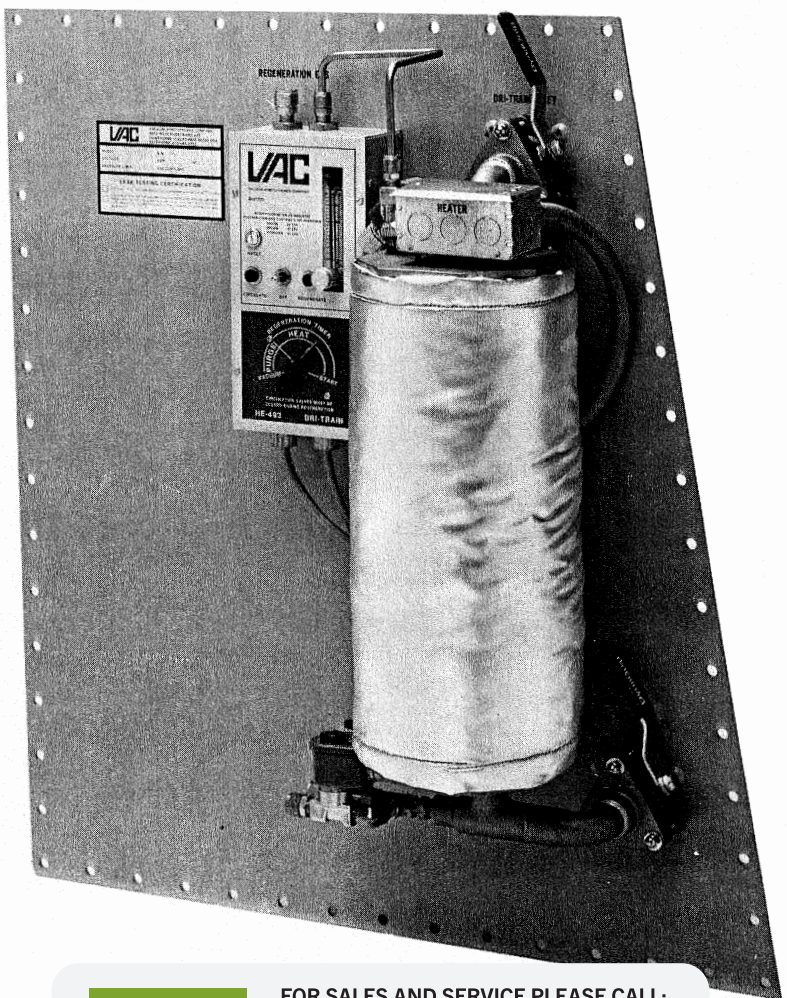
DRI-TRAIN TECHNICAL MANUAL

MODEL HE-493



HE-493-7/80

VACUUM/ATMOSPHERES COMPANY
4652 ROSECRANS AVE. • HAWTHORNE, CA 90250-6896
TELEPHONE (310) 644-0255 • FAX (310) 970-0980

INTRODUCTION

This manual is presented to provide the users of Vacuum/Atmospheres DRI-TRAIN systems with data pertinent to installation, operation, and maintenance of the HE-493.

Additional information is provided concerning the applications, theory of operation, and parts.

A table of contents and a subject index (at the back of the manual) provide ready accessibility of all data.

Drawings and photos herein add to the overall clarity and accuracy of the text.

Additional requirement for information relative to any VAC system should be referred to:

Vacuum/Atmospheres Company
4652 West Rosecrans Avenue
P. O. Box 1043
Hawthorne, California 90250-6896
Telephone: (310) 644-0255
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IMPORTANT
SERVICE BULLETIN

READ CAREFULLY

Dear Customer:

Vacuum/Atmospheres Company wishes to continue to provide you with the very best service possible. Recent changes in environmental laws now require some changes in our "returned goods" policies.

Before any item may be returned for repair or replacement, a **Returned Goods Authorization Number (RGA)** must be obtained from the VAC Sales Department. Be prepared to provide information about the chemicals which the item to be returned has been exposed. VAC Sales may be reached at:

Telephone:	(310) 644-0255	(8:00am - 5:00pm PST)
Fax:	(310) 970-0980	(24 Hours)

The **RGA** Number must be shown on the packing slip accompanying the item and be marked on the outside of the shipping container. Items without a **RGA** Number will not be accepted for repair or replacement.

Material Safety Data Sheets (MSDS) for each chemical to which the returned item has been exposed, must accompany the item being returned.

Any item being returned must be cleaned for safe handling before being shipped to VAC. **Documentation showing that all contamination has been removed must be provided.** Vacuum Pumps must be drained of all pump oil before being returned. Items that have not been cleaned and made safe for handling **WILL NOT BE ACCEPTED** for repair or replacement.

If you have any questions, please call or fax VAC at the numbers listed above.

OVER

EFFECTIVE JANUARY 1, 1992

DECONTAMINATION OF ROTRON BLOWERS

Vacuum/Atmospheres Company will not accept a returned Rotron Blower unless the blower has been decontaminated by your facility. **Documentation showing that all contamination has been removed must be provided.**

An RGA (Returned Goods Authorization) must be obtained from VAC before any blower may be returned for repairs.

Rotron Blower
Disassembly Instructions

Tools Required:

1. 5/32" Allen wrench.
2. 3/8" socket wrench 1/4" drive.
3. 3/8" open end wrench.
4. Rubber or Wooden mallet.
5. Safety Glasses and Respirator.
6. #2 Phillips screwdriver.
7. #3 Phillips bit and an impact type screwdriver.
8. Soap and Water.

The following procedures are intended to be guide lines for disassembly and should only be followed after a complete review and approval from the Health and Safety officials in your company.

Provide your personnel with material safety data sheet(s) (MSDS) for all the materials that your blower has been exposed to in your system **BEFORE** they disassemble it.

Steps:

1. Remove the two end cap retainer screws using the 3/8" socket and the 3/8" open end wrench.

2. Using the mallet to remove the end caps, strike the end cap outwards from the center at the point where the retainer screws went through. You must work on one side at a time working back and forth on the retainer point. It will not matter which side you start on.

3. After removing both end caps, use the 5/32" Allen wrench on the center screw turning it (CCW) to loosen the impeller. Next, slide off the impeller from the shaft.

4. On one end there are three #2 Phillips screws. Remove the screws and the small retainer cap. Next remove the four large phillips screws using the impact screwdriver.

5. Pull the case apart. Do Not Use A Screwdriver Between The Case Halves. Now all of the parts can be washed clean with the appropriate solvents. Air dry completely.

6. Reassemble the blower. Do not tighten the screws or fully reinstall the end caps.

WARRANTY

This unit is warranted to be free from defect in factory material and workmanship for a period of one year from date of purchase, subject to normal wear and freedom from undue abuse during handling and operation. Components purchased from others and included in the unit are subject to warranties as offered by the manufacturer of said components; of these components certain expendable items are not covered; others are warranted for 90 days; others are warranted for one year.

VAC warrants that it will repair, or furnish, F.O.B. its factory, a replacement provided a part is found to have been defective at the time it was received and further provided the defective part is returned to the factory, charges prepaid.

This warranty applies only to new equipment which after shipment from the factory has not been altered or treated in any manner whatsoever and does not extend to trade accessories operated with VAC's own equipment.

This warranty is the only warranty expressed, implied or statutory upon which said equipment is sold. All other damages and warranties, statutory and otherwise, being hereby expressly waived by purchaser.

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SECTION 1. GENERAL

1-1 APPLICATION

The purpose of the HE-493 DRI-TRAIN is to provide a moisture and oxygen-free atmosphere by recirculating an inert gas inside a glove box such as a Vacuum/Atmospheres DRI-LAB. This permits handling of materials sensitive to moisture and oxygen contamination. The gas circulated by the DRI-TRAIN may be argon or helium. Nitrogen, although not totally inert, may also be used.

1-2 FUNCTIONAL DESCRIPTION

The HE-493 DRI-TRAIN, hereinafter referred to as the HE-493, produces a moisture and oxygen-free environment in a glove box. This is done by replacing all the air from the box with dry, inert gas. This inert gas is then continuously cycled through a purifier which removes moisture and oxygen contamination from any source, such as:

- Diffusion through the rubber gloves in the glove box.
- Insertion of contaminated parts into the glove box.
- Use of makeup gas which is not completely free of moisture or oxygen.

Because the glove box is a hermetically sealed system, slight changes in pressure caused by temperature variations will readily affect the pressure in the system, and hence the position of the gloves.

The HE-493 is capable of attaining and maintaining an inert atmosphere with less than one-part-per-million, by volume, moisture and oxygen in a hermetically sealed system of an appropriate volume, and is constructed of appropriate materials.

The DRI-TRAIN/DRI-LAB system is a completely sealed, recirculating system. When the desired atmosphere is attained, the gas is continuously recirculated. This recirculating gas continually undergoes moisture and oxygen removal, and is automatically replenished as necessary. (See Figures 1-1 through 1-4.)

A vacuum pump (purchased separately) is used as the source for pressure reduction in the glove box, and is used to evacuate the purifier during the regeneration cycle. In some applications, this pump may also be used to evacuate the glove box ante-chamber.

1-3 MODEL VARIATIONS

The HE-493 is the only single-purifier, 5 cfm DRI-TRAIN manufactured by Vacuum/Atmospheres. (Other DRI-TRAINS, single or dual purifier, come with 20, 40 or 120 cfm capabilities. Purifier capacity is determined by the customer based on glove box volume, and on the operations to be performed by the system.)

1-4 SPECIFICATIONS/DIMENSIONS

The HE-493 is mounted on the side of a DRI-LAB as shown in Figures 1-2 and 1-3. The DRI-TRAIN can be mounted at another location on the DRI-LAB, with modifications. Specifications and dimensions are as shown in Table 1-1.

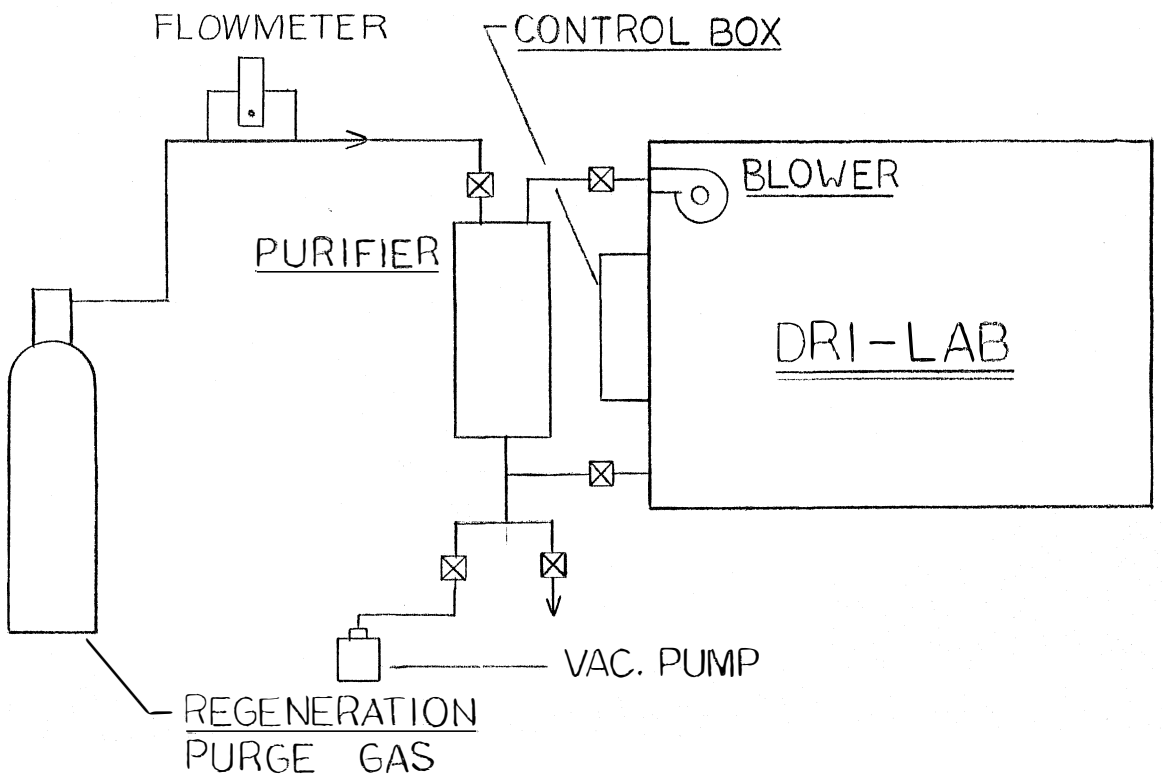


Figure 1-1. DRI-TRAIN/DRI-LAB Simplified System

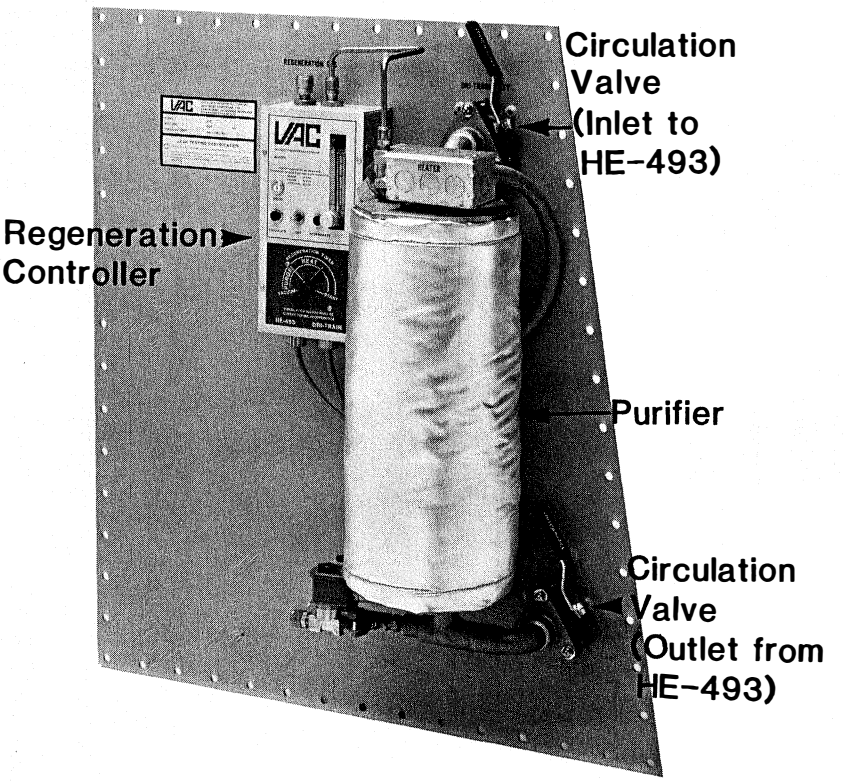


Figure 1-2. HE-493 DRI-TRAIN (Standard mounting on left end panel of DRI-LAB)

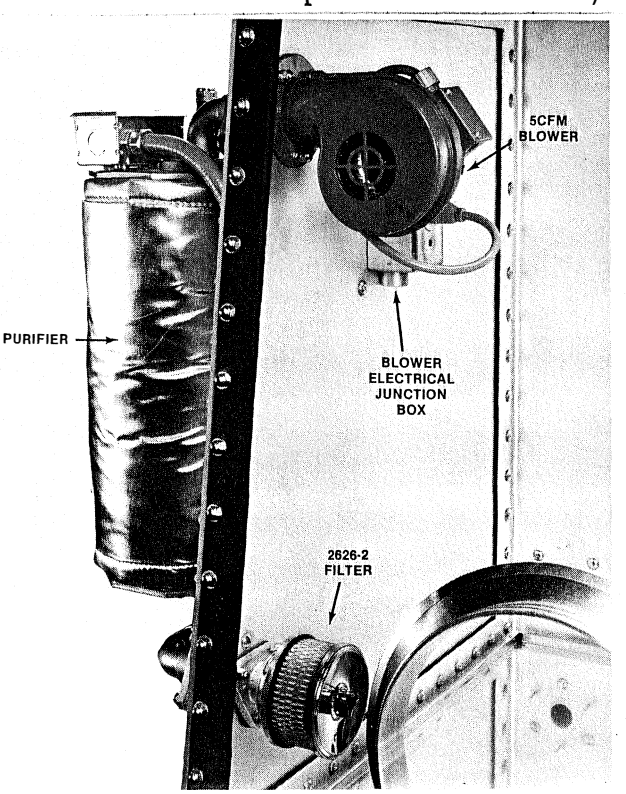


Figure 1-3. HE-493 DRI-TRAIN (From front of DRI-LAB)

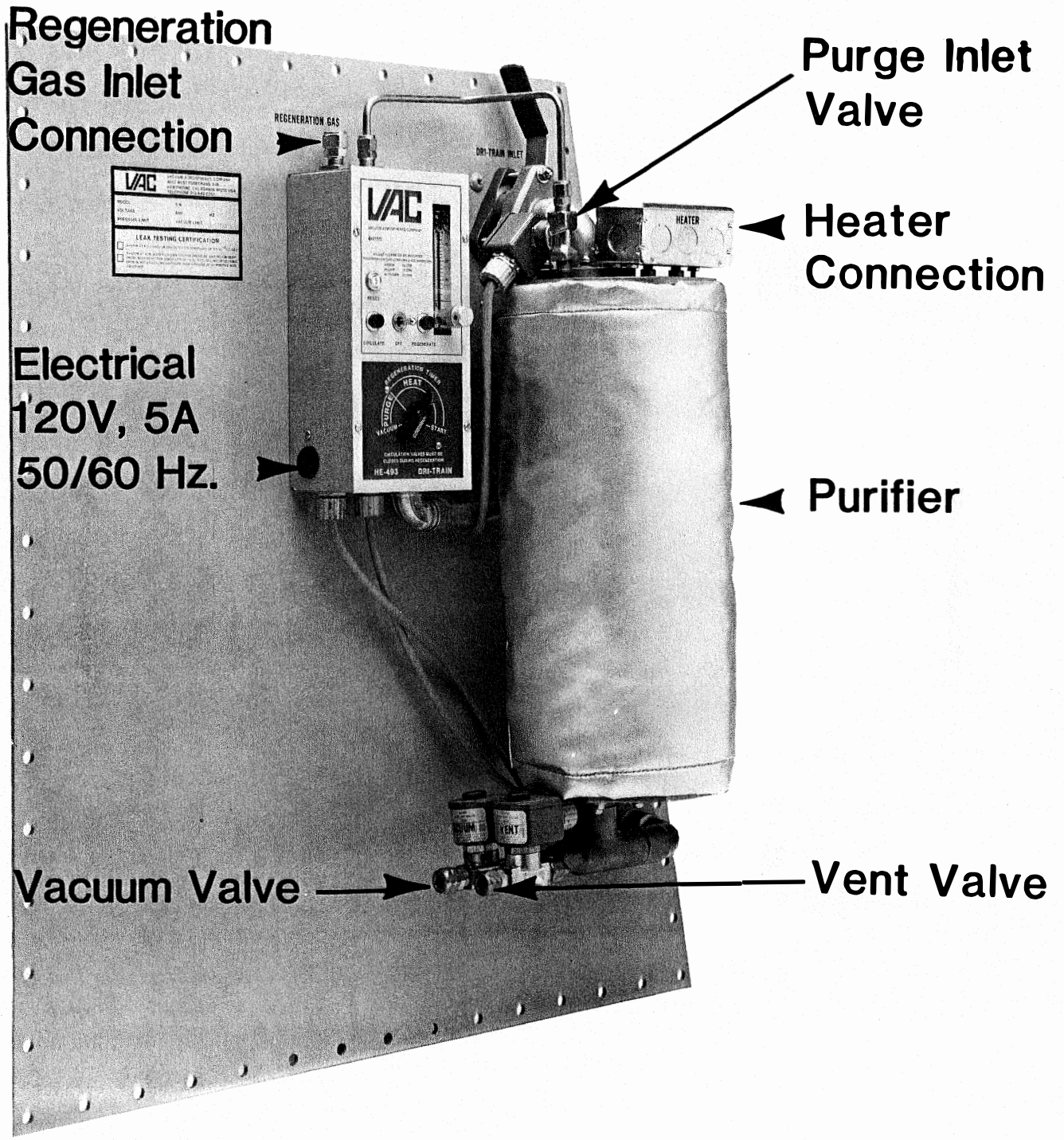


Figure 1-4. HE-493 Assembly

Table 1-1. SPECIFICATIONS AND DIMENSIONS

Flow Rate:	5 cfm.
Piping:	1" copper. Connections are O-ring sealed.
Power:	5 amp, 115 v, 50/60 cy.
Purifier:	100% of atmosphere passes through the moisture/oxygen purifier beds at room temperature. Oxygen removal capacity: 13 liters; moisture removal capacity: 136 liters, at STP and 1 ppm contaminants.
Automatic Regeneration:	Retort is isolated from the circulation system; reactant and absorbent are heated with a stainless steel sheathed heater inside the purifier column. Separate vacuum pump (customer provided) removes all residual gas.
Instrumentation:	Automatic Regeneration Timer on Manual Command.
Tests & Certification:	No detectable leaks under vacuum with helium mass spectrometer calibrated 3×10^{-10} std cc/sec. Electrical wiring conforms to City of Los Angeles code.
Dimensions:	Purifier: 16 x 6-1/4 Timer: 10-1/4 x 5 x 3-1/4

1-5 OTHER FEATURES

Major components of the HE-493 are listed in Table 1-2. Table 1-3 provides a list of controls and indicators.

Table 1-2. MAJOR HE-493 DRI-TRAIN COMPONENTS

ITEM	SYMBOL	NOMENCLATURE
1		PURIFIER. A stainless steel canister containing heating coils and oxygen and moisture adsorbents. Purifies circulated gas of oxygen and moisture.
2		CIRCULATOR/BLOWER. A fan located inside the glove box which maintains circulation of gas throughout the system.
3		REGENERATION PROGRAMMER. A small box usually mounted beside the purifier which holds the automatic controls for the sequenced steps of the regeneration process. (Does not include controls for the manually controlled Circulation Inlet and Outlet Valves A & B.)
4	A	CIRCULATION INLET VALVE. Inlet for inert gas from glove box to purifier. Acts as circulation valve during normal operation. Acts as isolation valve during regeneration process. Operated manually.
5	B	CIRCULATION OUTLET VALVE. Outlet for inert gas which flows back to glove box from purifier during normal operations. Acts as isolation valve during regeneration process. Acts as refill valve following regeneration. Operated manually.
6	J	PURGE solenoid valve. Allows for introduction of regeneration gas to the purifier during regeneration cycle when energized by regeneration timer.
7	K	VACUUM solenoid valve. Allows for evacuation of the purifier during regeneration cycle when energized by regeneration timer.
8	N	VENT solenoid valve. Acts as exhaust valve during purge cycle of regeneration, and also as a pressure relief valve. Is activated by purge mode of regeneration timer.

Note

PURGE and VENT solenoid valves work simultaneously.

Table 1-2. MAJOR HE-493 DRI-TRAIN COMPONENTS (Cont.)

ITEM	SYMBOL	NOMENCLATURE
9		Junction Boxes (2). One inside glove box for connecting power to blower. One above purifier for connecting power to heater in purifier.
10		VACUUM PUMP. (Separate purchase.) Evacuates the system.

Table 1-3. LIST OF CONTROLS AND INDICATORS

ELECTRICAL SWITCHES	
On REGENERATION TIMER	
REGENERATE/OFF/ CIRCULATE switch	Controls REGENERATE, CIRCULATE and OFF cycles of DRI-TRAIN.
REGENERATION TIMER indicator	Indicates Regeneration Cycle mode, i.e., START, HEAT, PURGE, VACUUM (right to left).
FUSE	
On Regeneration Programmer	
5 amps	Fuses the Regeneration Timer.
LIGHTS	
On Regeneration Programmer Fuse	When light glows, fuse is either missing or burned out.
HANDLES	
DYNAQUIP. Top and bottom of Purifier	Controls circulation inlet ball valve (A), and circulation outlet ball valve (B).
FLOWMETER	
On Control Panel	Controls rate of gas flow through Purifier during purge cycle of Regeneration.

SECTION 2. INSTALLATION

2-1 GENERAL

Read all instructions through completely before beginning. These instructions are standard, and some may not apply to custom systems.

- Remove components from crate.
- Remove all packing, tape, and shipping blocks or bands.
- Do not use DRI-TRAIN as a handle if shipped with DRI-LAB. Damage to plumbing may result.

CAUTION

If HE-493 purifier is charged, keep in upright position. (For charging instructions, refer to index at back of this manual.)

Note

Refer to installation data provided for the glove box or other equipment to be connected to the HE-493 to ensure complete system installation.

WARNING

DO NOT TURN ON ELECTRIC POWER UNTIL READY FOR INITIAL SETUP AS DETAILED IN SECTION 3 OF THIS MANUAL.

2-2 UTILITY REQUIREMENTS

Utility requirements are as outlined below, and as shown in Table 2-1 for easy access.

Note

Vacuum/Atmospheres recommends the use of copper or stainless tubing and fittings for all external plumbing connections. VAC recommends Swage Lock or Sealstik fittings; compression fittings and flare fittings are not recommended. If in doubt, please consult with the VAC representative for your area, or contact the factory direct.

2-2.1 Regeneration Gas

Connection is located on top of Regeneration Control Box (see Figure 1-4) HE-493 assembly. System requires les than 4% hydrogen mixed with argon or nitrogen gas, approximately 20 cfm required per regeneration. Mixed gas is required only during regeneration of purifier. Gas is to be pressure and flow regulated at rates indicated on Control Panel. The hookup requires 3/8" o.d. tube.

2-2.2 Vacuum

Connection is located at VACUUM (k, see Figure 2-1) solenoid valve. Install vacuum pump (separate purchase) at desired location. Use 3/8" o.d. tube to the VACUUM solenoid valve.

2-2.3 Electrical

Connection at junction box outside the glove box. Requires 115 vac, 5 amps, 50/60 hz.

2-2.4 Vent Line

WARNING

THIS OUTLET MUST BE PLUMBED TO A SAFE FREE AIR PORT.

Vent line is connected at VENT (N, see Figure 2-1).

2-2.5 Circulator/Blower

The circulator/blower is located inside the glove box and is plugged into the glove box junction box for power. Its passage to the DRI-TRAIN is the circulation inlet valve (A).

Table 2-1. UTILITY REQUIREMENTS

UTILITY	SIZE OF CONNECTION	FLOW	PRESSURE	FUNCTION
Regeneration/ Forming Gas	3/8" tube	1/3 cfm	Approx. 5 psi	Used for purging the purifier.
Vent	1/4" npt	1/3 cfm		Vent for regeneration/ forming gas during regeneration. Usually vented to outside exhaust system.
Vacuum Valve	3/8" tube	N/A		Evacuates air from the purifier.

UTILITY	CONNECTION	VOLTS/AMPS	PHASE/FREQ.	FUNCTION
Electrical	Junction Box	115 vac, 5 amps	Single 50/60 hz	To supply electrical power for Purifier operations.

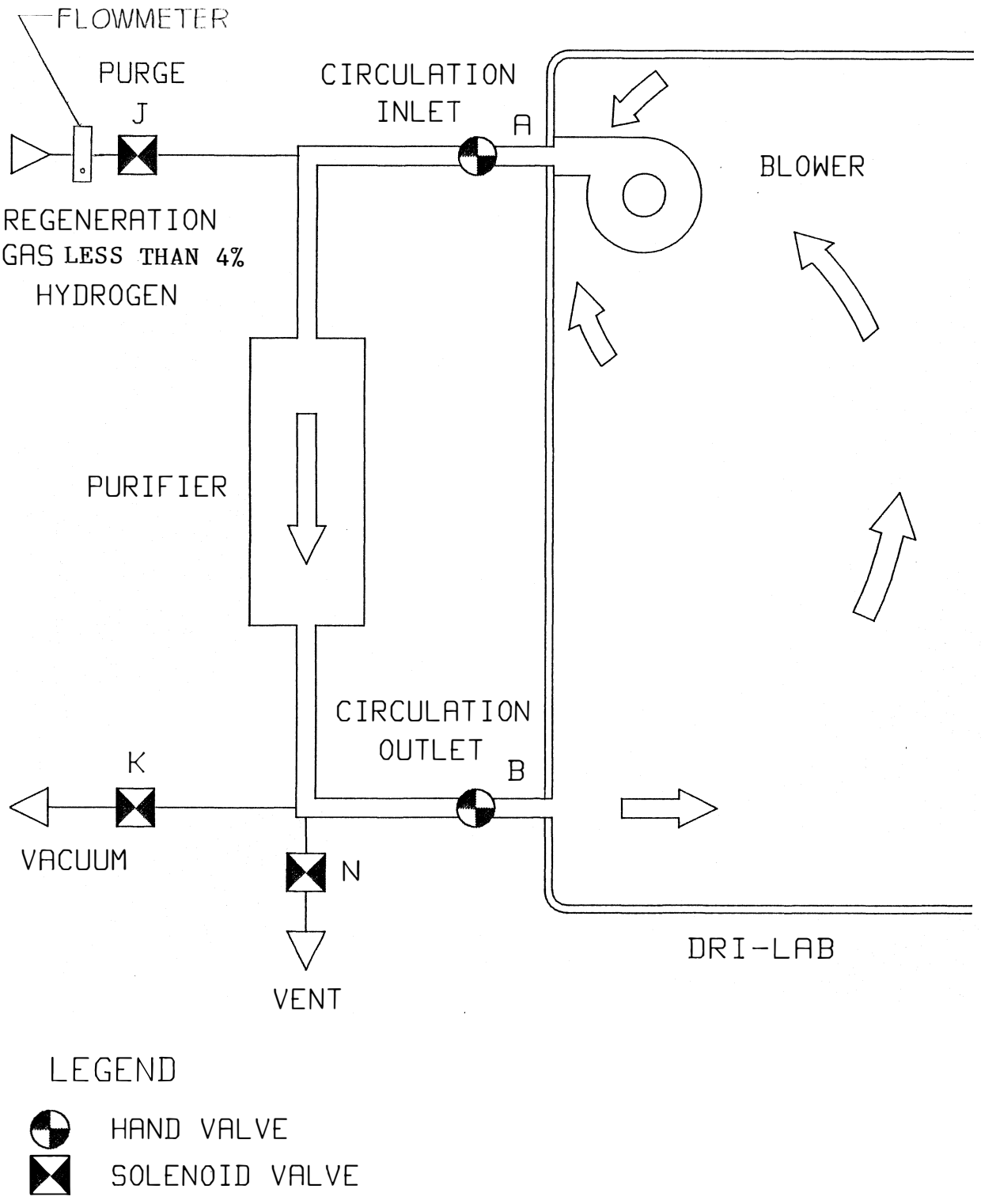


Figure 2-1. HE-493 DRI-TRAIN Flow Diagram

SECTION 3. INITIAL SETUP

3-1 GENERAL

It is strongly recommended that anyone attempting to set up and operate the HE-493 read the entire manual through before beginning.

Initial setup of the HE-493 follows the general sequence below:

- Electrical checkout
- Leak test
- Establishing an inert atmosphere
- Initial regeneration

3-2 ELECTRICAL CHECKOUT

From this point on the HE-493 is assumed to be fully assembled, all utilities connected, and connections made to a glove box. A check should be made to ensure all joints are tight before startup. Table 3-1 provides a step-by-step electrical checkout procedure. (See also Figures 3-1 through 3-3.)

CAUTION

Ensure vacuum pump is OFF while performing this test so as not to evacuate purifier.

Note

Blower will run continuously when power is applied to control box. Blower is not damaged by running with circulation valves (Inlet and Outlet) closed.

Table 3-1. ELECTRICAL CHECKOUT

STEP	ACTION	EXPECTED RESULT
1.	External power off.	
2.	5 amp circuit breaker	Reset by pushing in if required.
3.	Turn REGENERATION TIMER to VACUUM.	
4.	Turn REGENERATE/CIRCULATE switch to OFF.	
5.	Connect power to control box.	
6.	Check valves (PURGE, VENT, & VACUUM) for electrically deenergized mode by placing a small magnet near the red cap of the valve.	If energized: Magnet will be strongly attracted to the center core and the 60-cycle "hum" in the coil will be felt in the magnet.
	All valves should be deenergized.	If deenergized: Magnet will pull normally.
7.	Lift J-box cover. With voltmeter, check for no voltage across heater elements.	Heat OFF.
8.	Always turn counter clockwise.	
9.	Turn REGENERATE/OFF switch to REGENERATE.	Heat will begin in purifier.
10.	Turn timer ccw to purge cycle until you hear "click" of solenoid engaging.	a. PURGE and VENT valves will be energized. b. Heat will continue in purifier.
11.	Turn timer ccw to VACUUM.	a. PURGE and VENT valves will be deenergized.
	(Apply voltmeter again across heater elements in J-box to ensure elements are deenergized.)	b. Heat will shut off in purifier. c. Timer will stop. (Normal off position.) d. VACUUM valve will energize.

Table 3-1. ELECTRICAL CHECKOUT (Cont.)		
STEP	ACTION	EXPECTED RESULT
12.	Turn REGENERATE/CIRCULATE switch to OFF.	a. All valves should be deenergized. b. Heat should be off.
13.	Turn REGENERATE/CIRCULATE switch to CIRCULATE.	a. Blower starts running, all other valves and heater off.

3-3 LEAK TEST

These instructions are standard and may not apply to custom systems. VAC recommends the use of a helium leak detector if possible.

CAUTION

Do not use halogen leak detection equipment for leak testing. Halogens are harmful to seals, copper, and other materials used in the construction of VAC equipment. VAC will not assume responsibility for systems tested by methods other than defined in this manual.

3-3.1 Vacuum Leak Check

Regeneration/Circulate Switch is OFF.

A. Connect leak detector at Vacuum valve (K).
B. Close Inlet and Outlet Circulation valves (A & B).
C. Turn timer to VACUUM position.
D. Turn Regeneration/Circulate Switch to REGENERATE.
E. Vacuum valve should open.
F. Proceed with leak check.
G. Turn Regeneration/Circulate Switch OFF.

Vacuum /Atmospheres Corporation
"Leak Testing #105-HE-493 & MO-5"

Leak Test Procedures for HE-493, MO-5, HE-493-SB & MO-5 SB Dri-Train with HE-63-P or PC-1 Pedatrol, Dri-Lab and Oxygen Analyzer

These tests assume that the gloves are installed, the antechamber doors and valves are closed and manual purge exhaust valve is closed. They, also, assume that the system has operated well until now. Read through the SYMPTOMS and TESTS, below, and identify your symptoms before starting the TESTS.

TESTS:

+4" POS Test #1. Select Circulate Mode. Blower OFF. Circulation Valves DLV-1 and DLV-2 OPEN. Automatic Pressure Control ON and set at +4" POS and +5" POS (Water Column Pressure). Gloves are extended out horizontally. Listen for the click of the Pedatrol V-2 gas solenoid valve opening to correct the pressure up if pressure drops. Watch closely the black needle of the Photohelic or the Yellow lights of the SSG gauge for any drop in pressure. Any drop in pressure simply tells you there is a leak or leaks somewhere in the system but not specifically what area. If there is indication of a leak, use +4" POS Test #2 to determine if the leak is in the Dri-Lab or tin the Dri-Train.

+4" POS Test #2. Select Circulate Mode. Blower OFF. Circulation Valve DLV-1 and DLV-2 Closed. Automatic Pressure Control set at +4" POS and +5" POS (Water Column Pressure). Gloves are extended out horizontally and pressure raises to +4" POS. Watch closely the Black needle of the Photohelic or the Yellow lights of the SSG gauge for any drop in pressure. Any drop in pressure simply tells you there is a leak or leaks somewhere in the gloves or Dri-Lab part of the system but not in the Dri-Train. If there is NO leak indicated in this mode, this would mean the leak indicated, in +4" POS Test #1, was in the Dri-Train and not in the Dri-Lab; go back to +4" POS Test #1 and bubble test for leaks at all connections in the Dri-Train.

+4" Positive Wet Lips Test. Circulate Mode. Blower OFF. Automatic Pressure Control ON. DLV-1 and DLV-2 Circulation Valves open. Set limits of Automatic Pressure Control to +4 and +5 Inches Water Column Positive (gloves pushed out). Grasp an extended glove tightly near the glove port ring and twist it 5 to 6 times to force all fingers out. Hold the pressure, moisten your lips and move the glove back and forth near your moistened lips. Your will find even very small pin hole leaks this way.

+4" Positive Dunk in Water Test. Circulate Mode. Blower OFF. Automatic Pressure Control ON. DLV-1 and DLV-2 Circulation Valves open. Set limits of Automatic Pressure Control to +4 and +5 Inches Water Column Positive (gloves pushed out). Set a half full bucket of water under a glove and Dunk the glove into the water and watch for bubbles.

+4" Positive Snoop Test. Circulate Mode. Blower OFF. Automatic Pressure Control ON. DLV-1 and DLV-2 Circulation Valves open. Set limits of Automatic Pressure Control to +4 and +5

Inches Water Column Positive (gloves pushed out). Use Snoop (bubble solution) and Snoop everything on the Dri-Lab and/or Dri-Train watching closely for bubbles.

-2" Negative Test, (-2 Inches Negative Water Column Pressure).This test is most effective when you have an Oxygen Analyzer. Without an Oxygen Analyzer you would have to rely on the Broken Light Bulb Test or some other Indicator. You should have a stable PPM (parts per million) Oxygen reading of less than 50 PPM ; the lower the better. Circulate Mode. Blower ON. Automatic Pressure Control ON. DLV-1 and DLV-2 Circulation Valves open. Set Automatic Pressure Control limits to -2 and -3 Inches Water Column Negative (gloves sucked in). Check your watch second hand, if there is a significant leak, you should see the PPM rise dramatically within 60 seconds. If this happens, reset the pressure to +4" POS and +5" POS and look for leaks. If you can stay -2" NEG for 3 to 5 minutes with no more than 3 to 4 PPM rise, you may assume there are no significant leaks. Remember: The response time from the sample pump in the Dri-Lab to indication change at the Oxygen Analyzer meter can be 30 to 60 seconds depending on length of sample line.

Broken Light Bulb Test. This is the same conditions as the -2" NEG test except that you will be using broken light bulbs instead of an Oxygen Analyzer. Remember, this is an accumulative test for Oxygen and/or Moisture and not instant indicator. This simply means that the bulb might burn out at 30 minutes if exposed to a 10 PPM condition and it might burn out in 3 seconds if exposed to a 1000 PPM condition. The bulbs should be 25 to 40 watts. 100 watt bulbs may burn out from thermal shock even at a 1 PPM condition. Use a torch or hot rod to break the bulb; if this should produce only a very small hole, use a knife point to open it to about the size of a coin or larger.

SYMPTOMS and SOLUTIONS

Symptom #1. Circulate Mode. DLV-1 and DLV-2 Open. The blower is ON or OFF and automatic pressure control is ON and set at +¼" POS and +1" POS. The gloves try to <u>suck in</u> and the automatic pressure control corrects every few seconds and the Oxygen PPM may not be high. **Solution: Turn OFF Vacuum Pump which supplies vacuum source for pressure control.** Look for leak in the Pedatrol Vacuum Solenoid Valve and the Regeneration Vacuum Solenoid Valve. Check for leak through the Antechamber Refill Valve while Antechamber is evacuated.

Symptom #2. Circulate Mode. DLV-1 and DLV-2 Open. The blower is ON or OFF and automatic pressure control is ON and set at +¼" POS and +1" POS. The gloves try to <u>push out</u> and the automatic pressure control corrects. Oxygen PPM may not be high. **Solution:** Close the Regeneration Gas cylinder valve. If this stops the gloves from pushing out, look for leak in Regeneration Purge Solenoid Valve. Close Inert Gas Cylinder Valve (or Inert Gas House Supply Valve). If this stops the gloves from pushing out, look for leak in the Pedatrol Gas Solenoid Valve. If neither of these stop gloves from rising, find any other source of gas coming into the system.

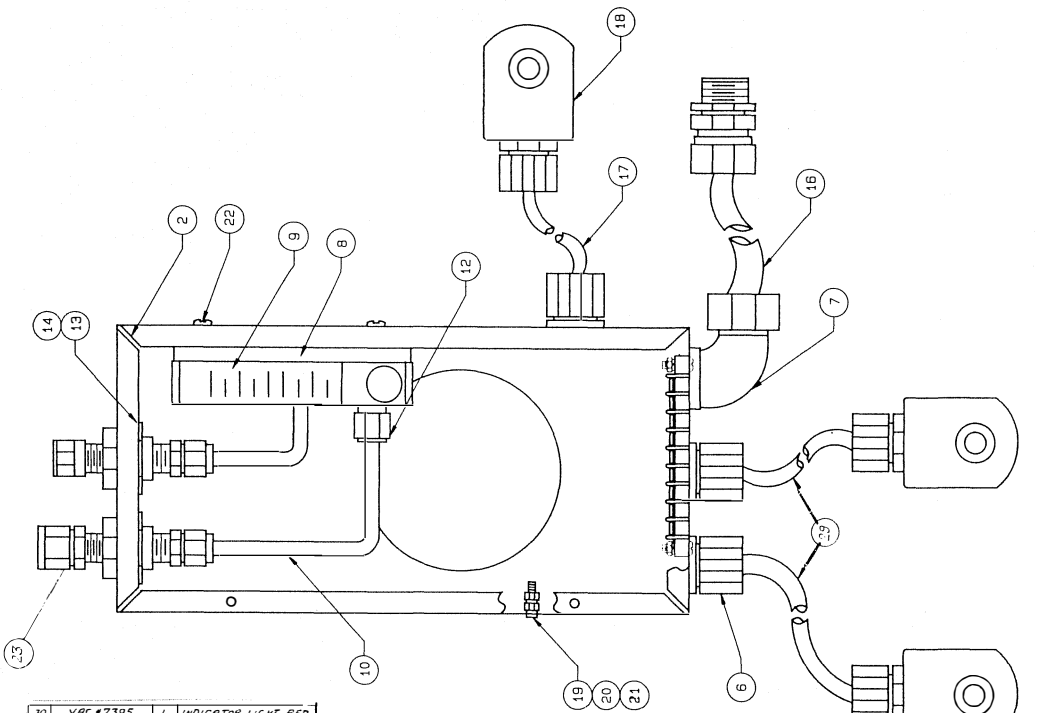
Symptom #3. After regeneration. In normal circulation, Oxygen PPM is good for a few hours or a day or two but then the Oxygen steadily goes higher and higher. **Solution:** This may be a contaminated purifier charge. Run another regeneration and check to assure that: (A) The purifier

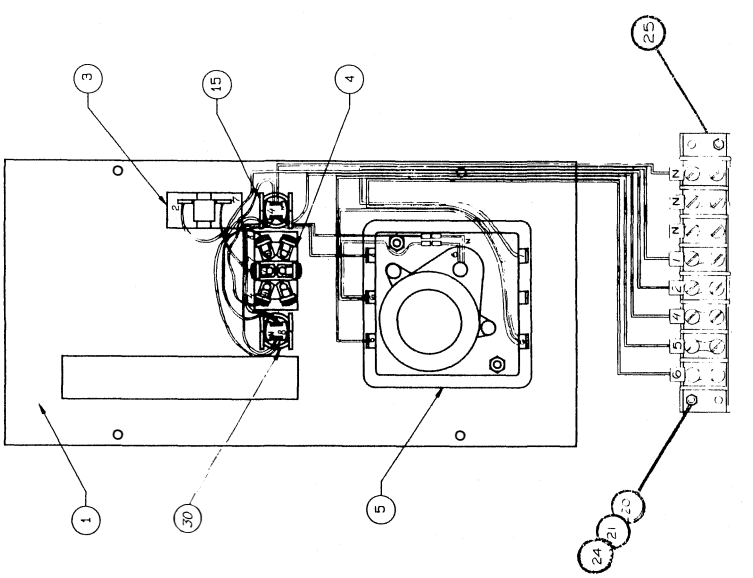
does get warm after two or three hours into the regeneration cycle; if not, check fuse for heater and voltage at heater terminals. (B) Record regeneration gas cylinder pressure before and after regeneration to assure that proper amount was consumed. {C} Check to see that the regeneration gas is actually Forming Gas (inert gas with Hydrogen). Assuming thorough leak testing and (A), (B) and {C} have been completed, you may assume the purifier charge is contaminated and should be replaced.

Symptom #4. Circulate Mode. The blower is ON and the Oxygen PPM may be OK but with the automatic pressure control set to hold +2" POS or higher, the pressure drops gradually and corrects every second or two. **Solution:** Run the **+4" POS Test** and look for large hole in gloves using the "wet lips" test and/or the "dunk-in-water" test. If gloves check OK, use bubbles solution and check the entire Dri-Lab. See also Symptom #6.

Symptom #5. The blower is ON. The automatic pressure control limits are set at +3" POS and -2" NEG. Use the foot switch and push the gloves out to +3"POS. The gloves gradually drop and the pressure indicator gradually drops but the gloves do not suck in and the pressure does not go Negative. The Oxygen may not be high. **Solution:** This is an indication of a leak in the gloves or some anywhere on the Dri-Lab, or the Dri-Train. Use the **+4" POS TESTS** and find the leak.

Symptom #6. Circulate Mode. Blower OFF. DLV-1 and DLV-2 Open. Automatic pressure control limits set at +5" POS and -1"NEG. Use "R" foot switch and try to pressurize to +4" POS. You find that you can only reach one to three inches Positive Pressure. **Solution:** Use "L" foot switch to drop glove to "limp". Check Oil Level in Bubbler. Close Manual Purge Exhaust Valve. Find Fist Size Hole in glove.





ITEM	PART NUMBER	QTY.	DESCRIPTION
30	VAC #7395	1	INDICATOR LIGHT RED
29	VAC # 51	2'	RUBBER COVERED WIRE 18/2 x 15" LG
28			
27			
26			
25	1 TB 28F706 or 65F1166	1	TERMINAL STRIP NEWARK
24	6-32 x 5/8 LG	2	BIND HEAD SCREW
23	VAC # 2000	1	CONNECTOR
22	8-32-3/8 LG.	2	PAN HD. CAP SCREW
21	6-32	4	FLAT WASHER
20	6-32	4	HEX NUT
19	6-32-1/2 LG.	1	BIND HD. SCREW
18	VAC # 1283	AR	COIL & HOUSING ONLY
17	VAC# 51	1	RUBBER COVERED WIRE 18/2 x 12½" LG.
16	VAC# 42-1	1	3/8" x 18" LG. SEALTITE FLEX
15	VAC# 1264	1	INDICATOR LIGHT GREEN
14	VAC# 2001	3	CONNECTOR
13	VAC#2117	2	BULKHEAD FTG:.
12	VAC# 2002	2	ELBOW
11			
10	1/4"	AR	S/S TUBING
9	VAC# 7619	1	FLOW METER
8	014646	1	FLOW METER BRACKET
7	ST-9038 VAC# 1161	1	FLEX CONNECTOR APPLETON
6	VAC# 1163-1	3	CORD GRIP RED DOT
5	VAC# 110A	1	2 POLE TIMER CRAMER
4	82608 (VAC#1054)	1	SWITCH 2 PST
3	VAC# 7625	1	CIRCUIT BREAKER
2	08693-5	1	ELECTRICAL BOX HE-493
1	014603	1	ANTIWORK FRONT PANEL

Figure 3-1. Regeneration Programmer Chassis Assembly

Deleted

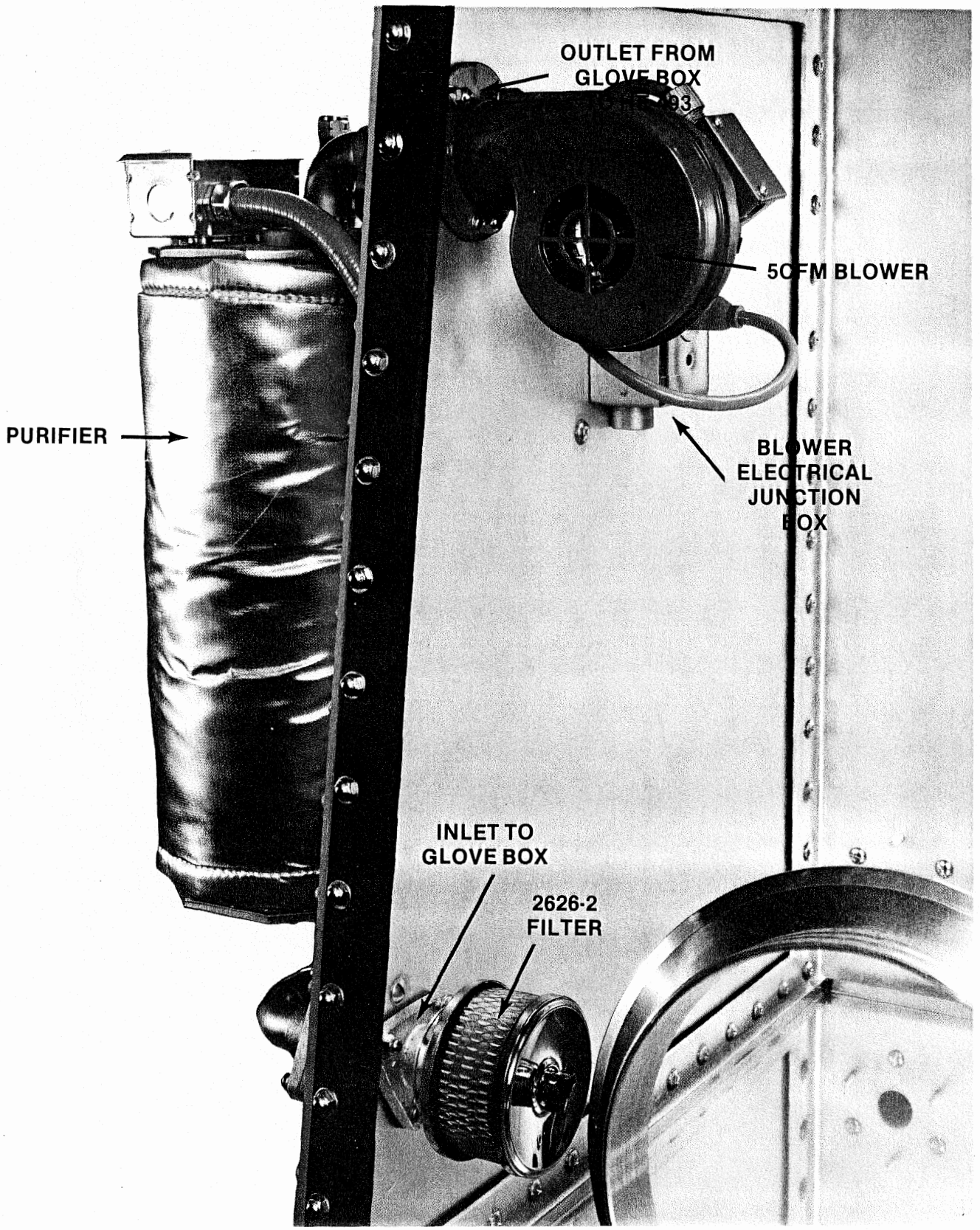


Figure 3-3. HE-493 Inlets to Glove Box

CAUTION

Open circulation outlet valve (B) slowly (Step H) to refill purifier. If connected to DRI-LAB (glove box), care should be taken in refilling to avoid a vacuum condition in the DRI-LAB.

H. Refill purifier with Outlet Circulation valve (B) open.

I. Reconnect vacuum pump to Vacuum valve (K).

3-4 INITIAL REGENERATION

For initial regeneration, it is recommended that the normal regeneration procedure be repeated two or three times because the oxygen reactant in a purifier is shipped in a completely saturated condition. While this section provides procedures for regeneration, Section 4 gives a more theoretical description of the regeneration procedure and the purifier. It is suggested that Section 4 be read before going through a regeneration cycle.

3-4.1 Regeneration Cycle

WARNING

BEFORE PERFORMING THIS PROCEDURE, ENSURE THAT THE REGENERATION FORMING GAS CAN BE EXHAUSTED TO A SAFE PLACE. ALSO, CONSULT TABLE 3-2 FOR SAFE/UNSAFE CHEMICALS.

To perform the required regeneration for the first time on a new or saturated purifier, use the following procedure:

A. Establish an inert atmosphere in the glove box.

CAUTION

Never force the REGENERATION TIMER indicator in a clockwise direction as this may damage the indicator.

B. REGENERATE/CIRCULATE switch is OFF, initially.

C. Check gas supply available to PURGE valve (J). 20 cubic feet per regeneration is required.

Table 3-2. SAFE/UNSAFE CHEMICALS

DRI-TRAINS contain an adsorbent for water and a reactant for oxygen. These will regenerate even though exposed to many common solvents. The following is a list of satisfactory chemicals which may be used in DRI-BOXES equipped with DRI-TRAINS:

Inert Gases: nitrogen, argon, helium, etc.

Hydrocarbons: ethane, ethylene, propane, propylene, n-butane, isobutane, butylene, butadiene, isobutylene, pentane, cyclohexane, n-heptane, isoprene, benzene, toluene and mixed xylenes.

Esters: ethers, amines, amides, ketones.

Others: dimethyl ether, diethyl ether, isopropyl ether, amyl acetate, n-butylamine, 2-ethylhexyl amine, dimethylformamide, acetone, acrylonitrile and pyridine. (Some of these will be adsorbed or react with the reactant material in the DRI-TRAIN but will regenerate.)

WARNING

SULFUR AND SULFUR COMPOUNDS SUCH AS H_2S, RSH, COS, SO_2, SO_3, ETC. WILL POISON THE REACTANT MATERIAL IN THE DRI-TRAIN, THEREFORE, SHOULD NOT BE USED IN AN ATTACHED GLOVE BOX.

LARGE QUANTITIES OF HALIDES, CHLORIDES, HALOGENS (FREON), ALCOHOLS, HYDRAZINE, PHOSPHENE, ARSINE, ARSINATE, MERCURY AND SATURATION WITH WATER MAY ALSO DEACTIVATE THE OXYGEN REACTANT IN THE DRI-TRAIN. THE MOISTURE AND ADSORBENT IS NOT AFFECTED BY THESE CHEMICALS.

THE REACTANT IN THE REDUCED STATE SHOULD ALWAYS BE REGENERATED WITH THE RECOMMENDED 5% H_2 + INERT GAS MIXTURE. IF O_2 IS ACCIDENTALLY USED, THE REACTANT WILL BE DEACTIVATED.

IF ANY OF THE "POISONS" IN ABOVE PARAGRAPHS ARE TO BE USED IN THE DRI-LAB (GLOVE BOX) SERVED BY THE DRI-TRAIN, A SUITABLE TRAP SHOULD BE INSTALLED IN THE LAB OR IN THE CIRCULATING LINE AHEAD OF THE TRAIN.

D. Close Circulation Inlet and Circulation Outlet valves (A & B).

E. Turn REGENERATION TIMER indicator counter clockwise to START.

F. Turn REGENERATE/CIRCULATE switch to REGENERATE. Timer will automatically cycle slowly to VACUUM.

   i. Three hour HEAT cycle.

   ii. One hour in PURGE cycle.

   iii. Eight hours in vacuum cycle.

G. After the above twelve hours (or more), turn REGENERATE/OFF switch to OFF. (This must be done manually as REGENERATION TIMER will remain in VACUUM mode until switch is turned off.)

H. Open Circulation Valves A and B.

I. Turn REGENERATE/CIRCULATE switch to CIRCULATE.

This is the end of the Regeneration Cycle.

Note

Vacuum pump oil should be changed after each regeneration cycle.

3-5 ESTABLISHING AN INERT ATMOSPHERE

If customer uses an evacuable vacuum glove box or VAC-LAB, evacuate VAC-LAB, back fill with inert gas, then start regeneration (paragraph 3-5).

CAUTION

Install a valve in pressure sensing line of PEDATROL. Valve must be closed when VAC-LAB is evacuated, otherwise diaphram in Photohelic(1) will rupture.

For DRI-LABS and other ambient pressure glove boxes having a PEDATROL, the following procedure is suggested.

After instslling, electrical check (paragraph 3-2) and Leak Testing (paragraph 3-3) of the entire DRI-LAB system, and after regeneration (paragraph 3-4), perform the following steps:

A. Turn PEDATROL ON.

B. Set left indicator to approximately 5-inch positive and the right indicator to approximately 4-inch positive.

C. Remove the plug from one of the service ports of the DRI-LAB.

D. This will cause continuous flow of gas from the reserve gas supply. If the service port is large enough, the 20 psi setting the reserve gas regulator will probably not hold more than approximately 1-inch H_2O positive pressure. The setting may be raised up to 40 to 50 psi to speed the process, if desired. Reset to 20 psi when through.

E. The regulator setting and the service port opening should be such that the box pressure stays below 4-inch H_2O positive, but above 1-inch H_2O positive.

(1) The Photohelic is a pressure sensing gage on the face of the PEDATROL.

(2) The SSG is the alternate sensing gage.

F. When the gas cylinder nears empty (or when approximately eight volumes of gas have been purged through the glove box), reset regulator to 20 psi, replace service port plug, and then reset Photohelic pressure limit as desired.

Note

For initial startup, proceed to Regeneration Procedure, Paragraph 3-5.

For startup after purifier has been previously regenerated and the Inlet and Outlet Circulation Valves have been kept closed, now open these two valves for normal circulation.

SECTION 4. OPERATIONS & THEORY

4-1 GENERAL

The HE-493 DRI-TRAIN is designed to control the oxygen and moisture content in the atmosphere of a sealed glove box. It can run continuously and need not be turned off, except for maintenance.

The heart of the HE-493 is a chemical purifier. The purifier canister contains a moisture adsorbent and an oxygen reactant. The adsorbent removes water vapor from any gas which passes through it. The oxygen reactant combines chemically with oxygen, thereby removing oxygen from the gas which is circulated through it. When the agent becomes saturated with oxygen it should be regenerated.

This section will explain further the purifier and its operation (paragraph 4-2), and the process of regenerating the purifier (paragraph 4-8). Oxygen and water removal, the blower, and the vacuum pump will also be discussed in this section.

4-2 PURIFIER

The purpose of the purifier is to remove moisture and oxygen from the gas flowing through the controlled atmosphere of a glove box. The purifier contains two chemical purification agents. One is a molecular sieve which removes moisture from gas flowing through it by a process of molecular absorption. There are two layers of molecular sieve in the purifier canister, four pounds above the lower plenum, and 1-3/4 pounds below the upper plenum. The other agent is an oxygen reactant, Q-5, five pounds of which constitutes the middle layer in the purifier canister.

The HE-493 purifier is constructed so that in normal operation the gas to the purifier enters the port which opens into the upper plenum of the canister. (See Figure 4-1.) Gas flows from this upper plenum down

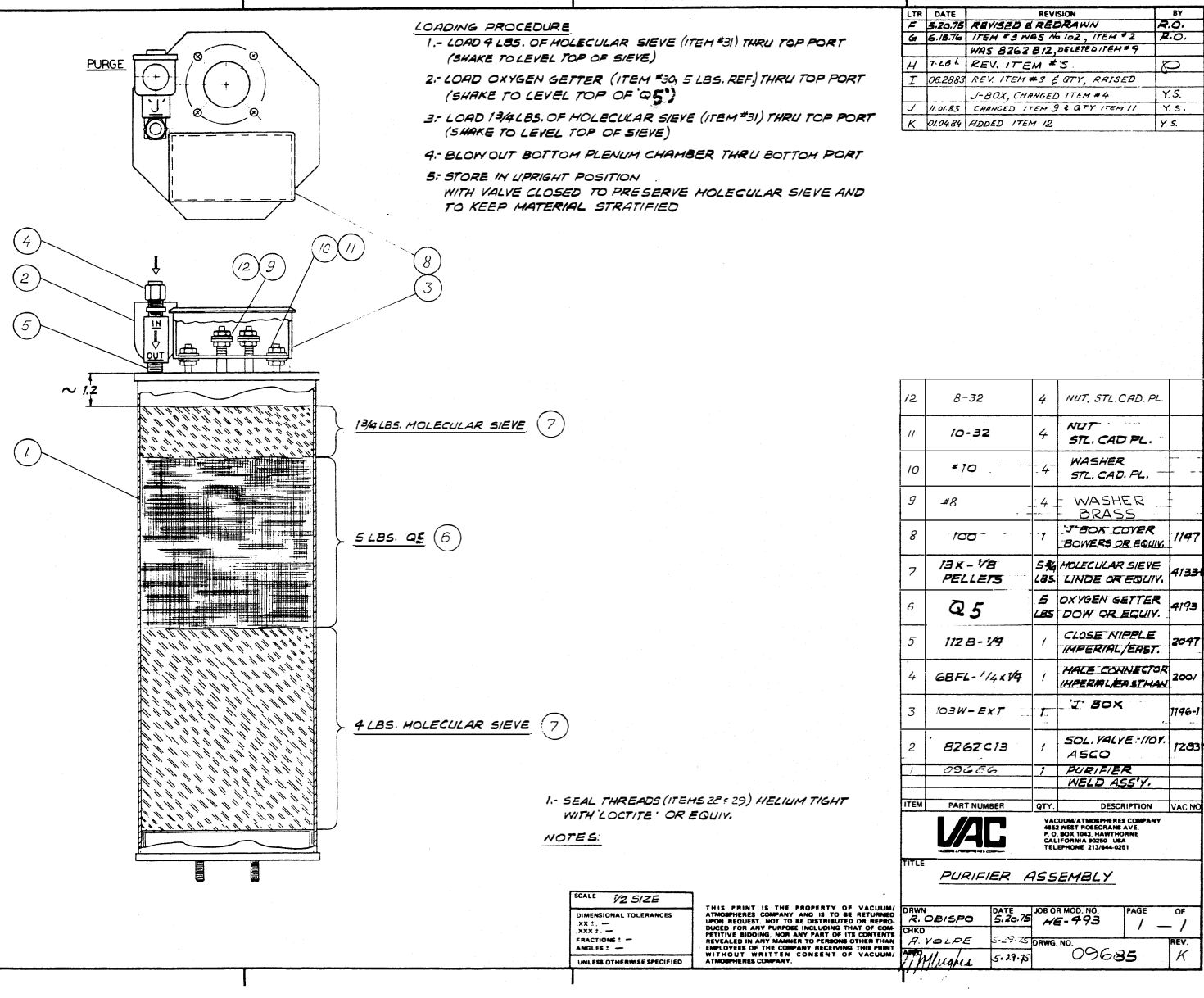


Figure 4-1. Purifier Assembly (Cutaway)

through the three layers of chemicals into the lower plenum, and then through the lower outlet where it is returned to the glove box.

The purifier comes encased in an insulation blanket for the protection of the operator during the regeneration cycle.

4-3 CHARGE

If the HE-493 DRI-TRAIN is not delivered as part of a system, the purifier is delivered empty and must be filled. See Figure 4-1 for Loading Procedures.

When delivered as part of a system, the HE-493 purifier is charged before delivery, and the chemicals can be used continuously over a period of many years. However, poisonous substances can cause contamination which would necessitate refilling the purifier canister. These poisons are listed in Table 3-2 of this manual, and the warnings presented should be read, understood, and heeded by all who are involved in the use of the HE-493 system.

4-3.1 Replacing the Charge

WARNING

PROTECTIVE MASKS, CLOTHING, ETC. MAY BE REQUIRED WHEN EXPOSED TO THE FUMES OF THE CONTAMINATED CHEMICALS. THE NATURE AND EXTENT OF PROTECTION REQUIRED IS DEPENDENT ON THE NATURE OF THE CONTAMINANTS PRESENT IN THE EXPENDED CHEMICALS.

THE DETERMINATION OF THE TYPE AND EXTENT OF THE PRECAUTIONS REQUIRED IS THE SOLE RESPONSIBILITY OF THE USER. WHEN IN DOUBT, CONTACT VACUUM/ATMOSPHERES COMPANY DIRECT.

The purifier can be easily removed from its fittings in the following manner:

- Unfasten the four upper and four lower retainer nuts and the three upper and lower retainer flange nuts.

- Open Junction box located on top of the purifier and disconnect wiring.

- Remove red cap from purge solenoid valve (J) to slip valve off fitting.

This disconnects the canister from its assembly and allows for removal and emptying of the contamnated contents.

To refill, see Figure 4-1, Loading Procedure, for instructions. Then replace the purifier, reversing the instructions above for disconnecting.

4-4 OXYGEN REMOVAL

Oxygen removal from argon, helium, or nitrogen is accomplished with a reactant (Q5), a material consisting of finely divided copper on an Alumina Matrix, developed by the Dow Chemical Company. The Q5 operates at ambient temperature and down to -80°C (-112F). Oxygen removal is possible at space velocities of more than 6,000 volumes of gas/volume of Q1/hour with little loss of efficiency. Q5 is compatible with molecular sieves in operation and regeneration. This reactant's capacity for oxygen is 2.3 cc O^2/gram Q5. The copper reacts with oxygen to form cuprous or cupric oxide, and the oxides are reduced to metallic form by hydrogen at 150-300°C (302-572°F) during regeneration. The regeneration product is water. Repeated regeneration does not reduce efficiency of the reactant. Q5 is deactivated by large amounts of H_2O and other compounds containing reduced sulfur.

4-5 WATER REMOVAL

Water is removed by a molecular sieve enclosed in the purifier as is the oxygen reactant. (See Figure 4-1.) Molecular sieve and Q5 both operate

at ambient temperature, and are regenerated by the same process. Also removed by the sieve at ambient temperature are carbon dioxide, sulfur dioxide, nitrogen dioxide, hydrogen sulfide, carbon monoxide, and many organic compounds including: alcohols, aromatics, amines, halogenated compounds, oxygenated compounds, hydrocarbons, and organic acids. Inorganic acids are removed, but the sieve is poisoned and cannot be regenerated. Under normal circumstances it is regenerated at temperatures of 205-593°C (400-1100°F) while purging with dry gas, followed by evacuation. The capacity of the sieve for water is 0.031 gm H_2O/gm sieve at a bed temperature of 27°C (80°F), and increases as the bed temperature is reduced. At a bed temperature of 5°C (40°F), capacity is increased to 0.080 gm H_2O/gm sieve.

4-6 LEVELS OF PURITY ATTAINABLE

In most cases it is practical to attain less than 1 ppm of oxygen and 5 ppm water. Lower levels are possible when care is taken in eliminating sources of contamination.

The time required for the DRI-TRAIN to remove oxygen and moisture to any desired level from a glove box is dependent on the size of the glove box, the initial oxygen and moisture levels, and the present chemical state of the purifier. The present state of the purifier depends primarily on the time elapsed since the last time the purifer was regenerated and the amount of oxygen and moisture to which it has been exposed.

Figure 4-2 depicts the time, measured by Vacuum/Atmospheres Company, required to recover measured amounts of oxygen from a glove box. This data was taken under carefully controlled, laboratory conditions.

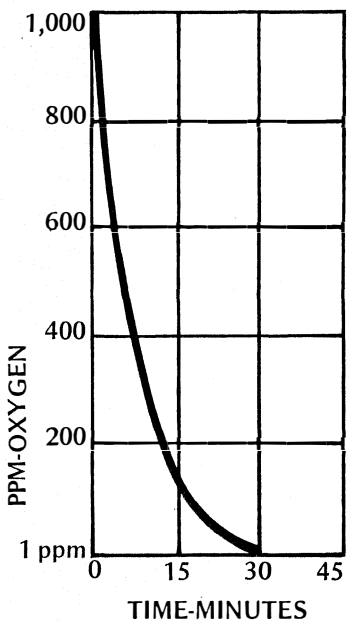


Figure 4-2. Oxygen Recovery Rates

4-7 REGENERATION

Regeneration of the purifier is performed when the purifier is no longer maintaining the required atmospheric purity in the glove box. Regeneration is a process of restoring purification capability to the purifier. To do this, two general actions must take place:

- The moisture trapped by the molecular sieve must be removed completely.

- The oxygen must be removed from the Q5 (oxygen gettering material), and the copper contents returned to its essentially pure form.

This is accomplished by isolating the purifier from the glove box (at circulation inlet and outlet valves, A & B). The heat is turned on in the purifier and heated to approximately 200°C which heats the getter-

ing material, boiling off any contaminants. After a period of three hours, the purifier is purged and vented with hydrogen mixed gas (PURGE valve J, and VENT N). This releases contaminants and regenerates the oxygen gettering material. Then the purifier is evacuated for a period of eight hours or overnight (VACUUM valve K). This removes any contaminants left after the purge.

The purifier is then refilled from the glove box by opening circulation outlet valves A and B.

The entire regeneration process takes twelve hours. (See paragraph 3-5.1, Regeneration Cycle). As mentioned in Section 3.

Note

VAC recommends that the customer regenerate the purifier approximately once a week if customer's processes produce corrosive or normally harmful vapors that tend to saturate the contents. Normal regeneration is about once a month.

It should be mentioned that regeneration is an automatic process carried by the action of the regeneration programmer except for starting (REGENERATE) and stopping (OFF) the regeneration switch. During the regeneration period, the HE-493 cannot be used for circulating and purifying operations.

4-7.1 Regeneration/Forming Gas

A gas which is less than 4 percent hydrogen is used during regeneration and is known as regeneration gas, or regeneration/forming gas. The HE-493 Circulation Inlet and Circulation Outlet hand valves (A & B) are closed before the beginning of the regeneration process. The regeneration gas PURGE inlet valve opens to allow regeneration gas to flow directly into and through the purifier. This gas should be passed to

the purifier at a fixed flow rate of one-third cubic foot per minute (a rate set during installation ensuring an adequate amount of hydrogen in the Q5 absorbent during the PURGE cycle of the regeneration process). As a result, a chemical reduction in the Q5 is obtained.

The regeneration gas is used for approximately one hour of the regeneration cycle. (See Figure 4-3.)

4-7.2 Regeneration Programmer

As stated above, the regeneration process is performed by activating the regeneration programmer which is an integral part of the HE-493 DRI-TRAIN. The regeneration programmer allows for automatic regeneration of the purifier. The programmer is mounted in a small box adjacent to the purifier assembly. The front of the box displays the timer cycle, timer indicator, REGENERATE/CIRCULATE switch, 5 amp breaker, printed directions for regenerating the purifier.

The regeneration time cycle shows START, HEAT, PURGE, and VACUUM (reading from right to left) as stages of the regeneration cycle. Once the REGENERATE/CIRCULATE switch is turned to REGENERATE and the timer indicator is set at START, the programmer automatically controls the regeneration process which lasts about 12 hours -- or until the operator turns the REGENERATE/CIRCULATE switch to OFF. The process must be stopped manually by the operator. The switch is kept in CIRCULATE position during normal operations of the HE-493 DRI-TRAIN while purifying the atmosphere of the glove box.

4-8 CIRCULATOR/BLOWER

The HE-493 uses a gas circulator blower (mounted in the glove box) with a 5 cfm capacity. This unit can be run continuously with the DRI-TRAIN inlet and outlet valves closed. The circulator blower operates when REGENERATE/CIRCULATE switch is in CIRCULATE position.

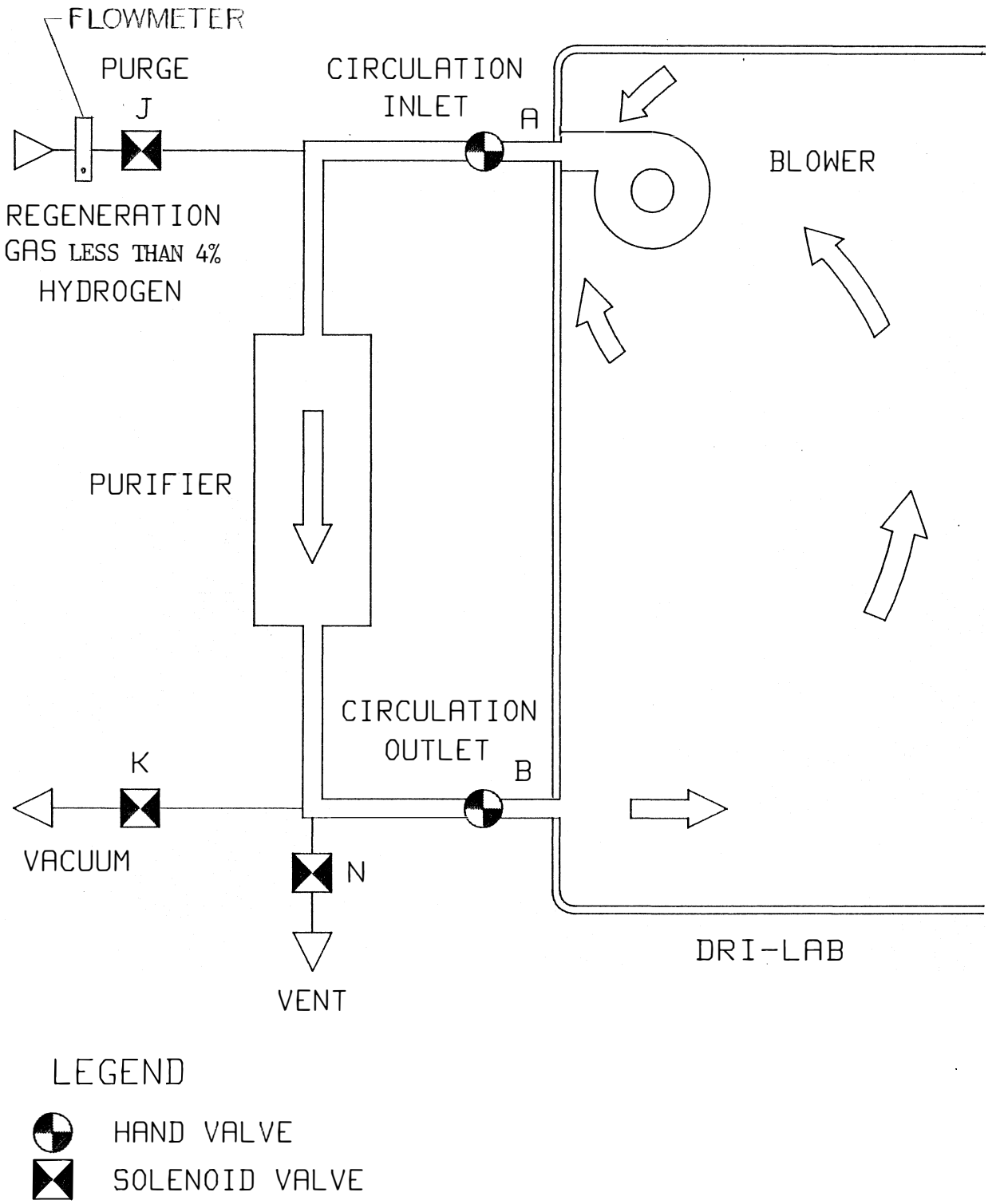


Figure 4-3. Gas Flow Diagram

4-9 VACUUM PUMP (Customer Furnished)

A two-stage 4.5 cfm pump, or equivalent, is required during regeneration of the HE-493 (and during pressure control of the glove box). The vacuum pump runs continuously when main (outside) power is on. Information on the vacuum pump is provided as an addenda to this manual for the information of the user.

SECTION 5. MAINTENANCE AND TROUBLESHOOTING

5-1 MAINTENANCE

General scheduled maintenance of the glove box system should include inspection of the HE-493 DRI-TRAIN. Specifically, regular maintenance of the HE-493 should include the following:

- Leak testing
- Inspection of all lines and connections
- Replacement of vacuum pump oil (pump customer furnished)

5-1.2 Leak Testing

Instructions herein are standard and may have to be modified for custom systems.

CAUTION

Do not use halogen leak detection equipment for leak testing. Halogens are harmful to seals, copper, and other materials used by Vacuum/Atmospheres Company.

VAC will not assume responsibility for systems tested by methods other than defined in this manual, and recommends that the customer use a helium leak detector.

The vacuum leak check is performed as follows:

- Ensure that the REGENERATION TIMER is in the VACUUM position.
- REGENERATE/CIRCULATE switch in OFF.

- Vacuum pump disconnected from the VACUUM valve and associated plumbing.
- Connect the helium leak detector at the VACUUM valve line.
- Close the DRI-TRAIN inlet and outlet valves (manually).
- With the REGENERATION TIMER in VACUUM position, the regeneration gas PURGE and VENT valves are deenergized. (J and V.) (There is no heat at this time.)
- Turn REGENERATE/CIRCULATE switch to REGENERATE.
- VACUUM valve open.
- After the system is totally evacuated, spray helium on all joints and components.

Any leaks, even small ones will be detected.

Note

The vacuum leak check covers not only the purifier evacuation system, but also the purge and circulation systems.

The system is leak checked at full vacuum and detector sensitivity (3 x 10^{-10} cc/sec, or better).

- Turn REGENERATE/CIRCULATE switch to OFF.
- VACUUM valve closes.
- Disconnect the helium leak detector from the system.
- Open (manually) the DRI-TRAIN inlet and outlet valves (A & B).
- Turn REGENERATE/CIRCULATE switch to CIRCULATE.

CAUTION

If the HE-493 is installed on a DRI-LAB, a slight negative effect will occur in the glove box when refilling the purifier.

- Reconnect the vacuum pump to the VACUUM valve plumbing.

5-1.3 Vacuum Pump Oil

The oil in the vacuum pump should be replaced:

- After each regeneration.
- Whenever the surface of oil is below the sight glass oil level line.
- Whenever the oil looks dirty.

Vacuum/Atmospheres provides an instruction sheet for the type of vacuum pump supplied as a part of each technical manual shipped with all DRI-TRAINS. (See Appendix A at the end of this manual.)

5-1.4 Lines & Connections

Periodically, or at recommended three-month intervals, all valves, fittings, lines, tubing, and electrical connections should be inspected for general mechanical, pneumatic, and electrical integrity.

5-2 TROUBLESHOOTING

Because high reliability components with low failure rates are used in VACUUM/ATMOSPHERE'S products, troubleshooting problems are rare in the DRI-TRAIN. However, should failures occur in the HE-493, troubleshooting one or more of the following areas is recommended:

- Valves - solenoid and manual
- Regeneration Timer
- Leaks
- Circulator/Blower
- Replacement of charge in purifier
- Pressure (in glove box)

5-2.1 Solenoid Valves

Proper operation of the solenoid valves is verified by testing for the presence of a magnetic field around the body of the solenoid. This is done by placing a small magnet near the red cap on the solenoid. When the solenoid is energized, the magnet will be strongly attracted to the center core and the 60-cycle "hum" in the coil will be felt in the magnet. If the solenoid is deenergized, only a steady pull will occur.

Reference to Figure 5-1, the HE-493 Schematic Diagram, provides the necessary information on how to test any given solenoid when so desired. No attempt will be made here to explain the basic procedures normal to tracing the flow of electrical current in the HE-493. This schematic is straightforward, and a basic knowledge of electrical troubleshooting is credited to anyone authorized to attempt any kind of trouble analysis of the HE-493 DRI-TRAIN. Table 5-1 herein provides a list of the valves and those evident symptoms which might logically point to a failure of the valve to energize.

In the event of a solenoid valve failure, check the electrical operation first. If the valve is/has been energized, but the failure symptom persists, it may become necessary to disconnect the valve from its plumbing to determine whether or not it is mechanically defective.

If the solenoid is found to be defective, this component may be easily replaced by disconnecting its leads from its terminal strip and removing the red plastic retaining cap.

In the event that a new solenoid is to be installed, it may be necessary

to splice wires onto the pigtail leads attached to the replacement solenoid. It is strongly recommended that the electrician use pre-insulated splices of the STAKON type.

If the solenoid and its related circuitry are not at fault, and a mechanical failure is indicated, refer to Table 5-1 as a means of verifying the symptom of valve failure. The two manual valves (A & B) are also included in Table 5-1.

5-2.2 Regeneration Programmer

The most obvious symptom of failure of the programmer would be a failure of the timer to progress from START. This would indicate that the built-in motor is not running. (See Figure 5-2.)

- If power is present at the motor and it does not run, replace the entire Regeneration Programmer assembly.

- If voltage is not present at the motor, trace the circuitry to determine the point at which the circuit is broken and repair or replace accordingly. (See Figure 5-1.)

5-2.3 Leaks

Refer to paragraph 5-1.2, Leak Testing.

5-2.4 Circulator Blower

The Circulator blower has a long, trouble-free history.

Note

The blower is overload-protected by the 5 amp fuse on the regeneration timer, and runs when REGENERATE/ CIRCULATE switch is in Circulate position.

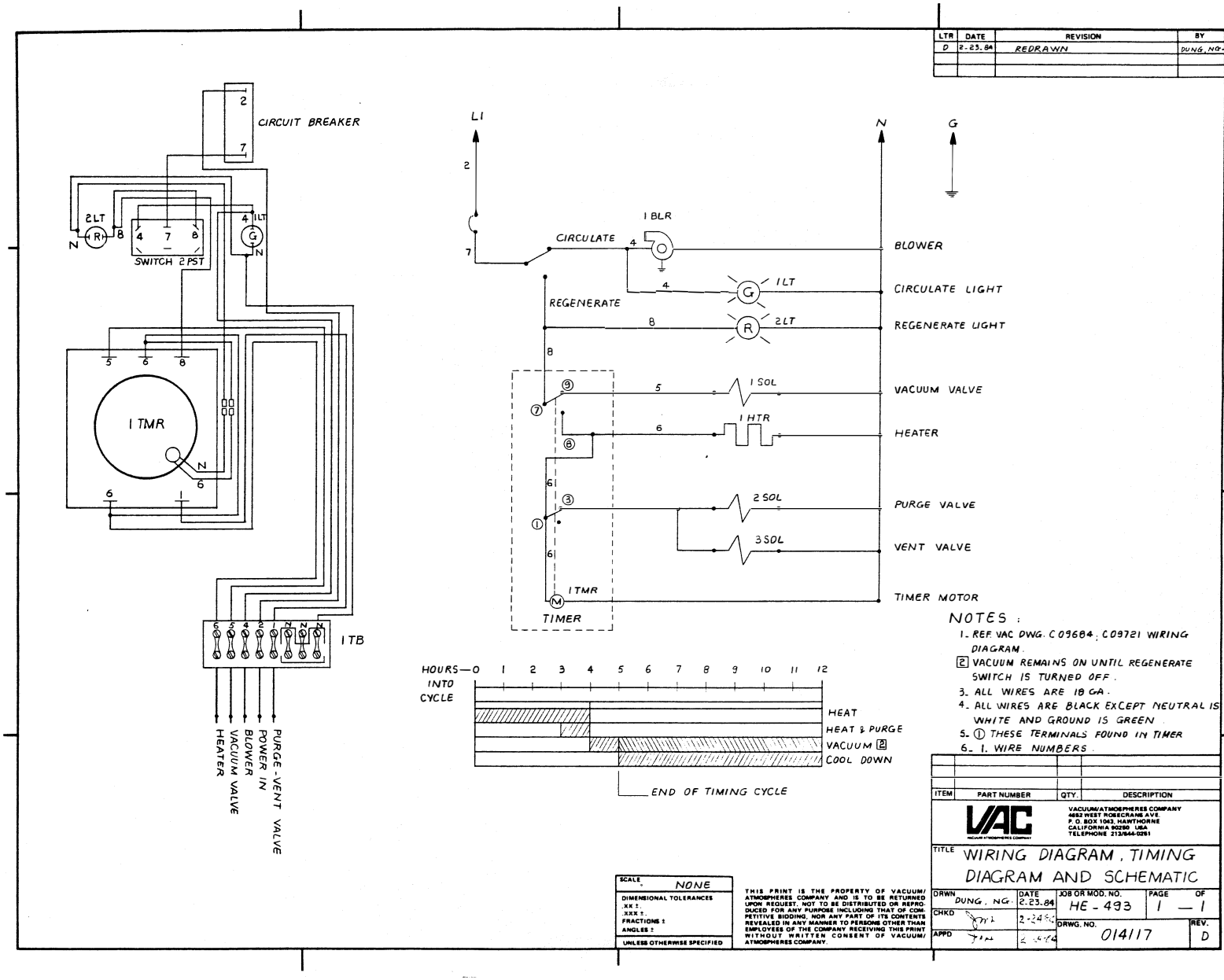


Figure 5-1. Schematic Diagram

Table 5-1. VALVE (SOLENOID AND MANUAL) FAILURE INDICATION

VALVE	FAILURE INDICATION
PURGE (J) VENT (N)	FAILURE TO ENERGIZE **Note** Both J and N solenoid valves work together. If either fails, the following would be evident: - Regeneration failure. - Moisture will not be purged out of the saturated molecular sieve, and there will be no conversion of the saturated Q1. - If the valve "freezes" in the deenergized position, excess pressure might build up in the purifier during heating. - Purifier may overheat and damage charge if there is no flow during regeneration.
	FAILURE TO DEENERGIZE - Purifier will be backfilled with air when the VACUUM cycle starts. - Entire DRI-TRAIN system would be continuously vented to the outside atmosphere. Pressure would never build up. - Regeneration failure.
VACUUM (K) (Solenoid)	FAILURE TO ENERGIZE - Regeneration failure.

Table 5-1. VALVE (SOLENOID AND MANUAL) FAILURE INDICATION (Cont.)

VALVE	FAILURE INDICATION
VACUUM (K) (continued)	**Note** Regeneration failure is a term which means that after a full regeneration cycle (paragraph 3-5.1) the purity of the system is not being maintained. Moisture and oxygen are not being removed from the saturated purifier. Therefore, the purifier cannot perform its function of removing oxygen and moisture from gas circulating through it. - The purifier will not be evacuated during the regeneration process, and the waste products generated as moisture during earlier portions of the cycle will not be removed. - The purifier remains saturated with moisture.
	FAILURE TO DEENERGIZE - If VACUUM valve (K) sticks - remains open - when the purifier is refilled with inert gas from the glove box, the box pressure becomes negative. **CAUTION** If pressure control in the glove box system is turned off, or the box runs out of makeup gas, the box could be damaged.

Table 5-1. VALVE (SOLENOID AND MANUAL) FAILURE INDICATION (Cont.)

VALVE	FAILURE INDICATION
CIRCULATION INLET (A) CIRCULATION OUTLET (B)	FAILURE TO OPEN If either of the manual inlet/outlet valves fail, the following would occur: - Inert gas cannot be circulated, and purification will not occur.
	FAILURE TO CLOSE - The glove box will be evacuated and purged with purifier during the regeneration process.
	Note All valve failures could be due to debris lodged inside. If not, check for mechanical malfunction and replace the valve.

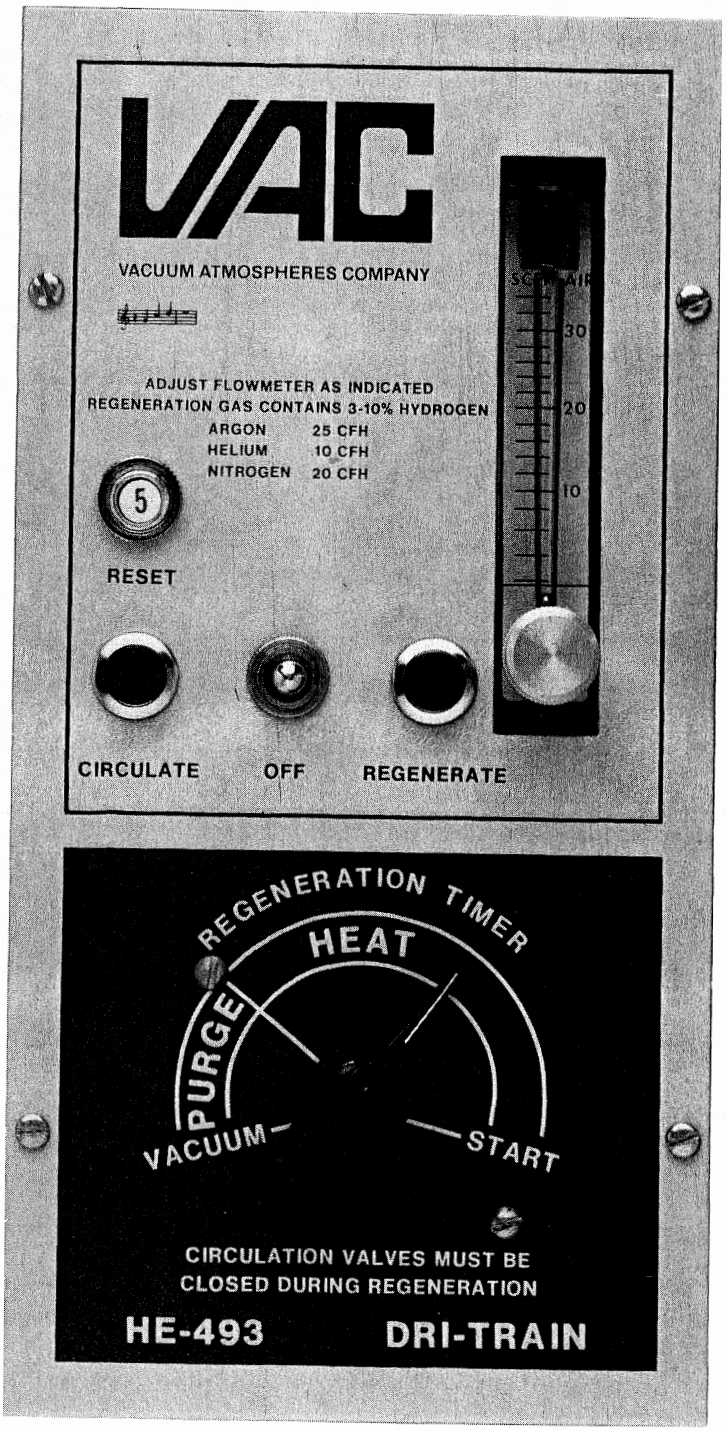


Figure 5-2. Regeneration Programmer - Detail

Blower is not damaged by running when the DRI-TRAIN inlet and outlet valves (A & B) are closed.

5-2.5 Charge Replacement

Refer to paragraph 4-3.1, herein.

5-2.6 Pressure Problems

Malfunctions in the HE-493 DRI-TRAIN which could cause increases or decreases in the glove box pressure are as follows:

A. Circulation Inlet and Outlet valves (A & B) are not completely closed, or debris stuck in valves.	This could cause increase or decrease in glove box pressure during regeneration cycle.
B. Vacuum valve (K) malfunction.	This could cause negative pressure condition in the glove box any time circulation valves are open.
C. Purge valve (J) and Vent valve (N) malfunction(s).	This could cause positive pressure condition in glove box if circulation valves are open.

Any one of these malfunctions will also adversely affect the regeneration cycle.

SECTION 6. PARTS

6-1 REPLACEMENT POLICY

Vacuum/Atmospheres Company warrants all parts in the DRI-TRAIN. This means that all parts or assemblies installed in the HE-493, whether or not they are built by VAC, are guaranteed in accordance with the WARRANTY at the beginning of this manual.

6-2 REWORKED PARTS

Most parts purchased by VAC for use in the HE-493 are reworked at the factory in various necessary ways to make them leak free under light gas conditions such as those which are common to DRI-TRAIN applications.

Most valves used by VAC are reworked and fitted with special "O-rings".

6-3 CIRCULATOR

The Circulator/blower is covered by an exchange policy through Vacuum/Atmospheres Company.

6-4 VACUUM PUMP

This pump (if one is purchased) is also covered under the exchange policy.

6-5 ORDERING PROCEDURES

To order spare or replacement parts, contact Vacuum/Atmospheres Company direct, by phone or letter.

Vacuum/Atmospheres Company
4652 West Rosecrans Avenue
P. O. Box 1043
Hawthorne, California 90250-6896
Telephone: (310) 644-0255
FAX: (310) 970-0980

6-6 PARTS LIST

The parts list, Table 6-1, provides the proper nomenclature and the VAC ordering numbers.

Table 6-1. PARTS LIST - HE-493

ITEM	SYMBOL	DESCRIPTION	VAC NO.
1		Circulator Blower	3093-1
2		Purifier Assembly	09685
3	J, K, V	Solenoid Valves (3)	1283
4		Switch 2 PST	1054
5		Control Box Assembly	014645
6		J-Box	1146-1
		J-Box	1307
7		Timer - Regeneration (2 Pole)	1110
8		Light - Amber (110 vac)	1263
9		Fuse - 5 amp	7625
10		Control Panel	014603
11		Knob-Timer	1101A1
12		Flowmeter	7619

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APPENDIX A

VACUUM PUMP