

MADVent Mark V ventilator parts and detailed assembly procedure guide



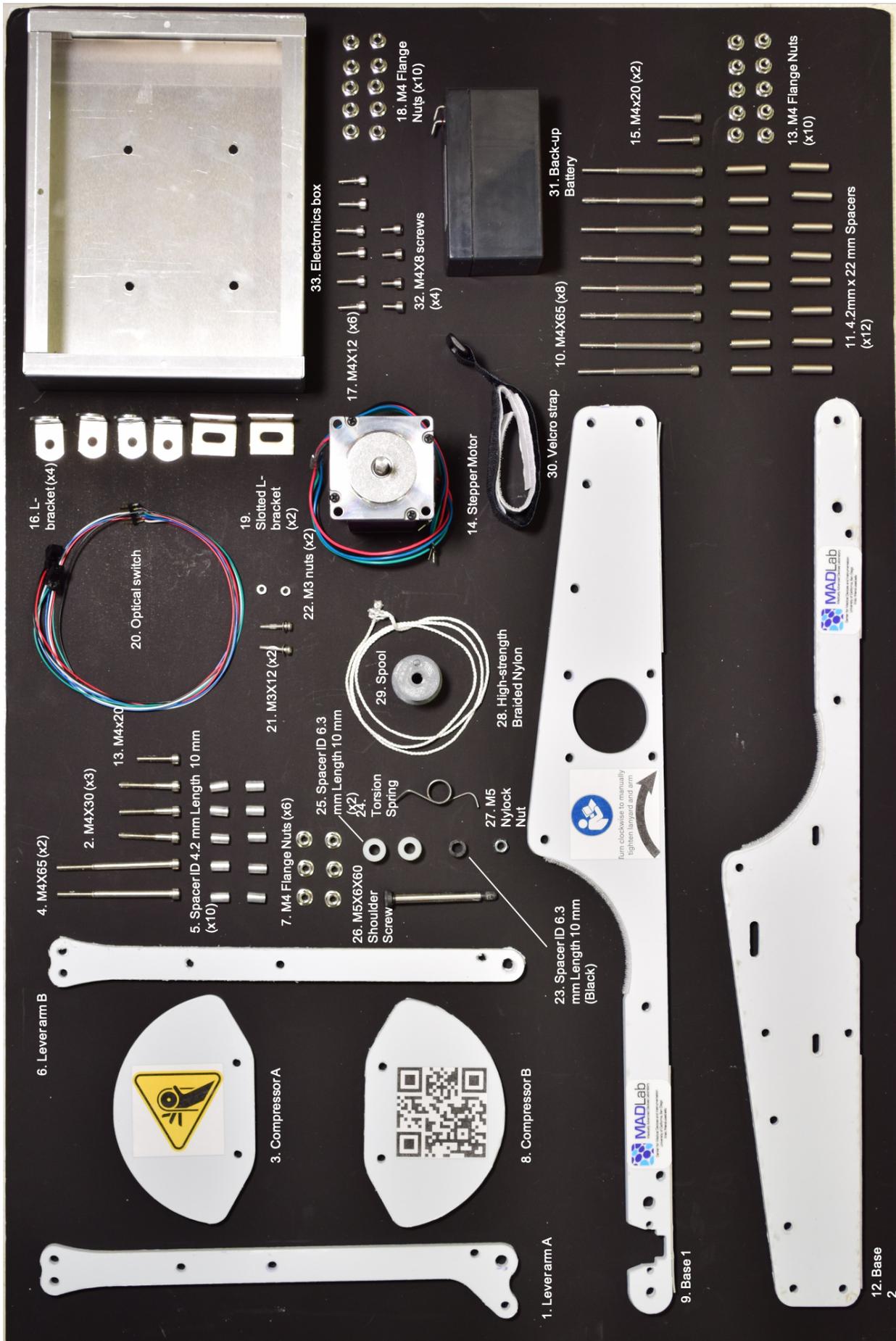


Figure 1: All parts for MADVent ventilator system

Introduction

This document details the parts and assembly procedure for MADVent.

The system is designed to be assembled using the following instructions in under 15 minutes by unskilled personnel.

Step 1: Ensure that the package comes with all the components listed below and pictured in Figure 1.

Component	Quantity
Stepper motor	1
Optical switch with attached wire	1
Spool	1
Velcro	1 packet
Base and lever arm part kit: lever arm A & B, Base and Base 1, Compressor A & B	1
Slotted L-bracket	2
L-bracket	4
High-strength braided nylon lanyard	1
Spacer ID 4.2 mm x 22 mm length	10
Torsion Spring	1
M3 nuts	2
M3 Screw 12 mm length	3
M4 flange nuts	26
M4 Screw 8 mm length	4
M4 Screw 12 mm length	6
M4 Screw 20 mm length	3
M4 Screw 30 mm length	3
M4 Screw 65 mm length	10
M5 Shoulder screw 60 mm length	
Spacer ID 4.2 mm x 10 mm length	10
Spacer ID 6.3 mm	2
M5 Nylock Nut	1
Set screw	1
Electronics box	1
Back-up battery	1
<i>The items below are not shown in Figure 1 for clarity but should be present in your kit</i>	
Wall power adapter	1
Bag valve respirator	1
PEEP valve	1
Rotary encoder	1
Pressure sensor	2
Viral filter	1

Step 2: Take lever arm A [Refer to Fig.1 and identify **Part 1**] (Fig. 2a) and insert M4X30 socket head screws [Fig.1: Part 2] into each of the following holes: one is offset from the midline near the bottom of the arm (Fig. 2b) and two more are at the top of the arm (Fig. 2c). Set this lever arm aside.

Step 3: Take compressor A [Part 3] and insert the two M4X65 socket head screws [Part 4] into the two holes (Fig. 2d).

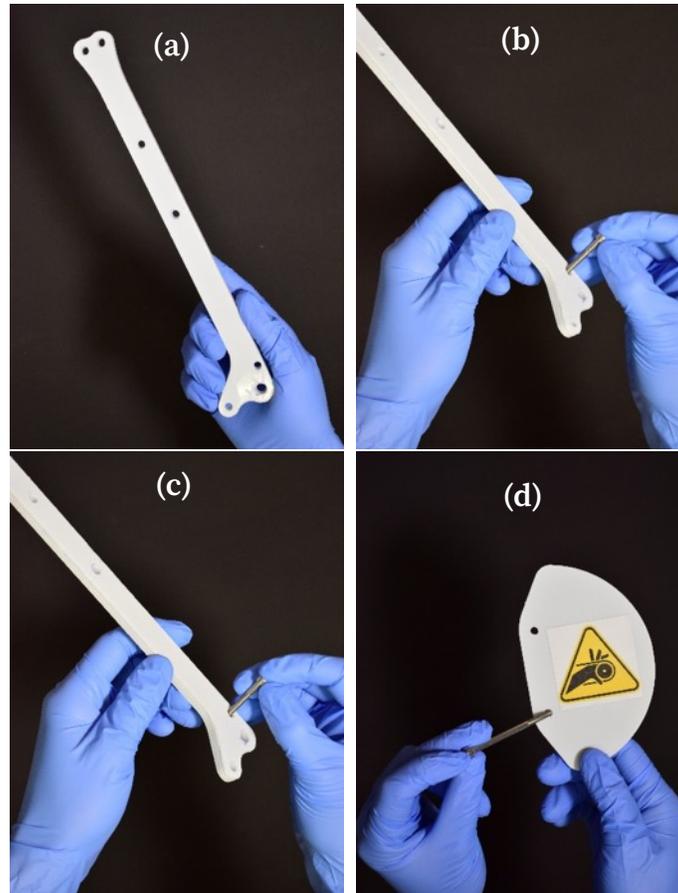


Figure 2

Step 4: Place one 4.2mm x 10mm spacers [Part 5] on each of the M4X65 screws [Part 4] that were previously inserted into the compressor (Fig. 3). A total of two spacers should be used on this step.

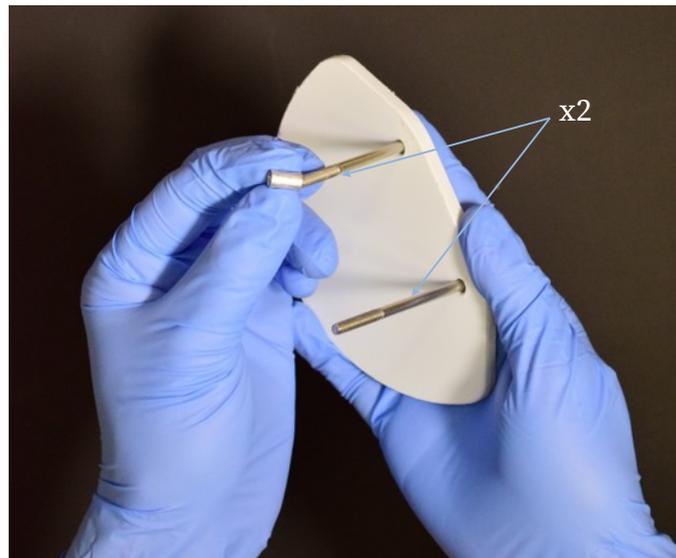


Figure 3

Step 5: Take the lever arm, screw assembly from step 2, with the offset hole pointed down, and insert the ends of the two M4X65 screws [Part 4] from the compressor, screw, and spacer assembled in steps 3 and 4 into the two open holes near the center (Fig. 4).

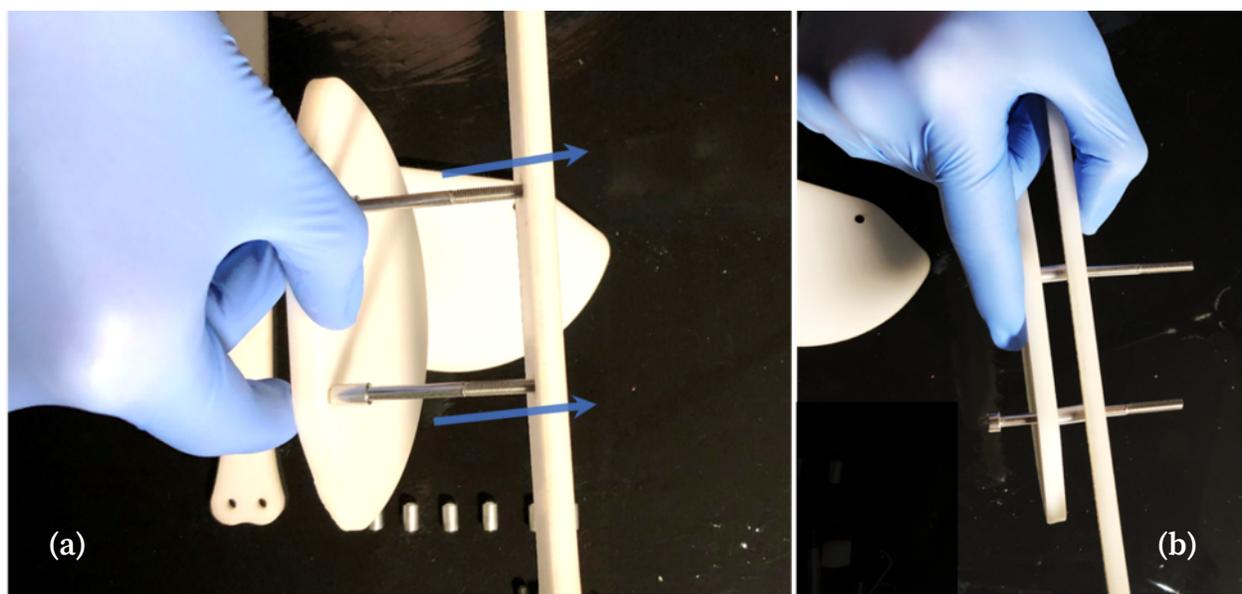


Figure 4

Step 6: Place one 4.2mm x 10mm spacer [Part 5] on each of the five screws (Fig. 5). A total of five (5) spacers should be used on this step.

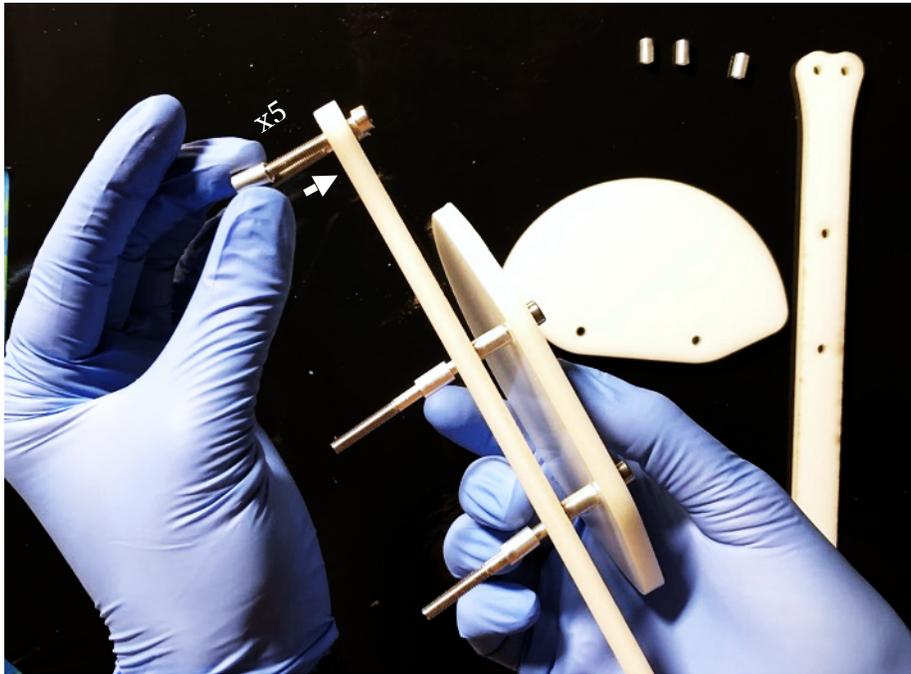


Figure 5

Step 7: Take lever arm B [Part 6] and slide it onto all five screws (Fig. 6). Be sure to match the holes on the lever arms.

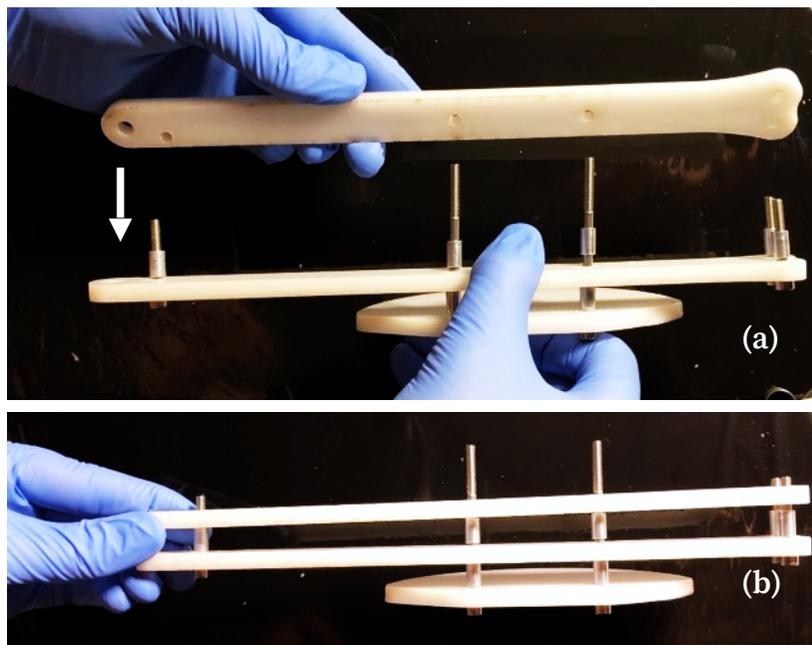


Figure 6

Step 8: Place and partially tighten one M4 flange nut [Part 7] on each M4X30 screw [Part 2] (Fig. 7). A total of three nuts should be used in this step.

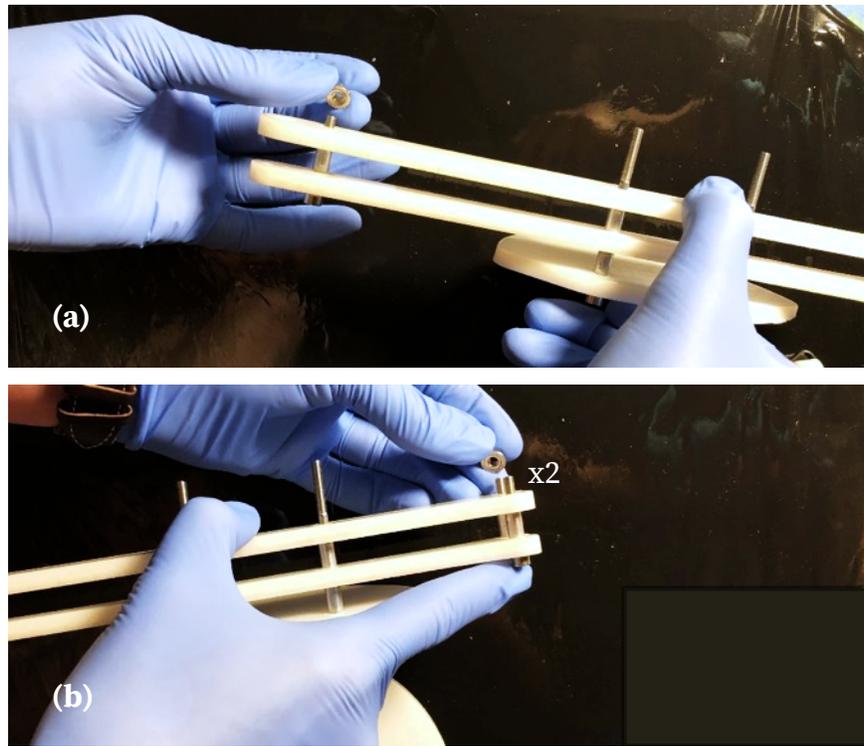


Figure 7

Step 9: Place one 4.2mm x 10mm spacers [Part 5] on each of the M4X65 screws [Part 4] (Fig. 8a). A total of two spacers should be used on this step.

Step 10: Place compressor B [Part 8] onto the two M4X65 screws [Part 4] (Fig. 8b). Both compressor parts should be in the same orientation.

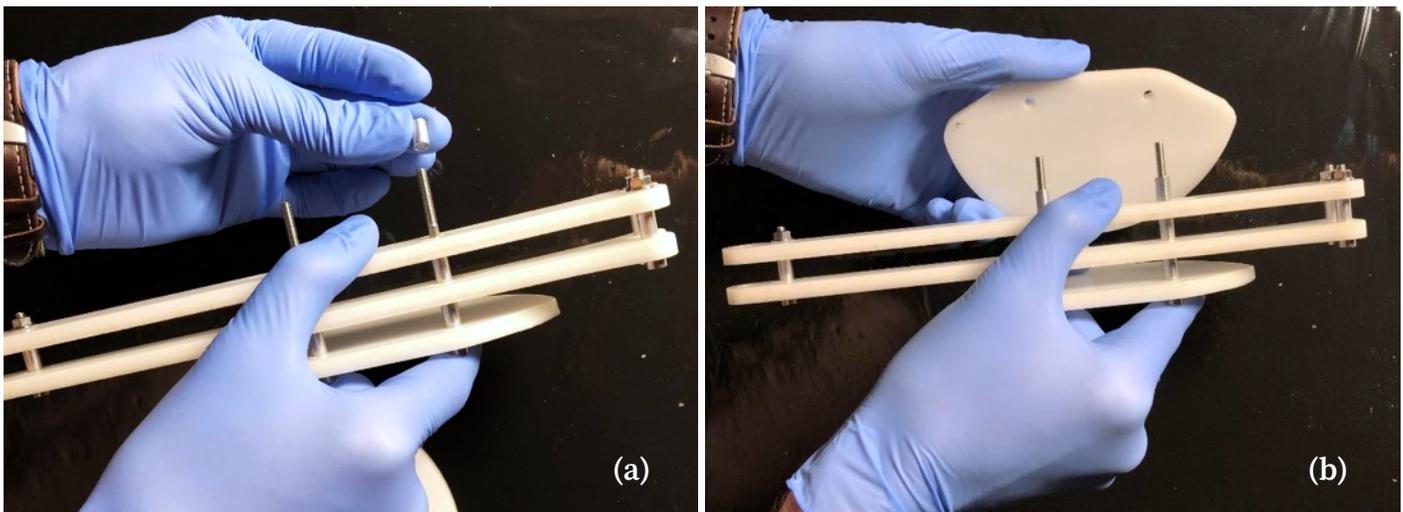


Figure 8

Step 11: Place and tighten one M4 flange nut [Part 7] on each M4X65 screws [Part 4] (Fig. 9a). A total of two nuts should be used on this step.

Step 12: Place a 4.2mm x 10mm spacer [Part 5] on a M4X30 socket head screw [Part 2]. Feed the screw through the hole as shown in figure 9(c) and attach a flange nut until snug. Fig 9(e) represents a completed lever assembly.

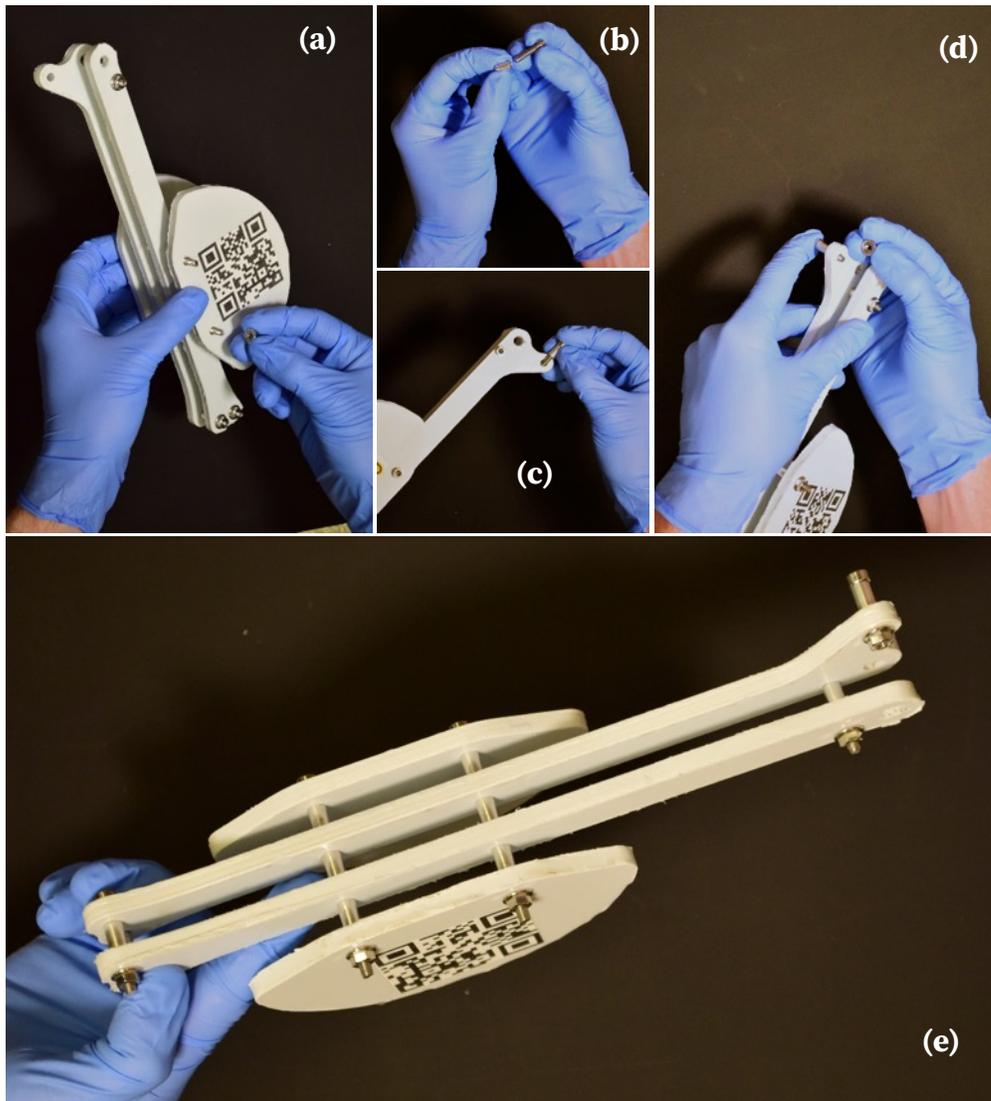


Figure 9

Step 13: Take Base 1 [Part 9] and place one M4X65 screw [Part 10] into the hole near the front which is offset from the midline (Fig. 10b).

Step 14: Place two 4.2mm x 22mm spacers [Part 11] onto the M4X65 screw [Part 10] (Fig. 10c).

Step 15: Slide the M4X65 screw [Part 10] from step 14 onto the matching hole in Base 2 [Part 12] (Fig. 10d). Be sure all other matching holes align correctly.

Step 16: Place and partially tighten one M4 flange nut [Part 13] onto the M4X65 screw [Part 10] (Fig. 10e).

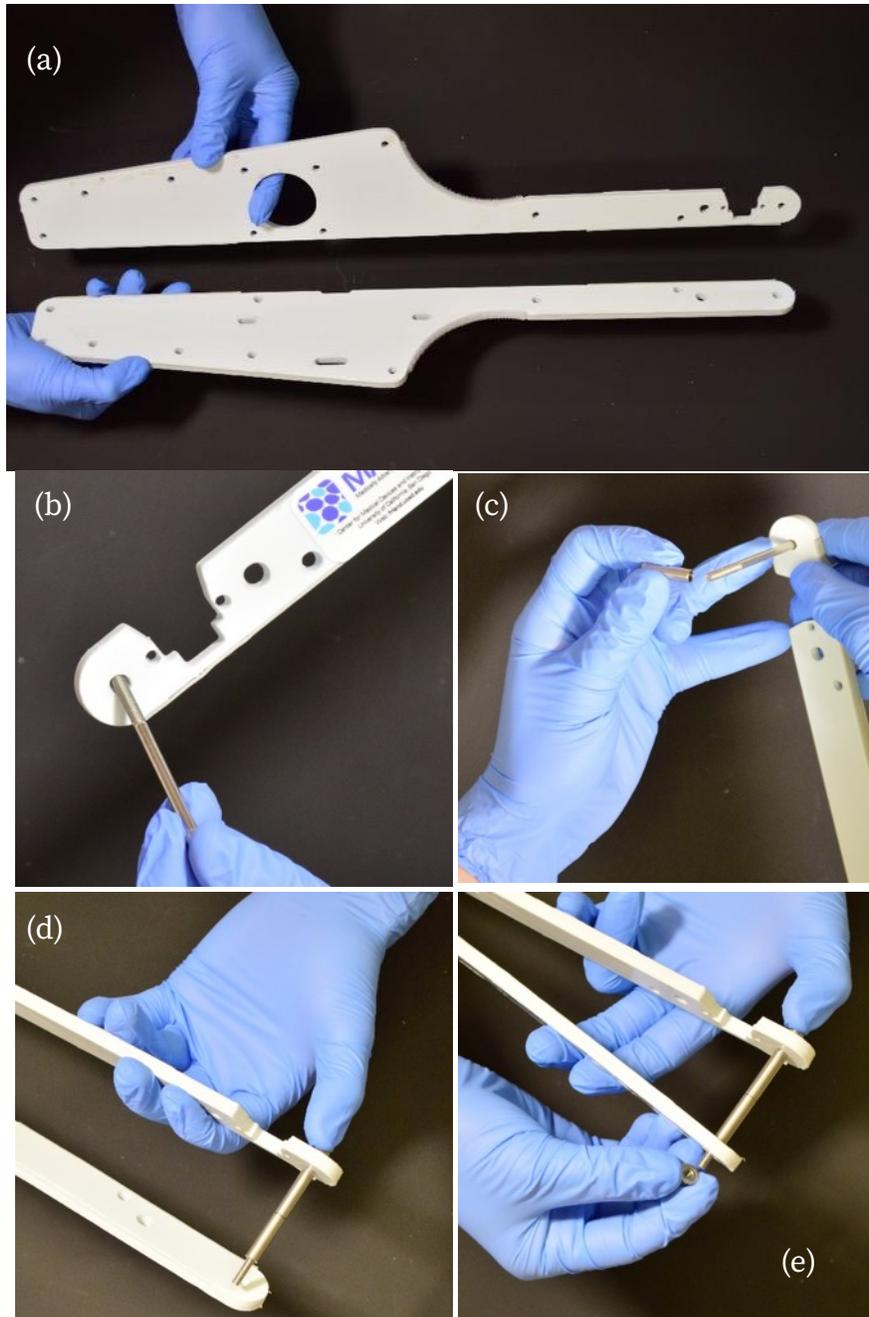


Figure 10

Step 17: Repeat steps 13 through 16 for each of the holes indicated in Figure 11.



Figure 11

Step 18: Take the **stepper motor [Part 14]** and place its shaft into the motor hole of **Base 1 [Part 9]** (Fig. 12). Orient the motor such that the wire exit points towards the back of the base.

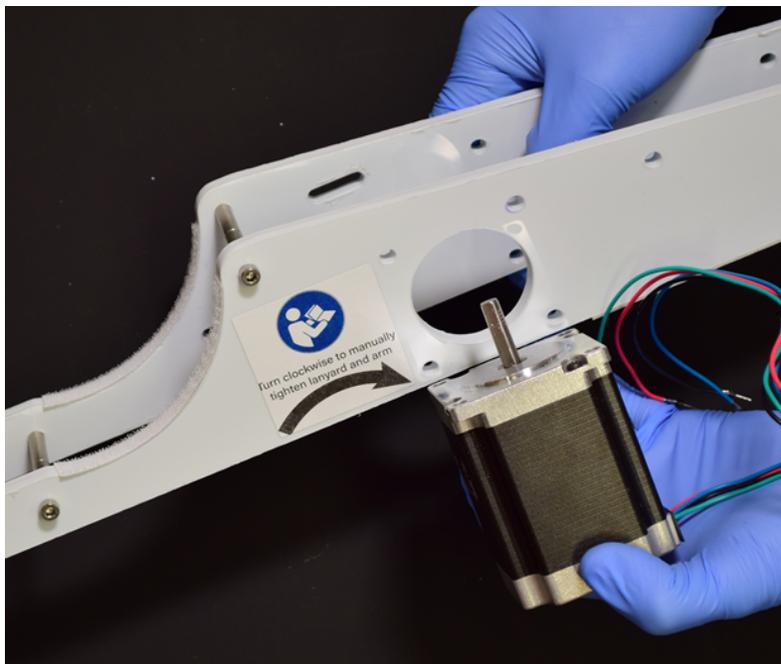


Figure 12

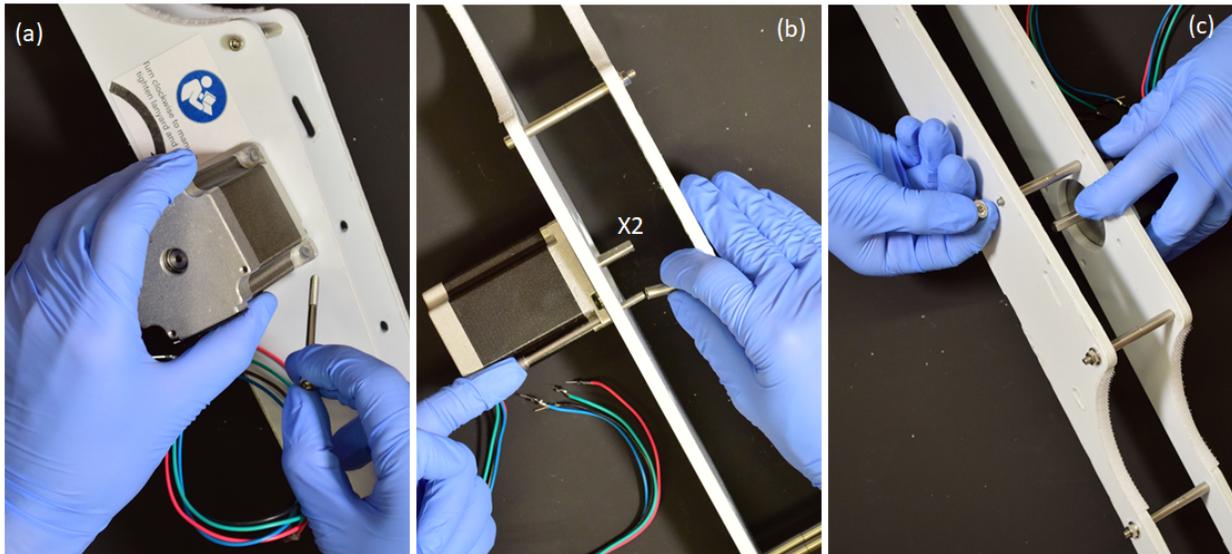


Figure 13

Step 19: Align the corner hole of **Base 1 [Part 9]** with the corresponding hole in the **stepper motor [Part 14]** mounting flange and slide one **M4X65 screw [Part 10]** through both holes (Fig. 13a).

Step 20: Place two **4.2mm x 22mm spacers [Part 11]** onto the **M4X65 screw [Part 10]** from step 19 (Fig. 13b).

Step 21: Feed the **M4X65 screw [Part 10]** into the corresponding hole on **Base 2 [Part 12]** (Fig. 14).

Step 22: Place and partially tighten one **M4 flange nut [Part 13]** on to the **M4X65 screw [Part 10]** from steps 19, 20, 21 (Fig. 14d). A total of one nut should be used on this step.

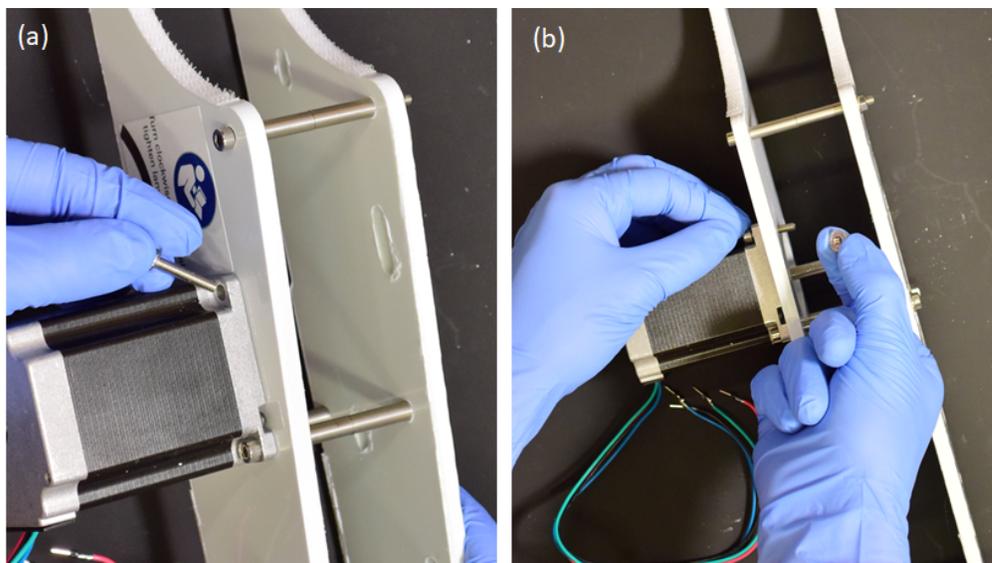


Figure 14

Step 23: Place one **M4X20 screw [Part 15]** into one of the open holes on the **stepper motor [Part 14]** mounting flange.

Step 24: Place and partially tighten one **M4 flange nut [Part 13]** on to the **M4X20 screw [Part 15]** from step 23. A total of one nut should be used on this step.

Step 25: Repeat steps 23 and 24 for the remaining two mounting holes on the **stepper motor [Part 14]**

Step 26: Tighten all nuts until snug. The screws and spacers should no longer be free to rotate. Refer to Figure 15.

Step 27: Take an **L-bracket [Part 16]** and insert an **M4X12 screw [Part 17]** into one of the holes.

Step 28: Insert the end of the **M4X12 screw [Part 17]** into one of the mounting holes behind the motor.

Step 29: Place and tighten an **M4 flange nut [Part 18]** on to the **M4X12 screw [Part 17]** such that the bracket is nearly flush with the top surface of the base.

Step 30: Refer to Figure 16 and repeat steps 27-29 for each of the four mounting holes.

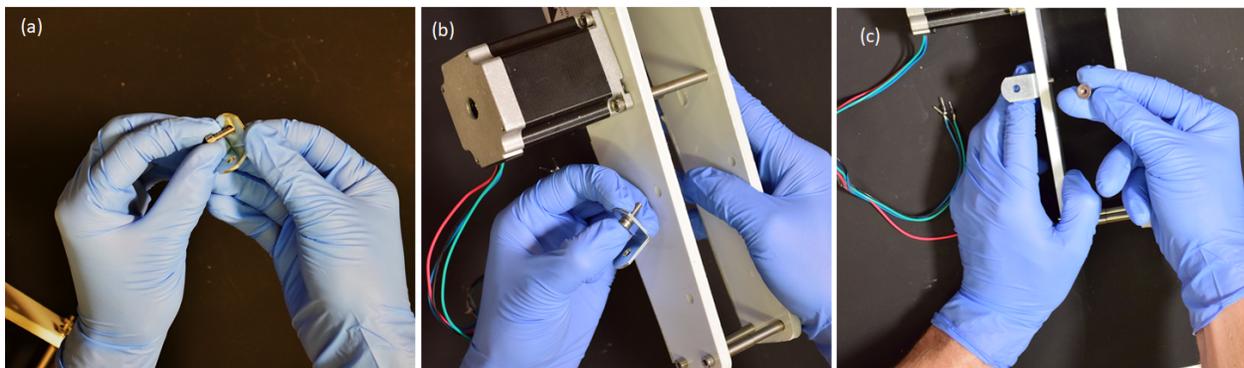


Figure 16

Step 31: Take a **slotted L-bracket [Part 19]** and insert an **M4X12 screw [Part 17]** into the non-slotted hole.

Step 32: Insert the end of the **M4X12 screw [Part 17]** into the small horizontal slots on the **base 2 [Part 12]**.

Step 33: Place and partially tighten an **M4 flange nut [Part 18]** on to the **M4X12 screw [Part 17]**.

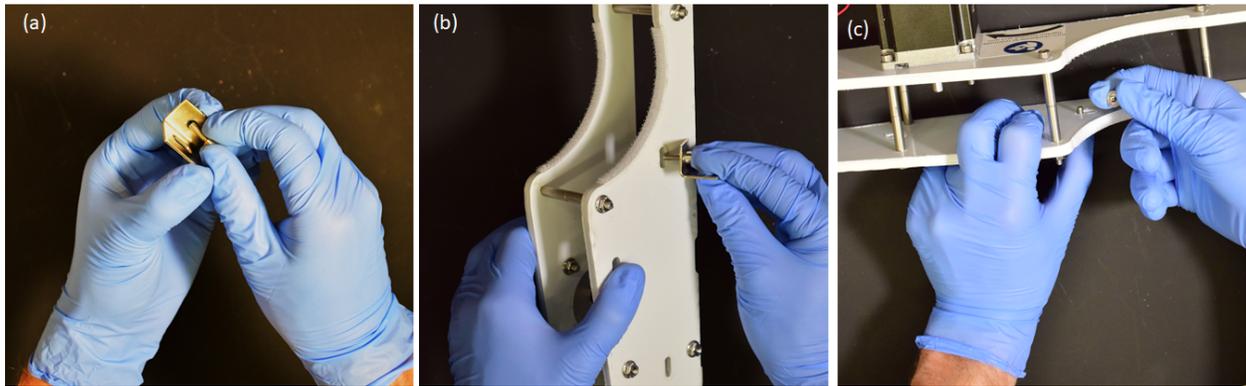


Figure 17

Step 34: Repeat steps 31-33 for both small horizontal slots. Refer to Figure 17.

Step 35: Take the **optical limit switch [Part 20]** and place an **M3X12 screw [Part 21]** through one of the holes.

Step 36: Insert the end of the **M3X12 screw [Part 21]** into the optical switch cradle on the **base 1 [Part 9]** such that the **optical limit switch [Part 20]** is resting as shown in figure 18b.

Step 37: Place and tighten an **M3 flange nut [Part 22]** onto the **M3X12 screw [Part 21]**.

Step 38: Refer to Figure 18. Repeat steps 35-37 for both holes on the **optical limit switch [Part 20]**.

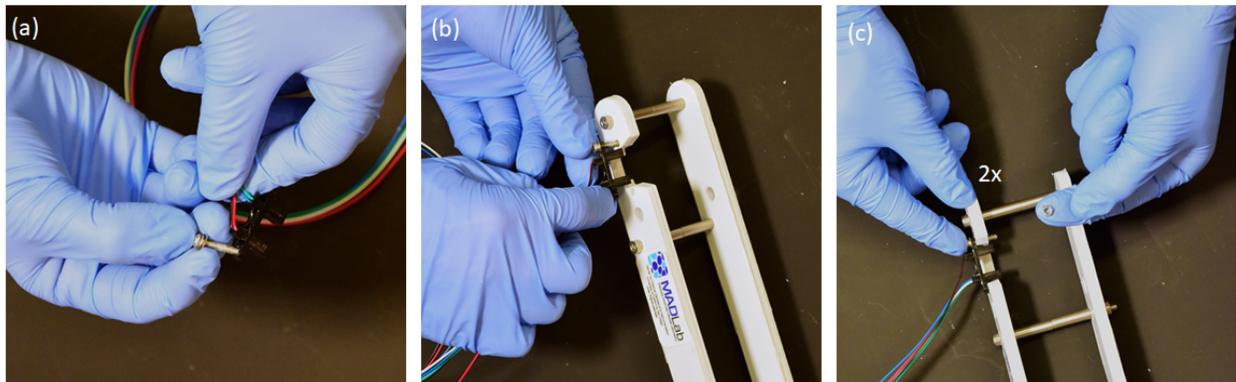


Figure 18

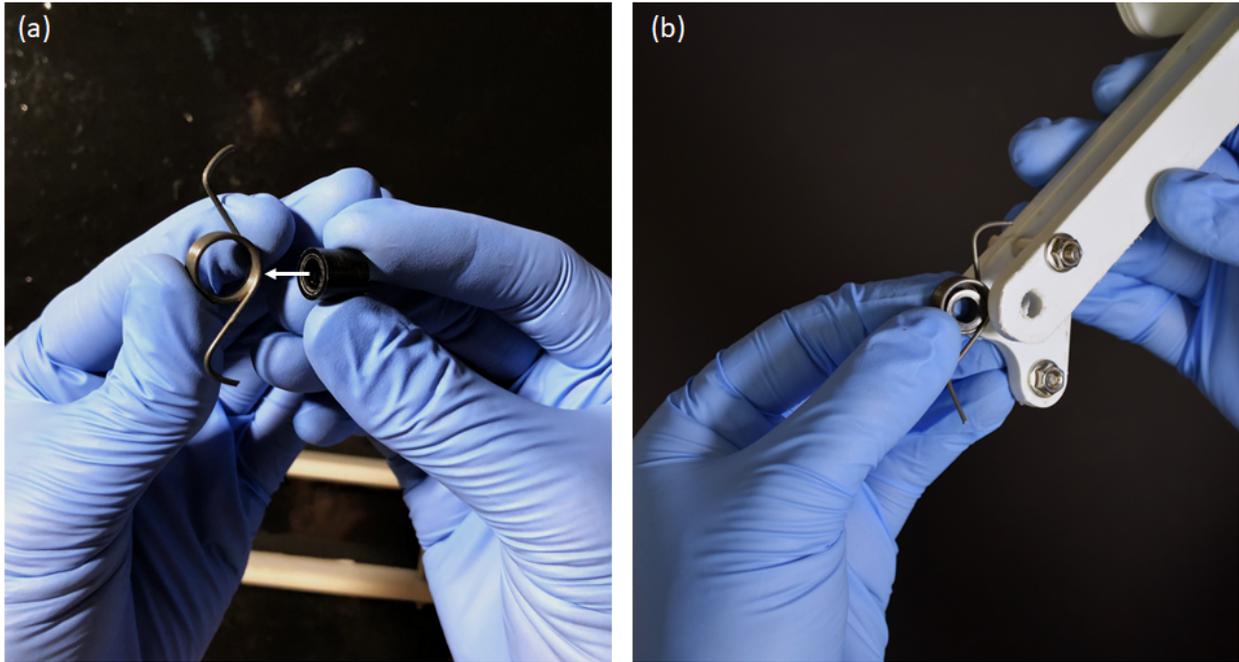


Figure 19

Step 39: Place the **6.3mm x 10mm black spacer [Part 23]** into the **torsion spring [Part 24]** (Fig. 19a).

Step 40: Lay the assembled arm and base inline such that the hinge holes are approximately aligned and the **compressors [Parts 3 & 8]** are facing up (Fig. 19b)

Step 41: Place the **torsion spring [Part 24]**, **black spacer [Part 23]** assembly into the opening of the lever arm assembly (Fig. 15b) such that the arms of the **torsion spring [Part 24]** hook around the spacers of the offset holes on both the base and lever arm assemblies (Fig. 19b).

Step 42: Place a **6.3mm x 10mm white spacer [Part 25]** into the gap between **Base 1 [Part 9]** and the lever arm assembly such that the hole aligns with the hinge hole (Fig. 20b).

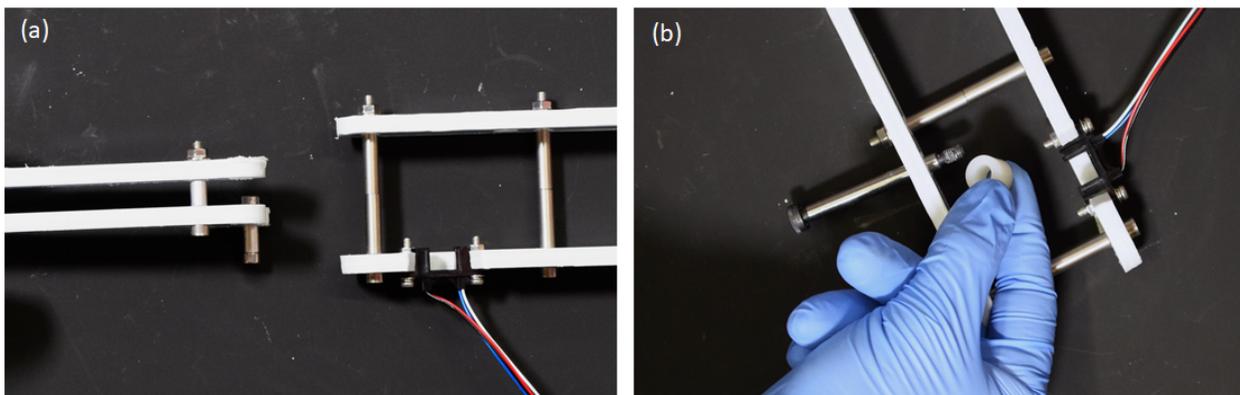


Figure 20

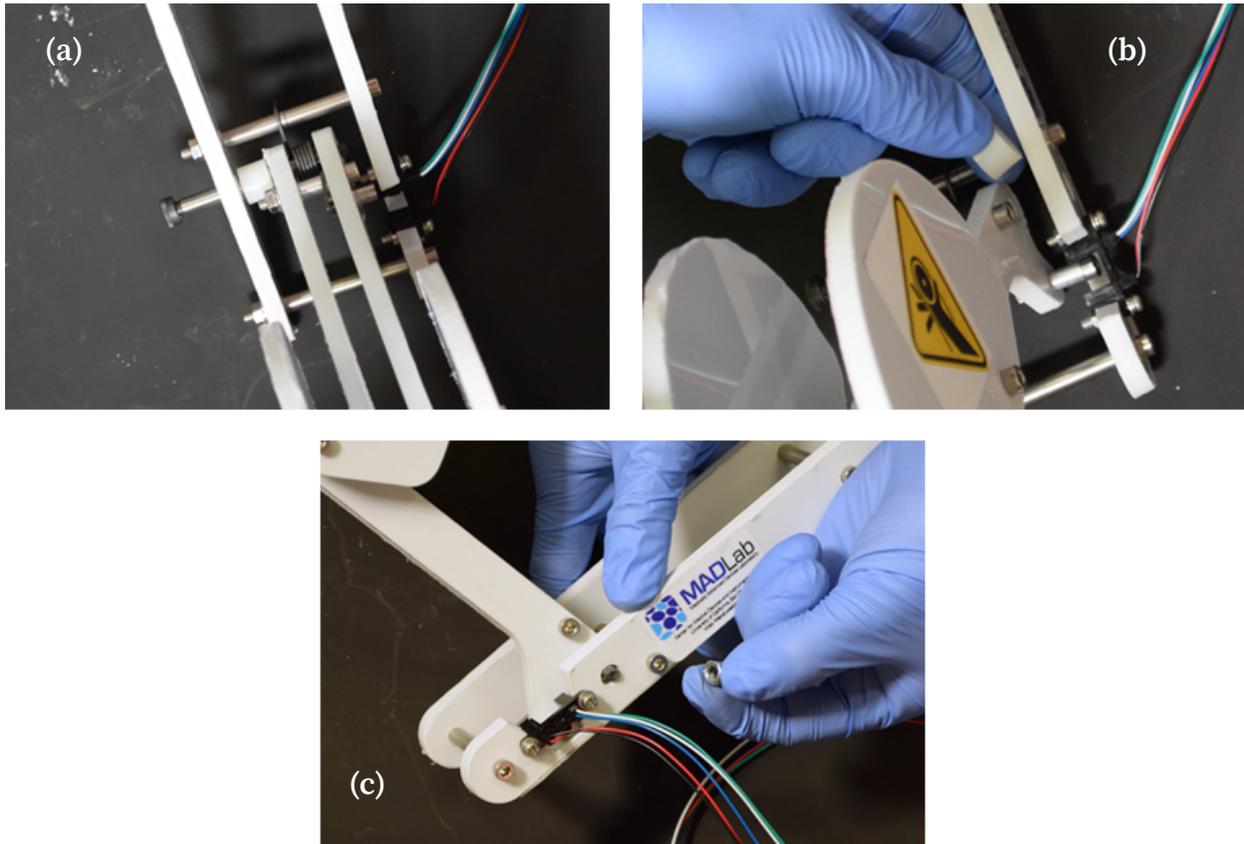


Figure 21

Step 43: Feed the **M5X6X60 shoulder screw [Part 26]** into the hinge hole on **Base 1 [Part 9]** and through the **6.3mm x 10mm white spacer [Part 25]**, the first lever arm assembly hole, the **6.3mm x 10mm black spacer [Part 23]** hole, and then the second lever arm assembly hole (Fig. 21a).

Step 44: Place a **6.3mm x 10mm white spacer [Part 25]** into the gap between the second lever arm assembly hole and the hinge hole in **Base 2 [Part 12]** (Fig. 21b).

Step 45: Continue feeding the **M5X6X60 shoulder screw [Part 26]** from step 31 through the **6.3mm x 10mm white spacer [Part 25]** and into the hinge hole on **Base 2 [Part 12]** (Fig. 21c).

Step 46: Place and tighten the **M5 nylock nut [Part 27]** onto the **M5X6X60 shoulder screw [Part 26]** from steps 31&33 (Fig. 21c).



Figure 22

Step 47: Take the **high strength braided nylon twine [Part 28]** and feed it through the **spool [Part 29]** (Fig. 22).

Step 48: Pull the **twine [Part 28]** through the wall hole of the **spool [Part 29]** and loop around the wall and through such that pulling on the free end of the string tightens down on the looped end (Fig. 22).

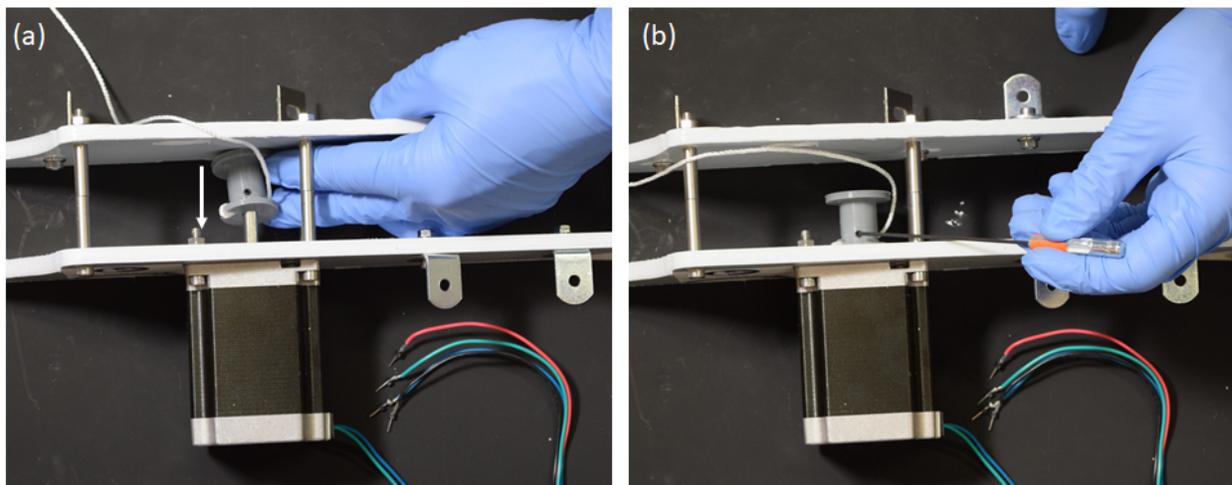


Figure 23

Step 49: Place the **spool [Part 29], twine [Part 28]** assembly inside the base aligning the shaft hole with the **stepper motor [Part 14]** drive shaft. Be sure to place the **spool [Part 29]** oriented such that the **twine [Part 28]** tie off is closest to the **stepper motor [Part 14]** and the set screw is perpendicular to the flat of the drive shaft (Fig. 23).

Step 50: Slide the **spool [Part 29]** until the wall closest to the **stepper motor [Part 14]** is close to aligned with the inside face of **Base 1 [Part 9]** and tighten the set screw (Fig.23).

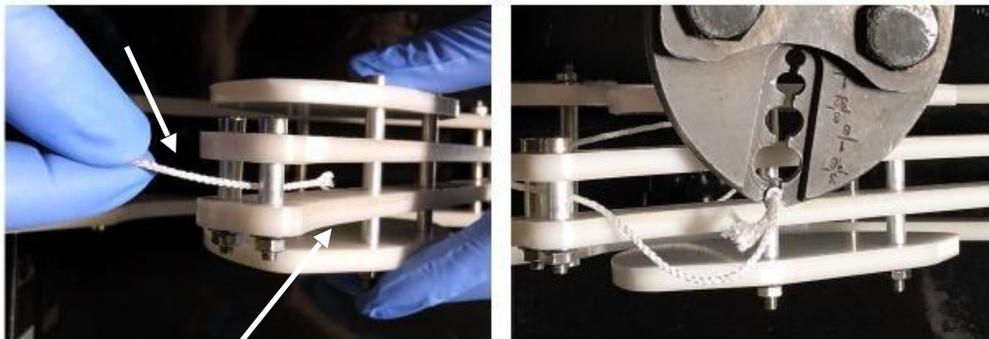


Figure 24

Step 51: Take the free end of the **twine [Part 28]** and feed it through the opening between the two **spacers [Part 5]** at the top of the lever arm assembly and loop it around the next **spacer [Part 5]** (Fig. 24).

Step 52: Tie off the looped **twine [Part 28]** using an aluminum ferrule and crimping tool (Fig. 24).

Step 53: Take the **hook-and-loop strap [Part 30]** and insert the non-buckle end into the large horizontal slot in **base 2 [Part 12]**.

Step 54: Feed the strap through the slot and down under **base 2 [Part 12]** such that it rests in the notch at the bottom.

Step 55: Place the **battery [Part 31]** into the space between the **slotted L-brackets [Part 19]**.

Step 56: Wrap the **hook-and-loop strap [Part 30]** around the **battery [Part 31]** and through its buckle.

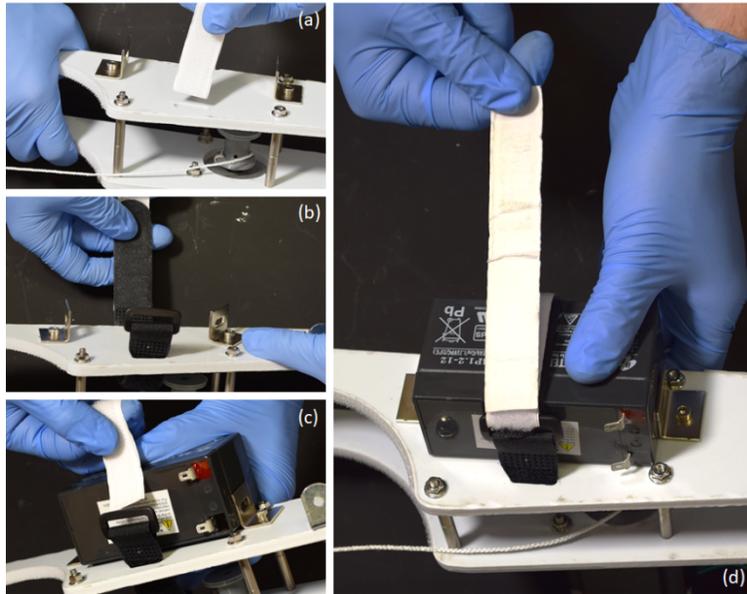


Figure 25

Step 57: Cinch the **hook-and-loop strap [Part 30]** down around the **battery [Part 31]** until snug. Then tighten the **M4 flange nuts [Part 18]** on each of the **slotted L-brackets [Part 19]** to fully fix the battery in place. Refer to figure 25.

Step 58: Take an **M4X8 screw [Part 32]** and place it in the open hole of one of the **L-brackets [Part 16]**.

Step 59: Place the **electrical box [Part 33]** onto the **L-brackets [Part 16]** and align the holes on the bottom and feed the **M4X8 screw [Part 32]** through one of the open holes. Be sure to orient the **electrical box [Part 33]** such that its longest side is perpendicular with the **bases [Parts 7 and 8]**.

Step 60: Place and tighten an **M4 flange nut [Part 19]** on the **M4X8 screw [Part 32]**.

Step 61: Repeat steps 58 and 60 for all four holes on the **electrical box [Part 33]**. Refer to figure 26.

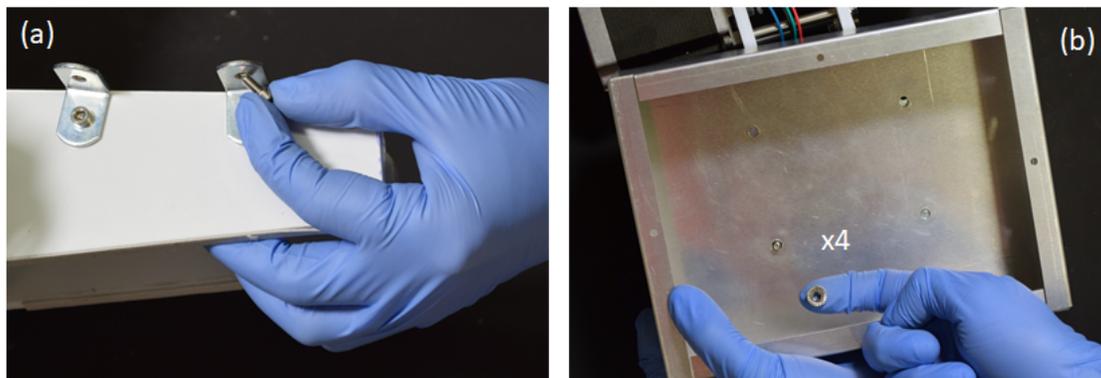


Figure 26

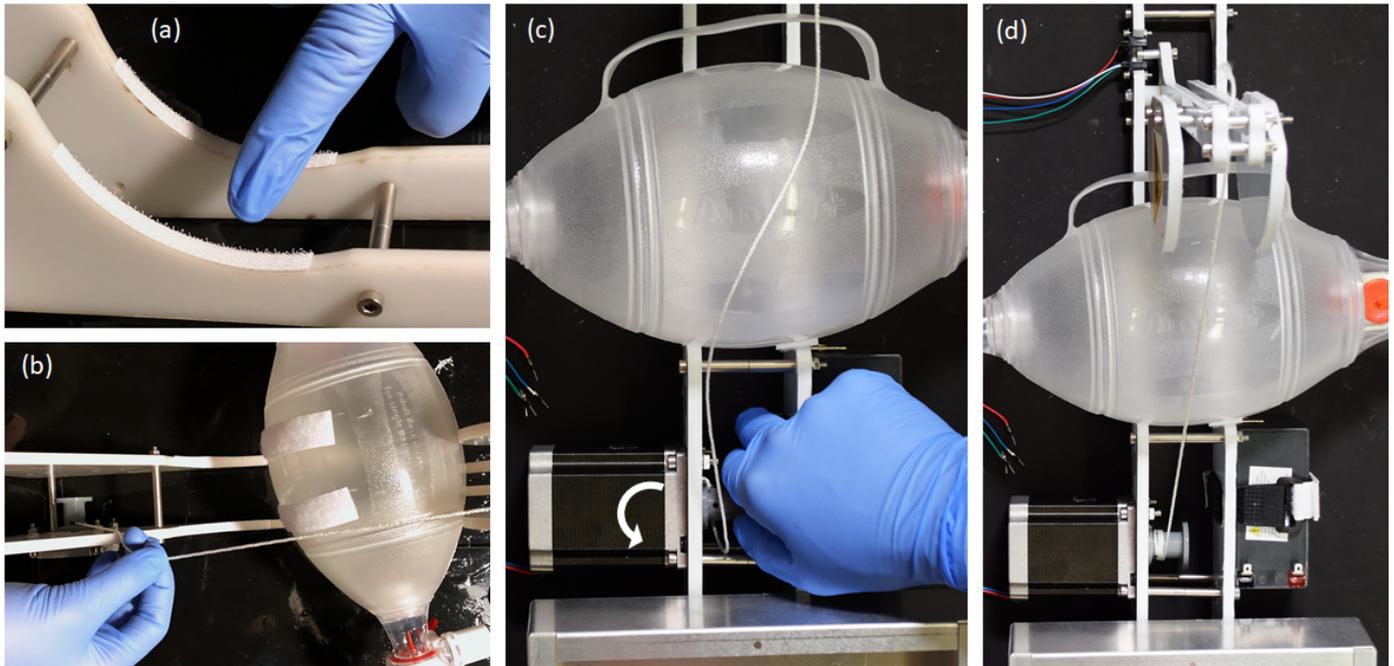


Figure 27

Step 62: Place strips of hook and loop fastener (Velcro) along the bag cradles of **Base 1 [Part 9]** and **Base 2 [Part 12]** (Fig. 27). Place corresponding strips on the bag (Fig. 27). It is recommended to place the hook side in the cradle and the loop side on the bag.

Step 63: Place the bag in the cradle (Fig. 27) and rotate the **spool [Part 29]** in the clockwise direction to tighten the lever arm assembly onto the bag (Fig. 27). Rotate the **spool [Part 29]** until the **compressors [Parts 3 & 8]** just begin to depress the bag (Fig. 27). This should be approximately 2-3 turns of the **spool [Part 29]**.

Aditya Vasani, Reiley Weekes, William (Bill) Connacher, Jeremy Seiker, Mark Stambaugh
Prototype put together by above authors at UCSD's MADLab and Bill/Aditya's garage during the 2020 COVID Pandemic.

Work(s) (the "Work") by:
COVID-19 Acute Ventilation Rapid Response Taskforce (AVERT)
Medically Advanced Devices Laboratory
Department of Mechanical and Aerospace Engineering
Jacobs School of Engineering and the School of Medicine
University of California, San Diego
9500 Gilman Drive MC411
La Jolla, CA 92093-0411

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9500 Gilman Drive, Mail Code 0910
University of California
La Jolla, CA 92093-0910
(858) 534-5815
innovation@ucsd.edu

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