

KS90 Assembly Instructions

These instructions cover:

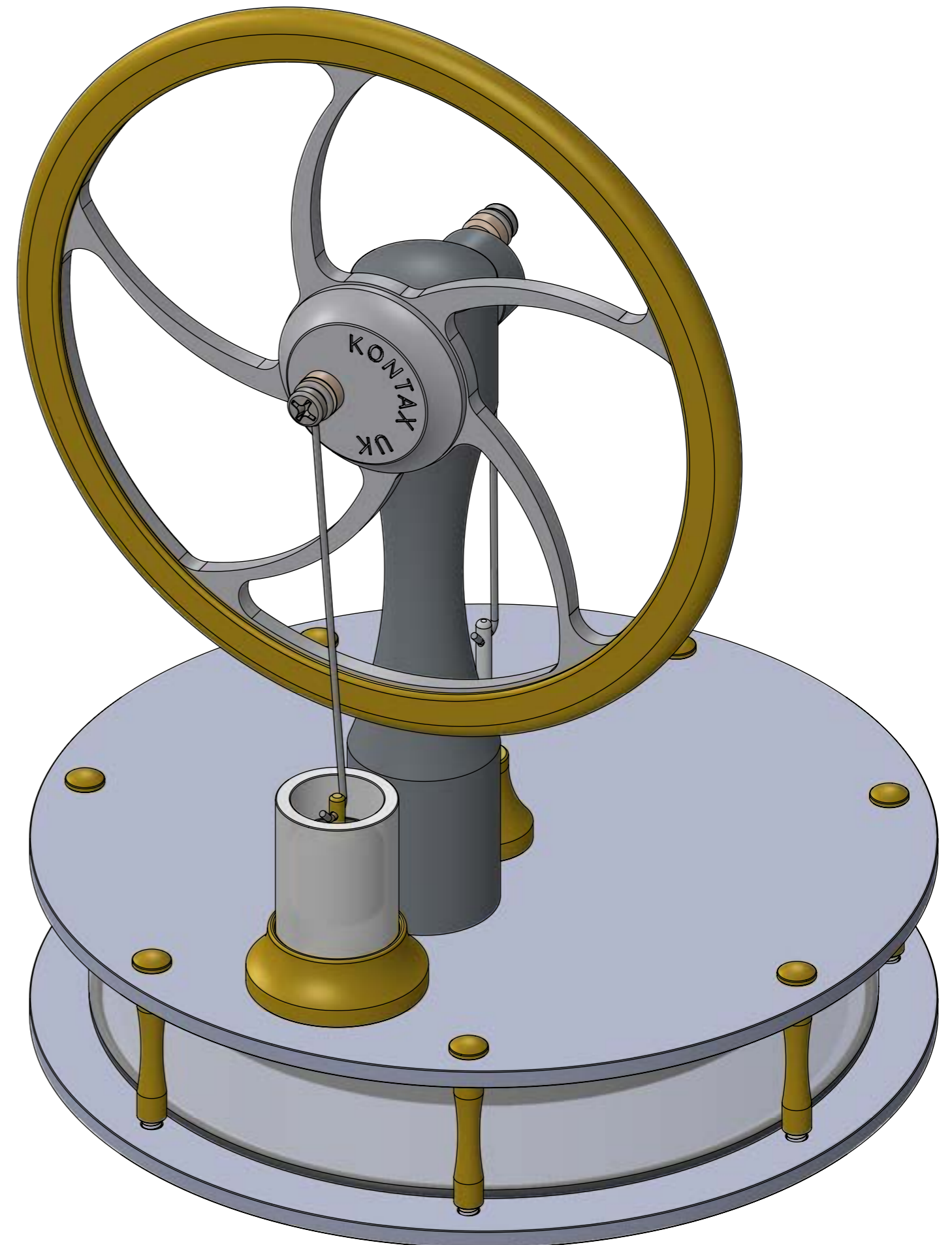
- KS90 Black (anodised aluminium plates)
- KS90 Blue (anodised aluminium plates)
- KS90 Solar (acrylic plates)

Operation instructions are on page 40.

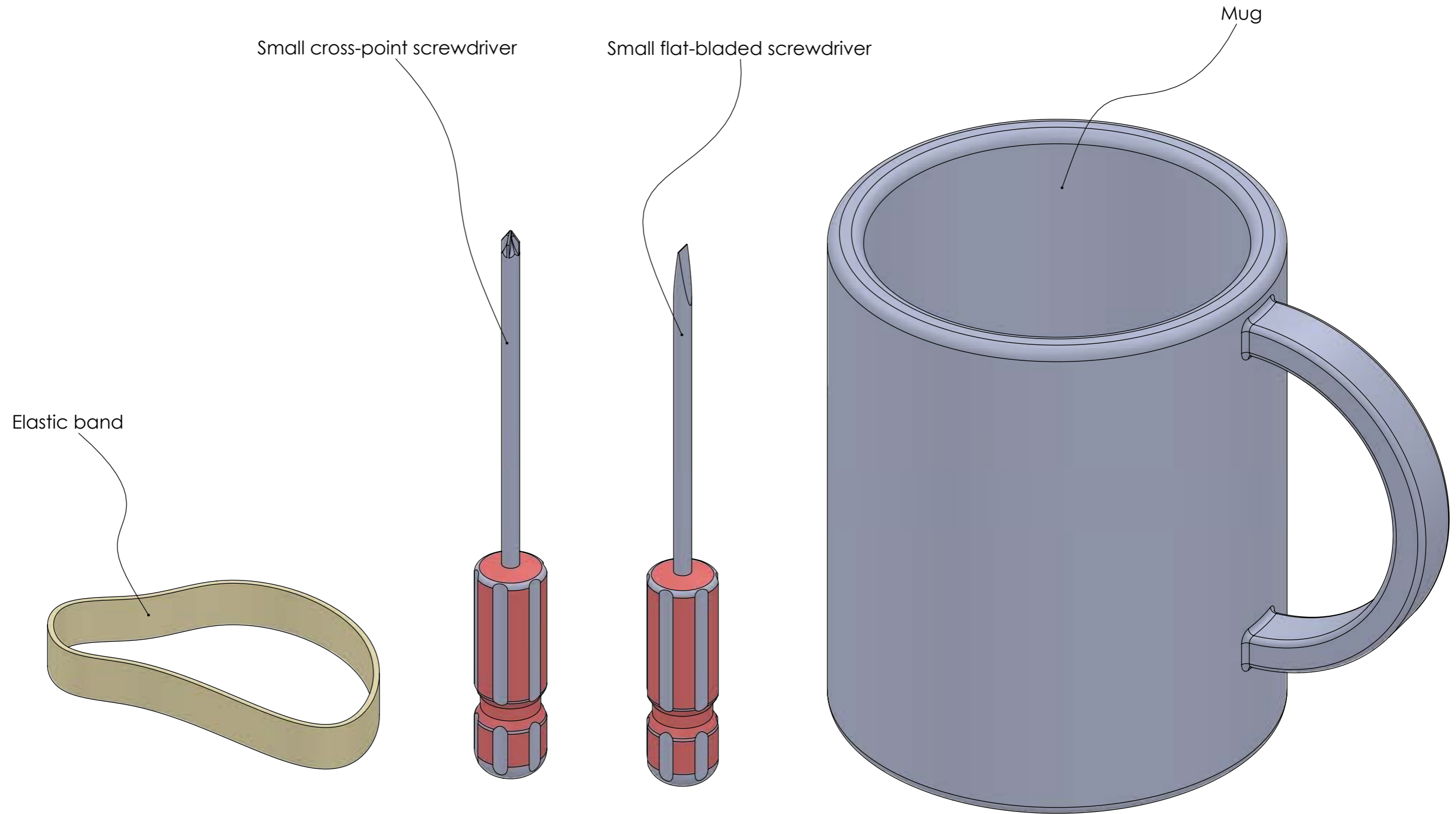
Maintenance instructions are on pages 41-43.

Please read all the way through the assembly instructions to familiarise yourself with the process before you start and pay close attention to the alignment of all the parts in the diagrams.

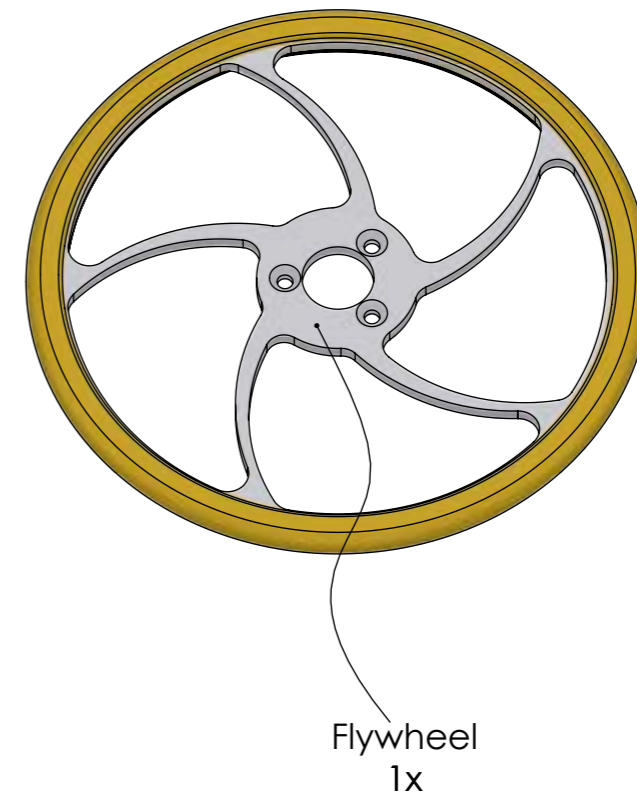
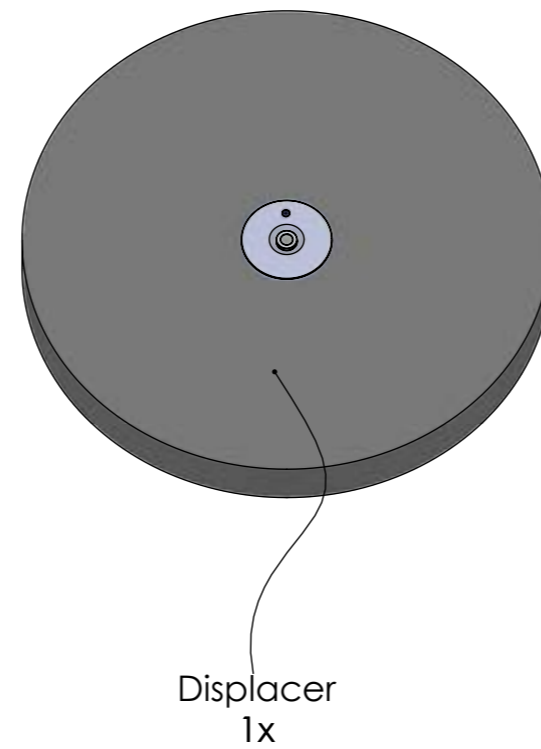
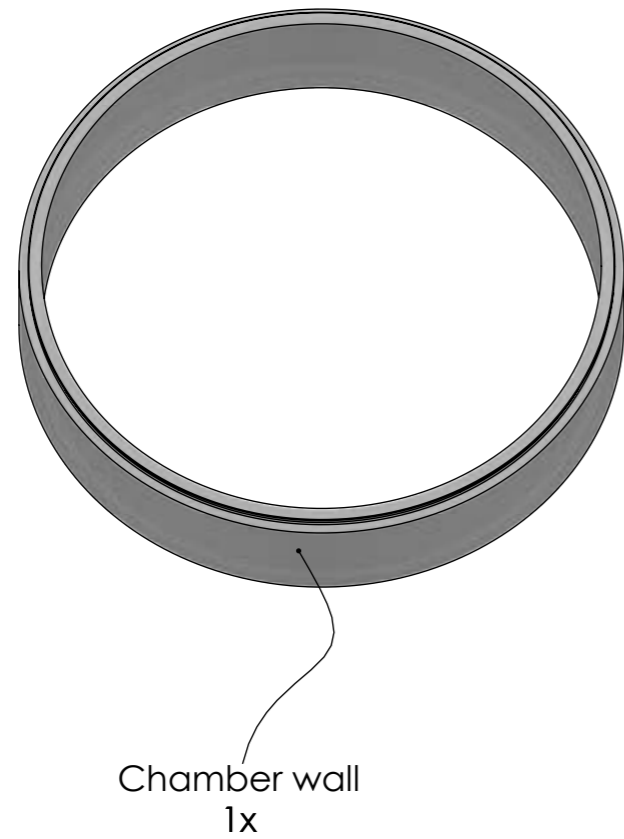
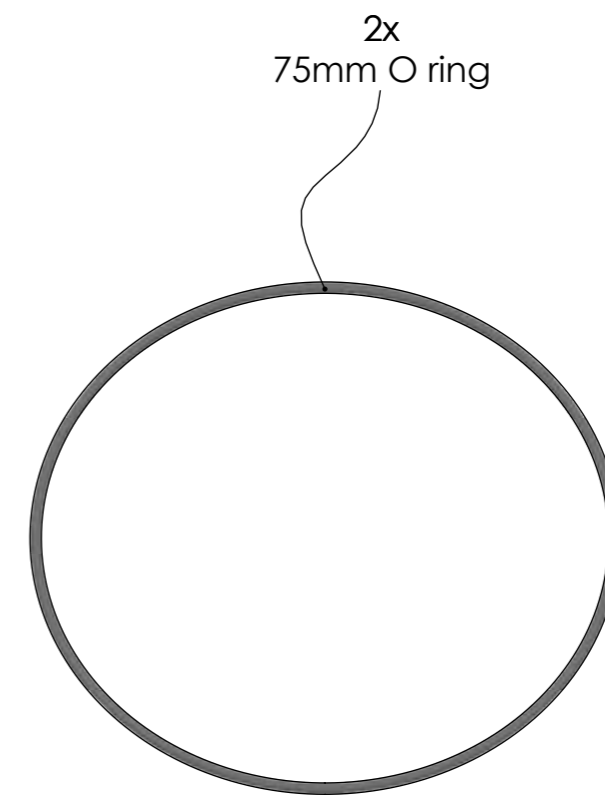
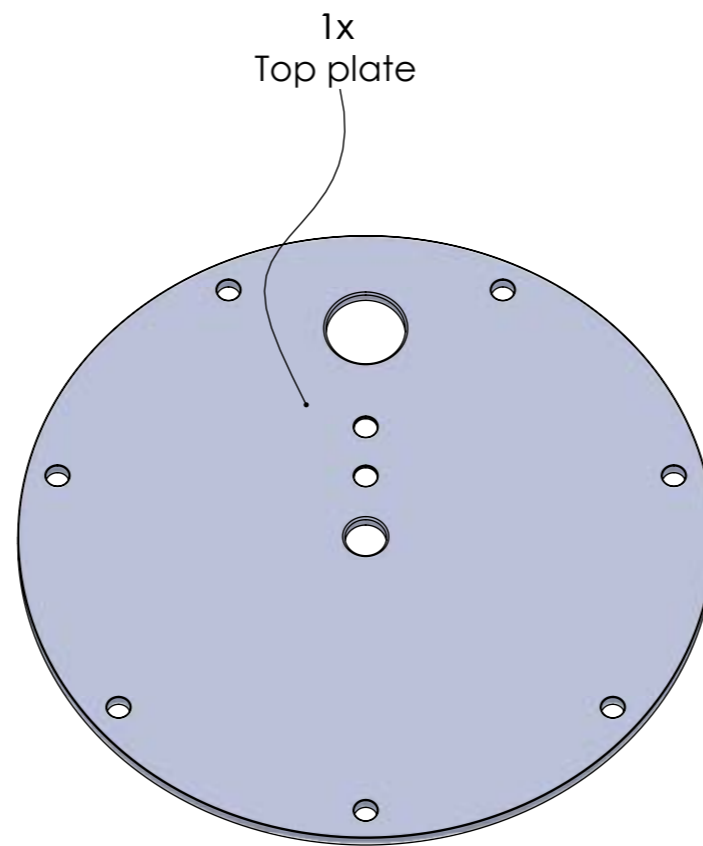
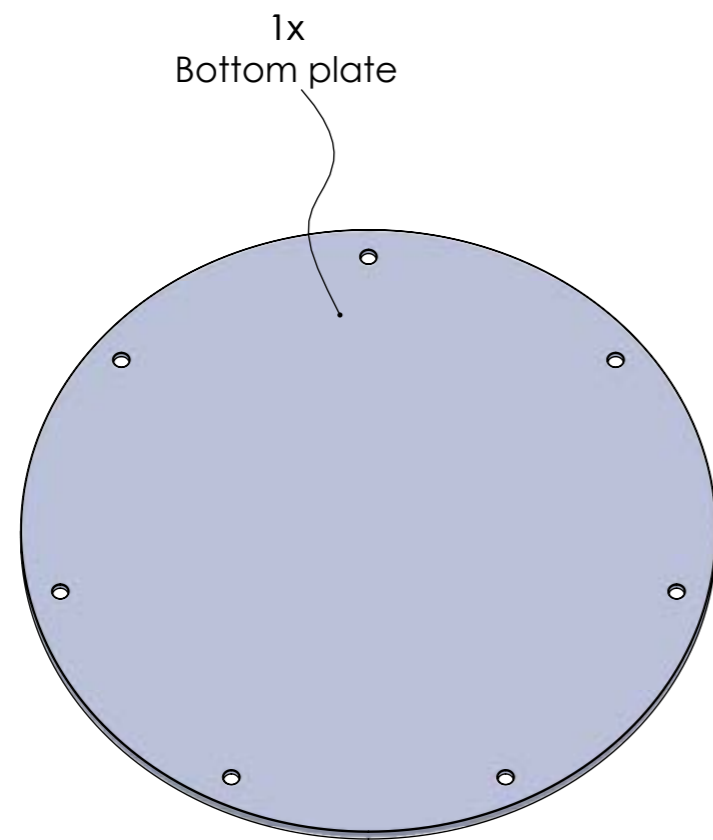
Assembly time should be approximately 35-40 minutes.



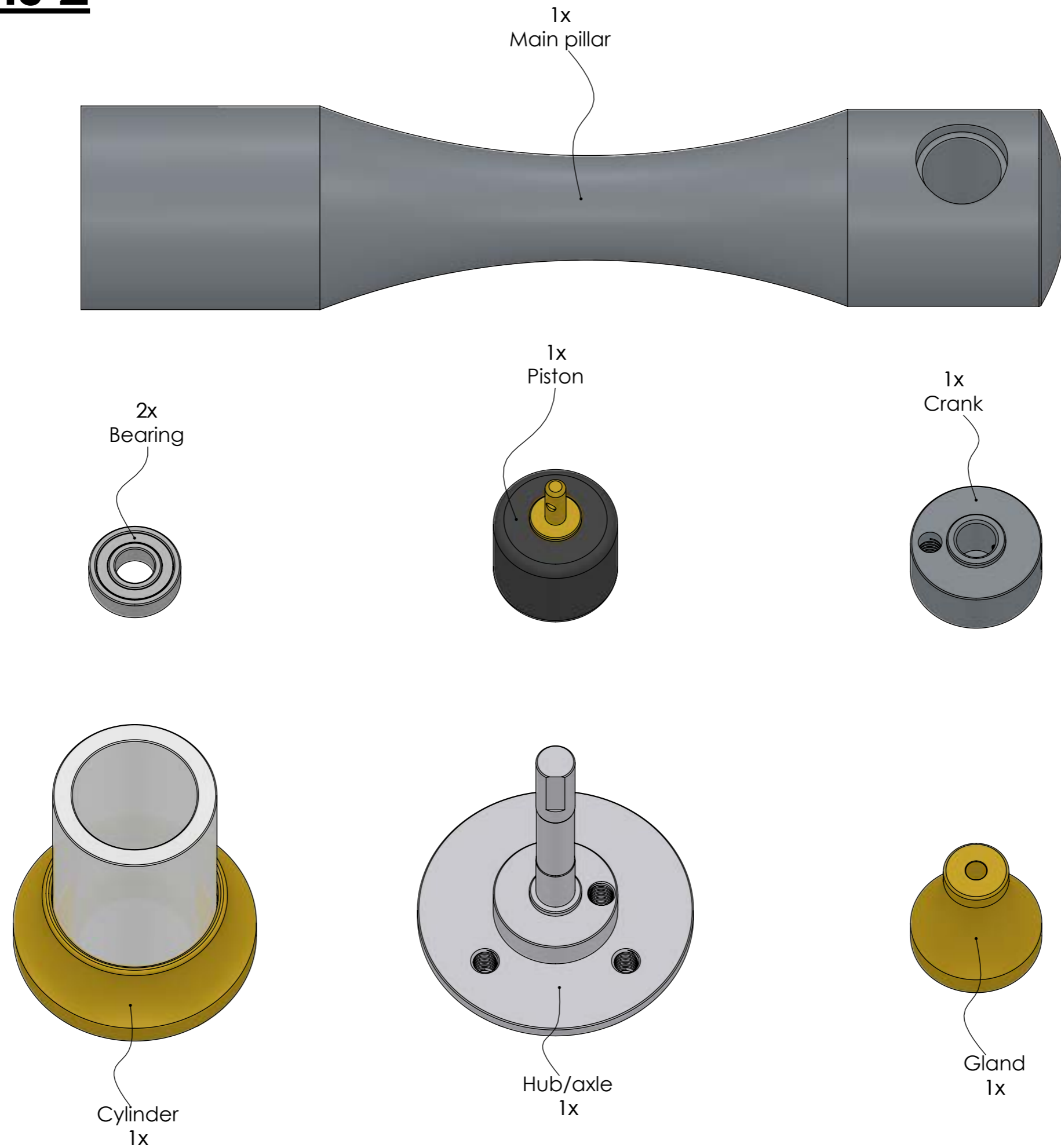
KS90 Assembly Tools



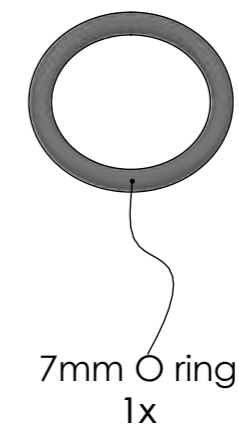
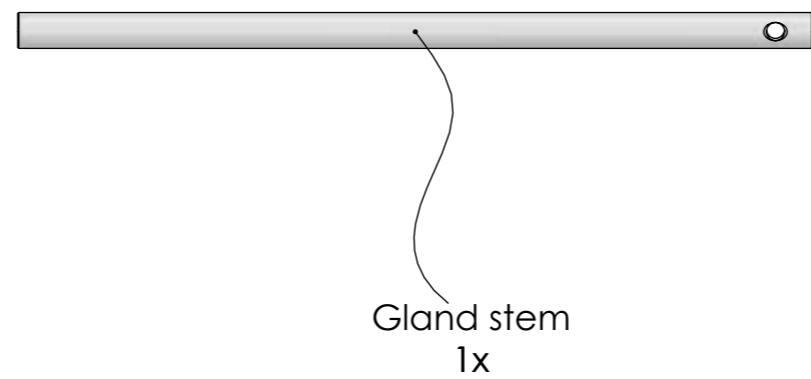
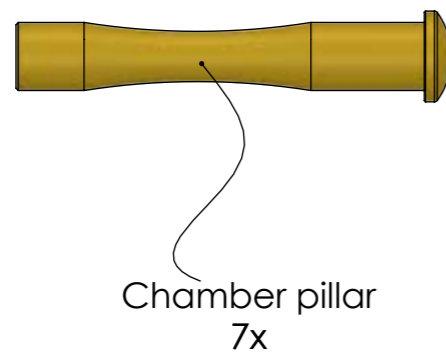
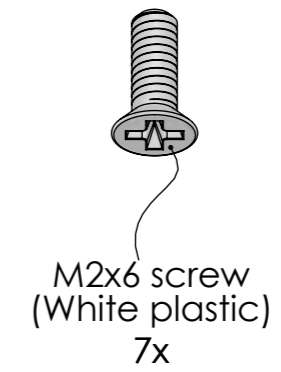
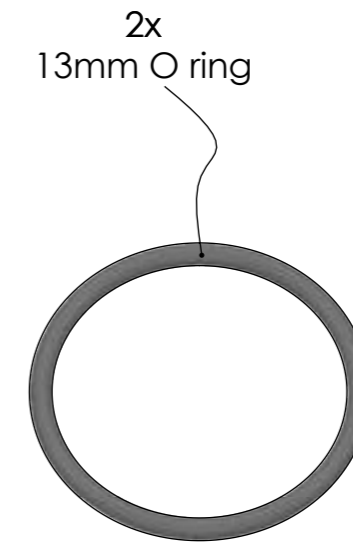
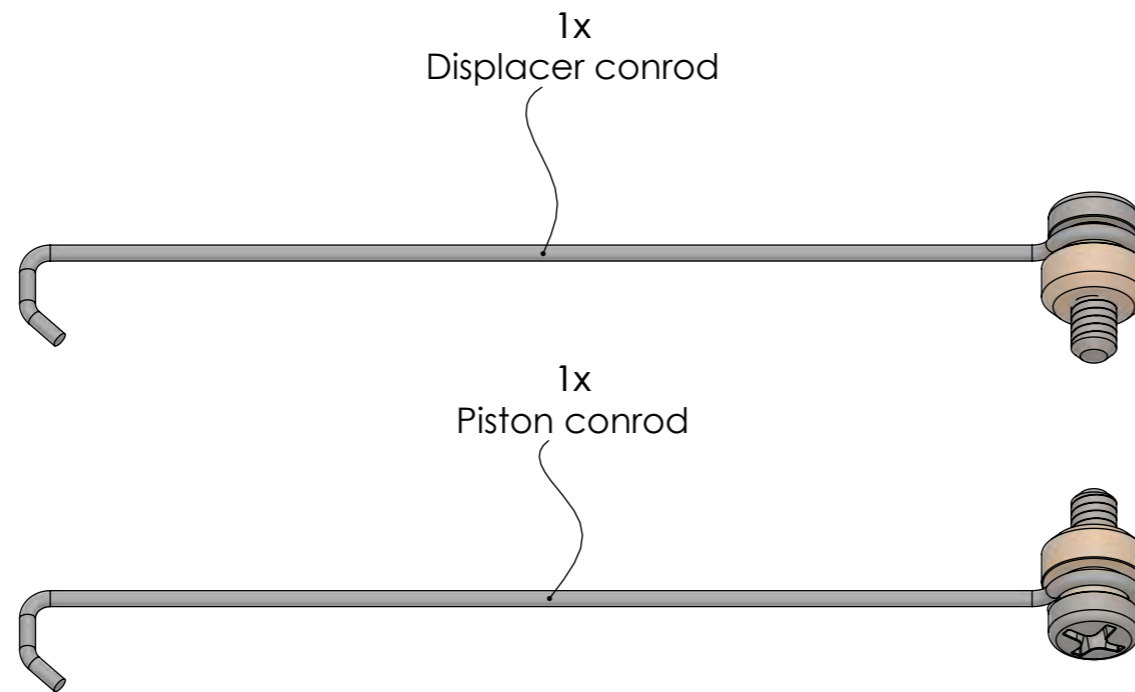
KS90 Parts 1



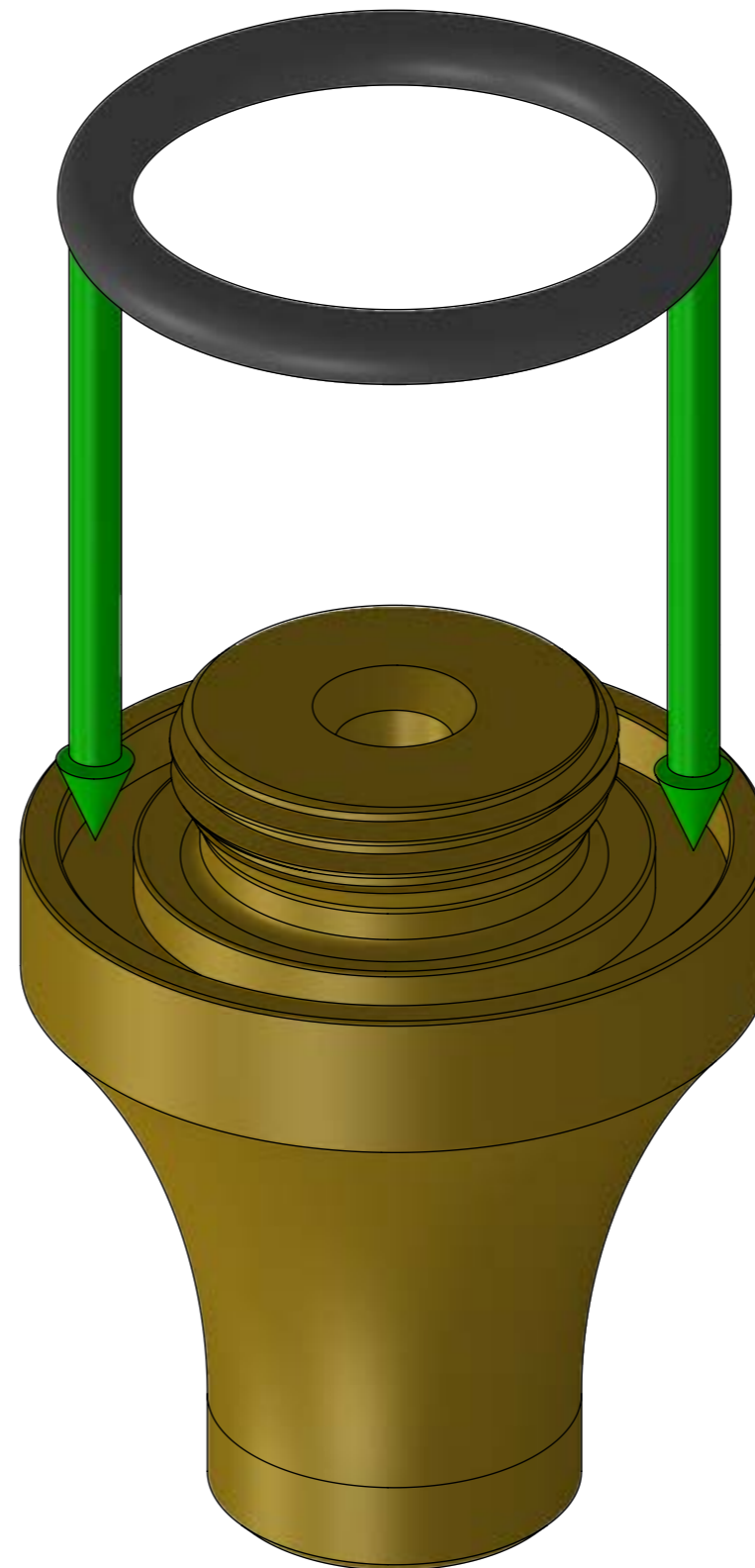
KS90 parts 2



KS90 parts 3

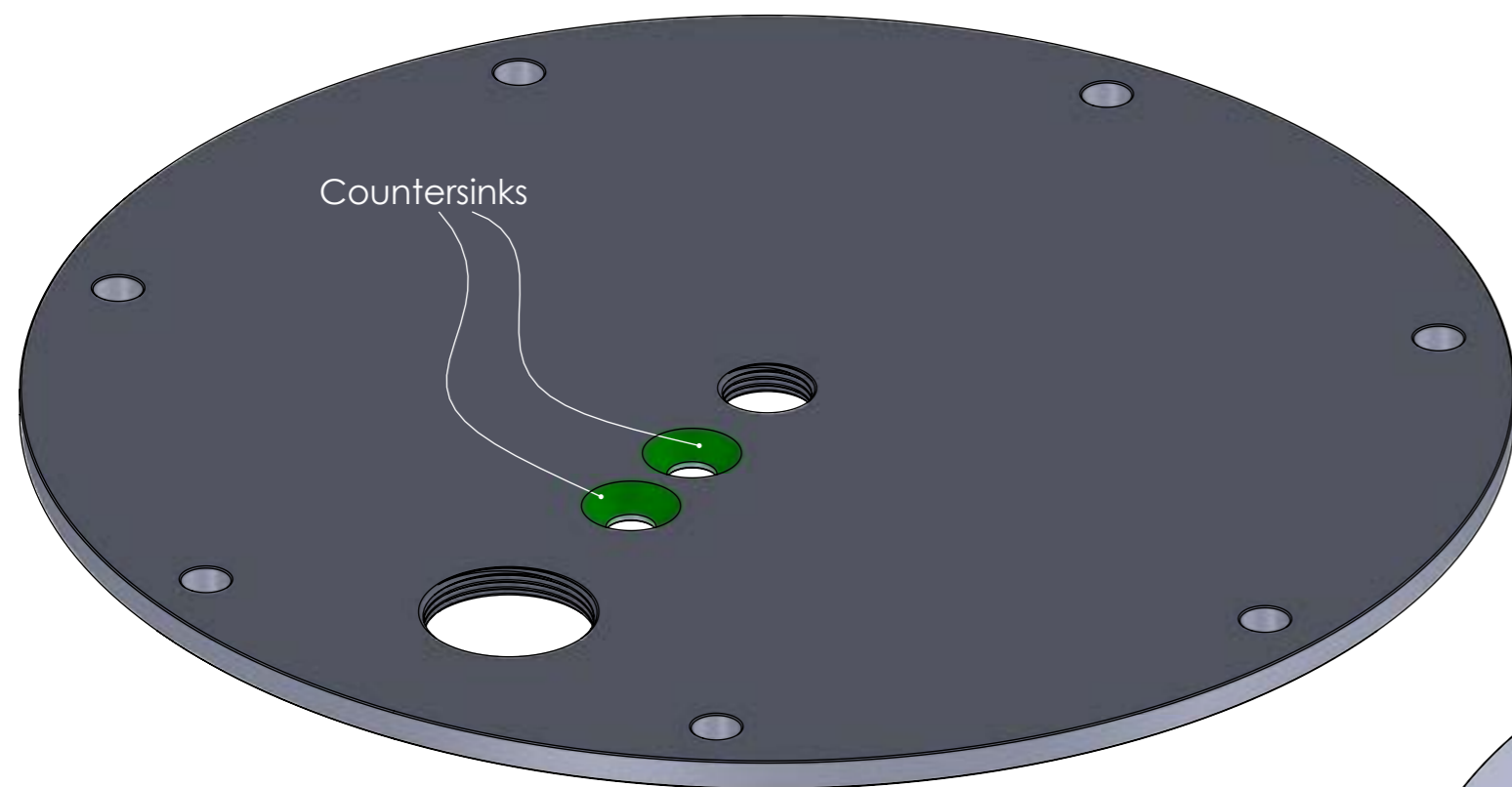


Fit one 7mm O ring into the groove in the bottom of the gland.

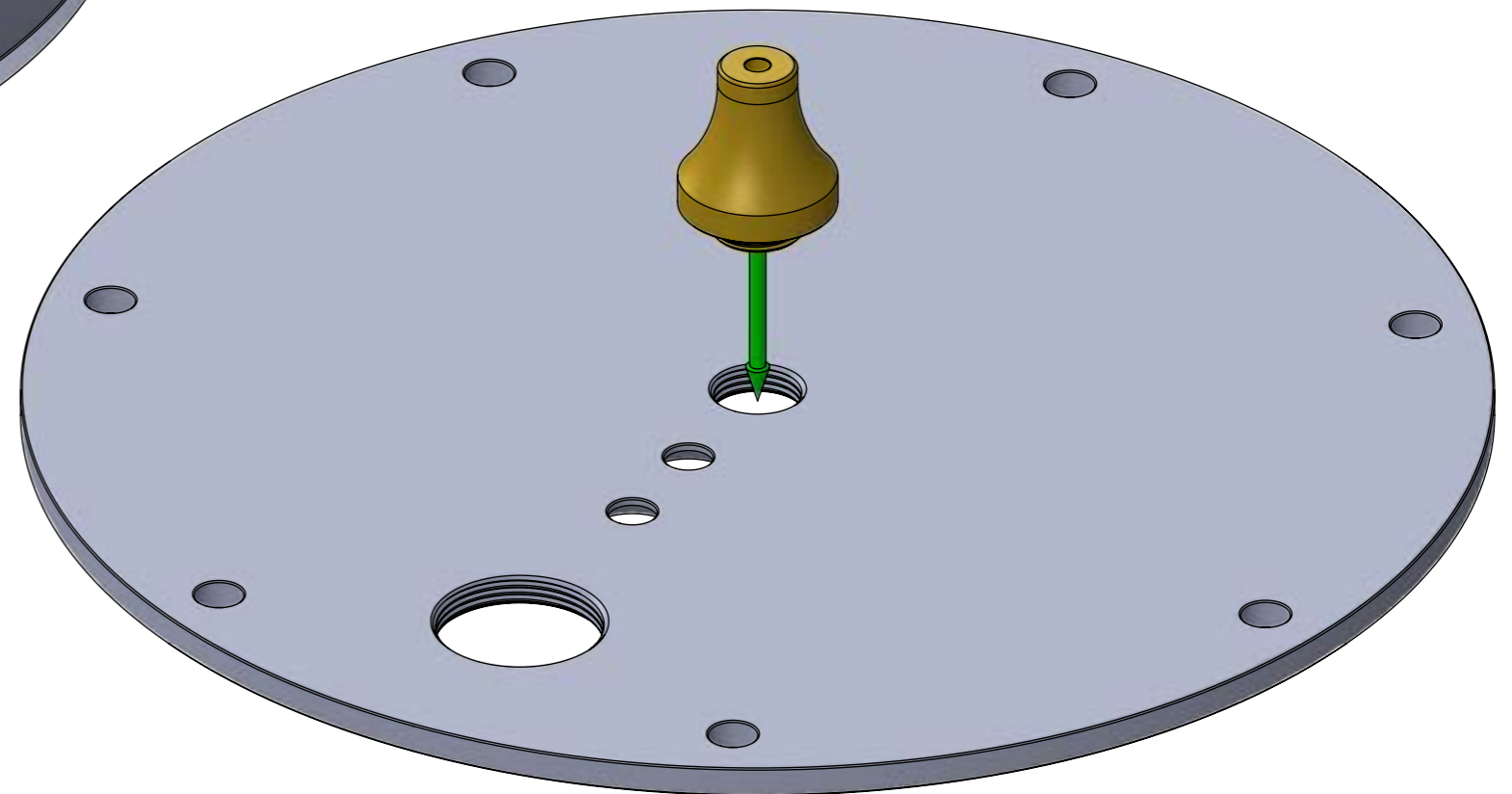


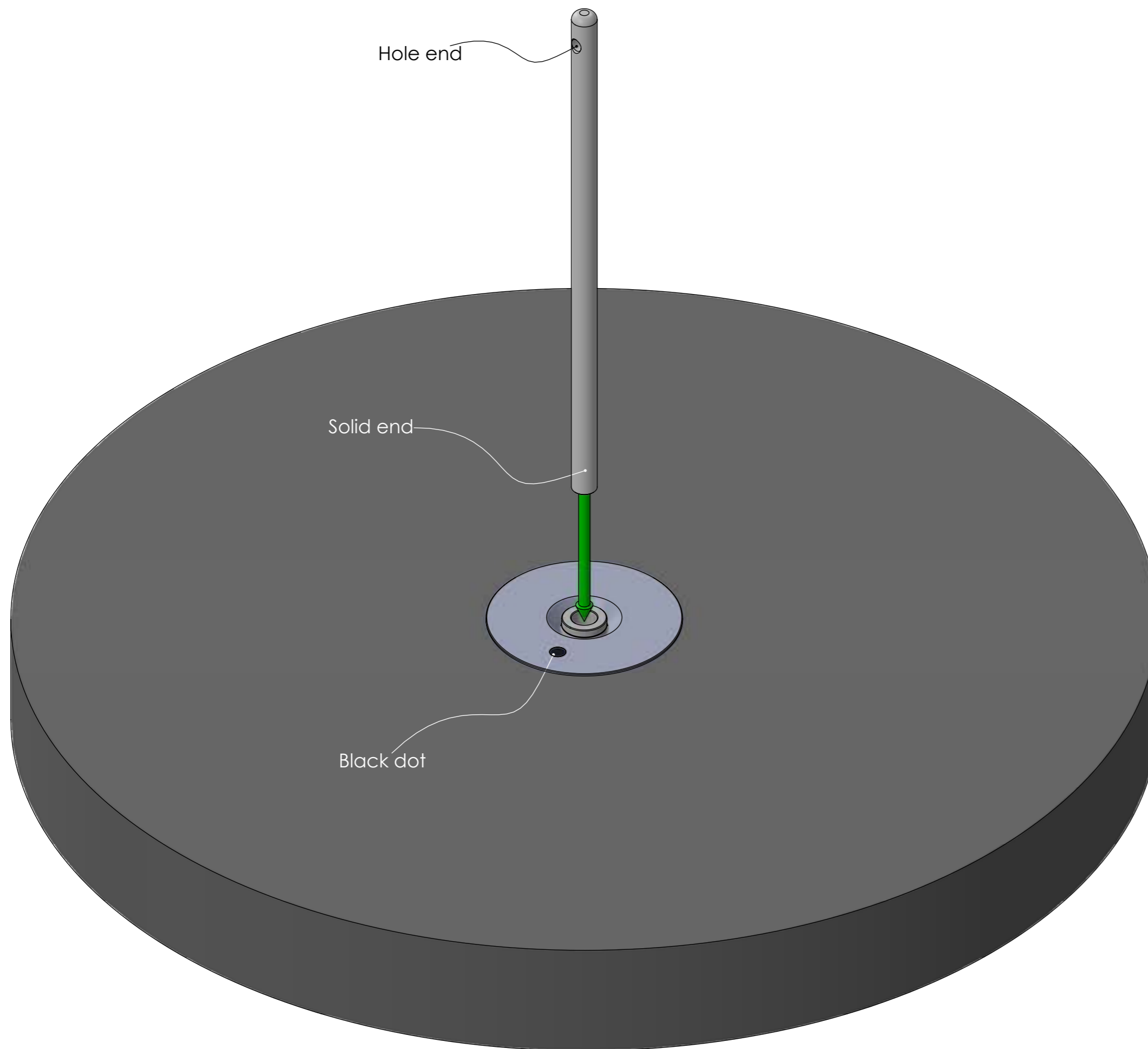
If you have solar (acrylic) plates you will need to remove the protective film from both sides of the top plate now. Once you have removed the film try to handle the plate by its edges, this will minimise fingerprints. Black and blue (aluminium) plates do not have protective film.

Identify the underside of the top plate. The underside is the side with the countersinks on the two holes as shown.



Screw the gland into the top side of the top plate and fully tighten, you might need to wrap an elastic band around it for grip. Make sure that the O ring does not become pinched or fall out of its groove. If you have trouble with the O ring falling out you can turn the plate upside down and screw the gland in from underneath.

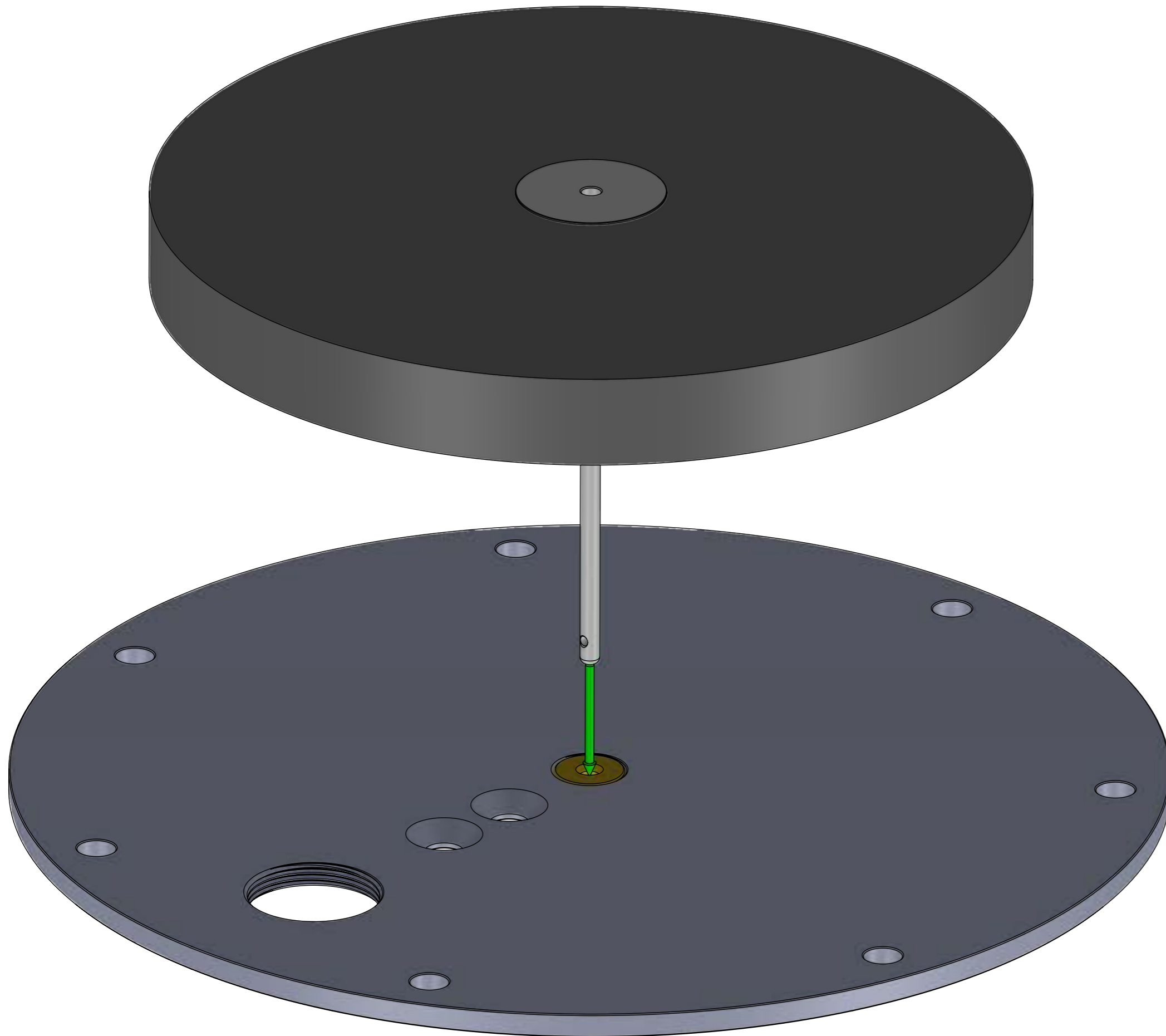




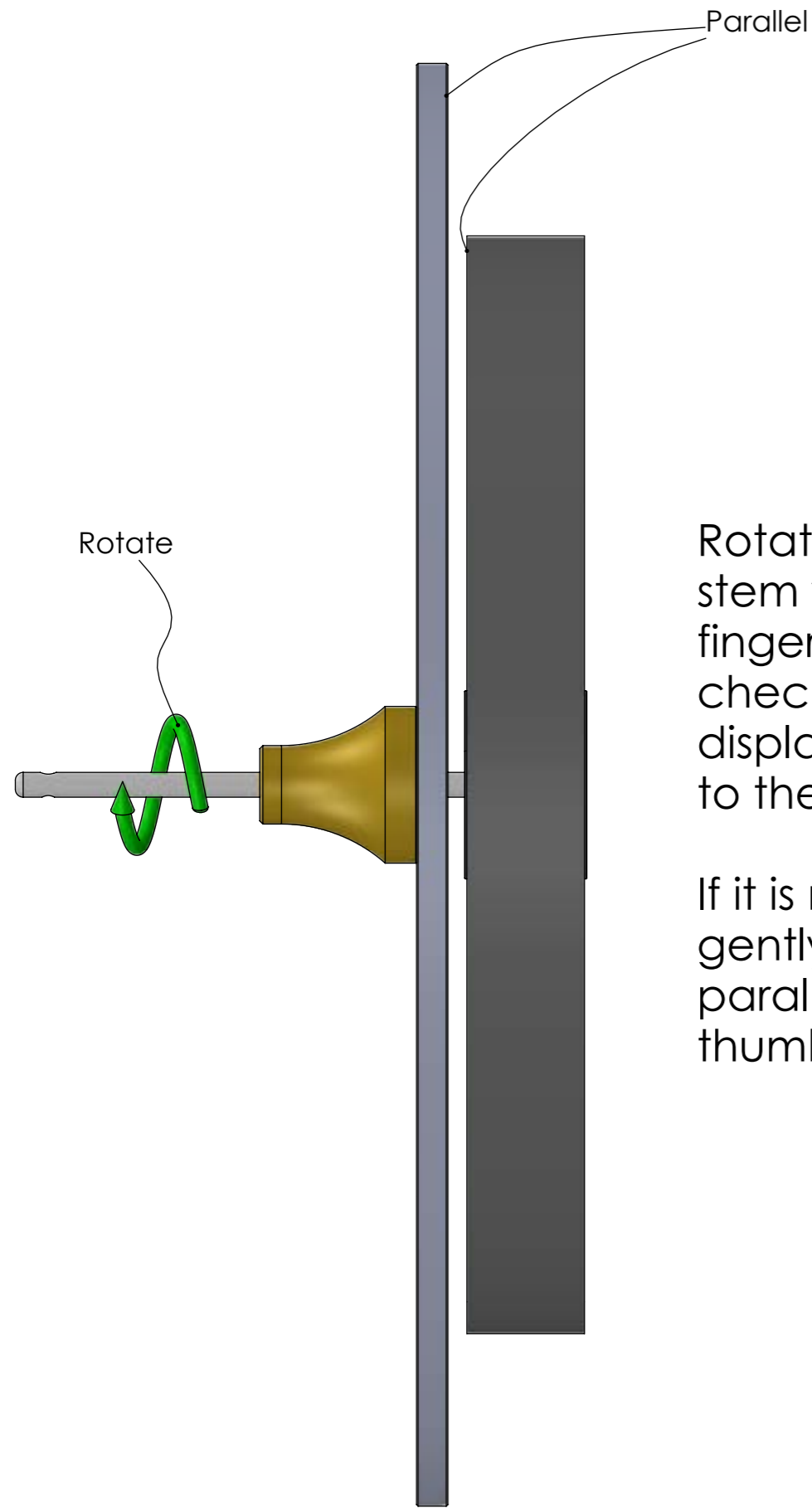
The top face of the displacer has been marked with a coloured dot near the centre.

One end of the gland stem is plain and the other has a small through it.

Insert the solid end of the gland stem into the top face of the displacer; it will be a reasonably tight fit. You only need to push the stem in a quarter of the way for now; final positioning will be done at a later stage.

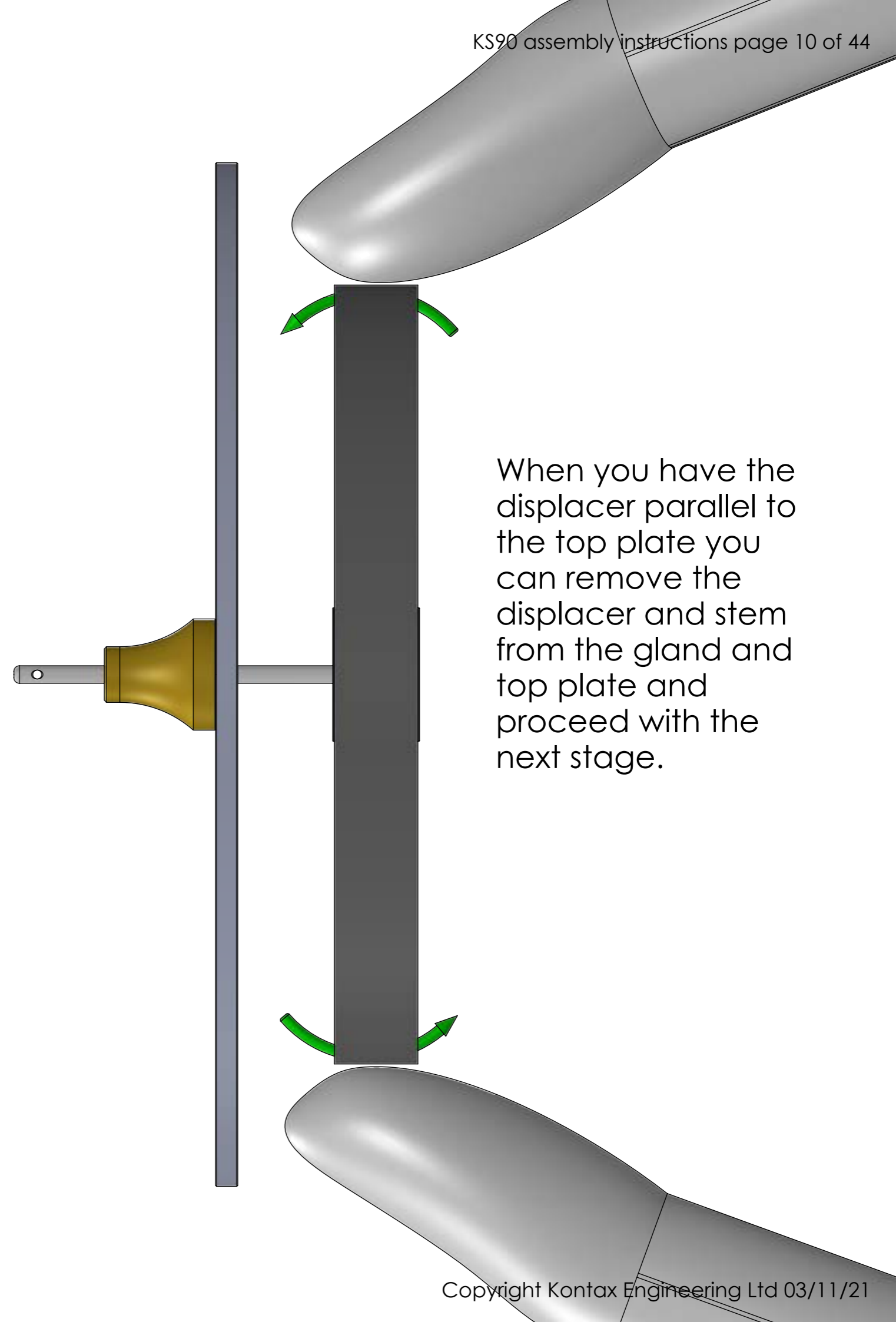


Slide the stem into
the gland.



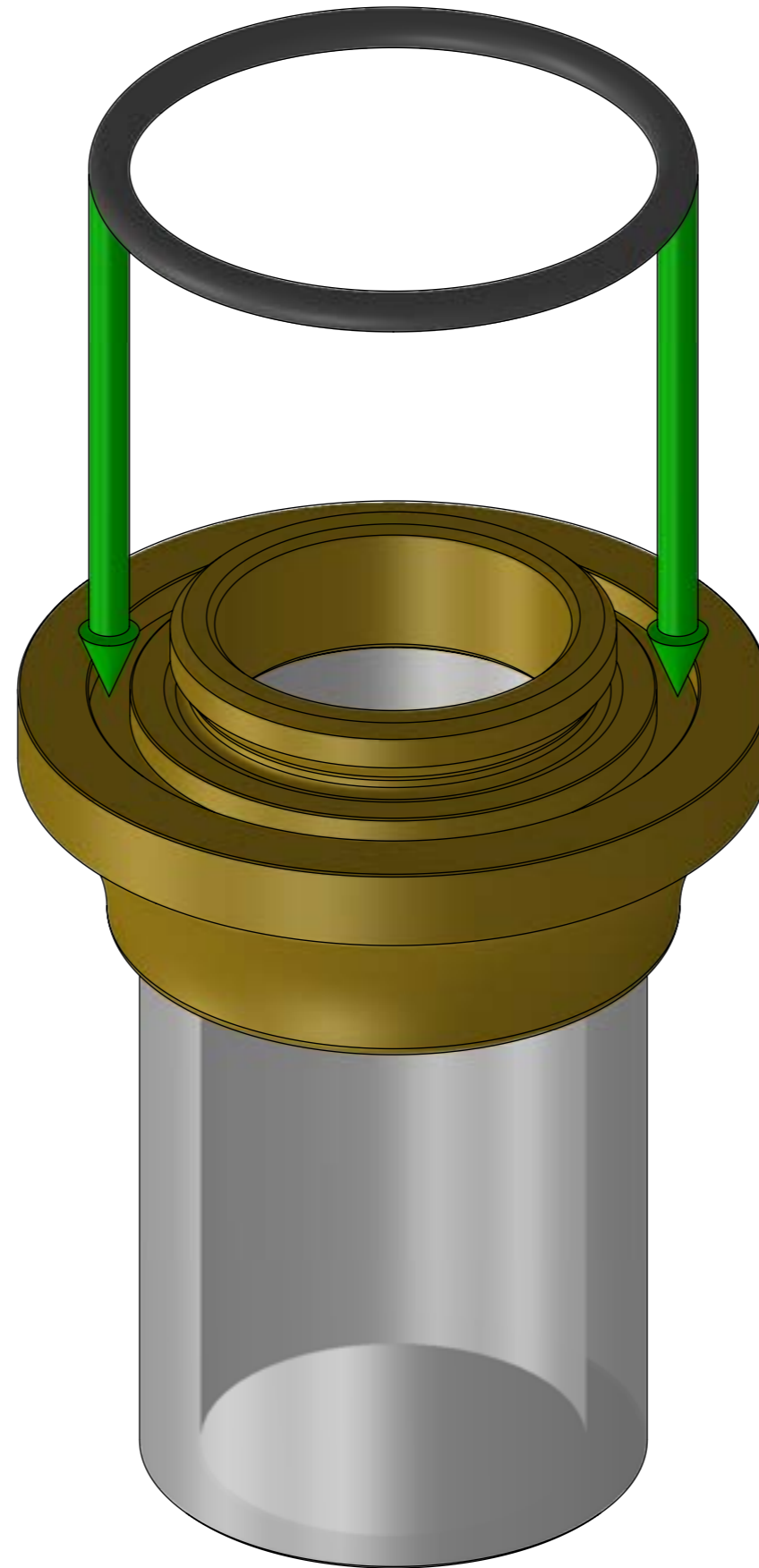
Rotate the gland stem with your finger and thumb to check that the displacer is parallel to the top plate.

If it is not, you can gently ease it parallel with your thumb and finger.

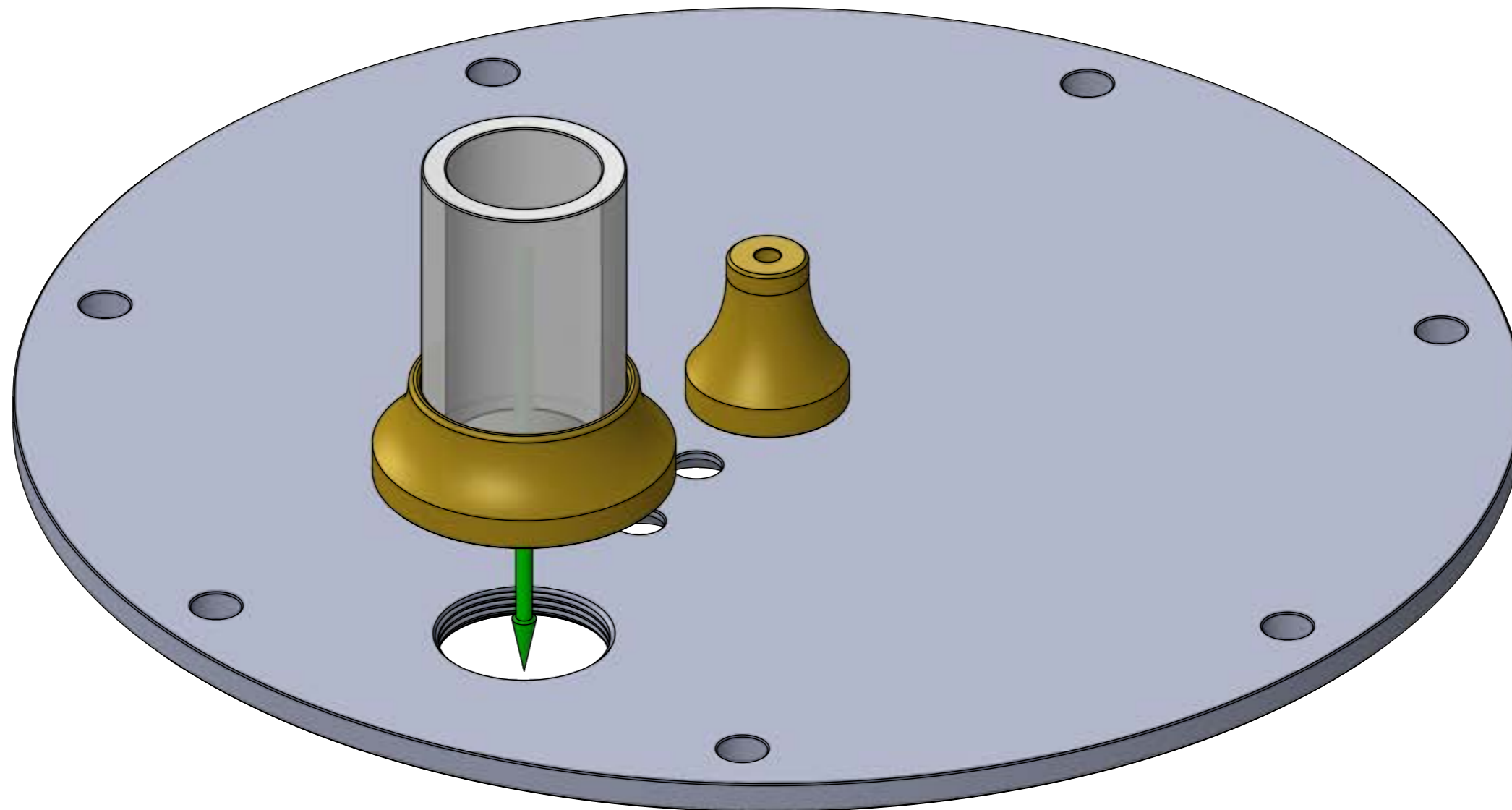


When you have the displacer parallel to the top plate you can remove the displacer and stem from the gland and top plate and proceed with the next stage.

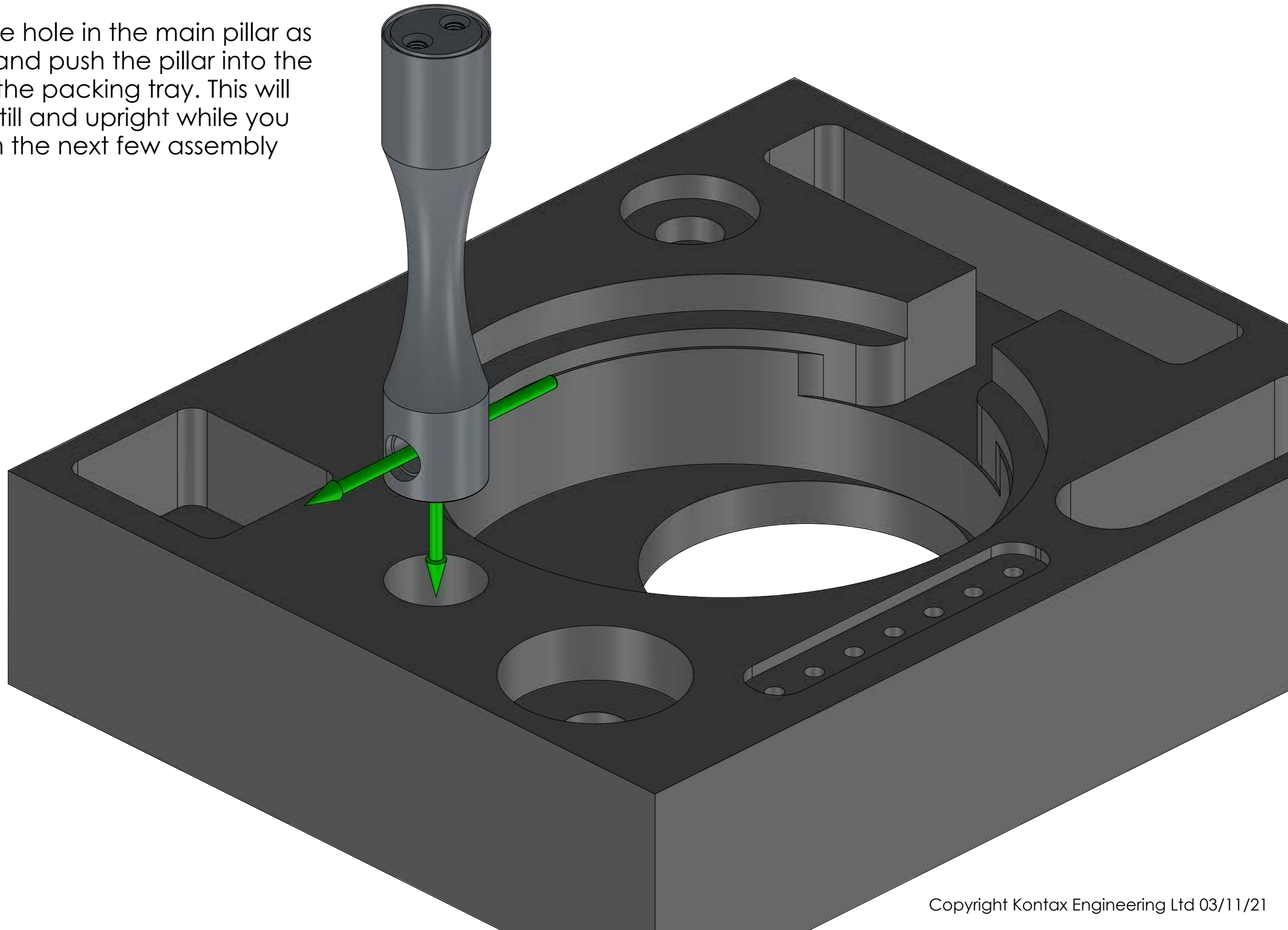
Fit one 13mm O ring into the groove in the bottom of the cylinder.



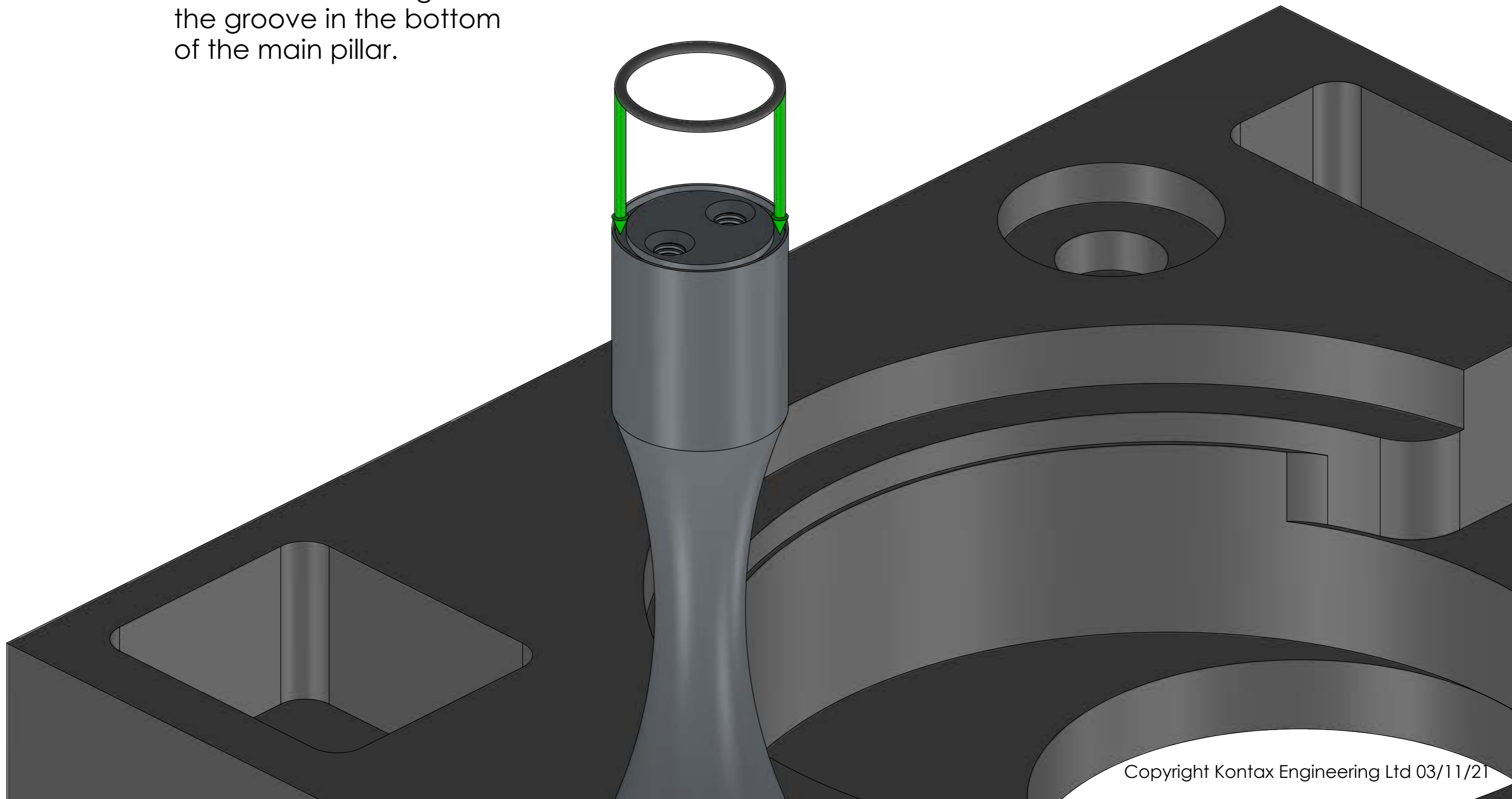
Screw the cylinder into the top side of the top plate and fully tighten, you might need to wrap an elastic band around it for grip. Make sure that the O ring does not become pinched or fall out of its groove. If you have trouble with the O ring falling out you can turn the plate upside down and screw the cylinder in from underneath.



Align the hole in the main pillar as shown and push the pillar into the hole in the packing tray. This will hold it still and upright while you perform the next few assembly stages.



Fit one 13mm O ring into the groove in the bottom of the main pillar.

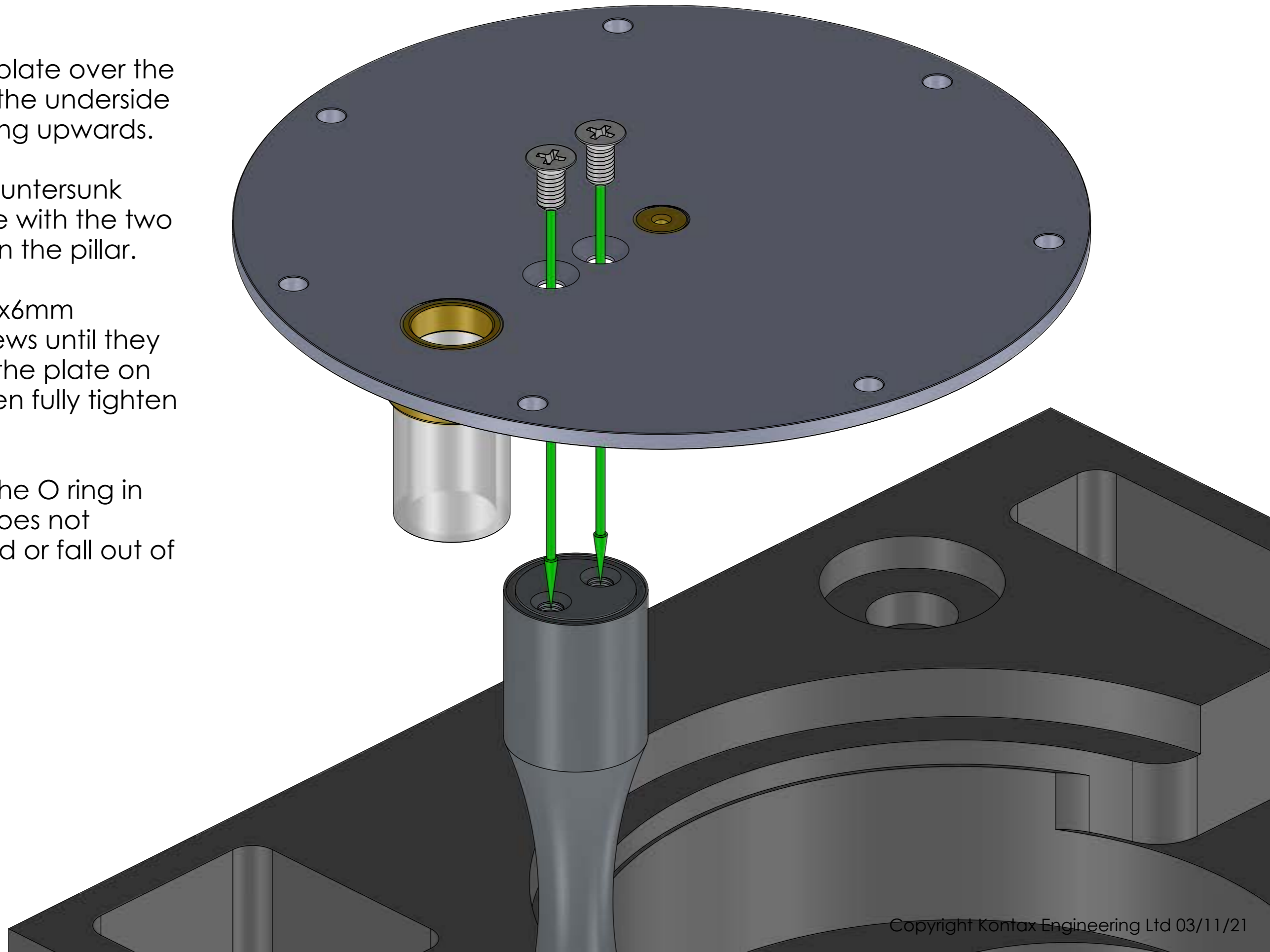


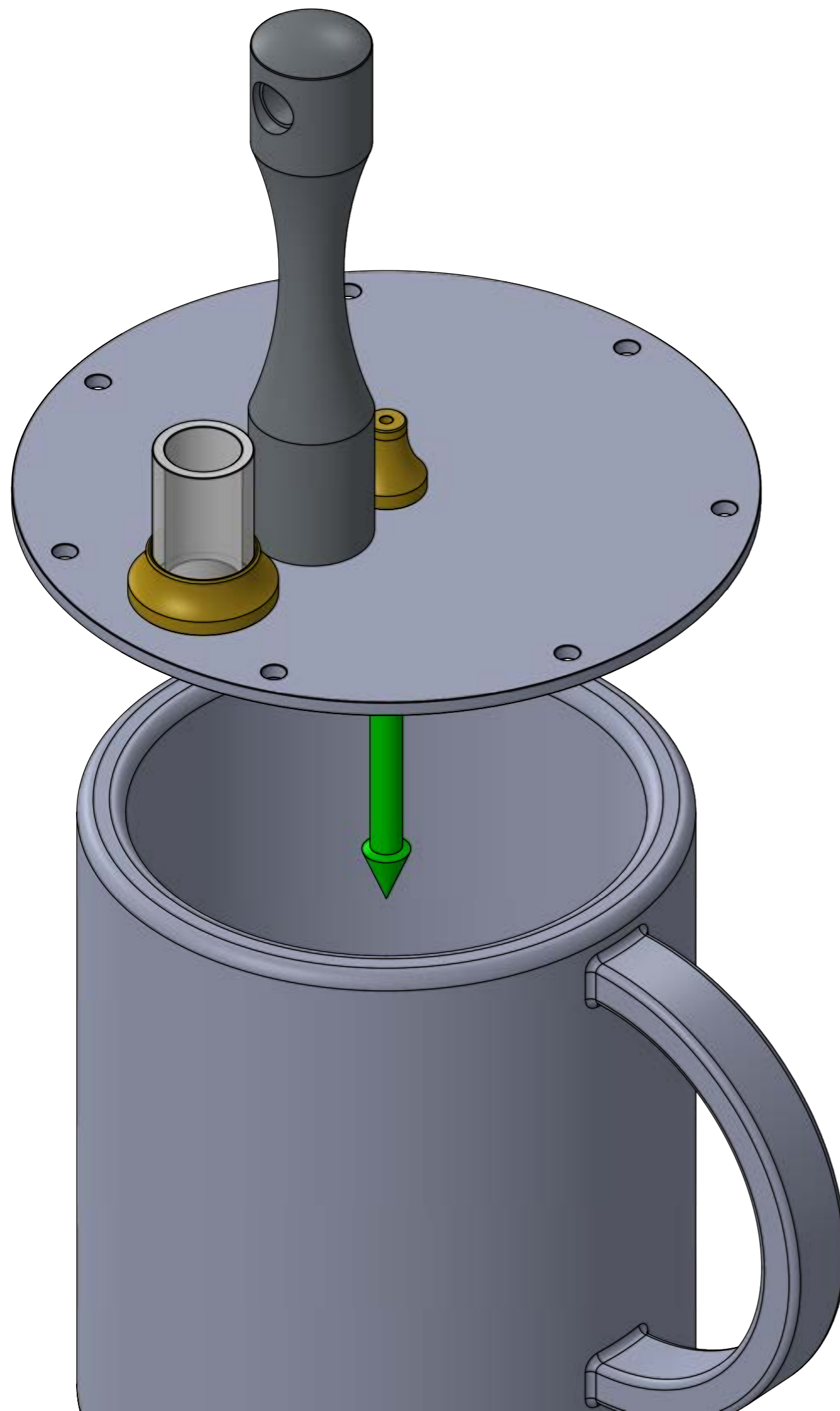
Position the top plate over the main pillar, with the underside of the plate facing upwards.

Align the two countersunk holes in the plate with the two threaded holes in the pillar.

Screw in two M3x6mm countersunk screws until they both lightly grip the plate on the pillar and then fully tighten both screws.

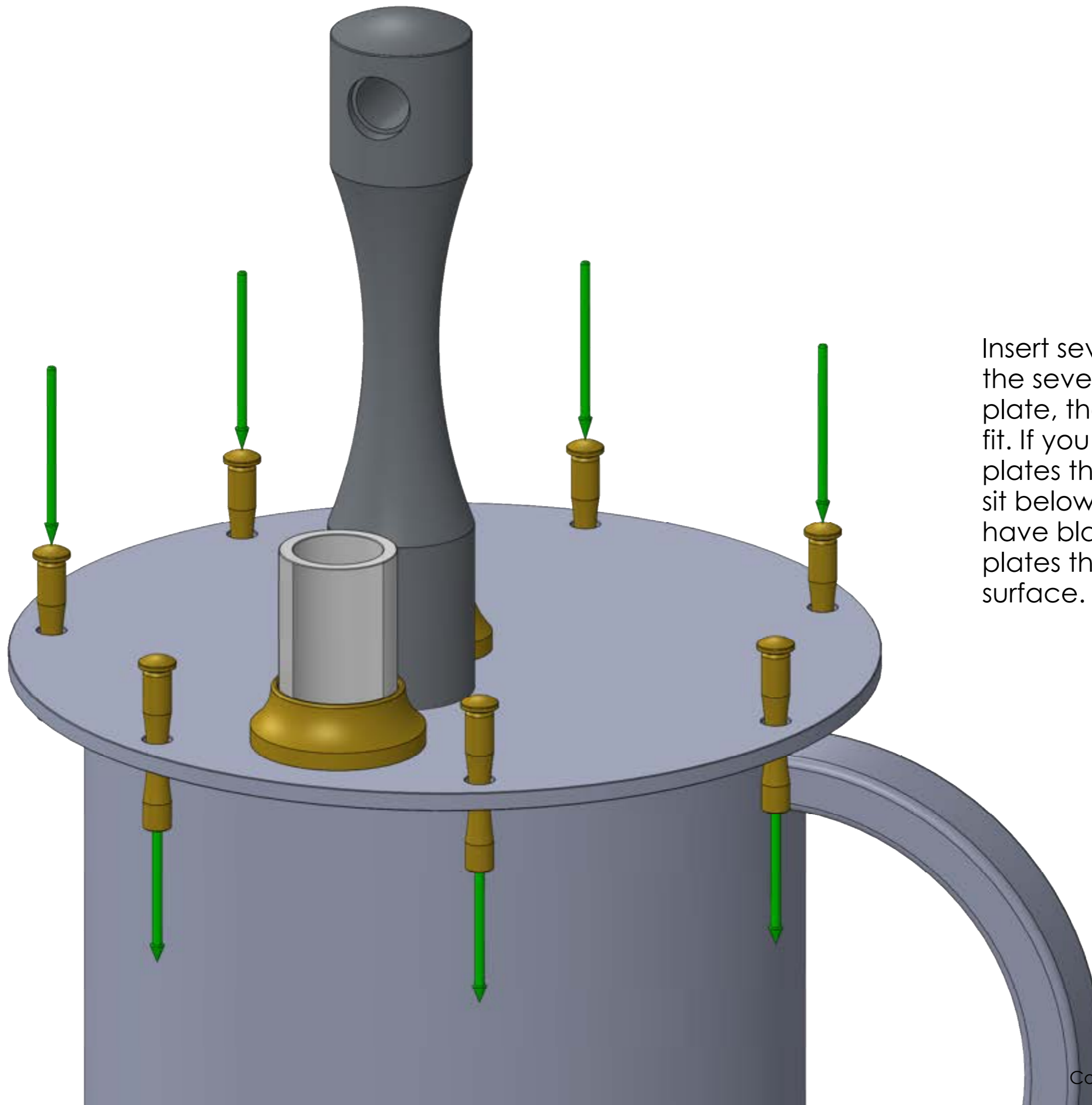
Make sure that the O ring in the main pillar does not become pinched or fall out of its groove.





Remove the partially assembled engine from the packing tray and place it over the top of a coffee mug.

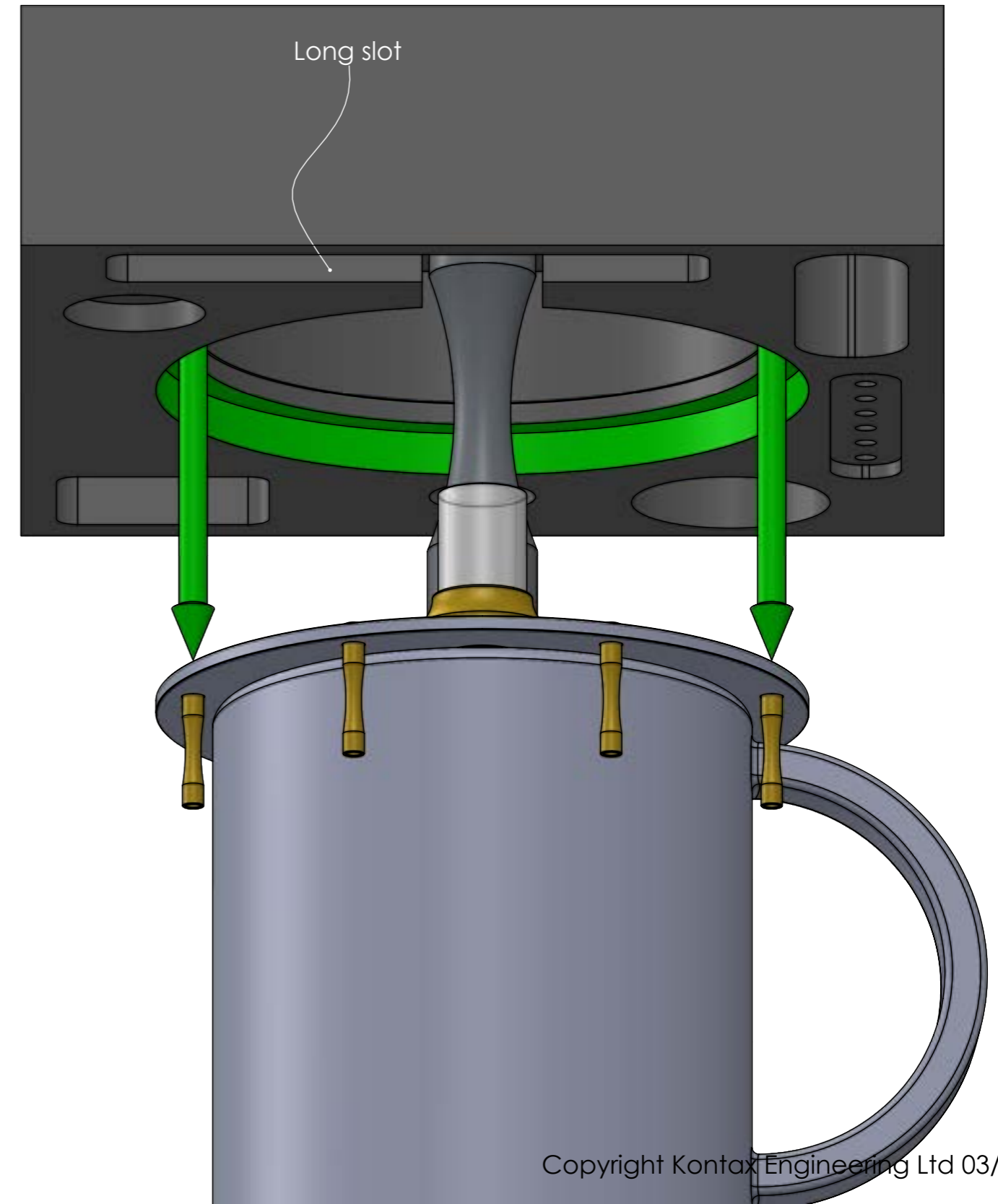
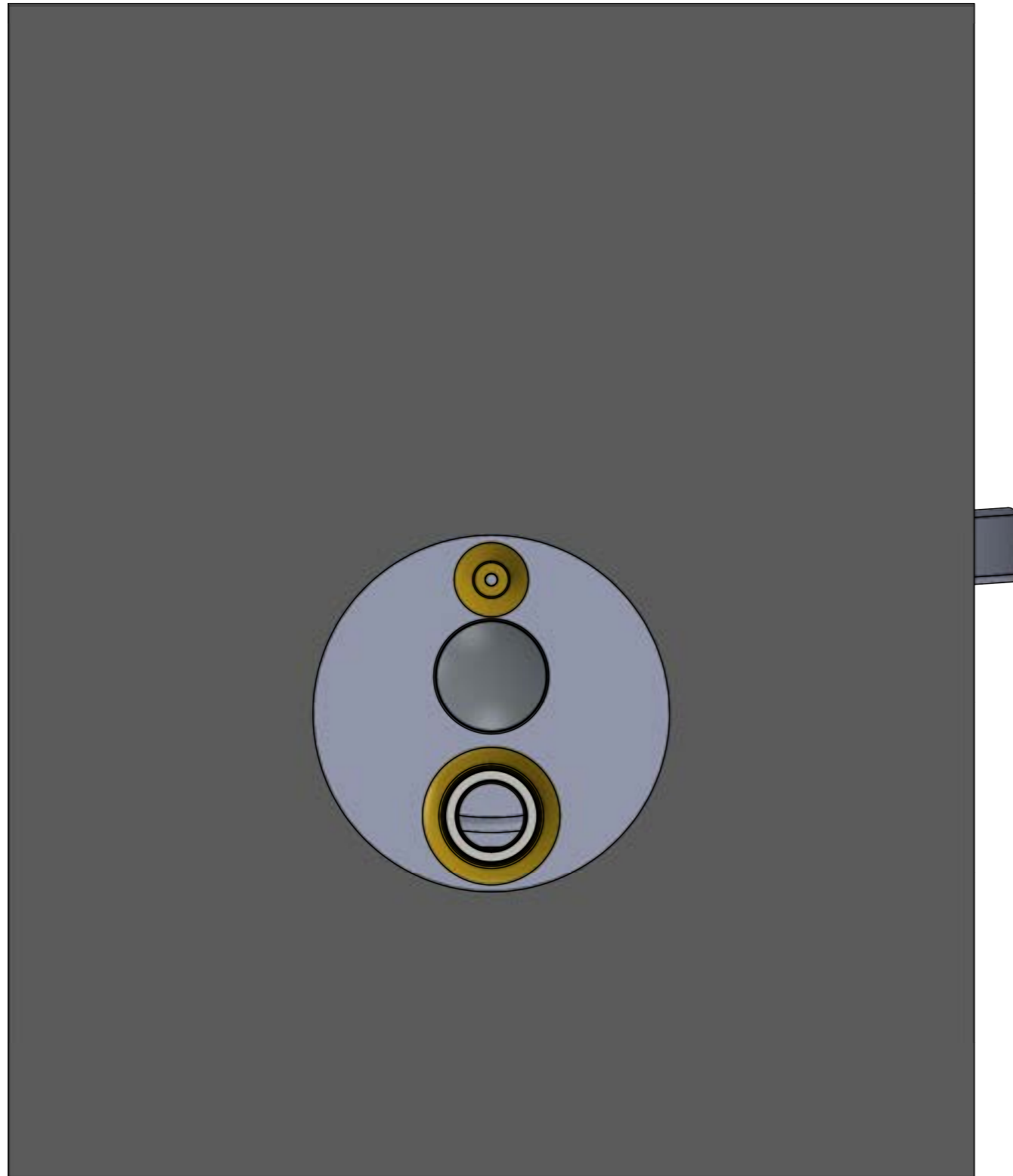
This will hold it still so that you can use both hands for the next few assembly stages.

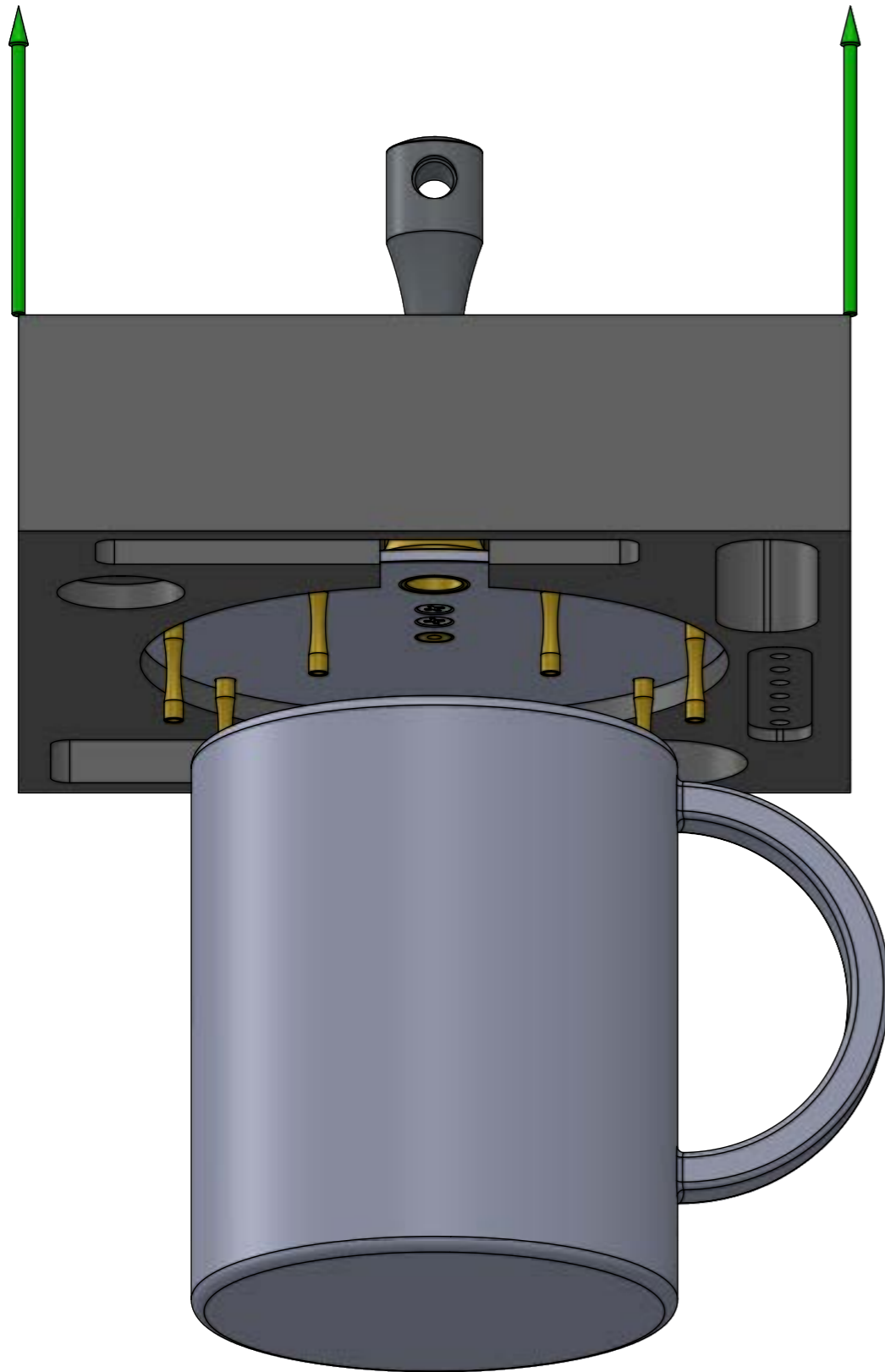


Insert seven chamber pillars into the seven small holes in the plate, they should all be an easy fit. If you have solar (acrylic) plates the heads of the pillars will sit below the surface, if you have black or blue (aluminium) plates the heads will sit on the surface.

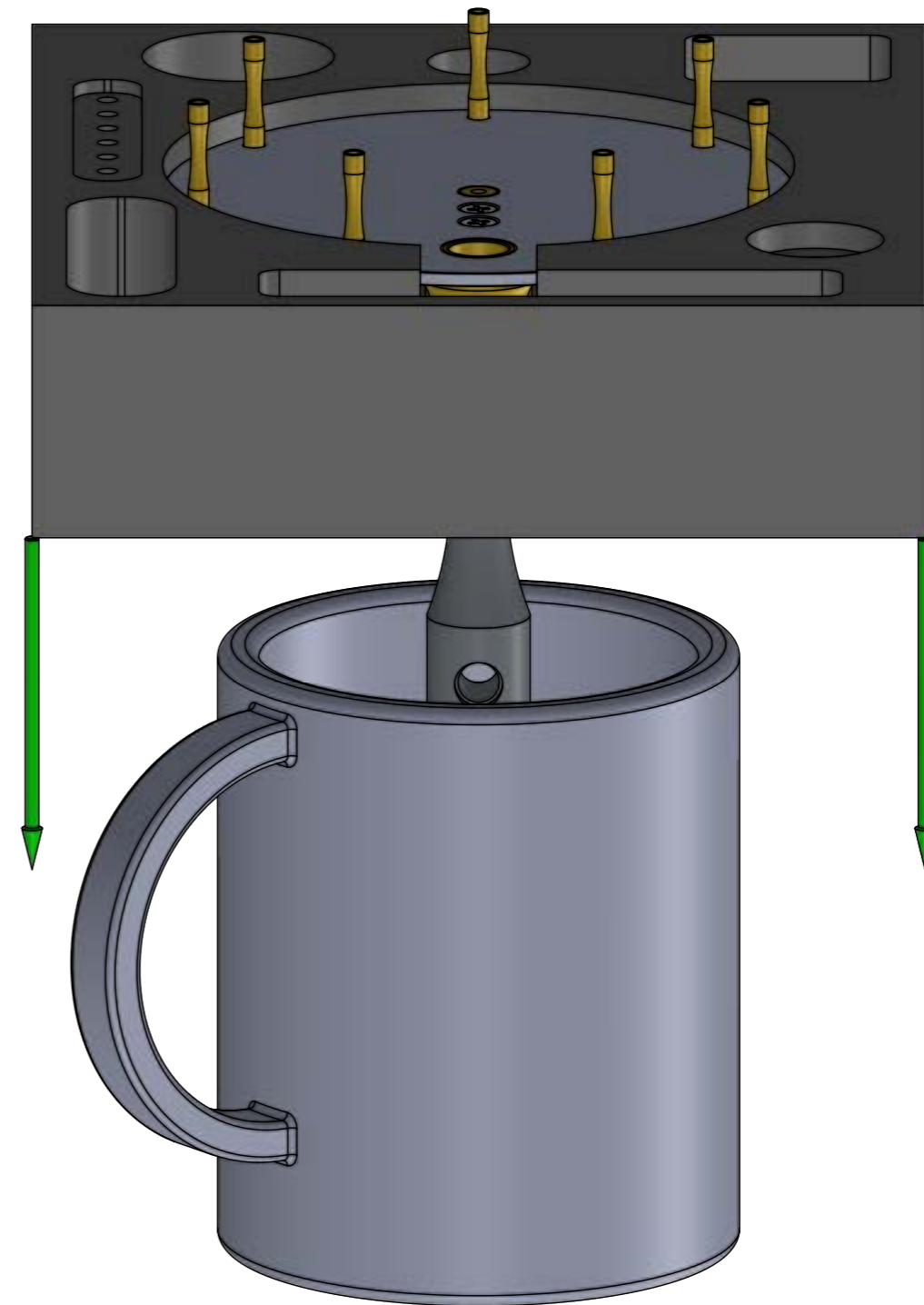
Align the packing tray so that the hole that goes all the way through is over the gland, main pillar and cylinder on the top plate. The long slot should face forwards as shown.

Lower the tray down until it sits on top of the brass chamber pillars. The top plate will fit inside the first step in the tray (shown in green) and the cylinder, main pillar and gland will fit through the hole in the tray.

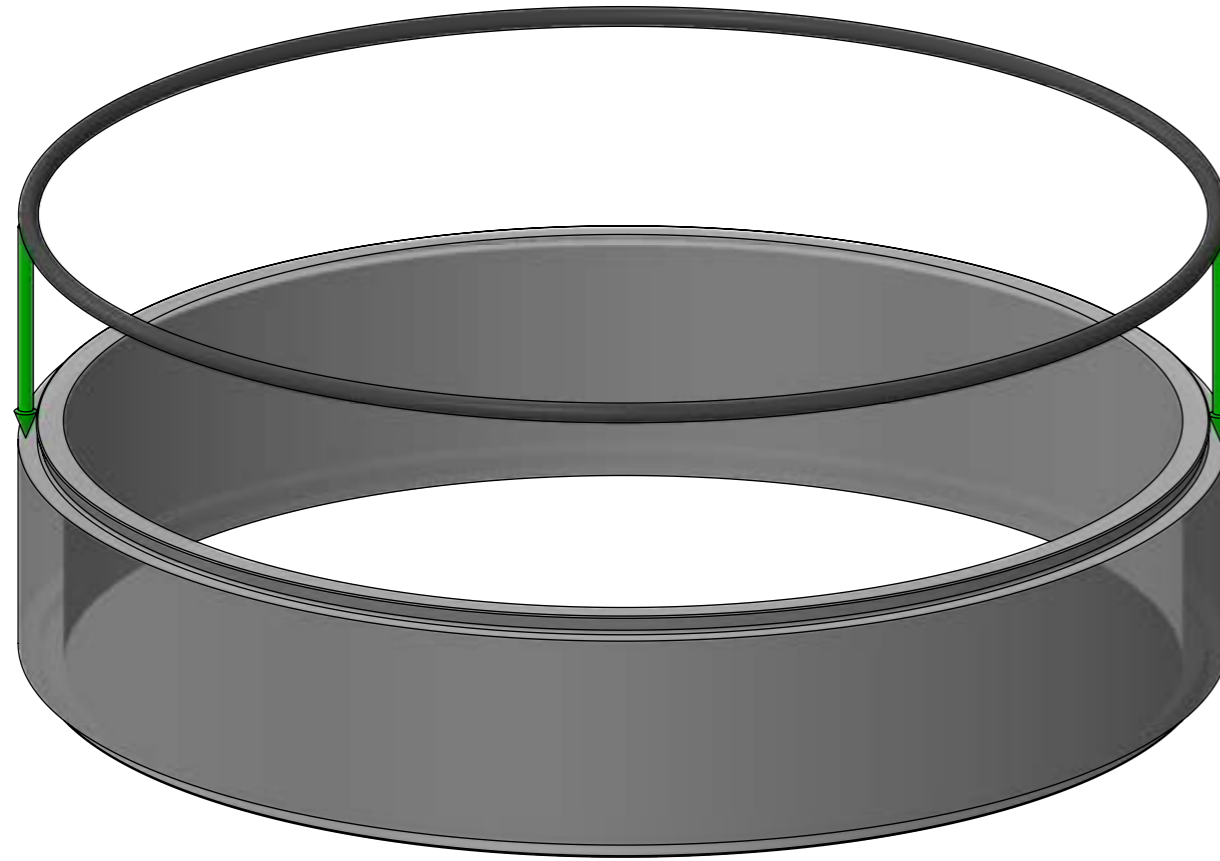




Hold the packing tray and engine firmly together so that the chamber pillars do not fall out of the top plate and remove the tray and engine from the mug.

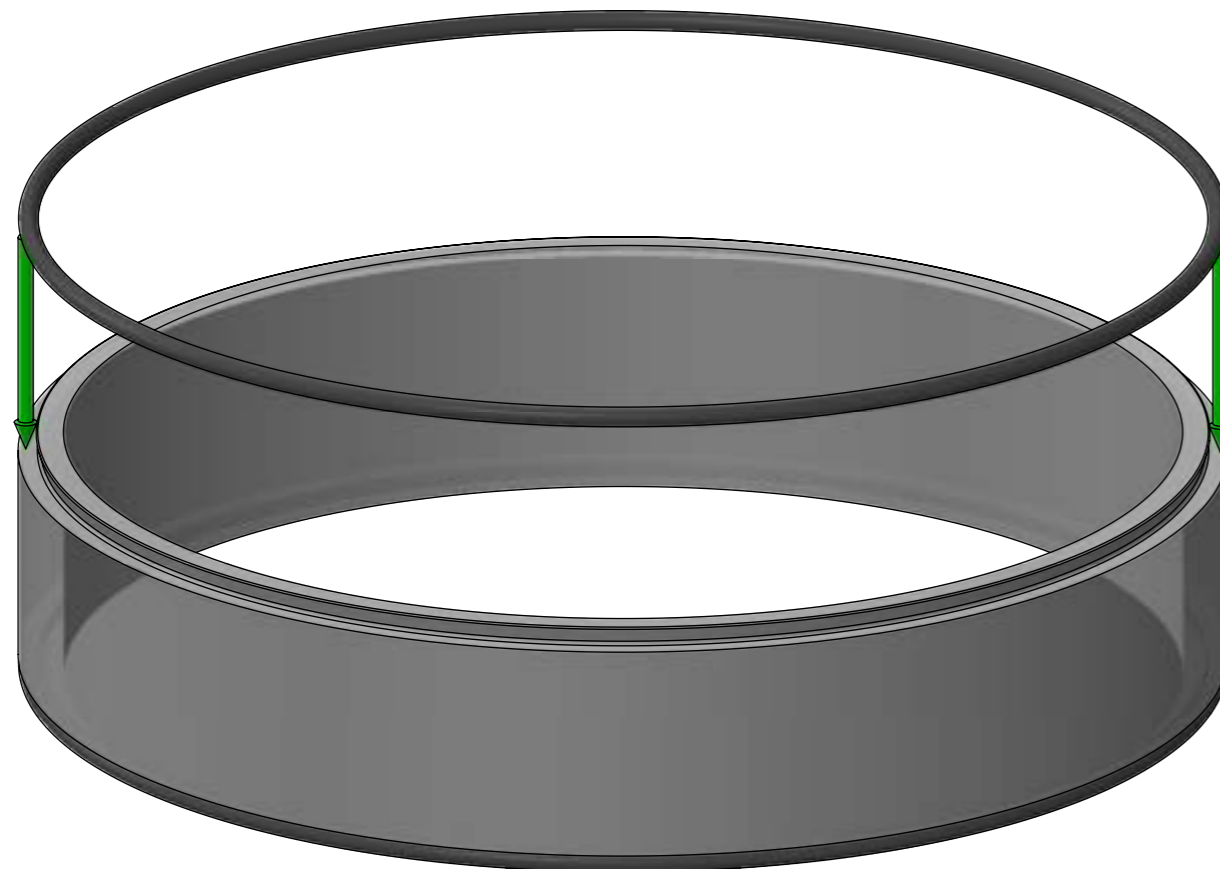


Still holding tray and engine firmly together carefully turn everything upside down and place back on top of the mug, with the main pillar inside the mug. The packing tray will hold the chamber pillars in a vertical position while you perform the next few assembly stages.

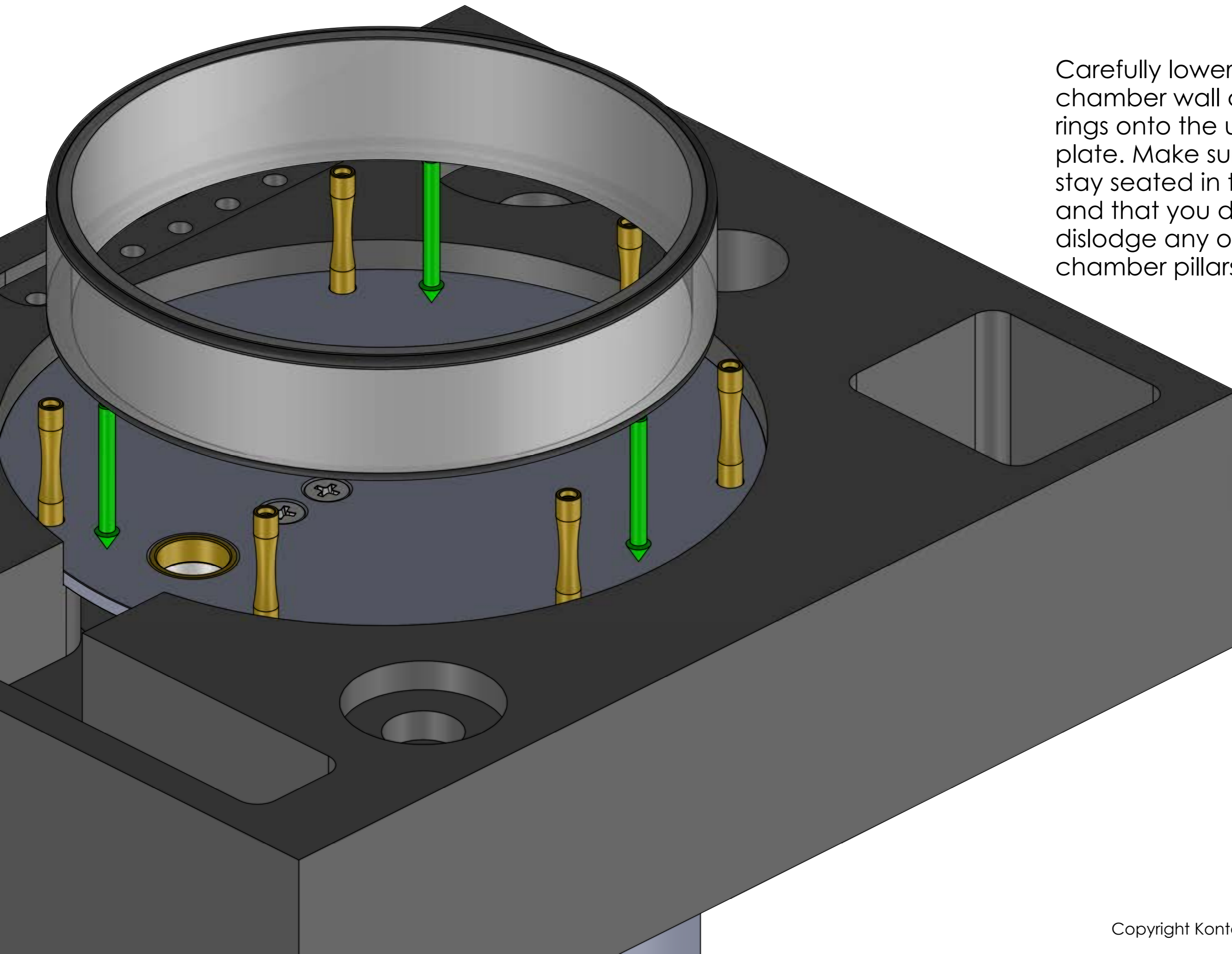


Wipe the chamber wall with a dry cloth to remove any fingerprints.

Stretch one 75mm O ring over the step on one end.

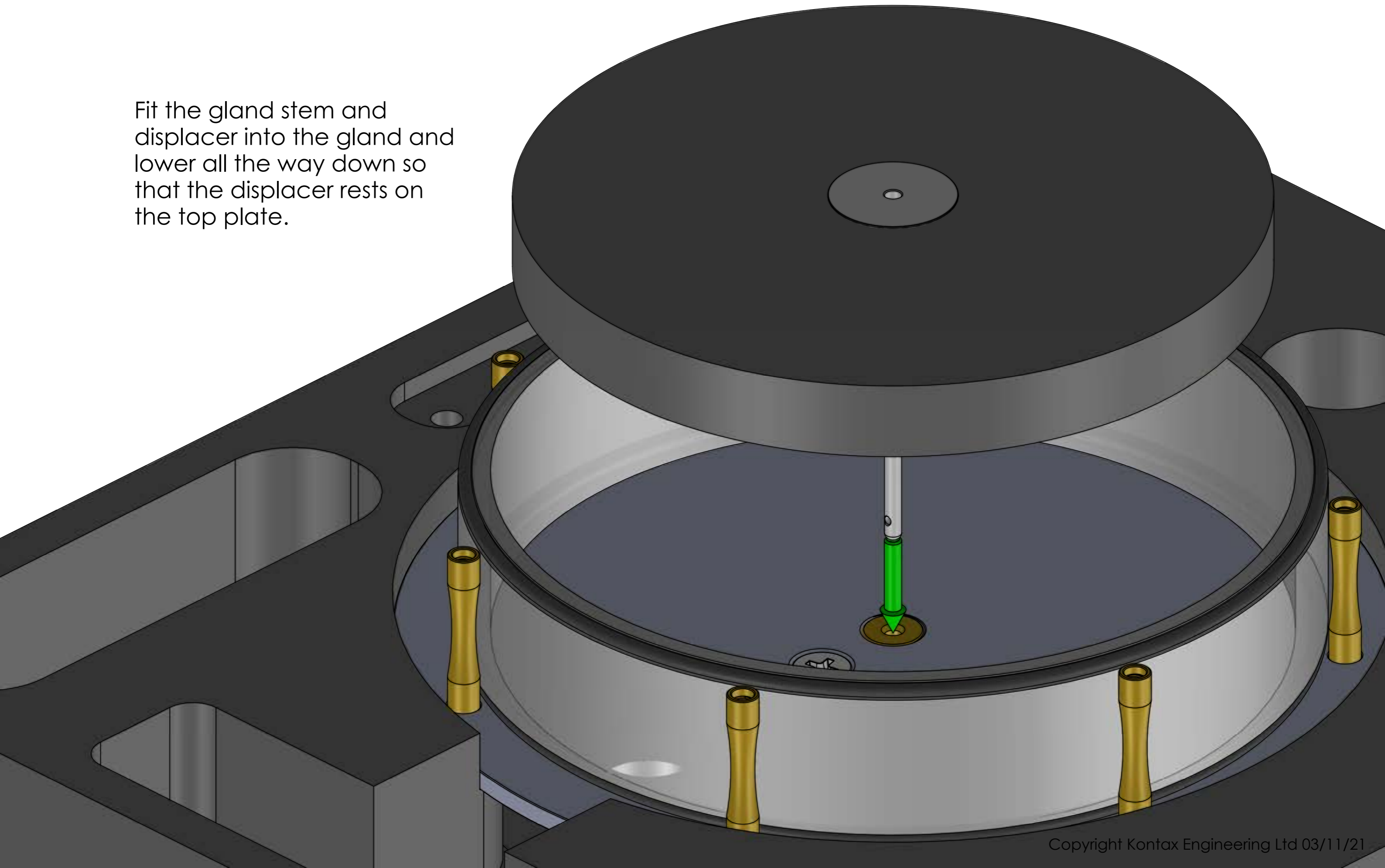


Stretch the other 75mm O ring over the step on the other end of the chamber wall.

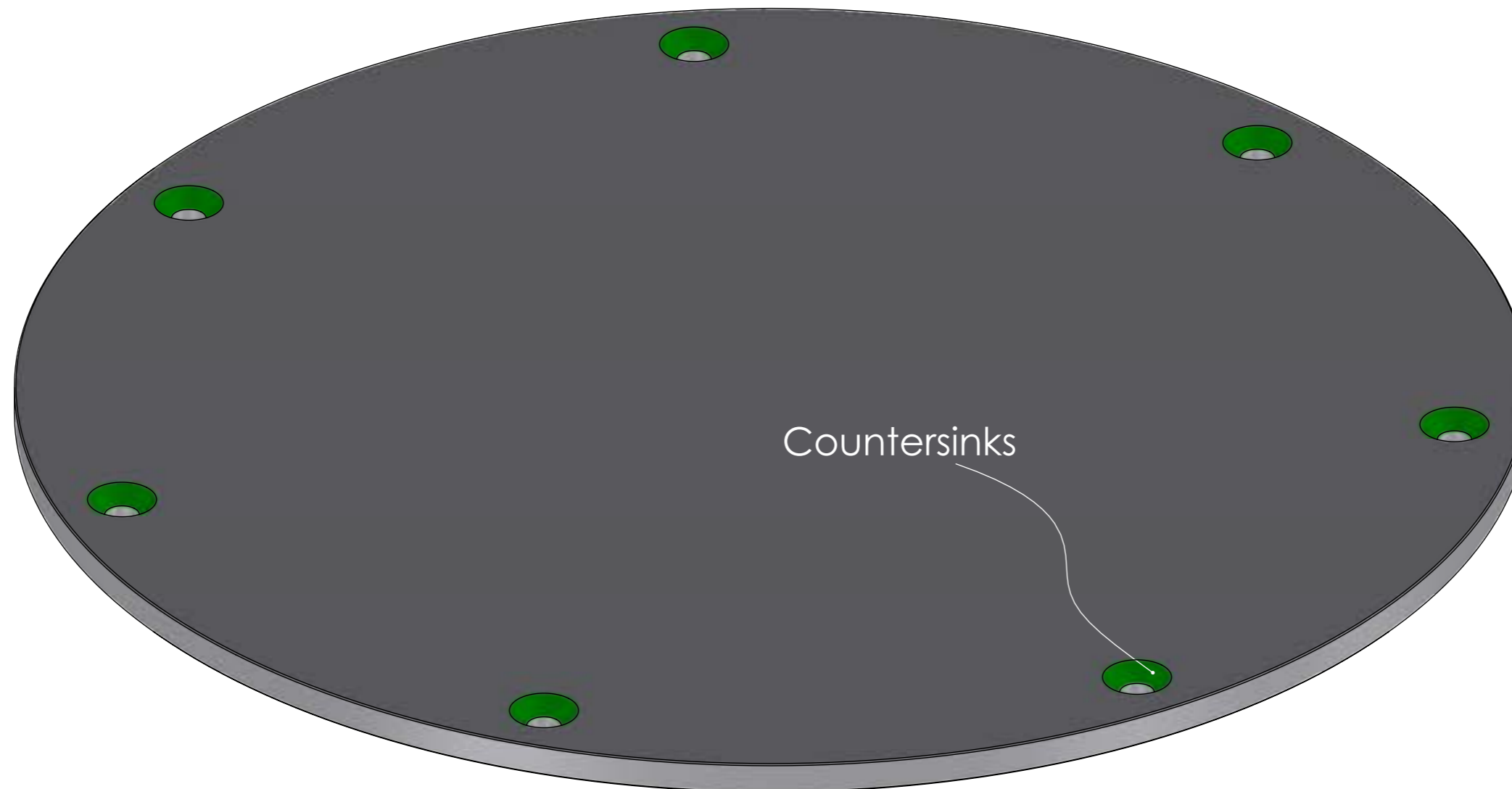


Carefully lower the chamber wall and fitted O rings onto the upturned top plate. Make sure the O rings stay seated in their steps, and that you do not dislodge any of the chamber pillars.

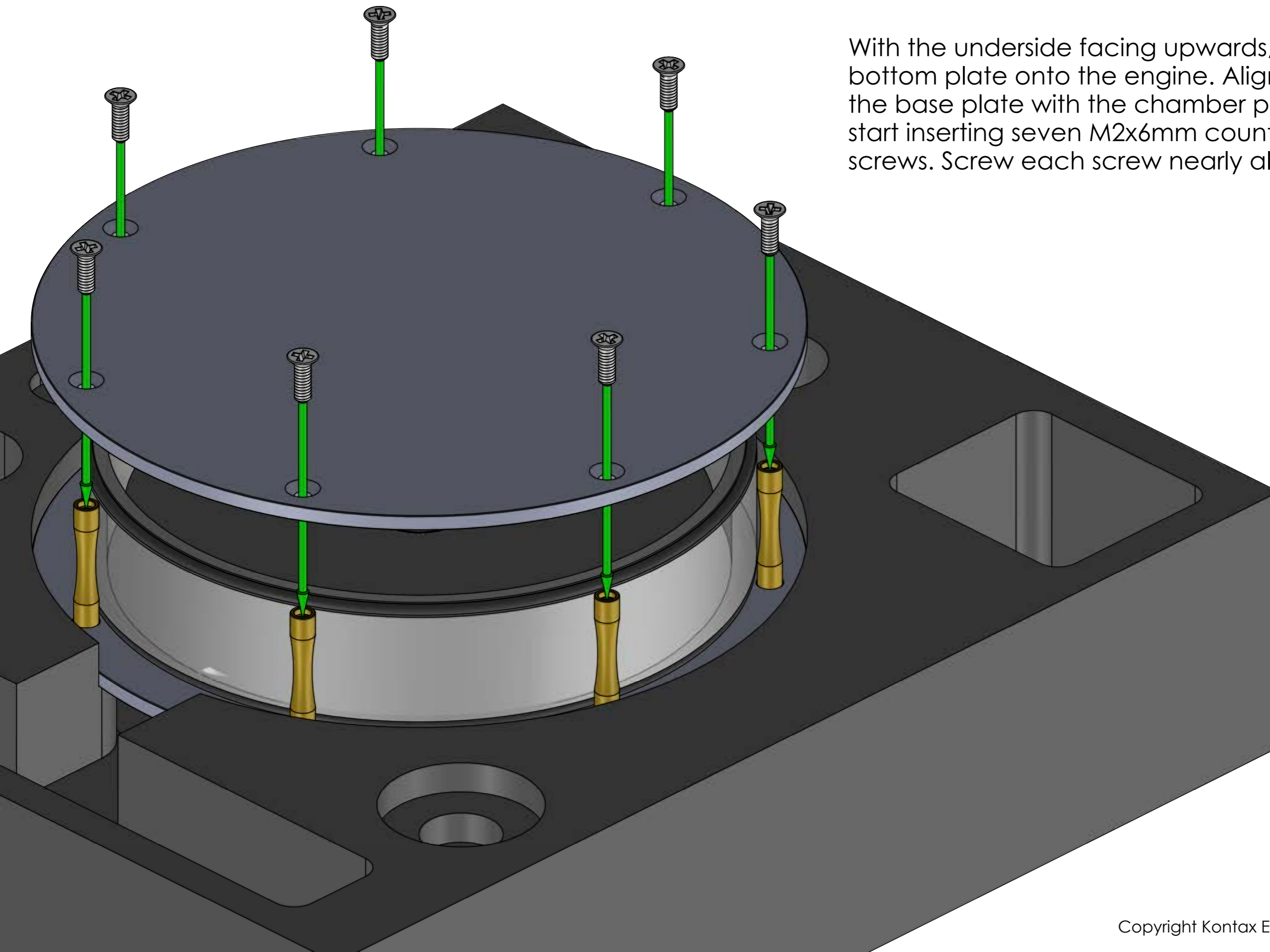
Fit the gland stem and displacer into the gland and lower all the way down so that the displacer rests on the top plate.



If you have solar (acrylic) plates you will need to remove the protective film from both sides of the bottom plate now. Once you have removed the film try to handle the plate by its edges, this will minimise fingerprints. Black and blue (aluminium) plates do not have protective film.

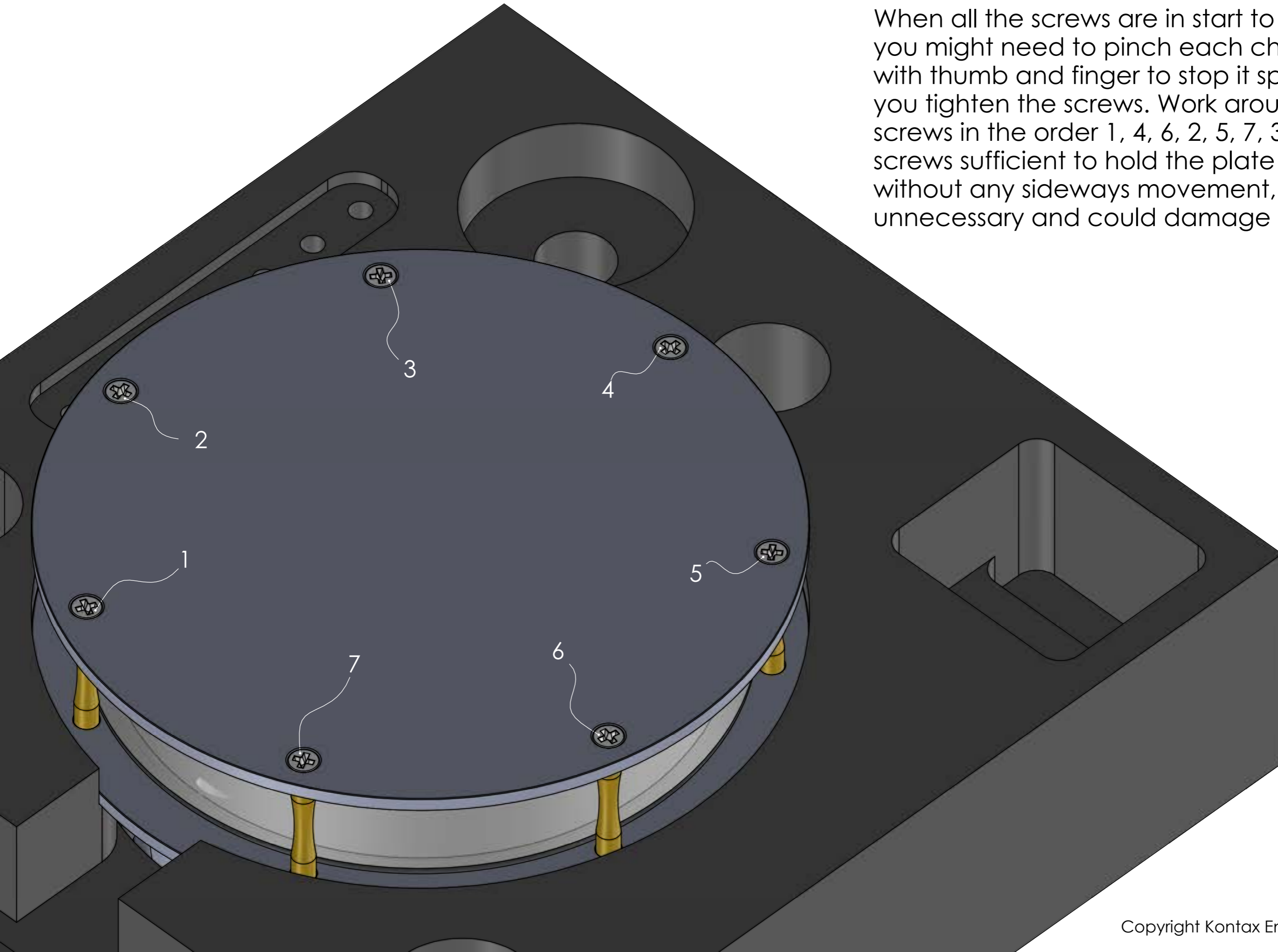


Identify the underside of the bottom plate.
The underside is the side with the countersinks on the seven holes as shown.



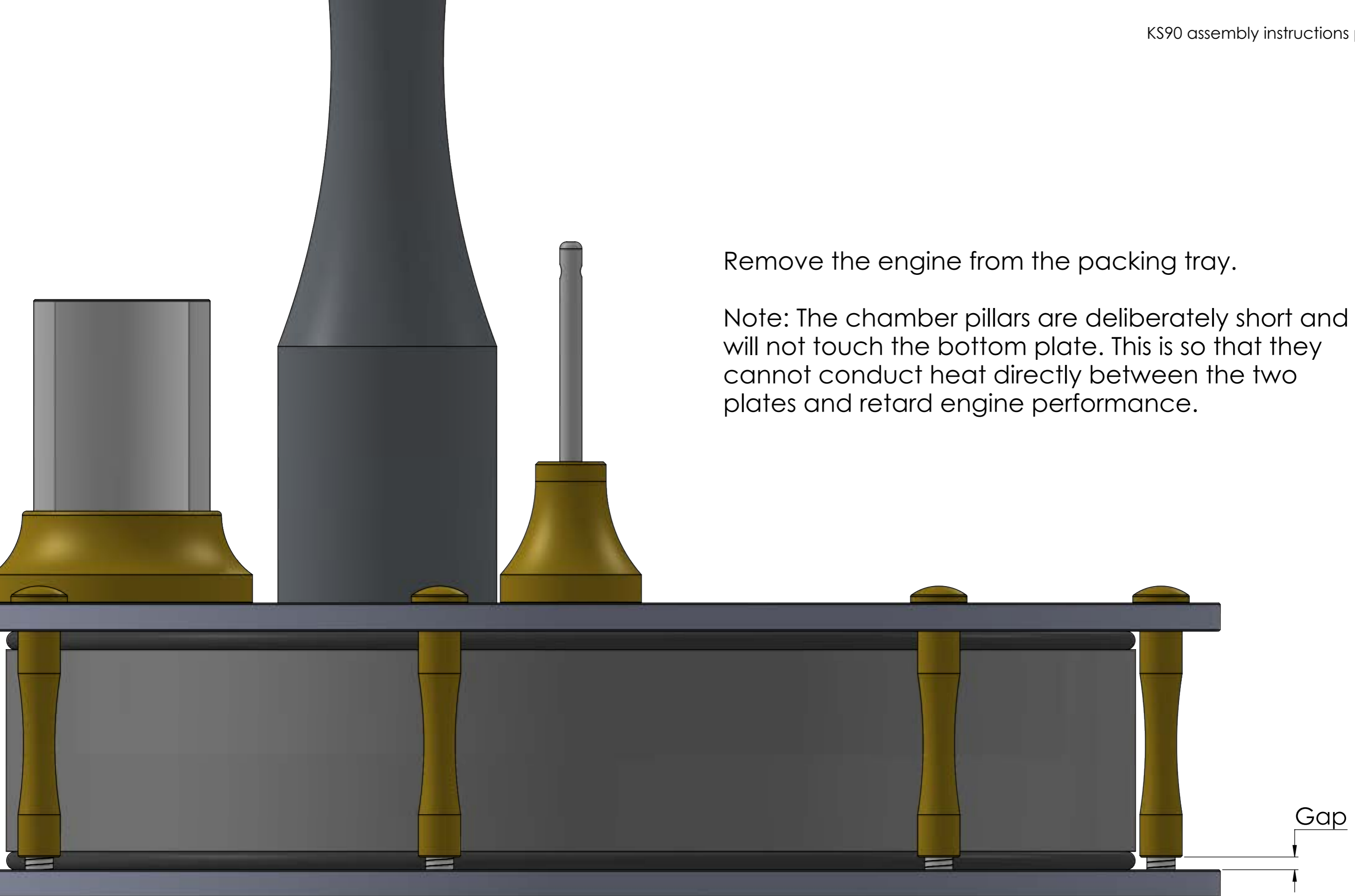
With the underside facing upwards, lower the bottom plate onto the engine. Align the holes in the base plate with the chamber pillars and start inserting seven M2x6mm countersunk screws. Screw each screw nearly all the way in.

When all the screws are in start to tighten them, you might need to pinch each chamber pillar with thumb and finger to stop it spinning while you tighten the screws. Work around the screws in the order 1, 4, 6, 2, 5, 7, 3. Tighten the screws sufficient to hold the plate in place without any sideways movement, any tighter is unnecessary and could damage the screws.



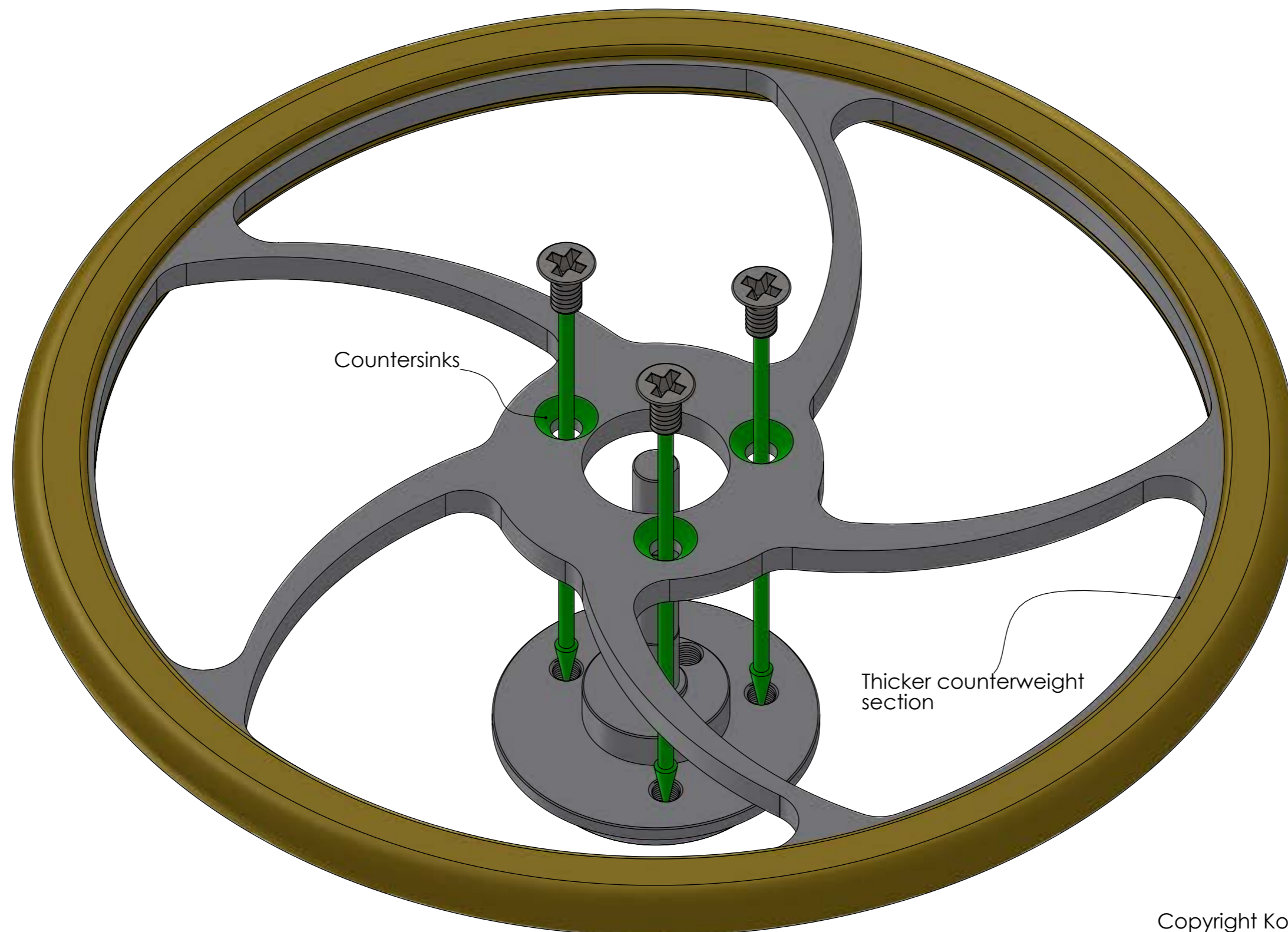
Remove the engine from the packing tray.

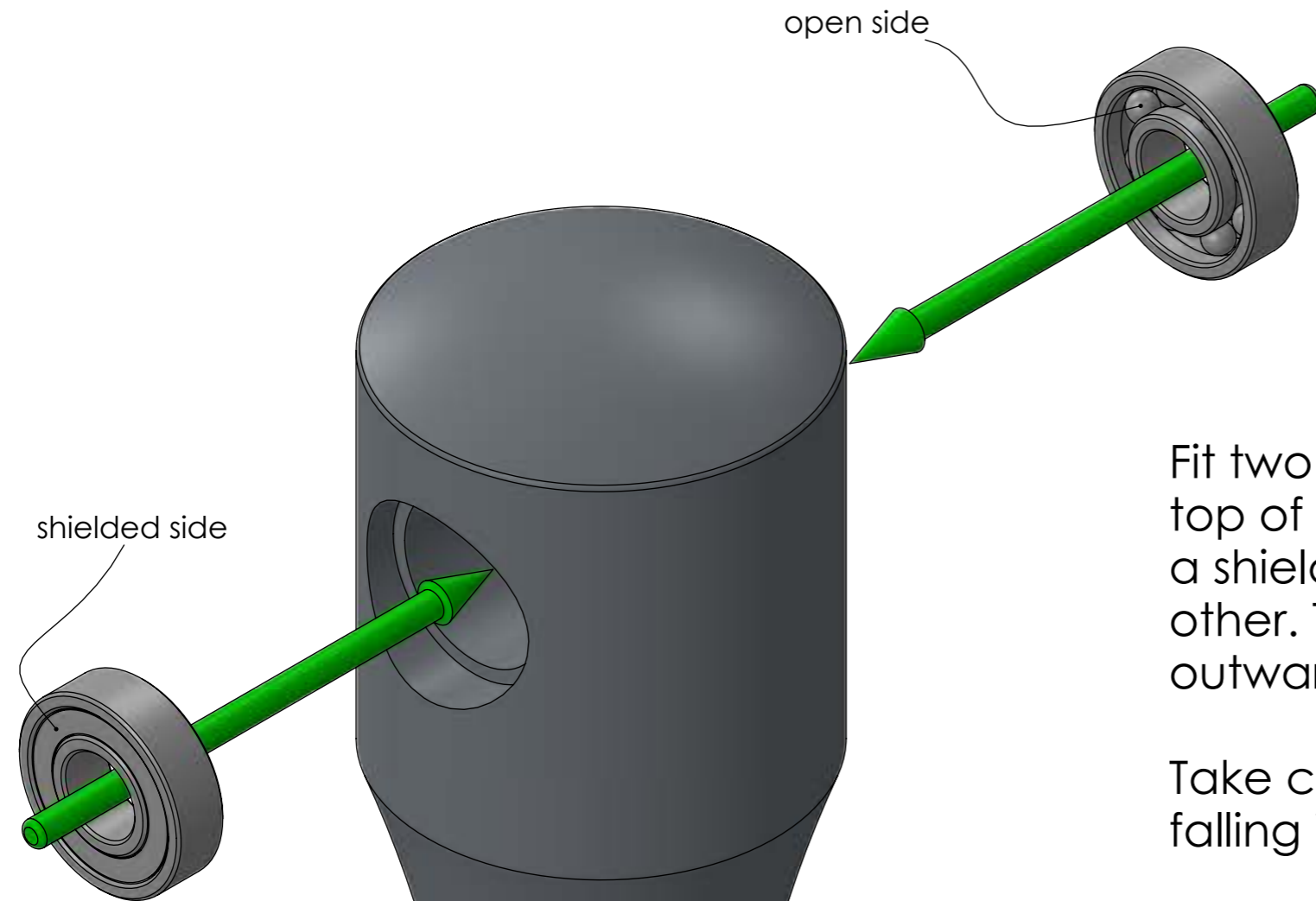
Note: The chamber pillars are deliberately short and will not touch the bottom plate. This is so that they cannot conduct heat directly between the two plates and retard engine performance.



Identify the top side of the flywheel. The top side is the side with the countersinks on the three holes as shown.

With the countersinks facing upwards fit the flywheel onto the hub/axle. Align the holes in the flywheel with the holes in the hub, there is only one way that they will all line up together, this ensures the flywheel counterweight section is in the correct position. Screw in three M2x4mm countersunk screws until they all just touch the flywheel and then tighten.



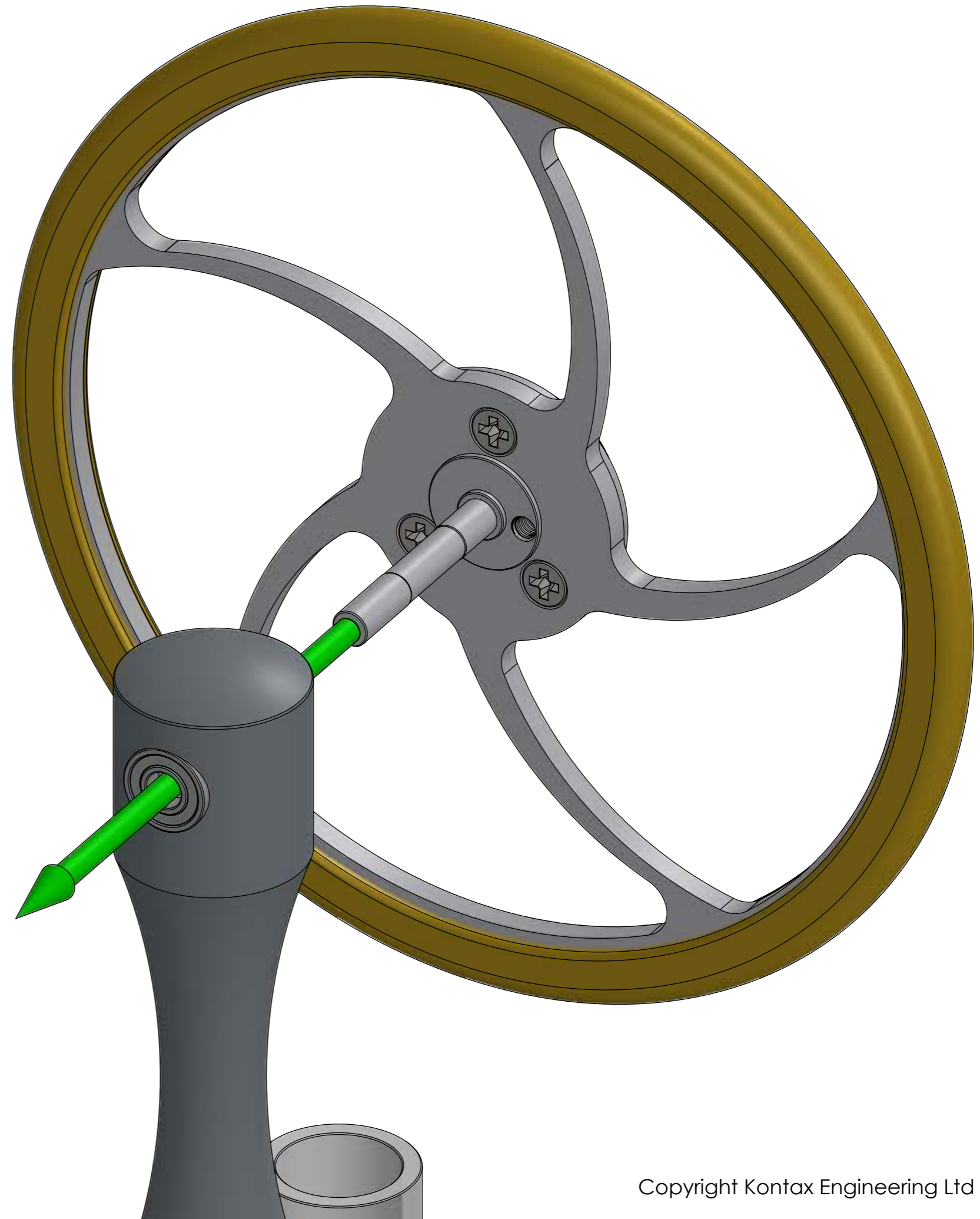


Fit two bearings into the recesses in the top of the main pillar. The bearings have a shield on one side and are open on the other. The shielded sides should face outwards after fitting.

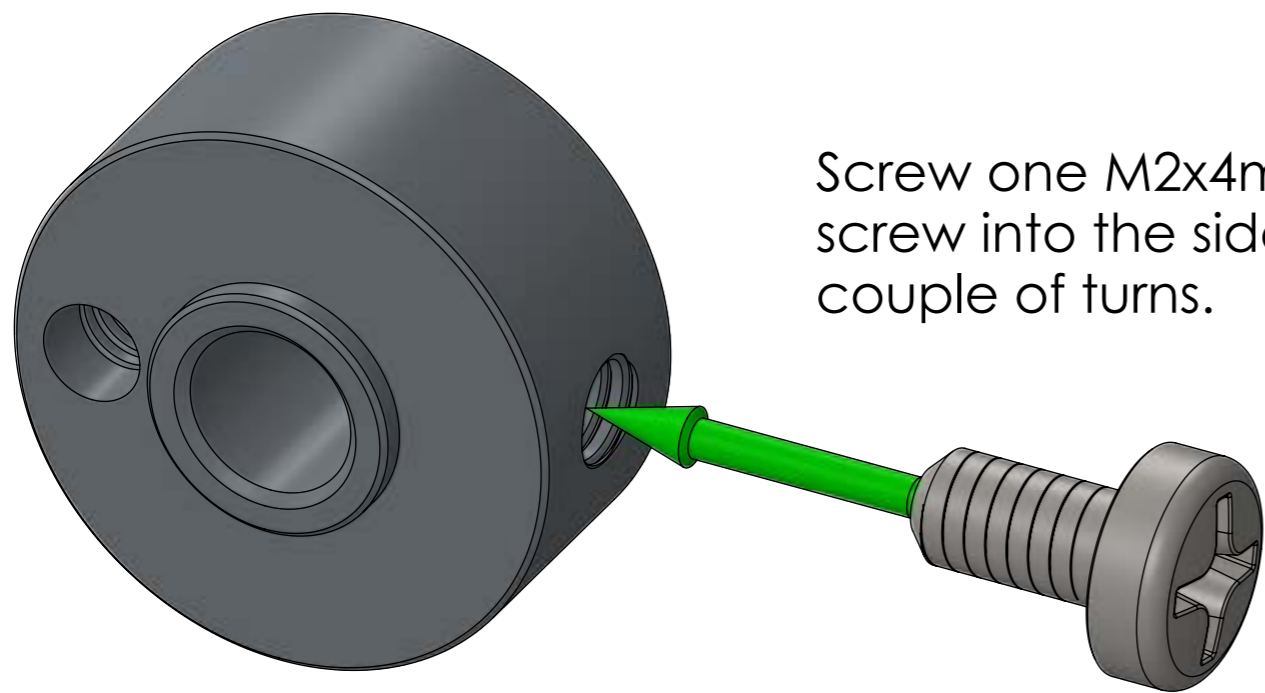
Take care to prevent the bearings from falling into the glass cylinder.

Slide the axle through the bearings.
It should be a good fit but not tight
in the bearings.

Take care that the second bearing
does not get pushed out by the
axle.



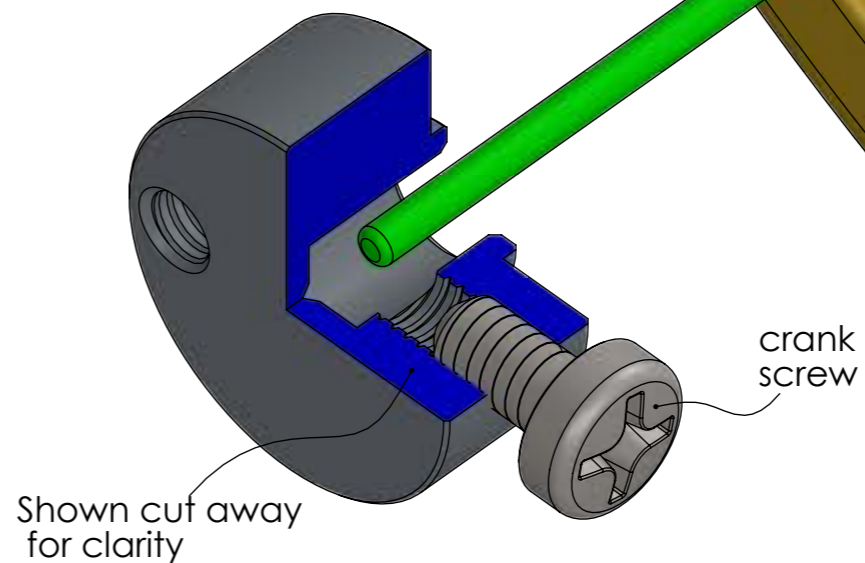
Screw one M2x4mm roundhead screw into the side of the crank a couple of turns.



Identify the flat section on the axle.

Slide the crank onto the end of the axle, the crank screw should be aligned perpendicular to the flat section on the end of the axle.

Screw the screw gently onto the flat section and carefully tighten.



Flat section

crank
screw

Shown cut away
for clarity

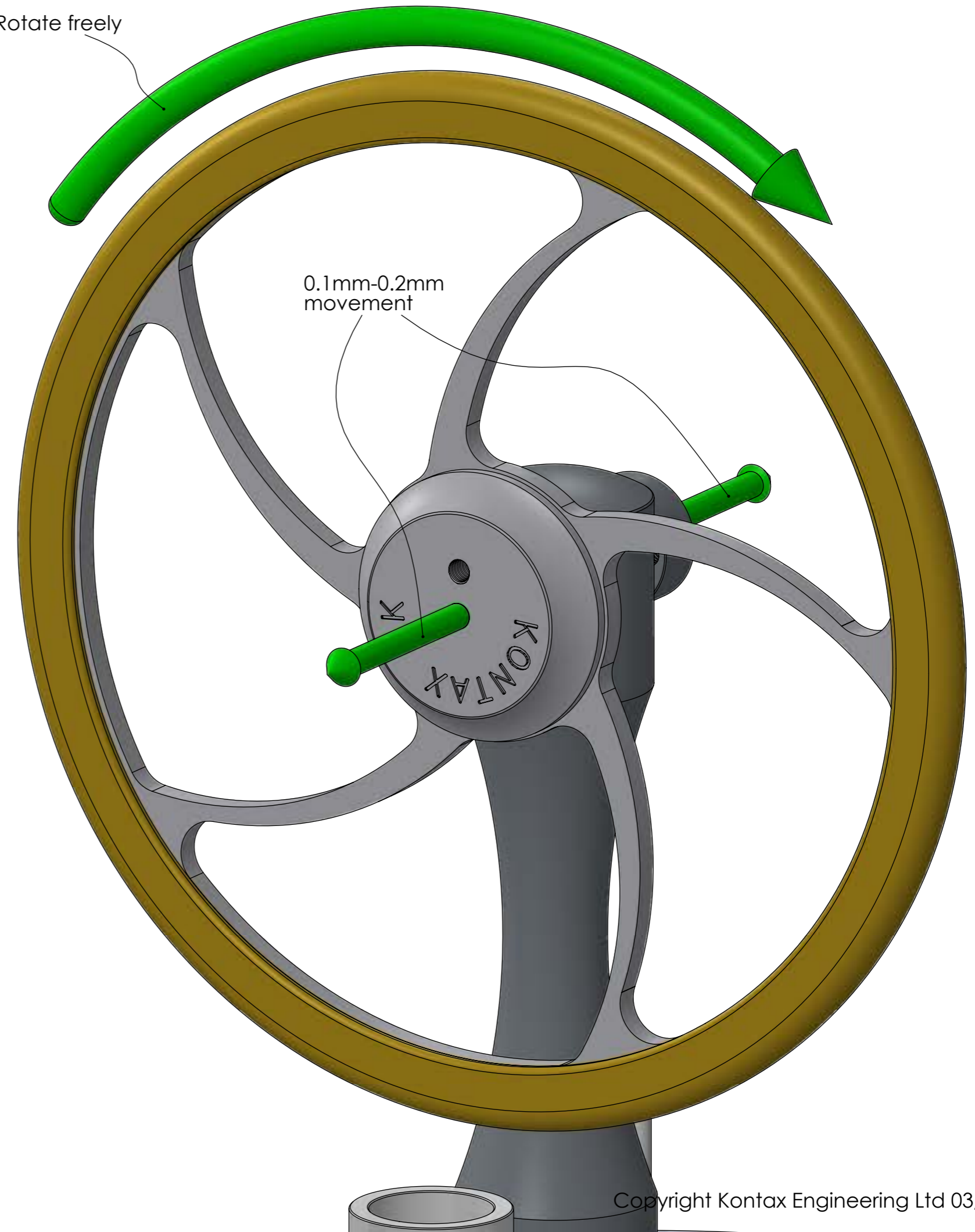
Rotate freely

Gently push the flywheel back and forward, there should be about 0.2mm of movement.

Give the flywheel a sharp spin, it should keep spinning for several minutes.

If there is no movement or the flywheel does not spin freely then you will need to adjust the crank.

To adjust the crank slacken the crank screw, move the crank out a fraction and tighten. Make sure that when tightening the crank screw again it stays located on the flat section on the axle.

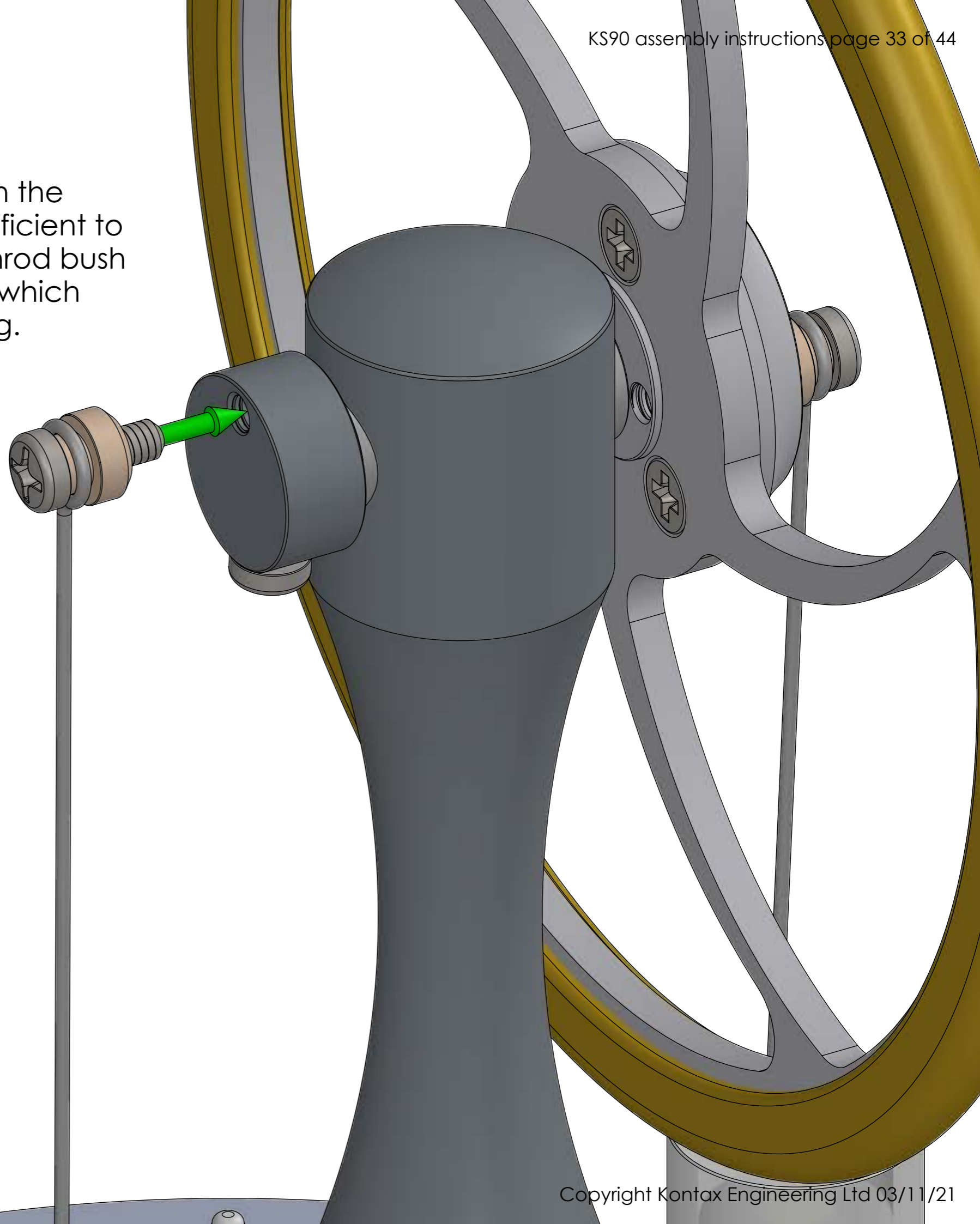


Identify the displacer conrod, it is the one with the hook pointing towards the threaded end of the conrod screw.

Fit the hook on the conrod through the hole in the top of the gland stem.

Gland stem to fit here

Screw the conrod screw into the hole in the front face of the crank. Tighten only sufficient to lock, over-tightening will cause the conrod bush to expand and pinch the conrod eye, which could prevent your engine from running.

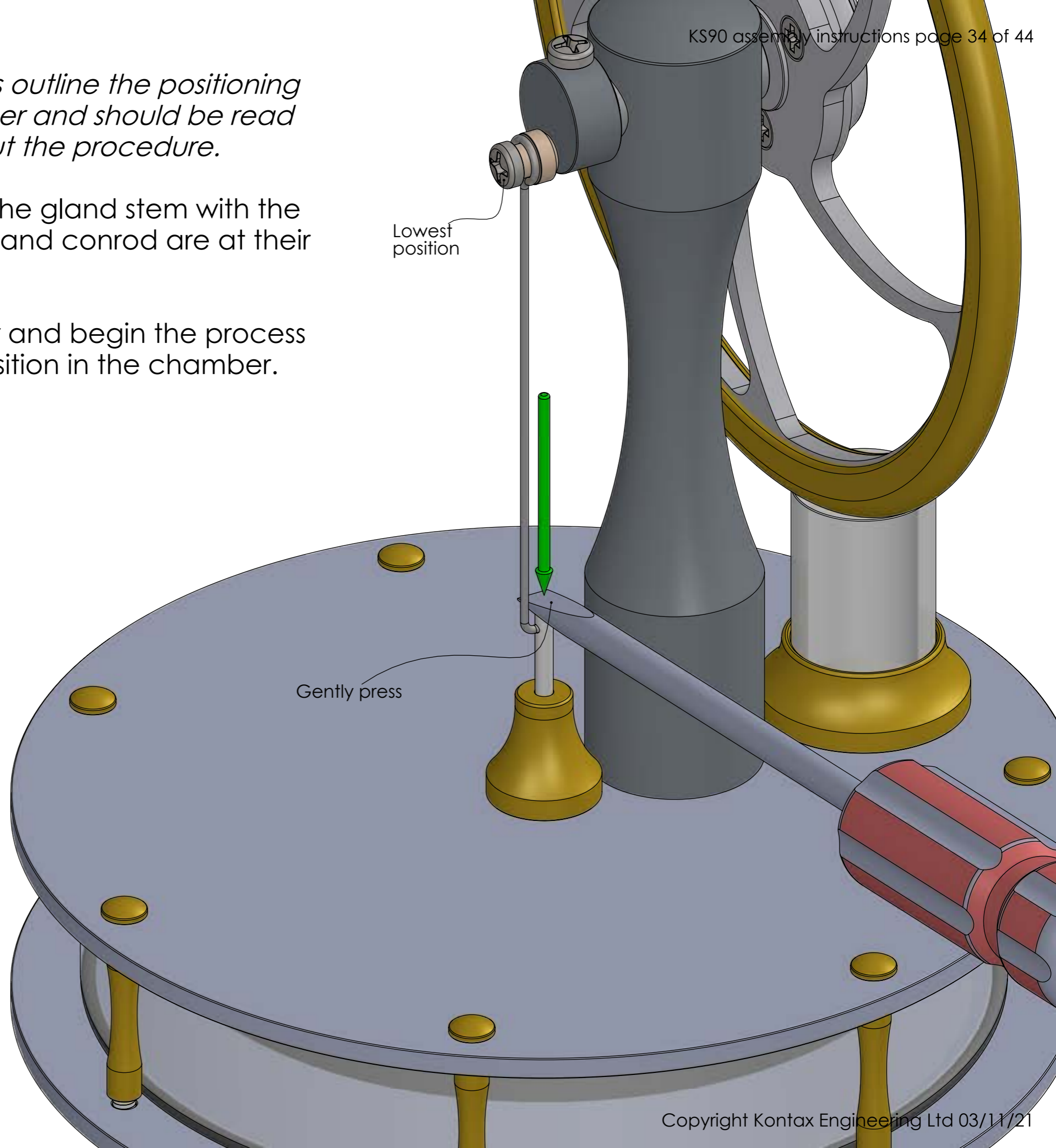


The instructions on the next three pages outline the positioning of the displacer within the main chamber and should be read and understood fully before carrying out the procedure.

Gently press downwards on the top of the gland stem with the side of a flat screwdriver until the crank and conrod are at their lowest position.

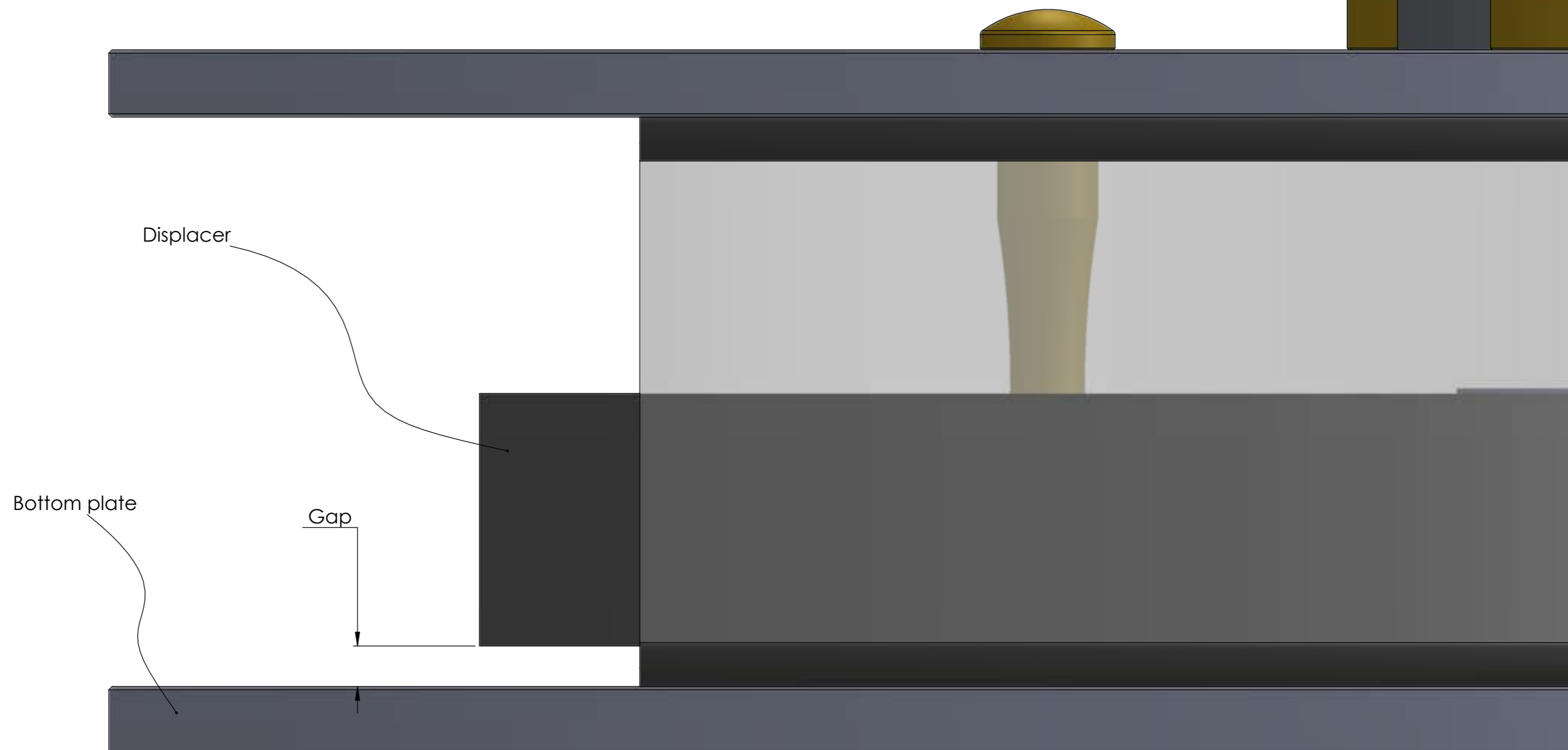
This will press the stem into the displacer and begin the process of setting the displacer to its correct position in the chamber.

At this stage the displacer should be touching the bottom plate. There is a small amount of flex in the conrod, you will be able to take advantage of this and over-press the top of the stem very slightly and carefully so that when you release the pressure on the screwdriver the displacer lifts off the bottom plate slightly. It is best to press tiny amounts several times and check often rather than try to press all in one go.



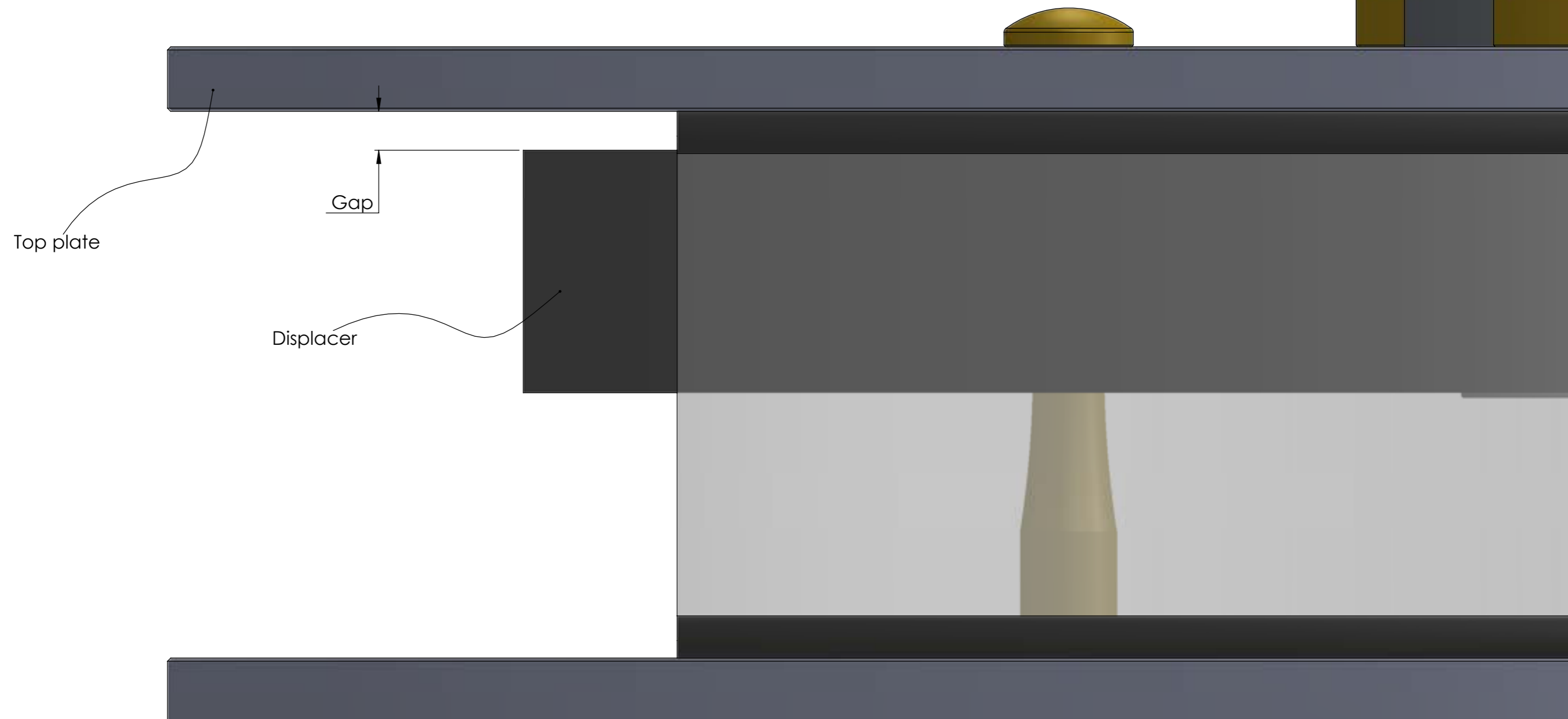
Slowly rotate the flywheel to move the displacer up and down in the chamber. Check that it does not touch the bottom plate. If it does touch you can go back and press the top of the gland stem a tiny bit more.

Note, the chamber wall and 75mm O rings are shown cut away for clarity.



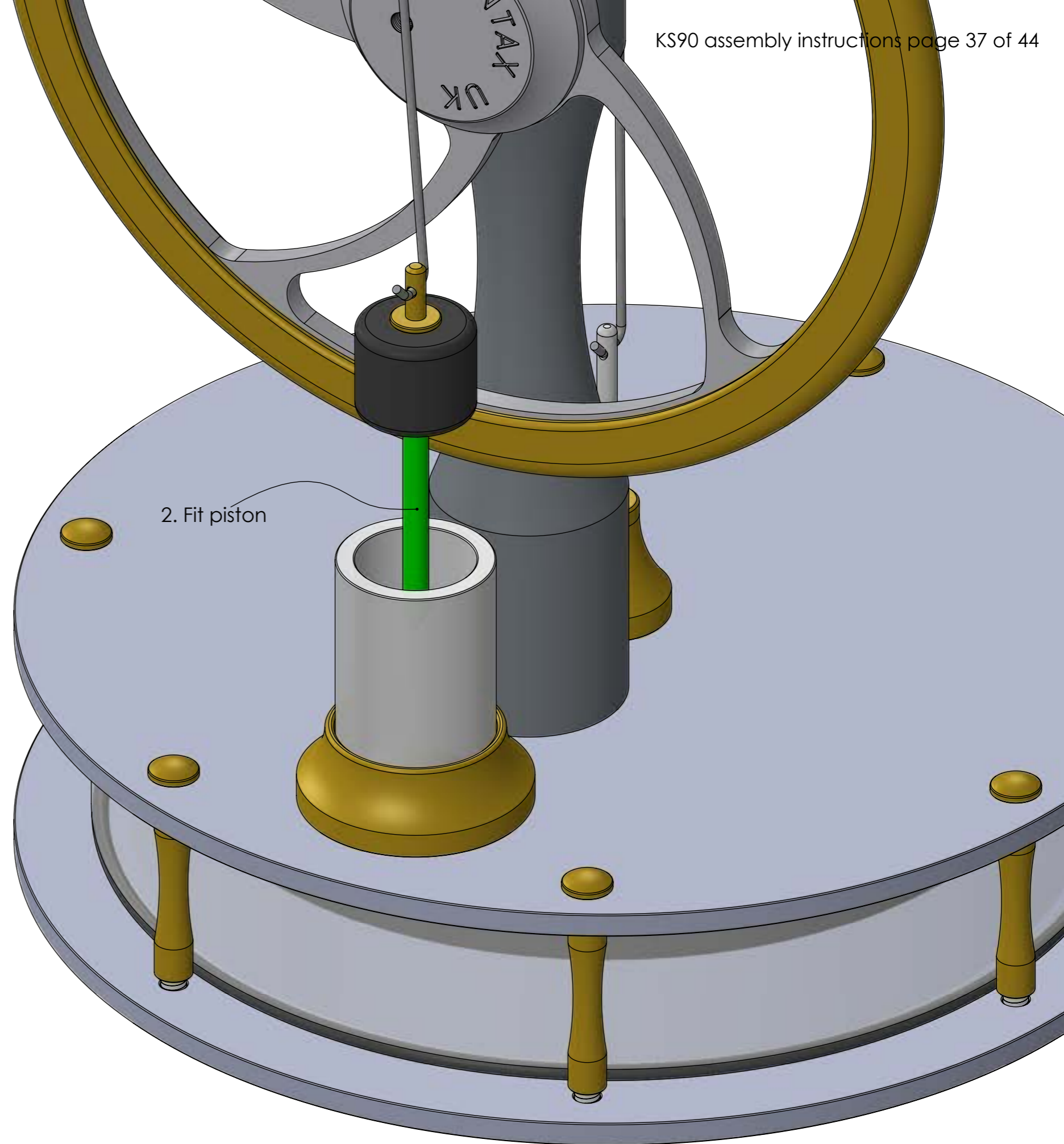
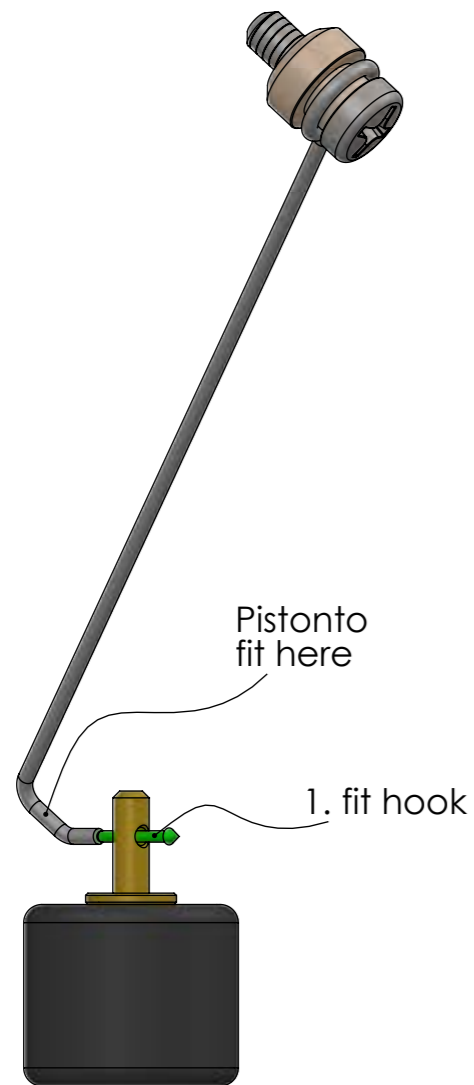
Check that the displacer does not touch the top plate. If it does this means that you might have over-pressed slightly on the top of the gland stem. To fix this you will need to unscrew the top of the conrod from the crank, leave it hooked in the gland stem and use it to pull the stem up in the displacer a small amount. Be careful not to bend the hook on the bottom of the conrod when doing this. Re-check and adjust until the displacer does not touch either plate. An equal gap top and bottom is ideal but not strictly necessary. As long as the displacer does not touch either plate the engine will run.

Note, the chamber wall and 75mm O rings are shown cut away for clarity.

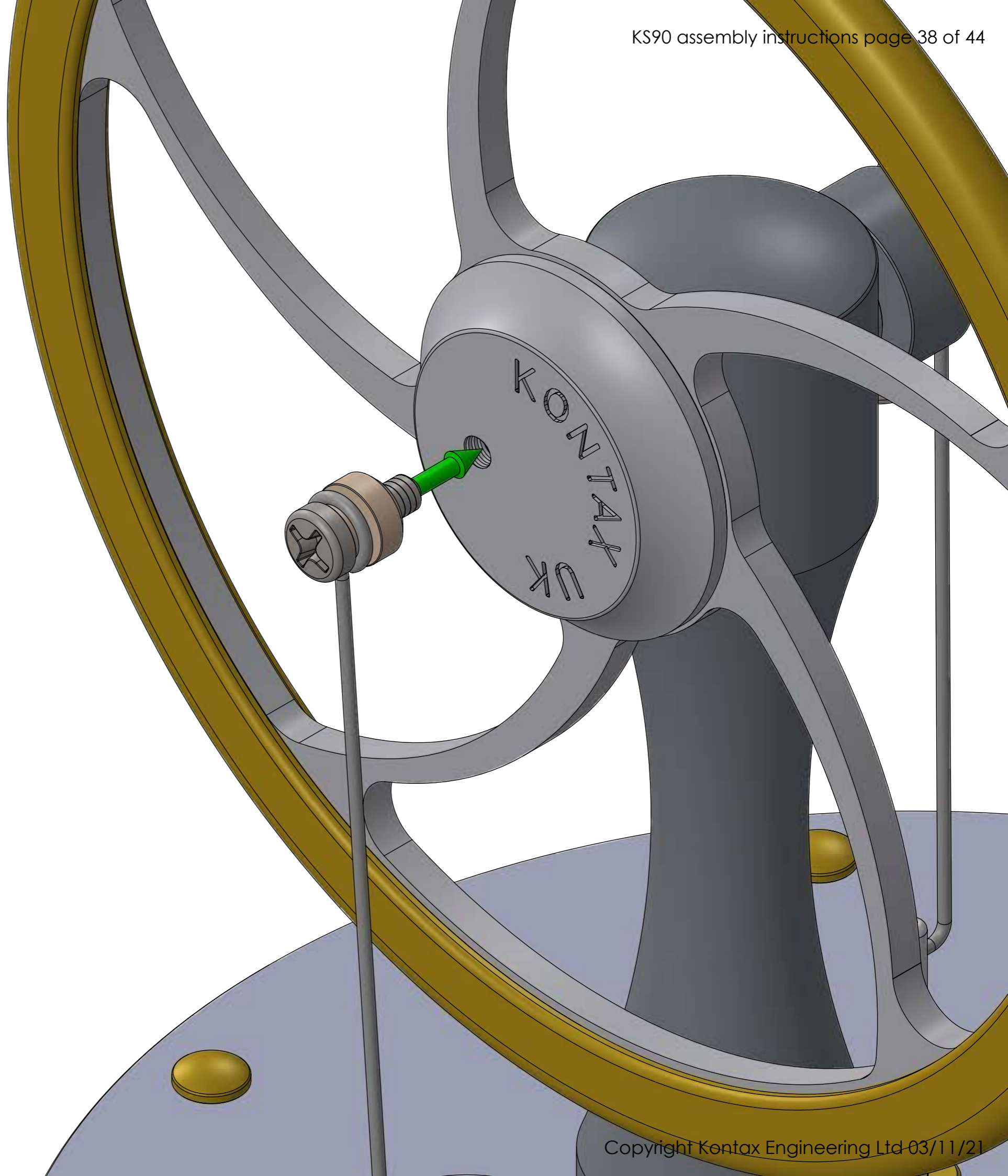


1. Fit the hook on the second conrod through the hole in the top of the piston.

2. Slide the piston and conrod into the cylinder. Some air pressure should be felt as you slide it in.



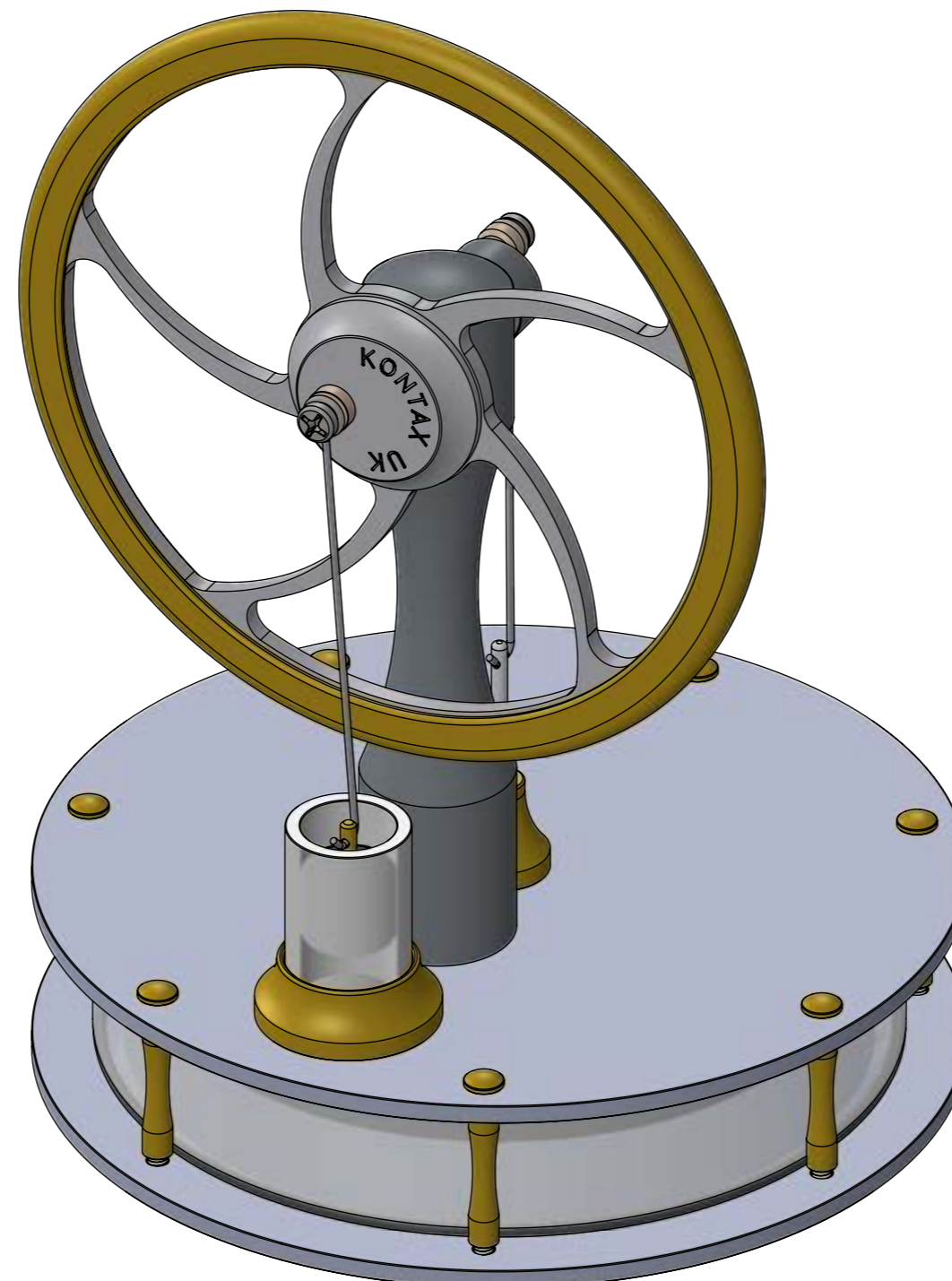
Screw the conrod screw into the hole in the front face of the hub. Tighten only sufficient to lock, over-tightening will cause the conrod bush to expand and pinch the conrod eye, which could prevent your engine from running.



Your KS90 Stirling engine is now fully assembled. Check that the flywheel rotates fully and easily, a small amount of resistance will be felt on rotation due to the air pressure inside the main chamber. Re-check that the displacer does not bump into either plate. Once you have made these final checks you are ready to operate your engine.

Operation and maintenance information can be found in the next few pages.

If you need help with your engine you can email us at: support@stirlingengine.co.uk



KS90 operation

The engine has been designed to run on hand heat, but will run equally as well from a wide variety of heat sources, including Digital TV box, adsl modem, table lamp, hot water - tea or coffee, warm sunlight. For the engine to run on hand heat you will need to have a warm hand in a cool room.

The engine is not self-starting; you will need to give the flywheel a little spin to get it going. After the engine has been on your heat source for half a minute to a minute gently spin the wheel clockwise to start it. If you are running it on a very low temperature heat source such as your hand you may need to leave it a bit longer and spin it a few times.

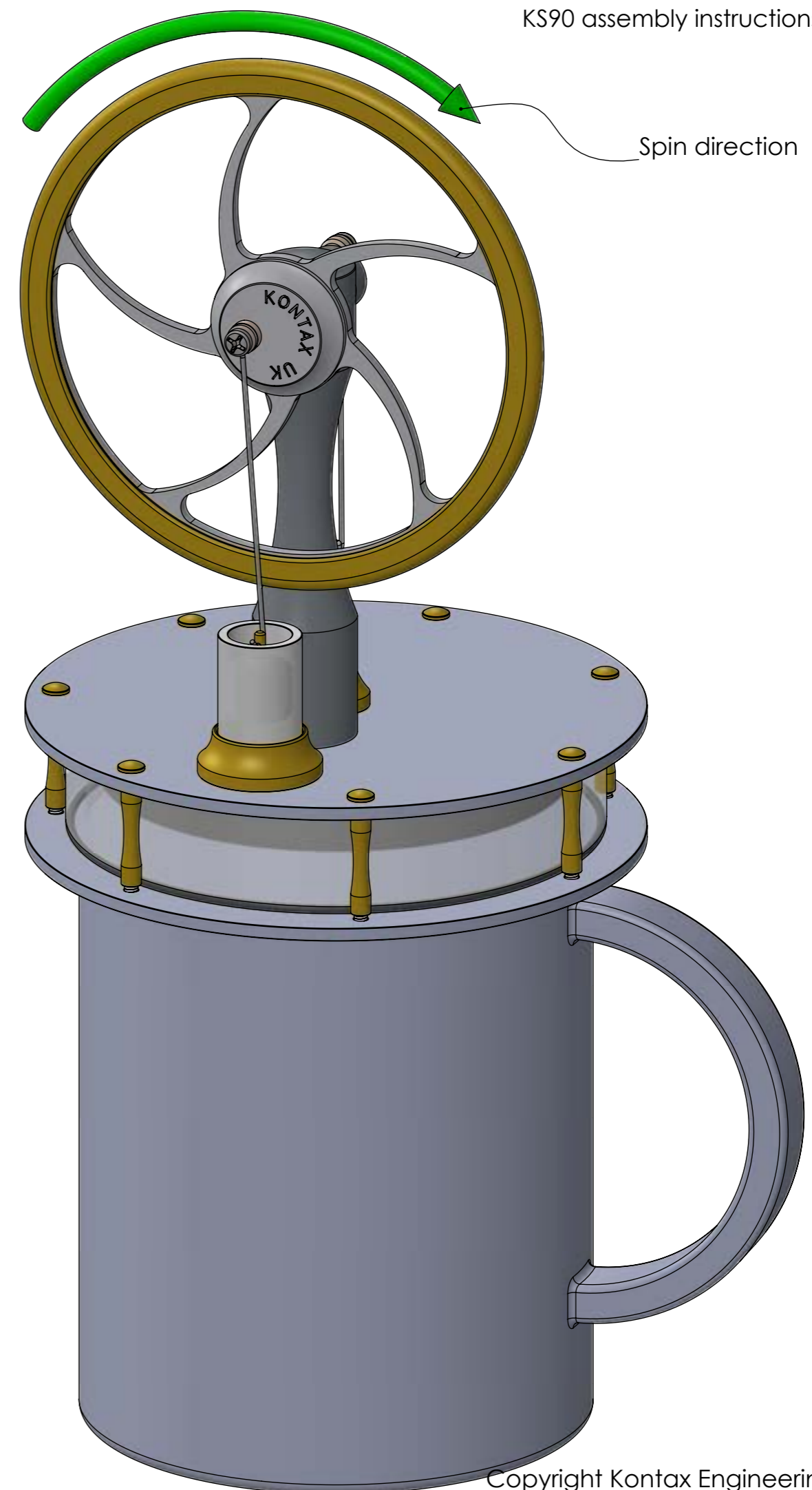
The engine will operate in reverse if you place it on a bowl of ice. This is because Stirling engines operate on a temperature difference, one plate must be warm and the other cool. It doesn't matter if the top plate is warm and the bottom cool, or if the bottom plate is warm and the top cool.

IMPORTANT:

The engine only requires a small temperature difference between the top and bottom plates to operate, anything hotter than hot water WILL damage it. DO NOT place it on any high temperature heat source (cooker, wood burning stove, candle etc.). This will melt a number of parts on the engine.

If you wish to operate your engine on hot coffee or tea you must allow the liquid to cool for a few of minutes first.

The hottest heat source that you should use for your engine should not be hotter than 70°C (158°F).

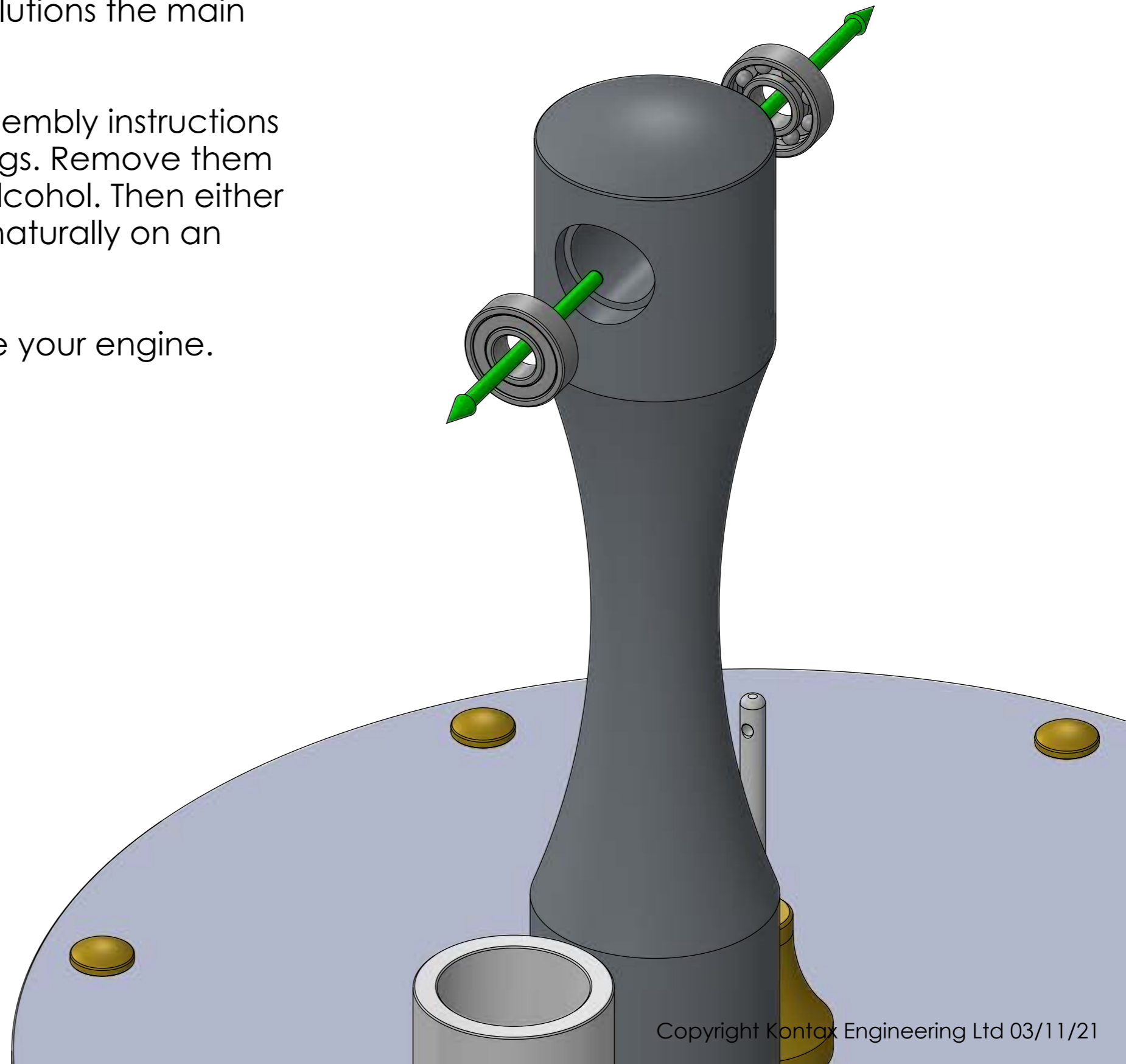


KS90 maintenance 1

If your engine stops suddenly after a few revolutions the main axle bearings might need cleaning.

Disassemble your engine (by following the assembly instructions in reverse) until you gain access to the bearings. Remove them and rinse in Methylated spirits or Denatured alcohol. Then either blow dry with compressed air or allow to dry naturally on an absorbent cloth or paper towel.

Follow the assembly instructions to reassemble your engine.



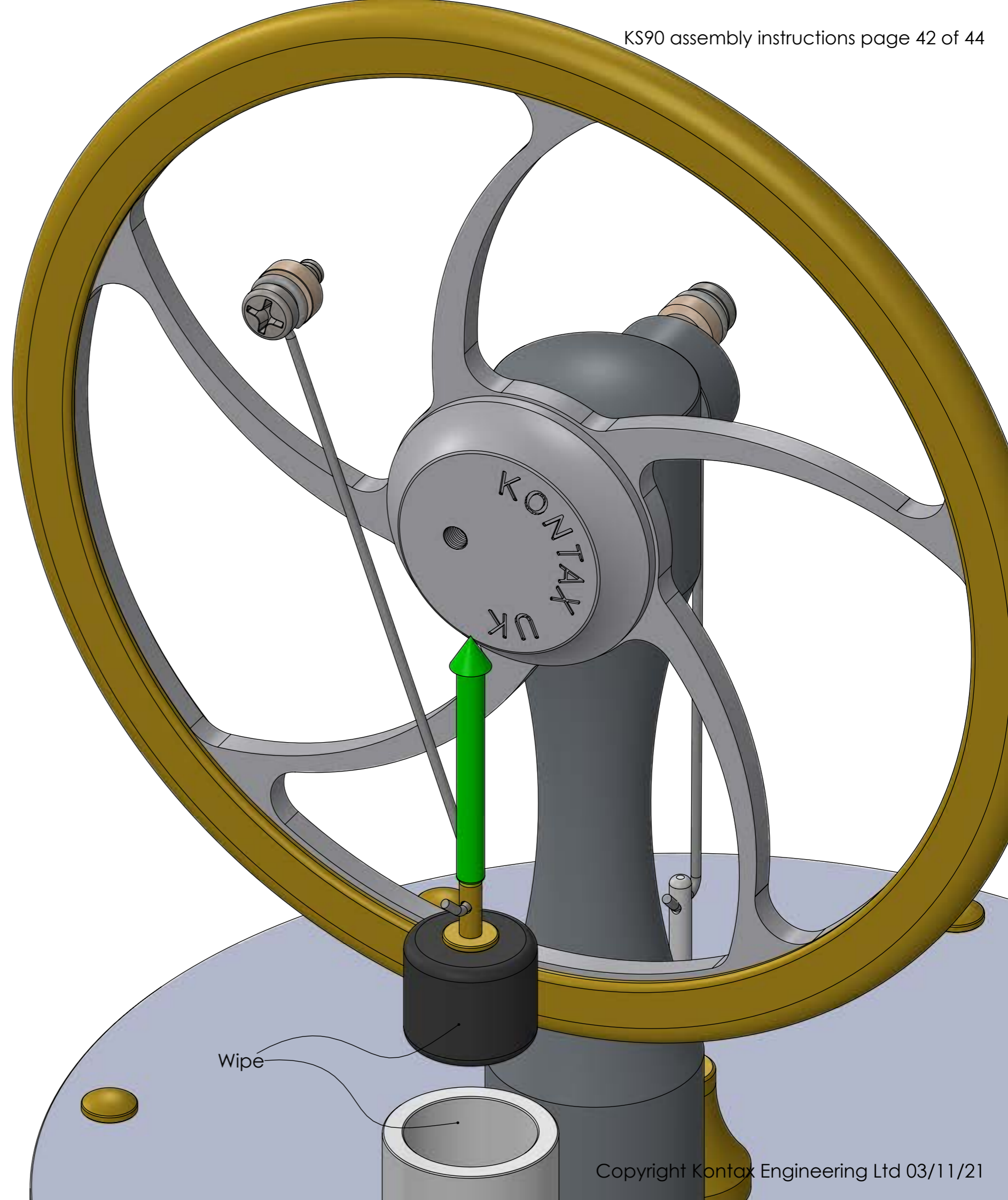
KS90 maintenance 2

If your engine is running slower than usual you might need to clean the piston and cylinder.

Unscrew the conrod screw from the hub and slide the conrod and piston out of the cylinder.

Wipe the piston with a paper towel and clean the inside of the cylinder with a rolled up paper towel or cotton bud.

Make sure there are no stray fibres on the piston or in the cylinder and re-fit by sliding the piston into the cylinder (some air pressure will be felt, this is normal) and screwing the conrod screw into the hole in the face of the hub.

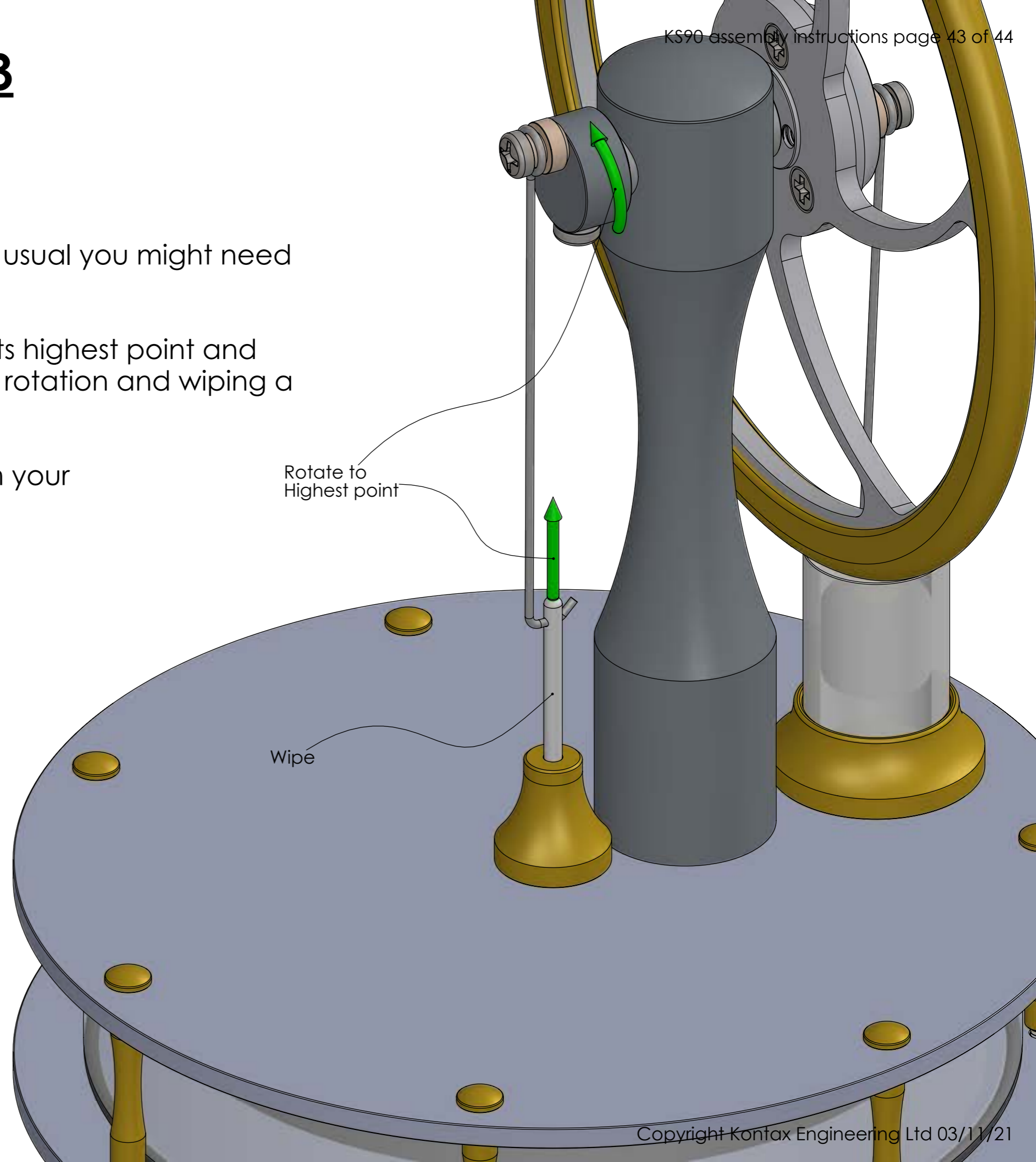


KS90 maintenance 3

If your engine is still running slower than usual you might need to clean the gland stem.

Rotate the flywheel until the stem is at its highest point and wipe the stem with a cloth. Repeat the rotation and wiping a few times.

Make sure there are no stray fibres from your cloth left on the stem.





Our workshop is located in the Thames Valley, United Kingdom and is staffed by a skilled team of 9 designers, machinists and assemblers. We have 3 CNC mills, 3 CNC lathes and 2 CNC mill-turn centres.