

Autodesk Inventor Tips & Tricks: Digital Prototypes in Inventor—Belleville Springs



In the world of machine design, multiple types of mechanical elements are used. One element that is used to accomplish many different results is the spring. Springs come in a variety of different styles and configurations, one of which is the Belleville Spring.

The Belleville Spring is essentially a conical washer made of a spring material such as Inconel or spring steel. These versatile springs can be used one at a time or in stacks. They can be stacked in parallel, in series, or in any combination. Stacking in parallel increases the load and stacking in series increases deflection.

Another Tool in the Functional Design Arsenal

Starting with the 2008 release, Autodesk® Inventor® has been enhanced with a Belleville Spring Generator. This tool allows the designer to select the Belleville size, stacking configuration, and location.

The Setup

Imagine that you are responsible for completing the design of a hydraulic vibration damper. The damper is complete with the exception of the piston backup spring. The forces required (and the internal dimensions) within the damper are such that a compression spring will not work in this application. It has been determined that a stack of Belleville Springs will do the job.

Using of the Belleville Spring Generator in Inventor, it is relatively simple to create a Belleville stack within the assembly. Let's look at the steps necessary to create your spring stack.

1. With your partially designed accumulator assembly file open, begin by starting up the Belleville Spring Generator. The Belleville Spring Generator dialog opens and displays several options pertaining to the design of Belleville Springs.

Tip:

Start the Belleville Spring Generator by clicking at the top of the Panel Bar, selecting Design Accelerator, expanding the Spring flyout, and selecting the Belleville Spring Generator icon from the panel bar.



Tip:

The Belleville Spring Generator tool provides the means to create a single spring, a series stack, a parallel stack, or a combined series and parallel stack. In addition, the springs can be modeled relaxed, compressed, or in a custom state.

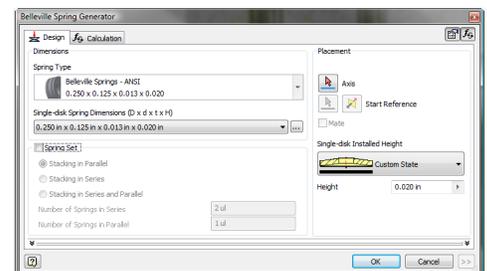
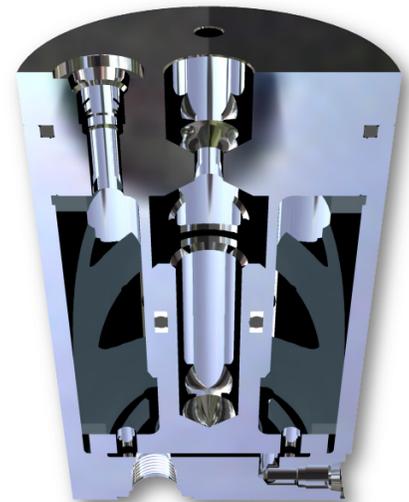


Figure 1, Belleville Spring Generator Tool.

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2. In the damper assembly, the spring envelope is defined by the inside diameter of the barrel, the outside diameter of the cap, the lower face of the upper retaining ring, and the upper face of the piston seal ring. The first step is to locate our spring stack. Select the inner face of the barrel to determine the stack axis and the upper face of the piston seal ring as the starting reference.

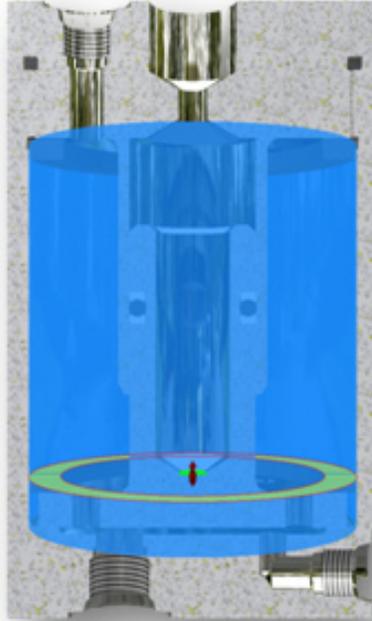


Figure 2, Spring Stack Location Definition.

3. Once the spring stack is located, you can determine the type and size of the Belleville required. For this application, the Spring Type is an ANSI Belleville, and the size we need is 3.0 x 1.5 x 0.075 x 0.169. As the spring is selected, the preview updates to reflect the selection.

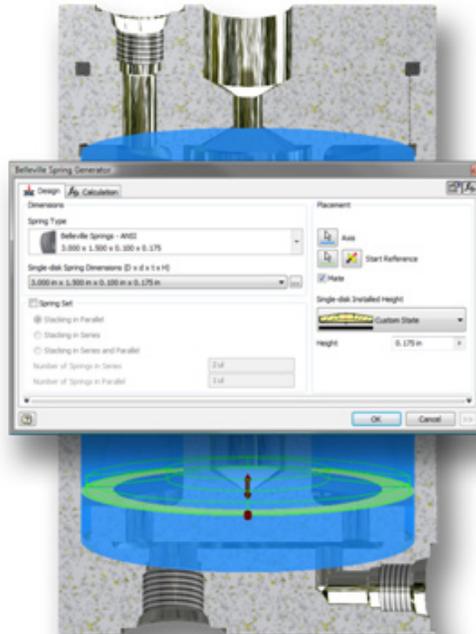


Figure 3, Spring Selection.

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4. After selecting the spring type and size, the next step is to define the spring set. In this particular case we would like to use a stack of Bellevilles in Series. Eighteen springs are required to fill the cavity. In this assembly, the springs are under load when the piston is fully extended. Therefore, the springs need to be modeled slightly compressed. To accomplish this, we specify a Height of 0.165 inches.

Tip:

The overall height of the spring stack can be specified in the dialog or by dragging the arrow glyph in the preview.

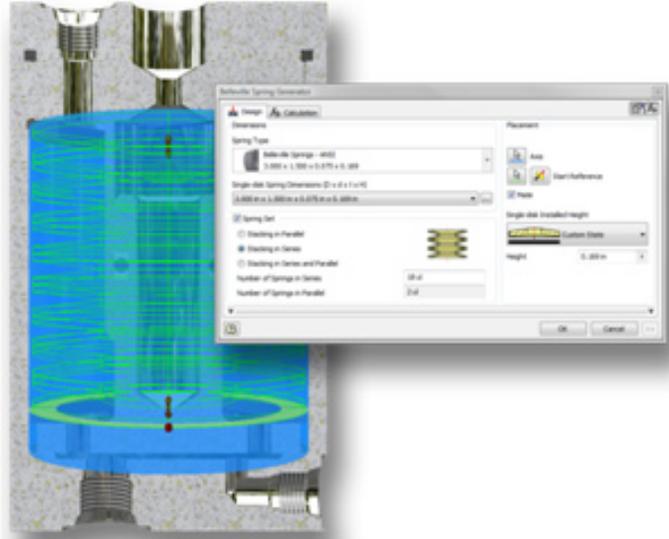


Figure 4, Spring Stack Definition.

5. Once the size and stack has been determined, the load and deflection can be evaluated based on material. After specifying a material, stroke and allowable deflection, the Belleville Spring Generator will calculate the load. By entering the load, the Generator will determine the stroke.

Tip:

The entire stack can be designed based on desired load or stroke.

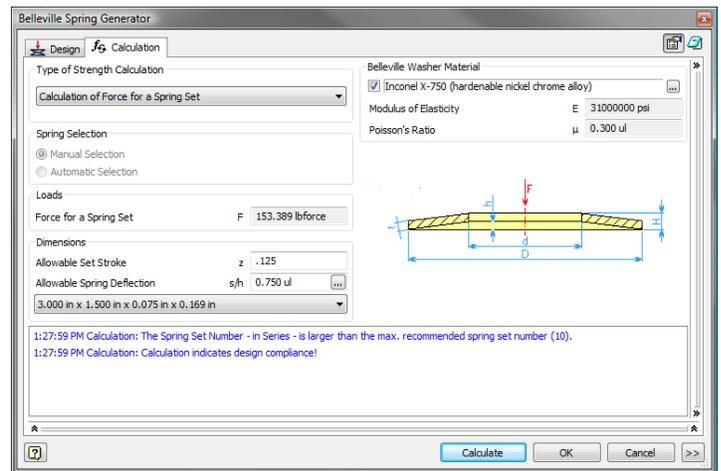
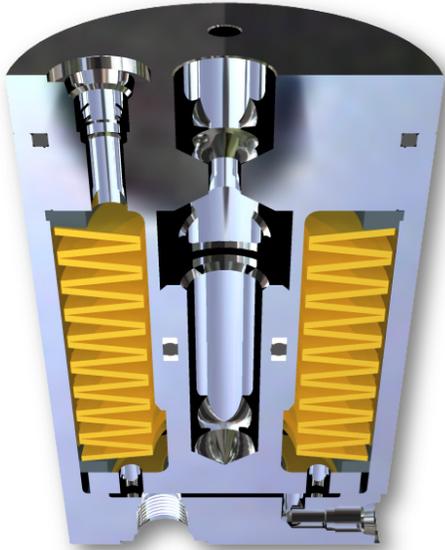


Figure 5, Belleville Spring Calculations.

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Conclusion

Belleville Springs can be created and placed efficiently – either individually or in stacks – with the Belleville Spring Generator. The generator provides a means of determining the resulting spring characteristics based on desired spring geometry, or the resulting spring geometry by entering the desired spring characteristics.

By leveraging this tool, you will find that it is a very simple process to design assemblies and evaluate digital prototypes in Inventor.