Figure. Camshaft of an IC engine.

In order to have the acceleration and retardation within the finite limits, it is necessary to modify the conditions which govern the motion of the follower. This may be done by rounding off the sharp corners of the displacement diagram at the beginning and at the end of each stroke, as shown in Figure (*a*). By doing so, the velocity of the follower increases gradually to its maximum value at the beginning of each stroke and decreases gradually to zero at the end of each stroke as shown in Figure (*b*). The modified displacement, velocity and acceleration diagrams are shown in Figure. The round corners of the displacement diagram are usually parabolic curves because the parabolic motion results in a very low acceleration of the follower for a given stroke and cam speed.

Displacement, Velocity and Acceleration Diagrams when the Follower Moves with Simple Harmonic Motion

The displacement, velocity and acceleration diagrams when the follower moves with simple harmonic motion are shown in Figure (*a*), (*b*) and (*c*) respectively. The displacement diagram is drawn as follows:

1. Draw a semi-circle on the follower stroke as diameter.

2. Divide the semi-circle into any number of even equal parts (say eight).

3. Divide the angular displacements of the cam during out stroke and return stroke into the same number of equal parts.

4. The displacement diagram is obtained by projecting the points as shown in Figure (*a*).

The velocity and acceleration diagrams are shown in Figure (*b*) and (*c*) respectively. Since the follower moves with a simple harmonic motion, therefore velocity diagram consists of a sine curve and the acceleration diagram is a cosine curve. We see from Figure (*b*) that the velocity of the follower is zero at the beginning and at the end of its stroke and increases gradually to a maximum at mid-stroke. On the other hand, the acceleration of the follower is maximum at the beginning and at the ends of the stroke and diminishes to zero at mid-stroke.

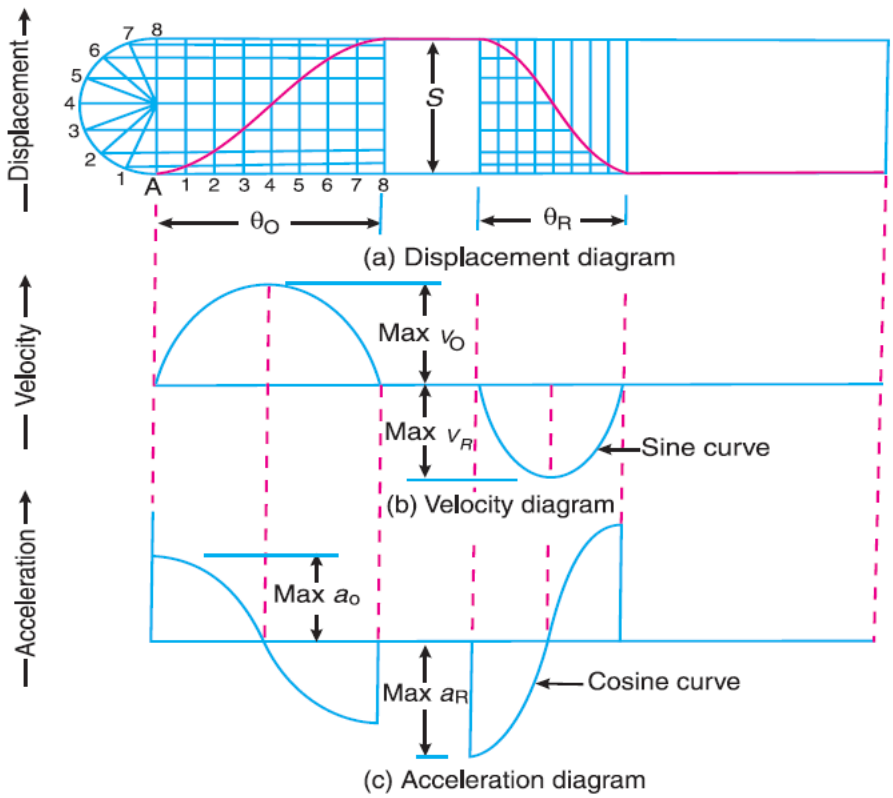

Figure. Displacement, velocity and acceleration diagrams when the follower moves with simple harmonic motion.

<u>Displacement, Velocity and Acceleration Diagrams when the Follower Moves with Uniform Acceleration and Retardation</u>

The displacement, velocity and acceleration diagrams when the follower moves with uniform acceleration and retardation are shown in Figure (*a*), (*b*) and (*c*) respectively. We see that the displacement diagram consists of a parabolic curve and may be drawn as discussed below:

1. Divide the angular displacement of the cam during outstroke (θ_O) into any even number of equal parts (say eight) and draw vertical lines through these points as shown in Figure (*a*).

2. Divide the stroke of the follower (*S*) into the same number of equal even parts.

3. Join *Aa* to intersect the vertical line through point 1 at *B*. Similarly, obtain the other points

C, *D* etc. as shown in Figure (*a*). Now join these points to obtain the parabolic curve for the out stroke of the follower.

4. In the similar way as discussed above, the displacement diagram for the follower during return stroke may be drawn. Since the acceleration and retardation are uniform, therefore the velocity varies directly with the time. The velocity diagram is shown in Figure (*b*).

Let S = Stroke of the follower,

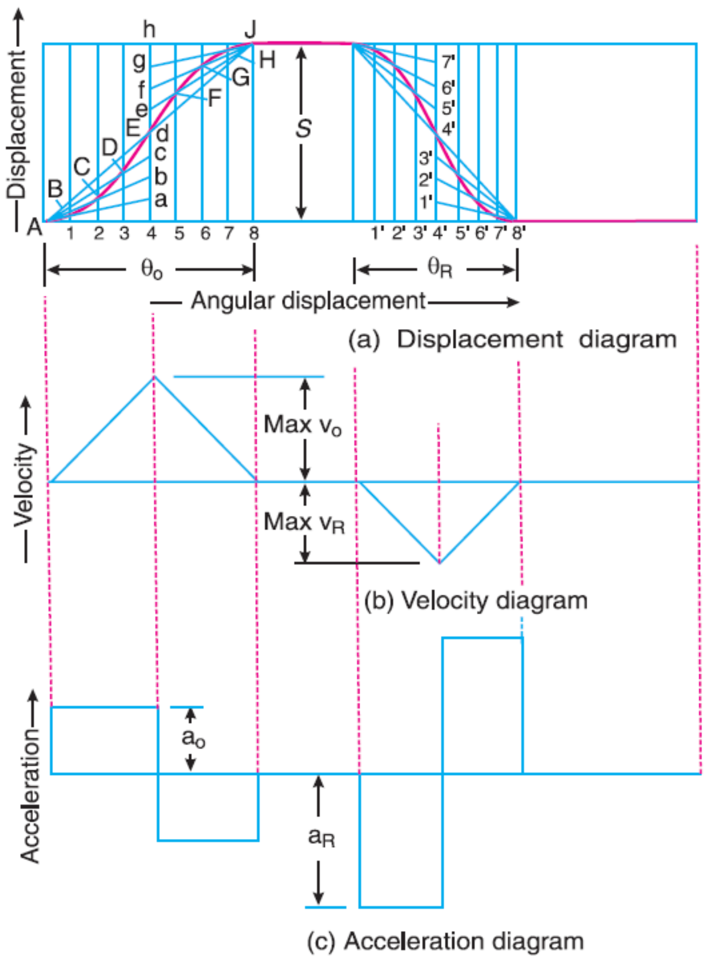

Figure. Displacement, velocity and acceleration diagrams when the follower moves with uniform acceleration and retardation.

Since the maximum velocity of follower is equal to twice the mean velocity, therefore maximum velocity of the follower during outstroke,

$$v_O = \frac{2S}{t_O} = \frac{2\,\omega.S}{\theta_O}$$

Similarly, maximum velocity of the follower during return stroke,

$$v_R = \frac{2\,\omega . S}{\theta_R}$$

Displacement, Velocity and Acceleration Diagrams when the Follower Moves with Cycloidal Motion

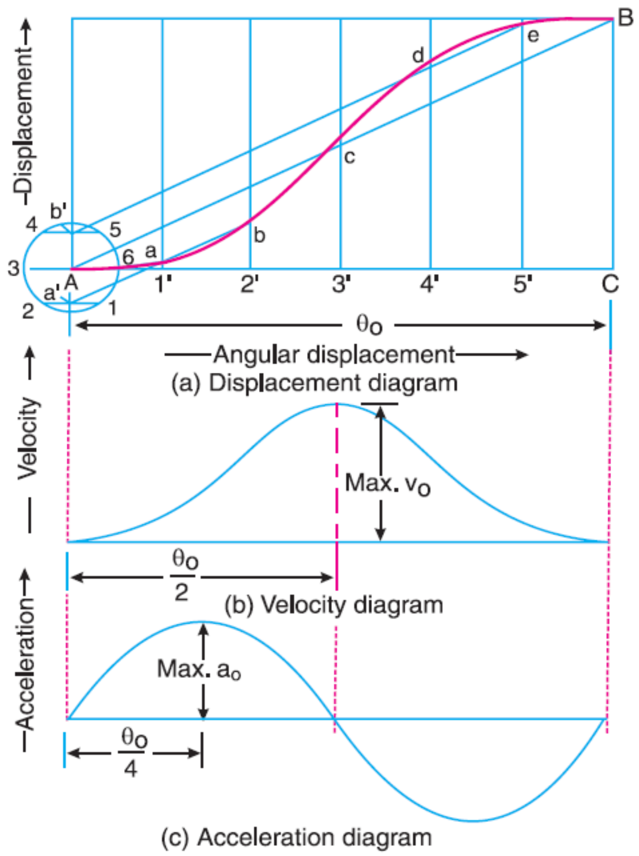

Figure. Displacement, velocity and acceleration diagrams when then follower moves with cycloidal motion.

The displacement, velocity and acceleration diagrams when the follower moves with cycloidal motion are shown in Figure (*a*), (*b*) and (*c*) respectively. We know that cycloid is a curve traced by a point on a circle when the circle rolls without slipping on a straight line. In case of cams, this straight line is a stroke of the follower which is translating and the circumference of the rolling circle is equal to the stroke (S) of the follower. Therefore, the radius of the rolling circle is $S / 2\pi$. The displacement diagram is drawn as discussed below :

1. Draw a circle of radius $S / 2\pi$ with A as centre.