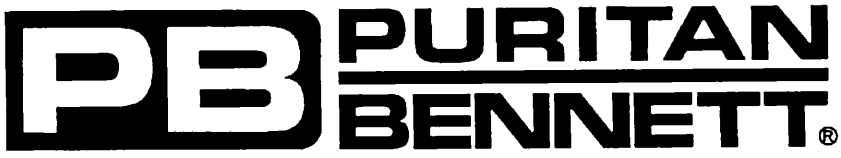

COMPANION® 492a AND COMPANION® 590 OXYGEN CONCENTRATORS

SERVICE MANUAL
PART NUMBER 492779

PREFACE

This manual provides the information needed to service the Puritan-Bennett Companion 492a and 590 Oxygen Concentrators. This information is intended for use by technicians or personnel qualified to repair and service medical equipment. The information is not all-inclusive and may not be applicable to future Companion 492a and 590 models.

Technicians should direct any questions regarding Companion concentrator service to Puritan-Bennett Oxygen Concentrator Division: 1-800-248-0890 or 314-739-7070.

The information contained in this document, including performance specifications, are subject to change without notice.

Puritan-Bennett makes no warranty of any kind with regard to the material in this manual, including but not limited to the implied warranties of merchantabilities and fitness for a particular purpose.

Puritan-Bennett shall not be liable for errors contained herein or for incidental or consequential damages in connection with providing this manual or the use of material in this manual.

DEFINITION OF STATEMENTS

Statements in this manual preceded by the following words are of special significance.

WARNING

Means there is the possibility of injury or death to yourself or others.

CAUTION

Means there is the possibility of damage to the unit or other property.

NOTE

Indicates point of particular interest for more efficient and convenient operation.

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SECTION 1. INTRODUCTION AND GENERAL INFORMATION

This section provides introductory information on the Companion 492a and 590 Oxygen Concentrators, including optional equipment, performance specifications, preparation for use, operating procedures, routine maintenance, and recommended tools and test equipment.

1.1 General Product Description

The Companion 492a and 590 Oxygen Concentrators provide supplemental oxygen at high concentrations. Each concentrator is equipped with a flowmeter calibrated in .25 liter increments with maximum settings of 4 lpm for the 492a and 5 lpm for the 590.

Both the 492a and 590 are compact, lightweight units equipped with four wheels and a handle for ease in delivery to the home and in transport by the patient at home. The unit's height of 25.4 inches (64.5 cm) enables the operator to reach the controls with ease (Figure 1-1). In addition, the filter compartment on the side of the unit makes accessible, without disassembly of the unit, the compressor filters, hour meter, battery, and circuit breaker.

Always observe the **WARNING** and **CAUTION** labels affixed to the front and rear panels as follows:

WARNING:
This machine produces oxygen. Keep away from heat and open flames. Do not smoke near patient or machine. Do not oil this machine.

CAUTION:
Federal (U.S.A.) law restricts this device to sale by or on the order of a physician.

CAUTION:
Do not use in the presence of fluids.

CAUTION:
Electrical shock hazard. Do not remove cover. Refer service to qualified service personnel.

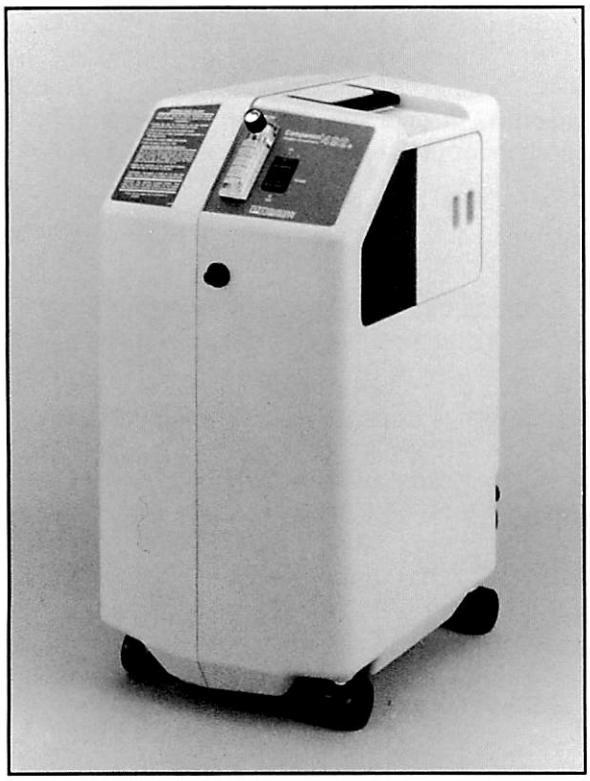


Figure 1-1: Companion 492a Front View

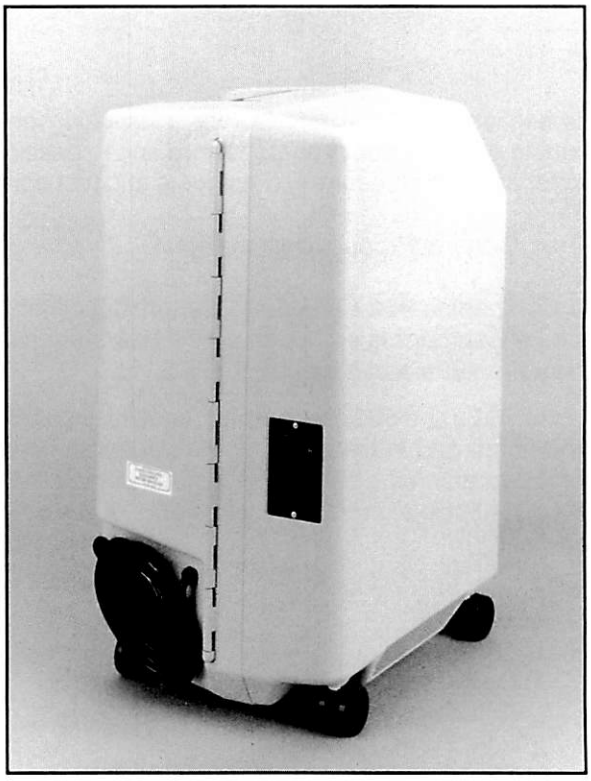


Figure 1-2: Companion 492a Rear View

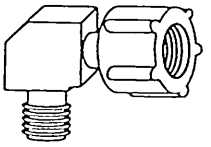
NOTE

With the exception of flowmeter range and cabinet labeling, the exterior of the Companion 492a and 590 are identical.

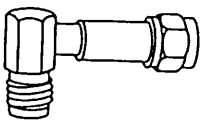
1.1.1 Optional Accessories and Literature

The following Puritan-Bennett accessories and literature may be used with the Companion 492a and Companion 590.

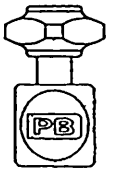
Literature	Part Number
Companion 492a Patient Instruction Manual	492931*
Companion 492a Patient Instruction Manual with O.C.I.**	492778*
Companion 590 Patient Instruction Manual	492932*
Companion 590 Patient Instruction Manual with O.C.I.**	492827*
Companion Concentrator Patient Checklist	799609
Humidifier Adapter Illustration Sheet	799660
Accessory	
Adapter, Humidifier (standard)	492922*
Adapter, Humidifier (long)	492392
Tail Piece	492587
Wing Nut	492588
Humidifier, Bubble (disposable)	001083
Oxygen Concentration Indicator (O.C.I.) (installation required)**	492888
Companion Flowsplitter	493219
Companion Flowsplitter Plug	493220
Companion Flowsplitter Nozzles:	
.5 LPM	493221
.75 LPM	493222
1.0 LPM	493223
1.5 LPM	493224
2.0 LPM	493225
2.5 LPM	493226
3.0 LPM	493227
3.5 LPM	493228



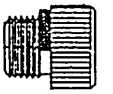
Adapter, Humidifier (Standard)



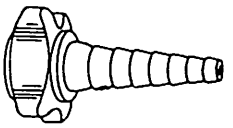
Adapter, Humidifier (Long)



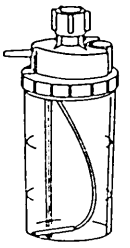
Companion Flowsplitter



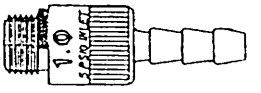
Companion Flowsplitter Plug



Tailpiece & Wingnut



Humidifier, Bubble (Disposable)



Companion Flow Nozzle

*Appropriate part supplied with unit
**Refer to Section 6 for information concerning OCI

The Companion 492a and 590 physical characteristics, environmental and electrical requirements, and pneumatic characteristics are listed in Table 1-1. In most cases the information provided in this table applies to both the 492a and 590. Any differences in characteristics or requirements between the two models are listed separately.

TABLE 1-1. PERFORMANCE SPECIFICATIONS

PHYSICAL CHARACTERISTICS

PARAMETER	MEASUREMENT/CONDITION
Cabinet size:	
Height	25.4 in. (64.5 cm)
Width	12.5 in. (31.75 cm)
Depth	16.5 in. (41.9 cm)
Assembly weight	
492a	57 lb. (25.8 kg)
590	59 lb. (26.8 kg)
Shipping container size:	
Height	28.5 in. (72.4 cm)
Width	14.6 in. (37.1 cm)
Depth	19.5 in. (49.5 cm)
Shipping weight	
492a	65 lb. (29.5 kg)
590	67 lb. (30.4 kg)
Noise Level	< 50 dBA at 1 meter
Cabinet construction	Molded case, hinges open for easy service equipped with carry handle and 4 casters.
POWER switch	Rocker-type standard. When ON, LED illuminates to indicate AC power. When unit is equipped with optional Oxygen Concentration Indicator (O.C.I.), Power Switch is a push-button type. When ON, LED illuminates to indicate AC power. Refer to section 6 for all information pertaining to OCI operation.
Audio alarm	When POWER switch is ON, sounds to indicate low pressure, which may be caused by cycle failure, or power disconnect. Powered by internal source with battery back-up.
Oxygen Concentration Indicator (O.C.I.)	Refer to section 6 for information pertaining to OCI operation.

ENVIRONMENTAL REQUIREMENTS

PARAMETER	REQUIREMENT
Storage/shipping temperature	-40°F to 158°F (-40°C to 70°C)
Operating temperature	50°F to 110°F (10°C to 43°C)
Stabilization time	20 minutes minimum
Operating Altitude*	Up to 3000 ft. (914 m) above sea level without degradation of performance.

ELECTRICAL REQUIREMENTS

PARAMETER	REQUIREMENT		
Power	Voltage	Frequency	Operating Current (nominal)
492a	120 ± 10 V AC	60 Hz	2.9 amps
590	120 ± 10 V AC	60 Hz	3.3 amps
Consumption			
492a	350 W average		
590	400 W average		
Battery	9 V, long-life alkaline		
Power Cord**	Double-insulated		
Circuit Breaker			
492a	5 amp, time-delay		
590	6 amp, time-delay		
Control Printed Circuit Board fuse	63 mA, 250 VAC		

PNEUMATIC CHARACTERISTICS

PARAMETER	MEASUREMENT
Flow rate	
492a	0 to 4 lpm with .25 liter increments
590	0 to 5 lpm with .25 liter increments
Oxygen concentration*	
492a	95 ± 3% for 1-3 lpm 92 ± 3% at 4 lpm
590	95 ± 3% for 1-4 lpm 90 ± 3% at 5 lpm
Static delivery pressure	5 ± 0.5 psig
System operating pressure	Cycles from approximately 14 to 29 psig

*Atmospheric pressure at altitudes of 3000 ft. (914 m) above sea level may decrease oxygen concentration levels.

**Unit is Canadian Standard Association (CSA) certified as being Double Insulated.

1.3 Unpacking and Receiving Inspection

Unpack and inspect the Companion 492a/590 as follows:

a. Examine shipping container for exterior damage. If container is damaged or contents are suspected of being damaged, contact carrier to request that inspection of damage be made. Photograph damaged container before concentrator is unpacked. Contact the shipping point immediately.

b. Position shipping container so that shipping arrows are pointing up.

> **NOTE**
>
> If staples were used to seal the shipping carton, take care in opening and removing the staples so that the shipping carton will not be damaged.

c. Open shipping carton top flaps and lay carton on its side.

d. Hold container down with one hand. Grasp handle, and slide concentrator out of container.

e. Stand upright on casters and remove yellow cap from oxygen outlet.

f. Compare packing slip attached to container's exterior with shipment received. If any discrepancies exist, contact Puritan-Bennett immediately.

g. Thoroughly inspect the exterior of the Companion 492a/590 for damage.

h. **SAVE ALL PACKING MATERIALS AND SHIPPING CONTAINER FOR REUSE.**

> **NOTE**
>
> Contact Puritan-Bennett for a returned goods authorization (RGA) number if it is necessary to return a unit to the factory. Write the RGA number on the outside of carton before shipping.

When required, repack the Companion 492a/590 as follows:

a. Disconnect any fitting or accessory at oxygen outlet.

b. Replace oxygen outlet cap (yellow).

c. Ensure that power cord is wrapped around rear holder.

d. Ensure that side filter compartment door is securely in place.

e. Place concentrator inside foam-lined shipping container.

f. Close the two shorter container flaps, then the two longer flaps.

g. Secure container with packing tape.

> **CAUTION**
>
> Report any problems found during inspection to freight carrier or contact Puritan-Bennett Oxygen Concentrator Division for assistance if necessary.

1.4 Operating Procedures

This section provides the operational check and the operating instructions for the Companion 492a/590.

1.4.1 Operational Check

Perform the following steps before initial use of concentrator at patient site.

> **NOTE**
>
> The use of a properly calibrated oxygen analyzer is required.

a. Ensure that the following filters are clean and securely in place. (Figure 1-3)

Item	Location
Air inlet filter	Side panel
Compressor inlet prefilter	Prefilter housing in filter compartment
Compressor inlet bacteria filter	Filter compartment

b. Verify that all internal pressure has been vented by turning the flowmeter knob fully counterclockwise. The flowmeter ball should indicate zero flow.

c. Set POWER switch on top panel to ON before connecting power cord to outlet. If audio alarm does not sound or is weak, replace nine-volt battery in side compartment. Set POWER switch to OFF.

d. Connect power cord to AC outlet.

> **NOTE**
>
> If concentrator has been exposed to temperatures below 40°F (14°C), allow it to reach ambient temperature (approximately 30 minutes) before turning on.

e. Set POWER switch to ON and flowmeter to maximum lpm on scale. The audio alarm will sound for a maximum of one minute, then cease. If alarm does not sound or continues to sound after one minute, see section 3, Performance Verification and Troubleshooting.

f. Verify that POWER switch L.E.D. is illuminated. If indicator is not illuminated, see section 3 Performance Verification and Troubleshooting.

g. Note hour meter reading. (Figure 1-3)

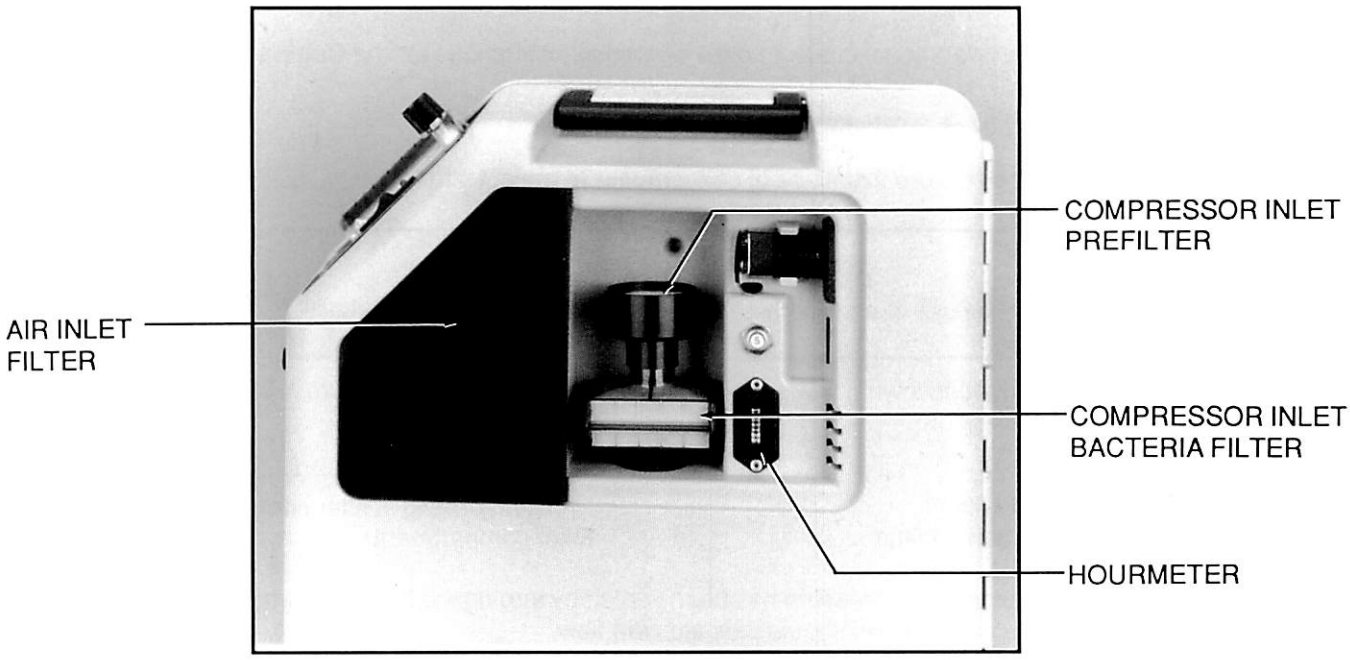


Figure 1-3: Side Panel View

1.4.1 Operational Check (continued)

> **NOTE**
>
> Allow concentrator to run (stabilize) for approximately 20 minutes before proceeding.

h. Connect calibrated oxygen analyzer to concentrator's oxygen outlet as shown in Figure 1-4. Follow Oxygen Analyzer manufacturers recommendations for proper connection to concentrator.

i. After the 20 minute stabilization time, verify that the concentration is 92% ± 3% at 4 lpm for the **492a** and 90% ± 3% at 5 lpm for the **590.**

j. If the unit is equipped with the optional OCI verify that the green (normal) L.E.D. is illuminated.

If oxygen concentration is not as specified, see section 3.3, Troubleshooting.

k. Ensure that air flow is emitted through cooling air exhaust vents at base of concentrator (side opposite air inlet filter).

Perform routine maintenance as outlined in Table 1-2. If concentrator is operated in a dusty environment, the recommended frequency of routine maintenance should be increased.

Figure 1-4: Oxygen Concentration Testing

1.4.2 Operating Instructions

NOTE

For additional operating instructions, refer to the appropriate Patient Instruction Manual listed in subsection 1.1.1, Optional Accessories and Literature.

Perform the following steps:

a. Ensure that air inlet filter (Figure 1-3) is clean.

b. Position concentrator near appropriate AC outlet so that power cord can be connected without using extension cord.

WARNING

Oxygen greatly accelerates combustion. Keep concentrator at least five feet (1.5 m) away from sources of heat, smokers, open flames, or electrical equipment that may spark or become heated during operation. Oil and grease are highly flammable. Do not allow contact with concentrator.

CAUTION

Keep air inlet filter and cooling air exhaust vents at least six inches (15.2 cm) away from walls or draperies. Obstacles next to unit impede room air from entering concentrator.

c. Set flowmeter control knob to setting prescribed by physician. Do not change setting unless ordered by physician.

NOTE

Refer to 1.1.1., Optional Equipment, for Puritan-Bennett part numbers of accessories used in steps d and e.

d. If humidified oxygen has been prescribed by physician, proceed as follows:

1) Remove humidifier adapter (Figure 1-5) from side panel filter compartment.

2) Connect humidifier adapter to a properly filled bubble humidifier (Figure 1-6).

3) Attach the humidifier and adapter to the oxygen outlet spout at unit's front (Figure 1-7).

4) Connect oxygen tubing to humidifier outlet (Figure 1-8).

5) Proceed to step f.

e. If humidified oxygen has not been prescribed by physician, proceed as follows:

1) Place wing nut on tail piece to form tubing adapter (Figure 1-5).

2) Connect tubing adapter to oxygen outlet at unit's front.

3) Connect oxygen tubing to tubing adapter (Figure 1-9).

1.4.2 Operating Instructions (continued)

f. Connect power cord to AC outlet.

NOTE

If concentrator has been exposed to temperatures below 40°F (14°C), allow it to reach ambient temperature (approximately 30 minutes) before turning on.

g. Set POWER switch to ON. The audio alarm will sound for a maximum of on minute, then cease.

NOTE

Allow concentrator to run (stabilize) for approximately 20 minutes before using.

NOTE

If concentrator is accidently tipped over, impact of hitting floor may activate the Printed Circuit Board relay and the audio alarm may sound. Return concentrator to upright position. Set POWER switch to OFF, and after five seconds back to ON. Alarm may sound for a maximum of one minute, then cease.

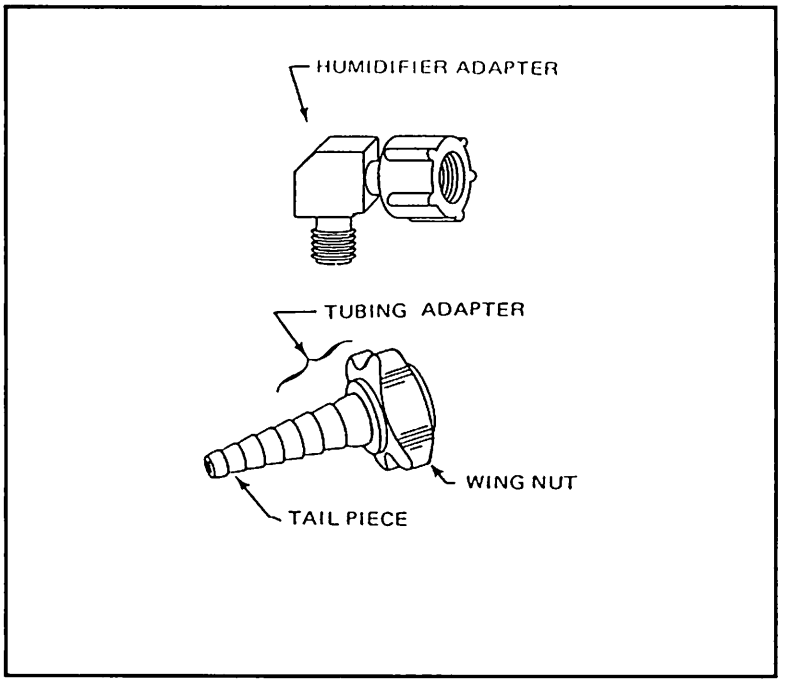


Figure 1-5: Oxygen Outlet Adapters

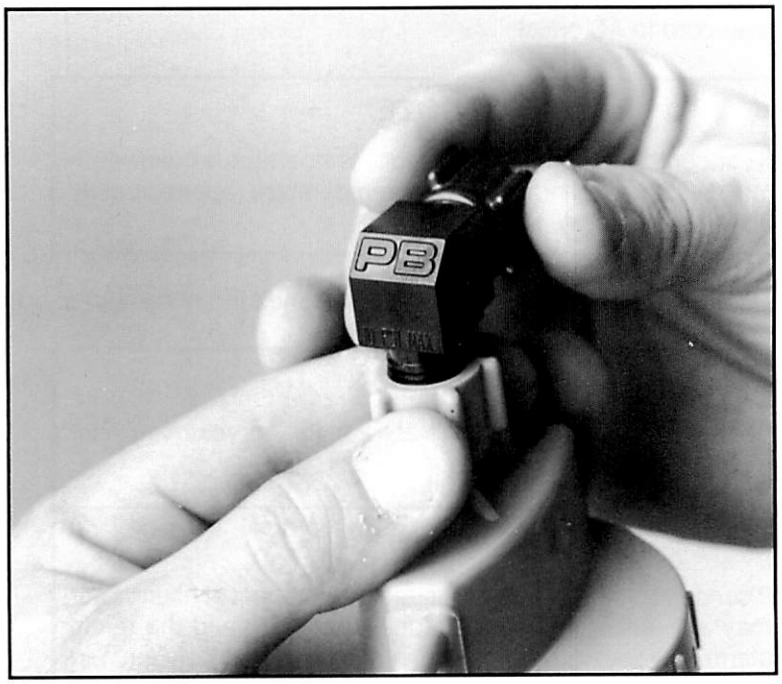


Figure 1-6: Humidifier Adapter Attachment

Figure 1-7: Humidifier Attachment

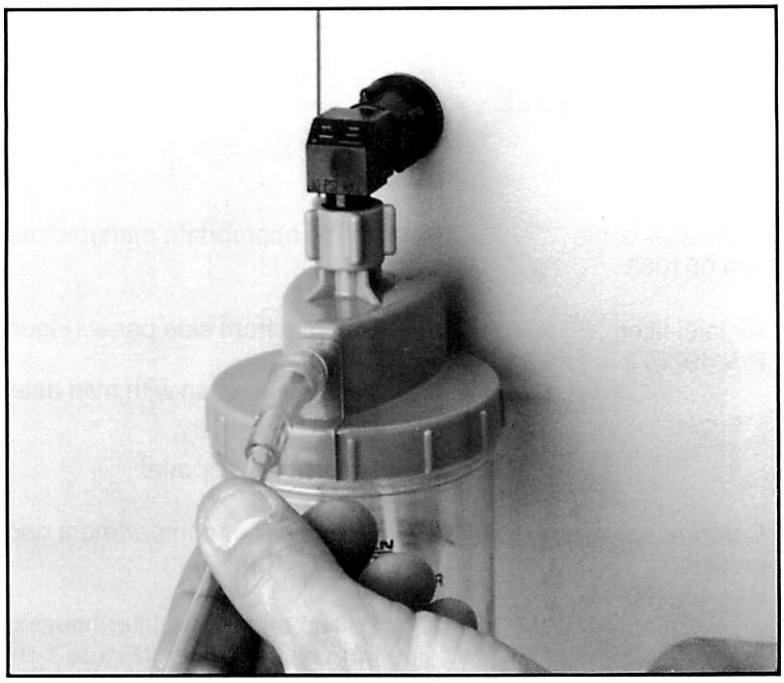


Figure 1-8: Oxygen Tubing Attachment To Humidifier

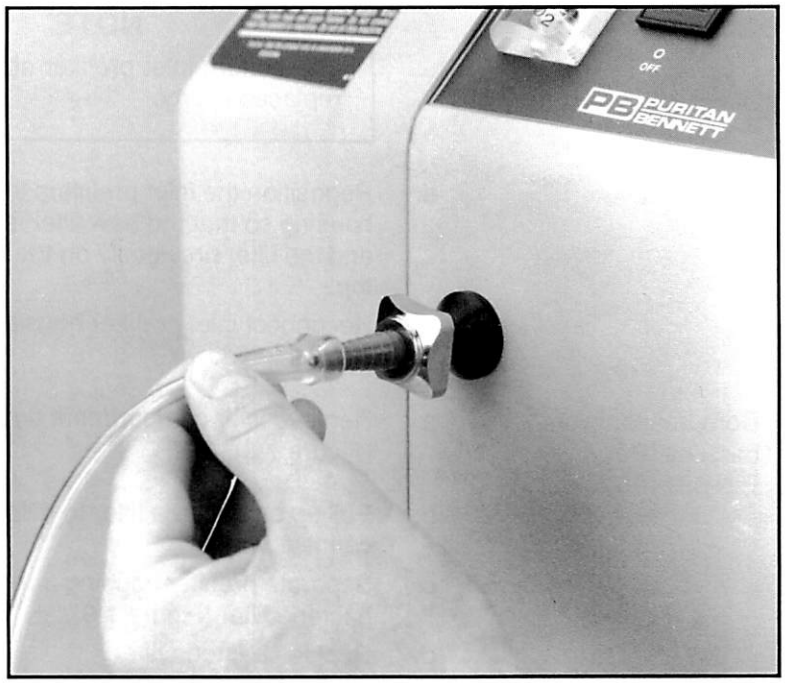


Figure 1-9: Oxygen Tubing Attachment To Adapter

Perform routine maintenance as outlined in Table 1-2. If the concentrator is operated in a dusty environment, the frequency of maintenance should be increased.

TABLE 1-2 MAINTENANCE SCHEDULE

	FREQUENCY	ITEM	ACTION
1.	Daily	Humidifier bottle P/N 001083	Refer to the appropriate manufacturer's operating manual.
2.	Daily	Air inlet filter P/N 492672	a. Remove from side panel (Figure 1-3). b. Vacuum or wash with mild detergent and water. c. Rinse and air dry. d. Return to side panel.
3.	Monthly*	Compressor inlet prefilter P/N 492193	a. Remove filter compartment door of concentrator (Figure 1-3). b. Pull up on inlet prefilter housing to disconnect from bacteria filter. (Figure 1-9) c. Remove both compressor inlet prefilters from the prefilter housing (Figure 1-9) and exchange the top filter for a new one. **NOTE** The bottom inlet prefilter should also be replaced if dirty. d. Reposition the inlet prefilters in the prefilter housing so that the new filter is on the bottom and the filter previously on the bottom is now on top. e. Reconnect inlet prefilter housing to bacteria filter by pushing down.
4.	Every Six (6) months	Compressor inlet bacteria filter P/N 492190	a. Remove filter compartment door of concentrator (Figure 1-3). b. Pull up on bacteria filter to disconnect from connector. c. Separate prefilter housing from compressor inlet bacteria filter (Figure 1-9). d. Replace bacteria filter. e. Insert prefilter housing onto bacteria filter. f. Reconnect filter assembly to filter connector, and reinstall compartment door.

TABLE 1-2 MAINTENANCE SCHEDULE

	FREQUENCY	ITEM	ACTION
5.	Every 1 Year	Alarm battery P/N 492297	a. Remove filter compartment door of concentrator (Figure 1-3). b. Unplug connector from battery. c. Remove and discard battery. d. Install new battery and connect plug to battery terminals. e. Reinstall filter compartment door.
6.	Every 15000 Hrs.	Outlet gas filter P/N 492141	Refer to outlet gas filter service procedure Section 4.
7.	As needed	Cabinet exterior	**WARNING** To prevent a possibility of electrical shock to the operator or damage to the concentrator, disconnect power cord before cleaning. Wipe with damp cloth or sponge and mild house hold cleaner.
8.	As needed	Oxygen connecting tubing and cannula	Clean or replace.
9.	As needed	Cabinet interior	a. Open concentrator cabinet. Refer to the cabinet service procedure in Section 4. **CAUTION** Ensure that the compressed air supply used to clean the cabinet interior is clean and oil-free. b. Blow or vacuum any dust which may have accumulated inside the concentrator. Leave air inlet and exhaust vents unobstructed. c. Close concentrator cabinet.

*For those units with OCI installed, change the compressor inlet prefilter every 3 months or as necessary.

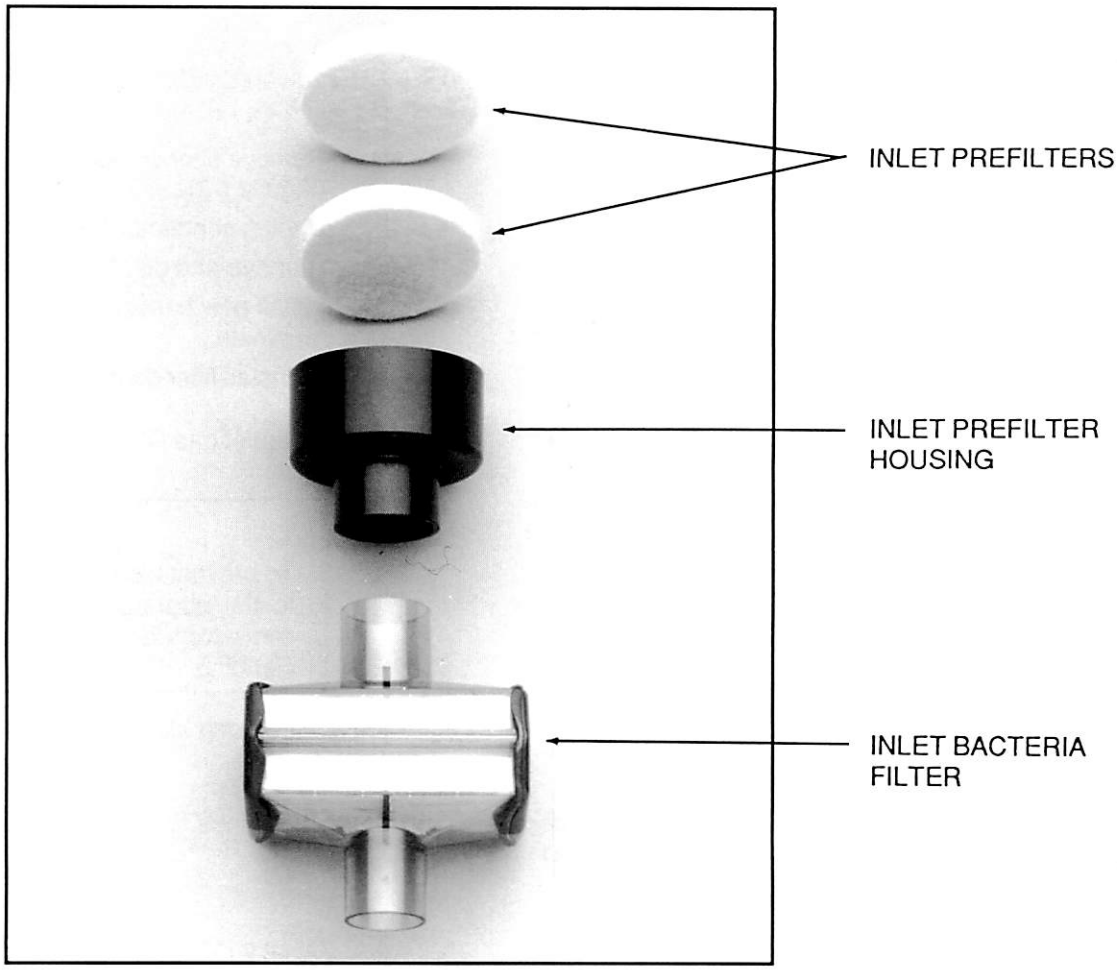


Figure 1-10: Side Panel Compartment Filters

1.6 Recommended Tools and Test Equipment

Standard test equipment tools, and materials used to test and service the Companion 492a/590 are listed below. If equipment other than specified is used, the substitute must be equal to or better than that listed.

TABLE 1-3. RECOMMENDED TOOLS AND TEST EQUIPMENT

DESCRIPTION	MANUFACTURER	MODEL/PART NUMBER
TEST EQUIPMENT		
Digital Multimeter	John Fluke Co Seattle, WA	8000A
Oxygen Analyzer	Hudson	6400, cell 5500
Test Flowmeter	Sierra Instruments	820 Top Trak
Stopwatch	Local Supplier	NA
Pneumatic Test Kit	Puritan-Bennett	P/N 492381
SPECIAL TOOLS		
Kit, Pop-Rivet Gun	Jensen Tools, Inc	Y339B750
Pliers, Truarc (for internal retaining ring with 1/8-inch hole)	Waldes Kohinoor, Inc	0309 (90° tip)
Wrench, Torque	Torque Controls	TS-30
#0 Phillips screwdriver	Local Supplier	NA
#2 Phillips screwdriver (min. shaft length of 7 in. recommended)	Local Supplier	NA
#2 Magnetic Phillips screwdriver	Local Supplier	NA
SERVICE MATERIALS		
Alcohol, Isopropyl	Local Supplier	NA
Loctite	Loctite Corp	242,680,262
Swabs, Cotton	Hardwood Products, Inc	806
Pipe Cement	Flouramics Inc.	LOX 8
Leak Detector	Puritan-Bennett Corp	775272
Cabinet Touch-Up Paint (4 oz)	Puritan-Bennett Corp	492648

SECTION 2. THEORY OF OPERATION

This section details the operational theory for the Companion 492a/590 Oxygen Concentrators. It includes an overview of the operation, the pneumatic system and components, the electrical system and components, the pressure-swing process, and the safety features.

NOTE

Numeric values found in this section are nominal values used for descriptive purposes only. Due to atmospheric pressure changes, compressor strength and other factors, pressure characteristics may vary.

2.1 OVERVIEW OF CONCENTRATOR OPERATION

The Companion Oxygen Concentrators use the pressure swing method of concentrating oxygen from room air. In this method, compressed air is alternately applied to two canisters containing molecular sieve material which adsorbs (attracts) nitrogen from the air and allows oxygen and trace gases to pass through.

Molecular sieves belong to a class of compounds known as zeolites. Zeolites are highly porous adsorbents both naturally occurring and synthetically produced. Within each granule of man-made zeolite exists a system of precisely arrayed cavities and pores. These are uniform in size and molecular dimension so that molecules are either readily adsorbed or completely excluded.

In an oxygen concentrator, nitrogen-selective zeolite (molecular sieve material) is used to adsorb nitrogen molecules in a pressurized tank. It is by physical force (pressure) that this molecular sieve traps nitrogen and yet allows other gases to flow through the sieve bed. Nitrogen molecules are then desorbed (released) by venting the sieve bed to the atmosphere thereby reducing the pressure and the adsorptive force.

High oxygen concentration and long sieve bed life is accomplished by the proper use of pressure swing cycles and efficient purging. However, molecular sieve has a strong affinity for water and will displace any other molecule in favor of H_2O. When this happens, nitrogen-selective zeolite loses its affinity for nitrogen and can be considered to be contaminated. During normal operation though, room humidity does not affect the sieve's ability to adsorb nitrogen. A thin layer of sieve at the top of the bed is used as a desiccant to wick humidity from the supply gas preventing further contamination during a concentrating cycle. This moisture is atomized back into the atmosphere during the exhaust phase. Regeneration of the sieve bed is then completed by purging the exhausting tank with concentrated, humidity free oxygen.

The pneumatic system (Figure 2-1), under the control of the electrical system, produces a source of compressed supply air, switches supply air between two molecular sieve canisters, regulates internal pressures, and controls the final output flow rate of oxygen. The components of this system are the compressor and capacitor, heat exchanger, four canisters, three solenoid valves, five pilot valves, two restrictors, pressure switch, regulator, two check valves, flowmeter, expansion chamber, muffler, and four filters.

The electrical system (Figure 2-2) provides the controlling and monitoring functions for the concentrator and distributes the electrical power required for operation. In addition to the compressor and solenoids mentioned above, the components of this system are an electronic printed circuit board (PCB), power switch, audio alarm, hour meter, nine-volt battery, circuit breaker, cooling fan, and an Oxygen Concentration Indicator (OCI) system (optional).

Following is a description of each of the components that make up the two concentrator systems.

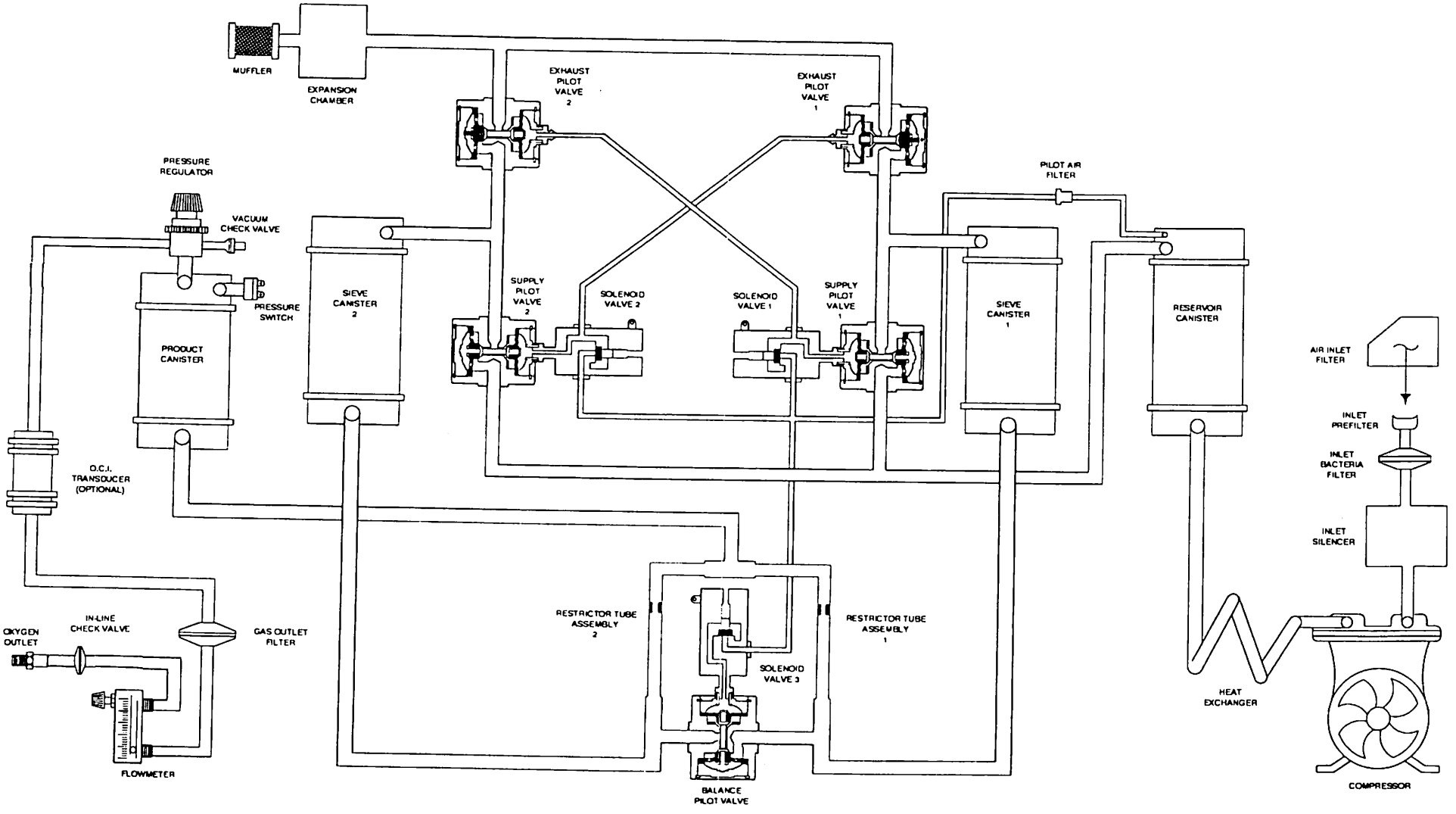
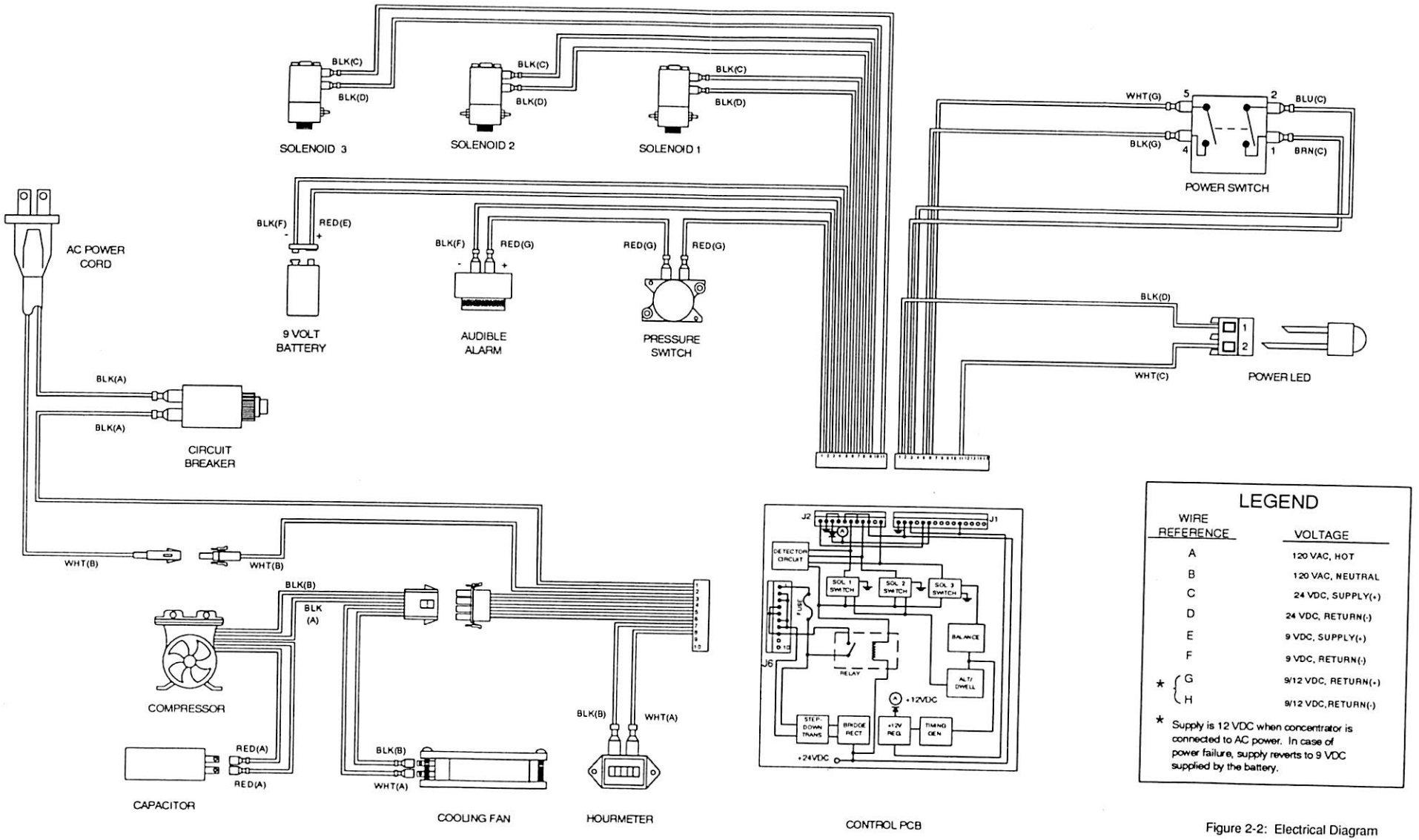


Figure 2-1: Pneumatic Diagram



LEGEND

WIRE REFERENCE	VOLTAGE
A	120 VAC, HOT
B	120 VAC, NEUTRAL
C	24 VDC, SUPPLY(+)
D	24 VDC, RETURN(-)
E	9 VDC, SUPPLY(+)
F	9 VDC, RETURN(-)
* G	9/12 VDC, RETURN(+)
* H	9/12 VDC, RETURN(-)

* Supply is 12 VDC when concentrator is connected to AC power. In case of power failure, supply reverts to 9 VDC supplied by the battery.

Figure 2-2: Electrical Diagram

2.2 PNEUMATIC SYSTEM COMPONENTS

Air Inlet Filter

The air inlet filter (Figure 2-3) is a gross particle filter made of a reusable foam material. It filters large particulate material from air drawn into the concentrator cabinet by the action of the cooling fan. It is secured to the right hand side of the cabinet with velcro strips and may be easily cleaned for servicing. (See Table 1-2 Maintenance Schedule).

Inlet Prefilter

The compressor inlet prefilter (Figure 2-3 & 2-4) consists of two felt elements that filter particulate matter and smoke from room air drawn into the compressor. Approximately 60 to 70 liters of air are drawn through the filters each minute. The felt filter elements are individually replaceable. (See Table 1-2 Maintenance Schedule).

Inlet Bacteria Filter

The compressor inlet bacteria filter (Figure 2-3 & 2-4) consists of a bacteria grade element in a sealed housing that filters bacteria and particulate matter greater than .2 microns in diameter from room air drawn into the compressor. (See Table 1-2 Maintenance Schedule).

Both the inlet prefilter and bacteria filter are located in the filter compartment accessible from the outside of the right hand side of the cabinet. The combination of the inlet prefilter and the bacteria filter enables the compressor to provide clean air to the molecular sieves canisters.

Inlet Silencer

The inlet silencer (Figure 2-6) is a hollow chamber molded into the compressor platform. The inlet silencer muffles the sound of the air being pulled into the compressor's inlet.

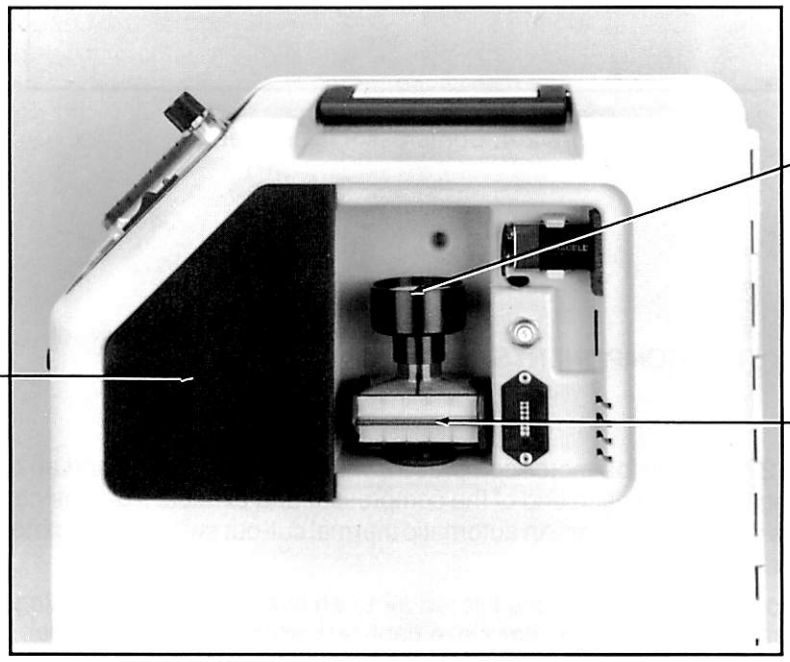


Figure 2-3: Side Panel View

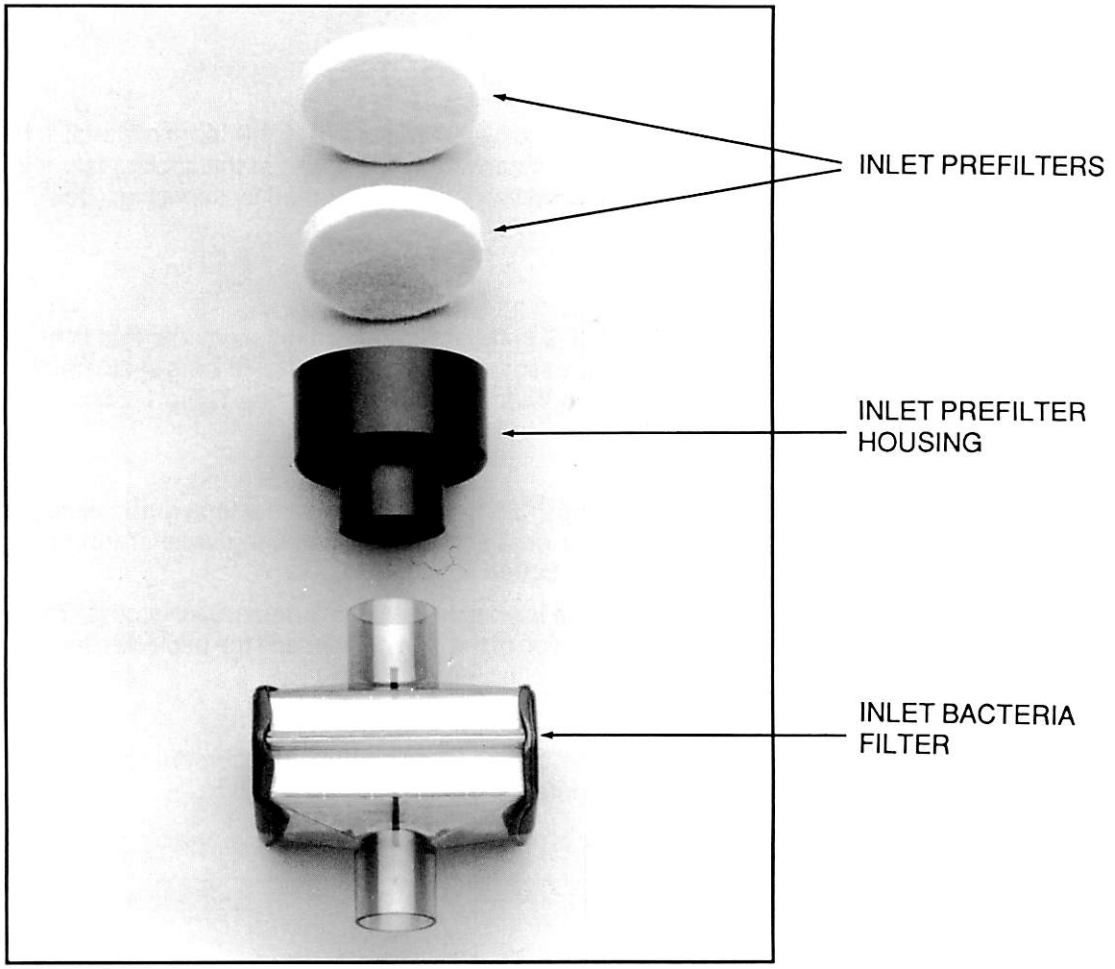


Figure 2-4: Compressor Inlet Filters

2.2 PNEUMATIC SYSTEM COMPONENTS (continued)

Compressor

The compressor (Figure 2-5) is a piston motor-compressor with dual cooling fans and an open chassis design. The two fans draw cooling air in from each end of the compressor and exhaust it out the center to provide equal cooling of the bearings as well as the motor. An automatic thermal cut-out switch in the motor interrupts electrical power to the compressor if it overheats.

The function of the compressor is to compress filtered air to an average system working pressure of 18 PSI. This compressed air is routed to the molecular sieve canisters which require air under pressure to produce oxygen. Compressor maintenance can be reduced by proper ventilation and filtering.

Capacitor

The capacitor (Figure 2-6) is an electrical storage device used to help start the compressor motor and improve compressor performance during operation.

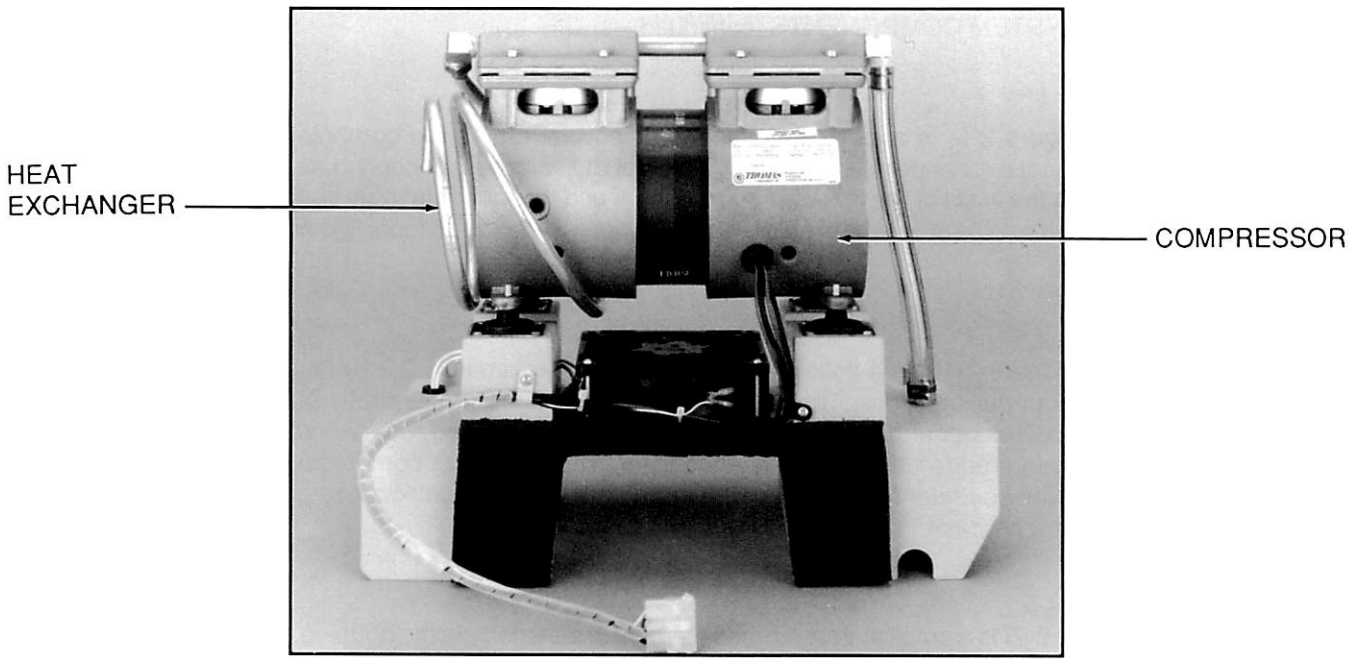


Figure 2-5: Compressor Drawer, Front View

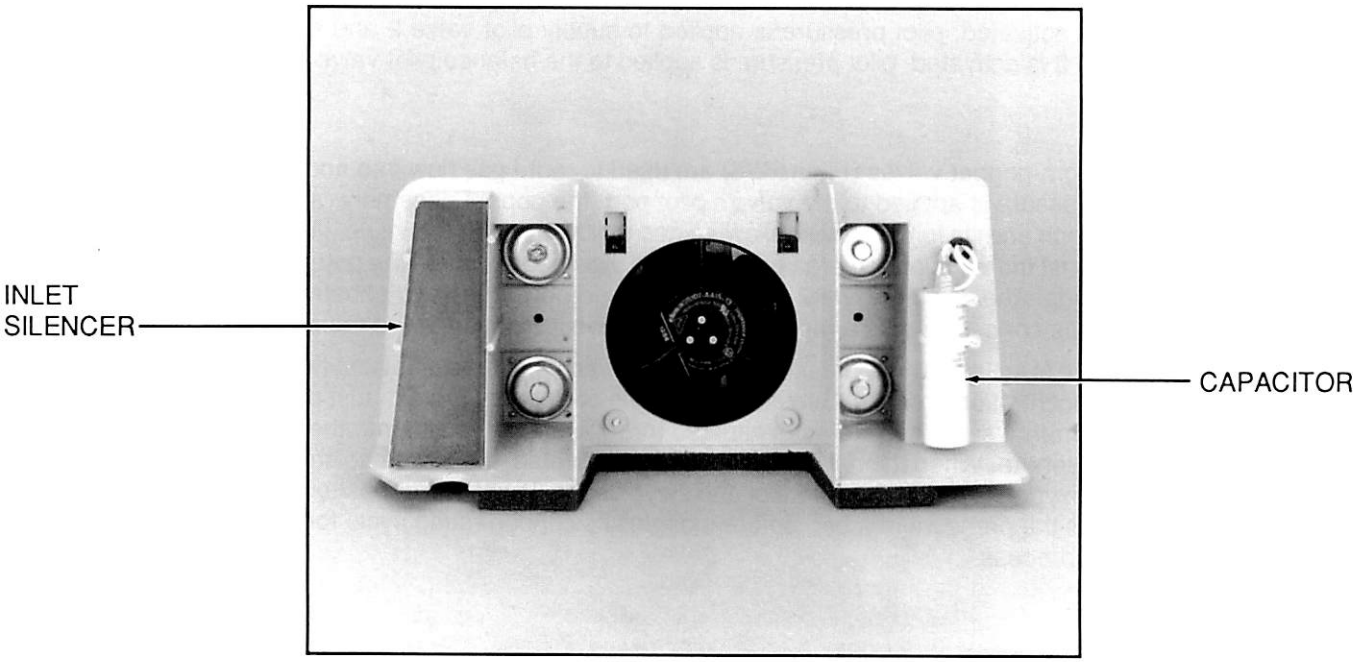


Figure 2-6: Compressor Drawer, Bottom View

Heat Exchanger

The heat exchanger (Figure 2-5) is a loop of aluminum tubing that routes the compressor outlet gas to the reservoir canister. The heat exchanger is located in the path of the compressor cooling air flow and is designed to dissipate heat through the walls of the tube. This component and the four aluminum canisters (product, sieve (2), and reservoir) create a "heat sink" to allow warm compressed gas to cool by dissipation during the concentrator's operation.

Reservoir Canister

The reservoir canister (Figure 2-10) is a hollow aluminum tank, approximately 2.3 liters in volume, that stores air from the compressor under pressure. The reservoir canister acts as a pneumatic pulsation dampener to moderate the pressure pulses generated by the two compressor pistons. The reservoir canister then supplies the large volume of air required to charge the sieve canister. This source of compressed air is also used to pressurize the five pilot valves under the control of the three solenoids. In addition, this canister plays a major role in the heat dissipation process.

Pilot Air Filter

The pilot air filter (Figure 2-7) is a small sintered-brass element in a sealed plastic housing that filters particulate matter as small as 25 microns in diameter from the pilot line air coming from the reservoir canister. This filtering action prevents contaminants from accumulating and occluding the small passages in the pilot tubing and solenoid valves. Normally, this filter should not need to be serviced.

Solenoid Valves

Three miniature 24 VDC solenoid valves (Figure 2-8) are used to control the pressurization of the pilot valves. By system design, if one sieve bed is open to supply air, then the opposite sieve bed is open to exhaust. Therefore, if solenoid valve 1 is activated, pilot pressure is applied to supply pilot valve 1 and exhaust pilot valve 2. If solenoid valve 2 is activated, pilot pressure is applied to supply pilot valve 2 and exhaust pilot valve 1. Finally, if solenoid valve 3 is activated, pilot pressure is applied to the balance pilot valve.

Pilot Valves

Five air piloted, diaphragm-poppet valves (Figure 2-8) are used to route gas flow into and out of the two sieve canisters. When pilot pressure is applied to the valve's pilot port, the poppet assembly (a brass stem with two rubber diaphragms at each end) is forced down, allowing gas to flow through the valve. When pilot pressure is removed, pressure against the unbalanced area of the bottom diaphragm moves the poppet assembly against its seat to stop flow through the valve (Figure 2-9). A spring, used only in the two exhaust pilot valves, keeps the valve closed when the concentrator is turned off to prevent contamination of the molecular sieve material.

When a supply pilot valve is actuated, compressed air from the reservoir canister is admitted to a sieve canister to begin the oxygen concentration process. Simultaneously, the corresponding exhaust pilot valve is actuated and adsorbed nitrogen from a sieve canister is exhausted through the valve and into the expansion chamber and muffler and to atmosphere. When the balance pilot valve is activated, the sieve canisters are pneumatically connected to allow the oxygen layer at the bottom of one sieve bed to flow to the opposite bed. This pre-charge of oxygen gas increases the pressure in a bed before it begins its concentrating cycle for greater efficiency in the nitrogen adsorption process.

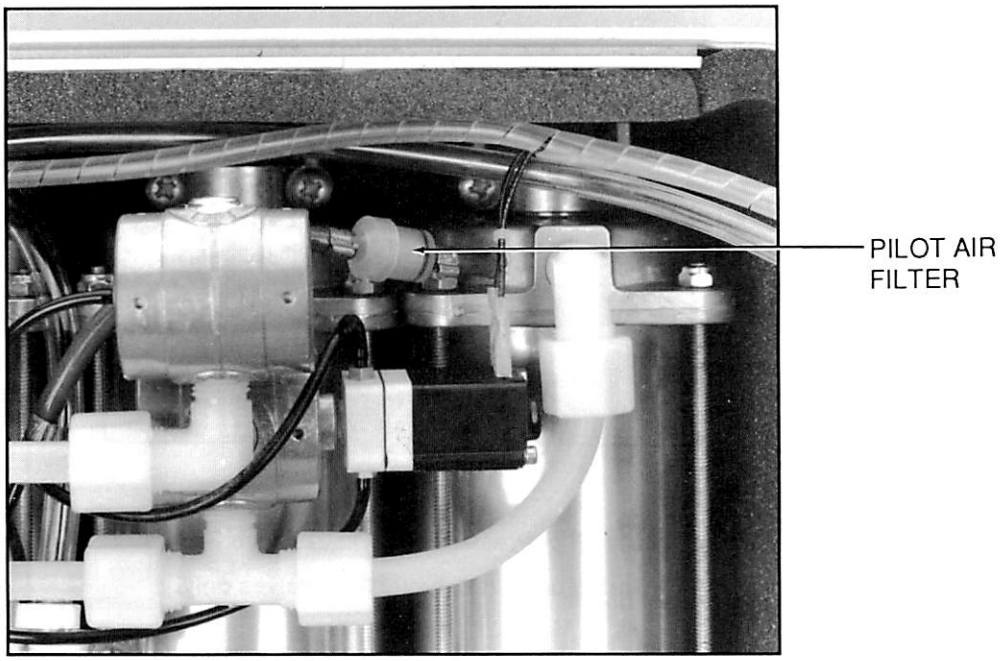


Figure 2-7: Pilot Air Filter

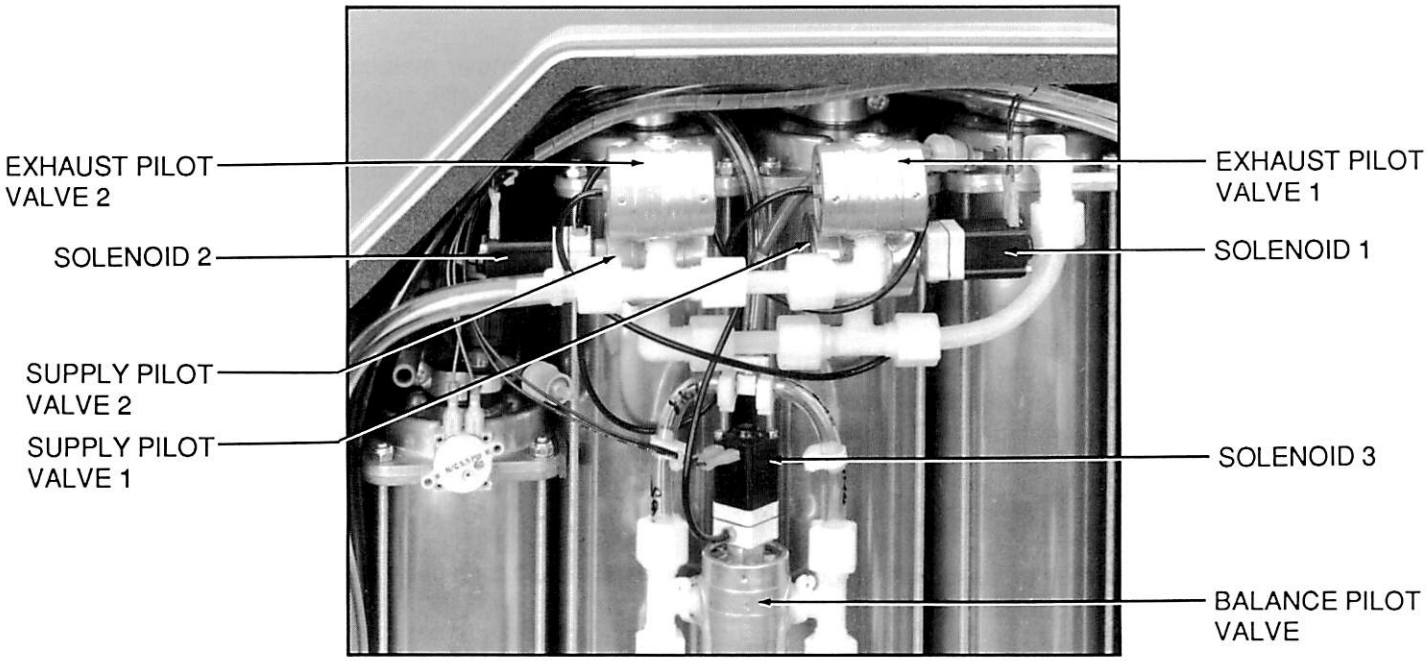


Figure 2-8: Solenoid and Pilot Valves

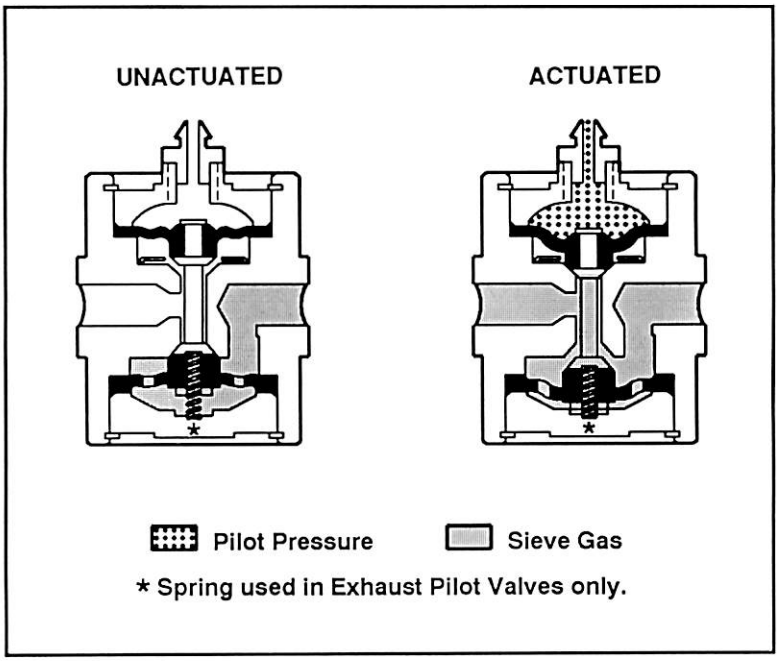


Figure 2-9: Pilot Valve Operation

2.2 PNEUMATIC SYSTEM COMPONENTS (continued)

Sieve Canister

The two sieve canisters (Figure 2-10) are aluminum tanks that contain granular molecular sieve material, a nitrogen selective zeolite that strips nitrogen from air by an adsorption process while allowing oxygen and trace gases to pass through the sieve.

Nitrogen adsorption occurs when the sieve canister is pressurized from approximately 14 to 20 PSI with compressed room air. A sieve canister that is saturated with adsorbed nitrogen is regenerated (desorbed) by venting the sieve canister pressure to atmospheric pressure. Some of the product oxygen is supplied as a purge gas to increase the efficiency of regenerating the sieve by removing any residual nitrogen molecules remaining in the canister. This oxygen readily combines with the nitrogen and is flushed from the canister by the purge pressure.

The sieve canisters must be kept sealed from the atmosphere to prevent contamination of the molecular sieve material by migration of moisture (humidity) into the canister. Because of sieve material's high affinity for water, moisture drawn into the sieve canister without proper purging action will render the sieve useless for future nitrogen adsorption.

Expansion Chamber and Muffler

The expansion chamber/muffler assembly (Figure 2-11) consists of a paper filter element and a plastic foam-lined chamber that is connected to the exhaust tube coming from the exhaust pilot valves. The assembly effectively muffles the sound of gas exhausting to atmosphere when the sieve canisters are depressurized (desorbed) during the regeneration (exhaust) cycle.

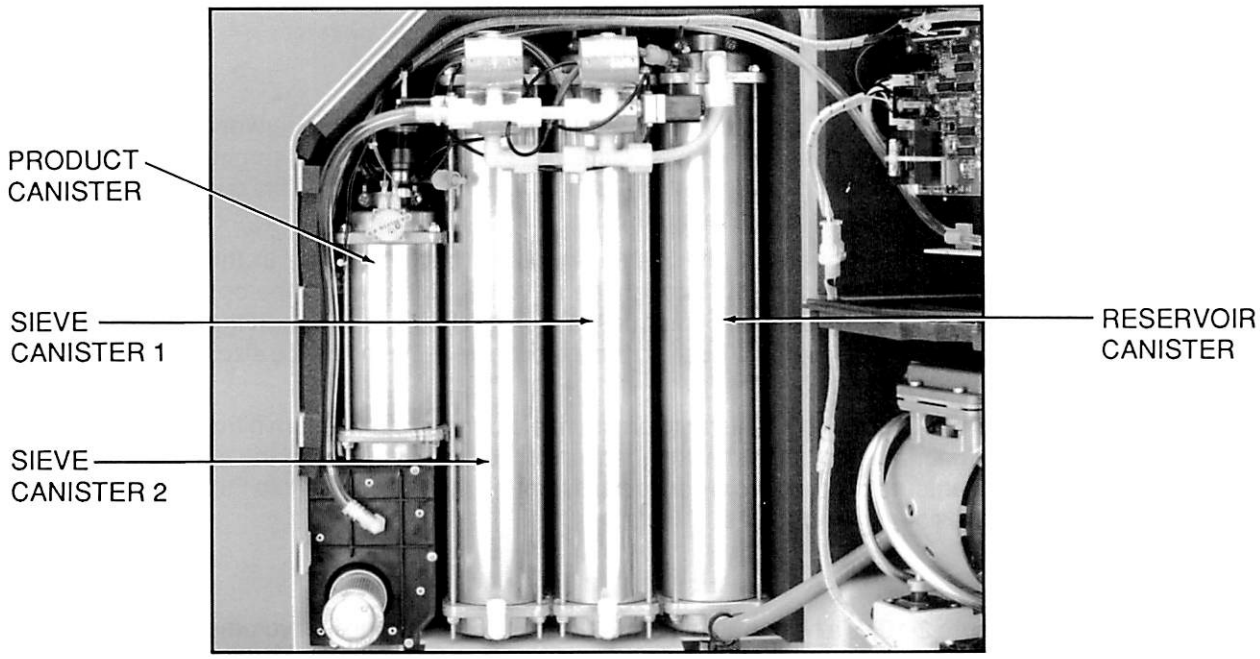


Figure 2-10: Sieve Canisters

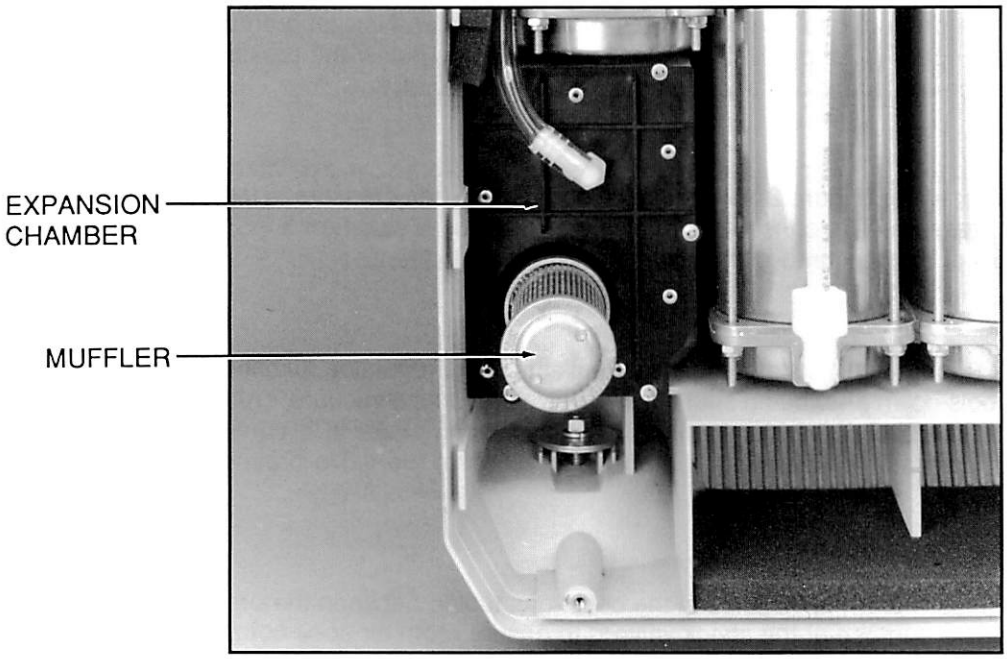


Figure 2-11: Expansion Chamber & Muffler

Restrictor Tube Assemblies

Two restrictor tubes (Figure 2-12) are located just above the balance pilot valve between the tubing coming from the outlets of the sieve canisters and the product tank. Each restrictor tube assembly contains an orifice drilled to a specific size and a number recorded on the tube for size identification. This number represents the liter flow of a gas through the orifice at a standard pressure.

While supply air is entering one sieve bed, the restrictor creates back pressure in this canister and thus determines the rate at which room air can flow through the sieve bed. Meanwhile, the opposite restrictor acts as a metering device allowing a small amount of product gas (oxygen) to pass through this orifice and into the bottom of the exhausting sieve bed for purge. Thus, increasing or decreasing the orifice size will alter the balance of pressure within the sieve beds.

This regulation of pressure allows a filling canister to pressurize properly for maximum nitrogen adsorption. The product tank pressure is maintained by the "checking" action of the restrictor tube of the exhausting tank while still permitting a sufficient amount of product oxygen to pass through this orifice and into the exhausting canister for efficient purge of any residual nitrogen gas.

Product Canister

The product canister (Figure 2-10) is a hollow aluminum tank, approximately one liter volume, that stores product gas (oxygen) from the sieve canisters under pressure. The product canister functions as a reservoir of oxygen to ensure a smooth, steady outlet flow as the unit cycles back and forth between the sieve canisters. It is also responsible for providing sufficient pressure to permit some product oxygen to be used as purge gas through the restrictors. The amount of purge oxygen then is directly dependent upon the product tank pressure. In turn the product tank pressure is affected by both the size of the restrictors and the flowmeter setting.

Pressure Switch

The electro-pneumatic, normally closed pressure switch (Figure 2-13) is mounted on the product canister and senses the pressure of the product gas (oxygen) in the product canister. Normal product canister pressure keeps the switch contacts open. If the product canister pressure drops below the pressure switch threshold setting of 4.0 PSI, the switch contacts close and the audio alarm will sound.

Pressure Regulator

The adjustable pressure regulator (Figure 2-13) reduces a nominal oxygen pressure in the product canister to a constant 5 PSI outlet pressure. The concentrator flowmeter requires a constant 5 PSI source pressure to accurately control the flow of oxygen through the flowmeter and to the patient.

Vacuum Check Valve

The vacuum check valve (Figure 2-13), located on the output side of the regulator, functions as a siphon break when the concentrator cools down after being shut off. The valve prevents a vacuum, created when gas in the product canister cools after the concentrator is shut off, from drawing water in a humidifier bottle into the flowmeter. When the concentrator is operating, the checking action of the valve prevents output flow from bleeding to atmosphere.

In-Line Check Valve

The in-line check valve (Figure 2-14) is installed in the outlet gas tubing between the pressure regulator and outlet gas bacteria filter. The purpose of the check valve is to ensure room air does not migrate back into the sieve canisters through the gas outlet circuit when the concentrator is turned OFF. The check valve is installed in the outlet gas tubing with the black connector toward the outlet of the concentrator.

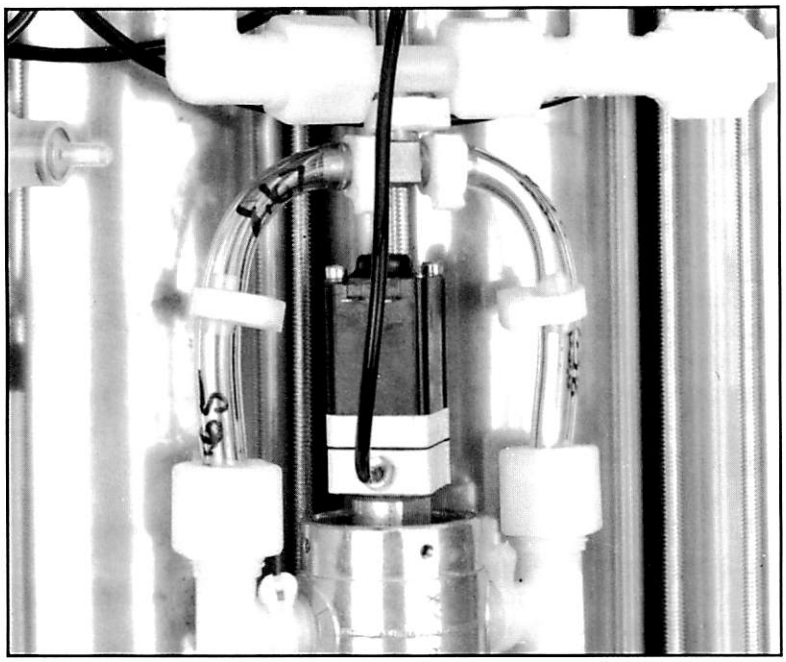


Figure 2-12: Restrictor Tubes

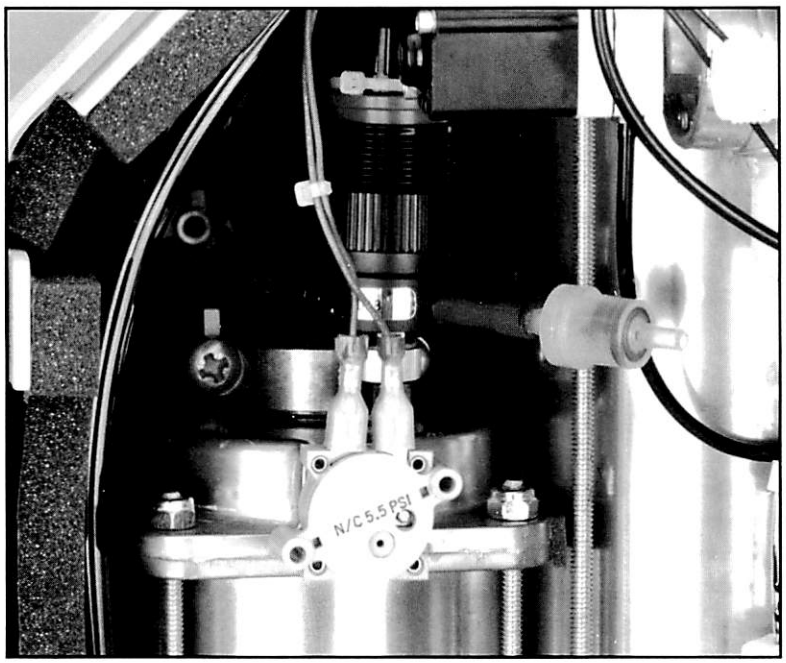


Figure 2-13: Product Canister, Regulator and
Vacuum Check Valve

Outlet Gas Filter

The outlet gas filter (Figure 2-14) consists of a bacteria-grade element in a sealed housing that filters particulate matter greater than 0.3 microns in diameter from the oxygen flowing to the flowmeter and eventually to the patient. This filter provides clean, bacteria-free oxygen to the patient. (See Table 1-2 Maintenance Schedule).

Flowmeter

The flowmeter (Figure 2-15) is a back-pressure compensated gas measuring device which controls the amount of product oxygen dispensed to the patient. It consists of a tapered hollow tube inscribed with flow markings, a needle valve, an adjusting knob, an indicator ball, and an inlet and outlet port. With the concentrator operating, the ball will move up in the tube indicating the amount of oxygen delivered to the patient.

2.3 ELECTRICAL SYSTEM COMPONENTS

Power Switch

The power switch (Figure 2-15) is a double-pole single-throw rocker type with a bezel mounted green L.E.D. indicator. When the switch is in the ON position, one set of contacts routes 24.6 VDC to the coil of a relay mounted on the control printed circuit board. This relay activates the compressor, cooling fan, hour meter, and printed circuit board timing circuits. The second set of power switch contacts routes DC current from the circuit board to the pressure switch and audio alarm. This DC current is provided at 12 volts while the concentrator is running and drops to 9 volts, provided by the nine-volt battery, in case of a power failure. (**NOTE:** If the power switch is set to ON, the audio alarm will sound when the pressure switch contacts close, regardless of whether the concentrator is plugged in or not).

Concentrators equipped with the optional Oxygen Concentration Indicator (OCI) incorporate a push button type power switch. Refer to section 6 for details.

Control Printed Circuit Board

The control printed circuit board (PCB) (Figure 2-14) contains the electronic logic for controlling the operation of the concentrator. The PCB contains a step-down transformer and a full-wave bridge rectifier that converts AC voltage to 24 VDC for PCB use and for powering the solenoids. A 63 milli-ampere 250 VAC fuse protects the PCB components in the event of an over-current condition. The circuitry includes a timing generator and a detector circuit.

The timing generator produces pulses that are used by the alternate/dwell circuit and the pre-charge time circuit. The alternate/dwell circuit uses the timing pulses to activate solenoid valve 1 and solenoid valve 2 alternately for approximately eight seconds each. A dwell period, approximately 0.8 seconds occurring between the activation of the solenoids valves 1 and 2 enables the balance time circuit to activate solenoid valve 3 for the balance cycle.

The detector circuit activates a relay if an open condition is detected in a solenoid's electrical circuit caused, for example, by a disconnected wire or an open solenoid coil. The relay, when activated, removes power from the compressor, cooling fan, and solenoids. The detector circuit thus prevents the concentrator from operating with an electrical failure of the solenoid circuit that could contaminate the molecular sieve material and thereby destroy its nitrogen-adsorbing properties.

Since complementary metal-oxide semiconductor (CMOS) integrated circuits are present on the PCB, care must be used when handling the board to prevent static discharge from possibly damaging board components. Always handle PCBs by their edges only and store them in a static-proof bag.

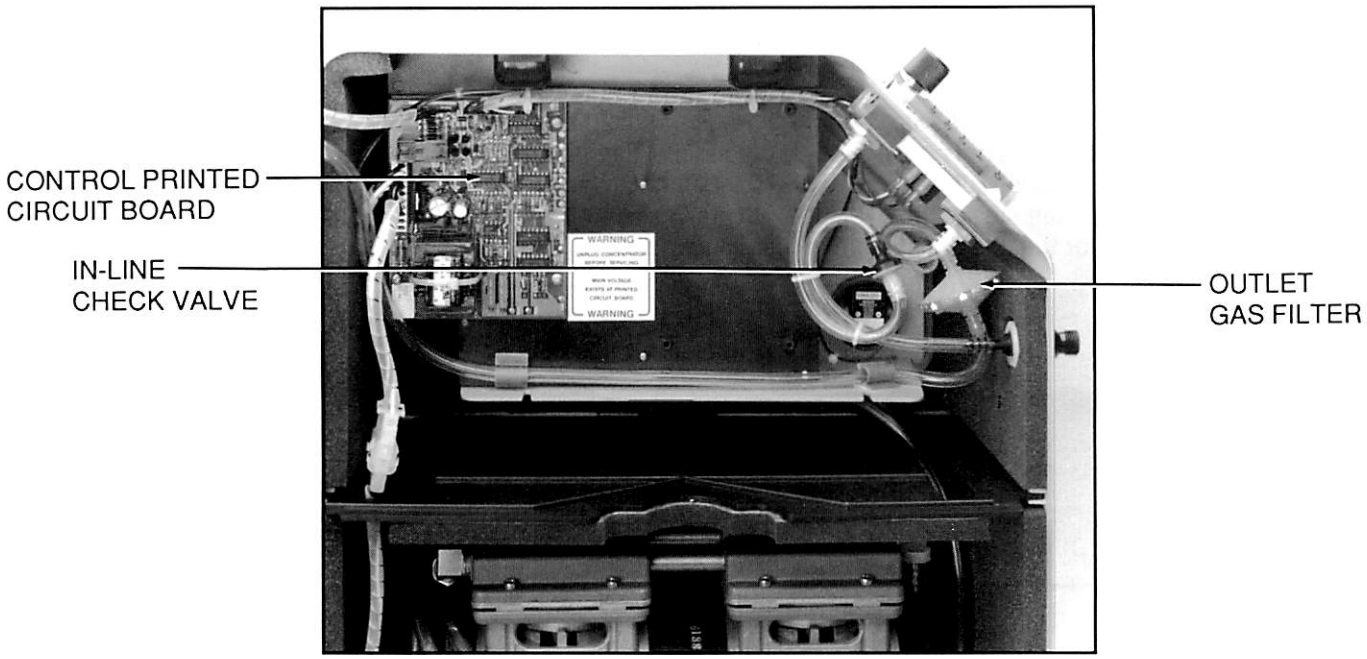


Figure 2-14: Right Cabinet, Interior View

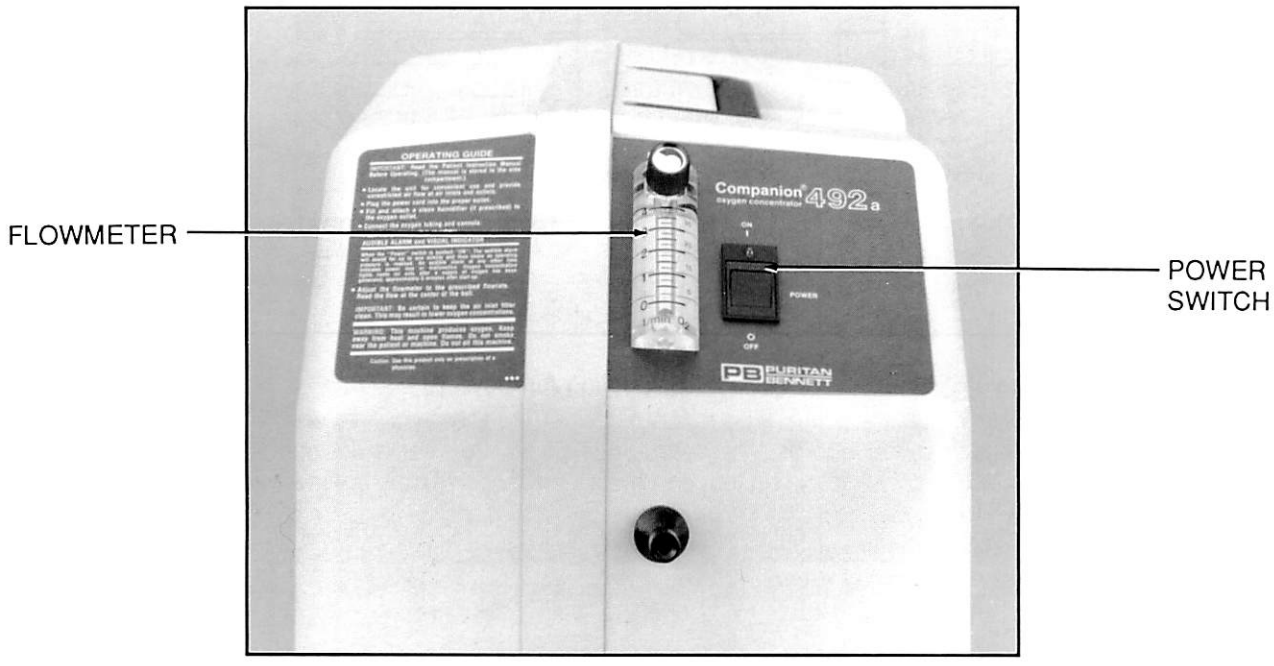


Figure 2-15: Control Panel

Cooling Fan

Cooling-air flow through the concentrator (Figure 2-16) is provided by a fan (Figure 2-17) located beneath the compressor. The fan draws in cooling air through the air inlet filter located on the upper right hand side of the cabinet. The cooling air travels down across the concentrator's four canisters and the compressor and is exhausted out the bottom left side of the cabinet. Both the intake air filter and exhaust vents of the cabinet must be free of obstructions for the cooling system to function properly.

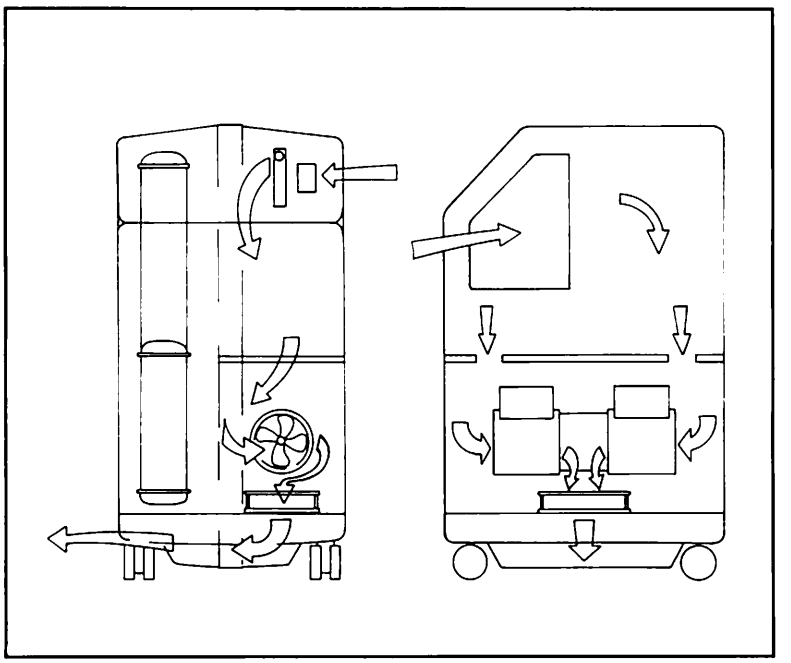


Figure 2-16: Cooling Air Flow

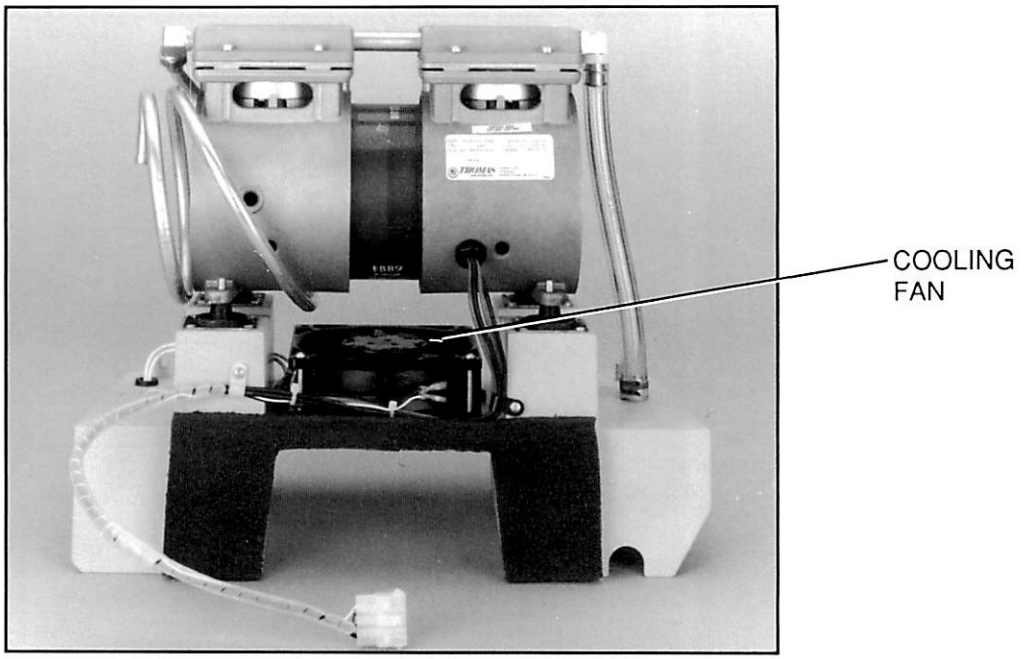


Figure 2-17: Cooling Fan

2.3 ELECTRICAL SYSTEM COMPONENTS (continued)

Hour Meter

The digital hour meter (Figure 2-18) located in the filter compartment, indicates total concentrator running time. The meter records up to 99,999.99 hours before resetting to zero.

Circuit Breaker

The AC electrical system is protected from short circuits and power surges by a five-ampere (for Companion 492a) or a six-ampere (for Companion 590) resettable push-button circuit breaker (Figure 2-18) located in the filter compartment.

Audio Alarm

The audio alarm (Figure 2-18) consists of an electronic module powered by either the control printed circuit board or the nine-volt battery. When the POWER switch is in the ON position, and the pressure switch contacts are closed, the alarm sounds. If the concentrator is operating on AC, the audio alarm is powered by 12 VDC from the circuit board. In the event of an AC power failure, the audible alarm will be powered by the nine-volt battery.

Battery

A nine-volt long-life alkaline battery (Figure 2-18) located in the side panel filter compartment, provides back-up power to the audio alarm. See Table 1-2. Maintenance Schedule.

Oxygen Concentration Indicator

(See Section 6)

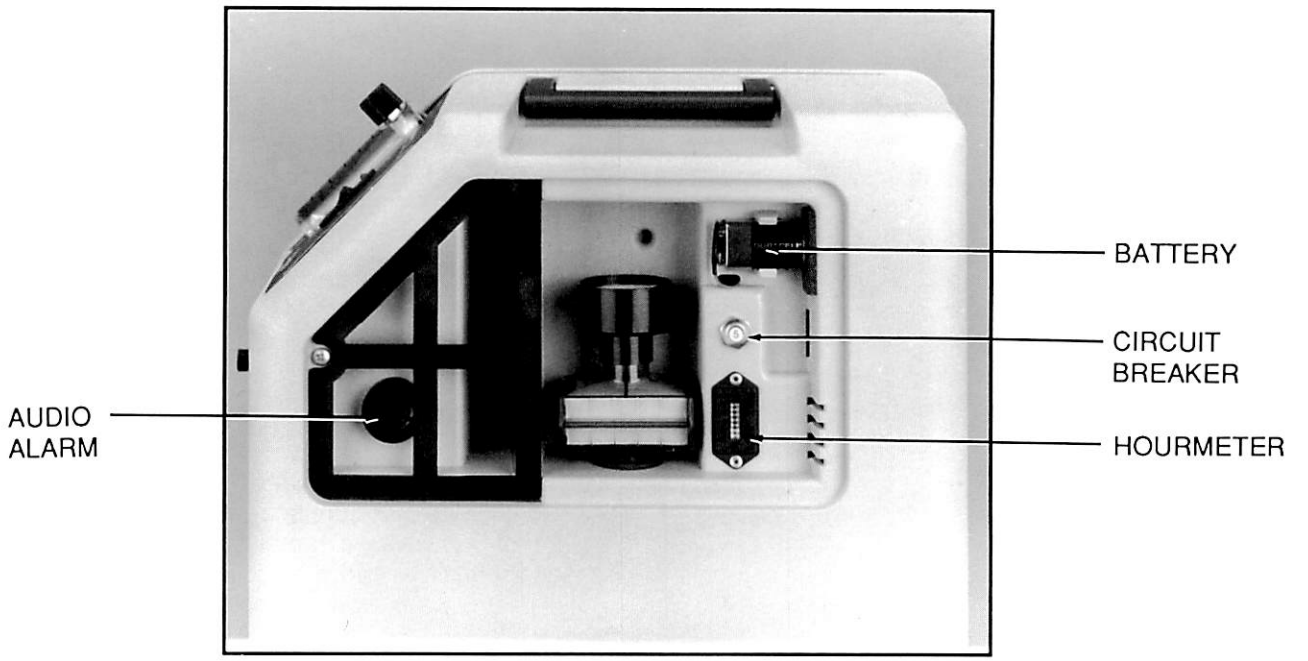


Figure 2-18: Filter Compartment

2.4 CONCENTRATOR SYSTEM OPERATION

The Companion 492a/590 concentrates oxygen from room air by a process known as pressure-swing adsorption. This cyclic process involves two molecular sieve canisters which are alternately pressurized to approximately 20 PSI with room air and then vented to atmospheric pressure. The nitrogen-selective zeolite in the molecular sieve canisters adsorbs nitrogen from air under pressure and, in turn, desorbs (releases) nitrogen when the canister is vented to atmospheric pressure. The process is further enhanced by the incorporation of a pressure-balance cycle and by the use of product gas (oxygen) as purge gas to increase the efficiency of regenerating the sieve.

A complete system cycle of approximately 17.6 seconds in duration consists of two 8-second concentrating cycles and two 0.8-second balance cycles. Gas flow through the Companion 492a/590 pneumatic system is shown in Figures 2-19 through 2-21.

Sieve Canister 1 Concentrating Cycle

Discussion of the complete system cycle may begin with sieve canister 1 concentrating oxygen (Figure 2-19). The compressor pressurizes the reservoir canister, the supply air tubing, and the pilot air tubing with filtered room air. At the appropriate time, the electronic timing circuit on the PCB sends a 24 VDC signal to energize solenoid valve 1 for approximately eight seconds. Then, pilot gas under pressure flows through the solenoid and is applied to the pilot ports of supply pilot valve 1 and exhaust pilot valve 2, simultaneously opening each pilot valve.

Supply air from the reservoir canister passes through open supply pilot valve 1 and into sieve canister 1 where first, water vapor is attracted and held in the top of the canister, then nitrogen is adsorbed and oxygen-rich gas flows to the product canister metered by restrictor 1. Next, some oxygen-rich gas passes through restrictor 2 and into sieve canister 2 once the pressure in this canister has exhausted to atmosphere through exhaust pilot valve 2. This purge oxygen migrates up into sieve canister 2 to increase the efficiency of regenerating the molecular sieve by removing any trace nitrogen in the canister.

Oxygen in the product canister, at a pressure higher than that required at the flowmeter, is reduced and maintained at 5 PSI by the pressure regulator. Oxygen then passes through the outlet gas filter, the flowmeter, and finally the oxygen outlet.

Balance Cycle 1

After sieve canister 1 has been concentrating for approximately eight seconds, the electronic timing circuit on the PCB simultaneously de-energizes solenoid valve 1 and energizes solenoid valve 3 for approximately 0.8 seconds (Figure 2-20). When solenoid valve 1 is de-energized, the pilot pressure source for supply pilot valve 1 and exhaust pilot valve 2 is cut off and the piloting pressure for the valves is vented to atmosphere through the normally open port of solenoid valve 1. Pressure against the unbalanced area of the bottom diaphragm closes supply pilot valve 1. An internal spring closes exhaust pilot valve 2. Now solenoid valve 3 is energized and pilot air pressure is applied to the pilot port of the balance pilot valve to open the valve.

With the balance pilot valve open and the remaining pilot valves closed, oxygen-rich gas at system pressure from sieve canister 1 is routed directly to sieve canister 2 to increase pressure in this canister in preparation for its concentrating cycle.

The placement of restrictor 1 and restrictor 2 downstream of the balance pilot valve ports allows gas from sieve canister 1 under pressure to flow into and pressurize sieve canister 2 during the balance cycle with minimal effect on gas in the product canister. This increase of pressure in sieve canister 2 during the balance cycle helps ensure immediate oxygen flow from this canister at the beginning of its concentrating cycle.

Sieve Canister 2 Concentrating Cycle

At the end of balance cycle 1, the electronic timing circuit on the PCB simultaneously de-energizes solenoid valve 3 and energizes solenoid valve 2 for approximately eight seconds (Figure 2-21). When solenoid valve 3 is de-energized, the pilot pressure source for the balance pilot valve is cut off, and the piloting pressure for this valve is vented to atmosphere through the normally open port of solenoid valve 3. Pressure against the unbalanced area of the bottom diaphragm closes the balance pilot valve. When solenoid valve 2 is energized, pilot air pressure is applied to the pilot ports of supply pilot valve 2 and exhaust pilot valve 1 and simultaneously opens each pilot valve.

Supply air passes through open supply pilot valve 2 and into sieve canister 2 where water vapor is trapped and nitrogen is adsorbed while oxygen-rich gas flows to the product canister through restrictor 2. Meanwhile, gas is allowed to exhaust out of sieve canister 1 through open exhaust pilot valve 1 and to atmosphere. This exhaust gas drives any water vapor from the top of the sieve bed back into the room. (Maintaining this desiccant layer through proper valving action is critical to long sieve bed life). Then, some oxygen-rich gas also passes through restrictor 1 and into sieve canister 1 once the pressure in sieve canister 1 has exhausted to the atmosphere through exhaust pilot valve 1. This purge oxygen migrates up into sieve canister 1 to increase the efficiency of regenerating the molecular sieve. This cycle duplicates the process of the first concentrating cycle and ensures constant flow of oxygen to the product canister.

Balance Cycle 2

After sieve canister 2 has been concentrating for approximately eight seconds, the electronic timing circuit on the PCB simultaneously de-energizes solenoid valve 2 and energizes solenoid valve 3 for approximately 0.8 seconds (Figure 2-20). This cycle then allows the pressure between the two sieve canisters to pre-charge sieve canister 1 in preparation for its concentrating cycle.

Upon completion of balance cycle 2, the complete system cycle begins again.

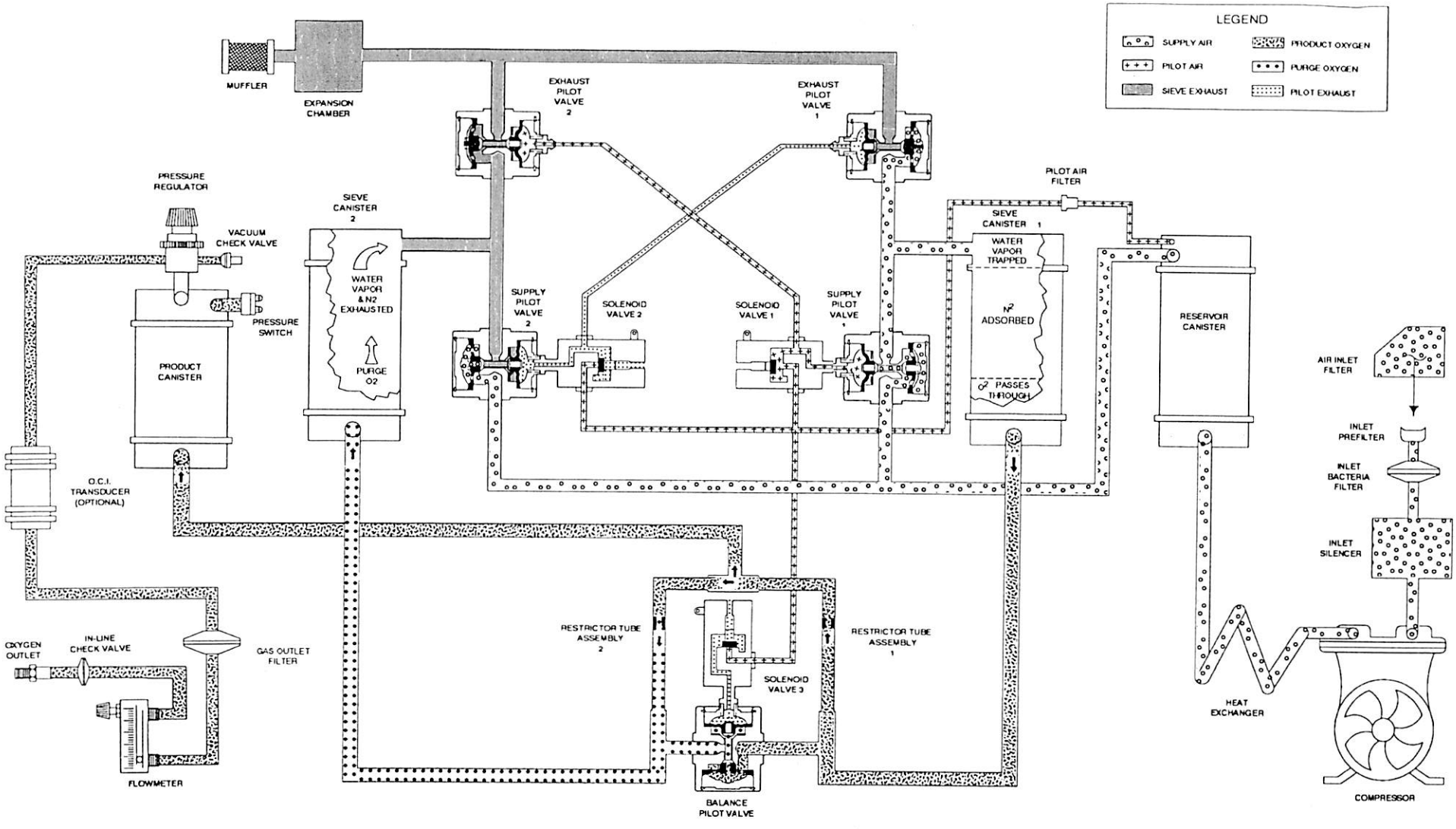


Figure 2-19: Sieve Canister 1, Concentrating Cycle

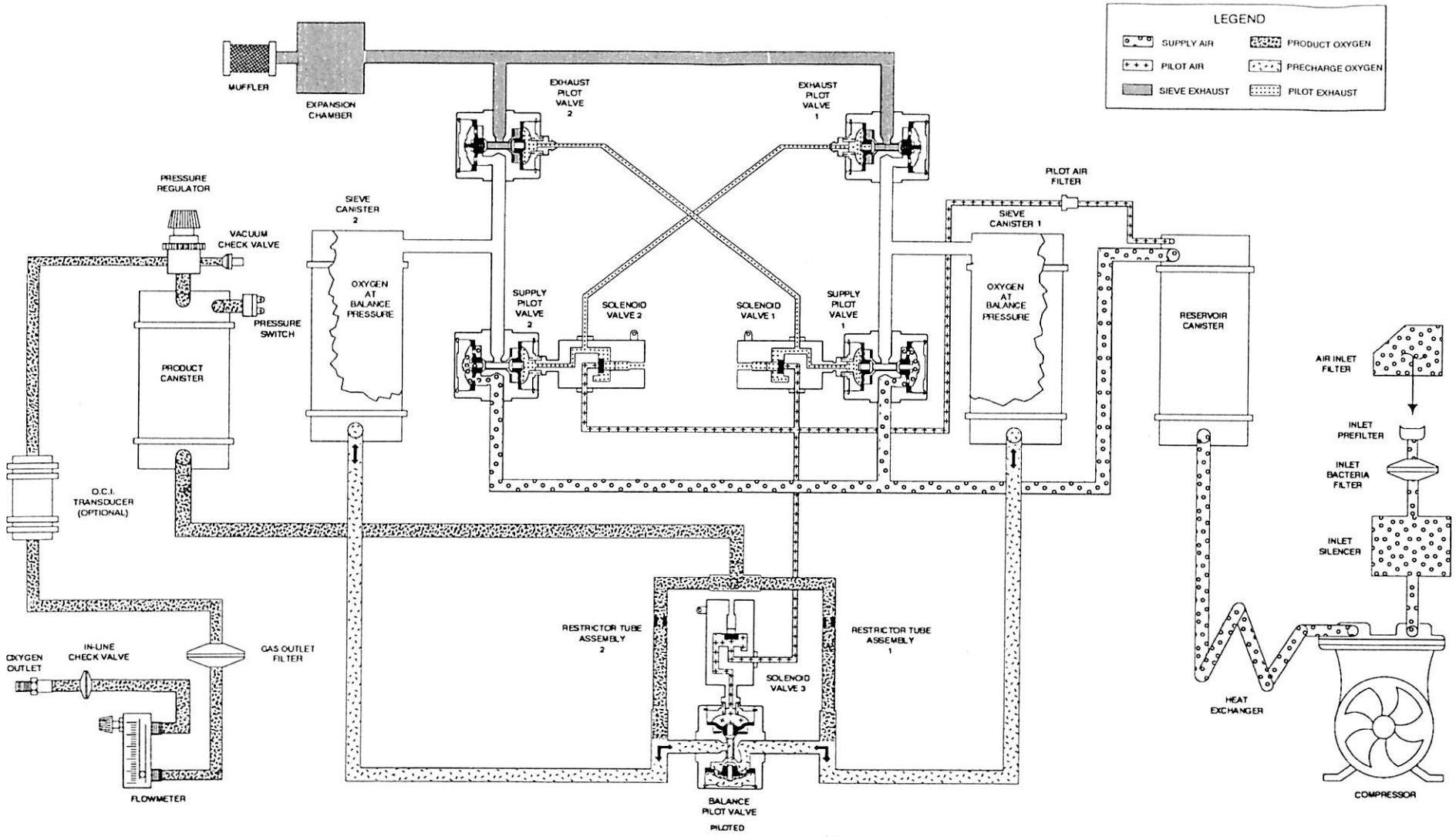


Figure 2-20: Balance Cycle

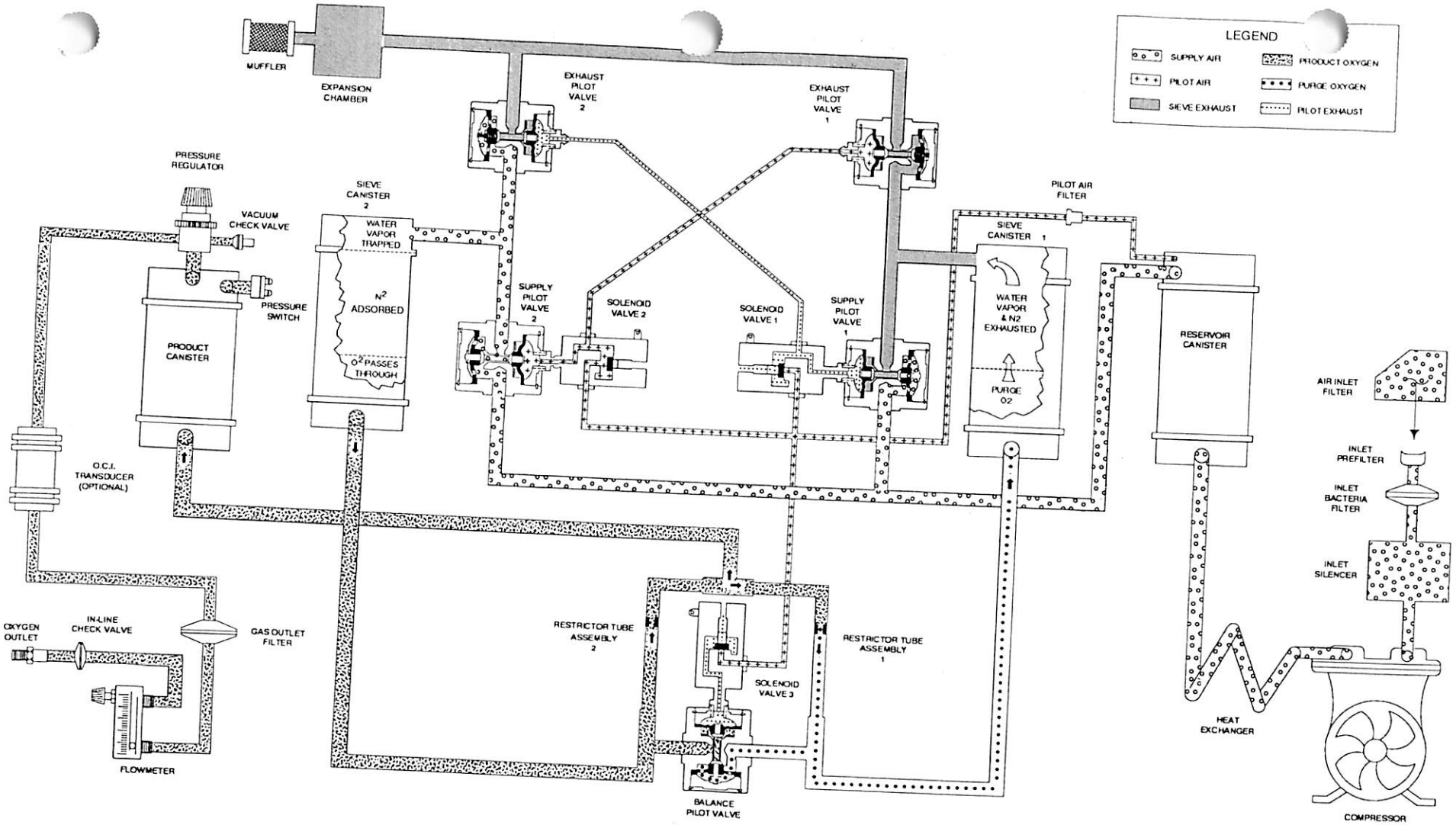


Figure 2-21: Sieve Canister 2, Concentrating Cycle

2.5 SAFETY FEATURES

The Companion 492a/590 has an audio alarm, a solenoid valve shut-down feature, and an optional Oxygen Concentrator Indicator to alert the patient and protect the concentrator in the event of improper operation. The audio alarm will sound due to inadequate system pressure caused by AC power loss, dirty compressor inlet filters, or leaks/restrictions in the internal pneumatics. When inadequate system pressure is sensed, an electro-pneumatic pressure switch, mounted on the product canister, activates the aduio alarm. If system pressure drops below 4.0 PSI, the pressure switch contacts close to activate the audio alarm.

The solenoid shut-down feature consists of a detector circuit on the PCB that monitors the solenoid's electrical circuits. If an open condition is detected, caused by a disconnected wire or an open solenoid coil, the detector circuit activates a relay which removes power from the compressor, cooling fan, and the solenoids. This feature protects the molecular sieve material from contamination in the event of a solenoid electrical problem. The relay is reset by first correcting the problem and then setting the POWER switch OFF, wait five seconds - then back ON.

NOTE

Residual pressure in the reservoir canister may prevent the compressor from starting for up to 20 seconds.

For units equipped with the optional Oxygen Concentration Indicator (OCI) refer to section 6 for details regarding additional safety features.

SECTION 3. PERFORMANCE VERIFICATION AND TROUBLESHOOTING

It may be necessary to service or verify performance of either the Companion 492a or 590 Oxygen Concentrator. This section is designed to assist the user in identifying a problem or in checking out the concentrator before application. There are three conditions where this section may be helpful:

a) To determine the reason for an operational failure.

b) To check overall system operation after the repair or replacement of a component (or system).

c) To verify the concentrator is operating within specification.

For condition **a**, refer to subsection 3.2; Operational Checklist for help in troubleshooting and problem analysis. For conditions **b** and **c**, subsection 3.1; Performance Verifications will provide checkout procedures for individual systems and key components. Also, refer to any checkout procedures found in Section 4; Service And Repair and Section 1; General Information, pages 1-7 through 1-13.

3.1 Performance Verification

This subsection is divided into six performance areas: 1) oxygen concentration, 2) pneumatic, 3) electrical, 4) cooling, 5) flow, and 6) sound. Although each may be considered a separate system or function for testing, they all must perform in harmony to achieve the concentrator's end result - high oxygen purity delivered at a continuous pre-determined flow rate. Should the concentrator fail to pass any performance tests, refer to subsection 3.2; Operational Checklist, subsection 3.3; Troubleshooting and/or Section 4; Service and Repair, as needed.

> **WARNING**
>
> The concentrator is electrically powered. To prevent serious injury or death, observe standard safety procedures when testing the concentrator. The compressor and other internal components are not grounded. To prevent serious electrical shock, do not touch metal components when operating the concentrator with cabinet enclosure opened.

Before testing, ensure the following :

a) Air inlet filter, inlet prefilters, inlet bacteria filter, and 9 volt battery are installed (Figure 2-3).

b) Power cord and plug is not damaged or frayed

c) Humidifier bottle and any other delivery apparatus is removed from concentrator outlet.

3.1.1 Oxygen Concentration

Oxygen concentration levels may be checked whenever it is necessary to know that the concentrator is producing correct oxygen purity. Due to system design, this area of performance verification may be considered to be the most crucial. Generally, if the concentrator is producing oxygen at or above the minimum specification at the maximum flow rate, there should be a high confidence level that the other systems are operating properly. (If your concentrator is equipped with the optional OCI, refer to Section 6 for all information related to this system).

A) Oxygen Test (Figure 3-1)

1) With the concentrator plugged in, turn power switch to ON. Set flowmeter to maximum flowrate (4 LPM or 5 LPM) and allow unit to run for 20 minutes in an open environment. The flowmeter ball should be occasionally checked and adjusted to ensure that it is bisected by the line corresponding to the selected flowrate.

2) Using a properly calibrated oxygen analyzer, follow the manufacturer's recommendations for how to sample the oxygen outflow of an oxygen concentrator. (Generally, it is necessary to allow the oxygen to flow across the sampling device of the analyzer. Do not allow the oxygen to back pressure against the sampling device).

3) Record the oxygen concentration and compare to the performance specifications in Table 1-1 page 1-5. Should the concentration be below anticipated levels, check the following:

a) Air inlet, inlet prefilters, and inlet bacteria filters are clean.

b) Flowmeter setting is correct (see subsection 3.1.5 Flow).

c) Analyzer accuracy - not calibrated, battery weak, or inadequate oxygen to sampling device.

If still out of specification, refer to subsection 3.2.1 Low Concentration.

Figure 3-1: Oxygen Concentration Testing

3.1.2 Pneumatic

Because oxygen concentrators are principally pneumatic devices, verifying the pressure specifications in the Companion concentrator is valuable information in analyzing performance. To do this, the Companion Pneumatic Test Kit P/N 492381 should be used for all tests in this sub-section.

A) Leak Test

If a concentrator has a leak in a system, it may cause loss of oxygen concentration or possibly sieve contamination. It is important to leak test the unit before proceeding to pressure tests.

1. Open the cabinet of the Concentrator. (See service procedure step 1, Section 4).
2. Inspect all hoses, connections, and fittings in the pneumatic system. Check for tightness, kinks, wear, or damage to parts. Correct any deficiencies.
3. Plug concentrator's power cord into AC outlet, turn power switch ON and allow unit to run for several minutes.
4. Use a leak detector to carefully spray all connections in the concentrator and observe them for a bubbling action indicating a leak. Start with the compressor and work through all of the canisters and valves to the outlet. (The outlet side of each exhaust pilot valve does not need to be leak tight). If a leak is detected, correct by tightening, resealing with pipe cement, or repairing the connection.

WARNING

Use caution with leak detector. Do not allow to contact electrical connectors or components. Electrical shock or damage to the concentrator may occur.

3.1.2 Pneumatic (continued)

B) Pressure Tests

There are three pressure tests to perform on the Companion concentrator. Do the following steps to check out the reservoir canister pressure (which indicates sieve canister filling pressure), product canister pressure and outlet gas pressure. Because the pressure in a concentrator can vary with altitude, barometric changes and compressor performance, a range of acceptable pressures are shown for the following tests. With experience you should be able to identify a normal range for your testing location and concentrators.

1. Turn concentrator off after completing the leak test described in step A.
2. Locate 1/4" ID tubing connected between the brass tee, above the restrictor tube assemblies, and the product tank.
3. Remove clamp and product tank tubing from tee fitting. Tee in 1/4" ID tubing from pneumatic test kit (Figure 3-2).
4. Locate and disconnect the small pilot air tubing leading to the brass nipple on the balance solenoid valve. Tee in the 1/16" ID tubing from the pneumatic test kit (Figure 3-3).
5. Set the selector switch on test kit to RSVR (to the left), and turn the concentrator's power switch ON. Set the flowmeter to the maximum LPM indicated on its scale and allow the unit to run for several minutes. (**NOTE:** If needle on gauge reaches 30 PSI, turn unit OFF and see subsection 3.3; Troubleshooting Guide.
6. Verify pressure in reservoir canister slowly increases, from 14 ± 1.5 PSI (drop point) to 20 ± 2.0 PSI (fill) and then rapidly climbs to 27 ± 2.0 PSI (kick). After the kick, the pressure should fall back to the drop point and repeat. Record all three pressures on two consecutive cycles. Record only the drop point pressures to the tenth of a PSI, (i.e. 14.2).
7. Verify the balance (the difference of pressure) at the drop point on two consecutive cycles is not greater than 0.4 PSI. (i.e. 14.2 and 14.4 PSIG). Refer to subsection 3.4; Balancing Orifices, if difference is greater than .4 PSIG.
8. Set selector switch on test kit to PROD (to the right). Verify the product canister pressure is between 6.5 to 11.0 PSI (Figure 3-2). Although there is not a "balance" of pressure in the product tank, the pressure on two consecutive cycles should not vary by more than 4.0 PSI.

> **NOTE**
>
> If either of the above tests yield unsatisfactory results, perform Balancing orifices procedures in subsection 3.4.

9. With thumb and forefinger, crimp the short 1/4" ID tube above the brass restrictor tube tee. (Figure 3-4) to restrict the flow of gas to the test kit gauge and product canister.
10. Gradually reduce gauge pressure until the pressure switch in the product canister activates the audio alarm. Verify the alarm sounds at 4.0 PSI ± 0.2 PSI. Refer to Section 4; Service And Repair, step 14 if set incorrectly.
11. Set the concentrator's power switch to OFF and disconnect test kit tubing. Reconnect 1/4" ID tubing from product tank to restrictor tube assembly brass tee and secure with new clamp. Reconnect 1/16" ID tubing to brass nipple at base of balance solenoid valve.
12. Connect tailpiece (P/N 492587) and wingnut (P/N 492588) outlet adapters to outlet of concentrator. Connect 1/4" ID tubing of test kit to adapter and verify the test gauge selector switch is set to PROD (right).

3.1.2 Pneumatic (continued)

13. Set the concentrator's power switch to ON, turn flowmeter to 1 lpm, and let run for several minutes.
14. Place thumb over open end of large tee from test kit (Figure 3-5).
15. Verify concentrator outlet static pressure is 5 ± 0.5 PSI. Refer to Section 4, step 15, if out of tolerance.
16. Disconnect the 1/4" ID tubing and outlet adapters.

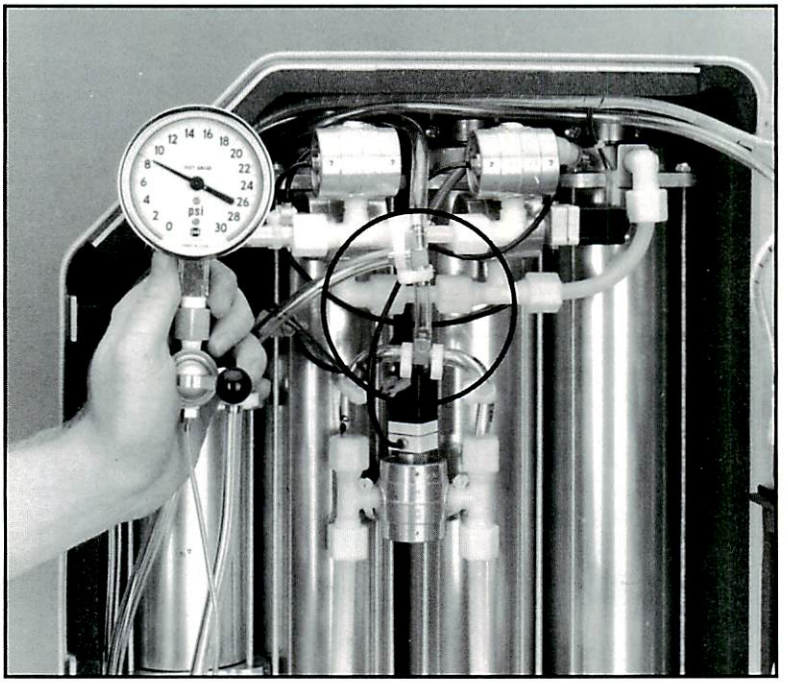


Figure 3-2: Pneumatic Test Kit Connection/Testing

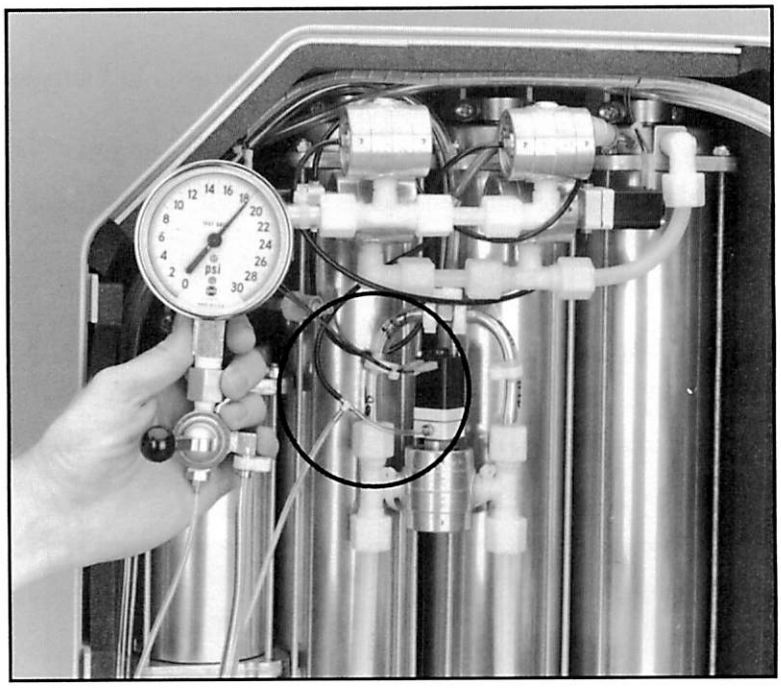


Figure 3-3: Pneumatic Test Kit Connection/Testing

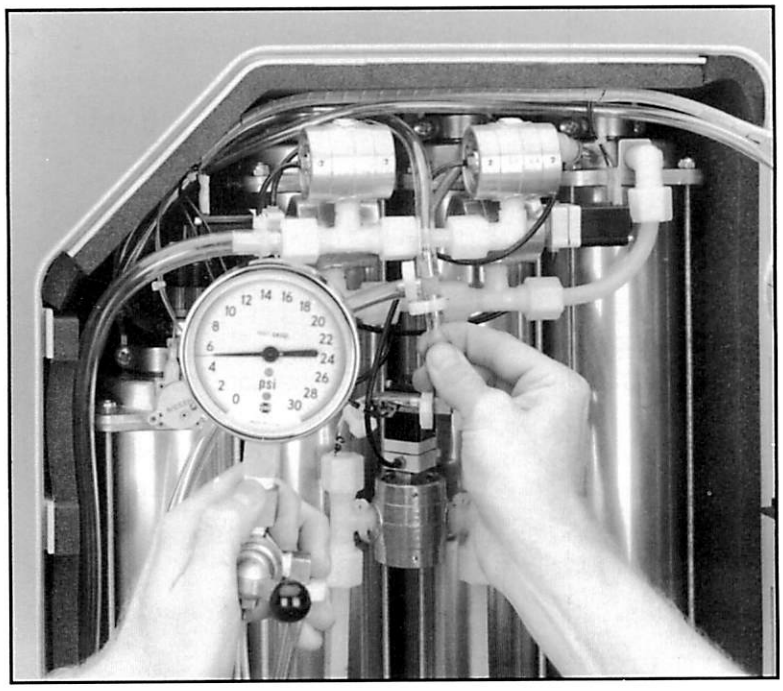


Figure 3-4: Pressure Switch Testing

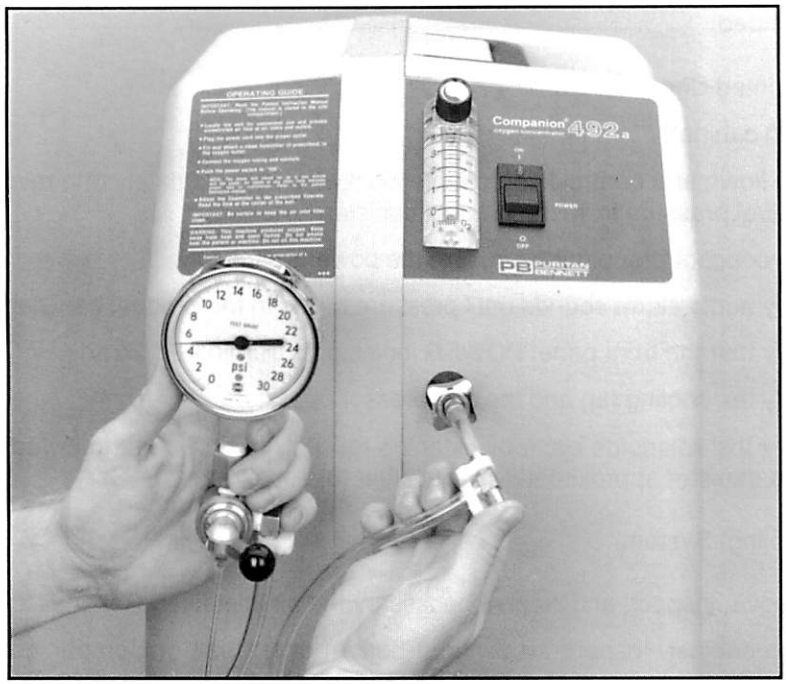


Figure 3-5: Outlet Pressure Testing

3.1.3 Electrical

The electrical systems provide the controlling and monitoring functions for the oxygen concentrator. The following tests and observations should be made to verify performance of these components.

A) Physical Observation

With the unit unplugged, open the Companion cabinet and inspect all wires, connectors and terminals for tightness, wear or fraying. Inspect power cord and plug. Repair or replace as necessary.

B) Low Pressure Alarm

1. With the unit unplugged, turn flowmeter control knob counterclockwise to drain any residual pressure from product canister.
2. Remove 9V battery from its holder in the filter compartment.
3. Use a multimeter tester to check battery voltage. Replace if less than 8.0 volts.
4. Connect concentrator's power cord to an appropriate AC outlet and turn power switch to ON.
5. Verify audio alarm activates. Turn the concentrator's power switch OFF.
6. Install 9V battery into holder. Disconnect power cord from AC power source. Turn the concentrator's power switch to ON.
7. Verify audio alarm activates. Turn the concentrator's power switch OFF.

NOTE

When the Companion concentrator is connected to an AC power source, the audio alarm is powered from a 12V signal from the Control PCB. The 9V battery powers the audio alarm only during a loss of power or Control PCB failure.

3.1.3 Electrical (continued)

C) Control Printed Circuit Board

1. Open cabinet
2. Turn flowmeter control knob counterclockwise approximately one revolution and drain any residual pressure from the product canister.
3. With concentrator plugged in, turn the power switch ON.
4. Verify audio alarm sounds until pressure builds in the product canister.
5. Verify that the front panel POWER indicator is illuminated.
6. Verify the cooling fan and the compressor operate.
7. Verify the solenoids cycle by listening for a slight puff of air followed by the exhaust of a sieve canister approximately every eight (8) seconds.

3.1.4 Ventilation (Cooling) System

1. Remove, inspect, and clean if necessary the air inlet filter. Reinstall the filter.
2. Open cabinet. Inspect air vents at bottom of left half of Companion cabinet. Clean and remove any blockage at vents.
3. Connect concentrator's power cord to AC outlet and set the power switch to ON. Observe the cooling fan and verify its operation.
4. Close cabinet and verify there is a strong push of air coming from the vents at the bottom left of concentrator.

3.1.5 Flow

1. Connect concentrator power cord to AC and set power switch to ON. Allow unit to run a minimum of 5 minutes.
2. Verify outlet static pressure is 5 $\pm$ 0.5 PSI. (See subsection 3.1.2 B, Steps 12 through 15).
3. Connect the test flowmeter (Sierra Top-Trak model 820 mass flowmeter) to the concentrator as shown in Figure 3-6.
4. With the line bisecting the flowmeter ball, verify the flow is $\pm$ 5% of full scale at each setting.

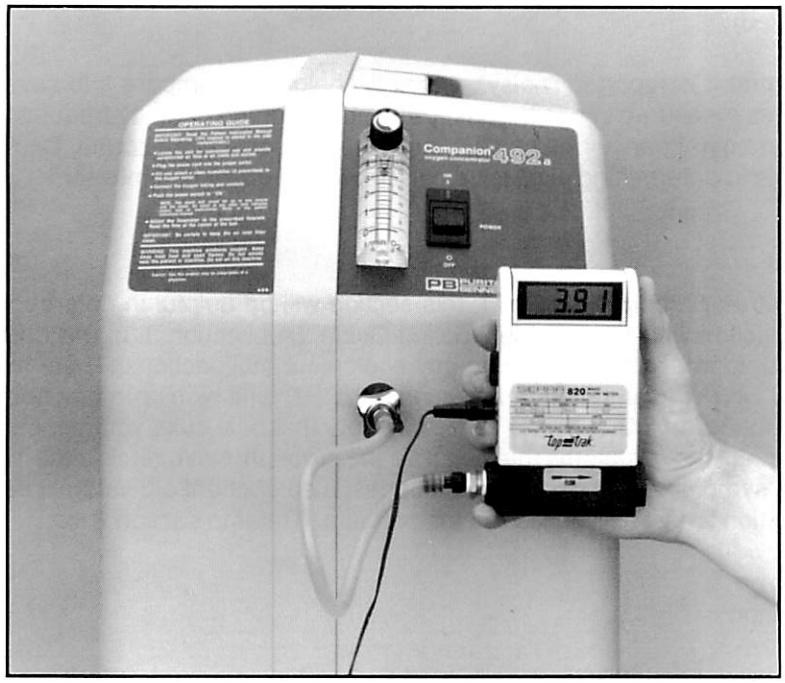


Figure 3-6: Flowmeter Testing

3.1.6 Sound

Occasionally, it may be necessary to determine if a concentrator is operating above the minimum acceptable decibel levels. To achieve an accurate measurement requires duplicating the same environmental conditions under which the factory tests are conducted. This may prove to be expensive and difficult. As an alternative, there are comparison tests and observations that may resolve concerns about the noise level of a Companion concentrator.

If an unusually loud noise is heard, generally it is detectable by attempting to locate the source of the sound. Open the concentrator cabinet and inspect for the following:

1. Inlet bacteria filter properly seated in filter compartment.
2. Compressor inlet hoses properly connected.
3. Shock mounts for tears allowing compressor to drop. Loose compressor bolts.
4. Heat exchanger rubbing.
5. Internal tubing disconnected. Check especially exhaust hose at exhaust pilot valves and expansion chamber.
6. Noisy compressor or cooling fan. Disconnect one terminal from cooling fan during operation to segregate. Reconnect when done.

NOTE

To resolve problem, adjust, repair, or replace as needed. Refer to Section 4 for appropriate component.

3.1.6 Sound (continued)

If a Companion concentrator is reported "noisy", it may be helpful to compare it to several other Companion units. The sound level (as measured in decibels) is a weighted average of many frequencies. Some users may be more sensitive to certain frequency ranges and, therefore, perceive more sound. Comparison of one unit to another may be valuable in determining excessive noise reported on a concentrator.

3.2 Operational Checklist

If a Companion concentrator requires servicing, this section will be helpful in determining the source of the problem. Used in conjunction with the Troubleshooting Guide, (subsection 3.3), this checklist will provide the technician with a logical approach to discovering any equipment malfunctions. There are three categories of concentrator failures 1) Low concentration (subsection 3.2.1), 2) Unit won't run (subsection 3.2.2), or 3) Unit operates improperly (subsection 3.2.3). Refer to the category that best suits your concentrator's problem and follow the checklist to reveal the symptoms that describe the problem. Next, refer to the Troubleshooting Guide by matching your unit's symptoms to those listed to suggest a component or system most suspect. Follow the suggested corrective action to test and/or resolve the problem. (Refer to section 6 for Troubleshooting the OCI system).

3.2.1 Low Concentration

1. Verify oxygen analyzer is calibrated and working properly. Check manufacturer's operating instructions for proper use and maintenance.
2. Measure concentration at maximum setting on flowmeter scale to determine if unit is producing the minimum specified level of oxygen after 20 minutes. (Refer to Table 1-1).
3. Inspect and clean all filters.
4. Open cabinet. Visually inspect all hoses, tubes, and fittings for looseness or kinks.
5. With concentrator running, use a leak detector to spray all pneumatic fittings and observe for a bubbling action which indicates a leak. All fittings with the exception of those coming from the pilot exhaust valves through to the muffler must be air tight. Repair by tightening or removing and resealing the fitting with an approved pipe cement. (Refer to subsection 3.1.2 A).

> **NOTE**
>
> It is critical that all leaks be eliminated from the concentrator before proceeding.

6. Connect the Pneumatic Test Kit to the concentrator (Refer to subsection 3.1.2 B; Pressure tests). Turn the unit on and allow to cycle several minutes.
7. With the selector switch set to RSVR observe the pressures in the reservoir canister. Read subsection 3.1.2 B, steps 5 through 7 and compare results with the expected pressures.
8. If the readings are not normal, refer to the Troubleshooting Guide. (i.e. low, high, imbalance or erratic pressure). Refer to symptom with appropriate description for the observed behavior.
9. Turn selector switch to PROD and repeat observations for product tank. Compare pressures to specifications in subsection 3.1.2 B, step 8 and use Troubleshooting Guide appropriately.

3.2.2 Concentrator Won't Run

1. Verify unit is plugged into proper AC power source. Set power switch to ON position.
2. Green front panel power indicator should illuminate. Audio alarm should activate (open flowmeter and drain product canister first). If circuit breaker pops out refer to Troubleshooting Guide.
3. Test for fan operation by placing hand over vents at bottom left side of cabinet.
4. With concentrator unplugged, inspect all wiring and connections for looseness or disconnects.
5. Open cabinet and observe compressor and cooling fan. If compressor and cooling fan start to operate and both immediately stop, see Section 4, step 16 for solenoid testing.
6. If cooling fan runs and compressor runs momentarily and then stops, remove the small pilot air tube from the balance solenoid valve to vent pressure from the reservoir canister. Reconnect the pilot air hose and attempt to restart the concentrator.

3.2.3 Improper Operation

1. Noise beyond normal operation is usually detectable by careful observation with cabinet open.
2. A pneumatic leak, especially on the intake tubes and fittings of the compressor may cause excessive noise. Compressor vibration may cause component rubbing which may be another source of noise.
3. Refer to subsection 3.1.6 for discussion on sound.
4. Reported erratic behavior or intermittent shutdown should be tested and observed where possible. Refer to subsection 3.2.2 if appropriate.

3.3 Troubleshooting Guide

This section is designed for easy reference to determine the problem with a Companion concentrator. Generally, it is necessary to do some investigation to discover what symptoms the concentrator is exhibiting. Subsection 3.2 Operational Checklist should be consulted before proceeding with troubleshooting in order to get a clear understanding of all of the symptoms a concentrator problem may have. Then match the descriptions in the "Symptom" column that describes the unit's problem as accurately as possible. Next, look at the "Probable Cause" column which will detail several possible reasons (most likely to least likely to occur) to explain the observed behavior of the concentrator. Finally, column three "Corrective Action" suggests possible solutions, tests and/or repairs to resolve a suspected probable cause. This guide is not all-inclusive but it is intended to serve as an outline for solving operational problems.

WARNING

Some of the following procedures require AC power be applied when testing. To prevent the possibility of serious electrical shock, connect grounding wire to metal components and follow standard safety procedures.

TABLE 3-1

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
1. No audio alarm when power switch turned ON and AC power connected to concentrator.	a. Residual pressure in product tank	Open flowmeter knob to reduce product tank pressure below 4.0 psi.
	b. Loose electrical connection	Inspect all electrical connections, especially pressure switch, power switch, audio alarm, and Control PCB at J2 for good connection.
	c. Defective audio alarm	Remove wires from audio alarm terminals. Using wire jumpers and observing both the battery and alarm polarity, connect the 9V battery directly to the alarm terminals. If audio alarm does not activate, replace alarm per the appropriate procedure in Section 4.
	d. Defective pressure switch	Remove wires from pressure switch terminals. Using a wire jumper, connect both wires together. If unit alarms, replace pressure switch per the appropriate procedure in Section 4.
	e. Defective power switch	Test power switch by jumping white and black wires connected to terminals 4 and 5. If alarm sounds replace switch per appropriate service procedure in Section 4.
AC power disconnected	f. Defective battery	Test with multimeter set on DC. If less than 8.0 volts, replace battery.
	g. Control PCB fuse	Test and replace per appropriate service procedure in Section 4.
AC power connected, battery removed.	h. Defective control PCB	Replace per appropriate procedure in Section 4.
2. Continuous alarm/ power switch on/ pilot lamp not lit/unit not operating.	a. No power to unit	Connect power cord to AC outlet.
	b. No power at AC outlet	Inspect household circuit breaker or fuse.
	c. Circuit breaker activated or defective	Reset circuit breaker. If circuit breaker activates, disconnect concentrator from AC power and inspect internal wiring for short circuits. Inspect for locked compressor, shorted capacitor, or faulty circuit breaker.
	d. Control PCB fuse	Test and replace per appropriate service procedure in Section 4.
	e. Defective control PCB	Replace per appropriate service procedure in Section 4.
	f. Loose electrical connection	Inspect AC power cord, circuit breaker, power switch and Control PCB for good connections.

TABLE 3-1

SYMPTOM		PROBABLE CAUSE		CORRECTIVE ACTION
		g.	Defective power switch	Test power switch by jumping blue and brown wires connected to terminals 1 and 2. If unit starts, replace switch per appropriate service procedure in Section 4.
3.	Continuous alarm/ power switch and pilot lamp ON/ compressor and cooling fan not running.	a.	Disconnected wire to one of the three solenoids	Reconnect. Set power switch off, then on.
		b.	Defective solenoid valve	Test and replace per appropriate service procedure in Section 4.
		c.	Loose electrical connection	Inspect internal wiring
		d.	Defective PCB	Replace per appropriate service procedures in Section 4.
		e.	Defective cooling fan causing compressor thermal cutoff switch activated after concentrator has been operating	Test for 120 VAC at fan terminal wires. Replace per appropriate service procedure in Section 4.
4.	Continuous alarm/ power switch and pilot lamp ON/ compressor runs for a period of time, then stops/ cooling fan still operating.	a.	Compressor over-heated due to restricted cabinet cooling-air flow	Check that unit is operating in an open environment and the air inlet is unobstructed. See also subsection 3.1.4. Allow compressor to cool and retest.
		b.	Defective compressor internal thermal switch	Replace compressor per appropriate service procedure in Section 4.
5.	Continuous alarm/ power switch and pilot lamp ON/ compressor won't start/ cooling fan operates.	a.	Residual pressure in reservoir canister	Wait 10-15 seconds for valves to cycle and relieve pressure.
		b.	Capacitor (may cause circuit breaker to actuate)	Check wire terminals at capacitor. Replace capacitor per appropriate service procedure in Section 4.
		c.	Loose electrical connection	Inspect internal wiring.
		d.	Faulty compressor	Replace compressor per appropriate service procedure in Section 4.
6.	Concentrator runs - No power switch light	a.	Loose wires to L.E.D.	Check wires to power switch L.E.D.
		b.	Plug to L.E.D. reversed	If the plug to the L.E.D. is reversed, the L.E.D. will not illuminate. Refer to Section 4, step 7h ACTION and NOTE statements.
		c.	Faulty L.E.D.	Replace lamp.

TABLE 3-1

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
7. Low reservoir pressure/ compressor and cooling fan running/ low concentrations/ concentrator may alarm.	a. Compressor inlet prefilters or bacteria filter dirty	Replace dirty filters.
	b. Leak	Leak test entire pneumatic system, per subsection 3.1.2 A.
	c. Diaphragm leak in supply, exhaust, or balance pilot valves	Inspect all 5 pilot air valves per appropriate service procedure in Section 4. Replace as necessary.
	d. Defective solenoid valve	If air leaks through pilot valve exhaust port and pilot valve has been inspected with no problems found, replace solenoid per appropriate service procedure in Section 4.
	e. Weak or worn compressor	Replace entire compressor or replace piston cup seals per appropriate service procedure in Section 4.
	f. Outlet pressure too high	Test per subsection 3.1.2 B steps 12 through 15. If incorrect reset regulator per Section 4, step 15.
8. High reservoir canister pressure/ low concentrations/ unit may alarm.	a. Stuck diaphragm in pilot air valve	Inspect solid diaphragms in the supply and exhaust pilot valves per appropriate service procedure in Section 4.
	b. Contaminated sieve beds	Replace per appropriate service procedure in Section 4.
9. Imbalance in drop point pressure/ low concentration/ unit may alarm.	a. Leaks	Leak test per subsection 3.1.2 A. Check especially bottoms of sieve beds, and supply and balance pilot valve fittings. Repair as necessary.
	b. Faulty diaphragm in pilot air valve	Remove test and replace, if necessary per appropriate service procedure in Section 4.
	c. Restrictor tube assembly blocked	Remove compression nuts from restrictor tube assemblies and inspect orifice for blockage.
	d. Mismatched restrictor tube assembly	Drop point differences greater than 0.4 PSI between cycles. See subsection 3.4; Balancing Orifices.

TABLE 3-1

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
10. Low or erratic product canister pressure/ low concentrations/ unit may alarm.	a. Leaks	Leak test per subsection 3.1.2 A. Check especially from restrictor tubes to flowmeter. Repair as necessary.
	b. Regulator dirty, out of adjustment or defective	Disassemble, clean, reassemble, and test per appropriate service procedure in Section 4. Replace if necessary.
	c. Faulty diaphragm in balance pilot valve	Remove, test and replace, if necessary per appropriate service procedure in Section 4.
	d. Stuck supply or exhaust pilot valve solid diaphragm	First disassemble and inspect the supply pilot valve diaphragms and then the exhaust pilot valve diaphragms. Refer to the appropriate service procedure in Section 4.
	e. Incorrectly sized restrictors	Change restrictors per subsection 3.4, Balancing Orifices.
11. Unit alarms/ cycles/ oxygen flows and concentration within specifications/ pressures normal.	Defective pressure switch or setting out of adjustment	Test or replace per appropriate service procedure in Section 4.
12. Low or no oxygen flow or pressure/ unit operating/ no alarm.	a. Flowmeter knob turned off	Set flow to desired level.
	b. Kinked or obstructed tubing	Inspect internal tubing from product canister to flowmeter.
	c. Regulator out of adjustment or defective	Test per subsection 3.1.2 B, steps 12 through 15. Replace per appropriate service procedure in Section 4.
Unit Alarm	d. Disconnected tubing	Inspect internal tubing and connections from compressor to flowmeter.
13. Noise.	a. Component rubbing	Inspect per subsection 3.1.6; steps 3 through 6.
(Pulsating air)	b. Tubing disconnected	Inspect per subsection 3.1.6; steps 1 through 5.
	c. Compressor	Piston seal torn or worn out. Replace per appropriate service procedure in Section 4.
(Grinding sound)	d. Compressor or cooling fan	Inspect per subsection 3.1.6, step 6. Replace as needed per Section 4.

3.4 Balancing orifices

Restrictor tube assemblies each contain an orifice drilled to a specific size. A number is assigned to each tube that represents the liter flow of gas through the orifice at a standard pressure. It may be necessary to change restrictor tubes in a Companion Concentrator for one of the following reasons:

A) During performance verification testing, concentration is out of specification and pneumatic testing reveals an imbalance in the reservoir canister drop point pressures. (Refer to subsection 3.1.2)

B) The drop point pressures are within specifications, however the concentration at the maximum flowrate is out of specification.

> **NOTE**
>
> Before performing the following procedure it is necessary to ensure that all leaks have been eliminated from the concentrator's system.

1. Open the concentrator cabinet, connect the pneumatic test kit, and after five minutes of operation, record the drop, fill, and kick pressures of each sieve cycle as described in subsection 3.1.2 B, steps 1 through 7.
2. To determine the balance pressure of the sieve beds, compare the drop pressures of two consecutive pressure cycles. If the pressures differ by more than 0.4 PSI, one or both of the restrictor tubes may need to be replaced to achieve a pressure balance.
3. Determine which drop pressure value corresponds to which restrictor tube (and consequently which sieve bed), by operating the concentrator and observing the test gauge. Lay your finger lightly over the open exhaust port on the end of solenoid valve 2 (refer to Figure 2-8 for solenoid 2 location). With the test gauge connected and the concentrator operating, feel for a slight puff of air from the exhaust port of solenoid 2. This represents the close of the solenoid and thus the end of the fill cycle for sieve canister 2. Immediately observe the gauge and you should note a rapid climb (kick pressure). After this kick pressure the gauge needle should fall to the next drop point. This drop point is the beginning pressure for the right sieve canister (sieve canister 1), which corresponds to the right restrictor tube.
4. In order to balance (bring the pressures within .4 PSI at the drop point) the orifices, it will be necessary to change one restrictor tube and install a new one with a larger or smaller orifice. (A larger rating on the tube will result in more flow and lower sieve bed filling pressure. The opposite will occur for a smaller orifice number.) Refer to the example below to appropriately size the restrictors.

   EXAMPLE: After five minutes of continuous operation, the drop point pressures are 14.9 PSIG and 14.2 PSIG. The restrictors are rated 8.8 (left) and 8.7 (right). Through the testing described above, you have determined that the right restrictor is producing the 14.2 PSIG drop pressure. Preferably, you should bring the lower drop pressure up to the higher drop pressure of the other sieve canister. Thus, to bring the 14.2 PSIG drop pressure up, replace the right restrictor tube with one having less flow (and a smaller rating). Try a restrictor that is .1 or.2 smaller. (Refer to the parts list for Figure 4-2 in Section 4 for part numbers that correspond to the desired orifice size. In this case, an orifice sized 8.6 or 8.5).
5. By trying different orifice sizes you should be able to accomplish a balance. Although the actual pressures may change up or down as the concentrator acclimates, the drop point balance should remain constant.

3.4 Balancing orifices (continued)

6. Occasionally a drop point balance may exist but the oxygen concentration may not be within specification. In this case the restrictor tubes may have orifice sizes that are too restrictive (sieve bed fills too slowly) or too large (sieve bed pressure too low for proper adsorption.) Increase or decrease the orifice sizes as appropriate by observing the reservoir canister pressure specifications as a guide.

7) Whenever restrictor tubes have been changed, operate the concentrator a minimum of 12 hours and recheck both the reservoir canister pressures and the oxygen concentration for compliance with specifications.

SECTION 4. SERVICE AND REPAIR

This section describes how to service the individual components of the Companion 492a and 590 Oxygen Concentrators. Included are instructions, where applicable, for removal, disassembly, operational check, cleaning, adjustment, alignment, reassembly, and installation.

After removing a component, visually inspect for damage or any other indication that the component is defective. Unless otherwise specified, replace as needed with a new component. Refer to the exploded-view drawings for replacement part numbers.

For service and repair procedures relating to the optional Oxygen Concentration Indicator (OCI) refer to section 6.

WARNING

The concentrator is electrically powered. To prevent serious injury or death, observe standard safety procedures when servicing. Always ensure that power is removed before servicing concentrator.

CAUTION

After a component has been serviced, the concentrator's overall system operation must be verified per section 3.3, Performance Verifications, before the concentrator is used.

CAUTION

Ensure that the compressed-air supply used to clean and dry components is clean and oil-free.

Service procedures are provided in Table 4-1 as follows:

Step Number	Component
1	Cabinet
2	Circuit Breaker
3	Hour Meter
4	Audio Alarm
5	Flowmeter Flow Control Valve
6	Flowmeter
7	Power Switch
8	Control Printed Circuit Board
9	Compressor Platform Assembly
10	Compressor (492a)
11	Compressor (590)
12	Capacitor
13	Cooling Fan
14	Pressure Switch
15	Pressure Regulator
16	Solenoid Valve
17	Sieve Canister
18	Pilot valve
19	Restrictor Tube Assemblies
20	Outlet Gas Filter
21	Shock Mount
22	Compressor Cup Seals (590)

TABLE 4-1. SERVICE PROCEDURES

(Refer to the appropriate figure(s) for numbers shown in bold print.)

COMPONENT	ITEM	ACTION
1. Cabinet (Figure 4-1)		
OPENING	a. Companion 492a/590	Remove humidifier, (if installed), from oxygen outlet connector.
		WARNING Electrical shock hazard. Verify AC power is removed before opening concentrator cabinet.
	b. Air inlet filter **14**	Remove from right side panel.
	c. Screw **16**	Using a #2 phillips screwdriver, remove from cabinet side panel.
	d. Screw **15**	Using a #2 phillips screwdriver with a shaft at least seven inches long, loosen screw **15**. The cabinet's left and right case halves will separate as screw is loosened.
		NOTE An O-ring is installed over screw item **15** on interior of cabinet and is intended to hold screw in place during reassembly of cabinet's case halves. Removal of screw from right case half is not necessary.
	e. Cabinet	Pull left and right side panels away from one another to open cabinet. The cabinet will hinge in rear of concentrator. Do not open cabinet more than approximately a 90 degree angle.
		CAUTION The concentrator will not be stable setting on its casters if left and right side panels are opened more than approximately 90 degrees.
CLOSING	f. Cabinet side panels (Figure 4-3)	Ensure that cabinet screw **37** and o-ring **41** are installed in right side panel.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
	g.	Cabinet side panels	Close right and left side panels to within approximately two inches of each other. Insert screw **18** through right side panel. Push screw in far enough so that it extends through right side panel tube **22** and into left side panel tube **50** (Figure 4-2).
	h.	Cabinet side panel screws **18** and **37** (Figure 4-3)	Tighten screw **37** first and then screw **18.**
	i.	Air inlet filter	Reinstall on right side panel.
2. Circuit Breaker **19** (Figure 4-3)			
REMOVAL	a.	Cabinet	Perform OPENING procedure.
			WARNING Electrical shock hazard. Verify AC power has been removed before servicing concentrator.
	b.	PCB harness connectors	Remove three wire harness connectors from Control PCB **44.**
	c.	Tube	Remove from tube clamp **24.**
	d.	Inlet air duct cover **46**	Remove five screws **45,** and air duct cover **46,** from right case interior. Control PCB does not need to be removed from cover.
	e.	Circuit breaker terminals	Disconnect two terminal wires.
	f.	Filter compartment door **16**	Remove.
	g.	Hex nut **10**	Remove from circuit breaker (Figure 4-1).
	h.	Circuit breaker	Remove from cabinet interior.
INSTALLATION (Figure 4-1)	i.	Replacement circuit breaker	Install knurled nut, item **6,** (Figure 4-1) onto circuit breaker's threaded shaft so that approximately 1/4 inch of threads are exposed.
	j.	Replacement circuit breaker	Install in right side panel so that circuit breaker number is in a vertical and readable position. Secure circuit breaker with hex nut in interior of filter compartment.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
	k.	Circuit breaker terminals	Using needle-nose pliers and old circuit breaker as a guide, carefully bend each terminal at approximately a 45 degree angle toward cabinet hinge. Reconnect wires to terminals. The circuit breaker is not polarity sensitive, either wire may be connected to either terminal.
	l.	Air inlet duct cover, tube and Control PCB wire harness connectors	Reverse removal procedures and reinstall.
	m.	Cabinet	Perform CLOSING procedures.
3. Hour Meter **21** (Figure 4-3)			
REMOVAL	a.	Cabinet	Perform OPENING procedure.
			WARNING Electrical shock hazard. Verify AC power has been removed before servicing concentrator.
	b.	PCB harness connectors	Remove three wire harness connectors from Control PCB **44.**
	c.	Tube	Remove from tube clamp **24.**
	d.	Air inlet duct cover **46**	Remove five screws **45** and cover **46** from right case interior. Control PCB does not need to be removed from cover.
	e.	Hour meter terminals	Disconnect two terminal wires.
	f.	Filter compartment door **16**	Remove.
	g.	Rivets (Figure 4-1)	Remove two rivets **13** securing hour meter with 1/8 inch drill.
	h.	Hour meter	Remove from filter compartment interior.
INSTALLATION	i.	Replacement hour meter	Insert into mounting hole from filter compartment so that last digits (red numerals) are toward bottom of concentrator. Secure to cabinet with two 1/8 inch pop-rivets.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
	j.	Hour meter terminals	Using needle-nose pliers and old hour-meter as a guide, carefully bend each terminal at approximately a 45 degree and toward cabinet hinge. Reconnect wires to terminals. The hour meter is not polarity sensitive, either wire may be connected to either terminal.
	k.	Air inlet duct cover, tube and Control PCB wire harness connectors	Reverse removal procedures and reinstall.
	l.	Cabinet	Perform CLOSING procedures.
4. Audio Alarm **25** (Figure 4-3)			
REMOVAL	a.	Cabinet	Perform OPENING procedure.
	b.	Audio alarm terminals	Disconnect two terminal wires.
	c.	Air inlet filter **17**	Remove.
	d.	Retaining ring **11** (Figure 4-1)	Remove from filter compartment.
	e.	Audio alarm	Remove from cabinet interior.
INSTALLATION	f.	Replacement audio alarm	Insert into mounting hole from right cabinet interior.
	g.	Retaining ring	Attach to replacement audio alarm from filter compartment.
	h.	Audio alarm terminals	Reconnect red wire to positive terminal and black wire to negative terminal.
	i.	Cabinet	Perform CLOSING procedures.
5. Flowmeter Flow Control Valve **2** (Figure 4-3)			
REMOVAL	a.	Flowmeter knob **1**	Remove by pulling away from flowmeter.
	b.	Flow control valve	Remove from flowmeter body with 1/2 socket wrench.

CAUTION

To prevent flowmeter damage, the flow control valve must be set to a fully counterclockwise position before reassembly.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
	c.	Replacement flow control valve	Install into flowmeter body and carefully tighten with 1/2 inch socket wrench.
	d.	Flowmeter knob	Align with flat on flow control valve shaft and install.
6. Flowmeter **3** (Figure 4-3)			
REMOVAL	a.	Cabinet	Perform OPENING procedure.
	b.	Oxygen Tubes **12, 10**	Disconnect two tubes from flowmeter inlet and outlet connectors.
	c.	Two flowmeter brackets **8** and nuts **9**	Remove from flowmeter's threaded connectors.
	d.	Cabinet control panel	Remove flowmeter.
INSTALLATION	e.	Replacement flowmeter	Install in mounting hole with control knob at top of concentrator.
	f.	Flowmeter brackets and nuts	Install on replacement flowmeter.
	g.	Oxygen tubes	Reconnect tubing to inlet and outlet flowmeter connectors. Refer to Section 2, (Figure 2-1) for tubing orientation.
	h.	Cabinet	Perform CLOSING procedures.
7. Power Switch **5** (Figure 4-3)			
			NOTE For units equipped with optional O.C.I refer to section 6 for Power Switch service procedures.
REMOVAL	a.	Cabinet	Perform OPENING procedure.
			WARNING Electrical shock hazard. Verify AC power has been removed before servicing concentrator.
	b.	Power L.E.D. **4**	Using a needle-nose pliers, unplug the connector from the Power L.E.D.'s leads.
	c.	Power switch terminals	Disconnect four terminal wires.
	d.	Power switch body	Locate four retaining tabs at each corner.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
	e.	Four retaining tabs	Press inward with flat-blade screwdriver, one after the other, while pushing switch through control panel toward outside of cabinet.
INSTALLATION			**NOTE** The Power L.E.D. is mounted in a removable bezel. The bezel and L.E.D. are supplied with replacement power switch. Verify correct orientation of bezel before installation. Power L.E.D. should be positioned above switch closest to terminals #2 and #5.
	f.	Replacement power switch	Position so that power L.E.D. is towards top of concentrator.Press into mounting hole from outside of control panel until retaining tabs catch.
	g.	Power switch terminals	Connect four terminal wires. Refer to Section 2, (Figure 2-2) for wire orientation.
	h.	Power L.E.D. leads	Connect to wire harness connector. The longer L.E.D. lead must connect to position 2 (black wire) on wire connector. Refer to Section 2, (Figure 2-2) for connector orientation.
			NOTE The Power L.E.D. is a polarity sensitive device. Improper connection of wire harness connector will not damage L.E.D., but will prevent illumination when power is applied. Verify proper operation of the Power L.E.D. after installation. If the L.E.D. does not illuminate, remove the connector, rotate it 180 degrees, reinstall the connector, and retest.
	i.	Cabinet	Perform CLOSING procedure.
8. Control Printed Circuit Board **44** (Figure 4-3)	a.	Cabinet	Perform OPENING procedure.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
			CAUTION The control printed circuit board contains complementary metal-oxide semiconductor (CMOS) integrated circuits (IC's) which are static-sensitive devices. To prevent IC damage, observe standard safety procedures as follows: • Wear grounding wrist strap. • Work on grounded conductive mat. • Handle PCB by edges only. • Store PCB in conductive plastic bag.
			WARNING Electrical shock hazard. Verify AC power has been removed before servicing concentrator.
FUSE TESTING	b.	Fuse **69**	Remove from fuse holder on Control PCB. Verify resistance of approximately 15 ohms using digital multimeter. Reinstall in fuse holder.
REMOVAL	c.	PCB harness connectors	Remove three wire harness connectors from Control PCB **44.**
	d.	Control PCB	Remove five screws **43** from control PCB. Separate Control PCB from cover.
INSTALLATION	e.	Replacement Control PCB	Install into cabinet and secure with five screws.
	f.	Three wire harness connectors	Reverse removal procedures and reinstall.
	g.	Cabinet	Perform CLOSING procedure.
9. Compressor Platform Assembly **49** (Figure 4-3)			
REMOVAL	a.	Cabinet	Perform OPENING procedure.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
			WARNING Electrical shock hazard. Verify AC power has been removed before servicing concentrator.
	b.	Compressor wire harness connector **25** (Figure 4-4)	Disconnect and remove compressor wire harness connector and grommet **26** (Figure 4-4) from air dam **62** (Figure 4-3).
	c.	Compressor platform assembly	Using a magnetic tip #2 phillips screwdriver, remove two screws **50.** Disconnect inlet tube **26** from platform connector while sliding platform assembly out of cabinet.
DISASSEMBLY (Figure 4-4)	d.	Inlet tube and clamp **35**	Remove from compressor and platform connectors.
	e.	Two screws **14** and two clamps **15** and **21**	Remove from platform assembly.
			WARNING To prevent serious electrical shock, discharge capacitor by shorting terminals with insulated - handle screwdriver.
	f.	Capacitor **17** terminals	Disconnect two terminal wires.
	g.	Strap **6** and grommet **16**	Cut strap and pull each capacitor wire, one at a time through the grommet.
	h.	Cooling fan **22** terminals	Disconnect two terminal wires.
	i.	Two screws **33**, washer **28**, and locknuts **29**	Use a 5/64-inch 90° Allen wrench and a 5/16-inch socket to remove from compressor. Two clamps **27** do not need to be removed from the heat exchanger.
	j.	Heat exchanger **30**	Unscrew brass nut **31** and remove heat exchanger **30** from compressor.
	k.	Compressor	Support compressor with one hand and remove four cap screws **12** with 7/16-inch socket wrench. Separate compressor from platform.
REASSEMBLY	l.	Compressor platform assembly	Reverse DISASSEMBLY procedure.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
			NOTE Apply a small amount of Loctite 242 to threads of four compressor mounting bolts **12** before reassembly.
INSTALLATION	m.	Compressor platform assembly	Reverse REMOVAL procedure. Do not over-tighten two screws **50.**
10. Compressor (492a)			
REMOVAL	a.	Compressor platform assembly	Perform REMOVAL and DISASSEMBLY procedures steps 9a through 9k.
DISASSEMBLY (Figure 4-5)	b.	Twelve cylinder head screws **1**	Remove from cylinder heads **26, 9.**
	c.	Cylinder heads and valve plates	Remove both cylinder heads, along with connector tubes **2,** and both valve plates **4.**
	d.	Piston sleeves	Remove both sleeves **6.**
HOUSING WELL **A**	e.	Four-blade fan **19**	Pry away from motor shaft **15** with flatblade screwdriver.
	f.	Connecting rod screw **8**	Turn motor shaft until screw is visible through lower access port on wire-harness side of housing.
	g.	Connecting rod screw	Loosen several turns with 5/32-inch allen wrench.
	h.	Set screw **17**	Turn eccentric **18** until screw is visible through upper access port.
	i.	Set screw	Loosen only 1/4-turn with 1/8-inch allen wrench.
	j.	Piston **7**	Slip piston connecting rod off of bearing **16,** and slide entire eccentric bearing assembly **20** off shaft.
			NOTE Bearing is bonded to connecting rod with Loctite. If necessary, insert screwdriver blade into slit at rod bottom, and turn to break rod loose from bearing.
	k.	Piston	Grasp at top inside housing well, and slip connecting rod off shaft.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
	l.	Connecting rod	Move to one side of shaft, and then lift while moving back into housing above shaft. Remove through top of housing. Replace connecting rod screw.
HOUSING WELL **B**	m.	Five-blade fan **11**, eccentric bearing assembly, and piston	Repeat steps e through l to remove.
CLEANING			**WARNING** To prevent personal injury, use face shield and observe standard safety procedures when using compressed-air gun.
	n.	Cylinder head interiors and housing wells	Blow out or brush away dirt and dust.
	o.	Valve plates	Wipe off both sides with clean cloth.
	p.	Eccentric bearing assemblies	Wipe off with clean, cloth. Scrape off excessive Loctite from outside diameter with knife.
REASSEMBLY	q.	Compressor body	Stand on end, housing well **B** facing up.
			CAUTION Keep Loctite away from all plastic parts.
	r.	New connecting rod screw	Place one drop only of Loctite 242 on threads, and insert, but do not tighten, into side hole on connecting rod.
	s.	Piston	Position above housing well so that connecting rod screw head is facing wire-harness side of housing.
	t.	Piston	Insert into housing, and place connecting rod over shaft end.
	u.	Bearing	Wipe any grease or oil off outer race.
			CAUTION Do not allow Loctite to seep inside bearing or on eccentric.
	v.	Bearing	Apply very thin film of Loctite 680 to outer circumference with small pad.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM	ACTION
	w. Eccentric bearing assembly	Position so that set screw is aligned with flat on shaft.
	x. Eccentric bearing assembly	Hold piston steady with one hand, and slip assembly onto shaft, bearing first, and into connecting rod.
	y. Eccentric	Turn until connecting rod screw is visible through lower access port on wire-harness side of housing.
	z. Connecting rod	Center on eccentric bearing assembly so that bearing face is flush with rod face.
		CAUTION To prevent bearing failure, do not overtighten connecting rod screw.
	aa. Connecting rod screw	Tighten to 15 inch-pounds (1.69 newton/meters) with torque wrench.
	ab. Sleeve	Wipe out inner surface. Inspect for scratches and burrs.
	ac. Sleeve	Position above housing well so that stepped edge is facing out.
	ad. Sleeve	Install carefully onto piston, taking care not to damage seal around piston head.
	ae. Compressor body	Set on feet.
ECCENTRIC-PISTON ALIGNMENT	af. Sleeve	Position in center of housing well.
	ag. Valve plate	Position over piston, O-ring **5** side down, so that head of reed valve screw is aligned with notch on piston head.
	ah. Valve plate	Place on housing well to engage stepped edge of sleeve. Note that six mounting holes are aligned with those in housing.
	ai. Two of the six cylinder head screws	Insert into two valve plate holes on housing's center line, and rotate two turns.
	aj. Motor shaft	Hold valve plate in place over piston, and spin shaft.
	ak. Motor shaft	Turn unit eccentric set screw is visible through upper access port.
	al. Set screw	tighten to 30 inch-pounds (3.39 newton/meters) with torque wrench. Do not allow eccentric to move on shaft.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM	ACTION
	am. Valve plate	Remove two cylinder head screws and then plate.
	an. Sleeve	Hold, and turn eccentric. Ensure that sleeve is not touching front or back shoulder of well.
	ao. O-ring	Inspect for cuts and tears. Ensure properly seated in valve plate groove.
	ap. Valve plate	Repeat steps ag and ah.
	aq. Head gasket **3** for cylinder head **B 9**	Inspect for cuts and tears. Ensure properly seated in cylinder head groove.
	ar. Cylinder head **B**	Place over valve plate, and place connecting rod in the up position.
	as. Two cylinder head screws	Insert into holes on housing's center line, and tighten until snug.
	at. Eccentric	Turn and check for alignment between piston and valve plate.
	au. Compressor body	Stand on end, housing well **A** facing up.
	av. Compressor	Repeat steps r through at with the following change: Connector tubes **2** are inserted between cylinder head **A** and **B** before head **A** is connected to housing.
	aw. Cylinder head screws	Insert remaining into heads, and tighten all 12 to 20 inch-pounds (2.27 newton/meters) with torque wrench in sequence shown in (Figure 4-7).
	ax. Cylinder head screws	Repeat step aw for 30 inch-pounds (3.41 newton/meters).
	ay. Four-blade fan	Press onto housing well **A** shaft, with flat in fan hole aligned with flat on shaft and with spring clamp facing in.
	az. Five-blade fan	Press onto housing well **B** shaft, with flat in fan hole aligned with flat on shaft and with spring clamp facing in.
		CAUTION Ensure that both fans are securely in place.
INSTALLATION	ba. Compressor platform assembly	Reverse DISASSEMBLY and REMOVAL procedures steps 9a through 9k.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
11. Compressor (590)			
REMOVAL	a.	Compressor platform assembly	Preform REMOVAL and DISASSEMBLY procedures setup 9a through 9k.
DISASSEMBLY (Figure 4-6)	b.	Eight cylinder head screws **29**	Remove from cylinder heads **28** and **10.**
	c.	Cylinder heads and valve plates	Remove both cylinder heads, along with connector tubes **1** and both valve plates **3.**
	d.	Piston sleeves	Remove both sleeves **5.**
HOUSING WELL **A**	e.	Fan **A 19**	Pry away from motor shaft with flat-blade screwdriver. Label Fan **A** for correct reassembly.
	f.	Connecting rod screw **16**	Turn motor shaft until screw is visible through lower access port on wire-harness side of housing.
	g.	Connecting rod screw	Loosen several turns with 5/32-inch allen wrench.
	h.	Set screw **17**	Turn eccentric **20** until screw is visible through upper access port.
	i.	Set screw	Loosen only 1/4-turn with 1/8-inch allen wrench.
	j.	Piston assembly	Slip connecting rod **9** off bearing **21,** and slide entire eccentric bearing assembly **18** off shaft **22.**
			NOTE Bearing is bonded to connecting rod with Loctite. If necessary, insert screwdriver blade into slit at rod bottom, and turn to break rod loose from bearing.
	k.	Piston assembly	Grasp at top inside housing well, and slip connecting rod off shaft.
	l.	Connecting rod	Move to one side of shaft, and then lift while moving back into housing above shaft. Remove through top of housing. Replace connecting rod screw.
	m.	Piston assembly	Remove four screws **6** on each piston to separate retainer plate **7,** cup seal **8,** and connecting rod **9.**

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
HOUSING WELL **B**	n.	**B** fan **12**, eccentric bearing assembly, and piston	Repeat steps e through m to remove.
			WARNING To prevent personal injury, use face shield and observe standard safety procedures when using compressed-air gun.
	o.	Cylinder head interiors and housing wells	Blow out or brush away dirt and dust.
CLEANING			**CAUTION** Use care not to damage intake and exhaust reed valves **23** on valve plates.
	p.	Valve plates & piston assembly components	Wipe off with clean cloth.
	q.	Eccentric bearing assemblies	Wipe off with clean cloth. Scrape off excessive Loctite from outside diameter with knife.
REASSEMBLY	r.	Compressor body	Stand on end, housing well **B** facing up.
	s.	Piston assembly	Install cup seal on stepped edge of retainer plate. Cupped side of cup seal should face retainer plate.
	t.	Piston assembly	Install the cup seal and retainer plate on the connecting rod. Rotate the retaining plate to position the index mark and beveled edges as shown in Figure 4-8.
	u.	Piston assembly	Place one drop of Loctite 242 on threads of the four screws. Install the screws and torque to 20-inch pounds (2.27 newton/meters).
	v.	Piston assembly	Repeat steps s through u for the second piston assembly.
			CAUTION Keep Loctite away from all plastic parts.
	w.	New connection rod screw	Place one drop of Loctite 242 on threads, and insert, but do not tighten, into side hole on connecting rod.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM	ACTION
	x. Piston	Position above housing well so that connecting rod screw head is facing wire-harness side of housing.
	y. Piston	Insert into housing, and place connecting rod over shaft end.
	z. Bearing	Wipe any grease or oil off outer edge of bearing.
		CAUTION Do not allow Loctite to seep inside bearing or onto eccentric.
	aa. Bearing	Apply very thin film of Loctite 680 to outer circumference with small pad.
	ab. Eccentric bearing assembly	Position so that set screw is aligned with flat on shaft.
	ac. Eccentric bearing assembly	Hold piston steady with one hand and slip assembly onto shaft, bearing first, and into connecting rod.
	ad. Eccentric	Turn until connecting rod screw is visible through lower access port on wire-harness side of housing.
	ae. Connecting rod	Center on eccentric bearing assembly so that bearing face is flush with rod face.
		CAUTION To prevent bearing failure, do not overtighten connecting rod screw.
	af. Connecting rod screw	Tighten to 15 inch-pounds (1.69 newton/meters) with torque wrench.
	ag. Sleeve	Wipe out inner surface. Inspect for scratches and burrs.
	ah. Sleeve	Install carefully onto piston, taking care not to damage cup seal.
	ai. Compressor body	Set on feet.
ECCENTRIC-PISTON ALIGNMENT	aj. Sleeve	Position in center of housing well.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM	ACTION
	ak. Valve plate	Position over piston, O-ring side down, so that head of reed valve screw **26** is aligned with notch on piston head and the reed valve on the top of the valve plate is positioned nearest to the harness side of the compressor.
	al. Valve plate	Place on housing well to engage edge of sleeve. Note that four mounting holes are aligned with those in housing.
	am. Four cylinder head screws	Insert into four valve plate holes and rotate two turns.
	an. Motor shaft	Hold valve plate in place over piston, and spin shaft.
	ao. Motor shaft	Turn until eccentric set screw is visible through upper access port.
	ap. Set screw	Tighten to 30 inch-pounds (3.39 newton/meters) with torque wrench. Do not allow eccentric to move on shaft.
	aq. Valve plate	Remove four cylinder head screws and then plate.
	ar. Sleeve	Hold sleeve, and turn eccentric. Ensure that sleeve is not touching front or back shoulder of well.
	as. O-ring **6**	Inspect for cuts and tears. Ensure properly seated in valve plate groove.
	at. Valve plate	Repeat steps ak and al.
	au. Head gasket **4** for cylinder head **B**	Inspect for cuts and tears. Ensure properly seated in cylinder head groove.
	av. Cylinder head **B**	Place over valve plate, and place connecting rod in the up position.
	aw. Four cylinder head screws	Insert into holes on housing's center line, and tighten until snug.
	ax. Eccentric	Turn and ensure piston does not contact valve plate.
	ay. Compressor body	Stand on end, housing well **A** facing up.
	az. Compressor	Repeat steps aw thru ax for cylinder head **A** side of compressor with the following change: Connector tubes **1** are inserted between cylinder head **A** and **B** before head **A** is connected to housing.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM	ACTION
	ba. Cylinder head screws	Tighten all to 20 inch-pounds (2.27 newton/meters) with torque wrench in a crisscross pattern.
	bb. Cylinder head screws	Repeat step ba for 30 inch-pounds (3.41 newton/meters).
	bc. Fan **A**	Press onto housing well **A** shaft, with flat in fan hole aligned with flat on shaft and with spring clamp facing in.
	bd. Fan **B**	Press onto housing well **B** shaft, with flat in fan hole aligned with flat on shaft and with spring clamp facing in.
		CAUTION Ensure that both fans are securely in place.
INSTALLATION	be. Compressor platform assembly	Reverse DISASSEMBLY and REMOVAL procedures.
12. Capacitor **17** (Figure 4-4)		
REMOVAL	a. Cabinet	Perform OPENING procedure.
	b. Compressor platform assembly	Perform REMOVAL procedure, step 9 a through c.
		WARNING Electrical shock hazard. Verify AC power has been removed before servicing concentrator. Discharge capacitor by shoring terminals with insulated - handle screwdriver.
	c. Capacitor **17** terminals	Disconnect two terminal wires.
	d. Two straps **18**	Cut straps and remove capacitor from compressor platform.
INSTALLATION	e. Replacement capacitor	Attach to underside of platform assembly with two new straps **18**.
	f. Capacitor terminals	Reconnect two terminal wires.
		NOTE The capacitor is not a polarity sensitive component. Either wire may be connected to either terminal.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
	g.	Compressor platform assembly	Perform INSTALLATION procedure.
	h.	Cabinet	Perform CLOSING procedure.
13. Cooling Fan **22** (Figure 4-4)			
REMOVAL	a.	Cabinet	Perform OPENING procedure.
			WARNING Electrical shock hazard. Verify AC power has been removed before servicing concentrator.
	b.	Cooling fan **22** terminals	Disconnect two terminal wires.
	c.	Two screws **4**	Remove from compressor platform assembly.
	d.	Cooling fan	Remove by sliding fan toward front of compressor platform assembly. The rear of the cooling fan is retained by clips which are molded into the platform.
INSTALLATION	e.	Replacement cooling fan	Position the fan with the flow arrow pointing down and blades up as shown in Figure 4-4 and slide the rear of the fan into the two clips on the compressor platform.
	f.	Two screws	Install into compressor platform assembly and tighten.
	g.	Cooling fan terminals	Reconnect the two terminal wires.
	h.	Cooling fan	Verify correct operation per subsection 3.1.4.
			NOTE The cooling fan is not a polarity sensitive component. Either wire may be connected to either terminal.
	i.	Cabinet	Perform CLOSING procedure.
14. Pressure Switch **37** (Figure 4-2)			
REMOVAL	a.	Cabinet	Perform OPENING procedure.
	b.	Pressure switch terminals	Disconnect two terminal wires.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM	ACTION
	c. Pressure switch	Using a 7/16-inch open end wrench, unscrew from product canister **34**.
INSTALLATION	d. Replacement pressure switch	Apply a small amount of pipe cement to pressure switch thread. Distribute the cement around the entire fitting. Do not allow cement to enter interior of pressure switch.
	e. Replacement pressure switch	Install into product canister and tighten with wrench. Do not overtighten. Position the switch so that the terminals are toward the top of the concentrator.
	f. Pressure switch terminals	Reconnect two terminal wires.
SETTING	g. Pressure switch	The pressure switch is factory preset. To verify current setting perform subsection 3.1.2 B steps 2, 3, 8, 9 and 10. If incorrect, turn adjustment screw on face of switch with small screwdriver and retest. If switch will not hold a setting, replace.
		NOTE The pressure switch is not a polarity sensitive component. Either wire may be connected to either terminal.
	h. Cabinet	Perform CLOSING procedures.
15. Pressure Regulator **41** (Figure 4-2)		
REMOVAL	a. Cabinet	Perform OPENING procedure.
	b. Vacuum check valve **38** and tubing **40**	Disconnect from pressure regulator connector.
	c. Oxygen tubing **44**	Disconnect from pressure regulator connector.
	d. Pressure regulator **41** and fitting assembly **39**	Turn counterclockwise at fitting assembly **39** until regulator and fitting are removed from product canister **34**.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM	ACTION
DISASSEMBLY (Figure 4-9)		**NOTE** DISASSEMBLY procedure is provided for regulator cleaning purposes only. Internal regulator repair parts are not available. A faulty regulators must be replaced as a complete assembly.
	e. Regulator body **10**	Hold firmly in one hand and unscrew bonnet assembly **2**.
		CAUTION To prevent damage to regulator plastic seat **6**, remove seat carefully from body with 3/8-inch wide flat blade screwdriver.
		NOTE During disassembly, removal of fitting assembly **11** from regulator body **10** is not necessary.
	f. Regulator body	Remove remaining internal parts per Figure 4-9.
CLEANING		**WARNING** To prevent personal injury, use face shield and observe standard safety procedures when using compressed-air gun.
	g. Regulator body	Apply isopropyl alcohol with cotton swab to cavities. Blow dry with compressed-air gun.
REASSEMBLY		**CAUTION** To prevent damage to regulator plastic seat, install seat carefully into body and hand tighten with 3/8-inch wide blade screwdriver.
	h. Regulator body	Replace internal parts per Figure 4-9.
	i. Bonnet assembly **2**	Screw onto regulator body. Do not overtighten.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
INSTALLATION (Figure 4-9)			**NOTE** If a replacement regulator is to be installed, reuse the fitting assembly **11** from the faulty regulator. Apply a small amount of pipe cement to replacement regulator and fitting assembly threads. Distributed the cement around the entire fitting. Do not allow cement to enter interior of regulator. Do not overtighten.
	j.	Pressure regulator	Install into the product canister. Use care not to cross thread. Position the regulator as shown in Figure 4-2.
	k.	Oxygen tubing **44** (Figure 4-2)	Connect to pressure regulator.
	l.	Vacuum check valve **38** and tube **40**	Connect to pressure regulator.
TESTING			**WARNING** The following procedure requires AC power be applied to concentrator. Metal components are not grounded. To prevent possibility of serious electrical shock, connect grounding wire to metal components before applying power to unit.
	m.	AC power cord	Connect to AC outlet.
	n.	Front control panel	Push power switch to ON position.
	o.	Concentrator flowmeter	Adjust flow to 1 lpm. If installing a new regulator, it is necessary to turn the regulator adjustment knob several turns clockwise to achieve an outlet pressure.
			NOTE Allow concentrator to run (stabilize) for approximately 20 minutes before proceeding.
	p.	Test pressure gauge	Connect to oxygen outlet spout **28** or **32** Figure 4-3. Perform subsection 3.1.2 B steps 12 through 15.
	q.	Test pressure gauge	Verify pressure reading of 5.0 ± 0.5 psig.
ADJUSTMENT (Figure 4-9)	r.	Bonnet assembly **2**	Cut and remove strap **1**. Push lock ring **14** up against adjustment knob **15**.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
			NOTE To prevent pressure trapping between the pressure regulator and test pressure gauge, make adjustments to the regulator in small increments and vent a small amount of oxygen at the pressure gauge between each adjustment.
	s.	Adjustment knob **15**	Adjust for test pressure gauge reading of 5.0 ± 0.5 psig.
	t.	Locking ring **14**	Pull down to lock, and install a new strap.
	u.	Concentrator	Set the power switch to OFF, unplug the AC power cord, and disconnect the test pressure gauge.
	v.	Cabinet	Perform CLOSING procedure.
16. Solenoid **20**, **24** (Figure 4-2)	a.	Cabinet	Perform OPENING procedure.
	b.	Solenoid terminals	Disconnect two terminal wires.
TESTING (Electrical)	c.	Solenoid terminals	Using digital multimeter, verify resistance is approximately 850 ohms.
	d.	Solenoid terminals	Apply 24 V dc using external power supply. Verify faint clicking sound inside solenoid when 24 V dc is applied.
			WARNING The following procedure requires AC power be applied to the concentrator. Metal components are not grounded. To prevent possibility of serious electrical shock, connect ground wire to metal components before applying power to the unit.
TESTING (Pneumatic)	e.	AC power cord	Connect to AC outlet.
	f.	Front control panel	Push power switch to ON position.
	g.	Solenoid valve	Verify solenoid is correctly activating pilot valve by presence of appropriate supply, exhaust, or balance gas flows. Perform subsection 3.1.2 B steps 4 through 6 for correct cycling.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
	h.	Solenoid valve	Leak test solenoid gasket joints and threaded connection with conservative use of liquid leak detector.
	i.	Front control panel	Push power switch to OFF position
	j.	AC power cord	Remove from AC outlet.
REMOVAL	k.	Small pilot tubing C, D, or E	Mark for correct replacement location then remove from solenoid brass connectors.
	l.	Solenoid valve	Hand loosen and rotate counterclockwise to remove from pilot valve.
INSTALLATION	m.	Replacement solenoid valve	Apply small amount of pipe cement to threads. Do not allow cement to enter interior of solenoid.
	n.	Replacement solenoid valve	Install into pilot valve and hand tighten. Position the solenoid's electrical terminals as shown in Figure 4-2.
	o.	Replacement solenoid valve terminals	Connect two terminal wires.
			NOTE The solenoid valve is not a polarity sensitive component. Either wire may be connected to either terminal.
	p.	Solenoid Valve	Leak test threaded connection with conservative use of liquid leak detector solution.
	q.	Cabinet	Perform CLOSING procedure.
17. Sieve Canister Assembly **33** (Figure 4-2)			
REMOVAL			**NOTE** Replacement of sieve canisters is not a normal maintenance procedure. Sieve canisters should only be replaced when all other efforts to achieve factory specified oxygen levels have been exhausted. Consult your authorized Puritan-Bennett repair facility before proceeding.
	a.	Cabinet	Perform OPENING procedure

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM	ACTION
		CAUTION The following service procedure requires removal of fittings or components which will expose the sieve canister's internal sieve material to room air. Care should be taken so that this material is not exposed to room air for long periods of time (i.e overnight). When ever possible plug open ports and fittings to prevent sieve contamination. Do not remove plugs from replacement sieve canisters until ready to install. Do not interrupt the installation process until completed or until all open ports are plugged.
	b. Two straps **17**	Cut and remove.
	c. Two compression nuts **12** (connected to plastic elbows on bottom of sieve canisters)	Loosen and disconnect from plastic elbows.
	d. Oxygen **a** and pilot pressure tubing **d**	Disconnect from center port of brass tee **21** and brass fitting **11** of solenoid valve **20**.
	e. Balance pilot valve **19** (including attached fitting and components)	Remove from concentrator cabinet and set aside.
	f. Canister insulation **57**	Remove from interior of concentrator.
	g. Pilot air filter assembly **6** and 1/16-inch pilot tubing **10**	Remove 1/16-inch pilot air tubing from both brass connectors **11** of solenoids **24**. Remove 1/16-inch pilot air tubing both exhaust pilot valves **7**.
	h. Six plastic compression nuts **12, 14** (connected to elbows and tees of four pilot valves **7, 25**)	Loosen and disconnect plastic tubing from pilot valves elbows and tee.
	i. Screws **4** and canister clamps **3**	Remove the two screws and canister clamp for each sieve canister.
	j. Sieve canister **33**	Remove by pulling top of canister away from cabinet interior and sliding canister toward top of concentrator.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM	ACTION
		NOTE For this procedure it is not necessary to separate each sieve canister's solenoid valve, exhaust pilot valve, and supply pilot valve from each other. These components may be removed from each sieve canister as an assembly thus reducing the possibility of creating system leaks.
		CAUTION When removing solenoid and pilot valves from sieve canister, do not apply force to solenoid body. Remove this assembly as described below.
	k. Two brass tees **9**	Remove the solenoid, exhaust pilot, and supply pilot valves as one assembly from each sieve canister by turning brass tee with 1/2-inch open-end wrench in counterclockwise direction.
	l. Two plastic elbows **8**	Remove elbows connected to bottom of each sieve canister.
		CAUTION When applying pipe cement, do not allow cement to enter interior of fitting.
REPLACEMENT	m. Two plastic elbows, and brass tees	Add a small amount of pipe cement to threads which were removed from the sieve canister of brass tee and plastic elbows. Distribute the cement evenly around the entire threaded area.
	n. Replacement sieve canister	Remove plugs from threaded connectors.
	o. Two plastic elbows and brass tees	Thread into appropriate port of each sieve canister. Take care not to cross thread or over tighten. Position as shown in Figure 4-2.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
	p.	Replacement sieve canisters	Reverse remainder of removal procedure performed above. Hand tighten plastic compression nuts. Refer to Figures 2-1, 2-2, and 4-2, if necessary, for positioning of components and connection of wires and tubes.
	q.	Concentrator	Perform performance verification procedures in subsection 3.1.1 and 3.1.2.
18. Pilot Valve **7,25,19** (Figure 4-2)			
DISASSEMBLY	a.	Cabinet	Perform OPENING procedure.
			CAUTION If pilot valve remains disassembled for extended lengths of time, (i.e. longer than necessary to perform service), seal valve openings to prevent contamination of sieve material.
	b.	Solenoid valve **20,24** terminals	If disassembly is to be performed on supply or balance pilot valves, remove terminal wires and pilot air tubing from solenoid valve and remove solenoid from pilot valve. Refer to solenoid valve REMOVAL and INSTALLATION procedures when necessary.
(Figure 4-10)	c.	Snap ring **1**	Carefully remove from end cap **2** with snap ring pliers (90-degree tip).
	d.	End cap **2**	Remove slowly. Then carefully pull out spring **3** (For exhaust pilot valves only).
	e.	Diaphragm (slotted) **4**	Peel edge away from valve body, and pull off of poppet **5**.
	f.	Snap ring **1**	Carefully remove from port cap **9.**
	g.	Port cap **9**	Pull carefully away from valve body.
	h.	Poppet **5**	Push poppet, with solid diaphragm **8** attached out of pilot valve body **6**.
	i.	Support washer **7**	Remove from valve body.

TABLE 4-1. SERVICE PROCEDURES (continued)

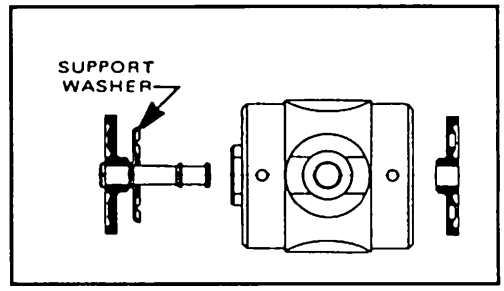
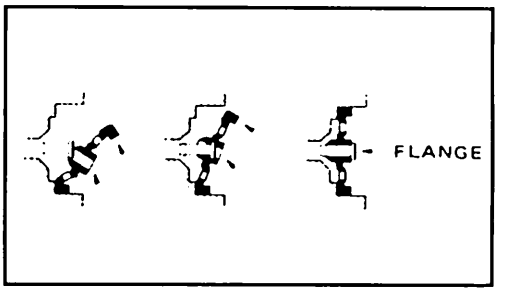
COMPONENT	ITEM	ACTION
		WARNING To prevent personal injury, use face shield and observe standard safety procedures when using compressed-air gun.
CLEANING	j. Pilot valve body **6**	Apply isopropyl alcohol with cotton swab to cavities and seating surfaces. Blow dry with compressed-air gun.
	k. Two diaphragms	Apply isopropyl alcohol with soft brush. Blow dry with compressed-air gun.
INSPECTION	l. Two diaphragms	Hold up to light, stretch, and check for cuts, holes, and cracks, especially at seating surfaces. If either is defective, replace both diaphragms with kit **10**.
	m. Pilot valve body	Inspect for corrosion, cracks, and burrs. If defective, replace entire component.
REASSEMBLY		**CAUTION** To prevent damage to concentrator, ensure that parts remain clean during reassembly.
	n. Support washer **7**	Place into port cap side of body, with concave end facing inward as shown below.
		
	o. Pilot valve body	Place poppet, with solid diaphragm attached, into port cap side, and push in until diaphragm meets support washer.
	p. Slotted diaphragm	Place into end cap side of body with seating surface facing in.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM	ACTION
	q. Pilot valve body	Hold poppet steady at port cap side and at end cap side. Press seating surface around poppet flange until flange is visible as shown below. 
	r. Pilot valve body	Install spring (for only exhaust pilot valves) into cavity of poppet on slotted diaphragm side of pilot valve.
	s. End cap	Install over slotted diaphragm and secure with snap ring. Ensure that snap ring is pressed into valve body groove with ring's sharp edge facing out.
	t. Port cap	Install over solid diaphragm and secure with snap ring. Ensure that snap ring is pressed into valve body groove with ring's sharp edge facing out.
	u. Solenoid valves	Apply a small amount of pipe cement to the threads of the solenoids that were removed. Evenly distribute the cement around the entire solenoid fitting without allowing any cement to enter the interior of solenoid. Reinstall each solenoid and reconnect the appropriate terminal wires. The solenoid is not a polarity sensitive device. Either wire of the appropriate wire pair may be connected to either solenoid terminal.
	v. Cabinet	Perform CLOSING procedures.
19. Restrictor Tube Assemblies **13** (Figure 4-2)	a. Cabinet	Perform OPENING procedure.

CAUTION

If restrictor tubes are removed for extended lengths of time, (i.e. longer than necessary to perform service), seal open legs of tees connected to balance pilot valve to prevent contamination of sieve material.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
	b.	Oxygen tube **a**	Remove from center leg of brass tee **21**.
	c.	Plastic compression nuts **14**	Loosen and remove two plastic compression nuts which are attached to bottom of restrictor tubes, from balance pilot valve's two plastic tees **16**.
	d.	Clamp **22**	Loosen and remove each restrictor tube from brass tee **21**.
	e.	Tubing inserts **15** plastic compression nuts **14**	Remove two inserts and nuts from restrictor tubes.
INSTALLATION	f.	Tubing inserts, plastic compression nuts, and brass tee	Connect to replacement restrictor tube assemblies.
	g.	Replacement restrictor tube assemblies	Reinstall into cabinet. Reconnect and hand tighten plastic compression nuts. Reconnect oxygen tubing to center leg of brass tee.
	h.	Concentrator	Perform pneumatic test procedures listed in subsection 3.1.2 B steps 4 through 7. Refer to subsection 3.4 if necessary.
	i.	Cabinet	Perform CLOSING procedure.
20. Outlet Gas Filter **13** (Figure 4-3)			
REMOVAL	a.	Cabinet	Perform OPENING procedures.
	b.	Oxygen tubing **12, 14**	Cut flush with inlet and outlet of outlet gas filter. Discard filter.
INSTALLATION	c.	Replacement outlet gas filter	Install between oxygen tubes **12** and **14.** If flow arrows are present on replacement filter, point arrow toward oxygen tube which is connected to the flowmeter inlet. Filters without arrows may be installed in either direction.
	d.	Cabinet	Perform CLOSING procedures.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
21. Shock Mounts **8** (Figure 4-4)			
REMOVAL	a.	Compressor platform assembly	Perform REMOVAL and DISASSEMBLY procedures steps 9a through 9i.
DISASSEMBLY	b.	Sixteen 1/8" rivets **7**	Use a 1/8" drill bit to drill out the center of the rivets. Remove and discard.
	c.	Four shock mounts **8**	Remove shock mounts from compressor platform and discard.
REASSEBMLY	d.	Four replacement shock mounts	Place shock mounts on compressor platform with rivet holes of shock mounts aligned with rivet holes in compressor platform.
	e.	Rivets	Secure each shock mount to compressor platform with four 1/8" rivets.
REASSEMBLY	f.	Compressor platform assembly	Perform REASSEMBLY and INSTALLATION procedures steps 9m and 9n.
22. Compressor Cup Seal **8** (Figure 4-6)			
REMOVAL	a.	Compressor platform assembly	Perform REMOVAL and DISASSEMBLY procedures setup 9a through 9d.
			NOTE Some compressors may require a #25 torx head screw driver to remove the eight cylinder head screws.
	b.	Eight cylinder head screws **31**	Remove from cylinder heads **30** and **10.**
	c.	Cylinder heads and valve plates **3**	Remove both along with connector tubes **1.**
	d.	Piston sleeves **5**	Remove and discard.
	e.	Cup seal **8**	Remove four retaining plate screws **6** on each piston to separate retainer plate **7,** cup seal, and connecting rod **9.** Discard cup seals.
REASSEMBLY			**NOTE** An extra connecting rod is required to fit cup seal and retainer plate into piston sleeve.

TABLE 4-1. SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
COMPONENT	f.	Piston sleeve	Place over top of extra connecting rod and let drop to the bottom of the rod.
	g.	Cup seal	Place new cup seal on extra connecting rod top. Make sure that the inside diameter of the cup seal fits over the outside diameter of the ridge on the top of the connecting rod.
	h.	Retainer plate	Place over the cup seal and connecting rod. Line up screw holes.
	i.	Retaining plate screw	Install two screws hand tight to secure retainer plate and cup seal to the extra connecting rod.
	j.	Piston sleeve	Pull up around the cup seal and the retainer plate to form the cup seal.
	k.	Cup seal assembly	With piston sleeve in place over the cup seal remove the two screws 6 and remove the complete assembly from the extra connecting rod.
	l.	Cup seal assembly	Place the piston sleeve, cup seal and retainer plate assembly on the connecting rod 9 in the compressor.
	m.	Retaining plate screws	Place loctite 242 in the four screw holes of the connecting rod and tighten four screws to twenty inch pounds.
			NOTE Repeat steps f through m for other piston.
	n.	Valve plates, cylinder heads, connector tubes	Reverse REMOVAL procedures.
	o.	Cylinder head screws	Install eight screws and tighten to thirty inch pounds in a criss cross pattern.
INSTALLATION	p.	Compressor platform assembly	Reverse DISASSEMBLY and REMOVAL procedures 9a through 9d.

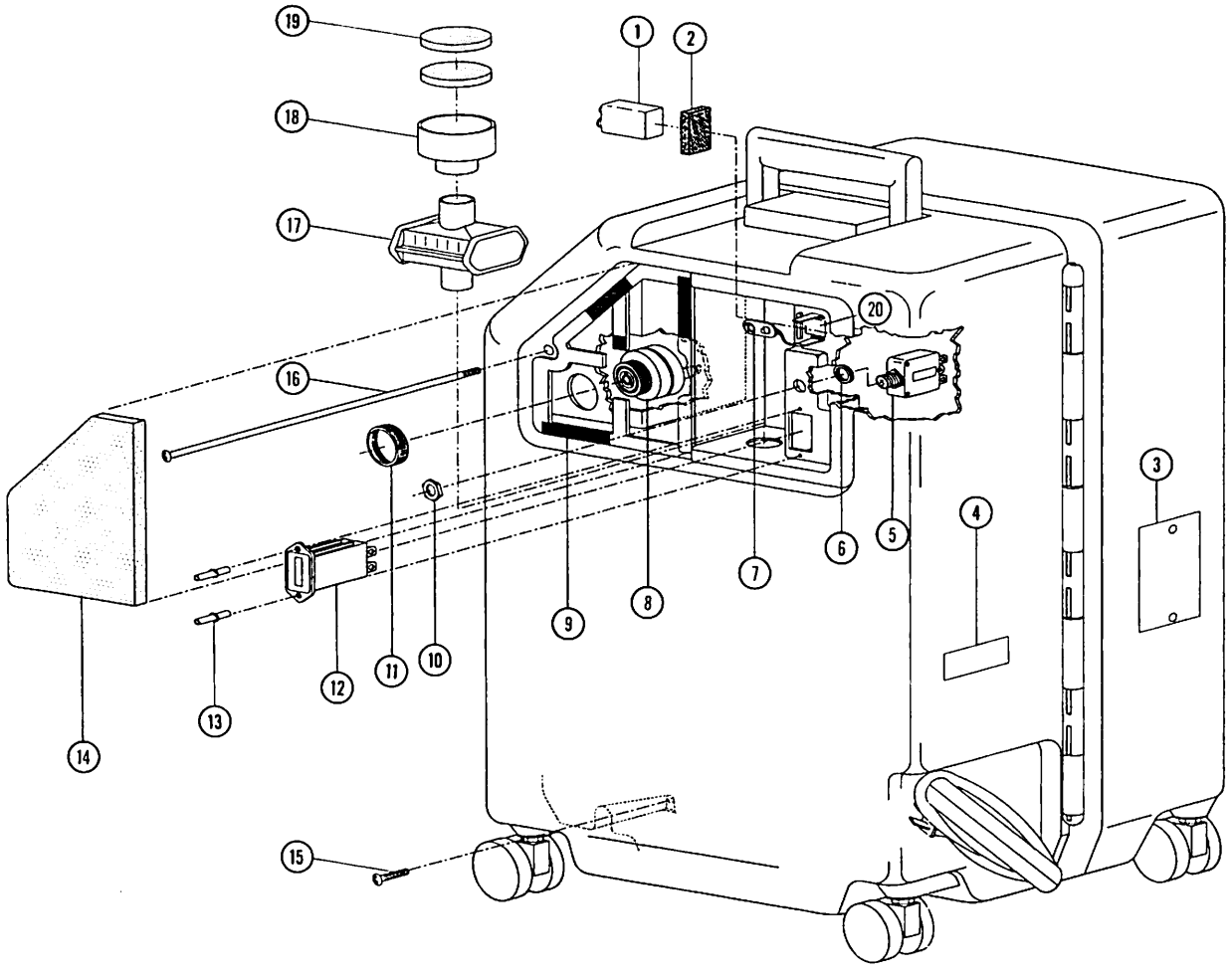


Figure 4-1: Companion 492a/590 Exterior

COMPANION 492a/590 EXTERIOR PARTS LIST (Figure 4-1)

ITEM	PART NUMBER	DESCRIPTION
1	492297	Battery, 9V
2	492884	Battery Cushion
3	Reference*	Serial Plate
4	492288	Warning Label
5	492196	Circuit Breaker, **492a,** 5 AMP
	492437	Circuit Breaker, **590,** 6 AMP
6	Included in item 5	Knurled Nut
7	492832	Battery Connector Assembly
8	492782	Audio Alarm
9	492687	Velcro Strip (5 Required)
10	Included in item 5	Hex Nut
11	Included in item 8	Locking Ring
12	492187	Hour Meter (120V)
13	492111	1/8" Rivet (2 Required)
14	492672	Air Inlet Filter
15	492661	Short Cabinet Screw
16	492662	Long Cabinet Screw
17	492190	Inlet Bacteria Filter
18	492192	Prefilter Housing
19	492193	Inlet Prefilter (2 Required)
20	492350	Battery Label

*Item shown for descriptive purposes only and is not available for sale as an individual repair part.

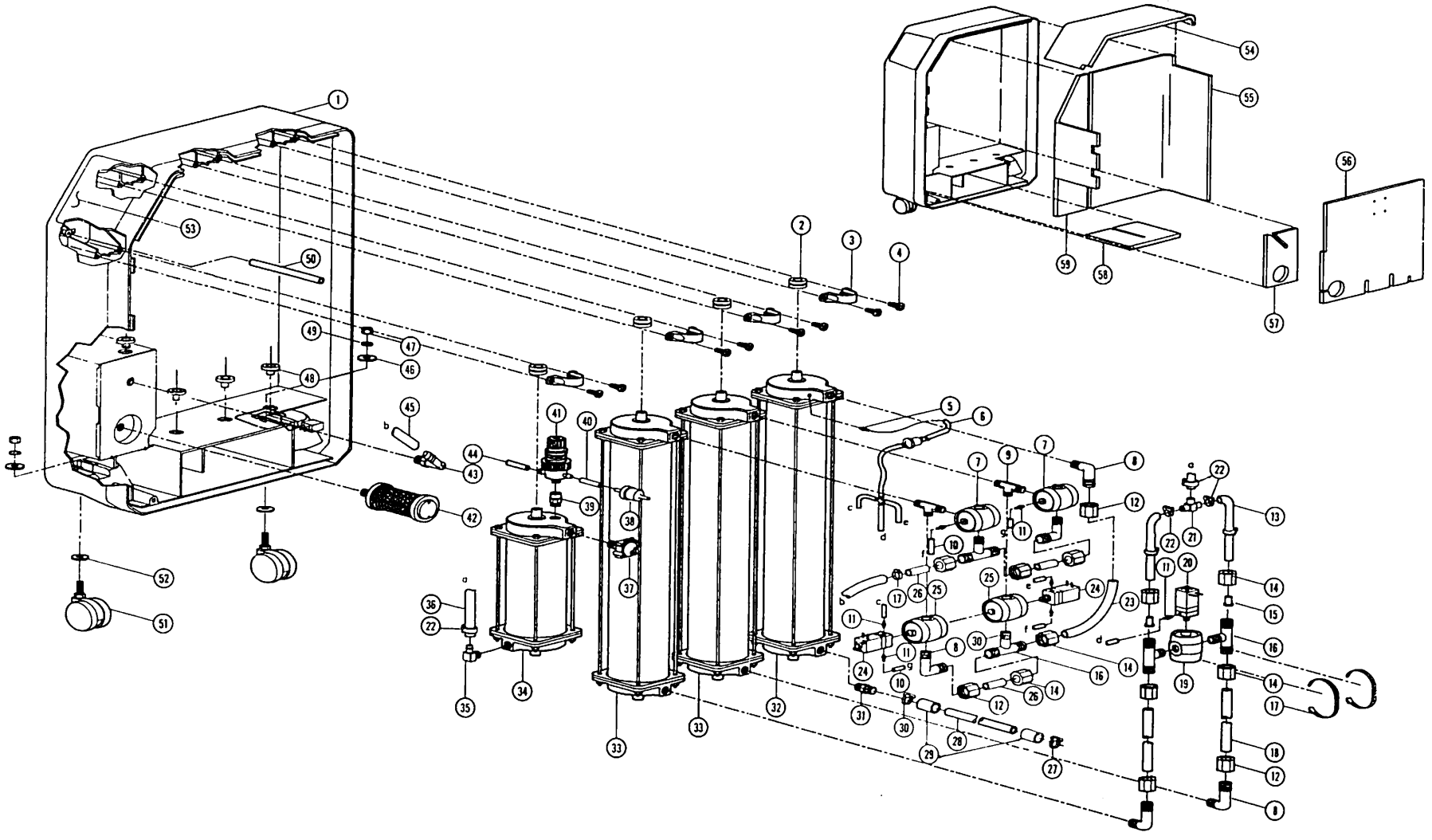


Figure 4-2: Left Cabinet Interior

LEFT CABINET INTERIOR PARTS LIST (Figure 4-2)

ITEM	PART NUMBER	DESCRIPTION
1	492967	Cabinet Assembly, Left (Does not include item 53 & 60)
2	492665	Grommet
3	492664	Canister Clamp
4	492717	Screw
5	492287***	Brass Fitting
6	492760	Pilot Air Filter Assembly
7	492634	Exhaust Pilot Valve
8	492875	Plastic Elbow w/Insert
9	492666	Brass Tee
10	493176*	1/16" Tubing
11	492284	Brass Fitting
12	Included in item 8	Compression Nut
13	492133	Restrictor Tube Assembly Set (add suffix to part number for correct size)

Suffix	Restrictor Size	Suffix	Restrictor Size
-01	6.5	-19	8.3
-02	6.6	-20	8.4
-03	6.7	-21	8.5
-04	6.8	-22	8.6
-05	6.9	-23	8.7
-06	7.0	-24	8.8
-07	7.1	-25	8.9
-08	7.2	-26	9.0
-09	7.3	-27	9.1
-10	7.4	-28	9.2
-11	7.5	-29	9.3
-12	7.6	-30	9.4
-13	7.7	-31	9.5
-14	7.8	-32	9.6
-15	7.9	-33	9.7
-16	8.0	-34	9.8
-17	8.1	-35	9.9
-18	8.2	-36	10.0

P C-493930-00
C-493931-00

ITEM	PART NUMBER	DESCRIPTION
14	Included in item 16	Compression Nut
15	492132	Tubing Insert
16	492874	Plastic Tee w/Insert
17	492104	Plastic Strap, Large
18	492130	1/4" I.D. Plastic Tubing
19	492100	Balance Pilot Valve
20	492443	Balance Solenoid Valve
21	492135	Brass Tee
22	492134	Clamp
23	492095	1/4" I.D. Plastic Tubing

LEFT CABINET INTERIOR PARTS LIST (Figure 4-2) (continued)

ITEM	PART NUMBER	DESCRIPTION
24	492442	Supply Solenoid Valve
25	492100	Supply Pilot Valve
26	492087	1/4" I.D. Plastic Tubing
27	492890	Clamp
28	492862	Compressor Exhaust Hose
29	492926	Sleeve
30	492890	Clamp
31	492556	Reservoir Intake Fitting
32	493299	Reservoir Canister Assembly
33	492990	Sieve Canister Assembly, **492a** (set of 2)
	492991	Sieve Canister Assembly, **590** (set of 2)
34	493300	Product Canister Assembly
35	492139	Brass Elbow
36	493177*	1/4" I.D. Tubing
37	492633	Pressure Switch
38	492050	Vacuum Check Valve Assembly
39	492953	Fitting Assembly
40	Included in item 38	Tubing
41	492621	Pressure Regulator
42	492114	Exhaust Muffler
43	492182	Plastic Elbow
44	493174**	3/16" I.D. Tubing
45	493178*	3/8" I.D. Tubing
46	492873	Large Caster Washer
47	492171	5/16" Hex Nut
48	492910	Bushing
49	492172	5/16" Lockwasher
50	492663	Left Upper Cabinet Tube
51	492174	Caster
52	492309	Small Caster Washer
53	Refer to Figure 4-3 item 7	Control Panel Label (set of two for left and right cabinets)
54	Included in item 60	Cabinet Insulation
55	Included in item 60	Cabinet Insulation
56	492801	Canister Insulation
57	Included in item 60	Cabinet Insulation
58	Included in item 60	Cabinet Insulation
59	Included in item 60	Cabinet Insulation
60	492929	Left Cabinet Insulation Kit

* Tubing Sold in 3 foot lengths.
** Tubing Sold in 4 foot lengths.
***For units manufactured August, 1991 and later order P/N 492284.

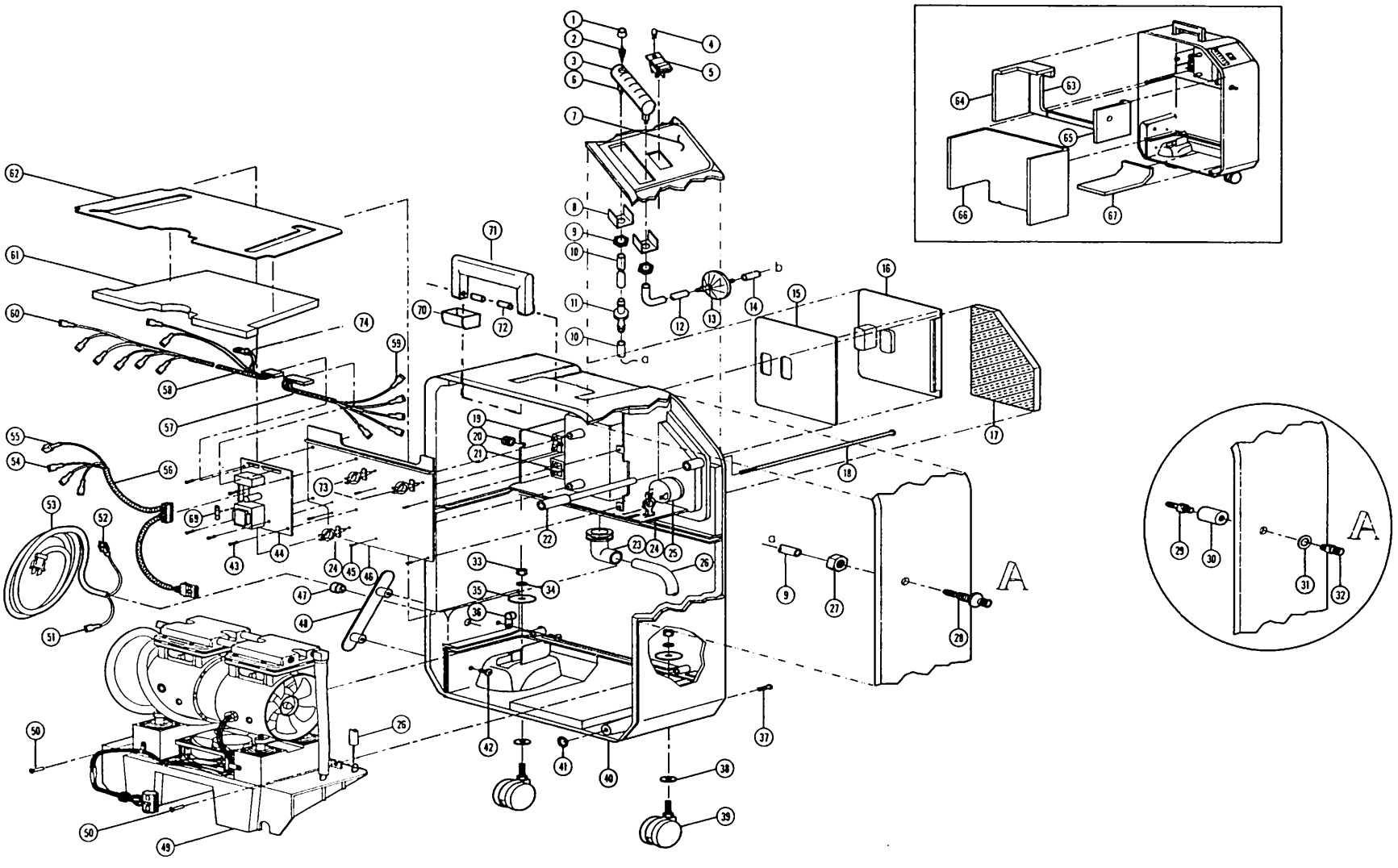


Figure 4-3: Right Cabinet Interior

RIGHT CABINET INTERIOR PARTS LIST (Figure 4-3)

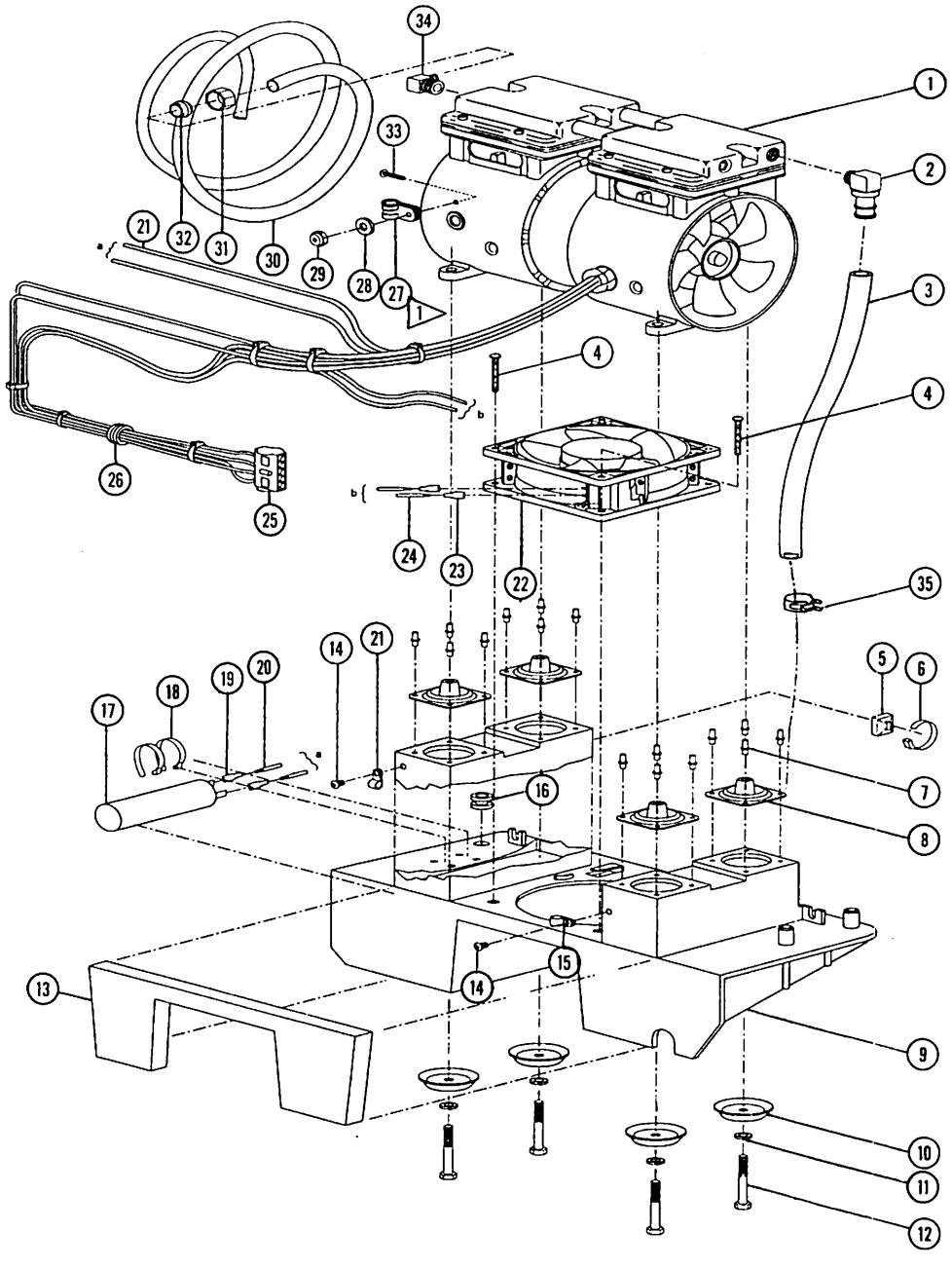
ITEM	PART NUMBER	DESCRIPTION
1	492596	Flowmeter Knob
2	492595	Flowmeter Valve Assembly
3	492072	Flowmeter, **492a,** 4 lpm
	492558	Flowmeter, **590,** 5 lpm
4	492828	Green L.E.D.
5	492823	Power Switch (includes item 4)
6	492807	Flowmeter Fitting
7	492623	Label, Control Panel, **492a** w/o OCI*
	~~492810~~	Label, Control Panel, **590** w/o OCI* w/OCI 493366
8	492597	Flowmeter Bracket
9	492210	Flowmeter Nut
10	493174**	Tubing, 3/16" I.D.
11	492071	In-line Check Valve
12	493174**	Tubing, 3/16" I.D.
13	492141	Outlet Gas Filter
14	493174**	Tubing, 3/16" I.D.
15	492802	Filter Door Insulation (Also included in item 68)
16	492647	Filter Compartment Door
17	492672	Air Inlet Filter
18	492662	Long Cabinet Screw
19	492196	Circuit Breaker, **492a,** 5 amp
	492437	Circuit Breaker, **590,** 6 amp
20	492671	Wire Grommet
21	492187	Hour Meter, 120VAC
22	492656	Right Upper Cabinet Tube
23	492682	Intake Filter Adapter
24	492987	Small Tube Clamp
25	492782	Audio Alarm
26	493175**	Tubing, 3/8" I.D.
27	492885	Spout Nut
28	492627	Oxygen Outlet Spout, Plastic
29	492278	1/4" x 3/16" Spout Fitting
30	492168	Spout Coupling
31	492167	Spout Washer
32	492166	Oxygen Outlet Spout, Chrome
33	492171	5/16" Hex Nut
34	492172	5/16" Lock Washer
35	492873	Large Caster Washer
36	492107	Cord Clamp
37	492661	Short Cabinet Screw

RIGHT CABINET INTERIOR PARTS LIST (Figure 4-3) (Continued)

ITEM	PART NUMBER	DESCRIPTION
38	492309	Small Caster Washer
39	492174	Caster
40	492964	Cabinet Assembly, Right (Does not include item 7 & 68).
41	492290	O-Ring
42	492673	Cord Wrap Screws
43	492789	Control PCB Screws
44	492746	Control PCB, 120VAC w/oCI 492971
45	492660	Screw
46	492650	Inlet Air Duct Cover
47	492771	Cord Retainer
48	492653	Cord Wrap
49	Refer to Figure 4-4	Compressor Module Assembly
50	492661	Screw
51	Included in item 53	Connector
52	Included in item 53	Connector
53	492870	Power Cord Assembly
54	Included in item 56	Connector
55	Included in item 56	Connector
56	492840	High Voltage Wire Harness
57	492839*	Power Switch Wire Harness
58	492868	Low Voltage Wire Harness
59	Included in item 57	Connector
60	Included in item 58	Connector
61	492800	Air Dam Insulation
62	492774	Air Dam
63	Included in item 68	Insulation, Top Middle
64	Included in item 68	Insulation, Top Back
65	Included in item 68	Insulation, Top Front
66	Included in item 68	Insulation, Middle
67	Included in item 68	Insulation, Exhaust Tunnel
68	492928	Right Cabinet Insulation Kit
69	492560	Control PCB Fuse (63 MA)
70	492651	Handle Cap
71	492652	Handle
72	492654	Dowel Pins
73	492713	Large Tube Clamp
74	492832	Battery Connector Assembly

* If unit is equipped with OCI Refer to Section 6 for appropriate part number.

** Tubing sold in 4 foot lengths.



COMPRESSOR PLATFORM PARTS LIST

ITEM	PART NUMBER	DESCRIPTION
	492961	
1	Refer to Figure 4-5 or 4-6	Compressor Assembly
2	492043	Intake Fitting
3	493175*	Tube, 3/8" I.D.
4	492108	Fan Screw
5	492770	Tyrap Mount
6	492044	Plastic Strap, Small
7	492111	1/8" Rivet
8	~~492110~~ 494700	Shock Mount
9	492965	Platform Assembly (includes items 7 & 8)
10	492078	Cup Washer
11	492079	Lock Washer
12	493289	Compressor Mounting Bolt
13	492799	Insulation
14	492789	Screw
15	492107	Clamp
16	492671	Wire Grommet
17	492989	Capacitor, 120 VAC
18	492104	Plastic Strap, large
19	Included in item 1	Connector
20	Included in item 1	Wire Harness
21	492773	Clamp
22	492109	Cooling Fan, 120 VAC
23	Included in item 1	Connector
24	Included in item 1	Wire Harness
25	Included in item 1	Connector & Wire Harness
26	Included in item 1	Grommet
27	492942	Clamp
28	492946	Flat Washer
29	492944	Locknut
30	492966	Heat Exchanger Assembly (includes items 31 & 32)
31	Included in item 31	Brass Nut
32	Included in item 31	Ferrule
33	492943	Allenhead Screw
34	492042	Exhaust Fitting Assembly (includes items 31 & 32)
35	492822	Clamp

* Tubing sold in four foot lengths.

1 An additional set of items 27, 28, 29 and 33 are installed on the rear of the compressor but are not s in this figure.

Sq Felt UPPER 493931

Sq Felt 493930 LOWER

Figure 4-4: Compressor Platform Assembly

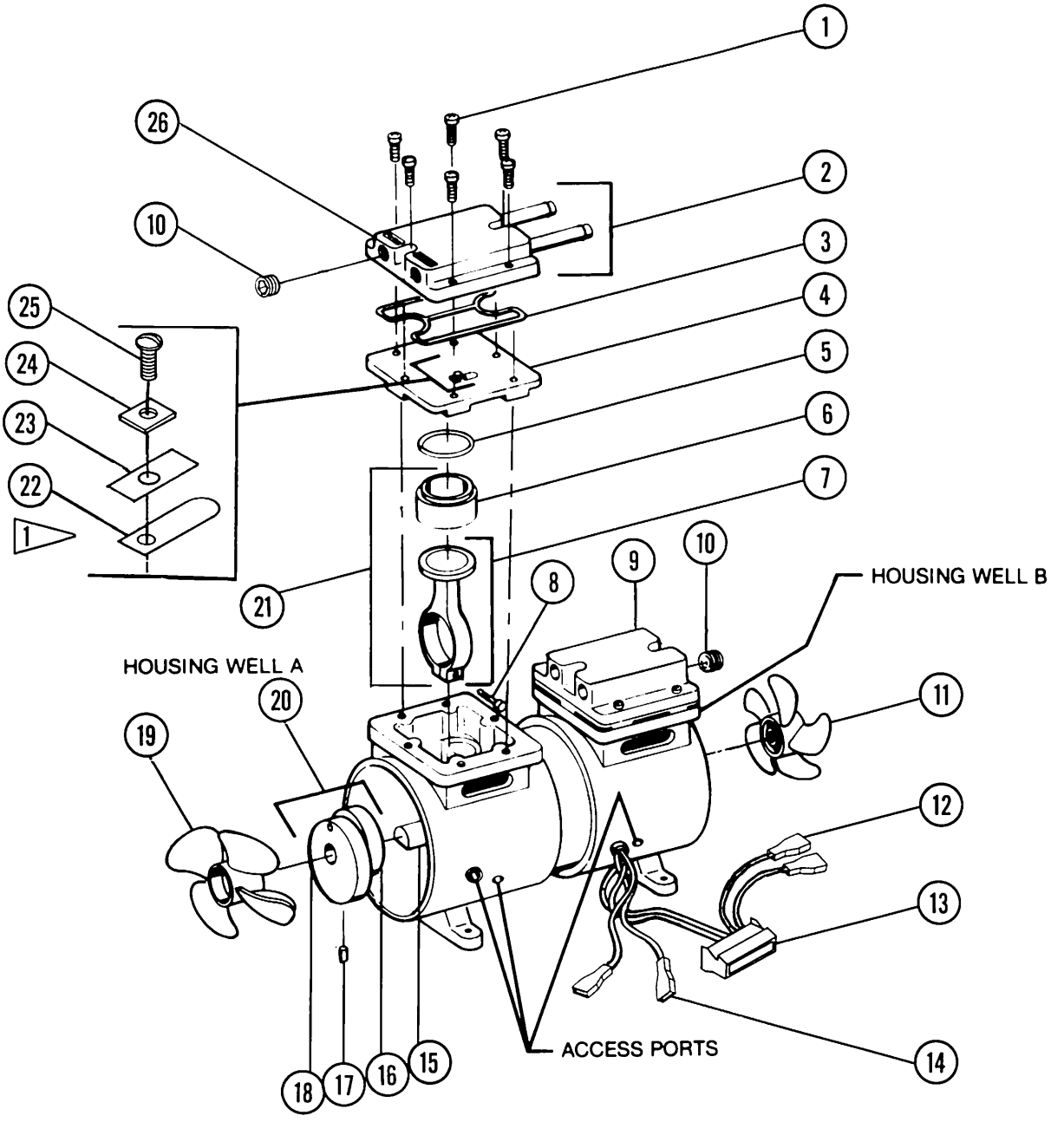


Figure 4-5: Companion 492a Compressor

492a COMPRESSOR PARTS LIST (Figure 4-5)

ITEM	PART NUMBER	DESCRIPTION
—	492956	492a Compressor Assembly, 120VAC, **NEW** (includes items 1 through 26)
—	492957	492a Compressor Assembly, 120VAC, **REMANUFACTURED** (includes items 1 thorugh 26)
1	492027	Cylinder Head Screw
2	492028	Connector Tubes (2) with O-Rings (4)
3	492031	Head Gasket
4	492032	Valve Plate
5	492033	Valve Plate O-Ring
6	Included in item 21	Sleeve
7	Included in item 21	Piston/Rod Assembly
8	492036	Connecting Rod Screw
9	492030	Cylinder Head B
10	492592	Cylinder Head Plug
11	492038	Five-Blade Fan
12	Reference*	Cooling Fan Wires/Connector
13	Reference*	Compressor Wires/Connectors
14	Reference*	Capacitor Wires/Connectors
15	Reference*	Motor Shaft
16	Included in item 21	Bearing
17	492039	Set Screw
18	Included in item 21	Eccentric
19	492040	Four-Blade Fan
20	492041	Eccentric Bearing Assembly (includes items 16, 17 & 18)
21	492954	Piston & Sleeve Assembly (includes items 6 & 7)
22	492465	Reed Valve
23	492963	Reed Valve Restraint
24	492563	Reed Valve Keeper Strip
25	492962	Reed Valve Plate Screw
26	492029	Cylinder Head A

* Item shown for descriptive purposes only and is not available for sale as an individual repair part.

1 Items 22, 24 and 25 are also used on the underside of each valve plate, item 4. The reed valve restraint, item 23 is not used in this location.

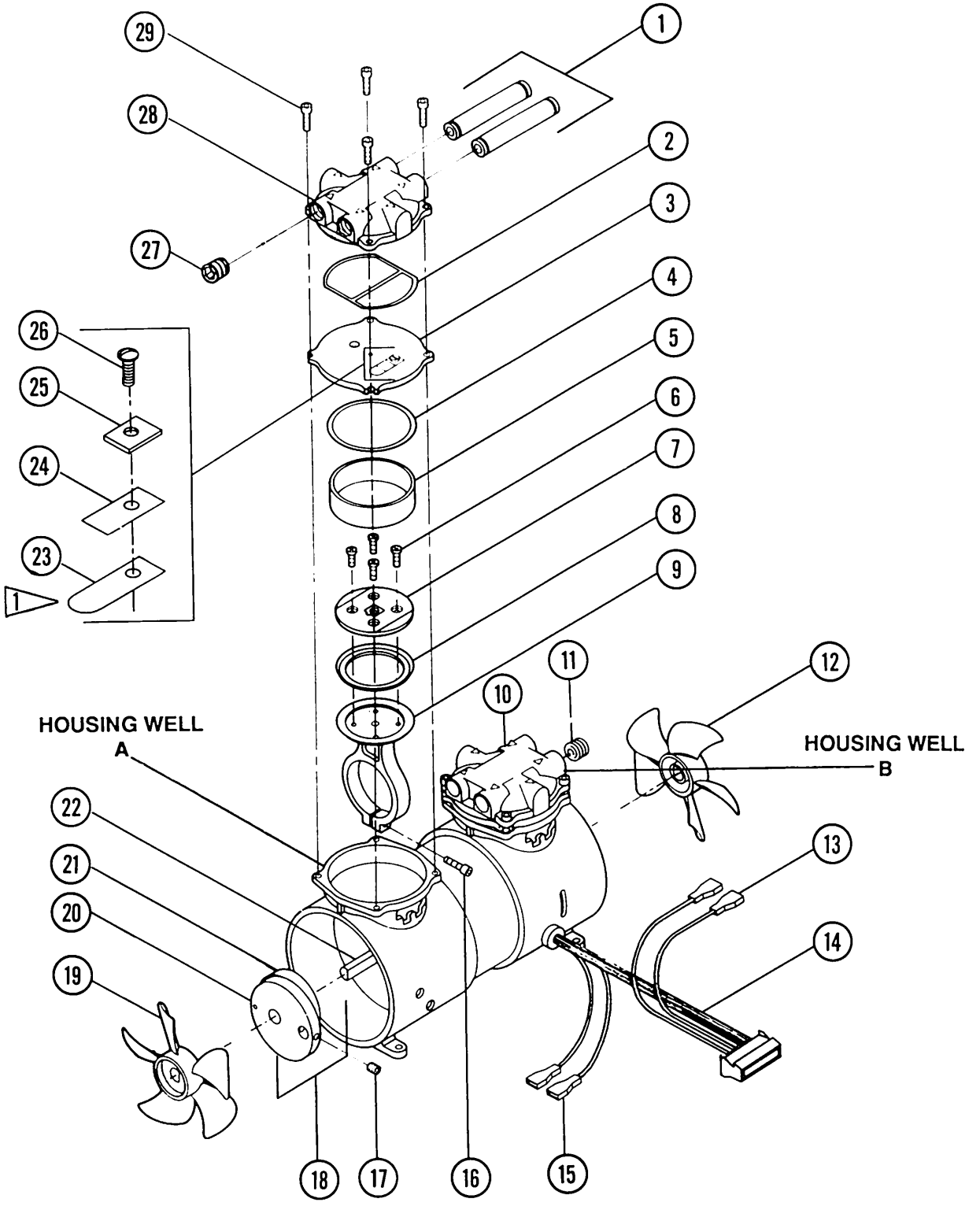


Figure 4-6: Companion 590 Compressor

590 COMPRESSOR PARTS LIST (Figure 4-6)

ITEM	PART NUMBER	DESCRIPTION
—	492959	590 Compressor Assembly, 120 VAC, **NEW** (includes items 1 through 29)
—	492961	590 Compressor Assembly, 120 VAC, **REMANUFACTURED** (includes items 1 through 29)
1	492482	Connector Tubes (2) and O-Rings (4)
2	492481	Head Gasket
3	492480	Valve Plate
4	492479	Valve Plate O-Ring
5	492478	Sleeve
6	492477	Retaining Plate Screw
7	492476	Retaining Plate
8	492475	Cup Seal → GAST C-494270-00 $33.00
9	493125**	Connecting Rod
10	492471	Cylinder Head **B**
11	492592	Cylinder Head Plug
12	492038	Fan **B**
13	Reference*	Cooling Fan Wires/Connectors
14	Reference*	Compressor Wire Harness
15	Reference*	Capacitor Wires/Connectors
16	492036	Connecting Rod Screw
17	492039	Set Screw
18	493340**	Eccentric Bearing Assembly (includes items 17, 20 & 21)
19	492470	Fan **A**
20	Included in item 18	Eccentric
21	Included in item 18	Bearing
22	Reference*	Motor Shaft
23	492465	Reed Valve
24	492963	Reed Valve Restraint
25	492563	Reed Valve Keeper Strip
26	492962	Reed Valve Screw
27	492592	Cylinder Head Plug
28	492472	Cylinder Head **A**
29	492027	Cylinder Head Screw

* Item shown for descriptive purposes only and is not available for sale as an individual repair part.

** For concentrators whose last 6 digits are 009055 or lower order part number 492474 for item 9 and item 18 should be part number 492473.

1 Items 23, 25 and 26 are also used on the underside of each valve plate item 3. The reed valve restraint, item 24 is not used in this location.

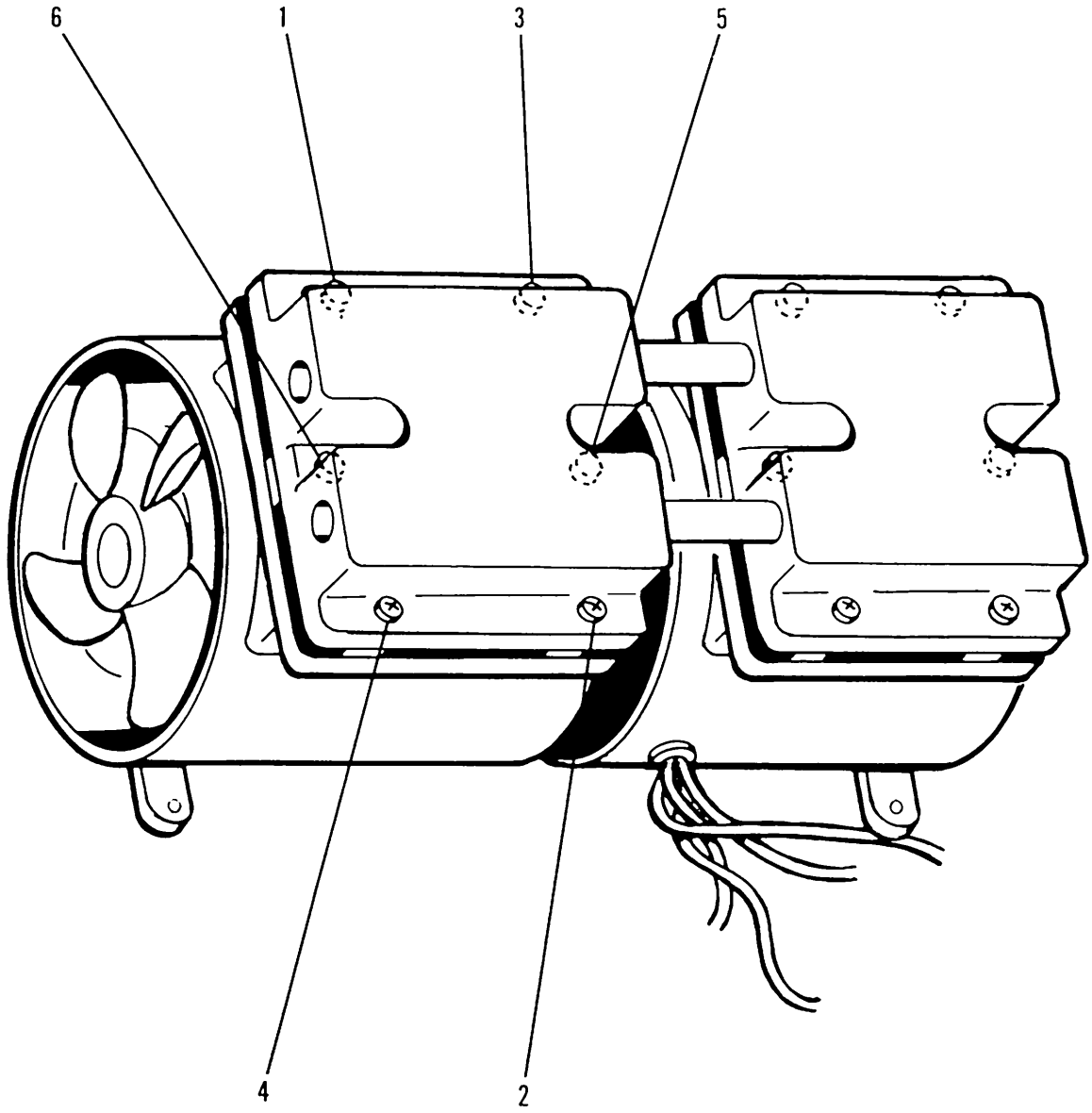


Figure 4-7: Compressor Cylinder-Head Screw Torque Sequence

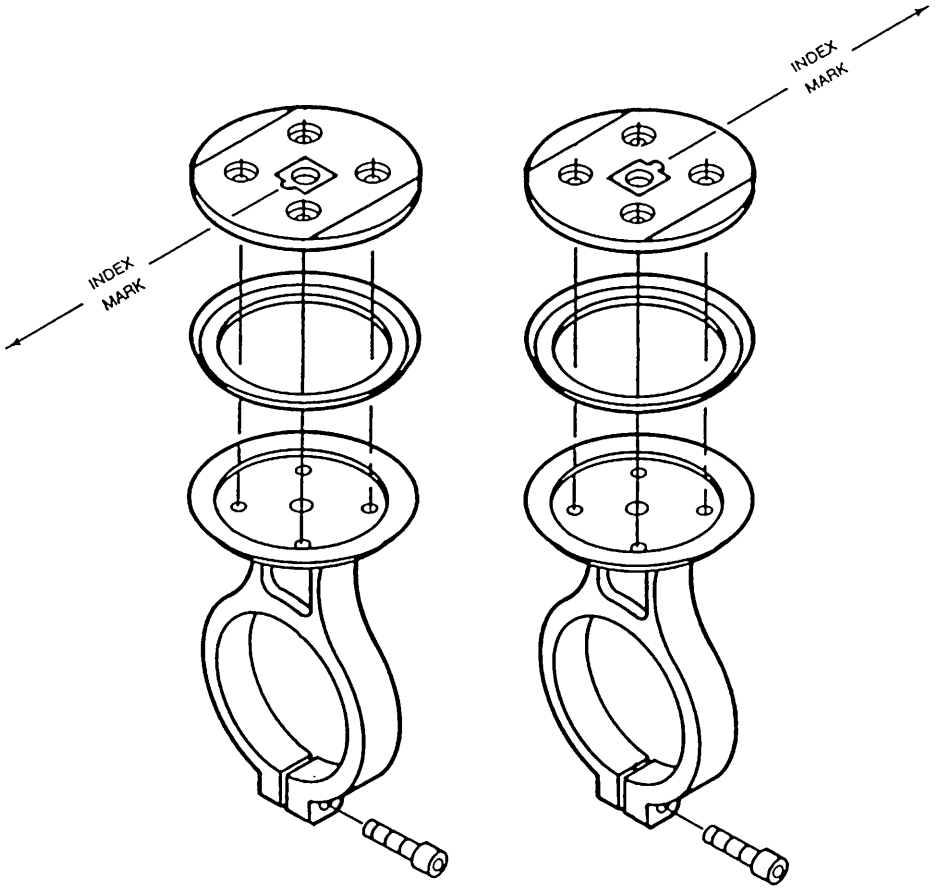
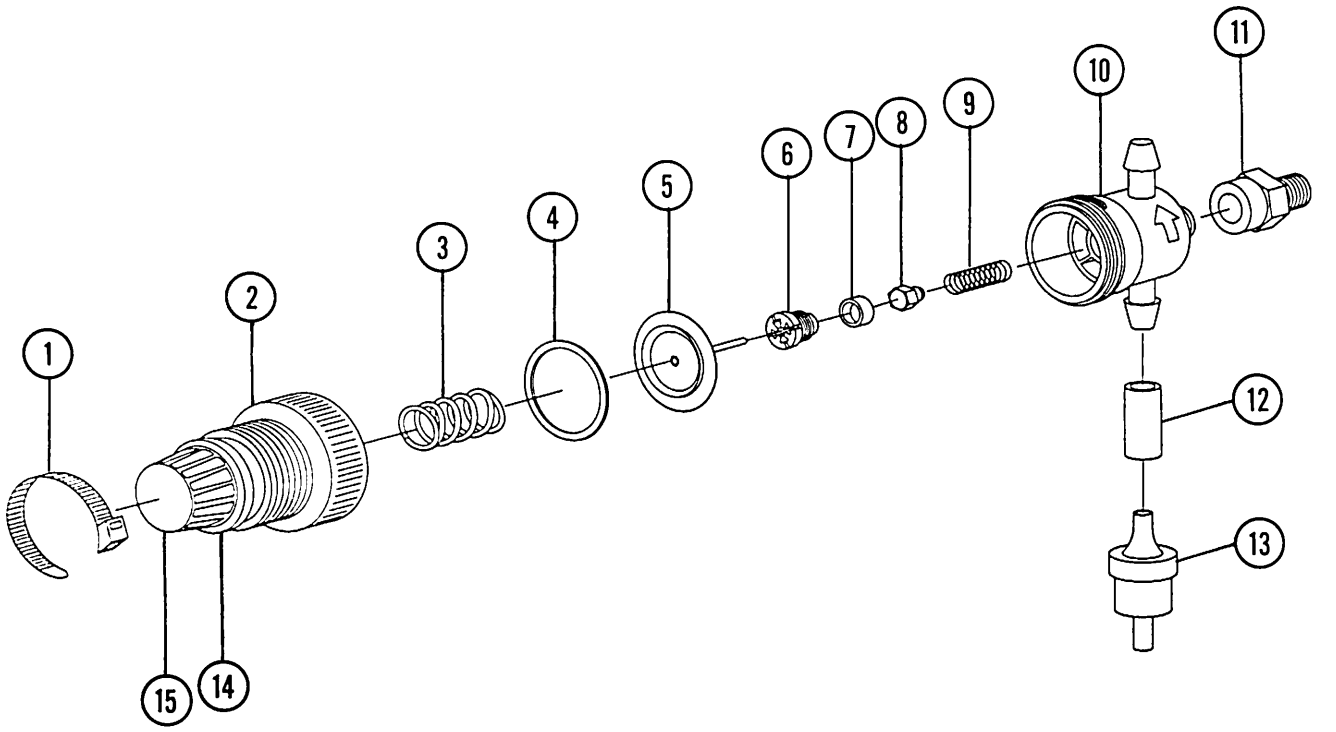


Figure 4-8: Companion 590 Compressor Retaining Plate Indexing

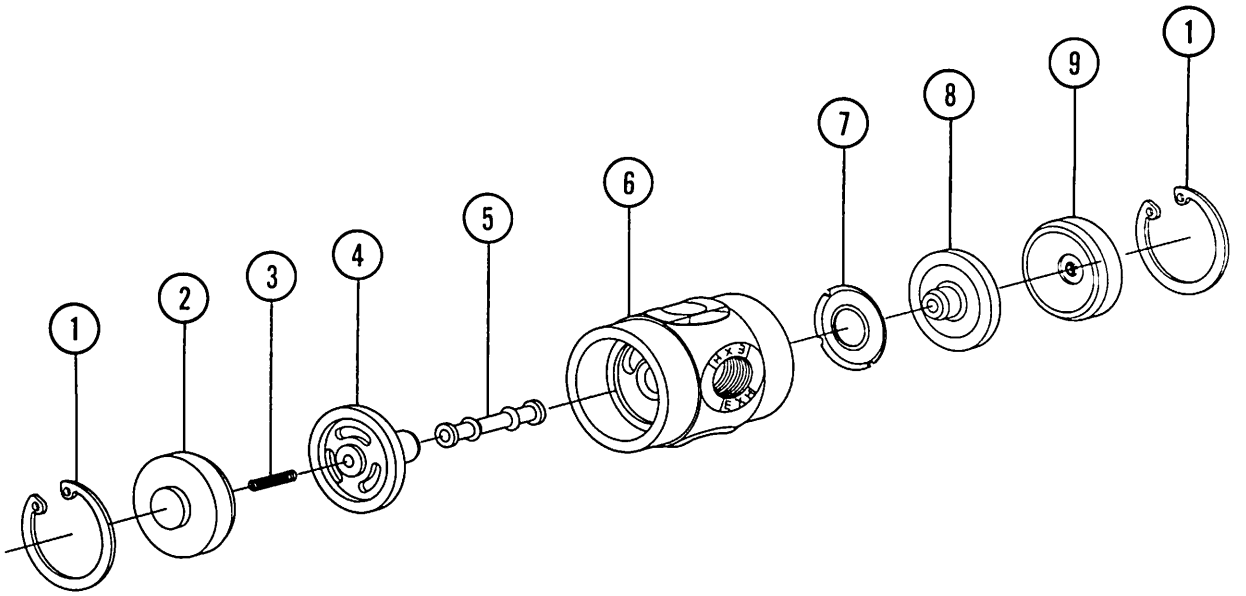


PRESSURE REGULATOR PARTS LIST

ITEM	PART NUMBER	DESCRIPTION
—	492621	Pressure Regulator, Complete (items 2 through 10)
1	492044	Plastic Strap
2	Reference*	Bonnet Assembly
3	Reference*	Spring
4	Reference*	Plastic Washer
5	Reference*	Diaphragm
6	Reference*	Plastic Seat
7	Reference*	Black Seal
8	Reference*	Poppet
9	Reference*	Spring
10	Reference*	Regulator Body
11	492953	Fitting Assembly
12	Included in item 13	Tube
13	492050	Vacuum Check Valve Assembly
14	Reference*	Lock Ring
15	Reference*	Adjustment Knob

* Item shown for descriptive purposes only and is not availalbe for sale as an individual repair part.

Figure 4-9: Pressure Regulator



493799

PILOT VALVE PARTS LIST

ITEM	PART NUMBER	DESCRIPTION
—	492634	Exhaust Pilot Valve
—	492100	Supply or Balance Pilot Valve
1	492052	Snap Ring
2	Reference*	End Cap
3	492935	Spring (used only in exhaust pilot valve)
4	Included in item 10	Diaphragm (slotted)
5	492936	Poppet
6	Reference*	Valve Body
7	492055	Support Washer
8	Included in item 10	Diaphragm (solid)
9	Reference*	Port Cap
10	492952	Pilot Valve Diaphragm Kit (items 4 & 8)

* Item shown for descriptive purposes only and is not available for sale as an individual repair part.

Figure 4-10: Pilot Valve

SECTION 6. OXYGEN CONCENTRATION INDICATOR (OCI™)

This section provides information required to test, troubleshoot, and repair the optional Oxygen Concentration Indicator, including additional information in the form of a general product description and theory of operation.

6.1 General Product Description

The Companion 492a and 590 oxygen concentrators may be equipped with an OCI which may be either factory or field installed. For field installation, a conversion kit including step by step instructions is available (492888). Changes to the concentrator with OCI installed consists of a different front control panel and addition of an internal circuit board (Figures 6-1 and 6-2).

The Oxygen Concentration Indicator (OCI) is a real-time oxygen sampling device utilizing ultrasonic sound wave technology. An internal sensor is located in-line between the concentrator's product canister and flowmeter to analyze the product gas being delivered to the patient. The OCI system will automatically activate after five minutes of concentrator operation. Upon activation, one of three front panel L.E.D.s will illuminate indicating that the percentage of oxygen in the concentrator's output gas is within the ranges shown below.

INDICATORS	RANGE (± 3%)
Green	Above 85%
Yellow	Between 70 and 85%
Red	Below 70%

If the oxygen concentration drops to below 70%, and the red indicator activates, the OCI circuitry will interrupt power to the concentrator's compressor. A low pressure alarm will activate after the gas in the product canister is depleted.

NOTE

Concentrators with OCI installed require a minimum of 1/4 lpm flow for the system to function properly.

Figure 6-1: 492a Front Panel with OCI

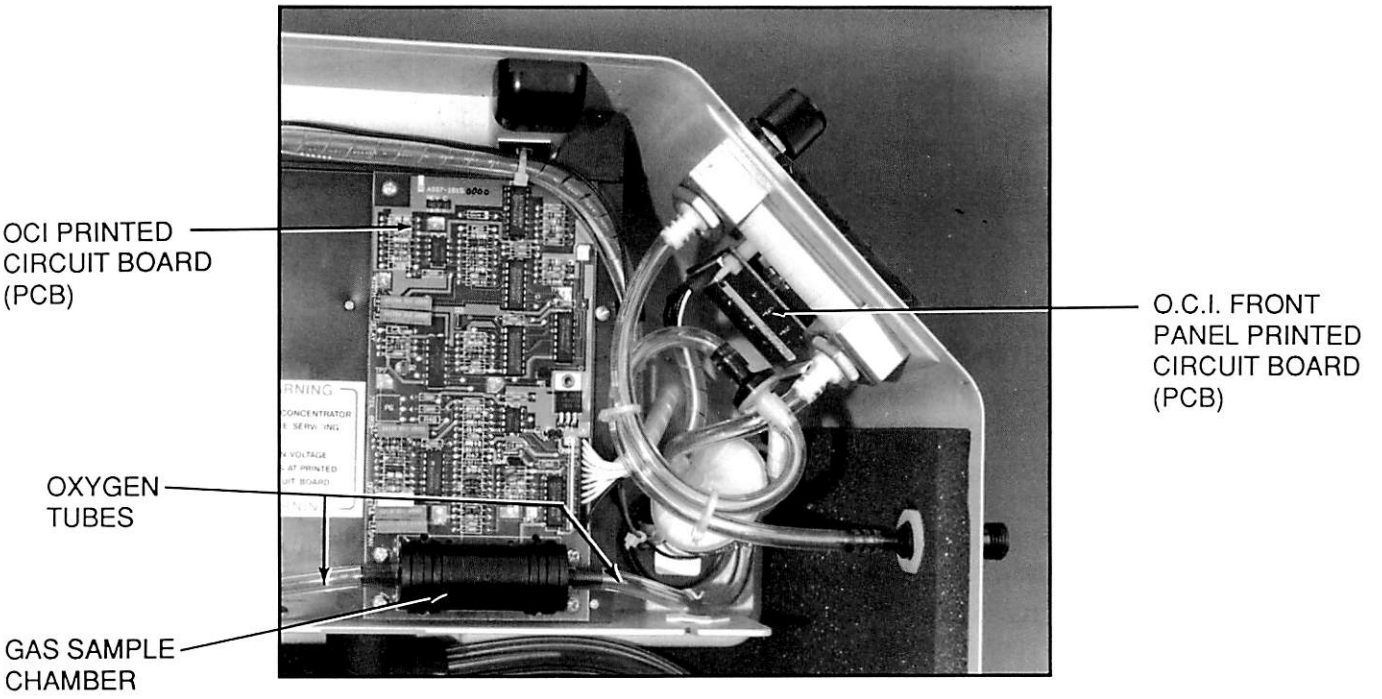


Figure 6-2: OCI Circuit Board Installed

6.2 Theory Of Operation

The OCI makes use of the well known principle that different gases have different characteristics in their abilities to propagate, or transmit, ultrasonic sound waves. One of the systems components is a gas sample chamber that samples the concentrator gas in a continuous flow. A sound wave is transmitted over a fixed distance from one end of the gas sample chamber to the other end of the chamber. This "time-to-fly" is electronically measured and converted to an electronic signal. The "time-to-fly" is dependent upon the concentrator gas purity, the gas temperature, and the pressure of the concentrator gas. A temperature sensor is located within the concentrator gas stream in order to electronically compensate for temperature effects. The concentrator gas in the sample chamber is maintained at a constant pressure level.

The "time-to-fly" is measured and converted to an electronic signal, external factors are compensated for, and the resultant output is processed into useful analytical information (the LEDs and shutdown system) through standard electronic circuitry.

6.3 Performance Verification

Before attempting to verify the performance of the OCI, it is essential that the Companion Concentrator meets all performance specifications found in Section 1: Introduction and Section 3: Performance Verification and Troubleshooting. If during this process, the OCI is suspect or prevents further concentrator verification (i.e. unit shuts off) open the cabinet, and with the concentrator unplugged, disconnect the OCI by disconnecting the wire harness header, item 12 from the OCI board at J5 (Figure 6-3). This will disarm the OCI and control panel indicators but will not affect the concentrator's operation.

a. Allow the concentrator to stabilize by running a minimum of 20 minutes at the maximum flow rate as indicated on the flowmeter.

b. Attach a properly calibrated oxygen analyzer to the outlet spout (Figure 1-4). Verify the concentrators' performance is within specification (see 1.4.1, step i).

c. Verify the green OCI front panel indicator labeled NORMAL is illuminated five minutes after concentrator start-up.

d. Rotate the flowmeter knob counter-clockwise two turns for 492a or 1 1/4 turns for 590 to increase the flow and decrease oxygen concentration.

e. Observe the oxygen analyzer. Within several minutes the concentration will drop. When the analyzer reads approximately 85%, the yellow OCI front panel indicator should illuminate.

f. Allow the concentration to fall until the unit shuts off and the red OCI front panel indicator is illuminated. The analyzer readout should be approximately 70%.

> **NOTE**
>
> The oxygen analyzer is located several feet downstream from the concentrator. Therefore, the oxygen analyzer is measuring the product gas at a different location and point in time than the OCI. This fact combined with the instantaneous measurement time of the OCI as compared to the relatively long measurement time of common analyzers will cause an apparent disagreement between the OCI and the analyzer indicators.

g. Within a few minutes the audio alarm should sound. Depress the power switch to OFF.

6.4 Troubleshooting and Repair

The OCI installed on a Companion concentrator is a gas monitoring device and does not affect the performance of the concentrator. Should operation of the OCI be suspect, refer to the following sections.

6.4.1 Troubleshooting

This section is designed for easy reference to determine the problem with a concentrator equipped with OCI. Refer to the category that matches the symptom(s) you observe. Then refer to the probable cause column which suggest problems in order of most likely to least likely to occur.

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
1. Concentrator runs 5 minutes then shuts off	a. No flow	Set flow at minimum of 1/4 lpm.
	b. Flowmeter set too high	Set flowmeter ball at or below maximum setting on flowmeter scale.
	c. Oxygen below 70%	Troubleshoot concentrator per Section 3.
	d. High outlet pressure	Check outlet pressure per 3.1.2 steps 12 through 15. Reset if necessary per appropriate service procedure in section 4.
	e. Defective OCI	Disconnect wire harness from OCI PCB connector J5. Run unit for 5 minutes at maximum flow rate. If Oxygen is above 70% replace OCI board per repair Section 6.4.2.
2. Concentrator runs/ concentration above 85% / no green OCI LED.	a. Concentrator has not run for 5 minutes	Run unit for more than 5 minutes.
	b. Loose connection	Verify secure wire harness connections between OCI PCB at **J5** and front panel PCB at **J4.**
	c. High outlet pressure	Check outlet pressure per 3.1.2 steps 12 through 15. Reset if necessary per appropriate service procedure in section 4.
	d. Defective OCI	Follow steps a through g, subsection 6.3. If yellow indicator illuminates at step e and the red indicator illuminates (concentrator shuts down) at step f or if no indicators illuminate but concentrator shuts off below 70%, then the front panel PCB may be defective. Replace the front panel PCB as described in repair subsection 6.4.2. If no OCI lights function, and unit does not shut off below 70%, then the OCI PCB is most likely defective. Replace the OCI PCB as described in repair subsection 6.4.2.
3. Concentrator runs/ concentration range does not agree with OCI indicators (See subsection 6.1)	a. Incorrect outlet pressure	Check outlet pressure per 3.1.2 steps 12 through 15. Reset if necessary per appropriate service procedure in section 4.
	b. Defective OCI PCB board	Replace as described in repair subsection 6.4.2.

6.4.2 Repair

The following section describes how to service the individual components of the Oxygen Concentration Indicator (OCI) system. Included are instructions for removal and installation for each major component of the OCI system.

After removing a component, visually inspect for damage or any other indication that the component is defective. Unless otherwise specified, replace as needed with a new component. Refer to Figure 6-3 for replacement part numbers. Perform subsection 6.3, Performance Verification, after completing service procedures found in Table 6-1.

Service procedures for the OCI system are provided in Table 6-1 as follows.

Step Number	Component
1	OCI Printed Circuit Board
2	OCI Front Panel Printed Circuit Board

TABLE 6-1 SERVICE PROCEDURES

(Numbers in bold print correspond to items shown in Figure 6-3)

COMPONENT	ITEM		ACTION
1. OCI Printed Circuit Board (PCB) **16** (Figure 6-3)			**CAUTION** The OCI printed circuit board contains complementary metal-oxide semiconductor (CMOS) integrated circuits (IC's) which are static-sensitive devices. To prevent IC damage, observe standard safety procedures as follows: • Wear grounding wrist strap. • Work on grounded conductive mat. • Handle PCB by edges only. • Store PCB in conductive plastic bag.
REMOVAL	a.	Cabinet	Perform OPENING procedure located in Section 4.
	b.	Harness connector **12**	Disconnect from OCI PCB at **J5.**
	c.	Oxygen tubes	Cut and carefully remove the two oxygen tubes where they connect to the gas sampling chamber on the OCI PCB (Figure 6-2).
	d.	Screw **15**	Remove six screws which attach OCI PCB to air inlet duct cover **18.**

TABLE 6-1 SERVICE PROCEDURES (continued)

COMPONENT	ITEM		ACTION
INSTALLATION			**NOTE** The wire harness connectors are keyed and may only be installed in one direction. Match connector configuration to OCI PCB pins before attempting to reinstall the connector.
	e.	Replacement OCI PCB	Reverse REMOVAL procedure. Install and tighten six screws in a criss-cross pattern.
	f.	Cabinet	Perform CLOSING procedures located in Section 4.
2. OCI Front Panel Printed Circuit Board (PCB) **8**	a.	Cabinet	Perform OPENING procedure located in Section 4.
REMOVAL	b.	Oxygen tubes (not shown)	Remove from flowmeter **1** inlet and outlet connectors.
	c.	Two flowmeter brackets **5** and nuts **6**	Remove from flowmeter threaded connectors.
	d.	Flowmeter	Remove from concentrator.
	e.	Two connectors **10,11**	Remove from OCI front panel PCB at **J4** and **J3.**
	f.	Four nylon nuts **9**	Remove using a 5/16-inch socket wrench.
	g.	OCI front panel PCB	Remove from concentrator cabinet interior.
INSTALLATION			**NOTE** The wire harness connectors **10** and **11** are keyed and may only be installed in one direction. Verify correct location, and match connector configuration to front panel PCB pins before attempting to reinstall the connector.
	h.	Replacement OCI front panel PCB	Reverse REMOVAL procedure. After hand tightening four nylon nuts, turn each nut no more than 3/4 of a turn. Verify correct connection of oxygen tubing to flowmeter. Refer to Pneumatic Diagram Figure 2-1 if necessary.
	i.	Cabinet	Perform CLOSING procedure located in Section 4.

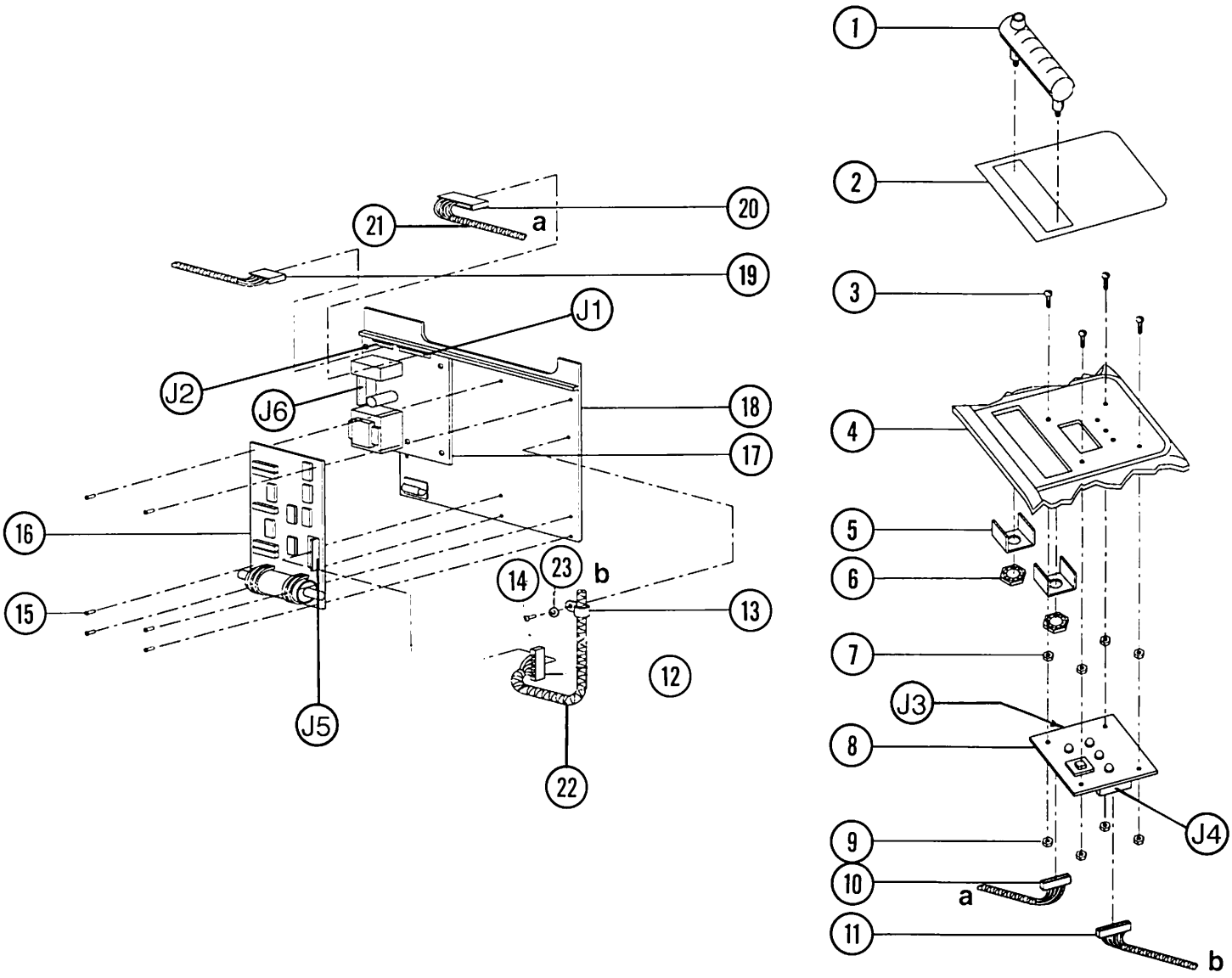


Figure 6-3: O.C.I. System

OXYGEN CONCENTRATION INDICATOR (OCI) SYSTEM PARTS LIST

ITEM	PART NUMBER	DESCRIPTION
1	492072	Flowmeter (492a)
	492558	Flowmeter (590)
2	492624	OCI Control Panel Label (492a)
	492809	OCI Control Panel Label (590)
3	492438	Nylon Screw
4	492964	Right Concentrator Cabinet
5	492597	Flowmeter Bracket
6	492210	Flowmeter Nut
7	492667	Nylon Spacer
8	492745	Front Panel PCB
9	492439	Nylon Nut
10	Reference*	Connector (15 pin)
11	Reference*	Connector (14 pin)
12	Reference*	Connector (14 pin)
13	492939	Clamp
14	492741	Screw
15	492789	Screw
16	492744	OCI PCB
17	492746	Control PCB
18	492650	Air Inlet Duct Cover
19	Reference*	Connector (11 pin)
20	Reference*	Connector (15 pin)
21	492837	Wire Harness (Control PCB to Front Panel PCB)
22	492838	Wire Harness (Front Panel PCB to OCI PCB)
23	492946	Washer
J1	Reference*	Control PCB connector (connects to front panel PCB J3)
J2	Reference*	Control PCB connector
J3	Reference*	Front panel PCB connector (connects to control PCB J1)
J4	Reference*	Front panel PCB connector (connects to OCI PCB J5)
J5	Reference*	OCI PCB connector (connects to front panel PCB J4)
J6	Reference*	Control PCB connector

* Item shown for descriptive purposes only and is not available for sale as an individual repair part.