Mechanisms for linear motion

Petr Zelený – Production machines I

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INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Ball screw

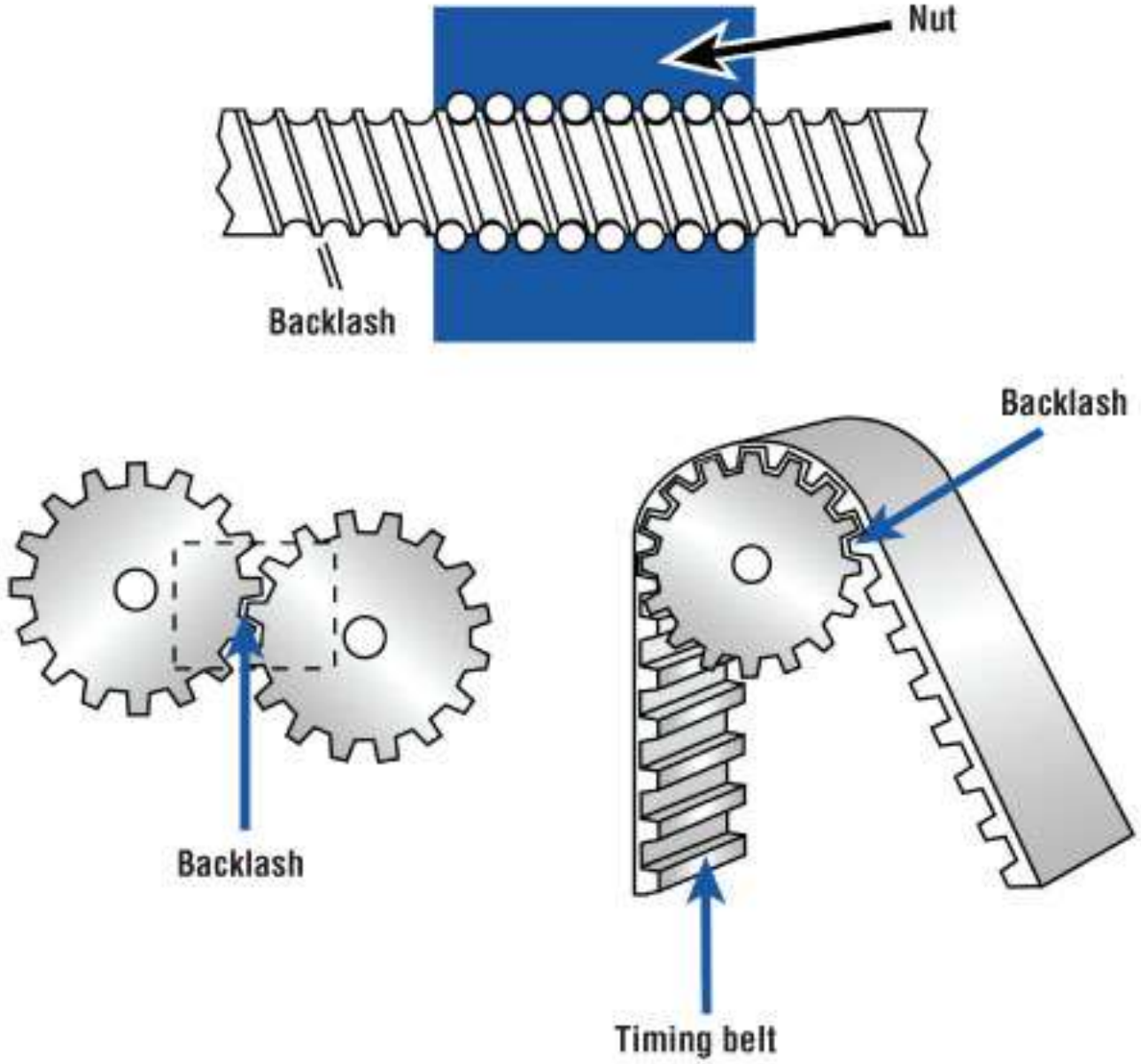
a) rotate the nut - screw stands
b) rotate screw - nut stands

Thread:
1. trapezoidal (common)
2. flat
3. for ball nut

Steel screw R_m= (700 ÷ 800) MPa, bronze nut.

Screw and nut are not in direct contact but are separated by balls which roll on concurring tracks threaded at screw and nut. The orbit in the nut is in several threads filled with balls which roll and the sliding friction is replaced by rolling. Effectiveness of ball transfer depends on the selected pitch for a given diameter and achieves values greater than 90%. High efficiency without preload has resulted in its no self-locking.

Advantages: screw is stiff, transfer simple, good check and do not wear much.
Disadvantages: backlash.



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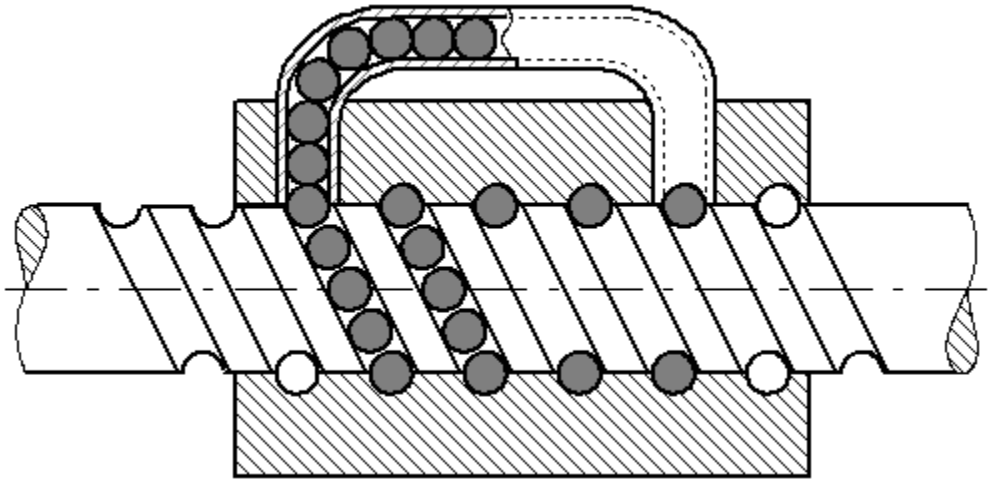
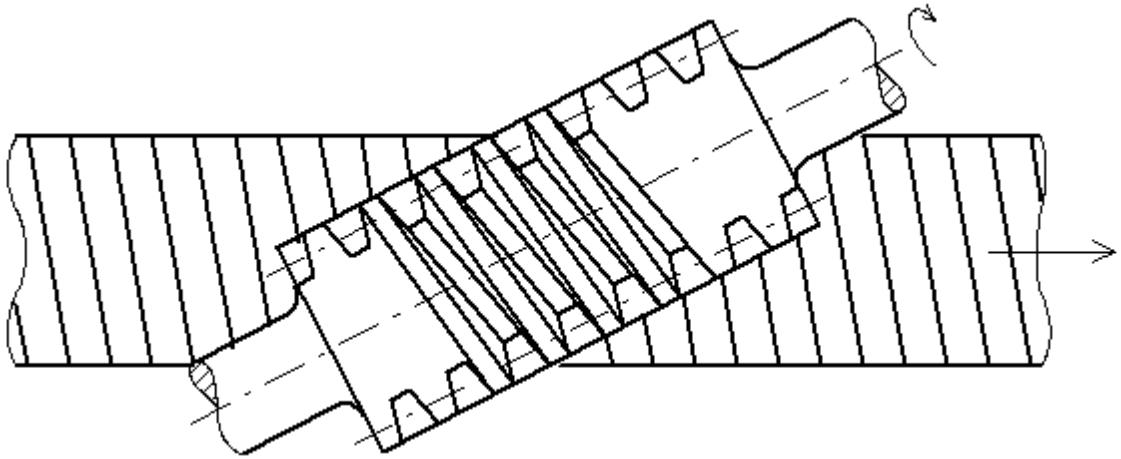


Screw and rack

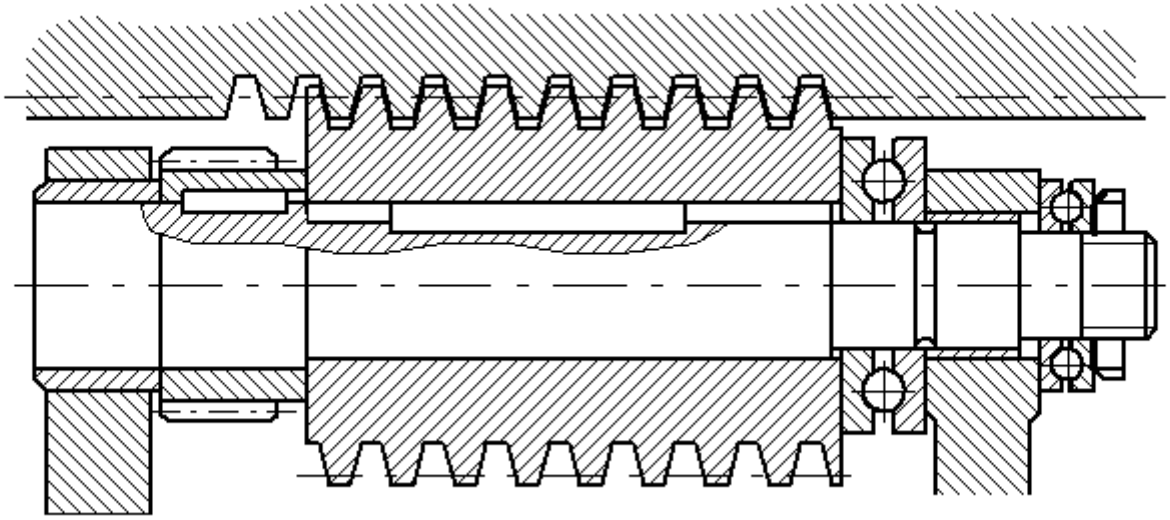
The axes of the worm and rack are skew.



- Contact in line segments, the possibility of a large reduction gear, the possibility of good lubrication (by wading).
- Poor efficiency, short life (rapid wear) - used rarely (extraordinarily up).
- Use: Long rapid feedrates.

Worm and worm rack

The axes of the worm and worm rack are parallel (worm ≈ screw, rack ≈ nut).

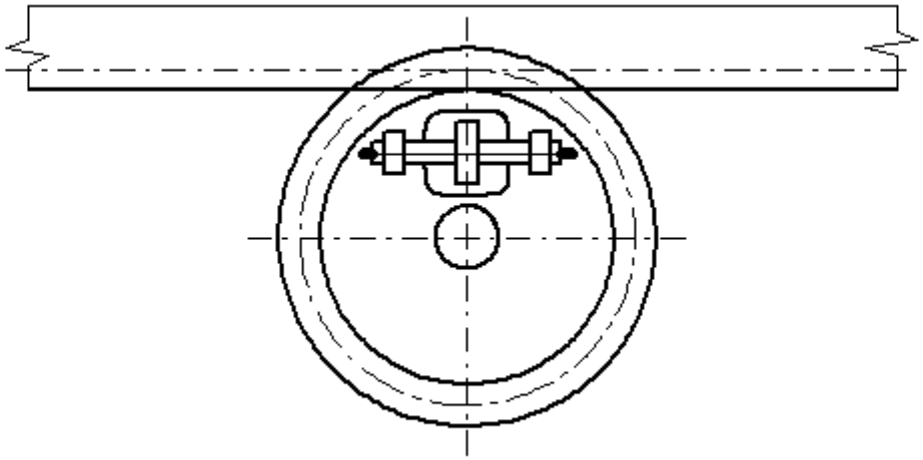


The length of contact is 8 ÷ 10 pitches. The lower part of the worm is wading in oil. This transfer has high rigidity (without backlash), slightly higher efficiency and low ratio for small size.

Use: long thread (planning)
Material:
worm - steel , rack - bronze p_d= 8 ÷ 12 MPa
or worm - steel , rack – cast iron p_d= 4 ÷ 6 MPa

Pinion and rack

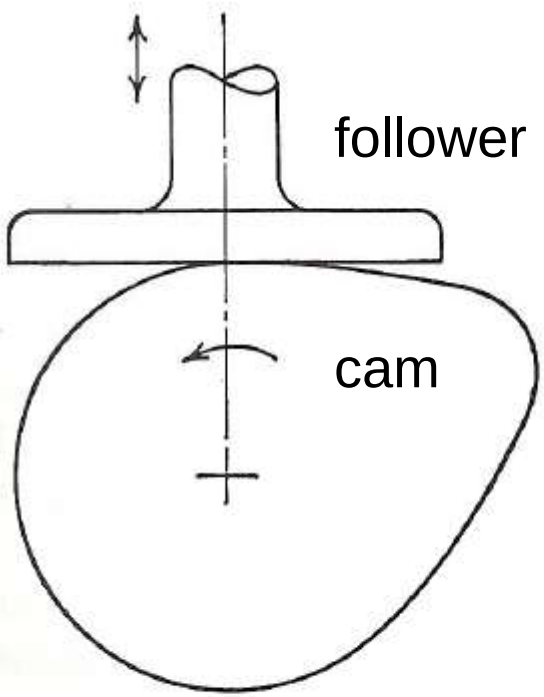
This gear is often used for smaller gear (faster movement) reducing and it is suitable for large lengths. It is often used to measure the lengths.



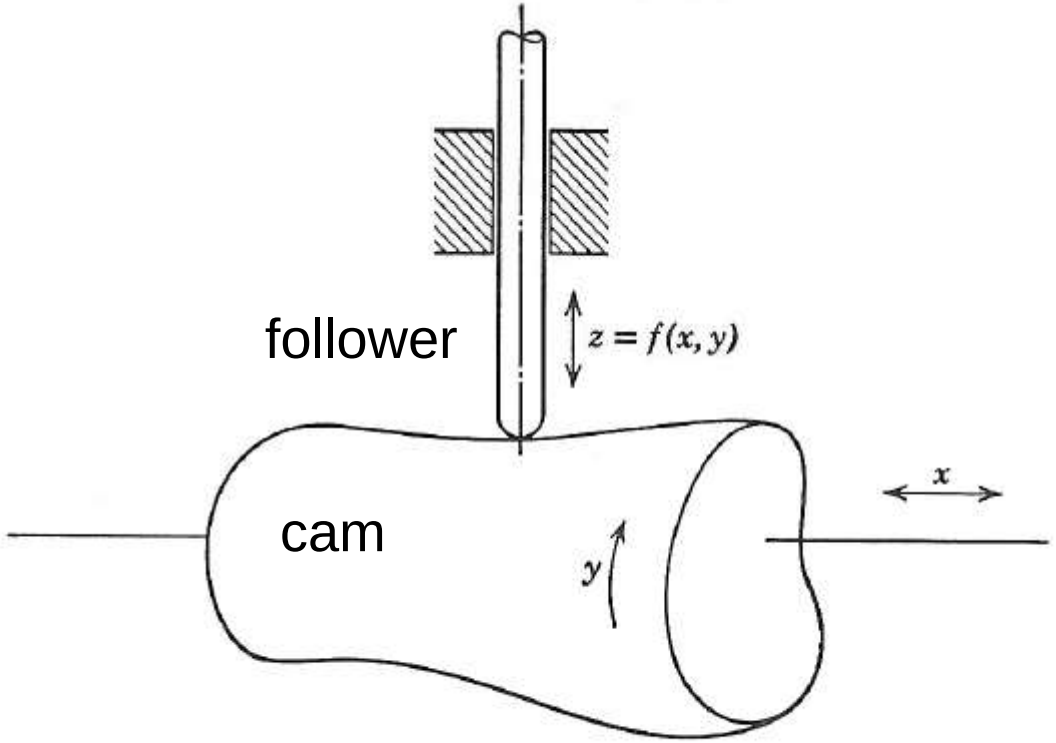
Gear accuracy „pinion - rack“ is smaller than that of screw and nut (tables planers). It has better efficiency, less accuracy and therefore it is necessary to define backlash. Determine backlash is carried out by dividing the pinion and opposite preload wheels.

Cams

Typical cam mechanism includes a **cam** with **follower**, the cam operates as drive member and follower as driven member. A driven member of the cam mechanism (follower) is connected with the cam by general kinematic pair. Follower with rotational motion referred to as **rocker**. According to the movement of the cam is divided cam 2D and 3D.

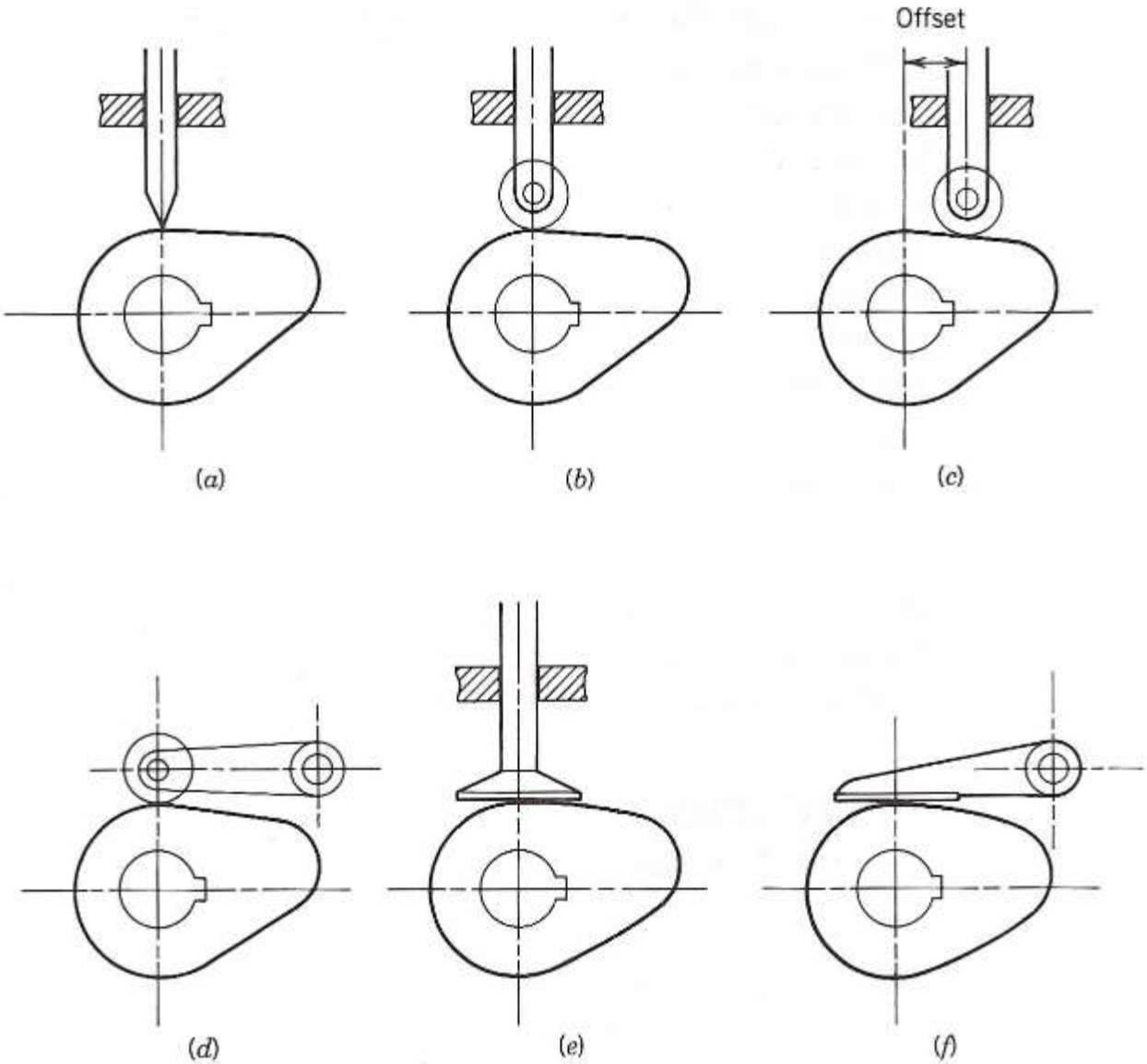


2D cam



3D cam

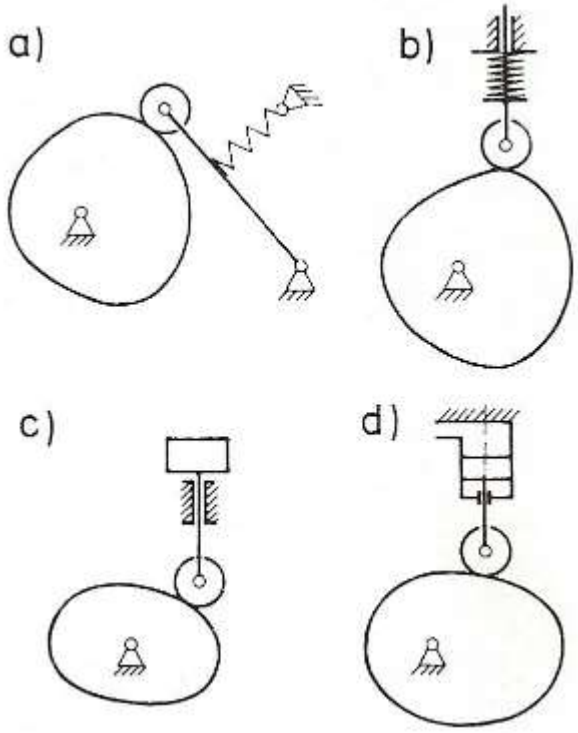
Types of arrangement cam - follower (rocker)



a) Follower with tip, axis of the follower passes through the axis of rotation of the cam
b) Follower with roller, axis of the follower passes through the axis of rotation of the cam
c) Follower with roller, axis of the follower don‘t passes through the axis of rotation of the cam
d) Rocker with roller
e) flat follower
f) flat rocker

Contact in general kinematic pair

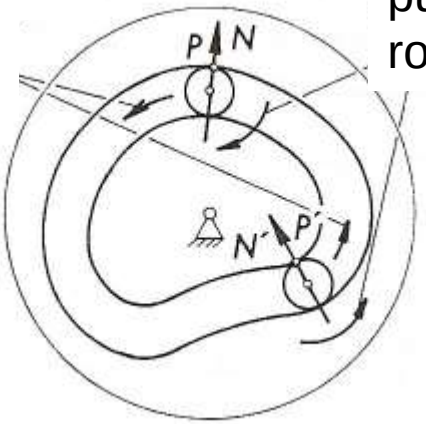
One of the preconditions of the proper function of the cam mechanism is driven member constant contact with the cam during movement. Contact in general kinematic pair is either **power** or **forced**. **Power** contact can be realized using the return springs [a), b)], gravitational forces [c)], or using hydraulic and pneumatic components [d)]. **Forced** contact may be realized e.g. using grooved cam.



Power contact cam and follower

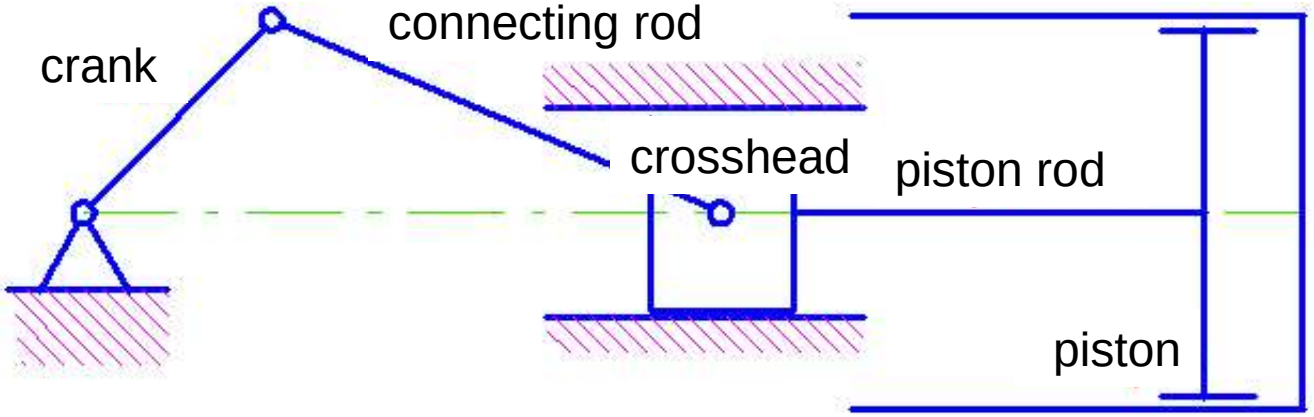
sense of movement pulleys in the groove

sense of pulleys rotation

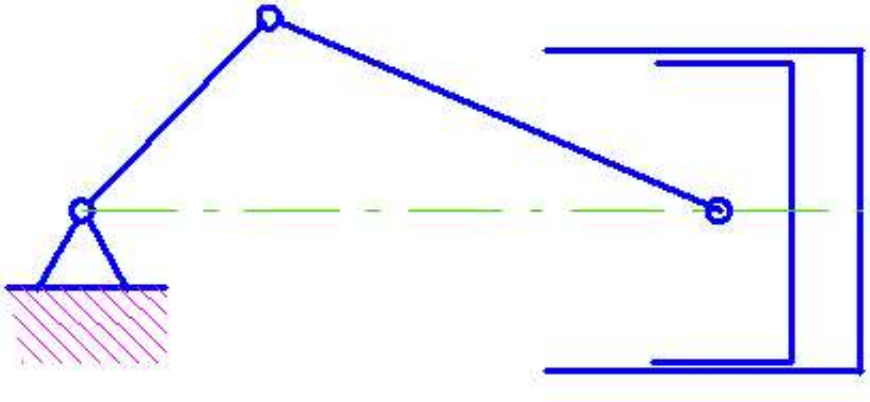


Forced contact – grooved cam

The crank mechanism



Complete crank mechanism



Shortened crank mechanism

The crank mechanism

Shortened crank mechanism
Application: For single-acting tools (working pressure agents acting on one side only).

Complete crank mechanism
Application:

- Double-acting machines (working pressure agents acting alternately on both sides of the piston)
- Previously: steam locomotive
- Today: double acting piston pumps

Consists:

- Piston
- Piston rod
- Crosshead
- Connecting rod
- Crank
  - Piston and piston rod and crosshead does reciprocating movement
  - Connecting rod does general movement
  - Crank does rotational movement

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The crank mechanism

Piston

- It moves in the cylinder reciprocatory.
- On the bottom act steam pressure, liquid, air (gas).
- To avoid pressure losses in the working space, the piston is provided with sealing rings or gaskets.
- To reduce weight, the pistons are hollow.

Piston rod

Connecting rod

- It is connected with the piston with a hollow piston pin.
- The other end is articulated connected with the crank.
- Reciprocates generally planar, since one end of the piston moves linearly and the second rotational movement takes place together with the crank.
- Does change of movement.

The crank mechanism

Crank

- Mounted in bearings.
- Does rotary motion.
- In multi-cylinder machines used crankshaft.
- For small strokes are used eccentric disc - eccentric -> The mechanism is then called Eccentric.

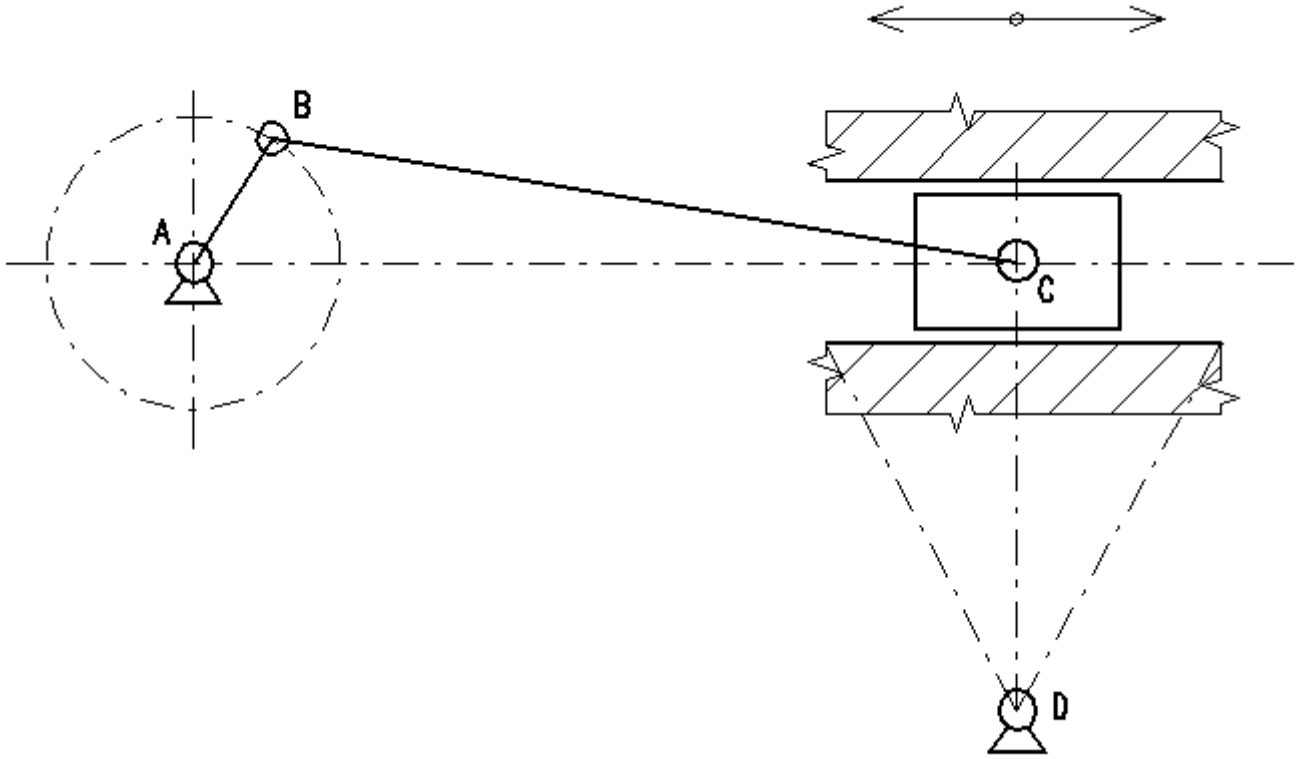
Flywheel

- Mounted on the same shaft as the crank.
- It is an accumulator of kinetic energy which is released as needed -> compensation irregular running.
- For single-cylinder machines used to overcome extreme piston positions

The crank mechanism

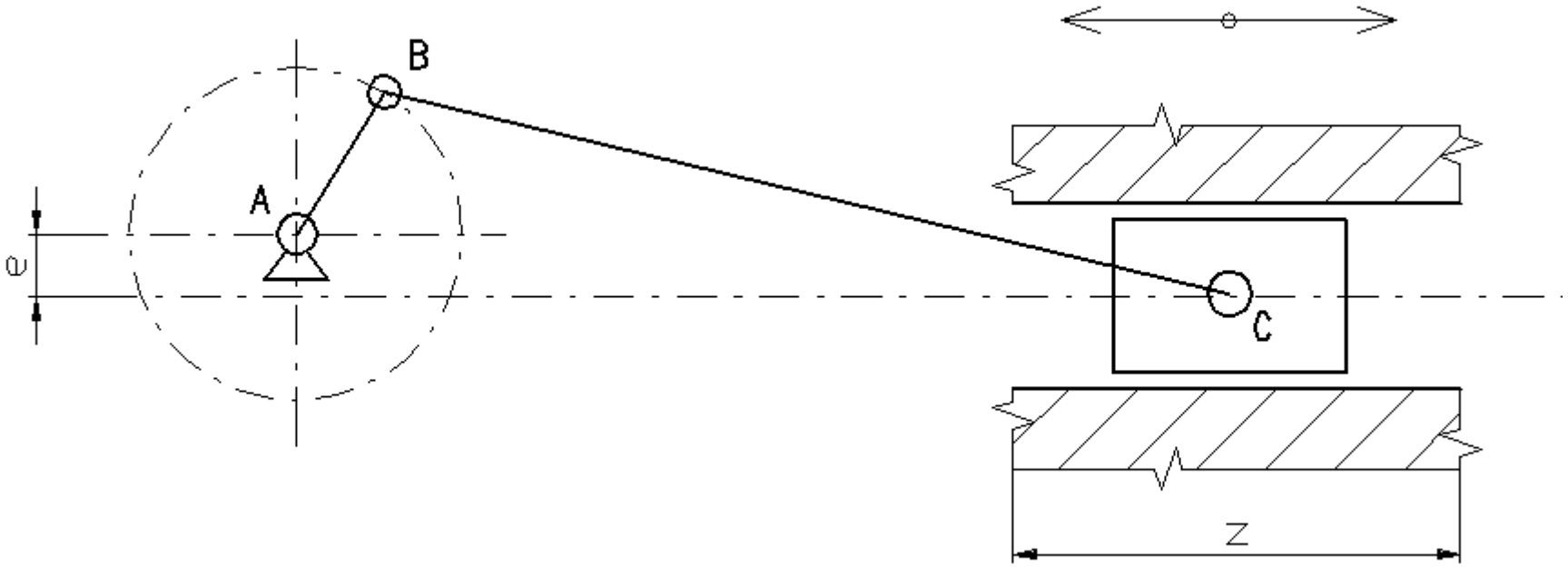
1. Central:

The crank mechanism is also central, axis moving piston intersects the axis of rotation of the crank. Moves in the axis.



The crank mechanism

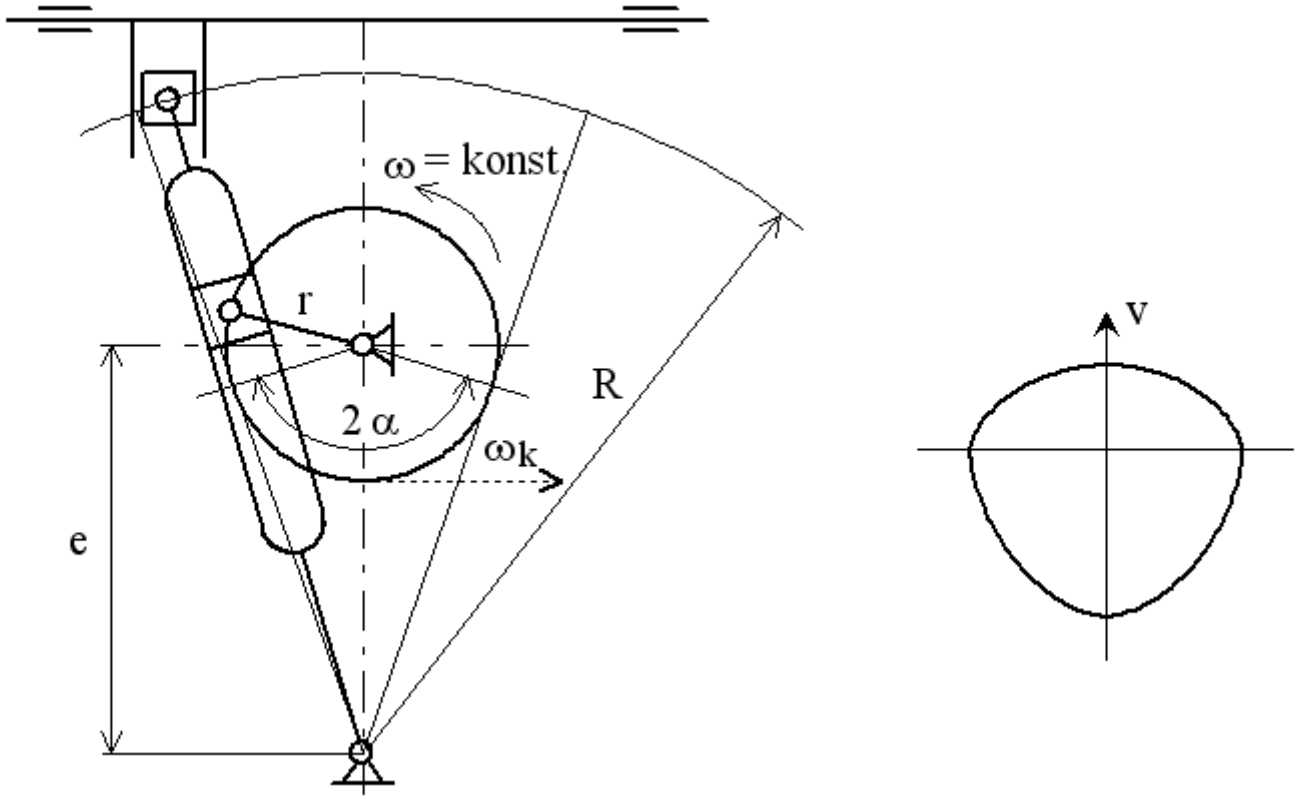
2. Eccentric :



Slotted-link mechanism

There are various modifications of slotted link mechanism:

Crank with slotted link - Whitworth mechanism - (planning) - symmetric



Asymmetric solutions - are simpler to manufacture, they have better efficiency