

## **General Terms and Descriptions:**

**Axes:** y axis - forward/ backward. Axis measurements to .001 inches (one mil).

x axis- left/right. Big wheel.

compound axis- Adjustable angle axis. This will be used for threading and for cutting the cone on the brass part.

**Gears:** We use high gear and low gear. Low gear is for threading only, and high gear is for any other type of cutting. A demonstration of this should be done in person. Change gears only when the lathe is off, and change speed only when it is on.

Threading should be done at 80 RPM. For brass, cutting is done at 500 RPM. For steel, cutting is done **at 500 RPM.**

**Tools:** This refers to the different cutting tips that go on the lathe. There are four that we use: facing, for cutting a flat side; turning, for reducing the diameter; threading, for cutting threads; and grooving, for cutting a groove. There is also a drill, which is separate from these tools.

**Mil:** This is a unit of measure, equal to .001 inches. This is what everything will be measured in.

## **IMPORTANT STUFF:**

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**BE SAFE. DON'T BE STUPID.**

**If you have any questions, don't hesitate to ask a TA. They are pretty helpful, and they all know what they are doing.**

**Before you do anything, think through it. From experience, it is really easy to ruin your part, and this can be avoided by not making any silly mistakes. Make sure you are familiar with the operation of the lathe before you use it.**

**Some Tips and Tricks:** These can be useful.

- When you are cutting threading, the best way to check if you are done is screw the threads into another part. Use emery cloth to sand down the threads a little bit. If you are worried about cutting to deep (especially on the steel part), you can finish the threads with a die. However, this is only for cleaning up and finishing the threads, not cutting them entirely.
- When tapping or drilling, be very liberal with the cutting fluid, and use it frequently. If something starts smoking, back out the bit and give it a minute to rest.
- Use your calipers early and often. It's really easy to mess up the part because you didn't measure something correctly the first time.

## **Steel part:**

- 1 Use the horizontal band saw to cut a piece from the bar that is ~1/8 of an inch longer than the full length of the part.

- 2 Put the piece into the lathe,. Less than half should be sticking out. Put the facing tool on the lathe.
- 3 Face the end of the part. Don't take much material off, you just need a flat face.
- 4 Put in the turning tool. Touch off against the end of the part (x direction) to get a zero point. Then, touch off in the y direction and take note of the position to get a zero point here.
- 5 Cut down the smaller diameter. Do this by moving in steps of ~20 mils in the y direction, then moving along the part in the x direction. Watch the indicator to know how far to go. Make sure to check your diameter after a few times with a caliper to see how much is left to take off, as it is more accurate.
- 6 Move the cutting tool out of the way, and set up the drill with a centering bit. Cut a centering hole (not very deep) using plenty of cutting oil.
- 7 Get a drill bit size C. MEASURE THE BIT BEFORE YOU USE IT. DON'T TRUST PEOPLE TO PUT IT BACK IN THE CORRECT SPOT. Drill all the way through the part. Use plenty of cutting oil.
- 8 Put the threading tool on the lathe. On your left is a threading chart. Make sure that the levers are set to cut at 24 threads per inch.
- 9 Put the lathe into low gear.
- 10 Set the compound axis to 29.5 degrees. This will be what you use for depth of cut. The y axis is for backing away from the part only.
- 11 Touch off using the y axis, this is your zero point. Each time through the threads, return the y axis to exactly this point.
- 12 Move the x axis to the right a few inches. Look at the threading indicator (a spinny thing with numbers 1-4 on it). When it gets to a line, pull up the lever below it to engage. You may want to practice this a few times before you actually cut threads into the part.
- 13 Let the auto-threading run until just before the tip hits the shoulder of the part. At the same time, disengage the threading and back out the y axis several turns. If you don't do both of these things simultaneously you will ruin the part.
- 14 Go through this process several times. Each time, move the compound axis in ~5 mils. In order to test if you are finished threading, get a 5/16-24 washer and see if it fits. When it gets close, take off only 2 mils at a time. It may help to use some emery cloth. Once the washer fits on, you are done this side of the part.
- 15 Put the machine back into high gear (lever forward, pin out).
- 16 Take out the part and turn in around. Put the facing tool on the lathe and cut a flat face on the other side of the part. Don't take off too much, just enough to make a flat surface.
- 17 Take the part out again and measure its length. Put it back in the lathe, and face it to the correct length, in about 20 mil segments.
- 18 Get a drill bit size I. Check its diameter. Drill out the part to more than ½ inch depth.
- 19 Get a tap (5/16-24), a tap handle, and a supporter. With the piece still in the lathe, tap the hole. Go in 1-2 turns, then back out and spin the tap back and forth. Use lots of cutting oil, and every few turns back the tap all the way out and wipe it off. Keep going until you have tapped in about ½ inch.

You are finished making the steel part. You should check everything over to make sure its correct. Blow out the inside of the part with compressed air to clean it. If the edge is sharp, you can deburr it with the sander. If you have a finished brass part, make sure it screws in.

## Brass Part

The brass part uses the same lathe, and most of the same cutting tools, as the steel part. Remember to leave the piece attached to the rest of the rod while machining the bottom half. If you are doing more than one piece at a time, first machine on both ends of the rod, then cut the ends off.

- 1 Put the brass bar into the lathe. Face off the part.
- 2 The next tool you will need is the turning tool. You will machine the bottom half (the one with the cone) first.
  - a You should set up a zero point at the end of the rod. Make sure you also touch off on the y axis.
- 3 Cut the first diameter (the side with the cone).
- 4 Set up the compound axis at 45 degrees. The handle should be facing away from you. The compound axis will be making the cut, which is a good check to see if it is set up correctly.
- 5 Make the cut with the compound axis, and take the depth of cut using the x- axis. Take very small cuts, and try to only cut in one direction (so that the bit is pushing, not pulling).
  - a this part is finished when you have a sharp cone. It's time to stop when you are no longer cutting the cone and are only shortening the piece. There isn't really a good way to measure this, just eyeball it.
- 6 Cut the threading on the long end. This doesn't actually thread into anything, it is where the nichrome wire lies. Try to make the grooves wide enough so that the wire will fit.
- 7 Take out the part and flip it around.
- 8 Using the turning tool, cut down the diameter of the back end.
  - a **BE REALLY CAREFUL HERE.** The tool will be VERY close to the chuck on the lathe. DO NOT hit the lathe with it, you will break something. If necessary, angle the tool away a little bit so that it will not hit the lathe.
  - b If you are unsure how to do this part without breaking something, please ask for help. It is a huge pain to recenter the lathe, which will have to be done if you knock it.
- 9 Put the grooving tool on the lathe, and cut the groove. You only need to cut one width of the tool. Depth isn't critical, but be careful not to cut so deep that it will interfere with the hole for the filament.
- 10 Cut the threading. This is slightly easier than all of the other threading, because of the groove. It allows you to first stop the feeding and then back away from the part, rather than doing both at the same time.
- 11 Cut the hole for the filament. Make sure to use a centering bit first, then the .125 drill bit. The idea is to cut as deep as possible without actually coming out the other end. The better you do at this, the less likely someone is to break a drill bit cutting the tiny hole.

- 12 Congrats! You're finished. Make sure everything fits together, and that it generally looks right. Check against another tip that has already been machined. All that's left is to drill the tiny hole and put in some teflon tubing.
- 13 The tiny hole is drilled using a chuck, centering bit, and drill bit that are from the RepRap class, not the learning factory. Please try to keep them separate. The hole is drill from the outside of the piece, not the inside. Use as high RPM as possible while still being safe (~2200). Be careful, it's really easy to snap the drill bit, and that is bad.