

ASSEMBLY MANUAL

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You are about to begin a significant project. This project is a reproduction of the culmination of Curt Herztark's work. This calculator represents an incredible achievement during a dark period of its inventor's life.

It is hard to say what this calculator meant to Curt while he was designing it, but for me it is the embodiment of engineering and ingenuity. This device will forever hold my imagination and inspire me to design and build.

Good luck on your journey!
Marcus Wu

PRINT GUIDELINES

Please refer to the “3D Printed Parts” section of the BOM for general print settings for each part.

HOW TO GET HELP

If you need assistance with your build, our Discord group is available for your questions. This should be an excellent resource for myself and other builders to help.



Discord

<https://discord.gg/k7JcmqUPjh>

ASSEMBLY VIDEO

There is also a video detailing the assembly process on YouTube.



YouTube

<https://youtu.be/zh2Z11miQ0w>

PRINTED PARTS

FDM 3D Printers create parts by extruding plastic in layers. Each layer has a rounded shape which means vertical walls are composed of multiple rounded layers of plastic that approximate the vertical wall.

Motion against these surfaces will wear the rounded edges and change the way parts fit. I first encountered this issue while running fitment tests while planning this project.

To combat this problem, I designed the various parts to fit properly after some filing or sanding. Unfortunately, this also means that each part has to be sanded and tested against its mating parts for fit until the desired fit is achieved. It is tedious and time-consuming, but necessary for reliable function over time.

PAINTING PARTS

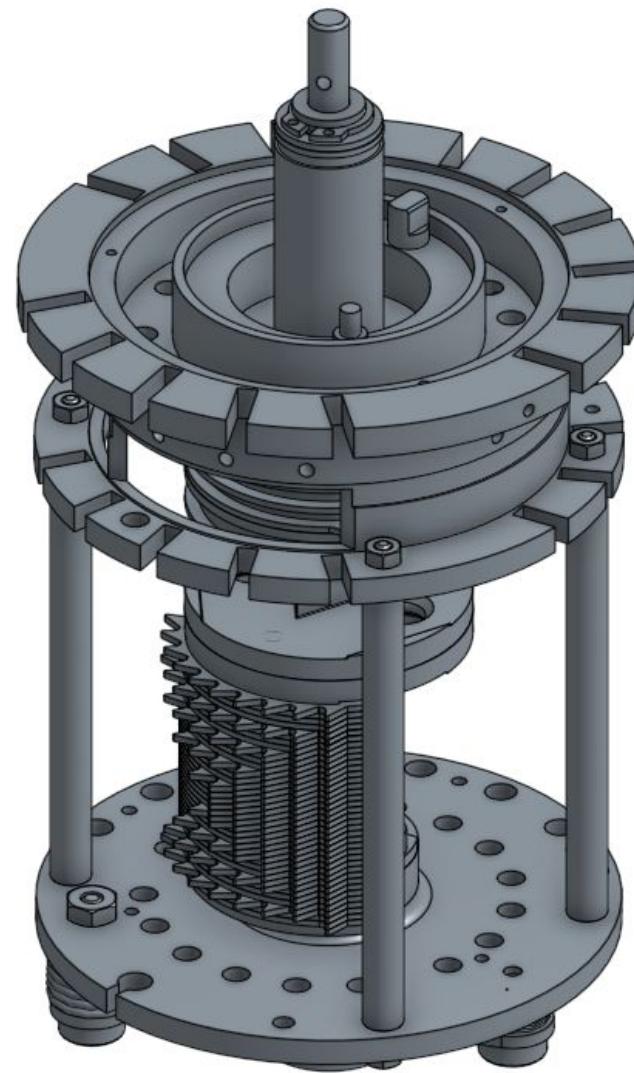
I use a combination of these two methods to prepare for painting

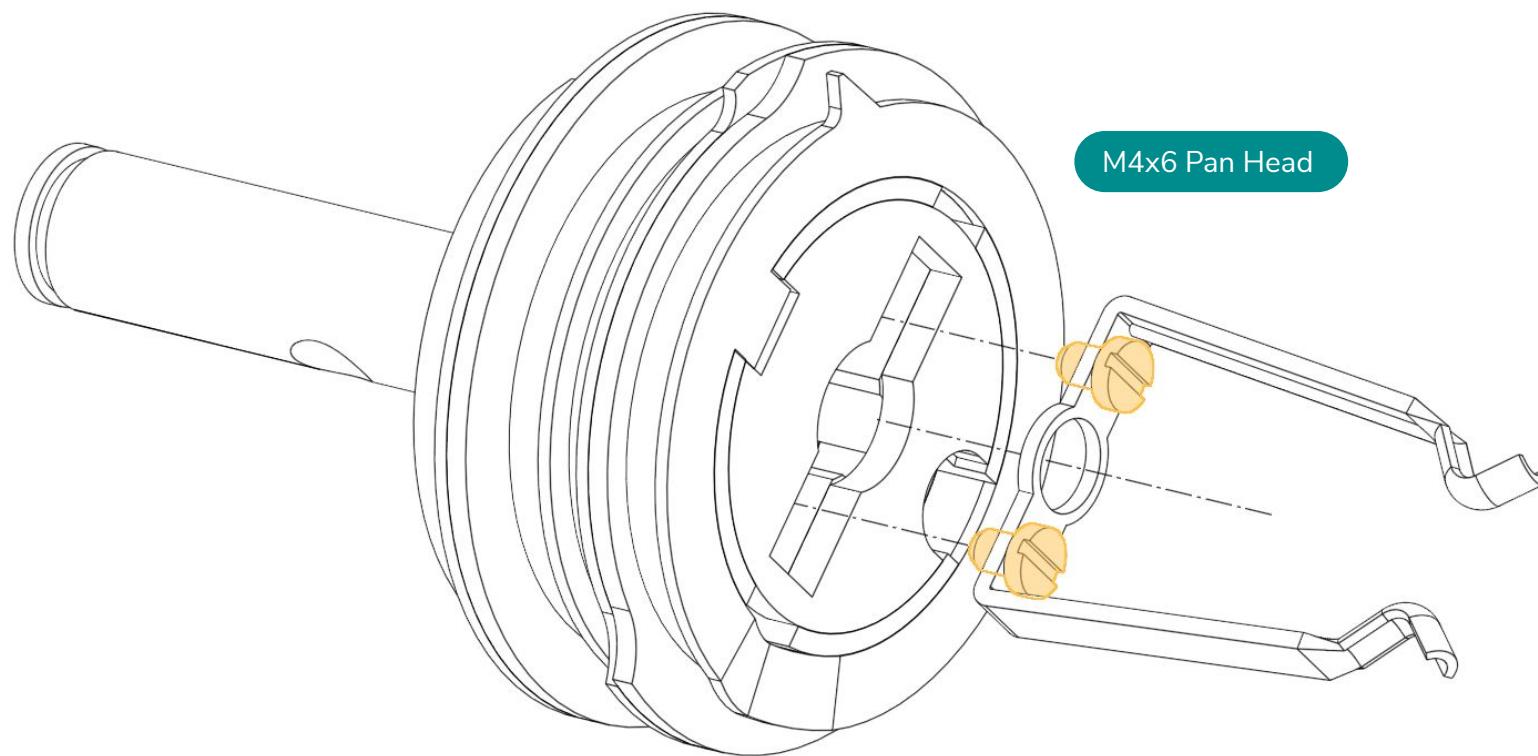
- Sand down
- Fill in

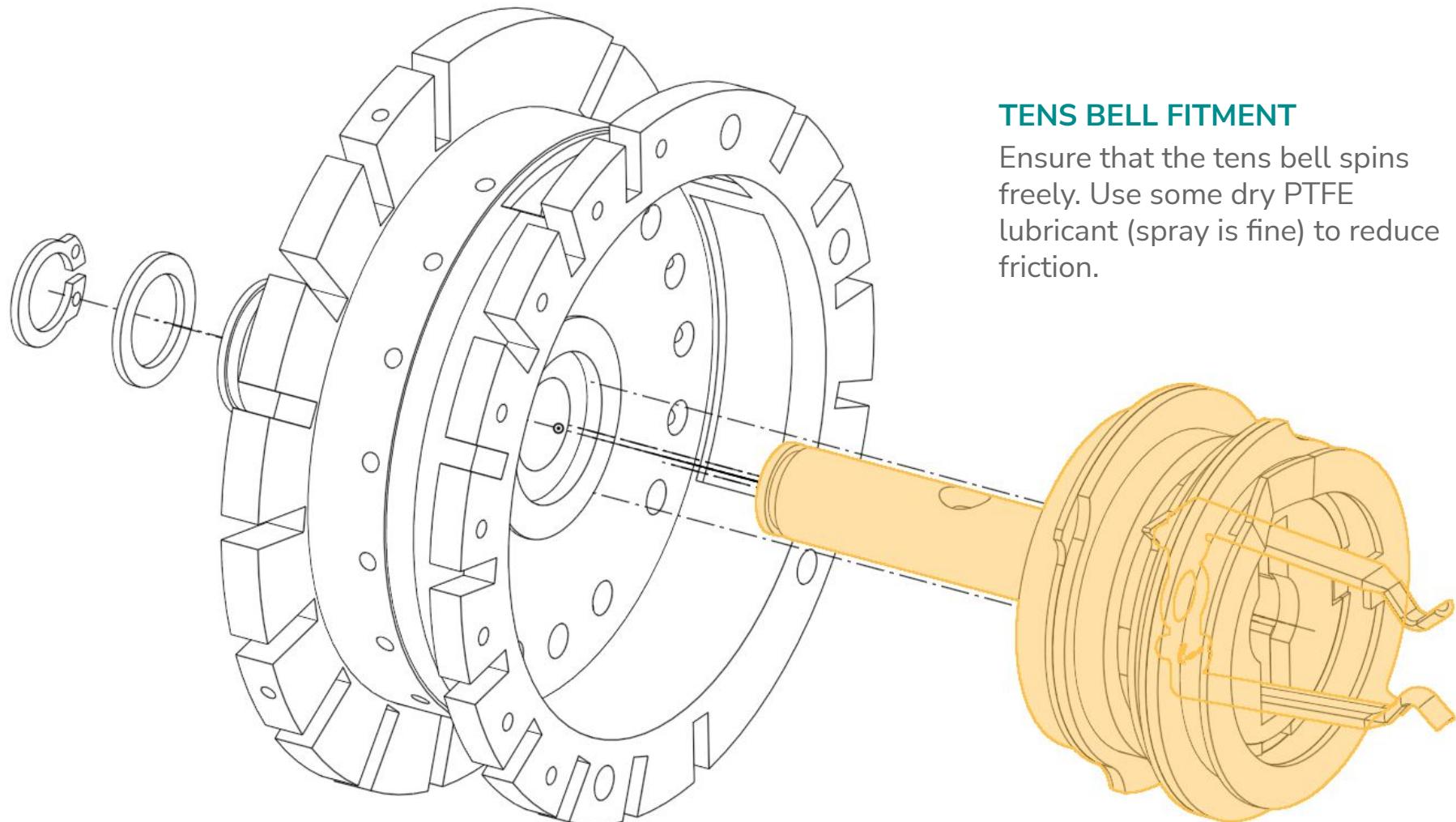
There are some great videos on how this is done. For this manual, I will list the steps I found to work for me:

- Sand with 220 grit until layers feel pretty smooth to the touch
- Use spot putty to fill in inconsistencies
- Spray with a filler primer
- Sand with 320-400 grit
- Repeat spot putty and filler primer as necessary

For painting, I used a multi layer approach. Start with a flat paint, add any details, then finish with a clear coat. I used a satin clear coat on the middle section of the Curta and gloss clear on the lower knurling as well as the upper knurling and above.

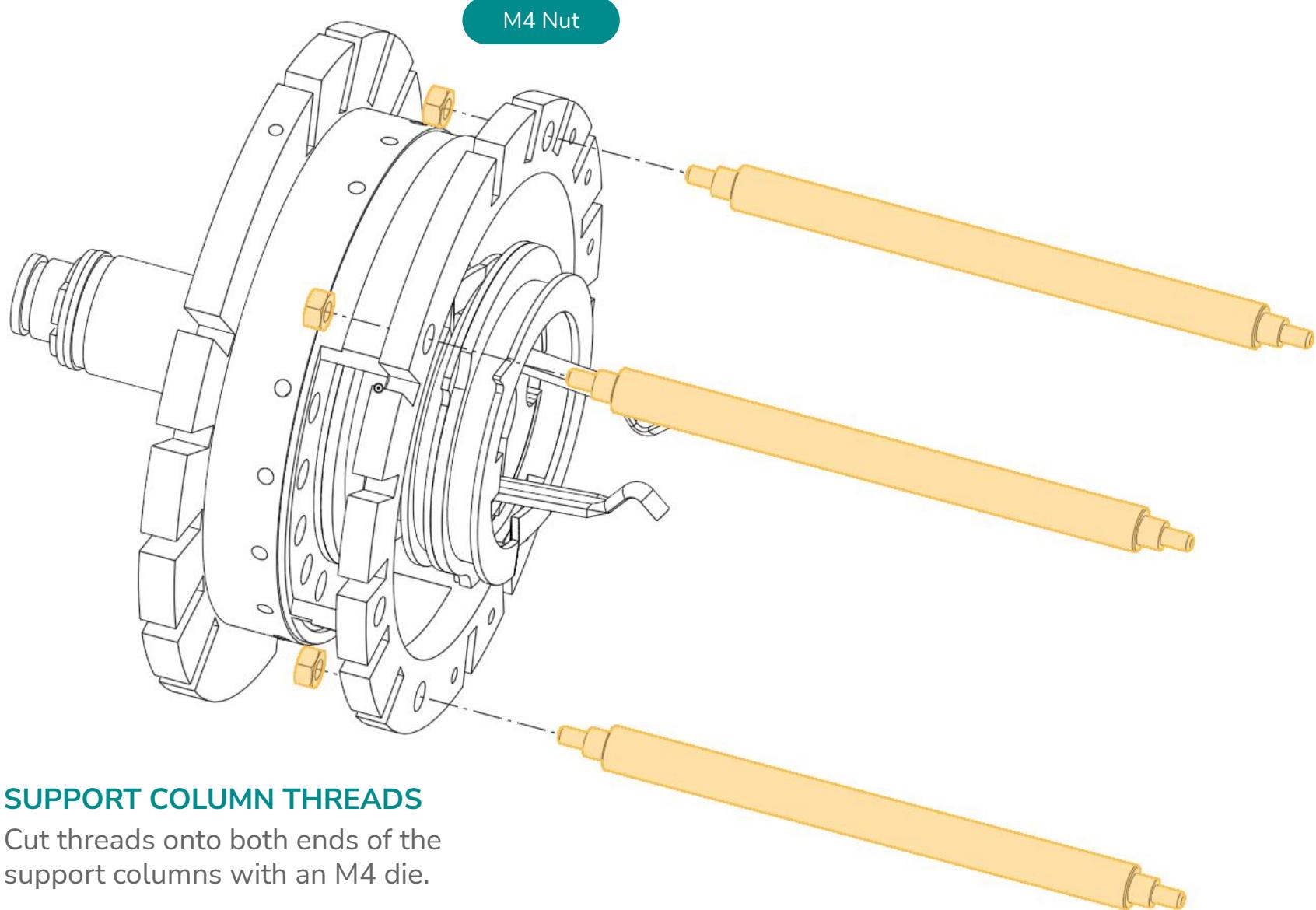






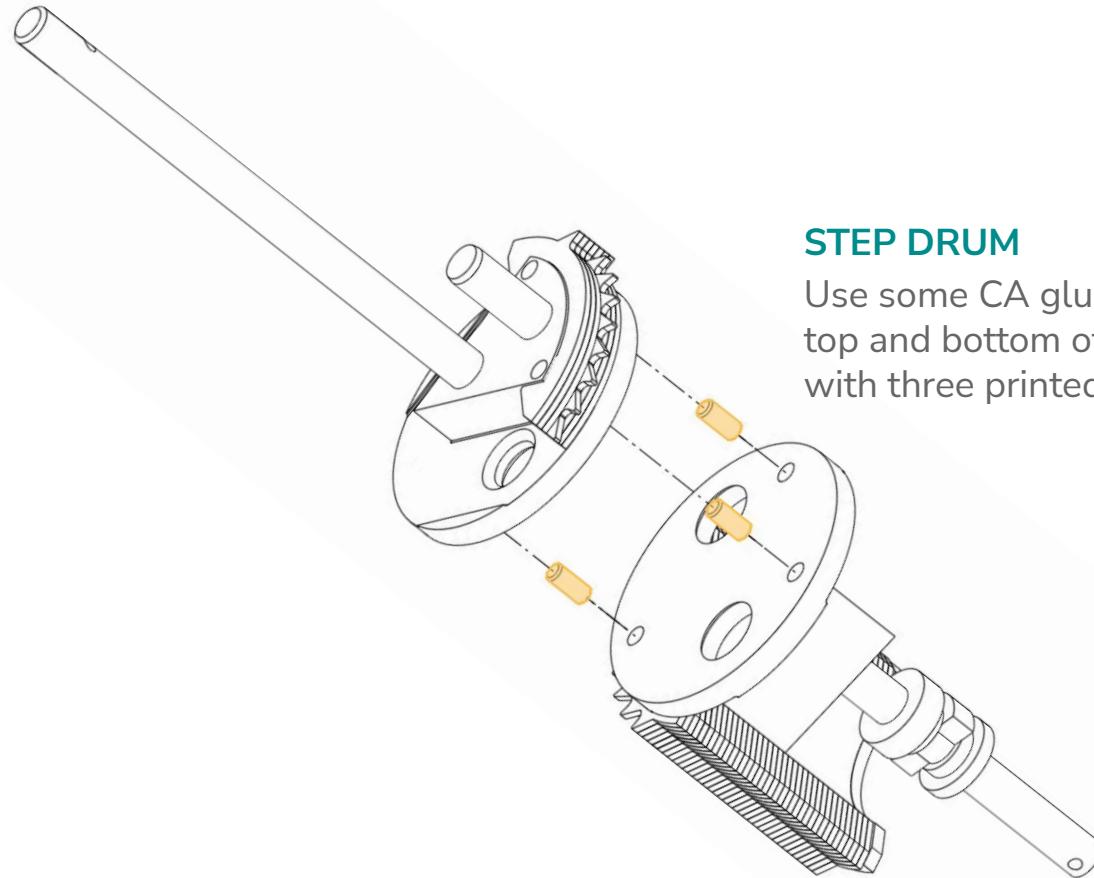
TENS BELL FITMENT

Ensure that the tens bell spins freely. Use some dry PTFE lubricant (spray is fine) to reduce friction.



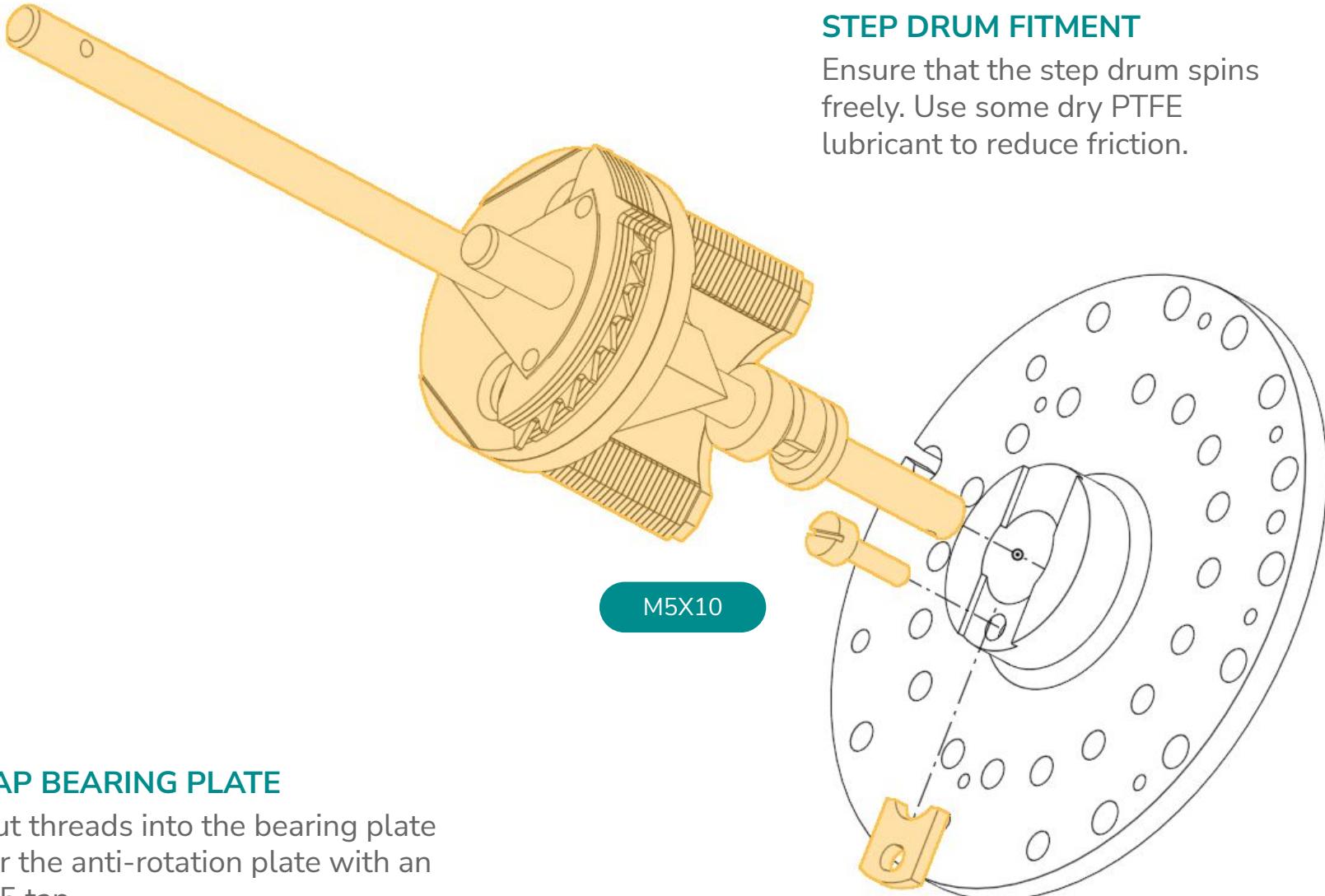
SUPPORT COLUMN THREADS

Cut threads onto both ends of the support columns with an M4 die.



STEP DRUM

Use some CA glue to combine the top and bottom of the step drum with three printed pins

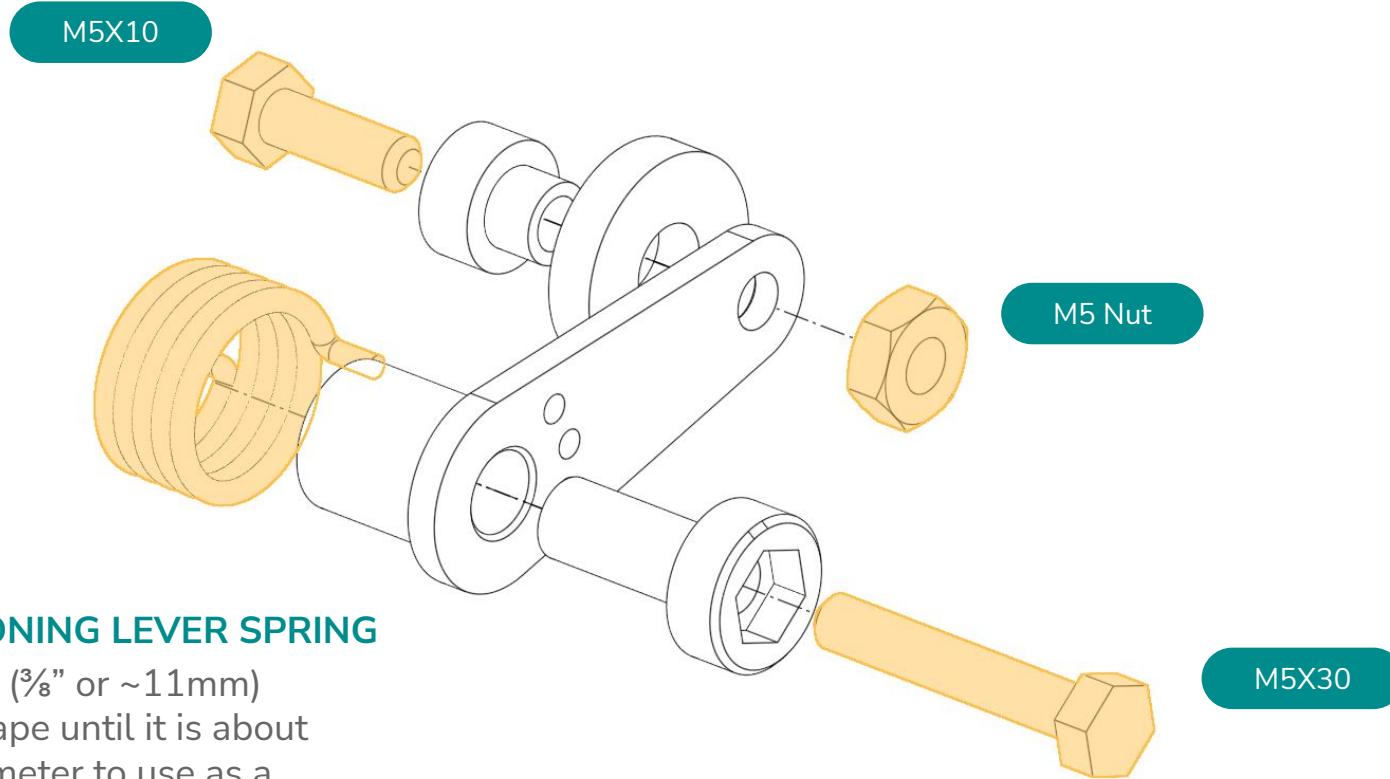


TAP BEARING PLATE

Cut threads into the bearing plate for the anti-rotation plate with an M5 tap.

STEP DRUM FITMENT

Ensure that the step drum spins freely. Use some dry PTFE lubricant to reduce friction.

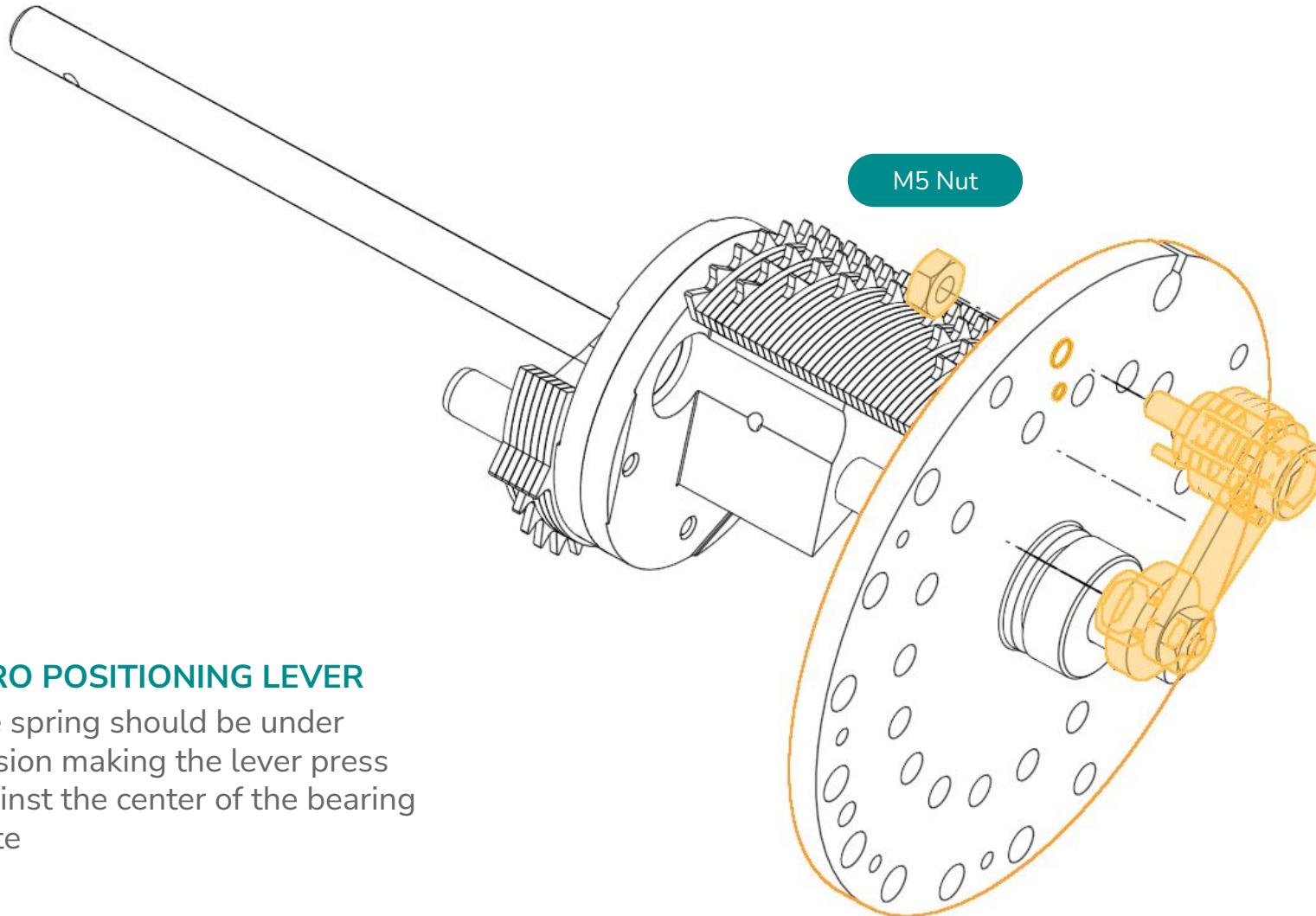


ZERO POSITIONING LEVER SPRING

Wrap a drill bit ($\frac{3}{8}$ " or ~11mm) with painters tape until it is about 11.5mm in diameter to use as a mandrel for winding this spring using 1.1mm (0.043") music wire. It needs to have 5 counter-clockwise windings. It's a good idea to wrap extra and cut it down.

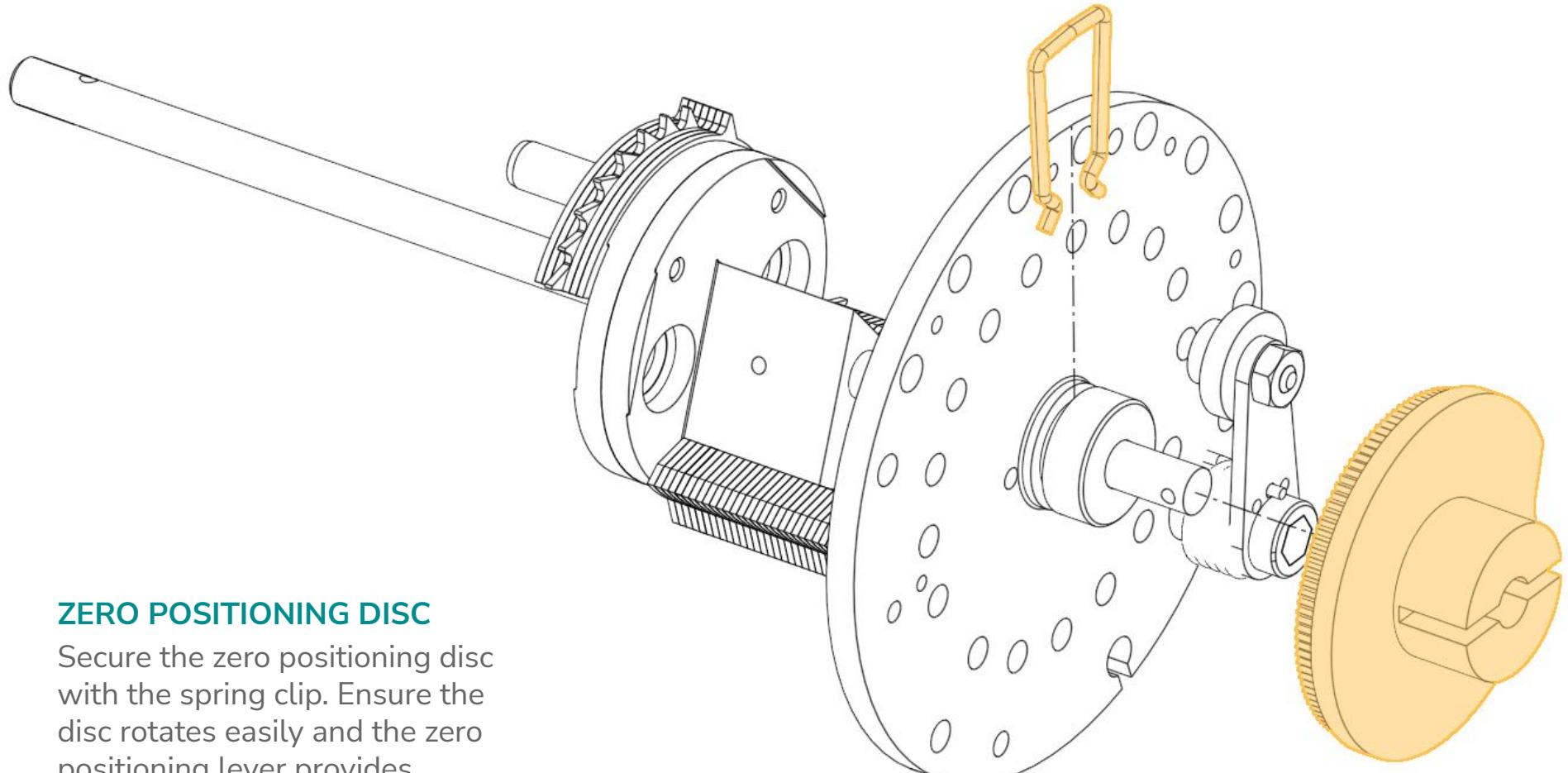
CAUTION

Winding this spring puts spring steel under tension! Be very careful doing this and wear hand and eye protection!



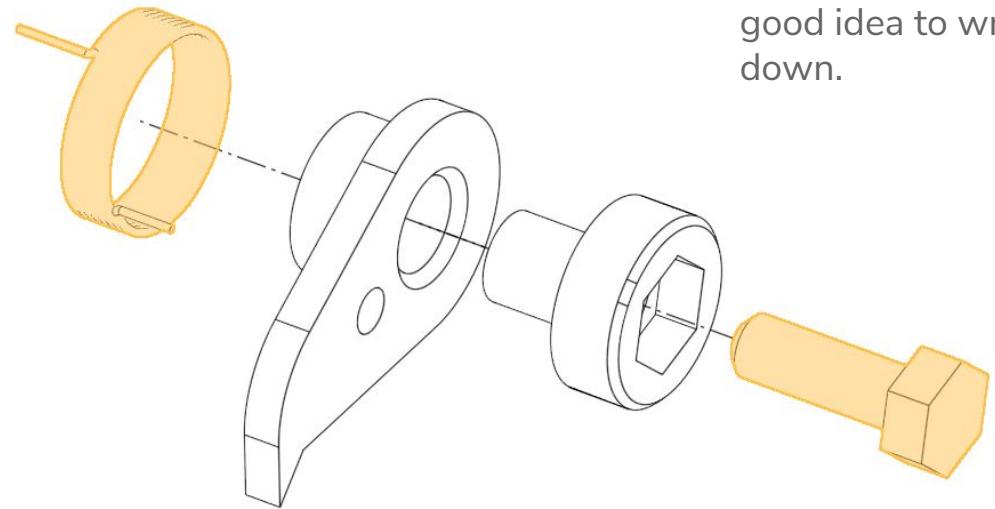
ZERO POSITIONING LEVER

The spring should be under tension making the lever press against the center of the bearing plate



ZERO POSITIONING DISC

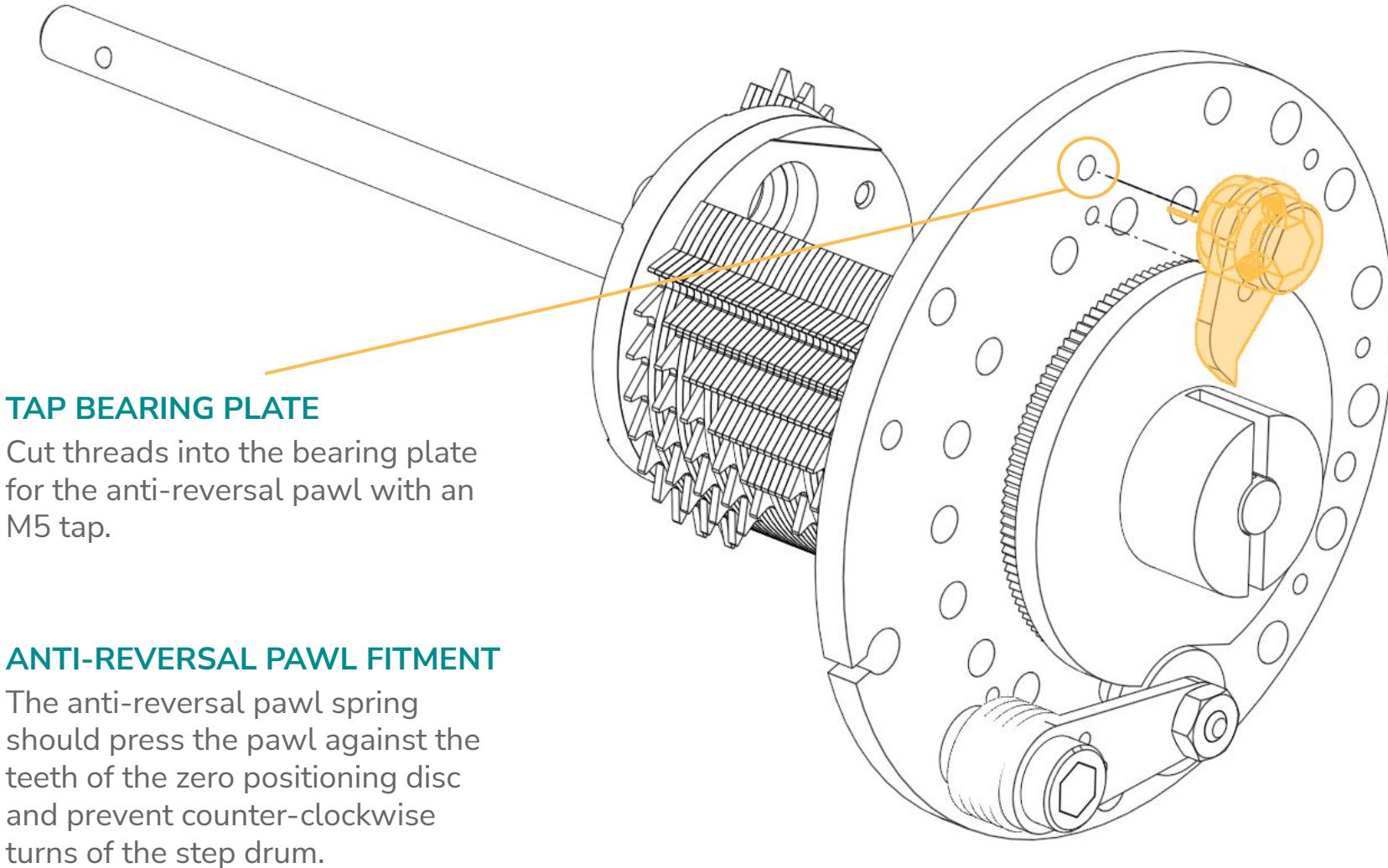
Secure the zero positioning disc with the spring clip. Ensure the disc rotates easily and the zero positioning lever provides additional resistance when resting at the detent.



M5X20

ANTI-REVERSAL PAWL SPRING

Wrap a drill bit ($\frac{3}{8}$ " or 9mm) with painters tape until it is about 9.5 mm in diameter to use as a mandrel for winding this spring using 0.6mm (0.024") music wire. It needs to have 7 counter-clockwise windings. It's a good idea to wrap extra and cut it down.

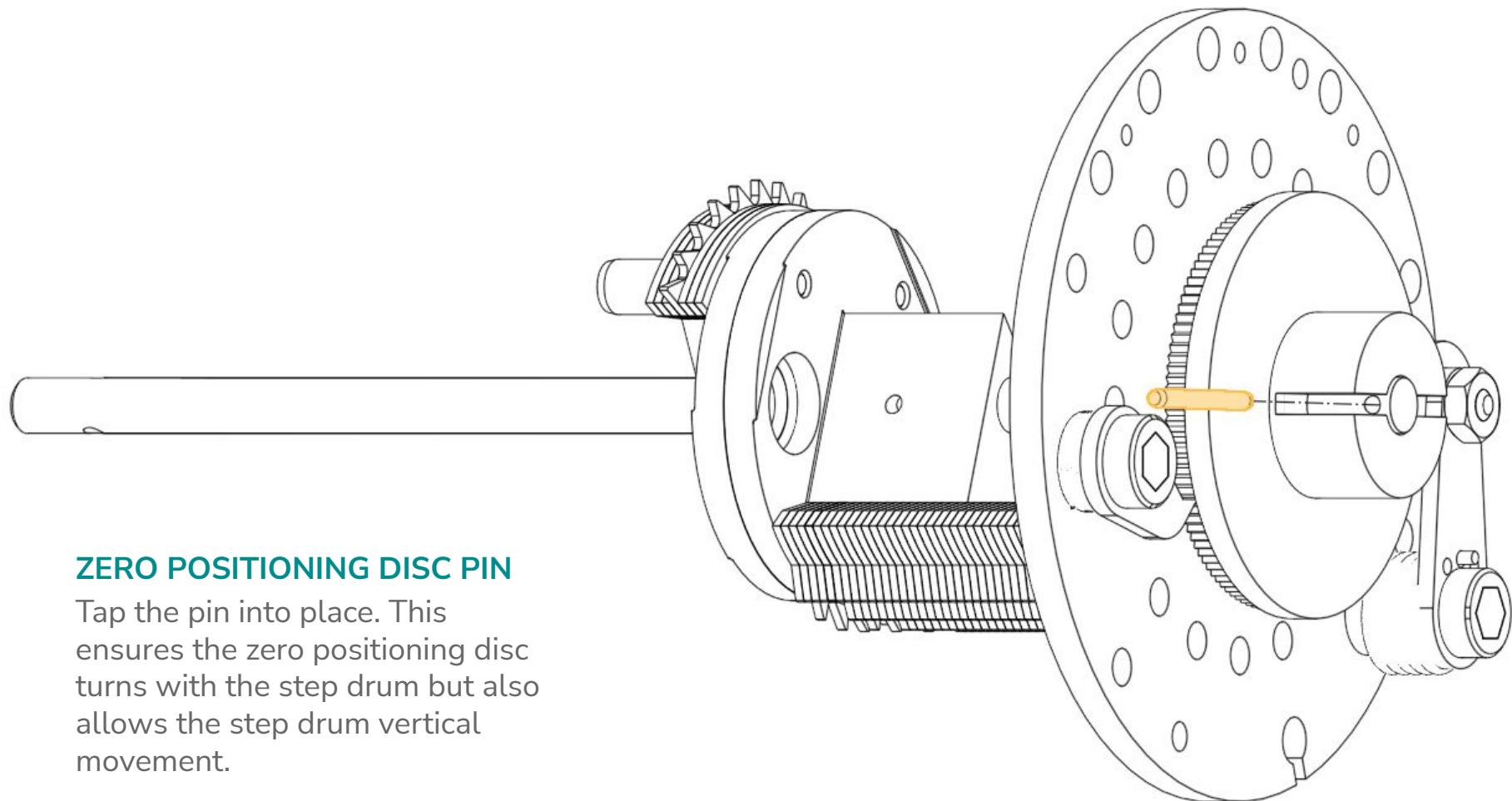


TAP BEARING PLATE

Cut threads into the bearing plate for the anti-reversal pawl with an M5 tap.

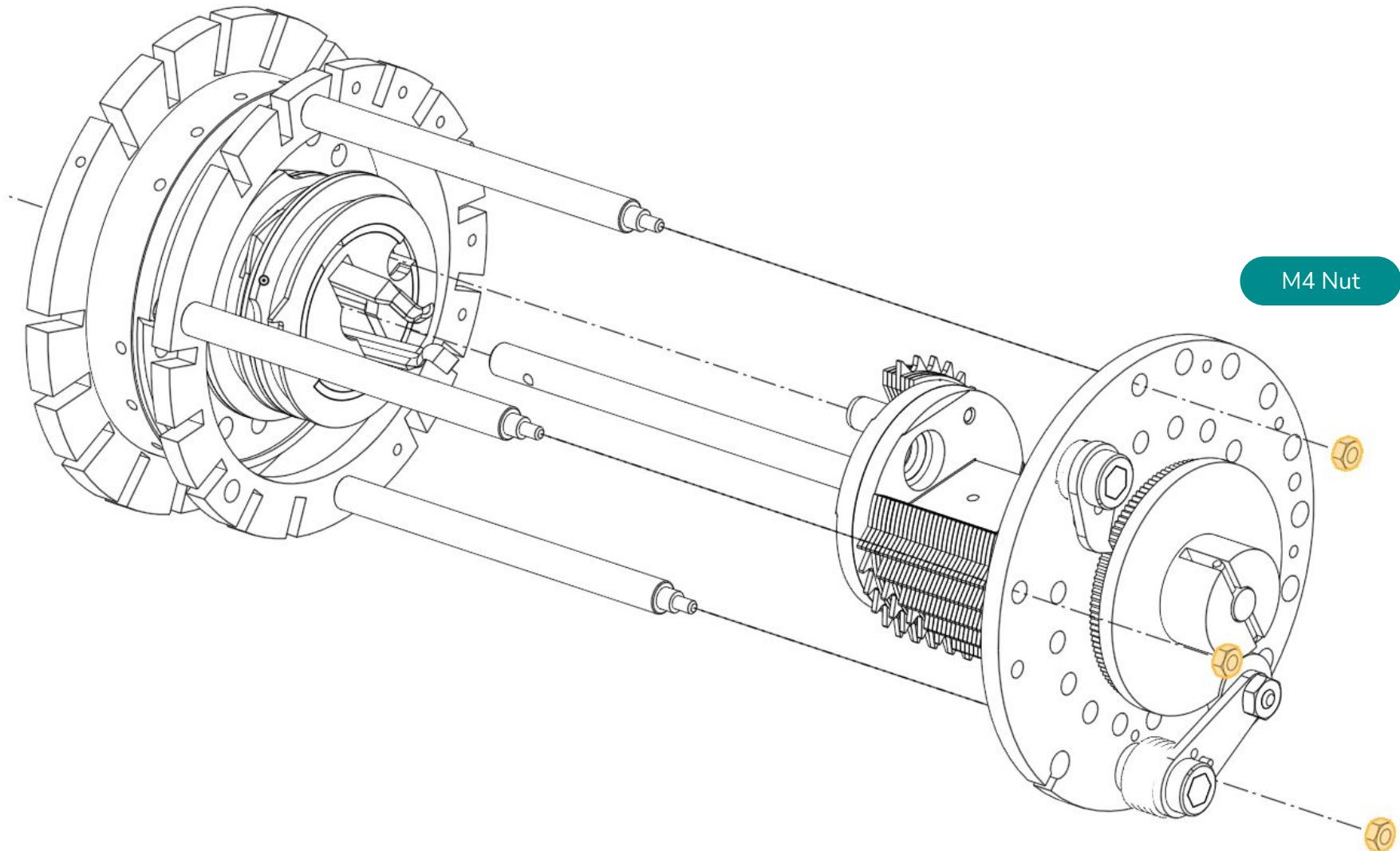
ANTI-REVERSAL PAWL FITMENT

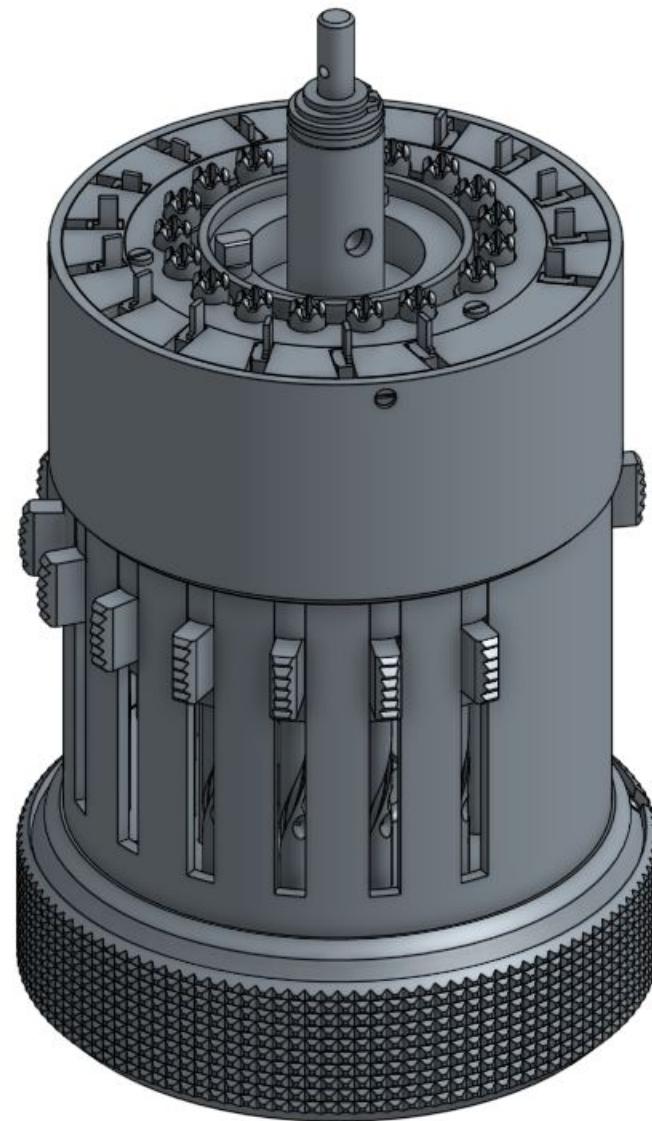
The anti-reversal pawl spring should press the pawl against the teeth of the zero positioning disc and prevent counter-clockwise turns of the step drum.



ZERO POSITIONING DISC PIN

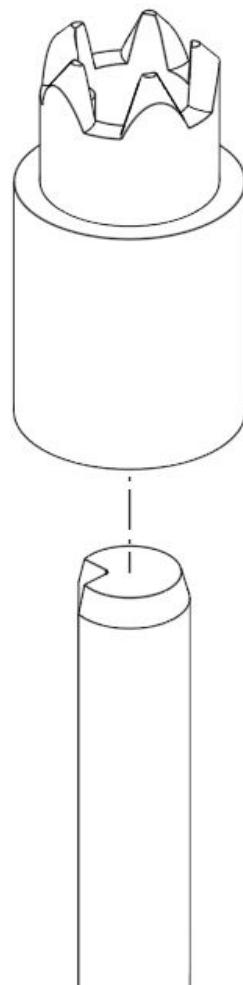
Tap the pin into place. This ensures the zero positioning disc turns with the step drum but also allows the step drum vertical movement.





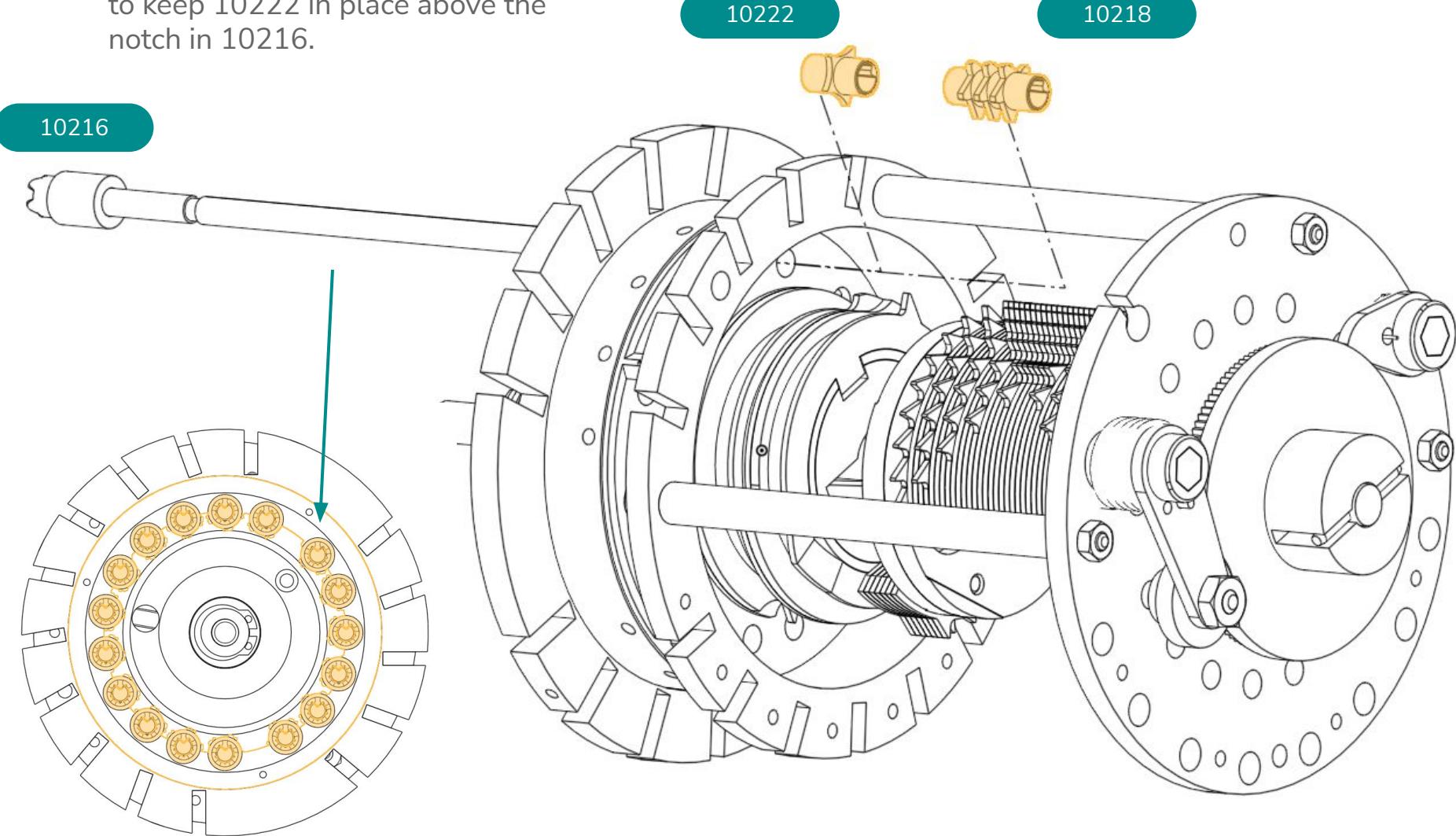
FIXING GEAR TIPS

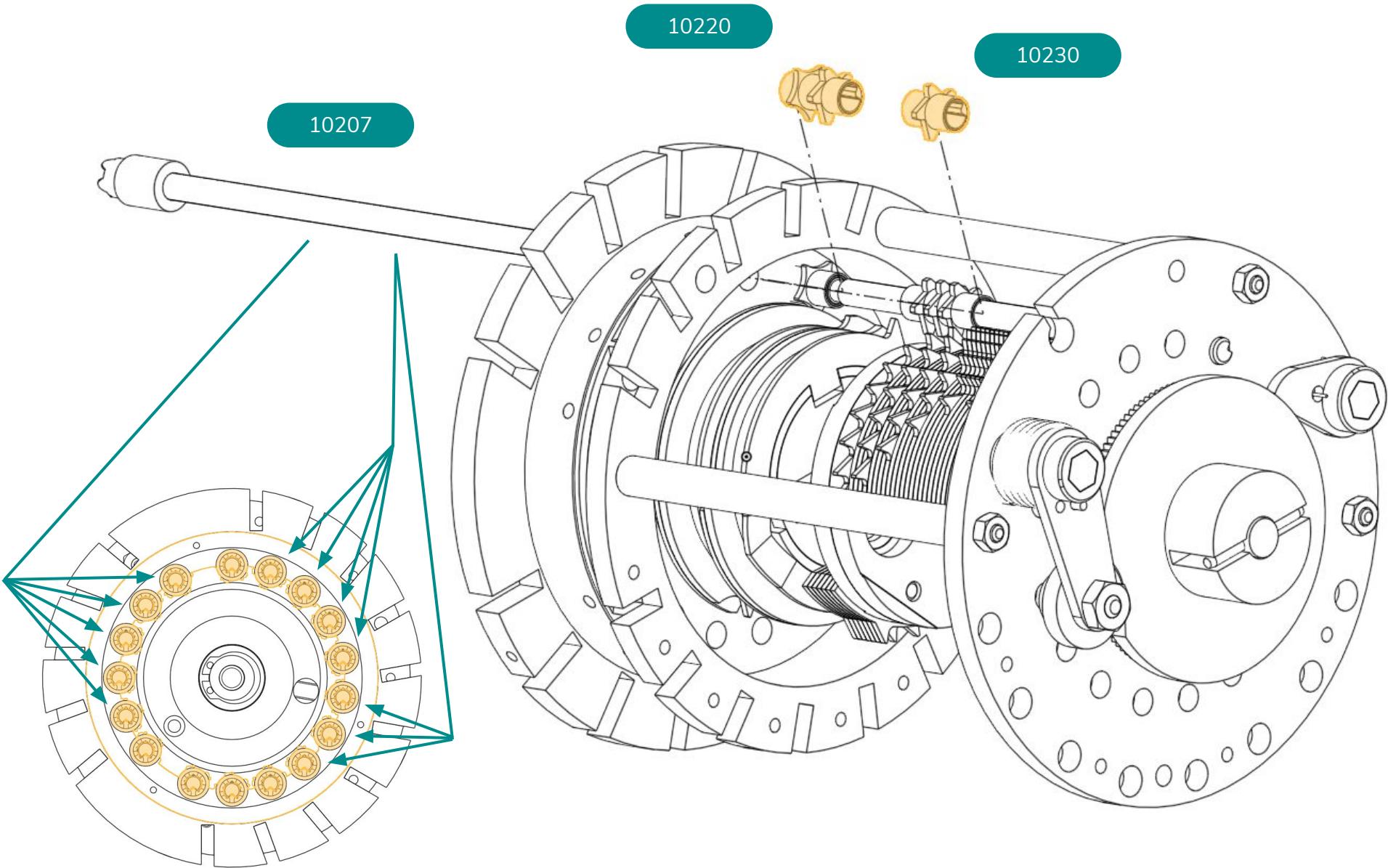
Fit these parts without adhesive first. Add some CA glue if necessary (they should be a tight fit already). There should be about 5 mm from the tips to the top of the shaft.

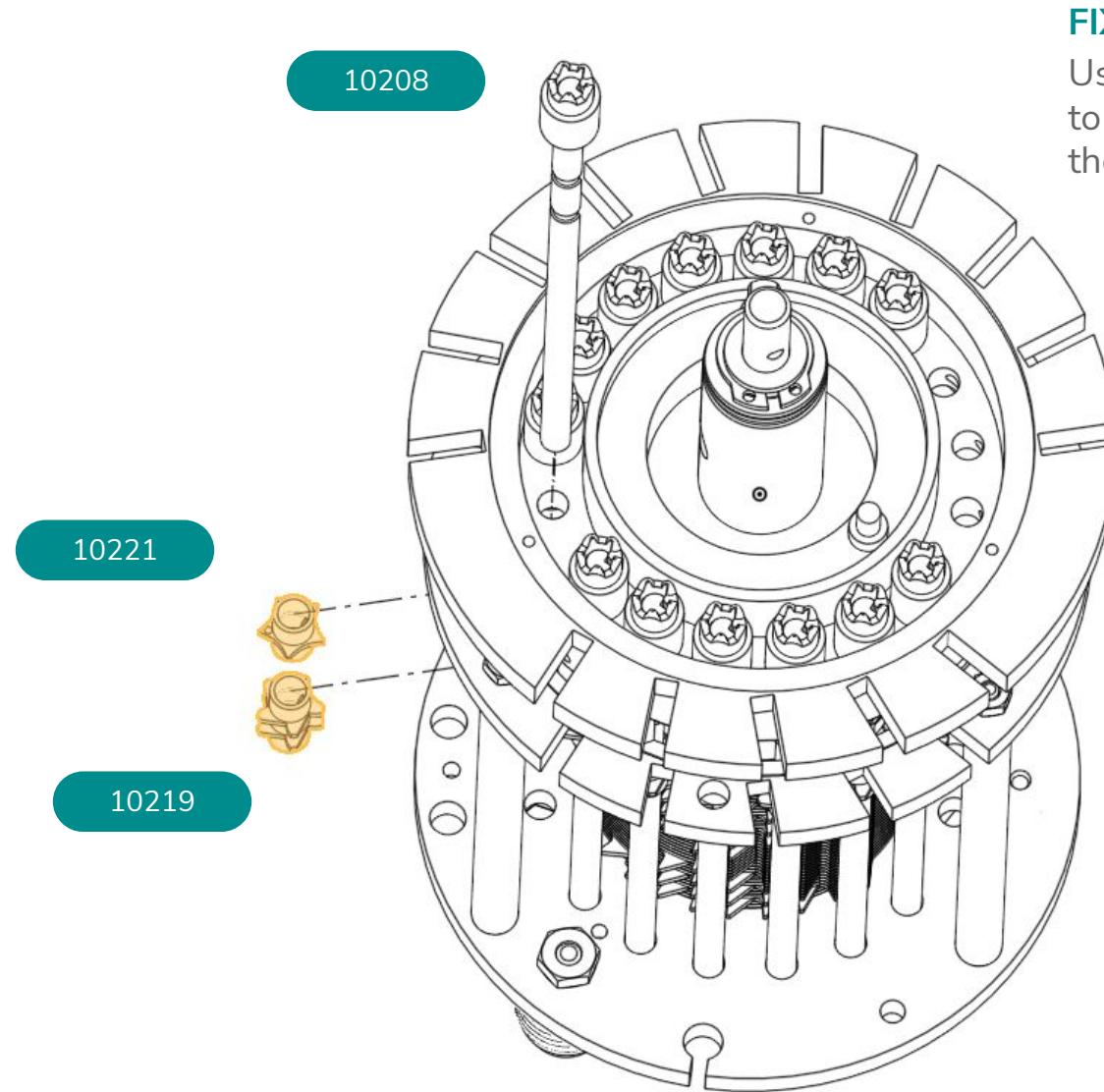


FIXING 10222 IN PLACE

Use a little bit of fingernail polish to keep 10222 in place above the notch in 10216.

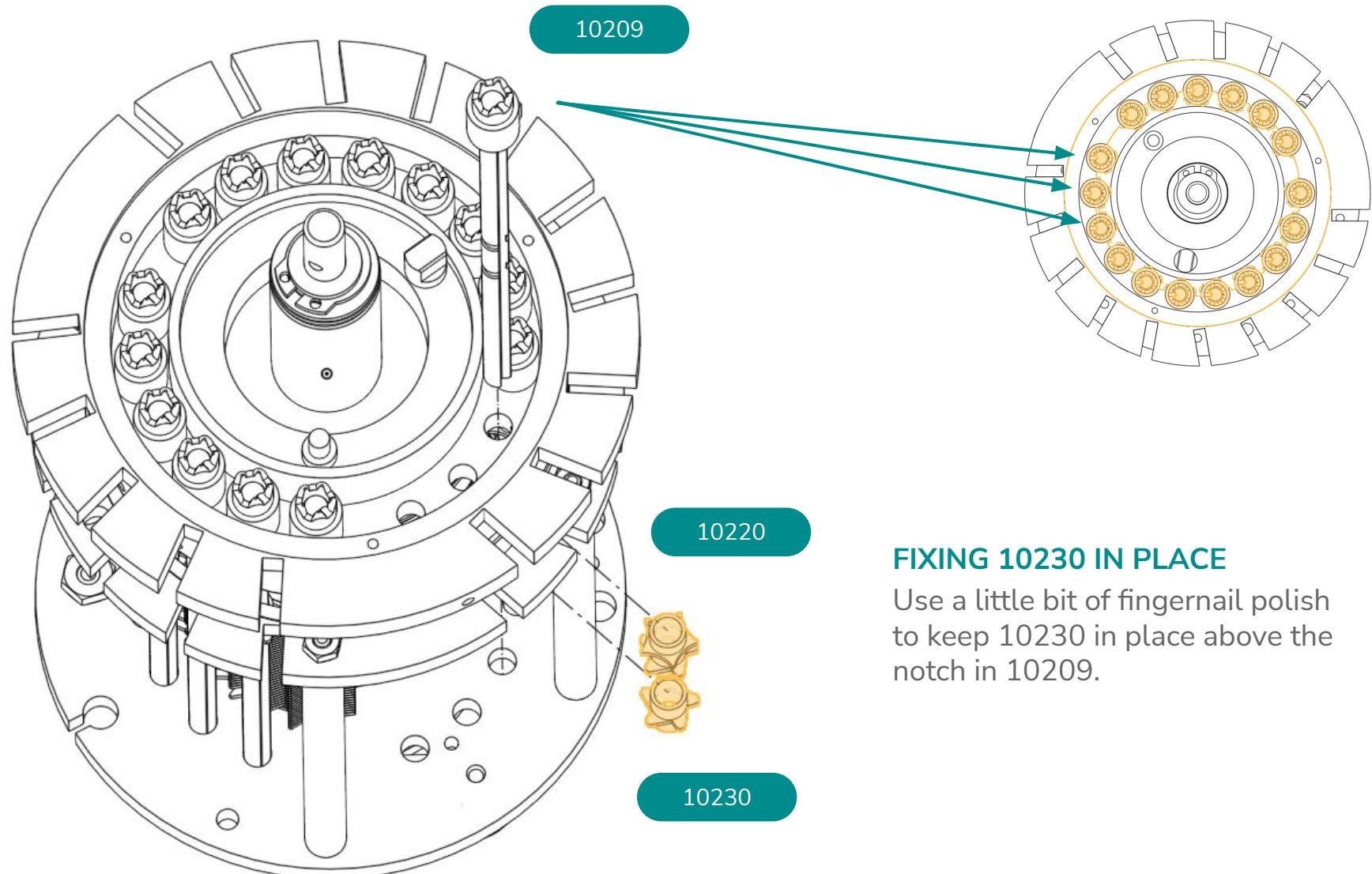






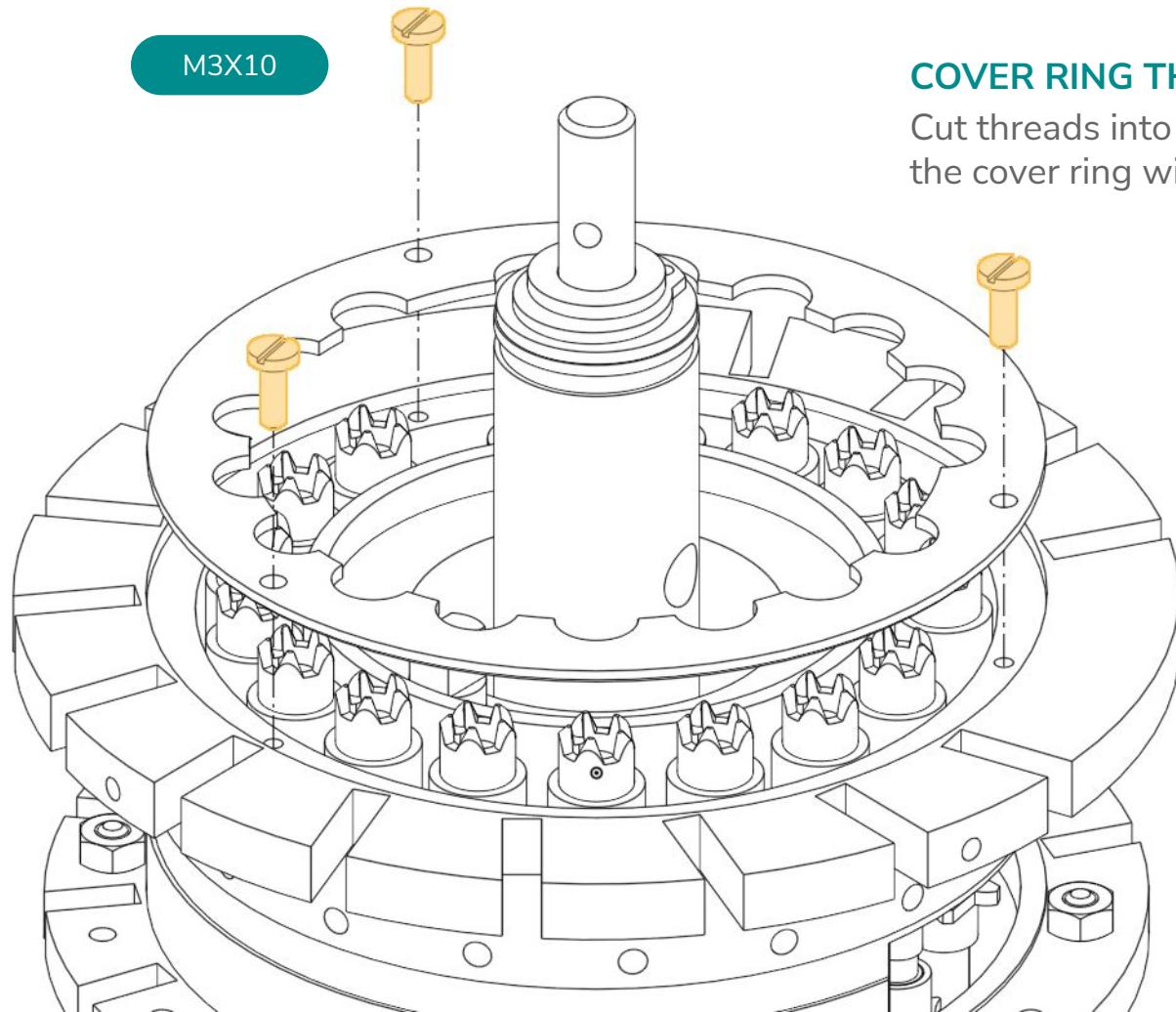
FIXING 10221 IN PLACE

Use a little bit of fingernail polish to keep 10221 in place between the notches in 10208.



FIXING 10230 IN PLACE

Use a little bit of fingernail polish to keep 10230 in place above the notch in 10209.

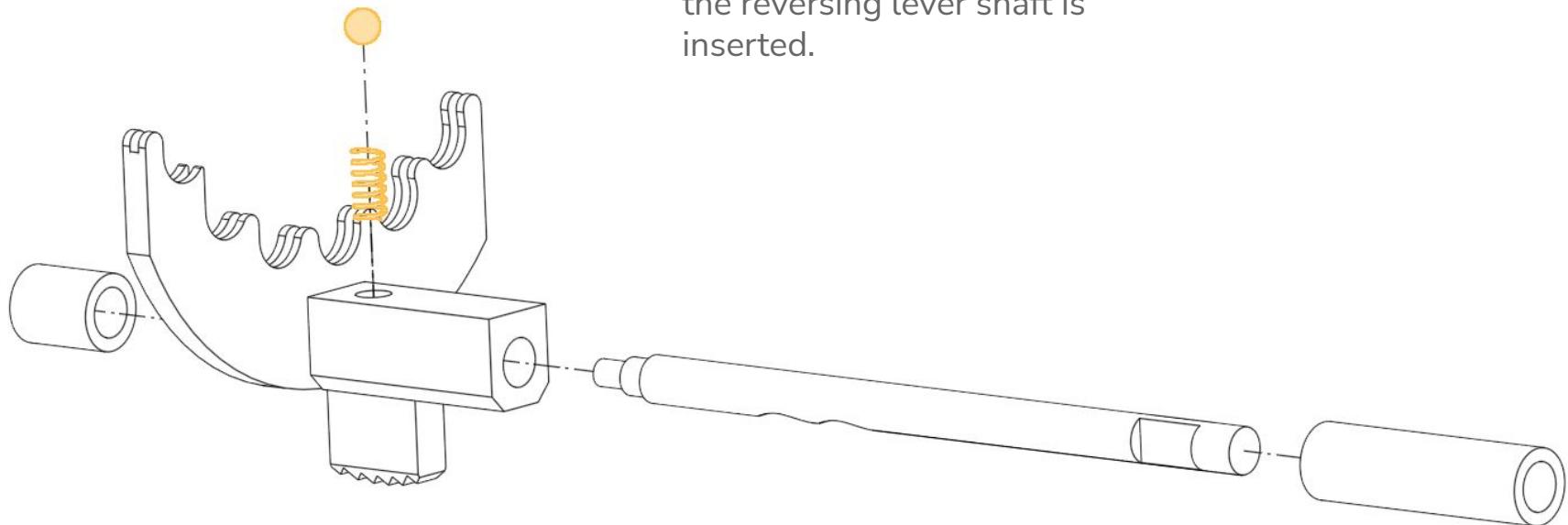


COVER RING THREAD

Cut threads into the main body for the cover ring with an M3 die.

REVERSING KNOB SPRING

The ball and spring will need to be pressed and held into place while the reversing lever shaft is inserted.



REVERSING LEVER KNOB

The knob for the reversing lever is externally facing. Prepare and paint it before assembly if you will be painting your Curta.

REVERSING LEVER THREAD

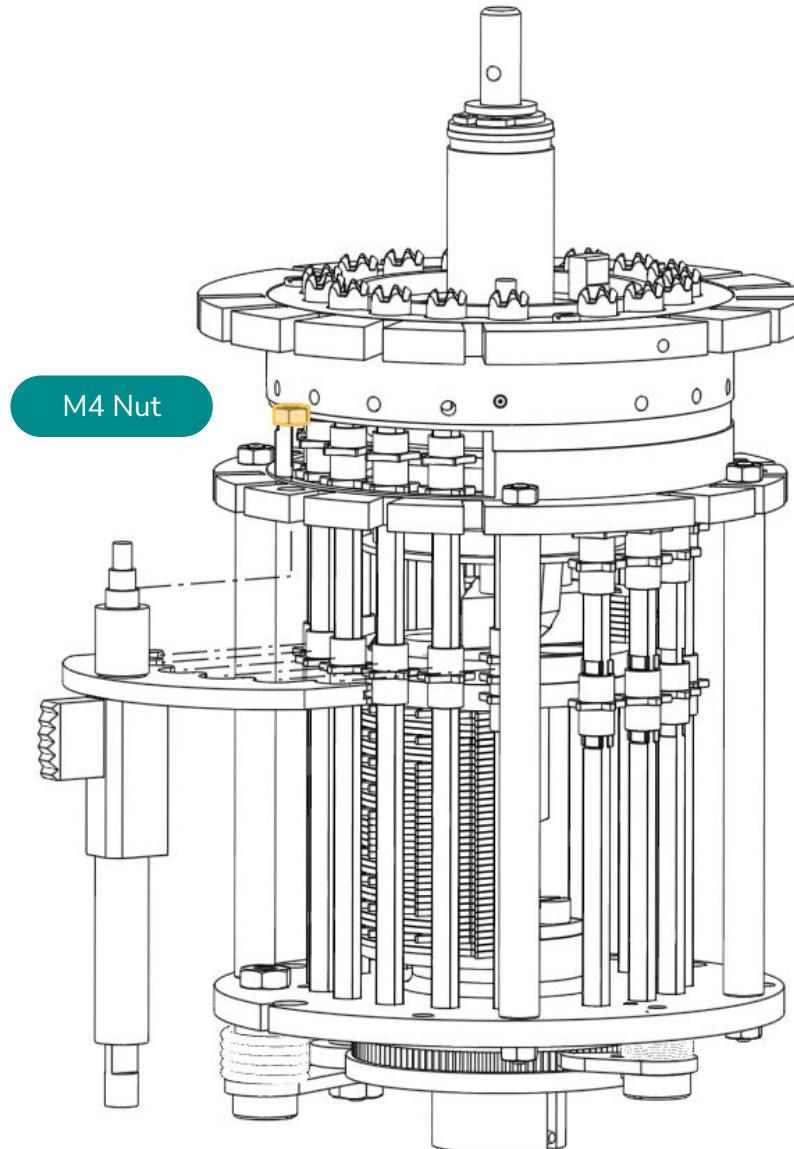
Cut threads into the reversing lever shaft with an M4 die.

ALIGN TURNS COUNTER GEARS

Align the reversing lever to fit each of the turns counter gears. The first position should have the center gear aligned to the reversing lever mechanism.

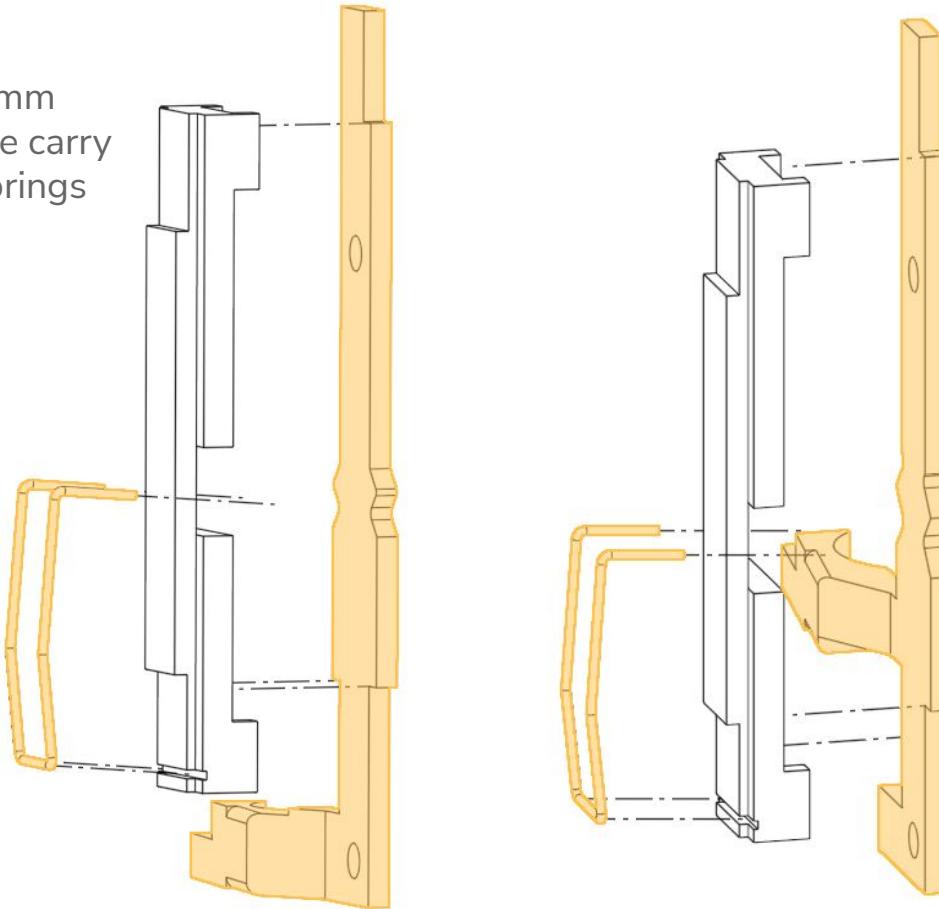
ALIGN REVERSING LEVER SHAFT

The shaft must be aligned low at first so it can fit through the slot in the bearing plate. After the gears are aligned, push the reversing lever shaft up and secure with the M4 nut. Finally, ensure that the reversing lever is engaged with one of the two detents in the reversing lever shaft.



CARRY LEVER SPRINGS

Use ~57mm lengths of 0.6mm (0.024") music wire with the carry lever spring tool to bend springs for the carry levers.



RESULTS CARRY LEVERS

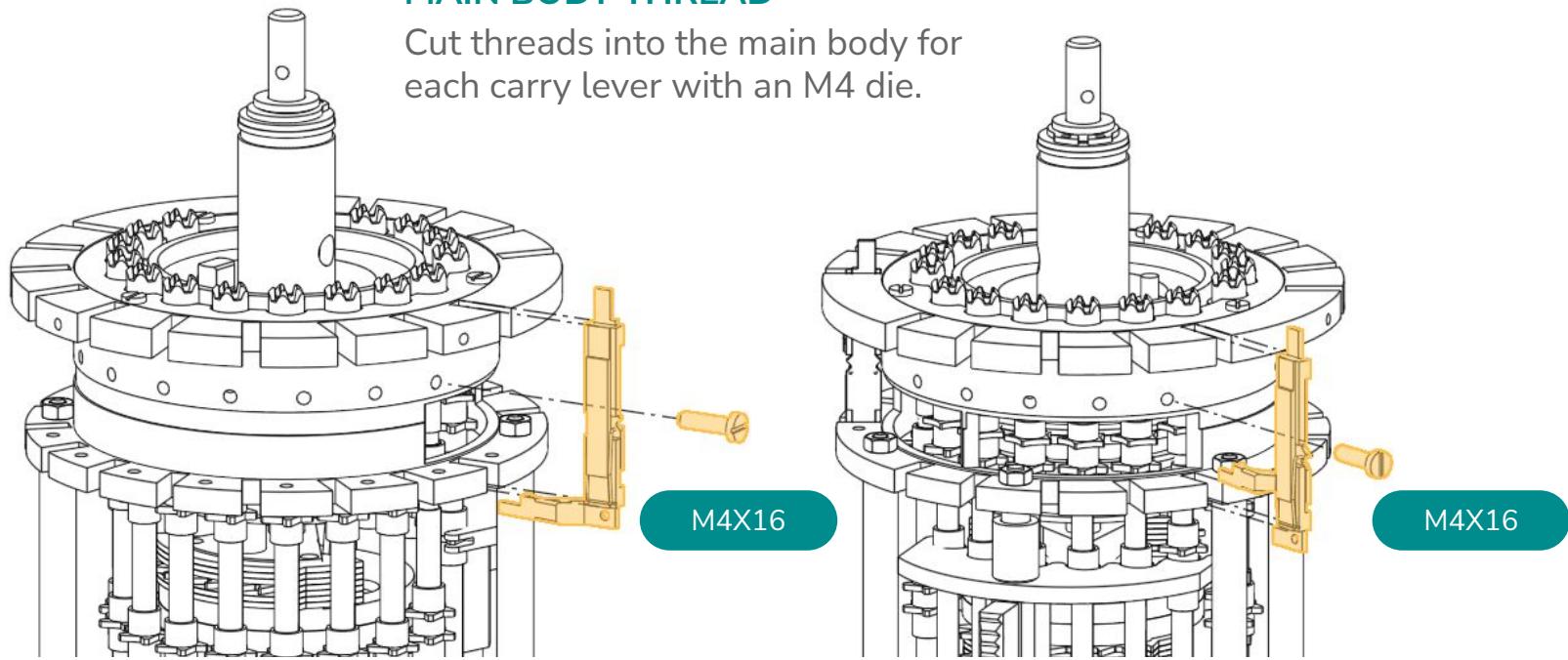
Assemble 10 results carry levers

TURNS CARRY LEVERS

Assemble 5 turns carry levers

MAIN BODY THREAD

Cut threads into the main body for each carry lever with an M4 die.

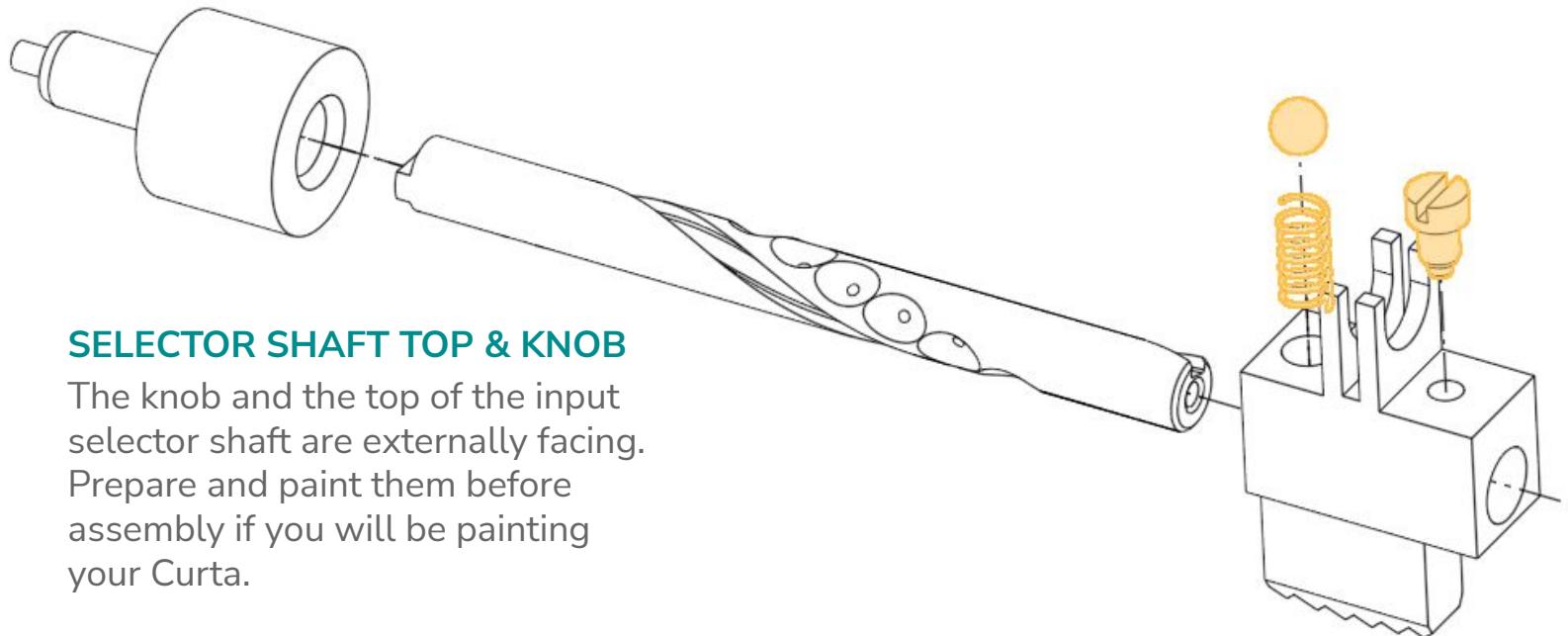


CARRY LEVER PLACEMENT

The legs of the carry levers should fit between the flanges of the upper gears of the transmission shaft next to it.

CARRY LEVER FITMENT

Each carry lever should easily snap between its upper and lower positions. When in the lower position, a full rotation of the main shaft should reset the lever into its upper position.



SELECTOR SHAFT TOP & KNOB

The knob and the top of the input selector shaft are externally facing. Prepare and paint them before assembly if you will be painting your Curta.

SELECTOR KNOB SPRING

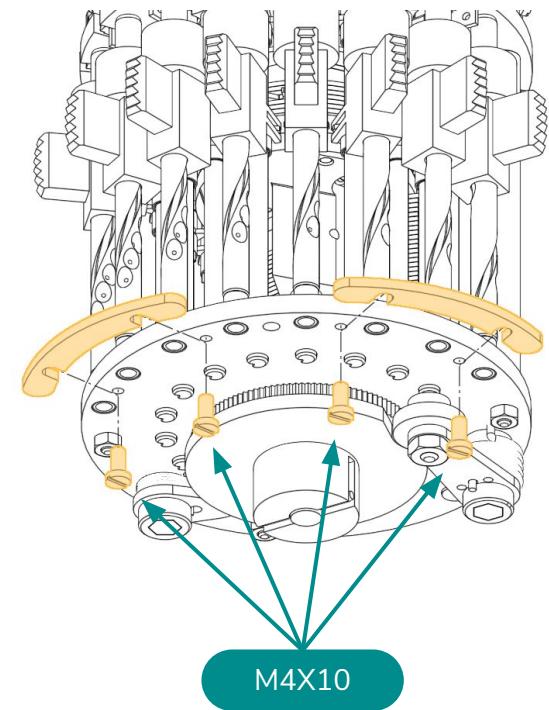
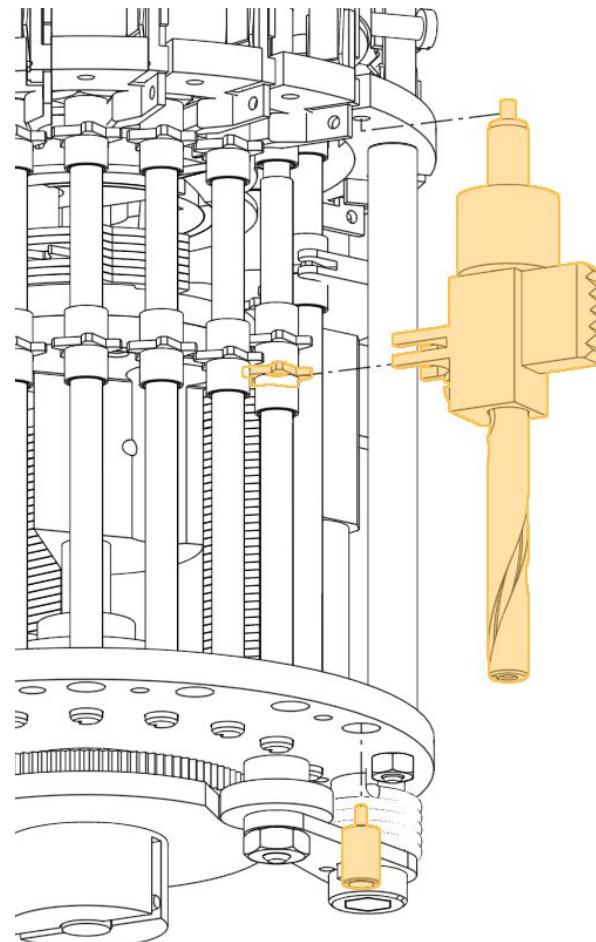
The ball and spring will need to be pressed and held into place while the selector shaft is inserted.

SELECTOR KNOB THREAD

Cut threads into the selector knob with an M4 tap and into the pin screw with an M4 die.

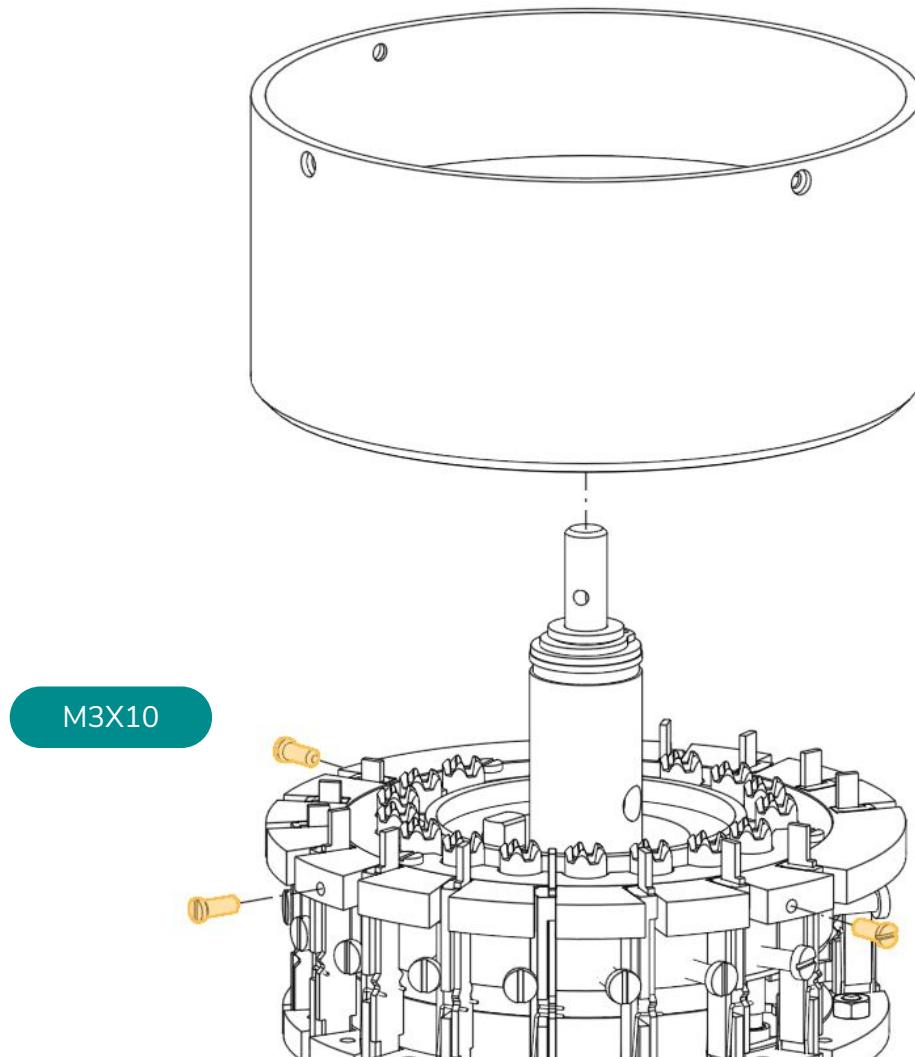
ALIGN INPUT SELECTOR SHAFTS

For each input selector, align the gear between the selector knob fingers. For the one's place, align the lower of the two gears.



BEARING PLATE THREAD

Cut threads into the bearing plate with an M4 tap to fasten the holding plates.

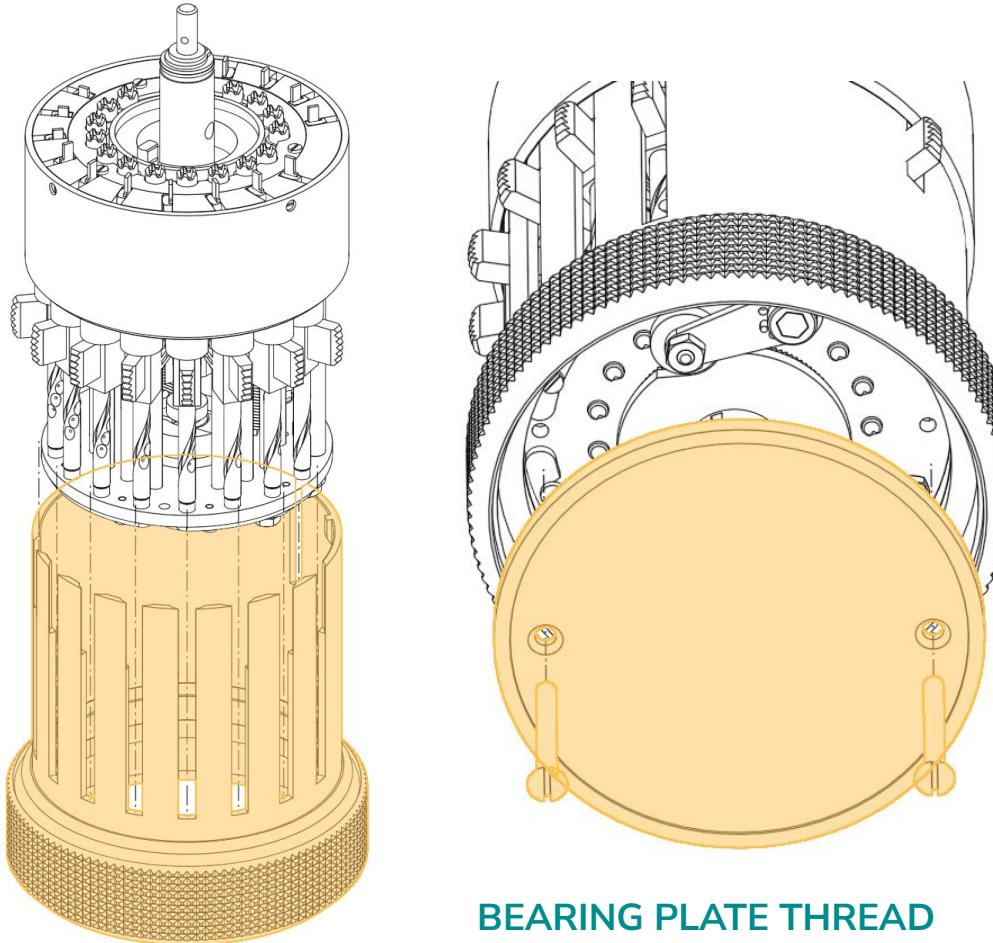


UPPER SLEEVE

The upper sleeve is externally facing. Prepare and paint it before assembly if you will be painting your Curta.

MAIN BODY THREAD

Cut threads into the main body with an M3 tap to fasten the upper sleeve.



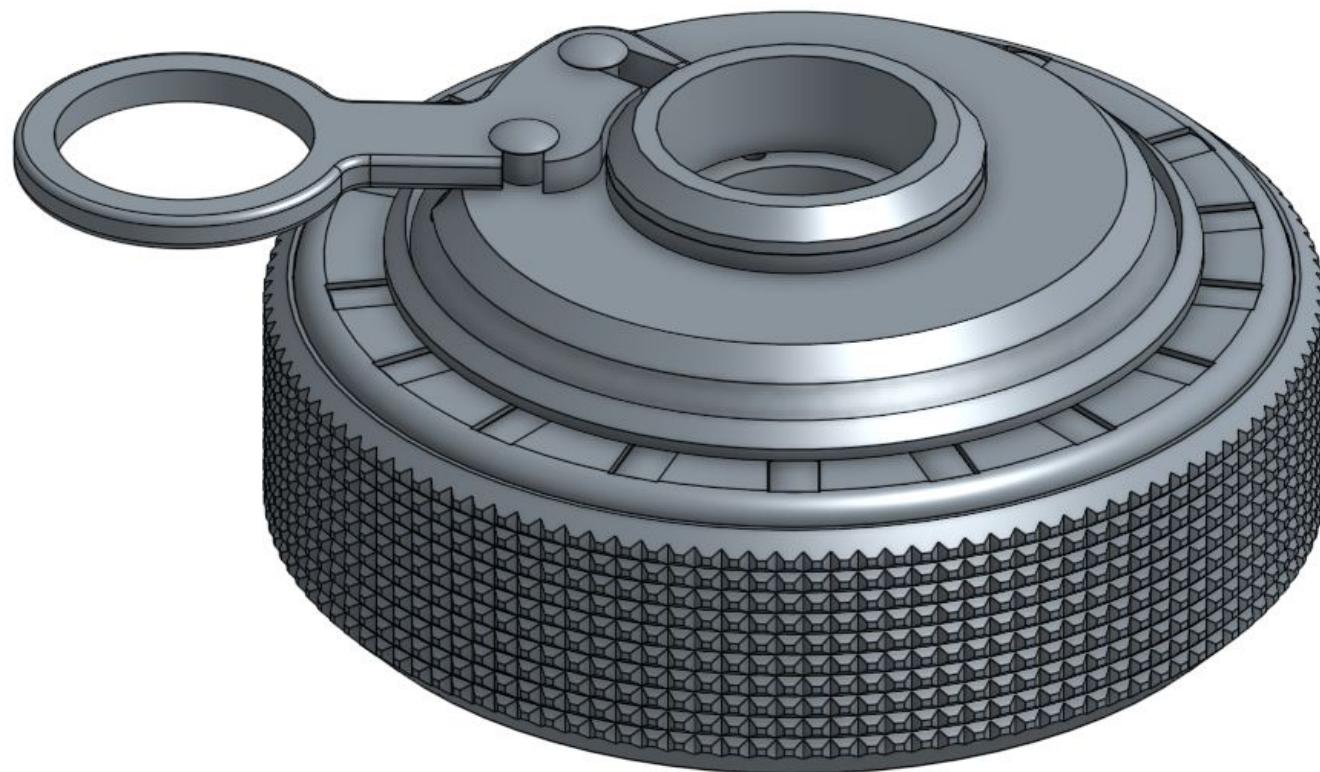
LOWER HOUSING & BASE PLATE

Both the lower housing and the base plate are externally facing. Prepare and paint them before assembly if you will be painting your Curta.

BEARING PLATE THREAD

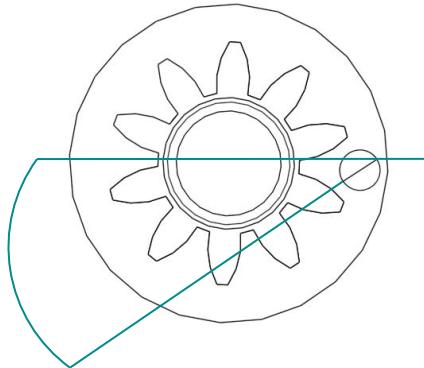
Cut threads into the bearing plate with an M5 tap to fasten the base plate.

M5X60



RESULTS DIALS

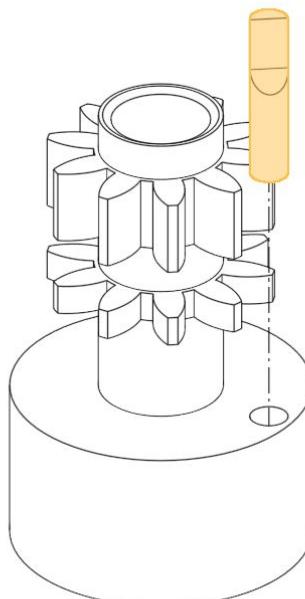
The results dials are externally facing. Prepare and paint them before assembly if you will be painting your Curta.



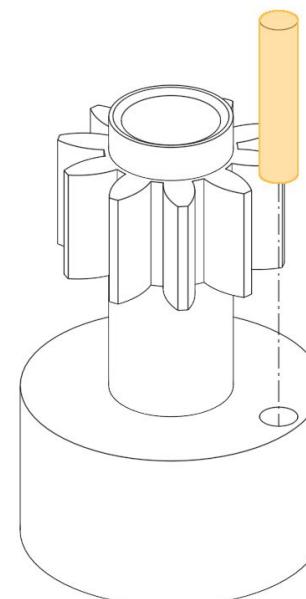
HALF PINS

The half pinned results dials should be at an approximate 36 degree angle.

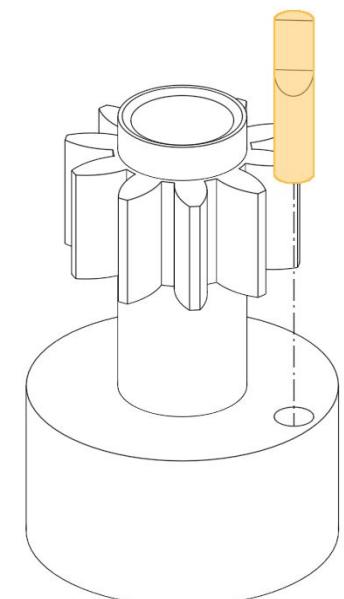
4 x 10043



7 x 10045



4 x 10045

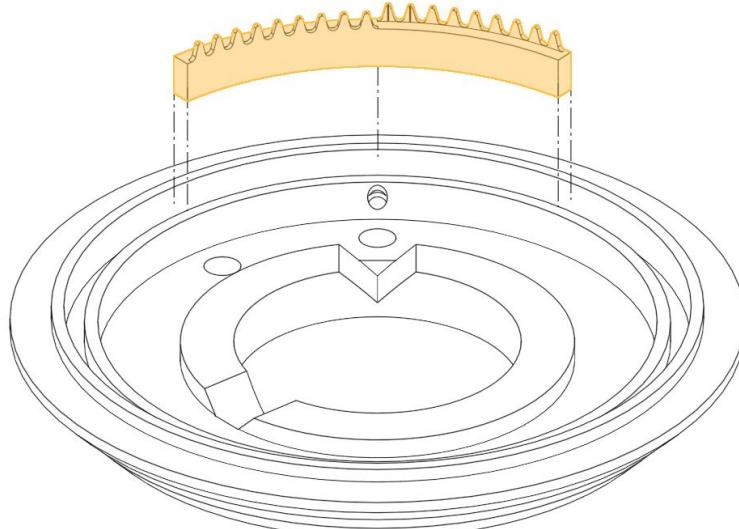


RESULTS DIAL PINS

The results dial pins need to be exposed enough to depress the carry levers when rotating past 9, but not so exposed that they contact the digits cover when they spin.

UNPINNED RESULTS DIALS

There are two results dials that do not get a pin. These unpinned dials plus the pinned dials sum to 11 results and 6 turns dials.



CLEARING RING RIVETS

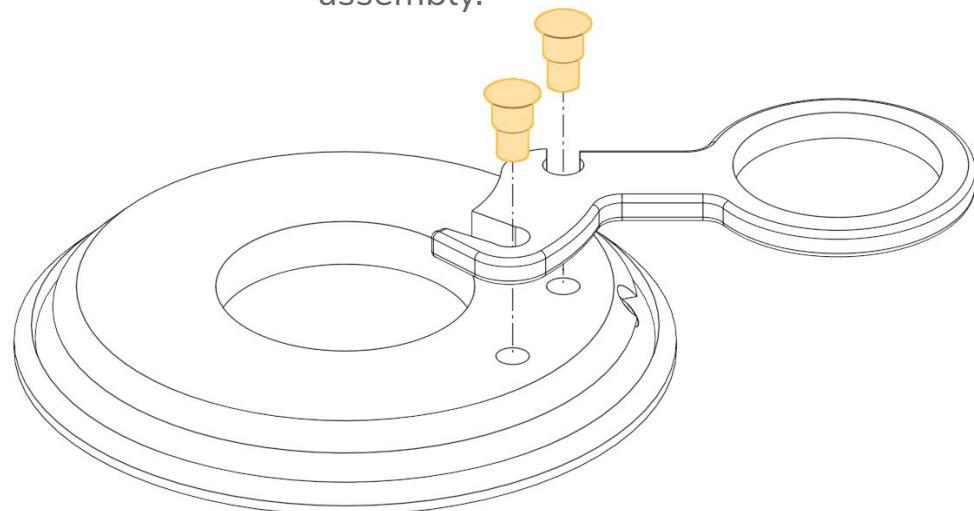
The clearing ring rivets must be glued into place with some CA glue. Test the clipping and unclipping of the ring before gluing the rivets. Some modification of the parts may be necessary for the clipping to work.

CLEARING TEETH

The clearing teeth are a layer of two copies of the teeth plate and one spacer. Make sure they are ordered properly and register the middle with the screw hole and rivet that are aligned.

CLEARING COVER

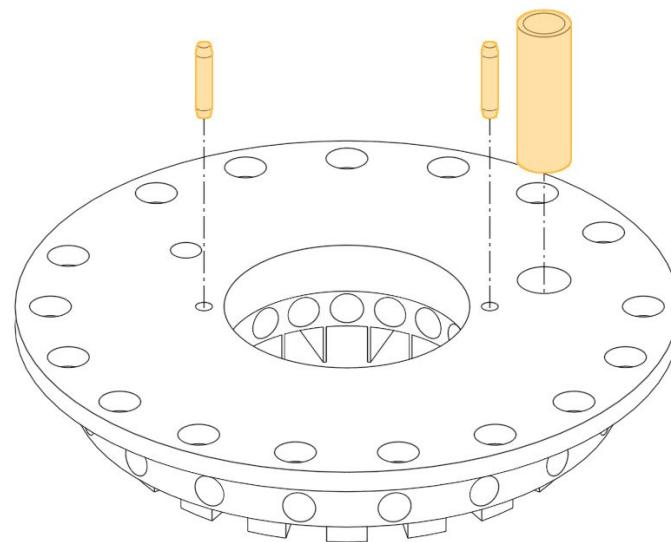
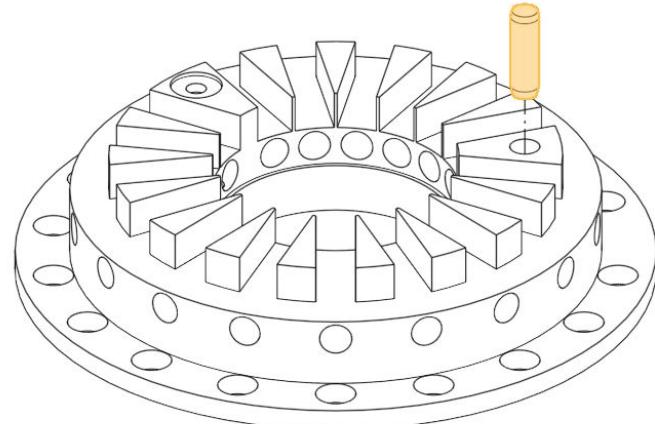
All of these parts except the clearing teeth are externally facing. Paint them prior to assembly.



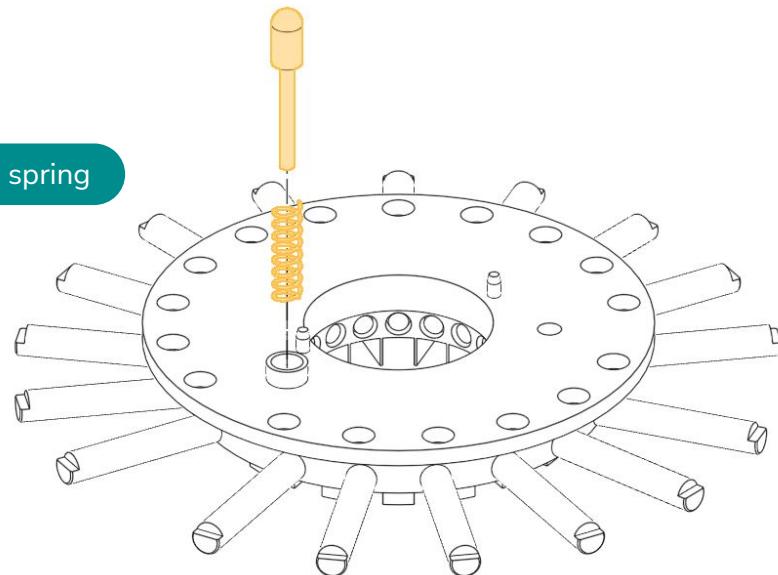
PINS & CLEARING PIN SLEEVE

Leave the two top pins exposed by about 4 mm for the spider spring. The clearing pin sleeve is inserted until it is very close to the bottom.

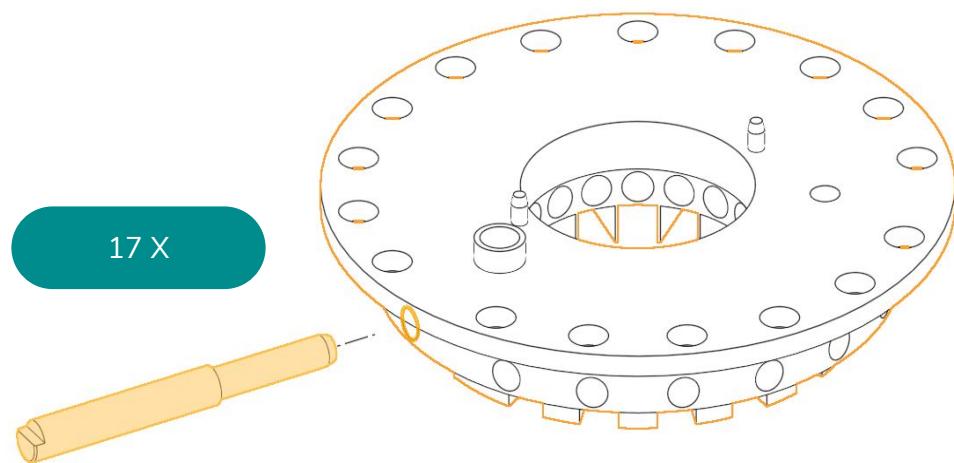
The stop pin at the bottom should also be exposed by about 4 mm from the bottom.

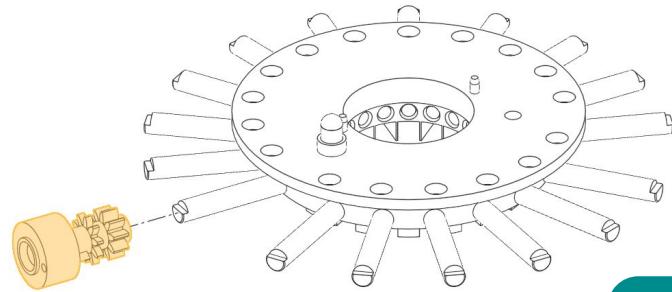


0.6 x 5 x 20mm spring



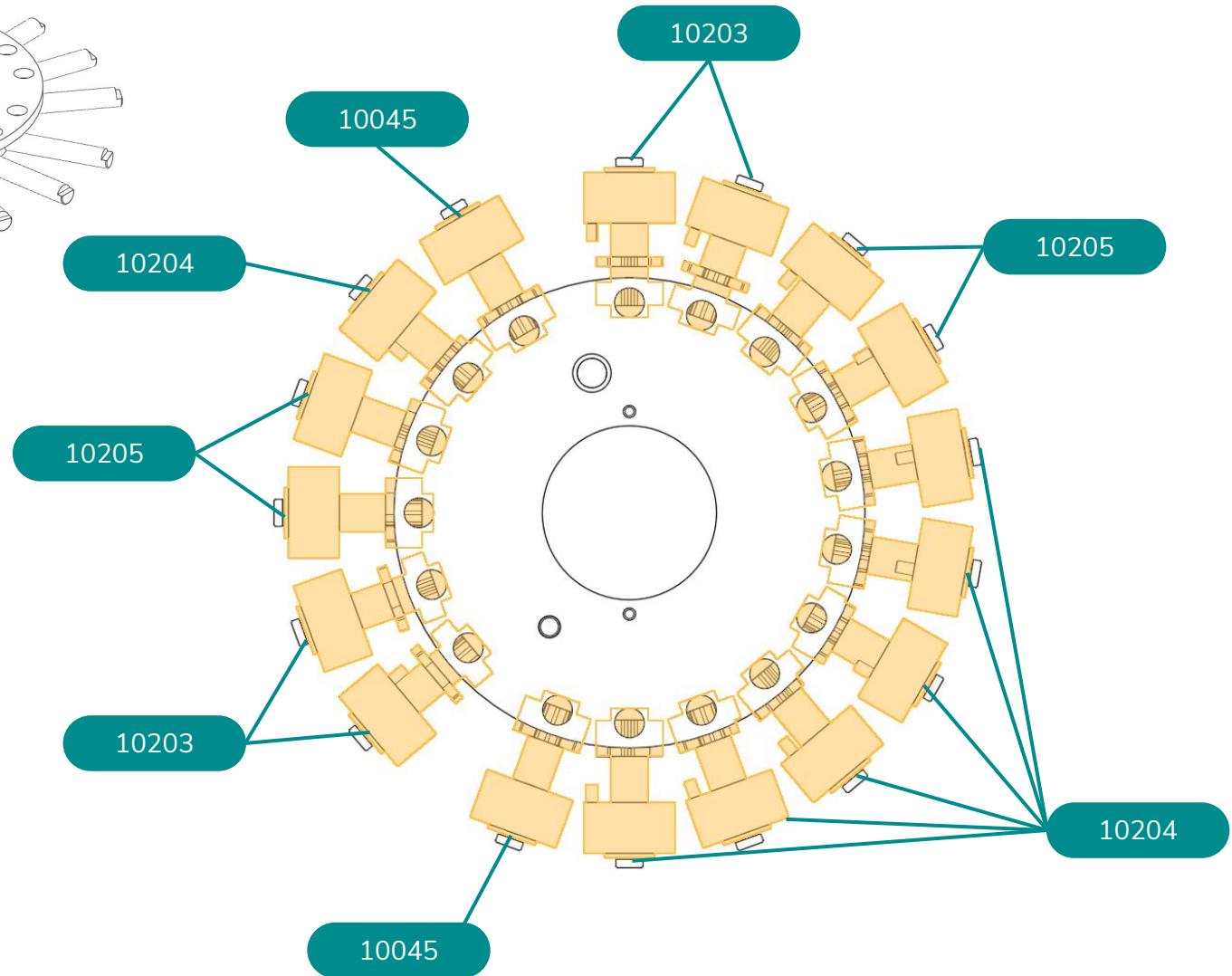
17 X





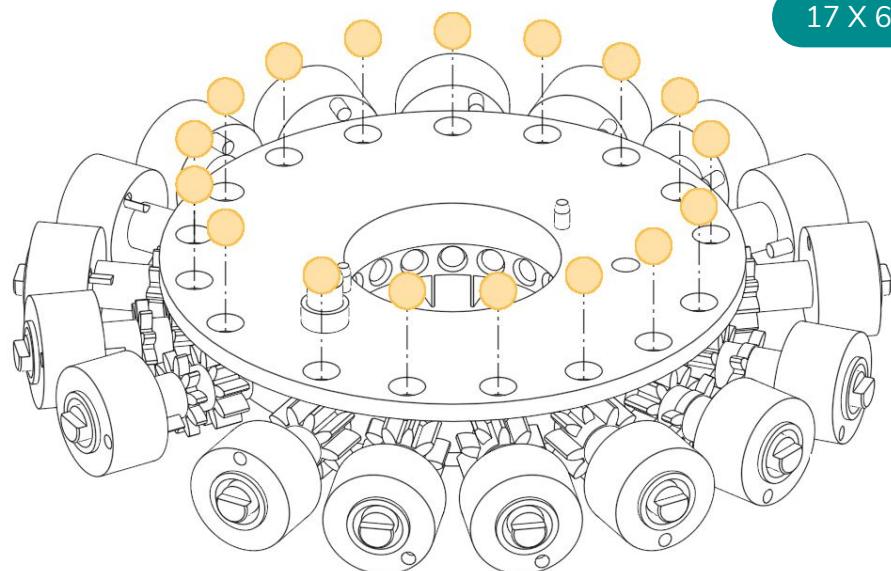
RESULTS DIALS FITMENT

Each dial should spin freely on their axle. Use some dry PTFE lubricant to reduce friction.

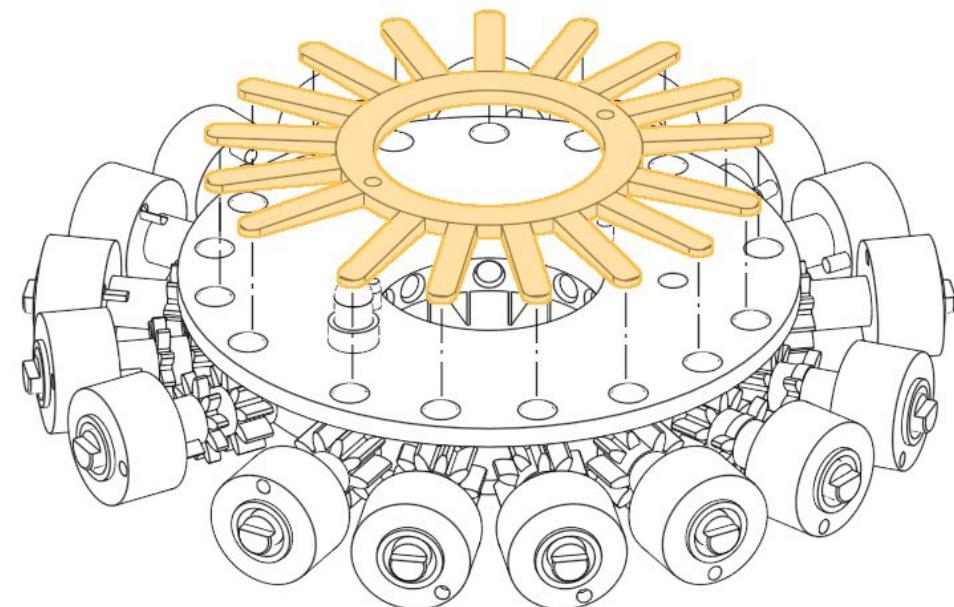


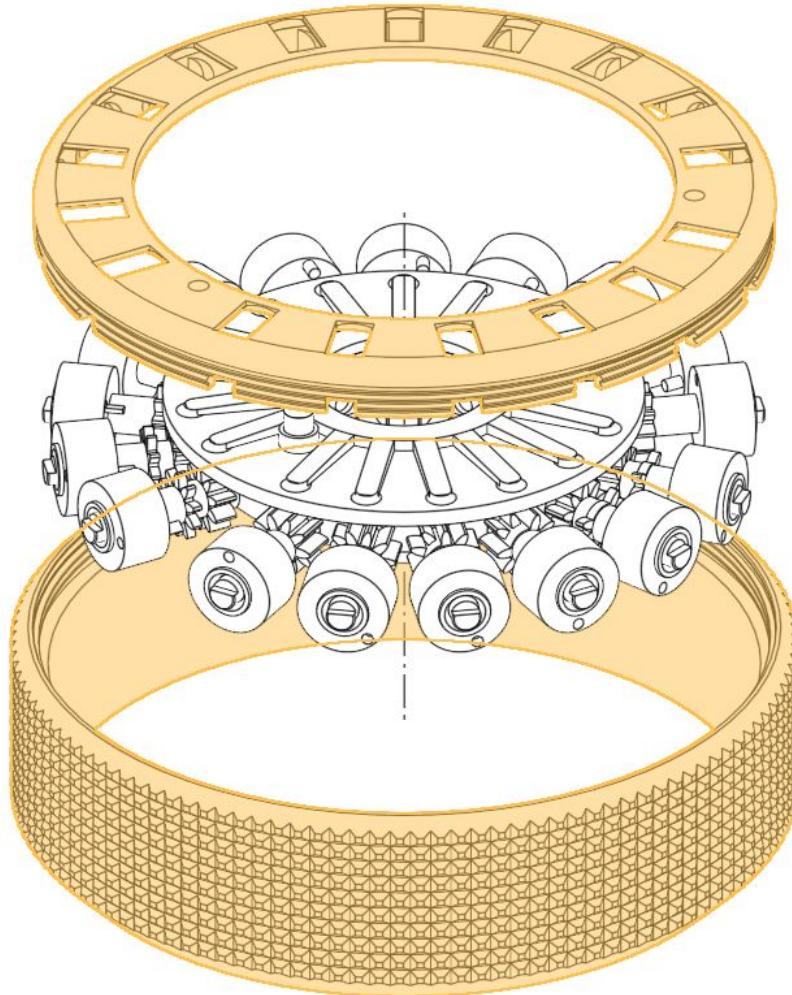
RESULTS DIALS

All of these parts except the clearing teeth are externally facing. Paint them prior to assembly.



17 X 6mm ball



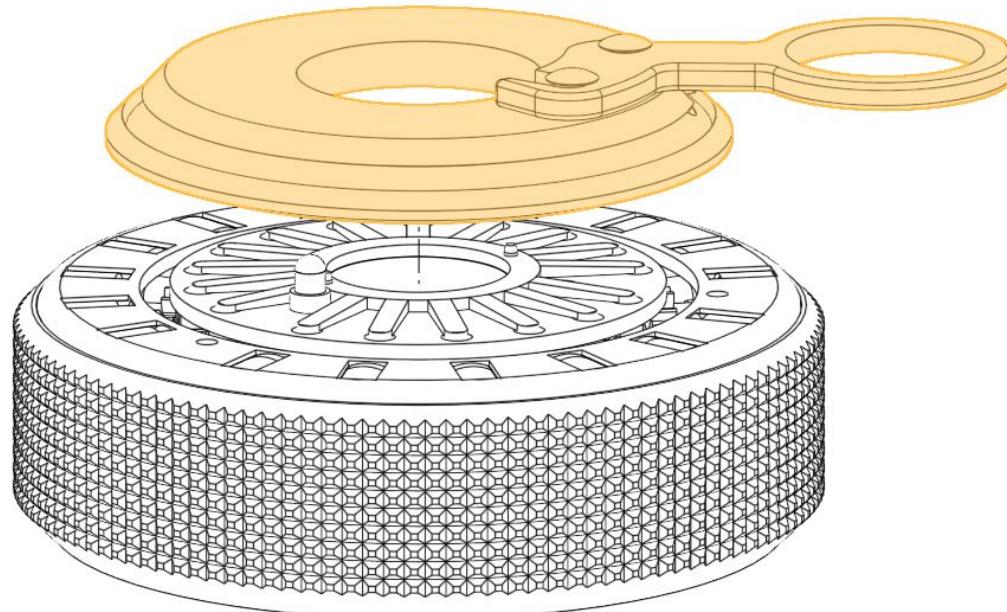


THREADING

The threading for these parts are built in. They may require some work to fasten together depending on how good your printer's overhangs are. Make sure these fit together before painting. The open circles at the top of the digit cover can be used with a tool to help get purchase to fasten it.

DIGIT COVER & UPPER HOUSING

The cover and housing are externally facing. Paint them prior to assembly.

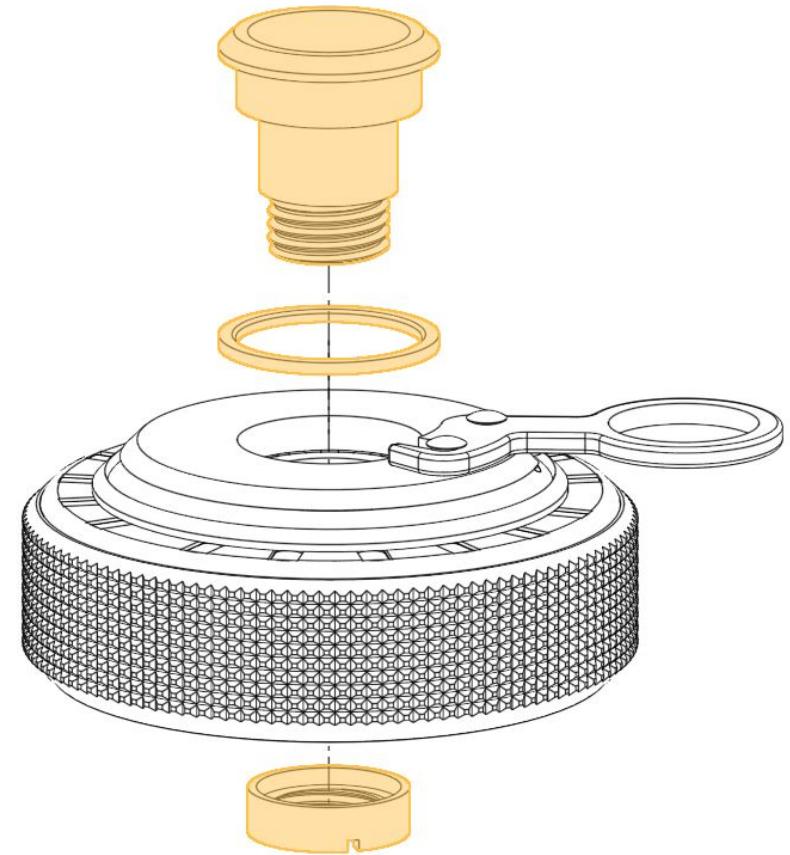


THREADING

The threading for these parts are built in. They may require some work to fasten together depending on how good your printer's overhangs are. Make sure these fit together before painting.

COLLAR AND RING

The collar and ring are externally facing. Paint them prior to assembly.

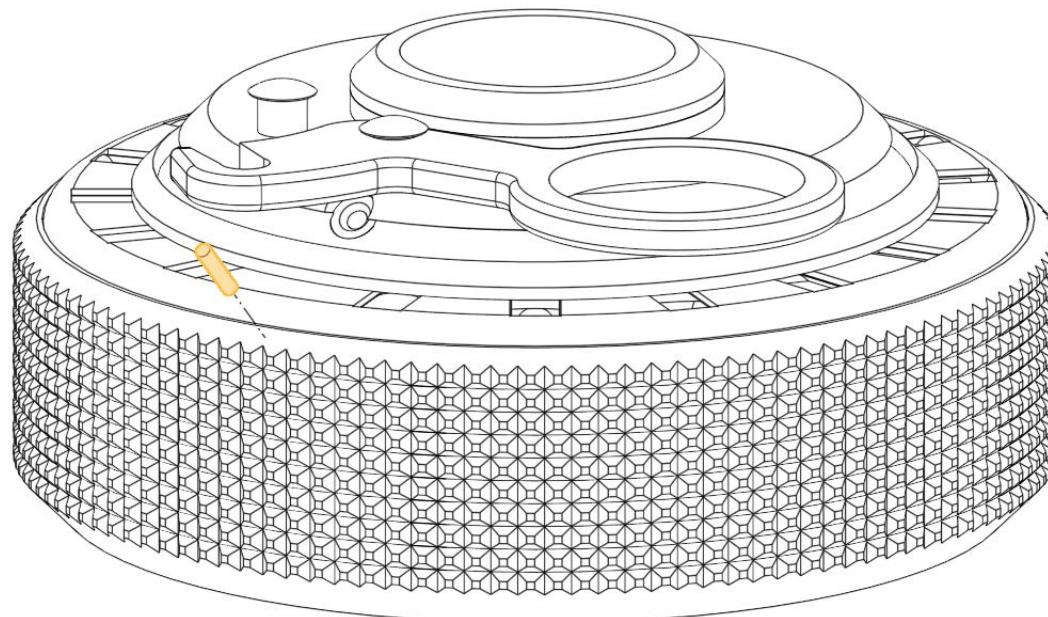


DRILL HOLE FOR PIN

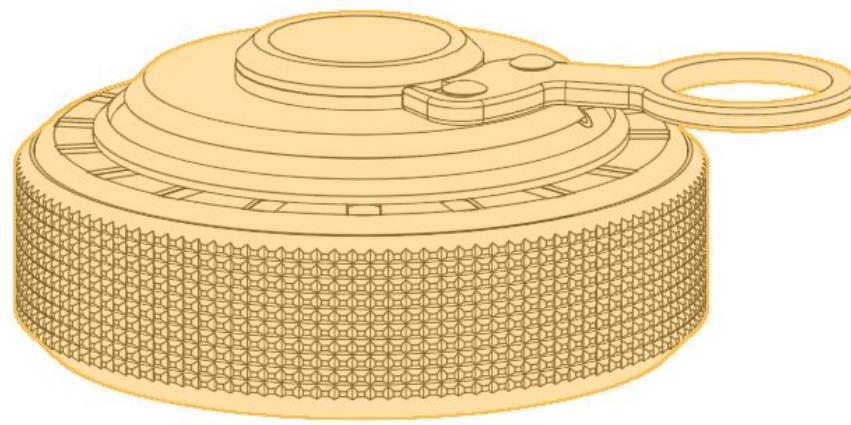
Between the last turns counter digit and the first results digit, drill using a 3/32 inch (2.4mm) bit through the edge of the upper housing into the thread for the digits cover at 45 degrees from vertical.

PIN DIGITS COVER AND HOUSING

Pin the digits cover and upper housing with the carriage pin.

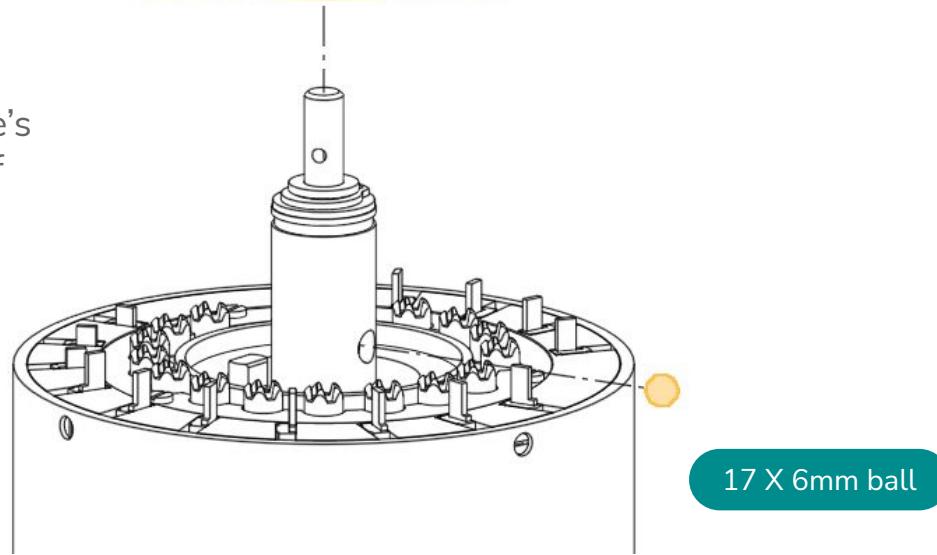




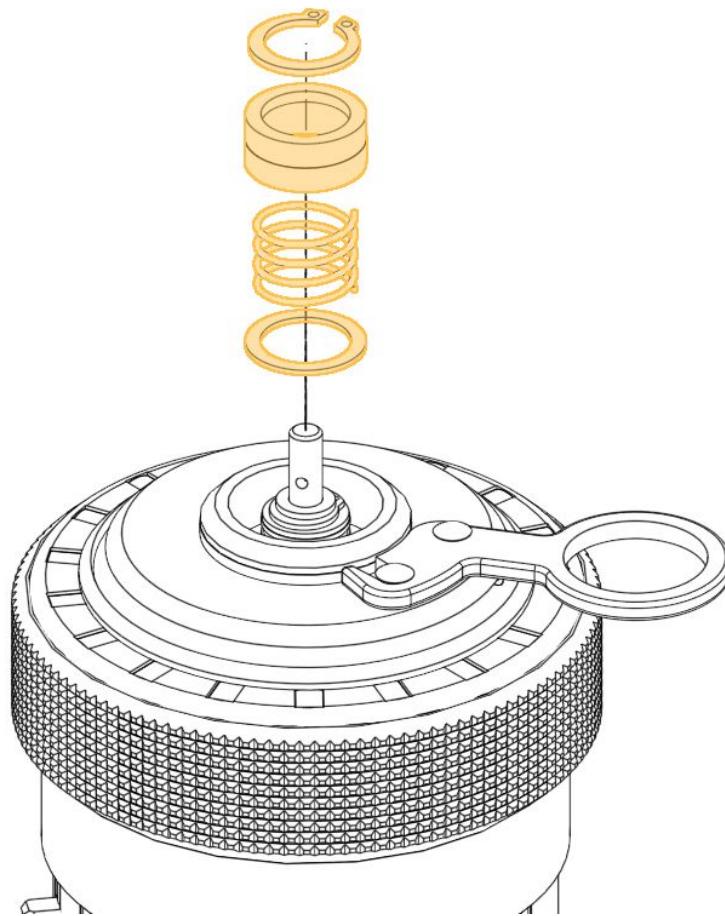


CARRIAGE ALIGNMENT

Align the carriage so that the one's digit aligns with the one's digit of the main body.

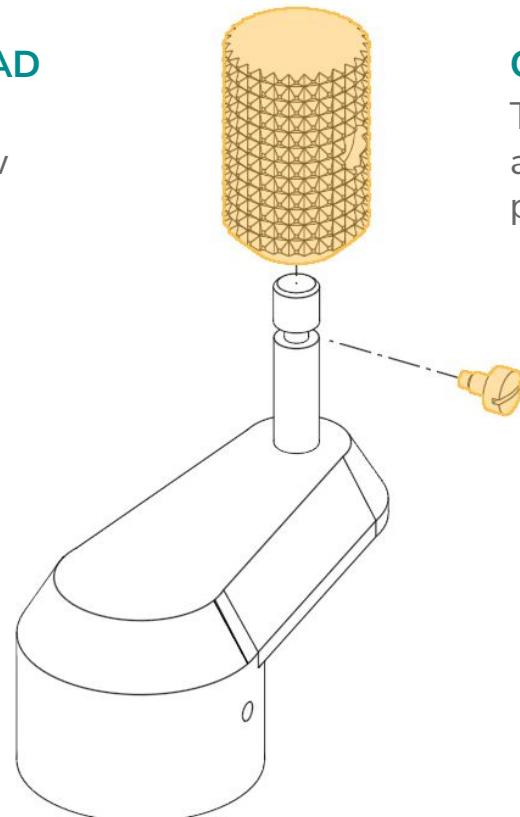


CARRIAGE SPRING
DESCRIBE THIS



HANDLE & PIN SCREW THREAD

Cut threads into the handle with an M4 tap and into the pin screw with an M4 die.

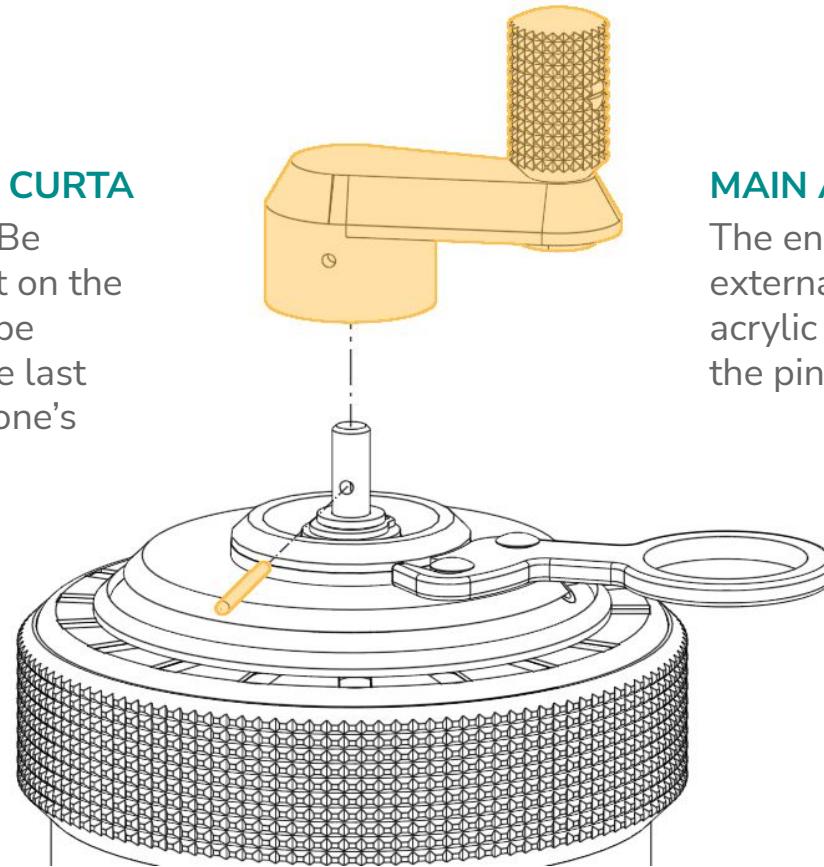


CRANK, HANDLE, & PIN SCREW

The crank, handle, and pin screw are externally facing. Paint them prior to assembly.

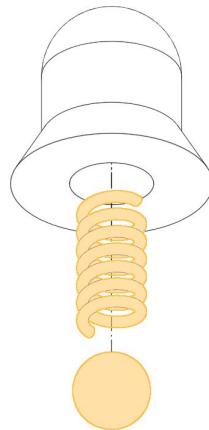
PIN THE HANDLE TO THE CURTA

But don't do it blindfolded. Be careful not to marr the paint on the handle. The handle should be oriented to rest between the last turns counter digit and the one's digit of the results.



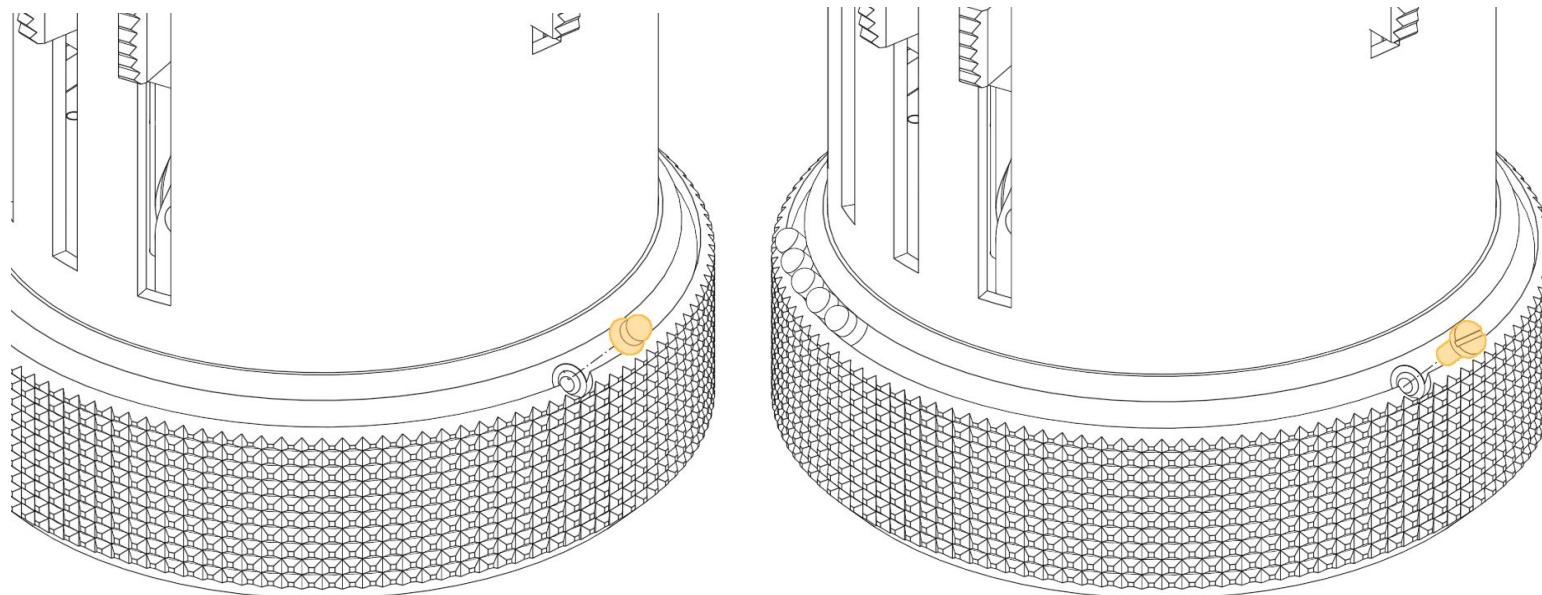
MAIN AXLE PIN

The ends of the main axle pin are externally facing. Use a brush and acrylic paint to cover the ends of the pin **after assembly**.



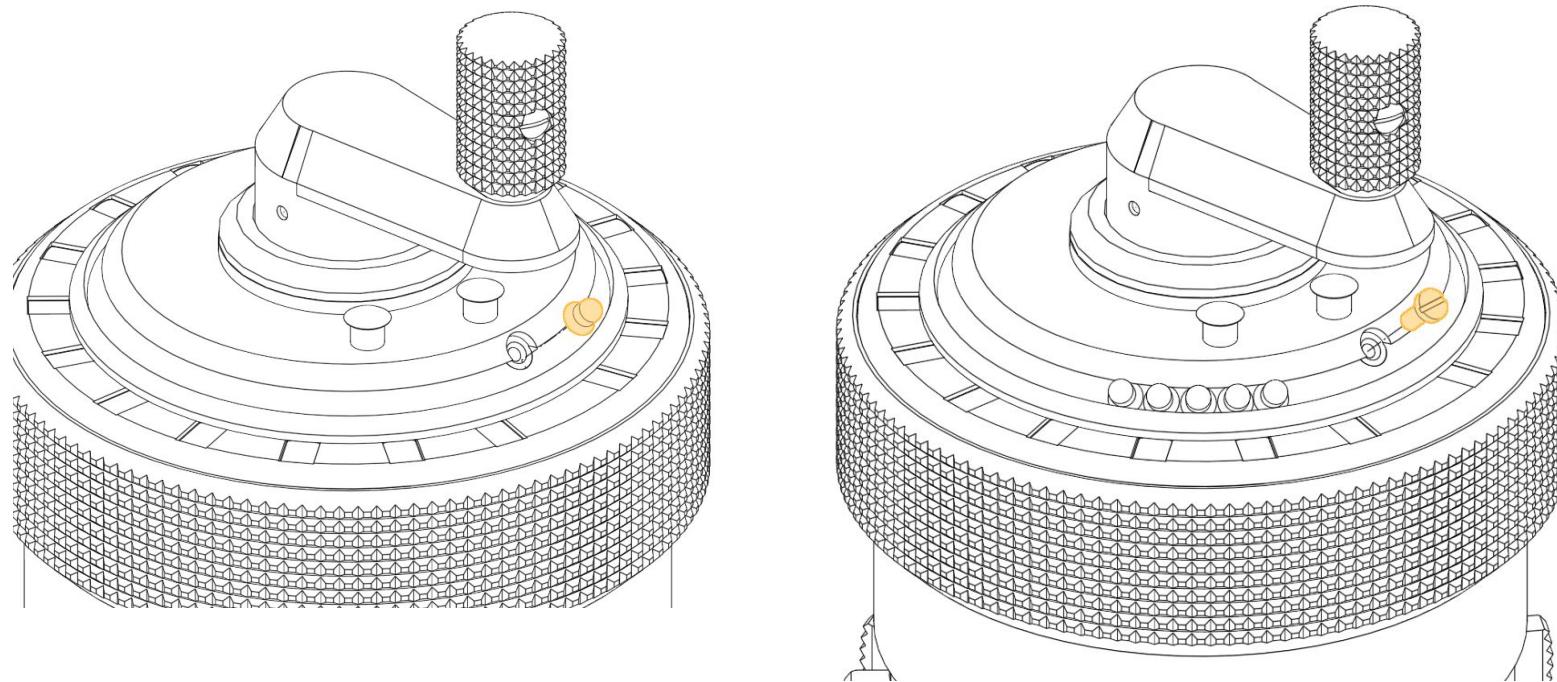
DECIMAL PLACE MARKERS

The decimal place markers are externally facing. Paint them prior to assembly.



DECIMAL PLACE MARKERS

The decimal place markers are externally facing. Paint them prior to assembly.



The carry levers are touchy and each may require fine tuning to work properly. Here are steps I took to get the calculator running:

1. Set all selector shafts to zero (topmost position), then rotate once. It should yeild a zero result with '1' on the turns counter.
2. Set the first selector shaft to '1', then rotate once. It should yield one as a result with '2' now showing on the turns counter.
3. Set the first selector shaft to '9' (bottom-most position), then rotate once. The result should carry to the ten's digit yielding '10' as a result with '3' on the turns counter.
4. Reset the first selector shaft to '0' and repeat step three using ten's digit. This should yield '100' as a result and '4' on the turns counter.
5. Continue repeating this for each input selector to ensure that each carry operation works.

If any of the carry operations do not work these are some things to check:

- With the carriage removed, the step drum facing the transmission shaft in question, and the selector knob set to '0', the transmission shaft should turn freely. If not, check fitment of the shaft and lubricate it.
- Depress the carry lever and see that the carry gear lines up with the tens bell carry tooth and when the crank is turned, the tooth engages the gear causing the transmission shaft to rotate.
- Ensure that another rotation causes the carry lever to pop back up and that the tens bell carry tooth does not engage the carry gear.
- Also check all of the above on the transmission shaft for the next less significant digit.

To test all carry levers, lift the carriage and manually set every results dial and turns counter dial to 9. Set the first input knob to 1. One turn of the crank should send a cascading carry to return all of the Curta's dials to zero.

The ultimate test of the Curta that I have found is starting from 0, add 1 to get 1 on the turns counter and 1 on the results, then subtract 1. The result should be zero on both the turns counter and the results.

