

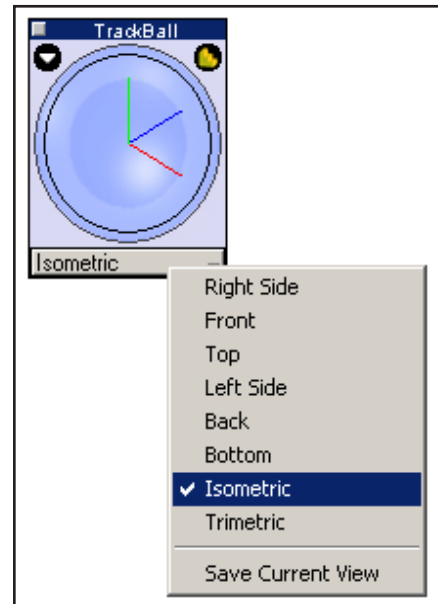
# Creating a Composite Curve Tension Spring

Start a new file and save it with the name, Tension Spring. All units noted in this tutorial are in inches. You will begin by creating the helical portion of the spring, which is only one piece of the curves required to complete our part. Once we have all of our curves we will use the sweep command to create the final part.

## Creating the Helix

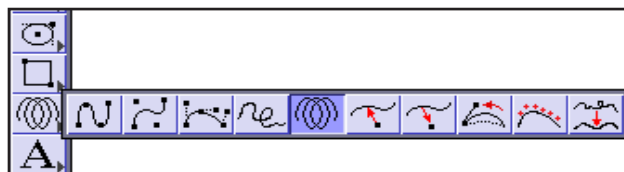
1. Switch the drawing view to Isometric using one of the following methods:

- **View>Isometric**
- **Right-Mouse Click, View>Isometric**
- **Use the keyboard shortcut (the letter “f”)**
- **Use the drop down menu on the trackball**



2. Starting at the Origin, create a helix curve with the following properties:

- **Pitch - .10"**
- **Diameter - .25"**
- **Length - 1.25"**
- **Draft Angle - 0**

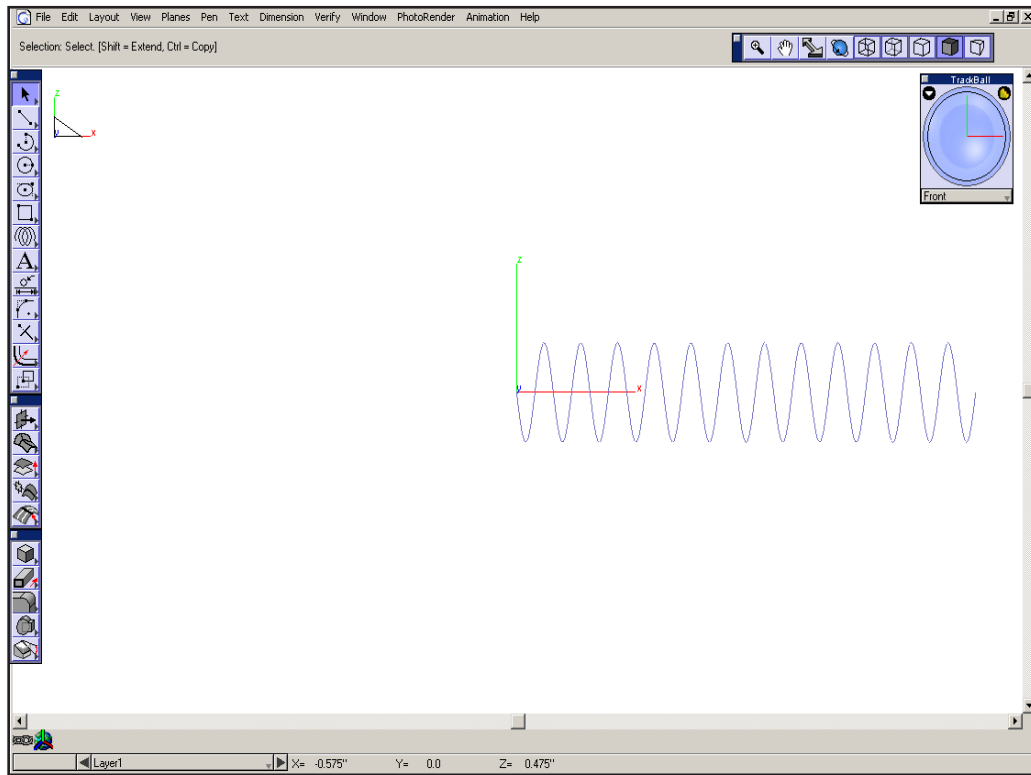


You will want to perform a Zoom All operation in order to see the helix clearly. That is all it takes to create a helix; very simple. (At any time you may edit the parameters of the helix through the Edit Objects box.)

## Creating the Tension Spring Arms

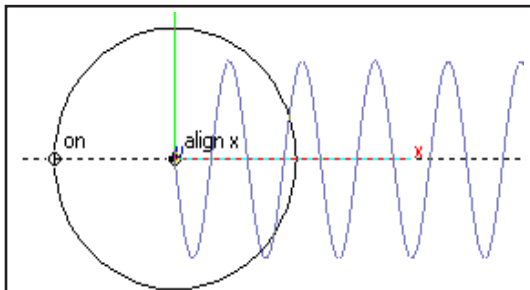
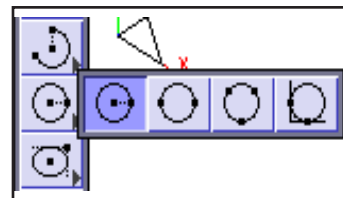
The next step is to create the arms for the tension spring. This will be accomplished by adding several curves together after we have slightly modified them.


- Switch the drawing view to **Front**, using one of the methods listed above. The exception is the keyboard shortcut; use the letter “s.”

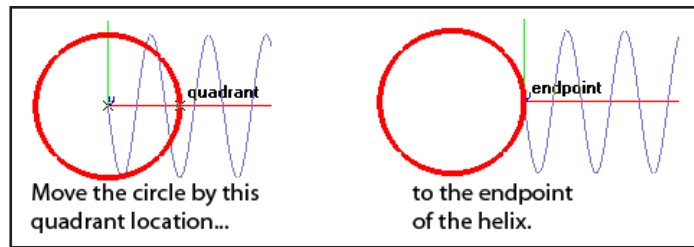


Once in the Front View you will want to perform another **Zoom All** command (in the **View** Menu, note the keyboard shortcut, Ctrl or Command f). Now move the helix around your screen so that it is positioned as in the image above. (Use the **Zoom Out** keyboard shortcut “[” and then **Pan** the drawing using the space bar on the keyboard.)

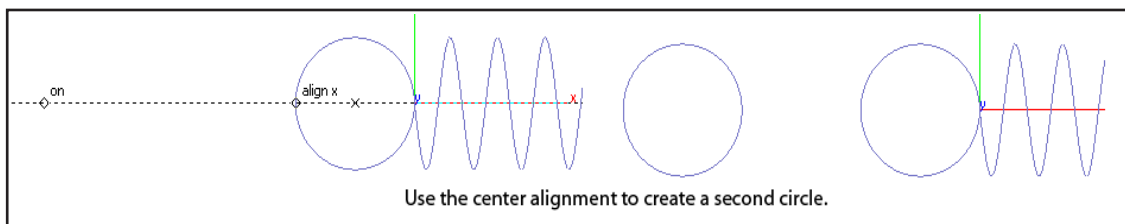
- Draw a circle using the Center Point Circle tool. Place the center of the circle at the endpoint of the helix. Make the diameter of the circle **.25”**.



5. Take the Selection Tool  and move the circle. Grab the circle by its quadrant and move that quadrant to the endpoint of the helix.



6. Create a second circle using the align x Drafting Assistant construction line. The Diameter of this circle is also **.25"**. DO NOT hit Enter yet!

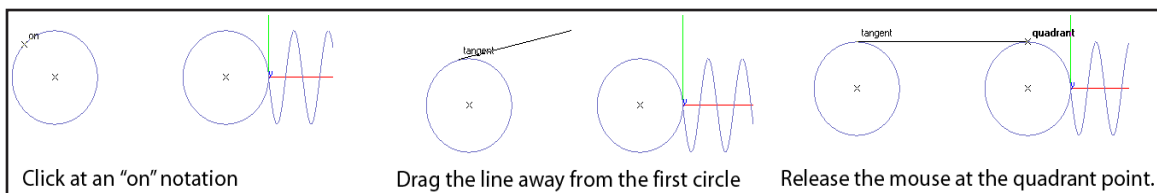
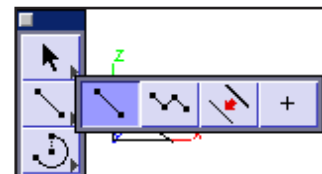


7. The centers of these circles need to be **.5"** apart. The easiest way to accomplish this is to type in the information into the **Status Line**. Because we are locating the center point of the circle a little basic math is required. We must add **.5"** plus the radius of the circle together for the exact center of the second circle ( $.5 + .125 = .625$  X location, be sure to add the negative symbol as we are in the negative X axis). Hit the Enter key and the circle is created at the specified location.

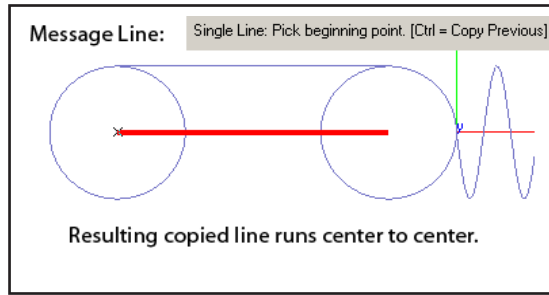
## Curve Modification

The next operation is to dissect these circles creating the shape we want for the arm of the tension spring.

8. We need to create a tangent line from one circle to the other. This operation is very simple in Ashlar-Vellum programs. Use the **Single Line** tool to create the tangent line (see the illustration below). One important thing to note, when creating the line make sure that you see the "on" notation only. No other Drafting Assistant notation will allow you to create the tangent line.




9. Create a copy of the line by holding down the Ctrl (PC) or Option (Mac) key. Click the center of the left circle to create an exact copy of the original line.

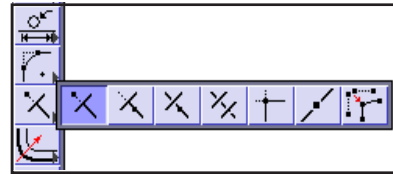


Now you are going to trim the unwanted pieces of the circle away.

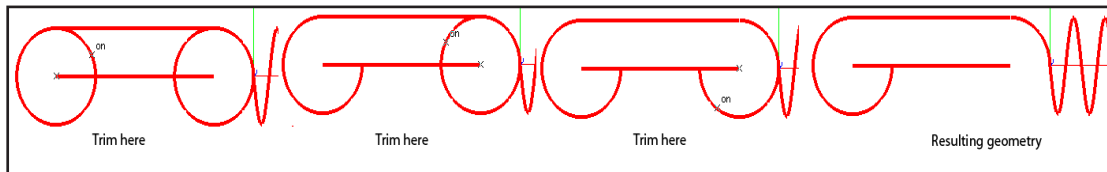
10. Select all of the geometry created to this point. There are several ways to accomplish this:

- **Double Click the Selection Tool.** 
- **From the Edit Menu, choose Select All.**
- **Right Mouse click and choose Select All > All Objects.**

11. Select the Simple Trim tool.



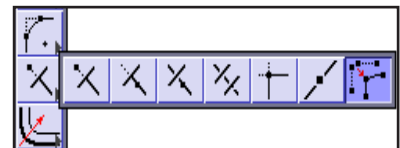
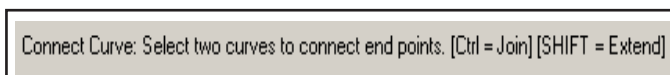
12. Trim the sections indicated below.



13. Delete the center line.

Now, the resulting geometry must be joined together.

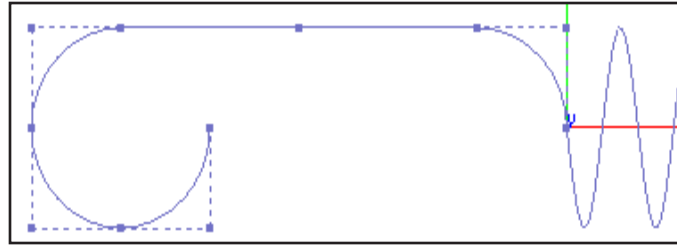
14. Select the **Connect Curve** tool. Notice the Message Line:



Using the Ctrl (PC) or Option (Mac) key we can join multiple curves together, creating one entity.

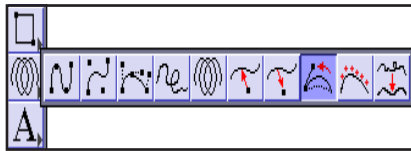
15. Select the larger arc, hold down the Ctrl or Option key, and then select the line. Select the resulting joined curves and add the smaller arc to it.

16. Show the points for the resulting joined curve (**Edit Menu>Show Points**). If the points of your curve do not look like the image below, tangency was not achieved when you created the line between the two circles in step eight. You will need to go back to that point and try again.

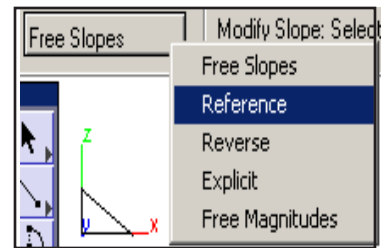


## Modifying Tangency

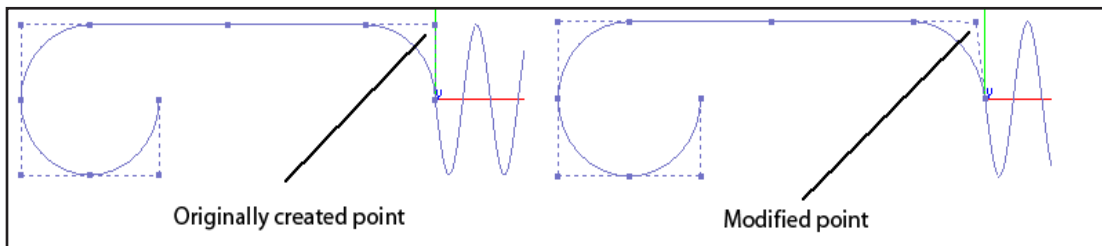
The next steps will create tangency between our joined curves and the helix.



17. Select the **Modify Slope** tool from the spline tools palette. Choose the **Reference** option from the drop down box located in the **Message Line**.



18. Select the joined curve for the first step of this tool. Select the helix as the second step of this tool. Select the vertex (the point at which the arc and the helix meet) for the last step of this tool. Notice how one point of our joined curve is repositioned creating the tangency.

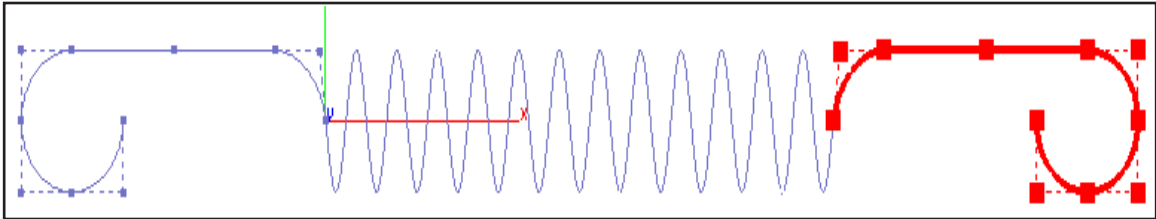


Next we will mirror the modified joined curve to the other side of the helix.

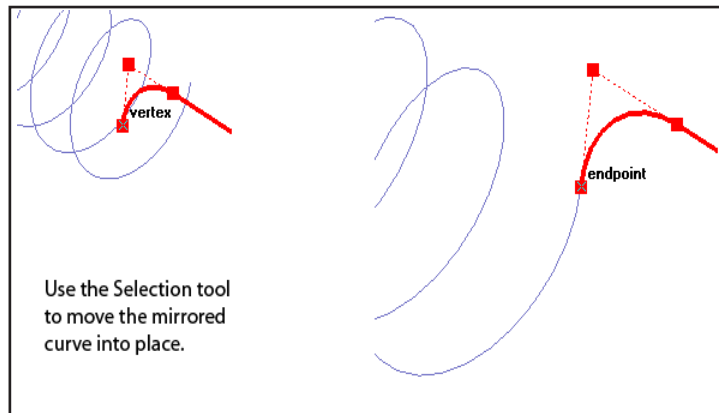
19. Select the **Mirror tool**.



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20. Select the modified joined curve (if it is not already selected) and choose a point roughly half way across the helix. The exact location doesn't matter because we will move the mirrored part to the correct location. Make sure to hold down the Ctrl or Option key to create a copy.

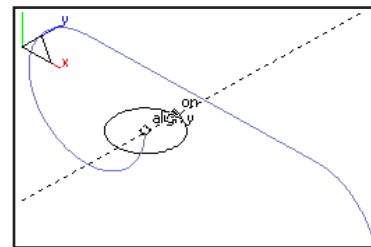


21. Change the drawing view to Isometric.
22. Move the mirrored curve into place using the **Selection** tool.



The last steps are very simple, create a circle profile that will be swept along our tension spring path, creating a solid part.

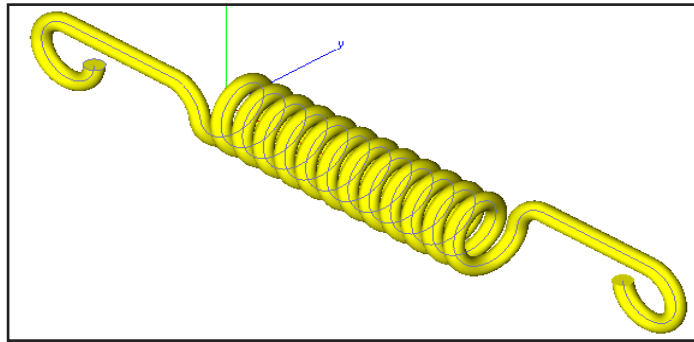
23. Take the Center Point Circle tool, create a .075" Diameter circle at the endpoint of either tension spring arm.



24. Select the Swept Solid Along 1 Rail tool.



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25. Sweep the circle profile along all three pieces of the tension spring, the left arm, the helix and the right arm. (Hold down the Shift key to select these curves.)



That completes the tutorial. Some important things to note are:

- ***You never had to create work planes prior to creating geometry.***
- ***All curve creation was easily and expertly accomplished with the aid of the Drafting Assistant.***
- ***The ease in which tangency was created or modified.***