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Backup ventilation module

Authors & Affiliations

Nasser M Al-Dwaik,
Abdullah A. Al Sous,
Radi A. Al-Khlaifat,
Ahmad S. Al-Kuz,
Mu'ath S. Al-Amreen

The Institute of Bio-Medical Technology, Royal Medical Services, Amman - Jordan

Corresponding Author

Nasser M Al-Dwaik

Abstract:

In the intensive care unit, patient breathing depends on the ventilator to survive. In case of malfunction in ventilator system or outages in the main power system, the ambient valve opens when unpowered, thereby, opening the patient circuit to the atmospheric pressure, so it makes inhalation possible for patient who is able to breath for himself, it doesn't actively aid the patient to breath in any way. Complete ventilator failure causes ventilator to go into ambient state.

In case the patient cannot breathe for himself, he will need an assist from stuff to breath by manual resuscitator, if not, so he is in danger of death.

In this project, we accomplished a design of a pneumatic breathing system, which can work automatically in the event of a complete failure of ventilator, to let the patient to breathe continuously, using fraction of inspired oxygen (FiO2) at 50% or 100%.

Keywords: Backup ventilation module, ventilator, ventilator failure, malfunction in ventilator, pneumatic breathing system, Back up ventilation system, Ventilator technical fault response, Ventilator with power outages

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Introduction:

In respiratory system, ventilation is the movement of air between the environment and the lungs via inhalation and exhalation that is called breathing. Breathing is one of the most natural and fundamental processes of life, but for a long time the nature of breathing was intractable and unknown. The cell was first discovered in the 19th century, revolutionizing our understanding of life, almost everything about life is centered on the cell. When humans breathe in, both lungs on either side of the heart expand outward to allow oxygen to enter, within the lungs are small sacs composed of clusters of alveoli, which are wrapped in blood vessels, here oxygen diffuses into the blood in exchange for carbon dioxide, binding to hemoglobin. Four oxygen molecules can bind to a single red blood cell. The oxygen is then pumped to the heart through the pulmonary artery and sent out to the rest of the body. Anyone who has difficulty breathing normally, either because of acute diseases or chronic condition, may need to use mechanical ventilation.

A ventilator is a machine that supports breathing. These machines mainly are used in hospitals.

A ventilator often is used for almost short periods, such as during surgery when the patient is under general anesthesia. The term "anesthesia" refers to a loss of feeling and awareness. General anesthesia temporarily puts the patient to sleep.

The medicines used to induce anesthesia can disrupt normal breathing. A ventilator helps make sure that the patient continues breathing during surgery.

A ventilator also may be used during treatment for a serious lung disease or other condition that affects normal breathing.

Some people may need to use ventilators long term or for the rest of their lives. In these cases, the machines can be used outside of the hospital - in long-term-care facilities or at home.

In case of ventilator failure due to any reason, the patients must have stuff assist to continue breathing, if the patient is unable to breath for himself. Otherwise, they cannot breathe, so they will lose their life.

The goal of our project is to find a modification or an alternative system to keep the respiration on its performance and efficiency so the unconscious patients supplied with oxygen without any intervention from the operators.

Methodology:

The operators in the ICU face a serious problem if there is a technical fault in the ventilator or power outage, so necessitate intervention from operators to save the patient's life at the absence of his ability to breath.

The ventilator is one of the important life support equipment used in the ICU, which the unconscious patients depend on it in their respiration, if there is a technical fault, the response of the ventilator is:

- Sound high priority (buzzer) alarm that cannot be silenced by the user.
- Display the technical fault number on the screen, against a red background.
- Enter ambient state (that mean the patient can take breath from the ambient if he can).
- Write the technical fault number in the event log.

Some of these ventilators work on electricity only and the other have a backup battery in case of electricity interruption, but it doesn't work for long period, if there is an electricity interruption for long period and the emergency power generator doesn't work then the unconscious patient's life on ventilators are at risk, this may happen in some conditions such as war, earthquake, snow storm, main power outges, etc.

Most hospitals supplied by electricity from the national electricity, in case it outages an emergency electric generator automatically switched on, some hospitals supply the life support and necessary medical equipment's by uninterrupted power supply (U.P.S.), if the emergency generator shutdown.

The systems are:

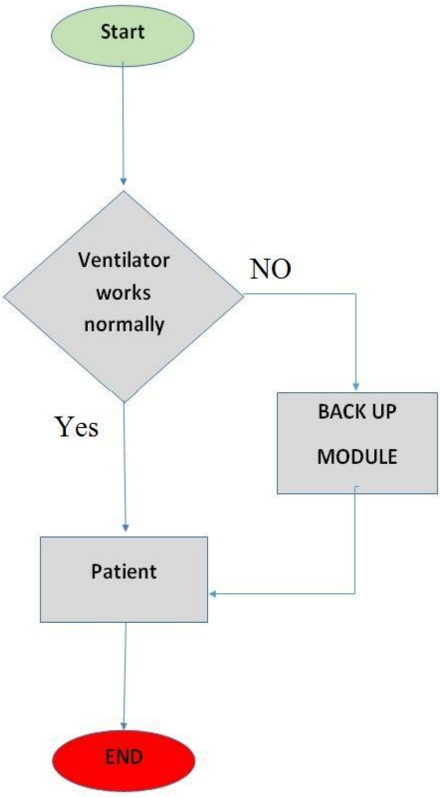
1.Main power system: using three phase alternative current supplied from the national electricity to hospital, then single phase or three phase lines supply the medical (equipment /system).

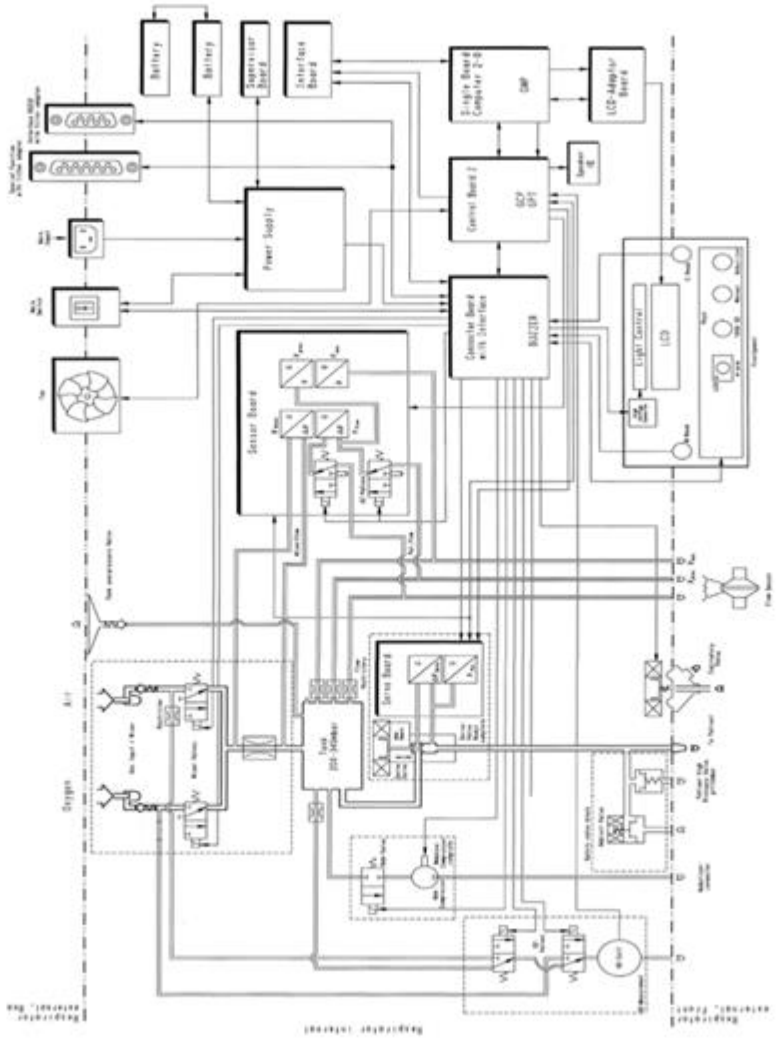
2.Emergency power: using back-up electric generator if the main power system outages, so the electrical loads connected from the main grid lines to the backup generator lines automatically.

3.Uninterrupted power supply (U.P.S.): using a series of (12V DC) batteries then oscillated to (220V AC) or (110V AC) to supply the life support and necessary medical equipment.

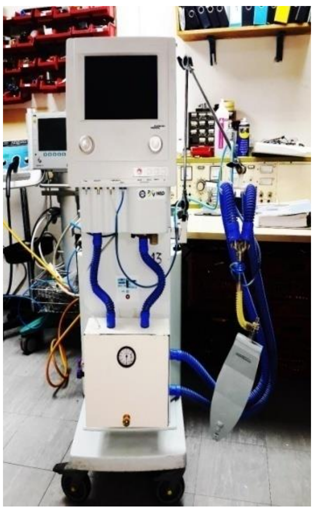
The intensive care unit (ICU) in the hospital supplied in electricity from these systems as the other wards and departments.

For these reasons, ventilator failure or electricity interruption, we do hard to find a modification or an alternative system to keep the respiration on its performance and efficiency so the unconscious patient supplied with oxygen without any intervention from the operators, this is what we will explain and describe the function of each part in this modification.


Start
Ventilator works normally
NO
BACK UP MODULE
Yes
Patient
END



Ventilator without backup ventilation modul



Ventilator with backup ventilation module

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Results:
Analysis

1.Relationship between pressure and minute volume at slow rate speed is linear, breathing rate relationship with pressure is reverse at slow rate speed, and this is suitable to be used for adult and pediatric.

*As shown in table (IV.1) below.

2.Relationship between pressure and minute volume at medium rate speed is approximately linear, breathing rate relationship with pressure is reverse at medium rate speed. this is suitable to be used for adult and pediatric.

*As shown in table (IV.2) below.

3. Relationship between pressure and minute volume at fast rate speed is approximately reverse, breathing rate relationship with pressure is reverse at fast rate speed.

*As shown in table (IV.3) below.

Table (IV.1) Pressure with Slow Rate speed

Pressure Setting CMH_2O	Pressure Measured CMH_2O	T.V. Measured m liter	PEEP Measured CMH_2O	M.V. Measured Liter/min	Rate Calculated Breath/min	Test Lung Type	Patient Weight K.G.
15	13	65	3	3.5	54	0.5 L	6.5
20	19	90	4	5.3	59	0.5 L	9
25	24	120	5	6	50	0.5 L	12
20	19	180	4	5.8	32	1 L	18
25	24	280	5.5	6.4	23	1 L	28
30	28	500	6	7	14	1 L	50
35	33	680	7	7.4	11	1 L	68
40	39	710	8	7.8	11	1 L	71

Table (IV.2) Pressure with Medium Rate speed

Pressure Setting CMH_2O	Pressure Measured CMH_2O	T.V. Measured m liter	PEEP Measured CMH_2O	M.V. Measured Liter/min	Rate Calculated Breath/min	Test Lung Type	Patient Weight K.G.
15	14	70	3	6.8	97	0.5 L	7
20	20	100	4	7.1	71	0.5 L	10
25	25	130	4	7.2	54	0.5 L	13
20	19	190	5	7.2	38	1 L	19
25	25	420	6	7	17	1 L	42
30	30	500	6	7.2	14	1 L	50
35	35	600	8	7.4	12	1 L	60
40	40	600	9	7.8	13	1 L	60

Table (IV.3) Pressure with Fast Rate speed

Pressure Setting CMH_2O	Pressure Measured CMH_2O	T.V. Measured m liter	PEEP Measured CMH_2O	M.V. Measured Liter/min	Rate Calculated Breath/min	Test Lung Type	Patient Weight K.G.
15	14	70	3	7.8	111	0.5 L	7
20	20	100	4	7.7	77	0.5 L	10
25	25	130	4	7.1	55	0.5 L	13
20	20	160	5	6	37	1 L	16
25	25	320	6	6	19	1 L	32
30	30	480	6	--	*	1 L	48
35	34	670	7	--	*	1 L	67
40	40	690	8	--	*	1 L	69

Conclusion:

We can use this design to save patient’s life, in case the ventilator failure or power interrupted for any reason, the patient will continue breathing either he is able or unable to breathe for himself.

This design will keep the respiration on its performance and efficiency, so the unconscious patients supplied with oxygen without any intervention from the operators.

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