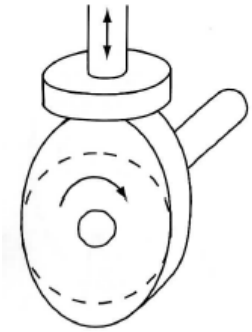
Mechanisms and Algorithms

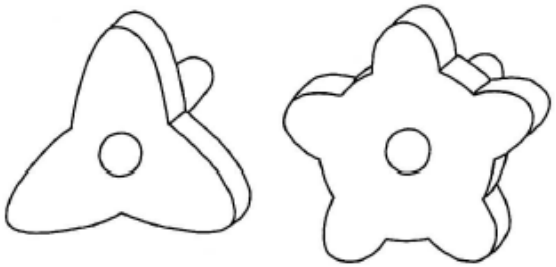
Simple Machines II: Cams, Springs and Linkages

Cams

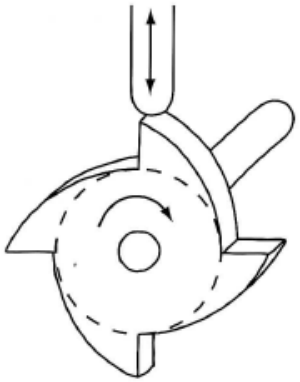
Cams turn rotary motion into an upward and downward motion



Many Shapes
And Sizes



- Lobe Cams
- Produce multiple events per cycle
- Long event sequence demands more space on cam profile (big cam)

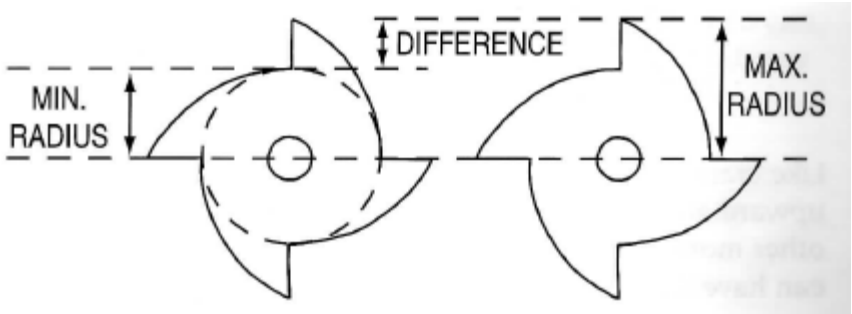


What does this Lobe Cam do?

- Provides steady upward motion followed by a sudden downward one
- This one only works by rotating CW. Jams if rotates CCW

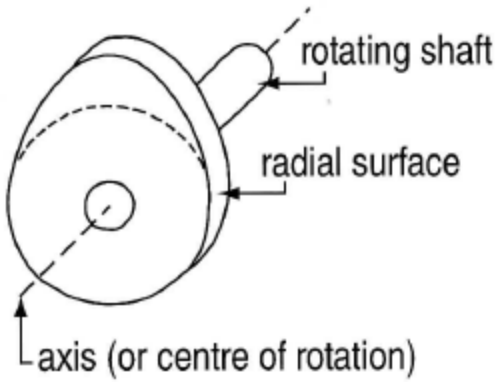
What's this Cam Called?

- Snail Cam
- 1 event per cycle
- This one: only CCW



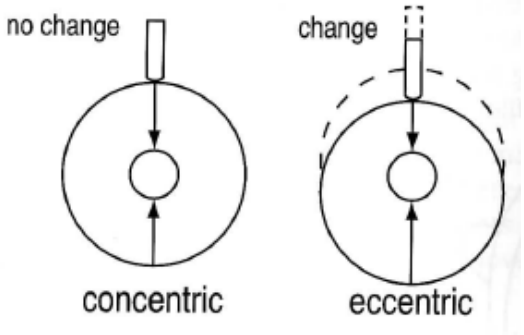
- Throw: difference between min and max radii

http://www.youtube.com/watch?v=2eMZMb8__i0



Eccentricity

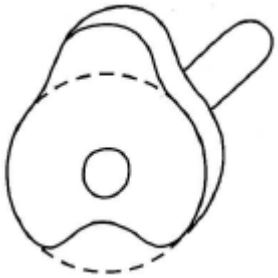
- means to be off-center
- one off-center method: vary cam's surface from axis to cause follower to either lift or drop



- another off-center method: move center of rotation

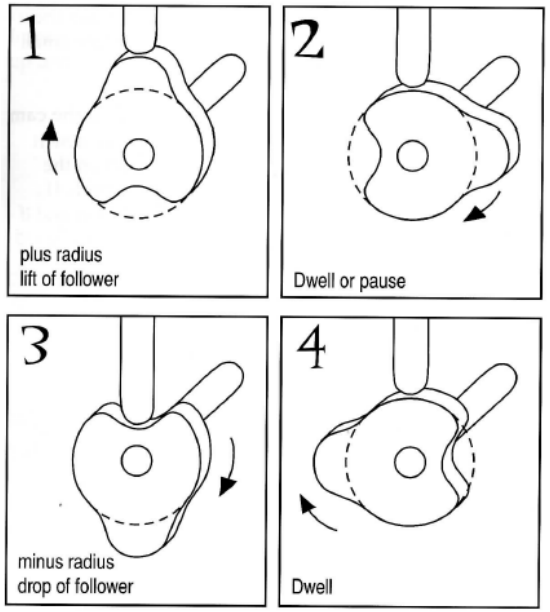
Any advantages of a cam with center of rotation moved?

- Smoother motion
- Good for lifting heavier loads



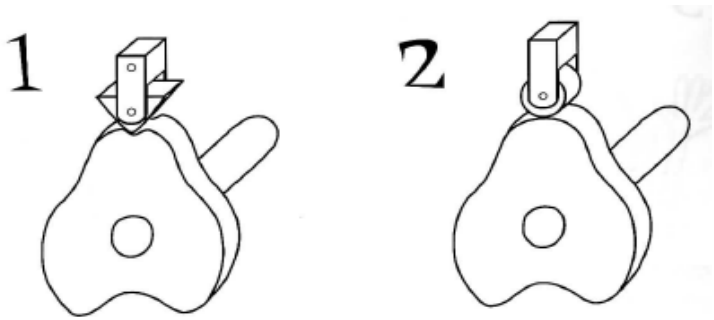
Dwell (or Pause)

- Raised and Dipped radii
- At points where profile returns to constant radius, no movement in follower
- Such points in the profile are called the dwell angle



Practical Points

- Start with smooth and true running shaft
- Cam is a lever: bigger cams will produce smaller movements more easily
- Shape of follower important

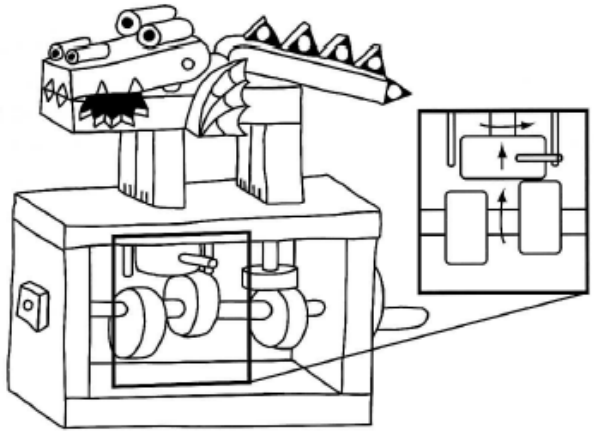


When would you use 1 versus 2?

- Follower: sharper point tracks more intricate variations
- Follower: roller used when friction is a concern

Friction Drive

- Cam and follower working like pair of gears at right angles
- The cam rotates a follower. The follower rotates in a different plane



Dragon by Peter Markey

Explain the effects of crank rotation

- Tongue moves side to side and jaw moves up and down
- Rightmost cam lifts and rotates the follower CCW
- Leftmost cam lifts and rotates the follower CW
- Pins prevent follower from over-rotating

Single mechanism: acts as a cam and friction drive

Cams for Memory and Switching

- Unlike cranks, cams have ability to store information
- Cams are the mechanical version of computer programs

- As cam rotates, info is retrieved by a cam follower
- Follower tracks the cam's profile, reproducing the same movement every cam cycle

- Series of cams on a single shaft can carry out a complex program
- Industrial processes were controlled with cams (before microprocessors took over)
- Older washing machines used cams as timers for various functions e.g. like spin and rinse cycle

Interesting demonstration of cams as a program (to play music)

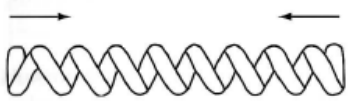
http://www.youtube.com/watch?v=RtjAGW8C57s

Springs

- Have the ability to return to their original shape after stretching or compressing
- Like cams, springs are memory devices; they can “remember” a position and return to it

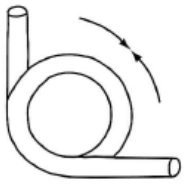
4 Basic Types

- Compression
- Extension
- Torsion
- Radial



Compression (Push) Spring

Extension (Pull) Spring



Torsion Spring

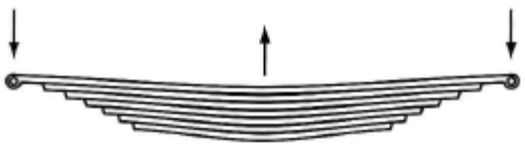
Radial Spring

Classification also depends on instance

Rubber Bands can be:

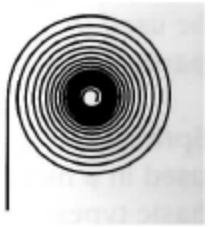
- Extension Spring example? Paperclip slingshots
- Radial Spring example? Preventing a rolled up newspaper from unrolling
- Torsion Spring example? Propeller driven model airplanes

Laminated Spring



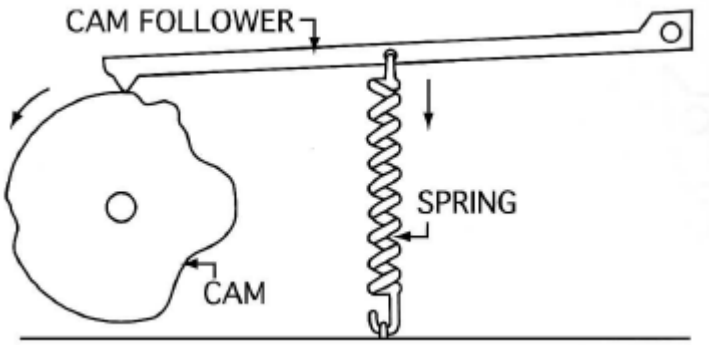
- Also called leaf springs
- Special type of compression spring
- Suspension system in some cars

Coiled Spring



- Also called clock springs
- Special type of torsion spring
- Windup toys: as unwinds, the energy drives the mechanism

Springs in Cam Followers

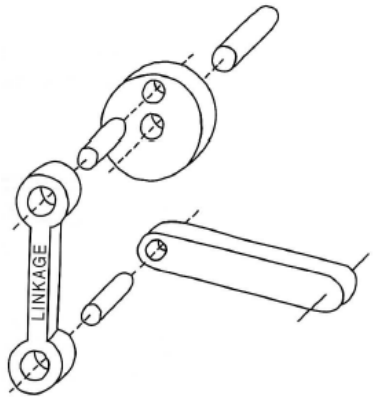


- Keeps lever against cam so it follows profile
- Better than simply gravity
- But increases friction – so use a tensioner

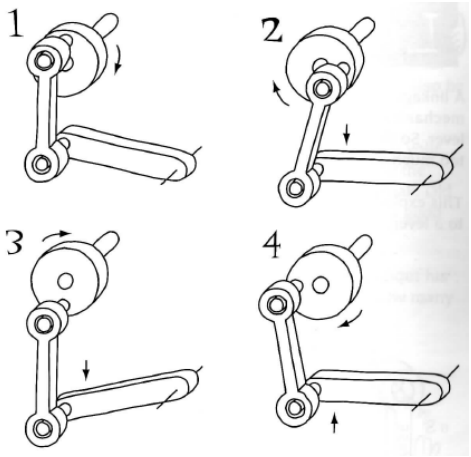
Practical Point: using a weight provides constant load; spring's load varies on amount stretched

Linkages

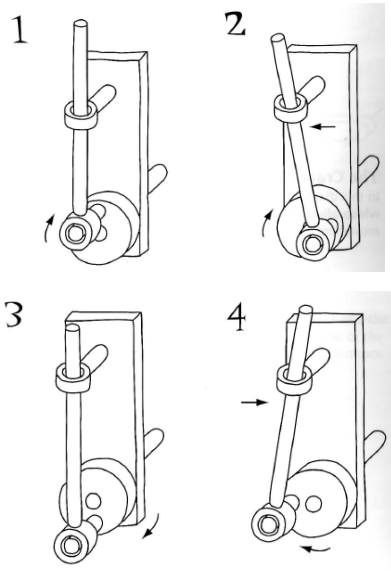
A connection that transfers motion from one mechanical component to another



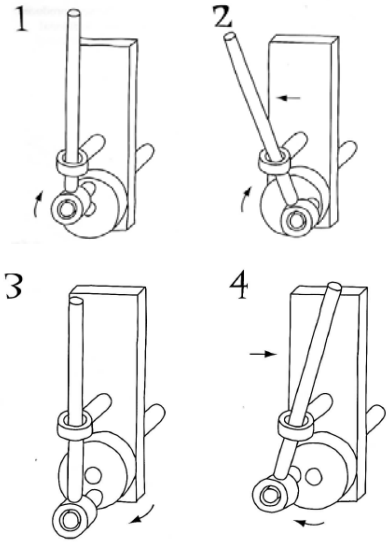
Recall, lever attached to a crank



Slider Crank



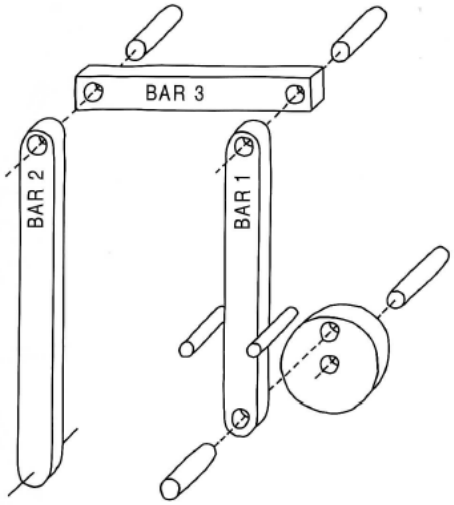
Slider Crank with High Bearing



Slider Crank with Low Bearing

- Change lever's sideways motion by changing bearing position
- Lowering bearing increases lever sway
- Throw remains constant

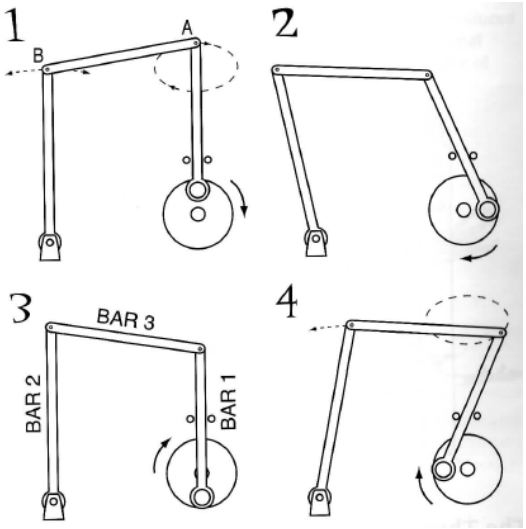
3-Bar Linkage



When would you use a 3-Bar Linkage?

- Levers move in a circular arc
- 3-Bar is for straight-line motion

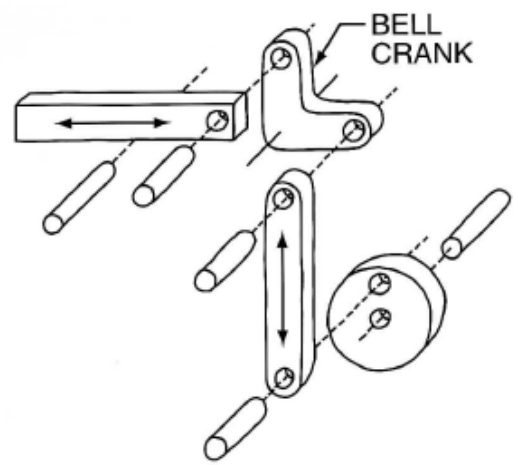
- Bar 2: side-to-side motion
- Pegs prevent Bar 1 from rotating too far with the crank



- Slider-crank makes top of Bar 1 trace an elliptical path (point A)
- Bar 2 is a lever with fixed pivot (at ground)

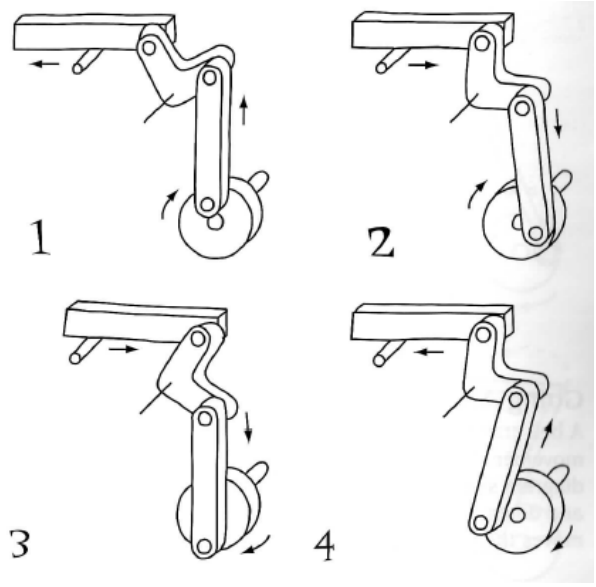
- Bar 3 connected to other two bars
- Top of Bar 3 (point B) approximates straight-line motion

Bell Crank



When would use a Bell Crank?

- Change up-down motion to side-to-side motion (and vice-versa)
- Crank pushes vertical rod up-down
- Bell crank rotates around pivot
- Horizontal rod moves sideways



Bell Crank Sequence

- Bell crank is simply a type of lever
- Increasing bell crank size, increases movement
- Can make bell crank's sides different lengths

Next Week: Simple Machines III: Ratchets, Drives and Gearing