

## Drawing an Approximate Representation of an Involute Spur Gear Tooth

### Project Description

Create a solid model and a working drawing of the 24 pitch gears specified below. It is only necessary to create an approximation of the gear tooth form. These models can be used in both virtual and actual mechanical assemblies that you design and build using the GEARS-IDS kit.

#### 60 Tooth Gear Specifications

Pitch	24
Teeth	60
Bore	7/16" Hex
Material	Delrin
Set Screw	#10-24 (not shown)
Hub Dia.	0.90"
Face Width	0.250"
PA	20 <sup>0</sup>

Note: #10-24 Set Screw to intersect the middle of the flat on the hex bore.

#### 36 Tooth Gear Specifications

Pitch	24
Teeth	36
Bore	7/16" Hex
Material	Delrin
Set Screw	#10-24 (not shown)
Hub Dia.	0.90"
Face Width	0.250"
PA	20 <sup>0</sup>

Note: #10-24 Set Screw to intersect the middle of the flat on the hex bore.

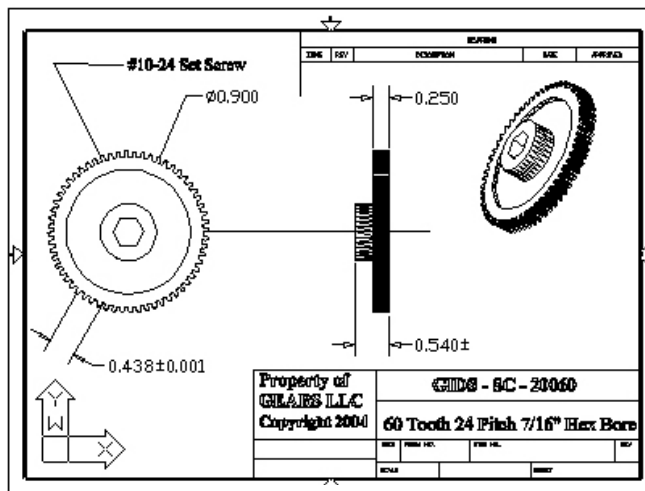


Fig. 1 Working Drawing of a Spur Gear

The figure on the left is an example of a working drawing of the 60 tooth gear specified above.

This example also includes a pictorial representation of the gear. Drawings and specifications like these are prepared for a manufacturer so that he/she might prepare a production quote. The only additional information required to estimate the cost of producing this gear would be the quantity required.

# Procedure for Drawing an Approximation of a Spur Gear

The following procedure can be used to create gear models using CAD workstations. This method will produce an approximation of the gear tooth form well suited for assemblies and animations. *It is neither necessary nor efficient to take the time to draw an exact involute tooth form for the purpose of creating working drawings and models.*

Note: Refer to the **Spur Gear Definitions and Formulas** table at the end of this document for explanations of the formulas listed below.

In this example we will draw the 36 tooth, 24 pitch spur gear. Using this example you will be able to draw a spur gear having any number of teeth and pitch. Begin by laying out the Pitch, Root and Outside circles of the 36 tooth gear.

1. Calculate and draw the Pitch Circle. The Diameter of the Pitch Circle is calculated below;

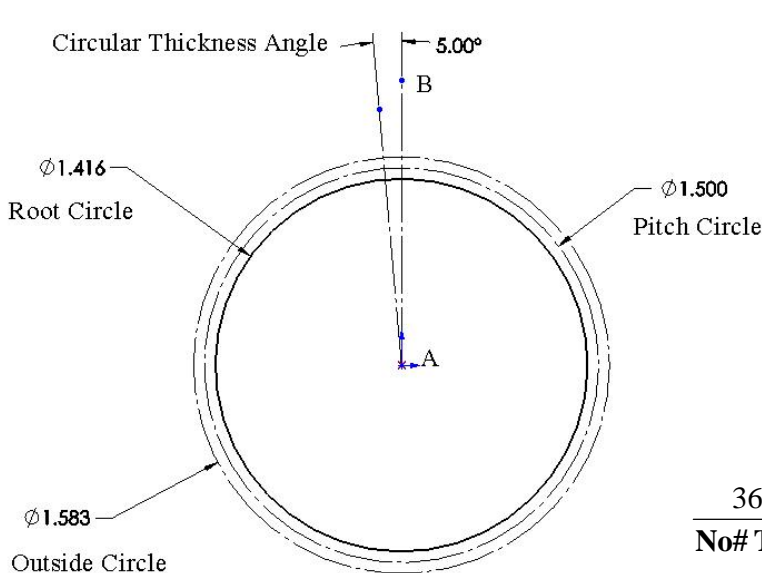
$$a. \quad D = \frac{N}{P} \quad D = \frac{36}{24} = 1.5''$$

2. Calculate and draw the Root Circle. The formula to determine the Root Circle Diameter is given below;

$$a. \quad RD = \frac{N - 2}{P} = RD = \frac{36 - 2}{24} = RD = \frac{34}{24} = 1.416''$$

3. Calculate and draw the Outside Circle. The formula to determine the Outside Circle Diameter is given below;

$$a. \quad OD = \frac{N + 2}{P} = OD = \frac{36 + 2}{24} = OD = \frac{38}{24} = 1.583''$$



4. Draw a vertical center line (AB) from the center of the circles to a point outside the circles.

5. Calculate and layout the Circular Thickness angle to the left (CC W) of the vertical center line.

- a. Calculate the angular measurement for the circular thickness using the following formula

For this example:

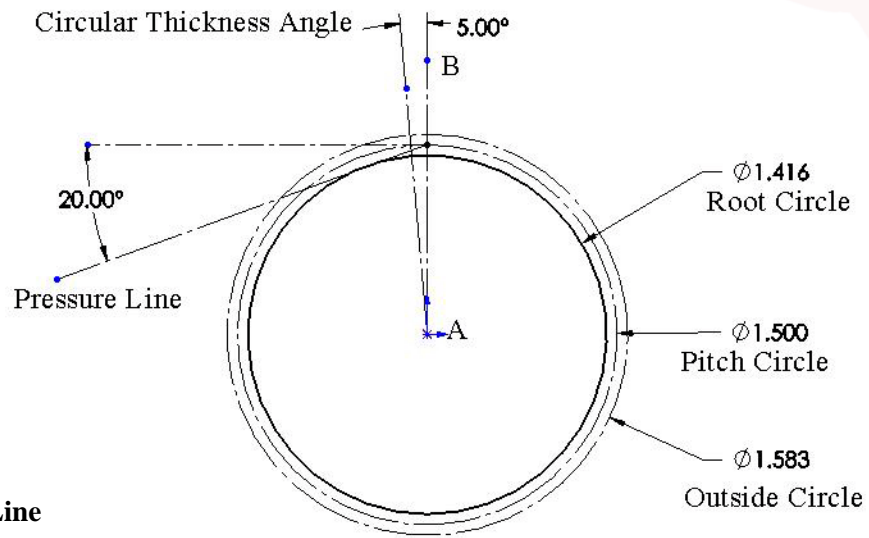
$$\frac{360^\circ}{\text{No\# Teeth}} * 0.5 = \text{Circular Thickness Angle}$$

$$\frac{360^\circ}{36} * 0.5 = 5^\circ$$

**Fig. 2 Initial Layout and Circular Thickness Angle**

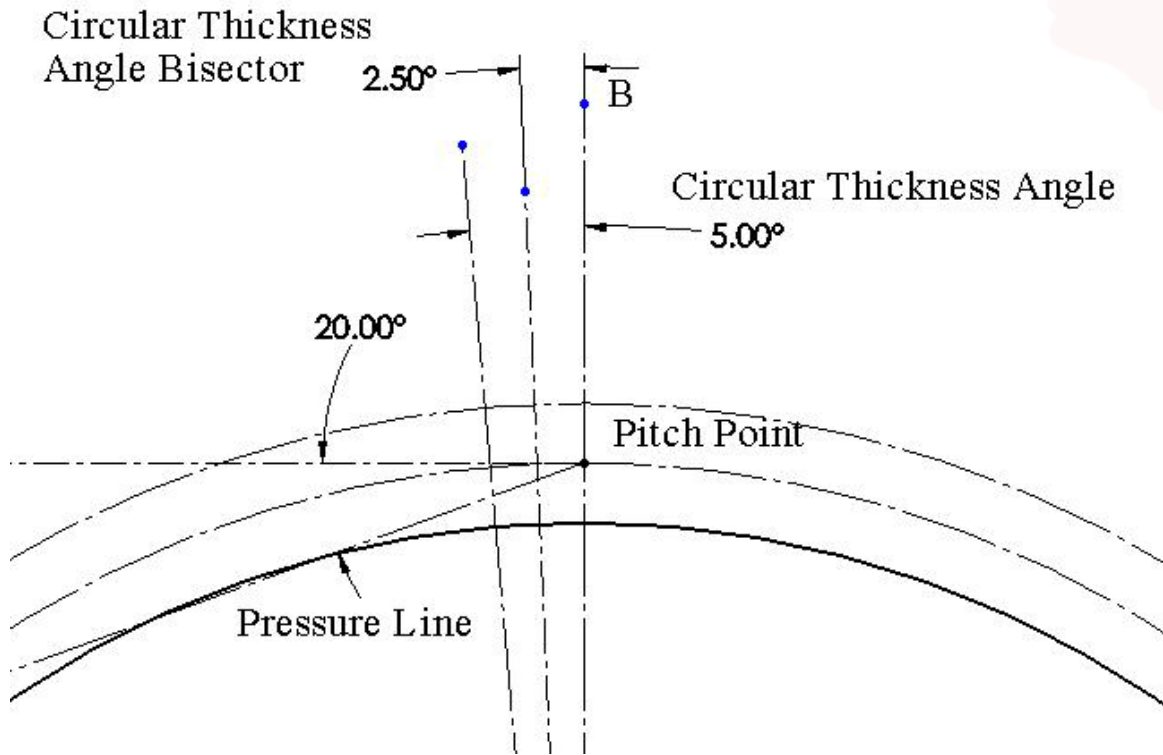
Note: In the equation above, it is necessary to multiply by 0.5 (or divide by 2) since there are always an equal number of teeth and spaces in each gear!

6. Draw the Pressure Line. The pressure line is drawn through the pitch point at an angle of 20 degrees from a line tangent to the top of the pitch circle.



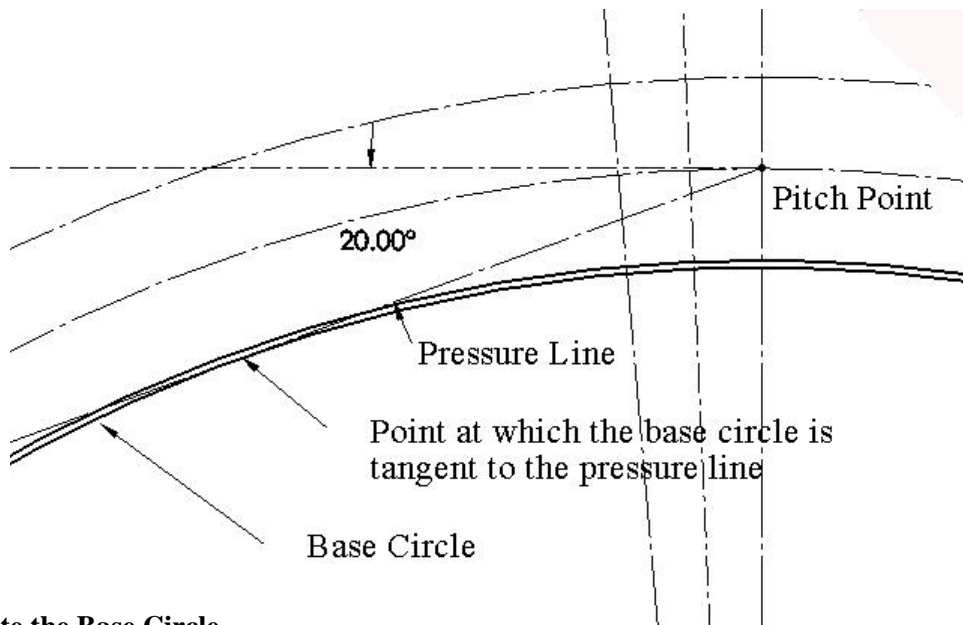
**Fig.3 The Pressure Line**

7. Create a line that bisects the circular thickness angle. This line should intersect or extend beyond the outside circle as shown in figure 3 below.



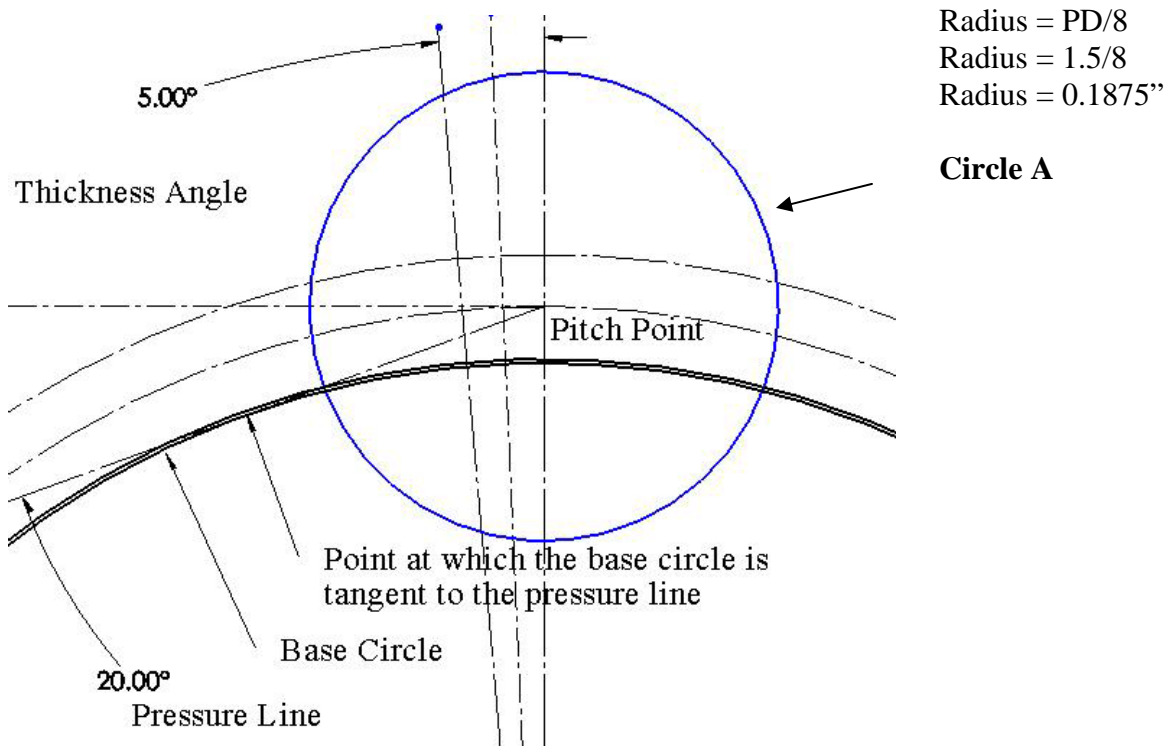
**Fig.4 The Circular Thickness Angle Bisector**

8. Beginning at the center of the circles, draw the Base Circle tangent to the 20 degree pressure line. *Note that in this 36 tooth, 24 pitch gear example, the base circle will have nearly the same diameter as the root circle. This will not be the case with spur gears having different numbers of teeth, or different pitch. Therefore it is necessary to follow these instructions closely in order to establish accurate gear tooth geometry.*



**Fig.5 Create the Base Circle**

9. Locate the Tooth Form Circle by drawing circle (A) whose radius is 1/8 of the Pitch Diameter and whose center is at the Pitch Point.



**Fig. 6 – Tooth form locator**

10. Draw another circle (B) of the same radius whose center is at the intersection of circle A and the Base Circle. This circle will form the top right curve of the gear tooth

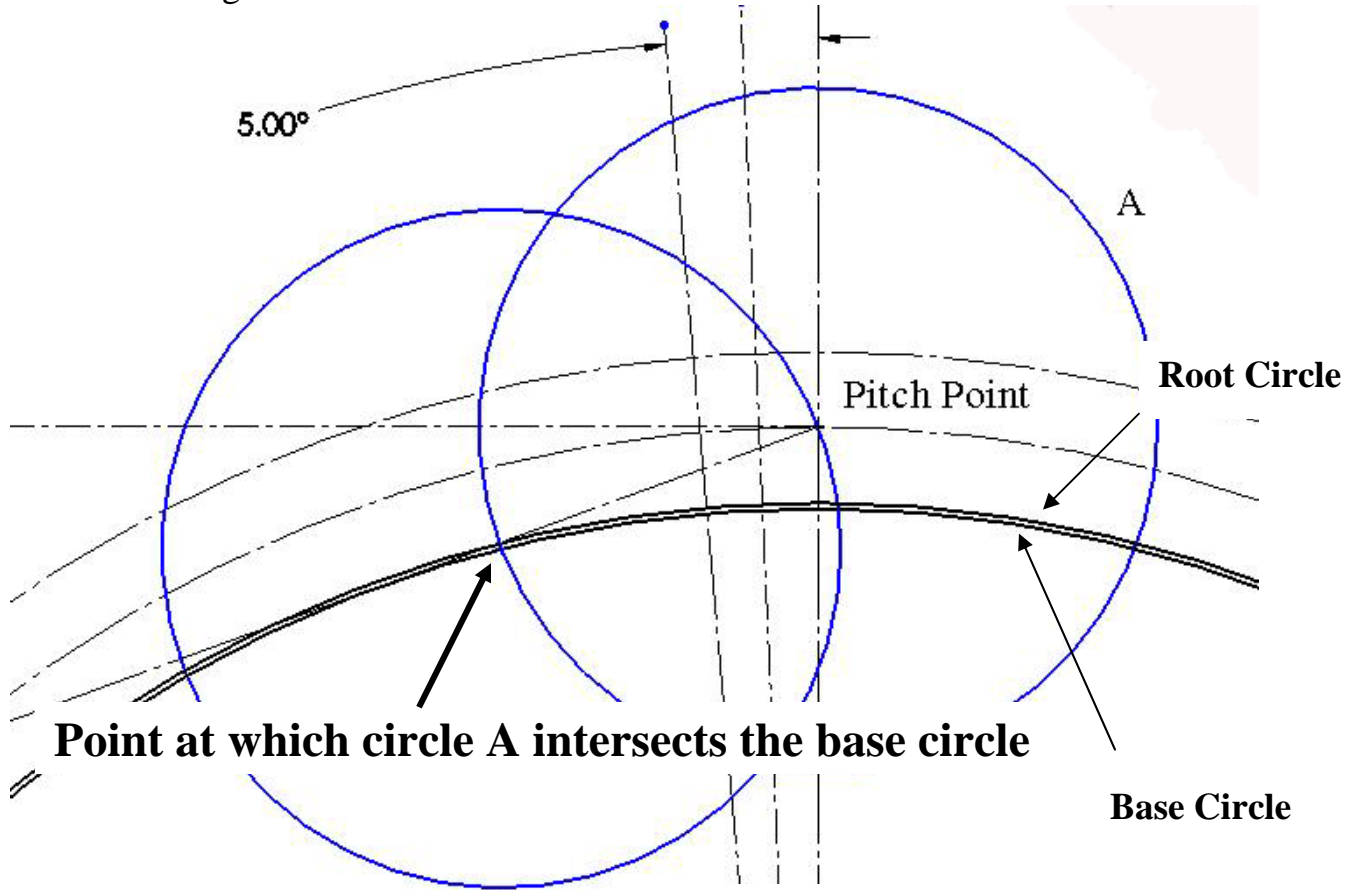


Fig. 7 Locate the Tooth Form

11. Erase Circle A and trim away all of circle B, except the tooth form which is arc PT beginning at the pitch point and intersecting the outside circle. Erase the Base circle.

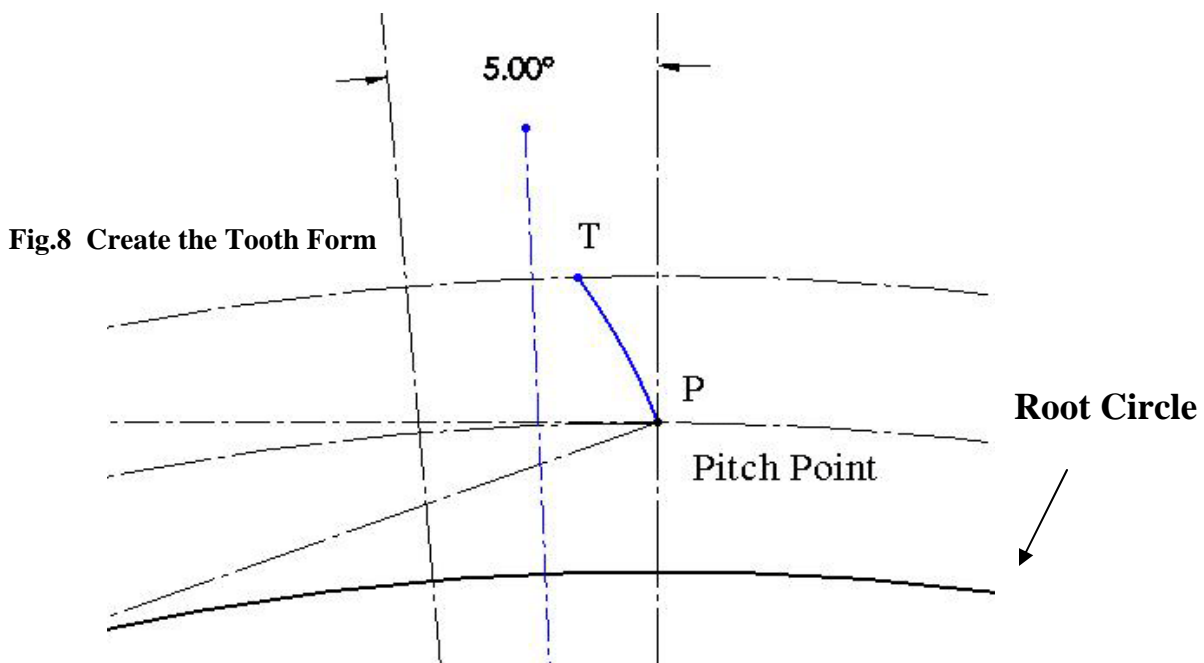
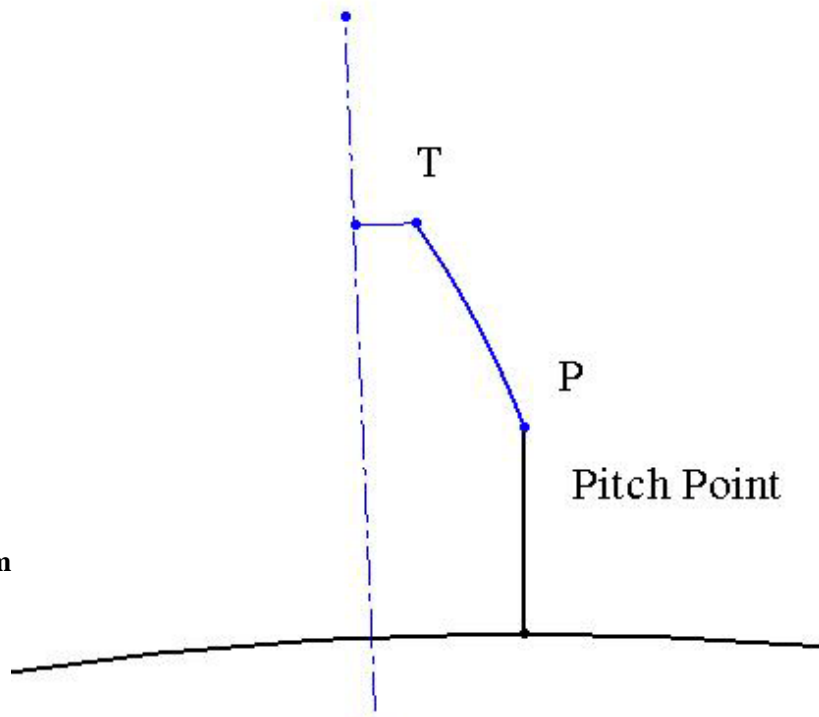
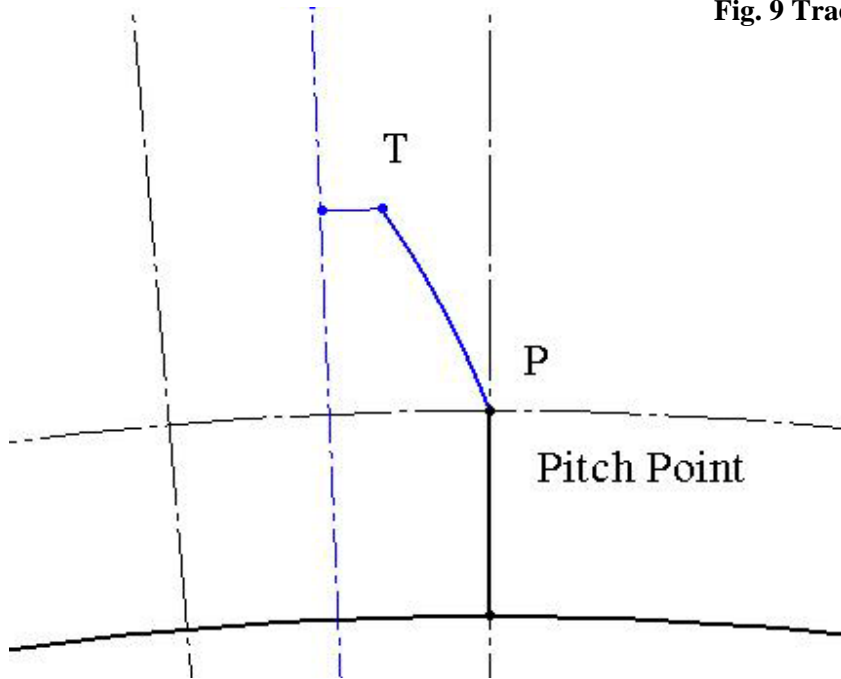


Fig.8 Create the Tooth Form

12. As you can see in this example, the tooth form is generated from the Pitch Point. Continue developing the gear tooth form by tracing over the vertical centerline and trimming away the outside circle. After creating the tooth form, erase all lines EXCEPT the circular thickness bisector, the tooth form lines and the base circle. See figure 8 and 9 below.

**Fig. 9 Trace the Tooth Form**



**Fig. 10 Tooth Form**

13.Mirror the tooth form lines about the circular thickness bisector.

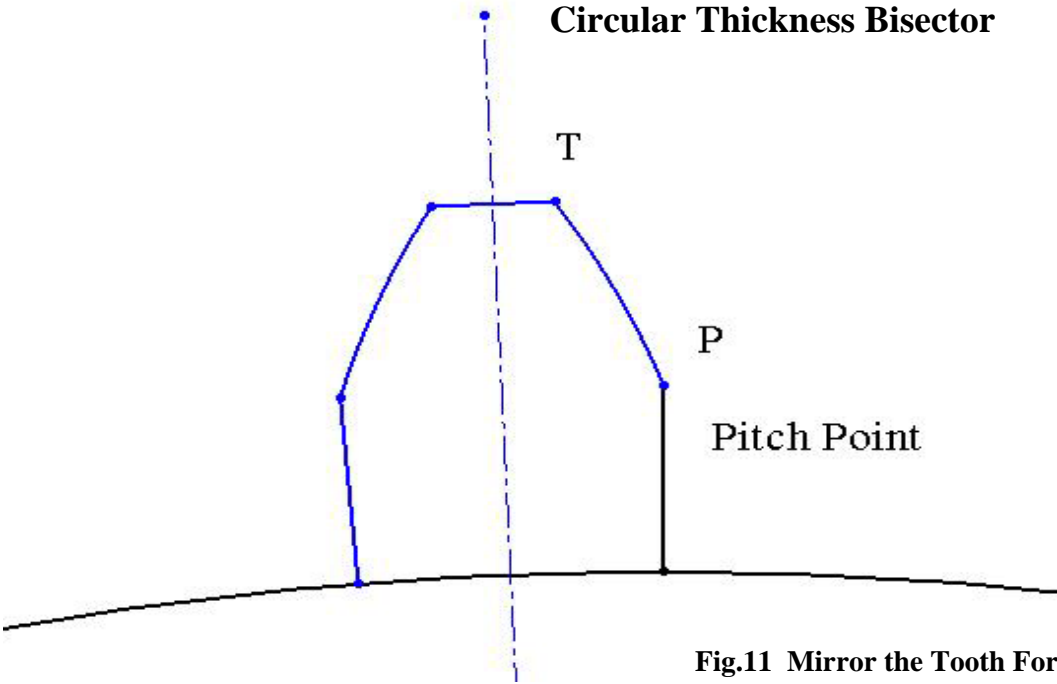


Fig.11 Mirror the Tooth Form

14.Erase the circular thickness bisector and array the completed tooth form about the base circle.

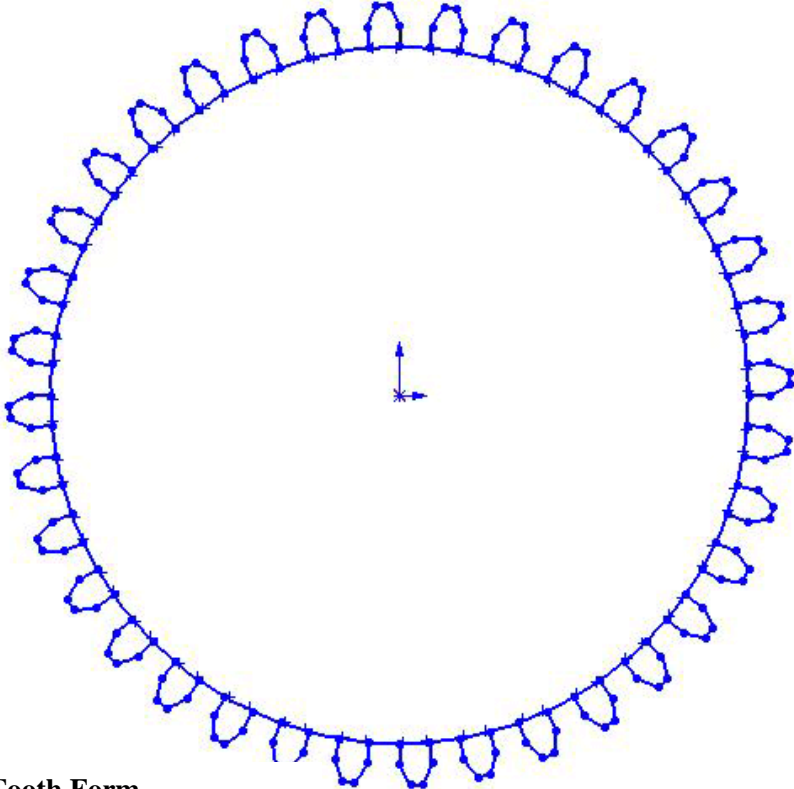
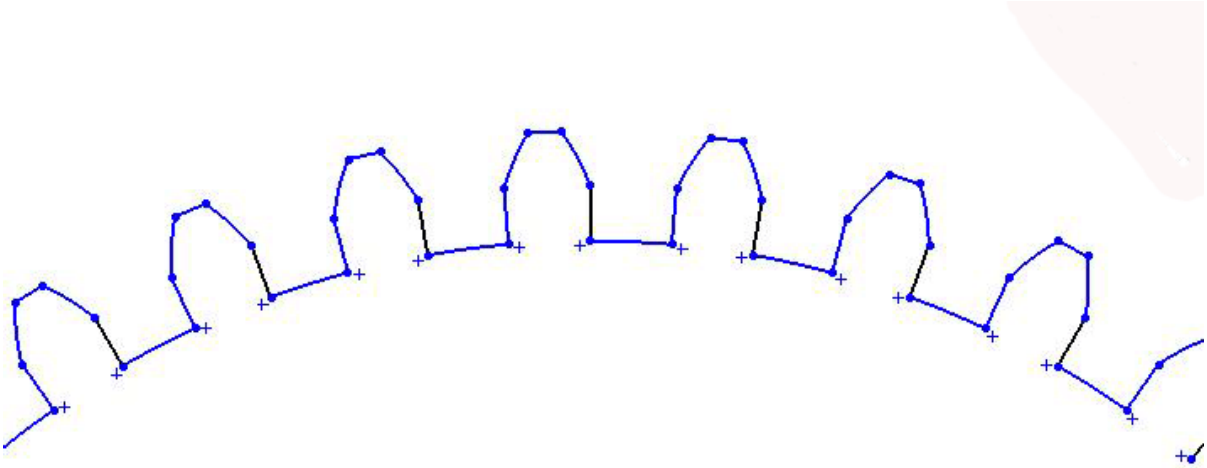


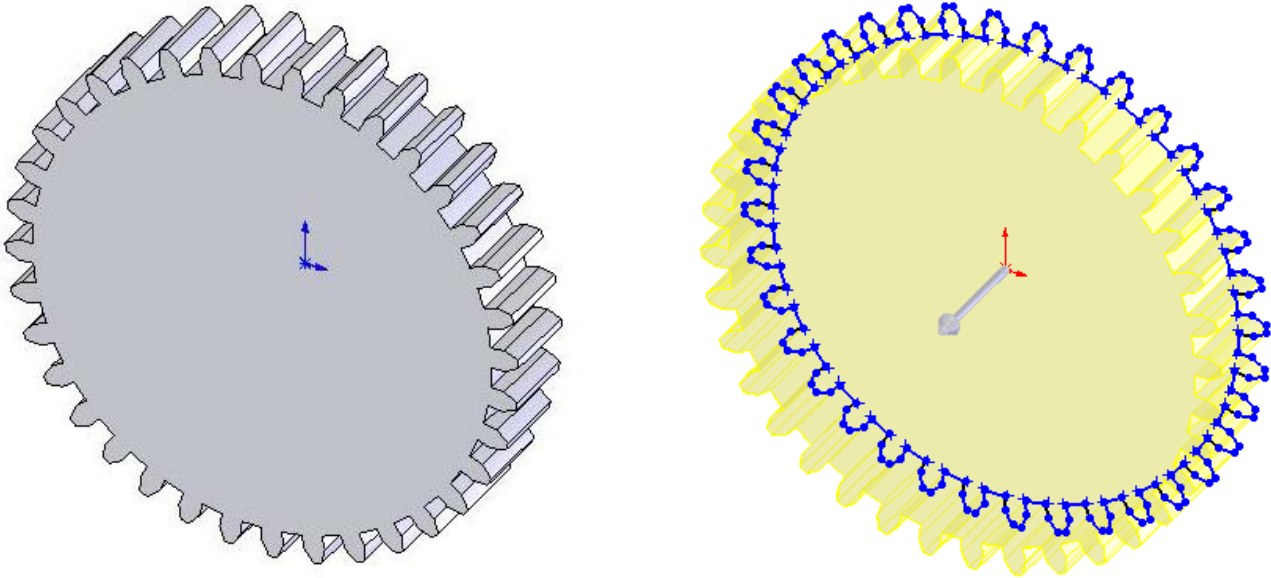
Fig.12 Array the Tooth Form

15. Trim the base circle line under each tooth to create a single closed form.



**Fig.13 Trim the Tooth Form**

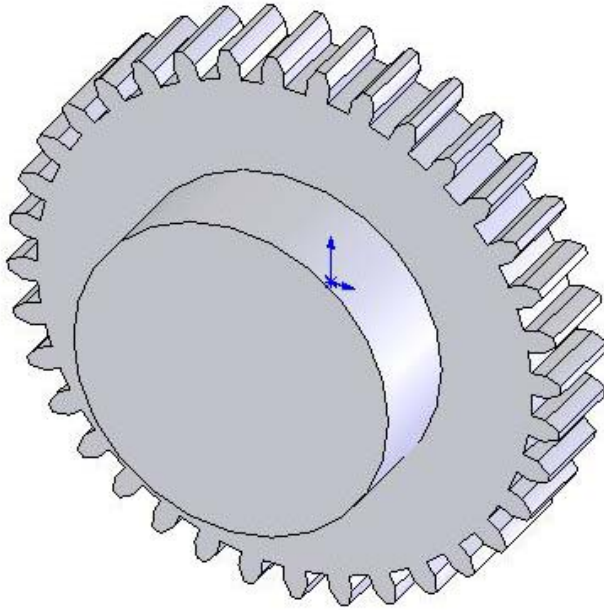
16. Extrude the gear a distance of 0.25". This dimension is given in the specifications on the first page of this text. Note: If the gear does not extrude, zoom into the original tooth form and check for irregularities such as additional lines, broken lines or lines that have been drawn over other lines.



**Fig.14 Extrude the Gear ( 0.25")**

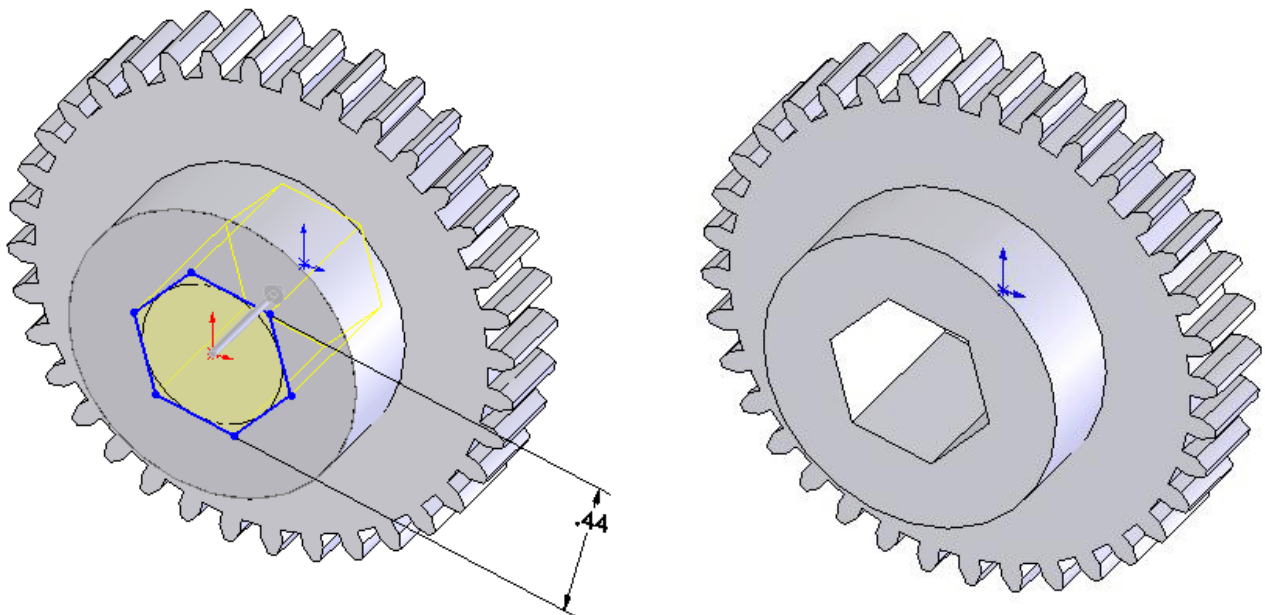


17. Create the gear boss. Draw a 0.90" diameter circle centered on the gear face. Extrude the boss 0.29".



**Fig.15 Gear Boss**

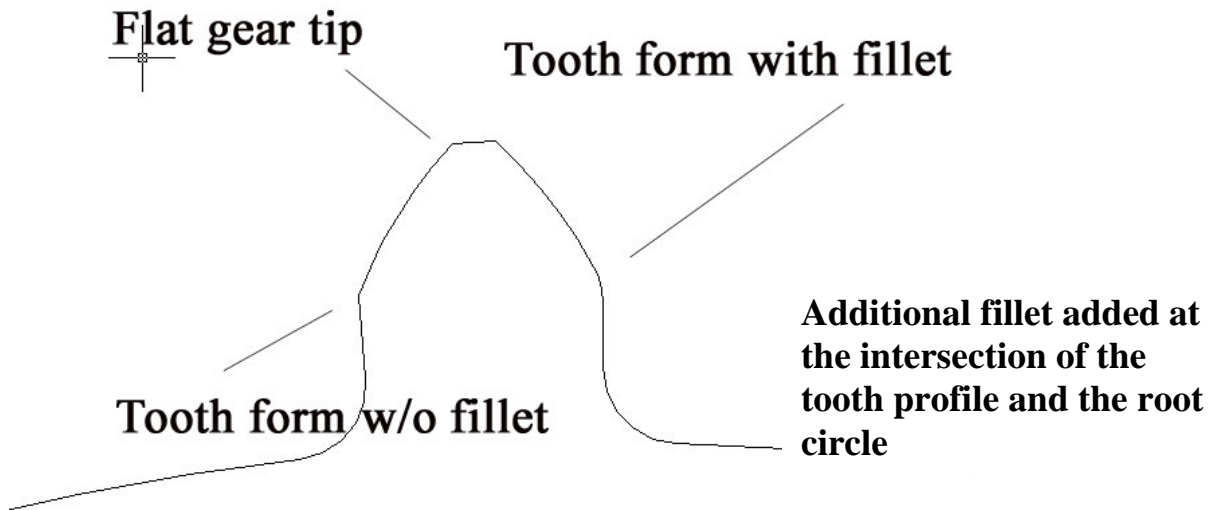
18. Draw and cut a 7/16" (0.44") hex bore in the center of the gear boss.



**Fig.16 Hex Bore**

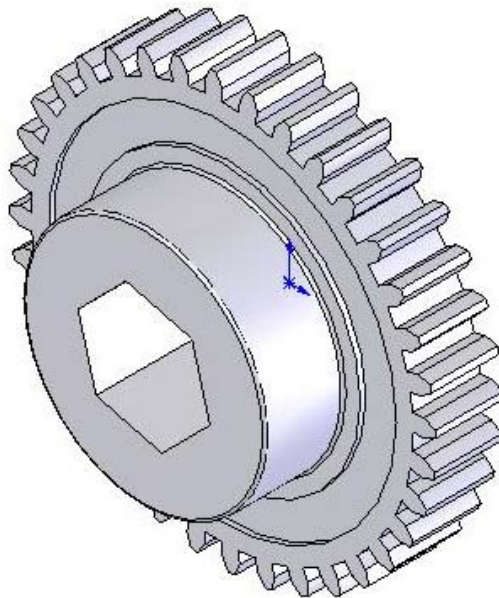
Optional: To create a more realistic tooth form, add a fillet between the radial line that forms the tooth profile below the Pitch Point and the arc that forms the tooth profile above the pitch point. You can also add a fillet where the tooth form intersects the root circle and you can flatten the top of the gear tooth slightly.

Add other gear details as they appear on the gears. (See fig. 17 and 18 below)



**Fig.17 Optional Gear Fillet**

This gear model has mold details as they exist on the GEARS-IDS™ delrin gears/



**Fig.18 Optional Gear Details**