Review on Designing and Fabrication of Medical Ventilator

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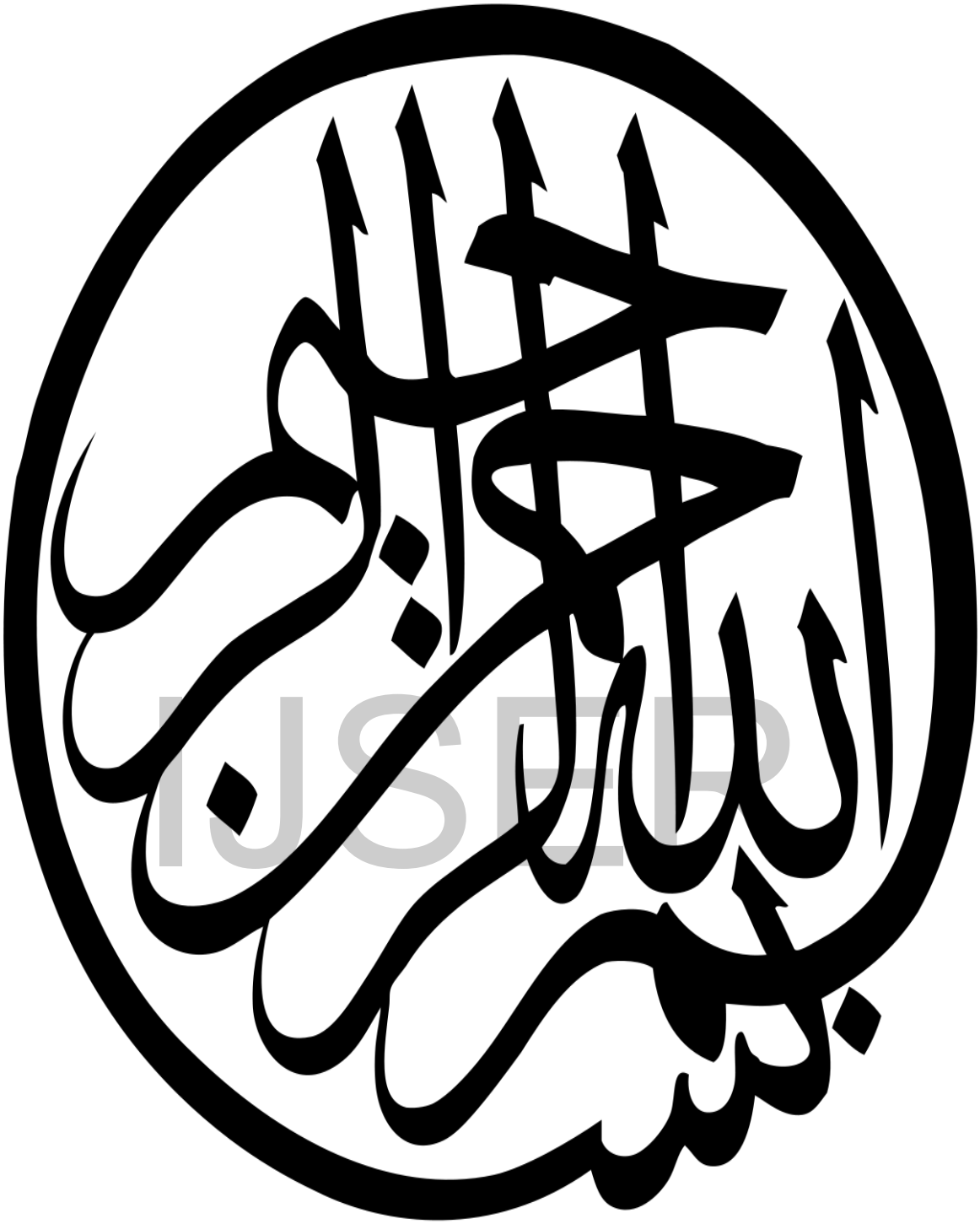

DECLARATION

I **Jawad Haider** BS scholar in the subject of Physics, hereby declare and certify that the printed materials in this thesis entitled **Review on Designing and Fabrication of Medical Ventilator** is my individual review research work and it has not been submitted concurrently to any other University/Institute etc. for any other degree or diploma in Pakistan and abroad.

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CERTIFICATE

It is certified that the research work contained in this thesis entitled Review **on Designing and Fabrication of Medical Ventilator** has been carried out and completed by **Jawad Haider** under our supervision.

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RIGHTS OF THE THESIS

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DEDICATION

I would like to dedicate this work to my parents for their great support and continuous care, my Teachers (for a constant source of knowledge and inspiration).

ACKNOWLEDGEMENT

All praises & heights to **ALLAH ALMIGHTY** who is the one and only creator of the universe and the peace & blessings of ALLAH be upon the Prophet **MUHAMMAD** whose Prophet Hood is the climax of revealed guidance.

I would like to express my sincerest gratitude to my worthy supervisor, **Dr. Maqsood Ahmad.** Preston University Islamabad who supervised my work with keen interest and professional skills. I am extremely thankful to him for benefitting me with from his vast technological knowledge and practical experience.

My acknowledgement is also for all of the faculty and staff members of Department of Physics, Preston University, and Islamabad.

In the last, but not least, I offer affectionate regards to my mother, father, sisters, and all my family members who always remained with me in all circumstances and provide me with timely backup, financial and moral support.

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ABSTRACT

This thesis descriobes the review work useful device for saving life of human being while it is the most commonly used device for the ventilation of oxygen in human lungs. In the stated practical work it's functioning of parts and connections are discussed in detail and the type of sensors used for the flow of inhalation and exhalation gases. This also covers the control panel of the medical ventilator and the parameter like blood pressure, heart

beat, respiration rate, lung tidal volume and the amount of pressurized oxygen to be provided to the patient for the survival of patient .Finally this practical work is related to the medical ventilator design having different pressure and other sensors with the related power input to provide exact output of the oxygen to the patient.

CHAPTER 1
INTRODUCTION

A medical ventilator is a device having an electronic circuits designed for monitoring and assist pulmonary ventilation and respiration system of the patient under observation.

1.1 Ventilation

It is the mechanical systems which maintains the exchange of gases from the certain area or any other matter or material But there are different uses of ventilator in medical field as

when the person is in the critical conditions due to surgery, heart attack, serious injury due to accidents or suffering from acute pneumonia, where the patient is unable to take oxygen in his body and he is unable to provide sufficient oxygen to the lungs. it is also used of heart transplant or liver transplant as before its discovery the transplant was not successful most people now a days the transplant can be done without having risk on the respiration of person

Structurally it contains pressurized air and pressurized oxygen sources, mixer, tubes and valves, patient circularly, compressed air reservoir and sensors used at different stages so that they can run the ventilator properly. The inhaled air has mixture of 77-79% compressed air with 21-23% of poured compressed oxygen from the oxygen cylinder. An excellent working and operations of ventilator we should have to care about following things

1. Accurate measurement
2. Correct instrumentation
3. Power management (in case failure there should a backup)
4. Signal integrity

Mechanical ventilators can be called as "weight generators" and “stream generators". The weight is compelled in a weight generator while the stream is heavily reliant on it the mechanical properties of the respiratory framework. In the event of an acute change within the impedance of the respiratory structure, a stream ventilator is planned to preserve flow design. In order to transfer fluid volume to a topic by a high resistance and/or a small complaint, independently of cycling parts for the shift from incentive to termination, the inside resistance and the control of a ventilator will be high. Stream generators are regularly utilized to ventilate little rodents pneumatically. This piece of

technology consisted of a syringe whereby an internal combustion engine drives the cylinder and supports it. Despite knowing because such an implementation may deliver a steady tidal volume with that of the creature in the same fractional disorder, the strength of the aviation destination could significantly reduce.

Raises due to gas compression throughout the loop to the day since experimentally activated respiratory deformation. Such a form of breathing machine delivers another off-low structure which is relatively independent of breathing mechanics and thus occurs within the same steady amount of thermal assistance. In addition, another stream breathing tube facilitates computation of the breathing application's mechanical variables. In fact, the presence of a coherent stream in the presence of motivation enables the inquiry of the relationships between tension-flow-volume, both in the midst of the inspiration phase and even in the middle of the stimulation obstacle and the decision. Such investigation was submitted as a pulmonary dynamics calculator throughout the medical field and was the topic of a sizeable amount of examinations. Long-term variables In this consideration, they suggest a fundamental scheme for the development of a circle with a high conductivity breathing machine for lung testing in rodent mechanical ventilation[6].

Despite the reality that ventilation with low axial quantities is suggested in patients with accumulated severe lung trauma, most of the others get extremely varying orbital volume, partially contributing to legitimizing blood oxygen readings in the blood vessel. They have attempted the assumption which severe lung damage harm caused by ventilators after initiation is associated with recognized danger ingredients for breathing machine-induced lung damage including extensive atmospheric quantity ventilation [7].

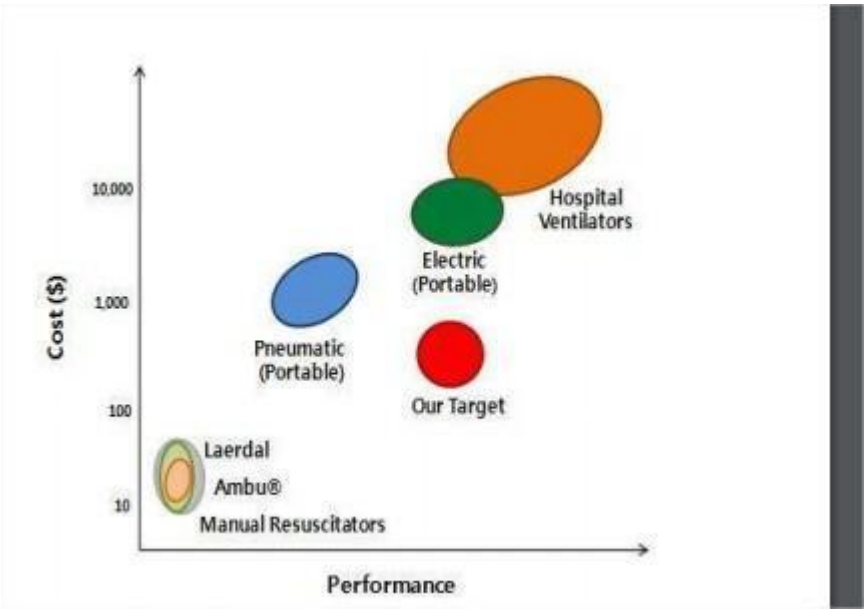

Figure 1 Cost-Performance of medical ventilator [7]

The Save II is planned to be utilized in lieu of a Pack Valve Cover (BVM) within the pre-hospital environment or amid inter-and intra-hospital transport. It is implied to evacuate the mystery and diminish the administrator mistake related with BVMs and excessively modern transport ventilators. The Save II employments a battery-powered compressor to provide discuss to a persistent for up to 10 hours on a single charge. To back utilize in stark situations, where compressed oxygen is inaccessible or sick exhorted, the gadget does not require compressed oxygen. Be that as it may, FiO2 can be expanded in the event that compressed oxygen or an oxygen concentrator is accessible. Responders can rapidly send the Save II by selecting the patient's stature. The unit dials in a preliminary tidal volume and respiratory rate suitable for grown-ups of that measure. After introductory setup, clients with an appropriate level of preparing can fine-tune the settings. To moderate the hazard of understanding damage, airway pressure is checked and clients are cautioned to possibly unsafe moo and tall weight circumstances. In a high pressure circumstance, the pump will halt in case the weight comes to the top aspiratory weight (PIP) cutoff. The PIP setting is movable but defaults to 30 cm H2O. Visual

caution markers found at the foot of the client interface offer assistance the client rapidly troubleshoot issues [1].

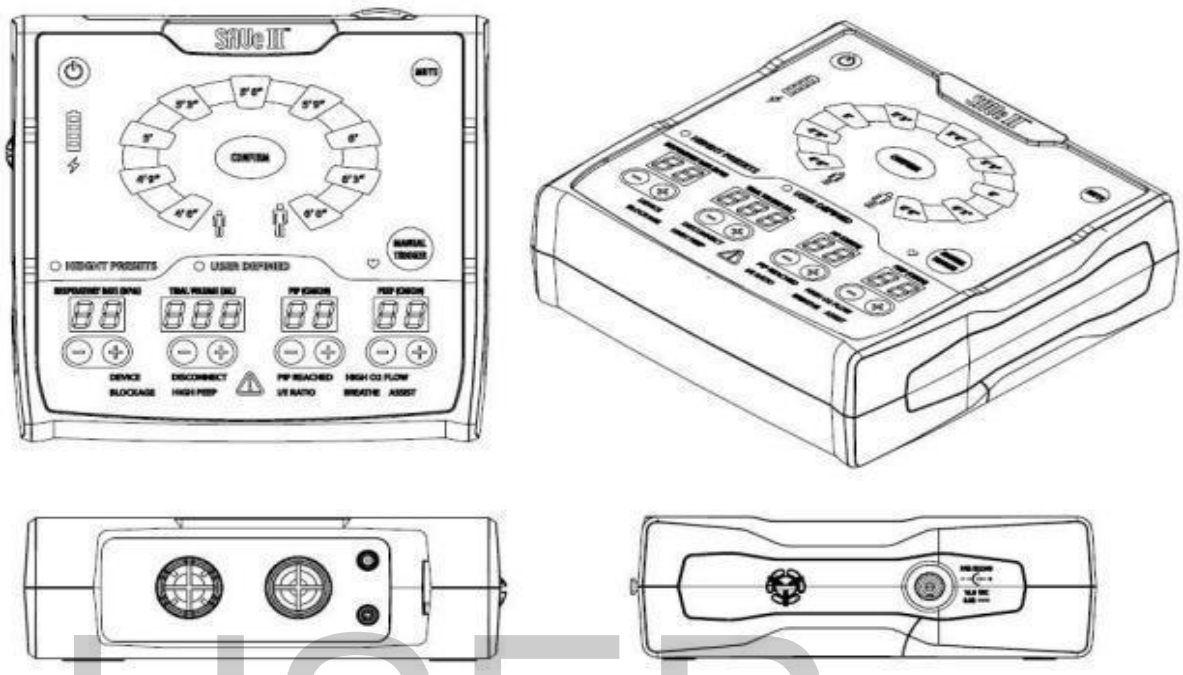

Figure 2 Apparatus of Medical ventilator [1]

In the introduction of thesis as my topic was medical ventilator designing and fabrication for this purpose need to describe about the devices which i want to research. Let me discussed in short about the device descriptions. Mechanical ventilation is an imperative treatment which is ordinarily utilized to ventilate patients who cannot breathe satisfactorily on their possess. Patients with fundamental lung malady may create respiratory disappointment beneath an assortment of challenges and can be backed by mechanical ventilators. There are numerous methods and strategies of fake ventilation, both manual and mechanical.. In spite of the fact that there are numerous rich positive-pressure ventilators with advanced security controls, they are seldom accessible within the field, in this manner driving are secure to resort to manual strategies of ventilation. In show work, planning principle of a low-cost versatile mechanical ventilator based on the

BVM, alongside the strategy for its development and execution test has been portrayed. The prime targets of extend are portrayed underneath. (1) To plan and build a convenient mechanical ventilator by computerizing the operation of bag-valve-mask or 'Ambu bag'. (2) To test the execution of the developed mechanical ventilator utilizing BIOPAC wind current transducer. (3) To evaluate the taken a toll of generation of the planned ventilator to legitimize its utilize rather than manual resuscitators and existing convenient ventilators [8].

Figure 3 Different parts of Ambu Goad II resuscitator [8]

1.1 Device Description:

1. Client Interface
2. Device Labels
3. Caution Dashboard
4. Device Disposables & Adornments

Details of these points discussed in research methodology, now let me discussed about another device description and its diagram[9].

1.2 Device Description and diagram:

This area gives common data around the Servo-I Ventilator Framework together with rules for fitting utilize.

The elements of the Servo-I Ventilator System are:

1. Server application — for operating techniques of ventilation, displaying details on comprehension, and alarm indicator.
2. Facility of Understanding — for gas mixing.
3. Patient Respiration Process for the supply and trading of gas.

The Servo-I Ventilator System was designed to cure and monitor pulmonary and respiratory dysfunction patients [9].

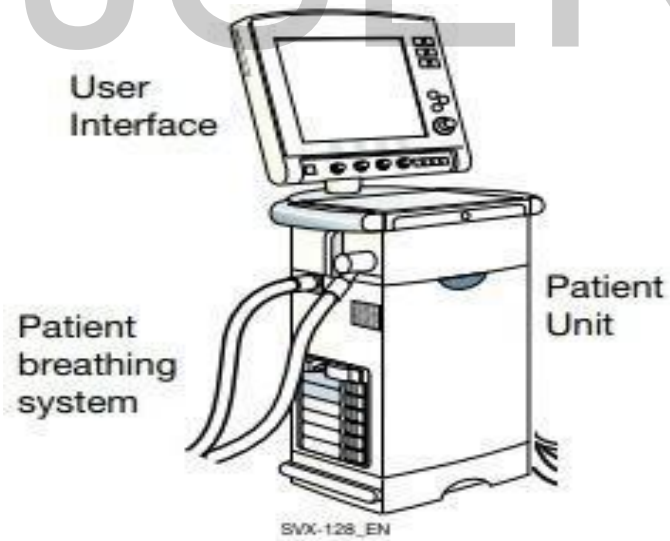

Figure 4 Servo I [9]

One of the main negative-pressure devices widely used during ventilators was the 1929 Consumer and Shaw tank-type ventilator. Way better known as the press lung, this metal barrel totally immersed the quiet up to the neck. A vacuum pump created negative weight within the chamber, which brought about in the development of the patient's chest. This altar in chest geometry diminished the aspiratory weight and permitted encompassing discuss to stream into the patient's lungs. When the vacuum was ended, the negative weight connected to the chest dropped to zero, and the flexible drawback of the chest and lungs allowed inactive exhalation[10].

Figure 5 Iron Lung (Negative pressure Ventilator) [10]

Ventilation of the patient was finished without the arrangement of tracheostomy or endotracheal tube. All things considered, this mode of ventilation was lumbering and driven to persistent inconvenience. In expansion, it restricted get to to the understanding by health care suppliers. Since the negative weight made within the chamber was applied on the midriff as well as the chest, the cardiac yield tended to diminish from pooling of venous blood within the lower middle.Elisa 500 is a seriously care ventilator for clinical mechanical ventilation. Planned as a ventilation stage, it gives a 15.6" touch show for ease of operation. The portable trolley gives the utilitarian interface for all fringe gear and guarantees ideal ICU versatility. The stage concept makes it conceivable to execute any required arrangement. Framework engineering is adaptable so that any future therapeutic and specialized necessities and advancements can be coordinates. The most recent turbine

innovation and imaginative ventilation treatments set an unused standard within the field of seriously ventilation[10].

Saliva Elisa 500 is a seriously care ventilator for clinical mechanical ventilation. Planned as a ventilation stage, it gives a 15.6" touch show for ease of operation. The portable trolley gives the utilitarian interface for all fringe gear and guarantees ideal ICU versatility. The stage concept makes it conceivable to execute any required arrangement. Framework engineering is adaptable so that any future therapeutic and specialized necessities and advancements can be coordinates. The most recent turbine innovation and imaginative ventilation treatments set an unused standard within the field of seriously ventilation [11].

Figure 6 Saliva Elisa 500[11]

Elisa 300 is a seriously care ventilator for clinical mechanical ventilation. Outlined as a ventilation stage, it gives a 10.2" touch show for most extreme compactness to encourage intra-hospital transport or ceiling mounting. The stage concept makes it conceivable to execute any required setup. The framework engineering is adaptable so that any future

therapeutic and specialized necessities and developments can be coordinates. The most recent turbine innovation and imaginative ventilation treatments set an unused standard within the field of seriously ventilation [12].

Figure 7 Saliva Elisa 300[12]

CHAPTER 2
REVIEW LITERATURE

Mechanical ventilation (MV) is a fundamental portion of seriously care for respiratory failure. Careful titration of ventilator settings to person needs inside certain secure limits is necessary, as MV something else can decline or indeed deliver lung harm. Assessment of local compliance with worldwide rules and the writing is of significance, but the last Scandinavian overview of high legitimacy was performed in 1999. All whereas, the number of international considers inside the zone of mechanical ventilation is consistently increasing. Therefore, a reestablished study comparing real treatment to the more seasoned Scandinavian study and updated information is alluring. We performed a planned, observational study, amid four weeks in Sweden's biggest grown-up blended seriously care unit (CIVA). During this period, ventilator settings and restorative information were assembled for all patients subjected to mechanical ventilator bolster in

any frame. Information were compared with authentic studies within the same field, and analyzed utilizing graphic measurements and measurable calculations. Our results show that the ventilator treatment given is inside secure limits. Exceptionally few perceptions of possibly hurtful respiratory factors were made. We conclude that ventilator treatment in CIVA in common compares well with advanced science, in spite of the fact that a few enhancements may still be made [1].

The whole thesis describes the layout and development and testing of an affordable mechanical ventilator for use in instances of mass casualties and poor storage situations. Through duplicating a customary bag-valve mask (BVM) with a rotating cam arm, the breathing machine transmits inhales, dispensing with what has been actually required for a BVM human administrator [2].

Quick, on-scene crisis medical reaction can decrease the number of fatalities supported amid military operations. Without restorative bolster, harmed officers must be transported over significant separations to an office capable of regulating definitive restorative care, an activity that will not be conceivable. Household mass casualty bolster has moreover come to the bleeding edge as of late, with the proceeding risk of fear based oppression. Current capabilities for giving basic respiratory help for hundreds or indeed thousands of casualties of chemical or biological weapons of mass devastation don't exist. We report here on the improvement of two lightweight, versatile ventilator and therapeutic demonstrative frameworks for the treatment of far forward battlefield and mass civilian casualties [3].

Precise observing of stream rate and volume trades is basic to play down ventilator-induced lung damage. Mechanical ventilators utilize flow meters to assess the sum of gas

conveyed to patients and utilize the stream flag as a criticism to alter the required sum of gas to be conveyed. Since flow meters play a significant part in this field, they are required to fulfill strict criteria in terms of energetic and inactive characteristics. Subsequently, mechanical ventilators are prepared with as it were the taking after sorts of flow meters: straight pneumatic echo graphs, settled and variable whole meters, hot wire anemometers, and ultrasonic flow meters. This paper gives an outline of these sensors. Their working standards are depicted at the side their pertinent focal points and drawbacks. Besides, the foremost promising rising approaches for flow meters plan (i.e., fiber optic innovation and three dimensional micro-fabrications) are briefly checked on appearing their potential for this application [4].

OptiHaler reevaluates MDI delivery. Its licensed streamlined design creates a more compelling vaporized blend — wealthier in little particles, with fewer of the bigger, less alluring ones; OptiHaler makes more vaporized available for conveyance to the lungs than ordinary static spacers. Noninvasive ventilation with BiPAPSfY is perfect therapy for supporting suddenly breathing patients. Clinical thinks about demonstrate the BiPAPSfY Framework to be a successful elective to conventional volume ventilators. In expansion, compare the volume of ventilators, BiPAPSfY. Is more reasonable Offers more prominent understanding consolation can lead to the next rate of compliance Is simple to use while common cover spills can meddled with therapy delivered by volume ventilators, BiPAPSfY S/T is designed to both endure and compensate for most spills successfully. The BiPAPSfY System's interesting technology enables it to:

• Consequently make internal alterations to tolerate most leaks • Alter understanding affectability with each breath to convey reliable treatment, indeed within the presence of most leaks • Adjust stream to preserve superb pressure stability. Successful hand-washing

can anticipate nose comical contaminants. Especially in clinic's of high hazard areas. There are several clinical assumes regarding the current efficacy of specific Hand-cleaning experts to avoid the transmission of pathogens from a well-being specialists to patients. We passed out a proposed dual-hybrid trailing in 1,894 elderly patients in three emergency departments (ICUs) for 8 months. The ICU used a hand-washing mechanism which included either chlorhexidine in a particular month. Consultant within antibacterial wide spectrum. Or isopropyl by 60%, Essential using anti-medicated soap liquor: all other mechanism has been used in replacement days straight. Gradually have been noted rates of nosocomial poisoning and compliance with hand-washing. There were 152 nosocomial diseases when chlorhexidine was used compared to 202 when the mixture of liquor and cleanser has been used (balanced incidence-density ratio. 0.73: 9.5 material of certainty. (0.59-0.90). A gastrointestinal inflection (ll) R was the highest decrease to chlorhexidine. 0.19: interns with 95 percent certainty. 0.05- 0.64).When there has been chlorhexidine. For each ICU, the yields of nosocomial infection decreased, And well-being cuie workers had been wash their hands more frequently than using alcohol and cleanser (comparative hazard 1.28: 95 percent interim certainty 1.02- 1.60). The total volume of liquor and cleanser used chlorhexidine ($p < 0.001$) as 46 percent [5].

We have constructed a fundamental high frequency ventilator that produces a stream design that is largely independent of respiratory mechanics to mechanically ventilate anesthetized small animals. Involves compressed gas reservoir with such an electronic unit and an inspiratory side stream valve and an expiratory side moment valve. A programmable controller drives both valves. We measured the conveyed tidal volume to monitor the execution of this ventilator, whereas the ventilator was associated with an external, constantly varying resistance. This resistance was continuously expanded to simulate bronchoconstriction of the respiratory system. Comparison with a volume-

controlled ventilator was made. The use of a programmable controller moreover allows control of distinctive designs of mechanical ventilation, such as end-inspiratory stop or the inactive pressure volume relationship, which can be utilized to perform lung function tests. The structure can be a fundamental, flexible gadget that enables both strong ventilators and assessment of lung function in small rodents and is appropriate for the timetable used in study facilities [6].

Mechanical ventilator could be a therapeutic device which is more often than not utilized to ventilate patients who cannot breathe satisfactorily on their own. Among numerous types of ventilators Pack Valve Veil (BVM) could be a manual ventilator in which a sack is squeezed to deliver air into the lungs of the persistent. In show work, a mechanical framework together with micro controller has been created to automate the operation of BVM. The built model contains two arms of 0.30 m long, fueled by two servo engines through pulling wires and pulleys, upheld by wooden outline. These arms compress the BVM in endorsed way at the rate set by the administrator through a control handle. With foremost measurements of 0.55m,0.15m,0.3m, weight 2.5 kg and three 9 V battery for providing control for at slightest one hour nonstop operation, the model can be moved effortlessly. The measurements of the outline are chosen as such to be congruous with the physical measurement of Ambu pack. The execution of the gadget was tested using BIO PAC Wind current Transducer which outlines that the Tidal Volume vs. Time chart of the mechanized framework is comparable to the chart created by manual operation of the BVM and to the chart created by a human subject, but with a cruel deviation of 0.332 Liters with manual operation and 0.542 Liters with human subjects. In spite of the fact that the created gadget cannot compress the pack totally due to moo fueled servo engines, it demonstrates the concept of computerizing the operation of BVM utilizing mechanical framework for creating a versatile ventilator [8].

Various works and literary works on the authentic improvement of mechanical ventilation and the plan of convenient ventilators are accessible. Displayed a chronicled audit of different methods of mechanical ventilation is. It is curious to note that manufactured ventilation isn't an unused or advanced concept; or maybe it can be followed back to Scriptural times. But advanced and programmed gadgets didn't show up until the early 1800s.outlines a 19 the century mechanical ventilator which is negative-pressure sort. Robert M.K, et al. advancement of Mouth-to-Mouth to Bag-Valve-Mask Ventilation is outlined. Different advancements within the components of Ambu pack and its valves are discernible .A. Khoury, et al.[8].

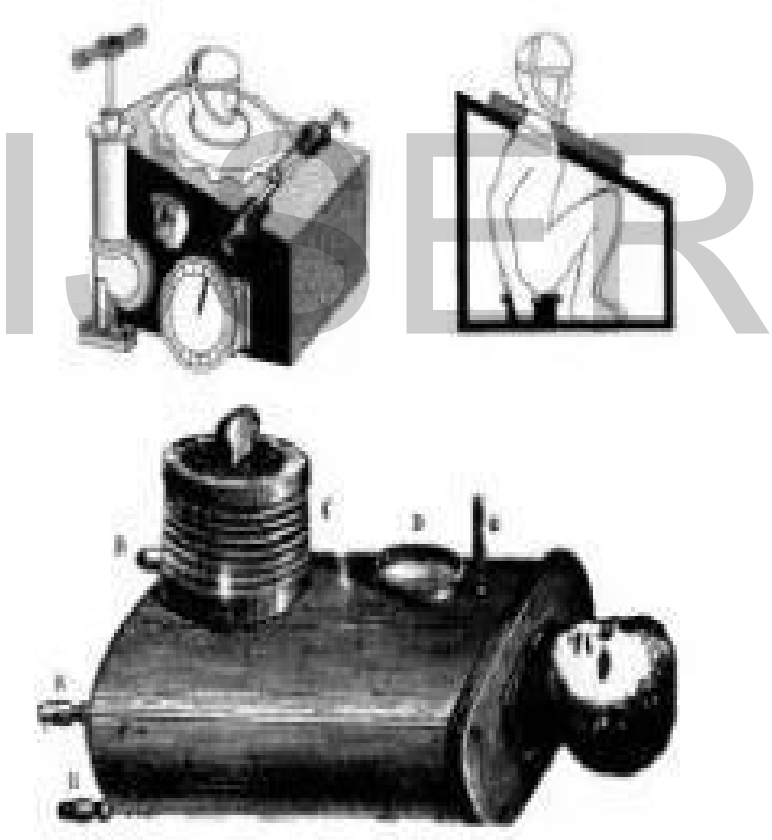

Figure 8 Mechanical Ventilation in 19th century [8]

History has been enhanced in both manual and mechanical techniques of artificial ventilation. In this article two strategies of manual counterfeit revival strategies, namely Sylvester's and Schafer's strategy and five mechanical devices for manufactured ventilation, specifically Howls, the Pul engine, the Press Lung, Cuirass and Shaking Bed are portrayed in chronological arrangement.

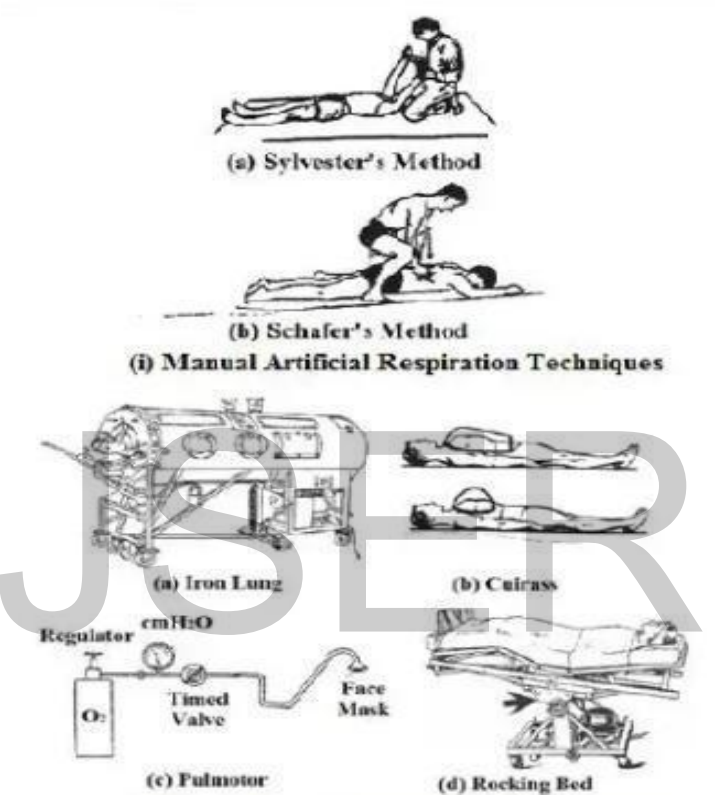

Figure 9 Old artificial ventilators method to save life [8]

Different sorts portable ventilators and there authentic development. The concept of portable ventilators is or maybe modern compared to ICU ventilators versatile ventilators are advanced from the need of ventilating a quiet amid moving or moving from one put to another. Ambu sack is regularly not dependable or it cannot be utilized for the

inaccessibility of prepared staff. For these reasons, convenient ventilators came into presence. S.Fludger, et al .[8].

In 1949, John Safe house Emerson created a mechanical as sister for anesthesia with the participation of the anesthesia division at Harvard College. Mechanical ventilators started to be utilized progressively in anesthesia and seriously care amid the 1950s. Their advancement was invigorated both by the have to be treat polio patients and the expanding use of muscle relaxants during anesthesia. Relaxant drugs paralyze the persistent and make strides working conditions for the specialist but too paralyze the respiratory muscles. Within the Joined together Kingdom, the East Radcliffe and Beaver models were early illustrations; the last mentioned utilizing a car wiper engine to drive the howls utilized to expand the lungs. Electric engines were, be that as it may, an issue within the working theatres of that time, as they utilize caused a blast danger within the nearness of combustible anesthetics such as ether and cyclopropane. In 1952, Roger Manley of the Westminster Clinic, London, created a ventilator which was totally gas driven, and got to be the foremost prevalent show utilized in Europe. It was a rich and powerful plan, and had to be an amazing top option for four decades with European anesthetists to present electronic-controlled models previously. It was electrical control independent and did not cause any blast security risk.8The first Check I unit was created to be the Manley Check II in collaboration with the Blasé company, who made numerous thousands of these units. Its rule of operation was exceptionally straightforward; an approaching gas stream was utilized to lift a weighted howls unit, which fell discontinuously beneath gravity, driving breathing gasses into the patient's lungs. The swelling weight might be changed by sliding the mobile weight on best of the bellows. The volume of gas conveyed was flexible employing a bended slider, which confined bellows excursion. Leftover weight after the completion of close was too configurable,

employing a little weighted arm unmistakable to the lower right of the front board. This was a strong unit and its accessibility empowered the presentation of positive weight ventilation strategies into standard European anesthetic hone. The 1955 discharge of Forrest Bird's winged creature All inclusive Therapeutic Respirator within the Joined together States changed the way mechanical ventilation was performed, with the little green box getting to be a commonplace piece of therapeutic equipment. The unit was sold as the feathered creature Stamp 7 Respirator and casually called the "Feathered creature". It was a pneumatic gadget and so required no electrical control source to function. Intensive care situations around the world revolutionized in 1971 by the presentation of the primary SERVO 900 ventilator (Elema-Schönander). It was a little, noiseless and compelling electronic ventilator, with the popular SERVO input framework controlling what had been set and controlling conveyance. For the primary time, the machine seems to convey the set volume in volume control ventilation. In 1991 the SERVO 300 ventilator arrangement was presented. The stage of the SERVO 300 arrangement empowered treatment of all quiet categories, from grown-up to neonate, with one single ventilator. The SERVO 300 arrangement gives a totally modern and special gas conveyance framework, with fast flow-triggering response. In 1999 the LTV (Portable workstation Ventilator) Arrangement was presented into advertise. The modern ventilator was altogether littler than the ventilators of that time weighing ~14 lbs and around the estimate of a tablet computer. This modern plan kept the same usefulness of the in clinic ventilators, whereas presently opening up a world of opportunity of versatility for the patients. A secluded concept, meaning that the healing center has one ventilator show all through the ICU office rather than an armada with distinctive models and brands for the diverse client needs, was presented with SERVO-I in 2001. With this measured concept the ICU divisions might select the modes and choices, program and equipment required.

Within the twenty-first century little portable ventilators, for case the Spare II, have been made for forward combat utilize [9].

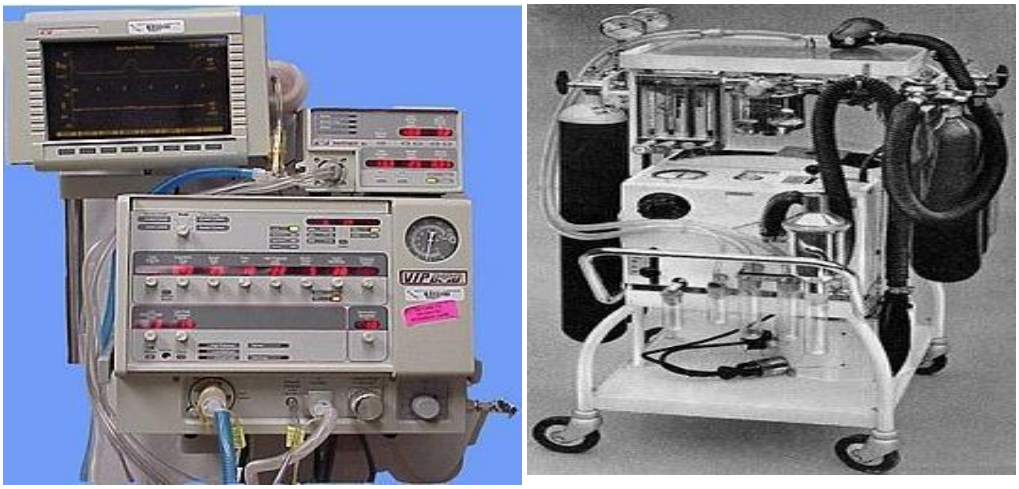

Figure 10 Pulmonology ventilator Respiratory model in mid 20th century [9]

The Roman doctor Galen to begin with utilized mechanical breathing within the moment century by blowing discuss into the larynx of a dead creature employing a reed. Creator George Poe utilized a mechanical respirator to resuscitate a suffocated puppy. Nowadays, negative-pressure ventilation is utilized in only a number of circumstances. The cuirass, or shell unit, permits negative weight to be applied only to the patient's chest by employing a combination of a form-fitted shell and a delicate bladder. It gives an appropriate and alluring alternative for patients with neuro solid clutter, particularly those with remaining strong work, since it does not require a tracheostomy with its inalienable problems. Seriously utilize of positive-pressure mechanical ventilation picked up energy amid the polio plague in Scandinavia and the Joined together States within the early 1950s. In Copenhagen, the understanding with polio and respiratory loss of motion that was backed by physically driving 50% oxygen through a tracheostomy had a diminished mortality rate. Be that as it may, this gallant intercession required the ceaseless action of

1400 therapeutic understudies enlisted from the colleges. The overpowering labor required, coupled with diminish in mortality rate from 80% to 25%, driven to the adjustment of the positive-pressure machines utilized within the working room for utilize within the ICU [10].

CHAPTER 3
MATERIAL & METHOD

3.1 Material:

The following materials are used for the designing and fabrication of medical ventilator

1. Circutary(contains sensors and ADC etc)
2. Cylinders(oxygen and air)
3. Patient panel(tubes for inspiaration and expiration)
4. Monitoring unit (User interface)

3.2 Research Methodology:

In my research about the review of designing and fabrication of Medical Ventilator which is an artificial device to give breath to critical patients, before discussing about the methodology of ventilator lets discussed about the respiratory tract and its anatomy by review its structure and know about the respiration process because the medical ventilator work on same respiratory process principal.

3.2.1 Life systems of Respiratory Tract:

Respiratory system consists of lungs, nasal cavity, Trachea, Nasophyrynx; etc. The human respiratory system can be a reliable organ mechanism for oxygen intake and carbon dioxide outtake. The respiratory system's vital organs are the lungs that carry out this gas trade as we breathe. The lungs operate to pump oxygen-rich blood into all cells within the body with the circulatory structure. The blood gathers carbon dioxide and other waste products at that stage and transports them back to the lungs where they will be When we breathe out, pumped out of the body and competed with the American Lung Association. The human body needs to maintain itself with oxygen. After as it were around five minutes without oxygen, brain cells start passing on, agreeing to the National

Founded of Neurological Disarranges and Stroke, which can lead to brain harm and eventually passing. As seen in figure;[16].

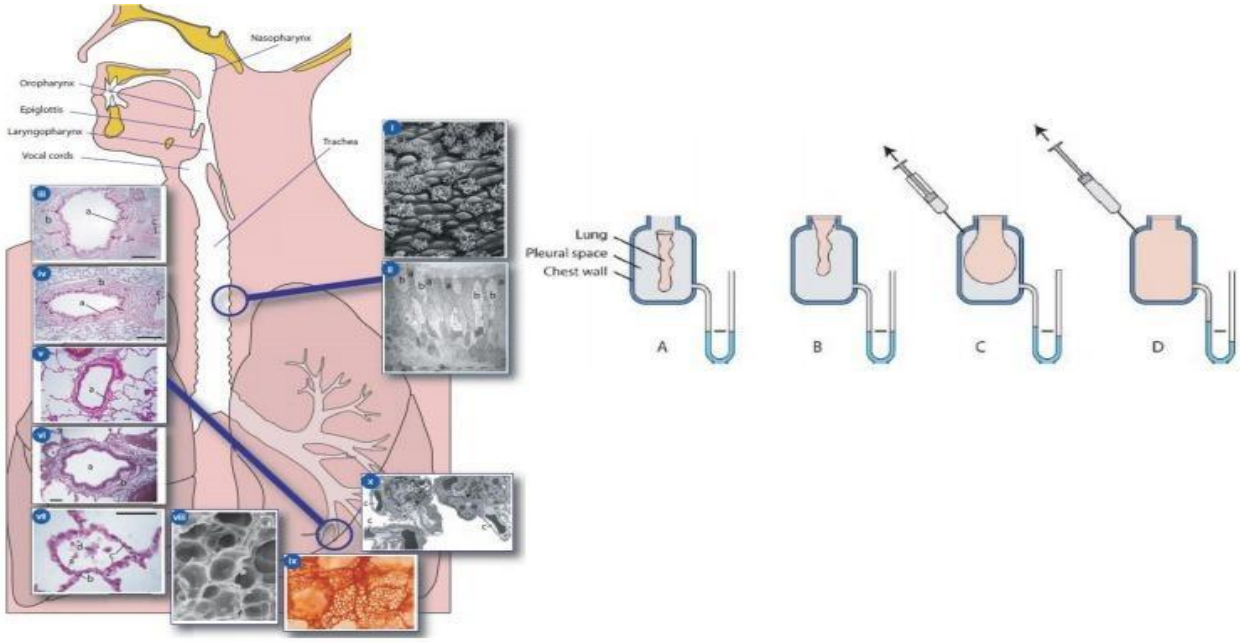

Figure 11 Experimental view of Respiratory system [16]

For the most portions, age depends heavily on the normal breathing or respiratory rate in individuals. In humans, the normal breathing rate, or respiratory rate, mostly depends on age. The ordinary breathing rate of a newborn is about 40 to 60 times per miniature, and can moderate to 30 to 40 times per miniature when the child is resting, coinciding with the well-being of Stanford children. Resting breathing rates for grown-ups are 12 to 16 breaths per diminutive and up to 40 to 60 breaths per diminutive in the work-out, in conjunction with the European Respiratory Society. As we breathe, oxygen enters the nose or mouth and passes the sinuses, which are empty spaces within the cranium that offer assistance to control the temperature and stickiness of the discuss we breathe. From the sinus, discuss passes through the trachea, moreover called the windpipe, and into the bronchial tubes, which are the two tubes that carry discuss into each lung (each one is

called a bronchus). The bronchial tubes are lined with modest hairs called cilia that move back and forward, carrying bodily fluid up and out. Bodily fluid may be a sticky liquid that collects clean, germs and other matter that has attacked the lungs and is what we remove when we wheeze and hack [13].

3.2.2 Lung surface tension, Force & Compliance:

In 1991 Cockshutt and Possmeyer was two scientists who research on lung surface tension how it will be affected told in a later paper in your diary by Scarpelli and Mautone (1994) sustains a myth, presently a few 30 a long time ancient, that lung surfactants, whether "characteristic" or "manufactured" and consisting primarily of a blend of water insoluble phospholipids can reduce the surface pressure at an air/water interface to <5 dyne/cm. Another scientist however others claim to have accomplished <1 dyn/cm in 1976-1992.

The property of a liquid that makes it behaves as if its surface is enclosed in an elastic skin. The property results from intermolecular forces: a molecule in the interior of a liquid experiences a force of attraction from other molecules equally from all sides, whereas a molecule at the surface is only attracted by molecules below it in the liquid. The surface tension of water is very strong, due to the intermolecular hydrogen bonding, and is responsible for the formation of drops, bubbles, and meniscuses, as well as the rise of water in a capillary tube (capillarity), the absorption of liquids by porous substances, and the ability of liquids to wet a surface.The surface pressure at any vapor/liquid interface is an unavoidable result of the >1000-fold distinction within the thickness of the two stages. The surface pressure of a vapor/water interface as it were approaches zero at the basic temperature (374.1°C) when the thickness of vapor atoms nearly breaks even with the thickness of the (exceptionally hot) water, person particles within the inter-facial locale being similarly pulled in to the vapor and the water stages. Any claim to have

dispensed with the surface pressure of water (at 37°C) as a result of nearness of a blend of proteins and phospholipids suggests either that the exploratory had fizzled to watch the vanishing of the water or vapor stages through and through or their technique was imperfect [14].

The pressure inside a really round alveolus (Pa) would ordinarily be calculated as twice the surface pressure (Ts) separated by the alveolar radius (r):

$$P_A = \frac{2 \times T_s}{r}.$$

Figure 12 Lung surface tension formula [15]

On the off chance that Ts is consistent, all of the alveoli in a lung would purge into one gigantic alveolus! Luckily, surface pressure isn't consistent: surfactant diminishes the surface pressure in extent to the altar within the surface range. The littler surface region of the alveolus, the more noteworthy the decrease in surface tension. Gas streams from bigger to littler alveoli [15].

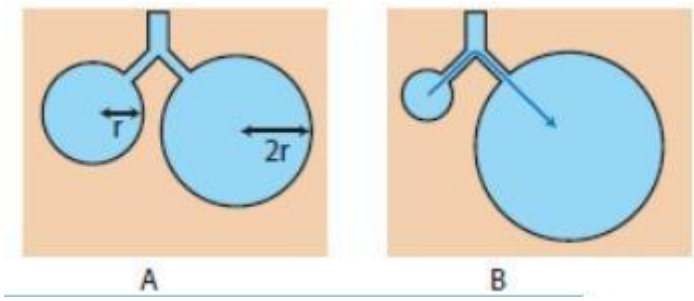

Figure 13 Lungs Pressure [15]

The lungs compliance show by following figure;

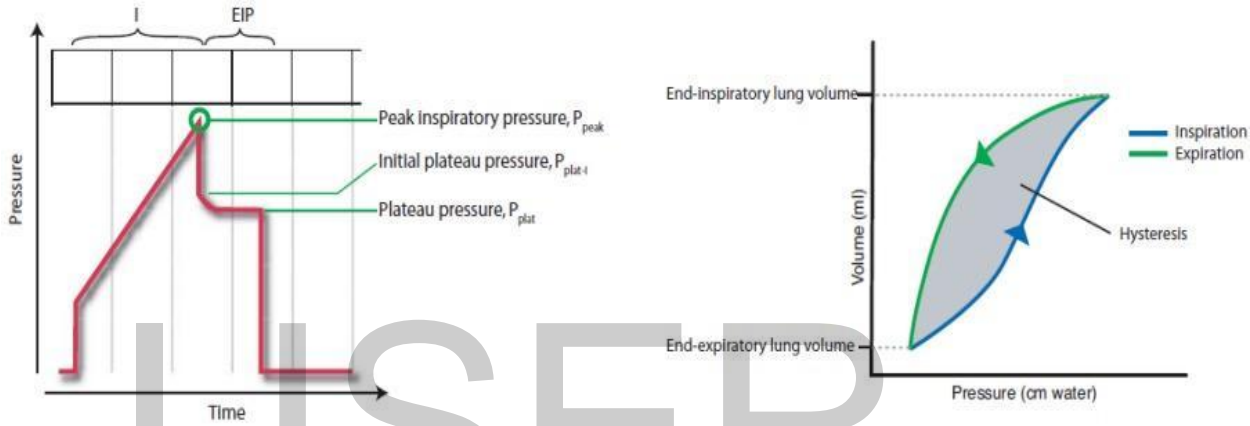

Figure 14 Compliance graphic view [15]

The compliance of a system is characterized as alter in volume that happens per unit alter within the weight of the system. In layman terms, compliance is the ease with which a versatile structure can be extended. Compliance is, subsequently, fundamentally an estimation of the versatile resistance of a system. Pulmonary compliance (C) is the overall compliance of both lungs, measuring the degree to which the lungs will expand (alter in volume of lungs) for each unit increment within the trans-pulmonary weight (when sufficient time is permitted for the system to reach balance).Lung Compliance (C) = Change in Lung Volume (V) / Alter in Trans-pulmonary Weight {Alveolar Weight (Palv) – Pleura Weight (Ppl)}.Trans-pulmonary weight is the weight angle between the inferior alveolar weight and

exterior pleura weight. It primarily measures the drive of lung versatility at each point of breath (draw back weight). Alveolar weight is the discuss weight interior the alveoli. Pleura weight is the weight of the liquid display interior the space between visceral pleura (layer followed to lungs) and parietal pleura (chest divider lining layer). Ordinarily the full compliance of both lungs in a grown-up is approximately 200 ml/ cm H2O. Doctors depend on this concept to get it a few respiratory pathologies and offer assistance direct treatment and alter ventilator weight and volume settings [16].

3.2.3 Two-Compartment Demonstrate of Inactive and Dynamic Compliance;

Before discussing about the two-compartment compliance of lungs let's discuss about its types which is measured by different methods.

Inactive Compliance: It is the representation of respiratory compliance at a given settled volume when there's no wind current and muscles are loose. This circumstance takes out when trans-pulmonary weight rises to the flexible draw back weight of the lungs. It as it were measures the versatile resistance. It is measured with a basic water manometer, but electrical transducers are presently more commonly utilized. Within the cognizant person, it is troublesome to realize total certainty of respiratory muscle unwinding. But the compliance estimation is considered substantial since the inactive weight contrast is unaffected by any muscle movement. In case of a paralyzed person as within the working theater, it is clear to degree inactive compliance utilizing recordings captured through electrical transducers [16].

Cstat = V / (Pplat – PEEP) Where, Pplat = Plateau pressure, PEEP = Positive End Expiratory Pressure

Dynamic Compliance: It is the persistent estimation of respiratory compliance calculated at each focuses speaking to schematic changes amid musical breathing. It screens both

flexible and aviation route resistance. Aviation route resistance depends on the discuss consistency, thickness, and length and span of aviation routes. But for the span of the aviation route, all other factors are moderately steady. In this way, aviation route resistance can be physiologically changed by changes within the span of the aviation route bronchus [16].

Following figures show the compliance of lungs;

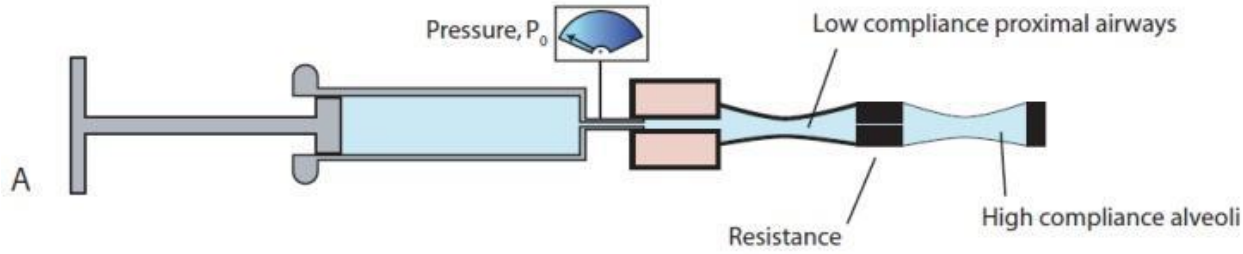

Figure 15 Compliance of Lungs [16]

The following figure A shows the structure where different components as following;

1. **Pressure. P_o**
2. **Low Compliance proximal airways**
3. **Resistance**
4. **High Compliance Alveoli**

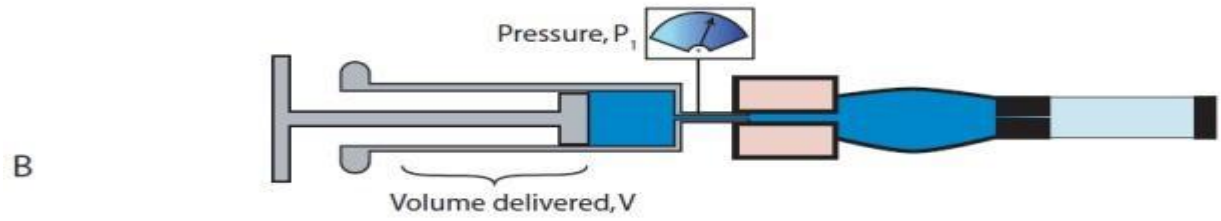

Figure 16 Compliance of Lung [16]

The figure B also show Compliance which also have some components which are as following;

1. **Pressure,P_1**
2. **Volume delivered**

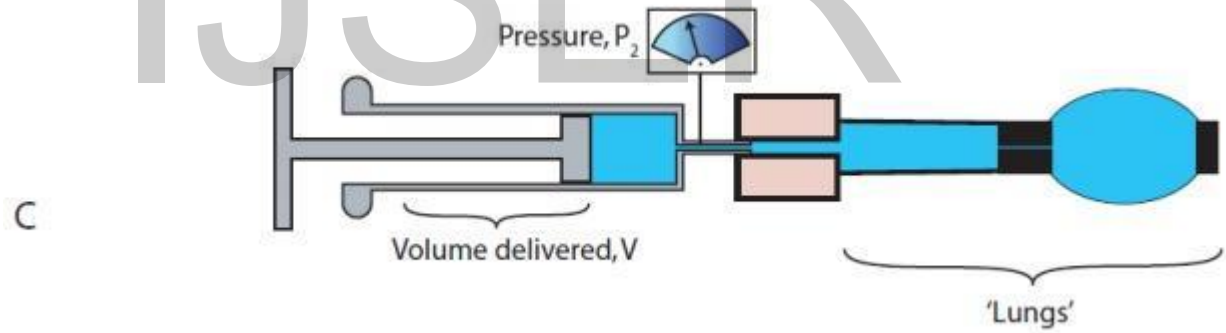

Figure 17 Compliance of Lung [16]

The following fig.C as shown also relates which fig.B but it has Lungs as extra component;

1. **Pressure,P_2**
2. **Volume delivered**

3. **Lungs**

Lung compliance is conversely relative to elastance. This flexible resistance is both due to the flexible property of lung tissue or parenchyma and the surface versatile constrain. Any changes happening to these strengths seem lead to changes in compliance. Compliance decides 65% of the work of breathing. On the off chance that the lung has moo compliance, it requires more work from breathing muscles to blow up the lungs. In particular pathologies, nonstop checking of the lung compliance bend is valuable to get it the movement of the condition and to choose on helpful settings required for ventilator administration [16].

3.3 Ventilator Features:

3.3.1 Primary Parts:

1. MCF51MM256 32-bit Chilly Air Rescale Marvel universe with analog modules (DAC, inner Op Amps) ideal for rehabilitative and inertial navigation system appliances.
2. Freescale sensors were matched by MPXV5050GP (0 to 50 KPa single weight) and MPX7002DP (-2 to + 2 KPa differential weight).
3. Electric tubes MHP1-M4H (14 lts / min, 5 V, 1 W, 250 Hz, 2/2, M3).
4. 12 V at 10 A i300 Major Decade Car Swordtails 15 lts / min compressor.
5. Control of 500 mA transistors for valves and buzzers (TIP31C) and 15 The socket (JSM1A-12V-5) for unit compressors.
6. Aluminum describe 4 returns (M3) of the mixture compartment (30 PSI max)..
7. Analog temperature sensor with multiple gains 0-3 V yield voltage. Showing 20 X 4 character 5 V LCD (C-51847NFJ-SLW-ADN)
8. MAG 2.0 KHZ 3 V Alert buzzer Material buttons and indicators driven. Connector for the USB gadget.
9. 1 L hypnotic pouch for the re-enactment of living lungs Therapeutic heat exchanger pipe to degree the difference in weight from either the stream [17].

3.3.2 Gas Exchange in Lungs as in Ventilator:

The following figure Show how gases pass and exchange during respiration;

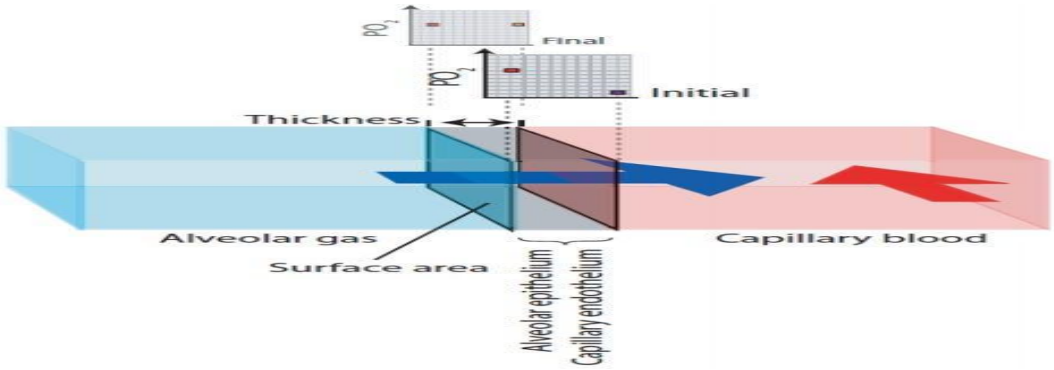

Figure 18 Gasses exchange during Respiration [15]

Speed of dissemination is determined by:

- ✔ Halfway weight gradient
- ✔ Thickness of barrier
- ✔ Dissolvability of oxygen in barrier

Contact time is inversely proportional to the cardiac output

- ✔ At rest is ordinarily 0.75 s
- ✔ At ocean level, as it were 0.25 s is needed [15].

3.3.3 Ventilator Function:

1. To assist, monitor, or regulate ventilation, move air in and out of the air holder Control air mixing speed by pressure.
2. Living creature software for screening and controlling basic parameters such as breath rate, physical stress, units of degree and manipulate phase.

3. Reenactment is importance of respiratory conduct (air holder bag). Three modes of control (weight, repeat and assisted)

4. Monitor of one air pump and four gaskets with helping PID capabilities [17].

3.3.4 Useful Square Chart:

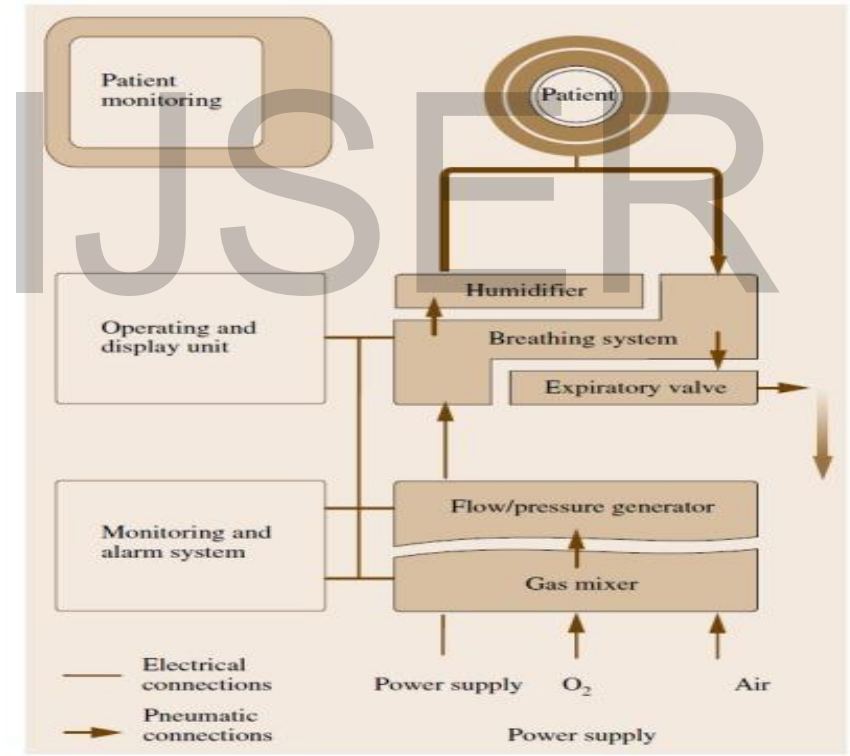

Figure 19 Power supply [15]

3.3.5 Working of Ventilator:

The breathing tube is connected with the person by means of a tube (endotracheal or ET tube) that has been placed in the mouth or nose and in the windpipe. It is termed incubation whenever the medical practitioner positions the ET tube in the windpipe of the person. Some people go through surgery to have a hole in their neck and then through gap a tube (tracheostomy or trach tube) is connected. The trach valve could still stay in just as long as humanly possible. Sometimes an individual can use an extraordinary socket called a talking sensor to engage in conversation with a trach tube in place .The ventilator blows gas (discuss additionally oxygen as required) into a person's lungs. It can offer assistance an individual by doing all of the breathing or fair helping the person's breathing. The ventilator can provide higher levels of oxygen than conveyed by a cover or other gadgets. The ventilator can moreover give what is called positive conclusion respiratory weight (PEEP). This makes a difference to hold the lungs open so that the discuss sacs don't collapse. The tube within the windpipe too makes it easier to expel bodily fluid on the off chance that somebody contains a frail hack [18].

3.4 Ventilator Modes:

3.4.1 Assisted Mode:

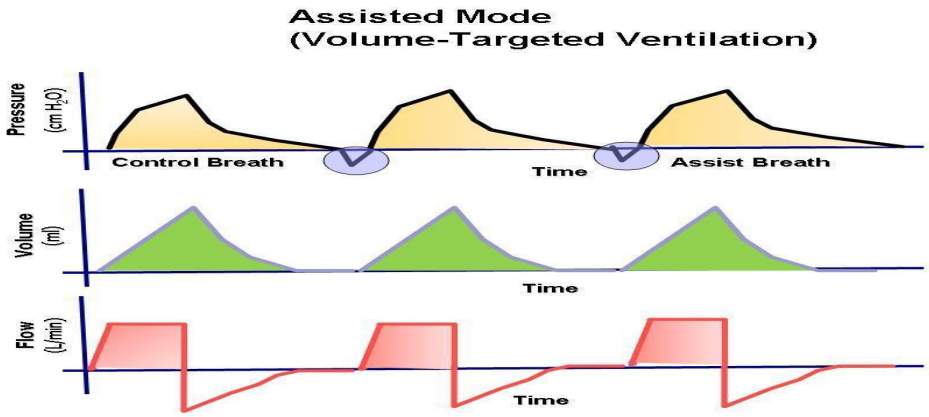

Figure 20 assisted mode [18]

3.4.2 Controlled Mode:

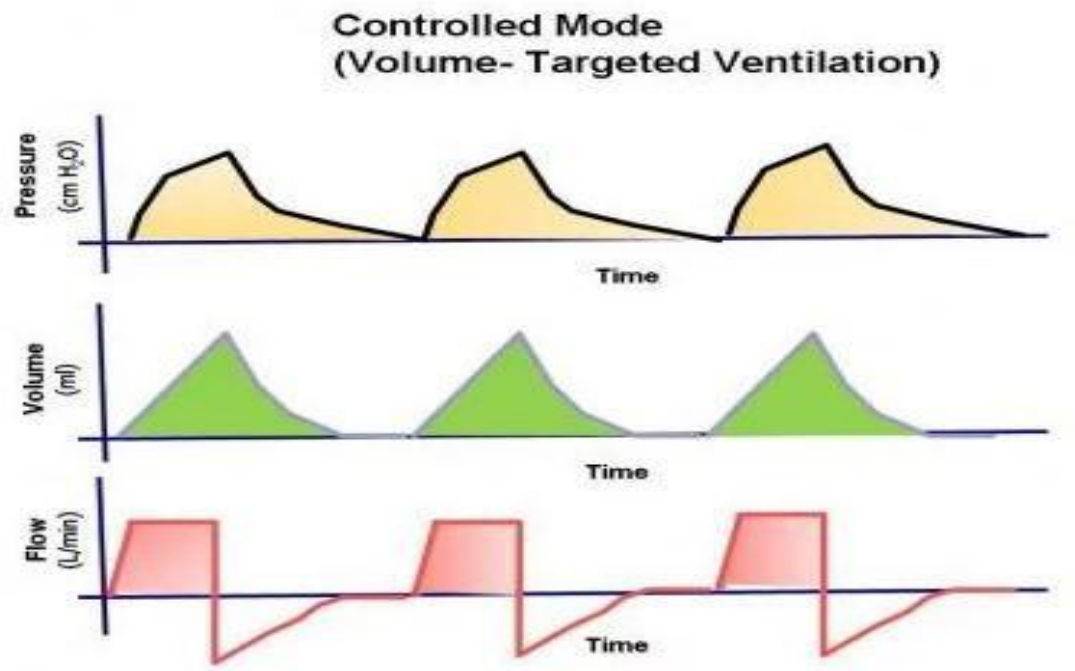

Figure 21 controlled mode [18]

3.5 Hardware Designing of Ventilator:

3.5.1 Block Diagrams of Components:

The system has the following components:

1. **Supply of Air and O_2**
2. **Cable of power**
3. **User Interference**
4. **Patient Unit**
5. **Expiratory Intel**
6. **Servo Guard filter**
7. **Respiratory outlet**

8. **System of Patient**

9. **Compartment Module**

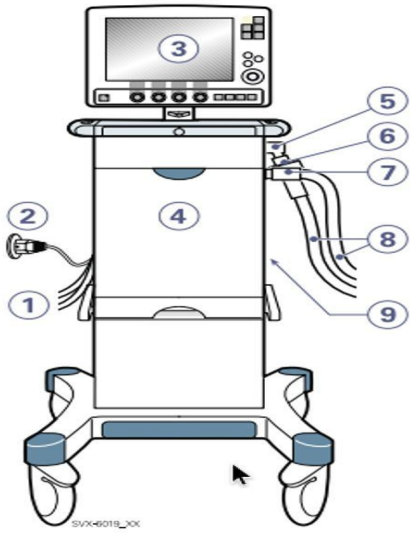

Figure 22 Servo I block diagram [18]

3.5.1.2 User Interference:

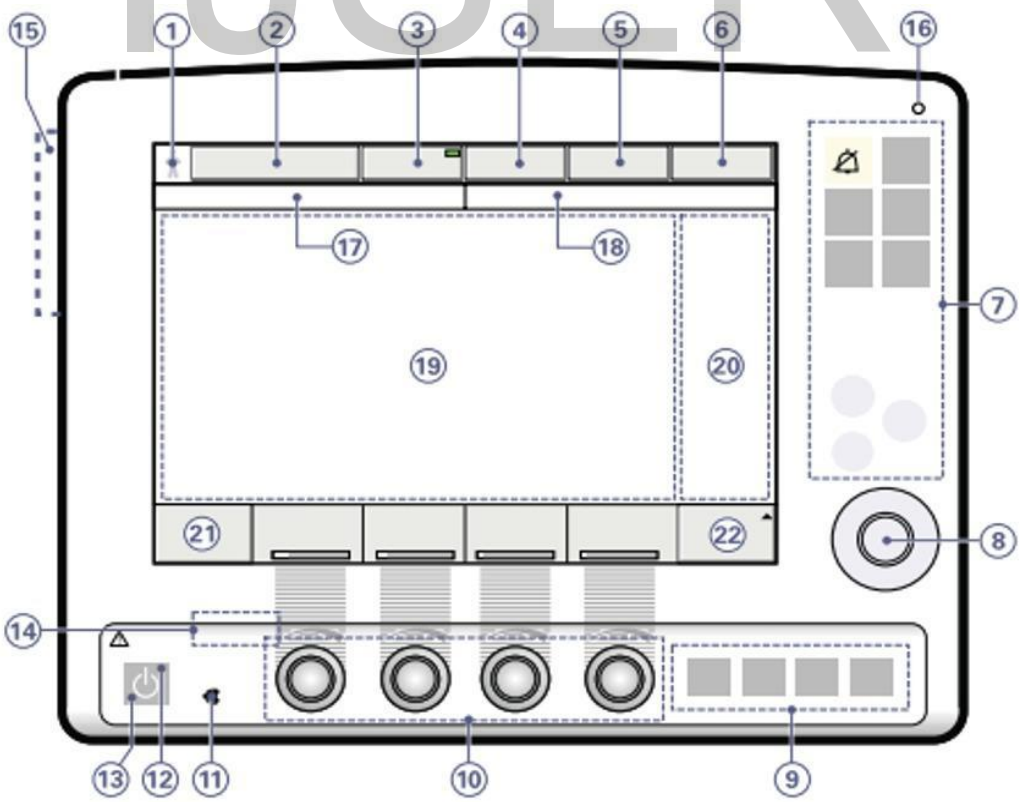

Figure 23 User interference screen [18]

1. Patient category
2. Dynamic mode of ventilation
3. Auto-mode On/Off
4. Concede patient/Entered understanding information and admission date
5. Nebulizer On/Off
6. Framework status parameters
7. Fixed keys
8. Fundamental Rotational Dial—used to choose a menu touch cushion or parameter box, to adjust values, and to affirm settings
9. Uncommon Work Keys—used to start special ventilators functions
10. Coordinate Get to Knobs—used for immediate alteration of breathing parameters
11. AC Control marker (green)
12. Standby marker (yellow)
13. Start/Stop (Standby) ventilation key
14. On/Off switch (raise side)
15. Space for Ventilation Record Card
16. diancie detector—for automatically altering screen brightness
17. Enlightening content messages, which include a purple image when triggered by the patient
18. Caution messages
19. Waveform area—for observing two to four independently scaled parameters, including a pressure/flow circle
20. Measured values and alarm limits display (customizable)
21. Extra settings
22. Extra measured values

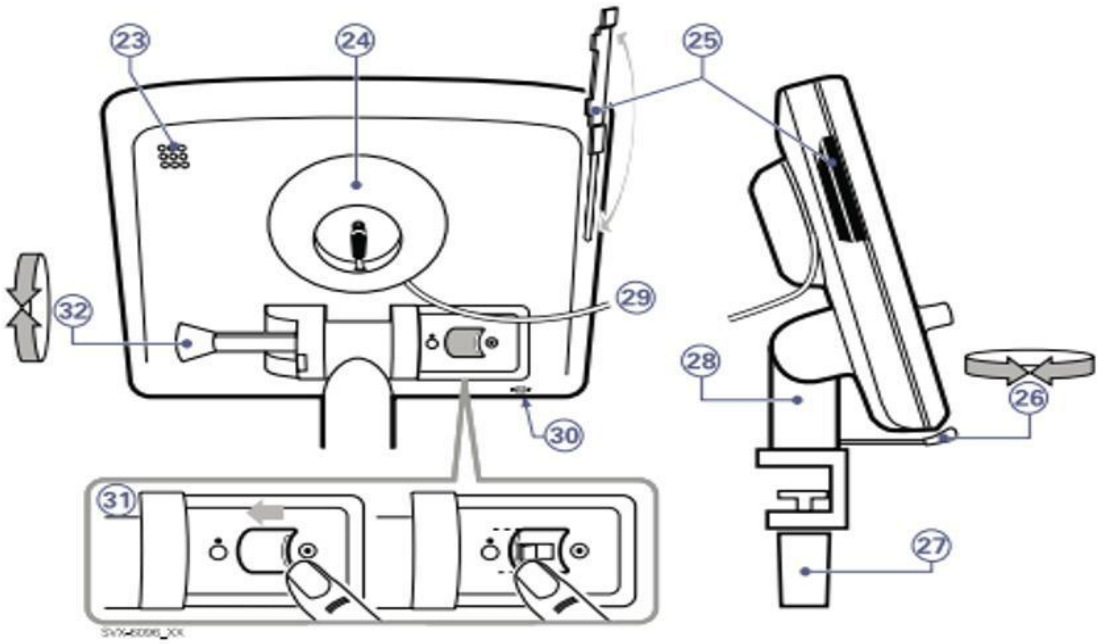

Figure 24 User Interference [18]

23. Loudspeaker

24. Cable reel for the control cable

25. Opening for Ventilation Record Card

26. Screen turn locking lever

27. Locking screw for elective cart mounting

28. Board holder for situating on the Mobile Cart

29. Control cable (2.9 meters long)

30. Benefit connector

31. On/Off switch (Set to On; when off, battery proceeds to charge)

32. Locking arm for tilting the screen

3.5.1.3 Touch Screen:
To alter ventilator settings:

01. Actuate the required menu by touching one of the cushions at the top of the screen.
02. Enact the required parameter by pressing its touch pad. The cushion is presently highlighted in white with a blue frame and it is conceivable to enter a new value.
03. Turn the Most Rotating Dial to the desired value or line.
04. Affirm your setting by squeezing the parameter touch cushion or by squeezing the Main Rotating dial. The parameter touch cushion turns blue again indicating the modern setting has been entered.
05. Touch Acknowledge to enact your settings.
06. Press Cancel to begin over.

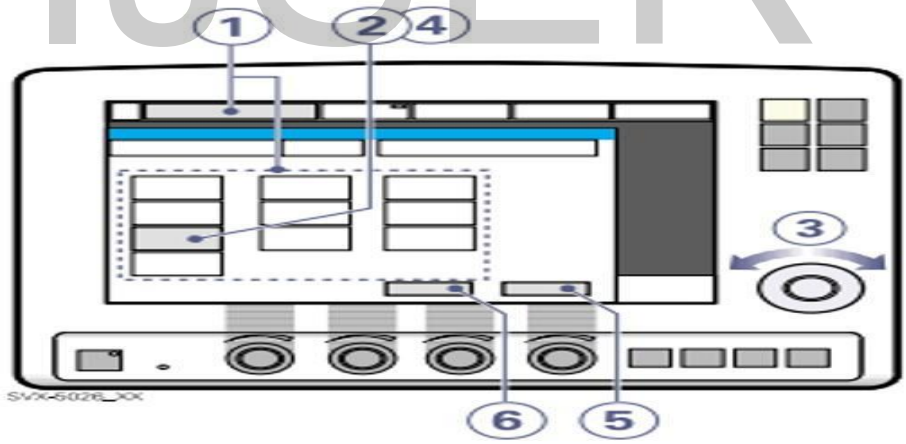

Figure 25 Touch screen [18]

The different sigs which are been shown on the ventilator screen are shown below in the figure

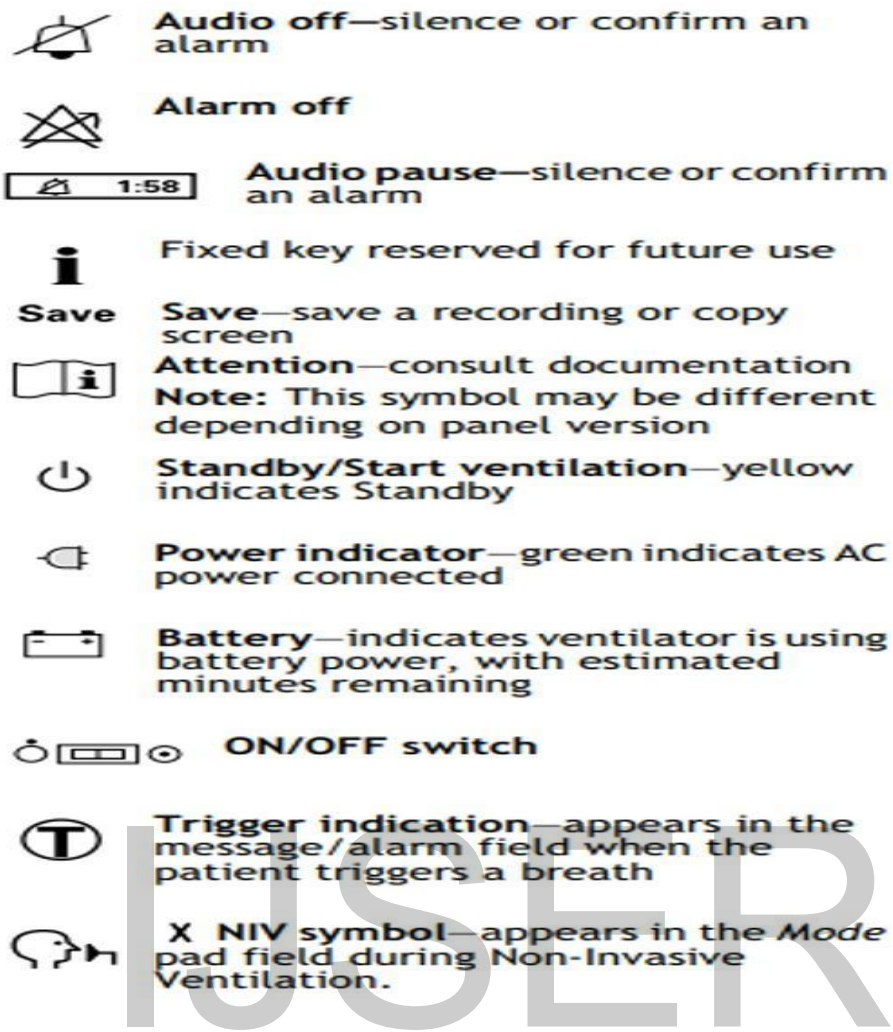

Figure 26 signs [18]

3.5.1.4 Fixed and Rotary keys:

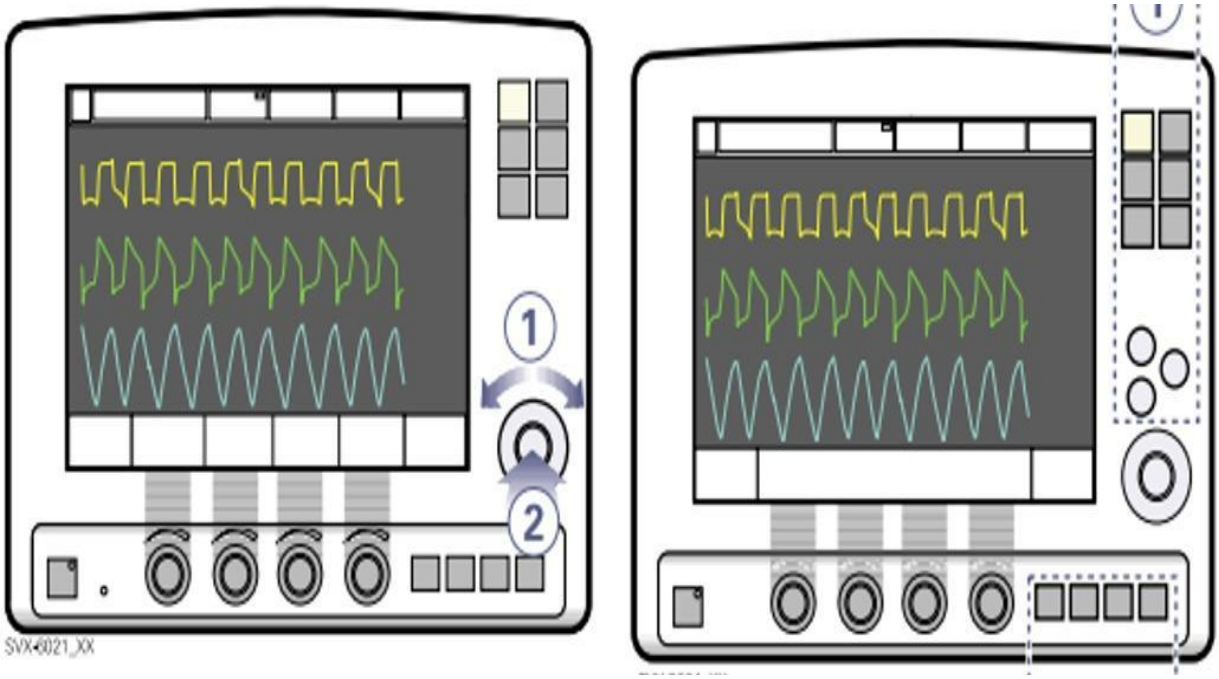

Figure 27 fixed and rotary interference [18]

There are two bunches of settled keys on the user interface screen:

1. The keys in gather 1 actuate user interface capacities such as Spare and access different screens such as Menu.

2. The keys in bunch 2 begin special ventilator capacities.

3.5.1.4.1 Direct Access Knob:

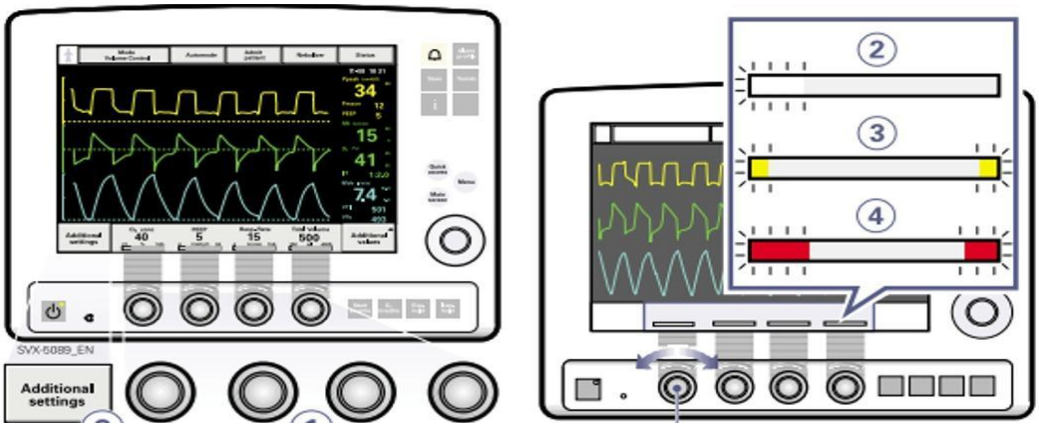

Figure 28 Direct Access Knob Diagram [18]

3.5.1.5 Menu Key:

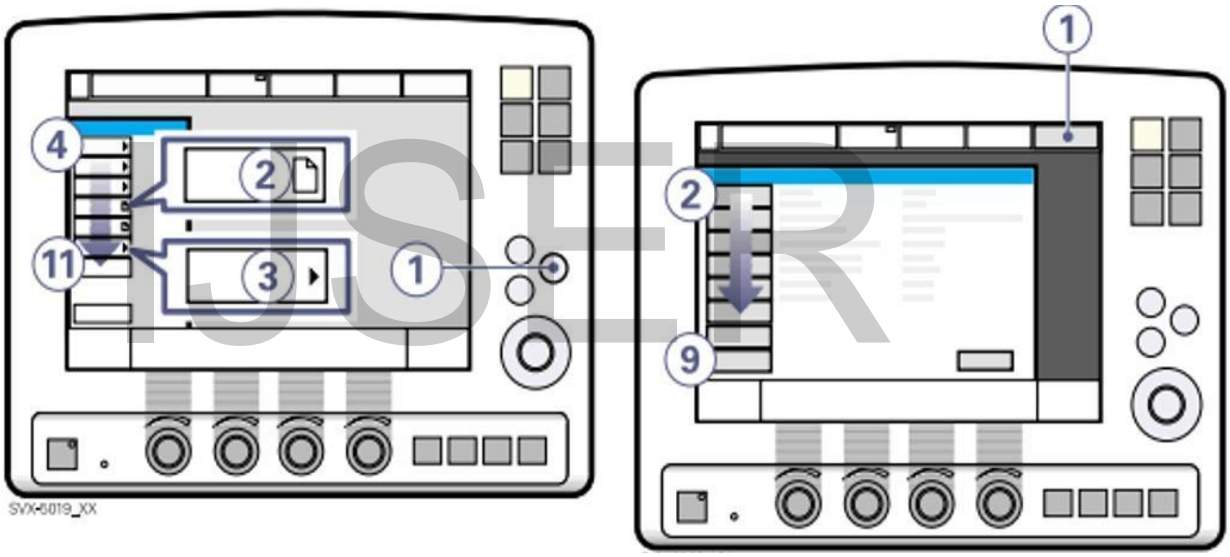

Figure 29 Menu key diagram [18]

To access the windows of the customer interface:

1. Tap the menu of the settled key. Touch pads appear in the windows of the client operating system.

2. If a sheet icon appears on the touchpad, click the touchpad to open the user interface window,

3. In case the touch cushion appears a bolt icon, press the touch cushion to show the sub menu.

3.5.2 Power Supply:

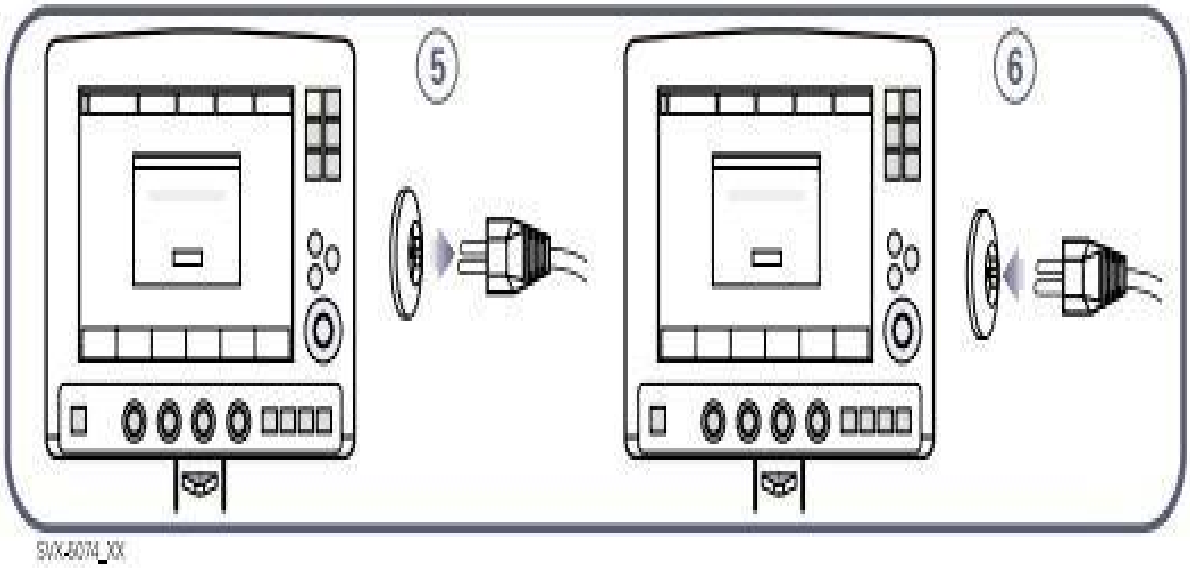

Figure 30 Power supply [18]

3.6 Circulatory Diagram or Structure:

3.6.1 Electronic Circuit:

System involves controlling a few electronic control sensors requiring high present usage and generating electrical clamor from EMI to the framework. To dodge the commotion era and device protection like optical switch and snubbers for exchange, the structure needs an excellent electrical scheme. Additionally, it is essential to back up and provide enough current. The Darlington transistor paradigm chooses for isolators and transmits to transport rectify power establishment [17].

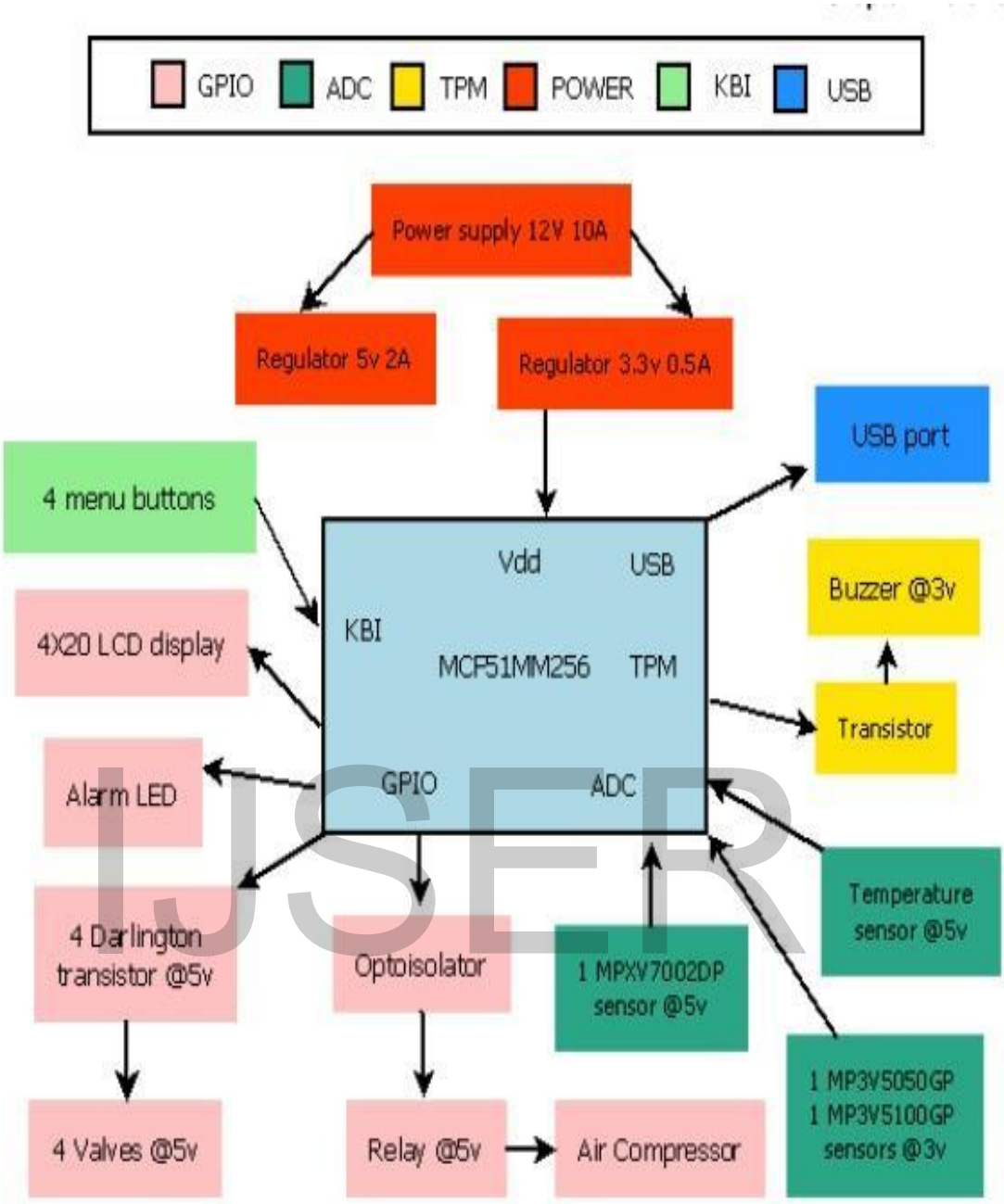

Figure 31 Flow chart of electronic circuit [17]

3.6.2 Boost converter:

Among the most elementary components for this application is the treatment and measurement of the flag, since the respirator acts in accordance with the information provided. In case this information is not reliable, Ventilator might well perform erroneous activities that may pose a risk to the health of the patient. Choosing the appropriate MCU and sensors for instrumented apps is essential. Free scale provides reliable MCUs for

instrumented therapy. Two situation are where these are 8-bit MCU (MC9S08MM) and 32-bit MCU (MCF51MM). The MCU selected for this reference design was the MCF51MM256 [17].

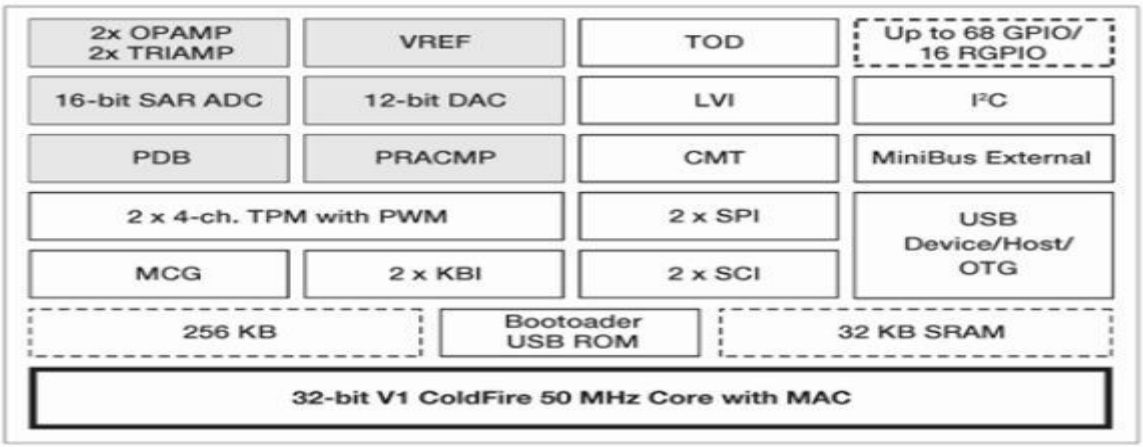

Figure 32 MAC flow chart [17]

3.6.3 MCU Circuit Diagram:

Figure 33 Circuit diagram of MCU [17]

3.6.4 Power Supply:

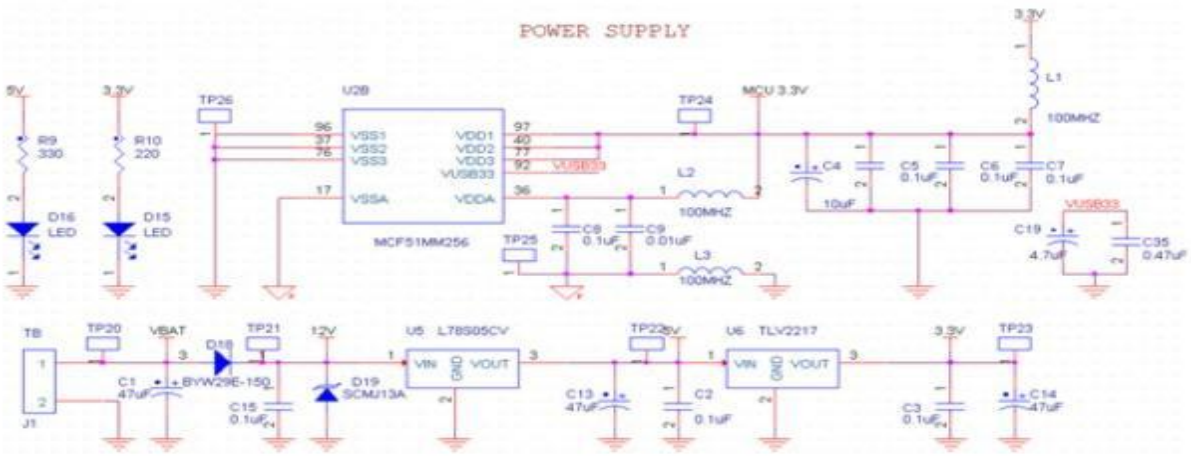

Figure 4-8. Power supply

Figure 34 Power supplies [17]

3.6.5 Background Investigate Mode:

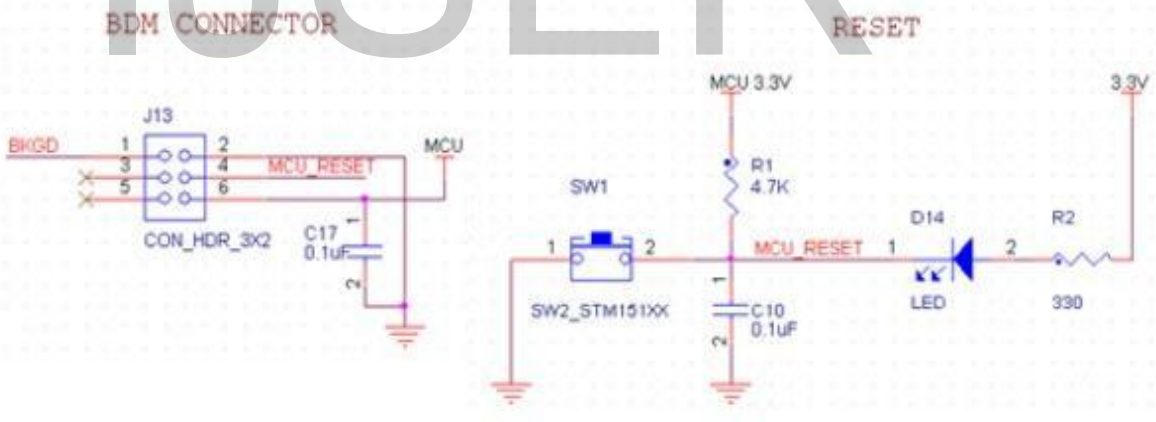

Figure 4-9. BDM and reset

Figure 35 BDM and reset [17]

3.6.6 USB & Clock:

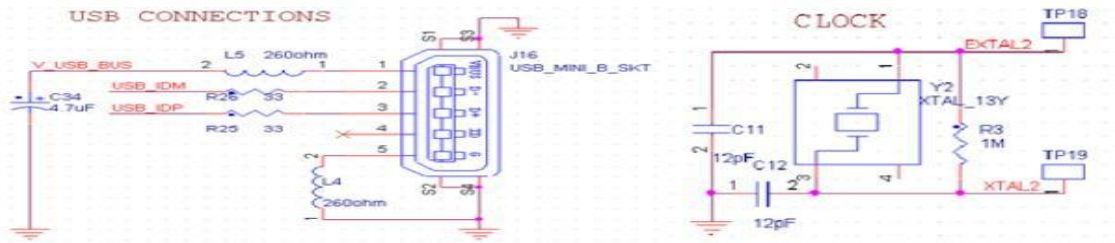

Figure 4-10. USB and clock

Figure 36 USB and Clock [17]

3.6.7 Actuators exchanging:

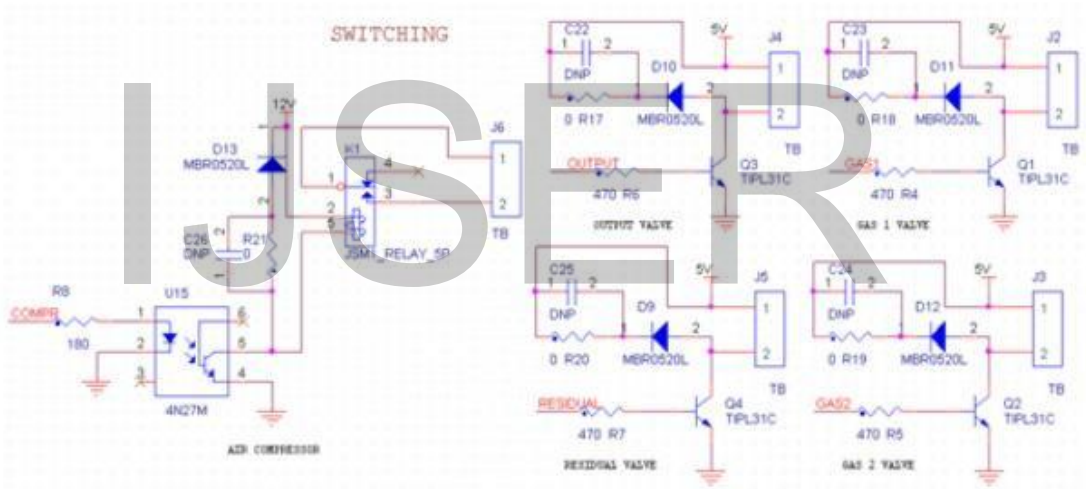

Figure 4-11. Actuators switching

Figure 37 Actuators switching [17]

All over vents, MCU ports move Darlington transistor base (TIP31C 500mA) to switch 5 V at 1 W valves, which means 200 mA. For both cases, an MCU resistor is required to control the current consumption of the MCU stick. Engage in conversation currents are secured by the use of RCD snubbers [17].

3.6.8 Alarms:

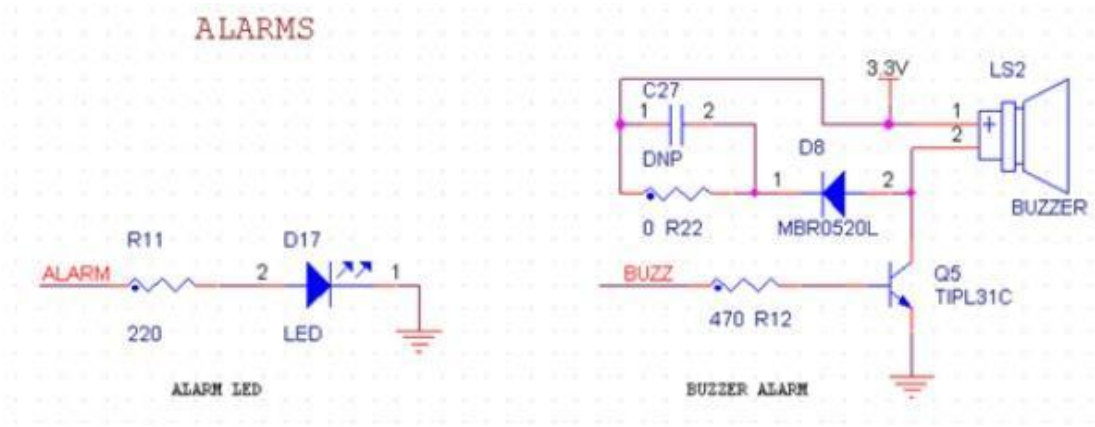

Figure 38 Alarms flow chart [17]

3.6.9 Sensors:

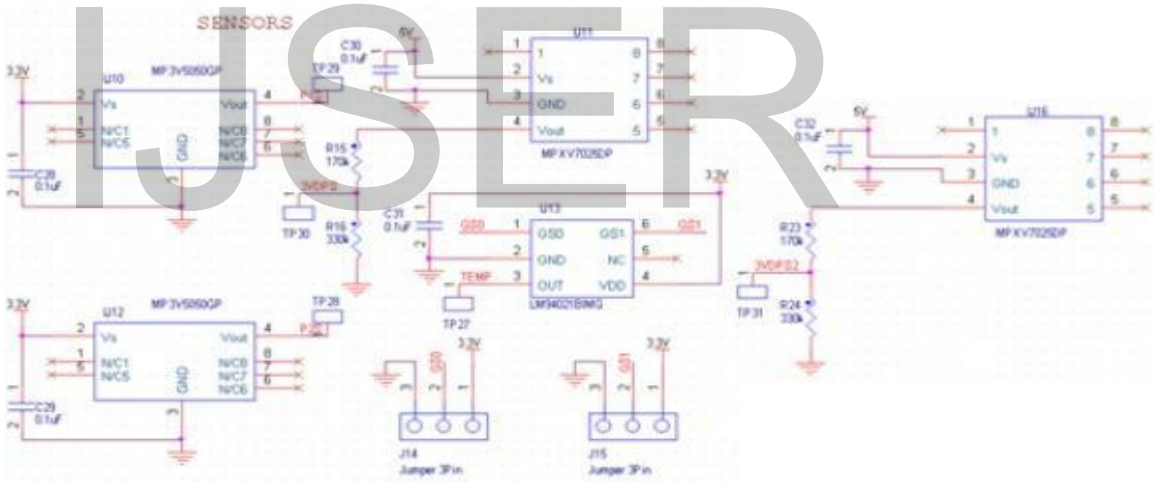

Figure 39 Sensors [17]

3.7 Layout Design:

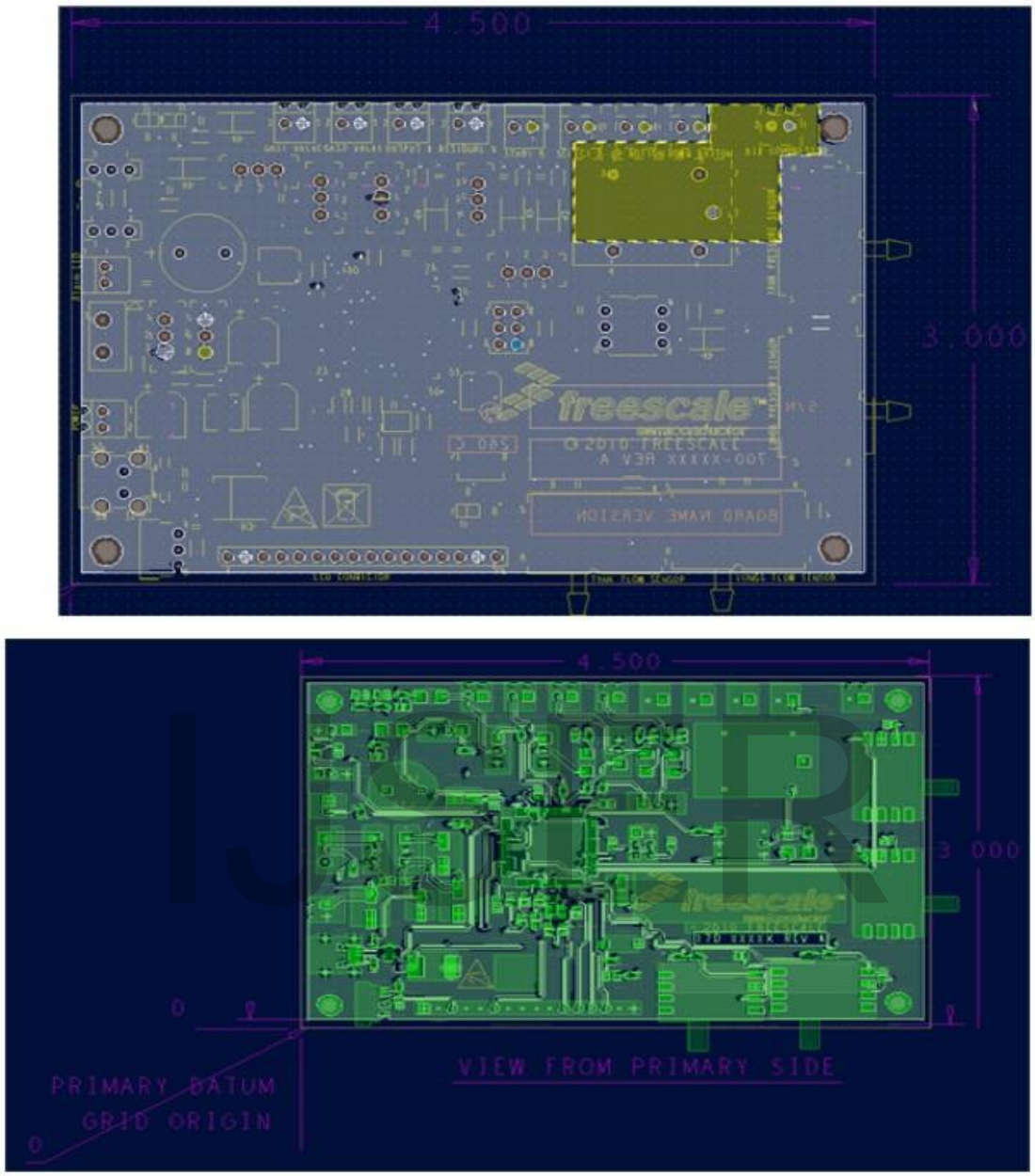

Figure 40 41 Layout design [17]

3.7.1 Front View of Ventilator:

Figure 41 Front view of ventilator [17]

3.8 Software Designing of Ventilator:

Display PC program must follow the taking after focuses:

• Capability to show up every single valuable mode—Pressure, repeat, and helped.

• Investigating signals: LED for this situation will turn on when the system is dynamic in certain control modes.

• Test major occasions—Lungs moo and tall weight limits, tank moo and tall weight limits, examine blower turns off while the system is dynamic [17].

• Arrangement abilities to modify and test fundamental qualities.

• Menus Recurrent

• The customer must assert modifications to foresee any bothersome changes [18].

3.8.2: Universally useful Op Amp (GPAMP):

Typically the MCU module controls the internal Op Amps. For this situation equipment design can be used as a support or as non inverter enhancer with no outer parts variable get.

3.8.2.1 GPAMP.c:

void vfn Init _GPAMP(void)— This limits starts the Op Amp arrangement, this course of action can modify agreeing to the pickup picked, Op Amp game plan, and information and yield decision, for this case the DAC yield as Op Amp information picked use to get a non Zero reference for upgrade [17].

3.8.3 Sensor systems

These documents are used to regulate the sensor values, using the ADC and computerized channels, performing the specific modifications.

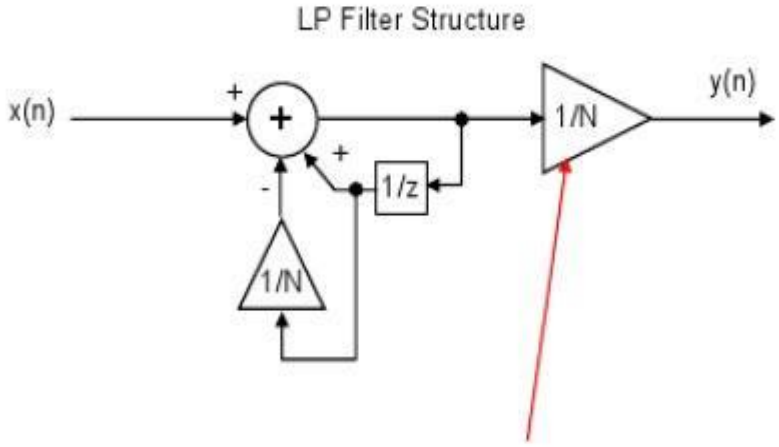

Figure 42 LP Filter structure [17]

3.10 Configuration:

It's Configuration record contains all the features used in the fundamental segment and shows the limits, sensors and then all the varying limitations that can be adjusted. There are a couple of parts, described below; the record can be easily split. Section Setup says: General characterizes the most parameters from the most menus to design or not to design. The most characteristic of this short but significant region are CONFIG IDLE and CONFIG PARAMETERS [17].

Parameter Menu	Unit Definition Section
LUNGS PRESSURE	INSPIR.TIME: The: The rate of time an individual can respire on ventilator, the beginning esteem will be 25.
TANK PRESSURE	EXPIR.TIME: it will esteem is to complete the past esteem, and it's important to continuously whole 100percent.
OPERATION MODE	RESPIR/MINUTE: its recurrence persistent will be reaching to respire; the starting esteem will be 14.
TEMPERATURE	TIM. Mode: Time mode sit still characterizes for machine to state.
OXYGEN PERCENTAGE	INSPIR.STAT: Inspiration state characterize for machine to state.
TANK LOW PRESSURE	EXPIR.ST: Expiration state characterize for machine to state
TANK HIGH PRESSURE	LUNGS/Low limit. PRESS: it will be stated that the lower weight that may be in ending, 700 PSI is the introductory esteem.
ALARM TIME	LUNGS/High limit. PRESS: It will be stated that the higher weight that can be in an inspiration, 900 PSI is the starting esteem.
LOW PRESSURE in Lungs	LUNGS/High Critical. PRESS: States the basic weight that may be in any lung, 1600 PSI is the introductory esteem.
Lungs that have HIGH PRESSURE	TNK/HIGH: Limit. PRESS: It will be stated that the higher weight that can stand in the weight in assembly room; its beginning esteem is 14500 PSI.
INSPIRATION PERCENTAGE	TNK/LOW: Limit. PRESS: It defines as the lower weight that's maintained will be important within the weight in assembly room;

	12000 PSI is the beginning esteem for that.
RESPIRATION TIMES	SENS/HIGH: Limit. PRESS: it Defines most extreme weight the sensor can be measured, constrain for that sensor is 14000 PSI
PRESSURE UNITS	
TEMPERATURE UNITS	
MENU LENGTH	**Table No:3.10[17]**

CHAPTER 4
RESULTS AND DISCUSSION

The machine is difficult it is a very useful machine to be operated for the artificial respiration of the human lungs when they are not working properly it operates upon a sensor which gives output different inputs of the powers like the pressure sensors

COMPONENT	VOLTAGE REQUIRED TO DRIVE	OPERATION CONSUMPTION
MCF51MM	2.4-4.0V	FREQUENCY BETWEEN 20-60MHz
MP3V5050	2.7-3.3V	FREQUENCY BETWEEN 20-50MHz
MPXV7025	4.75-5.25V	FREQUENCY BETWEEN 20-50MHz
AIR COMPRESSOR	12V DC	10A CONSUMPTION
ELECTRO VALVES	4.5-5.5V	200mA CONSUMPTION
BUZZER	4.75-5.25V	80mA CONSUMPTION

Table NO: 4.1 Parametrs for operation

4.1 CONNECTIONS

4.1.1 MAIN PROCEDURE FOR CONNECTION

Sometimes the ventilator does not operate even though the power is on that is due to the operator mistakes or either designers has some error while designing the medical ventilator .See the control rope is associated to the most control source within the bag, and attached to AC voltage. Look up that somehow the power supply picked is the right voltage supplied to the energy source of the ventilator. The normal estimate for this can be 120 Vrms, but verify if you have this standard from your energy provider. Adjust to

the source of command. Breathing tube to verify if most of the board has a problem or the power source doesn't operate (you'll need to unwind the ventilator to check that) [17].

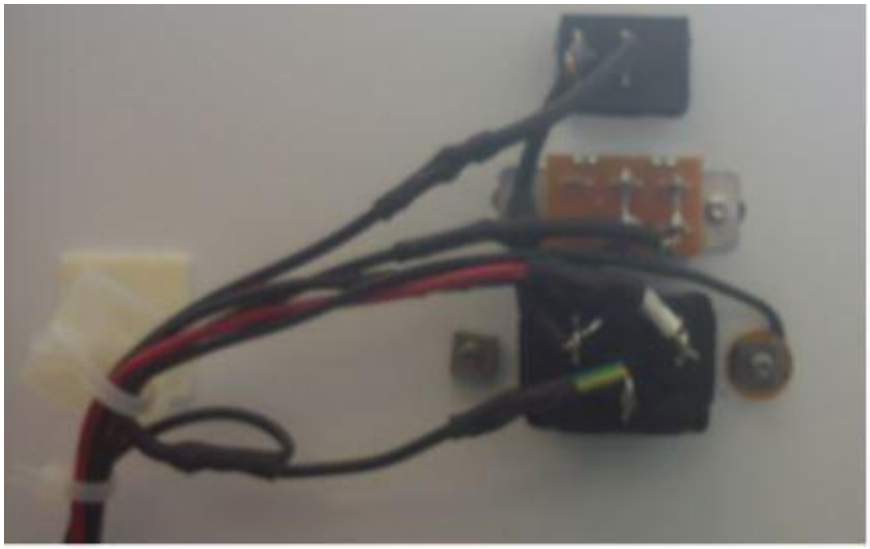

Figure 43 Connection diagram [17]

On the off chance that the LCD is appearing a few mistakes you should therefore brought the bag away from magnetic fields like microwave ovens, recognition stoves, and a few cell phones in its display [15].

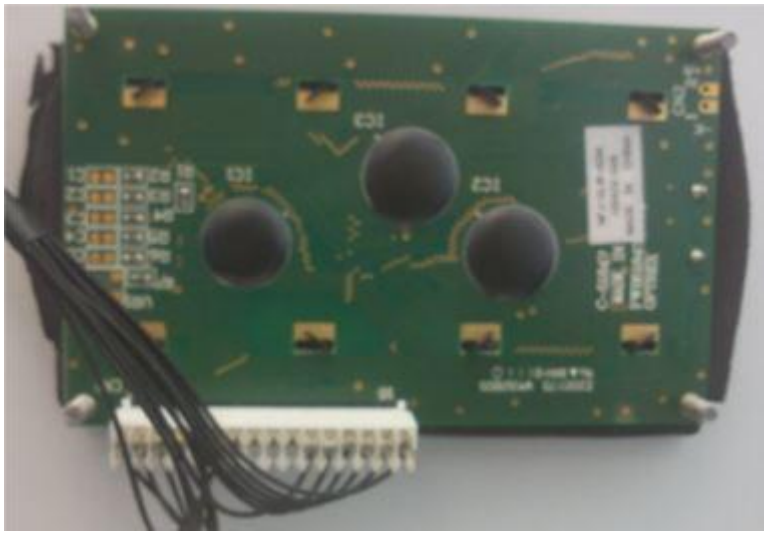

Figure 44 LCD display [17]

Sometimes The generator does not switch on the main moment you press the start button, this problem can be resolved with the following steps: see if the control source on which the most panel LED is switched is switched on. This year's generator does not switch on the main moment you press the start button, that problem can be resolved with the following steps: check if the control source on which the most panel LED is switched is switched on. Very few PCB control switch. Connections Figure Control 2. If the previous illustration does not work, remove the majority of the board and determine that [17].

Figure 45 PCB switch [17]

4.1.2 PCB (Print circuit board):

These organizations get inside the bag, button interactions. They need to be linked through the client interface to regulate the request. The buttons will not react if a few wires are deactivated [15].

Can monitor switch from the compressor. This adapter switches the compressor's energy to achieve the defined weight throughout the chamber. If this connector is disconnected, it would not be the compressor on Circulates and weighted sensor. All such detectors are

connected through pipes that carry pressure inside them. The application may not operate legitimately if any of these sensors are removed. Notice that not all sensors need to be connected to at least three and can be amplified for future control requirements. There are connectors to the LCD. A certain connector stick out sends to the LCD board the most information and control. The LCD operating system will not operate if this connector is off chance. USB connectors, connectors work as an application interface to other MCUs or to any graphical interface directly [17].

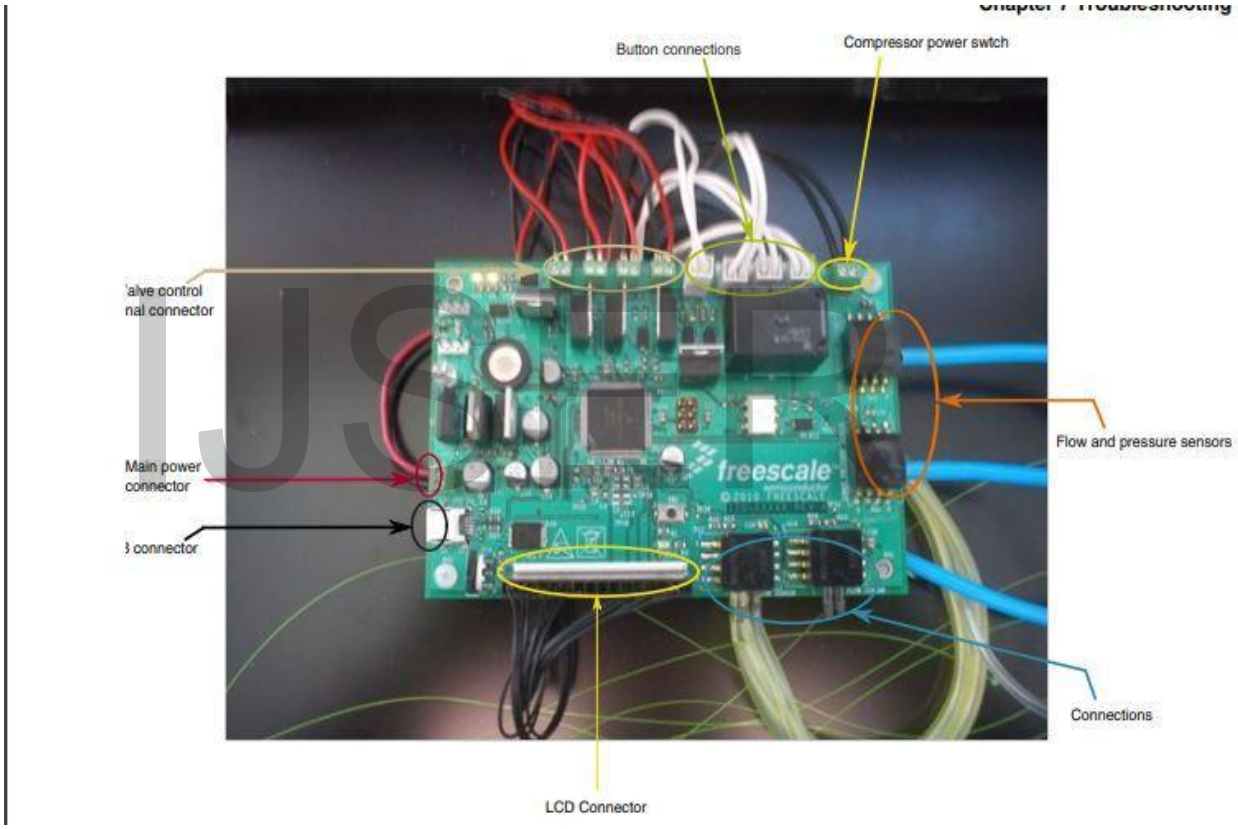

Figure 46 Graphical interference [17]

CHAPTER 5
CONCLUSION AND DISCUSSION

The whole complicated and fundamental restorative framework shows the feasible use of Free Scale components for a patient.

• Weight detectors allow accurate and accurate estimates for this type of restorative implementation. • For such applications, the MCF51MM MCU is the perfect choice;

That has enough control, memory, and speed for processing. Their interfaces (USB) are one of the best alternatives for the therapeutic industry, and a compelling toll of analog modules has been taken .These modules .Permit adaptability to ad lib and test with unused settings without changing the PCB format.

ADVANTAGES OF VENTILATOR:

1. Better gas distribution.
2. Lower mean airway pressure.
3. Less Hemodynamic disturbance.
4. Less sedation is required.
5. Weaning is easier (in most cases).

CHAPTER 6
FUTURE WORK

This thesis will be helpful for the young scientists and engineers for the operation, designing and fabrication of medical ventilator

Secondly it will help to the doctors of different hospitals for appropriate use and exact mixture of oxygen with air to ventilate patient lungs

In future it will be helpful to the new researcher to have work on it and design cheap ventilator using different latest techniques.

It is important for pakistan to design and fabricate medical ventilator so that the cost will be at least 20 times reduced.

The most important factor is cost effectiveness while designing medical ventilator so that not only in Pakistan it is available easily but in other poor communities like South Africa and other Muslims countries so it will be helping and life saving cheap machinery all over the world.

REFERENCES

1. Richard Adamsson. Mechanical Ventilation. *Medicine Gothenburg, Sweden;* **2,** (2014),22-35**.**

2. Abdul Mohsen Al Husseini, et al.Design and Prototyping of a Low-cost Portable Mechanical Ventilator. *Design of Medical Devices Conference DMD;* **3845**,(2010)**.**

3. Charles W. KerechaninII,et al. Development of Field Portable Ventilator Systems for Domestic and Military Emergency Medical Response. *JOHNS HOPKINS APL TECHNICAL DIGEST;* **25,** (2004), 35-48.

4. Emiliano Schena,et al. Flow measurement in mechanical ventilation. *Medical Engineering & Physics;* **37,** (2015), P257-264.

5. N.R.Maclntyre, et al. Respiratory care.*;***37,**(1992),P10-168.

6. M. Dojat A. HarfC.Walton, et al. High impedance mechanical ventilator for small animals: use of programmable controller. *Pflugers Arch*;**420,**(1991)P136-139.

7. Luxmi , Gahlot, Eric B. Milbrandt,and James Snyder..Higher initial tidal volumes associated with the subsequent development of acute lung injury in dose-response relationship. *Critical Care:* **9,**(2005),P152-198..

8. S. M. Tamjid Hossain et al.Design Construction and Performance Test of a Low-Cost Portable Mechanical Ventilator for Respiratory Disorder. International Conference on Mechanical, Industrial and Energy Engineering, (2018), P318-405.

9. WikiPedia.org. Medical ventilator. *Wikipedia;*(2016),Retrieved from https://en.wikipedia.org/wiki/Medical_ventilator#targetText=%5Bedit%20on%20Wikidata%5D,%20breathe%2C%20or%20breathing%20insufficiently. 12. September2019, 09:50am

10. Christopher D Jackson. Mechanical Ventilation.*Medscape,*(2019), Retrieved from https://emedicine.medscape.com/article/304068-overview#a1. 12. September2019, 11:50am

11. World design guide. Salvia Elisa 500 / Medical device. *World Design*, (2019); Retrieved from https://ifworlddesignguide.com/entry/236234-salvia-elisa-500. 12. September2019, 12:50am.

12. World design guide. Salvia Elisa 500 / Medical device. *World Design, (*2019*);* Retrieved from https://ifworlddesignguide.com/entry/236239-salvia-elisa-300. 13. September2019, 11:50pm.

13. Kim Ann Zimmermann. Respiratory System: Our Avenue for Gas Exchange. *LiveScience,*(2019)*;*31-33.Reterivedfrom https://www.livescience.com/22616-

respiratorysystem.html#targetText=Advertisement,of%20gases%20as%20we%20breathe. 13. September2019, 9:50pm.

14. Scarpelli and Mautone. Surface Tensions in the Lung. *Biophysical Journal;* **68,**(1995)**:**1630-1633.

15. Yasser Mustafa's. Design principles: mechanical ventilators.*Space.org,*(2015)*;* Retrieved from https://www.kspace.org/Class_Info/EE497/KAU_Ventilator_lec.13.September 2019,6:50pm.

16. Jay P. Desai, et al.(2019).Pulmonary Compliance.*StatPearls;*35-36.

17. Free Scale. Ventilator/Respirator Hardware and Software Design Specification.*Freescale Semiconductor,* (2011)*;* **42,** 10-58.

18. A.m J Respire. Mechanical Ventilation. *American Thoracic Society;* ***196,*** *(*2017)***:**P3-10.