

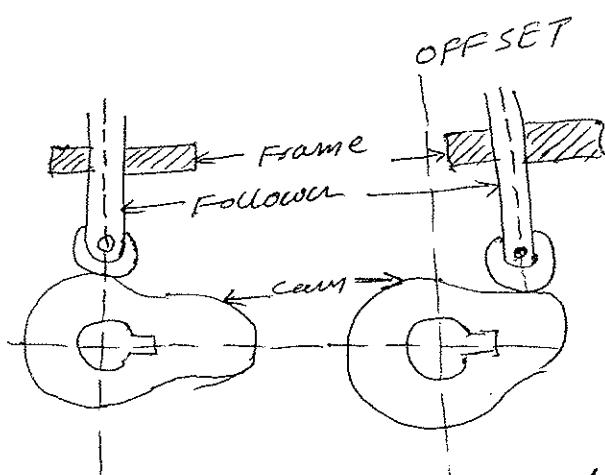
CAMS

A cam is a machine element which drives other element through a specified motion by direct contact. The cam and Follower constitute a higher pair, because they maintains a line contact b/w the contacting surface.

CAM mechanism :-

A cam and Follower mechanism is shown in following Fig. The Three basic links of cam mechanism are:

1. cam
2. follower, and
3. frame.



cam rotates about an axis perpendicular its plane, and its profile impart a desired motion to a follower which bears against the cam edge. Follower is kept in contact with the cam profile by gravity or by a spring. Frame is used to support the cam and to guide the follower.

APPLICATIONS OF CAM mechanism:-

Cam mechanisms are widely used in many fields of engineering.

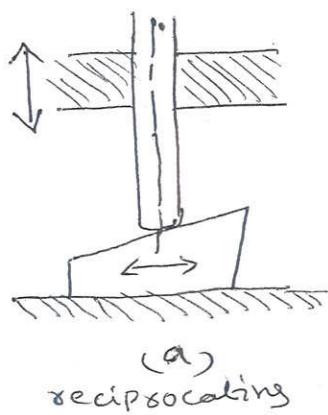
especially in printing machine, automatic devices and machine and internal combustion engines for operating the valves.

A) TYPES OF CAMS :-

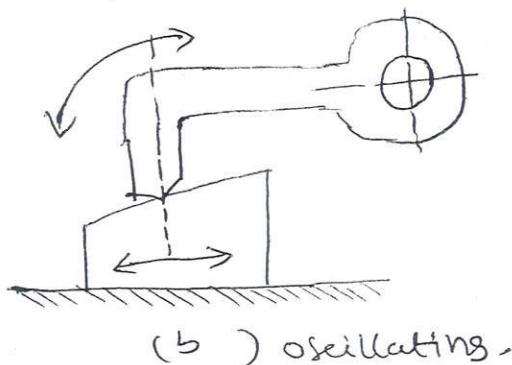
The cams are designed such that their profile will import desired motion to the follower. They are classified as:

- ① wedge cam
- (2) Radial or disc cam
 - (a) Tangent cams, and
 - (b) circular cams.
- ③ cylindrical cams

① wedge cam :- In wedge cams the reciprocating (translatory) motion of the cam is transferred into reciprocating (or) oscillating motion of the follower.



(a) reciprocating



(b) oscillating

② Radial cam :- In radial or disc cams the follower reciprocates in a plane right angle to the axis of the cam.

A radial cam having straight flank and circular nose is called tangent cam (Fig a-b). A circular cam has circular flank and circular nose. (Fig(c)).

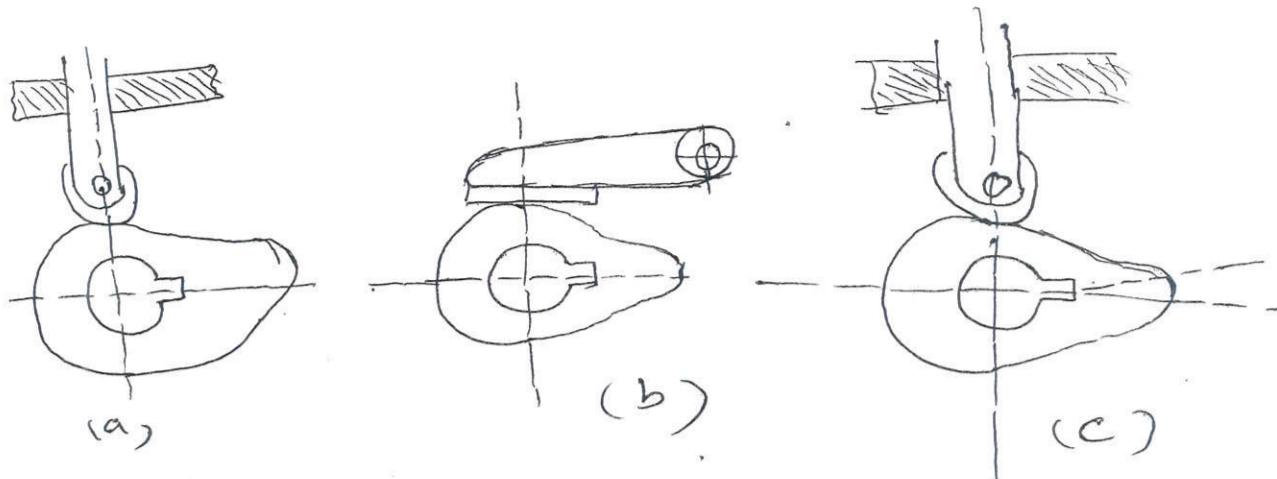
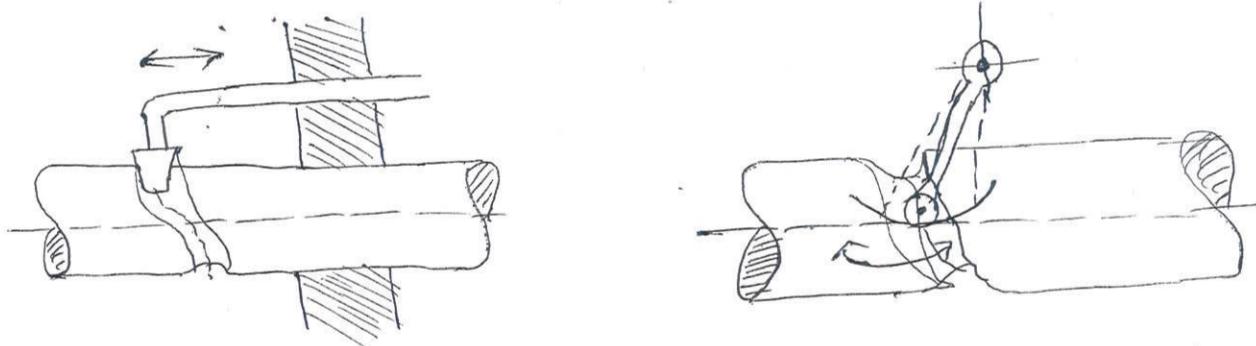


Fig:- Radial Cam

③ Cylindrical cams :- In cylindrical cams the follower reciprocates or oscillates in a plane parallel to the axis of the cam. The following Fig shows the cylindrical cam.

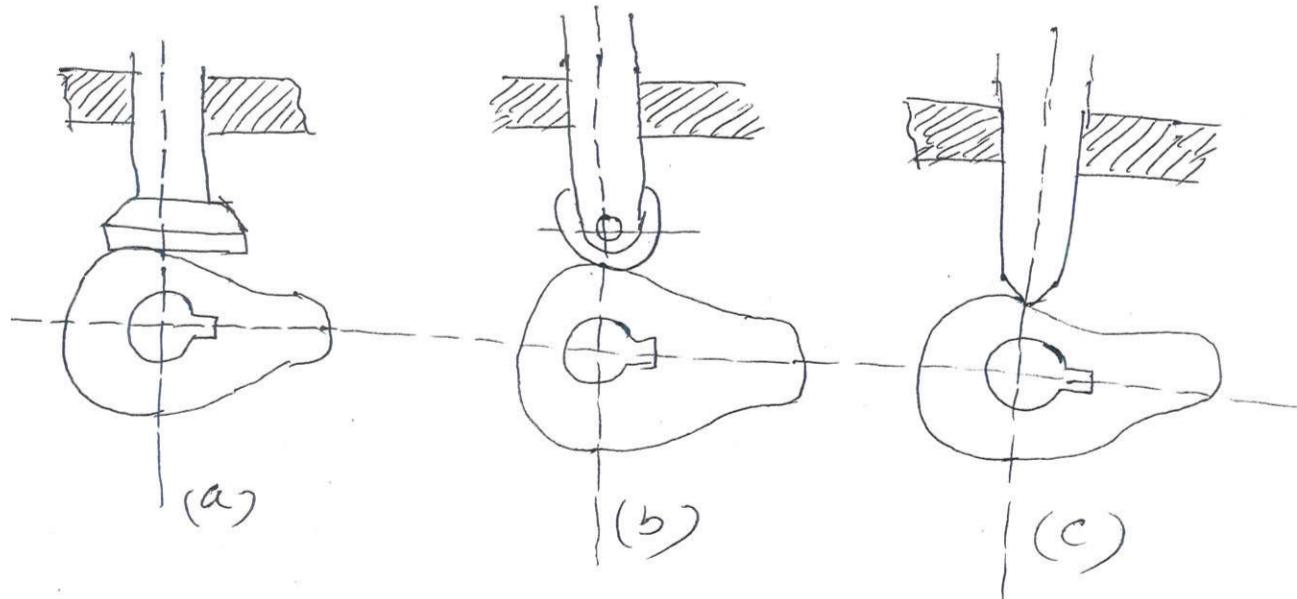


* Types of Follower :-

According to the profile of contact surface, the follower may be classified as:

- (i) Flat Follower
- (ii) Roller Follower
- (iii) Knife edge Follower

flat followers [Fig(a)] are generally used for slow moving cams, and roller follower [Fig(b)] are for high speed, and can transmit high forces. The knife edge follower [Fig(c)] is not in common use because of high rate of wear.

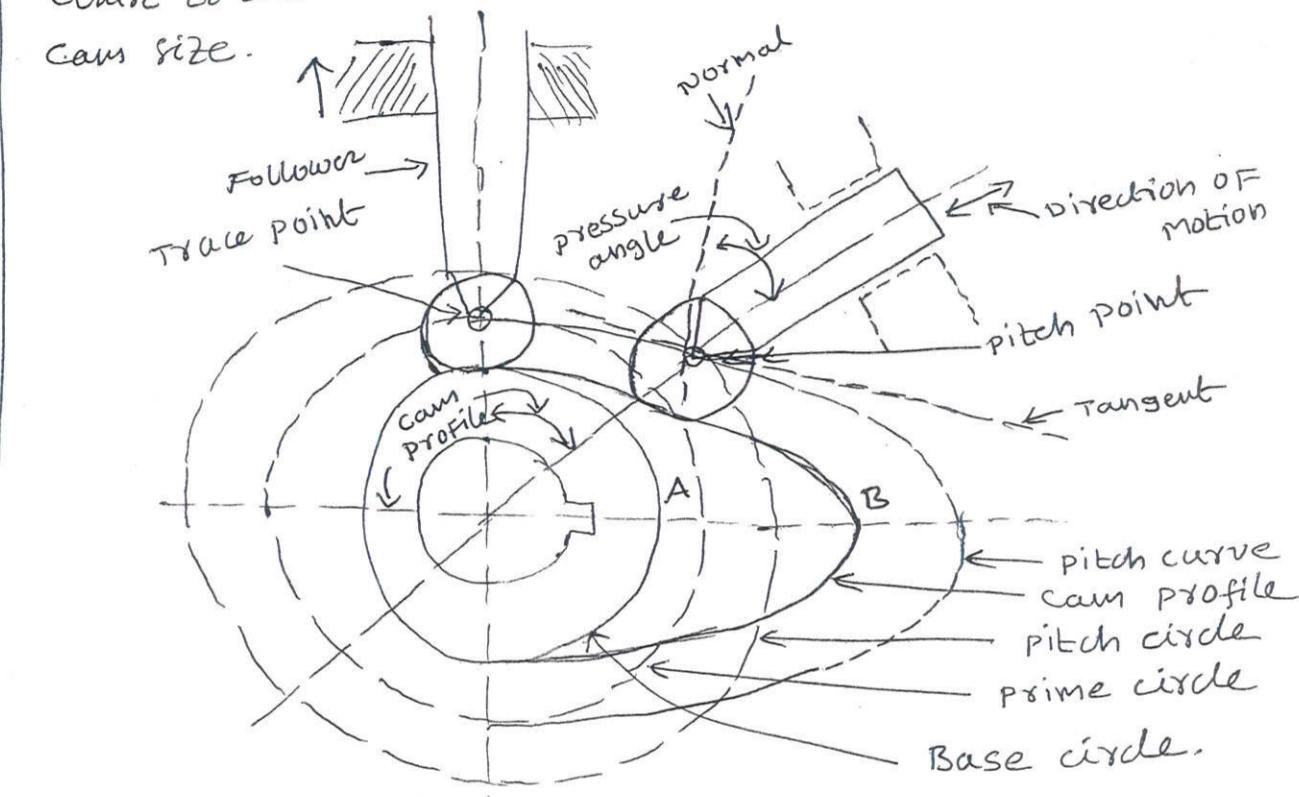


Fis:- Types of Followers.

Terminology of cam profile

The following Fig. are used in order to draw the cost profile:

- ① Cam profile :- The surface in contact with the follower is known as cam profile. This is the actual working curve of the cam.
 - 2) Trace point :- It is the reference point on the follower for the purpose of tracing the cam profile. It is situated at the knife-edge follower and at the centre in a roller follower.
 - ③ Base circle :- Base circle is the smallest circle drawn from the cam centre to the cam profile. The size of the cam circle decides the



- (4) Prime circle :- is the smallest circle drawn from the cam centre. For a knife-edge and a flat-face follower, the prime circle and the base circle are identical. For a roller follower, the prime circle is larger than the base circle by radius of the roller to the pitch curve.

(5) The pitch curve :- is the curve traced by the trace point if it is assumed that follower is rotating round the cam. (instead of cam rotation)

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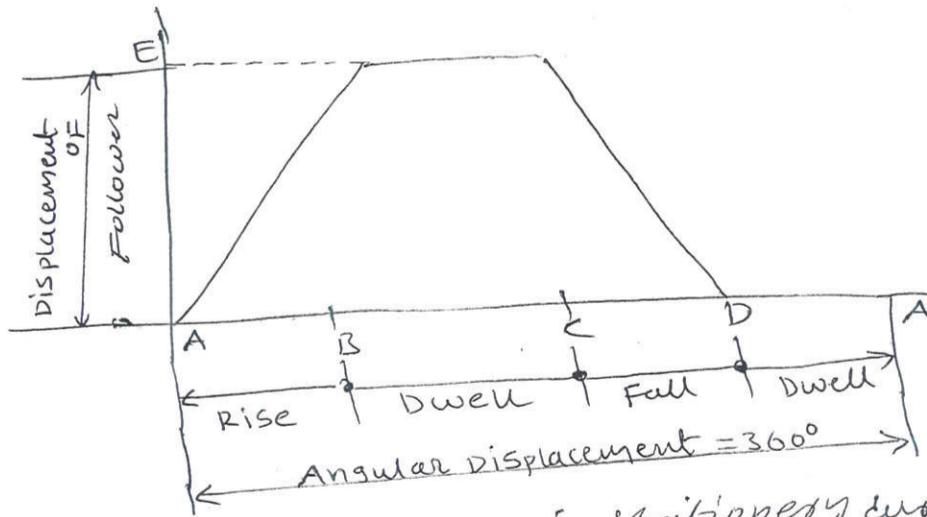
- (6) The pitch point :- is the point on the pitch curve of the cam having maximum pressure angle.
- (7) cam angle :- is the angle of rotation of the cam for a definite displacement of the follower.
- (8) The pressure angle :- is the angle b/w the direction of motion of follower and a normal to the pitch curve.
- (9) pitch circle :- is the circle having centre at the centre of cam and radius equal to the distance b/w the centre of cam and pitch point.
- (10) life or stroke :- is the maximum travel of the follower from its lowest position to the top most position. It is equal to the distance AB as shown in Fig.
- (11) period of dwell :- is the period during which the follower remains stationary during some finite rotation of the cam.
- (*) DISPLACEMENT DIAGRAM :-
- Displacement diagram are used to analyse the movement of the follower relative to the rotation of the cam. The cam usually rotates at uniform speed and therefore, the equal angular displacement takes place in equal intervals of times. cams can be designed to produce the following motion of the follower.

- (1) uniform velocity,
- (2) Simple Harmonic Motion (SHM),
- (3) Uniform acceleration and retardation, and
- (A) cycloidal motion.

The displacement diagram for uniform velocity, SHM and uniform acceleration and retardation are discussed below.

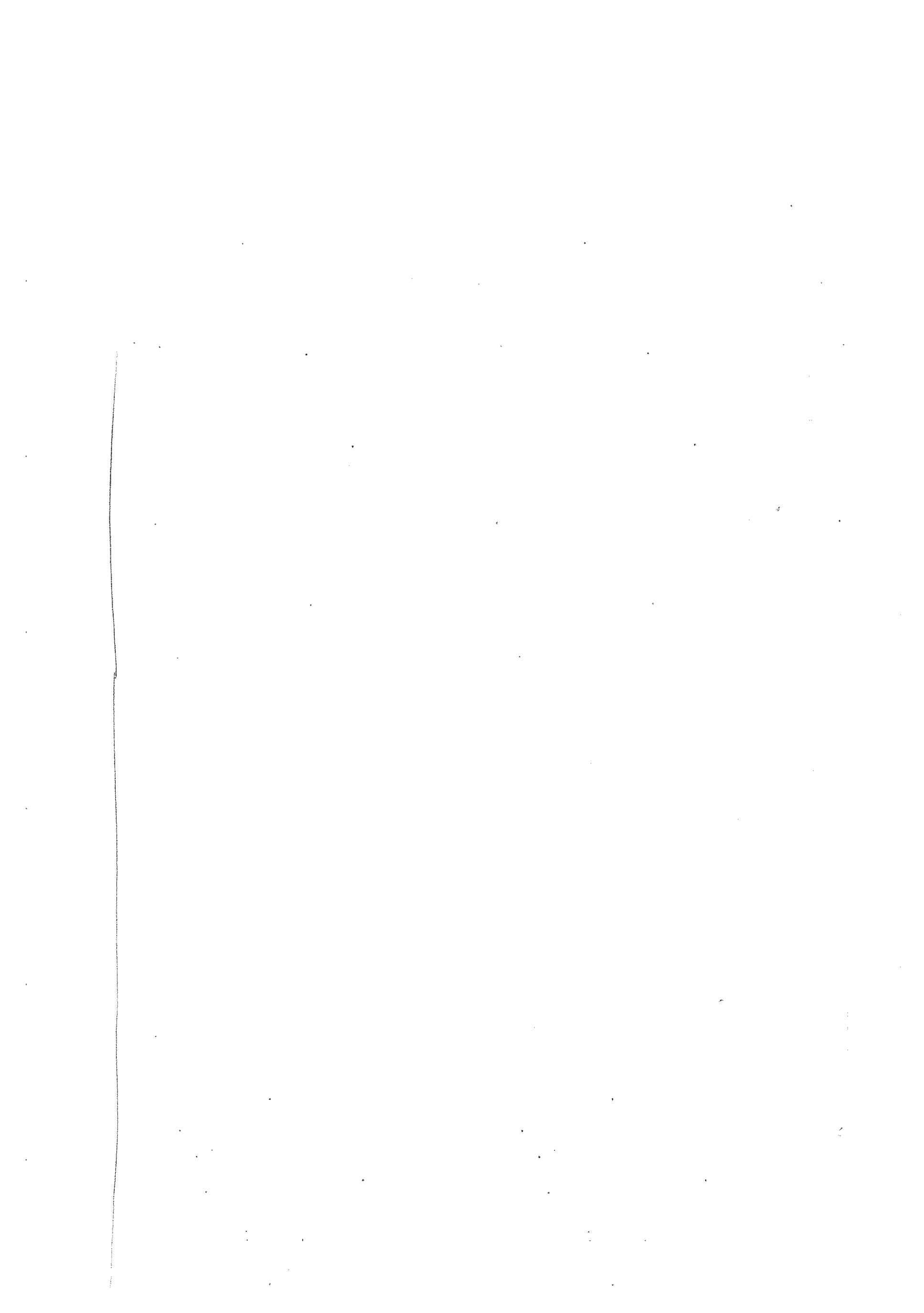
i) Uniform velocity :-

The displacement diagram when the follower moves with uniform velocity is shown in Fig. The ordinate (Y-axis) represents the Follower movement and the base (X-axis) represents the angular displacement or cam (or) time interval. As the cam rotates about its axis, the follower moves from A to E during the period AB.



The follower then remains stationary during BC, and moving inward (returning) during the period CD. A second dwell period occurs during DA and cycle is represented for the next revolution.

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Let : s : Stroke of the Follower or max. lift of the Follower
 n = lift of the Follower
 θ_0 = Angle turned by cam in time 't'
 ω = Angular velocity of cam

we know that

$$\theta = \omega * t \dots \text{--- (1)}$$

from above Fig, the displacement of Follower during outstroke
in time 't' is given by

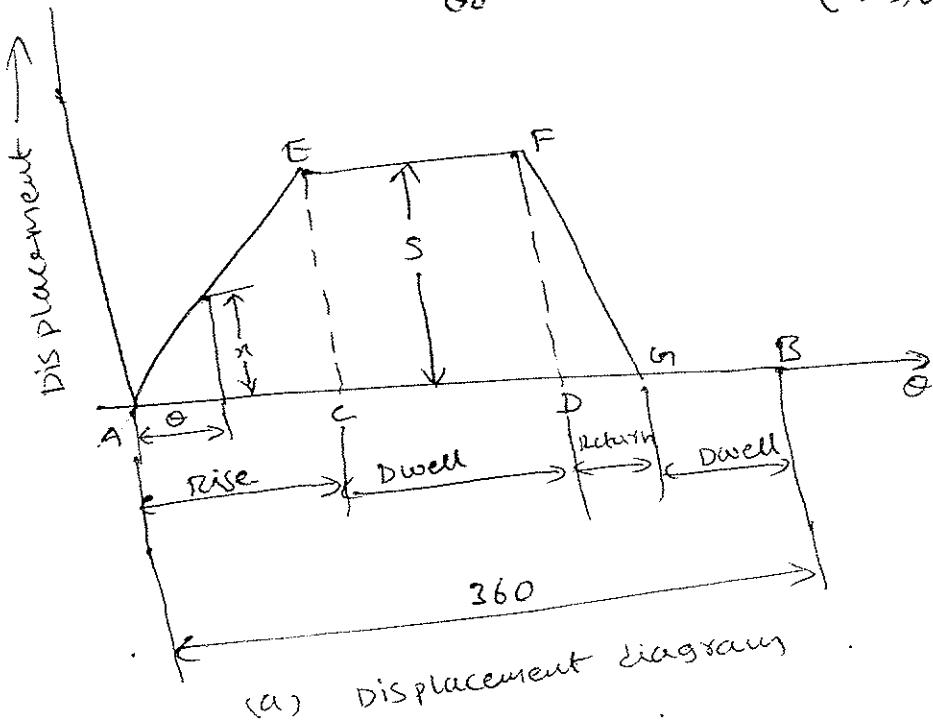
$$x = \frac{s}{\theta_0} * \theta \quad [\because \frac{x}{\theta} = \frac{s}{\theta_0} \therefore x = \frac{s}{\theta_0} * \theta]$$

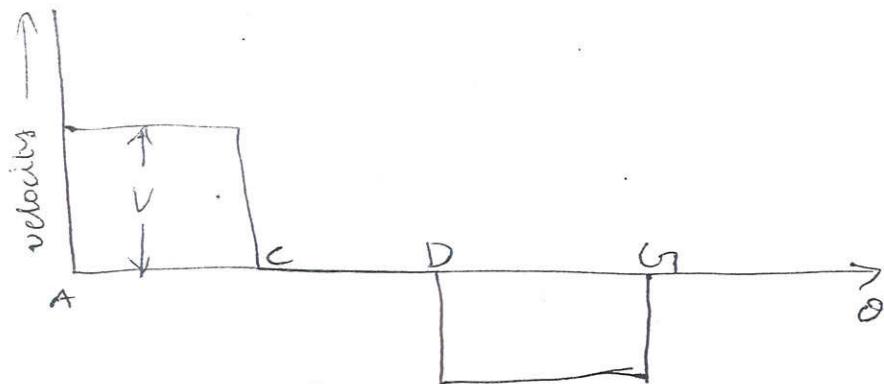
$$x = \frac{s}{\theta_0} * \omega * t \quad [\because \theta = \omega * t]$$

The velocity of Follower (v_0) during outstroke is given by

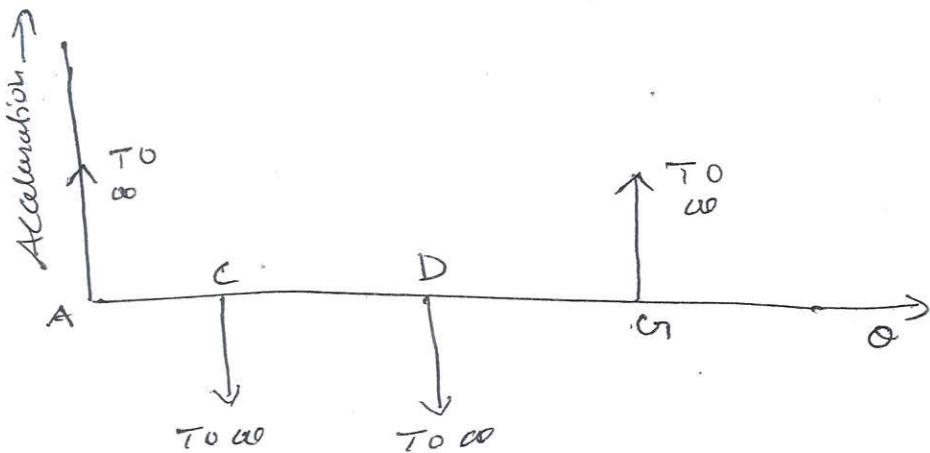
$$v_0 = \frac{dx}{dt} = \frac{d}{dt} \left[\frac{s}{\theta_0} * \omega * t \right]$$

$$= \frac{s}{\theta_0} * \omega = \text{constant} \quad [\because s, \theta_0 \text{ and } \omega \text{ are constant}]$$





(b) velocity diagram.



(c) Acceleration diagram

The acceleration of the follower (f_o) during out-stroke is given by

$$f_o = \frac{dv}{dt} = 0 \quad (\because v \text{ is constant, Hence } \frac{dv}{dt} = 0)$$

$$\therefore f_o = 0$$

Similarly, the velocity and accel during return stroke are obtained

Changing θ_0 to θ_r .

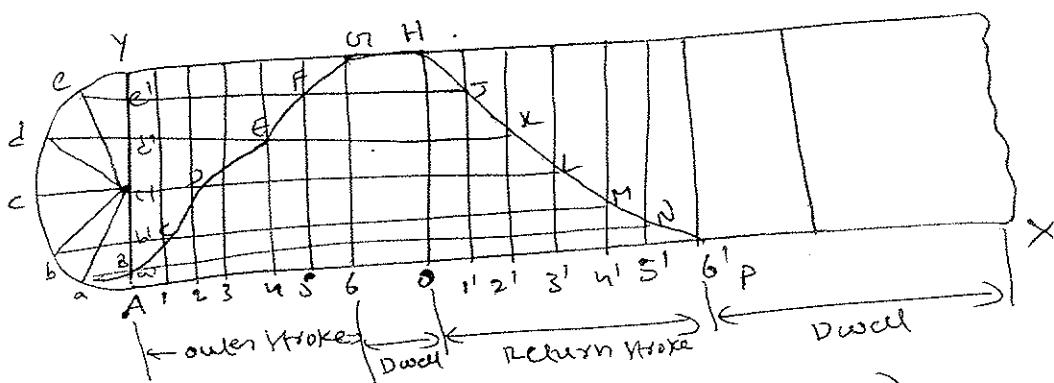
$$v_r = \frac{s}{\theta_r} \times \omega$$

$$f_r = 0$$

④ simple Harmonic motion [SHM] :-

The displacement diagram for simple harmonic motion of follower as shown in Fig.

The displacement diagram is constructed as follows:



Displacement diagram (SHM)

- (1) Draw a semi circle of diameter equal to the lift or stroke of the follower
- (2) Divide the semi circle into any number of even equal parts (say 6)
- (3) Divide the angular displacement of the cam during out stroke and return stroke into same number of equal parts and draw vertical lines to each point.
- (4) From points a, b, c, ... etc, draw horizontal lines intersecting the vertical lines drawn through 1, 2, 3, ... etc, and 0', 1', 2', ... etc, at B, C, D, ... M, N, P
- (5) Joint the points A, B, C, ... M, N, P etc, with a smooth curve which will give the displacement curve for SHM.

