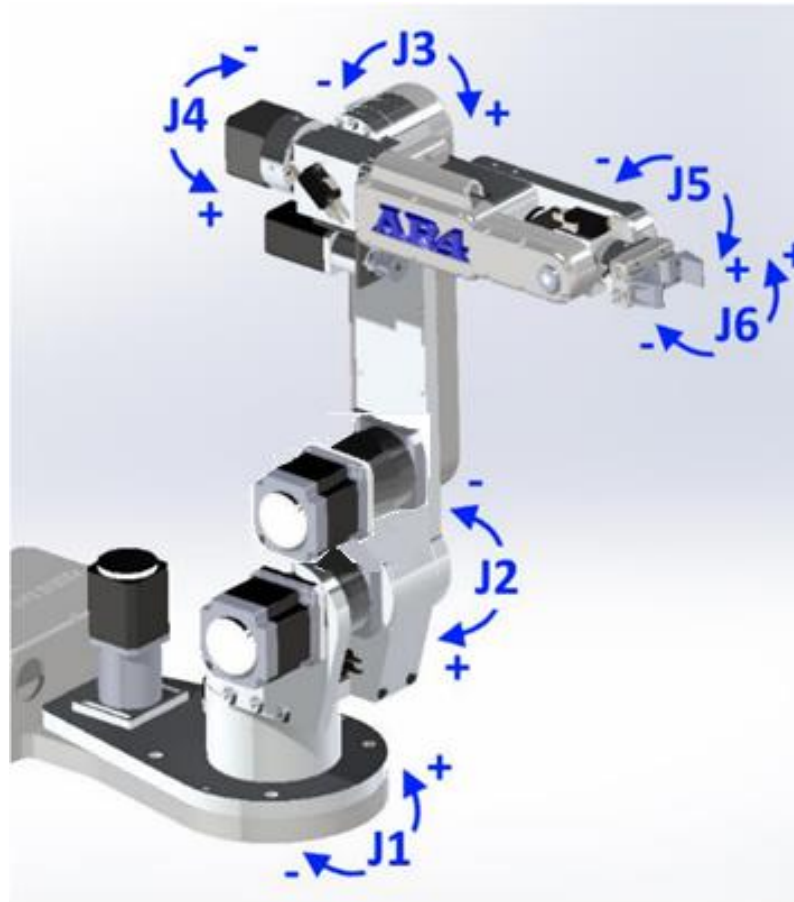# AR4 Upgrade Guide for Increasing Torque in Joint #3

This guide reuses the older Nema 23 gearbox (SKU: 23HS22-2804D-HG50-AR4), initially used in joint #2 in manual version 1.5; however, you have the flexibility to choose a motor that suits your preference.

Assista Robotics

ANNIN ROBOTICS

Created for the AR4 community by Elijah Peralta
Founder of Assista Robotics
Elijahperaltav@gmail.com
Twitter.com/Assistabotics

This guide is not endorsed by Annin Robotics

Electrical Safety

▸ ELECTRIC SHOCK HAZARD. The construction of this control enclosure poses potential exposure to alternating current and direct current which has the potential to cause injury or death. This equipment should be constructed and serviced by trained or qualified persons.

▸ Keep the area around the device clear and free from dust before, during, and after installation.

▸ Wear safety glasses if you are working under any conditions that could be hazardous to your eyes.

▸ Do not perform any actions that create a potential hazard to people or make the equipment unsafe.

▸ Never install or manipulate wiring during electrical storms.

▸ Never install electrical jacks in wet locations unless the jacks are specifically designed for wet environments.

▸ Operate the device only when it is properly grounded.

▸ Ensure that the separate protective earthing terminal provided on this device is permanently connected to earth.

▸ Replace fuses only with fuses of the same type and rating.

▸ Do not open or remove chassis covers or sheet-metal parts unless instructions are provided in the hardware documentation for this device. Such an action could cause severe electrical shock.

▸ Do not push or force any objects through any opening in the chassis frame. Such an action could result in electrical shock or fire.

▸ Avoid spilling liquid onto the chassis or onto any device component. Such an action could cause electrical shock or damage the device.

▸ Avoid touching uninsulated electrical wires or terminals that have not been disconnected from their power source. Such an action could cause electrical shock.

▸ Always ensure that all modules, power supplies, and cover panels are fully inserted and that the installation screws are fully tightened.

Bill of Materials

It is recommended to make or source these parts out of aluminum, however they can be 3d printed as well:

❑ Key for J3 Motor Shaft

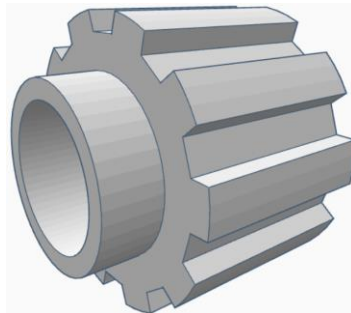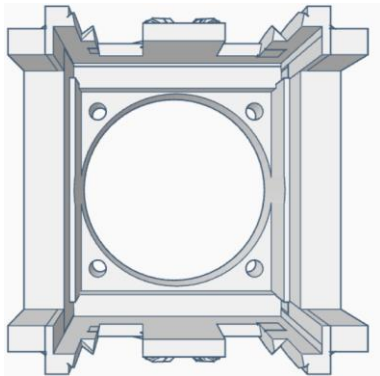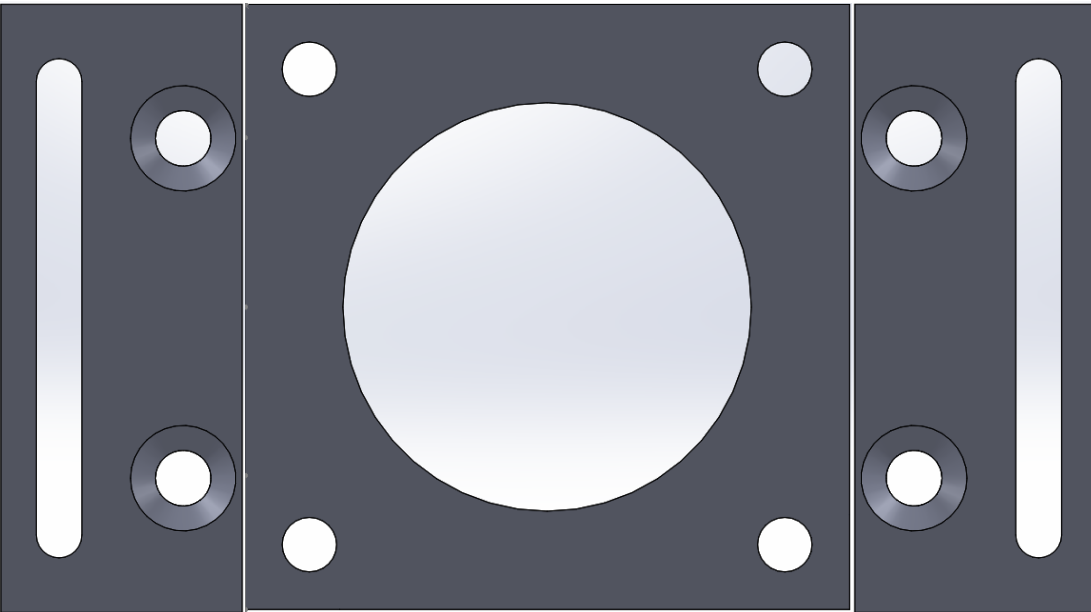❑ L10 Pulley (J3 long pulley), 14mm inner bore dimeter *

3D print these parts:

❑ J3 Front Spacer

❑ J3 Side Spacer (2)

❑ J3 motor bracket

❑ Key for J3 motor shaft (to fabricate the aluminum one)

❑ Tool for alignment (2)

Optional helpful tools:

❑ V-drill guides, Metric or ANSI

*It is highly recommended to reuse the J3 pully on the old J3 motor or source a new one from Annin Robotics (info@anninrobotics.com)

You will need to extend the pully's inner shaft diameter to 14mm

Size: **M4x90mm**

Required parts:
- ❑ M4 x 90 socket head screws (4)
- ❑ M4 x 8 set screw (1)
- ❑ M5x20 hex flat head screws (4)
- ❑ 6 x 6 x 0.236 aluminum sheet (1)
- ❑ HK1612 Needle Roller Bearing (1)
- ❑ CL-34-SS Shoulder Screw Diameter 5/8, Length 5/8 (1)

Required tools:
- ❑ Center punch
- ❑ 3.5 mm (9/64 0.1406) drill bit
- ❑ 11.11 mm (7/16 inch) drill bit
- ❑ 14mm (9/16 0.5511) drill bit
- ❑ <=5mm (3/16 0.1968) mill bit
- ❑ M4 tap
- ❑ M5 tap
- ❑ 12.7 mm - 13 TPI (1/2 inch - 13 TPI) UNC tap

Metric Alloy Steel Hex Drive Flat Head Screws

Lg., mm	Threading	Min. Thread Lg., mm	Head Dia., mm	Head Ht., mm	Drive Size, mm	Tensile Strength, psi	Specifications Met	Pkg. Qty.		Pkg.
Black-Oxide Class 10.9 Alloy Steel—90° Countersink Angle										
M4 × 0.7 mm										
14	Fully Threaded	—	8	2.3	2.5	120,000	DIN 7991, ISO 10642	100	91294A193	12.50
16	Fully Threaded	—	8	2.3	2.5	120,000	DIN 7991, ISO 10642	100	91294A194	7.57
18	Fully Threaded	—	8	2.3	2.5	120,000	DIN 7991, ISO 10642	100	91294A195	12.89
20	Fully Threaded	—	8	2.3	2.5	120,000	DIN 7991, ISO 10642	100	91294A196	8.93
22	Fully Threaded	—	8	2.3	2.5	120,000	DIN 7991, ISO 10642	50	91294A197	13.52
25	Fully Threaded	—	8	2.3	2.5	120,000	DIN 7991, ISO 10642	100	91294A198	10.91
30	Fully Threaded	—	8	2.3	2.5	120,000	DIN 7991, ISO 10642	100	91294A200	17.91
35	Fully Threaded	—	8	2.3	2.5	120,000	DIN 7991, ISO 10642	50	91294A202	11.59
40	Fully Threaded	—	8	2.3	2.5	120,000	DIN 7991, ISO 10642	50	91294A204	12.85
45	Fully Threaded	—	8	2.3	2.5	120,000	DIN 7991, ISO 10642	50	91294A484	16.75
50	Fully Threaded	—	8	2.3	2.5	120,000	DIN 7991, ISO 10642	25	91294A537	15.58
M5 × 0.8 mm										
6	Fully Threaded	—	10	2.8	3	120,000	DIN 7991, ISO 10642	25	91294A541	8.00
8	Fully Threaded	—	10	2.8	3	120,000	DIN 7991, ISO 10642	100	91294A207	8.96
10	Fully Threaded	—	10	2.8	3	120,000	DIN 7991, ISO 10642	100	91294A208	10.35
12	Fully Threaded	—	10	2.8	3	120,000	DIN 7991, ISO 10642	100	91294A210	10.35
14	Fully Threaded	—	10	2.8	3	120,000	DIN 7991, ISO 10642	100	91294A211	10.36
16	Fully Threaded	—	10	2.8	3	120,000	DIN 7991, ISO 10642	100	91294A212	10.56
18	Fully Threaded	—	10	2.8	3	120,000	DIN 7991, ISO 10642	100	91294A213	15.00
20	Fully Threaded	—	10	2.8	3	120,000	DIN 7991, ISO 10642	100	**91294A214**	11.93

Black-Oxide Alloy Steel Hex Drive Flat Head Screw, 90 Degree Countersink, M5 x 0.80 mm Thread, 20 mm Long

Packs of 100

ADD TO ORDER

Delivers Tuesday

Stock photo for illustration purposes
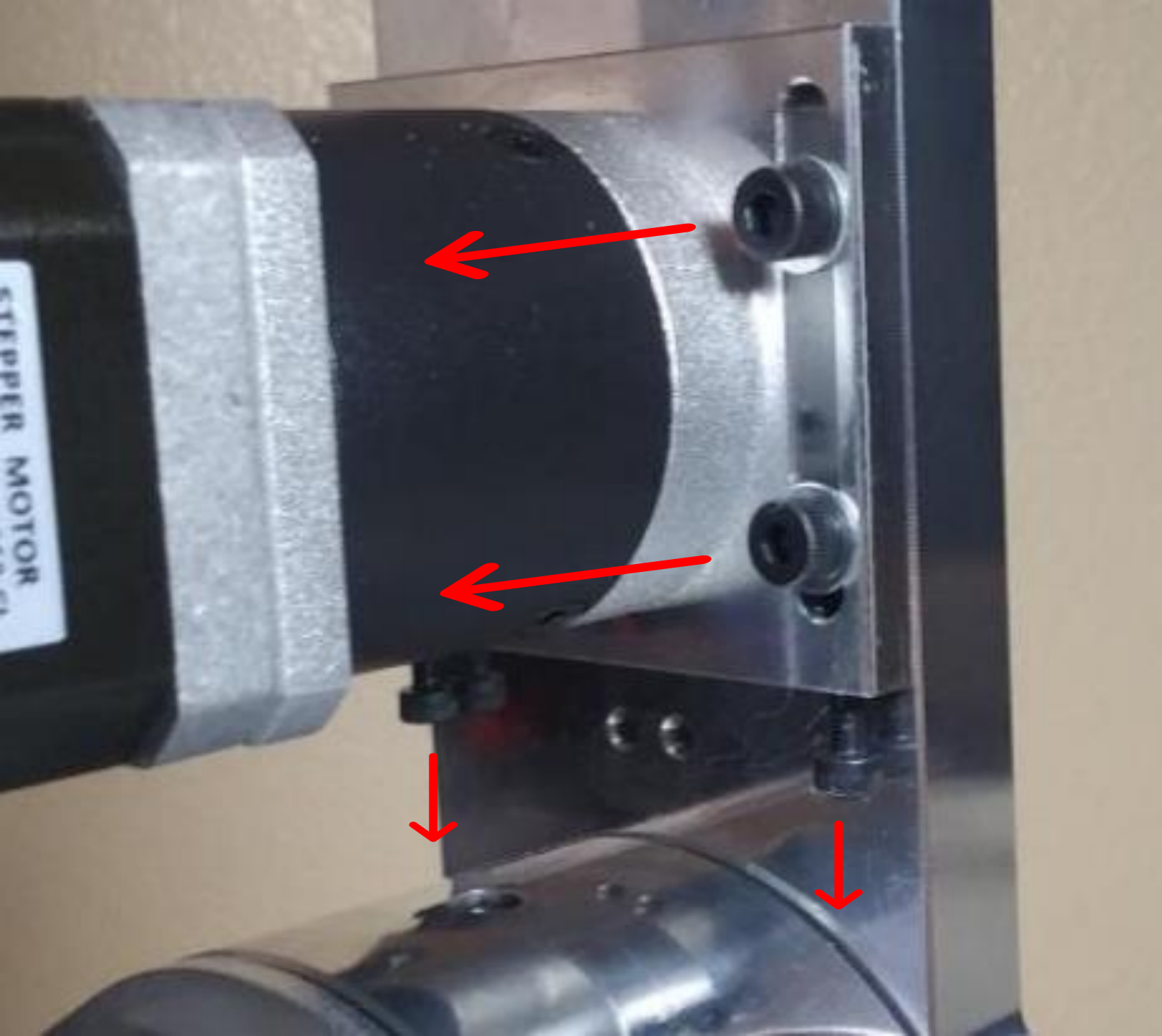
For hand drilling, use a metric or ANSI drill guide based on your bit set. Clamp it over the drilling spot for alignment and stability.

Motor Assembly Instructions

Undo the steps for installing the J3 motor
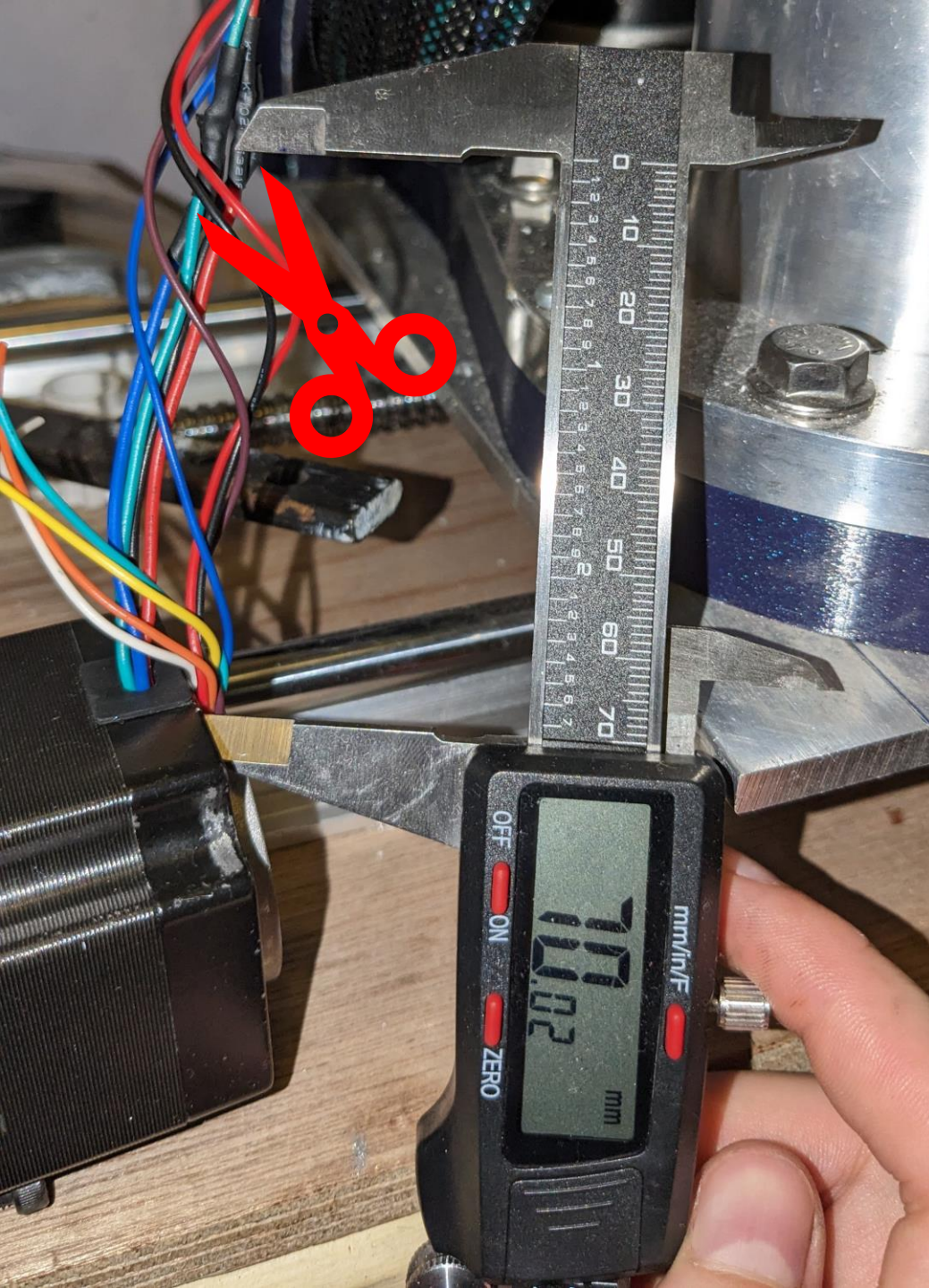
>>

Remove J3 arm top and bottom cover
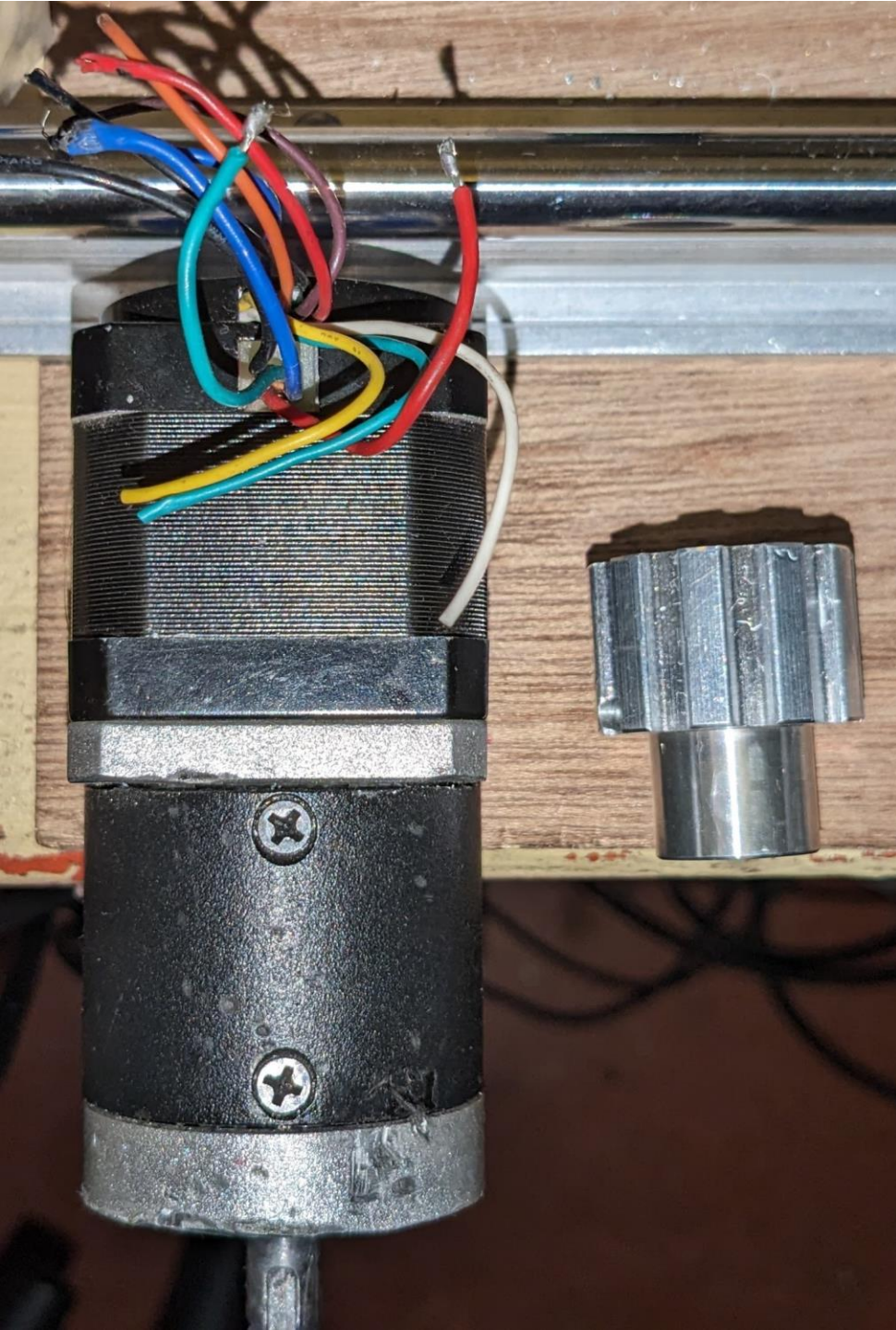
>>

Unscrew and remove motor mount
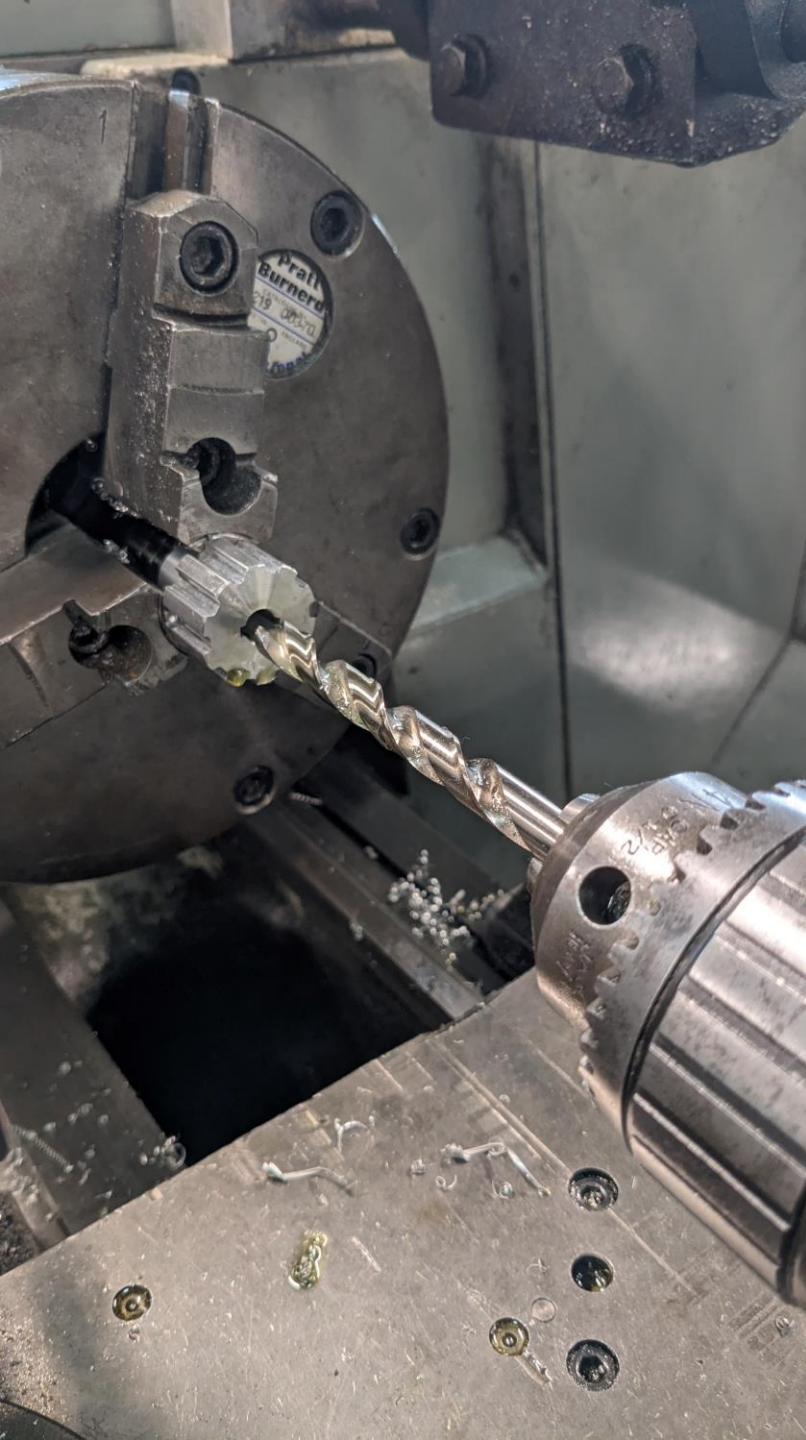
>>

Remove the belt

>>

Save the screws as they will be reused in future steps

Using wire cutters, cut the encoder and motor wires 70 mm away from the motor

Remove the J3 pully off the motor shaft

There are many ways to expand the shaft diameter using a drill, drill press, end mill, and lathe. This example shows a lathe.

Enlarge the hole starting with a smaller drill bit working up to a larger bit. This allows for more precise alignment and centering of the hole.
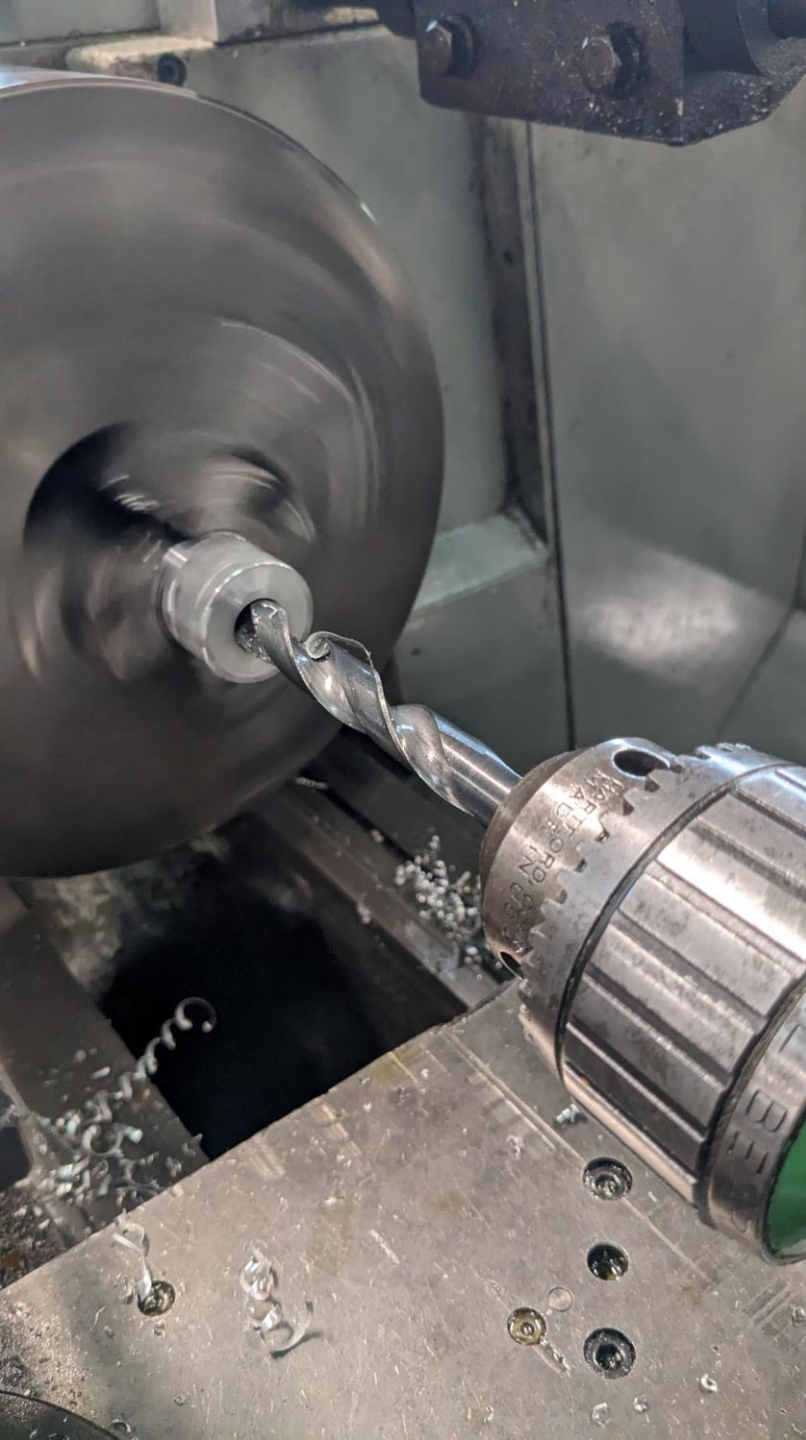
Each subsequent drill bit then follows the path of the previous one, ensuring that the hole remains true to the desired location and orientation

Continue this process up to a 14mm drill bit.

If you don't have a 14mm drill bit, you may use a boring bar once the shaft hole is large enough for it to fit inside. Manually expand the hole to 14.1mm

Tolerance is +0.05mm, -0.0mm

Using the 3D printed key, trace an outline onto the 6mm thick aluminum sheet

>>

Use a center punch to mark the location where the screw will be inserted

>>

Drill and tap the marked spot for the M4 set screw

>>

Cut the aluminum into a rough rectangular shape using a saw

>>

Refine the edges of the aluminum piece using a sander to match the outline of the key
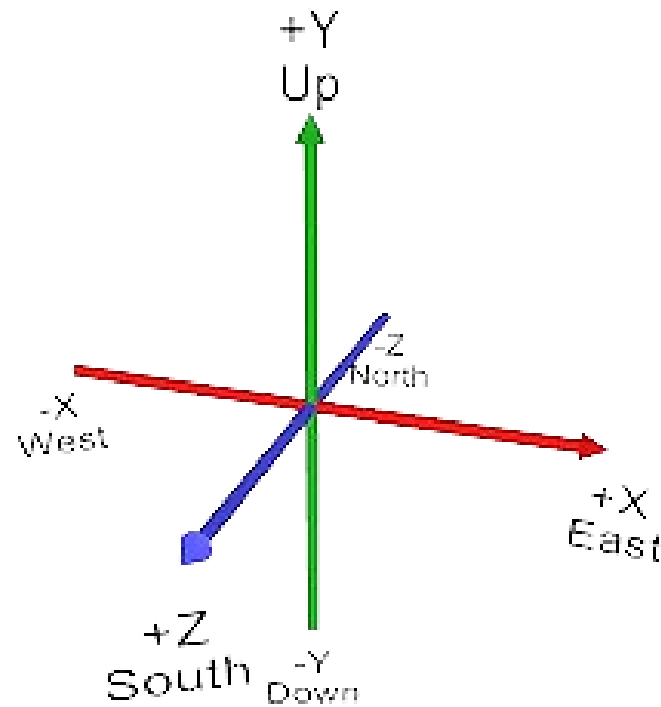
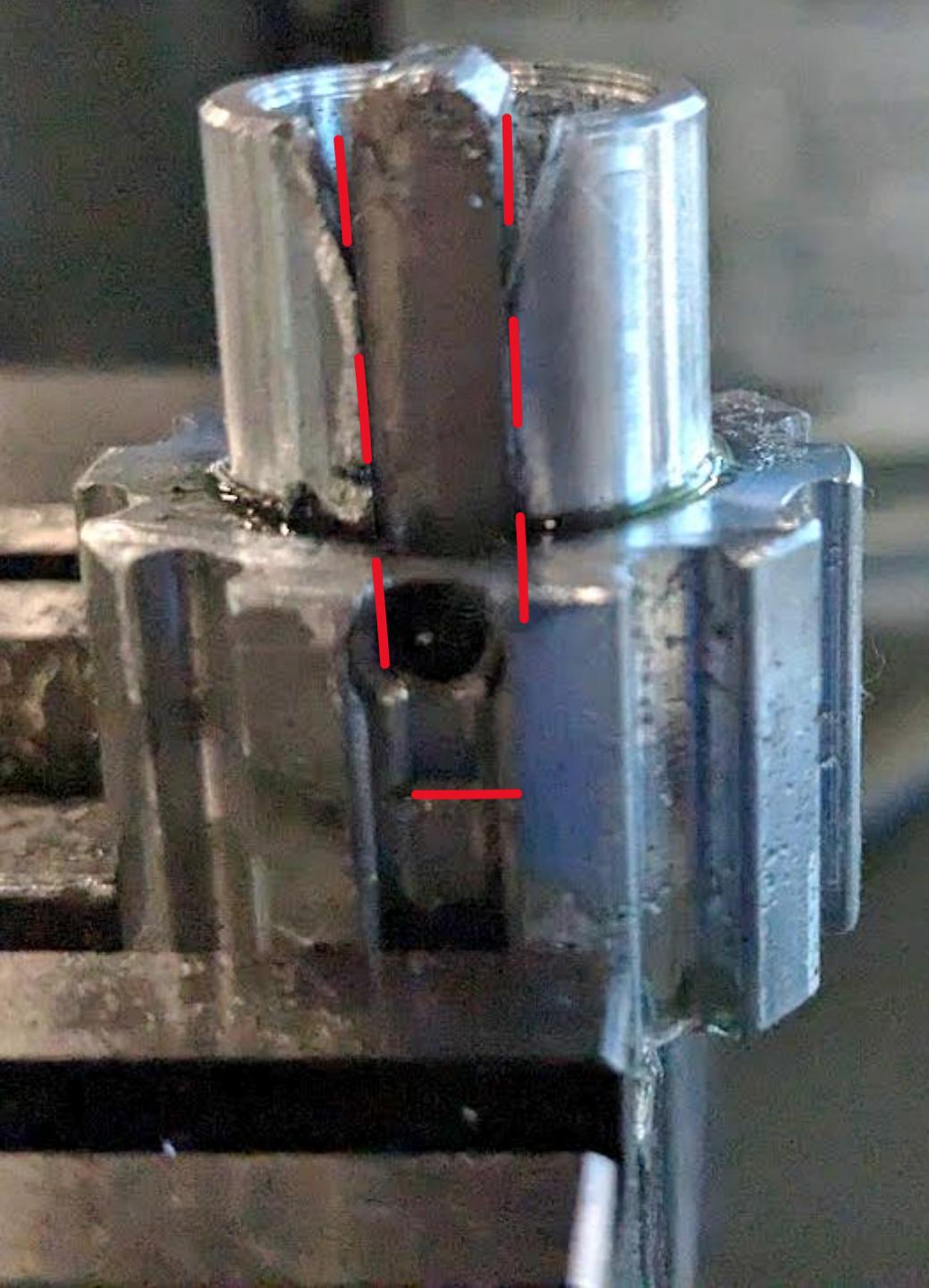Insert the set screw into the key and pully to verify that the key is held by the screw in the pully

Using a scribe, razor, etc.., mark lines on the pulley to guide cutting into the pully

Mill into J3 Pully using a <=5mm mill bit

+Z 3.25mm (Going towards the screw hole)

-Y 21.8mm

+X 2.5mm, -X -2.5 (Slot needs to be 5mm wide)

*This photo shows an edge finder bit, not a mill bit

Debur the key and pully

Ensure the key's screw hole aligns with the pulley screw hole.

The m4 set screw should screw through the pully into the key.

Insert the set screw into the pulley
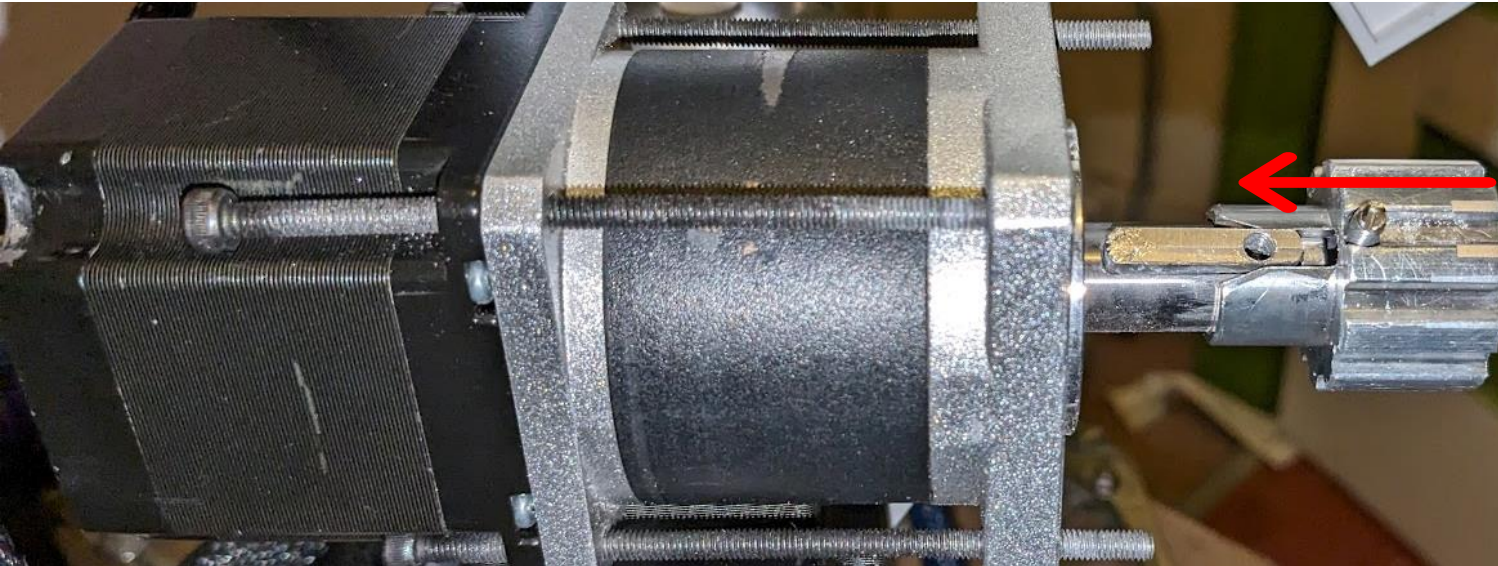
>>

Insert the key into the key slot
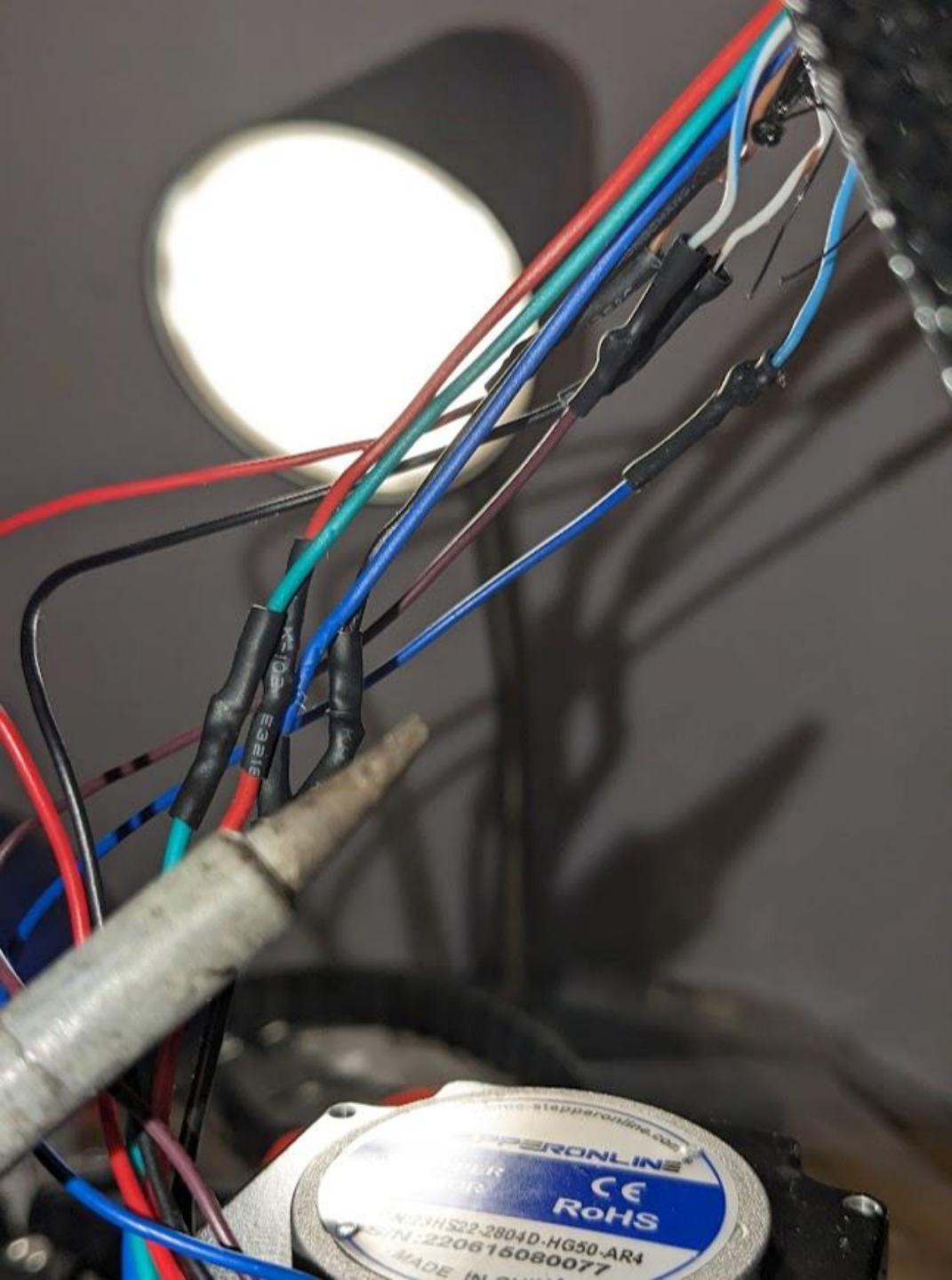
>>

Slide the J3 pully over the motor shaft

>>

Tighten the set screw

>>

The motor and pully are complete

Solder and heat shrink the connection from the J3 encoder to the Cat6 cable as follows:

Encoder red wire to the cable brown wire.

Encoder black wire to the cable white – brown stripe wire.

Encoder brown wire to the cable white – blue stripe wire.

Encoder blue wire to the cable blue wire

Solder the connection between the J3 motor and the motor wires, and then apply heat shrink tubing for insulation

Be sure to match colors so that red goes to red and so on.

These settings are used for the J3 Motor Driver:

J3 – (DM542T):
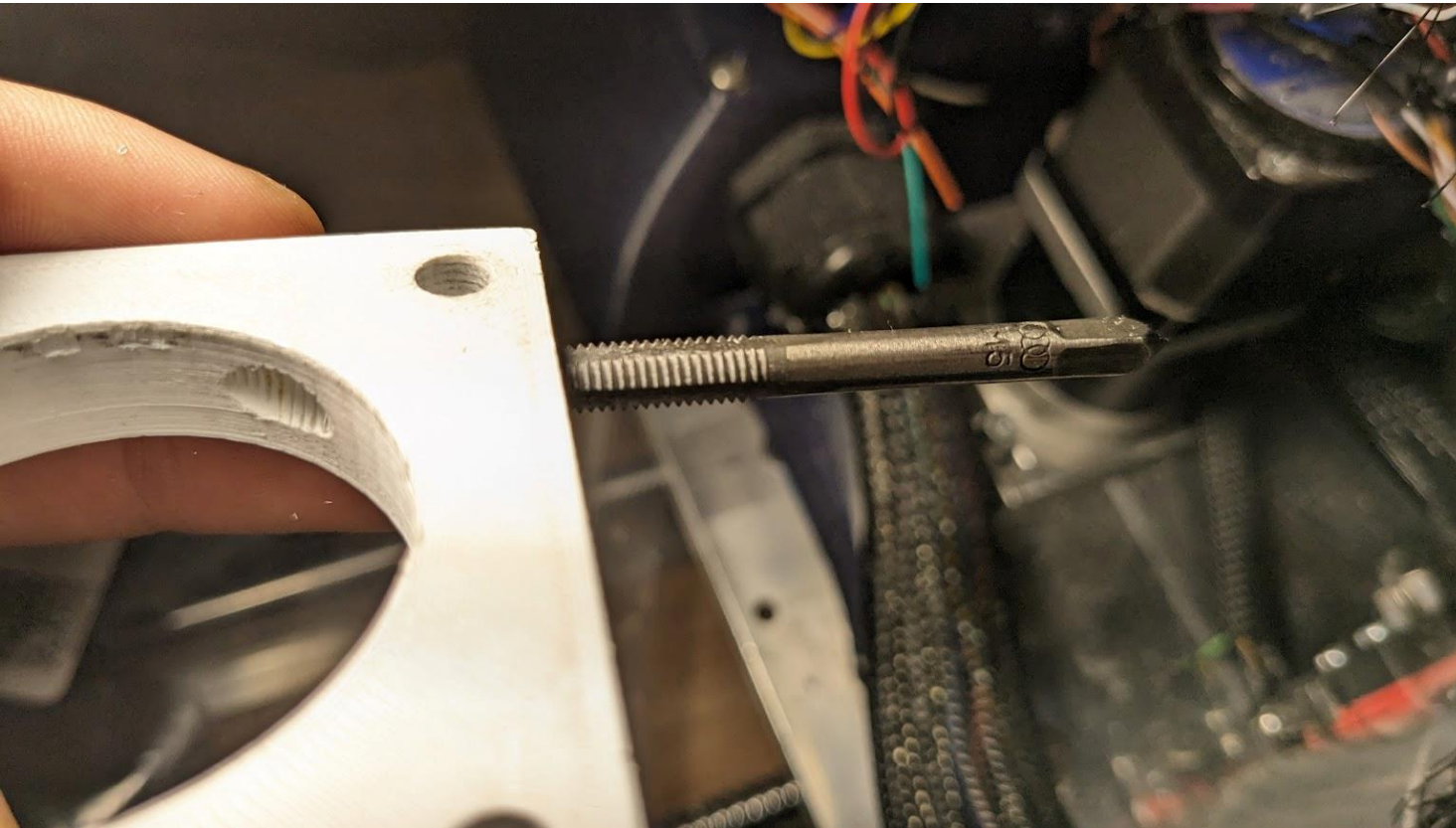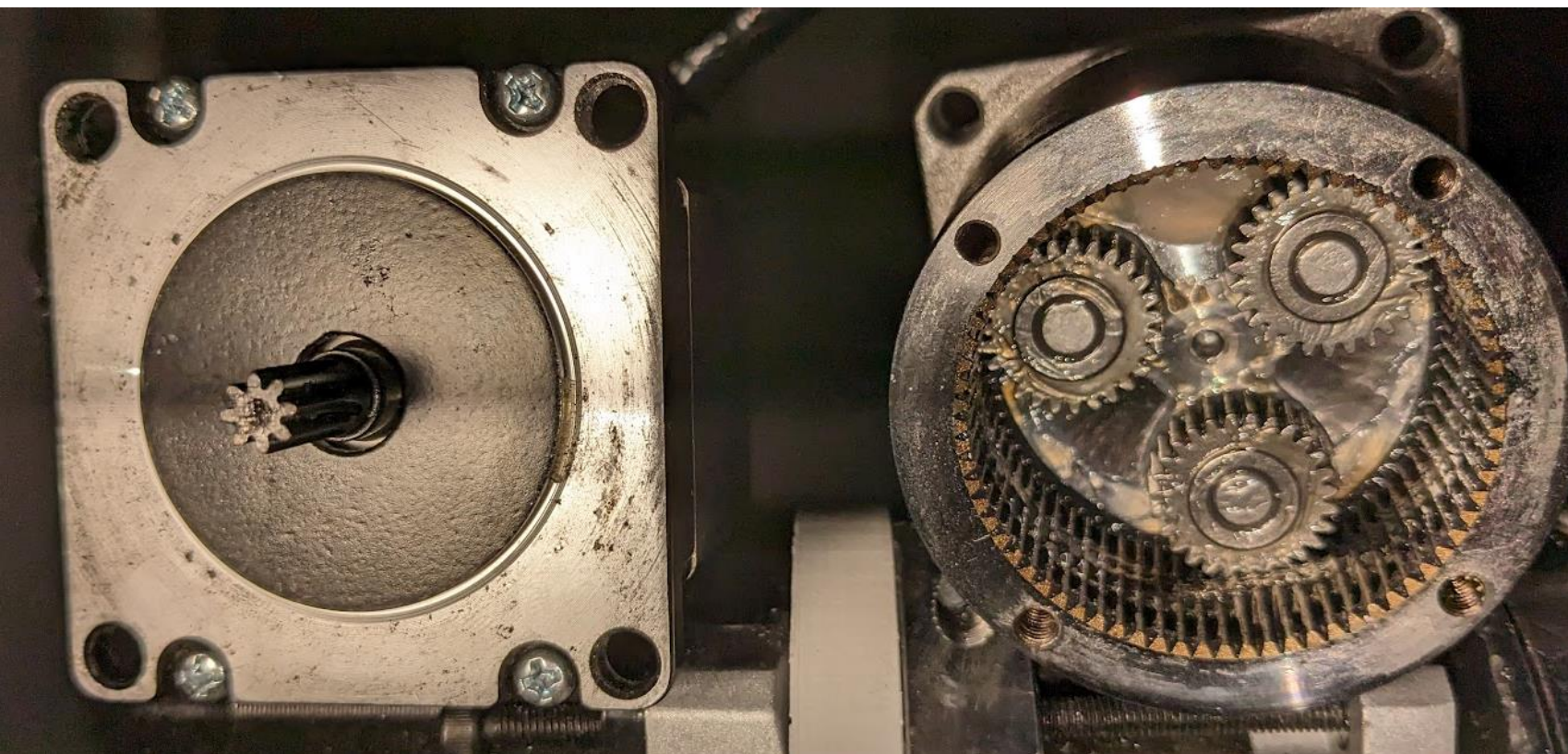
SW1 = OFF

SW2 = OFF

SW3 = ON

SW4 = ON

SW5 = OFF
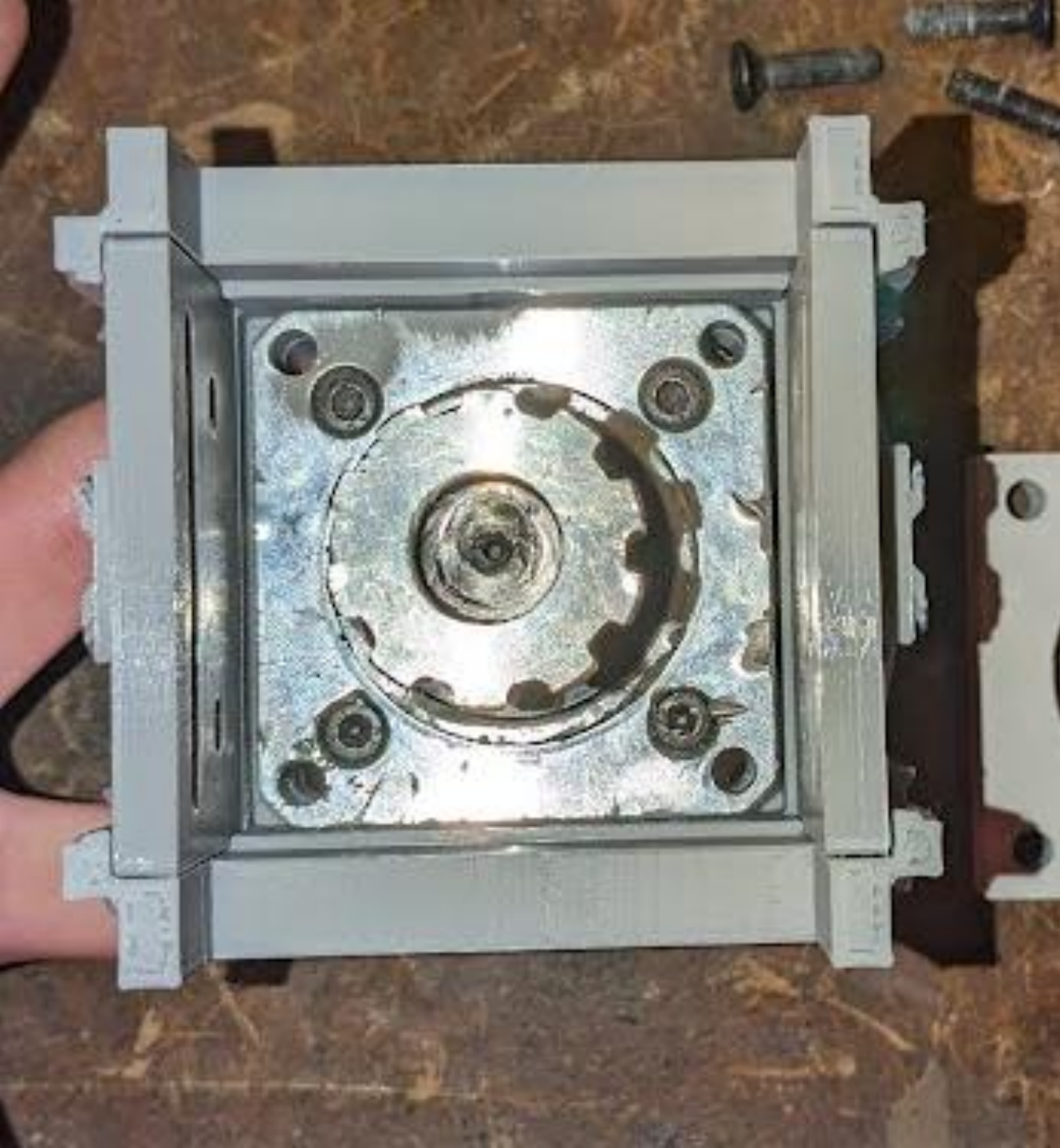
SW6 = ON

SW7 = ON

SW8 = ON

Using an M5 tap, tap the holes that guide into the shaft in the J3 Front Spacer

Remove the motor's default screws, then disassemble the motor and gearbox

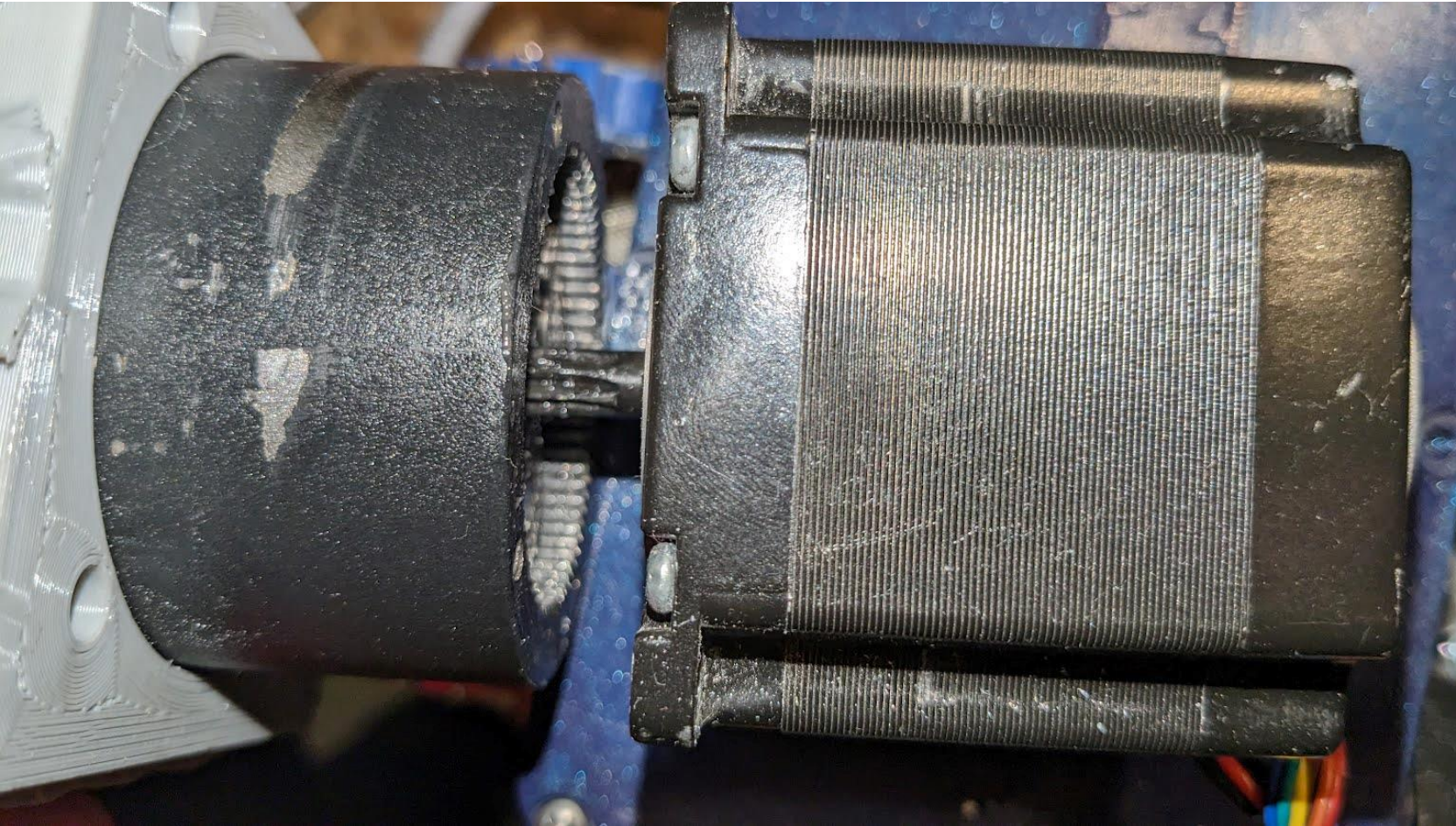Be careful to avoid removing the inner gears from the gearbox, as was mistakenly done in the example

Holding the gears in the gearbox, slide the outer motor bracket on the gearbox shaft

\>\>

Insert the Side Motor Brackets
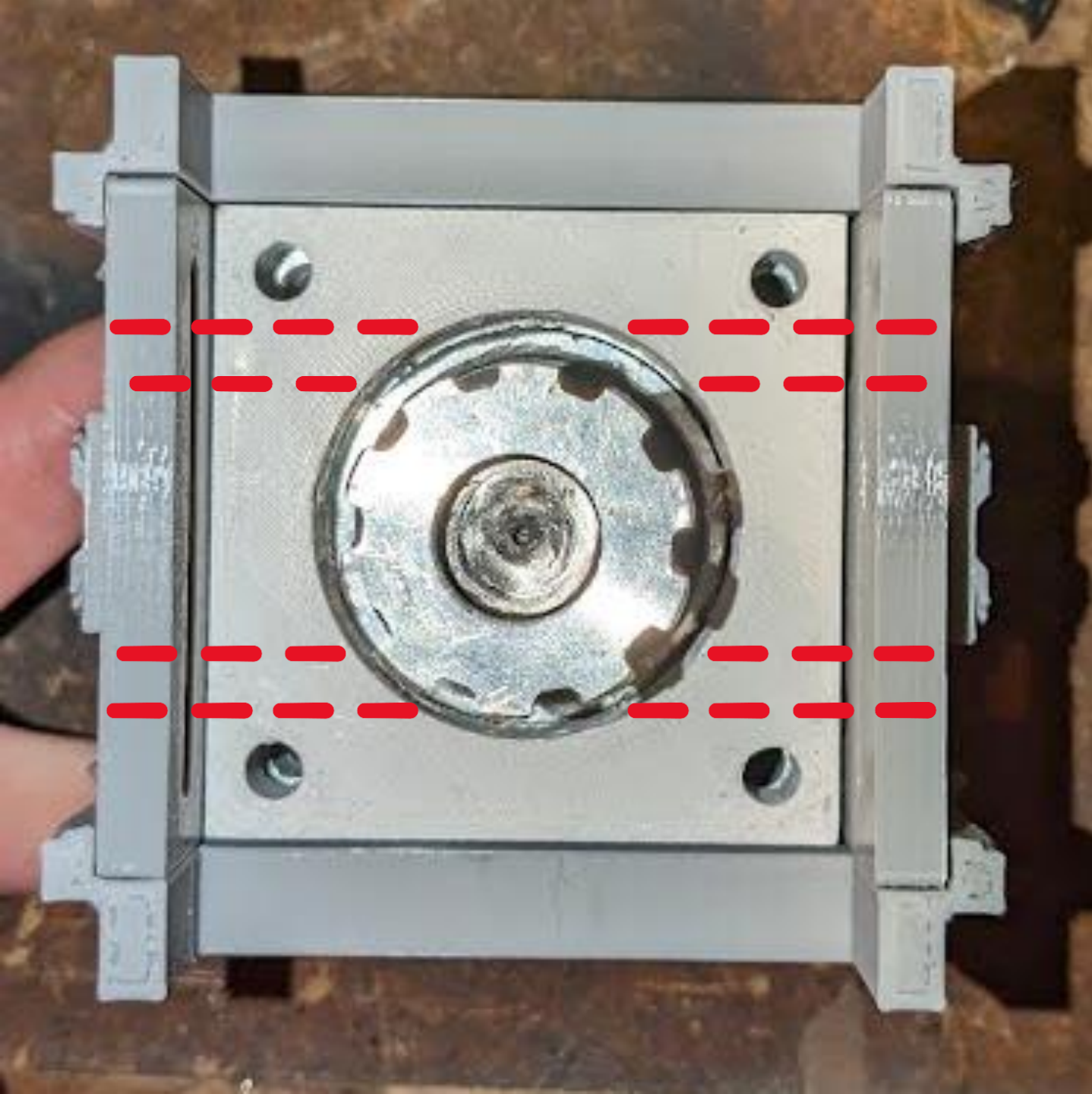
If the gears fall out of the gearbox:

The gearbox can be put back together by inserting the gears into their proper place within the gear box to the best of your ability

>>

Insert the motor shaft and power the motor, it will spin the gears into place

Screw in the gearbox closure

Insert the inner motor bracket

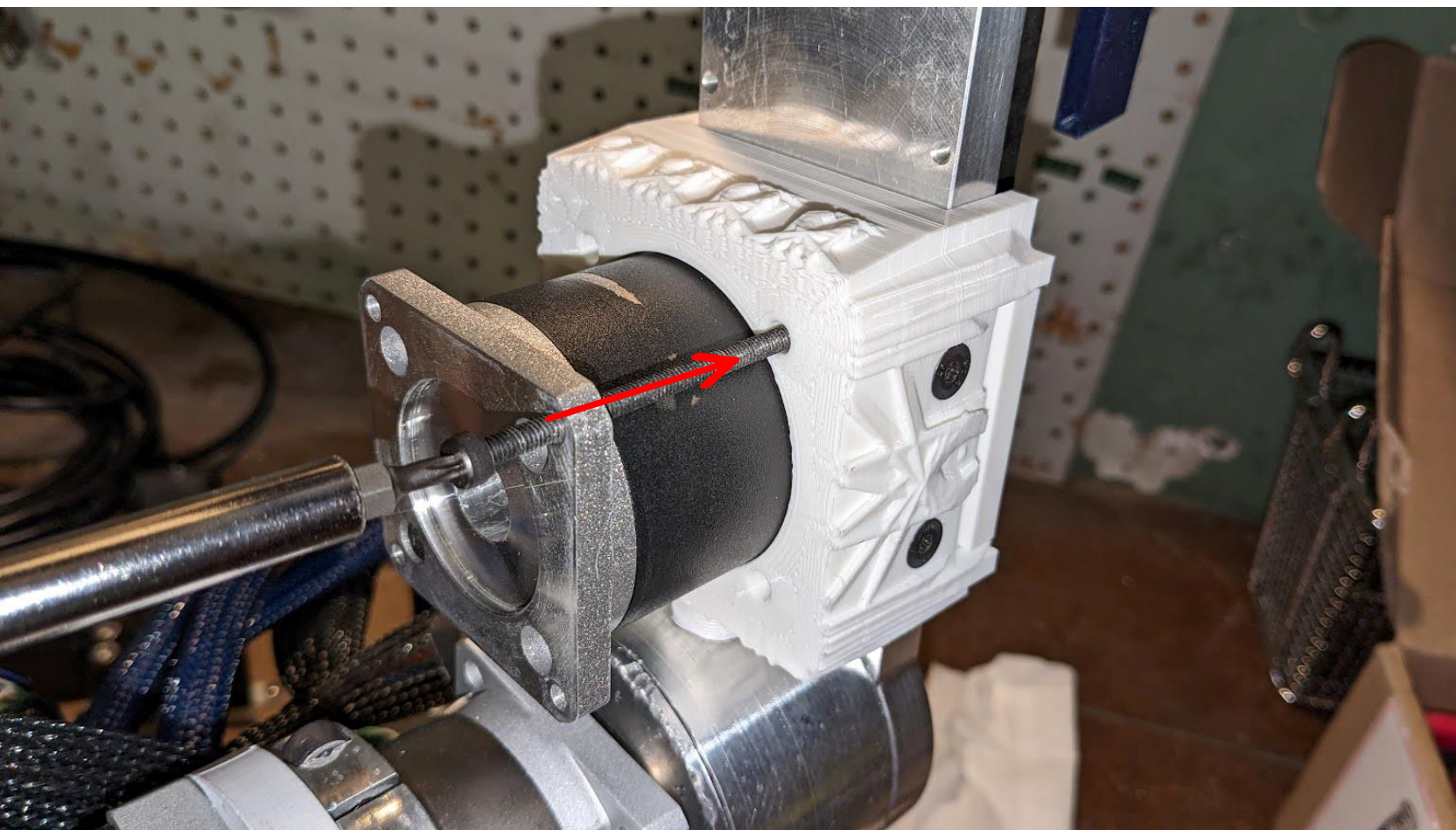Ensure the holes on the side of the outer bracket align with the holes on the side of the inner bracket

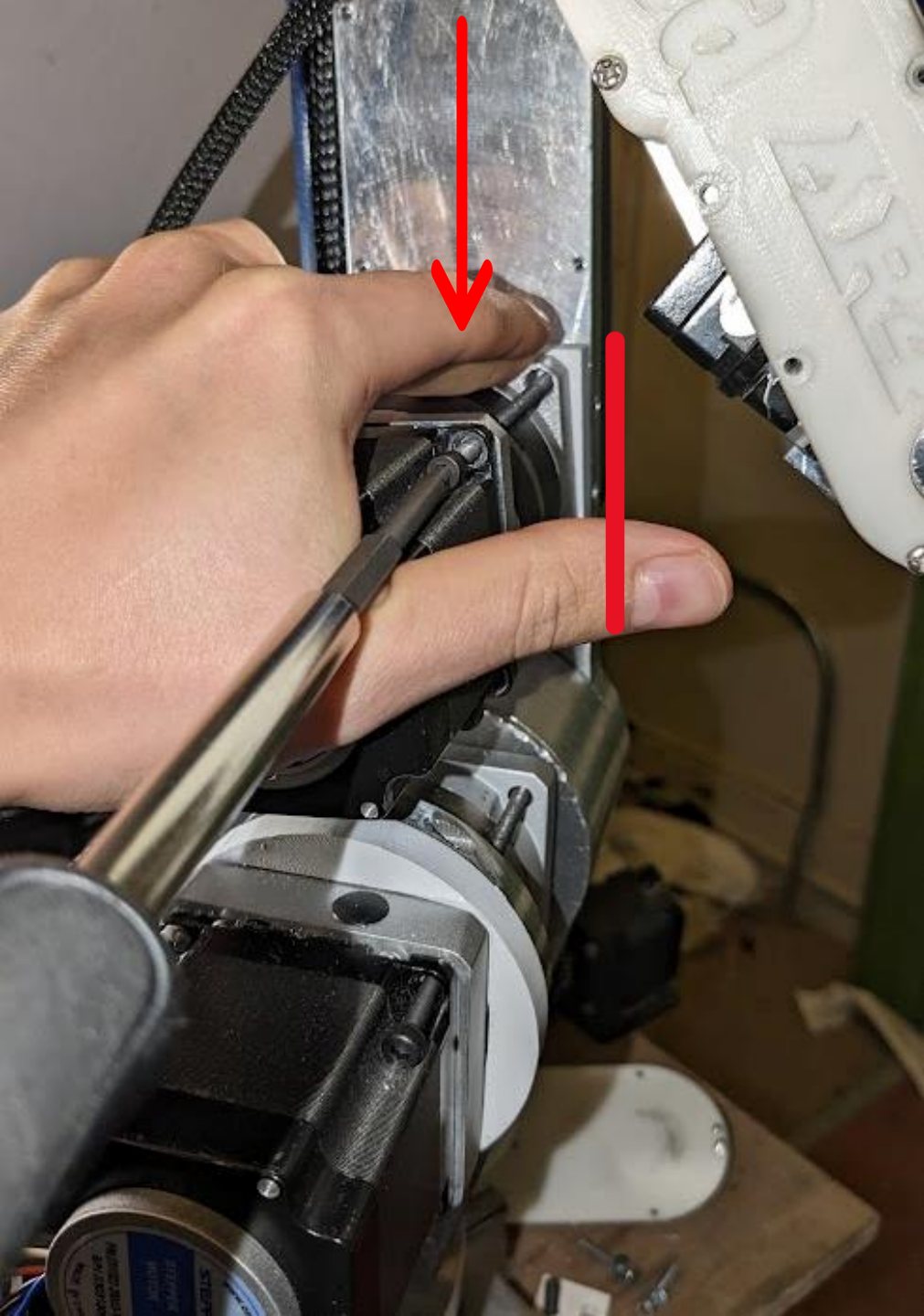Screw the four M5x20 hex flat head screws into the Motor Bracket, J3 Side Spacers, and J3 Front Spacer

Position the J3 belt over the pulleys and insert the motor into its designated J3 slot

Apply force towards the base until the belt experiences tension

Screw in four M4 x 90 mm socket head screws into motor and bracket

Maintain tension on the J3 belt by pressing the motor downward, carefully turn each M4 x 90mm screw until it lightly engraves the aluminum arm. Ensure the engraving is clear enough to serve as a visual guide for a center punch
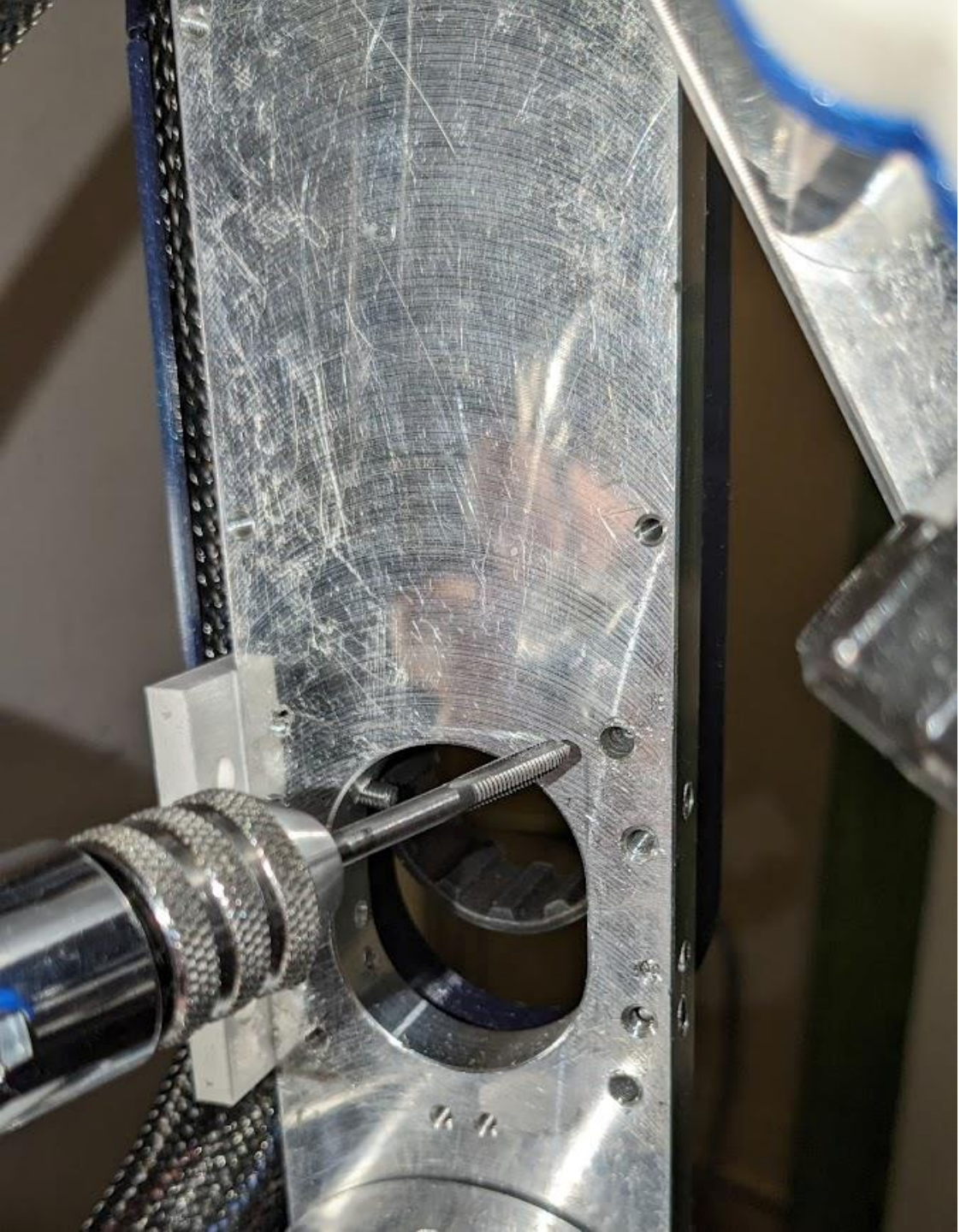
Do this for all four screws
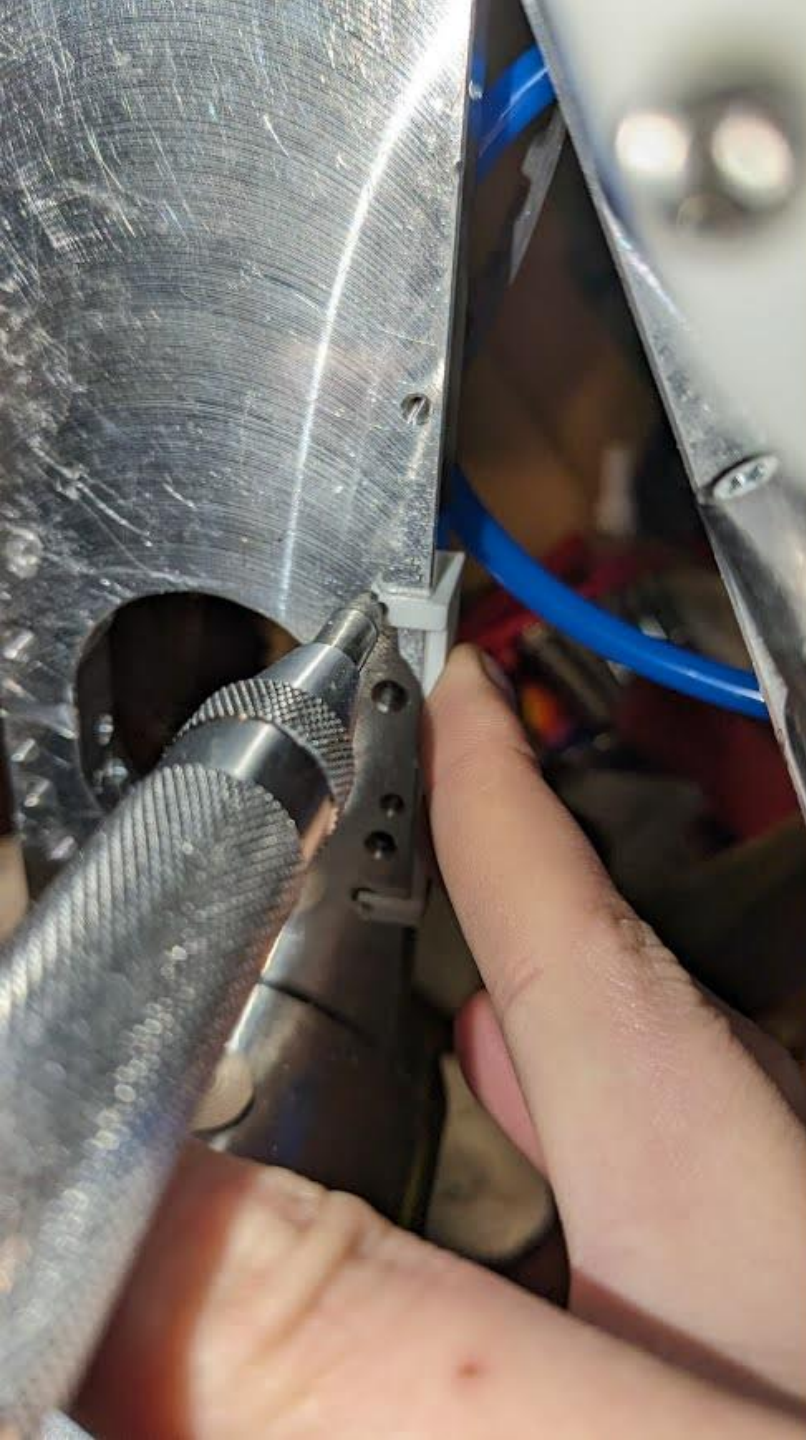
Once you have the engravings, you may use the Tool for Alignment to help steady the center punch

The tool will likely break, print two

Drill the four holes using a 3.50 mm bit

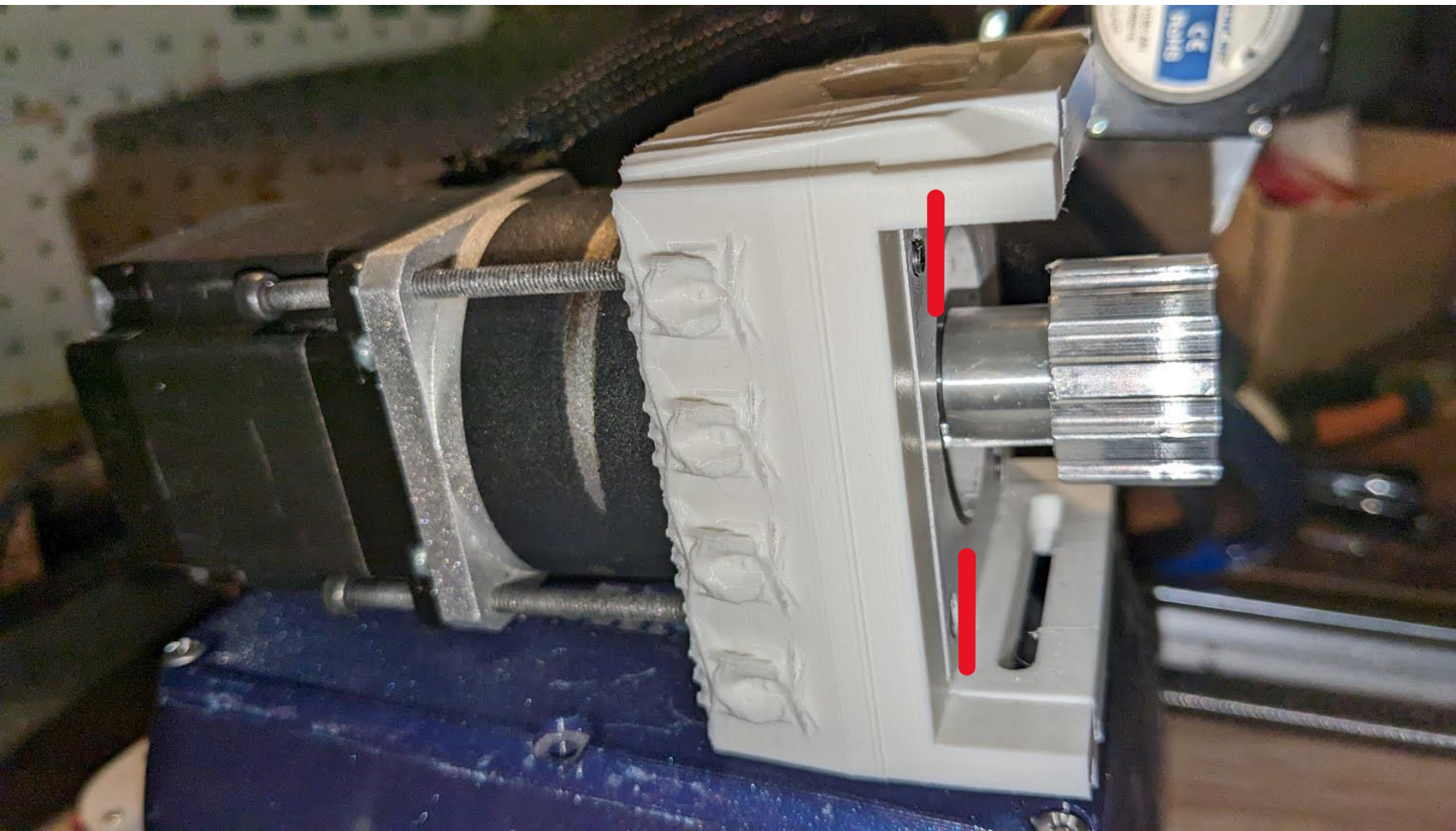You may use any bit in the range of 3.3 mm - 3.5 mm

Use an M4 tap to create threads in the drilled holes

On each side of the arm, drill two holes using 3.50 mm bit or any bit in the range of 3.3 mm - 3.5 mm

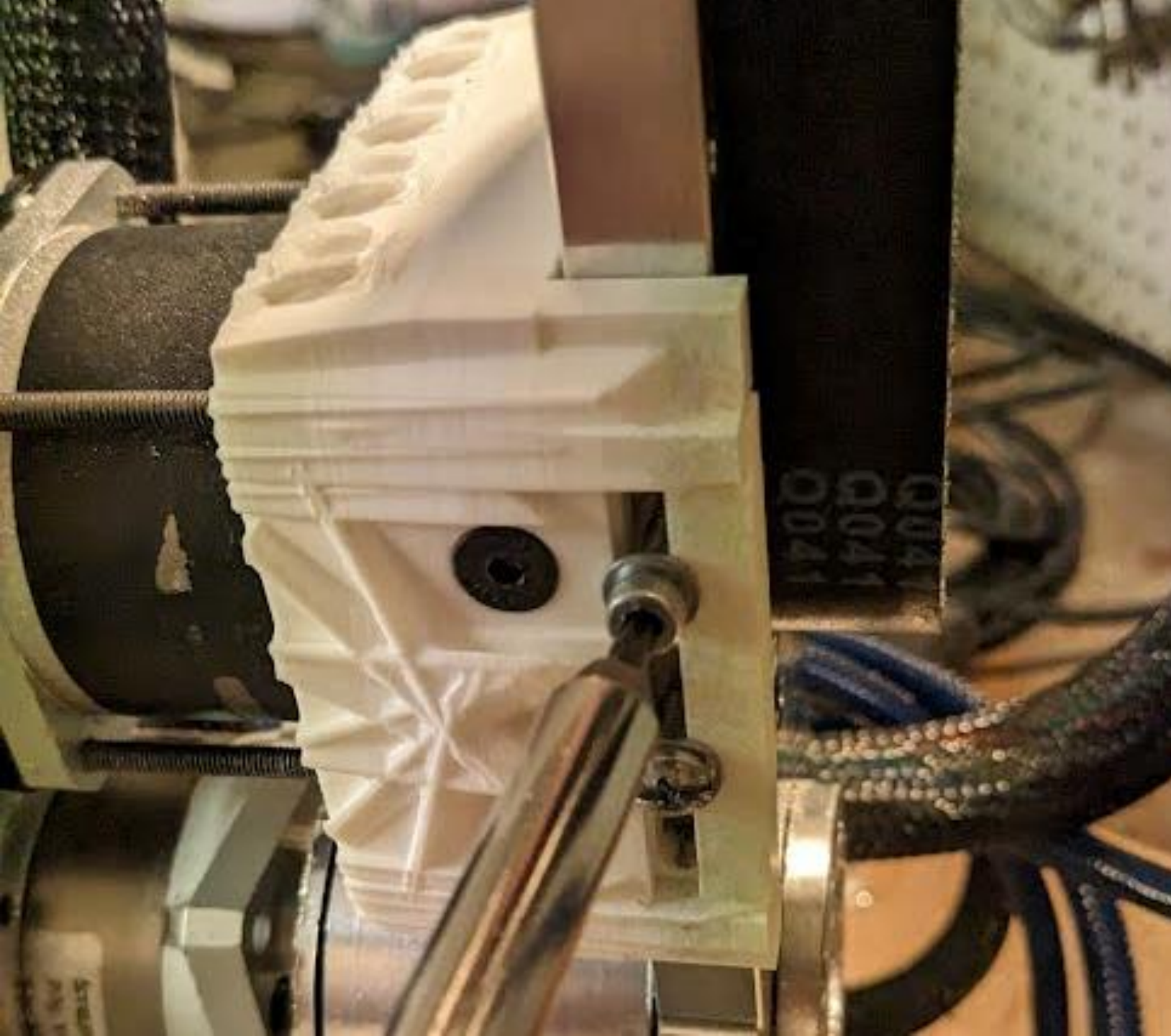Use an M4 tap to create threads in the drilled holes

Assemble the gearbox and motor using the M4x90 socket head screws

Do not screw past the motor bracket

Secure the motor to the arm by fully tightening the screws into their designated positions

Do not slide the belt on the motor yet

Use the original screws from the previous J3 mount to secure the motor to the side of the arm

Attach the belt on both pulleys

If you encounter difficulty sliding the belt onto the motor: power the motor, allowing it to rotate and catch the belt, pulling it onto the pulley

Tighten the screws securely to the top and bottom cover of your robot