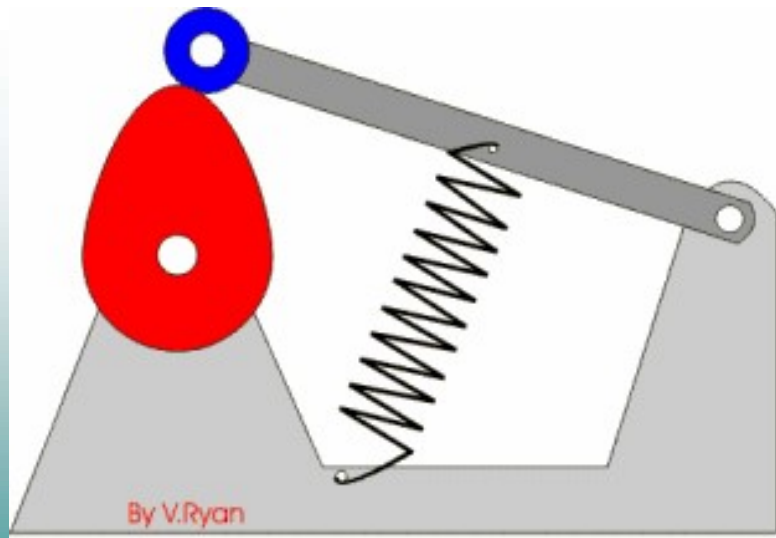


# CAMS AND FOLLOWERS

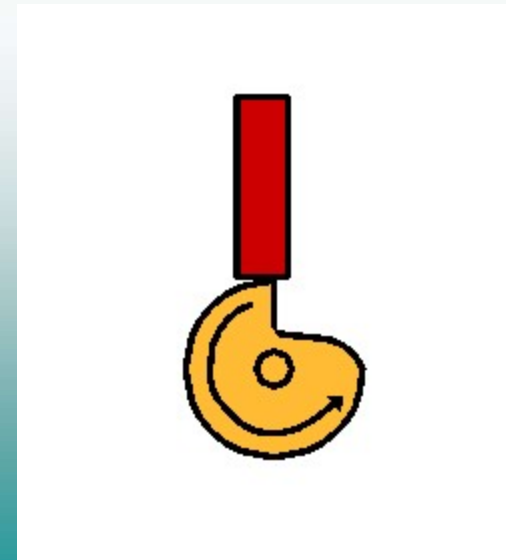
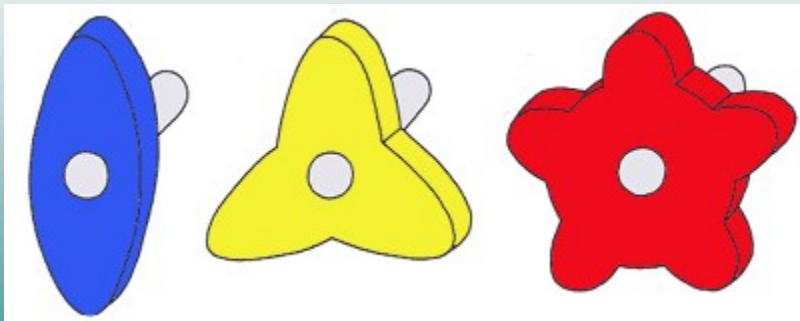
# CAMS

- Cam - A mechanical device used to transmit motion to a follower by direct contact.
- Cam – driver; Follower - driven
- In a cam - follower pair, the cam normally rotates while the follower may translate or oscillate.

# Example of cam action



- **Concept and Definition of Cam.**
- **Application Of Cam And Follower**
- **Types Of Cams**
- **Types Of Cam Followers**



# CONCEPT AND DEFINITION

A cam is a rotating machine element which gives reciprocating or oscillating motion to another element known as follower. The cam and follower has a point or line contact constitute a higher pair.

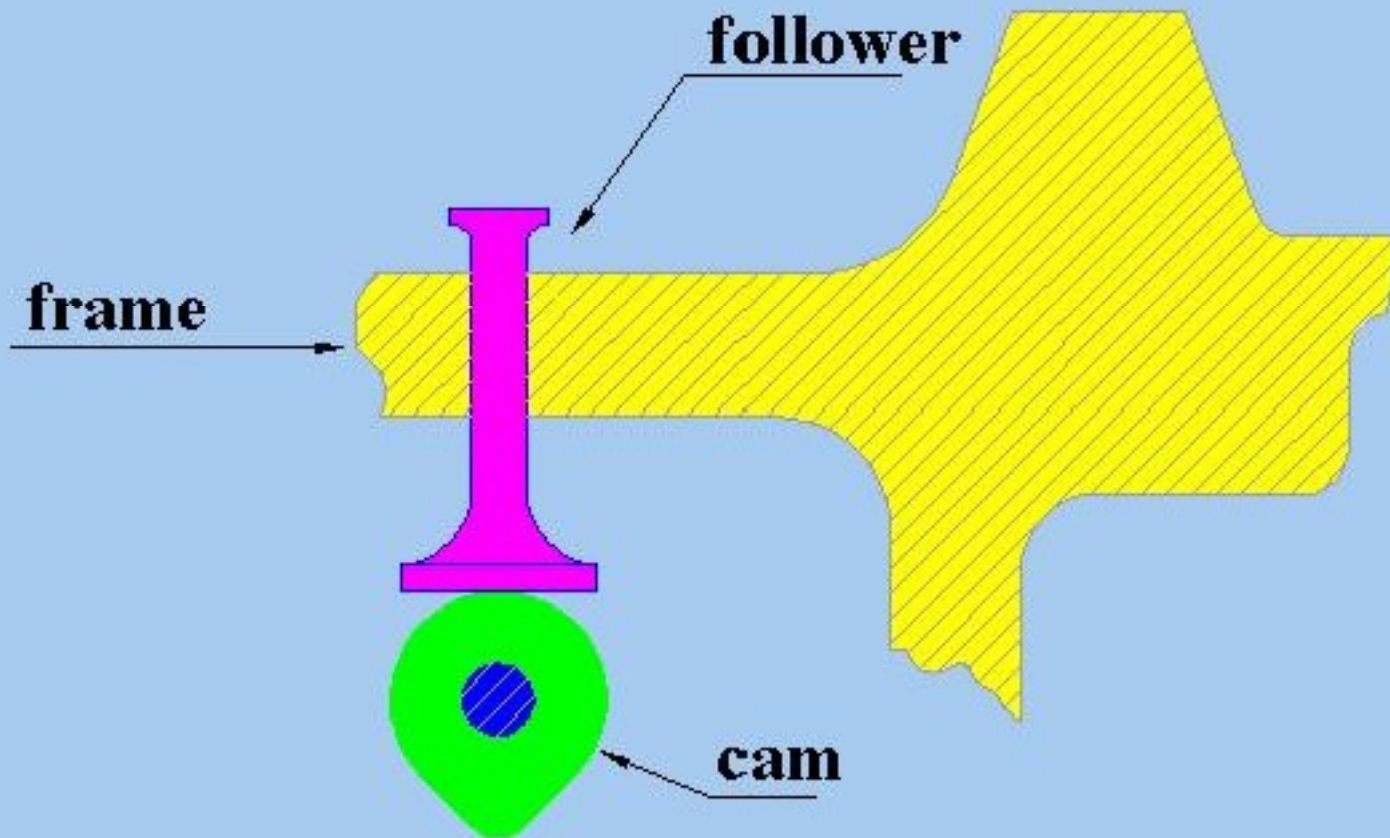
OR

A cam is a mechanical component of a machine that is used to transmit motion to another component, called the follower, through a prescribed motion program by direct contact.

- The contact between them (cam & follower) is maintained by an external force which is generally provided by a spring or sometimes by the weight of the follower itself, when it is sufficient.
- The cam convert rotary motion of one element into reciprocating (linear motion) or into oscillatory motion. Cam is a driver member and follower is a driven member.

- A cam mechanism consists of three elements:  
a) the cam, b) the follower (or follower system),  
c) and the frame.
- The follower is in direct contact with the cam.
- The cam may be of various shapes.
- The follower system includes all of the elements to which motion is imparted by the cam. This may be connected directly to the follower, or connected through linkages and gearing.
- The frame of the machine supports the bearing surfaces for the cam and for the follower.

# Three elements of the cam





# Applications of Cam and Follower

- Cam and follower are widely used for operating inlet and exhaust valve of I C engine.
- These are used in wall clock.
- These are used in feed mechanism of automatic lathe Machine.
- These are used in paper cutting machine.
- Used in weaving textile machineries.

**The cam mechanism is a versatile one. It can be designed to produce almost unlimited types of motioning the follower.**

**It is used to transform a rotary motion into a translating or oscillating motion.**

**On certain occasions, it is also used to transform one translating or oscillating motion into a different translating or oscillating motion.**

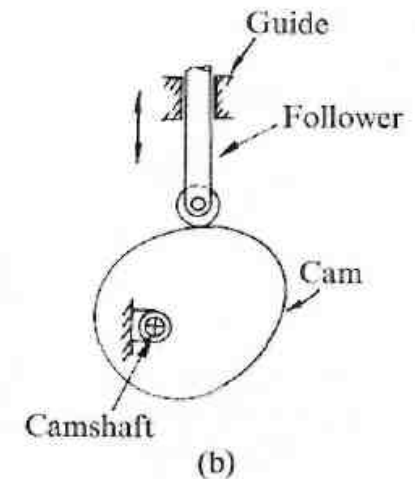
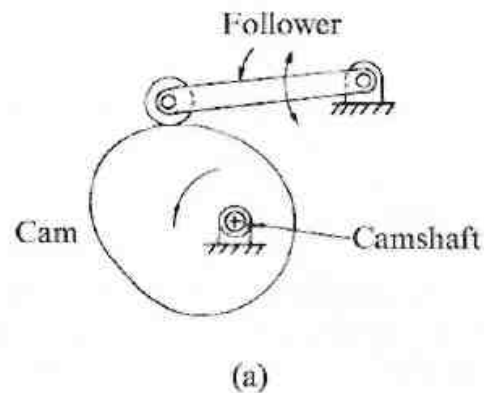
**Cams are used in a wide variety of automatic machines and instruments.**

**Typical examples of their usage include textile machineries, computers, printing presses, food processing machines, internal combustion engines, and countless other automatic machines, control systems and devices. The cam mechanism is indeed a very important component in modern mechanization.**

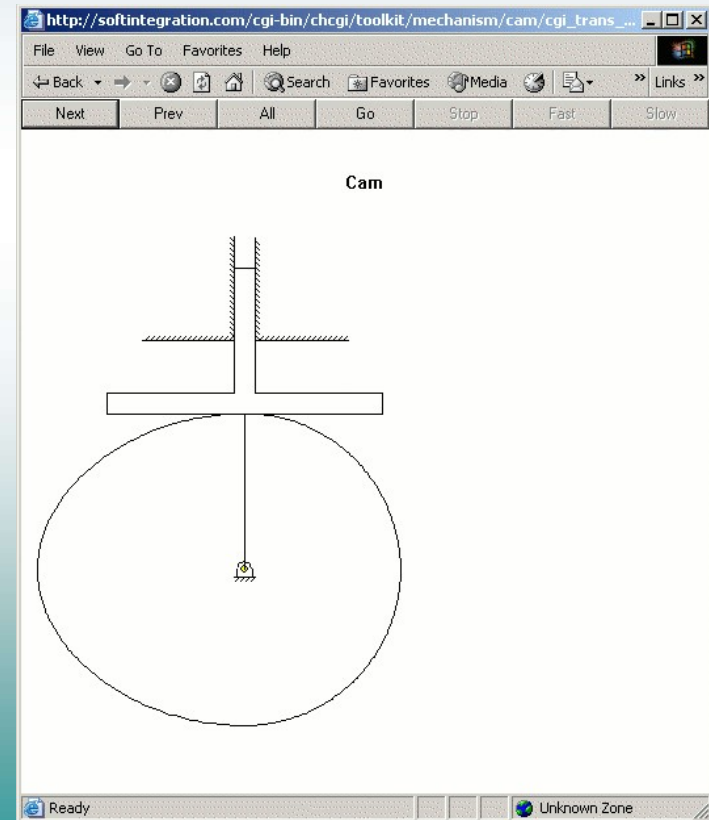
# CLASSIFICATION OF CAMS

(i) Based on the physical shape

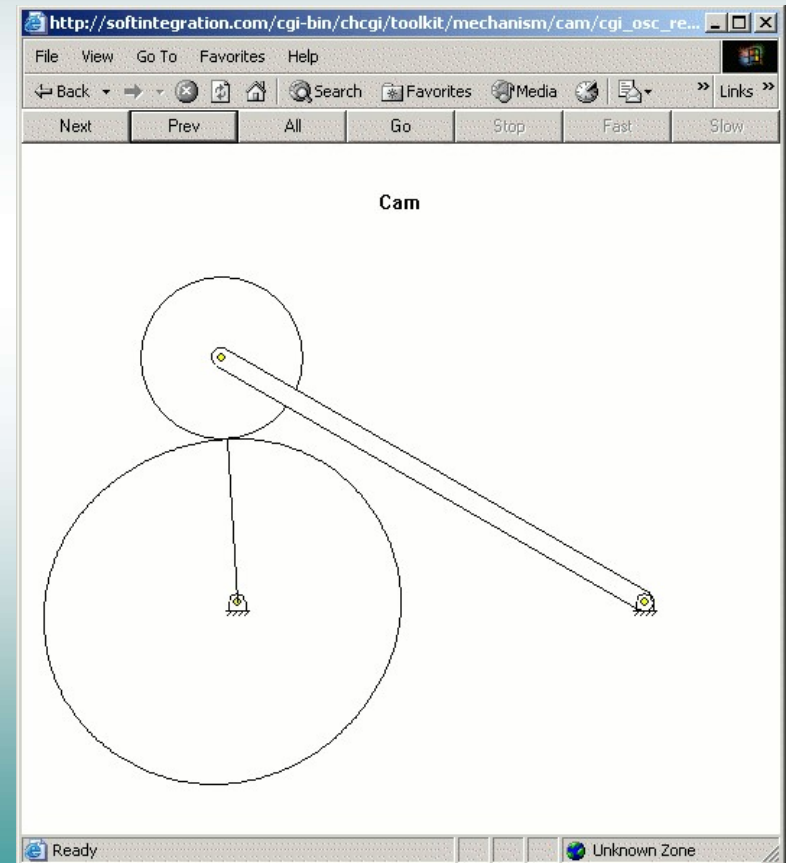
**(a) Disk or plate cams**



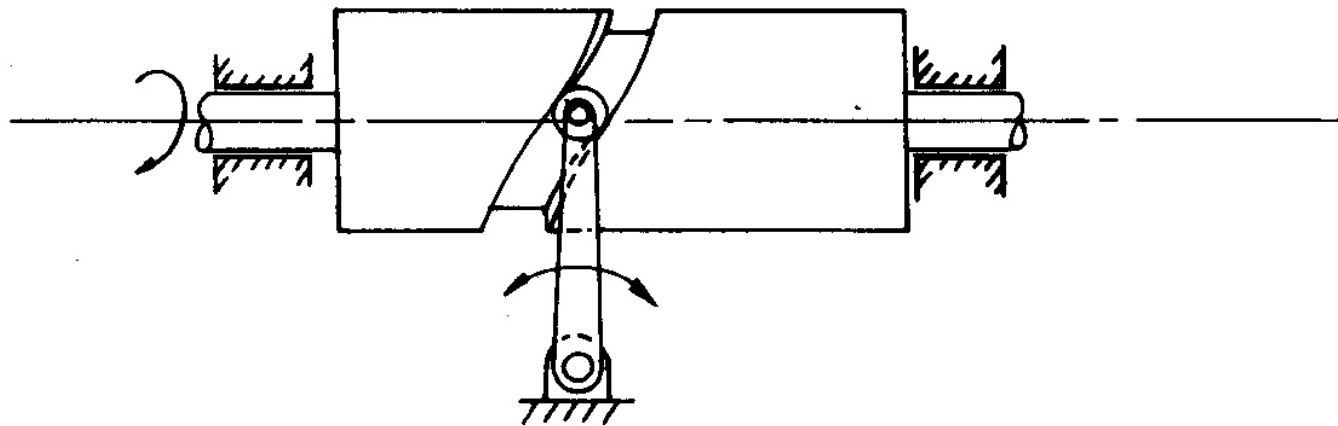
# Working of disc cam with reciprocating follower



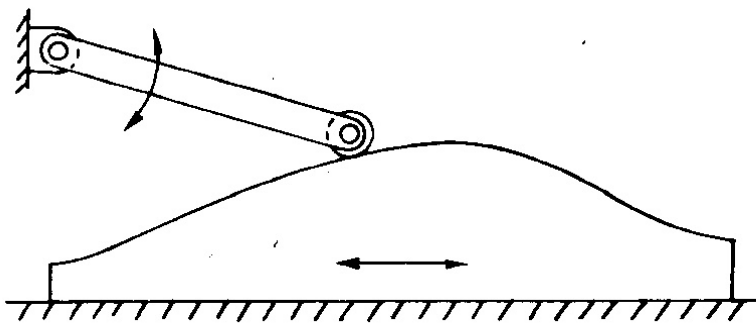
# Working of disc cam with oscillating follower



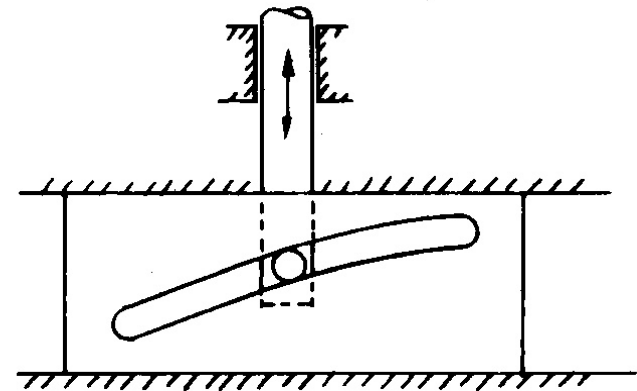
## (b) Cylindrical cam



## (c) Translating cam



(a)



(b)

# CLASSIFICATION OF FOLLOWERS

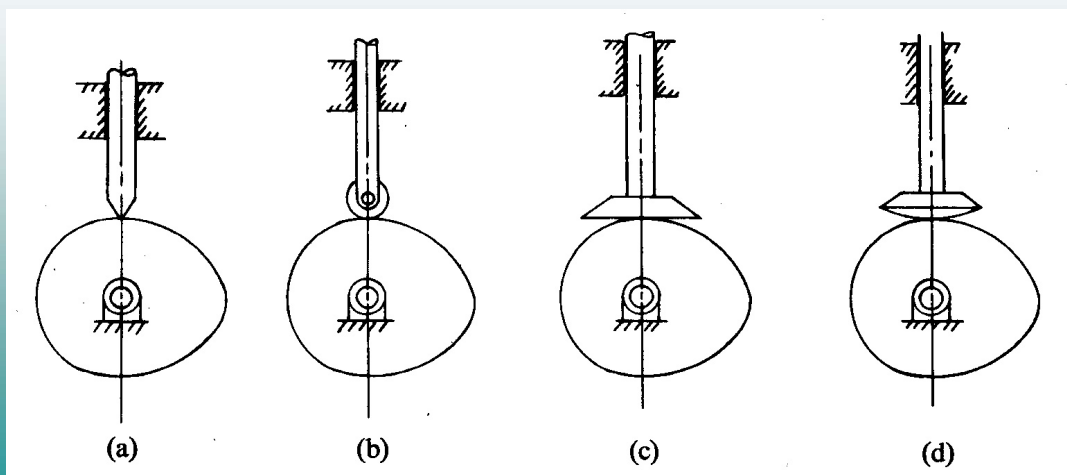
## (i) Based on surface in contact

(a) Knife edge follower

(b) Roller follower

(c) Flat faced follower

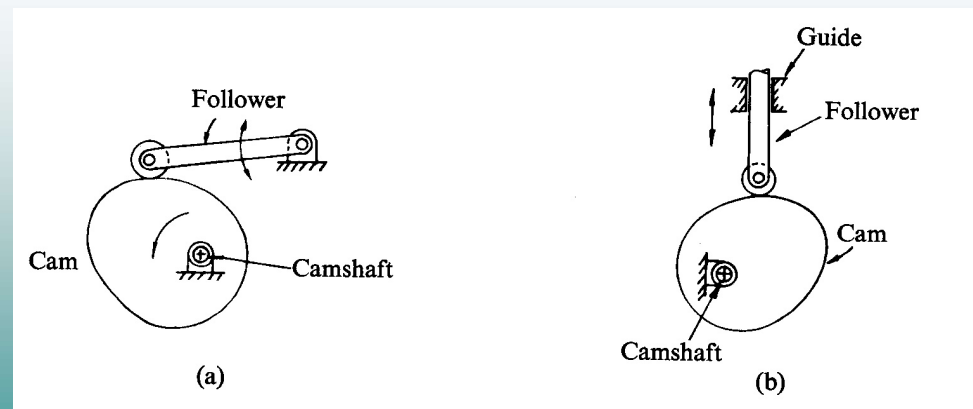
(d) Spherical follower





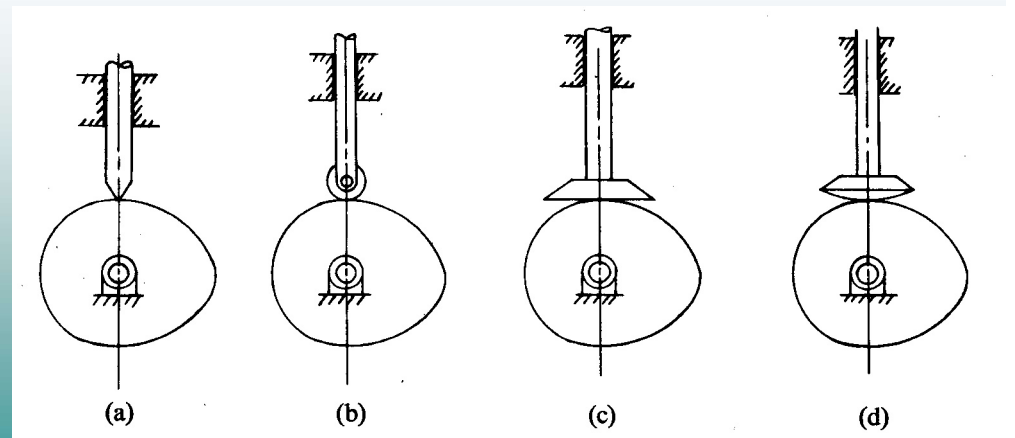
## (ii) Based on type of motion

- a) Oscillating follower
- b) Translating follower

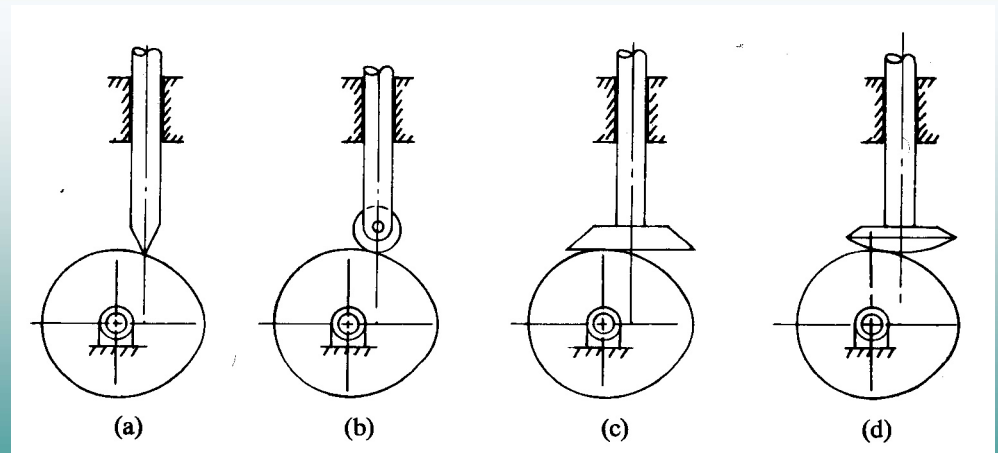


### (iii) Based on line of action

#### a) Radial (in line) follower



## (b) Off-set follower



# Classifying cams

Cams can be conveniently classified into two main groups:

## Group a:

Cams that impart motion to the follower in a plane in line with the axis of rotation of the cam (as does a cylindrical cam).

## Group b:

Cams that impart motion to the follower in a plane at 90 degrees to the axis of rotation, as with face or edge cams. Most cams fall into this category.

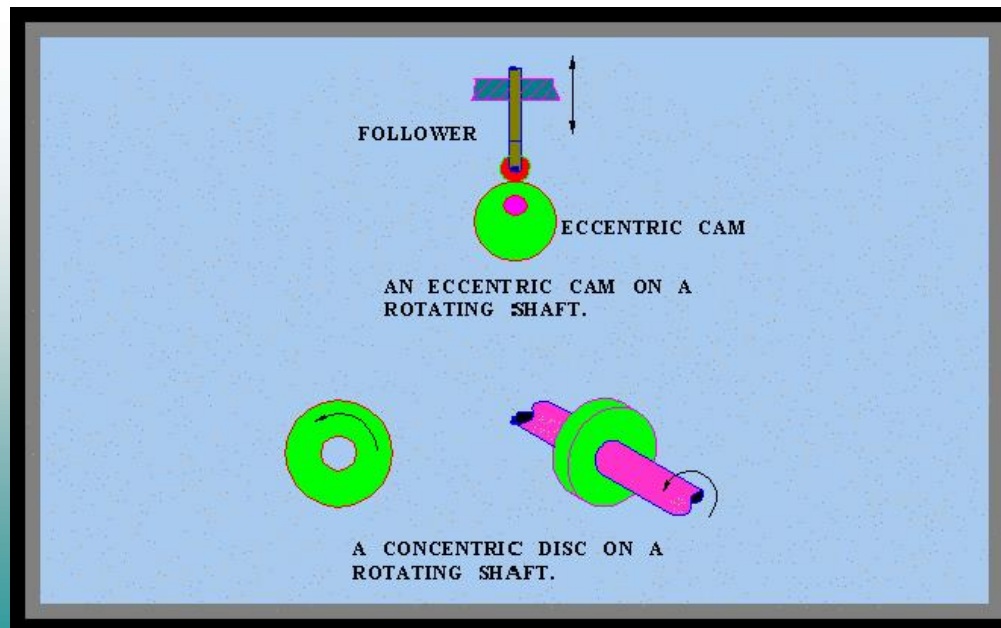
# TYPES OF CAMS

## Eccentric cam:

A circular cam is often called an eccentric cam because the axis of rotation of the cam is offset from the geometric center of the circular disc.

## Concentric disc:

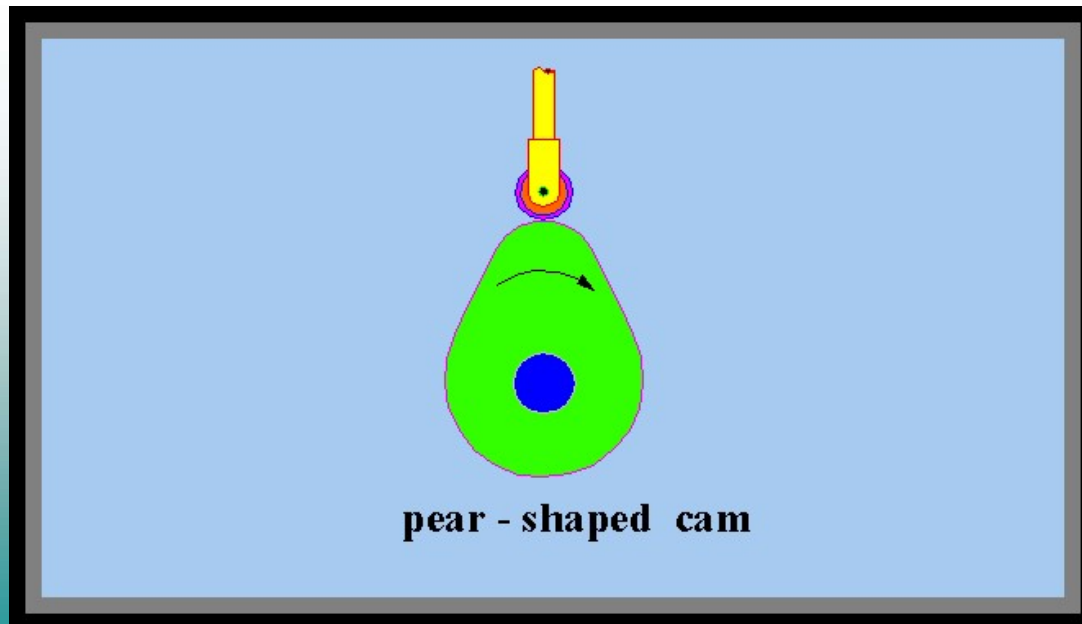
A concentric disc attached to a rotating shaft would have its axis of rotation coinciding with its geometric center.



# PROFILE SHAPES OF SOME CAMS

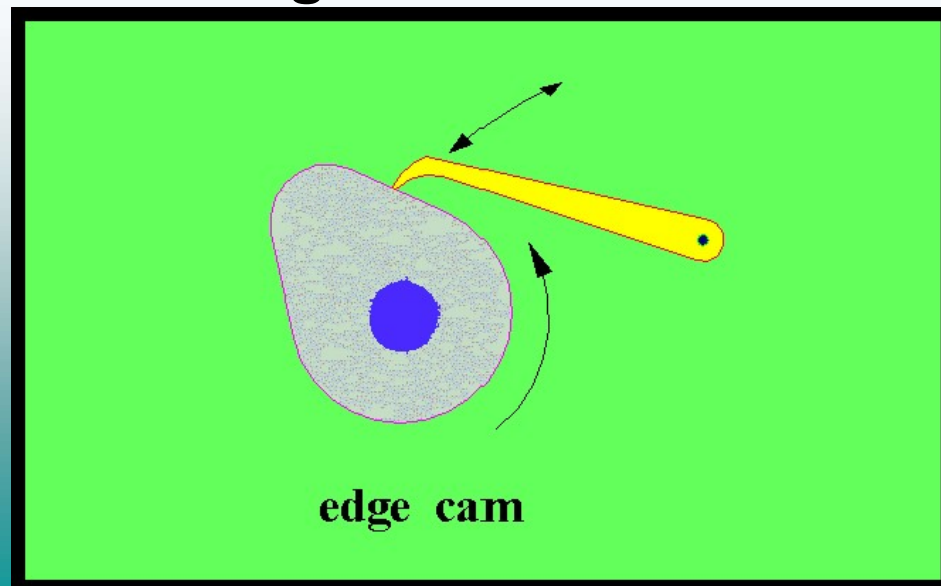
## PEAR-SHAPED CAMS:

These type cams are often used for controlling valves. For example, **they are used on motor car camshafts to operate the engine valves.** A follower controlled by a pear-shaped cam remains motionless for about half a revolution of the cam. During the time that the follower is stationary, the cam is in a dwell period. During the other half revolution of the cam, the follower rises and then falls. As the pear-shaped cam is symmetrical, the rise motion is the same as the fall motion.



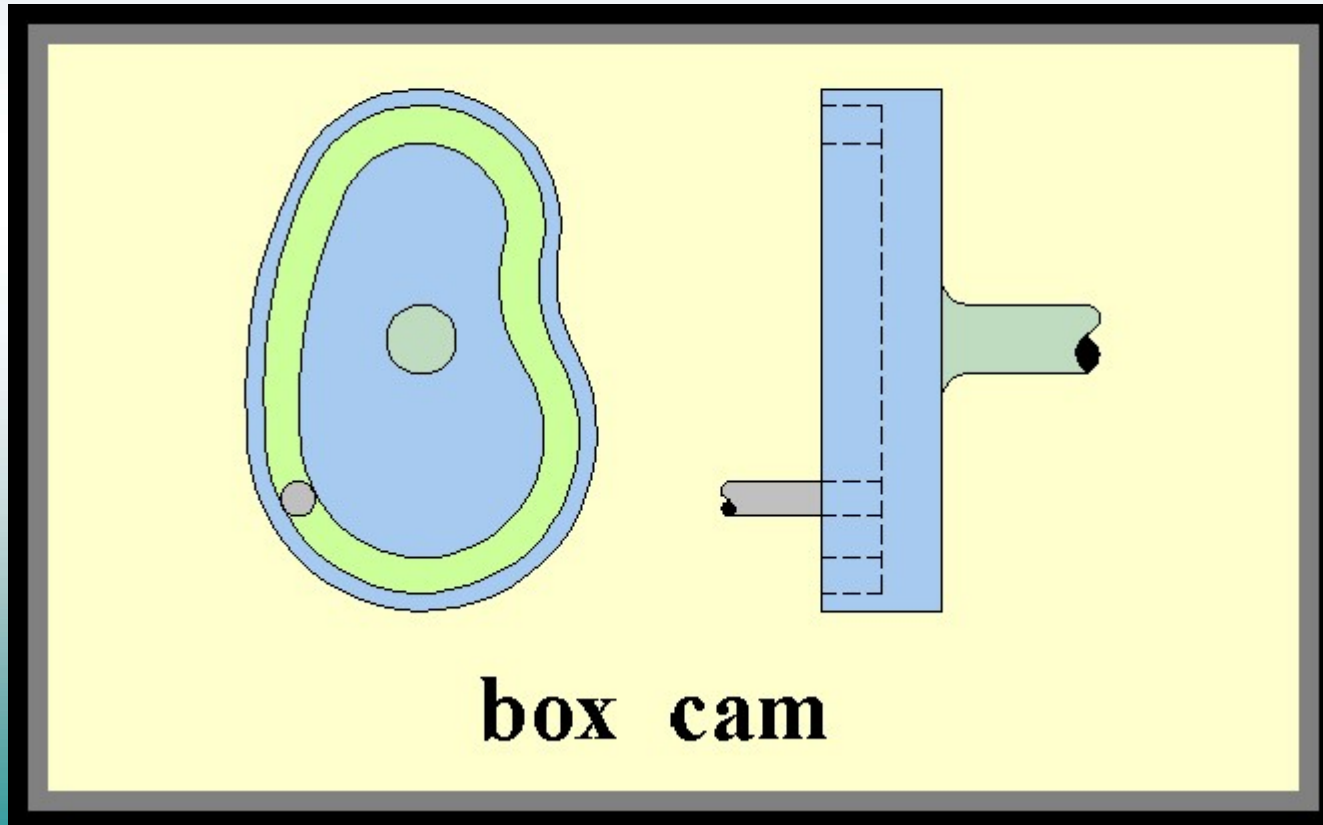
## Edge cams

It must be appreciated that this type of cam, where the follower is in contact with the edge of the cam disc, is only capable of imparting positive motion to its follower in one direction, that is, during the rise portion of the cam movement. During the fall portion of the cam movement the follower must be maintained in contact with the cam either by the mass of the follower and its mechanism or, more usually, by a spring. Both methods have their advantages.



## Box cams

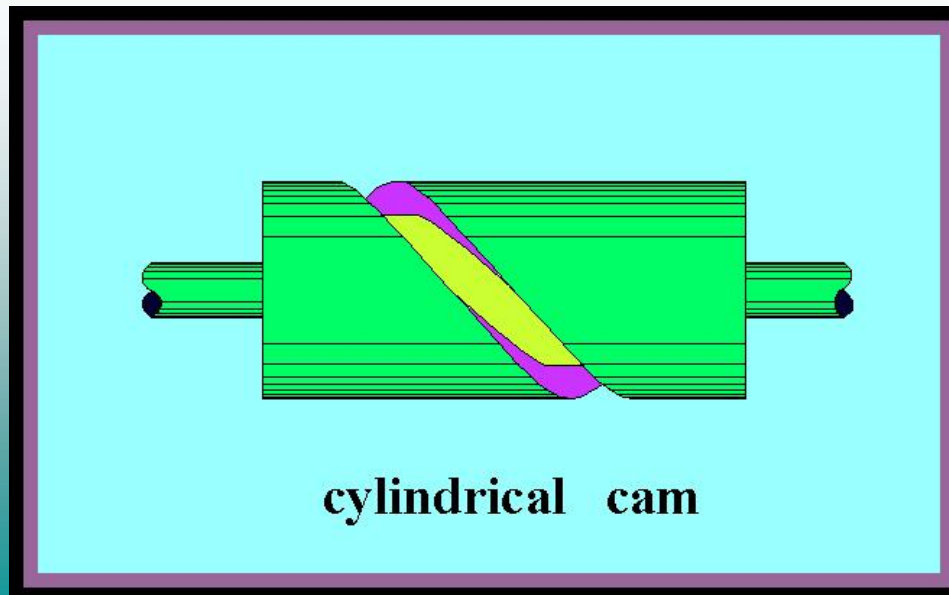
A groove can be milled in the face of cam discs. As the cam rotates, a follower located in the groove has its motion guided by the groove. This type of cam is called a box cam.





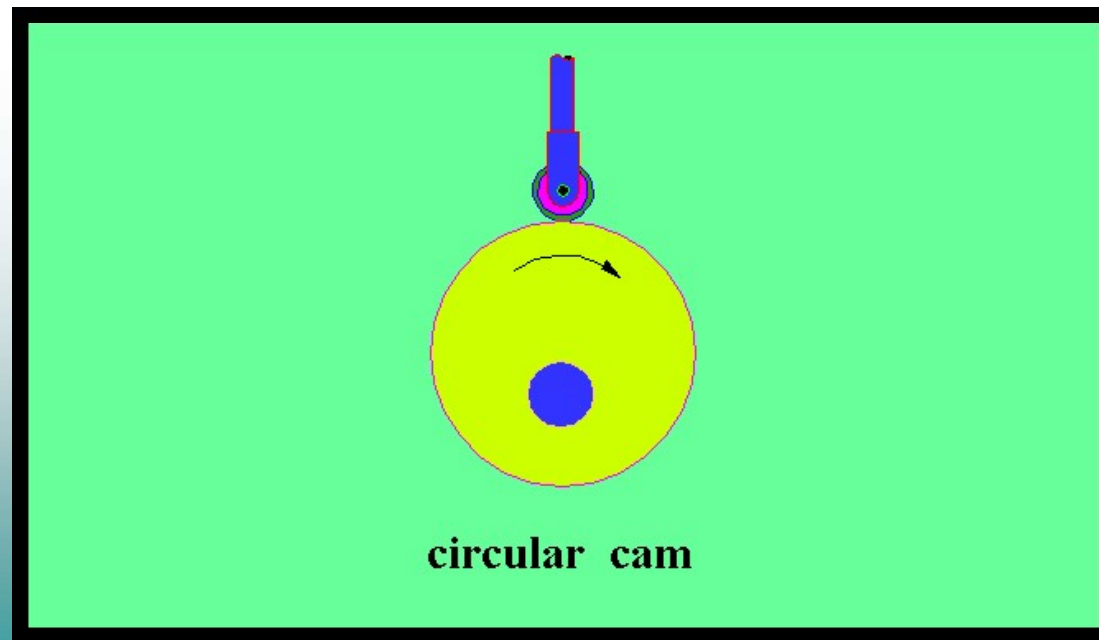
## Cylindrical cams:

Cylindrical cams are used when motion has to be transmitted parallel to the axis of rotation of the cam. The cylindrical or barrel cam consists of a rotating cylinder with a helical (screw shaped) groove in its curved surface. A follower with a tapered roller end is located in the groove. As the cylinder turns, the follower moves in a straight line parallel to the axis of the rotation barrel cam. This type of cam is often used to guide thread on sewing machines, looms and fabric making machines.



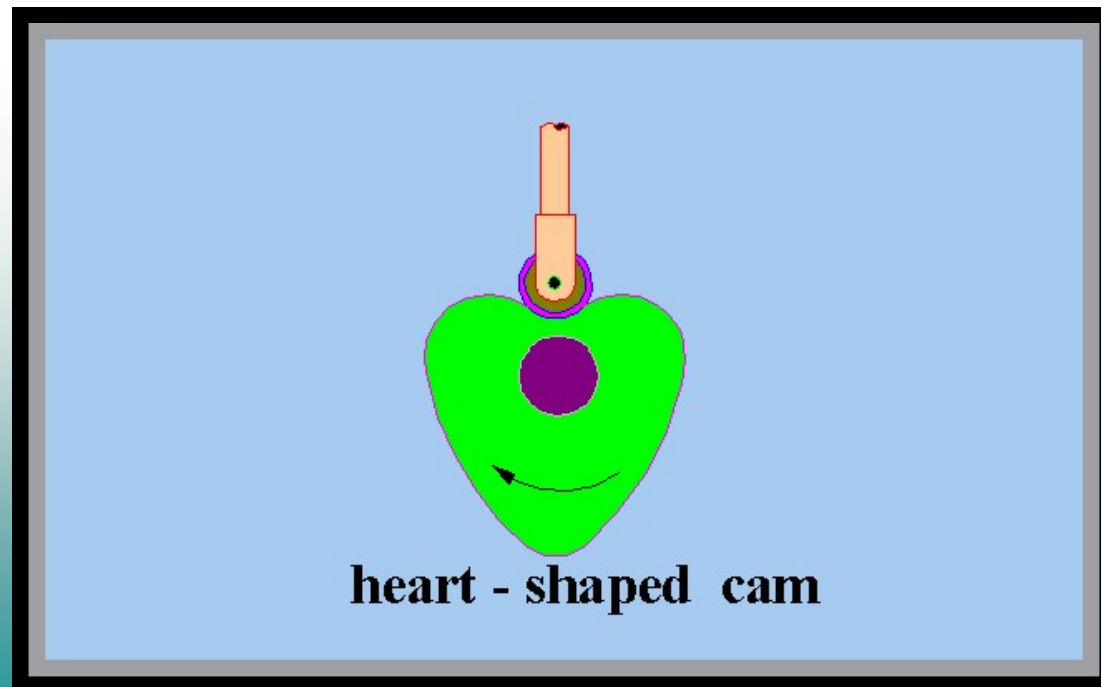
# CIRCULAR CAMS:

These cams are sometimes called eccentric cams. The cam profile is a circle. The center of rotation of the cam is often from the geometric center of the circle. The circular cam produces a smooth form of motion called a simple harmonic motion. These cams are often used to produce motion in pumps. Circular cams are often used to operate steam engine valves. As the cam is symmetrical, the rise and fall motions are the same.



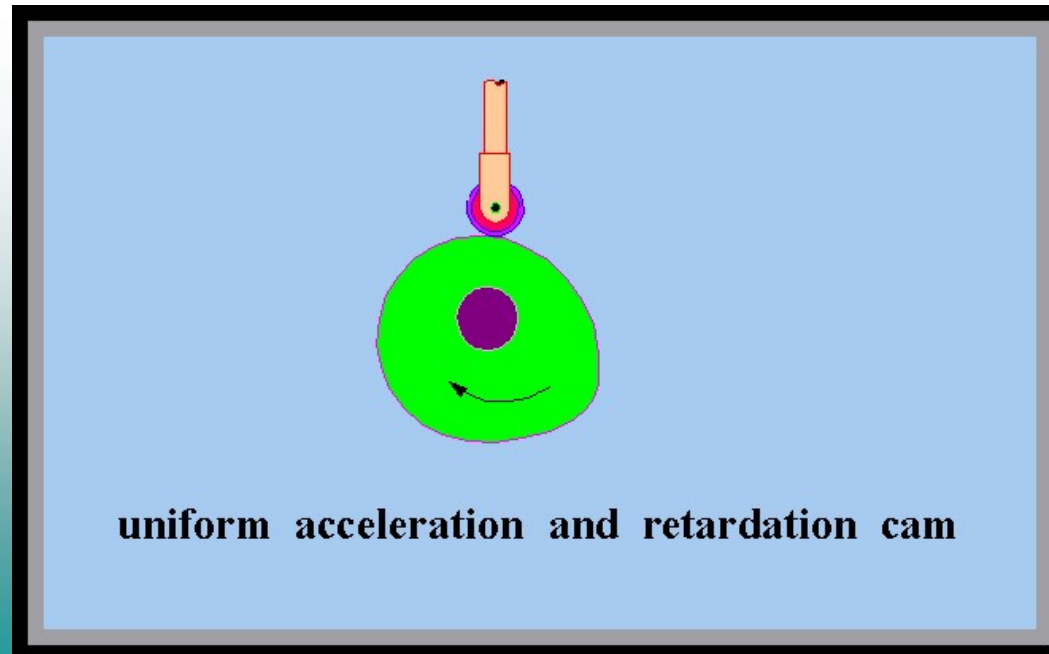
# HEART SHAPED CAMS:

This cam causes the follower to move with a uniform velocity. Heart-shaped cams are essential when the follower motion needs to be uniform or steady as, for example, in the mechanism that winds thread evenly on the bobbin of a sewing machine. A heart-shaped cam can be used for winding wire evenly on the former of a solenoid.



# UNIFORM ACCELERATION AND RETARDATION CAMS:

A cam shaped as shown controls the motion of the follower so that it moves with uniform acceleration and retardation. The follower gains and loses velocity at a constant rate. Uniform acceleration and retardation cams are used to control the motion of linkages in complex machinery.



# **Types of Cam Followers**

**There are three types of cam followers, and since the type of follower influences the profile of the cam it is worthwhile considering the advantages and disadvantages of each type. The three types are the knife-edge, the roller follower and the flatfoot or mushroom follower.**

## **The Knife Edge Follower:**

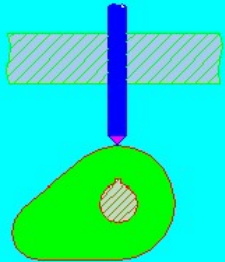
**This is the simplest type, is not often used due to the rapid rate of wear. When it is adopted, it is usually for reciprocating motion, running in slides and there is considerable side thrust, this being a component of the thrust from the cam.**

# **The Roller Follower:**

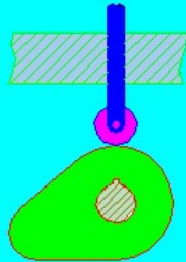
**This eliminates the problem of rapid wear since the sliding effect is largely replaced by a roller action. Some sliding will still take place due to the varying peripheral speed of the cam profile, due to the changing radius of the point of contact. Note also that the radial position of the contact between the cam and the roller, relative to the follower center, will change according to whether a rise or fall motion is taken place: this fact has to be considered when constructing the cam profile. Again, with the roller follower, considerable side thrusts are present, a disadvantage when dealing with reciprocating motions. This side thrust will be increased when using small rollers.**

## **The Flat Foot or Mushroom Follower:**

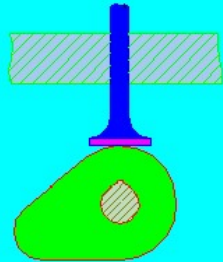
**This has the advantage that the only side thrust present is that due to the friction between the follower and the cam. The problem of wear is not so great as with the knife-edge follower, since the point of contact between the cam and follower will move across the face of the follower according to the change of shape of the cam. A trick to lessen further the effect of wear is to design the follower to be capable of axial rotation and arrange the axis of the follower to lie to one side of the cam. Thus the contact with the cam will tend to cause rotation of the follower. The cam profile, to work with a flatfoot follower, must be convex at all parts, in order to prevent the corners of the follower digging into the cam profile. The minimum cam radius should be as small as possible to minimize sliding velocity and friction.**



POINT OR  
KNIFE EDGE  
FOLLOWER

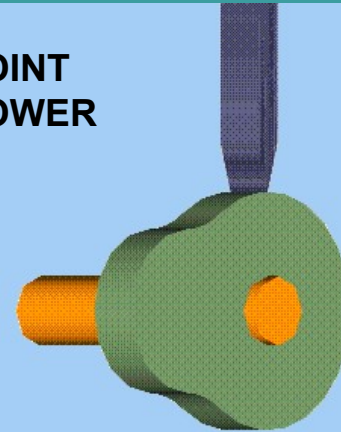


ROLLER  
FOLLOWER

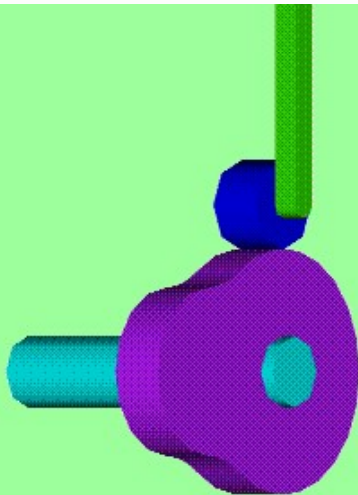


FLAT FACED  
FOLLOWER

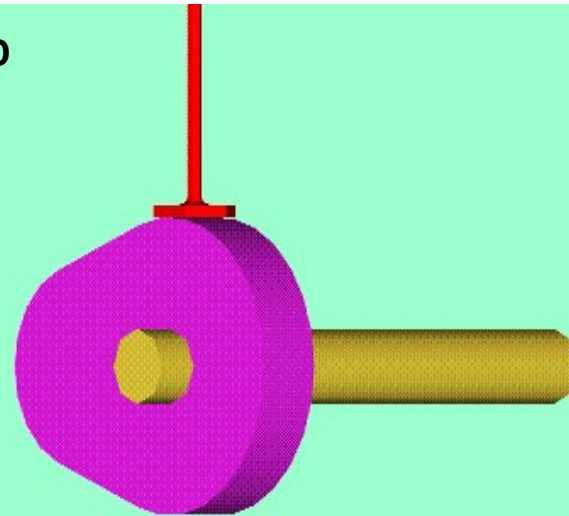
KNIFE OR POINT  
EDGE FOLLOWER



ROLLER  
FOLLOWER



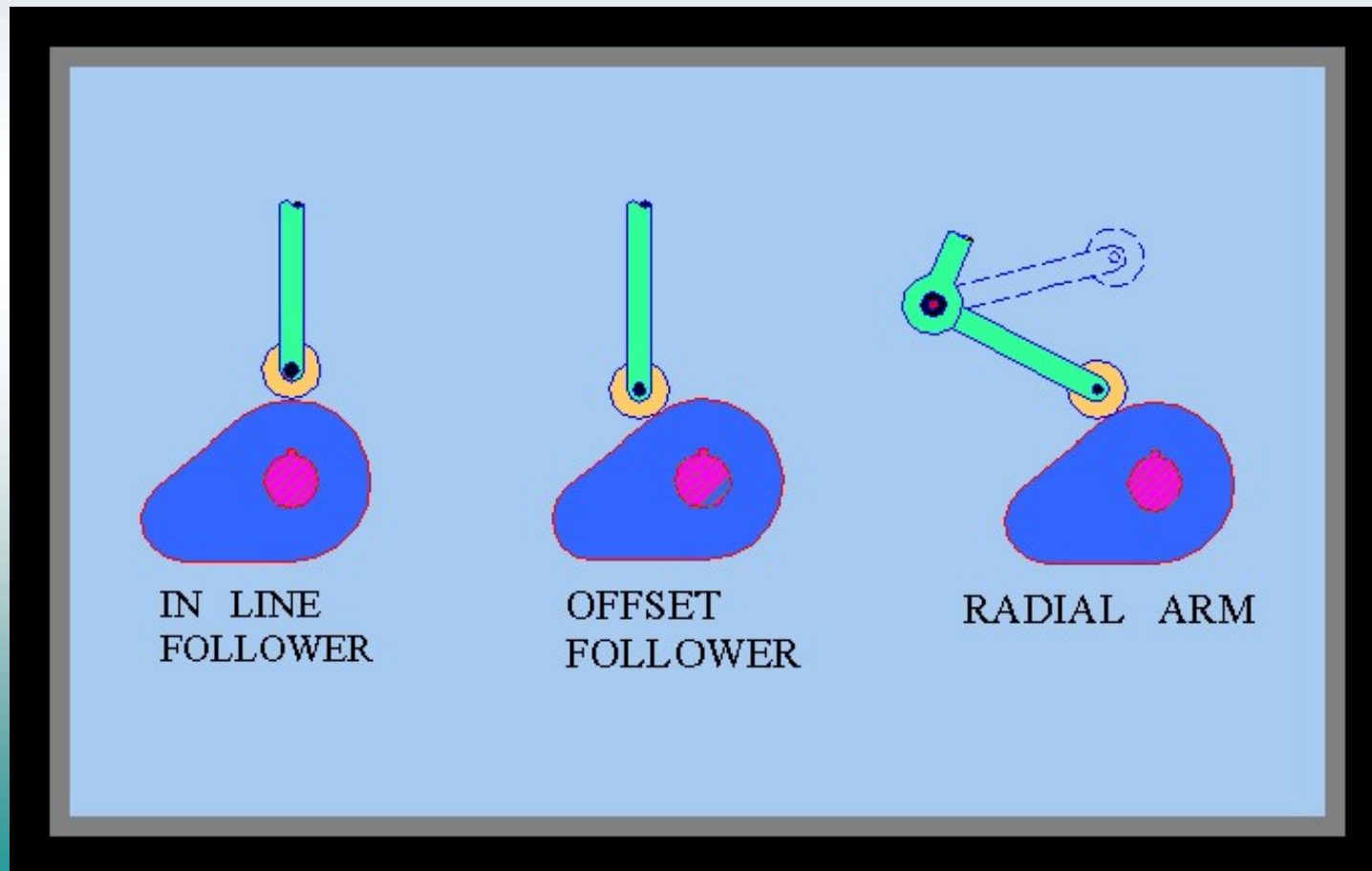
FLAT FACED  
FOLLOWER





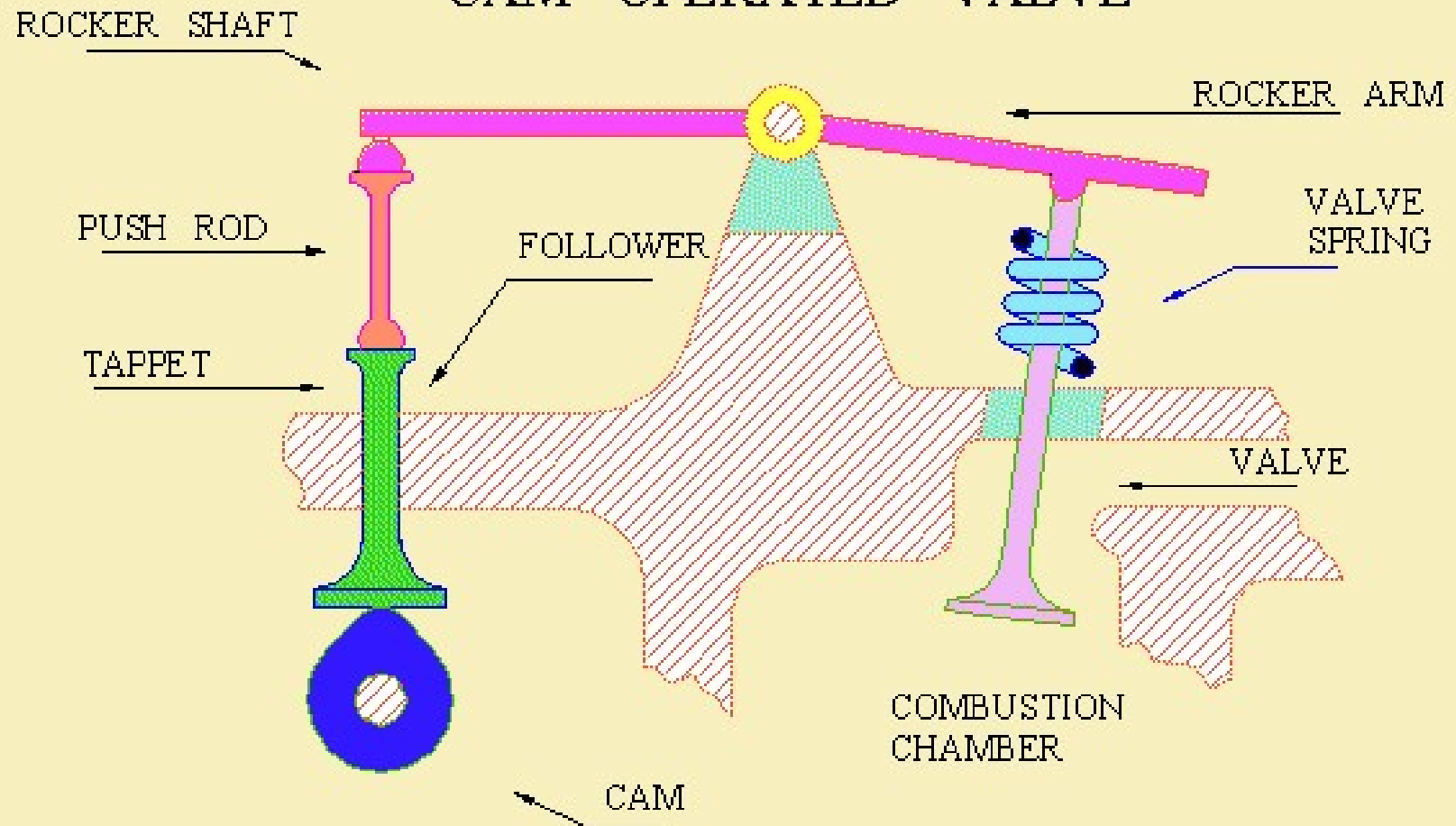
# All three types of cam followers can be mounted in the following ways:

- 1) In-line with the cam center line,
- 2) Offset from the cam center line, or
- 3) Mounted on a swinging radial arm.

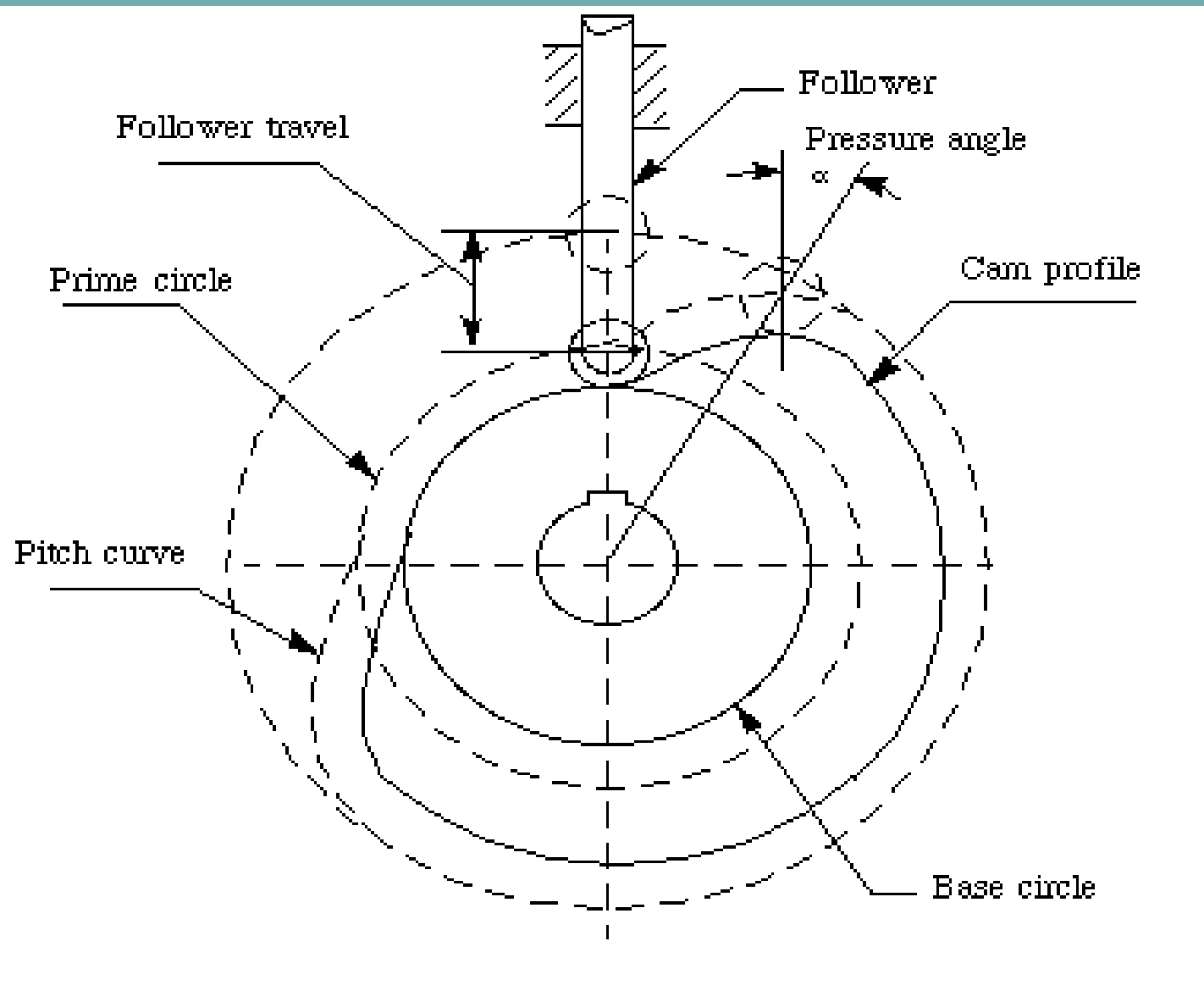


# Cam-Valve

## CAM OPERATED VALVE



# Cam Terminology



### 1. Trace point:

A theoretical point on the follower, corresponding to the point of a fictitious *knife-edge follower*. It is used to generate the *pitch curve*.

In the case of a *roller follower*, the trace point is at the center of the roller.

### 2. Pitch curve:

The path generated by the trace point at the follower is rotated about a stationary cam.

**3. Working curve:** The working surface of a cam in contact with the follower. For the *knife-edge follower* of the plate cam, the *pitch curve* and the *working curves* coincide. In a *close or grooved cam* there is an *inner profile* and an *outer working curve*.

**4. Pitch circle:** A circle from the cam center through the pitch point. The pitch circle radius is used to calculate a cam of minimum size for a given *pressure angle*.

**5. Prime circle (reference circle):** The smallest circle from the cam center through the pitch curve.

**6. Base circle:** The smallest circle from the cam center through the cam profile curve.

**7. Stroke or throw:** The greatest distance or angle through which the follower moves or rotates.

**8. Follower displacement:** The position of the follower from a specific zero or rest position (usually its the position when the *follower* contacts with the *base circle* of the cam) in relation to time or the rotary angle of the cam.

**9. Pressure angle:** The angle at any point between the normal to the pitch curve and the instantaneous direction of the follower motion. This angle is important in cam design because it represents the steepness of the cam profile.

# Types of follower motion

Follower motion with,

- a) Uniform velocity
- b) Modified uniform velocity
- c) Uniform acceleration and deceleration
- d) Simple harmonic motion
- e) Cycloidal motion