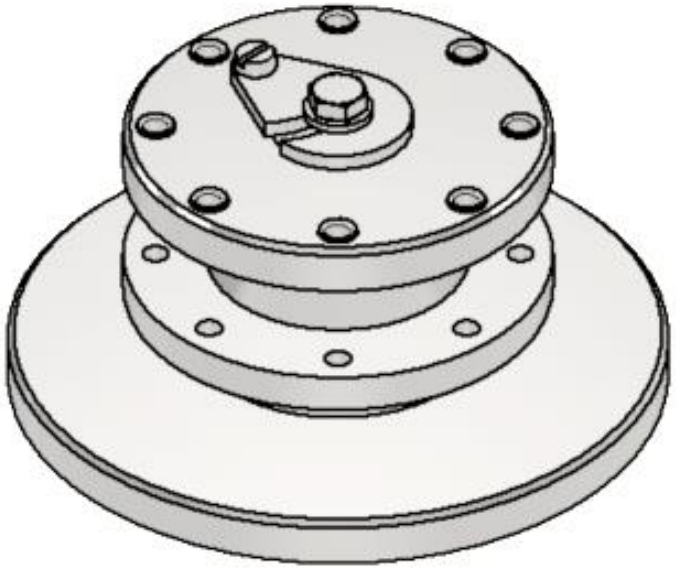

JIG DESIGN PROJECT

Machine Design II

ABSTRACT

Design of a manually operated drilling jig, which would be used to manufacture a component.

Kyle Flanegan

s220324085

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Plagiarism Declaration

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Introduction

Drilling jigs are used to machine holes in mechanical products to obtain accurate positions of the holes. A jig's primary purpose is to provide repeatability, accuracy, and interchangeability in the manufacturing of products.

The objective of the Jig described in the following report was to design a manually operated drilling jig. The drilling jig will be used to manufacture a component, which I have selected.

The chosen part had to contain holes. The tooling used in the methods of manufacturing need to be inexpensive as it will be manufactured in limited volumes. Standard components were used to ensure that the costs of the jig were minimal.

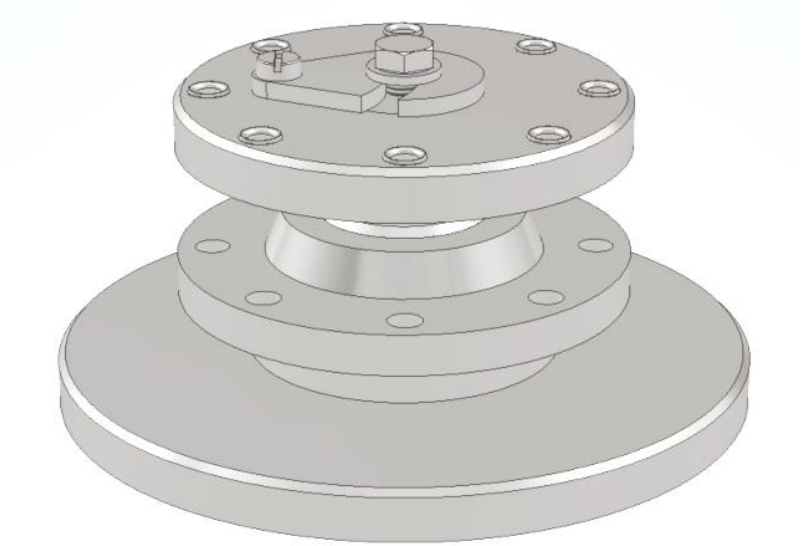


Figure 1: Drill Jig with Circular Flange (selected part)

Factors Influencing Design

1. **Functionality**

   The designed jig needs to be manually operated when used to manufacture the component. It is going to be used to manufacture a component having holes.

2. **Strength**

   It is crucial for the jig to securely hold the part in place during the milling process.

3. **Accuracy and Liability**

   The jig need to produce multiple products which have negligible differences. These parts need to be replicated one after the other. This means that the positioning system needs to be designed specifically for the chosen part.

4. **Cost**

   It is important that the jig is not costly. It needs to be designed as inexpensive as possible while still ensuring high standards in terms of accuracy of the manufacturing process. Rougher finishes and larger tolerances will for a reduction in manufacturing costs.

5. **Availability**

   The cost of the jig will be determined by the availability of materials and parts. Some suitable materials may be difficult to source and therefore more expensive. Therefore, it is crucial to make use of standard parts in the design of the drilling jig.

6. **Manufacturability**

   Manufacturing needs to be fast and efficient in terms of the drilling to the component. This is related to the functionality of the jig in terms of ease of operation.

7. **Materials**

   The use of standard materials insures that the production of the jig is made easier, quicker and cheaper.

Final Design

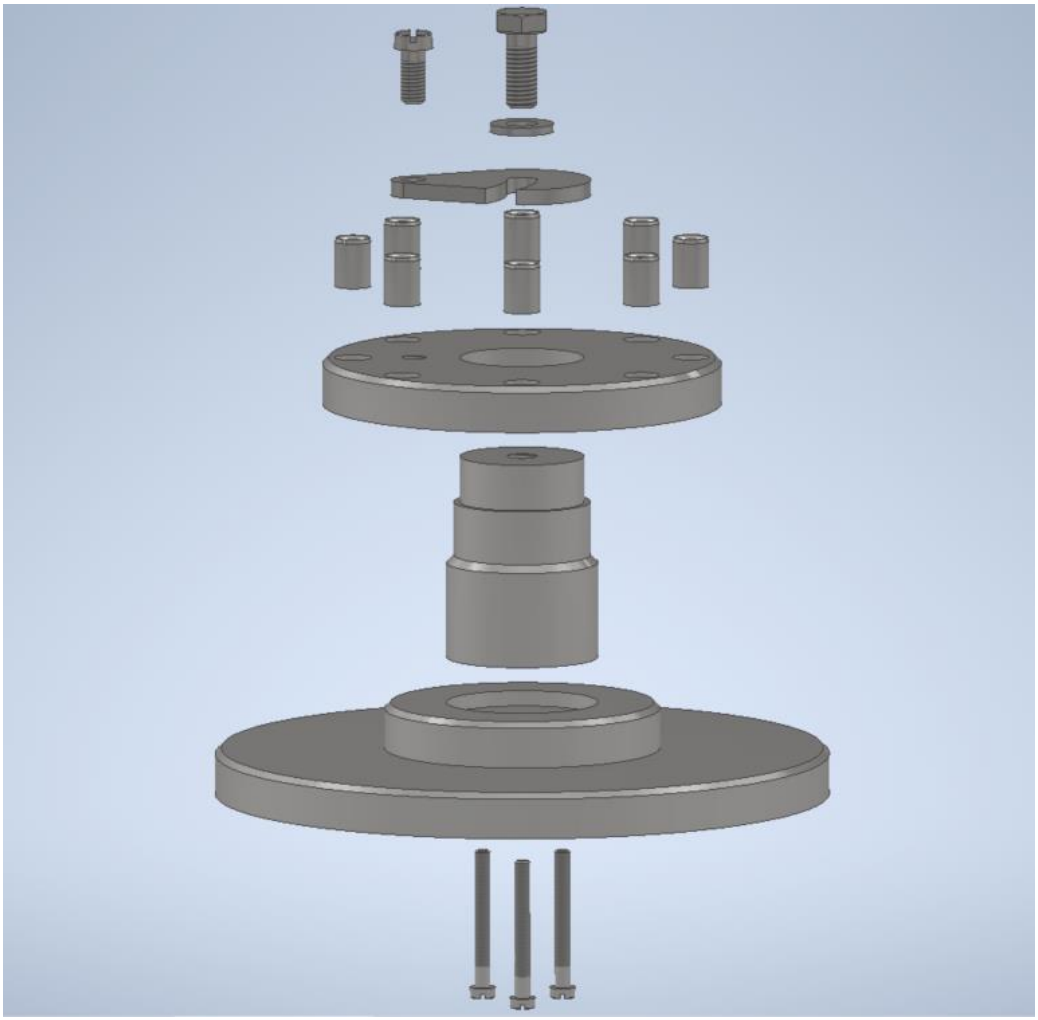


Figure 2: Final Drill Jig Design for Circular Flange

The final design consists of:

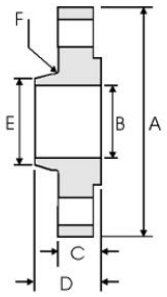
- 1 x Stainless steel base
- 1 x Stainless steel stem
- 1 x Stainless steel jig plate
- 1 x Stainless steel latch washer
- 8 x DIN 179 - B 10,1 x 12:6 drill bushings (STANDARD)
- 3 x CSN 02 1131 A M5 x 45:1 socket head bolts (STANDARD)
- 1 x CSN 02 1131 A M8 x 18:1 socket head bolt (STANDARD)
- 1 x AS 1110 - Metric M10 x 25:1 bolt (STANDARD)
- 1 x AS 1970 (1) 10:1 washer (STNDARD)

Description of Design Approach

The following process of approach was practiced when designing a drill jig to meet the design factors mentioned before.

Selection of Mechanical Component

After extensive research and obtaining multiple different mechanical parts, the chosen mechanical part to be manufactured is a Stainless steel BS 4504 slip on circular flange (CODE 112). This specific part is widely used for pipes, valves and fittings. The standard dimensions for the selected flange are shown below. The flange has 8 holes (diameter 8) evenly spaced out around the flange. The hole in the middle has thread which screws onto the stem and is used as extra support and accuracy for drilling the holes.



DN	PN	A mm	B mm	C mm	D mm	E mm	F mm
40	6	130	49.5	14	26	70	5
	10 &16	150		16	26	70	
	25 & 40	150		18	32	70	

Figure 3: Standard Dimensions for Selected Mechanical Part

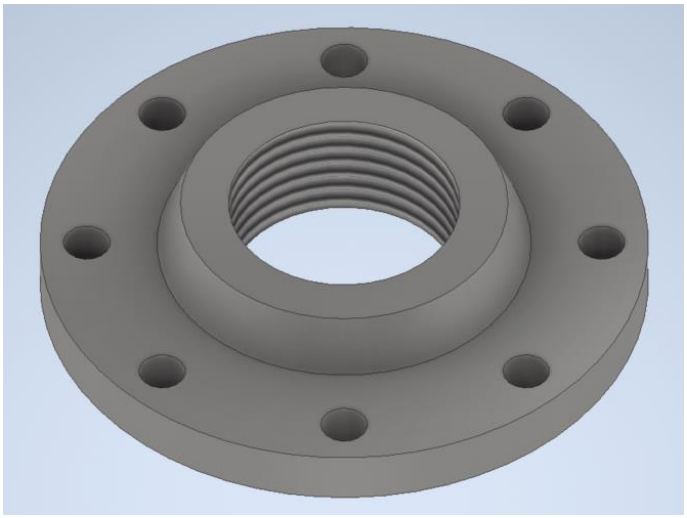


Figure 4: Flange Design in Inventor

Jig Base

The size of the jig base was determined per the size of the part to be manufactured, while considering the components required to mill the part correctly. It is more logical to build a jig to a suitable size as opposed to a standard size – this reduces the cost of the jig and allows for improved control over the positioning of the part. The jig base is made from stainless steel, which is a cheap standard material that maintains a high level of performance. This was the first step towards the jig design. Once the base was correctly sized, the other components of the jig were sized accordingly. The figure below shows the complete base.

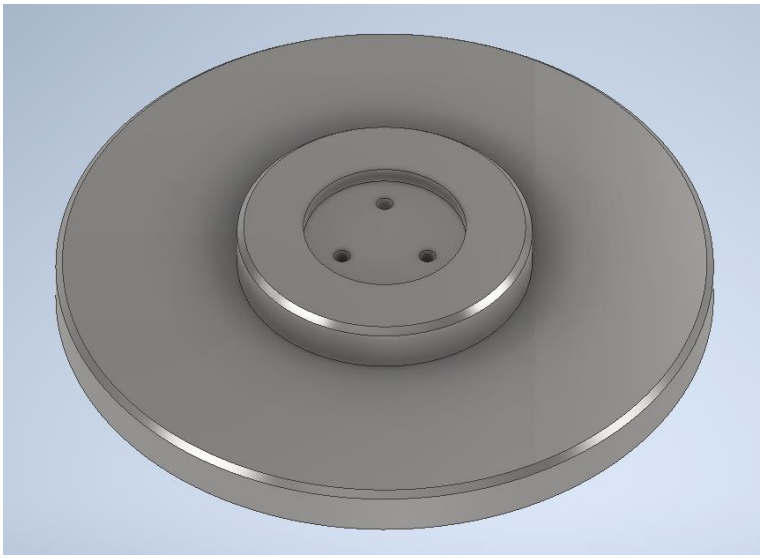


Figure 5: Jig Base Design in Inventor

Positioning system

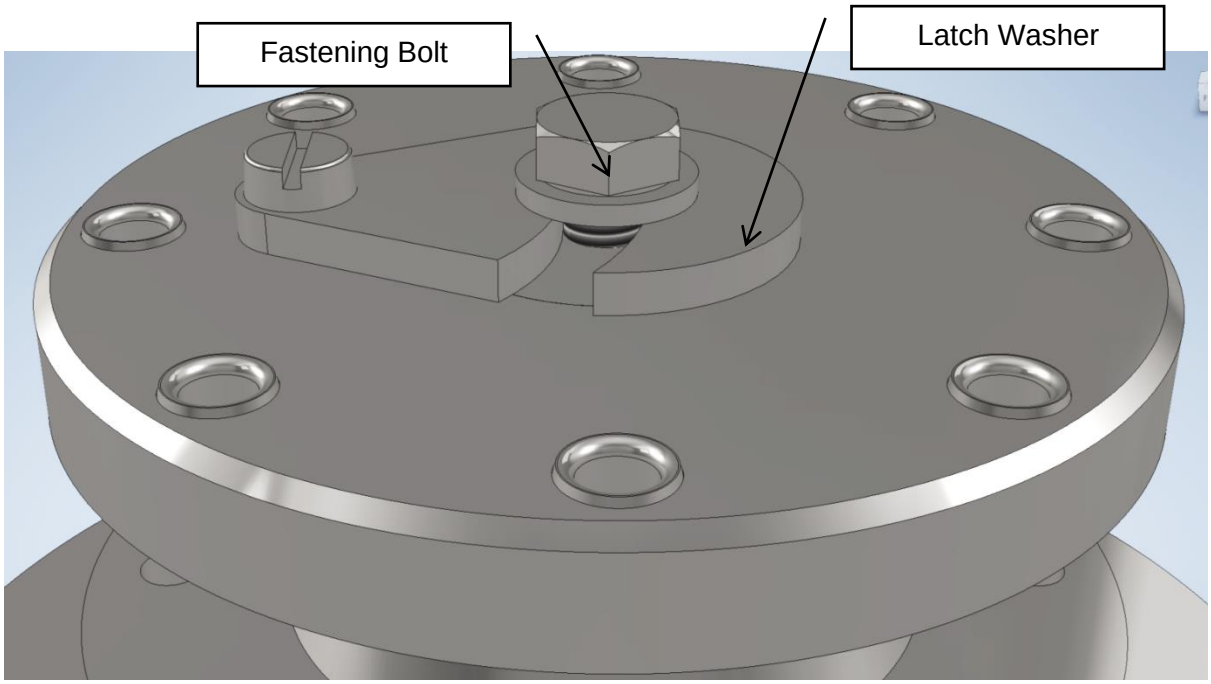
The stem forms a major role in the positioning system and is in fact the most important component when it comes to accuracy and reliability of the drill jig. It is designed to fit each part snug into place. The stem fits into the 5mm indent in the base plate and is fastened by 3 standard bolts which penetrate through the base and into the bottom of the stem. Once this is fitted securely, the flange is then screwed onto the thread of the stem.

The jig plate slips onto the top of the stem and is fastened by the latch washer, as well as the bolt. Once all bolts and parts are fastened together, the jig is ready for use.

Clamping system

One of the most important aspects to consider when designing a drill jig is the clamping system. Without a reliable clamping system, many things can go wrong during the milling process.

A unique component called the latch washer forms a vital part of the clamping of the jig plate. Once the jig plate is in place, the latch washer is secured in place and the bolt is used to tighten it. This will hold the jig plate in place and will allow for zero movement during the milling process. Figure below shows the security of the jig plate:



The latch washer can be released when the bolt is loosened, and the jig plate can be removed to retrieve the complete mechanical component. This is a very simple yet effective design.

Accuracy and Operation

The jig plate consists of 8 holes which contain standard drill bushings. The bushings have a drill diameter of 8mm. The choice to include drill bushings was made because it provides more accuracy when it comes to guiding the drill bit through the jig plate to the flange. The thickness of the jig plate was increased to allow for vertical and accurate drilling.

Ergonomics Safety

The drill jig is going to be manually operated and therefore needs to be safe and easy to use. The design is very easy to operate and allows quick and efficient placing and removal of the part.

Materials

Most of the designed components, including the jig base, stem, jig plate and the latch washer were made from stainless steel.

Material Selection

The choice of materials used in manufacture is important as it can affect the cost, durability and strength of the design. After researching many different material characteristics and properties, I have chosen to design a stainless steel drill jig. There are many properties of stainless steel that make it such a popular material to use in the design of mechanical parts.

Advantages of Stainless Steel:

- High resistance of heat.
- Impact resistance and strength.
- Sustainable and cheap as it is typically created from 70% scrap metal.

Properties of Stainless steel are shown below:

Property	Value
Density (x 1000 kg/m^3)	8
Tensile Strength (MPa)	515
Yield Strength (MPa)	205
Hardness (HRB)	88

Calculations

Stress on latch washer

Material: Stainless Steel with a yield strength of 205 MPa

Factor of safety:

$$n = 2\ (factor\ of\ safety)$$

$$\sigma = \frac{S_{sy}}{n} = \frac{205MPa}{2} = 102.5\ MPa$$

Inventor manually calculates the mass of each part. The mass of the assembly is 8.159 kg as shown below:

Mass	8,159 kg (Relative Err
Area	181976,846 mm^2 (R
Volume	1020179,411 mm^3 (

Estimated Cost

The estimated cost of the drill jig was calculated by multiplying the mass of the assembly by the cost of stainless steel per kg.

Estimated Cost of Stainless steel = R 300 / kg

Therefore, the cost to design the jig is calculated below:

$$Cost = Mass\ \text{x}\ Price\ per\ kg$$
$$= 8.159\ \text{x}\ 300$$
$$= \pm R2500$$

Conclusion

The report has reflected on all the steps taken to design the drill jig. It has used standard components were possible to save the cost of the overall design, as the part is manufactured in limited volumes. Some other parts have been designed to meet the needs of the design.

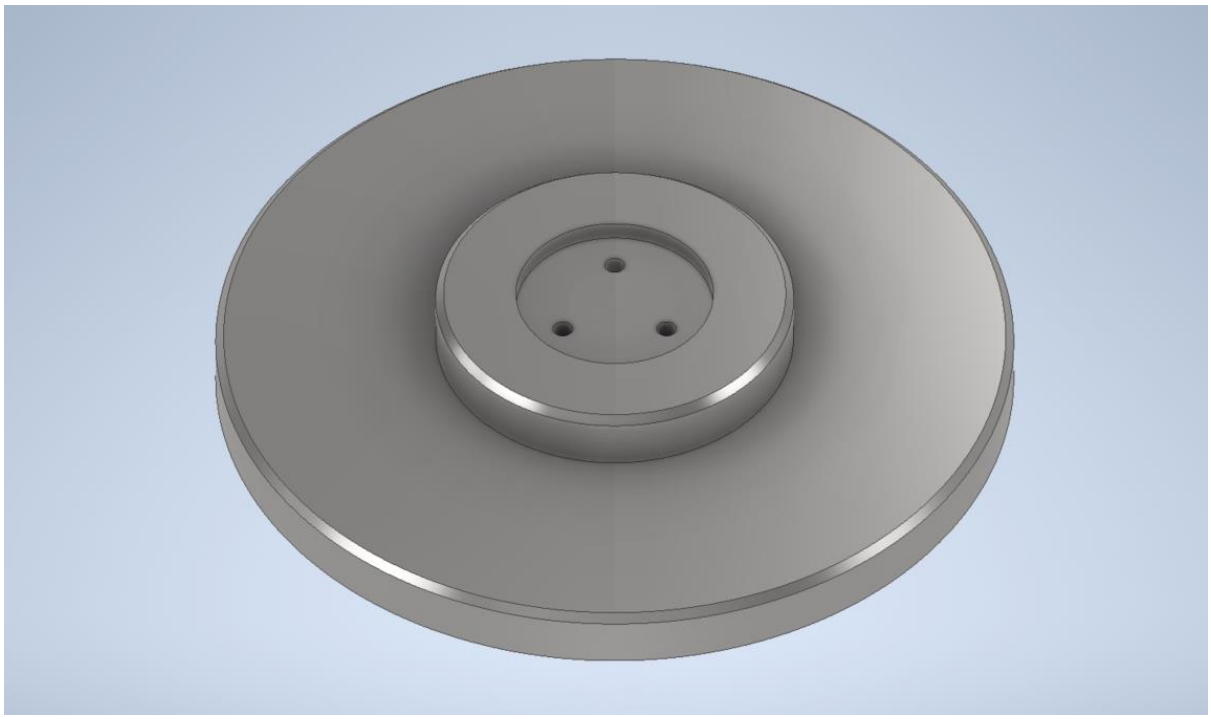
Another benefit to using standard parts is not only saving cost wise but saving the trouble of finding the parts if they get worn or damaged.

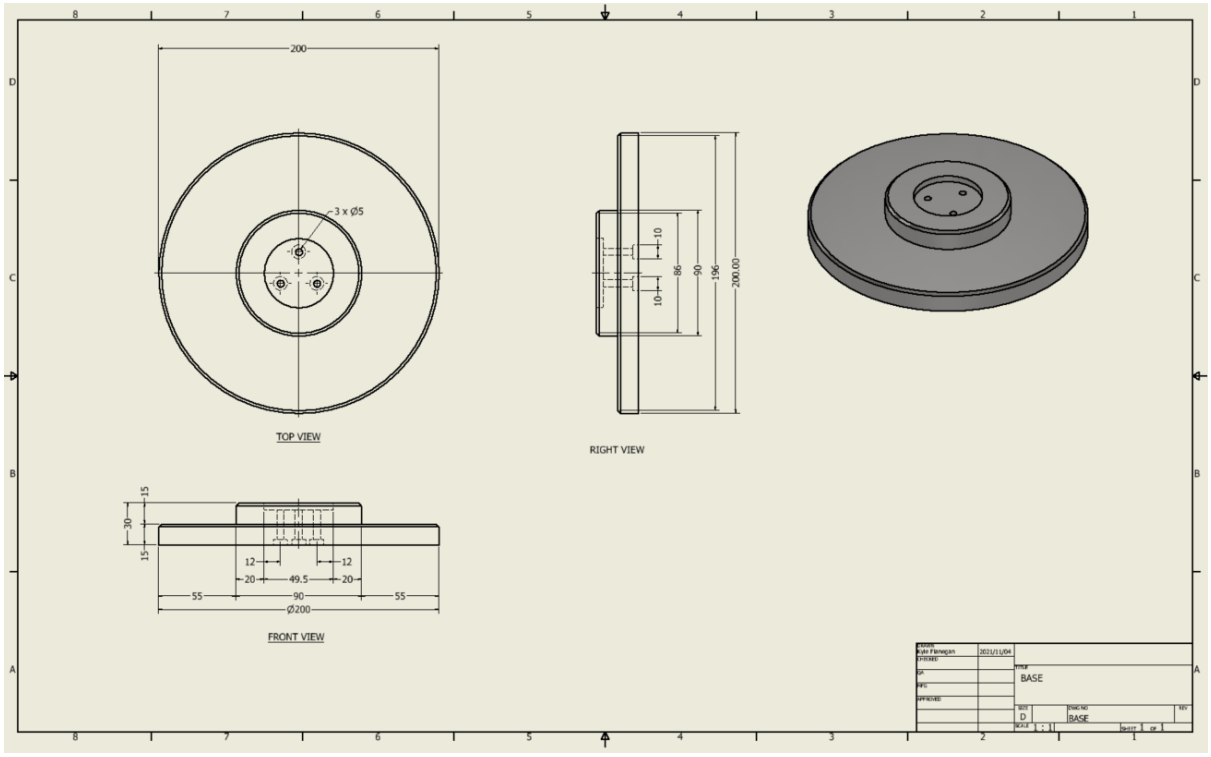
The clamping system is very reliable as I have mentioned above. All components of the jig fit perfectly together which will allow for very accurate results during the milling process.

The drill jig was designed for high precision and performance. Stainless steel was chosen as the material that was used mostly throughout the design of the components due to its incredible strength, durability, cost and many more factors.

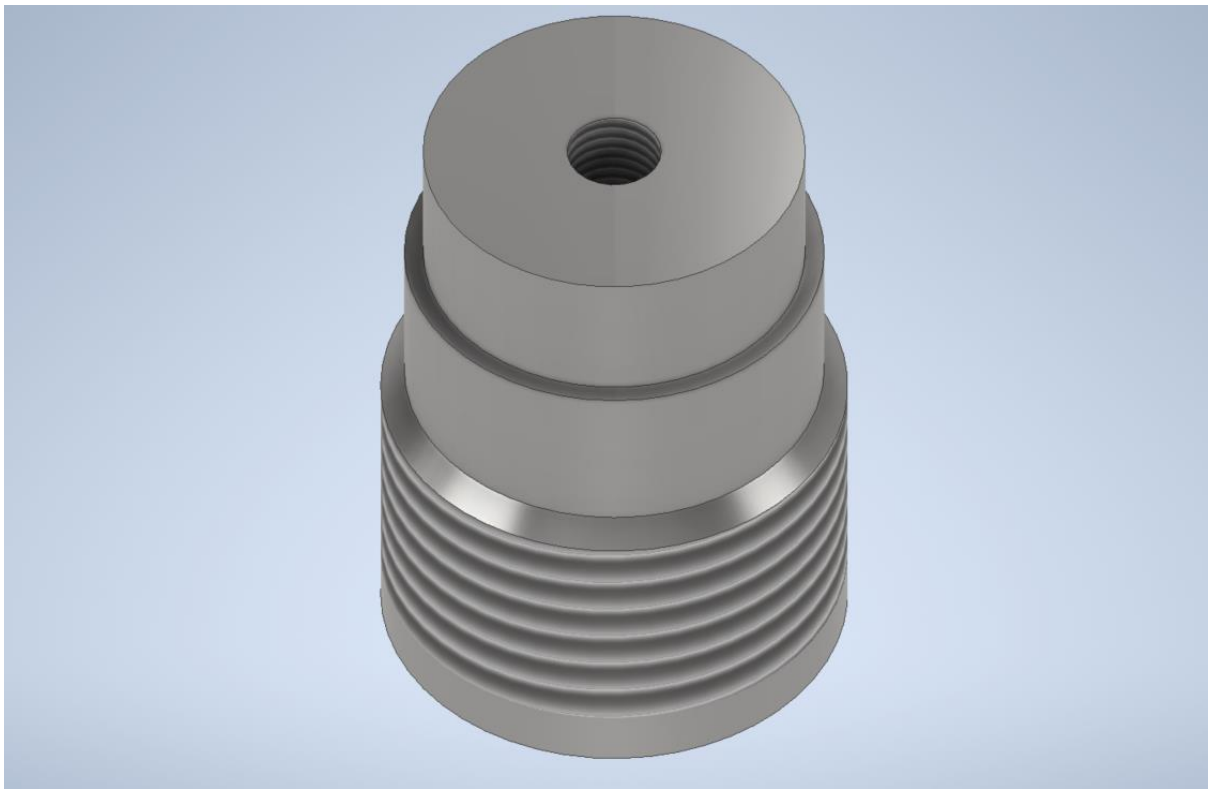
Drawings

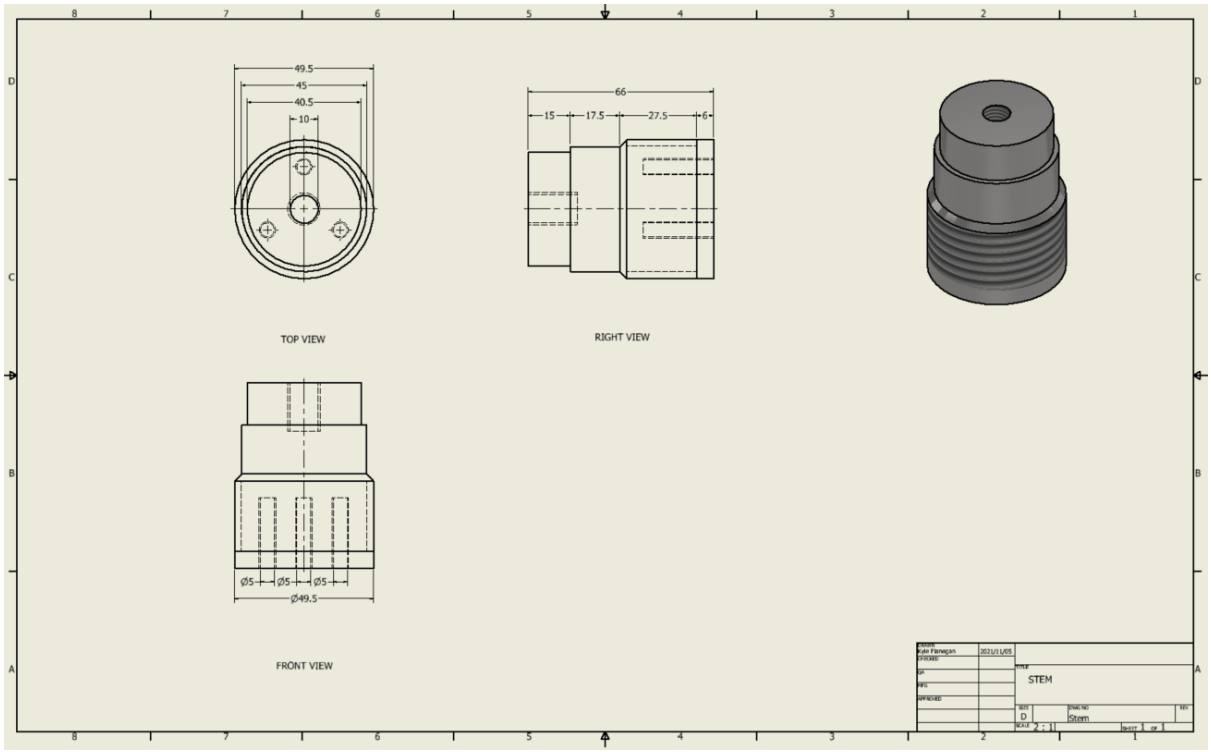
Base plate



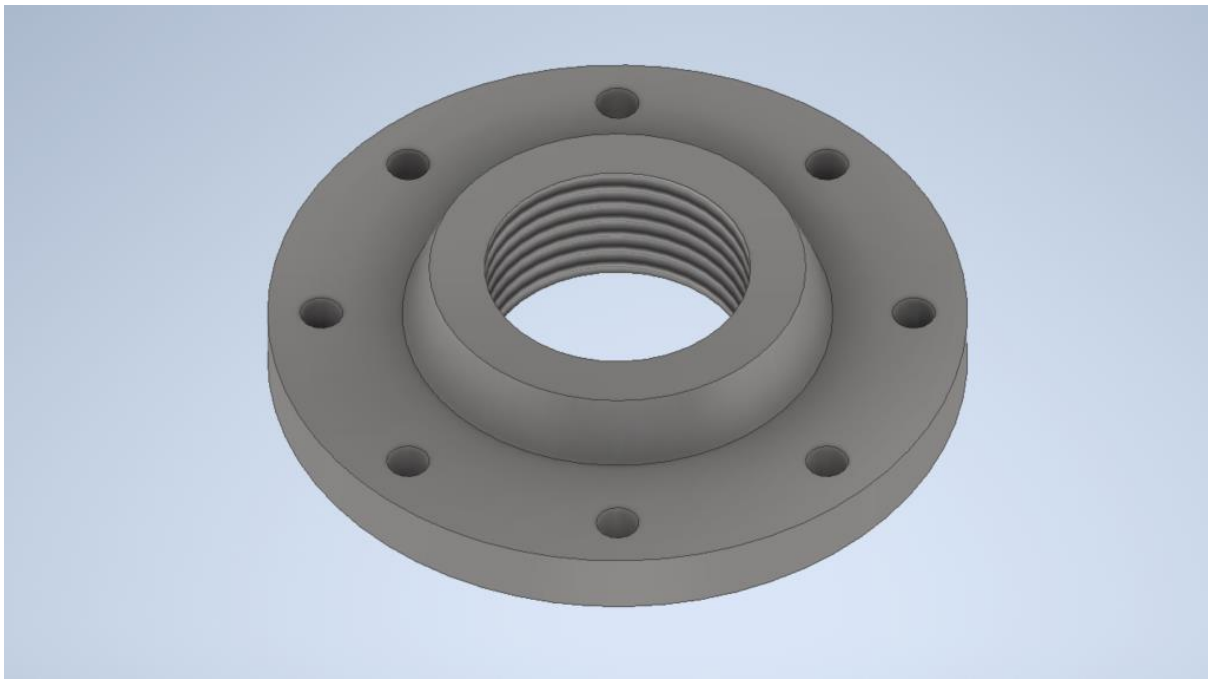


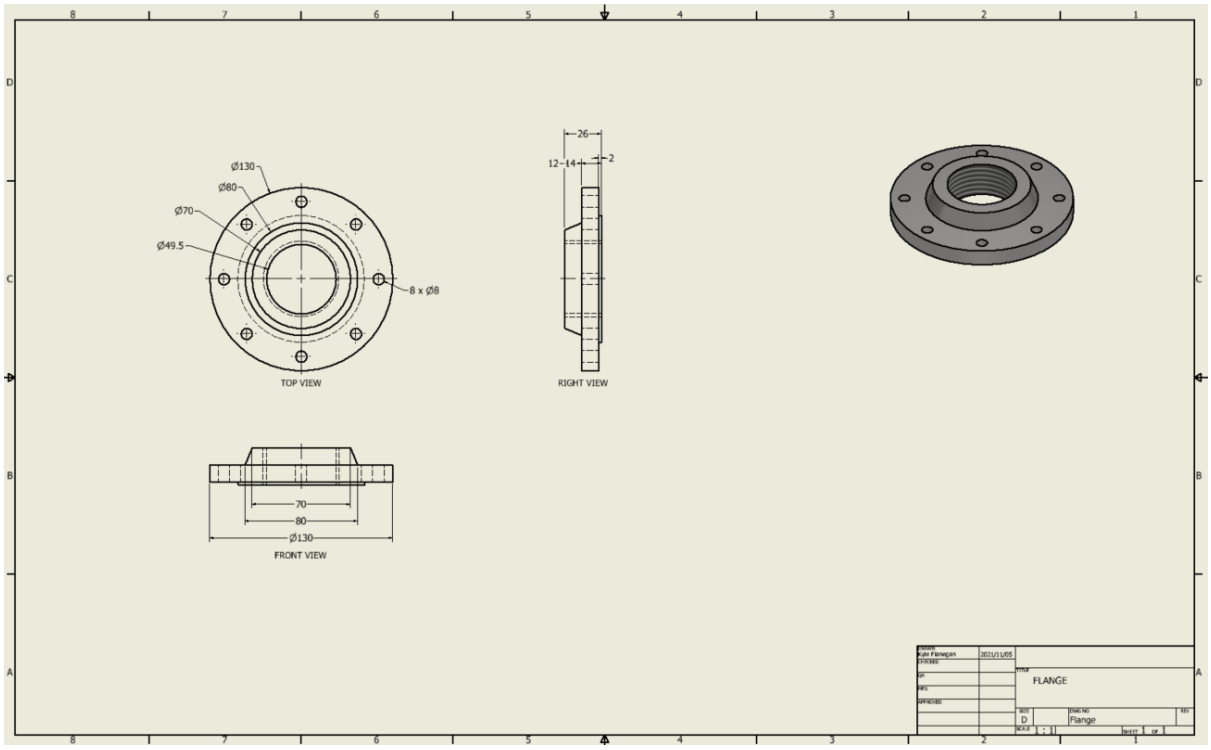
Stem



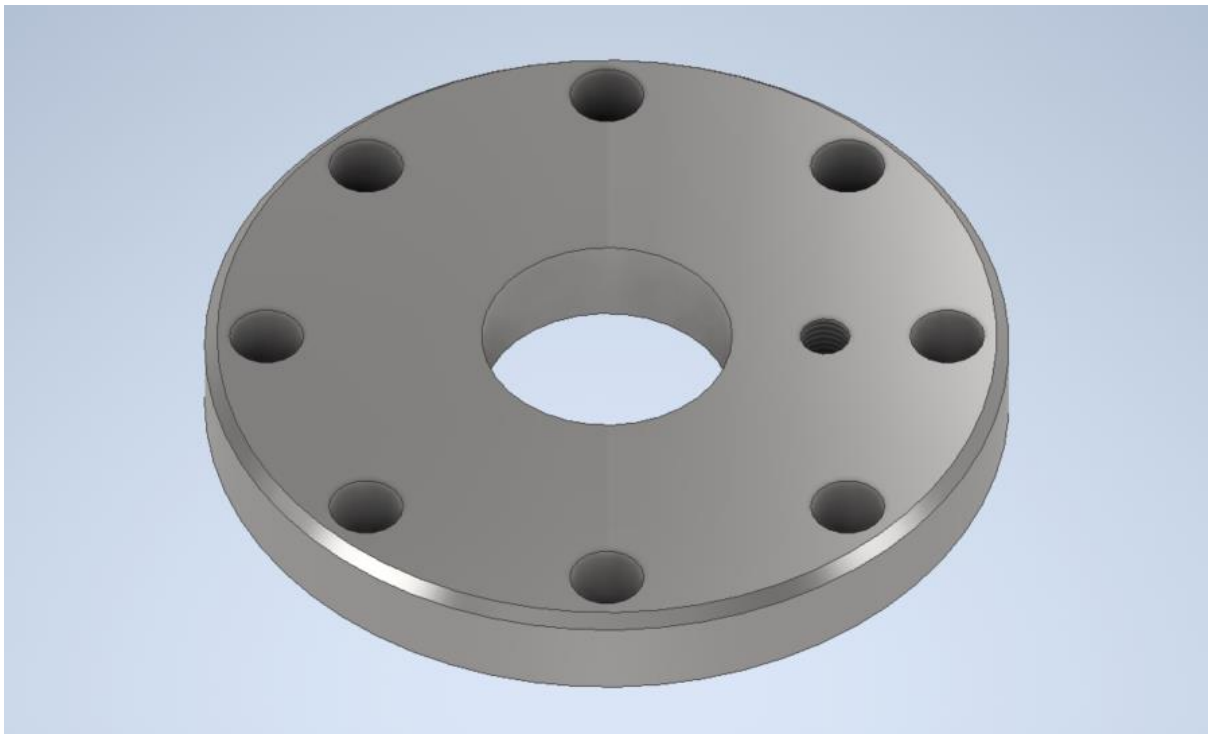

49.5
45
40.5
10
TOP VIEW
66
15
17.5
27.5
6
RIGHT VIEW
Ø5
Ø5
Ø5
Ø49.5
FRONT VIEW
STEM
D
Stem
SCALE 2 : 1

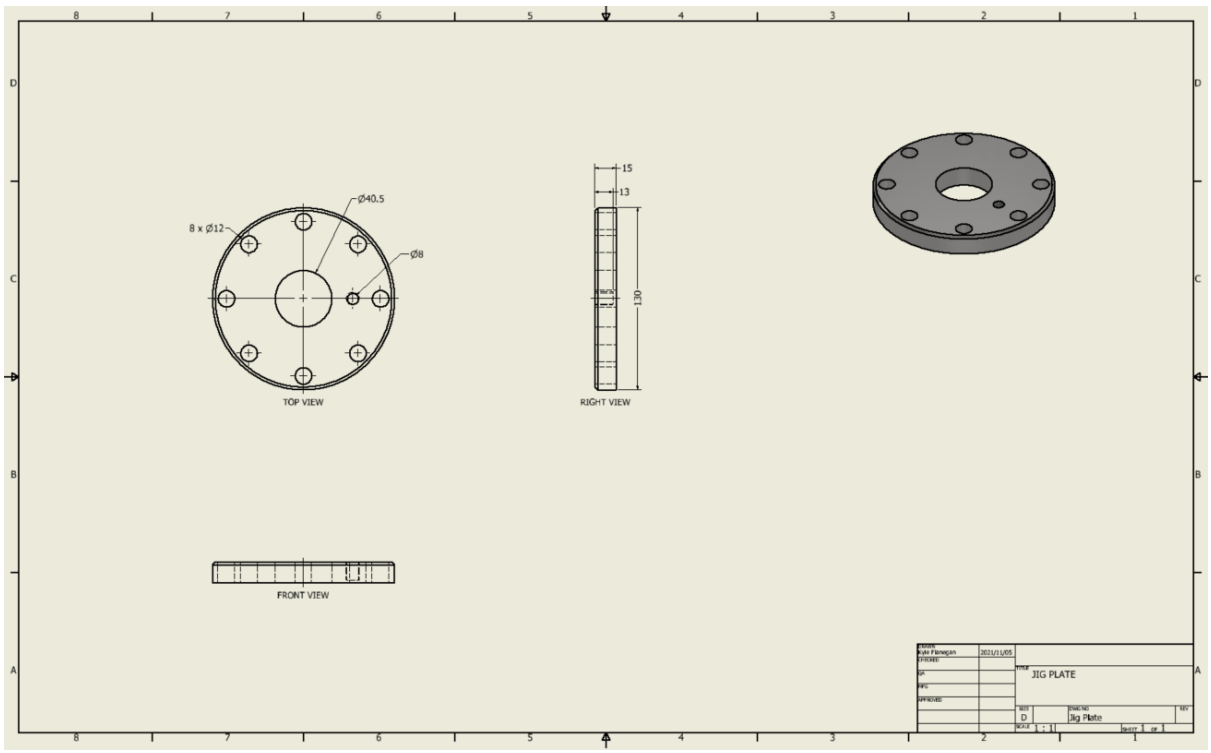
Flange



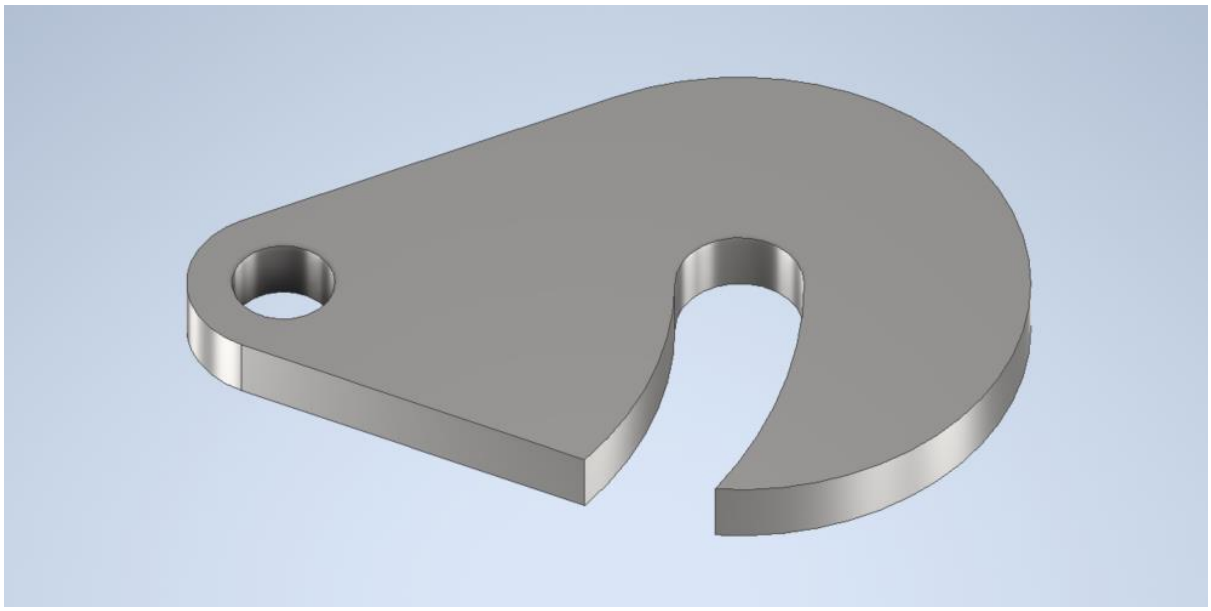

Ø130
Ø80
Ø70
Ø49.5
8 x Ø8
TOP VIEW
26
12-14
2
RIGHT VIEW
70
80
Ø130
FRONT VIEW
FLANGE
D
Flange

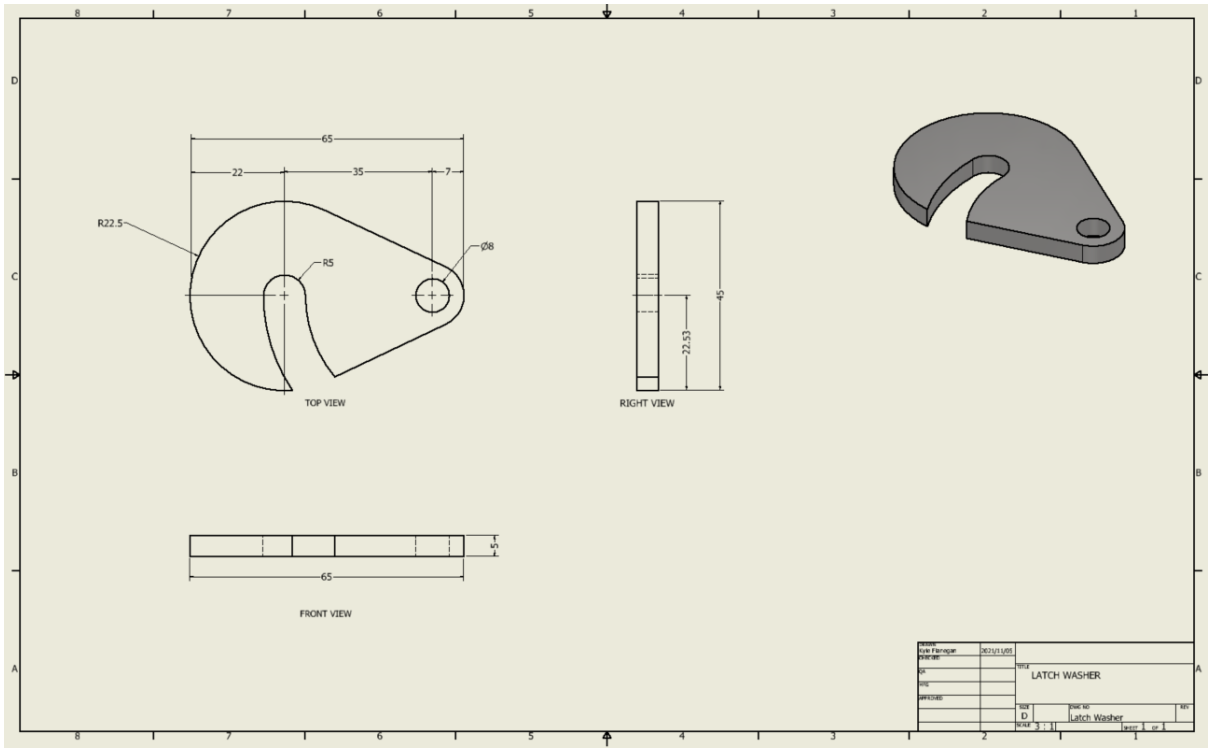
Jig Plate



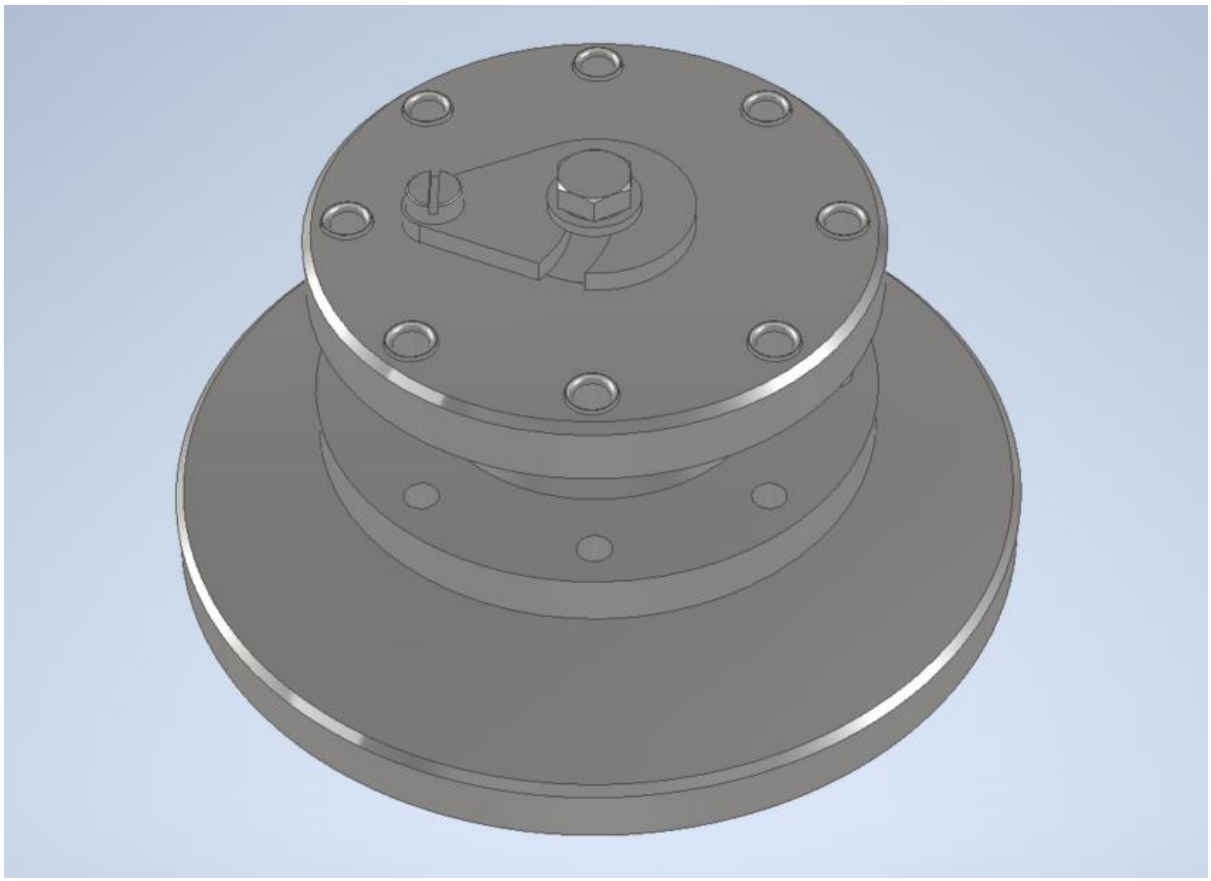

8 x Ø12
Ø40.5
Ø8
TOP VIEW
15
13
130
RIGHT VIEW
FRONT VIEW
JIG PLATE
Jig Plate
D

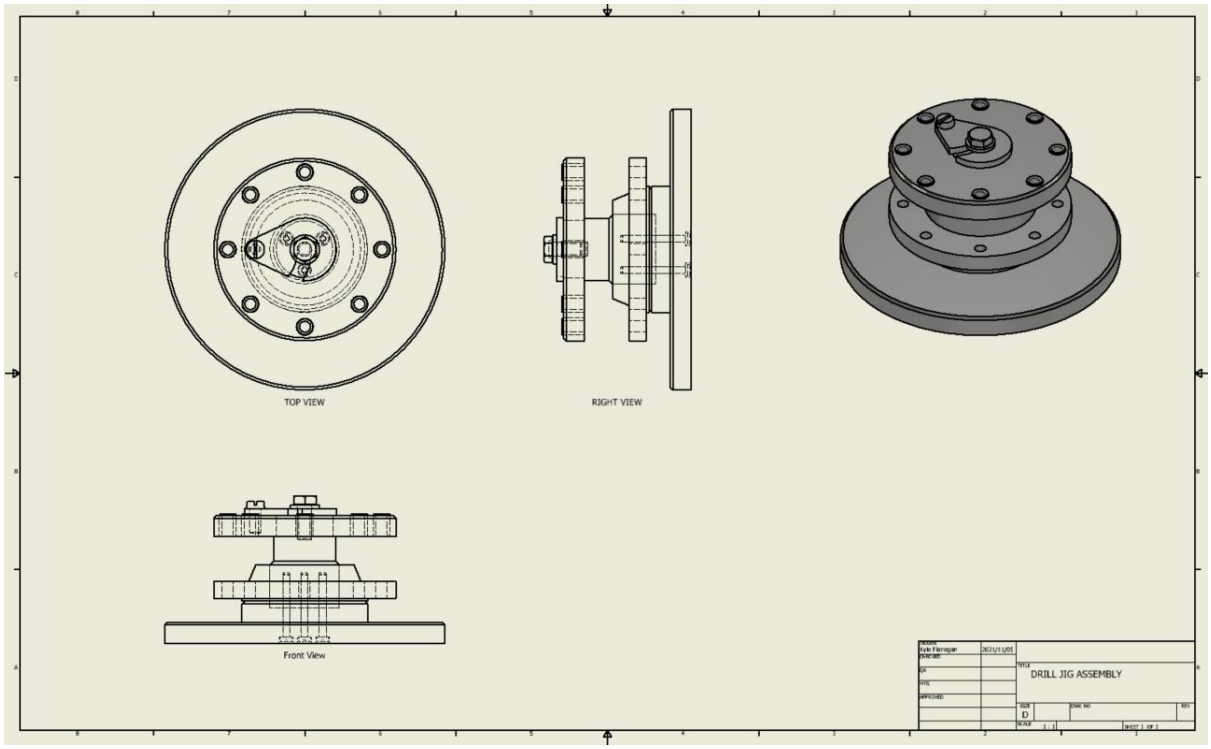
Latch Washer





Assembly





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Google.com. 2021. Before you continue to Google Search. [online] Available at: <https://www.google.com/search?q=why+do+you+need+drill+bushings&oq=why+do+you+need+drill+bushings&aqs=chrome..69i57j0i22i30j0i390.6756j0j7&sourceid=chrome&ie=UTF-8> [Accessed 5 November 2021].

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