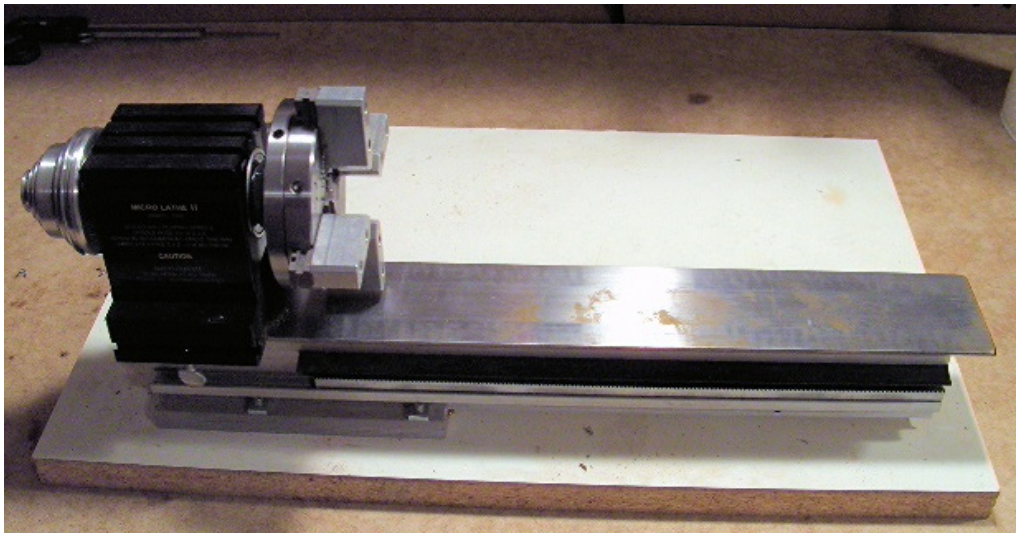
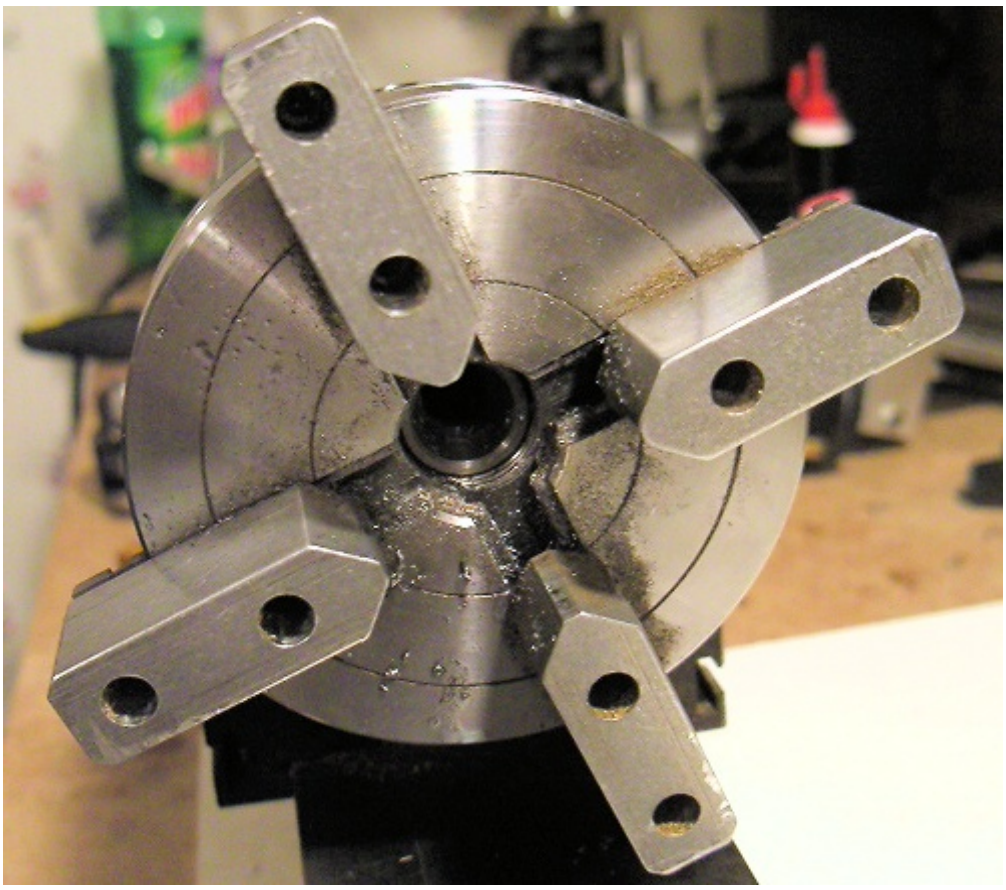
Part 1 - Basic Lathe

I am going to describe the lathe using a Taig (Peatol) lathe, because that's what I have. All metal lathes are basically the same, with only minor differences.

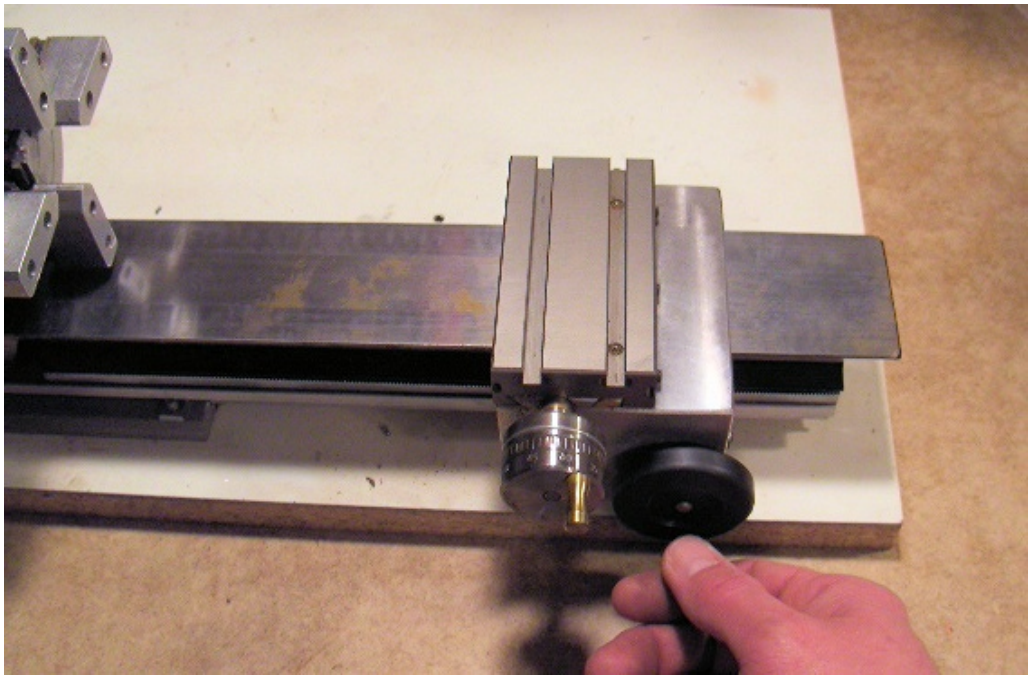


This is the lathe bed with the headstock mounted. There is a pulley on the back with six different grooves. By changing which groove the belt runs in-you change the speed. Some lathes may have a speed switch instead.

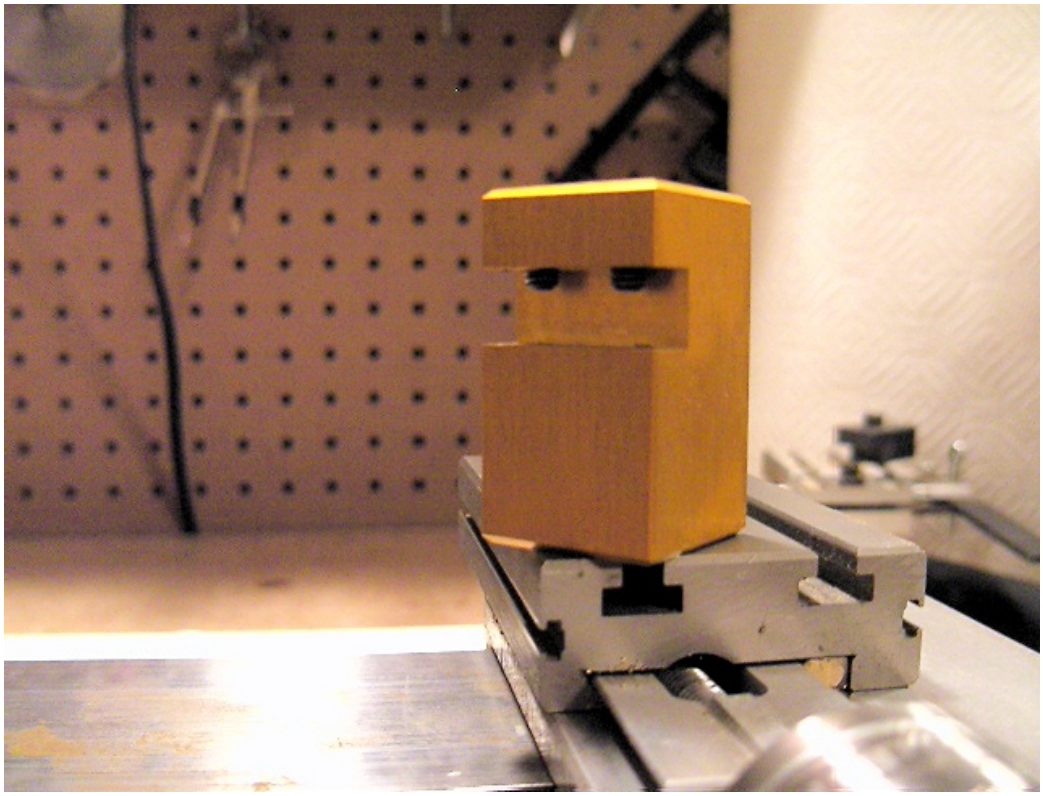


This is the chuck of the lathe, it is a four jaw scroll chuck-the best kind for all around hobby use. This will grip both round and square stock. Its called a scroll chuck because all four jaws close at the same time. There is also a three jaw scroll-this is good for round and hex shapes -we don't use hex very often, and it wont grip square

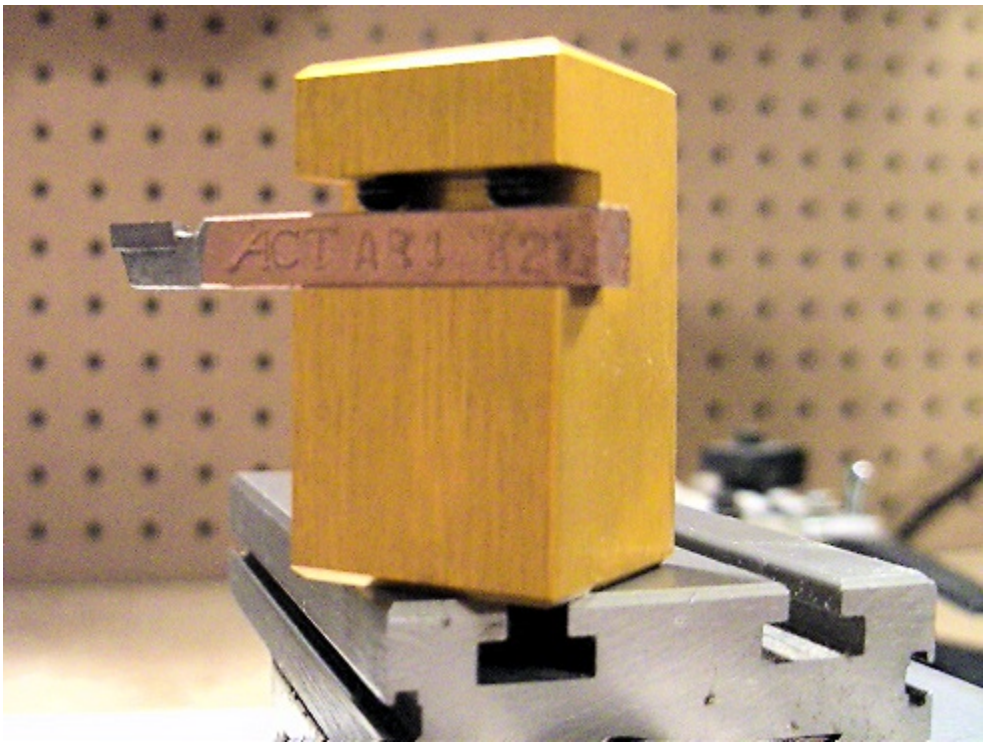
stock. Then there is an advanced chuck called a four jaw independent chuck, this is the most versatile chuck because it will grip any shape-but it requires additional tools and quite a bit of time to master. Each jaw moves separately -so stock can be off-set and any size shape can be clamped. I only use a four jaw scroll chuck for ship-modeling.



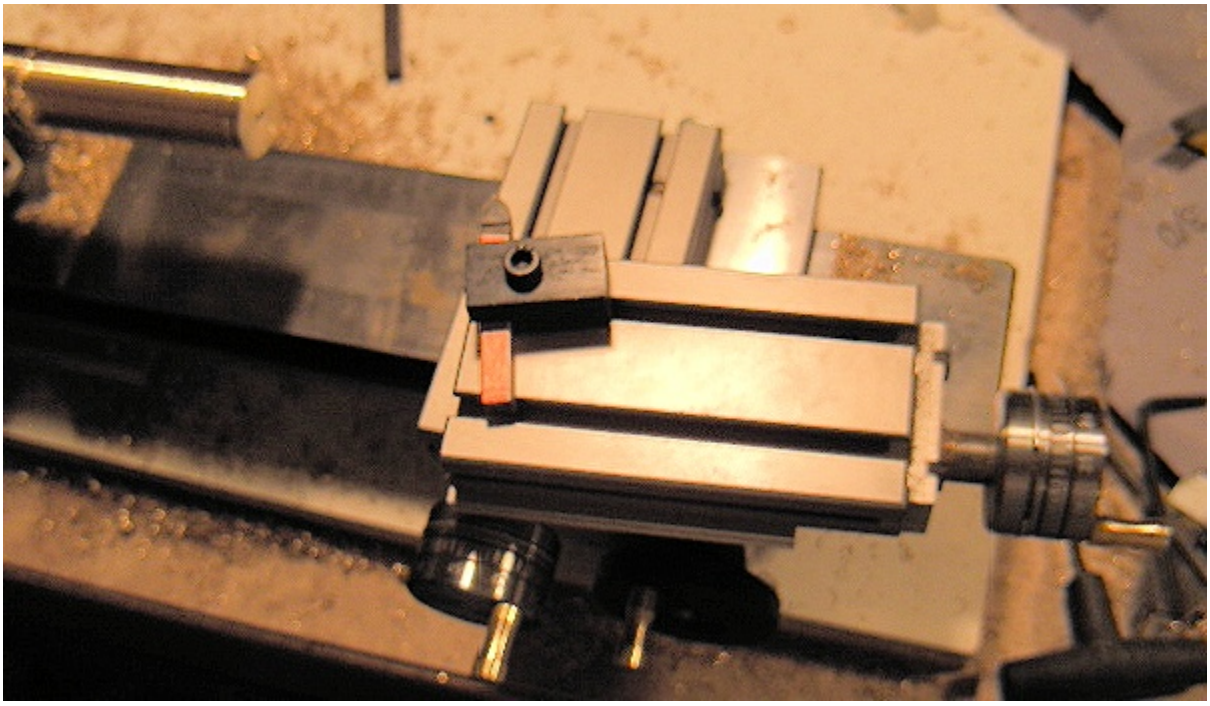
This is the carriage and cross slide. This gives you two axis (direction) of movement-straight toward the chuck, and across the table. My hand is on the hand wheel to move the carriage toward the chuck-the other wheel is for moving side to side in front of the chuck.



This is the basic tool post, the slot is wider then the tool so you can adjust the bit-tip up or down. The post mounts to a T-slot on the cross feed carriage. Your tool post might mount differently.

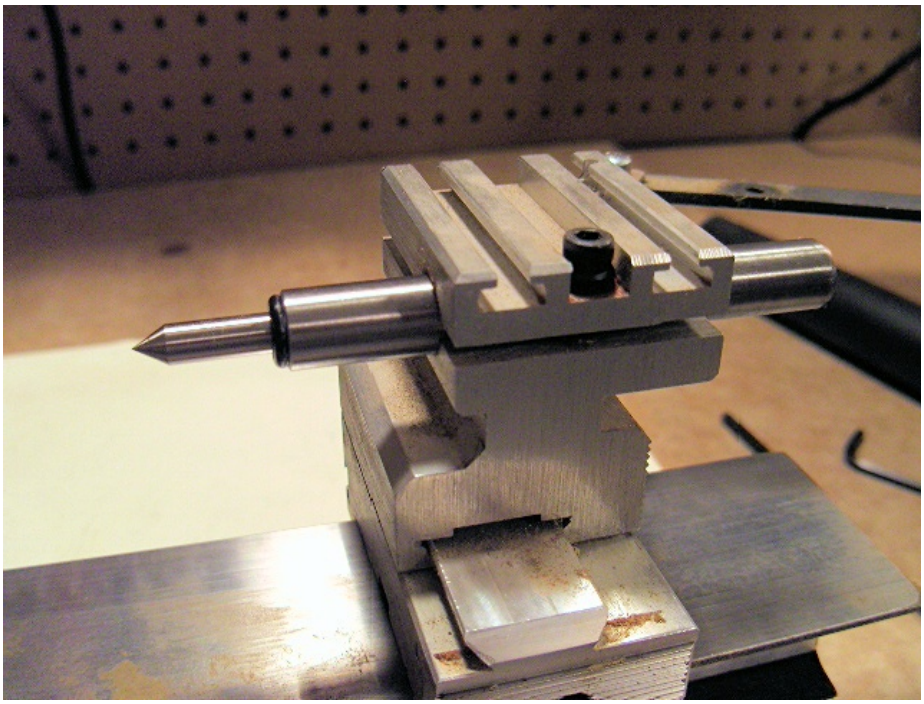


A bit mounted in the post, you can see that by using shims under the bit you cold raise it-by placing the shim only under the back of the bit, you could lower the tip. On this post, the bit is held in by two allen head set screws. Some lathes have clamp systems-one way or the other basic tool posts adjust the same.

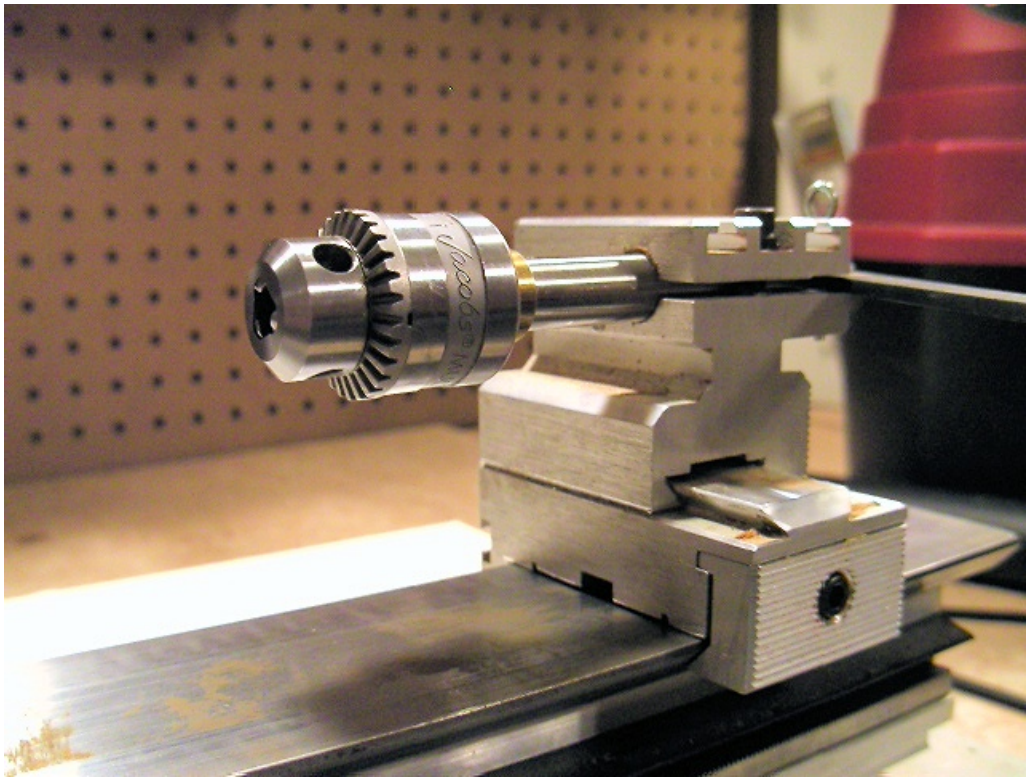


This is the taper slide on the Taig, it mounts to the top of the cross slide. You can see that a special type tool post is used to keep the tip of the bit centered on the work. This gives you a third axis, the angle you set it at is the degree of taper you will get. It uses the exact same bits as a regular post. Your lathe might be different; maybe the headstock rotates, or has a totally different set-up for tapers. Just always be sure the taper attachment/ adjusters are tight before you start-this is rather easy to forget to do.

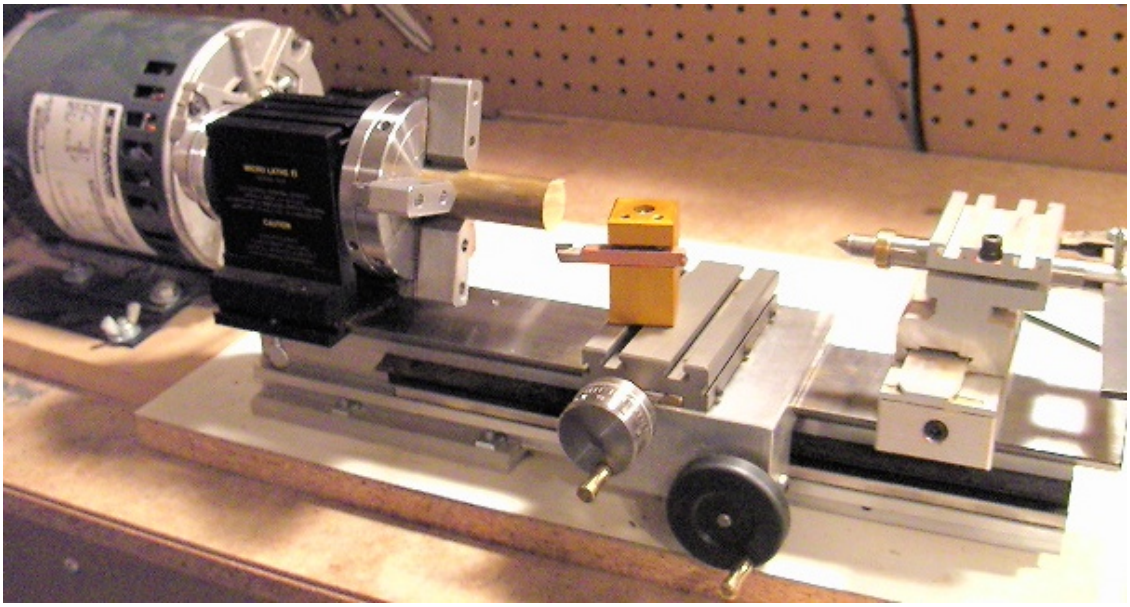
Here is a hand wheel with markings. It doesn't matter if your lathe is metric or imperial; the hand wheels work the same. This is imperial measure and each "line" is one one-thousandth of an inch, but remember-moving the bit in one line will take off two thousandths of an inch, because you are removing material from BOTH sides of an object at once. It is very easy to move only one quarter of a line at a time, and on larger machines the graduations are even smaller-but for hobby use this is perfect.



This is the tailstock, and it holds centers, drill chucks, etc. Not all tailstocks are the same in design, but they all do the same things. This picture has the "live center" mounted. "Live center" means the pointed tip you see spins along with the work. That way friction doesn't scorch or leave marks on the piece. A "dead center" is just a piece of pointed metal, there is no bearing inside and oil or some other lubricant should always be used with a one. Just a drop on the tip every five minutes of working will be fine-not too much or the oil gets thrown off, and makes a mess.



Here is the tailstock again, but now a drill chuck is installed. A unique feature of the Taig is that the drill chuck mounts to the “dead center”. There will be a picture of this later. Other lathes will probably have a different set-up, but this gives you the idea. Remember, the drill or dead center do not turn in the tail stock, these are held motionless and the work spins, not the drill bit.



Here is the entire lathe with a piece of brass chucked up. A nice thing with this lathe is I made sure the motor is separate from the rest. This keeps the weight down and lets me use the motor for other things. The motor is 1/3 horsepower, and connected by a pulley. The great thing about a belt-driven lathe is that if something goes wrong (and it will sooner or later)-the belt will slip before something breaks. It is easy to get totally involved in the turning, and never realize you are going to run the carriage into the spinning chuck. This makes a hell of a noise, but don’t panic! Always know where the on/off switch is in a hurry-actually practice being able to shut the lathe down fast in an emergency. This will save your lathe, and is important for safety. Some lathes have a plastic gear instead of a belt, always have an extra gear laying around-once the carriage hit’s the chuck you will need it!

Before starting the lathe, place a couple drops of light machine oil on the moving parts-slides, lead screws, into the “racks” of the chuck, etc. This is a good habit, and will prolong the life and accuracy of your lathe.

After you are done with a project, do a little maintenance. I don’t use my lathe very often, but it is nice to pull it out of storage and not have a rusted up mess! Remove all chips with a brush (I use a small paint brush), and you must search these out. Turning metal makes quite a mess and these chips get into every nook and cranny!

When everything is cleaned up, wipe the entire lathe down with a oily rag, add a drop or two of oil to the slides and work them back and forth a few times. Loosen any allen head bolts that might seize up in storage, but don’t remove them (might go missing). Wrap all the bits in an oily rag for storage, and always cover the lathe protecting it from dust. Do this little bit of work and the lathe will last a long time.

This takes care of the lathe itself. Now I will give you my opinion on what you need for this hobby-again this is my list and yours might be different.

1. Lathe with tailstock and cross-slide (optional on some, standard on others).

2. At least one tool post, I have two just in case one goes missing in a messy shop.

3. I like to have both centers, live and dead.

4. A drill chuck(s) that mounts to the tail stock, so you can use tiny and large drill bits.

5. About 10-20 H.S.S. (high speed steel) lathe bits. You can buy pre-sharpened bits if you want, but you don’t have to. HSS bits are very inexpensive, always order extra.

6. A four-jaw scroll chuck, works with almost anything we use for this hobby.

7. A good assortment of allen wrenches, on most lathes all changing of bits or tooling is done with these.

8. A means to turn tapers, on some lathes this is built-in; on others it is an optional part you must purchase.

9. Other stuff- eye protection, drill bits, oil, and a chip brush.

Part 2 – Grinding Lathe Bits

In this part, I will concentrate on how to get a good finish on your work, a little about lathe set-up, and most importantly how to grind your own bits. There is nothing complicated about any of this, and I wont go to far into any one thing because you will find its mostly stuff you really don't need to know for ship modeling.

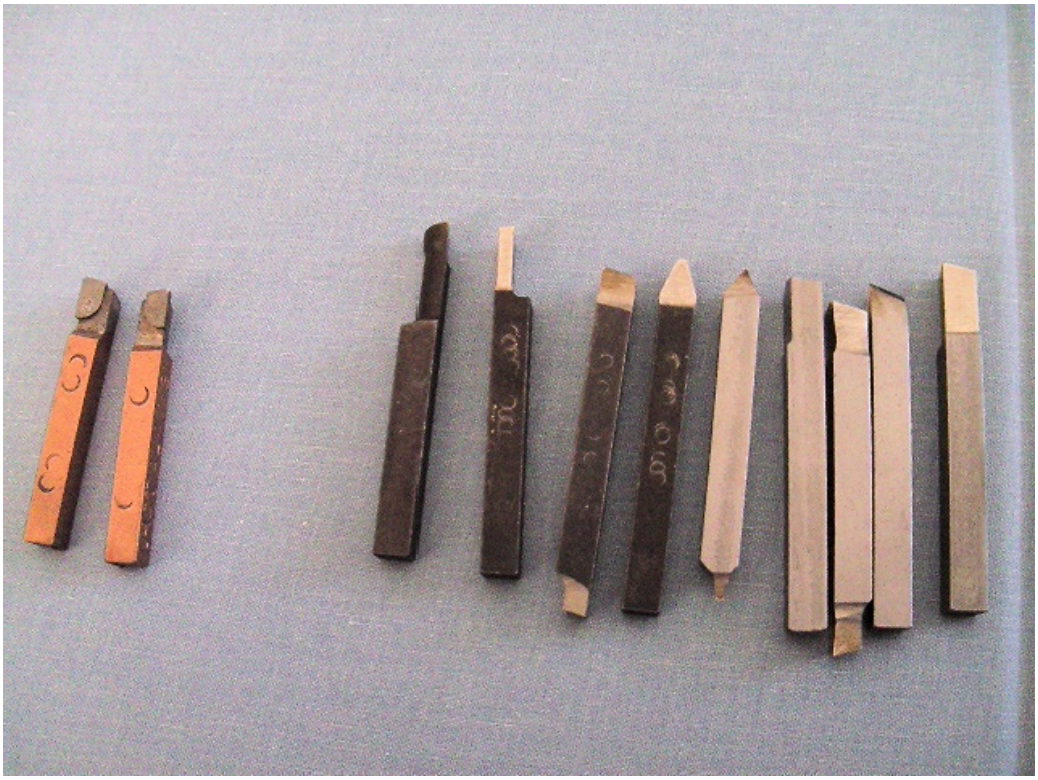
First lets talk a little about bit choices. Basically for hobby use there are only two, high speed steel (hss for short) or carbide.

Carbide bits are factory ground to cut many different materials-what works well on steel may not work for aluminum or brass, or at least give you the finish you want. Most carbide bits that are within the hobby-use price range are cheaply made in Asia, the material grades range from OK to plain garbage. It is very hard to know until you have bought them and given them a try- this gets expensive. Carbide can be sharpened when it gets dull, but often for us it costs the same amount to buy a new bit-we are not sending in hundreds at a time!

Good luck finding some carbide bits that will do a GREAT job on brass - I have never found any. I will show the finish you get with a couple I have later.

High Speed Steel, this is what I always use unless I am turning steel or cast iron. Properly sharpened these will give a great finish on brass, aluminum, and wood. They also work with the much harder materials-but then you actually have to sharpen them carefully-with brass you do not.

HSS is also very inexpensive to buy, and cheaper still is to buy them as "blanks". Blanks are just short pieces of completely unsharpened tool steel. You can also buy them pre-shaped, but for our use you don't have to, I will show you the "quick and dirty" way to shape and sharpen your own. Don't take the "quick and dirty" part to mean poorly-I mean the easy way. There are entire books written about sharpening bits, and for the hobbyist this is way more information then you will ever need-and just causes confusion.

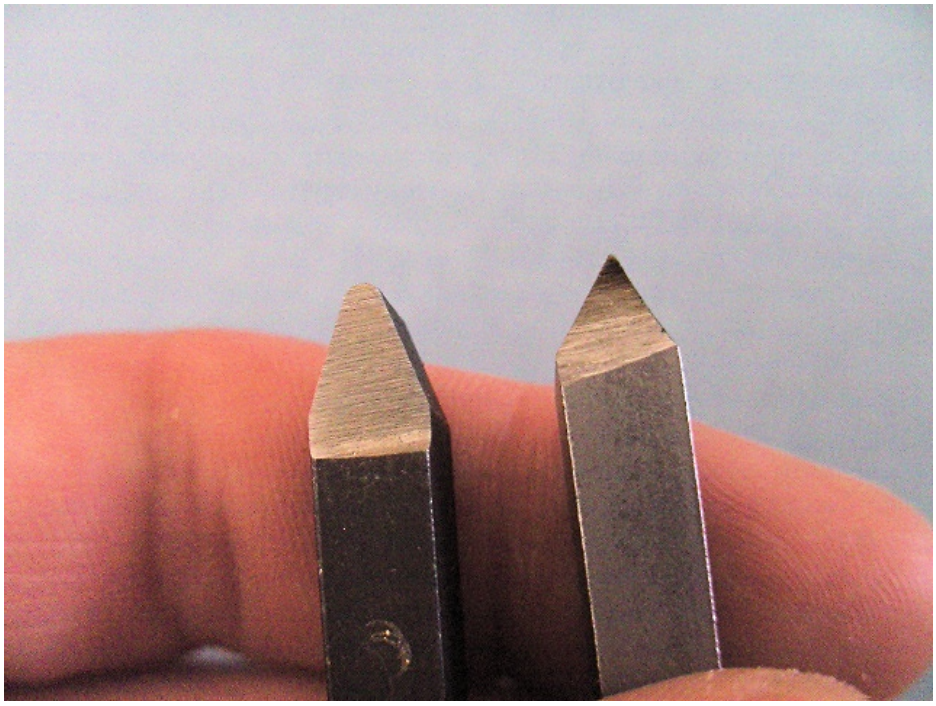


You can see the carbide bits on the left, the end has a extra piece (this is the carbide) brazed on.

On the right are a few HSS bits, I am showing many shapes, but I use my lathe for many things other then ship modeling. In reality we need two basic shapes for brass, wood, and aluminum. Though there are two colors of HSS bits, they are the same-just bought at different times. All HSS is just that-tool steel.

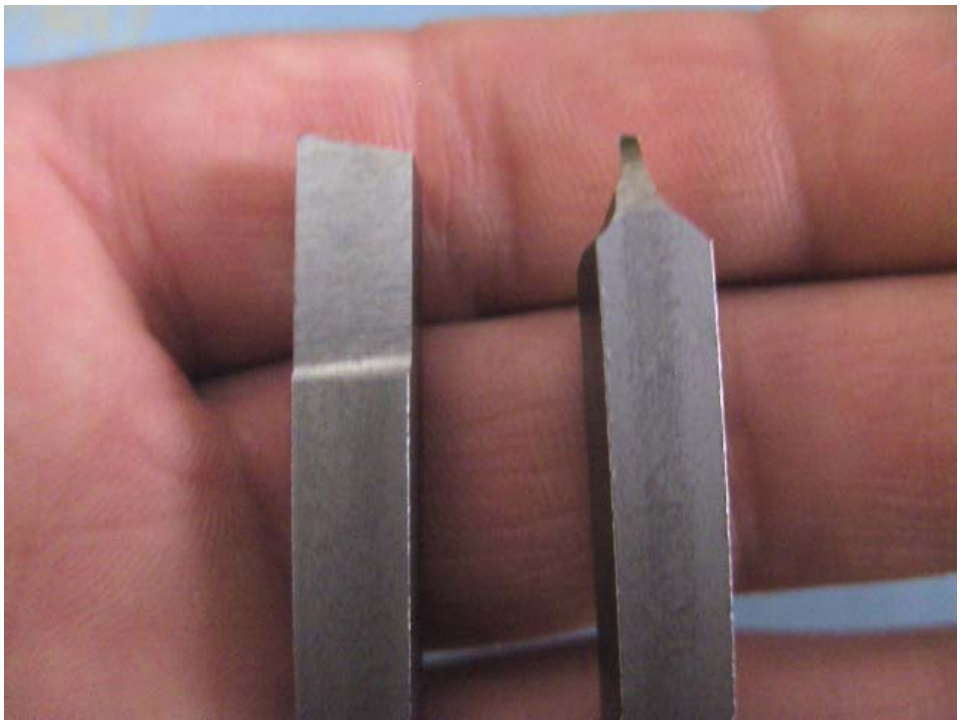
To get the basic idea of the actual shapes available, I recommend you buy one set pre-sharpened and then about 20 “blanks”. The ones that are factory sharpened will give you a general pattern, then for ship modeling make your own tips MUCH smaller-we are not making crank shafts!

By grinding the ends down to a tiny size, you will cut way down on a lot of the problems people have turning brass-poor finish and “chatter marks”. I will go into finish in a minute, but first the shapes I used for the turnings I will show.



On the left is a stock “finishing” bit, you notice the size of the tip-great for steel but poor for brass! Also, the tip on this is rounded off, again this is for very hard materials-not what we work with. But that is how you will get them, a “one size fits all” kind of thing.

The one I have ground on the right has the same GENERAL shape, but it is not rounded over at all-and the tip is very tiny and sharp. This type of grinding will give you a far superior finish in soft materials like brass and wood. I use this bit for 99% of all the brass work I do. For the other 1% I use a regular turning bit, but again ground very small. This bit is small enough to do inside turning (like inside a bell) and I also use it for parting purposes-you will see this later.



Stock on the left, mine on the right-same BASIC shape-just much smaller. And you are starting to see the words “precision ground” don’t apply to how I do the shaping-it doesn’t have too!

All the “keeper” turning I will show was done using this ONE bit, another great thing about HSS!

I will show my grinding set-up now, nothing expensive or “high tech” at all.

Here is my entire set-up for sharpening bits.

All I use is an old grinder (it doesn’t even have a wheel rest-lost that years ago), and a cup of water. You notice the old miter box, I only use this as a wrist support-you probably wont even need this, and if you do absolutely anything will work.

Each bit will need three “bevels”, again you can get the idea of the general shape from the stock ones you bought. If you don’t have any stock ones, just search the inter-net for some pictures. I really don’t have space for all that, and the resources are readily available elsewhere.

What I’m going to show you I learned a long time ago from a very good machinist, back before CNC and high-tech equipment. Guys that could actually RUN a machine totally manual are a dieing breed, now everything is done for you by a computer-you basically put the part in, and hit start. The machine beeps when it is done-not like it used to be at all.

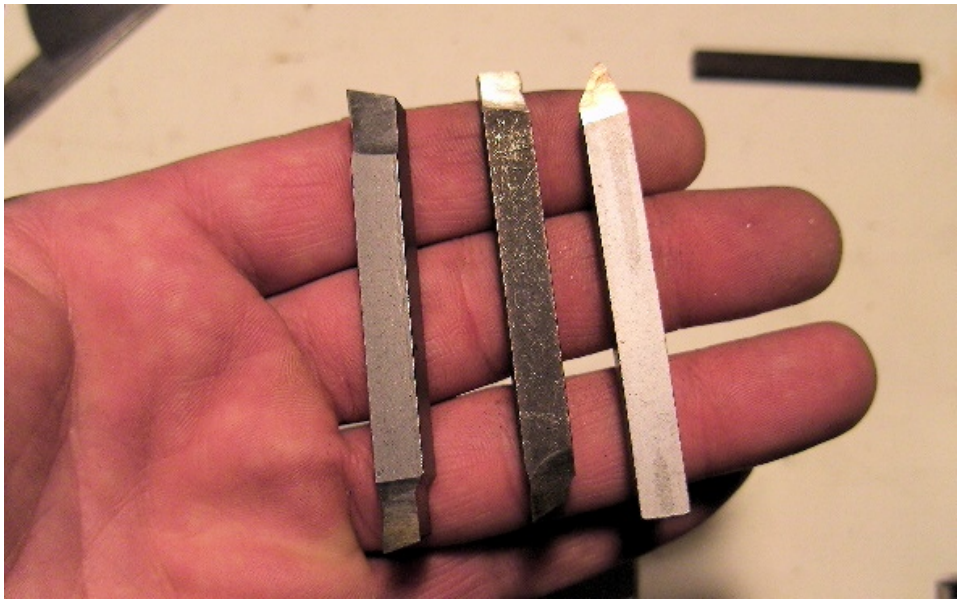
Books will tell you that you have to have an EXACT amount of bevel on your bits, or they wont cut. One book I read said you need 9.5 degrees of bevel for brass, or it wont cut. This is false. I measured the bevels on the bits I am about to show and they varied from 6 degrees to 21, and they all cut great. I think there is so little to sharpening bits for brass they make stuff up to fill the pages of the book, and in doing so make this seam like voodoo.

Here is what I learned- use your bare hands and turn the lights down!

Bare hands because: when you are grinding, the metal is going to get hot-if the bit gets too hot to hold before you have one complete bevel done-you are grinding to steep an angle! This will teach you “how much is too much” in a hurry, and once the bevel on one side is ground-dip the bit in the water, then grind a bevel on the next side.

Turn the lights down because: as you grind you are working toward the very front of the bit-or the cutting tip. By turning the lights almost off-you will be able to watch the sparks “climb” toward the tool tip. Once the sparks reach the top-the bevel is done. It’s that simple-and it really does work.

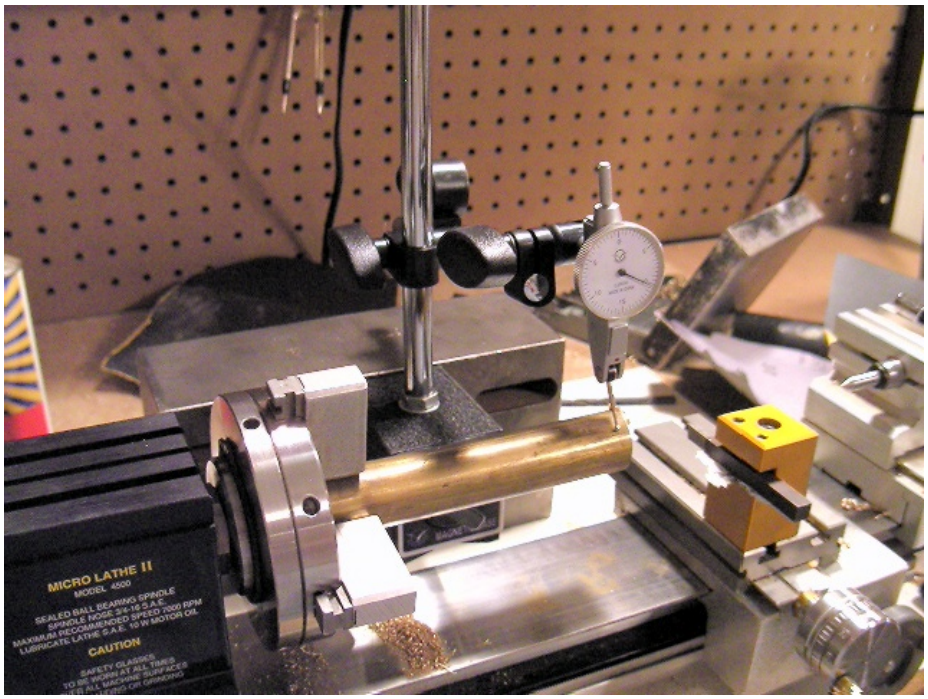
If you have always had trouble getting bits to cut brass with a good finish, follow this method. There are no exact bevels, no rocket science, nothing hard at all. Just remember-small tips for ship modeling and soft material, bare hands, lights dimmed, and use HSS.



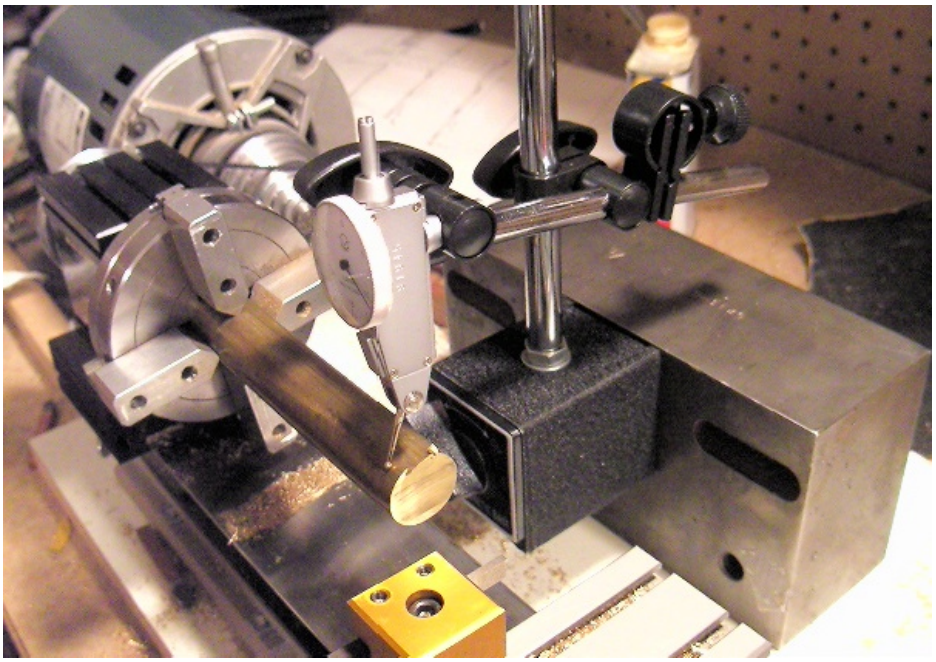
These are bits I just ground using this method. The two on the left are not small enough for ship modeling; those are for a project in steel. But, the one on the right I will use in this tutorial.

Part 3 – Setting Up Using a Dial Gauge

I am going to show a little advanced set-up. You will probably never need any of this for our hobby, but this will give you some ideas in case you ever do need it. This is dial test indicator- this is different from a normal indicator because it has a “finger” that moves side-to -side. A regular indicator has a “plunger” that moves only in and out- both will work for hobby use, but a test indictor is a little more versatile.



All this does is measure how far out of round something is, or used a different way- how flat something it, or how far off center something is. Any deviation is measured by the finger, and the amounts are shown on the dial. They can be set-up on a base like I have here, or actually mounted to the lathe or mill-WHAT you are trying to measure determines how you set these.



You can see the arms for the set, these are totally adjustable-up, down, angled, in and out, etc, etc. All the arm does is hold the indicator head itself-the set up I have here has a magnetic base for mounting. This is a good set-up for the lathe-just make sure the base and arm are very solid or the measurements of TIR will be off. Total Indicated Run-out (TIR) is just what it sounds like, total amount out of “not perfectly centered, flat or round” something is, as measured by an indicator. I am not going far into this advanced stuff, because you will never need it for our hobby- but again this will give you some of the terminology.

Here is the face of the indicator, notice the minimum it will measure. This is a very inexpensive set, less then $100.00-but more then adequate for my home use or anything related to our hobby. You can get ones called “tenths indicator” meaning one tenth of one thousandth of an inch, or .0001. We do NOT need or WANT one of these for our hobby-the finger moves back and forth such a tiny bit-we could never measure anything without running out of finger travel! If you buy one for hobby machining, this size is fine. Notice the gage is set at 11 (or about), I just quick set this up, normally you would rotate the outer face of the dial until it read zero to start (one of my bad habits right here). You want to set one of these up so the finger (when you first begin) is about in the middle of its travel.

Now spin the stock by hand and read the maximum amount the finger has moved both ways. Now using the last picture and this one, the needle has moved 3.75 lines, for a total indicated run-out (TIR) of .00175 or close to that. Remember, each line on the face is equal to 5000-10000th of an inch, or one half of one thousandth of an inch (same thing). People often misunderstand tolerances for machining, and a real machine shop setting up important parts will use much more accurate tools, getting much, much closer to a .000000 (perfect) TIR. But for anything I would do at home, this is way close enough.

Now, remember - you don’t need any of this equipment for our hobby, but if you do for something else, at least you will have some understanding of what it does.

Part 4 – Facing and Finish

As I mentioned a while ago, I learned most everything from a good machinist- but he had some bad habits and he passed these on to me. I thought about doing this tutorial keeping my bad habits in mind-I didn't want to pass these on again and maybe have someone get hurt-I would feel terrible. So while reading this, if you see something unsafe looking, or odd, or "un-workman like"-it is. And DON'T DO IT! I have edited all my pictures as carefully as I could to weed these out, but my bad habits are hard to break, and that's how I learned. I may not have spotted them all, because its what I do every time.

Remember to be safe, use common sense at all times. No-matter what happens, the lathe and work can be replaced with a few dollars, a hand or an eye cannot.

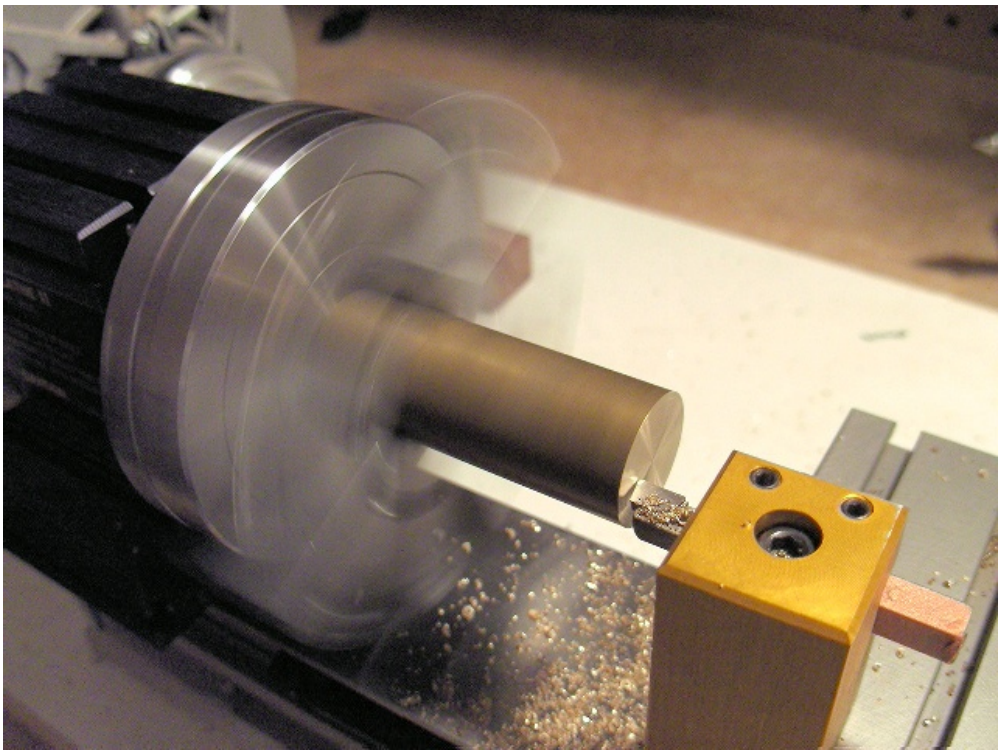
NEVER reach into a lathe to clear something out, turn it off first.

ALWAYS wear something over your eyes, the chips can really fly- these are sharp and sting like hell. If you don't wear something (it does not have to be safety glasses-anything to cover your eyes will work) sooner or later you wont be able to remove the chip from your eye yourself, and you will be driving to the hospital crying like a little girl.

Now put a piece of brass in the chuck-something round. This is the shape that is most common for all the metal work on a ship model. I use ONLY 360C free machining brass-this is very common and easy to find. There are other types of brass, and each has its own quality's- but 360C will give you a superior finish and is easy to work with.

Tighten the work in the chuck well, then before ever turning the lathe on-spin the chuck around a few times with your hand. It is VERY easy to leave a wrench, tommy bar or anything else on or in the path of the lathe jaws. By doing this EVERY time, you will avoid damage to the lathe (and more importantly, yourself!)

Now turn the lathe on, the first thing we are going to do is called 'facing'. All this means is we are squaring up the end of the work. I am using a carbide bit for this, I will show the finish. Move the bit across the face of the work, removing just a tiny amount.



Here is a picture of the face off after I had centered the bit. See how rough it is? I cant do all that much better with any carbide bit on brass- and this is not my first time! I will continue to show some work with carbide bits, and HSS-this will help you recognize some of the problems you might encounter with your finish.

What is meant by centering the bit is this-when you are done facing off if there is a little nipple of metal left in the very center of the work-the bit needs to be adjusted up or down just a tiny bit until that nipple is gone. Unless your bit is WAY out of center (if it is way out, re-shape the bit), a shim can be used - I will mostly use different thickness of paper to do this. Starting with a very thin shim- tracing paper, then writing paper, then card stock, then folded card stock or any combination of these. When turning brass it is very important that the bit tip is dead center to the work!

NOT HAVING THE BIT PERFECTLY CENTERED ON THE WORK IS ONE OF THE CAUSES OF POOR FINISH ON BRASS.

Because this picture also shows a small hole bored, lets talk about drilling brass. You can buy what is called a “center drill”, this is a special tapered drill bit, and they work well, (in the tips and tricks forum of MSW there is an article called “how to drill brass”- read this for more information on regular drill bits-center drills are the same). These center drills are also kind of pricey, and again don’t work that well in brass without “dulling down” the bit a little.

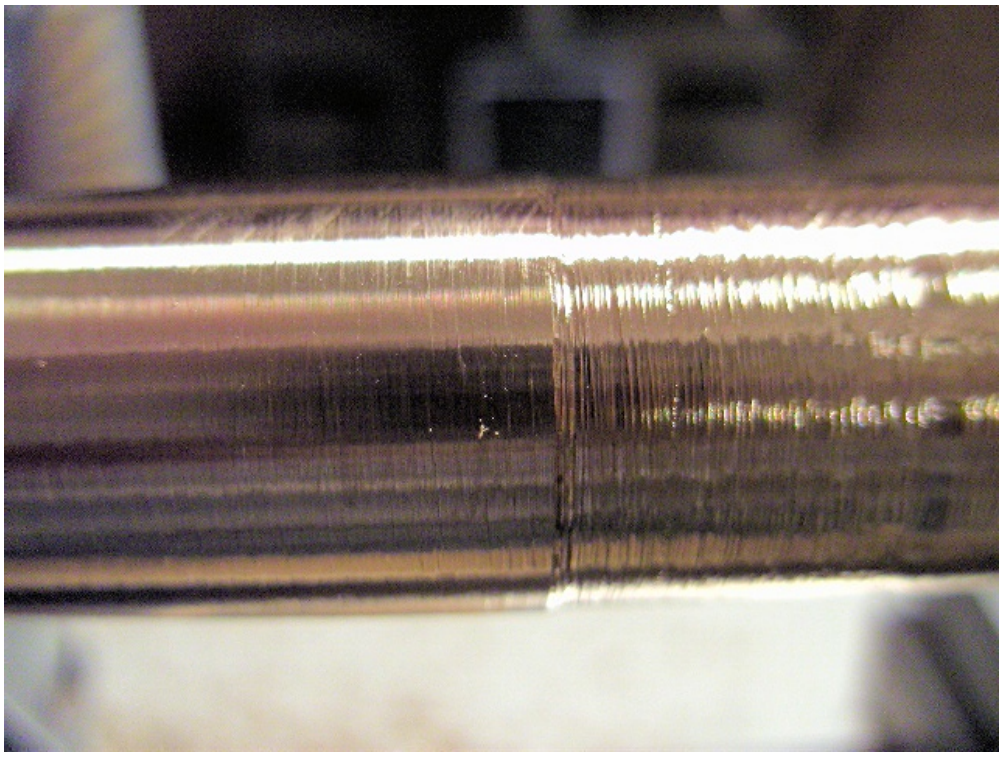
What the picture shows is how I do this, in the drill chuck is a 1/16 inch end mill. This end mill is a four flute center cutting mill, meaning it will cut like a drill bit-straight in. These are not very pricey, do a great job without flexing off center like a drill bit-and a good one will last your life-time for brass without ever sharpening. You can but them on E-Bay, just type “end mill” into the search box. These never try to “screw themselves in” like a regular drill bit, avoiding many headaches.

Now that you have faced-off the brass, and drilled a small hole- mount the DEAD center in the tail stock and insert it in the brass. Don’t ram it in too hard, just make it a tight fit. Now I know the hole we have drilled is not the right shape for the center, but this does not matter much for a soft material like brass (in a hard material like steel-it matters a lot!). You might want to enlarge the hole a little if you have problems with the finish you are getting though. In this case it is “whatever works” the best. If you are not comfortable with this, use a 60 degree center drill, this will match up perfectly with most centers (live or dead).

Whenever you use a DEAD center, you must use a lubricant-for brass just a drop of oil is enough-apply it whenever the tip of the center looks dry.

Now that everything is faced, and mounted solidly we can do some turning on the side.

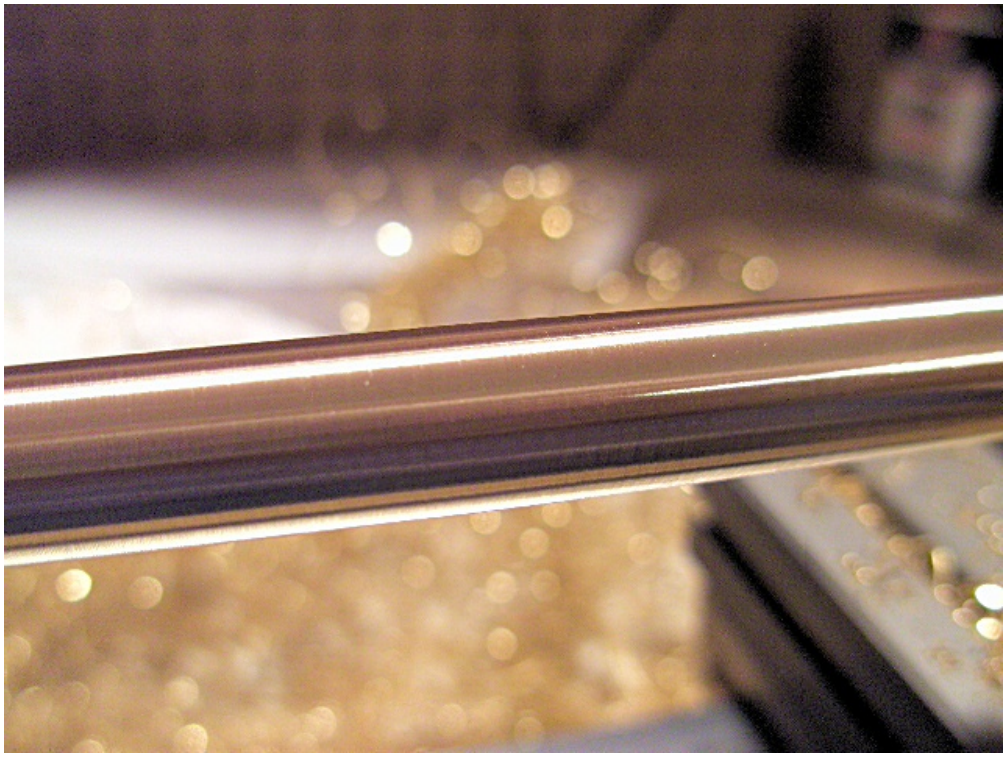
IMPORTANT! Chatter marks are mostly caused by the work “flexing” on the lathe. Sounds impossible, but even this 1 inch thick piece will flex. Working with metal takes a lot of pressure, and by not having a rigid set-up, the work WILL flex, even much thicker pieces. I will show chatter marks and some ways to get a better finish. MOST CHATTER MARKS ARE CAUSED BY A NON-RIGID SET-UP!



Here is a close up of a medium finish and a very poor finish. If you look close at the far right side of the poor finish, you will see some “chatter” marks-see how the light reflects like little mirrors in the center of the work? Those are marks caused by flex of the 1 inch brass rod! I used a carbide bit for this shot, with and without a center mounted. The finish on the right is without a center, left with one mounted. Even the finish on the left is pretty poor-the camera made it look much better then it really was. I would call the one on the left a “medium” finish at best.

Chatter sounds like hammering to me, and if it is really bad its quite load. Again, this is the work slamming into, moving away, then slamming back into the bit-it happens very fast and a tiny amount. Chatter can also be caused by speed-but that is much less likely to be the problem and we will go over that later. Rigid set up is the most important part of turning anything on a lathe. If you are working very close to the chuck, you can get away without a center-but still might have some problems. ALWAYS USE A CENTER WHEN YOU CAN.

The hardest thing to get a good finish on is bit boring on a long piece, I tried to take some picture of this but my camera just wouldn’t show what I wanted. Boring with a bit begins by making a hole in the end of the stock, large enough to fit a bit into. Then you slowly move the bit TOWARD yourself and this removes stock. A turning bit is not a drill bit, and will not make its own starting hole! This type of turning would be used inside of a bell for instance.



Now this is a perfect finish, hardly a tool mark on the piece. This was done using HSS and a dead center. See the gold stuff in the back ground?

These are brass shavings and chips. Chips are made because of chatter. Think of it this way, metal is like a roll of toilet paper (stick with me here), if you tore off one tiny sheet at a time and threw them on the floor-those are chips. The motion is jerky and not smooth at all.

Now if you grabbed the end of the toilet paper roll and smoothly rolled it all off the core, it works nice. THIS is how metal wants to be cut, one long smooth shaving. The “gold stuff” in the last picture is a big pile of smooth shavings.

Books will quote lathe speeds, all these charts were designed to get the maximum amount of production out of the workers and still acquire a good finish. Most of the charts say 1400 RPMs with HSS in brass-a good guide line, but that’s all it is- a suggestion.

I am not working on the floor of a shop when doing ship model building. I will tell you that I turn brass mostly at about 2200 RPMs, but I can also turn it VERY slowly, around 500 RPMs.

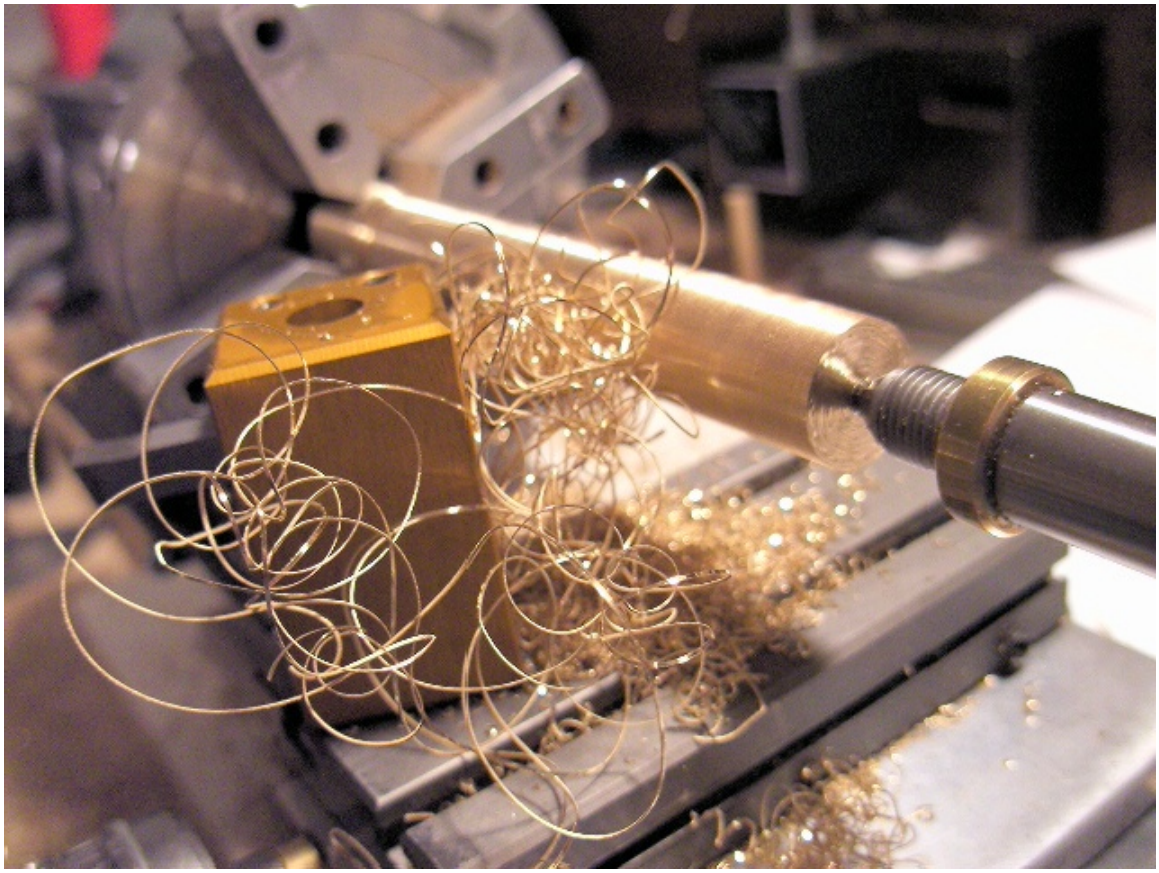
Don’t go by what a book says, use the speed that works for you. The speed of the lathe is nowhere near as important as the “feed speed” you use, and how much material you try to remove in one pass.

Feed speed is how quickly you move the bit along the work using the hand wheels. Too slow and you wont get a nice shaving-but you should bet some shaving. Too fast and you will get shaving but a poor finish. Feed speed cannot be taught, it will take just a little practice.

Now imagine I set my lathe speed at maximum-7000 RPMs. No matter how fast I turned the hand wheel I cant do it fast enough! I will never get a god turn this way. So lathe speed is a little important, if you are having trouble try slowing or speeding up your feed speed-if that doesn’t help at all, slow the lathe down.

Depth of cut is important also. If you try to take too much off at a time, this will make some noise-kind of a high pitched squealing, or worse- chatter. It is easy to try and remove too much, but it is impossible to remove too little. Again, books say this and that-remember that’s to get the most production done-most are not written with a hobbyist in mind.

It is impossible to explain some things in this tutorial, you have to do a little practice. I will try to explain the noise you will hear when everything is right though-- scscscscscscscscscccscscccscscscscscscs--lol.



And that’s what it will look like!

(Notice the dead center in use here, and the threads to mount a drill chuck to it.)

Now I admit, it took me a solid 10-20 minutes of messing with feed speed, and lathe speed to get this. If you are brand new at turning, it will take longer but it will happen with just a little practice. Don’t use oil for turning on brass, you don’t need it and it just makes a mess. Only use oil on the tip of dead center.

Now lets make some examples.