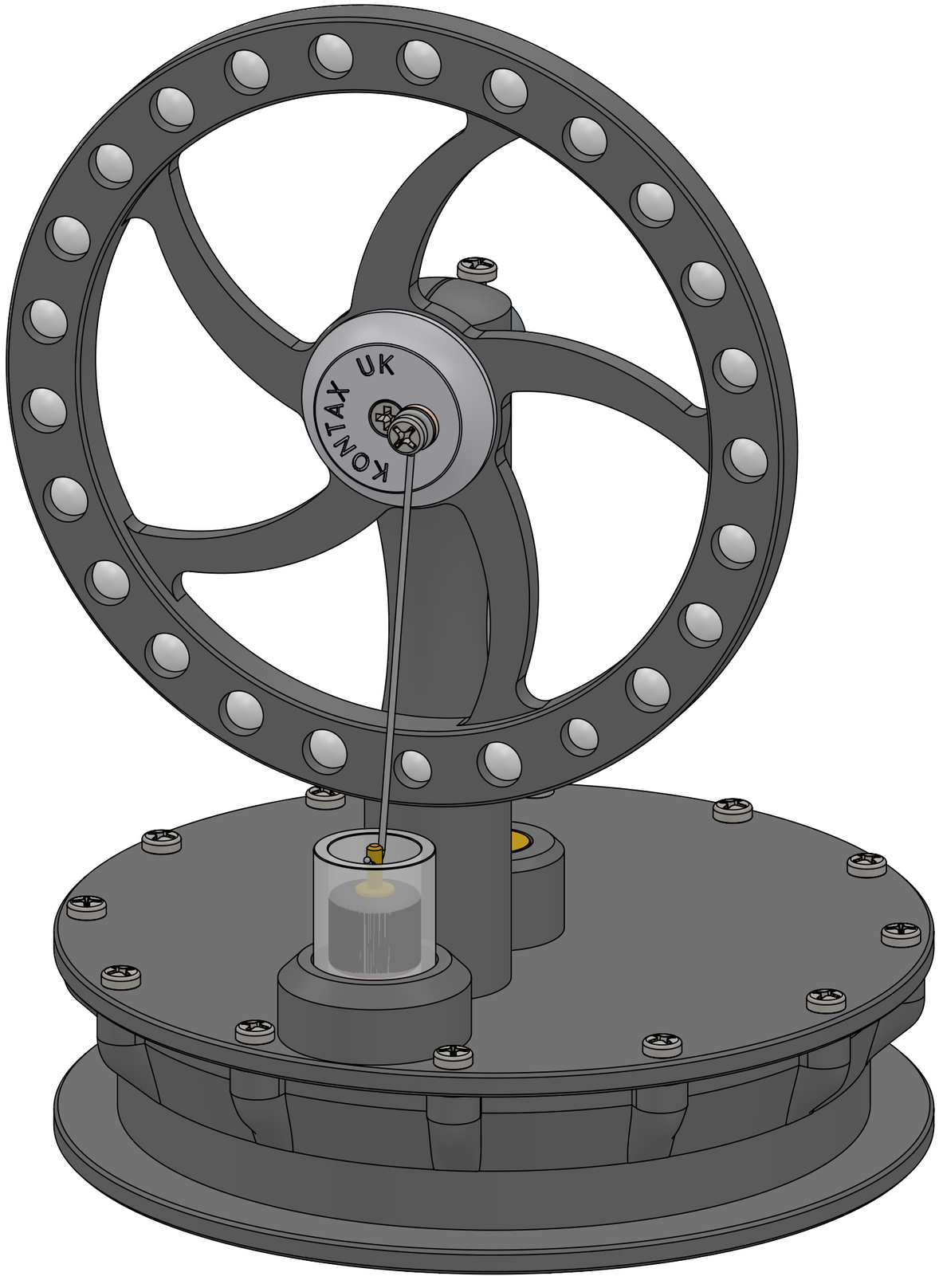


LT3D Stirling Engine

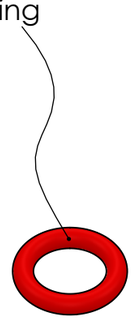
Please read all the way through the assembly instructions to familiarise yourself with the process before you start.

You will need a small cross-point and a small flat-bladed screwdriver to assemble the engine.

Pay close attention to the alignment of all the parts in the diagrams.

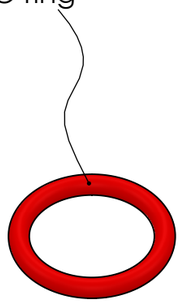
Operation and maintenance instructions can be found at the end of this document.

2x 7mm O ring

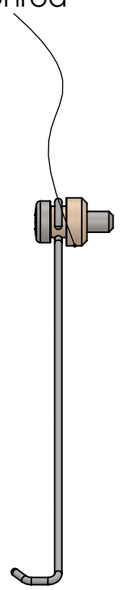


2x ballrace bearing

1x 12mm O ring

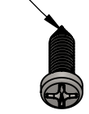


2x conrod



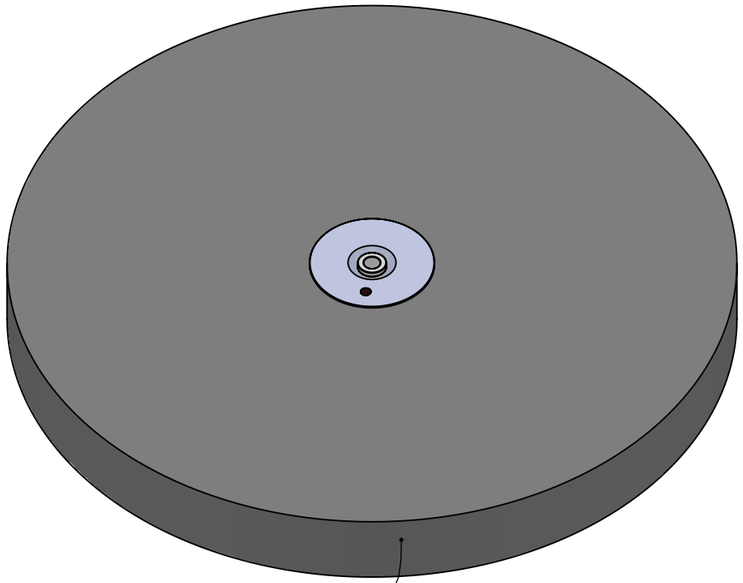
1x stem

13x self-tapping screw (1 spare)

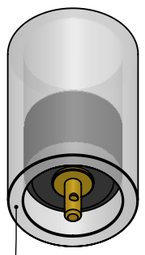


4x counter-sunk screw

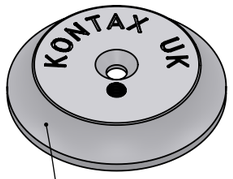
1x neoprene gasket



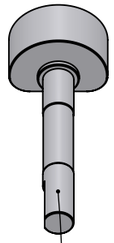
1x displacer



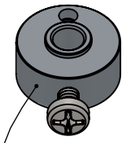
1x piston & 1x cylinder



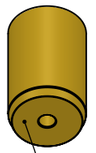
1x hub



1x axle



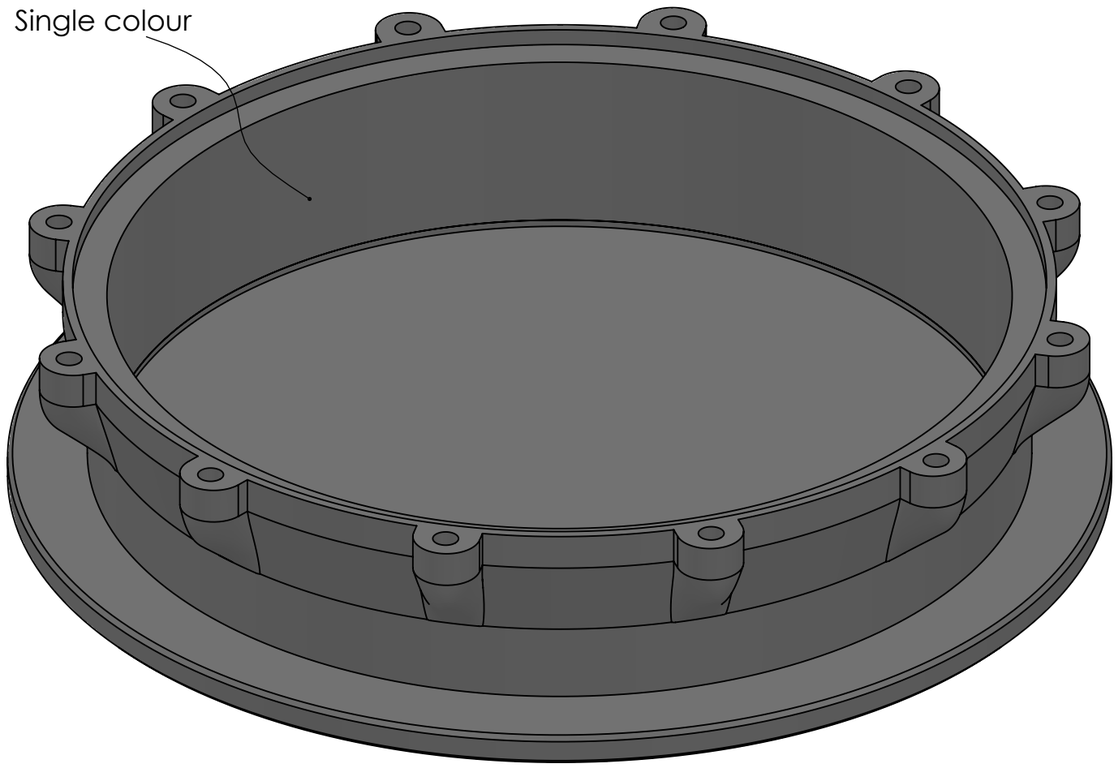
1x crank



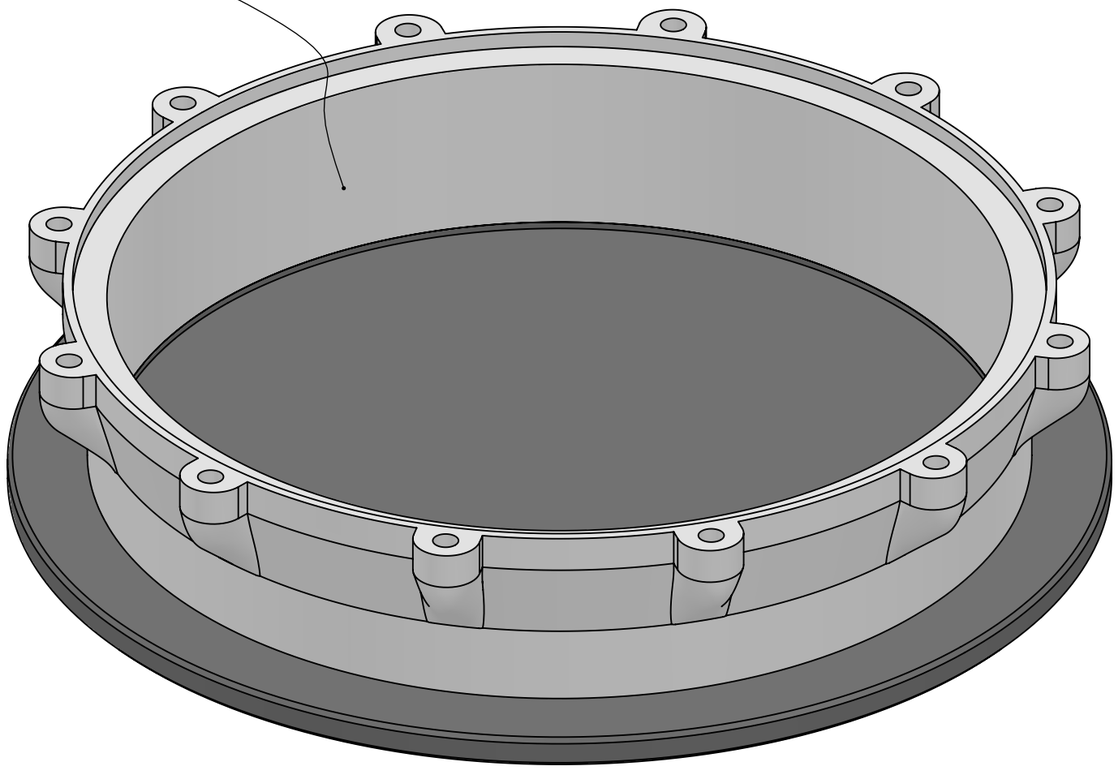
1x gland

24x 3/16" ball (1 spare)

2x 4mm ball



Multi-material printer
OR colour change from layer 14



Print the Base in PLA with these settings:

- 0.4mm nozzle
- 0.2mm first layer
- 0.2mm layer height
- 6 bottom layers
- 7 top layers

The extra top and bottom layers are so that there is not a void inside the plate that might interfere with heat transfer.

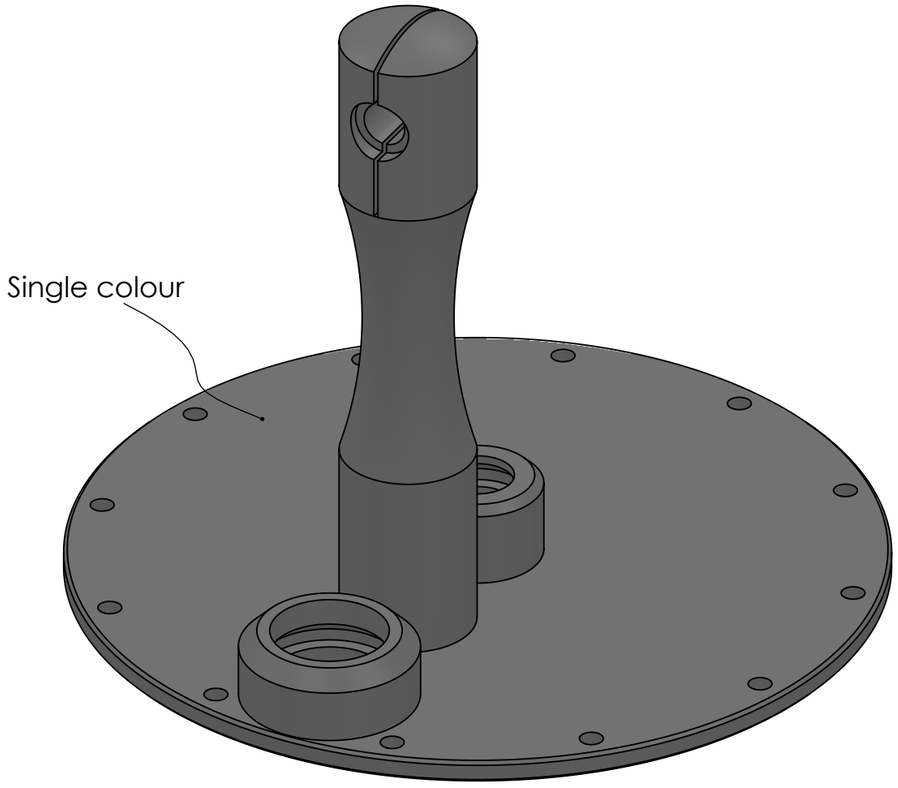
The STL file should load into your slicer in the correct orientation, and is split for convenient multi-colour printing.

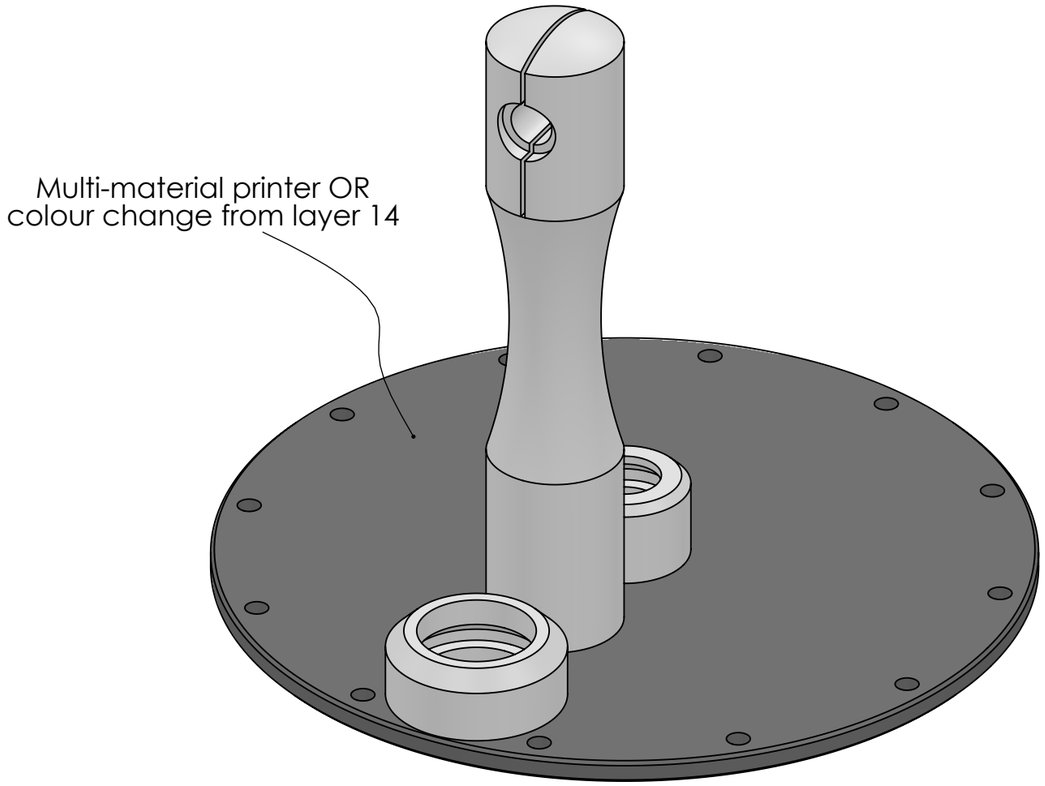
If you don't have a mulit-colour printer you can trigger a colour change in your slicer.

Note:

The Base, Top and Flywheel are all designed so that the colour change is at the same layer.

This means you can load all three parts into your slicer and print them together for convenience.





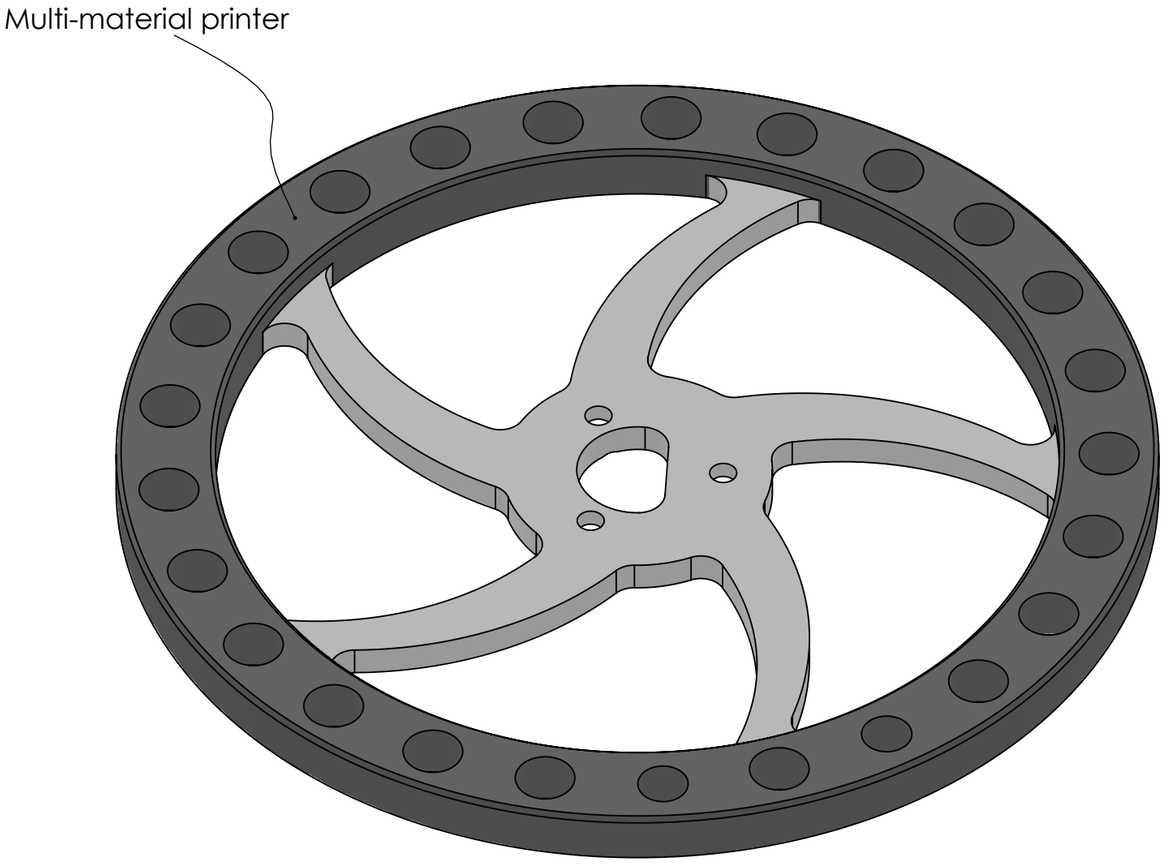
Print the Top in PLA with these settings:

- 0.4mm nozzle
- 0.2mm first layer
- 0.2mm layer height
- 7 bottom layers
- 6 top layers

The extra top and bottom layers are so that there is not a void inside the plate that might interfere with heat transfer.

The STL file should load into your slicer in the correct orientation, and is split for convenient multi-colour printing.

If you don't have a mulit-colour printer you can trigger a colour change in your slicer.

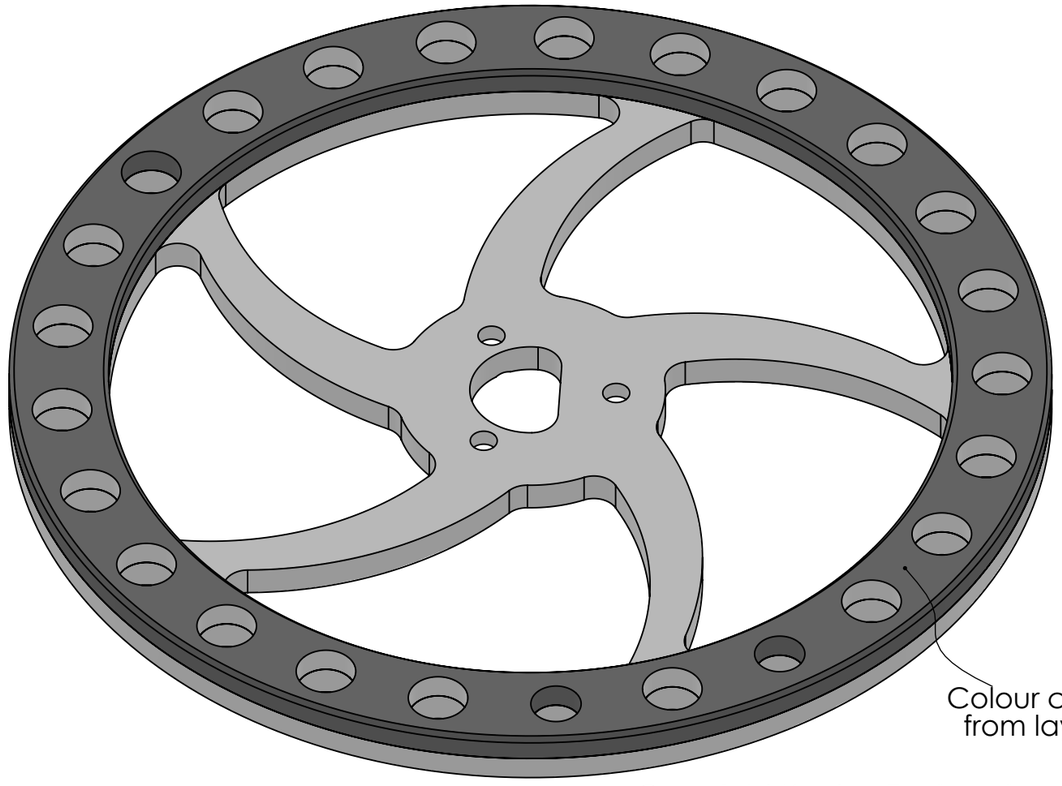


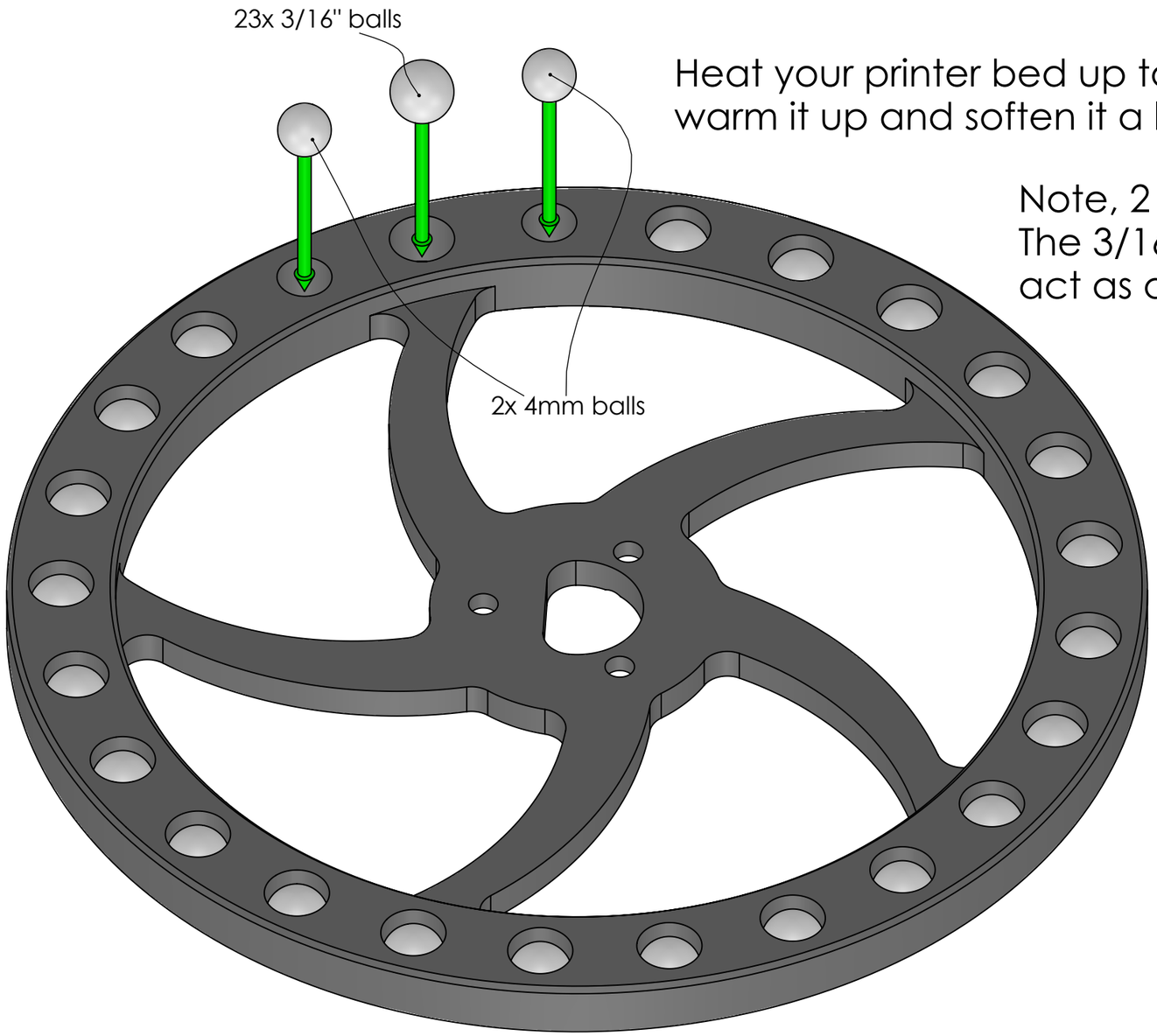
Print the Flywheel in PLA with these settings:

- 0.4mm nozzle
- 0.2mm first layer
- 0.2mm layer height
- 6 bottom layers
- 7 top layers
- 4 walls

The STL file should load into your slicer
in the correct orientation, and is split for convenient multi-colour printing.

If you don't have a mulit-colour printer you can trigger a colour change in your slicer after the top spokes layer to get the spokes a different colour to the rim.

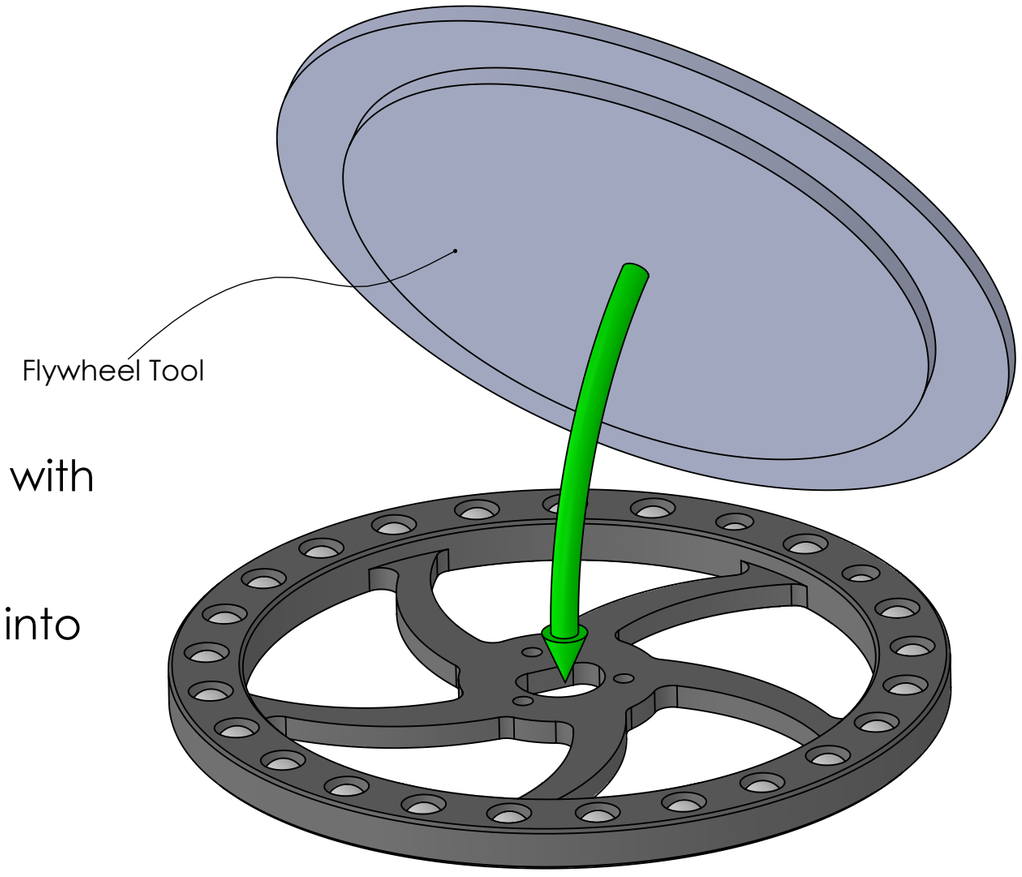




Heat your printer bed up to 60° and place the Flywheel on it for 4-5 minutes to warm it up and soften it a little bit. This will make fitting the balls easier.

Note, 2 of the Balls are 4mm diameter, the rest are 3/16". The 3/16" Balls give mass to the flywheel and the 4mm Balls act as a counterbalance.

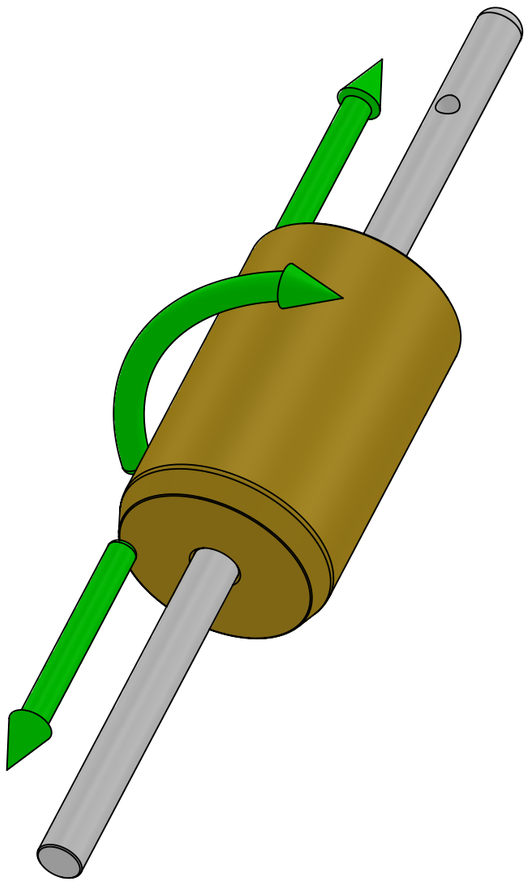
While the Flywheel is still warm remove it from the printer bed and press a few Balls in until they are flush with the Rim. Return to the bed to warm up again and repeat until all the Balls are in. You can use a coin to press on the Balls to save your fingers, and there will be a small gap under the 4mm Balls.

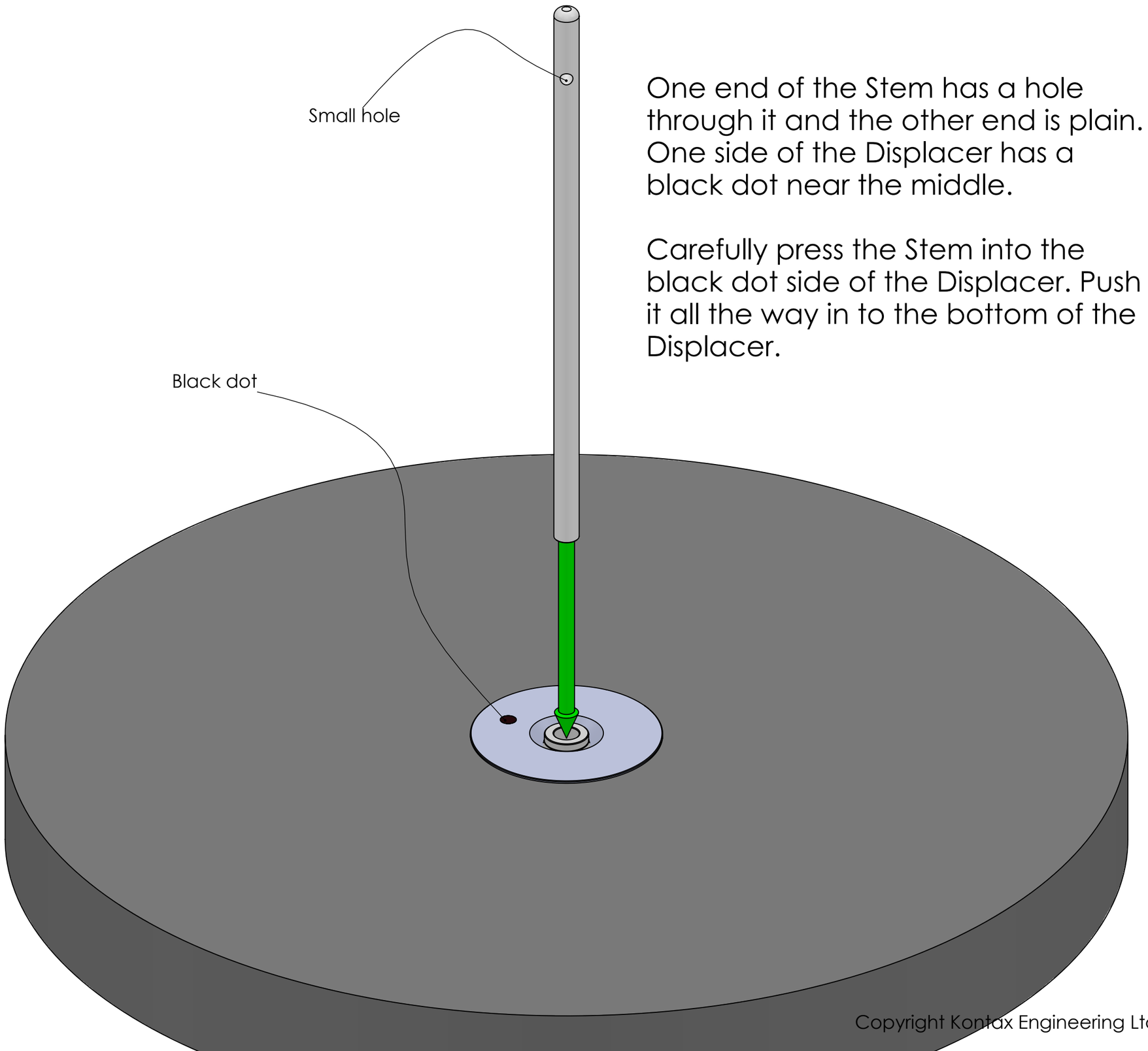


If you find the Flywheel has warped you can print the Flywheel Tool with 100% infill for solidity and use it to flatten the Flywheel.

Heat your bed to 60°, place the Flywheel on it, fit the Flywheel Tool into the Flywheel and put medium weight on it such as a mug of warm water. Leave it for 5-10 minutes to flatten the Flywheel. Leave everything in place and let the bed cool down completely before removing the weight.

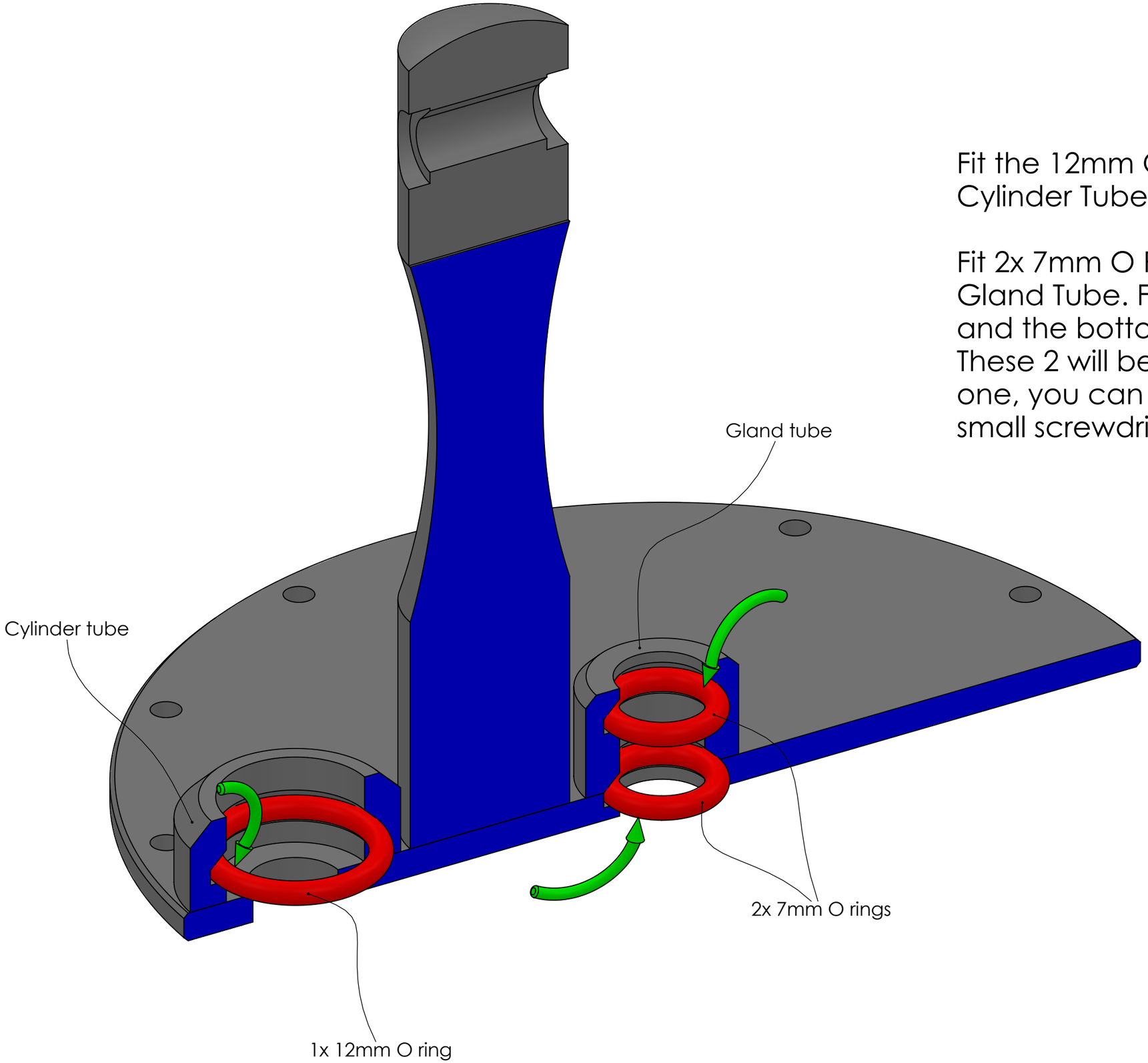
Slide and rotate the Gland up and down the Stem to clean out any particles of dust.





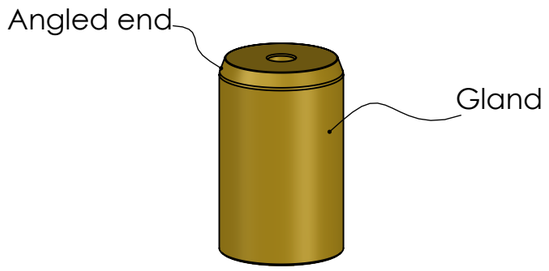
One end of the Stem has a hole through it and the other end is plain. One side of the Displacer has a black dot near the middle.

Carefully press the Stem into the black dot side of the Displacer. Push it all the way in to the bottom of the Displacer.

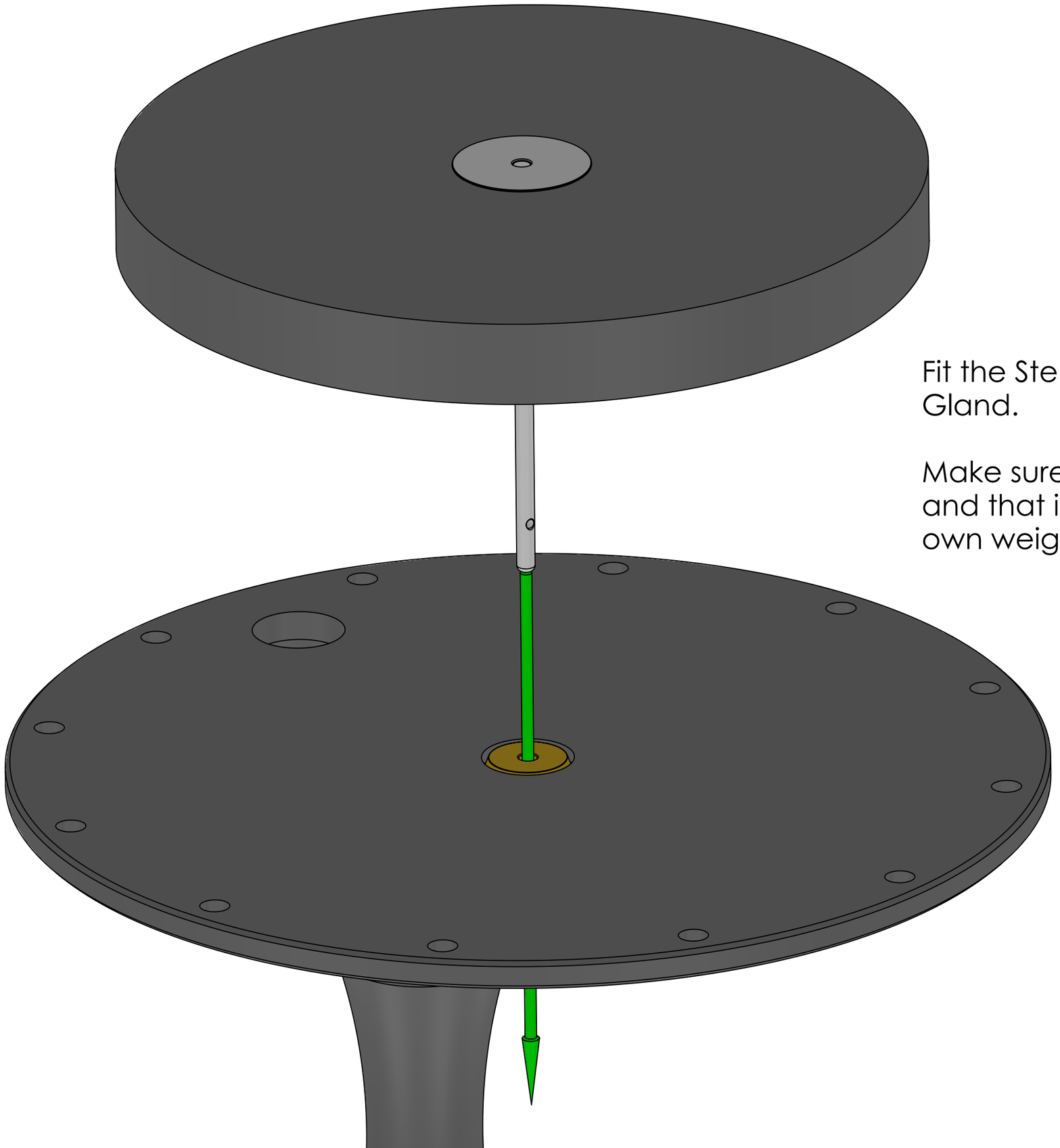


Fit the 12mm O Ring in the groove in the Cylinder Tube. It should fit quite easily.

Fit 2x 7mm O Rings in the grooves in the Gland Tube. Fit the top one in from the top and the bottom one in from the bottom. These 2 will be more difficult than the 12mm one, you can use fine tweezers or a very small screwdriver to help if needed.



Fit the Gland with the angled end downwards into the Gland Tube and press it down through the O Rings until the top is flush with the top of the Gland Tube.

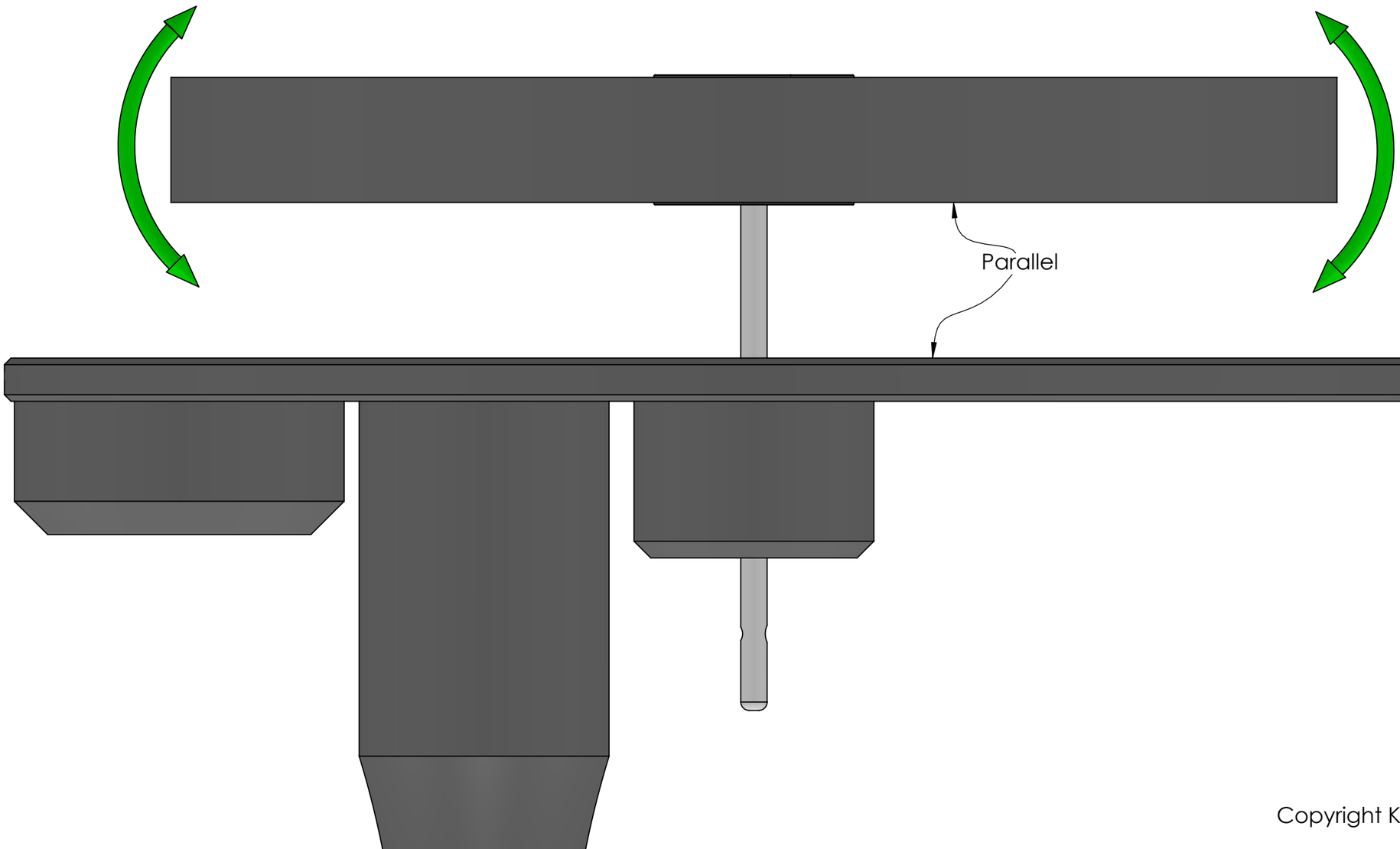


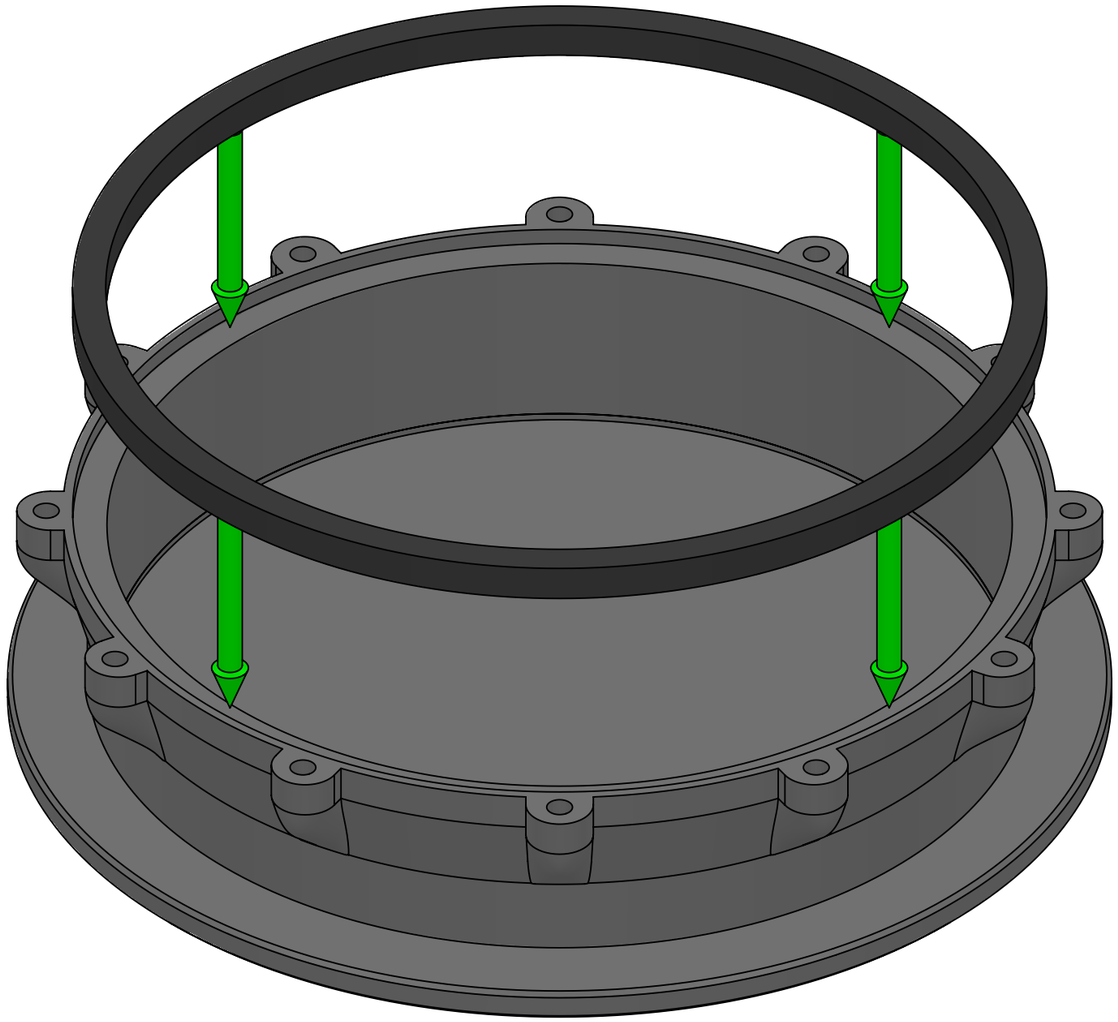
Fit the Stem all the way through the Gland.

Make sure it slides up and down freely and that it can drop it freely under its own weight.

Check that the Displacer is parallel to the bottom surface of the Top.

If it is not you can gently grip the edges of the Displacer and carefully straighten it. Use only gentle movements, you need to use just enough force to move the foam Displacer disc in the white plastic clips and NOT bend the Displacer Stem.

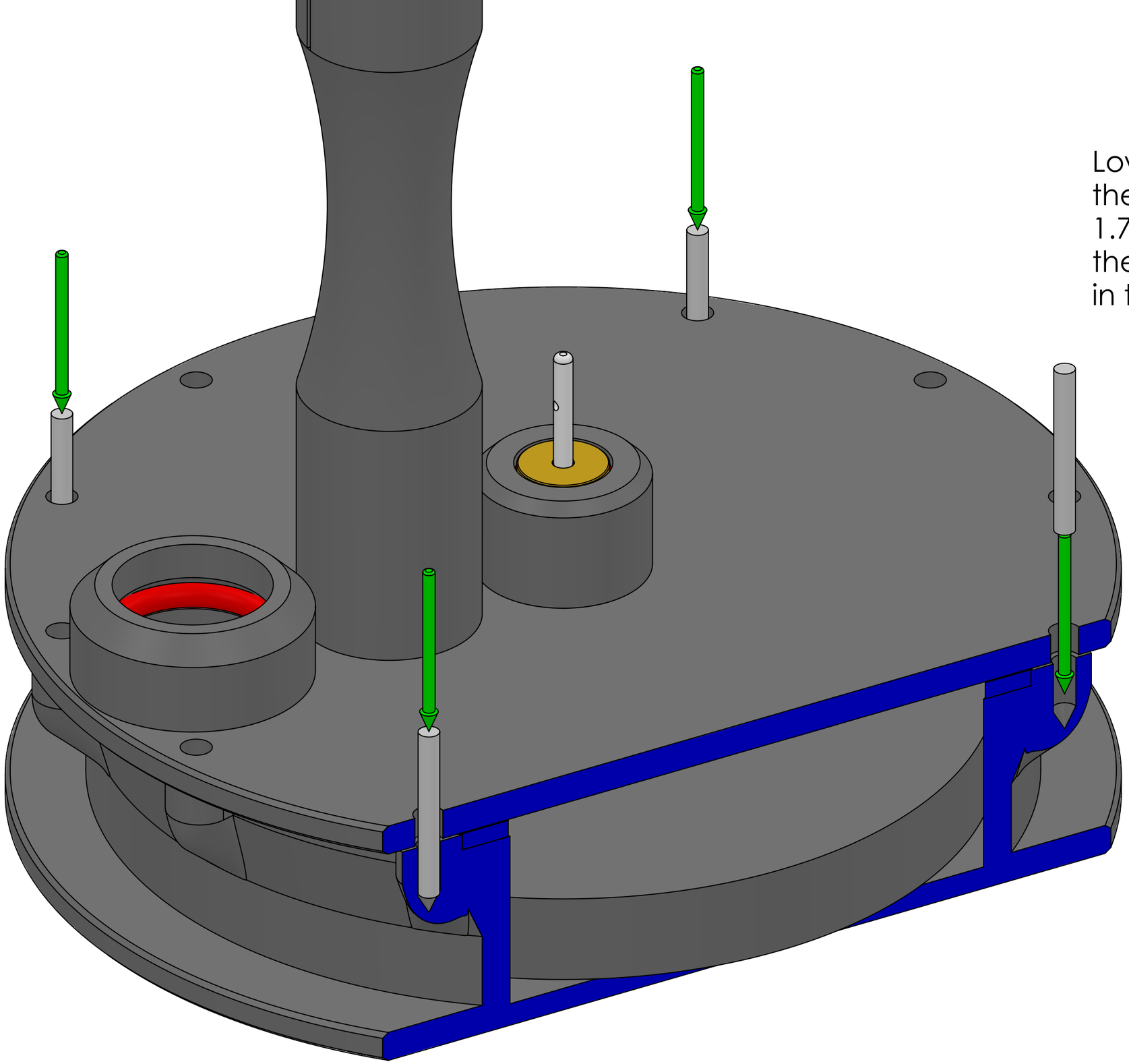


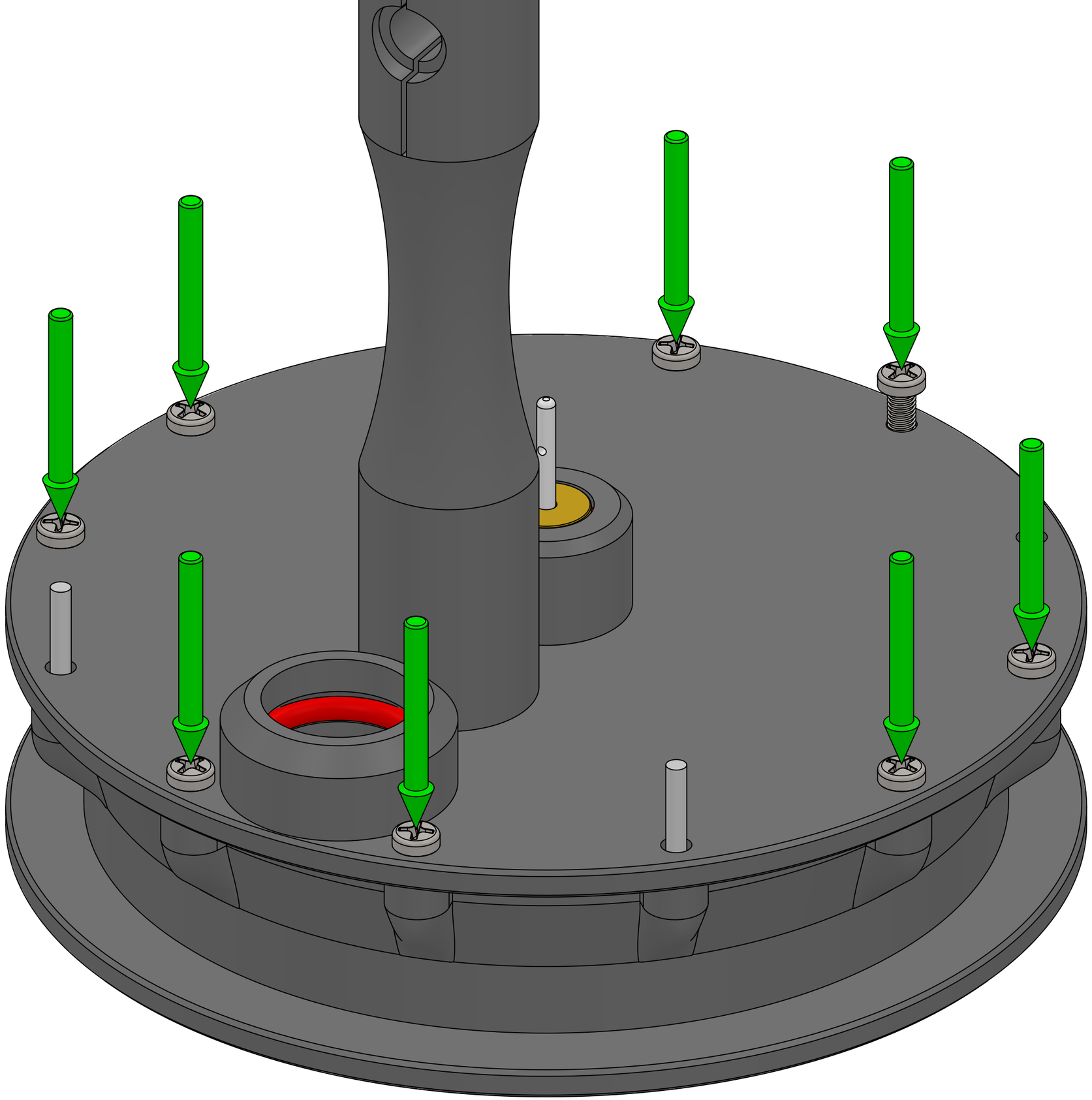


Fit the Neoprene Gasket into the step in the Base. Make sure it is laying flat and is up against the outer diameter of the step.

When it is in place correctly it will sit above the top surface of the Base by about 1.5mm.

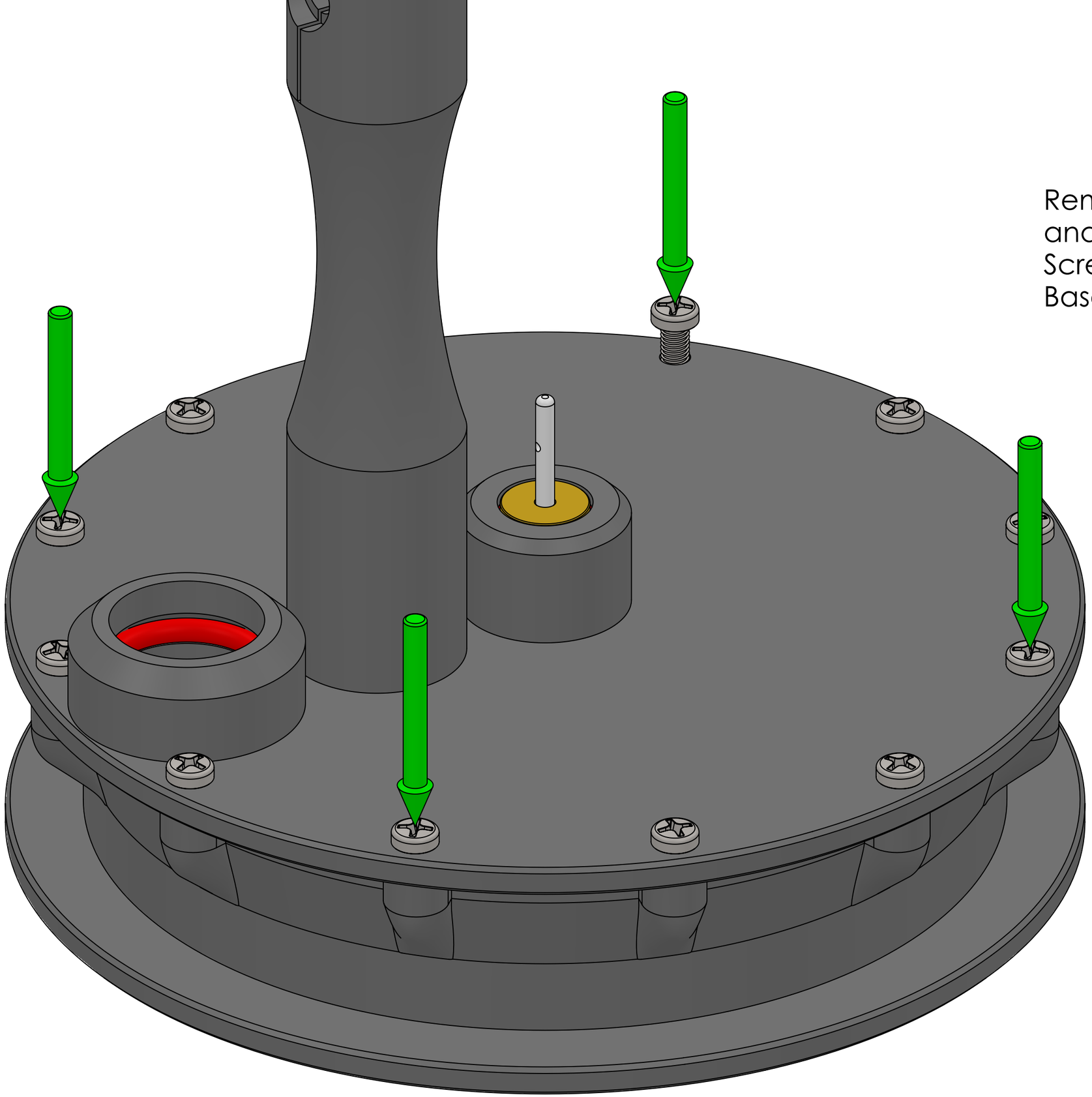
Lower the Top and Displacer onto the Base. Use 4 short pieces of 1.75mm diameter filament to align the holes in the Top with the holes in the Base.





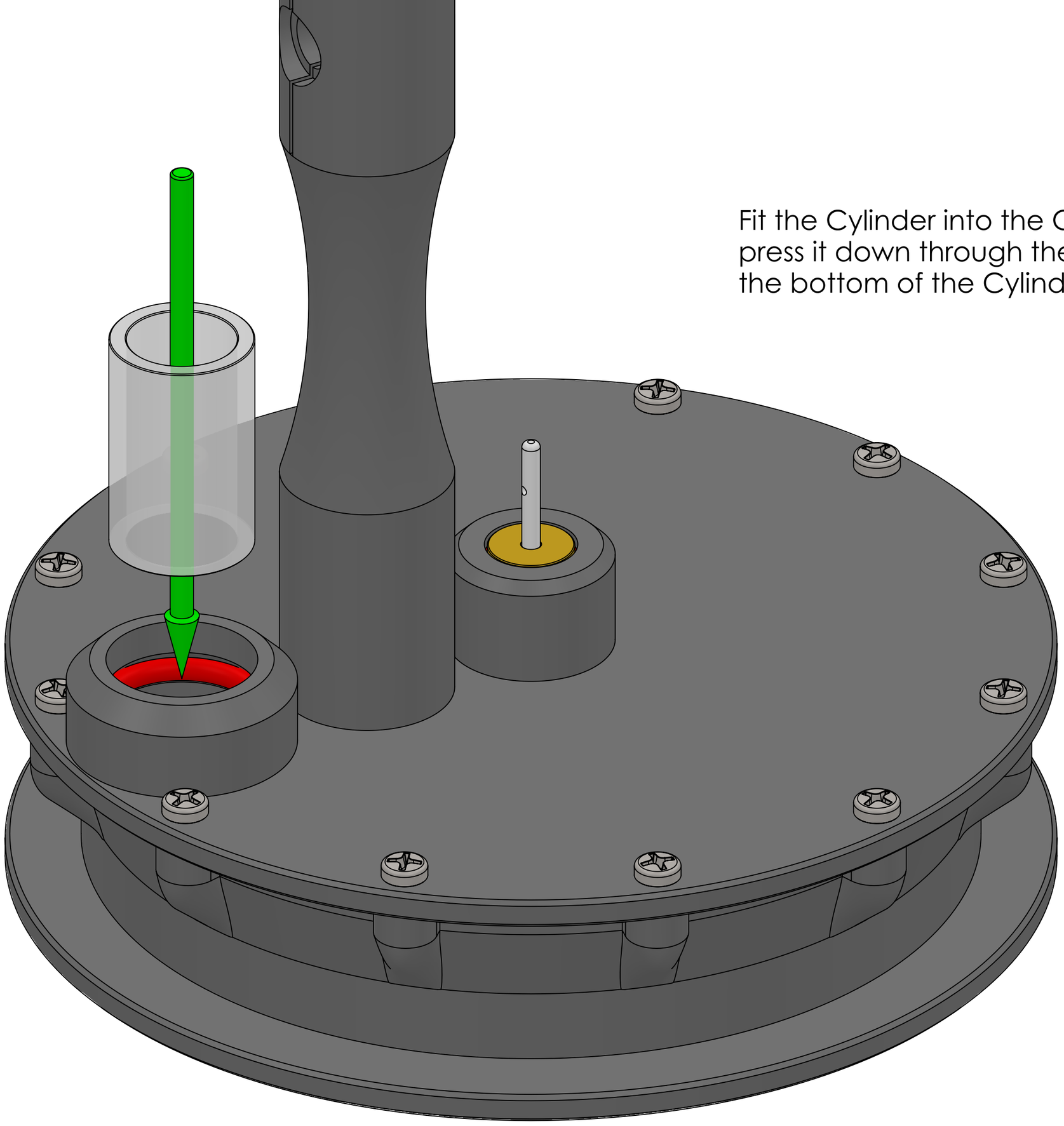
Keeping the pieces of filament in place, screw 8x Self-tapping Screws through the Top into the Base. As they tighten they will compress the Neoprene Gasket, screw them right down until the Top is tight against the Base.

The screws will be reasonably tight when screwing them into the Base because they are self-tapping (ie forming their own threads in the plastic).

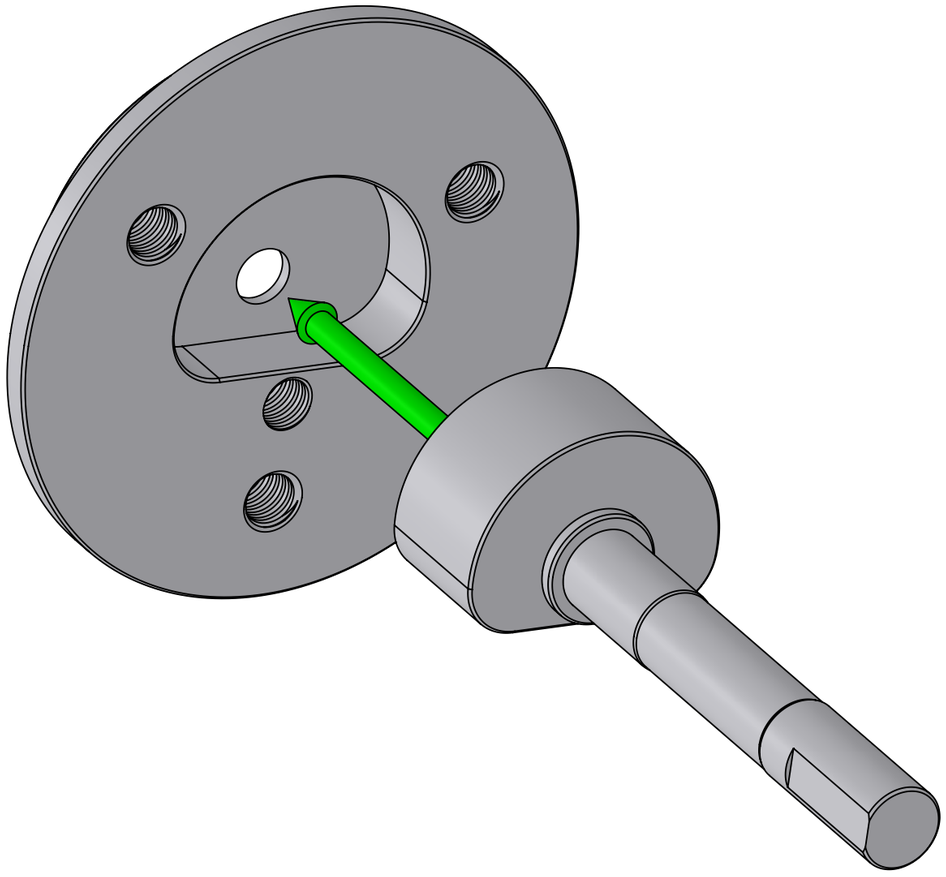


Remove the pieces of filament and screw the last 4x Self-tapping Screws through the Top into the Base as in the previous step.

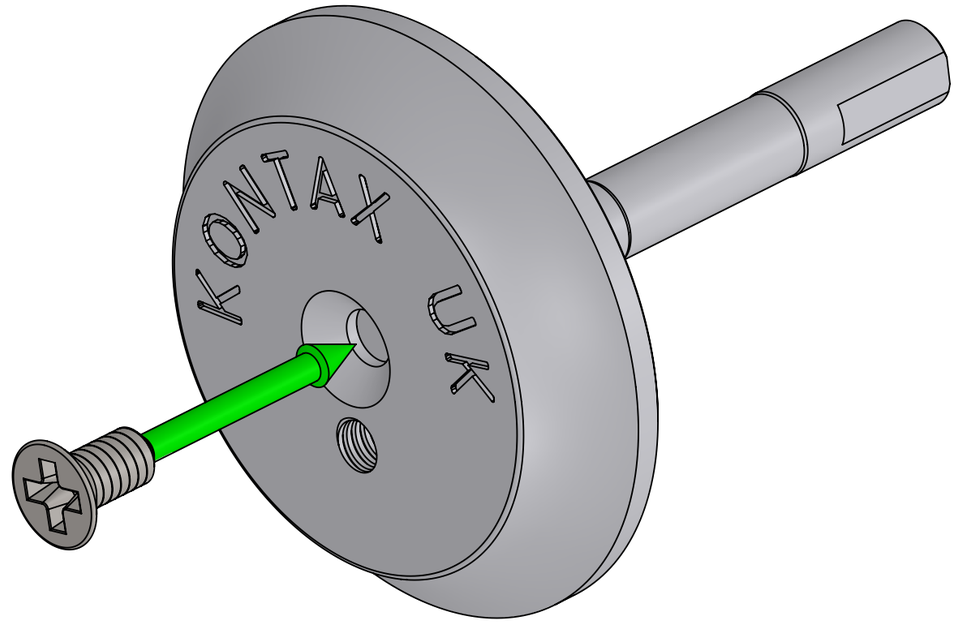
Fit the Cylinder into the Cylinder Tube and press it down through the O Ring until sits in the bottom of the Cylinder Tube.



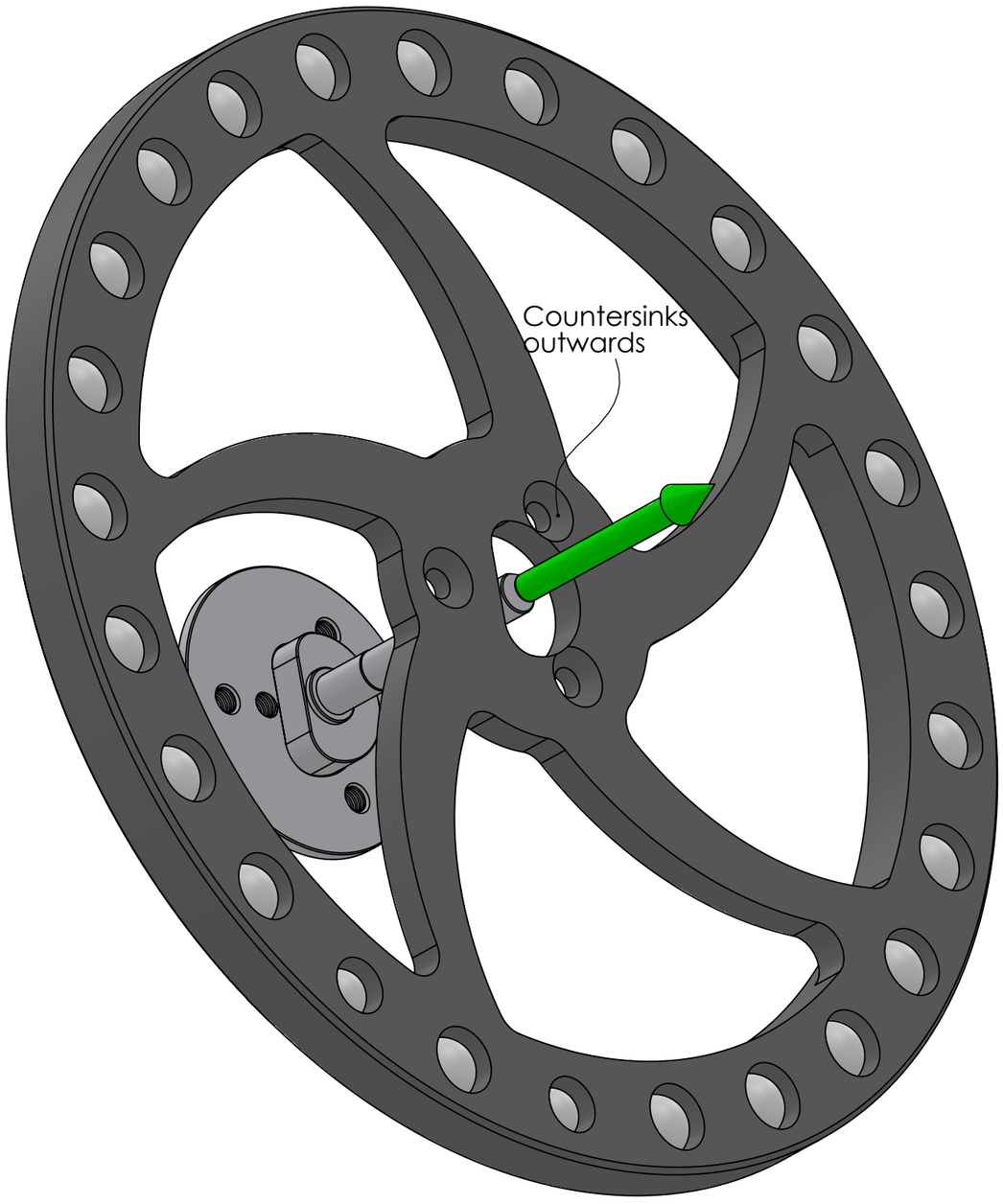
Fit the Axle into the Hub.

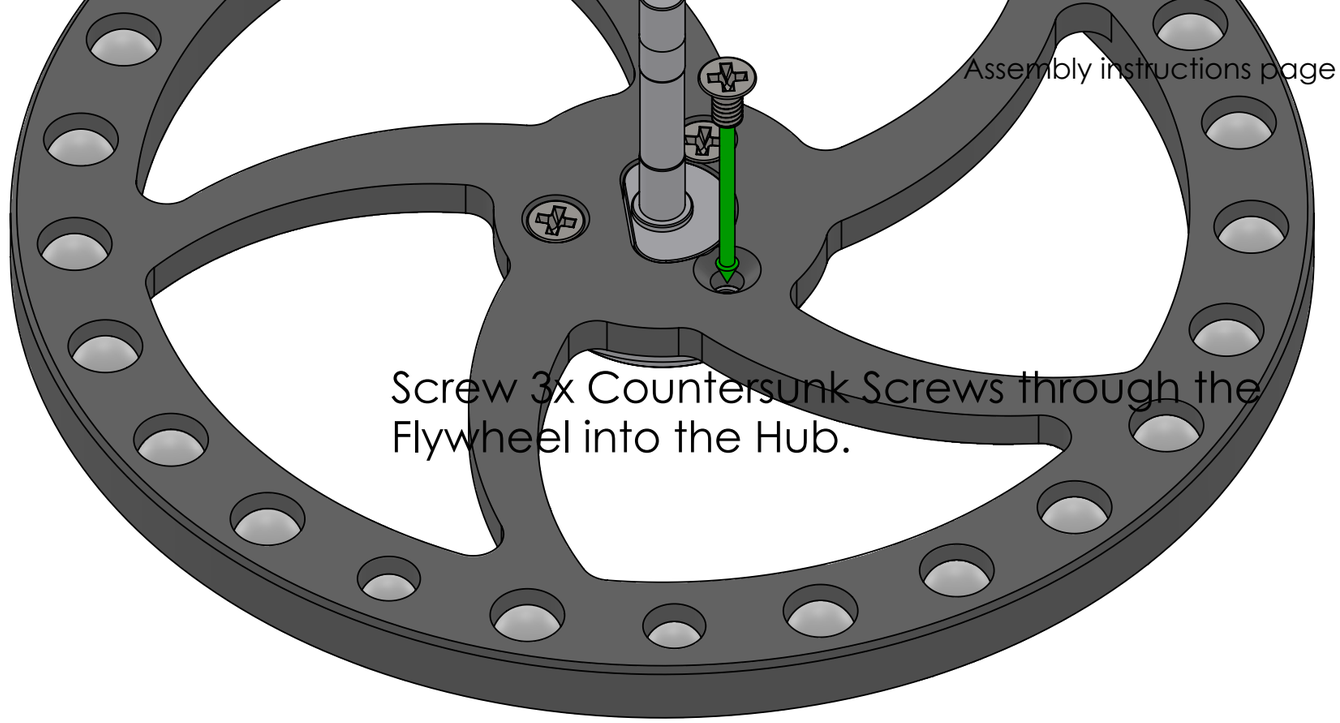


Screw 1x Countersunk Screw
through the Hub into the Axle.



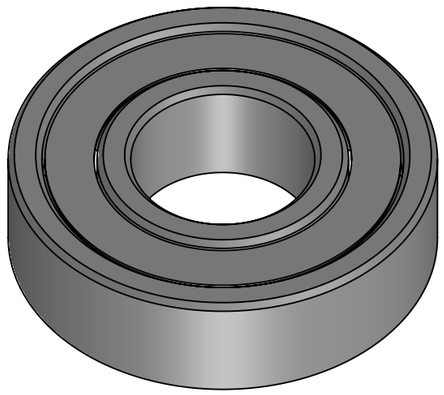
Fit the Hub & Axle into the D-shaped hole in the Flywheel, note the alignment of the Flywheel.

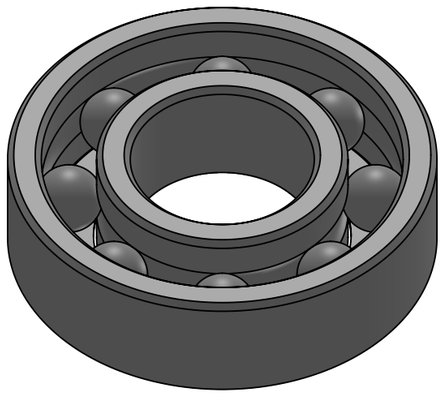




Screw 3x Countersunk Screws through the Flywheel into the Hub.

Note, the Ballrace Bearings have a caged side and an open side.





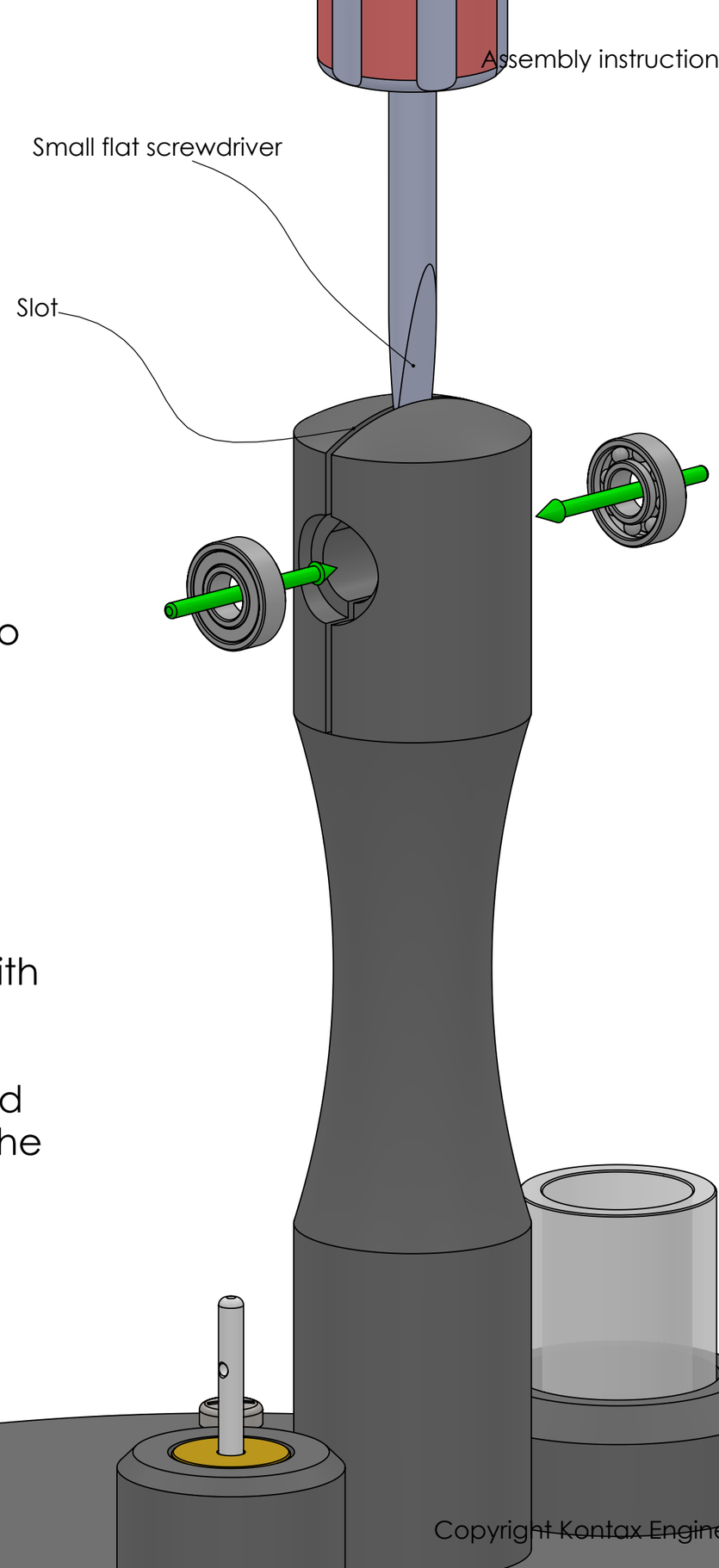
BEFORE fitting the bearings check there are no strings of filament in the Bearing pockets that might interfere with operaton.

Wedge a small flat screwdriver into the slot in the Pillar to open out the Ballrace Bearing pockets.

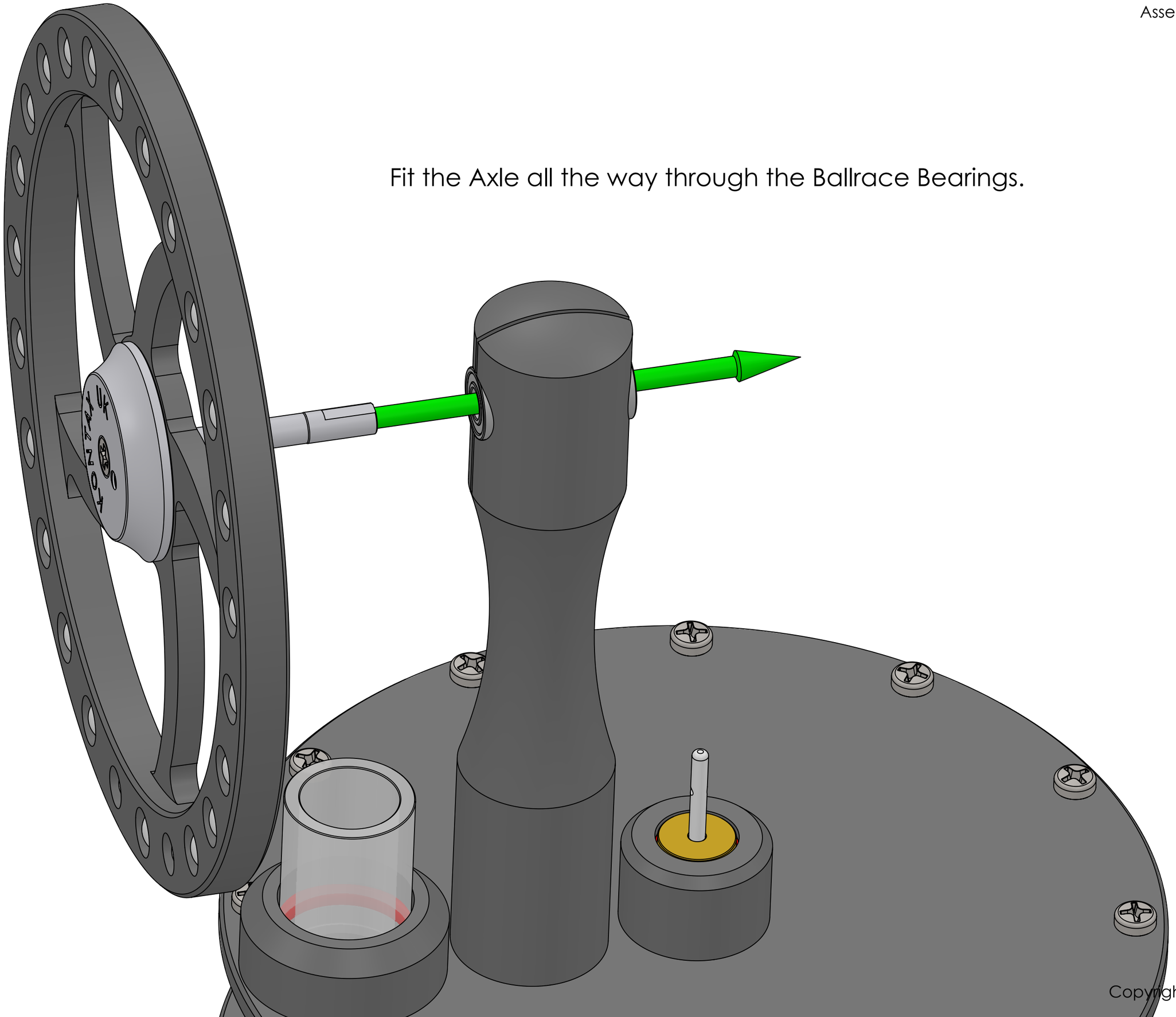
Fit the Bearings into the pockets in the Pillar with their open sides inwards.

Hold the Bearings in place with your finger and thumb and remove the screwdriver to allow the Pillar to gently grip the Bearings.

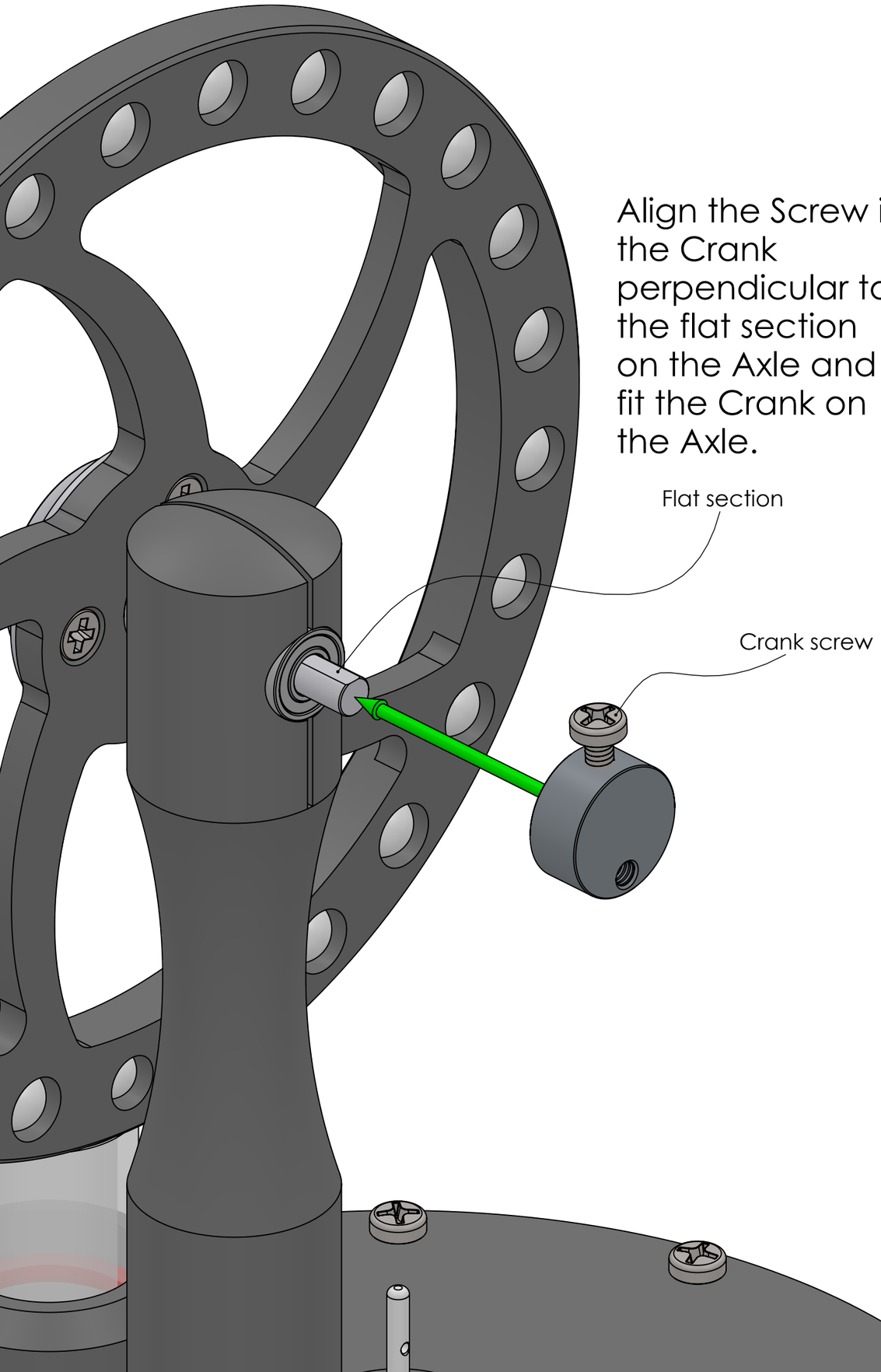
Both Bearings should fit flush with the outside diameter of the Pillar.



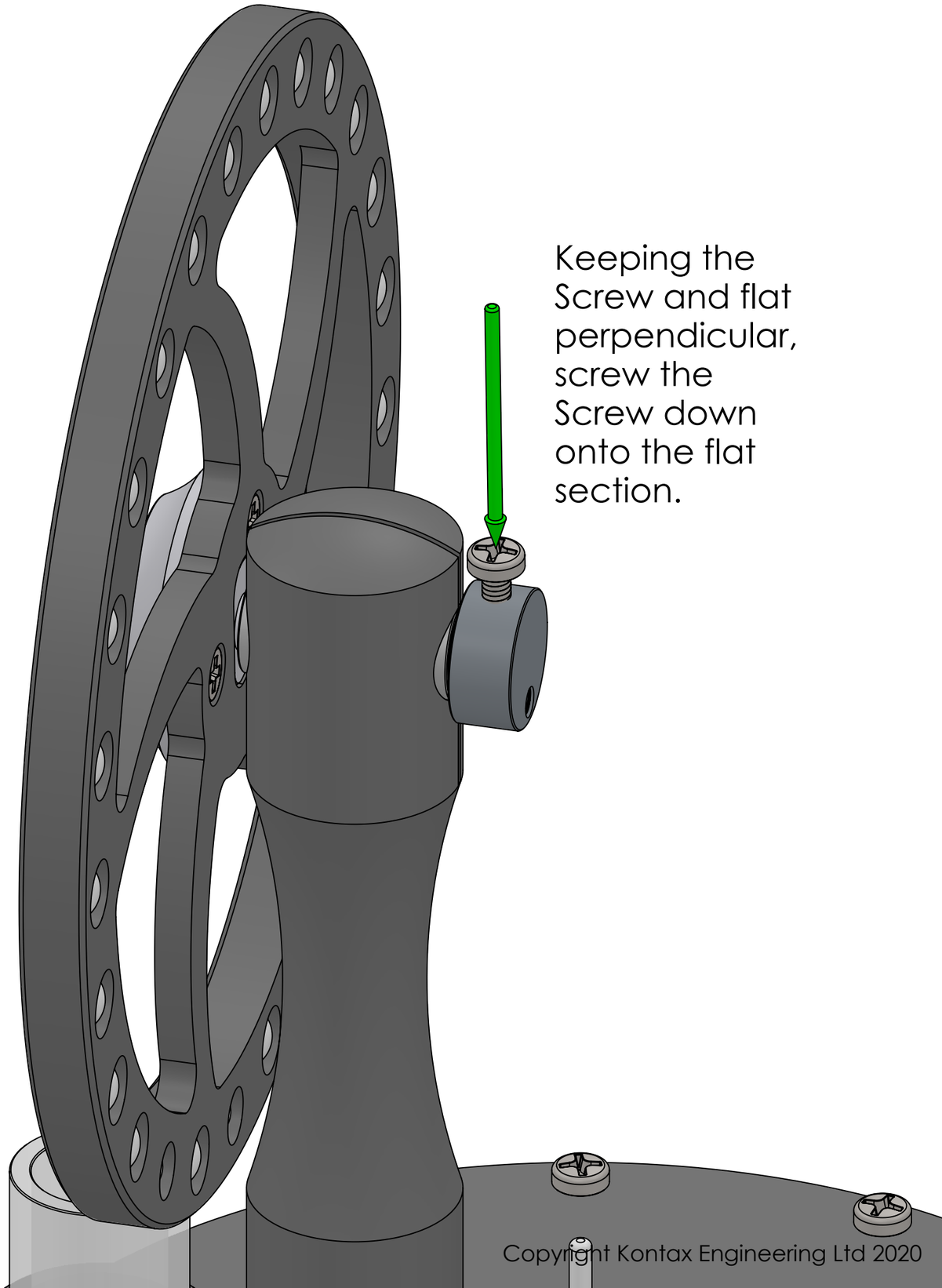
Fit the Axle all the way through the Ballrace Bearings.

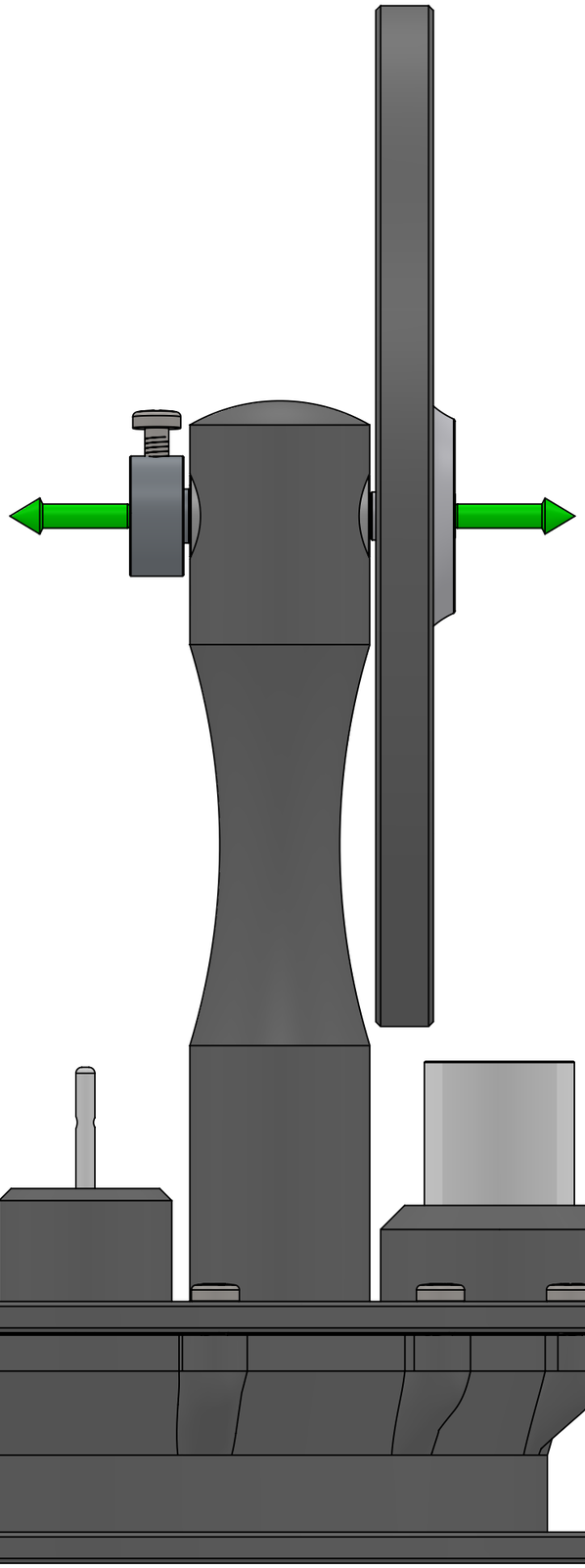


Align the Screw in the Crank perpendicular to the flat section on the Axle and fit the Crank on the Axle.



Keeping the Screw and flat perpendicular, screw the Screw down onto the flat section.





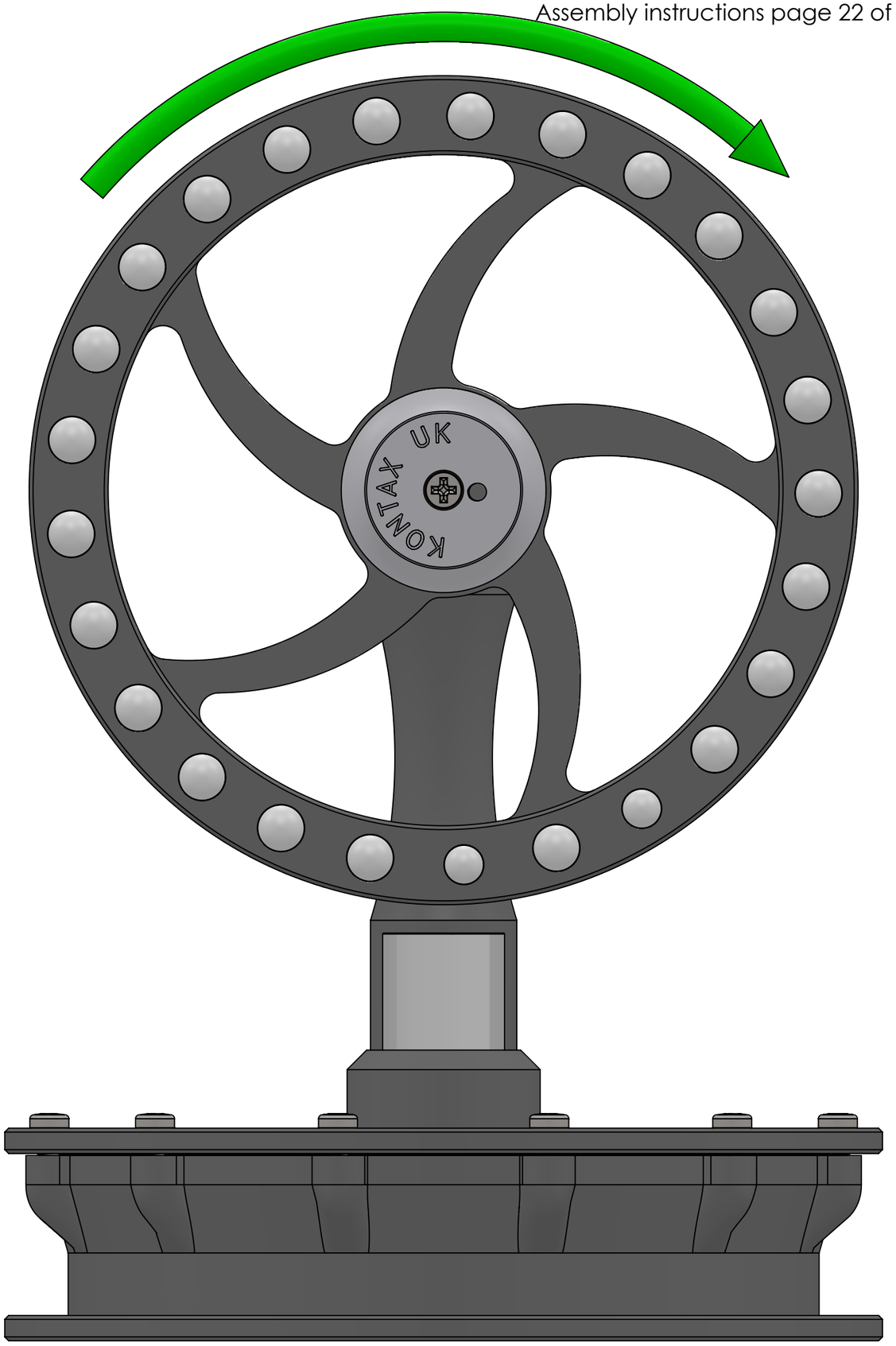
There should be about 0.2mm of movement axially on the crank/flywheel assembly.

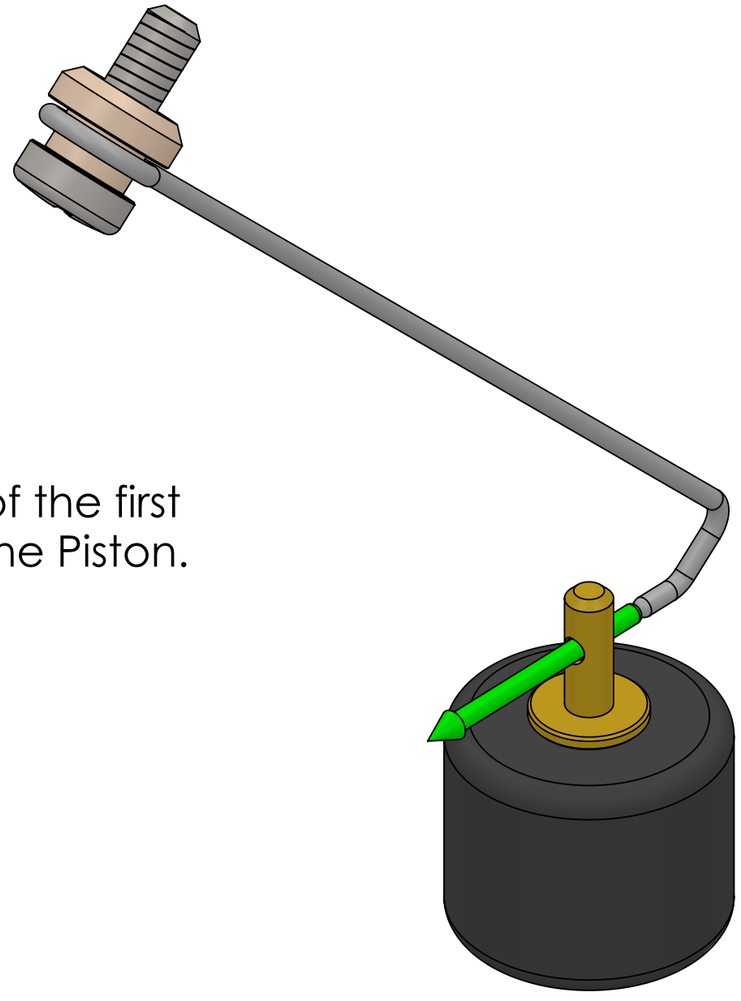
If there is no movement then you will need to loosen the crank screw, move the crank out 0.2mm and re-tighten the screw.

You can check for free running by holding the Base down and giving the Flywheel a sharp spin.

It should run freely for a least 1 minute.

If you have the corrent amount of movement and the Flywheel does not spin freely the you might need to remove the Ballrace Bearings, clean them in IPA/ denatured alcohol/ methylated spirits and re-fit.



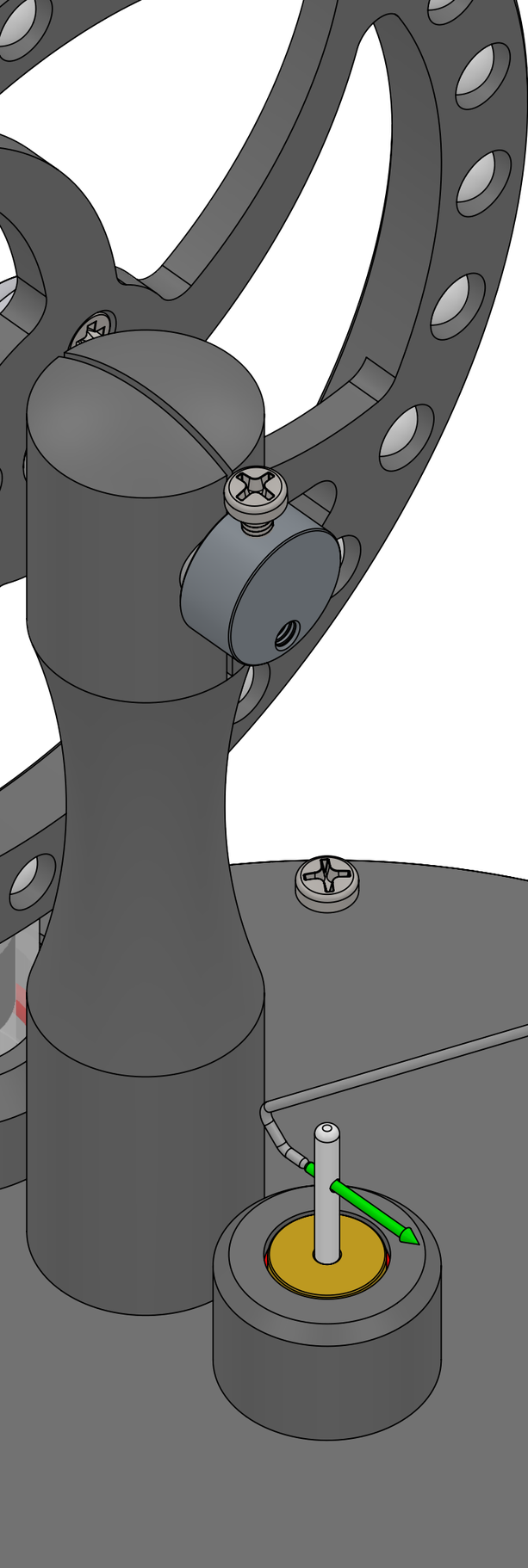


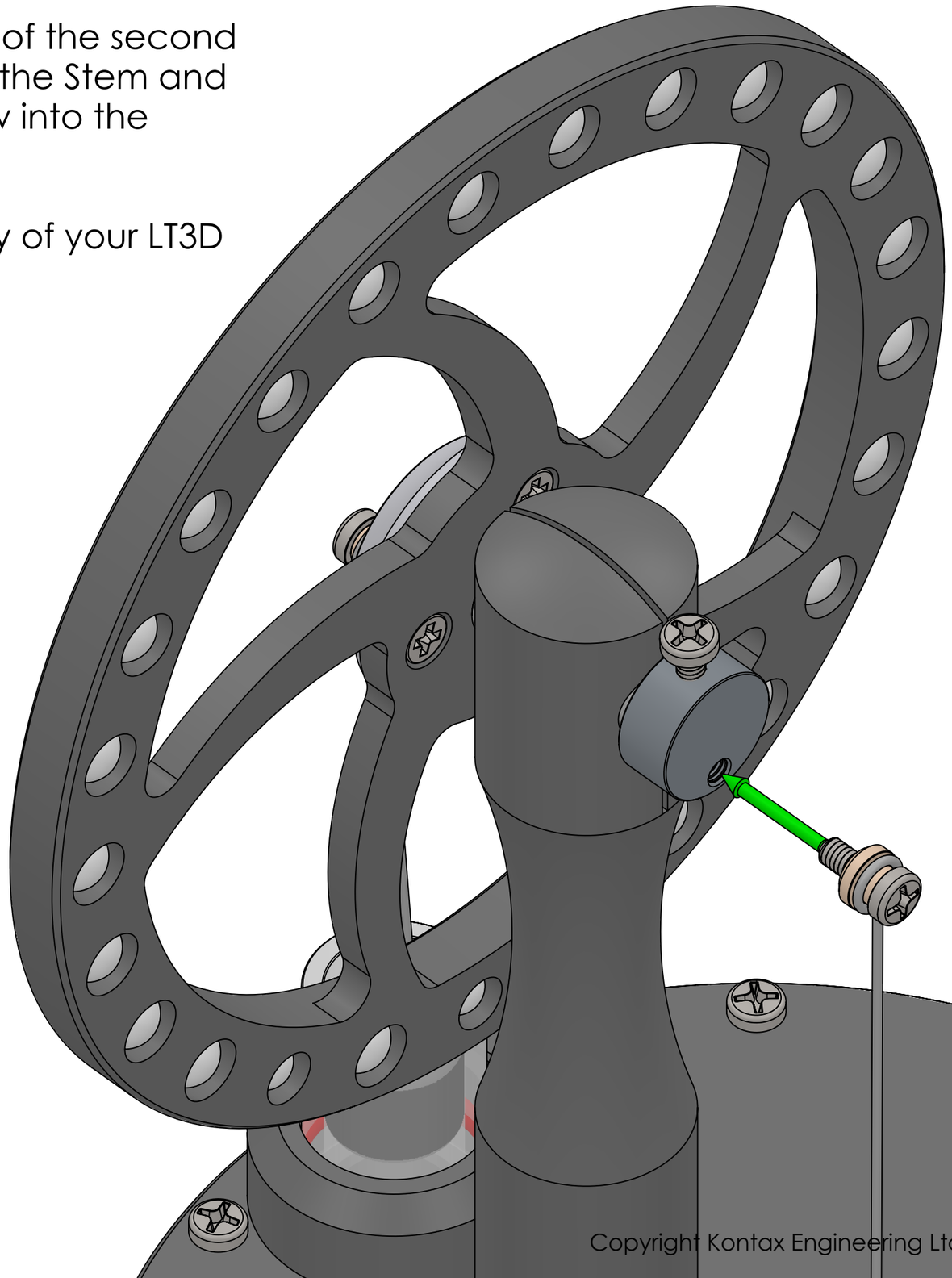
Fit the hook on the end of the first Conrod into the hole in the Piston.

Fit the piston into the Cylinder and screw the Conrod screw into the Hub.

Fit the hook on the end of the second Conrod into the hole in the Stem and screw the Conrod screw into the Crank.

This completes assembly of your LT3D Stirling engine.





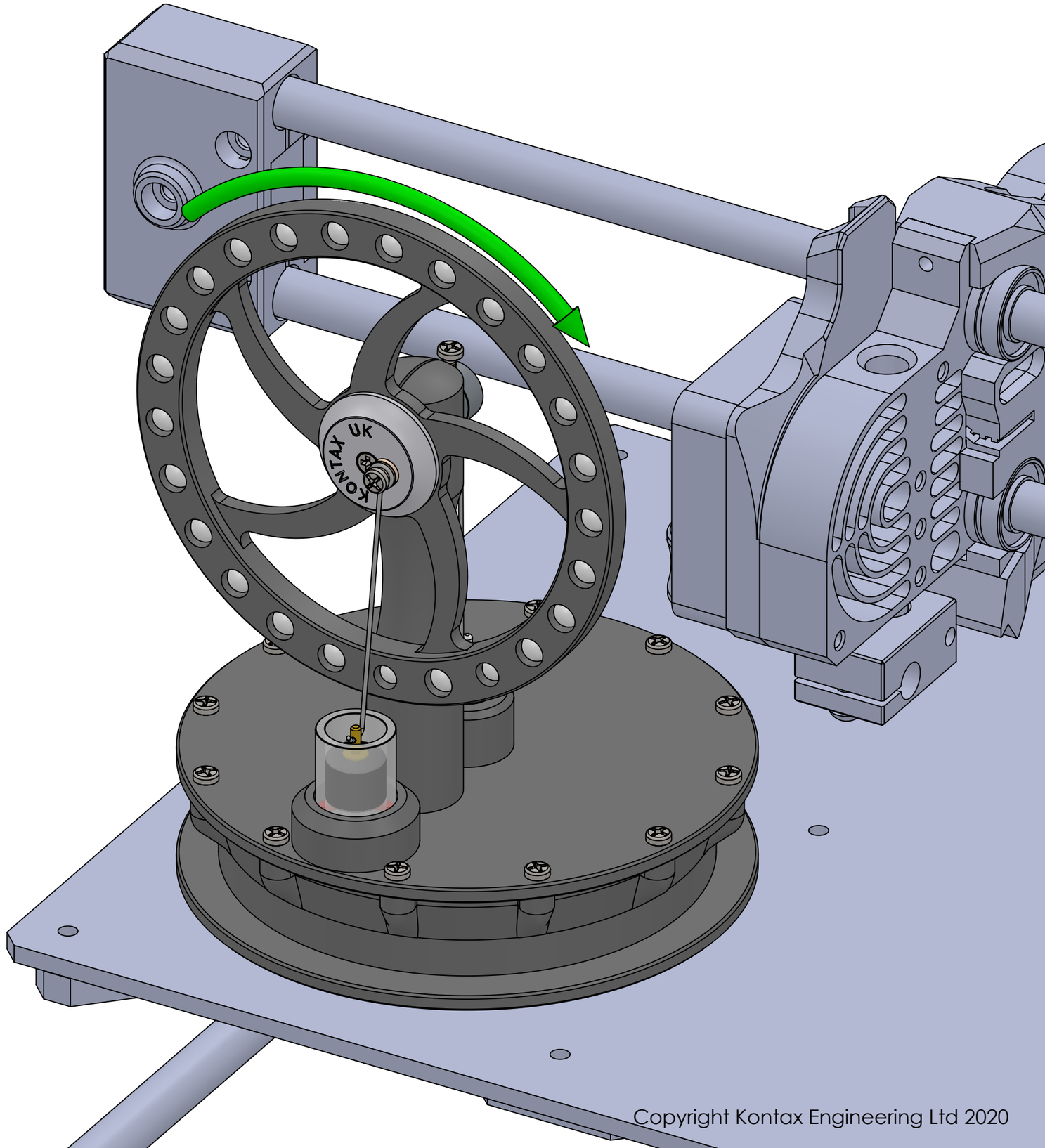
Operation

Place the engine on your printer bed and heat the bed up to 35°C above the ambient temperature. When it has reached the required temperature give the flywheel a spin firm enough to rotate it a few turns in the direction shown.

The engine should carry on running and should run between 60 to 120 rpm.

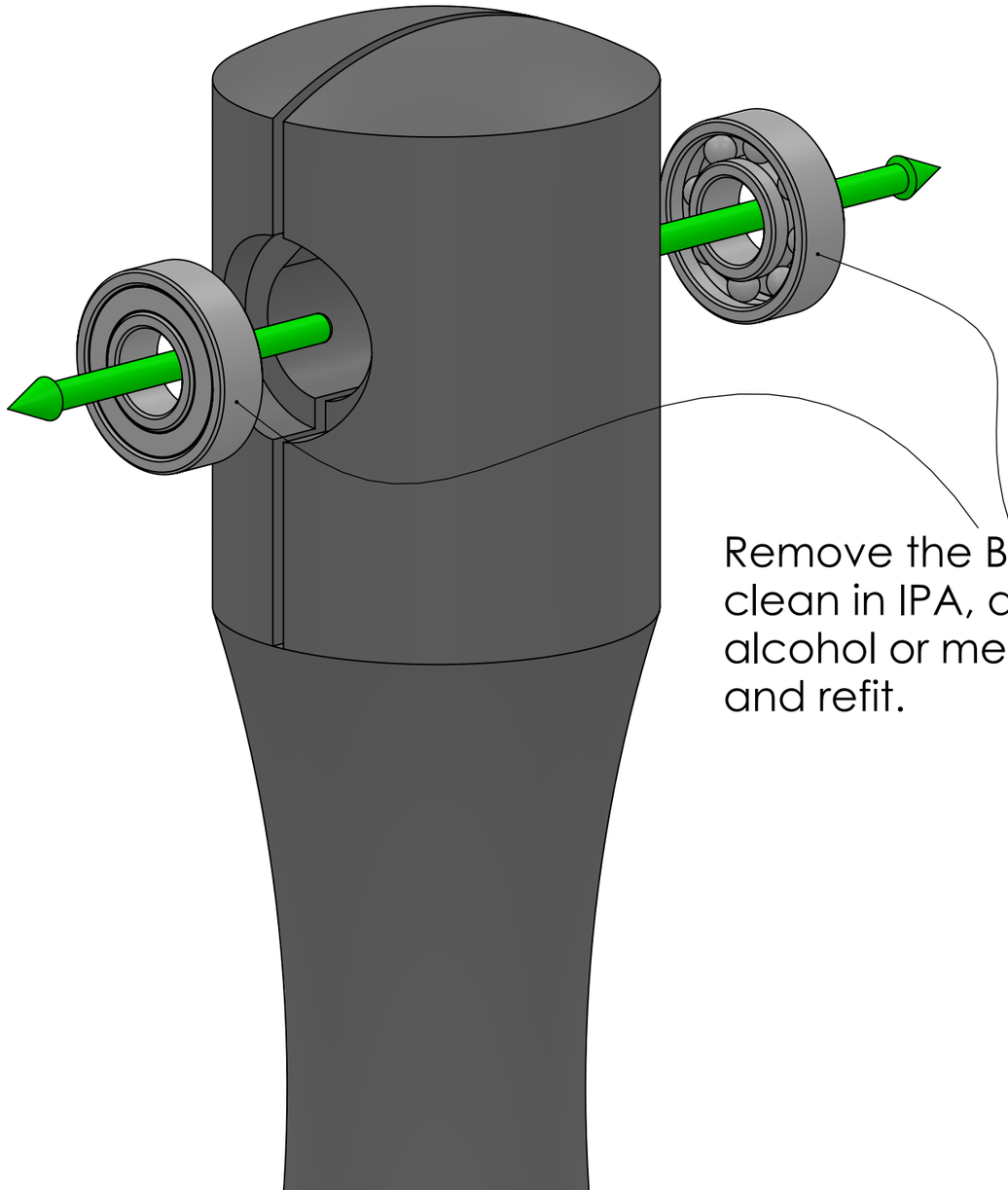
You can experiment with lowering the temperature to see if the engine will still run. The lower temperature limit will depend on many factors, including machining tolerances on the kit parts, but the most significant will be the thermal properties of the PLA used.

Please note, the engine will make a tiny ticking noise during operation. This happens because there is a small difference in diameter between the plastic Conrod bush and the Conrod connected to the Piston to allow for free running, and as the Piston reverses direction each rotation the Conrod eye is pushed and pulled against the Bush.

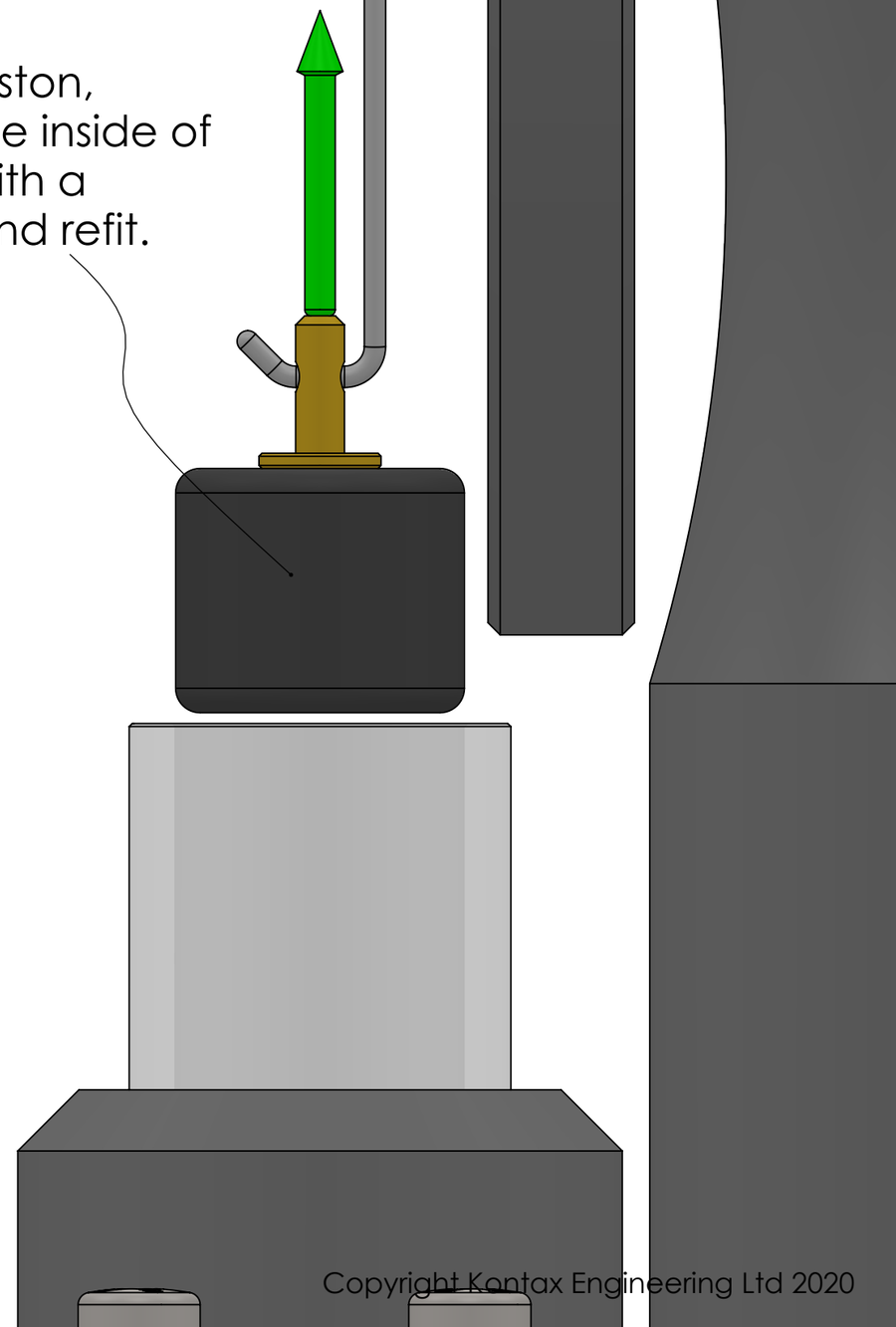


Maintenance

Your LT3D Stirling Engine should run for many hours without needing any maintenance. If you do notice a drop in performance the most likely reason is dust getting into the Ballrace Bearings or down into the Cylinder.



Remove the Ballrace Bearings, clean in IPA, denatured alcohol or methylated spirits and refit.



Remove the Piston, clean it and the inside of the Cylinder with a paper towel and refit.