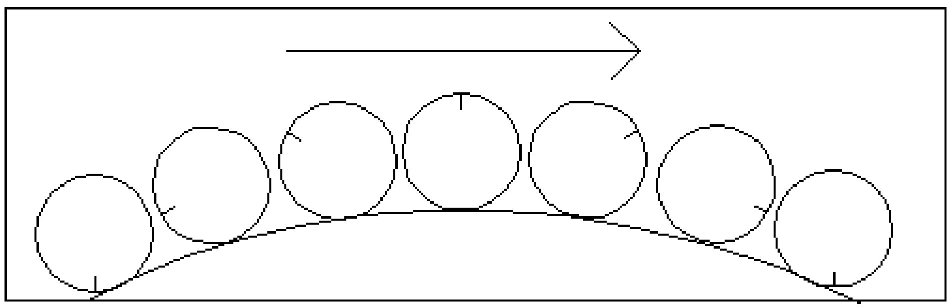
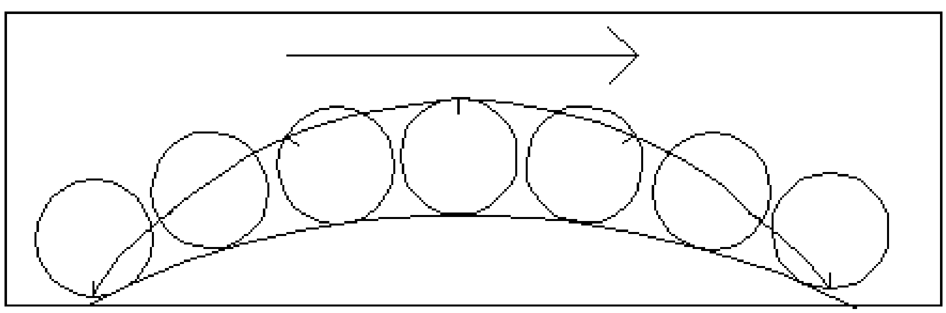
The Epicycloidal Curve.

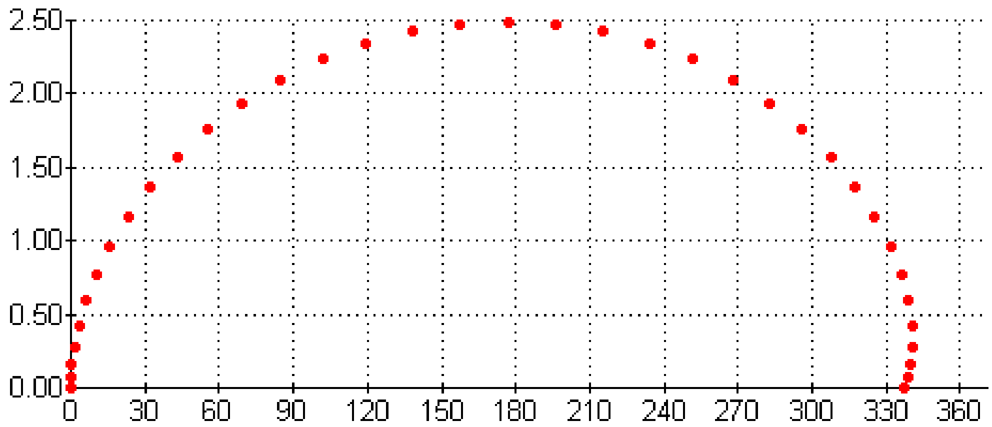
The epicycloidal curve is similar to the cycloidal curve, except that you consider the path of the point on the circle as it rotates along the edge of a curve: the edge of another circle. Imagine a ball rolling up a hill and down the other side. Now imagine a pinion gear rolling around the edge of a larger gear.



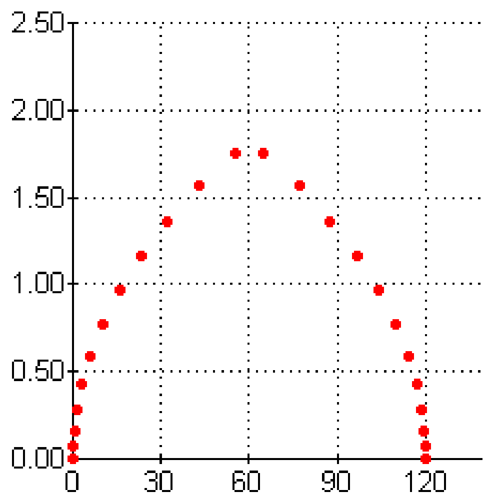
If you draw a line to trace the path of the point on the circle as it rotates along the edge of another circle, the result is called an Epicycloidal Curve.



Since this drawing is inaccurate (for the same reasons as the cycloidal curve drawing is inaccurate), below is a graph of the epicycloidal curve that is much more accurate (with Rotation in Degrees on the X axis and Displacement in Inches on the Y axis).



The addendum consists of part of the epicycloidal curve. If the pinion has 12 leaves, the addendum consists of the first 30° of the epicycloidal curve (because 12x30=360°). If the pinion has 6 leaves, the addendum consists of the first 60° of the epicycloidal curve. The other side of the addendum consists of a mirror image of the curve. Below is a graph of an addendum using the first 60° of an epicycloidal curve. This looks like a typical clock tooth's addendum (with Rotation in Degrees on the X axis and Displacement in Inches on the Y axis).



If you select this link, you will see an animation of a gear and lantern pinion (with 8 wires) in action. This animation was created by Thomas Miglinci of Vienna, Austria. You can see that contact between the gear tooth and the pinion wire does not take place until the mid-point of the impulse, with the result that the gear does not release the pinion wire until after the next pinion wire has entered the disengagement phase of the impulse. This animation also demonstrates how the curve on the addendum simulates the rolling action desired in the interaction of the gear teeth with the pinion wires. The gear tooth comes into contact with only a very small portion of the pinion outside the pitch circle of the pinion (the addendum portion), so that designing the addendum as a half circle would be acceptable: this means that the lantern pinion is not an inferior design. Many pinion leaves also have semi-circular addenda.

The number of teeth on the gear determines the proportion of the epicycloidal curve used to design the pinion leaf's addendum, and the number of teeth on the pinion determines the proportion of the epicycloidal curve used to design the gear tooth's addendum.

Therefore, the shape of a gear tooth should be different if the pinion has 12 leaves versus 6 leaves. Since the 12 leaf pinion occupies a much smaller angle, the shape of the gear tooth would be based on only the steepest portion of the epicycloidal curve. This means that the gear tooth should have a radial dedendum and an addendum with only slight curvature and an end that follows the circumference of the addendum circle. The result looks quite similar to a gear tooth based on the Involute Curve!

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