

Chapter 02: How Ventilators Work

Cairo: Pilbeam's Mechanical Ventilation: Physiological and Clinical Applications, 7th Edition

MULTIPLE CHOICE

1. The respiratory therapist enters modes and parameters into the ventilator with which of the following?
 - a. Control logic
 - b. Input power
 - c. User interface
 - d. Drive mechanism

ANS: C

The user interface or control panel contains certain dials or a touch panel where the ventilator operator sets or enters certain information to establish how the pressure and pattern of gas flow are delivered by the machine. Inside the ventilator is the control logic or control system that interprets the operator settings and produces and regulates the desired output. The input power is the ventilator's power source that provides the energy to enable the ventilator to perform the work of ventilating the patient. The drive mechanism is a mechanical device that produces gas flow to the patient.

2. A patient being transferred from a hospital to a skilled nursing facility requires mechanical ventilation with a fractional inspired oxygen (F_{iO_2}) of 0.21. The skilled nursing facility has no piped in gases. Which of the following ventilators will be able to function in the skilled nursing facility without any extra equipment?
 - a. Servoⁱ
 - b. LTV 1000
 - c. Bird Mark 7
 - d. PB 980

ANS: B

The type of ventilator that will be appropriate for this situation is one that is electrically controlled and powered with a built-in air compressor. The LTV 1000 fits this description. The Servoⁱ and the PB980 require both a high-pressure gas source and electrical power. The Bird Mark 7 is a pneumatic ventilator and will not be able to function in this situation.

3. The internal circuit of a ventilator allows the gas to go directly from its power source into the patient. This is known as which of the following?
 - a. Single-circuit
 - b. Open loop
 - c. Closed loop
 - d. Double-circuit

ANS: A

There are two types of internal circuits, the single- and the double-circuit. The single-circuit allows the gas to flow from its power input source to the patient. The double-circuit utilizes a primary power source to generate a gas flow that compresses a mechanism such as a bellows. The gas within the bellows will then flow to the patient. Open loop and closed loop refer to the absence and presence, respectively, of a feedback loop system.

4. A ventilator for which the primary power source generates a gas flow that compresses another mechanism and causes the gas from inside the mechanism to be delivered to the patient is known as which of the following?
 - a. Single-circuit
 - b. Double-circuit
 - c. Closed loop
 - d. Open loop

ANS: B

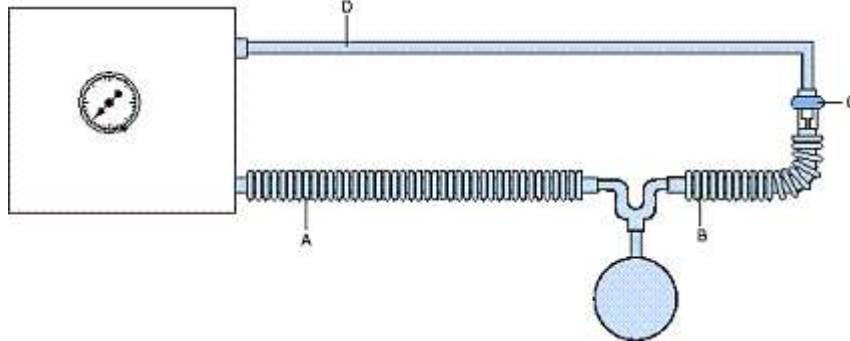
In a double-circuit ventilator, the primary power source generates a gas flow that compresses a mechanism such as a bellows or “bag-in-a-chamber.” The gas in the bellows or bag then flows to the patient. In a single-circuit ventilator, the primary power source travels directly to the patient. The closed and open loops refer to whether or not the ventilator has a feedback loop system.

5. The function of the exhalation valve is to do which of the following?
 - a. Adjust the flow going to the patient.
 - b. Close during exhalation to vent patient gas.
 - c. Seal the external circuit during inspiration.
 - d. Determine the volume being delivered.

ANS: C

During inspiration, gas fills the balloon and closes a hole in the expiratory valve. Closing of the hole makes the patient circuit a sealed system. During expiration, the balloon deflates, the hole opens, and gas from the patient is exhaled into the room through the hole.

6. In the image, what does “B” represent?



- a. Expiratory valve line
- b. Exhalation valve
- c. Expiratory line
- d. Main inspiratory line

ANS: C

The external exhalation valve is represented by the letter “C” in the figure. “B” is pointing to the expiratory line. The main inspiratory line is represented by the letter “A.” The expiratory valve line is represented by “D.”

7. The type of compressor that is used by hospitals to supply wall compressed air has which of the following?
- Piston
 - Bellows
 - Rotating blades
 - Moving diaphragm

ANS: A

Hospitals use large, piston-type, water-cooled compressors to supply wall gas outlets.

8. The power transmission and conversion system of a ventilator is defined as which of the following?
- A mechanical device that produces gas flow to the patient
 - An electrical motor that is connected by a special gearing mechanism
 - The system that interprets the settings and produces or regulates the desired output
 - Internal hardware that changes electrical or pneumatic energy into mechanical energy

ANS: D

The power transmission and conversion system changes the energy from the power source into mechanical energy. The linear drive piston is a mechanical device that produces gas flow to the patient. The drive mechanism is an electrical motor that is connected by a special gearing mechanism. It is the control system that interprets the operator settings and produces or regulates the desired output.

9. The volume-displacement device that creates a sinusoidal flow waveform is which of the following?
- Rotary drive piston
 - Linear drive piston
 - Spring-loaded bellows
 - Proportional solenoid

ANS: A

The rotary drive piston creates a flow pattern that is slow at the beginning of inspiration, achieves highest speed at mid-inspiration, and tapers off at end-inspiration, creating a sinusoidal waveform (sine waveform).

10. Modern intensive care units' (ICU) ventilators regulate gas flow to the patient by using which of the following?
- Rotary drive pistons
 - Linear drive pistons
 - Proportional solenoids
 - Spring-loaded bellows

ANS: C

Proportional solenoid valves control flow by opening and closing either completely or in small increments. These valves, which are driven by various motor-based mechanisms, have a rapid response time and great flexibility in flow control. The other answers are all volume-displacement devices.

11. A series of tubes that allow gas to flow inside the ventilator and between the ventilator and the patient is referred to as the
 - a. pneumatic circuit.
 - b. control circuit.
 - c. control scheme.
 - d. patient circuit.

ANS: A

A pneumatic circuit, or pathway, is a series of tubes that allow gas to flow inside the ventilator and between the ventilator and the patient.

12. In a spring-loaded bellows volume-delivery device, the amount of pressure is determined by the
 - a. location of the bellows.
 - b. volume setting on the ventilator.
 - c. tightness of the spring.
 - d. electrical power provided to the spring.

ANS: C

In a spring-loaded bellows model, an adjustable spring atop a bellows applies a force per unit area, or pressure ($P = \text{force/area}$). Tightening of the spring creates greater force and therefore greater pressure. The bellows contains pre-blended gas (air and oxygen), which is administered to the patient.

13. Which of the following is an example of a flow control valve?
 - a. Linear piston
 - b. Spring-loaded bellows
 - c. Solenoid
 - d. Rotary drive piston

ANS: C

Flow-control valves include proportional solenoid valves and digital valves with on/off configurations.