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Wooden 6 lb Stinger Missile Tooling

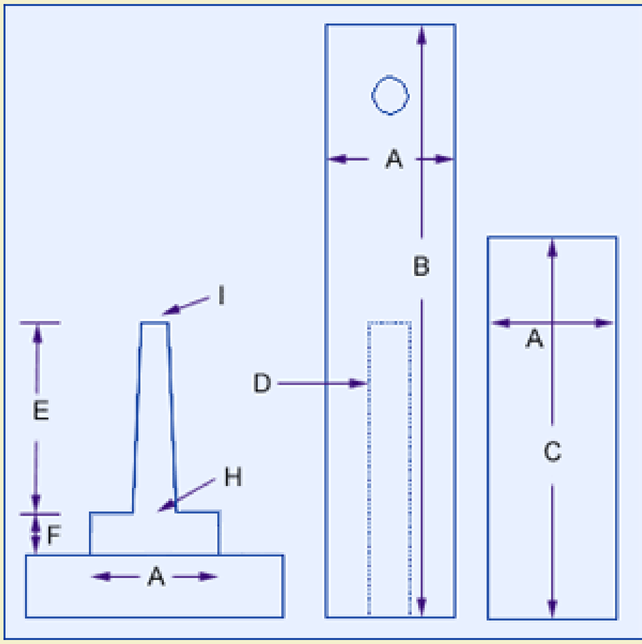

Figure 1: Dimensions for 6 pound Stinger Missile Tooling.

Description	Letter	Size
Rammer Diameter	A	1.5"
Hollow Drift Length	B	7"
Solid Drift Length	C	4.5"
Hollow Drift Hole Diameter	D	0.5"
Spindle Length	E	2.22"
Nipple Height	F	0.5"
Spindle Base Diameter	H	0.5"
Spindle Tip Diameter	I	0.3"


Figure 2: Laminating 1-1/2" thick stock from two pieces of 3/4" thick stock.

Introduction:
This article shows how to build the tooling required to make the 6 lb whistle rocket described here. The tooling is designed for making 6 pound stinger missile rockets, which is a type of spin stabalized rocket that uses a choked exauhst in combination with a side drilled exhaust to impart a spin to the engine as it rises. The spin actually stabalizes the engine via gyroscopic forces to the point that no stick or fins are required to insure an upward trajectory.

Rocket tooling is ideally made from non-sparking, non-corrosive metal such as brass or aluminum. A high quality version of the tooling shown here can in fact be purchased from Wolter Pyro Tools for just under $100 at the time of this writing.

While making smaller rocket spindles from wood can be quite difficult, the task becomes easier for larger tool sets. Metal rocket tooling becomes quite expensive as the rocket bore size increases, thus making wood an attractive alternative for those capable of working a simple wood lathe. The $300 cost of a typical wood lathe can be quickly reclaimed after making

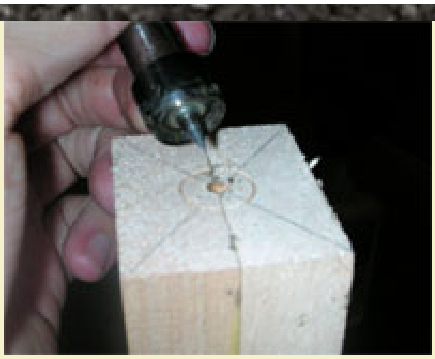

Figure 3: Punching and oiling the tailstock center.

Figure 4: Notching the end to receive the spur center.

Figure 5: Reducing turning time by shaving off the corners on a bandsaw.

Figure 6: Proper tool rest position.

a few simple projects such as a 6" case former, 4" comet pump and this 6 pound rocket tool. Only a minimal amount of woodworking skill is required to make lathe projects, as you will generally only be making straight cylinders.

Preparing the Stock:

The wood of choice for making smooth and strong tooling is Rock Maple with the closest grain possible. Since maple is no longer sold in most home improvement stores, you will have to go to a wood specialty supplier to obtain a piece. This project will go considerably faster if you can get a piece of maple that is already turned down to a 1-1/2" dowel rod. However, this would be a lucky find so I will describe how to take standard 3/4" thick stock and make a cylinder.

Start by ripping two 2" wide pieces that are 16" long (grain running in the long direction of course). These will be glued and clamped together as seen in Figure 2.

When the glue dries, mark the center point at both ends with an 'X'. Remove the tailstock center from your lathe and use it as a punch to make the indentation shown in Figure 3. The wood piece will be spinning on this joint, so make sure you hammer it hard enough to sink in the rim of the cupped edge around the center point. Applying oil to the wood around this pivot point is highly recommended.

The "headstock" end of the work piece needs to be scored with a crossing set of cuts, as seen in Figure 4. These notches will receive the claw of the spur center, allowing it to securely grab the wood as it turns.

While the work piece can be turned at this point, removing the corners will greatly reduce the time required to achieve a cylinder and make turning much easier. Figure 5 shows one way of shaving off the corners using a band saw with the table set at 45 degrees. Draw a 1.5" circle around the center point of each end to be sure you do not shave off too much. Cutting too deep will ruin the piece and you will have to start over.

Figure 6 shows the piece chucked up in the lathe. The tool rest is placed just above the center point and is adjusted so that there is only about 1/4" gap between the edge of the tool rest and the widest part of the work piece.

A wide skewing chisel is now used to reduce the octagonal shape to a smooth cylinder. The piece is most likely too long for your tool rest to allow the entire length to be turned in one swipe, so you will need to turn down half the piece, move the tool rest and then turn down the other half.

As you approach the destination diameter of 1.5", you will need to turn off the lathe frequently and check for the correct diameter and evenness. While a caliper can be used for this, I prefer to make a half circle template out of thin plywood and use this to check sizing instead. This template can be quickly


Figure 7: Using a half-circle template to check for proper diameter and eveness.

dragged down the length of the piece to scan for size inconsistency. Having an oversized region along the shaft somewhere will result in your rammer getting wedged into the rocket engine!

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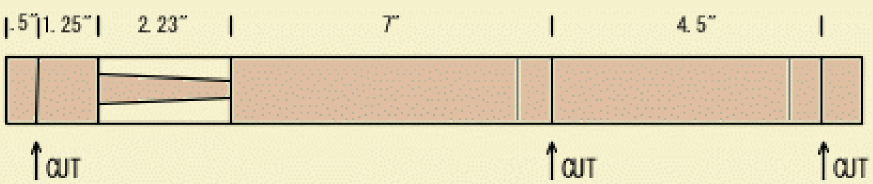


Figure 8: Marking cut points with a pencil while work rotates.


Figure 9: Turning down key spindle diameters with a parting chisel.


Figure 10: Removing the remaining material with a skew chisel.

Turning the Spindle:
A stone sculptor who was well known for the realism of his work was once asked how it was that he could take a block of cold stone and turn it into the amazing likeness of an elephant. He replied "I start with the block of marble, then carefully chip away everything that does not look like an elephant."

Lathe work is a lot like this subtractive procedure, although a lot simpler than carving elephants from stone. In the case of the tooling being made here, we basically carve away everything that does not look like a rocket spindle! The remaining two components are merely cylinders that are cut from the larger cylinder to produce the two ramming drifts.

The diagram above shows how the three components of the toolset will be cut from the single piece of 16" long round stock. Having turned an even 1-1/2" diameter rod at this point, the only real challenge left is turning down the spindle.

Begin by marking five lines on the work piece as shown above. With the lathe turned off, mark each point with a pencil as seen in Figure 8. For each tick mark, place the pencil on the tool rest with the tip on the mark, then turn the lathe on and press to create guidelines that are visible while the stock is rotating. Two extra lines can be made a little to the left of the drift ends, which will indicate where to cut a small decorative channel to mark the handle end.

A parting chisel is used to quickly turn down a channel at the base and tip of the spindle. Turn both ends down to just above .5". These two cuts will also serve to face off the base of the spindle and the bottom of the hollow drift. The two cuts can be seen in Figure 9. A parting chisel has a pointed end that cuts from a sideways position instead of laying flat on the tool rest like most other chisel types. This narrow profile is designed to cut straight into the work piece as deep as required. This chisel cuts it's own clearance and will not bind, making it ideal for facing off right angles or cutting all the way through a work piece.

Next use the flat skewing chisel to shave down the remainder of the spindle to match the diameter of the slots on either side, as seen in Figure 10. Care must be taken as the diameter nears the stopping point, as trying to take of too much material at once can cause flexing and possibly break the spindle.

Once the entire spindle is pretty near .5" diameter, use a metal file as seen in

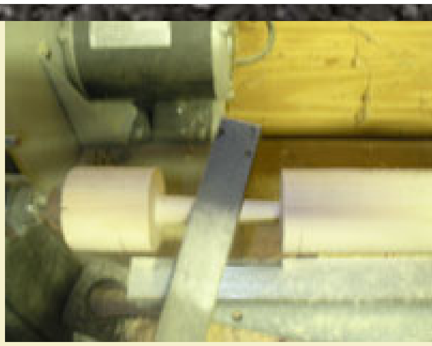

Figure 11: Using a file to produce an ultra smooth finish.

Figure 12: Using a caliper to check critical diameters near the finish point.

Figure 11 to fine tune the taper and give the spindle a smooth finish. One end of the file sits on the tool rest, while you other hand should hold the tip of the file to help hold it down on the workpiece. Material will be removed very slowly this way, allowing you more control as you approach the final profile of the spindle. The tip needs to be .3" in diameter, while the base needs to finish at .5". A caliper is used to verify the correct diameter of the base and tip, but there is no easy way to ensure an even taper without some kind of guide jig. You just have to eyeball the taper and hope your judgment is good!

While you have the file handy, give the edge of the spindle base and hollow drift a slight taper to help help when loading casings and inserting the rammer.

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Figure 13:Using a modified hand saw to make three separation joints.

Figure 14:Using a thin kerf pull saw to cut make the final separation cuts.

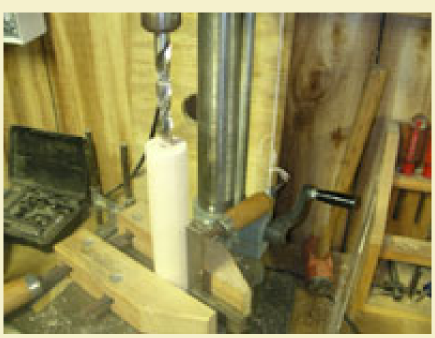

Figure 15:Drilling out the hollow drift with a 1/2" bit.

Separation and Assembly:
After the spindle is complete, the pieces are ready for separation. While the stock could simply be removed and cut into the various pieces using a table saw, cutting it on the lathe has several advantages. Separating the pieces on the lathe insures that the resulting cut is square with the sides of the rod. Separating the pieces on the lathe also makes it easy to determine the center point of the hollow drift for drilling purposes.

The pieces are not actually completely separated while on the lathe. A cut is made almost to the center, but stopping short so that about 1/2" of rod is left connecting them together. This connector piece is then cut apart afterwards using a hand saw.

While the parting chisel can be used to make the separation cuts, I prefer the use of modified hand saw that has a notch cut out near the handle. This notch allows the saw to hook onto the tool rest and thus avoid kick-back as the work piece spins into it. The saw is simply hooked in place above the guideline, then slowly brought down into the work piece while it is spinning. Care must be taken to check the depth of cut periodically to prevent from cutting too far. Otherwise a mark can be placed on the saw using masking tape so that you know when to stop.

Because the ends of the work piece are marred from the center points and are most likely not very square, both ends are lopped off and not used. This means that you will need to make three separation cuts with the saw, as seen in the illustration at the top of page 2.

Once the separation cuts are made, the stock is removed from the lathe and clamped in a vice as shown in Figure 14. Rubber no-slip matting is used around the work piece to prevent the vice teeth from damaging the finish. A thin kerf pull saw is then used to finish the separation cuts and also separate the spindle from the bottom of the hollow drift. A sander can be used to sand down any nubs left by the connector joint.

Now it is time to drill out the hollow drift. A 1/2" diameter hole must be made dead center into the bottom of the drift. The hole must be about 3" deep and be perfectly parallel with the length of the rammer. The best way to make this type of hole is to have a lathe that can be adapted with a chuck that will hold the rammer on the headstock while a drill bit is mounted in a chuck adapter on the tailstock. This way the drill bit is perfectly centered and parallel to the rammer, and it is fed into the work piece. This is standard practice on a metal lathe but not a common feature on many wood lathes. Thus, you will most likely have to do things the hard way and drill the hole using a drill press.

First you will want to center punch the mid point of the rammer where the hole is to be drilled. The lathe markings should make it easier to determine the center, as will the seam where the two boards were glued together. One key to insuring a straight hole in the rammer is to insure that the top of the rammer is truly square. Placing the rammer on end and using a right-angle gauge will reveal if your separation cut was squared off. The piece is then clamped in a wood clamp under the drill press, as seen in Figure 15. This helps insure that the rammer is perpendicular to the table. Note the angle gauge being used in Figure 15 to check for perpendicular positioning as well. Make sure everything is aligned for this critical step, then drill away!


Figure 16:Finished pieces ready for sealing and hardening.

Figure 16 shows the turned pieces ready to be finished. The last bit of woodworking left is to build up a base block around the spindle piece. The nipple was cut 3/4" longer than it needs to be so that it can seat securely into a 3/4" block of wood.


Figure 17:Using an adjustable hole cutter to make a 1.5" hole for the base.

Prepare two 2" square pieces of maple for the base. One piece will need a 1-1/2" hole drilled all the way through it. The best way to do this is to use an adjustable hole cutting jig as seen in Figure 17. This tool uses a cutting bit mounted into an adjustable arm that rotates around a center bit which drills into the wood and holds the center point. Figure 17 shows the tool along with the plug that results after the hole is cut. Since a lot of torque is involved, the wood block must be secured firmly in a clamp. Do not attempt to hold it by hand, especially since the adjustment arm of the hole cutter will be swinging around at high speeds!

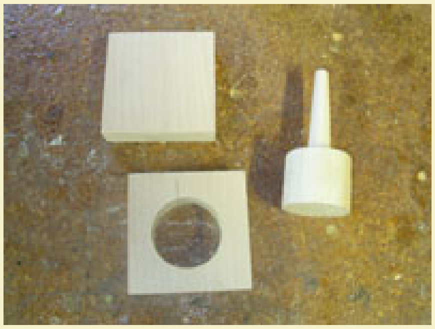
Figure 18: Spindle base parts ready for assembly.

With the hole successfully cut, you should have three pieces that will make up the spindle base as seen in Figure 18. Wood glue is applied to the inside of the hole and to the face of the solid block and the two blocks are clamped together so that their grains run in opposite directions. The spindle is inserted into the hole and four clamps are used to secure the pieces for drying (see Figure 19).


Figure 19: Gluing the spindle and two base plates together.

At this point the tooling is complete and needs the final step of water proofing. I prefer the use of marine epoxy for this step, as it is very strong, waterproof and goes on thick for a nice glossy finish. I apply two coats, sand, then apply a third and final coat.

Marine epoxy is a bit pricey and if you do not have any on hand then you really can't justify buying the pumps, brushes, gloves, resin and hardner just for this project. Polyurethane or Kryolite should also serve the purpose of protecting the wood when washing off your tooling between uses. Apply as many coats as it takes to get a smooth, glossy finish.

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