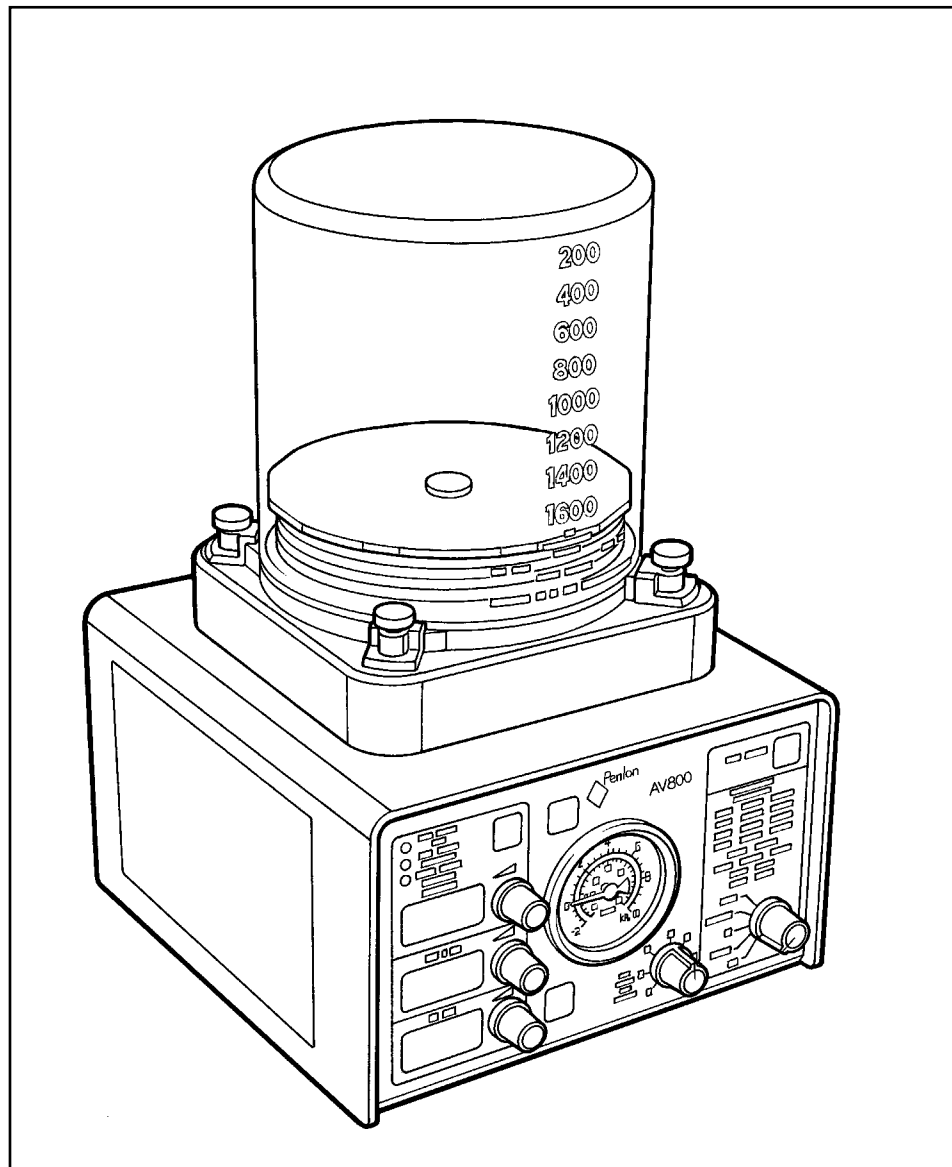


InterMed

Penlon

# AV800 Anaesthesia Ventilator Service Manual



**Quality and Assurance in Anaesthesia**



# IMPORTANT

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## Servicing and Repairs

In order to ensure the full operational life of this ventilator, servicing by a **Penlon-trained engineer** should be undertaken periodically.

The ventilator must be serviced to the following schedule:

- (a) Six monthly service - inspection and function testing.
- (b) Annual service.
- (c) Five year major service including battery replacement.

Details of these operations are given in this AV800 Service Manual, available only for Penlon trained engineers.

For any enquiry regarding the servicing or repair of this product, contact the nearest accredited Penlon agent:

or communicate directly with:

Technical Support  
Penlon Limited  
Abingdon  
OX14 3PH  
UK

Tel: +44 (0) 1235 547076  
Fax: +44 (0) 1235 547062  
E-mail: [technicalsupport@penlon.co.uk](mailto:technicalsupport@penlon.co.uk)

Always give as much of the following information as possible:

1. Type of equipment
2. Product name
3. Serial number
4. Approximate date of purchase
5. Apparent fault

# FOREWORD

---

This manual has been produced to provide authorised personnel with information on the function, routine performance, servicing, maintenance checks and repairs applicable to the AV800 Anaesthesia Ventilator.

Information contained in this manual is correct at the date of publication.

The policy of Penlon Limited is one of continued improvement to its products.

Because of this policy, Penlon Limited reserves the right to make any changes which may affect instructions in this manual, without giving prior notice.

Personnel must make themselves familiar with the contents of this manual and the machine's function before servicing the apparatus.

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# USER RESPONSIBILITY

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This anaesthesia ventilator has been built to conform with the specification and operating procedures stated in this manual and/or accompanying labels and notices when checked, assembled, operated, maintained and serviced in accordance with these instructions.

To ensure the safety of this device it must be checked and serviced to at least the minimum standards laid out in this manual. A defective, or suspected defective, product must not under any circumstances be used.

The user must accept responsibility for any malfunction which results from non-compliance with the servicing requirements detailed in this manual.

Additionally, the user must accept responsibility for any malfunction which may result from misuse of any kind or non-compliance with other requirements detailed in this manual.

Worn, broken, distorted, contaminated or missing components must be replaced immediately. Should such a repair become necessary it is recommended that a request for service advice be made to the nearest accredited Penlon agent.

This device and any of its constituent parts must be repaired only in accordance with written instructions issued by Penlon Limited and must not be altered or modified in any way without the written approval of Penlon Limited. The user of this equipment shall have the sole responsibility for any malfunction which results from improper use, maintenance, repair, damage or alteration by anyone other than Penlon or its appointed agents.

USA and Canadian Federal Law restricts the sale and use of this device to, or on the order of, a licensed practitioner.

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

**WARNING**      *means there is a possibility of injury to yourself or others.*

**CAUTION**      *means there is a possibility of damage to the apparatus or other property.*

**NOTE**            *indicates points of particular interest for more efficient and convenient operation.*

Always take particular notice of the warnings, cautions and notes provided throughout this manual.

# 1. WARNINGS AND CAUTIONS

---

The following WARNINGS and CAUTIONS must be read and understood before servicing or repairing this ventilator.

## WARNINGS

### General Information

1. *Personnel must make themselves familiar with the contents of this manual and the machine's function before using the ventilator.*

### Servicing and Repair

2. *Opening the control unit by unauthorised personnel automatically voids all warranties and specifications.*

*Prevention of tampering with the control unit is exclusively the user's responsibility. If the control unit seal is broken, the manufacturer assumes no liability for any malfunction or failure of the ventilator.*

3. *Great care must be taken not to damage the precision surface of the valve seat on the patient gas exhalation diaphragm valve in the base of the bellows assembly.*

*Never use any hard object or abrasive detergent to clean it; use only a soft cloth. If the valve seat is damaged, the valve will leak and may cause serious ventilator malfunction.*

4. *For continued protection against fire hazards, replace the two fuses only with the identical type and rating of fuse. See section 4.39 for fuse rating.*

5. *If the internal battery is fully discharged, the ventilator will not function in the event of mains power failure. The battery must be recharged before the ventilator is used clinically, otherwise backup*

*cannot be guaranteed. See section 8 for battery maintenance. See also CAUTION No. 7.*

6. *No oil, grease or other flammable lubricant or sealant must be used on any part of the machine in close proximity to medical gas distribution components. There is a risk of fire or explosion.*
7. *Exterior panels must not be removed by unauthorised personnel and the apparatus must not be operated with such panels missing. There is a possible electric shock hazard. Always disconnect the ventilator from the mains electrical supply and drive gas supply before removing the cover.*

### Before Using the Ventilator

8. *Before the ventilator is used clinically for the first time, verify that the hospital engineering department has carried out an earth continuity test.*

9. *Excessive electronic noise caused by other poorly regulated devices, such as an electrocautery unit, may adversely interfere with the proper functioning of the ventilator.*

*To avoid this problem, do not connect the ventilator's power cord into the same electrical wall outlet or adaptor strip into which an electrocautery unit is connected.*

10. *If used with a mains extension cord, the unit may be subject to electro-magnetic interference.*

11. *The driving gas supply must be clean and dry to prevent ventilator malfunction.*



# WARNINGS AND CAUTIONS

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12. *This ventilator is designed to be driven by oxygen or medical air only. It is calibrated during manufacture for use with either gas.*

*Before the ventilator is used clinically for the first time, the commissioning engineer must confirm that the internal Air/Oxygen switch is set correctly for the gas that is to be used.*

*The use of any other gas will cause inaccurate operation and may damage the ventilator, resulting in potential injury to the patient.*

13. *The driving gas is discharged through the opening in the back of the ventilator control unit. This opening is labelled: EXHAUST DO NOT BLOCK and must be completely free of any obstruction and nothing should be connected to it.*

*The discharged gas does not contaminate the environment, but on machines using oxygen as the drive gas it can cause a fire hazard if allowed to accumulate.*

*In addition, do not block the PRV outlet on the back of the control unit, and also the pneumatic system outlet on the base of the unit.*

14. *The bellows can only support approximately 1 kPa (10 cmH<sub>2</sub>O) differential positive pressure, above which it may be dislodged from the mounting ring, resulting in dangerous malfunction of the ventilator.*

*Do not connect a PEEP valve or other restrictive device to the exhaust port on the bellows base.*

*This would increase the pressure inside the bellows and the bellows could detach from the base, causing serious malfunction.*

15. *The breathing system which conveys gases from the anaesthetic machine to the patient, and disposes of expired gases, is a vital part of the anaesthetic delivery system.*

*Because breathing systems require frequent cleaning and disinfection they are not a permanent part of the anaesthetic ventilator and therefore cannot be directly under the control of the anaesthetic ventilator manufacturer.*

*However, we strongly recommend that only breathing systems which have been approved and authorised by Penlon for use with AV800 should be employed.*

*Do not use conductive or anti-static breathing system hoses.*

16. *Applying negative or positive pressure to the exhaust port may result in positive or negative pressure in the patient breathing system. Therefore the scavenging system must not generate more than 0.5 cmH<sub>2</sub>O positive or negative pressure when connected to the ventilator.*

*Any problem arising from an improperly functioning scavenging system is solely the user's responsibility.*

17. *Do not connect a spirometer to the exhaust port on the bellows base. The device will not measure exhaled volumes.*

18. *The operation of each alarm function should be verified daily. See section 5.3.1.*

*Periodically check the alarms at suitable intervals. If the audible alarm or the visual indicator of any alarm function fails to activate during any alarm condition or fails to reset after the alarm has been cleared, refer the unit to an authorised service technician.*

# WARNINGS AND CAUTIONS

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19. *Before using the ventilator check that all connections are correct, and verify that there are no leaks.*

*Patient circuit disconnects are a hazard to the patient. Extreme care should be taken to prevent such occurrences.*

*It is recommended that Penlon Safelok fittings are used throughout the breathing circuit.*

## Using the Ventilator

20. *This apparatus must not be used with, or in close proximity to, flammable anaesthetic agents.*

*There is a possible fire or explosion hazard.*

21. *Anaesthesia apparatus must be connected to an anaesthetic gas scavenging system to dispose of waste gas and prevent possible health hazards to operating room staff. This requirement must be observed during test procedures as well as during use with a patient. Any problem arising from an improperly functioning scavenging system is solely the user's responsibility.*

22. *When the ventilator is connected to a patient, it is recommended that a qualified practitioner is in attendance at all times to react to an alarm or other indication of a problem.*

23. *In compliance with good anaesthesia practice, an alternative means of ventilation must be available whenever the ventilator is in use.*

24. *The AV800 is not equipped with an oxygen analyser. It is recommended that the patient oxygen concentration be*

*monitored continuously, at or near the proximal airway with an oxygen monitor that includes high/low alarms.*

25. *If the drive gas supply pressure drops below a nominal 262 kPa (38 psig), the LOW DRIVE GAS SUPPLY alarm will activate both audibly and visually. Patient minute volume may be reduced due to lowered flow rates*

26. *An audible alarm indicates an anomalous condition and should never go unheeded.*

27. *The characteristics of the breathing circuit connected between the ventilator and the patient can modify or change patient ventilation.*

*To assist the maintenance of the delivered patient tidal volume, the ventilator control system software includes a compliance compensation algorithm.*

*However, patient ventilation must be monitored independently from the ventilator.*

*It is the responsibility of the user to monitor patient ventilation.*

28. *On models with spirometry, the spirometer flow sensor must be installed in the expiratory limb of the breathing circuit.*

*A breathing system filter, or heat and moisture exchanger (HME), must be connected upstream of the sensor to prevent blockage of the side-stream sample lines*

29. *The Vent Inop (ventilator inoperative) alarm indicates that one of the following conditions has occurred:*

- A) A solenoid has failed.*
- B) The flow control valve has failed.*
- C) Internal electrical fault.*
- D) Internal communications error*

# WARNINGS AND CAUTIONS

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- E) Battery disconnected*
- F) Software error*

**Note that if a ventilator error is detected, an error code will be displayed in the Rate BPM display window on the front control panel.**

30. **The High and Low Airway Pressure Alarms are important for patient care.**  
**The ventilator is designed to be used with a distal sensing tee only. (Catalogue No. 53194, Breathing System Tee Assembly - see section 8 in the user manual).**

**The distal sensing tee must be located close to the circle system, in the inspiratory limb of the circuit between the patient and the circle system inspiratory one way valve. See section 5.1.4.**

- 4. *The exhalation valve located in the bellows base assembly and the paediatric bellows adaptor must be cleaned and sterilised separately. See sections 7.2 and 7.3.*
- 5. *Care must be taken not to let any liquid run into the control unit; serious damage may result.*
- 6. *Always check for correct fitment, and carry out a full function test before clinical use, if the bellows has been removed and refitted for any reason. See sections 5.2 and 7.2.*
- 7. *Damage may occur to the battery if it is allowed to remain in a discharged state.*

*Check the battery frequently if the ventilator is in storage (see Appendix 1).*

## CAUTIONS

- 1. *Do not sterilise the ventilator control unit.*  
*The internal components are not compatible with sterilisation techniques and damage may result.*
- 2. *For ventilator components which require sterilisation, peak sterilisation temperatures should not exceed 136°C (275°F) to prevent possible damage. (See sections 7.2 and 7.3).*
- 3. *Those parts suitable for ethylene oxide sterilisation should, following sterilisation, be quarantined in a well ventilated area to allow dissipation of residual gas absorbed by the components.*

*Follow the steriliser manufacturer's recommendations for any special aeration periods required.*



## 2. PURPOSE

---

The AV800 Ventilator is a software controlled, multi-mode ventilator, designed for mechanical ventilation of adult and paediatric patients under general anaesthesia.

In addition, in spontaneous mode, it can be used to monitor spontaneously breathing patients

It is designed for use in closed-circuit anaesthesia and also to drive a Mapleson D circuit.

### 3. DESCRIPTION

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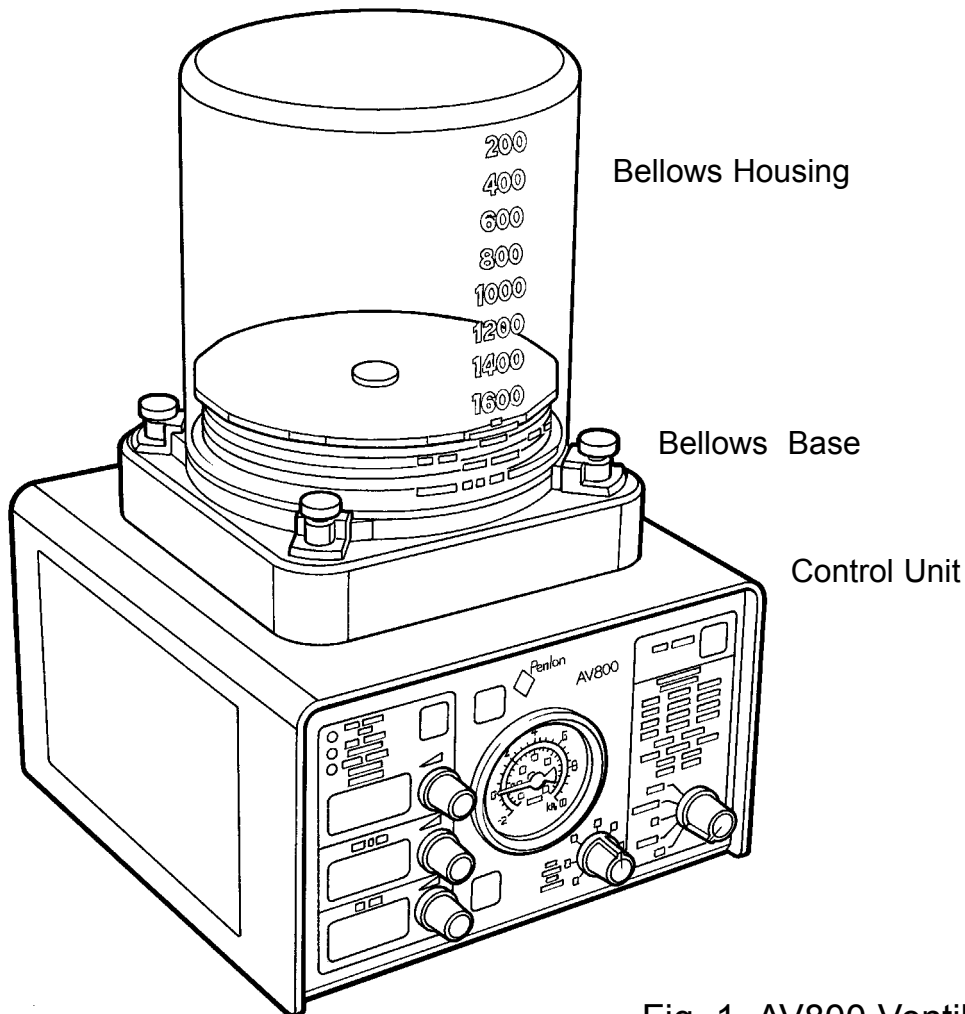


Fig. 1 AV800 Ventilator

#### 3.1 General

The AV800 is a multi-mode, time-cycled, volume/pressure controlled, and pressure limited ventilator for closed circuit ventilation or for use with a Mapleson D circuit.

The ventilator is compliance compensated and has a user selectable option of an inspiratory pause fixed at 25% of the inspiratory time.

The print function provides a permanent record of function activity for up to eight hours during a procedure.

The bellows unit can be easily detached and then refitted to the bellows base assembly to facilitate cleaning.

The ventilator drive gas supply can be oxygen or air, and the supply must be at 38 to 100 psig. Note that the drive gas is specified by the customer prior to delivery. To change the drive gas, refer to a Penlon-trained service engineer.

Models are available with a manometer and/or spirometry, and the ventilator can be used with power supplies from 110 to 240 VAC.

**All components used in the ventilator, including the bellows, are latex-free ( but note that the optional paediatric bellows is not latex free).**

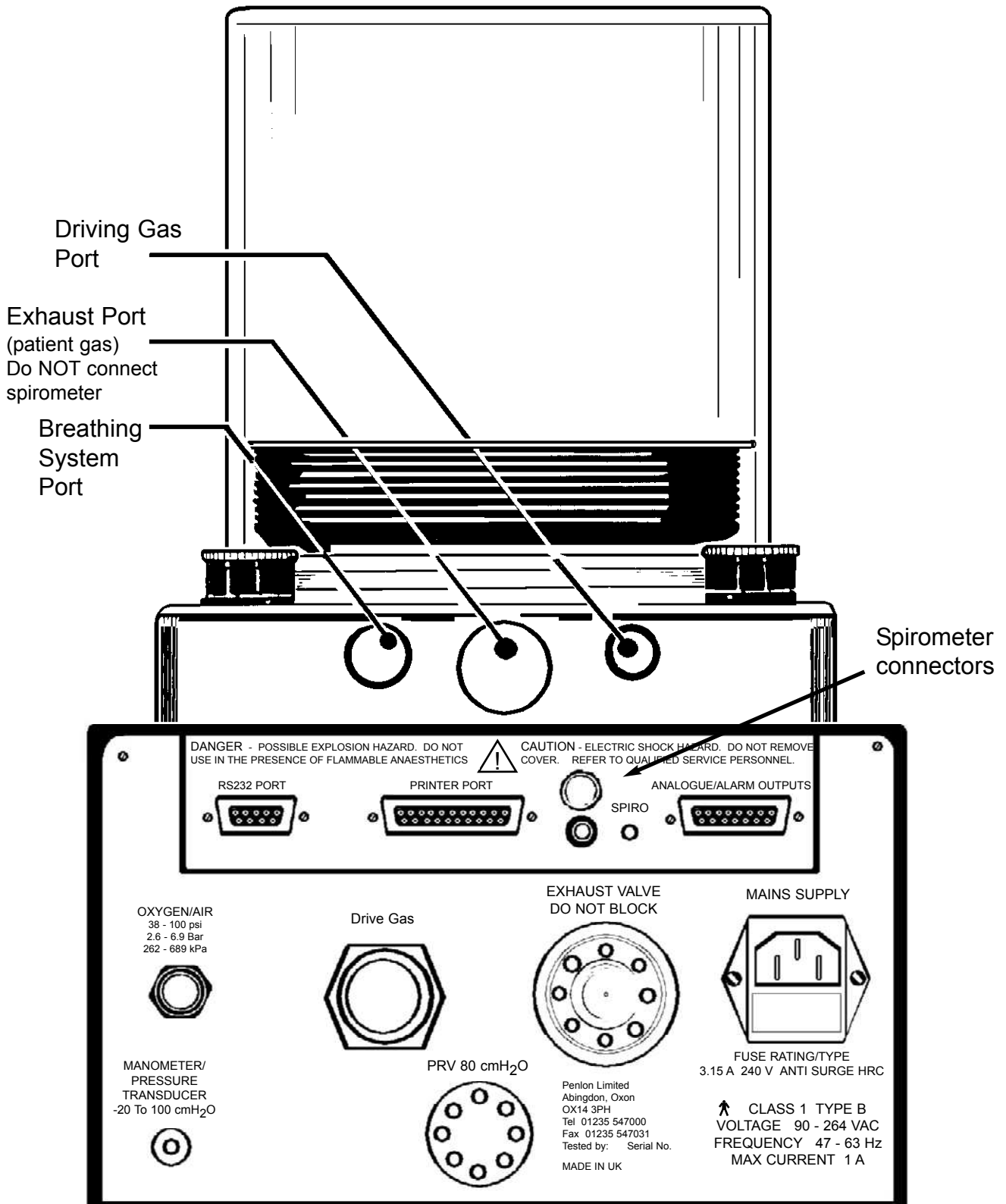


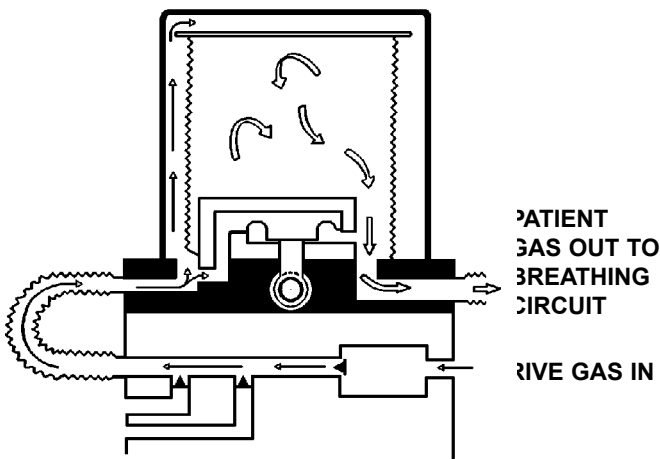
Fig. 2 Ventilator Rear Panel and Gas Ports

# DESCRIPTION

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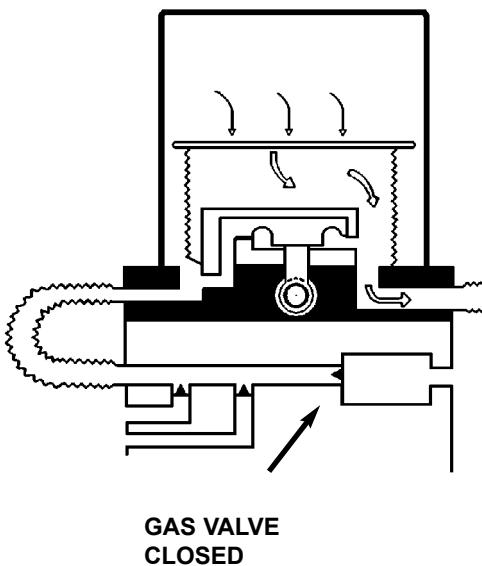
## 3.2 Ventilation Cycle

This section provides a simplified description of the ventilation cycle.



### 1. Beginning of Inspiratory Phase

Drive gas pressure builds up above the bellows, which starts to move down, forcing patient gas into the breathing system.



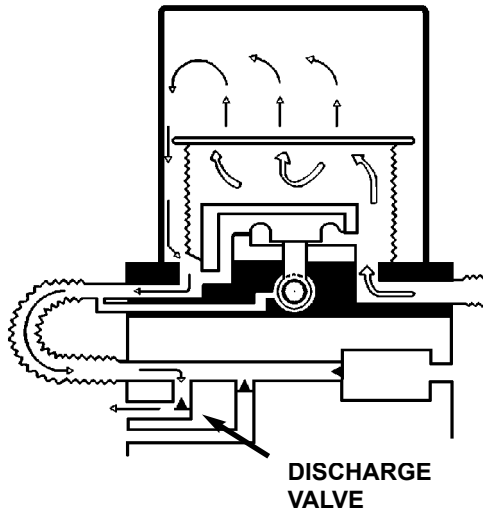
### 2. End of Inspiratory Phase

The main drive gas valve closes and the bellows stops moving.



# DESCRIPTION

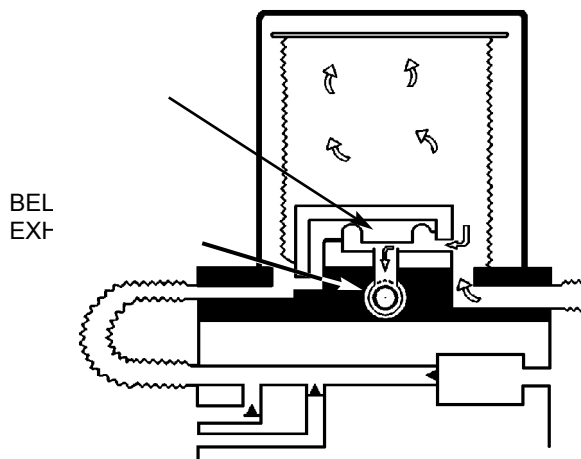
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### 3. Beginning of Expiratory Phase

The discharge valve opens, allowing the drive gas above the bellows to escape to atmosphere.

The bellows starts to rise and exhaled gas enters the bellows.



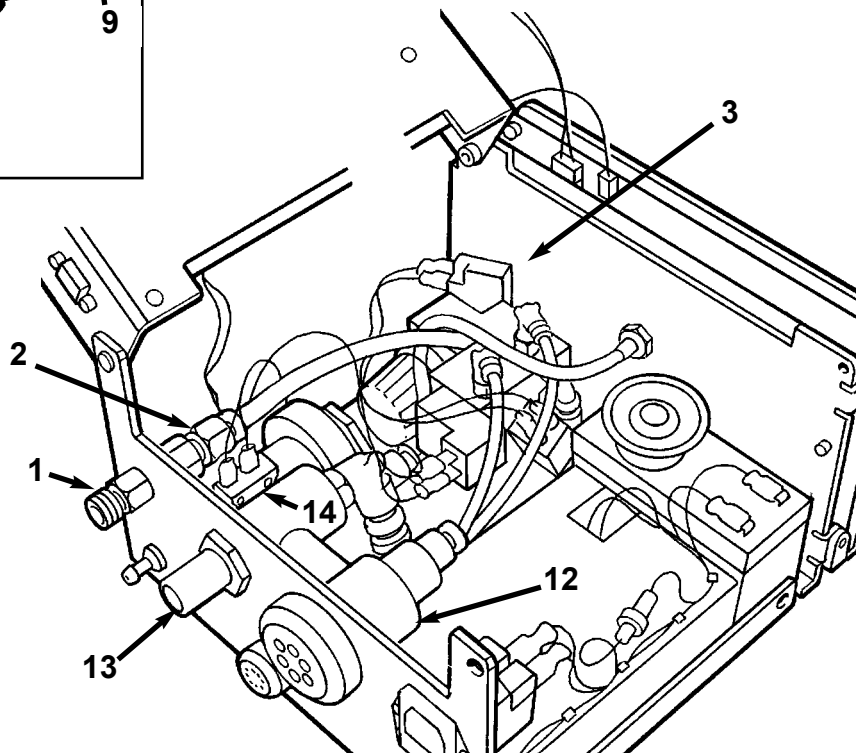
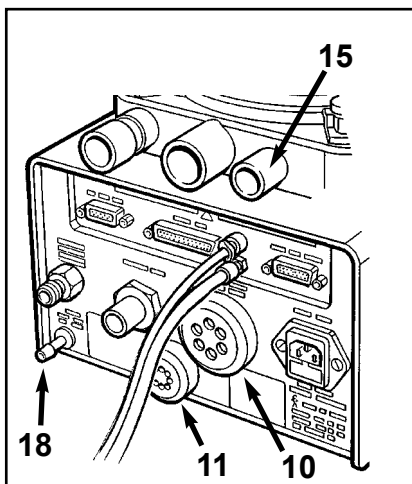
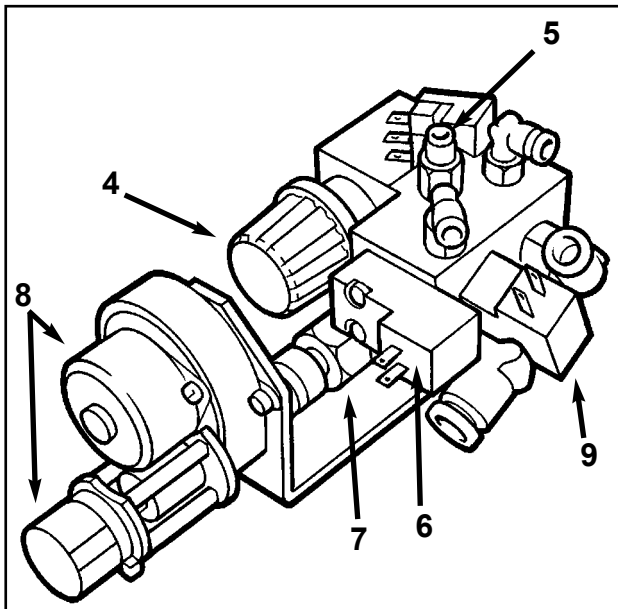
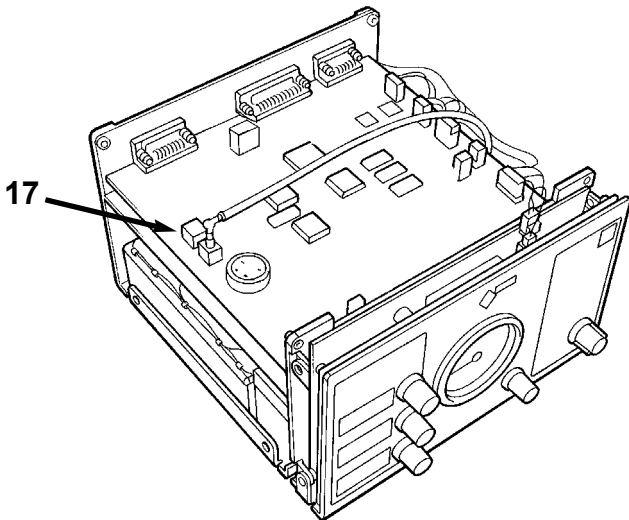
### 4. End of Expiratory Phase

The bellows exhalation diaphragm valve in the base of the bellows assembly opens when the bellows reaches the top of the chamber.

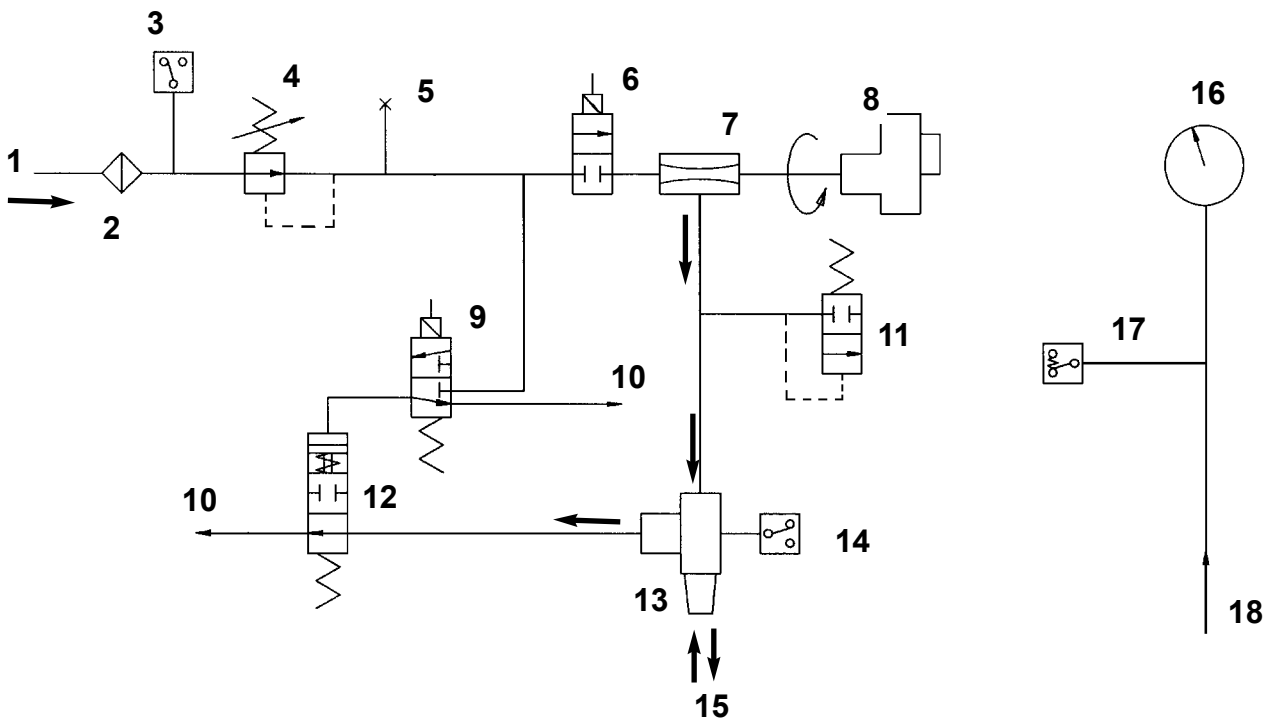
Patient circuit gas exits through the bellows assembly exhaust port.

## PNEUMATIC SYSTEM COMPONENTS

1. Gas supply inlet
2. Input gas filter
3. Low supply pressure detector
4. Input pressure regulator
5. Test point
6. Inspiratory valve
7. Drive gas flow metering valve
8. Stepper motor and feedback potentiometer (for 7)
9. Expiratory valve
10. Exhaust outlets (outlet on rear panel as illustrated, the outlet through the base of the control unit is not shown)
11. Pressure relief valve
12. Exhaust valve
13. Bellows drive gas connector
14. Driving gas over-pressure switch
15. Bellows driving gas port
16. Pressure gauge
17. Pressure transducer
18. Inlet from breathing circuit / manometer connection



# DESCRIPTION



## PNEUMATIC SYSTEM DIAGRAM

- |    |  |     |   |
|----|--|-----|---|
| 1. | Gas supply                                       | 10. | Exhaust outlets                                     |
| 2. | Input gas filter                                 | 11. | Pressure relief valve                               |
| 3. | Low supply pressure detector                     | 12. | Exhaust valve                                       |
| 4. | Input pressure regulator                         | 13. | Bellows drive gas connector                         |
| 5. | Test point                                       | 14. | Driving gas over-pressure switch                    |
| 6. | Inspiratory valve                                | 15. | Bellows driving gas port                            |
| 7. | Drive gas flow metering valve                    | 16. | Pressure gauge                                      |
| 8. | Stepper motor and feedback potentiometer (for 7) | 17. | Pressure transducer                                 |
| 9. | Expiratory valve                                 | 18. | Inlet from breathing circuit / manometer connection |

### 3.3 Pneumatic System

Refer to the system diagrams above.

The AV800 Ventilator is designed to operate on a 38-100 psig drive gas supply (oxygen or air - to customer's requirement).

The gas source is connected to the Drive Gas Supply DISS fitting on the rear of the ventilator control unit and should be capable of a flow rate of 75 L/min while maintaining a minimum pressure in excess of 38 psig.

The drive gas is filtered with a 40-micron Input Gas Filter which protects the pneumatic components from incoming particulate matter.

The Low Supply Pressure Detector is a pressure switch set at a predetermined level to detect a loss or reduction of the input gas source pressure. When the pressure falls below 38 psig (262 kPa), the LOW SUPPLY PRESSURE indicator will illuminate and the high priority alarm will activate.

# DESCRIPTION

---

The Input Pressure Regulator conditions the input drive gas to a stable 35 psig pressure which will operate the internal pneumatic system.

The Inspiratory Valve is a large orifice, electro-pneumatically-driven valve which supplies the drive gas to the Drive Gas Flow Metering Valve .

The Drive Gas Flow Metering Valve is a variable-orifice needle valve which determines the drive gas flow rate of the bellows during inspiration.

The Valve Position Feedback Potentiometer and the Flow Control Motor function together to set a flow rate as required by the front panel controls.

The flow from the Drive Gas Flow Metering Valve goes to the Bellows Assembly, via the drive connector, closes the exhalation diaphragm valve and pushes the bellows downward.

As the bellows moves downwards, the gas inside the bellows is forced into the Breathing System.

At the end of inspiration the exhaust valve opens and allows the drive gas in the top of the bellows housing to exhaust out through the Exhaust Outlet.

As the pressure in the top of the bellows housing is reduced to zero, the patient exhales into the breathing system and the bellows rises.

## Compliance Compensation

### **WARNING**

*The AV800 has compliance compensation but the actual tidal volume delivered to the patient may be different to the ventilation parameters set by the user due to:*

- A) an extreme compliance condition,*
- B) a substantial system leak, or*
- C) patient circuit pressure effects.*

*In addition, high fresh gas flows will lead to an increased  $V_t$  being delivered to the patient.*

*Note that on models fitted with*

*spirometry, the actual tidal volume exhaled will be displayed.*

*The patient must be monitored independently from the ventilator. It is the responsibility of the user to monitor the patient for adequate ventilation.*

A compliance compensation algorithm is built into the control software which monitors the volume of gas delivered and the rate of pressure rise.

It calculates an additional volume to deliver into the breathing system to compensate for the reduced volume delivered to the patient as a result of the increased breathing system pressure.

As a safety feature, this additional volume is restricted to a maximum of 15% of the set tidal volume irrespective of the maximum pressure rise.

## User Selectable Inspiratory Pause

A user selectable inspiratory pause is provided which, when activated, holds the inspiratory phase at the end of inspiration, for a period of 25% of the inspiratory time before reverting to the expiratory phase.

### **NOTE**

*This function is not available in PRESSURE controlled cycle*

## Automatic altitude compensation

Ambient pressure is monitored and the ventilator automatically compensates the delivered volume according to the local atmospheric pressure.

## Manometer (if fitted)

The manometer connection is connected to the pressure gauge.

## Patient Gas Pressure Transducer

The Patient Gas Pressure Transducer is connected to the patient breathing system via the manometer connection.

In VOL CYCLE mode whenever this pressure exceeds the maximum working

# DESCRIPTION

---

pressure as set on the front panel an alarm is activated and the following occurs:

1. The HIGH AIRWAY PRESSURE visual indicator is illuminated (high priority alarm).
2. The audible alarm is activated (high priority alarm).
3. The Inspiratory Valve is closed, and the inspiration cycle is ended.  
Note that the rate of breaths per minute will be affected in this condition as the ventilator will cease to deliver flow above the maximum working pressure.

## **WARNING**

***If this warning is ignored, the patient may receive an insufficient minute volume.***

In PRESSURE controlled mode, when the set pressure is reached the following occurs:

1. The Inspiratory valve is closed.
2. The ventilator maintains the set pressure until the end of the inspiration cycle.

## **High Pressure Protection**

High pressure in the ventilator is limited by three independent protective systems.

The pressure transducer has already been described.

In addition, the Driving Gas Over-pressure switch is set at 80 cmH<sub>2</sub>O and will shut off drive gas flow at this value.

Further, the Pressure Relief Valve is a mechanical over-pressure relief which will open at 80 cmH<sub>2</sub>O, diverting the driving gas to atmosphere through the PRV exhaust port.

The Exhaust Outlets on (a) the back of the control unit, and (b) the base of the control unit, accept the drive gas exhaust from all internal pneumatic components.

## **3.4 Control Unit**

### **Ventilator parameters:**

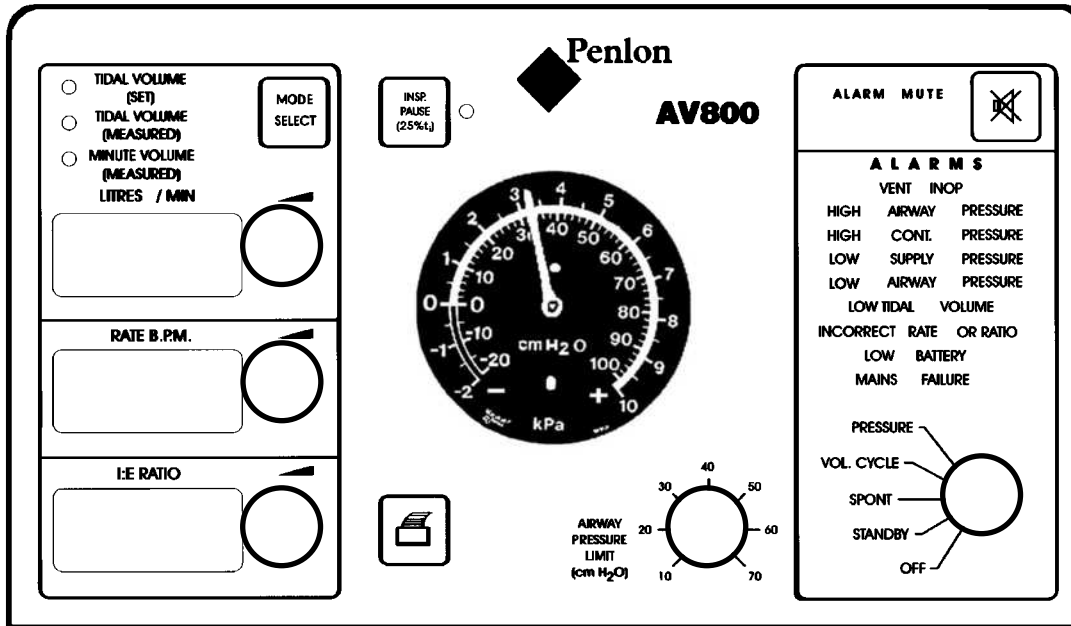
VENTILATION MODE  
TIDAL VOLUME  
RATE,  
I:E RATIO,  
INSPIRATORY PAUSE, and  
AIRWAY PRESSURE CONTROL

These parameters are set on the front panel by five rotary controls and one momentary action push button.

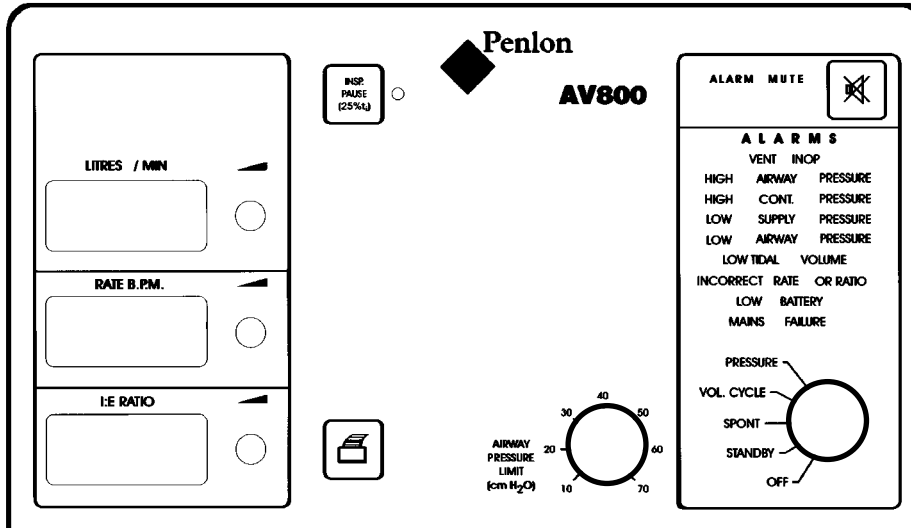
Based on the control settings, the system:

1. Calculates the INSPIRATORY FLOW and the INSPIRATORY and EXPIRATORY times (see section 3.7).
2. Controls the flow metering valve.
3. Displays the value of the tidal volume, rate, and I:E Ratio parameters on three digital displays.
4. Generates the appropriate messages and alarms.

# DESCRIPTION



Front panel - Models with Manometer and Spirometry



Front panel - Models without Manometer and Spirometry

# DESCRIPTION

---

## 3.5 Front Panel Operating Controls

A description of each control is given in the following paragraphs.

### 3.5.1 Power Switch

#### OFF

(mains power connected)

All power is removed from the ventilator circuitry (except the battery charger circuit).

The text display 'OFF' will be illuminated with a yellow light when the mains electrical power is connected and the battery is being recharged.

#### STANDBY

Allows for ventilator function check and set-up.

The text display 'STANDBY' will be illuminated with an amber light.

1. During the first two seconds in this position, all LED segments and alarm indicators are lit and the audible alarms will activate.
2. After the first two seconds, the following control/display functions are available for set-up without cycling of the ventilator.

TIDAL VOLUME  
RATE  
I:E RATIO  
AIRWAY PRESSURE LIMIT

3. The following alarms are functional in the STANDBY mode:

LOW SUPPLY PRESSURE  
MAINS FAILURE  
VENT INOP  
LOW BATTERY  
HIGH AIRWAY PRESSURE  
INCORRECT RATE/RATIO

#### Spirometry

Spirometry (if fitted) can be enabled / disabled by using the following procedure

(in STANDBY mode only):

1. Press the MODE SELECT switch.
2. Rotate the I:E ratio control fully clockwise for ON, or anti-clockwise for OFF.
3. Press MODE SELECT to return to STANDBY.

#### SPONT (spontaneous)

Applicable for Vt of  $\geq 200$  ml.

The indicator SPONT will be illuminated with a green indicator and the ventilator will monitor and display the functions listed below.

No gas will be delivered in this mode.

VENT INOP  
HIGH AIRWAY PRESSURE  
LOW SUPPLY PRESSURE  
LOW AIRWAY PRESSURE  
(Apnoea)  
LOW BATTERY  
MAINS FAILURE

If the ventilator is fitted with the spirometer option the ventilator will also display the tidal or minute volume value, when selected.

#### VOLUME CYCLE MODE

Ventilator cycling will commence and all alarms will be activated.

In this mode the VOL CYCLE indicator will illuminate with a green indicator.

Maximum breathing system pressure will be monitored and when maximum pressure is reached the HIGH AIRWAY PRESSURE alarm will be activated and the ventilator will immediately revert to the expiratory phase, irrespective of the function of the inspiratory pause.

The inspiratory pause function operates in this mode.

#### PRESSURE CONTROL MODE

In this mode the PRESSURE indicator will illuminate with a green indicator.

Ventilator cycling will commence and all alarms will be activated, except high airway pressure.

The ventilator will attempt to deliver the set tidal volume until the pressure limit is reached.

# DESCRIPTION

---

At this point the ventilator will stop delivering gas and pause in this condition until the calculated end of inspiration time has been reached.

The ventilator will then return to the exhalation phase.

The inspiratory pause function does not operate in this mode.

## 3.5.2 Tidal Volume Control

This dial controls the requested tidal volume (LITRES).

Adjustment is only possible when the ventilator is in volume set mode.

### **Models without spirometry:**

The digital display indicates the requested tidal volume.

### **Models with spirometry:**

In any of the operating modes, press the MODE SELECT button to obtain a display of the tidal volume (set or measured) and minute volume (measured).

### **NOTE**

*When the ventilator is switched from standby to the required operating mode, the spirometer will take 1 - 2 minutes before stabilising*

The TIDAL VOLUME is set by the control knob. If the set parameters are within normal limits, the system will deliver the set volume indicated.

If during adjustment the required flow rate is less than 2 L/min or exceeds 75 L/min, the set tidal volume will be limited accordingly.

### **WARNING**

**The AV800 has compliance compensation but the actual tidal volume delivered to the patient may be different to the ventilation parameters set by the user due to:**

- A) an extreme compliance condition,**
- B) a substantial system leak, or**
- C) patient circuit pressure effects.**

***In addition, high fresh gas flows will lead to an increased Vt being delivered to the patient.***

***Note that on models fitted with spirometry, the actual tidal volume exhaled will be displayed.***

***The patient must be monitored independently from the ventilator.***

***It is the responsibility of the user to monitor patient ventilation.***

## 3.5.3 Ventilation Rate Control

### **RATE BPM**

This dial controls the requested ventilator rate.

The respiratory RATE is set by a control knob and the system accepts the setting as long as the set parameters are within normal limits

The digital display indicates the requested RATE.

If during adjustment the required flow rate is less than 2 L/min or exceeds 75 L/min, the set rate will be limited accordingly.

## 3.5.4 Ventilator I:E Ratio

### **WARNING**

***The ventilator settings can allow for and inverse I:E ratio up to 1:0.3. The clinician must always ensure that sufficient time is allowed for the patient to adequately exhale.***

### **I:E RATIO**

This dial and digital display controls and indicates the requested ventilator I:E RATIO.

If during adjustment the required flow rate is less than 2 L/min or exceeds 75 L/min, the set I:E ratio will be limited accordingly.

### **NOTE**

*Minute Volume = Tidal Volume x Rate  
(see section 3.7)*



# DESCRIPTION

---

## 3.5.5 Airway Pressure Limit (cmH<sub>2</sub>O)

This dial sets the maximum breathing system pressure as sensed by the pressure transducer via the patient breathing circuit via the manometer connection.

In the Volume Cycle mode, the inspiratory cycle is terminated whenever this set pressure is achieved. The ventilator then reverts to the exhalation phase.

In the PRESSURE CONTROLLED mode the inspiration is terminated whenever this set pressure is achieved and the ventilator pauses until the end of the calculated inspiratory time before reverting to the exhalation phase.

## 3.5.6 Alarm Mute

When the alarm mute push button is depressed during an alarm condition the audible alarm can be muted for the following periods:

Low Airway pressure	30 seconds
Low Tidal Volume	30 seconds
Incorrect rate or ratio	120 seconds
Low battery	120 seconds only

No other alarm conditions are silenceable. Mutable alarms will be immediately reinstated upon fresh alarm conditions.

## 3.5.7 Inspiratory Pause

In volume ventilation mode depressing the Insp Pause button will allow a 25% inspiratory pause to be included at the end of the inspiratory phase.

The I:E ratio will be maintained.

To compensate for the reduced inspiratory flow time period, the inspiratory flow rate is increased (up to a maximum flow rate of 75 litres per minute).

The inspiratory pause does not function in Pressure Ventilation mode.

## 3.5.8 Print

A printed copy of the ventilator conditions for up to eight hours of the procedure can be provided.

Connect a HPL 2 (or greater) format printer to the printer output port on the rear of the ventilator.

At the end of the clinical procedure switch the ventilator to standby, and press the print push button once.

Pressing the print button a second time will cancel the print function.

Turn the ventilator to OFF, and switch the ventilator back on again to clear the stored print information.

The printer port must only be connected to devices that comply to EN 60950.

# DESCRIPTION

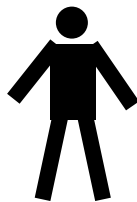
## 3.6 Rear Panel

### 3.6.1 Labelling Terminology

The terms Class 1, and Type B are defined in IEC 601-1 (the standard for electrical medical equipment).

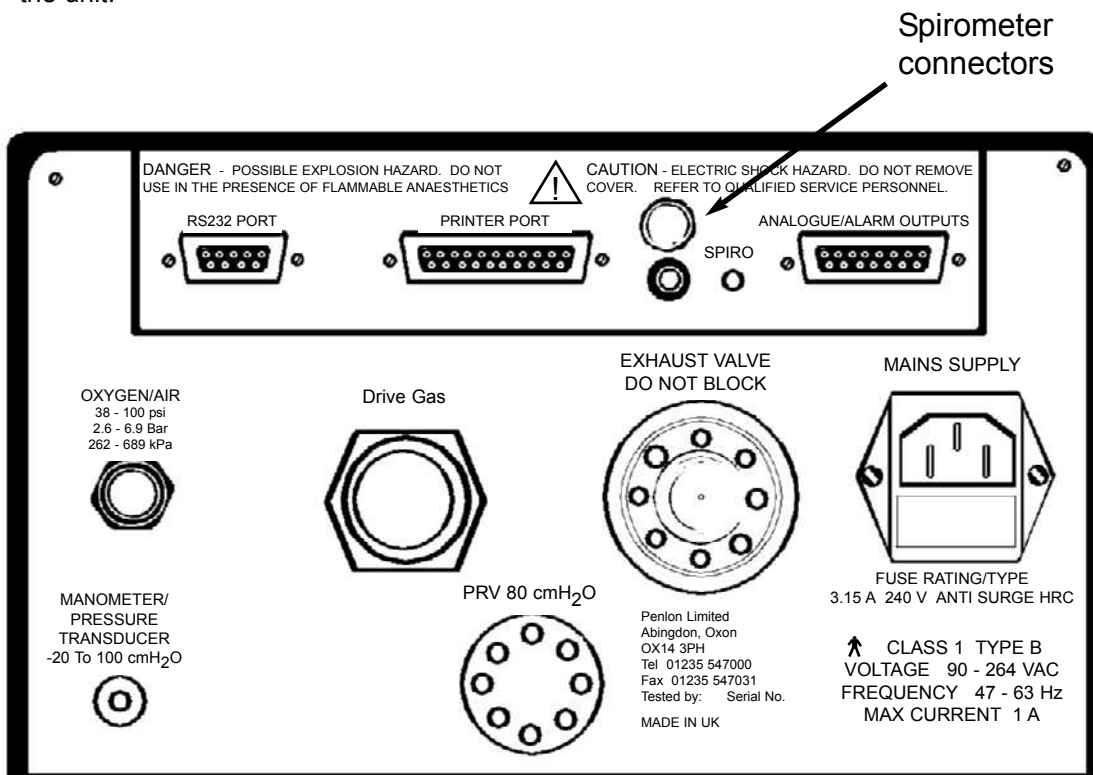
**NOTE**

This symbol denotes Type B equipment.



Type B equipment calls for a particular degree of protection against electric shock.

Class 1 equipment has additional protection such that metal parts of the unit that are accessible to the user (e.g. the metal casing of the AV800 control unit) cannot become live in the event of failure of the basic insulation of the electrical components within the unit.



Ventilator Rear Panel

# DESCRIPTION

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## 3.6.2 Mains supply

The mains supply inlet is designed for connection to any mains voltage from 90 to 264 VAC and a frequency of 47 to 63 Hz without any adjustment.

The connector is a standard IEC type dismountable connector.

## 3.6.3 Oxygen/Air

Ventilator driving gas is attached to this connector at a pressure of 38 - 100 psi (262 - 689 kPa) and capable of supplying gas at a flow rate of not less than 80 L/min at the minimum pressure. Air or Oxygen may be used as the drive gas but the supply must be clean and dry.

Note that the drive gas is specified by the customer. To change the drive gas, refer to a Penlon-trained service engineer.

## 3.6.4 Drive Gas

The drive gas outlet is a special 17 mm diameter taper connector and delivers the drive gas from the control unit to the ventilator bellows assembly.

## 3.6.5 Exhaust Valve

Exhaust bellows drive gas, either air or oxygen, returned from the bellows assembly is exhausted through this outlet. The port must not be blocked.

## 3.6.6 Manometer / Pressure Transducer

The breathing system is connected to this port with a 6 mm flexible sample tube.

## 3.6.7 PRV 80 cmH<sub>2</sub>O

The drive gas over pressure relief valve is set at a non-adjustable 80 cmH<sub>2</sub>O.

The PRV outlet port must not be blocked.

## 3.6.8 RS 232 Port

Configuration details for this port are available by special order from Penlon Limited.

The port must only be connected to devices that comply to EN 60950.

## 3.6.9 Printer Port

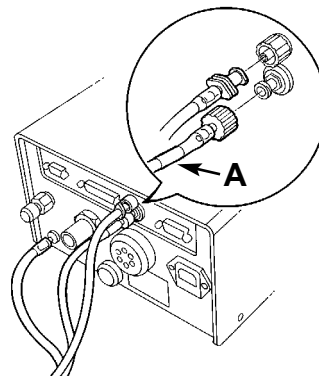
This standard Centronics 36 way parallel port is configured to output to any HPL 2 or greater compatible parallel printer.

The port must only be connected to devices that comply to EN 60950.

## 3.6.10 Spirometer connections

Male and female Luer lock connections are provided for the connection of the side stream spirometer system. Correct polarity must be observed to ensure that the correct flow is measured.

To maintain the accuracy of the flow measurement only the specified sample lines may be used.



Latest type tubing assemblies have a restrictor fitted to the tube fitted to the lower connector on the ventilator rear panel.

This tube is labelled 'VENT END' (A) to assist correct fitment.

### CAUTION

A) The lines must not be trapped during use.

B) Do not alter the length of the sample lines.

## 3.6.11 Analogue/alarm Outputs

This port may be configured to interface with a medical information bus system by special order.

The port must only be connected to devices that comply to EN 60950. See also section 10.

# DESCRIPTION

---

## 3.7 Message Displays

### 3.7.1 Alarm Mute

For those alarms which can be silenced, the mute button will provide 30 seconds of muting for high priority alarms and 120 seconds of muting for medium priority alarms.

### 3.7.2 Alarm Indicators

Visual indicators are backlit, no warnings are visible when the power is turned off.

All alarms are self-cancelling (with a minimum activation period of 2 seconds), except VENT INOP (ventilator inoperative). Alarms comply with EN475.

#### NOTE

*There are no means provided to defeat any visual alarm.*

*Alarms are priority configured. The highest priority alarm will always take precedence.*

Normal conditions must be restored or the unit turned off in order to cancel the alarms.

#### LOW DRIVE GAS SUPPLY

##### (High priority)

A visual indicator and audible alarm which activate if the input drive gas pressure has dropped below 38 psig (262 kPa).

This alarm is not silenceable.

#### HIGH AIRWAY PRESSURE

##### (High priority)

##### Standby, Spontaneous, and Volume Cycle Mode

A visual indicator and audible alarm which activate when the pressure sensed at the patient tee exceeds the setting of the AIRWAY PRESSURE LIMIT control.

This alarm will remain on until the pressure falls below the control setting for a minimum of 1 second.

This alarm will also activate if the drive gas supply overpressure switch operates (and also operates in Pressure control mode).

This alarm is not silenceable.

#### HIGH CONT (Continuing) PRESSURE

##### (High priority)

A visual indicator and audible alarm which activate when the pressure sensed at the patient tee exceeds 30 cmH<sub>2</sub>O just prior to the next inspiratory cycle.

Once activated, this alarm remains on until the pressure falls below the required baseline at the beginning of a breath.

This alarm is not silenceable.

#### LOW AIRWAY PRESSURE

##### (High priority)

##### (Disconnect Alarm)

A visual indicator and an audible alarm which activate if the pressure sensed at the patient tee-piece in the expiratory limb of the breathing circuit does not increase by at least 4-14 cmH<sub>2</sub>O during a ventilator inspiratory cycle, depending on tidal volume setting.

Once this alarm is activated, it remains on until the required pressure difference is reached.

This alarm can be silenced for 30 seconds.

#### LOW TIDAL VOLUME

##### (High priority)

The AV800 can be fitted with an external volume spirometer which provides signals to the volume display. If the apparent tidal volume as measured by the spirometer falls below 50% of the set tidal volume, a visual indicator and audible alarm are activated.

This alarm can be silenced for 30 seconds.

#### Spirometer Disconnect

If the spirometer tube becomes disconnected, causing an erroneous measured volume greater than 50% of the set tidal volume, the Tv display will flash.

#### INCORRECT RATE OR RATIO

##### (Low priority)

A visual indicator and audible alarm which indicates that the required inspiratory flow rate is below 2 L/min, or has reached the upper limit of 75 L/min as determined by the settings for TIDAL VOLUME, RATE, I.E. RATIO, and INSP PAUSE.

This alarm can be silenced for 120 seconds.

# DESCRIPTION

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## **MAINS FAILURE**

### **(Low priority)**

A visual indicator and an audible alarm (low priority) that is battery driven.

The alarm activates when electrical power is disconnected when the ventilator is operating.

Note that if fully charged, the back-up battery will power the ventilator for 60 minutes.

## **LOW BATTERY**

### **(Low priority / Medium priority)**

A visual indicator and an audible alarm which activate if the internal battery is almost exhausted, indicating that ventilation will soon cease.

*When approximately ten minutes of battery backup time remains, the alarm will change from low to medium priority.*

To prevent damage to the battery, the ventilator will shut down before the battery is fully discharged.

## **VENT INOP**

### **(High priority)**

The VENT INOP (ventilator inoperative) alarm indicates that one of the following conditions has occurred:

- A) A solenoid has failed,
- B) The flow control valve has failed,
- C) Internal electrical fault,
- D) Internal Communications error,
- E) Battery disconnected,
- F) Software error

In the event of a ventilator error being detected an error code will be displayed in the RATE / BPM window and additionally will be stored in a non volatile memory which can be accessed by the service engineer to assist with fault finding subsequently.

## **WARNING**

***The only way to reset a VENT INOP alarm is to turn the Power switch OFF for a minimum of one second and then back ON.***

***If the VENT INOP alarm occurs again, remove the ventilator from use and refer to an authorised service technician.***

## **3.8 Back-up Battery**

In the event of mains electrical failure, the back-up battery cuts in automatically.

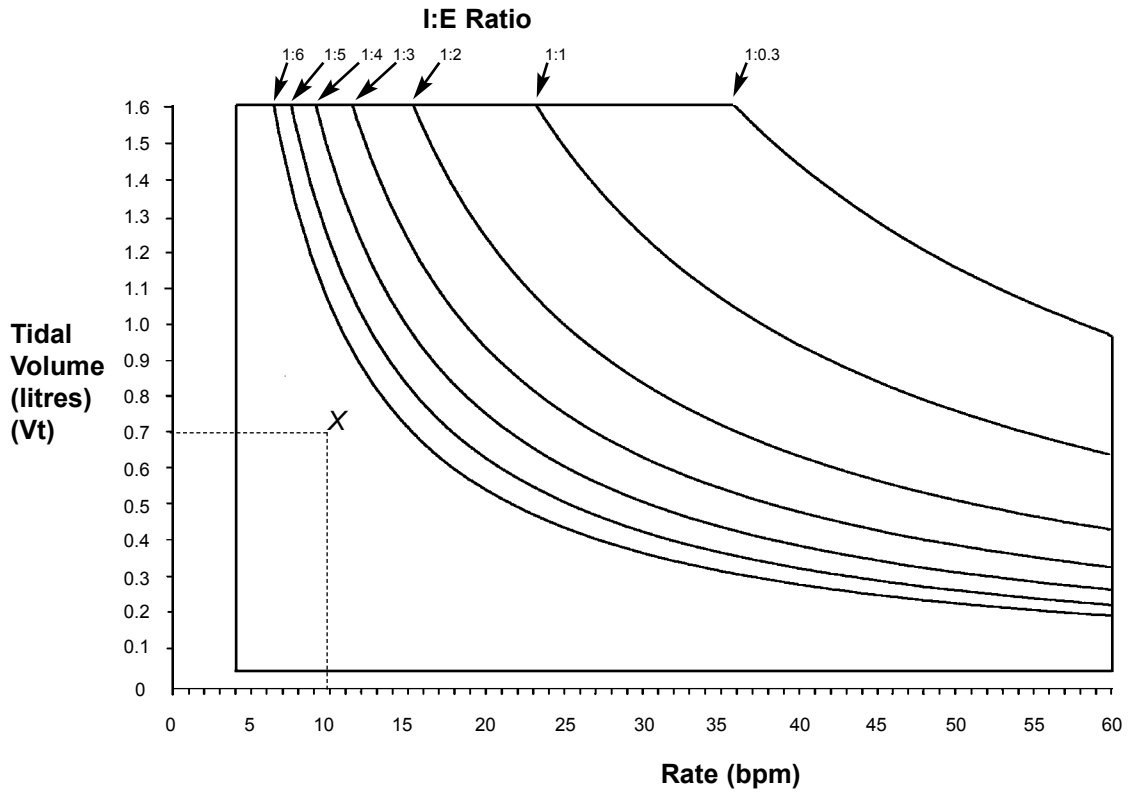
A fully charged battery will power the ventilator for 60 minutes.

See Appendix 1 for battery care procedures.

# DESCRIPTION

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## 3.9 Operational Capability



The ventilator is capable of operating at the volumes and rates below each I:E ratio curve.

- Note*
- The minimum tidal volume setting is 50 ml.*
  - The minimum rate setting is 4 bpm.*

### Example

- Select required volume (V<sub>t</sub>) (e.g. 0.7 litres)
- Select rate (e.g. 10 bpm).
- Select I:E ratio of 1:2.

The point X on the graph lies beneath the 1:2 ratio curve, and is therefore within the ventilator's capability.

# DESCRIPTION

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## 3.10 System Software

The software controls all ventilator functions including performance accuracy and safety checks.

In addition, the software controls the ventilator/user interface, apart from the manometer.

The software is held in 256 kbytes of Flash EPROM, and is copied into RAM at power-up and runs there.

### Upgrades

Any upgrades will be offered to customers for downloading via a connector on the main PCB.

### Digital to Analogue Converter

Provides analogue output of the following parameters:

Breathing circuit pressure  
Average breathing circuit pressure  
Airway pressure limit  
Tidal volume  
BPM  
I:E ratio  
Measured volume

These are all generated using an 8 bit, 8 channel D/A converter (TLC5628). This is driven using synchronous serial communications using three I/O bits on the processor.

15 pin D-type connector pin layout	Description	Range	Analogue scaling
1	Ground		
2	Breathing Circuit Pressure	-20 to 80 cmH2O	0.05 V/cmH2O
3	Average Breathing Circuit Pressure	-20 to 80 cmH2O	0.05 V/cmH2O
4	Airway Pressure Limit	10 to 70 cmH2O	0.05 V/cmH2O
5	Tidal Volume	0-1.6 litres	0.3 V/100ml
6	BPM	0-60 bpm	0.08 V/bpm
7	I:E Ratio	1:0.3 to 1:6.0	0.08 V/O.IE
8	Measured Volume	0-1.6 litres	0.3 V/100ml

# DESCRIPTION

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## Alarm Outputs

Alarm outputs are provided on the system for various system parameters. Alarm outputs are on pin 9-15.

15 pin D-type connector pin layout	Alarm Outputs	Logic level
9	System OK	High
10	Power problem - mains fail, battery missing or battery low	Low
11	Incorrect rate/ratio	Low
12	Low measured tidal volume	Low
13	Low supply pressure	Low
14	Low airway pressure	Low
15	High airway pressure / high continuous pressure	Low

## Real Time Clock

Provides a time stamp for the error log and any printouts. The clock is set at the factory to GMT (Greenwich Mean Time).

## Engineering Mode

A facility to allow Penlon-trained service engineers access to the following functions:

1. Software revision information - indicates the versions currently installed .
2. Error log - displays a log of the last 40 events which caused a system operational error. Note that after power-up, only the most recent operational error is displayed.
3. Set date and time on the real time clock.
4. Abort to the FORTH interpreter to allow communication to the unit through the serial port, for possible software debug.

To gain access to Engineering Mode, switch the power control to STANDBY, and then press the INSP PAUSE and MODE SELECT buttons simultaneously.

Rotate the Tidal Volume control knob clockwise / anti-clockwise to move between the above functions. Press the INSP PAUSE button to exit Engineering Mode.



## 4. SPECIFICATION

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4.1	Application	Ventilation for use in anaesthesia.
4.2	Internal Compliance	3 ml/cmH <sub>2</sub> O (nominal)
4.3	Minute Volume Range	This parameter cannot be set on the machine, but can be calculated if required. (see section 3.5.4).
4.4	Tidal Volume Range	50 to 1600 ml (±10%)
4.5	Frequency (Rate) Range	4 to 60 bpm, limited by tidal volume setting
4.6	Inspiratory Phase Time Range	0.14 to 11.54 seconds
4.7	Expiratory Phase Time Range	0.23 to 12.9 seconds
4.8	Inspiratory/Expiratory Phase Time Ratio Range (I:E ratio)	1: 0.3 to 1: 6.0 - limited by tidal volume and rate settings
4.9	Pressure Control Range (pressure ventilation mode)	10 to 70 cmH <sub>2</sub> O (±10%)
4.10	Inspiratory Flow Range	2 to 75 L/ min
4.11	Airway Pressure Limit (volume ventilation mode)	10 to 70 cmH <sub>2</sub> O (±10%)
4.12	Inspiratory Triggering	No trigger
4.13	Inspiratory Triggering - Response Time	No trigger
4.14	Maximum Safety Pressure	80 cmH <sub>2</sub> O
4.15	Maximum Working Pressure	70 cm H <sub>2</sub> O
4.16	Minimum Safety Pressure	-10 cm H <sub>2</sub> O
4.17	Minimum Working Pressure	Atmospheric
4.18	Sub-atmospheric Pressure Range	None
4.19	Expiratory Resistance (60 L/min)	5 cmH <sub>2</sub> O/Ls <sup>-1</sup>
4.20	Sigh Characteristics	None
4.21	Inspiratory Mixture	No mixture controls

# SPECIFICATION

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4.22	Flowmeters	None
4.23	Manual Changeover	None
4.24	Inspiratory Relief Valve	Fixed, 80 cmH <sub>2</sub> O
4.25	Humidifiers and Monitors	No humidifier. Volume monitor optional (spirometer) Pressure monitor built in
4.26	System Pressure Gauge	None
4.27	Airway Pressure Gauge	Optional
4.28	Spirometer Accuracy	Optional Varies with gas composition. Note that the spirometer is calibrated for typical clinical gas mixtures. Differing gas composition will cause variances from actual values. Maximum variation is $\pm 20\%$ .
	Range	300 ml V <sub>t</sub> minimum in Spontaneous mode. 50 to 1600 ml in all other operating modes.
4.29	Alarms (in priority order)	See section 3 for detailed descriptions.  Vent. inop. (ventilator inoperative) High airway pressure High cont. (continuing) airway pressure (PEEP) Low supply pressure Low airway pressure Low tidal volume Incorrect rate or ratio Low battery Mains failure
4.30	Power Source Electrical	90 to 264 VAC 47/63 Hz, universal input.
	Input Drive Gas	Oxygen or air (dry, and oil free) at 38 to 100 psig (262 to 689 kPa).
4.31	Power Consumption Electrical Gas	37 watts maximum 75 L/min intermittent maximum inspiratory flow. 37.5 L/min minute volume
4.32	Dimensions Height Height of control unit only Width Depth	370 mm 135 mm 235 mm 260 mm

# SPECIFICATION

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4.33	Weight Weight with adult bellows Weight with paediatric bellows Weight of control unit only	9.0 kg 8.7 kg 7.6 kg
4.34	Method of Disinfection or Sterilisation	Bellows base assembly and inside of bellows require sterilisation - section 7.3
4.35	Bacterial Filter	None (see section 5.1.4 for recommendations for breathing system)
4.36	Fail Safe Mechanism	Battery back-up in case of mains electricity failure
4.37	Reliability	MTBF: $5 \times 10^6$ to $50 \times 10^6$ cycles
4.38	Waveform Tests	Not applicable
4.39	Volume Tests	Not applicable
4.40	(A) Mobility  (B) Mounting	Secure mounting on anaesthesia machine required. Mounting bracket available as optional extra. Bellows assembly can be separated from the control unit for remote mounting.
4.41	Fuses	220/240 V: two fuses, 3.15 A, 20 mm, anti surge
4.42	Environmental Ambient Temperature Storage  Operating  Humidity  Altitude  Ingress protection	-5 to 50°C (23 to 122°F). Refer to Appendix 1 for battery care during storage. 10 to 38°C (50 to 100°F)  10-95% RH (relative humidity), non- condensing  Up to 2775 m (9000 feet)  Conforms to EN 794-1 Clause 44 (spillage test)

# 5. PRE-OPERATION PROCEDURES

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## 5.1 Set-up

### 5.1.1 Components supplied with the ventilator

Check that the ventilator has been supplied with:

- (a) A 210 mm long, 16 mm diameter, corrugated hose to connect the control unit to the bellows assembly
- (b) Drive gas hose (to customer specification)
- (c) Electrical mains supply cable (to customer specification).
- (d) Pressure sampling line and T-piece.
- (e) Spirometer sampling line and T-piece (supplied with spirometer option machines only)

### 5.1.2 Mounting the ventilator

The AV800 can be mounted on the anaesthetic machine as a single, complete unit.

#### Locate the ventilator in a safe place.

Preferably, mount it permanently on the anaesthesia shelf of the machine or on a strong bracket to protect the ventilator from accidental fall and accidental disconnection of the hoses.

To mount the ventilator permanently on a Penlon bracket:

- 1. Align the four mounting feet over the mating holes in the bracket.
- 2. Use four M4 screws inserted through the bracket and rubber feet and screwed into into the threaded inserts in the base of the ventilator.

Pole-mount type mounting brackets are available, see section 8.

### 5.1.3 Ventilator electrical connections

Before connecting the ventilator to the mains supply, check that the power supply is within the correct rating as stated on the label on the rear of the control unit.

#### **WARNING**

*Excessive electronic noise caused by other, poorly regulated devices, such as electrocautery, may adversely interfere with the proper functioning of the ventilator.*

*To avoid this problem, do not connect the ventilator power cord into the same electrical wall outlet or strip into which an electrocautery unit is connected.*

### 5.1.4 Ventilator gas connections

Before the ventilator can be used, the following preparation must be made:

- 1. Verify the drive gas specified for the ventilator (oxygen or air) and connect the drive gas inlet port on the rear of the control unit to a dry, oil free supply at 38 to 100 psi (2.6-6.9 bar, 262-689 kPa)

To change the drive gas, refer to a Penlon-trained engineer.

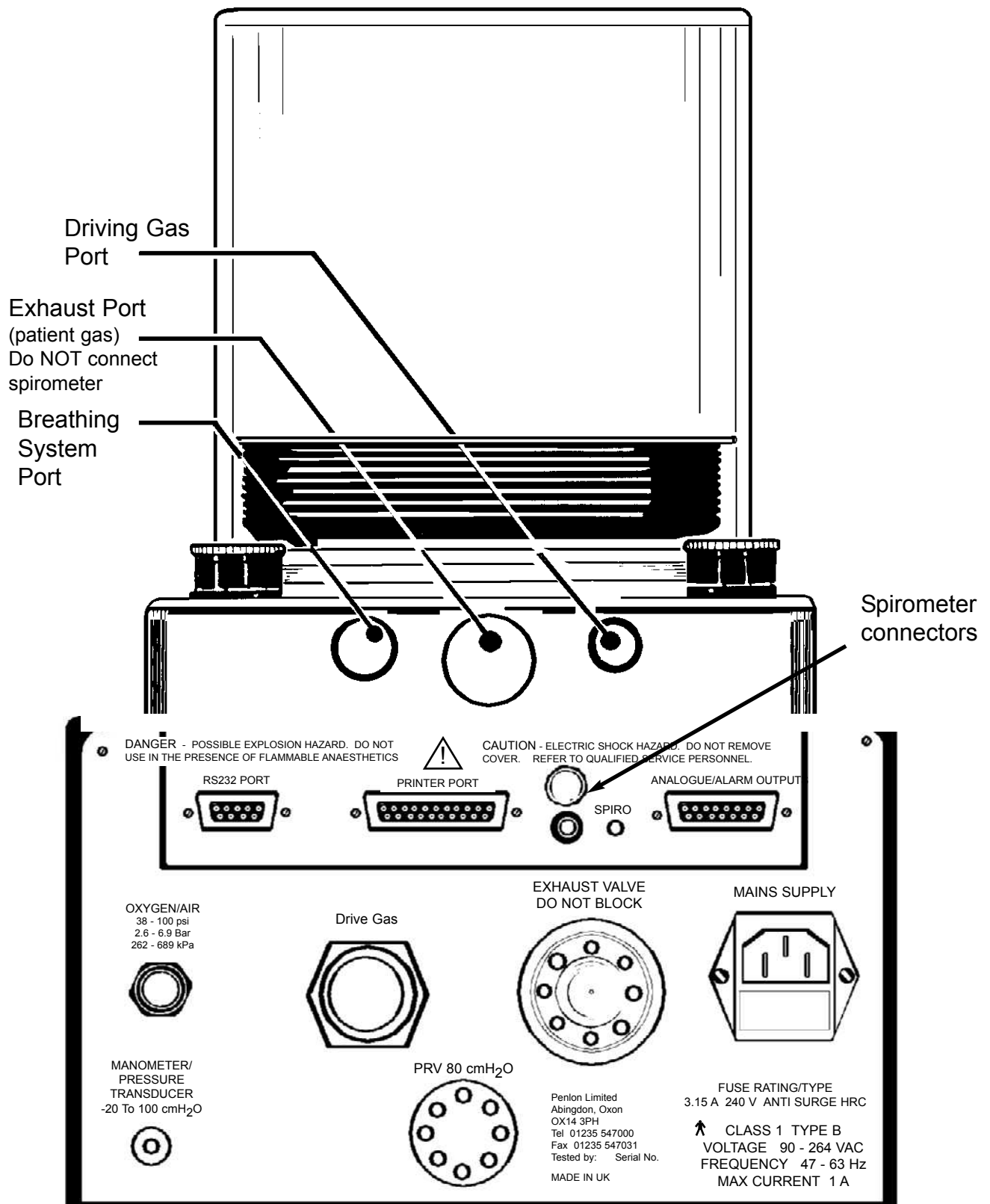
The drive gas inlet port is labelled:

OXYGEN / AIR 38 -100 PSI

OXYGEN SUPPLY - O<sub>2</sub> cylinder, anaesthetic machine O<sub>2</sub> auxiliary gas outlet, or O<sub>2</sub> pipeline supply from a wall outlet.

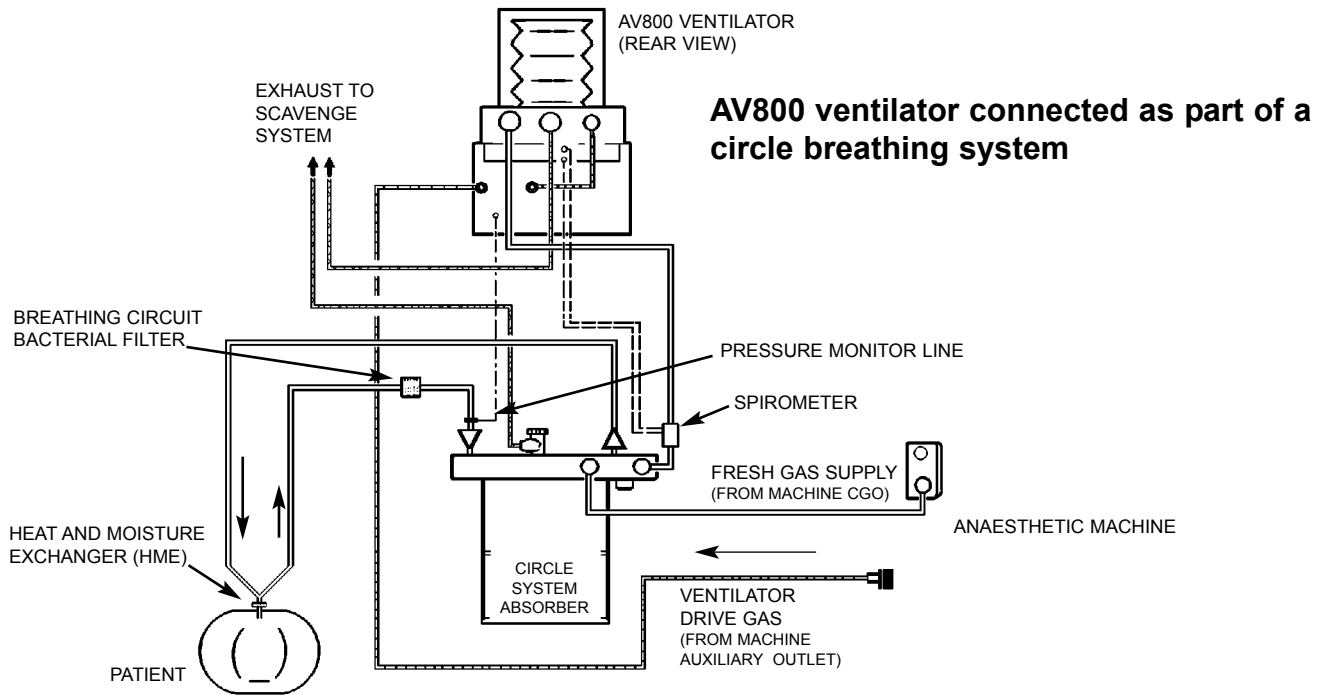
AIR SUPPLY - Air cylinder, anaesthetic machine air auxiliary gas outlet or air pipeline supply from a wall outlet.

- 2. Connect the 16 mm diameter corrugated hose (provided), between the control unit drive gas outlet (labelled: BELLOWS DRIVING GAS) and the bellows base DRIVING GAS port.
- 3. Connect the bellows base EXHAUST port, with a 30 mm hose, to a properly functioning scavenging system. The diaphragm valve under the bellows is connected internally to the EXHAUST port to facilitate the discharge of excess breathing gas at the end the expiratory phase.



## Ventilator Rear Panel and Gas Ports

# PRE-OPERATION PROCEDURES



4. Connect the spirometer (if fitted) - see Section 5.1.5.

expiratory limb to protect the breathing system.

## **WARNING**

*Applying negative or positive pressure to the bellows exhaust port results in positive pressure in the patient breathing system.*

*Therefore, the scavenging system must not generate more than 0.5 cmH<sub>2</sub>O positive or negative pressure when connected to the ventilator.*

*Any problem arising from an improperly functioning scavenging system is solely the user's responsibility.*

5. Connect the MANOMETER/PRESSURE TRANSDUCER port on the rear panel of the control unit to the breathing system.

The recommended placement for the distal sensing tee is in the inspiratory limb of the breathing system close to the circle system inspiratory valve.

Use a Heat and moisture exchanger (HME) at the patient Y piece, or a breathing system filter in the

## **WARNING**

*The High and Low Airway Pressure Alarms are important for patient care.*

*The ventilator is designed to be used with a distal sensing tee only. (Catalogue No. 53194, Breathing System Tee Assembly.) It is important that the distal sensing tee is properly located in the inspiratory limb of the breathing system.*

6. Set the AIRWAY PRESSURE LIMIT control to 50 cmH<sub>2</sub>O.
7. Attach a printer to the printer port if a printed output of the ventilator function is required.
8. Connect the ventilator bellows base BREATHING SYSTEM port to the breathing system.  
Use a breathing system bacterial filter in the expiratory limb of the breathing circuit or a heat and moisture exchanger (HME) at the patient Y piece. See illustration above.

# PRE-OPERATION PROCEDURES

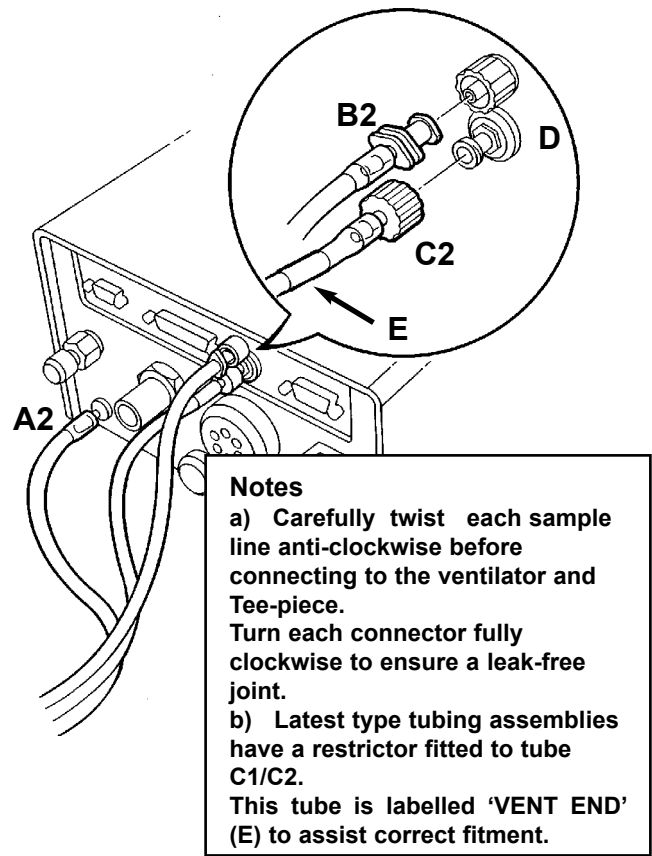
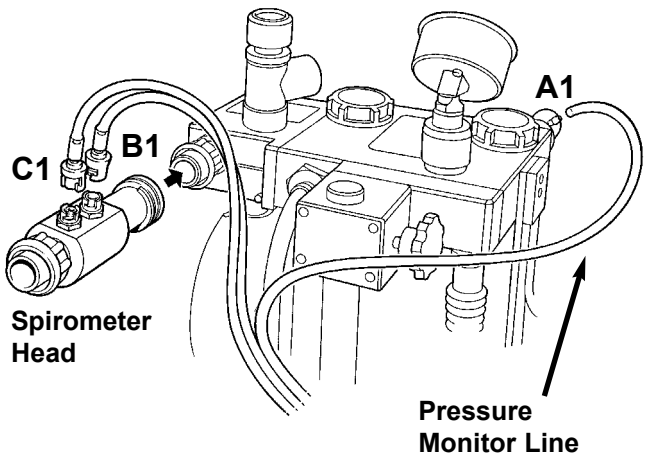
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9. Connect a 2-litre breathing bag to the patient connection as a test lung.
10. Close the anaesthetic machine APL or PRV valve in the breathing system.
11. Turn the ventilator POWER switch to STANDBY and :
  - set the tidal VOLUME to 800 ml,
  - set RATE to 10 bpm,
  - set I:E RATIO to 1:2.0.
12. Use the O<sub>2</sub> flush button on the anaesthetic machine to fill the bellows.
13. Turn the ventilator POWER switch to VOL CYCLE.
14. The delivered tidal volume read on the scale of the bellows housing should be 800 ml.

Before using the ventilator clinically:

- a) Check that all connections are correct, and verify that there are no leaks.
- b) Carry out the function checks listed in section 5.3.1.

# PRE-OPERATION PROCEDURES



## 5.1.5 Spirometer Connections

**WARNING** The lumen assembly must be connected as illustrated. Do not connect to the expiratory limb of the breathing circuit.

The triple lumen assembly incorporates the ventilator pressure monitor line (shown as Tube A1/A2).

This line **must** be connected to the breathing circuit at the absorber expiratory hose connector.

1. Use a breathing system bacterial filter in the expiratory limb, or a heat and moisture exchanger (HME) at the patient Y piece. See section 5.1.4, operation 8.
2. Fit the spirometer head to the Safelock connector at the ventilator port on the back of the Circle Absorber.
3. Connect the tubing from the spirometer head to the connectors at the rear of the AV800 ventilator as shown.

### For additional identification:

- i) The centre tube (C1/C2) has a **RED** connector at C2 which must be fitted to the lower connector on the ventilator (fitted with a **RED** washer ,D). Later assemblies have a label (E) (VENT END) on tube C1/C2
- ii) Connector B1 is **BLUE**.

### Notes

- a) Carefully twist each sample line anti-clockwise before connecting to the ventilator and Tee-piece. Turn each connector fully clockwise to ensure a leak-free joint.
- b) Latest type tubing assemblies have a restrictor fitted to tube C1/C2. This tube is labelled 'VENT END' (E) to assist correct fitment.

4. Check for secure connection at each connector.

### NOTE

A) If the connection is incorrectly made at the spirometer sensor, the ventilator will alarm **LOW TIDAL VOLUME**. To allow the ventilator to be used in the event of damage or or non-functioning of the spirometer head, turn off the spirometry function - see **STANDBY mode**.

B) Connection of the spirometer into the exhaled limb also provides an indication of breathing system disconnect.

C) When testing the spirometer prior to clinical use, it is preferable to use a 70% N<sub>2</sub>O / 30% O<sub>2</sub> mixture.

If 100% oxygen is used, the Measured V<sub>t</sub> value display may flash. This is not significant, and should be disregarded.

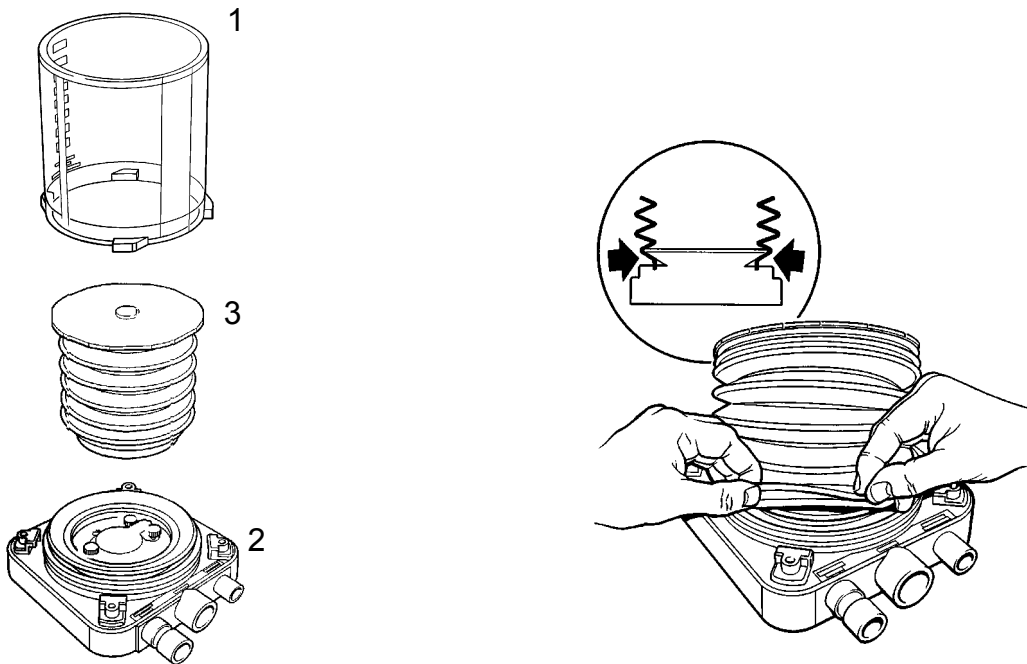
### Absorber switched to Bag mode

**NOTE** If the absorber bag/ventilator switch is set to 'Bag', the spirometer will not measure tidal volume.



# PRE-OPERATION PROCEDURES

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## 5.2 Bellows Assembly

### CAUTION

Always ensure correct fitment of bellows (see illustration above), and carry out a full function test before clinical use, if a bellows is removed and refitted.

1. Remove the bellows housing (1) by twisting it slightly counterclockwise until the bayonet tabs become free, then lift it up from the base (2).
2. Remove the bellows (3) from the base.

3. Fit the bellows, and then fit the bellows housing to the base by pushing it down, then twisting it slightly clockwise until the bayonet tabs completely engage.
4. Function test the ventilator - section 5.3.1.

### NOTE

If there is any malfunction, the ventilator must NOT be used.

If the problem cannot be located, refer to section 6 - Fault Finding, or return the ventilator for repair to a Penlon accredited agent, or to the manufacturer.

# PRE-OPERATION PROCEDURES

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## 5.3 Pre-use Checklist

### 5.3.1 Daily Checklist

The following tests should be done at least at the beginning of every working day:

#### **WARNING**

*The operation of each alarm function should be verified daily. Periodically check the alarms at suitable intervals. If the audible alarm or the visual indicator of any alarm function fails to activate during any alarm condition or fails to reset after the alarm has been cleared, refer the unit to an authorised service technician.*

#### **WARNING**

*If the internal battery is fully discharged, the ventilator will not function.*

Recharge the battery before the ventilator is used clinically.

Charging the battery for 14 hours from a discharged state will allow a minimum of 45 minutes of continuous operation. Connect the ventilator to a mains power supply. The OFF indicator will turn yellow when the battery is being charged (it is not necessary to run the ventilator).

#### **Ventilator internal test**

Turn the POWER switch to STANDBY.

A two-second internal test is initiated.

The following must occur if everything performs correctly:

1. All three digital displays must read 8.
2. All ALARMS messages must be lit.
3. The audible alarm drivers must sound - one high tone, and one low tone.

#### **Functional checkout:**

1. Set the AIRWAY PRESSURE LIMIT control to 50 cmH<sub>2</sub>O.
2. Check that the MANOMETER / PRESSURE TRANSDUCER port on the rear of the control unit is correctly connected to the inspiratory limb of the breathing circuit, close to the patient tee piece (see operation 5, section 5.1.4).

3. Connect the ventilator bellows base BREATHING SYSTEM port to the breathing system.
4. Connect a 2-litre breathing bag to the patient connection as a test lung.
5. Close the anaesthetic machine APL or PRV valve in the breathing system,
6. Set the tidal VOLUME to 800 ml; RATE to 10 bpm, and I:E RATIO to 1:2.0.
7. Use the O<sub>2</sub> flush button on the anaesthetic machine to fill the bellows.
8. Turn the ventilator MODE switch to VOL/CYCLE.
9. The delivered tidal volume read on the scale of the bellows housing should be 800 ml.  
  
If the delivered tidal volume is less than 700 or greater than 900 ml, refer to a Penlon trained engineer.
10. Fill the bellows using the O<sub>2</sub> flush again.
11. Occlude the patient connection port of the breathing system, distal end.
12. The HIGH AIRWAY PRESSURE alarm should be activated. The peak pressure read on the breathing system pressure gauge is the maximum working pressure limit and should agree with the setting.
13. Open the patient connection port to ambient pressure. At the second cycle, the LOW AIRWAY PRESSURE alarm should be activated.
14. Turn the ventilator MODE switch to STANDBY.  
Before using the ventilator clinically, check that all connections are correct, and verify that there are no leaks.

# PRE-OPERATION PROCEDURES

---

## 5.3.2 Weekly Checklist

At least every week, in addition to the daily functional check:

1. Turn the ventilator MODE switch to STANDBY.
2. Unplug the mains power cable from the AC outlet.

The MAINS FAILURE alarm should activate.

3. Reconnect the mains power cable to the AC outlet. The alarm should turn off.
4. Turn the MODE switch to VOL/CYCLE.
5. Disconnect the drive gas supply hose. The LOW SUPPLY PRESSURE alarm should activate.

### **NOTE**

*If there is any malfunction, the ventilator must NOT be used.*

If the problem cannot be located, refer to section 6 - Fault Finding, or return the ventilator for repair to a Penlon authorised service centre or to the manufacturer.

## 6. FAULT FINDING

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CONDITION	POSSIBLE CAUSE / REMEDY
No power at switch on (no VENT INOP alarm)	<ol style="list-style-type: none"> <li>1. Check mains supply/plug.</li> <li>2. Check yellow OFF LED (mains indicator).</li> <li>3. Check fuses - mains input socket.</li> <li>4. Check voltage from power supply unit - 14.3 V.</li> <li>5. Replace ON/OFF switch.</li> </ol>
LOW BATTERY message is on	<ol style="list-style-type: none"> <li>1. Charge battery by plugging unit into the mains supply.</li> <li>2. Defective battery - replace.</li> <li>3. Mains fuse blown.</li> </ol>
Bellows does not fill, or, collapses.	<ol style="list-style-type: none"> <li>1. No fresh gas flow.</li> <li>2. Breathing system hose leak or hose disconnected.</li> <li>3. Broken bellows base.</li> <li>4. Defective or detached bellows.</li> <li>5. Damaged exhalation diaphragm valve.</li> <li>6. Missing or defective O-ring seals.</li> </ol>
Bellows progressively becomes less full despite usual fresh gas flow setting.	<ol style="list-style-type: none"> <li>1. Check breathing system for leaks.</li> <li>2. Check and close anaesthesia system APL or PRV valve.</li> <li>3. Check exhalation diaphragm valve seat under the bellows for damage.</li> <li>4. Damaged O-ring on bellows base - replace.</li> </ol>
LOW BREATHING SYSTEM PRESSURE alarm is on but ventilation is normal.	<ol style="list-style-type: none"> <li>1. Check pressure pick-up tubing.</li> <li>2. Look for disconnect or kink.</li> <li>3. Control unit internal failure</li> </ol>
LOW DRIVE GAS SUPPLY alarm activated	<ol style="list-style-type: none"> <li>1. Check drive gas supply pressure (&gt; 38 psi)</li> </ol>

# FAULT FINDING

---

CONDITION	POSSIBLE CAUSE / REMEDY
Displayed values incorrect	<ol style="list-style-type: none"> <li>1. Check with stopwatch / Vt measurement.</li> <li>2. Check that the inlet filter is not blocked.</li> <li>3. Replace/reset pressure switch.</li> </ol>
Continuous high airway pressure limit alarm	<ol style="list-style-type: none"> <li>1. Potentiometer set too low (or knob out of calibration) - adjust.</li> <li>2. Error code 12 Potentiometer failure - replace display assembly PCB.</li> <li>3. Error code 8 Potentiometer sensor failure - replace main PCB.</li> </ol>
Unwanted PEEP and bulging, full bellows	<ol style="list-style-type: none"> <li>1. Defective or poorly regulated scavenging system, creating too high resistance or too much vacuum.</li> <li>2. Exhaust partially obstructed.</li> <li>3. Bellows diaphragm defective.</li> </ol>
Pressure limit fails to operate	<ol style="list-style-type: none"> <li>1. Error code 8 Pressure sensor failure - replace main PCB.</li> <li>2. Internal tube disconnected - reconnect and secure.</li> </ol>
Stacking breaths (inadvertent PEEP)	<ol style="list-style-type: none"> <li>1. Error code 3 Expiratory valve solenoid failed to open, resulting in high airway pressure alarm.- replace.</li> </ol>
Continuous flow of drive gas, or, bellows driven to bottom.	<ol style="list-style-type: none"> <li>1. Error code 2 Faulty inspiratory solenoid valve - replace.</li> </ol>
Tidal volume not delivered and HIGH AIRWAY PRESSURE alarm is on.	<ol style="list-style-type: none"> <li>1. Check/increase AIRWAY PRESSURE LIMIT setting.</li> <li>2. Check breathing system for obstruction.</li> </ol>
Zero tidal volume.	<ol style="list-style-type: none"> <li>1. Error code 2 Inspiratory solenoid valve faulty - replace.</li> </ol>

# FAULT FINDING

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CONDITION	POSSIBLE CAUSE / REMEDY
Zero tidal volume and drive gas leak from exhaust port.	<ol style="list-style-type: none"> <li>1. Error code 3 Expiratory solenoid failed open - replace.</li> <li>2. Exhaust valve failed - replace.</li> </ol>
Low tidal volume	<ol style="list-style-type: none"> <li>1. Error code 2 Inspiratory solenoid valve faulty - replace.</li> <li>2. Pressure relief valve leaking - replace O ring.</li> <li>3. Inlet filter blocked - replace.</li> <li>4. Defective spirometry head or leak in spirometry system.</li> <li>5. Breathing system leak or hose disconnected.</li> <li>6. Exhaust valve leaking - replace O ring / silicon washer.</li> </ol>
High tidal volume	<ol style="list-style-type: none"> <li>1. Leaking spirometer connector.</li> <li>2. Incorrect calibration of drive gas flow - recalibrate needle valve / stepper motor position.</li> </ol>
Tidal volume incorrect or inconsistent	<ol style="list-style-type: none"> <li>1. Missing small O-ring under the exhalation diaphragm valve.</li> <li>2. Partially detached or defective bellows.</li> <li>3. Damaged exhaust valve seal or seat.</li> <li>4. Very high/low breathing system resistance or compliance.</li> <li>5. High/low fresh gas flow - check volume delivered using standard calibration method.</li> <li>6. Incorrectly regulated gas pressure - check pressure / replace regulator.</li> <li>7. Error code 1 Flow valve fails to adjust correctly due to mechanism binding - realign and check calibration.</li> <li>8. Component failure on main PCB - replace PCB.</li> </ol>

# FAULT FINDING

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CONDITION	POSSIBLE CAUSE / REMEDY
Tidal volume incorrect or inconsistent (continued)	9. Spirometer faulty - replace spirometer head and lead.
	10. Loose grub screws on motor drive / needle shaft / potentiometer drive shaft. - check security of grub screws. - return ventilator to accredited agent or manufacture for calibration.
	11. Broken or damaged potentiometer flexible coupling - return ventilator to accredited agent or manufacture for calibration.
	12. Worn needle valve - return ventilator to accredited agent or manufacture for calibration.

# **FAULT FINDING**

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# 7. SERVICE SCHEDULE

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The AV800 ventilator **must** be serviced to the following schedules.  
Only Penlon-trained engineers should undertake servicing and repairs..

## 6 Month Service

1. Full service performance check.

## 12 Month Service

1. Fit Preventive Maintenance Kit components :

AV800 12 month service Kit	Part No. 57633
Part No. 042819	Quad Seal ( Exhaust valve )
Part No. 0314	'O' Seal Viton ( PRV )
Part No. 041204	'O' Seal Viton ( Bellows base diaphragm valve )
Part No. 041226	'O' Seal Viton ( Bellows Base to housing )
Part No. 300045	Silicon Sealing Washer ( Exhaust valve )
Part No. 0762	Filter - W9151 - 40 Micron.
Part No. 15446	Warranty sticker
Part No. 300329	Spirometer tubing assembly

2. Full service performance check.

## 5 year Overhaul

1. Fit overhaul kit components :

5 year overhaul kit	Part No. 57635
Parts listed in 12 month kit, plus:	
Part No. 104019	Lithium Battery ( Real time clock )
Part No. 103996	Lead Acid Battery ( Mains back up )
Part No. 045438	Internal Regulator
Part No. 300116	Internal Tubing Set
Part No. 011052	Adhesive tape (battery and speaker)

2. Full service performance check.

## Software Upgrades

Software upgrades will be offered to distributors and customers by means of a software program which will be loaded via the main PC.104 connector using a specially developed ROM Card

For distributors and customers who do not have access to a computer, a PCB board and front panel pic chip replacement will be available for early machines.

## Special Tools

<i>Part No.</i>	<i>Description</i>
-----	Multimeter
300128	PRV and Exhaust - cap removal tool
-----	Test Gauge

# SERVICE SCHEDULE

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## AV800 SERVICE PROCEDURE (version 2.0 software)

Item	Operation	Service frequency
1	<b>Initial Checks</b>	
1.1	Check and record serial number and determine service required.	
1.2	Check general condition of ventilator assembly	Six months
1.3	Check configuration of attachments and note.	(ALL item 1
1.4	Check and record front panel control settings.	operations)
2	<b>Engineering mode test</b>	
2.1	Switch ventilator selector switch to 'OFF'. Press MODE SELECT and INSP PAUSE simultaneously, and hold. Switch Ventilator selector switch to 'STANDBY'. The ventilator is now in Engineering Mode. NOTE To set a non spirometer version in engineering mode press the panel where the 'MODE SELECT' switch is hidden from view.	Six months (ALL item 2 operations)
2.2	Check date and time Turn the I:E ratio knob to move between parameters. Turn the RATE knob to adjust, if necessary, If any adjustments have been made, press 'MODE SELECT' at the end of the procedure (i.e., in <i>Check Time - Minute</i> mode) to save new settings. Turn the I:E ratio knob to move between parameters.	
2.3	Verify correct revision level.	
2.4	Note all errors and investigate. Error codes :- 0 - Watchdog reset. 1 - Stepper position error. 2 - Inspiratory solenoid fail. 3 - Expiratory solenoid fail. 4 - Front panel comms fail. 5 - Wild reset detected. 6 - Stepper feedback pot fail. 7 - System power fail. 8 - Airway pressure transducer fail. 9 - Ambient pressure transducer fail. 10 - Software Exception error - Parameter gives the exception number. 11 - Stack underflow or overflow. 12 - Front panel pressure limit pot fail. 13 - Flash checksum changed.	
2.5	Press MODE SELECT to clear errors, Press INSP PAUSE to exit engineering mode.	

TIDAL VOLUME (SET)  
 TIDAL VOLUME (MEASURED)  
 MINUTE VOLUME (MEASURED)  
 LITRES / MIN

MODE SELECT

INSP PAUSE (25%)

**Check Date - Year**  
 Year shown - 1998  
 Turn RATE knob to adjust.  
 Turn I:E knob clockwise to get to Check Date - Month

RATE B.P.M.  
 98

I:E RATIO  
 4r

TIDAL VOLUME (SET)  
 TIDAL VOLUME (MEASURED)  
 MINUTE VOLUME (MEASURED)  
 LITRES / MIN

MODE SELECT

INSP PAUSE (25%)

**Check Date - Month**  
 Month shown - December  
 Turn RATE knob to adjust.  
 Turn I:E knob clockwise to get to Check Date - Day

RATE B.P.M.  
 12

I:E RATIO  
 12h

TIDAL VOLUME (SET)  
 TIDAL VOLUME (MEASURED)  
 MINUTE VOLUME (MEASURED)  
 LITRES / MIN

MODE SELECT

INSP PAUSE (25%)

**Check Date - Day in Month**  
 Day shown - 10th  
 Turn RATE knob to adjust.  
 Turn I:E knob clockwise to get to Check Date - Day of Week

RATE B.P.M.  
 10

I:E RATIO  
 dAY

TIDAL VOLUME (SET)  
 TIDAL VOLUME (MEASURED)  
 MINUTE VOLUME (MEASURED)  
 LITRES / MIN

MODE SELECT

INSP PAUSE (25%)

**Check Date - Day of Week**  
 Day shown - Sunday  
 Turn RATE knob to adjust.  
 Turn I:E knob clockwise to get to Check Time - Hour

RATE B.P.M.  
 Su

I:E RATIO  
 dow

TIDAL VOLUME (SET)  
 TIDAL VOLUME (MEASURED)  
 MINUTE VOLUME (MEASURED)  
 LITRES / MIN

MODE SELECT

INSP PAUSE (25%)

**Check Time - Hour**  
 Time shown - 15.00  
 Turn RATE knob to adjust.  
 Turn I:E knob clockwise to get to Check Time - Minute

RATE B.P.M.  
 15

I:E RATIO  
 hr

TIDAL VOLUME (SET)  
 TIDAL VOLUME (MEASURED)  
 MINUTE VOLUME (MEASURED)  
 LITRES / MIN

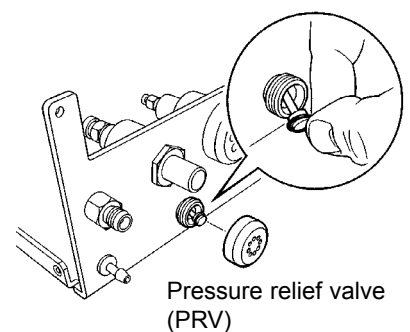
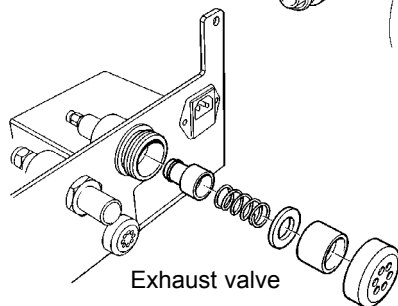
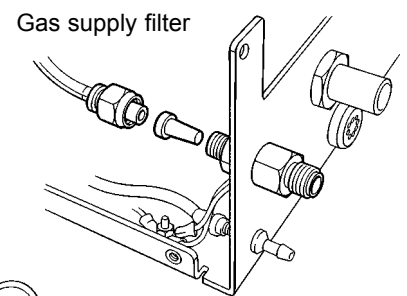
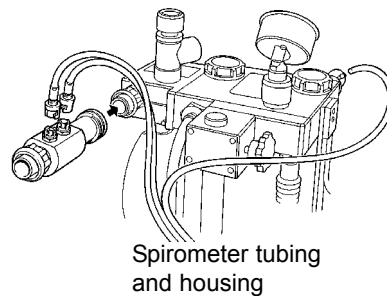
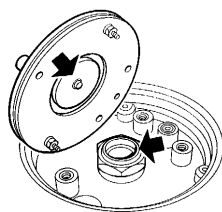
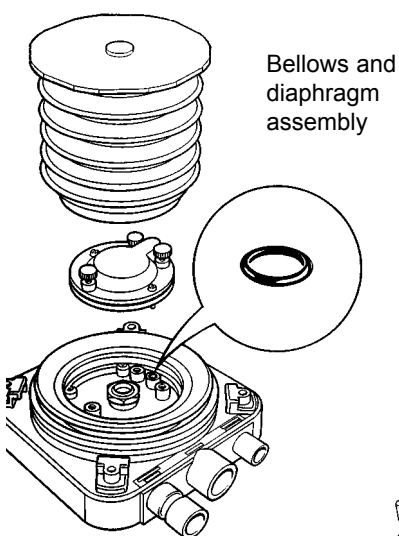
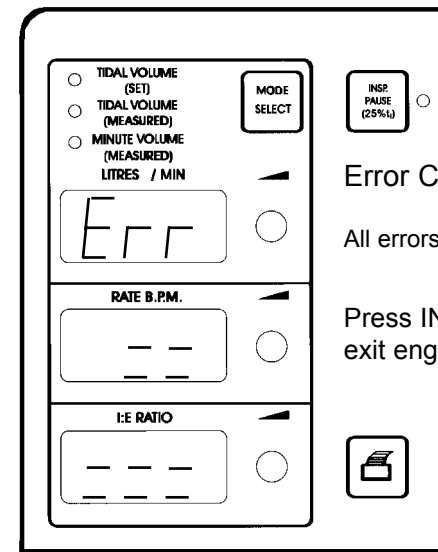
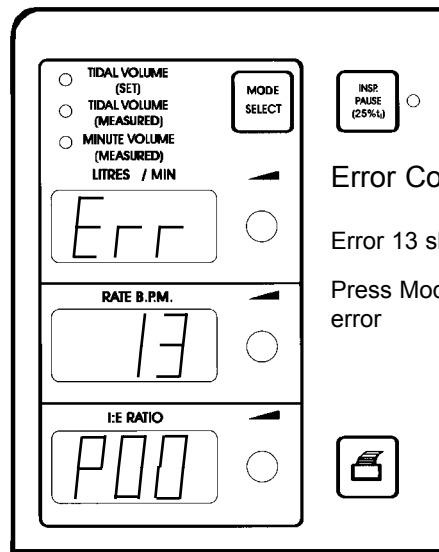
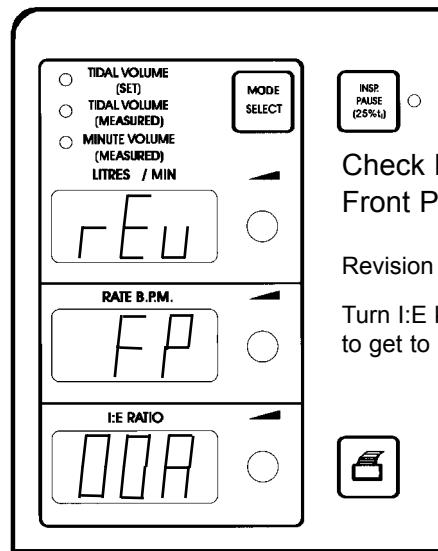
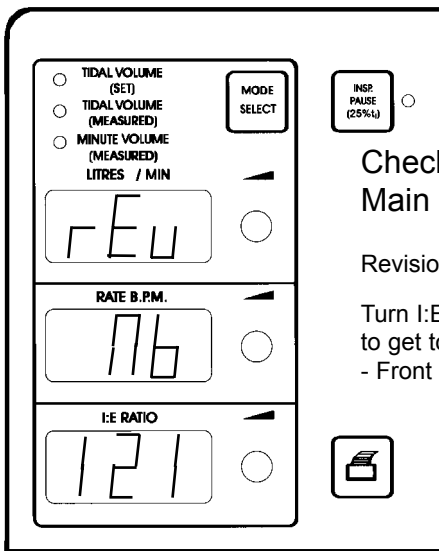
MODE SELECT

INSP PAUSE (25%)

**Check Time - Minute**  
 Time shown - two minutes past the hour  
 Turn RATE knob to adjust.  
 Turn I:E knob clockwise to get to Check Revision  
 Press Mode Select button to save any new settings.

RATE B.P.M.  
 02

I:E RATIO  
 10



# SERVICE SCHEDULE

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		<b>Service frequency</b>
3	<p><b>Electrical Safety Checks</b>  <i>Carry out the electrical safety checks with the ventilator power switch in the 'OFF' position.</i></p>	Six months (ALL item 3 operations)
3.1	Earth continuity (max 0.2 ohms )	
3.2	Insulation resistance ( not less than 10 m ohms )	
3.3	Earth leakage ( max 100 micro amps )	
4	<p><b>Bellows Assembly</b> (refer to illustrations on previous page)</p>	
4.1	Remove and clean bellows housing.	One year
4.2	Remove bellows assembly from base.	Six months
4.3	Unscrew the three thumb screws and remove the diaphragm valve. Inspect the valve seat for damage, check the valve disc lies horizontal. ( Do NOT attempt to dismantle diaphragm assembly ). Clean the valve seat and valve disc, use an alcohol wipe.	Six months
4.4	Remove and discard the O seals from the bellows base and diaphragm valve.	One year
4.5	Reassemble using correct service kit.	One year
5	<p><b>Pneumatic System</b> (refer to illustrations on previous page)</p>	
5.1	Remove covers and unlock the main PCB Tray to gain access.	Six months
5.2	Using special tool, replace the Quad seal in the exhaust valve.	Six months
5.3	Replace Exhaust valve silicon seal.	One year
5.4	Using special tool replace 'O' seal in PRV	One year
5.5	Check internal spirometer tubing, and replace if necessary.	One year
5.6	Check external spirometer tubing, and replace if necessary	One year
5.7	Replace O seal in spirometer housing Safelock connector	One year
5.8	Replace gas supply filter.	One year
5.9	Replace pressure reducing regulator.	Five years
5.10	Replace all internal tubing.	Five years
5.11	Connect a test gauge to the pneumatic assembly, ensure regulator is set to 35 psi (240 kPa) at 5 L/min.	Six months
5.12	Pressure test the gas inlet to inspiratory valve	Six months
5.13	Connect the ventilator to a power supply, turn the power switch to STANDBY. Set Litres, Rate and I:E Ratio to minimum, and check that at this position the needle valve is almost shut.	Six months
6	<p><b>Control Unit</b></p>	
6.1	Check all electrical connections and components for security.	Six months
6.2	Replace Back up battery.	Five years
6.3	Replace real time clock battery.	Five years
7	<p><b>Set Up</b></p>	Six months
7.1	Select drive hose O2 or Air and attach to the OXYGEN/AIR connection to the rear panel and ensure the drive gas switch is in the correct position. (Air down O2 up) connect mini-Schrader to anaesthetic machine.	(ALL item 7 operations)
7.2	Connect the small corrugated hose to the Driving Gas Ports.	
7.3	Connect a hose from the Breathing System Port to a CO2 absorber.	
7.4	Connect the pressure tube to MANOMETER/PRESSURE TRANSDUCER connection on the rear panel and to the To Patient port of the CO2 absorber	

# SERVICE SCHEDULE

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Item	Operation	Service frequency
7.5	Connect the spirometer tubing to SPIRO connections on the rear panel and to the spirometer 'Tee' piece which should be connected to the 'From Patient' port of the CO2 absorber.	
7.6	Connect the breathing tubes to the CO2 absorber and attach the patient 'Y' to a test lung.	
7.7	Attach the FRESH GAS SUPPLY to the CO2 absorber and set O2 flow at 0.25 L/m or min flow.	
7.8	Connect the gas scavenging system to the EXHAUST PORT.	
7.9	Connect the mains cable from the main socket in the rear panel to a 240 VAC supply.	
8	<b>Standby mode test</b>	Six months (ALL item 8 operations)
8.1	Switch the ventilator power switch to 'ON' verify that two bleeps sound and all LEDs light up.	
8.2	Check that previous settings are returned to display, (Litres, Rate and I:E Ratio)	
8.3	Set an incorrect rate, i.e. increase Litres and/or Rate controls clockwise, check 'INCORRECT RATE OR RATIO' alarm	
8.4	Verify setting lock, and check I:E Ratio display flashes.	
8.5	Press 'MODE SELECT' check 'SPIRO' can be set 'ON' or 'OFF', leave set to 'ON'.	
9	<b>Spontaneous</b>	Six months (ALL item 9 operations)
9.1	Switch ventilator switch to SPONTANEOUS and press MODE SELECT to access TIDAL VOLUME (MEASURED).	
9.2	Switch CO2 absorber to BAG	
9.3	Operate Bag Squeezing and check 'LITRES / MIN' and 'RATE B.P.M' displays indicate readings.	
9.4	Stop Bag Squeezing, ensure pressure gauge falls to zero, after 30 seconds delay. Check 'LOW AIRWAY PRESSURE' alarm, and also check that displays show = =	
9.5	Press 'MUTE' and verify audible alarm is muted for 30 seconds.	
10	<b>Volume cycle</b>	Six months (ALL item 10 operations)
10.1	Switch Ventilator switch to 'VOL CYCLED'	
10.2	Set 'TIDAL VOLUME LITRES / MIN' to 0.8, set 'RATE BPM' to 10, 'I:E RATIO' to 1:2 and 'AIRWAY PRESSURE LIMIT' to max.	
10.3	Verify 800 ml is delivered (indicated on bellows canister).	
10.4	Press 'INSP PAUSE' check 25% pause during the inspiratory phase.	
10.5	Press 'MODE SELECT' check displays indicate values on 'LITRES / MIN' and 'RATE BPM. Note these will show incorrect values due to gas and agent variations.	
10.6	Remove and occlude expiratory breathing hose and check that the following alarms operate. 'HIGH AIRWAY PRESSURE' 'HIGH CONTINUOUS PRESSURE' 'LOW AIRWAY PRESSURE' 'LOW TIDAL VOLUME'	
10.7	Disconnect mains supply, verify ventilator continues to operate on battery, check 'MAINS FAIL' alarm	

# SERVICE SCHEDULE

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<b>11</b>	<b>Pressure ventilation</b>	<b>Service frequency</b>
11.1	Switch Ventilator selector switch to 'PRESSURE'	Six months
11.2	Set 'AIRWAY PRESSURE LIMIT' to 20 cmH <sub>2</sub> O and verify that the pressure is held at setting.	(ALL item 11 operations)
11.3	Carry out leak test. Set 'LITRES' to 1 L/m, 'RATE' to 5 bpm and 'AIRWAY PRESSURE LIMIT' to 20 cmH <sub>2</sub> O, ensure rotameter is set to 200 ml or min. Fill bellows using O <sub>2</sub> flush, allow bellows to cycle and verify bellows remain full. Maximum permissible leak 200 ml.	
11.4	Remove mini schrader from gas supply pressure and check 'LOW SUPPLY PRESSURE' alarm, verify 'LITRES / MIN' display flashes.	
<b>12</b>	<b>Completion</b>	<b>Service frequency</b>
12.1	Check in Engineering Mode for error messages	Six months
12.2	Sign and date service card, indicate Commissioning, attach card and plastic wallet to equipment.	(ALL item 12 operations)
12.3	Fill out service report.	
12.4	Leave equipment ready for use as requested by the customer.	

## 8. SERVICE PROCEDURES

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### 8.1 Cleaning

#### 8.1.1 Outside surfaces and bellows housing

##### **CAUTION**

*Care must be taken not to allow liquids to run into the control unit; serious damage may result.*

*Check that the unit is disconnected from the electrical supply before cleaning.*

*Do not use cleaning solutions containing alcohol; the bellows housing may be damaged.*

To clean the outside surface of the ventilator, use a damp cloth.

If necessary use a warm, mild detergent solution to remove resistant grime. Make sure that all detergent residues are fully removed after cleaning.

Never use any harsh abrasive cleaning agent. The transparent acrylic bellows housing (canister) and, in general, the surfaces of the control unit are not scratch resistant.

The inside of the canister, under normal conditions, is not in contact with the breathing gas and therefore only needs cleaning as described above.

Remove the canister by slightly twisting it counter-clockwise until the tabs at the bottom clear the bayonet locks, then lift it straight up from the base.

#### 8.1.2 Bellows and exhalation diaphragm valve

Refer to illustration on next page.

Each time the bellows assemblies are opened for cleaning, all visible components must be carefully inspected and damaged parts must be replaced.

##### **Bellows**

As with all elastomers, the bellows material deteriorates with aging and should be

inspected at least every six months or after 1200 hours of use, whichever comes first. The bellows must be replaced if it shows signs of aging. The bellows can be removed by carefully pulling it off the base.

##### **Exhalation Diaphragm Valve**

The exhalation diaphragm valve is under the bellows and can be removed by loosening the three thumbscrews.

The valve seat is now visible.

##### **WARNING**

***Great care must be taken not to damage the precision surface of the diaphragm valve seat (A).***

***Never use any hard object or abrasive agent to clean it; use only a soft cloth (alcohol wipe recommended).***

***If the valve seat is damaged, the diaphragm valve will leak and may cause serious malfunction.***

Using an alcohol wipe, clean the seat (A), and the metal disk (B) attached to the base of the diaphragm valve, thoroughly and remove all contamination from the surfaces of both components.

##### **NOTE**

*If excessive contamination is discovered, check that a bacterial filter is used in the expiratory limb of the breathing circuit (or an HME at the patient tee-piece).*

*See section 5.1.4.*

After cleaning, check that the small O-ring (C) located in the bellows base under the diaphragm valve is in place. The ventilator will not function if the O-ring is missing.

See section 8.2 for information on sterilisation procedures.

Refit the diaphragm valve assembly to the bellows base and reassemble the bellows assembly.

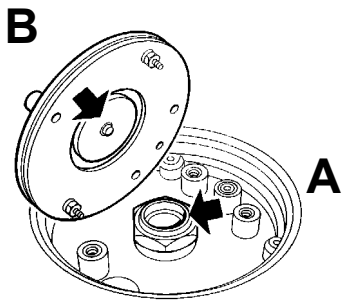
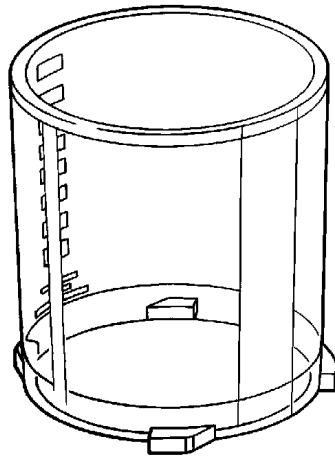
##### **CAUTION**

***Always check for correct fitment of the bellows (see illustration) and carry out a full function test of the ventilator before clinical use.***

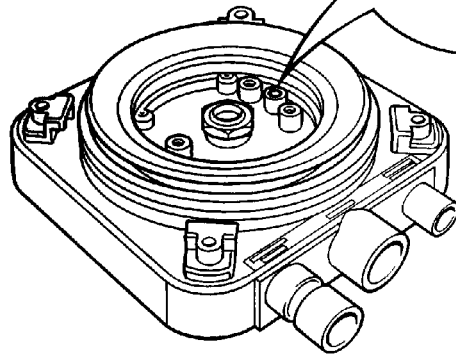
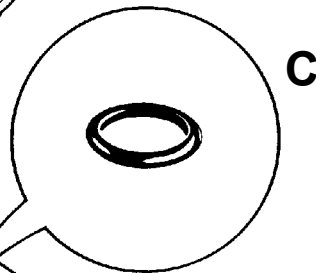
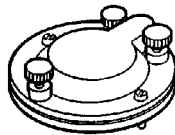
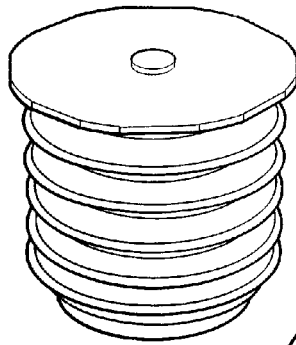


# SERVICE PROCEDURES

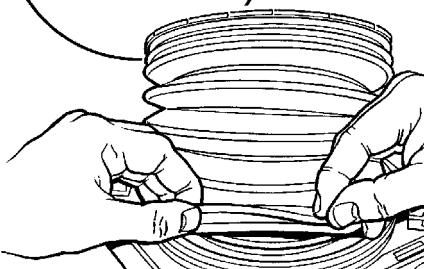
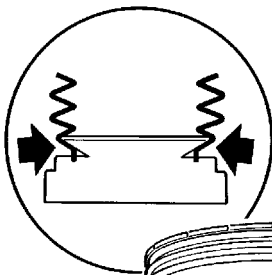
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**Exhalation Diaphragm Valve Assembly**



**Bellows Base**



**Refitting the Bellows**

# SERVICE PROCEDURES

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## 8.1.3 Spirometer Sensor and Tubing Assembly

On a regular basis (at least weekly), the sensor assembly and sample lines must be thoroughly cleaned, and sterilised as necessary.

a) Carefully detach the sample lines from the Luer taper connectors on the rear panel of the ventilator, and remove the spirometer assembly (A) from the absorber.

b) Wash the components, and sample lines by rinsing with clean (distilled) water poured into the outlet (not under pressure). Ensure that all traces of solid contamination are flushed out.

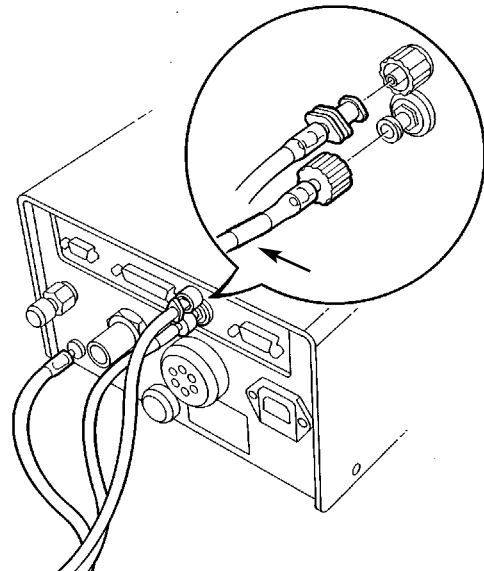
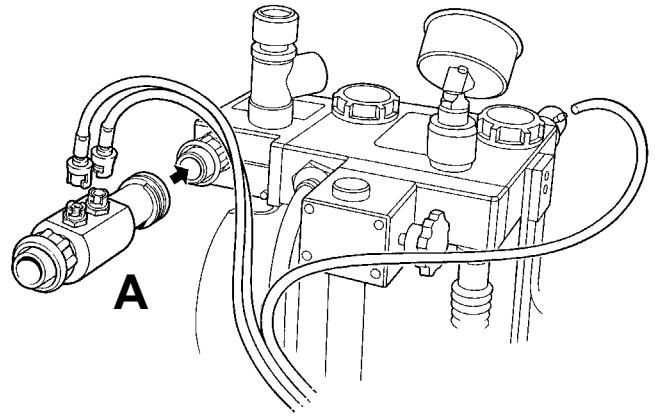
**Note**

Latest tubing assemblies have a restrictor fitted to the tube marked 'VENT END' (B)  
After washing, check that the restrictor is not blocked.

c) Sterilisation - see section 8.2, below.

d) When the components are dry, refit the sample lines to the spirometer sensor assembly and connectors on the rear panel of the ventilator.

The tube labelled 'VENT END' (B), must be fitted to the ventilator rear panel, as illustrated above.



# SERVICE PROCEDURES

---

## 8.2 Sterilisation

**Recommended guidelines for sterilisation:**

### **CAUTION**

*To prevent possible damage to components, peak sterilisation temperatures must not exceed 54°C (130°F) for gas (ethylene oxide) or, 134°C (275°F) for steam autoclave.*

*Do not sterilise the ventilator control unit. The internal components are not compatible with sterilisation techniques and may be damaged.*

*Following sterilisation with ethylene oxide, components must be quarantined in a well ventilated area to allow dissipation of any residual gases.*

Follow the recommendations given by the steriliser manufacturer for aeration periods.

<b>ITEM</b>	<b>METHOD</b>
Bellows *	Gas, liquid, autoclave (20 cycles max.)
Hoses	Gas, liquid, autoclave
O rings	Gas, liquid, autoclave.
Bellows base	Gas, liquid, autoclave.
Exhalation valve assembly	Gas, liquid, pasteurise, low temperature autoclave.
Control unit	Do not sterilise - see section 9.1.
Bellows canister	Liquid.
Spirometer sensor tee piece	Gas, liquid, autoclave
Spirometer sample lines	Liquid
Distal sensing Tee	Liquid

*\*Applies to standard size bellows only, the optional paediatric bellows must not be steam autoclaved.*

### **NOTE**

*Examples of suitable liquid agents are: Nu-Cidex, Sporidicin, and Sonacide. The exhalation diaphragm valve must be removed, cleaned and sterilised separately.*

# SERVICING PROCEDURES

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## 8.3 Tubing Connectors

To connect and disconnect the tubing from the push-in connectors, follow the procedures detailed below.

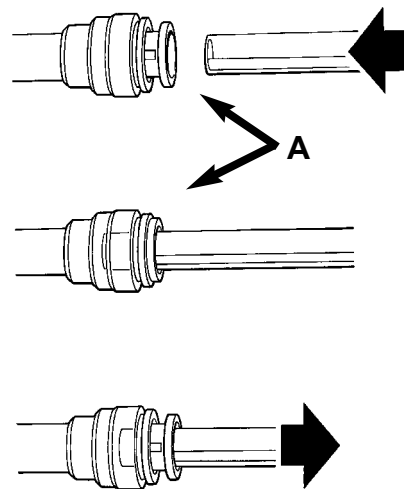
Do not use excess force.

### Disconnecting tubing from connector

Push in the tube and the connector end piece 'A'.

Hold the end piece 'A' in place.

Pull the tube out to disconnect.



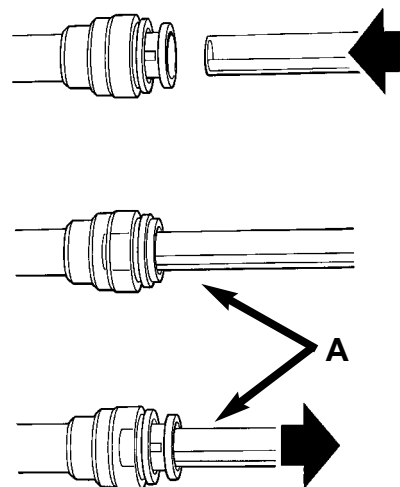
### Fitting tubing to connector

Push in the tube as far as possible  
Do not use excessive force.

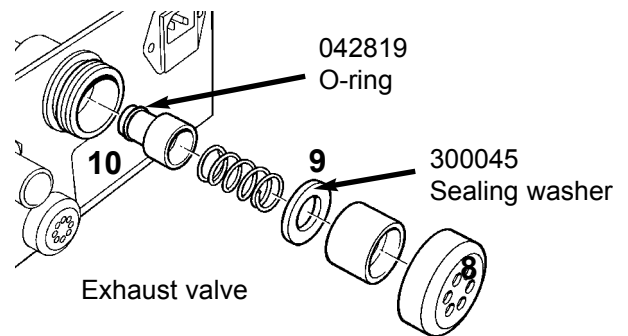
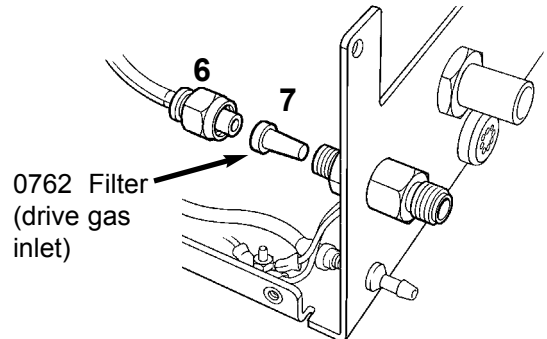
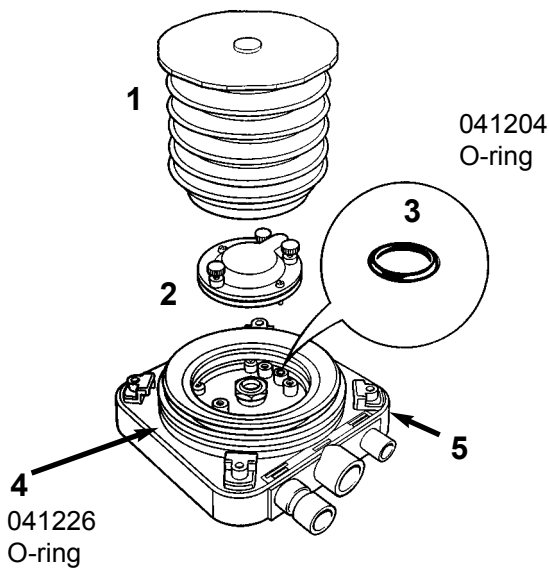
The connector end piece 'A' will also move inwards.

Pull the tube carefully outwards.

The end piece 'A' will be pulled outwards to the 'locked' position



# SERVICING PROCEDURES



## 8.4 Fitting the Annual Preventive Maintenance Kit

1. Disconnect the mains electrical and gas supply.

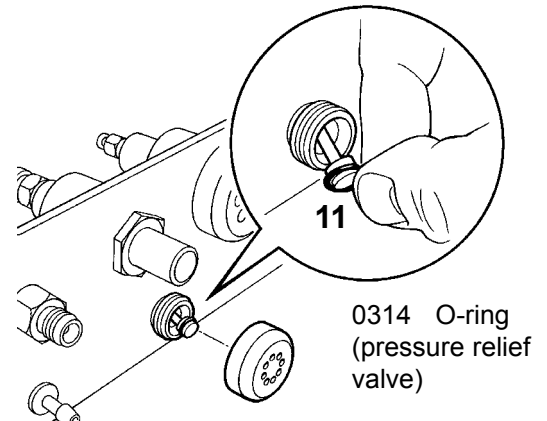
### Bellows assembly

1. Remove the bellows housing and bellows (1).
2. Loosen the three screws securing the exhalation diaphragm valve (2) and remove.
3. Fit a new O rings (3 and 4) to the bellows base (5).
4. Check the condition of the exhalation valve disk and valve seat (see section 9.1.2)

**NOTE** If a ventilator is equipped with an optional paediatric bellows assembly, the O-ring on the paediatric adaptor must also be renewed annually.  
Order O-ring, Part No. 041225

### Drive gas inlet filter

1. Remove the chassis unit cover.
2. Undo the hose connector (6).
3. Fit a new filter (7), and refit the hose connector.



### Exhaust valve

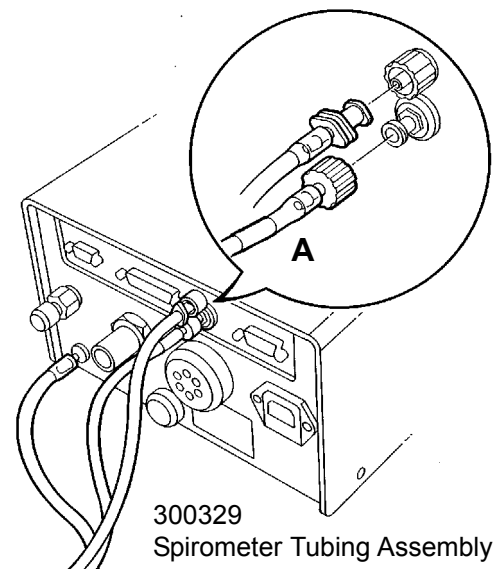
1. Use service tool to unscrew the exhaust valve cover (8).
2. Remove the valve components and fit a new sealing washer (9) and O-ring (10).

### Pressure relief valve (PRV)

1. Use service tool to unscrew the PRV cover.
2. Fit a new O-ring (11) to the valve plunger.

### Spirometer Tubing Assembly

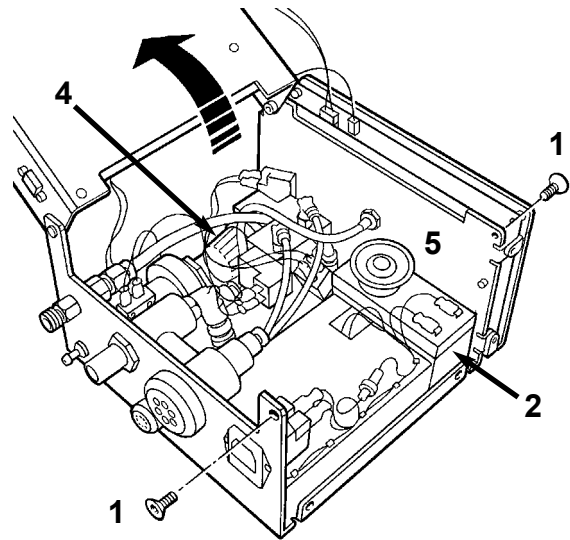
1. Fit the tubing with label 'VENT END' (A) to the lower connector at the rear of the ventilator



# SERVICING PROCEDURES

## 8.5 Fitting the Five Year Overhaul Kit

1. Disconnect the ventilator from electrical and gas supplies. Remove the cover from the ventilator chassis.
2. Remove the two screws (1) to allow the main PCB / tray assembly to be pivoted upwards.
3. Disconnect the leads from the battery (2).

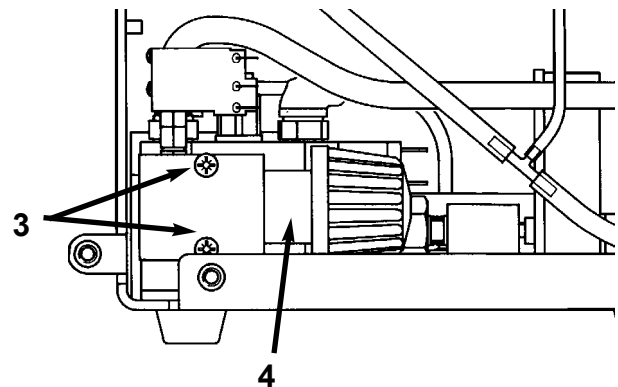


### Regulator assembly

4. Remove the securing screws (3), and detach the regulator (4) from the manifold assembly.

### Mains back-up battery

5. Carefully break the adhesive seal and detach the alarm system speaker (5) from the top of the battery.
6. Break the adhesive seal between the battery and the base of the ventilator chassis and remove the battery.
7. Fit a new battery, using a new adhesive pad to hold in place.
8. Refit the speaker (5), using a new adhesive pad to hold in place.
9. Reconnect the battery leads.

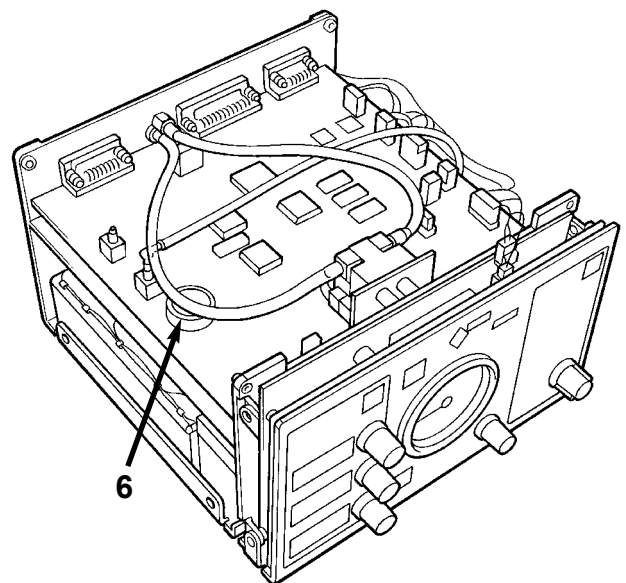


### Real time clock battery

#### CAUTION

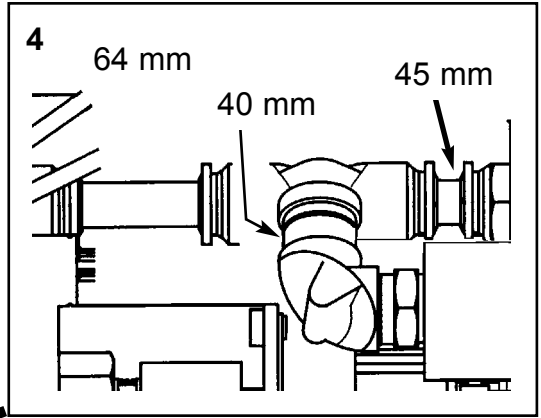
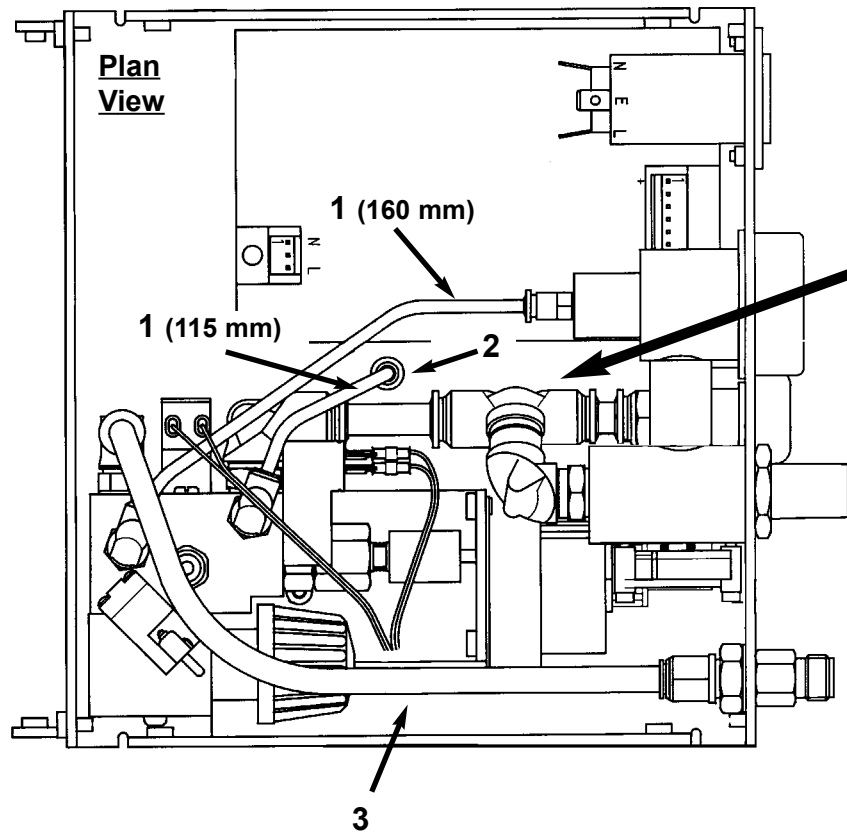
To prevent possible contamination and subsequent corrosion, do not handle the battery.

10. Fit a new battery (6). Check for real time errors which may occur because of battery replacement.

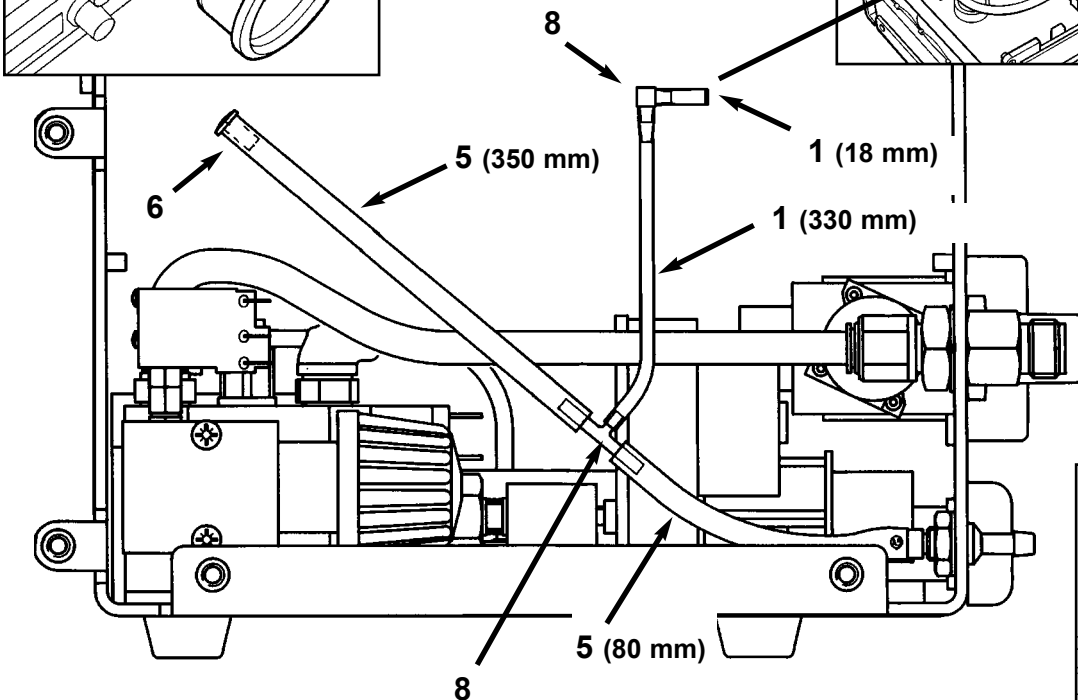
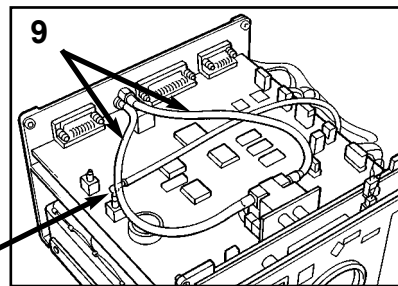
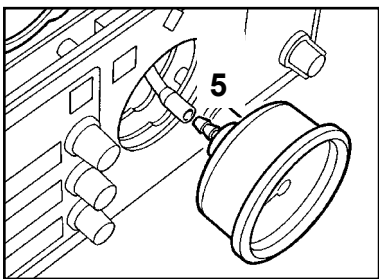


### Internal Tubing

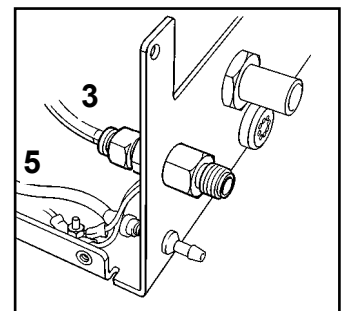
11. Renew all internal tubing (including spirometer tubing if fitted).  
**Cut the new tubing to the exact lengths specified below. Spirometer accuracy is dependant on correct tubing lengths.**



Ref	Part No.
1	462541 (623 mm / 4 mm o.d.)
2	054541 (Adaptor)
3	462544 (220 mm / 8 mm o.d.)
4	462545 (149 mm 10 mm o.d.)
5	011092 (430 mm / 6 mm o.d.)
6	053211 (Plug - fitted only to models without gauge)
7	054947 (Tee piece)
8	054949 (Connector)
9	011092 (510 mm / 6 mm o.d. (models with spirometer))



**Side View**

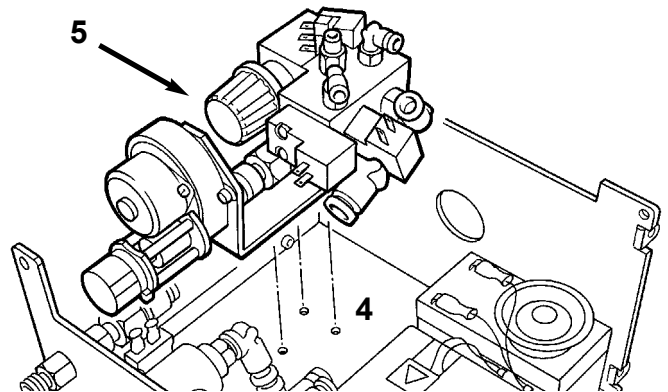
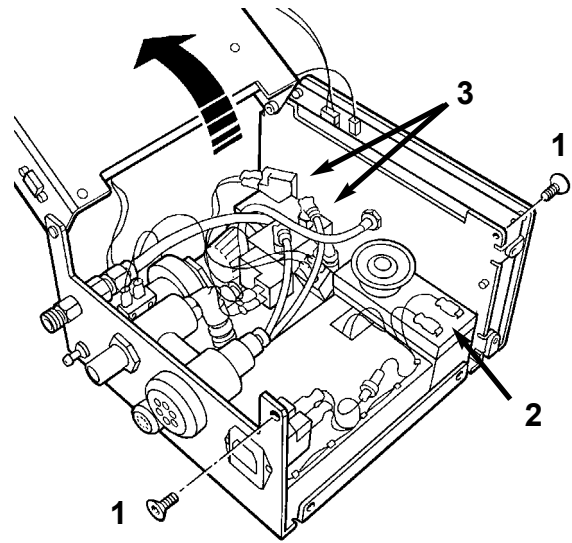


# SERVICING PROCEDURES

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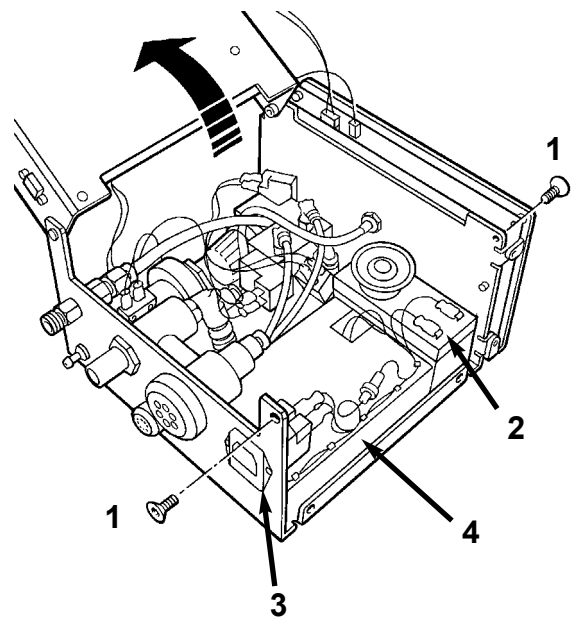
## 8.6 Manifold Assembly

1. Disconnect the ventilator from electrical and gas supplies. Remove the cover.
2. Remove the two screws (1) to allow the main PCB / tray assembly to be pivoted upwards.
3. Disconnect the back-up battery wiring (2).
4. Disconnect all tubing and wiring connectors (3) from the manifold assembly.
5. From underneath the ventilator, remove the three screws (4) to allow removal of the manifold assembly (5).



## 8.7 Electrical Power Supply

1. Disconnect the ventilator from electrical and gas supplies. Remove the cover.
2. Remove the two screws (1) to allow the main PCB / tray assembly to be pivoted upwards.
3. Disconnect the back-up battery wiring (2).
4. Remove the two screws and detach the mains in/out socket / filter unit (3) from the chassis, but do not disconnect the wiring.
5. From underneath the ventilator, remove the four screws and lift the power supply unit (4) from the chassis.  
Disconnect the wiring from the power supply unit to allow removal.





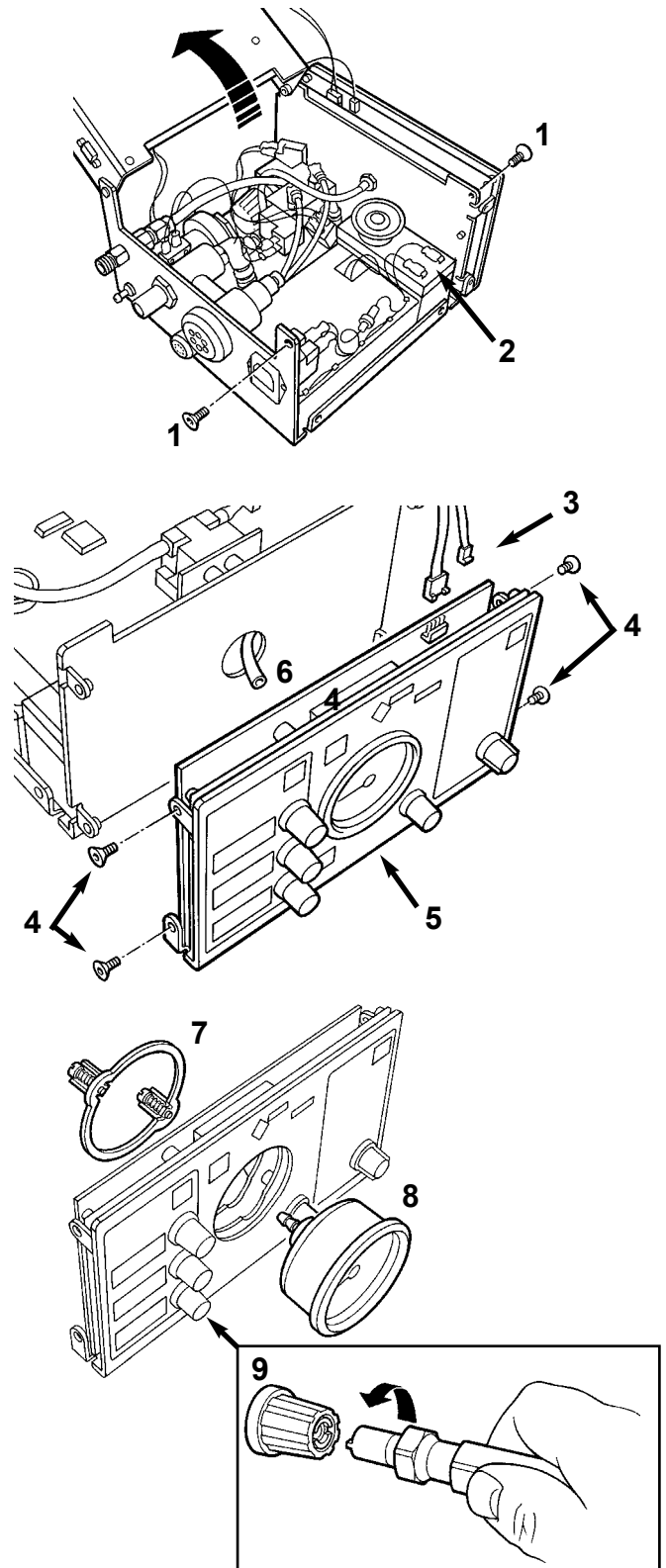
# SERVICING PROCEDURES

## 8.8 Front Panel and PCB Assembly, and Gauge

### NOTE

The display PCB and the control PCB are not available as separate items. A front panel and PCB assembly must be ordered if either PCB is faulty.

1. Disconnect the ventilator from electrical and gas supplies. Remove the cover.
2. Remove the two screws (1) to allow the main PCB / tray assembly to be pivoted upwards.
3. Disconnect the back-up battery wiring (2).
4. Disconnect the wiring connectors (3) from the PCB.
5. Remove the four screws (4) and detach the front panel assembly (5) from the ventilator.
6. On models with a manometer: Disconnect the tubing (6) from the back of the gauge.
7. Slacken the screws on the retaining ring (7) and detach the gauge (8) from the assembly.
8. Carefully remove the caps from each control knob (9), then use the special tool to remove each knob.
9. To reassemble, reverse the removal procedure
9. Fitting a new front panel assembly - On models with a manometer, the new front panel must be cut before the gauge can be refitted. to allow fitment of the gauge.



# SERVICING PROCEDURES

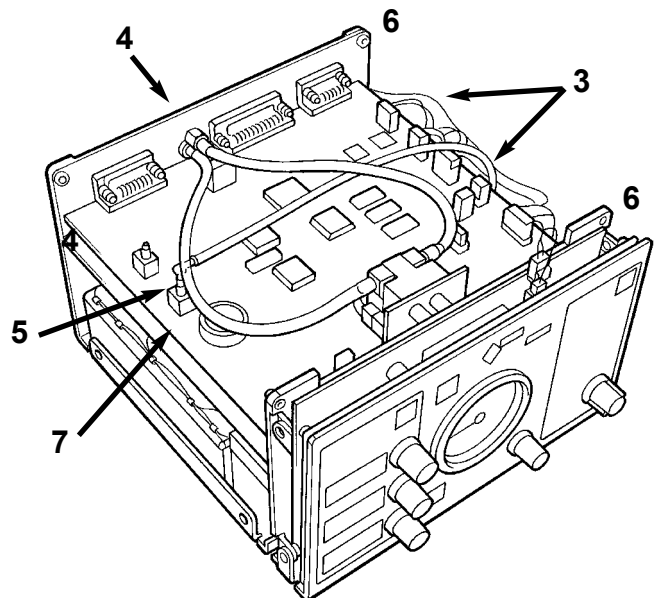
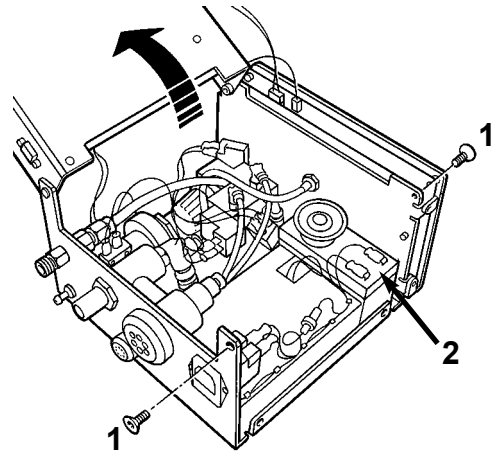
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## 8.9 Main PCB Tray Assembly

### NOTE

The main PCB is not available as a separate item. A tray assembly complete with pre-programmed PCB must be ordered if the PCB is faulty.

1. Disconnect the ventilator from electrical and gas supplies. Remove the cover.
2. Remove the two screws (1) to allow the main PCB / tray assembly to be pivotted upwards.
3. Disconnect the back-up battery wiring (2), then relocate the tray assembly.
4. Disconnect the wiring connectors (3) from the PCB .
5. Disconnect the spirometer tubing from the connectors (4) on the rear panel (models with spirometry).
6. Disconnect the pressure transducer tubing from the connector (5) on the PCB.
7. Remove the two remaining screws (6) and detach the tray assembly (7) from the ventilator chassis.
8. To reassemble, reverse the removal procedure.



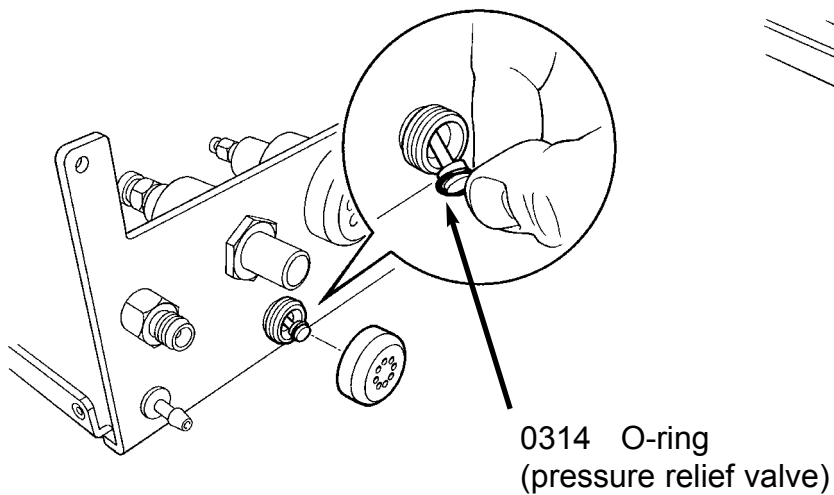
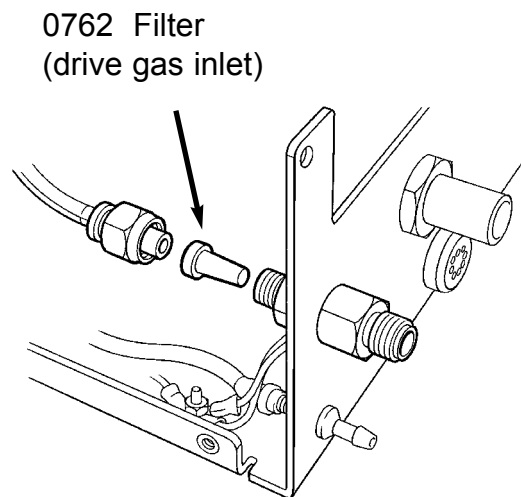
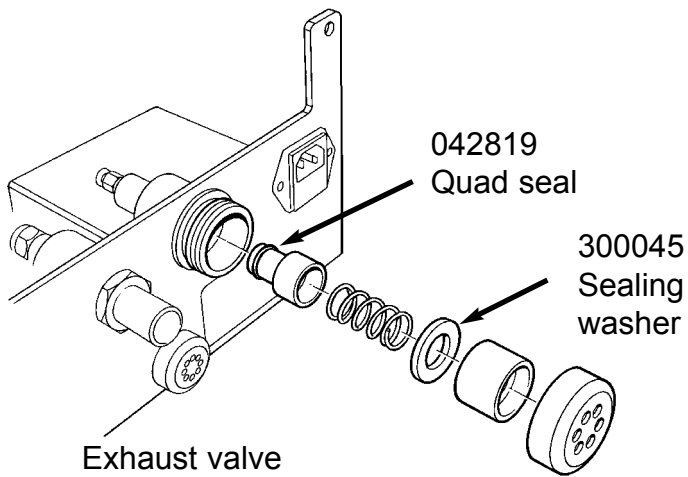
## 9. PARTS LIST

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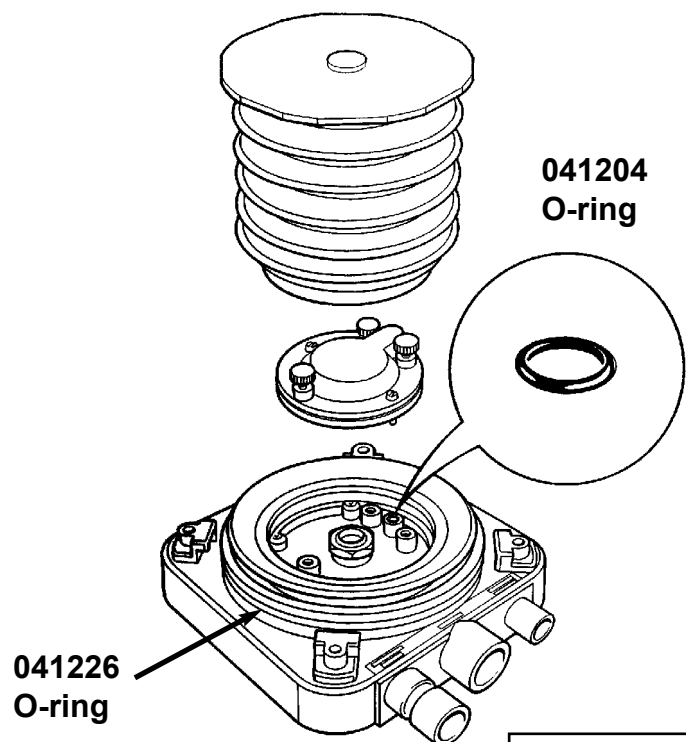
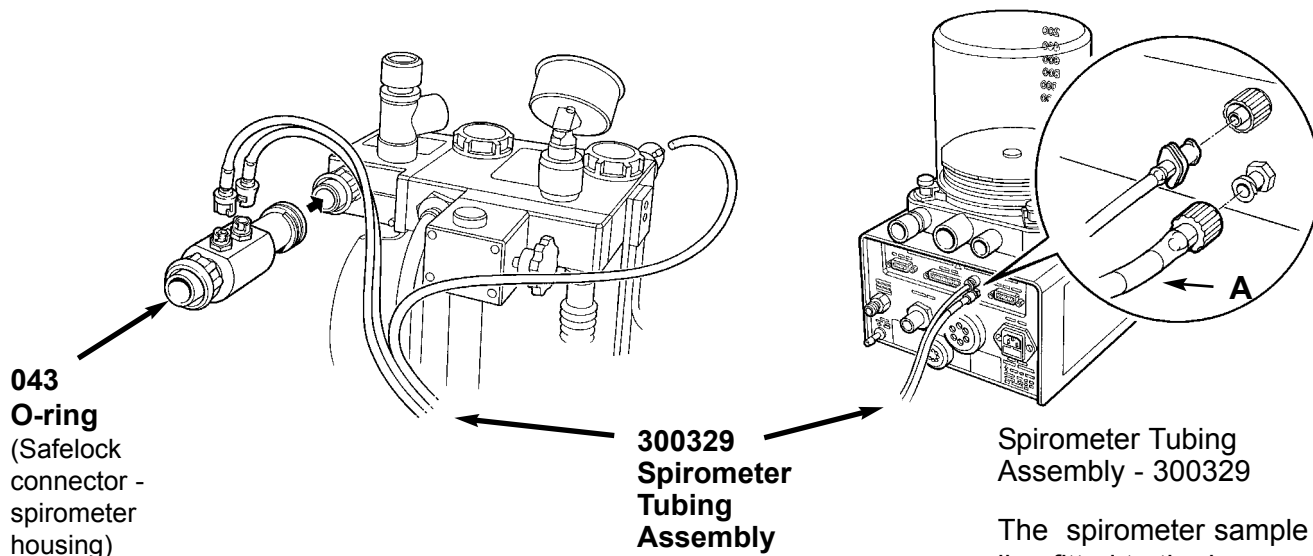
### Annual Preventive Maintenance Kit

Cat No 57633

041204	O-ring - bellows base
041226	O-ring - bellows base
042819	Quad seal - exhaust valve
300045	Sealing washer - exhaust valve
0314	O-ring - Pressure relief valve
0762	Filter - drive gas inlet
043	O-ring (Safelock connector - spirometer housing)
300329	Spirometer Tubing Assembly



# PARTS LIST



**Note**  
If a paediatric bellows assembly is used with the AV800, the O-ring on the bellows adaptor must be renewed annually. Order O-ring, Part No 41225.

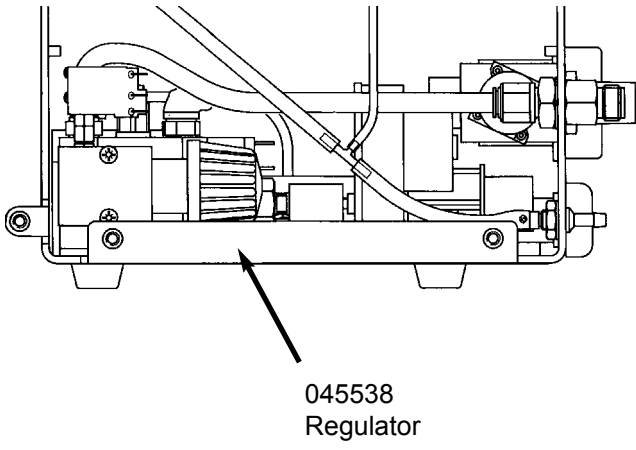
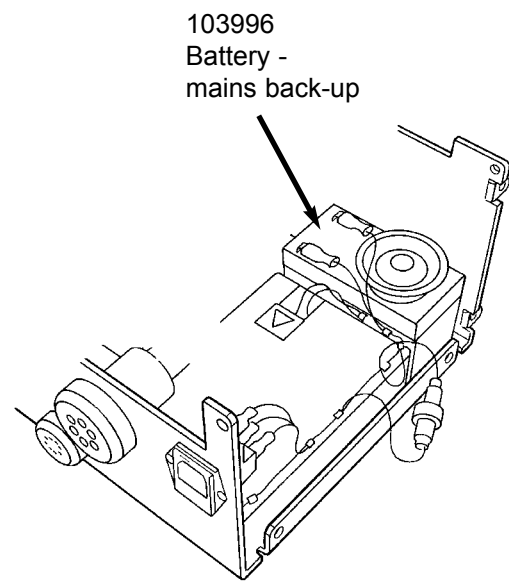
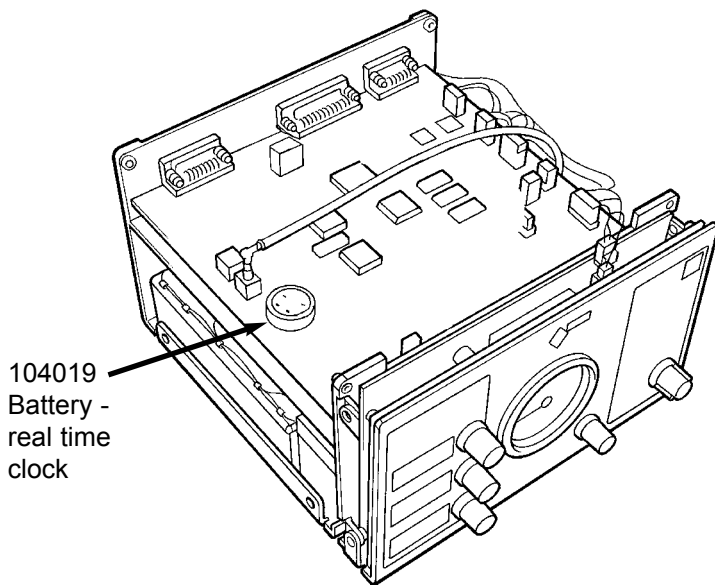
# PARTS LIST

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## Five Year Overhaul Kit

Cat No 57635

- 104019 Battery - real time clock
- 103996 Battery - mains back-up, 12 V
- 045538 Regulator
- Tubing - internal (see next page)



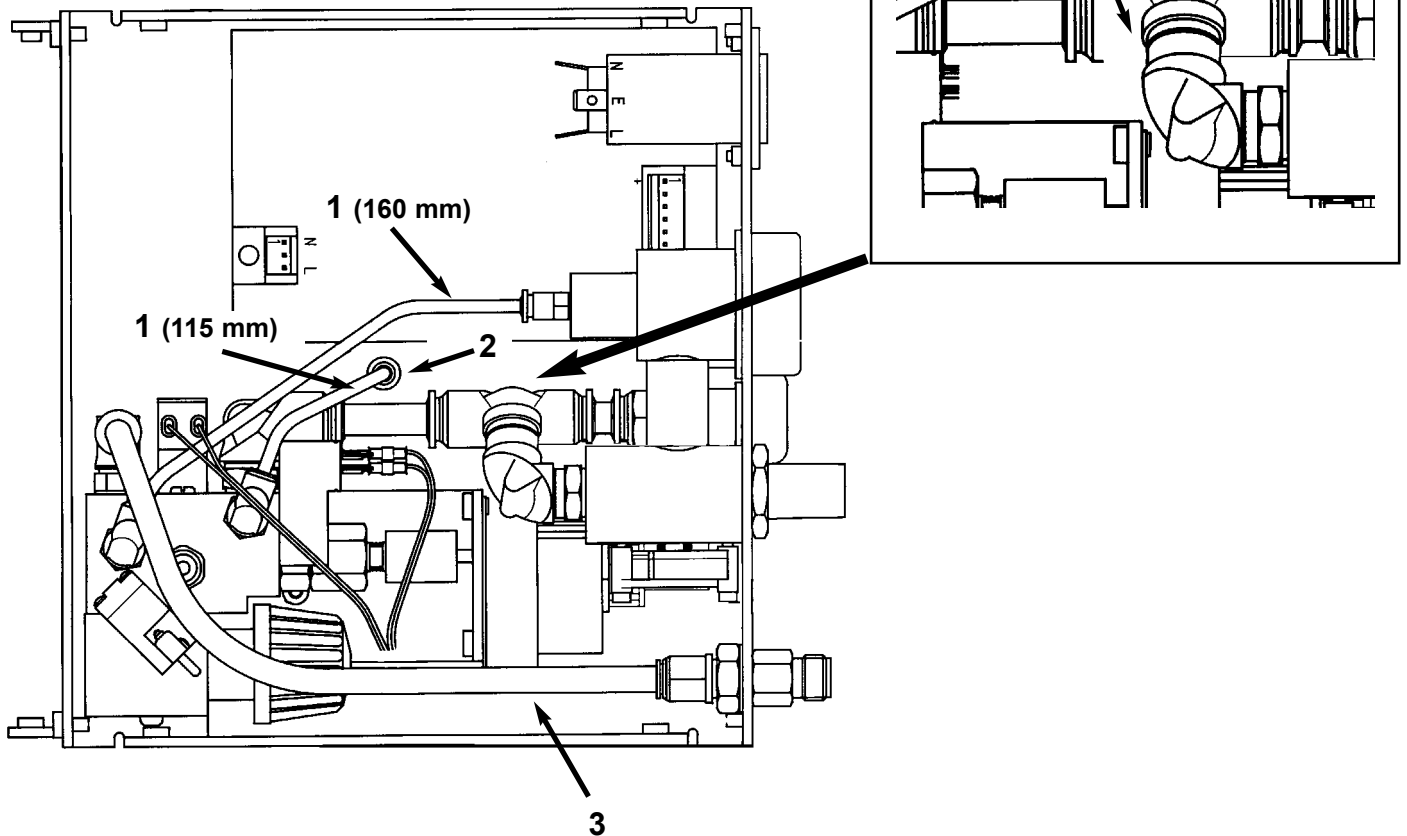
# PARTS LIST

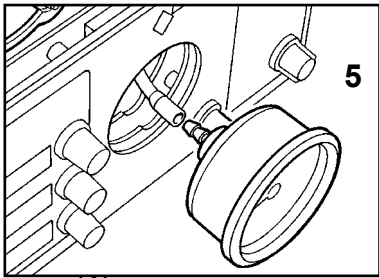
## Internal Tubing

**NOTE :** Replacement tubing must be to the length as specified on illustrations

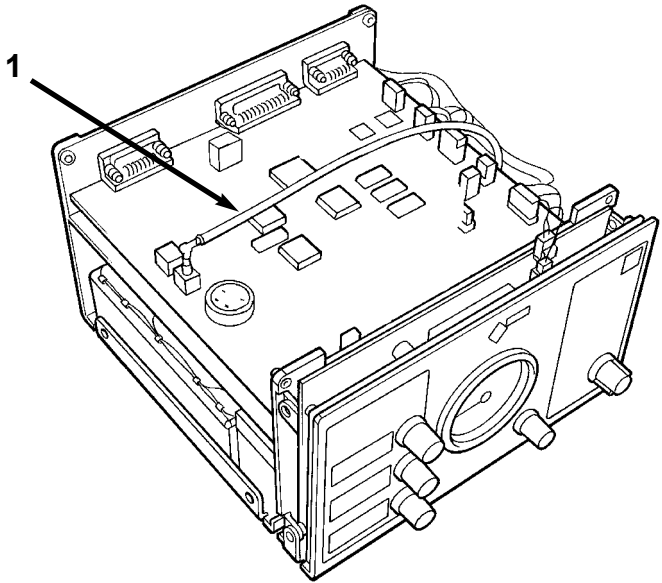
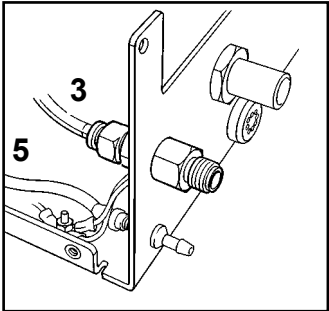
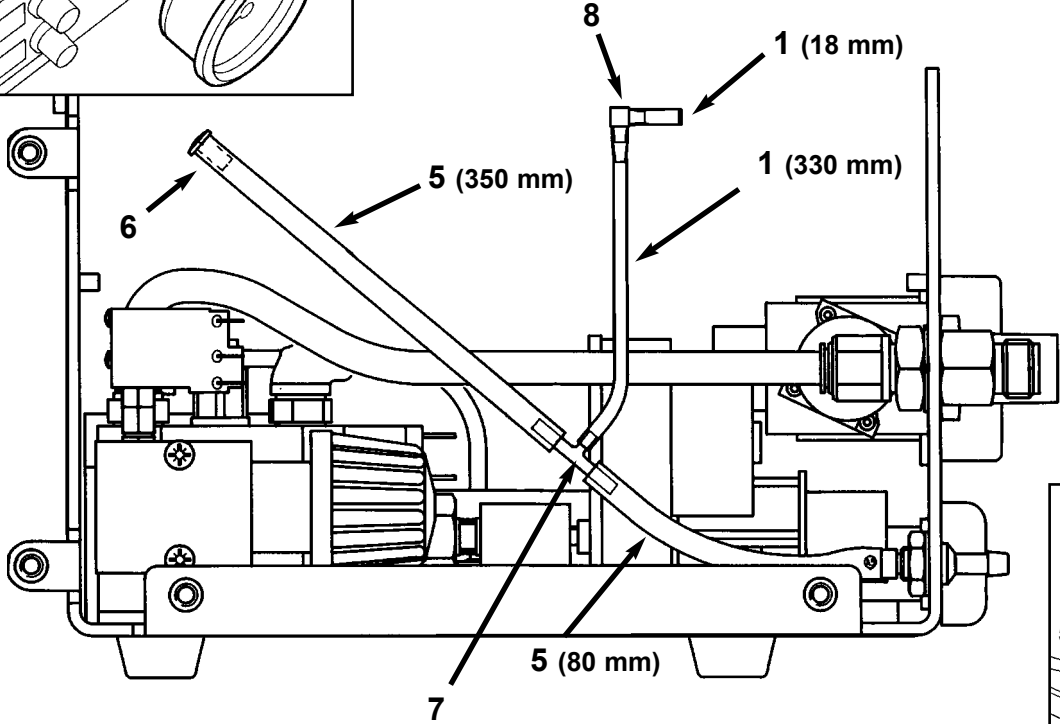
<i>Ref</i>	<i>Part No.</i>	<i>Qty.</i>	<i>Description</i>
1	462541	623 mm	Tubing 4 mm o.d.
2	054541	1	Adaptor
3	462544	220 mm	Tubing 8 mm o.d.
4	462545	149 mm	Tubing 10 mm o.d.
5	011092	430 mm	Tubing 6 mm o.d.
6	053211	1	Plug (fitted only to models without gauge)
7	054947	1	Tee piece (3 mm / 2.25 mm)
8	054949	1	Connector

## Plan View

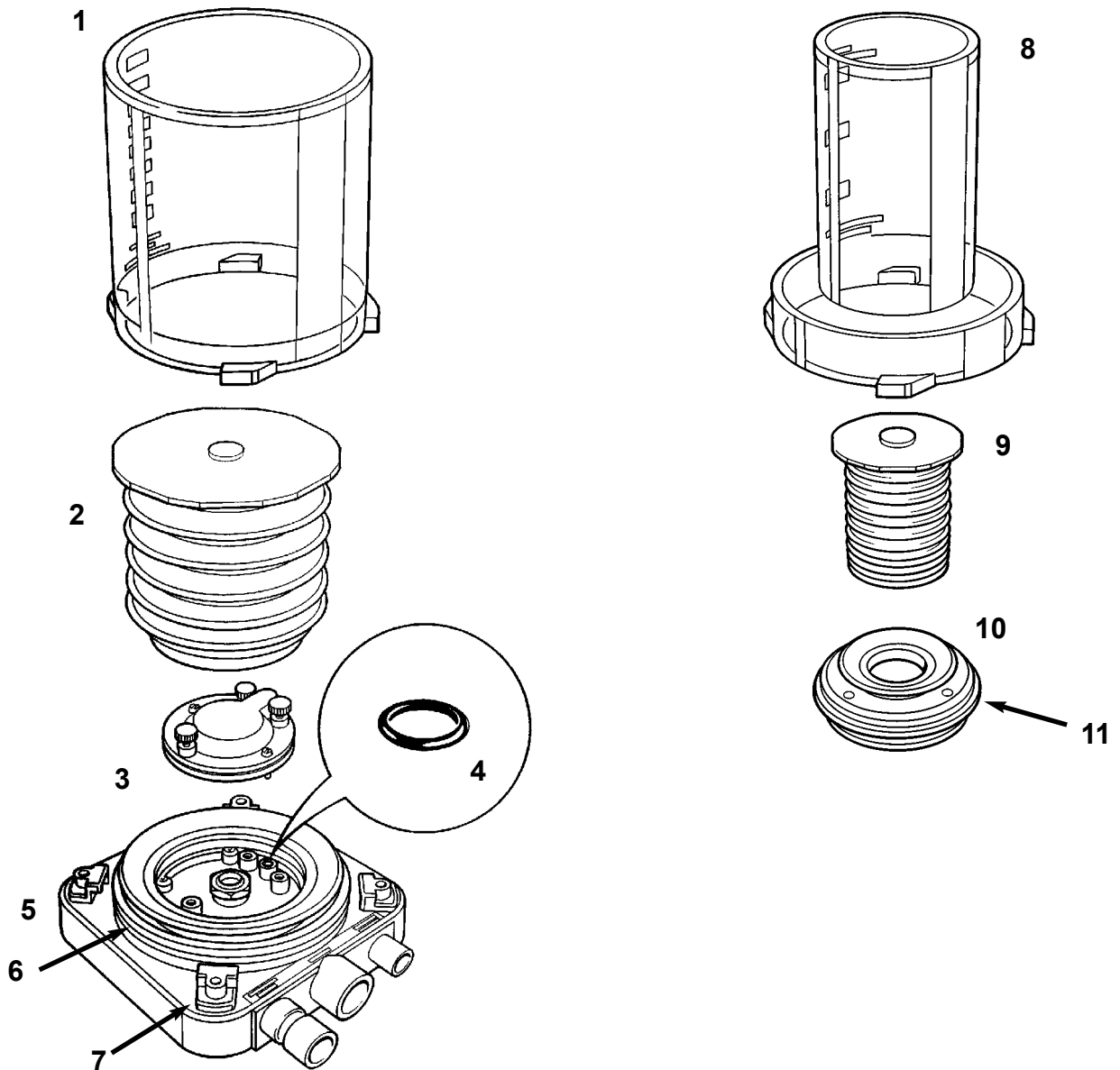




**Side View**



# PARTS LIST

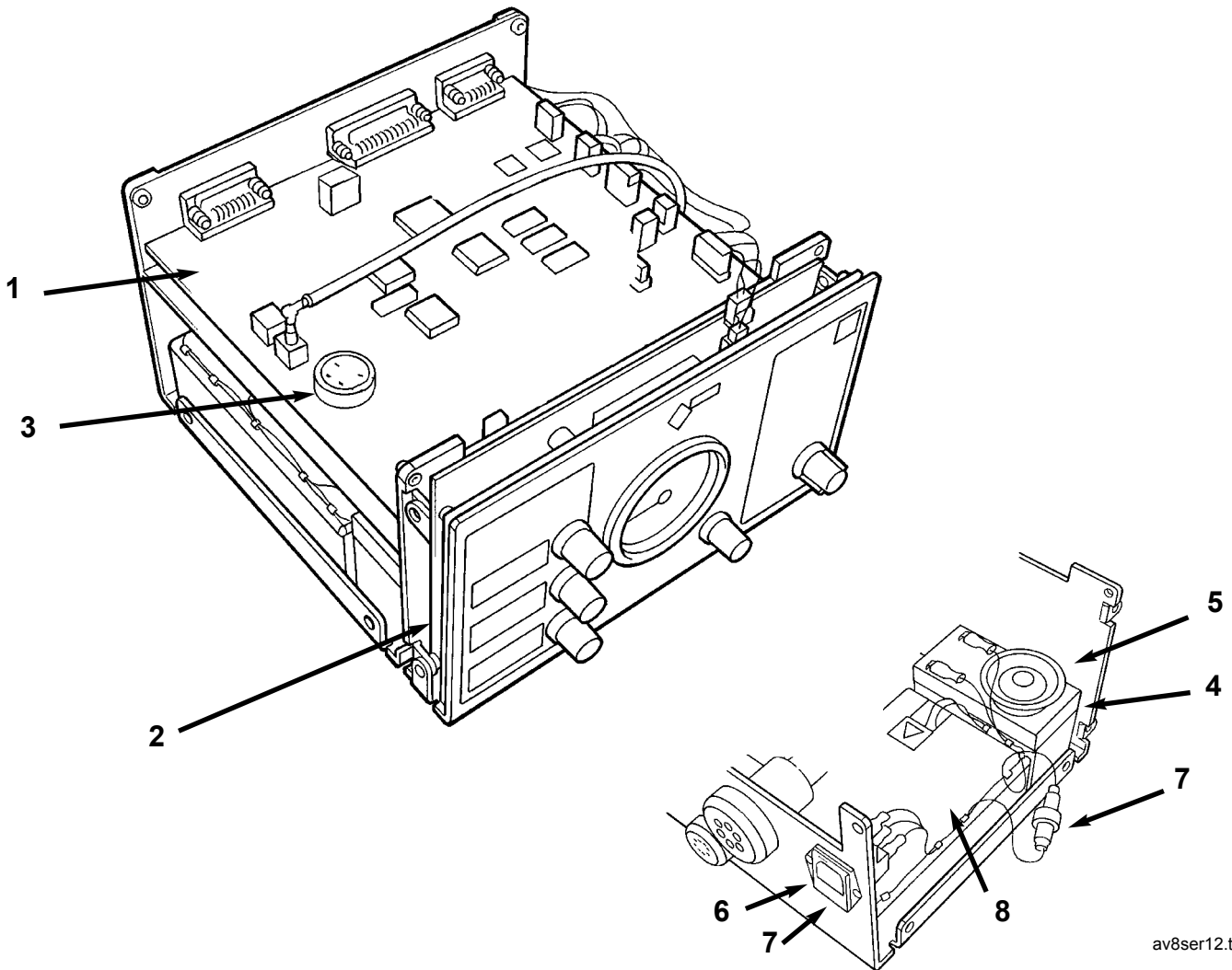


## Bellows and Base Assembly

Ref	Part No.	Qty.	Description
1	57551	1	Canister
2	57550	1	Bellows
3	406020	1	Diaphragm valve assembly
4	041204	1	O ring
5	57548	1	Bellows base assembly
6	041226	1	O ring
7	019103	4	Screw - M5
	011107	4	Knurled knob
8	57553	1	Canister - paediatric (available as an option)
9	57552	1	Bellows - paediatric (available as an option)
10	57544	1	Adapter assembly - paediatric (available as an option)
11	041225	1	O ring



# PARTS LIST



av8ser12.tif

## PCBs and Electrical System Components

<i>Ref</i>	<i>Part No.</i>	<i>Qty.</i>	<i>Description</i>
1	300xxx	1	<b>AV80</b> Main PCB tray assembly
2	300xxx	1	<b>AV800</b> Display PCB and front panel assembly
3	104019	1	Battery - PCB, LiMn, 3 V, 260 mAh, 24.5 mm
4	103996	1	Battery - mains back-up, 12 V
5	104007	1	Speaker - alarm systems
	300006	1	Speaker and wiring loom
6	105715	1	Mains inlet / Filter assembly
7	1040008	2	Fuse, 3.15 A, 20 mm , anti-surge
8	103998	1	Electrical power supply assembly

# PARTS LIST

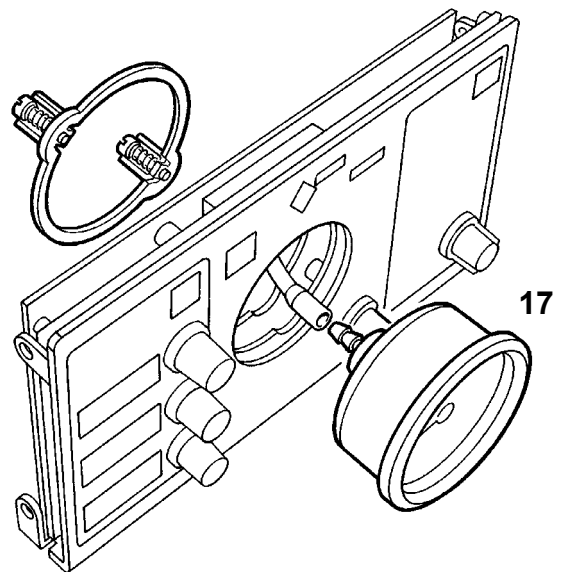
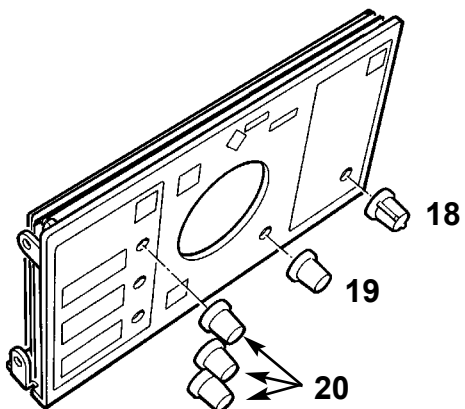
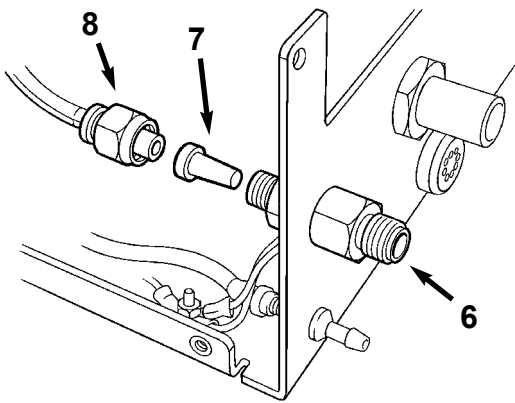
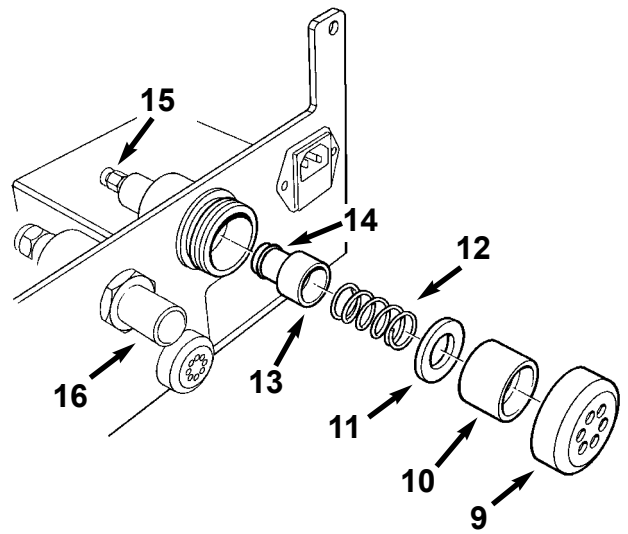
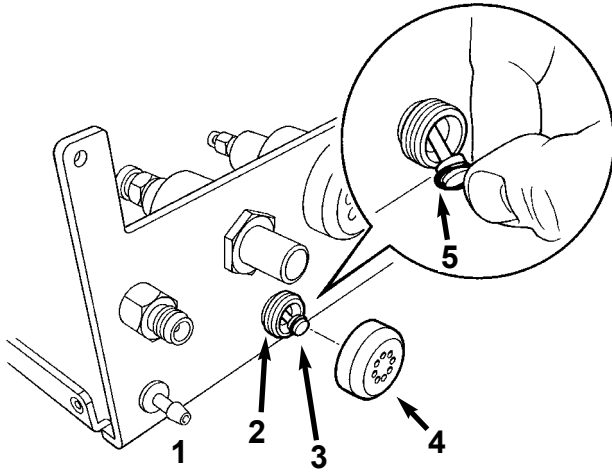
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## Rear panel Connectors, Valve Assemblies, and Manometer

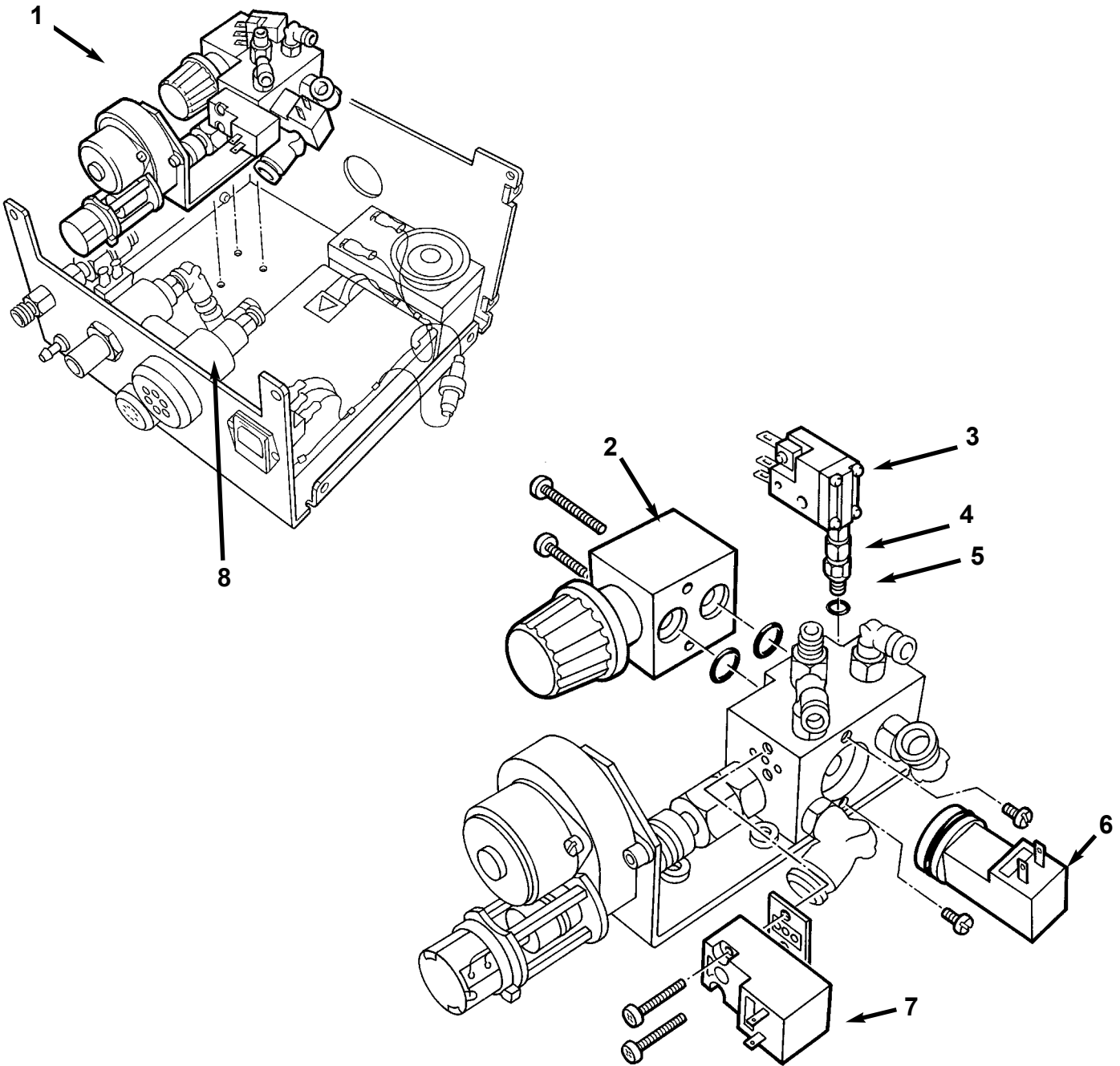
<i>Ref</i>	<i>Part No.</i>	<i>Qty.</i>	<i>Description</i>
1	35150	1	Hose connector - manometer / pressure transducer
<b>Pressure Relief Valve</b>			
2	300073	1	PRV body
3	300072	1	Valve plunger
4	300074	1	Cap
5	0314	1	O seal, Viton
-	031047	1	Spring
-	054540	1	Connector
6	300038	1	O2 connector - DISS
	020013	1	Locking nut, M12
	025205	1	Washer, 0.5 inch i.d.
7	0762	1	Filter
8	054519	1	Straight adaptor. 1/8 BSP to 8 mm tube
<b>Exhaust valve</b>			
9	300041	1	Cap
10	300044	1	Spacer
11	300045	1	Washer
12	031045	1	Spring
13	300043	1	Piston
14	042819	1	Seal, quad ring
15	054541	1	Straight adaptor, M5 to 4 mm tube
16	300040	1	Tapered connector - bellows drive gas
17	049040	1	Gauge assembly (includes locking ring)
18	104001	1	Knob - off/standby/mode control
	104010	1	Nut cover
	104009	1	Cap
19	104000	1	Knob - airway pressure limit control
	104010	1	Nut cover
	104009	1	Cap
20	103999	1	Knob
	104002	1	Nut cover
	104003	1	Cap

# PARTS LIST

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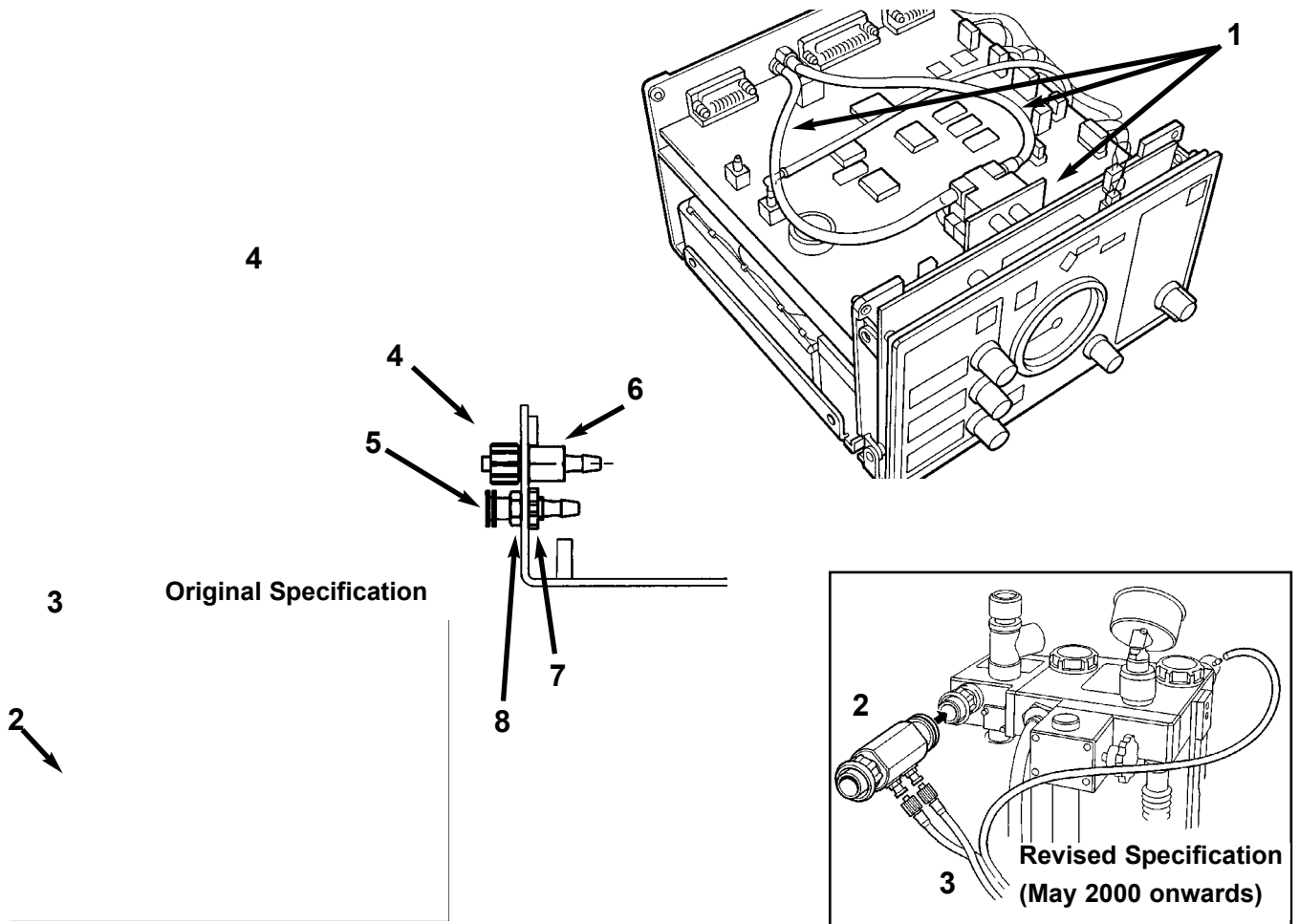
# PARTS LIST



## Pneumatic System Assemblies

Ref	Part No.	Qty.	Description
1	300027	1	Manifold assembly (includes wiring - not shown, and items 2 to 7:
2	045438	1	Regulator assembly (includes O rings)
3	102952	1	Pressure switch
4	054946	1	Coupling (flexible)
5	054948	1	Coupling (includes washer)
6	045053	1	Solenoid valve
7	045052	1	Solenoid valve
8	300011	1	Connector assembly

# PARTS LIST



## Spirometer System Components

Original Specification				Revised Specification - May 2000 onwards			
Ref	Part No.	Qty.	Description	Ref	Part No.	Qty.	Description
1	300109	1	Sensor and PCB assembly (includes tubing and fittings)	1	300117	1	Sensor and PCB assembly (includes tubing and fittings)
2	57631	1	Spirometer assembly, includes:	2	300124	1	Spirometer assembly, includes:
	34331	1	Safelock nut		34331	1	Safelock nut
	043	1	O seal		043	1	O seal
3	57632	1	Hose assembly (tubing and connectors)	3	300329	1	Hose assembly (tubing and connectors)
Panel connectors				Panel connectors			
4	011245	1	Luer connector	4	011245	1	Luer connector
5	011244	1	Luer connector	5	011244	1	Luer connector
6	300059	1	Nut - tube adaptor	6	300059	1	Nut - tube adaptor
7	011249	1	Luer connector	7	011249	1	Luer connector
				8	011260	1	Identification Ring (Red)

# PARTS LIST

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# 10. APPENDIX

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## APPENDIX 1

### CARE OF BACK-UP BATTERY

#### CAUTION

*Damage may occur if the battery is allowed to remain in a discharged state. Never discharge the battery to below 10.2 volts.*

#### A. Battery installed in ventilator

The battery must be charged before the machine is released for use with an 14 hour charge from the ventilator's internal power supply (ventilator connected to the mains supply, but not running).

Note that the OFF indicator will show a yellow light during charging.

Subsequently the recharge periods for a battery on a machine in store are similar to those in B, below.

Batteries in machines in normal use will be kept charged by the internal power supply and will only require special charging care following the discharge test carried out during function testing, or if the battery is fully discharged following use during mains failure.

#### B. Battery care/storage requirements.

During storage batteries will require a periodic recharge, the frequency of which is determined by the storage temperature, which must not exceed 50°C (120°F).

<b>Storage temperature</b>	<b>Recharge period</b>
38 to 50°C (100 to 122°F)	1 month
21 to 38°C (70 to 100°F)	3 months
7 to 21°F (45 to 70°F)	6 months
0 to 7°C (32 to 45°F)	9 months
-5 to 0°C (23 to 32°F)	12 months

Duration - recharge until the charge current is less than 25 mA (typically overnight). It is recommended that at each charge an updated label is affixed to each battery to indicate date of the last charge.

#### C Battery disposal

Dispose of used batteries according to hospital, local, state, and federal regulations.







Penlon



Cat No 52704  
Doc No AV8 0103SM  
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