B-002
Regarding Procedure to Mill a V-Groove

Vincent W. Finley*

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Abstract: Cutting a long v-groove in a part is a frequent operation in machining. This article presents a method to mill a v-groove by locating the desired groove center on the work surface.

Given:

- An object with a planar (flat) surface mounted $\theta = 45°$ to the horizontal.
- *and* a coordinate system drawn from some arbitrary starting location on the object's surface plane, with +x axis to the left, +y axis into the page, and +z axis downward.
- *and* a right triangle with angles θ, and sides a, b of length L and a hypotenuse c.
- *and* a hypotenuse midpoint that coincides with the coordinate system origin.
- *and* a milling tool with diameter D whose bottom-left corner is at the coordinate origin.

Find:

- The distance to the left, in the +x direction, the milling tool must travel to remove a v-groove in the planar surface.
- The downward distance, +z direction, the milling tool must travel to remove a v-groove in the planar surface.

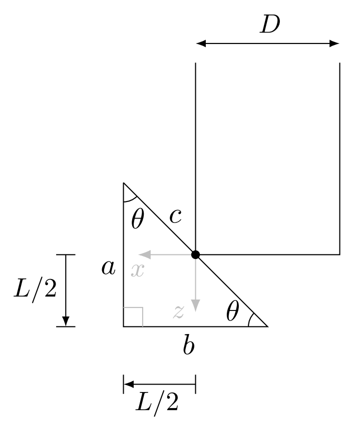

Figure 1: Initial relationship of work object and milling tool

1 Solution

As given, the right triangle shown in Figure 1 has sides $a = b = L$. Therefore $\triangle abc$ is an isosceles triangle.

Furthermore, angles θ are

$$\theta = \frac{180° - 90°}{2} = 45° \tag{1}$$

This is expected since the mounting angle of the work relative to the cutting tool was given as $\theta = 45°$.

Symmetry of the initial setup can be used to create a symmetrical v-grove in the work.

The diameter D is relatively unimportant since removal of material from the v-grove is accomplished by the travel of the cutting tool. By gradually plunging the cutting tool downward a distance $L/2$ along the z-axis, and shifting leftward a distance $L/2$ along the y-axis, the groove is formed.

Ideally the machinist should use a cutting tool where $D > L$, but this is not strictly necessary. This will avoid the need to return past the initial cutting pass.

Choosing $L \geq D$, or using a cutting tool with diameter $D \leq L$, is possible but will leave missed material before the starting cut. The machinist will need to make extra passes to remove the missed material.

Follow these steps to create a symmetrical v-grove in the work.

1.1 Method 1

This method starts cutting on the surface of the v-groove centerline. It is easy to setup. An advanage to this method is the machinst can choose to increase the value of L while machining, without disturbing the zero position of Digital Readouts or dial indicators.

1. Determine the diameter D of the cutting tool.
2. Mount the cutting tool in the milling machine.
3. Choose the desired length L for the depth of side a and width of side b.
4. Calculate $L/2$, this will determine the travel of the cutting tool.
5. Locate and scribe the place on surface of the work where the v-grove will be centered.
6. Mount the work at a $\theta = 45°$ angle in a vise in the milling machine, with the scribed line parallel to the y-axis.
7. Position the milling machine table so that the scribed line touches the bottom-left corner of the cutting tool.
8. Zero out any Digital Readouts or dial indicators.
9. Turn on the milling machine, make an initial pass along the y-axis.
10. On subsequent passes, advance the cutter leftward in the x-axis until it has traveled a maximum of $L/2$ to the left.
11. Advance the depth of cutter downward along the z-axis until it has sunk a maximum of $L/2$.

1.2 Method 2

This method takes a little longer to setup, but it will be easier to machine. If $D > L$, then it will only require the machinist to advance the cut depth along the z-axis until the maximum L depth (not $L/2$) is reached.

1. Determine the diameter D of the cutting tool.
2. Mount the cutting tool in the milling machine.
3. Choose the desired length L for the depth of side a and width of side b.

4. Calculate $L/2$, this will determine the SETUP travels of the cutting tool.

5. Locate and scribe the place on surface of the work where the v-grove will be centered.

6. Mount the work at a $\theta = 45°$ angle in a vise in the milling machine, with the scribed line parallel to the y-axis.

7. Position the milling machine table so that the scribed line touches the bottom-left corner of the cutting tool.

8. Zero out any Digital Readouts or dial indicators.

9. Now raise the cutting tool a distance $L/2$ along the z-axis.

10. Move the cutting tool leftward a distance $L/2$ along the x-axis.

11. Again, zero out any Digital Readouts or dial indicators.

12. Turn on the milling machine, make an initial pass along the y-axis.

13. On subsequent passes, advance the depth of cutter downward along the z-axis until it has sunk a maximum of L (not $L/2$ here)!!!

2 Example

Given:

- A piece of flat steel

- Milling cutter whose diameter $D = 0.75\,inches$

Find: Methods to mill out a v-groove where:

- $a = b = L = 0.7\,inches$

- One setup method is along desired groove centerline.

- Another setup method promotes depth-only cutting.

Basic Steps:

1. Start by labeling Figure 1 with the values of D and L.

2. Calculate the value $L/2 = 0.70/2 = 0.35\,inches$ and label the drawing with it, this will be the maximum travel of the cutting tool along the x-axis and z-axis.

3. Locate and scribe the place on surface of the work where the v-grove will be centered.

4. Mount the work at a $\theta = 45°$ angle in a vise in the milling machine, with the scribed line parallel to the y-axis.

5. Position the milling machine table so that the scribed line touches the bottom-left corner of the cutting tool.

6. Zero out and Digital Readouts or dial indicators.

Method #1:

1. Turn on the milling machine, make an initial pass along the y-axis.

2. On subsequent passes, advance the cutter leftward in the x-axis until it has traveled a maximum of $L/2 = 0.70/2 = 0.35\,inches$ to the left.

3. Advance the depth of cutter downward along the z-axis until it has sunk a maximum of $L/2 = 0.70/2 = 0.35\,inches$.

Method #2:

1. Now raise the cutting tool a distance $L/2 = 0.70/2 = 0.35\,inches$ along the z-axis.

2. Move the cutting tool leftward a distance $L/2 = 0.70/2 = 0.35\,inches$ along the x-axis.

3. Again, zero out and Digital Readouts or dial indicators.

4. Turn on the milling machine, make an initial pass along the y-axis.

5. On subsequent passes, advance the depth of cutter downward along the z-axis until it has sunk a maximum of $L = 0.70\,inches$, (not $L/2 = 0.35\,inches$ here)!!!