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Ventilator System For Patient Health

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ABSTRACT :

The ventilator uses reverse motion to inflate the lungs with pump motion. The ventilation mechanism should be able to provide 1030 breaths per minute and accommodate two sets of increments. The Ventilator ought to additionally be capable of alter the quantity of air this is driven into the lungs with every breath. Last but not least, so far it has been set to adjust the duration of the inhalation-exhalation ratio. In either case, the ventilator should be able to monitor the patient's blood oxygen levels and exhaled lung pressure while avoiding gauge / high pressure. Designed and developed using Arduino here, the ventilator meets all of these requirements, creating a reliable and affordable ventilator to help during a pandemic.

Our system makes use of blood oxygen sensor along with sensitive pressure sensor to monitor the necessary vitals of the patient and display on a mini screen. Also an emergency buzzer alert is fitted in the system to sound an alert as soon as any anomaly is detected.

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Keywords: Arduino based Ventilator , Breathing Pump, Motion Ventilator with Adjustable Air Volume, Inhalation-Exhalation Ratio

1.Introduction :

A ventilator system is an essential medical device used to provide mechanical ventilation to patients who are unable to breathe effectively on their own. Breathing is a vital physiological process that supplies oxygen to the body while removing carbon dioxide, a waste product of metabolism. When this natural process is compromised due to various medical conditions, such as acute respiratory failure, chronic obstructive pulmonary disease (COPD), pneumonia, or severe trauma, a ventilator becomes necessary to ensure adequate oxygenation and ventilation.

Ventilators work by delivering air, often enriched with oxygen, directly into the lungs through an artificial airway (such as an endotracheal tube or a tracheostomy tube). The device can be set to provide various modes of ventilation, including controlled, assist, or mixed modes, depending on the patient's condition. By regulating parameters such as tidal volume, respiratory rate, oxygen concentration, and inspiratory pressure, ventilators ensure that the patient's lungs receive optimal ventilation, reducing the risk of hypoxia (low oxygen levels) and hypercapnia (excess carbon dioxide).

Modern ventilators are equipped with advanced features, including real-time monitoring of key respiratory parameters, alarms for abnormal conditions, and automated adjustments to ensure patient safety. These systems have become indispensable in critical care units, emergency departments, operating rooms, and long-term care facilities, especially in situations where spontaneous breathing is insufficient.

This introduction explores the importance of ventilator systems in healthcare, highlighting their role in respiratory support, their technological advancements, and the impact they have on patient health outcomes. As medical technology continues to evolve, ventilators are becoming more sophisticated, portable, and tailored to meet the specific needs of individual patients, ultimately improving survival rates and quality of life for those with respiratory impairments.

2.Review of Literature :

1. Ventilator technology has significantly advanced over time. Early mechanical ventilators were basic and provided limited support. The introduction of the positive pressure ventilator in the 1950s allowed for better control of airflow to the lungs. In the 1960s and 1970s, innovations like positive end-expiratory pressure (PEEP) and synchronized ventilation modes were developed, leading to improved outcomes for patients with conditions like acute respiratory distress syndrome (ARDS).[1]

2. Ventilator modes, including volume-controlled ventilation (VCV), pressure-controlled ventilation (PCV), and adaptive support ventilation (ASV), are tailored to patient needs for controlling pressure, volume, or both. Adjusting parameters like tidal volume, respiratory rate, inspiratory pressure, and oxygen concentration is crucial for personalized care. Research shows that individualized settings help optimize patient outcomes and reduce the risk of ventilator-associated lung injury.[2]
3. Ventilators, while life-saving, can cause complications like ventilator-associated pneumonia (VAP) and ventilator-induced lung injury (VILI). VAP is more common in patients on prolonged ventilation, and proper monitoring, tube cleaning, and hygiene protocols are essential to reduce its risk. VILI, caused by inappropriate ventilator settings like excessive tidal volumes, can worsen lung damage, highlighting the importance of optimal ventilator settings.[3]
4. Modern ventilators feature advanced real-time monitoring systems that track lung compliance, airway pressure, oxygenation, and blood gas values, allowing for immediate adjustments. They also include alarms for issues like high airway pressure or low tidal volumes, helping prevent complications. Portable and non-invasive ventilators have become popular in emergency and homecare settings, providing flexibility for managing chronic conditions like COPD.[4]

Problem statement

Since the outbreak of the -COVID19 pandemic, researchers have worked to help society deal with some of the pandemic's challenges. In a latest initiative, the writer specializes in the manufacturing of low-price open supply ventilators. The motivation comes from the worldwide scarcity of ventilators with inside the remedy of sufferers with COVID 19. Ventilators preserve significantly sick sufferers alive

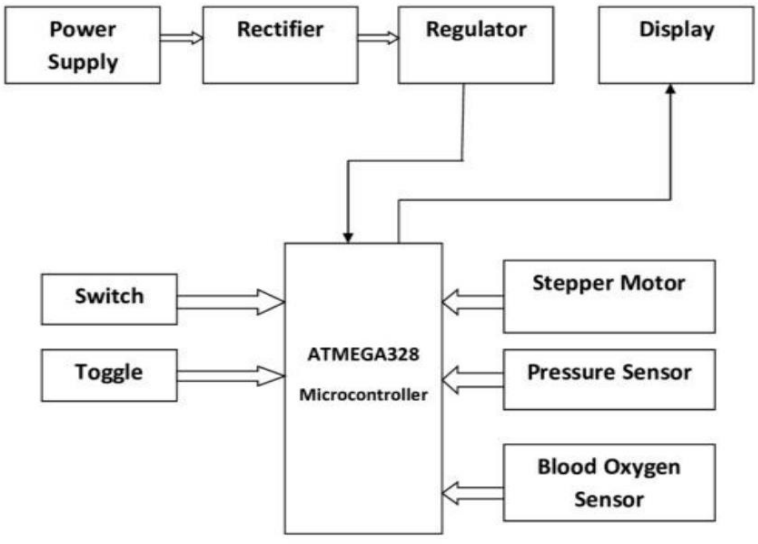
Proposed solution

Human lungs use the reverse pressure generated by contraction motion of the diaphragm to suck in air for breathing. A contradictory motion is used by a ventilator to inflate the lungs by pumping type motion.

A ventilator mechanism must be able to deliver in the range of 10 – 30 breaths per minute, with the ability to adjust rising increments in sets of 2. Along with this the ventilator must have the ability to adjust the air volume pushed into lungs in each breath. The last but now the least is the setting to adjust the time duration for inhalation to exhalation ratio.

Apart from this the ventilator must be able to monitor the patients blood oxygen level and exhaled lung pressure to avoid over/under air pressure simultaneously.

3. Block diagram :



Component List

- **Arduino UNO** - The main controller.
- **Blood Oxygen Sensor (MAX30102)** - Measures SpO2 levels.
- **Pressure Sensor** - Monitors exhaled lung pressure.
- **Servo Motor** - Controls the ventilator bag.
- **Breather Mask** - Connects to the patient.
- **Valves & Joints** - For airflow control.
- **Air Breather Bag** - Inflates and deflates for breathing.

- **Push Rods & Connector Rods** - Mechanical movement.
- **Gear Mechanism** - For precise control.
- **Plastic Enclosure** - Houses the components.
- **LCD Display** - Shows vital stats.
- **Voltage Regulator IC** - Stabilizes power supply.
- **Resistors, Capacitors, Transistors** - Various electronic components.
- **Cables and Connectors** - For wiring.
- **LEDs** - Indicators.
- **Transformer/Adapter** - Power supply.
- **Push Buttons** - User interface.
- **Buzzer** - Alerts for anomalies.

4.Summary :

A ventilator system is a crucial medical device used to assist patients who cannot breathe effectively on their own due to conditions like acute respiratory failure, COPD, pneumonia, or trauma. It delivers air, often with oxygen, through an artificial airway to regulate key parameters such as tidal volume, respiratory rate, and oxygen concentration, ensuring proper oxygenation and ventilation. Modern ventilators feature advanced monitoring systems, alarms, and automated adjustments, enhancing patient safety and care in critical settings. As medical technology advances, ventilators are becoming more sophisticated, portable, and customized to improve patient outcomes, survival rates, and quality of life for individuals with respiratory issues.

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