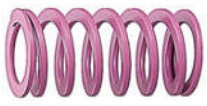
Setup:

To deal with an unfortunate situation of Covid-19, a low cost simple to assemble ventilator has been designed. Components can be easily sourced in the market. The components and assembly process is described below.

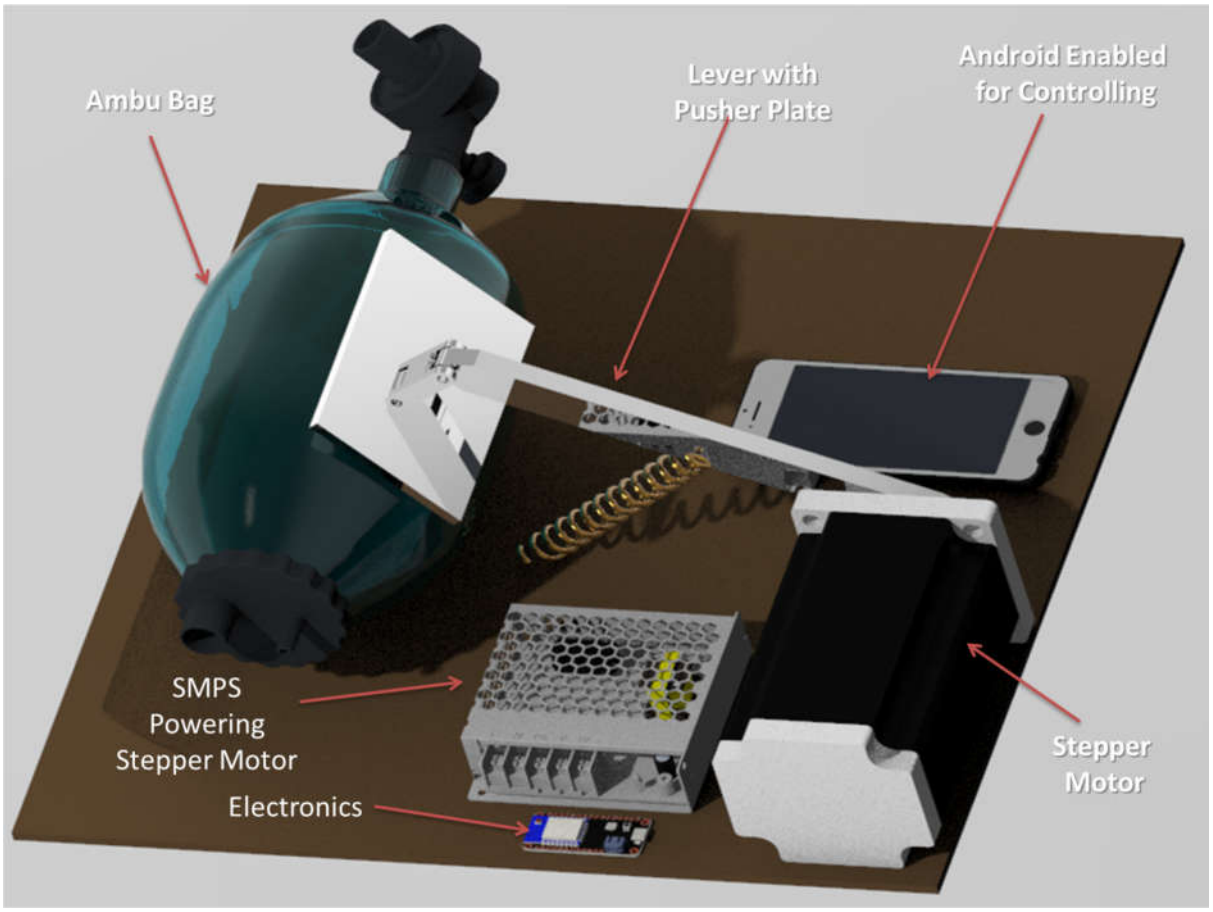
Components:

Particulars	Link	
NEMA34 stepper motor 85kgcm torque	https://robokits.co.in/motors/stepper-motor/stepper-motor-without-gearbox/nema34-stepper-motor-85kgcm-torque	
Rhino micro-stepping stepper motor drive 18-80v 7amp	https://robokits.co.in/motors/stepper-motor/micro-stepping-stepper-motor-drive-18-80v-7amp	
Ambu Type Bag Capacity 1600ml.	https://www.surgicalshop.in/emergency-medical-products/buy-resuscitators/index.php	
Spring	For Restraining	

Electronics Components:

- Arduino Nano
- ESP8266 – Wifi Module
- SMPS
- PowerBank
- Switch (On/Off Button)
- Fuse

Assembly:



Calculations:

Ventilator has been designed by considering the upper limits of IE Ratio, Breaths per minute, Airway Pressure and Tidal Volume. Ventilator can be operated under these limits. The values for following parameters are as follows:

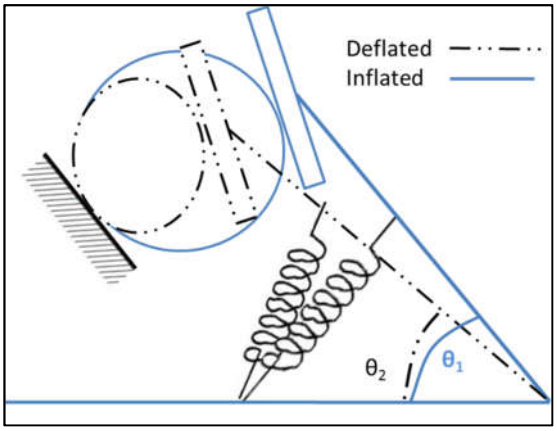
- IE Ratio - 1:4
- Breaths per minute : 50
- Maximum Airway Pressure: 40 cm of H20
- Tidal Volume : 800 ml
- PEEP : 5-15 cm of H2O

On the Basis of above requirements maximum power required was calculated.

- Breath Cycle Time: 1.2 seconds
- Inspiration time : 0.24 seconds
- Discharge Q : 0.0033 m^3/sec
- Power required to Ventilate: 13.1 Watts
- Factor of Safety (for Accommodating losses) : 2
- Motor power required : 26.2 Watts

Finally, parameters for structural mechanism were calculated:

- Lever Arm length : 20 cm
- Swept Angle : 0.4 rad or 23 degrees (θ_1- θ_2)
- Swept Rate : 1.67 rad/sec
- Overall Torque Required : 15.7 Nm
- Force : 78.5 N
- Area of Pusher Plate : 200 cm2
- Spring Distance from Motor Axis : 10 cm
- Spring Force : 78.5 N
- Spring Torque : 7.85 Nm
- Motor Torque Required : 7.85 Nm



Controls Description:

An android application has been developed to change the settings for ventilator. As shown in the picture the following settings can be made:

- BPM : 10 to 50
- IE Ratio : 1:1 to 1:4
- Tidal Volume : 400 to 800 ml

On clicking the submit button, settings will be saved on Arduino.

Arduino will then change the encoder settings on the Motor driver.

Motor driver will adjust the Motor Swept angle and Sweeping Rate accordingly, to get the desired motion of the lever. Lever will press the Ambu bag according to the settings requested through android application