2.3.2 Cooling Connections (Refer to Figure I)

The PMC pumps require water cooling at a nominal inlet temperature of 20° C. Refer to Section 2.1 for the nominal water flow requirements applicable to your particular pump. The FPT connector just below the pump inlet flange is the water inlet; the water outlet is the FPT connector on the outlet arm. The upper connector of the boiler quench coil is for supply line connection and the lower for drain line connection.

It is often advantageous to use a solenoid-operated inlet valve wired to the forepump switch as an on-off control for the water.

1. For the Upper Pump Casing

   Install a valve in the water discharge line. This valve is needed to turn the water on and off. The valve must also be used to adjust the rate of flow to the recommended value each time the water is turned on. If your pump is being installed in a production unit where failure to adjust the rate of flow of cooling water could have serious results, place a valve in the inlet line as shown in Figure I. The discharge valve can be regulated to establish and maintain the proper flow rate; the inlet valve can be used as an on-off control.

2. For the Boiler Quench Coil

A. Connect both a water supply line and a compressed air line to the upper connector of the coil. Both water and air lines should be provided with shut-off valves. The air supply line is utilized to blow the quench coil free of water before energizing the pump heaters.

B. Connect an adequate drain line to the lower connection.

NOTE: It is not essential to the successful operation of the pump that the boiler quench coils be connected. This feature is provided solely for rapid shut-down of the pumps. On some CVC systems this is not connected. It is imperative that the two Caplugs be removed.

2.3.3 Electrical Connections

PMC-PMCS pumps utilize cartridge-type heaters. These heaters are inserted up in the wells in the bottom of the pump boiler. Each heater, with the exception of the 2C, is wired to a plug assembly mounted on the side of the heater guard at the bottom of the pump. The heater wires of the 2C may be connected to a switch or directly to the service cord. The recommended procedure for replacing heaters is presented in Section 4.4., Step 3.

To wire the PMC-4B, 6B or 10C pump, first separate the male and female parts of the power plug assembly. Connect the necessary supply (See Specifications table for volts and wattages) to the female part of the connector plug. CVC recommends that a switch be installed in the line for turning the pump heaters on and off. The purpose of the plug is to permit installation and removal of the pump from the system for cleaning, etc., without the service of a skilled electrician; it is not intended for use as an on-off switch.

The actual heater input of a diffusion pump has an important effect on pump performance. To assure optimum pump operation check the voltage and current to the power supply at or near the pump heater plug to determine whether the recommended operating wattage is available.

2.3.4 Diffusion Pump Backing Requirements

Since diffusion pumps cannot compress gases to atmospheric pressure a forepump, such as rotary, oil sealed mechanical pump, must be employed to further compress the gas load delivered by the diffusion pump. Thus the mechanical pump is also known by one of its primary functions, as a backing pump.

Selection of a mechanical pump to back a given diffusion pump will be determined by (1) the customer's performance requirements, (2) the forepressure characteristics of the diffusion pump (which may be different for different gases), and by (3) the foreline impedance. Because of these variables, the exact mechanical pump rating which is most suitable for your particular application cannot be stated here. Table I lists the required backing speeds at the outlet flanges, of PMC pumps both for normal operating range and for operation at high throughputs.

TABLE I

Backing speed required for air and H_2 at the outlet flange for:

	Normal Operating Range	Utilizing pumps high throughput
PMCS 2C	1.5 CFM	5 CFM
PMC (S) 4B	5 CFM	30 CFM
PMC (S) 6B	10 CFM	80 CFM
PMC (S) 10C	20 CFM	100 CFM

$\frac{CFM}{2.12} \approx$ liters/sec.

2.4 Leak Testing the System

1. Refer to the data supplied with your mechanical pump for information on cooling rate, starting procedure, adjusting the oil flow rate, and ultimate pressure.

2. Start the mechanical pump.

3. Check the ultimate pressure of the mechanical pump. A pressure which is equal or nearly equal to that listed in the manufacturer's data indicates that the system is leak tight. Thermo-conductivity gauges will indicate higher pressures than those given in the mechanical pump manufacturer's data. A high ultimate pressure indicates that the pump is not performing properly or that the system leaks.

   A. If the system is valved, isolate the mechanical pump from the remainder of the system and test the pump alone to make sure it is performing properly.

   B. Open the entire system to the mechanical pump. After an interval of pumping (the length of this interval for a particular pump depends primarily on the size of the system) the pressure should approximate that obtained in step 3.

4. Valve off the system and check the rate of pressure rise (See Appendix II, Section 8.3).

2.5 Charging the Pump with Fluid

Make certain all containers, funnels, tubing, etc., that will come in contact with the fluid are clean, to avoid contaminating it.

Several types of pump fluid are available for use in diffusion pumps. The general characteristics of each of these fluids and the general effects of the fluid on the pump performance differ as indicated in Table II. The fluid quantity requirements of the various size PMC pumps are shown in the Specifications (Section 2.1).

TABLE II

Pump Fluid Type	Recommendations*
Convoil-20	General purpose fluid
Convalex®-10 DC-705	For low ultimate pressures and high resistance to decomposition
DC-704	For high resistance to decomposition

*See attached literature for further details.

2.5.1 Methods of Charging the Pump

Select whichever of the following techniques will cause the least disturbance of the seals.

1. By pouring the fluid down through the forearm:

   A. Remove the foreline connections.

   B. Pour the required amount of fluid into the foreline port.

   C. Reconnect the foreline.

2. By pouring the fluid in through the pump inlet:

   A. Pour the required amount of fluid down the inside of the casing wall. If there is interference in the form of valving, etc., select an alternate method or remove the pump from the system.

   B. Reinstall the pump in the system.

3. By drawing fluid up through the boiler drain:

   A. Place the required quantity of fluid in a clean container.

B. With the system at atmospheric pressure, remove the boiler drain cap.

C. Start the mechanical pump.

D. Slowly draw the fluid from the container into the boiler through a length of clean tubing connected to the boiler drain.

WARNING: After the fluid is in the pump DO NOT allow air to be continually drawn into the pump.

E. Remove the tubing and quickly replace the drain cap.

F. Turn off the mechanical pump.

2.5.2 Storage of Pump Fluids

1. Light-sensitive fluids should be stored in tightly stoppered, brown glass bottles.

2. All fluids should be stored in clean, tightly-closed, plainly labeled containers.

3.0 OPERATION

3.1 Start-Up Procedure

1. Start the mechanical pump.

2. Open appropriate valves to the pump foreline. Adjust the water cooling (quench coil OFF) rate for the diffusion pump. See Section 2.1. Outlet temperature should be approximately 50° C if either Convoil-20 or DC-704 is used.

3. Turn on the diffusion pump heaters. Warm up time is dependent upon pump size, water cooling temperature, etc. A small quantity of dissolved gas will be liberated from the warming fluid causing a short duration pressure rise.

4. Check the inlet pressure of the diffusion pump after it has been operating for a short interval. It should be in the ion gauge range.

3.2 Performance Check

1. Pump performance data should be recorded each time the pump is operated. This performance record will indicate a need for maintenance or repair before the pump performance deteriorates. A gradual increase in the ultimate pressure of the mechanical pump or the diffusion pump may indicate fluid or system contamination or leakage. The following performance characteristics should be recorded daily.

   A. Ultimate pressure of the mechanical pump (blanked off if possible).

   B. Ultimate pressure of the diffusion pump.

   C. Time required to reduce the pressure in the system to the required operating value.

   D. Cooling water temperature, in and out.

   E. Monitor heater current if convenient.

3.3 Shut-Down Procedure

1. Turn off the diffusion pump heaters.

2. Turn on the water supply to the boiler quench coil (if utilized).

3. Allow the diffusion pump to cool until the boiler bottom is cool to the touch, then turn off all cooling water.

4. If the boiler quench coil was used to expedite the cool-down, blow all traces of water out of the coil. Failure to do this will result in a build up of mineral deposits.

5. It is now safe to break vacuum (Recommended practice is to break vacuum by bleeding gas to the system on the intake side of the diffusion pump. This removes the chance of mechanical pump fluid being forced into the diffusion pump).

CAUTION: If air is accidentally admitted to the hot diffusion pump and the pressure rises above 1 torr, the pump heaters should be turned off and the quench coil activated. Ordinarily damage to the hot fluid will be negligible as long as the temperature is not caused to rise above the normal operating temperature as would be the case if the heaters were not turned off and the vaporization suppressed by the presence of gas at pressures above 1 torr.

3.4 Need for Spare Parts

If a supply of spare parts is stocked, down time can be minimized. All parts which should be stocked for your pump are indicated on the parts list.

4.0 MAINTENANCE

If pump operation meets your requirements (as evidenced by the results of the Performance Check), no further attention need be given to the pumping system at this time. Monitoring the daily performance records will indicate the need for corrective action. A routine periodic inspection should also be made.

4.1 Periodic Inspection Procedure

This procedure should be performed at regular intervals. The length of the interval depends upon the particular installation and can best be determined by experience. An interval of approximately 14 operating days may be used as a starter. This can be extended contingent upon satisfactory system performance.

1. Check the quantity and condition of the diffusion pump fluid. Replace or add fluid as indicated. Loss of fluid may be caused by:

   A. Periodic or continuous lack of proper cooling.

   B. Excessive operation above the recommended maximum inlet pressure.

   C. A horizontal inlet line which does not allow migrating fluid to return to the diffusion pump.

2. Check the heater input.

   If an ammeter in the heater line indicates a low amperage, one or more heaters may have burned out. See Section 4.4, step 3 for the recommended replacement procedure.

4.2 Cleaning Procedure

This procedure is used when pump fluid is changed as well as when the pump is dirty.

1. Remove the pump from the system.

2. Remove the nozzle assembly and heater sleeves from the casing.

3. Remove all traces of pump fluid from the nozzle assembly and casing. The following Table III list recommended solvents for the basic types of pump fluid. Refer to "CAUTION" on page 8.

TABLE III

Type of Fluid	Pump Fluid Trade Names	Solvent
Ester Fluid	Octoil ®, Butyl Phthalate	Acetone
Hydrocarbon Fluid	Convoil	Benzene or "Skelly F"
Polyphenyl Ether*	Convalex®-10	Xylene (followed by Methyl-Ethyl-Ketone)
Silicone Fluid	DC-702, -703 and DC-704, -705	Toluene or trichlorethylene

4. Remove all traces of solvent from the nozzle assembly and casing by rinsing them with acetone, then isopropyl alcohol.

5. Use dry, oil-free compressed air to remove all the solvent from the nozzle assembly and casing.

6. Replace heater sleeves and the nozzle assembly in the casing. Make certain it is properly centered and is resting squarely on the bottom of the casing.

7. Connect the pump to the system.

8. Leak-test the system as outlined in Section 2.4.

*U.S. Patent No. 3,034,700.

9. Charge the pump in the manner described in Section 2.4. The pump is now ready for operation.

4.3 Special Procedures

1. To remove tars from the nozzle assembly and casing interior:

   A. Degreasing, scrubbing with steel wool, or sand blasting may be required if tars are very heavy.

   B. Follow such with an acetone rinse, etc.

2. To remove crystals resulting from decomposed ester fluids.

   A. Degrease.

   B. Clean with detergent.

   C. Rinse with water.

   D. Rinse with acetone.

3. To replace cartridge heaters:

   A. Disconnect the heater leads.

   B. Loosen the heater retainer with the screw on the side of the heater guard.

   C. Remove the burned out heater.

   D. Dip the replacement heater in milk of magnesia. This is important because it prevents the heater from seizing in the well.

   E. Insert the replacement heater in the well and tighten the heater retainer.

   F. Reconnect the heater leads.

4.4 Removing the Dri-Vap® Shield from the Nozzle Assembly

As has already been stated, the PMCS-2C has not been provided with a Dri-Cap® shield. Consequently, this section need not concern the owner of such a pump.

The PMC (S)-4B, 6B, & 10C pumps do have Dri-Cap® shields factory installed on their respective nozzle assemblies. Thes can be removed when the highest pumping speed is desired and when slight back-streaming of pump fluid presents no problem. This is done in the following manner:

4.4.1 Dri-Cap® Shield removal from the PMC(S)-4 & 6B.

1. Pry off the cap retainer (push-on speed nut).
2. Lift the Dri-Cap shield and two ceramic insulators off the stud on which they are positioned. Store these parts in a safe place.

4.4.2 Dri-Cap® shield removal from PMC(S)-10C.

This is accomplished by unscrewing three slot head screws and lifting the Dri-Cap shield and the insulators beneath it up off of the nozzle assembly. Store these parts for possible use at a later date.

4.5 Converting to 230 Volt or 460 Volt Operation

230 Volt, 300 watt cartridge heaters are available from CVC (See Replacement Parts) for direct conversion of the pump for use with 230 or 460 volt service. The cartridge substitution is accomplished as described in Section 4.3, No. 3 and as is illustrated in Figure 1.

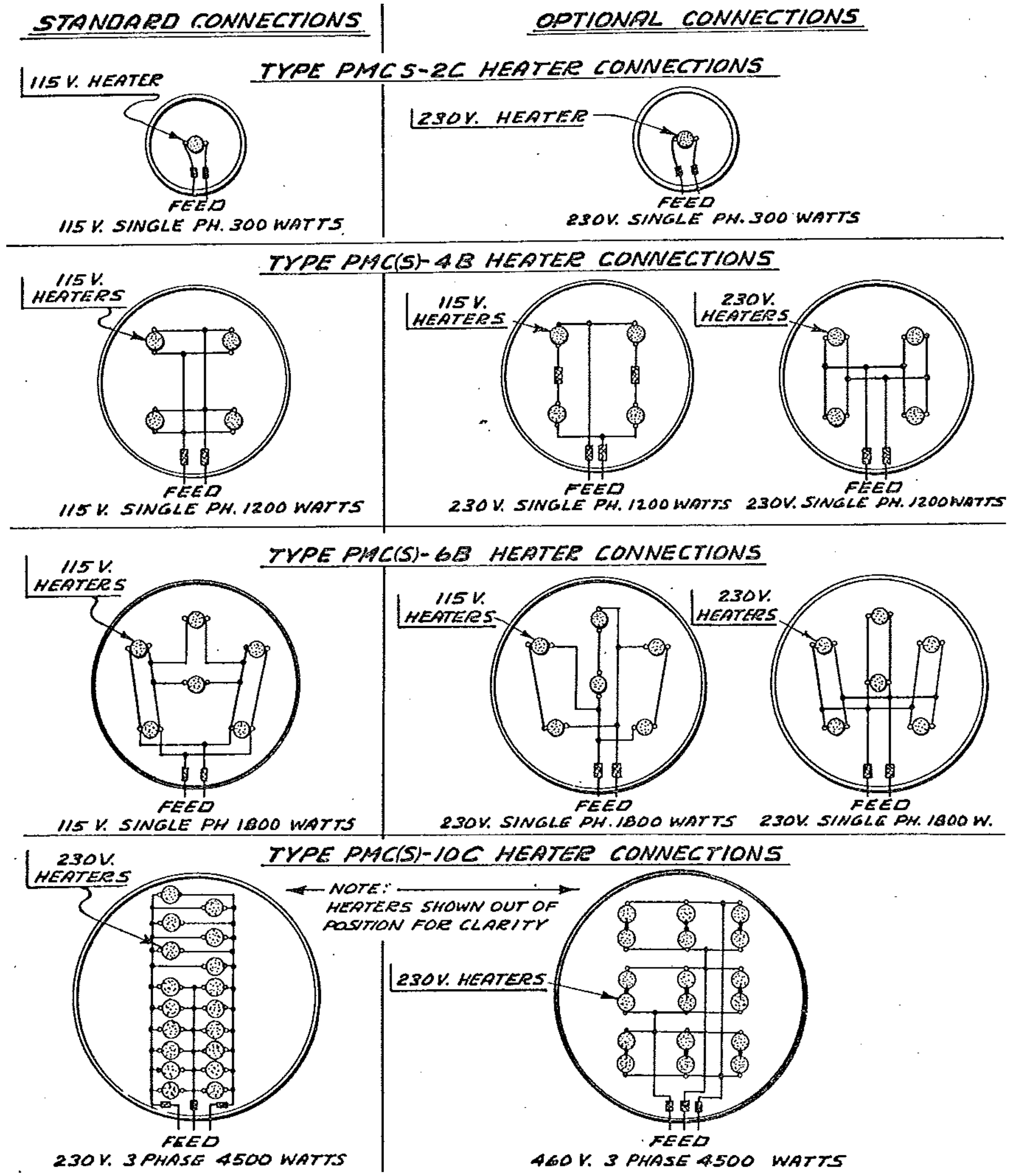


FIG. 2 STANDARD & OPTIONAL HEATER CONNECTIONS FOR PMC PUMPS

	PMCS-2C	PMC(S)4B	PMC(S)6B	PMC(S)10C
No. of heaters	1	4	6	18
Power	300 W	1200 W	1800 W	4500 W
Service				
1ϕ @ 115 V	STD.	STD.	STD.	
1ϕ @ 230 V	*	*	*	
3ϕ @ 230 V			*(#)	STD.
3ϕ @ 460 V			*(#)	*
1ϕ @ 460 V		*(#)	*(#)	
(#) - Plug not usable				

In cases where the electrical connector plug cannot be used, the larger plug used on the PMC-10C can be substituted. The customer will, however, have to develop his own mounting technique.

Refer to Figure 2 when wiring the cartridge heaters for the proper service.

* The asterisks indicate the conversions possible.

5.0 TROUBLE SHOOTING TABLE

Check the accuracy of the vacuum gauges used on the system before attempting to locate the cause of poor ultimate pressure.

Trouble	Possible Cause	Remedy
Deterioration of Operating pressure (or cycle time)	Component pump malfunctioning	Blank off the pump successively from the mechanical pump through the diffusion pump to check for satisfactory operation.
	Leakage	Refer to Appendix II.
	System Contamination	Clean as needed.
Poor ultimate pressure	Insufficient time of operation	
	Leak in system	Refer to Appendix II.
		Refer to manufacturer's instructions for mechanical pump.
	Insufficient or excessive diffusion pump heater input.	Make certain heater input is properly adjusted.
	Insufficient or excessive diffusion pump cooling	Make certain inlet temperature is as specified in Section 2.3.2, i.e., 20° C.
	Water in quench coil	Blow coil free of water.
	Excessive forepressure	Check foreline for leaks. Check the mechanical pump performance.

Trouble	Possible Cause	Remedy
	Vapor pump fluid contaminated with mechanical pump oil or damage by exposure of the hot fluid to excessive pressure or process contamination.	Drain diffusion pump boiler and refill with new fluid.
	Dirty process system	Clean the system.
Periodic Surges in inlet pressure of diffusion pump.	Heater input too high.	Check required heater input and adjust accordingly.
	Too much or too little fluid in pump.	Make certain pump boiler contains only recommended quantity of fluid.
	Outgassing of fluid. This is characteristic of some fluids during initial use.	Age fluid by operating pump.
	Too much grease or oil in the gasket groove of the inlet flange.	Remove pump from system and wipe groove dry.
	Loose or leaky boiler drain gasket.	Tighten drain plug or replace gasket.
Cracking noise in boiler.	This is not harmful unless accompanied by a decline in pump performance.	

6.0 ASSISTANCE FROM CVC

EQUIPMENT ASSISTANCE SERVICE IN THE FIELD. CVC offers two kinds of Equipment Assistance Service to customers. The first kind is equipment service in the field, and the second kind is in-plant service. Equipment Assistance Service in the field consists of two types: (1) Emergency Service, (2) Scheduled Service.

1. Emergency Service-The emergency service is on e of the most important services offered by CVC. Emergency service takes top priority over all other services offered. If a CVC vacuum system does not operate, call your CVC field sales offices to get a CVC customer engineering representative to the equipment as soon as possible.

2. Scheduled Service-The second kind of Equipment Assistance Service offered by CVC is the Scheduled Service. The lead time needed for scheduling this service is approximately ten days. This lead time is necessary for evaluating the situation and planning the length of time the CVC customer engineering representative will spend at the customer's plant. This lead time also will provide time for arranging a mutually convenient schedule.

   Scheduled Service is useful if CVC vacuum equipment requires modification or modernization. If difficulty is encountered in rebuilding, repairing, cleaning, reassembling, or installing accessories on CVC equipment, Scheduled Service will resolve the situation. The service can also be utilized if CVC vacuum equipment must be moved to a new location. Another reason for obtaining this service is a checkout of the CVC vacuum equipment.

The two types of Equipment Assistance Service do not include process assistance, nor service connections as electrical or water service. These the customer must provide.

EQUIPMENT ASSISTANCE SERVICE IN THE PLANT - The second kind of Equipment Assistance Service offered is in-plant service. This in-plant service consists of two types: (1) Instruction (2) Gauge Calibration.

1. Instruction - Instruction on CVC vacuum equipment for the most part is given at the CVC plant. On many occasions, vacuum-equipment instructions have been given at the customer's plant. This instruction is given on the customer's specific vacuum system and also includes (1) the latest vacuum technology (2) the range of system usefulness, and (3) optional suggestions for efficient system operation. The scheduling of this instruction is coordinated between the customer and CVC.

2. Gauge Calibration - The second type of Equipment Assistance Service that is given at CVC is gauge calibration. The frequency of CVC gauge calibration depends on the cleanliness of the process on which the gauge is used. The scheduling of gauge calibration is coordinated between the customer and CVC. This coordinated schedule gives a minimum time loss because of gauge absence from the customer's vacuum system.

OBTAINING EQUIPMENT ASSISTANCE SERVICE - Wherever there is a need for Equipment Assistance Service or information about the various services offered, the CVC field office will gladly schedule the services. Field Sales Offices and Locations are listed on the following page.

STANDARD WARRANTY

The following warranty will apply only upon condition that Buyer has utilized or operated the goods in strict conformance with operating instructions and manuals appropriate for the goods and any other instructions provided by Seller.

Seller warrants that all goods will be as specified on this order and will be free from defects. No warranty as to fitness, nor suitability to the Buyer's process, nor any other warranty, except of title, shall be implied. Minor deviations from specifications, which do not affect performance of the products covered hereby, shall not be deemed to constitute defects of materials or workmanship or a failure to comply with the specifications referred to herein.

Notice of any claim that the products are in any way defective shall be given the Seller immediately on discovery and the Seller shall thereupon correct the defects by repair or replacement without charge F.O.B. Shipping Point. The liability of the Seller arising out of the supplying of said products, whether based on warranty or otherwise, shall in no case exceed the cost of the parts or products, and all liability shall terminate within one year after shipment from the Seller's plant. The foregoing warranty does not apply to vacuum tubes, diodes, transistors, batteries, lamps or other items which are expendable by nature. No warranty whatever is made with respects to these items and Seller does not agree to reapir or replace them. All vacuum gauge sensing elements, such as, thermocouple tubes, Pirani tubes, Philips tubes, etc., are warranted against defects in manufacture in normal use, as determined by Seller's inspection, for a period of 90 days from date of shipment, provided the defective gauge tube is returned to Seller at Rochester, New York for inspection.

STANDARD ACCEPTANCE

The products covered by the order shall be deemed finally inspected and accepted within (10) days after delivery thereof, unless notice of rejection or notice of any claim, express or implied, is given in writing to the Seller within said period. Acceptance as aforesaid shall be deemed full performance of the Seller's obligations hereunder save for its obligation under the above warranty.

7.0 CONSOLIDATED VACUUM CORPORATION SALES OFFICES AND LOCATIONS

Albuquerque, New Mexico 87101
141 Wyoming, N.E.

Atlanta, Georgia 30305
3272 Peachtree Road, N.E.

Needham Heights, Mass. 46494
45 Fourth Avenue

Des Plaines, Ill. 60018
3150 Des Plaines Avenue
Room 25

Columbus, Ohio 43212
1350 West Fifth Avenue

Van Nuys, California ~~91401~~
~~5430 Van Nuys Blvd.~~
~~Suite 314~~

Dallas, Texas 75207
433 Regal Row

Springfield, New Jersey 07081
26 Linden Avenue
P.O. Box 142

~~Palo Alto, California 94303~~
~~4015 Fabian Way~~

Philadelphia, Pennsylvania 19145
2010 Oregon Avenue

Rochester, New York 14603
1775 Mt. Read Blvd.

Minneapolis, Minnesota 55410
7100 France Avenue
Suite 23

CONSOLIDATED VACUUM INTERNATIONAL-SERVICE AND SALES OFFICE LOCATIONS

B & H Ltd.
14 Commercial Road
Woking, Surrey, ENGLAND

CVC Products, Inc.
7120 Hayvenhurst Ave.
Van Nuys, Ca 91406
(213) 787-6001

B & H GmbH.
Frankfurter Strasse
Postbox 345
Friedberg, WEST GERMANY

26034 Eden Landing Rd.
Hayward, Ca 94545
(415) 785-4440

8.0 APPENDIX I - GENERAL RECOMMENDATIONS CONCERNING VACUUM SYSTEMS

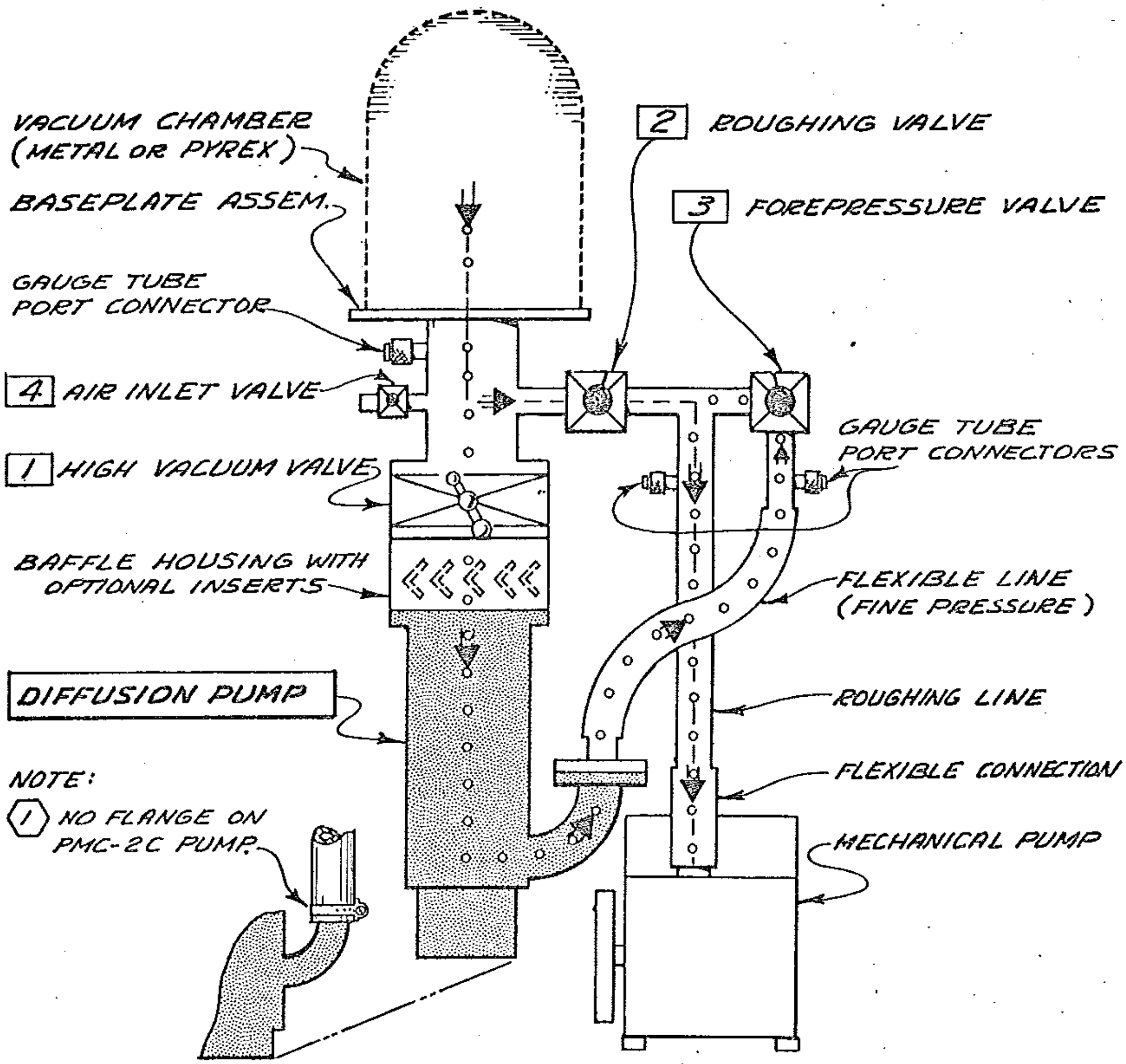
8.1 Vacuum Piping

The connection between the processing chamber and the diffusion pump should be as large in diameter as possible and as short as possible to take advantage of the speed of the pump. Incline the line downward towards the pump inlet if possible so that any pump fluid vapor which enters the line and condenses can flow back into the pump. A valve should be installed near the pump inlet so the processing vessel can be opened to atmosphere without cooling the pump.

The foreline between the diffusion pump and the forepump* should be at least as large in diameter as the inlet of the forepump. A flexible section of piping (tubing) should be installed between the forepressure valve and the mechanical pump to dampen vibration. A valve installed near the forepump inlet will facilitate measurement of the blank-off pressure of the forepump.

A separate roughing line (valves as indicated in Figure 3) may be installed between the chamber and the mechanical pump if short cycle time is desirable. With the piping arrangement, the mechanical pump can rapidly reduce the system pressure into the diffusion pump range. During this time, the diffusion pump is valved-off from the rest of the system and held at operating temperature and pressure. If the processing chamber is small, a single mechanical pump can often be used alternately for roughing the chamber and for backing the diffusion pump.

* Forepump - The pump which lowers the pressure into the operating range of the vapor pump.



TYPICAL VALVE OPERATION

SYM.	PUMPING PHASE	VALVES CLOSED				VALVES OPEN			
----	ROUGHING	1		3	4		2		
0000	FINE PRESSURE		2		4	1		3	
	OPEN CHAMBER	1	2					3	4
⇛	INDICATES PUMPING DIRECTION.								

FIG. 3 TYPICAL INSTALLATION & OPERATION OF TYPE PMC PUMPS

The foreline can be sized to serve as a ballast tank, or a tank can be installed in the line, to prevent the forepressure from building up to the value at which the action of the diffusion pump breaks down. If the chamber is large or the roughing cycle is long, a second mechanical pump can be connected to the forepressure line to serve as a holding pump while the roughing pump is reducing the chamber pressure into the diffusion pump range. Chamber size, allowable cycle time, and diffusion pump size all influence the capacity of the chosen mechanical pump or pumps.

8.2 Location of Gauge Ports

There are two locations in any vacuum system where pressure should be checked if you wish to maintain the system at optimum operating level. A gauge port should be installed in the vacuum chamber to monitor the pressure at which the process is being performed. A second port should be installed in the foreline to check the blank-off pressure of the mechanical pump. If the foreline is long, it is often advisable to install one gauge port near the diffusion pump outlet, and another near the mechanical pump inlet. The complexity of the pumping system influences the location of foreline gauging. It is convenient to have gauge ports provided wherever a section of the system can be isolated.

Convenient gauge ports consist of compression connectors (available from CVC) attached to the system piping.

8.3 Types of Vacuum Piping Joints

A welded joint is the most satisfactory type of permanent leak-tight joint. In some cases, however, welded joints are impractical. Examples of this situation are components (pumps, valves, etc.) which must occasionally be removed from the vacuum system for maintenance and/or repair. A flanged joint with a elastomer gasket (such as the Con-O-Ring gasket type) is most satisfactory.

9.0 APPENDIX II - LOCATING AND REPAIRING LEAKS

The subject of leak detection and repair is complex and cannot be treated in detail here. Several textbooks are available, e.g., "Vacuum Equipment & Techniques" by Guthrie and Wakerling, "Vacuum Technology", Guthrie and "Principles of Vacuum Engineering", Pirani and Yarwood.

9.1 Use of Vacuum Gauges

Hot filament ion gauge and thermal-conductivity types of gauges (Pirani and Thermocouple) will all indicate leakage into a vacuum system. The ionization sensing tube generally reads the pressure in the high vacuum area of a system and thus its leak detection application is mostly confined to this area.

The Pirani and Thermocouple sensing tubes, because of the higher pressure ranges they read, are located throughout the vacuum system.

The reason underlying the application of these gauges to leak detection is that their sensitivity is different for different gases. Of the gases most commonly used for leak detection (Freon, Acetone, Hydrogen and Illuminating gas) Freon is the more commonly used. The others are flammable and/or toxic and, in the case of acetone, will act as a solvent for most paint finishes.

Location where leakage is suspected should be sprayed with the agent selected (Freon, etc.). If a leak exists the gauge will show a noticable pressure rise when its sensing tube detects the influx of hydrogen.

9.2 Use of Special Leak Detecting Instruments

Consolidated Electrodynamics Corporation, Pasadena, California, manufactures helium-sensitive, mass-spectrometer, leak detectors which are capable of detecting leakage in the order of 5×10^{-11} atm. cc/sec. of helium. Additional information on these instruments is available from CEC.

9.3 Rate-of-Pressure-Rise Method

This method can be applied to vacuum systems or portions of vacuum systems which (A) can be isolated from the pumps by appropriate valving, and (B) contain suitable gauging for measuring the pressures to be encountered in the rate of rise measurement.

Though this technique will not pin-point a leak, it may isolate it to a portion of the system, or verify that a leak is present. It may be useful where the methods described under 8.1 and 8.2 cannot be applied. By interpreting the recorded data derived from the pressure readings, rises resulting from leakage can also be differentiated from outgassing pressure rises.

The procedure is as follows:

1. Evacuate the system.

2. Valve off the section of the system under suspicion.

3. Record the pressure increase vs. time readings in the section from an appropriate continuously indicating vacuum gauge.

This data can then be compared with similar data taken previously under conditions where no leaks were present. If such previous data are not available then a linear plot of pressure vs. time should be made.

The resulting curve is a composite of the pressure rise due to inleakage and outgassing. Inleakage alone will give a straight line rise. Outgassing on the other hand decreased with time and the plot of pressure rise due to outgassing alone (without inleakage) is a rising curve of decreasing slope. The composite curve thus reflects the sum of a curve and a straight line. To distinguish the inleakage rate, the outgassing rate must be small enough that the composite curve is almost straight. Such a constant rate of rise multiplied by the volume of the system (or section) will provide the rate of inleakage.

The rate of inleakage can only be determined if knowledge of the outgassing characteristics of the system are known or if the system is pumped until outgassing is small compared to inleakage.

9.4 Check List for Joint Repair

The following deck list indicates the location in vacuum systems where experience has shown that leaks most often occur. Corresponding remedial action, both temporary and permanent, is listed for each.

Type of Joint	Temporary	Permanent
Flange Connection	Further tighten stopping short of applying force which could dimple seal surface	Remove and inspect the gasket for wear, cracks, etc. Check the seal areas for scratches etc. Redress the seal areas and replace the gaskets as is necessary.
Diffusion Pump Drains	Further tighten using care not to strip threads	Remove the plug and replace the gasket.
Compression Fittings	Apply more pressure	Replace the compression gaskets
Threaded Fittings	Apply more torque	Separate the threaded members. Paint the male thread with Glyptal or, if the thread size is relatively small, wrap it with Teflon tape. Reconnect.
Welded Joints	Apply Dux-Seal or vacuum wax directly to the leak. Repeated coats of Glyptal may also be painted on the leak. If the area will be subjected to elevated temperatures, these measures will be ineffective.	Grind away the weld in the area of the leak. Reweld the area.

Type of Joint	Temporary	Permanent
Soldered Joints	Same as temporary measures for welded joints.	Apply flux, heat and more solder to the leak area. Sweated joints may have to be separated, cleaned and resweated together again.

10.0 REPLACEMENT PARTS LIST FOR THE 2-INCH OIL DIFFUSION PUMP, TYPE PMCS-2C

MINIMUM ORDER BILLING OF $10.00 PER ORDER. PLEASE INCLUDE PART NUMBER AND DESCRIPTION OF EACH PART ORDERED.

Description	Part No.
Nozzle Assembly	65573
Cartridge Heater, 115 V., 300 W	65192
Cartridge Heater, 230 V., 300 W	65192-1
Con-O-Ring Gasket (Buna-N) 2"	265056-2
Gasket for Drain Plug	26441
SUPPLY ITEMS:	
NOTE: See Attached ADVANCE ORDER BLANK for fluid supplies.	
Celvacene® Vacuum Grease (Medium) 1/4 lb.	269352-11
O-Ring Replacement 2" Buna-N	70011-8
O-Ring Replacement 2" Viton-A	264091-15
Thermostat	264727

REPLACEMENT PARTS LIST FOR THE 4-INCH OIL DIFFUSION PUMPS, TYPES PMC, PMCS-4B

MINIMUM ORDER BILLING OF $10.00 PER ORDER. PLEASE INCLUDE PART NUMBER AND DESCRIPTION OF EACH PART ORDERED.

Description	Part No.
Gasket, Drain Plug, Copper	261122-2
Con-O-Ring Gasket, Buna-N 4"	265056-4
Con-O-Ring Gasket, Buna-N 2"	265056-2
Cartridge Heater, 115 V., 300 W	65192
Cartridge Heater, 230 V., 300 W	65192-1
Nozzle Assembly	64956

SUPPLY ITEMS:

NOTE: See attached ADVANCE ORDER BLANK for fluid supplies.

Description	Part No.
Celvacene® Vacuum Grease (Medium) 1/4 lb.	269352-11
O-Ring, 4" replacement, Buna-N	70011-34
O-Ring, 2" replacement, Buna-N	70011-8
O-Ring, 4" replacement, Viton-A	264091-18
O-Ring, 2" replacement, Viton-A	264091-15
Thermostat	264727

REPLACEMENT PARTS LIST FOR THE 6-INCH OIL DIFFUSION PUMP, TYPES PMC, PMCS-6B

MINIMUM ORDER BILLING OF $10.00 PER ORDER. PLEASE INCLUDE PART NUMBER AND DESCRIPTION OF EACH PART ORDERED.

Description	Part No.
Cartridge Heater, 115 V., 300 W	65192
Cartridge Heater, 230 V., 300 W	65192-1
Gasket for Drain Plug, Copper	261122-2
Con-O-Ring Gasket, Buna-N 6"	265056-6
Con-O-Ring Gasket, Buna-N 3"	265056-3
Nozzle Assembly	261725

SUPPLY ITEMS:

NOTE: See attached ADVANCE ORDER BLANK for fluid supplies.

Celvacene® Vacuum Grease (Medium) 1/4 lb.	269352-11
O-Ring, 6" replacement, Buna-N	70011-42
O-Ring, 3" replacement, Buna-N	70011-20
O-Ring, 6" replacement, Viton-A	264091-19
O-Ring, 3" replacement, Viton-A	264091-17
Thermostat	264727

REPLACEMENT PARTS LIST FOR THE 10-INCH OIL DIFFUSION PUMPS, TYPES PMC, PMCS-10C

MINIMUM ORDER BILLING OF $10.00 PER ORDER. PLEASE INCLUDE PART NUMBER AND DESCRIPTION OF EACH PART ORDERED.

Description	Part No.
Cartridge Heater, (18 Req'd.) 230 V., 250 W	270819
Gasket for Drain Plug, Copper	261122-2
Con-O-Ring Gasket, Buna-N, 10"	265056-11
Con-O-Ring Gasket, Buna-N, 3"	265056-3
Nozzle Assembly	270909
Plug, 4 Wire	68150
Connector - Cord (Receptacle)	68149
SUPPLY ITEMS:	
NOTE: See Attached ADVANCE ORDER BLANK for fluid supplies.	
Celvacene® Vacuum Grease (Medium) 1/4 lb.	269352-11
O-Ring, 10" replacement, Buna-N	70011-56
O-Ring, 3" replacement, Buna-N	70011-20
O-Ring, 10" replacement, Viton-A	264091-20
O-Ring, 3" replacement, Viton-A	264091-17
Thermostat	264727