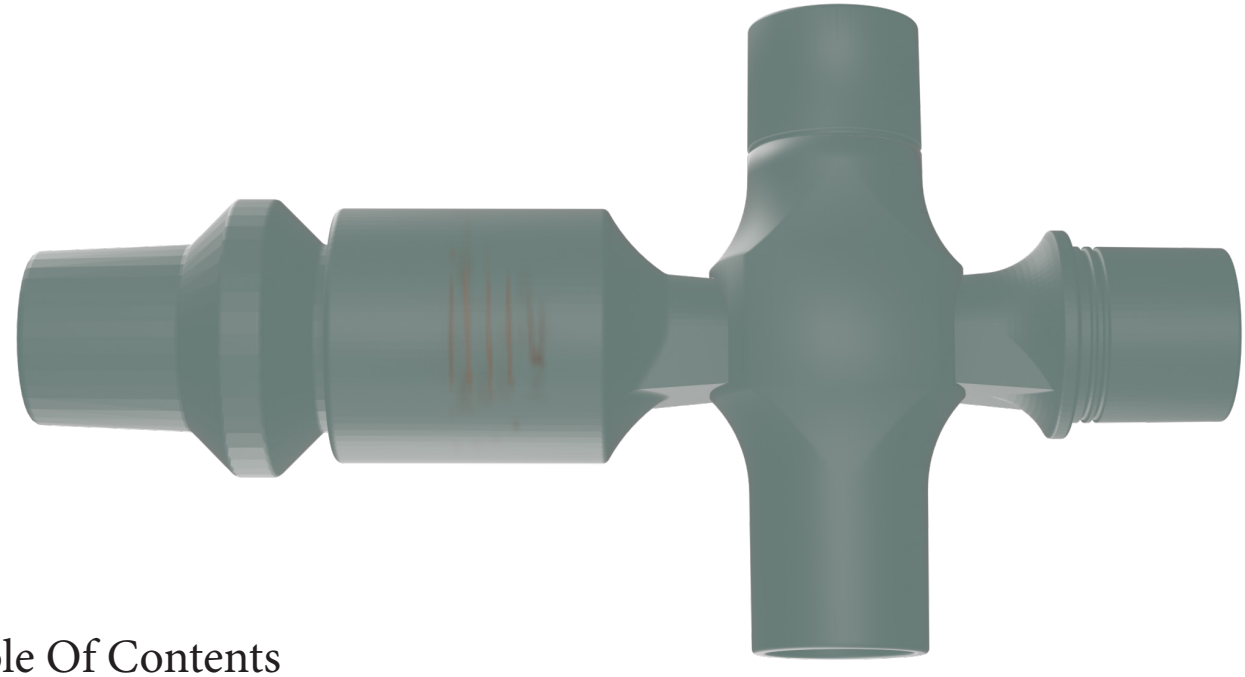
VapoJET

3D Printed Ventilator and Anesthesia System User Manual

vapojet.site



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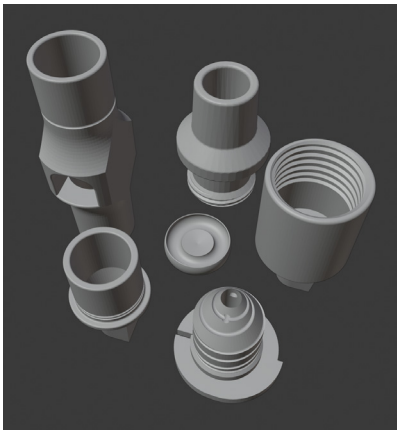
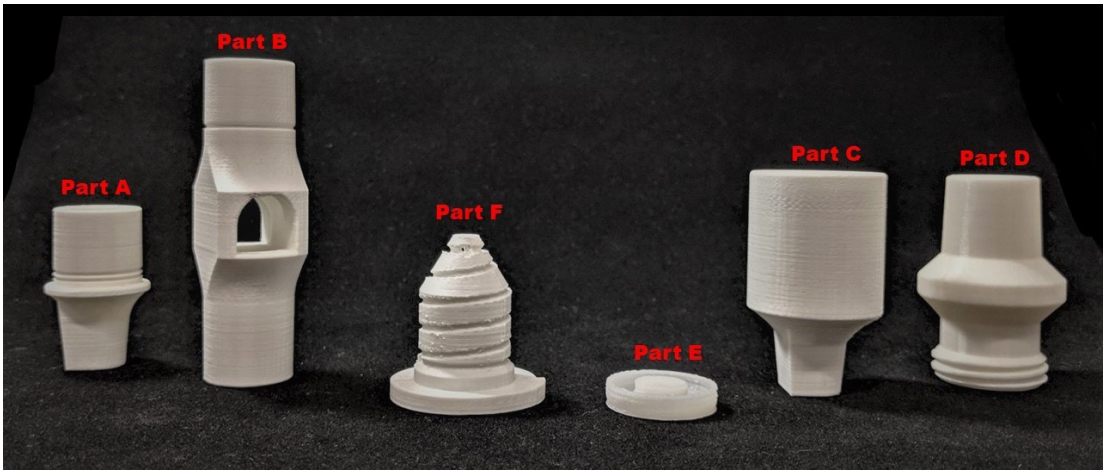


Required Materials:

- VapoJET STL file
- 3D Printer
- ABS filament in printer
- ABS filament section 40cm (for spring, assembled separately)
  ONLY USE ABS FILAMENT

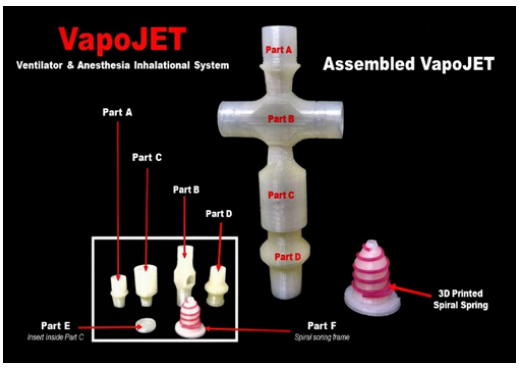
A1. Print Parts

1. Load the 3D Ventilator stl files for printing.
2. 3D Print the component parts on any commercial available 3D printer.



3D Printed Part Output List:

A. Interface for patient airway devices.
B. Middle junction where parts A and C connect, and syringe and air input are connected.
C. Modified patented relief valve housing which part E is inserted, along with the spring and closed with part D.
D. Valve cap with pressure exhaust port.
E. Pressure valve for insertion into part C.
F. Frame for creation of spiral spring for insertion into part C.



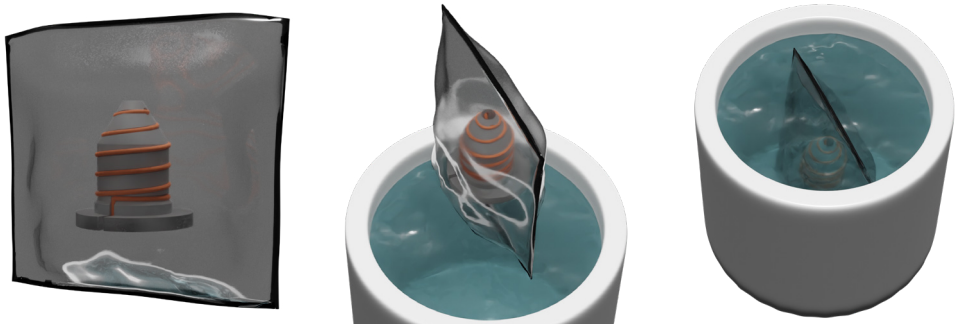
A. 3D Printing and Spring Creation Cont.

A2. Make The Spring

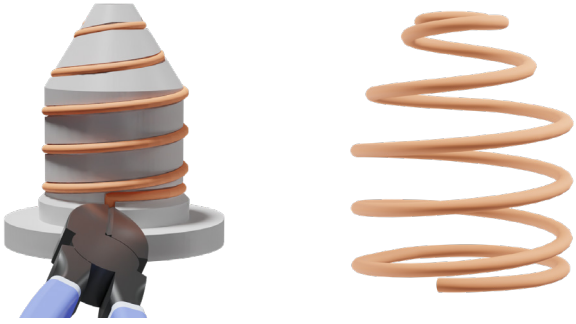
Required Materials:

- ABS filament (40cm) ONLY USE ABS FILAMENT
- Cutting pliers
- Part F Spiral Spring Frame
- Hot Water
- Zip-lock Bag

1. Insert ABS filament into holes at top of spiral spring frame
2. Wind ABS filament around the spiral spring frame. Insert end of ABS filament into notch at bottom spiral spring frame and cut end with pliers

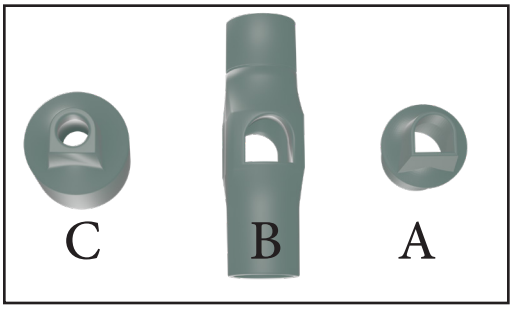


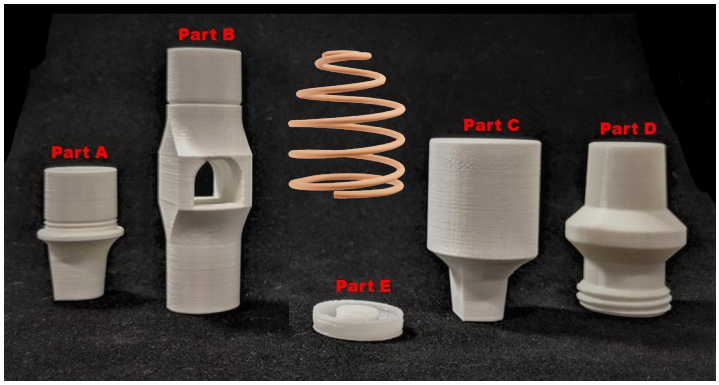
3. Insert filament and spiral Spring frame into zip-lock plastic bag
4. Insert zip-lock bag with spiral spring & frame into boiling hot water at over 80 degree Celsius for 15 minutes
5. Remove spiral spring and frame from water and cool

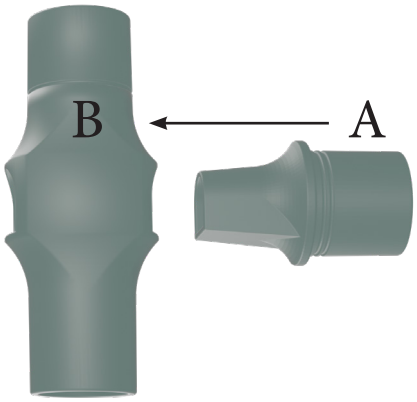


6. Cut excess ABS filament from bottom
7. Remove spiral spring from the Spiral frame Part F

B. Assembly of VapoJET Components

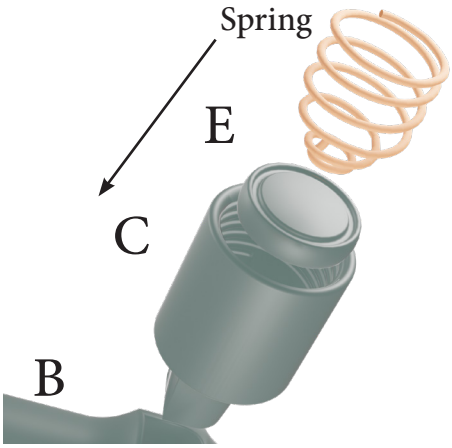






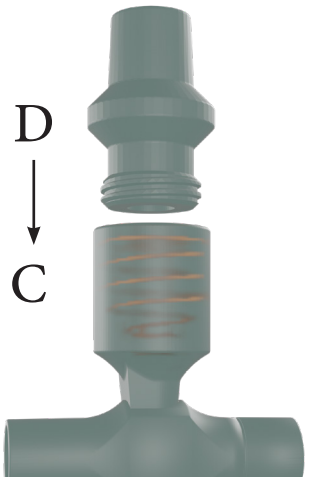
NOTE: Align Orientation of Part Arches

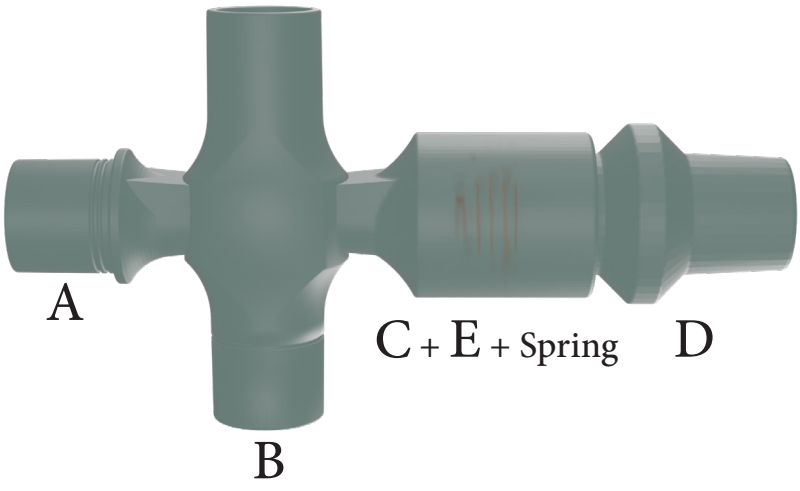
1. Take Part A and insert into one end of Part B.
2. Take Part C and insert into the small arch shape end to other arch shape end of Part B.
3. Next, insert Part E, a small flat circular shape piece (with flat side facing out) into Part C.
4. Insert the Spiral Spring with the narrow end of spring face-down first. Note, this pieces is made separately using Part F as the framework.
5. Next, insert and twist the serrated end of Part D into open wide end of Part C.



The VapoJET is assembled.

Note: you can wind some duct tape around the ends of the pieces to maintain the structure and to keep the pieces intact).





C. Configuration and Usage of VapoJET

C1. Use As Ventilator

C2. Deliver Anesthesia

C3. Overview

Required Materials:

Ⓐ. VapoJET Assembly

B. Manometer

- Airway Device
  - C. Mask & Extension Tube
  - D. Endotracheal tube
  - E. Laryngeal Mask
- Pump
  - F. Ambubag
  - G. Foot Pump
  - H. Air Compressor

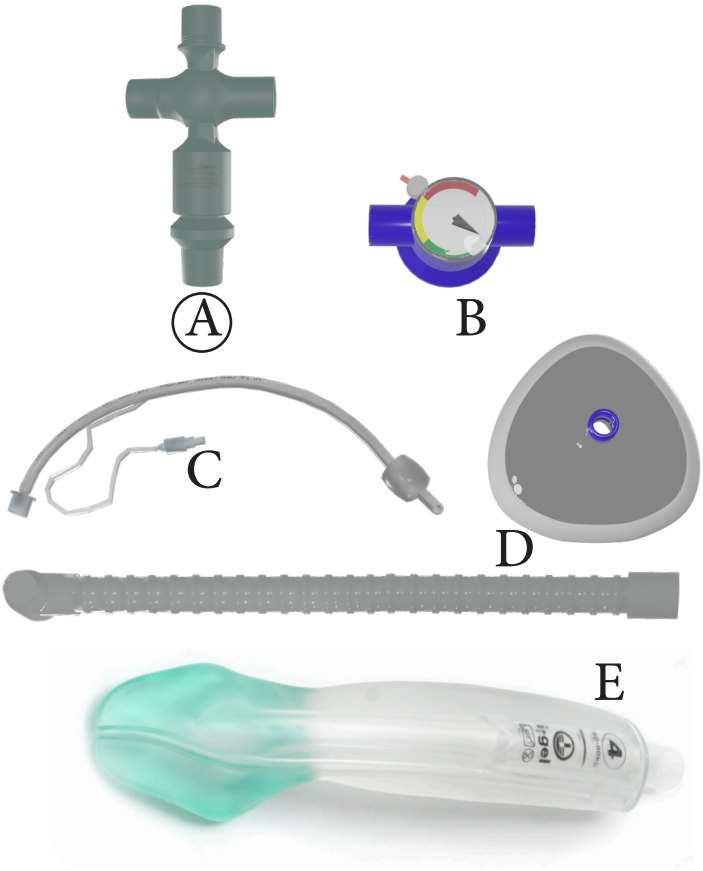
Specific Materials

I. Viral Filters x 2

J. Carbon Sequester

K. Syringe

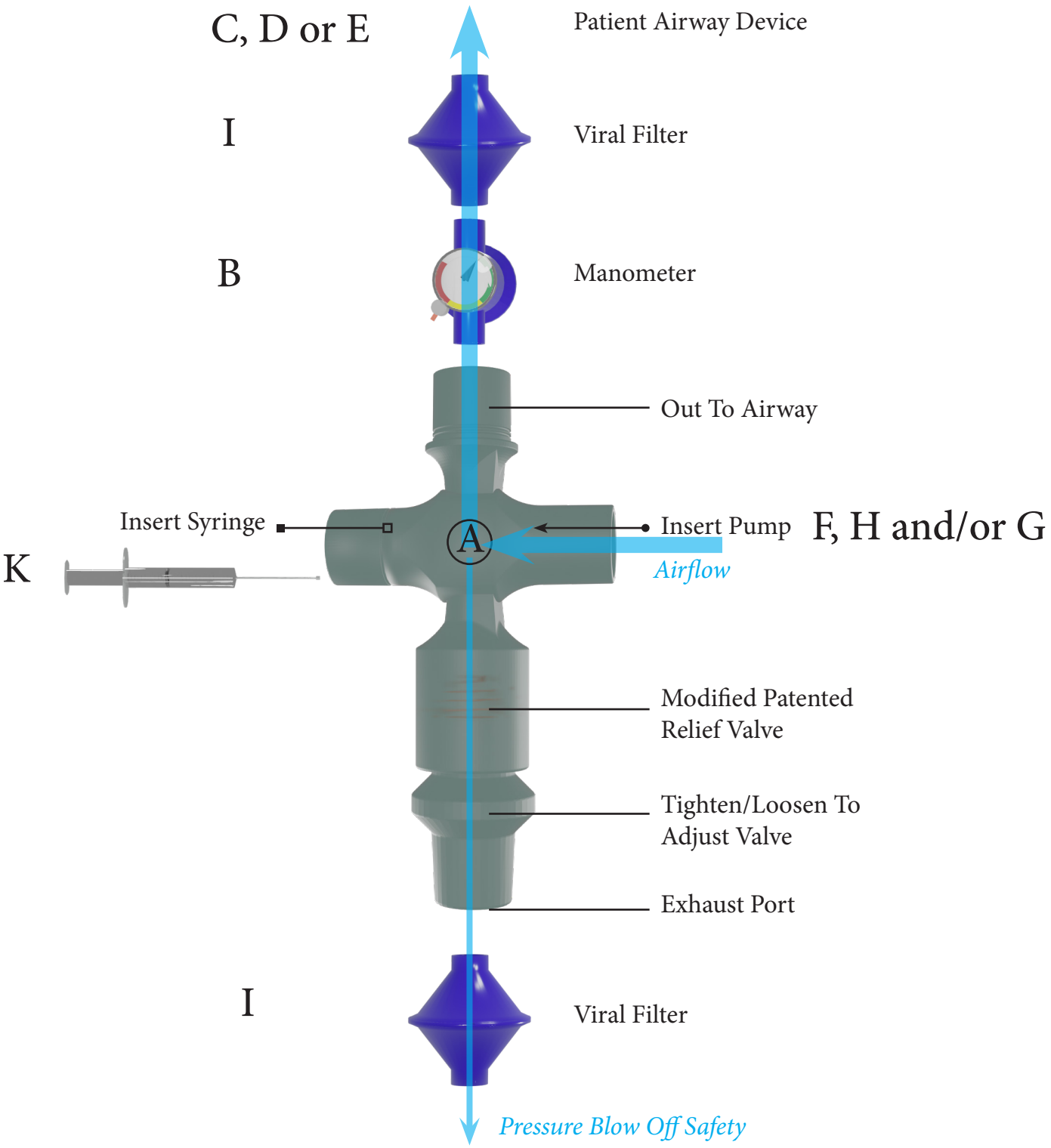
L. Anesthetic Solution



C. Configuration and Usage of VapoJET

C1. Use As Ventilator

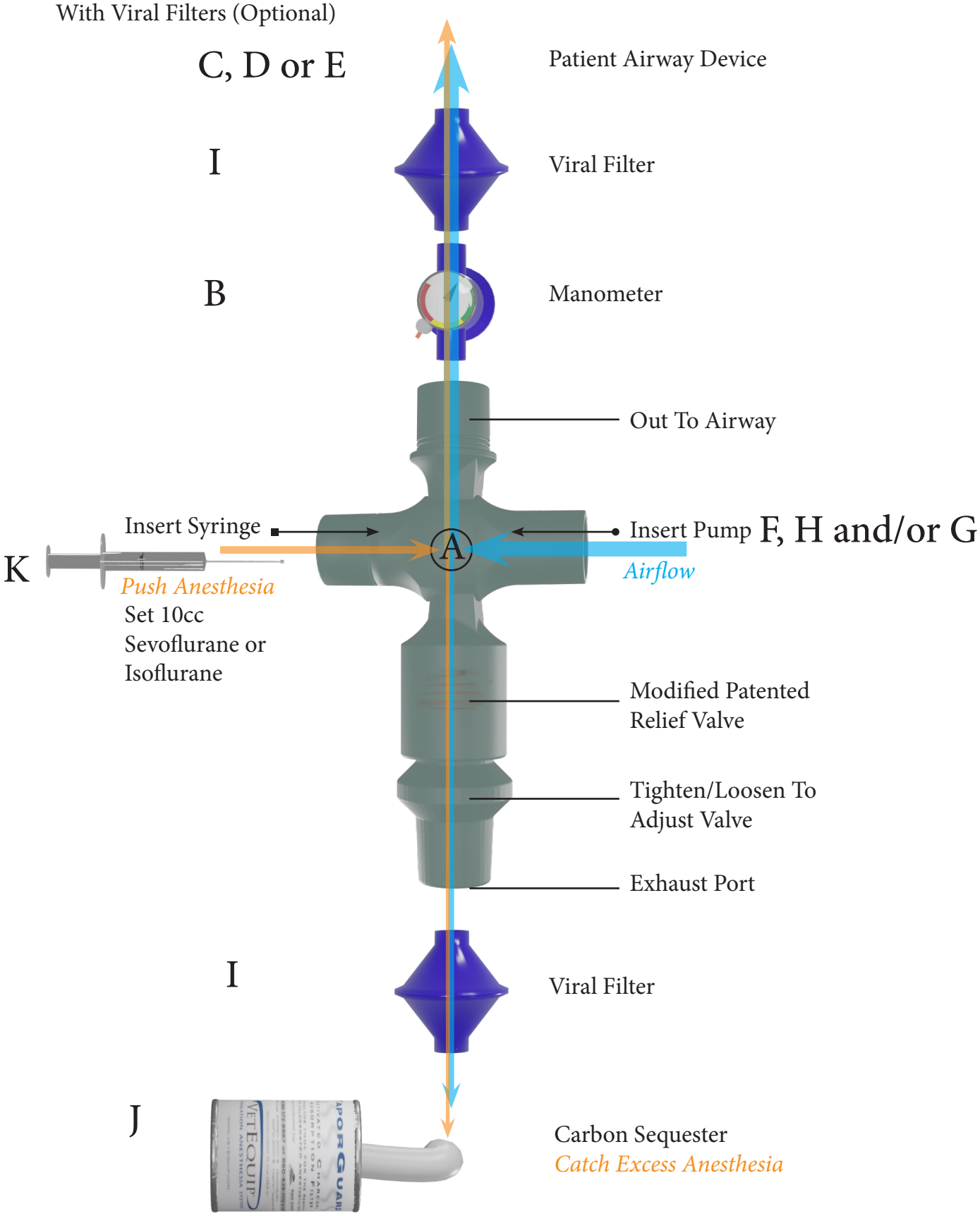
With Viral Filters (Optional)



C. Configuration and Usage of VapoJET

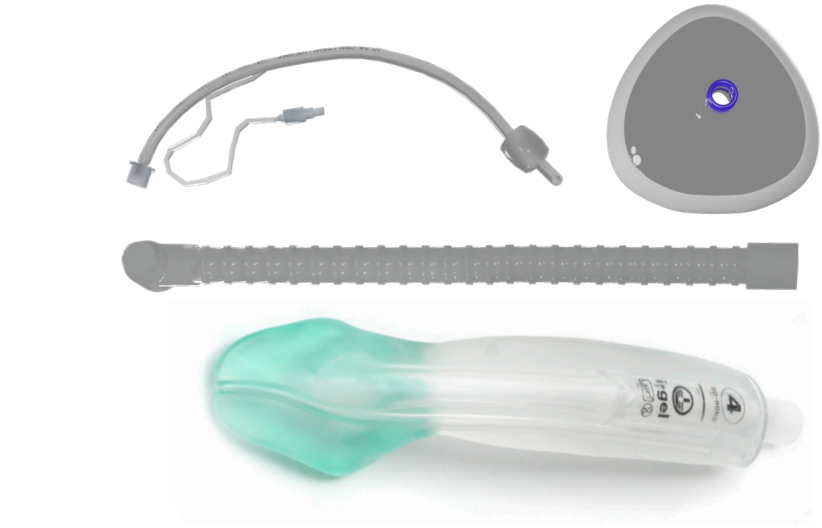
C2. Deliver Anesthesia

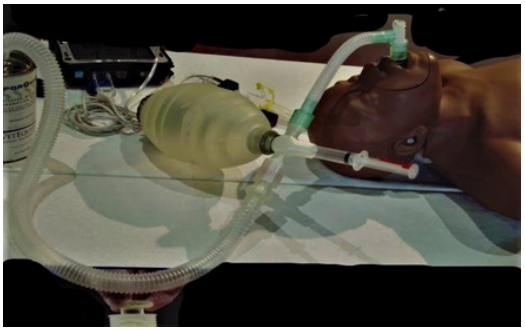
With Viral Filters (Optional)

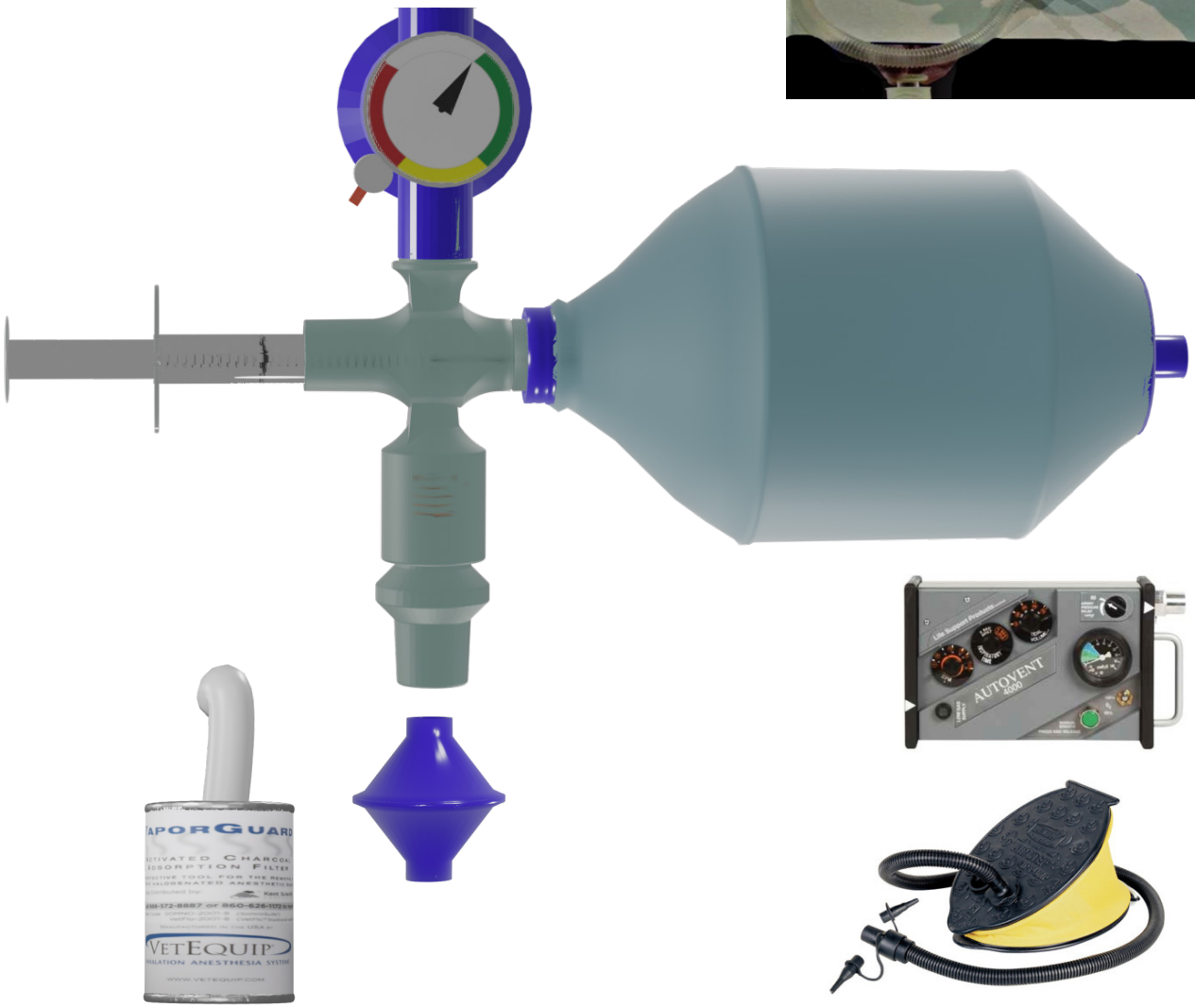


C. Configuration and Usage of VapoJET

C3. System Overview







D. Appendix

D1. Testing & Validation

A. VapoJET Ventilation System testing, validation,and training of non-medical and medically-trained analog astronaut crews in austere, remote, Isolated & Confinement Environments (I.C.E) – Mars Medics Simulation Training (Mars Academy USA)

MAU alumni are physician-scientists, developers, engineers, artists working and living together in austere Isolated, Confinement Environments (I.C.E) - which is very similar to the COVID-19 mandatory lock-downs and quarantine imposed across the world - are challenged to learn and solve medical scenarios in real-time and conduct TELEMEDICINE / TELEMENTORING simulations, e.g...., TELEANESTHESIA-TELESURGERY SIMULATION TRAINING, intubation and basic surgical techniques using exponential technologies, e.g., the testing of MAU;s solar powered 3D Printer for off-grid printing of medical tools and medical equipment including the 3D printed anesthesia inhalation and ventilation device "VapoJET".

Mars Academy USA (MAU) analog astronaut crews testing, validating and skills acquisition of VapoJET Ventilation System during I.C.E. missions.

D. Appendix

B. 3D EMAIL VENTILATOR 3D PRINTED IN SPACE ON ISS

The Email Ventilator was successfully 3D printed and assembled on the International Space Station, ISS, by NASA astronaut Peggy Whitson

NASA Astronaut Peggy Whitson on orbit assembly and demo of ventilator regulator valve
https://youtu.be/I8uIswih2WQ

C. VapoJET and 3D EMAIL VENTILATOR TESTED & VALIDATED IN PARABOLIC “Zero-G” WEIGHTLESSNESS FLIGHT

The 3D email ventilator was successfully tested in two parabolic flights under zero-g conditions.

3D Printed VapoJET and Email Ventilator device was successfully tested in an operation protocol in parabolic flight under a “zero gravity” environment.

D. Appendix

D2. Overview

This project was started by Dr Naoyuki Ishikita MD, PhD, in conjunction with the National Hospital, Niigata Clinical Research Department, Medical Equipment, Innovation. The 3D Print Artificial Respiratory Model was invented by Dr Ishikita et al. This is an artificial respiratory model that has succeeded under initial operational pilot testing under zero gravity environment on parabolic flights including successfully 3D Printed on the International Space Station 2017 on the Micro-gravity adapted 3D Printer Made In Space, MIS, 3D Printer.
Dr. Ishikita et al, Professor Akihiko Tree (Associate Professor of the Hiroshima University Translational Research Center) in partnership with Dr Susan Ip-Jewell MD (President, Mars Academy USA, MAU), and John Hanacek MA, CEO, AvatarMEDIC will continue on-going R&D, optimization, validation and integration of the 3D Printed VapoJET Ventilation and Inhalation System Project for long-term strategic goals to enable further development and integration of the VapoJET Ventilation System into MAU's teleanestheisa-telesurgery simulation training and near-future capability to perform space surgery and remote medical operations for isolated and confined environments in Space and on Earth, including application to address and support the current COIVD-19 pandemic emergency and into clinical settings around the world.

D3. Conceptual Design

- There is a generic 3D printer and network environment that meets certain performance requirements, and if you have a 3D Printer and the raw material (use ABS filament ONLY), you can 3D Print and build the VapoJET Ventilation system anywhere in the world. (NOTE: currently, we at early prototype phase until we acquire certifications so cannot be used as a medical device)
- Manual air flow is supplied by squeezing BVM or use of foot pump for the power source so it can function and work under any situations where electricity is not available. It can be connected to an electrical air compressor if electricity is available,
- The system is operated with a one person BVM or foot pump or under testing conditions, it is powered by 23 Watt air compressor. The level of discharge is about 25 l / minutes. Under testing current testing conditions using the laboratory with the Hospital's Central Plumbing System Compressor it is equivalent to 1.5 k to 22 KW. If an air compressor is not available, it is possible to operate the pressed air, oxygen tank, and BVM (ambu-bag) with manually supplied pneumatic pressure or use of a commercial camping foot pump. For latter, once a foot pump is connected to system the air flow is manually supplied by continuously by the foot, thus, leaving hands-free to work on the patient.
- The VapoJET uses the adapted and more advance 3D printed design of the early "Email Ventilator" model. We are currently testing a long-term endurance test of the latter under "live" conditions in the laboratory. The testing is on-going and to-date has been running continuously and automatically w for over 120 hours without any interruptions or interference to the system.

See video: Testing a long-term endurance test with Email Ventilator:
https://www.youtube.com/channel/UCkAfUnmFBB7yxE_BAFN2rtA
https://www.nicovideo.jp/user/95769049

D. Appendix

D4. History

- December 2010: Dr Ishikit et al inspired the simple inhalation anesthetic attachment called “sniffing syringe” and started research and development of the VapoJET design
- May 2011: support given from the Industrial Promotion Center, Otake Patent Attorney, and technical support by Newton Co Ltd. Obtained two patents.
- April 2013: Translational Research on VapoJET device at Iwate Medical University. Team conducted clinical exams on several small animals, ie, rat, small dog, micro-mini pig) by cooperation of Shizuoka Cancer Center
- May 2015: NASA Ames Research Center, concluded a joint research contract with Made in Space. Successfully tested 3D printing of the device
- November 2015: Validated testing of the “sniffing syringe” , VapoJET device in two parabolic “weightlessness” Zero Gravity flights under the “Micro-Artificial Respiratory System Zero Gravity Operation Exam” (USA)
- August 2016: sniffing syringe and micro-Artificial Respiratory System Zero Gravity Operation Exam (Japan)
- November 2017- Present: Signed Memorandum of Understanding, MOU, for both joint collaboration in co-research and collaboration as Co-Principal Investigators (Co-PIs) with Dr Susan Ip-Jewell MD, President of Mars Academy USA (MAU) and Dr Naoyuki Ishikita MD, Co-founder of STONY. The objectives and goals are scientific data -collecting and optimization and focus on testing validation, viability, feasibility and acquisition of skills and knowledge pertaining to 3D printing and integration into MAU’s Teleanesthesia-Telesurgery Simulation Training Program and the viability for integration of the VapoJET Ventilator and Anesthesia Inhalation Device in austere, remote, isolated and confinement environments (I.C.E), and in training NON-MEDICAL and retraining of MEDICALLY TRAINED Analog Astronauts “Mars Medics” crews. The device has been tested in high altitudes environment sin Nepal, Himalayas at 10, 000 – 15, 000 ft and in the Utah and Death Valley, California deserts. To-date, the research is on-going with missions planned for Antarctica and Everest Basecamp in 2021-2022. Publications, abstracts and presentations has been acknowledged and peer reviewed by several accredited organizations and institutes, e.g., International Astronautical Congress, IAC2018, Aerospace Medical Association Conference, AsMA2018, 2019, 2020 (Abstracts accepted for presentations), International Space Station Research & Development Conference, ISSR&D 2019, Mars Society Convention 20118, 2019. www.marsacademyusa.com
- March 15 – present: The formation of the current VapoJET team for submission to COIVD-19 Ventilator Challenge in joint partnerships with founders and members from STONY, Inc, Mars Academy USA, LLC and AvatarMEDIC, LLC. Due to the influence of global infections, we recognize the plight of lack of ventilators, medical equipment, artificial respiratory machines and trained medical professionals around the world. AvatarMEDIC and HoloTRIAGE will offer real-time, remote educational training using spatial computing and AI including access on all mobile devices and phones. Additional support offer from Hiroshima University Trance Research Center by Associate Professor Akihiko (the Japanese Medical Association and the Ministry of Economy, trade and industry hosted by the Kanto Economic Industry Bureau, “2019 Bio Design Workshop (October 2019-January 2020, Tokyo) www.AvatarMEDIC.space

Project Plans Moving Forward

1. Obtain certifications and develop Standardized Operational Procedures (SOPs) to be qualified and utilized as a general medical device and system
2. Develop the necessary non-clinical exam expenses and the cost of document creation of the medical equipment standard
3. Establishment of Quality Management System and Safely certifications from FDA and various regulatory institutions from various countries.
4. Translational and Clinical Trials and Clinical Research System development for validity, data collecting system, monitoring system, data analysis system, and data for publication