Features:

1. Only concentrated for Covid-19 patients who required **ICU** and perform sedated intubating and providing ventilation including Clinical steps taken for **ARDS** ensuring all safety and alarm required by any medical authority global.

2. UI of the machine similar to an existing commercial machine.

3. Standard industrial component wick is widely available but robust quality low cost have been used.

4. No kind of mold is a necessity (if not emphasized on beatification) mold needs initial investment and one to two month lead time depending on complexity.

5. Deliberate mold biggest in size so or excessive shill is required to assemble it in confined space.

6. Components selected such a way that they are easily and accurately assembled by unshelled and uneducated men and a woman just loading into assembly picture step.

7. Assembly tools require very minimal and easily available in Bangladesh.

Special Attribute:

1. Power system used normal laptop charger battery which is widely available

2. 3d Printed parts are very small and very fast to print, Single 3d printer can print all required parts for 5 devices in a day.

3. A laser cutter is widely available all over the country. Laser cutter parts can be made in a day for 20 devices. If a laser cutter is not available by pasting paper print on PVC sheet manual can be cut with a grinder and a drill

4. GE makes an Ambu bag and ventilator circuit is used which is widely recommended by doctors and the Chinese one is known to be leaked or failed and this one is disposable. Reusable type Ambu bag also can be used as the clamp is made universal for any type available.

5. Most components have an alternative type. For example, if a lead screw is not found threaded rod can be used if the stepper motor is short in the only geared motor can be used with a hall effect sensor with minor modification of the code.

6. For the mechanical movement guide part, we did not choose square rail block or smooth rod linear lubrication and prone to rusting in-unit condition and also very expensive. We used normal 625zz volar bearing (which is widely available) with a POM rubber or tips printed cover assembled as D wheel. Guided on an aluminum profile which also serves as a rigid frame of the moving system.

7. We did not use fancy sensor few reasons

I. Bangladesh has no single manufacturer and due to the COVID-19 situation worldwide international sourcing from the USA, Japan even China is uncertain, lengthy and expensive.
II. Gancy Sensors have a reliability issue if not used properly. So they always need redundancy which means more cost

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Key Innovations:

1.Pressure sensor alternative: Our observation is Ambo bag is a good replication of the Ling that it is connected to, when due to obstacle in air way passage or deterring Lung compliance the stiffness of the ambo bag increased. It means stepper motor would require move torque to push stiffer lung fora a given amount of travel. More torque means more current. So stiffer (or Pressure) can be translated in to motor input current by motor drive.

2.Flow Sensor alternative: We can easily incorporate a flow sensor in our design. But still did not as an application area is Bangladesh or similar country where a reliable supply chain of special flow sensor has its own risk, time and cost. So we also have to check for a reliable alternative.

a) As we can detect stiffness, we can easily calibrate the volume VS motor distance travel under a given stiffness. And easily make a calibration table that can be easily verified with a flow sensor and also with air displacement volume underwater. On a final device that table or a 3-parameter fitted equation can be used to predict the flow rate and calculate the tidal volume. An error of the system can be minimized very much as it will be compared to two independent tests. One a flow sensor two a volume level.

B) We will use a very basic wheat stone bridge and an industrially widely used PT 100 sensor to detect temperature to resistance change. On q platinum wire used inside a PT100 placed on aluminum, the sink plate are very sensitive to temperature change and normally we test it by blowing air over it.

Problem and Solution: This will not be an instantaneous detection but a delay of few ms so onset peak pressure (Peak) the controller will provide alarm on Peak x 0.95 level

- **Redundancy 1:** As a complete independent redundancy a peak pressure relief valve with a preset pressure will be used in conjunction with the system.

- **Redundancy 2:** As we will use two-motor, so two TMS trivet will be used. So naturally, both driver can detect stiffness via current and act as redundancy or fail-safe each other So when reliability halter air has flowed on the plate it will suddenly change its resistance and we can amplify the signal to converts it to flow, It can easily detect flow or no flow, can detect flow rate rise or fall with adequate accuracy (±10%). So it can be used as a failsafe or an alternative calibration component a. Component B problem and solution: Heating and Cooling of PT100 platinum wire has one limitation which is a time lag of signal it can be easily overcome by making zero flow limit detection level-shifted positively by 5%. So on 55 it will detect no flow and combined with current detection which is highly sensible it can trigger the next logic. Trinamic motor drive made by dynamic Germany (or the very available Chinese clone) can detect and directly control motor current. How do we know it? Or have we used it? Yes. Because we make our 3d printer. And sensorless honing and crash detection already solved years ago by many other 3d printer companies on of which is popular Prusa I3 MK3.

COST: 15000 TK