INTERNSHIP

UNIVERSAL SOLUTION FOR FUNCTIONAL TEST OF THE VALVE UNDER PRESSURE (K-010 TEST 10)

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Report

Introduction

This report is a part of the internship carried out at Wouter Witzel, department of Werkvoorbereiding (Work preparation). This internship is conducted under the supervision of Bas Dierselhuis, Tooling and Work Preparation Manager, Wouter Witzel. A special thanks to Bob Schulten, Edwin, Jan, and others.

The internship is a part of the Master's course, Mechanical Engineering (Design Engineering specialization) University of Twente, the internship was carried out from the 26th 2019 of August through 13th of December 2019 and constitutes to 15EC. The aim of this internship is to gain insight into the application of the knowledge gained during the courses of the first four quartiles of the Master's Mechanical Engineering course with Design Engineering Specialization, the courses namely, TRIZ, Design, Production and Materials and modelling of technical design process etc.

Furthermore, my the objective I intend to achieve after the completion of this internship is to gain confidence that I can process the information at hand which is scattered and compile it. I also want to make sure that I am able to solve real life system(mechanical) problems.

Note: This assignment looks to explore the possible solutions for the problem and looks into the conceptual phase of the Design and some details. However, the detailed design will be carried out by Wouter Witzel.

Problem Definition

To understand the problem that the assignment is based on, it is necessary to understand the various aspects of the valves, actuators, Press(test machine) and the type of the test that is to be conducted.

The main types of valves that are produced and tested are EV, Dynaxe and Econaxe. Each type of the valves has different internal(nominal) diameters, flange type, flangeless and different face to face width, neck length etc., (these parameters will be explained in the coming sections) this product diversity is a huge problem as the test machine(press) has to adapt to these different variations. Till day this problem was addressed using different machines with different base sizes so that a machine is not too big or too small for any valve to perform the test. In addition to this various rings and conical fixtures are being used. The machine base is hinged to accommodate for proper alignment and proper clamping of the machine bridge, base, valve and rings.

There is also a crane which helps to raise and lower the valve and/or the actuator onto the machine base.

Here, there is an attempt to explain the different parameters of the valve. To explain this a dynaxe valve is chosen.

Figure 1

As shown in the figure above and in the figure(a) , one can find that by varying these parameters it would be difficult to perform the various tests that are needed to verify the valve according to the prescribed standards.

Actuators.

The most popular valve actuators that are used in these valves are hydraulic, pneumatic, electric and manual actuators. The electric and manual actuators are easier to operate as the disc opening(angle to opening) can be controlled. Whereas, when the hydraulic and the pneumatic actuators are mounted the valves have only two positions, completely open or completely closed.

There are 26 different tests that are performed on the valves. The most infamous test of all is the K-010 test 10. This test involves complete opening of the valve disc. The issue is when this test is performed on the flangeless, wafer type and center flanged valves as these valves have smaller face to face width than the disc diameter, which means that when the valve is opened during the test there is a chance that the disc protrudes out of the valve face and as the valve sits on the test machine face, the disc might hit the test machine when the valve is in the open position.

To tackle this problem, the solution that is currently implemented is by having cylindrical spacers(rings) placed between the valve and the machine base to avoid the collision. And as mentioned in the previous sections, the different sizes of the valves and different dimensions of each type of valve hence requires different rings with different inner diameters. And to address this a series of rings are stacked which can be interchanged to accommodate for different sizes of the valve.

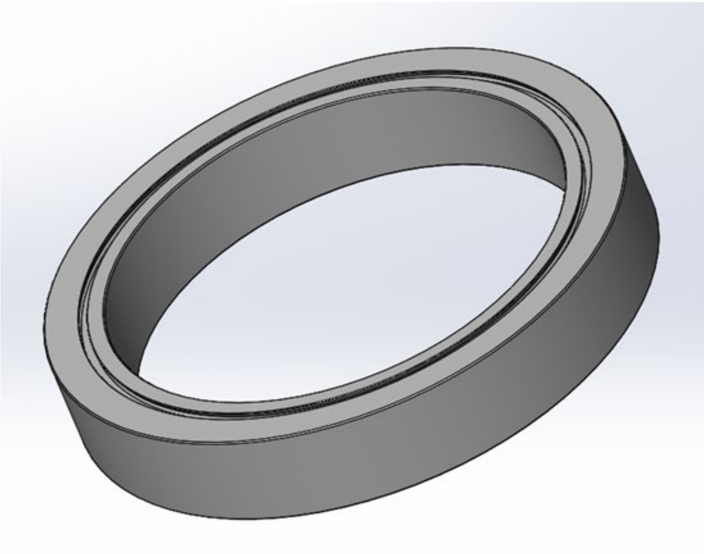


Figure 2

Due to the implementation of the above mentioned solutions, a series of different issues arise.

The issues are:

1. Unwanted movement of the rings(spacers) and valve.
2. The actuator is eccentrically mounted which leads to the tipping of the whole assembly.
3. To raise the actuator simultaneously with the valve to accommodate the raising the of the machine base while clamp the system.
4. Number of rings and the combinations involved.

Solution Requirements

Since the problems that are been identified are in some cases independent, for example, the unwanted movements of the rings and the valve and the raising the actuator, and in some cases, the issues are dependent, for example, number of rings involved and the unwanted movements. So solving one issue may lead to solving another, and in some cases, solving multiple small problems would result in solving of one particular issue.

There are a few things that are to be taken into account before a typical solution is proposed for the problem at hand. The requirements are:

1. The other tests can be performed on the setup without any hindrance.
2. All the sizes should be accommodated, the size difference is not just in height but also in the length and width and the type of the valves.
3. The actuators that are mounted on the valves are also to be supported.
4. To raise and lower the actuator along with the base of the actuator.
5. The new solution should not interfere with other systems that are in the vicinity of the testing system(other test equipment), the crane system.
6. The new solution should be operated by a single operator.
7. The solution should align the whole system and also clamp it.

Since the requirements that are mentioned in the above list are so independent and yet dependent, there is a need for a set of solutions that can be independent and dependent according to the requirements.

TRIZ

The approach that is used to reach a set of solution is TRIZ. TRIZ (Teoria Reshenia Izobretatelskih Zadatch) is Russian “THE THEORY OF SOLVING INVENTIVE PROBLEMS”. This approach was used as it implements the fact that creative problem solving patterns are universal across different domains. It also provides a systematic way for reusing previous experience and patterns of previous solutions.

The following techniques of TRIZ are used for solving the problem at hand.

1. Analysis RCA+(root cause analysis +)
    a. Comparative ranking of identified problems.
    b. RCA+(root cause analysis +) diagram
    c. Ranking contradiction causes discovered in the problem.
    d. Ideality criteria.
2. Generation(solution)
    a. Identifying the positive and negative effects of a problem cause
    b. Referring to the Altschuller matrix
    c. Selecting inventive principles.
    d. Applying inventive principles to generate ideas for solution.
3. Selection
    a. Building a solution portfolio.
    b. ABC filtering
    c. Multi Criteria Decision Matrix (problem specific criteria)
    d. Ideas landscaping
    e. Selection with problem independent criteria.

Altschuller matrix.

Altschuller’s Matrix provides generic recommendations on how to resolve a specific contradiction and generate ideas. It is a matrix which has rows and columns of generalized technical parameters. The vertical column has the technical parameters that are associated with positive effect of the contradiction(issue faced). The horizontal row is associated with the negative effect of the contradiction. When the negative and a positive technical parameters are identified for the issue, then, the intersection of the row and the column will give a cell in the matrix that has a selected array of inventive principles from the 40 inventive principles.[1]

40 Inventive Principles.

These are defined solution strategies for most typical conflicts and contradictions which create inventive problem.[2]

Ideas Landscaping

It is a visual diagram which relates Ideas Performance Indicator(Idea score) with estimated time for implementing the ideas on ground. The horizontal axis of the graph which is the longest time to market and the vertical which is the ideas highest score.

Elaboration of problem statements.

1. Unwanted movement of the rings(spacers) and valve.
   As discussed in the previous sections the number of variations in the valve there is a need for stacking of rings and the rings are different. This stacking of the rings causes issues like loss of seal between the rings and pressure leakage. It also lead to displacement of rings while pressurizing as the base moves. One more important issue is that the base is hinged and hence it also leads to displacement between the rings. This issue leads to the misalignment of the rings, valve and rings and the rings and base.
2. The actuator is eccentrically mounted which leads to the tipping of the whole assembly.
   The hinged table is also leads to the issue of the tipping of the valve and actuator as the actuator is eccentrically mounted on the valve and this leads to the eccentricity of the center of mass which will naturally tip the system(valve and actuator) and addition to this the base is hinged which adds to the tipping effect and also lead to misalignment of the system.
3. To raise the actuator simultaneously with the valve to accommodate the raising the of the machine base while clamp the system.
   The machine base is hinged and this leads to the issue while raising the machine base on which the valve and the actuator which is attached to the valve. To clamp the whole system the base has to move up and clamp against the top bridge of the base. This is fine when the actuator is not that heavy and the base is raised, but the actual actuator issue is when the weight of the actuator is heavy enough to tip the base.
4. Disc hits the machine hence the requirement of a number of rings and the combinations involved.
   As the diameter of the disc is not a fixed and the tests conducted do not always involve a stagnant state of the disc, like the K-010 Test 10, in this test the disc is open under a pressurized condition, this leads to need for the elevation of the valve from the base of the test machine to avoid the collision between the disc and the machine base.

The problems that are pertaining to the conflicting parameters are tackled using RCA+ as it deals with identifying the issues that give raise to contradiction where it(an effect) leads to both a positive and negative effects.

Problem 1

Definition

"Disc hits the machine hence the requirement of a number of rings and the combinations involved".

RCA+

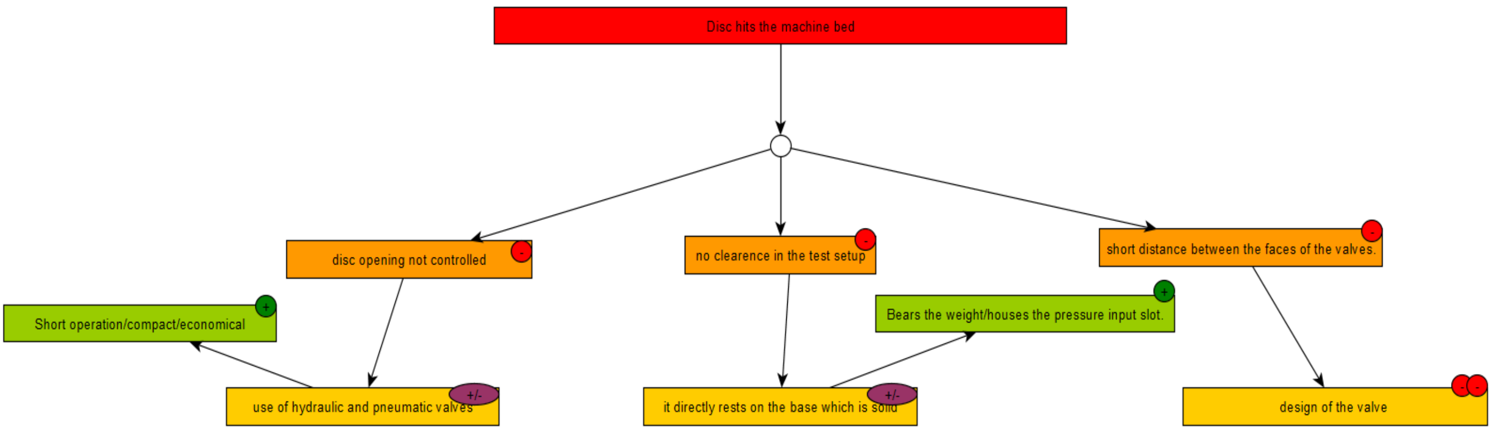


Figure 3

Contradiction selection

Since we have a case where we have dependent contradictions.

The three causes that identified here are

a) Disc not controlled
b) No clearance in the setup.
c) Short distance between the faces of the valve.

Eliminating any one of these two causes will result in solving the whole problem.
Therefore, the selected cause for solving is "No clearance between the setup and the valve".

Altschuller matrix and ideas generation.

Inventive principles obtained: 10 15 14 7 9 14 17 15 30 6 25

10→ Prior action: Add a mechanism or shell of some sort that can be mounted and dismounted before and after the test which will increase the height not only for the disc but also for the actuator. Isolate the valve in some sort so that these shells can be just put on and off the valve during the test.
14→ Spheroidality: have a concave base in which there will be adaptable rings/plates to change according to the size of the valve.
15→ Dynamization: Make the bed dynamic so that it is adaptable.
7→ Nesting :telescopic rings that can adapt to the required size.
17→ Another Dimension: instead of having multiple rings stacked have a single ring with adaptable plates with eccentric slots.
30→ Thin films and flexible shell: thin shell made of some sort of rubber which is like a dome and the size of the valves can be adjusted by using by some sort of mountable discs
6→ Universality: something like a camera aperture(iris diaphragm) adjusting device.
The primary analysis of this mechanism shows that the displacement induced in the mechanism is around 5 mm at the tip of the iris of the mechanism.
The next step is to have a design for these iris so that they have a better value of the displacement.
25→ Self Service: the base acts a rings and multiple plates that can be added to this ring to adapt to the different valve sizes.

MCDM: Multi-Criteria Decision Matrix.

	Weighting factor	**1. Prior Action**	**2. Spheroidality**	**3. Dynamization**	**4. Nesting**	**5. Another Dimension**	**6. Thin and flexible shell**	**7. Universality**	**8. Self Service**
No interference with other tests	10	5	10	5	10	8	5	8	10
Accommodate all the sizes	7	3.5	5	5	5	3.5	3.5	5	7
No interference with other systems.	7	3.5	5	3.5	5	5	3.5	7	2
Operated by a single operator	10	5	10	10	10	10	5	10	10
Align the system	5	5	0	2.5	2.5	2.5	2.5	2	2
Investment index	10	5	5	1		8	5	5	1
Total		27	35	27	32.5	37	24.5	37	32

Time for implementation	Months	3	4	6	4	2.5	2	2	4

Table 1

Solution/Ideas Landscaping

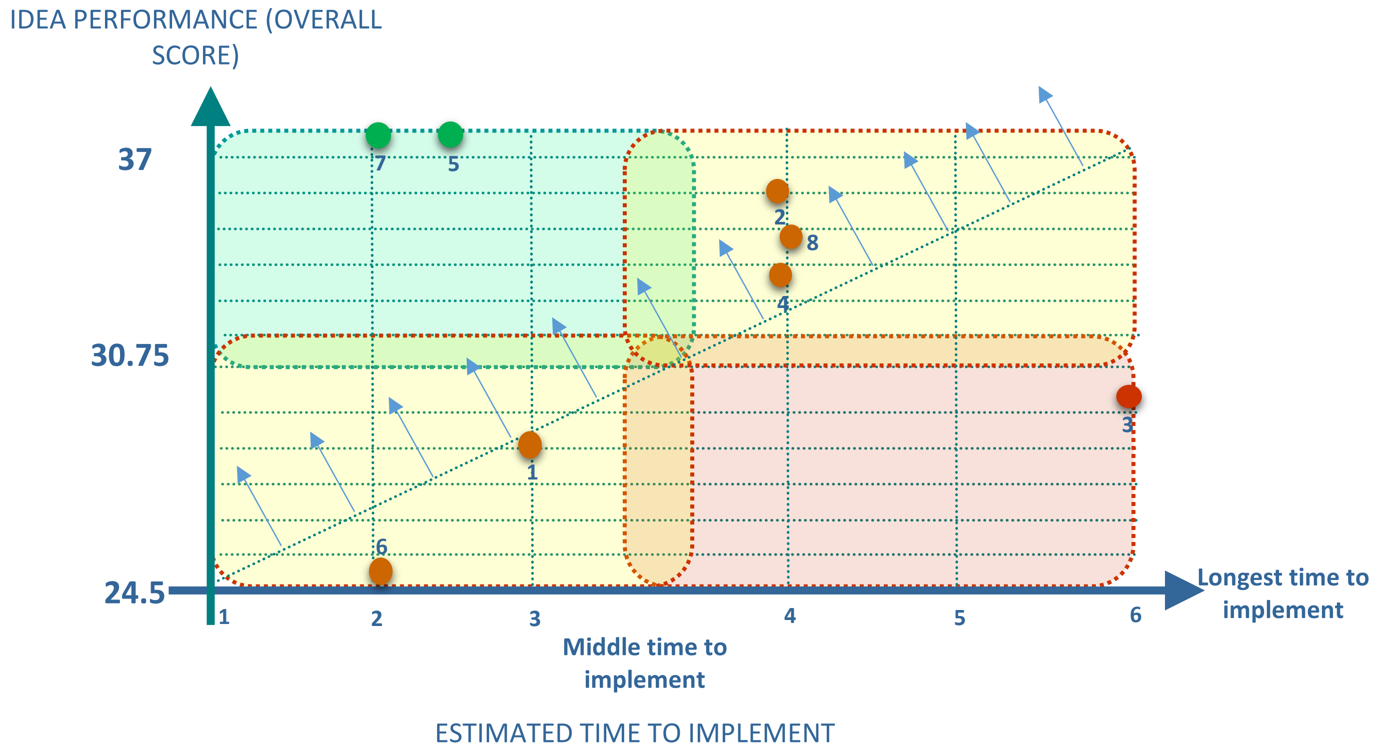


Figure 4

Solution Explanation

Universality

Iris Diaphragm

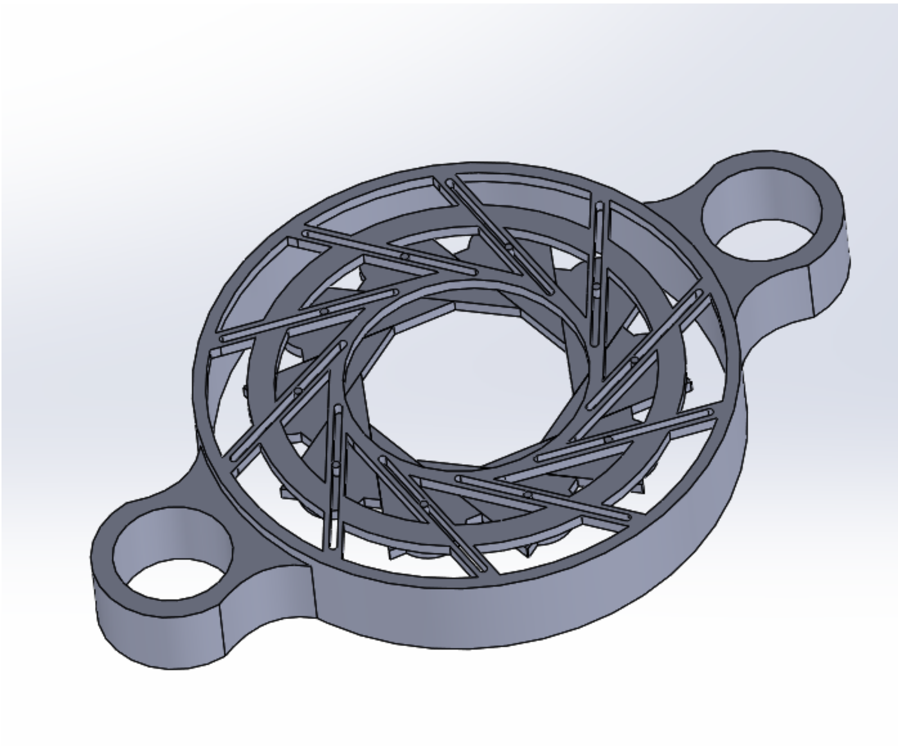


Figure 5

Solution Explanation

Iris diaphragm mechanism is a complex mechanism which accommodates to the changing sizes of the valves. The mechanism consists of an aperture frame and iris blades. The blades move in a tangential direction to the aperture inner diameter. The blade interface is sealed to prevent leakage. These mechanisms are to be integrated in the base of the machine and also at the machines bridge. In this way, the various sizes can be tested in this mechanism. However, there are many issues that arise in the process of implementation of this solution. The main problems being the difficultly of sealing the mechanism and also the issue of the valve flange and the actuator attached on the valve hitting the mechanism at the lower DN's because the slot in the mechanism is at the centre of the mechanism and when the valve is placed on the mechanism the flange neck is not long enough to avoid the mechanism.

Nesting

Telescopic ring

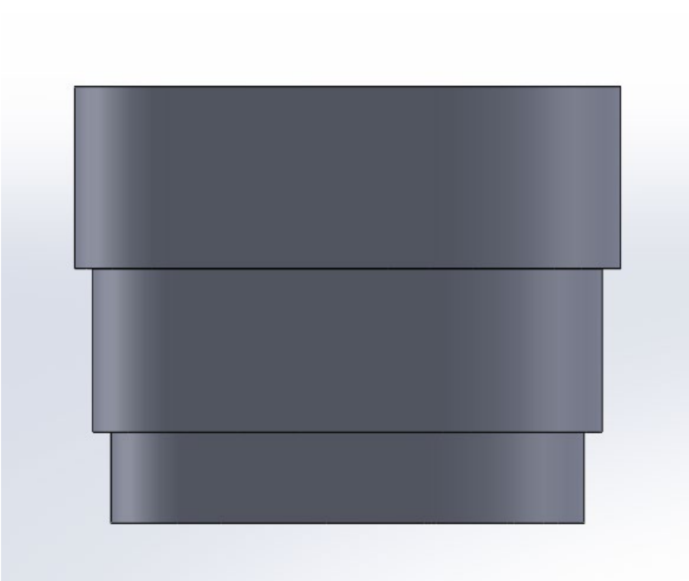


Figure 6

This is one among the promising solution ideas. It basically consists of concentric rings that are mounted in the concentric manner and the rings can expand and collapse as shown in the figures above. The smaller ring is on the bottom and is attached to the base and the as me move up the diameters of the ring keeps increasing. If the smaller rings are to be tested then all the bigger rings other than the one is required for the test collapse. And if the bigger rings are to be tested then the rings will expand. The issue with this solution is that the smaller valves will have their flanges hit the rings.

Another Dimension.

Single ring and multiple plates with slots.

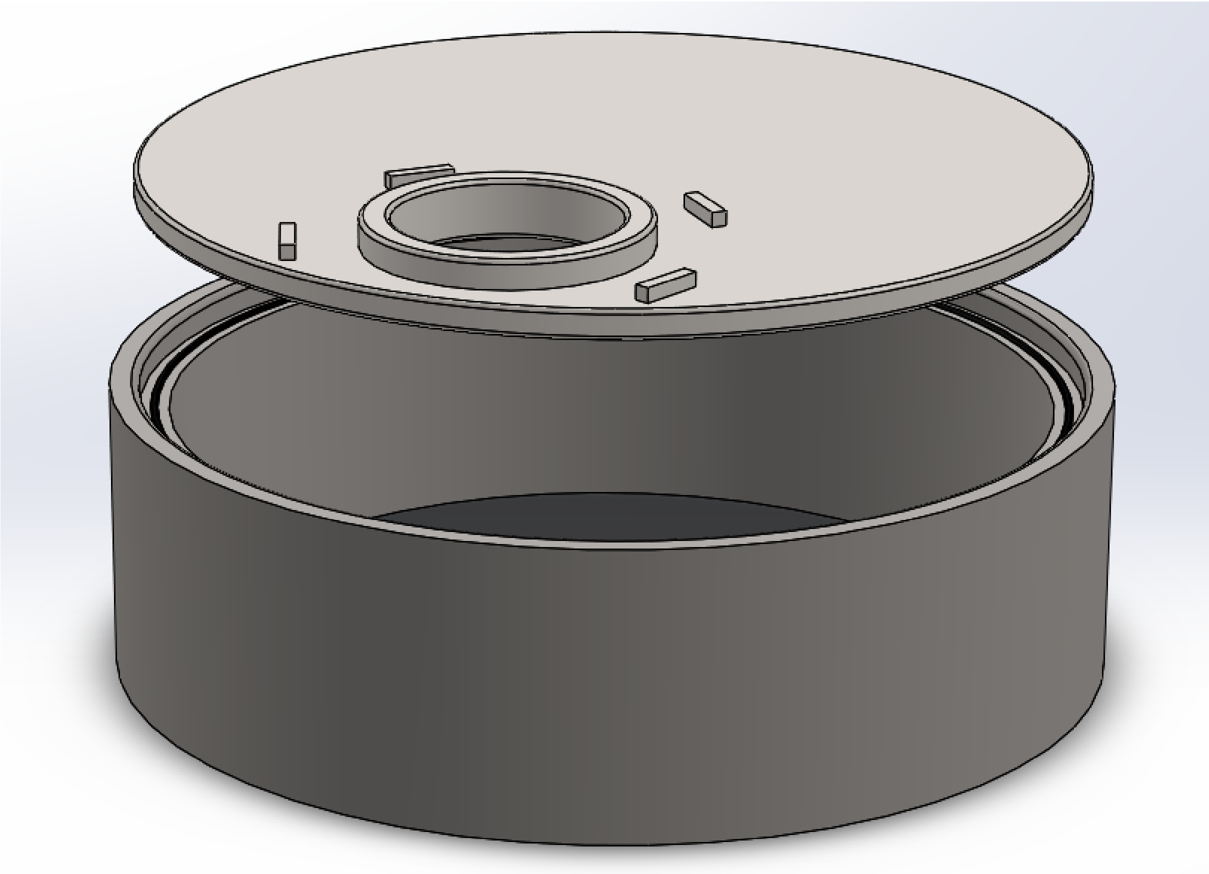


Figure.7 Base ring and Cover plate

The above figures are a representation of what the solution module looks like. The first figure is the main ring which is compensates for the multiple rings. This ring is to be fixed to the base and the plate placed on top of it. As the number of rings that are currently in use are rings with different diameter and will also different face to face width. The plate has slots which are eccentric which will help accommodate the size difference and the problem of having the flange and actuator that is attached to the valve hitting the plate and the ring. The eccentric slots make sure that the flange is protrude out of the ring/plate and prevent the collision mentioned above.

The ring has to be temporarily attached to the test press base and should be leak proof. The plate sits in the ring which has a concentric wedge of sort hence not requiring any sort of clamping. The plate and ring interface is sealed with rubber lining/ring(O-rings).

And the same plate will be used for the top bridge and the plate will be supported by three columns which are at 120° apart. This is shown in figure below

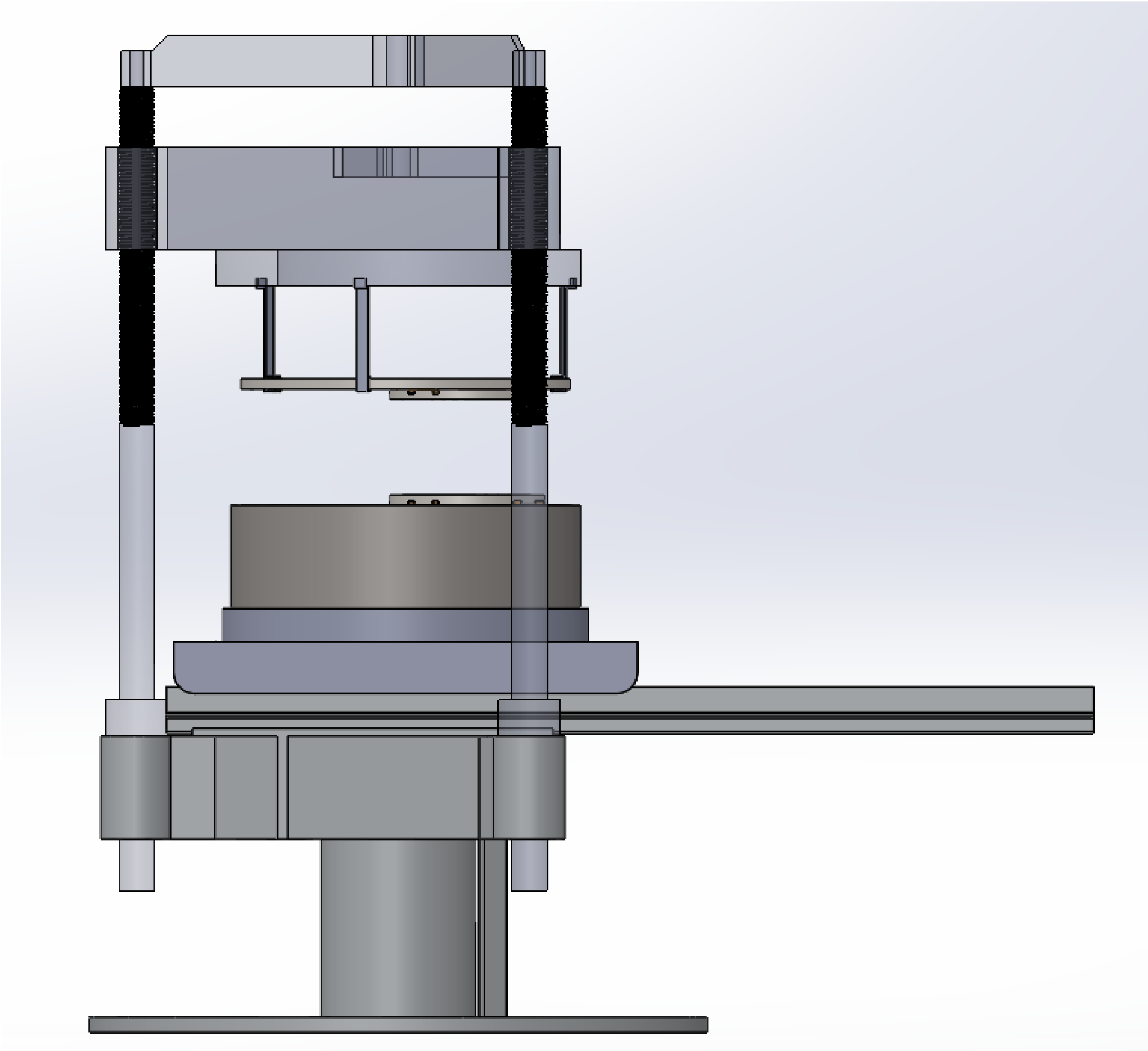


Figure 8 top plate for the assembly

Self Service/ Spheroidality

This solution involves replacing the current base of the test machine and replace it with a concave base which can accommodate all the different sizes of the valves that are present. The concave base has plates which are modular which will help to adapt to different sizes of the valves. This solution is similar to that of the single ring and multiple plates but the difference is that the ring is absent and the base serves as the ring

The found solutions are further filtered using the TRIZ-based essential criteria.

TRIZ based five essential criteria for problem solving.

I. The problem is solved in full
II. Contradiction is resolved in a win-win way
III. No harmful side effects
IV. High degree of Ideality

V. Solution provides extra benefits

Based on these criteria the above found solutions are filtered.

	Weight	Iris diaphragm	Single ring multiple plate	Telescopic rings	Concave base
Problem solved	5	4	5	4	4
Win-Win	4	4	3	3	3
No harmful Effect	3	2	3	2	2
Ideality	2	1	1	1	1
Extra Benefits	1	1	1	1	1
TOTAL:		12	13	11	11

Table 2

Based on the above analysis the solution selected is to have a single ring with multiple adaptor plates.

Problem 2

Definition

*"Unwanted movement of the rings and the valv*e which is a result of the presence of the rings".

Innovation Situation Questionnaire

QUESTION	ANSWER
Describe the existing innovative situation in free words:	We need to develop a system to help test align valve. The issue is with the alignment and also to hold them together
Describe a system (product) which has to be improved (limit it to those parts which can be changed by you):	Test rings/system to hold valves.
Describe a key problem extracted:	Alignment issues and clamping.
Describe a goal of improvement:	To have a system attached to the ring to help align and clamp at the same time.
Present a list principal demands and requirements to the future solution (5-10 requirements). Try to be as specific as possible:	1. Should not interfere with the testing. 2. Should be holding the rings and the valve. 3. Should be able to accommodate various types and sizes of the valves. 4. Should not hinder the movement of the operator. 5.
Are there any known solutions to solve the problem/challenge presented? If yes, mention them and specify why each of them cannot be used in your situation:	Three point contact: can only have one system clamped i.e. the ring can only clamp a ring or a valve.

RCA+

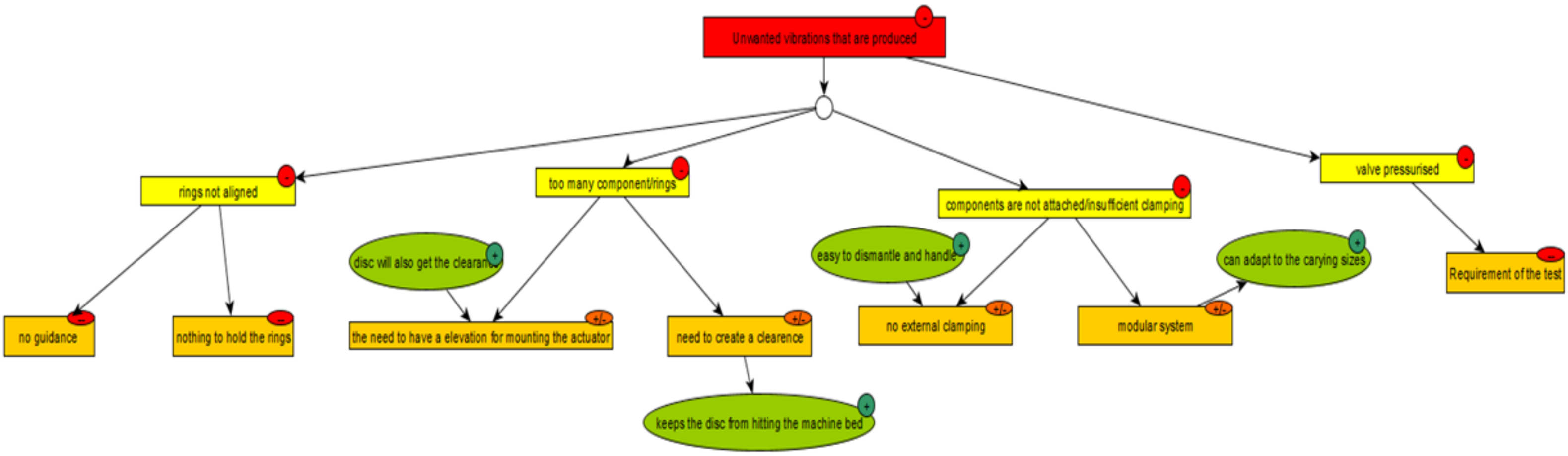


Figure 9

Contradiction selection

1. The need for an elevation for mounting the actuator
2. No external clamping
3. Modular system

Altschuller's Matrix and Ideas Selection

1. For " the need for an elevation for mounting the actuator".

Inventive Principles Identified: 1,7,4,35,29,30.
1→ Segmentation: Make the actuator in parts/ make the floor segmented.
7→ Nesting: Make the actuator nested in the machine or the valve.
4→ Asymmetry: make the ground asymmetric so that it can adapt to the change of the actuator size.
35→ Parameter change: make the actuator movable.
29→ Use of gases and fluids: use the fluid that pressurizes the valve to align the rings.

2. No external clamping.

Inventive Principles Identified: 11,22,39,30.

11→ beforehand cushioning:
The rings assembled before and then perform the test.
22→ blessing in disguise:
Use of something from the system to help clamping.
39→ Inert environment: use of vacuum or inert thing to hold the rings together
30→ thin film and flexible shells: the valve and the actuator assembly should be Isolated in some way and pressurized by attaching some sort of flexible shells.

3. *Modular system.*

Inventive Principles Identified:3,35,15.

3→ Local Quality: redesigning the object or the environment to help stabilize the rings. For examples adding pins and slots to that can help fix the rings fixed.

15→ Dynamization: Make the whole setup dynamic and adaptable to the size of the varying diameters of the valve.

MCDM: Multi-Criteria Decision Matrix

	Weighting factor	**1. Segmentation**	**2. Nesting**	**3. Asymmetry**	**4. Parameter Change**	**5. Use of Gases and Fluids**
No interference with other tests	8	8	1	1	1	4
Accommodate all the sizes	10	5	3	10	5	5
No interference with other systems.	8	8	4	1	1	8
Operated by a single operator	8	8	8	8	8	1
Align the system	10	5	0	0	5	5
Investment index	10	1	1	1	5	1
The actuators that are mounted on the valves are also to be supported.	5	0	0	5	1	1
To raise and lower the actuator along with the base of the actuator	5	0	0	5	0	1
Total		35	17	31	26	26
Time for implementation	Months	3	3	4	3	5

Table 3

	Weighting factor	**6. Beforehand Cushioning**	**7. Blessing in Disguise**	**8. Inert Environment**	**9. Thin and flexible shells**	**10. Local Quality**	**11. Dynamization**
No interference with other tests	8	4	8	4	4	4	8
Accommodate all the sizes	10	5	10	5	5	5	5
No interference with other systems.	8	4	4	8	4	4	4
Operated by a single operator	8	8	4	1	1	4	4
Align the system	10	10	5	5	10	5	1
Investment index	10	5	8	1	1	4	1
The actuators that are mounted on the valves are also to be supported.	5	0	0	0	0	0	5
To raise and lower the actuator along with the base of the actuator	5	0	0	0	0	0	0
Total		36	39	24	25	26	26
Time for implementation	Months	2	2	3	2	3	3

Table 4

Solution/Ideas Landscaping

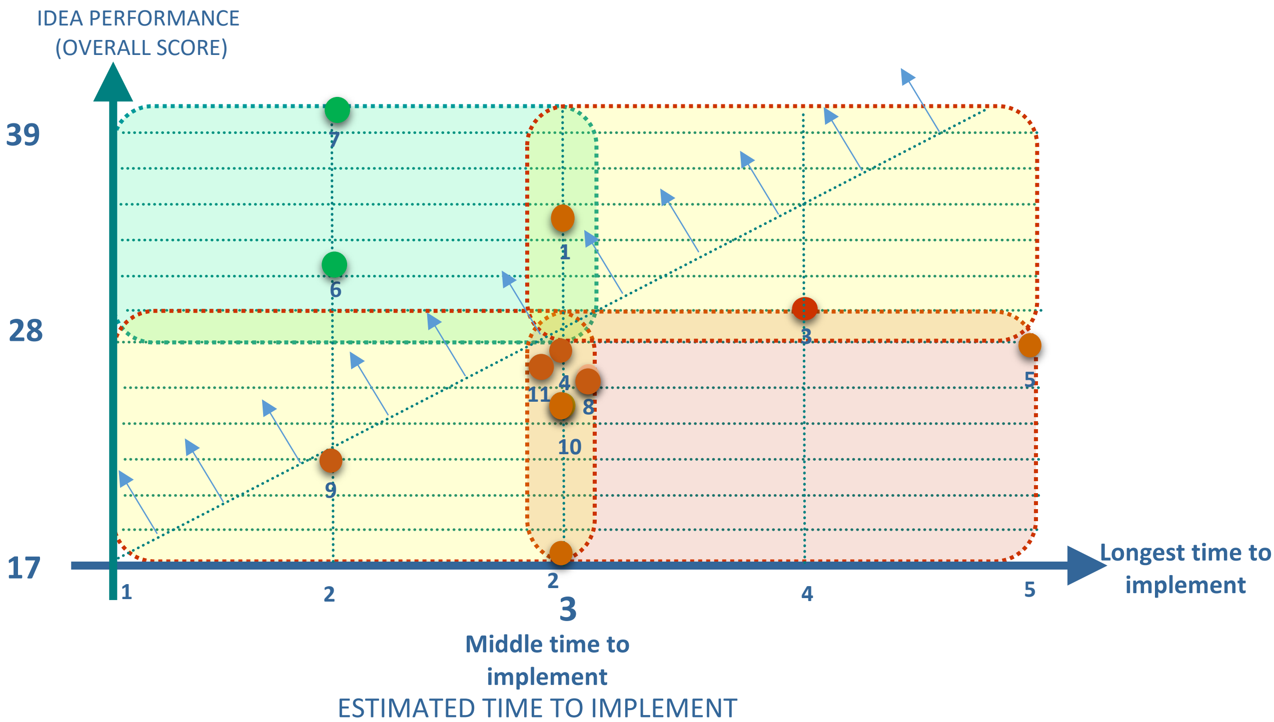


Figure 10

Solution explanation

Segmented

Make the actuator in parts/ make the floor segmented

This solution is to have either the actuator segmented or the floor segmented. Segmentation of the actuator is not possible as it a standard system which cannot be meddled with. Hence, the floor has to be segmented. The floor has to be transformed such that the floor houses the actuator and as the actuator size varies the floor should retract inwards so as to adapt to the height requirement of the valve. As the actuator is housed and mounted to the floor the valve is hence fixed.

The issue of raising the machine base is also not present anymore as there will be no need for clamping anymore.

Beforehand cushioning

The rings are assembled on the valve and then perform the test.

The valve is first assembled with the rings before it is mounted to the test machine, and this whole setup is then mounted on the machine to perform the test. The subparts of this solution are rings on either face of the valves. The rings can be modular or single rings. If the rings are modular then number of rings can be limited as the combination of the rings can be used to achieve the sort of required depth. If singular rings are used then there will be no need for external clamping of the rings.

Blessing in disguise

Use of one of the system elements to achieve the solution.

This solution is basically using one of the elements of the system(test press) to achieve the goal.

The following are the elements of the system.

1. Actuators
2. Machine bridge
3. Bridge column.
4. Base of the machine.
5. Ring.
6. Ring plate.

Actuator: The actuator, as mentioned in one of the previous sections, cannot be meddled with hence it cannot be used to serve as an element for the solution.

Machine Bridge: The machine bridge can be used to align and clamp the system. The bridge can be used to house the system to align and clamp the system. The issue is that the bridge is not in a relative halt with the base of the press which move up and down during pressurizing and depressurizing the system. Which will lead to the loss of clamping and alignment.

Machine Column: Machine column is one of the important elements of the system which can be used to serve as the base for having a clamping system. The solution consists of having two or three(depending on the machine) clamp on the columns of the bridge. Each of the sliders houses extendable clamp arms with end cushion(rubber) which can adapt to the sizes of the valves to be tested. The issue with this solution is

1. Since the base of the press moves up and down during clamping of the system and while depressurizing the system, the slider has to also move up and down along with the base. If the clamp is not attached to any of the elements like the base or the bridge of the press then the clamp moves accordingly to adapt to the lowering and raising the valve. But the clamp arms will not be always in contact with the valve, hence leads to irregularity in clamping forces and resulting in loss of alignment.

Machine base: The machine base is the most convenient of all the elements of the systems which can be used to deliver the solution. The base is the element which holds the valve and the ring and which moves along the valve and the ring. So it is very appropriate to have a solution housed on the ring as it can do the same motion as that of the valve and the base.

The machine base can be used to house a manipulator arm with a gripper at the end which can grip the flange of the valve and hence be used to align and clamp the valve to the system. The manipulator arm has three degrees of freedom. These degrees of freedom helps the system to adapt to various sizes of the valves. The end effector/gripper which hold the valve will be able to stabilize the valve. The gripper also has to be adaptable to the different dimensions of the valve flange.

Although, the main issue faced in this type of the solution is that the gripper has to be tightly clamped to the valve and this leads indentation, and paint removal

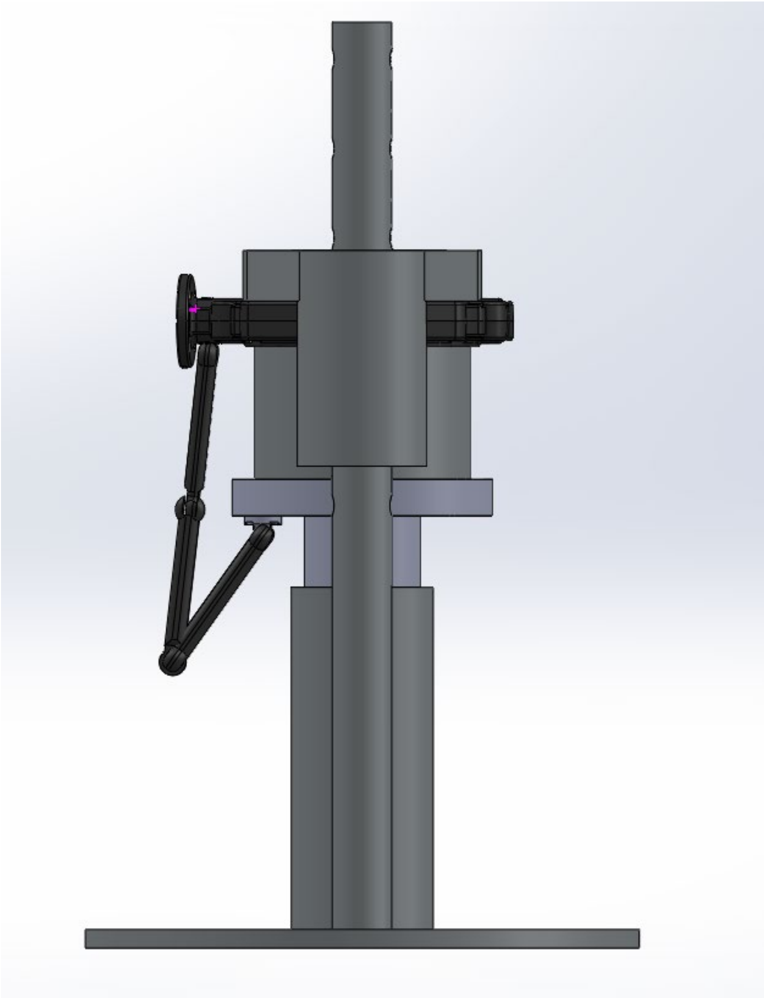


Figure 11

Ring:

Ring is another element of the system which can be used to help clamp and align the system. The ring can accommodate the system to align and clamp the valve.
The system consists of:

1. Brackets
2. A body with a bearing
3. A sliding arm
4. A rubber cushion

The brackets are provided on the outer periphery of the ring. These slots will house the body with a bearing which is connected to an adjustable arm with the help bracket.

Issues that are faced when this solution is implemented is that when the rings have protruding elements, then there is also a possibility for these slots to be damaged while storing and also while

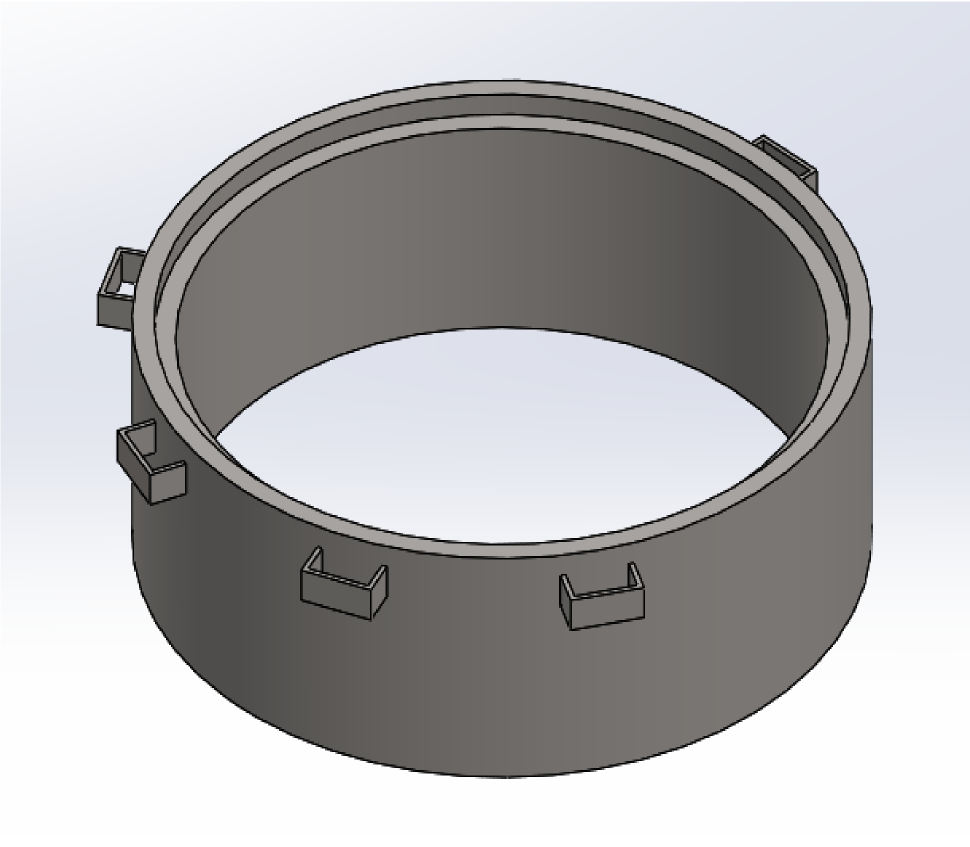


Figure 12

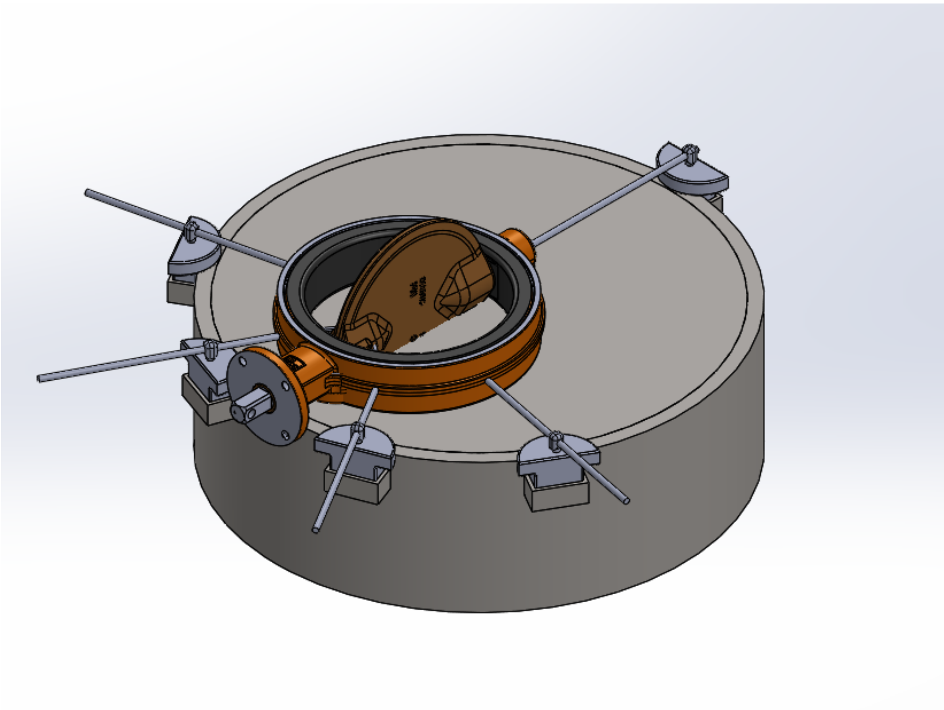


Figure 13

Ring plates:

The ring plate can also be used to clamp and align the system. This solution is similar to that of the previous solution involving the ring. It consists of the following components.

1. C-brackets.
2. Clamp arm.
3. Locking piston.
4. Connecting linkage.
5. Clamp base.
6. Cushion for the piston.

In this solution, the clamp is housed on the ring plate and it can be accommodate to different sizes as the clamping system is modular and only the brackets are fixed to the ring plates. Everything apart from the brackets can be used on different rings plates which have different diameter slots.

To accommodate the dynaxe and econaxe valves which have varying shell diameter and also the Lugged flanged valves which have protruding elements on the shell which are of varying diameters hence a little modification in the clamp base and the bracket.

The clamp base is hence made to adapt to the different shell sizes by having two different length of the clamp base so that the smaller shell dimensions and the larger shell dimensions are accommodated and the clamping mechanism will be mounted on the clamp base to adapt to the ring size.

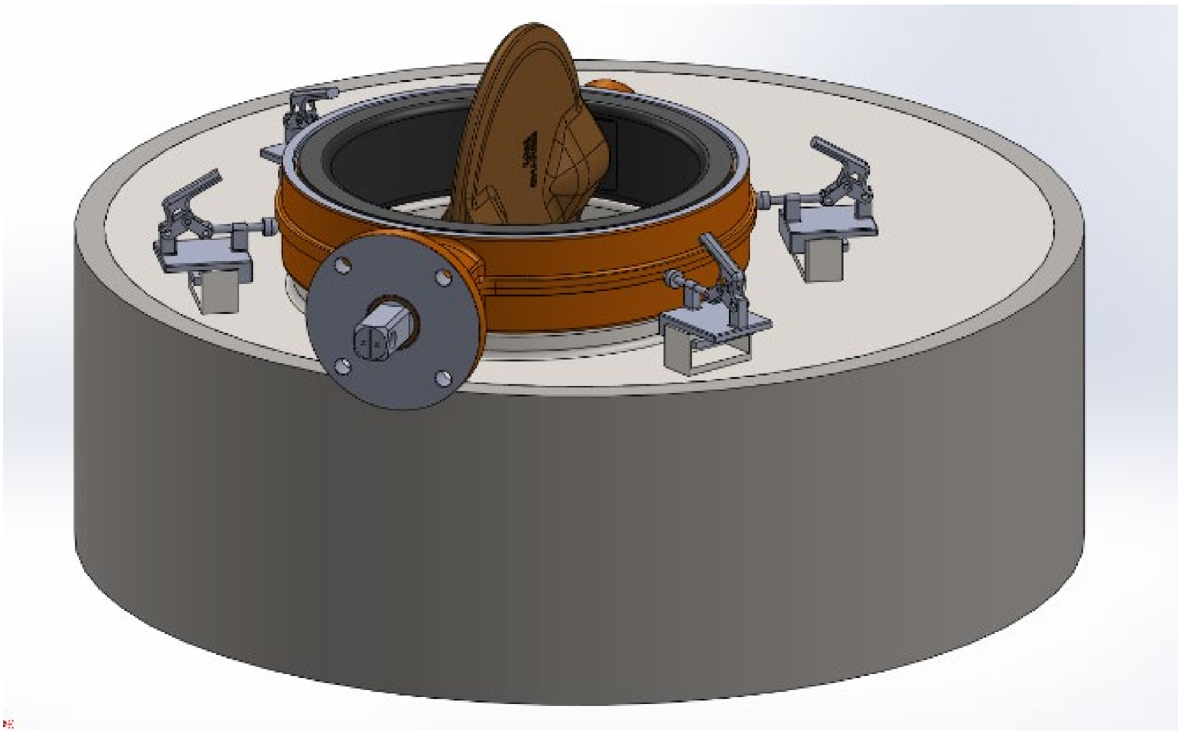


Figure 14

The clamps that are shown in the figure above can be outsourced[3] the description number of parts that are used in the solution are explained in details

The found solutions are further filtered using the TRIZ-based essential criteria.

	Weight	Segmentation	Pre-assembled	Manipulator arm	Clamp on ring	Clamp on plate
Problem solved	5	2	3	3	3	4
Win-Win	4	2	2	3	4	4
No harmful Effect	3	1	2	2	2	2
Ideality	2	1	1	1	1	1
Extra Benefits	1	0	0	1	1	1
TOTAL:		6	8	10	11	12

Detailed design

As seen in the solution for the previous problem, that is the ring plates, we see that the slots on the rings are eccentric, as to accommodate the flange lengths. Therefore, the clamp brackets are to be placed accordingly and should not hinder the structural integrity of the plate and should not interfere with the ring. Apart from the previously mentioned issues there is also an issue related to the different sizes of the valve shell. Hence the following table and the diagrams will help with the dimensions of the plate and their brackets.

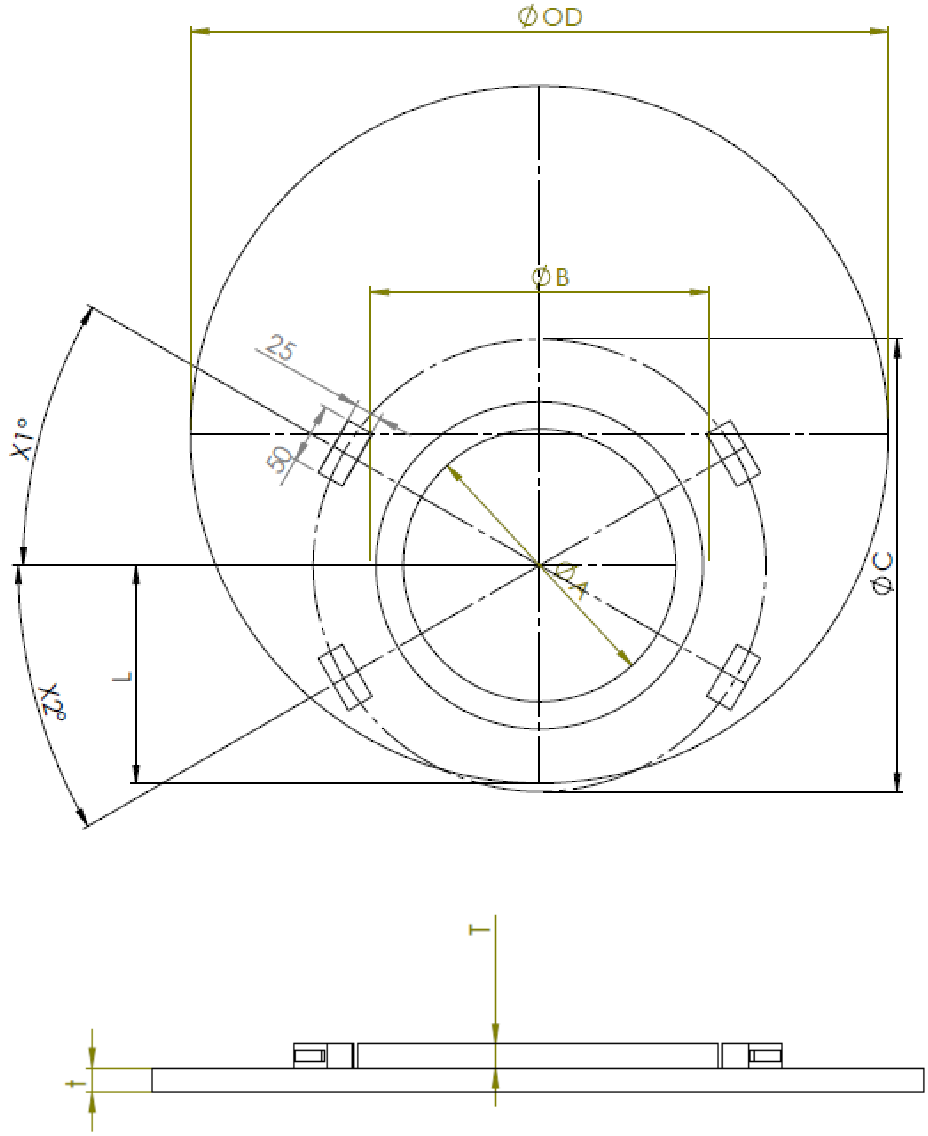


Figure 15

A, B, C, L, t and T are dimension in mm

X1° and X2° are in degree

valve Size	A	B	C	L	t	T	OD	X1°	X2°
DN 50	50	90	110	60	20	20	350	45	30
DN 65	65	105	130	70	20	20	350	45	30
DN 80	80	120	160	75	20	20	350	45	30
DN 100	100	140	190	90	20	20	350	45	30
DN 125	125	165	220	100	20	20	350	45	30
DN150	150	190	240	120	20	20	350	45	30
DN 200	200	240	270	145	20	20	350	45	30
DN 250	250	290	400	200	20	20	400	30°	30°
DN 300	300	350	430	210	20	20	400	30°	30°
DN 350	350	400	500	255	20	20	400	30°	30°
DN 400	386	436	530	318	20	20	400	30°	30°
DN 450	436	486	560	320	20	20	640	30	30°
DN 500	486	536	580	-	20	20	640	30°	30°
DN 550	536	586	Extension needed	Extension needed	20	20	640	30°	30°
DN 600	586	636	Extension needed	Extension needed	20	20	640	30°	30°

The extension that is mentioned for the table above for the DN 550 AND DN 600 are to be welded to the ring plates so that there is enough space for the clamping system to be mounted on the plates.

Design of the Rings

The rings are designed in solid works and static analysis is also carried out in solid works.
The internal pressure of the rings are taken as 32 bars and the vertical force on the rings is taken to be 5000N due to the machine clamping.
The following example is for the ring for the machine 3311

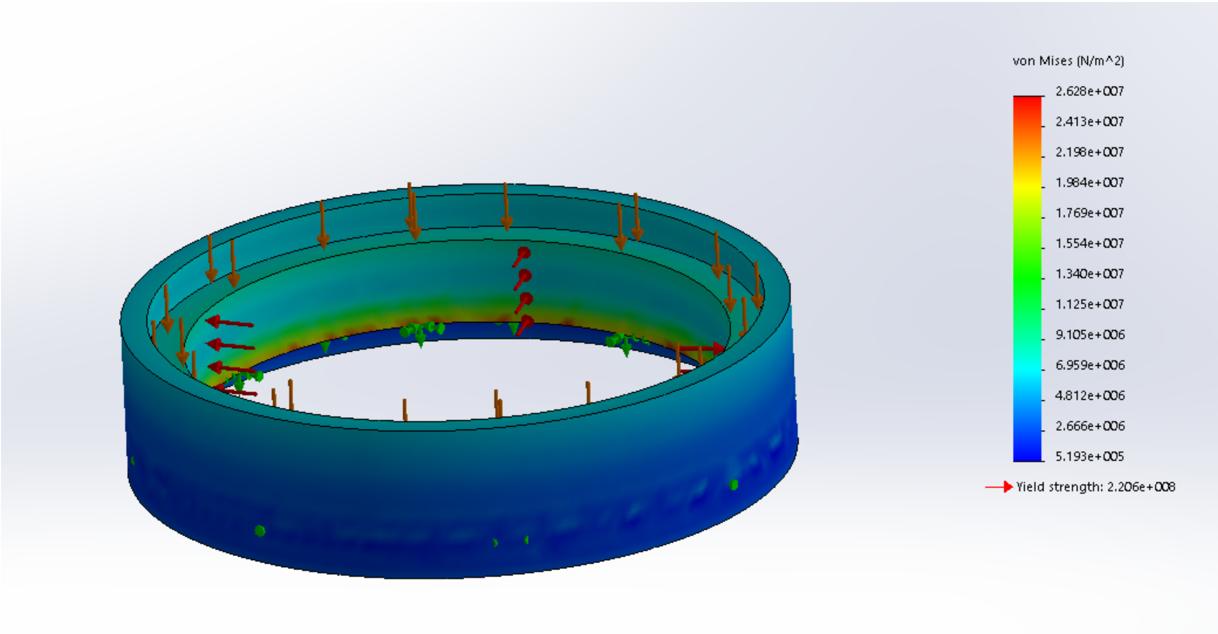


Figure 16 van mises stresses

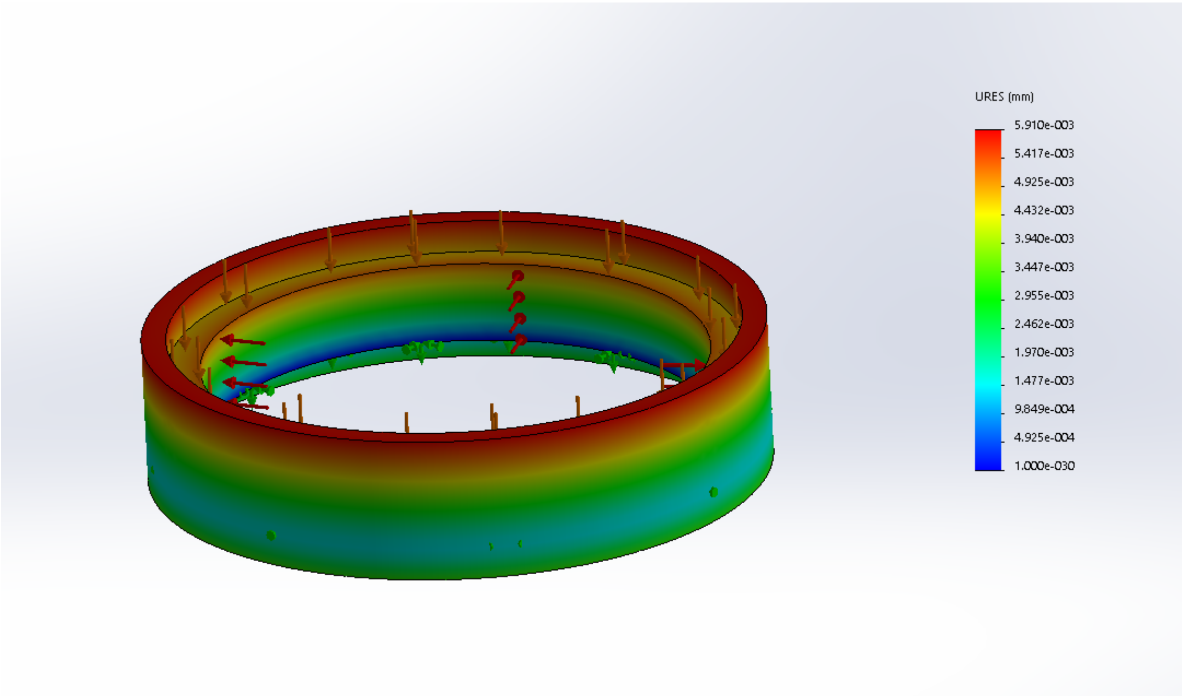


Figure 17 Deflections

The results of the simulation of the other two rings along with the technical drawings can be found in the appendix.

Problem 3

Using ARIZ 85C to solve problem.

ARIZ 85C is a TRIZ tool which is basically used to solve problems involving physical contradictions and not technical contradiction. ARIZ is used to solve the problems which are couldn't be solved by either inventive principles nor inventive standards.

The following are the steps that are involved in solving problem using ARIZ:

1. Problem definition and modelling.
2. Problem model analysis.
3. Defining ideal final result and a physical contradiction.
4. Problem solving by using resources.
5. The use of triz based knowledge.

Definition

"To hold, raise and lower the actuator".

There is already an idea that is available but is not sufficient to deliver the solution. This idea is further developed using the tool ARIZ 35C.

Using pulley/crane to rise and lower the actuator

Since there is already a solution that that is used to attain a solution that can solve the above mentioned problem. Current solution involves a crane that lowers and raises the actuators and the valves . Therefore there needs to be a pulley system that can, not just raise but also lower the actuator.

1. Problem definition and modelling
   1.1. Defining mini problem
      1.1.1. A technical system for help raise, lower and also hold the actuator, the system includes an actuator, a pulley, the valve, the machine, the hydraulic system.
      1.1.2. Technical Contradiction 1: if the force on the pulley is too much, the actuator flies, but will not let the actuator fall.
      1.1.3. Technical Contradiction 2: if the force is too small, the actuator will not raise, but the actuator will not fly.
   1.2. Defining the conflicting pair.
      1.2.1. Conflicting pair: the actuator and the pulley system.
      1.2.2. Product: actuator.
      1.2.3. Tool: pulley force.
   1.3. Selection of contradiction.
      1.3.1. Main process: to hold the actuator.
      1.3.2. Contradiction TC1 is chosen: if the force on the pulley is too much, the actuator flies, but will not let the actuator fall.
   1.4. Intensify.

      Technical Contradiction 1: if the force on the pulley is too much, the actuator will not fall but the actuator will fly to space.

1.5. New problem definition
    1.5.1. Conflicting pair: pulley force and the actuator.
    1.5.2. Intensified conflict: if the force is extremely high, then the actuator will not fall but the actuator will fly into space.
    1.5.3. An X component must therefore protect the actuator from flying into space.

2. Problem model analysis.
    2.1. Operational zone: pulley and chain contact.
    2.2. Operational time: during raising and lowering the actuator.
    2.3. Analysis of resources:

	Substances	Fields
System resources	Actuator, pulley, chain, valve, machine.	Mechanical, friction, electricity
Freely available resources	Pressure system.	Gravity, friction.
Super-system resources	Electricity, rings, valves, tables etc.	Mechanical, hydraulic, friction. Etc.

3. Defining ideal final result and a physical contradiction.
    3.1. An X-component, without complicating the system and without causing harmful side effects.
        3.1.1. Eliminates: flying of the actuator.
        3.1.2. During: holding the actuator.
        3.1.3. While holding and also not let it fall.
    3.2. An existing resources, without complicating the system and without causing harmful side effects.
        3.2.1. Eliminates: flying of the actuator.
        3.2.2. During: holding the actuator.
        3.2.3. While holding and also not let it fall.
    3.3. Pulley and chain interaction is the place of contact.
        3.3.1. During raising the actuator, the force should high to hold the actuator and should be low to not let the actuator fly.
    3.4. There should be a layer of particles in the place of contact of the elements during the raising. Holding and lowering of the actuator and there should be no layer of particles(or very less) in order help the actuator not fly.
    3.5. The palace of contact must provide both presence of a layer of particles and absence of a layer by itself during the holding, raising, and holding the actuator.

4. Problem solving by using resources.
    4.1. Using the dwarfs problem description
    Using the dwarfs a solution was obtained and is explained in the section below.

Solution

The solution got from the "DWARFS" give a solution that is presented in this section. The solution involves the dwarfs that are used to attain the objective of the solution. The dwarf solution is added to the appendix for reference.

The solution involves a frame with three pulleys positioned at different locations as shown in the figure below. These pulleys hoist a chain that can be tensioned and released using a turnbuckle. The frame is adjustable and also has a hydraulic system to help the adjustment.

The system that is referred here can be outsourced from market and would cost around 250Euros[4]

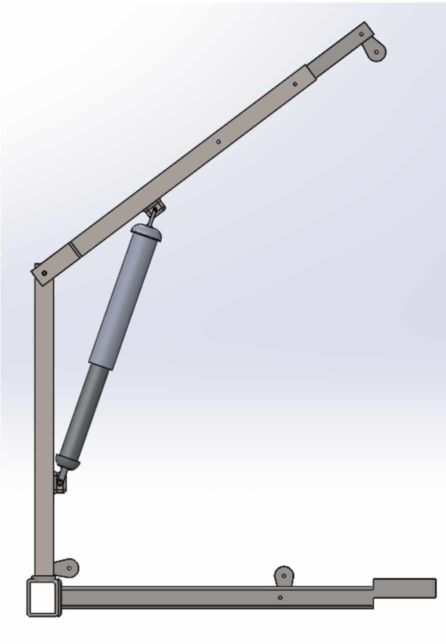


Figure 18

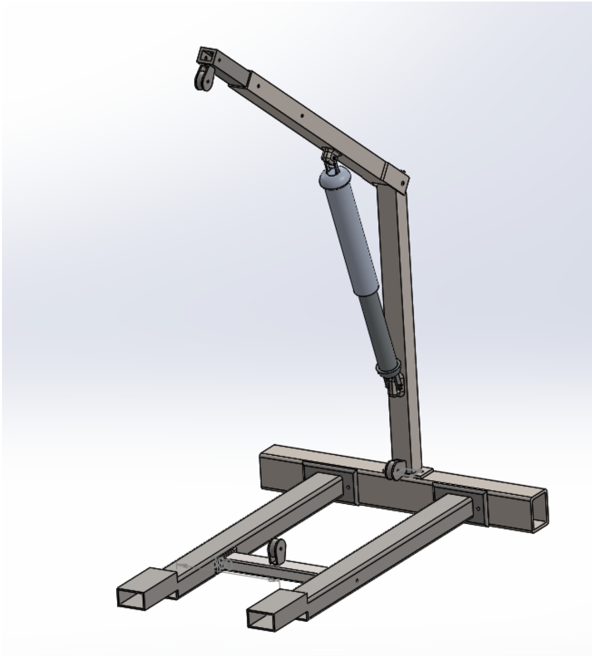


Figure 19

Conclusion

Integrated solution

Combining the solutions got in the previous section, we have a holistic solution which addresses all the problems which were identified in the beginning of the analysis of the current test setup.

To solve the problems The unwanted movement of the rings and the disc hitting the base of the test machine- the solution Single ring and adaptable plates is suggested.

To solve the problem of having the actuator supported and to avoid the tipping of the valve due to the eccentricity of the actuator- the solution of the Frame(Figure 33) with pulleys and chain used.

To address the issue of the valve alignment and clamping- the solution of having the clamping system on the plates is used.

The combined solution looks as following(Figure 35).

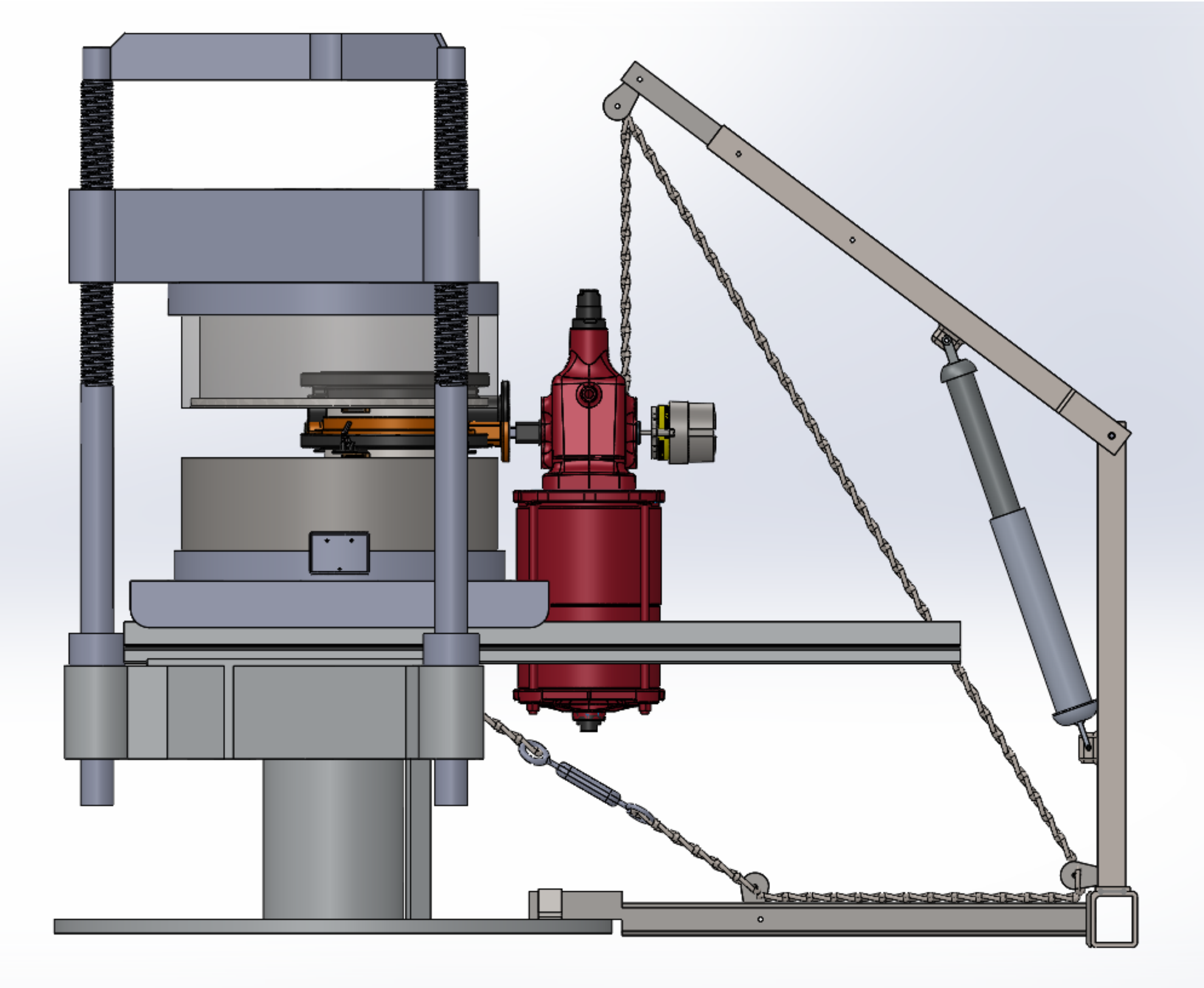


Figure 20

Reference

1. http://www.triz40.com/aff_Matrix_TRIZ.php
2. https://triz-journal.com/40-inventive-principles-examples/
3. https://www.amazon.com/KangTeer-Capacity-Plunger-Vertical-Operation/dp/B06VTCXXL1/ref=pd_sbs_469_10?_encoding=UTF8&pd_rd_i=B073SB5BLY&pd_rd_r=56df4c22-a105-421a-bb22-c91338d52cda&pd_rd_w=ivxdj&pd_rd_wg=AT5Hn&pf_rd_p=5873ae95-9063-4a23-9b7e-eafa738c2269&pf_rd_r=ZDXMS96B5R9Z8TRAV0QC&refRID=ZDXMS96B5R9Z8TRAV0QC&th=1
4. https://profit-tools.nl/index.php?id_product=617&id_product_attribute=0&rewrite=2t-weber-werkplaatskraan-opvouwbaar&controller=product

Appendix

A typical Dynaxe valve

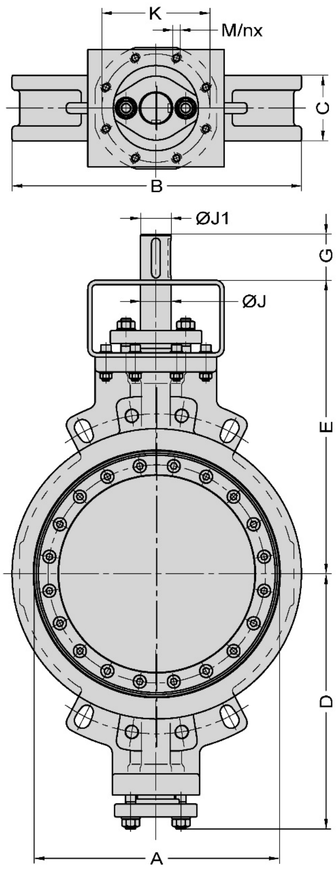


Figure (a)

Where,

A - the disc diameter.

B - outer diameter.

C - face to face width.

D - center to bottom length.

E - center to top length.

The iris mechanism for the base and bridge.

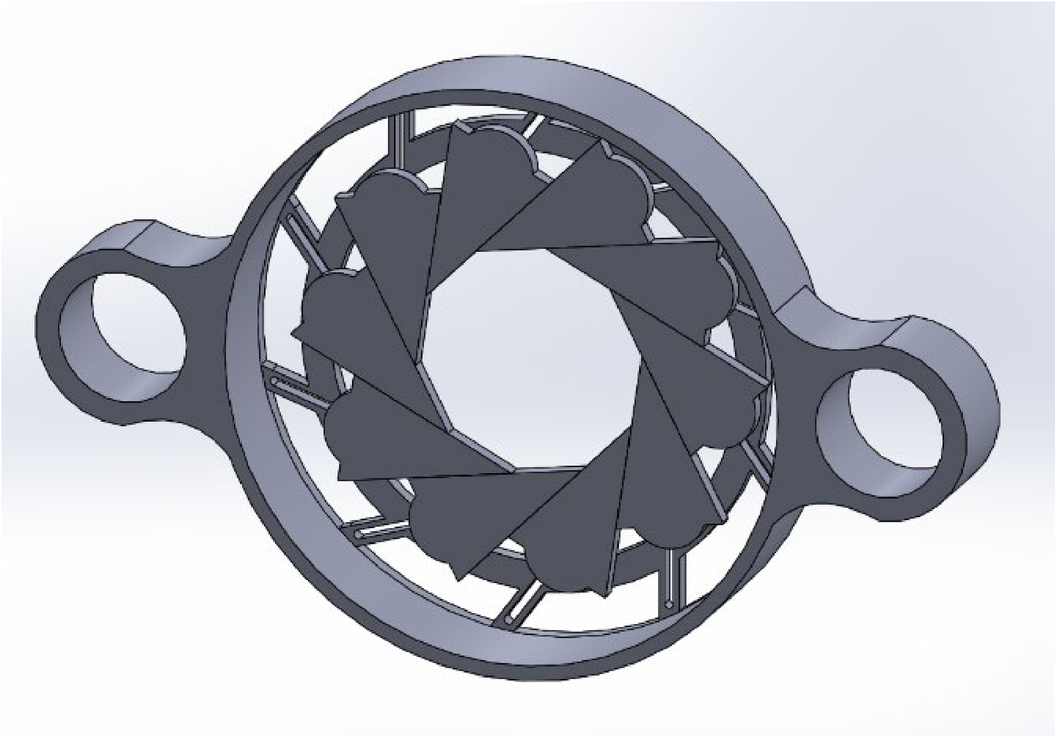
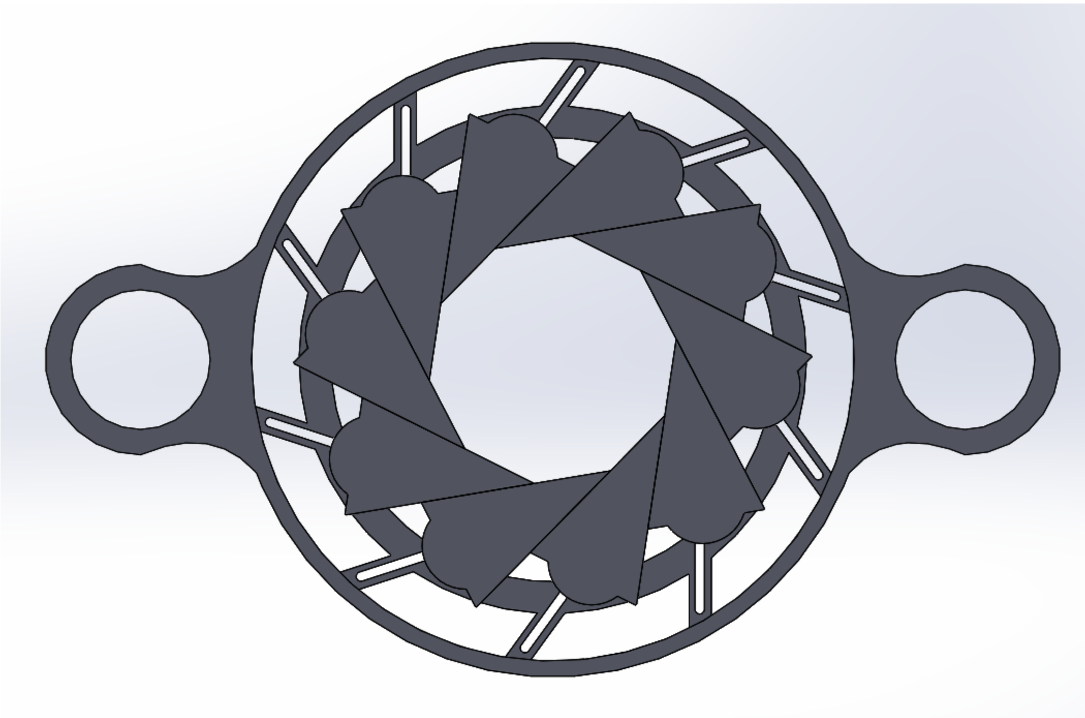


Figure b



Figures c

Telescopic base attachments/rings.

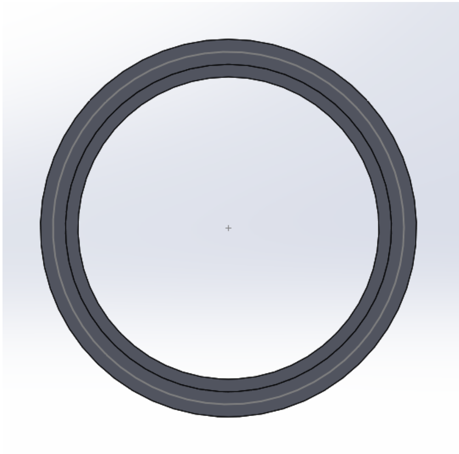


Figure d

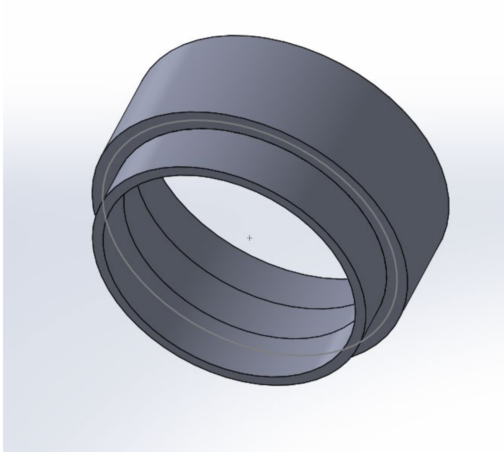


Figure e

The ring used for clamping the valve to the system.

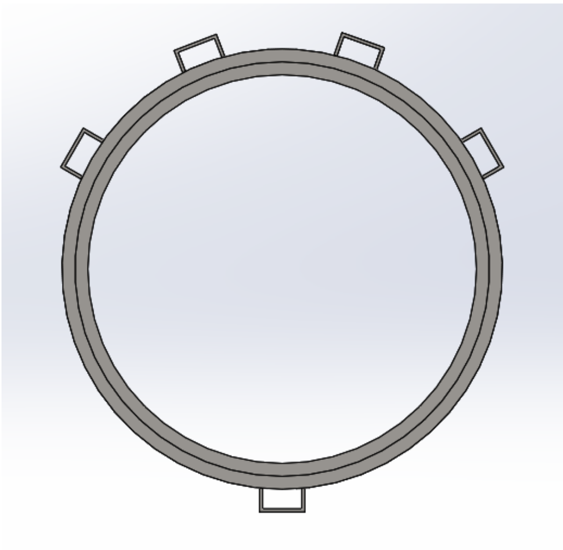


Figure f

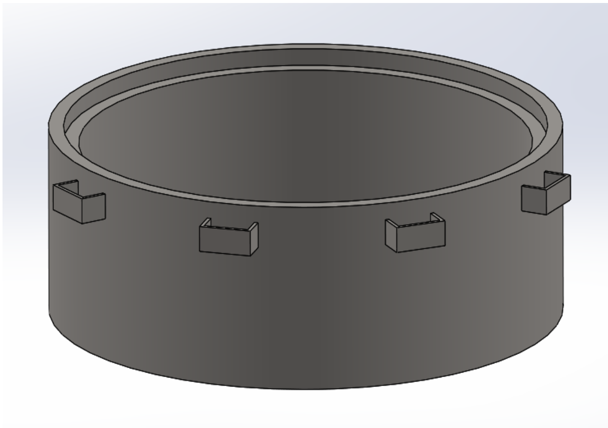


Figure g

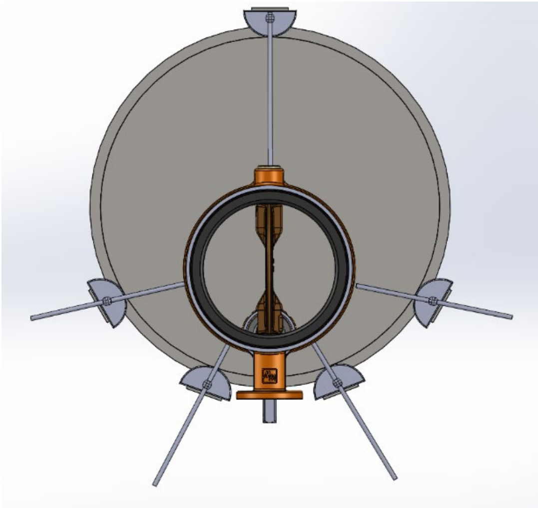


Figure h

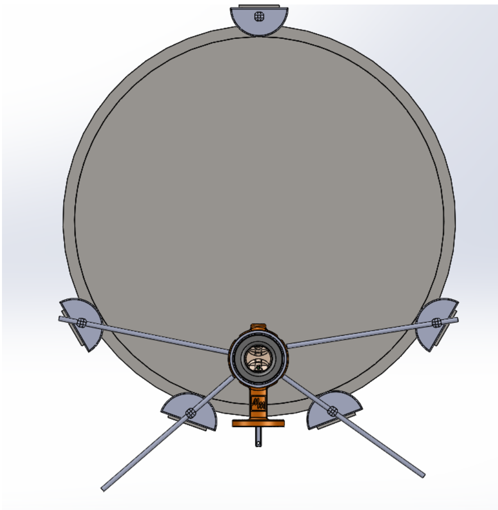


Figure i

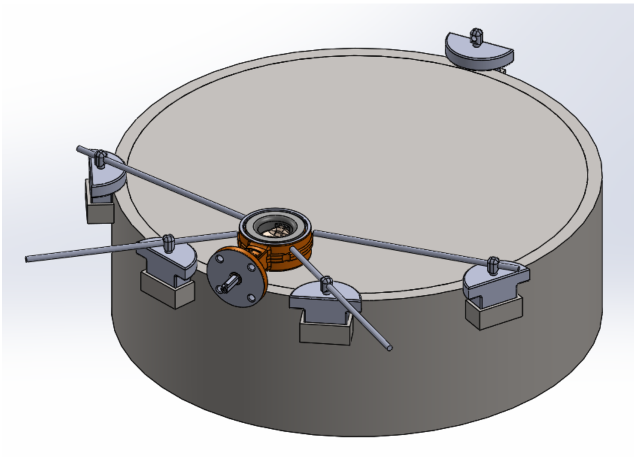


Figure j

Using the plate to align and clamp the valve to the system

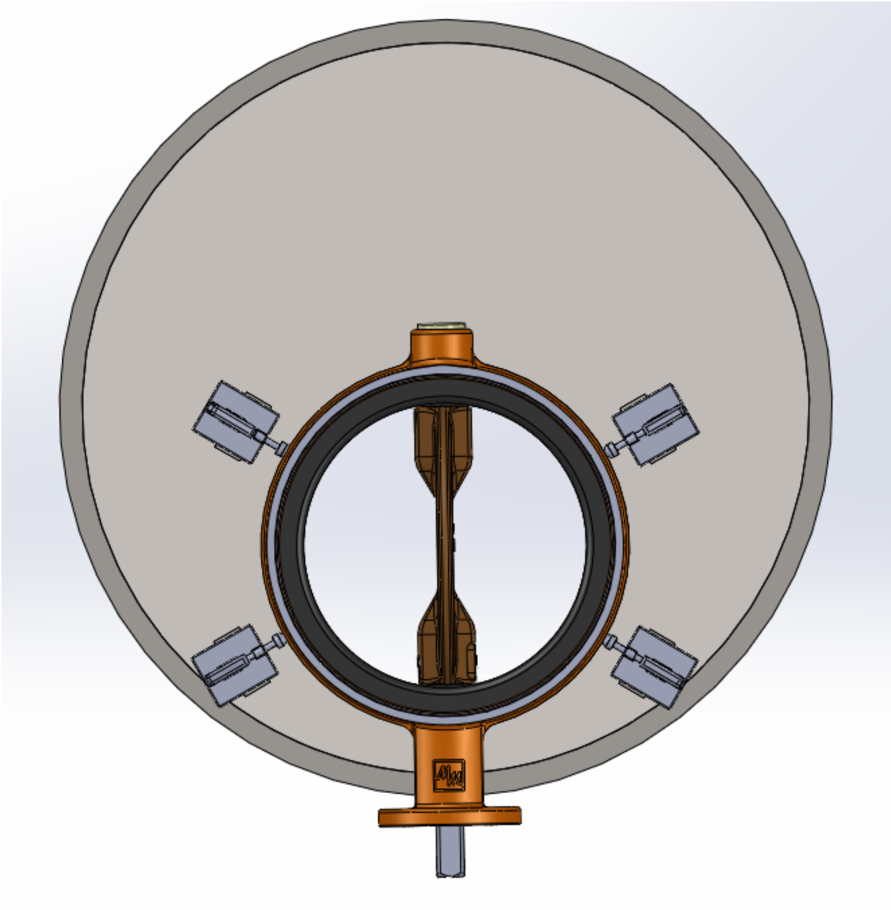


Figure k

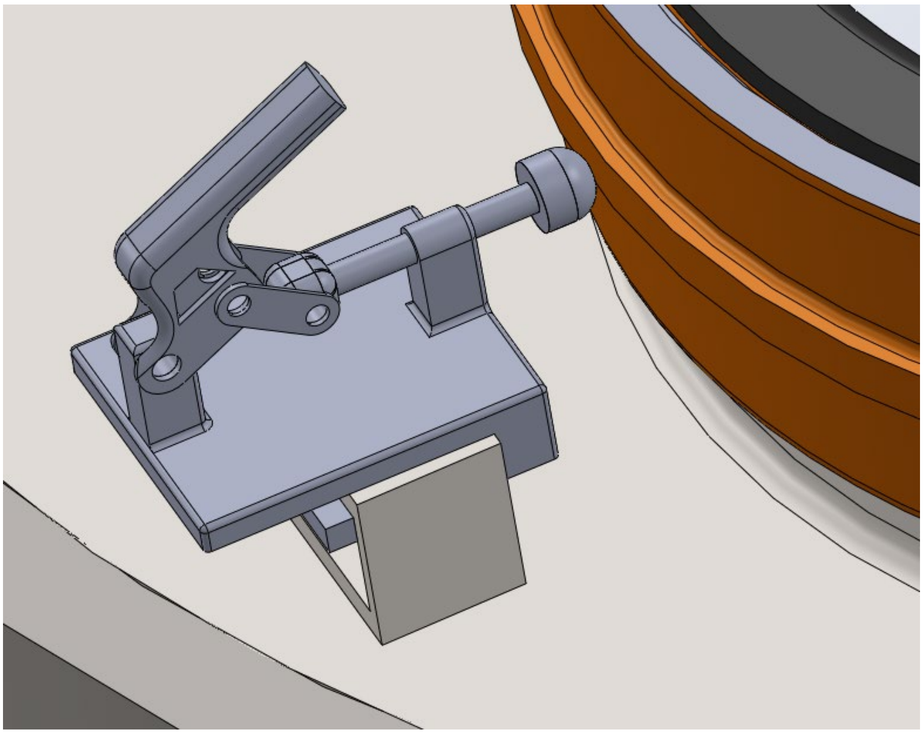


Figure l

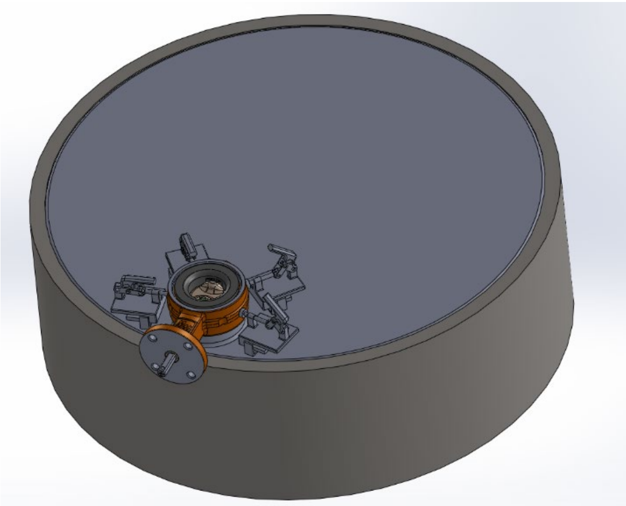


Figure m

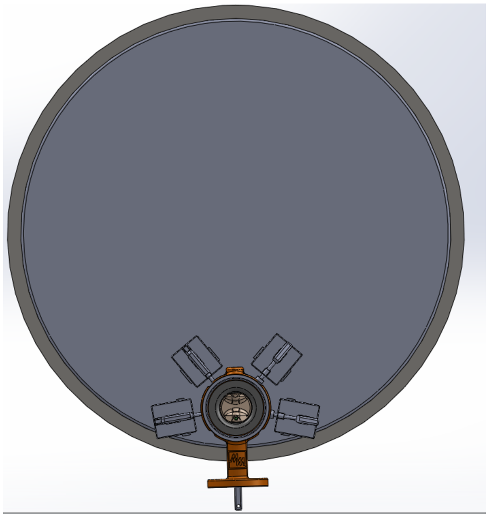


Figure n

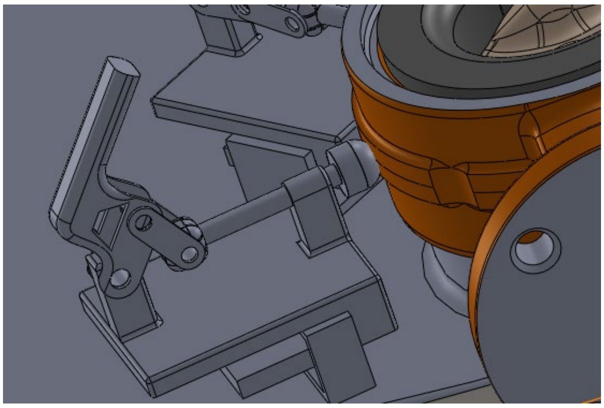


Figure o

Stress and Displacement simulations for rings for the machine 3308

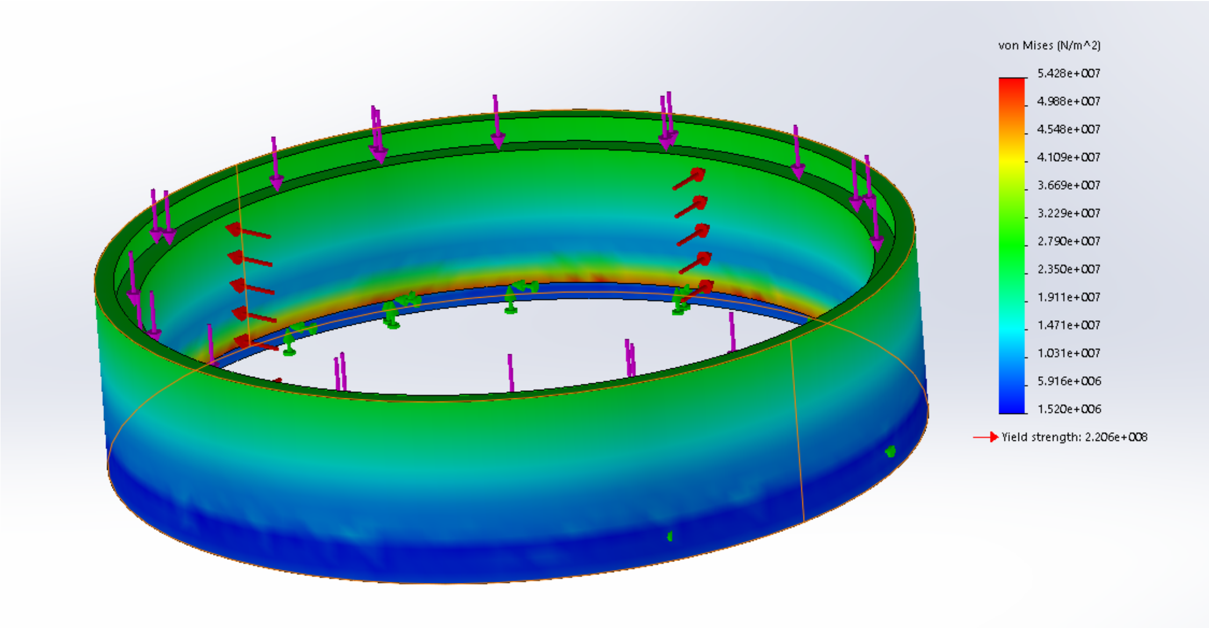


Figure p

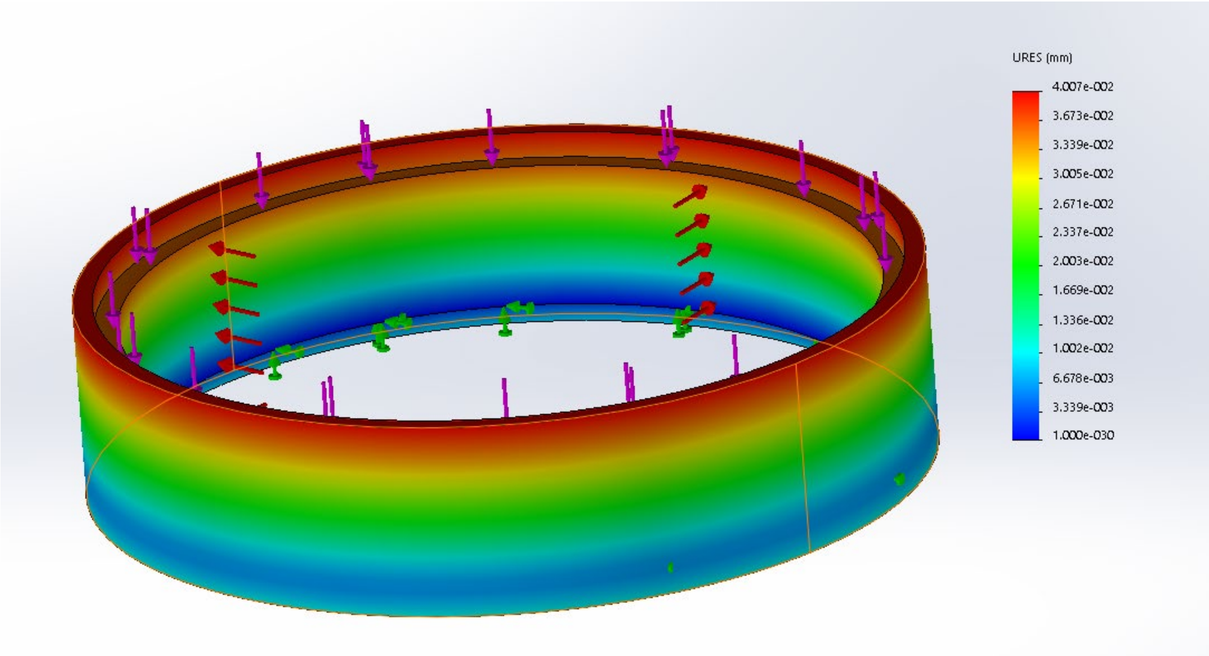


Figure q

Displacement and stress simulations for rings for the machine 3309

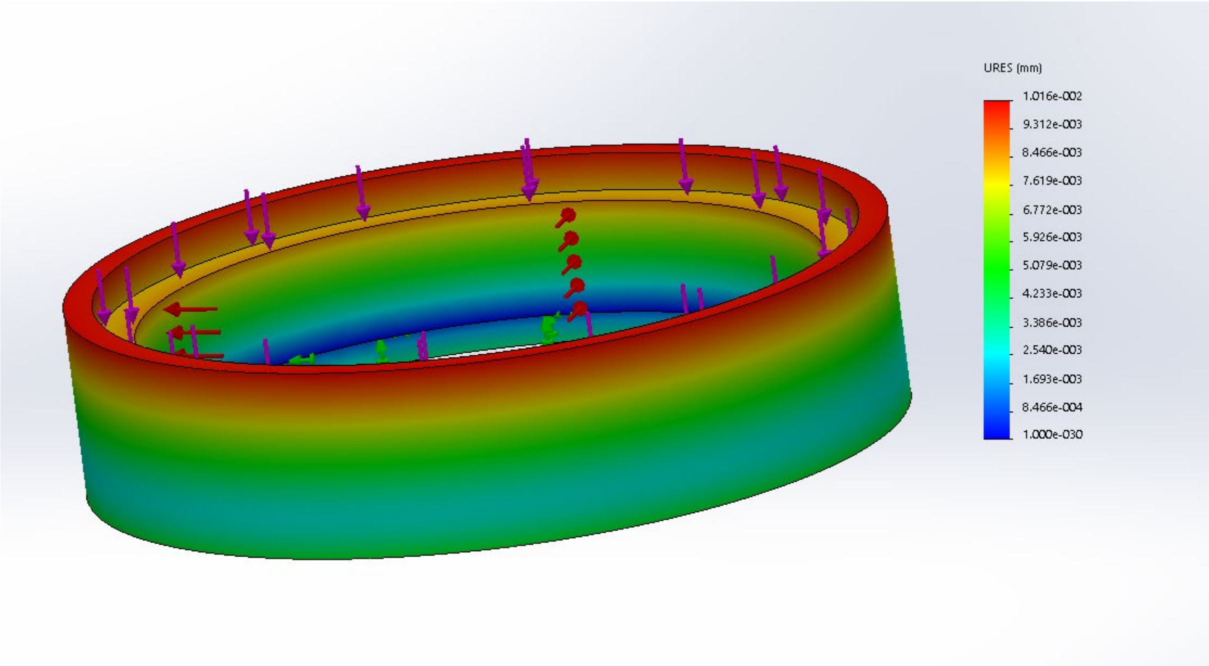


Figure r

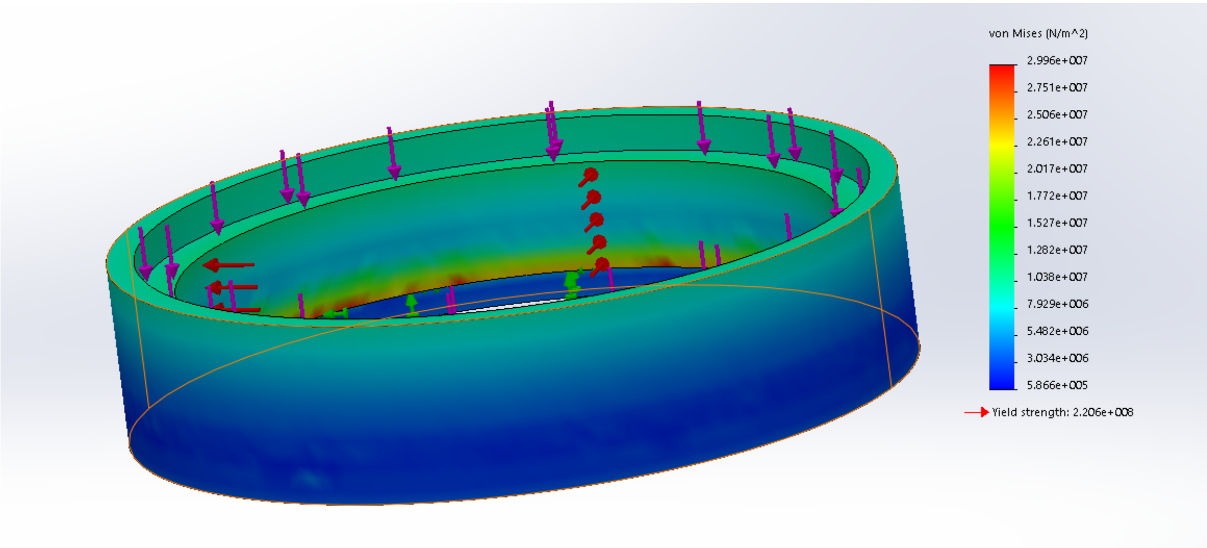
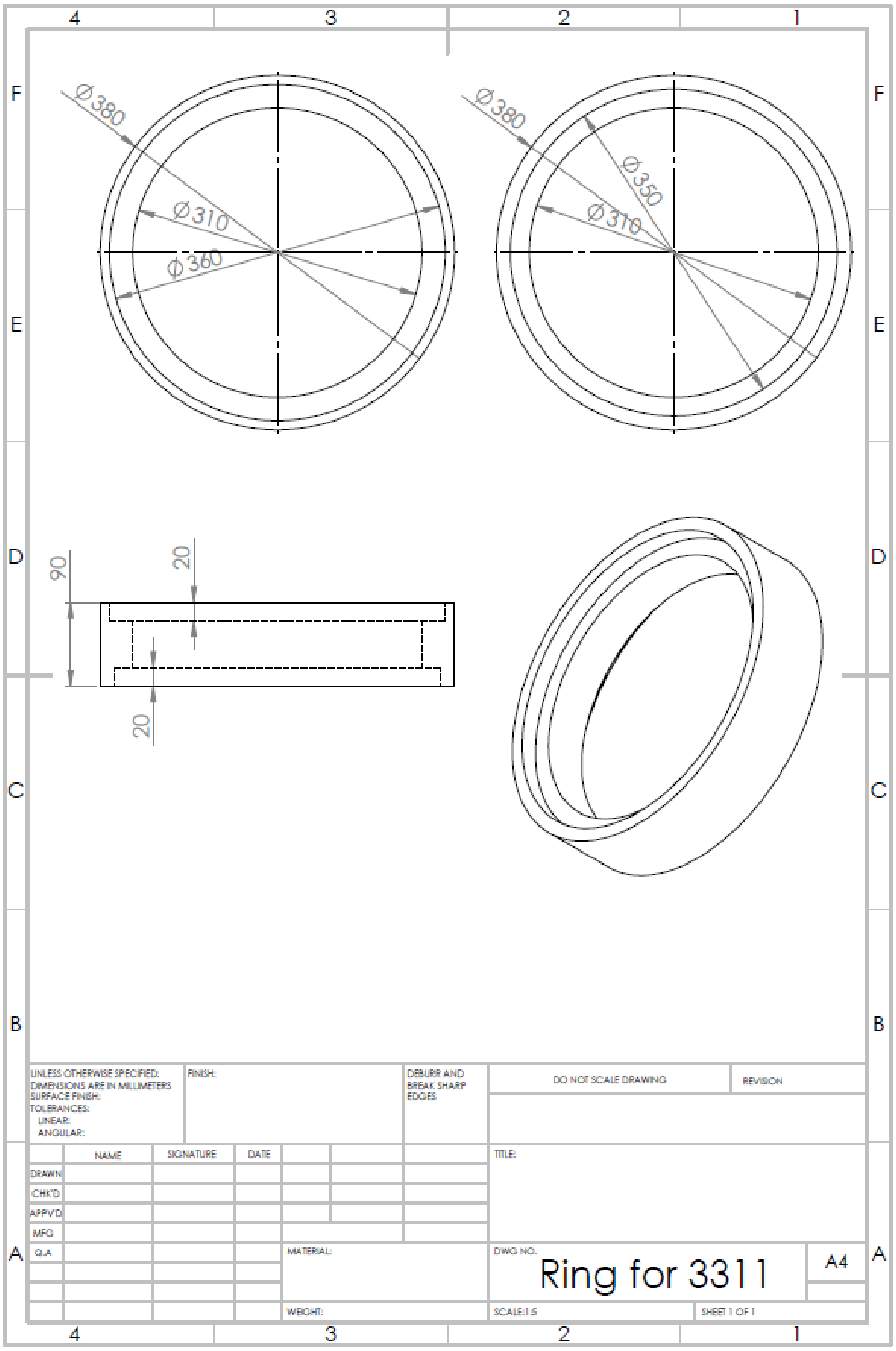
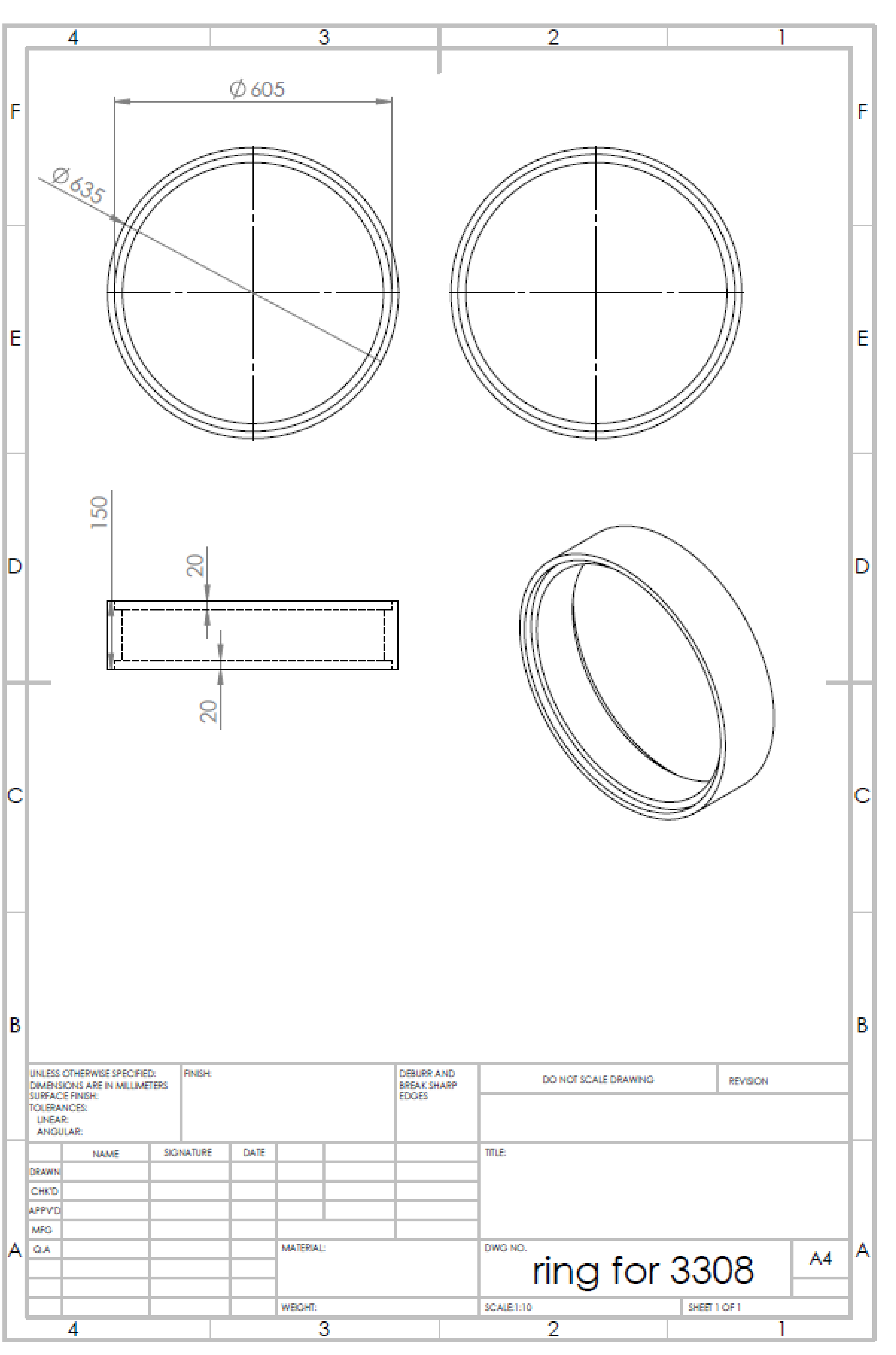


Figure s

Technical Drawings for the rings





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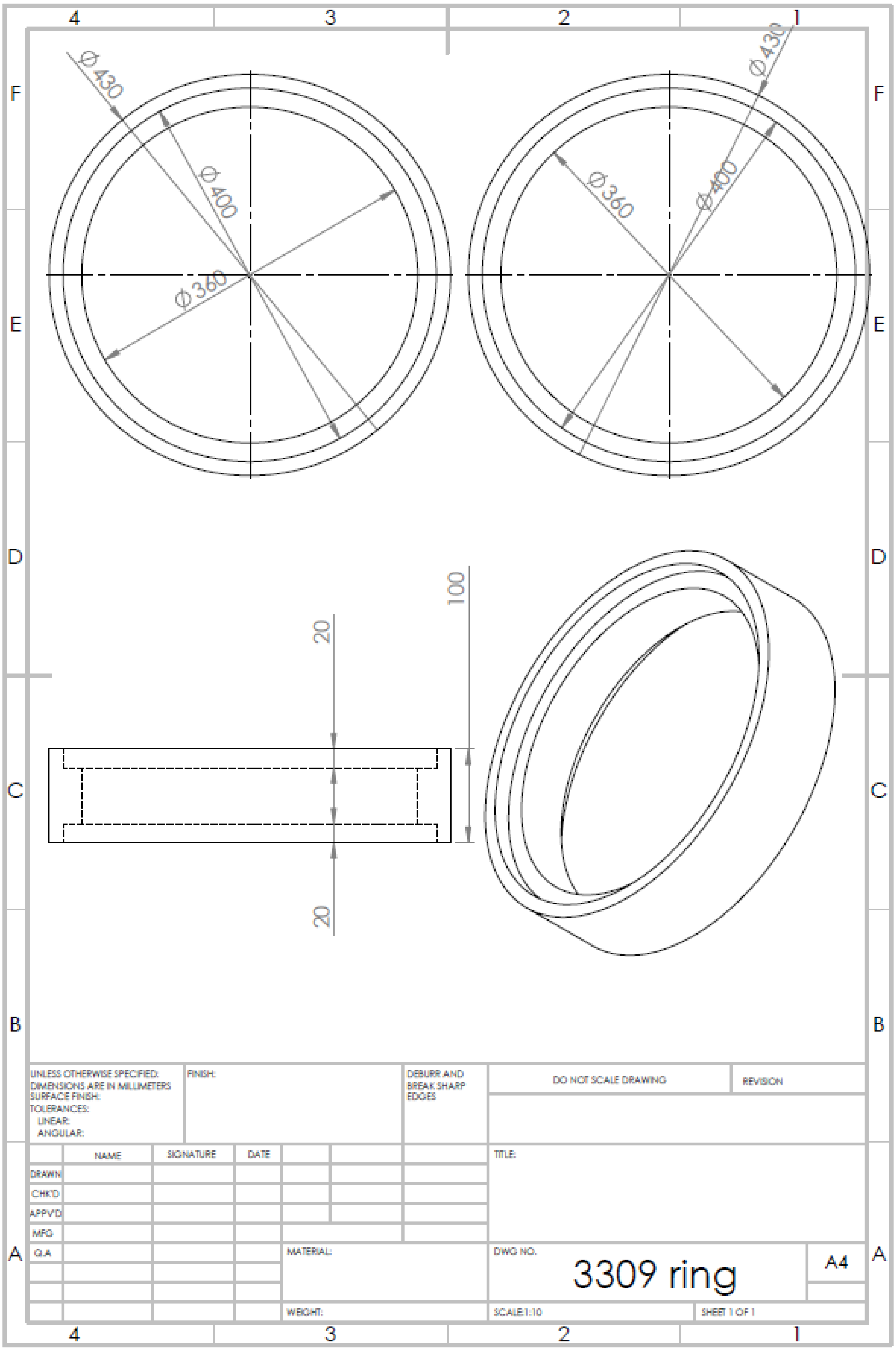
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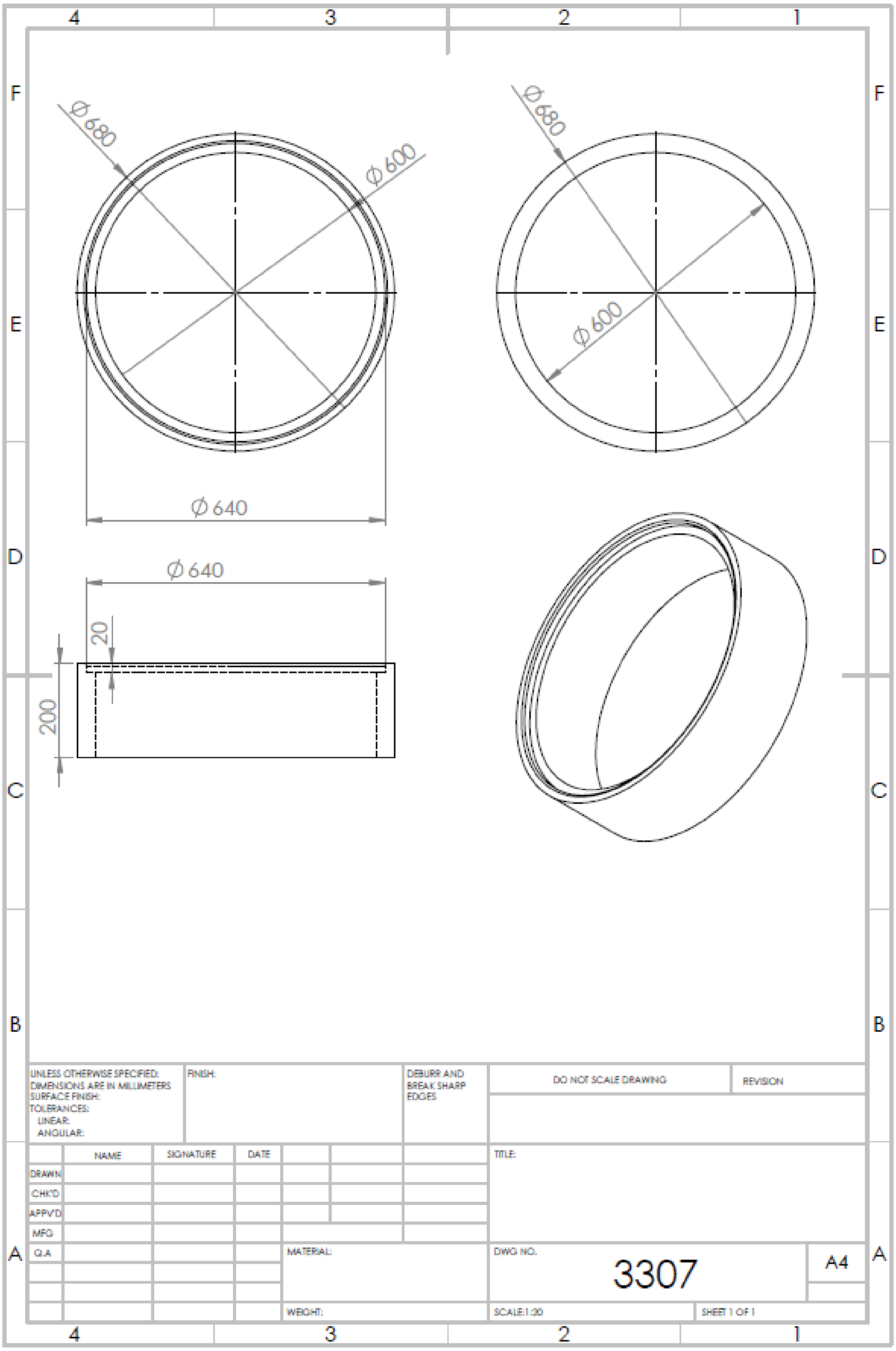
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