Guidance on Piston Ring Clamp Tooling

Introduction

Piston rings come with a vast range of different diameters, axial lengths and radial thicknesses, combined with a large range of different profiles, including plain, taper faced, symmetric barrel faced, asymmetric barrel faced, wedge, trapezoidal, internally stepped, internally chamfered etc. Further to this, the piston ring, when relaxed, is invariably of greater diameter than its corresponding liner.

The adjustable radius ring clamp is designed to allow:

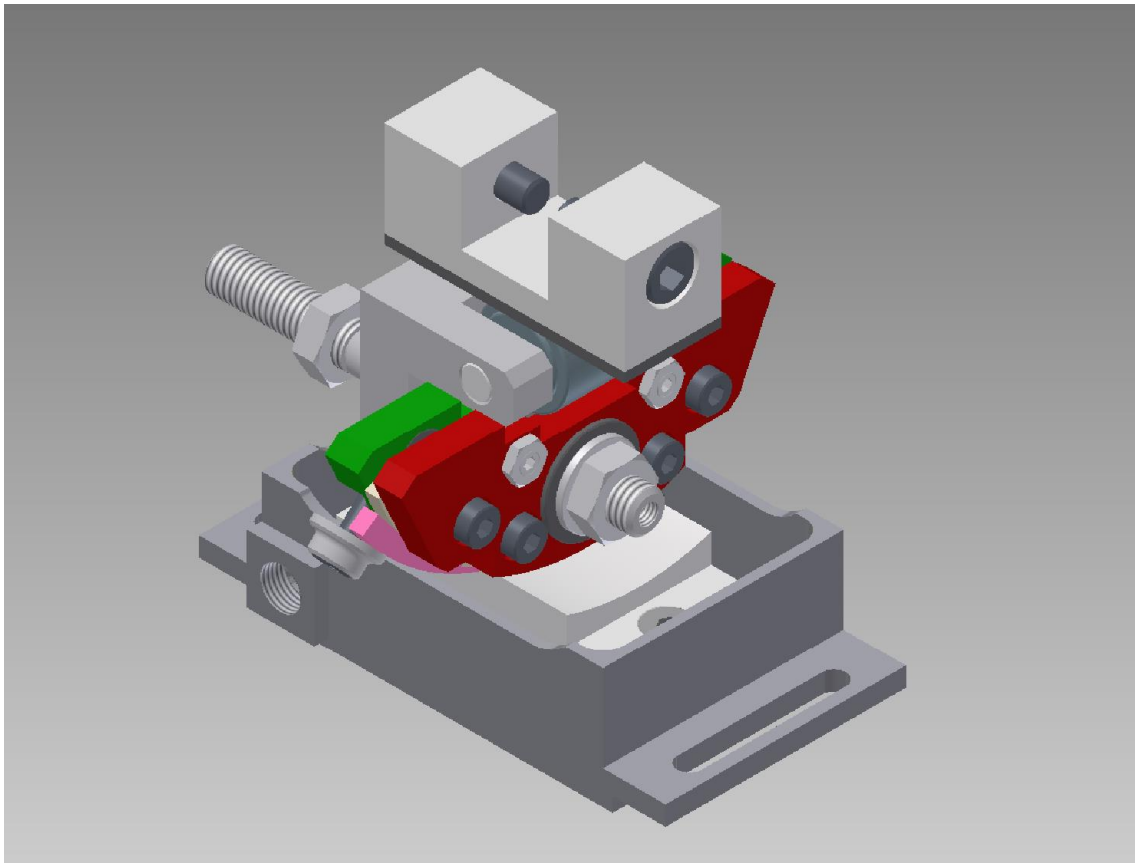
1. adjustment of the ring section radius to make it conform with the corresponding liner section
2. axial alignment of the ring section with the liner bore

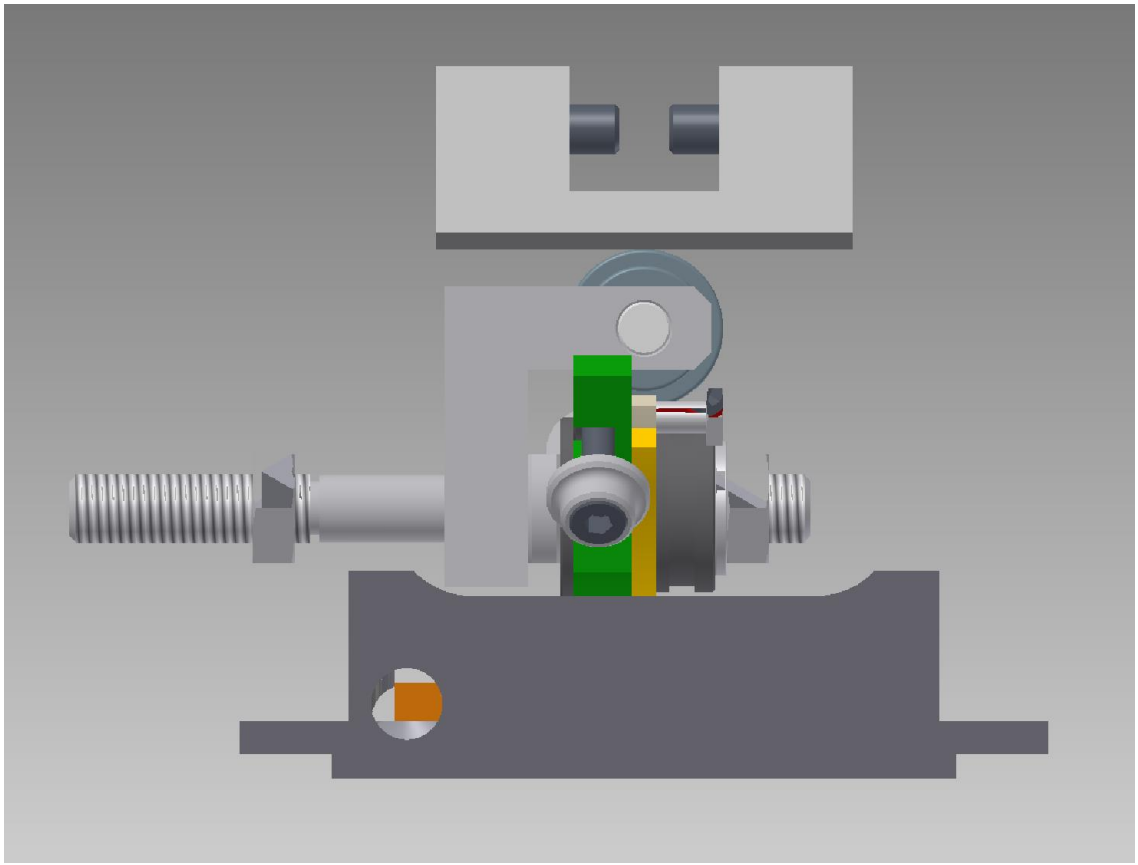
It is important to understand what else is necessary in order to achieve satisfactory alignment of ring and liner.

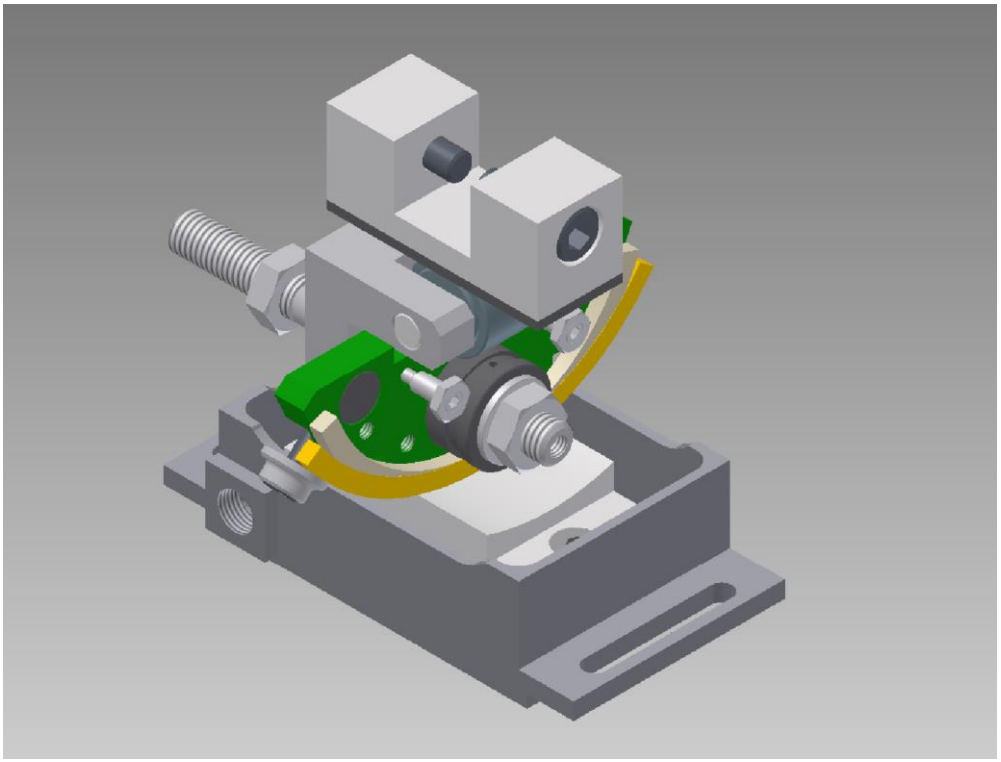
How the clamp works

The following example shows a model of a clamp designed to accommodate plain section rings of 3 mm axial length and 4 mm radial thickness. Two rings are shown with diameters 80 mm and 100 mm, this representing the practical range of diameters that can be achieved with a single clamp.

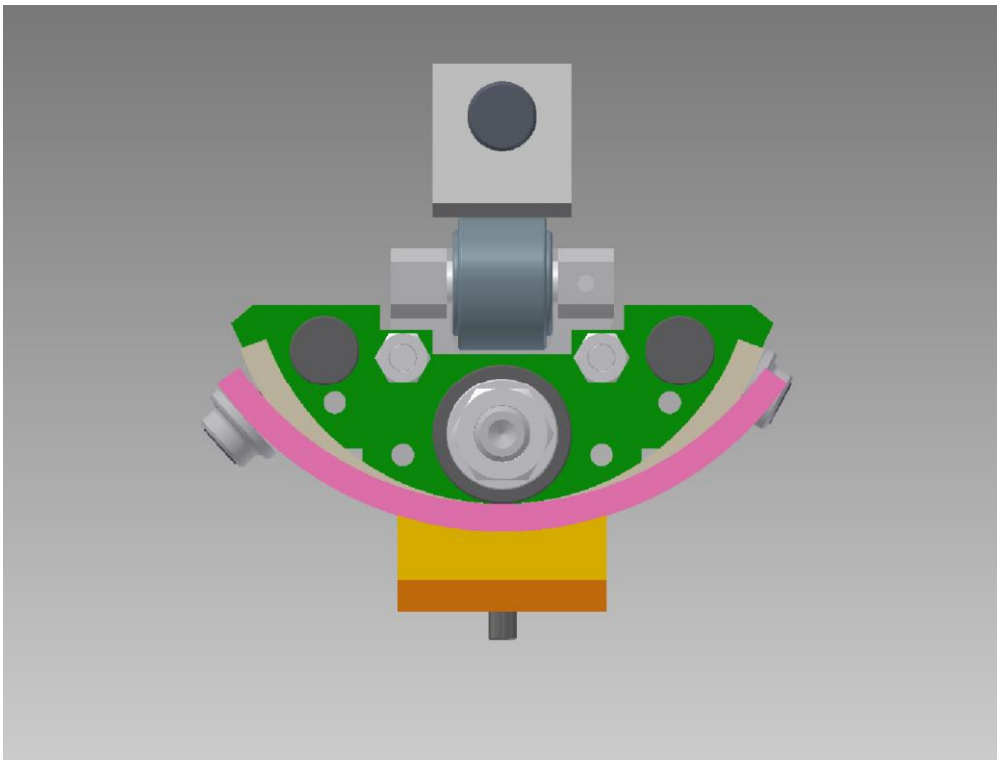
The following pictures show the ring clamp and bath assembly with progressive removal of components.



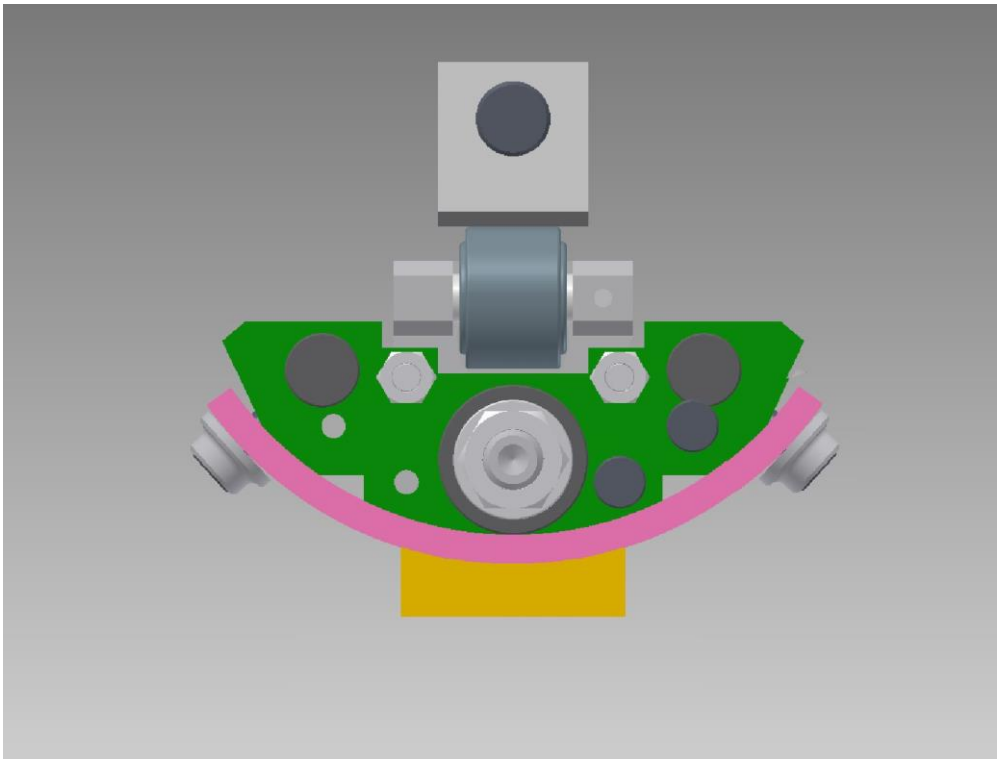




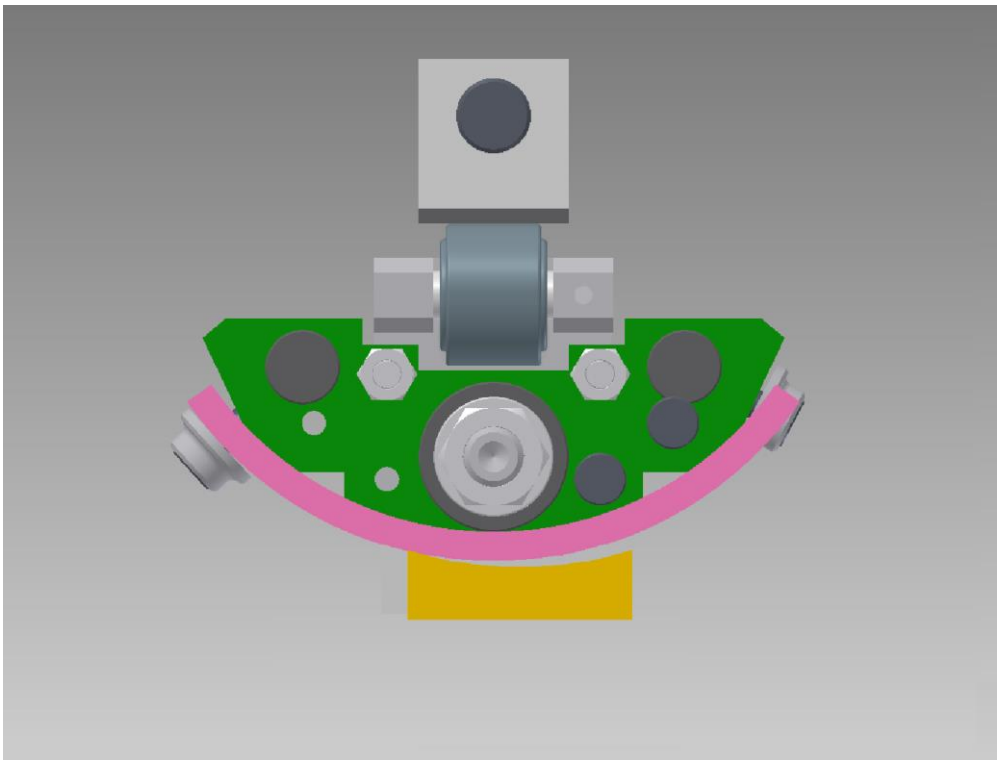
This is the view with the outer clamp plate removed.



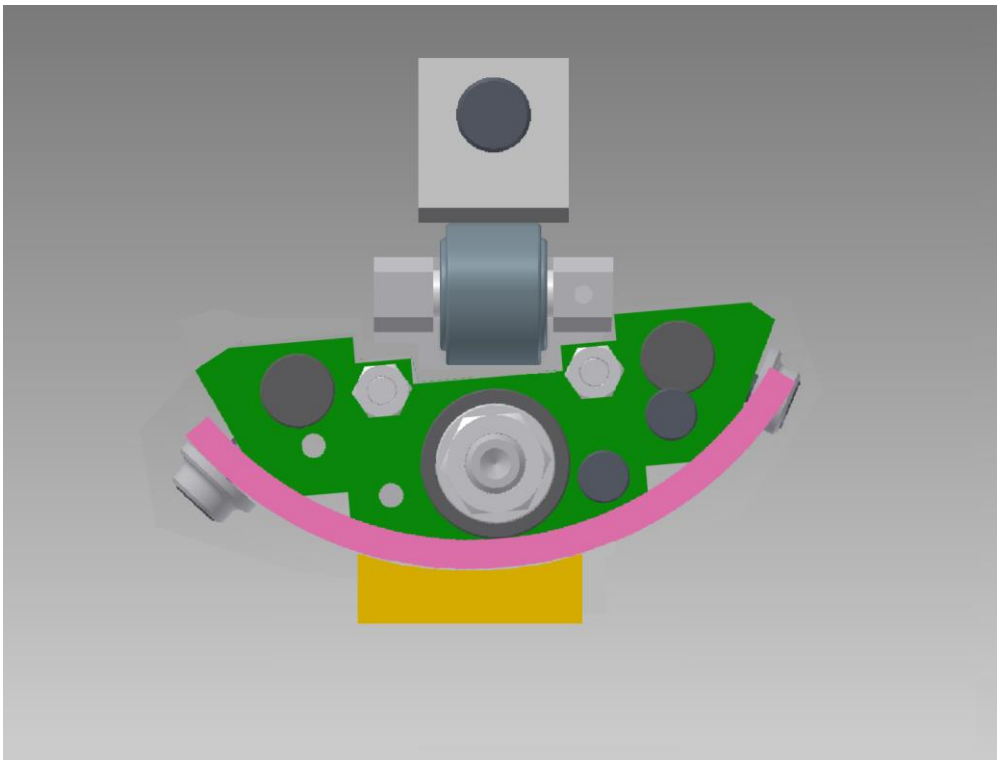
This is the view showing both the 80 mm and the 100 mm diameter ring segments.



This view shows just the 80 mm diameter ring segment in place. The middle of the ring rests against a central bush and the radius is adjusted by tensioning screws at either end of the segment, to make the ring conform with the liner segment. The outer clamping plate, shown in red on the first model, holds the tensioned ring in place.



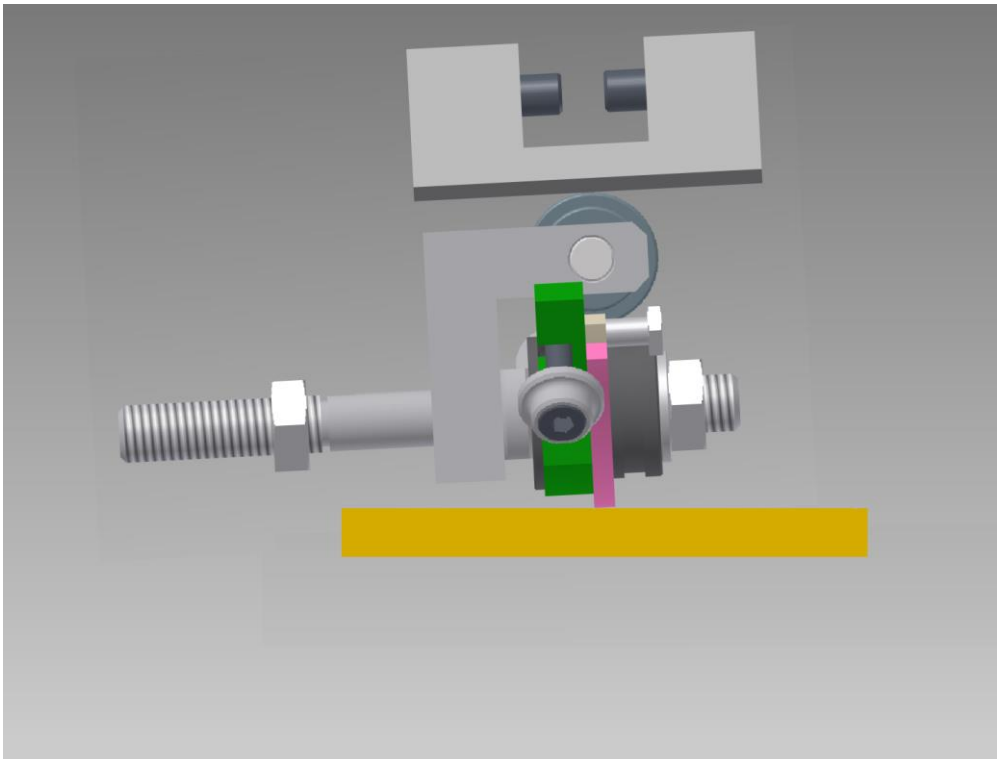
To accommodate lateral misalignment between the ring segment and the liner sample, as shown (exaggerated) above, the clamp assembly is free to rotate about the axis of the reciprocating shaft.



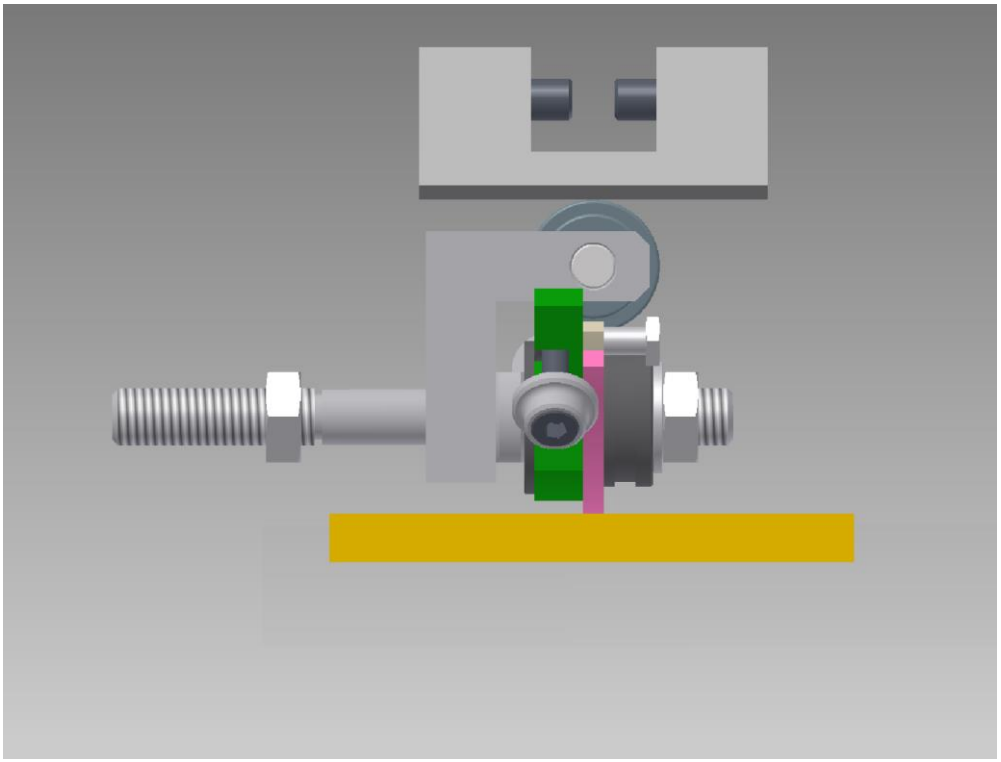
Although lateral adjustment is primarily achieved by lateral movement of the fixed specimen bath relative to the reciprocating head, this arrangement provides an important self-aligning function, thus eliminating the risk of edge running.

Why tooling and specimens must be custom designed

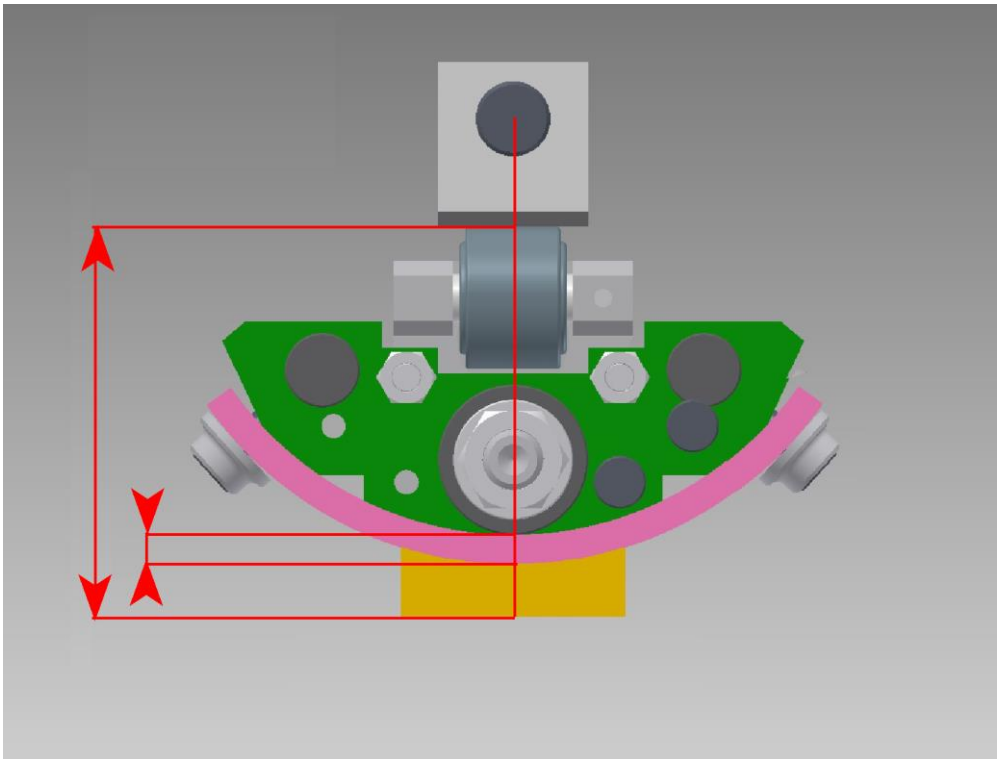
As well as getting the ring to conform and axially align with the liner, it is also necessary to ensure that the plane of the ring is orthogonal with the diameter of the liner. If this is not done, the angle of attack between ring and liner will be wrong.



With a plain liner, for example, this could give rise to a scraping action in one direction and enhanced entrainment in the other.



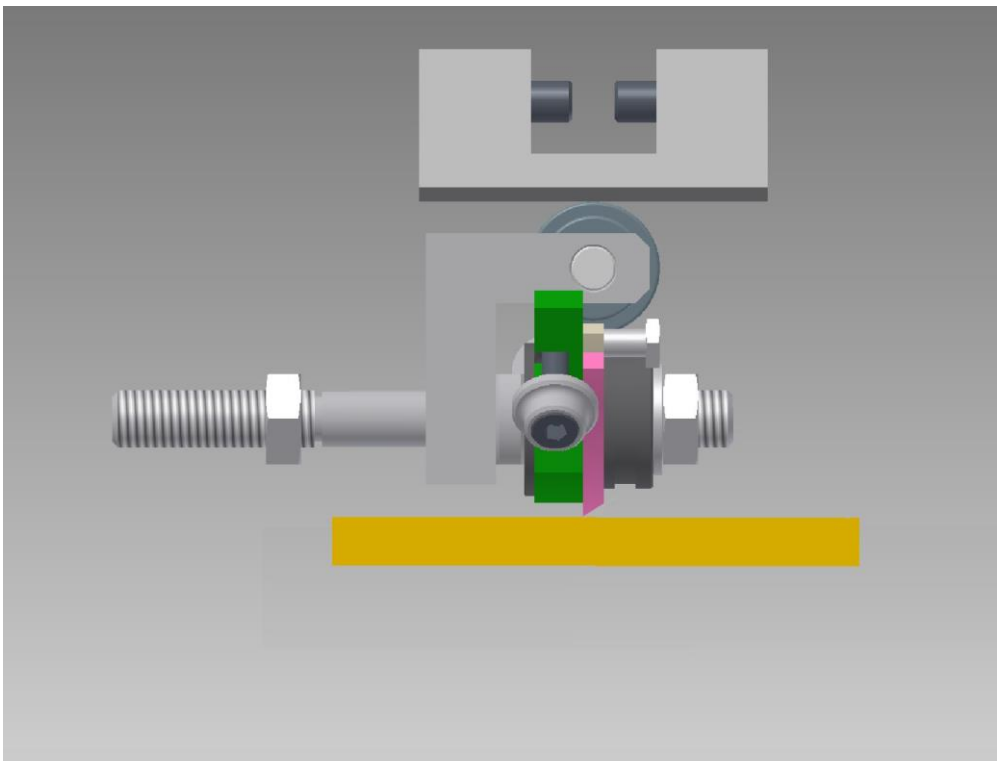
The prime method of achieving correct orthogonal adjustment is to alter the thickness of the liner sample.



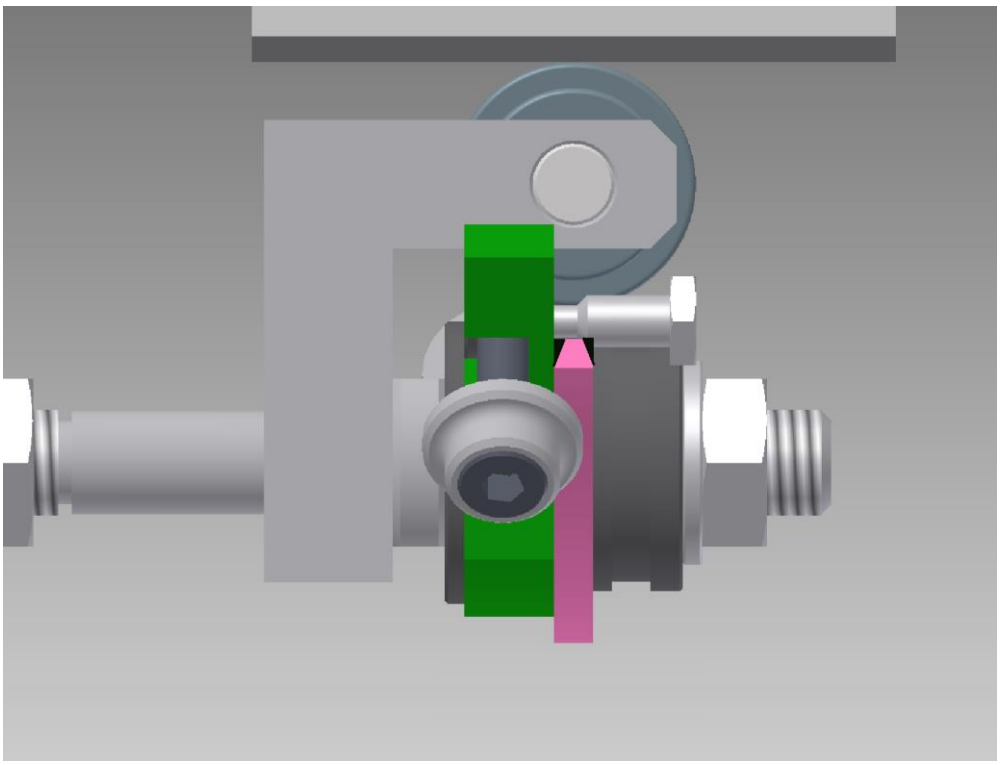
The distance between the upper surface of the specimen bath and the top of the cam roller follower is fixed, when the reciprocating arm is horizontal. For a given radial thickness of the ring segment, the thickness of the liner segment must be adjusted to ensure that the reciprocating arm is horizontal, hence the plane of the ring is orthogonal with the diameter of the liner.

If there is insufficient room to accommodate the chosen ring sample, the machine can be modified to increase the distance between the specimen bath and the roller follower running plate. This is done by raising the motor and cam drive assembly and by extending the loading yoke.

Accommodating non-plain profiles



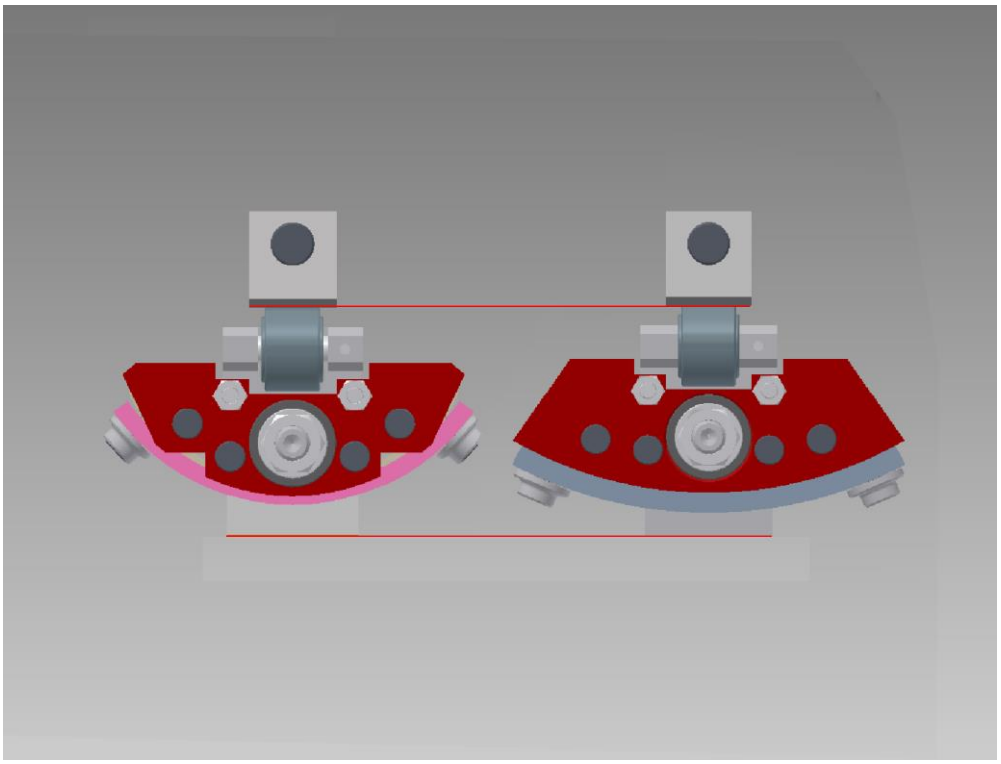
Barrel faced profiles do not present a problem. Scraper profiles require the same attention to specimen thickness as with plain profiles.



Special care and attention is required with wedge and, in particular, trapezoidal ring profiles. One solution is to grind the top and bottom surfaces of the ring to make it a plain profile, but this will clearly affect the inlet in the direction of sliding, which may be an unacceptable compromise. The other solution is further modification of the ring clamp tooling to create and appropriate equivalent of the corresponding piston ring groove.

Conclusion

It is possible to make one single, adjustable radius, ring clamp to accommodate rings of different diameters and thickness, but the ranges of variation are limited.



80/100 mm diameter clamp and 200 mm diameter clamp for comparison

Before manufacturing a ring clamp, a detailed design will be required, in particular to determine the thickness of the corresponding liner sample and the detailed components of the ring clamp. In all cases, it is necessary to provide full details of the ring or rings to be accommodated, including diameter and section, plus the dimensions of the corresponding liner or liners, before design or manufacture can proceed.