

MODULE 4

Ventilator

- In intensive care , the patient may require assistance for breathing, a ventilator is used to provide oxygen enriched , medicated air to a patient at a controlled temperature.
- Three modes of operation

- 1. Controlled mode**

In controlled mode, breathing is initiated by a timing mechanism. It is an automatically timed breathing which is usually provided for patients who cannot breath on their own. This mode provides inspirations & expirations at fixed rates except during the rest period for the patient.

- 2. Assisted mode**

In assisted mode, patient has to initiate breathing. The patients own spontaneous attempt to breath-in will activate the inspiration cycle of ventilator. This mode will be used for patient who have difficulty in breathing due to high air way resistance.

- 3. Assist- Control mode**

In assist-control mode, the machine will be automatically switched to either controlled mode or assisted mode depending upon the condition of the patient. The patient controls his breathing as far as he can, but if he cannot, then the control mode automatically takeover the breathing cycle.

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The benefits of ventilator treatment are as follows:

1. Enough oxygen is supplied and the right amount of carbon dioxide is eliminated. Hence hyperventilation which creates respiratory alkalosis can be avoided.
2. Respiration will be maintained in case of inability by the patient.
3. Increased intrathoracic pressure will prevent atelectasis (A type of collapse of portions of lung). It may also prevent edema of the lung.

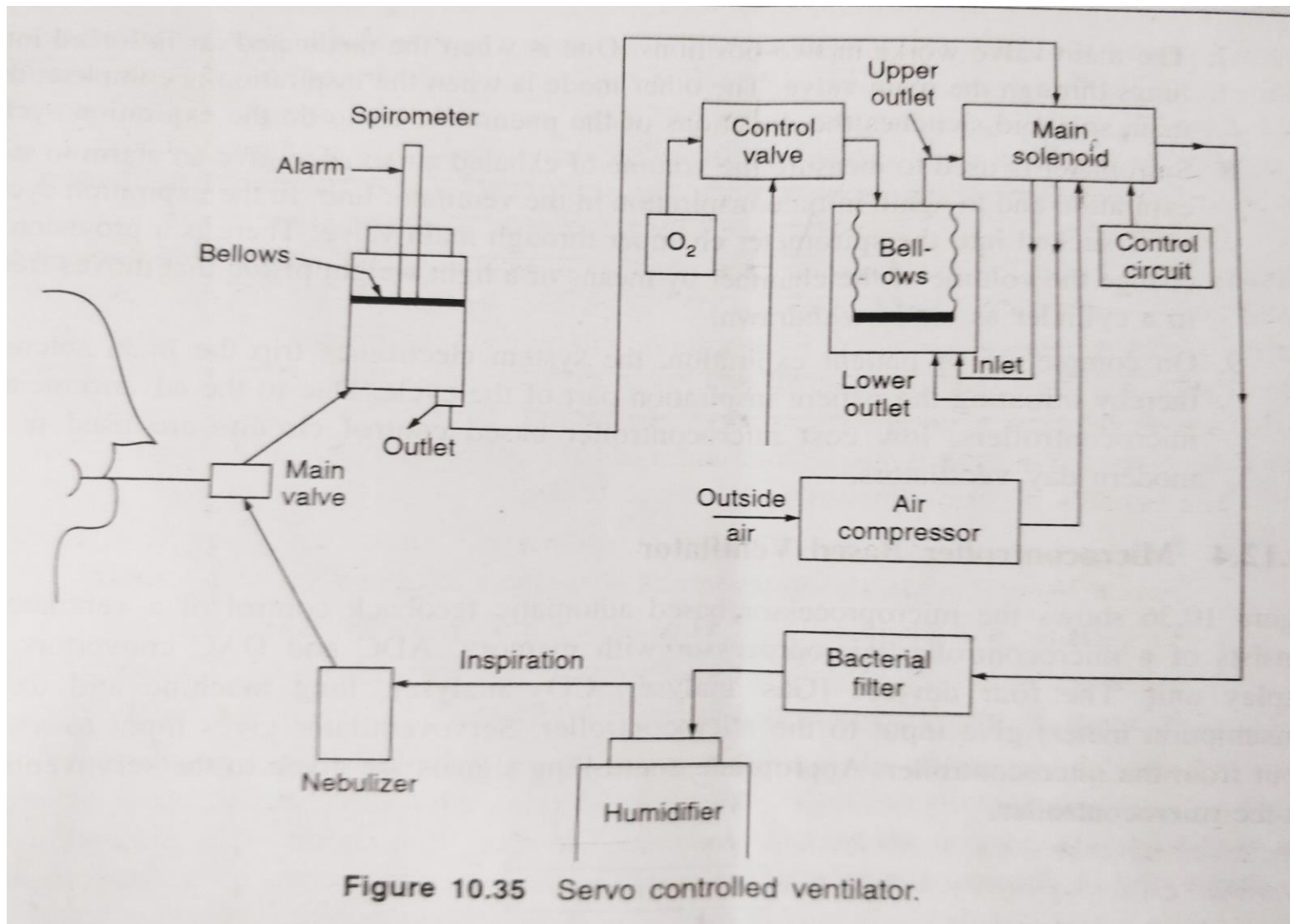
All ventilators operate on continuous cycle. During inspiration (insufflations), air or some other gaseous mixture is inhaled into the lungs. During expiration, the pressure ceases. This cycle is maintained by a mechanical, pneumatic or electronic circuit. The regulation can be obtained either by pressure limited or volume limited or by servo controlled systems. Further, modes of ventilation can be seen discussed already in section 6.9.2.

10.12.1 Pressure Limited Ventilators

In this method, the inspiration is stopped when the air pumped into the patient's lung till it reaches a preset pressure. Pressure limited ventilators are driven by the compressed air or gas mixture. Its design is simple and reliable in operation.

10.12.2 Volume Limited Ventilators

It works on the principle that for each breath a constant volume of air is delivered during inspiration, the constant volume of air is sent into the lungs by applying pressure to a chamber containing constant volume of air. The volume limited method does not give desired ventilation in cases where the preset maximum pressure cannot completely empty the chamber.



SERVO CONTROLLED VENTILLATORS

It works with the help of electronics circuits to monitor pressure, activate alarms and compute mechanical lung parameters 1. During the inspiration cycle, the air compressor draws room air through an air filter and passes it to the main solenoid.

2. Main solenoid forces the bottom inlet valve of the internal bellows chamber to open. At the same time, the lower outlet valve closes.
3. Oxygen is passed into bellows chamber and the flow rate of oxygen is controlled by a control valve. The high pressure developed in the bellows chamber compresses the bellows and forces the upper outlet valve to open. Now, the compressed oxygen enriched air is passed through the main solenoid into the external tubes and then to the bacterial filter, humidifier, nebulizer and finally to the patient lungs.
4. Dry air cum oxygen may damage the patient's lungs. To avoid that the air cum oxygen must be humidified either by heat vapourization (steam) or by bubbling an air stream through a water column.
5. Nebulizer compressor gives a fine spray of water or medication to the inspired air in the form of aerosols. In a nebulizer, water or medication is picked up by a high velocity jet of oxygen enriched air and thrown against one or more baffles to break the substance into small droplets which are thus applied to the patient. Nowadays ultrasonic nebulizers are available.
5. A control system monitors the negative pressure necessary to initiate the inspiration when the ventilator is used in the assisted mode. A suction apparatus is often included as a part of ventilator to remove mucus and other fluids from the airways.

7. The main valve works in two positions. One is when the medicated air is forced into lungs through the main valve. The other mode is when the inspiration is complete; the main solenoid switches the directions of the pneumatic air to do the expiration cycle.
8. Spirometer is used to measure the volume of exhaled air so as to give an alarm to stop expiration and to again initiate inspiration in the ventilator unit. In the expiration cycle, air is sucked into the spirometer chamber through main valve. There is a provision to change the volume of the chamber by means of a light weight piston that moves freely in a cylinder as air is withdrawn.
9. On completion of patient expiration, the system electronics trip the main solenoid, thereby initiating the patient inspiration part of the cycle. Due to the advancement of microcontrollers, low cost microcontroller based control circuits are used in the modern day ventilators.