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DESIGN OF COST AND SIZE EFFECTIVE VENTILATOR WITH CAM SHAFT MECHANISM

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Abstract—A ventilator is a device that delivers air into and out of the lungs in order to provide breaths to a patient who is unable to breathe in normally or is breathing insufficiently, and are used in a multitude of medical fields, as in ambulatory services, the ICU, and for patients of respiratory disorders. The ventilator delivers artificial breaths to the lungs of the patient via the oro- nasal cavity with a range of 10-30 breaths per minute, and may vary with a number of determining factors, and aims to match the normal time duration for inhalation to exhalation ratio. In comparison to conventional ventilators, the design in discussion aims to improve the functioning by increasing power efficiency, adding alternating sources of power, and making a compact design. Cost effectiveness is aimed as one of the priorities, by adding a motorized camshaft mechanism for automation, to rhythmically compress a silicon ventilation bag in order to achieve the desired results. The whole system is also designed to monitor other critical data of the user, such as their exhalation pressure, blood oxygen and glucose levels and displays the results on a mini screen. Included within is an emergency alert system with a buzzer for indication if the vitals of the patient are at a critical state. The entire system is driven by a controller circuitry to achieve desired results and to assist patients and in other emergency situations.

Keywords: Silicon Ventilator Bag, Cam Shaft Mechanism, Stepper Motor, Blood Oxygen Sensor, Pressure Sensor .

I. INTRODUCTION

In order to provide breaths to a patient who is actually unable to inhale or breathing insufficiently, a ventilator is a device that delivers breathable air into and out of the lungs. Such a ventilator may extend boundaries of experimentation and also be utilized in a plethora of fields, especially for outpatients and patients in the ICU who need critical care. A mechanism called a ventilator must be able to deliver in the range of 10 – 30 breaths per minute and with the ability to adjust rising increments in sets of 2. The ventilator must also have the ability to adjust the air volume pushed into the lungs of humans with each breath. It must adhere to the setting that modifies the time duration for the ratio of inhalation to exhalation. Our mechanism fulfills these conditions. Our system uses a sensitive pressure sensor and a blood oxygen sensor to track the patient's vital signs and display them on a small screen. Additionally, the system is equipped with an emergency buzzer alert that will sound a warning whenever an anomaly is found.The entire system is driven by a controller circuitry to achieve desired results and to assist patients and in other emergency situations.

II LITERATURE SURVEY

Anyarin Thitirattanapong,Salila Ongtrakul ,Chuchart Pintavirooj et al. [2021].Ventilator has become an intensively important part of medical healthcare, especially in this widespread pandemic of COVID-19. An Ambu Bag with a bag valve mask is the most common (BVM). The limited air volume inside the bag of this ventilator, however, necessitates the use of a manual resuscitator to perform its function. Additionally, it makes a loud noise while operating because of its mechanism. Utilizing a Non Ambu Bag ventilator is an alternative. This optional ventilator has volume and flow settings that can be customised, and it can be controlled using the user's smartphone. Index Terms—Ambu Bag, bag valve mask, COVID-19, non Ambu Bag, oxygen concentrator, ventilator.[1]

Abishek pandey , Aradhya Juhi, Abishek pratap, Anupam pratap singh et al. [2021].This paper offers some insight into the history of mechanical ventilators today.Based on reviewed literature, a simple , easy-to-use and easy-to-build design of low-cost-portable ventilator is proposed in this paper. The proposed ventilator prototype is anticipated to operate more effectively than currently on the market ventilators at a very low cost. This ventilator helps in the situation like covid-19 when the whole world facing the difficulties related to ventilators.[2]

Rajalakshmi,Kavipriyabai,Vinodhini et al. [2022].The Proposed ventilator is able to monitor the patient's blood oxygen levels and exhaled lung pressure while avoiding gauge

/ high pressure. Here, an Arduino-based ventilator was created that satisfies all of these criteria, making it a dependable and affordable tool for use in pandemics. In this instance, a stepper motor drives the ventilator bag. Our system monitors the patient's necessary vital signs and displays them on a miniature LCD screen using a blood oxygen sensor, a heart rate sensor (KY039), and temperature sensors (18B20). The patient is affected by ambient air, so air purifiers are used to clean the air. A buzzer sounds to alert a nearby carer whenever a patient is in a risky position. A relay is used to connect the buzzer and Arduino so that the voltage can be increased. Through an IOT modem, patient records are uploaded to the cloud. The whole machine is managed with the aid of using the Arduino controller to get the preferred result.[3]

Sergio Morales, Styven Palomino, Ricardo Terreros, Victor Ulloque, Noe Baz an-Lavanda, Marıa Palacios-Matos, Julio Valdivia-Silva, Emir. A Vela and Ruth Canahuire.[2021]Many studies in recent years have been focused on treating diseases caused by the Covid-19 disease. For the treatment of patients with mild virus-related symptoms, the development of mechanical ventilation systems became crucial. The non-intrusive mechanical ventilation system was used in the majority of developed works. This work is centered on automating the manual Bag-Valve-Mask (BVM) ventilation of the Emergency Mechanical Ventilator for ICU (UTECAE EMV-ICU). The control system implemented for the UTEC-AE EMV-ICU is based on LQR method for the three non-invasive ventilation modes (volumen controlled ventilation, pressure controlled ventilation, and assisted ventilation). [4]

B.M. Hardas5, Kritika Jain, Advait Kolse, Pallavi Gadewar, and Monika Bhole, among others .[2020]

The most important piece of medical gear needed in the event of an accident or illness is a ventilator. It is required when human life is in danger, and the patient feels difficulty in breathing, external support is provided from outside by a machine. With the increase in new lung diseases, it has now been important to build a Ventilator, which will be as effective as available in the clinic and can be provided in large numbers by considering different situations. Since the ventilators available in medical centers are bulky and costly, and the shortage of such critical equipment can lead to threatening human life. . In this study, the academic literature reviews various Ventilator Mechanisms and ventilation techniques, mostly considering the positive pressure ventilation and high-frequency ventilation and different parameters to consider. [5]

Neha Dhadave1, Shital Katole 2, Prof. Nikita Wankhede 4, Komal Meshram 3, Prof. S. G. Bhele [2021] Ventilator devices are external tools created to help a patient complete a specific task. If a person experiences difficulties with their own breathing, it is to maintain or improve that person's breathing ability. Ventilators are essential to human life. It's a piece of technology, a piece of software, or a product system that helps people with disabilities increase, maintain, or improve their functional capabilities during the breathing phase. The hardware design of a lab model ventilator is the subject of this paper. The ventilator has been tested and designed as a prototype. [6]

Rakibul Islam, Mohiuddin Ahmad, Shahin Hossain, Muhammad Muinul Islam, Farid Uddin Ahmed [2019]This paper proposes a simplified structure of microcontroller based mechanical ventilator integrated with a BVM ventilation mechanism. Here, an Ambu bag is operated with CAM arm that is commanded via a microcontroller and manual switches by sending a control signal to the mechanical system and according to this control signal, the mechanical CAM arm simultaneously compresses and decompresses the Ambu bag. Based on the respiratory rate, the control signals are designed with three modes called adult mode, paediatric mode, and child mode. By setting the tidal volume for each individual control signal, the device is in assist controlled mode. The suggested device is lightweight, portable, compact, and capable of performing well. Rural area hospitals can access it for immediate treatment while saving money and reducing risk.It doesn't require any special knowledge or training to use, unlike an ICU ventilator, so anyone can do it. The proposed system is safe, riskless, and repairable.[7]

Sandeep Kumar, Amit Kumar [2022] The requirement for a ventilator occurs when people experience respiratory failure. When respiratory failure occurs, that person cannot get enough oxygen and is unable to expel carbon dioxide very well either. So, the ventilator is a device that recreates the process of breathing by pumping air into the lungs. It may also go by the names vent or breathing machine. The Doctors use ventilators if any person cannot breathe adequately on

their own. This situation occurs when a person is undergoing general anesthesia or has an illness that affects their breathing. These are of different types, and each provides varying levels of support. The doctor's uses type of a ventilator will depend on a person's condition. This machine called a ventilator plays an important role in saving lives.[8]

III. EASE OF USE

A. OXYGEN LEVEL

Ventilators need to achieve a target level of 92 to 96 % of SpO2 for any given adult, as any level exceeding or preceding this range may cause further problems or even prove to be fatal. Another sub-parameter to note for is the oxygen saturation level, which again should not be below 93% for any patient.

B. BLOOD PRESSURE

Blood pressure is also another parameter to measure during ventilation is Blood Pressure. During mechanical ventilation, LV transmural pressure and LV afterload both decrease, which may lead to severe heart problems. This is especially notable in patients with congestive heart failure.

C. LUNG CAPACITY

People with respiratory problems will be on a ventilator for extended periods of time, and if not maintained / used properly, there is a high chance that the patient may experience barotrauma due to the extended high pressure in the lungs. It is for this reason that lung capacity is also measured with a program, embedded into the ventilator.

IV. BLOCK DIAGRAM

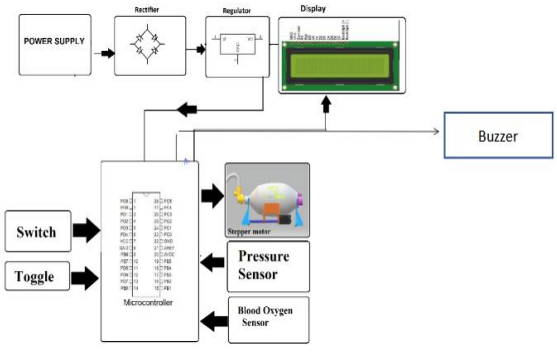

Fig 1 Block Diagram

V. PROPOSED METHODOLOGY

The ventilator bag is made of silicon and is pushed by a stepper motor using a single-side push mechanism. Using the cam Shaft mechanism, inflation and deflation are accomplished. Here, rotary motion is changed into linear motion by connecting the stepper motor shaft to a cam. The cam is oval and designed to push one end of the pressing arm upwards. The pressing arm is connected to the joint mechanism & mounted on the top of the ventilator. When the stepper motor rotates and pushes the arm upwards on one side, it presses against the bag on another end. The rate of inflation and deflation depends on the RPM of the motor.

VI. RESULT AND DISCUSSION

After implementing all setup and successful run of our ventilator several times to obtain results. So, it delivers in the range of 15 – 30 breaths per minute, with the ability to adjust rising increments in sets of 2. and airflow for the pneumonia cases of COVID-19 patient lungs. It also monitors the patient's blood oxygen level and exhaled lung pressure to avoid over/under air pressure simultaneously. Its emergency buzzer also makes an alert sound when an anomaly is detected.

VII. CONCLUSION

Designing a portable ventilator is provided with a very basic & light design and reliable structure that is easily acceptable by the patient. The main focus is to minimize the components and increase the efficiency of the device so that while using this device the patient, should feel as comfortable as the normal ventilator. It is much easier to carry around, and also costs a fraction of the once available in the market. It also reduces a significant number of wastes generated and reduces necessary to purchase and use a ventilator, which helps to save a significant number of lives.

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