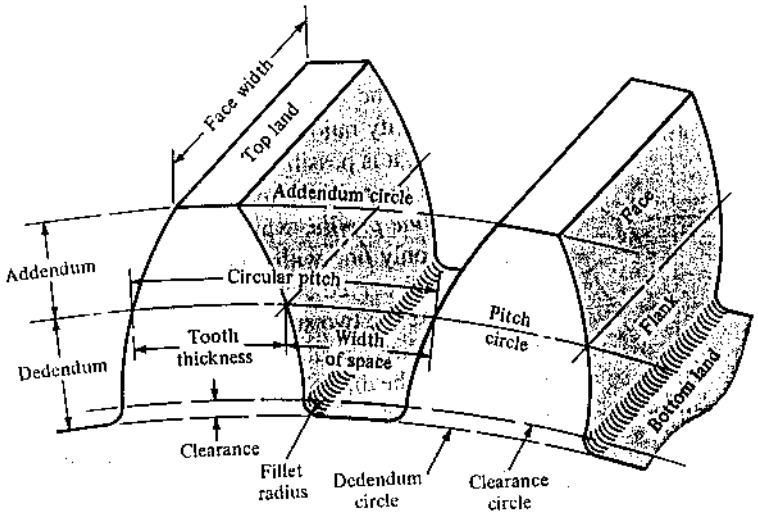
Gears

- **Spur Gears**
- **Helical Gears**
- **Worm Gears**
- **Bevel Gears**

Gear Nomenclature



Pitch Circle—Theoretical circle upon which all gear calculations are usually based. Pitch circles of mating gears are tangent to one another

Addendum—The amount of tooth that protrudes above the pitch circle (from top land to pitch circle)

Dedendum—The amount of tooth below the pitch circle to the bottom land

Whole Depth—addendum + dedendum

Circular Pitch—a distance measured on the pitch circle form a point on tooth to a corresponding point on an adjacent tooth; it is equal to the sum of the tooth thickness and the width of space.

p = circular pitch = π**d/N**

Diametral Pitch—is the ratio of the number of teeth on the gear to the pitch diameter, the **module** is the reciprocal of the diametral pitch

P= N/d N = # of gear teeth, d = pitch diameter

m = d/N = 1/P (module is usually in millimeters)

Clearance Circle—A circle that is tangent to the addendum circle of the mating gear.

Clearance—the amount by which the dedendum in a given gear exceeds the addendum of a mating gear

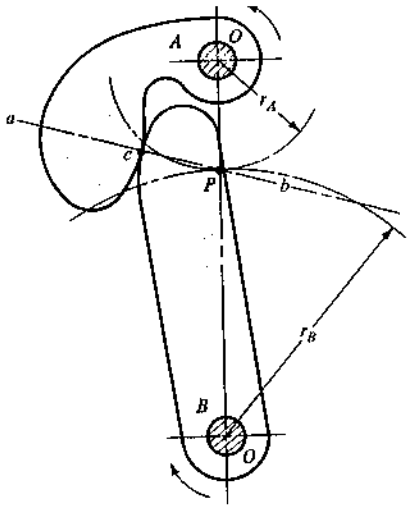
Backlash—The amount by which the width of a tooth space exceeds the thickness of the engaging tooth, measured on the pitch circle

Fundamental Law of Gearing

The angular velocity ratio between the gears in a gear-set must remain constant throughout the gear mesh

Why do gears work?

The fundamental law of gearing can be enforced because of special **kinematic** property called **conjugate action**



Do you remember from dynamics what **instant centers** are?

An instant center is point that describes, at an instant, the velocity of two bodies that is same for both bodies. In the picture above, there are three bodies, A, B, and the ground, or point O. A and O share the same velocity where O grounds body A (the pin in A), instant center AO. B and O share the same velocity where O grounds B (the pin in

link B). There is one last instant center—a point where A and B share the same velocity. Where is it?

How do we find this particular instant center?

Is there a way to ensure that this special point, **called the pitch point**, always falls on the line connecting the grounds of A and B?

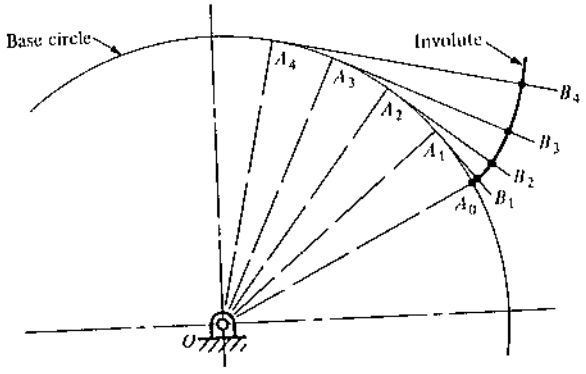
If we could design the shapes of A and B, so that the pitch point always fell on the line of centers, the fundamental law of gearing would be enforced

Vp = $\mathbf{r_a p} * \omega_a = \mathbf{r_b p} * \omega_b$

$\mathbf{r_a p} / \mathbf{r_b p} = * \omega_b / \omega_a$

(**Vp** is called the **pitch line velocity**)

A special shape called an **involute** can be built into the gear tooth to ensure that conjugate action occurs between mating gear teeth.



Examples:

Design a speed reducer such that the input speed is 1800 RPM and the output speed is 1200 RPM.

$$\frac{w_{in}}{w_{out}} = \frac{r_{out}}{r_{in}} = \frac{1800}{1200} = \frac{3}{2}$$

$$2r_{out} = 3r_{in}$$

$$d_{out} = \frac{3}{2} d_{in}$$

$$\frac{N_{out}}{P} = \frac{3N_{in}}{2P} = N_{out} = \frac{3}{2} N_{in}$$

(P = diametral pitch, N = number of teeth)

Draw the pitch circles, base circles, addendum and dedendum circles for the following gear set:

N1 = 18 teeth N2 = 30 teeth

Diameteral Pitch = 2 teeth/inch

1. find r1, r2—center distance = r1 + r2
2. draw pitch circle 1, radius r1
3. draw pitch circle 2, radius r2,tangent to circle 1
4. draw the common tangent to the circles, perpendicular to the center distance and through the common tangent—pitch point
5. draw a line at an angle ϕ from the common tangent; this line is called the **line of action** , the angle ϕ is called the **pressure angle**
6. draw a circle tangent to the pressure line for each gear—these circles are called the **base circles**—the radius of the base circle is, $\mathbf{r_b = r \cos (}$ f**)**
7. **draw an involute on each base circle**
8. addendum, a = 1/P, draw the addendum circle
9. dedendum = 1.25/P, draw the dedendum circle
10. tooth thickness = t = p/2; p = π/P

Solve the following problems:

A gearset consists of a 16-tooth pinion driving a 40 tooth gear. The diametral pitch is 2, and the addendum and dedendum are1/P and 1.25/P respectively. The gears are cut using a pressure angle of 20°.

Compute the circular pitch, the center distance, and the radii of the base circle.

In mounting these gears, the center distance was incorrectly make ¼ inch larger. Compute new values of the pressure angle and pitch radii.

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