OVERVIEW ON DESIGN FOR MACHINING OF PEPPER GRINDER

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ABSTRACT

This design for machining relied upon the use of primary investigation through models which tested the ergonomics and anthropometrics, the optimum size for the shaker holes and the balance of the inverted form. These grinders stand inverted on a tumbler base which is also the reservoir for the peppercorns. This stops loose grindings soiling tables and creating mess. The pepper is ground into a stainless steel ‘bulb’ from which it can be shaken over food therefore combining the benefits of freshly ground condiment with the accurate dispensing of a shaker. The form of the grinder makes a visually interesting table feature. The construction utilizes existing technologies and high quality materials. The ergonomics make the grinder pleasing to handle with the polyamide grip having a soft touch finish. The design has a deliberate ‘retro’ feel that looks back to shapes and forms from a past era but utilizes contemporary materials.

Key words: Grinder, Shaker and Polyamide grip.

Introduction

In machining, material is removed from the work piece until the desired shape is achieved. Clearly, this is a wasteful process, and many engineers feel that a main objective should be to design components that do not require machining. Since most manufacturing machines are designed to remove metal by machining, the view that machining should be avoided must be considered impracticable for the immediate
future. However, the trend toward the use of "near net shape" processes that conserve material is clearly increasing, and when large-volume production is involved, this approach should be foremost in the designer's mind.

**Machining of pepper grinder (Implementation of Design for Machining)**

A pepper grinder comprising a pepper seed bottle having upper and lower openings, through which upper opening the bottle may be refilled. A pepper grinding mechanism is provided in the lower bottle opening, through which ground pepper may be dispensed. The mechanism comprises a female grinding member and a male grinding member supported co-axially therein for relative rotation to grind pepper, the two members being spaced apart by an annual gap in which pepper is to be ground. The mechanism includes a positioning ring in engagement with the male grinding member, which may be turned to adjust the axial position of the male grinding member relative to the female grinding member and hence the width of the gap and in turn the pepper grinding size. The positioning ring comprises a ring body and two spokes that extend across opposite sides of the ring body for engagement by a user to turn the ring.

**Dual Mechanism Pepper Grinder**

The salt and pepper mills shown here have the same shape and dimensions. What sets them apart is the choice between the 8" traditional (see Figure 1) and the CrushGrind shaft mechanism (see Figure 2); which one you choose is up to you! You will be able to use the drilling dimensions for the two mills to develop your own designs Dimension Notes. The dimensions given on Figure 3 are for the inside bore of the wooden body of the grinder. The outside dimensions will vary to suit the design, but the wall thickness should be at least 3/16". The length of the main wooden body and cap will vary, depending upon the size of grinder mechanism chosen, but the various bore dimensions will always remain the same. The finished length of the body/cap must be 1/8" (± 1/16") longer than the shaft of the mechanism. In other words, a 6" mechanism will fit in a finished body/cap with a length of 61/8", a 10" mechanism in a 101/8" tall (long) grinder body/cap, etc. When determining the length of your blank is sure to allow extra length for tenons, parts, and material to be held by turning chuck jaws. Using a scroll jaw or collets chuck for the complete turning operation. The wood blank used should allow for making the body and cap as well as the waste held in the chuck and parted off during turning. The base of the grinder will be on the tailstock end of the lathe.

**Turning Method 1: 1.** Cut the internal step used to accommodate the grinding mechanism base (Figure 1). This hole would be 15/8" diameter and 1/2" or deeper in depth. 2. Center and bore a 11/16" diameter hole in the wooden blank to create the cavity for holding the peppercorns, grinding mechanism, and internal spindle. This hole can be cut using turning tools or by using a 11/16" diameter multi-spur bit. 3. If a multi-spur bit is used, the bit should be held by a Jacob's
chuck in the tailstock of your lathe. Set your lathe speed for approximately 500-700 RPM and drill to depth by advancing the tailstock/multi-spur bit into the wood blank. It helps if the bottom surface of the wood blank is faced or turned flat before drilling. This center hole should be bored completely through the length of the body plus about 1/4” for tenon (Figure 2).

**Turning Method 2**

1. All turnings and boring for the body are the same as Method 1 except that no tenon is cut on the top of the wooden body. Instead, after parting the body from cap turns a 1” diameter by 1/4” long tenon on the bottom of the cap. Drill a 1/4” hole through the cap. 2. Place center bore of the wooden body onto the cap tenon and with the help of a conical plug hold the entire assembly in place with the ball bearing tailstock. Complete the turning, matching the cap and body.

**Traditional mill**

1. Prepare the Blanks: The base blank should be 3-1/2” square x 6-5/8”. The top requires a piece 3-1/4” square x 4-1/8”. Mount the individual blanks between centers and rough-turn to the shape and size shown in Diagram A and Figure 4a
2. Prepare and drill the base. Hold the tenon in compression jaws. Be sure that it is running true and support it initially with the tailstock. Face off what will be the bottom of the mill. Before starting to drill, refer to Diagram B to clarify the series of actions you will be taking (use Forstner sawtooth bits). The drilling order is as follows:
   - Drill a 1-5/8” hole 1/2” deep (see Figure 4b).
   - Drill a 1-1/16” hole as far as your drill will allow.
   - Sand and seal the base.
3. Remove the blank and hold the bottom in expansion jaws. When running true, bring up the tailstock and mark the length of the base (5-13/16”). Part of the tenon and use a cleanup cut to ensure that it is to the required length.

4. Prepare and drill the top. Hold the top’s tenon in compression jaws and ensure it is running true before bringing up the tailstock for support. Turn the spigot’s diameter to be a tight fit in the 1-1/16” hole in the base in preparation for shaping the outside of the mill. Clean up what will be the mating surface of the top. Reduce the length of the spigot to 3/8”. Drill a 9/32” hole halfway through the top (see Figure 4c).

5. Shaping: The bottom of the mill’s base will fit into the drive plug (see Diagram D). Two halves of the mill are pushed together and supported by the tailstock for shaping outside of body (as shown in Figure 5). I used 3/8” and 1/2” spindle gouges for this. Don’t forget to create a shadow line between the top and base as shown on Diagram A. Power hacksaw blade to create this narrow groove.
6. Turn the top: The spigot’s diameter can now be reduced to fit into the base for ease of turning. Holding the tenon in compression mode, reduce the spigot to be a comfortable fit into the base, allowing for...
potential movement in the wood. Remove it from the chuck and wrap some masking tape around the spigot to reduce any marking by the jaws. As an alternative, a piece of bicycle inner tube can be slipped over the spigot (Figure 5). Initially, hold the spigot in compression jaws with the tailstock in place for support. Remove the tenon to give the correct length of 2-3/8". A 1-1/4" diameter insert was glued in the top of each mill. This provided a nice contrast to the overall look of the traditional, and it indicates that the contents are pepper. Drill a 1-1/4" hole 5/16" deep for the insert.

**Crush grind mill:**

(1) Prepare and drill the base

Prepare the blank in the same manner as for the traditional mill. Hold the tenon in compression jaws. Be sure that it is running true and then support it with the tailstock. Face off what will be the bottom of the mill. Before starting to drill, refer to Diagram to clarify the series of drilling actions that you will be taking (use Forstner sawtooth bits). The drilling order is as follows: Drill a 1-3/4" hole 7/8" deep, Drill a 1-1/2" hole 1-5/16" deep. Mark the distance 2-3/16" (7/8" + 1-5/16") on the drill using masking tape. It must be accurate to ensure that the mechanism fits. An alternate method of drilling is to use the Mill/Drill (Figure 6). Using a recess tool with a 5mm (13/64") cutting edge, form a recess 3mm (1/8") deep. The lathe speed should be around 700 rpm. Mark the required base length of 5-13/16", referring to Diagram C, and face off. Drill a 1-1/4" hole to meet the previously drilled hole. Sand and seal the top of the mill base, (2)

Prepare and drill the top Hold the top’s tenon in compression jaws, and while turning the piece by hand, ensure that it is running true before bringing up the tailstock for support. Form the spigot’s diameter to be a tight fit in the 1-1/4" hole of the base. Clean up what will be the mating surface of the top. Reduce the length of the spigot to 3/8". The drilling order is as follows: Drill a 7/8" hole 25/32" (20mm) deep. This is a critical dimension, so it is advised that you mark the distance on masking tape as before. Using the recess tool again, form a recess 3mm (1/8") deep. Drill a 1/2" hole 1-9/16" deep, Sand and seal the bottom. Measure and mark to 2-3/8" long, plus a small amount of waste, and part as far as the tenon, (3) Shaping: The bottom of the mill’s base will fit into the drive plug. The two halves of the mill are pushed together and supported by the tailstock for shaping the body (see Figure 7). Don’t forget to create a shadow line between the top and base as shown on Diagram B. I used a reshaped power hacksaw blade to create this narrow groove. Sand and seal. To enlarge the bottom opening in the base of the CrushGrind mill, turn a 1-1/4" drive plug and mount the top of the mill’s base on it. Take light cuts with a 1/2" skew to open the hole, giving easier access to the knurled knob (see Figure 7), (4) Base: The best way to ensure that the grinding half of the mechanism is fitted squarely is to use the jig made earlier, and just reverse it (see Figure 7). Prepare a piece of planed hardwood, approximately 1/2" x 3" x 3", with a 7/8" hole in
its center. Lock the tailstock in position. Gently screw the locked tailstock against the piece of hardwood. The mechanism will be forced into the base and you will hopefully hear the springs click into the recess. These DFM curriculum modules were developed through the cooperative efforts of three different Midwestern institutions and with industrial experts serving as advisors to this development. Although the development team is confident in the design of this new curriculum, there is a need for conducting pilot tests too continuously and improve the modules (Table 1 and Figure 8).

Conclusion
The development of the design relied upon the use of primary investigation through models which tested the ergonomics and anthropometrics, the optimum size for the shaker holes and the balance of the inverted form. These grinders stand inverted on a tumbler base which is also the reservoir for the peppercorns. This stops loose grindings soiling tables and creating mess. The pepper is ground into a stainless steel ‘bulb’ from which it can be shaken over food therefore combining the benefits of freshly ground condiment with the accurate dispensing of a shaker. The form of the grinder makes a visually interesting table feature. The construction utilizes the existing technologies and high quality materials. The ergonomics make the grinder pleasing to handle with the polyamide grip having a soft touch finish. The design has a deliberate ‘retro’ feel that looks back to shapes and forms from a past era but utilizes contemporary materials. The invention has been given by way of example only, and various other modifications and/or variations to the described embodiment may be made by persons skilled in the art without departing from the scope of the invention as specified in the accompanying claims.

References
Figure 1: Dual Mechanism Pepper Grinder

Figure 2: Crush Grind shaft mechanism.
Figure 3: The drilling dimensions for the two mills.

Figure 4 (a): Mount the individual blanks between centers and rough-turn to the shape and size.
Figure 4 (b-c): Mount the individual blanks between centers and rough-turn to the shape and size.

Figure 5: Two halves of the mill are pushed together and supported by the tailstock for shaping outside of body.
Figure 6: Hold the tenon in compression jaws.

Figure 7: The two halves of the mill are pushed together and supported by the tailstock for shaping the body.
Figure 8: An example of proposed new product designs. The left pepper grinder is the original design of a pepper grinder. The right one is the proposed new design.

Table 1

<table>
<thead>
<tr>
<th>Original cost of the old product design</th>
<th>Comparison Chart</th>
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