This proportional pinch valve is designed to be fully 3D printed and utilizes a readily available, inexpensive NEMA 17 stepper motor for mechanical control. The valve has been tested for full closure up to 15psi and can go from fully closed to fully open in 0.03 seconds or faster depending on the quality of the stepper motor. The valve operates by using a a cam to pinch a section of 3/8" OD, 1/4" ID soft tubing and reduce the flow area. This design means that the working fluid only ever contacts the inside of the tubing to mitigate the risk of contamination. The tubing can be easily replaced between patients. Note that the current design uses latex tubing - we are exploring alternative materials so that the ventilator can be used on patients with latex allergies.
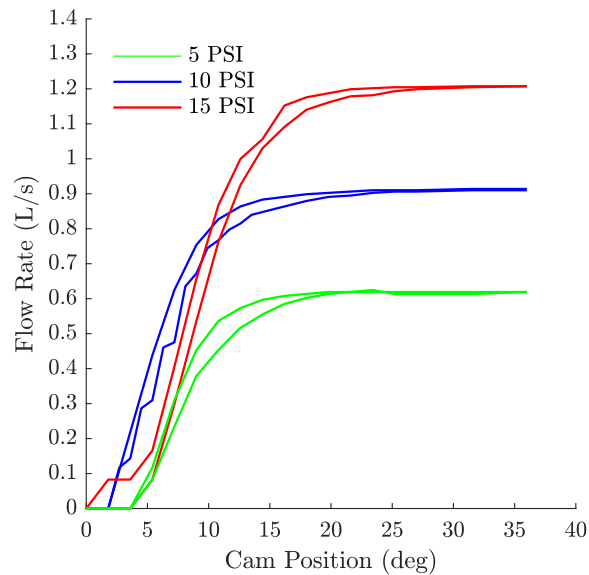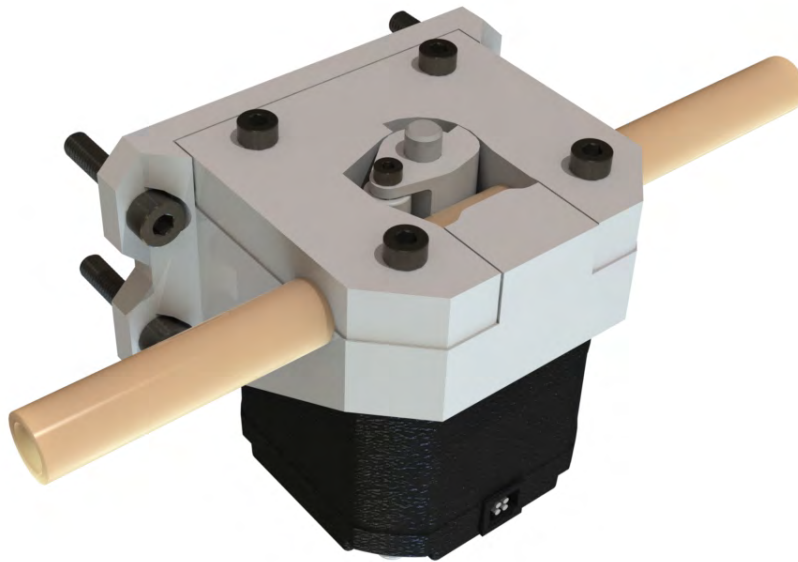

Flow rate vs. cam position for 5, 10 and 15 PSI pressure drop across the valve. Both opening and closing are shown to demonstrate minimal hysteresis.

Required Materials

Part	Quantity	Supplier
Housing	1	3D printed
Housing cover	1	3D printed
Cam	1	3D printed
Roller	1	3D printed
M3x22 screw	4	McMaster
M2x16 screw	1	McMaster
M4x20 screw	4	McMaster
M3x4 set screw	1	McMaster
NEMA 17 stepper motor	1	Adafruit
3/8OD, 1/4ID soft latex tubing	6"	McMaster

| Tool	Use
1.5mm Allen key	Set screw and roller screw
2.5mm Allen key	Housing cover screws
3mm Allen key	Valve mounting screws
5mm or letter F drill	Fit cam to motor shaft
Small wire cutters	Remove supports
Small files and sandpaper	Remove support remnants

Assembly Instructions
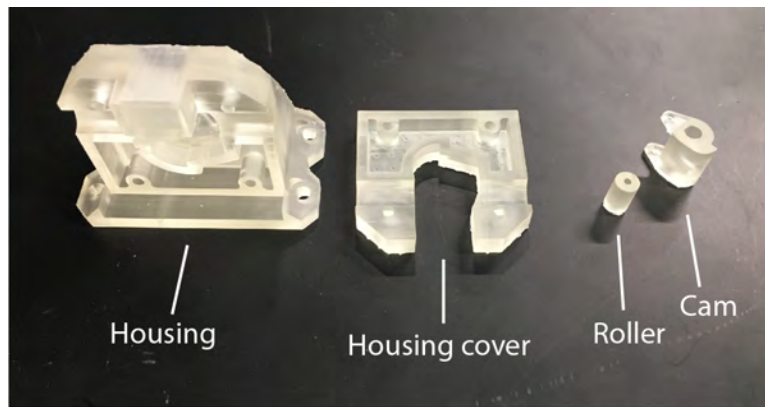
Four components must be 3D printed for each cam valve. They are the housing, the housing cover, the cam, and the roller. We recommend using a resin 3D printer rather than a filament one due to its higher dimensional accuracy - we printed with a FormLabs Form 2 with clear resin and 0.05mm layer height. Be mindful of reference surfaces when placing supports. We found that it works best to print with the internal features of the housing components facing away from the build platform, so the parts are supported on external features. After the print finishes, remove the supports with small wire clippers and sand and file away the remnants.


Begin by assembling the cam and roller using a M2x16 socket head cap screw. One side of the cam is a clearance hole and the other is threaded M2x0.4. After installing the roller, make sure that it spins freely. Don't over tighten the screw as it will pinch the roller. You may need to work the roller back and forth until it spins freely.
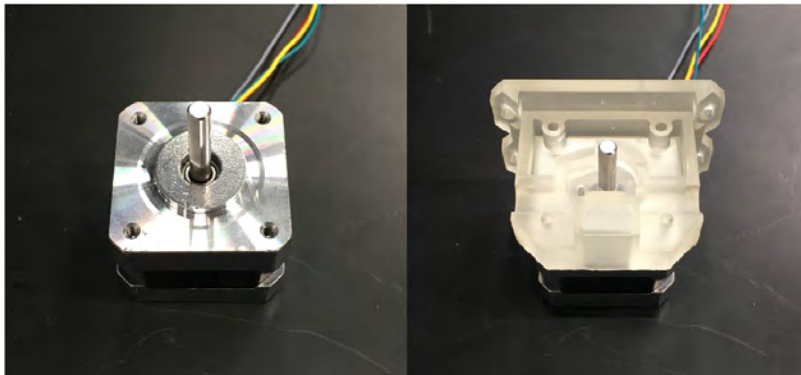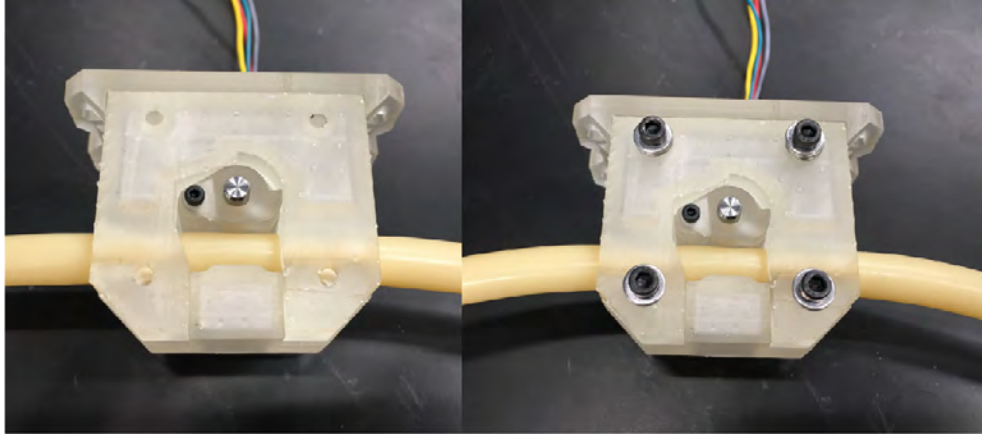

Place the housing onto the face of the stepper motor. The circular boss on the stepper motor should register in the housing. The motor can be oriented in any direction so pick one based on desired wire routing after the valve is mounted.
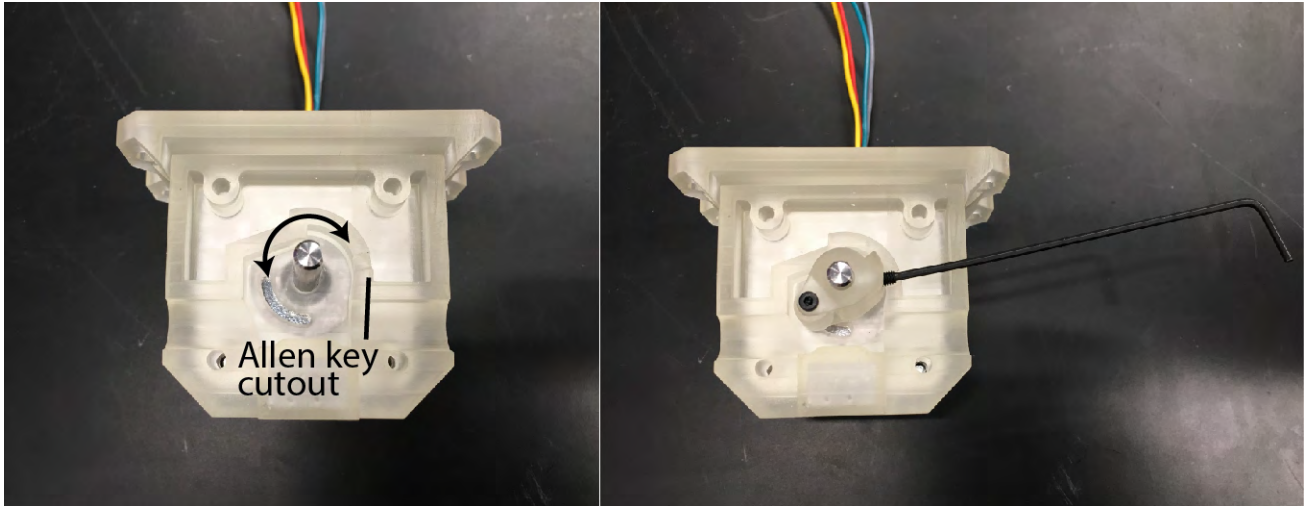
Turn the motor shaft by hand until the flat points towards the circular cutout in the housing intended for Allen key access. Slip the cam/roller subassembly onto the shaft. You may need to expand the hole in the cam slightly using a 5mm or letter F drill. Use the drill with a hand chuck or by hand, not under power. Use a 1.5mm Allen key to install the M3x4 set screw. Tighten onto the motor shaft.
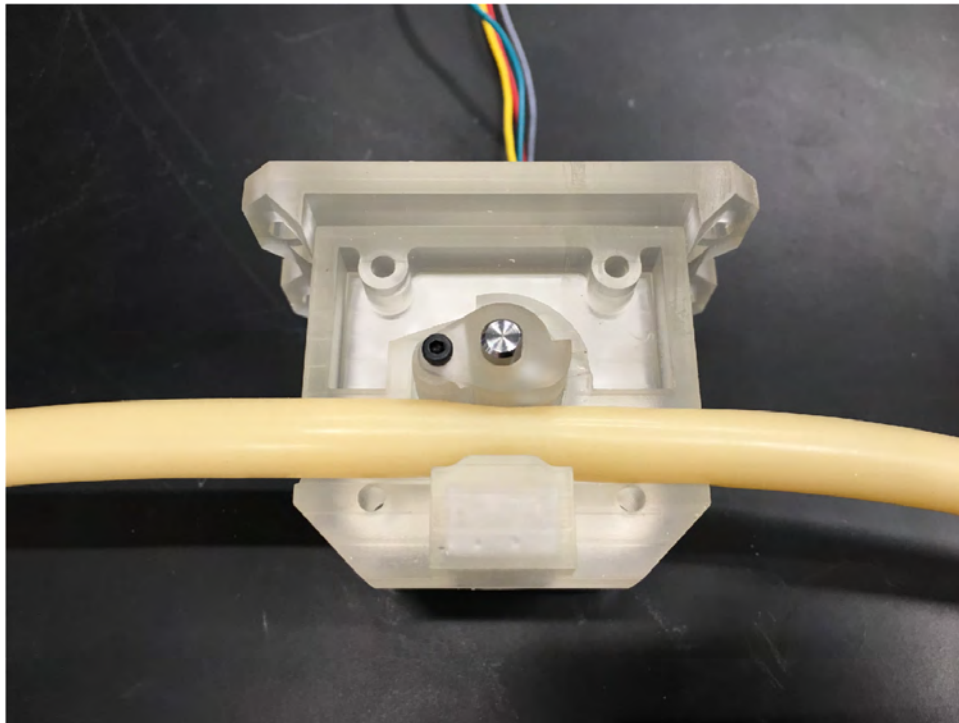
Turn the cam so that it is out of the way and press the soft latex tubing into the semicircular channel. If you are using a short section of tubing and adapting it to other tubing in the circuit, center the tubing in the housing. This is a good time to make sure that the tolerances on the printed parts are correct. Try turning the cam by hand to pinch the tubing shut. It should not require much force to seal completely. If the force is excessive or the tubing does not appear to be fully compressed, we have included STL files for undersized and oversized rollers.

Place the housing cover onto the housing and ensure that the cam does not bind as a result. The housing cover may need to be sanded if this occurs. Once the fit is good, fasten the housing cover and housing to the stepper motor with M3x22 screws. The housing includes holes for 4 M4 screws which can be used to mount the valve to a device.