THE MAKING OF CLOCK PARTS

Learning “to think”.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

“ I’M NOT HERE TO THINK FOR YOU BUT TEACH YOU TO THINK FOR YOURSELF. ”

A QUOTE FROM ONE OF MY WATCH AND CLOCK REPAIR TEACHERS 30 PLUS YEARS AGO.

ALWAYS WEAR YOUR SAFETY GLASSES!

Ask my friends for help.

- No one really knew how to "make" anything.
- I was given formulas how to calculate a part, or a step by step procedure but not "how to make the part" without spending a substantial amount of money on equipment.
- I wasn't looking to go into the clock manufacturing business, just wanted to make a part to fix a clock.
- I know that clocks and watches were made forever without a lot of equipment so why is this so difficult. They always had some sort of lathe.
- One very good friend of mine told me to "figure it out"!
  - He told me if I tell you how to make this, you really haven't learned anything.
    - Come back next week with a "plan" how you think it should be made.

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- Coming to class.
  - Drive, fly, walk?
  - Stay at a hotel?
  - What should I bring to class.
  - Do I need any additional information from the instructor?
- Without a plan, how can you expect to learn. The same holds true for making parts.

A PLAN!

ALWAYS WEAR YOUR SAFETY GLASSES!

- Reference material.
  - Many books will have formulas to calculate a clock or watch part, but not the procedure on making it.
    - We will concentrate more on producing, than the calculation of the part.
    - I will show different techniques to make a part using different types of tools and equipment.
    - The techniques you learn will help you make almost any part.
    - Remember to always depend on your strengths.

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A PLAN

ALWAYS WEAR YOUR SAFETY GLASSES!

What is the part called.

What material will you be using.

What tools will you need.

What are your strengths.

What are your weaknesses.

What procedure will you use to make the part.

A plan should contain even the smallest details. This will help eliminate mistakes.

YOUR PLAN IS YOUR PLAN, EXCLUSIVE TO YOU!

ALWAYS WEAR YOUR SAFETY GLASSES!

THE PLAN WORK SHEET.

Part Name: _____

Material: _____

Tools: _____

Strengths: _____

Weakness: _____

Procedure:

1._____

2._____

3._____

4._____

5._____

6._____

7._____

9._____

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Material:

Will you make your part from:

Brass

Steel:

Cold Rolled Steel

12L14 Leaded Steel

Tool Steel

Spring Steel

Other?

Plastic

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BRASS

- Brass should be hard or half-hard leaded engraving brass.
- Brass such as CZ 118, CZ 119, or CZ 120, with a hardness of 120-130 VNP.
- A typical composition would be Copper 61-64% lead 1-2% and remainder zinc. Do not use soft brass which will clog the cutter and spoil the work.

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STEEL

- Steel for should be a free cutting steel such as 12L14.
  - Contains a small amount of lead for easy machining.
  - This can’t be hardened.
- For something that needs to be hardened, a W1, or O1 tool steel will work very well.
  - These steels will harden by water or oil. Very good for verges and arbors.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

- Tools:
  - What tools will you need:
    - Lathe
    - Drill Press
    - Milling Machine
    - Cutters
      - Graver
      - Ground Tooling
    - Saws
    - Other Disposable Tooling
      - Drills
      - Taps

ALWAYS WEAR YOUR SAFETY GLASSES!

What Are Critical Surfaces.

- Bearing surfaces.
- Mating surfaces.
- Escape Wheel Hubs.
- Wheel and pinion diameters.

What Are Not.

- Clearance surfaces.
- The spokes on wheels.
- Size of the plates.

CRITICAL SURFACES

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Strengths

- Machining in the lathe
- Sawing
- Taping Holes
- Making a drawing and following it.

Weakness

- Drilling a hole in a round object on center.
- Taping holes
- Measuring machined surfaces
- Following a drawing

YOUR PLAN IS YOUR PLAN

ALWAYS WEAR YOUR SAFETY GLASSES!

- Make a step by step procedure that you feel comfortable following.
- Include the smallest of details
  - How will you hold your material.
  - What are the critical surfaces.
  - If I machine this surface will I be able to machine the other surfaces.
  - Were is my starting point.
- Make “A DRAWING”. Include all your dimensions.

YOUR PLAN

ALWAYS WEAR YOUR SAFETY GLASSES!

UPDATES TO YOUR EQUIPMENT

These are some of the updates that will help in making clock parts on the your Lathe.

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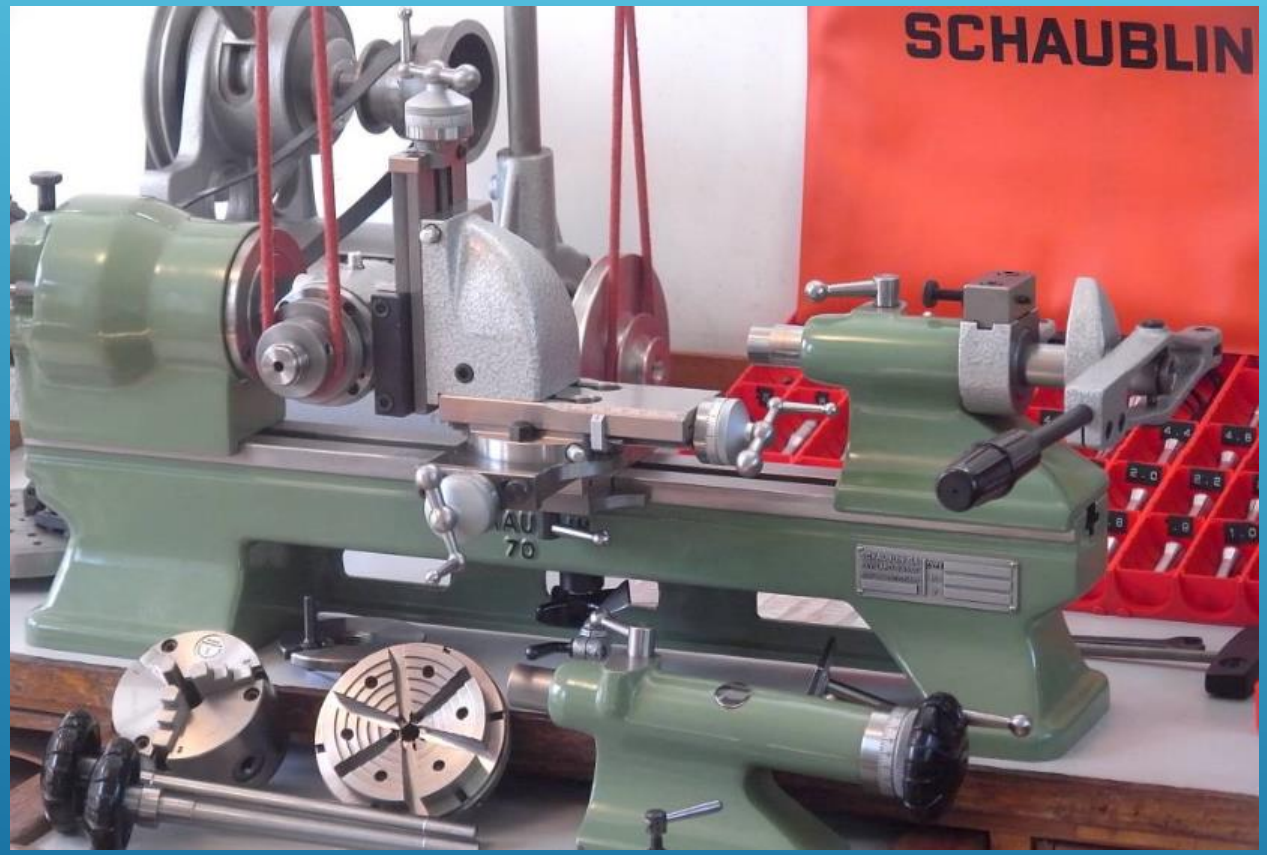


SCHAUBLIN 70 LATHE

This is very much like the lathe I use for making all my watch and clock parts.

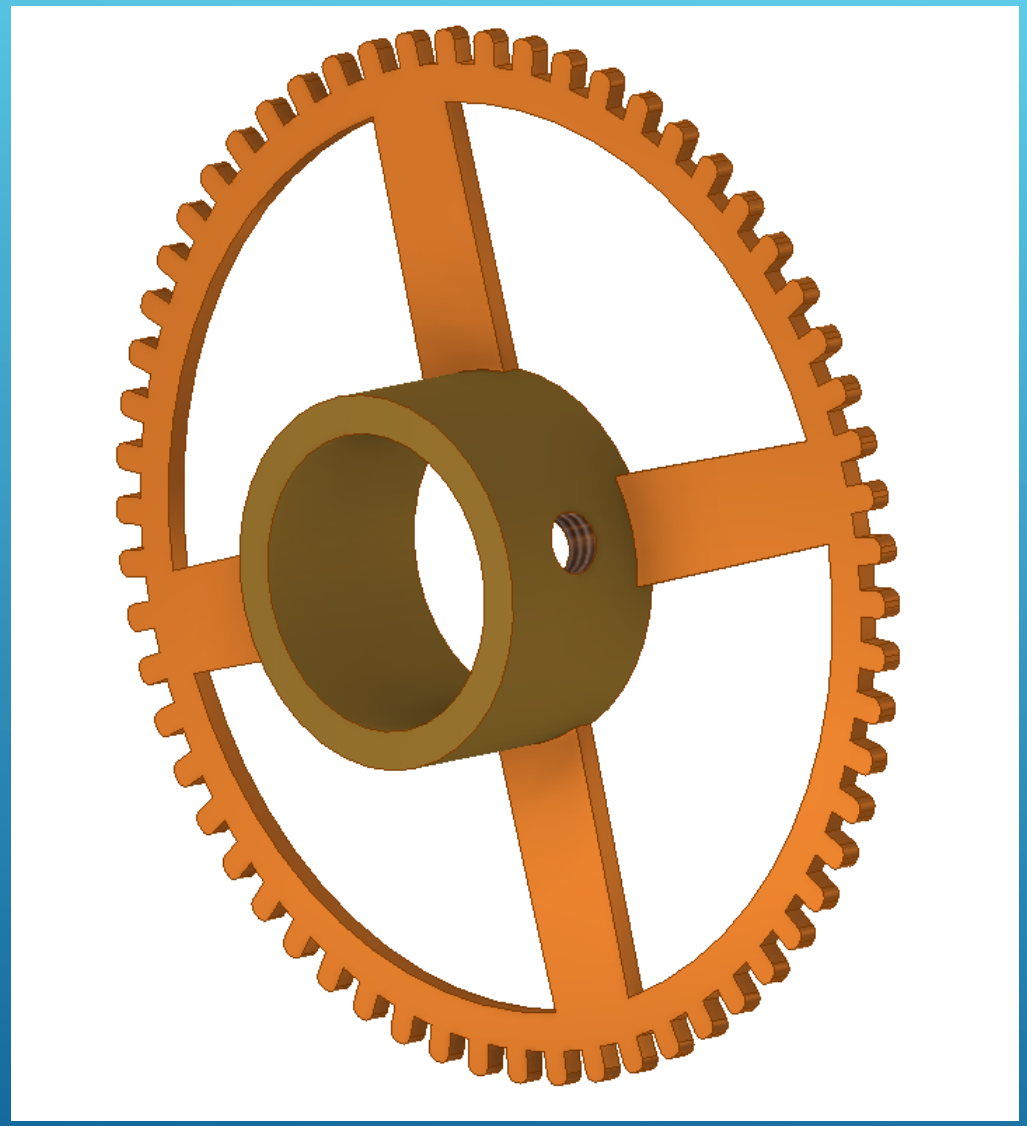
Notice the milling attachment.

With all the accessory's that my lathe has, I'm sure it has a value of over $8000.00.

Not what the novice repair person would spend.

This is one of the reasons why I came up with this class.

You don't need to spend a lot of money to get good quality parts.



INDEX FIXTURE

Made from a 60 tooth old clock wheel.

This will aid in indexing the headstock to a specific position.

Mounts to headstock shaft.

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60 TOOTH CLOCK WHEEL

This wheel is mounted to a hub and then mounted to the headstock shaft of the lathe.

A 60 tooth wheel will handle many of the increments we are looking for.

Making a square (every 15 teeth)

Making a 5 tooth lantern pinion,

(every 12 teeth).

Making a 6 tooth lantern pinion,
(every 10 teeth).

INDEXING LOCK SPRING

This will lock the headstock to a specific division of a circle.

Very inexpensive to make, and very effective.

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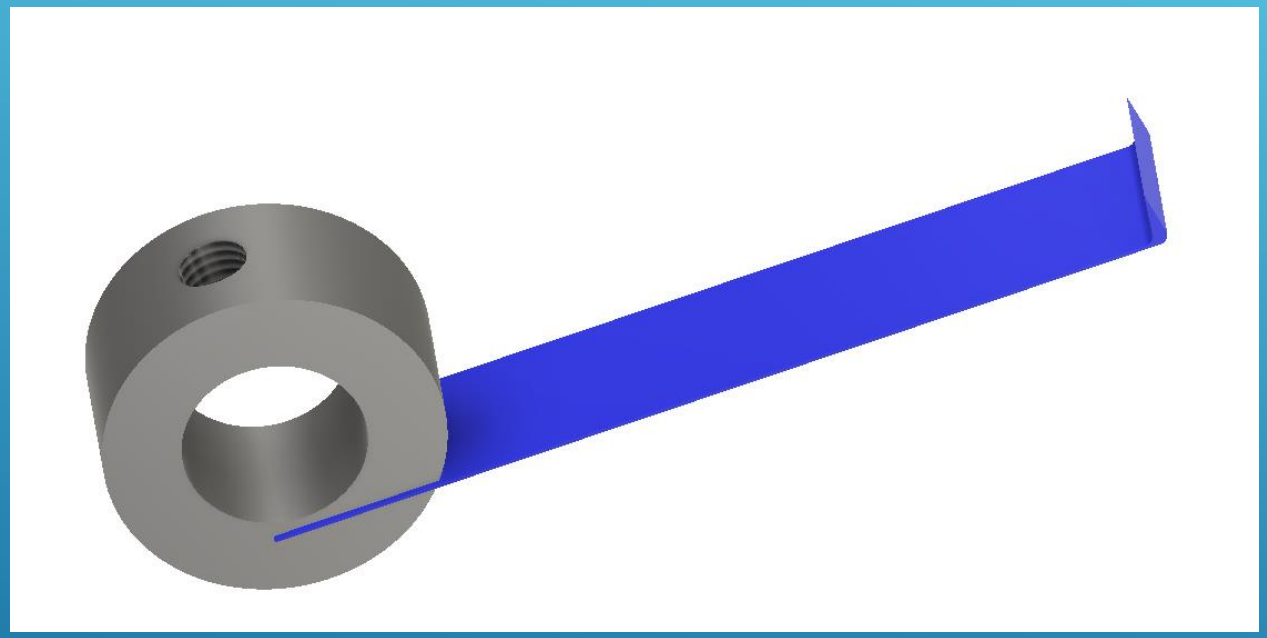

INDEXING LOCK

Spring steel for the lock lever.

Cold rolled steel for the holder.

Drill and tap for a set screw.

INDEX PLATE 1/8" X 3.6 DIA. SHERLINE - WATCHMAKER LATHE - CLOCK WHEELS USA

Purchased on EBay for $59.00

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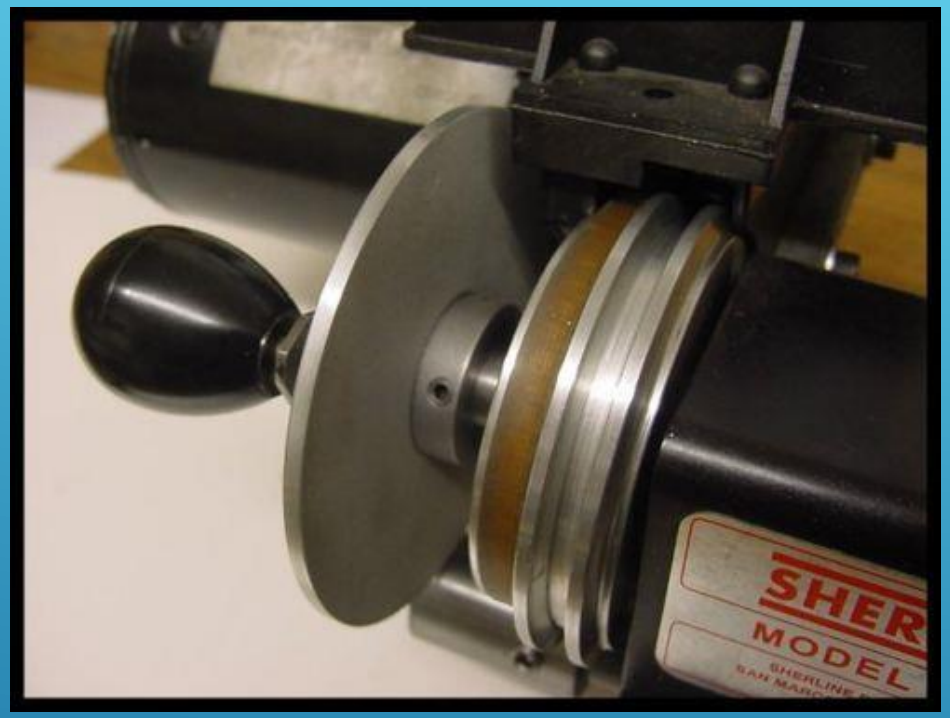

ASSEMBLED TO THE LATHE

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QUICK CHANGE TOOL POST FITS SHERLINE

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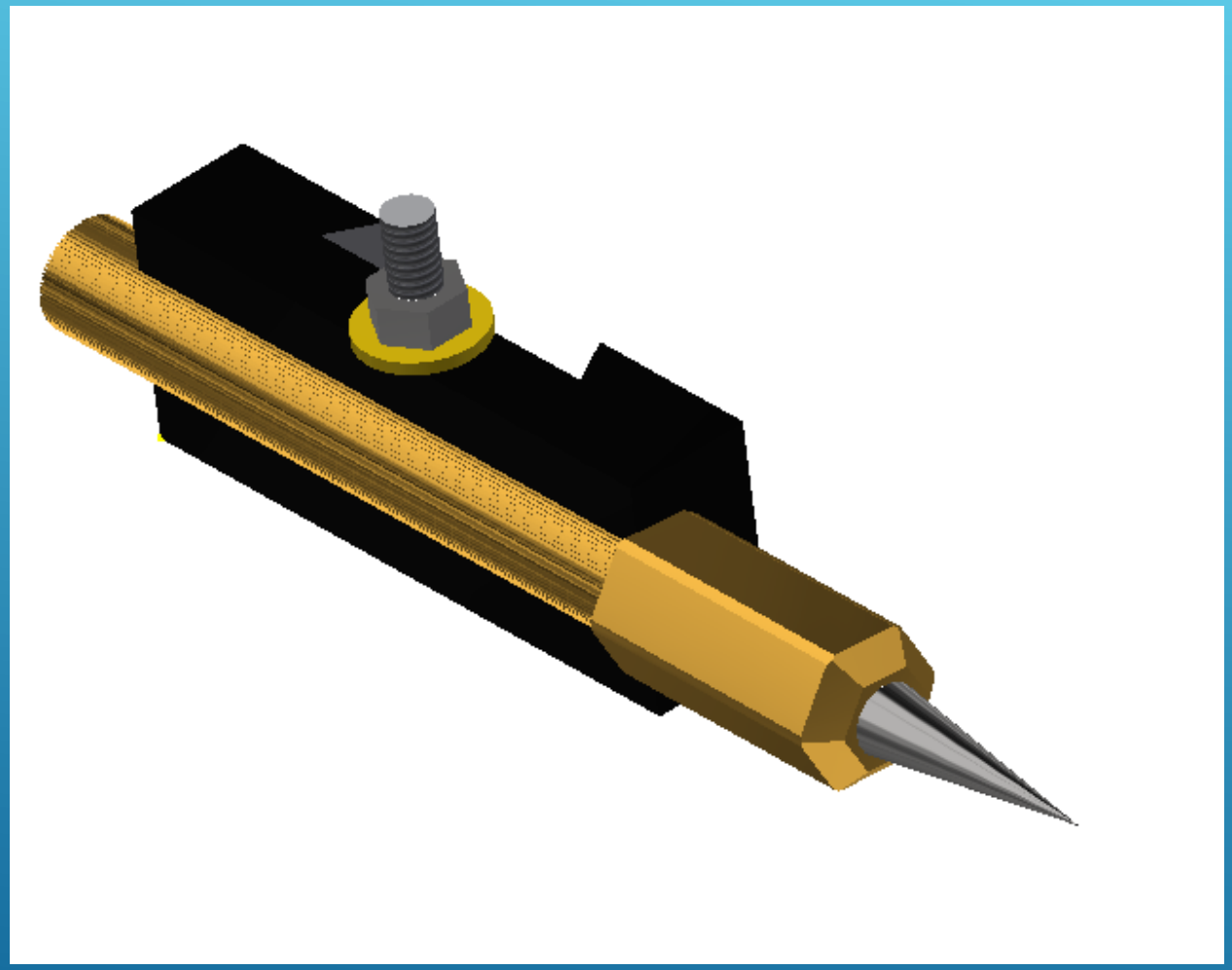
TOOL POST RISER BLOCK

Use this block under the tool post if you need more clearance.

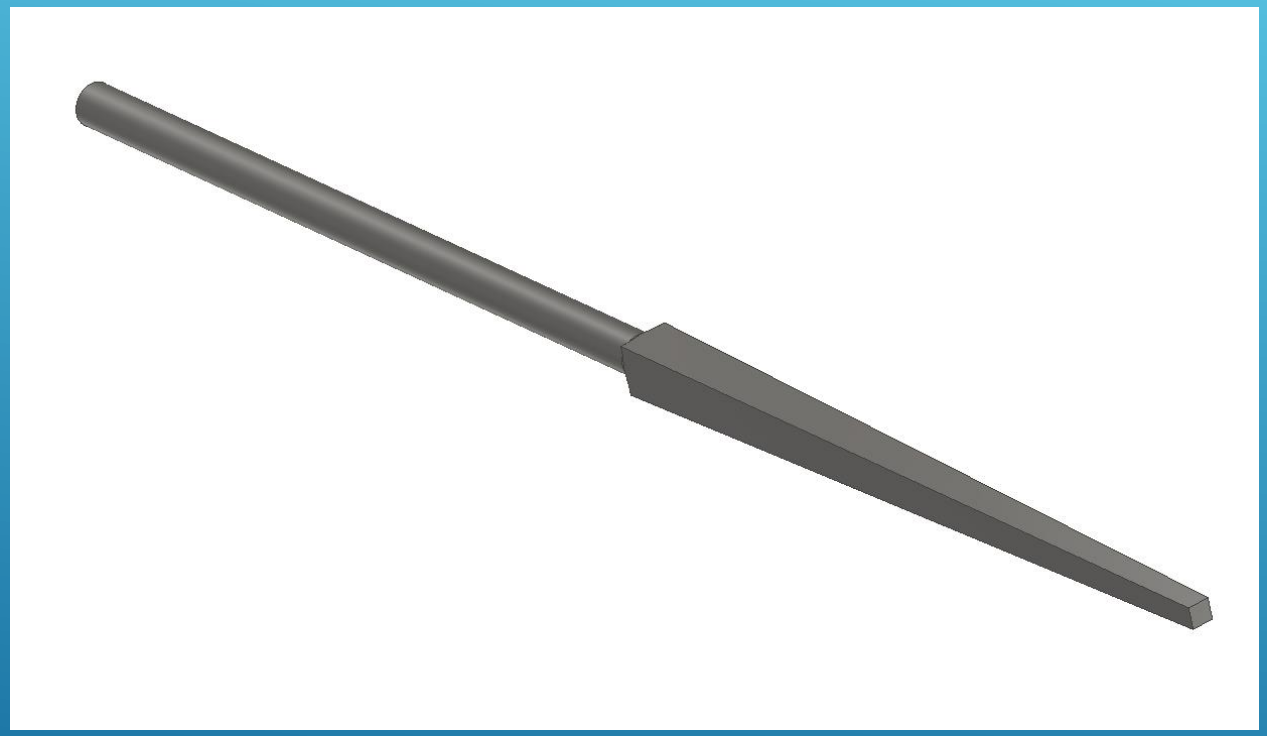


LAYOUT TOOL

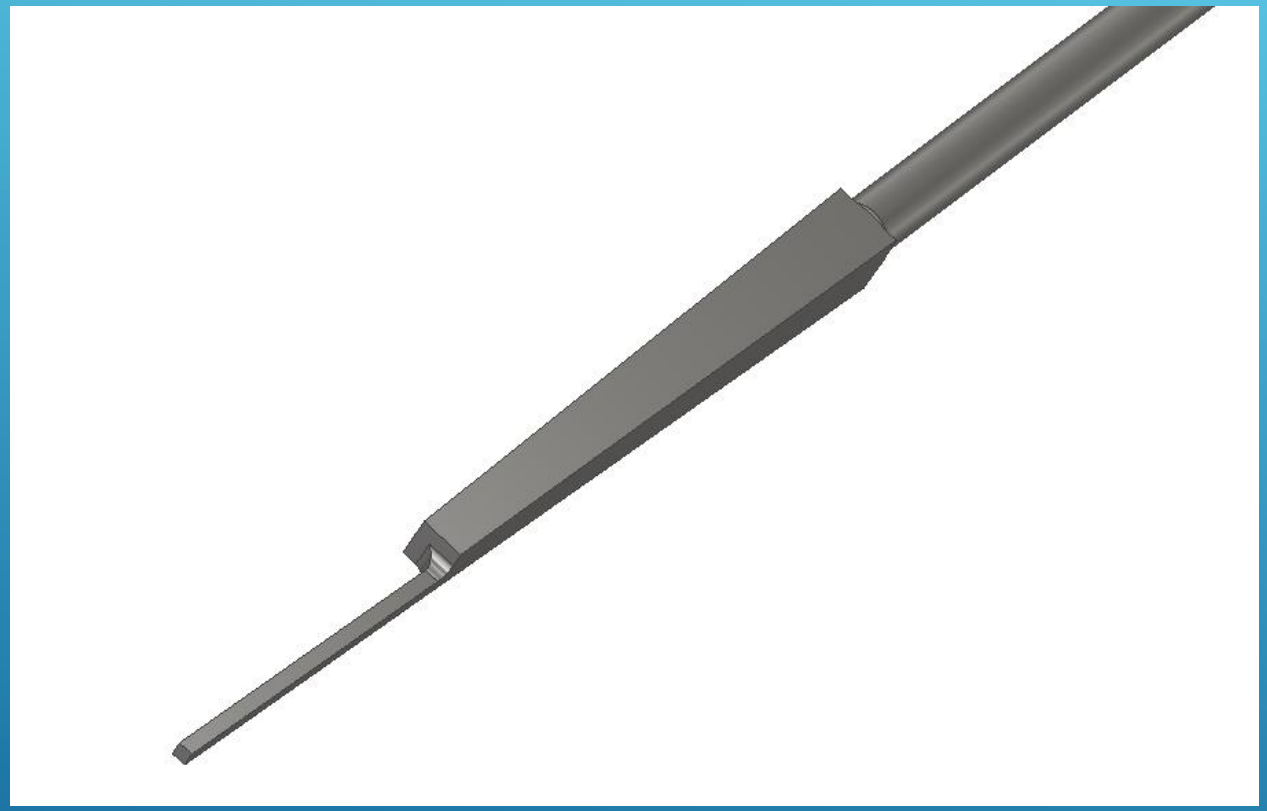
This is a pin vise in a tool holder.

The pin is a phonograph needle. These are very hard a do a great job in scribing a circle or line.

MAKING A SMALL SQUARE FILE



ALWAYS HAVE YOUR SAFETY GLASSES ON!



MAKING A SQUARE FILE

Grind a safety edge on two sides of a file to reduce the size of the cutting edge.

Using the two untouched edges, you can now file a small square hole.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

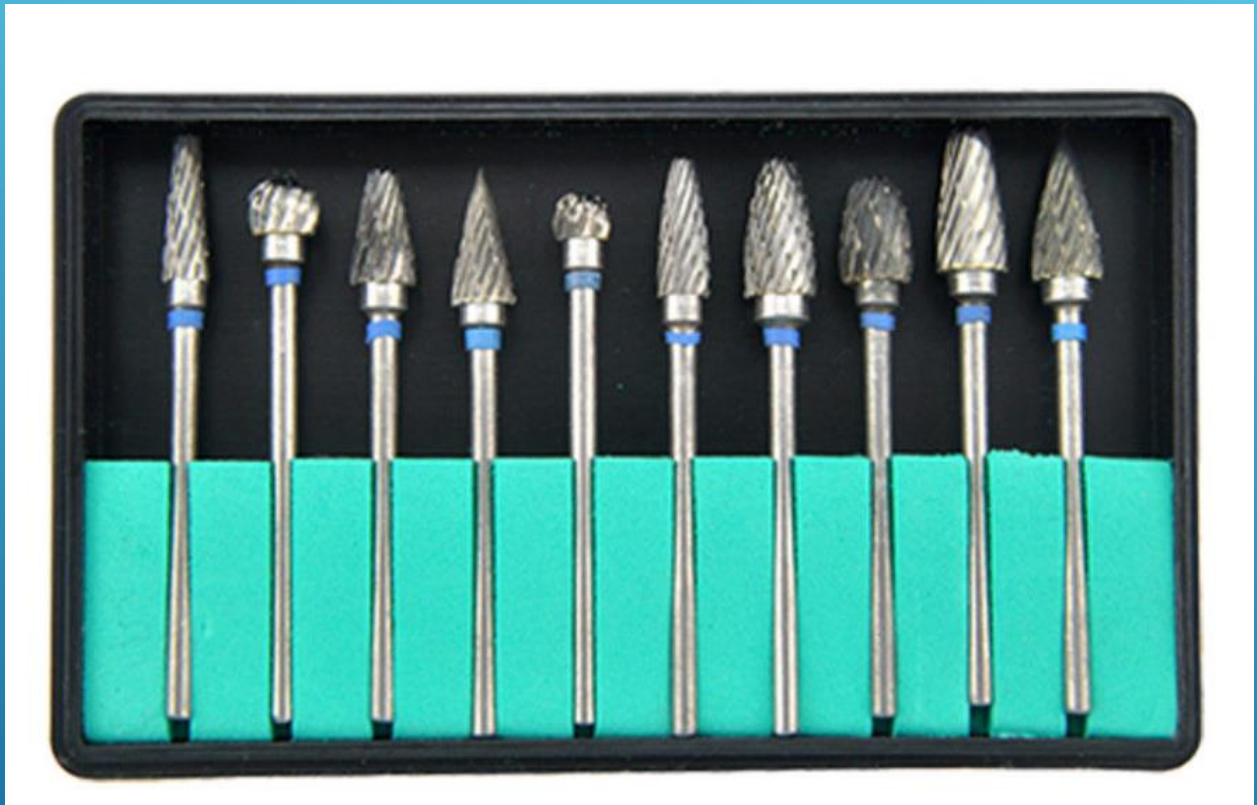
DENTAL CARBIDE BURS

This is the type I use the most.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

DENTAL CARBIDE BURS

Nice close-up of the cutting surfaces.



DENTAL CARBIDE BURS

Don't waste your time on diamond burrs. Only use carbide.

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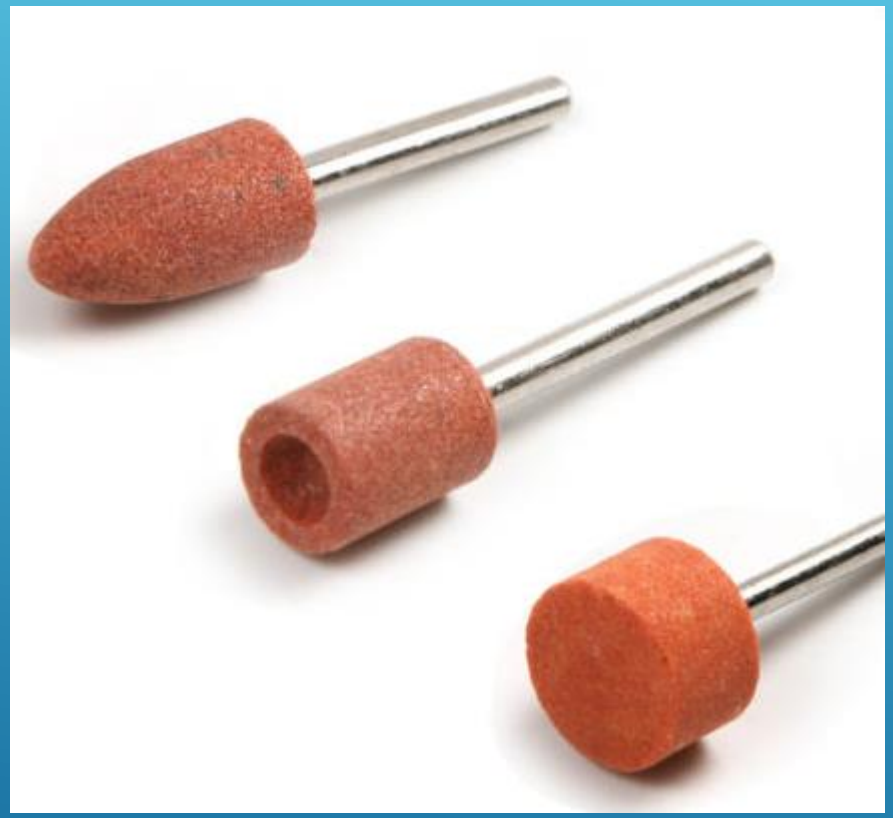

ROTARY TOOL GRINDING STONE

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SILICON CARBIDE GRINDING WHEEL

These are what I usually use the most if I need a grinding wheel.

They mount to one of the Dremel shafts.

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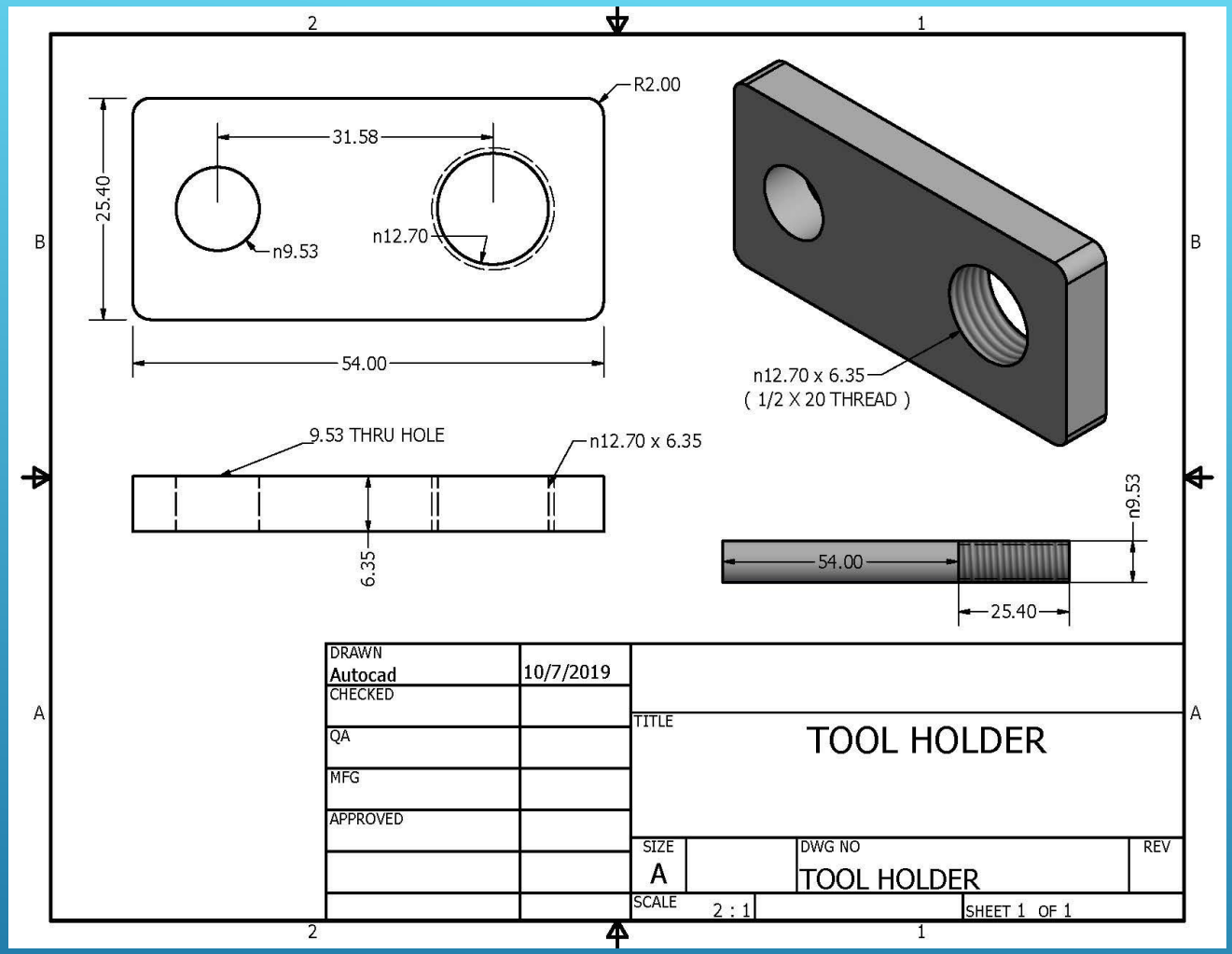
DREMEL Rotary Tool

CLOSEUP OF MOUNT

DREMEL FLEX SHAFT DREMEL ROTARY TOOL FLEXIBLE SHAFT FLEX ATTACHMENT 225

ALWAYS HAVE YOUR SAFETY GLASSES ON!



MOUNT DRAWING

ALWAYS HAVE YOUR SAFETY GLASSES ON!

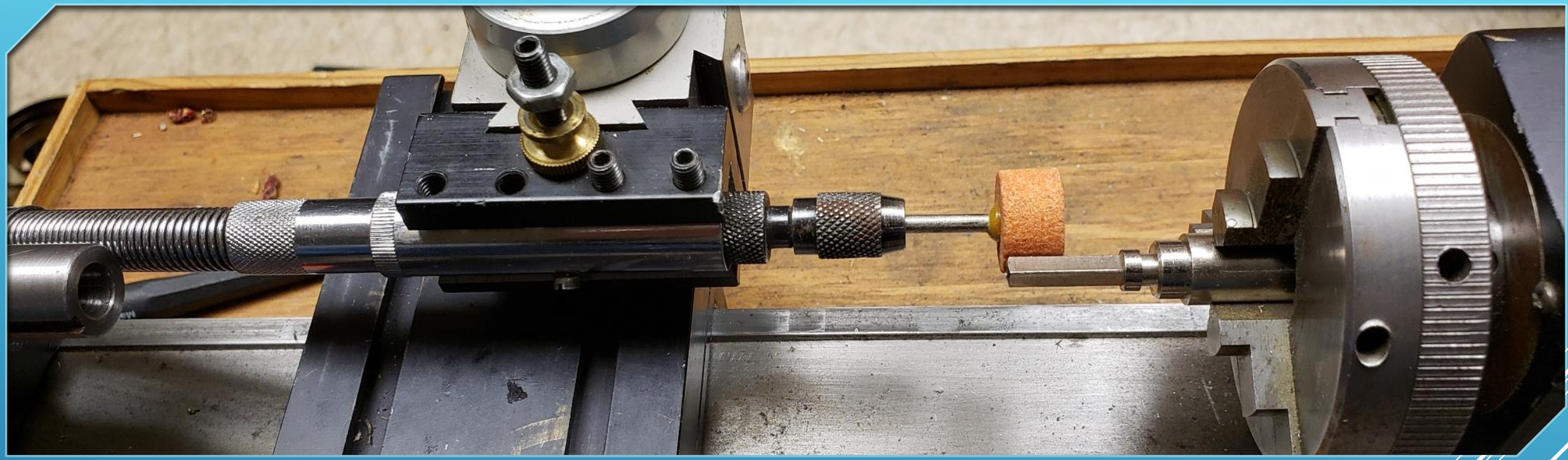
DREMEL FLEX SHAFT

On the mount.

FOREDOM FLEX SHAFT

More expensive than the Dremel.

This has more power than the Dremel, but not sure if its an advantage.



FLEX SHAFT MOUNTED TO TOOL POST

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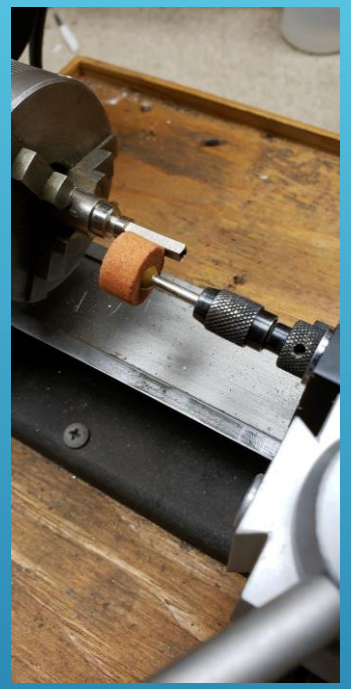

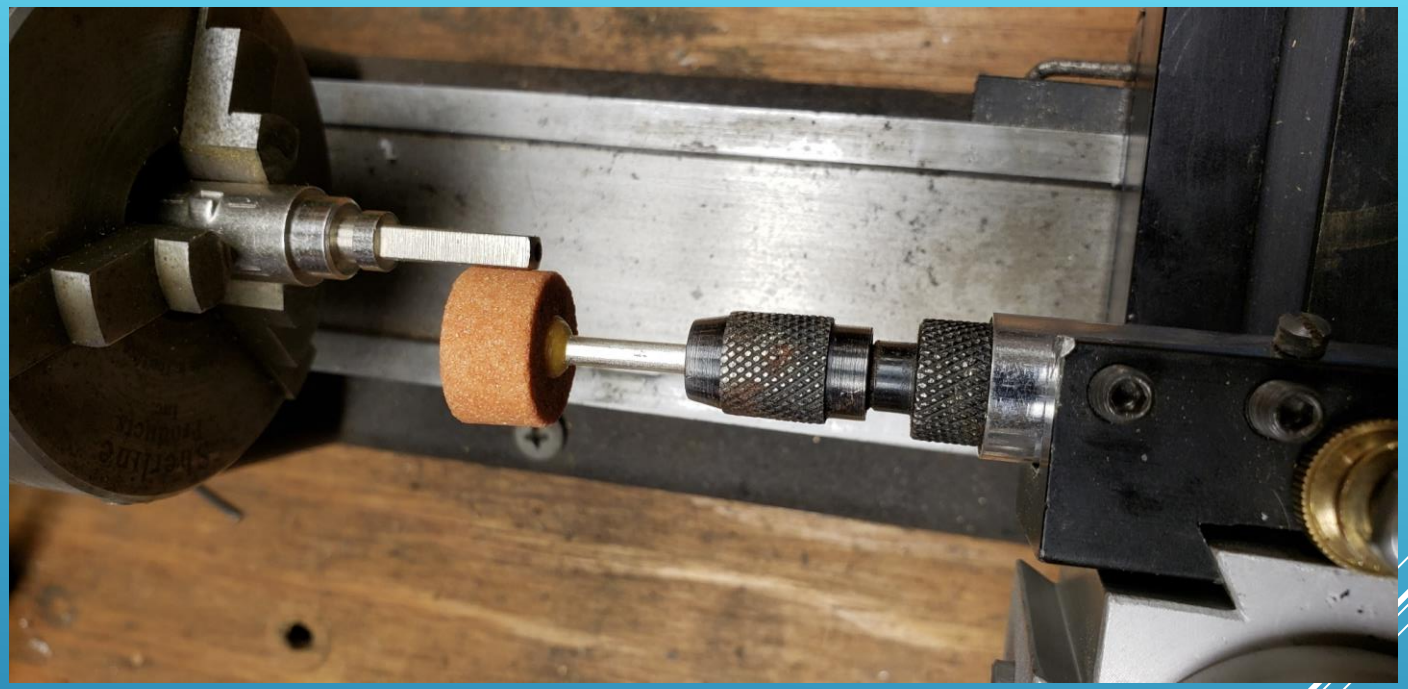

GRINDING A SQUARE

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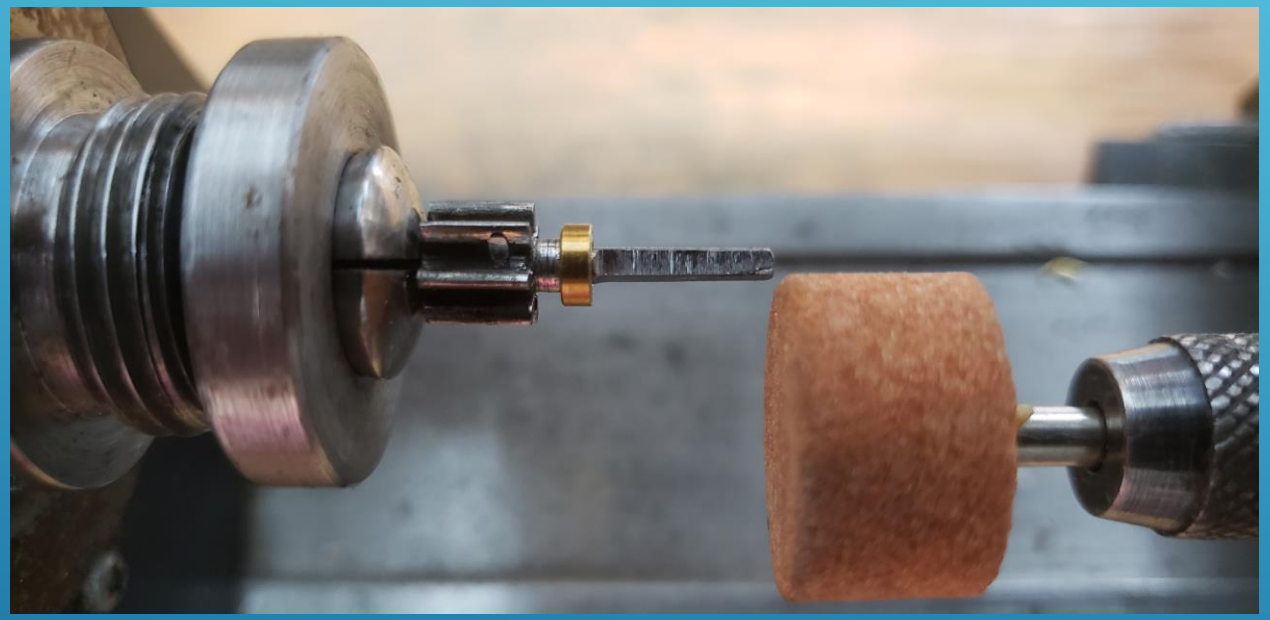
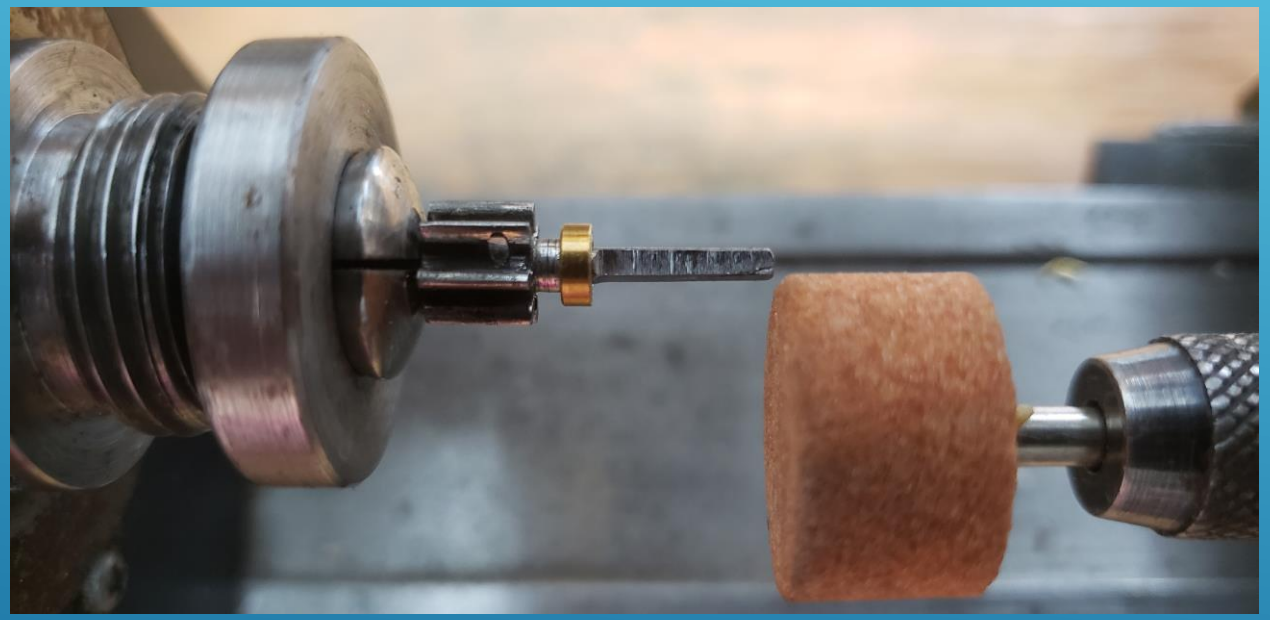


GRINDING A TAPERED SQUARE

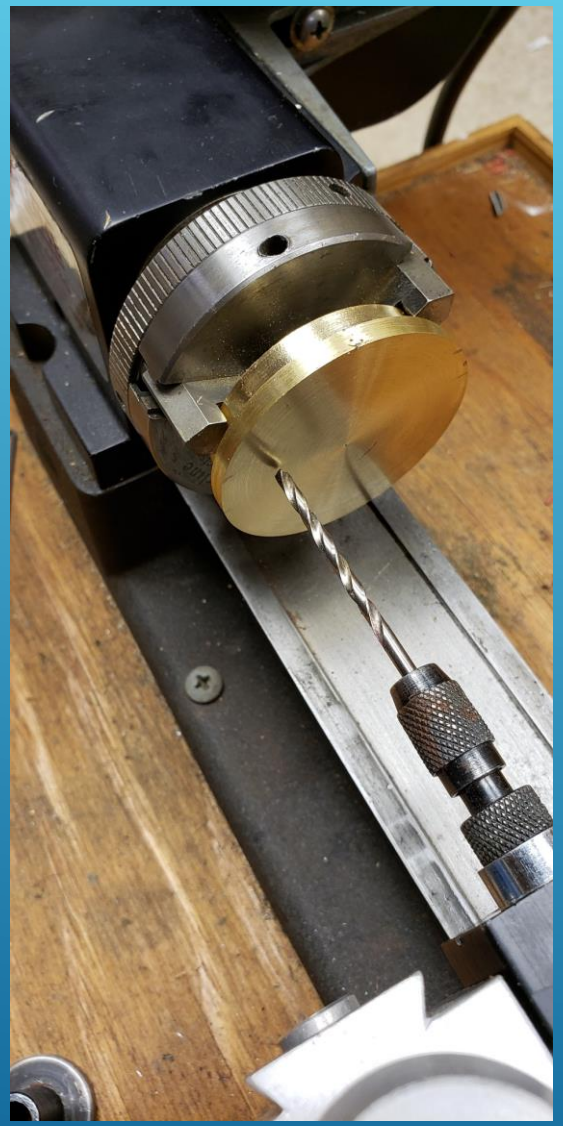
Notice brass bearing to protect the bearing surface.

Brass bearing also keeps all 4 sides equal length.



NOTICE REPAIR

Grinding a tapered square.



DRILLING HOLES OFF THE CENTER

Using a flex shaft in a tool post.

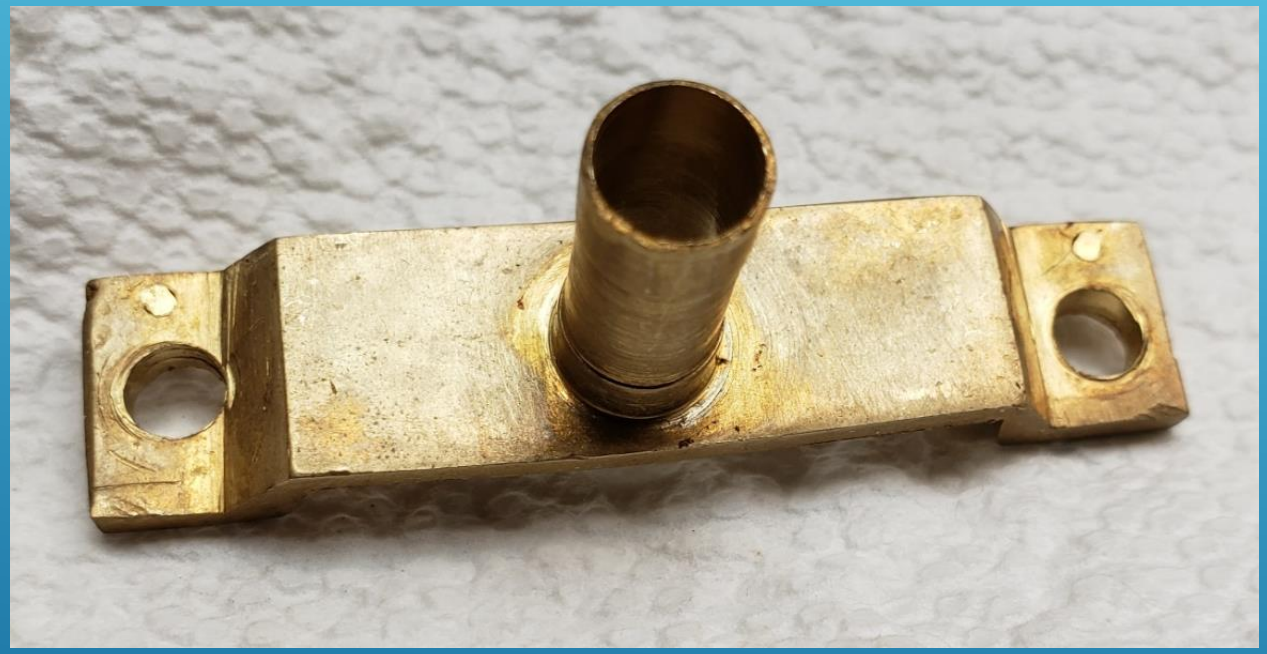
ALWAYS HAVE YOUR SAFETY GLASSES ON!

USING TOOL POST FOR LAYOUT

ALWAYS HAVE YOUR SAFETY GLASSES ON!

QUESTIONS?

ALWAYS HAVE YOUR SAFETY GLASSES ON!



MINUTE WHEEL BRIDGE

Imagining what's in front of you.

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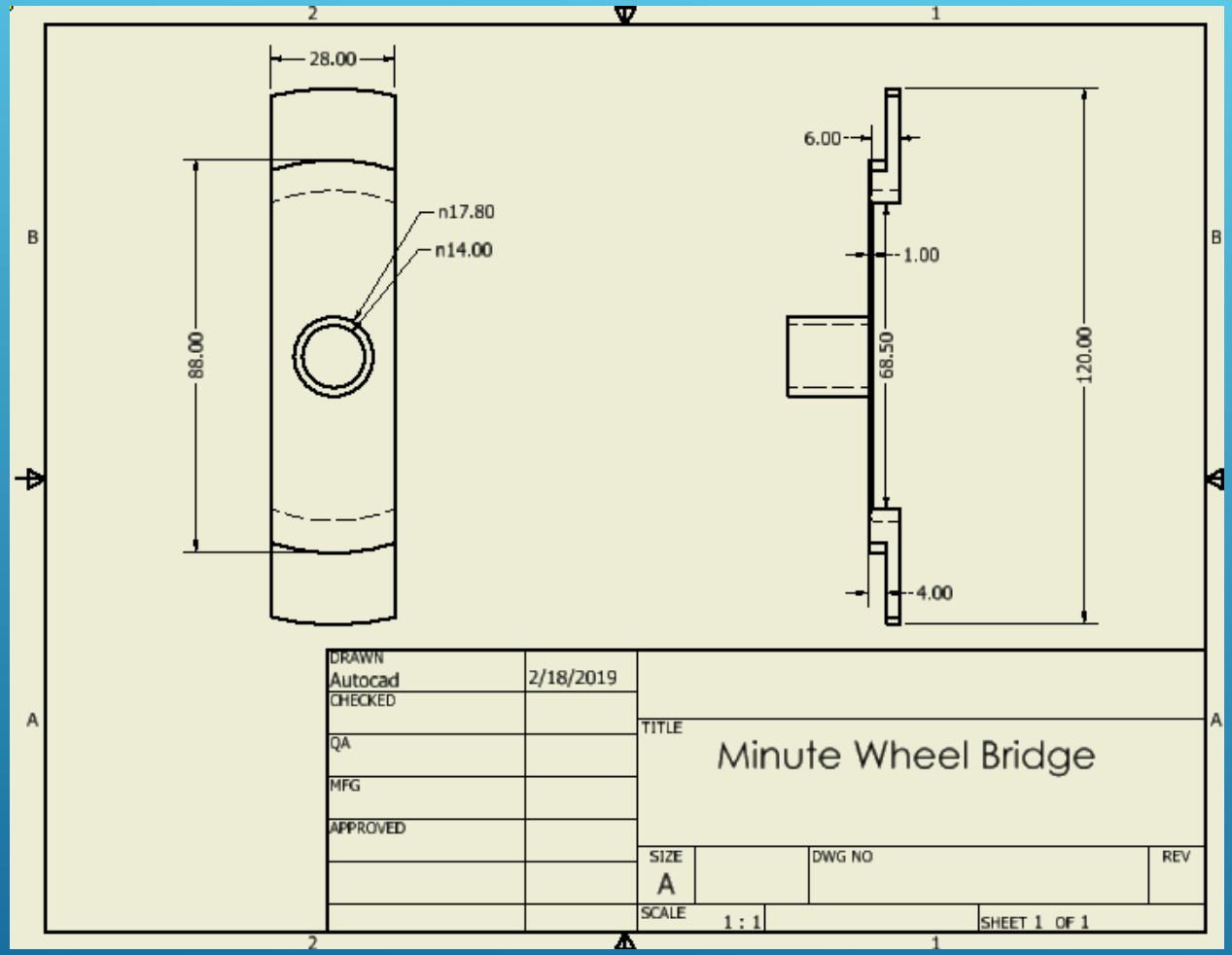
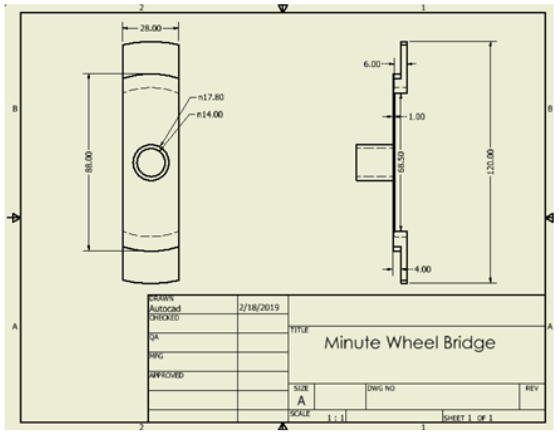


MINUTE WHEEL BRIDGE

Always start with a good drawing.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



Part Name: *Minute Wheel Bridge.*

Material: Brass

Tools: *Lathe, center drill, caliper, jewelers saw, file*

Strengths: *Sawing with a jewelers saw*

Weakness: *Layout of cutting lines.*

Procedure:

1. Make a drawing then cut material to size.
2. *Layout cutting lines.*
3. *Use jewelers saw to remove the material.*
4. *Drill center hole in material*
5. *Mount to a "dummy" shaft and put it into a 3 jaw chuck.*
6. *Turn material for hour wheel.*
7. *Center punch holes on centers for mounting screws.*
8. Drill holes.

MINUTE WHEEL BRIDGE

Put a good plan together.

What are the critical areas?

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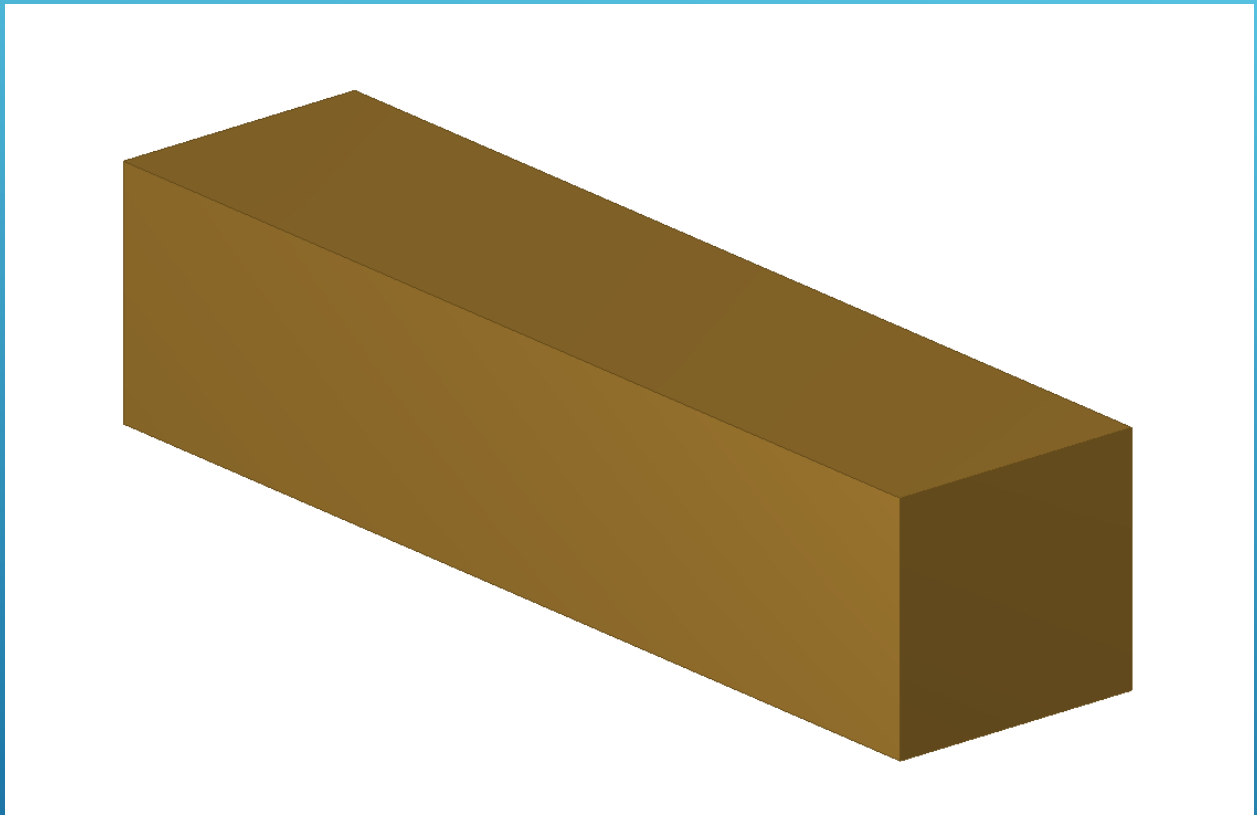
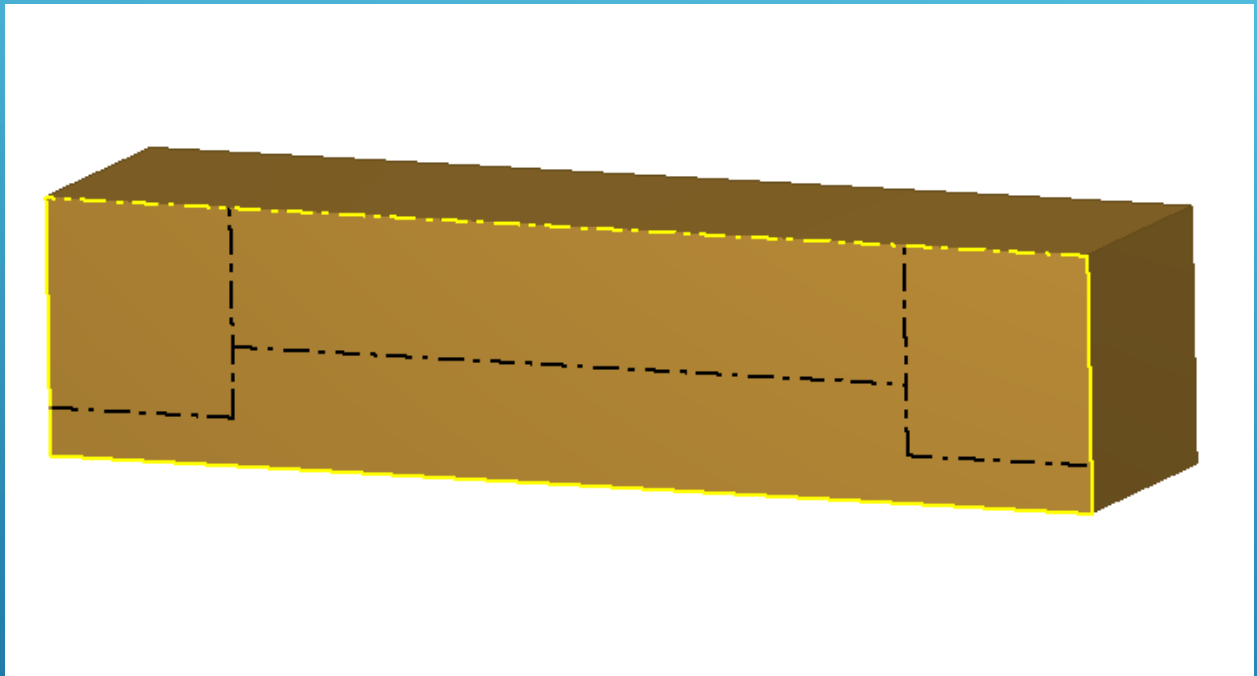


MINUTE WHEEL BRIDGE

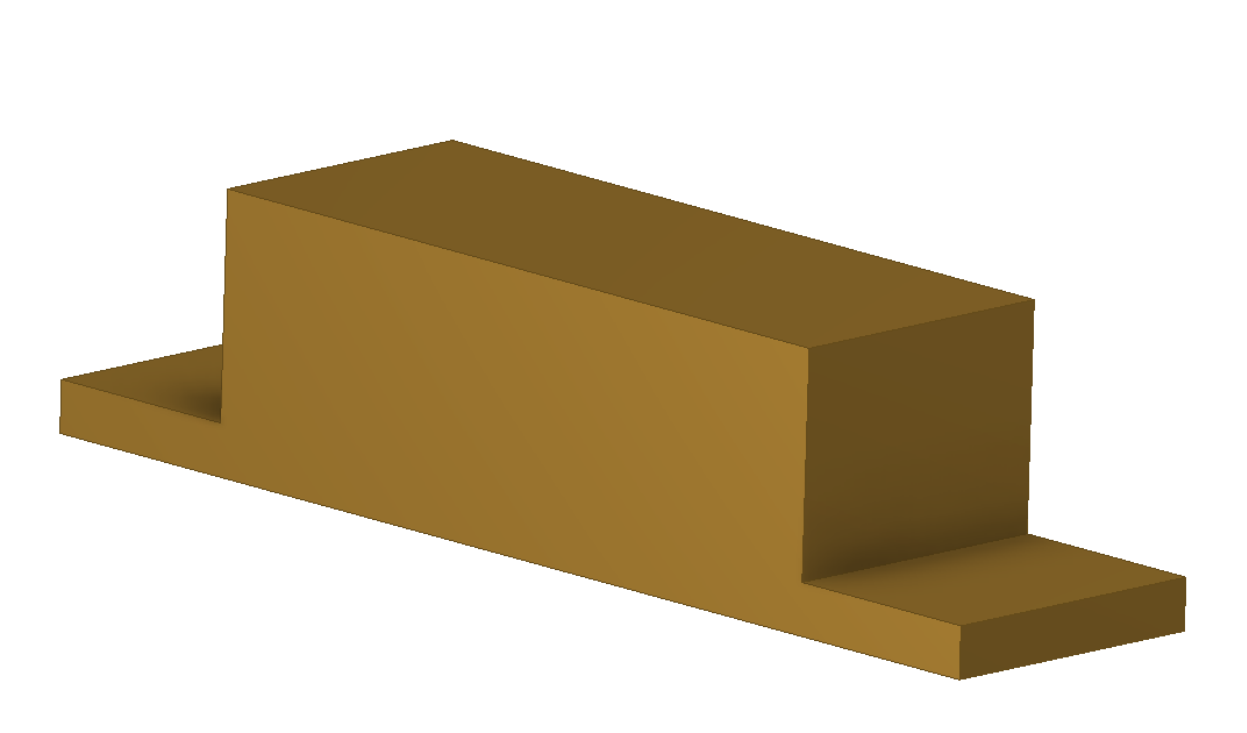
I've given this assignment to many students and all have chosen to make this part in this way.

They only see what's in front of them, not imagining what's in front of them.



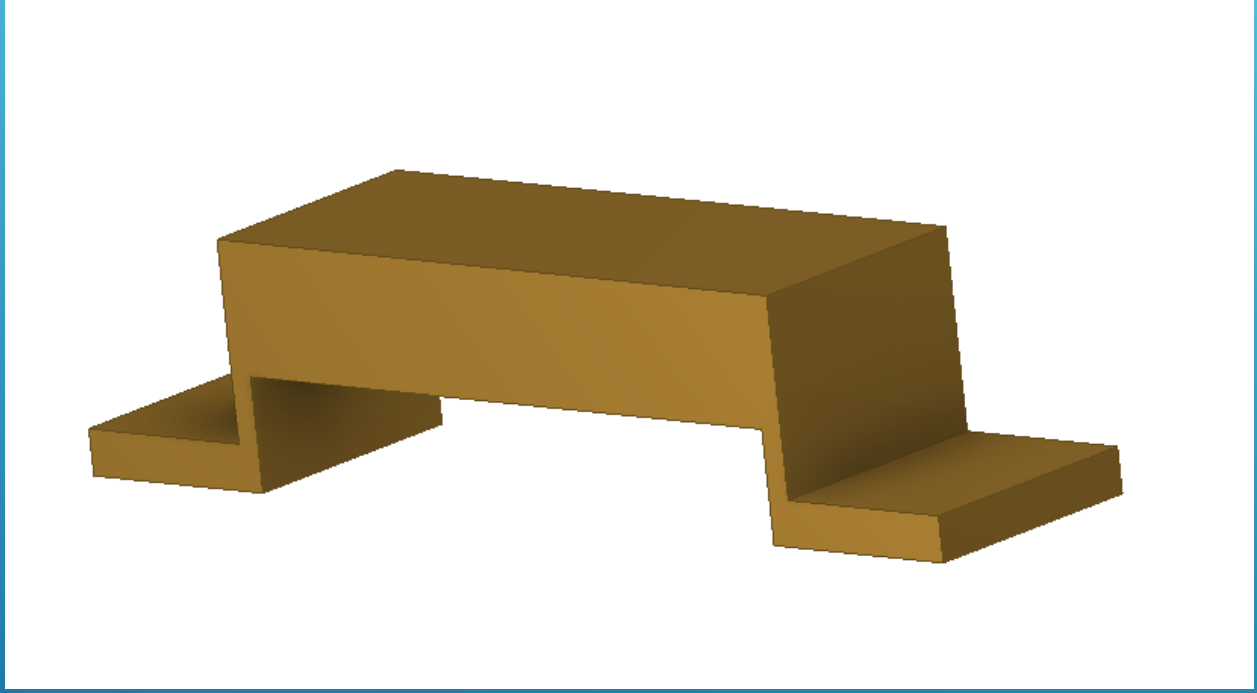
MINUTE WHEEL BRIDGE

Layout cutting lines.



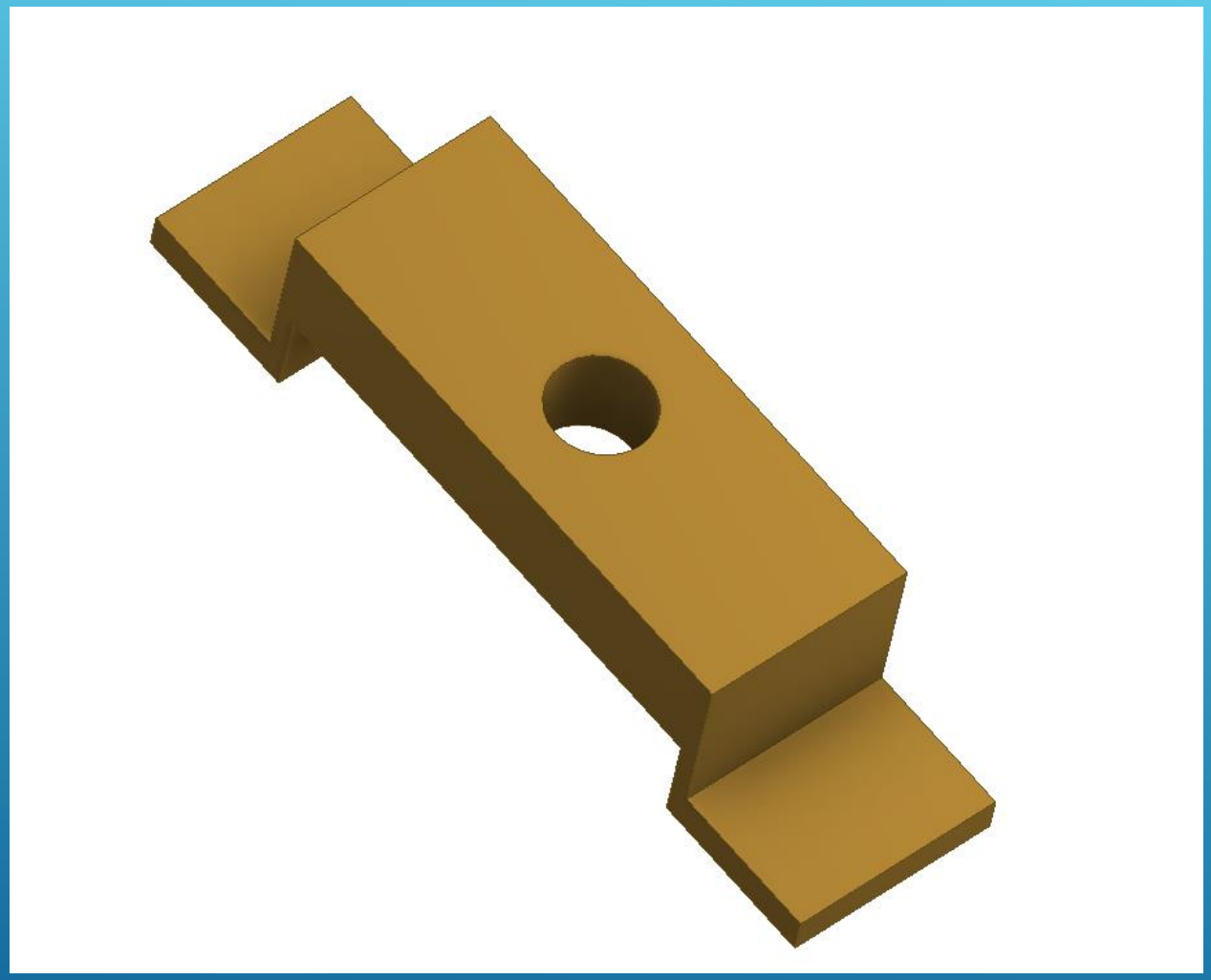
MINUTE WHEEL BRIDGE

Saw out the side pieces.



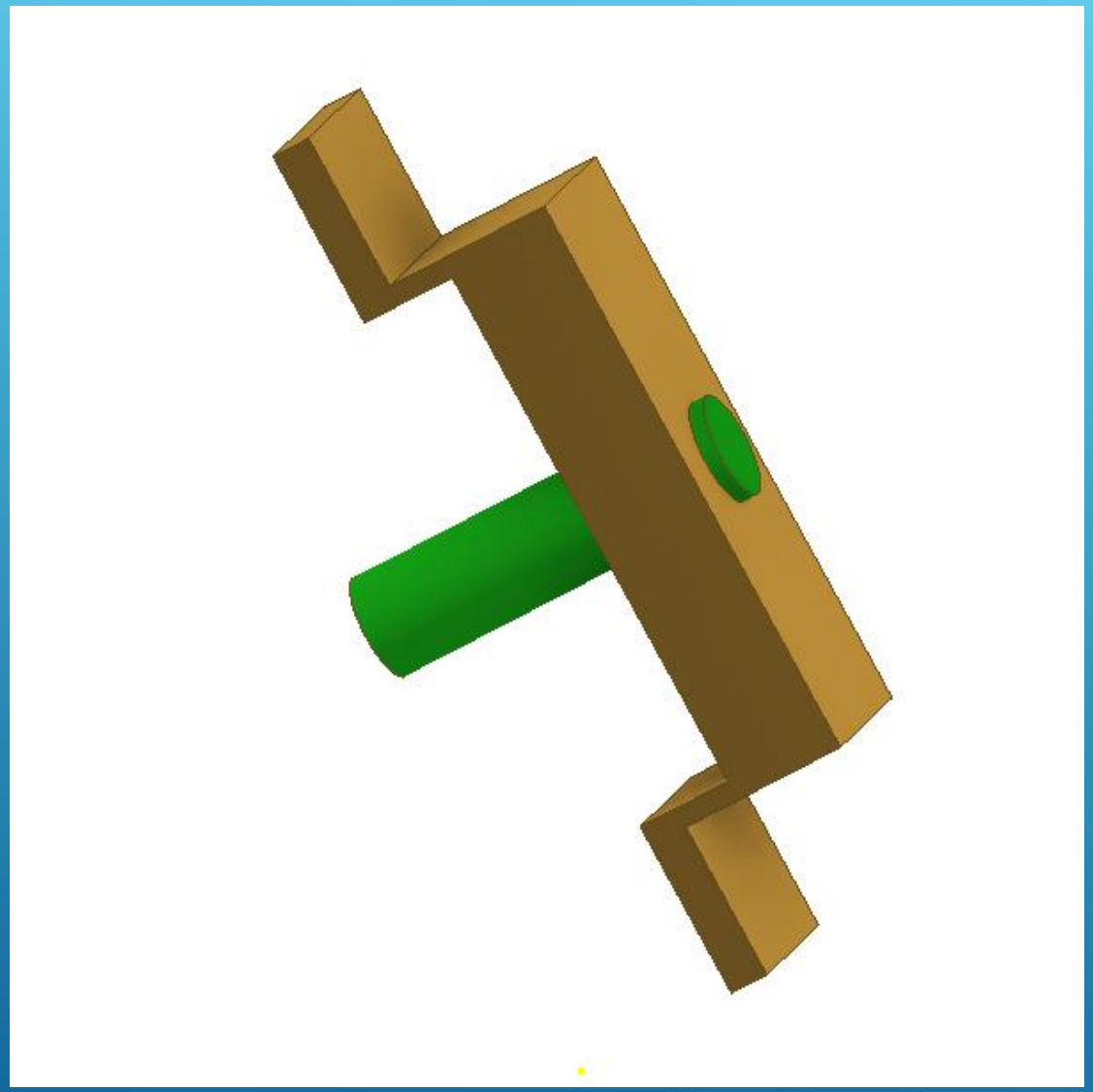
MINUTE WHEEL BRIDGE

Turn it over and saw out the bottom section.



MINUTE WHEEL BRIDGE

Layout, center punch, and drill hole.



MINUTE WHEEL BRIDGE

Make a shaft and press into the hole so that it can be mounted into a 3 jaw chuck.

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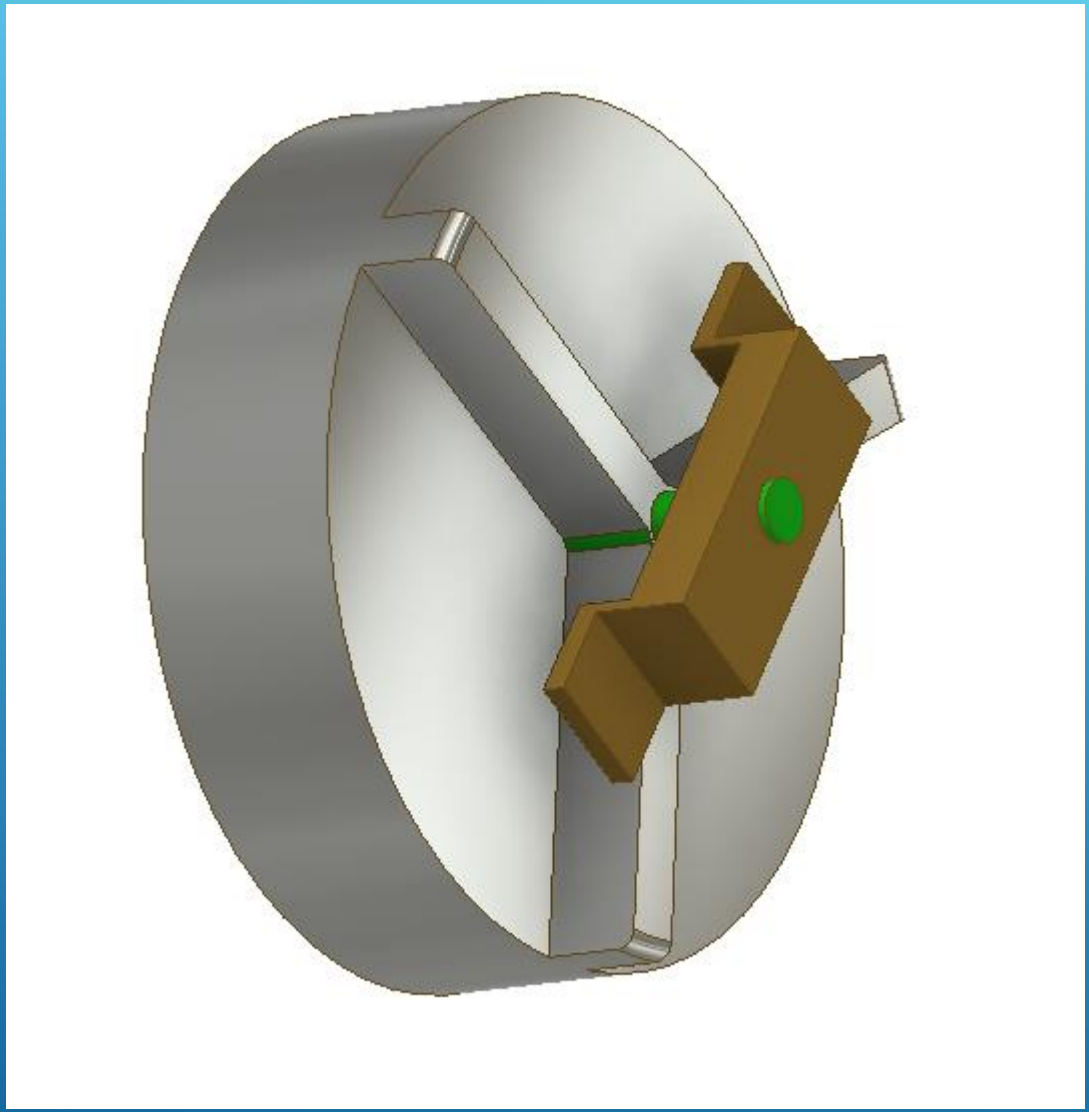
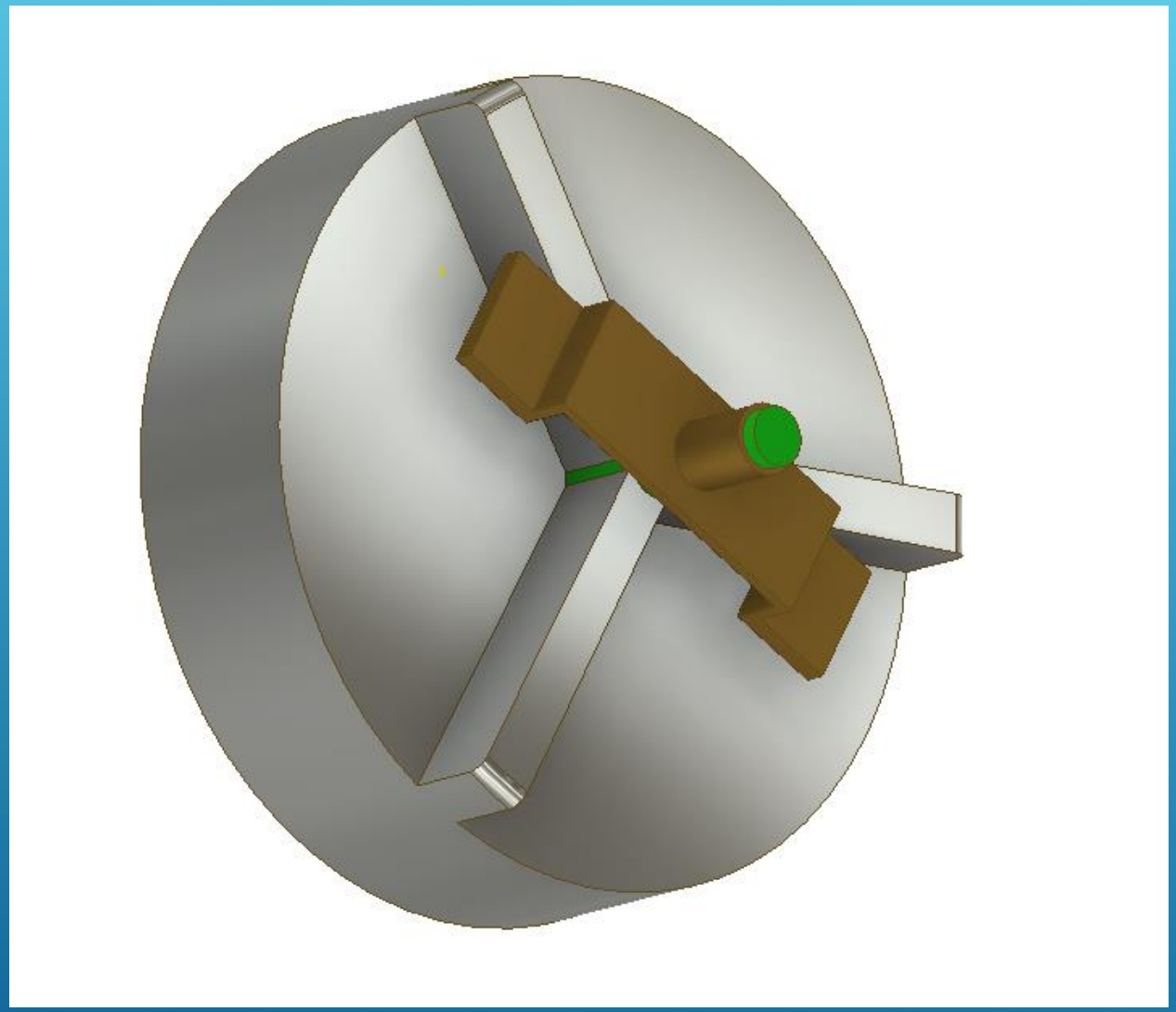


MINUTE WHEEL BRIDGE

Mount to a 3 jaw chuck to turn face.

This is what we would call an intermittent cut, hard way to machine something.



MINUTE WHEEL BRIDGE

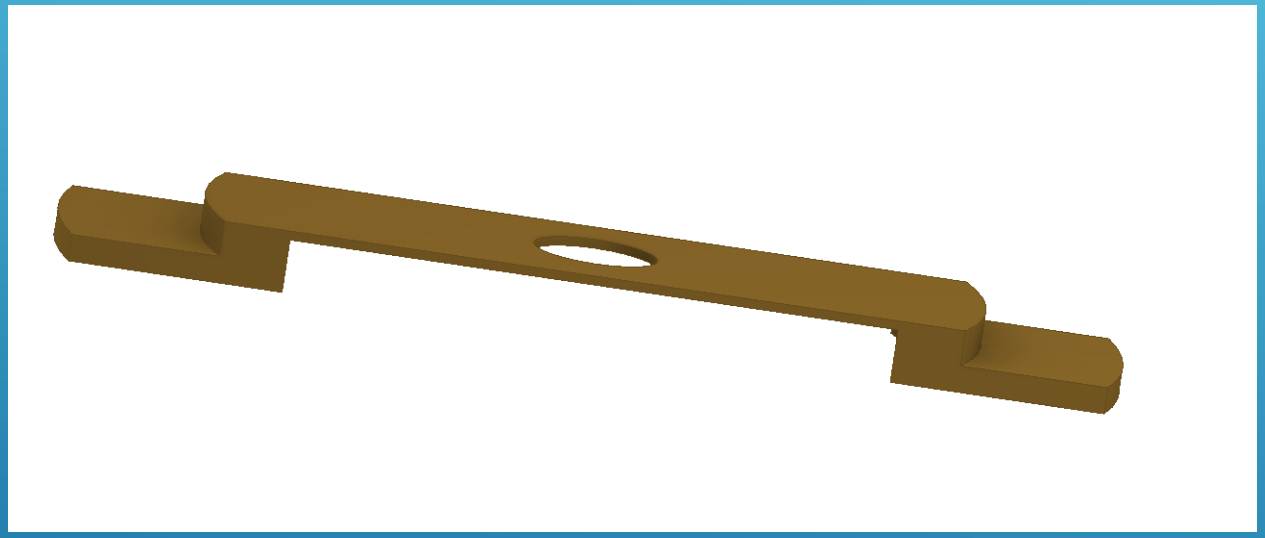
All machining is done so you can press it off the shaft.

Now hand fit to the clock.

Were are the obstacles making it this way?

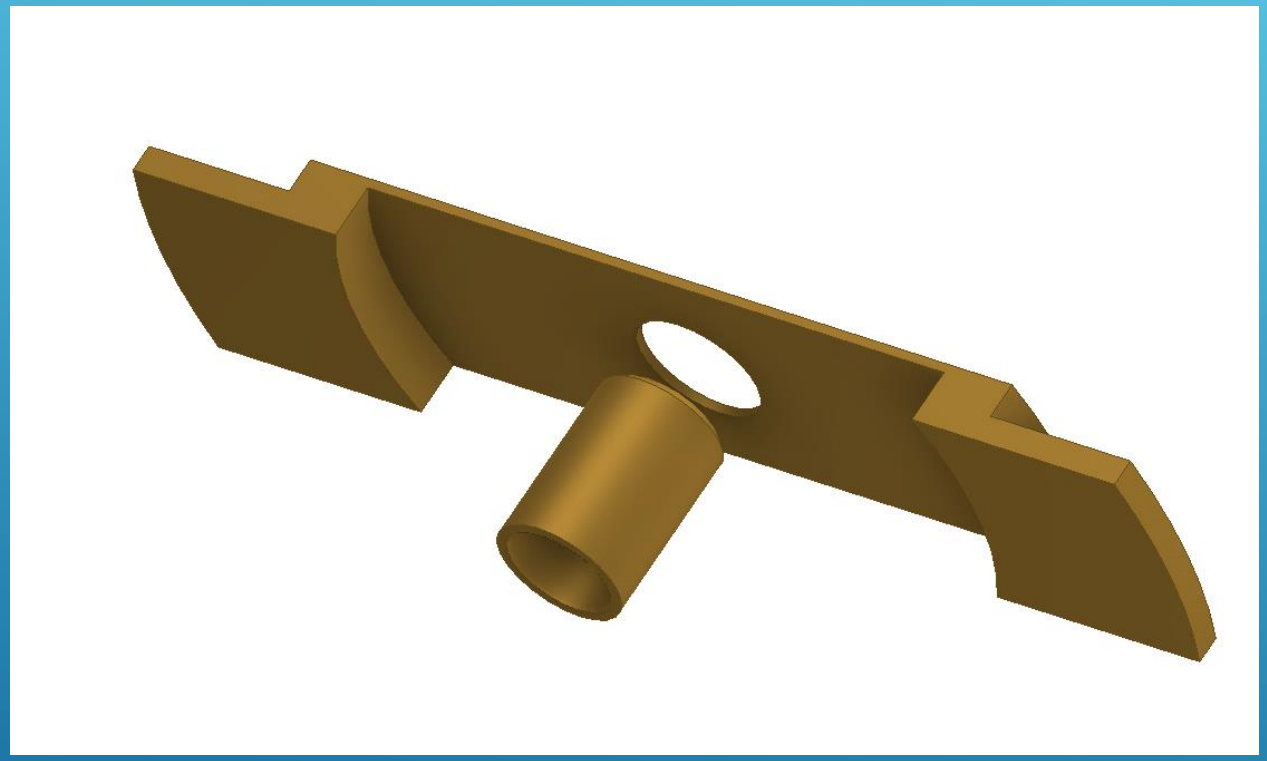
Strengths? Weaknesses?

MINUTE WHEEL BRIDGE



You could also layout and saw off the top to the correct thickness.

What would your strengths have to be to do this?



MINUTE WHEEL BRIDGE

Then machine the tube and press it into the hole.

MY PLAN

Minute wheel bridge

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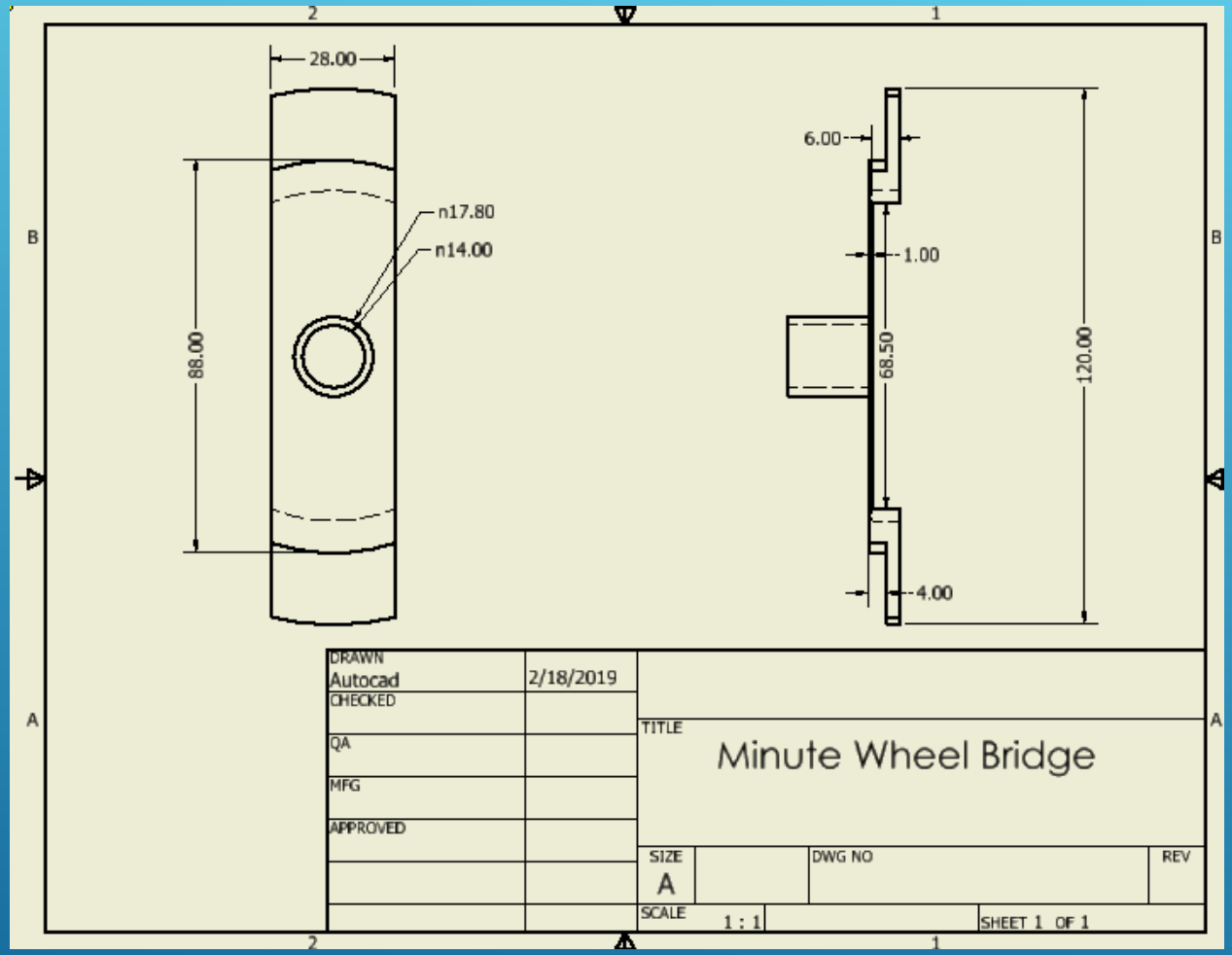
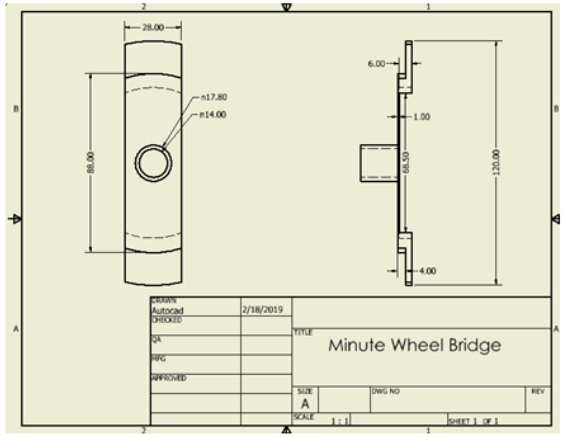


MINUTE WHEEL BRIDGE

Always start with a good drawing.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



Part Name: *Minute Wheel Bridge.*

Material: Brass

Tools: *Lathe, center drill, caliper, jewelers saw, file*

Strengths: *Turning with the lathe.*

Weakness: *None*

Procedure:

1. Make a drawing then cut material to size.
2. *Mount in a 3 jaw chuck.*
3. *Machine center hub.*
4. *Center drill and then drill to size.*
5. *Machine the first step.*
6. *Flip the material in the 3 jaw chuck, cut the counter bore.*
7. *Layout your cutting planes.*
8. Saw off the 2 ends.

MINUTE WHEEL BRIDGE

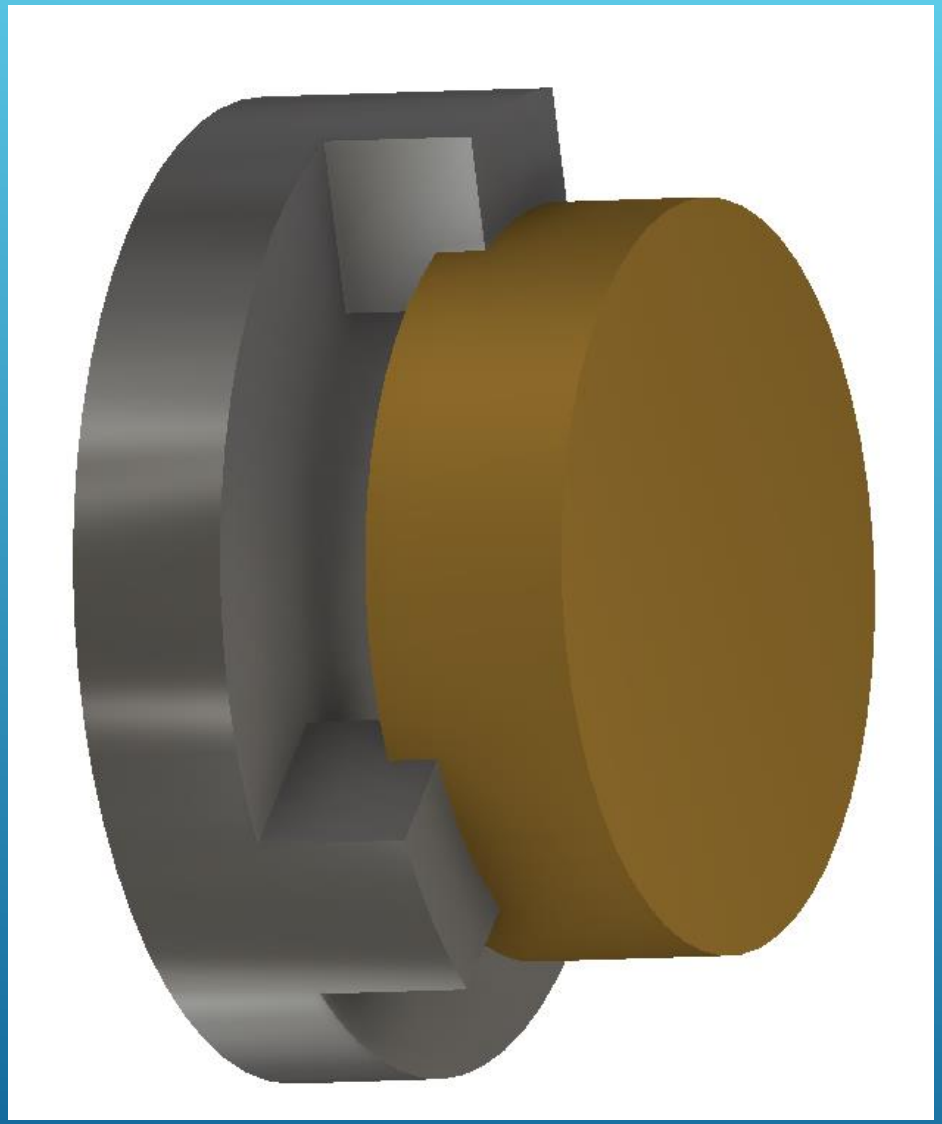
This plan is my plan for making the bridge.

With your plan, you should pay attention to your strengths and weaknesses and design to them.

As I'm making the drawing , I may think of many ways to make something and different ways to make it.

This is why I think the drawing is so important.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



MINUTE WHEEL BRIDGE

Mount in a 3 jaw chuck. For this part, you will have to reverse the jaws in the chuck.

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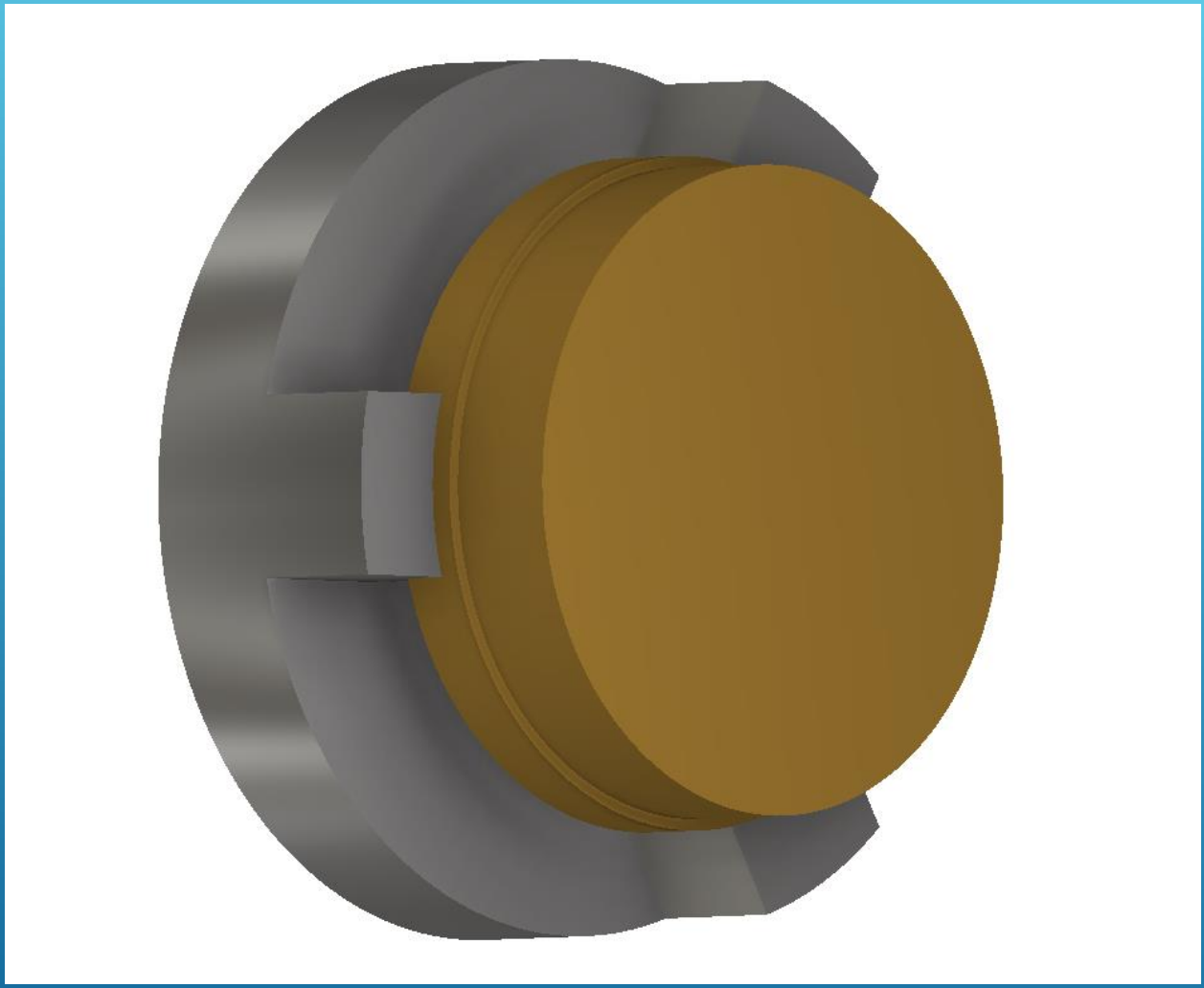

MINUTE WHEEL BRIDGE

Turn the outside diameter.

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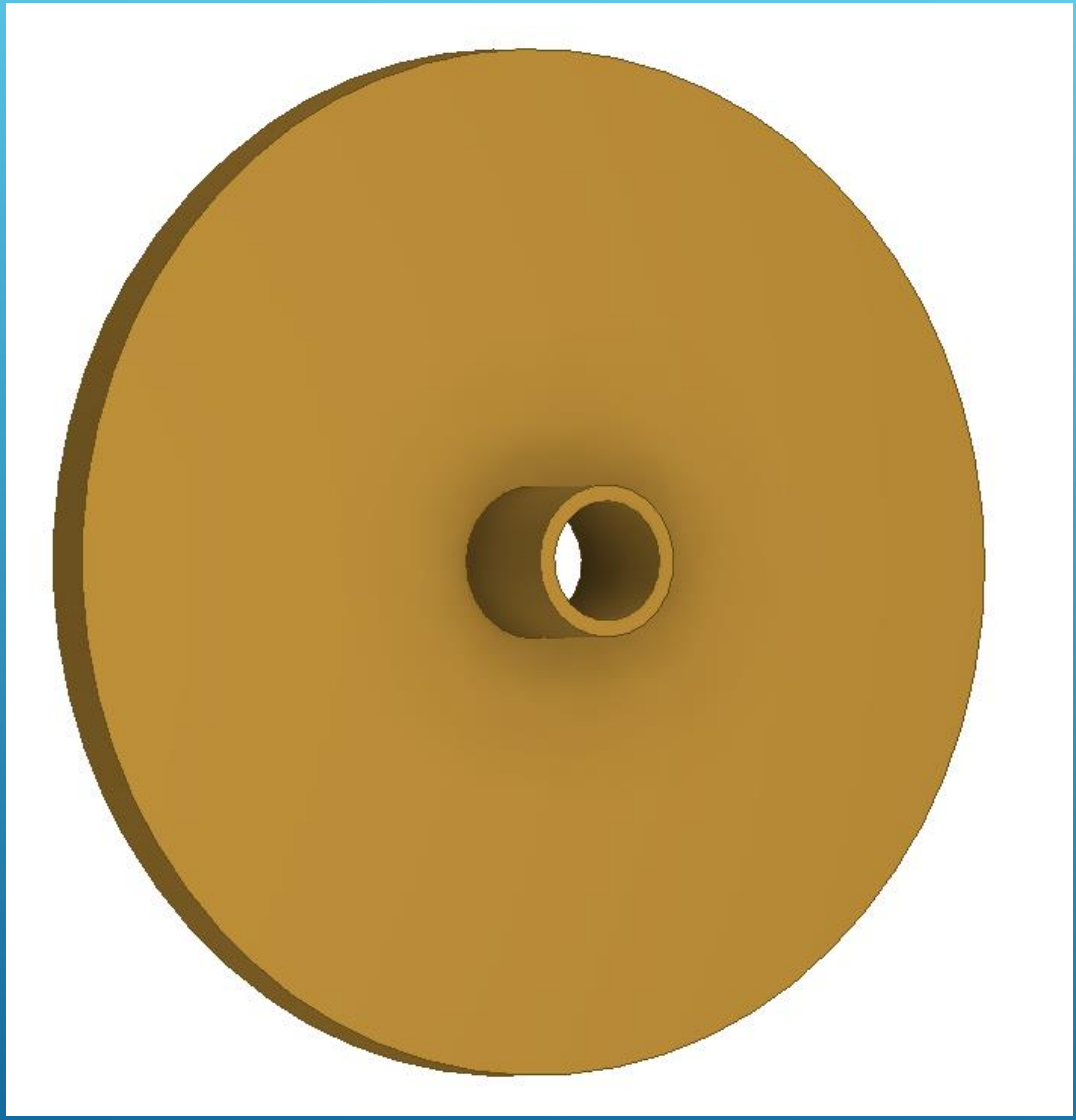

MINUTE WHEEL BRIDGE

Machine the center hub.

Center drill and then drill to size.

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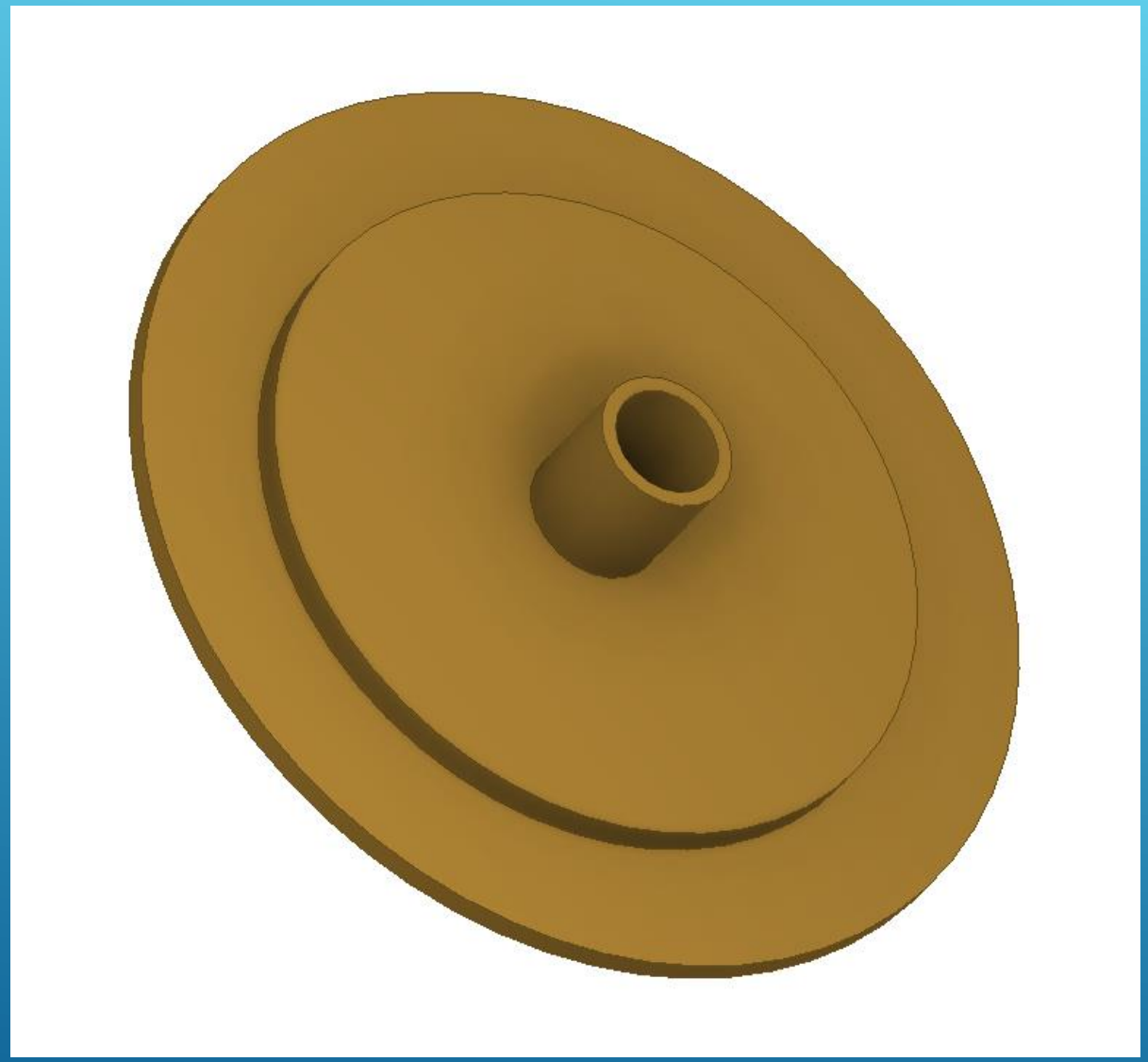
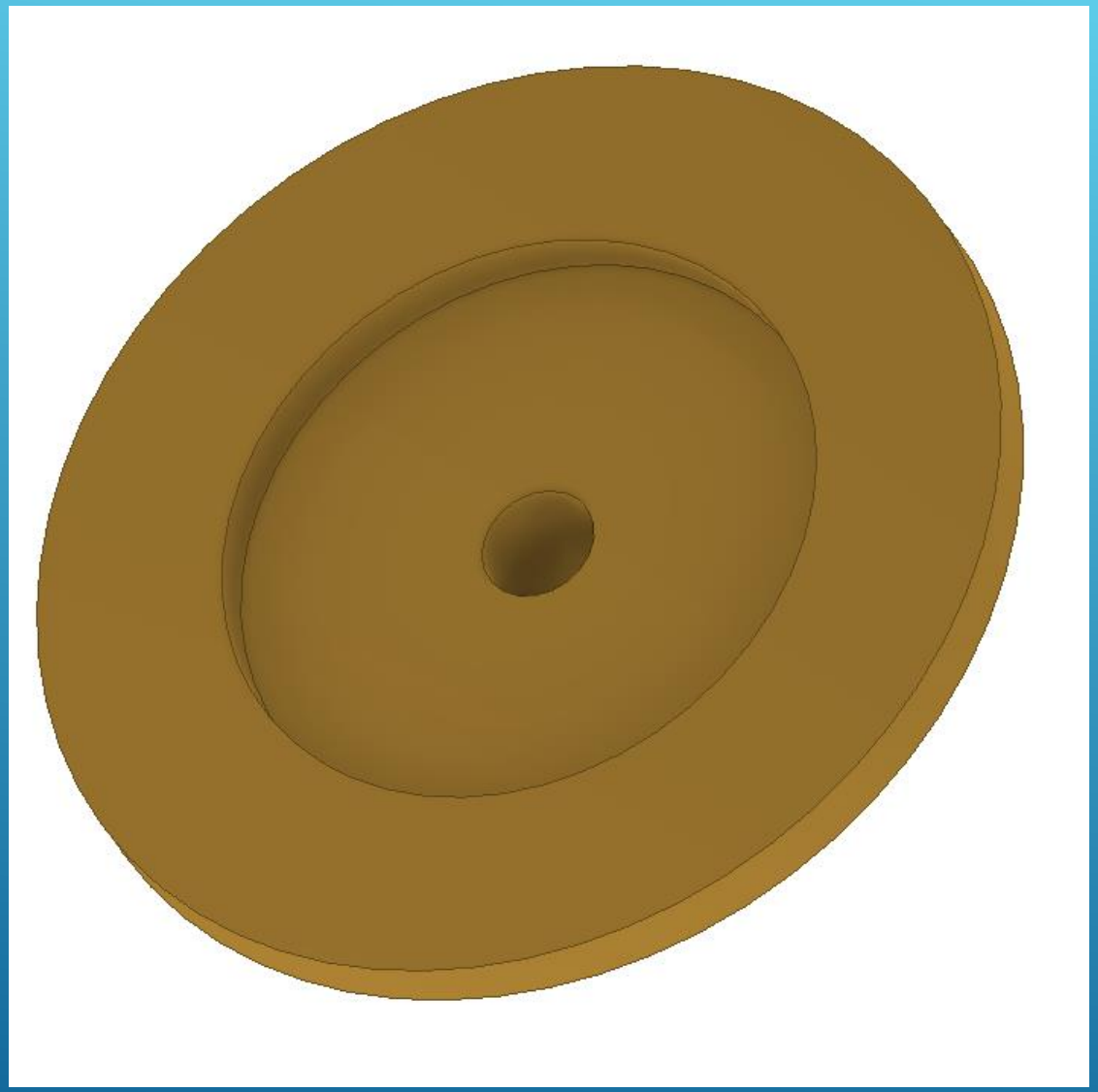


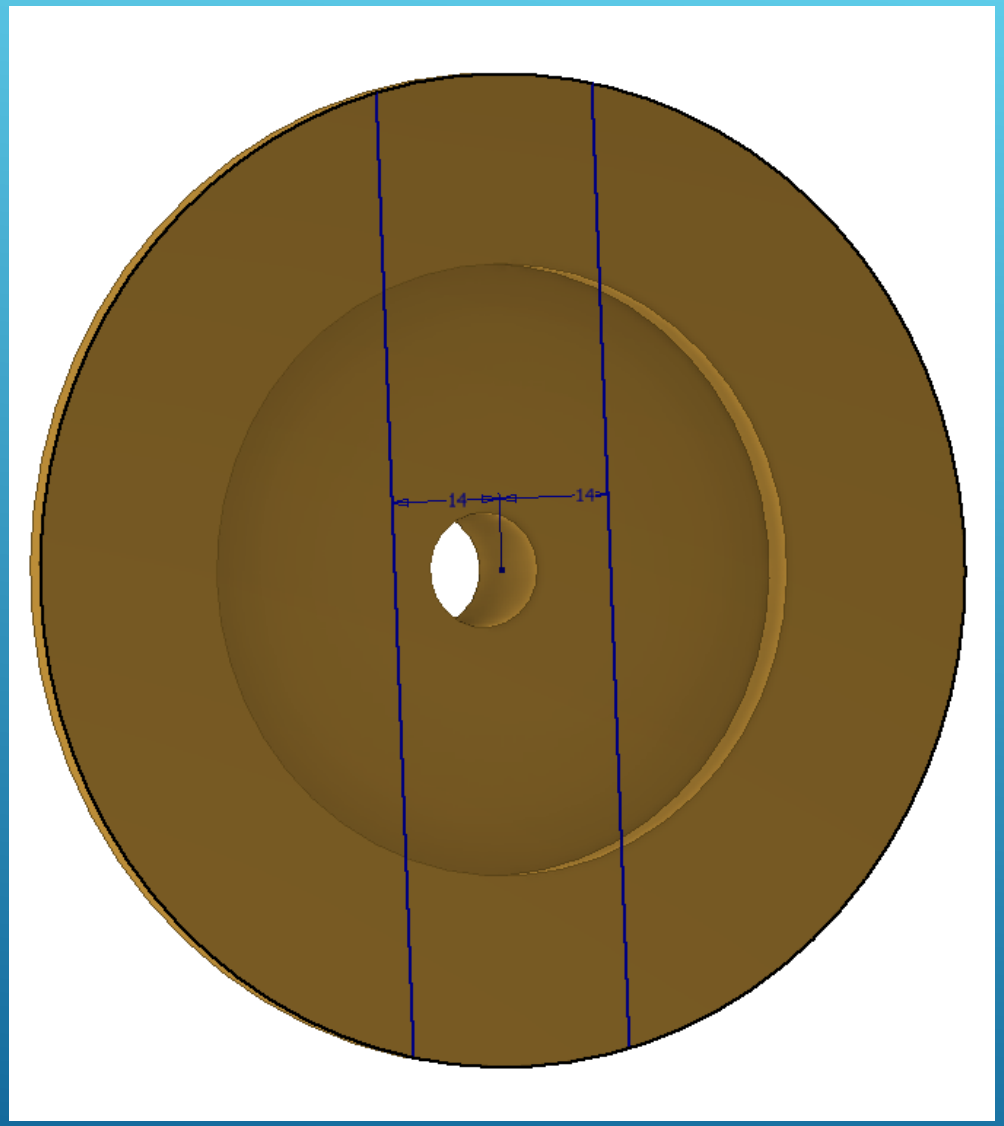
MINUTE WHEEL BRIDGE

Now machine the first step.



MINUTE WHEEL BRIDGE

Now flip it in a chuck and counter bore the back side.

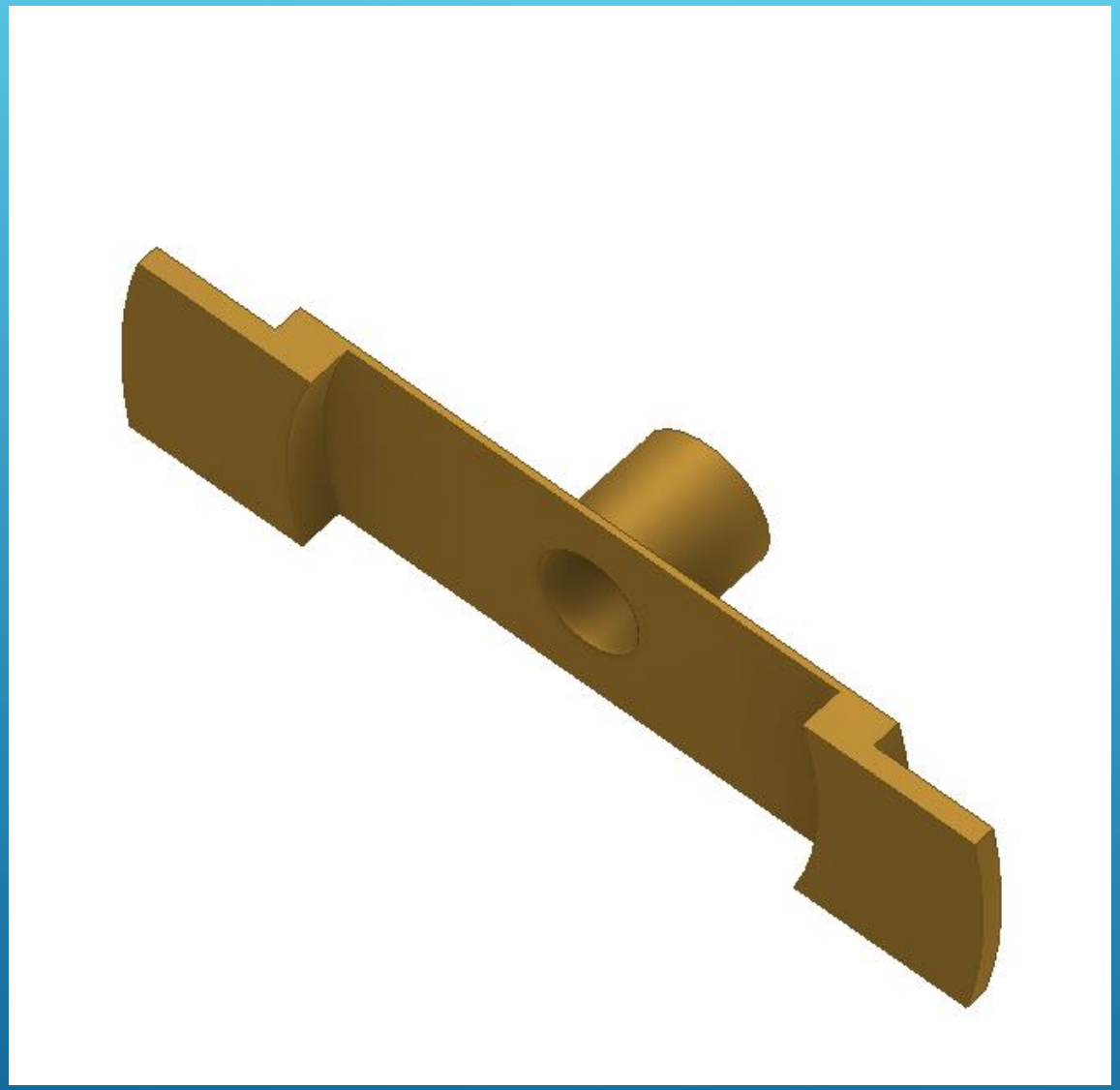


MINUTE WHEEL BRIDGE

Layout cutting lines with tool post and scribe.

I like to do this on the back side.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



MINUTE WHEEL BRIDGE

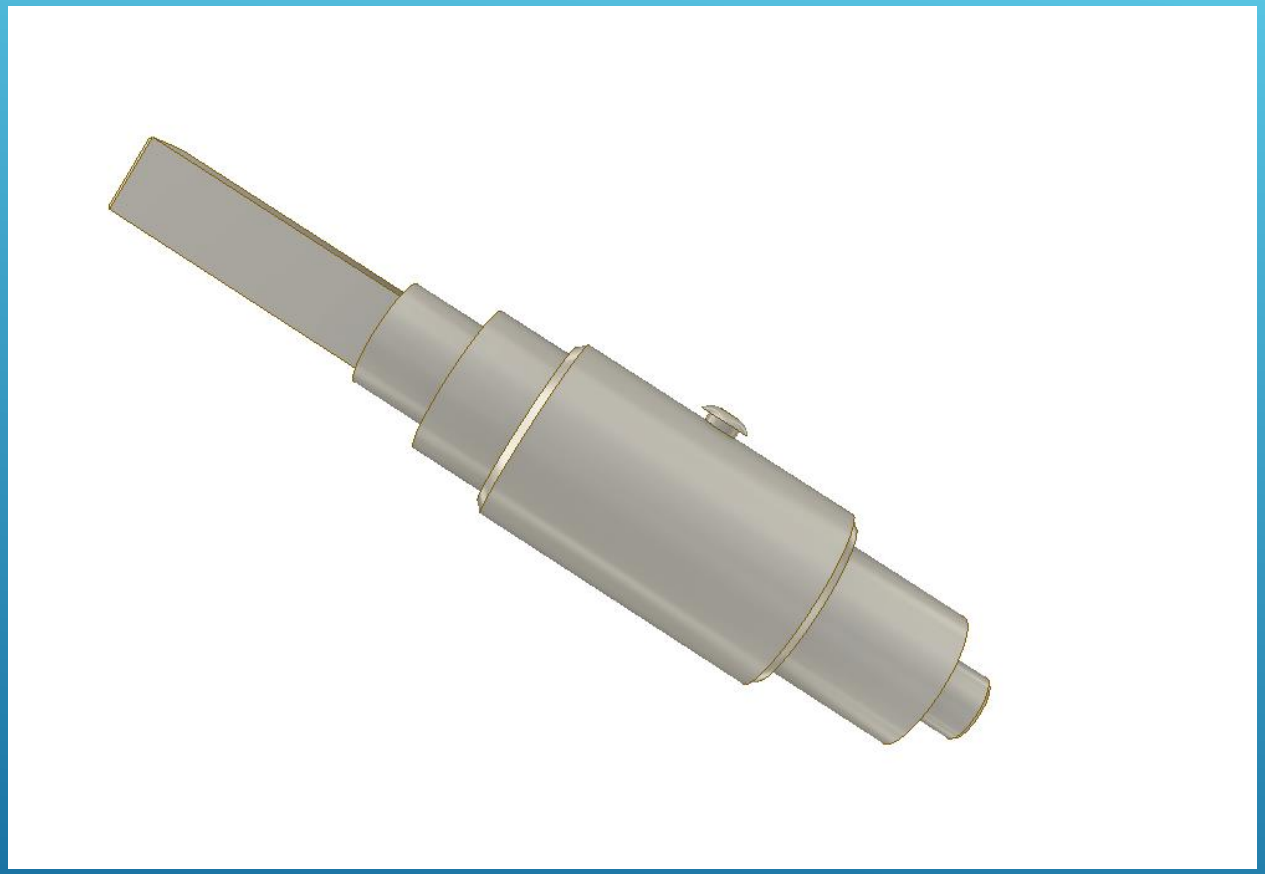
Saw off the two sides.

The bridge is now ready for hand fitting.

What are the advantages or disadvantages between the three procedures?

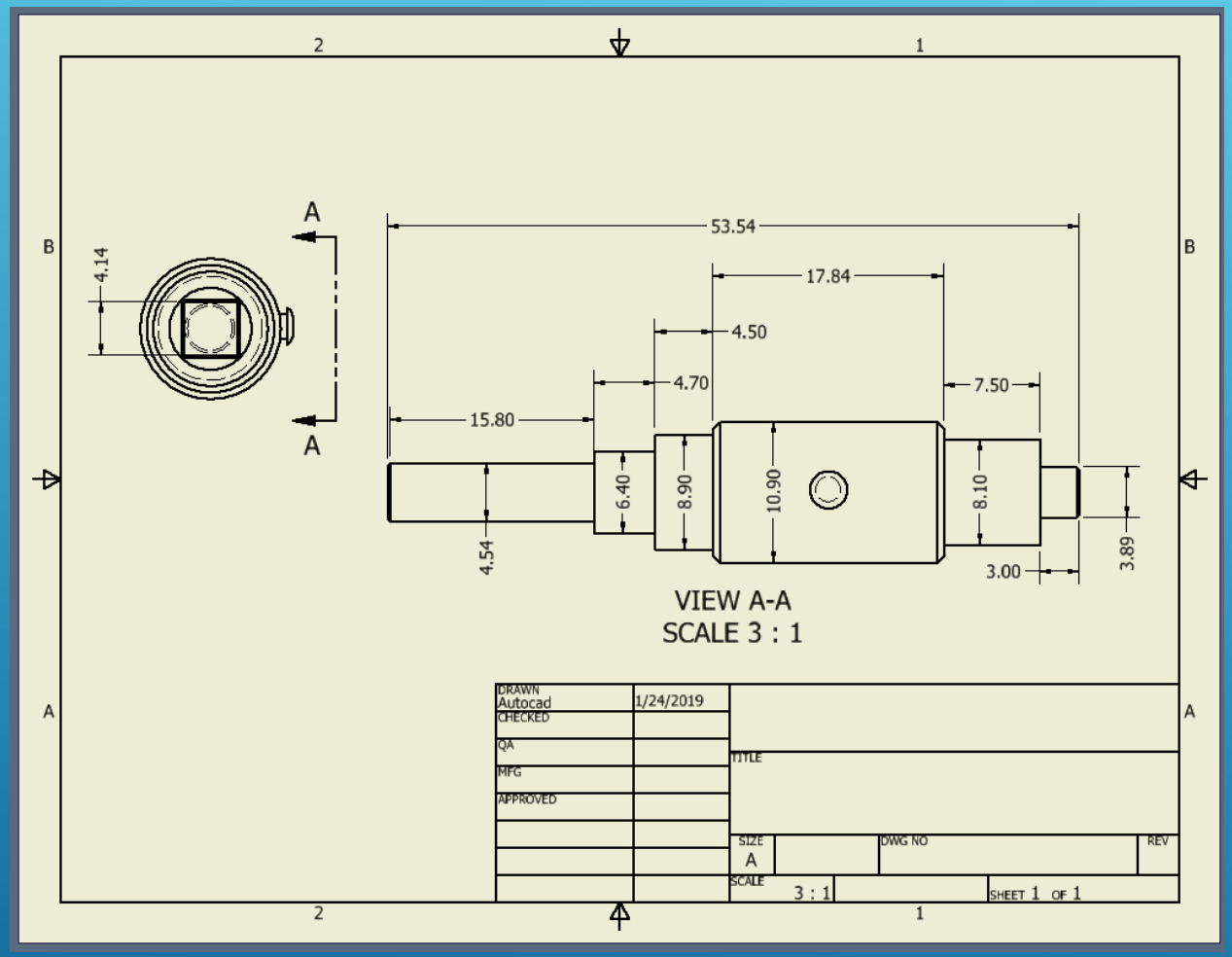
FRENCH WINDING ARBOR

ALWAYS HAVE YOUR SAFETY GLASSES ON!



FRENCH WINDING ARBOR

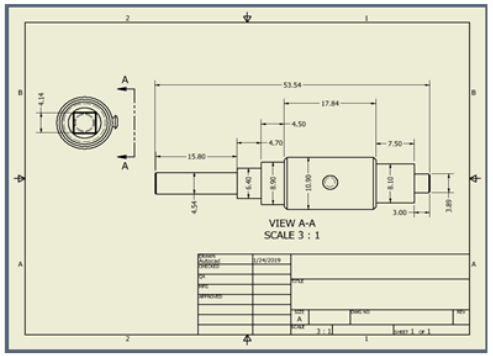
ALWAYS HAVE YOUR SAFETY GLASSES ON!



ARBOR DRAWING

What are the "critical surfaces"

ALWAYS HAVE YOUR SAFETY GLASSES ON!



Part Name: *French Clock Arbor*

Material: *Steel*

Tools: *Lathe, center drill, caliper*

Strengths: *Turning Between Centers*

Weakness: *Drilling round stock*

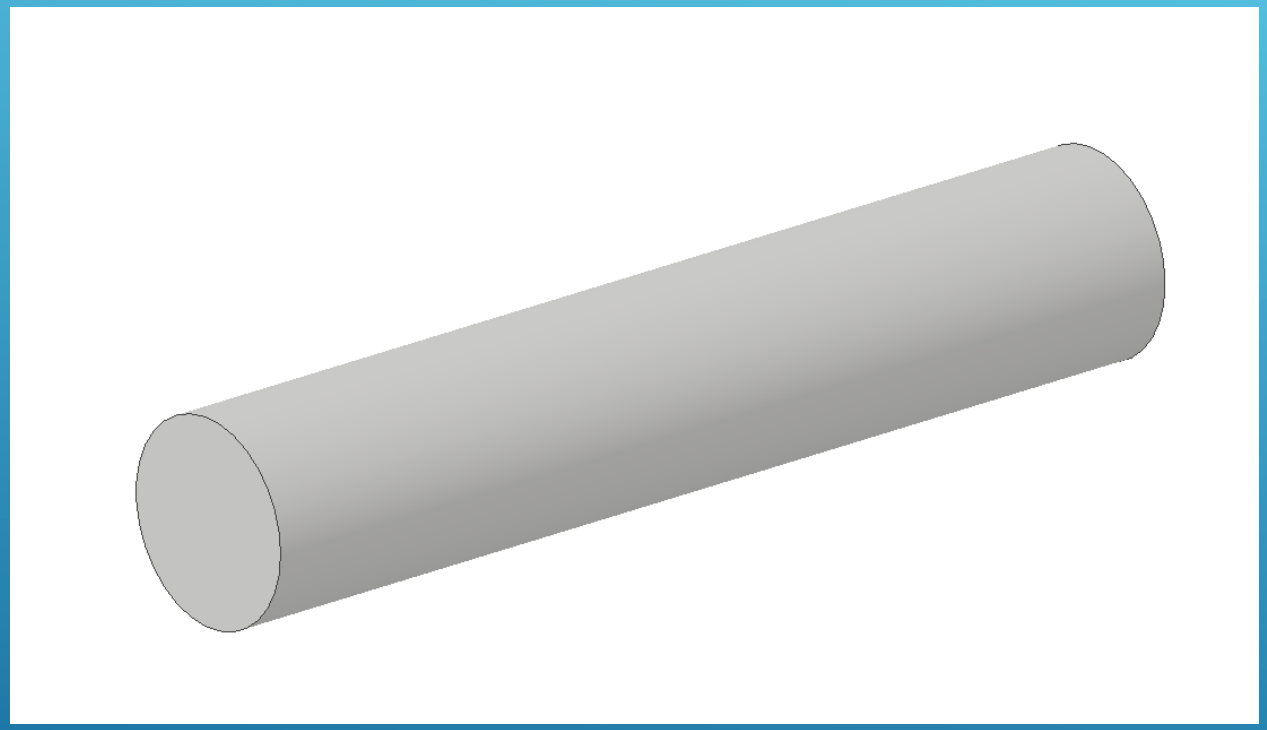
Procedure:

1. *Cut material to length (add 6mm for centers)*
2. *Drill hole for barrel hook*
3. *Center- Drill material*
4. *Setup lathe for turning between centers*
5. *Select proper cutting tools (graver, or cross slide)*
6. *Turn outside diameter*
7. *Turn all additional diameters*
8. Make the square key end. (grind or file)

ALWAYS HAVE YOUR SAFETY GLASSES ON!

ARBOR PLAN

An example of one of my plans for making an arbor.



CUT YOUR MATERIAL PLUS 2MM IN LENGTH.

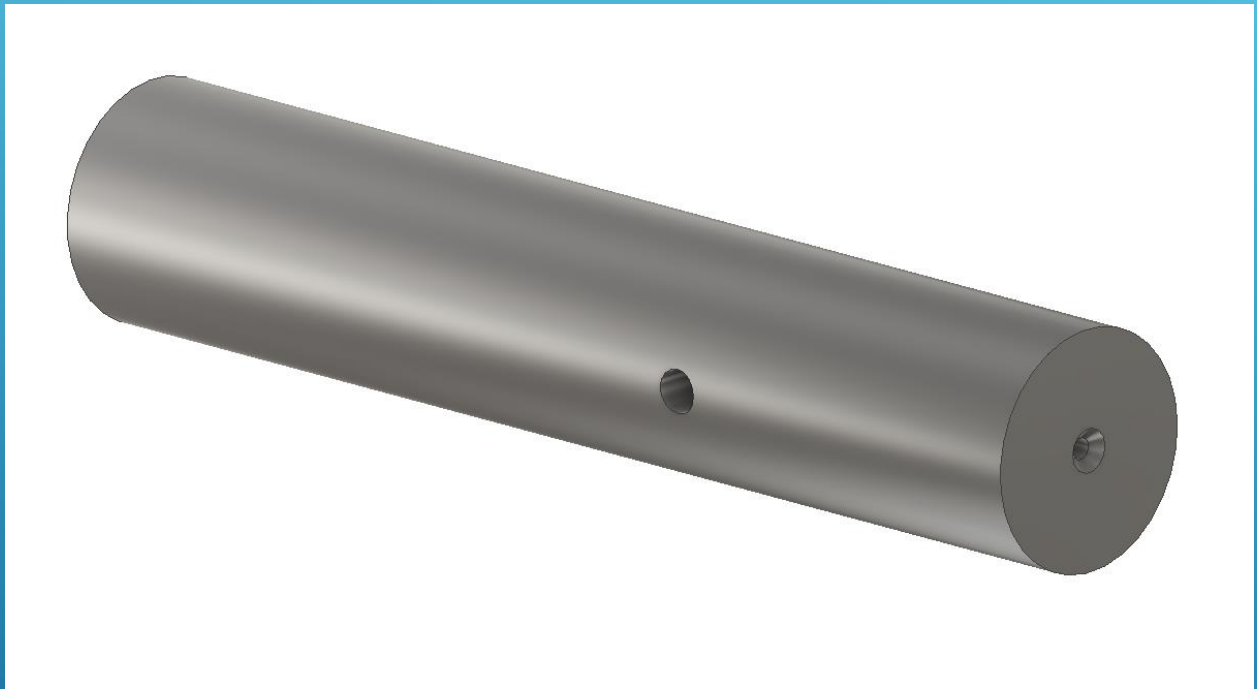
Steel, 12L14

The material for me, is cut longer so I can turn between centers.

Why not use a collet or 3 jaw chuck?

Every time you remove the material from a chuck, the chances of it running “true” again is difficult.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



SPRING HOOK HOLE

Drill hole for spring hook.

Center drill each end.

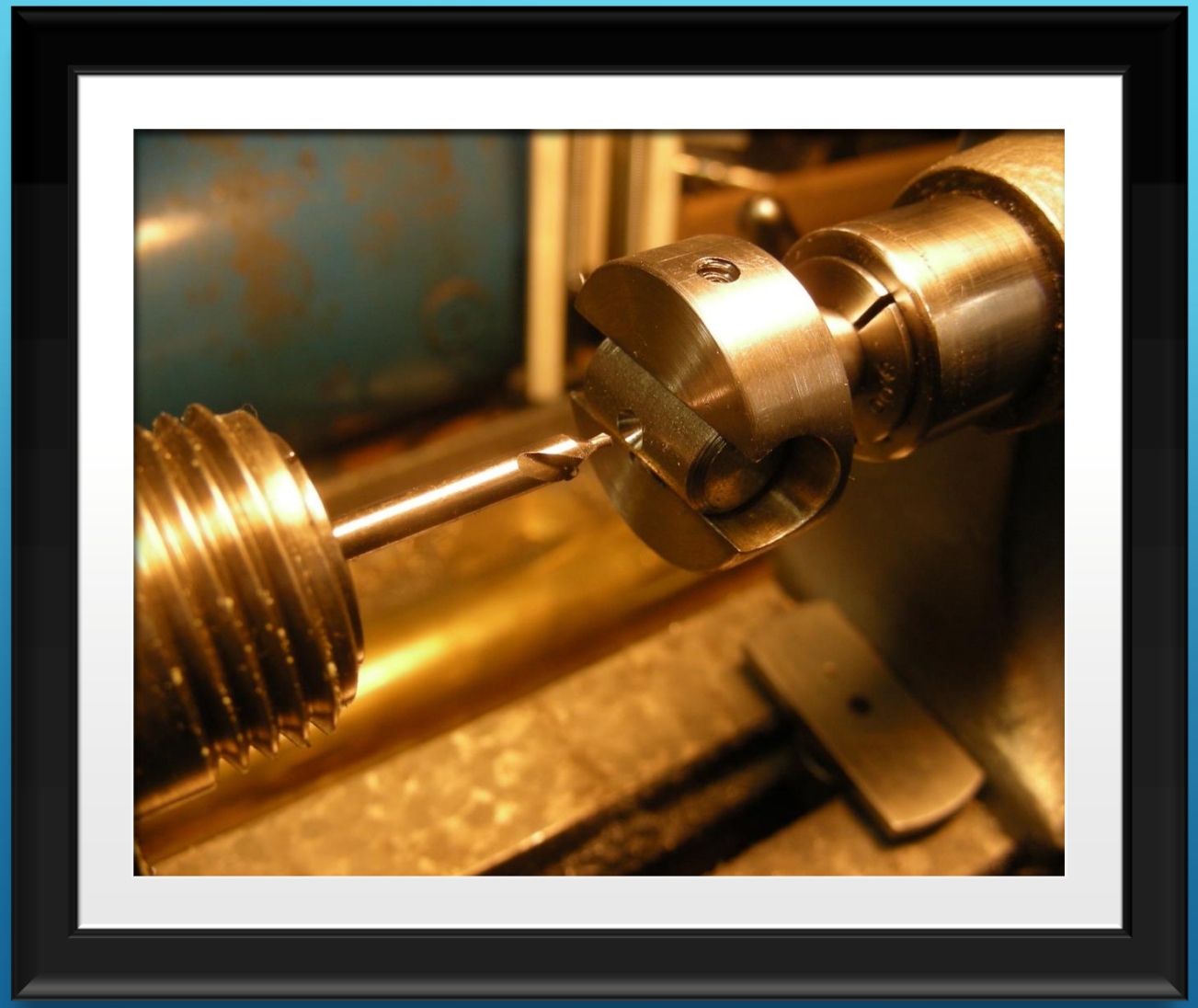
Why do this first?

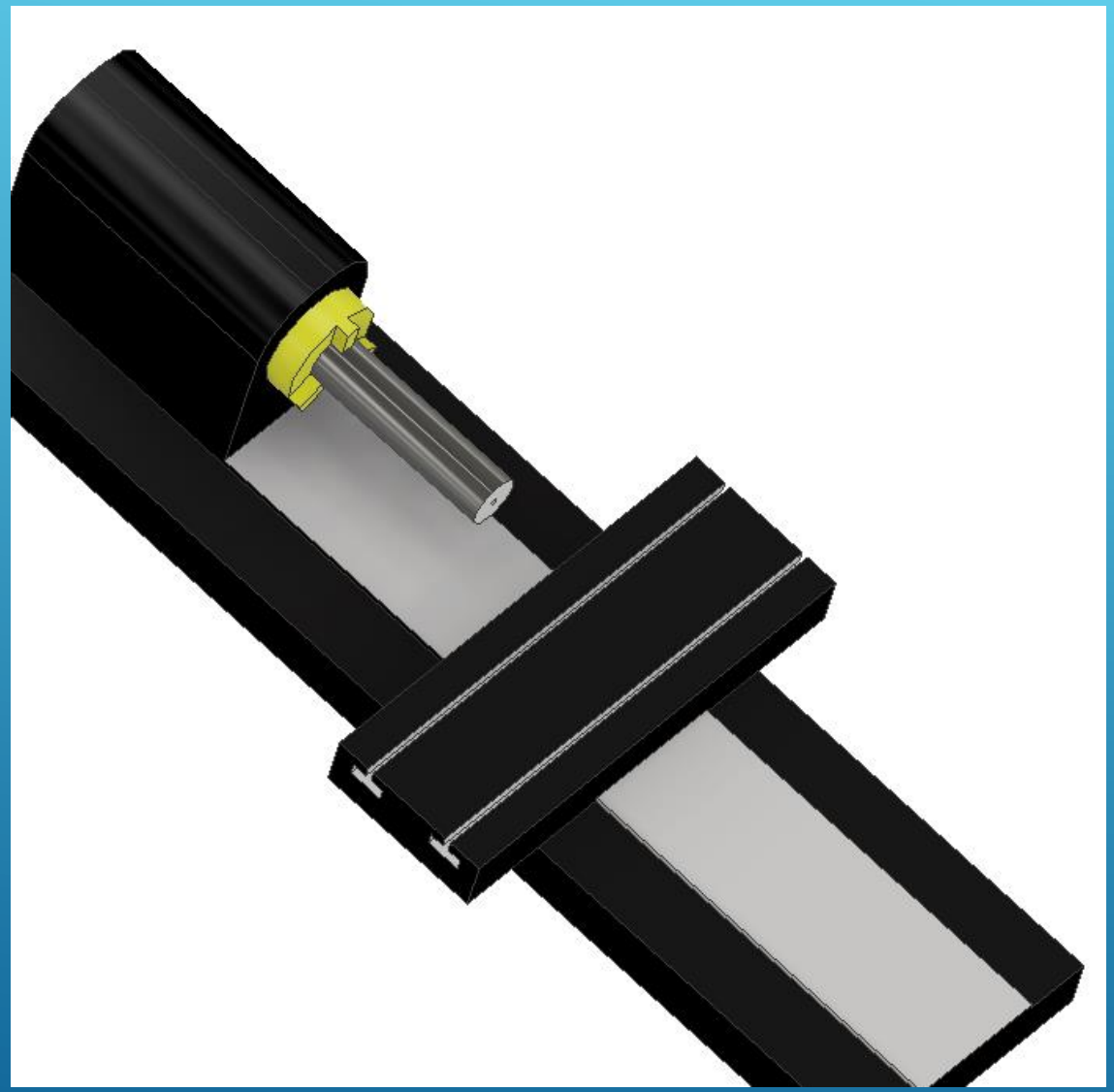
DRILLING ROUND MATERIAL FIXTURE

- My greatest weakness in making this arbor, is getting the hole in the proper location and doing it without breaking a drill.

DRILLING ROUND MATERIAL

- Use a center drill.
- If I went thorough all the effort of making the arbor first, and then drilled the hole off location, I have just went thorough a lot of work for nothing.
- Always start with your weaknesses if possible.





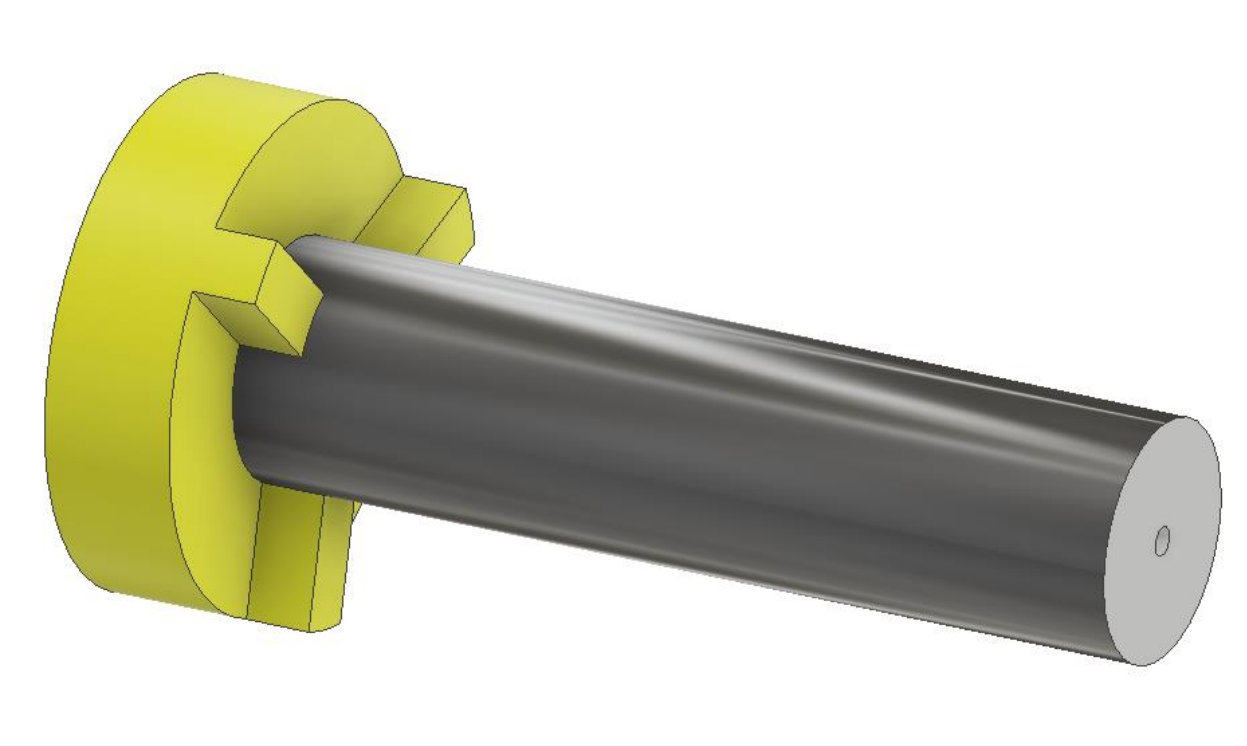
BARREL ARBOR

Insert your material into a 3 jaw chuck and mount on your lathe.

Center drill the material on both ends.

Layout your material.

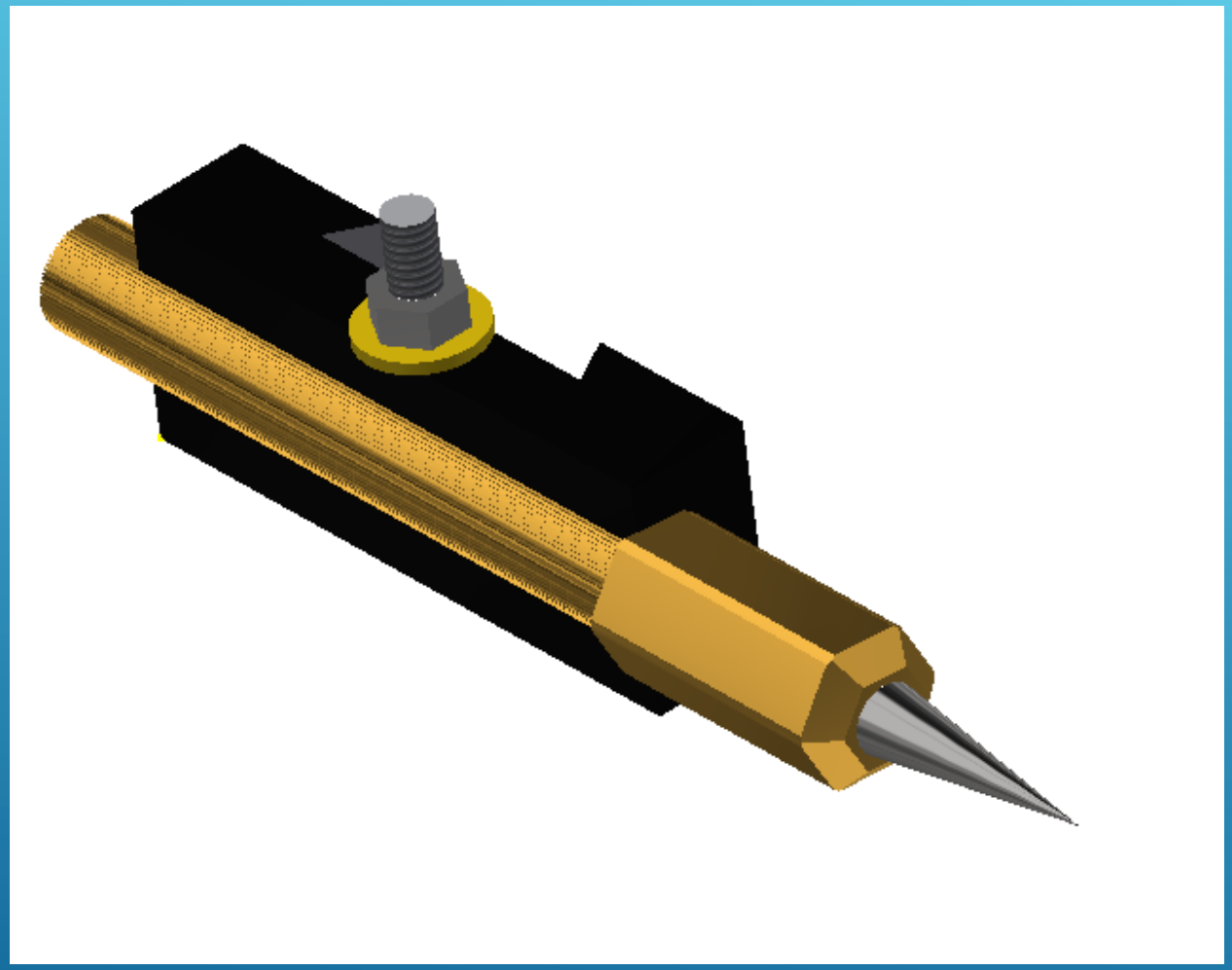
ALWAYS HAVE YOUR SAFETY GLASSES ON!



BARREL ARBOR

Now using your drawing as a reference, layout your material by scribing the shoulders on your piece.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



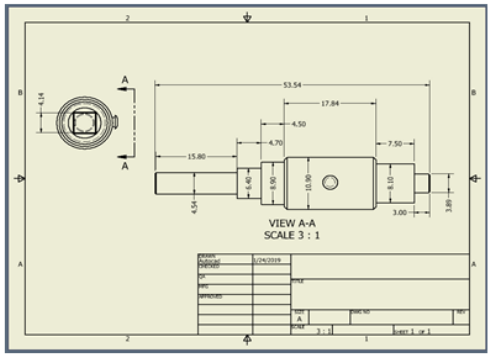
BARREL ARBOR LAYOUT

Using your tool post, use your pin vise to layout each shoulder.

Touch the pin to the end of the material and using the dials on your lathe, move the table to the correct length of the first shoulder.

Remember to look at your plan. If you made the material longer to accommodate for the centers to be drilled, you have to account for this in your layout.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



Part Name: *French Clock Arbor*

Material: *Steel*

Tools: *Lathe, center drill, caliper*

Strengths: *Turning Between Centers*

Weakness: *Drilling round stock*

Procedure:

1. *Cut material to length (add 6mm for centers)*
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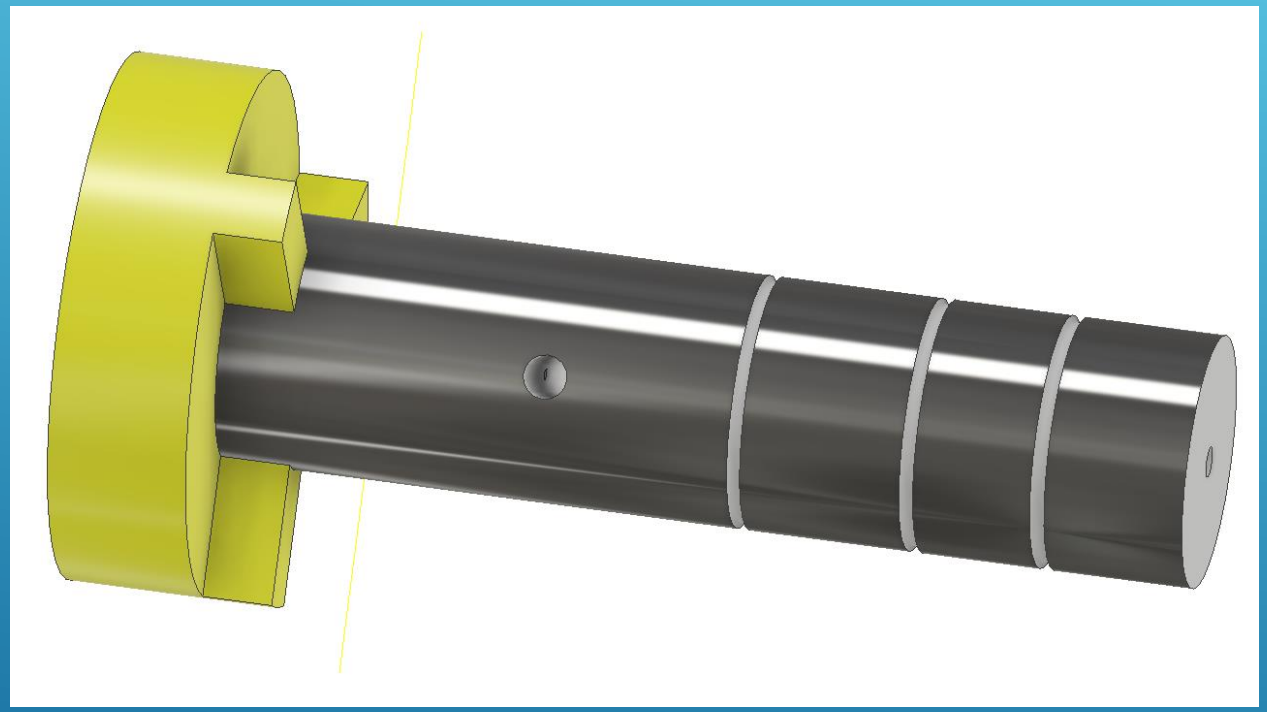
6. *Turn outside diameter*
7. *Turn all additional diameters*
8. Make the square key end. (grind or file)

ALWAYS HAVE YOUR SAFETY GLASSES ON!

ARBOR PLAN

An example of one of my plans for making an arbor.



LAYOUT

Layout the first side, and then flip the material and layout the other side.

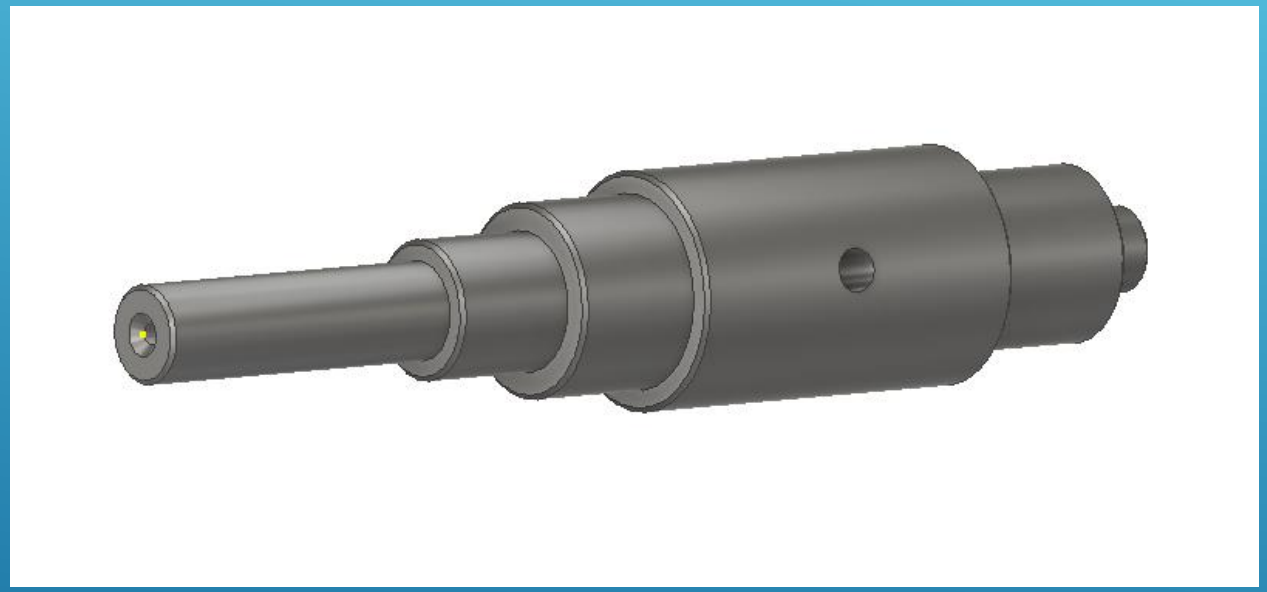
ROUGH TURNING THE PART

Turn two diameters and lengths, leaving a few tenths to finish turn.

Now flip the material around in the lathe and machine the other side.

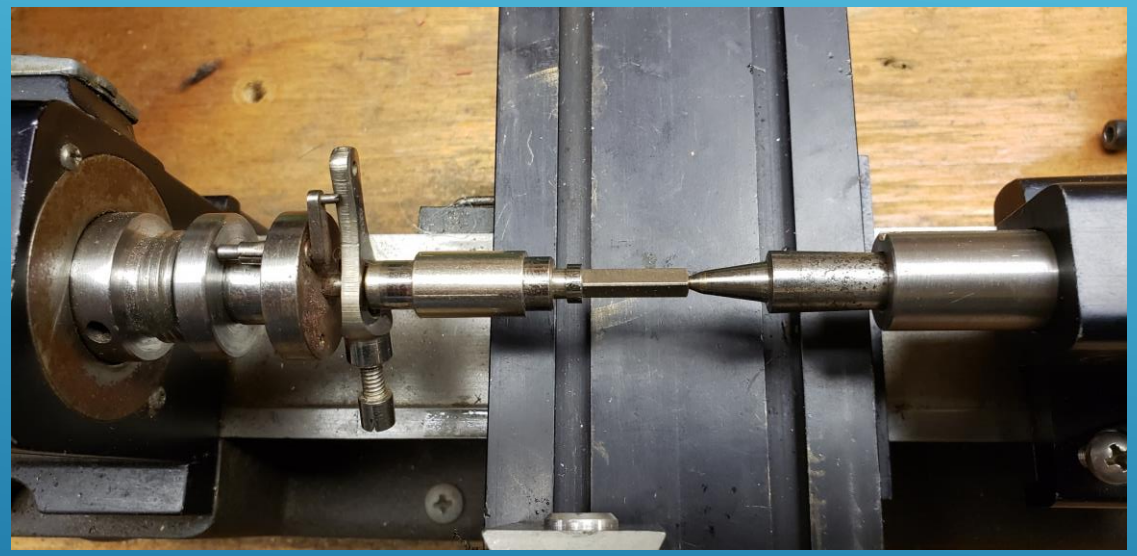
This will now be finish turned between centers.

ROUGH TURNING THE SECOND END OF THE ARBOR



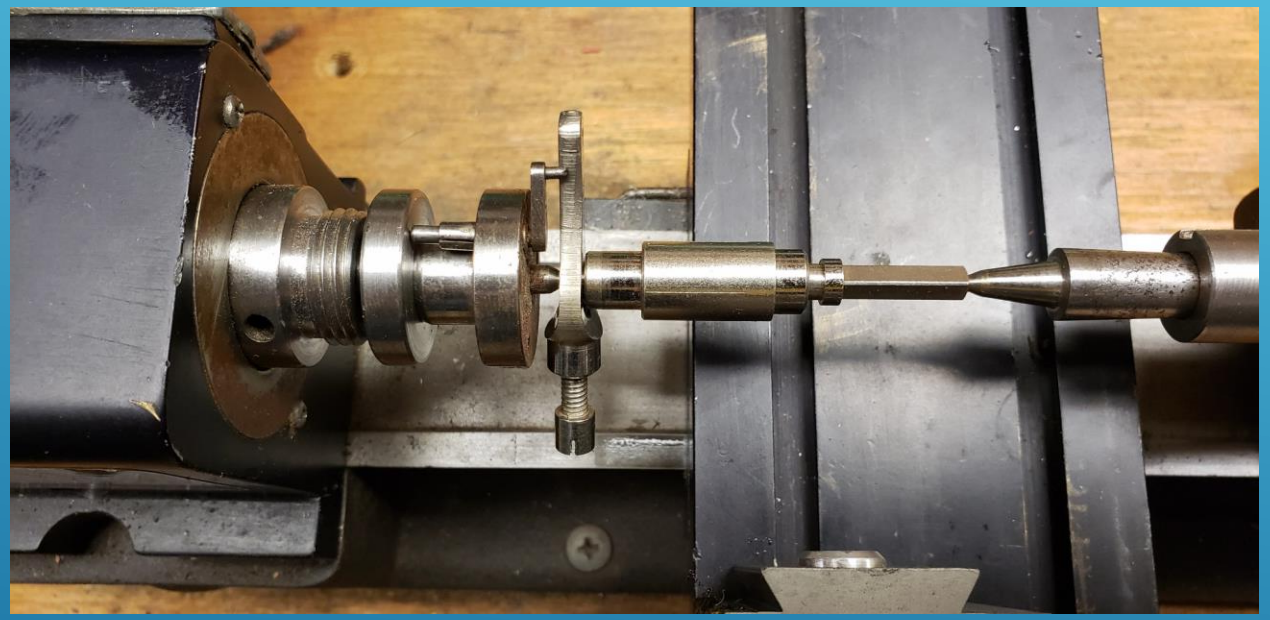
Turn three diameters to length.

TURNING BETWEEN CENTERS



This is the setup I like to use.

Remember, the 3 jaw chuck or collets are not the most accurate way of making something. If you have to keep changing the position of your part it will never run "accurately" true.

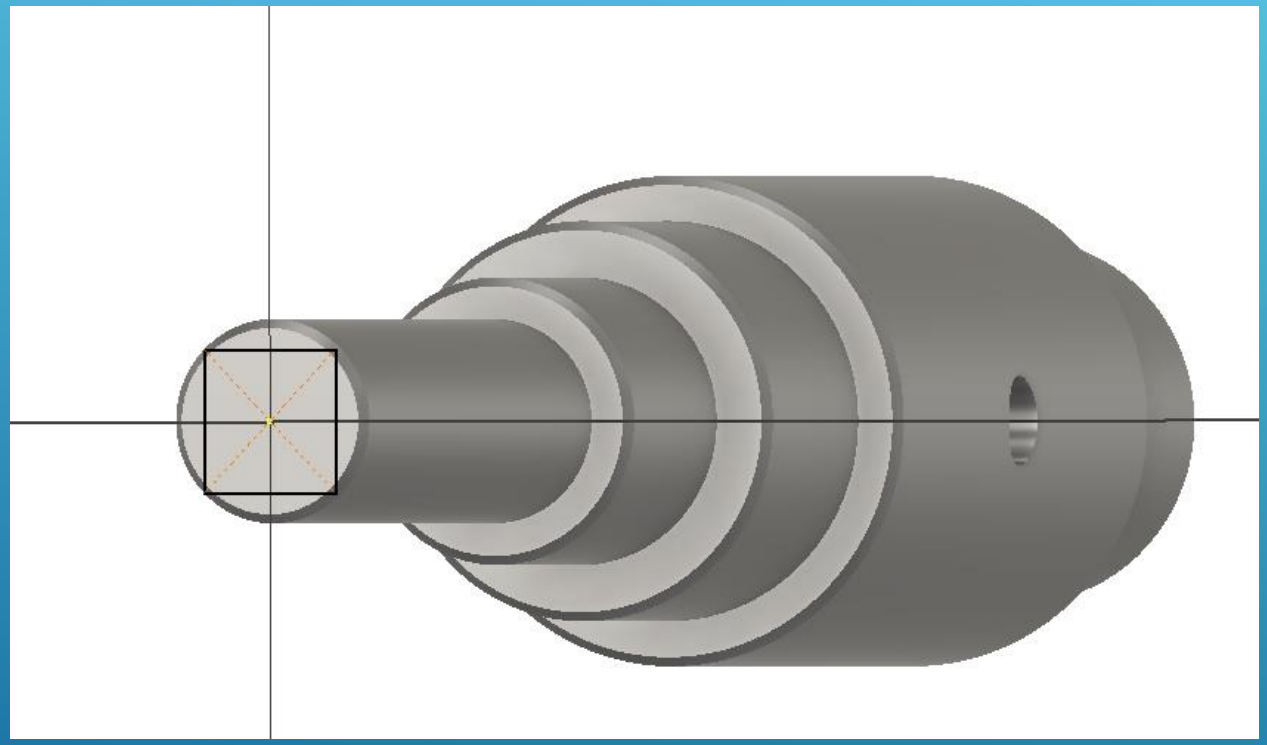


TURNING BETWEEN CENTERS

Turning between centers will always give you “true” running bearing surfaces.

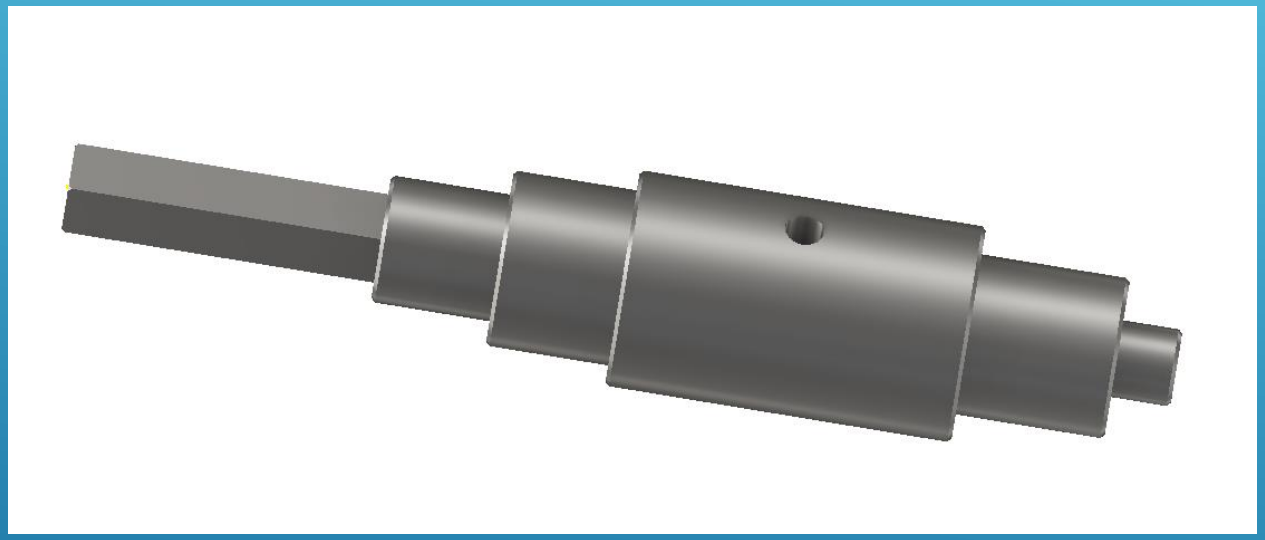
It’s a useful setup to remove the part for measuring and putting it back between centers.

It will always run true.



LAYOUT FOR THE SQUARE

File or grind.

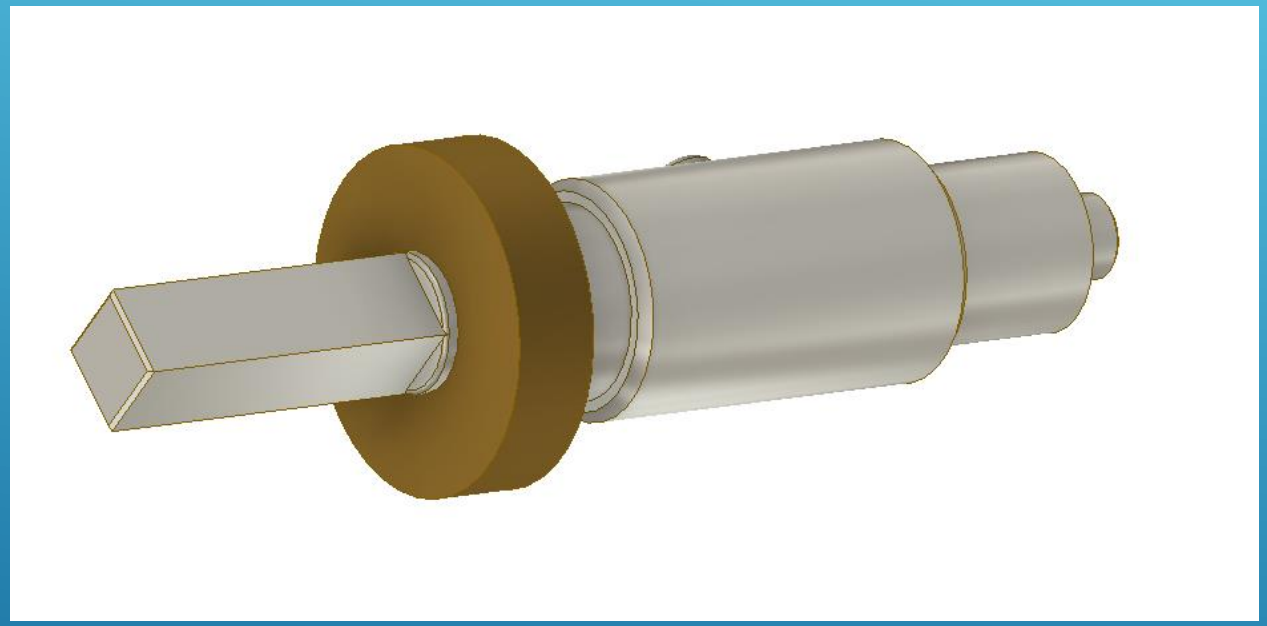


MACHINE THE SQUARE TO PROPER DIMENSION

How would you machine the square?

What or how would you protect the critical surfaces. Would you need to.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



PROTECTING CRITICAL SURFACES

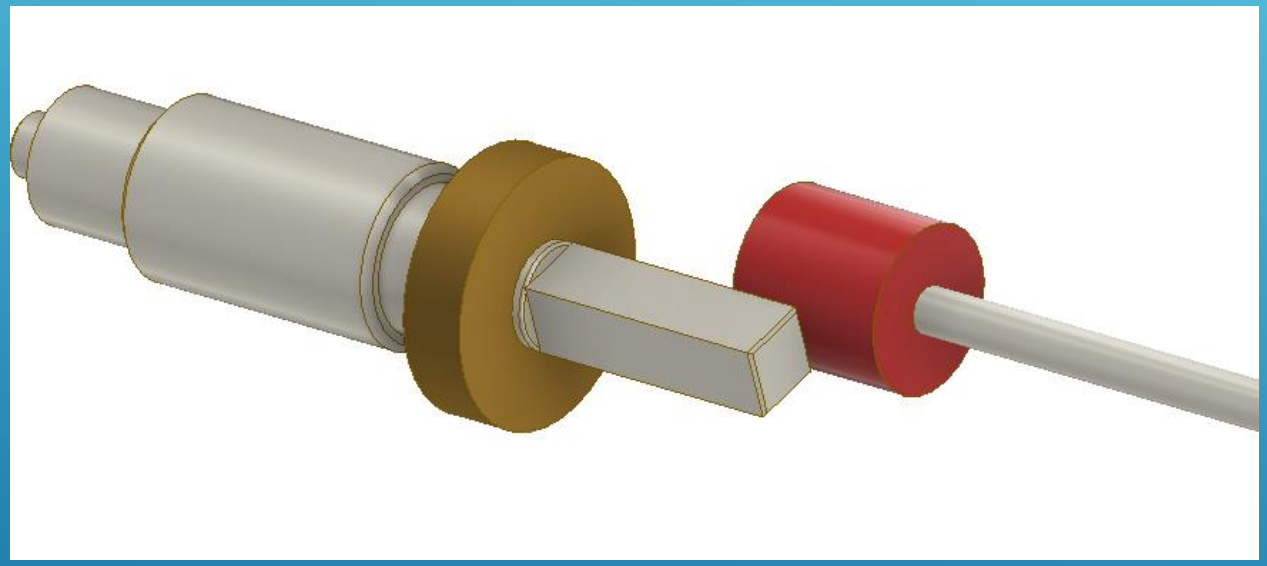
Always cover critical surfaces with some kind of protection.

I like to use a brass washer to protect these surfaces.

Now you can file or grind the surfaces.

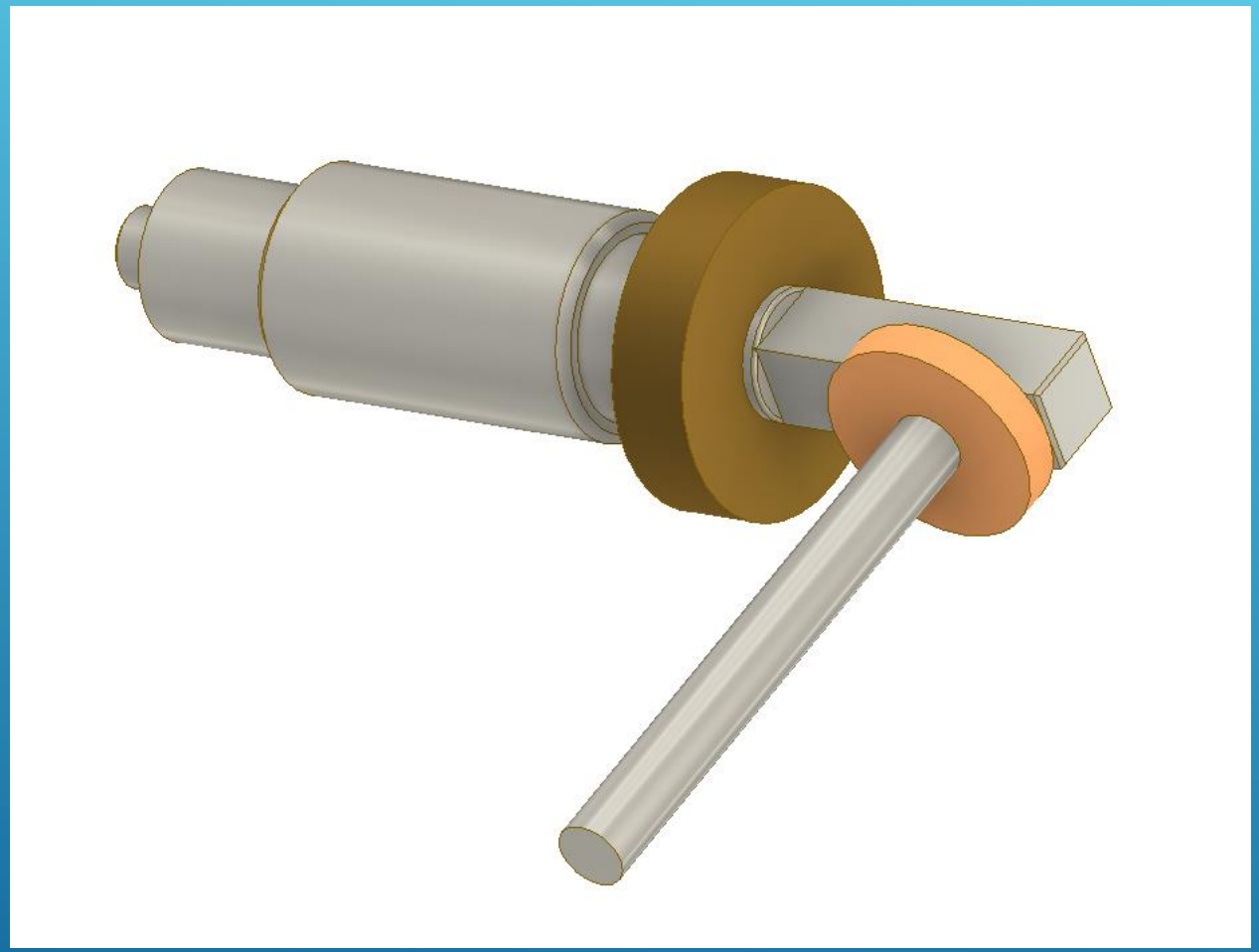
How would we get the flat surfaces at 90 degree angels?

GRINDING THE SQUARE



Grinding with a stone.

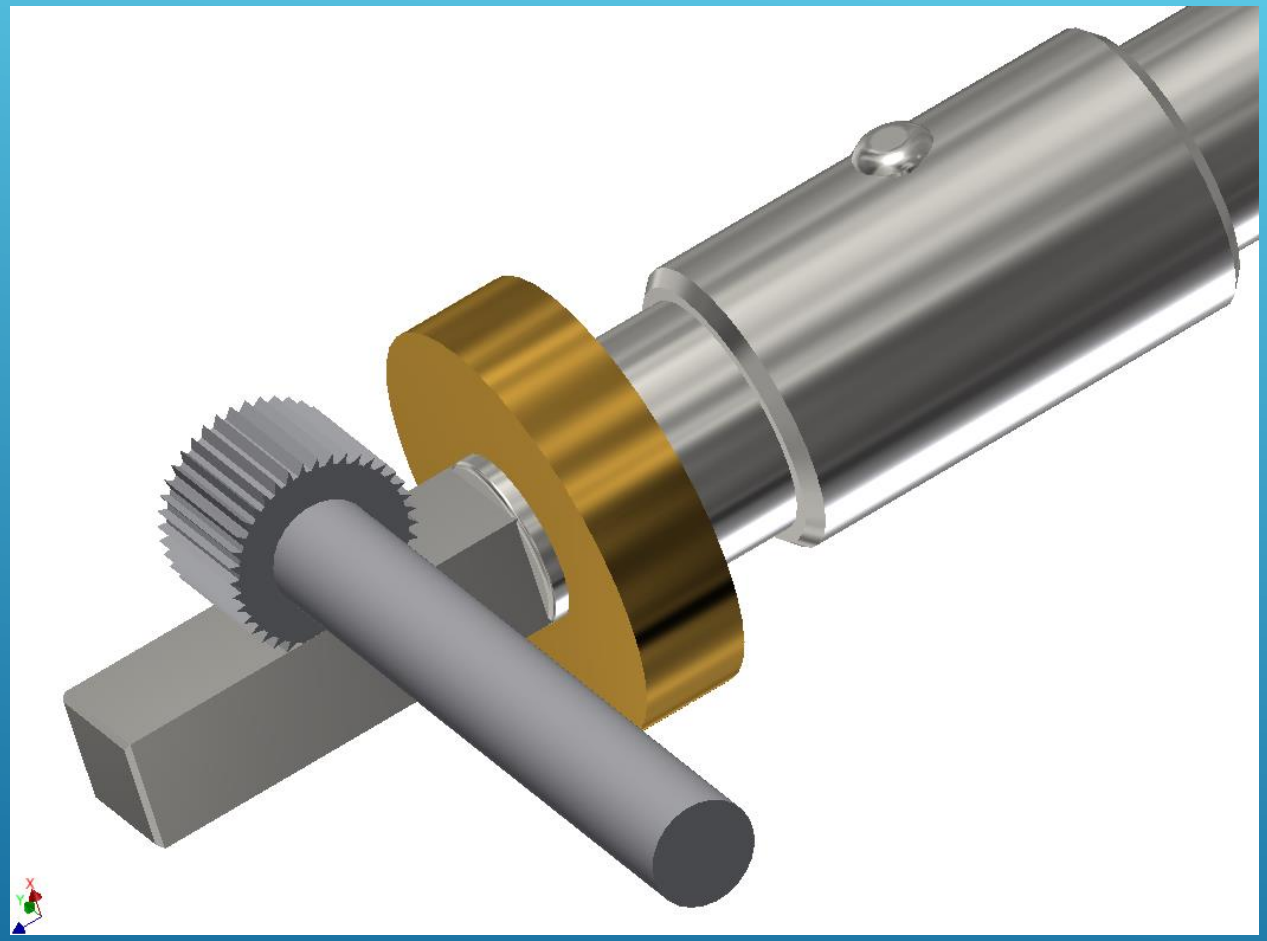
ALWAYS HAVE YOUR SAFETY GLASSES ON!



GRINDING THE SQUARE

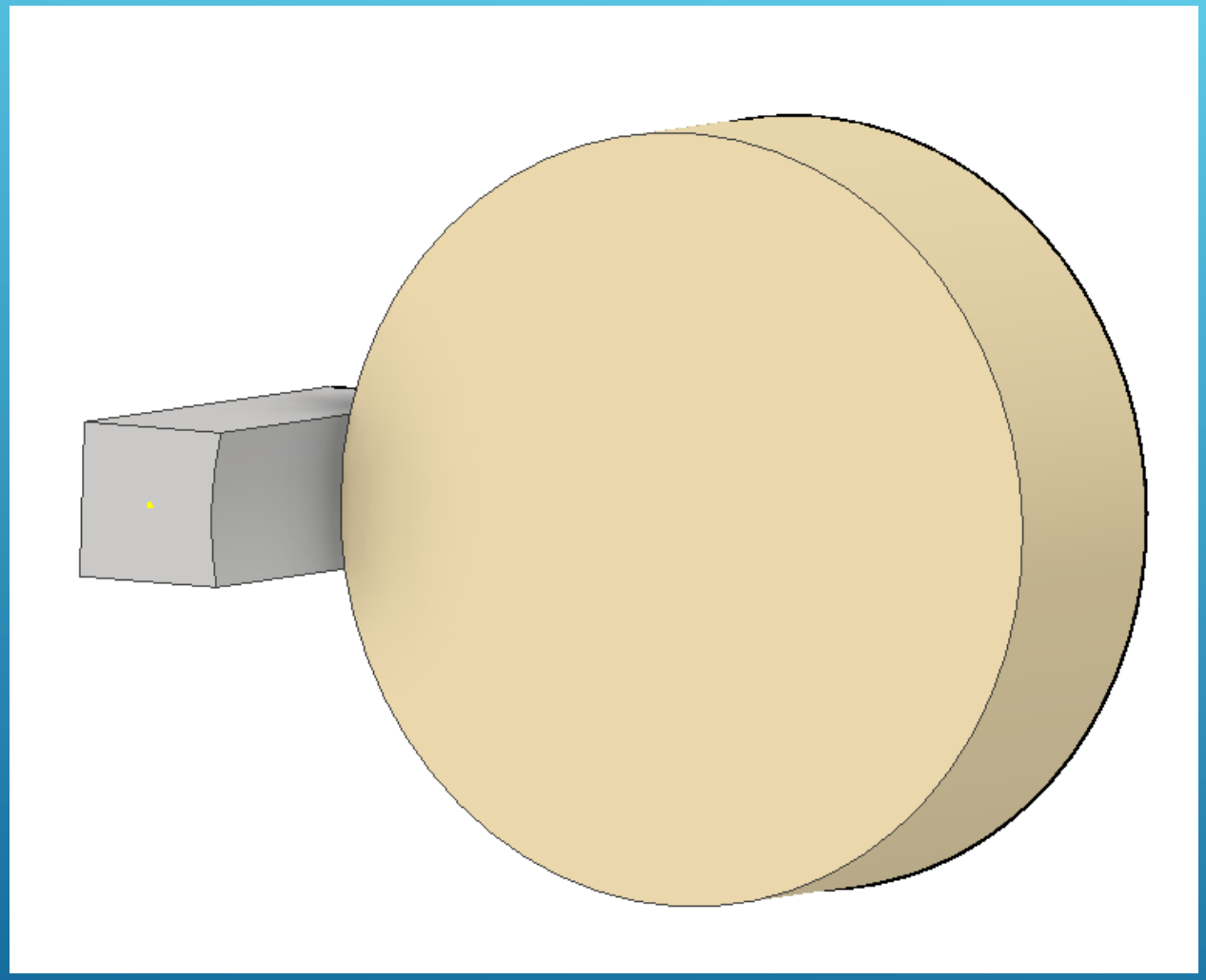
Using a “ Dremal” cut off wheel.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



GRINDING THE SQUARE

Or this setup with a milling cutter.



GRINDING

Make sure you draw file the surfaces when your done grinding.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

INDEXING THE ARBOR

Use the indexing fixture to make the square.

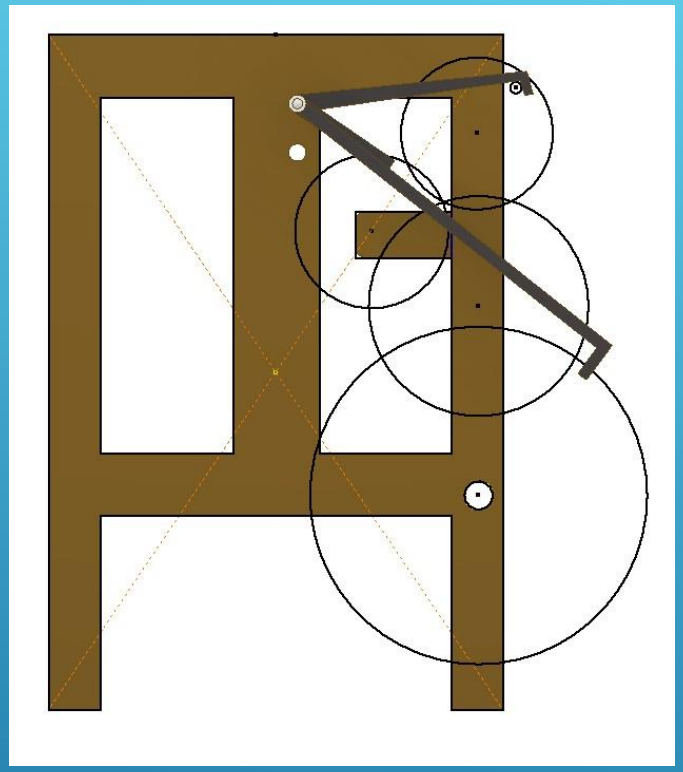
Since this is a 60 tooth wheel, index the wheel every 15 teeth.

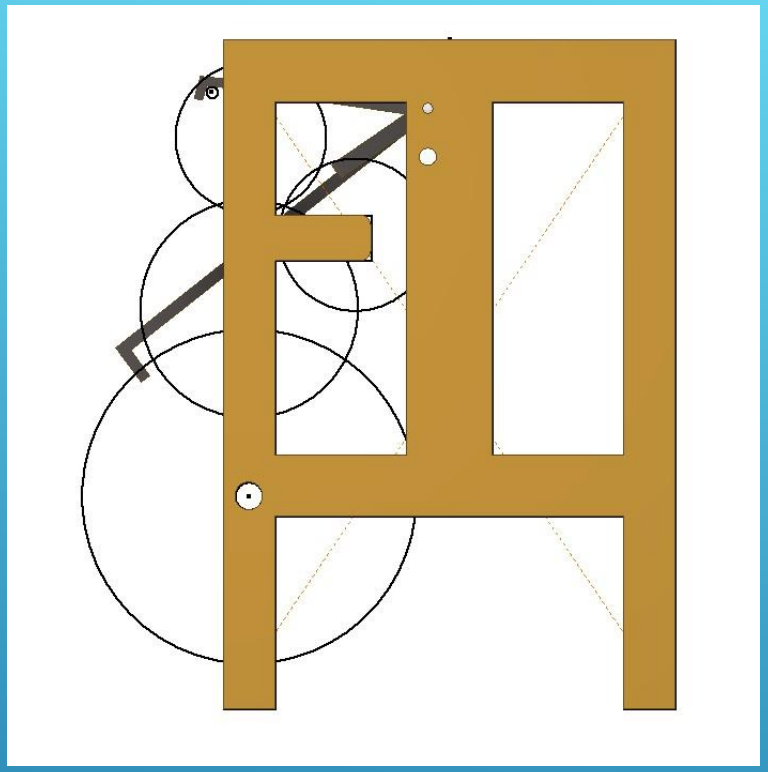
Slowly grind or mill the material away. Take one pass with the cutter, and index the arbor until each of the four surfaces are done.

Repeat until the desired dimension.

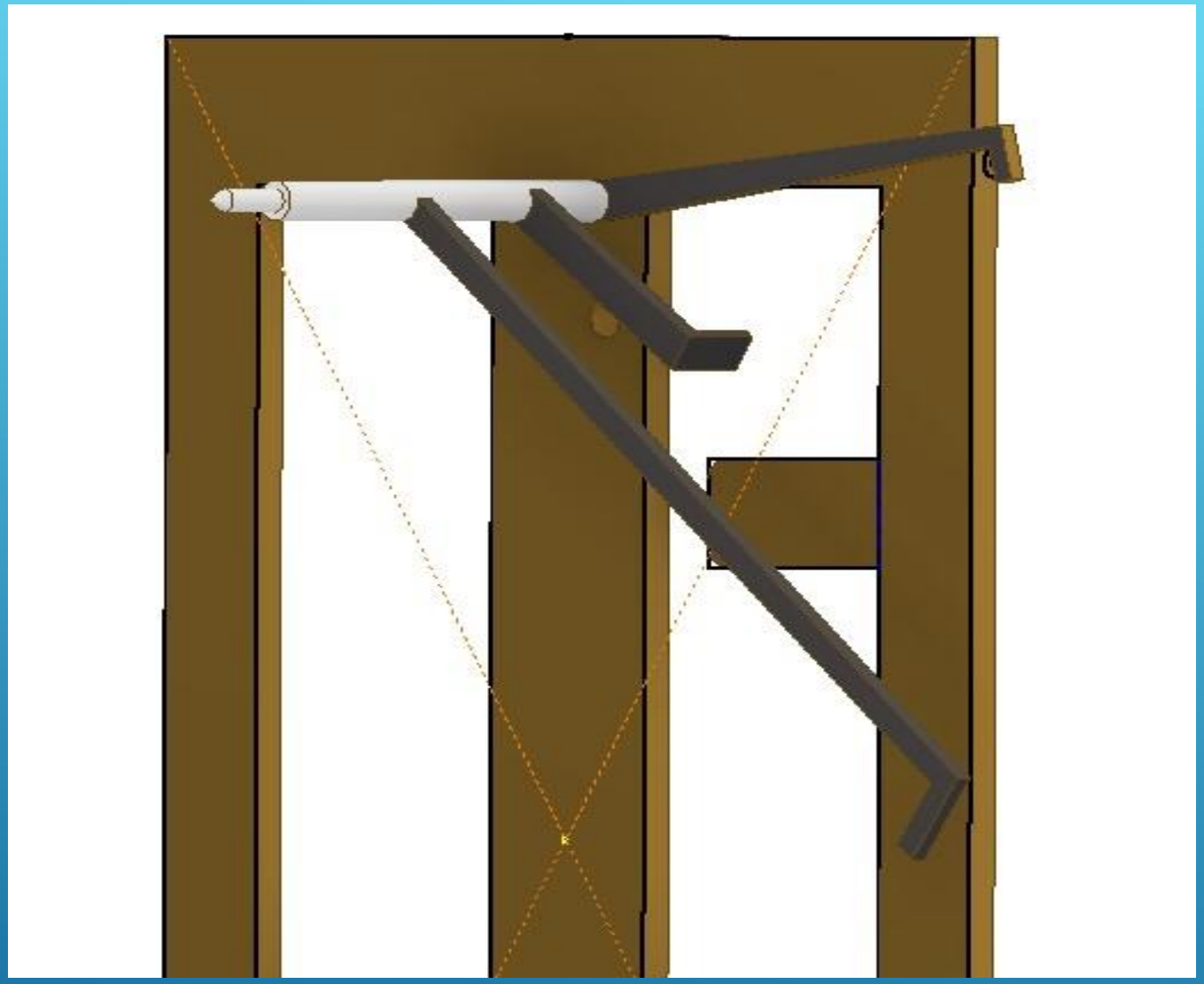
TIME AND STRIKE ARBOR

ALWAYS WEAR YOUR SAFETY GLASSES!



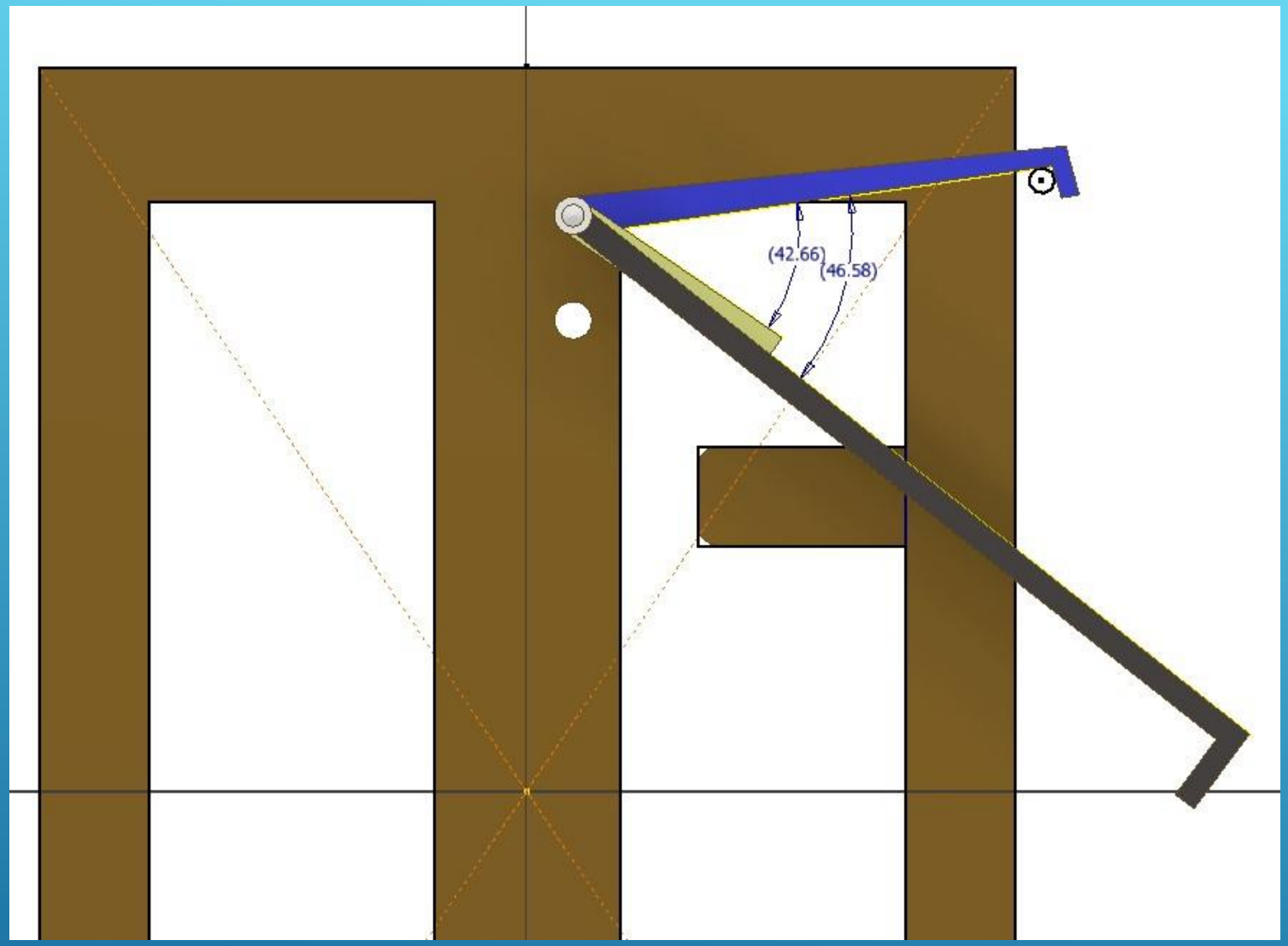


ALWAYS HAVE YOUR SAFETY GLASSES ON!



THE ANGELS BETWEEN EACH LEVER

ALWAYS HAVE YOUR SAFETY GLASSES ON!



THE ANGELS BETWEEN EACH LEVER

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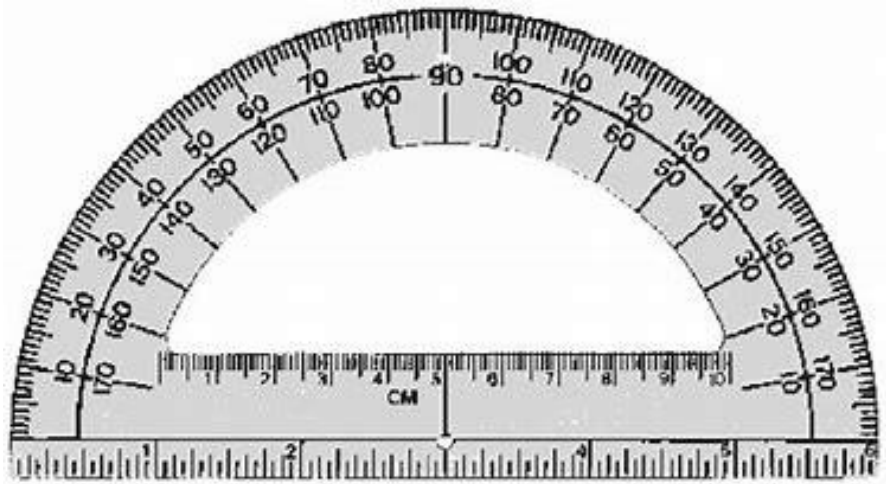
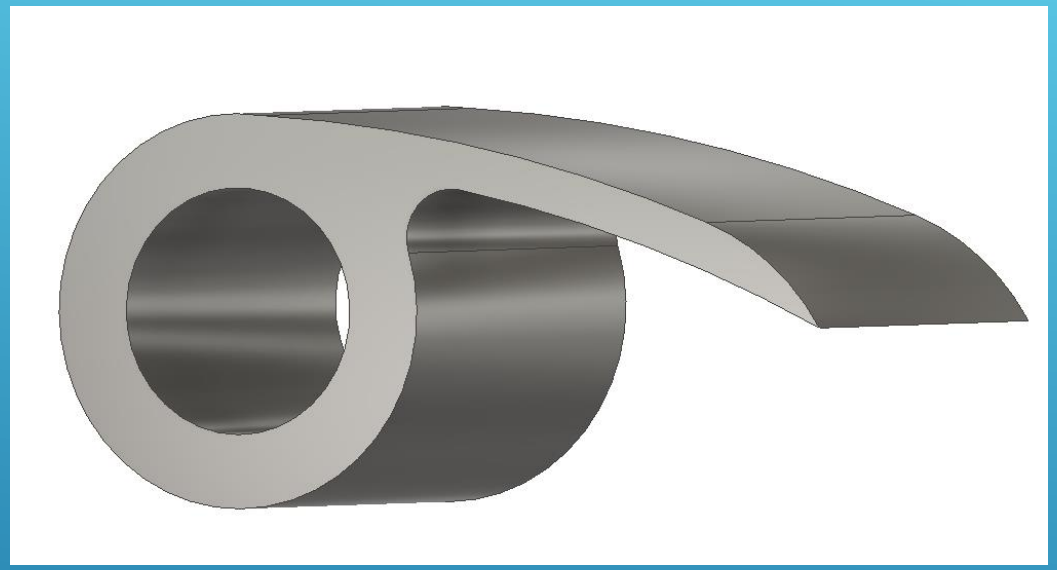


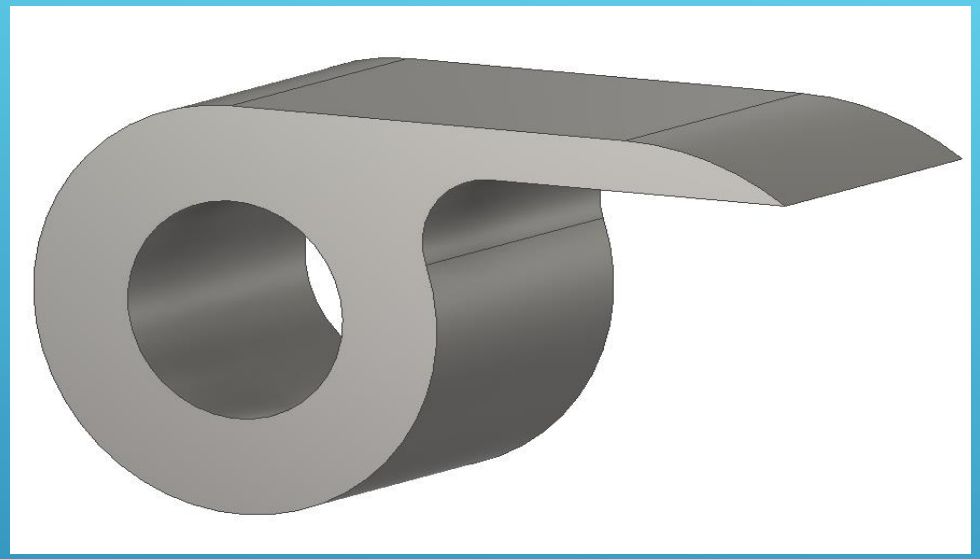
PROTRACTOR TO FIND THE ANGLES

ALWAYS HAVE YOUR SAFETY GLASSES ON!

GATHERING PALLET FOR FRENCH CLOCKS

ALWAYS HAVE YOUR SAFETY GLASSES ON!





GATHERING PALLET FOR FRENCH CLOCKS

ALWAYS HAVE YOUR SAFETY GLASSES ON!

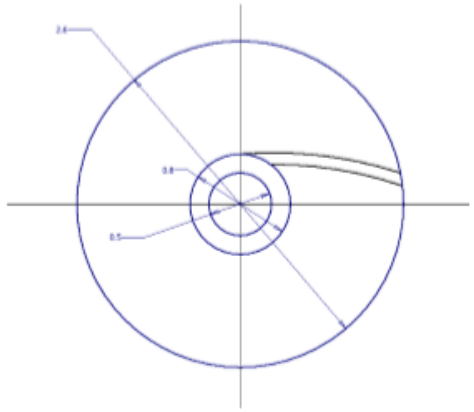
TAKING OUR MEASUREMENTS TO MAKE OUR DRAWING

Need to know:

Distance between the arbor and the root of the rack teeth.

Diameter of the arbor pivot.

Clearance between the pivot center and the tip of the rack teeth.



Part Name: *French Gathering Pallet*

Material: *Steel*

Tools: *Lathe, center drill, caliper, file, grinding fixture*

Strengths: *Turning*

Weakness: *Removing excess material, layout*

Procedure:

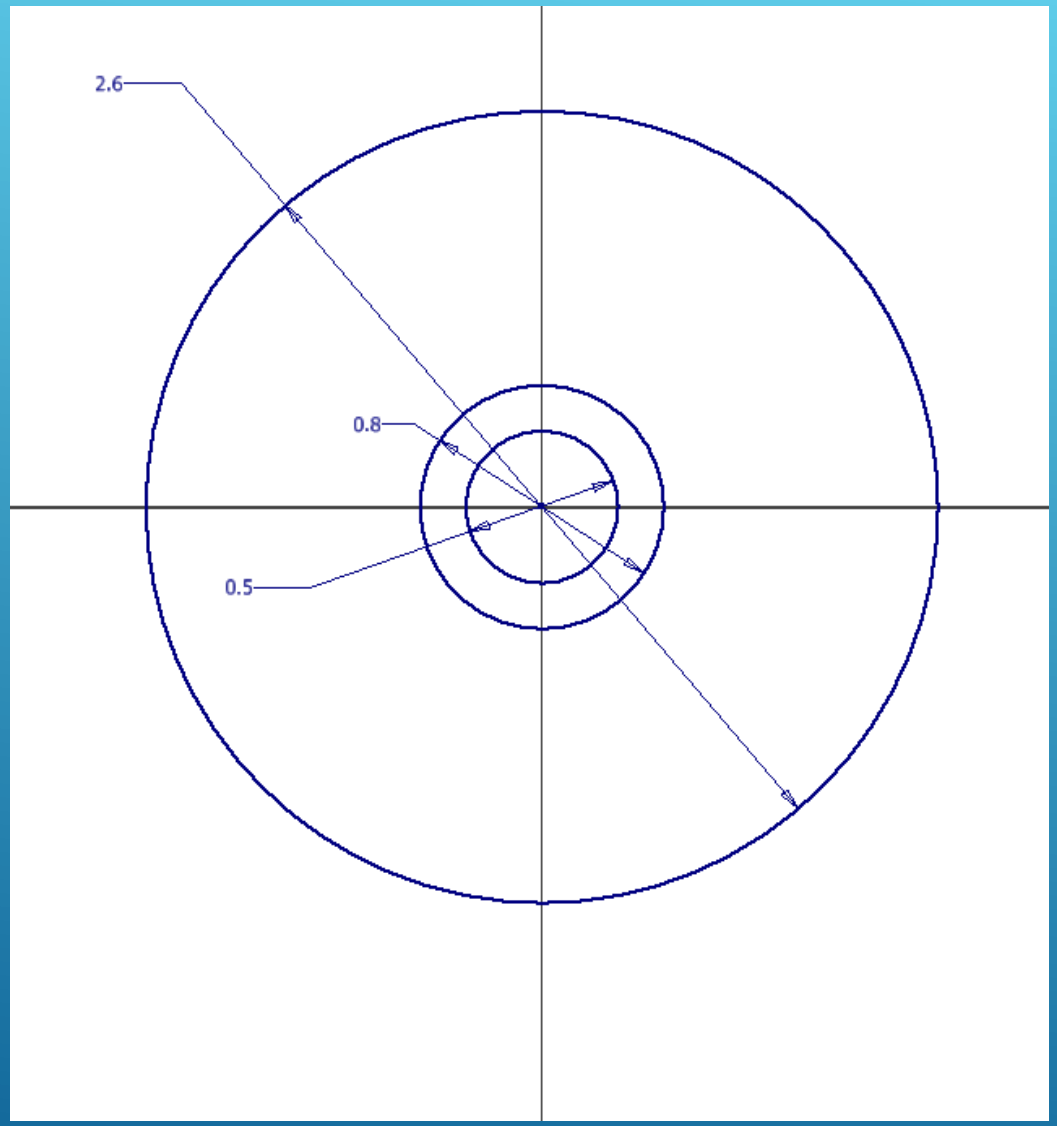
1. Figure out how long the material and cut to length
2. *Center- Drill material and then drill hole for arbor pivot.*
3. *Setup the lathe.*
4. *Select proper cutting tools (graver, or cross slide)*
5. *Turn outside diameter*
6. *Layout the hub and flag*
7. *Remove excess material*
8. Taper hole to fit arbor pivot.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

START WITH YOUR PLAN.

Material?

I have seen wire wrapped around the end of the shaft, bent washers, and the best was the one made from epoxy.



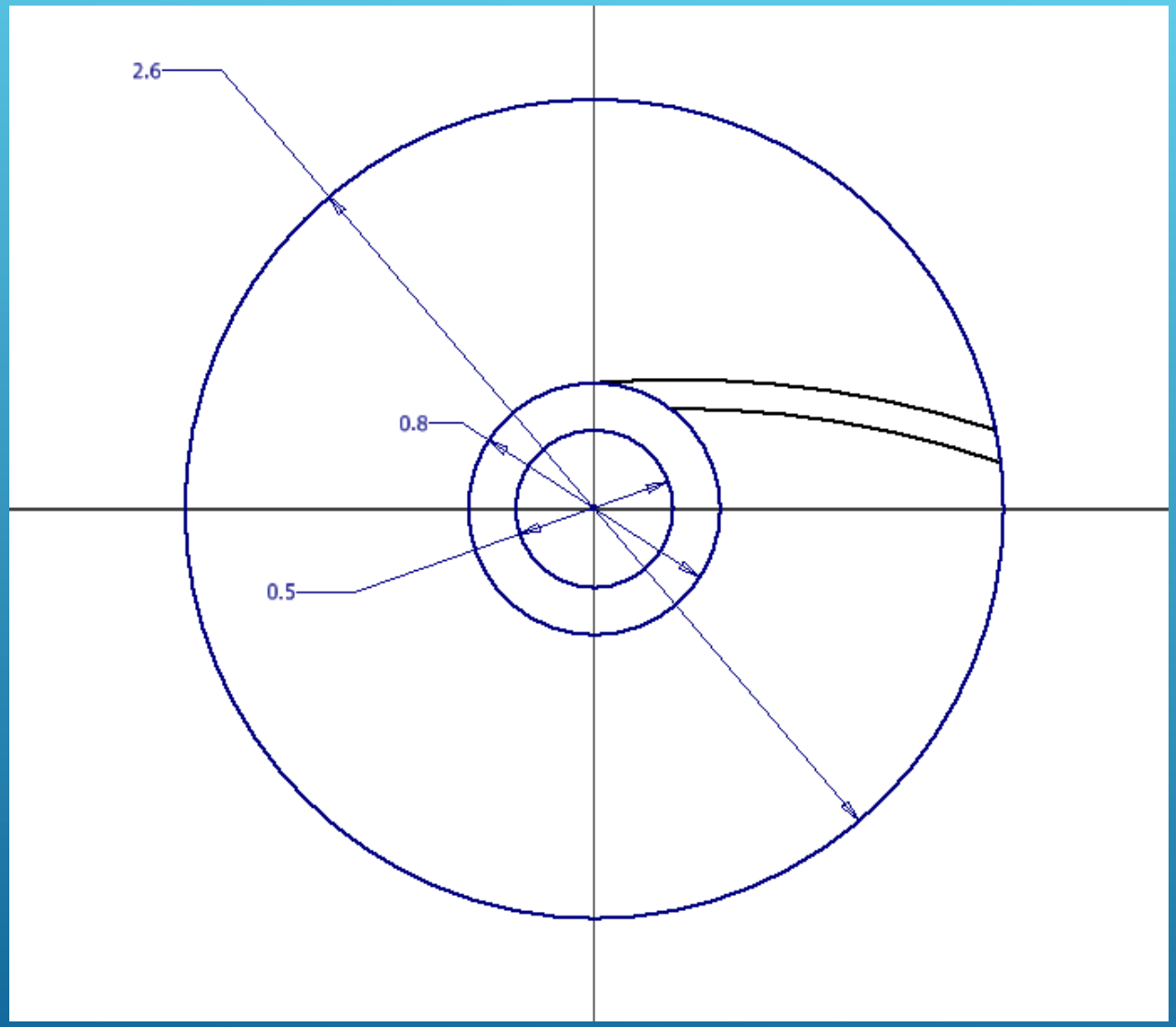
START WITH A BASIC DRAWING

2.6mm is the distance of the flag from the center of the shaft to the depth of the rack.

.8mm is the outside diameter of the "barrel".

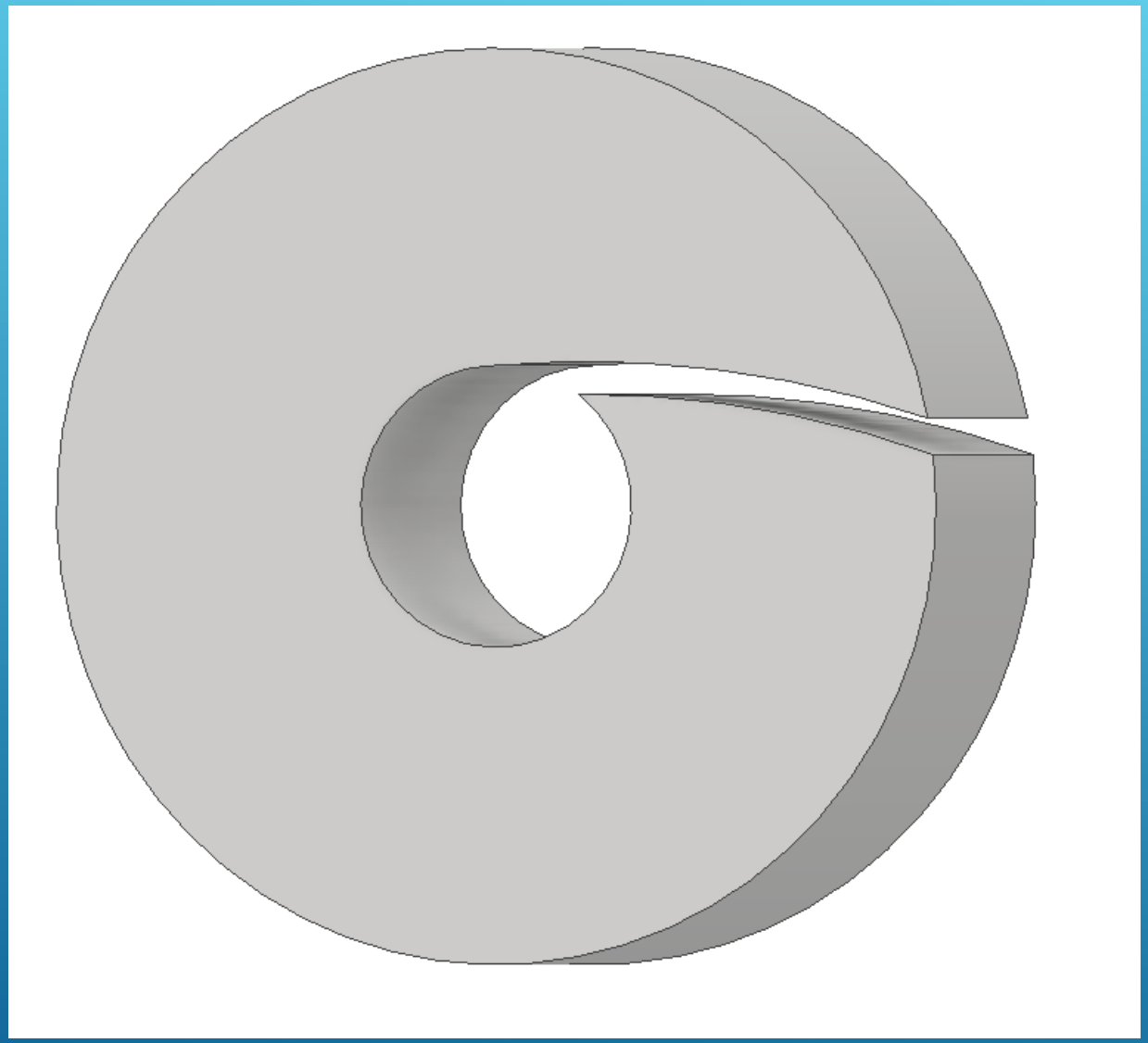
.5mm is the diameter of the shaft.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



DRAWING CONTINUED

Add the flag to the drawing.

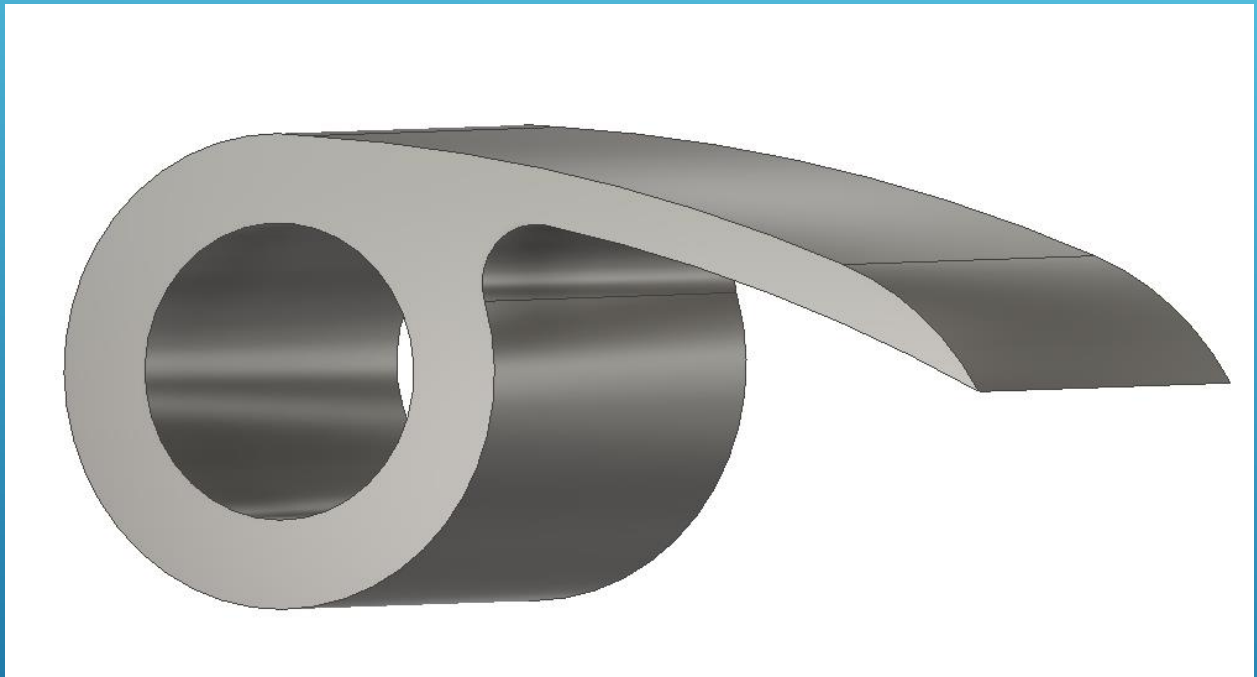


MATERIAL TO BE REMOVED

How will you decide to do this.

- Grind?
- Saw?
- File?

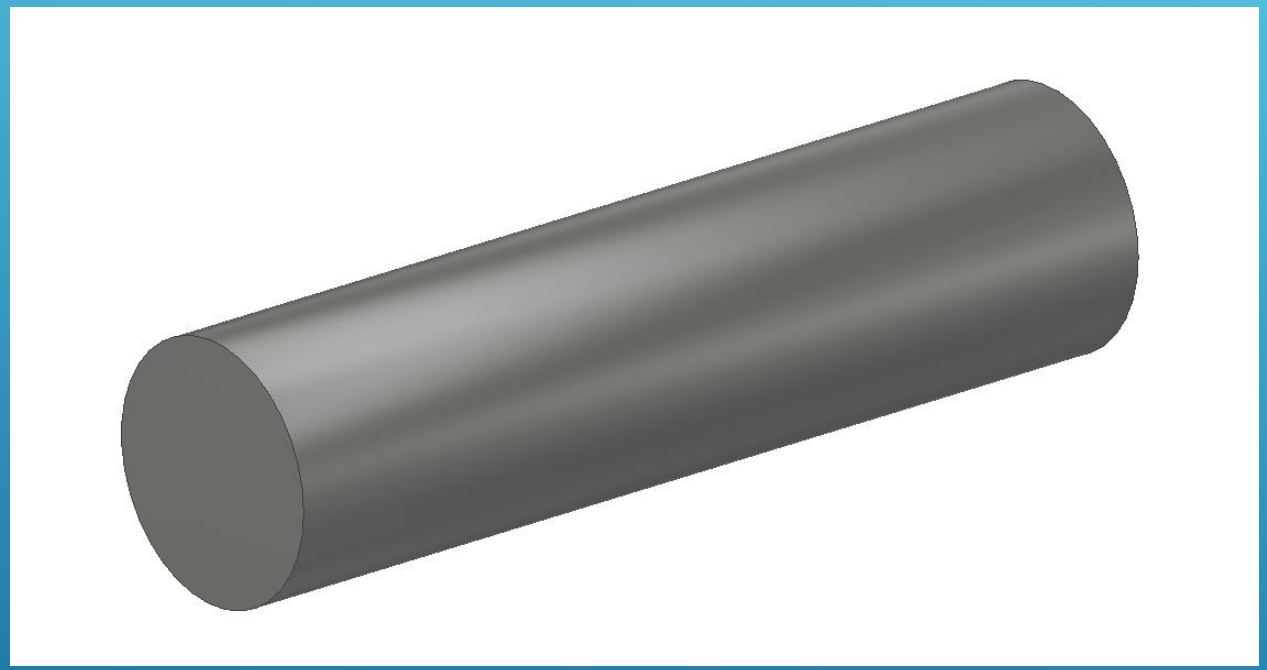
ALWAYS HAVE YOUR SAFETY GLASSES ON!



GATHERING PALLET FOR FRENCH CLOCKS

Making the part.

Lately I have put a small radius on the end of the pallet.



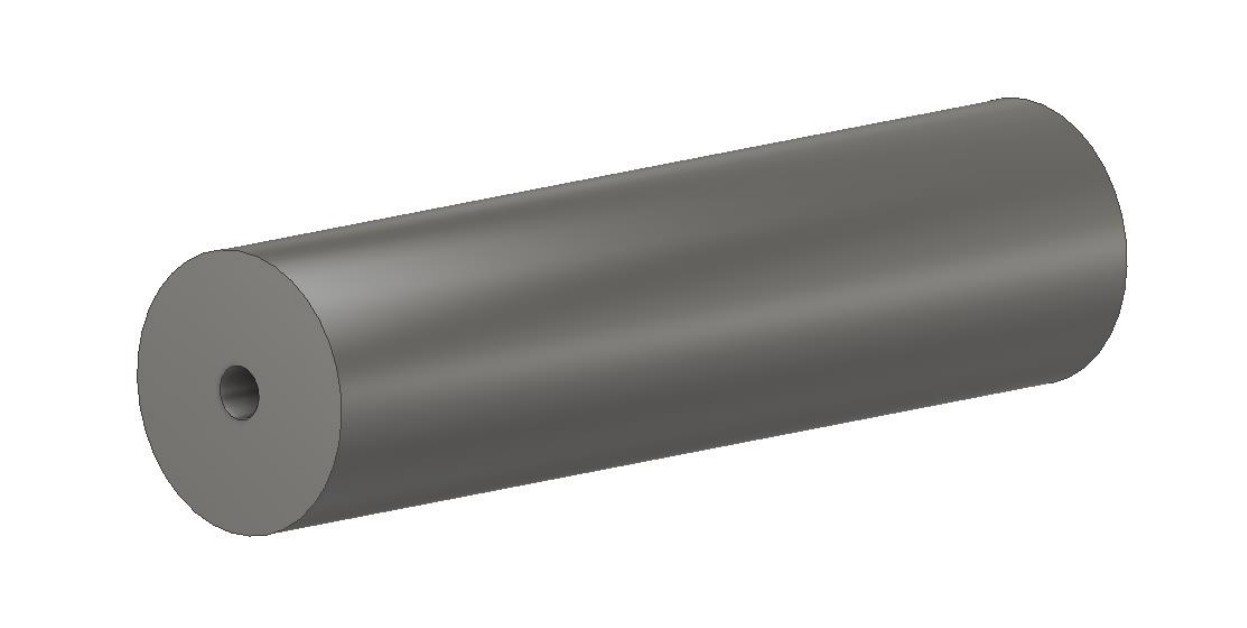
SELECT MATERIAL

Steel, brass? Check your plan.

I used steel for this.

Since this won't need to be heat treated, I use 12L14.

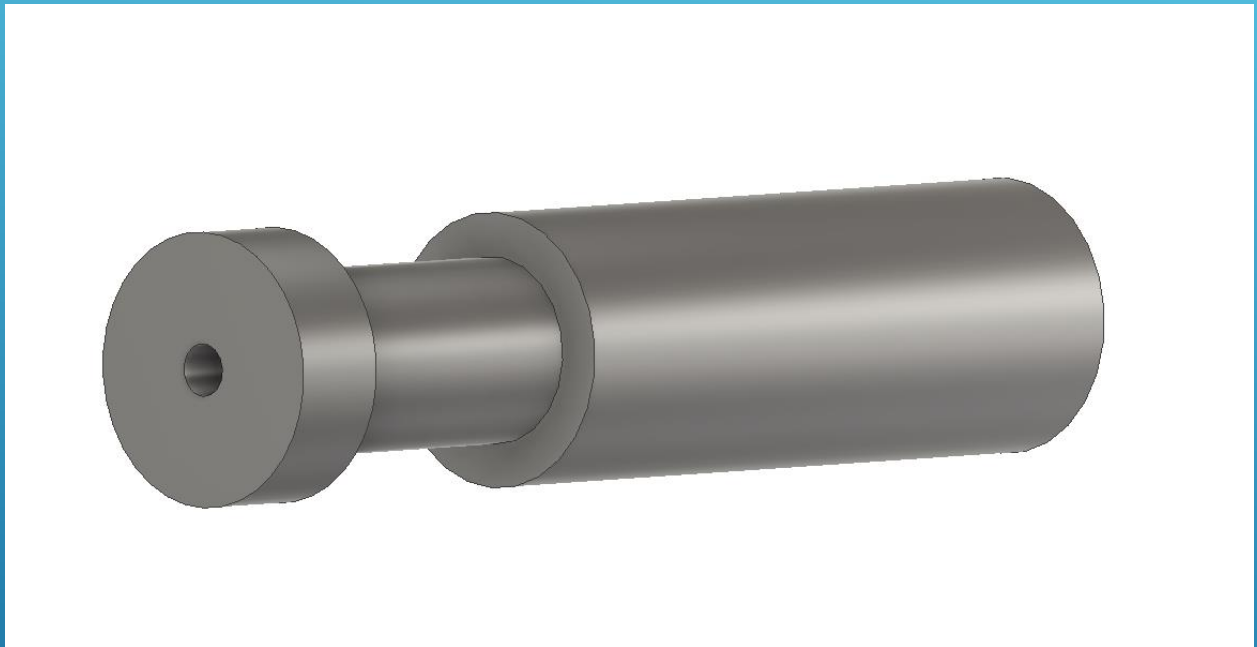
Make sure your material is long enough to manufacture the part.



DRILL CENTER HOLE

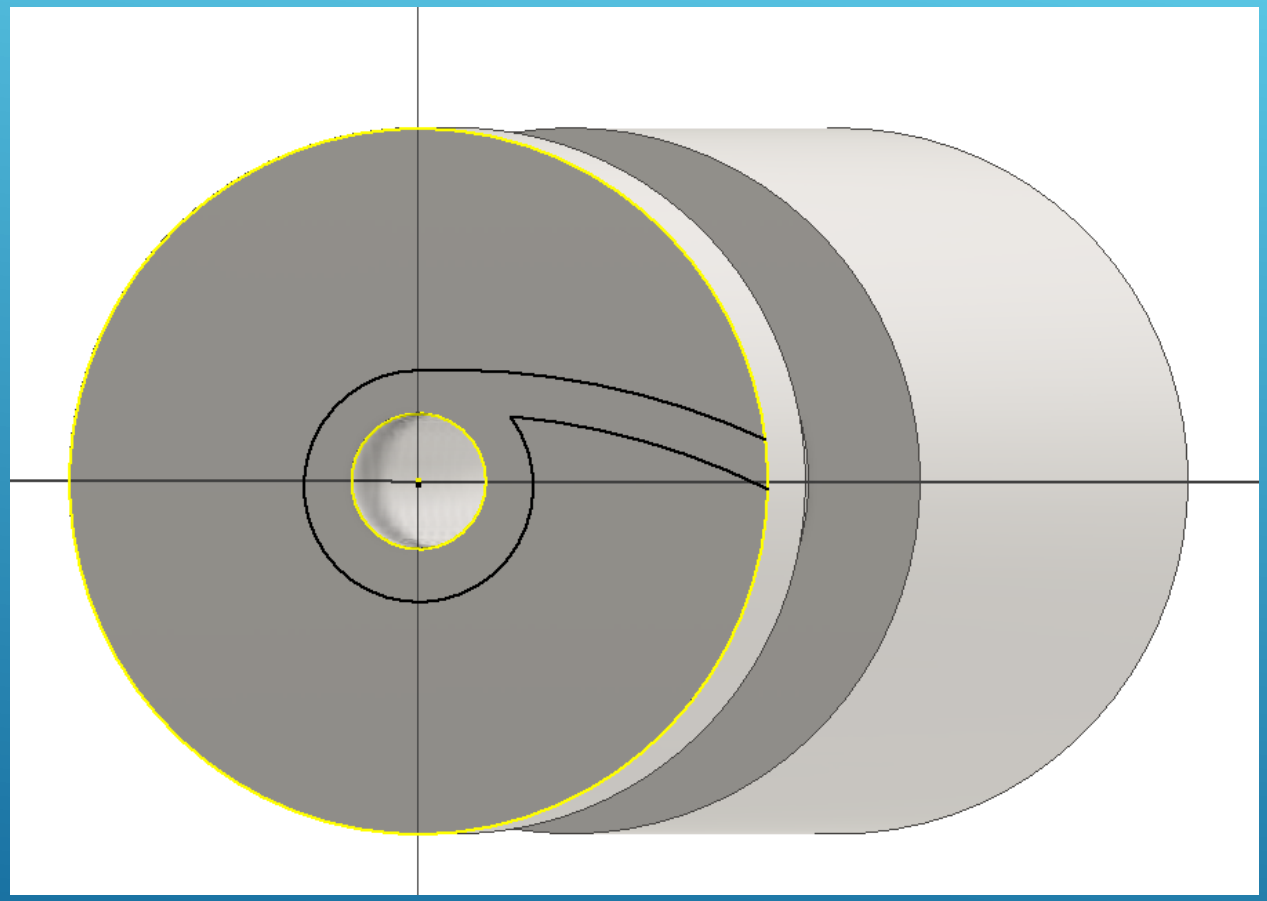
Will I use the lathe or a drill press.

Hold this in a collet or 3 jaw chuck.



MACHINE CLEARANCE

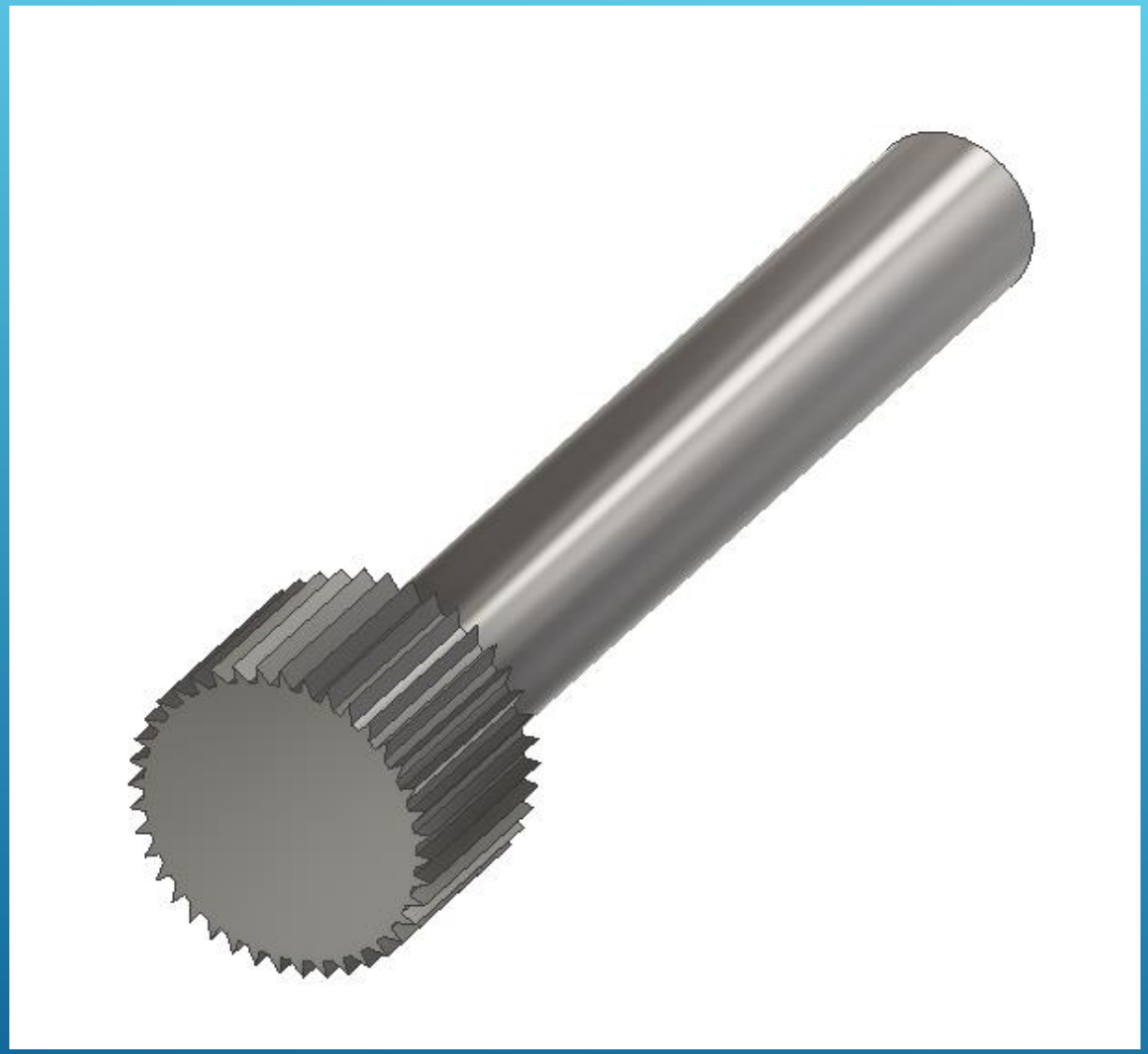
A random relief cut is made on the back side of the pallet.



LAYOUT OF THE HUB AND FLAG

What method would you use to remove the material?

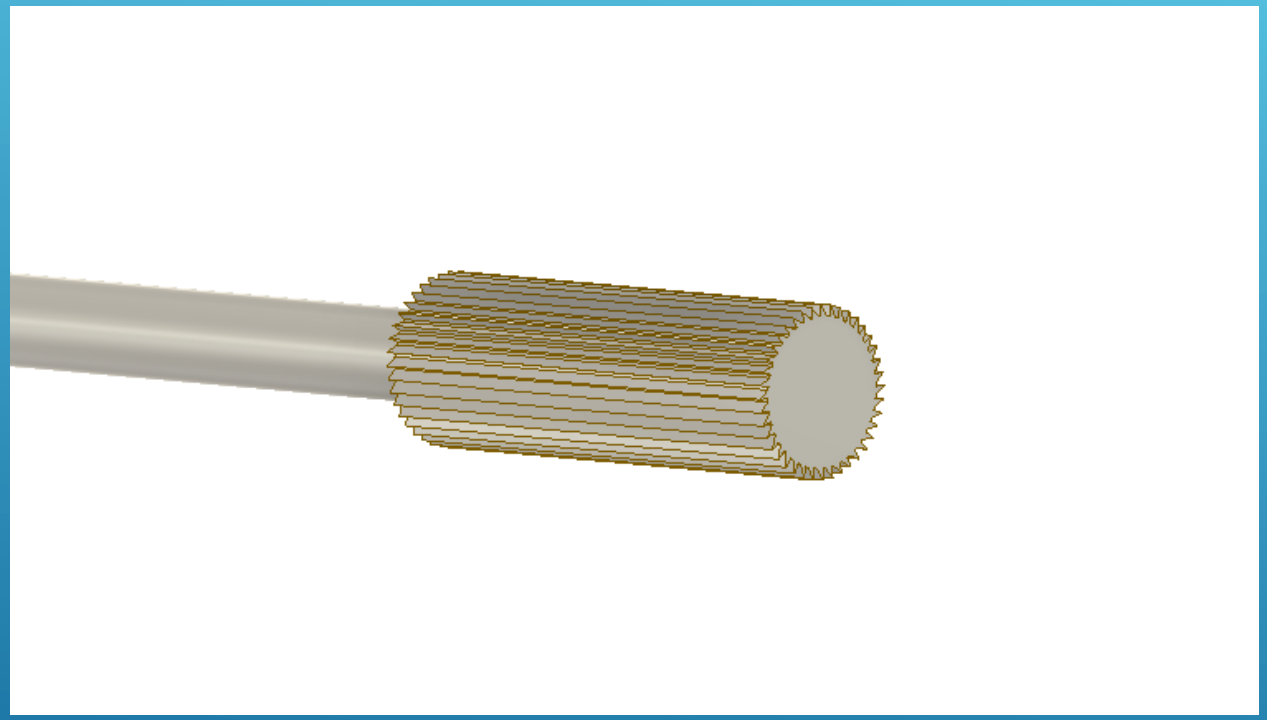
- Saw
- Grinder
- File



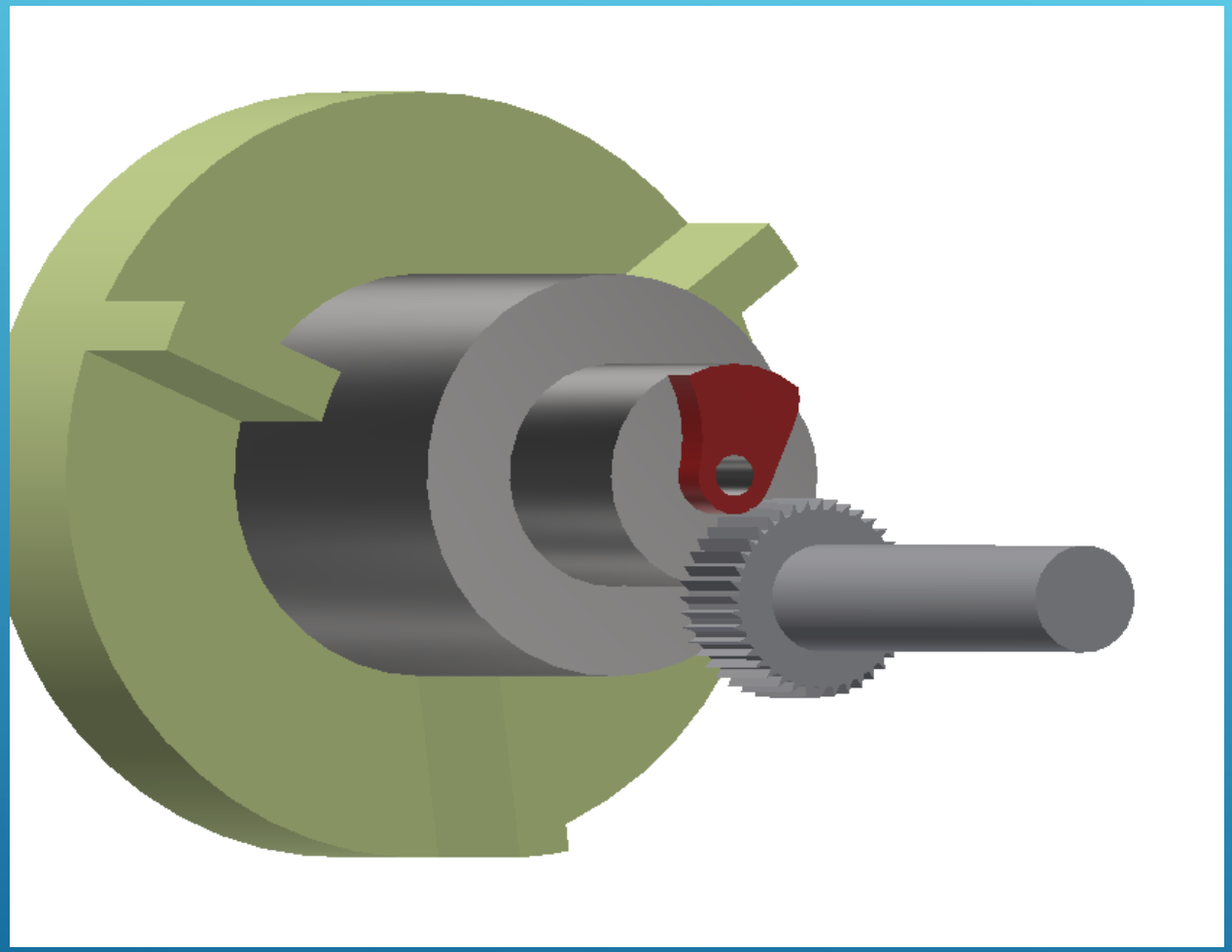
LARGE MILLING CUTTER

ALWAYS HAVE YOUR SAFETY GLASSES ON!

SMALL MILLING CUTTER



ALWAYS HAVE YOUR SAFETY GLASSES ON!

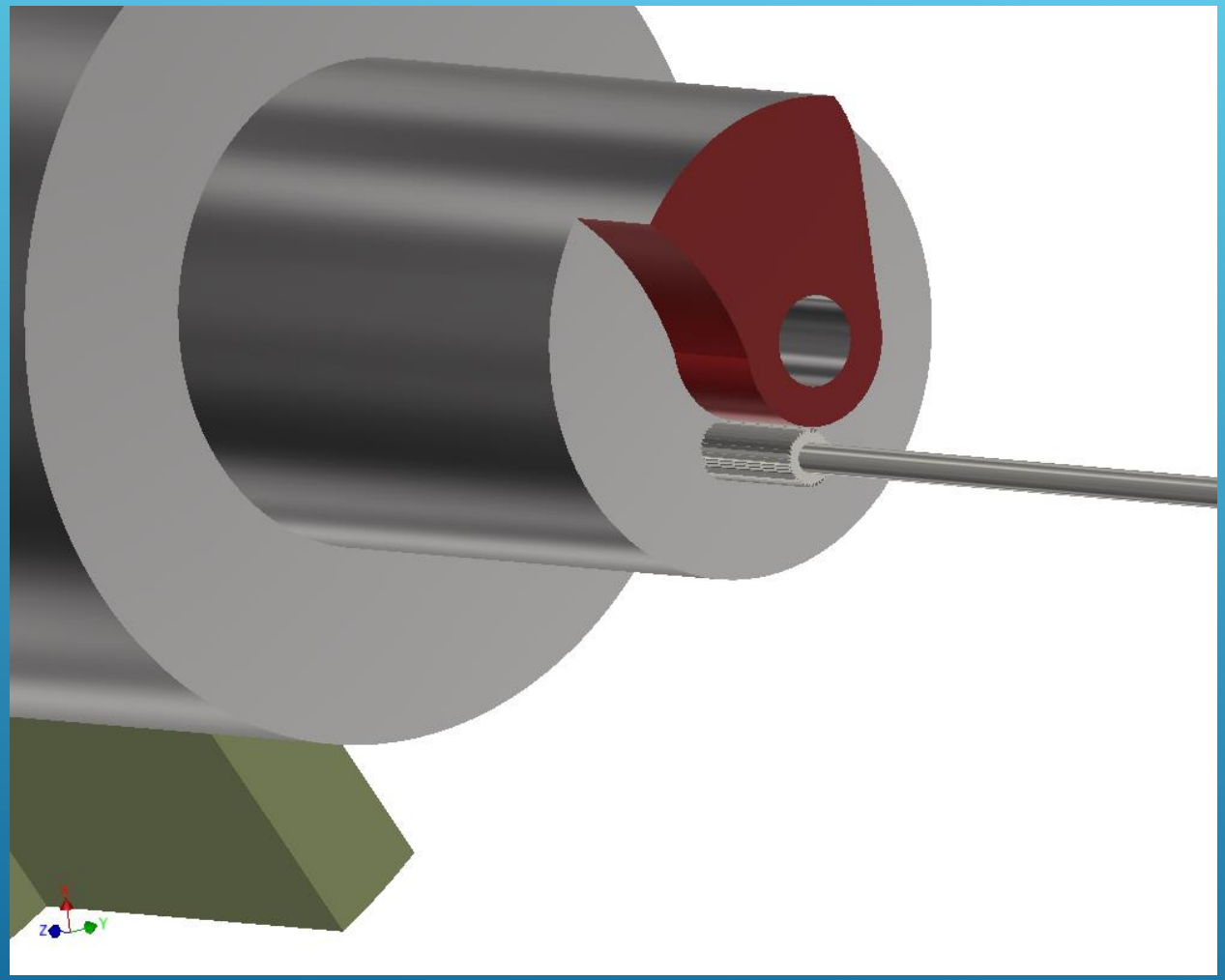


MILLING CUTTER

Using the milling cutter, remove the as much material as possible by rotating the headstock by hand.

DO NOT TURN ON THE MOTOR!

ALWAYS HAVE YOUR SAFETY GLASSES ON!

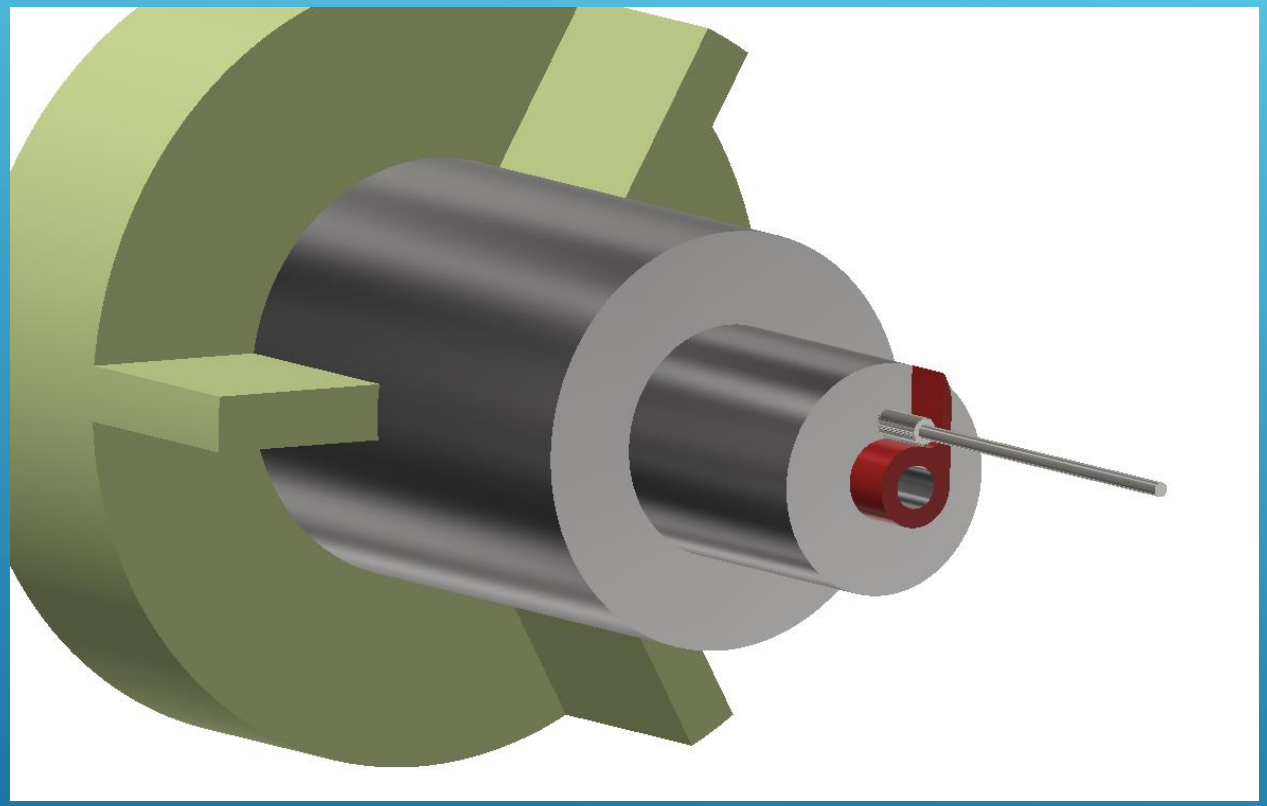


USE A SMALLER CUTTER

Using the smaller milling cutter, remove the as much material as possible by rotating the headstock by hand.

DO NOT TURN ON THE MOTOR!

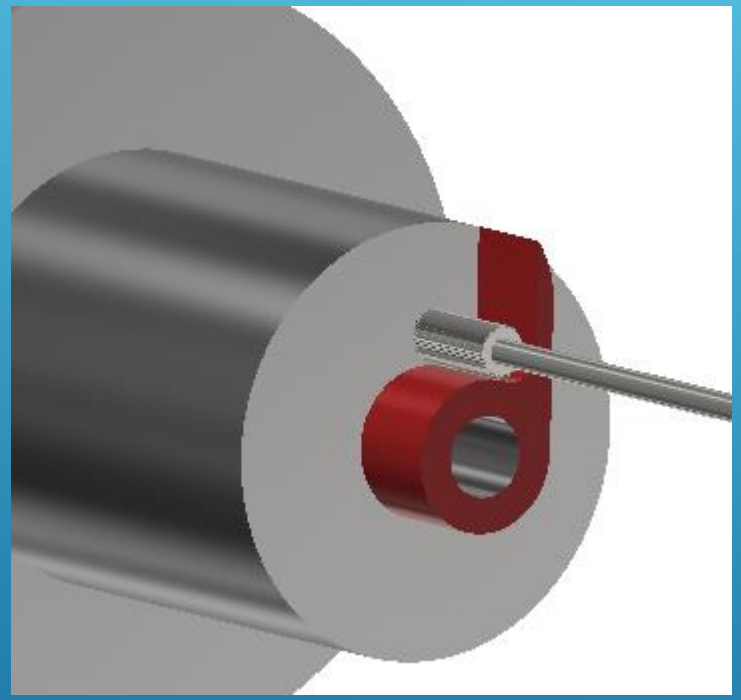
ALWAYS HAVE YOUR SAFETY GLASSES ON!



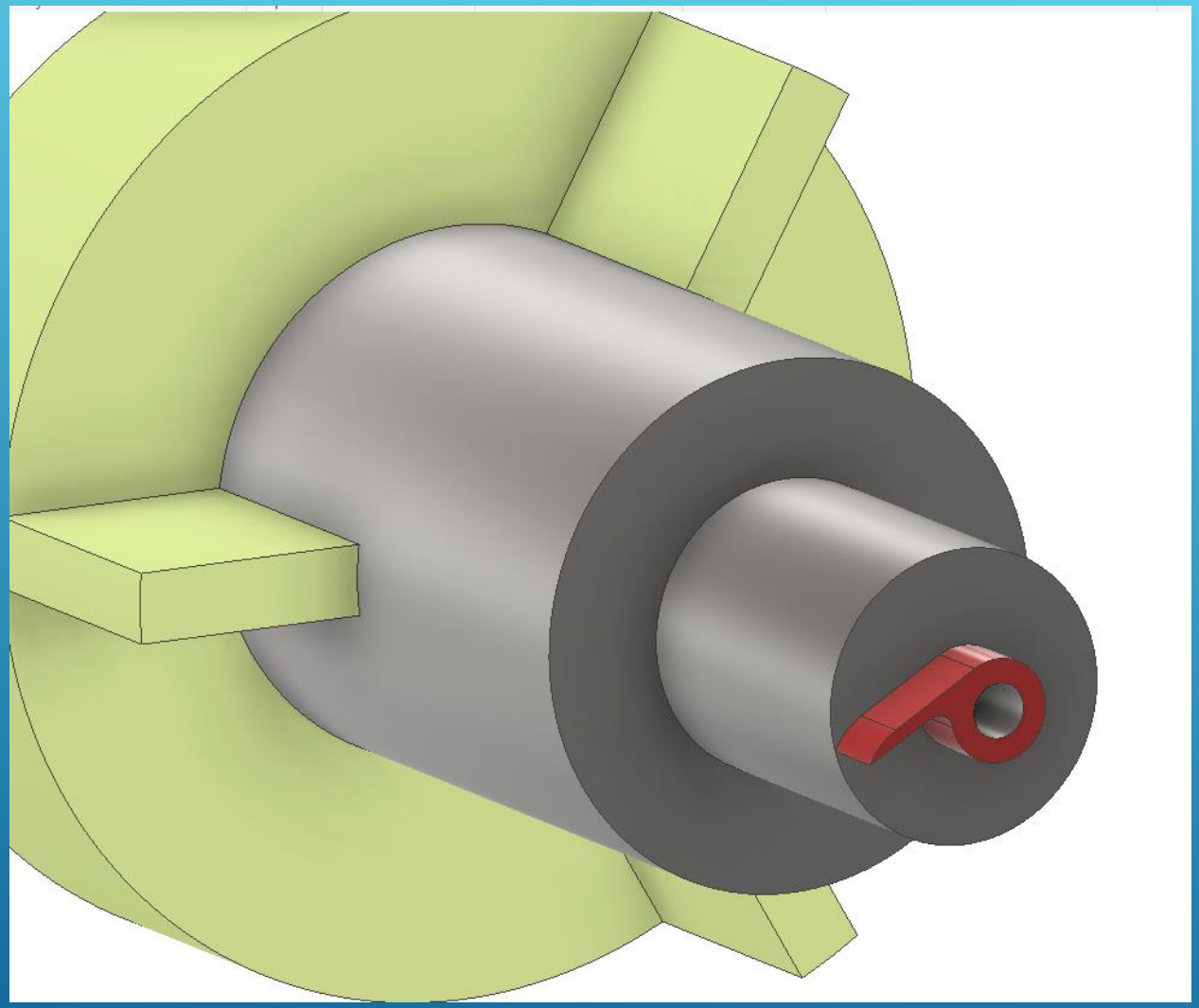
SMALL CUTTER

The smaller cutter can get very close to your layout lines.

CLOSE-UP OF THE CUTTER



ALWAYS HAVE YOUR SAFETY GLASSES ON!

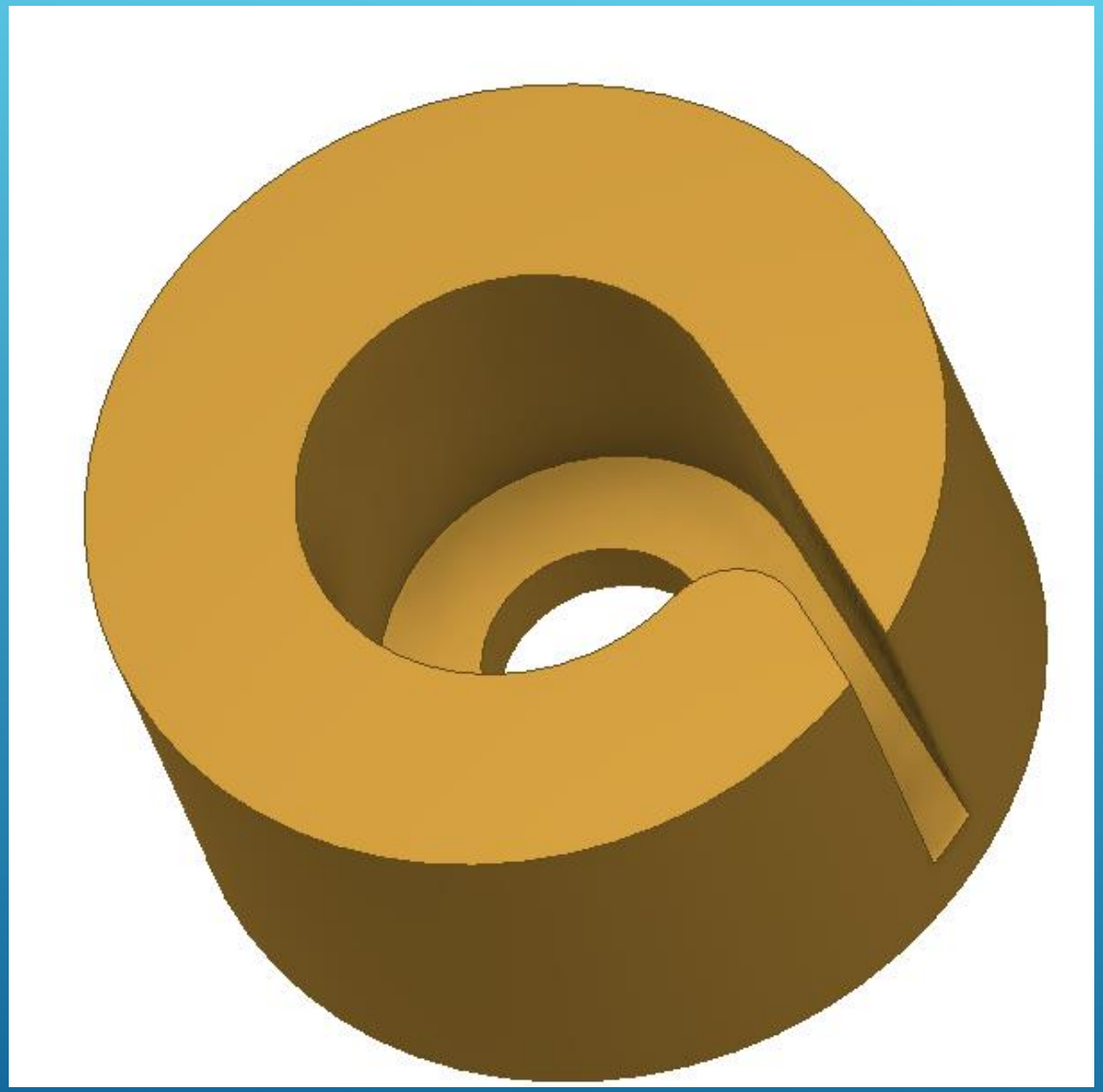


MATERIAL REMOVED

Now its time to remove all tool marks before cutting it off.

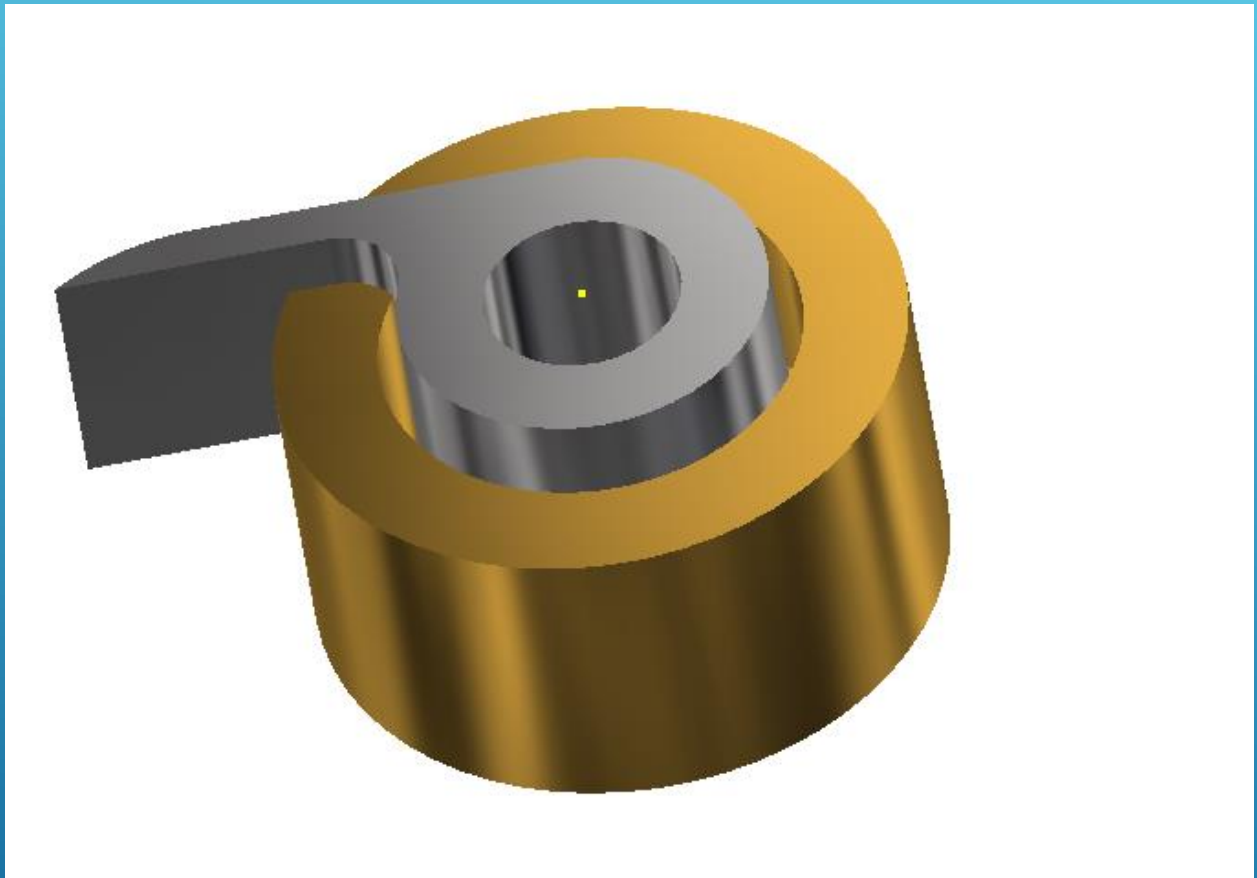
How do we taper the inside hole?

ALWAYS HAVE YOUR SAFETY GLASSES ON!



BRASS HEAT SINK

ALWAYS HAVE YOUR SAFETY GLASSES ON!

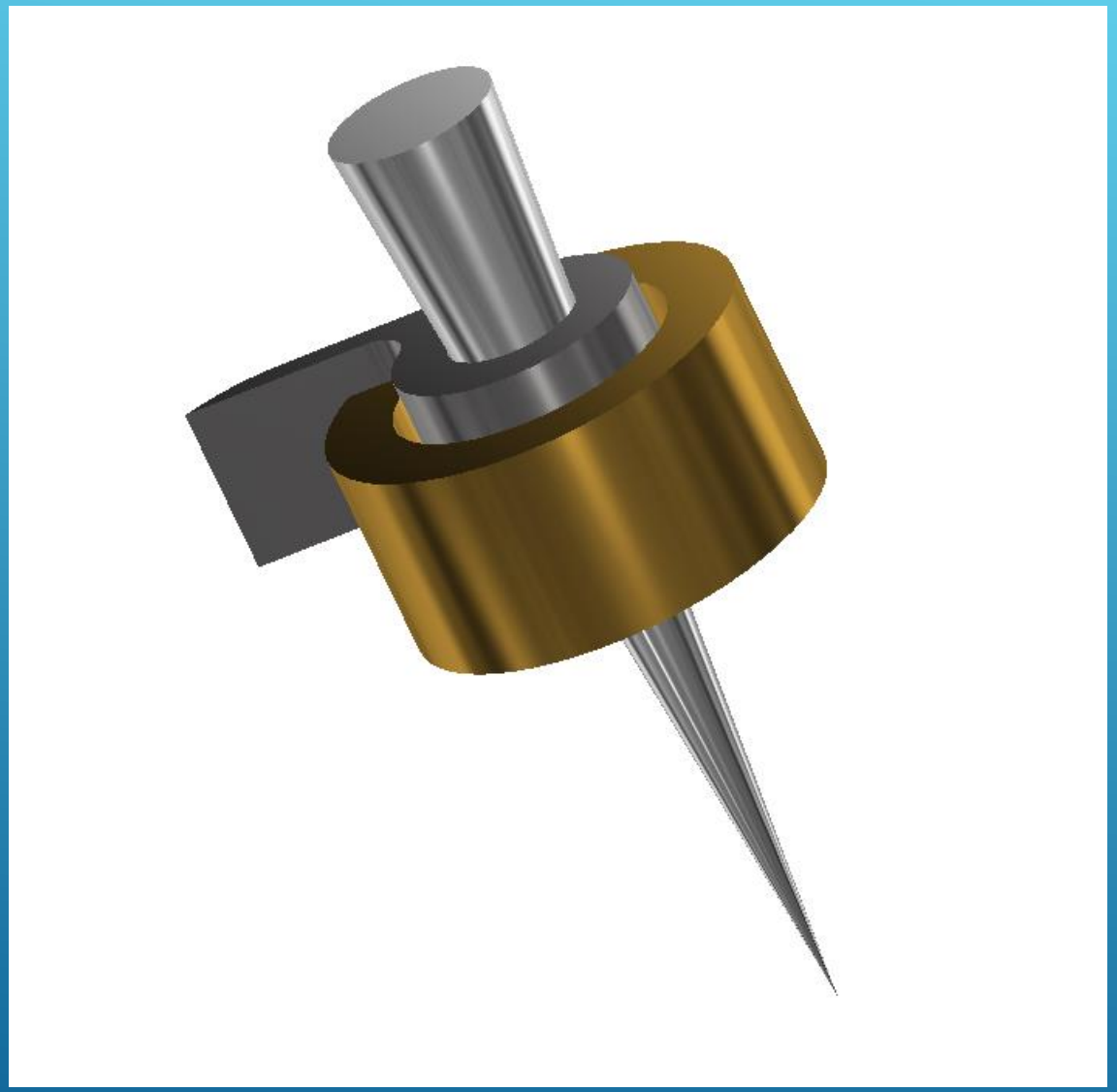


PALLET IN HEAT SINK

ALWAYS HAVE YOUR SAFETY GLASSES ON!

TAPER PIN

Made from tool steel and hardened and tempered to straw color.



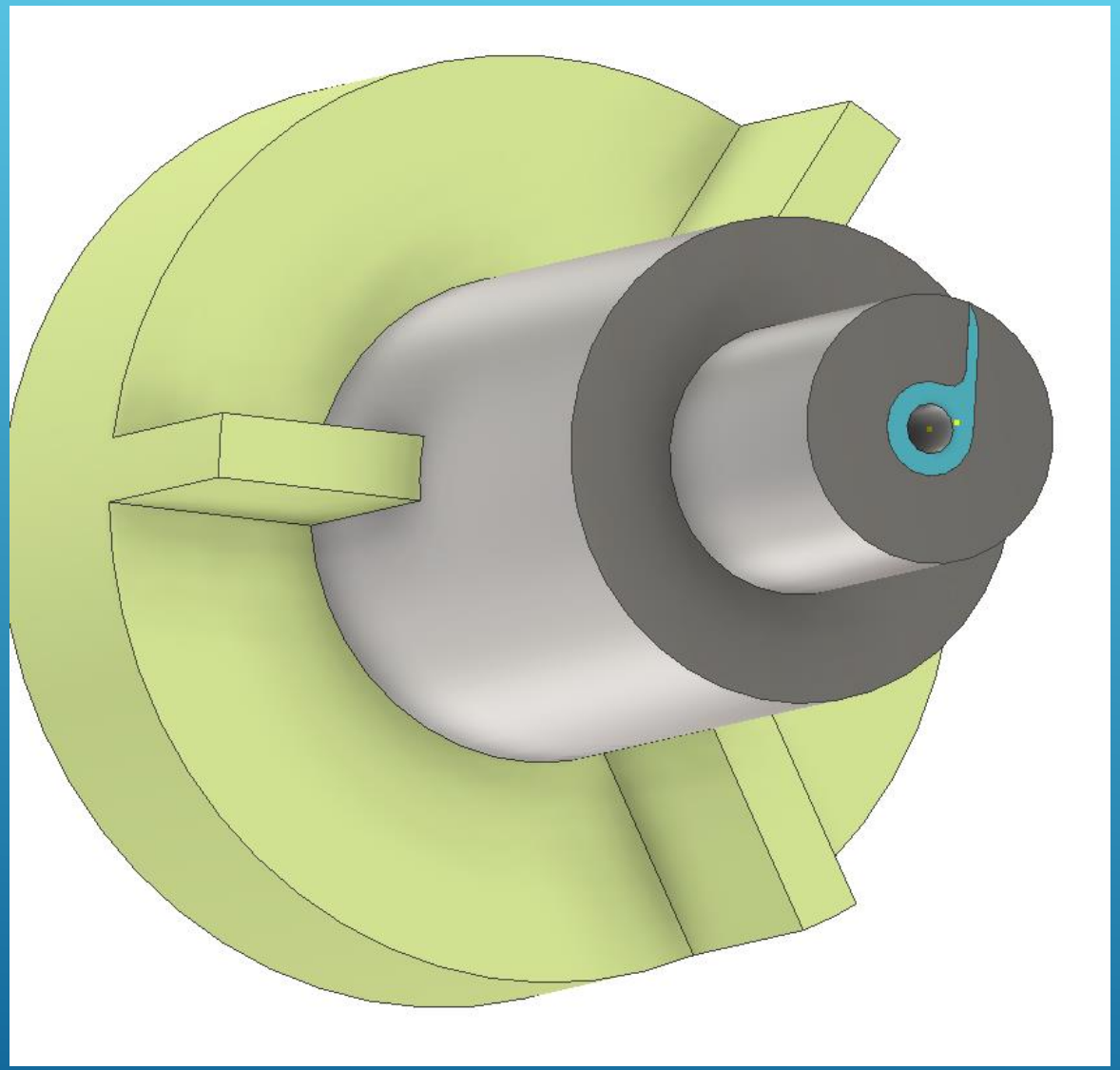
TAPERING THE HOLE

Install pallet into heat sink fixture.

Heat fixture assembly so the pallet reaches red. (Hot Plate)

Tap taper pin into hole to make the taper, only after the pallet turns red in color.

The flag is outside the fixture and will have little affect on its hardness.

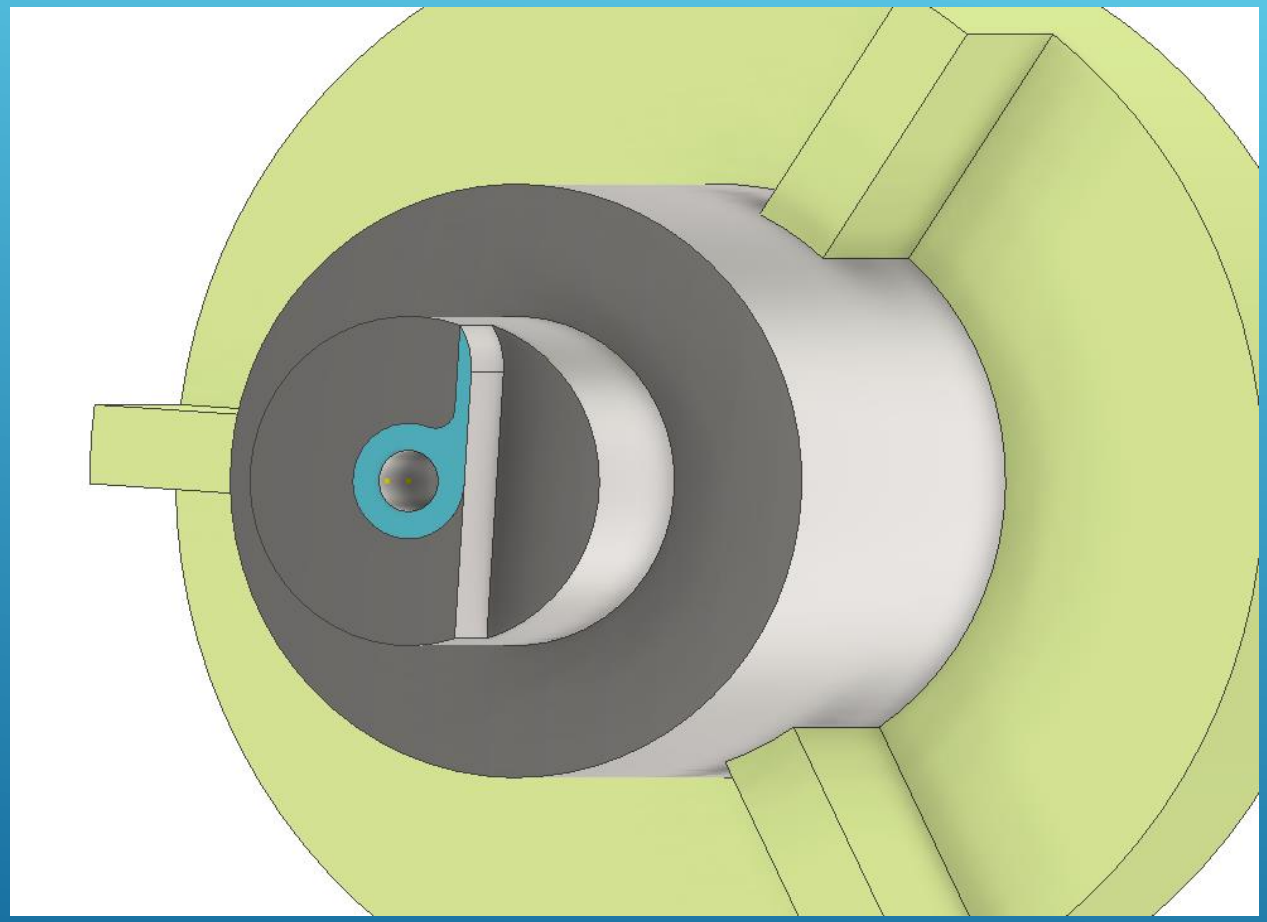


SAWING THE BLANK

Using a jewelers saw, cut away the material the best you can. If this is one of your strengths, it's a great approach.

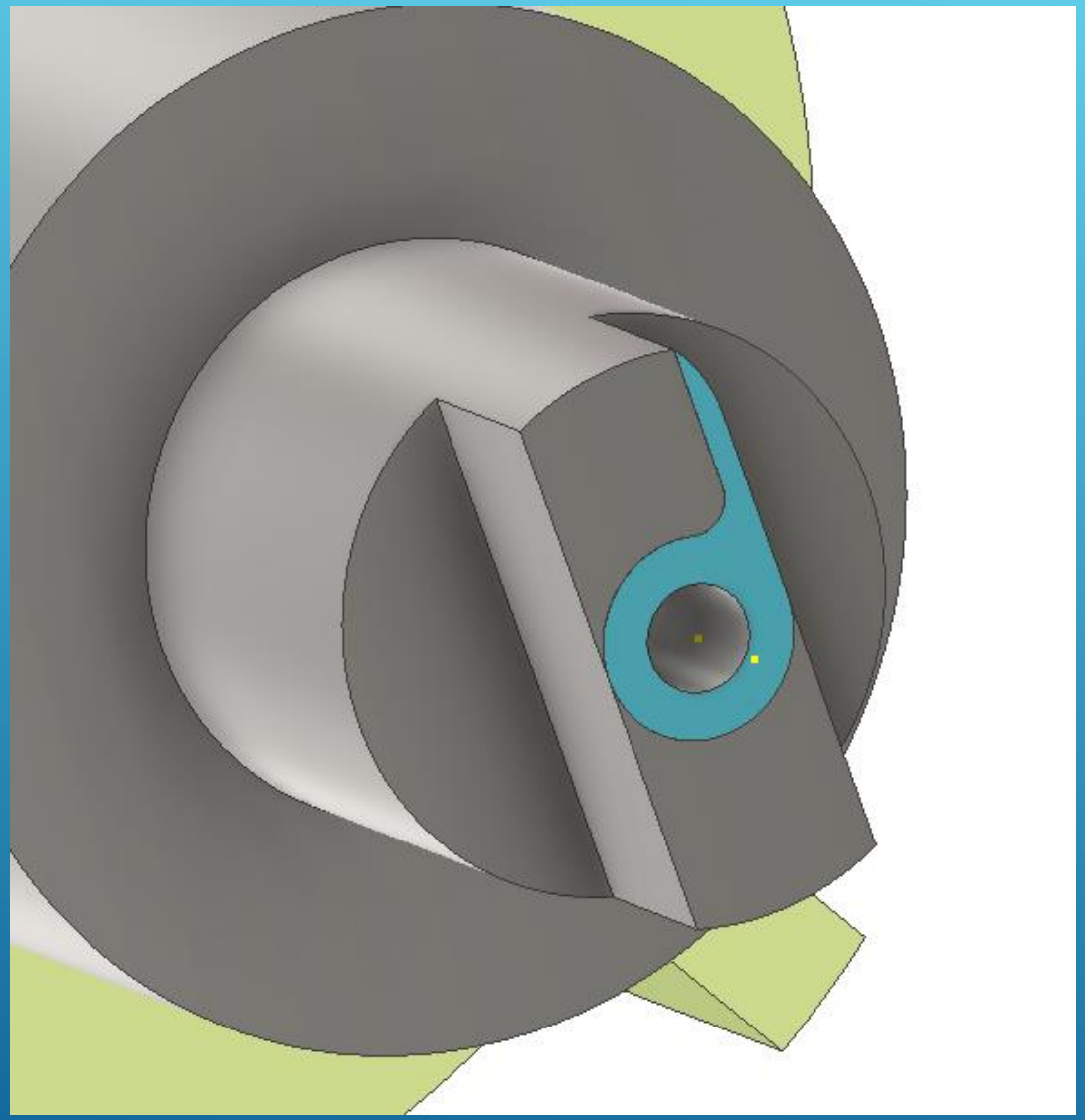
I would remove the 3 jaw chuck from the lathe, lay it flat on your bench and then saw .

ALWAYS HAVE YOUR SAFETY GLASSES ON!



SAWING OUT SECTION BY SECTION.

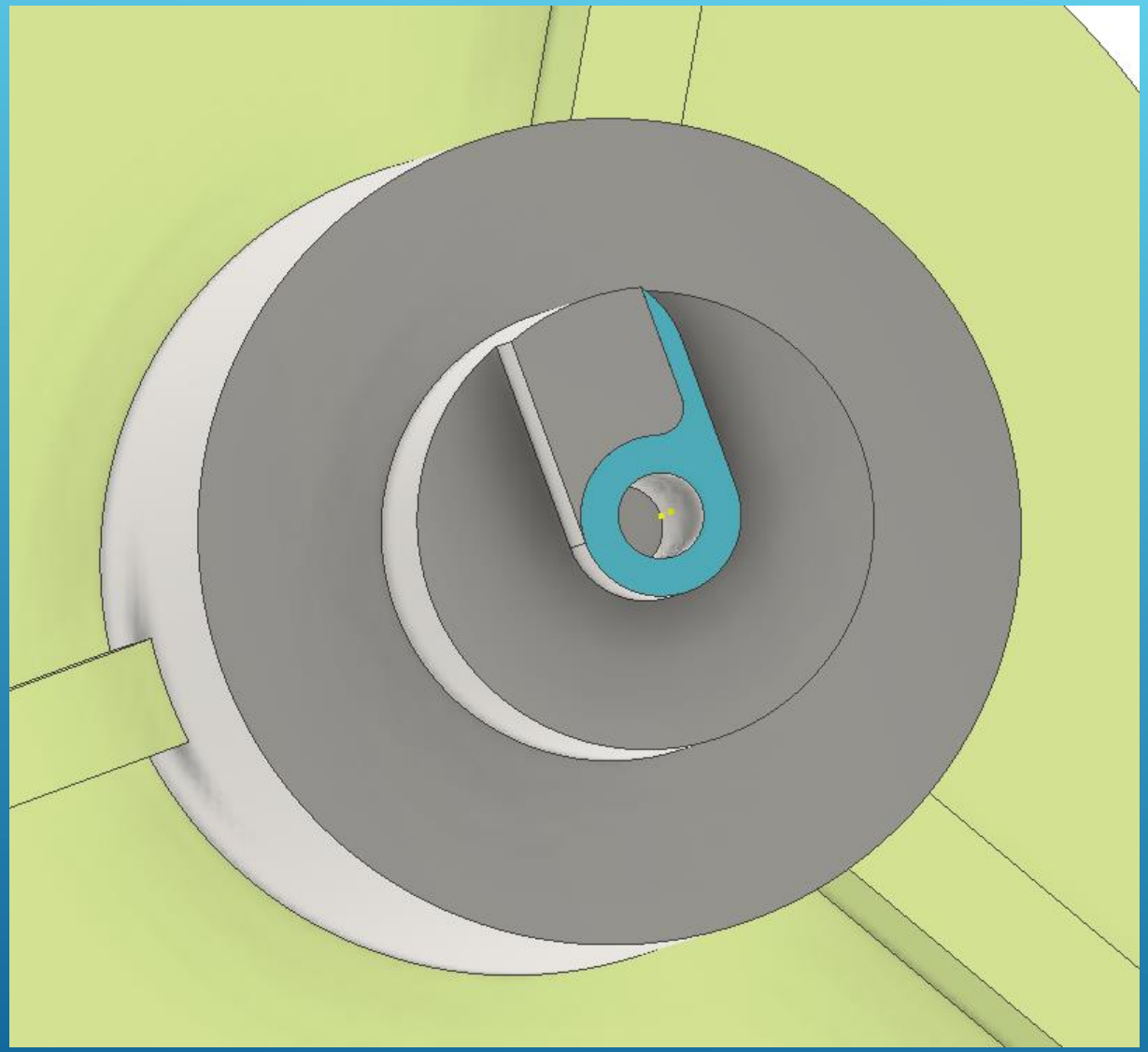
ALWAYS HAVE YOUR SAFETY GLASSES ON!



SAWING OUT SECTION BY SECTION.

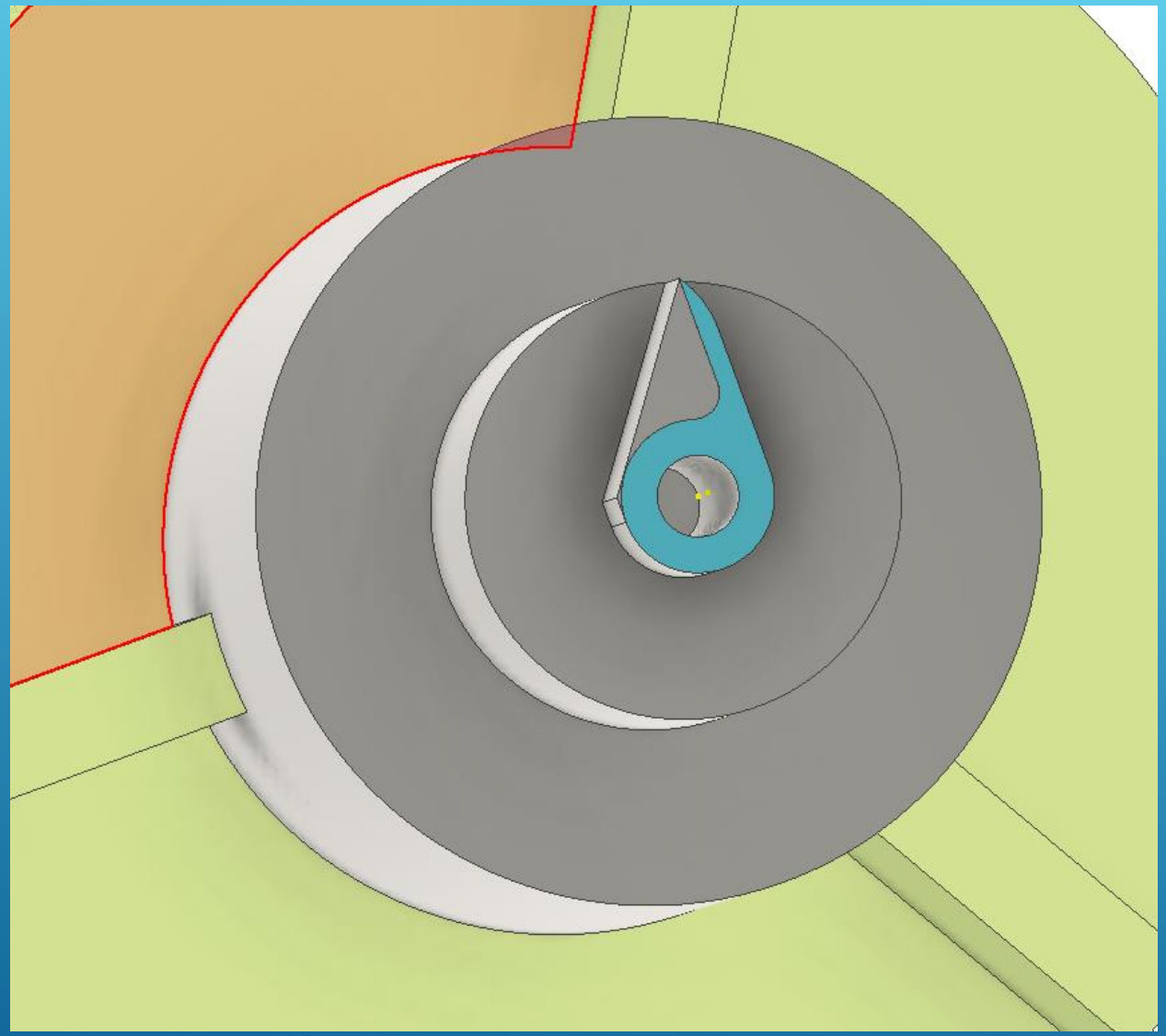
I try to remove the largest pieces first.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



SAWING OUT SECTION BY SECTION.

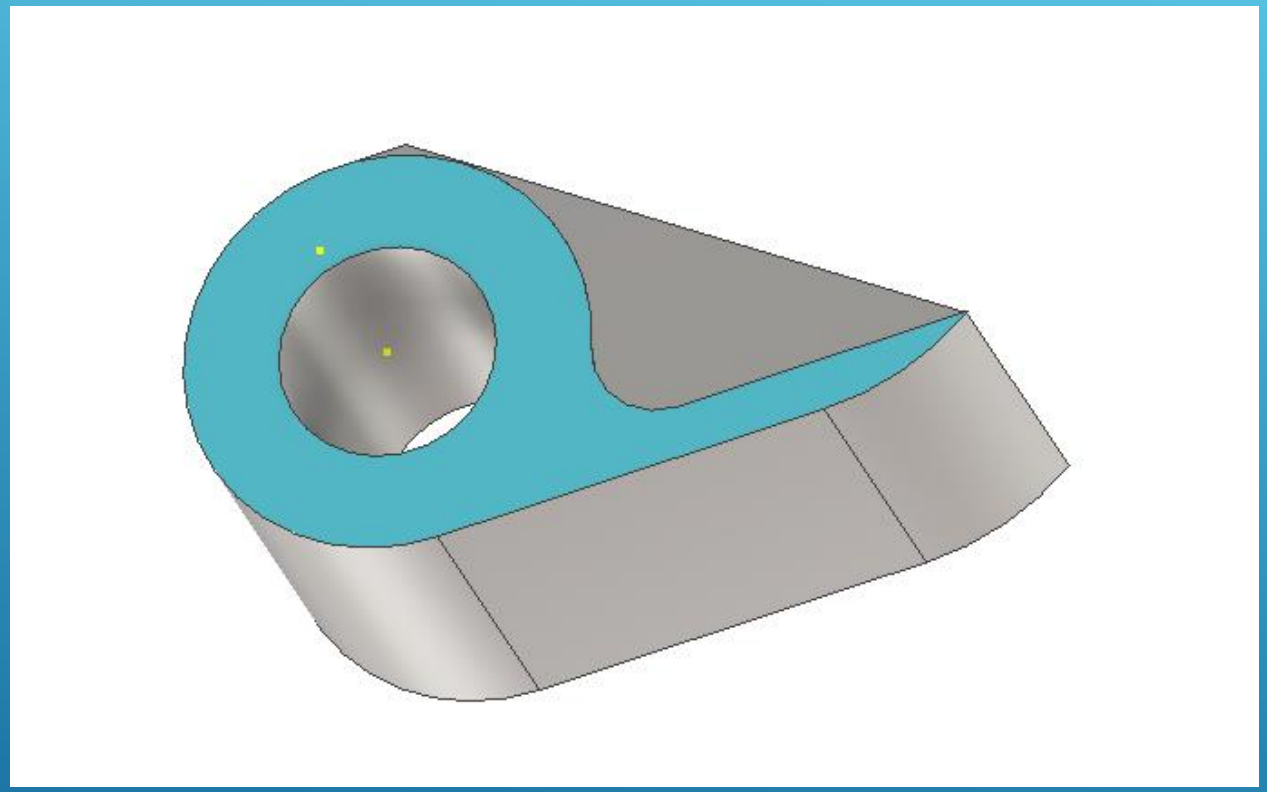
ALWAYS HAVE YOUR SAFETY GLASSES ON!



SAWING OUT SECTION BY SECTION.

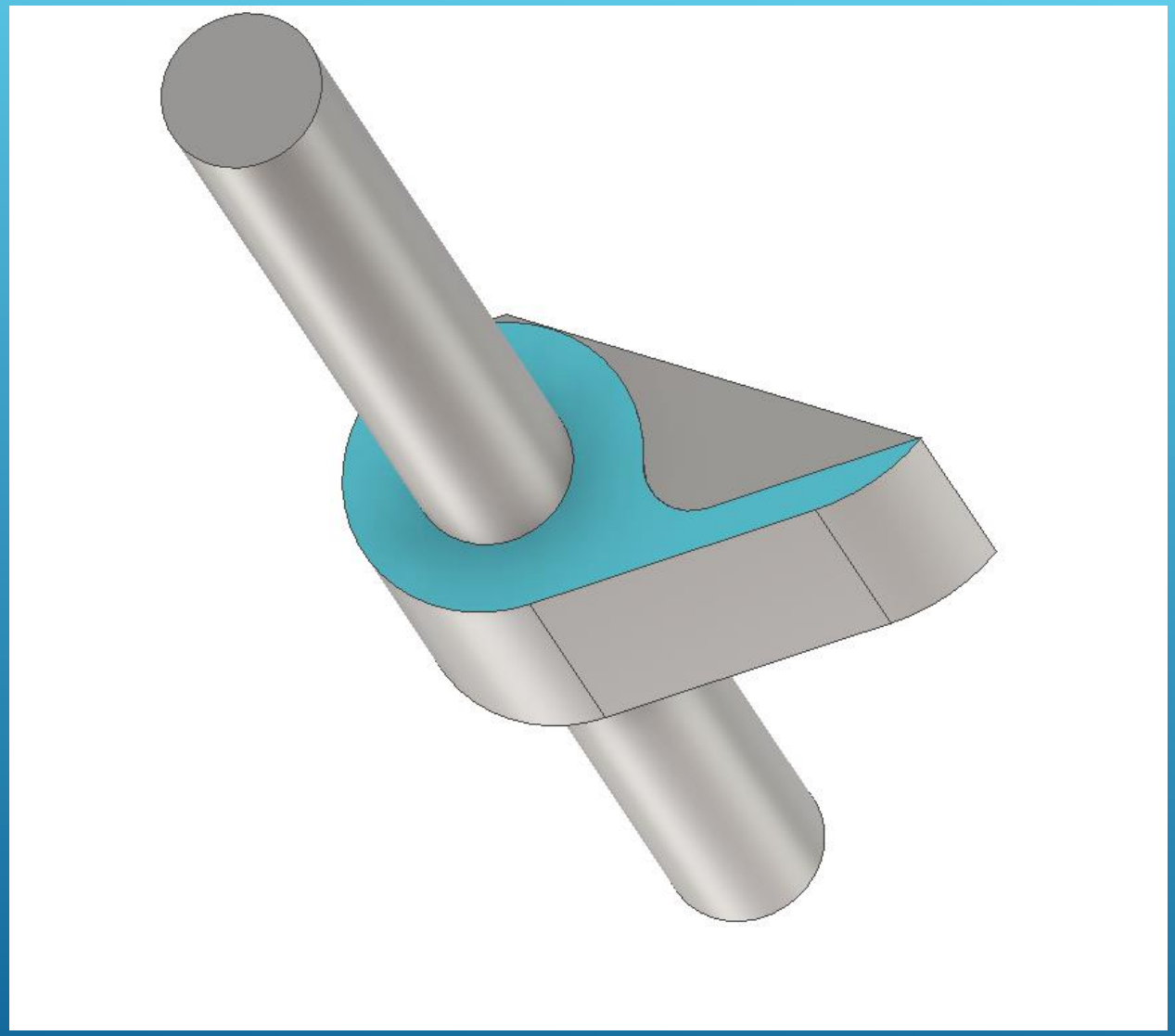
I have now sawed as much as I possibly can without removing the part from the stock.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



CUT THE PALLET OFF THE STOCK MATERIAL

You can now cut away more material or finish with a file.

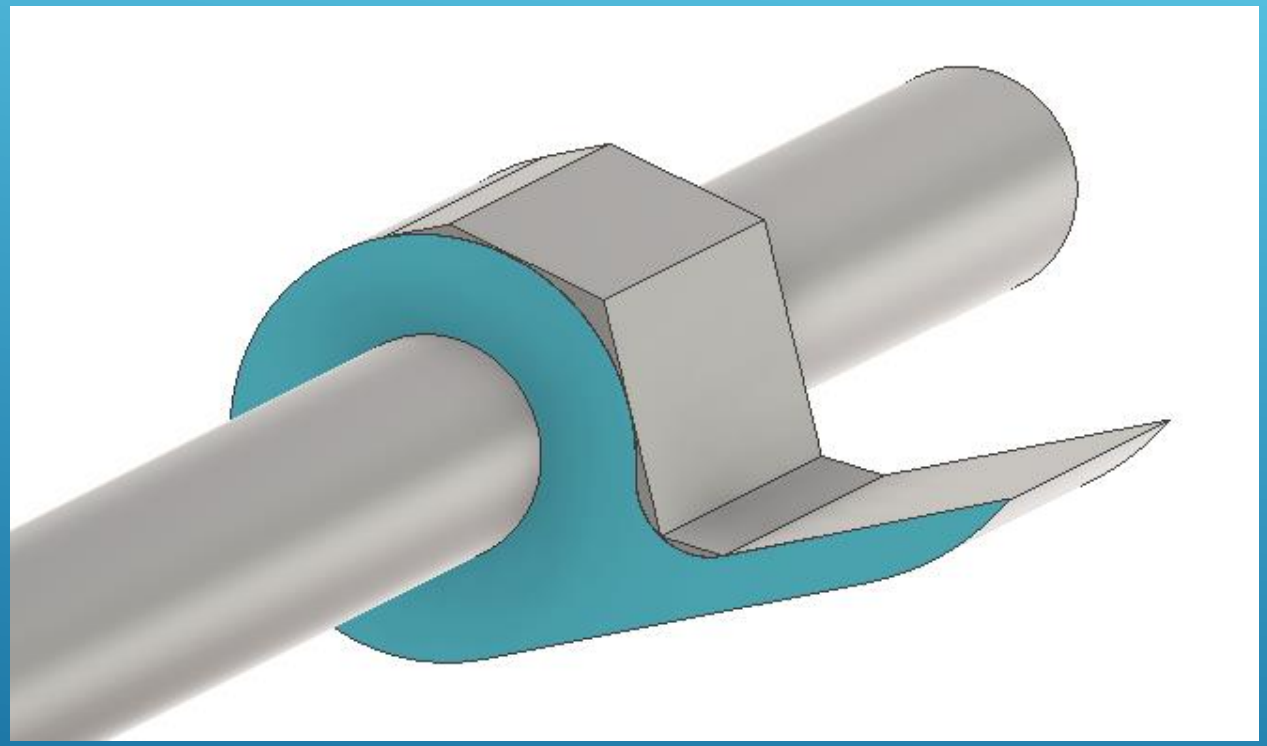


MOUNTING TO A SHAFT

Mounting the pallet to a shaft will aid in the completion by giving you a way of handling a small part.

It will also help if you drop it.

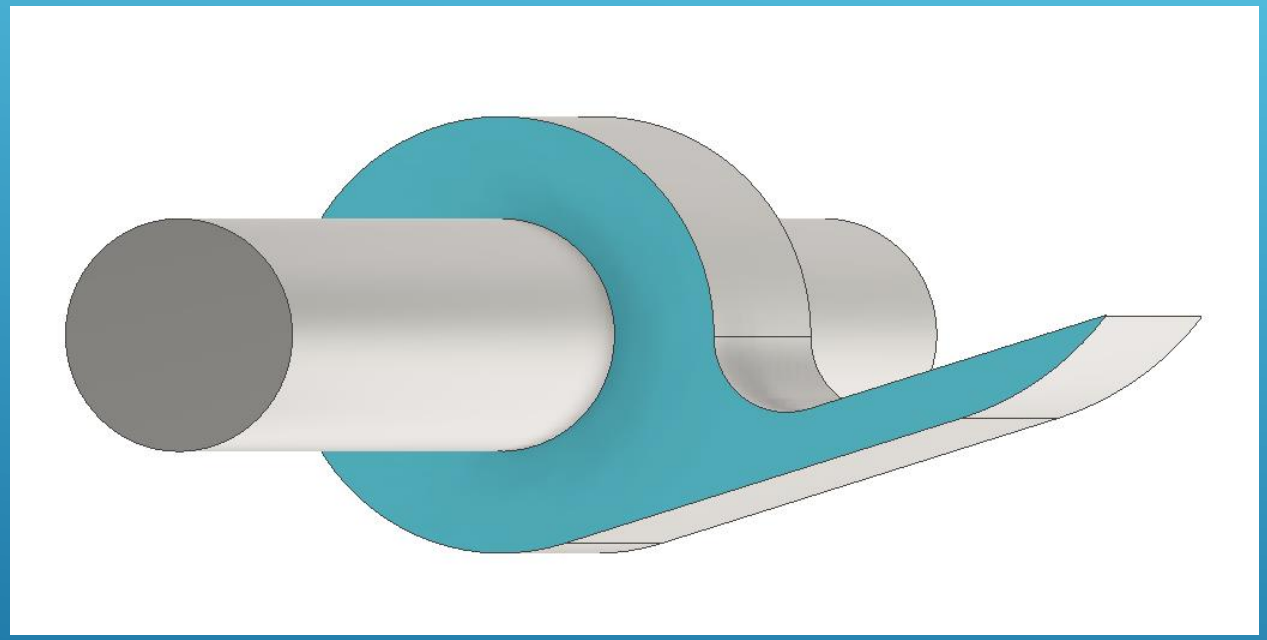
I usually "crazy glue" the part to the shaft. This way I can tighten the shaft in a vise and the part wont rotate while I'm sawing or filing.



THIS IS ABOUT THE BEST YOU CAN GET FROM SAWING.

The rest of the material needs to be removed by filing to shape.

The taper the hole the same way we did in the last example.

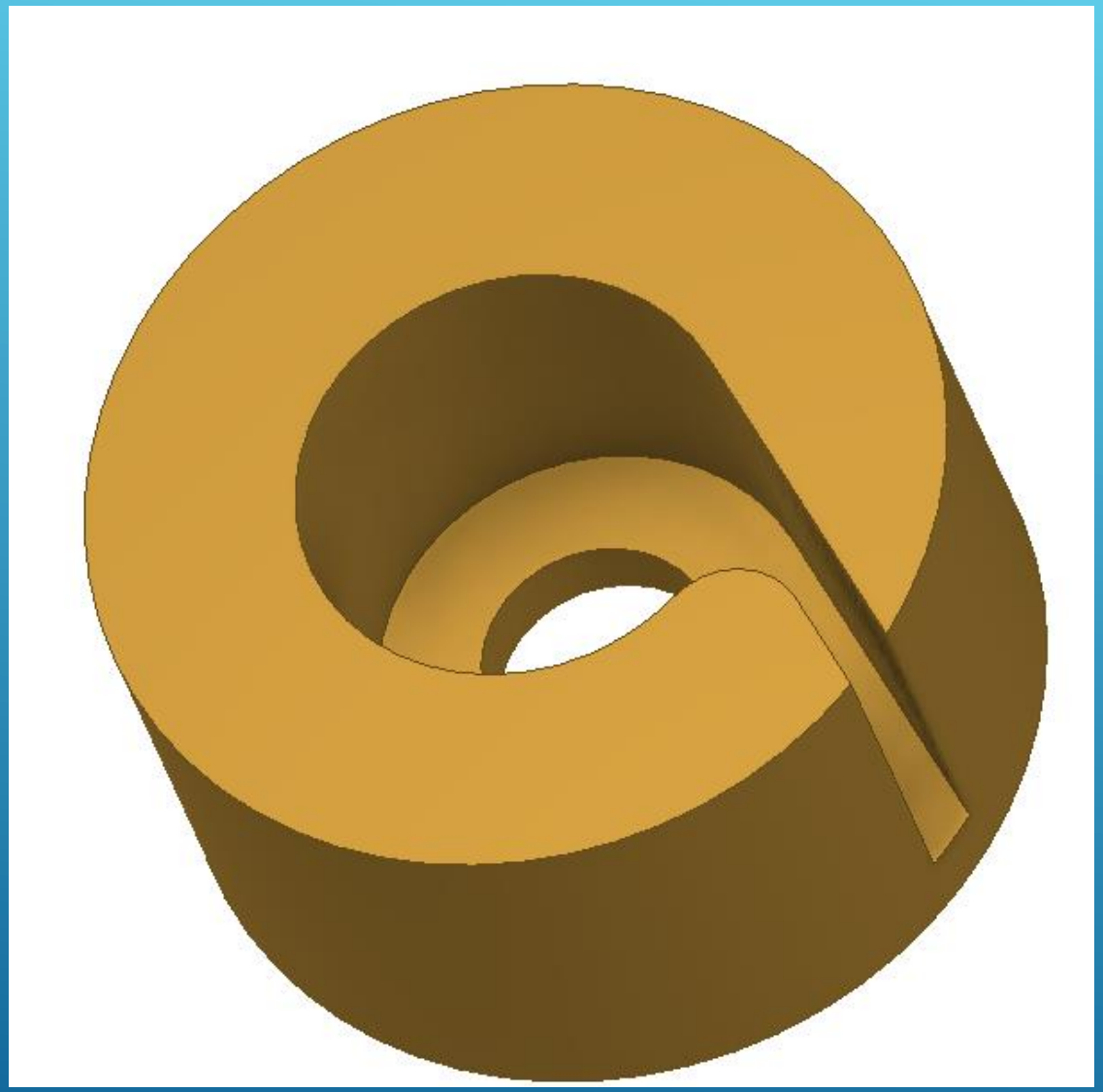


EXCESS MATERIAL REMOVED

To remove pin, drop part in a bath of acetone and let it soak for a few minutes. Then remove pin. Clean out all excess glue.

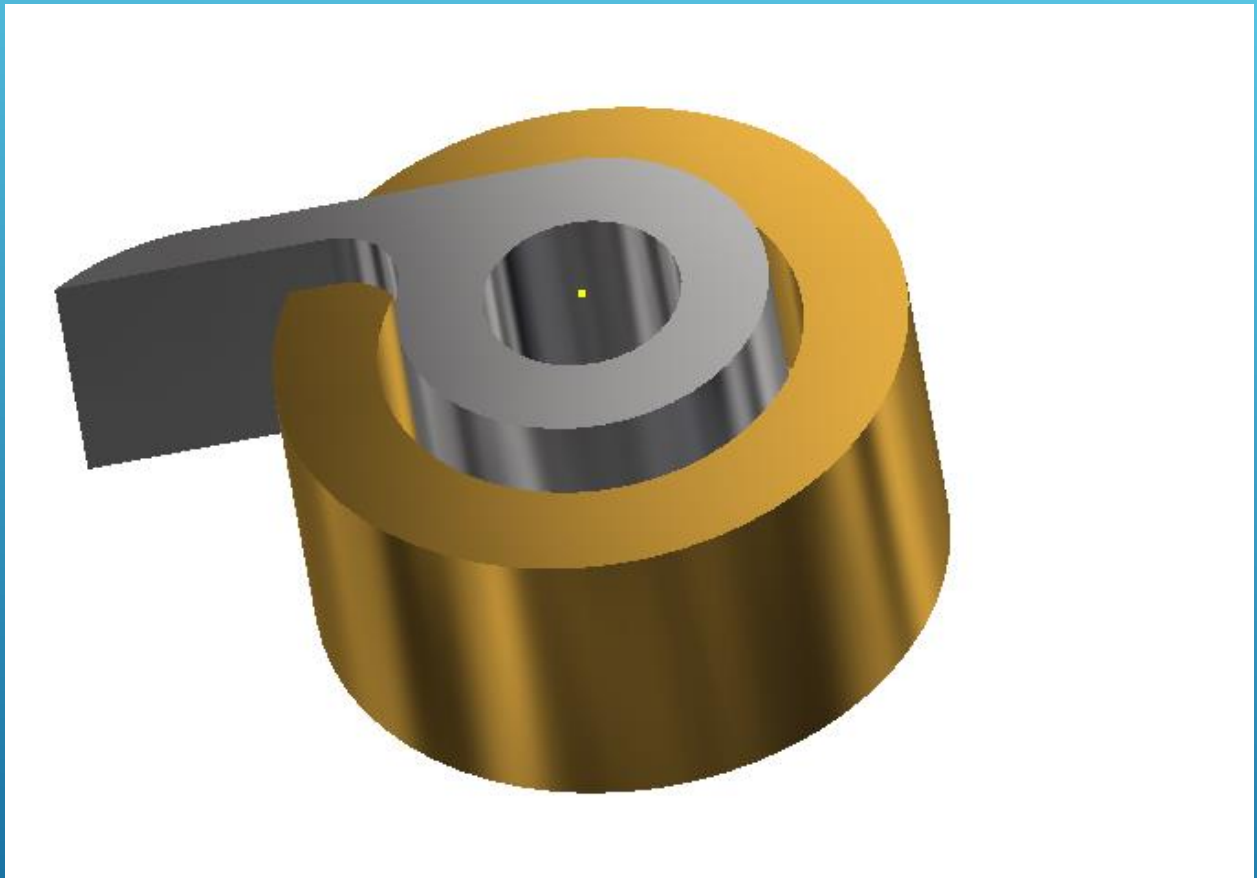
COMBINATION OF BOTH PROCEDURES

You could use both procedures to make the pallet. Saw out as much as possible, and then mill the rest of the material. After, cut it off the stock.



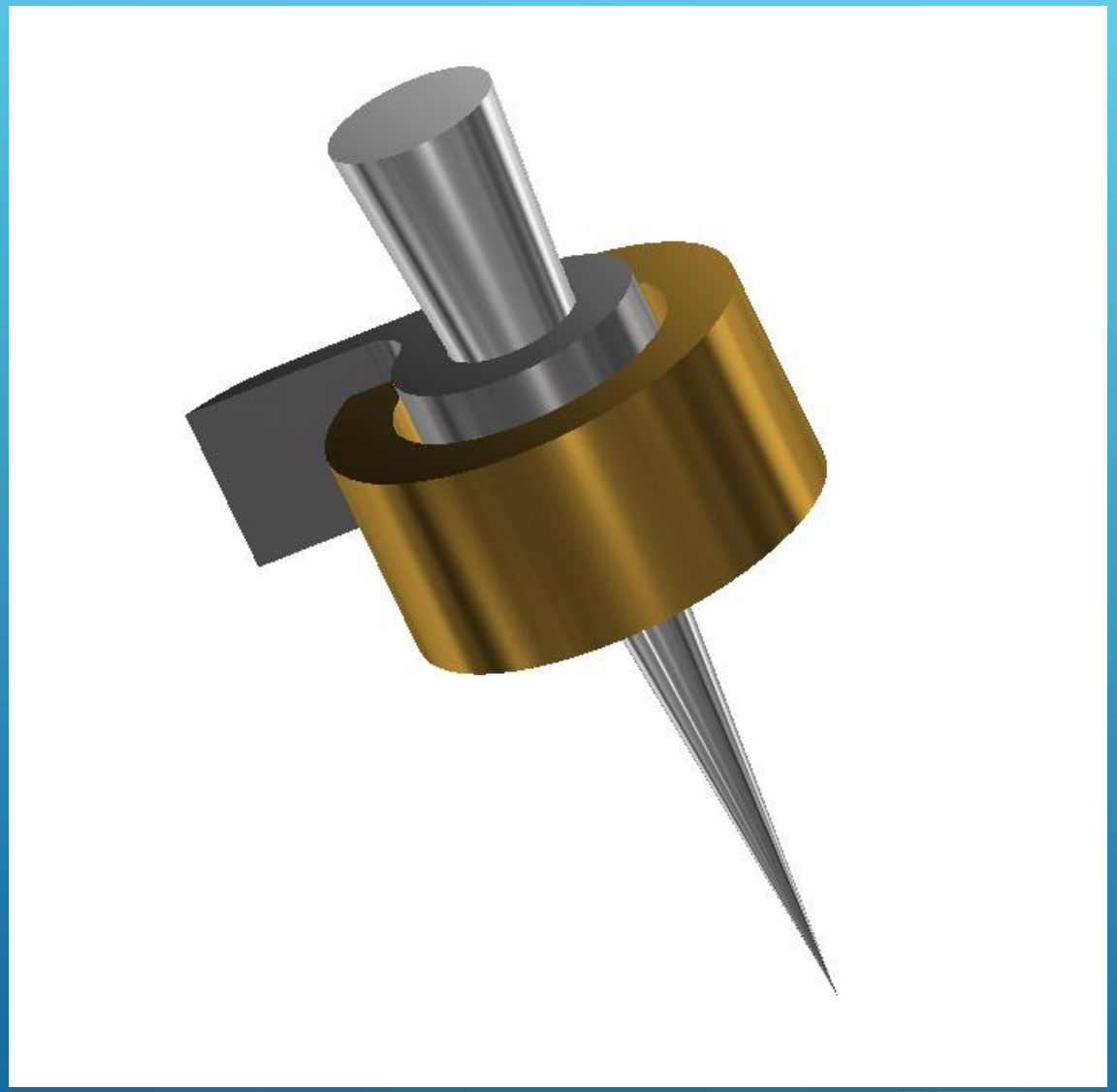
BRASS HEAT SINK

ALWAYS HAVE YOUR SAFETY GLASSES ON!



PALLET IN HEAT SINK

ALWAYS HAVE YOUR SAFETY GLASSES ON!



TAPERING THE HOLE

Install pallet into heat sink fixture.

Heat fixture assembly so the pallet reaches red. (Hot Plate)

Tap taper pin into hole to make the taper, only after the pallet turns red in color.

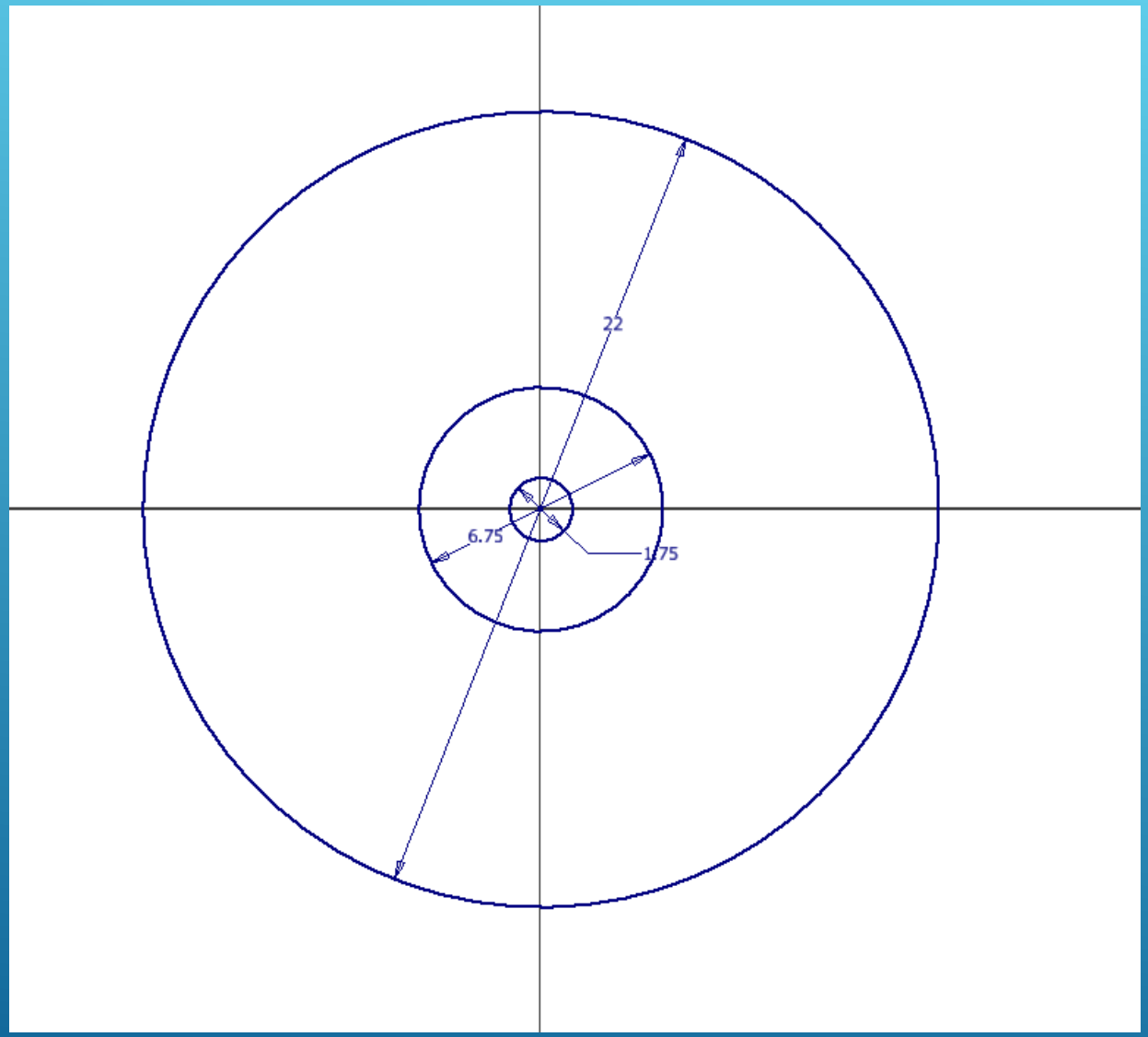
The flag is outside the fixture and will have little affect on its hardness.

GATHERING PALLET FOR ENGLISH GRANDFATHER CLOCK

ALWAYS HAVE YOUR SAFETY GLASSES ON!

GATHERING PALLET FOR ENGLISH GRANDFATHER CLOCK

ALWAYS HAVE YOUR SAFETY GLASSES ON!



START WITH A BASIC DRAWING

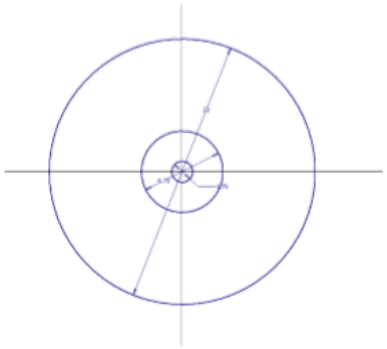
11mm is the distance of the gathering pallet center to the stop pin on the rack.

3.375mm is the length of the “flag”.

1.75mm is the diameter of the shaft.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

PUT YOUR PLAN TOGETHER



Part Name: *English Grandfather Clock Gathering Pallet*

Material: Tool *Steel*

Tools: *Lathe, center drill, caliper, 6 jaw chuck, milling cutter*

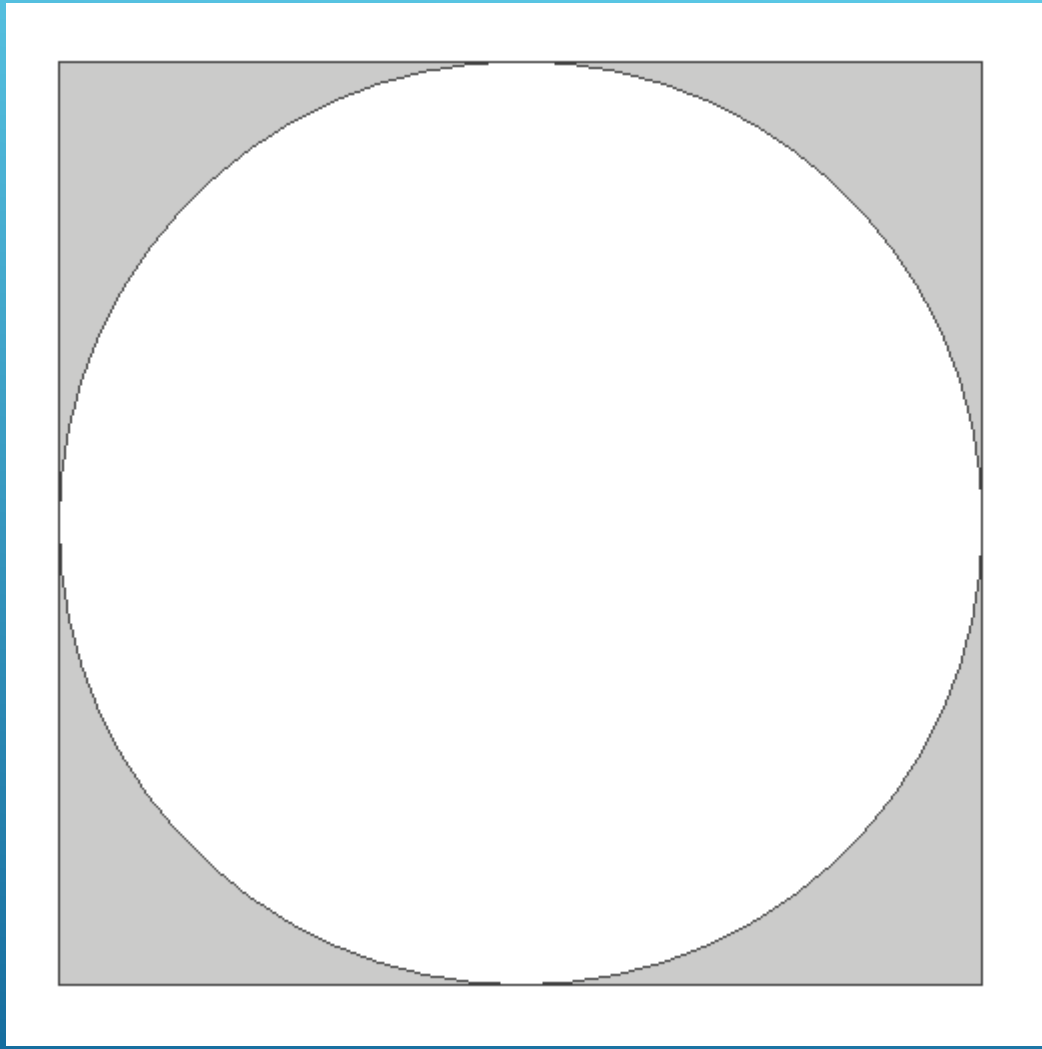
Strengths: *Turning*

Weakness: *Removing excess material.*

Procedure:

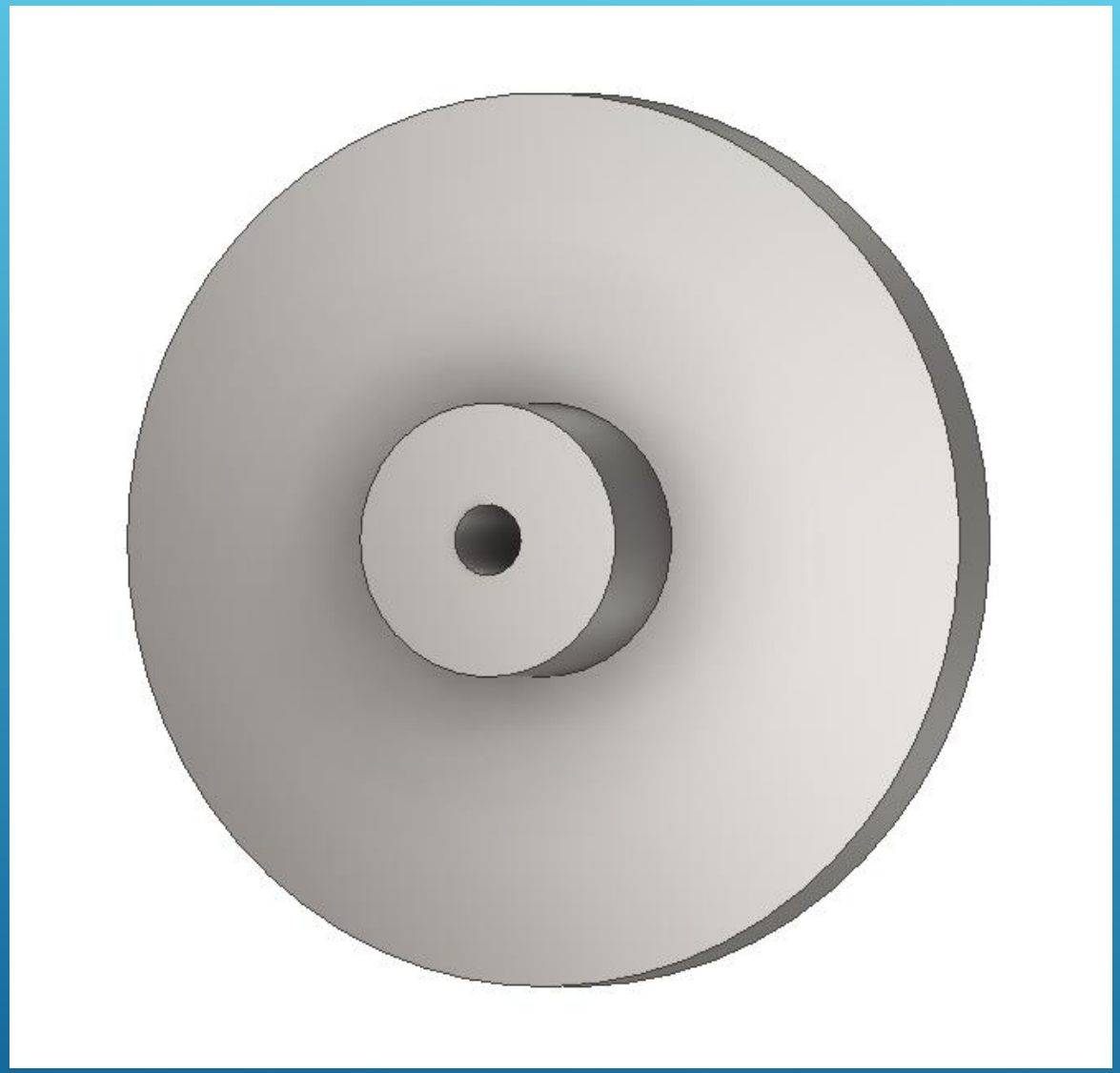
1. *Cut material to length*
2. *Setup lathe*
3. *Select proper cutting tools (graver, or cross slide)*
4. *Drill center hole in material*
5. *Turn outside diameter*
6. *Turn all additional diameters*
7. *Remove excess material with saw and milling cutter*
8. File the square key hole

ALWAYS HAVE YOUR SAFETY GLASSES ON!



SQUARE HOLE

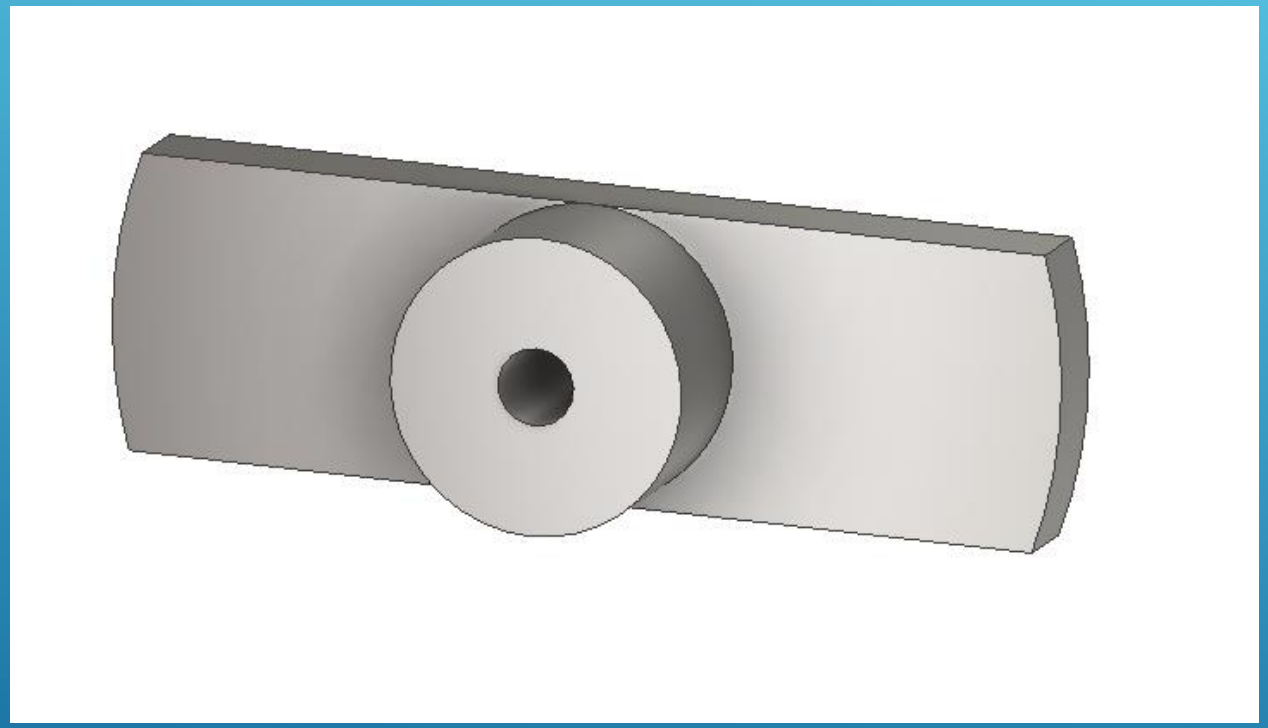
Remember when your drilling a round hole for clearance for a square hole, you need to measure the flats of the square and drill to that dimension.



GATHERING PALLET BLANK

Diameters machined to dimension.

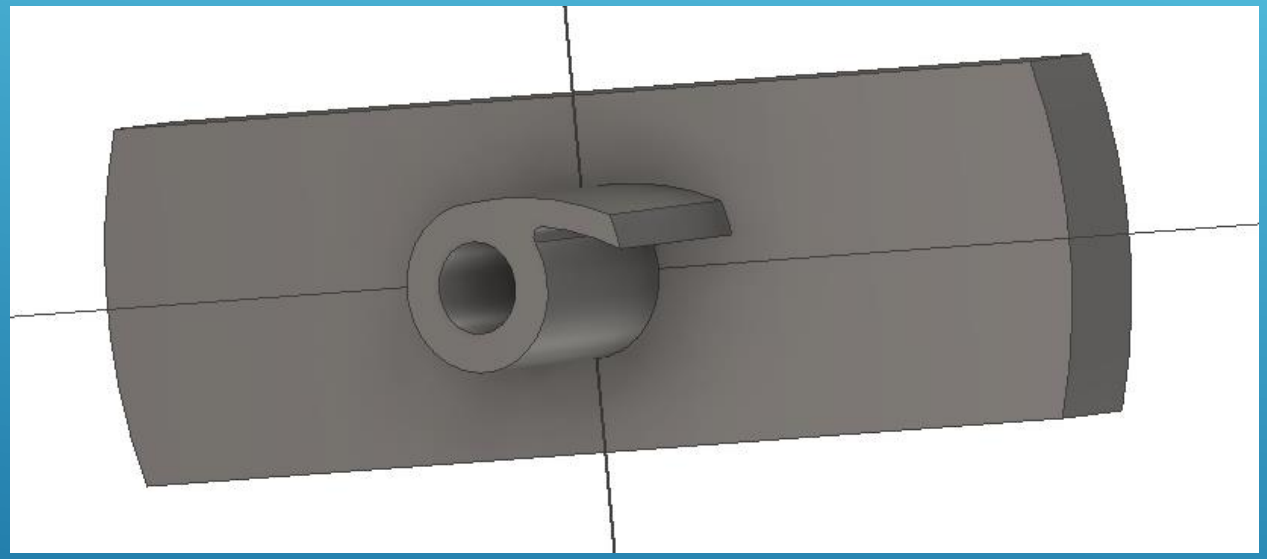
ALWAYS HAVE YOUR SAFETY GLASSES ON!



BLANK PARTLY MACHINED

Mill, grind, saw?

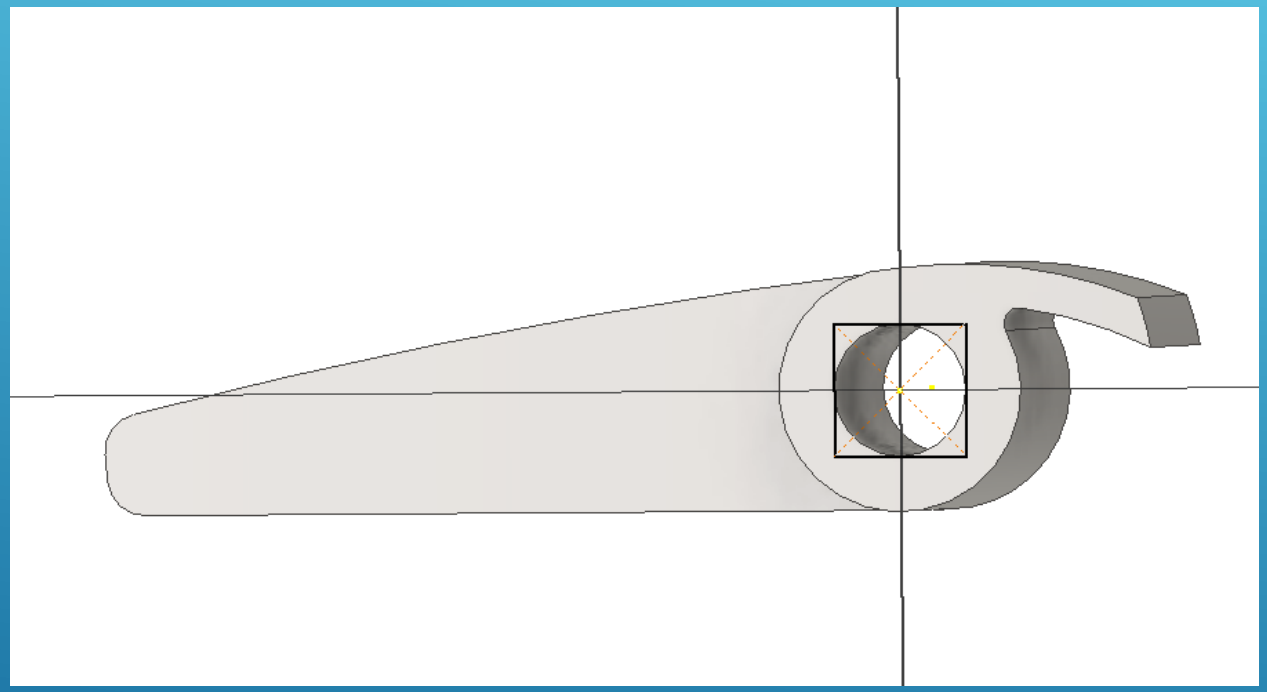
Left hand or right hand pallet needed.



PALLET FLAG TO SIZE

What did we forget to do.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

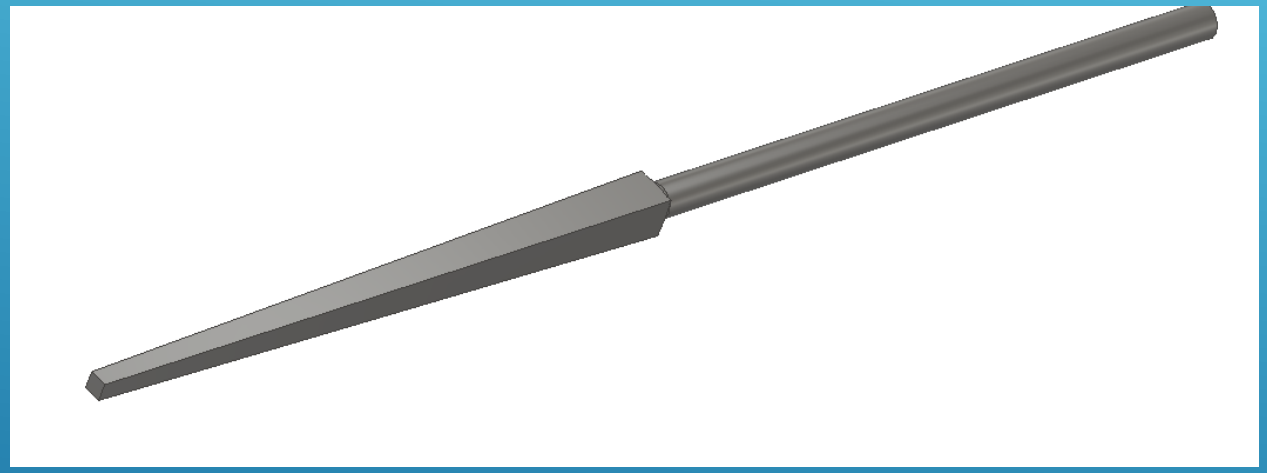


FILE TO SHAPE

Layout for square hole.

Use a square file.

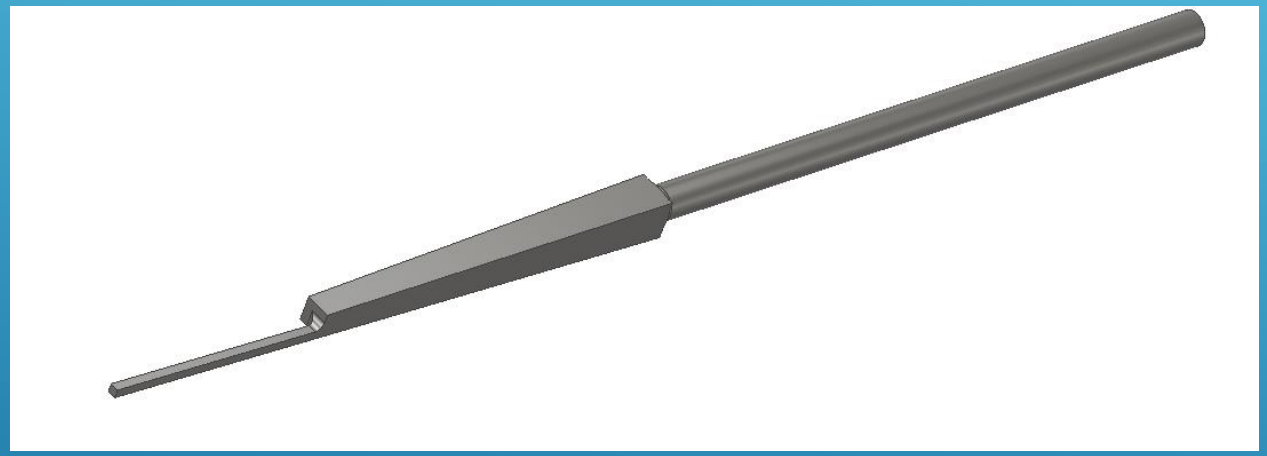
Adapt a file if you don't have one that fits.



SQUARE FILE

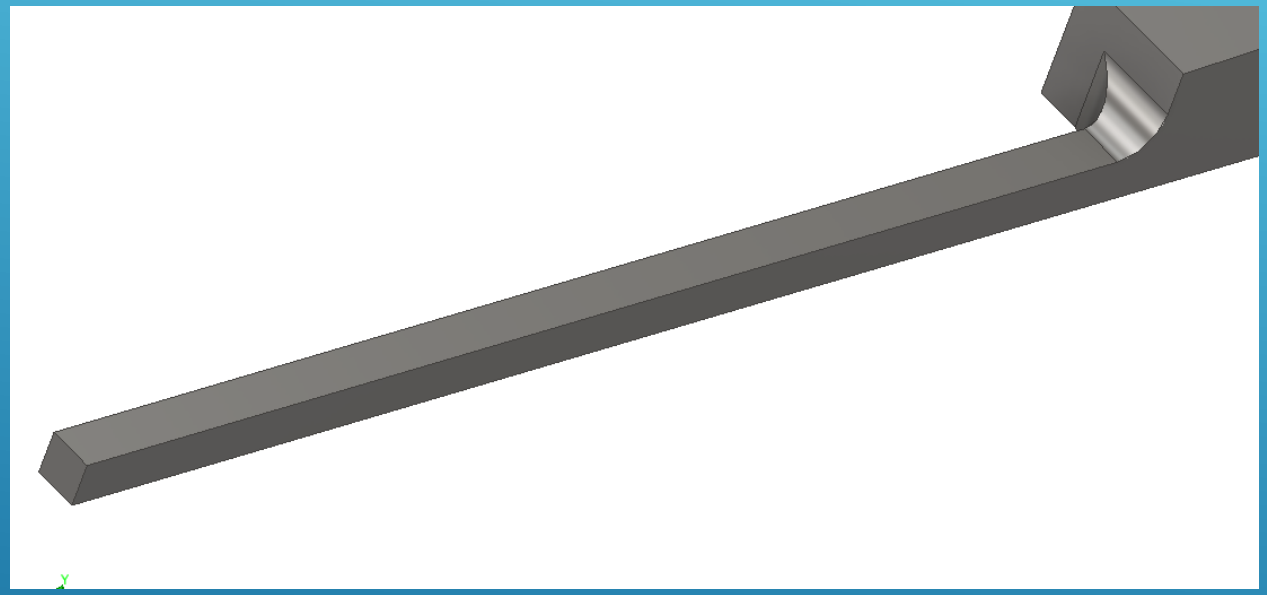
Use a square file to file the hole to the proper dimension.

SQUARE FILE



Its hard to find a square file to fit the small square.

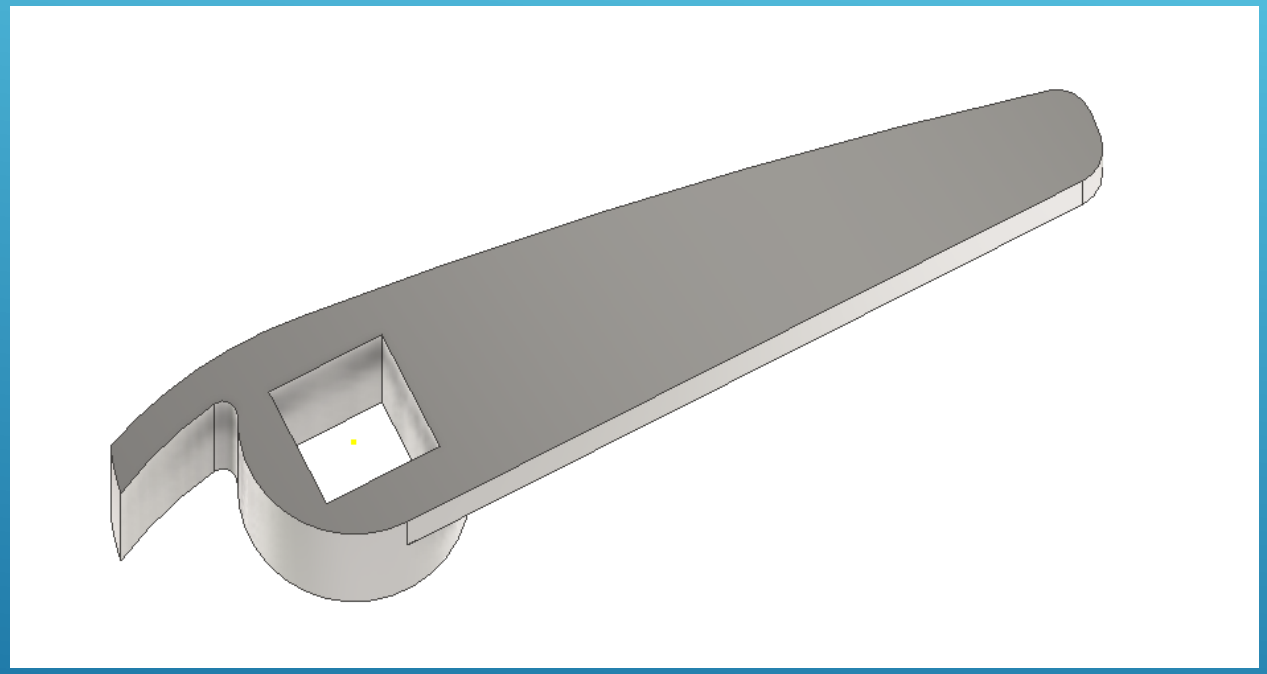
Grind two safety edges on a file to file the hole.



SQUARE FILE

When grinding the surfaces, make sure you leave a radius at the end so the file doesn't brake off during use.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



FILE SQUARE HOLE

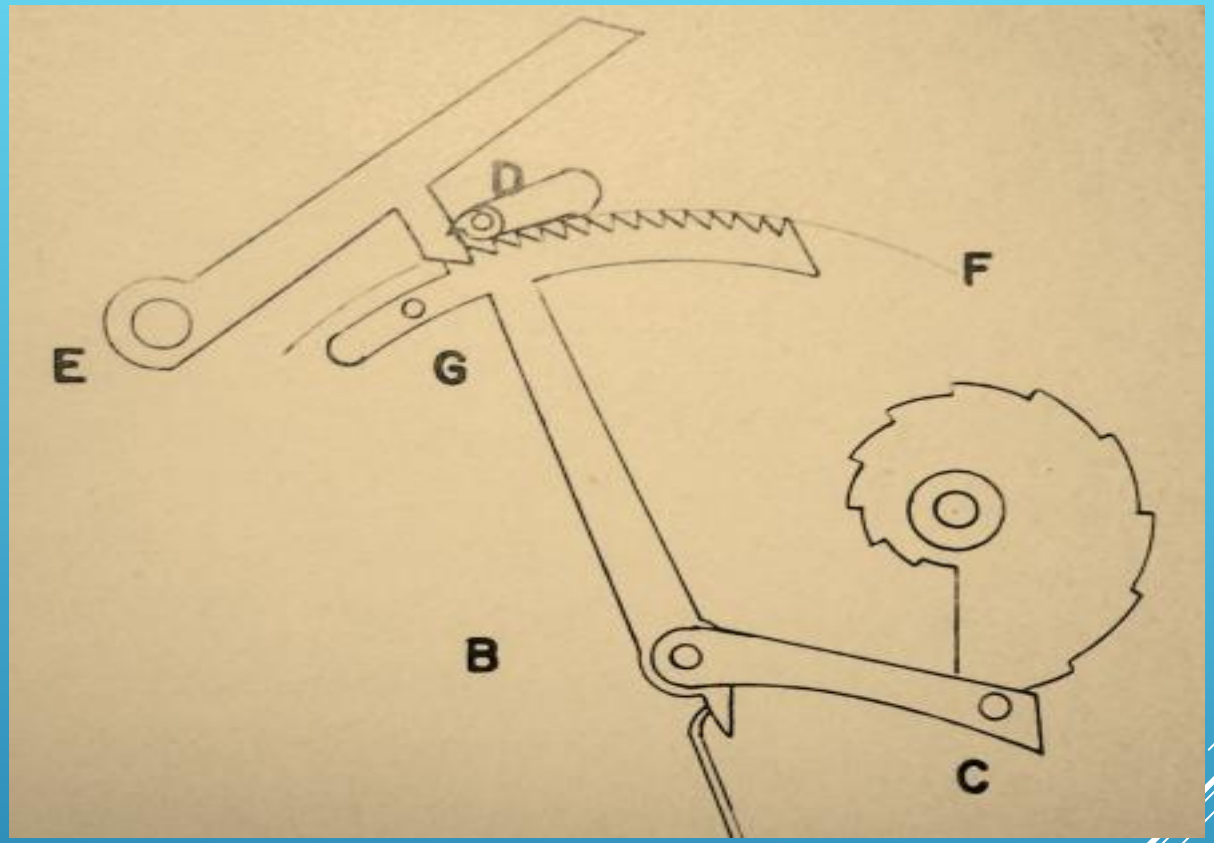
Hand “fit” to get correct operation.

THE RACK AND SNAIL

How to make these parts

ALWAYS HAVE YOUR SAFETY GLASSES ON!

- “B” The Rack Center
- “C” Stop Pin On Tail
- “D” Gathering Pallet
- “E” Pivot Center For Retaining Ratchet
- “F” Radius Of Rack
- “G” Stop Pin On Rack

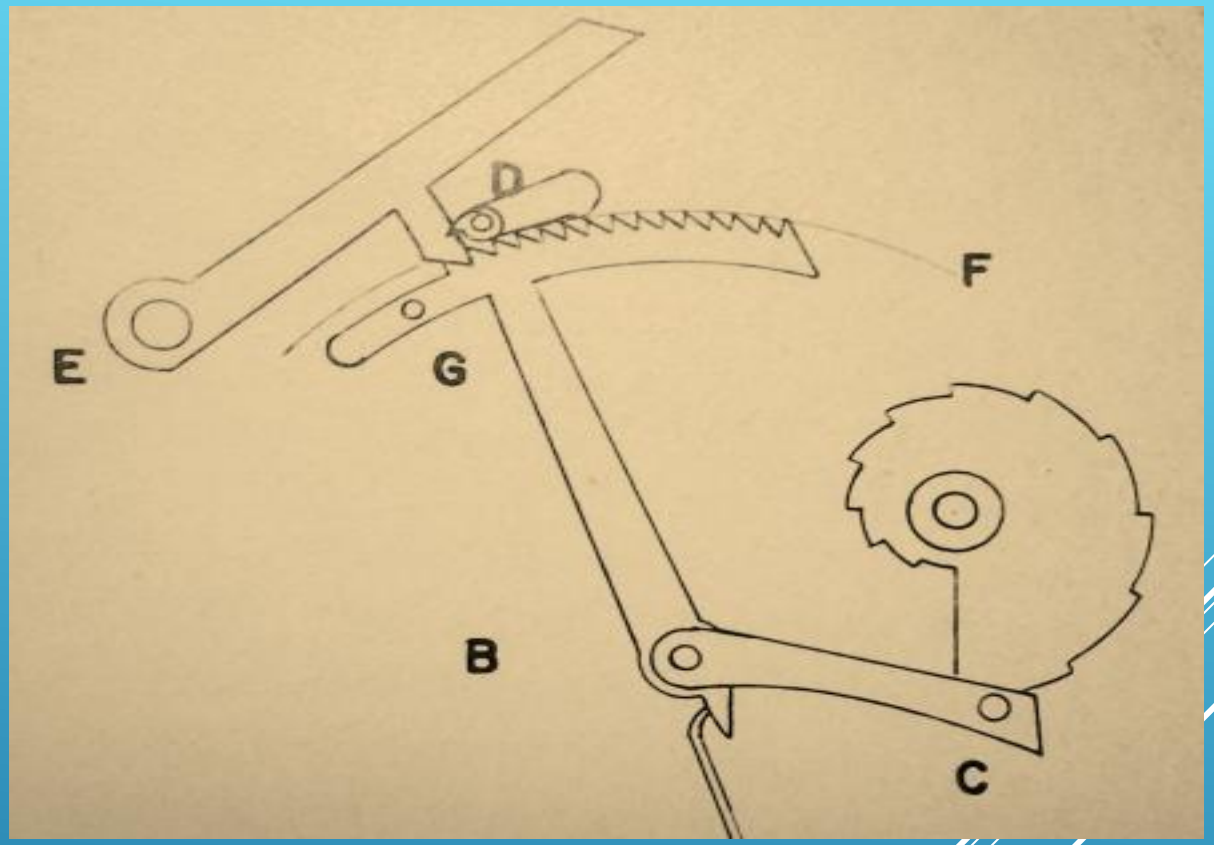


MAKING A RACK AND SNAIL

AMERICAN HOROLOGIST AND JEWELER NOVEMBER 1970

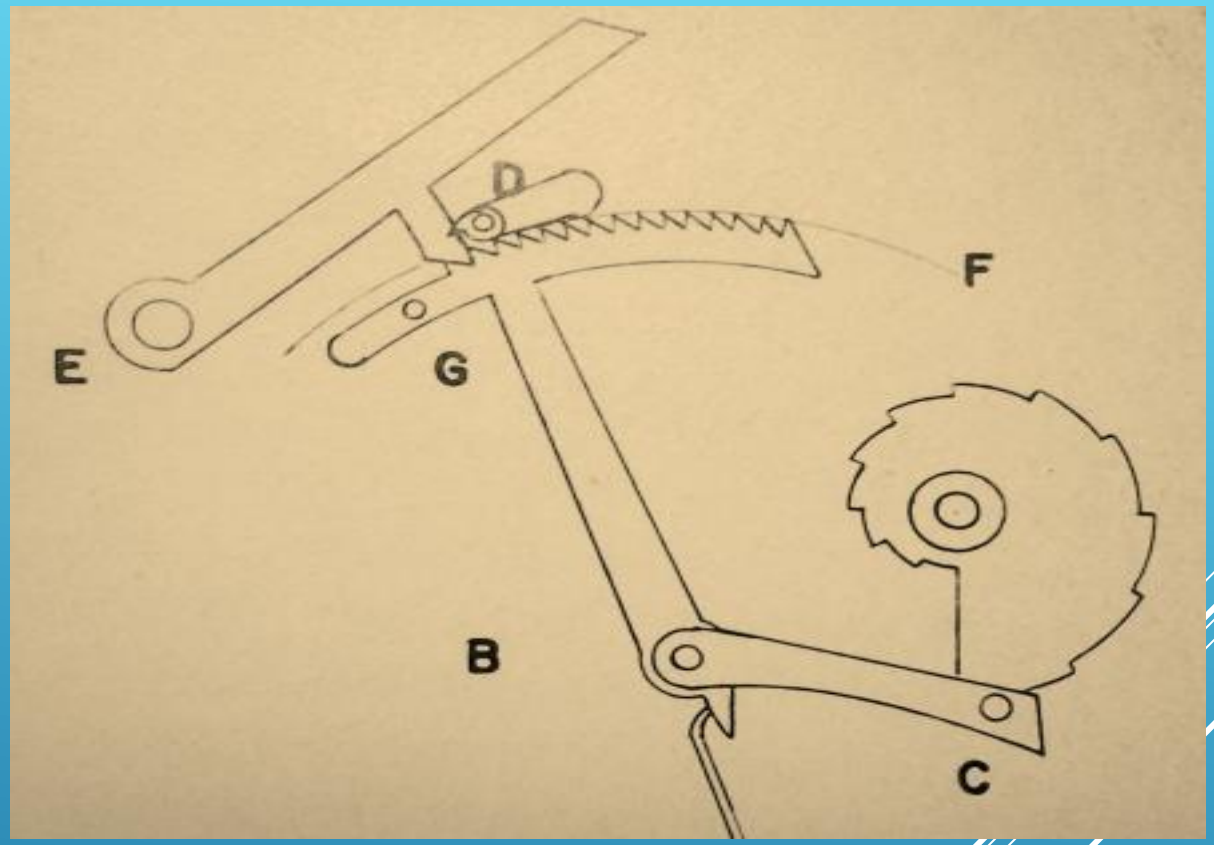
MAKING A RACK AND SNAIL

- Make a Drawing of the necessary part.
  - Obtain measurements from the clock plate.
  - Layout the centers of the rack and gathering pallet.
  - Layout the retaining ratchet and hour snail.



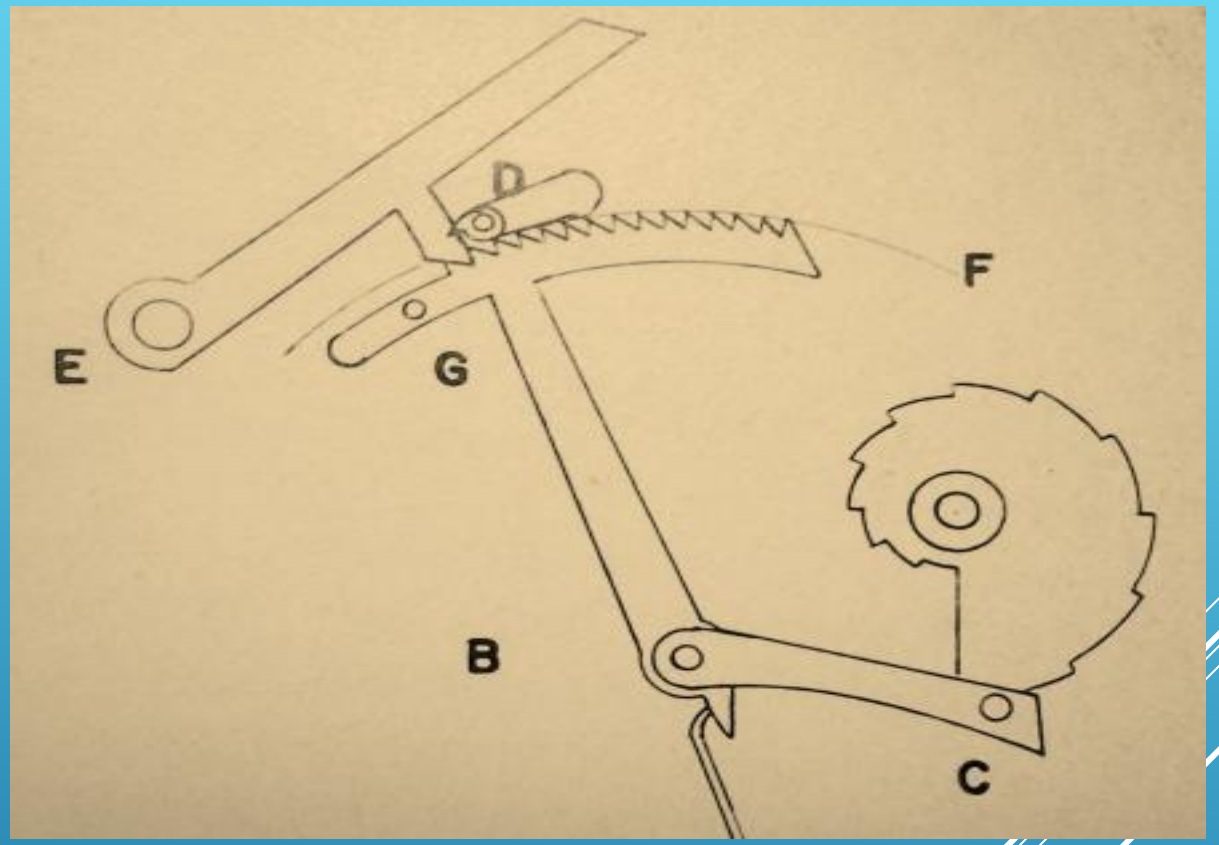
MAKING A RACK AND SNAIL

- Measure the distance from the rack pivot center and the gathering pallet.
- Subtract for clearance.
- Scribe an arc using the rack center “F”.
- Determine the pitch.



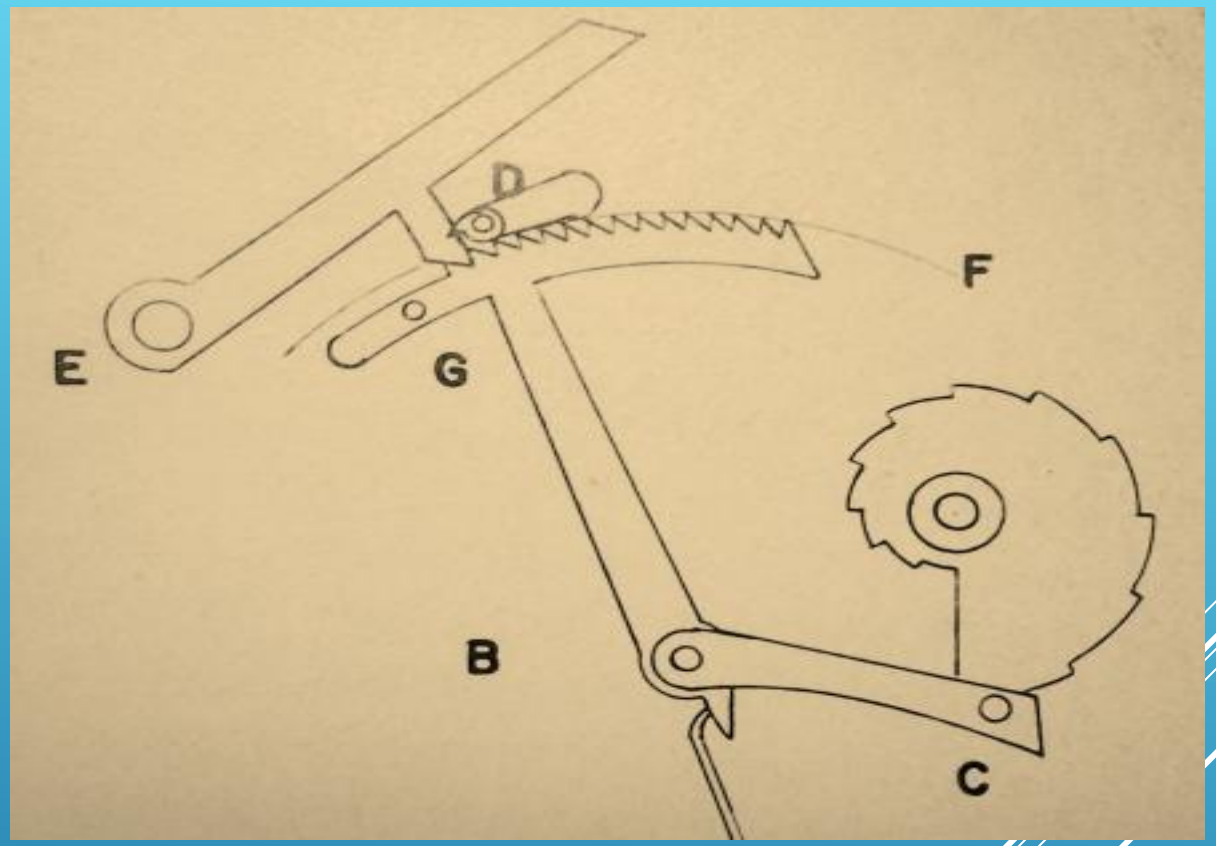
MAKING A RACK AND SNAIL

- Pitch Formula
  - P = H x BF / B C
    - H = measure the lowest radius or the “12” step on the snail. Then measure the highest radius or the “1” position on the snail.
    - Subtract the “12” measurement from the “1” measurment then divide by 11. This is the amount of motion or drop for each tooth of the rack.

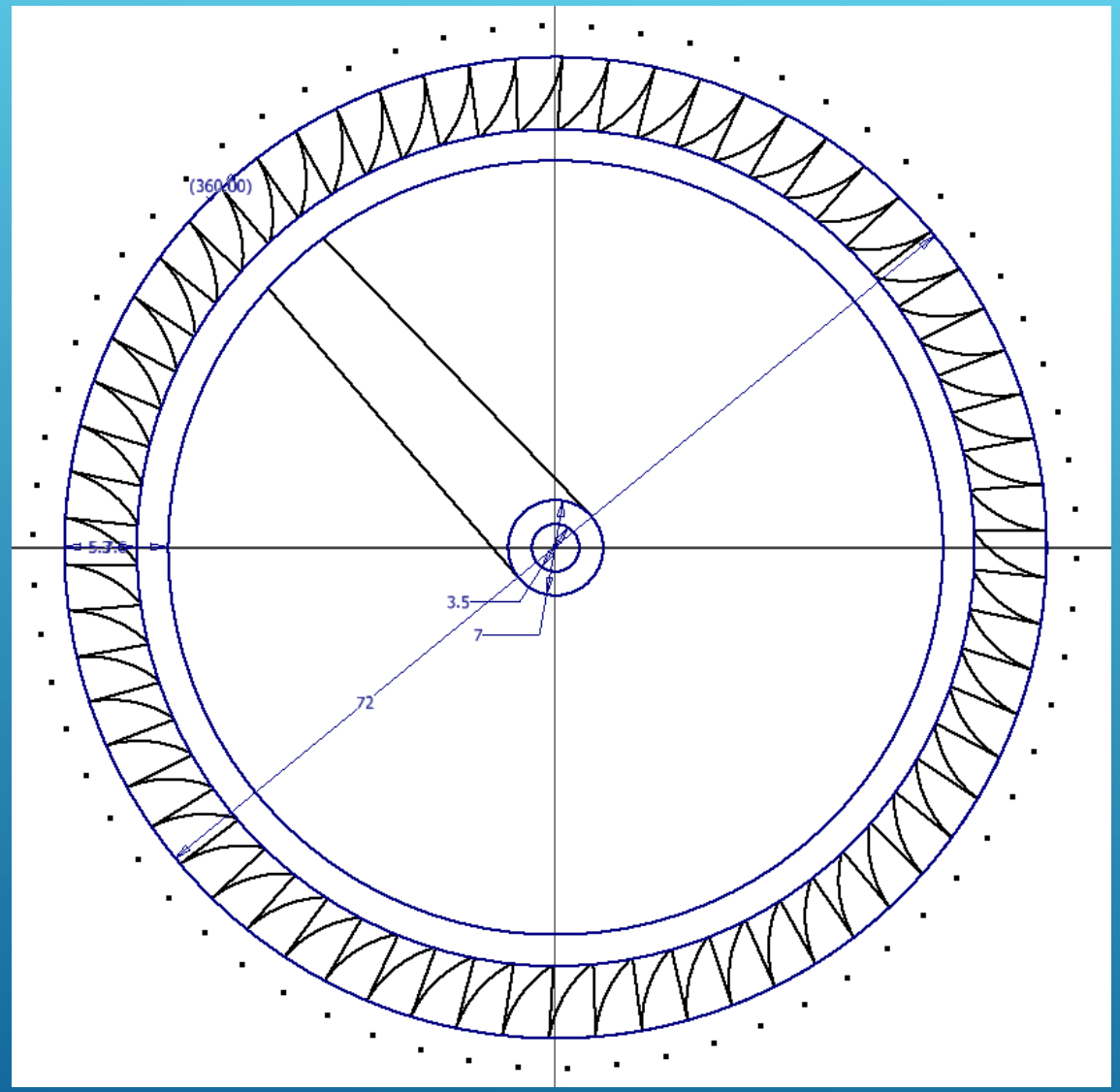


MAKING A RACK AND SNAIL

- Rack should contain at least 15 teeth.
- Take the “BF” radius times 2 and times 3.1416 for the cirumference of the circle.
- This gives the correct number of teeth in the complete circle.

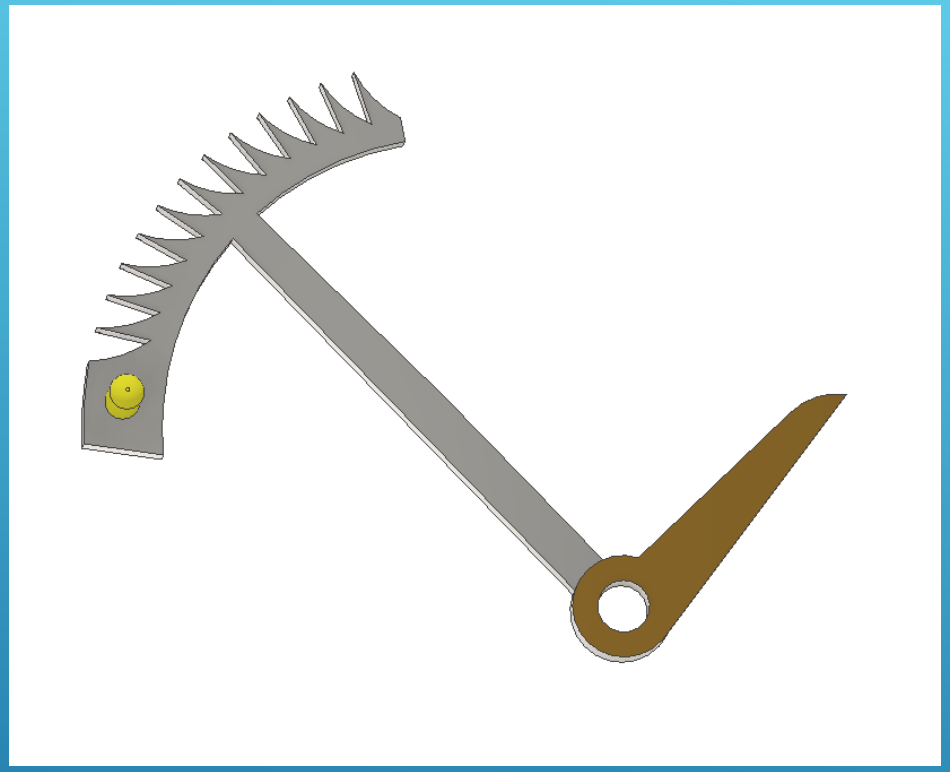


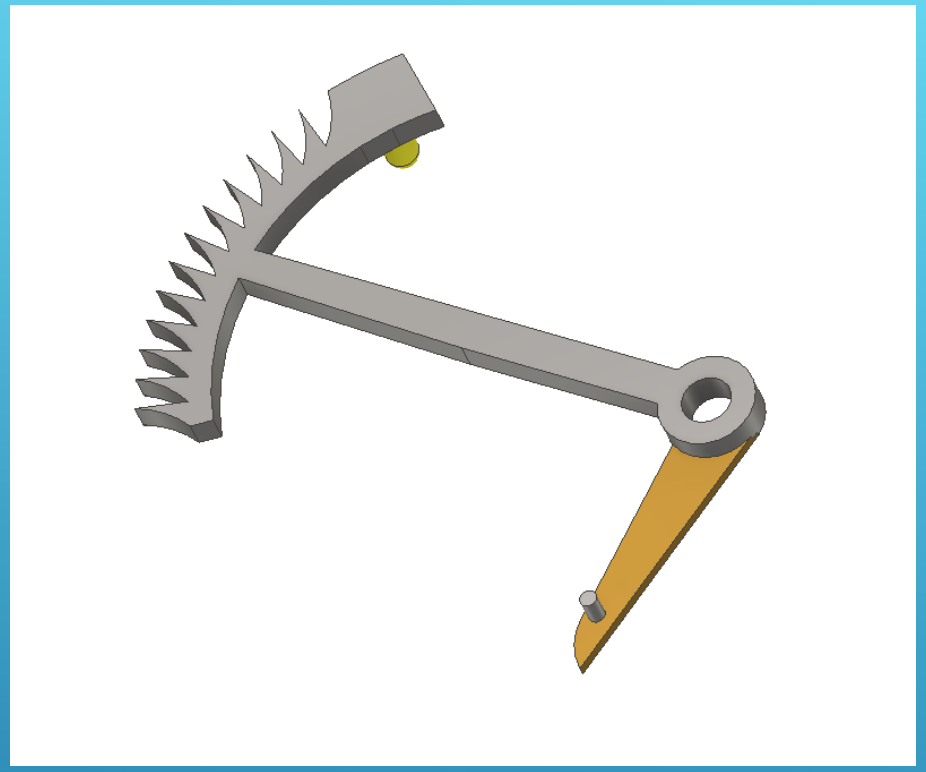
ALWAYS HAVE YOUR SAFETY GLASSES ON!



THE RACK

Remember the rack is just a section of a large wheel.





FRONT AND BACK SIDE OF THE RACK

ALWAYS HAVE YOUR SAFETY GLASSES ON!

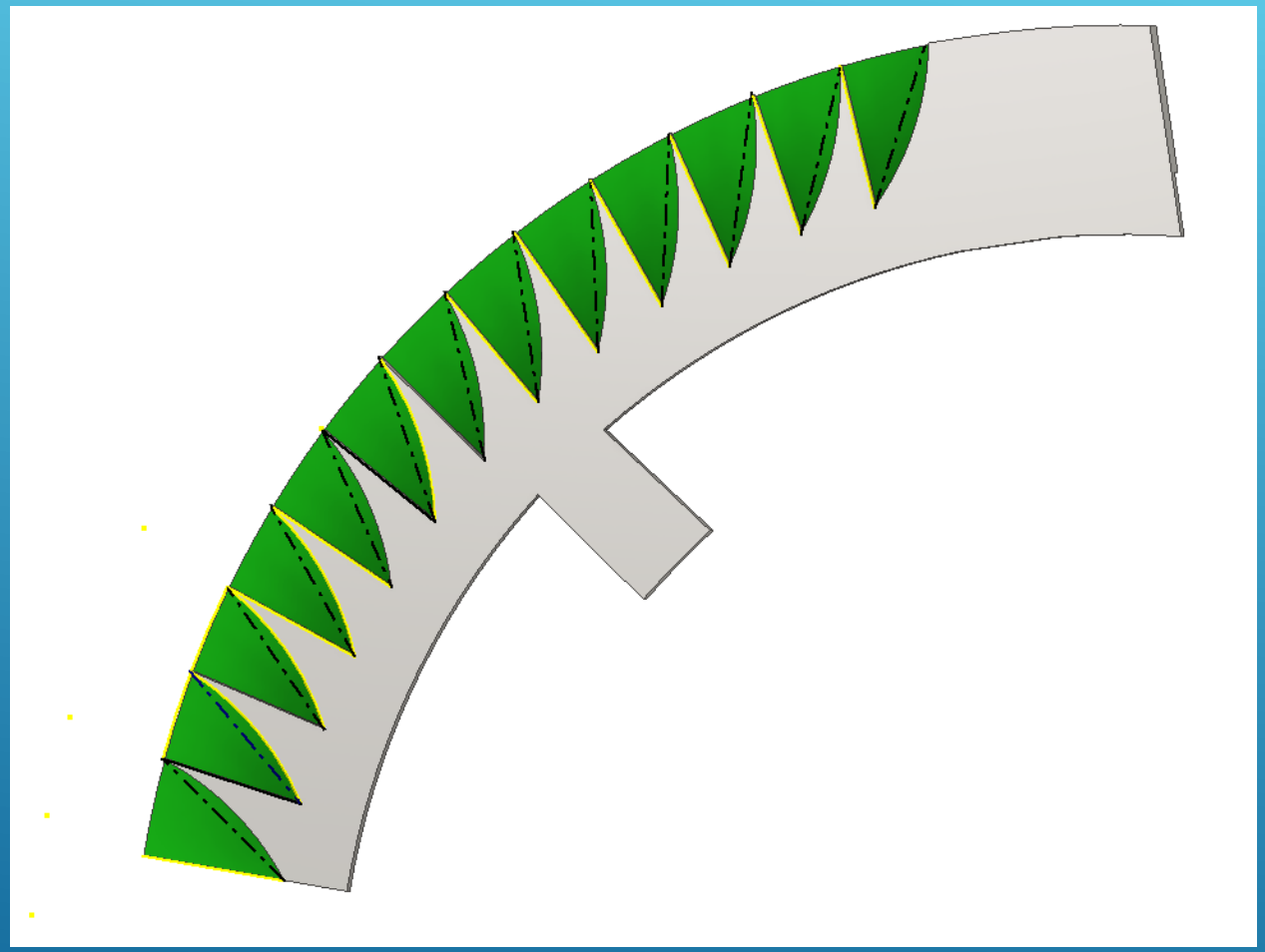
THE RACK

All the green must be removed.

Remember the sections are just radius from the center.

I would scribe both circles and layout a straight line for each tooth.

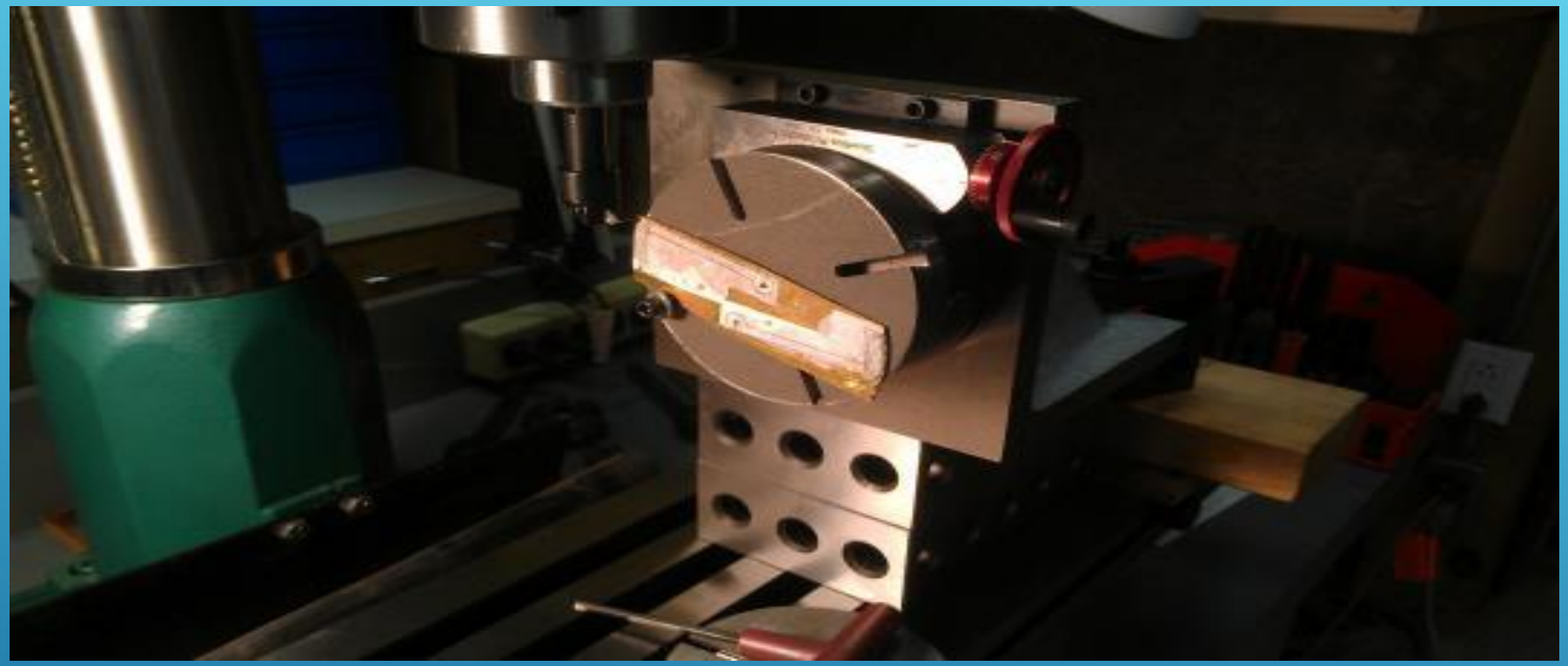
I always file the clearance radius by hand.



THE RACK

I would use the jewels saw to remove the material.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



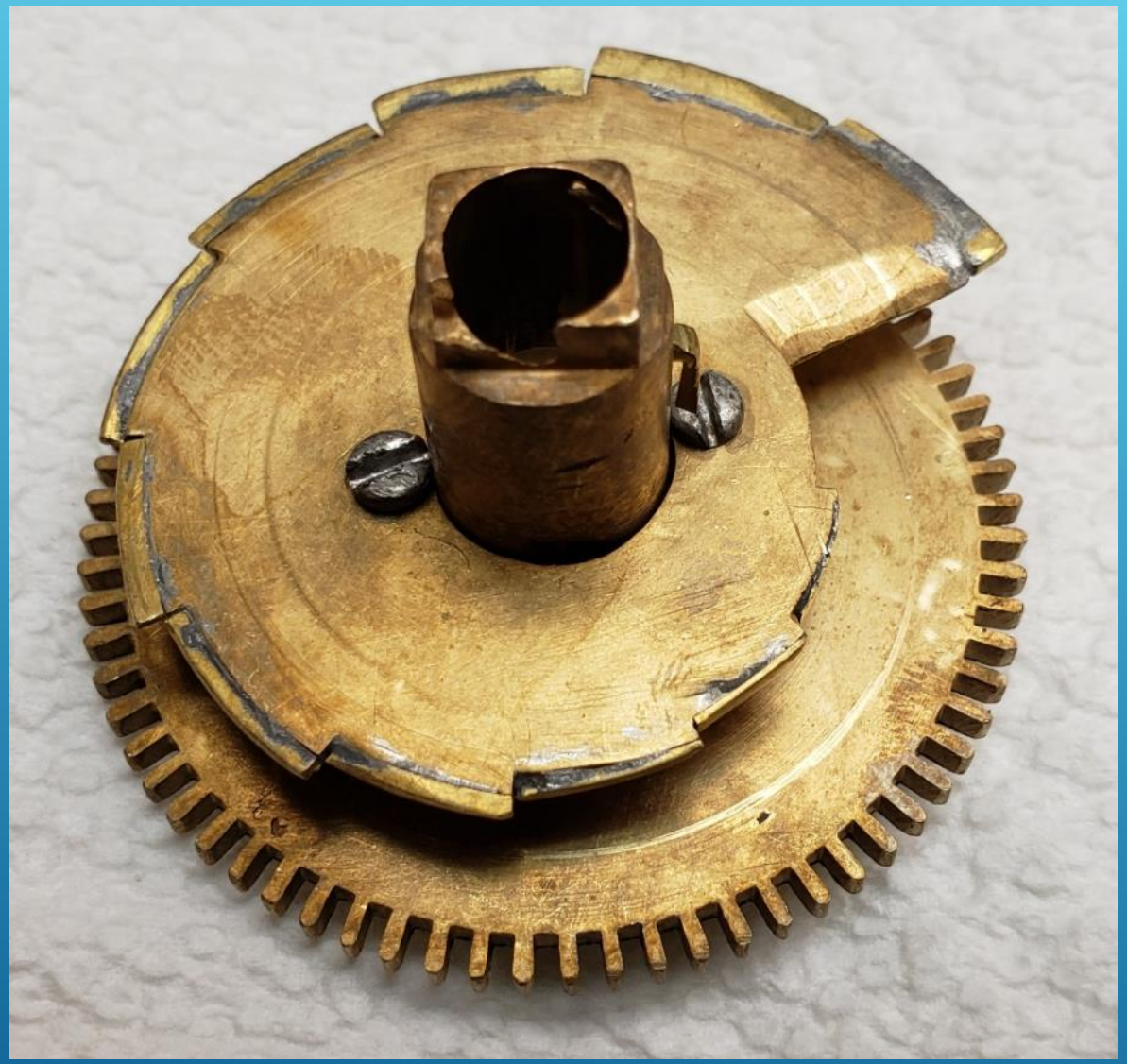
MOUNTING TO DIVIDING HEAD

CLOSE-UP OF CUTTING RACK

FINISHED CUT RACK

MAKING A SNAIL

ALWAYS HAVE YOUR SAFETY GLASSES ON!



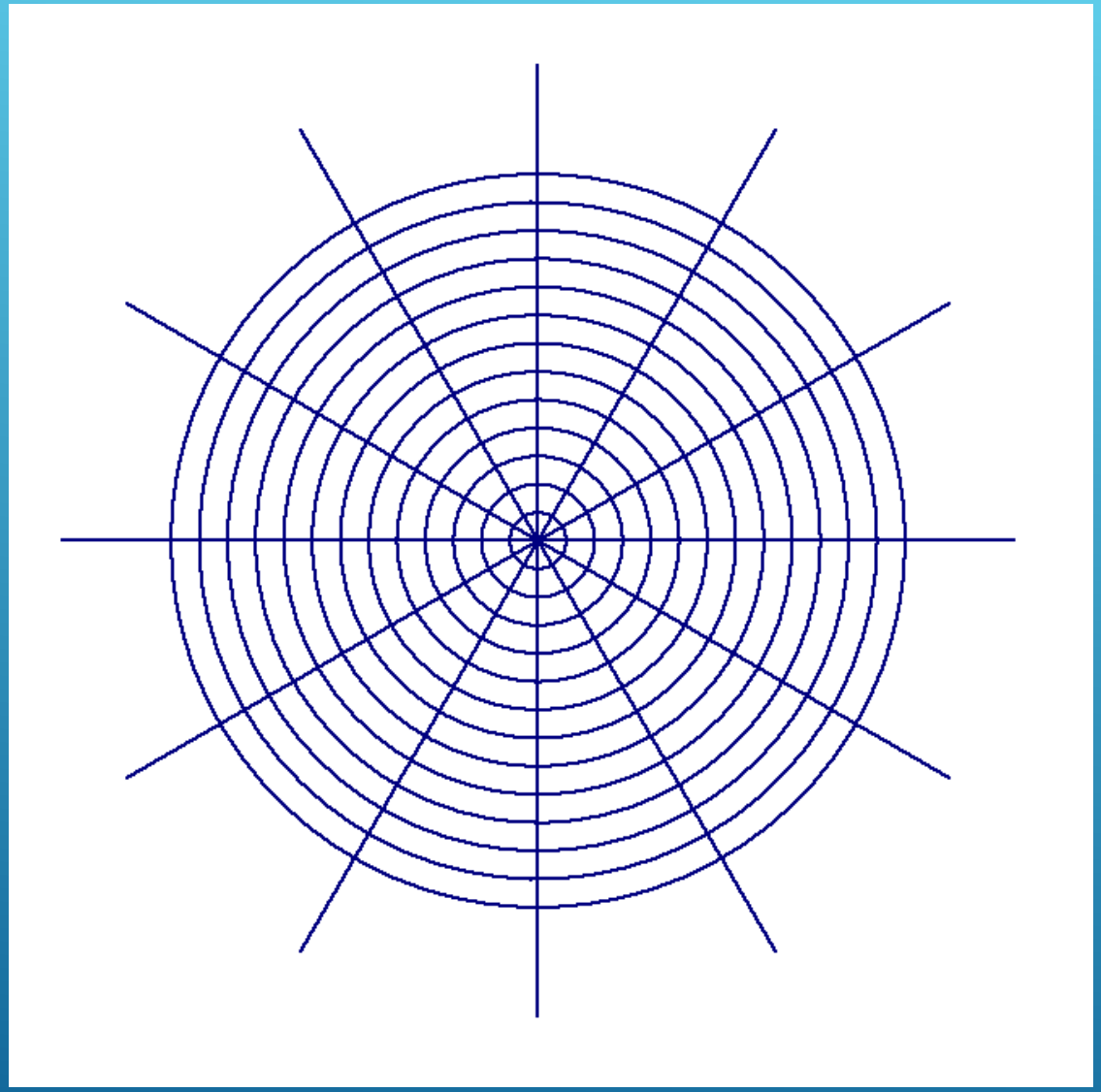
SNAIL

This is the snail of a clock that I need to replace.

I'm sure I didn't come from the original clockmaker this way.

Strips of brass were soldered to get it to strike correctly.

It didn't.



LAYING OUT A SNAIL

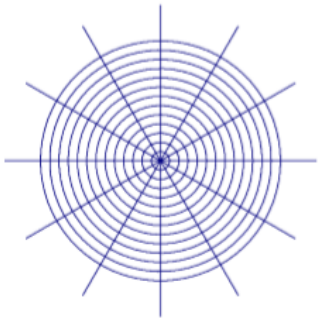
Use the formula to create the dimensions for the snail.

Layout 12 equal circles, 12 equal sections.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

SNAIL

My plan



Part Name: *Snail*

Material: Brass

Tools: *Lathe, center drill, caliper, 3 jaw chuck, indexing fixture*

Strengths: *Turning*

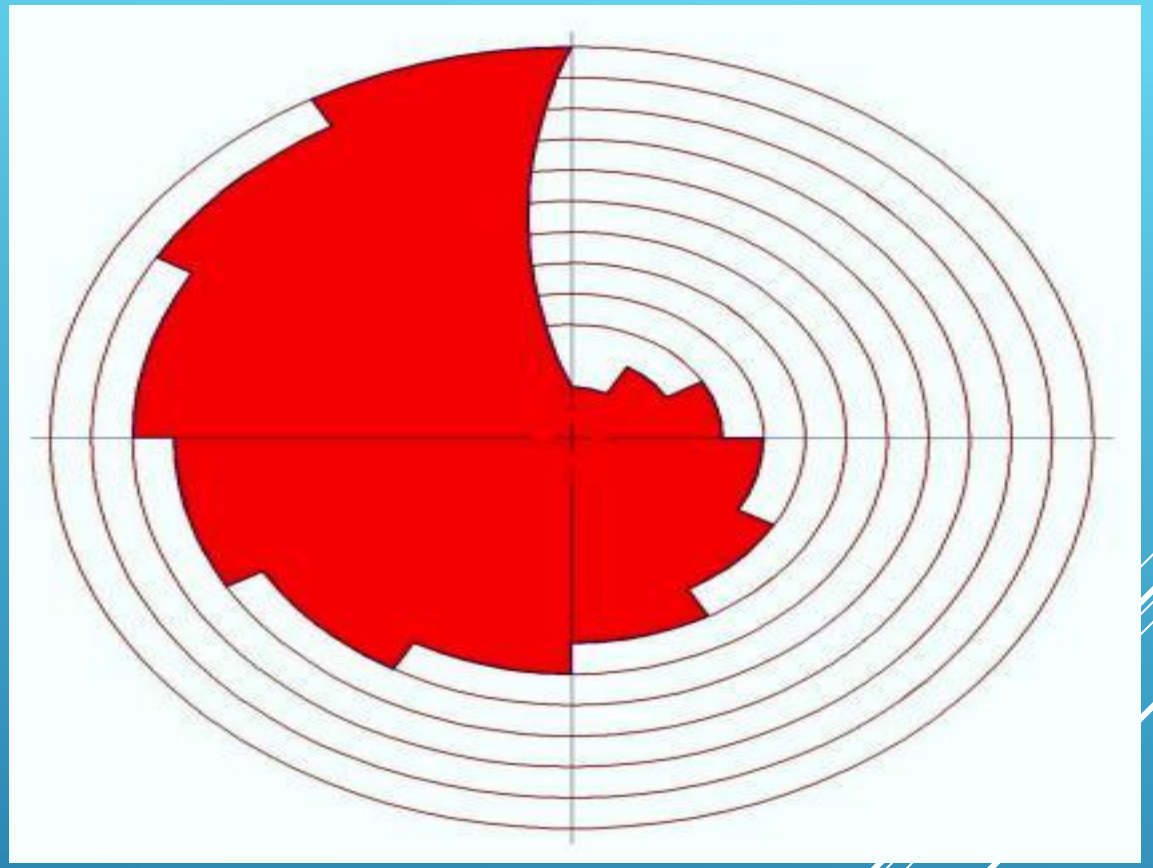
Weakness: *Layout of holes.*

Procedure:

1. *Cut material to length*
2. *Setup lathe*
3. *Select proper cutting tools (graver, or cross slide)*
4. *Drill center hole in material*
5. *Layout the equal circles and then the 12 sections.*
6. *Remove the material with a saw or milling cutter.*
7. *File the edges.*
8. Check the operation and adjust if necessary.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

- Same formula
- H = P x BC / BF
  - “H” is the height
  - “P” is the pitch
- 12 equal circles.
- 12 equal divisions.

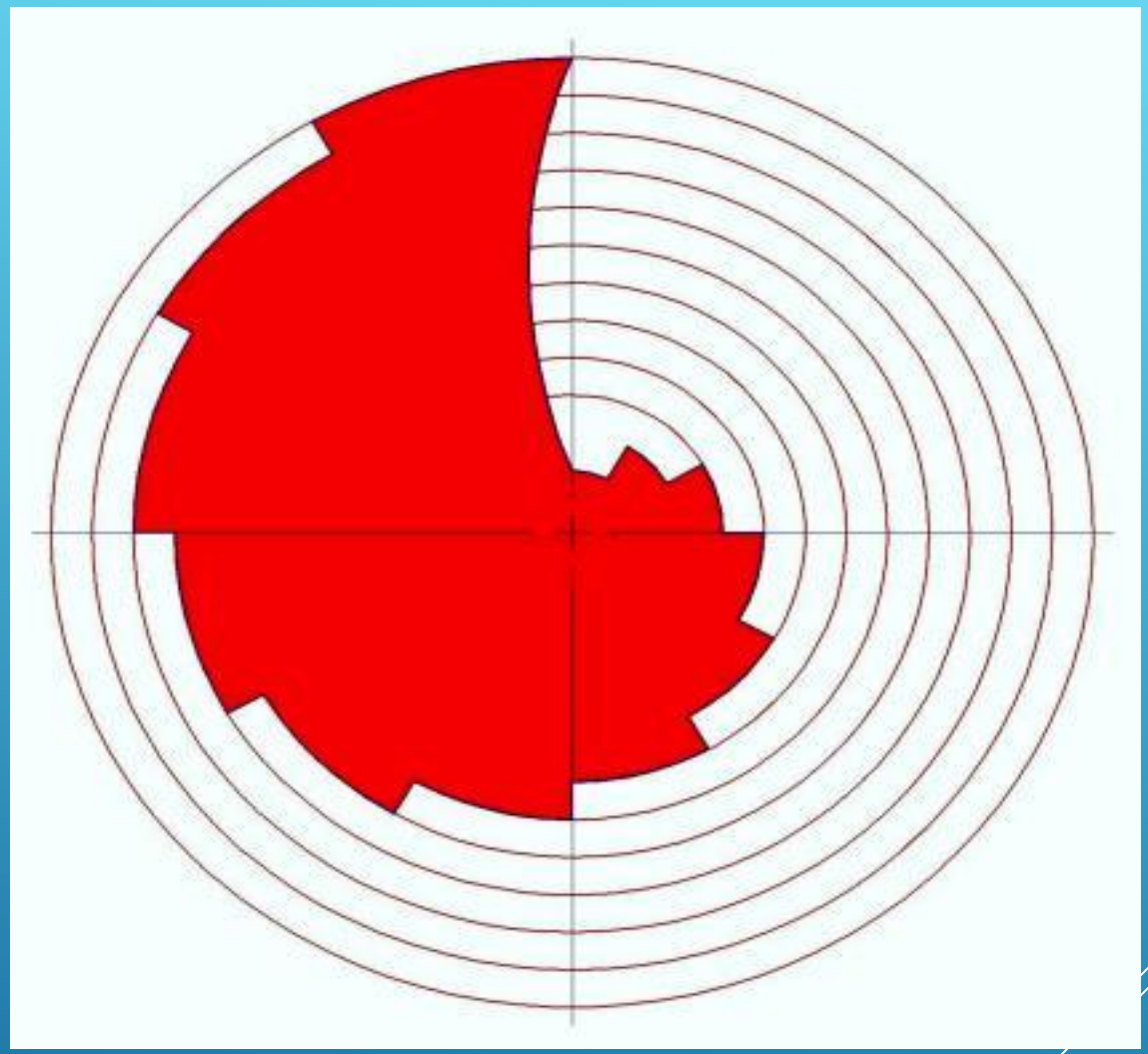


MAKING A RACK AND SNAIL

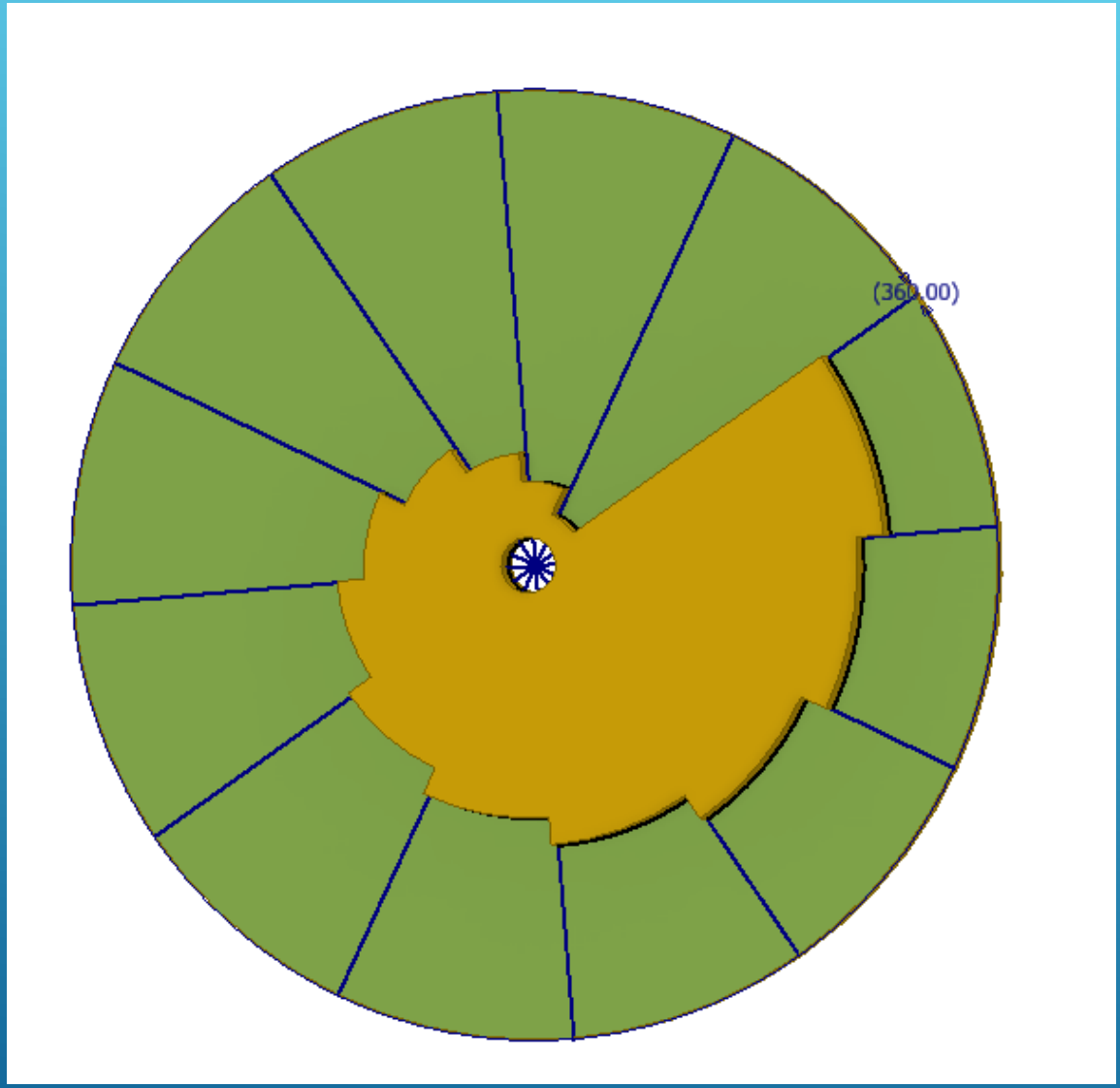
AMERICAN HOROLOGIST AND JEWELER NOVEMBER 1970

MAKING A SNAIL

- 12 equal circles.
- 12 equal divisions.



ALWAYS HAVE YOUR SAFETY GLASSES ON!

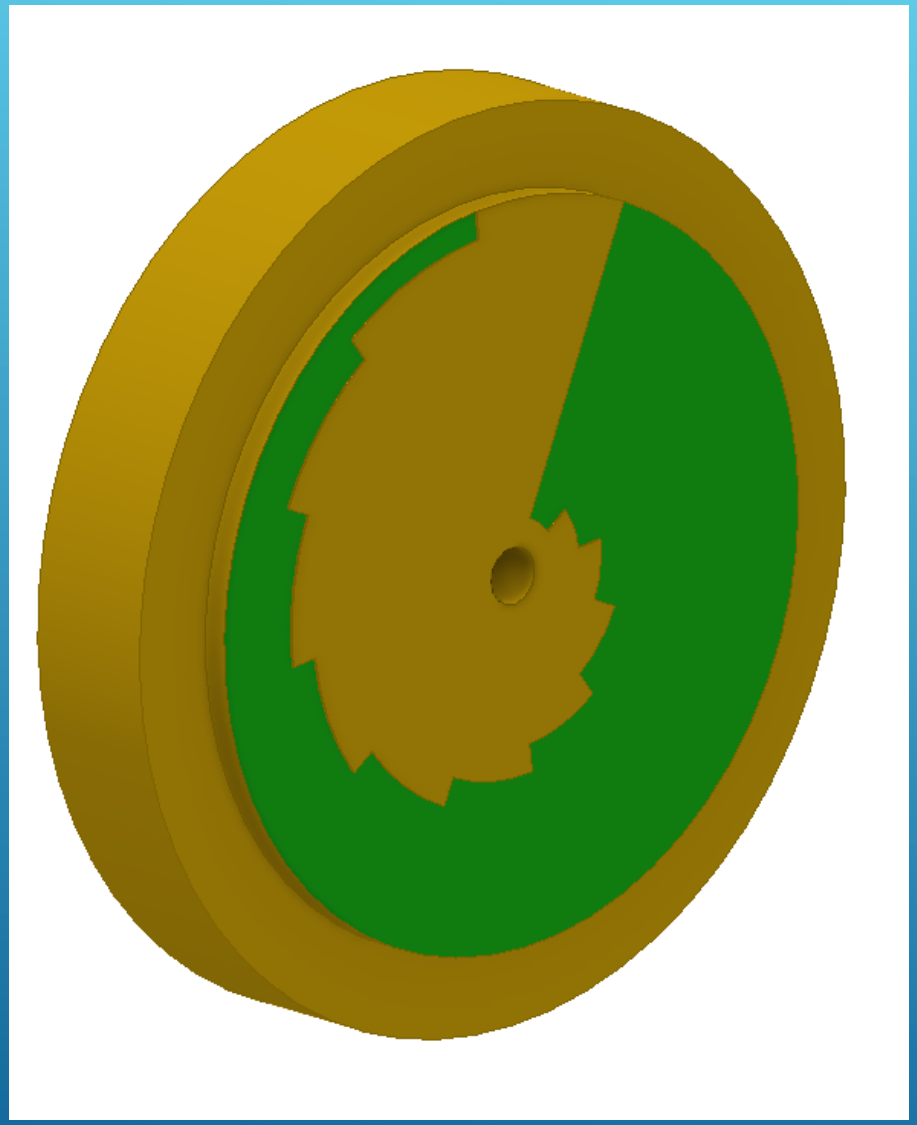


SNAIL

Layout 12 equal circles.

Layout 12 equal sections.

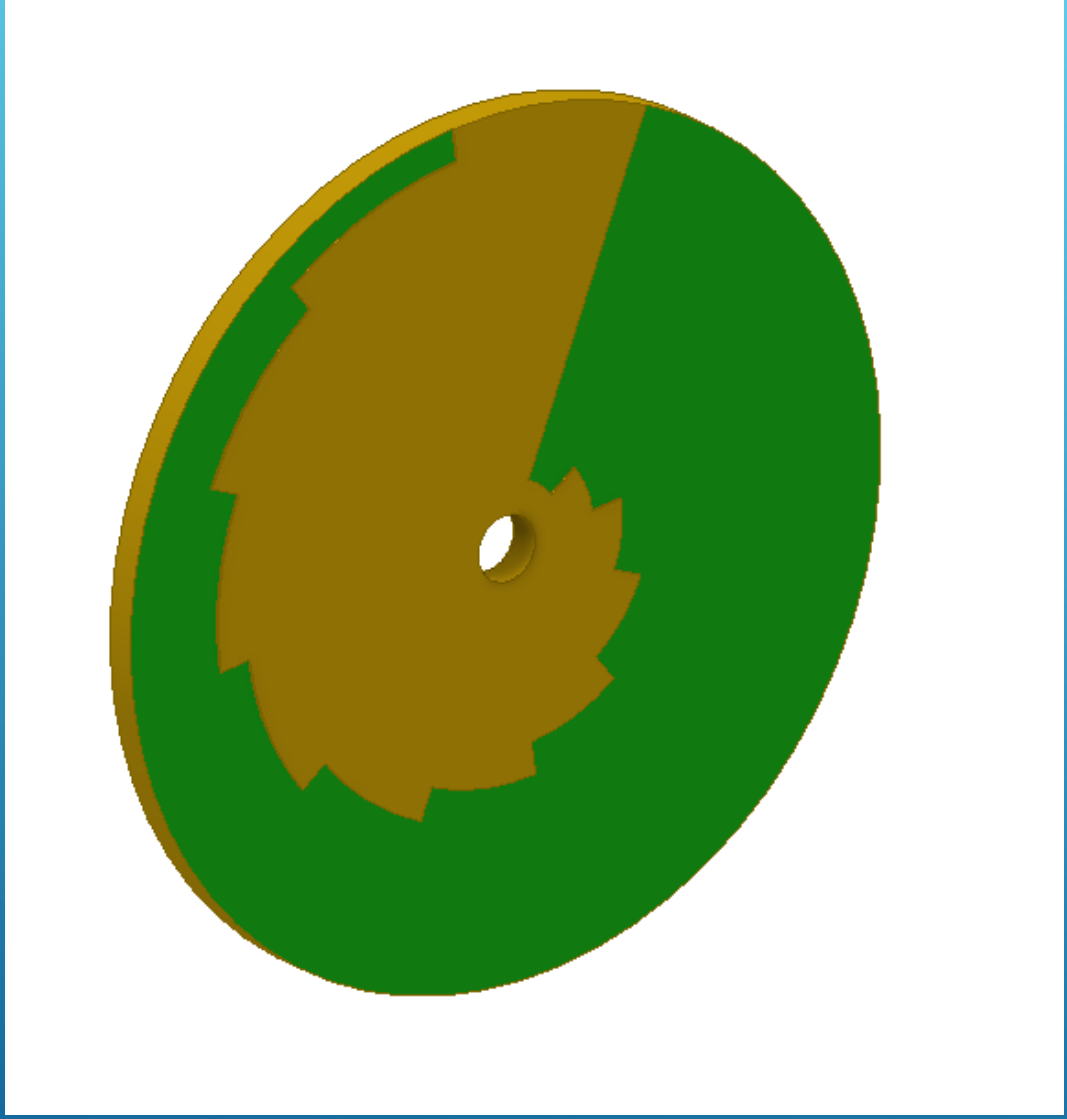
The “green” needs to be removed.



SNAIL

I like to turn the largest outside diameter in my lathe mounted to a 3 jaw chuck.

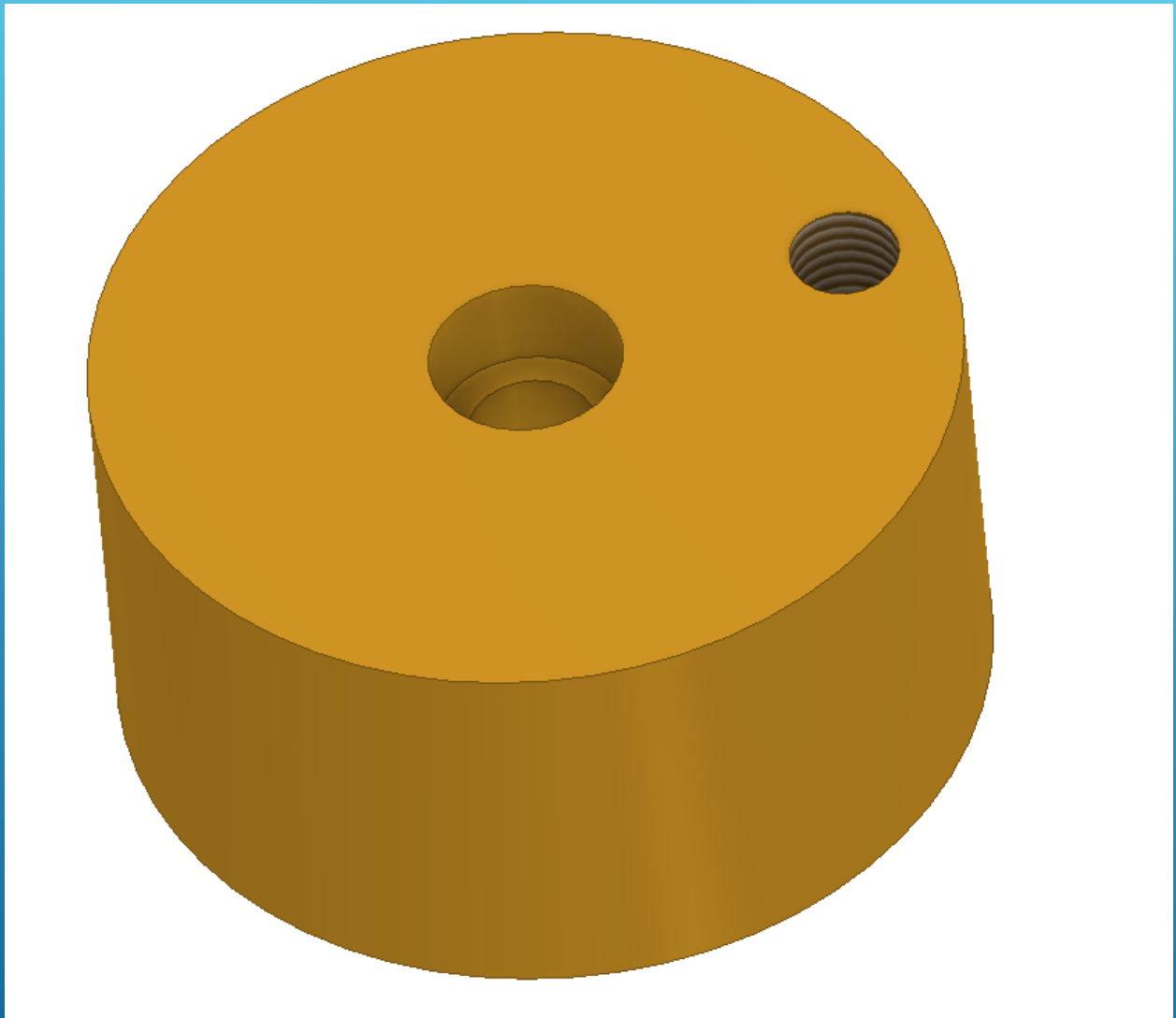
ALWAYS HAVE YOUR SAFETY GLASSES ON!



SNAIL

After I get the largest diameter turned, I flip the part in the 3 jaw chuck and reduce the thickness to the proper dimension.

Now its time to remove the rest of the material.



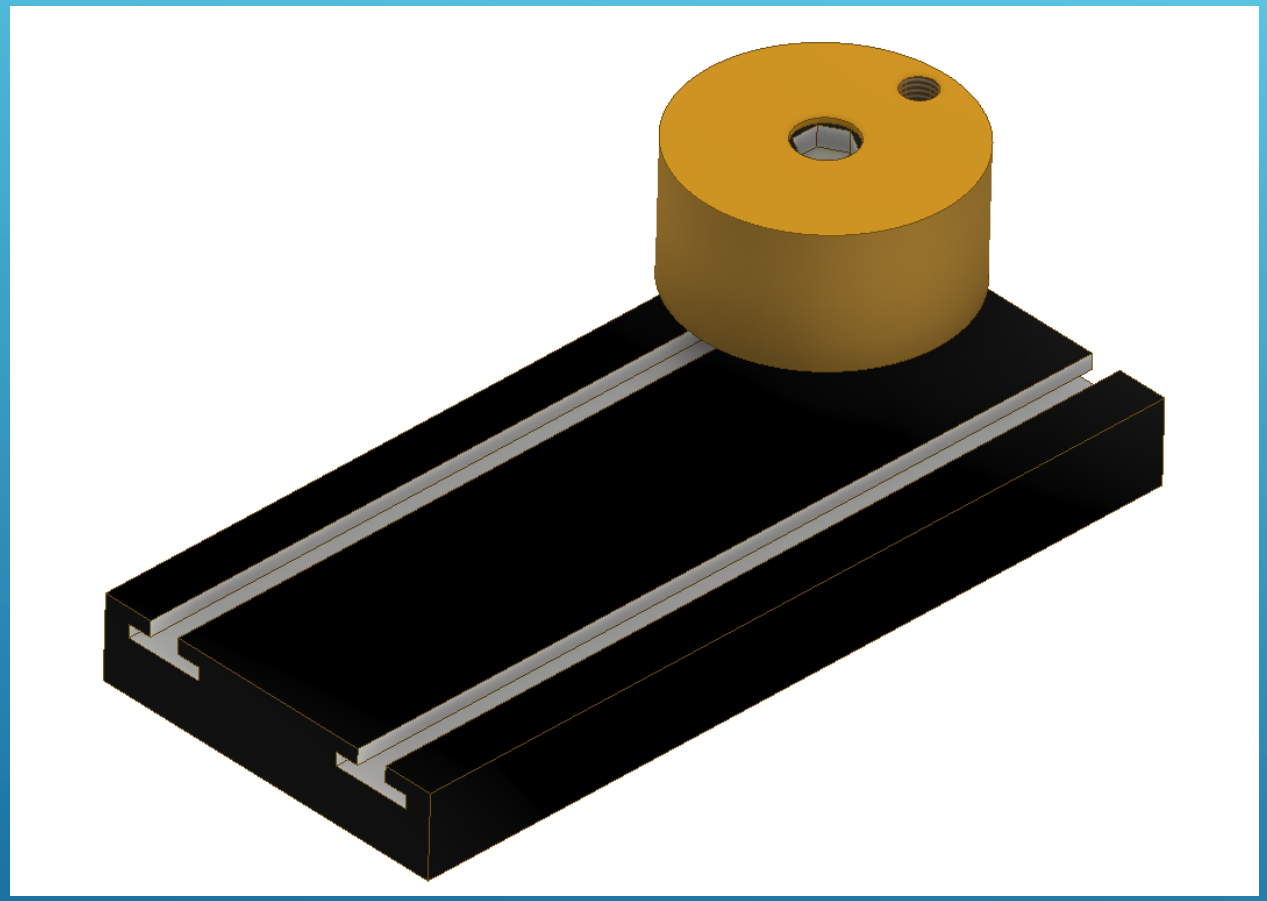
BRASS CUTTING TABLE

This cutting table will be used to saw the remaining material.

Its drilled and counter sunk in the middle for a socket head bolt to fasten to the cross slide.

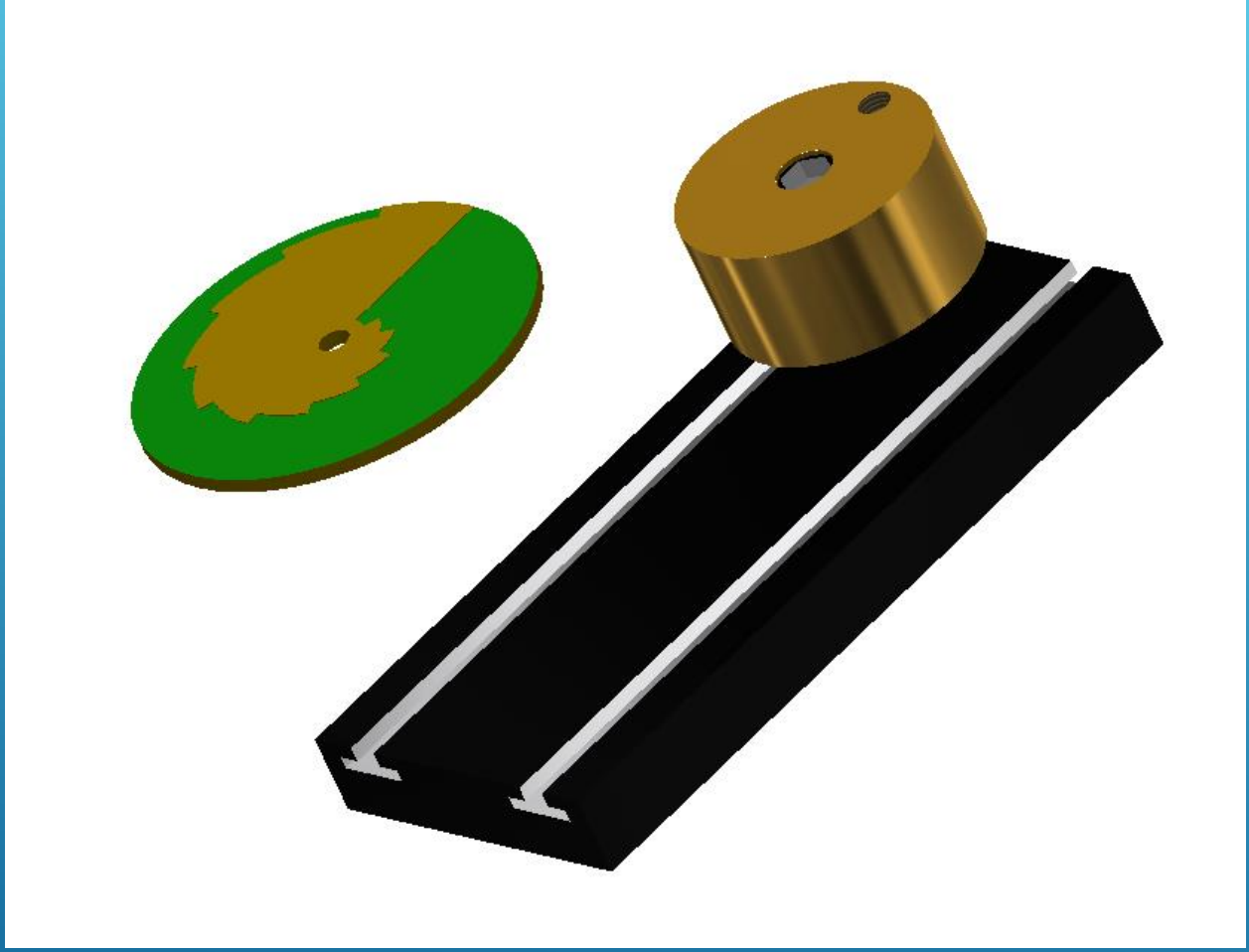
The other hole is for mounting the snail blank.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



CUTTING TABLE

Cutting table mounted to the cross slide.

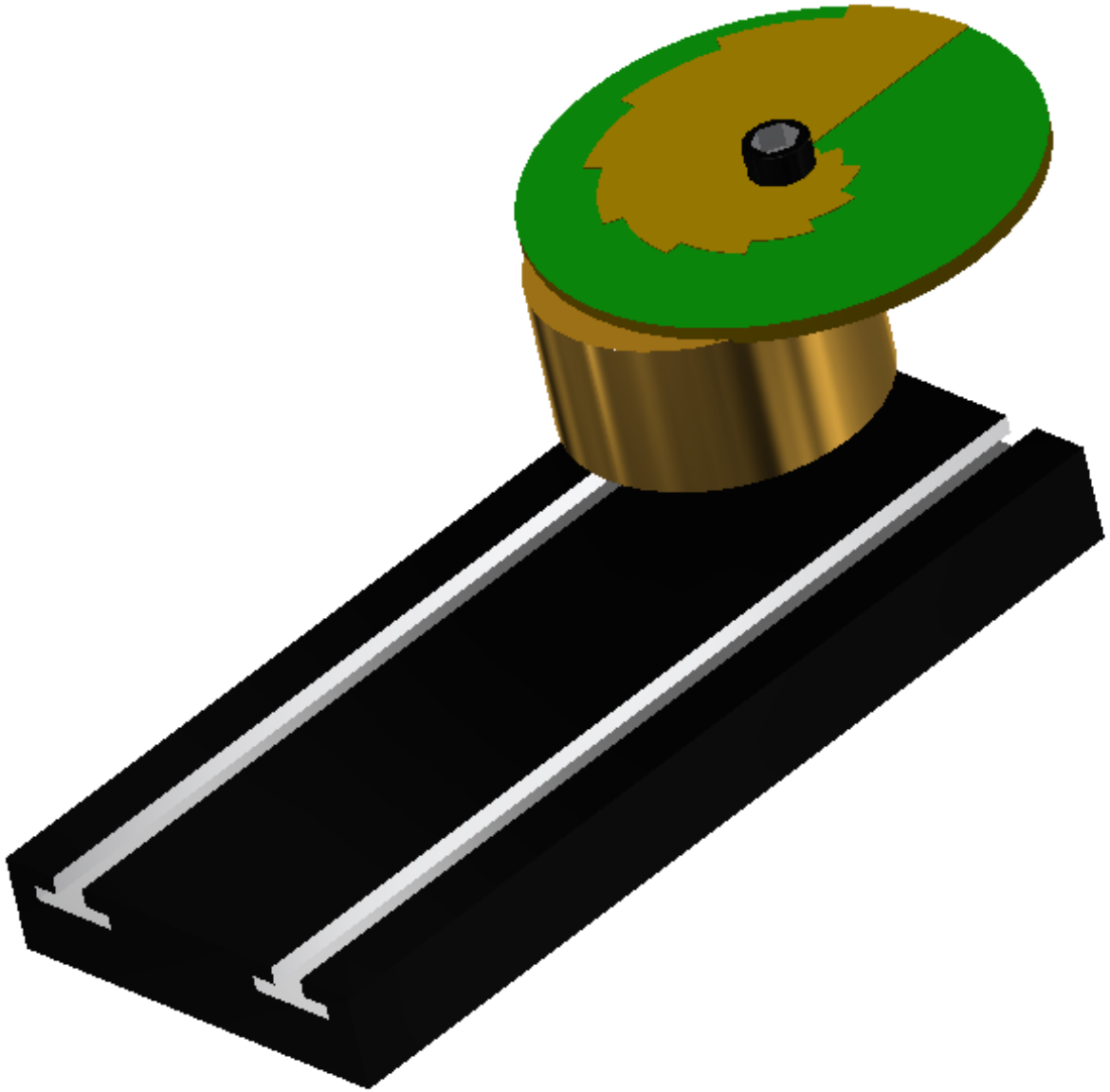


SNAIL

Now you have to decide how to cut the material away.

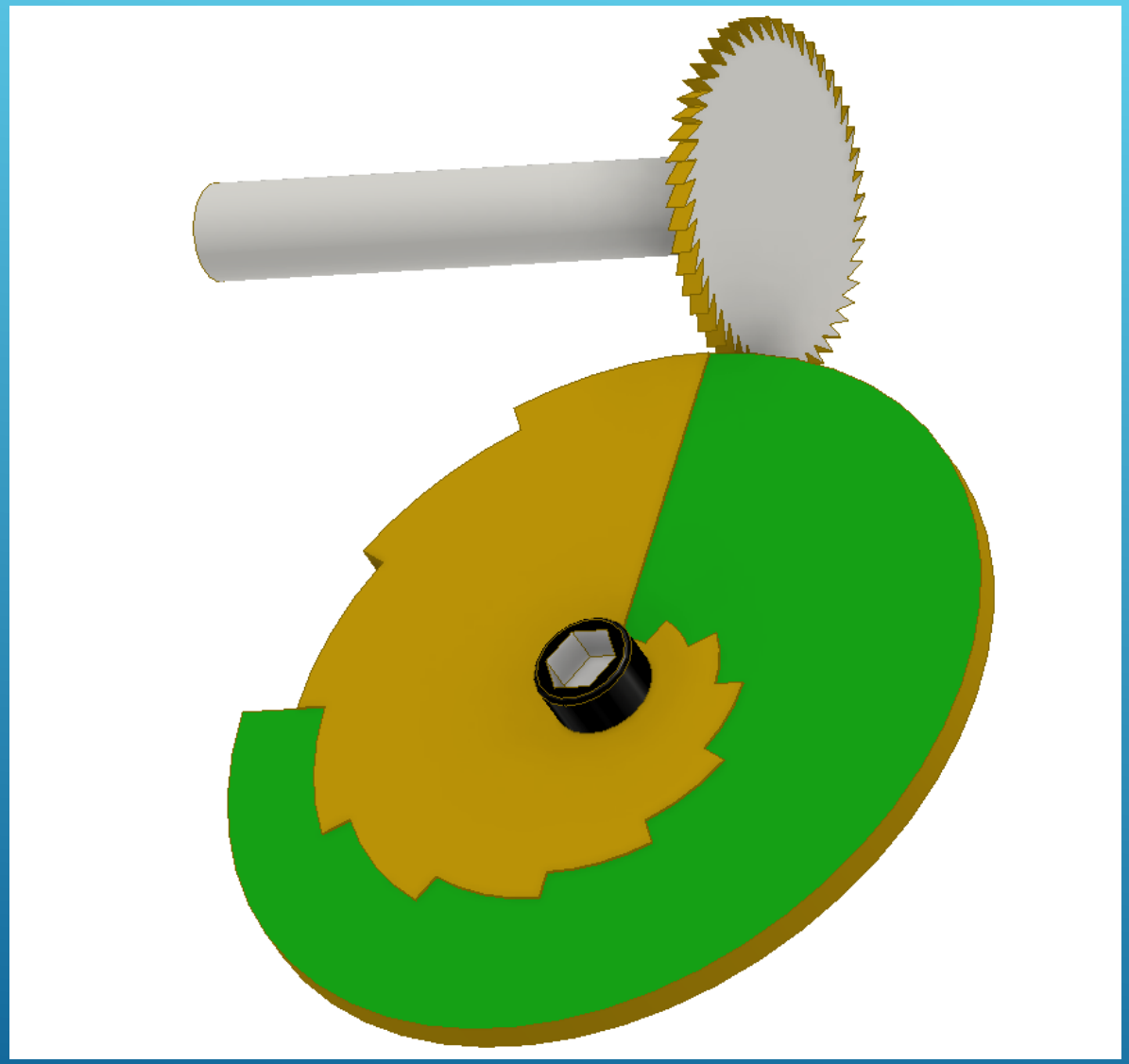
You could take the part and saw a large amount of the material away and then put it back in the lathe to finish it. This method will assure that the diameters are correct.

You could use a small milling cutter to finish this up.



CUTTING TABLE

The cutting table is now mounted to the cross slide and the blank is mounted to the table.

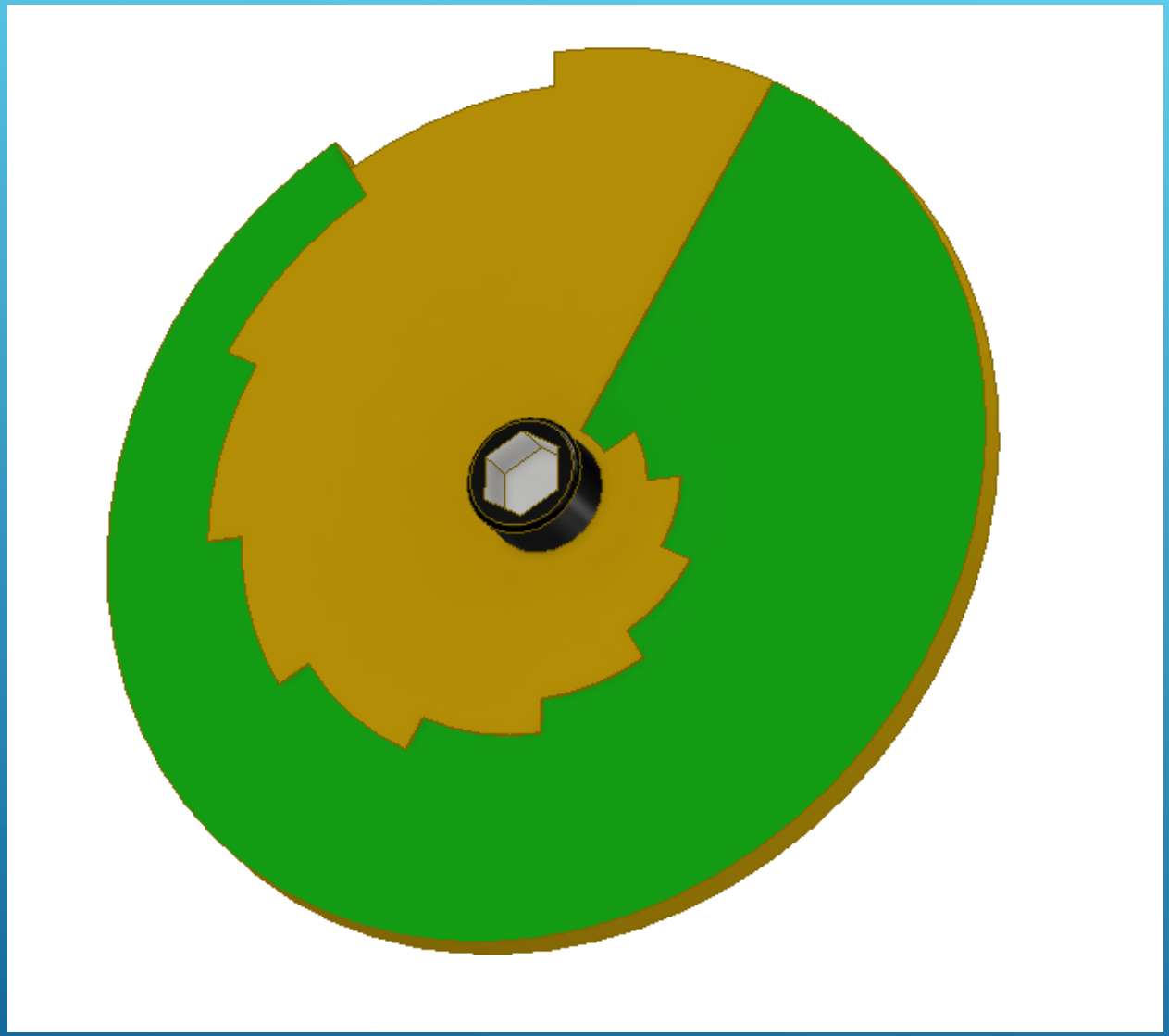


CIRCULAR SAW BLADE

Mount a saw blade and arbor in the headstock.

Turn on the lathe and bring the material into the blade.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

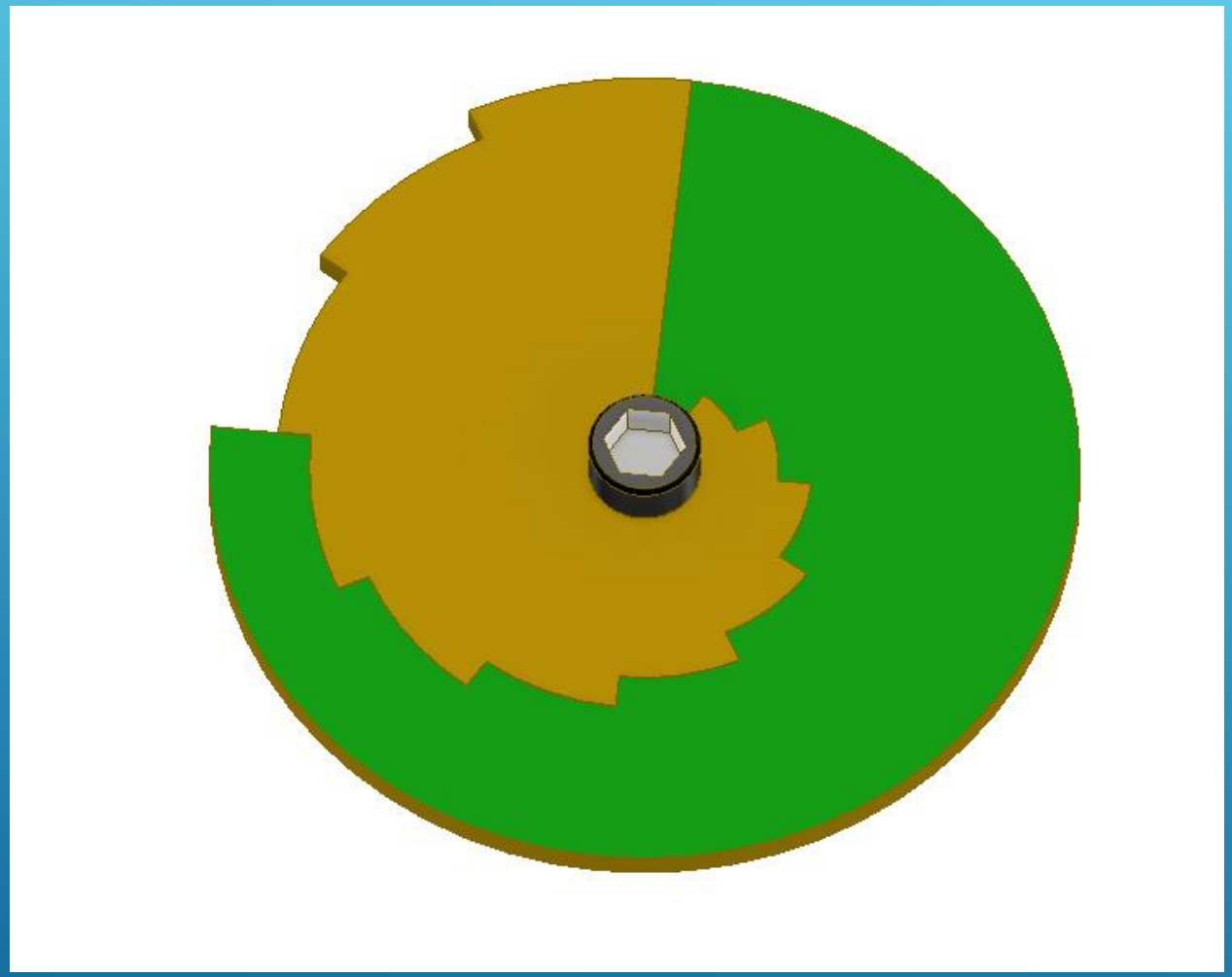


CUTTING OUT SEGMENTS

Slowly rotate the blank on its axis back and forth to remove the material.

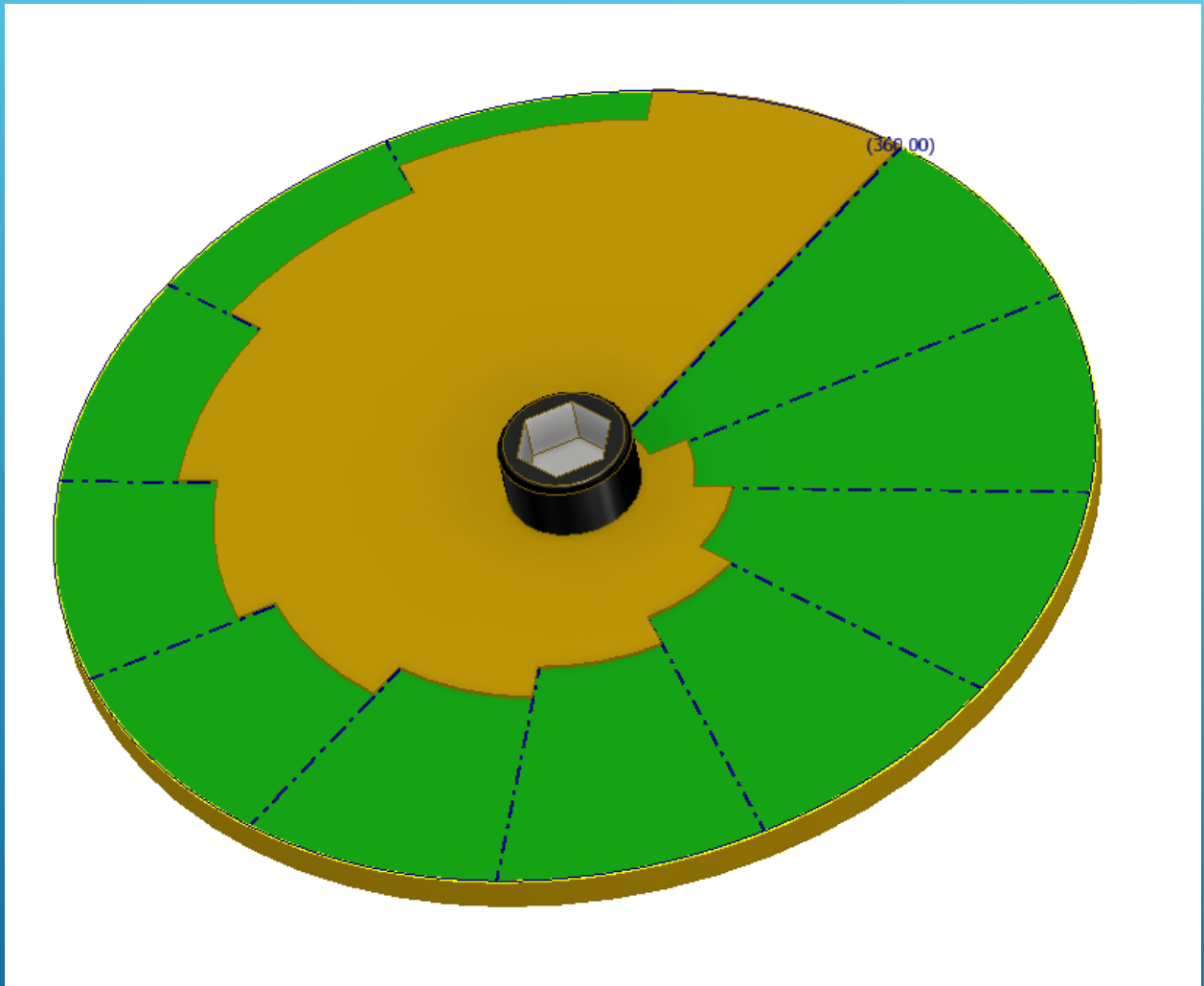
Remove a small amount of material and make sure you follow the radius.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



CUTTING OUT SEGMENTS

Continue until all the material is removed.



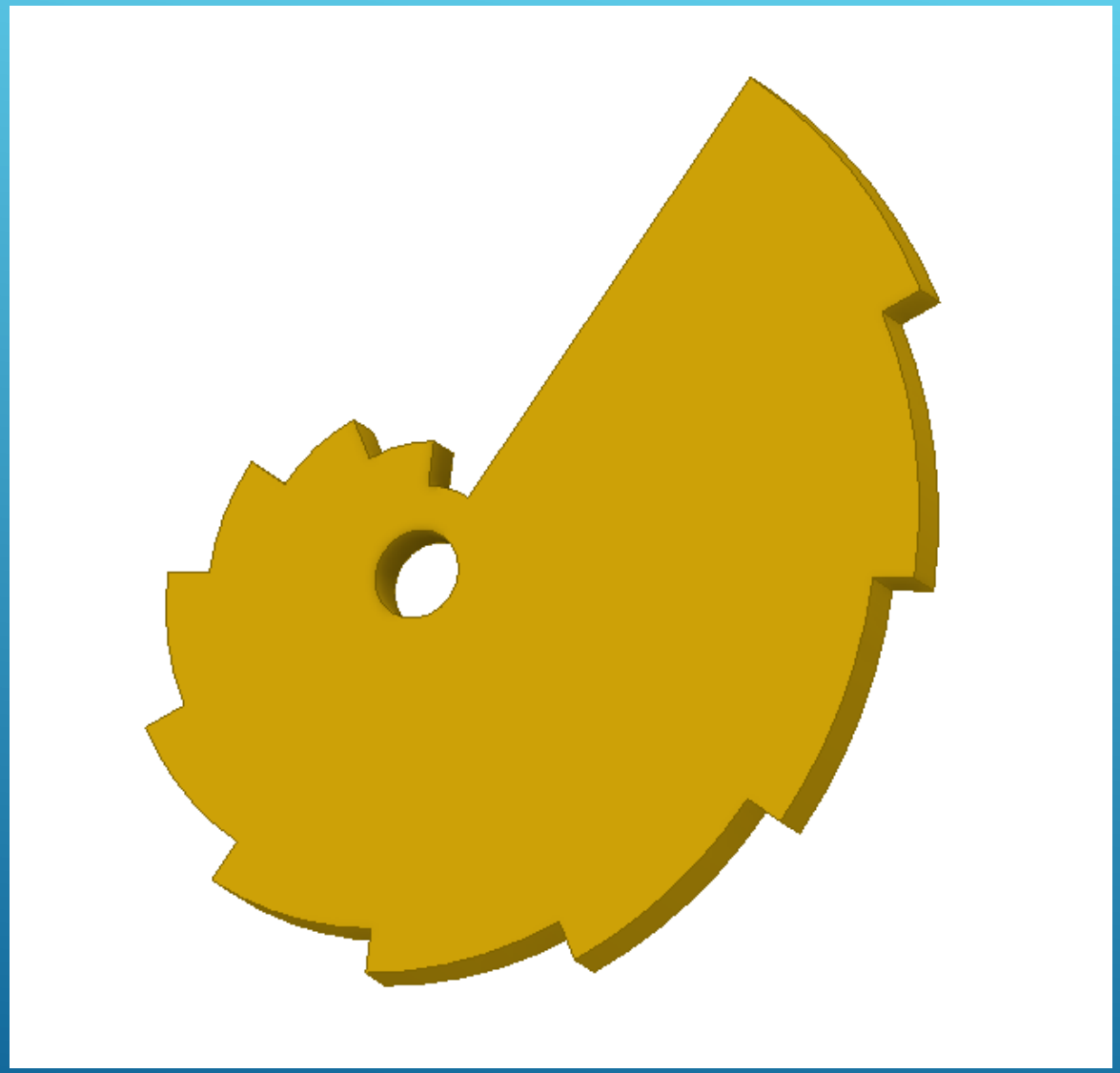
CUTTING OUT SEGMENTS

A jewelers saw can also be used to remove the material. Cut down each of your layout lines.

Continue to each segment is removed.

Remember, these surfaces are diameters off the center. They will have to be hand filled.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



SNAIL WITH MATERIAL REMOVED

This can also be done with a jewelers saw, mount to the saw table, and trued up with a milling cutter.

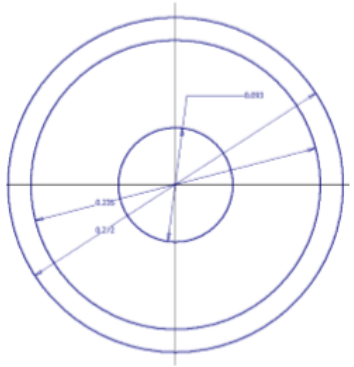
ALWAYS HAVE YOUR SAFETY GLASSES ON!

THE LANTERN PINION

Design or repair of the lantern pinion.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

MY PLAN



Part Name: *American Time and Strike Pinion*

Material: Brass

Tools: *Lathe, center drill, caliper, 3 jaw chuck, indexing fixture*

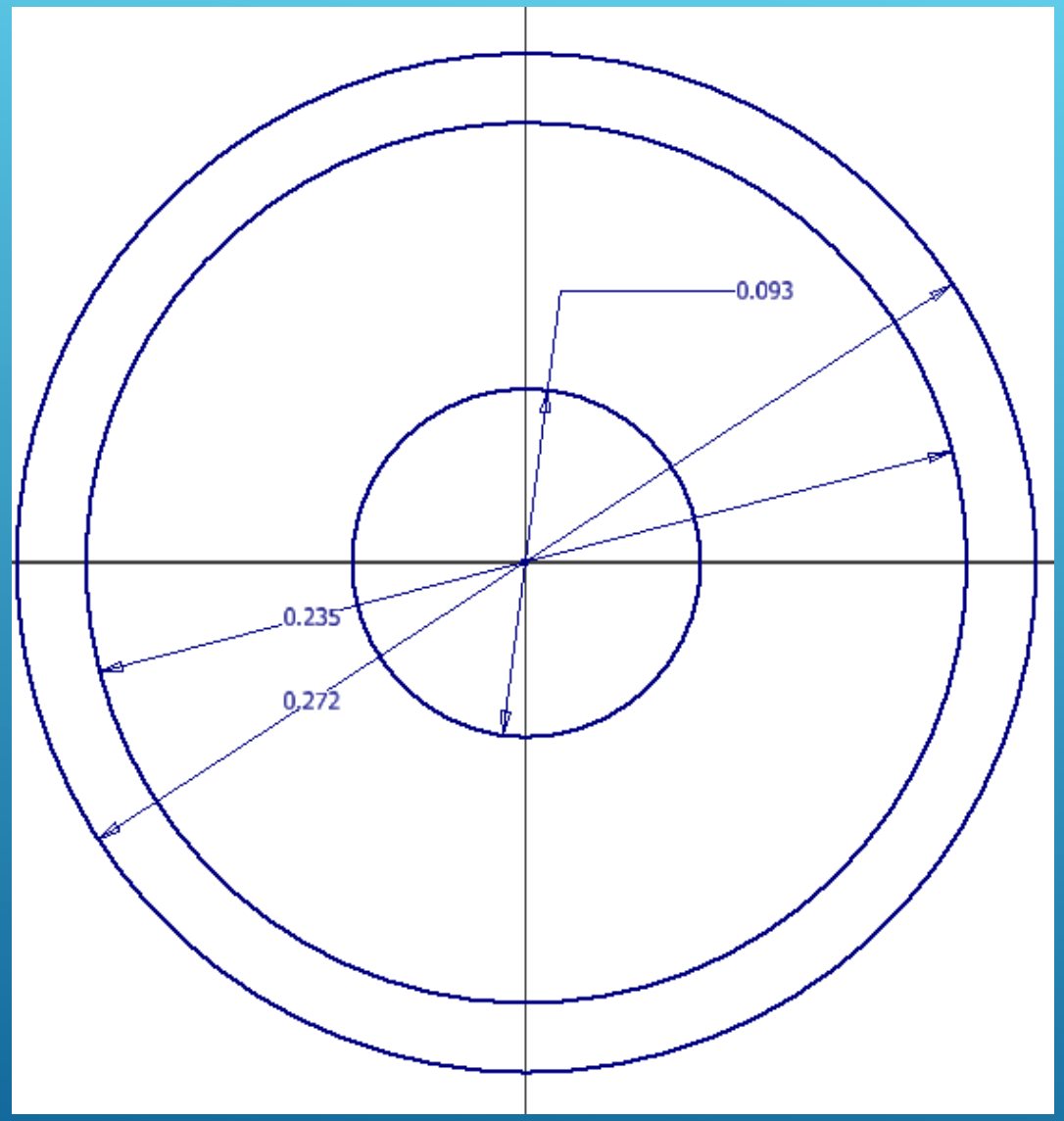
Strengths: *Turning*

Weakness: *Layout of holes.*

Procedure:

1. *Cut material to length*
2. *Setup lathe*
3. *Select proper cutting tools (graver, or cross slide)*
4. *Drill center hole in material*
5. *Turn outside diameter*
6. *Layout the diameter of the pinion holes and the sections*
7. *Center punch holes on center*
8. Drill holes.

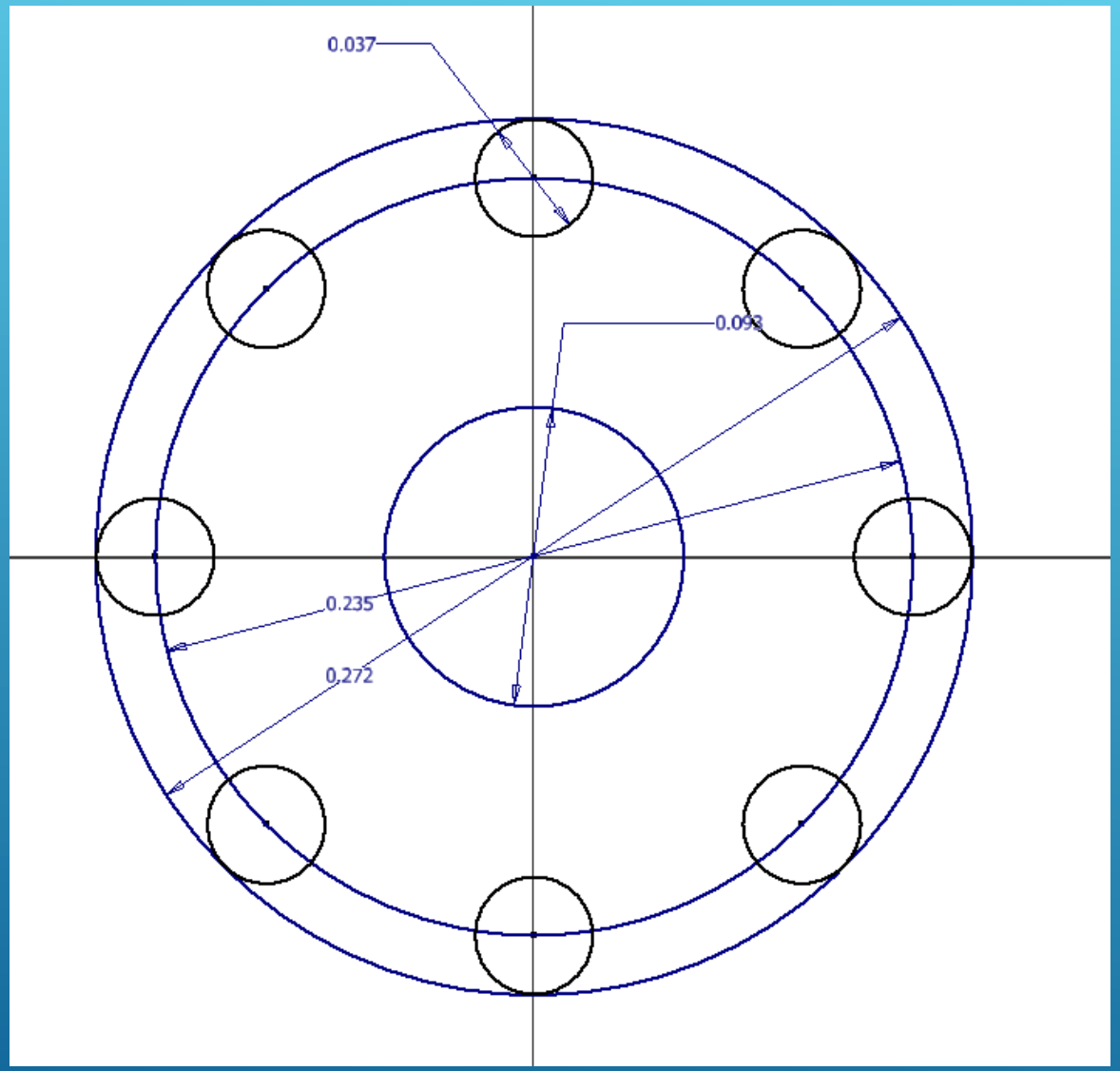
ALWAYS HAVE YOUR SAFETY GLASSES ON!



LANTERN PINION

Pinion Data:

- Number of teeth: 8
- Pitch: 34
- Outside Diameter: .272
- Pitch Diameter: .235
- Thickness of tooth: .037



LANTERN PINION

The holes are drilled on the pitch circle.

The pitch circle on this example is .235.

The diameter of the pins are .037.

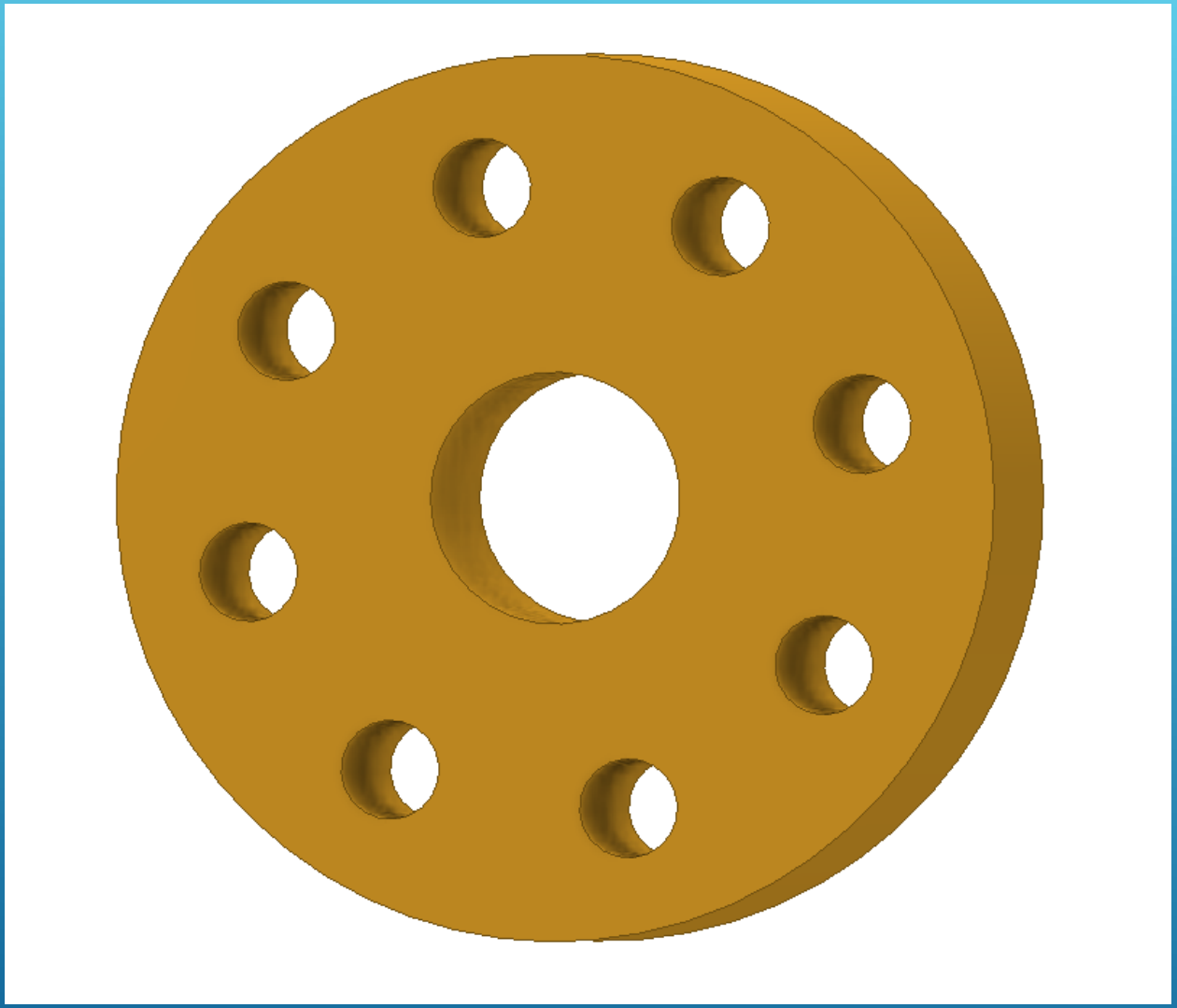
Use your Dremel in the tool post to drill the holes.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

PINION DRILLED

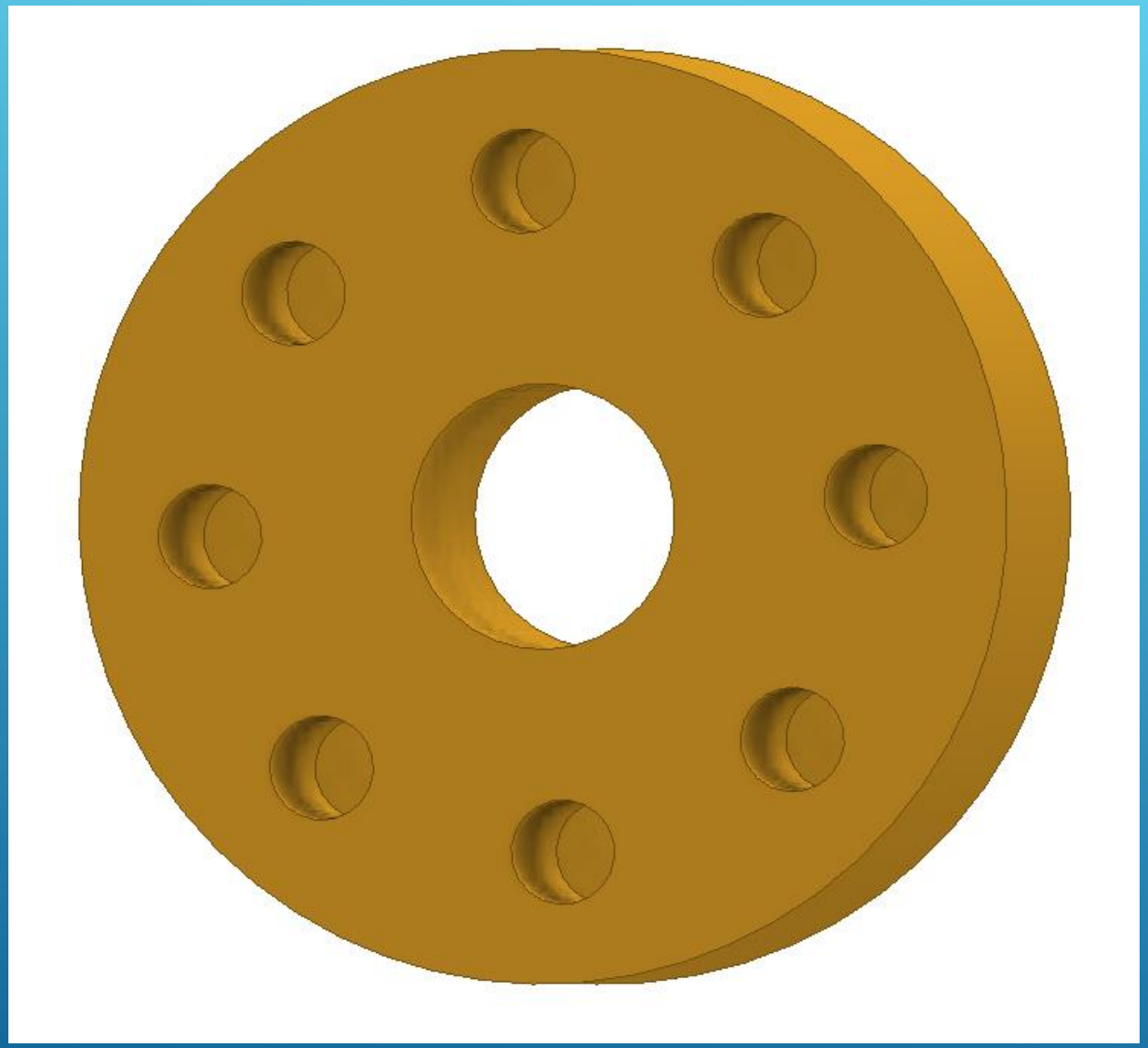
This pinon is now drilled but if you look closely, the pins would brake out of the cap.

Anyone see a problem here?



THE RIGHT DIAMETER

I make the outside diameter addition, twice the thickness of the pin.



LANTERN PINION

I rarely drill completely through the cap.

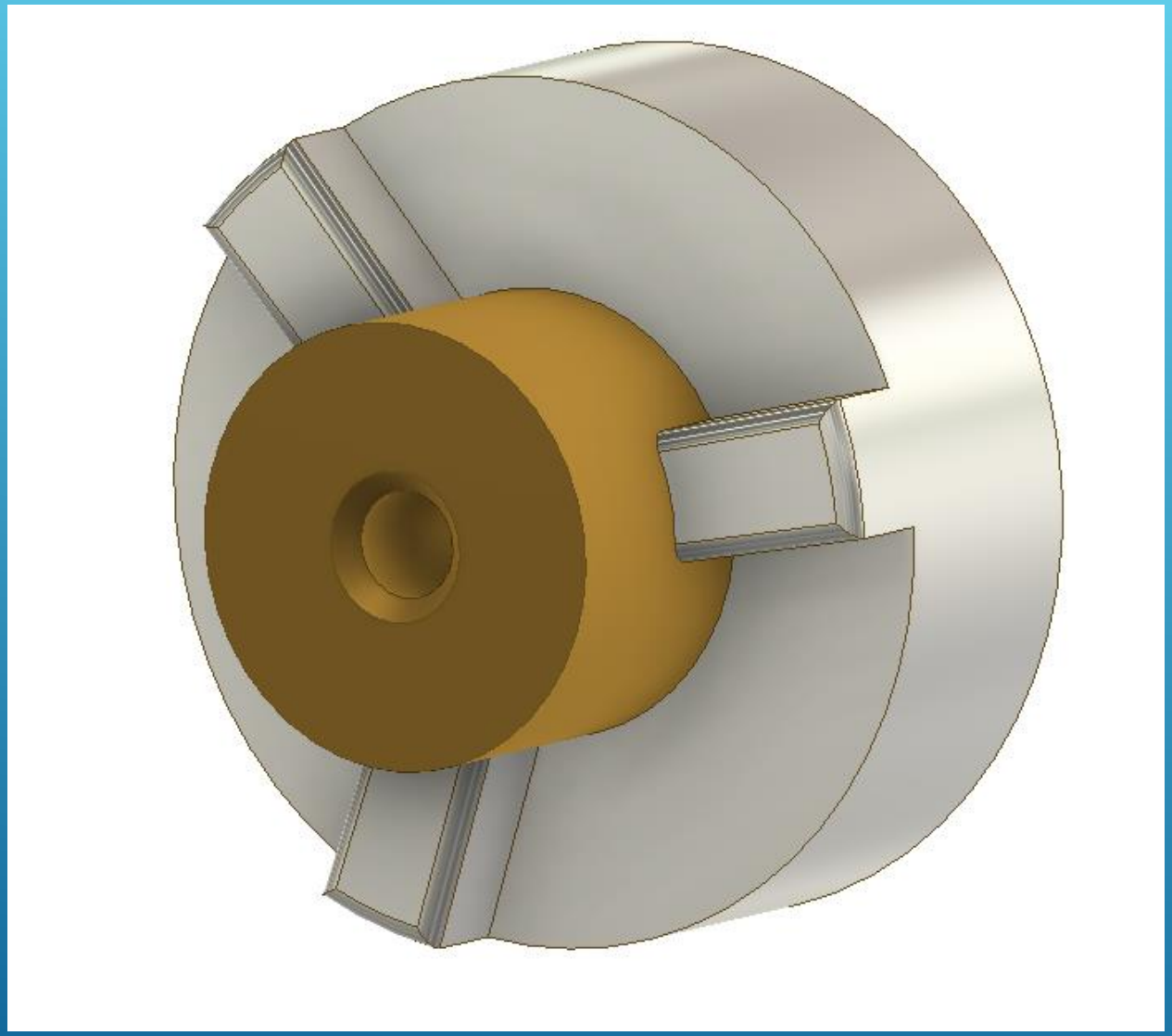
I make the cap thicker than needed to start.

I use the cross slide to control the depth of each hole assuring they are the same depth.

I then machine down to the proper thickness.

It saves me the time of closing the holes.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

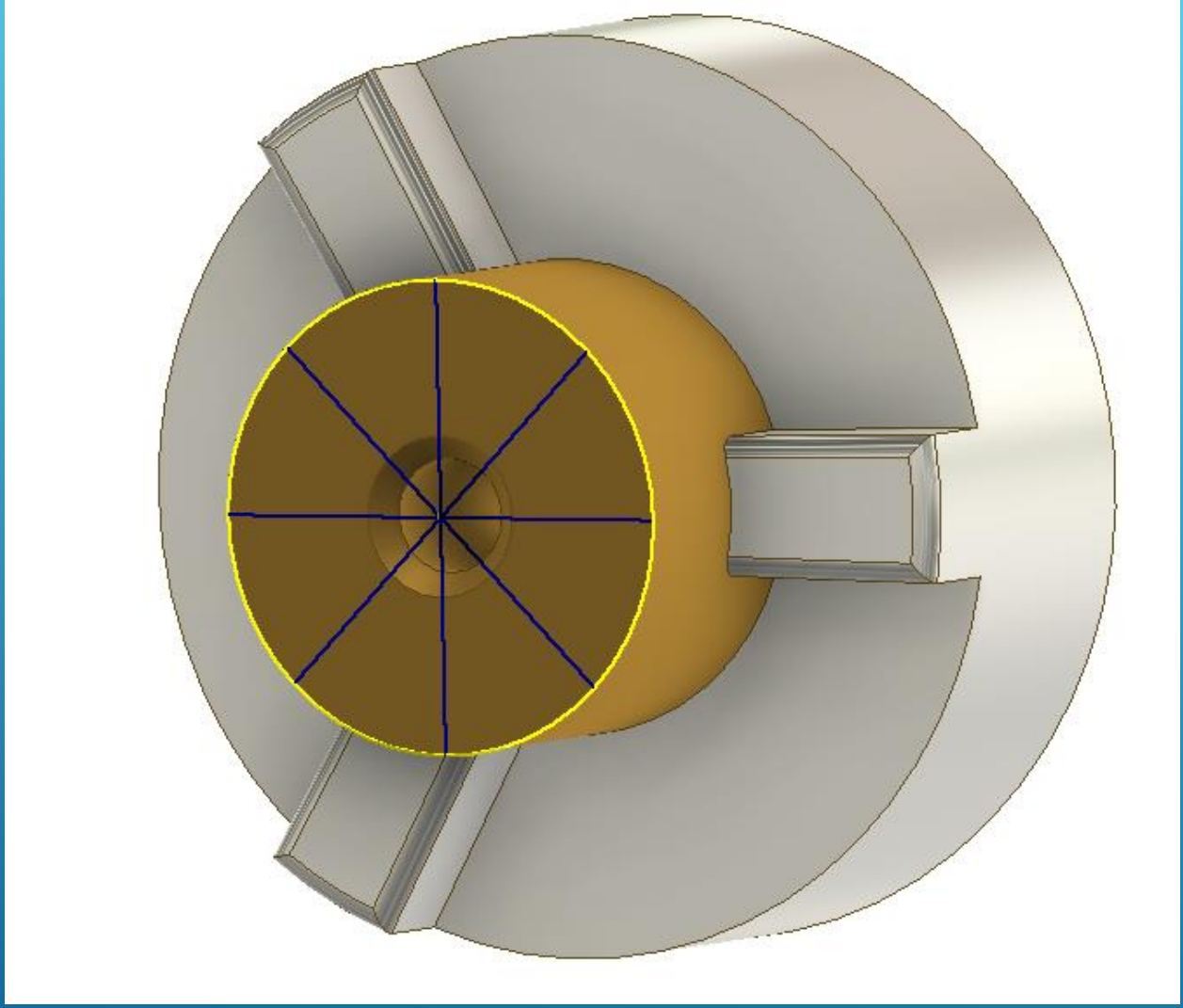


STEPS FOR MAKING 8 LEAF PINION

Mount in a 3 jaw chuck and use a center drill, drill a center.

This center will be used for the layout.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



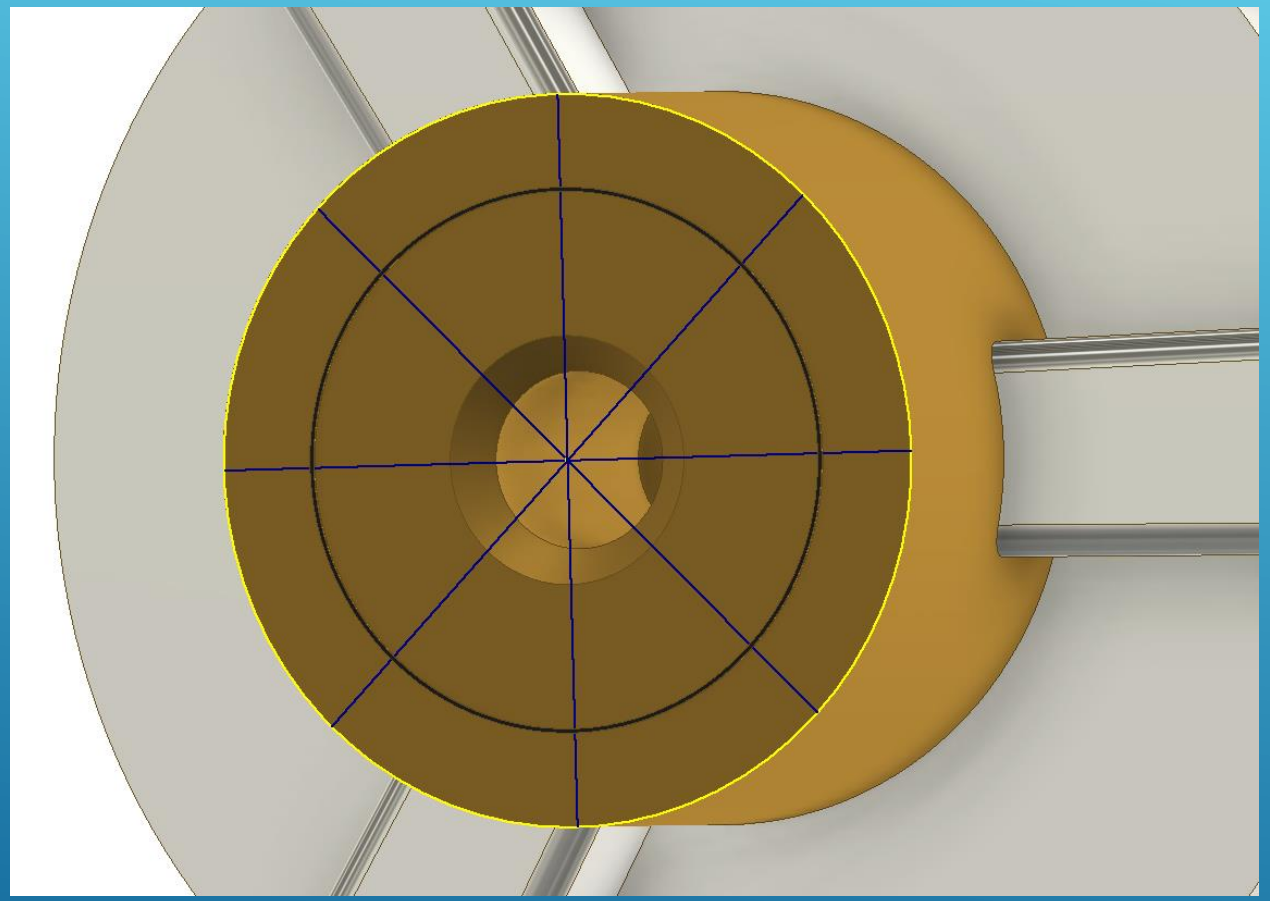
LAYING OUT THE 8 HOLES.

Use the center tool holder and layout 8 lines.

Use the dials on your lathe to get the right dimension.

Use your indexing tool to get the line divisions.

A 60 tooth wheel fixture will not work for this.

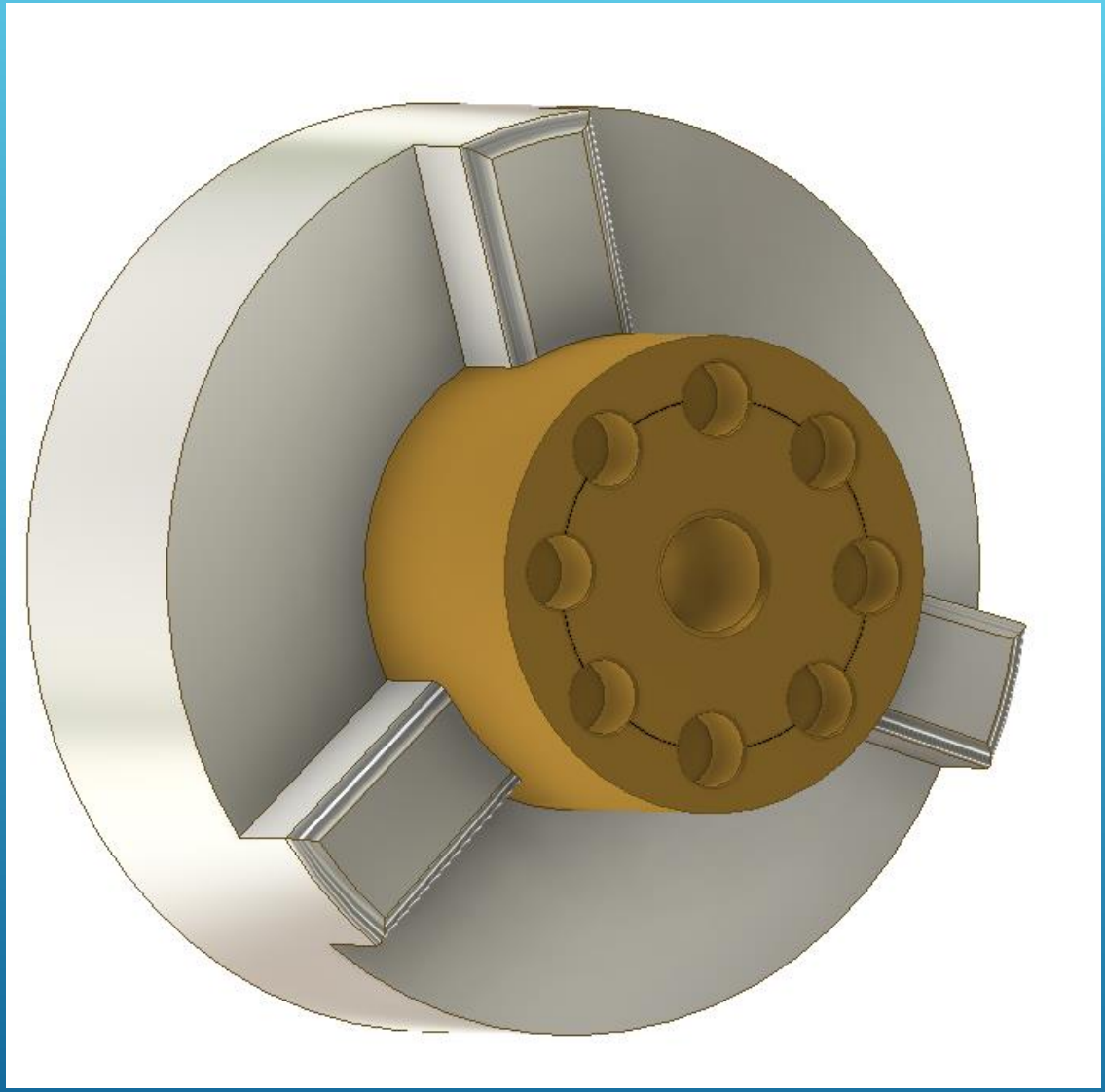


LAYING OUT THE 8 HOLES.

Now we have the centers for the holes.

I would use a small punch and center punch the holes.

Then use a center drill on each hole.



DRILLING THE HOLES

Now that the holes have been center drilled, proceed to finish drill the holes to the proper size.

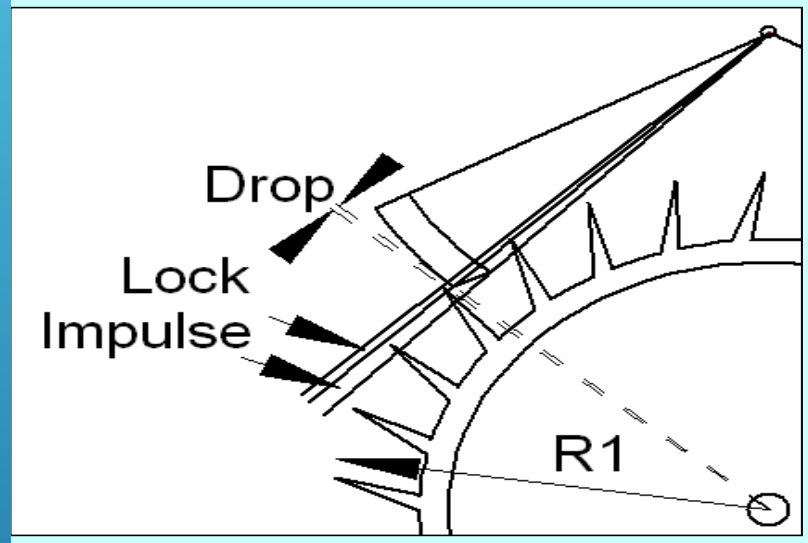
ALWAYS HAVE YOUR SAFETY GLASSES ON!

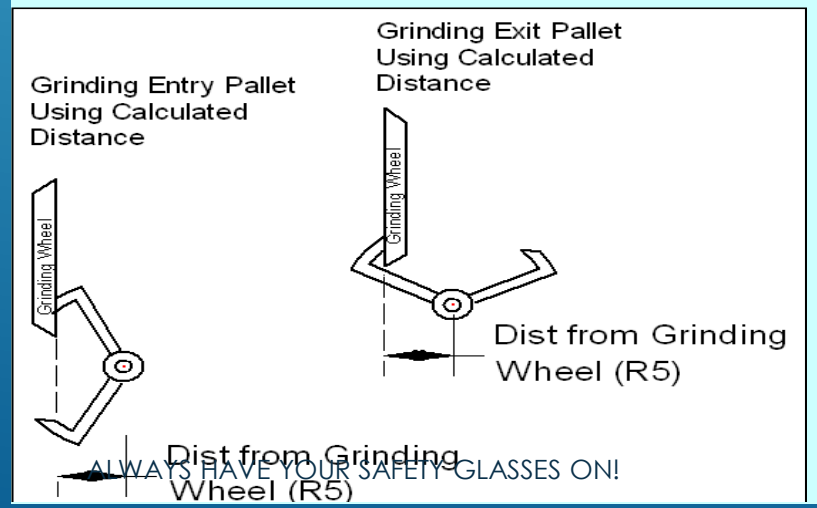
DEAD BEAT VERGE

ALWAYS HAVE YOUR SAFETY GLASSES ON!

INPUT Data (refer to diagram)

Description	Symbol	Value
Escape Wheel Diameter (in/mm)	$2xR_1$	38.0000
No Escape Wheel Teeth	Z	30.0000
No Teeth spanned (Whole No)	N	7.0000
Pendulum impulse angle (deg)	Φ	2.0000
Angular Lock (deg)		1.0000
Angular drop (deg)		1.0000

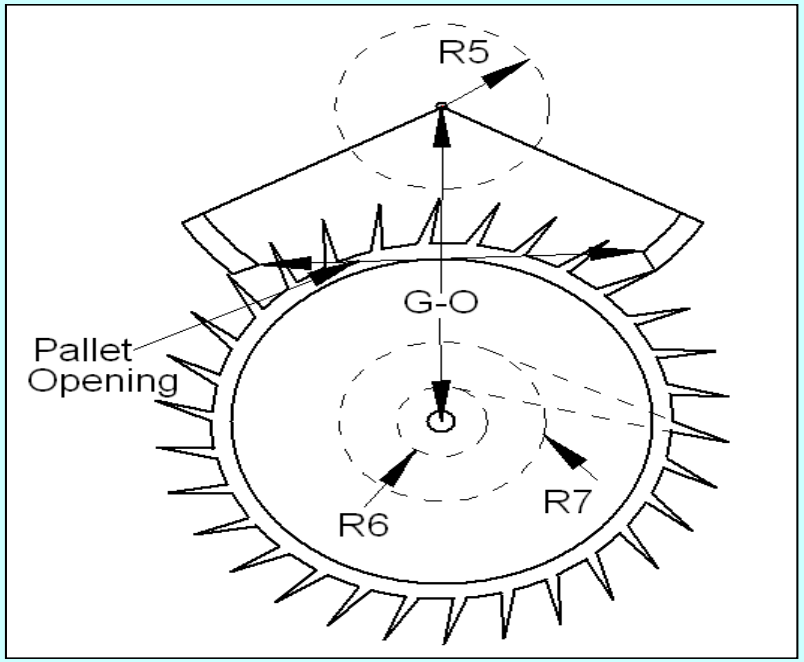




ALWAYS HAVE YOUR SAFETY GLASSES ON!

CALCULATIONS (refer to diagram)

Description	Symbo	Value
Center distance (in/mm)	G-O	26.8701
Arc of Pendulum (end-to-end) (deg)	θ	3.0000
One angular tooth pitch (deg)	ρ	12.0000
Pallet internal radius (in/mm)	R_3	18.1712
Pallet external radius (in/mm)	R_4	19.8288
Pallet thickness (in/mm)	T	1.6575
Pallet impulse base-circle radius (in/mm)	R_5	7.0450
Tooth front-slope angle (deg)	γ	9.0000
Tooth back-slope angle (deg)	Ψ	21.0000
Tooth front-slope base-circle radius (in/mm)	R_6	2.9723
Tooth back-slope base-circle radius (in/mm)	R_7	6.8090
Pallet Opening (in/mm)	X	25.4728
Clearance - pallet to back of tooth (in/mm)	Z	0.1908



Deadbeat Escapement Construction Aid

The Deadbeat Construction Aid Spreadsheet was prepared by David Robertson

The approach to design, the formulae, the terminology and the symbols were those used in the NAWCC Bulletin Supplement 8 published in 1973, titled: "George Graham's Classic Escapement or Dead-Beat by Design" authored by Guy D. Aydlett.

The concept for using the pallet opening and clearance as an aid to fabricating the pallets in a more predictable manner was presented by GM Smith in a Nov 2005 article in the BHI Horological Times and has been provided as an add-on to the Aydlett calculations.

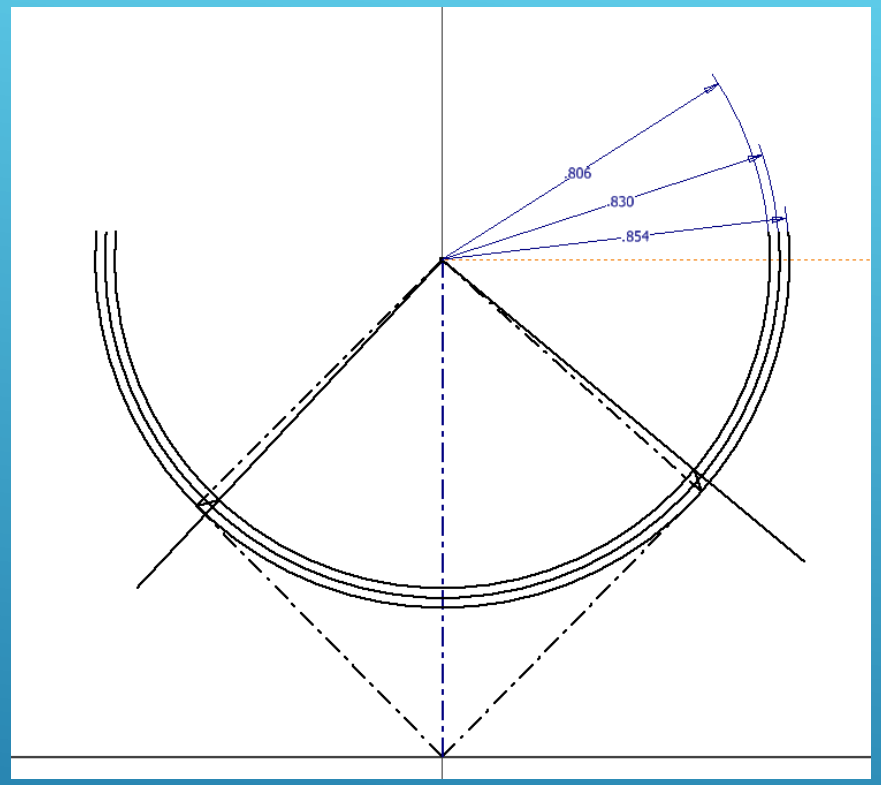
Thanks to Rex Swensen for reviewing and providing corrections and suggestions for improvement to the work

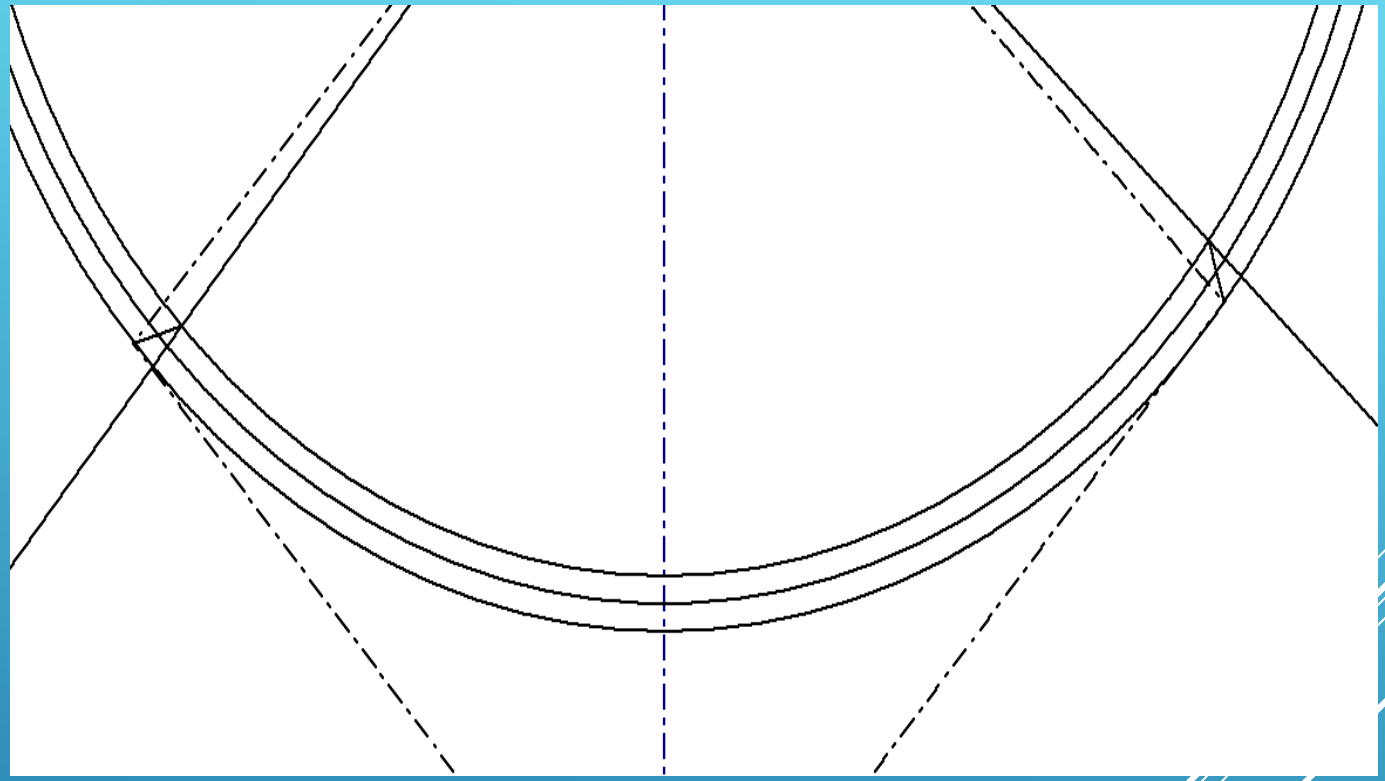
Design Notes:

1. Tooth angles are calculated rather than input by user. The included angle is fixed at 12 deg. The slopes are not particularly critical, but will affect (and can limit) clearance.

2. Any flat on the tooth tip (tooth witness) will approximately deduct from available pallet clearance to back of tooth.

3. The pendulum amplitude shown does not include supplementary arc (overswing) which is typically 0.5 deg on each side. So the final pendulum swing will be typically 1 deg or so more than shown.





DEAD BEAT VERGE

ALWAYS HAVE YOUR SAFETY GLASSES ON!

MY PLAN

Part Name: *Dead Beat Verge*

Material: Tool Steel

Tools: *Lathe, center drill, caliper, 3 jaw chuck, indexing fixture*

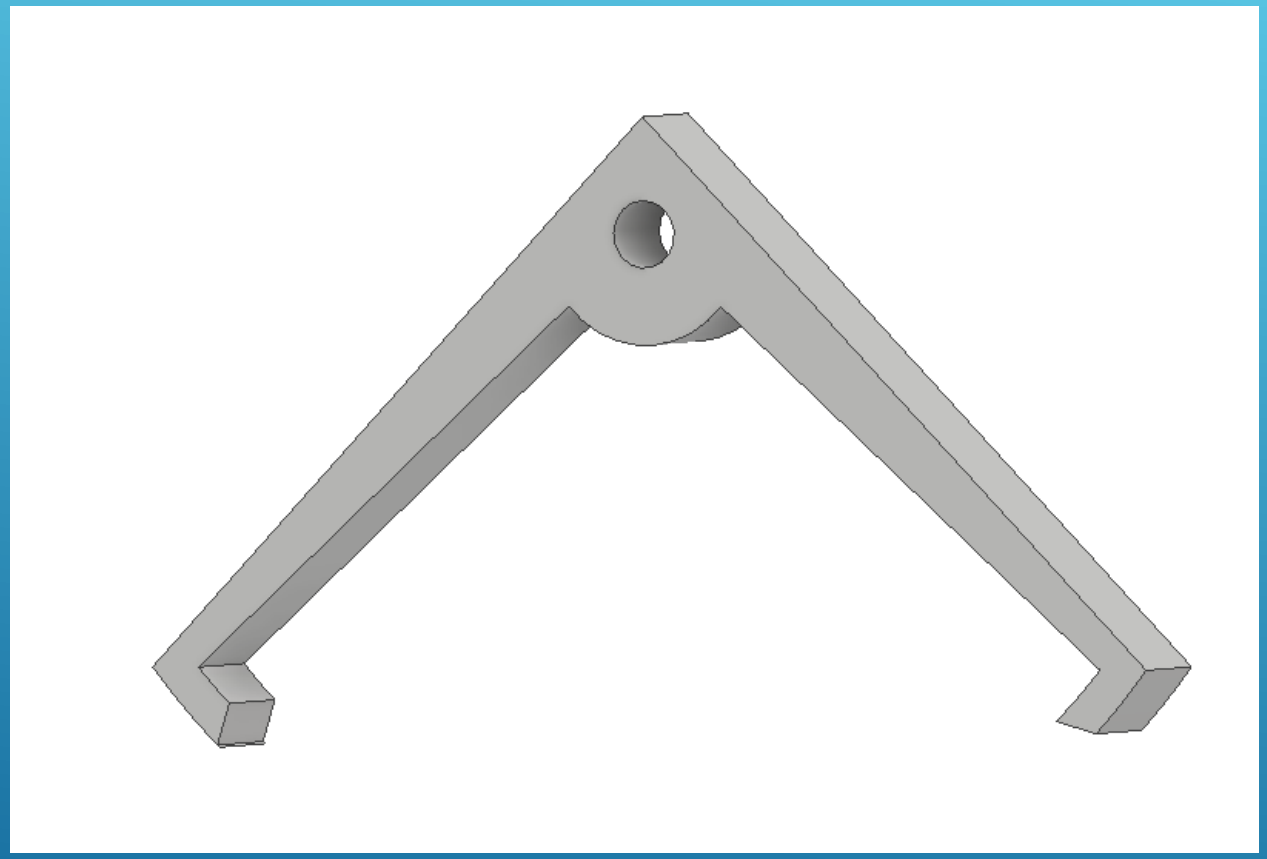
Strengths: *Turning*

Weakness: *Sawing*

Procedure:

1. *Use Excel spread sheet to calculate the verge dimensions.*
2. *Draw the verge on paper and cut out.*
3. *Glue to the steel and cut it out using a jewelers saw.*
4. *Drill center hole in material*
5. *Turn outside diameter*
6. *Use milling cutter to shape the verge including the pallet faces.*
7. *Use diamond wheel and grind the pallet faces.*
8. Mount to arbor and test in the clock.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

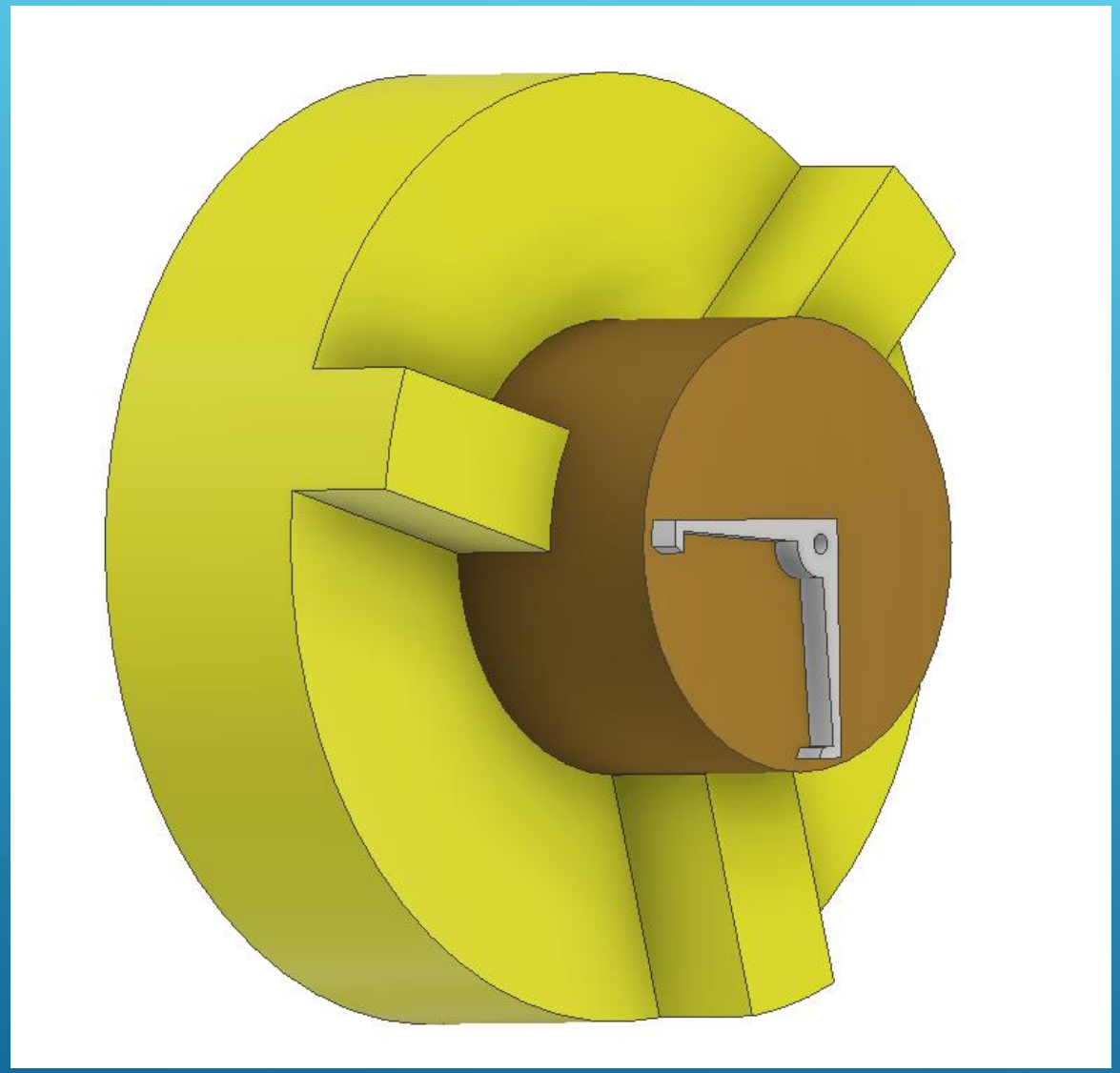


OUR VERGE BLANK

Using our drawing, cut out the verge and glue it to a piece of paper.

Saw it out with a jewelers saw.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

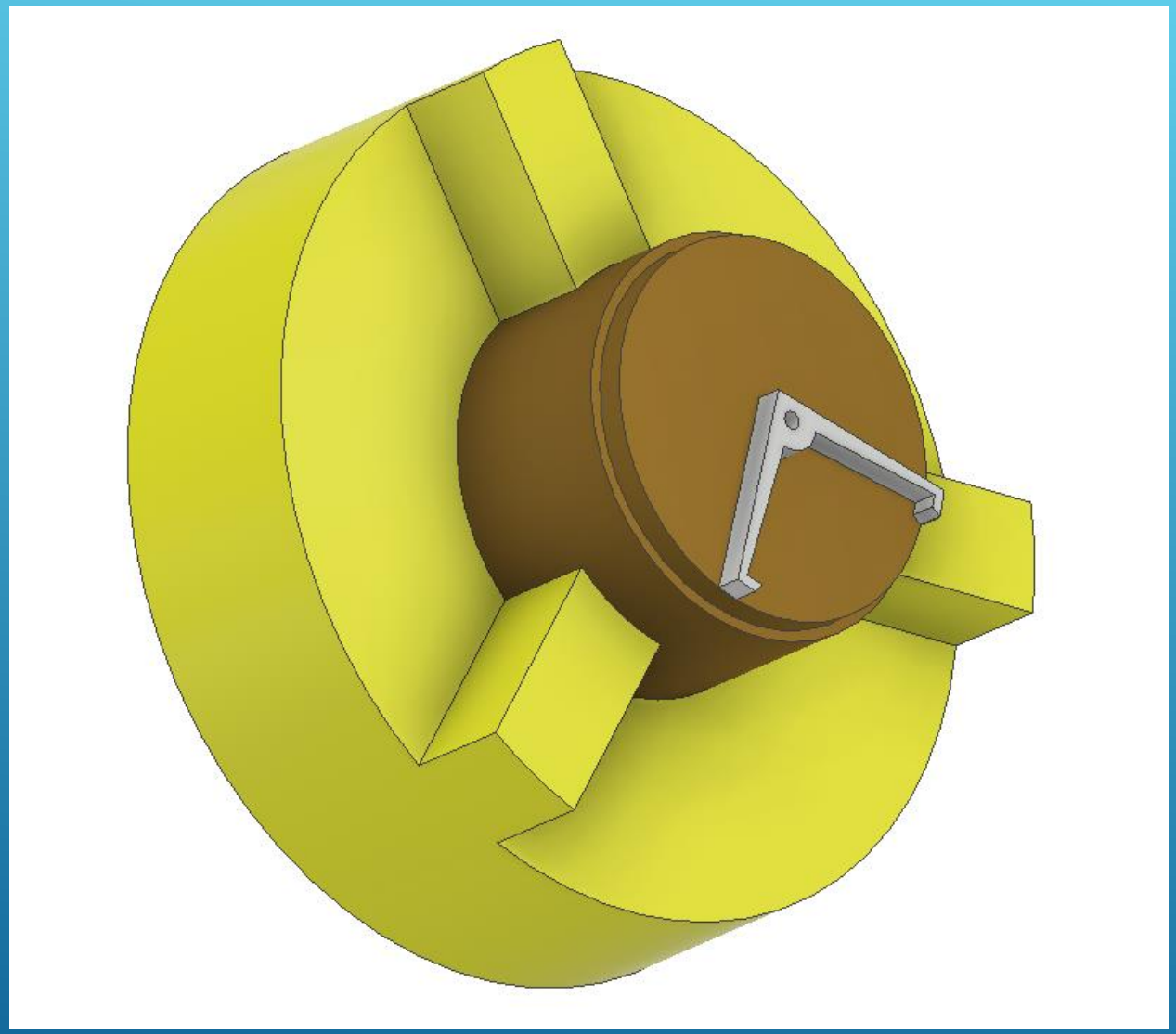


MOUNTING TO LATHE

Use a brass plug in the 3 jaw chuck.

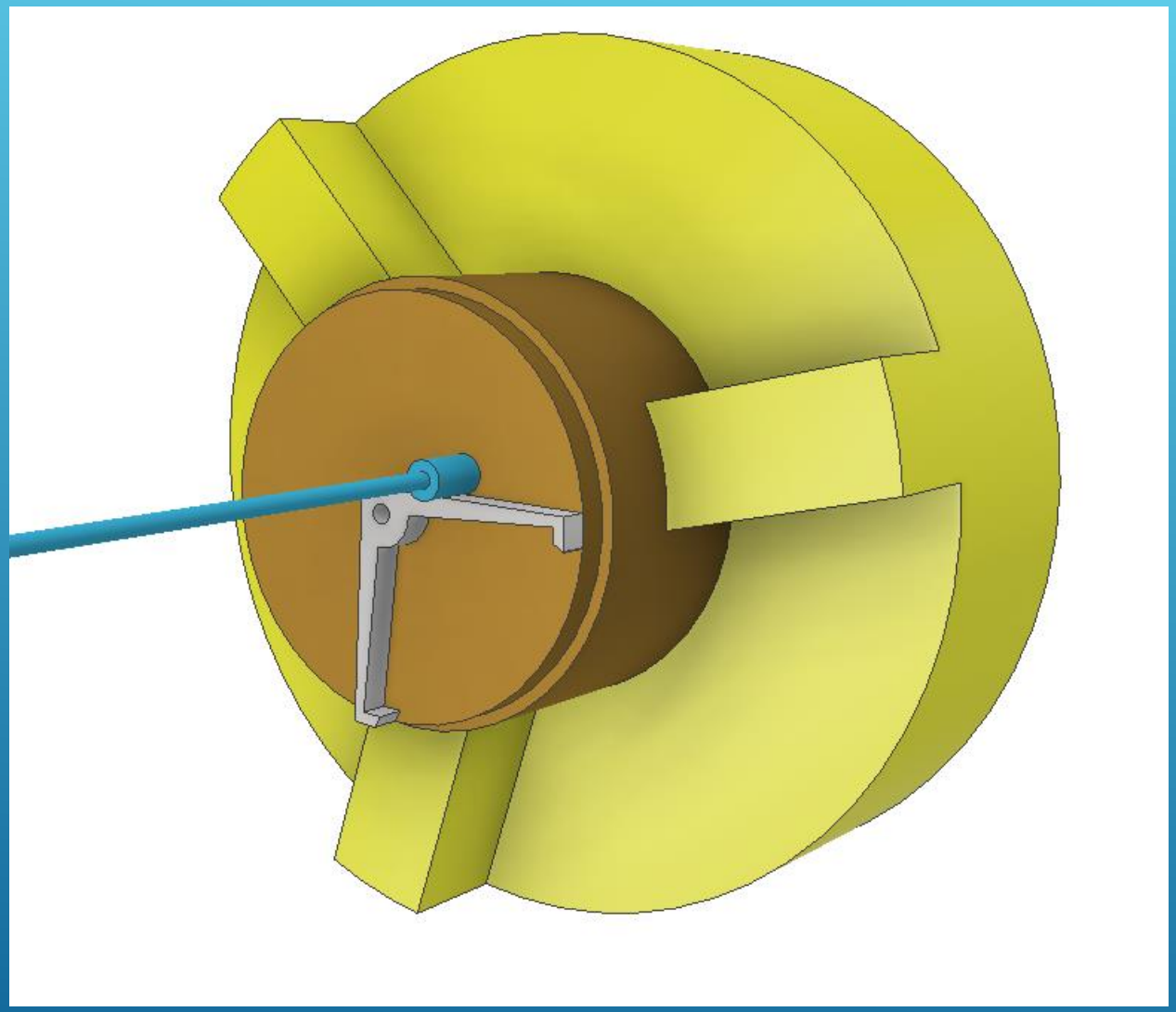
Glue the verge blank to the plug. Use the tailstock to align with the center hole of the verge.

Is this critical?



TURN THE OUTSIDE DIAMETER

ALWAYS HAVE YOUR SAFETY GLASSES ON!

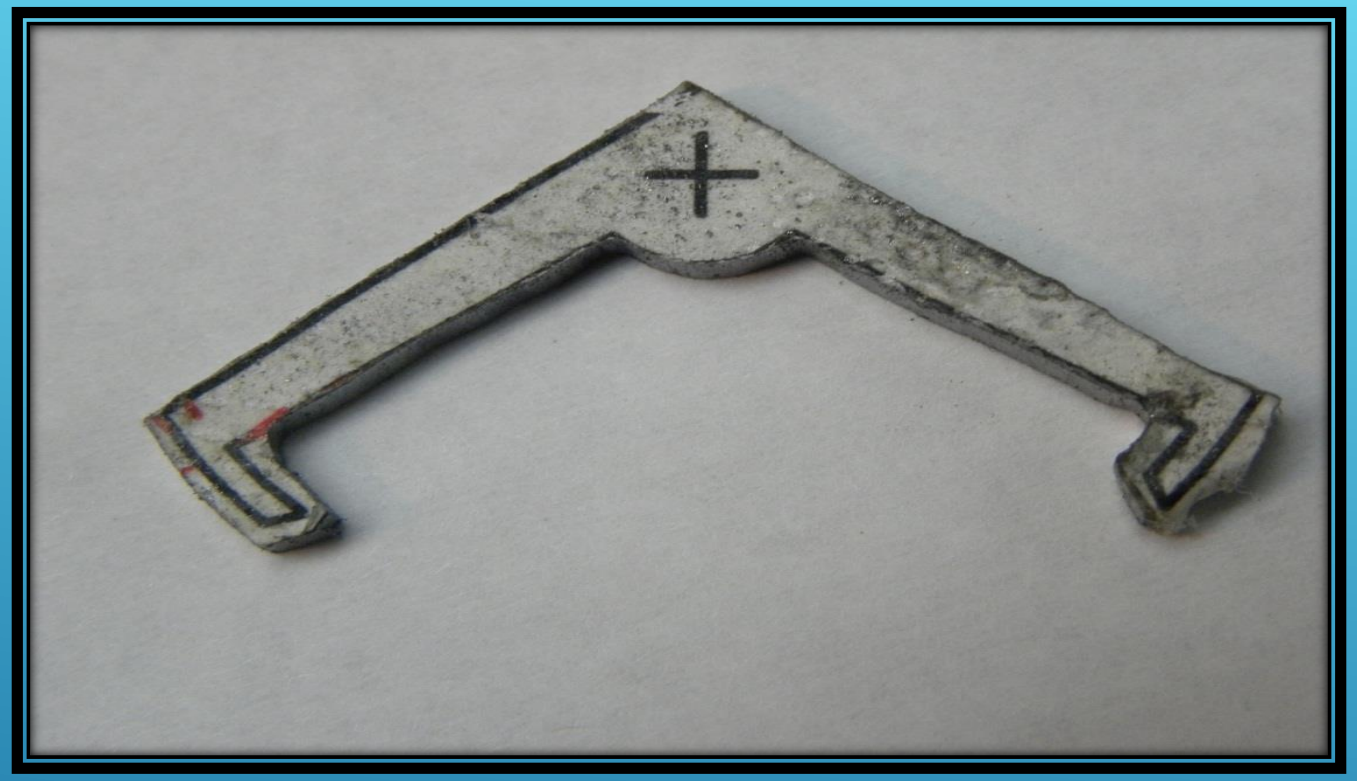


SHAPING THE BLANK

You can remove the blank from the brass plug once all the critical faces are machined.

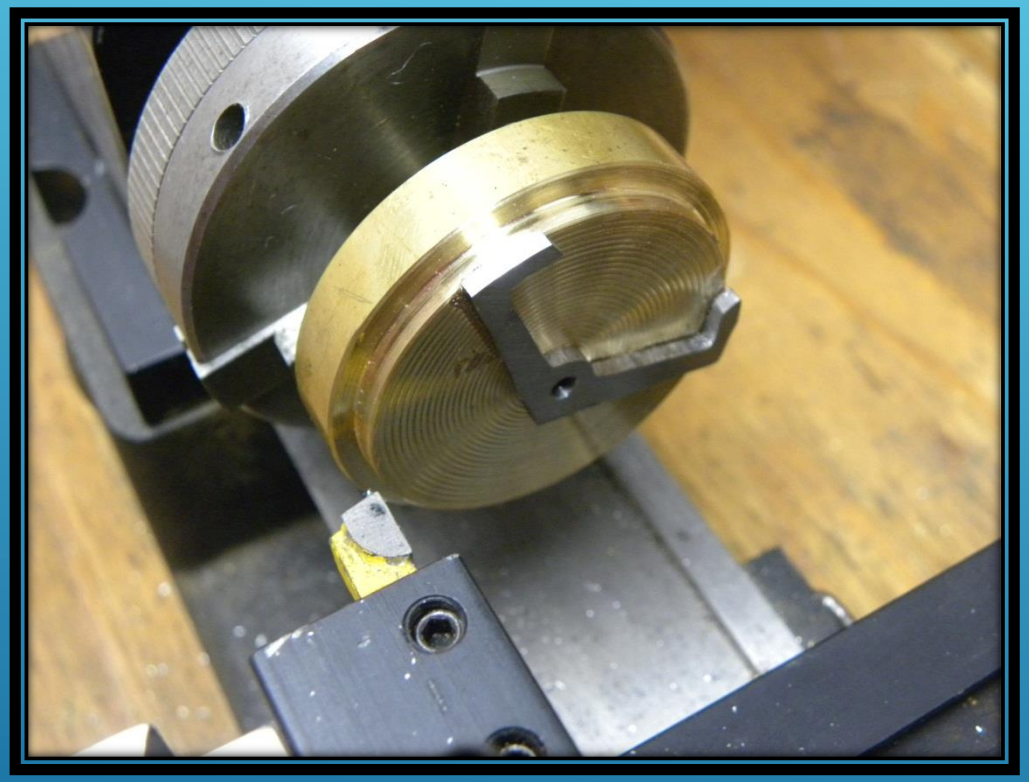
You can remove the verge from the plug and hand file the shape if you like.

You could also mill the shape and then remove it.



THE SAWN VERGE BLANK

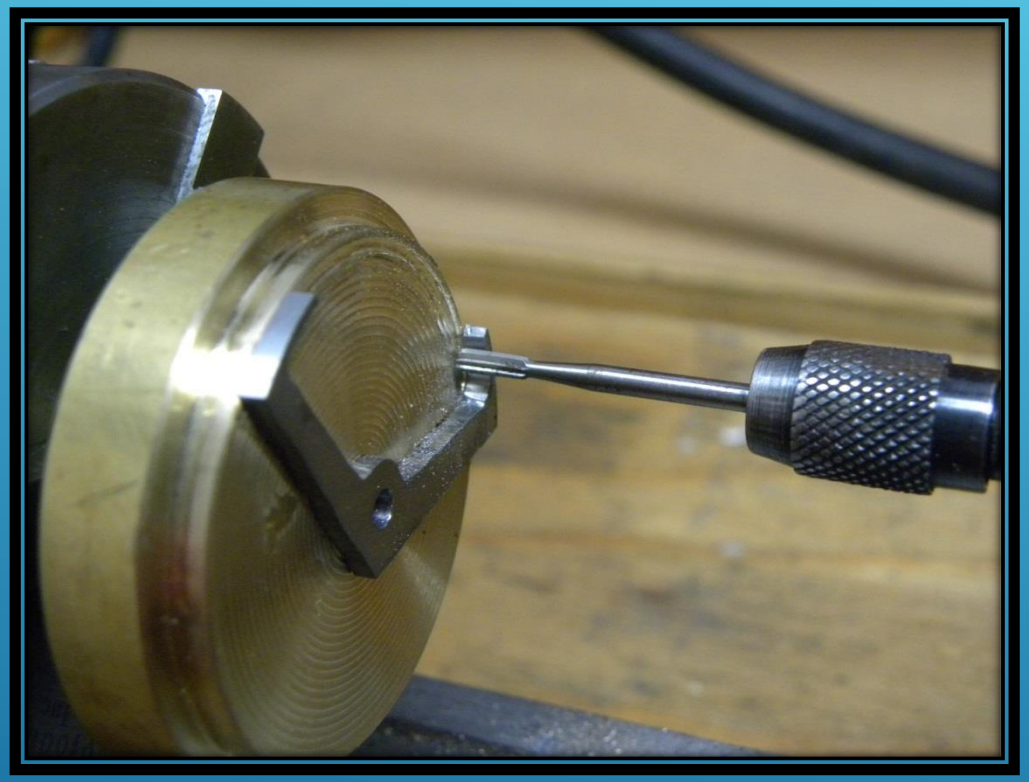
ALWAYS HAVE YOUR SAFETY GLASSES ON!



SHERLINE LATHE

Turning out side diameter.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



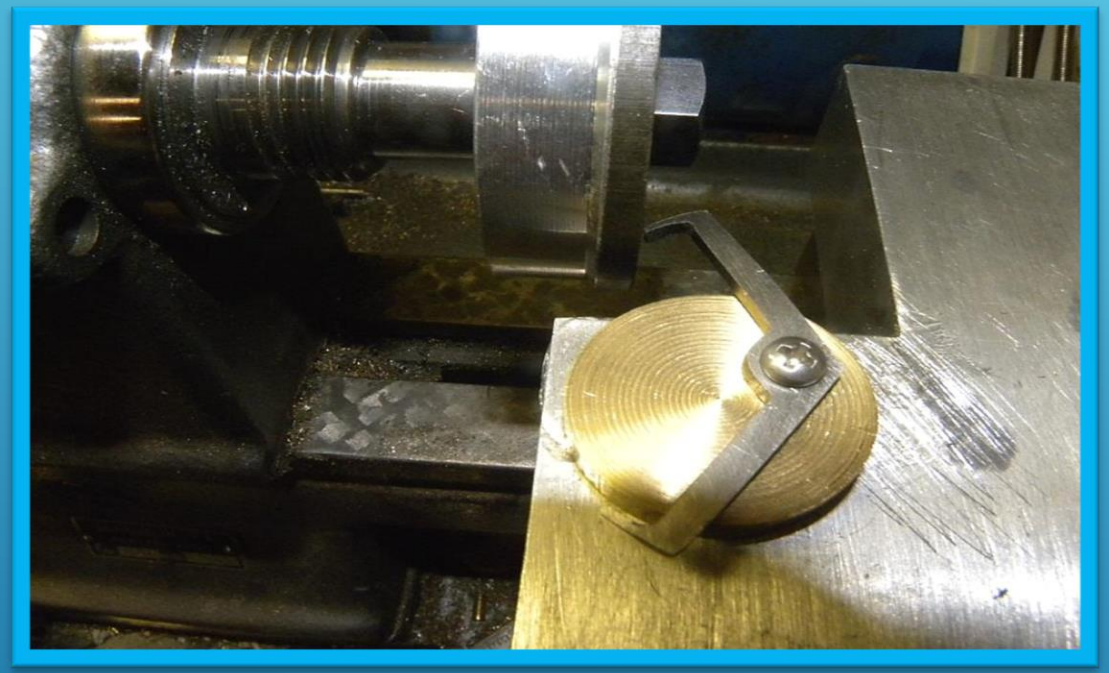
USING A SMALL MILLING CUTTER

Use a milling cutter to grind the inside of the pallet faces.

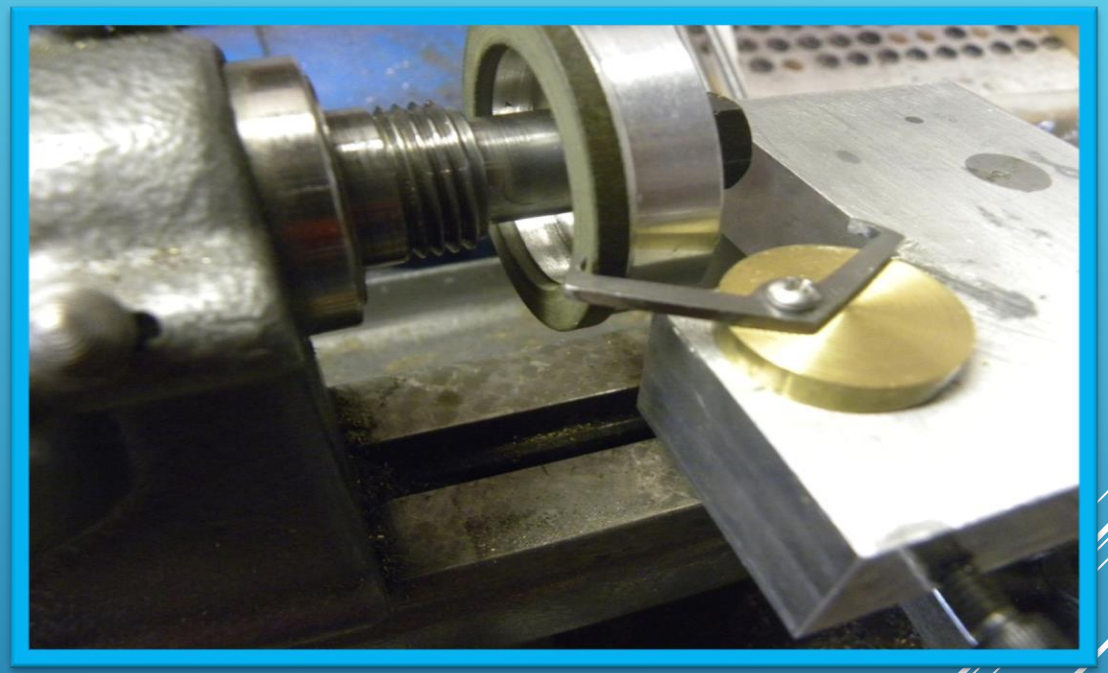
Mill the sides and the top faces. Use your dividing head to align the surfaces.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

Entrance Pallet



Exit Pallet



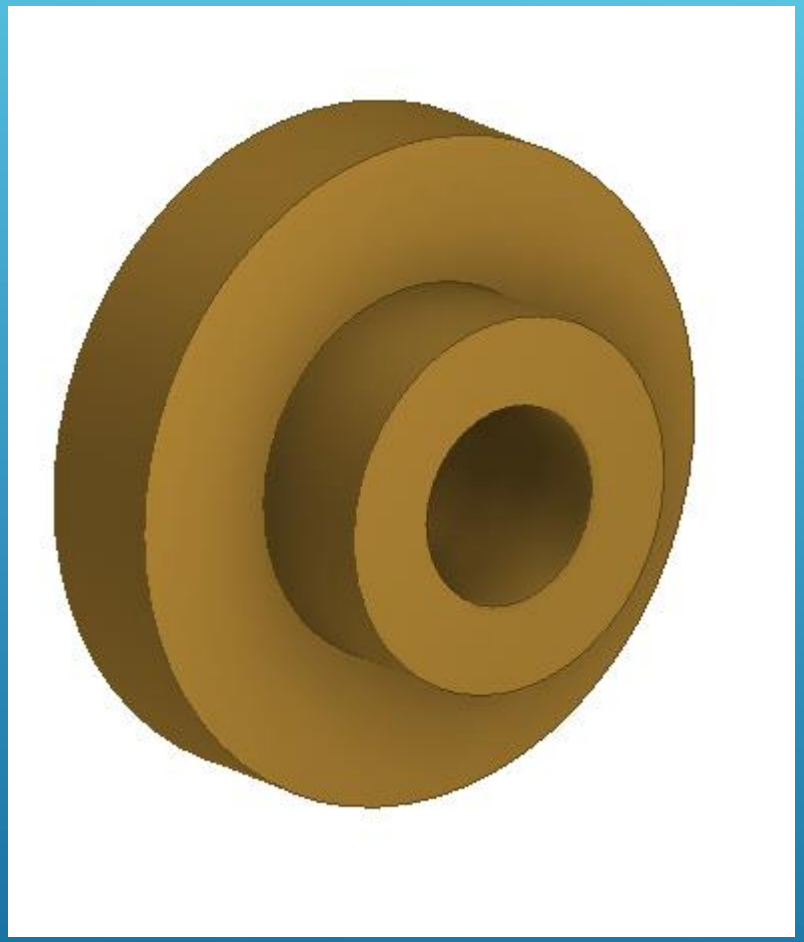
GRINDING THE IMPULSE FACES

ALWAYS HAVE YOUR SAFETY GLASSES ON!

HOW WOULD YOU MAKE THESE PARTS.

Think “out of the box”.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

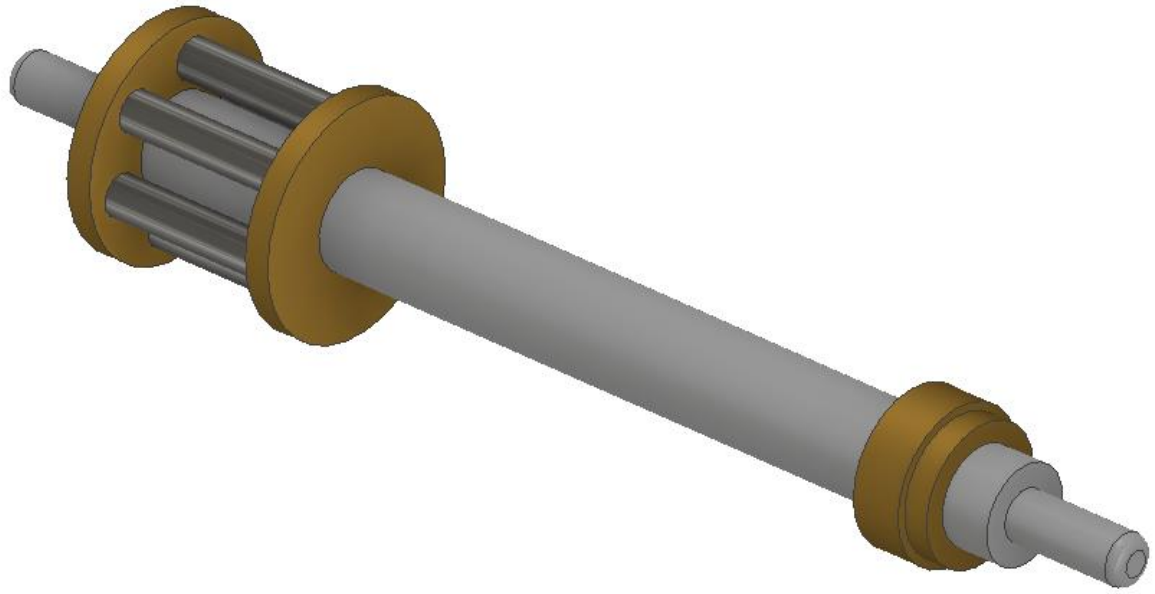


SIMPLE WHEEL HUB

How would you make this?

Would you mount the escape wheel then mount it to the arbor?

Critical surfaces?

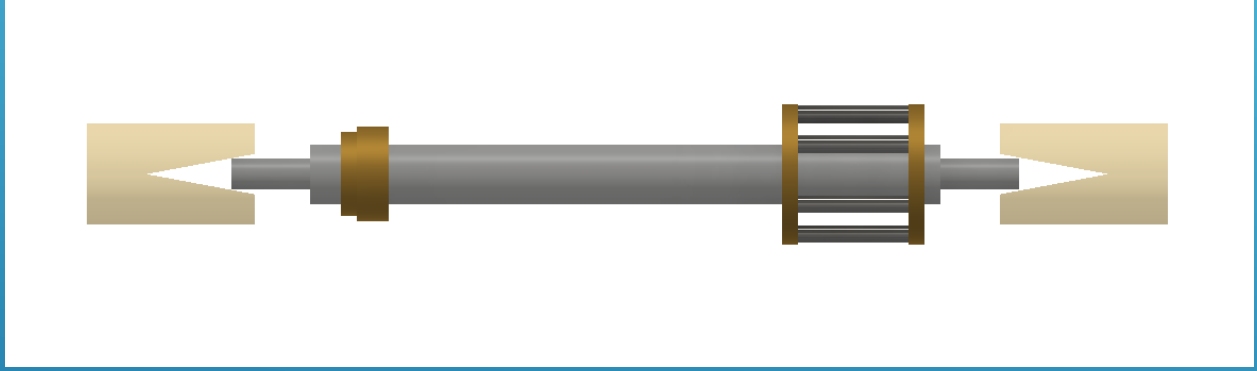


TURNING A ESCAPE WHEEL HUB

How would you turn this hub so that it would run concentric with the center?

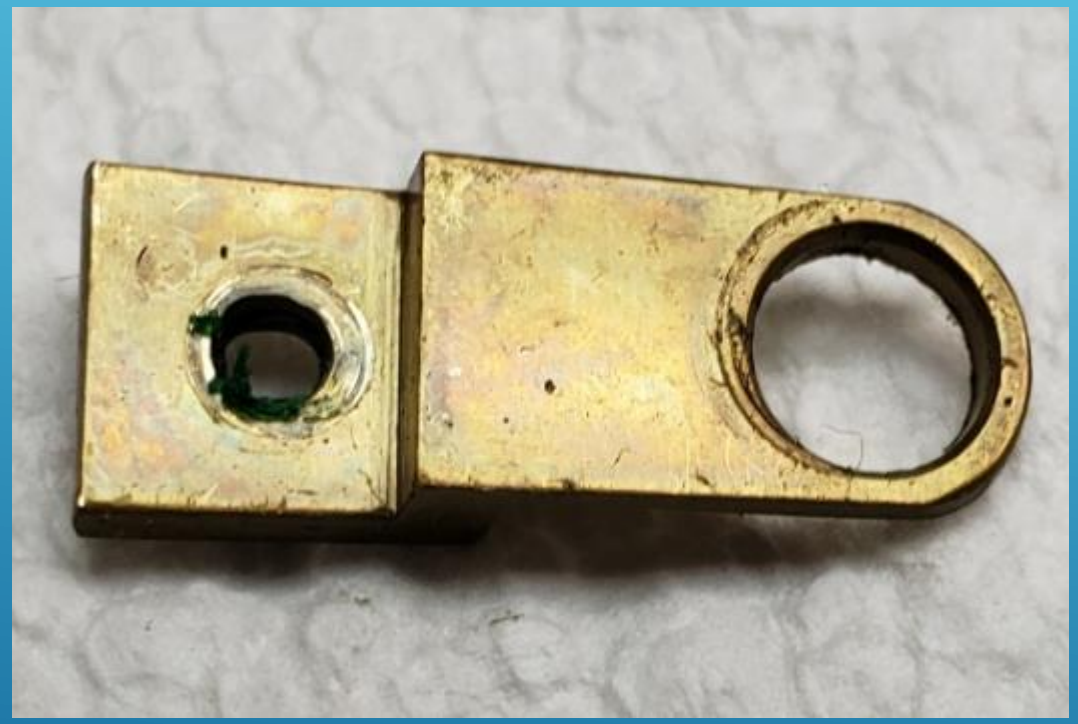
ALWAYS HAVE YOUR SAFETY GLASSES ON!

TURNING A ESCAPE WHEEL HUB



Turning between centers is the only way to assure that the escape wheel will run “true” to the bearing surfaces.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

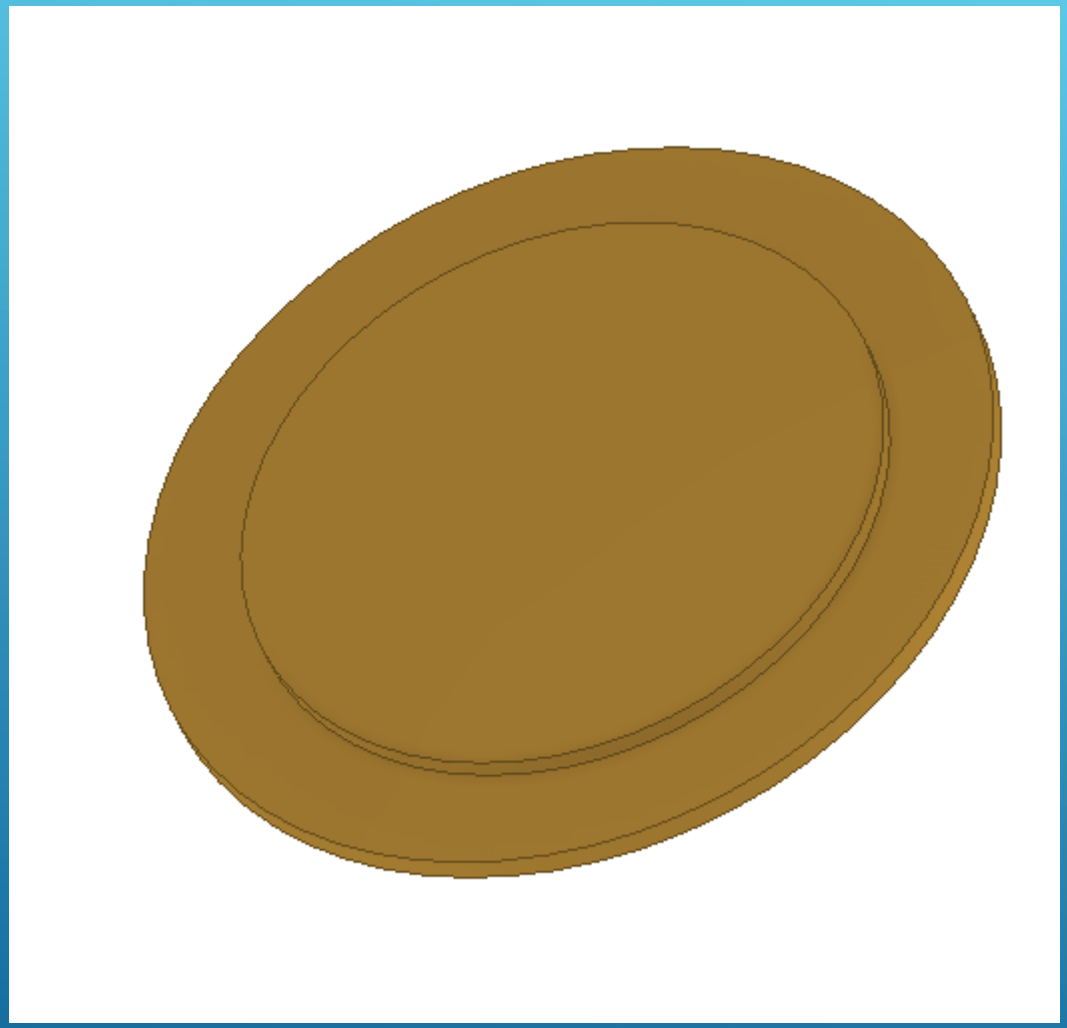


MAKING A RATCHET WHEEL BRIDGE.

How would we make this?

One was missing on the clock.

ALWAYS HAVE YOUR SAFETY GLASSES ON!



MAKING A RATCHET WHEEL BRIDGE.

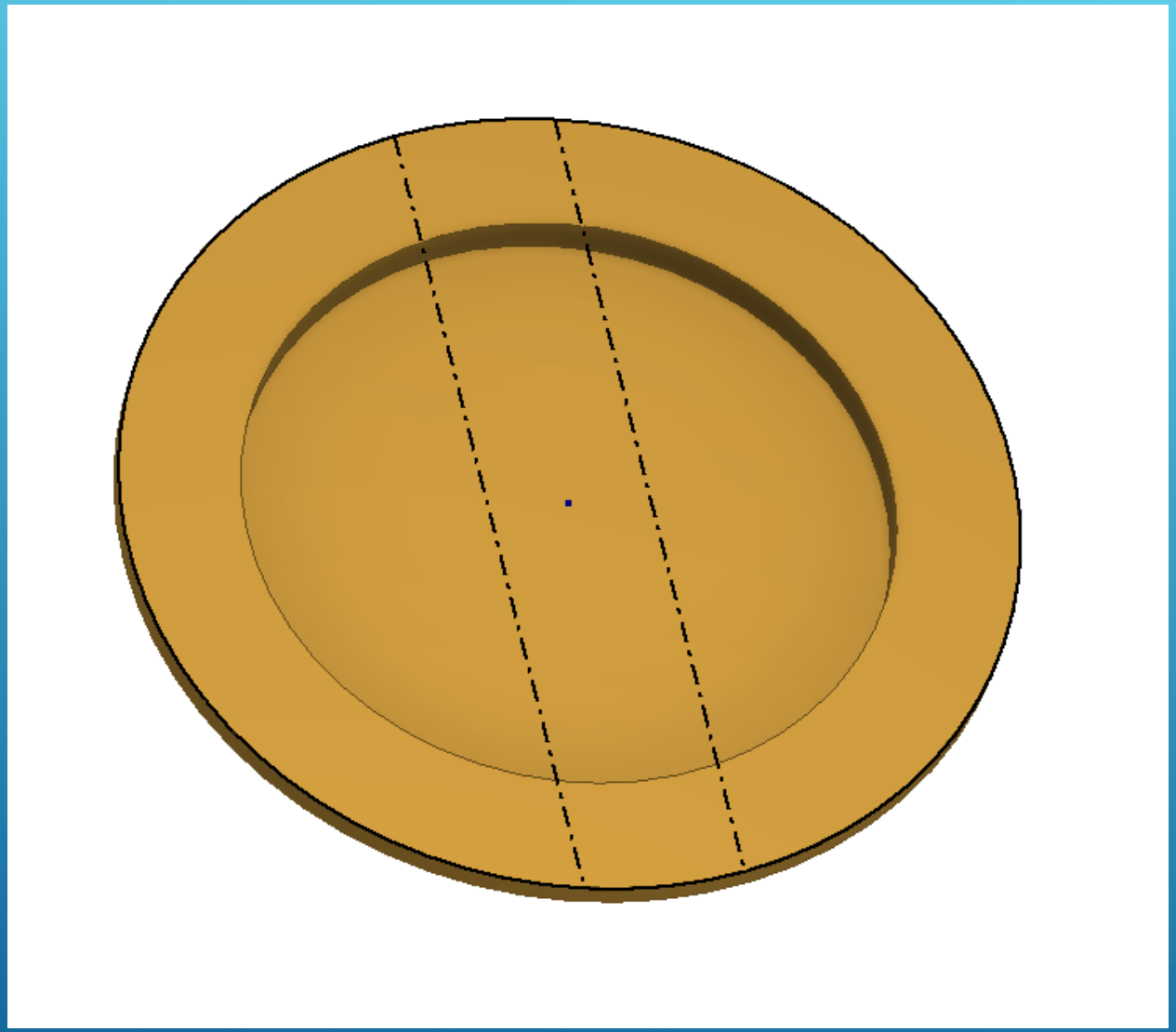
Turn the first diameter.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

MAKING A RATCHET WHEEL BRIDGE.

Counter bore the back side diameter.

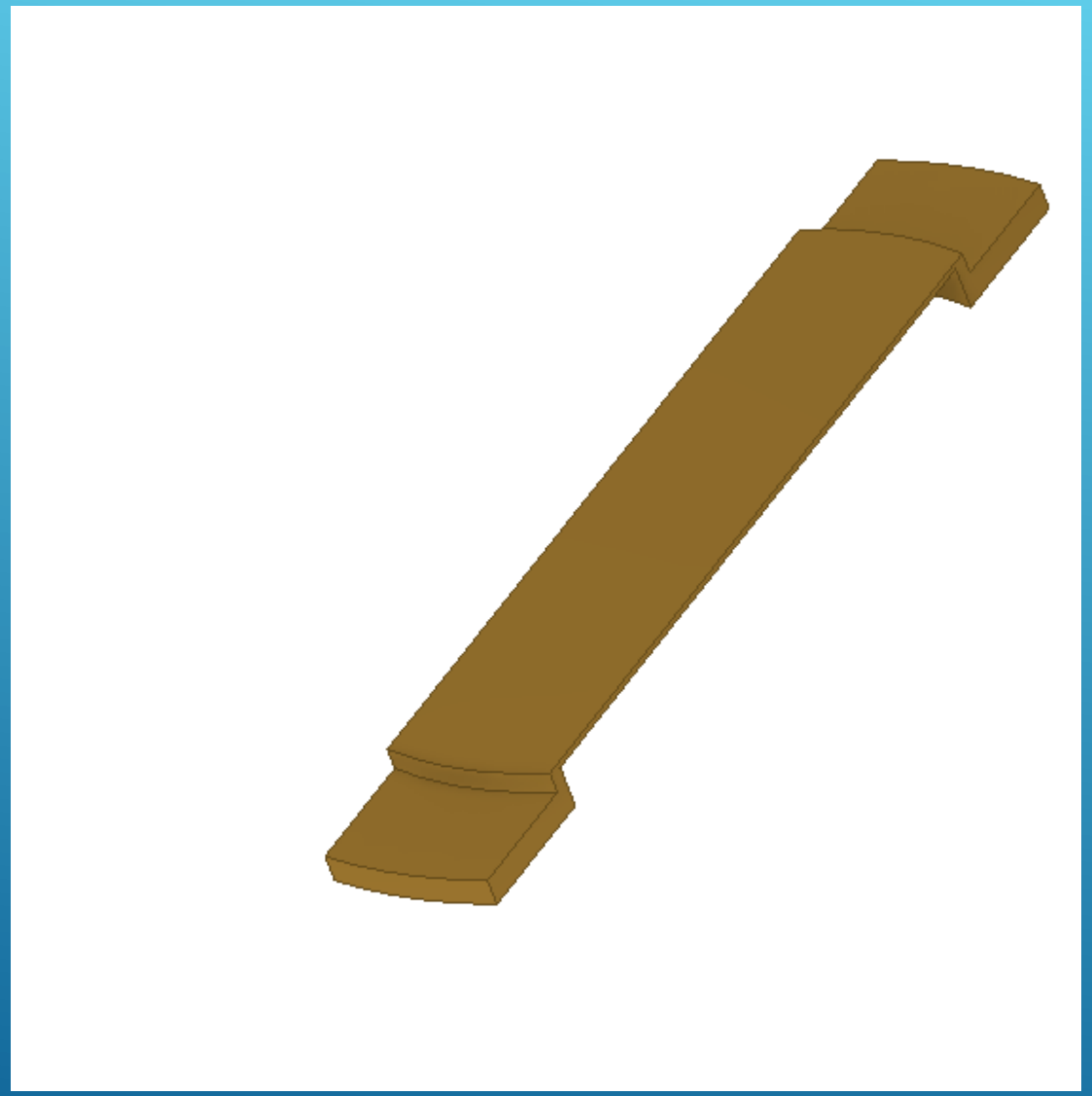
ALWAYS HAVE YOUR SAFETY GLASSES ON!



MAKING A RATCHET WHEEL BRIDGE.

Use your lathe to scribe the cutting lines.

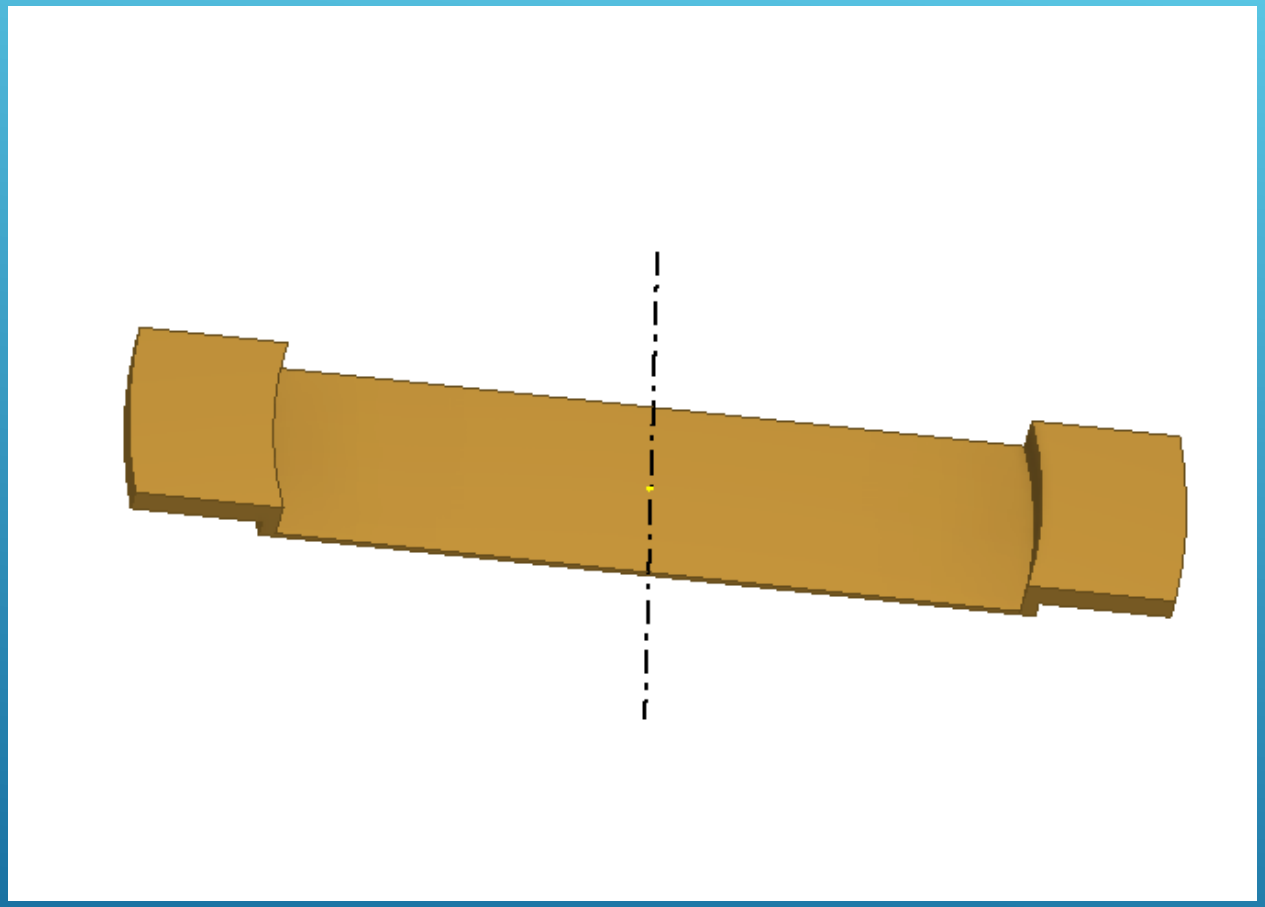
ALWAYS HAVE YOUR SAFETY GLASSES ON!



MAKING A RATCHET WHEEL BRIDGE.

Saw on the lines to remove the excess material.

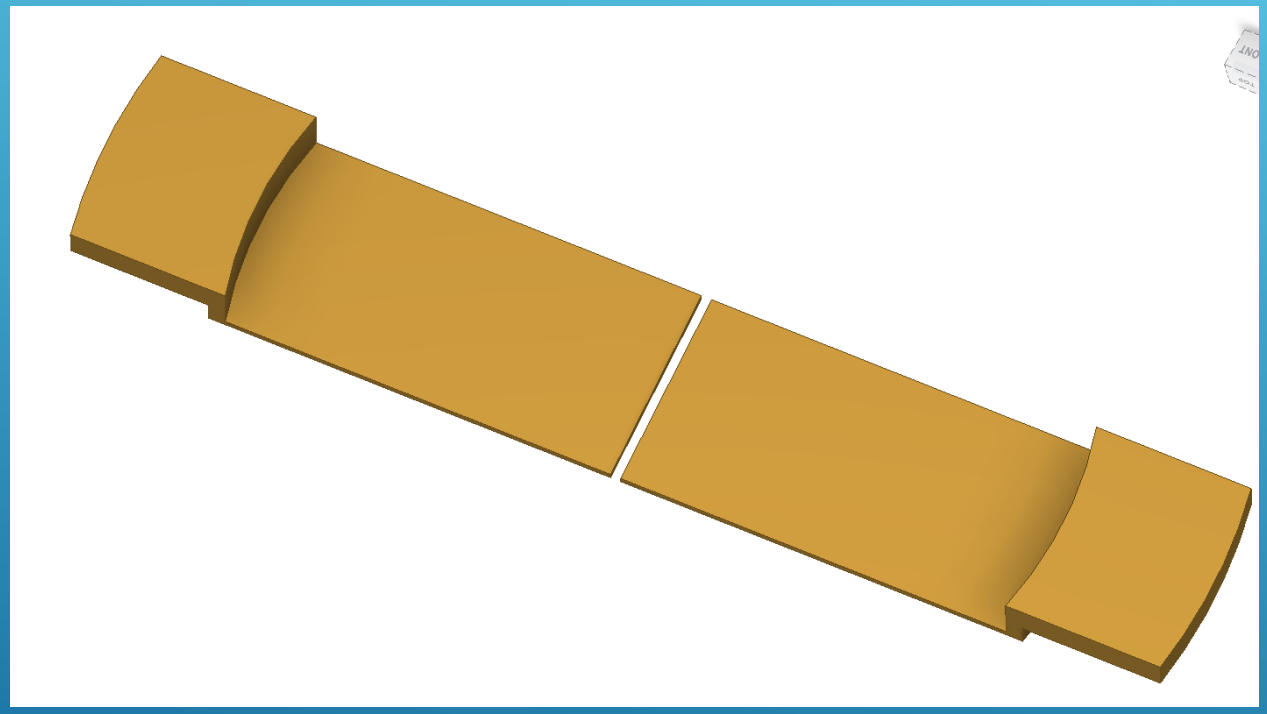
ALWAYS HAVE YOUR SAFETY GLASSES ON!



MAKING A RATCHET WHEEL BRIDGE.

Layout the center line and saw it apart.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

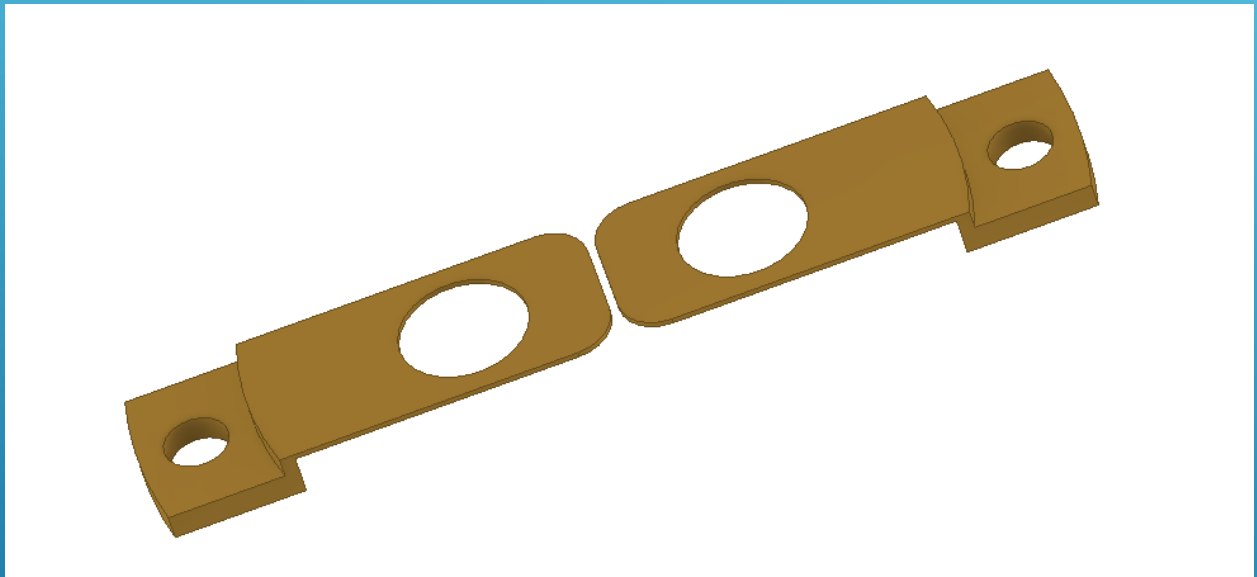


MAKING A RATCHET WHEEL BRIDGE.

We now have two of them.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

MAKING A RATCHET WHEEL BRIDGE.



Layout and drill your hole for the barrel arbor, and for the mounting screw.

I always like to finish the ends with a nice hand filed radius.

ALWAYS HAVE YOUR SAFETY GLASSES ON!

LEVER POST

ALWAYS HAVE YOUR SAFETY GLASSES ON!

LEVER POST

How would we make this?

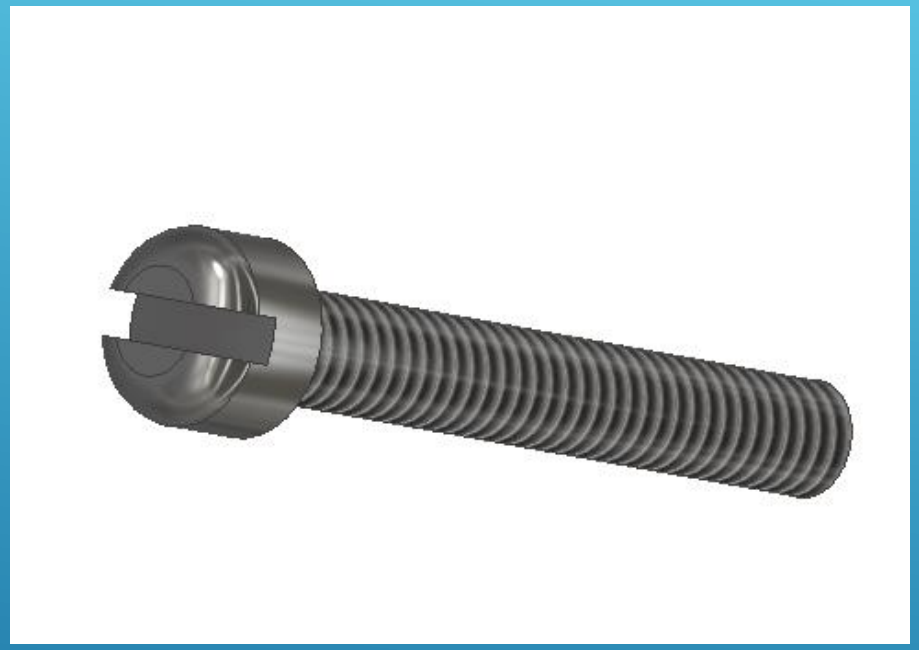
Anything critical?

What is the hardest step to do?

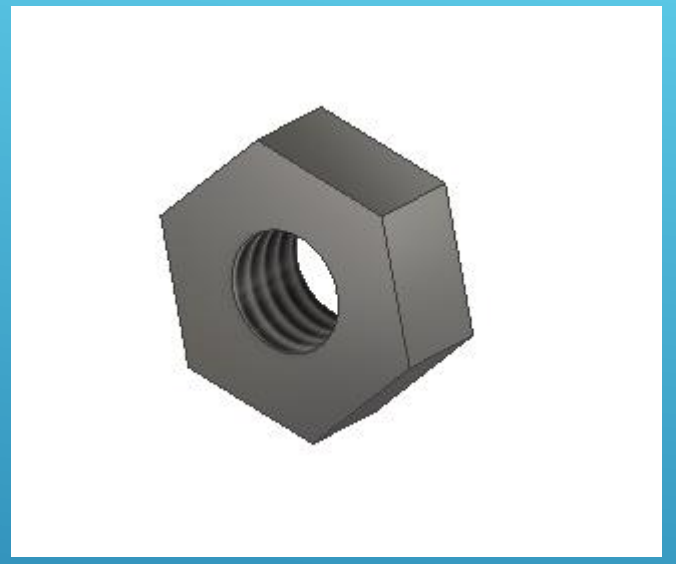
I have seen nails, and tapered pins hammered through the plates, steel soldered to the plates, even parts crazy glued to the plates.

This is a very simple part to make.

3-40 Bolt

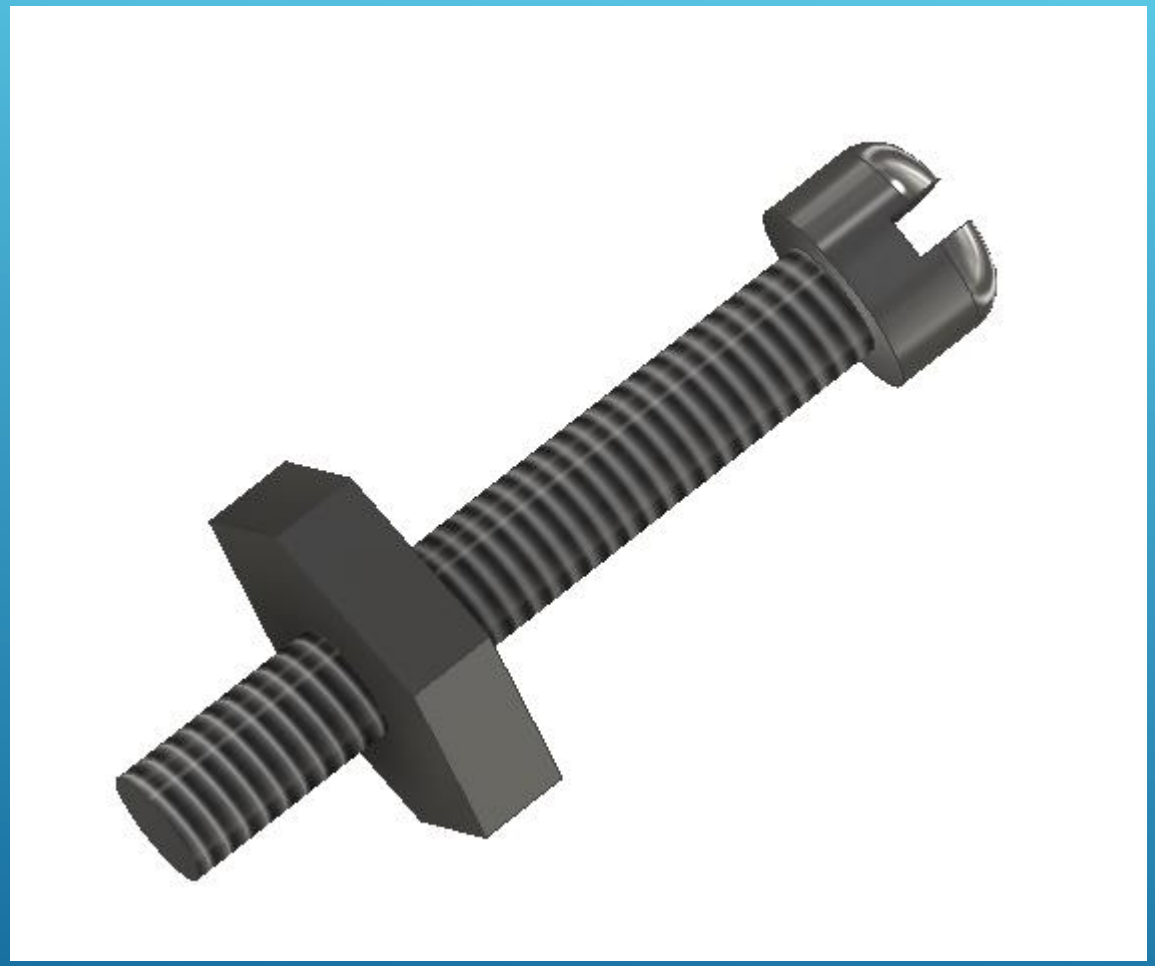


3-40 Nut



MAKING A LEVER POST

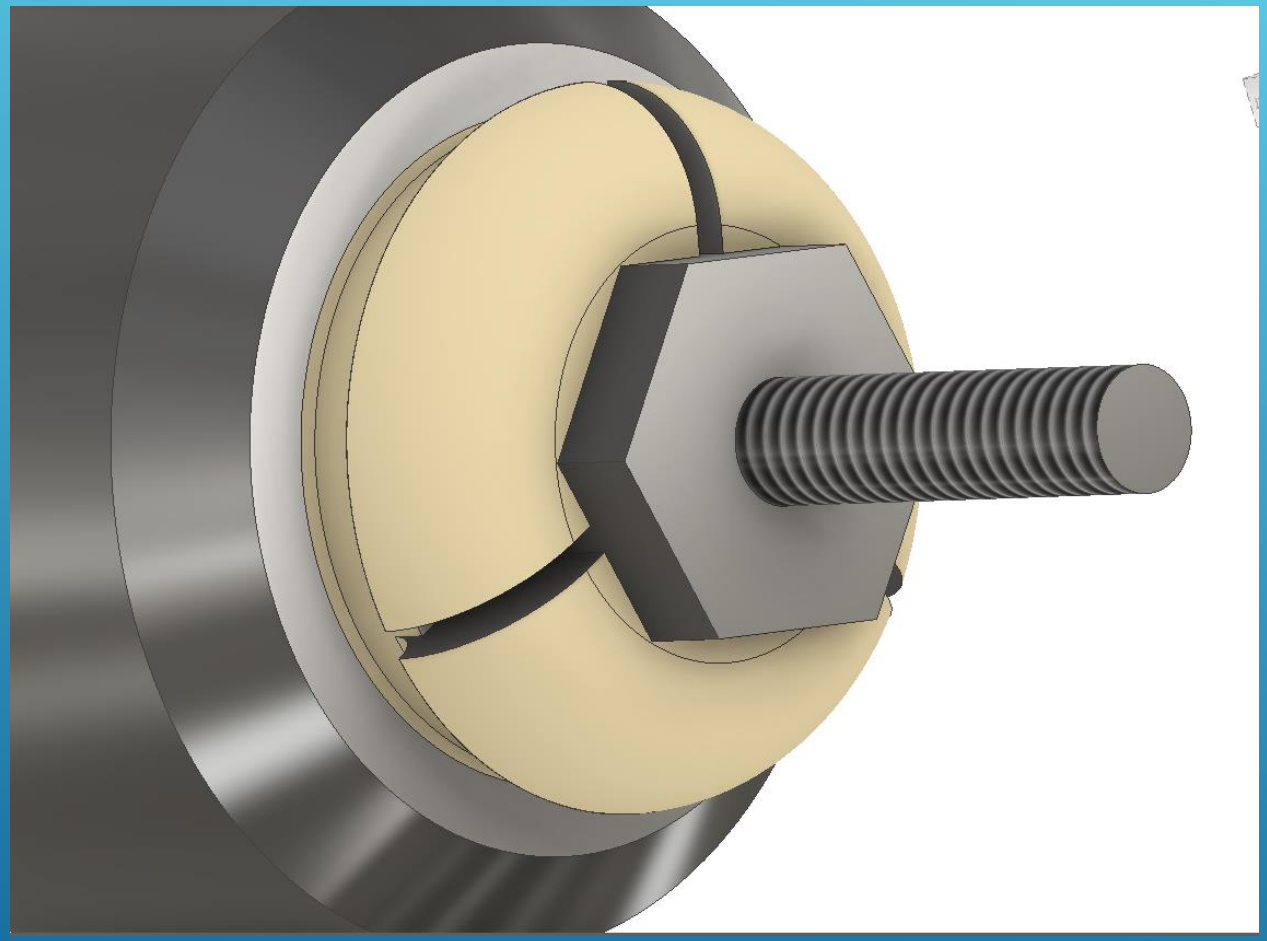
ALWAYS HAVE YOUR SAFETY GLASSES ON!



LEVER POST

Loctite the nut to the bolt.

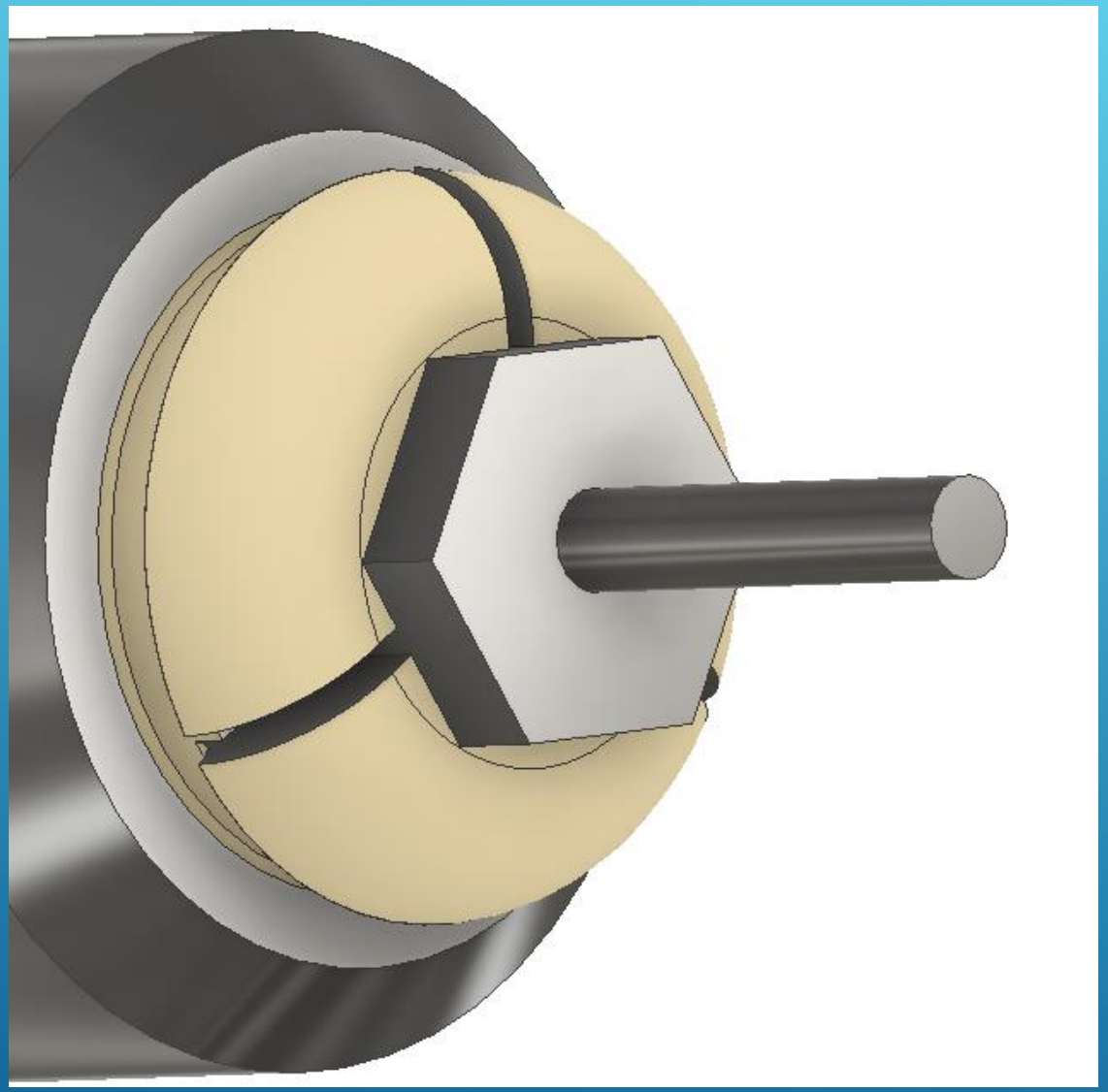
Remove the head.



LEVER POST

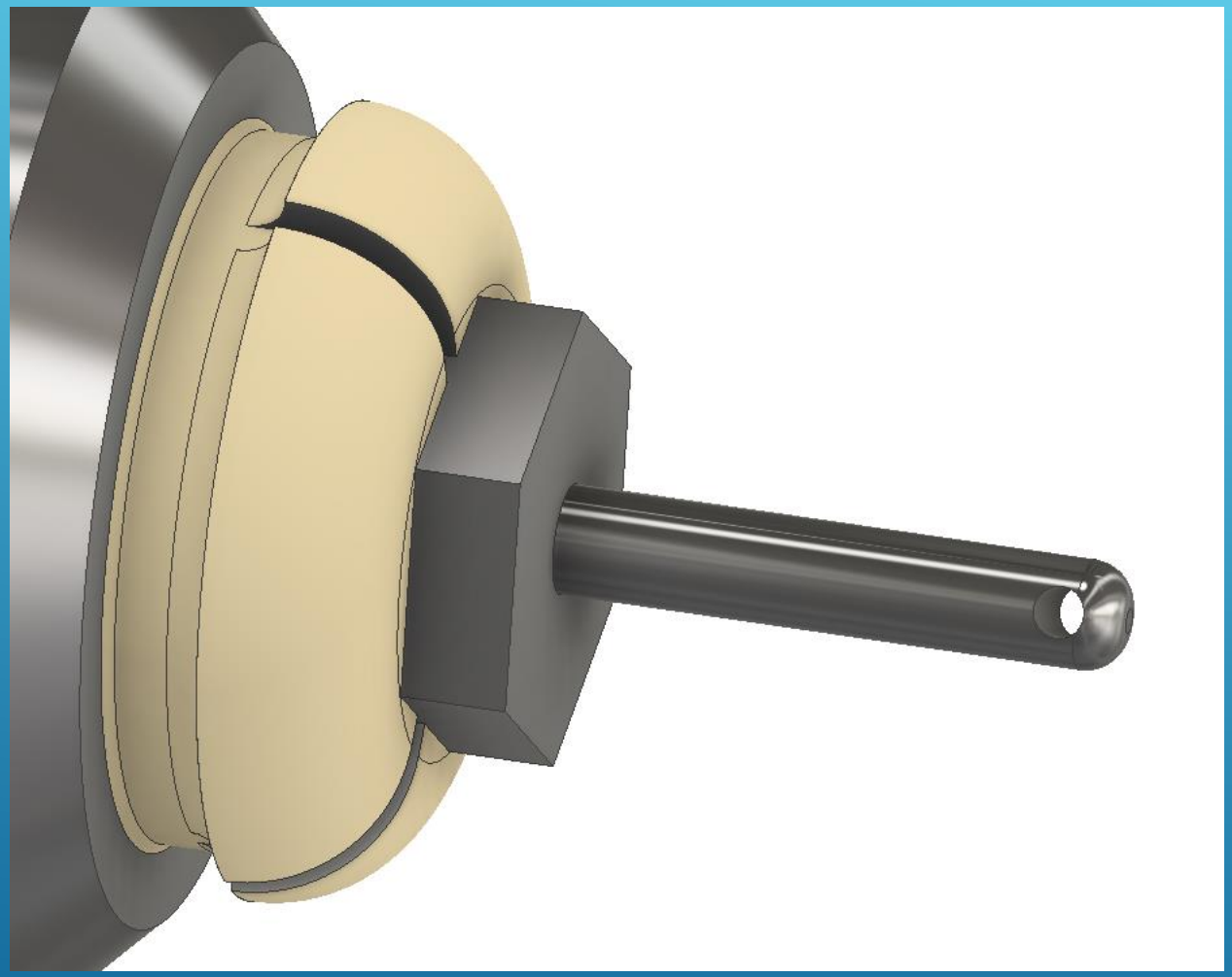
Saw the head off.

Now turn to the proper diameter.



LEVER POST

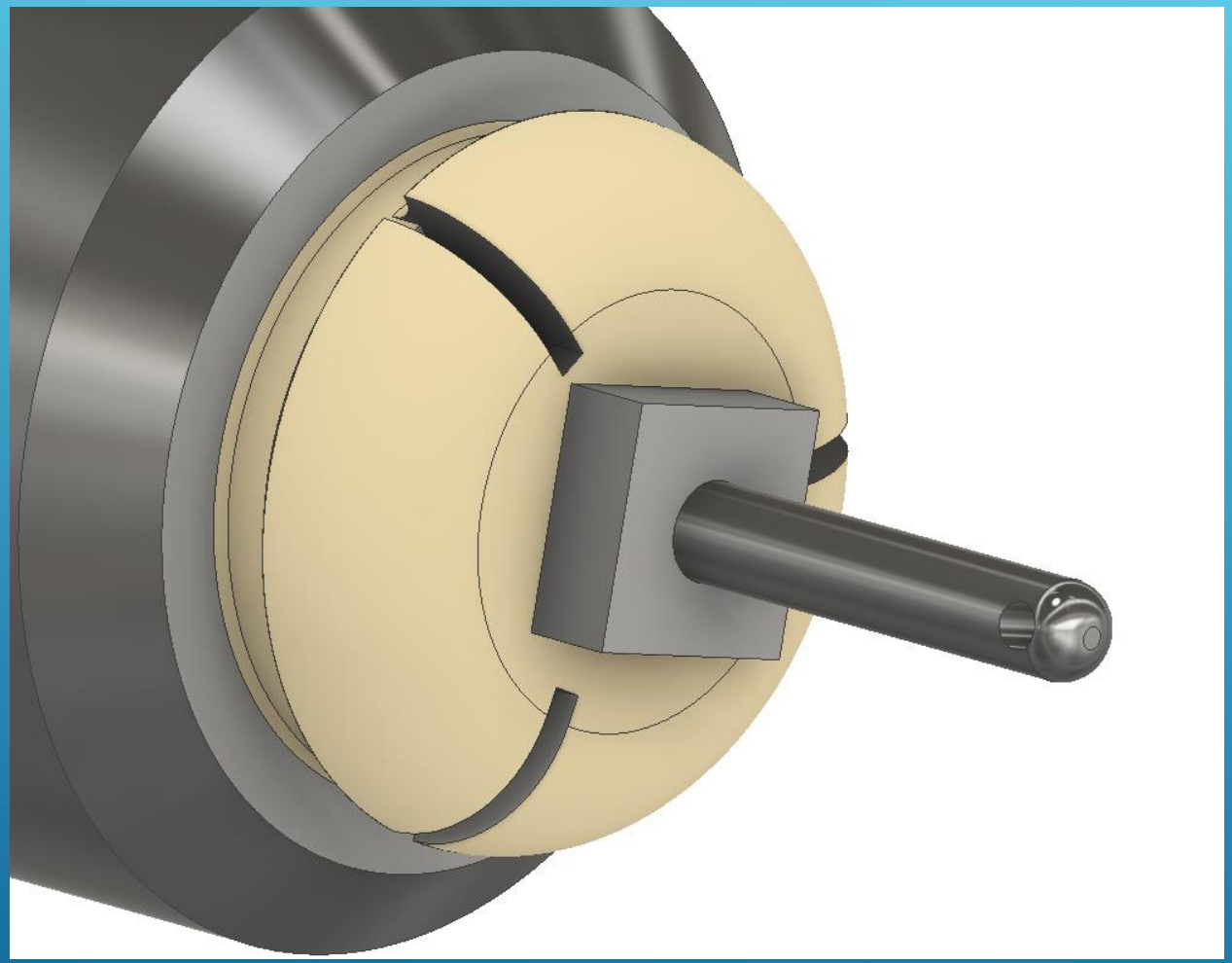
Turned to the diameter.



LEVER POST

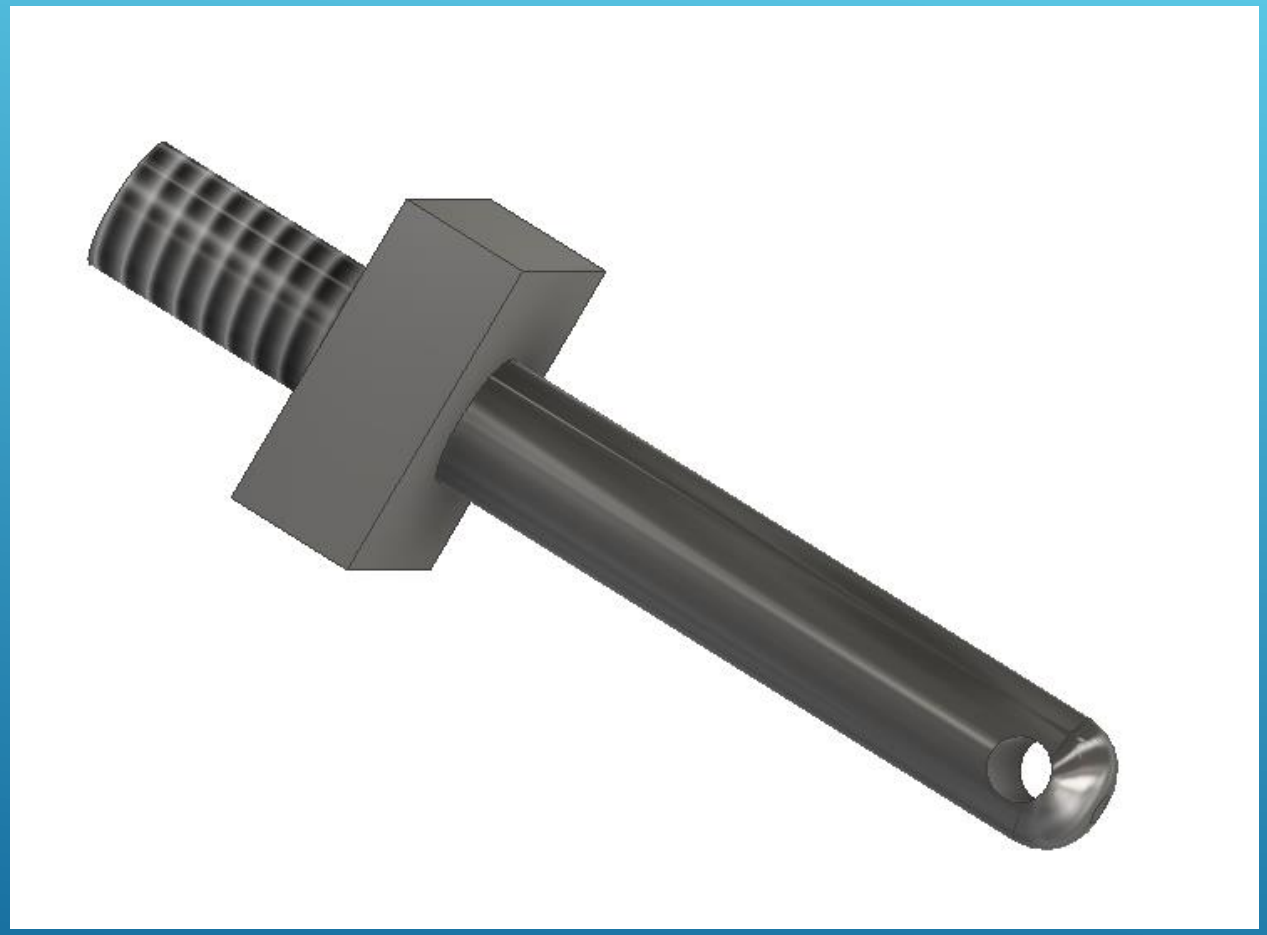
Drill hole for pin.

How would we do this?



LEVER POST

Use your indexing attachment and mill the nut into a square so it matches the other posts.



LEVER POST

Part complete.

Tap the plate to 3-40.

Ready to install in the plate.

QUESTIONS

ALWAYS HAVE YOUR SAFETY GLASSES ON!