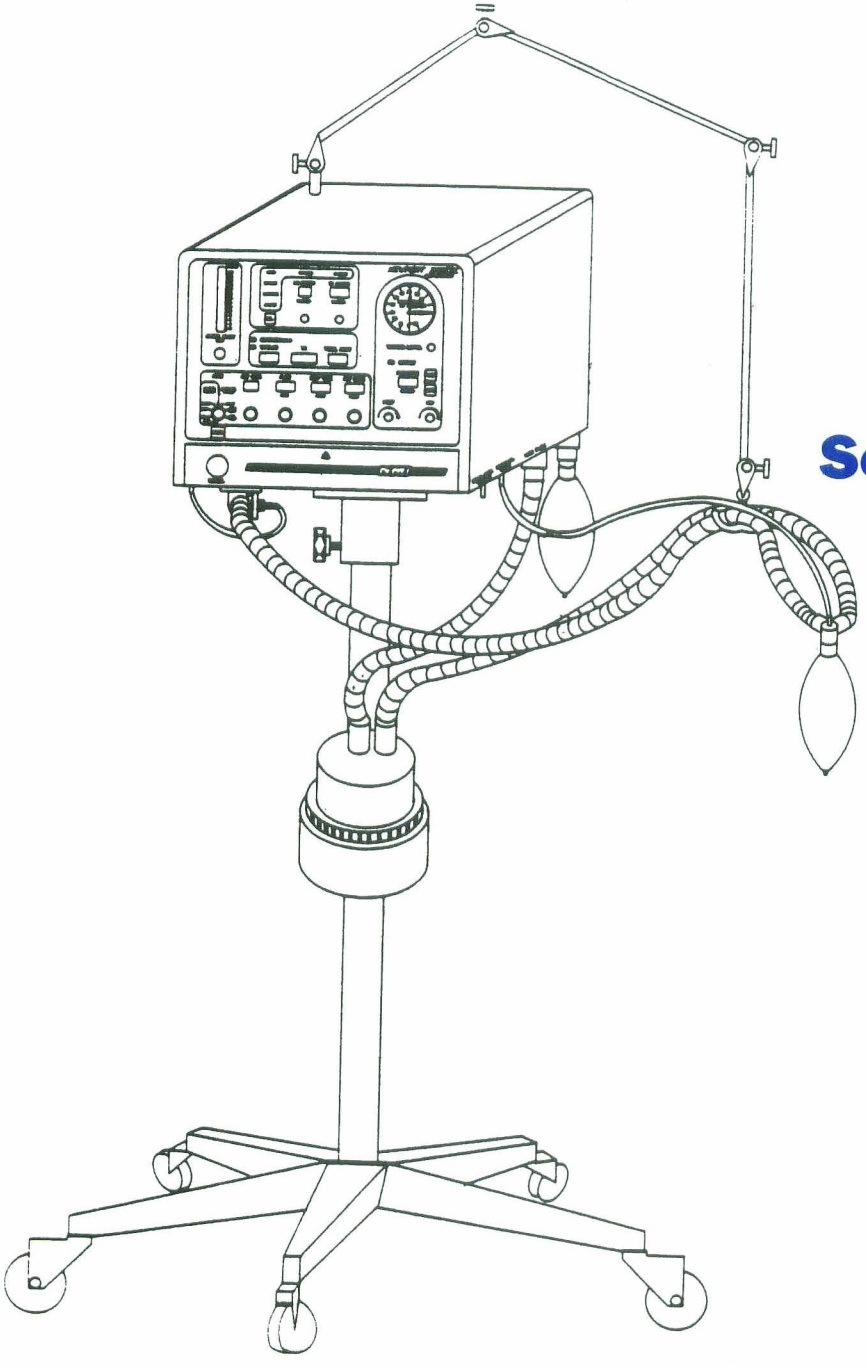
NEWPORT BREEZE VENTILATOR



Service Manual

MODEL E150

NEWPORT NMI

Newport Medical Instruments

Newport Breeze E150 Ventilator

Service Instructions

SER150 Rev. B
(serial #9010DB160 and later)

EU REPRESENTATIVE:
Newport Medical Instruments
Att: Robert Brink
Barton-on-Humber
18 Pasture Rd.
South Humberside
DN18 5HN, England

Tel: 44.4682.31311
Fax: 44.1652.633399

NEWPORT MEDICAL INSTRUMENTS
Post Office Box 2600
Newport Beach, California 92658 USA
800.451.3111
949.642.3910
949.548.3091 FAX
Customer Service Ext. 282

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SECTION ONE

1.1 INTRODUCTION

The Newport Breeze Ventilator can be used to ventilate infant, pediatric or adult patients. It's versatility provides for a safe and effective use throughout the entire patient range.

This service manual **(Part No. SER150)** contains the necessary information to enable a **qualified service person** to maintain and service the Newport Breeze ventilator. This manual is a companion to the operating manual **(Part No. OPR150)**. Both the operating and service manuals should be read before any service or repair is attempted on the Breeze.

Together the manuals will provide the service person with enough information to operate, maintain and service the Breeze to an assembly or subassembly level.

We recommend that you do not attempt to make repairs of a complex nature such as electronic circuit board repairs unless you are a fully qualified service person and possess the appropriate test equipment.

We also recommend that you contact your authorized service representative or the service department at **NEWPORT MEDICAL INSTRUMENTS INC.** for circuit board and other complex repairs, as the Newport Medical personnel are properly trained and equipped to provide this service.

If at any time the Breeze cannot be restored to properly operating condition the unit should be returned to the NMI factory for the service or repairs as needed.

The material in this manual is organized as follows:

Section One provides a brief description of the Newport Breeze Ventilator, options and accessories.

Section Two covers mechanical drawings and parts.

Section Three covers acceptance tests and calibration procedures.

Parts, Accessories and Optional equipment may be ordered by part number through your local NMI dealer or by contacting NMI customer service.

Customer Service

800 • 451 • 3111 or
949 • 642 • 3910 ext. 282
Fax 949 • 548 • 3091

Technical Support

800 • 451 • 3111 or
949 • 642 • 3910 ext. 500
Fax 949 • 548 • 3091

Newport Medical Instruments Inc.

Correspondence: Post Office Box 2600
Newport Beach, CA 92658

Ship product to: 760 W. 16th Street, Bldg B
Costa Mesa, CA 92627

1.2 NEWPORT VENTILATOR

Fig 1.1 Shows the Newport Breeze Ventilator.

The Breeze may be operated in either **Volume limited** or **Pressure limited** modes.

Volume limited operation has four basic modes:

Assist **C**ontrol with **S**igh **(A/C Sigh)**
Assist **C**ontrol **(A/C)**
Synchronized **I**ntermittent **M**andatory **V**entilation **(SIMV)**
Spontaneous

Pressure limited operation has three basic modes:

Assist **C**ontrol Plateau **(A/C) PLATEAU)**
Synchronized **I**ntermittent **M**andatory **V**entilation
Plateau **(SIMV) PLATEAU)**
Spontaneous

The manual inflation button will deliver a pressure limited or a volume limited breath as defined by the ventilator settings.

Pressure Relief Valve

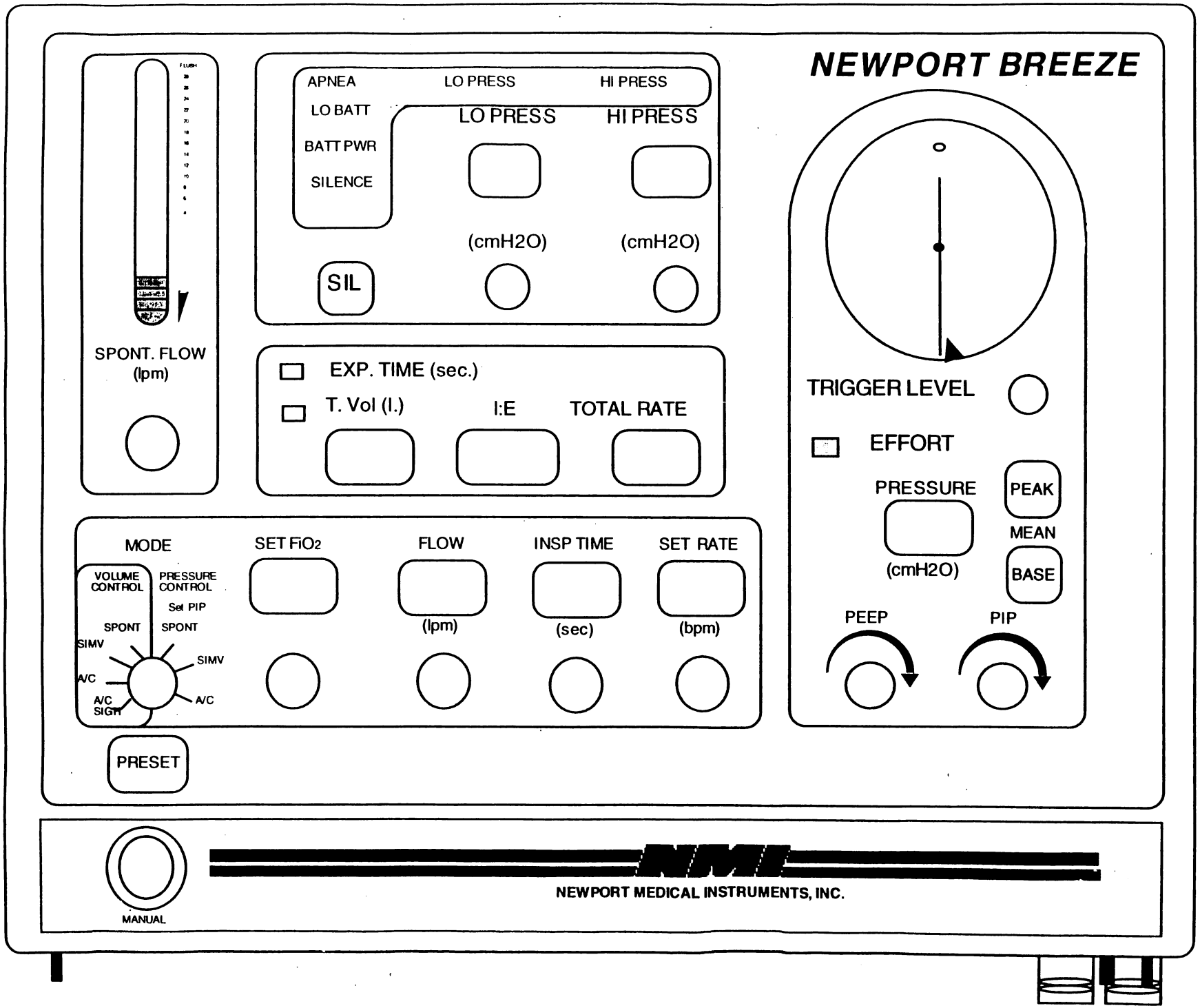
The pressure relief valve **(Part No. POP120A)** is shown in Figure 1.2. The pressure relief valve is located on the back of the unit. It functions as a mechanical pressure safety device which provides protection for the patient against high pressure. This is accomplished by bleeding off gas and limiting pressure in the circuit at a preset pressure. This setting is achieved by turning the knurled knob on the pressure relief valve either clockwise or counterclockwise.

(The pressure relief valve is set to 0 cmH_2O before being shipped from the FACTORY.)

Exhalation Valve

The exhalation valve for adults only **(Part No. EXH100A)** is shown in figure 1.3a.

Figure 1.3b shows the exhalation valve assembly for use on neonatal through adult range of patients.



NEWPORT BREEZE VENTILATOR

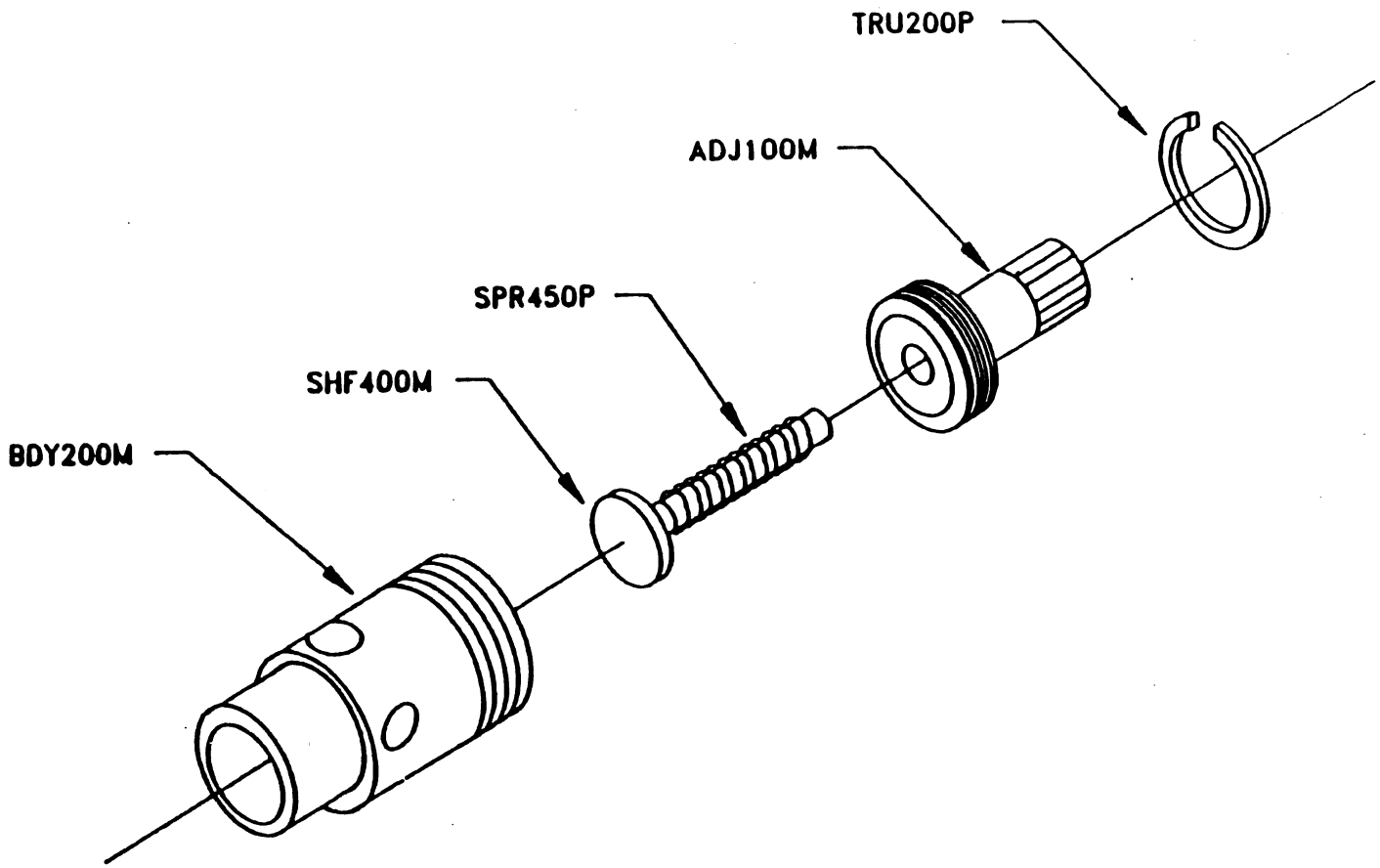


Figure 1.2 Pop-Off Valve

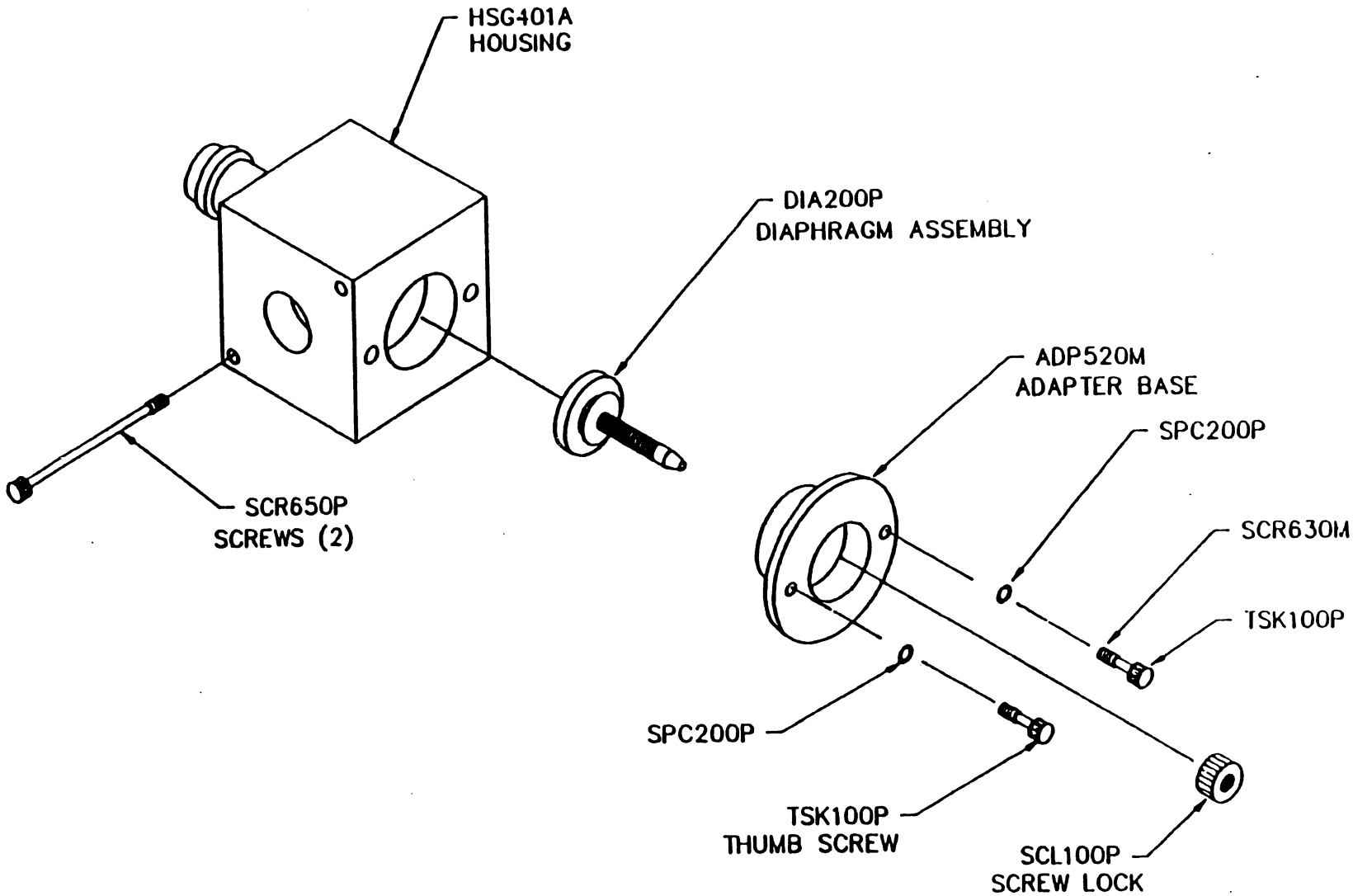


Figure 1.3 (a) Exhalation Valve Assembly (Adult)

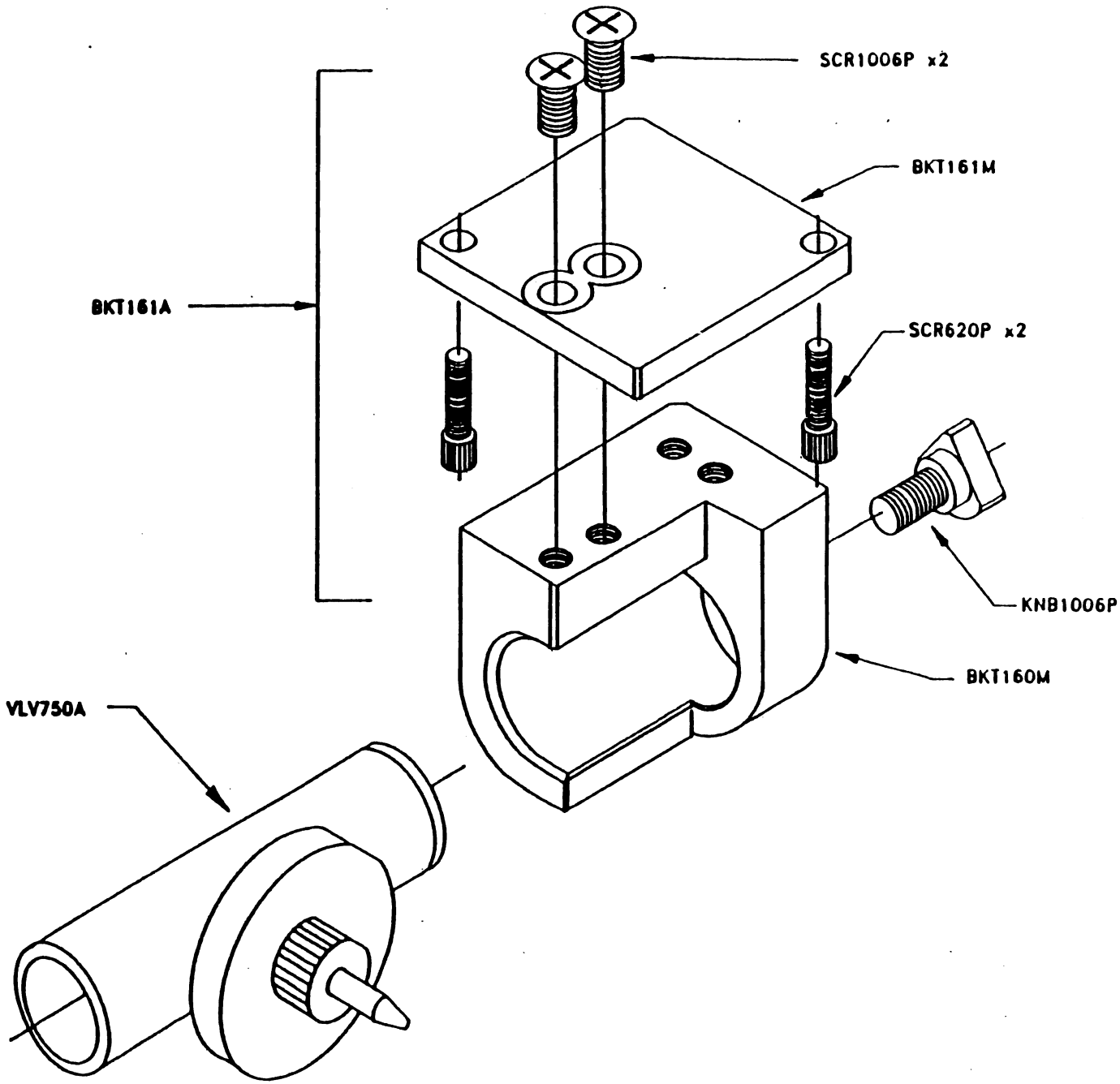


Figure 1.3 (b) PB Exhalation Valve Block Assembly

The exhalation valve is mounted beneath the Breeze in the square area marked **EXH VALVE**. The exhalation valve controls the release of the exhaled gas to the atmosphere. The opening and closing of the valve is controlled by the pressure in the pneumatic drive line, marked **EXP. OUTLET**, located beneath the unit and to the left of the exhalation valve. The drive line **(EXP. OUTLET)** is connected to the exhalation valve by means of a tubing.

Water Trap Assembly

The water trap assembly **(Part No. WTR300A)** is shown in Figure 1.4. It is mounted to the air inlet connector of the mixer on the rear of the unit. The water trap helps reduce condensates and contaminates in the air supply to the unit. A drain valve assembly, located at the bottom of the water trap is opened by pushing upwards to release contaminates collected in the bowl. Contaminated air enters the inside of the microfiber element (.1 micron filter) where condensates and particles are removed from the air stream. Liquids (oil or water) collect on the elements outer surface and then fall to the bottom of the bowl.

1.2 STAND AND POLE ASSEMBLY

The stand and pole assembly **(Part No. SPA450A)** is shown in Figure 1.5. The ventilator is mounted on the stand and pole assembly and is secured onto the pole by a knob screw. The base has two locking casters and three non-locking casters. When the casters are in the lock position they assist in keeping the unit stationed in one location.

1.3 OPTIONAL ACCESSORIES

Auxiliary Flow Outlet Assembly

The auxiliary flow outlet assembly **(Part No.AXF150A)** is an optional accessory supplied upon request only. This feature allows the user to obtain gas flow for various needs. Figure 1.6 shows a unit with the auxiliary flow outlet assembly.

NOTE: (AXF150A also includes FLOWMETER FLW300P with nipple and tubing.)

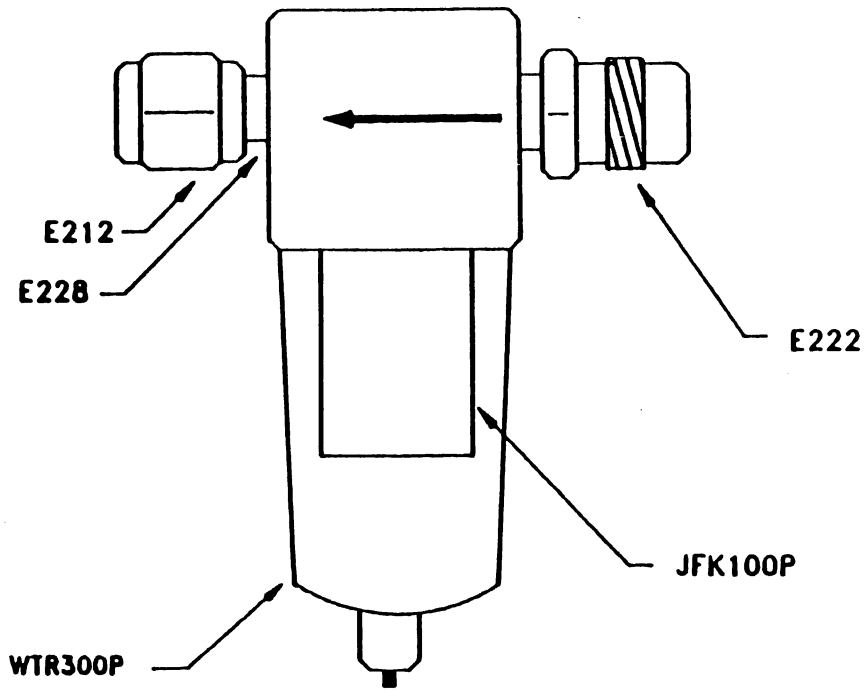


Figure 1.4 Water Trap Assembly

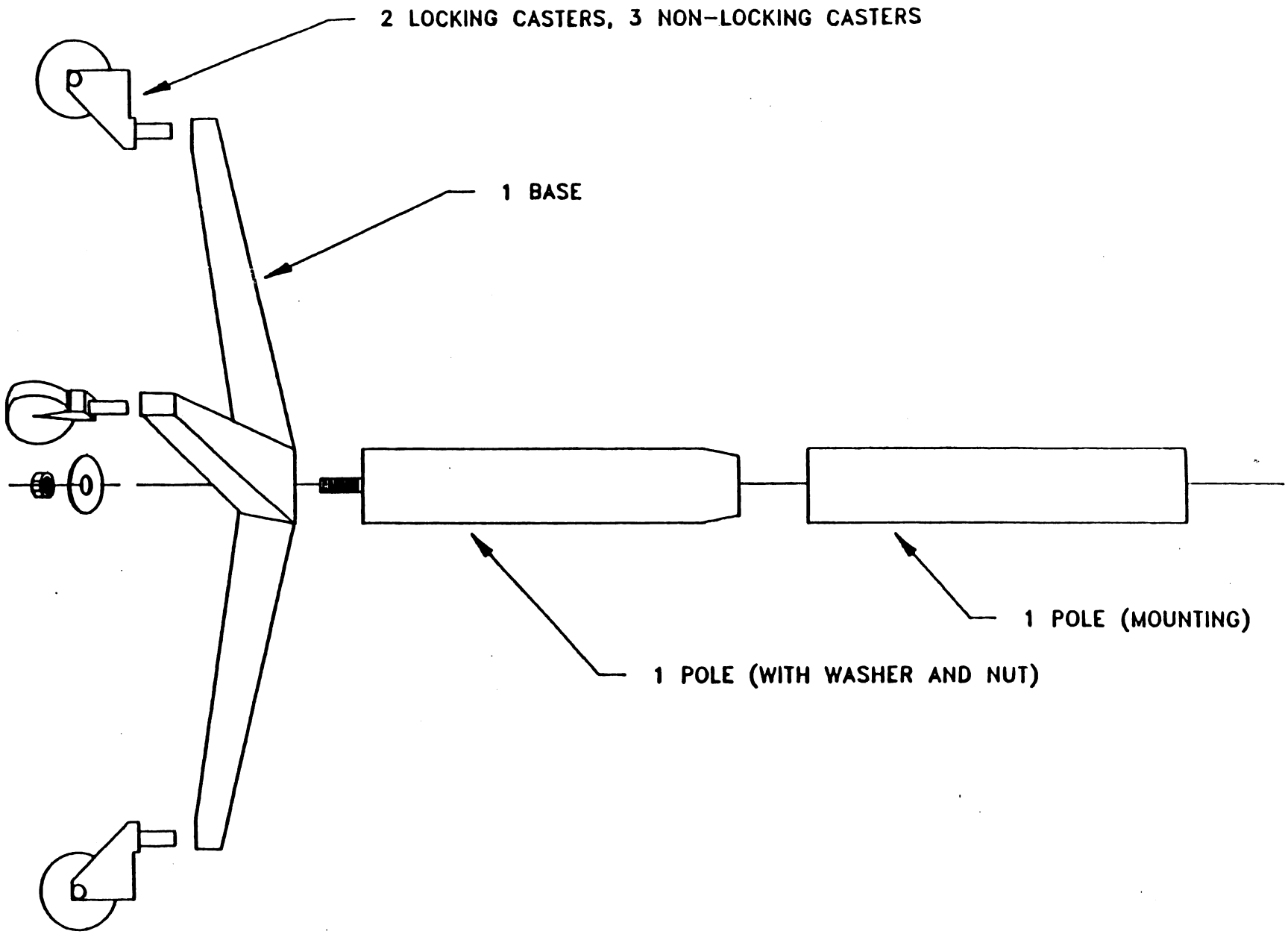


Figure 1.5 Standing Pole Assembly

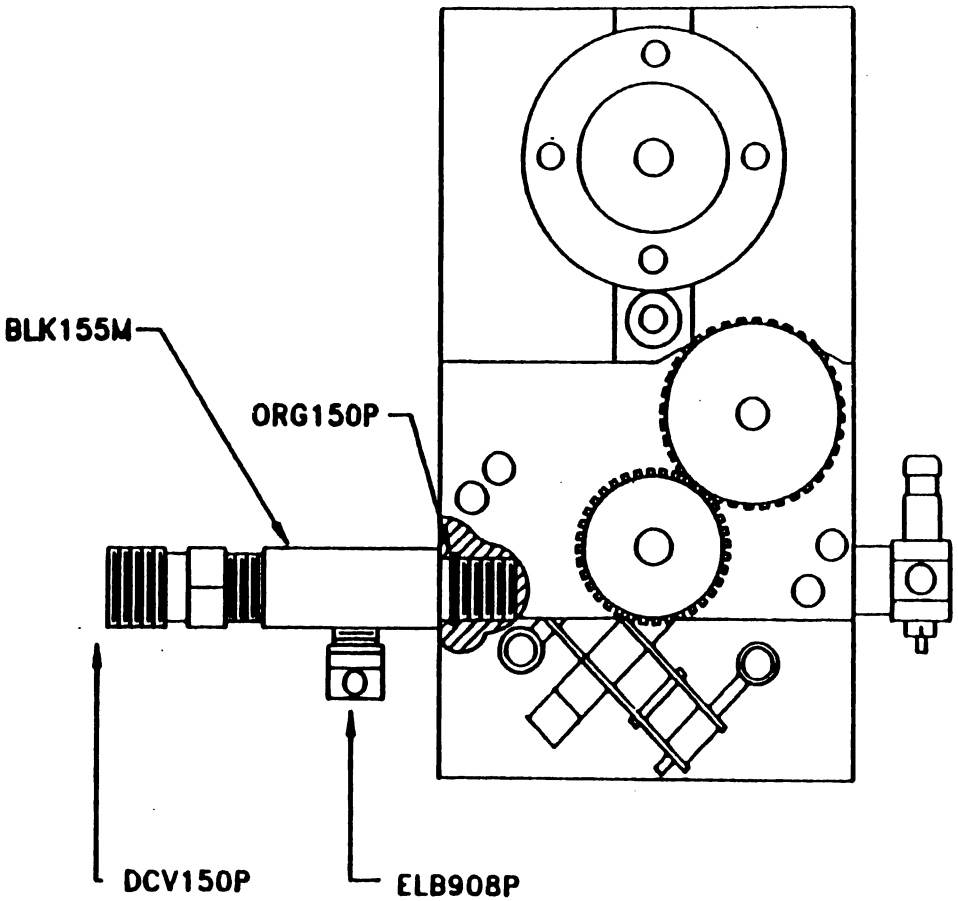


Figure 1.6 **Mixer Auxiliary Flow Outlet Assembly**

1.4 NEWPORT BREEZE SPECIFICATIONS

CONTROLS

Power Switch:	ON-OFF / charge
FIO_2:	21% - 100%
FLOW:	3 - 120 LPM
Inspiratory Time:	0.1 - 3.0 sec.
Rate:	1 - 150 BPM
PEEP / CPAP	0 - 60 cmH_2O
Peak Insp. Pressure	0 - 60 cmH_2O
Spontaneous Flow	0 - 40+ LPM
Trigger Level	-10 - +60 cmH_2O
Pneumatic Pressure Relief	0 - 120 cmH_2O
Nebulizer	ON / OFF

MODES:

VOLUME LIMITED	**PRESSURE LIMITED**
Assist CMV + Sigh Assist CMV SIMV Spontaneous	SIMV Plateau A/C Plateau Spontaneous
Manual Breath	2 sec. Max.
Alarm Loudness	72 - 97 dBa (at a distance of 1 meter.)
Alarm Silence	60 sec.

ALARMS

Audible & Visual

High Pressure	10 - 120 cmH_2O
Low Pressure	3 - 99 cmH_2O
Apnea	5 (LOW CPAP ALRAM IN SPONT. MODE ONLY), 10, 15, 30, 60 sec. **(EPROM REV. 1.1 ONLY)**
Low Battery	When 15 minutes of operating time remains.

Visual only

Battery Power	Indicates unit operating on battery power

Audible only

Gas supply source failure
Power failure
System failure

DISPLAYS

FIO_2	(%)
FLOW	(LPM)
SPONTANEOUS FLOW	(LPM)
INSPIRATORY TIME	(SEC)
RESPIRATORY RATE	(BPM)

TOTAL RESP. RATE	(BPM)
TIDAL VOLUME Volume Limited Mode only	(LPM)
EXPIRATORY TIME Pressure Limited Mode only	(SEC)
I:E RATIO	
MEAN AIRWAY PRESSURE	(cmH_2O)
BASE AIRWAY PRESSURE	(cmH_2O)
PEAK AIRWAY PRESSURE	(cmH_2O)
HIGH PRESSURE	(cmH_2O)
LOW PRESSURE	(cmH_2O)

OTHER FEATURES

PRESSURE SENSING	Proximal Airway pressure
PRESET	Displays machine settings
RS-232 /ALARM	Remote alarm outlet
HOURMETER	0 - 99,999 hours

POWER REQUIREMENTS

A C POWER	100/120/220/240 VAC +/- 10% 47 - 63 Hz, 45W Max.
BATTERY POWER	Sealed Lead Acid 12V, 3.4AHr 1 Hour minimum operating time Recharge time - 18 hours maximum

GAS REQUIREMENTS

AIR	40 - 60 PSI (2.81 - 4.22 kg/cm^2)
OXYGEN	40 - 60 psi (2.81 - 4.22 kg/cm^2)

DIMENSIONS & WEIGHT

HEIGHT	11" (27.94 cm)
WIDTH	13" (33 cm)
DEPTH	12" (30.5 cm)
WEIGHT	32 Lbs. (14.6 kg)
SHIP WEIGHT	64 Lbs. (29 kg)
AGENCY REQUIREMENTS	Meets requirements of UL 544, CSA 22.2, IEC 601 - 1 and City of Los Angeles - Electrical Testing Lab.

SECTION TWO

INSTRUMENT DESCRIPTION

2.1 GENERAL

A simple functional description and principle of operation of the Newport Breeze is presented in this section. The function of various components, different modes and various settings are also explained.

2.2 POWER SOURCE

The ventilator may be powered by an electrical supply of 100vac, 120vac, 220vac or 240vac +/- 10% at 47 - 63 Hz, 45W maximum. The voltage adjustment on the power entry module located at the rear of the unit must be set for the supply voltage.

2.3 SOLENOIDS AND VALVES

The Newport Breeze has four solenoids and four valves. The solenoids are electronically controlled and the valves are pneumatically controlled by the solenoids. The function, switching cycles and control methods of these components are explained in Table 1 and Table 2. The reader is advised to refer to pneumatic diagram Figure 2.7.

2.3 TABLE 1

Valve/ Solenoid	Part Number	Function
Flow Pilot Solenoid	PLV150P	Control of main flow valve and spontaneous flow valve.
PEEP Solenoid	PLV300P	Control of PEEP and exhalation valve.
Plateau Solenoid	PLV350P	Control of Plateau valve.
Nebulizer Solenoid	PLV250P	Control of Nebulizer output
Main Flow Valve	SOL200P	Control Valve Main flow output.
Spontaneous Flow Valve	VLV150P	Control Spontaneous flow output.
Plateau Valve	VLV150P	Control of Plateau pressure.
PEEP/Exhalation	VLV150P	Controls PEEP and Expiratory drive line pressure.

2.3 TABLE 2

Valve/ Solenoid	Part Number	Condition Inspiratory Phase	Condition Expiratory Phase	Controlled by
Pilot Solenoid	PLV150P	open	closed	electronics
PEEP Solenoid	PLV300P	open	closed	electronics
Plateau Solenoid	PLV350P	In pressure limited open In volume limited closed	open closed	electronics
Nebulizer Solenoid	PLV250P	normal	open	electronics
Main flow Valve	SOL200P	open	closed	flow pilot solenoid
Spontaneous Flow Valve	VLV150P	closed	open	flow pilot solenoid
Plateau Solenoid	VLV150P	pressure limited: open between L — S S — L volume limited: EXH — L L — EXH	 L — S S — L EXH — L L — EXH	plateau solenoid
PEEP/Exhalation Valve	VLV150P	S — L L — S	EXH — L L — EXH	PEEP solenoid

NOTE: During SPONTANEOUS - PEEP solenoid is always closed except during manual breath and the peep/exhalation solenoid is NC (normal closed) to load.

Normal: OPEN ONLY WHEN NEBULIZER SWITCH IS TURNED ON.

S = SOURCE, **L** = LOAD, **EXH** = EXHAUST

2.4 AIR / OXYGEN MIXER

The air/oxygen mixer has the dual function of mixing air and oxygen to a desired FIO_2 and regulating the output mixture to a preset pressure. The pressure of the air and oxygen supply gases are lowered to 2.0 kg/cm2 (28.5 psi) by means of a diaphragm and regulator assembly. The regulated gases are then mixed and supplied at the desired FIO_2.

The input pressure of the gases must be between 40 - 60 psi for the mixer to maintain accurate FIO_2 and regulate the output pressure.

Figure 2.1 displays the four output ports of the mixer.

(1) Main Flow port:
Supplies the main flow of the unit.

(2) Continuous Flow port:
Supplies bleed flow to the atmosphere. This flow is the minimum flow required out of the mixer to maintain the FIO_2 within specifications.

(3) Auxiliary Flow port:
Supplies the Spontaneous flow and Auxiliary flow to the unit.

(4) Air Port:
Supplies gas to the pneumatic control circuit and is equal to the input pressure of the air side.

MIXER ASSEMBLY

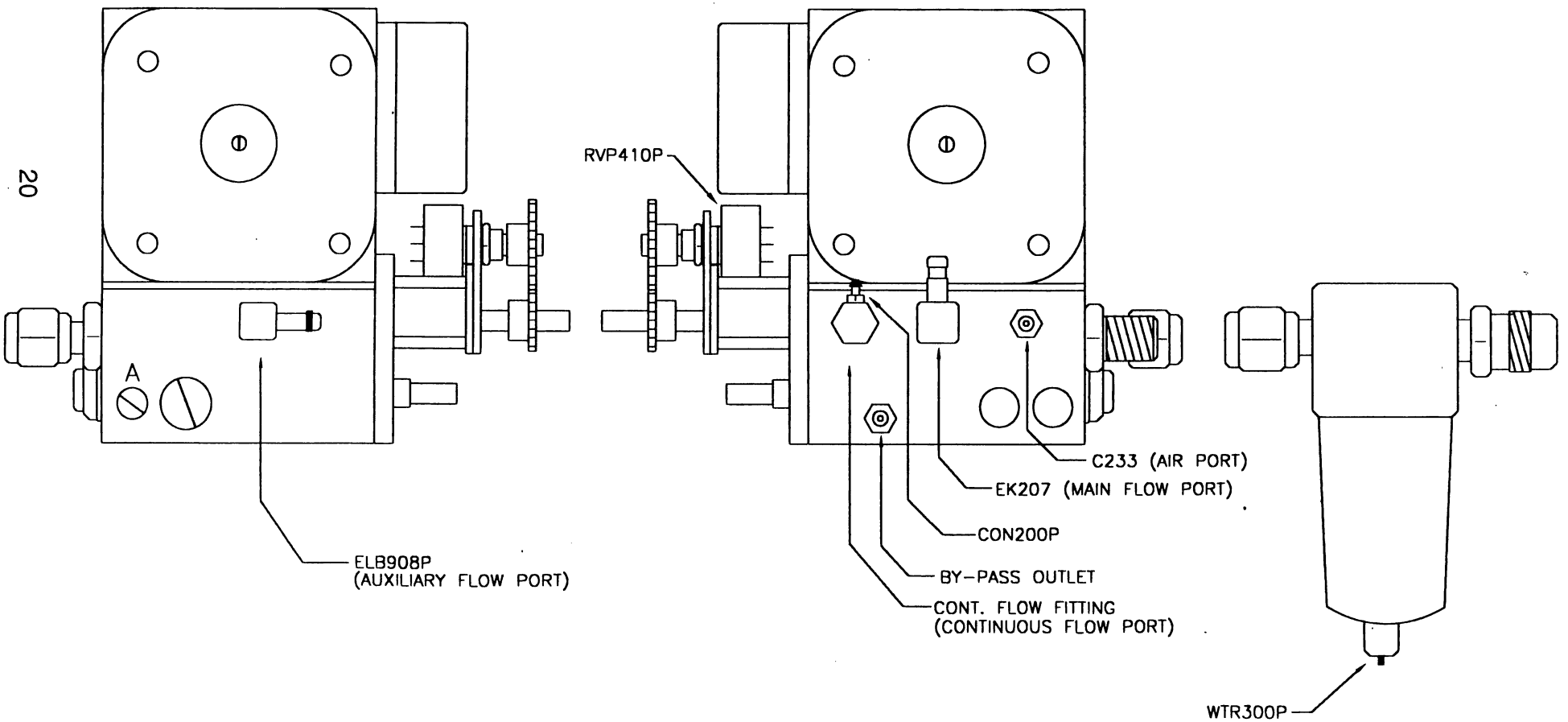


FIG. 2-1

2.5 PRINTED CIRCUIT BOARDS

The **NEWPORT BREEZE** has three printed circuit boards which control and display its functions:

These are:
(1) The power board (PCB 420A).
(2) The main (CPU) board (PCB 410A).
(3) The display board (PCB 400A).

The power board is located on the back panel. It receives AC input power from the transformer and it rectifies the AC to DC and then regulates the DC output voltage to the battery, hourmeter and the main (CPU) board.

The CPU board is located in the top portion of the unit and contains the electronic circuitry that controls and monitors the operation of the unit.

The display board is located behind the front panel and consists of LEDs which display the various settings and alarms as determined by the CPU board.

2.6 MANOMETER ASSEMBLY

The manometer assembly (Part No. MAN120A, Figure 2.2) consists of the manometer and the trigger level mechanism. The manometer has a pressure range of -10 to 120 cmH_2O. The trigger level mechanism consists of a photocell (for sensing patient inspiratory effort) and a gear and shaft assembly for trigger level setting. The photocell is attached onto the trigger level indicator such that the needle passes through the photocell and cuts it's photo beam each time the instantaneous inspiratory pressure equals the trigger level setting. This cutting of the photo beam is sensed by the electronic circuitry and is used as a means of sensing patient effort.

MANOMETER ASSEMBLY MAN120A

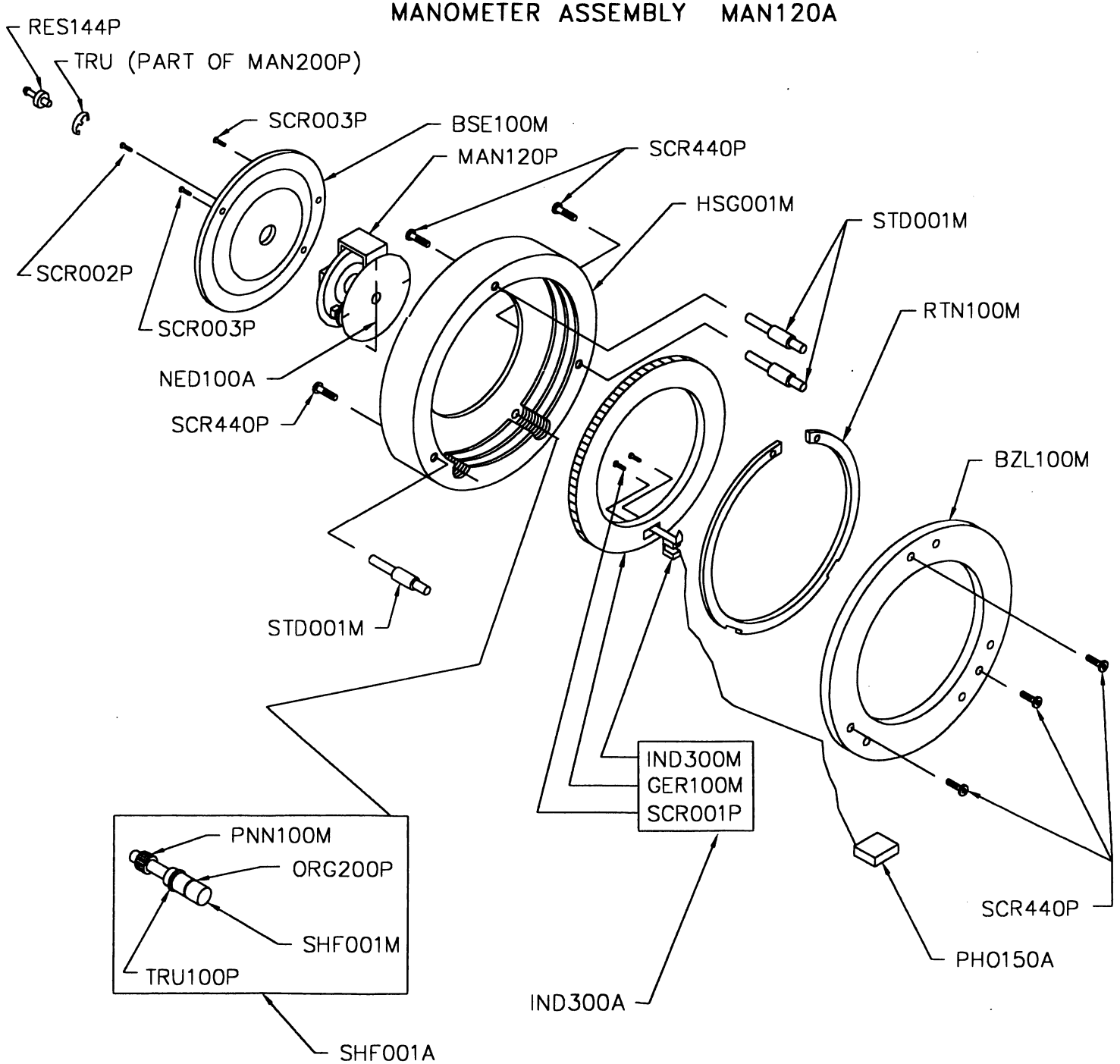


FIG. 2-2

2.7 THEORY of OPERATION

2.7.1 GENERAL

The theory of operation of the ventilator in the **volume limited** and **pressure limited** modes will be discussed in this section. We shall study the path of gas flow from the mixer to the main flow outputs. We shall consider various conditions that affect or change the flow path. The inspiratory time, respiratory rate, FIO_2 and the amount of flow will not be considered since these do not affect the flow path. They will only determine the quantity, quality and duration of the flow. An understanding of the switching of the solenoids and valves is important in tracing the flow of gas and the outputs in the **Newport Breeze**.

2.7.2 VOLUME LIMITED MODES

The flow path in the three modes

(A) **A**ssist **C**ontrol + sigh **(A/C + sigh)**
(B) **A**ssist **C**ontrol **(A/C)**
(C) **S**ynchronized **I**ntermittent **M**andatory **V**entilation **(SIMV)**

is different only in the pattern in which it is delivered. The difference between A/C and A/C + Sigh is that in A/C + Sigh the first breath has an inspiratory time 1.5 times that of the setting and thereafter every 100th breath is equal to 1.5 times the inspiratory time setting. The difference between A/C and SIMV is in the timing of the delivered breath. In SIMV the timing of the synchronized breaths is set by the respiratory rate.

EXAMPLE: If the respiratory rate is set at 6 BPM then the **S**ynchronized **T**iming **P**eriod = 60 / 6 = 10 seconds. The 10 sec. is divided into a 75% and 25% window. A breath can not be initiated during the 75% window. The machine watches for the patient effort during the 25% window and will deliver a breath when a patient effort is sensed. If no patient effort is sensed the machine will deliver a breath at the end of the 25% window.

In the A/C mode a breath is delivered each time an inspiratory patient effort is sensed regardless of the respiratory rate setting, while the SIMV breaths are delivered only at the respiratory rate setting.

FLOW PATHS

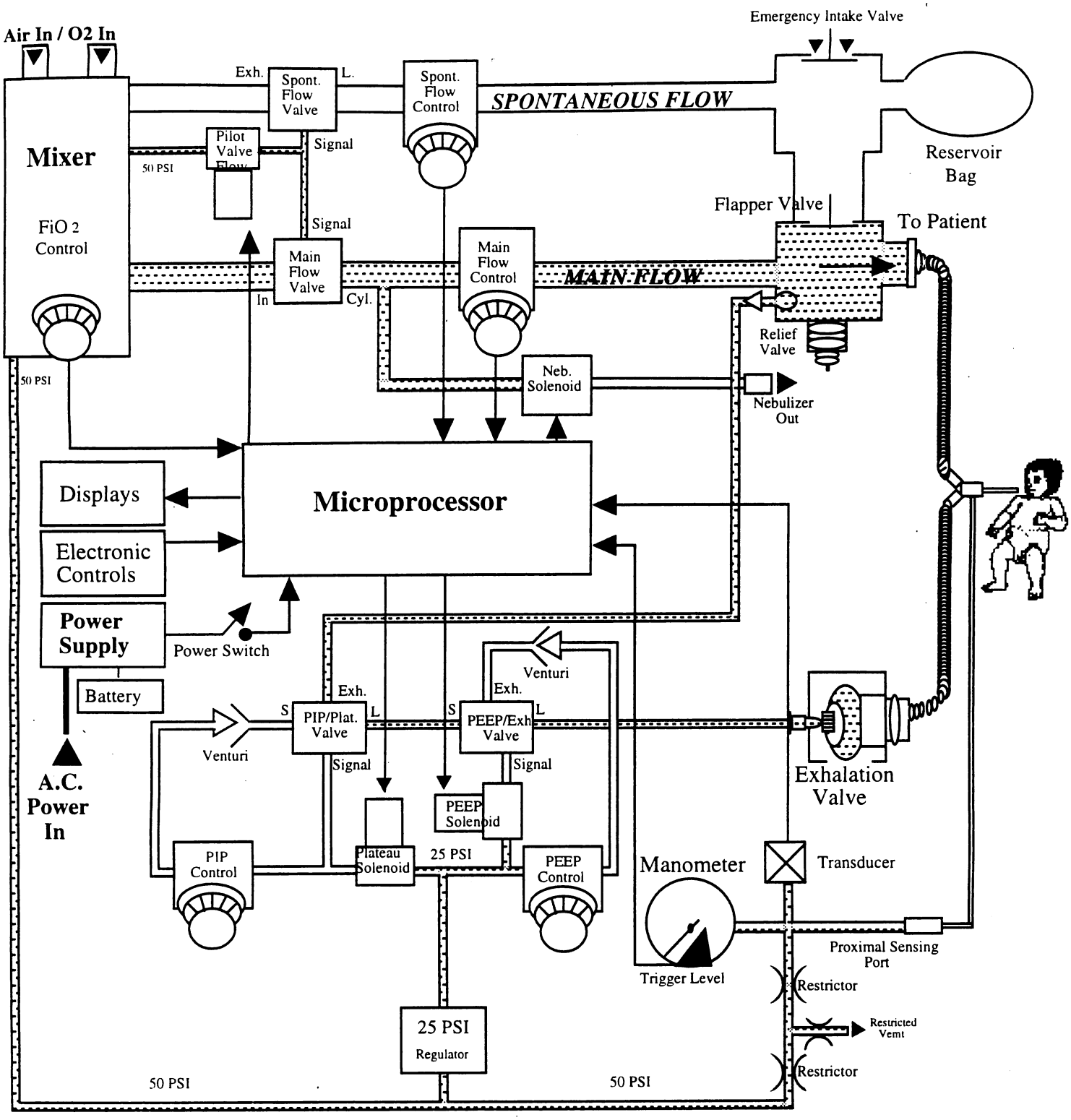
Figure 2.3 and Figure 2.4 show the path of flow during the inspiratory and expiratory phase in the volume limited A/C mode.

INSPIRATORY PHASE

In the inspiratory phase the flow pilot solenoid receives an electrical signal which opens the solenoid. This sends a pneumatic signal to the master valve. The master flow valve opens allowing gas to flow through the main flow valve tubing into the main flow adapter assembly from where it is delivered to the breathing circuit. At the same instant the spontaneous valve (which is normally open) receives a pneumatic signal which shuts off the spontaneous flow.

The Plateau solenoid is off and the plateau valve is closed during volume limited modes which allows flow between the exhaust **(EXH)** and load **(L)** ports.

The PEEP solenoid receives an electrical signal during each inspiratory cycle. This signal opens the solenoid, supplying a pneumatic signal to the PEEP/Exhalation valve which opens allowing gas flow between supply (S) and load (L) ports. The gas from the auxillary flow block passes through the plateau valve into the PEEP/Exhalation valve and then into the Expiratory drive line. This causes a pressure build up in the Expiratory drive line. The Exhalation valve closes resulting in gas flow to the patient.



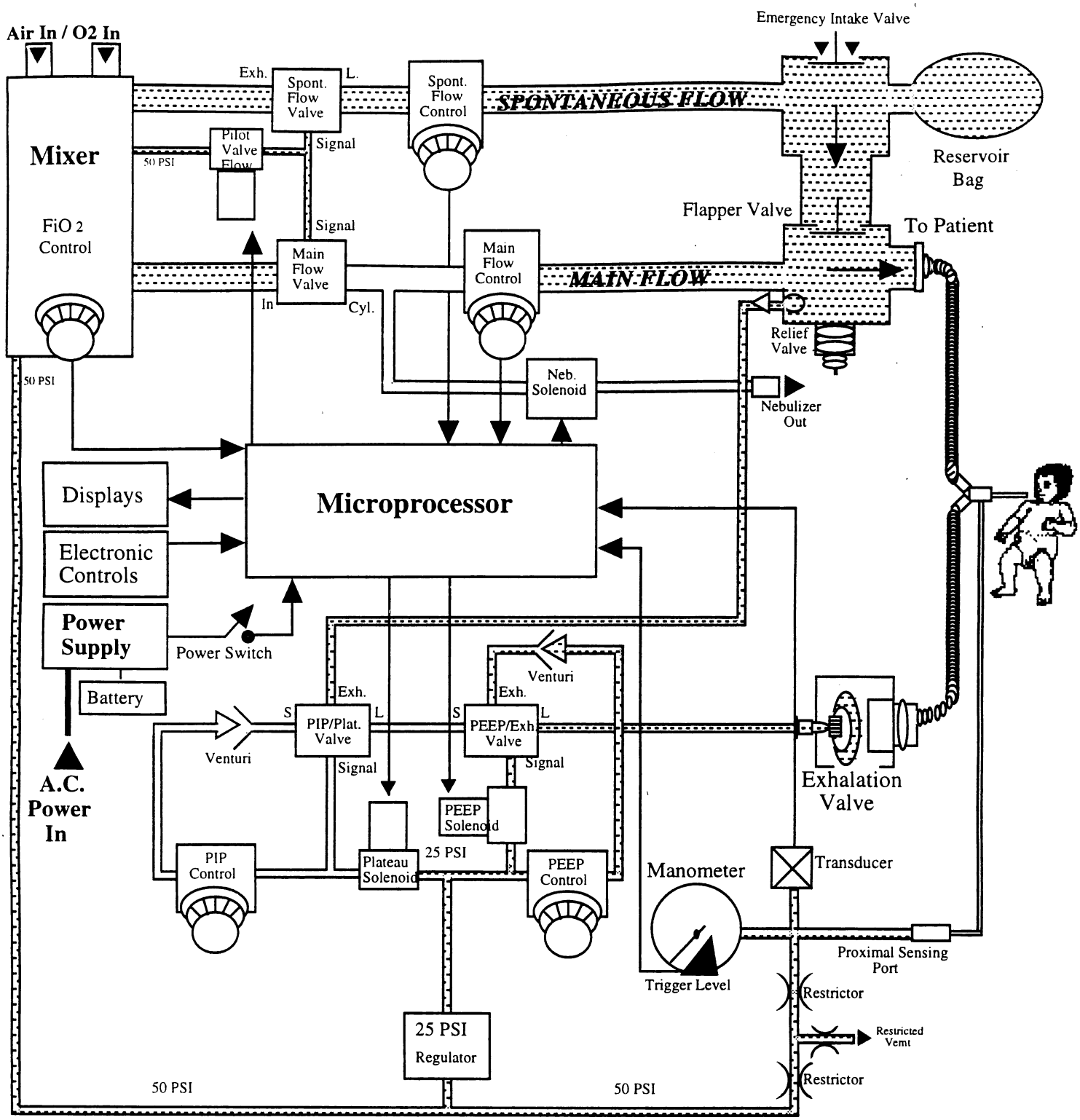
NEWPORT *BREEZE* VENTILATOR

Pneumatic Diagram

Volume limited mode, inspiratory phase

Exh.: Exh. Port
S: Supply Port
L: Load Port

Fig. 2-3



NEWPORT *BREEZE* VENTILATOR

Pneumatic Diagram

Volume limited mode, expiratory phase (PEEP ON)

Exh.: Exh. Port
S: Supply Port
L: Load Port

Fig. 2-4

EXPIRATORY PHASE

At the beginning of the Expiratory phase the electrical signal to the PEEP solenoid is turned off, which closes it. The pneumatic signal to the PEEP/Exhalation valve is removed and the valve closes. The gas in the peep valve now flows only between the load(L) and exhaust(EXH). If PEEP is set at 0 cmH_2O there is no gas flow from the PEEP regulator into the PEEP venturi assembly. The gas from the expiratory drive line flows back into the PEEP/exh. valve and bleeds out of the PEEP venturi assembly. The expiratory drive line pressure falls to 0 cmH_2O and the exhalation valve opens allowing the patient to exhale.

If the PEEP were set above zero, then at the end of inspiration, the gas from the PEEP regulator would flow into the PEEP venturi assembly, and through the PEEP/Exhalation valve to maintain the expiratory drive line pressure. The expiratory drive line pressure depends on the PEEP setting. The expiratory drive line pressure will close the exhalation valve enough to maintain the PEEP pressure in the breathing circuit. The PEEP pressure in the circuit is read on the manometer or baseline pressure display during expiration. In normal operation the PEEP pressure is always set below peak inspiratory pressure. In the expiratory phase the spontaneous valve is open and a spontaneous flow (depending on the settings), flows through the circuit.

2.7.3 PRESSURE LIMITED MODES

The pressure limited modes

(a) Assist Control Mechanical Ventilation with Plateau (A/C Plateau)

(b) Spontaneous Intermittent Mechanical Ventilation/ Plateau (SIMV/ Plateau)

differ from one another in the same way as in the volume limited mode. In the pressure limited modes each breath is limited in inspiratory pressure by the peak inspiratory pressure **(PIP)** setting. The PEEP/exhalation valve controls the expiratory drive line pressure which limits the maximuminspiratory pressure. In the pressure limited modes the path of main flow and spontaneous flow is similar to that of the volume limited mode. Figure 2.5 and Figure 2.6 show the path of gas flow in the inspiratory phase and expiratory phase respectively.

The operation of PEEP and PIP **(P**eak **I**nspiratory **P**ressure**)** in the pressure limited modes is as follows:

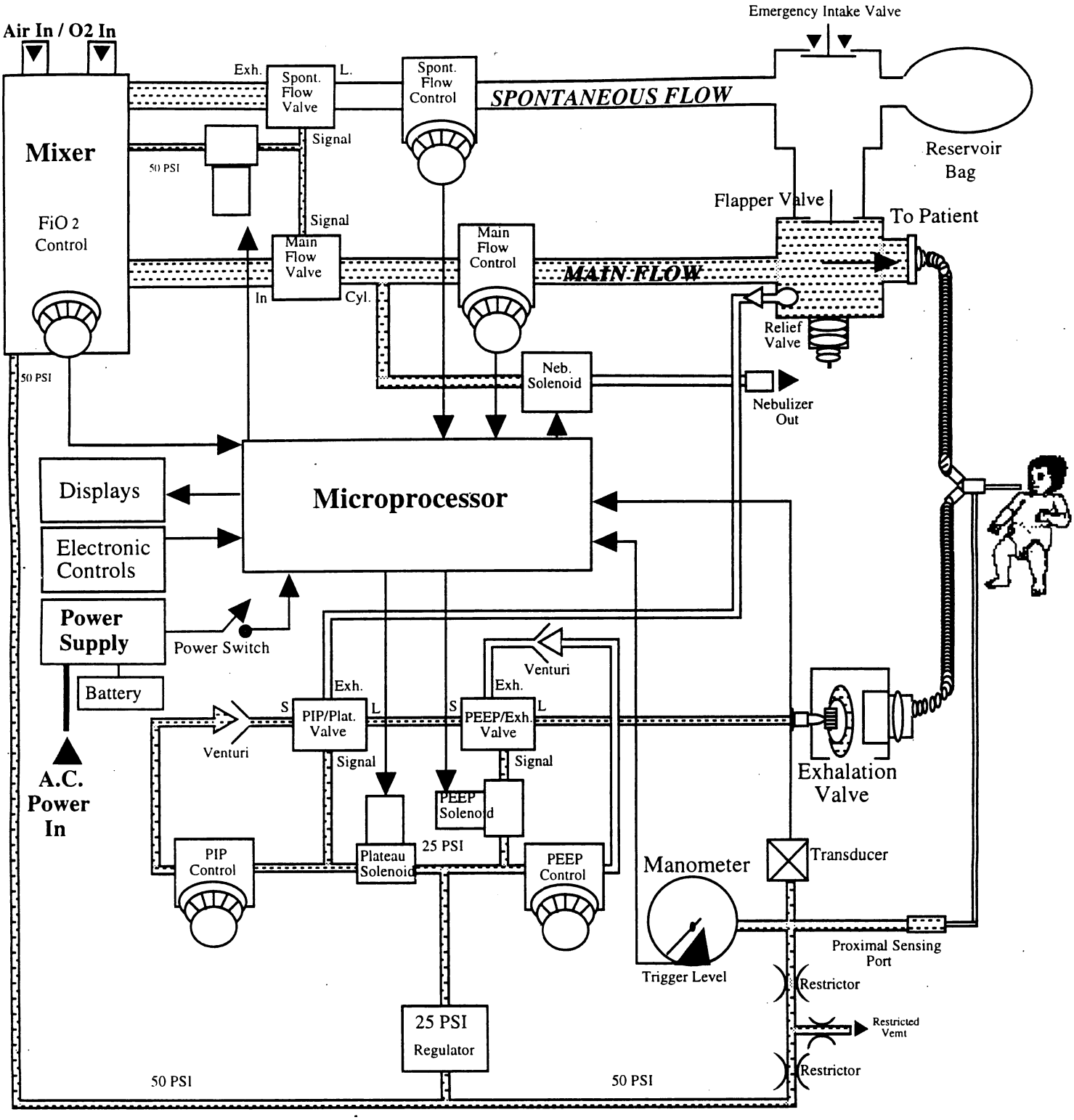
With PEEP

In the inspiratory phase the PEEP solenoid receives an electrical signal thereby supplying a pneumatic signal to the PEEP/exhalation valve which opens allowing gas to flow between the load (L) and supply (S) ports. Air flows into the plateau regulator and the regulated output flows through the plateau venturi assembly, and this generates the control pressure which flows into the PEEP plateau assembly. This gas flows out of the PEEP/Exhalation valve into the expiratory drive line building up a pressure which depends on the plateau **(PIP)** regulator setting. The main flow at this time flows into the breathing circuit where it is confined by the exhalation valve. When the pressure of the gas in the breathing circuit exceeds that of the expiratory drive line pressure the exhalation valve opens up partially to bleed off the excess gas and thereby maintains the Peak Inspiratory Pressure **(PIP)**.

In the expiratory phase the PEEP solenoid is closed and therefore the PEEP/Exhalation valve is in the normally closed condition. It allows flow through the Exhaust and Load ports. The gas from the PEEP regulator flows into the PEEP/Exhalation valve through its venturi assembly. The excess gas is bled off from the venturi assembly. An increase or decrease in the expiratory drive line pressure is obtained by adjusting the PEEP pressure regulator. This results in a similar change in the exhalation valve, and thus the PEEP pressure.

WITH NO PEEP

With PEEP off (i.e. set at zero) the opening and closing of the valves and solenoid is similar to the case with PEEP on. Since there is no flow out of the PEEP regulator, there is no flow into the PEEP venturi assembly or into the PEEP/Exhalation valve, so at end of the inspiration cycle the gas in the expiratory drive line bleeds out of the PEEP venturi base assembly dropping the pressure in the expiratory drive line to 0 cmH_2O and subsequently the exhalation valve opens allowing the patient to exhale. This in turn results in a drop in pressure in the breathing circuit and lung to zero.



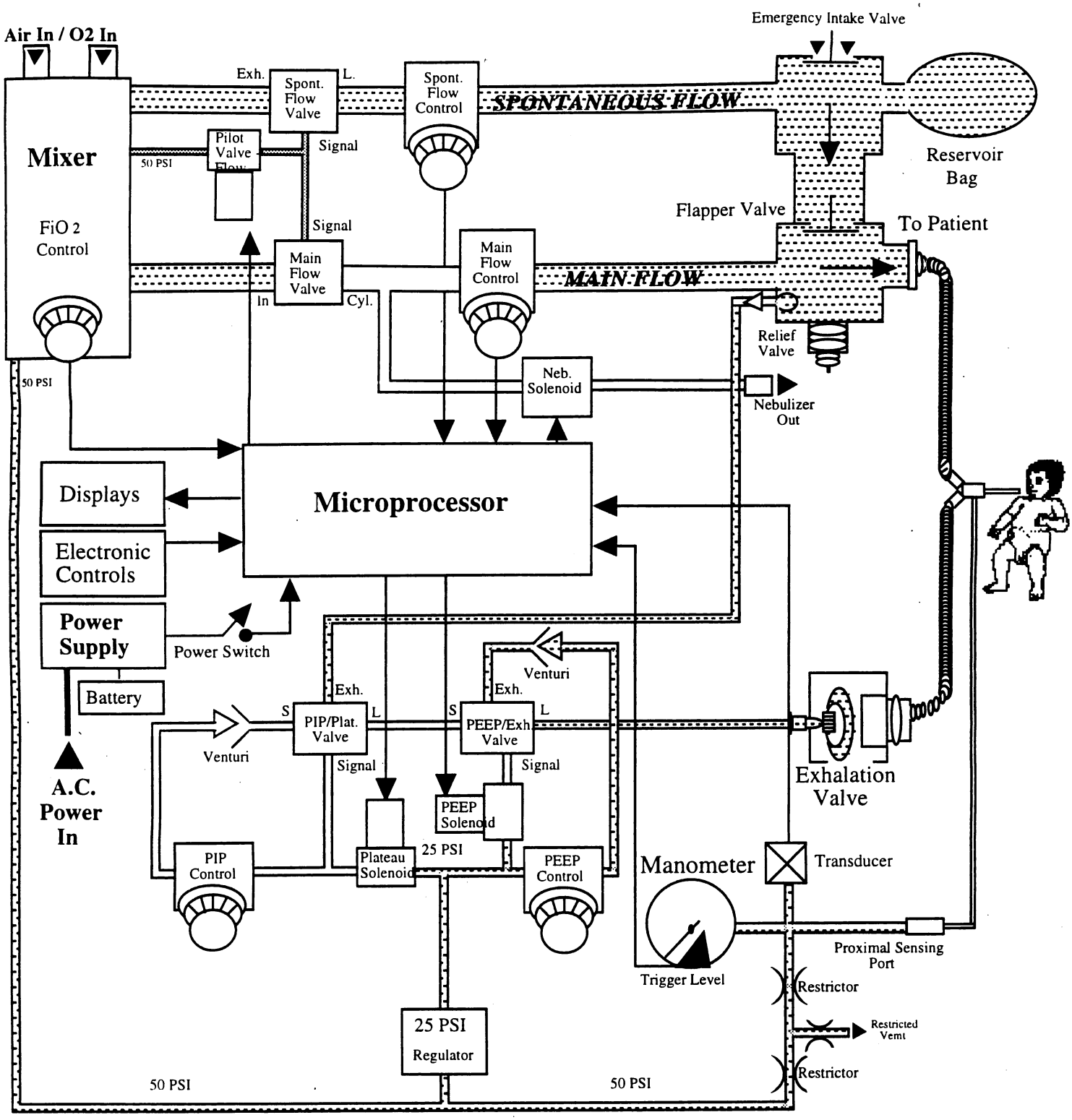
NEWPORT *BREEZE* VENTILATOR

Pneumatic Diagram

Pressure limited mode, inspiratory phase

Exh.: Exh. Port
S: Supply Port
L: Load Port

Fig. 2-5



NEWPORT *BREEZE* VENTILATOR

Pneumatic Diagram

Pressure limited mode, expiratory phase. (PEEP ON)

Exh.: Exh. Port
S: Supply Port
L: Load Port

Fig. 2-6

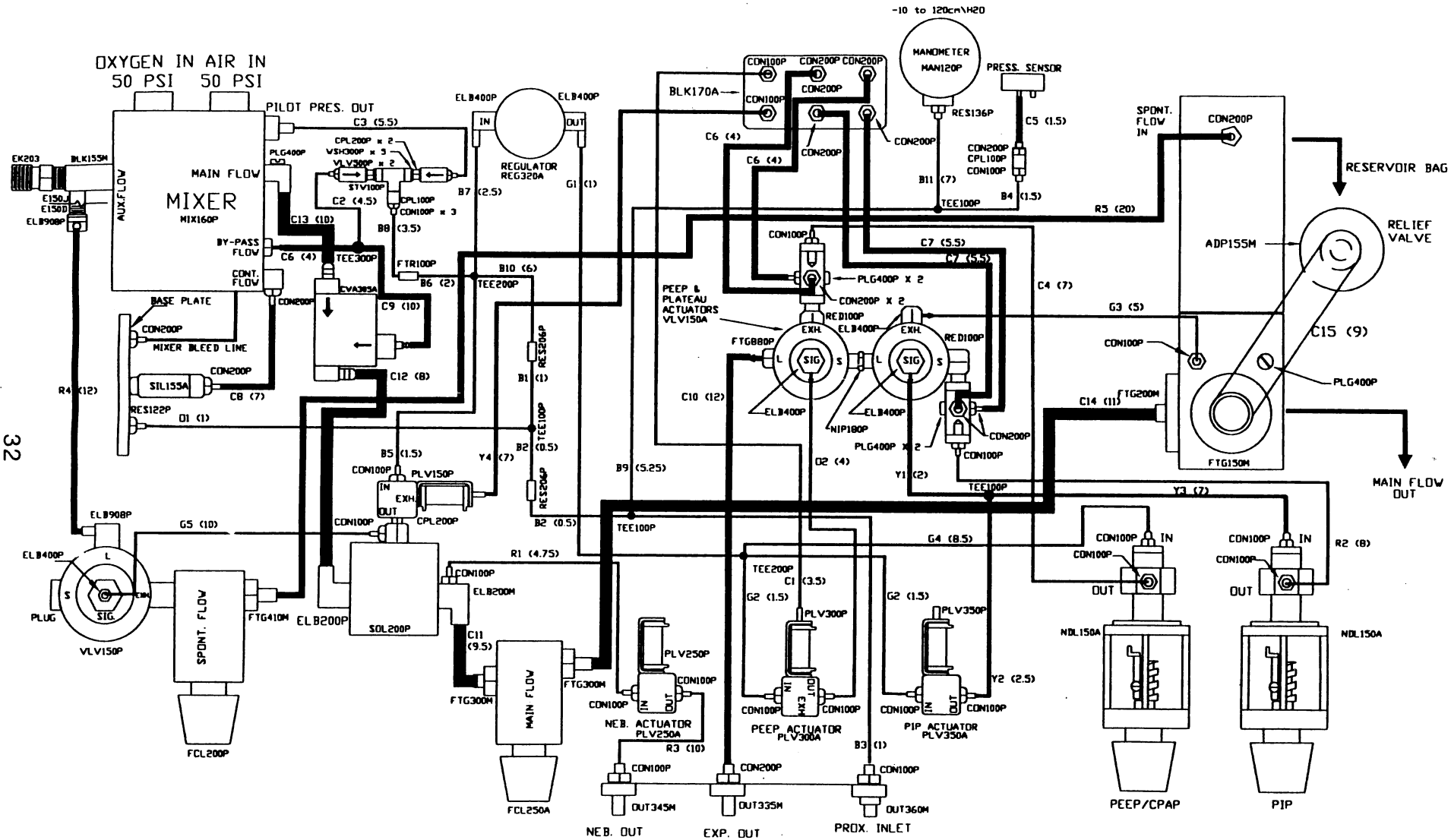


Figure 2.7 **E150 Breeze Pneumatic Diagram**

2.7.4 SPONTANEOUS MODES

In the spontaneous modes

(A) Volume Limited
(B) Pressure Limited

there is continuous flow into the breathing circuit from the spontaneous flow valve depending on setting. If PEEP is set to some value the gas flow from the PEEP regulator flows into the venturi base assembly, and into the PEEP valve and then into the expiratory drive line. This flow results in a pressure build up in the expiratory drive line resulting in PEEP.

If the manual breath button is depressed in the spontaneous mode the ventilator will deliver a breath whose characteristics depend on the ventilator settings, which are displayed when the preset switch is depressed. In the volume limited spontaneous mode the ventilator will deliver a volume limited breath as per the machine settings. While in the pressure limited spontaneous mode the ventilator will deliver a pressure limited breath as per the machine settings.

2.7.5 NEBULIZER

The nebulizer is operational when the **NEB.** switch located on the front of the unit behind the door is turned "ON". When the switch is turned "ON" an electrical signal is supplied to the Nebulizer solenoid, which opens. The opening of the solenoid allows gas to flow from the main flow and out to the nebulizer through the outlet located on the right hand side the unit. The gas flows in the nebulizer circuit only during the inspiratory cycle. The nebulizer flow is about 6 LPM (100 cc/sec). When the nebulizer switch is turned on the tidal volume displayed takes into account the flow through the nebulizer and adds the appropriate volume to the display tidal volume.

SECTION 3

CALIBRATION AND OPERATIONAL VERIFICATION PROCEDURES

3.1 GENERAL

This section describes the various test and calibration procedures. The unit should be tested periodically to verify that operation is within the specifications. The Operational verification should be performed at least every month. If the BREEZE is subjected to heavy usage the frequency of the operational verification should be increased accordingly. All alarms (audible and visual) and the FIO_2 should be checked regularly (every 24 hours) if the unit is used continuously.

NOTE: The unit should be inspected each time new usage is begun.

3.2 PREVENTATIVE MAINTENANCE

Preventive Maintenance on the ventilator should be completed after every 3000 hours of operation (or earlier if required), or a minimum of once each year. The Preventive Maintenance is intended to be done in the hospital.

The preventive maintenance includes:

* Visual inspection of external surfaces, controls, attachments and accessories.
* Replacing the Air and O_2 mixer inlet filters (part no. MFK110A).
* Cleaning the air inlet Water Trap (WTR300P) and replacing the jar filter (JFK100P).
* Removing top cover and visually inspecting the interior, all tubing, wires and wiring connectors, screws,nuts and hardware, checking the general condition of the components.
* Performing operational verification on the unit and recalibration of the unit if required.

CAUTION: Do not use strong solutions for cleaning the unit. Use only alcohol or a mild soap solution.

Overhaul

The ventilator should be overhauled every 3 years or after 15000 hours of operation or more often if required. The overhaul should be performed by a Newport Medical service technician at the factory service center. In addition to the items performed during Preventive Maintenance, an overhaul will include the overhaul of the Air/O_2 mixer and replacement of moving parts if required. Contact NMI customer service for further information on the above service.

3.3 OPERATIONAL VERIFICATION AND CALIBRATION PROCEDURES

This procedure is included to assist the Qualified Operator or Hospital Service Technician in establishing a routine verification procedure to verify that the BREEZE ventilator is in operating condition. The procedure is explained and is intended to help test the unit after repair/replacement of parts on the unit.

CAUTION: Before using any test equipment for calibration, verify that the accuracy of the instrument is certified by a testing laboratory whose master test instruments are traceable to The National Institute of Standards and Technology or equivalent.

Preliminary Adjustments:

The Preliminary adjustments are done at the factory and need not be adjusted unless the parts that directly affect them are replaced.

Connect Air and O_2 sources to their respective inlets at the rear of the unit.

1. **Input Voltage:** Adjust the power input on the power entry module on the back of the unit to desired input voltage.

   For U.S.A.: 120 vac., 1A

2. a). Pull out the tubing at the output of the pressure regulator for PEEP/Plateau supply.

   b). Hook a standard pressure gauge to it.

   c). Adjust the regulator output to read 25 psi.

   d). Reattach tubing.

3. **Transducer adjustments:**

   a. R14 (Reference voltage)

      1. Measure the voltage across VREF TP3 and Pin 7 of I.C. U20 on the CPU PC board (PCB410A).

      2. Adjust trim pot R14 to adjust the voltage read to 5 volts.

   b. R22 (Transducer offset)

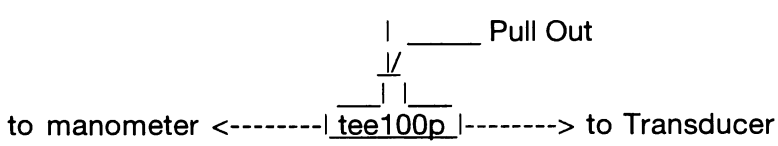
      1. Fix a jumper on JP1 on CPU PC board.

      2. Turn the mode selector switch to spontaneous mode.

      3. Adjust the pot R22 (offset) to get a pressure display readout of 0 cmH_2O. (The left digit display of the pressure display helps adjust the precise zero value. When the adjusted value is towards the positive side the top segment of the left display shall light up and the bottom segment shall light up when the adjusted zero value is towards the negative end. The pot R22 should be adjusted so that the display toggles between the two segments indicating the most precise zero value.)

   c. R27 (Transducer gain)

      1. Pull out the tubing that feeds the manometer and the pressure transducer at the tee.



2. Fix a syringe (150cc) at the tee.

3. With the help of the Syringe build a pressure of 60 cmH_2O in the assembly so that the manometer reads 60 cmH_2O.

4. Adjust pot R_{27} so that display reads 60 cmH_2O.

NOTE: **REPEAT** steps (b) and (c) after each time the pots are adjusted.

5. **REMOVE JUMPER** on JP1 on CPU board.

6. **RECONNECT TUBING.**

d. R_4 (Battery charging voltage)

CAUTION: **Caution must be taken to avoid a short between the battery terminals.**

1. Remove the positive terminal to input of the battery.

2. Hold a voltmeter across the terminal and fuse mounting contact of fuse f1 of the power supply board (PCB420A).

3. Connect a load resistor(e.g. 1.5K ohm, 1/2 watt) between the positive input terminal of the battery and the voltmeter probe.

4. Adjust R_4 (BATT CHARGE) on the power PC board on the back panel so that the charging voltage read by voltmeter is 13.8 volts.

5. Reconnect the wire onto the battery.

OPERATIONAL VERIFICATION AND CALIBRATION PROCEDURE

Set up the unit with the standard breathing circuit as shown in fig 3-1. Connect the input Air and O_2 supply lines at the input to the ventilator located at the rear of the unit. Adjust the input pressures of the input gases to 50 psi.

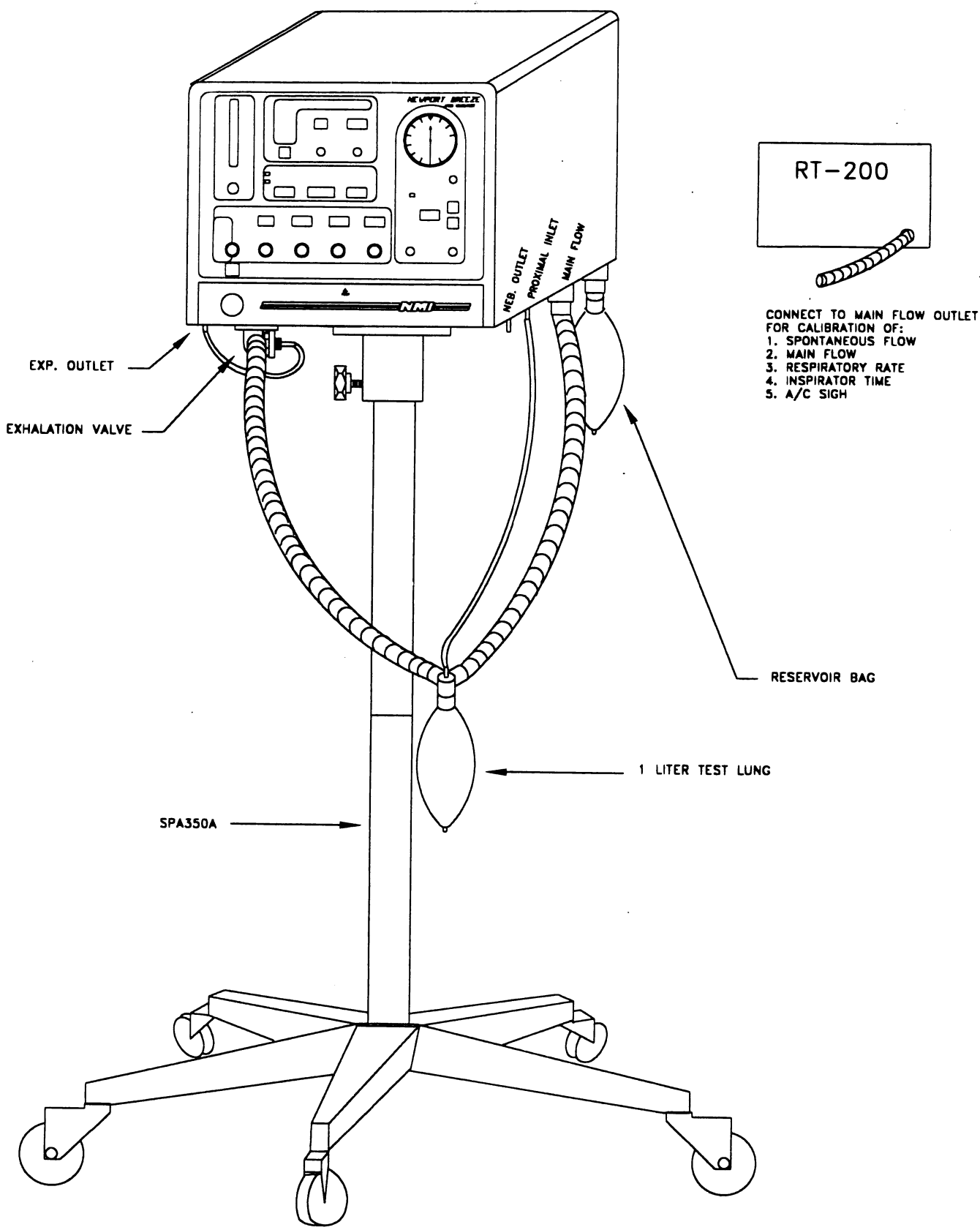


Figure 3.1: BREEZE TEST SET-UP

NOTE: For several of the operational verification tests we have used the calibration analyzer series RT-200 manufactured by Timemeter Instrument Corporation. However any flow measuring instrument capable of reading flows up to 120 LPM may be used.

Gas Input Pressure Alarm Test:

1. Adjust the pressure of input air source to 50 psi.

2. Reduce the pressure of the input O_2 source slowly and note the pressure at which the low input pressure alarm sounds. Verify that the alarm sounds when the pressure of the source is 31 ± 3 psi.

3. Adjust the pressure on the O_2 side to 50 psi.

4. Reduce the pressure on the Air source side slowly and verify that the alarm sounds when the pressure drops to around 31 $\pm$ 3 psi. If the low gas input pressure alarm fails to sound, check that the alarm hole located and marked mixer audible alarm on the rear of the panel is not occluded. The alarm may not sound if contaminated with moisture from the input sources. Unscrew the alarm by turning counter-clockwise and dry by blowing out the air gently or leaving it open until dry. Do not handle the reed in the alarm. It is easily damaged by handling.

TEST / CALIBRATION PROCEDURE

Adjust the front panel controls to the following standard settings. Return to the standard settings after each test unless otherwise stated.

Power	:	ON
Mode	:	A/C
FiO_2	:	.60
Flow	:	20 LPM
I.T.	:	1.0 Sec
Resp. Rate	:	20 BPMPEEP:0 cmH_2O
Peak Insp. Press (PIP)	:	OFF (Fully counter-clockwise)
Apnea time	:	LOW CPAP ALARM
Nebulizer	:	OFF
Trigger Level	:	-10 cmH_2O

1. LED/ALARM

   Turn OFF unit and turn ON again. Verify that the LED's light up and the alarm sounds momentarily before the unit resumes cycling as per the settings.

2. ALARM LOUDNESS

   A. Disconnect breathing circuit at the main flow outlet. Verify that the low pressure alarm sounds.

   B. Rotate the alarm loudness knob and verify that the alarm volume increases or decreases as the knob is turned.

3. FLOW

   A. Spontaneous Flow

   1. Connect main flow outlet of the unit to RT-200 with a 24" large bore tube.

   2. Set the RT-200 to read flows.

   3. Set ventilator to spontaneous mode.

   4. Attach a reservoir bag (or plug) at the reservoir outlet.

   5. Adjust spontaneous flow to various settings and verify that flow is within $\pm$ 2 LPM of the displayed value.

   Calibration method for spontaneous flow

   1. Disengage potentiometer on spontaneous flow assembly on the back of the front panel. This is done by loosening the screw on the gear on the potentiometer.(use 1.5 mm allen wrench)

   2. Adjust display to read the same as the actual flow read by the RT-200, by turning the shaft of the pot.

   3. Tighten the screw on the gear of the pot to re-engage it electrically to the spontaneuous flow assembly.

   4. Verify calibration. (Tolerance range $\pm$ 3 LPM).

B. Main Flow

1. Adjust the front panel controls as follows:

Mode	A/C
R.R.	10 BPM
I.T.	3.0 Sec.
Spontaneous flow	OFF

2. Remove the reservoir bag (or plug) so that the reservoir outlet is open to atmosphere.

3. Attach RT-200 to the main flow outlet of the unit using a 24" adult breathing circuit tube.

4. Adjust RT-200 to read flows.

5. Set the flow on unit and verify that the flow read by the RT-200 is within the tolerance range.

6. Repeat step (5) for several settings.

NOTE: Refer to Test Record sheet for settings and their tolerance ranges.

Calibration Method for Main flow

Use the potentiometer R54 on the CPU PC board (PCB410A) to make adjustments in the flow. If the flow cannot be calibrated with R54, then use the flow potentiometer on the flow control assembly and adjust as explained in the following steps.

1. Set R54 in mid-range so that it could be used for fine flow adjustments during calibration.

2. Loosen the set screw on the potentiometer mounted on the assembly so as to disengage it electrically from the main flow assembly.

3. Adjust the display to read the same as the actual flow read by the RT-200, by turning the shaft of the potentiometer manually.

4. Tighten the set screw on the gear of the potentiometer to re-engage the potentiometer electrically to the flow assembly.

5. Verify calibration. Repeat if necessary.

TOLERANCE RANGE

SETTING	TOLERANCE
5 - 60	± 3 LPM
80	± 4 LPM
100 - 120	± 5 LPM

4. RESPIRATORY RATE

1. Adjust Inspiratory Time to 0.2 sec.

2. Set Respiratory Rate to 1 BPM.

3. With a stop-watch verify that the unit cycles at the rate of 1 BPM.

4. Connect RT-200 to the main flow of unit with 24" adult breathing tube.

5. Adjust RT-200 to read Respiratory Rate.

6. Set the Respiratory Rate on the unit to 50 BPM.

7. Verify that the RT-200 readout indicates 50 ±1.

8. Repeat steps (6) and (7) for Respiratory Rate settings of 100 and 150 BPM.

5. INSPIRATORY TIME

1. Connect RT-200 to the main flow of unit.

2. Adjust RT-200 to read Inspiratory Time.

3. Set Respiratory Rate to 10 BPM.

4. Set Inspiratory Time control to 0.1 sec.

5. Verify that Inspiratory Time read by RT-200 indicates 0.1 to 0.2 sec.

6. Verify Inspiratory Time for setting of 1.0 sec, 2.0 sec, and 3.0 sec. (tolerance range ±.1).

NOTE: For tolerance range refer to Test Record sheet.

6. A/C SIGH

1. Connect RT-200 to main flow of unit.
2. Adjust RT-200 to read Inspiratory Time.
3. Set Inspiratory Time to 2.0 sec .
4. Note the Inspiratory Time readout on the RT-200.

NOTE: The unit gives an A/C Sigh in its first breath after switching into this mode and thereafter every 100th breath is an A/C Sigh. Otherwise in this mode the unit functions the same as in A/C mode.

5. Switch the mode control to A/C Sigh.
6. Note the Inspiratory Time readout of the RT-200 in the first breath.
7. Note the Inspiratory Time in its regular breaths.
8. Verify that the Inspiratory Time is 1.5 times longer in the A/C Sigh breath than the set value of I.T.
9. Note also that the Tidal Volume display flashes and displays a larger (1.5 times) Tidal Volume in the breath that delivers an A/C Sigh breath.
10. Allow the unit to cycle and verify that every 100th breaths is an A/C Sigh breath.

7. NEBULIZER

1. Depress nebulizer switch.
2. Connect a standard pressure gauge at the nebulizer outlet.

Range: 0 - 50 psi

3. Verify that during each inspiration phase the pressure gauge indicates pressure between 16 psi to 30 psi during the full inspiration.

4. Check nebulizer pressure over the entire flow range and verify that it is between 16 PSI and 30 PSI.

NOTE: With the nebulizer switch ON the tidal volume displayed is equal to the actual tidal volume (tidal volume = flow x I.T.) plus 6 LPM. The additional 6 LPM accounts for the gas flow through the nebulizer circuit.

8. PEEP

1. Turn mode switch to spontaneuous.

2. Attach a reservoir bag to (or plug) the reservoir outlet.

3. Turn spontaneous flow to 10 LPM.

4. Turn PEEP control clockwise until PEEP holds at around 60 cmH_2O.

5. If unable to obtain 60 cmH_2O then use the following steps.

Setting of PEEP:

1. To limit the PEEP to 60 cmH_2O first adjust the PEEP to read 60 cmH_2O.

2. Using a **COLLET** wrench loosen the knob on PEEP control. (A collet wrench may be acquired from Newport Medical Instruments.).

3. Push knob on face of panel and retighten knob.

9. PEAK INSPIRATORY PRESSURE (PIP)

1. Turn mode control to SIMV or A/C plateau mode.
2. Attach a standard 750 c.c. test lung to breathing circuit.
3. Set Respiratory Rate control to 10 BPM and Inspiratory Time to 3.0 sec.
4. Turn the PIP to control knob clockwise till the pressure plateau of 60 cmH_2O is reached.
5. If unable to obtain 60 cmH_2O then use the following steps.

Setting the PIP:

1. Set the flow on the unit to 20 LPM.
2. Loosen the knob on the control and set the PIP on the unit to 60 cmH_2O.
3. Allow the unit to cycle and verify that the PIP is 60cm.H_2O.
4. Push knob on face of panel and retighten knob.

10. LEAKAGE TEST

1. Attach a 50 c.c. infant test lung on breathing circuit.
2. Turn PEEP control to maximum.
3. Set mode control to spontaneous mode.
4. Depress manual switch and observe peak pressure on manometer. Obtain a pressure of 50 - 70 cmH_2O.

CAUTION: Do not depress manual switch for more than 0.2 sec. to avoid damage to the manometer. Repeat if required.

5. If the peak pressure drops more than 5 cmH_2O in 1 minute, check the entire circuit for leakage.

NOTE: There will be an initial pressure drop due to compliance of the circuit and expiratory pressure conditions at the exhalation valve. This drop will be fairly rapid after which the pressure should hold steady. The actual leakage would be slower and the pressure would drop down finally to 0 cmH_2O.

11. TIDAL VOLUME

Verify that the Tidal Volume displayed by the unit for the following settings of flow and Inspiratory Time.

Flow(LPM)	I.T.(sec)	calculated value
30	1.0	0.5
20	2.0	0.67
40	3.0	2.0

12. TOTAL RATE

1. Set the Resp. Rate to 10 BPM.
2. Verify that unit displays Total Rate of 10 BPM. after 1 minute.
3. Initiate spontaneous breaths which are detected by the trigger level (Effort LED glows when breath is sensed i.e. when manometer needle passes through trigger level setting).
4. Verify that the total rate displayed is the total of the machine breaths delivered by the machine and the mechanical (spontaneous) breaths detected by the trigger level.
5. Set Resp. Rate to 150 BPM.
6. Verify that the unit displays Total Rate of 150 BPM after 1 minute.

13. I:E RATIO

Verify the I:E ratio displayed for the following settings of BPM and Inspiratory Time.

BPM	I.T.(Sec.)	Calculated Value of I:E Ratio
10	1.0	1:5
20	1.0	1:2
15	3.0	3:1

NOTE: The E150 has an I:E ratio ranging from 4:1 to 1:99. The display will flash when the I:E ratio exceeds 1:99.

14. MANUAL BREATH

1. Turn Resp. Rate to 10 BPM.
2. Depress the manual breath switch and verify that a breath is delivered each time the manual switch is depressed.

NOTE: The duration of the manual breath is limited to period for which the switch is depressed. The maximum duration of the breath is limited to 2.0 secs.

15. ALARM SILENCE

1. Pull out the breathing tube at the main flow outlet. The low pressure alarm will sound.
2. Depress the alarm silence switch.
3. Verify that the alarm is silenced for one minute.
4. Depress the Silence switch. The Silence display should turn on.

16. EXPIRATION TIME/LED

1. Turn the mode selector to SIMV plateau.
2. Verify that the Expiratory Time LED lights up and the display now displays Expiratory Time instead of tidal volume.

EXAMPLE:	SETTING		READING
	I.T.	R.R.	Expiratory Time
	3.00 SEC	10 BPM	3.00

NOTE: The expiratory time displayed depends on the inspiratory time and BPM settings.

17. APNEA TIME

    1. Turn mode switch to Spontaneous mode.
    2. Turn apnea time selector switch to 10 sec.
    3. Move the trigger level through the manometer needle.
    4. Verify that the Apnea Alarm sounds and its indicator light comes ON after 10 seconds.
    5. Repeat the above steps to verify that the alarm operates for all apnea time settings.

18. PRESET

    1. Turn the mode selector switch to Spontaneous mode.
    2. Notice that all the displays do not light up.
    3. Press PRESET button and verify that all the displays light up and indicate their respective control settings.

19. PRESSURE (Peak, Mean & Base)

    NOTE: Normally the pressure displayed is Mean Pressure. The Base or Peak value of the pressure will be displayed for a period of 30 seconds when the Base or Peak switch is depressed. The 30 second time will start from the time the switch is depressed. If the Base value is being displayed and the Peak switch is depressed before the 30 second time has elapsed then the machine shall reset and will now display the Peak value. The time shall be calculated from the last time the switch is depressed and will display the value for which the switch was depressed.

The preset switch should be pressed to return to the Mean value anytime the Mean value of presssure is to displayed. Otherwise the machine will return to the Mean value after the 30 second time has elapsed.

1. Press Peak Pressure button located near the pressure display. Verify that the displayed value is the peak pressure (by comparing to manometer) and that it is displayed for 30 seconds before the display returns to the Mean value.

2. Press switch for Base Pressure and verify that the pressure displayed is the Base Pressure (by comparing to the manometer) and that it is displayed for a period of 30 seconds before it returns to the Mean value.

3. Depress the Base and Peak switches one after the other in sequence and verify that the display changes to the value of the last switch depressed even before the 30 second time has elapsed.

20. MODE SELECTOR

Rotate the switch through all the modes and verify the unit's operation in the various modes.

21. TRIGGER LEVEL

1. Turn the mode selector switch to Spontaneous mode or SIMV.

2. Shift the trigger level manually so as to pass through the manometer needle.

3. Verify that the effort LED is lit up momentarily each time the needle passes through the trigger indicator.

4. Turn the mode selector switch to A/C mode.

5. Adjust Respiratory Rate to 1 BPM.

6. Repeat Step 2 and verify that the machine gives a breath each time the needle passes through the trigger sensor.

NOTE: After the end of each breath there is a trigger lockout time for which the machine will not sense any trigger effort. This lockout time is equal to 1/4th of the inspiratory time setting or a maximum of 400 msec.

22. LOW PRESSURE ALARM

1. Pull out the breathing tube at the main flow outlet.
2. Verify that the low pressure alarm sounds and the visual indicator lights up.
3. Press the Silence switch and verify that the alarm is silenced for a period of 1 minute.

23. HIGH PRESSURE ALARM

1. Adjust the high pressure alarm to 60 cm.H_2O.
2. Increase the flow and allow the unit to cycle.
3. Verify that the high pressure alarm comes on when the high pressure setting is reached and the breath is cut off.
4. Verify also that the visual indicator lights up.

24. EXTERNAL POWER OFF/POWER DISCONNECT ALARM

1. Pull out the input power cord on the rear of the unit.
2. Verify that the unit switches over to battery power and BATT PWR indicator lights up. Also verify that the Battery power alarm sounds momentarily and repeats every five minutes.
3. Connect power cord and verify that the alarms disappear.

25. BATTERY POWER

1. Run the unit on battery power until the low battery alarm sounds and its indicator lights up. Verify that the battery powers the unit for a minimum of 1 hour before the alarm comes on.

2. Recharge the battery. The battery should charge fully in a minimum of 18 Hours.

26. LOW BATTERY ALARM

1. Disconnect electric power to the unit.

2. Connect the battery terminals to an already discharged battery (or a low voltage battery).

3. Verify that the low battery alarm display lights up and that the audible alarm sounds.

NOTE: The above test can be done along with the battery power test (TEST no. 25).

27. SYSTEM FAILURE ALARM

The system failure alarm will sound when there is a malfunction in the electronics. The system failure alarm may be tested by shorting capacitor C4. When capacitor C4 is shorted a continuous alarm will sound, after approximately 3 seconds the unit should reset to the cycle mode in which it is in.

28. NURSE'S CALL/REMOTE

NOTE: To use this feature the output from unit is connected to the hospitals Nurse's call circuit. Pin Nos. 4 & 9 on the terminal marked RS232/ALARM located on the back of the unit functions like a contact which is normally open, and is closed during an alarm condition. This feature can be used for remote monitoring of the alarms.

1. Connect a multimeter across the Pins 4 & 9 of the terminal marked RS 232 to check continuity.

2. Verify that with normal operation of unit and (no alarm conditions exist) the pins show discontinuity (open contact).

3. Create an alarm condition.Verify that in an alarm condition the pins show continuity (close contact).

29. PROXIMAL

1. Pinch the proximal tubing connected to the proximal inlet.

2. Verify that the pressure in the proximal circuit rises and the manometer reads a pressure of 30 - 60 cm.H_2O.

3. If the pressure is not within the specified range, clean out or replace restrictors RES206 and RES122 in the proximal circuit. (Refer to figure 2.7, pneumatic diagram)

30. FIO_2

1. Connect a standard Oxygen Analyzer at the main flow side of the unit.

2. Remove reservoir bag and plug the outlet for the reservoir bag.

3. Set the unit to spontaneous mode.

4. Adjust the spontaneous flow to 10 LPM.

5. Set the FIO_2 at .21 and note FIO_2 read by the analyzer.

6. Repeat step 5 for FIO_2 settings of .3, .6, .9,and 1.0.

7. Verify that the FIO_2 read is within tolerance range.

TOLERANCE RANGE	
.21	20.9 - 24.0
.30	26.5 - 33.4
.60	56.5 - 63.4
.90	86.5 - 93.4
1.0	96.5 - ABOVE

CALIBRATION of FIO_2

NOTE: Use a certified O_2 analyzer for FIO_2.

1. To calibrate FIO_2, Set the spontaneous flow to maximum. (approximately 45 lpm)
2. Adjust pot R55 on CPU PC board so that the displayed value is equal to the actual FIO_2 read.
3. Turn the FIO_2 knob through its full range to verify that the display indicates full range.
4. If the display does not go through its full range adjust pot R55 to its mid position.
5. Loosen the set screw and disengage the gear on the FIO_2 pot mounted on the mixer.
6. Adjust the pot until the display reads the same as the actual FIO_2 reading.
7. Re-engage the gear with the mixer gear and tighten the set screw.
8. Verify that the display and actual FIO_2 are the same. (If not adjust pot R55 on the CPU board or repeat steps 5 to 7 until there is no difference.)
9. Turn the spontaneous flow to 10 lpm and verify the actual FIO_2 and the display read the same at several settings through the entire range.

31. HOURMETER

Record the hours indicated by the hourmeter at the end of the test.

BASE PLATE ASSEMBLY (TOP VIEW)

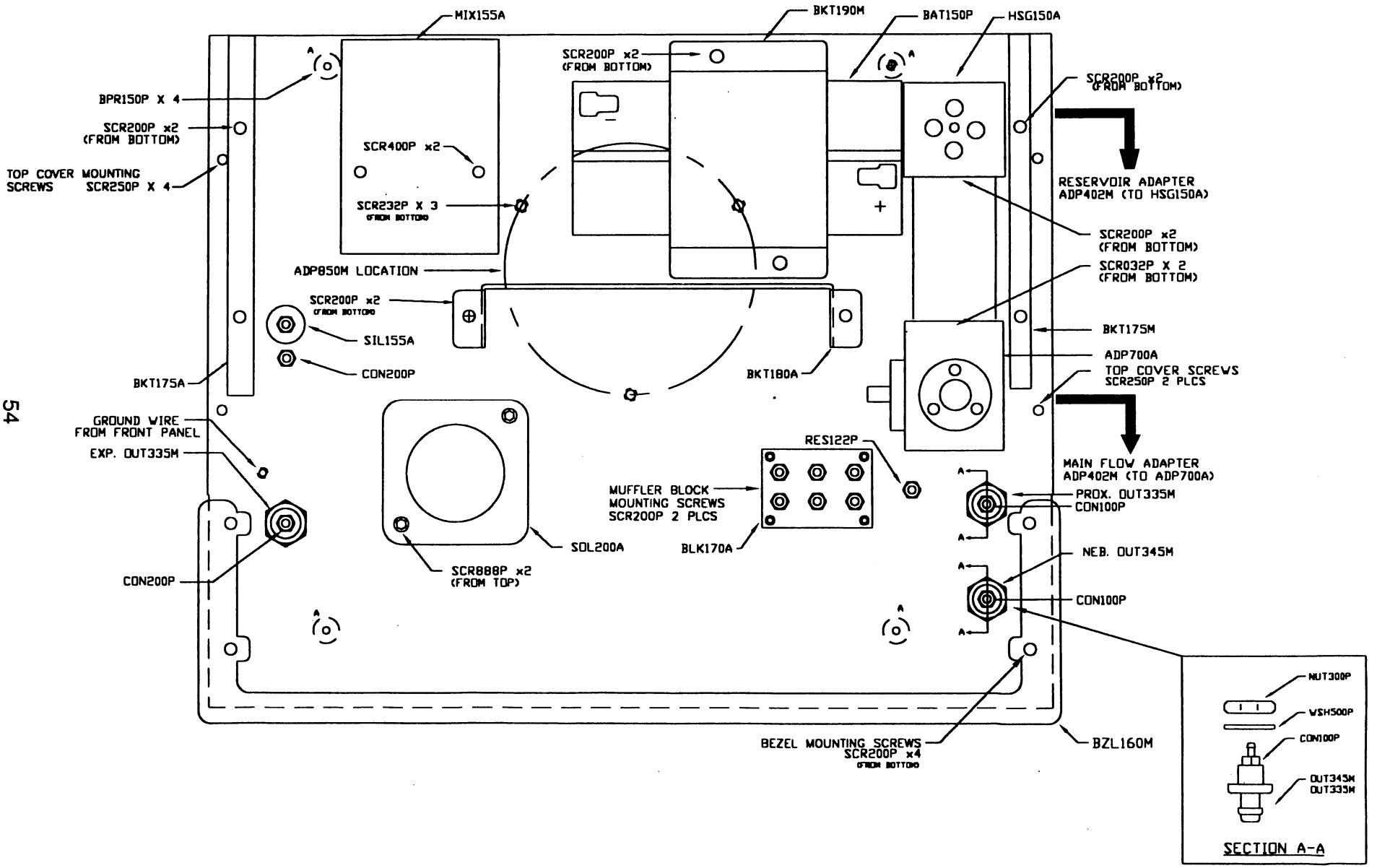
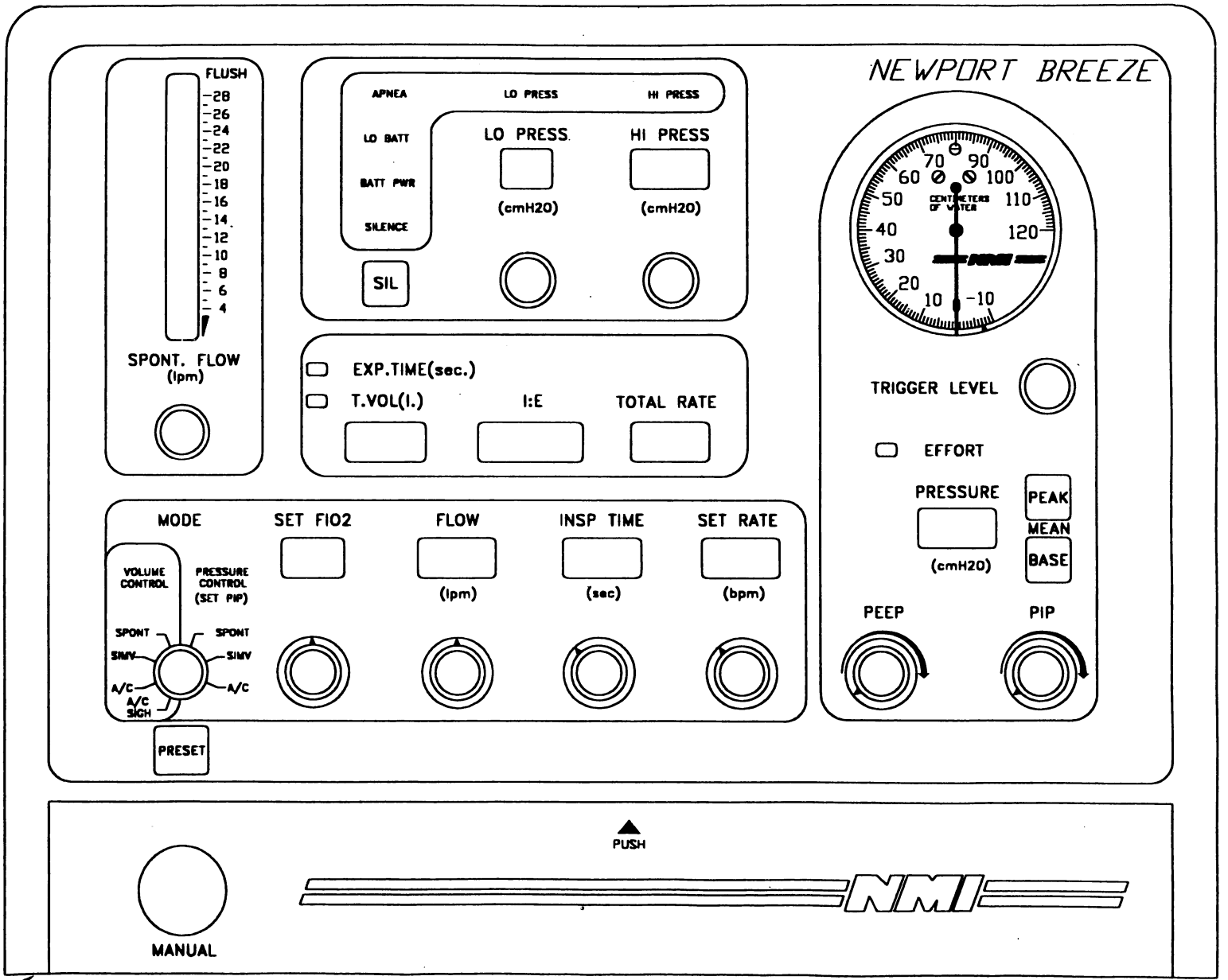


FIG. 4-1

E150 FRONT VIEW



SCR200P x 2

SCR200P x 2

FIG. 4-2

FRONT PANEL PNL150A ASSEMBLY DIAGRAM

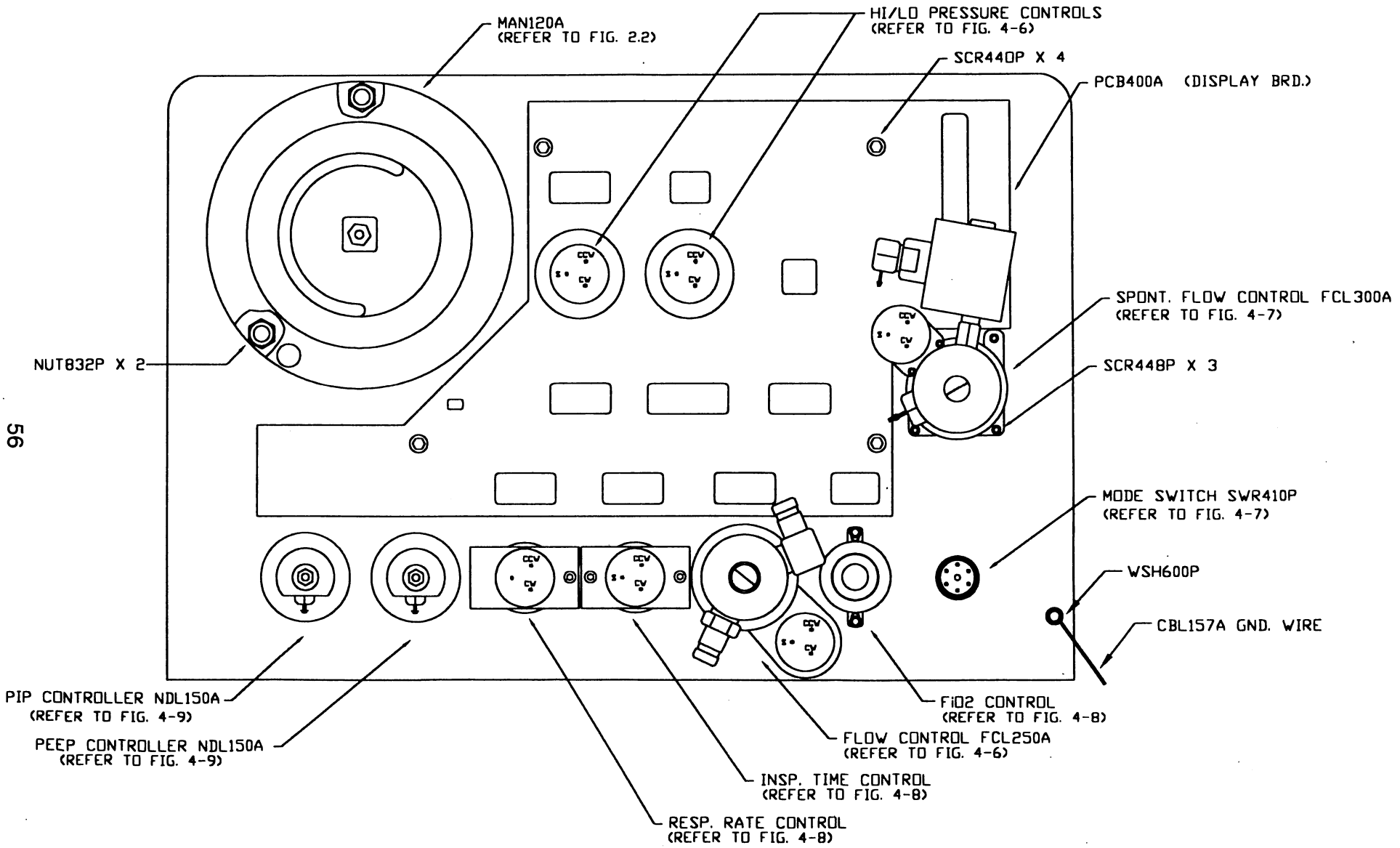


FIG. 4-3

INSIDE VIEW OF BACK PANEL

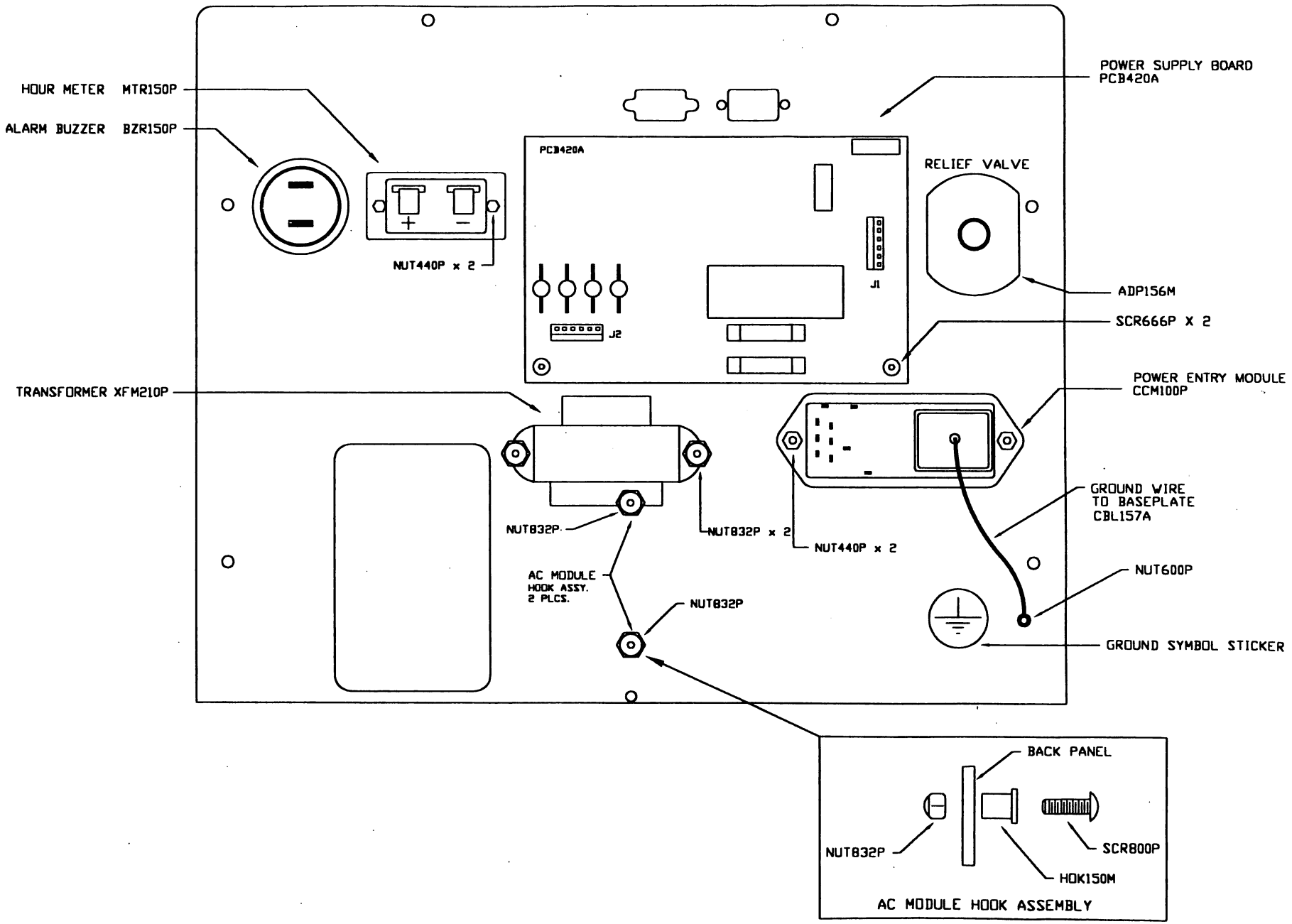


FIG. 4-4

BACK PANEL ASSEMBLY–PNL175A (BACK VIEW)

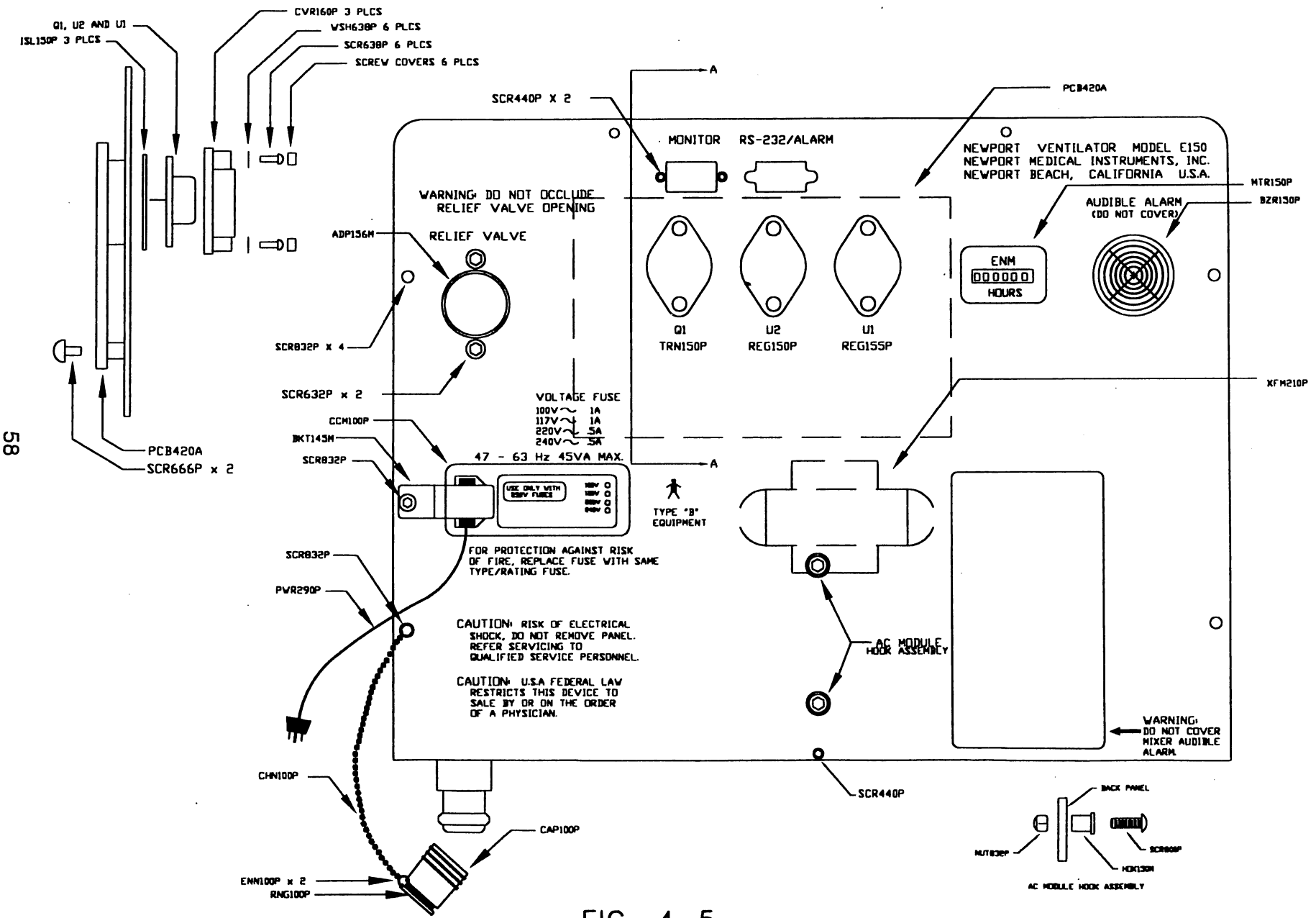


FIG. 4–5

FLOW CONTROLLER FCL250A AND HI/LO PRESSURE CONTROL ASSEMBLIES

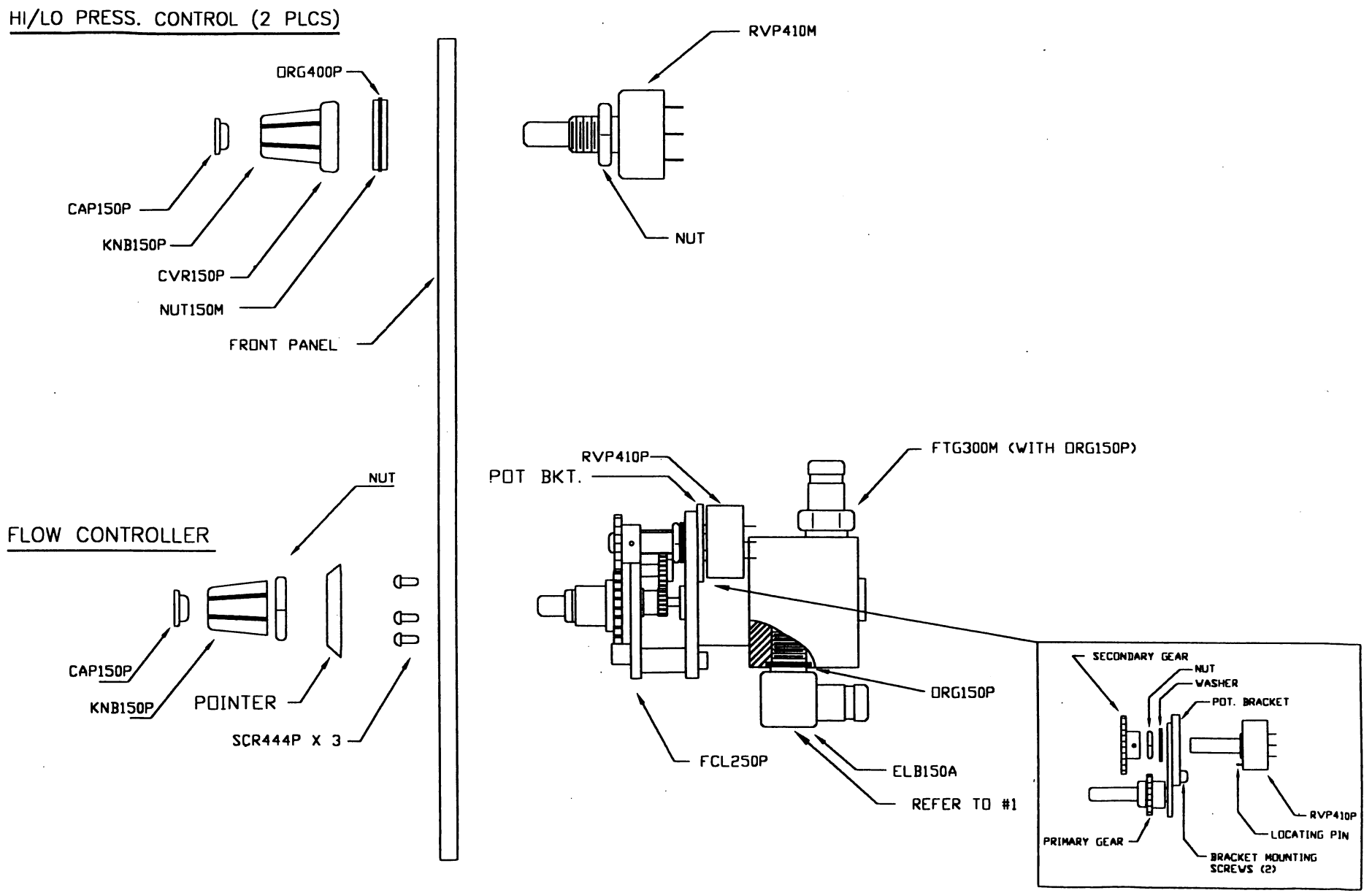


FIG. 4-6

SPONT. FLOW FCL300A AND MODE SWITCH SWR410P ASSEMBLY DIAGRAM

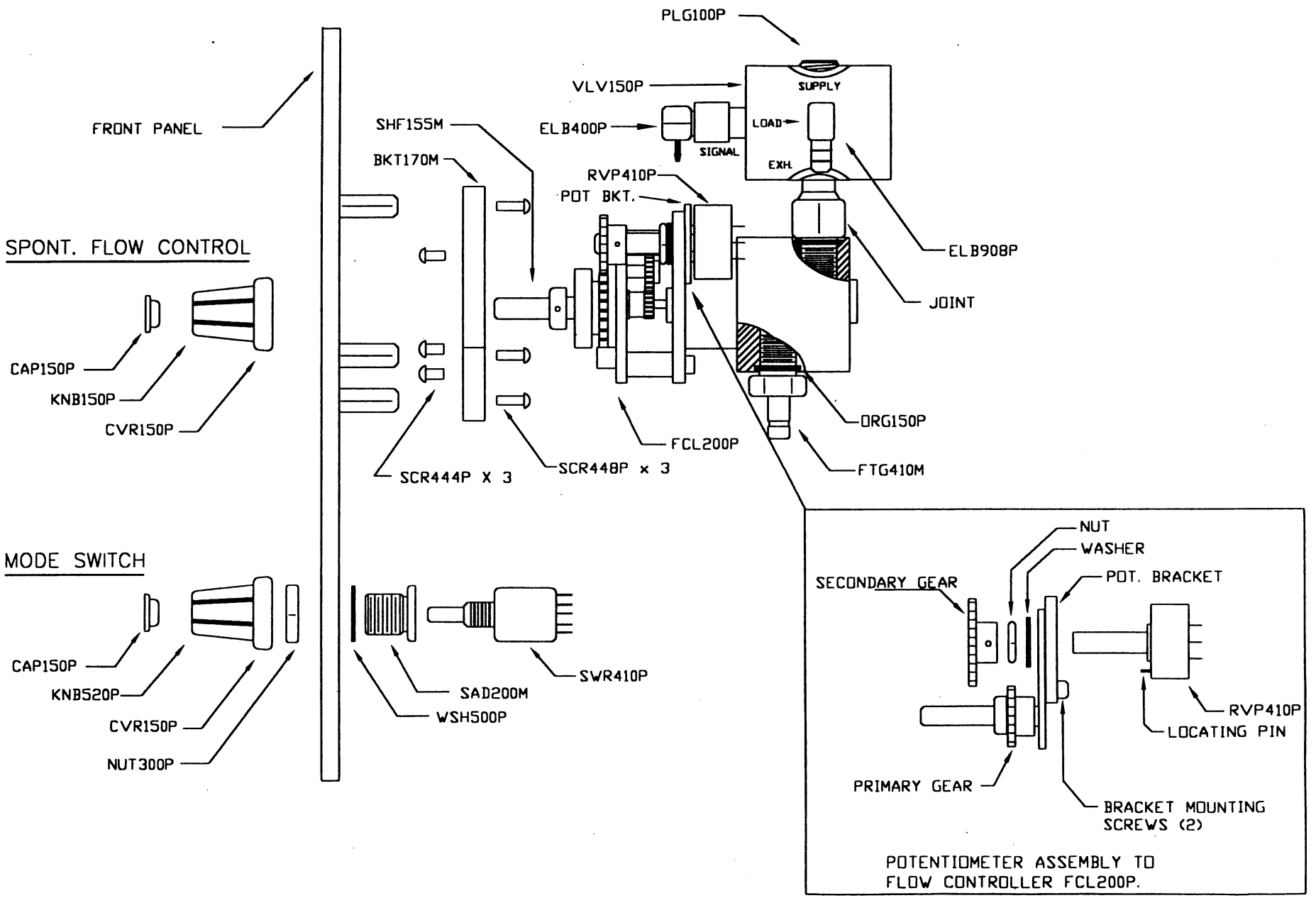


FIG. 4-7

I.T./R.R. POTENTIOMETER (RVP410P) ASSEMBLY AND MIXER SHAFT ASSEMBLY.

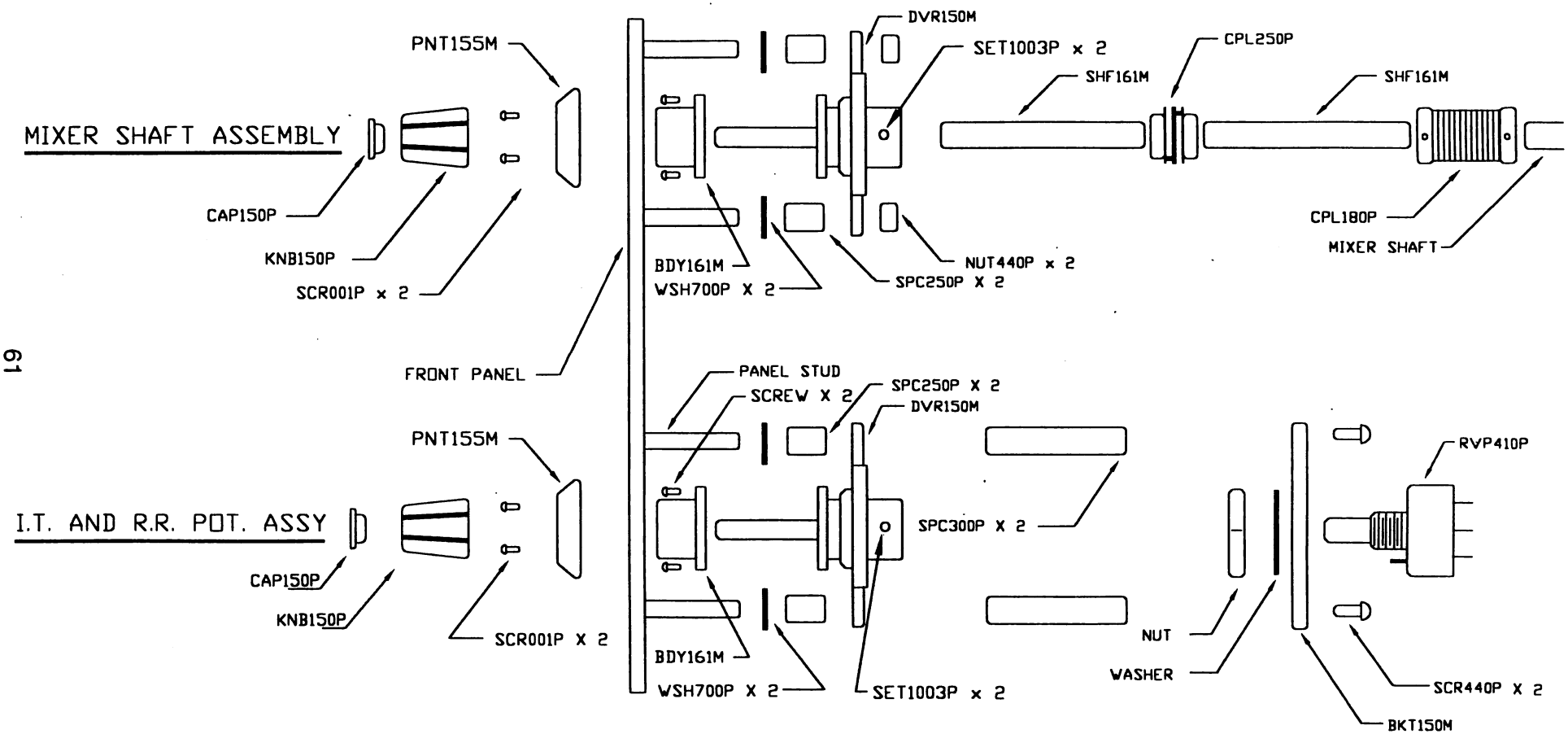


FIG. 4-8

PEEP/PIP ASSEMBLY REG310A

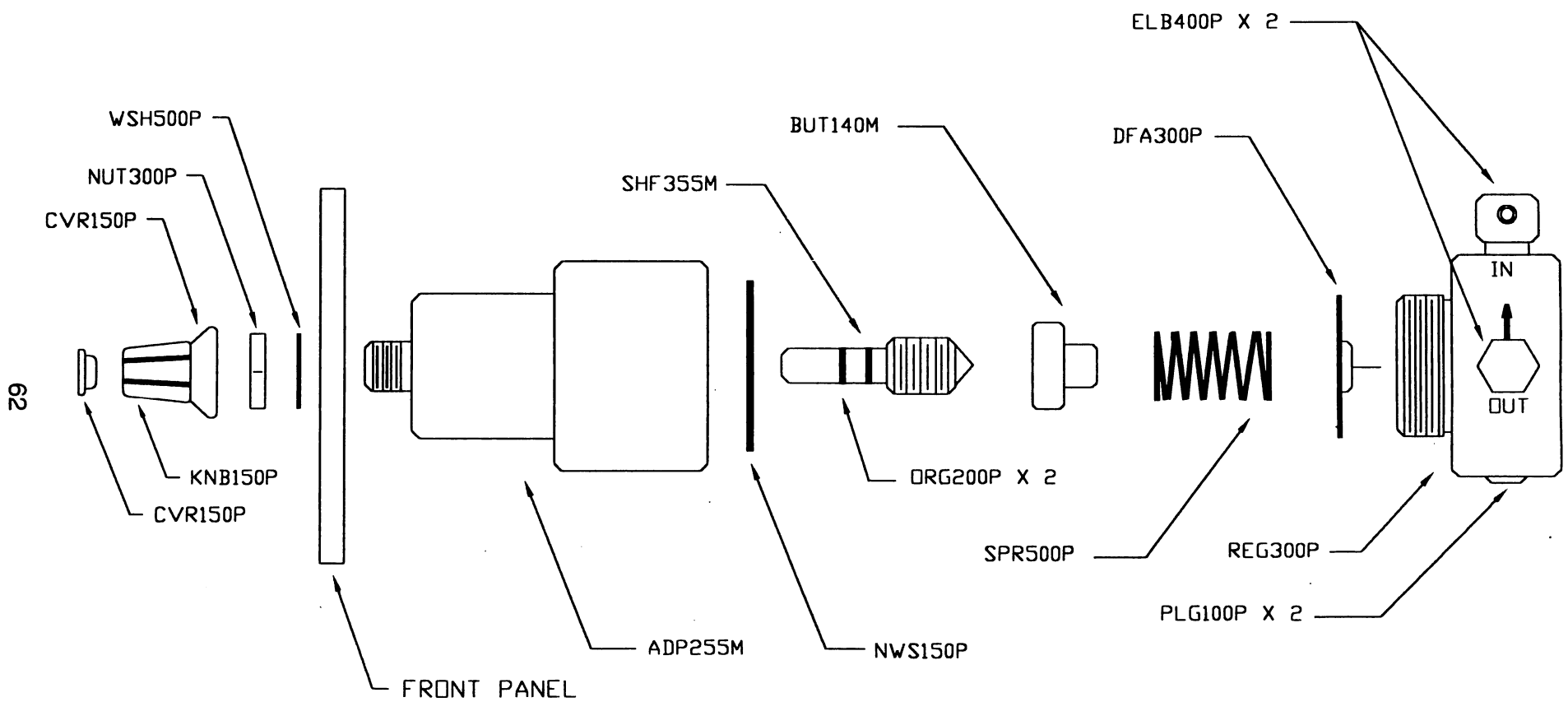
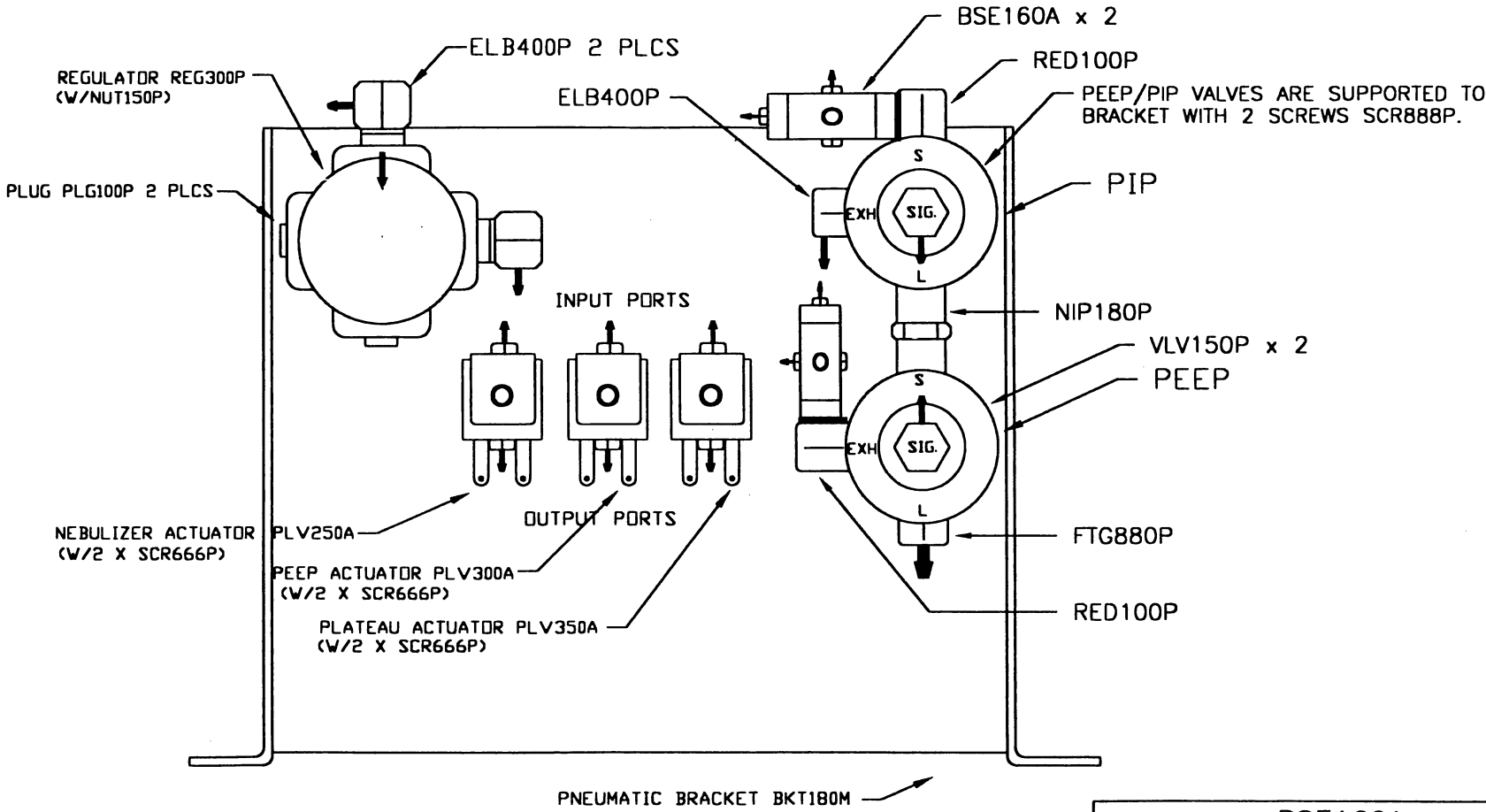


FIG. 4-9

PNEUMATIC BRACKET ASSEMBLY BKT180A



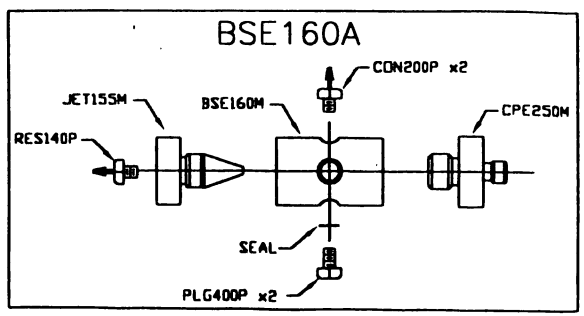


FIG. 4-10

WARRANTY

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