Nguyen Duc Thang

1700 ANIMATED MECHANICAL MECHANISMS

With

Images,
Brief explanations
and Youtube links.

Part 1

Transmission of continuous rotation

Renewed on 31 December 2014

This document is divided into 3 parts.
Part 1: Transmission of continuous rotation
Part 2: Other kinds of motion transmission
Part 3: Mechanisms of specific purposes

Autodesk Inventor is used to create all videos in this document.
They are available on Youtube channel “thang010146”.

To bring as many as possible existing mechanical mechanisms into this document is author’s desire. However it is obstructed by author’s ability and Inventor’s capacity. Therefore from this document may be absent such mechanisms that are of complicated structure or include flexible and fluid links.

This document is periodically renewed because the video building is continuous as long as possible. The renewed time is shown on the first page.

This document may be helpful for people, who
- have to deal with mechanical mechanisms everyday
- see mechanical mechanisms as a hobby

Any criticism or suggestion is highly appreciated with the author’s hope to make this document more useful.

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- Mechanical engineer, 1969, Hanoi University of Technology, Vietnam
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Job history:
- Designer of small mechanical engineering enterprises in Hanoi.
- Retirement in 2002.

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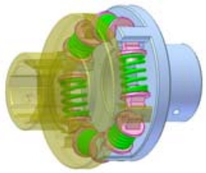
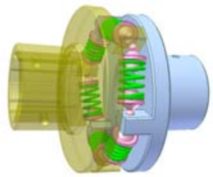
1. Continuous rotation transmission

1.1. Couplings

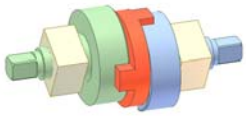
Chain drive 1C
http://youtu.be/FKuhi8hk96s
Chain coupling



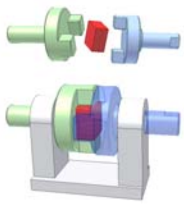
Coil spring coupling 1
http://youtu.be/CJ53SLiqGKQ
Due to revolution joints of the spring supports (in pink) this coupling can compensate a large offset of the shaft axes.
For this simulation:
Coupling outer dia. = 20 mm
Offset = 1 mm
Velocity variation is considerable.



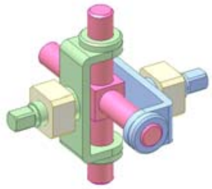
Coil spring coupling 2
http://youtu.be/xayBA5MaE2E
Due to spherical joints of the spring supports (in pink) this coupling can compensate a large offset of the shaft axes and a large angular misalignment between them.
For this simulation:
Coupling outer dia. = 20 mm
Offset = 1 mm
Angular misalignment = 4 deg.
Velocity variation is considerable.



Oldham coupling 1
http://www.youtube.com/watch?v=VPVxy9uW45E

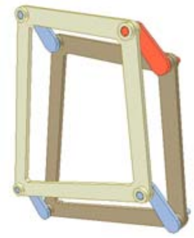


Oldham coupling 2
http://www.youtube.com/watch?v=M2IIDz_27GY
An embodiment of Oldham coupling
Axial dimenssion is reduced in comparison with “Oldham coupling 1”.



Oldham coupling 3
http://www.youtube.com/watch?v=OqpvbqdHgHc
An embodiment of Oldham coupling.
Axial dimenssion is reduced. Cylindrical joints are used instead of prismatic ones. It looks like Cardano coupling but it is totally diferent.

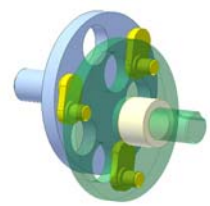
Parallel link coupling
http://www.youtube.com/watch?v=pkcdVQZubiM



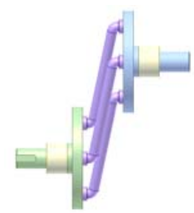
The absence of backlash makes this parallel coupling a precision, low-cost replacement for gear or chain drives that can also rotate parallel shafts. Any number of shafts greater than two can be driven from any one of the shafts, provided two conditions are fulfilled:

1. All cranks must have the same length.
2. The two polygons formed by shafts centers on the moving and grounded frames must be identical.

The main disadvantage of this mechanism is its dynamic unbalance. The moving frame should be made as light as possible. The mechanism can not be used for high speed.



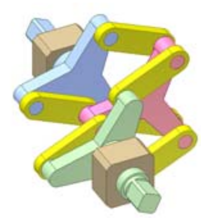
Application of parallelogram mechanism 1
http://www.youtube.com/watch?v=7ihoj7SRZLg
Transmission of rotation movement between parallel shafts.



Application of parallelogram mechanism 2
http://www.youtube.com/watch?v=ZsThxf0OEuU
Transmission of rotation movement between parallel shafts

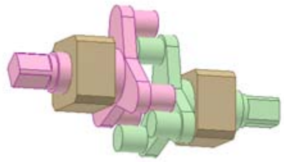
Application of parallelogram mechanism 3
http://www.youtube.com/watch?v=Bh0uDdx7z6M
Transmission of rotation movement between parallel shafts
The red disk rotates without fixed bearing.

Schmidt coupling
http://www.youtube.com/watch?v=ARs3y3i0enE&feature=endscreen&NR=1
Transmission of rotation movement between parallel shafts.
The pink link rotates without fixed bearing.
Both shafts can move during transmission.



Pin coupling 1

http://www.youtube.com/watch?v=vjOqNd3c4rY



The pins are arranged on circles of equal radius on the two shafts
A = R1 + R2
A: Axis distance of the two shafts (eccentricity)
R1: Rose pin's radius
R2: Green pin's radius
Thus the coupling meets conditions of a parallelogram mechanism.
It is a constant velocity coupling.
Numbers of pins on the two shafts must be equal.

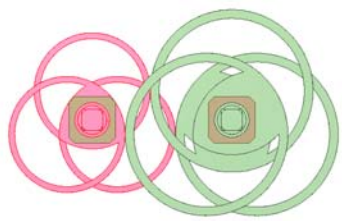
Pin coupling 2

http://www.youtube.com/watch?v=tYDqAES59C8

The pins and the holes are arranged on circles of equal radius on the two shafts
A = R2 - R1
A: Axis distance of the two shafts (eccentricity)
R2: Rose hole's radius
R1: Green pin's radius
Thus the coupling meets conditions of a parallelogram mechanism.
It is a constant velocity coupling.
This type of mechanism can be installed in epicyclic reduction gear boxes. See:
http://www.youtube.com/watch?v=MGVSRrI0ir4

Pin coupling 3

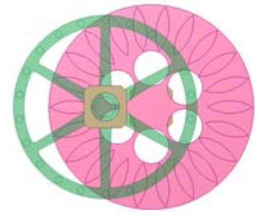
http://www.youtube.com/watch?v=xzwCuLT89EI



An embodiment of Pin Coupling 1
http://www.youtube.com/watch?v=vjOqNd3c4rY
when R1 is different from R2 and pin's radius is larger than shaft's radius. Transmission ratio is 1.
The mechanism now looks like a gear drive but the two shafts rotate the same direction.
It has a high sensitivity to error in distance between the shaft axes.

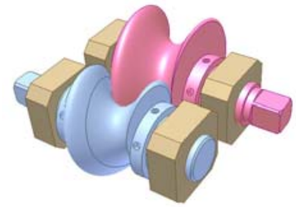
Pin coupling 4

http://www.youtube.com/watch?v=1fe2QSs1HWY



An embodiment of Pin Coupling 1
http://www.youtube.com/watch?v=vjOqNd3c4rY
when R1 is different from R2, number of pins on each disks is 22. Pins on the pink disk is of lens shape because their radius is too large.
Transmission ratio is 1.

Pin coupling 5
http://www.youtube.com/watch?v=QfiJSTRDASs
An embodiment of Pin Coupling 3
http://www.youtube.com/watch?v=xzwCuLT89EI
when:
- R1 is different from R2
- pins radius are larger than shafts radius
- number of pins is infinite so screw surfaces are created.

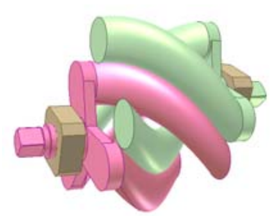


The working surface of the blue shaft is created when a circle of radius 10 (in the plane perpendicular to the shaft axis, its center is 5 from the shaft axis) moves along a helix of pitch 20. The working surface of the pink shaft is created similarly by a circle of radius 15 (in the plane perpendicular to the shaft axis, its center is 5 from the shaft axis) moving along a helix of pitch 20. Distance between the shafts is 25.
Transmission ratio is 1. The mechanism now looks like a gear drive but the two shafts rotate the same direction.

Pin coupling 7
http://www.youtube.com/watch?v=dTW8nhMjw-0
An embodiment of Pin Coupling1.
http://www.youtube.com/watch?v=vjOqNd3c4rY
when number of pins is infinite so screw surfaces are created.

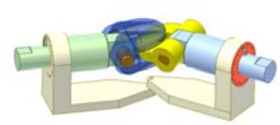
The working surface of each shaft is created when a circle of radius 5 (in the plane perpendicular to the shaft axis, its center is 20 from the shaft axis) moves along a helix of pitch 40. Distance between the shafts is 10.
Transmission ratio is 1. The two shafts rotate the same direction.
The mechanism is pourely imaginary product, perhaps no practise application.

Pin coupling 8
http://www.youtube.com/watch?v=IC2GSi7deX4
An embodiment of Pin Coupling7
http://www.youtube.com/watch?v=dTW8nhMjw-0
when the number of working surfaces is 3.



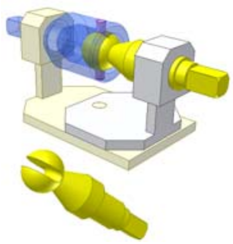
Transmission ratio is 1. The two shafts rotate the same direction.
The mechanism is pourely imaginary product, perhaps no practise application.

Universal joint 1
http://www.youtube.com/watch?v=rAM7YRCQWEc
Axles of the two shafts may be
1. Parallel and coincident
2. Parallel and distinct (with eccentricity)
3. Intersecting
4. Skew

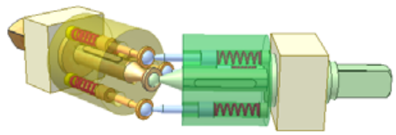


It is a constant velocity joint for cases 1, 2 and 3.
For details see:
http://meslab.org/mes/threads/20223-Khop-truc-ngam

Universal joint 2
http://youtu.be/NKaMj1oeP-Y
This low torque joint allows axial shaft movement.
The angle between shafts must be small.
Output velocity is not constant.

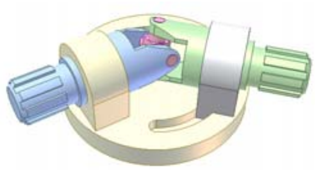


Universal joint 3
http://youtu.be/a_PbP0o-GOE
This pump type coupling has the reciprocating action of sliding rods in cylinders.
Centers of spherical joints are always in the plane that bisects the angle α between the two shafts even when α changes so it is a constant velocity joint.

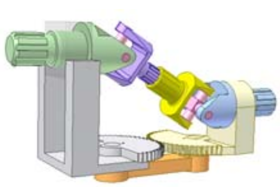


Pin universal joint
http://youtu.be/N_rHZwytmOk
It is a constant velocity joint.
There is a spherical joint between pink shaft and green one.
For each shaft the opposite contact straight lines must be symmetric about the rotary axis and have a common intersection point with it.
Angle between the two shafts reaches up to 30 deg. in this video.
The mechanism can not be used for reversing rotation because of large backlash.

Study of Cardan universal joint 1
http://youtu.be/ZQt6cAmsgXQ
Universal joints allow to adjust A angle between input and output shafts even during rotary transmission. This case shows +/- 45 deg regulation. It is clear that single Cardan joint is not of constant velocity when A differs from 0 deg.

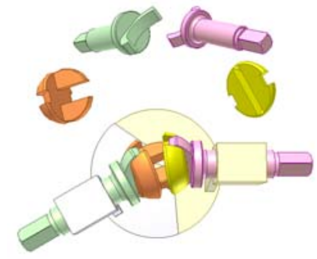


Study of double cardan universal joint 1a
http://youtu.be/gBoJT_PI-RA
Double Cardan drives allow to adjust relative linear positions between the input and output shafts even during rotary transmission. The output velocity is always equal to the input one (constant velocity joint) because their shafts are kept parallel each other.
The pin axles on the intermediate half shafts (in yellow and in violet) must be parallel each other.



Tracta joint 1

http://youtu.be/IFQgH73W2Ao

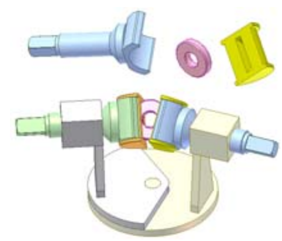


It is a constant velocity joint.
There are a revolution joints between:
- orange male swivel and yellow female swivel.
- orange male swivel and green shaft
- yellow female swivel and pink shaft

Axes of cylindrical surfaces on each swivel are skew to each other at an angle of 90 deg.
The video shows the transmission when angle between two shafts is 0 deg. and then 30 deg.

Tracta joint 2

http://youtu.be/qg8MpZYZjFE

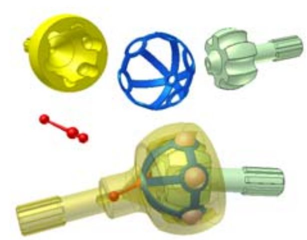


It is a constant velocity joint, an embodiment of mechanism shown in “Tracta joint 1”.
Yellow swivel and orange one are identical.
There are a revolution joints between:
- orange swivel and pink disk.
- yellow swivel and pink disk.
- orange swivel and green shaft
- yellow swivel and blue shaft

Axes of cylindrical surfaces on each swivel are skew to each other at an angle of 90 deg.
The video shows the transmission when angle between two shafts is 0 deg. and then 25 deg.

Rzeppa joint 1

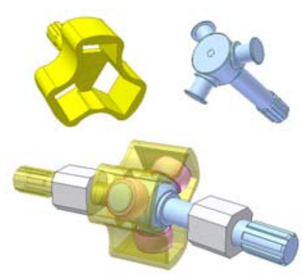
http://youtu.be/6thw8xPt6ro



Red bar and yellow shaft create a joint of class II (allowing four degrees of freedom).
Red bar and green shaft create a joint of class II.
Red bar and blue retainer create a spherical joint.
With this arrangement, the plane containing ball centers almost always remains in a plane that bisects the angle α between the two shafts when α changes. See: “Slider crank and coulisse mechanism 1”
http://youtu.be/SdwIGoJ-3ag
The video shows the transmission when α is 0 deg. and then 30 deg.
The output shaft rotates nearly regularly with max error of 1.5% at α = 30 deg.

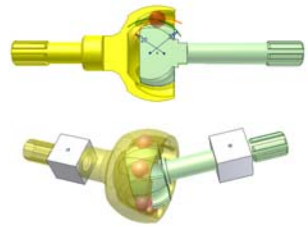
Tripod joint 1

http://youtu.be/U5TV5NC5YOg

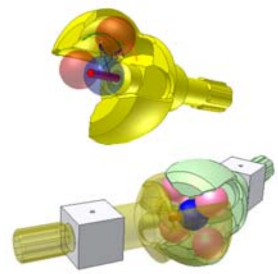


Pink spherical rollers slide in grooves of yellow shaft. Changes in the drive angle causes the rollers to move backwards and forwards along the grooved track as the joint rotates through one revolution. A small clearance is given between the roller and track to permit this movement.
The video shows the transmission when α (angle between two shafts) is 0 deg. and then 15 deg.
The simulation shows that the output shaft rotates nearly regularly with max error of 3.4% at α = 15 deg.

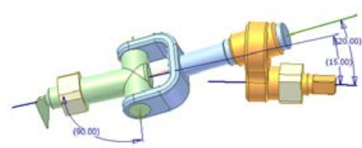
Birfield joint 1
http://youtu.be/OSTdCr-BcPc
There is an offset between center of circular grooves on each shaft and the clutch center (see upper picture). Balls are positioned by the contact with the grooves.
With this arrangement, the plane containing ball centers always remains in a plane that bisects the angle α between the two shafts when α changes to meet condition of constant velocity.



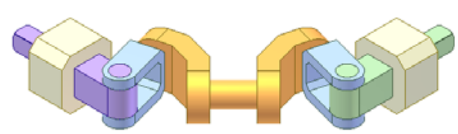
Weiss joint 1
http://youtu.be/euihZOu3Cb0
There is an offset between center of circular grooves on each shaft and the clutch center (see upper picture). Each pink ball is positioned by the contact with grooves on both shafts and blue central ball. The latter can rotate around red pin.
With this arrangement, the plane containing ball centers always remains in a plane that bisects the angle α between the two shafts when α changes to meet condition of constant velocity.



Spherical 4R mechanism 1b
http://youtu.be/BPMh7hd-ZNU
Spherical: Joint center lines intersect at a common point.
Angle between center lines of revolute joints:
for the orange input link is γ = 20 deg.
for the green output link is β = 90 deg.
for the blue link is α = 90 deg.
for the base link is δ = 15 deg.
The output link revolves irregularly.
Its 1 rev. corresponds 1 rev. of the orange input link.



Angular Transmission 4R Mechanism 2
http://www.youtube.com/watch?v=JgLKdfQHUSg

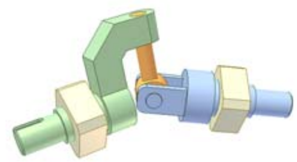


Two spherical 4R mechanisms are connected back to back.
4R: 4 revolute joints.
In each mechanism the center lines of 4 revolute joints intersect at a common point.
The angle between center lines of revolute joints for the orange link is not 90 deg. (rather than Cardan joints).
Angle between the input and output is A = 90 deg.
Angle between cylinder of the orange link and the input shaft is B = A/2 = 45 deg.
This condition makes the mechanism a constant-velocity joint.
The orange link rotates without fixed bearing.

Angular Transmission 4R Mechanism 1
http://youtu.be/LI996IZQUoU

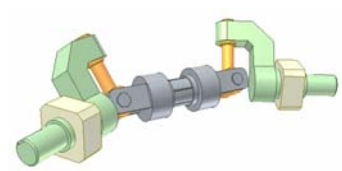
This is the double Cardan.
Angle between the input and output is A = 90 deg.
The orange S-link has a virtual axle.
Angle between the virtual axle of the orange S-link and the input shaft is B = A/2 = 45 deg.
This condition makes the mechanism a constant-velocity joint.
The orange link rotates without fixed bearing.

Spherical 4R mechanism 2a
http://youtu.be/o9RZ3goLvWA



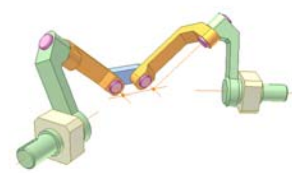
Axles of revolution joints must be concurrent.
Input: Green shaft, constant speed.
Output: Blue shaft, variable speed.

Spherical 4R mechanism 2b
http://youtu.be/4XJBJdCt8eY



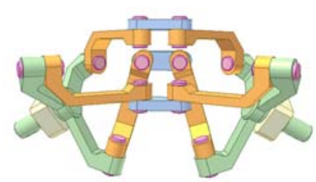
Combination of two “Spherical 4R mechanism 2a”.
It is a constant velocity joint.

Spherical 4R mechanism 2c
http://youtu.be/pjVjGtRy6T4



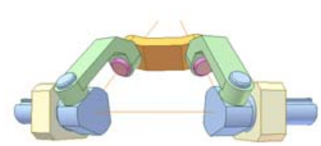
Modification of “Spherical 4R mechanism 2a” and “Spherical 4R mechanism 2b”.
It is a constant velocity joint.

Spherical 4R mechanism 2d
http://youtu.be/mFoiSRWdW5E



Persian joint.
It is a modification of “Spherical 4R mechanism 2c” by adding more connecting rods for balancing.
It is a constant velocity joint.

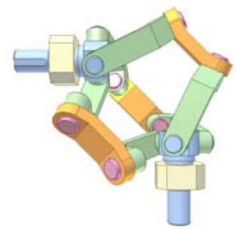
Spherical 4R mechanism 2e
http://youtu.be/SqQ9FLh9ktM



Modification of “Spherical 4R mechanism 2a” and “Spherical 4R mechanism 2b”.
It is a constant velocity joint.

Spherical 4R mechanism 2f
http://youtu.be/vH8r3IC-Fm4
Persian joint.
It is a modification of "Spherical 4R mechanism 2e" by adding more connecting rods for balancing.
Acute angle between input and output shafts is 60 deg.
It is a constant velocity joint.

Spherical 4R mechanism 2g
http://youtu.be/M0whLy5hPzg
Persian joint.
It is a modification of "Spherical 4R mechanism 2e" by adding more connecting rods for balancing.
Angle between input and output shafts is 90 deg.
It is a constant velocity joint.



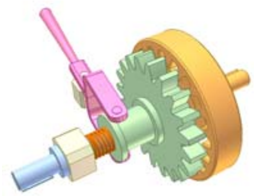
Bevel Gear Coupling 1
http://www.youtube.com/watch?v=OIQWXFE-yo4
Rotation directions of the drive and driven shafts are opposite.
Angle between them can be ±75 degrees.

Bevel Gear Coupling 2
http://www.youtube.com/watch?v=stswj7cXV0w
Combination of two bevel gear couplings.
Relative position of two shafts can be arbitrary, even skew.

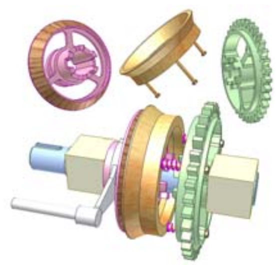
1.2. Clutches

1.2.1. Two way clutches

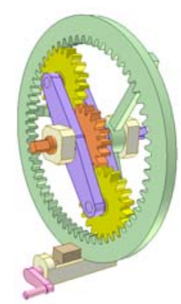
Toothed clutch
http://www.youtube.com/watch?v=KKOPif_yF8M
The orange shaft is driving. The clutch is connected by the spring force (manual force is possible).
Positioning device for the pink lever at the clutch's disconnected position is not shown.



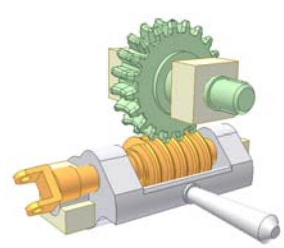
Synchronic toothed clutch 1
http://youtu.be/On1vXQ_ATu4
Input is blue shaft with which pink male cone disk has sliding joint.
Output is green gear (having face teeth) with which orange female cone disk has sliding joint due to three bolts.
To connect the clutch move the pink disk to the right (via the grey shifter). At first it makes the orange disk and the green gear rotate to some extend due to friction at cone surfaces to ease teeth engagment proccess after.



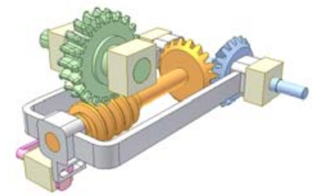
Planetary clutch
http://youtu.be/15vsNsWEdBM
The orange gear is input. The violet carrier is output.
Using the pink screw to hold or release the internal gear, hence to let the output carrier rotate or pause.
When the internal gear is released, the system has two degrees of freedom. However the load at the output carrier keeps it immobile to eliminate one.



Worm gear clutch 1
http://youtu.be/MXFImvrsrrE
There is an eccentricity between the rotary axis of orange worm and the one of the grey bracket.
Teeth on the worm and on the wheel must be rounded to ease the engagement process.
Positioning device for the bracket is not shown.
The clutch connection should be done when the driving shaft stops
Double Cardan joint (not shown) is used for transmitting motion to the worm.

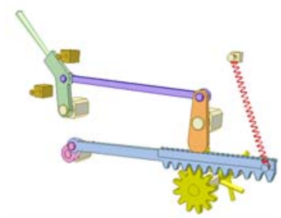


Worm gear clutch 2
http://youtu.be/s85DSggAZmI



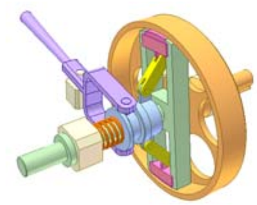
Turn pink lever (having an eccentrical pin) to raise or lower left end of the orange shaft thus to connect or disconnect the clutch.
Teeth on the worm and on the wheel must be rounded to ease the engagement process.
Positioning device for the lever is not shown. The clutch connection should be done when the driving shaft stops
Instead of bevel gear drive, double Cardan joint can be used for transmitting motion to the worm.
This idea is taken from US patent 20110247440 A1.

Rack gear clutch 1
http://youtu.be/PUKfykGfkV4



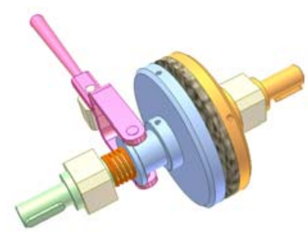
Input: pink crank that rotates continuously.
Output: yellow gear shaft that oscillates.
Use green lever to close or disclose the clutch via orange cam.
The mechanism is used in washing machines.

Friction clutch 1
http://youtu.be/_FKePQ8PvY0



The orange shaft is driving. The clutch is connected by the spring force (manual force is possible).
Positioning device for the violet lever at the clutch's disconnected position is not shown.

Friction clutch 2
http://youtu.be/NOwp_BQpNqw

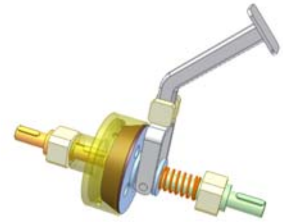


The orange shaft is driving. The clutch is connected by the spring force (manual force is possible).
Positioning device for the pink lever at the clutch's disconnected position is not shown.

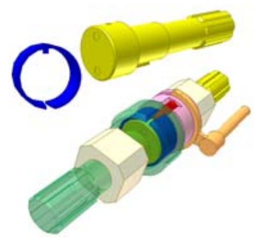
Friction clutch 3
http://youtu.be/_mMIk3RcPA0

Multiple-disk clutch.
The orange shaft and the yellow cylinder are driving. The two orange outer disks are slidingly splined in the yellow cylinder.
The green shaft is driven. The blue part and the two green inner disks are slidingly splined on the green shaft.
The clutch is connected by the spring force which presses inner disks and outer disks together through the blue part (manual force is possible).
Positioning device for the white lever at the clutch's disconnected position is not shown.

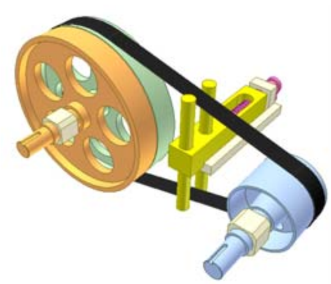
Friction clutch 4
http://youtu.be/QqaWJ7PDSg8
Cone clutch.
The orange shaft is driving. The clutch is connected by the spring force. To step on the white pedal to disconnect the transmission.



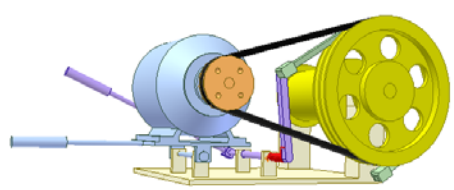
Friction clutch 5
http://youtu.be/JlQ0v77oGtE
Blue elastic bush is fixed on the yellow driven shaft by a pin. Pink bush carrying red wedge has sliding key joint with the yellow shaft. When the pink bush moves to the left, the red wedge expands the elastic bush. The latter goes into contact with the inner cylindrical surface of the green driving shaft thus connects the clutch by friction.



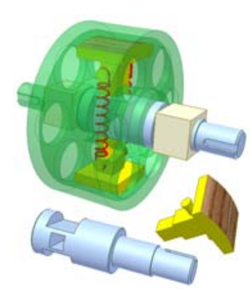
Belt clutch 1
http://youtu.be/fM-OMJnaLks
The blue pulley is driving The orange one is driven.. The green one is idle.
To rotate the pink crank to move the yellow slider for clutch controlling.



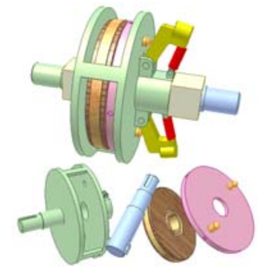
Belt clutch 2
http://youtu.be/83NuMbT_M7Y
The orange pulley is driving. The yellow one is driven..
Using the blue lever to move the orange pulley closer to the yellow pulley to stop the transmission.
The violet lever is for braking the driven pulley when it stops or rotates back under the lowered object's weight.
The red spring is for returning the violet lever.



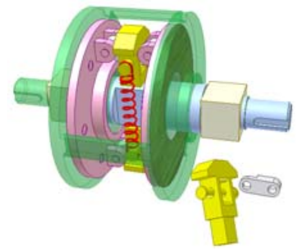
Centrifugal clutch 1
http://youtu.be/QpwWZloh-cw
Input: blue shaft.
Output: green shaft.
Yellow sliders have prismatic joints with the input shaft.
When velocity of the input shaft increases to prescribed value, the yellow sliders move outward by centrifugal force, press on the inner surface of the output shaft and thus connect the clutch by friction.



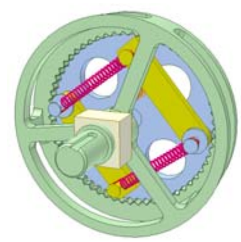
Centrifugal clutch 2
http://youtu.be/EwjFznLJJ4I
Input: green shaft.
Output: blue shaft.
The brown friction disk has prismatic joint with the blue output shaft.
When velocity of the input shaft increases to prescribed value, because of centrifugal force the yellow arms push orange pins of the pink disk towards the brown friction disk and thus connect the clutch by friction.



Centrifugal clutch 3
http://youtu.be/Uw4S9xpZd7Y
Input: blue shaft.
Output: green shaft.
Yellow sliders have prismatic joints with the input shaft.
When velocity of the input shaft increases to prescribed value, the yellow sliders move outward by centrifugal force. Pink friction disks press on the output shaft disks with large force (due to toggle action of the grey bars) and thus connect the clutch by friction.

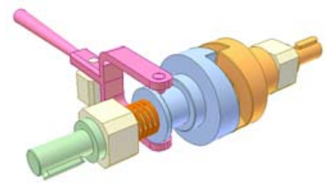


Centrifugal clutch 4
http://youtu.be/2oOX0L445Gw
Input: blue disk.
Output: green disk.
Yellow levers have revolution joints with orange pins of the input disk.
When velocity of the input disk increases to prescribed value, because of centrifugal force the yellow levers engage with teeth of the output disk and thus connect the clutch.

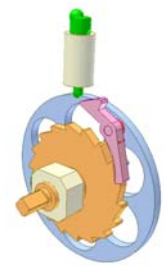


1.2.1. One way clutches

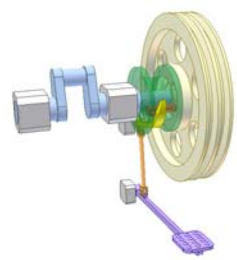
Jaw clutch
http://youtu.be/A6Az-YjwgeA
The orange shaft is driving. The clutch is connected by the spring force (manual force is possible).
Positioning device for the pink lever at the clutch's disconnected position is not shown.



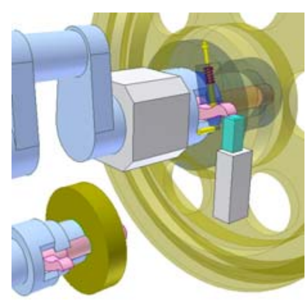
Ratchet clutch
http://youtu.be/4tz_Q8LhK90
The pink pawl connects the orange driving shaft to the blue driven one.
To rotate the green pin of helix slot for controlling the clutch.



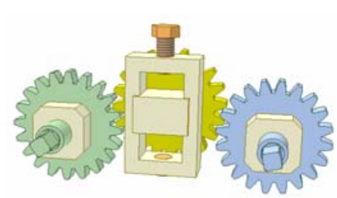
Pin clutch
http://youtu.be/wcYKttiovDA
Clutch for small-size eccentric presses.
The big pulley rotates continuously. For connecting the clutch push down the violet pedal to allow the pin come into contact with curve slots on the pulley under the pink spring's force.
The spring for return the pedal after pushing is not shown.
Keep pushing down the pedal to make the crankshaft rotate continuously.



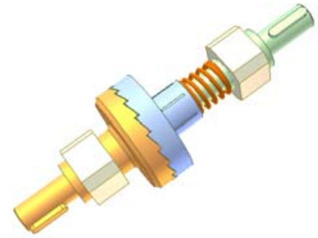
Rotary key clutch
http://youtu.be/f6q34XHP5Aw
Clutch for medium-size eccentric presses.
The big pulley rotates continuously. For connecting the clutch, step on a pedal (not shown) to pull down the green slider. Then the pink rotary key can rotate (under the red spring's force) when it meets the slot in the big pulley hole, thus makes the crankshaft rotate.
The green slider goes up to disconnect the clutch.
Keep down the pedal to make the crankshaft rotate continuously.
The small picture shows how the rotary key rotates in round hole between the crankshaft and the big pulley when they are immobile.



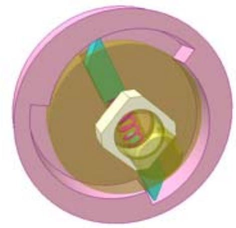
One way clutch 1 (gear)
http://youtu.be/X_fbDb4F5ZU
The blue gear is input.
A disengaging idler rises in a slot because of gear forces when the drive direction is reversed.
The mechanism should be used only for low speed because of gear collision.



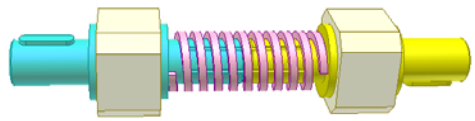
One way clutch 3 (jaw)
http://youtu.be/dMNITVka8vc
The orange input shaft rotates two directions but the transmission is possible for one direction only.
There is collision when the output green shaft stops, so the mechanism should be used only for low speed.



One way clutch 4 (slider)
http://youtu.be/nSP6F7qn1LM
The pink input disk rotates two ways but the transmission to the yellow disk is possible only for one.
The mechanism should be used for low speed because of collision.

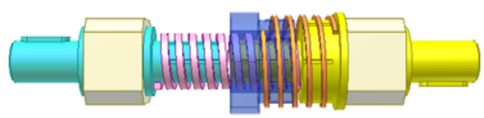


One way clutch 5 (spring)
http://youtu.be/Cshn6B2I2WQ



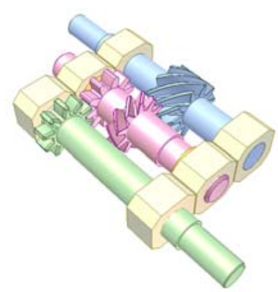
The cyan input shaft rotates two directions but the transmission is possible only for one. The rotation direction that tends to wind the spring is transmitted to the yellow output shaft due to friction force between the spring and the shafts. For the inverse direction the yellow output shaft may rotate if there is no braking force or load applied to it.
The helix spring needs not be fastened at either end; a slight interference fit is acceptable.
The spring helix direction decides the transmission direction.

One way clutch 6 (spring)
http://youtu.be/DESoTn5ui1c



The cyan input shaft rotates two directions but the transmission is possible only for one by the pink spring.
The rotation direction that tends to wind the pink spring is transmitted to the yellow output shaft due to friction force between the pink spring and the shafts.
The blue bush is stationary. The orange spring is for keeping the yellow output shaft immobile when it stops.
The helix springs need not be fastened at either end; a slight interference fit is acceptable.
The spring helix direction is the key factor for this mechanism.

One way clutch 7 (helical gear)
http://youtu.be/iL8gOluzKUk
The blue input shaft rotates two directions but the transmission is possible only for one. The pink shaft moves longitudinally when the input shaft reverses because of axial component of gear force in the helical gear drive.
The mechanism should be used only for low speed because of gear collision.

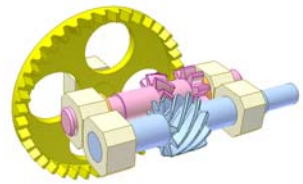


Face gear 14

http://youtu.be/CiaumcAX9ik

One way clutch.

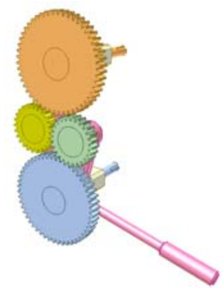
The blue input shaft rotates two directions but the transmission is possible only for one. The pink shaft moves longitudinally when the input reverses because of axial component of gear force in the blue gear drive. The orange rings represent thrust bearings. The mechanism should be used only for low speed case because of gear collision.



1.2.3. Reverse clutches

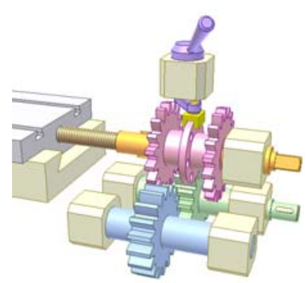
4-Roller clutch
http://youtu.be/15vsNsWEdBM
The blue roller is driving The orange one is driven.
The two small rollers are idle.
Using the pink arm to stop or reverse the orange roller's rotation.
The mechanism's weakness is needed measures to create pressure at the contact places of the blue, green and yellow rollers (not shown).

4-Gear clutch
http://youtu.be/9pCcmDICEOQ
The blue gear is driving. The orange one is driven.
The two small gears are idle.
Using the pink arm to stop or reverse the orange gear's rotation.
Measure for fixing the pink arm at its three working positions is not shown.
The mechanism's weakness is the possible collision of the orange gear and the two small gears.

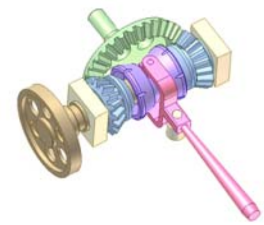


Gear and Roller clutch
http://youtu.be/GcGHLRV7cnE
The blue gear is driving. The orange roller is driven.
The two gear and roller combinations are idle.
Using the pink arm to stop or reverse the orange gear's rotation.
The mechanism does not have the weaknesses shown in 4-roller clutch or in 4-gear clutch:
http://youtu.be/15vsNsWEdBM
http://youtu.be/9pCcmDICEOQ

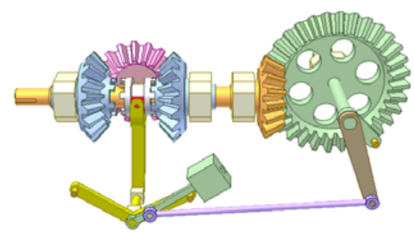
Reverse mechanism 1
http://youtu.be/Hc22Jqs8FhY
Violet lever has 3 positions: forward, neutral and backward.
Ball spring device for the lever positioning is not shown.
Green and blue gears are in permanent mesh. When left pink gear is in mesh with the blue gear, grey slider goes forward. When right pink gear is in mesh with the green gear, grey slider goes backward.
The lever neutral position is for stopping the grey slider or setting its position (by hand turning orange screw).
The mechanism is suitable for slow speed.
In case of fast speed to stop the input before reversing.



Bevel gear clutch for changing rotation direction 1
http://www.youtube.com/watch?v=lLm1Vqc7xVE

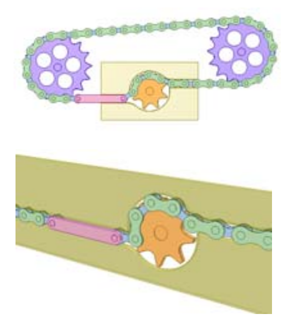


Bevel gear clutch for changing rotation direction 2
http://youtu.be/4cgamhTkBYQ



The pink gear is driving. The orange output shaft of a bevel gear oscillates. The two blue gears rotate freely on the orange shaft. The white clutch part is slidingly splined on the orange shaft.
The clutch connecting force is due to the weight on the green lever. The bevel drive on the right is for controlling the clutch. The oscillation forward and backward angles depend on transmission ratio of the said drive.
Instead of the weight action, the spring toggle mechanism can be used.

Chain drive 1E
http://youtu.be/Dkfwev3-Xug

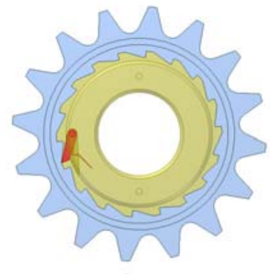


A chain drive that can itself reverse motion direction of the chain.
On the sketch: the orange sprocket is driving, the two large chain wheels are driven.
The animation shows the driving sprocket and chain behavior at reverse time: from the left-to-right motion of the chain to the right-to-left motion. For the reverse from the right-to-left motion of the chain to the left-to-right motion, the process is similar, the chain moves from the lower side of the orange sprocket to the the upper side.
The yellow leading plate and the pink link are key parts.
Time between two consecutive reverses depends on the chain length.

1.2.4. Overrunning clutches

Ratchet mechanism 5

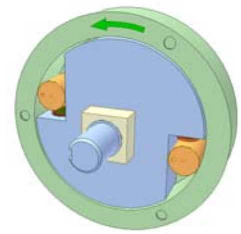
http://youtu.be/bAL_nWjuhOI



Bicycle free-wheel.
The blue sprocket receives motion from the pedaling bicyclist. The yellow hub rotates only when the sprocket rotates clockwise.
Clockwise rotation of the yellow hub has no inflection to the blue sprocket.
The red pawl is always pressed toward the sprocket's teeth by a spring. In reality two pawls are used.

Roller overrunning clutch 2

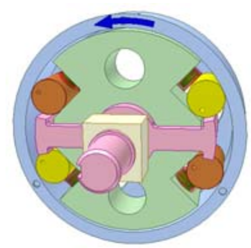
http://youtu.be/H4SiM5Dcblg



Green outter disk and blue inner disk rotate around a fixed axis.
The arrows show which link is the driving at different times.
When the outter disk is driving, its two way rotation can be transmitted to the inner disk only in clockwise direction.
When the inner disk is driving, its two way rotation can be transmitted to the outter disk only in anticlockwise direction.

Two way overrunning clutch 1

http://youtu.be/-Y_SQGMRx8k



Blue outter disk and pink fork rotate around a fixed axis.
Green inner disk rotates idly on the pink fork.
The arrows show which link is the driving at different times.

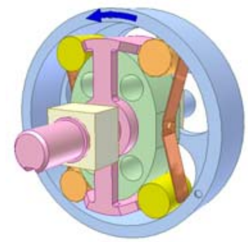
1. When the blue outter disk is driving, its rotation of both directions is transmitted to the green inner disk by wedging of the rollers between the blue outter disk and the green inner disk (orange rollers for anticlockwise direction, yellow rollers for clockwise direction).
The rotation of the green inner disk is transmitted to the pink fork by flexible contact via springs, red bushes and rollers (yellow rollers for clockwise direction, orange rollers for anticlockwise direction).

2. When the fork is driving, its rotation of both directions is transmitted to the green inner disk by flexible contact via rollers, red bushes and springs (orange rollers for clockwise direction, yellow rollers for anticlockwise direction)
The rotation can not transmitted to the blue outter disk because the wedging does not happen.

3. When the green inner disk is driving, its rotation of both directions is transmitted to the blue outter disk by wedging of the rollers between the blue outter disk and the green inner disk (orange rollers for clockwise direction, yellow rollers for anticlockwise direction).
The rotation of the green inner disk is transmitted to the pink fork by flexible contact via springs, red bushes and rollers (yellow rollers for clockwise direction, orange rollers for anticlockwise direction).

In brief, the rotation of two directions can be transmitted from the outter disk to the fork. The inverse is impossible. The fork and the inner disk always rotate together.
If the outter disk is kept immobile, the rotation can be transmitted only from the fork to the inner disk. The inverse is impossible, causing jam of the mechanism. So the inner disk can not act as a driving link.

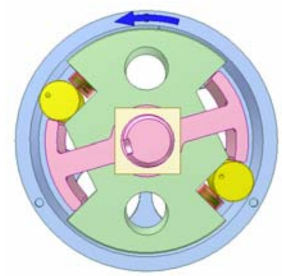
Two way overrunning clutch 2



http://youtu.be/VgciAZMn7Zc

Blue outter disk and pink fork rotate around a fixed axis.
Green inner disk of oval shape rotates idly on the pink fork.
Brown flat springs force rollers into wedgeshaped gaps between the outter and inner disks.
The arrows show which link is the driving at different times.
The rotation of two directions can be transmitted from the outter disk to the fork. The inverse is impossible. The fork and the inner disk always rotate together.
This is an embodiment of the mechanism shown in "Two way overrunning clutch 1"
http://youtu.be/-Y_SQGMRx8k

Roller overrunning clutch 3



http://youtu.be/LLJJsPTaKic

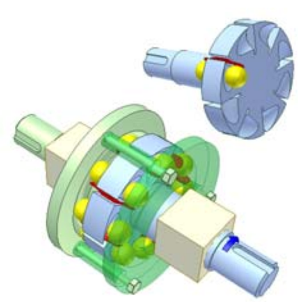
Blue outter disk and pink fork rotate around a fixed axis.
Green inner disk rotates idly on the pink fork.
The arrows show which link is the driving at different times.

1. When the blue outter disk is driving, its anticlockwise rotation is transmitted to the green inner disk by wedging of the yellow rollers between the blue outter disk and the green inner disk.
Clockwise rotation of the blue outter disk can not be transmitted to the pink fork.

2. When the fork is driving, its rotation of both directions is transmitted to the green inner disk by flexible contact via yellow rollers, red bushes and springs (for clockwise direction) or by direct contact between the fork and the green inner disk (for anticlockwise direction).
The rotation can not transmitted to the blue outter disk because the wedging does not happen.

3. When the green inner disk is driving, its clockwise rotation is transmitted to the blue outter disk by wedging of the yellow rollers between the blue outter disk and the green inner disk. Anticlockwise rotation of the green inner disk can not be transmitted to the blue outter disk.
The rotation of the green inner disk is transmitted to the pink fork by flexible contact via springs, red bushes and yellow rollers (for anticlockwise direction) or by direct contact between the green inner disk and the fork (for clockwise direction)

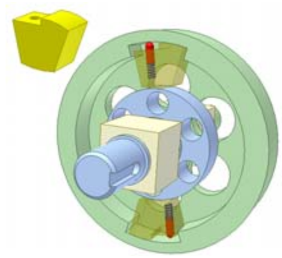
Ball overrunning clutch 1



http://youtu.be/qRmwoGlQ7V8

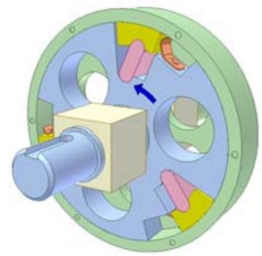
Blue and green shafts rotate around a fixed axis.
The red flat springs always force the yellow balls into wedgeshaped gaps between the shafts.
The arrows show which link is the driving at different times.
When the blue shaft is driving, its two way rotation can be transmitted to the green shaft only in anticlockwise direction.
When the green shaft is driving, its two way rotation can be transmitted to the blue shaft only in clockwise direction.

Sprag overrunning clutch 1
http://youtu.be/0gwzmLh03Bw



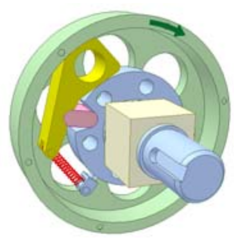
Blue and green shafts rotate around a fixed axis.
Blue springs and red pins maintain contact between yellow sprags and the two shafts.
The arrows show which link is the driving at different times.
When the blue shaft is driving, its two way rotation can be transmitted to the green shaft only in clockwise direction.
When the green shaft is driving, its two way rotation can be transmitted to the blue shaft only in anticlockwise direction.

Sprag overrunning clutch 2
http://youtu.be/6R8t0pnh7sk



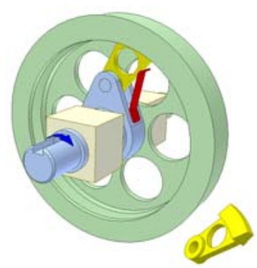
Blue and green shafts rotate around a fixed axis.
Copper springs maintain contact between yellow sprags, pink pins and the two shafts.
The arrows show which link is the driving at different times.
When the blue shaft is driving, its two way rotation can be transmitted to the green shaft only in clockwise direction.
When the green shaft is driving, its two way rotation can be transmitted to the blue shaft only in anticlockwise direction.

Sprag overrunning clutch 3
http://youtu.be/_pTC2iCmRkY



Blue and green shafts rotate around a fixed axis.
Red spring maintains contact between yellow sprag, pink pin and the two shafts.
The arrows show which link is the driving at different times.
When the blue shaft is driving, its two way rotation can be transmitted to the green shaft only in clockwise direction.
When the green shaft is driving, its two way rotation can be transmitted to the blue shaft only in anticlockwise direction.

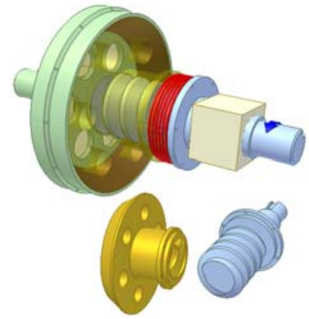
Sprag overrunning clutch 4
http://youtu.be/NagjHuASAoc



Blue and green shafts rotate around a fixed axis.
Red spring maintains contact between yellow sprag and V-shaped groove of the green shaft.
The arrows show which link is the driving at different times.
When the blue shaft is driving, its two way rotation can be transmitted to the green shaft only in clockwise direction.
When the green shaft is driving, its two way rotation can be transmitted to the blue shaft only in antclockwise direction.
If the green shaft is kept immobile, the blue shaft can rotate only anticlockwise. It is braked automatically when rotating clockwise (mechanism for preventing reverse rotation).

Screw overrunning clutch 1

http://youtu.be/M4d_8VpNe9k



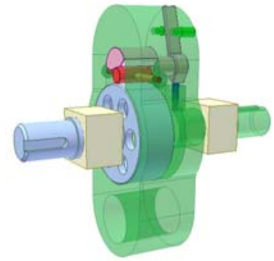
Blue and green shafts rotate around a fixed axis.
Yellow nut of male cone has a helical joint (right hand thread) with the blue shaft.
Red torsion spring tends to turn the yellow nut clockwise thus maintains contact for cone surfaces of the yellow nut and the green shaft.
The arrows show which link is the driving at different times.
When the blue shaft is driving and rotates anticlockwise, the green shaft tends to keep the nut immobile. The latter tends to move towards the green shaft, contact force at cone surfaces increases, the green shaft rotates together with the blue shaft.
When the blue shaft is driving and rotates clockwise, the green shaft tends to keep the nut immobile. The latter tends to move apart from the green shaft, contact force at cone surface decreases, the green shaft stays immobile.
In brief:
- When the blue shaft is driving, its two way rotation can be transmitted to the green shaft only in anticlockwise direction.
- When the green shaft is driving, its two way rotation can be transmitted to the blue shaft only in clockwise direction.
- If the green shaft is kept immobile, the blue shaft can rotate only anticlockwise. It is braked automatically when rotating clockwise(mechanism for preventing reverse rotation).
This mechanism is created purely on computer and needs to be verified in practice.

Screw gear overrunning clutch

http://youtu.be/2IlHyu6msTk

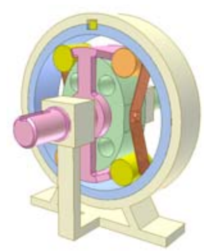
Green ring and blue gear rotate around a fixed axis.
The ring carries two yellow gear shafts with brown cones.
The arrows show which link is the driving at different times.
1. If the green ring is driving:
- When the ring rotates anticlockwise, gearing forces (axial components) push the yellow gear shafts towards the femal cones of the ring, the yellow gear shafts can not rotate and make the blue gear rotate.
- When the ring rotates clockwise, gearing forces push the yellow gear shafts away from the femal cones of the ring, the yellow gear shafts rotate idly and the blue gear is kept immobile by load applied on it.
2. If the blue gear is driving:
- When the blue gear rotates anticlockwise, gearing forces push the yellow gear shafts away from the femal cones of the ring, the yellow gear shafts rotate idly and the ring is kept immobile by load applied on it.
- When the blue gear rotates clockwise, gearing forces push the yellow gear shafts towards the femal cones of the ring, the yellow gear shafts can not rotate and make the ring rotate.
For an embodiment of this mechanism the three helical gears are replaced by a non self locking worm drive (one worm gear and two worms).

Roller overrunning clutch 3
http://youtu.be/Hvr8LC-Ph7w
Input: blue shaft rotating two directions.
Output: green shaft rotates with the input shaft only in the direction set by the pink lever.
The orange pins always force the red roller into wedgeshaped gaps between the input and output shafts.
The spring of the blue pin must be strong enough for positioning the pink lever.



Two-way anti-reverse transmission 1a
http://youtu.be/wZjoNIkYQqM
Pink input shaft transmits rotation to output green shaft in both directions.
Reverse transmission is impossible because yellow rollers wedge between the fixed outter rim and the green shaft.
The mechanism has self-locking feature like worm drive but transmission ratio is 1/1.
It can be used for motion control system where servo motor needs a rest (interrupting electric supply) when motion control is not required.
For more see: “Two way overrunning clutch 1”
http://youtu.be/-Y_SQGMRx8k

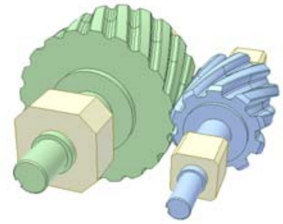
Two-way anti-reverse transmission 1b
http://youtu.be/5DBfEdX5Ow8
This is an embodiment of the mechanism shown in “Two-way anti-reverse transmission 1a”
http://youtu.be/wZjoNIkYQqM
Pink input shaft transmits rotation to output green shaft in both directions.
Reverse transmission is impossible because rollers wedge between the fixed outter rim and the green shaft.
The mechanism has self-locking feature like worm drive but transmission ratio is 1/1.
It can be used for motion control system where servo motor needs a rest (interrupting electric supply) when motion control is not required.
For more see: “Two way overrunning clutch 2”
https://www.youtube.com/watch?v=VgciAZMn7Zc



1.3. Gears

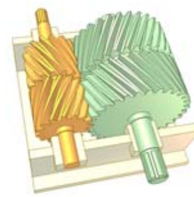
1.3.1. Spur gears

1.3.1.1. Simple drives



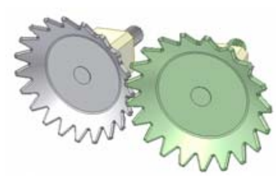
Novikov gearing
http://youtu.be/oHQ4ZaiRbgc
Features:
- Convexo-concave round spiral engagement.
- Point contact

It gives higher load capacity and efficiency than involute gearing.

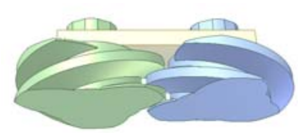


Herringborne gear
http://youtu.be/K_i4kU_L8Lw
By commbination of two helical gear of opposite hands it has advantage of helical gear: smooth and quiet engagement and avoids its disavantage: axial thrust.
Double helical gear

Sheet metal gears 1
http://youtu.be/c1nnWtySorQ
For light loads.
Low cost.
Adaptability to mass production.

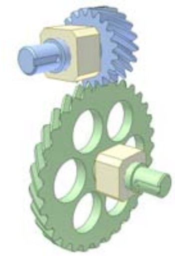


Sheet metal gears 4
http://youtu.be/NCAawnVw8tM
For light loads.
Low cost.
Adaptability to mass production.
Two blanked gears, conically form after blanking become bevel gears meshing on parallel axes.

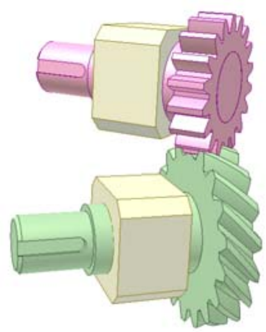


Standard transmission between 3 teeth gears (or screws)
http://www.youtube.com/watch?v=VIWn4GO5SUE
Two gears have opposite helix direction and rotate in opposite direction

Screw gear drive 1a
http://youtu.be/6F5GqB89Lkc
Normal module mn = 2 mm
Pinion:
- Helix angle B1 = 30 deg., right hand
- Face module ms1 = 2.31
- Tooth number Z1 = 20
- Pitch circle dia. D1 = 46.2 mm
Wheel:
- Helix angle B2 = 60 deg., right hand
- Face module ms2 = 4.0
- Tooth number Z2 = 30
- Pitch circle dia. D2 = 120 mm
Angle between gear axles E = B1 + B2 = 90 deg.
Velocity ratio: i = Z2/Z1 = 1.5 (not D2/D1 = 2.6)



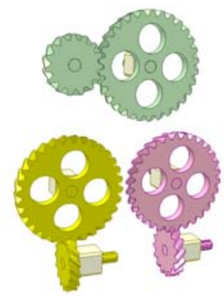
Screw gear drive 1b
http://youtu.be/_gE1v6ahjk4
This drive consists of a small gear (in pink) and a big one (in green) but its velocity ratio is 1. Screw gear causes this paradox.
Normal module mn = 2 mm
Pink gear:
- Helix angle B1 = 0 deg.,
- Face module ms2 = mn = 2 mm
- Tooth number Z1 = 18
- Pitch circle dia. D1 = 36.0 mm
Green gear:
- Helix angle B2 = 45 deg., right hand
- Face module ms2 = 2.83
- Tooth number Z2 = 18
- Pitch circle dia. D2 = 50.91 mm
Angle between gear axles E = B1 + B2 = 45 deg.
Velocity ratio: i = Z2/Z1 = 1 (not D2/D1 = 1.41)



Screw gear drive 2
http://youtu.be/MJRtf_RMUa8
Normal module mn = 2 mm
+ Pinion:
- Helix angle B1 = 30 deg., left hand
- Tooth number Z1 = 15
- Pitch circle dia. D1 = 34.64 mm
+ Wheel:
- Helix angle B2 = 30 deg., right hand
- Tooth number Z2 = 30
- Pitch circle dia. D2 = 69.28 mm
Angle between gear axles E = B1 + B2 = 60 deg.
Velocity ratio: i = Z2/Z1 = D2/D1 = 2

Screw gear drive 3
http://youtu.be/7bxZzhRREA8
Normal module mn = 2 mm
+ Pinion:
- Helix angle B1 = 30 deg., left hand
- Tooth number Z1 = 15
- Pitch circle dia. D1 = 34.64 mm
+ Wheels:
- Helix angle B2 = 30 deg., left hand
- Tooth number Z2 = 30
- Pitch circle dia. D2 = 69.28 mm
Velocity ratio: i = Z2/Z1 = D2/D1 = 2
Angle between gear axles E = B1 + B2 = 60 deg.
The wheels axles are not parallel even if the wheels engage with the pinion at its opposite sides.

Screw gear drive 4
http://youtu.be/WZRst3BMCag
This video aims to show:
1. For screw gear drive with parallel shafts, i.e. spur gear drive of helical teeth (in green): helix angles of the two gears must be equal and of opposite hands.
2. For screw gear drive with skew perpendicular shafts (in yellow and in pink): helix angles of the two gears B1, B2 must be of same hand, B1 + B2 = 90 deg. The yellow drive is of right hand. The pink drive is of left hand. If input gears (small ones) rotate in the same direction, the output gears (large ones) rotate in opposite directions.

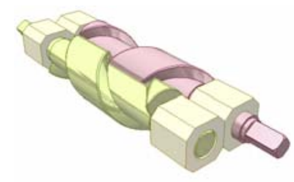


Screw gear drive 5
http://youtu.be/IYIVnTsG4E8
Orange pinion:
- Helix angle B1 = 45 deg., right hand
Green pinion:
- Helix angle B1 = 45 deg., left hand
Wheels:
- Helix angle B1 = 45 deg., right hand
Angle between pinion and wheel axles for the green drive E = B1 - B2 = 0 deg.
Angle between pinion and wheel axles for the orange drive E = B1 + B2 = 90 deg.
Pay attention to the rotation directions of the wheels in each drive. They are opposite for the orange drive and of the same direction for the green drive.

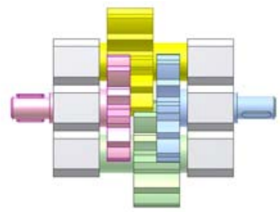
Spur gear drive 1a
http://youtu.be/zrUbFHnom1g
Input: blue gear of one tooth. Gear face width must be larger than tooth axial pitch.
Output: yellow gear of 10 teeth.
Transmission ratio: 1/10.

Spur gear drive 1b
http://youtu.be/DLJQTXQaBSE
Input: pink gear of one tooth. Gear face width must be larger than tooth axial pitch.
Output: yellow gear of 10 teeth.
Transmission ratio: 1/10.

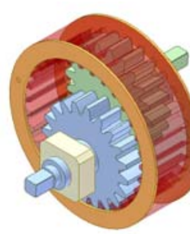
Spur gear drive 1c
http://youtu.be/L6Z5GY3DoI8
Each gear (screw) has only one tooth. Gear face width must be larger than tooth axial pitch.



Coaxial rotation reverser of 4 spur pinions
http://youtu.be/MB7zUQCQRxI
Input: pink pinion.
Output: blue pinion.
They are of equal tooth number.
Green and yellow pinions rotate idly.
Green pinion engages with yellow and blue pinions.
Yellow pinion engages with green and pink pinions.
Tooth numbers of green and yellow pinions can be arbitrary.
The input and output rotate in opposite directions.
Their speeds are equal.
This mechanism is used instead of 3 bevel gear drive to avoid using perpendicular shafts.



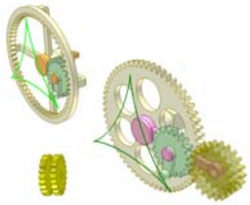
3-gear coupling 1
https://www.youtube.com/watch?v=uCzyQT930JY
There is no bearing for the internal gear.
Z1 = Z2 = 20
Z3 = 30
Z1, Z2 are tooth numbers of the external gears.
Z3 is tooth number of the internal gear.
The external gears have the same velocity and rotation direction.
Velocity can be altered if Z1 differs from Z2



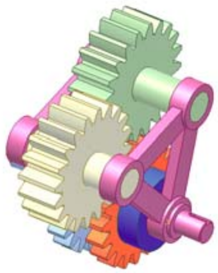
3-gear coupling 2
https://www.youtube.com/watch?v=nBCts0-4KIs
There is no bearing for the internal gear.
Z1 = 20, Z2 = 40
Z3 = 50
Z1, Z2 are tooth numbers of the external gears.
Z3 is tooth number of the internal gear.
The external gears have the same rotation direction.
Transmission ratio is 2.

1.3.1.2. Epicyclic drives

Internal and external gears
http://youtu.be/a4I0ZBnQ_20
The left planetary drive can be replaced by the right one when the manufacturing of internal gears is a problem. They give the same result (the green curves). Just lengthen the carrier and add an yellow double gear.
In this video tooth number of the fixed gears is triple of the one of the movables gears so the green curves are deltoids.

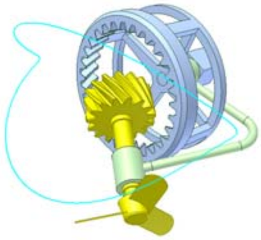


Reductor with gears of equal number of teeth 4
http://www.youtube.com/watch?v=dNsMZF7boCM
A result once generally supposed impossible.
The red gear is fixed.
The yellow gear engages with the red and the green gears.
The green gear engages with the yellow and the blue gears.
The blue shaft rotates two times faster than the pink crank.



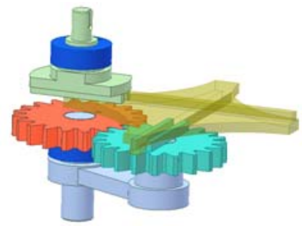
Screw gear drive 6
http://youtu.be/CC3L22A7M-E
Satellite external screw drive
Normal module mn = 2 mm
+ Pinion:
- Helix angle B1 = 30 deg., left hand
- Tooth number Z1 = 15
+ Wheel:
- Helix angle B2 = 30 deg., left hand
- Tooth number Z2 = 30
Angle between gear axles E = B1 + B2 = 60 deg.
The blue curve is locus of a point on the satellite pinion (a space epicycloid?)

Screw gear drive 7
http://youtu.be/hYjZuVhpEbQ
Satellite internal screw drive
Normal module mn = 2 mm
+ Pinion:
- Helix angle B1 = 30 deg., left hand
- Tooth number Z1 = 15
+ Wheel:
- Helix angle B2 = 30 deg., right hand
- Tooth number Z2 = 30
Angle between gear axles E = B1 + B2 = 60 deg.
The blue curve is locus of a point on the satellite pinion (a space hypocycloid?)

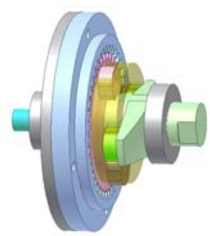


Screw gear drive 8
http://youtu.be/5AizQPWoGxI
Green ring and pink gear rotate around a fixed axis.
The ring carries two gears rotating idly on it.
The planetary mechanism has two degrees of freedom.
Input are the green ring and the pink gear.
The video shows case when the ring rotates regularly, at first the pink gear is kept immobile and then rotates.

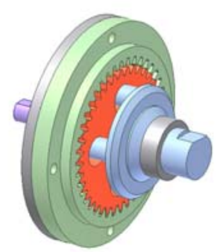
Reductor with gears of equal number of teeth 3
http://www.youtube.com/watch?v=H0aqcwNbMOA
A result once generally supposed impossible.
The green shaft rotates two times faster than the blue crank.
Rotation of the cyan gear is transmitted to the green shaft by Oldham mechanism



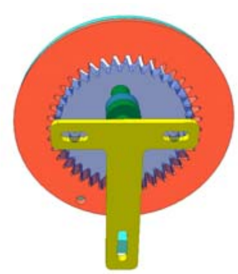
Planetary Reduction Gear 1 with Oldham coupling
http://www.youtube.com/watch?v=78gkc9mPT-w
Number of teeth of the fixed internal gear Z1 = 40
Number of teeth of the planetary gear Z2 = 38
Module m = 2 mm
The eccentricity caused by the blue shaft is 2 mm.
Transmission ratio i = - Z2 / (Z1 - Z2) = -19
Rotation of the pink gear is transmitted to the green shaft by Oldham coupling.



Planetary Reduction Gear 2
http://www.youtube.com/watch?v=MGVSRrI0ir4
Number of teeth of the fixed internal gear Z1 = 40
Number of teeth of two planetary gears (red and pink) Z2 = 38
Module m = 2 mm
The violet shaft has two 2 mm eccentric portions at 180o. The pink and red gears are on the portions.
Transmission ratio i = - Z2 / (Z1 - Z2) = -19
Rotation of the pink and red gears is transmitted to the blue shaft by four pins.

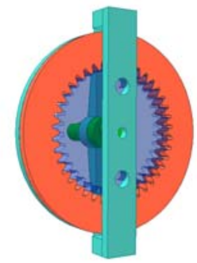


Planetary Reduction Gear 3
http://www.youtube.com/watch?v=XCpMWxyM9yc
Number of teeth of the red gear Z1 = 40
Number of teeth of the blue gear Z2 = 38
Module m = 2 mm
The eccentricity caused by the green shaft is 2 mm.
The blue gear Z2 has rotary translational motion due to the yellow plate that has linear translational motion.
Transmission ratio i = Z1 / (Z1 - Z2) = 20



Planetary Reduction Gear 4

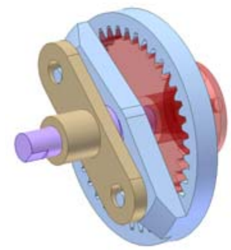
http://www.youtube.com/watch?v=RmUYrYai1S4



Number of teeth of the red gear Z1 = 40
Number of teeth of the blue gear Z2 = 38
Module m = 2 mm
The eccentricity e caused by the green shaft is 2 mm.
The blue gear Z2 has rotary translational motion due to the fixed green plate.
Radius of two holes on the green plate = e + radius of pins on the blue gear.
Transmission ratio i = Z1 / (Z1 - Z2) = 20

Planetary Reduction Gear 5

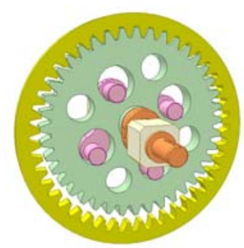
http://www.youtube.com/watch?v=czG3I4u8xMY



Number of teeth of the red gear Z1 = 38
Number of teeth of the blue gear Z2 = 40
Module m = 2 mm
The eccentricity e caused by the violet shaft is 2 mm.
The blue gear Z2 is on the eccentric portion of the violet shaft. It has rotary translational motion due to the fixed brown plate.
Radius of two holes on the brown plate = e + radius of pins on the blue gear.
Transmission ratio i = Z1 / (Z1 - Z2) = 20

Planetary Reduction Gear 6

http://youtu.be/U7WEXjV0t0A



Planetary speed reducer.
The orange input crank carries the green gear (Z1 = 40 teeth) that engages with stationary yellow gear (Z2 = 44 teeth). The pink output shaft has a disk of pins that engage with the holes of the green gear.
The radius difference of the pink pins and the holes is equal to the eccentricity of the orange crank.
i = n1/n3 = Z1/(Z2-Z1) = 10
n1: input crank velocity
n3: output velocity
If (Z2-Z1) small and Z1 large, i can be very large.
The input and the output rotate in opposite directions.

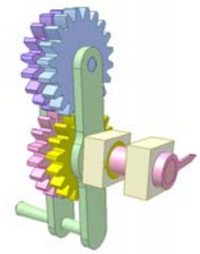
Planetary Reduction Gear 7

http://youtu.be/FBb9jIbf5xE

Teeth number of blue gear Z1 = 40
Teeth number of yellow gear Z2 = 36
Module m = 2 mm
The eccentricity of the orange input eccentric shaft (constant velocity V) is 4 mm.
Pink plate is the conrod of parallelogram mechanism of two green rockers.
A pin of the yellow gear and a cylinder portion of the orange shaft slide in slots of the pink plate. The pink plate has translational motion. Its direction is kept unchanged during motion.
The blue output gear Z1 rotates regularly with velocity V1
V1 = V.((Z1 - Z2)/Z1) = V/10

Crank for small angle rotation

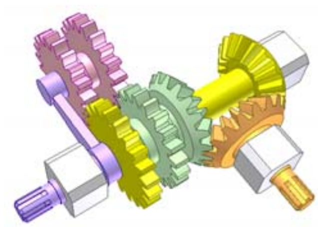
http://youtu.be/WAIg5tR1fzM



Input: green crank of Ng velocity.
Output: pink shaft of Np velocity.
Yellow gear is kept immobile.
Blue and violet gears are fixed each to other.
Tooth numbers of the pink, yellow, blue and violet gears:
Zp = 20, Zy = 19, Zb = 20 and Zv = 19 respectively.
Ng/Np = (Zp.Zb) / (Zp.Zb – Zv.Zy) = 10.26
The ouput rotates around 10 times slower than the input in the same direction.

Planetary Reduction Gear 8

http://youtu.be/l-2-v3Bkfp8



Input: violet carrier of velocity Nv
Output: orange bevel gear of velocity No
Three bevel gears have the same tooth number.
Yellow gear block has yellow spur gear of Zy teeth.
Green gear block has green spur gear of Zg teeth.
Pink gear block has pink gears of Zp1 teeth (gear on the left) and Zp2 teeth.
Zy + Zp1 = Zg + Zp2
No = Nv(1-A)/(1+A)
Where A = (Zp1.Zg)/(Zy.Zp2)
For this case Zy = Zp2 = 21; Zg = Zp1 = 20
No = Nv/20.51
If Zy = Zp2 = 101; Zg = Zp1 = 100
No = Nv/100.5
The three bevel gears aim that the yellow and green gear blocks rotate in opposite directions with the same velocity. Four spur gear drive can do that function. See:
https://www.youtube.com/watch?v=MB7zUQCQRxI

3-gear planetary mechanism A1

http://youtu.be/ZwdF96B55lY

i = nc/n1 = Z1/(Z1+Z3)
nc: velocity of the blue crank.
n1: velocity of the orange gear, its tooth number: Z1 = 20
Z2 = 20, tooth number of the yellow gear.
Z3 = 60, tooth number of the fixed green internal gear.
Z1 + 2Z2 = Z3
i = 1/4
The crank, the orange gear always rotate the same direction independently of the tooth numbers..

3-gear planetary mechanism A2

http://youtu.be/MfYuWLOqSwQ

i = nc/n3 = Z3/(Z1+Z3)

nc: velocity of the blue crank.

n3: velocity of the green internal gear, its tooth number: Z3 = 60.

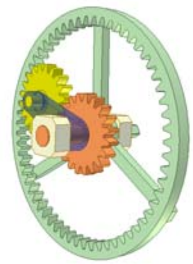
Z1 = 20, tooth number of the fixed orange gear.

Z2 = 20, tooth number of the yellow gear.

Z1 + 2Z2 = Z3

i = 3/4

The crank, the green and yellow gear always rotate the same direction independently of the tooth numbers..



3-gear planetary mechanism B

http://youtu.be/FMnWeK9-obg

i3 = n3/nc = (Z1 + Z3)/Z3

i2 = n2/nc = (Z1 + Z2)/Z2

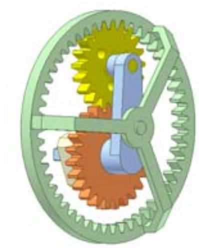
nc: velocity of the blue crank.

n3: velocity of the green gear, its tooth number: Z3 = 50

n2: velocity of the yellow gear, its tooth number: Z2 = 20

Z1 = 24, tooth number of the fixed orange gear.

The crank, the yellow and green gears always rotate the same direction independently of the tooth numbers..



3-gear planetary mechanism C

http://youtu.be/-y1_foDmOtY

i3 = n3/nc = (Z3 – Z1)/Z3

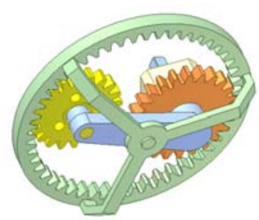
i2 = n2/nc = (Z2 - Z1)/Z2

nc: velocity of the blue crank.

n2: velocity of the green gear, its tooth number: Z2 = 50

n3: velocity of the yellow gear, its tooth number: Z3 = 20

Z1 = 24, tooth number of the fixed orange gear.



3-gear planetary mechanism D

http://youtu.be/JhCTd-LeZHU

i3 = n3/nc = (Z1 + Z3)/Z3

i2 = n2/nc = (Z2 - Z1)/Z2

nc: velocity of the blue crank.

n3: velocity of the yellow gear, its tooth number: Z3 = 20

n2: velocity of the orange gear, its tooth number: Z2 = 20

Z1 = 70, tooth number of the fixed green gear.

3-gear planetary mechanism E

http://youtu.be/upo4rQWg_EI

i3 = n3/nc = (Z3 – Z1)/Z3

i2 = n2/nc = (Z1 + Z2)/Z2

nc: velocity of the blue crank.

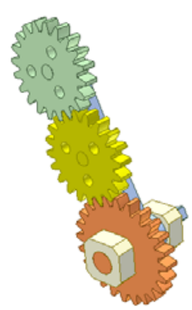
n3: velocity of the green gear, its tooth number: Z3 = 20

n2: velocity of the yellow gear, its tooth number: Z2 = 20

Z1 = 24, tooth number of the fixed orange gear.

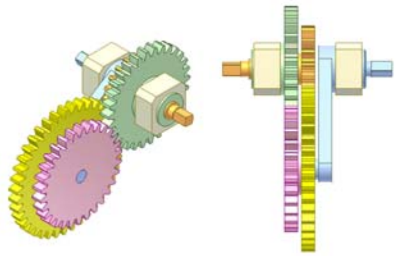
The crank, the yellow gear always rotate the same direction.

The rotation direction of the green gear depends on (Z3-Z1).



4-gear planetary mechanism A

http://youtu.be/5dSVJxebzLY



Mechanism for reversing rotation direction.

i = n1/nc = 1 - ((Z2.Z4)/(Z1.Z3)

nc: velocity of the blue crank.

n1: velocity of the orange gear, its tooth number: Z1 = 20.

Z2 = 40 (yellow gear); Z3 = 30 (pink gear); Z4 = 30 (fixed green gear)

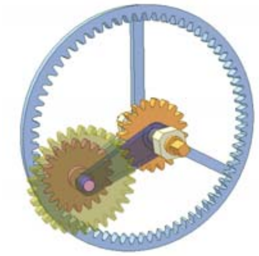
Z1 + Z2 = Z3 + Z4

i = - 1

The blue crank and the orange gear have equal velocity but rotate in opposite directions.

4-gear planetary mechanism B

http://youtu.be/DcegsYhZEug



i = nc/n1 = 1/(1+ ((Z2.Z4)/(Z1.Z3)))

nc: velocity of the blue crank.

n1: velocity of the orange gear, its tooth number: Z1 = 20.

Z2 = 30 (yellow gear); Z3 = 20 (pink gear); Z4 = 30 (fixed blue gear)

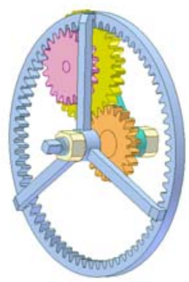
Z1 + Z2 = Z4 – Z3

i = 4/25

The crank, the orange gear always rotate in the same direction independently of the tooth numbers..

4-gear planetary mechanism C

http://youtu.be/hW7VrI7WskU



i = nc/n4 = 1/(1+ ((Z1.Z3)/(Z2.Z4)))

nc: velocity of the green crank.

n4: velocity of the blue internal gear, its tooth number: Z4 = 70.

Z2 = 30 (yellow gear); Z3 = 20 (pink gear); Z1 = 20 (fixed orange gear)

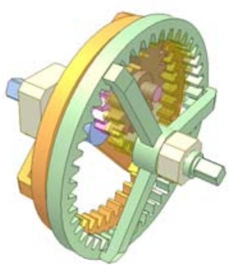
Z1 + Z2 = Z4 – Z3

i = 21/25

The crank, the blue internal gear always rotate in the same direction independently of the tooth numbers..

4-gear planetary mechanism D

http://youtu.be/-JBWH6UvZtM



i = n1/nc = 1 – ((Z2.Z4)/(Z1.Z3))

n1: velocity of the green internal gear, its tooth number Z1 = 44

nc: velocity of the blue crank.

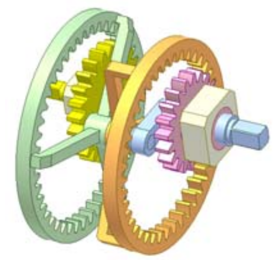
Z2 = 24 (yellow gear); Z3 = 20 (pink gear); Z4 = 40 (fixed orange internal gear). The yellow gear and the pink one are fixed together.

Z1 - Z2 = Z4 – Z3

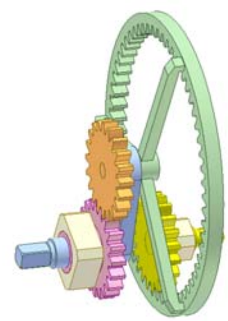
i = -1/11

The crank, the green gear rotate in opposite directions for this case.

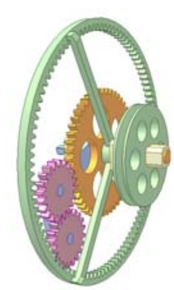
4-gear planetary mechanism E
http://youtu.be/c09J2mDX1yI
i = n1/nc = 1 – ((Z2.Z4)/(Z1.Z3))
n1: velocity of the yellow gear, its tooth number Z1 = 44
nc: velocity of the blue crank.
Z2 = 44 (green internal gear); Z3 = 40 (orange internal gear); Z4 = 20 (fixed pink gear). The green gear and the orange one are fixed together.
Z2 – Z1 = Z3 – Z4
i = 1/12
The crank, the yellow gear rotate the same direction for this case.



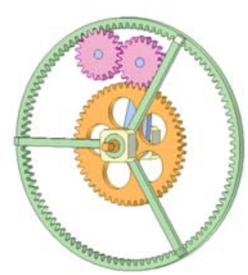
4-gear planetary mechanism F
http://youtu.be/798M628MUIM
i = n4/nc = 1 + ((Z1.Z3)/(Z2.Z4))
n4: velocity of the yellow gear, its tooth number Z4 = 20
nc: velocity of the blue crank.
Z2 = 20 (orange gear); Z3 = 60 (green internal gear); Z1 = 20 (fixed pink gear). The green gear and the orange one are fixed together.
Z1 + Z2 = Z3 – Z4
i = 4
The crank, the yellow gear always rotate the same direction independently of the tooth numbers.



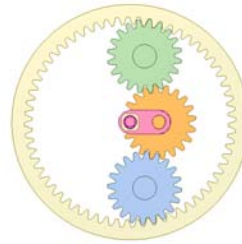
4-gear planetary mechanism G1
http://youtu.be/22hIFLhfDio
i = n4/nc = 1 – Z1/Z4
nc: velocity of the blue crank.
n4: velocity of the green gear, its tooth number: Z4 = 100.
Z2 = Z3 = 20 (pink gears); Z1 = 50 (fixed orange gear)
i = 1/2
The blue crank and the green gear always rotate in the same direction independently of the tooth numbers..



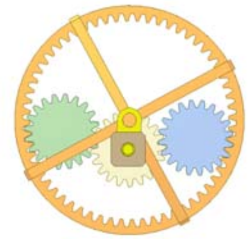
4-gear planetary mechanism G2
http://youtu.be/ZZN3JBacmIM
Mechanism for reversing rotation direction
i = n1/nc = 1 – Z4/Z1
nc: velocity of the blue crank.
n1: velocity of the orange gear, its tooth number: Z1 = 50.
Z2 = Z3 = 20 (pink gears); Z4 = 100 (fixed green gear)
i = - 1
The blue crank and the orange gear have equal velocity but rotate in opposite directions.



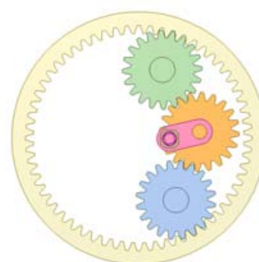
4-gear planetary drive 1
http://www.youtube.com/watch?v=OXy-ayPXFJM
Tooth number of:
- fixed ring gear: 60
- other gears: 20
N1 = 4 Nc
N1: velocity of the orange gear
Nc: velocity of the crank



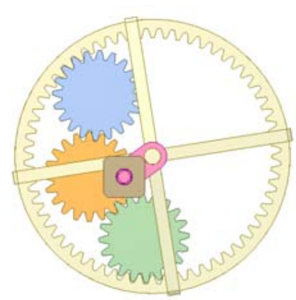
4-gear planetary drive 2
http://www.youtube.com/watch?v=BrCUnruM1j8
Tooth number of:
- ring gear: 60
- other gears: 20
N2 = (4/3) Nc
N2: velocity of the ring gear
Nc: velocity of the crank



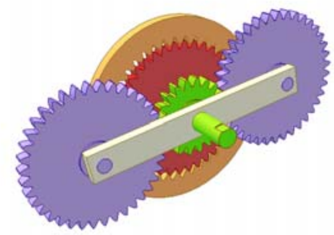
4-gear offset planetary drive 1
http://www.youtube.com/watch?v=jZ3BTzQ3ULw
Tooth number of:
- planet gears: 20
- fixed ring gear: 60
Gear module: 2 mm
Length of the crank = eccentric of the fixed bearing house with the ring gear, 17 mm.
N1 = 2Nc
N1: velocity of the orange gear
Nc: velocity of the crank
A successively increasing/decreasing space (suction/compression) is formed on either side of the ring gear and planet ones so the mechanism can be used for pumps.



4-gear offset planetary drive 2
http://www.youtube.com/watch?v=UEtjQV10SVw
Tooth number of:
- ring gear: 60
- other gears: 20
Gear module: 2 mm
Length of the crank = eccentric of the fixed bearing house with the orange gear, 17 mm.
N2 = (2/3)Nc
N2: velocity of the ring gear
Nc: velocity of the crank
A successively increasing/decreasing space (suction/compression) is formed on either side of the ring gear and planet ones so the mechanism can be used for pumps.

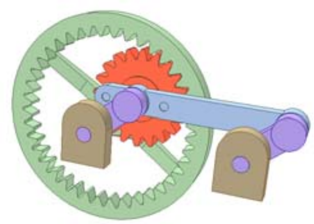


Parallelogram mechanism with gears 2
http://www.youtube.com/watch?v=2eFUqqiqOyk
The orange gear (internal teeth number Z5) is the connection rod.
Z4 is teeth number of the red gear.
Z2 is teeth number of the green gear.
Z1 is teeth number of the violet gears.
Velocity relation: $\omega 4 = \omega 2.(Z2/Z1).(Z5/Z4 - 1)$
$\omega 2$: velocity of Z2.
$\omega 4$: velocity of Z4.



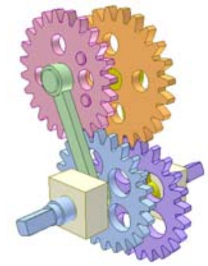
Reductor with gears of equal number of teeth 1
http://www.youtube.com/watch?v=wXX-kt7XPYE
A result once generally supposed impossible.
The cranks rotate two times slower than the red gear.

Parallelogram mechanism with gears 1
http://www.youtube.com/watch?v=JSaX43kX9CI
The red gear (teeth number Z2) is fixed with the blue connection rod.
The green gear has internal teeth number Z1.
Velocity relation: $\omega 1 = \omega c.(1-Z2/Z1)$
$\omega 1$: velocity of Z1
ωc: velocity of the violet crank.

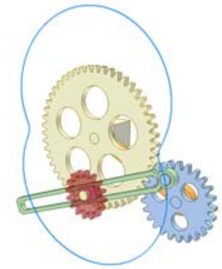


Gear and linkage mechanism 6a
http://www.youtube.com/watch?v=8Va05aWWTk0
Pink and orange gears are fixed together.
The pink gear and the blue one have revolution joints with green bar.
The orange gear and the violet one have revolution joints with yellow bar. The gears have the same tooth number. The two bars and the orange and pink gear block create a 4-bar linkage. The orange and pink gears are fixed together in such a way that the axis of one gear goes through the pitch circle of the other gear.
Input is the orange gear rotating regularly.
The bars oscillate. The violet and blue gears rotate irregularly and have dwells.
Their motion depends on the 4-bar linkage dimension.

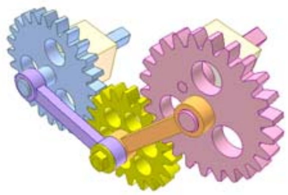
Gear and linkage mechanism 6b
http://youtu.be/f727Y_sfjJQ
Pink and orange gears are fixed together.
The pink gear and the blue one have revolution joints with green bar.
The orange gear and the violet one have revolution joints with yellow bar. The gears have the same tooth number. The two bars and the orange and pink gear block create a 4-bar linkage.
Input is the violet gear rotating regularly.
The bars and the blue gear rotate irregularly.
Their motion depends on the 4-bar linkage dimension.



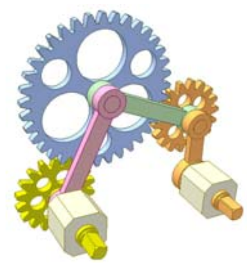
Gear and linkage mechanism 7
http://youtu.be/4lgI3KnQ8sQ
The blue and fixed popcorn gears and the orange carrier create a satellite drive. Tooth numbers of the gears are 25 and 50.
The green bar has revolution joint with the blue gear.
The red gear has revolution joint with the popcorn fixed gear and prismatic joint with the green bar.
While the orange carrier rotate regularly, the red gear rotates irregularly.
Beside geometric dimensions of the links, its motion also depends on the position between the pins of the blue gear and the popcorn gear when assembling.



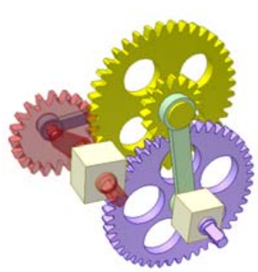
Gear and linkage mechanism 11a
http://youtu.be/gzMpuO2klGU
Tooth number of blue gear: 25
Tooth number of yellow gear: 20
Tooth number of pink gear: 25
The rotation axis of the pink gear is not its geometric one.
The input pink gear rotates regularly.
The blue gear rotates irregularly.



Gear and linkage mechanism 11b
http://youtu.be/j2QFbgwHwBU
Input: orange crank with gear fixed to it.
Output: yellow gear.
Blue gear idly rotates.
Depending on the gear diameters, the output gear can rotate, reach a short dwell, or even reverse itself briefly.

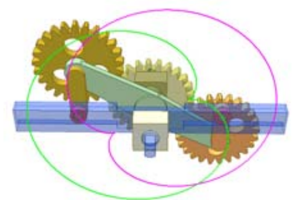


Gear and linkage mechanism 11c
http://youtu.be/WYrsowuLBn8
Tooth number of red gear: 20
Tooth number of violet gear: 45
Tooth numbers of yellow gears: 15 and 40.
The red gear and the red crank are fixed together and rotate regularly.
The violet gear has complicated rotation subject to the links dimensions.

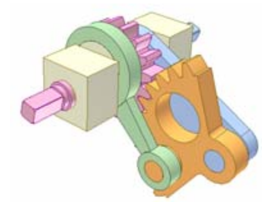


Gear and linkage mechanism 12
http://youtu.be/g9nYKdroNhM
Tooth number of green gear: 20
Tooth number of orange gear: 40
Tooth number of yellow fixed gear: 20
Input is the pink crank shaft rotating regularly.
The green and orange gears rotate irregularly.

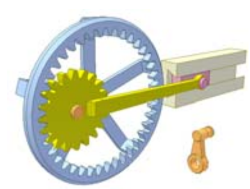
Gear and linkage mechanism 14
http://youtu.be/g0T0saXkA-E
Three gears have a same tooth number.
The yellow glass gear is immobile.
Crank radii of two orange gears are equal to gear pitch ones.
Input : green carrier rotating regularly.
Output: blue shaft rotating irregularly with dwell.
The pink and green curves are loci of red rollers centers.



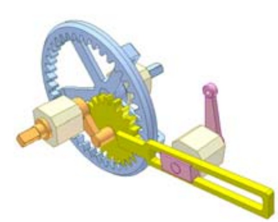
Gear and linkage mechanism 16
http://youtu.be/lMXCPIT4XRY
Blue crank, green bar and orange gear-conrod create a 4-bar linkage.
Rotation axes of the blue crank and the pink gear are coaxial.
Rotation axes of the green bar and the pink gear are not coaxial.
Input is the blue crank, rotating regularly.
The output pink gear rotates irregularly.



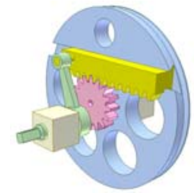
Planetary drive 3a
http://youtu.be/m_iEoDa2hZg
Blue input gear of tooth number Z1 rotates regularly.
Carrier of planetary drive is orange crank.
Yellow satellite gear of tooth number Z2 and yellow bar are fixed together. The orange crank rotates irregularly.
If Z1 = n.Z2, the pink slider reciprocates n times during 1 revolution of the blue gear. For this case n = 2.



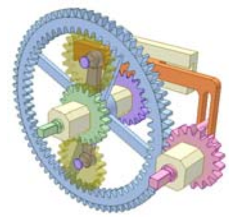
Planetary drive 3b
http://youtu.be/bep4vLIzR0g
Input carrier of planetary drive is orange crank rotating regularly.
Yellow satellite gear of tooth number Z2 and yellow slotted bar are fixed together. Pink slider oscilates around fixed axis.
Blue internal gear of tooth number Z1 rotates irregularly.
If Z1 = n.Z2, the blue gear turns 1 revolution during n revolutions of the input crank. For this case n = 2.



Gear, rack and linkage mechanism 2
http://youtu.be/i-wC0g5RZSo
Green crank, yellow rack-slider and blue disk create a coulisse mechanism.
Rotation axes of the blue disk and the pink gear are coaxial.
Rotation axes of the green crank and the blue disk are not coaxial.
The blue input disk rotates regularly.
The pink gear and the green crank rotates irregularly.

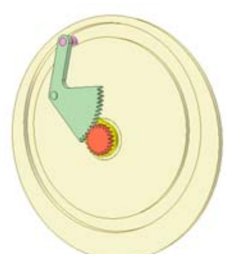


Gear, rack and linkage mechanism 3
http://youtu.be/-4ZrABfkOxM
Violet carrier, yellow satellite gears, blue and green gears create a differential planetary mechanism.
The blue gear is connected to the violet carrier via pink gear, orange rack and a sine mechanism.
The pink input gear rotates regularly.
The output green gear rotates irregularly.
Its motion is a sum of regular rotation and irregular rotation of sine function.

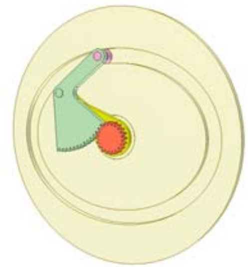


Cam and gear mechanism 12
http://youtu.be/_XsQhBFrGlM
Input: Pink gear shaft.
Block of two yellow gears and orange eccentric rotates idly on green cranks.
Blue output gear shaft, that is coaxial to the input, rotates irregularly.
This is a planetary drive in which the orange cam controls motion of the crank. The cam profile decides the output motion rule.
Tooth number of blue gear Zb = 24
Tooth number of pink gear Zp = 12
Tooth number of yellow gears: 12 and 18
Working cycle: 4 rev. of the input

Cam-controlled planetary gear 1
http://youtu.be/JKJfXL6TYXU
Grooved cam is fixed.
The red sun gear rotates on a fixed bearing.
The yellow planet arm rotates on a bearing that is coaxial with the red sun gear.
The green gear sector (planet gear) has follower roller which rides in the cam groove.
If the yellow planet arm is input link rotating regularly, the red output gear can get variety in the kind of motion depending on the cam groove contour and ratio of tooth numbers.
The contour is a eccentric circle in this video. The output rotates with dwell. 1 full revolution of the input corresponds 1 full revolution of the output.

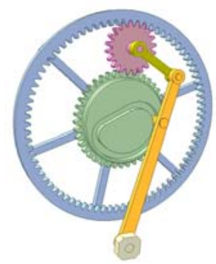


Cam-controlled planetary gear 2
http://youtu.be/B5XkX2ct0P8



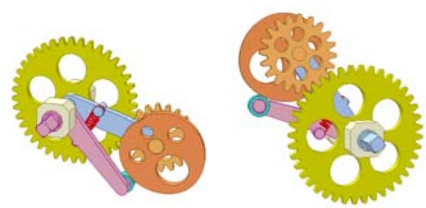
Grooved cam is fixed.
The red sun gear rotates on a fixed bearing.
The yellow planet arm rotates on a bearing that is coaxial with the red sun gear.
The green gear sector (planet gear) has follower roller which rides in the cam groove.
If the yellow planet arm is input link rotating regularly, the red output gear can get variety in the kind of motion depending on the cam groove contour and ratio of tooth numbers.
The contour is a concentric ellipse in this video. 1 full revolution of the input corresponds 1 full revolution of the output. The output rotates back two times in a cycle.

Cam and gear mechanism 11
http://youtu.be/5PT5H_tMa2E



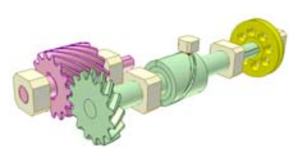
Input is the green gear and cam that rotate regularly. The blue output internal gear rotates with inconstant velocity.

Mechanism of cam's planar motion 3
http://youtu.be/vIU9uzsOLbU



Input is the blue crank of constant velocity. The big yellow gear is immobile. The orange cam fixed to the small gear has planar motion. The red spring maintains permanent contact between roller and cam.
The output pink crank rotates irregularly.

Barrel cam and helical gears 1
http://youtu.be/QzPfy8KnB6E



Input: green gear shaft of barrel cam. It rotates and linearly reciprocates simultaneously.
Output: pink shaft that rotates irregularly. The irregularity depends on helix angles of the helical gears and cam profile.

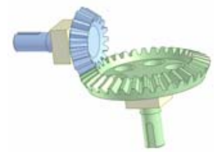
Barrel cam and helical gears 2
http://youtu.be/M7Wa-W6wqqY

Input: green gear shaft of barrel cam rotating regularly.
The blue intermediate shaft can slide only thanks to the green barrel cam. Block of two yellow gears can rotate on the blue shaft.
Output: pink shaft that rotates irregularly.
The irregularity depends on helix angles of the helical gears and cam profile.

1.3.2. Bevel gears

Bevel Gears 1
http://www.youtube.com/watch?v=kbBswXcIiKo
Angle between shafts α < 90 degrees

Bevel Gears 2
http://www.youtube.com/watch?v=Payj9xoQNjw
Angle between shafts α = 90 degrees

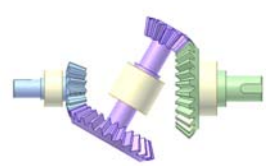


Bevel Gears 3
http://www.youtube.com/watch?v=fSfmEXJxebc
Angle between shafts α > 90 degrees.
Bevel gear with angle of wheel pitch cone of 180 degrees.

Bevel Gears 4
http://www.youtube.com/watch?v=omFu1uOtTEk
Angle between shafts α nearly equal 180 degrees.
Bevel gear with angle of wheel pitch cone of 180 degrees.

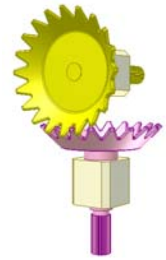
Bevel Gears 5
http://www.youtube.com/watch?v=S0fAeqzIA3k
Bevel gear with internal toothing.

Bevel Gears 6
http://www.youtube.com/watch?v=p_ZqoHcTQOU
Double reduction coaxial bevel gear.



Bevel Gears 7
http://www.youtube.com/watch?v=EIHiPaJiIGk
Double reduction coaxial bevel gear.

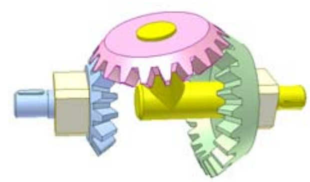
Sheet metal gears 3
http://youtu.be/BSvZs3uNNn0
For light loads.
Low cost.
Adaptability to mass production.
Two blanked gears, conically form after blanking become bevel gears.



Sheet metal gears 5
http://youtu.be/h6SRmSO2Mzo
For light loads.
Low cost.
Adaptability to mass production.
Yellow bevel gear is conically formed after tooth blanking.
Blue pinion is made by extruding or machining.

Reductor with gears of equal number of teeth 2
http://www.youtube.com/watch?v=aP1hr_9hQLA
A result once generally supposed impossible.
The blue gear rotates two times faster than the brass shaft.

Satellite Bevel Gear 8
https://www.youtube.com/watch?v=K7j8Pi4ATd0
Green gear is fixed.
Pink gear is idly mounted on yellow crank.
Pink gear axis is not perpendicular to rotary axis of the yellow crank.



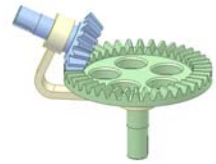
$Vy = Vb.Zb/(Zb+Zg)$
$Vp = Vy(Zg/Zp)$
Vb, Vy: velocities of blue gear and yellow crank.
Vp: velocity of pink gear around yellow crank.
Zg, Zb, Zp: tooth numbers of green, blue and pink gears respectively.
It is not easy to choose tooth numbers to meet assembly condition for this drive, especially in case of several satellite pink gears arranged symmetrically around the yellow crank.

Reductor with gears of equal number of teeth 5
http://www.youtube.com/watch?v=DT7N5GfLOUE
A result once generally supposed impossible.
The violet gears turn loosely on the brass shaft.
The yellow gear is fixed on the brass shaft.
The green gear rotates three times faster than the blue one.

Satellite Bevel Gear 1
http://www.youtube.com/watch?v=EXuUtS-jvQs

Satellite Bevel Gear 2
http://www.youtube.com/watch?v=YrSbMaC4Fx4

Satellite Bevel Gear 3
http://www.youtube.com/watch?v=rLDyDe9eaXs



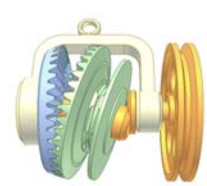
Satellite Bevel Gear 4
http://www.youtube.com/watch?v=JJfQAcXirhI

Satellite Bevel Gear 5
http://www.youtube.com/watch?v=nsk5zRCciww

Satellite Bevel Gear 6
http://www.youtube.com/watch?v=P1FX2Q5E1lk

Satellite Bevel Gear 7
http://www.youtube.com/watch?v=hV2LwzHDh2Q

Satellite Bevel Gear
http://www.youtube.com/watch?v=eT_rtLEcjls
Chain hoist with two bevel gears.
$n2 = n1 (Z2-Z1)/Z2$
n1: velocity of orange shaft
n2: velocity of green gear.
Z1: tooth number of blue gear
Z2: tooth number of green gear



Planetary drive 2

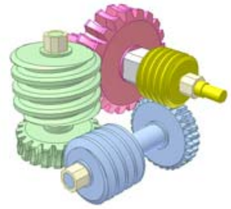
http://youtu.be/PuQ1K77piRM

Mechanism for winding yarn ball.

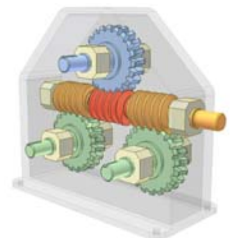
Pink gear, yellow satellite gear and green carrier create a differential planetary drive. The green carier is driving. The yellow satellite gear and yarn ball rotate around the vertical axis and around their own axis. Moreover the pink gear gets rotation from a worm drive and blue pulley. This motion helps increase or reduce the ball rotation around its own axis.

1.3.3. Worm gears

Worm Drive 1: Gear box
http://youtu.be/FZ1HQB4DEuQ
Serial connection of three worm drives. Input: the yellow worm; output: the pink worm wheel. They are coaxial.
Transmission ratio of each drive: i1, i2, i3.
Total ratio i = i1.i2.i3 = 30.20.20 = 12,000



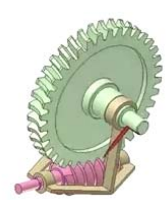
Worm Drive 2: Gear box
http://youtu.be/iQZegMhoYeU
One screw actuates 3 gears simultaneously. The axes of gears are at right angles to that of the screw. This mechanism can replace more expensive gear setups there speed reduction and multiple output from a single input is required.



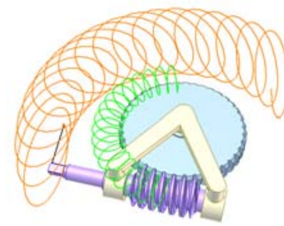
Worm Drive 4: Rotating and rolling worm
http://youtu.be/HVUwMqEiHBw
Swivel Table for Machine Tools
The worm rotates around its axle and rolls on the worm wheel simultaneously.

Worm Drive 5: Rotating and translating worm
http://youtu.be/kTCqSWVO32A
Beside rotation the input worm also moves longitudinally owing a cylinder cam. The worm wheel revolves with back rotation.

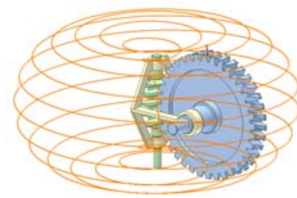
Worm Drive 6: Wheel rotating around worm
http://www.youtube.com/watch?v=4gS5QgwIkok
The wheel rotates around the worm.
The red hand proves that the wheel rotates around its axle.
Completing 1 revolution around the worm axle, the wheel makes Z1/Z2 revolution around its axle.
Z1: number of threads of the worm.
Z2: tooth number of the wheel.



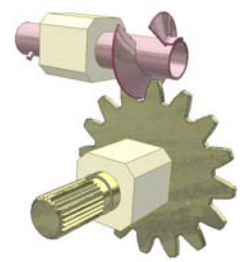
Worm Drive 7: Rotating and rolling worm loci
http://youtu.be/aOFozC13Wvg
The worm rotates around its axle and rolls on the wheel simultaneously. A worm's point (in the plane that is perpendicular to worm's axle and contains the wheel axle) traces a torus helix (green). A point that is not in the said plane traces skew torus helix (orange)



Worm Drive 8: Wheel rotating around worm locus
http://youtu.be/RcsllgLLm70
The wheel rotates around its axle and around the worm simultaneously.
The orange line is locus of a wheel's point situated in the plane that is perpendicular to the wheel's axle and contains the worm axle. The point's distance to the wheel's axle is equal to the axle distance between the worm and the wheel.



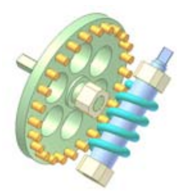
Sheet metal gears 8
http://youtu.be/zqYFVNY1CYA
For light loads.
Low cost.
Adaptability to mass production.
The worm is a sheet metal disk that was split and helically formed.
The worm can work only in one direction.



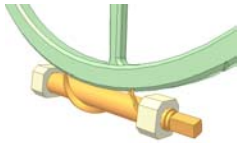
Worm Drive 9: Roller-Wheel
http://youtu.be/DNCOcXpccCk
The wheel is equipped with rollers to reduce friction loss.

Worm Drive 10: Spring-Worm
http://youtu.be/s71Vo2jSBuA
Spring gives worm and helps absorb heavy shocks.

Worm Drive 11: Spring-Worm, Pinned Wheel
http://youtu.be/928LPTiLgnc
Spring and pins give alternate ways for producing the worm and worm-wheel.



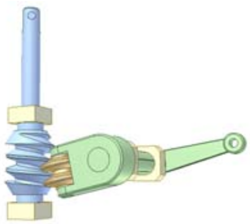
Worm Drive 12: Multiplying gear
http://youtu.be/YdfAwjfSYsA
Input: the green wheel.
The orange output worm has thread of large pitch.



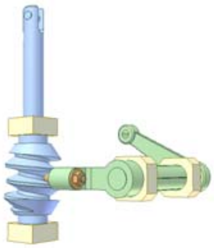
Worm Drive 13: Slotted Wheel
http://youtu.be/1V4x20xwbvo
Slots on a thin rim gives an alternate way for producing the wheel.
This concept is used for rubber pipe clamping, see:
http://kalyx.com/images/full/images_J/J_380030.jpg

Globoidal gear
http://youtu.be/wM4xuxoqiDI

Globoid worm and pin gear
http://youtu.be/k5UuUUFP6b8



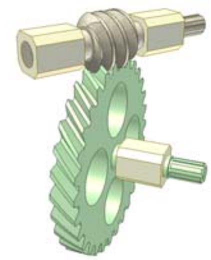
Globoid worm and roller drive
http://youtu.be/xxsgE8acedw
It is used in car steering system. The worm is connected to a steering wheel. The roller reduces friction at contact place. A globoid worm gives better performance than ordinary one.



Globoid worm and pin drive
http://youtu.be/NI4fmw2YRRk
It is used in car steering system. The worm is connected to a steering wheel. The rotary pin reduces friction at contact place. A globoid worm gives better performance than ordinary one.

Worm and external gear

http://youtu.be/vgDblGX8xFg



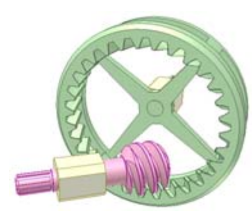
Normal module mn = 2 mm
Input worm:
- Number of starts Z = 2
- Lead Angle LA = 10.81 deg.
- Direction of thread: right hand
- Pitch circle dia. D = 20 mm

Gear:
- Helix angle B2 = 45 deg., right hand
- Tooth number Z2 = 30
- Pitch circle dia. D2 = 84.85 mm

Angle between worm and gear axes is L = 55.81 deg.
Velocity ratio: i = Z2/Z1 = 15

Worm and internal gear

http://youtu.be/jQFkUKiEwWU



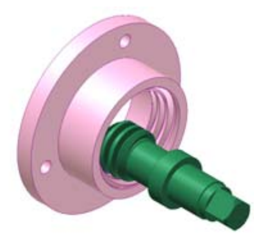
Normal module mn = 2 mm
Input worm:
- Number of starts Z = 2
- Lead Angle LA = 10.81 deg.
- Direction of thread: right hand
- Pitch circle dia. D = 20 mm

Gear:
- Helix angle B2 = 30 deg., right hand
- Tooth number Z2 = 30
- Pitch circle dia. D2 = 69.28 mm

Angle between worm and gear axes is L = 40.81 deg.
Velocity ratio: i = Z2/Z1 = 15

Rotary transmission between screw and nut

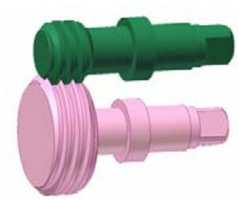
http://www.youtube.com/watch?v=KterrnNi-oA



n1/n2 = Z2/Z1 = D2/D1 = P2/P1 = 2
n1, n2: velosity of screw, nut
Z2, Z1: number of threads of nut, screw
D2, D1: average diameter of nut, screw
P2, P1: pitch of threads of nut, screw
Screw and nut have same helix direction (right-handed) and rotate in the same direction.

Rotary transmission between screws

http://www.youtube.com/watch?v=R-Dy2eZ8Y64

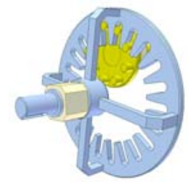


n1/n2 = Z2/Z1 = D2/D1 = P2/P1 = 2
n1, n2: velocity of screws 1, 2
Z1, Z2: number of threads of screws 1, 2
D1, D2: average diameter of screws 1, 2
P1, P2: pitch of threads of screws 1, 2
Screws have opposite helix direction and rotate in opposite direction.

1.3.4. Pin gears

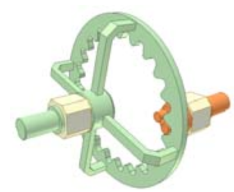
Pin gear drive 1A
http://youtu.be/5Wj3y08y4nQ
Transmission ratio i = 12/24
The pin wheel: orange. The tooth wheel: green.
The tooth profile is the envelope of a family of the pin circles, centers of which are on an epicycloid (external gearing) or a hypocycloid (internal gearing) traced by pin circle center when the pin wheel rolls without slipping on the tooth wheel.

Pin gear drive 1B
http://youtu.be/F6hr0np0zsY
Transmission ratio i = 9/22



Pin gear drive 1C
http://youtu.be/yQLhCzcUexM
Transmission ratio i = 8/9

Pin gear drive 1D
http://youtu.be/JA9lKOEsCV4
Transmission ratio i = 2/22

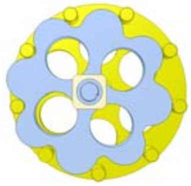


Pin gear drive 1E1
http://youtu.be/nOLV6L-3fsU
Transmission ratio i = 2/3

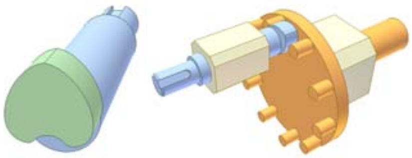
Pin gear drive 1E2
http://youtu.be/X9pqNhfv5fo
Transmission ratio i = 2/3
An embodiment of “Pin gear drive 1E1” with helical pins and teeth.

Pin gear drive 1F
http://youtu.be/nW1XrnThuRs
Transmission ratio i = 3/4

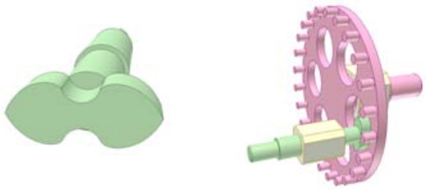
Pin gear drive 1G
http://youtu.be/hDWFOLADxsU
Transmission ratio i = 9/8



Pin gear drive 1H1
http://youtu.be/XXeFMr5kFI0
Transmission ratio i = 1/10

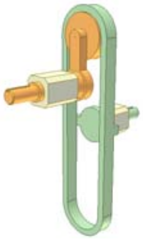


Pin gear drive 1H2
http://youtu.be/Gge11gvnM08
Transmission ratio i = 2/24



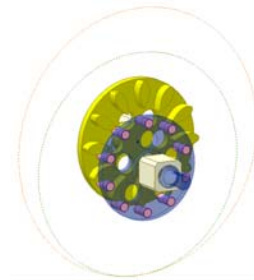
Pin gear drive 1H3
http://youtu.be/EocIZWIEAsY
Transmission ratio i = 3/24

Pin gear drive 1I1
http://youtu.be/L5oN9EiksOA
Transmission ratio i = 1/2
The gear profile is a straight line.
The mechanism has an unstable position, when the pin centerline and the green gear centerline are coaxial. It is avoided by using helical pin and gear. See: "Pin gear drive 1I2"

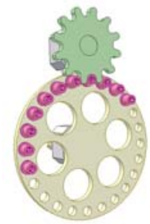


Pin gear drive 1I2
http://youtu.be/nGMOC7STi5E
Transmission ratio i = 1/2
An improvement of the mechanism shown in "Pin gear drive 1IA".

Pin gear drive 1M
http://youtu.be/yW8RGxV8xTU
Transmission ratio i = 10/12
The pin centers are not on the rolling circle of the pin wheel.
The two dashed circles are the rolling circles of the mechanism.
The tooth profile is the envelope of a family of the pin circles, centers of which are on an shortened hypocycloid traced by pin circle center when the pin wheel rolls without slipping on the tooth wheel.

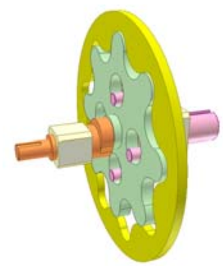


Pin gear drive 1K
http://youtu.be/N37KHV8CD6M
The green gear rotates interruptedly. During 1 revolution of the pin gear the green gear rotates 1 revolution and pauses.
Motion and dwell relation for the green gear can be easily adjusted by adding or cutting the pink pins.
The device to keep the green gear immobile during its dwell is not shown.

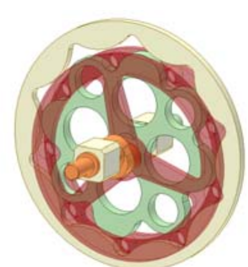


Pin gear drive 2
http://youtu.be/649flFhwUHE
An advantage of a pin wheel (the yellow one): it can work at the same time as a gear with external and internal teeth.

Pin gear drive 3A
http://youtu.be/h1I82ose0w4
Cycloidal speed reducer.
The orange input crank carries the green wheel. In fact it is a pin wheel (Z1 = 8 pins) that engages with stationary yellow tooth wheel (Z2 = 9 teeth). The pink output shaft has a disk of pins that engage with the holes of the green pin wheel. The radius difference of the pink pins and the holes is equal to the eccentricity of the orange crank.
i = n1/n3 = Z1/(Z2-Z1) = 8
n1: input crank velocity
n3: output velocity
If (Z2-Z1) small and Z1 large, i can be very large.
The input and the output rotate in opposite directions.

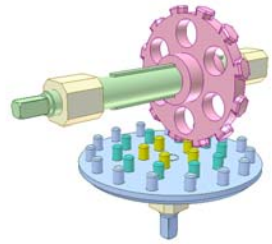


Pin gear drive 3B
http://youtu.be/mEx2qzJH37c
An advantage of a pin gear: it can work at the same time as a gear with external and internal teeth.
The orange input crank carries the red pin gear (Z2 = 9 pins) that engages with output green gear (Z1 = 8 teeth) and yellow stationary gear (Z3 = 10 teeth).
i = nc/n1 = Z1/(Z3-Z1) = 4
nc: input crank velocity
n1: output gear velocity
If (Z1-Z3) small and Z1 large, i can be very large.
The input and the output rotate in opposite directions.
The pins can be equipped with roller bearings to get a no-sliding speed reducer.



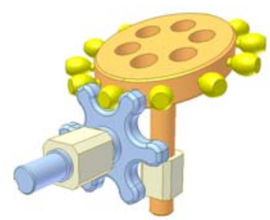
Multishaft driller
http://youtu.be/gLEKqk-8CEY
Special screw mechanisms are applied.
The output shafts rotate the same direction and with the same velocity in comparison with the input shaft although their axle distances to the input shaft are different.
For more see:
http://www.youtube.com/watch?v=QfiJSTRDASs

Pin gear drive 5
http://youtu.be/0n8wOO795Eg
Input: green shaft on which pink gear wheel can slide.
Output: blue disk with pins arranged in three concentric circles.
Adjust the pink gear position on the green shaft to get 3 forward and 3 reverse speeds.
The video shows cases of 2 forward and 1 reverse speeds.
A considerable backlash is present in the drive.



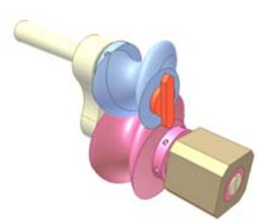
Space pin gear drive 1
http://youtu.be/VhyoKuoOv-8

Space pin gear drive 2
http://youtu.be/O5C8pUquixM
The pin centers are in a tilted plane, on an ellipse. The orange pin wheel rotates and reciprocates simultaneously. The up motion is caused by meshing force. The down motion is due to the gravity or spring force.



Space pin gear drive 3
http://youtu.be/RNP0O3NbWZA
The yellow pin rotor oscillates and reciprocates simultaneously.
The pin centers are on a helix curve. One end of the pinion shaft moves along the closed slot on the rotor.
This mechanism is taken from the video of a washing machine:
http://www.youtube.com/watch?v=-Eu2ca6MSUA
that an YouTube user (Mr. SolaPazEnergy) has introduced to me.

Pin coupling 6
http://www.youtube.com/watch?v=zfXDfoOAnrY
A planetary mechanism from Pin Coupling 5.
http://www.youtube.com/watch?v=QfiJSTRDASs
The direction of the red bar attached to the blue shaft is unchanged during the motion.

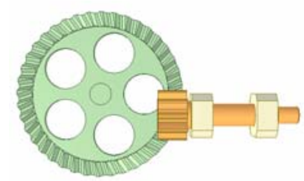


1.3.5. Face gears

Face gear 1
http://youtu.be/4QDNN8zon6k
Standard face gear.

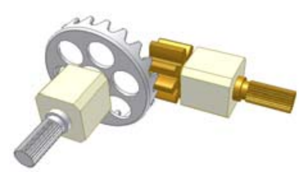
Face gear 2
http://youtu.be/MIPrAhNj7ag
Face gear with spur gear of helical teeth.

Face gear 3
http://youtu.be/b9zeHMyvUbY
Face gear with skew axles.

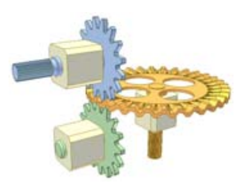


Face gear 16
http://youtu.be/ayOxgYGHCL0
Face gear according its expanding definition: angle between axes may differ from 90 deg..

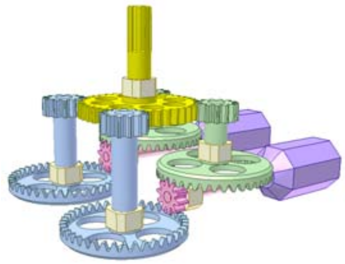
Sheet metal gears 6
http://youtu.be/2AMF48m9AX8
For light loads.
Low cost.
Adaptability to mass production.
The blanked, cup-shaped wheel meshes with a solid pinion on 90 deg. intersecting axes.



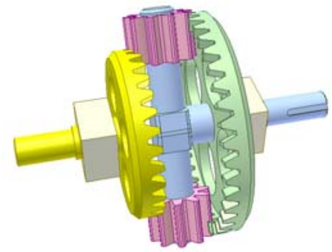
Sheet metal gears 7
http://youtu.be/Rb37-daSLQ4
For light loads.
Low cost.
Adaptability to mass production.
The horizontal wheel with waves on its out rim replacing teeth,
meshes with either one or two sheet-metal pinions. They have specially formed teeth and mounted on intersecting axes.



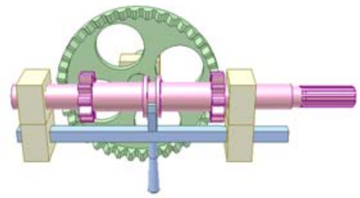
Face gear 7
http://youtu.be/QEIC9kO-3BQ
Transmission for helicopter rotor (Lewis Research Center, Cleveland, Ohio, USA).
Two horizontal engines (violet) transmit torques to vertical yellow shaft that is connected to the rotor through a planetary gearbox (not shown). The system apportions torques equally along multiple, redundant drive paths thereby reducing the stresses on individual gear teeth. Face gears help forgive error in manufacturing and alignment, thermal and vibration changes for the meshing parts.



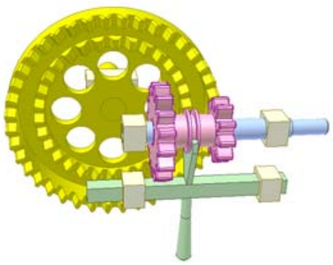
Face gear 8
http://youtu.be/dKYLYy8X4ts
Planetary mechanism with face gear.
The green gear (Z1 = 40 teeth) is fixed.
The yellow gear has 30 teeth (Z2).
n2/nc = (Z1+Z2)/Z2 = 7/3
nc: velocity of the blue crank
n2: velocity of the yellow gear
Unlike ordinary spur planetary mechanism there is no constraint between Z1, Z2 and tooth number of the pink gears.



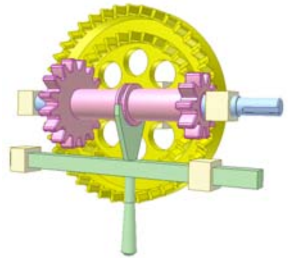
Face gear 10
http://youtu.be/-sA5_-3ZSa4
Reversing mechanism with face gear drive.
The pink shaft is input.
The blue slider is moved under manual action.



Face gear 11
http://youtu.be/vVRfKdGLjZ0
2-speed reducer.
The blue shaft is input.
The green slider is moved under manual action.



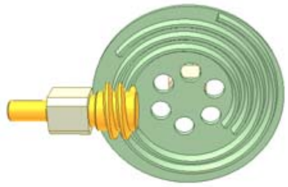
Face gear 12
http://youtu.be/W38bOovKApo
Reversing 2-speed reducer.
The blue shaft is input.
The yellow gears has two speeds of opposite directions.
The green slider is moved under manual action.



1.3.6. Archimedean spiral gears

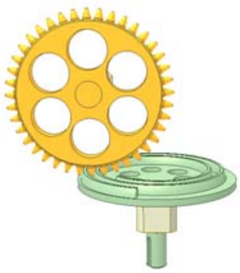
Archimedean spiral gear and Worm 1
http://youtu.be/kojrypcELnE
Input: the spiral gear of 1 start.
Output: the worm of 1 start.
Transmission ratio: 1
The number of stars can be more

Archimedean spiral gear and Worm 2
http://youtu.be/49WcDE64mRk
Input: the spiral gear of 2 starts (Z1)
Output: the worm of 1 start (Z2)
1 rev. of the input corresponds 2 rev. of the output (Z1/Z2).



Archimedean spiral gear and Spur gear
http://youtu.be/YaV-VAxkEAQ
Input: the spiral gear of 1 star (Z1).
Output: the spur gear of 18 teeth (Z2).
Axle of the spiral gear must be laid in the front face of the spur gear.
The helical angle of the spur gear teeth must be in accordance with spiral direction of the spiral gear.
1 rev. of the input corresponds 1/18 rev. of the output (Z1/Z2).
The number of stars can be more.

Archimedean spiral gear and Pin gear 1
http://youtu.be/LSx4anFA6nQ
Input: the spiral gear of 1 start (Z1).
Output: the pin gear of 40 pins (Z2).
1 rev. of the input corresponds 1/40 rev. of the output (Z1/Z2).
The number of starts can be more.



Archimedean spiral gear and Pin gear 2
http://youtu.be/FJfH1rz5EA4
Input: the spiral gear of 1 start (Z1).
Output: the pin gear of 30 pins (Z2).
1 rev. of the input corresponds 1/30 rev. of the output (Z1/Z2).
The axles of two gears are not parallel.
The number of starts can be more.

Archimedean drive 1a

http://youtu.be/D6XjnCc6gKQ

The green and orange cams of Archimedean profile are identical.
The green one is input.
Two cams rotate in opposite directions with the same speed, like in a drive of two equal gears.
If the cams have different pitches of Archimedean profile (p1 and p2) then transmission ratio = p1/p2.
Pitch of the Archimedean profile must be big enough to prevent possible jam.
A spiral spring can be used instead of the weight.

Archimedean drive 1b

http://youtu.be/y-8fU6q5iV8

The green and orange cams of Archimedean profile are identical.
The green one is input.
Two cams rotate in the same direction with the same speed, like in a belt drive of two equal pulleys.
If the cams have different pitches of Archimedean profile (p1 and p2) then transmission ratio = p1/p2.
Pitch of the Archimedean profile must be big enough to prevent possible jam.
A spiral spring can be used instead of the weight.

Archimedean drive 1c

http://youtu.be/naBSF38qeSY

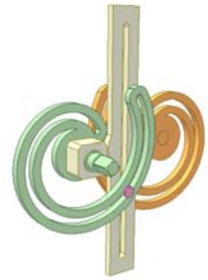
The green and orange cams have different Archimedean profiles (pitches p1 and p2, p1 = 2.p2). The green one is input.
Two cams rotate in opposite directions with different speeds, like in a drive of two gears of different tooth numbers.
Transmission ratio = 1/2.
Pitch of the Archimedean profile must be big enough to prevent possible jam.
A spiral spring can be used instead of the weight.

Archimedean drive 1d

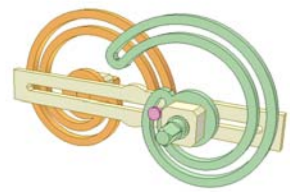
http://youtu.be/JAKbVNx4IpI

The green and orange cams have different Archimedean profiles (pitches p1 and p2, p1 = p2/2). The green one is input.
Two cams rotate in the same direction with different speeds, like in a belt drive of two different pulleys.
Transmission ratio = 2.
Pitch of the Archimedean profile must be big enough to prevent possible jam.
A spiral spring can be used instead of the weight.

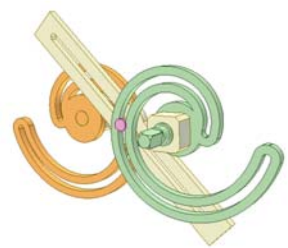
Archimedean drive 2a
http://youtu.be/dBYRbJxQSrw
The green and orange wheels of Archimedean grooves are identical.
The green one is input.
The pink pin slides in both grooves and in a straight slot of a fixed bar.
If the bar is perpendicular to the line connecting axes of the two wheels at its middle point, two wheels rotate in opposite directions with the same speed, like in a drive of two equal gears.
In case not at the middle point, the orange output wheel has irregular rotation.



Archimedean drive 2b
http://youtu.be/Jmls2qUs05w
The green and orange wheels of Archimedean grooves are identical. The green one is input.
The pink pin slides in both grooves and in a straight slot of a immobile bar. The slot is on the line connecting axes of the two wheels.
Two wheels rotate in the same direction with the same speed, like in a belt drive of two equal pulleys.

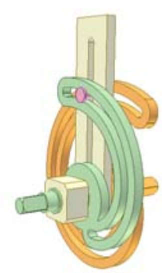


Archimedean drive 2c
http://youtu.be/-RIrEvSzv6Y
The green and orange wheels of Archimedean grooves are identical.
Input is the green wheel.
The pink pin slides in both grooves and in a straight slot of an immobile bar.
If the bar is not perpendicular to the line connecting axes of the two wheels, the orange wheel has irregular rotation.
The output will be diversified with various positions of the bar, various pitches of Archimedean grooves of the input and output wheels.



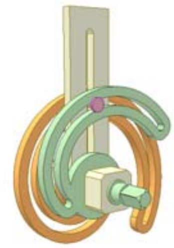
Archimedean drive 3a
http://youtu.be/r0AO8t-z3SI
The green and orange coaxial wheels of Archimedean grooves are identical.
The pink pin slides in both grooves and in a straight slot of a fixed bar.
The two wheels rotate in opposite directions with the same speed.
Pitch of the Archimedean groove must be big enough to prevent possible jam.

Archimedean drive 3b
http://youtu.be/bHDflbb9euc
The green and orange wheels are coaxial.
The pitch of Archimedean groove on the green is double the one on the orange.
The pink pin slides in both grooves and in a straight slot of a fixed bar.
The two wheels rotate in opposite directions with transmission ratio of 1/2.



Archimedean drive 3c

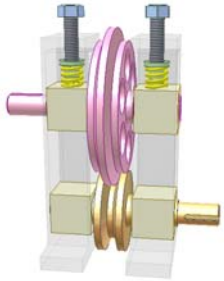
http://youtu.be/_pWGiUt36Ec



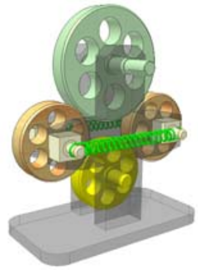
The green and orange wheels are coaxial.
The pitch of Archimedean groove on the green is double the one on the orange.
The pink pin slides in both grooves and in a straight slot of a fixed bar.
The two wheels rotate in the same directions with transmission ratio of 1/2.

1.4. Friction drives

Friction roller drive 1
http://youtu.be/HkjnM-g-dQ0
Input: smaller roller.
The adjustable friction forces at contact places are created by the blue bolts.
The roller angle profile helps to increase the friction force.
The springs give relatively constant pressure regardless of manufacturing errors.

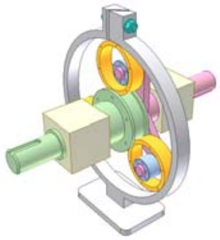


Friction roller drive 2
http://youtu.be/MZT4hg53IF8
Input: the yellow roller.
Output: the green roller.
The orange rollers idly rotate on their bearings which can slide horizontally.
The friction forces at contact places are created by the green springs.



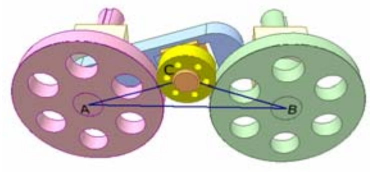
Friction roller drive 3
http://youtu.be/FNK92viLoo0
Input: the green roller.
Output: the pink roller.
The blue roller rotates idly.
The yellow bearings can move horizontally.
Pressure at contact places is created by the orange flexible ring.
The radial forces applied to the bearings are reduced to the minimum.

Friction roller drive 4
http://youtu.be/R9gJJq2hfh0
Input: the green roller.
Output: the pink shaft of 3 cranks carrying 3 blue idle rollers.
The orange flexible rings contacts with the green input roller and the fixed outer ring. Initial deformation of the orange flexible rings creates contact pressure which can be regulated to some extent by the cyan bolt.

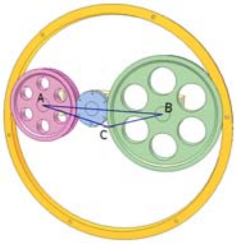


Friction roller drive 5
http://youtu.be/_JcSQM-URWA
Input: the pink roller.
Output: the green ring with belt groove.
The blue rollers idly rotate on their bearings which can slide horizontally.
The friction forces at contact places are created by the rim weight.

Friction roller drive 6
http://youtu.be/_jp1s8UZ0js
Input: the pink roller rotating clockwise.
Output: the green roller.
The blue crank can idly rotate on the pink shaft.
The yellow roller idly rotate on axle of the orange slider.
The friction forces at contact places are created automatically.
The transmission is possible if tg((a+b)/2) is less than m.
a is angle CAB, b is angle CBA
m is friction coefficient of roller materials (the smaller one)
Weights of the blue crank, the orange slider and the yellow roller create initial friction forces at the contact places.
No transmission if the pink roller rotates counterclockwise.

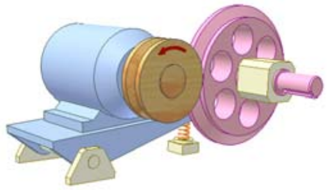


Friction roller drive 7
http://youtu.be/chSg5IbNkLM
Input: the pink roller, rotates counterclockwise.
Output: the green roller.
The orange ring contacts with the two rollers under its weight.
The friction forces at contact places are regulated automatically.
The blue roller of low friction coefficient material is for supporting the input and output rollers only (not for torque transmission).
The transmission is possible if tg((a+b)/2) is less than m.
a is angle CAB, b is angle CBA
C is the ring center.
m is friction coefficient of roller materials in contact with the ring (the smaller one)
Transmission is impossible if the pink roller rotates clockwise.

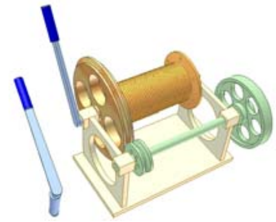


Friction roller drive 8
http://www.youtube.com/watch?v=uFn8h94SySU
The arm and the red roller create normal forces on contact surfaces.
It can be used as a controllable clutch.
Trasmission ratio i = n1/n2 = R2/R1
R1: Radius of contact surface of the pink shaft.
R2: Radius of contact surface of the green shaft.

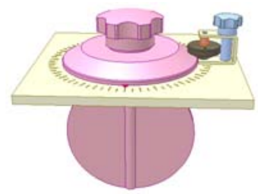
Friction roller drive 9
http://youtu.be/04jEqIn4SRI
Input: the orange roller installed on a plate that can turn around a fixed shaft. Center of the small roller must be above the line connecting center of the big roller and rocking center of the plate. The weight of the orange roller assembly causes the pressure at contact place between the rollers. The red arrow shows the recommended rotary direction due to which the pressure can be automatically increased in accordance with increasing load.
The orange spring is used to reduce the pressure in case the weight of the orange roller assembly is too large.



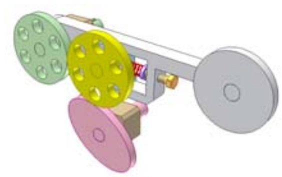
Friction roller drive 10
http://youtu.be/zaVAsLNgHIk
Friction windlass.
Input: the green shaft.
Output: the orange drum.
Pulling the lever of the blue eccentric shaft to bring the orange large roller into contact with the green small roller and create pressure at contact place.



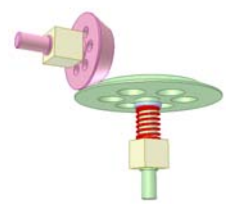
Friction roller drive 11
http://youtu.be/-59xRJqgIhs
The pink knob is for rough adjustment.
The blue one is for fine adjustment.
The small cone roller is made of rubber.



Friction roller drive 12
http://youtu.be/sN7oqKI8Zy8
The input pink ellipse roller rotates regularly.
The output green roller rotates irregularly.
Contact pressures are created by the grey weight and the orange screw.

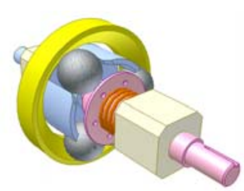


Friction cone roller drive 1
http://youtu.be/ZAWVAgUmAho
Input: the pink cone roller.
Output: the green cone roller.
The friction forces at contact places are created by the red spring.



Friction cone roller drive 2
http://youtu.be/E3EB3O7tiFw
This is a friction cone drive with V-groove rim.
The pressure at contact place is created by a spring.
The V-groove helps to increase the normal force at contact place.
The working surfaces are in orange color.

Friction ball drive 1
http://youtu.be/ohuHyiLLL0s
It is a planetary drive. The blue output shaft plays role of a planet carrier.
Input: the pink cone shaft (sun gear).
The yellow ring of internal cone surface (annulus) is fixed.
The friction forces at contact places are created by the orange spring.



This mechanism can be realized by using a ordinary ball bearing. Fix a shaft to its inner ring, replace its separator by a carrier.
Connect several mechanisms in series to get large transmission ratio.

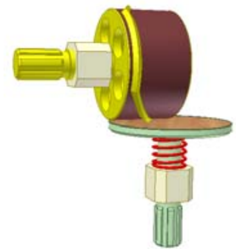
Barrel cam friction drive

http://youtu.be/UblRctFXjh4

Input: yellow barrel cam rotating regularly.

Output: Green disk rotating irregularly.

Red spring creates friction force for motion transmission.

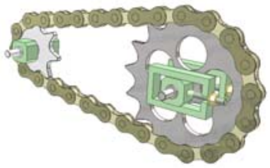


1.5. Chain drives

Chain drive 1A

http://youtu.be/A9FI4Bka7FE

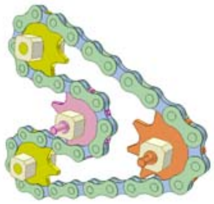
A typical chain drive having device for chain tensioning.



Chain drive 1B

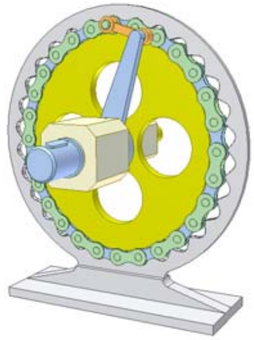
http://youtu.be/k0-Gd4PYR_o

Chain drive arrangement to get two shafts (pink and orange) rotating in opposite directions. The two yellow sprockets are idle.



Chain harmonic drive 1

http://youtu.be/VsDJqDnqbw8



Yellow input wave generator of oval shape always contacts with all rollers of a closed chain. A link of the chain has an elongated pin to create a revolution joint with orange conrod. The latter has revolution joint with blue output crank. The input, the output and the gear are coaxial. The chain performs a complicated motion forming "waves".

Tooth number of grey fixed gear Zg = 30

Link number of the chain Zc = 28

Transmission ratio: i = Zc / (Zg – Zc)

If (Zg – Zc) small and Zc large, i can be very large.

The input and output rotate in opposite directions.

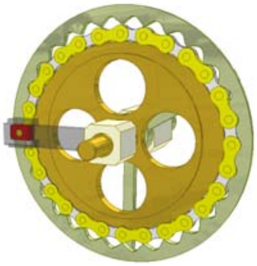
For this case 14 revolutions of the generator correspond 1 rev. of the blue output crank. Velocity of the latter is not constant.

For comparison: if chain, conrod and crank of this mechanism are merged into a flexible part, it becomes a familiar harmonic drive of flexible gear.

Replacement of revolution joint (the orange conrod) with a prismatic one (a slider sliding in a runway on the output crank) is possible.

Chain harmonic drive 2

http://youtu.be/yEWUGvWydQc



Orange input wave generator of oval shape always contacts with all rollers of a closed chain. A link of the chain has an elongated pin to create a revolution joint with red slider that moves in a slot of a fixed runway. The input and the output gear are coaxial. The chain performs a complicated motion forming "waves".

Tooth number of the gear Zg = 30

Link number of the chain Zc = 28

Transmission ratio: i = Zg / (Zg – Zc)

If (Zg – Zc) small and Zg large, i can be very large.

The input and output rotate in the same direction.

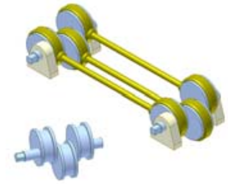
For this case 15 revolutions of the generator correspond 1 rev. of the output gear.

Velocity of the latter is not constant.

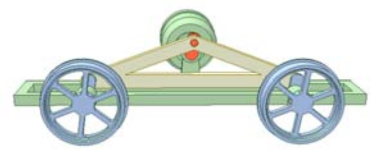
For comparison: if chain, slider and runway of this mechanism are merged into a flexible part, it becomes a familiar harmonic drive of flexible gear.

1.6. Bar drives

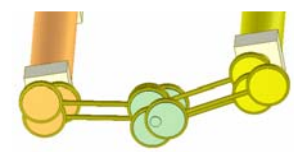
Parallelogram Mechanism
http://www.youtube.com/watch?v=prMefg7NCsc
Overcoming dead point by added cranks at various angles



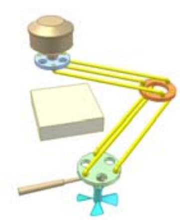
Application of parallelogram mechanism 5
http://www.youtube.com/watch?v=mP6WFS0_1jM
Transmission for electric locomotive.
There are 3 parallelogram mechanisms.
The one connecting the two wheels helps overcome dead positions that may happen to other parallelogram mechanisms.



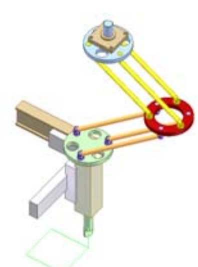
Application of parallelogram mechanism 9
http://www.youtube.com/watch?v=dg1C69jaoRw
Transmission of rotation movement between parallel shafts
The green shaft rotates without fixed bearing.



Application of parallelogram mechanism 4
http://www.youtube.com/watch?v=tjZ8qw3CTYA
Transmission of rotation movement between parallel shafts.
The red disk rotates without fixed bearing.
The driven shaft bearing is movable.

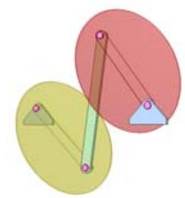


Application of parallelogram mechanism 10
http://www.youtube.com/watch?v=hPFvm6eisuQ
The tool head can move along Ox, Oy and Oz.

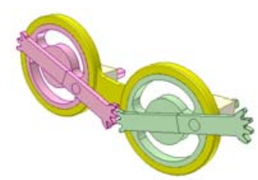


Parallel-link driller
http://www.youtube.com/watch?v=cHnnd78tUZ8
An application of parallelogram mechanism.
The yellow moving disk plays role of connecting rods.
Input crank and output cranks have the same length and the same speed.
Positions of the crank axes on the moving and fixed disks are the same.

Inverse Parallelogram Mechanism 1
http://www.youtube.com/watch?v=aPUcdGnf2uk
Inverse Parallelogram Mechanism = Ellipse Gear
Ellipse's major axis = b
Ellipse's minor axis = sqrt(b^b-a^a)
a: crank length; b: coupler link length
Ellipse's foci are centers of crank's rotary joints.

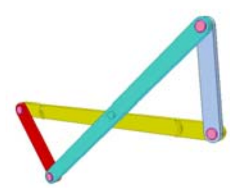


Inverse parallelogram mechanism 14
http://youtu.be/c9jSFZZX6uA
Input: pink crank rotating regularly.
Output: green crank rotating irregularly in opposite direction.
Added gears help the mechanism overcome unstable positions.



Inverse Parallelogram Mechanism 2
http://www.youtube.com/watch?v=I4V3NqwZG0o&feature=related
The concave curves and the pins on the red and blue cranks bar are for overcoming dead points.

Inverse Parallelogram Mechanism 3
http://www.youtube.com/watch?v=RkwA9F77IPQ&feature=related
The concave curves on the yellow fixed bar and the pin on the cyan rod are for overcoming dead points.

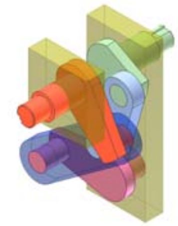


Inverse Parallelogram Mechanism 7
http://www.youtube.com/watch?v=cw0Wco_O600
Double Inverse Parallelogram
A second similar inverse parallelogram is connected to the first.
Similar ratio for this case is 2.
The red crank makes 2 revolutions while the violet one makes 1.

Inverse Parallelogram Mechanism 8

http://www.youtube.com/watch?v=ox03D0LQxck

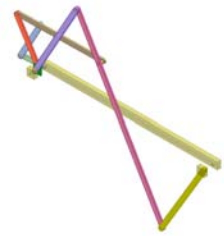
Double Inverse Parallelogram
A second similar inverse parallelogram is connected to the first.
Similar ratio for this case is 2.
It is a constructive embodiment of Inverse Parallelogram Mechanism 7
The red crank makes 2 revolutions while the violet one makes 1.
The mechanism consists of only bars and revolution joints.



Inverse Parallelogram Mechanism 9

http://www.youtube.com/watch?v=zlcf7e8L0Ho

Triple Inverse Parallelogram
A third similar inverse parallelogram is connected to a double inverse parallelogram.
Similar ratio for this case is 2.
The red crank makes 3 revolutions while the violet one makes 2 and the green makes 1.
Further similar connections allow getting transmission ratio of 4, 5, 6 …
There may be difficulty in arranging the crank bearing supports.



Inverse Parallelogram Mechanism 10

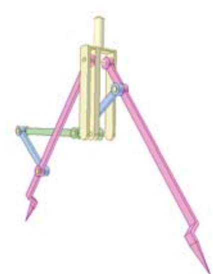
http://www.youtube.com/watch?v=YuqHVUsr2N0

Triple Inverse Parallelogram
A third similar inverse parallelogram is connected to a double inverse parallelogram.
Similar ratio for this case is 2.
The red crank makes 3 revolutions while the violet one makes 2 and the green makes 1.
Further similar connections allow getting transmission ratio of 4, 5, 6 …
The mechanism consists of only bars and revolution joints.
There may be difficulty in arranging the crank bearing supports.

Inverse parallelogram mechanism 12

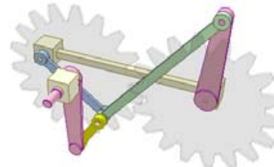
http://youtu.be/CsEWqFHsx9g

A compass of Double Inverse Parallelogram.
A second similar inverse parallelogram is connected to the first.
Similar ratio is 2.
The long bars of the first (big) are the left pink bar and the green bar.
The long bars of the second (small) are the right blue bar and the yellow ground bar.
The pink bars turn in opposite directions with the same velocity.
This mechanism can be used for the inverse transmission with limited rotation angle between two opposite coaxial shafts.



Inverse parallelogram mechanism 13

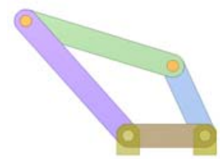
http://youtu.be/dqDHfOBE8EQ



Double Inverse Parallelogram.
A second similar inverse parallelogram is connected to the first.
Similar ratio is 2.
The long bars of the first (big) are the ground bar and the green bar.
The long bars of the second (small) are the blue bar and the left pink crank.
The pink cranks turn in opposite directions with the same velocity.
This mechanism acts as a spur gear drive (in glass, added for illustration), each gear is fixed to the pink crank. Measure for overcoming dead points is not shown.

Kite mechanism 1

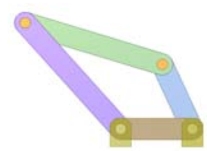
http://www.youtube.com/watch?v=5o-PS0ixoUQ



a = d; b = c; b > a
a, b, c and d are lengths of the blue, green, violet and tan link respectively.
It has two dead positions. The video shows how it works without measure to overcome dead positions.
At times it works as a mechanism of one link and one revolution joint.

Kite mechanism 2

http://www.youtube.com/watch?v=ukYuFjQ_92Y



a = d; b = c; b > a
a, b, c and d are lengths of the blue, green, violet and tan link respectively.
The video shows how it works, suppose it can overcome dead positions.
When the violet link makes one revolution, the blue makes two.
If one rotates regularly, the other not.

4 bar linkage mechanism a+b=c+d

http://www.youtube.com/watch?v=CJXSHnn0PiY

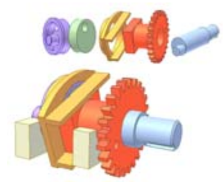
Kite mechanism.
Length of the red input crank a = 9
Length of the green rod b = 15
Length of the cyan crank c = 15
Distance between two fixed pins d = 9
When the red turns 2 rev., the cyan turns 1 rev.
The concave curve on the red crank and the pin on the cyan crank are for overcoming dead points.

Kite mechanism 3

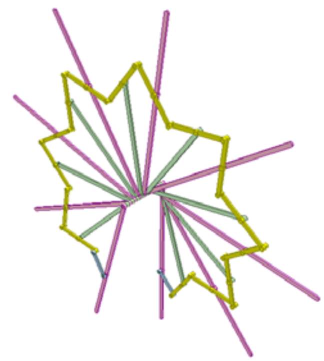
http://www.youtube.com/watch?v=R6kJK8_stjs

A development of kite mechanism by adding a coulisse mechanism.
When the red link makes one revolution, the blue makes two.
Both rotate regularly.
The measure to overcome dead positions is not shown.

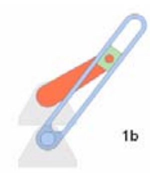
Kite mechanism 4
http://www.youtube.com/watch?v=BseymDwghxI
A development of kite mechanism by adding a coulisse mechanism.
When the red link makes one revolution, the blue makes two.
Both rotate regularly.
It is a constructive embodiment of Kite mechanism 3
The measure to overcome dead positions is not shown.
(Bar mechanism for speed reduction)



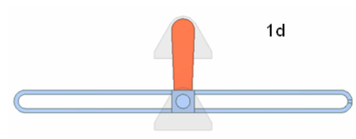
Kite mechanism 6
http://youtu.be/gY0oJDQ-uVU
It was proposed in 1877 by A. B. Kempe.
Length of blue bars: a
Length of yellow bars: a + a
Length of green bars: 4a
Distance between revolution joints of pink bars: 4a
Numbering:
0 for the fixed pink bar,
1 for the next pink bar, …
n for the last pink bar,
i = 1 to n
A1 is angle between bar 1 and bar 0
Ai is angle between bar i and bar 0
The mechanism maintains relation: Ai = i.A1
i.e.: A2 = 2.A1 ; An = n.A1
Theoretically it can be used for dividing an angle into n equal portions or for velocity multiplication of n times.



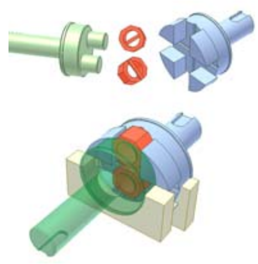
Coulisse mechanism 2
http://www.youtube.com/watch?v=E1wY_h4ZzhI
a > d: the coulisse revolves
a: crank length; d: axle distance



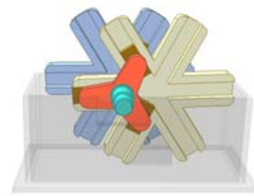
Coulisse mechanism 3
http://www.youtube.com/watch?v=p8bsOZu0BpE
a = d: the coulisse regularly revolves.
Its velocity is half of the crank one.
a: crank length; d: axle distance



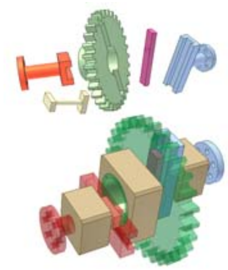
Coulisse Gearbox 2
http://www.youtube.com/watch?v=gKQ-ro9gRcg
An application of special coulisse mechanism when a = d.
a: crank length; d: axle distance. Transmission ratio: 1:2
See: http://www.youtube.com/watch?v=8YImZomIFWI
Compact due to the additional slots.



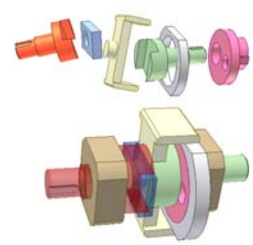
Coulisse Gearbox
http://www.youtube.com/watch?v=bQYQS2rt80k
An application of special coulisse mechanisms when a = d.
a: crank length; d: axle distance.
See: http://www.youtube.com/watch?v=8YImZomIFWI
Transmission ratio: 1:4



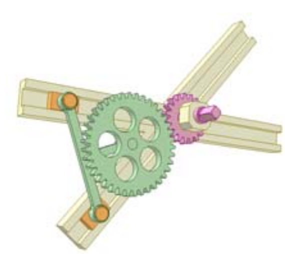
Altering speed with Oldham mechanism 1
http://www.youtube.com/watch?v=daLBKiA5Ing
If the green gear is driving, the two output shafts speed is half of the green gear one.
The remark in “Oldham mechanism 2”
http://www.youtube.com/watch?v=TBYJwi4BTsM
is used for this case.



Altering speed with Oldham mechanism 2
http://www.youtube.com/watch?v=3JrO7tWzYXQ
If the red shaft is driving, the green shaft speed is half of the red shalf one.
The remark in “Oldham mechanism 2”
http://www.youtube.com/watch?v=TBYJwi4BTsM
is used for this case.

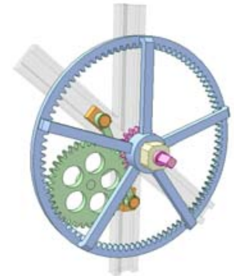


Ellipse mechanism 3a
http://youtu.be/TaraJQHhGNA
Ellipse mechanism with non 90 deg. angle between sliding directions.
The T-conrod and the large gear are fixed together. Position of the green gear center and and the center distance of gear drive must be selected based on the description in
http://www.youtube.com/watch?v=8WCee-fP9rg
Tooth number of the small gear: 19
Tooth number of the large gear: 38
5 rev. of the small gear corresponds 1 rev. of the green gear.
The strange thing is that the gear drive acts as a planetary gear one but without a carrier.
In case the center distance is small, an internal gear drive can be used instead.



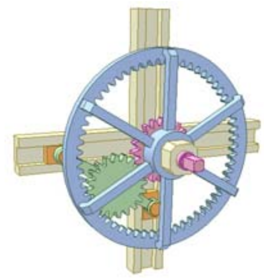
Ellipse mechanism 3b
http://youtu.be/VK0hndCKo8o

Ellipse mechanism with non 90 deg. angle between sliding directions.
The T-conrod and the large gear are fixed together. Position of the green gear center and and the center distance of the external gear drive must be selected based on the description in
http://www.youtube.com/watch?v=8WCee-fP9rg
Tooth number of the small external gear: 19
Tooth number of the large external gear: 38
Tooth number of the internal gear: 95
1 rev. of the internal gear corresponds 25 rev. of the pink gear, in same direction.
The strange thing is that the gear drive acts as a planetary gear one but without a carrier gear.



Ellipse mechanism 3c
http://youtu.be/HPJgUTGt6Ig

Ellipse mechanism with 90 deg. angle between sliding directions.
The conrod and the green gear are fixed together. Center of the green gear is in the middle of the conrod and the center distance of the external gear drive is a half of the conrod length.
Tooth number of the pink gear Z1 = 20
Tooth number of the green gear Z2 = 20
Tooth number of the internal gear: Z3 = 60
n3/n1 = (Z1.Z2)/(Z3.Z3)
n3: velocity of the internal gear
n1: velocity of the pink gear
1 rev. of the internal gear corresponds 9 rev. of the pink gear in same direction.
The strange thing is that the gear drive acts as a planetary gear one but without a carrier.



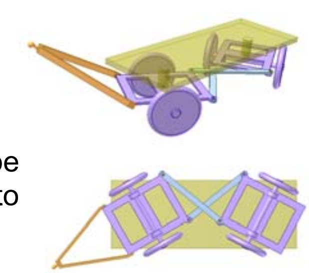
Fixed cam mechanism 1
http://youtu.be/FVQjX8p3UZ4

The orange cam is fixed. The pink input crank of constant velocity carries a green follower, one roller of which contacts with the cam. The other roller moves in a slot of the blue output shaft that has irregular speed. A red torsion spring forces the green follower towards the cam. This example shows that the disk cam does not always an input rotational link, it can be fixed.

Mechanism for steering a 4-wheel trailer with small turning radius
http://www.youtube.com/watch?v=Dp-7uB0U-ow

An application of 4-bar mechanism.
It can work only when the gaps in the revolution joints of the connection rods are big enough.

In case of small gaps one of the two connection rods must be removed. However the remainder is easy to be buckled due to longitudinal compression.



Angular transmission (90 degrees)
http://www.youtube.com/watch?v=2TgoJXbncf0
The simplest way to transmit rotation between perpendicular shafts.
Driving and driven shafts rotate regularly.

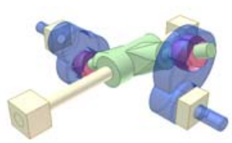
Angular transmission (90 degrees)
http://www.youtube.com/watch?v=NdzSqc8pxVg
The simplest way to transmit rotation between perpendicular shafts.
Driving and driven shafts rotate regularly.

Angular transmission (45 degrees)
http://www.youtube.com/watch?v=QEMpifDSqF0
The simplest way to transmit rotation between intersecting shafts.
Driving and driven shafts rotate regularly.

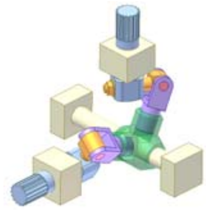
Angular transmission (135 degrees)
http://www.youtube.com/watch?v=8W6lziEuNzQ
The simplest way to transmit rotation between intersecting shafts.
Driving and driven shafts rotate regularly.

Transmission between intersecting shafts 1
http://www.youtube.com/watch?v=hzWU8A6hhTE
Both shafts rotate regularly.
Intersecting angle α = 90 degrees.
For other α value the angular arm must be amended accordingly.

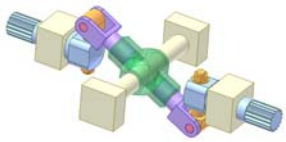
Transmission between coaxial shafts 1
http://www.youtube.com/watch?v=xjLXMhkRR8Q
Rotary directions are opposite.
Both shafts rotate regularly.



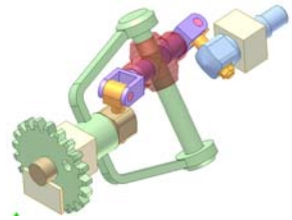
Transmission between intersecting shafts 2
http://www.youtube.com/watch?v=tp_-sN5VpA0
Both shafts rotate regularly.
Intersecting angle α = 90 degrees.
For other α value the angular arm must be amended accordingly.



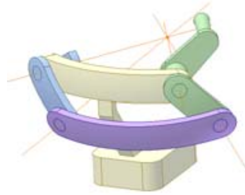
Transmission between coaxial shafts 2
http://www.youtube.com/watch?v=EWCK_IZLM_s
Rotary directions are opposite.
Both shafts rotate regularly.



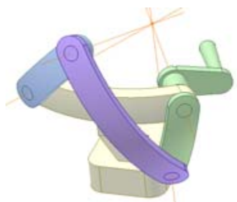
Bar mechanism for speed reduction
http://www.youtube.com/watch?v=XInp3zS6Qkg
When the blue shaft makes two revolutions, the green makes one.
Both rotate regularly.



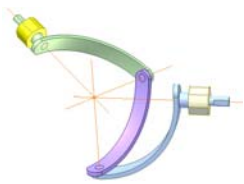
Spherical 4-bar linkage mechanism 2
http://www.youtube.com/watch?v=XQCVg_iXV7U
Axes of all revolution joints intersect at a common point.
Spherical parallelogram mechanism.
Measures to overcome dead points are needed.



Spherical 4-bar linkage mechanism 3
http://www.youtube.com/watch?v=q0erDDuPO7w
Axes of all revolution joints intersect at a common point.
Spherical anti parallelogram mechanism
Measures to overcome dead points are needed.



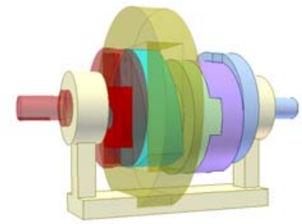
Spherical 4-bar linkage mechanism 7
http://www.youtube.com/watch?v=Y3QtVdXIKbc
Axes of all revolution joints intersect at a common point.
The simplest embodiment of a Cardan joint.



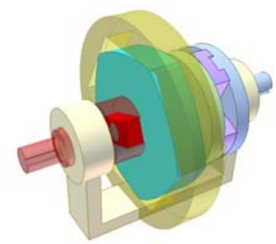
Spatial 4-bar linkage mechanism 1
http://www.youtube.com/watch?v=hXsG7eLSQbQ
Spatial "Parallelogram" Mechanism:
Transmission between two skew shafts.
Connection rod length = distance of two shafts.
The two shafts have the same eccentricity.
Angle between two shafts is arbitrary.

1.7. Cam drives

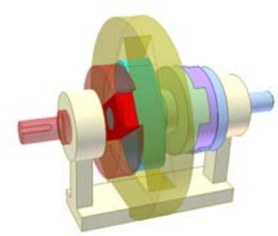
Altering speed with Reuleaux polygon 1
http://www.youtube.com/watch?v=8CuVNvTmbiI
The mechanism is built based on the fact that while the n-sided Reuleax polygon makes 1 rev in an ambient polygon, its center traces a loop n times. See:
http://www.youtube.com/watch?v=BnvT45CjD-E
Transformation ratio is 3 (= n, number of Reuleax polygon sides)
Velocity of the output shaft is very inconstant.
Theoretically, by increasing number of sides of a Reuleax polygon (7, 9, 11 …) it is possible to get large transformation ratio and make the velocity less inconstant.



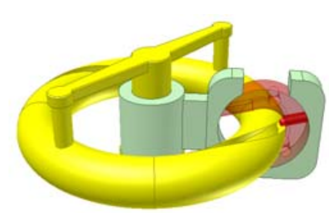
Altering speed with Reuleaux polygon 2
http://www.youtube.com/watch?v=aXOwSmVi94I
The mechanism is built based on the fact that while the n-sided Reuleax polygon makes 1 rev in an ambient polygon, its center traces a loop n times. See:
http://www.youtube.com/watch?v=oe8e-N3VusI
Transformation ratio is 5 (= n, number of Reuleax polygon sides)
Velocity of the output shaft is very inconstant.
Theoretically, by increasing number of sides of a Reuleax polygon (7, 9, 11 …) it is possible to get large transformation ratio and make the velocity less inconstant.



Altering speed with Reuleaux polygon 3
http://www.youtube.com/watch?v=gisagr0r5Ww
The mechanism is built based on the fact that while the n-sided Reuleax polygon makes 1 rev in an ambient polygon, its center traces a loop n times. See:
http://www.youtube.com/watch?v=gGNC3ltLJK4
It is a case of Reuleax polygon variation.
Transformation ratio is 2
Velocity of the output shaft is very inconstant.

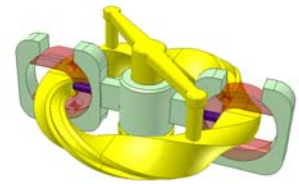


Torus transmission 1
http://youtu.be/blMbnSe44Ag
Helix torus joint.
Transmission of rotary motion between two 90 deg. skew shafts. Input is the yellow torus. Output is the red bush carrying a red pin that slide in a helix groove of the yellow torus. The helix groove has two rev. (n = 2) thus gives a transmission ratio of n = 2.



Torus transmission 2

http://youtu.be/bcrJcaKA4MA



Helix torus joint.

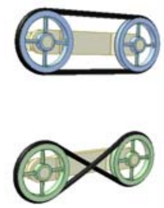
The green crank is input. The yellow torus cam is fixed. It has a helix groove of two rev.. The red bushes are output. They have blue pins sliding in cam groove.

1 rev. of the green crank corresponds 2 rev. of the red bushes.

This mechanism may be applied for park rotating equipments.

1.8. Belt drives

Belt drive 1
http://youtu.be/LVro9AMkPAU
Rotation transmission between two parallel shafts.
The reverse is possible for rope, flat belts, not for V-belt.



Belt drive 2
http://youtu.be/RpVSn_ZZCOI
Used with shafts at right angle rotating in one definite direction.
In order to prevent the belt from leaving the pulleys the latter should be sufficiently wide and fixed and secured finally only after a trial run.

Belt drive 3
http://youtu.be/m7ram9-X-2s
Used with shafts at right angle rotating in one definite direction.
In order to prevent the belt from leaving the pulleys the latter should be sufficiently wide and fixed and secured finally only after a trial run.

Belt drive 4a
http://youtu.be/tzg6DS9rNJc
Reversing rotation transmission between two coaxial shafts.
Rotation transmission between two skew shafts (skew angle is 90 deg.). Rotary directions of two coaxial shafts are opposite.
It uses rope belts only.

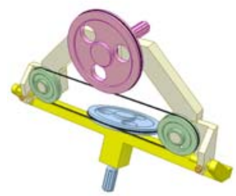
Belt drive 4b
http://youtu.be/LySVtyqfBBs
Rotation transmission between parallel shafts.
Rotation transmission between two skew shafts (skew angle is 90 deg.).
Rotary directions of two parallel shafts are opposite.
It uses rope belts only.

Belt drive 4c
http://youtu.be/ZXLJzeK2PSQ
Rotation transmission between two intersecting shafts.
Angle between the blue and yellow shafts may differ from 90 deg. It is similar to a bevel gear drive but rotay directions of the outputs are oposite.
It uses rope and flat belts, not V-belts.

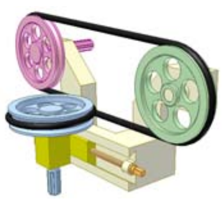
Belt drive 5a
http://youtu.be/dZllsgv0GyE
Rotation transmission between two intersecting or skew shafts with rope belt.
The belt wraps 1 rev. around the blue pulley.
Angle between the blue and pink shafts may differ from 90 deg.
Axle distance between the shafts can be adjusted in small range.

Belt drive 5b
http://youtu.be/YUOyXmsETi8
Rotation transmission between two skew shafts with rope belt.
By moving the yellow bar it is possible to adjust angle between the shafts (from 0 to 360 deg.) and their axle distance.
The belt wraps 1 rev. around the blue pulley.
Two belt branches connecting to the pink pulley can be crossed to increase arc of contact or to reverse output direction.
To some extent it is a constant velocity joint.

Belt drive 5c
http://youtu.be/eWL-9nD16Gk
Rotation transmission between two skew shafts with rope belt.
By moving the yellow bar it is possible to adjust angle between the shafts (from 0 to 360 deg.) and their axle distance.
The belt wraps 1 rev. around the blue pulley and the pink pulley.
To some extent it is a constant velocity joint.

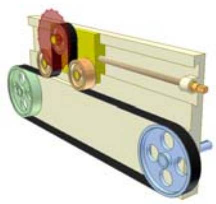


Belt drive 6
http://youtu.be/Idc3LDbRby8
Rotation transmission between two skew shafts with rope belt.
Angle between the blue and pink shafts is 90 deg. The belt wraps 1 rev. around the blue pulley.
The blue shaft can translate during rotation.

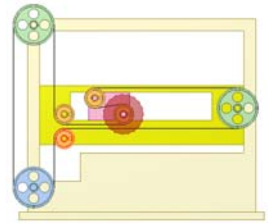


Belt drive 7
http://youtu.be/CTw53zSy4Wk
Rotation transmission between parallel shafts, one can move.
The key factor is: 3 belt branches connecting to the grey and blue pulleys must be parallel.
It uses rope and flat belts, not V-belts.

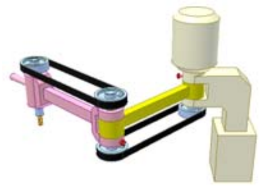
Belt drive 8
http://youtu.be/CnG6PuEGD-s
Rotation transmission between parallel shafts, one can move.
The key factor is: 4 belt branches connecting to the green and blue pulleys must be parallel.
It uses rope and flat belts, not V-belts.



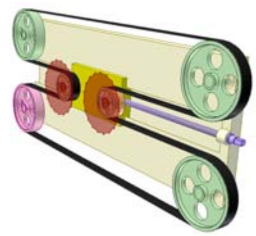
Belt drive 9
http://youtu.be/LZIZaLQipY0
Rotation transmission between parallel shafts, one can move in both vertical and horizotal directions.
Devices for moving vertical and horizotal sliders are not shown.
The key factor is: all belt branches must be vertical or horizontal (except the one connecting two small pulleys on the pink horizontal slider).
It uses rope and flat belts, not V-belts.



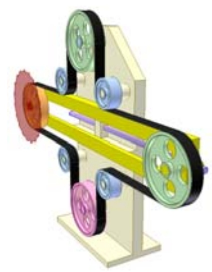
Belt drive 10
http://youtu.be/9XH9Htx9qTk
Rotation transmission between parallel shafts, one can move.
The tool can reach any point in an annulus, radii of which are (R1 + R2) and (R1 – R2).
R1, R2: lengths of yellow and pink bars respectively.
R1 is larger than R2.



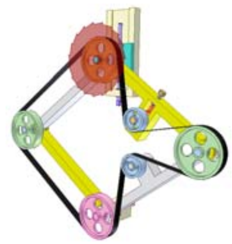
Belt drive 11
http://youtu.be/eBJ5gQ9LLZs
Rotation transmission between parallel shafts, one can move.
The key factor is: belt straight branches must be parallel.
It uses rope and flat belts, not V-belts.



Belt drive 12
http://youtu.be/AlLsfkpbmYQ
Rotation transmission between parallel shafts, one can move.
The key factor is: all belt straight branches must be vertical or horizontal.
It uses rope and flat belts, not V-belts.

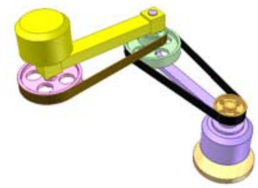


Belt drive 13
http://youtu.be/rOYx6JzlRSc
Rotation transmission between parallel shafts, one can move.
Input is the pink pulley.
Large pulleys are mounted at four vertices of a rhombus created by a four bar linkage. Small blue pulleys are for increasing arcs of contact.
It uses rope and flat belts, not V-belts.
In case no the runway, the mechanism can act as the mechanism of video "Belt drive 10"



Belt drive 14

http://youtu.be/3MCsaYiCbP4



Rotation transmission between parallel shafts, one can move.
Input is the yellow motor (Vy velocity) and the violet motor (Vv velocity). The violet crank carrying a tool (for example a polishing wheel) rotates with velocity Vc.
Alter Vy for a desired Vc.
This case:
The diameter of large pulleys is double the one of small pulleys,
Vy = 60 rev./min. Vv = 252 rev./min.
Vc = 10 rev./min.

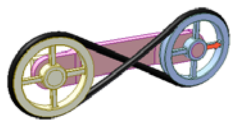
Belt planetary drive 2

http://youtu.be/8o6g-12cBEM

Two pulleys have the same diameter.
The green pulley orientation (red arrow) does not change during motion.

Belt planetary drive 1

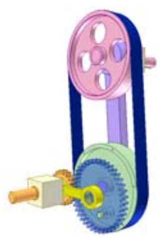
http://youtu.be/7Pq5YkXKIRw



Two puleys have the same diameter.
The blue pulley rotates twice faster than the pink crank..
It uses rope and flat belts, not V-belts.

Belt and gear drive 1

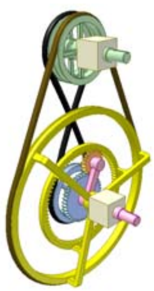
http://youtu.be/UZ8XRrBLAxs



Input is the pink pulley shaft rotating regularly.
Output is the orange gear shaft rotating irregularly.
The violet and yellow cranks, the block of green pulley and blue gear with a certain eccentricity create a 4-bar linkage.

Belt and gear drive 2

http://youtu.be/5uwvUzCRLtM



Input is the green shaft of two green pulleys (Dg dia.) rotating regularly with Vg velocity.
Output is the pink crank of Vp velocity.
The blue block of a blue small pulley (Db dia.) and a gear of Zb teeth idly rotates on the pink crank.
The yellow block of a yellow large pulley (Dy dia.) and a gear of Zy teeth idly rotates on the pink crank.
The orange gear of Zo teeth idly rotates on a pin of the pink crank.
Vp = Vg (Dg/(Dy.Db)).((Db.Zy – Dy.Zb)/(Zy + Zb))
This case:
Dy = 3.Dg + 3.Db
Zo = 20; Zb = 40; Zy = 80
Vp = 9.Vg
Vp can be very small by choosing appropriate pulley diameters anf gear tooth numbers in order to decrease value of ((Db.Zy – Dy.Zb).

Belt tensioner 1

http://youtu.be/-2bxol03MO8

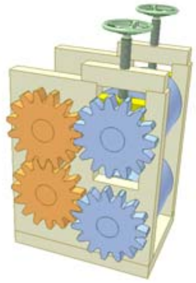
Input: the pink pulley.

The tensioner must not be placed on the tight side of the belt.

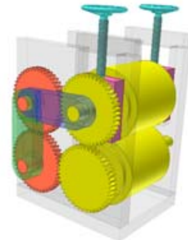
It uses rope and flat belts, not V-belts.

1.9. Transmission to two parallel shafts with adjustable axle distance

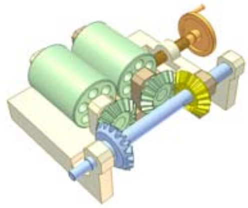
Transmission between two parallel shafts with adjustable axle distance 1
http://youtu.be/odUVzfuy9Qc
Added two orange idle gears extend adjustment range of axle distance in comparision with mechanism of two shafts having two gears directly meshing.



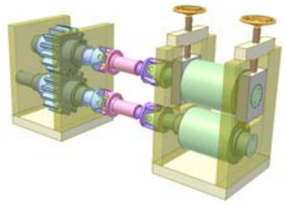
Transmission between two parallel shafts with adjustable axle distance 2
http://www.youtube.com/watch?v=37bJ8MsH4VA
Transmission between two parallel shafts with axle distance regulation. Added two orange gears and two bars maintain proper gear engagement.



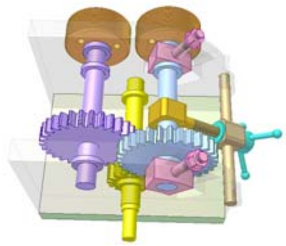
Transmission between two parallel shafts with adjustable axle distance 3
http://youtu.be/dMdbhUycRn0
The yellow sliding gear allows to adjust axial distance between the rollers.



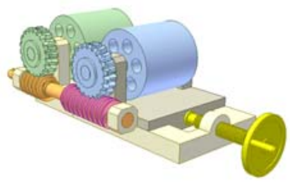
Transmission between two parallel shafts with adjustable axle distance 4
http://youtu.be/LLndwZXh50s
Cardan drives allow to adjust axial distance between the rollers.



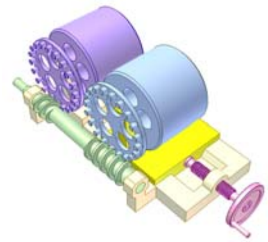
Transmission between two parallel shafts with adjustable axle distance 5
http://youtu.be/_Iay6sqmheU
When turning the cyan nut, the blue gear rolls on the yellow driving gear for adjusting axle distance. Two orange rollers have the same rotation direction. The mechanism finds application in tangential thread rolling.



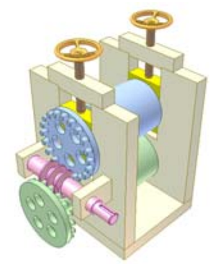
Worm Drive 3: Rolling worm wheel
http://youtu.be/vO0BYM-IZrg
The worm wheel rolls on the worm to adjust axle distance of two rolling cylinders.



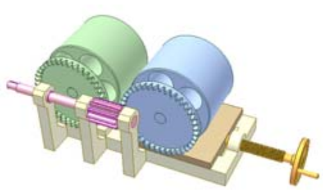
Transmission between two parallel shafts with adjustable axle distance 6
http://youtu.be/EGZBvA8ueuk
Pin gear and worm drives allow to adjust axial distance between the rollers.
The rollers rotate in opposite directions if worms are of opposite hand and vice versa.



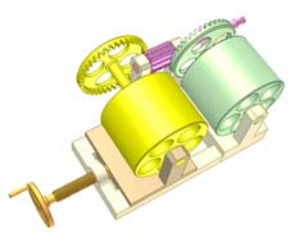
Transmission between two parallel shafts with adjustable axle distance 7
http://youtu.be/VOIqqDi7Ux0
Pin gear and worm drives allow to adjust axial distance between the rollers.
The rollers rotate in opposite directions.



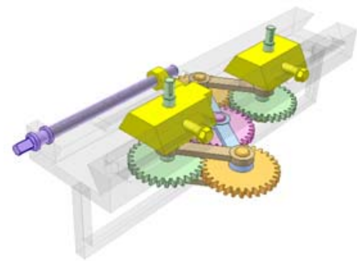
Face gear 4
http://youtu.be/hl6y-uoirio
Face gear drive allows to adjust axial distance between the rollers.
The rollers rotate in opposite directions. Their speeds can be different if tooth numbers of the two face gears are diferent.



Face gear 5
http://youtu.be/FoFoFWgVXuE
Face gear drive allows to adjust axial distance between the rollers.
The rollers rotate in the same direction. Their speeds can be different if tooth numbers of the two face gears are diferent.

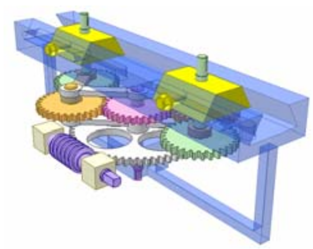


Gear and twin slider-crank mechanism 1
http://youtu.be/Tm6MwViCO04



Blue, brown bars and yellow sliders create a twin slider-crank mechanism.
Input is pink gear.
Two green output shafts rotate in the same direction.
The two yellow sliders can be moved towards the mechanism center synchronously by violet screw for adjusting the center distance of the two output shafts.
Yellow nuts are for fixing the sliders after adjusting.

Gear and twin slider-crank mechanism 2
http://youtu.be/rQaUncfdGgc



Grey, brown bars and yellow sliders create a twin slider-crank mechanism.
The grey bar and grey worm wheel are fixed together.
Input is pink gear.
Two green output shafts rotate in the same direction.
The two yellow sliders can be moved towards the mechanism center synchronously by violet worm for adjusting the center distance of the two output shafts.
Yellow nuts are for fixing the sliders after adjusting.

1.10. Transmission to two coaxial shafts

Drive for coaxial propellers 1
http://www.youtube.com/watch?v=4mWe9EnW9hE

Drive for coaxial propellers 2
http://www.youtube.com/watch?v=tS_1ut4Bp0w

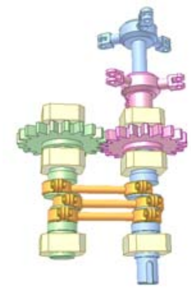
Drive for coaxial propellers 3
http://www.youtube.com/watch?v=QN500KQb0kw

Drive for coaxial propellers 4
http://www.youtube.com/watch?v=aC6qG0RHfO0

Drive for coaxial propellers 5
http://www.youtube.com/watch?v=b-qCk11Nfic
An internal gear without bearing is used.

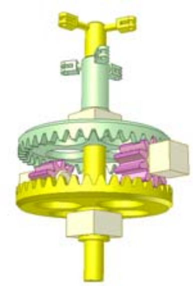
Drive for coaxial propellers 6
http://www.youtube.com/watch?v=eRH6-evj9VI
A special screw mechanism is applied.
For more see:
http://www.youtube.com/watch?v=QfiJSTRDASs
http://www.meslab.org/mes/threads/27853-bo-truyen-2-truc-vit-la

Drive for coaxial propellers 7
http://www.youtube.com/watch?v=_EBVoOqWhAg
Parallelogram mechanisms are used.

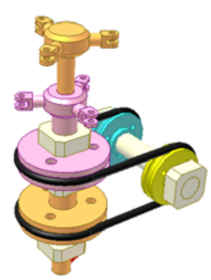


Drive for coaxial propellers 8
http://www.youtube.com/watch?v=c8ezdJ8Rdmc

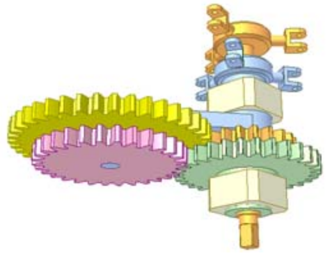
Face gear 6 - Drive for coaxial propellers 12
http://youtu.be/xda1WgL9fd0
Drive for coaxial propellers
The yellow shaft is input.
Face gears help forgive error in manufacturing and alignment, thermal and vibration changes for the meshing parts.



Drive for coaxial propellers 9
http://youtu.be/t5u-_HslCxg



Drive for coaxial propellers 10

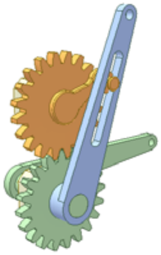


http://youtu.be/kRksNKMhkwc
The green gear of 30 teeth is fixed.
The pink gear of 30 teeth and the yellow gear of 40 teeth are fixed together and rotate on the blue crank.
The orange gear has 20 teeth.

Drive for coaxial propellers 11

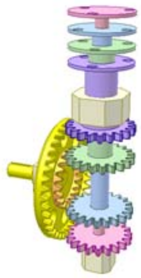
http://youtu.be/0ud5o1eIFM4
The green internal gear of 100 teeth is fixed.
The blue crank carries two pink gears of 20 teeth each.
The orange gear has 50 teeth.

Two coaxial cranks



http://youtu.be/E1c5ZbH2aUA
The orange gear and orange crank are fixed together.
Input is the green gear crank.
Output is the blue crank.
The two coaxial cranks synchronously oscillate in opposite directions with different angles and speeds.

Drive for coaxial propellers 13a



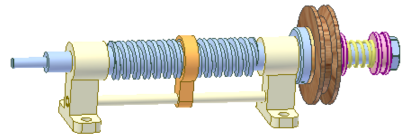
http://youtu.be/6Ak9MHpE4C0
Four coaxial propellers.
Input: yellow and orange gears that are fixed together.
Blue and green gears rotate with the same speed (A) but in opposite directions.
Pink and violet gears rotate with a double of A speed in opposite directions.
The video was made on request of an YouTube user, Mr. Vamilson Prudencio da Silva Jr from Brasil.

Drive for coaxial propellers 13b

http://youtu.be/XNBzl9GYwCc
Four coaxial propellers.
Input: yellow and orange gears that are fixed together.
Pink and violet gears rotate with the same speed (A) but in opposite directions.
Blue and green gears rotate with a double of A speed in opposite directions.
The video was made on request of an YouTube user, Mr. Vamilson Prudencio da Silva Jr from Brasil.

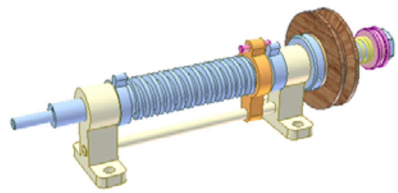
1.11. Rotation limitation

Shaft rotation limiter 1
http://youtu.be/BBYfNYadt0w
The brown driving pulley transmits rotation to the blue shaft through a friction clutch. Number of turns the shaft can rotate:14.



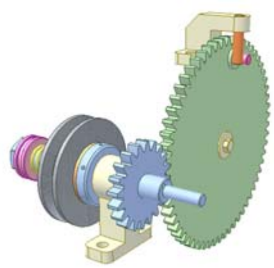
A traveling nut (orange) moves along the threaded shaft until the frame prevents further rotation. This is a simple device, but the traveling nut can jam so tightly that a large torque is required to move the shaft from its stopped position. For a way to avoid it see Shaft rotation limiter 2:
http://youtu.be/bZXCfSEa-OU

Shaft rotation limiter 2
http://youtu.be/bZXCfSEa-OU
The brown driving pulley transmits rotation to the blue shaft through a friction clutch.
Number of turns the shaft can rotate: around 12.
The fault said in Shaft rotation limiter 1:
http://youtu.be/BBYfNYadt0w



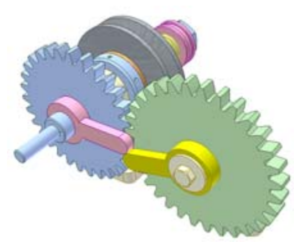
is overcome at the expense of increased device length by providing a stop pin in the orange traveling nut.
The engagement between the pin and the rotating finger must be shorter than the thead pitch so the pin can clear the finger on the first reverse turn. Using rubber ring and oil-impregnanted metal grommet for the sliding joint of the traveling nut and the lower rod helps lessen the impact

Shaft rotation limiter 3
http://youtu.be/MVkAum9f_qI



The driving grey pulley transmits rotation to the blue shaft through a friction clutch. The shaft can rotates only around 3 turns because the immobile orange pin allows the green gear (60 teeth) to rotate less than 1 turn. The tooth number of the blue gear is 20. So for the large turn number, the large trasmission ratio of the gear drive is needed.

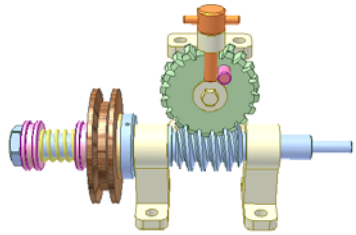
Shaft rotation limiter 4
http://youtu.be/go3LyVKVZoA



The driving grey pulley transmits rotation to the blue shaft through a friction clutch.
Tooth number of the blue gear Z1 = 30.
Tooth number of the green gear Z2 = 32.
The shaft can rotates around 15 turns (= Z1/(Z2-Z1)) until the moving stoppers (pink and yellow) collide each other.
There is no need of large trasmission ratio of gear drive as said in video Shaft rotation limiter 3:
http://youtu.be/MVkAum9f_qI

Shaft rotation limiter 5

http://youtu.be/c1XIah1sOEI



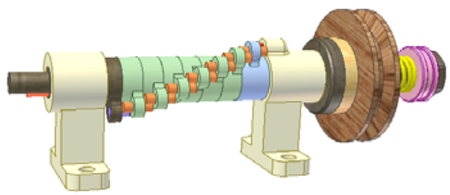
The brown driving pulley transmits rotation to the blue shaft through a friction clutch. A worm drive is used to get large trasmission ratio thus the working shaft can get large turn number (17 for this case).

The green worm wheel has 20 teeth and the number of the blue worm starts is 1.

To avoid reverse rotation for the new working cycle, at the end of the working process raise the orange stopper and rotate the green worm wheel to the starting position.

Shaft rotation limiter 6

http://youtu.be/3airCg2Xd-4



Pinned disks limit shaft turns to (N+1).α/360, where

N is the number of idle disks,

α is angle depending on pin diameter and distance between pin center and shaft center.

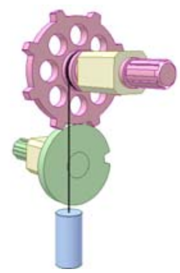
For this limiter: 7 idle disks allow shaft to rotate 7.1 turns.

There is a friction clutch between the driving pulley and the shaft.

The mechanism can be used for winding springs. The red wire on the left shows how to clamp the wire end for winding springs

Mechanism for rotary limitation

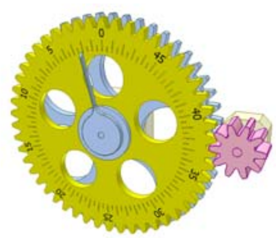
http://youtu.be/BLmpNDZX6Ts



The output pink shaft is always under a moment caused by the blue weight. The green disk plays role of regulation. In its one revolution the output can turn 1/8 rev. only.

Revolution counter 1

http://youtu.be/GNRqJLHD33A



Yellow gear (tooth number Zy = 50) idly rotates on blue gear (tooth number Zb = 51). Both are in mesh with pink gear (tooth number Zp = 10).

1 rev. of blue gear corresponds (Zb/Zy) rev. of yellow gear.

In 1 rev. of blue gear, yellow gear rotates faster than blue gear an amount:

((Zb/Zy) – 1) = (Zb – Zy)/Zy = (51-50)/50 = 1/50 rev.

The video shows two rev. of blue gear.

The hand and the dial on yellow gear show revolutions of blue gear.

Disavantage: reading difficulty due to the dial rotation.

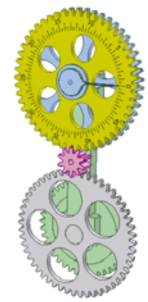
This mechanism shows that for a given center distance, a gear can meshes with two coaxial gears of different tooth numbers.

Backlash in mesh of yellow gear and pink pinion doesn't much affect the counting result.

To eliminate the backlash, teeth of the yellow gear can be made thicker (corrected gears).

Revolution counter 2

http://youtu.be/gxvHH1pdISY



This is a satellite drive developed from mechanism shown in “Revolution counter 1”. Input is green crank (carrier of this satellite drive).

Yellow gear (tooth number Zy = 50) idly rotates on blue gear (tooth number Zb = 51). Both are in mesh with pink gear (tooth number Zp = 10). Pink gear is also in mesh with a fixed grey gear (tooth number Zg = 51).

Because Zb = Zg, the direction of the blue gear and the hand fixed to it is kept unchanged during rotation.

Because Zy is not equal to Zb there is a relative rotation between the yellow and blue gears.

The video shows two rev. of the green crank.

The hand and the dial on yellow gear show revolutions of the green crank.

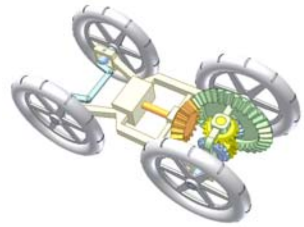
Backlash in mesh of yellow gear and pink pinion doesn’t much affect the counting result.

In the past a similar mechanism was called “Ferguson’s mechanical paradox” because of strange behaviour of the two satellite gears.

1.12. Car differentials

Car Differential with Bevel Gears 1

http://www.youtube.com/watch?v=YjhzkV5Ya2k

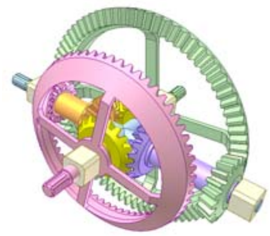


There are two mechanisms:

1. Changing direction: 4-bar linkage with two equal cranks enables axles of four wheels to intersect at a common point, avoiding wheel lateral slipping.
2. Differential: it allows driving rear wheels to rotate at different speeds mainly when cornering.

Car differential with bevel gears 2

http://youtu.be/yDcOhhbbc-U



Input is the blue cross shaft of n1 constant velocity. Output are the pink and green shafts of n2 and n3 velocities. The yellow, orange and violet gears have the same tooth number. The orange gear and the pink pinion are fixed together and idly rotate on the blue shaft. The violet gear and the green pinion are fixed together and idly rotate on the blue shaft.

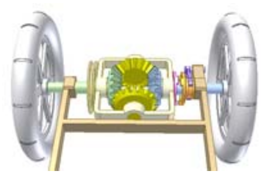
The pink and green bevel gear drives have the same transmission ratio.

The video shows when the pink shaft slows down, the green one speeds up and vice versa to maintain the equation n1 = (n2 + n3)/2.

The satellite gears turn around their own axles only when n2 differs from n3.

Car differential with locker

http://youtu.be/xTYGVGU_g88



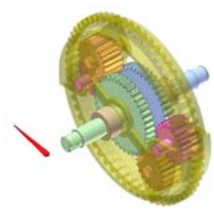
The popcorn case and pulley receive rotation from car engine.

The right wheel losses traction, slips. Due to the disavantage of a standard (open) drive, the moment delived to the left wheel reduces to null so it does not rotate.

To overcome this situation the driver closes the clutch (on the right) to deliver moment to both wheels and thus they rotate with the same velocity.

Car Differential with Spur Gears

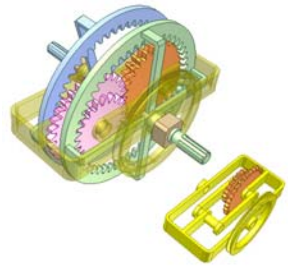
http://www.youtube.com/watch?v=tOSQK5ZZzhg



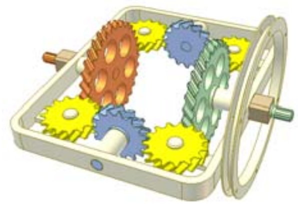
The red hand shows car moving direction.

When car turns left, the left disk slows down, the right one speeds up and vice versa.

Car differential with internal gears
http://youtu.be/PbXnxGb96go
Input is the case with pulley of n1 constant velocity. Output are the blue and green identical internal gear shafts of n2 and n3 velocities. The pink and orange gear blocks are identical.
The video shows when the blue shaft slows down, the green one speeds up and vice versa to maintain the equation n1 = (n2 + n3)/2.
The satellite gears turn around their own axles only when n2 or n3 differs from n1.

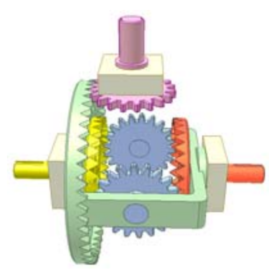


Car differential with helical gears 1
http://youtu.be/dux_RKg4-Xo
Input is the case with pulley of n1 constant velocity. Output are the orange and green identical gear shafts of n2 and n3 velocities. The yellow and blue satellite gears have the same tooth number.
The video shows when the orange shaft slows down, the green one speeds up and vice versa to maintain the equation n1 = (n2 + n3)/2.
The satellite gears turn around their own axles only when n2 or n3 differs from n1.

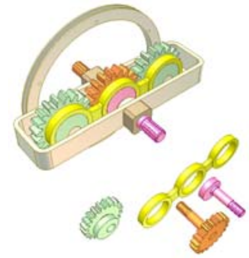


Car differential with helical gears 2
http://youtu.be/S4A0s3WXJCs
Input is the case with pulley of n1 constant velocity. Output are the orange and blue identical gear shafts of n2 and n3 velocities. The green and pink satellite gears have the same tooth number.
The video shows when the orange shaft slows down, the blue one speeds up and vice versa to maintain the equation n1 = (n2 + n3)/2.
The satellite gears turn around their own axles only when n2 or n3 differs from n1.

Face gear 9
http://youtu.be/7HM1O_-p4R4
Car differential with face gears.
The green gear (receiving torque from engine) rotates with constant speed Ng. If the speed N1 of the red gear of Z1 teeth varies (even reverses), the speed N2 of the yellow gear of Z2 teeth (Z2 = Z1) varies accordingly to maintain the equation:
2.Ng = N1 + N2
Advantages over bevel gear differential:
- No need for the exact axial positioning of the pinions.
- Tolerable contact pattern changing.

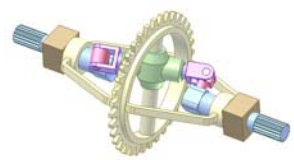


Car differential with gear and parallelogram mechanism
http://youtu.be/-NyBR2mlPDQ
Input is the case with pulley of n1 constant velocity. Output are the pink and orange shafts of n2 and n3 velocities. The gears have the same tooth number.
The video shows when the pink shaft slows down, the orange one speeds up and vice versa to maintain the equation n1 = (n2 + n3)/2.
The parallelogram acts only when n2 or n3 differs from n1.

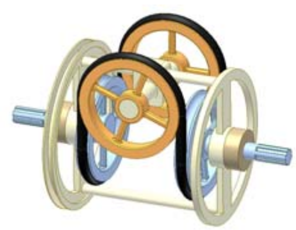


Car Differential with Bars 1
http://www.youtube.com/watch?v=BW_jGuIkOZw
The red hand shows car moving direction.
When car turns left, the left crank slows down, the right one speeds up and vice versa.

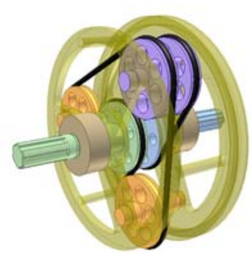
Car Differential with Bars 2
http://www.youtube.com/watch?v=J-vX0XtTQOI
The red hand shows car moving direction.
When car turns left, the left crank slows down, the right one speeds up and vice versa.



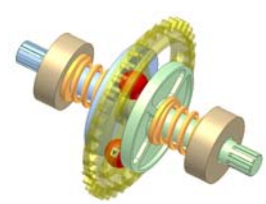
Car Differential with Belt 1
http://www.youtube.com/watch?v=-dtBWDVshYY
The red hand shows car moving direction.
When car turns left, the left blue wheel slows down, the right one speeds up and vice versa.



Car Differential with Belt 2 (or Chains)
http://www.youtube.com/watch?v=91QMBe-0i3g
It can become a car differential with chains by using chain transmissions in stead of the belt ones.
The red hand shows car moving direction.
When car turns left, the left blue wheel slows down, the right one speeds up and vice versa.

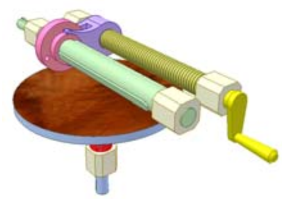


Car Differential with Balls
http://www.youtube.com/watch?v=IkpTGkMxgLc
The red hand shows car moving direction.
When car turns left, the left disk slows down, the right one speeds up and vice versa

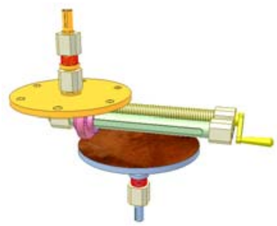


1.13. Variators (continuously variable transmission)

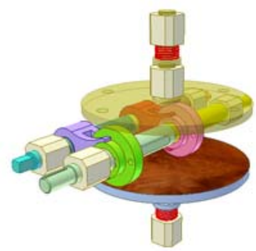
Friction disk variator 1
http://youtu.be/V1Y7ayNun-4
Input: the green shaft on which the roller can slide.
Turn the yellow screw for changing velocity or rotary direction of the blue output shaft carrying a friction disk.
Velocity of the output shaft depends on contact position of the roller with the disk.
The friction force at contact place is created by the red spring.
Input and output shafts are perpendicular to each other.



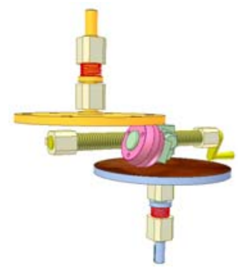
Friction disk variator 2
http://youtu.be/JlULYqF2hkA
Input: the orange shaft carrying a friction disk.
Turn the yellow screw to move the pink roller for changing velocity of the blue output shaft carrying a friction disk.
Velocity of the output shaft depends on contact position of the roller with the disks.
The two disks are forced toward the roller by red springs.
Input and output shafts are parallel.



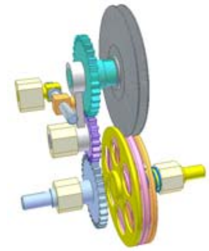
Friction disk variator 3
http://youtu.be/Zi-eMKKpOas
Input: the green shaft carrying a green friction roller.
Output: the yellow shaft carrying a pink friction roller.
Each roller can move along its shaft independently by turning its corresponding screw.
Velocity of the output shaft depends on contact positions of the rollers with the disks.
The friction forces at contact places are created by red springs.
Using two friction disks doubles transmitted torque.
Input and output shafts are coaxial.



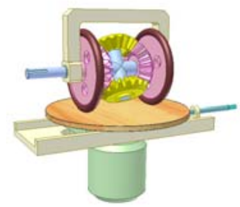
Friction disk variator 4
http://youtu.be/lorlO9hJ960
Input: the orange shaft carrying a friction disk.
Turn the yellow screw to move the pink double cone roller for changing velocity of the blue output shaft carrying a friction disk.
The two disks are forced toward the roller by red springs.
Input and output shafts are parallel.



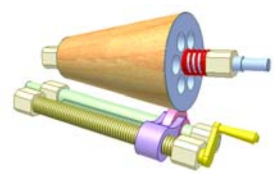
Friction disk variator 5
http://youtu.be/_D0GFcfO_VY
Input: the blue gear-shaft. Output: the yellow shaft.
The white crank, carrying cyan gear-shaft, can oscillate around a fixed axle. Two grey disks have sliding key joints with the cyan gear-shaft. The pink and orange disks have sliding key joints with the yellow shaft. The blue spring forces four mentioned disks towards the yellow disk.
Turn the blue screw to change contact place between the disks (near or far from the center of the grey disks), hence the output velocity.
Transmitted power can be increased by using more pink and grey disks.



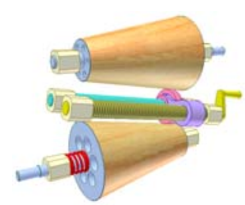
Friction disk variator 6
http://youtu.be/HJutD78Av4A
Input: the orange disc receiving rotation from the green motor.
Output: the blue shaft.
Turn the cyan screw to move the disc for desired output velocity n.
n = (n1 + n2)/2
n1, n2 are velocities of the pink rollers.
n can be 0 or minus (reversing).
Using the bevel gear differential enables accurate adjustment of output velocity.



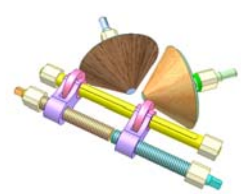
Friction cone variator 1
http://youtu.be/nCav0rm53uc
Input: the green shaft carrying a friction roller.
Output: the blue shaft carrying a friction cone.
The roller can move along its shaft by turning the yellow screw.
Velocity of the output shaft depends on contact position of the roller with the cone.
The friction force at contact places is created by the red springs.
Input and output shafts are intersecting.



Friction cone variator 2
http://youtu.be/GFEXGw7uXr8
Input: the lower shaft carrying a friction cone.
Output: the upper shaft carrying a friction cone.
The pink roller can move along its shaft by turning the yellow screw.
Velocity of the output shaft depends on contact position of the roller with the cones.
The friction forces at contact places are created by the red springs.
Input and output shafts are parallel.

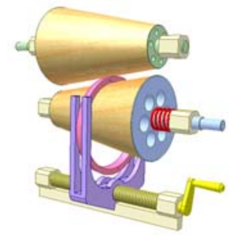


Friction cone variator 3
http://youtu.be/ZUGgT3NiYpI
Input: the green shaft carrying a friction cone.
Output: the blue shaft carrying a friction cone.
Each roller can move along the yellow shaft independently by turning its corresponding screw.
Velocity of the output shaft depends on contact positions of the rollers with the cones.
The friction forces at contact places are created by the green springs.
Input and output shafts are perpendicular to each other.



Friction cone variator 4

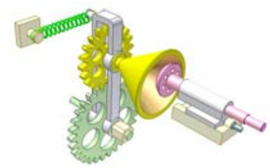
http://youtu.be/BlgAHk_MDBs



Input: the blue shaft carrying a friction cone.
Output: the green shaft carrying a friction cone.
The pink ring in contact with both cones can axially move by turning the yellow screw.
Velocity of the output shaft depends on contact positions of the ring with the cones.
The friction forces at contact places are created by the red springs.

Friction cone variator 5

http://youtu.be/u4IyOtNP9TE



Input: the pink shaft carrying a friction external cone.
Output: the green shaft carrying a spur gear. The yellow shaft with a gear and an internal cone can rotate on bearing of the white crank. The white crank can rotate around fixed bearing houses. The green spring creates pressure at contact place between the cones.
Turn the blue screw for changing velocity of the output shaft.
Input and output shafts are parallel.

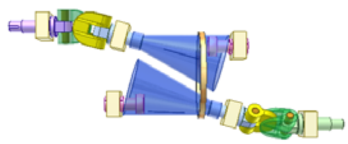
Friction cone variator 6

http://youtu.be/5yftEf5vpeg

Input: the green shaft carrying a disk.
Output: the pink shaft carrying a disk.
The blue pivoting lever has an axle which has cylindrical joints with two red bushes. Two yellow cone disks have spherical joints with the two red bushes. The two yellow disks can contact with the input and output disks.
Select angular position of the blue lever for desired output velocity.

Friction cone variator 7

http://youtu.be/cFTMUfRsHUc



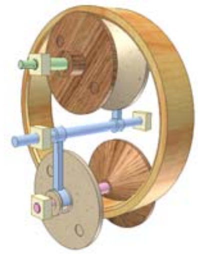
Input: the green shaft.
Output: the violet shaft.
Constant velocity joints connects the input shaft or the output shaft and the long hollow cones. Using this joint kind allows the input and output shaft to be parallel.
Move the orange flexible ring for desired output velocity. The moving mechanism is not shown.
The pink rollers are for supporting the cones additionally.

Friction cone variator 8

http://youtu.be/_v2aeJgbz9M

Input: the green shaft.
Output: the violet shaft on which an orange roller can slide.
A constant velocity joint connects the input shaft and the long hollow cone. Using this joint kind allows the input and output shaft to be parallel.
Move the orange roller for desired output velocity.
The pink roller is for supporting the cone additionally.
Devices for moving the roller and creating contact pressure are not shown.

Friction cone variator 9
http://youtu.be/LYGU8rMNApQ



Input: the green shaft of one fixed cone and one sliding cone.
Output: the pink shaft of one fixed cone and one sliding cone.
Thre orange ring contacts with all cones.
The blue bar can move the sliding cones to change contact positions of the ring for desired output velocity.
The pressure at contact places is created by choosing right value of the ring inside diameter.
Two cones on each shaft can be assembled back to back (instead of face to face) with appropriate section of the ring in embodiments of this variator.

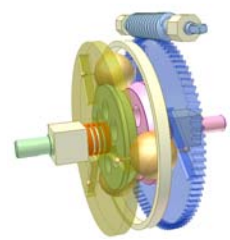
Friction cone variator 10
http://youtu.be/YP_QUjL9-J0

Input: the grey cone.
Output: the brown cone in which an yellow control bar can slide (not rotate). Two long rollers contact with both cones due to revolution joints between roller bearings and the control bar.
Move the control bar for desired output velocity.

Friction ball variator 1
http://youtu.be/VhTWbcQPMY4

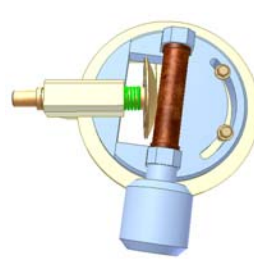
Input: the orange cylinder.
Output: the green disk that does not contact with the cylinder.
Velocity of the output shaft depends on contact position of the ball with the disk. Move the yellow slider for various velocities..
The friction force at contact places is created by the ball weight.

Friction ball variator 2
http://youtu.be/cXD2nyWu-aM



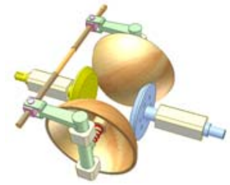
Input: the green cone.
Output: the pink cone.
Three orange balls contact with both cones.
Each ball has its shaft that slides in radial slots of the yellow fixed disc and in oblique slots of the blue disc.
Turn the blue disc through a worm wheel drive to change angular position of the ball axis, hence distances from contact points (with the input and output cone) to the ball axis, for desired output velocity.
The yellow fixed ring is for positioning the balls.
The pressure at contact places is created by red springs.

Friction sphere variator 1
http://youtu.be/UKxzoa0AfhI



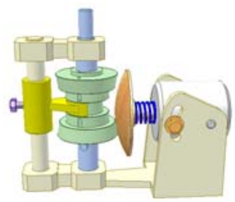
Input: the brown cylinder.
Output: the orange disk of spherical cap.
Velocity of the output depends on contact position.
Angular adjustment of the blue disk gives various velocities and rotary direction change of the output.
The friction force at contact places is created by the green spring.

Friction sphere variator 2
http://youtu.be/0s7YRBUoCR8



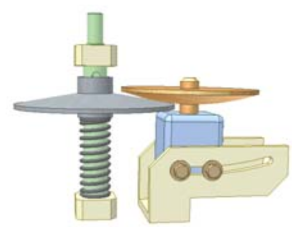
Input: the blue shaft with a cone disk.
Output: the yellow shaft with a cone disk.
The orange spherical caps idly rotate on their axles and are forced toward the cone disks by red springs.
The green shafts carrying the caps axles can rotate in fixed bearings.
The orange screw has two thread portions of opposite hands.
Turn the screw to change contact position between the disks and the spherical caps for various output velocities.
Using two caps instead of one reduces shaft bending forces.

Friction sphere variator 3
http://youtu.be/WMhGk7HMU4c



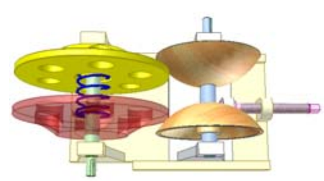
Input: the orange disk of spherical cap mounted on a motor shaft.
The green double cone has sliding key joint with the blue output shaft.
The disk can contact with the double cone under spring pressure.
Move the yellow slider with the double cone to one of their two positions for desired rotary direction.
Turn the white motor to get desired output velocity. The center of the orange spherical cap is laid on the axis of this rotary motion.

Friction sphere variator 4
http://youtu.be/jgg0WMAW_XA



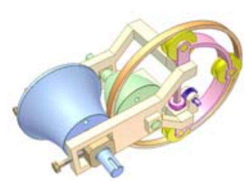
Input: the orange disk of spherical cap mounted on a motor shaft.
The grey disk has sliding key joint with the blue output shaft.
A spring creates contact pressure between the disks.
Turn the blue motor to get desired output velocity. The center of the orange spherical cap is laid on the axis of this rotary motion.

Friction sphere variator 5
http://youtu.be/l-TQdWADIZg



Input: the blue shaft having two orange disks of spherical cap.
The yellow and red disks have sliding key joints with the green output shaft.
A spring creates contact pressure between the disks.
Turn the pink screw for moving the input shaft to get desired output velocity.

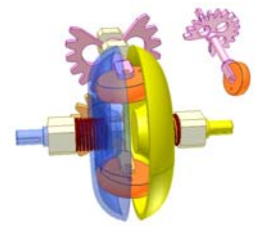
Friction globoid variator 1
http://youtu.be/pc0RThp_lw0



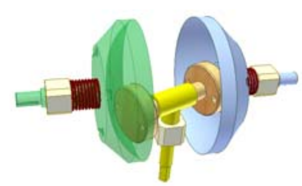
Input: the blue shaft.
Output: the green shaft.
The orange ring (a spherical segment) is supported by three rollers and contacts with the two shafts. The contact pressure is created by the brown screws.
Turn the pink frame (by the violet helical gear) to change contact position between the ring and the two shafts for various output velocities.

Friction globoid variator 2
http://youtu.be/RI7IQuxPOl4
Input: the yellow shaft of a globoid cone.
Output: the blue shaft of a globoid cone.
The green roller that can rotate on an axle of the pink shaft, contacts with both cones.
The contact pressure is created by the red springs.
Turn the pink shaft to change contact position between the rollers and the two cones for various output velocities.

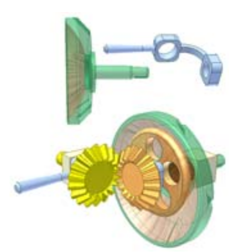
Friction globoid variator 3
http://youtu.be/VAfWV5Qnynw
Input: the yellow shaft.
Output: the blue shaft.
Each shaft has a disk of torus groove.
Two orange rollers contacts with both disks.
Each roller rotates on its gear shaft. The gear shafts are connected together by a gear drive.
The contact pressure is created by the brown springs.
The input and output shafts rotate in opposite directions.
Turn the pink gear shaft to change contact position between the rollers and the two disks for various output velocities.



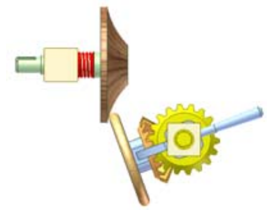
Friction globoid variator 4
http://youtu.be/hvF-SLZjABo
Input: the green disk.
Output: the blue disk.
The yellow bearing house of the orange roller can rotate around a fixed bearing.
The inside surface ot the disks is created by a round profile, center of which is on the axis of the yellow bearing house. This axis does not intersect the disk axes. There is a offset.
The roller contacts with the disks at its outside edges.
Contact pressure is created by two brown springs.
Turn the yellow shaft to change contact position for various output velocities.



Friction globoid variator 5a
http://youtu.be/dX2L_EirVD4
Input: yellow gear.
Output: green shaft.
Bearing of orange gear and friction disk can rotate around axis of the yellow gear.
Center of inner round profile of the green shaft and center of bevel gear drive are identical.
Contact pressure is created by red spring.
Turn the blue crank to change contact radius on the green shaft for various output velocities.
This video was made based on the idea of a Youtube user, Mr. Adrián Martín. See:
http://youtu.be/xkR_uuV-o-8

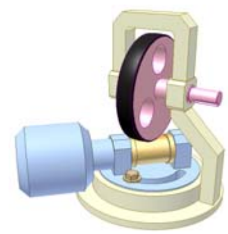


Friction globoid variator 5b



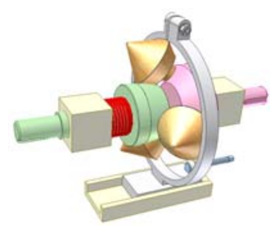
http://youtu.be/QfbN1DMNXuA
Input: yellow gear.
Output: green shaft.
Bearing of orange gear of friction disk can rotate around axis of the yellow gear.
Center of round profile of the green shaft and center of bevel gear drive are identical.
Contact pressure is created by red spring.
Turn the blue crank to change contact radius on the green shaft for various output velocities.
This video was made based on the idea of a Youtube user, Mr. Adrián Martín. See:
http://youtu.be/xkR_uuV-o-8

Friction roller variator 1



http://youtu.be/xQZ9gaKpQm4
Input: the motor shaft carrying a roller.
Output: the pink wheel of rubber rim.
Select angular position of the motor for desired output velocity.
Weakness: high wear at contact places

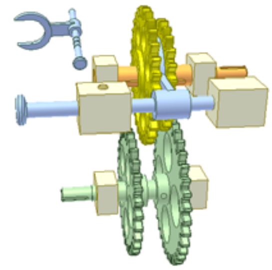
Satellite friction variator 1



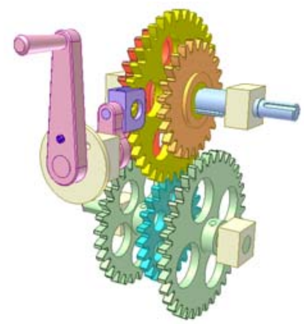
http://youtu.be/K6xu0qqBCxs
Input: the green shaft of a friction cone playing role of a sun. Output: the pink shaft playing role of a carrier.
The orange double cone rollers play role of satellites. They contact with the green cone and with a grey non rotary ring.
Input and output shafts are coaxial.
Turn the blue screw to move the ring for changing output velocity.
Contact pressure is created by the grey screw and the red spring.

1.14. Mechanisms for gear shifting

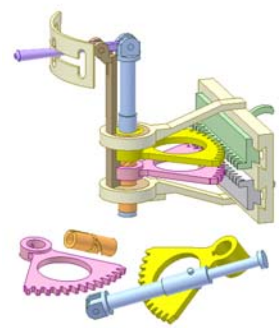
Shifting gear mechanism 1a
http://youtu.be/ap7WwwVzIAE
Input: the green shaft to which 2 gears are fixed. Output: the orange shaft on which a block of 2 gears can slide (key sliding joint).
Move the blue bar to get 3 positions of the gear block corresponding 3 speeds (one is zero) of the output. There is a positioning device (spring ball) for the bar.
To avoid gear collision the speed change must be carried out when the input shaft stops. The operation shown in this video is for the case of very slow speed.



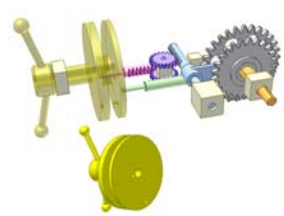
Shifting gear mechanism 1b
http://youtu.be/IUsQ_dyTTWk
Input: the green shaft to which 3 gears (green and cyan) are fixed. Output: the blue shaft on which a block of 3 gears (red, yellow and orange) can slide (key sliding joint).
Turn the pink lever to get 3 positions of the gear block corresponding 3 speeds of the output. There is a positioning device (spring ball) in the pink crank.
To avoid gear collision the speed change must be carried out when the input shaft stops. The operation shown in this video is for the case of very slow speed.



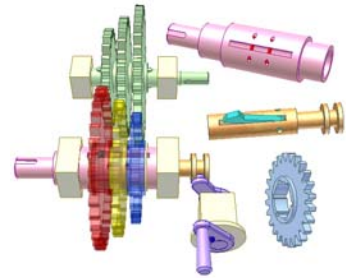
Shifting gear mechanism 2a
http://youtu.be/dCyL54KQAZc
The violet lever can turn in vertical and horizotal planes to control two racks carrying shifting forks. Each rack has 3 working positions.
The control lever pushes or pulls the blue shaft and the orange bush to turn the pink gear sector. There is a helical joint between the orange bush and the pink gear sector. There is a sliding key joint between the orange bush and the popcorn housing.
The control lever turns the blue shaft and the yellow gear sector. There is a sliding key joint between them.
The brown part can only rotate (no translation) in the popcorn housing.



Shifting gear mechanism 2b
http://youtu.be/J49Ro2ly1vY
Pull yellow disk, turn it to a new position and push it back to shift grey gear block through rack-pinion drives. Position devices are not shown.
Key factor is various depths of holes on the disk.
The mechanism is used in Russian lathe 1616

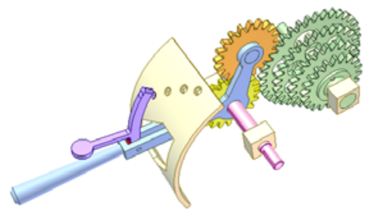


Shifting gear mechanism 3
http://youtu.be/2kRQHNAR3M0



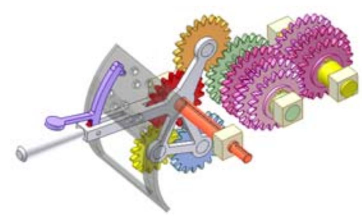
Input: green shaft carrying three gears.
Output: pink hollow shaft in which orange shaft slides. The pink and orange shafts rotate together owing cyan key, that has a revolution joint with the orange shaft.
Red, yellow and blue gears engage with the green gears and idly rotates (with different speeds) on the pink shaft.
Depending to axial position of the orange shaft which is controlled by violet crank, the cyan key enters into key slots of one of the red, yellow and blue gears and connects it with the pink output shaft. Red pins help retreave the cyan key from the gear key slots when the orange shaft moves longitudinally.
There is a flat spring (not shown) that forces the cyan key towards the gears.
The video shows 3 positions of the orange shaft that give 3 output speeds.

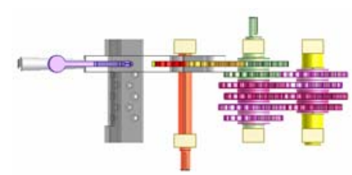
Shifting gear mechanism 4
http://youtu.be/9d2kf2A88rs



Input: green shaft with four gears fixed on it.
Output: pink shaft, that has a cylindrical joint with blue angle crank.
Yellow gear has sliding key joint with the pink shaft and engages with orange gear. The blue crank carrying the orange and yellow gears can move with them along the pink shaft.
To change speed:
1. Pull violet positioning trigger, turn back the blue crank and move them to other green gear.
2. Turn forwards the blue crank until the orange gear get in mesh with the green gear and release the trigger.
A red flat spring forces the trigger towards positioning holes.
The video shows the change from highest to lowest speed.

Shifting gear mechanism 5
http://youtu.be/xs9YzKWG1zs

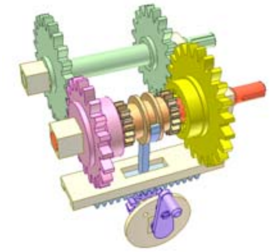




Input: green shaft with two green gears fixed on it.
Yellow shaft is fixed immobile. Blocks of two pink gears rotate idly on the green and yellow shafts. These blocks get rotation from the green shaft in a meandering manner.
Output: red shaft, with which grey crank has a cylindrical joint.
The grey crank carrying the red, orange, yellow and blue gears can move with them along the red shaft.
The red gear has sliding key joint with the red shaft and engages with orange and yellow gears. The yellow gear is in mesh with the blue gear.
To change speed:
1. Pull violet positioning trigger, turn back the grey crank and move them to other gear of the green shaft.
2. Turn forwards the grey crank until the orange gear (or the blue gear for reversing output direction) to get in mesh with the selected gear and release the trigger.
A red flat spring forces the trigger towards positioning holes.
The video shows the change from forward highest speed to reverse lowest one.

Shifting gear mechanism 6a

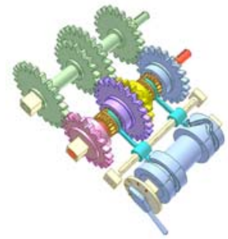
http://youtu.be/mecDD74_XXE



Input: green shaft with two green gears fixed on it.
Output: red shaft with yellow and pink gears rotating idly on it.
The gears are permanently in mesh. The orange toothed clutch has sliding key joint with the output shaft. The clutch's 3 positions are controlled by a rack-pinion drive.
To avoid clutch collision, the speed change must be carried out when the input shaft stops. The operation shown in this video is for the case of very slow speed.

Shifting gear mechanism 6b

http://youtu.be/p51_OnId75I



Input: green shaft with four gears fixed on it.
Output: red shaft with pink, violet, yellow and blue gears rotating idly on it.
The gears are permanently in mesh. The orange toothed clutches has sliding key joint with the output shaft. 3 positions of each clutch are controlled by blue barrel cam. The mechanism gives 4 speeds and neutral positions.
To avoid clutch collision, the speed change must be carried out when the input shaft stops. The operation shown in this video is for the case of very slow speed.

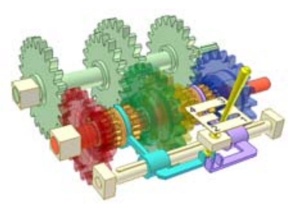
Shifting gear mechanism 6c

http://youtu.be/96yo_8AIHXs

Input: green shaft with four gears fixed on it.
Output: red shaft with pink, violet, yellow and blue gears rotating idly on it.
The gears are permanently in mesh. The orange toothed clutches has sliding key joint with the output shaft. 3 positions of each clutch are controlled by blue disk cam. The mechanism gives 4 speeds and neutral positions.
To avoid clutch collision, the speed change should be carried out when the input shaft stops.

Shifting gear mechanism 6d

http://youtu.be/uZDfj0u1MXo



Input: green shaft with four gears fixed on it.
Output: red shaft with pink, violet, yellow and blue gears rotating idly on it.
The gears are permanently in mesh. The orange toothed clutches has sliding key joint with the output shaft. 3 positions of each clutch are controlled by yellow lever and cyan and violet forks. The mechanism gives 4 speeds and neutral positions.
To avoid clutch collision, the speed change should be carried out when the input shaft stops.

Nguyen Duc Thang

1700 ANIMATED MECHANICAL MECHANISMS

With

Images,
Brief explanations
and Youtube links.

Part 2

Other kinds of motion transmission

Renewed on 31 December 2014

This document is divided into 3 parts.
Part 1: Transmission of continuous rotation
Part 2: Other kinds of motion transmission
Part 3: Mechanisms of specific purposes

Autodesk Inventor is used to create all videos in this document.
They are available on YouTube channel “thang010146”.

To bring as many as possible existing mechanical mechanisms into this document is author’s desire. However it is obstructed by author’s ability and Inventor’s capacity. Therefore from this document may be absent such mechanisms that are of complicated structure or include flexible and fluid links.

This document is periodically renewed because the video building is continuous as long as possible. The renewed time is shown on the first page.

This document may be helpful for people, who
- have to deal with mechanical mechanisms everyday
- see mechanical mechanisms as a hobby

Any criticism or suggestion is highly appreciated with the author’s hope to make this document more useful.

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- Retirement in 2002.

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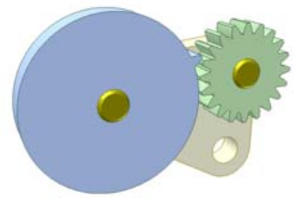
Table of Contents

2. Converting continuous rotation into interrupted rotation

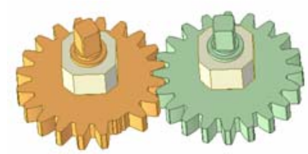
2.1. Tooth-uncompleted gears

Transmission with teeth-uncompleted gears 1
http://www.youtube.com/watch?v=AtoqZKDH-fY



The blue driving gear is a teeth-uncompleted one.
Its number of remained teeth Z1c = 1
Its number of teeth (teeth-completed) Z1 = 40
Its number of cut-off teeth Z1f = Z1 – Z1c = 39.
The number of the green driven gear (teeth-completed) Z2 = 20
When the blue makes 1 revolution, the green makes 3/20 revolution.
Avoid wrong calculation:
When the blue makes 1 revolution, the green makes Z1c/Z2 revolution.
For this case it means when the blue makes 1 revolution, the green makes 1/20 revolution (!).

Transmission with teeth-uncompleted gears 2
http://youtu.be/YNsSa9hSw4A

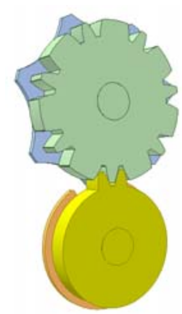


A funny mechanical problem:
There is a drive of two gears of 20 teeth each.
What is the motion of the driven gear if 1 tooth of the driving gear is broken?
Wrong answer: 1 revolution of the driving gear corresponds 19/20 revolution of the driven gear.
Correct answer:
The driven gear rotates as if the tooth was not broken, because if the driving gear has only 1 tooth, it makes the driven gear move 2 teeth.

Transmission with teeth-uncompleted gears 3
http://youtu.be/zSTqwzXCR9M

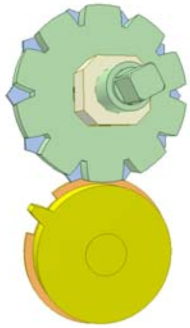
Input: the orange gear.
Its number of remained teeth Z1c = 5
Its number of teeth (teeth-completed) Z1 = 18
Its number of cut-off teeth Z1f = Z1 -- Z1c = 13
Output: the green gear.
Its number of teeth (teeth-completed) Z2 = 18.
When the orange makes 1 revolution, the green makes 1/3 revolution.

Transmission with teeth-uncompleted gears 4
http://youtu.be/LkweQilGCRs



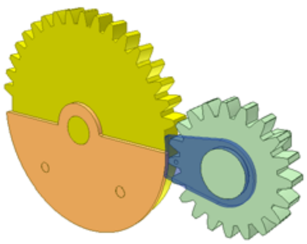
Input: the yellow gear.
Its number of remained teeth Z1c = 2
Its number of teeth (teeth-completed) Z1 = 20
Its number of cut-off teeth Z1f = Z1 -- Z1c = 18
Output: the green gear.
It has 14 tooth slots.
Its number of teeth (teeth-completed) Z2 = 21.
When the yellow makes 1 revolution, the green makes 1/7 revolution.

Transmission with teeth-uncompleted gears 5
http://youtu.be/ebMgECUuHdg
Input: the yellow gear.
Its number of remained teeth Z1c = 1
Its number of teeth (teeth-completed) Z1 = 20
Its number of cut-off teeth Z1f = Z1 -- Z1c = 19
Output: the green gear.
It has 10 tooth slots.
Its number of teeth (teeth-completed) Z2 = 20.
When the yellow makes 1 revolution, the green makes 1/10 revolution.

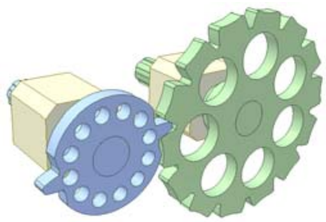


Transmission with teeth-uncompleted gears 8
http://youtu.be/wPxQOsEiJ2E
Input: the yellow gear.
Its number of remained teeth Z1c = 9
Its number of teeth (teeth-completed) Z1 = 20
Its number of cut-off teeth Z1f = Z1 -- Z1c = 11
Output: the green gear.
Its number of teeth (teeth-completed) Z2 = 20.
When the yellow makes 1 revolution, the green makes 1/2 revolution.

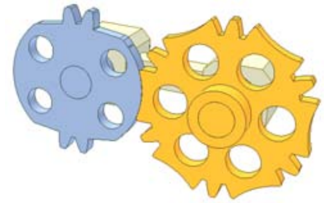
Transmission with teeth-uncompleted gears 10
http://youtu.be/scBbYOlmjUo
Input: the yellow gear.
Its number of remained teeth Z1c = 18
Its number of teeth (teeth-completed) Z1 = 40
Its number of cut-off teeth Z1f = Z1 -- Z1c = 22
Output: the green gear.
Its number of teeth (teeth-completed) Z2 = 20.
When the yellow makes 1 revolution, the green makes 1 revolution and pause during ½ revolution of the yellow.



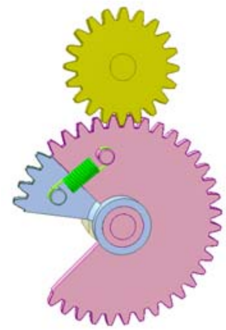
Transmission with teeth-uncompleted gears 18a
http://youtu.be/lj8J37zluhU
Input: the bue gear.
Its original number of teeth Z1 = 16
Output: the green gear
Its original number of teeth Z2 = 28
When the blue makes 1 revolution, the green turns two times and pauses two times.
The arcs on both gear keep the output gear immobile during its pause period.



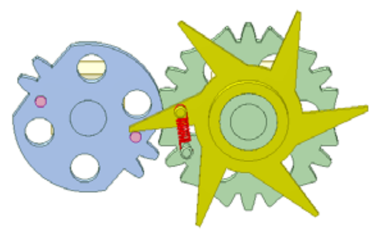
Transmission with teeth-uncompleted gears 19c
http://youtu.be/NmiXFGb-dD8
The blue gear is fixed. The orange gear is a satellite.
Input is the yellow crank.
In 1 revolution of the crank, the orange turns two times and pauses two times.
The arcs on both gear keep the orange gear immobile during its pause period.



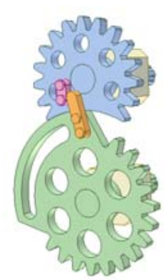
Transmission with teeth-uncompleted gears 17
http://youtu.be/_7ifFtlc5t8
A measure to ensure proper engagement (jam avoiding).
Input: the pink gear.
Its number of remained teeth Z1c = 30
Its original number of teeth Z1 = 40
Its number of cut-off teeth Z1f = Z1 -- Z1c = 10
The blue gear sector has 4 teeth (Zs)
Output: the yellow gear of Z2 = 20 teeth.
When the pink makes 1 revolution, the yellow makes (Z1c + Zs + A)/Z2 = (30 + 4 + 2)/20 = 36/20 = 1.8 revolution and pause during (40 – 36)/40 = 1/10 revolution of the pink.
Why A = 2?: If the pink gear has only 1 tooth and the blue gear sector is absent so when the pink makes 1 revolution, the yellow makes 3/20 revolution.
Measure to keep the output gear immobile during its pause is not shown.
Disadvantage: Pause time can not be long.



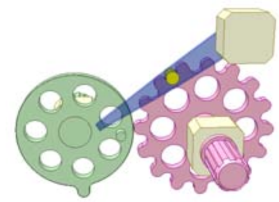
Transmission with teeth-uncompleted gears 19b
http://youtu.be/5nCJj2hxpUs
Input: the bue gear.
Its original number of teeth Z1 = 20
Output: the green gear
Its original number of teeth Z1 = 24
When the blue makes 1 revolution, the green turns two times and pauses two times.
The arcs on both gear keep the output gear immobile during its pause period.
The yellow star, red spring and two pink pins are used for reducing shock. Before teeth engagement, the pink pin pushes the star. The latter pulls the output blue gear though the spring and gives the output a low initial speed.



Transmission with teeth-uncompleted gears 20
http://youtu.be/CQTx412p6nI
Input: the green gear.
Its original number of teeth Z1 = 24
Output: the blue gear
Its original number of teeth Z2 = 19
In one rev. of the input, the output turns 1 rev. and then pauses.
The arcs on both gear keep the output gear immobile during its pause period.
The pink and orange bars gives the output an added rotation before the teeth engagement.



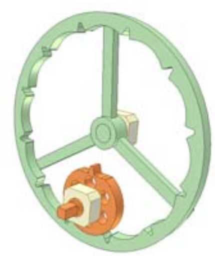
Transmission with teeth-uncompleted gears 21
http://youtu.be/RIVk2eYRw3Q
Input: the green gear of 1 tooth.
Its original number of teeth Z1 = 16
Output: the pink gear of Z2 = 16 teeth
In one rev. of the input, the output turns 1/8 rev. and then pauses.
The yellow pin of the blue arm keeps the output immobile during its pause period. The pin on the input controls the blue arm.



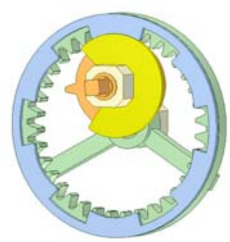
Transmission with teeth-uncompleted gears 22
http://youtu.be/PZ54x2hgU9A
Input: yellow gear of tooth number Zi = 18.
Output: green teeth-uncompleted gear.
Its tooth number (teeth-completed) Zo = 20
Its number of remained teeth Zoc = 17
Its number of cut-off teeth Zof = Zo – Zoc = 3.
When the input turns 2 revolutions, the output turns 1 revolution and has long dwell (time of 1 input revolution).
The key concept: Zi is less than Zo
Measure to kept the output immobile during its dwell is not shown.
The unusualness for this mechanism is that the input is a tooth completed gear. Not like in ordinary drive: the input is the teeth-uncompleted gear.

Transmission with teeth-uncompleted gears 23
http://youtu.be/anoaPGu2QMI
Input: yellow shaft of constant velocity
Output: blue shaft having two velocities (transmission ratio i = 20/10 and 12/18) in its every revolution.

Transmission with teeth-uncompleted gears 6
http://youtu.be/31vVO_i8WO8
Input: the orange gear.
Its number of remained teeth Z1c = 1
Its number of teeth (teeth-completed) Z1 = 20
Its number of cut-off teeth Z1f = Z1 -- Z1c = 19
Output: the green gear.
It has 12 tooth slots.
Its number of teeth (teeth-completed) Z2 = 60.
When the orange makes 1 revolution, the green makes 1/12 revolution.

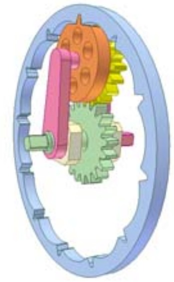


Transmission with teeth-uncompleted gears 9
http://youtu.be/p04ZgIiBLVY
Input: the orange gear.
Its number of remained teeth Z1c = 1
Its number of teeth (teeth-completed) Z1 = 20
Its number of cut-off teeth Z1f = Z1 -- Z1c = 19
Output: the green gear.
Its number of teeth (teeth-completed) Z2 = 36.
When the orange makes 1 revolution, the green makes 1/6 revolution.



Transmission with teeth-uncompleted gears 7

http://youtu.be/YzIYI4ssr9I



Planetary drive with dwell.
R1: pitch diameter of the green gear having 20 teeth.
R2: pitch diameter of the yellow gear having 20 teeth.
R3: pitch diameter of the orange gear having 1 tooth.
R4: pitch diameter of the blue internal gear having 12 tooth slots.
R1 = R2 = R3; R4 = 3R1
The green gear is input.
The output pink crank carrying the yellow and orange gear block rotates with periodical pauses.

Skew teeth-uncompleted gear drive 1a

http://youtu.be/ePdEwNcnoIo

Input: yellow gear rotating continuously.
Output: blue gear rotating interruptedly.
For the yellow gear:
Its number of remained teeth Z1c = 12 (180 deg.)
Its number of teeth (teeth-completed) Z1 = 24
Its number of cut-off teeth Z1f = Z1 -- Z1c = 12 (180 deg.).
There is an orange rim located in the place, where the teeth are cut off.
The number of the blue gear (teeth-completed) Z2 = 24.
It has two red triangular slots.
The rim and slots are for keeping the blue gear immobile during its dwell.
When the yellow makes 1 revolution, the blue makes an angle A = 1/2 revolution.
Alter Z1, Z1c and Z2 to get various values of A.

Skew teeth-uncompleted gear drive 1b

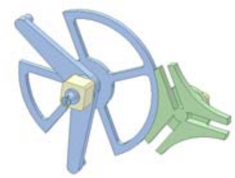
http://youtu.be/iBr34hiWXNE

Input: lower gear rotating continuously.
Output: upper gear rotating interruptedly.
For the lower gear:
Its number of remained teeth Z1c = 3 (45 deg.)
Its number of teeth (teeth-completed) Z1 = 24
Its number of cut-off teeth Z1f = Z1 -- Z1c = 21 (315 deg.)
There is a pink rim located in the place, where the teeth are cut off.
The number of the upper gear (teeth-completed) Z2 = 24.
It has eight red triangular slots.
The rim and slots are for keeping the upper gear immobile during its dwell.
When the yellow makes 1 revolution, the blue makes an angle A = 1/8 revolution.
Alter Z1, Z1c and Z2 to get various values of A.

2.2. Geneva drives

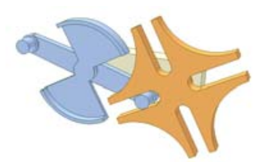
Geneva mechanism 1
http://www.youtube.com/watch?v=vEU5cXwiykQ
The ratio of motion period to dwell period is 1/5.
Angle of each rotation of the driven shaft is 120 degrees.

Geneva mechanism 2
http://www.youtube.com/watch?v=GbEJFDP8f_E
Angle between the three pins is 120 degrees.
During 1 revolution of the driving shaft the driven disk has 3 dwell times and 3 motion times alternately.
Angle of each rotation of the driven shaft is 120 degrees.



Geneva mechanism 3
http://www.youtube.com/watch?v=qFd-Kt_vTDs
Angle between the two pins is 120 degrees.
During 1 revolution of the driving shaft the driven disk has 2 dwell times and 2 motion times alternately. Dwell periods of the two dwell times are different.
Angle of each rotation of the driven shaft is 120 degrees.

Geneva mechanism 4
http://www.youtube.com/watch?v=TErAWmR66_s
The ratio of motion period to dwell period is 1/3.
Angle of each rotation of the driven shaft is 90 degrees.



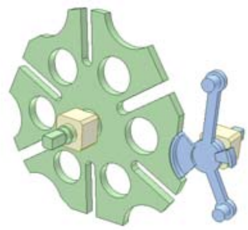
Geneva mechanism 5
http://www.youtube.com/watch?v=BM5fLiOxM3o
Angle between the two pins is 180 degrees.
During 1 revolution of the driving shaft the driven disk has 2 dwell times and 2 motion times alternately.
Angle of each rotation of the driven shaft is 90 degrees.

Geneva mechanism 6
http://www.youtube.com/watch?v=NjIfezPXpds
Angle between the two pins is 120 degrees, not a multiple of 90.
Angle of each rotation of the driven shaft is 90 degrees.

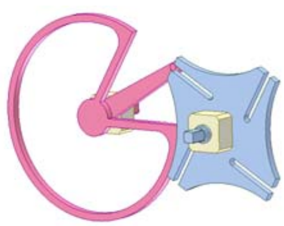
Geneva mechanism 7
http://www.youtube.com/watch?v=uhEvxBxFoXA
The ratio of motion period to dwell period is 1/5.
Angle of each rotation of the driven shaft is 60 degrees.

Geneva mechanism 8
http://www.youtube.com/watch?v=3Ju7N-VM7Qw
The disks rotate and pause one after another.
The ratio of motion period to dwell period is 1/5.
Angle of each rotation of the disks is 120 degrees.

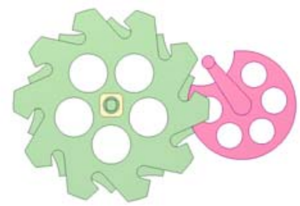
Geneva mechanism 9
http://www.youtube.com/watch?v=RF5JN2dHMMA
The disk interruptedly rotates 70 and 50 degrees.



Geneva mechanism 10
http://www.youtube.com/watch?v=BuuVSIchqZU
By applying skew slots the ratio of motion period to dwell period is 1/5, not 1/3 like in standard 4-slot Geneva mechanism:
http://www.youtube.com/watch?v=TErAWmR66_s
Angle of each rotation of the driven shaft is 90 degrees.



Geneva mechanism 11
http://www.youtube.com/watch?v=845_WfUmSI0
By applying skew slots the ratio of motion period to dwell period is 1/5, not 2/5 like in standard 10-slot Geneva mechanism.
Angle of each rotation of the driven shaft is 36 degrees.



Geneva mechanism 12
http://www.youtube.com/watch?v=pPhjq5IHVyY
Twin Geneva mechanism. The green disk interruptedly rotates 60 degrees with different dwell periods.

Geneva mechanism 13

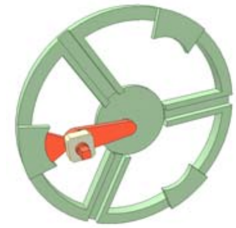
http://www.youtube.com/watch?v=PoJBGr5mR2c

Twin Geneva mechanism. The green disk interruptedly rotates 120 degrees. The ratio of dwell period to motion period is 8/1.

Internal Geneva mechanism 1

http://www.youtube.com/watch?v=n8xLpbwsTcg

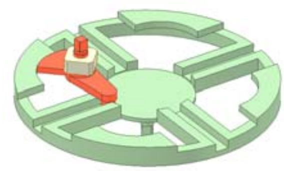
The ratio of dwell period to motion period is 1/2.
Angle of each rotation of the driven shaft is 120 degrees.



Internal Geneva mechanism 2

http://www.youtube.com/watch?v=ReXprJUMqF4

The ratio of dwell period to motion period is 1/3.
Angle of each rotation of the driven shaft is 90 degrees.



Internal Geneva mechanism 3

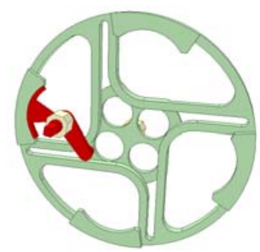
http://www.youtube.com/watch?v=MQP7yNxx3ag

The ratio of dwell period to motion period is 1/5.
Angle of each rotation of the driven shaft is 60 degrees.

Internal Geneva mechanism 4

http://www.youtube.com/watch?v=w1oT0Zx_xcU

The ratio of dwell period to motion period is 1/3.
Angle of each rotation of the driven shaft is 90 degrees.

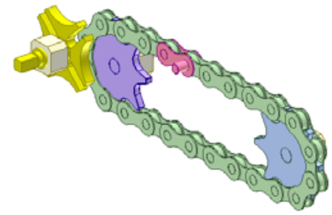


Trivision Billboard with Geneva mechanism

http://www.youtube.com/watch?v=uCx9riKxTvY

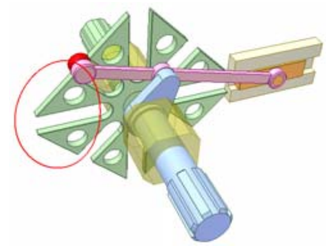
Meslab is the name of the Vietnamese forum of Materials, Mechanical, Automation and Industrial Engineering.

Chain drive 3D
http://youtu.be/1_yyZ93JJAI
The violet sprocket is driving.
Dwell time of the output Geneva disk depends on the number of the chain links.

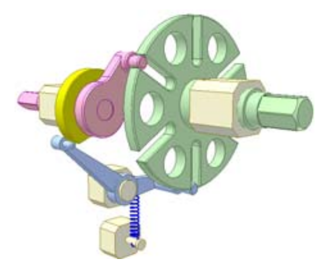


Geneva mechanism 14
http://youtu.be/_TmvoXFxyNw
Input: blue crank
Output: green disk rotating with dwells.
Input and output are coaxial.
In one revolution of the blue crank the green disk rotates ¼ rev.
Red curve is locus of the red roller center.
Orange slider kept the green disk immobile during its dwell.
Main dimensions of the mechanism are:
- crank radius of the blue crank
- side length of the green square disk
- length of the pink conrod.

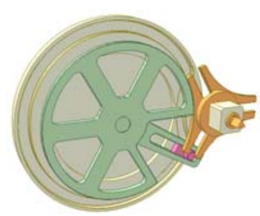
They are determined based on a sketch (not shown) where:
- Angle of crank and horizontal line is 60 deg.
- Angle of square side of the green disk and horizontal line is 45 deg.
- Square side (contains roller center), crank radius line and the line that is drawn from the slider center and perpendicular to the sliding direction of the runway, are concurrent.



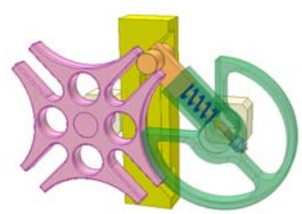
Geneva mechanism 15
http://youtu.be/TYRks3vmAlI
Input: pink crank
Output: green disk rotating with dwells.
Yellow cam (fixed to the crank) and blue lever with its pins keep the green disk immobile during dwells.



Geneva mechanism 16a
http://youtu.be/rI9VJuzrNVg
Input: green crank
Output: orange disk rotating with dwells.
Pink slider has pins that slide in grooves of the green crank and the orange disk.
Fixed popcorn disk cam and the pink slider help to reduce acceleration of the orange disk.

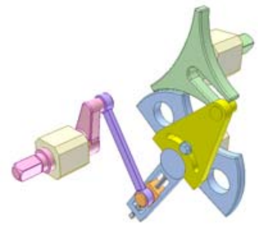


Geneva mechanism 16b
http://youtu.be/rhObov9nyVQ
Input: green crank carrying orange slider
Output: pink disk rotating with dwells.
The slider has pins that slide in grooves of the pink disk and of fixed yellow guide plate. The latter and the orange slider help to reduce acceleration of the pink disk.



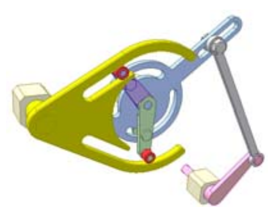
Geneva mechanism 19
http://youtu.be/LkYHh29c16A
Input: pink crank
Output: green disk rotating with dwells.
A four bar linkage makes angular speed of the output more regular.
Blue curve is locus of pin center of the blue V-shaped bar.
Measure to keep the green disk immobile during its dwells is not shown.

Geneva mechanism 20
http://youtu.be/CsEaqHMsXEA
Input: pink crank
Output: green disk oscillating with dwells at both stroke ends.
Adjust positions of orange slider and yellow plate to get various motion rules of the output.

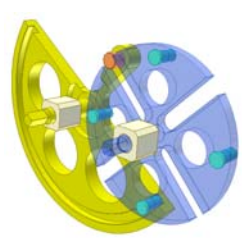


Geneva mechanism 20
http://youtu.be/vu6_WfDXUIQ
Input: blue crank with locking disk carrying green planet gear.
Output: orange disk rotating interruptedly.
Two gears have same tooth number. Blue crank radius is equal to gear pitch one.
The motion period of the output is decreased over ordinary Geneva mechanism.

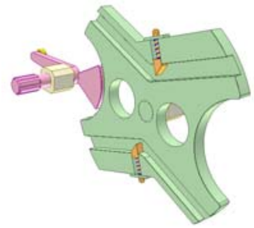
Geneva mechanism 22
http://youtu.be/QkzRb7b36IY
Input: pink crank.
Output: yellow Geneva disk oscillating with dwell at its stroke middle.
Output motion rule can be adjusted by setting positions of violet or green roller bars and grey conrod on blue disk.



Geneva mechanism 21
http://youtu.be/HuJSoUglKws
Input: yellow disk of orange pin rotating continuously.
Output: blue disk rotating interruptedly.
1 rev. of the input makes the output rotate 90 deg.
Other than standard Geneva mechanism it uses four cyan pins on the blue disk and circular groove of the yellow disk to keep the blue disk immobile during its dwells.

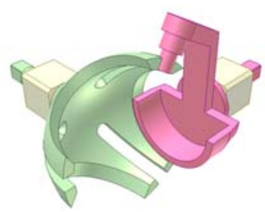


Geneva mechanism 17
http://youtu.be/J7-IAwdrEkw
Input: pink crank
Output: green disk rotating with dwells.
In one revolution of the pink crank the green disk rotates 180 deg., a thing that ordinary Geneva mechanisms can not get.
Orange sliders prevent reverse rotation of the green disk when yellow roller of the pink crank reaches corners of the disk grooves.



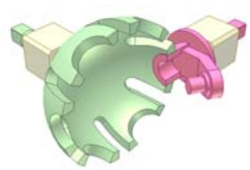
Geneva mechanism 18
http://youtu.be/uNVF-EZ6myA
Input: orange crank carrying an ellipsed-shape pin.
Output: green disk rotating with dwells.
I have tried to find out what is the advantage of this Geneva mechanism but no success. Unexpected result: its output acceleration is even larger than in ordinary Geneva mechanism.

Spatial Geneva mechanism 1
http://www.youtube.com/watch?v=rqDfalBVhlU
The ratio of dwell period to motion period is 1/1.
Angle of each rotation of the driven shaft is 120 degrees.
Angle between the pin axis and the crank axis is 60 degrees.



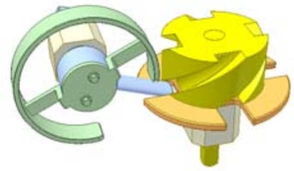
Spacial Geneva mechanism 2
http://www.youtube.com/watch?v=lUv4TaxKyuw
The ratio of dwell period to motion period is 1/1.
Angle of each rotation of the driven shaft is 90 degrees.
Angle between the pin axis and the crank axis is 45 degrees.

Spatial Geneva mechanism 3
http://www.youtube.com/watch?v=cKi_Hlp9rA8
The ratio of dwell period to motion period is 1/1.
Angle of each rotation of the driven shaft is 60 degrees.
Angle between the pin axis and the crank axis is 30 degrees.



Spatial Geneva mechanism 4
http://www.youtube.com/watch?v=-M3BlExZAYs
The ratio of dwell period to motion period is 1/1.
Angle of each rotation of the driven shaft is 20 degrees.
Angle between the pin axis and the crank axis is 10 degrees.

Spatial Geneva mechanism 5a
http://youtu.be/a-I3VCDKuvs
Input: blue crank with locking ring.
Output: yellow cylinder with orange locking disk rotating interruptedly.
Ellipse section of the blue crank pin is for easy designing the mechanism. Round section is possible.

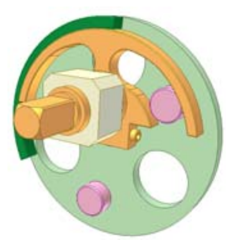


Spatial Geneva mechanism 5b
http://youtu.be/2vB68uod2Bc
Input: blue crank with locking ring.
Output: yellow cylinder with orange locking disk.
Ellipse section of the blue crank pin is for easy designing the mechanism. Round section is possible.
The mechanism performs 180 deg. indexing that is immpossible for ordinary Geneva mechanisms.

Star wheel drive 4
http://youtu.be/TaZKjLB-KVU
An invention of Martin Zugel of Cleveland, Ohio, USA.
Input: green disk of two pink pins.
Output: yellow disk rotating interruptedly.
In one revolution of the input, the output turns 90 deg.
Motion time is around 20% cycle time (25% cycle time for a standard Geneva one).
Inertia load is less than in a standard Geneva drive.

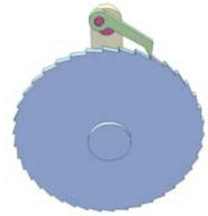
Star wheel drive 3
http://youtu.be/gFECTmIUtMM
An invention of Martin Zugel of Cleveland, Ohio, USA.
Input: green disk of two pink pins.
Output: yellow disk rotating interruptedly.
In one revolution of the input, the output turns 120 deg.
Motion time is around 40% cycle time (16.7% cycle time for a standard Geneva one).
Inertia load is less than in a standard Geneva drive.

Star wheel drive 1
http://youtu.be/9hG_dL40M6Y
An invention of Martin Zugel of Cleveland, Ohio, USA.
Input: green disk of two pink pins.
Output: orange disk rotating interruptedly.
The input and output are not coaxial.
In one revolution of the input, the output turns 360 deg.
This operation is not possible with standard Geneva drives.
Motion time is around 40% cycle time.
Dark green rim keeps the output disk immobile during its dwell.

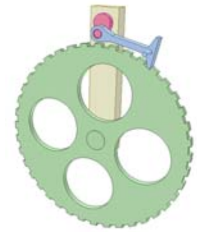


2.3. Ratchet drives

Ratchet mechanism 1
http://www.youtube.com/watch?v=eijyLC4ZzQk
A device directly converts the continuous rotary motion of a drive shaft into the intermittent rotary motion of a driven shaft.



Ratchet mechanism 2
http://youtu.be/V4yxGR4d7I8
This mechanism directly converts the continuous rotary motion of a drive shaft into the intermittent rotary motion of a driven shaft.
By flopping the blue pawl the motion direction of the driven shaft can be changed without changing the input motion direction.



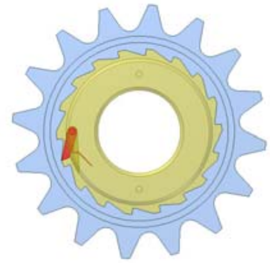
Sheet metal ratchet drive 1
http://youtu.be/qT3S7sOhyS8
For light loads.
Low cost.
Adaptability to mass production.
Permanent contact between pawl and ratchet wheel is maintained by pawl's weight.

Sheet metal ratchet drive 2
http://youtu.be/miDCNBMLR3E
For light loads.
Low cost.
Adaptability to mass production.
Permanent contact between pawl and ratchet wheel is maintained by pawl's weight.

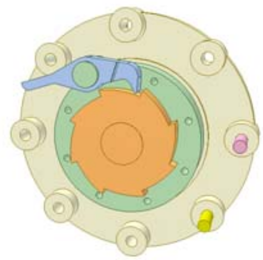
Ratchet mechanism 3
http://youtu.be/WeV89YavvO8
To adjust position of the pink cover for getting various rotation angle of the green wheel.
To pull the orange pawl and rotate it 180 degrees to change rotation direction of the green wheel.
This mechanism is used in shapers.

Ratchet mechanism 4
http://youtu.be/vW6PuvfIUrM
The ratchet wheel has internal teeth.

Ratchet mechanism 5
http://youtu.be/bAL_nWjuhOI
Bicycle free-wheel.
The blue sprocket receives motion from the pedaling bicyclist. The yellow hub rotates only when the sprocket rotates clockwise.
Clockwise rotation of the yellow hub has no influence to the blue sprocket.
The red pawl is always pressed toward the sprocket's teeth by a spring. In reality two pawls are used.

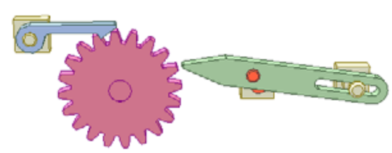


Ratchet mechanism 8
http://youtu.be/4wQkKdf9ReU
The input green disk through the blue pawl makes the output ratchet wheel rotate interruptedly. The pink and yellow pins control pause time of the ratchet wheel. Each pin makes the ratchet wheel pause for 1/8 revolution of the input disk.
The blue pawl is always pressed toward the sprocket's teeth by a spring (not shown).

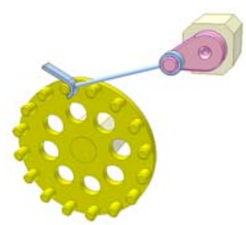


Ratchet mechanism 9
http://youtu.be/_wqPI2ms2kk
There are two pawls. The pink pushes the ratchet wheel. The green keeps the wheel immobile when the pink reverses.

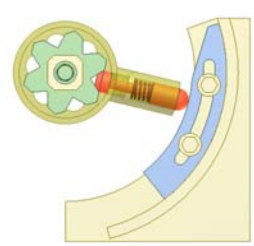
Ratchet mechanism 12
http://youtu.be/tvByEbHmcfc
There are two pawls. The green pushes the pink gear and is not always in contact with it (unlike ordinary ratchet mechanism). The blue keeps the wheel immobile when the green does not push the gear.



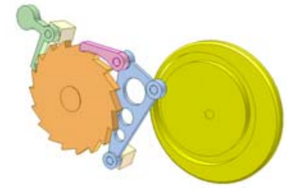
Ratchet mechanism of pin gear 1
http://youtu.be/ISQQZAvi7H0
Input: pink crank rotating continuously.
Output: yellow pin gear.
Gravity maintains contact between blue pawl and pin gear.



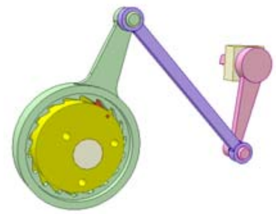
Ratchet mechanism 13
http://youtu.be/r-2Xe3moMPs
The input yellow disk through the orange pawl makes the output green ratchet wheel rotate interruptedly. The length of the blue cam regulates moving time of the wheel.



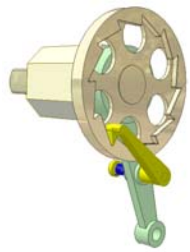
Ratchet mechanism 15
http://youtu.be/_k7JzvFg88g
There are two pawls. The pink pushes the ratchet wheel. The green keeps the wheel immobile when the pink reverses. The yellow slotted cam is the input.



Ratchet mechanism 16
http://youtu.be/5l74rKEJLp0
Input is pink crank of constant velocity.
Green rocker (ratchet wheel of internal teeth) turns an angle of around three teeth in each revolution of the crank. But the yellow disk rotates at different angles because of its eccentrical rotary axis.

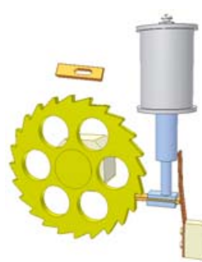


Ratchet mechanism 31
http://youtu.be/sSVz1cMMYIY
Input: green crank oscillating.
Output: ratchet wheel rotating interruptedly.
Blue spring maintains contact between yellow pawl and ratchet wheel.
Speciality: internal tooth wheel, external pawl.



Ratchet mechanism 17
http://youtu.be/GuM-WgaQnc8
Input: green eccentric shaft.
Output: grey ratchet wheel.
Gravity maintains contact between pawl and ratchet wheel.

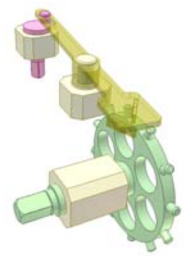
Ratchet mechanism 27
http://youtu.be/_vWezNG0l8g
Grey solenoid makes blue rod reciprocate.
The unusualness is: orange pawl has prizmatic joint with the blue driving rod, not revolution one as ordinary pawls.
Flat spring maintains the contact between pawl and yellow wheel.



Spatial ratchet mechanism 1
http://youtu.be/Hev7lm-DhVA
Input: eccentric shaft rotating continuously.
Output: face tooth ratchet wheel rotating interruptedly.
Gravity maintains contact between blue pawl and the wheel.

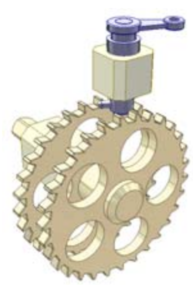
Cable drive for 180 deg. rotation
http://youtu.be/VzBuIhvWsJY
Pull and release brown tow to let yellow ratchet disk turn 180 deg. One end of the tow is fixed to blue disk. Orange leaf spring keeps the yellow ratchet disk immobile during its dwell. A circular slot on the blue disk and a pin on the case limit oscillating angle of the blue disk. A coil spring (not shown) makes the blue disk turn back when the tow is released.
Replacement of cable drive with rack-pinion one is possible.

Spatial ratchet mechanism 2
http://youtu.be/TuJxhLaOJjo
Input: pink crank rotating continuously.
Output: green ratchet wheel of tooth number Z.
Both go and back motions of yellow ocsillating crank make the wheel rotate in the same direction.
In 1 rev. of the input, the output rotates 2/Z rev. with two dwells.

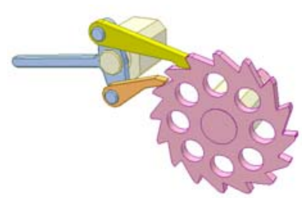


Spatial ratchet mechanism 3a
http://youtu.be/OGGWPJUgAA8
Input: orange oscillating crank.
Output: green twin ratchet wheel of tooth number Z.
Both go and back motions of the crank make the wheel rotate in the same direction.
In 1 rev. of the input, the output rotates 1/Z rev. with two dwells.
Angle deflection between the two ratchet wheels is 360/2Z deg.

Spatial ratchet mechanism 3b
http://youtu.be/HWZBdD80ZE4
Input: blue oscillating crank.
Output: twin ratchet wheel of tooth number Z.
Both go and back motions of the crank make the wheel rotate in the same direction.
In 1 rev. of the input, the output rotates 1/Z rev. with two dwells.
Angle deflection between the two ratchet wheels is 360/2Z deg.



Ratchet mechanism 18
http://youtu.be/urvRRQQMd9Y
Input: blue crank.
Output: pink ratchet wheel.
Both go and back motions of the blue crank make the wheel rotate in the same direction. The pawls push the wheel.
Gravity maintains contact between pawls and ratchet wheel.



Ratchet mechanism 19

http://youtu.be/RYrn5XjDTg4

Input: green crank.

Output: ratchet wheel.

Both go and back motions of the green crank make the wheel rotate in the same direction. The pawls pull the wheel.

Gravity maintains contact between pawls and ratchet wheel.

Ratchet mechanism 20

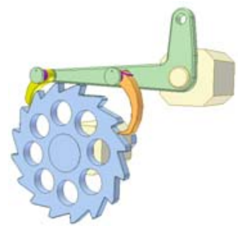
http://youtu.be/tZfwSkw8uGM

Input: green crank.

Output: blue ratchet wheel.

Both go and back motions of the crank make the wheel rotate in the same direction. Yellow pawl pushes and orange pawl pulls the wheel.

Violet springs maintain contact between pawls and ratchet wheel.



Ratchet mechanism 21

http://youtu.be/JZt-L8xFLyU

Input: pink crank.

Output: yellow ratchet wheel that can rotate interruptedly in both direction.

Blue rocker oscillates thanks to four bar mechanism.

Red springs maintain contact between pawls and ratchet wheel.

Use grey sector to prevent contact between the wheel and one of the pawls for changing rotary direction of the output.

Ratchet mechanism 22

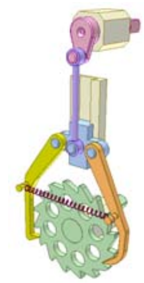
http://youtu.be/4wMlWhl2DhE

Input: pink crank.

Output: green ratchet wheel.

Both go and back motions of blue slider make the wheel rotate in the same direction. Orange pawl pushes and yellow pawl pulls the wheel.

Spring maintains contact between pawls and ratchet wheel.



Ratchet mechanism 23

http://youtu.be/jfjCLOztQZM

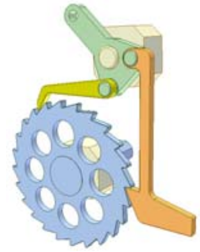
Input: green crank oscillating.

Output: blue ratchet wheel.

Both go and back motions of ocsillating green crank make the wheel rotate in the same direction.

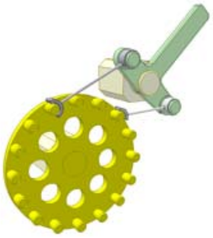
Yellow pawl pushes and orange pawl pulls the wheel.

Gravity maintains contact between pawls and wheel.

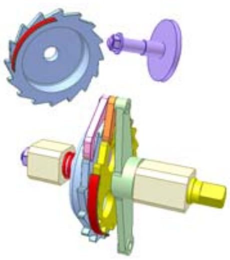


Ratchet mechanism 24
http://youtu.be/37kxWClRLO4
Input: green crank oscillating.
Output: ratchet wheel.
Both go and back motions of ocsillating green crank make the wheel rotate in the same direction.
The pawls pushes the wheel.
Spring maintains contact between pawls and ratchet wheel.

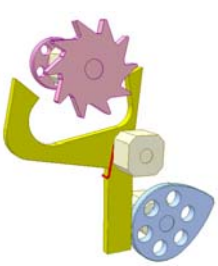
Ratchet mechanism of pin gear 2
http://youtu.be/PSMWGHKGu5k
Input: green crank .
Output: yellow pin gear.
Both go and back motions of the green crank make the gear rotate in the same direction. The greey bars push the gear.
Gravity maintains contact between pawls and pin gear



Ratchet mechanism 25
http://youtu.be/gzLSJ-6qvWA
Input: green oscilating crank.
Output: yellow ratchet wheel.
Blue ratchet wheel is idly mounted on violet fixed shaft.
Red spring creates friction between the blue ratchet wheel and fixed violet shaft thus prevents the blue wheel from reverse rotation.
Pink pawl makes the blue ratchet wheel rotate.
Orange pawl makes the yellow ratchet wheel rotate.
Red sector of the blue ratchet wheel periodically prevents contact between the orange pawl and the yellow wheel thus the latter rotates interruptedly with different dwell times.
Gravity maintains contact between pawls and wheels.

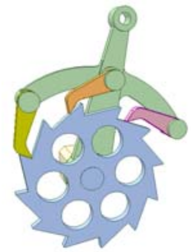


Ratchet mechanism 26
http://youtu.be/UFU1NkXvCJo
Input: blue cam.
Output: pink ratchet wheel rotating interruptedly with long dwells.
Both go and back motions of yellow ocsillating pawl make the wheel rotate in the same direction (one tooth).
The pawl keeps the ratchet wheel immobile during its dwells.
Red spring maintains contact between the pawl and the cam.

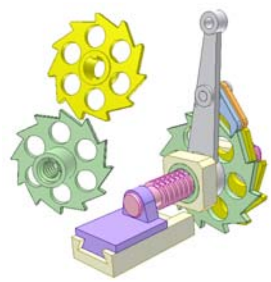


Ratchet mechanism 32
http://youtu.be/uwgsltwBa7g
Input: green crank oscillating.
Output: ratchet wheel of tooth number Z rotating interruptedly.
The gravity maintains contact between 2 coaxial pawls and ratchet wheel.
The ratchet wheel thickness must be twice the pawl ones.
Speciality: the mechanism acts as in case where there is one pawl and ratchet wheel tooth number is 2Z. It helps increase tooth strength.
The pawls one by one push the wheel.

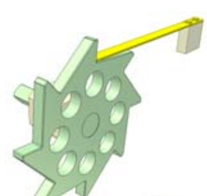
Ratchet mechanism 33
http://youtu.be/ZeAYihlABSw
Input: green crank oscillating.
Output: ratchet wheel of tooth number Z rotating interruptedly.
The gravity maintains contact between 3 identical pawls and ratchet wheel.
Speciality: the mechanism acts as in case where there is one pawl and ratchet wheel tooth number is 3Z. It helps increase tooth strength.
The pawls one by one push the wheel.



Ratchet mechanism 35
http://youtu.be/3e6axpv1SsY
Input: grey crank oscillating.
Output: violet slider that linearly moves interruptedly.
Tooth number of green wheel Zg = 12.
Tooth number of yellow wheel Zy = 11.
Blue pawl contacts the green wheel.
Orange pawl contacts the yellow wheel.
The green wheel has helical joint with pink screw.
The yellow wheel has prizmatic joint with pink screw.
The gravity maintains contact between the wheels and the pawls.
The screw pitch is P mm.
12 double strokes of the input crank make the green wheel turn 1 revolution and the yellow wheel turn 1 + 1/11 revolutions. Thus the screw turns 1/11 rev. in relation with the green wheel (nut) and the slider moves P/11 mm (small displacement).
The video also shows case when the orange pawl does not engage with the yellow wheel. The latter is immobile so the screw can not rotate. 12 double strokes of the input crank make the green wheel turn 1 revolution and the slider moves P mm (large displacement) in the opposite direction (in the same direction if Zg = 11, Zy = 12).



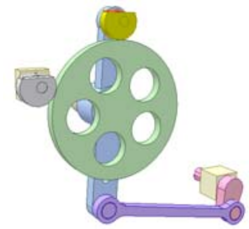
Ratchet mechanism for anti-reverse 1
http://youtu.be/rKYTr9NjgOA
Green ratchet wheel rotates only anticlockwise.
The reverse rotation is prevented by yellow flat spring.



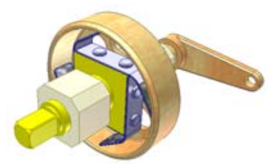
Ratchet mechanism for anti-reverse 2
http://youtu.be/g4vFJtps-_Q
Yellow ratchet wheel rotates only anticlockwise.
The reverse rotation is prevented by blue slider.

Ratchet mechanism for anti-reverse 3
http://youtu.be/14i2UWR87ik
Yellow face tooth ratchet wheel rotates only clockwise.
The reverse rotation is prevented by pink pawl.

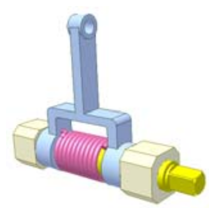
Friction ratchet mechanism 1
http://youtu.be/JWLXmY0QzP8
The yellow cam plays pawl's role. The friction force between the yellow cam and the green no-teeth wheel drives the latter.
No noise and backlash in comparison with ordinary ratchet mechanisms



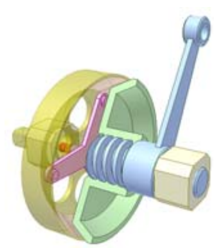
Friction ratchet mechanism 2
http://youtu.be/aCN-HEBsdYM
Input: orange oscillating drum.
Output: yellow shaft rotating interruptedly.
Four flat springs allow motion transmission only in anticlockwise direction.
The mechanism is for light duty works and where the kinematic relation between the input and output is not required strictly.



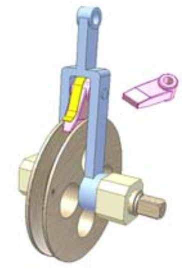
Friction ratchet mechanism 3
http://youtu.be/M-3eLefY3fw
Input: blue oscillating lever.
Output: yellow shaft rotating interruptedly.
One spring end is fixed to the blue lever. A slight grip between the spring and the yellow shaft is needed. Torsion spring allows motion transmission only in clockwise direction. The spring helix direction (right-handed in the video) decides the transmission direction.
The rotation direction that tends to wind up the spring is transmitted to the yellow output shaft due to friction force between the spring and the shaft.
For the inverse direction the yellow output shaft may rotate if there is no braking force or load applied to it.
The mechanism is for light duty works and where the kinematic relation between the input and output is not required strictly.



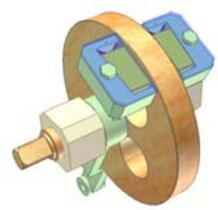
Friction ratchet mechanism 4
http://youtu.be/sRkZ_EgUIRQ
Input: blue oscillating lever with a threaded portion on its shaft.
Output: yellow inner cone disk rotating interruptedly.
The light friction of pink spring-loaded pins keeps the green outer cone disk (split for easy understanding) from rotating with the lever at moment when the lever changes it motion direction. Thus the green disk moves a little like a nut back and forth along the threaded portion of the lever. This motion creates or removes the contact between two disks (engagement or disengagement).
Thread direction (right-handed in the video) decides the transmission direction.



Friction ratchet mechanism 5
http://youtu.be/QCvbg2p0Uns
Input: blue oscillating lever.
Output: brown V-shaped groove wheel rotating interruptedly.
Yellow flat spring maintains contact between pink pawl and the wheel.

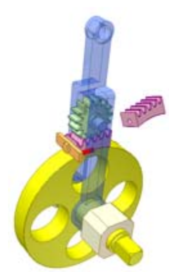


Friction ratchet mechanism 6
http://youtu.be/tlwmkvEeZLQ
Input: green oscillating lever.
Output: orange wheel rotating interruptedly.
Red flat spring maintain contact between yellow wedges and the wheel.



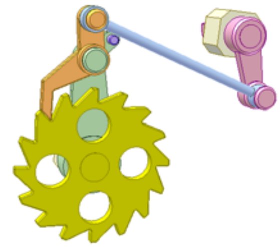
Friction ratchet mechanism 7
http://youtu.be/78I17ntJeqo
Input: pink crank.
Output: yellow wheel rotating interruptedly.
Violet pin keeps grey shoe in position during non transmission time.

Friction ratchet mechanism 8
http://youtu.be/4C8WE6frs9E
Input: blue oscillating lever.
Output: yellow wheel rotating interruptedly.
Gear force of the gear rack drive creates friction on the contact cylindrical surface between the rack and the wheel for transmission.
Orange plate prevents the rack from leave out during non transmission time.

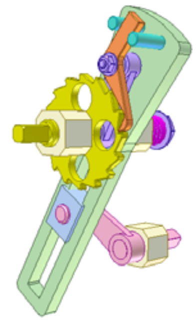


Friction ratchet mechanism 9
http://youtu.be/I0CpzCxGWEM
Input: yellow oscillating lever.
Output: blue shaft rotating interruptedly.
Pink pin can slide in the lever hole. Annular groove of the blue shaft contacts the pin flat bottom. Blue spring maintains this contact.
Transmission happens only when the input turns counterclockwise when the pin is wedged against the blue shaft.

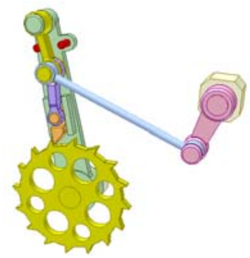
Quiet ratchet mechanism 1
http://youtu.be/xxsCE1E7jLI
Input: pink crank rotating continuously.
Output: yellow ratchet wheel rotating interruptedly.
Four-bar linkage (pink crank, blue conrod and block of orange pawl and green rocker) makes the green rocker oscillate.
A violet stopper is mounted on the green rocker.
Measure to create some breaking force for the green rocker is not shown.
The mechanism is quiet because when the rocker goes back, the pawl does not contact the wheel.



Quiet ratchet mechanism 2
http://youtu.be/OYhx7OXYKQA
Input: pink crank rotating continuously.
Output: yellow ratchet wheel rotating interruptedly.
Coulisse mechanism (pink crank, blue slider and green slotted rocker) makes the green rocker oscillate.
Violet crank has a pin for orange pawl. Pink spring creates some breaking force for the violet crank.
Two cyan pins on the green rocker contact the pawl.
The mechanism is quiet because when the rocker goes back, the pawl does not contact the wheel.



Quiet ratchet mechanism 3
http://youtu.be/9W9wgFsOVIA
Input: pink crank rotating continuously.
Output: yellow ratchet wheel rotating interruptedly.
Six-bar linkage (pink crank, blue conrod, yellow and violet levers, orange pawl and green rocker) makes the green rocker oscillate.
Two red stoppers are mounted on the green rocker.
Measure to create some breaking force for the green rocker is not shown.
The mechanism is quiet because when the rocker goes back, the pawl does not contact the wheel.



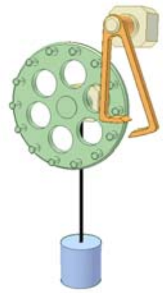
Escapement 1
http://youtu.be/fC8D_KzMGrk
Pink gravity pendulum performs a harmonic angular oscillation.
Green ratchet wheel tends to rotate clockwise due to blue weight.
The pink anchor allows the wheel rotate only two teeth during one oscillation of the pendulum.
Tick-tock sound is caused when the anchor collides the wheel teeth.
The mechanism is used in pendulum clocks where the wheel motion is transmitted to hands through a gear train to show time.

Besides the wheel transfers energy to the pendulum (timekeeper) to replace the energy lost to friction during its cycle and keep the timekeeper oscillating.

Escapement 2

http://youtu.be/S6ptnwOtpdQ

Orange pendulum performs a harmonic angular oscillation.
Green pin wheel tends to rotate clockwise due to blue weight.
The pendulum allows the wheel rotate only two teeth during one oscillation of the pendulum.



Escapement 3

http://youtu.be/D49F90k7_vE

Orange pendulum performs a harmonic angular oscillation.
Green pin wheel tends to rotate clockwise due to blue weight.
The pin number on each circle of the wheel is Z.
The pendulum allows the wheel rotate an angle of 360/Z deg. during one oscillation of the pendulum.

Escapement 4

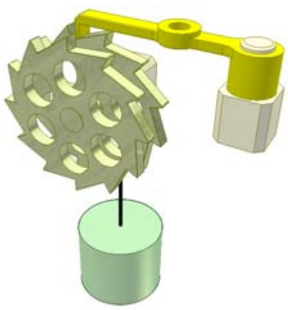
http://youtu.be/C26G-M_cNjI

Green pendulum performs a harmonic angular oscillation.
Blue wheel tends to rotate counterclockwise due to grey weight.
Two identify pawls are mounted on both sides of the pendulum.
The mechanism allows the wheel rotate two teeth during one oscillation of the pendulum.

Escapement 5

http://youtu.be/pN9COn0b4Dg

Yellow pendulum performs angular oscillation.
Twin ratchet wheel tends to rotate counterclockwise due to green weight.
The mechanism allows the wheel rotate one teeth during one oscillation of the pendulum.



2.4. Pin drives

Interrupted rotation 1
http://www.youtube.com/watch?v=WK2dRTJvN3o
1 revolution of the green shaft corresponds a half-revolution of the blue one.
The driving and driven shafts rotate in the same direction.
The shafts are parallel.

Interrupted rotation 2
http://www.youtube.com/watch?v=43FM0QRNS4Q
1 revolution of the green shaft corresponds one-sixth-revolution of the blue one.
The driving and driven shafts do not rotate in the same direction.
The shafts are parallel.

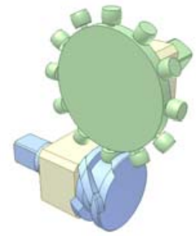
Interrupted rotation 3
http://www.youtube.com/watch?v=LsysC380Cdw
1 revolution of the blue shaft corresponds one-sixth-revolution of the green one.
The shafts are perpendicular to each other.

Interrupted rotation 4
http://www.youtube.com/watch?v=IX_TErmp4nc
1 revolution of the blue shaft corresponds one-third-revolution of the green one.
The shafts are perpendicular to each other.

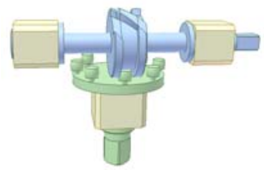
Interrupted rotation 5
http://www.youtube.com/watch?v=gG0dUrBT79k
1 revolution of the blue shaft corresponds one-fourth-revolution of the green one.
The two shafts are skew at angle of 45 degrees.

Interrupted rotation 6
http://youtu.be/8tSOQDxLYvo
1 revolution of the blue shaft corresponds one-fifteenth-revolution of the green one.
The two shafts are skew at angle of 90 degrees.

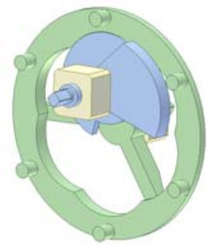
Interrupted rotation 7
http://www.youtube.com/watch?v=H5ZLztpr5uw
1 revolution of the blue shaft corresponds one-twelfth-revolution of the green one.
The two shafts are skew at angle of 90 degrees.



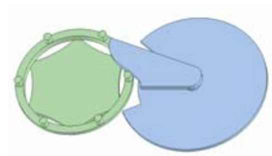
Interrupted rotation 8
http://www.youtube.com/watch?v=EX2Adzx53FE
1 revolution of the blue shaft corresponds one-twelfth-revolution of the green one.
The two shafts are skew at angle of 90 degrees.



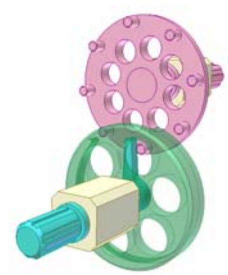
Interrupted rotation 9
http://www.youtube.com/watch?v=eT_bgIEK_7s
1 revolution of the blue shaft corresponds one-sixth-revolution of the green one.
The driving and driven shafts rotate in the same direction.
The shafts are parallel.



Interrupted rotation 10
http://www.youtube.com/watch?v=5RG3fCh4kqs
1 revolution of the blue shaft corresponds one-sixth-revolution of the green one.
The driving and driven shafts do not rotate in the same direction.
The shafts are parallel.



Pin gear drive 1N
http://youtu.be/B8dsC_QNyVg
Input: the cyan shaft having an arm.
Output: the pink pin wheel.
In 1 revolution of the cyan shaft, the arm makes the output rotate 1/8 rev. The green rim keeps the output immobile during its pause period.



Intermittent rotation mechanism

http://youtu.be/JdJNG3_dIQ8

Input: blue disk of two cyan pins rotating continuously.

Output: orange shaft of two three wing disks rotating interruptedly.

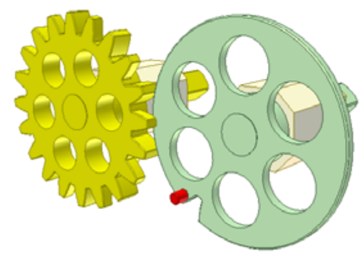
1 rev. of the input makes the output rotate 120 deg.

Beside keeping the output shaft immobile during its dwells, the blue disk also participates in motion transmission.

The mechanism can work for two rotation directions of the input. In case of one direction one cyan pin is enough.

Transmission with mutilated tooth gear

http://youtu.be/ITEHVWiZRPI



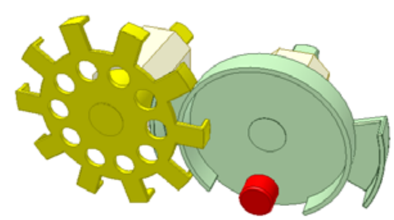
Green driving disk of width w has a tooth groove and a red pin nearby.

Yellow driven gear of width 2w has an even number of standard spur gear teeth. They alternately have full and half-width (mutilated) teeth.

During the dwell period, two full-width teeth are in contact with the circumference of the driving disk, thus locking the gear. The mutilated tooth between them is in front of the driver. At the end of the dwell period, the red pin contacts the mutilated tooth and turns the driven gear around one circular pitch. Then the full-width tooth engages the tooth groove and the driven gear moves around one more pitch. The dwell period starts again and the cycle is repeated. Totally in one revolution of the driver, the driven gear turns two circular pitches.

Interrupted rotation 11

http://youtu.be/bJFFoWd2Pr8



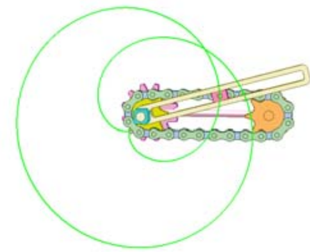
Input: green disk of a red pin.

Output: yellow gear interruptedly rotating.

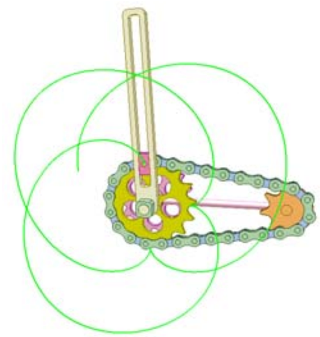
Inner cylinder on the green disk is for locking the output gear during dwell period. However shortly before and after the engagement of two teeth with red pin at the end of the dwell period, the inner cylinder is unable to cause positive locking of the driven gear. Consequently, a concentric auxiliary outer cylinder is added. Only two segments are necessary to obtain positive locking. Their length is determined by the circular pitch of the driven gear.

2.5. Bars and Cams

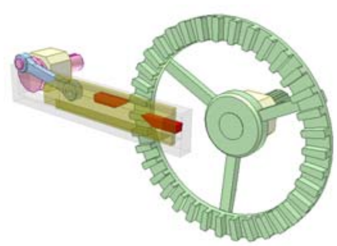
Chain drive 5B
http://youtu.be/spJVvyv9Oo0
The orange sprocket is immobile.
The pink gear and crank is driving. The coulisse rotates interruptedly with long dwells. Its motion depends on the ratio of tooth numbers of the two sprockets (8/8) and the chain link number (24). The green curve is locus of the center of the small slider.



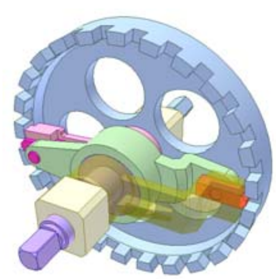
Chain drive 5C
http://youtu.be/ZRo3mszuHHw
The yellow sprocket is immobile.
The pink gear and crank is driving. The coulisse rotates interruptedly with long dwells. Its motion depends on the ratio of tooth numbers of the two sprockets (8/16) and the chain link number (28). The green curve is locus of the center of the small slider.



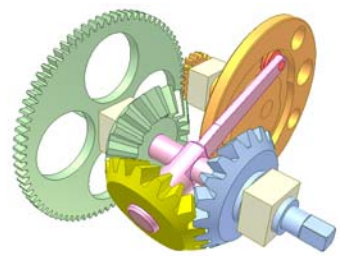
Translating cam and crank-slider mechanism 1
http://youtu.be/OTNmbroZkqc
Converting continuous rotary motion into intermittent rotary one.



Translating cam and crank-slider mechanism 2
http://youtu.be/QO2UoKZagIQ
Converting continuous rotary motion into intermittent rotary one.
Input is the violet shaft.
The green double conrod oscillates on eccentric portion of the violet shaft. The magenta slider moves in slot of the pink oscillating runway. The red slider moves in slot of the yellow fixed runway and keeps the blue output disk immobile during its dwells.
The blue output disk of Z slots rotates 1/Z rev. during 1 rev. of the input shaft.

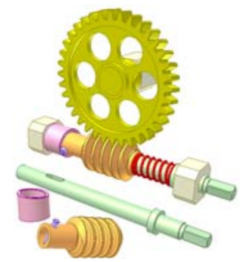


Cam and gear mechanism 4
http://youtu.be/jvAg5HHLPs4



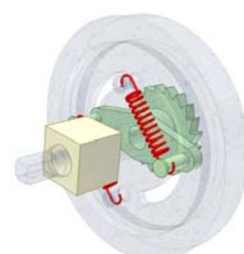
This is a combination of cam and bevel gear differential mechanisms. The bevel gears have the same tooth number.
Input is the orange spur gear shaft to which a cam is fixed.
The cam's profile is a symmetric double Archimedes curve.
The green spur gear shaft and the green bevel gear are fixed together.
Transmission ratio of the spur gear drive is 4.
The yellow bevel gear idly rotates on the pink arm carrying the red roller.
The blue output bevel gear has four dwells in one revolution of the green and blue bevel gears.

Worm Drive 5b: Rotating and translating worm
http://youtu.be/fI2cBpDs1tE



A worm drive, compensated by a cam on a work shaft, produces intermittent motion of the gear.
Input: green shaft.
Orange one start worm has prizmatic joint with the green shaft.
Pink cam is stationary. The cam profile consists of two helix curves of opposite directions. Pitch of the curves is equal to the worm pitch.
Red spring maintains contact between the cam and violet pin.
In one revolution of the input, the gear stays immobile and then turns one tooth.

Mechanism for converting interrupted rotation to continuous rotation 1
http://youtu.be/zjjv5NIT-54

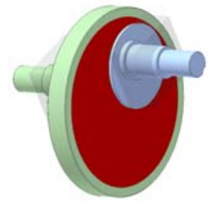


Input: green ratchet wheel of two spring pins rotating interruptedly.
Output: flywheel of two spring pins.
Flywheel inertia and spring connection between the input and output make the output rotate continuously.
Output motion irregularity depends on flywheel inertia and spring parameters.

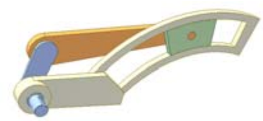
3. Converting continuous rotation into rotary oscillation

3.1. Bars

4-bar linkage mechanism
http://www.youtube.com/watch?v=4dHKbPAQEQY
Length of red connection rod is smaller than radius of its revolution joint with the green rocker.

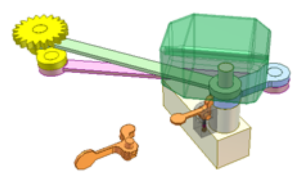


4-bar linkage mechanism
http://www.youtube.com/watch?v=mTxpSpPOUmU
Length of green rocker and radius of its revolution joint with the fixed link are equal.



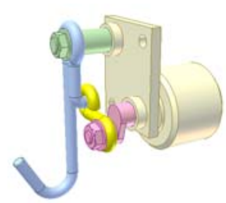
Fan swinging device
http://www.youtube.com/watch?v=lusvDse493g
A 4-bar linkage is used for fan swinging. The input link is the yellow connecting rod. The pink bar and the rotor house place the role of rockers.
For easy observation the transmission ratio is chosen less than in reality.

Four bar linkage 7
http://youtu.be/qwB-WuX2Z18
Four bars: blue, yellow, green and pink.
Input: the yellow bar rotating continuously.
Orange lever with positioning spring pin is for controlling the linkage.



When the orange lever enters in the slot of the blue bar, the latter is kept immobile and the green bar oscillates.
When the orange lever is not in the slot of the blue bar, the blue bar oscillates and the green bar does not move because of its huge mass.
The mechanism used to be applied for fan swinging control.
For example it can be used in this case:
https://www.youtube.com/watch?v=lusvDse493g

Auto rocker for hammock
http://youtu.be/gaD_Jl0YQHQ
Input: pink crank.
Output: blue rocker that has a hook serving as anchor point for hammocks or cradles.
Disadvantage: noise from revolute joints

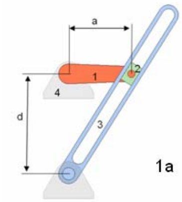


Coulisse mechanism 1

http://www.youtube.com/watch?v=dqt1jkwLgs0

a < d: the coulisse rocks

a: crank length; d: axle distance



Coulisse mechanism 6

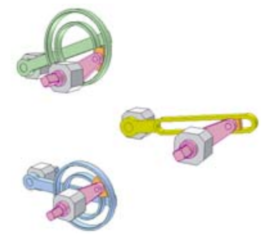
http://www.youtube.com/watch?v=RvyKFLZi2SM

Combination of two coulisse mechanisms.

The green rocker has working stroke slower than return one.

Coulisse mechanism with closed curve slot 1

http://youtu.be/qaion6T6nVg



Two identical mechanisms on the left give two different output motions due to different relative positions of the input and output at starting. Center distance of two grey fixed bearings and the eccentricities of circular slot of green and blue rockers are equal.

Input: pink cranks rotating regularly.

Upper mechanism: green rocker oscillates with large angle.

Lower mechanism: blue rocker is immobile.

The mechanism on the right is an ordinary coulisse one for comparison purpose.

Its yellow rocker oscillates with small angle.

Coulisse mechanism with closed curve slot 2

http://youtu.be/NwedertJEJI

Two identical mechanisms give two different output motions due to different relative positions of the input and output at starting.

Input: cranks (green and pink) rotating regularly.

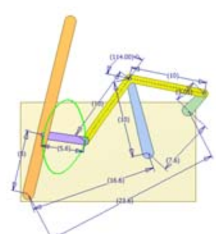
Upper mechanism: blue rocker oscillates with large angle.

Lower mechanism: yellow rocker oscillates with small angle and rather constant speed.

When the cranks and the rockers are in line, unstable positions happen. They can be overcome thanks to the rockers inertia.

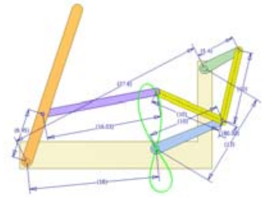
Dwell Rocker Linkage 1

http://youtu.be/rhyoWC6abSI

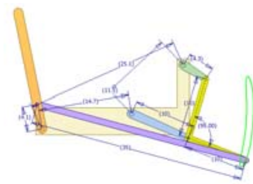


The green crank is the input. Choosing appropriate length of the violet rod in relation with the green locus enables the orange output rocker to have a long pause (half revolution of the green crank) at its rightest position.

Dwell Rocker Linkage 2
http://youtu.be/fECIXdX1G8M
The green crank is the input. Choosing appropriate length of the violet rod in relation with the green locus enables the orange output rocker to have a pause in the middle of its stroke.

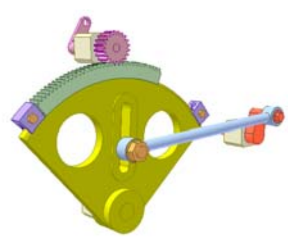


Dwell Rocker Linkage 3
http://youtu.be/ueyak6YAadE
The green crank is the input. Choosing appropriate length of the violet rod in relation with the green locus enables the orange output rocker to have a pause at the ends of its stroke.

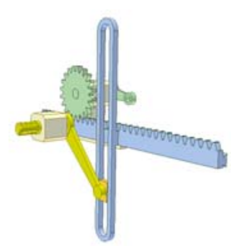


Six bar linkage of long output dwell
http://youtu.be/G9jeOxIRbY0
Input: orange crank.
Output: yellow rocker oscillating with long dwell at its extreme right position. This occurs because point C describes a green curve part that is approximately a circular arc with its center at P. The output is almost stationary during that circular arc.

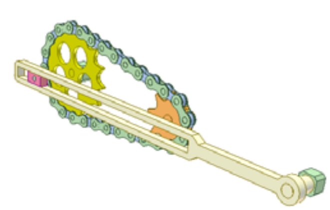
Dwell rocker mechanism 1
http://youtu.be/8h9mjKA5SjQ
The red crank is driving. The pink output gear shaft oscillates with dwell at its stroke ends. The oscillation angle and dwell time of the output depend on positions of the violet adjustable stoppers and position of the orange pin in the yellow sector slot.



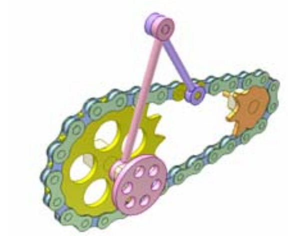
Sinus and rack pinion drive
http://youtu.be/BLTQ4cNahXs
Combination of a sinus mechanism (yellow crank and blue rack-slider) and rack-gear drive makes the green shaft oscillate with amplitude of 1 revolution.
The radius of the yellow crank is equal to Pi.D/2. D is pitch diameter of the green gear.



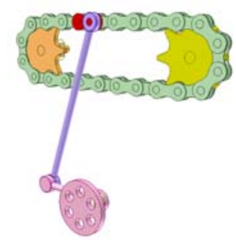
Chain drive 3A
http://youtu.be/WN01eHdUk_4
The coulisse rocks with long dwells at the ends of the stroke.

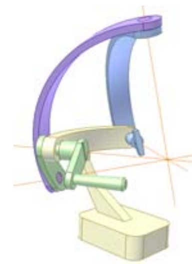


Chain drive 3B
http://youtu.be/_Xq5SSIjUwM
The orange sprocket is driving.
The motion of pink crank and disk depends on the ratio of tooth numbers of the two sprockets (8/16) and the chain link number (28).

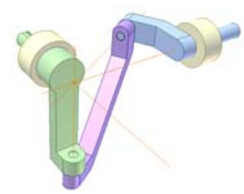


Chain drive 3C
http://youtu.be/V7sbSgITXVA
The orange sprocket is driving. The pink crank oscillates.

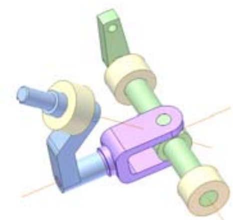




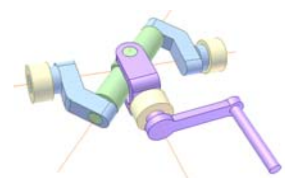
Spherical 4-bar linkage mechanism 1
http://www.youtube.com/watch?v=_fO4-0GOmS0



Spherical 4-bar linkage mechanism 4
http://www.youtube.com/watch?v=OE_BTQP3mE8
Axes of all revolution joints intersect at a common point.



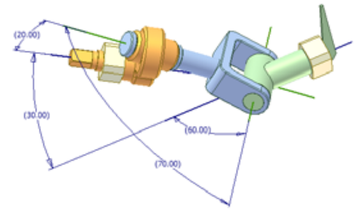
Spherical 4-bar linkage mechanism 5
http://www.youtube.com/watch?v=M7r-6CFFuK8
Axes of all revolution joints intersect at a common point.



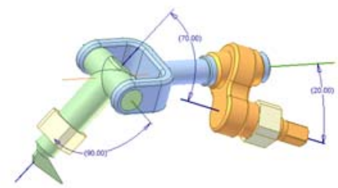
Spherical 4-bar linkage mechanism 6
http://www.youtube.com/watch?v=E8WxHclAyMw
Axes of all revolution joints intersect at a common point.

Spherical 6-bar linkage mechanism
http://www.youtube.com/watch?v=IF2btFdXEOA
Axes of all revolution joints intersect at a common point.

Spherical 4R mechanism 1
http://youtu.be/NnWwkSXiCBw
4R: 4 revolute joints.
Spherical: Joint center lines intersect at a common point.
Angle between center lines of revolute joints:
for the orange input link is γ = 20 deg.
for the green output link is β = 60 deg.
for the blue link is α = 70 deg.
for the base link is δ = 30 deg.
The output link oscillates.
Oscillation period is 2 rev. of the orange input link.

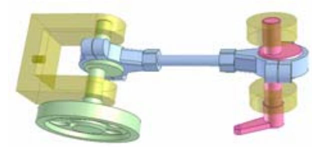


Spherical 4R mechanism 1a
http://youtu.be/mUB5VDFCZ44
4R: 4 revolute joints.
Spherical: Joint center lines intersect at a common point.
Angle between center lines of revolute joints:
for the orange input link is γ = 20 deg.
for the green output link is β = 90 deg.
for the blue link is α = 90 deg.
for the base link is δ = 70 deg.
The output link oscillates.
Oscillation period is 1 rev. of the orange input link.

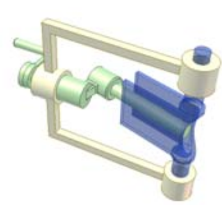


Space 4-bar mechanism 11 r
http://www.youtube.com/watch?v=-KYomnT8xSc
R-S-S-R mechanism
R-S-R-R: Joint symbols from input to output joint.
R: revolute
S: sphere
It does not meet Kutzbach criterion.

Spatial 4-bar linkage mechanism 2
http://www.youtube.com/watch?v=n44LvAEzovk
Shaft of bigger eccentricity is rocker.
Angle between two shafts is arbitrary.

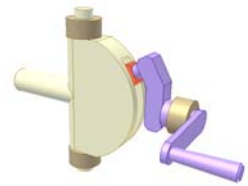


Spatial 4-bar linkage mechanism 4
http://www.youtube.com/watch?v=ZWgupzGoUP8

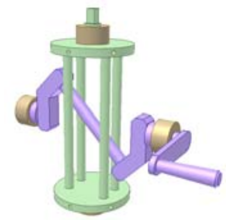


Oblique Crank - Rocker mechanism 1
http://www.youtube.com/watch?v=aYYJ-x_1nLg

Oblique Crank - Rocker mechanism 2
http://www.youtube.com/watch?v=pxQIrf1U7G8



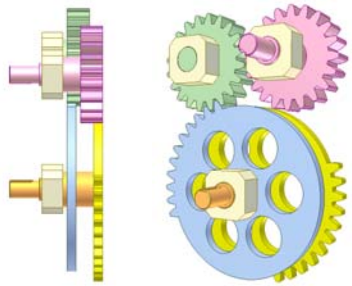
Oblique Crank - Rocker mechanism 3
http://www.youtube.com/watch?v=mrxWgPrdWNw



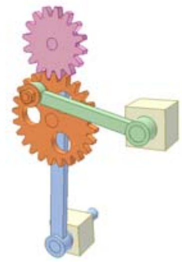
3.2. Gears

Transmission with teeth-uncompleted gears 12
http://youtu.be/ndwCVs9ssIo
The blue gear with external and internal teeth is driving. The orange gear oscillates with dwell. The dwell period is varied depending the tooth numbers of the blue gear.
The oscillation forward and backward angles may be different depending on numbers of external and internal teeth and stop positions of the orange gear.

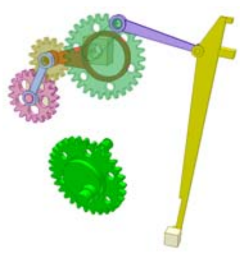
Transmission with teeth-uncompleted gears 11
http://youtu.be/cGcQhXtpFoY
The orange shaft splined with the blue and yellow gears is driving. The pink output shaft oscillates with dwell. The forward and backward angles may be different depending on the tooth numbers of the blue and yellow gears and stop positions of the pink and green gears.
The device to keep the output shaft immobile during its dwell is not shown.



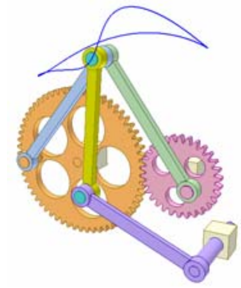
Gear and linkage mechanism 5
http://www.youtube.com/watch?v=zYdwKg6bYIc
Pink and orange gears (tooth numbers: 16 and 24) have revolution joints with the blue rocker. The orange gear has revolution joint with green rocker. The two rocker and the orange gear create a 4-bar linkage. When the pink input gear rotates regularly, two rockers (green and blue) oscillate. Their motion depends on the 4-bar linkage dimension.



Drive for weaving machine beater
http://youtu.be/n0rcMMRWuJk
Input is pink gear.
Output is yellow beater of a weaving machine.
Green gear rotates on its eccentric portion. The red bar has a revolution joint with the concentric portion of the green gear.
The drive enables the beater to perfom a quick push on the right and a long rest on the left.

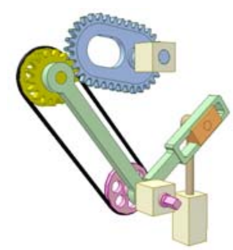


Gear and linkage mechanism 16
http://youtu.be/pPxXYyWJE44
Orange gear pitch diameter : 1.5R
Pink gear pitch diameter : 0.75R
Crank radius of orange gear : R
Crank radius of pink gear : 0.75R
Length of blue and green bars : 2.9R
Length of yellow bar : 2.6R
Length of violet crank : 2.5R
Distances between bearings: 2.25R + 1.5R + 3.2R
Assembly position: as start position of the simulation video.
Input : pink gear rotating regularly.
The violet crank oscillates with two dwells in one working period of 2 revolutions of the pink gear because the locus (in blue) of a cyan pin contains two portions of radius that is approximately equal to the yellow bar length.

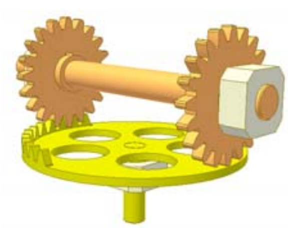


Triangular gear 1
http://youtu.be/y99G7yej3-Y
An input pink gear, rotating around fixed axis, engeges with a gear of triagular shape. The latter has revolution joint with blue output crank.
The crank oscillates with dwell. The gravity maintains gear engagement.

Oval gear 2
http://youtu.be/c3guaI5r2ks
A blue gear of oval shape, rotating around fixed axis, engages with yellow gear of a gear–pulley block. The latter has revolution joint with the green angle arm that can rock around a fixed axis.
Orange slider can reciprocate in the slot of the green angle arm.
Input is pink pulley. The blue oval gear rotates irregularly. Brown bar reciprocates with dwell.
Weight of the brown bar (or spring) maintains permanent engagement of the gear drive.
Input can be the blue oval gear. In that case the belt drive isn’t needed.

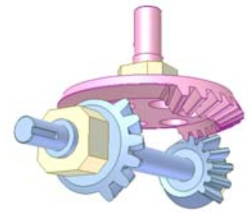


Transmission with teeth-uncompleted gears 14
http://youtu.be/ya7IC-0JyTg
The yellow gear is driving. The orange output shaft oscillates with dwell.
The tooth number of the yellow gear decides the oscillation angle and dwell time of the output.

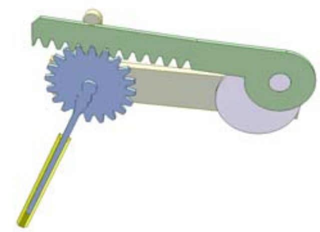


Transmission with teeth-uncompleted gears 15
http://youtu.be/eBIsbAaOOFc
The green gear is driving. The blue output shaft oscillates with dwell.
The tooth number of the green gear decides the oscillation angle and dwell time of the output.

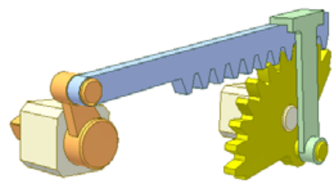
Transmission with teeth-uncompleted gears 16
http://youtu.be/pZihUvOKYko
The pink gear is driving. The blue output shaft oscillates with dwell. The tooth numbers of the pink gear and the blue gears decide the oscillation angle and dwell time of the output.



Application of rack pinion mechanism 2
http://www.youtube.com/watch?v=jNqET_RBLrs
Car windscreen wiper mechanism.

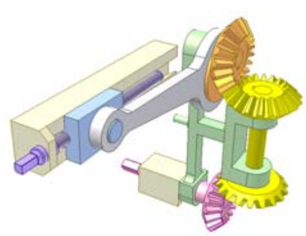


Rack and gear sector
http://youtu.be/IZddfZssoco
Input: orange crank
Output: yellow gear sector oscillating.
Green part maintains the engagement between blue rack and the gear sector.
The unusualness is: the gear sector oscillates around an eccentric axis, not its geometrical one. For comparison see:
http://www.youtube.com/watch?v=jNqET_RBLrs



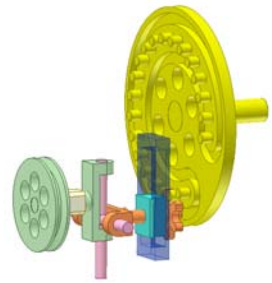
Reverse gear drive with dwell 1
http://www.youtube.com/watch?v=2fVz5KIZIlo
Oscilating angle of two gears depends on:
- Position of the orange pin on the yellow input crank.
- Length of the bars attached to the gears.

Two rocker mechanism with bevel gears
http://youtu.be/zv-yK7XECYE
Two rockers (in grey and green) oscilate while the input pink gear rotates continuously.
Bevel gears have the same tooth number. The orange gear shaft has an eccentric for the grey rocker. It is case of four-bar linkage, in which the conrod (orange eccentric) is the driving link.
To slow down the rocker oscillation, the transmission ratio of bevel gear drives can differ from 1.
Move the blue slider by turning the violet screw for getting various course positions of the green rocker.
Instead of bevel gear drives, worm or helical gear ones can be used.



Pin gear drive 4A

http://youtu.be/kz2vm9FCtjY

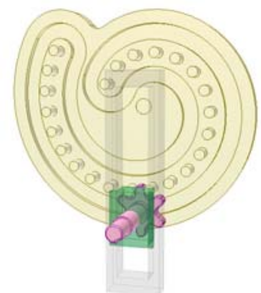


The orange pinion is input. Its shaft has an end sliding in the closed circular slot of the yellow pin wheel. Because of meshing force the cyan slider carrying the orange pinion reciprocates. The yellow pin wheel oscillates with constant speed.

The rotation from a stationary source (the green pulley) is transmitted to the orange pinion through the Oldham coupling.

Pin gear drive 4B

http://youtu.be/lo1c0V4GO-I



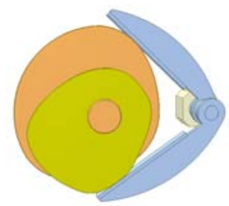
The pink pinion is input. Its shaft has an end sliding in the closed curved slot of the yellow pin wheel. Because of meshing force the green slider carrying the pink pinion reciprocates. The yellow pin wheel oscillates with varied speed. The angle of oscillation can be more than 360 deg.

The rotation from a stationary source is transmitted to the pink pinion by suitable mechanisms: double Hook's joint, Oldham coupling, …

3.3. Cams

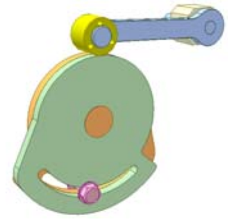
Disk cam mechanism DRr1
http://youtu.be/vWIyxkMVBwc
Dual cam.
The main cam is orange. The yellow one is added for cam geometrical closure.
Its profile must be designed to maintain permanent contact of both rollers with cams.

Disk cam mechanism DRp1
http://youtu.be/a9GfqAILs1Q
Dual cam.
The main cam is orange. The yellow one is added for cam geometrical closure.
Its profile must be designed to maintain permanent contact of both follower's planes with cams.

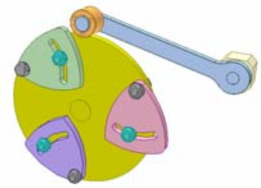


Cam mechanism of output with large oscillation angle
http://youtu.be/e6jSX1CbgVw

Disk cam assembly 1
http://youtu.be/Fo1XpEgY6MY
The cam assembly consists of orange cam and green one. They are fixed together by pink bolt. Their relative position can be adjusted to get various dwell times of the blue follower. Gravity maintains permanent contact between rollers and cam.

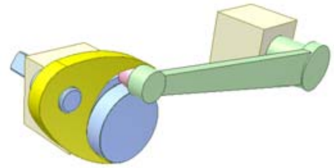


Disk cam assembly 2
http://youtu.be/paCOPz_h4jM
The cam assembly consists of a yellow round disk and some triangular cams. They are fixed together by cyan bolts. Their relative position can be adjusted to get various motions of the blue follower. Gravity maintains permanent contact between rollers and cam.



Disk cam mechanism DR1a

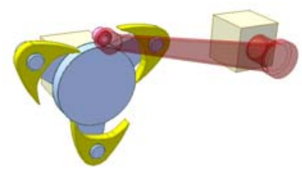
http://youtu.be/Ru1jSCA9pfk



The cam consists of two parts: blue round disk and yellow cam.
Green follower moves one time during two revolutions of the cam.
The weight forces the follower toward the cam. Spring force is another possible way. There must be sufficient friction between the yellow cam and the blue pin to avoid accidental motion of the yellow cam.
The idea of this video is taken from
http://www.youtube.com/watch?v=M7H-wnHxxXU
by the introduction of a Youtube user, TheWindGinProject.

Disk cam mechanism DR1b

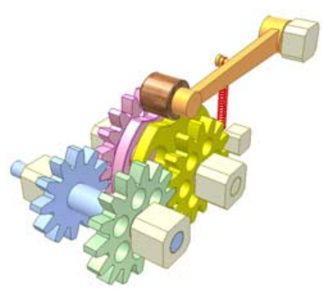
http://youtu.be/eNyDPvqZBVs



The cam consists of a blue round disk and n (=3) yellow cams.
The red follower is immobile during one revolution of the blue disk and then moves n (=3) times during the next revolution.
The weight forces the follower toward the cam. There must be sufficient friction between the yellow cams and the blue pins to avoid accidental motions.

Fast cam follower motion

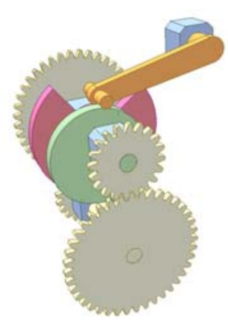
http://youtu.be/Zs4gKdqFwGk



Input: blue shaft with two gears fixed on it.
Yellow block and pink block rotates idly on a fixed shaft. Each block has identical cam. The yellow rotates faster tha the pink.
Output: orange rocker. Its roller contacts both cams. Motion of the follower is as fast as in case there is no the pink cam but the working cycle is long (every three revolutions of the yellow cam).
Tooth number of the blue gear 12
Tooth number of the pink gear 18
Tooth number of the green and yellow gears: 15
The cycle can be very long by altering gear tooth numbers.

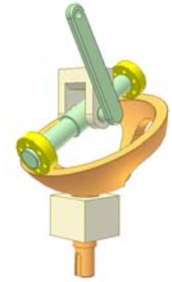
Cut-out cam

http://www.youtube.com/watch?v=4RJhFvLlrOo

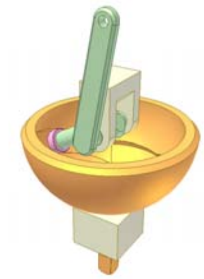


A rapid rise and fall within 90 deg. was desired. This originally called for the pink cam contour but produced severe pressure angles. The condition was improved by providing an additional green cam which rotates 4 times faster than the pink cam.
The pink cam was then completely cut away for the 90 deg. The desired motion, expanded over 360 deg. (90x4=360), is now designed into the green cam. This results in the same pressure angle as would occur if the pink cam rise occurred over 360 instead of 90 deg.

Sphere cam 1
http://youtu.be/_UId85q0hCc
Roller axis, crank axis and cam rotary axis intersect at the center of the cam sphere.

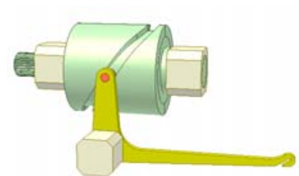


Sphere cam 2
http://youtu.be/HsIk7-EIVis
Roller axis, crank axis and cam rotary axis intersect at the center of the cam sphere.

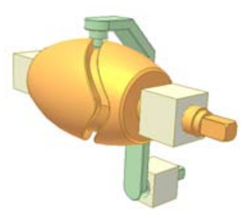


Sphere cam 3
http://youtu.be/scnSa6f6QCE
Roller axis, crank axis and cam rotary axis intersect at a point that is not the center of the cam sphere. The roller must be long enough to maintain contact between follower and cam that are of gravity constraint:

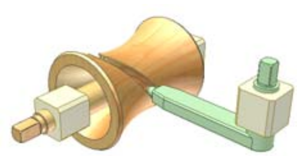
Barrel cam mechanism BR1
http://youtu.be/qYRU5eu1HHI
A barrel cam with milled grooves is used in sewing machines to guide thread. This kind of cam is also used extensively in textile manufacturing machines such as looms and other intricate fabric-making machines.



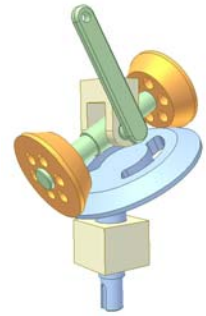
Globoid cam 1
http://youtu.be/sYJ3BoLOXBw



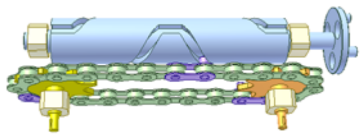
Globoid cam 2
http://youtu.be/jHDk9hKQ4M8



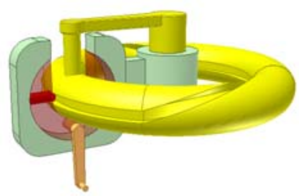
Oblique disk-rocker mechanism
http://www.youtube.com/watch?v=6CxfiO_afzo
A spherical mechanism: axes of all revolution joints intersect at a common point.
Rotation of the small bevel wheels around their axes is irregular.



Barrel cam mechanism BT7
http://youtu.be/gV9H8Gjp8KU
Rotational motion is converted into oscillating motion with dwells. When moving in the cam's groove, the violet chain's pins has linear motion.



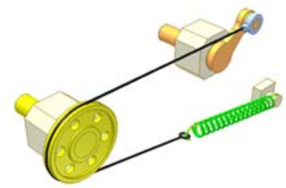
Torus cam
http://youtu.be/mCRdbEv3ACI
Helix torus joint.
Converting continuous rotation into oscillation between two 90 deg. skew shafts. The oscilating angle can be more than 180 deg.



3.4. Belts and cables

Cable drive 13a

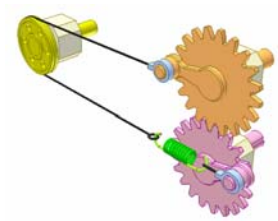
http://youtu.be/cHOMfNQPThY



A simple way to convert continuous rotation to oscillatory motion.
The spring creates friction between the yellow wheel and the cable.
It acts like the mechanism in video "Application of rack pinion mechanism 2" of this channel.
However in case of large motion the spring deformation is too big that causes unnecessary load on the bearings. See "Cable drive 12b" and "Cable drive 12c" of this channel for the ways to overcome this weakness.
The oscillatory angle can be more than 360 deg. by reducing the yellow wheel diameter.

Cable drive 13b

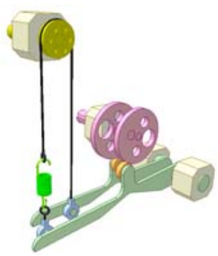
http://youtu.be/7IOxH017ZvU



Converting continuous rotation to oscillatory motion.
Using one crank more and gear drive reduces the spring deformation.
See "Cable drive 12a" of this channel for comparison.
Beside creating friction between the yellow wheel and the cable, the spring compensates velocity difference of the cable ends caused by the two cranks.

Cable drive 13c

http://youtu.be/2ECoeKLEj_c



Converting continuous rotation to oscillatory motion.
Using twincam and two levers reduces the spring deformation. See "Cable drive 12a" of this channel for comparison.
Beside creating friction between the yellow wheel and the cable, the spring ensures a permanent contact between rollers and cam and compensates velocity difference of the cable ends caused by the two levers.

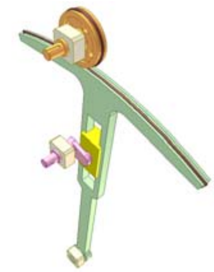
Chain drive 8B

http://youtu.be/yuTpsIrrljY

Converting continuous rotation into oscillation with dwells at one end of the course.
Three sprockets are identical. The pink one is driving. The violet chain link has an axle for a revolution joint with the red slider.
The dwell time depends on axle distance of two blue sprockets.

Cable drive 25

http://youtu.be/y8Squ43mUrE



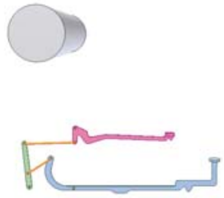
Converting continuous rotation of the pink crank to reciprocating rotation of the orange pulley.

The brown cable wraps 1 revolution around the orange pulley. Two cable ends are fixed to the green sector.

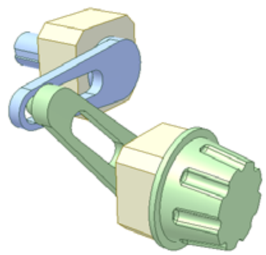
Rotation angle of the output orange pulley can be more than 1 revolution.

4. Altering rotary oscillations

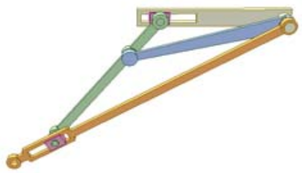
Typewriter drive
http://www.youtube.com/watch?v=jYhkRX--2zI
Two four-bar linkages are connected in series. The finger force of a typewriter is multiplied producing a strong hammer action at the roller from a light touch.



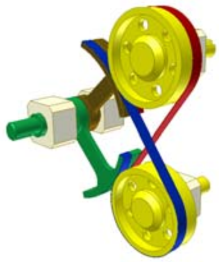
Angle doubling drive
http://youtu.be/zwYQ9fy5CtQ
This angle doubling drive will enlarge the oscillating motion of one machine member into an output oscillation of the other. If gears are employed, the direction of rotation cannot be the same unless an idler gear is installed. In that case, the centers of the input and output shafts cannot be too close. Rotating the input link clockwise causes the output to follow in a clockwise direction. For any set of link proportions, the distance between the shafts determines the gain in angle multiplication.
The video shows case when the green link rotates 90 deg., the blue rotates 180 deg.



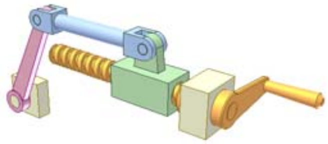
Slider crank and coulisse mechanism 1
http://youtu.be/SdwIGoJ-3ag
Input: blue crank that has turning angle α.
Output: orange bar that has turning angle β.
α, β = 0 when the blue crank and the orange bar are in line with the fixed runway.
Distance between revolution joints of the green bar is 16 + 6.
Distance between revolution joints (length) of the blue crank is 20.
In the α range from 0 to 20 deg., β is nearly double α with max error of 5%.
The mechism can be applied for controlling ball retainer in Rzeppa joints.



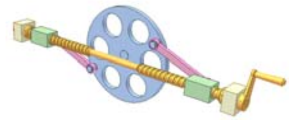
Cable drive 14
http://youtu.be/DaQR9lI_YMo
Input: The brown crank having oscillating rotational motion.
The green crank has the same motion but of inverse direction.
Two yellow wheel has oscillating rotational motion of opposite direction.
Each belt (red and blue) has one end fixed to the brown crank, the other to green one.



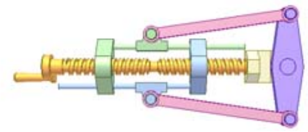
Nut-screw and bar mechanisms 1a
http://youtu.be/gFAj1TZCLMs



Nut-screw and bar mechanisms 1b
http://youtu.be/asan09b1Gsc



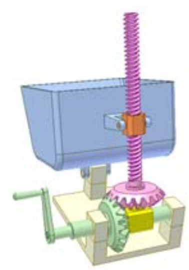
Nut-screw and bar mechanisms 1c
http://youtu.be/oA487meC_1w



Nut-screw and bar mechanisms 2a
http://youtu.be/xE8pSM9MIyo

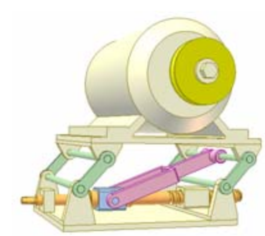
Nut-screw and bar mechanisms 6
http://youtu.be/_q5iKo63rjQ
Nut-screw brake.

Nut-screw and bar mechanisms 2b
http://youtu.be/FVahgIFr51c
Device for emptying a tank.



Nut-screw and bar mechanisms 3
http://youtu.be/o4N6iviUdgs

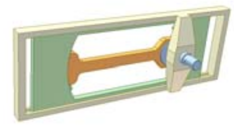
Nut-screw and bar mechanisms 7
http://youtu.be/fBJr9DMLQtQ
Belt tensioner.



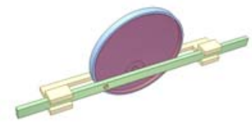
5. Converting continuous rotation into linear motion

5.1. Bars

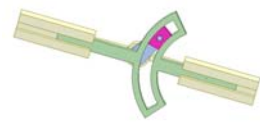
Slider-crank mechanism
http://www.youtube.com/watch?v=OltIA-RI86A
Rotary joint between the conrod (in orange) and the slider (in green) is larger than the conrod length.



Slider-crank mechanism
http://www.youtube.com/watch?v=0nnS8ycMVNA
Rotary joint between the conrod (in violet) and the crank (in blue) is larger than the conrod length.

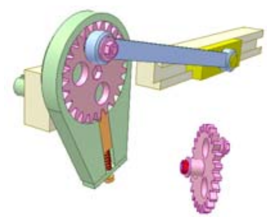


Slider-crank mechanism
http://www.youtube.com/watch?v=aJx1iQHzB6E
Rotary joint between the conrod (in pink) and the slider (in green) is larger than the conrod length.

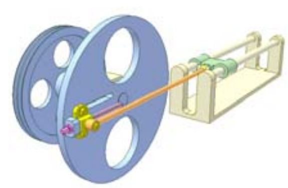


Crank slider mechanism 2
http://youtu.be/Dv6m1AFejJ4
Blue piston-rod is prolonged and works in a guide, which is in line with the center of yellow fixed cylinder. The lower part of green connecting-rod is forked to permit the upper part of the piston-rod to pass between. So the piston is guided very well.

Mechanism for adjusting crank radius 1a
http://youtu.be/xaMjCjWGpws
Radius of green crank is adjusted by turning pink gear after retracting the orange pin. The red nut at the back of the pin gear is for clamping the gear after adjustment.

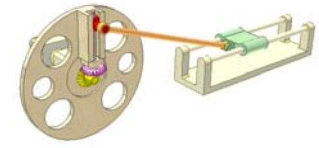


Mechanism for adjusting crank radius 2a
http://youtu.be/MCoOX06KnGo
Input: blue shaft.
Output: green slider linearly reciprocating.
The video shows the changing stroke length of the green slider by turning pink screw to change crank radius.



Mechanism for adjusting crank radius 2b

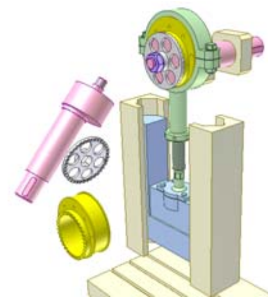
http://youtu.be/gpLN-fB08Vs



Input: beige disk carrying red slider-pivot.
Output: green slider linearly reciprocating.
Turn yellow bevel gear to change position of the red slider-pivot on the disk (to adjust crank radius) to get various output strokes.
Device for fixing the red slider-pivot to the disk after adjusting is not shown.

Mechanism for adjusting crank radius 1b

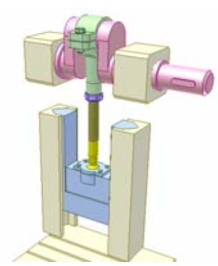
http://youtu.be/jLMNtKjM2CE



Input: pink eccentric shaft.
Output: blue slider linearly reciprocating.
Yellow eccentric bush is idly mounted on the eccentric of the pink shaft. Turn the yellow bush to get various angular positions in relation with the pink shaft, corresponding various stroke lengths of the output.
The grey gear disk and violet nut are for fixing the yellow bush and the pink crank together after adjustment.
Stroke position can be adjusted thanks to screw and round nut of the green conrod.
The video shows the process to reduce stroke length from max value to shorter one.

Slider-crank mechanism for adjusting stroke position 1

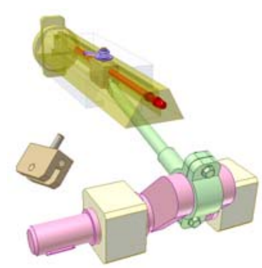
http://youtu.be/JMIEaNwuMEk



Input: pink crankshaft.
Output: blue slider linearly reciprocating.
Turn yellow screw to alter length of the assembly conrod (yellow screw, green bush and violet nut) for adjusting stroke position of the blue slider.
The violet nut is for fixing the conrod members together after adjusting.

Slider-crank mechanism for adjusting stroke position 2

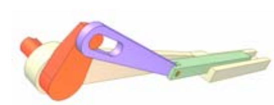
http://youtu.be/6iNz9Q6-0oc



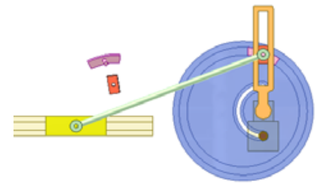
Input: pink crankshaft.
Output: yellow slider linearly reciprocating.
Turn red screw to alter position between the yellow slider and the brown inner slider for adjusting stroke position of the yellow slider.
The violet nut is for fixing the two sliders together after adjusting.

Slider-crank mechanism having a pause at both ends of stroke 2

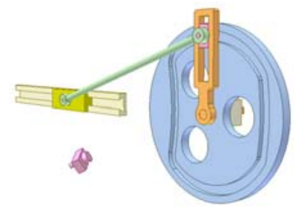
http://www.youtube.com/watch?v=TTbWZcg1N6c



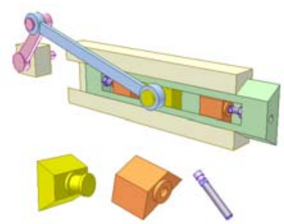
Slider crank mechanism with eccentric
http://youtu.be/zR_i_DdRlm0
Input is the orange crank.
Turn the blue eccentric and fix it to get various positions of the slider course.



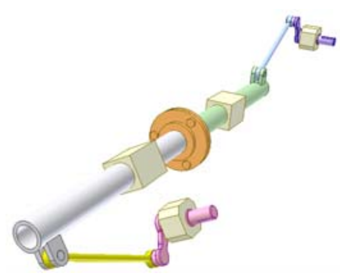
Slider crank mechanism with face groove cam
http://youtu.be/RFaLPuKkyAE
Input is the orange crank.
The blue cam is fixed. The cam proflie has two portions, radii of which are equal to the length of the green connecting rod. Thus the yellow slider reciprocates with dwells at both ends of it course.



Slider-crank mechanism having a pause at both ends of stroke 3
http://youtu.be/s0Lx-6c9JYk
Input: pink crank.
Output: green slider that linearly reciprocates with dwell at both ends of stroke.
Yellow slider moves along the dovetail shaped groove of the green slider.
Violet screws are for adjusting positions of orange sliders to get various stroke lengths of the green slider.
Ball spring devices for positionning the green slider at its end positions are not shown.

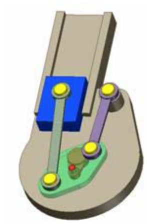


Transmitting rotation by two slider-crank mechanisms
http://youtu.be/OxVwOoN3eRI
There are two identical slider-crank mechanisms. Their positions in relation with the slider centerline are identical too.
Input: the pink crank rotating regularly.
Output: the violet crank.
Rotation direction of the output crank depends on its start position.
- If the two cranks rotate in opposite directions, the output crank rotates regularly as per this video.
- If the two cranks rotate in the same direction, the output crank rotates irregularly.

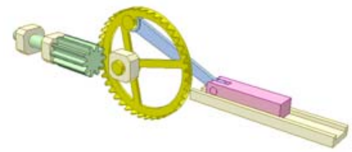


This phenomeno has been seen for parallelogram and anti-paralellogram mechanisms.
Measure to overcome dead points for the output crank is necessary (not shown).
This mechanism shows that slider-slider mechanisms can transmit rotary motion between two skew shafts of large center distance, subject to slider length. However the slider large inertia is a problem.
The revolution joint (in orange) between two sliders is for easy setting relative position of two crank shafts.

Slider-crank mechanism with added double crank
http://www.youtube.com/watch?v=fBS00ak30OU
The slider's stroke length is nearly 4 times of the red crank length.

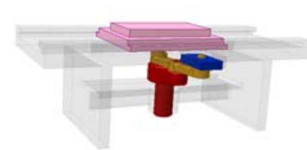


Face gear 15
http://youtu.be/2Y8jBdF8U-4



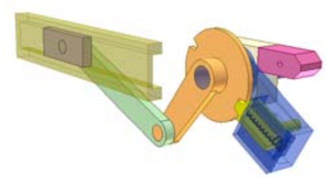
The face gear is placed eccentrically to the shaft, therefore the relative radius changes. Due to variable circular motion of the face gear the pink slider's left to right motion is faster than right to left one.
The face width of the face gear must be small to enable gear meshing.

Slider-crank mechanism with added double crank
http://www.youtube.com/watch?v=Glm8FxatmNI



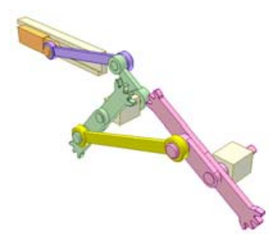
The slider's stroke length is 4 times of the red crank length.

Dwell Slider Mechanism 2
http://youtu.be/mq3jsfBg2OI



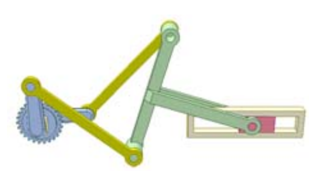
The input blue crank carries the yellow pawl which engages two slots of the orange disk to make the violet slider reciprocate with dwell in the middle of its stroke. The pink cam controls the pawl by pushing the pawl pin.
1 working cycle of the mechanism corresponds 2 revolutions of the blue input crank.
Angle between the two slots on the orange disk is not 180 deg.
The device (a ball plunger) to keep the slider immobile during its dwell is not shown.

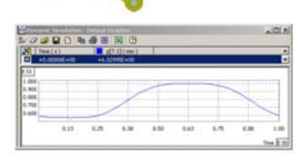
Inverse parallelogram mechanism 15
http://youtu.be/QmEalhjP8f0



Input: pink crank rotating regularly.
Output: orange slider.
Combination of inverse parallelogram mechanism and slider crank one gives the output an almost regular velocity during its forward stroke.
Added gears help the inverse parallelogram mechanism overcome unstable positions.

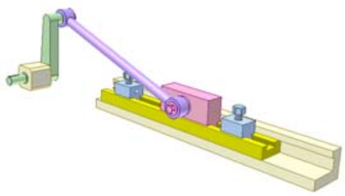
Slider-twin crank mechanism having a pause at both ends of stroke
http://www.youtube.com/watch?v=IkwYHs2Lba0



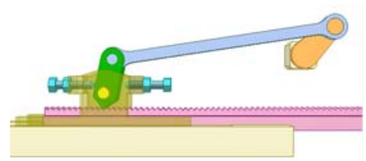


Angle between two cranks is 90 degrees.
Crank length = 8, Conrod length = 21
T-shape link is an isosceles triangle. Length of the bottom side = 21. Length of altitude to the bottom side = 18
Eccentricity = 0
The dwell period at each end of stroke is around 10% of cycle time.
The graph shows slider position.

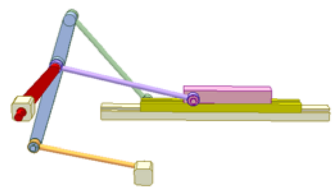
Dwell slider mechanism 4
http://youtu.be/YJhMMj3u73M
The green crank is driving. The yellow output slider reciprocates with dwell at its stroke ends.
The stroke length and dwell time of the out put slider depend on positions of the blue adjustatble stoppers. For max stroke length: distance between the stoppers equals to the pink slider length.



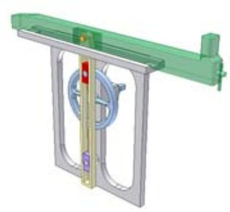
One way linear clutch 1
http://youtu.be/beMNGEcYTvc
The yellow slider reciprocates but the pink rack moves to the left only.
To adjust the blue screws positions for the move to the right.



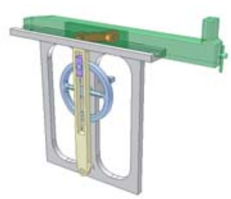
Double slider crank mechanism
http://youtu.be/r92k9A3sgrg
The pink slider moves on the yellow one. The latter moves on stationary runway. Both sliders are driven from the red driving crank. The stroke of the yellow slider is longer than the one of the pink slider. Their dead points are a little different in term of phase.
This mechanism is applied in wire bending machines.



Shaper with Coulisse mechanism 1
http://www.youtube.com/watch?v=hZEdBbc-JMo
Reciprocating motion having working stroke slower than return one.



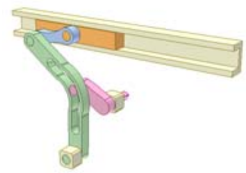
Shaper with Coulisse mechanism 2
http://www.youtube.com/watch?v=5cb7D9pLcq4
Reciprocating motion having working stroke slower than return one.



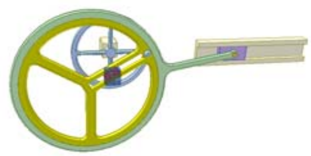
Shaper with Coulisse mechanism 3
http://www.youtube.com/watch?v=Icbya3378qE
Reciprocating motion having working stroke slower than return one.

Mechanism for increasing stroke length 3
http://youtu.be/ITYKygWmD9Q
Input: orange crank rotating regularly.
Output: grey bar linearly reciprocating with adjustable stroke length.
Yellow lower slider has revolution joint with pink slider.
Adjust position of the pink slider on the fixed runway to get various stroke lengths of the output.
The video shows stroke length reducing process when the mechanism is running.

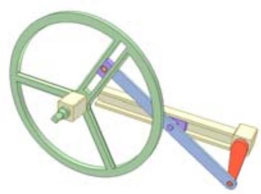
Coulisse mechanism of curved slot
http://youtu.be/J7BHvTM7gcA
The circular arc on the oscillating link permits the link to reach a dwell during the right position of the output slider.



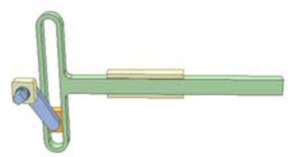
Coulisse mechanism 4
http://www.youtube.com/watch?v=zPh2EzvuVNc
Combination of a coulisse mechanism and a slider-crank mechanism.
Reciprocating motion has working stroke slower than return one.



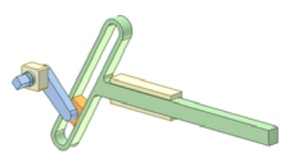
Coulisse mechanism 5
http://www.youtube.com/watch?v=yha4fgFOP0k
Combination of a coulisse mechanism and a slider-crank mechanism.
The green wheel has complicated rotation.



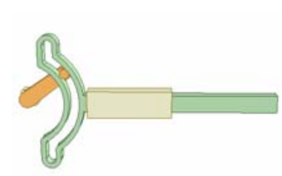
Sine mechanism 1
http://youtu.be/VALy2PIBuM4
Relation between the rotation angle of the crank and the position of the green slider is a sinus function.



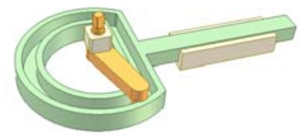
Sine mechanism 2
http://youtu.be/5GXZ2AzRJqE
Sine mechanism of inclined slot has the same stroke length as the one of uninclined slot but the rotation angles of the crank to reach the extremities of the slider are different.



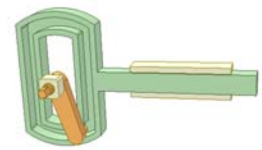
Sine mechanism of curved slot 1
http://youtu.be/VPZO7txZIZU
The circular arc on the reciprocating link permits the link to reach a dwell during its right position.



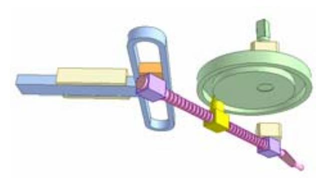
Sine mechanism of curved slot 2
http://youtu.be/BpU7YqW2eH4
The circular arc on the reciprocating link permits the link to reach dwell at its left position.



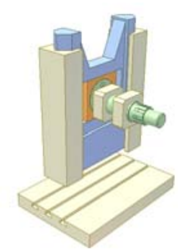
Sine mechanism of curved slot 3
http://youtu.be/Jb03Ru6E-UA
The circular arc on the reciprocating link permits the link to reach dwell at its center position.



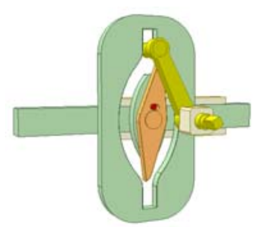
Sine mechanism 4
http://youtu.be/O4qYJ77Zbq0
Rotate the pink screw to adjust stroke of the blue slider.



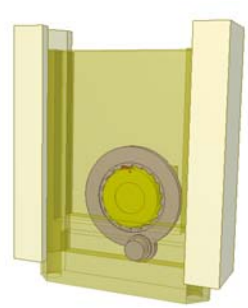
Sine mechanism 3: Press
http://youtu.be/TZR7ccjy9VQ
This kind of press can give 2500 ton forging force, 40 strokes per minute.



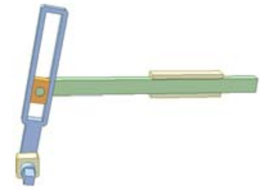
Cam and sine mechanism 2
http://youtu.be/CufL-cYm6eM
The green slider reciprocates with dwells at both ends of its stroke. The orange rhomb-shaped guide helps the yellow crank's pin enter into both round slots alternately. A spring forcing the guides against the red pin clockwise is not shown.



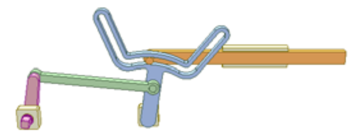
One way clutch 7: Press
http://youtu.be/pOYoSy33Lg4
The yellow input shaft carrying the red pawl rotates continuously anti-clockwise. The violet disk (ratchet wheel) has a pin that slides in a slot of the yellow slider.
The slider goes up by the ratchet mechanism action but goes down by its weight (when the slider moves faster than the input shaft) so that the motion cycle time is reduced. For this prototype, 4 revolutions of the input shaft correspond 7 double strokes of the slider.
The ratchet mechanism can be replaced by a roller clutch of video:
http://youtu.be/umaTetoaAao



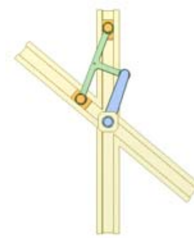
Tangent mechanism
http://youtu.be/DymKkYp-W-A
Relation between the rotation angle of the blue crank and the position of the green slider is a tangent function. No link can have full rotation



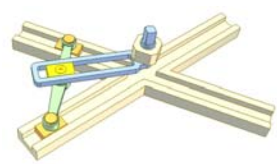
Tangent mechanism of curved slot
http://youtu.be/0wMIH4x0OKo
Combination of 4R mechanism and tangent mechanism. The latter has curved slot so the slider has a dwell in the middle of its stroke.



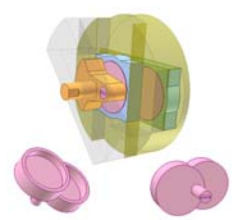
Ellipse mechanism 1a
http://youtu.be/gnJSN0T4AUw
Ellipse mechanism with non 90 deg. angle between sliding directions. Position of joint between the blue crank and the green connecting rod and radius of the blue crank must be selected based on the description in
http://www.youtube.com/watch?v=8WCee-fP9rg



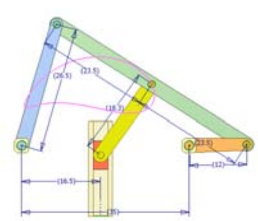
Ellipse mechanism 1b
http://youtu.be/0h0ofdDauQE
Ellipse mechanism with non 90 deg. angle between sliding directions.



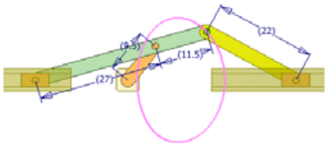
Ellipse mechanism 2
http://youtu.be/n59bLDYTEFE
Ellipse mechanism with 90 deg. angle between sliding directions. Stroke length of the blue and green sliders equal four times of the pink crank radius.



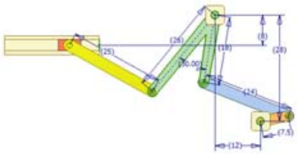
Dwell Slider Linkage 1
http://youtu.be/IDL-D7DMOc0
Length of the yellow conrod approximates to the radius of curve segment of the pink locus. The orange slider has dwell at its upper position.



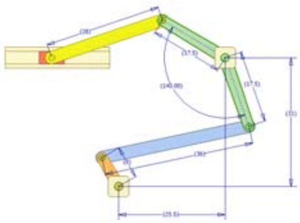
Dwell Slider Linkage 2
http://youtu.be/bAhpxjeDOBY
Length of the yellow conrod approximates to the radius of curve segment of the pink locus. The orange right slider has dwell at its left position.



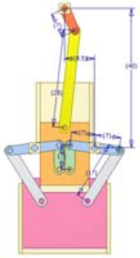
Dwell Slider Linkage 3
http://youtu.be/UBwra_MjI5g
The slider dwells at its leftest position, when toggle positions of the conrods happen one after another at the same time. The mechanism is used in screw making machines



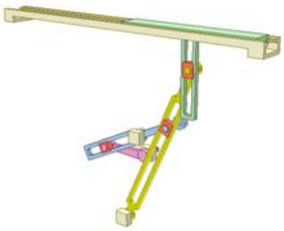
Dwell Slider Linkage 4
http://youtu.be/XI0HrvyT504
The slider dwells at its leftest position, when toggle positions of the conrods happen one after another at the same time.



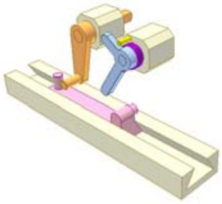
Dwell Slider Linkage 5
http://youtu.be/hP4hEeiqS4Y
This mechanism is used in deep stamp machines.
The outer slider has long dwell during 1/3 revolution of the red crank.



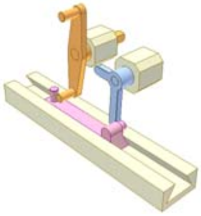
Double coulisse mechanism 1
http://youtu.be/m2_HCp8DmNU
Input is pink crank of constant velocity.
Output is green slider of forwards slow constant velocity motion to the left and quick return. The mechanism can be applied for shapers (machine tools)



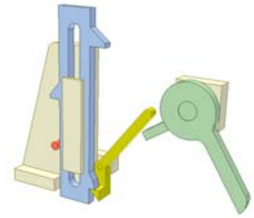
Slider crank mechanism with elbow-lever 1
http://youtu.be/QHqbYz8IBTI
Input: orange crank having a stud.
Output: pink slider linearly reciprocating with dwell at its leftest position.
Blue elbow-lever returns to its initial position thanks to violet coil spring.



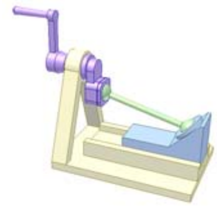
Slider crank mechanism with elbow-lever 2
http://youtu.be/fOO_7RDauiM
Input: orange crank having two studs.
Output: pink slider linearly reciprocating.
Blue elbow-lever returns to its initial position thanks to the gravity.
In one revolution of the input the slider performs two double strokes.



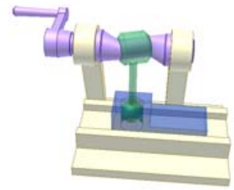
Dwell Slider Mechanism 3
http://youtu.be/-QT0RL93ST4
The green twin crank rotates with slow speed. The blue slider reciprocates with quick return and dwells at its end positions. The slider and the yellow pawl return by their weight or by springs force (not shown). Angle between the levers of the twin crank decides dwell time.



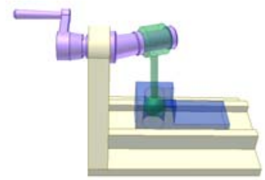
Spatial slider crank mechanism 1
http://www.youtube.com/watch?v=qAGZCB3vZDI



Spatial slider crank mechanism 2
http://www.youtube.com/watch?v=PM--PK5ROkg

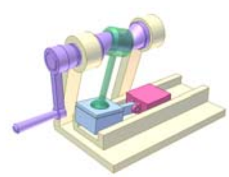


Spatial slider crank mechanism 3
http://www.youtube.com/watch?v=oqtN3Zrf9Nk

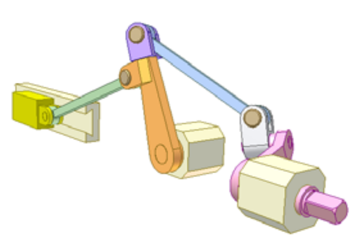


Spatial slider crank mechanism 4
http://www.youtube.com/watch?v=bBBuLt0Vz3k

Spatial slider crank mechanism 5
http://www.youtube.com/watch?v=sc-qsmidxVw



In-line reciprocator
http://youtu.be/EG7j2koS9DQ
Input: pink shaft.
This is a simple way to convert rotary motion to reciprocating motion. Both input and output shafts are in line with each other.
The right half of the device is a spatial reciprocator. Rotating the input crank causes its link to oscillate. A second connecting link then converts that oscillation into the desired in-line output motion.

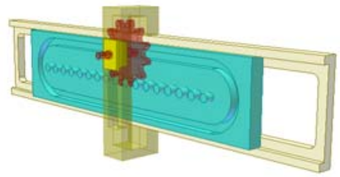


Rotary axes of the pink shaft and the orange crank, axis ot revolution joint between the orange crank and violet part, axis ot revolution joint between the pink shaft and grey part must be concurrent.

5.2. Gears

Pin rack drive 2A

http://youtu.be/RxgB1xEv5UM

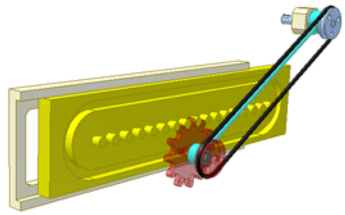


The red pinion is input. Its shaft has an end sliding in the running track shape slot of the cyan pin rack. Because of gear forces the cyan pin rack and the yellow slider carrying the red pinion reciprocate.

The rotation from a stationary source is transmitted to the red pinion by suitable mechanisms: double Hook's joint, Oldham coupling, …

Pin rack drive 2B

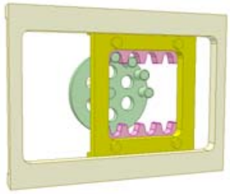
http://youtu.be/itP_dBADciU



The blue pulley is input. The red pinion shaft has an end sliding in the running track shape slot of the yellow pin rack. Because of gear forces the yellow pin rack reciprocates and the cyan arm oscillates.

Pin rack drive 3

http://youtu.be/ohRko--KoKc

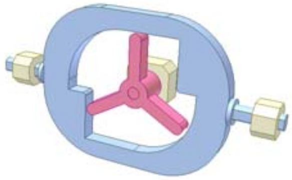


The green pin wheel is input. The yellow frame carrying two pink racks reciprocates with constant velocity. The dwell at the stroke ends is possible by cutting the pins.

Max stroke length = ½ circumference of the pin wheel rolling circle.

Pin rack drive 4

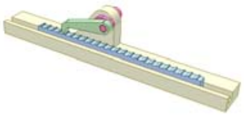
http://youtu.be/q7hpu95C-2M



The pink rotor (3-pin wheel) is driving. The blue frame (assembly of two racks of one tooth each) reciprocates with dwell.

Ratchet mechanism 6

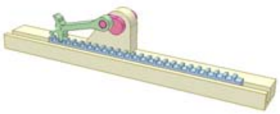
http://youtu.be/GSABM0GR-j8



This mechanism directly converts the continuous rotary motion of a drive shaft into the intermittent linear motion of a rack.

Ratchet mechanism 7

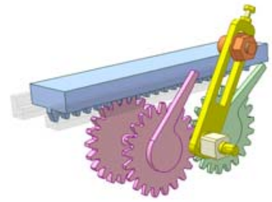
http://youtu.be/mDbLJR_bcZU



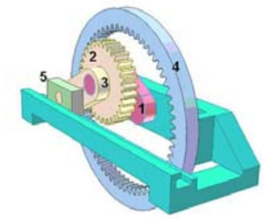
This mechanism directly converts the continuous rotary motion of a drive shaft into the intermittent linear motion of a rack.

To flop the green pawl to change the motion direction of the rack without changing the input motion direction.

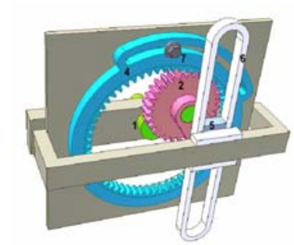
Reverse gear drive with dwell 2
http://youtu.be/1vQCTBensQc
The pink output gear mesh with the blue rack that reciprocates with dwell at both ends of its stroke.
The stroke length of the blue rack depends on:
- Adjustable position of the orange pin on the yellow input crank.
- Length of the bars attached to the gears.



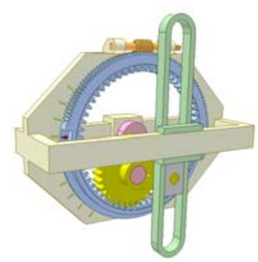
Slider-crank mechanism with satellite gear 1
http://www.youtube.com/watch?v=cfVyZkUzzyE
The slider's stroke length is 4 times of the crank length.
The tooth number of internal gear is two times of the one of satelite gear.
Radius of cranks = 1/2 Pitch diameter of the satelite gear.
An application of Cardano cycles.



Regulatable Slider-crank mechanism with satellite gear 1
http://www.youtube.com/watch?v=3g3Ke_1YmpM
The tooth number of internal gear is two times of the one of satelite gear.
Radius of cranks = 1/2 Pitch diameter of the satelite gear.
The slider's stroke length can be regulated from 4 times of the crank length to 0 by rotating the internal gear from 0 to 90 degrees.

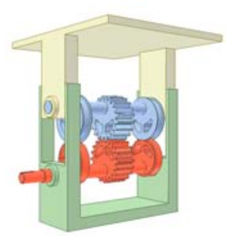


Regulatable slider-crank mechanism with satellite gear 2
http://youtu.be/5cbfFIlPENI
Pitch diameter of yellow satellite gear = 1/2 Pitch diameter of blue internal gear. Their rolling circles are Cardano ones.
Radius of cranks (pink and yellow) = 1/2 Pitch diameter of the satellite gear.
The green slider's stroke length can be regulated from 0 to 4 times of the crank radius by turning the internal gear via orange worm from 0 to 90 degrees.
The video shows regulating process: blue gear turns from 0 to 30 deg. for medium stroke then from 30 to 90 deg. for max stroke.

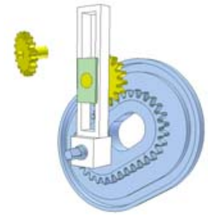


Rotation to translation mechanism 1
http://www.youtube.com/watch?v=wtn_T-WMDR4
Spur gears have eccentric shafts. The eccentricity is e.
The slider's stroke length = 4e.
Yellow plates have rotary translational motion

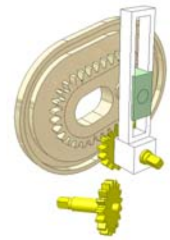
Rotation to translation mechanism 2
http://www.youtube.com/watch?v=kOyRtiDRZ_o
The spur gears and the round cams have eccentric shafts.
The eccentricity is e.
The lifting height of the working desk = 4e.
The cams bear lifting forces.



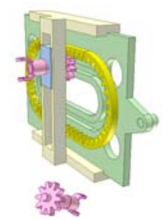
Oval gear 1a
http://youtu.be/CL-np3ocEqc
An input blue gear of oval shape, rotating around fixed axis, engages with an yellow gear. The latter has revolution joint with green slider.
The slider reciprocates with dwell. In case without teeth, the mechanism acts like an oval cam with possible slip.



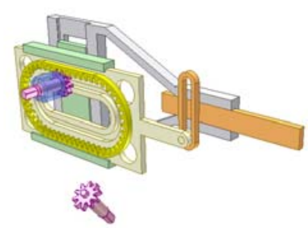
Oval gear 1b
http://youtu.be/MNDcRZvtaTI
An input yellow gear, rotating around fixed axis, engages with a gear of oval shape. The latter has revolution joint with green slider.
The slider reciprocates with dwell.



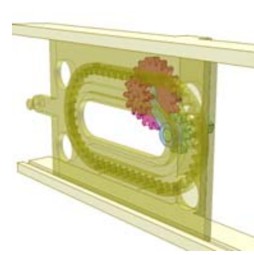
Oval gear 2a
http://youtu.be/HhNPb9MF1Hc
An input pink gear, rotating around movable axis of blue slider, engages with a yellow oval gear of green slider. The latter has reciprocating linear motion. Its speed is constant when the engagement takes place on straight portions of the yellow oval gear.
The input gear gets rotation from a double Cardan joint.



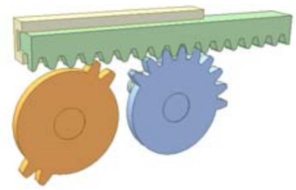
Oval gear 2b
http://youtu.be/niqX7iAH2ss
An yellow oval gear engages with a pink gear rotating around fixed axis.
A popcorn slider fixed to the yellow oval gear slides in groove of a green slider. The latter moves along runway of the grey base.
A pin on the pink gear face slides in an oval groove of the popcorn slider.
A pin on the right of the popcorn slider slides in the slot of orange slider. The latter moves along other runway of the grey base.
The green slider reciprocates linearly with dwells at both ends of its stroke.
The orange slider reciprocates linearly. Its speed is constant when the pink gear engages with the straight portions of the yellow oval gear.



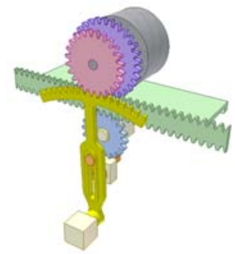
Oval gear 2c
http://youtu.be/pNcr06qe968
Green gear, pink large satellite gear and blue carrier create a differential planetary drive.
A pink small gear, which fixed to the pink large satellite gear, engages with a oval gear of yellow slider. A pin on the pink small gear face slides in an oval groove of the yellow slider.
The blue carrier is driving.
The yellow slider reciprocates linearly with dwell at one end of its stroke. Its speed is constant when the pink small gear engages with the straight portions of the yellow oval gear.



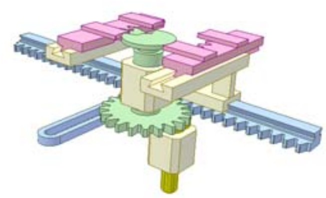
Transmission with teeth-uncompleted gears 13
http://youtu.be/Tt06tAkyHJQ
The orange gear is driving. The green rack reciprocates with dwell.
The forward and backward displacement may be different depending on the tooth numbers of the orange gear and stop positions of the rack and the blue gear.



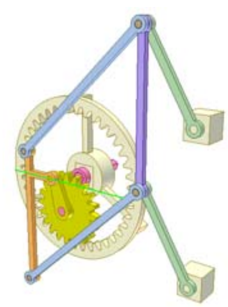
Drive for rotary printing press
http://youtu.be/PkBikUF369E
Input: the orange crank.
Output: the green printing bed which translates and the grey printing cylinder which rotates.
The blue gear is for additional supporting the bed.



Rack pinion mechanism 5
http://youtu.be/CBsb2Pdf2Jk
The sinus mechanism of yellow crank and blue rack-slider makes the green shaft oscillate with amplitude of 1 revolution (see “Sinus and rack pinion drive”).
The green teeth-uncompleted gear gives the pink racks dephasing reciprocating motions with pauses at both ends of stroke.
The green sector and 4 pink plates are for blocking pink output racks when pausing.

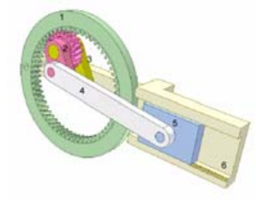


Linkage mechanism and planetary gear drive
http://youtu.be/Pc10Hwileik
An Artobolevski’s invention: combination of planetary gear drive and double parallelogram mechanism.
Lengths of blue bars are equal.
Lengths of green bars are equal.
Lengths of orange and violet bars and center distance of green bar fixed pivots are equal.
Pitch radius of the internal gear: R
Pitch radius of the external gear: r
R = 2r (Cardano circles)
Length of pink crank: r
Length of yellow crank (fixed to the external gear): r
The orange bar translates linearly.
The violet bar translates circularly.

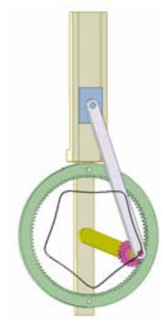


5.3. Bars and gears

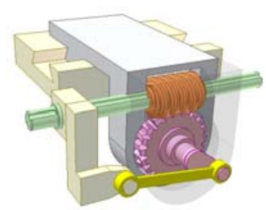
Slider-crank mechanism having a pause at the end of stroke.
http://www.youtube.com/watch?v=ObmXPNQhI1k
The tooth number of internal gear is 3 times of the one of satellite gear.
The short crank's length is half of the long crank's one. One axle of the connecting rod draws a deltoid that consists of 3 nearly round curves. The length of the connecting rod is equal the radius of the curve.



Slider-crank mechanism having a pause at the end of stroke 2.
http://www.youtube.com/watch?v=MhFiRHWSoUc
The tooth number of internal gear is 5 times of the one of satellite gear.
The short crank's length is half of the long crank's one. One axle of the connecting rod draws a closed curving line that consists of 5 nearly round curves. The length of the connecting rod is equal the radius of the curve.



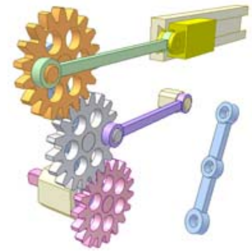
Worm drive and linkage mechanism 1
http://youtu.be/ihXqTX91n18
Input: green shaft rotating regularly.
Orange worm has sliding key joint with the green shaft.
Output: the grey slider carrying the worm drive reciprocates.
The mechanism performs two functions: reducing speed and converting rotation into linear translation.



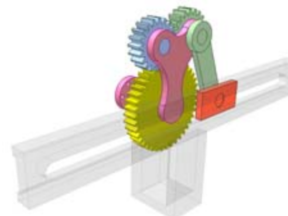
Gear and linkage mechanism 9a
http://youtu.be/rGYGc-Qtqgk
Tooth numbers of the gears are 50 and 25.
The gears have the same distance of their pins to their rotation axes (crank radius).
The blue slider has complicated motion that depends on dimensions of the orange and violet bars, tooth numbers, crank radii and relative positions of the gear pins.

Gear and linkage mechanism 9b
http://youtu.be/Se3318gM_cg
The mechanism is symmetric in term of dimension and assembly conditions so transverse force applied to the slider is limited. The pink conrods can be directly connected to the blue slider. The green bar is added for reducing the influence of manufacturing errors.

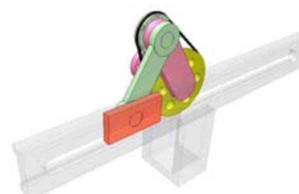
Three-gear stroke multiplier
http://youtu.be/w2sHE327EXk
Input: pink gear.
The rotation of the input gear causes violet conrod, attached to the machine frame to oscillate. This action produces a large-stroke reciprocating motion and fast return in the yellow output slider.



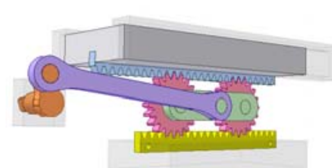
Slider crank mechanism with satellite gear 2b
http://www.youtube.com/watch?v=NctpLKvdneE
Tooth number of yellow gear is double one of green gear.
The gears axle distance = crank length = R
The slider's stroke length = 4R



Slider crank mechanism with satellite pulley
http://www.youtube.com/watch?v=T3pHRBBUSWo
The diameter of the big pulley is double the one of the green pulley.
The length of each crank = R
The slider's stroke = 4R
The belt should be toothed.
It is possible to use chain drive instead of belt one.



Reciprocating-table drive
http://www.youtube.com/watch?v=VzzaT_eqcmc
A combination of slider-crank mechanism and rack-gear drive.
When the input crank rotates, the table will move out to a distance of 4 times the crank length.

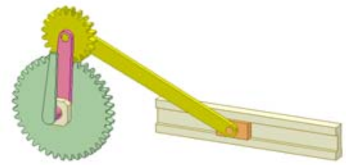


External gear slider mechanism 1
http://youtu.be/1N7XVZPPFj8
The yellow gear (Z2 = 20 teeth) is fixed to the connecting rod.
The green gear (Z1 = 20 teeth) is not fixed to the pink input crank.

The green output gear irregularly continuously rotates faster than the pink output crank in the same direction.
1 revolution of the pink output crank corresponds 2 revolutions of the green output gear.

External gear slider mechanism 2

http://youtu.be/QSRgQfbgLjI



The yellow gear (Z2 = 20 teeth) is fixed to the connecting rod.

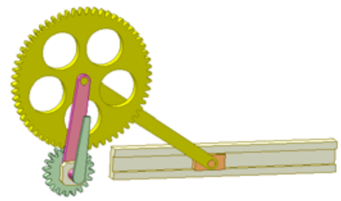
The green gear (Z1 = 40 teeth) is not fixed to the pink input crank.

The green output gear irregularly continuously rotates faster than the pink output crank in the same direction.

1 revolution of the pink output crank corresponds 1.5 revolutions of the green output gear.

External gear slider mechanism 3

http://youtu.be/rzXoR-OXLtA



The yellow gear (Z2 = 60 teeth) is fixed to the connecting rod.

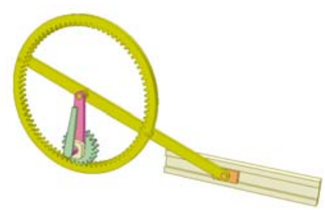
The green gear (Z1 = 20 teeth) is not fixed to the pink input crank.

The green output gear irregularly continuously rotates faster than the pink output crank in the same direction.

1 revolution of the pink output crank corresponds 4 revolutions of the green output gear.

Internal gear slider mechanism 1

http://youtu.be/tup8vGK4smA



The yellow gear (Z2 = 80 teeth) is fixed to the connecting rod.

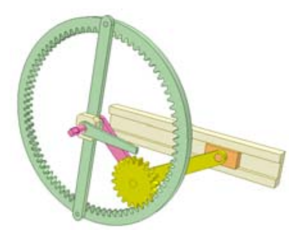
The green gear (Z1 = 20 teeth) is not fixed to the pink input crank.

The green output gear irregularly continuously rotates faster than the pink output crank in the opposite direction.

1 revolution of the pink output crank corresponds 3 revolutions of the green output gear.

Internal gear slider mechanism 2

http://youtu.be/CbFPxpRHyRI



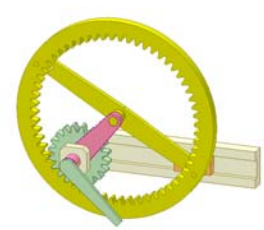
The yellow gear (Z2 = 20 teeth) is fixed to the connecting rod.

The green gear (Z1 = 80 teeth) is not fixed to the pink input crank.

The green output gear irregularly continuously rotates slower than the pink crank in the opposite direction.

Internal gear slider mechanism 3

http://youtu.be/diW797QmiyA



The yellow gear (radius r2 = 30) is fixed to the connecting rod.

The green gear (radius r1 = 60) is not fixed to the pink input crank.

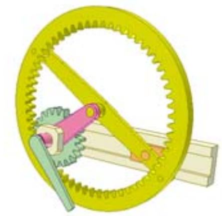
Crank length: R = 60

Connecting rod length: L = 90

(r1 = L – R)

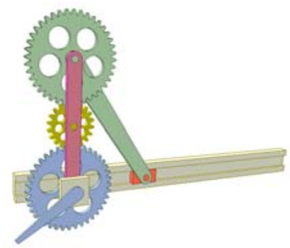
The green output gear irregularly rotates (with dwell) 2 revolutions when the pink crank rotates 1 revolution in the opposite direction.

Internal gear slider mechanism 4
http://youtu.be/W8Hv6cRyUTU



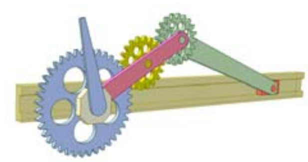
The yellow gear (radius r2 = 30) is fixed to the connecting rod.
The green gear (radius r1 = 60) is not fixed to the pink input crank.
Crank length: R = 60
Connecting rod length: L = 70
(r1 longer than L – R)
The green output gear irregularly rotates (with going back) 2 revolutions when the pink crank rotates 1 revolution in the opposite direction.

Three-gear-slider-crank mechanism 1
http://www.youtube.com/watch?v=jq_JI7BmXec



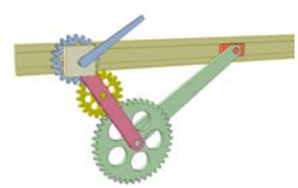
Modified-Watt's reverser
Teeth numbers of two large gears Z1 = Z2 = 40
Teeth number of the small gear Z0 = 20
Gear module m = 2
Length of the pink crank a = 180
Length of the green connecting rod b = 220
The output blue gear reverses after each 180-degree rotation of the input pink crank.
The output gear oscilates through the same angle as the green connecting rod.

Three-gear-slider-crank mechanism 2
http://youtu.be/DD5w0B8hpCg



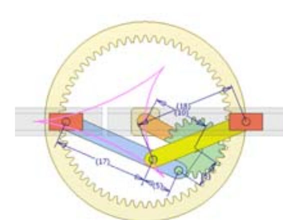
Teeth numbers of two small gears Z1 = Z2 = 20
Teeth number of the large gear Z0 = 40
Gear module m = 2 mm
Length of the pink crank a = 150 mm
Length of the green connecting rod b = 220 mm
The output blue gear irregularly continuously rotates slower than the pink crank in the same direction. 2 revolutions of the pink crank corresponds 1 revolution of the output blue gear.

Three-gear-slider-crank mechanism 3
http://youtu.be/aZI5tY-00J4



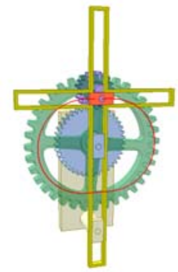
Teeth numbers of two small gears Z1 = Z2 = 20
Teeth number of the large gear Z0 = 40
Gear module m = 2 mm
Length of the pink crank a = 150 mm
Length of the green connecting rod b = 220 mm
The green gear irregularly rotates (with going back) 1 revolution when the pink crank rotates 1 revolution in the opposite direction.

Dwell Slider Mechanism 1
http://youtu.be/LjLH45PSf-s

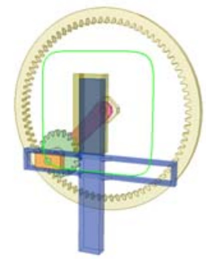


Tooth number of the fixed internal gear: 60
Tooth number of the planetary external gear: 20
Gear module: 0.5 mm
The pink curve is locus of the yellow conrod point.
Length of the yellow conrod approximates to the radius of curve segment of the pink locus. The red right slider has dwell at its right position.

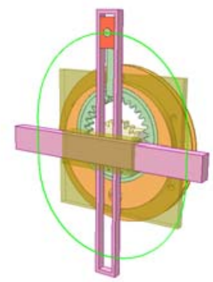
Slider-crank mechanism having a pause at both ends of stroke 1
http://www.youtube.com/watch?v=7Ewb5C-UNfo
Tooth number of the satellite gear Z1: 20
Tooth number of the fixed gear Z2: 100
e/A = 0.1
e: crank length
A: axle distance between gear Z1 and gear Z2.



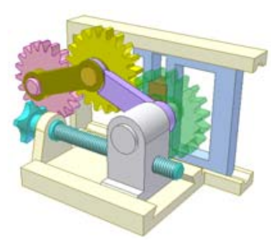
Loci in Epicyclic gearing A4b
http://youtu.be/ft9gmtesYUE
R: pitch radius of the fixed sun gear
r: pitch radius of the planetary gear
k = R/r = 4
Distance between the hole axis of the orange slider and the planetary gear axis is (11/30)r for getting a square of straight sides.
The blue cross has linear reciprocating motion with dwell at both stroke ends.



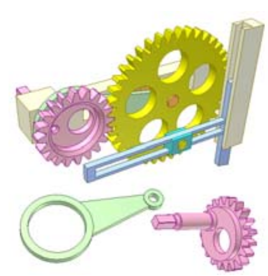
Loci in Epicyclic gearing B4
http://youtu.be/zMOeztecSu4
r: pitch radius of the fixed sun gear
R: pitch radius of the green planetary gear
k = R/r = 1.5
Distance between the hole axis of the orange slider and the planetary gear axis is (124/30)r for getting a curve having two straight segments.
The input link is the orange disk.
The pink cross has linear reciprocating motion with dwell at both stroke ends.



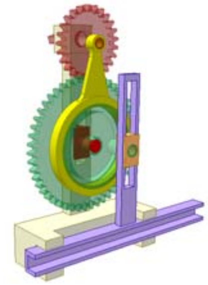
Sine mechanism 5
http://youtu.be/dtaLfwzwcDQ
Green gear-crank, red slider and blue slider create a sine mechanism. The green gear-crank receives rotation from pink input gear through yellow gear. The bars maintain gear engagement
The blue output slider has reciprocating linear motion. Its stroke position can be adjusted during motion by cyan screw.



Gear and linkage mechanism 13
http://youtu.be/i9ayXz9tEXU
Tooth number of pink crank gear: 20
Tooth number of yellow gear: 40
The crank gear, green connrod and orange slider create a slider crank mechanism. Input is the crank gear rotating regularly.
The green conrod length = Center distance of the gear drive.
The blue slider has linear motion of complicated velocity rule.
Beside geometric dimensions of the links, its motion also depends on the position between the pin of the yellow gear and the crank gear when assembling.

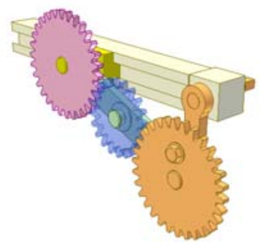


Gear and linkage mechanism 10



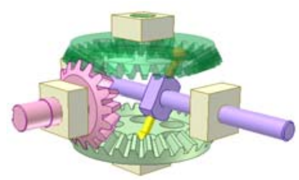
http://youtu.be/Pe_nNqVXAek
Pitch radius of red gear: R1.
Pitch radius of green gear: R2 = 2R1.
The rotation axis of the red gear is eccentric.
Its eccentricity is E1 = 0.125 R1.
Distance between rotation axis of the green gear and the pin for orange slider is E2 = R1.
Length of the yellow connrod L = 3R1
The red gear, the yellow connrod and the red slider create a slider –crank mechanism.
The violet slider has linear motion with approximately uniform speed in the middle of its stroke.
Assembly condition: There is mechanism position when gear rotation axes, pin axes are on the same plane.

Slider-crank mechanism with gears on conrod



http://youtu.be/doSUZ1AdKU8
Cơ cấu tay quay con trượt có bánh răng ở thanh truyền.
Bánh răng và tay quay dẫn màu cam ghép cố định với nhau.
Bánh răng hồng và xanh mỗi cái quay lồng không trên trục của nó.
Bánh răng màu cam và màu hồng có cùng số răng.
Tay quay dẫn quay đều còn bánh răng xanh và hồng quay không đều.

Bevel gear and slider mechanism

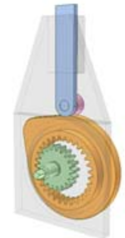


http://youtu.be/jrYQ6wZDRbw
Input is pink gear of constant velocity.
Yellow bars have spherical joints with green gears an cylindrical joints with violet slider.
The slider linearly reciprocates.

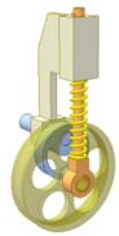
5.4. Cams

Disk cam mechanism DF9
http://youtu.be/F3scqTa1CDw
The cam profile is an archimedian spiral so the follower's speed is constant. Gravity maintains permanent contact between follower and cam.

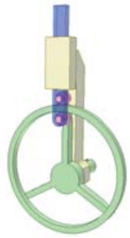
Gear cam
http://youtu.be/4p-6tIA-kuc
The orange cam is a combination of disk cam and internal gear.



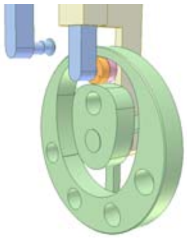
Disk cam mechanism DF1
http://youtu.be/AWq7r9YwU48
The roller is bigger than the cam.



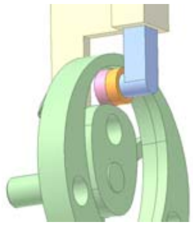
Disk cam mechanism DF2
http://youtu.be/gAyj_MAqmrQ
The follower has two rollers conctacting both sides of the cam rim of thickness A. If A is constant, distance between the rollers is slightly bigger than A.
If backlashless is required, A must be inconstant.



Disk cam mechanism DF3a
http://youtu.be/QoMAmxIJRCo
The follower has two rollers that move in the cam's slot. Rollers axles are slightly eccentric so the orange roller contacts with the outter wall of the slot; the pink roller contacts with the inner wall of the slot. This prevents the sliding of roller that happens in slot cam of one roller.

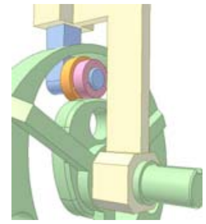


Disk cam mechanism DF3b
http://youtu.be/Wodc-C4a1m4
The follower has two rollers that move in the cam's slot. The slot is designed in the way that the orange roller contacts only with the outter wall of the slot; the pink roller contacts only with the inner wall of the slot (the slot outter wall is stepped). This prevents the sliding of roller that happens in slot cam of one roller.



Disk cam mechanism DF3c

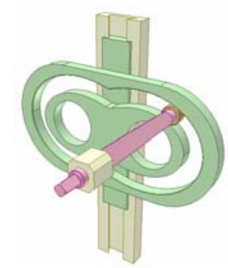
http://youtu.be/-uQCJx5bwBg



The follower has two rollers (of different diameters) that move in the cam's slot. The slot is designed in the way that the orange roller contacts only with the outter wall of the slot; the pink roller contacts only with the inner wall of the slot. This prevents the sliding roller that happens in slot cam of one roller.

Cam-slider mechanism

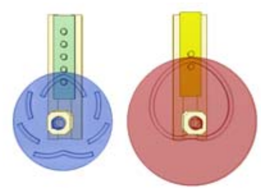
http://youtu.be/NLNBzzuOZiA



Input: pink crank.
Output: cam-slider that linearly reciprocates.
Its velocity is almost constant with the shown 8-shaped cam profile.

Multi-profile cam

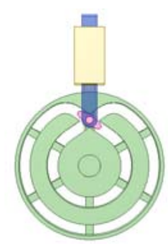
http://youtu.be/TLZ2vqH31zo



Left mechanism:
Blue cam contains various profiles. Its follower has some identical pins. This design helps reduce cam dimension and avoid cam-follower contact near to the cam center.
Geometric closure by pins causes a considerable backlash.
Right mechanism is shown for comparison purpose.
Red cam has continuous profile of Archimedean curves. Its dimenssion is to be large to reduce presure angle at cam-follower contact points near to the cam center.

Disk cam mechanism DF4a

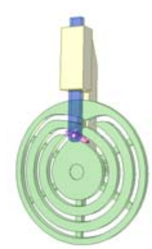
http://youtu.be/QFgPJGiIbzY



A working period of the mechanism corresponds two revolutions of the green slot cam. The pink rhomb-shaped part plays role of roller.

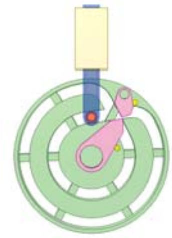
Disk cam mechanism DF4b

http://youtu.be/Sae9B_61i0I

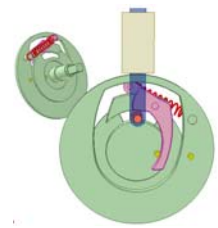


A working period of the mechanism corresponds three revolutions of the green slot cam. The pink rhomb-shaped part plays role of roller.

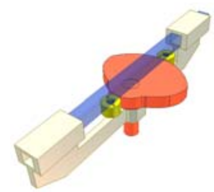
Disk cam mechanism DF4c
http://youtu.be/jVQVF-SQea8
A working period of the mechanism corresponds two revolutions of the green slot cam. The pink guides help the roller go through the slot cross. Springs forcing the guides against the yellow pins are not shown.
This roller concept is used instead of a rhomb-shaped slider when the slot's curvature is small.



Disk cam mechanism DF12
http://youtu.be/ssvJhSpClSI
Working cycle of the mechanism is 2 revolutions of the green cam. The pink guide helps roller come into the outer groove one time in every two rev. A spring toggle device and two yellow pins maintain right positions of the guide.

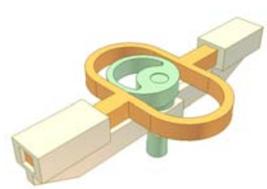


Disk cam mechanism D8a
http://youtu.be/AvxtHLCeykE
Cam mechanism of geometrical closure. To maintain backlashless, the distance between any two points of the cam theoretic profile laying on the line through the cam's center (parallel to the sliding direction of the follower) must be constant.

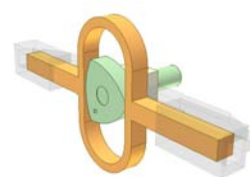


Disk cam mechanism DF8b
http://youtu.be/twiPc5QzxmM
Cam mechanism of geometrical closure.
To maintain backlashless, the distance between any two points of the cam theoretic profile laying on the line through the cam's center (parallel to the sliding direction of the follower) must be constant. The cam profile is a n-fold rotational symmetric closed curve, n is an odd number (here n = 3).

Disk cam mechanism DF10a
http://youtu.be/mCbe9RD61aA
With eccentric round cam the follower gets harmonic motion.

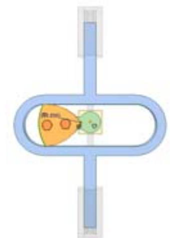


Disk cam mechanism DF10b
http://youtu.be/DhKg3nntPIA
Reuleaux triangle cam. The rotation center and the curved triangle's one are coincident. The follower goes forward and backward three times in one cam revolution.

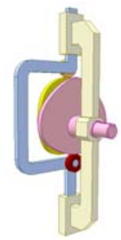


Disk cam mechanism DF10c
http://youtu.be/hLEnUOu2-kU
Reuleaux triangle cam. The follower goes forward and backward one time in one cam revolution with short dwell at stroke's ends.
Stroke length = DB

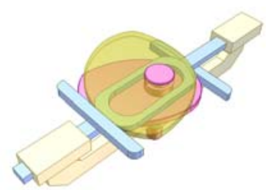
Disk cam mechanism DF10e
http://youtu.be/8NKh9lxNnTI
Reuleaux triangle cam. The follower goes forward and backward one time in one cam revolution with long dwell at stroke's ends.
Stroke length = DB + R



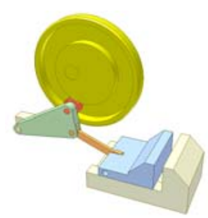
Disk cam mechanism DF8d
http://youtu.be/61oZWpqJ2yI
Dual cam.
The main cam is pink. The yellow one is added for cam geometrical closure.
Its profile must be designed to maintain permanent contact of both rollers with cams.



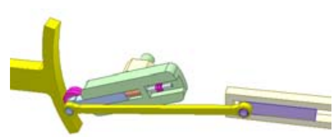
Disk cam mechanism DF8e
http://youtu.be/kjo85swsOrU
Dual cam.
The main cam is pink. The yellow one is added for cam geometrical closure.
Its profile must be designed to maintain permanent contact of both follower's planes with cams.



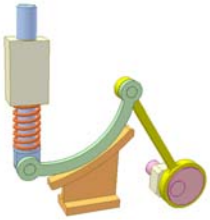
Cam driven press
http://youtu.be/hbtKTa6rCWg
Cam in combination with toggle mechanism gives high pressing force.



Fixed cam mechanism 4
http://youtu.be/0ZTaScDawKs
The yellow cam is fixed. The blue follower moves in a groove of the input crank. Length of the yellow rod plus radius of the magenta roller equals profile radius of the yellow cam. The violet slider reciprocates with dwell at its leftest position. Adjust position of the magenta nuts for various stroke lengths and dwell times.

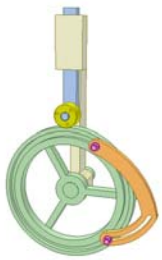


Fixed cam mechanism 5
http://youtu.be/1HdJEO3iHrM
The orange cam of contact radius R is fixed. The green follower of contact radius r has planar motion. If R = 2r and the axis of the contact cylindrical surface of the fixed cam intersects sliding axis of the blue slider (case of Cardano circles), the green follower rolls without sliding on the fixed cam.



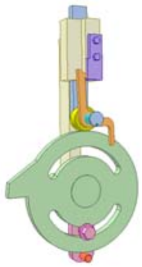
Cam mechanism of follower's planar motion 3
http://youtu.be/z3rnRgAbRBo
The orange cam is a triangle of six curves (curved polygon of constant width). The green follower has planar motion and the pink slider reciprocates with dwells at both stroke ends.

Disk cam assembly 3
http://youtu.be/0xx98A1VFlg
Cam 1 is a green round disk. The orange cam 2 is fixed on cam 1. Its position can be adjusted to get various motions of the follower, both in stroke length and in phase by moving the two pink T-slot bolts. Gravity maintains permanent contact between rollers and cam.

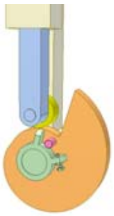


Disk cam mechanism DF5
http://youtu.be/QBGc2VD-drM
Adjust rollers distance to alter dwell time of the follower.
Gravity maintains permanent contact between rollers and cam.

Disk cam mechanism DF6
http://youtu.be/rvAWqUyXKLE
The green main cam moves the plunger to up position which is maintained by orange latch. The cyan springs forces the latch against the violet catch. The red pin lets the plunger go down by unlatching the orange latch. Dwell time is obtained by adjusting the red pin's position on the main cam.



Disk cam mechanism DF7
http://youtu.be/BkPOyRcEZVA
Input is the green shaft, on which the orange cam rotates idly. Motion is transmitted to the cam through the pink pin. A quick drop of the follower is obtained by permitting the cam to be pushed out of the way by the follower itself as it reaches the edge of the cam. Gravity maintains permanent contact between follower and cam.



Disk cam mechanism DF11 F4

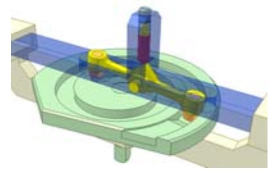
http://youtu.be/D2iXGzzfxiU

Beside the pink roller, the follower also has flat portion that contacts the cam after the roller leaves the cam at the follower’s highest position. This helps increase dwell time at the highest position and speed up the follower’s return. Gravity maintains permanent contact between follower and cam.

Archimedes groove cam

http://youtu.be/rJtRcneZ71A

The green cam rotates continuously. The motion reverse of the blue follower is due to the yellow toggle arm carrying two orange pins and the cam groove depth reduction at groove outter end.



Cam and crank slider mechanism 2

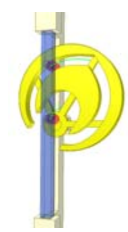
http://youtu.be/bZR6D3-jCDA

Input is the orange crank. The blue output slider performs two double strokes during one revolution of the input.

Disk cam mechanism DF8c

http://youtu.be/Y5mNeE00O58

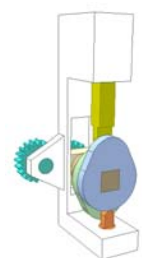
Two rollers and special shape of the cam slot help to increase stroke length.



Radial cam

http://www.youtube.com/watch?v=UITxt0RGG84

A measure to increase follower stroke while unchanged presure angle. Shortcoming: to transmit rotation to a moving shaft.

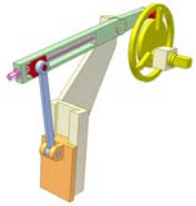


Cam and wedge mechanism

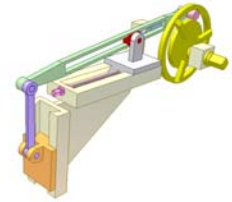
http://youtu.be/ChVw3_NZ3B8

The eccentricity of the green eccentric can be adjusted by turning the orange screw to move the pink wedge shaft. The latter and the yellow gear are fixed together. Input: the grey gear. Output: the red follower.

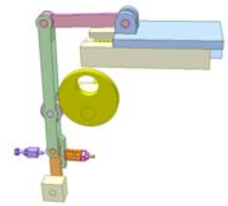
Cam and crank slider mechanism 3
http://youtu.be/86dNyTDlLkA
Input is the yellow cam. Stroke length of the orange output slider can be adjusted by moving the red slider.



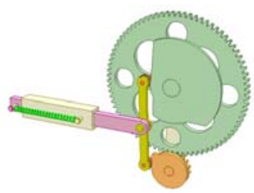
Cam and crank slider mechanism 4
http://youtu.be/SXp3gx46f7w
Input is the yellow cam. Stroke length of the orange output slider can be adjusted by moving the grey slider.



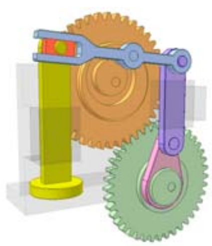
Cam and crank slider mechanism 5
http://youtu.be/9wReecQgktc
Input is the yellow cam. The follower consists of two bars connected together by a revolution joint and the orange spring. Once the orange bar collides with the violet screw, oscillating center of the follower is changed. Stroke length of the blue output slider can be varried by adjusting the violet screw.



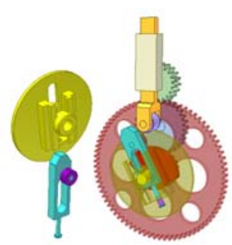
Cam and gear mechanism 3
http://youtu.be/IzJTBc3wkJ8
Input is the orange gear to which a small cam is fixed. The green gear and large cam are fixed together. Transmission ratio of the gear drive is 4.
The output pink slider, in its right to left course, has added motions during its three dwells.



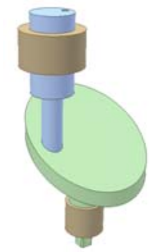
Cam and gear mechanism 5
http://youtu.be/UI5KDnQ9gTM
Input is the green shaft with a green gear and an eccentric portion on which the pink conrod idly rotates. The yellow output slider receives motion from the blue arm that has a pin sliding in the groove of the cam fixed on the orange gear. Transmission ratio of the gear drive is 1. The blue arm is also connected to the violet slider that received motion from the pink conrod.
The motion combination gives long stroke of the yellow slider, a slotter's ram.



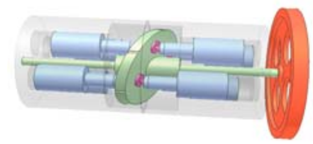
Cam and gear mechanism 6
http://youtu.be/CbPPV0D2fGM
Input is the yellow shaft having a gear and a disk. The cyan slider (a cam) reciprocates in a slot on the disk due to the red cam that fixed to the red gear. The red gear receives motion from the yellow gear through the blue and the green gears. The orange slider's roller can contact with the yellow disk and the cyan slider. Motion of the orange output slider depends on the cam's shape, its angle position on the red gear and the transmission ratio (= 4 for this case) of the 4-gear drive.



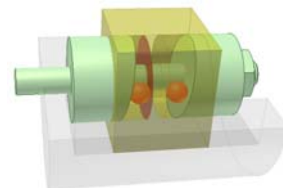
Inclining disk mechanism 1
http://www.youtube.com/watch?v=zrpZcZCRA1s
Flat contact. The follower rotates during reciprocation.



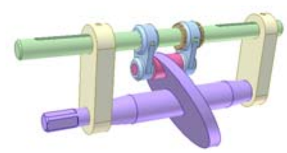
Inclining disk mechanism 2
http://www.youtube.com/watch?v=YsUQDb3cdhE
Application for engine. Flat contact with added spherical joints.



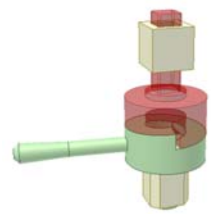
Inclining disk mechanism 3
http://www.youtube.com/watch?v=PkVVoCKGB5w
Two balls are inserted between contact faces of the disks and the slider.
Stroke time corresponds two revolutions of the disk.



Inclining disk mechanism 4
http://www.youtube.com/watch?v=dafYYCBo4VU
A rational design: flat contact, joint geometric closing, possibility of gap regulation.

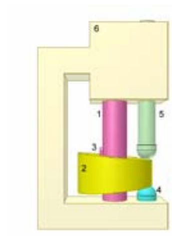


End cam mechanism ET1
http://youtu.be/qmABJ5lbnhc
The identical helical surfaces of the cam and the follower increases contact area and load capacity considerably. Gravity maintains permanent contact between follower and cam.

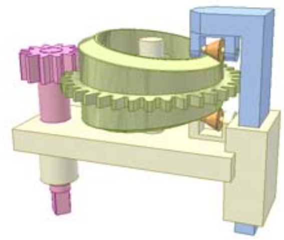


End cam mechanism ET2
http://youtu.be/5jE6yDqVbek
This steel-ball cam can convert the high-speed rotary motion of an electric drill into high-frequency vibrations that power the drill core for use as a rotary hammer for cutting masonry and concrete.

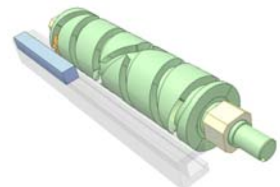
Facial cam
http://www.youtube.com/watch?v=hBh7dd36Vrc
A measure to increase follower stroke while unchanged pressure angle.



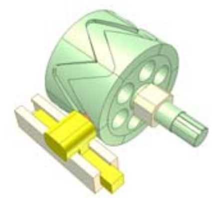
Facial cam 1b
http://youtu.be/THHIXrYS_-4
A measure to increase follower stroke while unchanged pressure angle. Gravity maintains contact between rollers and cam.



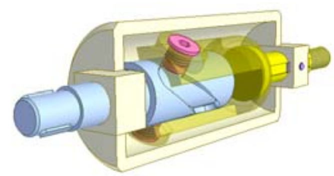
Barrel cam mechanism BT1a
http://youtu.be/LLIwVdaRViM
The space cam of helical slots of two opposite hands and diferent pitches (screw of two opposite hand threads) gives the blue follower reciprocal linear motion. The go speed is slow and the back one is fast.



Barrel cam mechanism BT2a
http://youtu.be/Atvhzgple5I
Rotational motion is converted into linear reciprocating one.

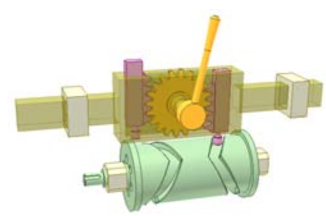


Barrel cam mechanism BT2b
http://youtu.be/HEJNQqBowHw
A development of mechanism shown in:
http://youtu.be/Atvhzgple5I
Rotational motion is converted into linear reciprocating one.
Input and output shafts are in line.

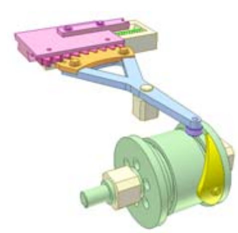


Barrel cam mechanism BT3
http://youtu.be/RuioMWd1NXU
A mixing drum has a small oscillating motion while rotating due to a barrel mechanism at the end of its shaft. It finds application in mixing paint, candy or food.

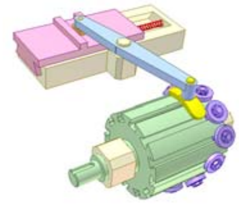
Barrel cam mechanism BT8
http://youtu.be/rmBnpM7K6To
The green barrel cam has two grooves. Motion of the yellow slider can be altered by rotating the orange gear to let one of two rack's rollers come into contact with its corresponding cam's groove.
The positioning device for the orange gear is not shown.



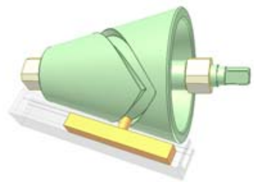
Barrel cam assembly 1
http://youtu.be/jsgA7GFfM8E
The yellow cam is fixed to the green cam drum by T-slot bolt that enable to change the cam or adjust its position on the drum.



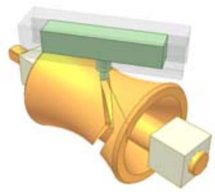
Barrel cam assembly 2
http://youtu.be/sSXEkDnkbqc
By T-slot bolts the positions of violet rollers on the green cam drum can be adjusted to get various motions of the pink slider,



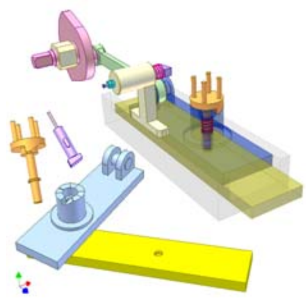
Cone cam 1
http://youtu.be/p2_4CQA2QT0



Hyperboloid cam
http://youtu.be/F9eP9wh0KqQ
The follower sliding line and the cam rotary axis are skew.



End cam mechanism ET3
http://youtu.be/CCu_U7kZhEQ
The blue slider during its every four double stroke gives the yellow slider only one double stroke by meshing lower end of the orange pin with a hole on the driven yellow slider.
The violet pin makes the orange pin rotate 90 deg. interruptedly.
The end cam on the blue slider makes the orange pin move up/down.
A device for positioning the yellow slider at its rest position is not shown.



5.5. Chains

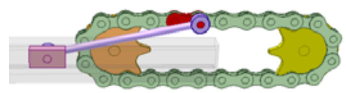
Chain drive 2A

http://youtu.be/iXbi7jod57Y

Rotation to linear reciprocation. The two sprockets have the same tooth number.
This mechanism is applied in bamboo cleavage machine.
See a machine made in Vietnam:
http://www.youtube.com/watch?v=MUzykcMLtdo&feature=player_embedded

Chain drive 2B

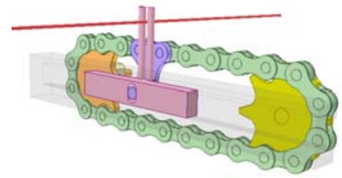
http://youtu.be/0jGOkJHN574



The orange sprocket is driving. The two sprockets have the same tooth number. The pink slider reciprocates with constant velocity.

Chain drive 2C

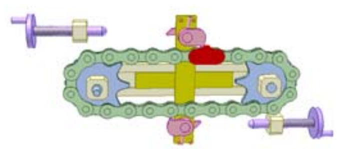
http://youtu.be/6Je0oI6CKcg



Rotation to linear reciprocation with dwell at the ends of the stroke. The two sprockets have the same tooth number. The pink slider reciprocates with constant velocity.
This mechanism is applied in wire drawing machines for leading wire (in red) to its coil.

Chain drive 2D

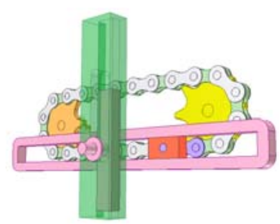
http://youtu.be/vzGjNXujqp0



Rotation to linear reciprocation with dwell at the ends of the stroke of the yellow slider. The two sprockets have the same tooth number. The pink pawls tend to rotate clockwise by springs (not seen). The red chain link pushes the yellow slider through the pawls and leave them when the pawls hit the violet adjustable stoppers.

Chain drive 2E

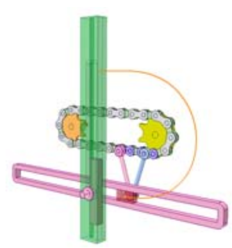
http://youtu.be/MsCYaTDbZsI



Converting continuous rotation into reciprocating translation with dwells at both ends of the course.
Two sprockets are identical.
The course length is equal to sprocket pitch diameter.
The dwell time depends on the axle distance of two sprockets.

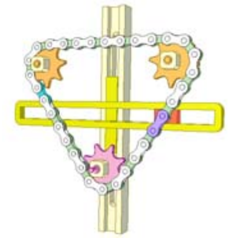
Chain drive 2F

http://youtu.be/VGUs5yiObmQ

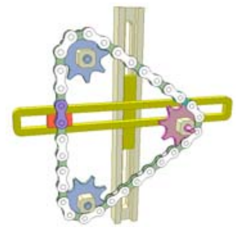


Converting continuous rotation into reciprocating translation with dwells at both ends of the course.
Two sprockets are identical.
The course length depends on sprocket pitch diameter and lengths of the blue and pink bars.
The dwell time depends on the axle distance of two sprockets.

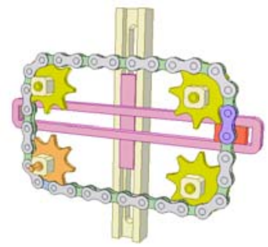
Chain drive 8A
http://youtu.be/Or0k0VpDtBw
Converting continuous rotation into reciprocating translation with dwells at one end of the course.
Three sprockets are identical. The pink one is driving. The violet chain link has an axle for a revolution joint with the red slider.
The course length depends on vertical axle distance between the pink sprocket and the orange ones.
The dwell time depends on axle distance of two orange sprockets.



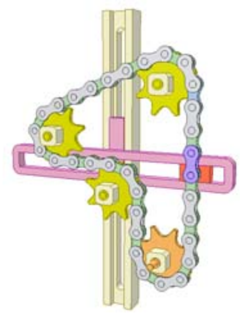
Chain drive 8C
http://youtu.be/7-0wXqRga4M
Converting continuous rotation into reciprocating translation with different times of go and back strokes.
Three sprockets are identical. The pink one is driving. The violet chain link has an axle for a revolution joint with the red slider.
The sprockets are arranged at vertices of an equilateral triangle so the ratio of go and back times is 2.
The course length depends on sprocket axle distance.



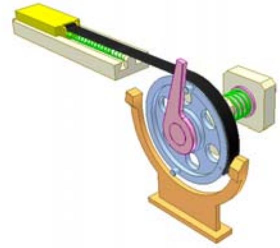
Chain drive 9
http://youtu.be/TlkOzXQpVL4
Converting continuous rotation into reciprocating translation with dwells at both ends of the course.
Three sprockets are identical. The orange one is driving. The violet chain link has an axle for a revolution joint with the red slider.
The course length depends on vertical axle distance between upper and lower sprockets.
The dwell time depends on horizontal axle distance between right and left sprockets.



Chain drive 10
http://youtu.be/V0_wqv0y7rg
Converting continuous rotation into reciprocating translation with dwells in the middle of the course.
Four sprockets are identical. The orange one is driving. The violet chain link has an axle for a revolution joint with the red slider.
The course length depends on vertical axle distance between the orange sprocket and the top one.
The dwell time depends on horizontal axle distance of two middle sprockets.
This video shows the possibility to create reciprocating translation with dwell at any point of the course by using chain drive with four sprockets and arranging them at appropriate positions.

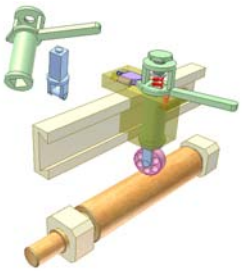


Cable drive 22
http://youtu.be/F5vEXHPrw6o
Converting continuous rotation to reciprocating translation.
An arm on the pink shaft turns the blue wheel when contacting with its pins. The arm moves axially to release the wheel when contacting with the orange wedges.

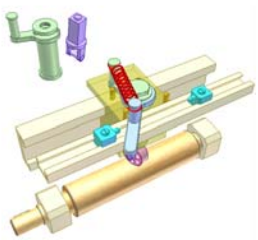


5.6. Friction drives

Spatial friction drive for translating motion 1a
http://youtu.be/i2J5au2czKo
Input: orange shaft rotating regularly.
Output: yellow slider moving linearly.
Turn the green swivel to change motion direction of the slider.
The slider velocity V depends on the skew angle λ between axes of the input shaft and the roller.
$V = \omega.R.\tan(\lambda)$
ω: angular velocity of the input shaft
R: contact radius of the input shaft
Pink roller is forced toward the input shaft by red spring.
Small violet slider is for positioning the green swivel.
The mechanism is for light duty works.
Kinematic relation between the input and output is not kept strictly due to contact slipping.

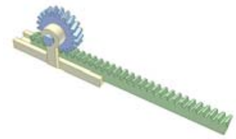


Spatial friction drive for translating motion 1b
http://youtu.be/XZy856ocYgk
Input: orange shaft rotating regularly.
Output: yellow slider linearly reciprocating.
The slider velocity depends on the skew angle between axes of the input shaft and the roller.
Pink roller is forced toward the input shaft by a spring (not shown).
The automatic changing motion direction is performed by a spring toggle mechanism that consists of blue and green levers, red spring and two cyan adjustable stoppers. Refer to:
http://youtu.be/KaRBadgcUlU



6. Converting rotary oscillation into linear motion

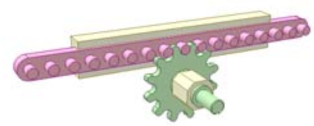
6.1. Gears



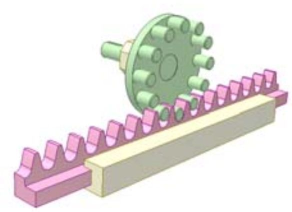
Rack pinion mechanism 1
http://www.youtube.com/watch?v=9hI85qZ5zKA

Sheet metal gears 2
http://youtu.be/b01b8Df4_88
For light loads.
Low cost.
Adaptability to mass production.

Rack with ring teeth
http://youtu.be/1qpLembF_mU
The mechanism acts as an ordinary rack pinion drive, furthemore the rack can rotate around its axis during transmission.

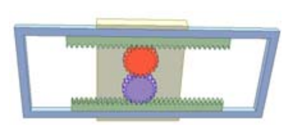


Pin rack drive 1A
http://youtu.be/ZyhJPFERP-k
The pinion tooth profile is the envelope of a family of the pin circles, centers of which are on an involute traced by pin circle center when the pin rack rolls without slipping on the pinion. The pinion can engage both sides of the pin rack. It is impossible for the tooth rack.



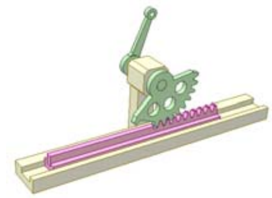
Pin rack drive 1B
http://youtu.be/kMXgu5HfcBg
The rack tooth profile is the envelope of a family of the pin circles, centers of which are on a cycloid traced by pin circle center when the pin wheel rolls without slipping on the rack.

Chain drive 1D
http://youtu.be/D70s_01VTGo
Using chain rack instead of ordinary one reduces production costs.

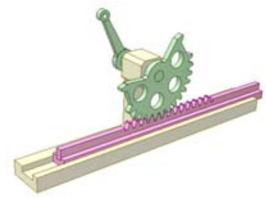


Application of rack pinion mechanism 4
http://www.youtube.com/watch?v=uEGpsi4upw8
A measure to reduce force applied to the runway.

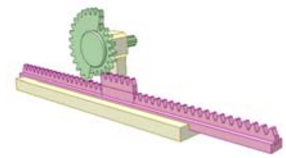
Rack pinion mechanism 4b
http://youtu.be/MSg2xD6OcMA
The pink input rack reciprocates. The green output shaft oscillates with dwell at one end of its stroke.
The rack flat portion prevents spontaneous motion of the shaft.



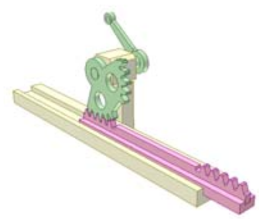
Rack pinion mechanism 4c
http://youtu.be/BjmKHHR18w8
The pink input rack reciprocates. The green output shaft oscillates with dwell at both ends of its stroke.
The rack flat portions prevents spontaneous motion of the shaft.



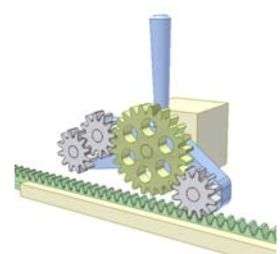
Rack pinion mechanism 4e
http://youtu.be/f7J54RvmApc
The green input shaft rotary reciprocates. During the go or back motion the velocity of the pink output slider changes in steps.



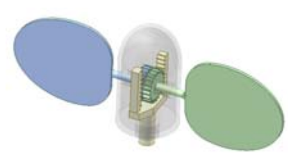
Rack pinion mechanism 4a
http://youtu.be/v46JRgJ2zbU
The pink input rack reciprocates. The green output shaft oscillates with dwell in the middle of its stroke.
The rack flat portion prevents spontaneous motion of the shaft.



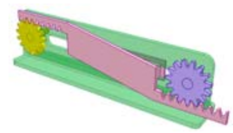
Reverse mechanism for rack
http://youtu.be/Bxtthb_6bO8
The large gear rotates continuously.
Use the blue lever to control motion of the rack: stop, forward, back. Positioning device for the lever is not shown.



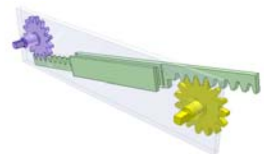
Application of rack pinion mechanism 5
http://www.youtube.com/watch?v=3_3_XFwMpIo
Controlling angle of the ship propeller blades



Rack pinion mechanism 6a
http://youtu.be/3fAMK2phOWE
Transmission of limited rotation between distant shafts.
Input and output rotary directions are opposite.

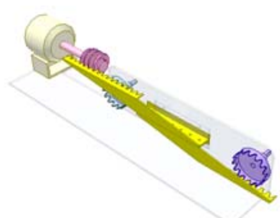


Rack pinion mechanism 6b
http://youtu.be/M0M-NKzOsZM
Transmission of limited rotation between distant shafts.
Pitch lines of two rack portions are coincident.
Input and output rotary directions are opposite.

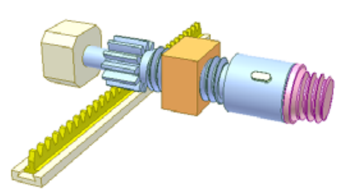


Rack pinion mechanism 6c
http://youtu.be/5lhNjpdCX8M
Yellow double rack receives motion from motor via grey worm and orange rack. In fact the orange rack is part of a nut.
The yellow double rack makes two face gears rotate in opposite directions.
Gears and racks are made of sheet metal.

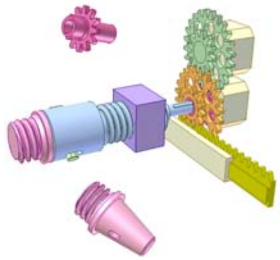
Rack pinion mechanism 6d
http://youtu.be/uf8BFrcmPgE
Yellow double rack receives motion from motor via pink worm.
The left rack engages with the pink worm and the blue gear.
The yellow double rack makes two face gears rotate in opposite directions.
Gears and racks are made of sheet metal.



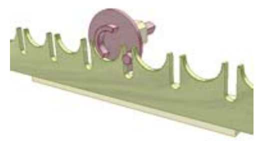
Mechanism for moving thread core of a plastic injection mould 1
http://youtu.be/7bVTvWGAdAA
Yellow rack is connected to the movable half mold.
When the movable half mold moves, the rack pinion drive and the screw drive (blue screw and orange fixed nut) make blue shaft carrying the pink thread core rotate and translate. Thus the thread core is inserted into or removed from the plastic injection part (not shown).
The blue gear must has enough length to enable its meshing with the rack when the blue screw translates.
Thread leads of thread core and the blue screw must be equal.



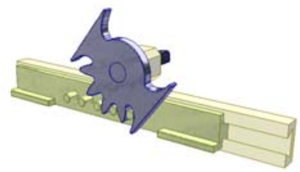
Mechanism for moving thread core of a plastic injection mould 2
http://youtu.be/WZHfFLtYCpg
Yellow rack is connected to the movable half mold.
When the movable half mold moves, the rack pinion drive, two gear drives and the screw drive (blue screw and violet fixed nut) make blue shaft carrying the pink thread core rotate and translate.
Thus the thread core is inserted into or removed from the plastic injection part (not shown).
The pink gear has sliding key joint with the blue screw.
Thread leads of thread core and the blue screw must be equal.
In consideration of short stroke of the movable half mold, two gear drives are used for increasing revolutions of the blue screw.



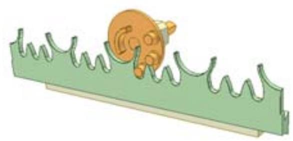
Rack–pinwheel drive 1
http://youtu.be/wGdxybcaRbo
Input: pink disk of a pin and a lock arc that rotates reciprocally.
Output: rack that has linear reciprocating motion of sinusoid law.



Pin rack drive 5
http://youtu.be/BM7hnxtp6Y0
Input: rack that has linear reciprocating motion.
Output: blue gear oscillating 180 deg. with dwells at both ends.
Its motion is of constant speed. Its gear profiles are involutes.
Flat portions on the gear and the rack are for keeping the gear immobile during dwells.

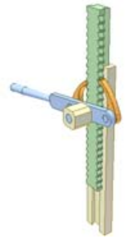


Rack–pinwheel drive 2
http://youtu.be/nKF5GybAtjU
Input: pink disk of pins and a lock arc that rotates reciprocally.
Output: rack that has linear reciprocating motion. Its motion is of constant speed. Its gear profiles are cycloids.

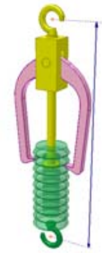


Ratchet mechanism 28
http://youtu.be/drAELRHyHgI
Input: blue crank oscillating.
Output: green ratchet rack.
Both go and back motions of the crank make the rack go up.
The pawls pull the rack.
Spring maintains contact between pawls and ratchet rack.

Ratchet mechanism 29
http://youtu.be/SM7QVSAWztk
Input: blue crank oscillating.
Output: green ratchet rack.
Both go and back motions of the crank make the rack go up.
The pawls push the rack.
The gravity maintains contact between pawls and ratchet rack.

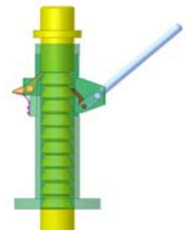


Ratchet mechanism 30
http://youtu.be/eL2QIyGE2Sg
Distance between two hooks can be adjusted easily thanks to a round rack and two pawls.

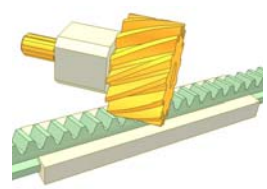


Ratchet mechanism 34
http://youtu.be/UifSW78QEeU
Orange roller allows green round rack to move up and prevents it from falling.

Round rack jack 1
http://youtu.be/dKJP2kc4pMA
Red pawl pushes yellow rod up when pushing blue lever down.
Orange pawl prevents the rod from falling during the red pawl return.



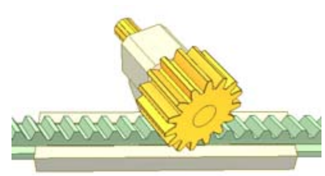
Space gear and rack 1a
http://youtu.be/54kRNC7K7KI
This drive consists of a pinion of helical teeth and a rack of helical teeth.
Normal module mn = 2 mm
Pinion:
- Helix angle B1 = 30 deg., left hand
- Face module ms1 = 2.31 mm
- Tooth number Z1 = 15
- Pitch circle dia. D1 = 34.64 mm



Rack:
- Helical teeth, B2 = 13.69 deg.

Angle between pinion axle and rack moving direction is L = B1 + B2 = 43.69 deg.
1 pinion revolution makes rack move Pi.D1.cosB1/cosB2 = 97.00 mm

Space gear and rack 1b
http://youtu.be/ri7evOSAQbQ
This drive consists of a pinion of straight teeth and a rack of helical teeth.
Normal module mn = 2 mm
Pinion:
- Helix angle B1 = 0 deg.
- Tooth number Z1 = 15
- Pitch circle dia. D1 = 30 mm

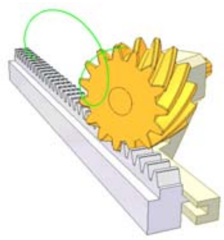


Rack:
- Helical teeth, B2 = 30 deg.

Angle between pinion axle and rack moving direction is L = B1 + B2 = 30 deg.
1 pinion revolution makes rack move Pi.D1.cosB1/cosB2 = 108.83 mm

Screw gear and rack 1c

http://youtu.be/Mulq_PUAbeY



This drive consists of a pinion of helical teeth and a rack of straight teeth.

The rack is stationary. The green curve is locus of a point on pinion pitch circle (a space cycloid?).

Pinion: Helix angle B1 = 30 deg., left hand

Rack: Helix angle B2 = 0 deg.

Angle between pinion axle and rack moving direction is L = 30 deg.

Space gear and rack 1e

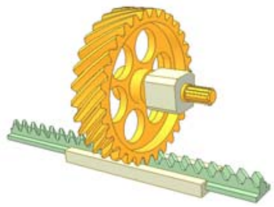
http://youtu.be/5lJS_bfkcXI

Angle between pinion axle and rack moving direction is 0 deg.

Normal module mn = 2 mm

Pinion:

- Helix angle B1 = 45 deg.
- Tooth number Z1 = 30
- Pitch circle dia. D1 = 84.85 mm



Rack:

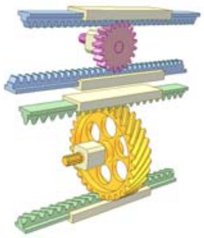
- Helical teeth, B2 = 45 deg.

1 pinion revolution makes rack move Pi.D1.cosB1/cosB2 = 266.56 mm

This drive resembles a screw-nut one when consider: the gear as a screw, the rack as a bar cut out longitudinally (axially) from a nut.

Space gear and rack 1f

http://youtu.be/h5avf2JatzE



Lower drive: Space gear and two rack drive, angle between gear axle and rack moving direction is 0 deg. Its two racks move in the same direction.

Upper drive: Planar gear and two rack drive. Its two racks move in opposite directions.

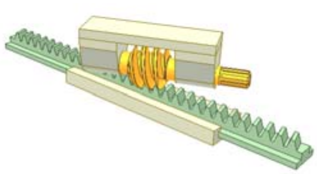
Worm-rack drive 1

http://youtu.be/nHkfWu0sYc0

Normal module mn = 2 mm

Input worm:

- Number of starts Z = 2
- Lead Angle LA = 10.81 deg.
- Direction of thread: right hand
- Pitch circle dia. D = 20 mm

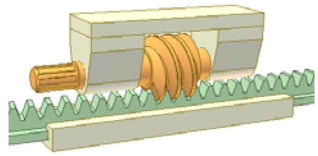


Rack:

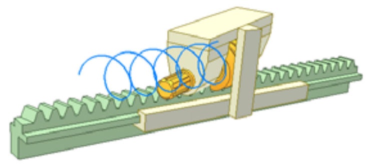
-Helical, B2 = 13.69 deg.

Angle between worm axle and rack moving direction is L = LA + B2 = 24.50 deg.

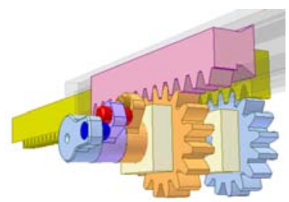
Worm-rack drive 2
http://youtu.be/FTKTd3EfORo
Normal module mn = 2 mm
Input worm:
- Number of starts Z = 2
- Lead Angle LA = 10.81 deg.
- Direction of thread: right hand
- Pitch circle dia. D = 20 mm
Rack:
-Helical teeth, B2 = -10.81 deg.
Angle between worm axle and rack moving direction is L = LA + B2 = 0 deg.



Worm-rack drive 3
http://youtu.be/_cZEc5gwrTM
The rack is stationary. The blue curve is locus of a point on worm pitch circle (a space cycloid?).
Input worm: Helix angle B1 = 30 deg., left hand
Rack: Helix angle B2 = 0 deg.
Angle between pinion axle and rack moving direction is L = 30 deg.

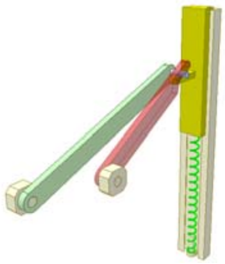


Motion delay mechanism 1
http://youtu.be/ju3c0naRhhM
Input: yellow rack reciprocating.
Output: pink rack that moves only after the blue gear makes around two revolutions.
The violet crank rotates idly on the blue gear shaft. Add more violet cranks to increase delay time.



6.2. Bars, cams

Regular oscilation to regular translation with bar mechanism



http://youtu.be/JmMer5vCIP4

The blue pin slides on flat portions of the red lever and of the yellow slider.

Input: the red oscillate lever.

Output: the yellow slider.

Dimension condition: d = 0.34b

d: center distance between two revolution joints of the red and green levers.

b: center distance between the blue pin and revolution joint of the green lever.

The slider velocity is constant if the red lever osciltates with a constant velocity in the range +/- 30 degrees (angle α) around the line connecting two revolution joints of the red and green levers.

Otherwise stated, the displacement relation between the red lever and the yellow slider is linear. This feature can be used for length measuring tools where the indicator graduation must be even.

In case without the green bar (the red bar has a pin that contact with the flat portion of the yellow slider) the slider velocity alters (cosine function of angle α).

Advantage over rack-pinion drive: high precision of transmission at low manufacture cost.

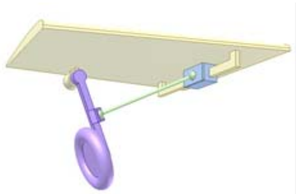
Double parallelogram mechanism 3

http://www.youtube.com/watch?v=RJBoh5k4KDs

The mechanism is used for a disappearing platform in a theater stage. The platform moves approximately vertically and has a contra-weight on the blue input link.

Press using spatial slider crank mechanism

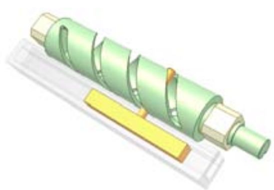
http://www.youtube.com/watch?v=613_NYKz68I



Airplane wheel retracting

http://www.youtube.com/watch?v=Te8UltGmcQQ

A spatial slider crank mechanism is used.

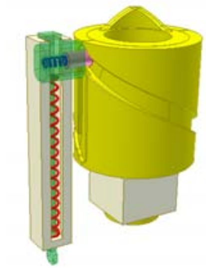


Barrel cam mechanism BT6

http://youtu.be/pln-xTLa1sQ

This mechanism converts linear reciprocating motion into oscillating motion or vice versa.

Barrel cam for 180 deg. rotation 1

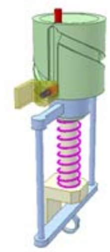


http://youtu.be/SzoF0VMtc7w

Pull and release green slider to let yellow barel cam turn 180 deg.

Blue spring forces pink pin towards the cam. Key factor is different deepths of the cam grooves.

Barrel cam for 180 deg. rotation 2



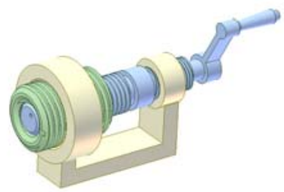
http://youtu.be/I25QNREEYRM

Pull and release blue frame to let green barel cam linearly reciprocate and turn 180 deg. for each stroke.

Blue spring forces orange pin towards the cam. Key factor is different deepths of the cam grooves.

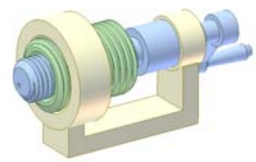
6.3. Screws

Screw mechanism 1
http://www.youtube.com/watch?v=zIAm3MVDAc0



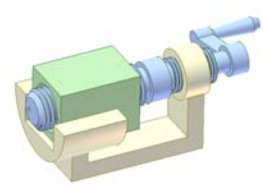
The mechanism consists of 2 movable links and 3 screw joints.
In 1 rev of the blue crank:
The nut's displacement s = h3.(h1-h2)/(h3-h2)
The nut's rotation φ = (h1-h2)/(h3-h2) revs.
h1: pitch of the screw joint of the blue screw and the base.
h2: pitch of the screw joint of the blue screw and the green nut.
h3: pitch of the screw joint of the green nut and the base.
h1, h2, h3 carry negative sign in case of left-handed thread and vice-versa.
For this case, h1 = 2, h2 = 3 and h3 = 4 so s = -4 φ = -1
Wanted s and φ values can be obtained by combination of appropriate h1, h2, h3 and the thread direction.

Screw mechanism 2
http://www.youtube.com/watch?v=0P-ao2F3jvc



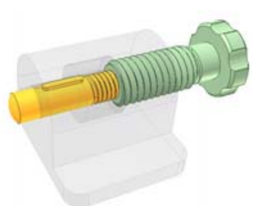
The mechanism consists of 2 movable links, 2 screw joints and 1 revolution joint.
In 1 rev of the blue crank:
The nut's displacement s = -h2.h3/(h3-h2)
The nut's rotation φ = -h2/(h3-h2) revs.
h2: pitch of the screw joint of the blue screw and the green nut.
h3: pitch of the screw joint of the green nut and the base.
h2, h3 carry negative sign in case of left-handed thread and vice-versa.
For this case, h2 = 3 and h3 = 4 so s = -12, φ =.-3
Wanted s and φ values can be obtained by combination of appropriate h2, h3 and the thread direction.

Screw mechanism 3
http://www.youtube.com/watch?v=Jhzh7CLr0cQ



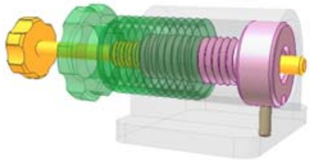
The mechanism consists of 2 movable links, 2 screw joints and 1 prismatic joint.
In 1 rev of the blue crank:
The nut's displacement s = (h1-h2).
h1: pitch of the screw joint of the blue screw and the base.
h2: pitch of the screw joint of the blue screw and the green nut.
h1, h2 carry negative sign in case of left-handed thread and vice-versa.
For this case, h1 = -2 and h2 = 3 so s = -5.
Wanted s values can be obtained by combination of appropriate h1, h2 and the thread direction.

Nut-screw differential mechanism 1
http://youtu.be/-ZN6Kj3sXtc



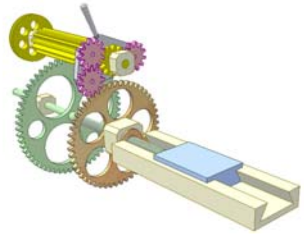
Thread on the orange screw is M5x0.8 (right hand).
External thread on the green knob is M8x1.25 (right hand).
The orange screw moves 1.25 - 0.8 = 0.45 mm during 1 rev. of the knob.
It is possible to reduce this difference by choosing appropriate leads.

Nut-screw differential mechanism 2
http://youtu.be/jbF4Jujf4Os



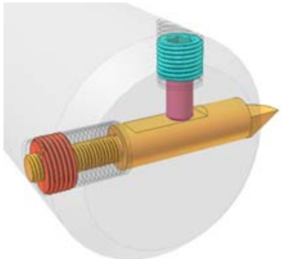
Thread on the orange screw is M5x0.8 (right hand).
External thread on the pink nut is M8x1.25 (right hand).
External thread on the green knob is M14x1.5 (right hand).
The brown pin is for preventing rotation of the pink nut.
Turn the orange screw for rough adjustment: the orange screw moves 0.8 mm for 1 rev. of the screw.
Turn the green knob for fine adjustment: the orange screw moves 1.5 – 1.25 = 0.25 mm for 1 rev. of the knob.
It is possible to reduce this difference by choosing appropriate leads.

Differential screw mechanism
http://youtu.be/YFzov0PbjpM



Input: yellow gear shaft.
Output: blue slider.
Orange gear creates a helical joint with green screw.
The video shows 3 motions of the blue slider: backward, fast backward and slow forward corresponding 3 positions of the grey lever carrying 3 pink pinions for controlling the orange gear rotation.
Braking device for the orange gear is not shown.

Adjustable tool for lathes
http://www.youtube.com/watch?v=I2f6AjUdNBw



A lathe turning tool in a drill rod is adjusted by a differential screw. When turning the red nut, it is advanced and the tool is retracted simultaneously. The resultant displacement of the tool is very small, (t2 – t1) mm in 1 rev. of the nut.
t2: pitch of the nut external thread.
t1: pitch of the nut internal thread.
The threads are right hand.
The tool is clamped by a setscrew after adjusting.

Nut-Screw drive 1
http://www.youtube.com/watch?v=q1DcU5txgJk

The input nut fixed to the green button is translated.
The output screw is rotated.
The screw is made by twisting a metal strip.
The mechanism has been used for winding cameras.

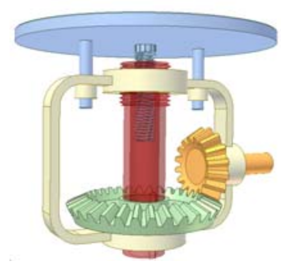
Tensioner 1a
http://www.youtube.com/watch?v=TvsxYUj_6wI

The screws have opposite-hand threads.
Measure to keep the orange screw from rotation is not shown.

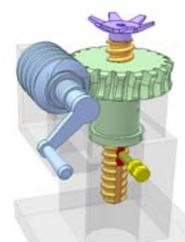
Tensioner 1b
http://www.youtube.com/watch?v=G2Urv8dambI
The screws have opposite-hand threads.
Flats on the screw ends restrain the orange screw against rotation.

Tensioner 2
http://www.youtube.com/watch?v=bwpbab9XITg
The green nut has opposite-hand threads on its internal and external cylinder surface. The mechanism occupies less longitudinal space than "Tensioner 1a":
http://www.youtube.com/watch?v=TvsxYUj_6wI
Measure to keep the orange screw from rotation is not shown.

Precise height adjustable table
http://www.youtube.com/watch?v=PRYNpNA8elw
A measuring table goes up and down very slowly for many turns of the input bevel gear. All the threads has the same hand. Their pitches are t1 mm and t2 mm. In 1 revolution of the green bevel gear the table moves (t2 – t1) mm.

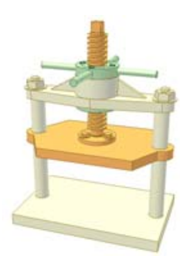


Nut-screw and worm jack
http://youtu.be/kp-dNLE8pMI
Combination of nut-screw and worm mechanisms gives the jack a high mechanical advantage.

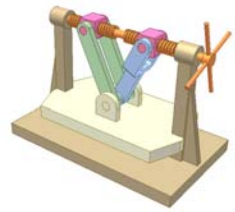


Manual screw press 1
http://www.youtube.com/watch?v=GrK5bhJjex4
The green nut is fixed. The orange screw is rotated and translated.

Manual screw press 2
http://www.youtube.com/watch?v=-DAtwJzmFdM
The green nut is rotated. The screw is translated.



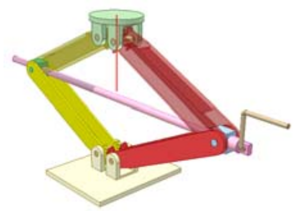
Manual screw press 3
http://www.youtube.com/watch?v=nGiS4ZScxII
The orange screw has right hand and left hand threads with the same pitch and is rotated. The pink nuts are translated.



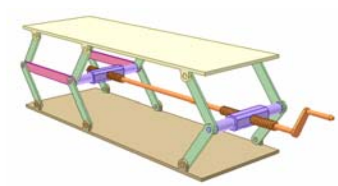
Manual screw press 4
http://www.youtube.com/watch?v=S7OIx_liVqY

A combination of slider-crank mechanism and nut-screw one gives a high mechanical advantage.
The orange screw is rotated. The pink nuts are translated. Both move slightly in vertical plan.

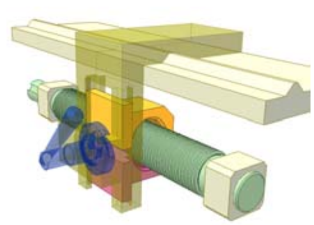
Gear and linkage mechanism 3c
http://youtu.be/78T8ufcyGjY
This jack is a combination of linkage, gear drive and nut screw one. The green disk moves along an absolutely straight line, its top plane is always horizontal.



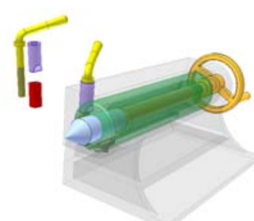
Double parallelogram mechanism 4
http://www.youtube.com/watch?v=nd8MWd1rz88
Raise or lower the table by turning the orange screw that has right hand and left hand threads with the same pitch.



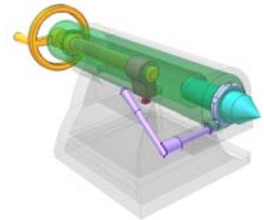
Half nuts for lathes
http://www.youtube.com/watch?v=yqYd2-52R5U
The haft nuts get engaged with the leadscrew by the blue slot face cam. The mechanism is used for turning threads.



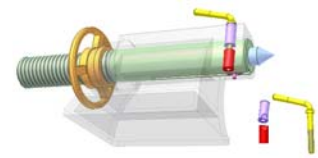
Lathe tailstock 1
http://youtu.be/pgsJJI5-zow
Use the yellow lever to release or tighten the green spindle.
Turn the orange screw to move the spindle that has a hole with internal thread. At right end position of the spindle, the screw pushes the blue center for its removing.



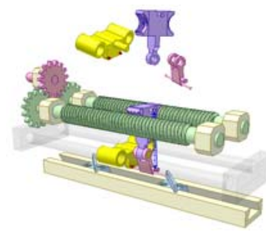
Lathe tailstock 2
http://youtu.be/gGVdUasdM9A
Use the violet lever (eccentric) to release or tighten the green spindle. Turn the orange screw to move the spindle. The pink nut is fixed to the tailstock house. The blue round nut is for removing the center.



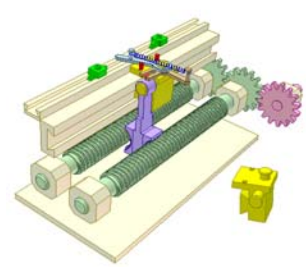
Lathe tailstock 3
http://youtu.be/Sf-WVtx5mio
Use the yellow lever to release or tighten the green screw-spindle. Turn the orange nut-wheel to move the spindle.



Twin screw mechanism 1
http://youtu.be/gxNnRek2tzM
Input: pink gear making two green screws rotate in the same direction. Threads of the screws have opposite helical directions.
Violet lever carrying two half nuts contacts with one of the two screws. The contact is controlled by a toggle mechanism of pink lever, blue spring and two blue stoppers.
Output: yellow slider having linear reciprocating motion. Its length and position can be adjusted by setting positions of the two blue stoppers.
Thread form must be square in order not to cause radial force that tends to push the nuts from the screws.
In case two green screws rotate in opposite directions, threads of the screws have the same helical direction.
Created only on computer, this mechanism needs to be verified in practice.

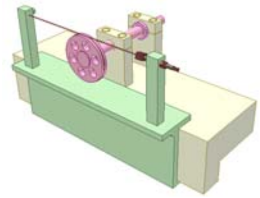


Twin screw mechanism 2
http://youtu.be/GBg--a5prRc
Input: pink gear making two green screws rotate in opposite directions. Threads of the screws have the same helical direction.
Violet lever carrying two half nuts contacts with one of the two screws. The contact is controlled by a toggle mechanism of blue spring, brown and blue levers and two green stoppers.
The violet lever has a red spherical pin that contacts the brown lever groove.
Output: yellow slider having linear reciprocating motion. Its length and position can be adjusted by setting positions of the two green stoppers.
Thread form must be square in order not to cause radial force that tends to push the nuts from the screws.
Created only on computer, this mechanism needs to be verified in practice.

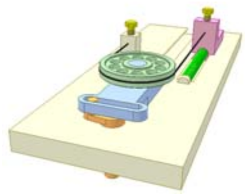


6.4. Belts and cables

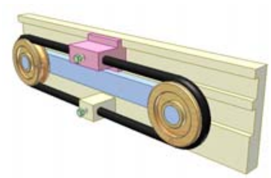
Cable drive 1
http://youtu.be/MDsTRN_a9hs
The brown cable is wound 1 rev. around the pink pulley. Its two ends are fixed to the green slider.
It is simplest way to convert rotation to translation and vice versa (as a rack-pinion drive).



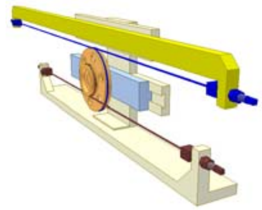
Cable drive 2
http://youtu.be/d2qLx8KYK1g
The pink slider moves twice faster than the blue one.



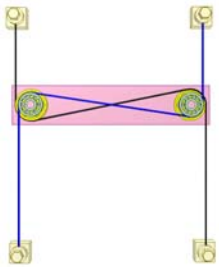
Cable drive 3
http://youtu.be/cbENtxMiRk0
The blue slider carries two orange identical pulleys.
A point (middle) of the lower cable branch is fixed (immobile).
The upper branch is fixed to the pink slider, velocity of which is double the one of the blue slider.



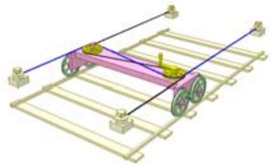
Cable drive 4
http://youtu.be/Kwobt2n7_HY
The blue and brown cables each wraps 1 rev. round the orange pulley of two radii (R and r, R is larger than r).
The pulley has a revolution joint with the blue slider.
Two ends of the blue cable are fixed to the yellow slider.
Two ends of the brown cable are fixed to the immobile base.
Velocity ratio between the yellow slider (Vy) and the blue one (Vb):
Vy/Vb = (R + r)/r
For this case R = 2r so Vy = 3Vb
If R = r then Vy = 2Vb



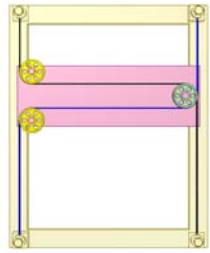
Cable drive 5
http://youtu.be/JkqfoA5LXR4
The green pulleys are identical. The yellow pulleys are identical.
The blue cable with two fixed ends wraps round the green pulleys.
The black cable with two fixed ends wraps round the yellow pulleys.
Four vertical cable branches must be parallel.
The pink slider has vertical translational motion (with or without guideway).
Eccentric arrangement between the green pulleys and the yellow pulleys in vertical direction is possible.
This mechanism was used for drawing parallel horizotal straight lines.



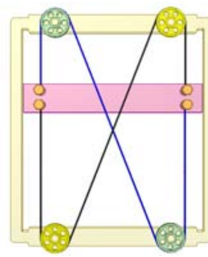
Cable truck
http://youtu.be/fks4ziPym18
Turn the yellow crank to move the pink truck on a straight railway.
The yellow pulleys have two round grooves for wrapping the black and blue cables.



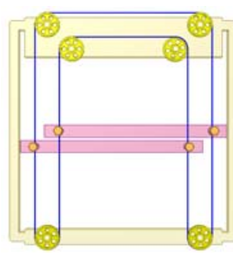
Cable drive 6
http://youtu.be/uju7Ut2n9fM
The yellow pulleys have 1 round groove.
The green pulley has 2 round grooves.
The black cable wraps on upper yellow pulley and the green one.
The blue cable wraps on lower yellow pulley and the green one.
All pulleys have the same contact (with the cables) diameter.
The pink slider have vertical translational motions (with or without guideway).



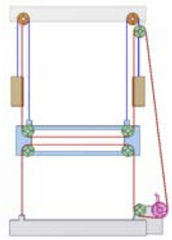
Cable drive 7
http://youtu.be/e4Wgiyk02U4
The yellow and green pulleys are identical.
The blue cable with two ends fixed to the pink slider wraps on the green pulleys.
The black cable with two ends fixed to the pink slider wraps on the yellow pulleys.
The pink slider has vertical translational motion (with or without guideway).



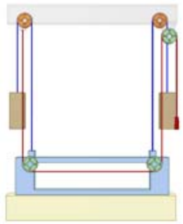
Cable drive 8
http://youtu.be/BpkbSWNvvSA
The yellow pulleys are identical.
The blue endless cable wraps on all the pulleys.
Each of two pink bars is fixed to the cable at two points.
The bars have vertical translational motions in opposite directions (with or without guideway).



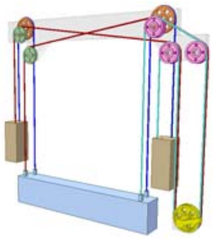
Cable drive 9A
http://youtu.be/5Ft3_hqnt30
Mechanism for vertical moving a working platform (in blue).
The blue cables carrying weights for platform equilibration. Turn the pink pulley to make the platform go up and down (through red cable).



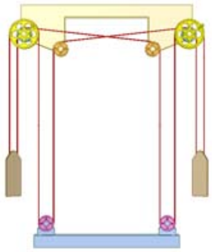
Cable drive 9B
http://youtu.be/7_0lsml0qDs
Mechanism for vertical moving a working platform (in blue).
The platform tends to get lowest position.
The blue cables carry contraweights. Pull the red cable to make the platform go up and fix it at desired position (fixing measure is not shown).



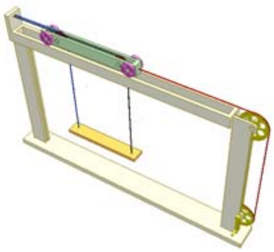
Cable drive 9C
http://youtu.be/NofhU1uEXJ4
Mechanism for vertical moving a working platform (in blue).
There are four cables. The ends of each cable are fixed to the platform and to the contraweight.
The pink and yellow pulleys have two cable grooves.
Turn the yellow pulley to make the platform go up and down (through red and cyan cables).



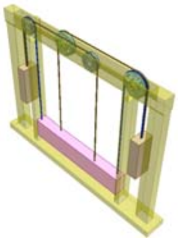
Cable drive 10
http://youtu.be/hzsfHbpbQIs
Mechanism for vertical moving a working platform (in blue).
Only one endless cable is used.
The green, pink and orange pulleys are identical.
The green pulley and the yellow one are fixed together
(two couples).
Turn one of the yellow pulleys to make the platform go up and down.



Cable drive 11
http://youtu.be/0KAmDnGBVJc
Turn the yellow crank to move the green trolley along a horizontal rail. The orange platform, while moving horizontally, also moves vertically due to the black and blue cables. Angle between its rectilinear trajectory and the horizontal line is 45 deg.

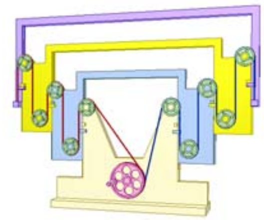


Cable drive 12
http://youtu.be/g9hmQTGQTO4
This is a good way for mounting equilibratory weights to prevent jam of the pink slider.
Four cables are used. Each weight has two connected to it.



Cable telescopic frame

http://youtu.be/yInMEfrQWwA



Turn the pink pulley to make the violet frame go up and down.

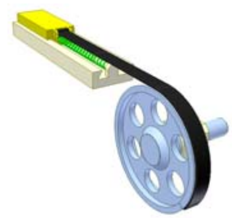
Each of the red and blue cables has one end fixed to the pink pulley, the other to the violet frame. The green pulleys are identical. The weight of the moving parts ensures the cable tension.

The verticality of some cable branches is not compulsory.

In case of horizontal arrangement it is possible to add a second similar cable system for return motion.

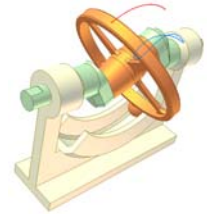
Cable drive 21

http://youtu.be/R6fhA3ln8JU

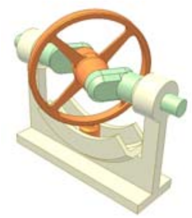


A simple way to convert reciprocating rotation to reciprocating translation.

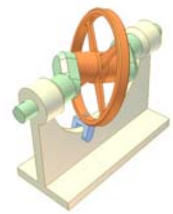
7. Rotation to wobbing motion



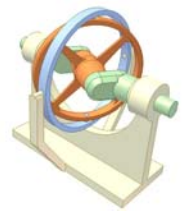
Wobbling disk mechanism 1a
http://www.youtube.com/watch?v=59WtZtcHV6M



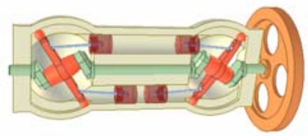
Wobbling disk mechanism 1b
http://www.youtube.com/watch?v=z1OxcLWpmck



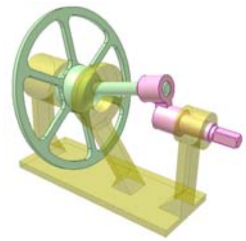
Wobbling disk mechanism 1c
http://www.youtube.com/watch?v=IqCKkvmwLoI



Wobbling disk mechanism 1d
http://www.youtube.com/watch?v=MqrIDAT-Agg



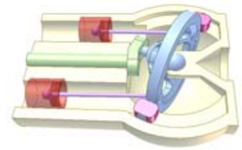
Application of wobbling disk mechanism 1
http://www.youtube.com/watch?v=4MshdQtQFeA



Wobbling disk mechanism 4
http://youtu.be/K7WahB1FD3g
This mechanism has two degrees of freedom.
Two independent rotary motions are assigned to pink crank and green disk.

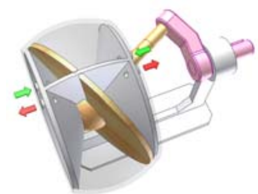
Wobbling disk mechanism 2
http://www.youtube.com/watch?v=oBqxuEjRnDM

Application of wobbling disk mechanism 2
http://www.youtube.com/watch?v=dygqFaX8srU

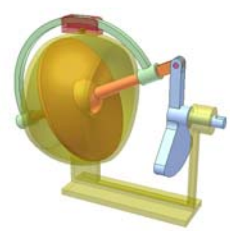


Wobbling disk mechanism 5
http://youtu.be/k2CVF-L1W2I
Input: pink crank.
The orange propeller performs a complicated motion that may find application for mixing machines.
There is a considerable backlash in the gear drive.

Wobbling disk mechanism 6
http://youtu.be/VpSXJkPBbQ4
Input: pink crank.
A vertical wall prevents orange disk from rotating. The orange disk rolls on two cone surfaces.
The mechanism may be used for pumps. The arrows show fluid flows. An amount of fluid is sucked into the pump during its first revolution and discharged during the next revolution.



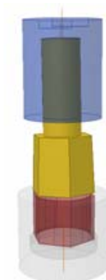
Wobbling disk mechanism 3
http://www.youtube.com/watch?v=TqBDpLp3RJg
Steam engine of disk piston.
Steam is admitted alternately on either side of piston.



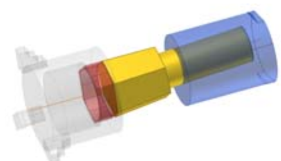
Ceilling fan 1a
http://youtu.be/YFyX6fxkvpA
Two inputs: rotor carrying yellow propeller and pink crank (two electric motors).
Axes of all revolution joints of the pink crank and the green frame are concurrent.

Ceilling fan 1b
http://youtu.be/WN4ATS2XcVU
Input: rotor carrying yellow propeller (electric motor).
Pink gear is fixed to the pink crank that is mounted idly on the fan base.
Motion is transmitted from the yellow propeller to the pink crank through two gear drives. Axes of revolution joints of the pink crank and the green frame are concurrent.
Use worm drives for large transmission ratio (for example: two worm drives and one spur gear drive).

Rotary broaching 1
http://www.youtube.com/watch?v=J2OAISkHHbI
The workpiece is fixed.
Angle between axles of the workpiece and the tool is 1 degree.
The yellow tool has wobbling and axial movement.
The red portion is to be cut off.
An application of Wobbling Disk mechanism.



Rotary broaching 2
http://www.youtube.com/watch?v=VcEhmpkMVrM
The workpiece and the yellow tool is rotated
Angle between axles of the workpiece and the tool is 1 degree.
The tool also has axial movement.
The red portion is to be cut off.

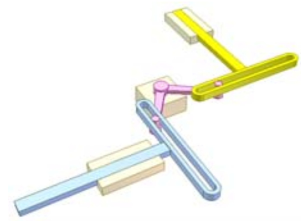


8. Altering linear motions

8.1. Bars, wedges and cams

Transmission of linear displacement 1a

http://youtu.be/pz_7UZRnMZM



Angle of the pink twin equal crank is A = 90 deg.. The crank length is a. Angle between sliding directions of the runways is B = 90 deg.. Transmission ratio of linear displacement between the blue slider and the yellow one is 1. When the blue bar move regularly, so does the yellow.
Position of the crank bearing can be arbitrary.
Transmission ratio of 1 can not be kept if A differs from B
Advantage over rack-pinion drive: high precision of transmission at low manufacture cost.

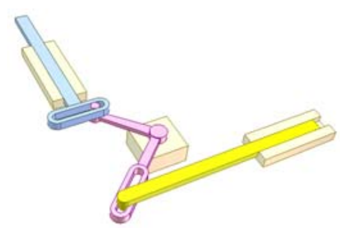
Transmission of linear displacement 1b

http://youtu.be/XnZQS6qhtaE

Angle of the orange twin equal crank is A = 60 deg.. The crank length is a. Angle between sliding directions of the runways is B = 60 deg. Transmission ratio of linear displacement between the blue slider and the yellow one is 1. When the blue bar move regularly, so does the yellow.
Position of the crank bearing can be arbitrary.
Transmission ratio of 1 can not be kept if A differs from B.
Advantage over rack-pinion drive: high precision of transmission at low manufacture cost.

Transmission of linear displacement 2

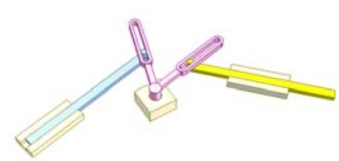
http://youtu.be/Bz4anYbkXmY



Angle of the pink twin arm is A = 90 deg..
Angle between sliding directions of the runways is B = 90 deg.. Transmission ratio of linear displacement between the blue slider and the yellow one is not 1.
When the blue bar move regularly, the yellow not.

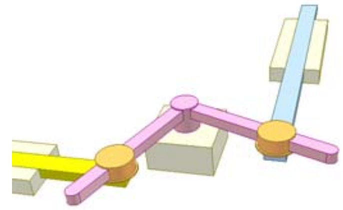
Transmission of linear displacement 3a

http://youtu.be/HnGQCls07r0

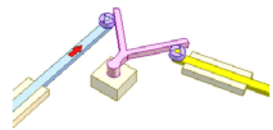


Angle of the orange twin equal crank is A = 60 deg.. Angle between sliding directions of the runways is B = A = 60 deg.
The crank pivot center must be on the bisector of sliding directions of two sliders.
Transmission ratio of linear displacement between the blue slider and the yellow one is 1.
When the yellow bar move regularly, so does the blue.
Advantage over rack-pinion drive: high precision of transmission at low manufacture cost.

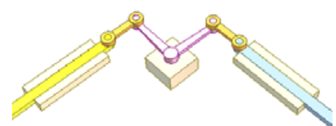
Transmission of linear displacement 3b
http://youtu.be/e51sMAdGS40
An embodiment of "Transmission of linear displacement 3a"
A = B = 90 deg.
Orange parts have revolution joints with the sliders and prizmatic joints with the pink arm.



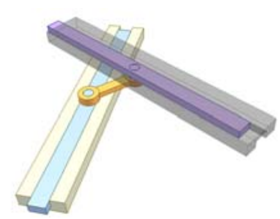
Transmission of linear displacement 4
http://youtu.be/BwYzRrFOt9E
Angle of the pink twin arm is A = 80 deg..
Angle between sliding directions of the runways is B = A = 80 deg..
The crank pivot center must be on the bisector of sliding directions of two sliders.
For the pink crank, the distance between planes, that contact with the violet rollers, and the crank's pivot centerline must be equal to roller's radius.
Transmission ratio of linear displacement between the blue slider and the yellow one is 1.
When the yellow bar move regularly, so does the blue.
Red arrow represents resisting force.



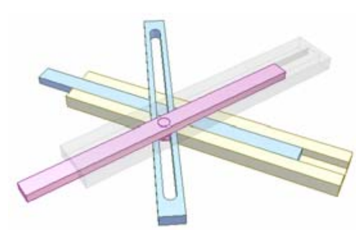
Transmission of linear displacement 5
http://youtu.be/9b6bNjXsBgo
Angle of the pink twin arm is A = 90 deg..
Angle between sliding directions of the runways is B = 90 deg..
Transmission ratio of linear displacement between the blue slider and the yellow one is not 1.
When the yellow bar move regularly, the blue not.



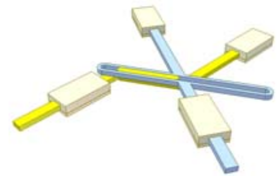
Transmission of linear displacement 6
http://youtu.be/qFjCFQ15ff8
Transmission ratio of linear displacement between the blue slider and the violet one is not 1.
When the blue slider move regularly, the violet not.



Transmission of linear displacement 7a
http://youtu.be/VVRj9mh_JEc
Angle between two sliding directions of the blue slider is A deg.
Angle between sliding directions of the runways is B = (180 – 2.A) deg.
Transmission ratio of linear displacement between the pink slider and the blue one is 1. When the pink slider moves regularly, so does the blue.
With other value of B, the transmission ratio differs from 1.
In substance it is a translating cam mechanism.



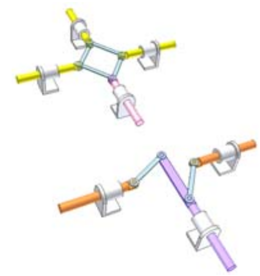
Transmission of linear displacement 7b



http://youtu.be/45DxLId4ZX0

Angle between two sliding directions of the blue slider is A deg. Angle between sliding directions of the runways is B = (180 – 2.A) deg.
Transmission ratio of linear displacement between the pink slider and the blue one is 1. When the pink slider moves regularly, so does the blue.
It is an embodiment of “Transmission of linear displacement 7a”.
The pin of the pink slider is replaced by a rectangular key that creates an angle A with the sliding direction of the yellow slider.
With other value of B, the transmission ratio differs from 1.
In substance it is a wedge mechanism.

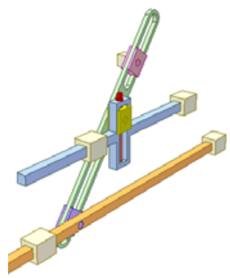
Linkage for linear motions 1



http://youtu.be/-P8eOBkzuYw

Back mechanism:
Input: pink slider. Opposite sliders move in opposite directions with the same speed.
Front mechanism:
Input: violet slider. Opposite sliders (in orange) move in the same direction with different speeds.

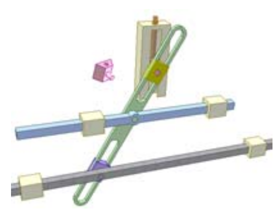
Mechanism for increasing stroke length 1



http://youtu.be/MbqEe-I3Z7M

Input: blue slotted slider linearly reciprocating with constant stroke length.
Output: orange slider linearly reciprocating with adjustable stroke length.
Yellow slider has revolution joint with green slotted bar.
Adjust position of the yellow slider on the blue slider to get various stroke lengths of the output.
Lo = Li.(a/x)
Li: input stroke length
Lo: output stroke length
x: pivot center distance between pink and yellow sliders in vertical direction.
a: distance from pivot center of the pink slider to sliding line of the orange slider in vertical direction.

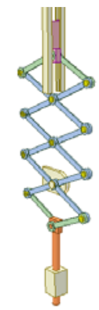
Mechanism for increasing stroke length 2



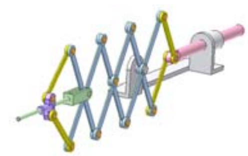
http://youtu.be/4G6mSwPguK4

Input: blue bar linearly reciprocating with constant stroke length.
Output: grey bar linearly reciprocating with adjustable stroke length.
Yellow slider has revolution joint with pink slider.
Adjust position of the pink slider on the fixed runway to get various stroke lengths of the output.
Lo = Li.(a+x)/x
Li: input stroke length
Lo: output stroke length
a: distance between sliding lines of blue bar and grey bar.
x: distance from pivot center of the pink slider to sliding line of the blue bar.
The adjustment can be performed when the mechanism is running.

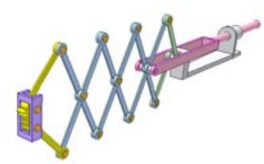
Lazy tong 1
http://youtu.be/Zm-4kJLdRcM
Input: pink slider.
Output: orange link.
Small longitudinal force on the input causes large one on the output (around 3 times in this case). The input and output move in opposite directions.
The mechanism finds application in lazy tong riveter:
https://www.youtube.com/watch?v=7D7ECCps0h4

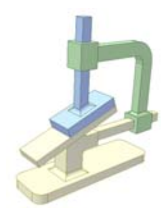


Lazy tong 2
http://youtu.be/UniRkbt0LOY
Input: pink slider.
Output: violet link.
Short input motion gives a long output one (around 3 times in this video). The input and output move in opposite directions.
The green link is for keeping the violet link direction unchanged.

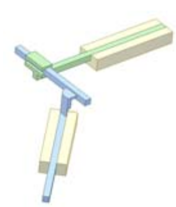


Lazy tong 3
http://youtu.be/cML0xKSmTPM
Input: pink slider.
Output: violet link.
Short input motion gives a long output one (around 4 times in this video). The input and output move in the same direction.
The gears on yellow links are for keeping the violet link direction unchanged.

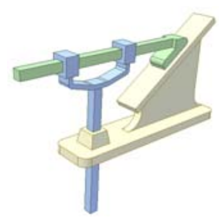




Wedge mechanism 1
http://youtu.be/IS5ivukXRrg
.

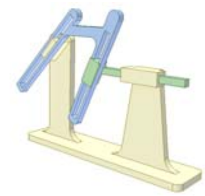


Wedge mechanism
http://www.youtube.com/watch?v=GeAEU2fGYKY

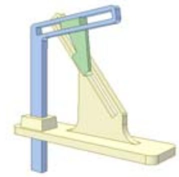


Wedge mechanism 2
http://youtu.be/6nWhE4ExegM

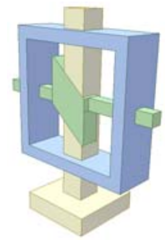
Wedge mechanism 3
http://youtu.be/9MTK6NNBCyc



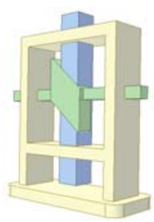
Wedge mechanism 4
http://youtu.be/A5a2mZNIHjw



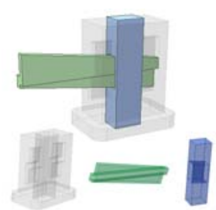
Wedge mechanism 5A
http://youtu.be/oP4NIjh8SIs



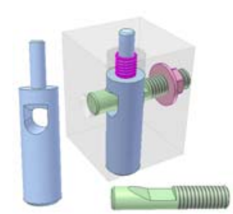
Wedge mechanism 5B
http://youtu.be/2Zc6MzhJZi4



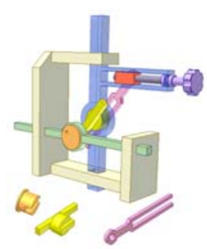
Wedge mechanism 6
http://youtu.be/vARgErImtro
A construction measure for increasing course of the horizontal wedge.



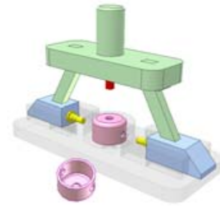
Wedge mechanism 7
http://youtu.be/IaQA6cUrkAU



Wedge mechanism 8
http://youtu.be/c3ep2XyCAow
Input is the green horizontal bar. The stroke length of the blue vertical bar can be adjusted by choosing appropriate position of the red slider (altering the wedge angle of the mechanism).

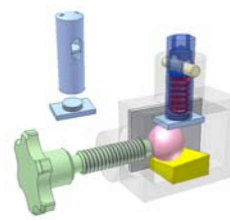


Wedge mechanism 9
http://youtu.be/uavruMk99v8
Piercing die. Vertical and horizontal holes are created at the same time by punches fixed on vertical and horizontal sliders.
The vertical wedges (in green) can be of rectangular section or circular one.

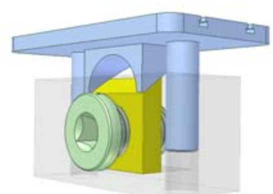


Wedge mechanism 10
http://youtu.be/C5DWm0ab7BU
The revolution joint between pink nut and green slider does not have kinematic significance. It is only for redeeming manufacture errors.

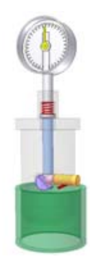
Wedge mechanism 13
http://youtu.be/f1FofjOrrP0
Combination of screw and wedge mechanisms gives precise small displacement of a slider (in blue).
The yellow fixed wedge has slopes in two directions for positioning the pink ball. The spring is located inside the slider to reduce slider's length.



Wedge mechanism 14
http://youtu.be/XYjx0u75HNs
Combination of screw and wedge mechanisms gives precise small displacement of a table (in blue).

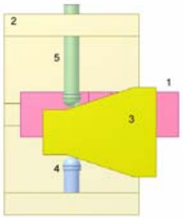


Wedge mechanism 15
http://youtu.be/_DIGLkp8Csg
Hole diameter measuring device.
The object to be verified is the green. The violet fixed wedge transfers horizontal displacement into vertical one which can be read out on the indicator.

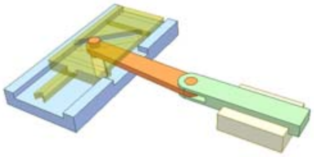


Wedge mechanism 18
http://youtu.be/3u9swq3XDSg
A bit of Morse taper tail can be removed easily by a wedge.

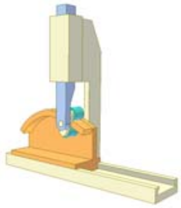
Translational cam
http://www.youtube.com/watch?v=f6ThkL0fQe8
A measure to increase follower stroke while unchanged presure angle.



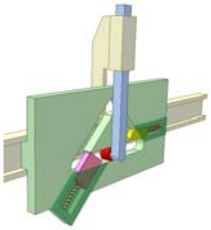
Stroke-multiplying mechanism
http://www.youtube.com/watch?v=XDe0WAmb5aw
The second slot in the blue base helps double stroke of the yellow output slider. The green input slider is driven by a cam (not shown).



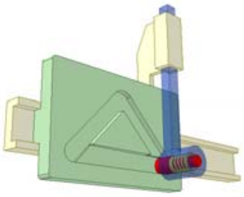
Translating cam mechanism TTr1
http://youtu.be/n6fXu9OAb6I
The follower has a twin arm carrying two rollers that conctact both sides of the cam rim of constant thickness A . No backlash if clearance between the rollers = A.



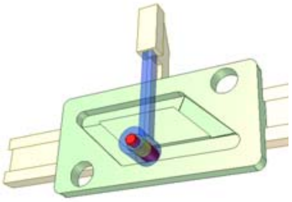
Translating cam mechanism TTr2a
http://youtu.be/uMkATPVaA9Y
The green input cam reciprocates. The blue follower rests during cam's right to left stroke and moves during return. The pink and yellow plates help the roller move clockwise.



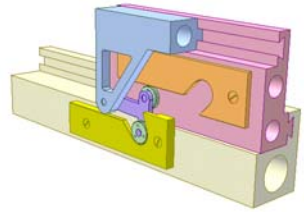
Translating cam mechanism TTr2b
http://youtu.be/nPcV9fF_h8A
The green input cam reciprocates. The blue follower rests during cam's right to left motion and moves during return.
The inconstant depth of the horizotal groove helps the red pin move clockwise.



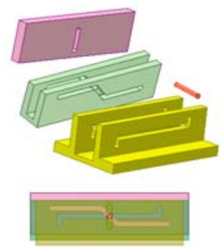
Translating cam mechanism TTr3
http://youtu.be/Bmp3OJiJQbw
The green input cam reciprocates. The blue follower moves at the ends of forth and back strokes.
The various grooves' depths enable the red pin to move clockwise.



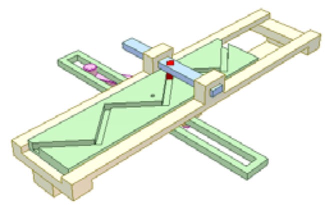
Double translating cam mechanism 1
http://youtu.be/1aQMPifquc4
The input pink slider has linear reciprocating motion. Due to the violet T-shaped lever carrying two rollers and the slots on the orange and yellow plates, the output blue slider moves with dwell at right end of the input stroke.



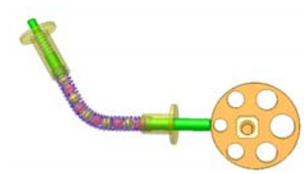
Double translating cam mechanism 2
http://youtu.be/HK7u_ncfScM
The input green slider has linear reciprocating motion. Due to the red pin moving in three slots of the parts, the output pink slider moves with dwell in the middle of the input stroke.



Translating cam mechanism 4
http://youtu.be/C053HbNN5-U
If the cam pitch line is a symmetric zigzag, a rhomb-shaped pin can be used for the cam and follower contact to increase load capacity.

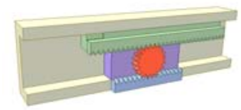


Drive for small linear movement
http://youtu.be/86ZG5x2IEEM
Truyền chuyển động nhỏ.
Phương chuyển động giữa đầu vào và đầu ra có thể tùy ý, thậm chí chéo nhau.
Rất tiếc mô phỏng không thể hiện được rung động của ống dẫn lò xo.

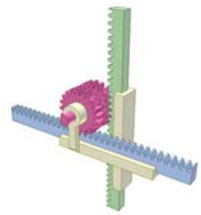


8.2. Gear drives

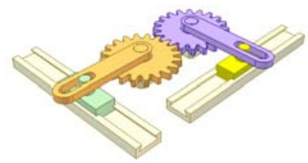
Application of rack pinion mechanism 1
http://www.youtube.com/watch?v=qdCOBf_qIGk
Velocity of the green slider is double the one of the violet slider



Application of rack pinion mechanism 3
http://www.youtube.com/watch?v=aF8vagao6CM
Changing direction of a rectilinear motion

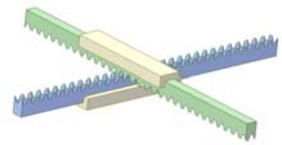


Transmission of linear displacement 9
http://youtu.be/hiEg-MAgpM0
One slider is the driver and moves regularly. In general the driven slider moves irregularly.
However there are exceptions.

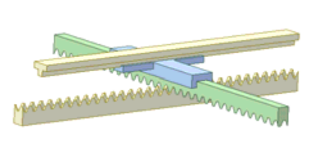


For example, the video shows a case where the sliders move regularly, transmission ratio is 1. Sliding directions are perpendicular to each other. The assembly enables a position of the mechanism where the gear cranks and the runways create a rectangle.

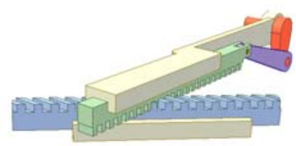
Rack-Rack transmission 1
http://www.youtube.com/watch?v=x1Ioh0bysM0



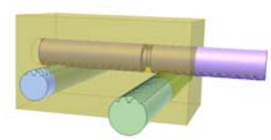
Rack-Rack transmission 2
http://www.youtube.com/watch?v=ad9rI5sb-u8



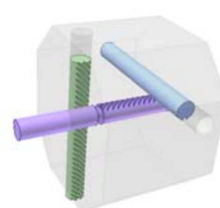
Rack-Rack transmission 3
http://www.youtube.com/watch?v=Ew9q6uQfZwY
Tooth shape: rectangular.
Tooth inclined angle β1 = 0 deg., β2 = 45 deg.
Angle between rack moving directions: γ = 45 deg.
Displacement relation: s2 = s1.cosβ1/cosβ2 = 1.41s1



Rack-Rack transmission 4
http://www.youtube.com/watch?v=p2Pf1NVVhNY
Tooth directions on the two gear parts of the violet rack are opposite.



Rack-Rack transmission 5
http://www.youtube.com/watch?v=r_G9Ho3FCJ8



8.3. Chains, belts and cables

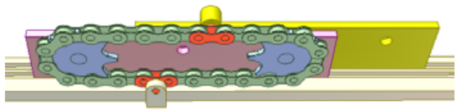
Chain drive 4A

http://youtu.be/grMBzq0YHH0

This mechanism is applied in lifting trucks. The violet fork moves two times faster than the green piston.

Chain drive 4B

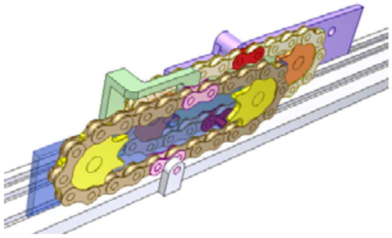
http://youtu.be/sEp-K6eyYz8



The pink plate is driving.
The yellow frame moves two times faster than the pink one.
The sprockets have the same tooth number.
The lower red link of the chains is fixed to the base.
The upper red link of the chains is fixed to the yellow plate.
The mechanism can be used for telescopic sliding gate of two panels. See:
http://www.youtube.com/watch?v=ASAxH51ify8

Chain drive 4C

http://youtu.be/CjVJk_0uYhE



The blue plate is driving.
The green plate moves two times faster than the blue one.
The violet plate moves two times faster than the green one or four times faster than the blue one.
The sprockets have the same tooth number.
The lower pink link of the front chains is fixed to the base.
The upper pink link of the front chains is fixed to the green plate.
The lower red link of the back chains is fixed to the blue plate.
The upper red link of the back chains is fixed to the violet plate.
The blue plate carries the front chain drive.
The green plate carries the back chain drive.
The mechanism can be used for telescopic sliding gate of three panels.

Transmission of linear displacement 8

http://youtu.be/HX_sU9Ye3VA

There are two belts. One belt end is fixed to pulley.
When the pink slider moves regularly, so does the yellow.
Transmission ratio of linear displacement between two sliders is 1 if two pulleys have the same belt contact diameter.
Spring may be cut down for the driving slider.
Angle between sliding directions is arbitrary.
This is similar to case of two rack-pinion mechanisms.

Cable drive 15

http://youtu.be/o2_0Ft6-Mq4

Pull and release the brown tow twice to let the green coulisse move forth and back. One end of the tow is fixed to the blue disk. The orange spring ensures that the yellow ratchet wheel rotates in one direction. The circular slot on the blue disk and a pin on the case limit oscillating angle of the blue disk. A spiral spring (not shown) makes the blue disk rotate back when the tow is released. Another spring (not shown) always forces the pawl toward the ratchet wheel.

Cable drive for changing direction of linear motion 1

http://youtu.be/LGEt58cRzIc

Input: yellow sliders moving along X axes.

Ouput: green sliders moving along axes Y or Z that are skew to X axes. Skew angles are 90 deg.

X,Y and Z are parallel to Ox, Oy and Oz of a Cartesian coordinate system Oxyz (not shown) respectively.

Cable drive for changing direction of linear motion 2

http://youtu.be/6Xt5xkjQQnY

Input: yellow slider moving along X axis.

Ouput: green slider moving along axis Y that is skew to X axis. Skew angle can be arbitrary, for this case is 45 deg.

Cable drive 16a

http://youtu.be/1-M_5u_GqIE

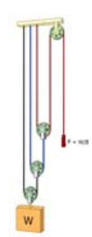
W: weight of the load

P: pulling force for moving up the load.

Mechanical advantage: 2

Cable drive 16b

http://youtu.be/Zgg0qqGG7NU



W: weight of the load

P: pulling force for moving up the load.

Mechanical advantage: 8

Cable drive 17a

http://youtu.be/BrUh4IK8oY0

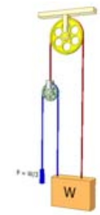
W: weight of the load

P: pulling force for moving up the load.

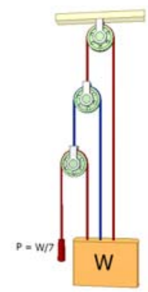
Mechanical advantage: 2

Cable drive 17b
http://youtu.be/bCWy9xnyZj8
W: weight of the load
P: pulling force for moving up the load.
Mechanical advantage: 8

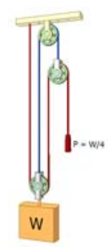
Cable drive 18a
http://youtu.be/ybHgot0jbUc
W: weight of the load
P: pulling force for moving up the load.
Mechanical advantage: 3



Cable drive 18b
http://youtu.be/XVXbkQ-DZSs
W: weight of the load
P: pulling force for moving up the load.
Mechanical advantage: 7



Cable drive 19
http://youtu.be/_1mvNDrcymk
W: weight of the load
P: pulling force for moving up the load.
Mechanical advantage: 4

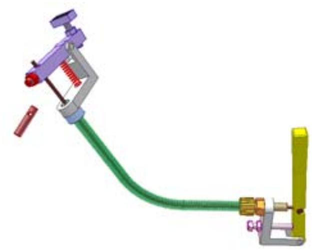


Cable drive 20
http://youtu.be/MLWs-9-HqqU
Four pulleys rotate independently.
W: weight of the load
P: pulling force for moving up the load.
Mechanical advantage: 4 (number of the cable branches that suspend the weight or twice number of movable pulleys)
Pulleys velocities:
Vg = 4Vb
Vo = 3Vb
Vp = 2Vb

Vg, Vo, Vp and Vb are velocities of green, orange, pink and blue pulleys, respectively.
Upper pulleys have the same rotation direction.
Lower pulleys have the same rotation direction, opposite to the one of the upper pulleys.

Bowden cable 1

http://youtu.be/HhzvytVW1kk



It is used to transmit a pulling force over short distances.
Input: yellow lever.
Moving direction of the violet output lever can be arbitrary.
The cable moves in green cable housing (a bended helical steel wire).
Orange inline hollow bolt (barrel adjuster) is for adjusting position of violet output lever.
Turning the bolt to the left means lengthening the cable housing relative to two grey fixed anchors and adjusting the output lever anticlockwise.

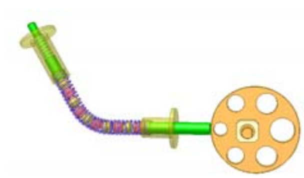
Bowden cable 2

http://youtu.be/wWdTjjE4usA

Input: pink button.
Output: blue pin.
The brown cable housing (a bended helical steel wire in practice) moves outside grey fixed cable.
Position of the pink button can be arbitrary in the space.
The mechanism is used to transmit a pushing force over short distances. It finds application for cameras
The displacement of the input can not be long.
The mechanism is cut off half for easy understanding.

Drive for small linear movement

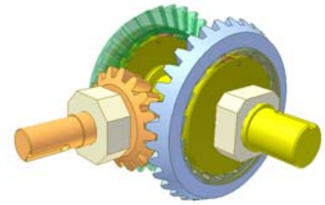
http://youtu.be/86ZG5x2IEEM



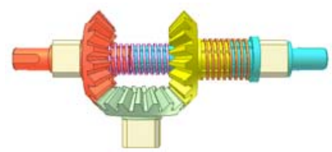
Movement directions between the input and the output can be arbitrary, even skew.
Regretably the animation can not show the vibration of the spring duct.

9. Converting reciprocating motion to continuous rotation

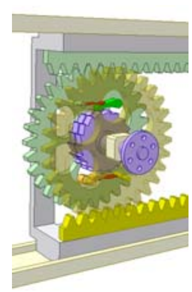
Mechanism for converting two-way to one-way rotation 1
http://youtu.be/N49LqVQChMg
The yellow input shaft may change rotation direction but the rotation direction of the orange output gear keeps unchanged because of ratchet mechanisms placed between the yellow shaft and the big gears. Friction overrunning roller clutch can be used instead of ratchet mechanism to avoid noise and backlash.



Mechanism for converting two-way to one-way rotation 4
http://youtu.be/AQRuCse7ENY
The red input shaft may change rotation direction but the rotation direction of the cyan output gear shaft unchanged due to two spring clutches. One connects the red input shaft and the cyan output shaft. The other connects the yellow gear and the cyan output shaft. The yellow gear rotates free of the output shaft in absence of the orange spring.
The spring helix direction is the key factor for this mechanism.

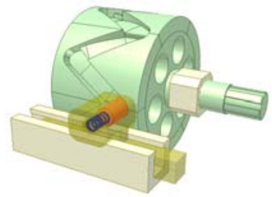


Converting two way linear motion into one way rotation 1
http://youtu.be/0dJC8lqa8K0
The green and yellow gears idly rotate on the output violet shaft of ratchet wheel. Each gear has its pawl engaging with the ratchet wheel.
Input grey frame carrying two racks has go and back linear motion. The green rack engages with the green gear. The yellow rack engages with the yellow gear. The red leaf springs force the pawls toward the ratchet wheel.
The ratchet wheel always rotate anti-clockwise regardless of go or back motion of the frame.



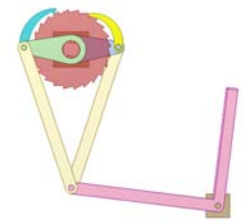
Ratchet mechanism 11b
http://youtu.be/Yb4wuEACcTk
Converting linear reciprocating motion into continuous rotation.
Input: pink slider.
Output: orange ratchet wheel.
Springs for forcing the pawls towards the ratchet wheel are not shown.
Both go and back motions of the pink slider are useful. Violet pawl pushes and green pawl pulls the wheel.

Barrel cam mechanism BT5
http://youtu.be/mNcr5Yv3pG8
Linear reciprocating motion is converted into continuous rotation. Key factor is the inconstant depth of the slots.
Stroke length of the yellow slider must be equal to axial length of the cam profile.



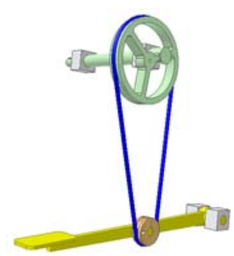
Ratchet mechanism 10
http://youtu.be/bj1UCX62Q-k
This mechanism is used in hand powered electric torches to convert oscillatory motion into continuous rotation.

Ratchet mechanism 11
http://youtu.be/GFcHRDEWYYo
This mechanism is used for converting oscillatory motion into continuous rotation. Both go motion and back motion of the pink angle lever are useful.

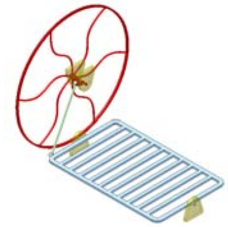


Cable drive 24
http://youtu.be/BHapT2BMHC8
A simple way to convert reciprocating rotation to continous rotation.
The orange contraweight tends to set the blue pedal at its highest position.
Driving force can make the output link rotate only half way, the contraweight and inertia do the rest way.

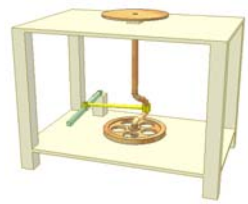
Belt drive 15
http://youtu.be/-d8RDSBxHjY
A simple way to convert oscillation to continuous rotation.
Pedal down motion creates driving moment for the green shaft. During pedal up motion the green shaft rotates thanks to its inertia.
Turning the green shaft at start-up is needed.



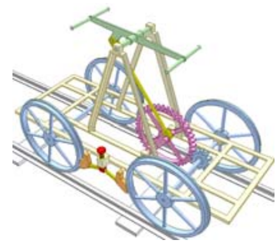
Foot driven mechanism for sewing machine
http://www.youtube.com/watch?v=rzdP9OZeaRU



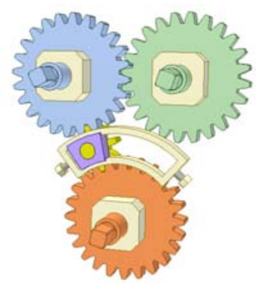
Pottery wheel
http://youtu.be/P-xT0xrK6AE
Operator's left foot pushes green lever to rotate the wheel. Continuous rotation is possible thanks to flywheel inertia. At starting use hands to turn the upper disk to overcome mechanism dead point when needed.
In another embodiment the green lever and the yellow conrod are removed. The operator rotates the flywheel directly by his foot (right or left).



Railway hand car
http://youtu.be/ZpnMvKxk4Iw
Swing green double lever to move the car via a 4 bar linkage and a gear drive.
Reverse of swinging means reversing the car.
Step on the red knob to operate a crank slider mechanism for braking.
This video is made based on G.S. Sheffield's invention in 1882.
Fore a real car see:
https://www.youtube.com/watch?v=rJq_9nxVc6A

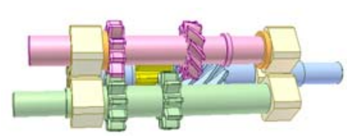


Mechanism for converting two-way to one-way rotation 2
http://youtu.be/esVq6jfTigM
The orange input gear may change rotation direction but the rotation direction of the blue and green gears keeps unchanged.
The yellow idle gear moves in the curved slot because of gear forces.
There is a slight lag during the input gear's reverse.
The mechanism should be used only for low speed case because of gear collision.

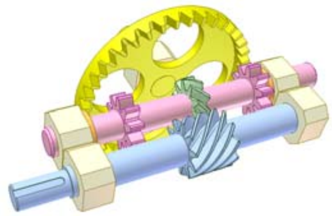


Mechanism for converting two-way to one-way rotation 3
http://youtu.be/qeotBGLVn7A
The blue input disk may change rotation direction but the rotation direction of the orange output ratchet wheel keeps unchanged.
The yellow adjustable eccentric cam is fixed on the disk and rocks the green U-shaped follower carrying the pink pawl.

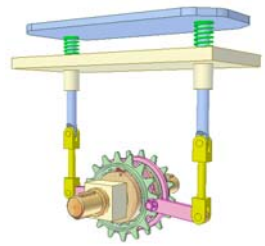
Mechanism for converting two-way to one-way rotation 5
http://youtu.be/x2JieVQIek0
The blue input gear may change rotation direction but the rotation direction of the green output shaft keeps unchanged.
The yellow gear rotates idly on the blue shaft. The orange rings represent thrust bearings.
The pink shaft moves longitudinally when the input reverses because of axial component of gear forces.
There is a slight lag during the input shaft's reverse.
The mechanism should be used only for low speed case because of gear collision.



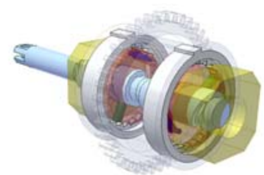
Face gear 13
http://youtu.be/h6upHEjsp74
Mechanism for converting two-way to one-way rotation.
The blue input shaft may change rotation direction but the rotation direction of the yellow output gear keeps unchanged.
The pink shaft moves longitudinally when the input reverses because of axial component of gear force in the blue gear drive.
The mechanism should be used only for low speed case because of gear collision.

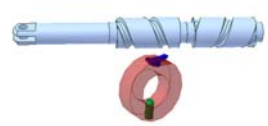


Converting two way linear motion into one way rotation 2
http://youtu.be/LjvhazEt0UA
Two bicycle freewheels are fixed in the same direction on orange output shaft.
Their green sprockets are connected to blue sliding plate via pink levers and yellow conrods. When the blue plate goes up down the output shaft turns in one direction.
This is a design of Mr. Keshav Rai from New Delhi.

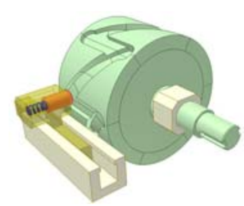


Converting two way linear motion into one way rotation 3
http://youtu.be/MswriP9QKxE
Input: blue screw having two threaded portions of opposite hands.
Output: glass gear having two ratchet wheels.
Two red bushes create revolution joint with the output gear and helical joints with the screw.
Reciprocate linear motion of the screw makes the two bushes oscillate in opposite directions. Ratchet mechanisms (two blue pawls) convert motions of the two bushes into one way rotation of the output gear.
Using ball screw drives and roller overruning clutches instead of lead screw drives and ratchet mechanisms gives better output motion.





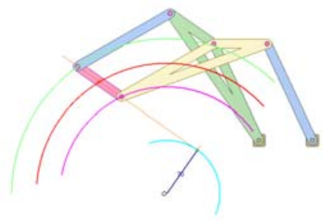
Barrel cam mechanism BT4
http://youtu.be/nMEpbyMCMdw
This mechanism converts linear reciprocating motion into intermittent rotation. Key factor is the inconstant depth of the oblique slots.



10. Mechanisms for creating complicated motions

Double parallelogram mechanism 2

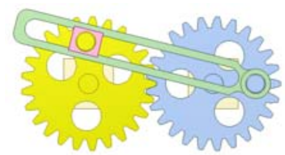
http://www.youtube.com/watch?v=U-Vn5SoRWCg



Length of two blue links is 140.
For the two triangular links lengths between the holes are 70 and 140 with angle of 150 degrees.
Lengths of the pink output and the grounded links is 70.
The pink output link rotates around point O.
This avoids the need for hinges at distant or inaccessible spots.

Gear and linkage mechanism 8b

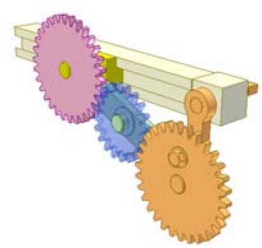
http://youtu.be/wTG1Ai2S9I8



The gears have the same tooth number and the same distance of their pins to their rotation axes.
The green bar has complicated motion in general.

Slider-crank mechanism with gears on conrod

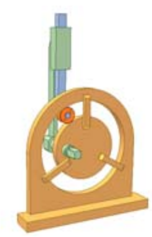
http://youtu.be/doSUZ1AdKU8



The orange gear and orange crank are fixed together.
The blue and pink gears, each rotates idly on its axle.
The orange and pink gear have the same tooth number.
The input crank rotates regularly while the blue and pink gears rotates irregularly.

Fixed cam mechanism 2

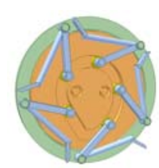
http://youtu.be/LFpE2USzXsU



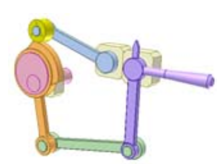
The green input crank rotates. The orange cam is fixed. This example aims to prove that the cam does not always an input rotational link and the follower has planar motion.

Fixed cam mechanism 3

http://youtu.be/MEfBhY9RI08



A device of machines for unhearthing potato.
Input is the green disk. The orange grooved cam is fixed. The blue follower, at one end of which is fixed a hoe, has planar motion.

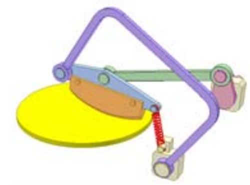


Mechanism of cam's planar motion 1

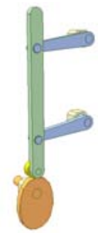
http://youtu.be/qGHpenVs6wg

Input is the pink eccentric shaft. The orange cam has planar motion.
Output is the blue crank. Adjust position of the violet lever to get various motions of the output crank. Gravity maintains permanent contact between rollers and cam.

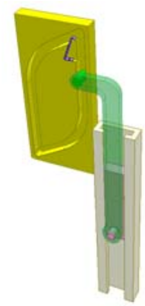
Mechanism of cam's planar motion 2
http://youtu.be/Gr-2Hbun0TA
Input is the pink crank. The orange cam has planar motion.



Cam mechanism of follower's planar motion 1
http://youtu.be/NXA99a7HjXg
The green follower, connecting rod of a parallelogram mechanism, has planar motion. Gravity maintains permanent contact between roller and cam.

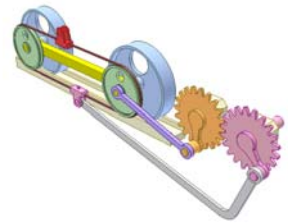


Fixed cam of parallelogram groove
http://youtu.be/Rx32dbLwf2c
Input: pink slider reciprocating with constant stroke length.
Output: green rocker of complicated motion.
Green pin of the rocker moves clockwise along the groove on yellow fixed cam.
Violet flat spring does not allow the pin go counter-clockwise at the cam upper corner.
The gravity does not allow the pin go counter-clockwise at the cam lower corner.

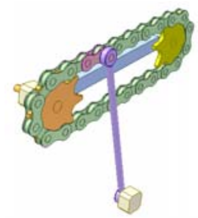


Cable drive 24
http://youtu.be/nT0DdQAaf-k
The pink crank and the pink pulley are fixed together. They are driving link of reciprocating rotation.
The red weight has a complicated motion.
It goes up and down under influence of the 4-bar mechanism and the cable drive of two pulleys.

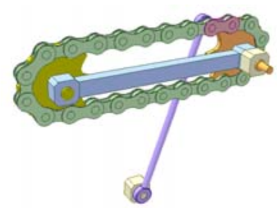
Cable drive 26
http://youtu.be/7b0V0cHyQas
Converting continuous rotation of the pink gear crank to reciprocating translation of the red slider.
The red slider and the pink slider are fixed to the cable.
The blue wheels and the green pulleys rotate idly on axles of the yellow bar.
The red slider receives two motions:
- From the orange crank slider mechanism.
- From the pink crank slider mechanism and cable drive.



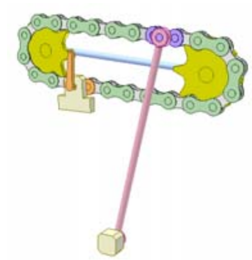
Chain drive 6A
http://www.youtube.com/watch?v=94rvs8aUWs8
Satellite chain drive.
The blue bar plays role of a carrier. The orange and yellow sprockets have the same tooth number. Input is the orange sprocket that has reciprocating rotation. Full rotation is impossible. The violet bar has a revolution joint with a chain link. The carrier and the violet bar oscilate.



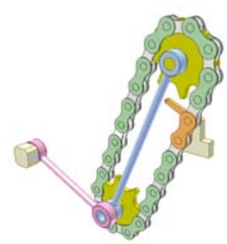
Chain drive 6B
http://www.youtube.com/watch?v=09Qz6ErIOEQ
Satellite chain drive.
The blue bar plays role of a carrier. The orange and yellow sprockets have the same tooth number. The violet bar has a revolution joint with a chain link.
Input is the blue bar that has reciprocating rotation. More than 1 revolution is impossible.
The sprockets and the violet bar oscilate.



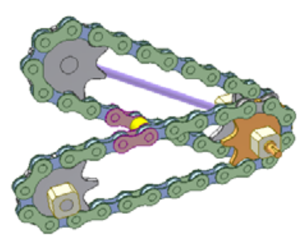
Chain drive 7A
http://youtu.be/s-H37-c1CP0
Chain drive of two movable sprockets.
The yellow sprockets have the same tooth number.
The driving pink lever, having a revolution joint with the violet chain link, oscilates around a fixed pivot.
The orange link oscilates in a fixed house.



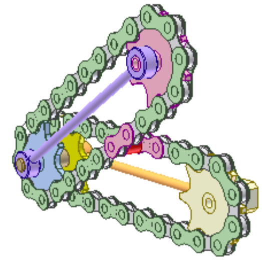
Chain drive 7B
http://youtu.be/OxLFWIWh5As
Chain drive of two movable sprockets.
The yellow sprockets have the same tooth number.
The driving pink lever, having a revolution joint with the blue carrier, oscilates around a fixed pivot.
The orange link oscilates in a fixed house.



Chain drive 11A
http://youtu.be/ClxbhMnXTfI
There are two chain drives. One is of satellite type.
They are connected together by two pink chain links and an yellow bush.
Input is the orange sprocket.
The video shows how complicatedly the satellite chain drive moves.

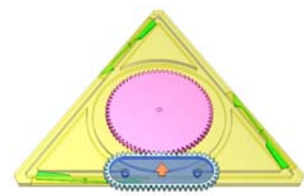


Chain drive 11B
http://youtu.be/Cv8h7LGBDm0



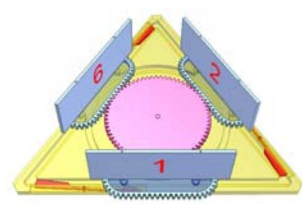
There are two chain drives. They are of satellite type.
The chains are connected together by two pink chain links and a red bush.
The blue and yellow sprockets are coaxial but rotate independently.
The porcorn sprocket is fixed.
Input is the orange carrier.
The video shows complicate motions of two drives.

Oval gear 3a
http://youtu.be/jedbQnuuiy0



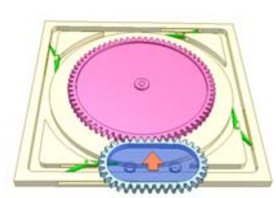
An input pink gear, rotating around fixed axis, engages with blue gear of oval shape. The latter has two pins that slide in grooves of the base. In one cycle of motion the blue gear performs two revolutions around rotary axis of the pink gear and changes its direction twice.
Green arms that always turn clockwise due to springs (not shown) in coordination with the front pin of the blue gear allow the front pin follow the straight grooves and direct the rear pin follow the circular groove.

Oval gear 3b
http://youtu.be/9kjUcsqieRg



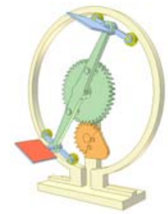
An input pink gear, rotating around fixed axis, engages with blue gears of oval shape. The latter have two pins that slide in grooves of the base. In one cycle of motion the blue gears performs two revolutions around rotary axis of the pink gear and changes its direction twice.
Red arms that always turn clockwise due to springs (not shown) in coordination with the front pin of the blue gear allow the front pin follow the straight grooves and direct the rear pin follow the circular groove.
On each side of the triangular base numbers 1, 2, …, 6 appear one after another.

Oval gear 3c
http://youtu.be/dPif6o4yf18

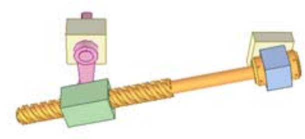


An input pink gear, rotating around fixed axis, engages with blue gear of oval shape. The latter has two pins that slide in grooves of the base. In one cycle of motion the blue gear performs four times of straight motion and four times of rotation alternately.
Green arms that always turn anticlockwise due to springs (not shown) in coordination with the front pin of the blue gear direct the front pin follow the straight grooves and the rear pin follow the circular groove.

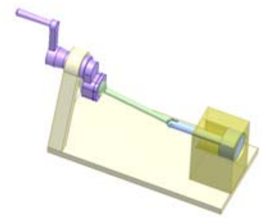
Cam and gear mechanism 2
http://youtu.be/-zOdLhISU1M
Input is the green gear to which a long arm is fixed.
Two short arms (each carries two rollers) are connected to both ends of the long arm by revolution joints. Due to the orange gear cam and a slot in the base, the short arms change their directions after every revolution of the long arm.
Trasmission ratio of the gear drive is 2.



Nut-screw and bar mechanisms 2a'
http://youtu.be/W10lxIOMVpo

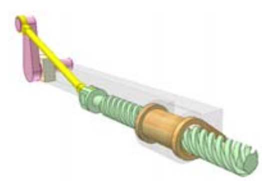


Spatial slider crank mechanism 6
http://www.youtube.com/watch?v=3h9C7mjcwoU



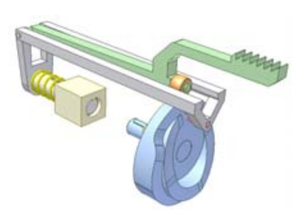
Twisted slider
http://www.youtube.com/watch?v=2_ioqY-O4Jo
Standard four-bar linkage has a screw substituted for a slider. The output is helical rather than linear.

Screw-slider-crank mechanism
http://youtu.be/OTdcOR3Byws
The helical joint between the green srcew slider and the orange bush makes the latter have reciprocating rotation.
Screw lead angle must be big enough to avoid jerk.

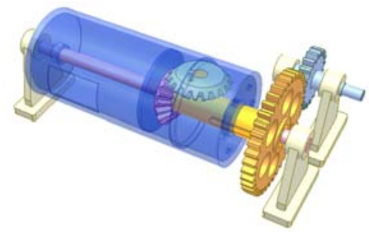


Barrel cam mechanism BT8
http://youtu.be/hs07gwcfbwM
The pink cam is fixed. The green crank rotates. The yellow follower slides in a rectangular hole of the crank.
.

Double cam mechanism 3
http://youtu.be/5UUPAd39ZG0
Four motion feed used on sewing machines for moving the cloth.
A combination of disk cam and face cam.
The grey fork carrying green bar translates thanks to blue face cam and pink pin. Yellow spring maintains their contact.
The green bar oscillates around a pivot on the fork thanks to blue disk cam and orange roller. Gravity maintains their contact.

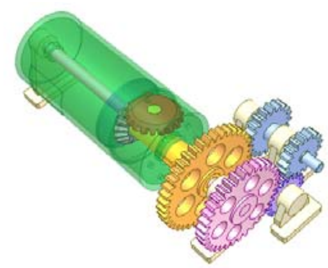


Converting Rotation to Rotary and Linear reciprocating motion 1
http://youtu.be/YwpGA-5lD4k



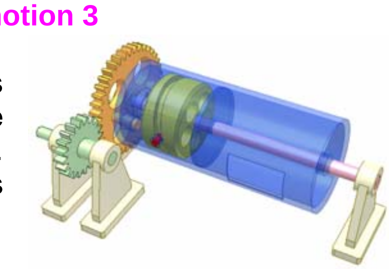
The pink shaft with a bevel gear is fixed.
The orange bush with a spur gear receives rotation from the input blue gear. The green satellite bevel gear has a pin sliding in a circular slot of the blue output cylinder.
The latter rotates and linearly reciprocates simultaneously.
If two bevel gears have the same tooth number, 1 revolution of the cylinder corresponds its 1 double stroke. This relation can be varied by using bevel gears with different tooth numbers.

Converting Rotation to Rotary and Linear reciprocating motion 2
http://youtu.be/TI5N3dX42mE

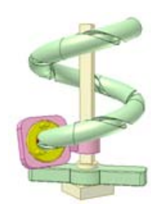


The pink shaft, the pink bevel gear and the pink spur gear are fixed together and receive rotation from the input blue shaft.
The orange bush and the orange spur gear are fixed together and receive rotation from the input blue shaft.
The red satellite bevel gear has a pin sliding in a circular slot of the green output cylinder. The latter rotates and linearly reciprocates simultaneously.
For this case, 1 revolution of the cylinder corresponds its 2 double strokes. This relation can be varied by altering speeds and rotary directions of the orange and pink spur gears.

Converting rotation to rotary and linear reciprocating motion 3
http://youtu.be/io1JL1U7kUs



Input: the green gear. The pink shaft with yellow cam is fixed. The orange gear rotates without axial motion. The blue cylinder has a red pin that slides in the cam groove. The cylinder rotates and linearly reciprocates simultaneously.



Helix torus cam
http://youtu.be/tlhtEbzVj5g
The green input part rotates. The yellow bush carrying a pin rotates around its own axis. The pink slider moves along a fixed runway.

Nguyen Duc Thang

1700 ANIMATED MECHANICAL MECHANISMS

With

Images,
Brief explanations
and Youtube links.

Part 3

Mechanisms of specific purposes

Renewed on 31 December 2014

This document is divided into 3 parts.
Part 1: Transmission of continuous rotation
Part 2: Other kinds of motion transmission
Part 3: Mechanisms of specific purposes

Autodesk Inventor is used to create all videos in this document.
They are available on YouTube channel “thang010146”.

To bring as many as possible existing mechanical mechanisms into this document is author’s desire. However it is obstructed by author’s ability and Inventor’s capacity. Therefore from this document may be absent such mechanisms that are of complicated structure or include flexible and fluid links.

This document is periodically renewed because the video building is continuous as long as possible. The renewed time is shown on the first page.

This document may be helpful for people, who
- have to deal with mechanical mechanisms everyday
- see mechanical mechanisms as a hobby

Any criticism or suggestion is highly appreciated with the author’s hope to make this document more useful.

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- Retirement in 2002.

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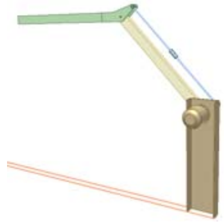
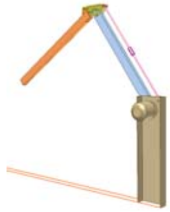
Table of Contents

11. Mechanisms for folding, contracting or stretching

Folding barrier 1
http://www.youtube.com/watch?v=bq0iiqCSTFg
An application of parallelogram mechanism.
Folding barrier is used for height limited place.

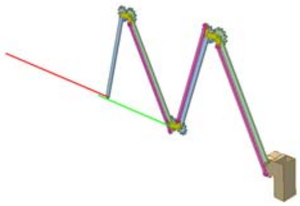


Folding barrier 2
http://www.youtube.com/watch?v=LF8kSTCZIxw
A combination of parallelogram mechanism and 4-bar linkage.
Folding barrier is used for height limited place.



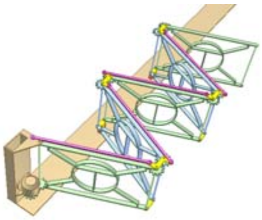
Folding barrier 3
https://www.youtube.com/watch?v=j3RNoijvcD4
A combination of a parallelogram mechanism and gears.
The gears are fixed to the bars.
Folding barrier is used for height limited place.

Folding barrier 4 (Straight line drawing mechanism)
http://www.youtube.com/watch?v=QNkODQMZfwc
A combination of parallelogram mechanisms and gears.
The gears are fixed with the bars.
It can be applied for folding barriers, gates, eaves or lamps.
By similar connecting of bars the barrier can be very long.



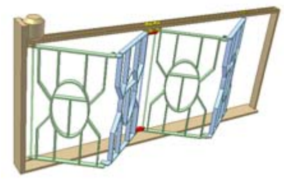
Stretch and contraction mechanism
http://www.youtube.com/watch?v=4UpjmxQ3900
A combination of parallelogram mechanisms and gears.
Loci of various points on the bars are shown. They can be ellipse, circle or straight line.
By similar connecting of bars the stretch can be very long.

Penta-folding gate
http://www.youtube.com/watch?v=6jSwpmr4k5I
A combination of parallelogram mechanisms and gears.
There is no need of railway.
If the construction is not heavy, the wheels can be removed.
It is an application of mechanism shown in:
http://www.youtube.com/watch?v=QNkODQMZfwc

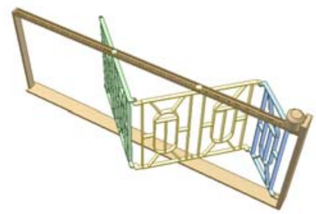


Bi-folding gate 1
http://youtu.be/LG2-y4iVDB4

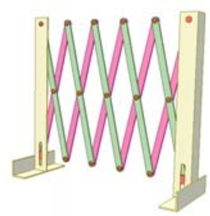
Orange conrod, green and upper yellow cranks create a parallelogram mechanism.
R1: pitch radius of green gear
R2: pitch radius of blue gear
i = R1 / R2 = 40 / 19. This ratio is needed to meet requirement when green gate rotates α = 58 deg., blue gate rotates 90 deg. in relation with the green gate.
i changes when α has different values. i = 1 if α = 90 deg.
If necessary a supporting swivel wheel for the blue gate is mounted at its lower right corner.
This video was made on request of Mr. JC Lo from Malaysia.
The two gears can be replaced by a bar to get similar effect. See:
http://www.youtube.com/watch?v=LF8kSTCZIxw



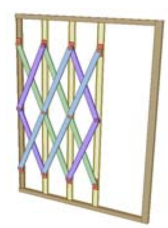
Tetra-folding gate
http://www.youtube.com/watch?v=Il88l0AP6-Q
A combination of slider-crank mechanisms and gears.
The gears are fixed with the two center gate panels.



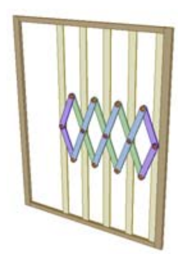
Tri-folding gate
http://www.youtube.com/watch?v=SoL0uq5K6fg
A combination of slider-crank mechanisms.



Folding scissor fence
http://www.youtube.com/watch?v=Do1DwSqkZoM
Combination of slider crank mechanism and parallelogram mechanism.

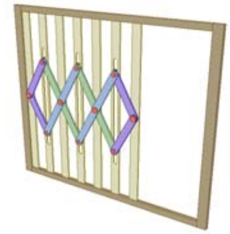


Folding scissor gate 1
http://www.youtube.com/watch?v=opSblgV2pSE
A combination of slider crank mechanisms and parallelogram mechanisms.



Folding scissor gate 2
http://www.youtube.com/watch?v=GvjFwcl9rro
A combination of slider crank mechanisms and parallelogram mechanisms.

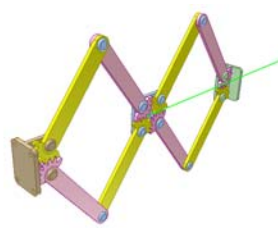
Folding scissor gate 3
http://www.youtube.com/watch?v=tb4H7Tr_W1s
A combination of slider crank mechanisms and parallelogram mechanisms.



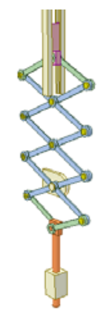
Folding scissor gate 4
http://www.youtube.com/watch?v=_GApddnCKz4
A combination of slider crank mechanisms and parallelogram mechanisms.

Kite mechanism 5c
http://youtu.be/AD_0MACi44M
A way to connect two (or more) "Kite and spear-head mechanism 5b" by adding gear drive (in violet). Thus very long rectilinear motion of the end bar (in pink) can be obtained. This mechanism may be applied for retractable gates.

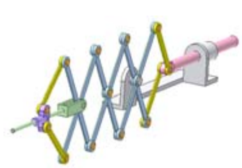
Gear and linkage mechanism 3b
http://youtu.be/jFVh3nKOVf8
Combination of linkage and gear drive. It shows the way to connect two (or more) mechanisms of "Gear and linkage mechanism 3a". The green part translates along an absolutely straight line.



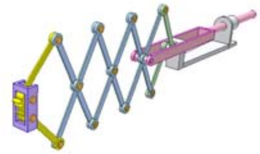
Lazy tong 1
http://youtu.be/Zm-4kJLdRcM
Input: pink slider.
Output: orange link.
Small longitudinal force on the input causes large one on the output (around 3 times in this case). The input and output move in opposite directions.
The mechanism finds application in lazy tong riveter:
https://www.youtube.com/watch?v=7D7ECCps0h4



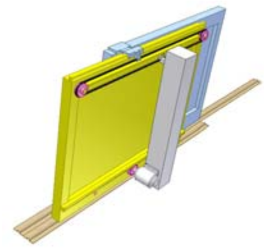
Lazy tong 2
http://youtu.be/UniRkbt0LOY
Input: pink slider.
Output: violet link.
Short input motion gives a long output one (around 3 times in this video). The input and output move in opposite directions.
The green link is for keeping the violet link direction unchanged.



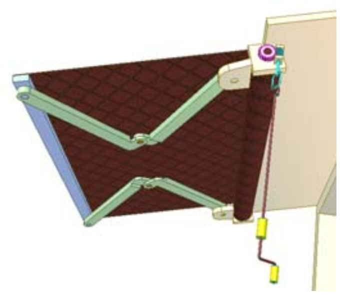
Lazy tong 3
http://youtu.be/cML0xKSmTPM
Input: pink slider.
Output: violet link.
Short input motion gives a long output one (around 4 times in this video). The input and output move in the same direction.
The gears on yellow links are for keeping the violet link direction unchanged.



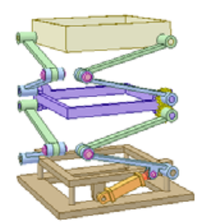
Telescopic sliding gate
http://www.youtube.com/watch?v=ASAxH51ify8
A roller cable mechanism is used.
A point on lower part of the cable is fixed with the grounded post.
A point on upper part of the cable is fixed with the blue panel 2 that moves twice faster than the yellow panel 1.



Contractible eave
http://www.youtube.com/watch?v=YmcJmXpR7XM
It is an application of the slider-crank mechanism.
Manual rotation of the detachable brown crank rolls the roof through a worm drive.
The roof has some slope so it keeps even during stretching.



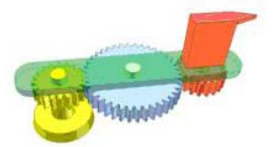
Sarrus linkage 3
http://youtu.be/FINFaiCQIAk
A way to connect two (or more) Sarrus linkages by adding gear drive (in yellow). Thus very long up-down rectilinear motion of the top floor can be obtained by just small displacement of a piston (in orange).



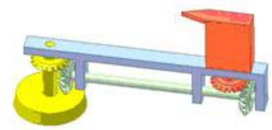
Retractable device for fluid supply
http://youtu.be/B3khF2IBUyU
"Sarrus linkage 3" in combination with helical hose.

12. Mechanisms for controlling direction during motion

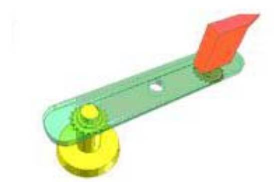
Keeping direction unchanged during rotation 1
http://www.youtube.com/watch?v=jMCBm9bG4EY
The direction of the red object is unchanged.
Using spur gears.
The end gears have the same number of teeth.
The number of intermediate gears must be odd.



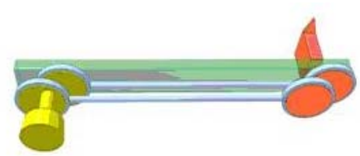
Keeping direction unchanged during rotation 2
http://www.youtube.com/watch?v=5Oa_7k1GMi0
The direction of the red object is unchanged.
Using bevel gears.
The gears have the same number of teeth.



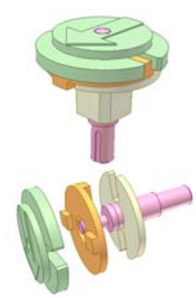
Keeping direction unchanged during rotation 3
http://www.youtube.com/watch?v=BkZswBBbvD8
The direction of the red object is unchanged.
Using chain (or tooth belt) drive.
The sprockets have the same number of teeth.



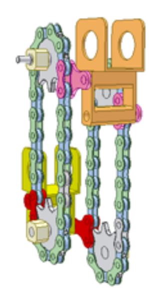
Keeping direction unchanged during rotation 4
http://www.youtube.com/watch?v=N8jE8gLbHR4
The direction of the red object is unchanged.
Using parallelogram mechanism.
Overcoming dead point by adding second parallelogram mechanism



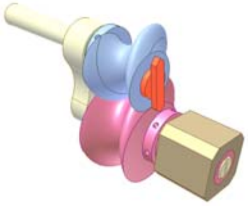
Keeping direction unchanged during rotation 5
http://youtu.be/-XsHSvDqG8s
The green disk receives motion from a pink eccentric shaft. Due to a Oldham mechanism that consists of three disks, the orientation of the green disk does not change during motion.



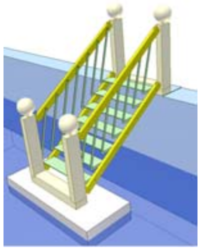
Keeping direction unchanged during rotation 6
http://youtu.be/D1lPLELEBuA
Two chain drives are arranged with a large non-coaxiality A.
The yellow link connects two drives by two red chain pivot links. Center distance between two revolution joints of the yellow link is equal to A.
The direction of the yellow link is kept unchanged during motion. More of the connecting links and the pivot links is possible.
This mechanism can be applied for continuous lift.



Pin coupling 6
http://www.youtube.com/watch?v=zfXDfoOAnrY
A planetary mechanism from Pin Coupling 5.
http://www.youtube.com/watch?v=QfiJSTRDASs
The direction of the red bar attached to the blue shaft is unchanged during the motion.



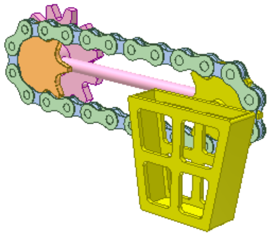
Application of parallelogram mechanism 6
http://www.youtube.com/watch?v=PJQEkv4UESw
Self-adjusting step ladder for wharfs. The steps remain horizontal whatever the water level rises or falls.



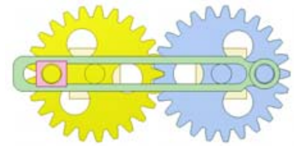
Application of parallelogram mechanism 7
http://www.youtube.com/watch?v=nn_v_DlZ6tY
Cable winding machine.
The bobbins rotate about the machine main shaft axle but not their own ones.

Application of parallelogram mechanism 8
http://www.youtube.com/watch?v=hWNt1ZhnSnk
Vertical blade paddle wheel.
The blades are kept always upright giving the most propulsion effectiveness.

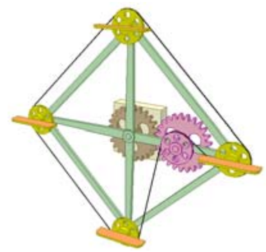
Chain drive 5A
http://youtu.be/DI6DdKPXctY
The orange sprocket is fixed. The orange and yellow sprockets have the same tooth number. The pink crank and gear is driving. The yellow basket, which is fixed with the yellow sprocket, stays vertically during rotation.



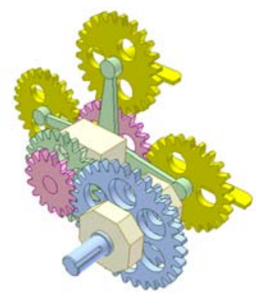
Gear and linkage mechanism 8a
https://www.youtube.com/watch?v=iGYtz_uVKTY
The green bar has unchanged direction during rotation.
The gears have the same tooth number and the same distance of their pins to their rotation axes.
Assembly requirement: there is mechanism position where pin axes and gear rotation axes are on a plane and both pins are in the middle (or outside) of the gear center distance.
If not the green bar has complicated motion as in:
https://www.youtube.com/watch?v=wTG1Ai2S9I8



Keeping direction unchanged during rotation 7
http://youtu.be/VcLRHZAFc9o
The gears have same tooth number.
Five pulleys have same pitch diameter.
Input: green carrier rotating regularly.
The yellow pulleys have unchanged direction during rotation.
Instead of belt drive using chain one is better.

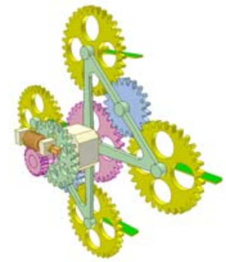


Keeping direction unchanged during rotation 8
http://youtu.be/W5tLTJraf84
Pink gear, four yellow satellite gears and green carrier create a differential planetary drive.
Four yellow satellite gears and the big pink gear have same tooth number.
Input is the blue shaft having two gears.
Receiving rotation from the input shaft, the pink gears and the green carrier rotate in the same direction. The pink gears rotate twice faster than the green carrier.
The yellow gears have unchanged direction during rotation.



Keeping direction unchanged during rotation 9a
http://youtu.be/g8HKd938yp0
Pink gear, four yellow satellite gears, four blue gears and green carrier create a differential planetary drive.
The gears (except the green one) have same tooth number.
Input: green carrier rotating regularly.
The yellow gears have unchanged direction during rotation while the pink gear is immobile.
Use the orange worm to rotate the pink gear for adjusting the direction. The video shows 90 deg. adjustment.

Keeping direction unchanged during rotation 9b
http://youtu.be/APdnbZI20S0

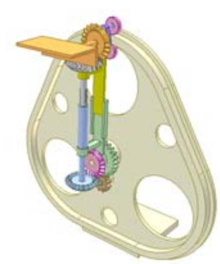


Pink gear, four yellow satellite gears, two blue gears and green carrier create a differential planetary drive.
The yellow gears and the pink spur gear have same tooth number.
The blue gears have same tooth number.
Input: green carrier rotating regularly.
The yellow gears have unchanged direction during rotation while the pink gear is immobile.
Use the orange worm to rotate the pink gear for adjusting the direction.
The video shows 45 deg. adjustment.
This mechanism is similar to the one in video:
http://youtu.be/g8HKd938yp0
but uses less gears.

Keeping direction unchanged during motion 1a
http://youtu.be/xAYL_MtkEgM

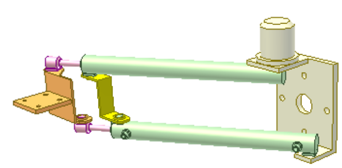
Orange plate performs planar motion without rotation. Its upper edges are kept always horizontal thanks to a parallelogram mechanism driven by brown cylinder. Distance between two revolute joints on the orange plate is equal to length of the violet conrod.
Change of popcorn fixed cam profile gives various trajectories of a point on the orange plate.
The mechanism has an unstable position when violet conrod is perpendicular to the rockers. So avoid it or use measures to overcome it.

Keeping direction unchanged during motion 2
http://youtu.be/iIYesahDn38



Orange plate performs planar motion without rotation. Its upper surface is kept always horizontal thanks to 4 bevel gear drive of equal tooth numbers driven by brown spur gear. Sliding joints between green and yellow bars and between blue and grey shafts allow radial displacements of the orange plate. Pink gear is fixed.
Change of popcorn fixed cam profile gives various trajectories of a point on the orange plate.
4 bevel gear drive can be replaced by 4 screw gear drive in another embodiment of this mechanism.

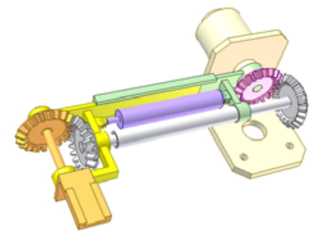
Keeping direction unchanged during motion 3a
http://youtu.be/4xGNB2jlcVk



Orange plate performs planar motion without rotation.
The plate direction is kept unchanged thanks to a parallelogram mechanism driven by a motor. Distances between two revolute joints on the yellow conrod and between two revolute joints of the orange plate are equal.
Motion of the orange plate along sliding joint between green bar and pink bar is controlled by two green cylinders.
This mechanism can be applied for manipulator of polar coordinate system.
Disadvantage: the cylinders are not base-mounted.

Keeping direction unchanged during motion 4

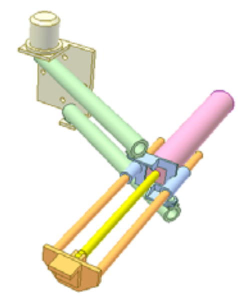
http://youtu.be/485OGPdp13g



Orange plate performs planar motion without rotation.
Its upper surface is kept always horizontal thanks to 4 bevel gear drive of equal tooth numbers driven by a motor. Pink gear is fixed.
Sliding joints between green and yellow bars and between grey shafts allow radial displacements of the orange plate that are controlled by violet actuator.
4 bevel gear drive can be replaced by 4 screw gear drive in another embodiment of this mechanism.
This mechanism can be applied for manipulator of polar coordinate system.
Disadvantage: the actuator is not base-mounted.

Keeping direction unchanged during motion 3b

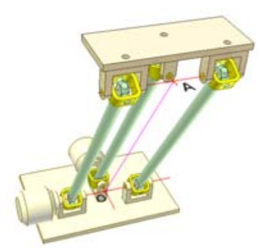
http://youtu.be/g2Foisj9re0



Orange slider performs planar motion without rotation.
Its upper surface is kept always horizontal thanks to a parallelogram mechanism driven by a motor. Distances between two revolute joints on the blue conrod and between two revolute joints of the base are equal.
Motion of the orange slider along sliding joint on the blue conrod is controlled by pink actuator.
Disadvantages:
The actuator is not base-mounted.
The calculation of trajectory of a point on the orange slider can not be based on polar coordinate system.

Keeping direction unchanged during motion 6

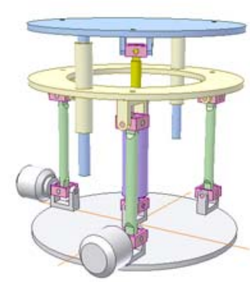
http://youtu.be/iQ5TkU04Xdc



Green bars are connected to lower and upper plates by universal joints of two degrees of freedom. The mechanism has two degrees of freedom based on computer test so two motors are used for controlling.
Upper plate is kept always horizontal during motion.
A point of the upper plate moves on a spherical surface.
Angle between motor rotary axes can be differ from 90 deg.

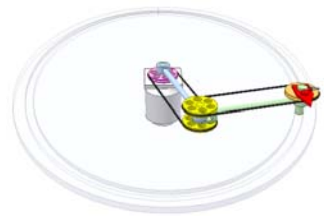
Keeping direction unchanged during motion 7

http://youtu.be/4smmgMNyrvc



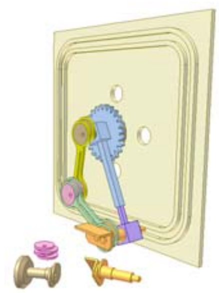
Blue upper table is kept always horizontal when moving in 3D space.
Motion of the popcorn disk is controlled by two base-mounted motors.
Motion of the blue table along sliding joint on the popcorn disk is controlled by violet actuator.
Disadvantages:
The actuator is not base-mounted.
The calculation of trajectory of a point on the blue table can not be based on spherical coordinate system.

Keeping direction unchanged during motion 6
http://youtu.be/inr1H2-mKS8
Red plate performs planar motion without rotation thanks to two toothed belt drives. Tooth numbers of four pulleys are equal. Pink pulley is immobile. Two yellow puleys are fixed together.
Change of glass fixed cam profile gives various trajectories (an ellipse in this video) of the red plate.
The belt drives can be replaced by chain ones.

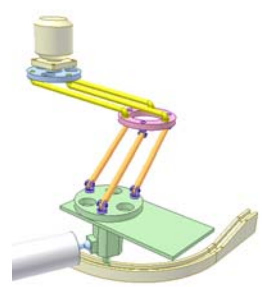


Keeping direction unchanged during motion 7
http://youtu.be/6NayQfZpSWY
Pink and yellow plates perform planar motion without rotation thanks to gear drives. Tooth numbers of 5 gears are equal. Grey gear is immobile. Four others gears idly rotate on their bearings.
Change of glass fixed cam profile gives various trajectories (a hexagon in this video) of the pink plate.

Keeping direction unchanged during motion 5
http://youtu.be/M3qFSlEA1Rg
Orange plate performs planar motion without rotation. Its upper surface is kept always horizontal thanks to a double parallelogram mechanism driven by blue gear. Each of brown and orange shafts has 2 eccentrics for overcoming dead positions of the parallelogram mechanisms. So the pink shaft has 4 eccentrics.
Change of popcorn fixed cam profile gives various trajectories of the orange plate.

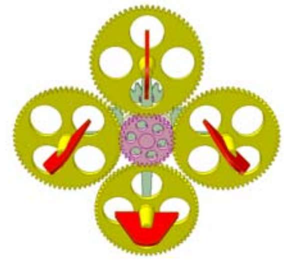


Keeping direction unchanged during spatial motion 1
http://youtu.be/Cu8oJTe8zrk
The green disk lower end moves along a 3D curve. When blue disk is immobile, green plate (fixed to green disk) performs spatial motion without rotation around all three coordinate axes thanks to yellow planar and orange spatial parallelogram mechanisms.
The grey cylinder is connected to the base via a spherical joint (not shown). The blue piston is connected to the green disk via a spherical joint.
Pay attention to violet universal joints (2 DoF).
Angular position of the green plate in horizontal plane can be adjusted by turning the blue disk. The video shows such adjustment occurring after first double strokes of the piston.
Gravity maintains contact between the green disk lower end and the groove bottom of the popcorn runway.



Planetary drive 1a

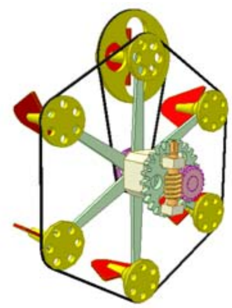
http://youtu.be/k6ap5Yxmk7M



Pink fixed gear, four yellow satellite gears and green carrier create a differential planetary drive. Tooth number of the yellow gears is double to the one of the pink gear.
Input: green carrier rotating regularly.
When the yellow gears reach highest position, their red plates are vertical. When the yellow gears reach lowest position their red plates are horizontal.
Use the orange worm for adjusting the direction of the plates.

Planetary drive 1b

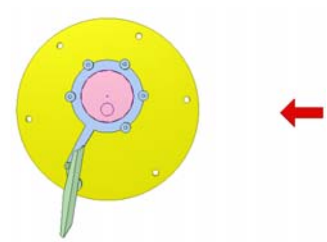
http://youtu.be/sLknrW47hzc



Pink fixed pulley, yellow satellite big pulley and green carrier create a belt differential planetary drive. Diameter of the yellow big pulley is double to the one of the pink pulley.
Six yellow small pulleys have same diameter. They are connected together by the black belt.
Using chain drive instead of belt one is better.
Input: green carrier rotating regularly.
When the yellow small pulleys reach highest position, their red plates are vertical. When the yellow small pulleys reach lowest position their red plates are horizontal.
The video also shows that after using the worm drive for adjusting the direction of the plates the situation is reversed.

Wind-mill 1a

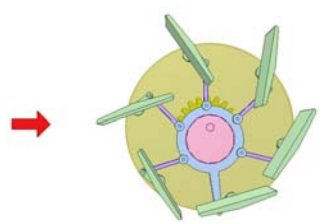
http://youtu.be/7pN7hFZuIUw



Plan view.
It is a 4-bar linkage consisting of two cranks (blue bar, yellow disk) and a connecting rod (green sail). Blue bar rotates on the eccentric of a pink fixed shaft.
Such arrangement makes the green sail present its edge in returning toward the wind, but present its face to the action of the wind, the direction of which is supposed to be as indicated by red arrow.
Output motion (clockwise rotation) is taken from the yellow disk.

Wind-mill 1b

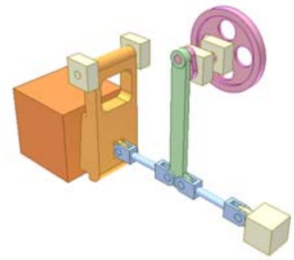
http://youtu.be/Y1X2b-dU7mU



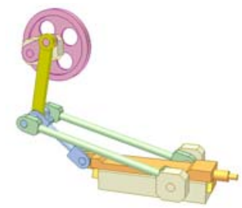
Plan view.
Green sails are so pivoted as to present their edges in returning toward the wind, but to present their faces to the action of the wind, the direction of which is supposed to be as indicated by red arrow.
Blue bar rotates on the eccentric of a pink fixed shaft.
Output motion (clockwise rotation) is taken from a gear fixed to the yellow disk.
The mechanism can be applied for simple water turbines (no need of flow guide).
This mechanism is developed from "Wind-mill 1a":
http://youtu.be/7pN7hFZuIUw
by adding more sails.

13. Toggle linkages

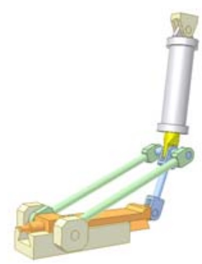
Toggle linkage 1a
http://youtu.be/1MmgKShth7w
Mechanism for a stone crusher.
It has two toggle linkages in series to obtain a high mechanical advantage. When green link reaches the top of its stroke, it comes into toggle with the pink crank. At the same time two blue links come into toggle. This multiplication results in a very large crushing force of the orange jaw.



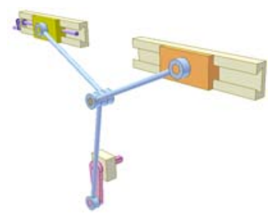
Toggle linkage 1b
http://youtu.be/FOe7o0dueI4
Two toggle links (the green and blue ones) can come into toggle by lining up on top of each other rather than as an extension of each other.



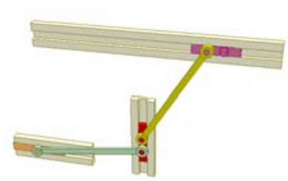
Toggle linkage 1c
http://youtu.be/MpuejSlBvjM
A riveting machine with a reciprocating piston produces a high mechanical advantage. With a constant piston driving force, the force of the orange head increases to a maximum value when green and blue links come into toggle.



Toggle linkage 2
http://youtu.be/dzcvYAQQSL4
In one revolution of the pink input crank, the orange output slider performs two strokes, one long and one short. At the rightest point of each stroke, the links are in toggle to get high mechanical advantage and low speed.
The violet screw and the yellow slider are for adjusting stroke position.
The mechanism is applied for cold-heading rivet machines where two consequent blows of hammer (the orange slider) are needed in one revolution of crankshaft.

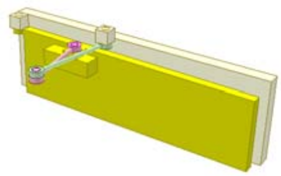


Toggle linkage 3
http://youtu.be/U2-SPNLPMeE
Input: pink slider.
Output: orange slider.
One double stroke of the pink slider corresponds two double strokes of the orange slider, that has long dwell at the left end of its stroke, when the yellow and green conrods come into toggle with the red and orange sliders.



Toggle linkage 4a

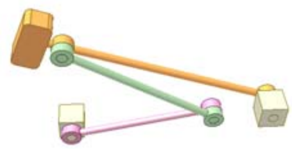
http://youtu.be/dmbLL-MSkyE



Door check linkage gives a high velocity ratio during the stroke.
As the door swings closed, connecting link (in green) comes into toogle with the shock absorber arm (in pink), giving it a large angular velocity, which helps the shock absorber be more effective in retarding motion near the closed position.

Toggle linkage 4b

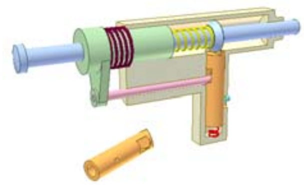
http://youtu.be/TAPhhX3ti8s



Pink crank rotates at constant velocity while orange crank moves slowly at the beginning and end of the stroke. It moves rapidly at the midstroke when the orange crank and the green conrod are in toggle. The accelerated weight on the orange crank absorbs energy and returns it to the system when it slows down.
This mechanism is used as an impact reducer in some large circuit breaker.

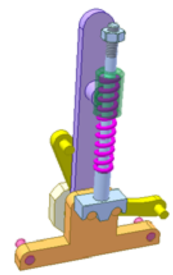
14. Mechanisms for snap motions

Snap motion 16
http://youtu.be/BwABcO1k2l0
When green part is pushed, pink wedge forces orange slider down and blue rod is shot to the right under action of yellow spring.
Pull back the blue rod for next shot.
Arrows show applied forces.

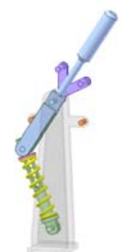


Spring toggle mechanism 1
http://youtu.be/u4oW1ZiiRGA
Spring toggle mechanism enables to reach end positions of a lever quickly and holds it there firmly.
In this prototype a compression spring is used to bear tension.
The violet sector represents manual action.

Spring toggle mechanism 2
http://youtu.be/T4EoESBFYLw
Toggle action here ensures that the gear shift lever (violet) will not inadvertently be thrown past its neutral position.
The pink pins are stoppers for the violet lever.
The yellow double crank represents manual action.

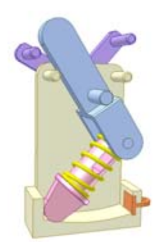


Spring toggle mechanism 3
http://youtu.be/l-G_uejx0Rs
Spring toggle mechanism enables to reach end positions of a lever quickly and holds it there firmly.
The violet double crank represents manual action.



Spring toggle mechanism 4
http://youtu.be/KaRBadgcUlU
Spring toggle mechanism enables to reach end positions of a lever quickly and holds it there firmly.
The violet double crank represents manual action.

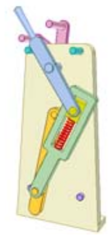
Spring toggle mechanism 5
http://youtu.be/vYSJn0U0kXI
Spring toggle mechanism enables to reach end positions of a lever quickly and holds it there firmly.
The violet double crank represents manual action.
The mechanism is used for electric switches.



Cam-guided latch
http://youtu.be/53_QBnREziY
Cam-guided latch has one cocked and two relaxed positions.
The violet double crank represents manual action.

Spring toggle mechanism 8
http://youtu.be/ymgxwQHVQUw
Spring toggle mechanism enables to reach end positions of a lever quickly and holds it there firmly.
The pink double crank represents action from outside.

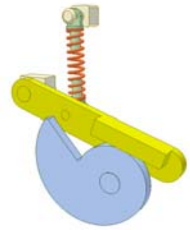
Spring toggle mechanism 9
http://youtu.be/TEH9aKqVhOE
Spring toggle mechanism enables to reach end positions of a lever quickly and holds it there firmly.
The pink double crank represents action from outside.



Snap motion 1
http://youtu.be/7y-Oez0v2l8
A orange latch and green cocking lever is spring-loaded so latch movement releases the cocking lever. The cocked position is held firmly. Studs in the frame provide stops, pivots or mounts for the springs.
A coil spring always forces the orange latch to rotate anticlockwise.

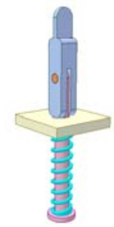
Snap motion 2
http://youtu.be/tR1LWzVCjk0
A latch mounted on a cocking lever (blue) allows both levers to be reached at the same time with one hand.
Rotate the latch clockwise to release the cocking lever.
Rotate the cocking lever anticlockwise to get the initial position.
A coil spring always forces the pink latch to rotate anticlockwise.

Snap motion 6
http://youtu.be/k1BAA75eR_0
A latching cam cocks and releases the cocking lever with the same counterclockwise movement.



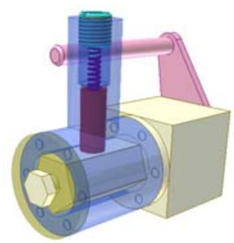
Snap motion 6B
http://youtu.be/jeKxnC6DffQ
The cam hub has a semi-circular slot in which a pin of the blue driving shaft moves. Snap motion occurs when the moment from the follower spring applied to the cam changes its direction.

Snap motion 8
http://youtu.be/FYyIZXn_8-M
Push or pull the blue lever to get snap motion. Raise it to get the initial position.

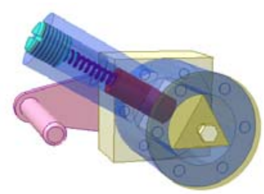


Snap motion 10
http://youtu.be/NMuZwvDJ27A
An identically shaped cocking lever and latch allow their functions to be interchangeable. The radii of the sliding faces must be dimensioned for a mating fit. Forces are alternatively placed on both levers.

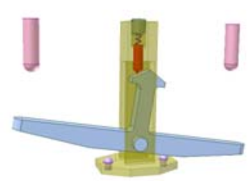
Spring toggle mechanism 6a
https://www.youtube.com/watch?v=YydcGLWbuZg
Indexing device. This spring toggle mechanism enables to reach five positions of a lever quickly and holds it there.
The pink pin represents action from outside.



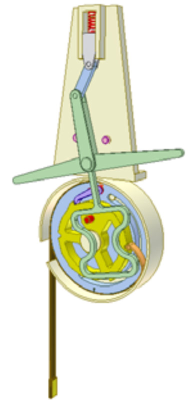
Spring toggle mechanism 6b
http://youtu.be/VftCJ6mScNQ
Indexing device. This spring toggle mechanism enables to reach three positions of a lever quickly and holds it there.
The pink pin represents action from outside.



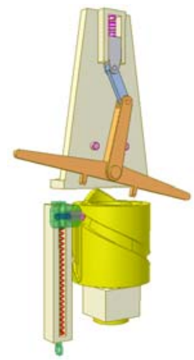
Spring toggle mechanism 7
http://youtu.be/kjRbsF9gkyI
Spring toggle mechanism enables to reach end positions of a lever quickly and holds it there firmly.
The pink pins represent action from outside.



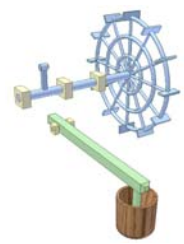
Cable drive for snap switching 1
http://youtu.be/39GDCZB-vFU
Pull and release brown tow for snap switching green arm.
It is a combination of two mechanisms shown in:
http://youtu.be/VzBuIhvWsJY
and
http://youtu.be/ymgxwQHVQUw
For reducing pulling stroke length, use three red pins arranged in a symmetric circular pattern then the yellow ratchet disk needs turn only 60 deg.



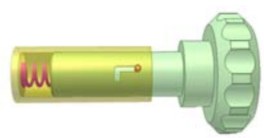
Barrel cam for snap switching 1
http://youtu.be/rKSc1A8HE3Q
Pull and release green slider for snap switching orange arm.
It is a combination of two mechanisms shown in:
http://youtu.be/SzoF0VMtc7w
and
http://youtu.be/ymgxwQHVQUw
For reducing pulling stroke length, use three face protrusions (instead of one) arranged in a symmetric circular pattern then the yellow cam needs turn only 60 deg. The barrel cam looks like the one in:
http://youtu.be/nMEpbyMCMdw



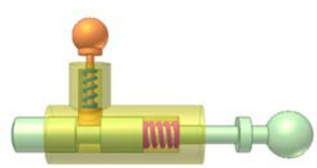
Snap motion 12
http://youtu.be/tipTlkBLhdk
Pestle powered by water flow.
Water flow turns the wheel carrying a toe that raises and suddenly releases the pestle.



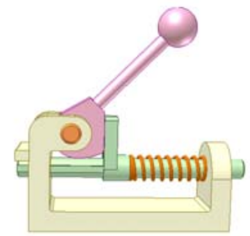
Snap motion 3
http://youtu.be/7APpIiiLziI
A yellow sleeve latch has an L-shaped notch. A pin in the green shaft rides in the notch. Cocking requires a simple push and twist.



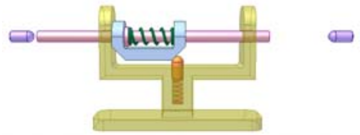
Snap motion 4
http://youtu.be/igdo6b4tg9s
The latch and plunger depend on axial movement for setting and release. A circular groove is needed if the plunger is to rotate.



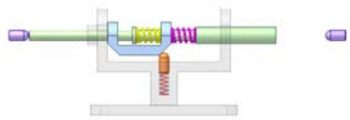
Snap motion 5
http://youtu.be/p4kDKY3UNFI
In this overcenter lock clockwise movement of the pink latching lever cocks and locks the green slide. A counterclockwise movement is required to release the slide.



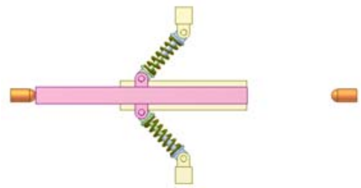
Snap motion 7A
http://youtu.be/J8r2zXYFT84
A blue spring-loaded cocking piece has chamfered corners. Axial movement of the pink push-rod forces the cocking piece against a spring-loaded pin set in frame. When cocking builts up enough force to overcom the pin spring, the cocking piece snaps over to the right.
Move the pink push-rod or the blue cocking piece to the left to get initial position.
The violet pins represent manual action.



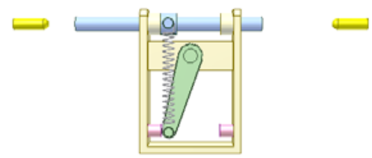
Snap motion 7B
http://youtu.be/RYcTAr8j2P0
A blue spring-loaded cooking piece has chamfered corners. Axial movement of the green push-rod forces the cocking piece against a spring-loaded pin set in frame. When cocking builts up enough force to overcom the pin spring, the cocking piece snaps over to the right.
The action can be repeated in either direction.
The violet pins represent manual action.



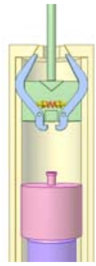
Snap motion 9
http://youtu.be/3ggXrotERfo
Push the pink slider to get snap motion. The action can be repeated in either direction.
The orange pins also play role of stoppers.



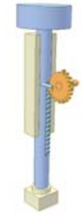
Spring toggle mechanism 10
http://youtu.be/HtLDYQnP1QQ
Spring toggle mechanism enables to reach end positions of a lever quickly and holds it there firmly. However the green lever is not forced against the pink button strongly.
The yellow pins represent action from outside.



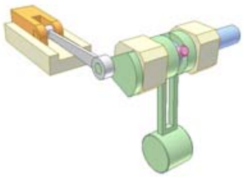
Snap motion 11
http://youtu.be/bt58Gw82938
Releasing-hook, used in pile-driving machines.
When the pink weight is sufficiently raised, the upper ends of the blue hooks, by which it is suspended, are pressed inward by the sides of the slot in the top of the frame. The weight is thus suddenly released and falls with accumulating force on to the pile-head.



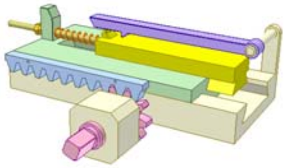
Snap motion 14
http://www.youtube.com/watch?v=yg1xDM0GDYM
The blue plunger carrying a rack suddenly falls when the orange toothed sector leaves the rack.
Small pins on the plunger and on the toothed sector are for maintaining a proper engagement of the rack-pinion drive.



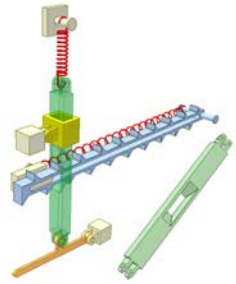
Snap motion 13
http://youtu.be/p2pdrXaIc_Y
The hub of a rotary weight has semi-circular slot in which a pin of the blue driving shaft moves. Snap motion occurs due to the falling of the weight.



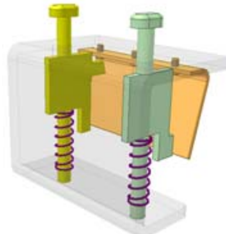
Snap motion 15
http://youtu.be/uMwHehjRyVo
The pink input gear has reciprocating rotary motion.
The green slider has reciprocating linear motion.
The yellow slider linearly reciprocates with dwell and snap motion.



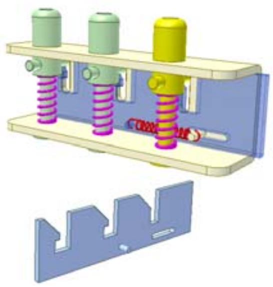
Interrupted linear motion 1
http://youtu.be/oDIOwSwk1JQ
Blue ratchet bar tends to move to the left under the action of red horizontal spring.
Push down and release orange lever to let the blue bar move one tooth pitch.



On-Off switch 1
http://youtu.be/LhaU0whb8Io
Push green button to get ON.
Push yellow button to get OFF.
The orange part is a flat spring.
The green button is connected to electrical contacts (not shown).



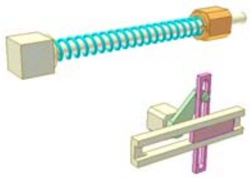
Switch mechanism for speed selection 1
http://youtu.be/UwcpsEW_PqA
The mechanism is used for speed control of desk fans
Push first green button to get speed 1.
Push second green button to release the first one and get speed 2.
Push yellow button to release the green button in down position and get OFF.
Half way pushing of the green buttons (in up position) has the same effect as pushing the yellow button.
The green buttons are connected to electrical contacts (not shown).
Add further green buttons for more speeds.



15. Mechanisms for creating vibration

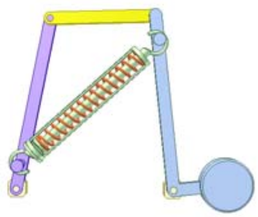
Gravity and spring pendulums
http://youtu.be/NycJBVNkmGI
Two pendulums perform harmonic angular oscillations.
The right pendulum oscillates thanks to the gravity.
The left pendulum oscillates thanks to green disk and flat spiral spring. One end of the spring is fixed to the green disk hub, the other end to base.

Harmonic motions
http://youtu.be/FRpUAQICbIc
Orange slider oscillates thanks to cyan spring.
Pink slider oscillates thanks to a sine mechanism.
Both perform harmonic linear oscillations.

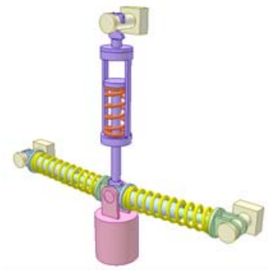


Spring vibration 2
http://youtu.be/bgzpOHozRPM
The mechanism is used for anti-vibration suspensions.

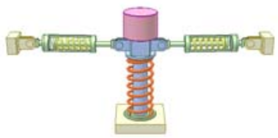
Spring vibration 3
http://youtu.be/Q7eHZX1iaSQ
A four bar mechanism in conjunction with a spring has a wide variety of load or deflection characteristics.



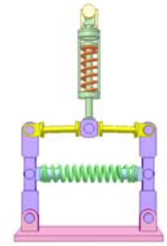
Spring vibration isolation 1
http://youtu.be/Kwm7c6kgQ70
This basic spring arrangement has zero stiffness.
The mechanism is used for vibration isolation.
The pink part represents the weight to be vibration isolated.



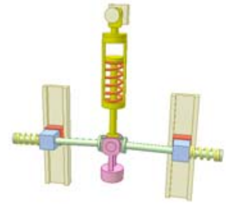
Spring vibration isolation 2
http://youtu.be/OpEjNNHcaEI
This basic spring arrangement has zero stiffness when the tension springs are in line. The pink part represents the weight to be vibration isolated.



Spring vibration isolation 3
http://www.youtube.com/watch?v=vIltfnIVBEc
This spring arrangement has zero stiffness when the yellow bars are in line. The pink part represents the weight to be vibration isolated.

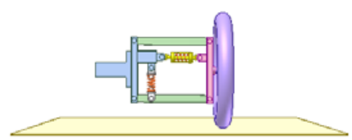


Spring vibration isolation 4
http://www.youtube.com/watch?v=OECw5X_geVE
This spring arrangement has zero stiffness when the yellow compression springs are in line. The pink part represents the weight to be vibration isolated.



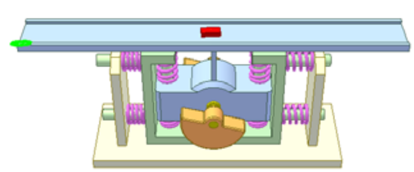
Spring vibration isolation 5
http://www.youtube.com/watch?v=0OB55DXQ5lw
This spring arrangement has zero stiffness (torsion vibration) when the compression springs are in line. The pink part represents the weight to be vibration isolated.

Wheel spring suspension
http://www.youtube.com/watch?v=9A9In_SbBfk
Coil spring suspension of automobiles can be reduced in stiffness by adding an horizontal spring.

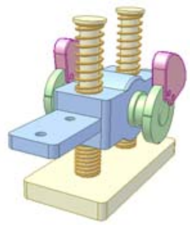


Seat spring suspension
http://youtu.be/sSJ-gizbep8
Tractor seat stiffness and transmitted shocks can be reduced with this spring arrangement.

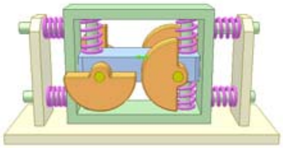
Eccentric vibrator 1A1
http://youtu.be/qPrDI5NYk_I
Vibrating conveyor.
The blue part vibrates in two directions (vertical and horizontal) under centrifugal forces caused by the orange eccentrics and move the material (red).
Angle A between the two eccentrics affects vibration characteristics.
A = 0 deg. for this case.
The green line is locus of a point on the blue part (nearly a proper ellipse)
No vibration if A = 180 deg.



Eccentric vibrator 1A2
http://youtu.be/7wWUhWTBIw0
The blue part vibrates in vertical direction under centrifugal forces caused by the pink eccentrics. The mechanism is used in vibration hammers and rammers.

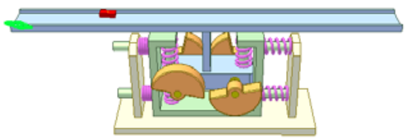


Eccentric vibrator 2A1
http://youtu.be/7zFYThhjm3s
The blue part vibrates under centrifugal forces created by two shafts carrying eccentrics. Vibration characteristics depend on
- rotation direction and velocity of the shafts,
- angle A between the eccentrics on each shaft
- angle B between the eccentrics between the shafts (set before moving).



It is possible to set up the mechanism for vibration only in horizontal (or vertical) direction or in both directions.
For this case there is only horizontal vibration when
- The shafts rotate in opposite directions
- A = 90 deg.
- B = 90 deg.

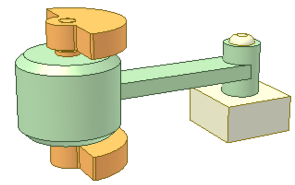
Eccentric vibrator 2A2
http://youtu.be/dHIVU5Uprzw
Vibrating conveyor.
The blue part vibrates under centrifugal forces created by two shafts carrying eccentrics. Vibration characteristics depend on
- rotation direction and velocity of the shafts,
- angle A between the eccentrics on each shaft
- angle B between the eccentrics between the shafts (set before moving).



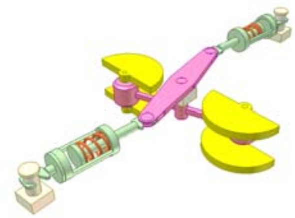
For this case there are vibrations in both directions when
- The shafts rotate in opposite directions
- A = 90 deg.
- B = 180 deg.
The green line is locus of a point on the blue part (nearly a slant line).

Eccentric vibrator 3A
http://youtu.be/6ucruMiqzbY
The blue part vibrates in vertical plane under centrifugal forces caused by the eccentrics and the gravity force.

Eccentric vibrator 3B
http://youtu.be/uZVF7w9jwLk
The green part rotates in horizontal plane under centrifugal forces caused by the eccentrics. The initial position of the eccentrics also affects the rotation characteristics.



Eccentric vibrator 3C
http://youtu.be/8r3M03JvvEg
Vibrator for torsion vibration.
The pink crank oscilates under centrifugal forces caused by the yellow eccentrics that rotate in the same direction.
The oscilation will not occurs if one eccentric shaft turns 180 deg. in relation with the other or the two shafts rotate in opposite directions.



Eccentric vibrator 4A
http://youtu.be/zj9yAVBzRWw
The blue part has complicated motion under centrifugal forces caused by the eccentrics.
The green line is locus of a point on the blue part.

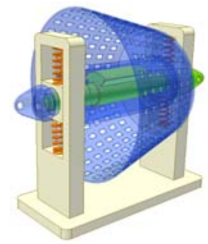
Eccentric vibrator 4B
http://youtu.be/Nksp0f3O_uI
The blue part has complicated motion under centrifugal forces caused by the eccentrics.
The green line is locus of a point on the blue part.

Eccentric vibrator 6A1
http://youtu.be/0GuQCGycMDA
With this lay-out of the eccentrics the blue part vibrates around vertical axle and reciprocates along vertical axle under centrifugal forces caused by the eccentrics.

Eccentric vibrator 6A2
http://youtu.be/CkdOZcf7v_8
With this lay-out of the eccentrics the blue part rotates around vertical axle and reciprocates along vertical axle under centrifugal forces caused by the eccentrics.

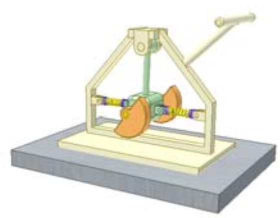
Eccentric vibrator 6A3
http://youtu.be/8p66DsDp554
With this lay-out of the eccentrics the blue part only reciprocates along vertical axle (not rocks around it) under centrifugal forces caused by the eccentrics.

Vibrating screen machine 1
http://youtu.be/JGF-8mG0OG0
The green inner shaft carrying a long eccentric rotates in a screen of cone shape. The later rotates in bearings supported by springs. The inner shaft and the screen are driven through double cardan joints (not shown).



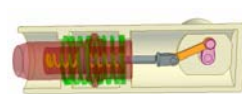
Vibrating screen machine 2
http://youtu.be/KdycXXdN3M0
Oscilating screen is supported by flat springs.
A motor carrying eccentrics is fixed to the screen.

Ramming machine 1
http://youtu.be/bX8TEvxAICo
The machine frame vibrates in two directions: vertical and horizontal under centrifugal forces caused by the orange eccentrics.
Angle A between the two eccentrics affects vibration characteristics.
A = 0 deg. for this case.
Only vertical vibration causes ramming effect. The horizotal one is born by the operator through the grips.

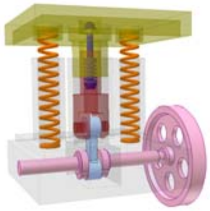


Ramming machine 2
http://youtu.be/M3foSpmDyEM

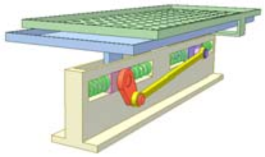
Hand-held spring hammer
http://youtu.be/2dg-x5POoAI
The red slider is born by two green springs, no contact between the slider and the hammer's house. It reciprocates under actions of two green springs, two yellow ones and the slider crank mechanism.



Sand mold vibrating machine
http://youtu.be/Ig5z7Zk1IPc
The yellow mold table reciprocates with vibration under actions of three springs and the slider crank mechanism.

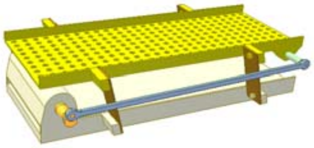


Vibrating screen machine 3
http://youtu.be/EjE1yw8odMw
The bearing and the slider of a linkage mechanism supported by springs can slide in a runway. The sieves are fixed to them. The red crank is driven through a double cardan joint (not shown)

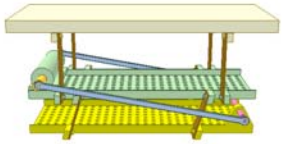


Vibration table
http://youtu.be/2uMzqueot7Q
Blue table with a mould on it vibrates in vertical direction due to centrifugal forces caused by four yellow eccentrics.
The violet screw is for regulating table position that may change because of mould weight .

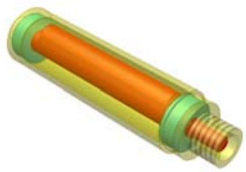
Vibrating screen machine 4
http://youtu.be/kfw1lToK4So



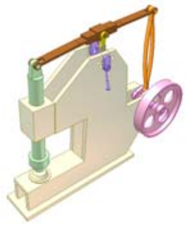
Vibrating screen machine 5
http://youtu.be/zr99xgCvURM



Poker concrete vibrator
http://youtu.be/9dTloL9WLI8
Vibration is created by the rotation of the orange shaft carrying an eccentric mass.



Leaf spring hammer 1
http://youtu.be/ibmCejKObgM
The violet part is an eccentric shaft for adjusting stroke of the green slider.

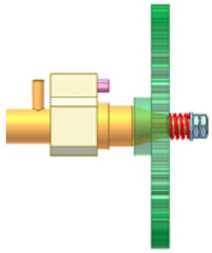


Leaf spring hammer 2
http://youtu.be/ZxoXAZEbYv4

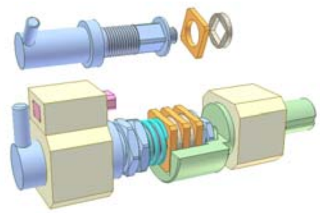
Flex testing machine
http://youtu.be/bSPbxa3flR0
The specimen (in orange) is tested under variable load.

16. Safety clutches

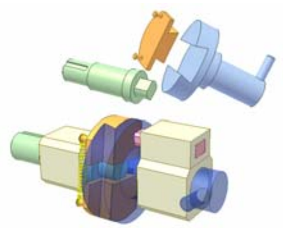
Safety clutch 3
http://youtu.be/b6uouA9Pqzo
A cone clutch is formed by mating a taper on the shaft to a bevel central hole in the gear. Increasing compression on the spring by tightening the nuts increases the drive's torque capacity.
An overload condition ir represented by the pink slider position.



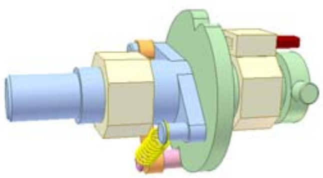
Safety clutch 4
http://youtu.be/Rrpg253rWto
Friction disks are compressed by an adjustable spring. Square disks are locked into the square hole in the right shaft and round disks onto the square rod on the left shaft.
An overload condition ir represented by the pink slider position.



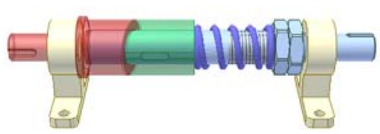
Safety clutch 5
http://youtu.be/YSp9pUJTfZI
Sliding wedges clamp down on the flattened end of the shaft. They spread apart when torque becomes excessive. The strength of the springs in tension that hold the wedges together, sets the torque limit.
An overload condition ir represented by the pink slider position.



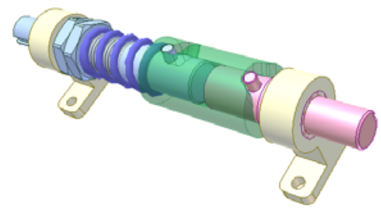
Safety clutch 6 (spring arm)
http://youtu.be/KJ4pp4CCnTc
Torque is transmitted from the blue input shaft to the green output one through the pink pin on the orange arm. When overload (represented by position of a red slider), the pin jumps out of the slot on the green shaft, the transmission is interrupted.



Safety clutch 7
http://youtu.be/ynfwLNaXU08
A cylinder cut at an angle forms a torque limiter. A spring clamps the opposing-angled cylinder faces together and they separate from angular alignment under overload conditions. The spring tension sets the load limit.
The animation has a weakness: the spring does not rotate as in reality.

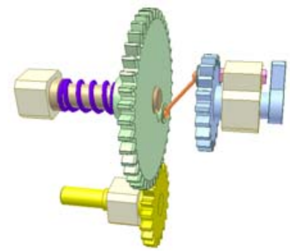


Safety clutch 8
http://youtu.be/6-cJUOWY9q8



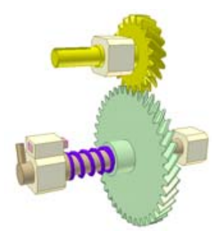
A cammed sleeve (green) connects the input (pink) and output (blue) shaft of this torque limiter. A driven pin (blue) does not allow the sleeve move to the right. When an overload occurs, the driving pin (pink) pushes the sleeve to the left and the driven pin (blue) drops into the L-shaped slot to keep the shafts disengaged. The limiter is reset by turning the output shaft backwards.
The animation has a weakness: the spring does not rotate as in reality.

Safety clutch 9 (oblique arm)
http://youtu.be/ZyfyPQlkXwc



Input: yellow shaft. The axial force of a spring and the orange driving arm are in balance. An overload condition (represented by the pink slider position) overcomes the spring force to slide the green gear out of engagement.
The animation has a weakness: the spring does not rotate as in reality.

Safety clutch 10 (helical gears)
http://youtu.be/sg9AjzaD7Ts

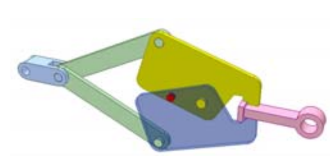


Input: yellow shaft. The axial force of a spring and the axial component of gear force in the spur gear drive (helical teeth) are in balance. An overload condition (represented by the pink slider position) overcomes the spring force to slide the green gear out of engagement.
The animation has a weakness: the spring does not rotate as in reality.

Safety clutch 11
http://youtu.be/plYw36oOPwY

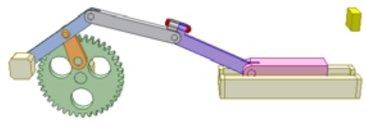
The yellow pulley is input, the green wormwheel is output. The blue worm rotates due to friction between a cone on the worm and a cone hole of the yellow pulley under spring force. When an overload occurs (represented by the pink slider), the blue worm is pushed to the right thus prevents cone contact and interrupts the transmission, reducing wear of cone surfaces.

Safety clutch 1
http://youtu.be/IUZAmjjQ7MA



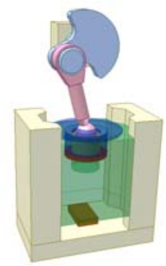
The shearing of a pin releases tension in this coupling. A toggled-operated blade shears a soft pin (red) so that the jaws open and realease an excessive load.

Safety clutch 2
http://youtu.be/trfFKC7xnTw



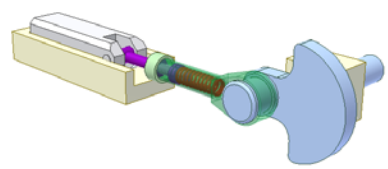
The grey and violet bars are fixed together by the red bolt. When the pink slider crashes with the yellow part, the red bolt is broken, the grey and violet bars are now conneted by a revolute joint to prevent overload for other parts.

Safety clutch 2B
http://youtu.be/YJbl6bSFY4U



When the green slider of a press crashes onto the brown object, the red disk is sheared (a smaller disk is created) by the yellow cushion. This prevents damage of other parts.

Safety clutch 12
http://youtu.be/zd1RT89jKVI

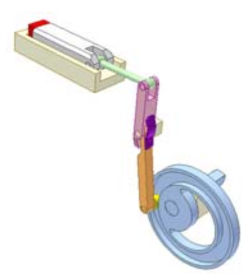


The conrod consist of two parts that can slide on each other. A spring clamps them together under working condition. When the slider crashes with the red part, the spring is compressed, the two parts of the conrod slide on each other to prevent damage of other parts.

Safety clutch 13 - Spring pestle
http://youtu.be/_EriVQKos3k

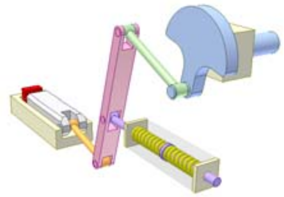
The spring between the slider and the pestle helps to avoid overload and to guarantee no gap between the pestle and the mostar at the lowest position of the pestle.

Safety clutch 14
http://youtu.be/Apye3XXRpYU



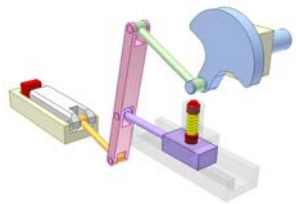
The cam follower consists of two parts (orange and pink) that can rotate in relation to each other. A leaf spring (violet) clamps them together under working condition. When the slider crashes with the red part, the spring is bended, the two parts of the follower rotate in relation to each other to prevent damage of other parts.

Safety clutch 15 (balance springs)
http://youtu.be/aUTmtQZtLKo



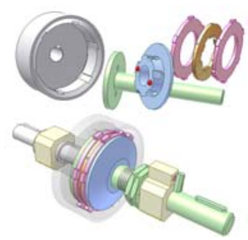
Under normal condition the violet rod is kept immobile by equal forces of the two springs. The pink bar rocks around a pin of the violet rod. When the slider crashes with the red part, the violet rod moves to the right to prevent damage of other parts.

Safety clutch 16 (friction)
http://youtu.be/QBOjcSYDykk



Under normal condition the violet rod is kept immobile due to friction generated by spring force. The pink bar rocks around a pin of the violet rod. When the slider crashes with the red part, the violet rod moves to the right to prevent damage of other parts.
Repositioning of the violet rod is needed for mechanism restore.

Safety clutch 17
http://youtu.be/3E0dW7UV9Ao

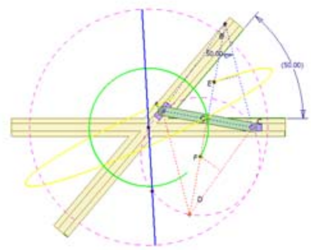


Input: grey shaft having internal cylindrical surface with grooves.
Output: green shaft having cylindrical joint with blue disk.
Pink friction disks engage with the grey shaft.
Orange friction disk engages with the blue disk.
In normal condition the green spring forces blue, pink and orange disks towards the disk of the green shaft to connect the clutch.
When overloading (represented by the pink pin position), the green shaft is kept immobile, the red balls (located in cone holes on faces of the green shaft and the blue disk) push the blue disk to the right, thus disconnect the clutch. At that time there is no contact between the disks so their wear is reduced remarkably.

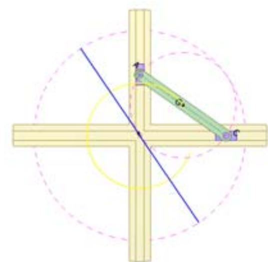
17. Mechanisms for drawing lines

17.1. Straight lines

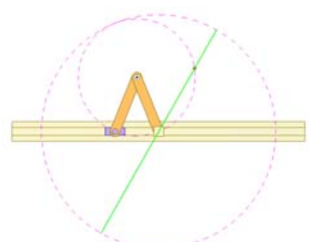
Straight line drawing mechanism 1
http://www.youtube.com/watch?v=8WCee-fP9rg
It is an ellipse mechanism.
Every point of the small magenta circle (circumcircle of isosceles triangle ACD) traces a straight line (in violet).
Circumcenter of triangle ACD traces a circle (in green).
The small magenta circle rolls inside the large fixed magenta one. They are Cardano circles.



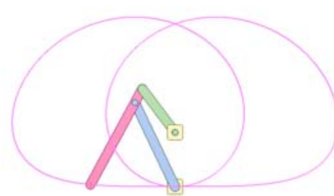
Straight line drawing mechanism 2
http://www.youtube.com/watch?v=zaJmNcmvGQQ
It is an ellipse mechanism.
Every point of the small magenta circle (AC diameter) traces a straight line (in violet).
The small magenta circle rolls inside the large fixed magenta one. They are Cardano circles.



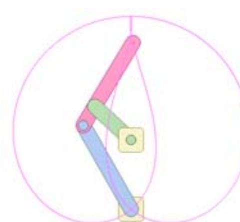
Straight line drawing mechanism 3
http://www.youtube.com/watch?v=JmYyRuiMajw
It is an isosceles slider-crank mechanism.
Every point of the small magenta circle (fixed with the conrod and its radius is equal to the conrod length) traces a straight line (in green).
The small magenta circle rolls inside the large fixed magenta circle. They are Cardano circles.



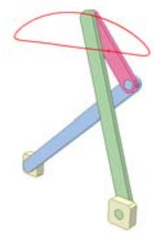
Four-bar linkage 1
http://www.youtube.com/watch?v=afK8PpDYy4Y
The connecting rod rotates fully.
A motion cycle of the linkage corresponds two revolutions of the connecting rod.
A part of the locus at the bottom is nearly straight.



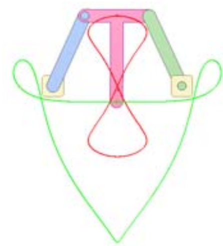
Four-bar linkage 2
http://www.youtube.com/watch?v=SzwoIVCGvu0
The connecting rod rotates fully.
A motion cycle of the linkage corresponds two revolutions of the connecting rod.
A part of the locus at the top is nearly vertical straight.



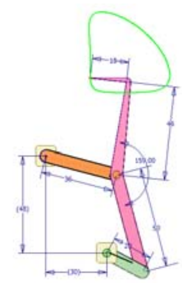
Tchebicheff's four-bar linkage 3
http://www.youtube.com/watch?v=IDDPW6NR5TE
Length of the connecting rod: a
Length of the two cranks: 2.5a
Distance between two fixed bearing houses: 2a
The connecting rod rotates fully.
A part of the locus of the middle point of the connecting rod is approximately straight.



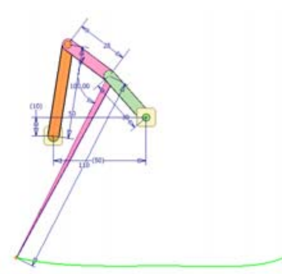
Robert's four-bar linkage 4
http://www.youtube.com/watch?v=q69bxfp3On4
Length of the connecting rod: a
Length of the two cranks: not less than 1.2a
Distance between two fixed bearing houses: 2a
Not any links have full rotation.
A part of the green locus of the lower point of the connecting rod is approximately straight.



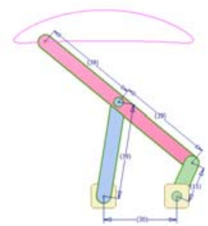
D-drive four-bar linkage 5
http://www.youtube.com/watch?v=7FRRGbw381k
The green locus has two approximately straight parts perpendicular to each other.



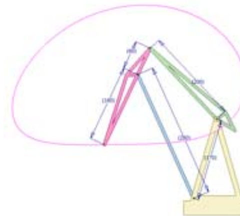
Four-bar linkage 6
http://www.youtube.com/watch?v=f4N1R8MPZTI
Four-bar linkage produces an approximately straight-line motion. A small displacement of the orange crank results in a long, almost-straight line. It is used for the stylus on self-registering instruments.



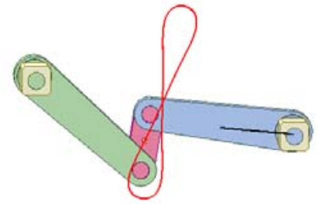
Four-bar linkage 2B
http://www.youtube.com/watch?v=nyALtYMTrAg
A part of the pink locus is a straight line.



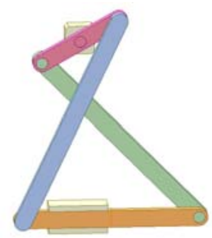
Four-bar linkage crane
http://www.youtube.com/watch?v=QGKnTEqHSS8
The end point of the connecting rod draws a straight line. This is used for moving load in horizontal direction.



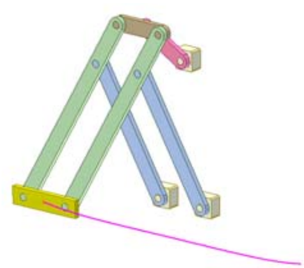
Watt's Linkage drawing straight line
http://www.youtube.com/watch?v=KpDpP0ZgKt8
Length of the two cranks: d
Length of the connecting rod: c
Horizontal distance between crank shafts: 2d
Vertical distance between crank shafts: c
The middle point of the connecting rod traces a 8-shaped curve.
Length of the line segment: 3c/2
Not any links have full rotation.



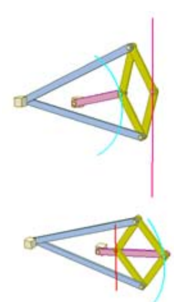
Tchebicheff's four-bar linkage 3B
http://www.youtube.com/watch?v=xPVcL0fMBCk
Length of the crank: a = 30 mm
Length of the two connecting rods: 2.6a = 78 mm
Length of the translating bar: 2a = 60 mm
The mechanism can work if the crank oscillates +/- 30 degrees around the horizontal direction and gap between the runway and the translating bar more than 0.044 mm.
The mechanism is deduced from the one of
Tchebicheff's four-bar linkage 3
http://www.youtube.com/watch?v=IDDPW6NR5TE



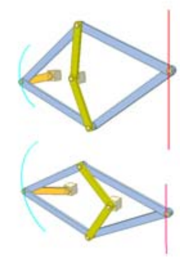
Double parallelogram mechanism 1
http://www.youtube.com/watch?v=u5XA2-E9ZDk
A combination of two parallelogram mechanisms.
The yellow bar has straight-line motion.
Lengths of the links:
Three shortest links: 8
Two blue links: 22
Two green links: 27 + 8 = 35
Height of the upper fixed bearing to the two lower ones: 22.



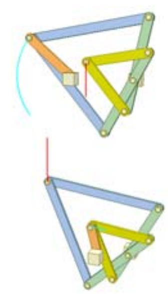
Peaucellier linkage 1
http://youtu.be/6fgrTZnO-ZM
Bars of identical colour are of equal length.
In each mechanism axle distance between the two fixed revolution joints and the pink bar length are equal.
An vertex of the yellow rhombus traces an absolutely straight line (in red).



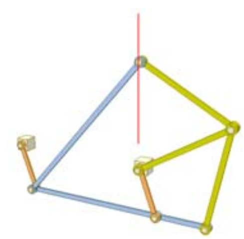
Peaucellier linkage 2
http://youtu.be/LhC9RVI2ln8
Bars of identical colour are of equal length.
In each mechanism axle distance between the two fixed revolution joints and the orange bar length are equal.
An vertex of the blue rhombus traces an absolutely straight line (in red).



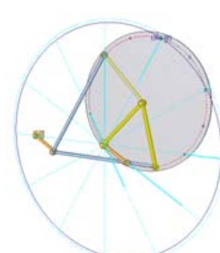
Kite mechanism 1
http://youtu.be/Izacj8CRsNc
A modification of Peaucellier linkage proposed in 1877 by A. B. Kempe, London.
Bars of identical colour are of equal length.
Axle distance between the two fixed revolution joints and the orange bar length are equal.
An vertex of the blue rhombus traces an absolutely straight line (in red).



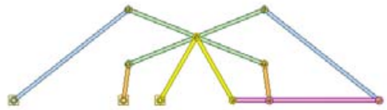
Kite mechanism 2a
http://youtu.be/kiIYIEd7Gj4
A modification of Peaucellier linkage proposed in 1877 by A. B. Kempe, London.
Length of blue bar: a
Length of blue bar of 3 joints: 0.75a + 0.25a
Length of yellow bars: 0.5a
Length of orange bars: 0.25a
Axle distance between the two fixed revolution joints 0.75a
An vertex of the big kite traces an absolutely straight line (in red).



Kite mechanism 2b
http://youtu.be/wuKQcDh4MFw
A modification of Peaucellier linkage proposed in 1877 by A. B. Kempe, London.
Length of blue bar: a
Length of blue bar of 3 joints: 0.75a + 0.25a
Length of yellow bars: 0.5a
Length of orange bars: 0.25a
Axle distance between the two fixed revolution joints 0.75a
The grey disk is fixed to the upper yellow bar. On this disk all points laid on small circle of diameter a (in pink) move along straight lines that are diameters of a big circle of 2a diameter (in cyan). The small circle rolls without slide in the big one. They are of Cardano.

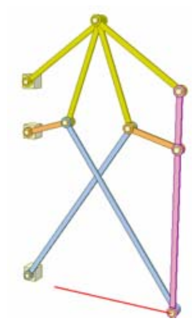


Kite mechanism 3
http://youtu.be/EQ0DLpqnN-g
A modification of Peaucellier linkage proposed in 1877 by A. B. Kempe, London.



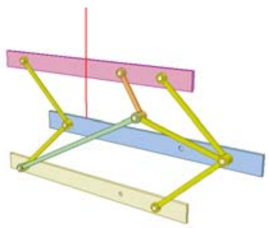
Length of blue bar: a
Length of green bar of 3 joints: 0.5a + 0.5a
Length of pink bar of 3 joints: 0.25a + 0.75a
Length of yellow bars: 0.5a
Length of orange bars: 0.25a
Axle distance between the three fixed revolution joints 0.75a + 0.25a
The pink bar moves along an absolutely straight line.

Kite mechanism 4
http://youtu.be/oKmy7CMYASA
A modification of Peaucellier linkage proposed in 1877 by A. B. Kempe, London.



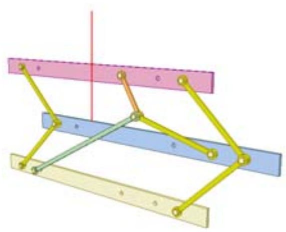
Length of blue bar: a
Length of pink bar of 3 joints: 0.25a + 0.75a
Length of yellow bars: 0.5a
Length of orange bars: 0.25a
Axle distance between the three fixed revolution joints 0.25a + 0.75a
The pink bar moves along an absolutely straight line.

Kite mechanism 5a
http://youtu.be/ShmKYOnMuw4
A modification of Peaucellier linkage proposed in 1877 by A. B. Kempe, London.



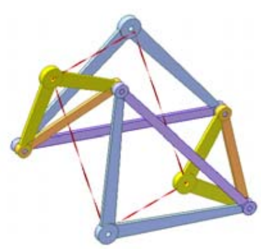
Length of green bars: a
Length of yellow bars: 0.5a
Length of orange bars: 0.25a
The pink plate moves along an absolutely straight line.

Kite mechanism 5b
http://youtu.be/oBgOfMio_LA
A modification of "Kite and spear-head mechanism 5a" proposed in 1877 by A. B. Kempe, London.



Length of green bars: a
Length of yellow bars: 0.5a
Length of orange bars: 0.25a
The pink plate moves along an absolutely straight line.

Inverse parallelogram mechanism 11
http://youtu.be/S8sIOrvrYJM
This modification of inverse parallelogram (4 V-shaped arm mechanism) was proposed in 1877 by A. B. Kempe, London.
The original consists of two orange bars and two violet ones.
Each bar is modified by adding a V-shaped arm and becomes an isosceles right triangle. Their right angle vertices create a variable rectangular (in red).



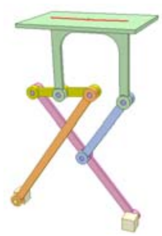
4 V-shaped arm mechanism
http://youtu.be/-FPMdta-Y_A

This linkage was proposed in 1877 by A. B. Kempe, London.
It is a development of "Inverse parallelogram mechanism 11".
Revolution joint centers of the yellow (or blue) V-shaped arm create a isosceles right triangle.
Axle distance between the revolution joints of the green table, axle distance between the ground revolution joints and length of the pink bar are equal.
The green table moves along an absolutely straight line.
Pay attention to the red variable rectangular and two variable parallelograms.

Tchebicheff stool 1
http://youtu.be/k0XrKv1B7h0

This is a development of "Tchebicheff's four-bar linkage 3".
Bars of identical colour are of equal length.
Axle distance between the revolution joints of the green seat, axle distance between the ground revolution joints are equal.
The green seat has horizotal motion (not strictly rectilinear).

Tchebicheff stool 2
http://youtu.be/gV0xl_IbdDs

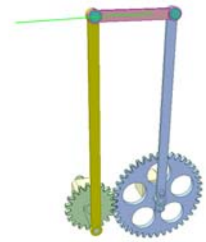


This is a development of "Tchebicheff's four-bar linkage 3".
Axle distance between the revolution joints of the green seat, axle distance between the ground revolution joints are equal.
The green seat has horizotal motion (not strictly rectilinear).

Gear and linkage mechanism 1
http://youtu.be/muF6Y7TUJz8

A slider crank mechanism of two conrods and two cranks. The latters are fixed to two gears in mesh. Owing to the symmetric arrangement the piston axle moves rectilinearly (even if no cylinder (the left mechanism)). Lateral forces from piston applied to cylinder are negligible.

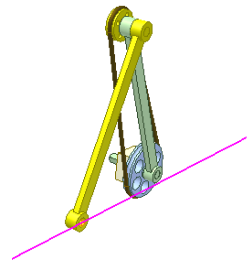
Gear and linkage mechanism 2
http://youtu.be/lDKUj8MV9Xc



Center of the yellow and pink bars revolution joint moves along a approximately straight line.
Radius of the small gear: a
Length of the green crank: a
Radius of the big gear: 2a
Length of the pink bar: 3a
Length of the blue bar: 8a
Length of the yellow bar: 9a

Straight line drawing mechanism 4

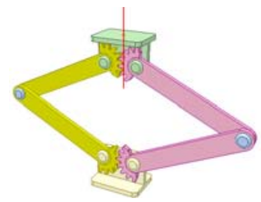
http://youtu.be/HmnA6E82-Wk



Input: green crank of length L1.
Blue pulley of radius R1 is stationary.
Yellow pulley of radius R2 is fixed to yellow bar of length L2.
R1 = 2.R2
L1 = L2
A point on revolution joint of the yellow bar traces a straight line. Its length is 4.L1.
This mechanism has a relation with Cardano cycles.
The belt should be toothed.
It is possible to use chain drive instead of belt one.

Gear and linkage mechanism 3a

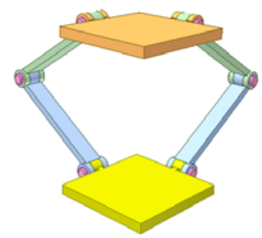
http://youtu.be/3FNWwFqunNU



Combination of linkage and gear drive. The green part translates along an absolutely straight line.

Sarrus linkage 1

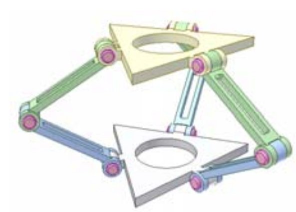
http://youtu.be/pQBJcgJe6t0



A space linkage of only revolution joints and gives absolutely straight motion. It was invented in 1853, sooner than the planar Peaucellier linkage (1864).
It is the combination of two planar slider-crank mechanisms that lay in two perpendicular to each other planes.

Sarrus linkage 2

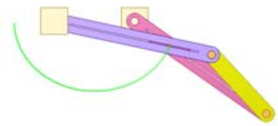
http://youtu.be/CPYbD1GUS1A



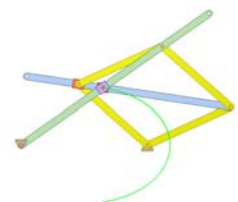
An embodiment of “Sarrus linkage 1”.
Two planes of two planar slider-crank mechanisms are not necessary to be perpendicular to each other. It is enough that they are not parallel.

17.2. Conic curves

Inverse Parallelogram Mechanism 4
http://www.youtube.com/watch?v=A4TvGoHsNyk
The intersection point of the cranks traces an ellipse.

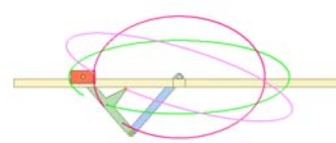


Conic section drawing mechanism 1
http://www.youtube.com/watch?v=4UhoyxrRquY
Drawing ellipses.
The four yellow bars create a rhombus.

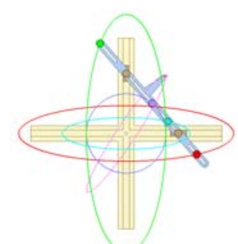


Drawing Ellipse Mechanism 1
http://www.youtube.com/watch?v=vbIYhFK_cYw
Lengths of the crank and the connection rod are equal.
The crank, the connection rod and two short links creates a rhombus.
Equation of traced ellipse: (x.x)/(a.a) + (y.y)/((a – 2b). (a – 2b)) = 1
the coordinate origin O is the fixed revolution joint center of the bue crank.
Axis Oy is vertical. Axis Ox is horizontal.
a is length of the crank.
b is length of the short link.
The blue bar can not turn full revolution because of interference between the orange long pin (connecting the pink and green bars) and the violet and blue bars. So the mechanism can draw only less than one-half of an ellipse (left or right).

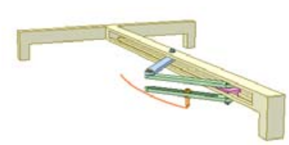
Drawing Ellipse Mechanism 2a
http://www.youtube.com/watch?v=Ug7TK4YTRIY
Lengths of the crank and the connection rod are equal.
Each point of the green connection rod draws an ellipse.



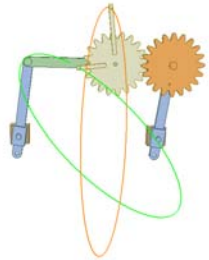
Drawing Ellipse Mechanism 3
http://www.youtube.com/watch?v=FoO2LIYLPEc
Each point of the blue bar draws an ellipse.



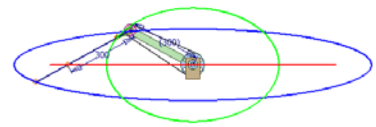
Drawing Ellipse Mechanism 2b
http://youtu.be/csg08Sm8okA
Lengths of blue crank and green conrod are equal.
Each point of the green conrod draws an ellipse.
Adjust position of the orange pen and move it to draw various ellipses. Push the crank or the conrod for overcoming dead points.



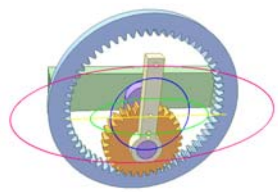
Drawing Ellipse Mechanism 4
http://www.youtube.com/watch?v=rH7tMg9sR1w
Tooth number ratio is 1.
Each point of the yellow gear draws an ellipse.



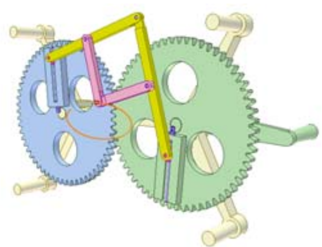
Belt satellite mechanism 2
http://www.youtube.com/watch?v=GBorVkFrhDQ
Diameter ratio between the fixed large pulley and the small one is 2.
A point on the small sprocket draws an ellipse. For the special case (the red line) it is a straight line.
It is similar to the case of a gear satellite with sun internal gear.
http://www.youtube.com/watch?v=2ER0rCFoITo



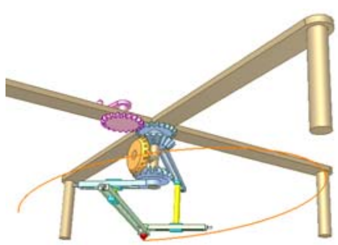
Drawing Ellipse Mechanism 5
http://www.youtube.com/watch?v=2ER0rCFoITo
Tooth number ratio is 2.
Each point of the small gear draws an ellipse.
A point on its rolling cycle draws a straight line (yellow).



Drawing ellipse mechanism 6
http://youtu.be/nPz6VfBF_-4
Combination of gear drive and linkage mechanism.
Two gears are identical. Axle distances between revolution joints on the pink and yellow bars are equal.
Equation of drawn ellipse:
$(x/a)^2 + (y/b)^2 = 1$
$a = (m+n)/2$
$b = (m-n)/2$
m, n: center distance of gear axle and its pink slider axle.
Use violet screws to alter m and n, which means a and b, for various ellipse shapes.
To get an ellipse axis coincident with the gear center line, the screws must be arranged in two sides of the line connecting gear centers with an equal angle.

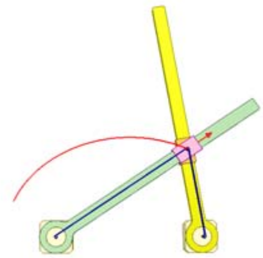


Drawing ellipse mechanism 7
http://youtu.be/Z5kFDYcoXS0
Four slotted bars create a parallelogram. The blue bars rotate with a same speed but opposite directions due to three identical bevel gear drive.
Equation of drawn ellipse:
$(x/(a+b))^2 + (y/(a-b))^2 = 1$
a: center distances between pivots of the long slotted bars.
b: center distances between pivots of the short slotted bars.
Use screws to alter a and b for various ellipse shapes.



Cable mechanism for drawing ellipse

http://youtu.be/UEIuvciAH7c

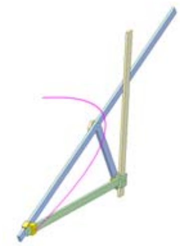


The tow wraps on the pivot of small diameter of two sliders. It is possible that the tow passes through a hole of the pivot. The tow ends are fixed to rotation centers of the yellow and green bars. Turn the bars while keeping the tow strained, the center of sliders pivot traces an ellipse.

Basic definition: Ellipse is locus of point P moving in a plane, the sum of its distances from two fixed points is constant (the tow length).

Drawing Parabola Mechanism 1

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



Equation of traced parabola: y.y = b.x

b: distance between the fixed revolution joint center of the T-bar (blue) O and the centerline of the fixed bar (popcorn).

Axis Oy is vertical. Axis Ox is horizontal.

Conic section drawing mechanism 2

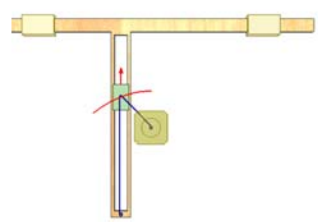
http://www.youtube.com/watch?v=JRynHxNjjhM

Drawing parabolas

The four yellow bars create a rhombus.

Cable mechanism for drawing parabola

http://youtu.be/BsBRUoL2XKE

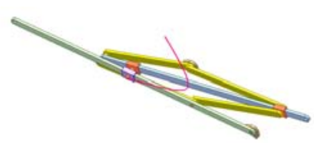


The tow wraps on the pivot of small diameter of green slider. It is possible that the tow passes through a hole of the pivot. One tow end is fixed to a immobile point, the other end is fixed to a point of the orange bar. Move the bar while keeping the tow strained, the center of slider pivot traces an parabola.

Basic definition: Parabola is locus of point P moving in a plane, the sum of its distances from one fixed point and from one fixed straight line is constant (the tow length).

Conic section drawing mechanism 3

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



Drawing hyperbolas

The four yellow bars create a rhombus.

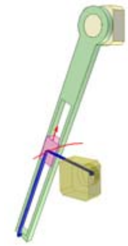
Inverse Parallelogram Mechanism 5

http://www.youtube.com/watch?v=i5uj88NBq_s

The intersection point of the cranks traces a hyperbola.

Cable mechanism for drawing hyperbola

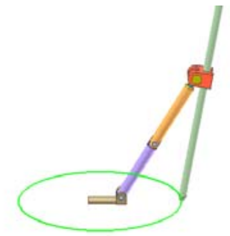
http://youtu.be/72bwAtzubiY



The tow wraps on the pivot of small diameter of pink slider. It is possible that the tow passes through a hole of the pivot. One tow end is fixed to a immobile point, the other end is fixed to a point of the green bar. Turn the bar while keeping the tow strained, the center of slider pivot traces an hyperbola.
Basic definition: Hyperbola is locus of point P moving in a plane, the difference of its distances from two fixed points is constant (the tow length).

Conic section compass 1

http://www.youtube.com/watch?v=EMTJHircC-A

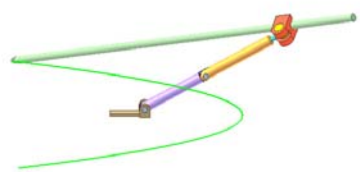


Drawing ellipses according to US Patent 5870830.
To adjust angles α and θ for each ellipse.
- α angle between the orange axis and the plane of paper
- θ: angle between the orange axis and the green arm

The green arm rotates around the orange axis to create a cone. Its intersection curve with the plane of paper is an ellipse.

Conic section compass 2

http://www.youtube.com/watch?v=Mfi9SgAyrK4

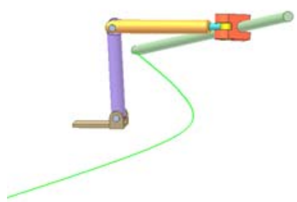


Drawing parabolas according to US Patent 5870830.
To adjust angles α and θ for each parabola.
- α angle between the orange axis and the plane of paper.
- θ: angle between the orange axis and the green arm.

α is equal to θ for parabola drawing.
The green arm rotates around the orange axis to create a cone. Its intersection curve with the plane of paper is a parabola.

Conic section compass 3

http://www.youtube.com/watch?v=dsQE7onpTYs

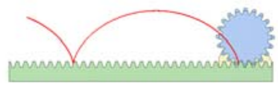


Drawing hyperbolas according to US Patent 5870830.
The violet axis is perpendicular to the plane of paper.
The orange axis is parallel to the plane of paper.
To adjust angles θ for each hyperbola.
- θ: angle between the orange axis and the green arm.

The green arm rotates around the orange axis to create a cone. Its intersection curve with the plane of paper is a hyperbola.

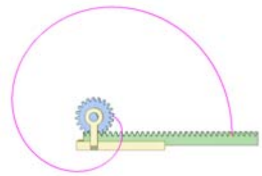
17.3. Other curves

Rack pinion mechanism 2
http://www.youtube.com/watch?v=RN-6AH52V8U
A point on the rolling circle of the pinion traces a cycloid.

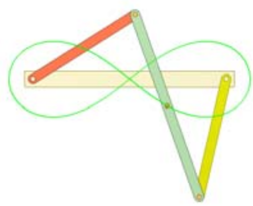


Chain drive 4D
http://youtu.be/eby46_IlQnU
A chain drive rolls on the ground.
Loci of various points on a link (the pink one) are shown. The red line is for the link's pin center. The curve portions of the line are cycloids.

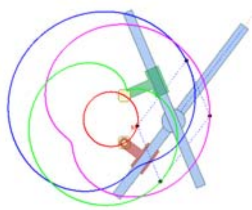
Rack pinion mechanism 3
http://www.youtube.com/watch?v=t_GxDXfQ0GA
A point on the rolling line of the rack traces an involute.



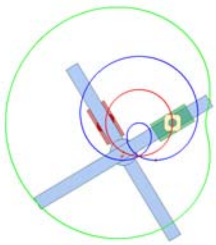
Inverse Parallelogram Mechanism 6
http://www.youtube.com/watch?v=rjxnoQz4xDs
The middle point of the coupler link traces a figure-eight shaped curve, a lemniscate.



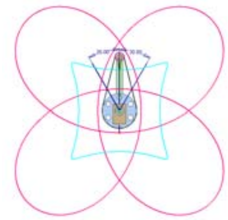
Oldham mechanism 1
http://www.youtube.com/watch?v=Zb2wx3yaCeE
It is the generalized case of Oldham mechanism
Loci of various points on the X-shaped bar are shown.
Point A traces a circle two times during 1 revolution of the cranks.



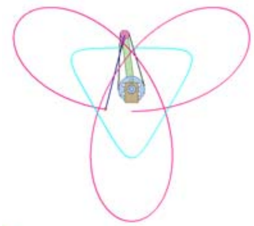
Oldham mechanism 2
http://www.youtube.com/watch?v=TBYJwi4BTsM
It is the standard case of Oldham mechanism
Loci of various points on the X-shaped bar are shown.
Remark: Point A traces a circle (in red) two times during 1 revolution of the cranks. Center of the circle is located in the middle of line segment connecting the two rotation joints.



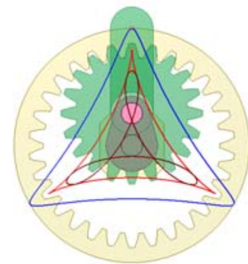
Belt satellite mechanism 1
http://www.youtube.com/watch?v=QNIhGtqKn_M
Diameter ratio between the fixed large pulley and the small one is 4.
If the green crank oscillates 60 degrees between the two blue lines, the small pulley makes a 180 degree oscillation.
It is similar to the case of a gear satellite with sun internal gear.



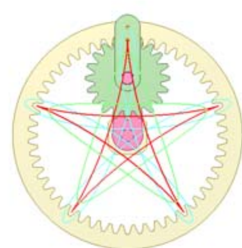
Belt satellite mechanism 3
http://www.youtube.com/watch?v=_d0cYQsQJP4
Diameter ratio between the fixed large pulley and the small one is 3.
The blue locus has three approximately straight parts.
It is similar to the case of a gear satellite with sun internal gear.



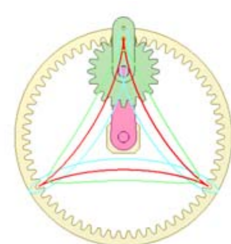
Loci in Epicyclic gearing A1
http://youtu.be/usF8GCmD7xM
R: pitch diameter of the fixed sun gear
r: pitch diameter of the planetary gear
k = R/r = 1.5
Loci of various points on the planetary gear are shown.
The red is for a point on the pitch circle of the planetary gear.
It is a hypocycloid. The two other loci are hypotrochoid.
1 cycle of the mechanism corresponds 2 revolutions of the input crank.



Loci in Epicyclic gearing A2
http://youtu.be/M4Sp2e6_BRw
R: pitch diameter of the fixed sun gear
r: pitch diameter of the planetary gear
k = R/r = 2.5
Loci of various points on the planetary gear are shown.
The red is for a point on the pitch circle of the planetary gear.
It is a hypocycloid. The two other loci are hypotrochoid.
1 cycle of the mechanism corresponds 2 revolutions of the input crank.

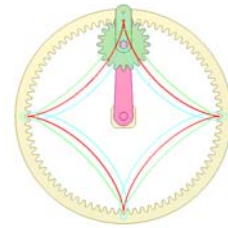


Loci in Epicyclic gearing A3
http://youtu.be/U8vf3DEmWS0
R: pitch diameter of the fixed sun gear
r: pitch diameter of the planetary gear
k = R/r = 3
Loci of various points on the planetary gear are shown.
The red is for a point on the pitch circle of the planetary gear.
It is a special hypocycloid: deltoid. The two other loci are hypotrochoid.
1 cycle of the mechanism corresponds 1 revolution of the input crank.



Loci in Epicyclic gearing A4

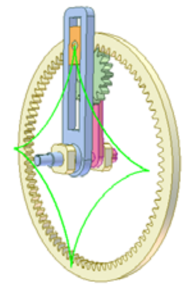
http://youtu.be/hGu6yUYF8mc



R: pitch diameter of the fixed sun gear
r: pitch diameter of the planetary gear
k = R/r = 4
Loci of various points on the planetary gear are shown.
The red locus is for a point on the pitch circle of the planetary gear.
It is a special hypocycloid: astroid. The two other loci are hypotrochoid.
1 cycle of the mechanism corresponds 1 revolution of the input crank.

Loci in Epicyclic gearing A4c

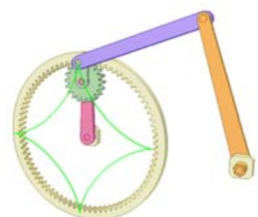
http://youtu.be/4QYQy2akPY0



R: pitch diameter of the fixed sun gear
r: pitch diameter of the planetary gear
k = R/r = 4
A point on pitch circle of the planetary gear traces a special hypocycloid: astroid (green)
The blue slotted crank has 4 dwells in a revolution.

Loci in Epicyclic gearing A4r

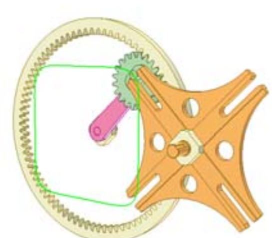
http://youtu.be/xfwYbT46mKo



R: pitch diameter of the fixed sun gear
r: pitch diameter of the planetary gear
k = R/r = 4
A point on pitch circle of the planetary gear traces a special hypocycloid: astroid (green)
The orange crank rocks with a dwell at its rightest position.

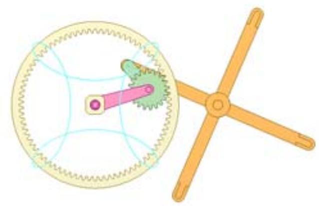
Loci in Epicyclic gearing A4m

http://youtu.be/B3eA9WydI24



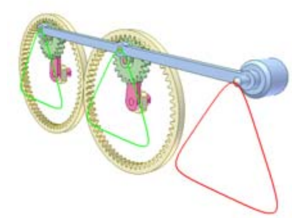
R: pitch diameter of the fixed sun gear
r: pitch diameter of the planetary gear
k = R/r = 4
Distance between the pin axis and the gear axis of the planetary gear is (11/30)r to get a square locus of straight side for the center of the pin.
This produces a smoother indexing motion of the orange Geneva disk rotates because the driving pin moves on a noncircular path, unlike in standard Geneva mechanism.

Loci in Epicyclic gearing A4mb
http://youtu.be/t0243w69178



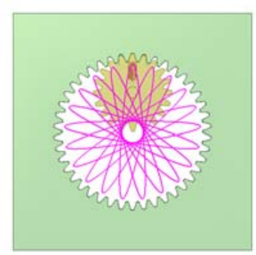
R: pitch diameter of the fixed sun gear
r: pitch diameter of the planetary gear
k = R/r = 4
Distance between the pin axis and the gear axis of the planetary gear is (5/3)r to get a appropriate loop locus for the center of the pin.
This produces a smoother indexing motion of the orange Geneva disk because the driving pin moves on a nearly circular curve, center of which is the rotation center of the Geneva disk.

Loci in Epicyclic gearing A3b
http://youtu.be/BdXXi4fgli0



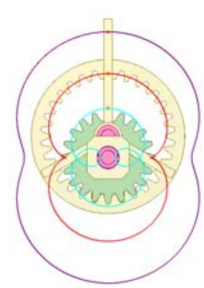
Two identical hypocycloid mechanisms guide the point of the blue bar along the triangularly shaped path.
Distance between the bar holes is equal to distance between the two fixed bearings of the pink cranks.
R: pitch diameter of the fixed sun gear
r: pitch diameter of the planetary gear
k = R/r = 3
Distance between the pin axis and the gear axis of the planetary gear is (1/2)r for getting a triangle of straight sides.
The mechanism are useful where space is limited in the area where the curve must be described. The mechanism can be designed to produce other curve shapes.

Loci in Epicyclic gearing A2.1
http://youtu.be/VMG5039DKoo



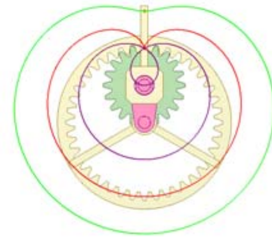
Drawing toy Spinograph.
This video shows how the pink pencil traces a 21 wing hypotrochoid.
Tooth number of green gear: 42.
Tooth number of yellow gear: 20.

Loci in Epicyclic gearing B1
http://youtu.be/lkwYaPxSUgw

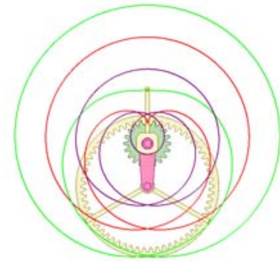


r: pitch diameter of the fixed sun gear with external teeth.
R: pitch diameter of the planetary gear with internal teeth
k = R/r = 1.5
Loci of various points on the planetary gear are shown.
The red is for a point on the pitch circle of the planetary gear.
1 cycle of the mechanism corresponds 3 revolutions of the input crank.

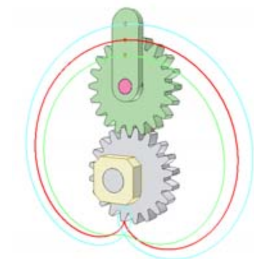
Loci in Epicyclic gearing B2
http://youtu.be/QzP8eA1h91g
r: pitch diameter of the fixed sun gear with external teeth.
R: pitch diameter of the planetary gear with internal teeth
k = R/r = 2
Loci of various points on the planetary gear are shown.
The red is for a point on the pitch circle of the planetary gear.
1 cycle of the mechanism corresponds 2 revolutions of the input crank.



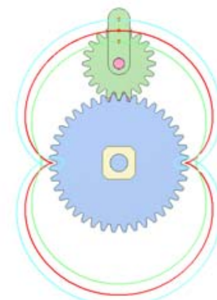
Loci in Epicyclic gearing B3
http://youtu.be/tzisrqQ8lls
r: pitch diameter of the fixed sun gear with external teeth.
R: pitch diameter of the planetary gear with internal teeth
k = R/r = 3
Loci of various points on the planetary gear are shown.
The red is for a point on the pitch circle of the planetary gear.
1 cycle of the mechanism corresponds 3 revolutions of the input crank.



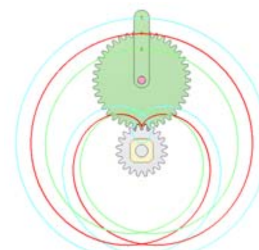
Loci in epicyclic gearing E1
http://youtu.be/rWe0P63_GjI
r: pitch diameter of the fixed sun gear.
R: pitch diameter of the planetary gear.
k = R/r = 1
Loci of various points on the planetary gear are shown.
The red is for a point on the pitch circle of the planetary gear.
1 cycle of the mechanism corresponds 1 revolution of the pink input crank.



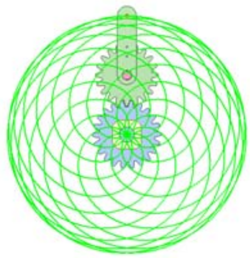
Loci in epicyclic gearing E2
http://youtu.be/ljMCYyT84mY
R: pitch diameter of the fixed sun gear.
r: pitch diameter of the planetary gear.
k = R/r = 2
Loci of various points on the planetary gear are shown.
The red is for a point on the pitch circle of the planetary gear.
1 cycle of the mechanism corresponds 1 revolution of the pink input crank.



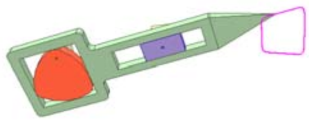
Loci in epicyclic gearing E2b
http://youtu.be/sjJLXzc-vlk
R: pitch diameter of the fixed sun gear.
r: pitch diameter of the planetary gear.
k = R/r = 0.5
Loci of various points on the planetary gear are shown.
The red is for a point on the pitch circle of the planetary gear.
1 cycle of the mechanism corresponds 2 revolutions of the pink input crank.



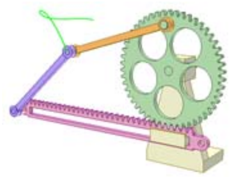
Loci in epicyclic gearing E1.1
http://youtu.be/jq4DZkcoR-A
R: pitch diameter of the fixed sun gear.
r: pitch diameter of the planetary gear.
k = R/r = 1.1
The red curve is locus of point on the pitch circle of the green planetary gear.
1 cycle of the mechanism corresponds 10 revolutions of the pink input crank.



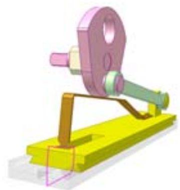
Drawing trapezium with Reuleaux triangle
http://www.youtube.com/watch?v=HEiAhhQwNQ0
The cam profile is a Reuleaux triangle with rounded vertices.
The mechanism is used for moving film in cameras.



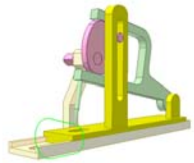
Rack and linkage mechanism 1
http://youtu.be/67GjJMQaWgM
The green input gear oscillates.
The orange and violet bars have complicated motions.



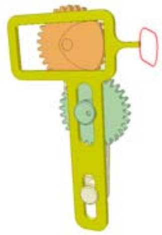
Cam and crank slider mechanism 1
http://youtu.be/TRbIgSk2ydI
The output flat spring tip traces a trapezium for moving film in cameras.



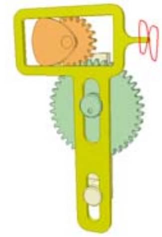
Cam and sine mechanism 1
http://youtu.be/o0bvLIWQYhk
The tip of the green follower traces a green curve for moving film in cameras.



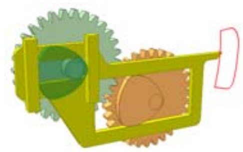
Cam and gear mechanism 7
http://youtu.be/HbeuoAhQ3kE
The yellow follower contacts with the orange cam fixed on the orange gear, eccentric portion of the green gear and the fixed lower pin. The cam is of constant width shape. A point of the frame follower traces the red curve that is used for moving film in cameras. Transmission ratio of the gear drive is 1.



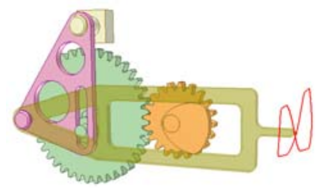
Cam and gear mechanism 8
http://youtu.be/Mv6IA8nlogs
The yellow follower contacts with the orange cam fixed on the orange gear, eccentric portion of the green gear and the fixed lower pin. The cam is of constant width shape. A point of the frame follower traces the red curve that is used for moving film in cameras. Transmission ratio of the gear drive is 2.



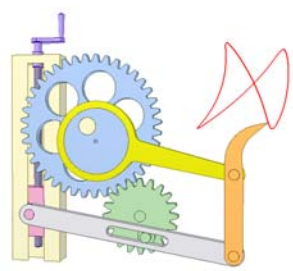
Cam and gear mechanism 9
http://youtu.be/8IiGR-OqX1Q
The yellow follower contacts with the orange cam fixed on the orange gear, concentric portion of the green gear and the green cam. The cams are of constant width shape. A point of the frame follower traces the red curve that is used for moving film in cameras. Transmission ratio of the gear drive is 1.



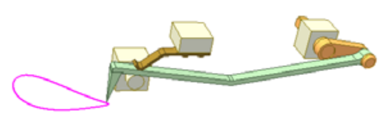
Cam and gear mechanism 10
http://youtu.be/dDITwo4j4SA
The yellow follower contacts with the orange cam fixed on the orange gear. The cam is of constant width shape. The pink plate has a slot in which an eccentric pin of the green gear slides. A point of the frame follower traces the red curve that is used for moving film in cameras. Transmission ratio of the gear drive is 2.



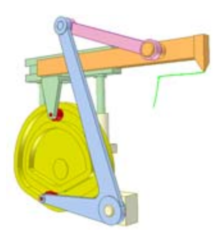
Gear and linkage mechanism 4
http://youtu.be/-VLFKkYmY-0
Orange bar tip traces red curve that is used for moving film in cameras.
Blue and green gears have eccentrics.
Transmission ratio of gear drive is 2.
Move pink slider by turning violet screw for various positions of the red curve.



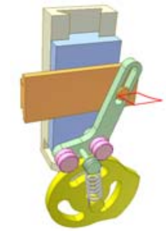
Spring linkage mechanism 3
http://youtu.be/DQB1pY3It08
A slot on the green lever of an ordinary coulisse mechanism is not needed if a leaf spring is used to force the lever against the fixed pin.



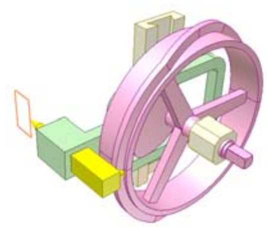
Cam mechanism of 2 followers
http://youtu.be/eOg1P04m8tM
The yellow grooved cam controls motions of two followers (one translating and one rocking). Thus the orange slider has complicated motion.



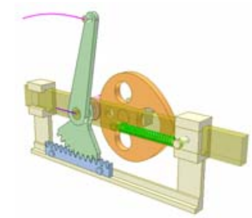
Cam and crank slider mechanism 6
http://youtu.be/JAtnB_WAhOE
Input is the yellow cam. The green follower has two pink rollers, both in permanent contact with the cam. The orange output slider has complicated motion.



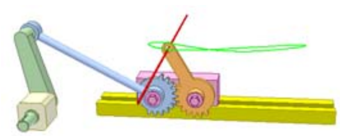
Double cam mechanism 1
http://youtu.be/hVaozVJ9C7w
A combination of disk cam and barrel cam.
The disk cam moves green follower.
The barrel cam moves yellow follower.
A point of the yellow follower traces the orange rectangle that is used for moving film in cameras.



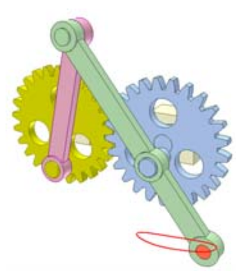
Cam and gear mechanism 1
http://youtu.be/nGqN-2ckst8
Input is the orange cam. Due to gear rack drive, the green output crank has longer stroke (the pink curve, an extended cycloid) than the yellow follower (the violet line).



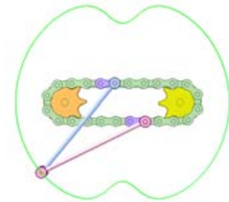
Gear slider crank mechanism
http://youtu.be/wql18kbXN1c
The hole center on the orange lever reciprocates according the motion rule (the green closed curve) that differs from the one of a ordinary slider-crank mechanism.
This mechanism is applied in wire drawing machines for guiding wire (in red) to its coil.



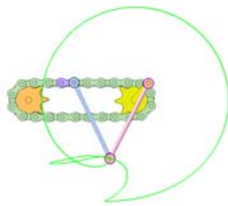
Gear and linkage mechanism 15
http://youtu.be/9JErtHWgtk4
The gears have a same tooth number.
Input : Blue gear rotating regularly.
The red pin traces a complicated curve in general.
This video is for special case, when a part of the red pin locus is linear:
Gear pitch diameters : 50
Crank radius of the blue gear : 5
Crank radius of the yellow gear : 18
Length of the pink bar : 62
Length of the green bar : 60 + 38
Assembly position: as start position of the simulation video.



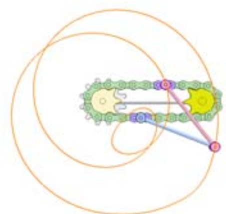
Chain drive 3E
http://youtu.be/rCyWwj-QU54
Two sprockets are identical.
Locus of center of the revolution joint between blue and pink bars is complicated.



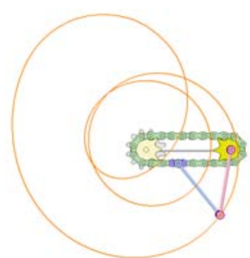
Chain drive 3F
http://youtu.be/fCTeC7_4bXI
Two sprockets are identical.
Locus of center of the revolution joint between blue and pink bars is complicated.



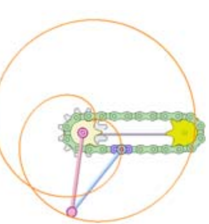
Chain drive 5D
http://www.youtube.com/watch?v=KDUgrrAbn6Q
Satellite chain drive.
The popcorn sprocket is fixed.
The popcorn and yellow sprockets have the same tooth number.
The grey crank and gear is driving.
Locus of center of the revolution joint between blue and pink bars is complicated.



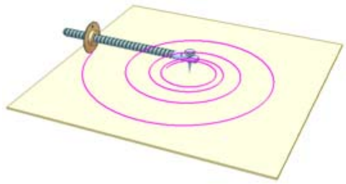
Chain drive 5E
http://www.youtube.com/watch?v=AOZXWyIFYFQ
Satellite chain drive.
The popcorn sprocket is fixed. The popcorn and yellow sprockets have the same tooth number. The pink bar has a revolution joint with the yellow sprocket at its center.
The grey crank and gear is driving.
Locus of center of the revolution joint between blue and pink bars is complicated.



Chain drive 5F
http://www.youtube.com/watch?v=FnWojsq3OFo
Satellite chain drive.
The popcorn sprocket is fixed. The popcorn and yellow sprockets have the same tooth number. The pink bar has a revolution joint with the popcorn sprocket at its center. The grey crank and gear is driving.
Locus of center of the revolution joint between the blue bar and the violet chain link is complicated. The pink bar rotates with dwell.

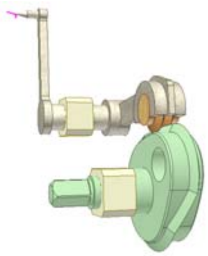


Instrument for drafting spriral
http://youtu.be/S2ILP90ATKI



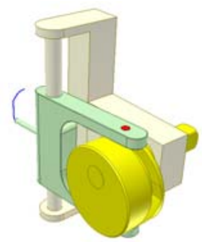
The orange nut-wheel, by revolving about the fixed central point, describes a spiral by moving along the screw threaded axle either way, and transmits the same to drawing paper on which transfer paper is laid with colored side downward.
The obtained spiral is not an Archimedean one.

Double cam mechanism 2
http://youtu.be/rZctm5qDcwU



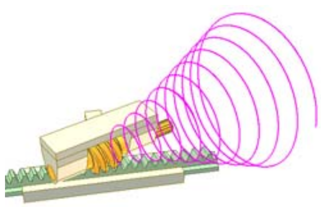
Input: green cam, a combination of disk cam and barrel cam.
Output: brown crank that oscillates and linearly reciprocates.
The gravity maintains contact between the cam and orange roller.

Barrel cam mechanism BR2
http://youtu.be/jfHfx-gCERs



The yellow cam is a combination of an eccentric cam and a barrel one. Contacting both cylinder surface (by two planes) and groove (by a red pin) of the yellow cam, the green follower has complicated motion.

Worm-rack drive 4
http://youtu.be/Sm6OHgdqSKI

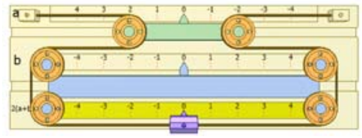


The worm is stationary. Input is the rack runway fixed to the worm bearing. The pink curve is locus of a point on rack pitch line (a space involute of a circle?).
Worm: Helix angle B1 = 30 deg., left hand
Rack: Helix angle B2 = 0 deg.
Angle between worm axle and rack moving direction is L = 30 deg.

18. Mechanisms for math operations and for object position control

Cable adding mechanism

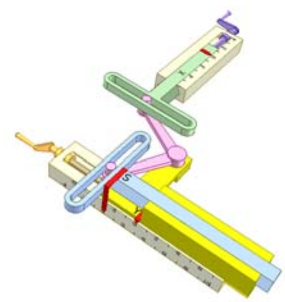
http://youtu.be/56mtxOTCezM



Two ends of the cable are fixed to the base.
Move the green slider to enter value a.
Move the blue slider to enter value b.
The violet cursor (fixed to the cable) gives value 2(a+b).
The video shows the operation 2(0.5 + 1) = 3 and the return to initial position.
For getting value (a+b) to connect the violet cursor to further mechanism such as to the pink slider in video "Cable drive 3" of this channel.

Linkage adding mechanism 1

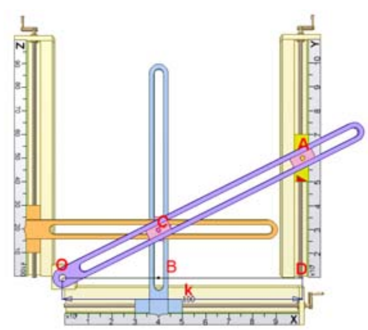
http://youtu.be/e_zW20jO48I



Turn the violet crank to enter value X.
Turn the orange crank to enter value Y.
The red arrow on the blue slider shows S = X + Y (algebraic addition).
The video shows the operation 2 + 4 = 6 and the return to initial position.
The slot on the green slider must be parallel to the sliding direction of the blue slider in order to keep the independence between X and Y entering.
Angle of the pink arm is A = 90 deg. Angle between sliding directions of the green and blue sliders is B = 90 deg. This ensures that the displacements of the green slider and the blue one are equal when the yellow slider is immobile.

Linkage multiplication mechanism 1

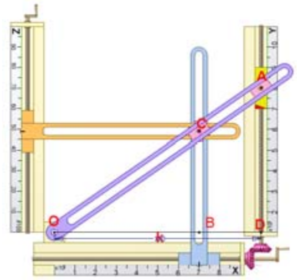
http://youtu.be/U262eypJ7ik



Move blue T-bar to enter positive number x
Move yellow slider to enter positive number y
Orange T-bar shows z = x*y
At point C there are 3 pink sliders (sliding in slots of violet, orange and blue bars respectively) connected together by revolution joints. The screw lead must be large enough to avoid self-locking.
The video shows operation 40*50 = 2000 and then 50*80 = 4000.
The mechanism works on congurent triangles rule. From triangles OBC and OAD: OB/OD = BC/AD
OB = x ; AD = y ; BC = z ; OD = k = 100 mm (constant) then z = (xy)/k
For the X and Y scale, 1 mm corresponds 1 unit.
For the Z scale, 1 mm corresponds 100 units.
The division x = z/y can be performed on this mechanism: enter z and y and get x.

Linkage square root mechanism 1

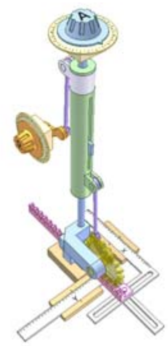
http://youtu.be/mUGOtdwxvYI



Move blue T-bar to enter positive number x to be squared. Orange T-bar shows z = x^2
Move orange T-bar to enter positive number z to be rooted. Blue T-bar shows x = sqrt(z)
At point C there are 3 pink sliders (sliding in slots of violet, orange and blue bars respectively) connected together by revolution joints. The screw lead must be large enough to avoid self-locking.
The video shows operation 40^2 = 1600 or sqrt(1600) = 40 and then 70^2 = 4900 or sqrt(4900) = 70.
The mechanism works on congurent triangles rule.
From triangles OBC and OAD: OB/OD = BC/AD
OB = x ; AD = y ; BC = z ; OD = k = 100 mm (constant) then z = (xy)/k
Because pink bevel gears have the same tooth number and their screws have the same lead, so x = y hence z = (x^2)/k or x = sqrt(z*k)
For the X and Y scale, 1 mm corresponds 1 unit.
For the Z scale, 1 mm corresponds 100 units.

Converting polar coordinates to Cartesian coordinates

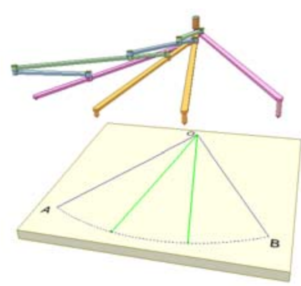
http://youtu.be/uBMnVAMafgI



Turn blue knob A to enter increment of polar angle DA
Turn orange knob R to enter increment of radius DR
The X scale shows increment along the X axis: DX = DR.cos(DA)
The Y scale shows increment along the Y axis: DY = DR.sin(DA)
A pin of the pink rack slides in slots of sliders X and Y.
Two slider-crank mechanisms ensure rotation angles of orange knob and yellow gear equal.
The inverse operation (Cartesian coordinates to polar coordinates) is possible.

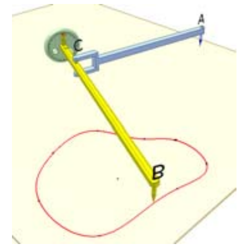
Compass for angle trisection

http://youtu.be/sxwMGcshJI8



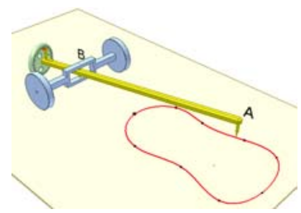
The compass is created by connecting three similar inverse parallelograms. Similar ratio is 2. Numbering:
0 for the left first fixed prong,
1 for the next prong, …
and 3 for the last prong,
A1 is angle between prong 1 and prong 0
A2 is angle between prong 2 and prong 0
A3 is angle between prong 3 and prong 0
The compass maintains relation: Ai = i.A1
i = 1 to 3
i.e.: A2 = 2.A1 ; A3 = 3.A1

Polar planimeter 1
http://youtu.be/kdxPEZnv-U0



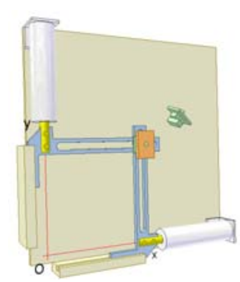
Instrument for determining the area (F) of an arbitrary two-dimensional shape (in red).
Move stylus B along the periphery of the shape (one complete round), the green roller gives two values:
B1: initial position angle (in radians)
B2: final position angle (in radians)
F = L.R.(B1-B2)
L = BC
R: radius of rolling circle of the green roller.
The roller rotation axis must be parallel to BC.
Mathematical basis of the mechanism: intergration in polar coordinates.
There must be sufficient friction between the green roller and the ground to prevent slipping.
In real planimeters there is reduction gear drive to ease reading angle values.

Linear planimeter
http://youtu.be/qThV6gTaYMI



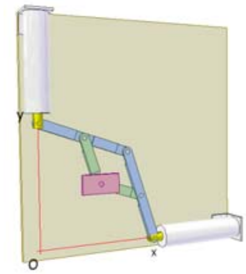
Instrument for determining the area (F) of an arbitrary two-dimensional shape (in red).
The blue bar can move only linearly in the direction perpendicular to the blue rollers axis.
Move stylus B along the periphery of the shape (one complete round), the green roller gives two values:
B1: initial position angle (in radians)
B2: final position angle (in radians)
F = L.R.(B1-B2)
L = AB
R: radius of rolling circle of the green roller.
The roller rotation axis must be parallel to AB.
Mathematical basis of the mechanism: Green's theorem.
There must be sufficient friction between the green roller and the ground to prevent slipping.
Linear planimeters are used for the determination of stretched shapes.
In real planimeters there is reduction gear drive to ease reading angle values.

Planar motion control 1a
http://youtu.be/tZj6O5biJ0M



Orange object has 3 degrees of freedom in its planar motion: two linear and one angular displacements.
This mechanism can deal with two linear ones.
Relations between coordinates of the object center A(x,y) and coordinates of pistons ends B(t,0) and C(0,s):
x = t
y = s
x and t are measured along Ox axis.
Large distance from point A to the runways is a disadvantage so ball bearing sliders should be used.
Angular position of the object is unstable and needs a control device (not shown).

Planar motion control 1b
http://youtu.be/7OX351jGXeM

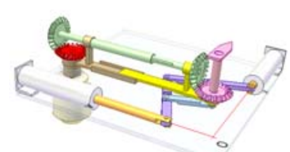


Pink object has 3 degrees of freedom in its planar motion: two linear and one angular displacements.
This pantograph can deal with two linear ones.
Relations between coordinates of the object center A(X,Y) and coordinates of pistons ends B(t,0) and C(0,s):
$x = (t+s.\cos\alpha)/2$
$y = (s+t.\cos\alpha)/2$
α is angle between Ox and Oy
x and t are measured along Ox axis.
If α = 90 deg.
$x = t/2$
$y = s/2$
Angular position of the object is unstable and needs a control device (not shown).
Advantage of pantograph: no prismatic joints.

Planar motion control 2a
http://youtu.be/cMA1BmS-Ptk

Pink object has 3 degrees of freedom in its planar motion: two linear and one angular displacements.
Two white actuators deals with two linear ones. See:
“Planar motion control 1a”
http://youtu.be/tZj6O5biJ0M
Servo motor turns red shaft and controls angular displacement via a double parallelogram drive. Each of red and pink shafts has 2 eccentrics for overcoming dead positions of the parallelogram mechanisms. So the cyan shaft has 4 eccentrics. Transmission ratio between the red and pink shafts is 1/1. The pink shaft and the object are fixed together.
If the red shaft is immobile, the object doest not rotate when moving along Ox and Oy axes.
The video shows how the pink object moves along Ox axis, along Oy axis and then rotates.
The parallelogram drive can be applied for “Planar motion control 1b”
http://youtu.be/7OX351jGXeM to control the pink object.

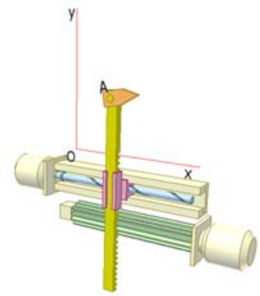
Planar motion control 2b
http://youtu.be/GMVuvjjDMPs



Pink object has 3 degrees of freedom in its planar motion: two linear and one angular displacements.
Two white actuators deals with two linear ones via a pantograph (two violet and two blue bars). For more about pantograph see:
“Planar motion control 1b”
http://youtu.be/7OX351jGXeM
Servo motor turns red gear and controls angular displacement via 4 bevel gear drive.
Four gears have the same tooth number.
Transmission ratio between the red and pink gear is 1/1.
If the red gear is immobile, the object doest not rotate when moving along Ox and Oy axes.
The video shows how the pink object moves along Ox axis, along Oy axis and then rotates.
The 4 bevel gear drive can be applied for “Planar motion control 1a”
http://youtu.be/tZj6O5biJ0M to control the orange object.

Planar motion control 1c

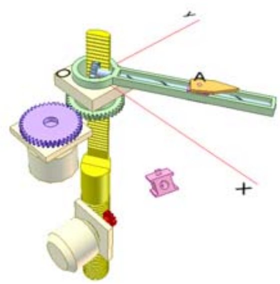
http://youtu.be/c49hIov2C2I



Orange object has 3 degrees of freedom in its planar motion: two linear and one angular displacements.
This mechanism can deal with two linear ones.
For object center A(x,y):
Left motor controls x value via screw-nut drive.
Right motor controls y value via rack-pinion drive.
Angular position of the object is unstable and needs a control device (not shown).
For angular control devices refer to:
http://youtu.be/cMA1BmS-Ptk
http://youtu.be/GMVuvjjDMPs

Planar motion control 1d

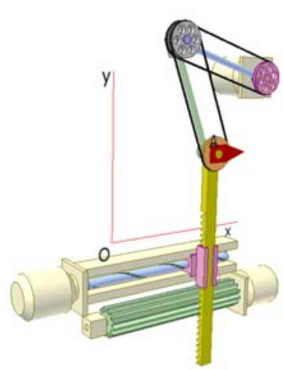
http://youtu.be/wQz2YepAH4k



Orange object has 3 degrees of freedom in its planar motion: two linear and one angular displacements.
This mechanism can deal with two linear ones x, y.
They are controlled based on the polar coordinate system
The object center A is determined by distance r from a fixed point O and angle φ from fixed direction Ox.
$x = r. \cos\varphi$
$y = r.\sin\varphi$
The video shows how the mechanism moves the object to get distance r and then angle φ.
Lower motor controls r value.
Upper motor controls φ value.
There is a helical joint between pink slider and blue shaft.
Round rack on lower half of the yellow shaft allows independent operation of the motors.
Angular position of the object is unstable and needs a control device (not shown).
For angular control devices refer to:
http://youtu.be/cMA1BmS-Ptk
http://youtu.be/GMVuvjjDMPs

Planar motion control 2c

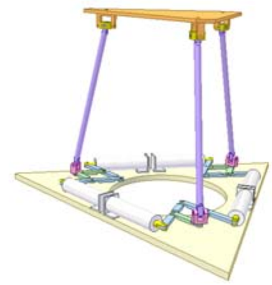
http://youtu.be/6jpgp8GXdgc



Red object has 3 degrees of freedom in its planar motion: two linear x, y and one angular displacements.
Left motor controls x motion via screw-nut drive.
Right motor controls y motion via rack-pinion drive.
Upper motor turns pink pulley and controls angular displacement via two toothed belt drives (chain drives are possible).
Four pulleys have same diameter (same tooth number).
Transmission ratio between the pink and orange pulleys is 1/1.
If the pink pulley is immobile, the object doest not rotate when moving along Ox and Oy axes.
The video shows how the red object moves along Ox axis, along Oy axis and then rotates.

Spatial motion control 1

http://youtu.be/iNa6y4aXG3g



It is a design of Goddard Space Flight Center, USA.

The position and orientation of the orange platform is governed uniquely, in all six degrees of freedom, by the positions of the drivers on the base plate.

The lower ends of the violet limbs are connected via universal joints (2 DoF) to the drivers.

The upper ends of the violet limbs are connected via universal joints (2 DoF) to the platform.

In this video the drivers are pantographs of two degrees of freedom (2 DoF). See:

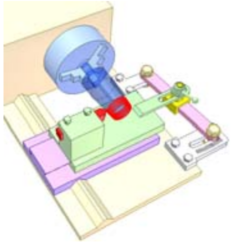
http://youtu.be/7OX351jGXeM

Other types of drivers of 2 DoF are possible.

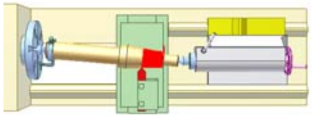
This mechanism is used for a minimanipulator producing small, precise motions and high mechanical advantage.

19. Mechanisms for processing metal and wood

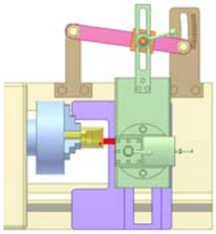
Tapered turning attachment 1
http://youtu.be/fm7uZqS3Oy0
The green slider carries red tool and yellow slider which has revolution joint with the green slider and prismatic joint with pink taper ruler. When the violet power-fed carriage moves along the axis of rotation of the blue work, the tool moves along a line parallel to the ruler to create cone surface on the work.



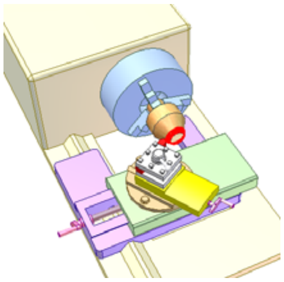
Tapered turning by offsetting of the tailstock
http://youtu.be/z3iYhKFPHKc
This method more suited for shallow tapers.
Approximately the set-over S = L.sinα
L: distance between the blue centers
α: half of taper angle



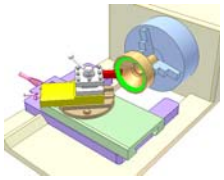
Tapered turning attachment 2
http://www.youtube.com/watch?v=9OcQW3Wc1eE
The green slider carries red tool and orange slider which has revolution joint with the green slider and prismatic joint with pink taper ruler. When the violet power-fed carriage moves along the axis of rotation of the yellow work, the tool moves along a line parallel to the ruler to create inner cone surface on the work.



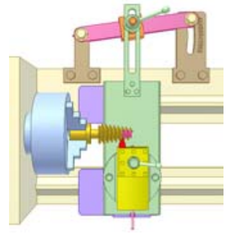
Tapered turning by using the compound slide 1
http://youtu.be/4LET_jHIZvM
The brown base of the yellow compound slide is turned an angle α (half of taper angle of cone surface to be created) and then fixed. This makes the tool moves along a line that creates an angle α with the axis of rotation of the orange work when turning the compound slide screw.
The green cross slide and the violet carriage are fixed during operation.



Tapered turning by using the compound slide 2
http://youtu.be/ysiVGfX4p_4
The brown base of the yellow compound slide is turned an angle α (half of taper angle of inner cone surface to be created) and then fixed. This makes the tool moves along a line that creates an angle α with the axis of rotation of the orange work when turning the compound slide screw.
The green cross slide and the violet carriage are fixed during operation.

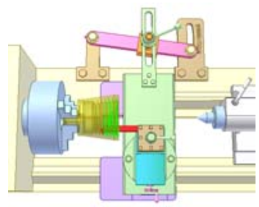


Taper thread turning 1
http://youtu.be/hIs4UHUUZdA



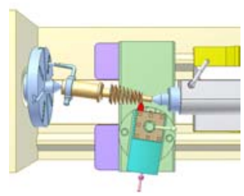
Thanks to the tapered turning attachment the tool moves along a line that creates an angle α (half of taper angle) with the axis of rotation of the yellow work.
The lathe is set to get when the chuck turns 1 revolution, the violet carriage moves L mm (thread lead). The tool is retrieved a little during the reverse stroke.

Taper thread turning 2
http://youtu.be/8yX4Q78QO6M



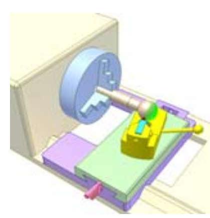
The green slider carries red tool and cyan slider which has revolution joint with the green slider and prismatic joint with pink taper ruler. When the violet power-fed carriage moves along the axis of rotation of the yellow work, the tool moves along a line parallel to the ruler to create inner taper thread on the work.
The lathe is set to get when the chuck turns 1 revolution, the violet carriage moves L mm (thread lead). The tool is retrieved a little during the reverse stroke.

Taper thread turning 3
http://youtu.be/ttK0LNuwQTk



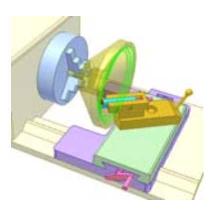
Thanks to tailstock offsetting the tool moves along a line that creates an angle α (half of taper angle) with the axis of rotation of the orange work.
This method more suited for shallow tapers.
Approximately, the set-over $S = L.\sin\alpha$
L: distance between the blue centers
α: half of taper angle
The lathe is set to get when the chuck turns 1 revolution, the violet carriage moves L mm (thread lead). The tool is retrieved a little during the reverse stroke.

External spherical turning
http://youtu.be/PhM5rsGChTk



Axis of the revolution joint between the yellow tool post and the green slider must intersect axis of rotation of the work. If not, the created surface is toric, not spherical.

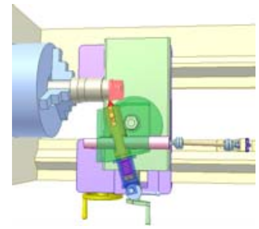
Internal spherical turning
http://youtu.be/f0IYSAXJyBs



Axis of the revolution joint between the orange tool post and the green slider must intersect the axis of rotation of the work.

Copying device on lathe 4

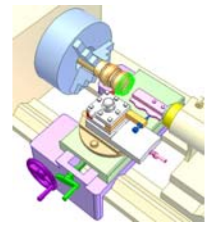
http://youtu.be/_Av-t9bY1wg



The violet carriage is power-fed along the axis of rotation of the workpiece. The orange tool spindle carrying a red tool and a red tracer can slide in the green post that is fixed to the cross slide of the lathe.
The tracer is forced toward the pink sample by a spring. The sample position in relation with the workpiece can be adjusted owing to the violet nut and a conrod of spherical joints (on the right).
Use the green screw of the cross slide to increase the cutting depth. The blue cam is used when moving the tracer to the initial position.

Manual copy turning

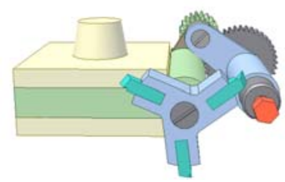
http://youtu.be/3kEpkg9RdwE



An immobile pink sample is fixed on the modified center of the tailstock.
When turning, the operator uses screws of the compound slide and the cross slide to let the blue screw-tracer follow the sample.
The red tool creates a surface of the orange work corresponding to the sample profile. Cutting depth is adjusted by the blue screw-tracer.
The sample position in relation with the workpiece can be adjusted by using the tailstock.

Making hexagon on a lathe

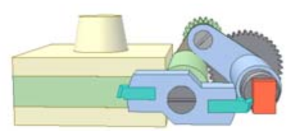
http://www.youtube.com/watch?v=3Kzk3_uzRAg



The tool shaft rotates twice faster than the workpiece shaft.
For details see:
http://meslab.org/mes/threads/13831-Gia-cong-luc-lang-tren-may-tien

Making rectangle on a lathe

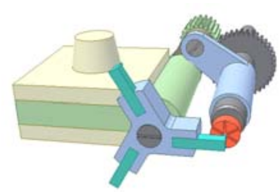
http://www.youtube.com/watch?v=yr0VVtuPAIE



The tool shaft rotates twice faster than the workpiece shaft.

Making face slots on a lathe 1

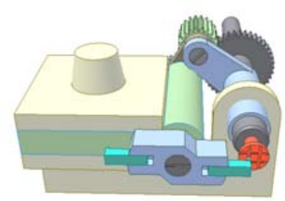
http://www.youtube.com/watch?v=KsMbm2mB7KI



The tool shaft rotates twice faster than the workpiece shaft.

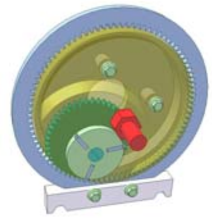
Making face slots on a lathe 2

http://www.youtube.com/watch?v=xQ_eQ2naSFc

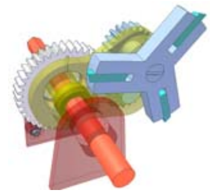


The tool shaft rotates twice faster than the workpiece shaft.

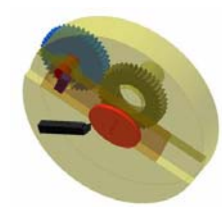
Device for making hexagon on a lathe
http://www.youtube.com/watch?v=XJb-kKOVBqU
The tooth number of the fixed gear is double the one of the satellite gear.



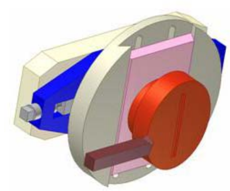
Device for making hexagon on a lathe
http://www.youtube.com/watch?v=AwkDB0ThXG8
The tooth number of the fixed gear is double the one of the satellite gear.
The processing length is not limited.



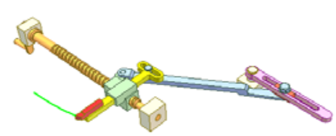
Device for turning ellipse 1
http://www.youtube.com/watch?v=TjaBYsAIwGc
Beside rotation, the workpiece has radial linear motion of sine law.
For details, see
http://meslab.org/mes/showthread.php?p=101930%23post101930



Device for turning ellipse 2
http://www.youtube.com/watch?v=xBIBvF7C3bA
Beside rotation, the workpiece has radial linear motion of sine law.
For details, see
http://meslab.org/mes/showthread.php?p=101930%23post101930

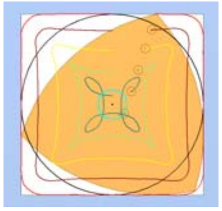


Nut-screw and bar mechanisms 5
http://youtu.be/9Fn6mx2pLUs
Device for moving tool (in red) for turning a profile (in green).
To adjust position of revolution joint between the pink rocker and the blue conrod for various profiles.



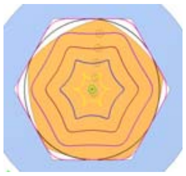
Wood hand screw drill
http://youtu.be/uBZWXZKDCDM
Press on the button, move the green grip up and down to rotate the red bit.

Drilling square holes 1a
http://www.youtube.com/watch?v=BnvT45CjD-E
Reuleaux triangle rotates inside a square.
Loci of various points on the triangle are shown.
The red locus is the section of the drilled square hole.
Its corners are rounded.
An inscribed round hole of the square hole must be predrilled.



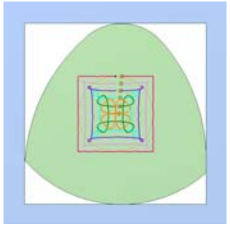
Drilling square holes 1b
http://www.youtube.com/watch?v=TioBY-JGI4I
Device for drilling square holes of rounded corners based on the principle shown in "Drilling square holes 1a"

Drilling hexagon holes 1a
http://www.youtube.com/watch?v=oe8e-N3VusI
Reuleaux pentagon rotates inside a hexagon.
Loci of various points on the pentagon are shown.
The red locus is the section of the drilled hexagon hole.
Its corners are rounded.
An inscribed round hole of the hexagon hole must be predrilled.



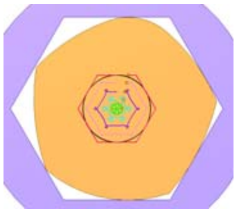
Drilling hexagon holes 1b
http://www.youtube.com/watch?v=_5OgWbMH8D8
Device for drilling hexagon hole of rounded corners based on the principle shown in "Drilling hexagon holes 1a"

Drilling square holes 2a
http://www.youtube.com/watch?v=UvgfqSvKAOI
Reuleaux triangle rotates inside a square.
Loci of various points on the triangle are shown.
The red locus is the section of the drilled square hole.
Its corners are sharp.
An inscribed round hole of the square hole must be predrilled.
There are blade's points that trace knotty loci unfavorable for cutting.

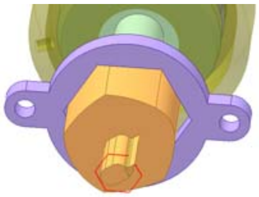


Drilling square holes 2b
http://www.youtube.com/watch?v=pT1H_cPYGAE
Device for drilling square holes of rounded corners based on the principle shown in "Drilling square holes 2a"

Drilling hexagon holes 2a
http://www.youtube.com/watch?v=4HVj89C1bxw
According to Barry Cox and Stan Wagon.
Reuleaux pentagon rotates inside a hexagon.
Loci of various points on the pentagon are shown.
The red locus is the section of the drilled hexagon hole.
Its corners are sharp.
An inscribed round hole of the hexagon hole must be predrilled.



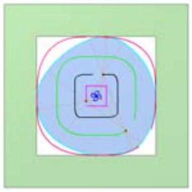
Drilling hexagon holes 2b
http://www.youtube.com/watch?v=W16f-qCXVkM
Device for drilling hexagon holes of sharp corners based on the principle shown in "Drilling hexagon holes 2a"



Drilling triangle holes 1a
http://www.youtube.com/watch?v=gGNC3ltLJK4
According to The Wolfram Demonstration Project.
An oval rotates inside a triangle.
Loci of various points on the oval are shown.
The red locus is the section of the drilled triangle hole.
Its corners are sharp.
An inscribed round hole of the triangle hole must be predrilled.

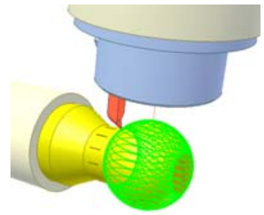
Drilling triangle holes 1b
http://www.youtube.com/watch?v=LNCHxxbMXEU
Device for drilling triangle holes of sharp corners based on the principle shown in "Drilling triangle holes 1a"

Irregular (scalene) Reuleaux triangle
http://www.youtube.com/watch?v=K1ZddTjkfc0
Irregular (scalene) Reuleaux triangle rotates inside a square.
Sketch of the Reuleaux triangle and loci of various points on the triangle are shown.

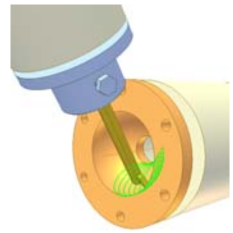


Making sphere on a milling machine 1
http://www.youtube.com/watch?v=BJtxfI_LKio
Workpiece is clamped in a dividing head's chuck and rotated by hand.
Tool is clamped in an arbor that allows it to be regulated radially.
For details see:
http://meslab.org/mes/threads/12255-Gia-cong-mat-cau-loi-tren-may-phay-thuong

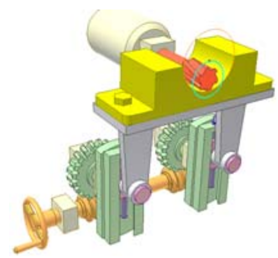
Making sphere on a milling machine 2
http://youtu.be/tx6b17qeOtg
Machining convex asymmetric sphere surfaces.
Workpiece is clamped in a dividing head's chuck and rotated by hand.
Tool is clamped in an arbor that allows it to be regulated radially. Axes of the workpiece and the arbor must be intersecting. The tool point position in relation with the workpiece decides dimension of the machined sphere surface.
For details see:
http://meslab.org/mes/threads/12255-Gia-cong-mat-cau-loi-tren-may-phay-thuong



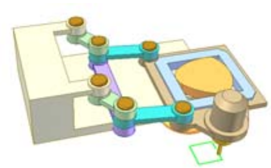
Making sphere on a milling machine 3
http://youtu.be/F22IBTB3cxY
Machining concave sphere surfaces.
Workpiece is clamped in a dividing head's chuck and rotated by hand.
Tool is clamped in an arbor that allows it to be regulated radially. Axes of the workpiece and the arbor must be intersecting. The tool point position in relation with the workpiece decides dimension of the machined sphere surface.



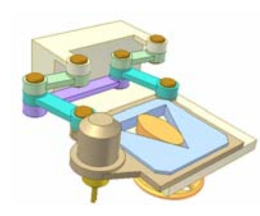
Jig for milling inner cylindrical surface
http://youtu.be/Vyqg7p_7HeE
The yellow work is clamped to the grey conrod of a parallelogram mechanism and has round translational motion.
Radius of inner cylindrical surface to be created is Rw (orange circle). Locus of center of the orange circle is the green circle of radius Rc (radius to be set of the green cranks by violet screws).
The red tool radius is Rt.
Rw = Rc + Rt
Tool setting position: as start position of the simulation video.
The jig is used for large inner cylindrical surfaces on bulky works.



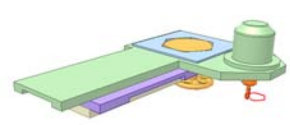
Milling square with Reuleaux polygon
http://www.youtube.com/watch?v=DoKT2fR9Rms



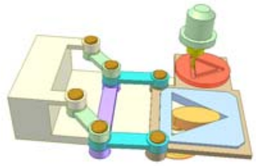
Milling triangle with Reuleaux polygon 1
http://www.youtube.com/watch?v=LOr-lb7E2YM



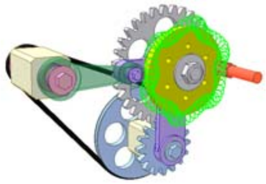
Milling hexagon with Reuleaux polygon
http://www.youtube.com/watch?v=_9j8mVfTS6M



Milling triangle with Reuleaux polygon 2
http://www.youtube.com/watch?v=4TIYYzs17B0

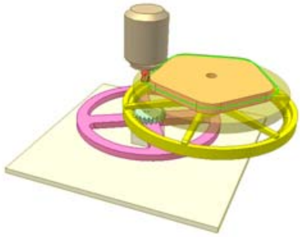


Milling profile 1
http://youtu.be/kPA6xngrYE8



Input is pink shaft having an eccentric.
Red cutter creates profile on yellow work that is fixed to grey gear shaft. Transmission ratio from pink pulley to the grey gear shaft is 6 so the created profile of star shape has 6 wings. The wing is not symmetric because the grey gear shaft rotates irregularly.
The profile shape also depends on relative position between the cutter and the work.
The black belt represents tooth belt. Using chain drive instead of belt one is better.

Loci in Epicyclic gearing B5
http://youtu.be/ydjIoRUng8I

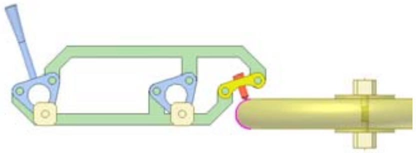


Device for milling a pentagon.
r: pitch radius of the fixed green sun gear
R: pitch radius of the yellow planetary gear
k = R/r = 5
Distance between the red tool axis and the sun gear axis is (8/30)r for getting a locus in shape of rounded corner pentagon (in relative motion between the tool and the yellow planetary gear). The input link is the pink disk. Select tool of larger diameter for getting a pentagon with sharp corners.
Similar device permits to get other regular polygons.

Device for milling Archimedean spiral groove
http://youtu.be/6gnsM7u8_1c

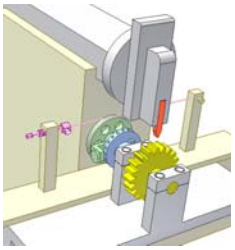
Combination of bevel gear satellite drive and nut-screw one.

Device for Correcting Grinding Wheel
http://youtu.be/yLGqlwvKinY



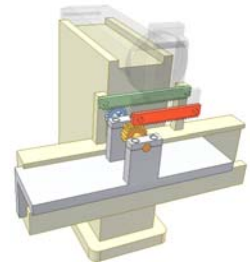
This combination of two parallelogram mechanisms enables the tool point to describe a circular-arc curve.
The yellow link rotates around a virtual axis.
It is used when the arrangement of fixed bearings for the virtual axis is impossible.

Cutting gear on the shaper 1
http://youtu.be/W69m2cDaqvY

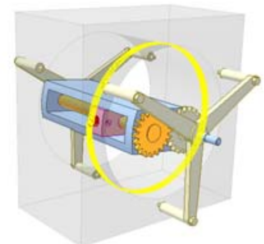


The cable contact diameter of the green disk must be equal to the gear pitch diameter. The hole number on the blue disk is equal to the tooth number.
After completing a tooth slot to index the blue disk (fixed to the yellow workpiece) for cutting the next slot.
A gear-rack drive can be used instead of cable to avoid cable slipping.

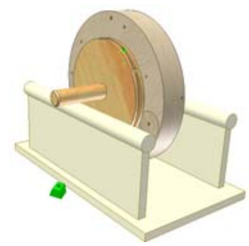
Cutting gear on the shaper 2
http://youtu.be/wkSI6H0-9XE
This method is applied only for gears of small module m and small tooth number Z. The tool is of rack shape. Indexing is not needed. Total displacement of the table carrying the workpiece must be more than π.m.Z.



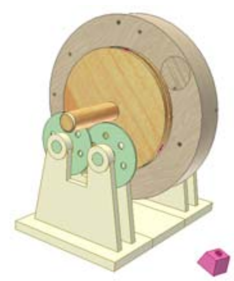
Portable boring machine 1
http://youtu.be/I2rstIly3PA
Combination of planetary gear drive and nut-screw one.
Input is the blue shaft carrying the nut–screw drive. The red tool fixed on the pink nut-slider has helical motion of fine pitch.
The machine is used for large workpieces (in glass) that are difficult to be processed on lathes or boring machines.



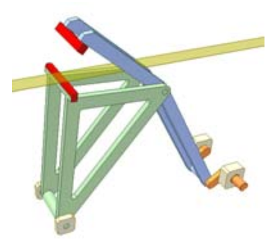
Grinding wheel equilibration 1
http://youtu.be/NQxPukE9y48
Grinding wheel assembly is laid on two horizotal shafts.
If the assembly is static imbalanced, the gravity turns it to the position at which the center of mass is below the assembly axis.
Move green contra-weights in circular dovetail groove of the assembly to upper positions and fixed them there for equilibrating, then test the assembly again.



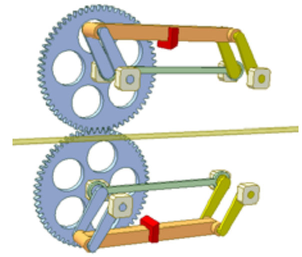
Grinding wheel equilibration 2
http://youtu.be/p6tEpwW9gJ4
Grinding wheel assembly is laid on four green idly rollers.
If the assembly is static imbalanced, the gravity turns it to the position at which the center of mass is below the assembly axis.
Move pink contra-weights in circular dovetail groove of the assembly to upper positions and fixed them there for equilibrating, then test the assembly again.
The structure of four roller helps to reduce the friction in rotary motion of the assembly to the least amount (in comparison with the assembly revolving in an ordinary bearing).



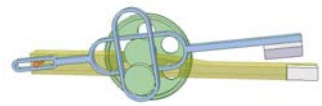
Web-cutting mechanism 2
http://youtu.be/Oe1erEBdHL8
This 4-bar linkage with an extended coupler can cut a yellow web at high speeds. The linkage is dimensioned to give the knife a velocity during cutting operation that is equal to the linear velocity of the web.



Web-cutting mechanism 1
http://youtu.be/VY8W3letECk
This parallelogram mechanism with knife on coupler can cut a yellow web at high speeds. The mechanism is dimensioned to give the knife a velocity during cutting operation that is equal to the linear velocity of the web. The green bars help the mechanism overcome its dead positions.

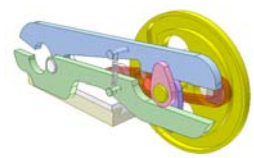


Mechanism for slicing machine
http://www.youtube.com/watch?v=F3hnQxzhZno

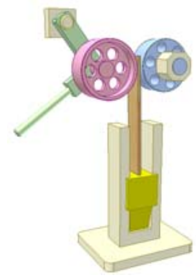


Cam-driven scissors 1
http://youtu.be/kOMxi0W2r3g

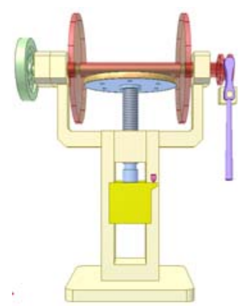
Cam-driven scissors 2
http://youtu.be/Qx0UItGXFRQ
The yellow grooved cam moves sciccor's pivot through the red rod. The upper and lower blades oscillate due to the violet and pink cams that are fixed to the yellow cam.



Drop hammer
http://youtu.be/NUIdUT32OaY
Input: the blue roller.
The pink roller idly rotates on the green lever.
The yellow slider has plank tail that is in contact with the two rollers.
Up and down motion of the yellow slider is controlled by the green lever that causes the pressure at contact places of the plank.

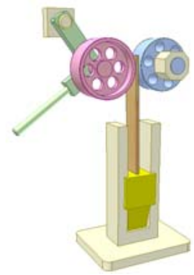


Friction press 1
http://youtu.be/ixZ78JGV0RE
Input: the green puley shaft.
There is a sliding key between the green shaft and the red hollow shaft of two discs.
The blue disc - screw can contact with the two red discs alternately.
Up and down motion of the yellow slider is controlled by the violet lever that causes the pressure at contact places of the three discs.
Be noted that the violet lever represents a multi-bar mechanism used in practice.
The slider reaches max velocity at lower end of its stroke and min velocity at upper end of its stroke.
The pink stopper on the frame (and a not shown brake) sets the highest position of the slider.

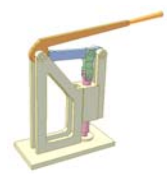


Friction press 2
http://youtu.be/AQX6kVQK7OE
Input: the small center gear receiving rotation from a motor.
The violet plate with a lever carries 4 gears and two rollers. The rollers alternately contact the yellow disc (its inside wall) and give the screw reciprocating rotation. The lever has three positions corresponding with up, down and dwell of the blue nut-slider motion.
Be noted that the violet lever represents a multi-bar mechanism used in practice.
There is a brake to keep the disc immobile during its dwell (not shown).

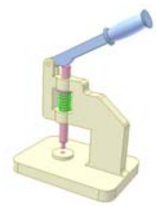
Drop hammer
http://youtu.be/NUIdUT32OaY
Búa rơi – búa ván.
Khâu dẫn là con lăn màu xanh.
Con lăn hồng quay lồng không trên tay đòn màu lục.
Đầu búa màu vàng có đuôi là tấm ván được điều khiển bởi tay đòn màu lục tạo áp lực ở chỗ tiếp xúc của tấm ván.



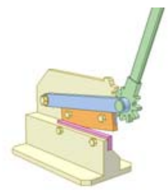
Hand punch machine 1
http://youtu.be/N9ni9wzh3gI
Combination of gear drive and slider-crank mechanism.



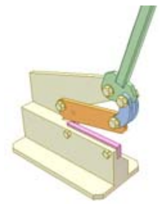
Hand punch machine 2
http://youtu.be/9xB4J91--8w
Disk cam and linear reciprocating follower.



Hand shearing machine 1
http://youtu.be/tp4qFdWDkT8
A planetary gear is used.
Hand force is applied to the satellite gear. The other gear is fixed. The upper tool blade is fixed to the carrier.



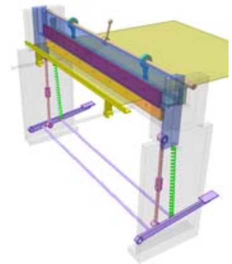
Hand shearing machine 2
http://youtu.be/zLLgQCJ4vSQ
A 4-bar linkage is used.
Hand force is applied to one crank. The upper tool blade is fixed to the other crank.



Foot shearing machine 1

http://youtu.be/GIcygJlH2BM

The blue slider carrying the red upper cutter is driven by a slider crank mechanism. The crank is the violet foot lever. The sheet is clamped before sheared by another slider crank mechanism of brown eccentric shaft. The orange lower cutter is fixed to the machine base. The red upper cutter has inclining cutting edge to reduce cutting force.



Foot shearing machine 2

http://youtu.be/pyGNgP6ZNvA

The blue slider carrying the red upper cutter is driven by a 6-bar mechanism. The sheet is clamped before sheared by a slider crank mechanism of brown eccentric shaft. The runway of the green slider is on the blue slider. The orange lower cutter is fixed to the machine base. The red upper cutter has inclining cutting edge to reduce cutting force.

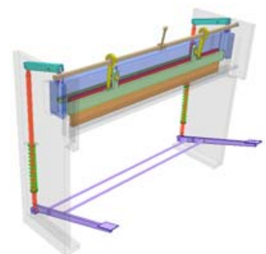


Table wood saw 1

http://youtu.be/J800VDgFpKk

Motions for position adjustment of orange circular blade are shown:

- Up and down by using pink nut. The motor turns around red pin.
- Leaning by using orange nut

The hinge (in red and cyan) for leaning must be arranged as closely as possible to the blade and to the table upper surface.

The mechanism is applied for light duty saw machines.

This video is a simulation of the machine in

http://woodgears.ca/homemade_tablesaw/index.html

by request of Mr. Spiros Kantas from Corfu, Greece.

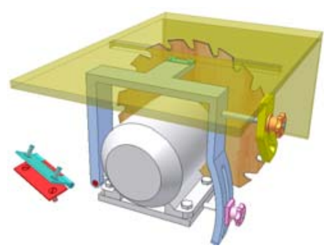


Table wood saw 2

http://youtu.be/0K1gm558V4k

Motions for position adjustment of orange circular blade are shown:

- Up and down by using pink screw. The motor and blade shaft turns around red pin.
- Leaning by using pink nut

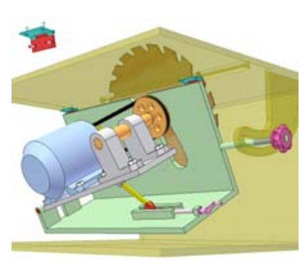
The hinge (in red and cyan) for leaning must be arranged as closely as possible to the blade and to the table upper surface.

The mechanism is applied for light duty saw machines.

This video is a simulation of the machine shown in

http://woodgears.ca/reader/pekka/tablesaw.html

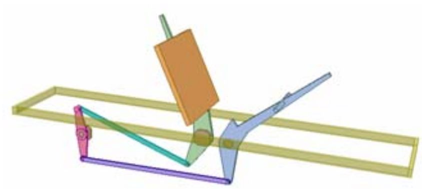
on request of Mr. Spiros Kantas from Corfu, Greece.



20. Mechanisms for manipulation and orientation of workpieces

Flipping mechanism 1

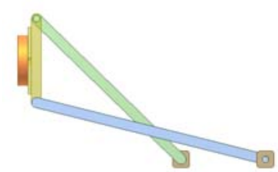
http://www.youtube.com/watch?v=KCJa2zRWpwg



This mechanism can turn over a flat piece by driving two four-bar linkage from one double crank. The two flippers are actually extensions of the fourth member of the four-bar linkage.
Link proportions are selected so that both flippers rise up at the same time to meet a line slightly off the vertical to transfer the piece from one flipper to the other by momentum of the piece.

Flipping mechanism 2

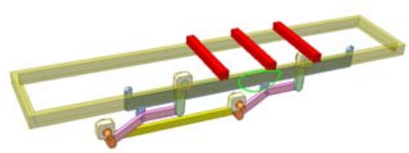
http://www.youtube.com/watch?v=bBWARLe2StQ



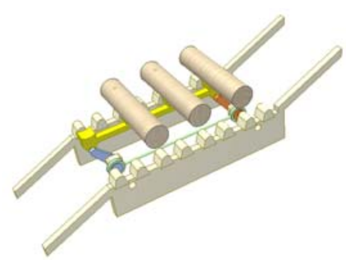
This is a four-bar linkage in which the orange workpiece fixed on the connecting rod is turned over (180 degrees).
Length of the connecting rod: 50
Lengths of the two cranks: 120 and 140
Distance between two fixed bearing houses: 50
The 180 deg. rotation of the workpiece corresponds the 90 deg. rotation of the blue crank.

Transport mechanism 1

http://youtu.be/MeQOVyR9a-E



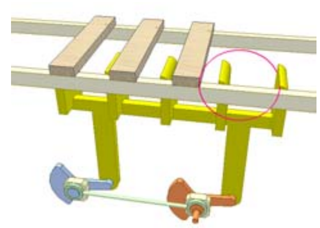
The blue transport has "egg-shape" motion that is used for moving the red works. It is the locus of a point on the pink 4-bar linkage's connecting rod. The yellow connecting rod used for uniting the orange cranks creates a parallelogram mechanism.



Parallel-link feeder 1

http://youtu.be/fK4sziwqOjo

A parallelogram mechanism is used for transporting the workpieces. The green bar helps the mechanism overcome its dead positions.



Parallel-link feeder 2

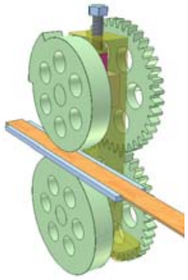
http://youtu.be/e3S_AldcqHI

A parallelogram mechanism is used for transporting the workpieces. The green bar helps the mechanism overcome its dead positions. The red circle is locus of a point on the yellow transporter

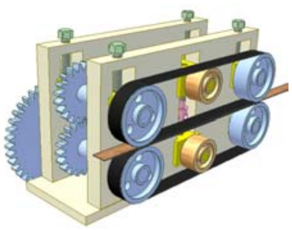
Movable spring feed-duct
http://youtu.be/t2QtIHVbU9U
A close-wound spring attached to a hopper is used as a movable feed-duct for balls or short rollers.

Part orientation 1
http://youtu.be/1Au-1clVp2A
This device makes the orange part to change its orientation after running haft-circle runway.

Mechanism for advancing a strip
http://youtu.be/RaRESa4QS84
Input: the lower green shaft to which a gear and a roller are fixed. The roller contacts with the orange strip through a rectangular hole in the blue runway.
The upper green shaft fixed with a gear and an incompleted roller rotates in a bearing that can slide in a vertical slot of the yellow base.
The friction forces at contact places between the strip and the rollers are created by the red spring. The strip is advanced periodically due to the incompleted circle profile of the upper roller.

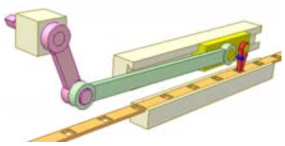


Band advancer
http://youtu.be/1jUDKLD4fms
Input: the blue shaft of two gears.
Friction force between the black belts and the band moves it forward.
The belt tensioner consists of two orange rollers and a pink screw of right and left hand threads at its ends.

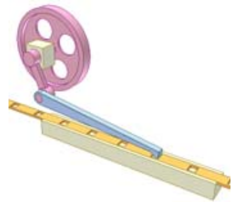


Mechanism for bar advancing
http://youtu.be/X7xW8_aRckM
Friction forces caused by red springs move brown bar. Adjust angle position of lower roller to get various speeds of the bar. Max speed: when the two rollers are parallel.

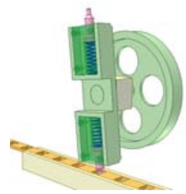
Mechanism for advancing perforated strip 1
http://youtu.be/UPkavC9eZPo
When moving to the right the red pawl is hold from rotation by the blue pin and pushes the orange strip to the right.



Mechanism for advancing perforated strip 2
http://youtu.be/-T14cCu-p7Y
When the pink crank rotates the blue long pawl pushes the orange strip to the right.

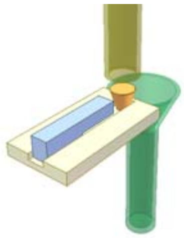


Mechanism for advancing perforated strip 3
http://youtu.be/MIBLtQEz4eE
The pink pins rotates together with the green double crank and can move along it, thus they can get into the strip holes and push it.

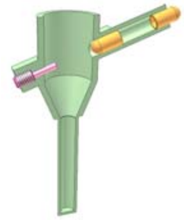


Part orientation 2
http://youtu.be/cXkOMI_Jd1Y
This device changes the orientation of the orange parts: from bottom down in the upper tube to bottom up in the lower tube. The yellow disk rotates interruptedly by an appropriate mechanism (not shown).
The device also has function of part separating.

Part orientation 3
http://youtu.be/0-USznSJAtw
This device makes the orange parts to drop with large bottom down regardless of their initial orientation in the upper tube. The blind slot in the yellow plate is a key detail.

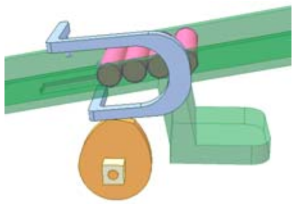


Part orientation 4
http://youtu.be/blv09DJr70Q
This device makes the orange parts to drop with closed bottom down regardless of their initial orientation in the upper tube. The pink screw is a key detail.

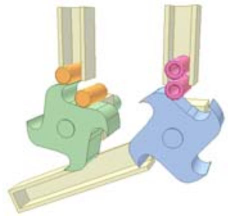


Part orientation 5
http://youtu.be/yCa2j8d8KyE
This device makes the violet parts to drop into the lower tube with small bottom down regardless of their initial orientation in the upper tube. The yellow shafts rotate with tendency to push up the parts to avoid their jam.

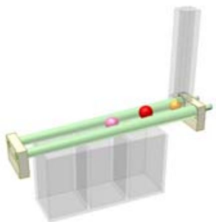
Part separation 1
http://youtu.be/qNftCnJGsvU
This device enables feeding parts one by one to the processing machine. The blue separator is driven by a cam.



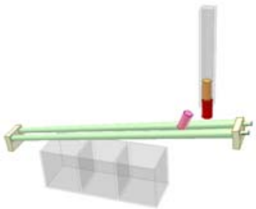
Part mingling 1
http://youtu.be/jXPQxMRaq8I
This device enables mingling two kinds of parts in an alternate order. The rotors rotate in opposite direction.



Part sorting 1
http://youtu.be/nKZX6EuvfiM
The balls are sorted on diameter. The first box receives smallest balls, the last box receives biggest ones.
The green conical shafts rotate in opposite direction with tendency to raise the balls.

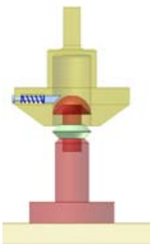


Part sorting 2
http://youtu.be/ZUM5xUA1GUQ
The rollers are sorted on diameter. The first box receives smallest rollers, the last box receives biggest ones.
The green conical shafts rotate in opposite direction with tendency to raise the rollers.



Paper cup dispenser
http://youtu.be/HWDkaef7mZE
Push and release the green slider to get cups one-at-a-time.
Red wedges on the green slider are for preventing the cup sticking.

Grapple frees loads automatically 1
http://youtu.be/9lBBBTgeB-4
This self releasing mechanism is developed at Argone National Laboratory in Illnois, USA, to remove fuel rods from nuclear reactors. It is useful also where human intervention is hazardous or inefficient, such as lowering and releasing loads from helicopters.
There are 3 blue latches disposed around the grapple's axle.
The green sliding collar is the design's key feature.
In original design a gasket spring is used instead of the 3 compressed springs.



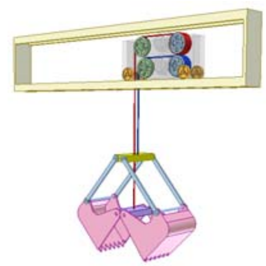
Grapple frees loads automatically 2

http://youtu.be/H-IrTZ2xQok

This self releasing mechanism is used to put an object to desired lower place, such as lowering and releasing loads from boats to sea bottom.
When the green rod strikes the ground, it is forced upward relatively to the grey rod and withdraws the pink catch from under the yellow object, which drops off and allows the grey rod to be lifted without it.
The mechanism is not suitable for lifting objects.

Crane bucket

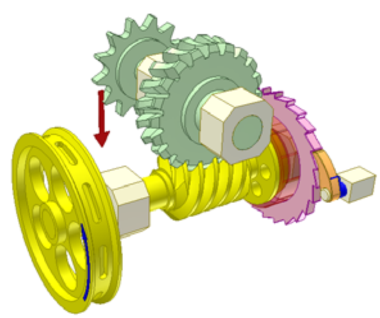
http://youtu.be/ySAYIjiSvKc



The blue cable is used for bucket moving up and down.
The red cable is used for bucket opening or closing.
Pay attention to the fact that the red cable must move when the bucket moves up and down to keep closing or opening state of the bucket.
Mechanism for moving the trolley is not shown.
To increase closing force (for stronger grabing material), a system of two pulley blocks (not shown) for the red cable is installed between the yellow and violet bars of the bucket.

Automatic brake in worm hoist

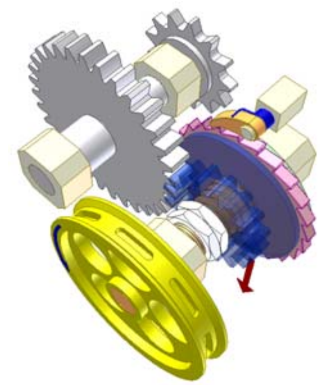
http://youtu.be/lIm5aJLaSCs



The red arrow represents load (to be raised or descended) applied to the hoist.
The blue arrows represent driving force applied to the hoist.
The yellow worm block can move axially a little so its male cone can contact with the female cone of the pink ratchet wheel.
The video shows three stages for the load:
1. Moving up: The worm is turned anticlockwise. Gearing force of the worm drive pushes the worm to the right to contact with the ratchet wheel. The cone clutch closes. The ratchet wheel rotates together with the worm.
2. Stop (no driving force): The load tends to turn the worm clockwise and pushes it towards the ratchet wheel. The cone clutch closes. The orange pawl prevents the load from descending.
3. Moving down: The worm is turned clockwise. Gearing force of the worm drive pushes the worm to the left: no more contact with the ratchet wheel. The cone clutch discloses. The worm wheel can rotate to descend the load. If the load descends faster than worm turning velocity, the situation said in item 2 happens. The moving down is a jerk process.
The key factor is the left hand thread of the worm in this case.
There is no need to use self locking worm drive.

Automatic brake in spur gear hoist

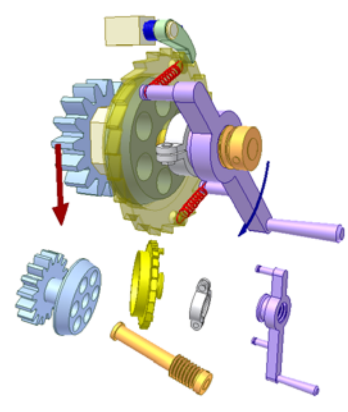
http://youtu.be/5X9SoTP1z2E



Input: Orange shaft of a threaded portion at its middle, on which a blue gear with a friction disk is mounted (helical joint). The blue gear can move axial a little. Its displacement is adjusted by white nuts. The pink ratchet wheel rotate idly on the input shaft.
There is a green friction disk behind the ratchet wheel. It is fixed to the input shaft.
Output: grey shaft of a big gear and a chain wheel.
The red arrow represents load (to be raised or descended) applied to the input shaft.
The blue arrows represent driving force applied to the input shaft.
The video shows three stages for the load:
1. Moving up: The input shaft is turned anticlockwise. Force at the helical joint pushes the blue disk to the right to contact with the ratchet wheel (forces it to the green disk). The ratchet wheel rotates together with the input shaft.
2. Stop (no driving force): The load tends to turn the blue disk clockwise and pushes it towards the ratchet wheel. The orange pawl brakes the load from descending.
3. Moving down: The input shaft is turned clockwise. Force at the helical joint pushes the blue disk to the left: no more contact with the ratchet wheel. The output shaft can rotate to descend the load. If the load descends faster than input velocity, the situation said in item 2 happens. The moving down is a jerk process.
The key factor is the right hand thread of the input shaft in this case.

Safety crank for windlass

http://youtu.be/6QsLCAuC_B0



Output: blue gear with a male cone. The red arrow represents load (to be raised or descended) applied to the gear.
The yellow ratchet wheel with a female cone rotates idly. It is connected to the violet crank by the white ring and two red springs. The crank makes a helical joint with the orange shaft.
The video shows three stages for the load:
1. Moving up: The crank is turned clockwise (the blue arrow). Due to the helical joint the crank presses the ratchet wheel towards the blue gear to close the cone clutch, hence the gear rotates to move up the load. The crank, the ratchet wheel, the gear and the orange shaft rotate together.
2. Stop (no force applied to the crank): The load tends to turn the blue disk anticlockwise but the springs maintain the press from the crank, hence the closing state of the clutch is continued. The pawl brakes the load from descending.
3. Moving down: The crank is pushed (not turned) anticlockwise (the pink arrow). Due to the helical joint the crank moves a little to the right to disclose the cone clutch, hence the gear can rotates to move down the load. If the crank is released, the springs pull the crank to close the clutch to brake the load.
Thus the crank does not rotate during descending the load to avoid accidents.
The key factor is the right hand thread of the orange shaft in this case.

Automatic brake for hoist 1a

http://youtu.be/IUntUq-0MBc

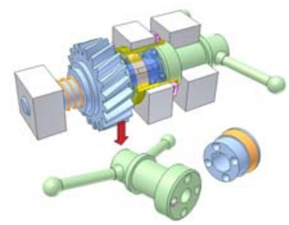
When torque in any direction is applied to green crank, four balls try to move red bush to the left. Its outer cone stops contact with inner cone of yellow fixed socket, the crank and blue gear shaft can rotate together. The torque is transmitted to the gear shaft through the balls.

If the torque is removed, green spring moves the bush to the right. Its contact with the yellow fixed socket brakes the hoist instantly. Orange bush acts as a stopper for the red bush in its motion to the left.

Designer: Joseph Pizzo.

Automatic brake for hoist 1b

http://youtu.be/aUO9Kyoj90E



When torque in any direction is applied to green crank, four balls try to move blue gear shaft to the left. Its outer cone stops contact with inner cone of the yellow fixed socket, the crank and the gear shaft can rotate together. The torque is transmitted to the gear shaft through the balls.

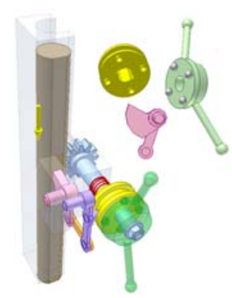
If the torque is removed, orange spring moves the gear shaft to the right. Its contact with the yellow fixed socket brakes the hoist instantly.

Red arrow shows load torque applied to the shaft. By right choice of helix gear direction (left hand in this video) the load helps increasing brake force.

This brake is a suggestion based on the design of Mr. Joseph Pizzo.

Automatic brake for slider 1a

http://youtu.be/5gYC986VqCA



When torque in any direction is applied to green crank, four balls try to move red bush towards. The later via 4 bar linkage stops contact between pink eccentric cam and brown rack-slider, the crank rotating together with the blue gear shaft moves the rack-slider up down. The torque is transmitted to the gear shaft through the balls.

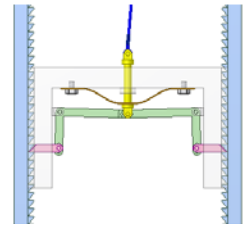
If the torque is removed, red spring moves the bush back and turns the pink cam to brake the rack-slider instantly.

Yellow arrow shows gravity force direction.

Pay attention to design the cam in order that friction between the rack-slider and the cam increases clamping force thanks the gravity force. If not the rack-slider will fall.

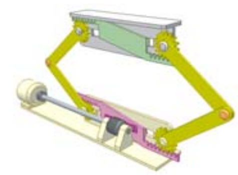
It can be used for moving a working table up down.

Safety stop for lifting apparatus



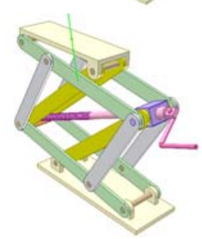
http://youtu.be/-sDqXmD1sEw
This mechanism is applied for hand powered lifting apparatus.
When there is a pulling force in blue cable, the yellow rod compresses brown leaf spring and the grey frame can move up down.
When there is no pulling force in blue cable or the cable is broken, the brown spring via yellow rod and green levers pushes two pink pawls into contact with two stationary racks thus the frame is kept immobile.
The moving down is a jerk proccess, pulling force in cable is only big enough to prevent the pawls from contact with the racks.
The video shows how the frame goes up, stops, goes down, stops, goes up again and stops when the cable is broken.
Leaf spring can be replaced with helical cylindrical one.

Lifting mechanism 1a



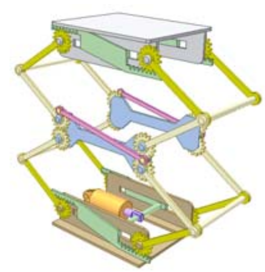
http://youtu.be/vCm01IeXh30
A nut portion is created on the lower rack and receives motion from a motor via the grey screw.

Car jack 1



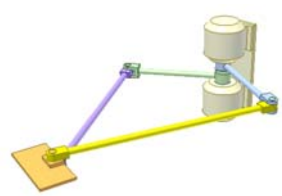
http://youtu.be/W70mJydYt0Q
Upper plate is kept horizontal during motion.
Its up-down motion (green line) slightly differs from vertical direction.

Lifting mechanism 1b



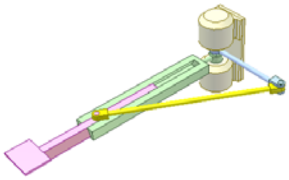
http://youtu.be/SyN7Uex2PLA
Serial connection of two mechanisms shown in “Lifting mechanism 1” http://youtu.be/vCm01IeXh30
Instead of double racks on blue middle plates, parallelogram mechanisms of pink conrods are used. Pins of revolution joints of the conrods are fixed to the gears.
Blue piston of orange hydraulic cylinder pushes green lower rack to lift the grey deck.
It is possible to arrange the gears only on one side.

Planar manipulator 1



http://youtu.be/CfKzBu-wDQo
The mechanism has two degrees of freedom.
Orange plate performs planar motion.
Features:
- Actuators are base-mounted
- Direction of the orange plate is unstable.
- Positon calculation of center of the revolute joint for the orange plate is complicated.

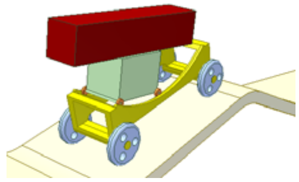
Planar manipulator 2
http://youtu.be/GuWlLurktAU



The mechanism has two degrees of freedom.
Pink slider performs planar motion.
Features:
- Actuators are base-mounted
- Pink slider and green bar have the same direction.
- Positon calculation of center of the revolute joint for the pink plate is less complicated in comparision with "Planar manipulator 1".

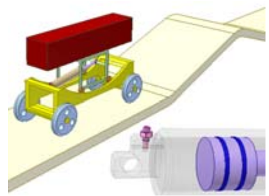
This is a design from Goddard Space Flight Center, USA.

Coffin carrier 1
http://youtu.be/3Bp_Z3Kovxc



Circular runways of the yellow chassis enable to keep the coffin always horizontal regardless of sloping road provided that the carrier does not move too fast. The carrier is used in funeral homes.

Coffin carrier 2
http://youtu.be/_vaAysAGf9g



Circular runways of the yellow chassis enable to keep the coffin always horizontal regardless of sloping road. The air cylinder is for damping, level of which is regulated by the pink screw.
The carrier is used in funeral homes.

21. Mechanisms for indexing and positioning

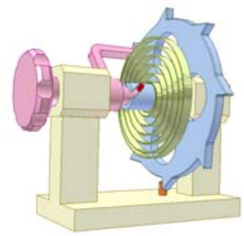
Indexing mechanism 1

http://youtu.be/FktyDQTLi78

Input: blue rod, each push of which makes green disk rotate 90 deg.
Brown springs and square portion of the green disk contribute to the green disk rotation and to its positioning.
Orange flat spring maintains contact between the pink pawl and the green disk.

Indexing mechanism 2

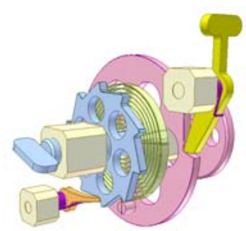
http://youtu.be/0bRevPdhEco



Input: pink knob, each around 45 deg. rotation of which makes blue disk rotate 45 deg. exactly.
Outer end of the spiral flat spring is fixed to the pink knob.
Inner end of the spiral flat spring is fixed to the blue disk hub.
The disk moves axially due to helical slot on the disk.

Indexing mechanism 3

http://youtu.be/-6uhkv5A29w



Output: pink ratchet wheel of two teeth, rotating 180 deg. each time when yellow pawl leaves it thanks to a spiral flat spring.
Outer end of the spiral flat spring is fixed to the pink wheel.
Inner end of the spiral flat spring is fixed to the blue ratchet wheel hub.
Orange pawl prevents clockwise rotation of the blue wheel.
The video shows also the winding up the flat spring by turning the blue wheel anticlockwise.

Positioning device 1

http://www.youtube.com/watch?v=6YDWcjRVHzo

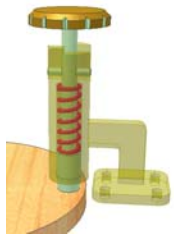
It is used for positioning a disk that rotates interruptedly.

Positioning device 2

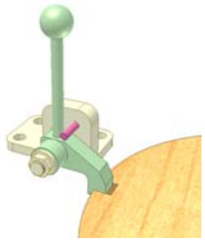
http://www.youtube.com/watch?v=xwK8Oa4SmX8

It is used for positioning a shaft that rotates interruptedly.

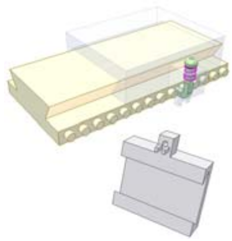
Positioning device 3
http://youtu.be/Uht_pvwbwVU
It is used for manual positioning a disk that rotates interruptedly.



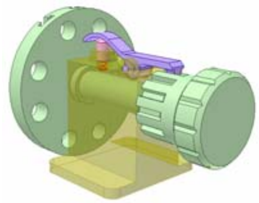
Positioning device 4
http://youtu.be/hLpjlgtKdf4
It is used for manual positioning a disk that rotates interruptedly.
The green lever weight maintains its two extreme positions when creates contacts between the pink pin and the lever.



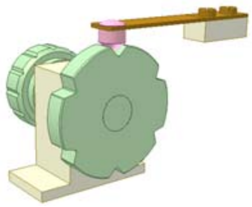
Positioning device 5
http://youtu.be/_01fYaAa56o
Push green button, move slider to new position and release the button.



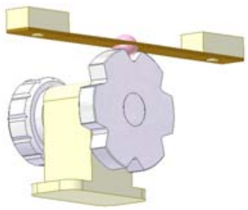
Positioning device 6
http://youtu.be/Edn0JsEvwn8
Press pink button via violet lever, turn green shaft to new position and release the button.



Positioning device 7
http://youtu.be/pRVqH-dwAzc
A leaf spring provides limited holding power.



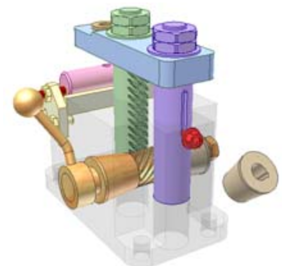
Positioning device 8
http://youtu.be/9m3amDpR3Jw
A leaf spring detent can be removed quickly.
Diameter of the hole for the ball is a little smaller than the ball diameter.
There are gaps in longitudinal direction between base pins and holes on spring ends that causes inaccurate positioning.

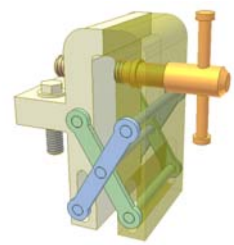


22. Jigs and fixtures

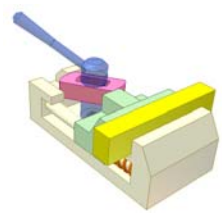
22.1. Clamping mechanisms

Drilling jig 1
http://youtu.be/rUDF2cTRwbk
This jig is for drilling a hole on pink work.
The work is located thanks to a V-block and red stopper. The work is clamped by blue plate having brown drill bushing.
The orange gear shaft has two cones that are located in cone holes of the base. The cone angle is around 11 deg.
The shaft can move axially within small range.
Orange crank makes the plate go up and down via 45 deg. helical gear rack drive. The gear does not contact violet cyliinder.
Turn the crank counterclockwise, the plate comes into contact with the work. Turn it further for clamping work. Axial gear force pulls orange gear shaft to the right to lock the shaft by action of the left cone.
Turn the crank clockwise, axial gear force pushes orange gear shaft to the left to unlock the shaft, the plate goes up.
The red screw stops the plate at its highest position. Turn further the crank for locking the plate by action of the right cone (in brown).

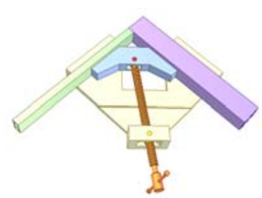




Nut-screw and bar mechanisms 4
http://youtu.be/IDvID90NT-A
Vice without runway.



Disk cam mechanism DF10f F3
http://youtu.be/xGQjTeLqTq0
Cam vise. The pink cam has a rectangular slot at its center so it has linear motion during rotation. This helps move the green clamping head longer and faster.

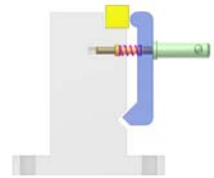


Angular Vice
http://youtu.be/Z2hujRfjv0U
Revolute joints for the red bush and the yellow nut of the screw enable clamping bars of different sizes.

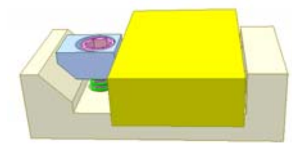
Wedge mechanism 11
http://youtu.be/Q9feu8j4OZ0
Double wedge mechanism.
Device for clamping workpiece (in orange).

Wedge mechanism 12
http://youtu.be/QXXe8tCdO1g
Device for clamping workpiece (in orange).

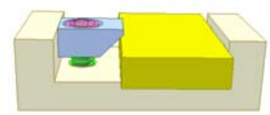
Wedge mechanism 25
http://youtu.be/LKYEhscIjHc
The wedge portion at lower end of the blue lever helps create vertical force component (friction) to press down the yellow workpiece (beside the horizontal one).



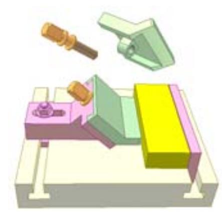
Wedge mechanism 26
http://youtu.be/fjdgmyK-WT8
The blue wedge helps create at the same time vertical (friction) and horizontal force components for clamping the workpiece.



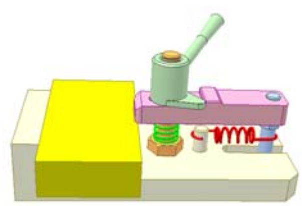
Wedge mechanism 27
http://youtu.be/pzj_AdvYZ7c
The blue wedge helps create at the same time vertical and horizontal force components for clamping the workpiece.



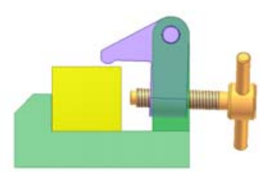
Machine tool fixture 5
http://youtu.be/H1utvZAUbUA
The green slider moves obliquely and creates at the same time vertical (friction) and horizontal force components for clamping the yellow workpiece.



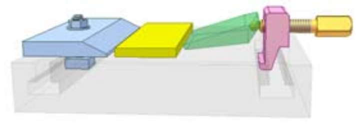
Machine tool fixture 1
http://youtu.be/F25gI0luThM
Turn the green cam-nut to tighten or release the workpiece and to clear space for its removing. Adjust positions of the green nut and the blue screw for adapting to the workpice’s thickness.



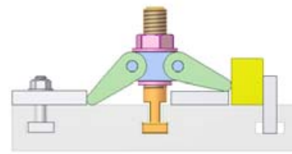
Machine tool fixture 2
http://youtu.be/geLVsyj88so
At the same time vertical and horizontal force components for clamping the yellow workpiece are created.



Machine tool fixture 3
http://youtu.be/JXT47Kpr8K0
It is used for clamping workpieces of small thickness.

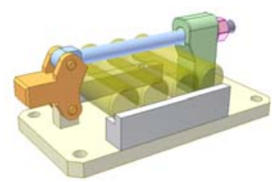


Machine tool fixture 4
http://youtu.be/BRkf-bi6_zM

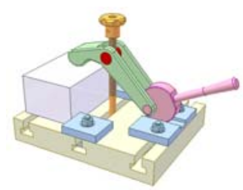


Machine tool fixture 9
http://youtu.be/B69K_33kapg
Turn the pink nut to clamp the yellow workpiece at two points.

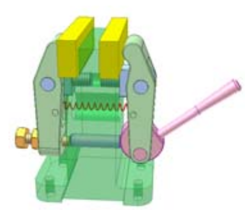
Machine tool fixture 17
http://youtu.be/C-EqQPTgXXQ
Multi-piece clamping.
Turn the pink nut to tighten or release the yellow cylindrical workpieces.



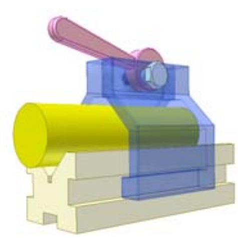
Machine tool fixture 6
http://youtu.be/RZIIRs0WWcw
The helix joint between the orange screw and the red pin-nut adapts the fixture to various thickness of workpieces.



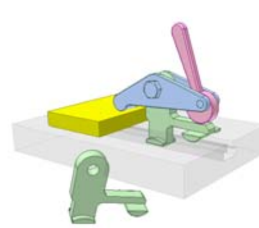
Machine tool fixture 10
http://youtu.be/Gq-Fe8A6ur0
The violet flowing pin enables firm clamping two yellow workpieces.



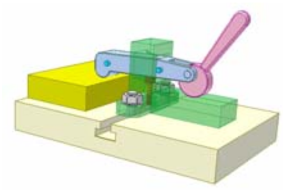
Machine tool fixture 12
http://youtu.be/rRajZ1XBzaY



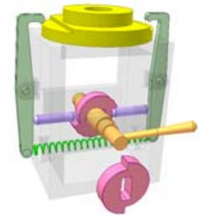
Machine tool fixture 13
http://youtu.be/H5W4arrmCPE
The green column is inserted into the table's T-slot. Its fixing to the table happens at the same time with the workpiece clamping.



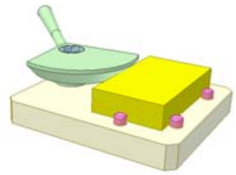
Machine tool fixture 14
http://youtu.be/ip7SyiZd7h4
The blue lever can move back to clear space for removing the yellow workpiece. The contact surfaces of the blue lever and the workpiece must be rough enough for the mechanism's good performance.



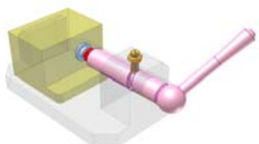
Machine tool fixture 8
http://youtu.be/wNckTzjwn4E
The pink double eccentric cam has a prismatic joint with the orange lever shaft. It enables firm clamping the yellow workpiece at two points.



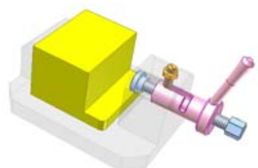
Machine tool fixture 11
http://youtu.be/_cPwqgrKJ-E
The green eccentric with a chamfer creates 3 force components including the down one to press the yellow workpiece toward locating elements.



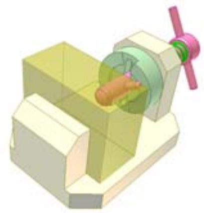
Machine tool fixture 15
http://youtu.be/5CWgcpLynnM
The pink lever can move back to clear space for removing the yellow workpiece. The clamping head's position can be adjusted by the red screw.



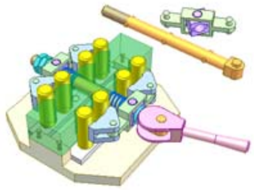
Machine tool fixture 16
http://youtu.be/_d2u8TEBMug
Use the blue screw to clamp or release the yellow worpiece.
Use the pink lever to move the pink nut for clearing space for removing the workpiece.



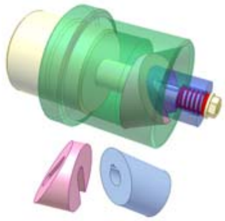
Machine tool fixture 7
http://youtu.be/L3Z5D3Ntor8
The green face cam is fixed. Push and turn the pink pin to tighten the workpiece. Turn the pink pin to release the workpiece. The cam slot and spring pushes back the pink pin quickly to clear space for removing the workpiece.



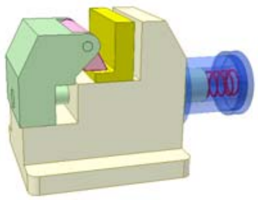
Machine tool fixture 18
http://youtu.be/HRxKJkVraLc
Multi-piece clamping.
Turn the pink lever to tighten or release the yellow cylindrical workpieces.



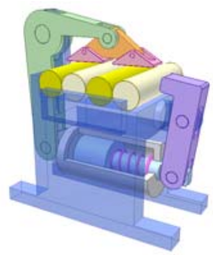
Wedge mechanism 16
http://youtu.be/oXlYX4AwXT0
Double wedge mechanism.
The green input slider and the blue output one move in opposite directions. The pink wedge moves perpendicularly to them
This mechanism can be applied for rotating clamping device.



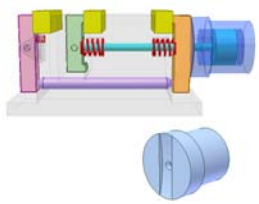
Machine tool fixture 19
http://youtu.be/0LukQCbXexY
Adding a pink bar that has a revolution joint with the green movable jaw enables clamping the workpiece from top side and left side simultaneously.
The movable jaw is fixed to the piston of a hydraulic cylinder.



Machine tool fixture 20
http://youtu.be/U9fi2DJrIZY
Floating cylinder enables clamping 4 workpieces from top side and right side simultaneously.

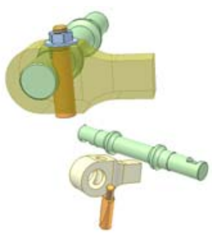


Machine tool fixture 21
http://youtu.be/fzz7-g6Qr1o
Floating cylinder enables clamping 3 workpieces simultaneously.
To clamp: Pressure fluid enters left space of the piston.
To unclamp: Pressure fluid enters right space of the piston.
Each workpiece has its vertical datum plane positioned directly to the base (to get better machining accuracy).
The orange bar has a revolution joint with the blue cylinder.



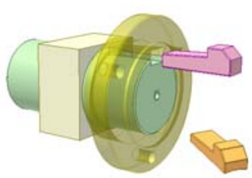
Wedge mechanism 19
http://youtu.be/pe3wTSXQa2c
Bicycle handlebar stem and fork coupling.
Wedge mechanism creates forces between the stem (yellow) and the fork (grey) and between the wedge (blue nut) and the fork to fix the stem to the fork.

Wedge mechanism 20
http://youtu.be/fO-NIQ-YFmA
Bicycle bottom axle and crank joint.
The orange cotter pin plays role of a wedge. The prestress is added by rotating the blue nut.

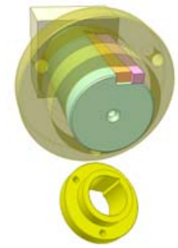


Wedge mechanism 21
http://youtu.be/Ybm4xZNfA9o
Cotter joint between two shafts. The slopes on the pink wedge and on the green shaft slot are equal. The prestress is created by collar of the green shaft.

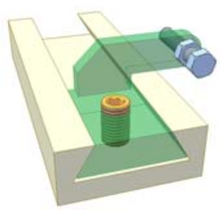
Wedge mechanism 22
http://youtu.be/6N0YcXU_0vc
Sunk taper key in strained joint.
The slopes on the pink key and on the yellow disk slot are equal.
Possible case for the taper key (in orange): no slot on the shaft and bottom surface of the taper key is cylindrical.



Wedge mechanism 23
http://youtu.be/qlPg8I8ZB1U
Tangential taper key in strained joint.
The slopes on two pink keys are equal.
If the green shaft is driving, the rotation direction must be clockwise.

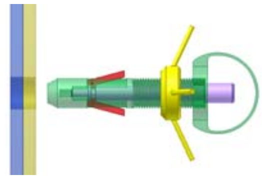


Wedge mechanism 24
http://youtu.be/tGYsP0KyO5k
Loose the screw for moving the stopper to new position and then tighten it.
The stopper is kept immobile by wedge mechnism.



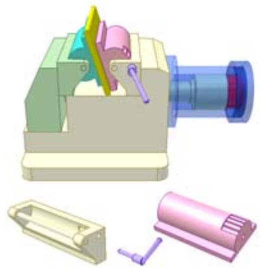
Quick changeable cam
http://youtu.be/TOi_2Xla5Xc
Move the blue sliding bush to free the cam for its change.

Fastener 1
http://youtu.be/wHIPzLIxdfI
Push the violet pin to retract the red wings.
Rotate the yellow nut to tighten the plates.
Pull the green ring to remove the fastener.
This NASA's invention is used for fasten things to a plate, back surface of which is inaccessible.

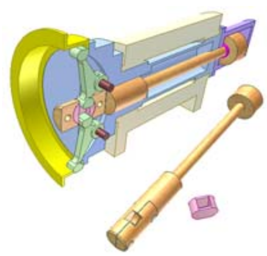


Self locking pressing device
http://youtu.be/cKJ9GfKJljg
In pressing stage the self locking occurs because the yellow slider causes a force that goes towards the blue lever pivot.
This mechanism can be used for belt tensioning: an idle pulley mounted on the pink lever is pressed towards the belt in self locking state.

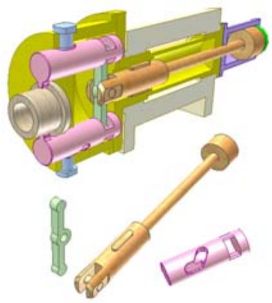
Machine tool fixture 22
http://youtu.be/9f1NolQBM94
A way for clamping a workpiece at an angle or clamping workpiece of non parallel planes.
Pink bar has revolution joint with the base. Its tilting angle is fixed by violet pin.



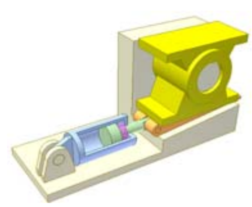
Machine tool fixture 23
http://youtu.be/YURD5Jf34EQ
Clamping a workpiece (in yellow) for lathes by a hydraulic cylinder (in violet).
In unclamping position green levers turn back and give space for mounting or removing the workpiece.
Revolution joint between pink cushion and orange piston is needed to compensate dimension error of the workpiece.
Most parts of the mechanism are cut off half for easy understanding.



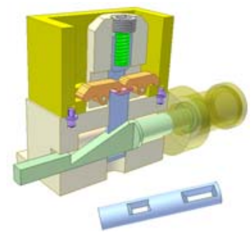
Machine tool fixture 24
http://youtu.be/UX5pEuTJGrY
Clamping a workpiece (in brown) for lathes by a hydraulic cylinder (in violet).
In unclamping position pink pins turn a little (thanks its helical groove) and give space for mounting or removing the workpiece.
Revolution joint between green arm and orange piston is needed to compensate dimension error of the workpiece.
Most parts of the mechanism are cut off half for easy understanding.



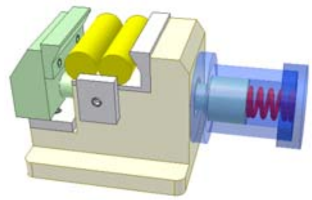
Machine tool fixture 25
http://youtu.be/ksDw--3vuhc
Clamping a workpiece (in yellow) by a hydraulic cylinder (in blue).
Orange wedge having revolution joint with green piston slides on the base. The cylinder has revolution joint with the base.



Machine tool fixture 26
http://youtu.be/OxDQFP5uAYo
Clamping a workpiece by a hydraulic cylinder through a wedge and two orange levers.
In unclamping position orange levers turn back and give space for mounting or removing the workpiece.
Revolution joint between pink cushion and blue vertical shaft is needed to compensate dimension error of the workpiece.
Most parts of the mechanism are cut off half for easy understanding.

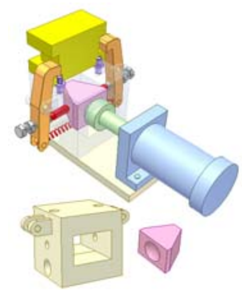


Machine tool fixture 27
http://youtu.be/p-dlg8IPLh4
Clamping two workpieces (in yellow) by a hydraulic cylinder (in blue).
Thanks to wedge-shaped plates (in green and grey) the workpieces are clamped firmly.

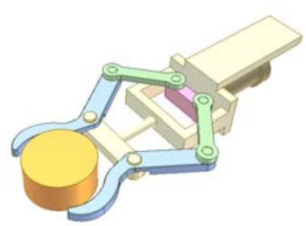


Robot gripper 1
http://youtu.be/itFsXPtNboA
A hydraulic or pneumatic cylinder via a rack and pinion mechanism opens and closes the jaws, permitting it to grasp and release objects.

Machine tool fixture 28
http://youtu.be/nwEsGuGf6wQ
Clamping a workpiece (in yellow, cut off half for easy understanding) by a hydraulic cylinder through a wedge and two orange levers. Two violet pins are for positioning the workpiece.
In unclamping position orange levers turn back and give space for mounting or removing the workpiece.
Spherical joint between the wegde and the green piston rod is needed to compensate dimension error of the workpiece.



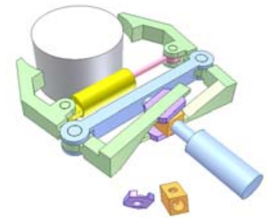
Robot gripper 2
http://youtu.be/YGIT0LtRzMw
A hydraulic or pneumatic cylinder opens and closes the jaws, permitting it to grasp and release objects.
Blue jaw, green conrod and pink slider create a slider crank mechanism.



Robot gripper 3

http://youtu.be/oCVqapAj-7s

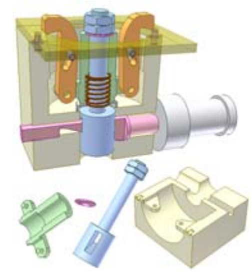
A hydraulic or pneumatic cylinder opens and closes the jaws, permitting it to grasp and release large objects.
Green jaw, violet swivel and orange slider create a tangent mechanism. There are revolution joints between violet swivels and orange slider.



Machine tool fixture 29

http://youtu.be/VPxWWgFwRQo

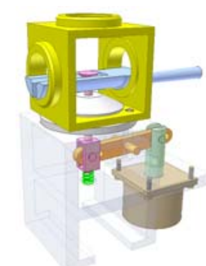
Clamping a workpiece (in yellow) by hydraulic cylinder through a wedge and two orange levers. Two vertical violet pins are for positioning the workpiece.
In unclamping position orange levers turn back (thanks to their grooves and fixed horizontal violet pins) and give space for mounting or removing the workpiece.
Pink spherical washer is needed to compensate dimension error of the workpiece.
Most parts of the mechanism are cut off half for easy understanding.



Machine tool fixture 30

http://youtu.be/xbQECJ3byeg

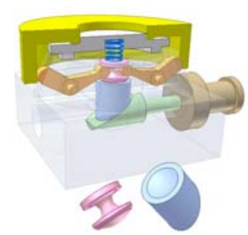
Clamping a workpiece (in yellow) by hydraulic cylinder through a orange lever, pink rod and blue detachable traverse. Violet pin is for angle positioning the workpiece.
Spherical portion on the pink rod is needed to compensate dimension error of the workpiece.



Machine tool fixture 31

http://youtu.be/QtFkUqAtxr0

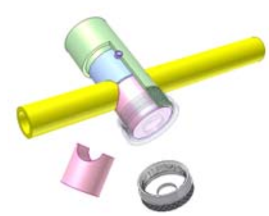
Clamping a workpiece (in yellow) by hydraulic cylinder through a blue wedge and orange levers.
Spherical portions on the pink cushion and the blue wedge are needed to compensate dimension error of the workpiece.
The workpiece and the grey positioning disk are cut off half for easy understanding.



Fastener 2

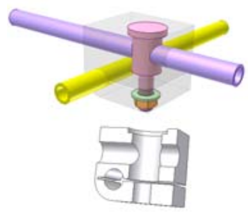
http://youtu.be/6dSCQNG35Nc

Green tube and blue fixed jaw are fixed together.
Tight or release grey nut for clamping or repositioning yellow tube.
The green tube is cut off for easy understanding.

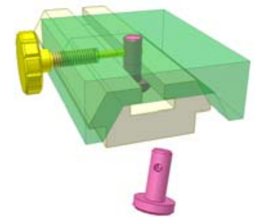


Fastener 3
http://youtu.be/ypf7OvwAJ8I
Tight or release orange nut for clamping or repositioning green bar.

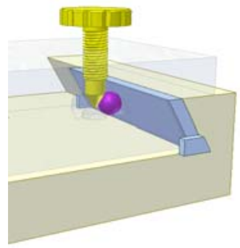
Fastener 4
http://youtu.be/abj9X8kSYP0
Tight or release orange nut for clamping or repositioning violet and yellow tubes simultaneously.
The yellow tube is released thanks to the flexibility of the white support.
The part below the mechanism is the support, which is cut off half.



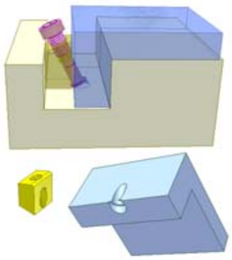
Slider clamp 1
http://youtu.be/uEAekWR-CsY
Turn yellow screw for clamping or releasing green slider. Cone portion of the screw raises pink stud for clamping.



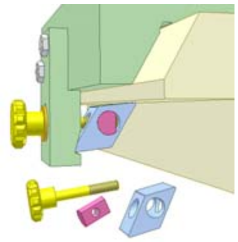
Slider clamp 2
http://youtu.be/NI45sSsPk_s
Turn yellow screw clockwise for clamping or counterclockwise for releasing the transparent slider.
Vertical hole of the slider is tapped. Horizontal hole of the slider contains violet ball that contacts with blue bar of a dovetail runway.



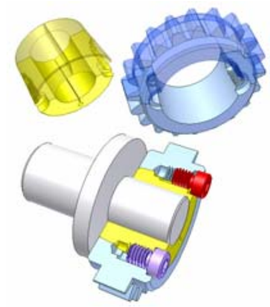
Slider clamp 3
http://youtu.be/Vo7-f7tCh4M
Turn pink screw clockwise for clamping or counterclockwise for releasing the blue slider.
Lower spherical head of the screw contacts with the runway. However its contact with the slider is possible for an embodiment of this mechanism. Axial displacement of the screw is restricted.



Slider clamp 4
http://youtu.be/dx_jKVq0gCo
Turn yellow screw for clamping or releasing green slider.
Blue clamp has revolution joint with the green bracket.
Yellow screw, pink nut and blue clamp create a sine mechanism.

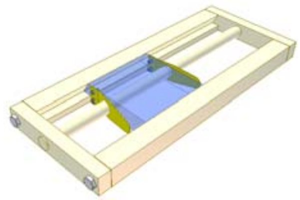


Fastener 5
http://youtu.be/8MnLVIU4Vuo



A way to fix a gear on a shaft thanks to a flexible split bush and two screws.
The bush has a tapered outer diameter.
The gear has a tapered inner diameter.
Only one hole among the two holes in the bush or in the gear is tapped.
Split tapped hole in the bush align with split un-tapped hole in the gear and vice versa.
Violet screw is for releasing the gear.
Red screw is for tighting the gear.
Use two symmetrical violet screws and two symmetrical red screws to avoid eccentric clamping and releasing forces.
This mechanism is used when the angular adjustment between gear and shaft is needed.

Slider clamp 5
http://youtu.be/tFh3CFgFBZQ



Press or release yellow flat springs for repositioning or clamping blue slider.
When pressing, the spring holes are coaxial with the popcorn shaft and the springs do not brake the slider.
When releasing, the spring holes contact the popcorn shaft and friction forces created do not allow the slider moving in both directions.
Motion to the left is prevented by the right spring and vice versa.

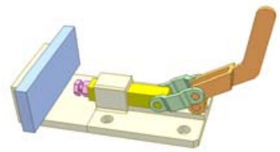
Table clamp
http://youtu.be/uzqd1rKp5qQ

Raise the pink latch to prevent its contact with the yellow table post for moving up down the table.
When releasing the latch, it turns down and comes into contact with the table post. Friction between them stops the table falling. There must be an adequate gap in sliding joint between the latch and the table post.
It is said that the table can support 350 kg.

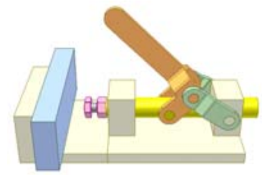
Toggle clamp 1a
http://youtu.be/dA_j05ut0FE

Toogle clamp using slider-crank mechanism.
Orange lever: crank. Green link: connecting rod. Yellow plate: slider.
The green link and the orange crank come into toggle by lining up on top of each other to hold the yellow plate firmly.
Red arrow represents resisting force.
The clamping force is applied to the crank.

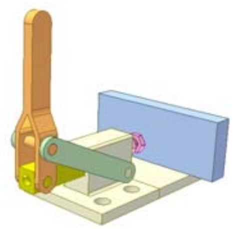
Toggle clamp 1b
http://youtu.be/lpjHsMKISB0
Toogle clamp using slider-crank mechanism.
Green conrod and orange crank come into toggle by an extension of each other.
The clamping force is applied to the crank.



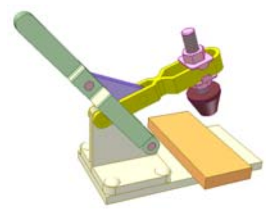
Toggle clamp 1c
http://youtu.be/Pjdb0CAj4Bc
Toogle clamp using slider-crank mechanism.
Green bar and orange conrod come into toggle by an extension of each other.
The clamping force is applied to the conrod.



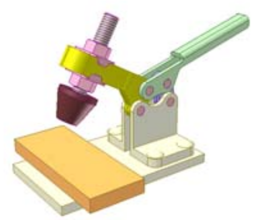
Toggle clamp 1d
http://youtu.be/cv8sqEfxCSs
Toogle clamp using slider-crank mechanism.
Green bar and orange conrod come into toggle by lining up on top of each other.
The clamping force is applied to the conrod.



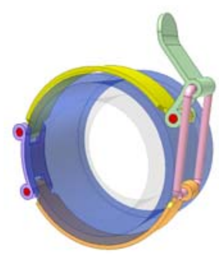
Toggle clamp 2a
http://youtu.be/Nmp_U-tkoH8
Toogle clamp using four bar linkage.
Green lever and violet conrod come into toggle by lining up on top of each other.
The clamping force is applied to the lever.



Toggle clamp 2b
http://youtu.be/lrL2_5tj1IE
Toogle clamp using four bar linkage.
Green conrod and violet lever come into toggle by an extension of each other.
The clamping force is applied to the conrod.



Toggle clamp 2c
http://youtu.be/k9tMxQfo2zo
Toogle clamp using four bar linkage.
Green conrod and pink lever come into toggle by lining up on top of each other.
The clamping force is applied to the conrod.



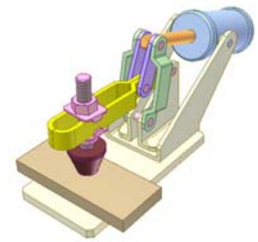
Toggle clamp 2d

http://youtu.be/ZtiW90wThO4

Toogle clamp using four bar linkage.

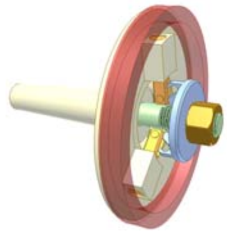
Violet conrod and green lever come into toggle by lining up on top of each other.

The clamping force of an air cylinder is applied to revolution joint between the violet conrod and the green lever.



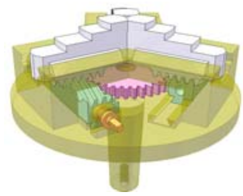
22.2. Self-centering mechanisms

Self-centering chuck for lathes
http://www.youtube.com/watch?v=QerPu2BaUNA
A combination of translation cam and nut-screw clamping.
The red ring is a workpiece.
The input nut is rotated and translated.
The screw is fixed.

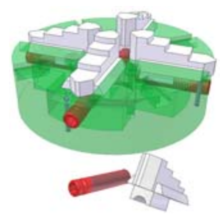


Three-jaw self-centering chuck 1
http://youtu.be/0ERIZeZhckw
Combination of bevel gear drive and spiral rack (scroll gear) mechanism.
Turn any one of the three blue bevel pinions for moving the jaws.

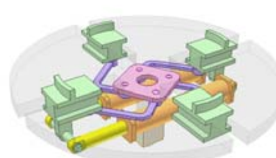
Three-jaw self-centering chuck 2
http://youtu.be/lPAfyZ5jCuA
Combination of screw-nut, gear-rack and rack-rack mechanisms.
Turn the sole orange screw for moving the jaws.



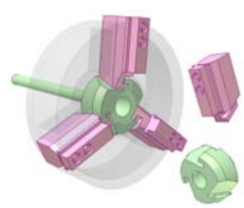
Four-jaw independent chuck 1
http://youtu.be/U_U0Cxrd_KE
Turn each red screw for moving the corresponsive jaw.



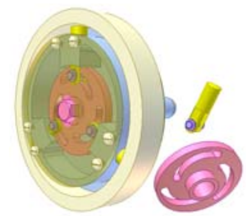
Four-jaw self-centering chuck 1
http://youtu.be/SEgw6hcujwk
An application of crank slider mechanism.
The pistons are connected to a green slider and the cylinders to opposite one. The cylinders can be connected to the rotary table in order to reduce pistons' displacement.
This chuck is used in tire mounting equipments.



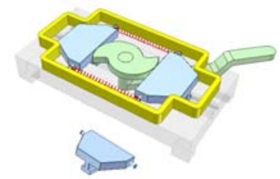
Three-jaw self-centering chuck 3
http://youtu.be/xUUeWQoY4CI
An application of the wedge mechanism.
The green rod is connected to a pneumatic cylinder (not shown) to get reciprocating motion.



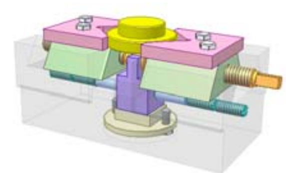
Three-jaw self-centering chuck 4
http://youtu.be/zzcj0-C6Njo
Turn the pink cam of three eccentric slots for clamping or releasing the popcorn workpiece. This chuck should be used only for operation of light cutting force.



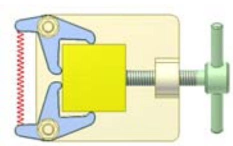
Self-centering fixture 1a
http://youtu.be/VQLBovXF9Uw
The green double eccentrics and two blue wedge-sliders center the yellow workpiece along transversal and longitudinal direction.



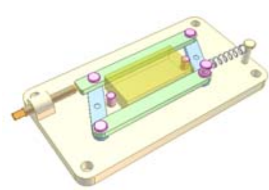
Self-centering fixture 1b
http://youtu.be/0kFUfX1m5aI
The orange screw having threads of right and left hand move the V blocks to center the yellow workpiece along transversal and longitudinal direction.
The blue pins anf screws (in lower part of the base) are used for adjusting the center position along longitudinal direction.



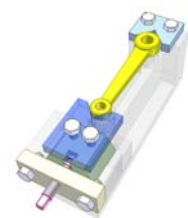
Self-centering fixture 2b
http://youtu.be/8UrBjWE96vc
Two symmetric V-shaped levers center the yellow workpiece along longitudinal direction.



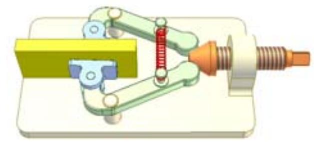
Self-centering fixture 2c
http://youtu.be/GzweOeQAiqM
The green connecting rods of a parrallelogram mechanism center the yellow workpiece along longitudinal direction.



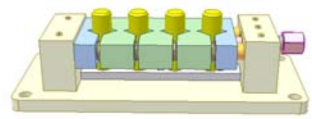
Self-centering fixture 2d
http://youtu.be/FpdSiDXOOCA
The V blocks (one is fixed, the other is movable) center the yellow workpiece along longitudinal direction.



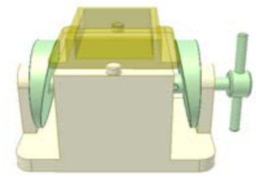
Translating cam mechanism 5
http://youtu.be/w8Hk3E5gfj0
Device for clamping workpiece (in yellow).
Wedge is the orange screw of cone head that has helical motion.



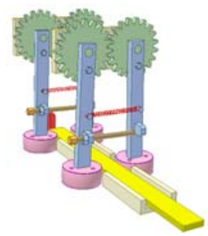
Self-centering fixture 4a
http://youtu.be/Oa5_0RAEbC0
Multi-piece clamping.
The V-blocks center the yellow worpieces along longitudinal direction. There are compression springs between the V-blocks.



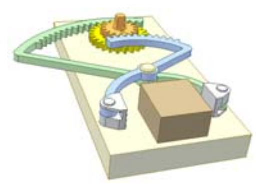
Self-centering fixture 2a
http://youtu.be/4tM1zNKiQPI
Two symmetric face cams center the yellow workpiece along longitudinal direction.



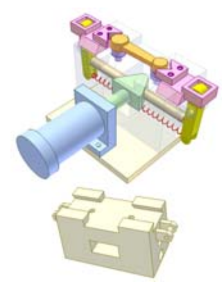
Self-centering fixture 3a
http://youtu.be/GF1Lw16lwco
The yellow running workpiece is centered along longitudinal direction when contacting with all the two pink roller couples. The fixture is used in a bamboo slitting machine. The red knife is stationary.



Self-centering fixture 4
http://youtu.be/lT49olsv-EU
Turn the block of orange and yellow gears to clamp brown work.
Two grey pads center the work along its longitudinal direction.
Condition for centering:
R1/R3 = R2/R4
(angle speeds of blue and green gears are equal)
Relation of gear pitch radia:
R4 = R1 + R2 + R3
R1, R2, R3 and R4 are pitch radius of the orange, yellow, blue and green gear respectively.



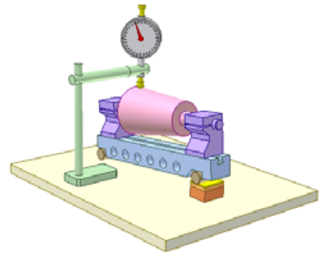
Self-centering fixture 5
http://youtu.be/L0BbQPfpMd0
Clamping a workpiece (in orange) by hydraulic cylinder through green wedge on the piston, two pins and two yellow levers.
Pink V blocks center the workpiece along its longitudinal direction.



23. Measurement and quality control

Male taper measurer 1

http://youtu.be/dduZx61R-eg



The taper to be measured is in pink color. It is mounted between two centres that are installed on a blue sine bar of two brown rollers. The rollers are always fixed to the bar.
Use slip gauge combination to make the highest generatrix of the taper parallel to the surface plate. The parallelism is checked by a dial indicator. Then

$\sin\alpha = H/L$

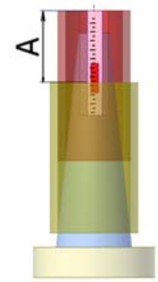
α: haft taper angle

H: thickness of the slip gauge combination

L: center distance of the sine bar rollers

Male taper measurer 2

http://youtu.be/AOTUgFgU2U0



The taper to be measured is in blue color.
Let the yellow and red tubes contact with the taper to get A dimension (distance between two faces).

$\tan\alpha = ((D2-D1)/(A+L2-L1))2$

α: haft taper angle

D2 and L2: inner diameter and length of the yellow tube

D1 and L1: inner diameter and length of the red tube

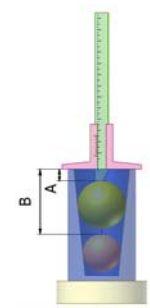
If L2 = L1 then

$\tan\alpha = ((D2-D1)/A)2$

In case of go-no and go control the red area on the scale of the red tube should be used. It is determined according to the tolerance of taper angle α.
This measurement is faster but less precise than other known methods (using sine bar)

Female taper measurer 1

http://youtu.be/QiDu1k-6HUs



The taper to be measured is in blue color.
Use a depth gauge to get A and B dimensions

$\sin\alpha = (R-r)/((B-A)/(R-r))$

α: haft taper angle

R: radius of the large ball

r: radius of the small ball

Female taper measurer 2

http://youtu.be/SvmRPrN7Zd4

The taper to be measured is in blue color.
Let the yellow and orange tubes contact with the taper to get A dimension (distance between two faces).

$\tan\alpha = ((D2-D1)/(L1-L2-A))/2$

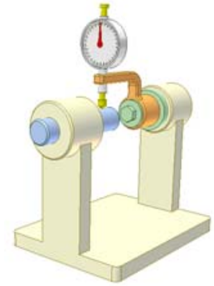
α: haft taper angle

D2 and L2: outer diameter and length of the yellow tube

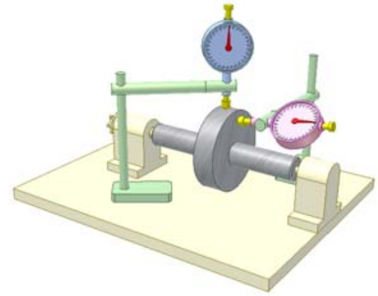
D1 and L1: outer diameter and length of the orange tube

In case of go-no and go control the red area on the scale of the orange tube should be used. It is determined according to the tolerance of taper angle α.
This measurement is faster but less precise than other known method (using balls)

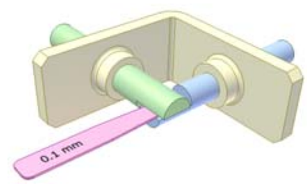
Checking coaxiality between two holes
http://youtu.be/DkmLCIVo-1Y
Two holes of the popcorn base is checked for coaxiality.
A blue shaft, a green shaft, an orange arm and a dial indicator are used.
Ensure no gap between shafts and holes.
Error in coaxiality is P = (E1-E2)/2
E1 and E2 are max and min values shown by the indicator during one revolution.



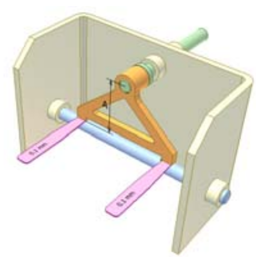
Checking eccentricity and face perpendicularity of a shaft
http://youtu.be/1JNCe9fwRUw
The blue indicator shows the eccentricity of the large cylindrical surface to the shaft centerline E = (E1 – E2)/2.
E1 and E2 are max and min values shown by the indicator.
The pink indicator shows the error in perpendicularity of the large face to the shaft centerline P = (E1-E2)/2A.
E1 and E2 are max and min values shown by the indicator.
A: distance between measuring point and the shaft centerline.



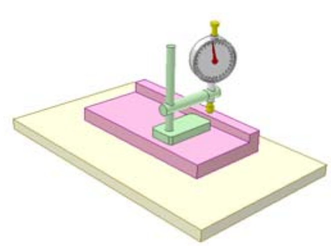
Checking intersection of two holes centerlines
http://youtu.be/7WBpFGT1ISo
Ensure no gap between shafts and holes.
The flat portion of each shaft must contain shaft centerline. Insert a feeler gauge (as thick as possible) into the gap between the shaft flat portions to get the error in intersection (feeler gauge thickness). Turn the shafts 180 deg. if no gap appears.



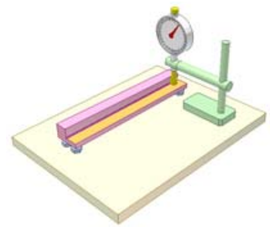
Measuring distance between 90 deg. skew holes
http://youtu.be/bLfvIWIZZBc
Ensure no gap between shafts and holes.
A is distance between the flat portions and the centerline of the orange part. It is determined according to allowed smallest value of the distance to be measured.
Insert two feeler gauges (of equal thickness and as thick as possible) into both gaps between the blue shaft and the flat portions of the orange part to get the value B (feeler gauge thickness).
Measuring result: D = A + B



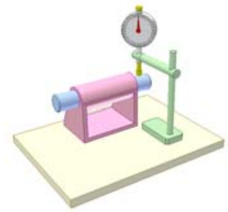
Checking parallelism between two planes 1
http://youtu.be/TYUZZ99Un1w
One plane is large enough for laying the indicator base.
Move the indicator set longitudinally to get values E1 and E2 at two points, distance between which is A.
Non-parallelism P = (E1-E2)/A
Using height gauge gives less accurate result.



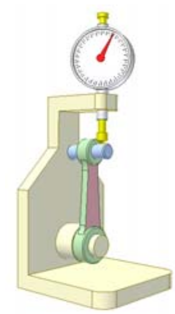
Checking parallelism between two planes 2
http://youtu.be/YedyhVrmThk
The planes are small so the indicator base can not be laid on one of them.
Make the orange plane paralell to the surface plate using the blue jack pins. Check the parallelism by the indicator, base of which moves on the surface plate.
Then check the parallelism of the pink plane to the orange one through its parallelism to the surface plate.



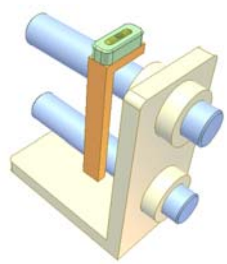
Checking parallelism between hole and bottom
http://youtu.be/OfmDN3FuWRs
Insert a shaft into the hole to be checked.
Ensure no gap between shaft and hole.
Non-parallelism P = (E1-E2)/A
E1 and E2 are extremal values shown by the indicator at two measuring positions distance of which is A.



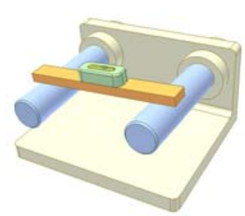
Checking parallelism between two holes
http://youtu.be/eEGu7azvNow
Insert a shaft into one hole of the green object.
Ensure no gap between shaft and hole.
Get the highest value E1 of the shaft at the measuring position.
Turn the object 180 deg.
Get the highest value E2 of the shaft at the measuring position.
Non-parallelism P = (E1-E2)/(A-B/2)
A: distance from indicator centerline to the positioning face of the basic axle.
B: length of the lower hole of the object.



Checking parallelism in horizontal plane between two holes
http://youtu.be/HONVeJB7Rsk
Insert two shafts into the holes to be checked. Ensure no gaps between shafts and holes.
Move the orange square of a spirit level along the shafts while keeping continuous contact between the shafts and the square.
The spirit level shows the error in parallelism between two holes in horizontal plane (not in vertical one).

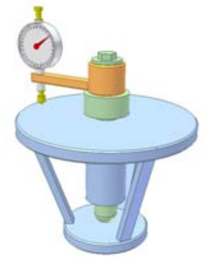


Checking parallelism in vertical plane between two holes
http://youtu.be/svSkqNaTHBE
Insert two shafts into the holes to be checked. Ensure no gaps between shafts and holes. Move the orange bar of a spirit level along the shafts.
The spirit level shows the error in parallelism between two holes in vertical plane (not in horizontal one).
Another way for checking (without the orange bar):
Put the spirit level directly on each blue shaft (along its length) and compare two values shown by the spirit level.



Checking perpendicularity between hole and face

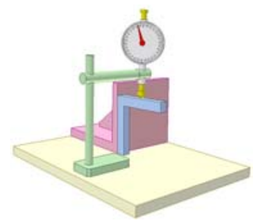
http://youtu.be/BEumouFrAj4



The top face the blue object is checked for perpendicularity to its hole. Ensure no gap between shafts and holes.
Error in perpendicularity is
P = (E1-E2)/A
E1 and E2 are max and min values shown by the indicator during one revolution
A: center distance of two holes of the orange crank.

Checking perpendicularity between two surfaces

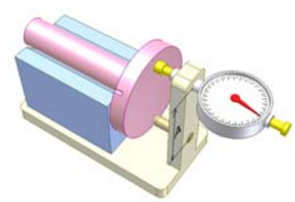
http://youtu.be/ZRvdzfM9lSo



Bottom surface and vertical one of the pink object is checked for perpendicularity.
Use a blue square that is pressed against the vertical surface of the object, thus perpendicularity checking is turned into parallelism one.

Checking perpendicularity between face and centerline of a shaft 1

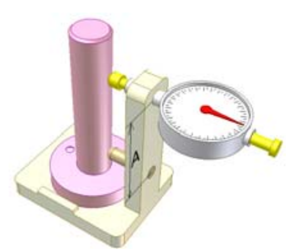
http://youtu.be/R7u0Af9dsIA



Turn the shaft several revolutions on the blue V-block while keeping a continuous contact between the shaft face and the brown pin (for example by setting the base inclined).
Get max and min values (E1 and E2) shown by the indicator.
Non-perpendicularity P = (E1-E2)/2A
A: center distance of indicator and the brown pin.

Checking perpendicularity between face and centerline of a shaft 2

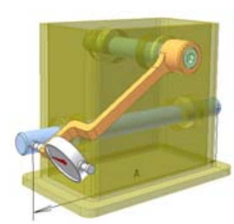
http://youtu.be/ZUurxNlb8r0



The face to be checked is the pink shaft bottom.
Turn the shaft several revolutions while keeping a continuous contact between the shaft and the brown pin (for example by setting the base inclined). Get max and min values (E1 and E2) shown by the indicator.
Non-perpendicularity P = (E1-E2)/2A
A: center distance of indicator and the brown pin.

Checking perpendicularity between 90 deg. skew holes

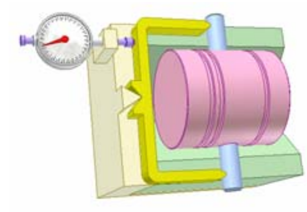
http://youtu.be/VKfFRS0H3Wc



Ensure no gap between shafts and holes and keep the shafts immobile. Get values E1 and E2 shown by the indicator at two positions, distance between which is A.
Non-perpendicularity P = (E1-E2)/A
With little modification this method can be applied for checking perpendicularity between 90 deg. intersecting holes centerlines.

Checking perpendicularity between shaft and its hole 1

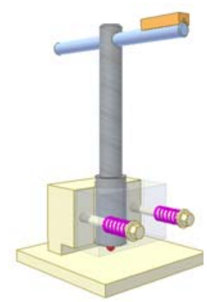
http://youtu.be/3TwxF7t4-_U



A blue shaft is inserted into the gudgeon pin hole. Ensure no gap there. Move the piston untill contact with both edges of the yellow arm to get value E1 shown by the indicator.
Turn the piston 180 deg. and do the same for value E2.
Error in perpendicularity is P = (E1-E2)/2A
A is center distance between the indicator and pivoting axle of the yellow arm.

Checking perpendicularity between shaft and its hole 2

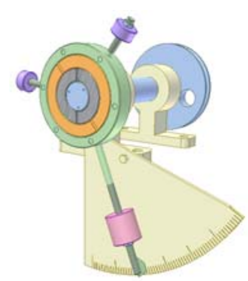
http://youtu.be/yr-MTaKDuis



A blue round bar is inserted into the hole of of the grey shaft.
Ensure no gap there.
V-block and the shaft are arranged vertically.
Small error in verticality does not affect the checking result.
The shaft always contacts V-block thanks to two pink springs.
There is a red ball at the shaft bottom.
Checking steps:
1. Put a bubble level (in orange) on the bar to get angle between bar axis and horizontal direction E1.
2. Turn the product 180 degrees.
3. Put the bubble level on the bar to get angle between bar axis and horizontal direction E2.
Error in perpendicularity P:
If the level's bubble moves in opposite directions for the two attempts:
P = (E1+E2)/2
If the level's bubble moves in the same direction (it may happen when the shaft is not absolutely vertical):
P = (E1-E2)/2
Here the error in perpendicularity P is understood as an angular error:
P = (B – 90) deg.
B is real angle between shaft axis and hole axis.
This method has advantage for checking bulky products.

Friction torque measuring

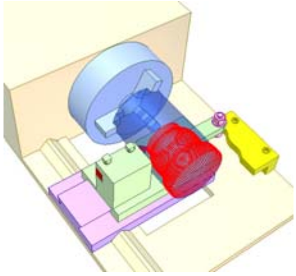
http://www.youtube.com/watch?v=QQfhv9AuYuM



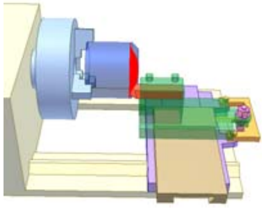
A simple method to measure friction torque M generated in revolution joint of the grey inner ring and the orange outer one. The grey ring is fixed on the blue shaft, the orange ring is fixed on the green hand assembly.
M = PLsinα
P: weight of the pink weight
L: distance from the pink weight to the rotation axis
α: angle shown by the green hand
Force applied to the revolution joint is the weight of the hand assembly including the pink weight.
The hand assembly (without the pink weight) must be adjusted with the violet nuts to be in static balance.

24. Mechanisms for copying

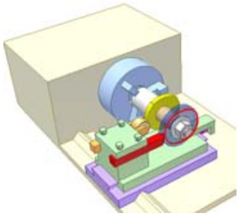
Copying device on lathe 1
http://youtu.be/kR-dbUTMNuU
The violet carriage is power-fed along the axis of rotation of the blue workpiece. The green slider carrying pink roller is forced by a spring (between violet and green sliders, not shown) towards the yellow template.
The tool traces a curve that corresponds to the template profile.



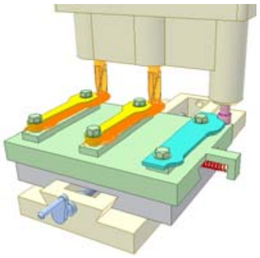
Copying device on lathe 2
http://youtu.be/DOd6PZm0iQY
The brown cross slide is power-fed square to the axis of rotation of the blue workpiece. The green upper slide carrying pink roller is forced by yellow spring towards the orange template.
The tool traces a curve that corresponds to the template profile.



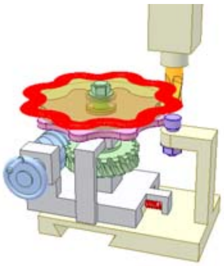
Copying device on lathe 3
http://youtu.be/5jUZNPiLxNc
The violet carriage is power-fed along the axis of rotation of the blue workpiece. The green slider carrying pink roller and red tool is forced by a pink spring towards the yellow template.
The tool traces a curve that corresponds to the template profile.



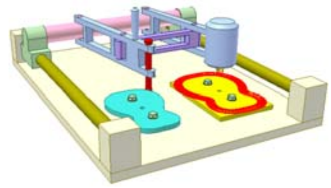
Copying device on vertical milling machine 1
http://youtu.be/4xFMKC-NgBE
Grey table moves in cross direction by a screw drive. Green upper table moves longitudinally by the contact between cyan template and pink immobile tracer. Red spring forces the template towards the tracer. Yellow works are fixed to the upper table.
Orange cutters create surface on the yellow works corresponding to the template profile.
The tracer and the cutter diameters must be equal if profiles of the template and the work are requested to be the same.



Copying device on vertical milling machine 2
http://youtu.be/lLognO-dzOE
Grey slider carries a worm drive (rotary table in practice). Pink template and yellow work are fixed to worm wheel shaft of the drive. The template contacts violet stationary pin under pressure of red spring and makes the slider move longitudinally when the blue worm is rotated by hand. Orange cutter creates a surface on the yellow work corresponding to profile of the template.
The pin and the cutter must be coaxial and their diameters must be equal if profiles of the template and the work are requested to be the same.

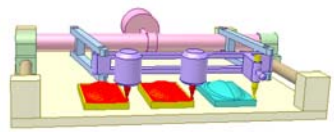


Wood 2D copy milling machine 1
http://youtu.be/WJeliwU6OzU



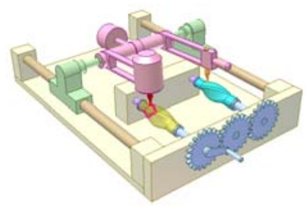
A parallelogram mechanism of violet conrod and two blue cranks can slide on two yellow rods.
Red tracer is on one crank, orange cutter is on the other. Their distances to pink bar pivots are equal (the tracer and cutter can be on the violet conrod also)
Move (by hand) the tracer along profile of fixed cyan template, the cutter creates a surface on fixed yellow work corresponding to the profile of the template.
The tracer and the cutter are kept perpendicular to the ground.
The tracer and the cutter diameters must be equal if profiles of the template and the work are requested to be the same.

Wood 3D copy milling machine 1
http://youtu.be/TzBM9iJa5mM



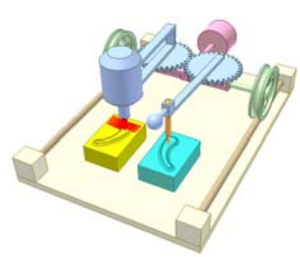
A parallelogram mechanism of violet conrod and two blue cranks can slide on two brown rods. The pink tube can pivot around the axle that connects green sliders.
Yellow stylus and red spherical milling cutters are on the violet conrod.
Move (by hand) the stylus on upper surface of cyan model, the cutters create corresponding surfaces on yellow works.
The stylus and the cutter diameters must be equal to get cut surfaces and model one identical.

Wood 3D copy milling machine 2
http://youtu.be/dxN5TNR_4WY



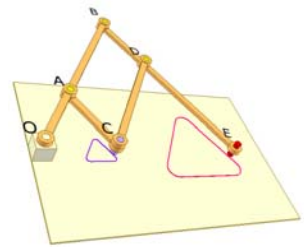
Pink double crank carrying orange stylus and red spherical milling cutter can pivot on axle of green double slider that can move along two brown rods.
Move (by hand) the stylus along the cyan model and turn (by hand) blue gear crank, the cutter create 3D surface on yellow work corresponding to the model surface.
Distances from the stylus and the cutter to base plan must be equal and their spherical diameters must be equal to get cut surface and model one identical.
Practice:
http://www.youtube.com/watch?v=dskTOImPJ0o

Wood 3D copy milling machine 3
http://youtu.be/x4zuhNgtR5I

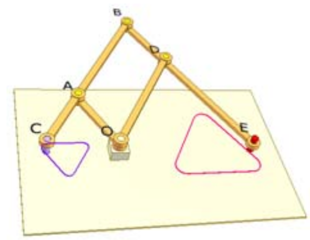


Pink tube can pivot on axle of green wheels that can roll along two brown rods.
The pink tube carries a drive of two identical gears. Motor with red spherical milling cutter is on one gear, orange stylus is on the other.
Move (by hand) the stylus on upper surface of cyan model, the cutter creates on yellow work a corresponding symmetrical surface.
Distances from the stylus and the cutter to base plan must be equal and their spherical diameters must be equal to get cut surface and model one identical (symmetrically).

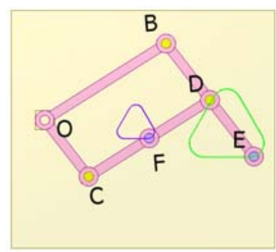
Bar pantograph 1
http://youtu.be/9H5hSLaRPTQ
ABCD: parallelogram.
OCE: straight line
O: immobile
OE/OC = BE/BD = k = constant
Figures traced by pen E and pen C are similar. Scale factor is k.



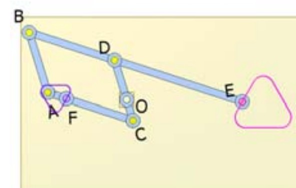
Bar pantograph 2
http://youtu.be/p8SDBkLV4mg
OABD: parallelogram.
COE: straight line
O: immobile
OE/OC = DE/BD = k = constant
Figures traced by pen E and pen C are similar but upside down each other when O is between C and E. Scale factor is k.



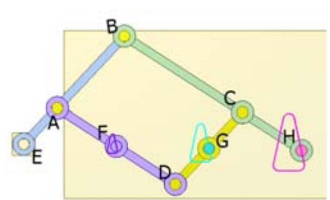
Bar pantograph 3
http://youtu.be/-Y8IyDkJpL0
OBCD: parallelogram.
OFE: straight line
O: immobile
OE/OF = BE/BD = k = constant
Point O or F do not necessarily coincide with an vertex of the parallelogram.
Figures traced by pen E and pen C are similar. Scale factor is k.



Bar pantograph 4
http://youtu.be/kjlwFXx2GI4
ABDC: parallelogram.
FOE: straight line
O: immobile
OE/OF =OD/OC = k = constant
Point O or F do not necessarily coincide with an vertex of the parallelogram.
Figures traced by E and F are similar but upside down each other when O is between F and E. Scale factor is k.

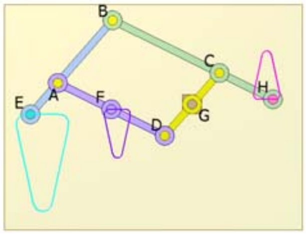


Bar pantograph 5a
http://youtu.be/oAhVbY0CBAk
ABDC: parallelogram.
EFGH: straight line
E: immobile
Point E, F, G and H do not necessarily coincide with vertices of the parallelogram.
Figures traced by pens F, G and H are similar.



Bar pantograph 5b

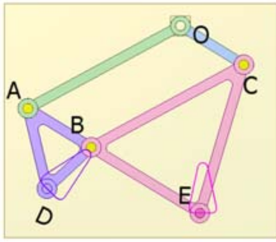
http://youtu.be/N0grDs9phHg



ABDC: parallelogram.
EFGH: straight line
G: immobile
Point E, F, G and H do not necessarily coincide with vertices of the parallelogram.
Figures traced by pens E, F and H are similar.

Bar pantograph 6

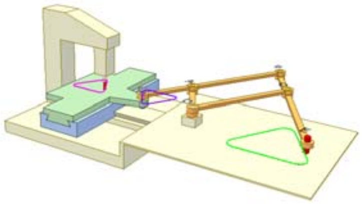
http://youtu.be/pGTyCtDIqBU



OABC: parallelogram.
Triangles ADB and CBE are similar.
Triangles DAO, DBE and OCE are similar.
Triangles ODE and ABD are similar.
O: immobile
Figures traced by pen E and pen D are similar but figure D is turned an angle DAB in comparison with figure E.
Scale factor is k = AD/AB = CB/CE = constant.

Bar pantograph 7a

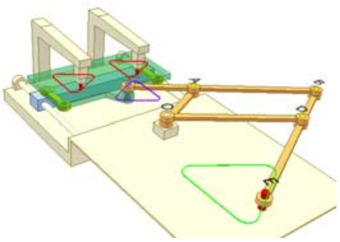
http://youtu.be/ZHWPj2dmMA8



ABCD: parallelogram
OCE: straight line
O: immobile
OE/OC = BE/BD = k = constant
Figures traced by pointer E and pin C are similar. Scale factor is k.
This is the case when the red tool is immobile (not installed in place of pin C) and the orange pantograph is connected to a system of two sliders (by pin C and a hole of the green plate). The tool traces pink figure on the upper slider. It has same size with the figure traced by pin C but upside down each other.
Instead of system of two sliders an other one can be used, provided that it enables the green plate to move translationally.
Several workpieces can be machined at the same time when many tool spindles are arranged.

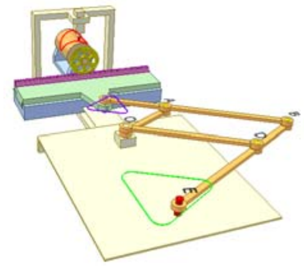
Bar pantograph 7b

http://youtu.be/E2t-rz36CcM



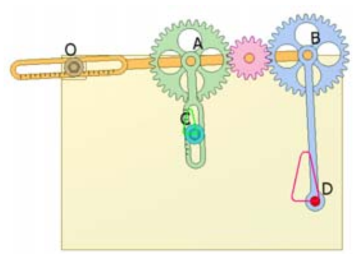
ABCD: parallelogram
OCE: straight line
O: immobile
OE/OC = BE/BD = k = constant
Figures traced by pointer E and pin C are similar.
Scale factor is k.
This is the case when the red tools are immobile (not installed in place of pin C) and the orange pantograph is connected to system of slider and parallelogram (by pin C and a hole of the green plate). The system enables the green plate to move translationally.
Red tools trace red figures on the green plate. They have same size with the figure traced by pin C but upside down.
Two workpieces are machined at the same time.

Bar pantograph 8
http://youtu.be/3h3NMbycOkk



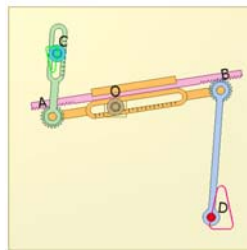
ABCD: parallelogram
OCE: straight line
O: immobile
OE/OC = BE/BD = k = constant
Figures traced by pointer E and pin C are similar.
Scale factor is k.
This is the case when red tool is immobile (not installed in place of pin C) and the orange pantograph is connected to system of two sliders (by pin C and a hole of the green plate).
A rack-pinion drive turns orange cylinder installed on the blue lower slider. Pitch diameter of the pinion and diameter of the cylinder are equal.
The tool traces red figure (having same size with the figure traced by pin C) on cylindrical surface of the cylinder.
Meshing place of the rack-pinion drive (at upper or lower portion of the pinion) affects direction of the figure traced on the cylinder.

Gear pantograph 1
http://youtu.be/slQuUX2kgxo

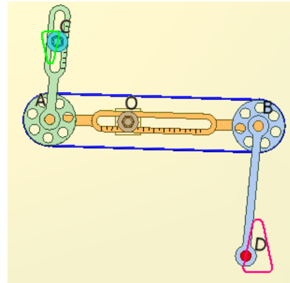


Green and blue gears have same tooth number.
OCD: straight line
AC and BD are parallel.
Triangles OAC and OBD are similar.
OC/OD = OA/OB = AC/BD = k = constant
O: immobile
Figures traced by pen E and pen C are similar. Scale factor is k.
Adjust OA and AC to get various values of k.
Bar linkage in a conventional pantograph is replaced by gear drive.
Instead of 3 gear drive a rack and two pinion drive can be used.

Gear pantograph 2
http://youtu.be/tVe5YADt4KE



Green and blue gears have same tooth number.
COD: straight line
AC and BD are parallel.
Triangles OAC and OBD are similar.
O: immobile
OC/OD = OA/OB = AC/BD = k = constant
Figures traced by pen D and pen C are similar but upside down each other. Scale factor is k.
Adjust OA and AC to get various values of k.
Bar linkage in a conventional pantograph is replaced by rack pinion drive.



Belt pantograph 1

http://youtu.be/_5G4Qb3VeUA

Green and blue pulleys have same diameter.

COD: straight line

AC and BD are parallel.

Triangles OAC and OBD are similar.

O: immobile

OC/OD = OA/OB = AC/BD = k = constant

Figures traced by pen D and pen C are similar but upside down each other. Scale factor is k.

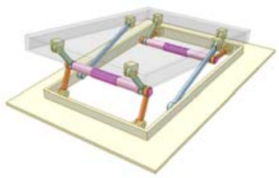
Adjust OA and AC to get various values of k.

Bar linkage in a conventional pantograph is replaced by belt drive.

25. Mechanisms for opening and closing entrances

Car roof window

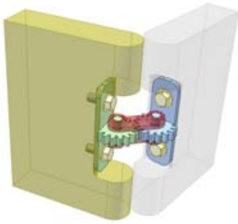
http://youtu.be/Url8JhauPYA



This mechanism (group of 4 bars and 6 revolution joints + two cranks) has 2 degrees of independence.
Use two pink grips to open the window to the desired direction.
Measure to create friction in the joints is needed for holding the window at adjusted position.

Hinge enabling 360 degree rotation 1

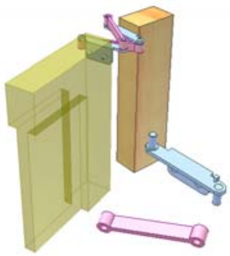
http://www.youtube.com/watch?v=pl8tq3Z76is



Ordinary hinges can not rotate 360 degrees because of thickness of moving and grounded parts. The proposed design does not have that limitation. A satellite gear drive is applied here.

Hinge enabling 360 deg. rotation 2

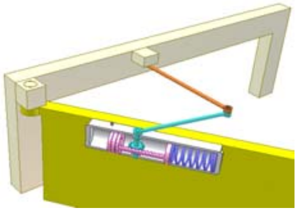
http://youtu.be/gItkHi0Rink



Ordinary hinges can not rotate 360 degrees because of thickness of moving and grounded parts. The proposed design does not have such limitation.
An anti-parallelogram mechanism is used here.
Lengths of blue and pink parts are 80 and 95 respectively.
There is a stopper on the blue part to prevent death positions so the rotation angle is a little less than 360 deg.
STEP files of this video are available at:
http://www.mediafire.com/download/9t6a7uvkrwi5b8q/360dHinge2STEP.zip

Door closer 1

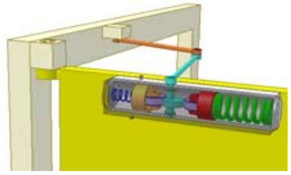
http://youtu.be/vBDIDc9MmI4



The cyan arm is connected to cyan gear that engages with pink rack-piston. At one end of the rack-piston is violet spring that accumulates energy during door opening and releases it during closing.
The spaces around the rack-piston contain oil. There are oil ways connecting the oil spaces including adjustment valves that regulate opening and closing speeds.
As the door swings closed, connecting link (in orange) comes into toogle with the cyan arm, giving it a large angular velocity, which helps the oil damping be more effective in retarding motion near the closed position.

Door closer 2

http://youtu.be/ppgPrFq6WXw



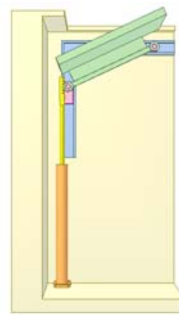
The cyan arm is connected to a cam (eccentric circle profile) that contacts with rollers of two pistons. The red piston has green spring that accumulates energy during door opening (the spring length is reduced) and releases it during closing. The orange piston has a blue spring that ensures its permanent contact with the cam. The cam must be arranged in such a way as to avoid self-locking during closing.

The spaces around the pistons contain oil. There are oil ways connecting the oil spaces including adjustment valves that regulate opening and closing speeds.

As the door swings closed, connecting link (in orange) comes into toogle with the cyan arm, giving it a large angular velocity, which helps the oil damping be more effective in retarding motion near the closed position.

Cover for basement entrance 1a

http://youtu.be/KHyIXFYPtfA



Green cover is a connecting rod of an ellipse mechanism of two pink sliders. Driving force from fixed cylinder is applied to the connecting rod via a pinion rack drive (instead of to pink lower slider) ensures smooth motion of the mechanism even at death position when the connection rod is vertical.

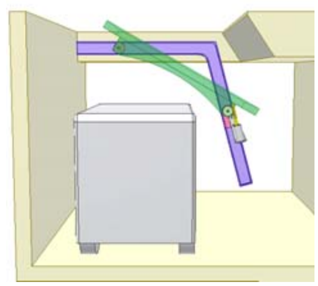
Gap between the floor and the cover is rather small.

The cover occupies rather small space during motion.

The mechanism can be used for a door with ceiling arrangement of the runways.

Cover for basement entrance 1b

http://youtu.be/iRH5lwF-1VE



Green cover is a connecting rod of an ellipse mechanism of two pink sliders. A green pinion is fixed to the cover. A grey actuator of yellow rack is fixed to the right slider. Driving force from the actuator is applied to the connecting rod via the pinion rack drive. That ensures smooth motion of the mechanism.

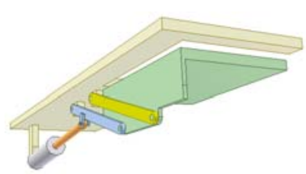
The obtuse angle of violet runway and the mounting actuator on the slider are measures to overcome limited height of the basement. Moving actuator causes some difficulties for connection with hydraulic or electric source.

The mechanism is cut off half for easy understanding.

The car is moved from the basement to the ground floor by a lift (not shown).

Cover for basement entrance 2

http://youtu.be/MeeW9S2qojE

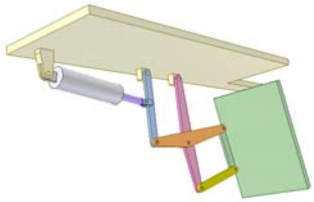


Green cover is a connecting rod of a four bar linkage.

There must be a considerable gap between floor and the cover at two short sides of the cover. The cover occupies large space during motion.

Cover for basement entrance 3

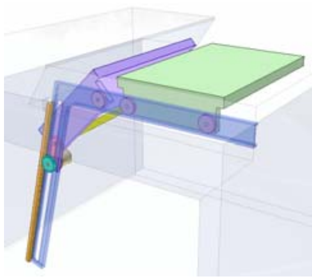
http://youtu.be/VN9ERN1UK1s



An application of double parallelogram mechanism shown in.
http://www.youtube.com/watch?v=U-Vn5SoRWCg
Green cover is a connecting rod of one parallelogram mechanism and rotates around a virtual axis that lies on the upper surface of the floor (or better, within the thickness of the floor).
Gap between the floor and the cover is rather small.
The cover occupies rather large space during motion.
The mechanism is cut off half for easy understanding.
The mechanism of two opposite moving covers is possible.

Cover for basement entrance 1c

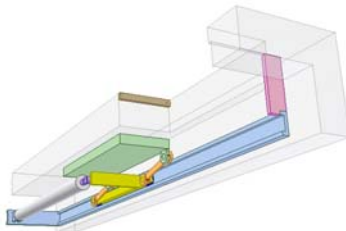
http://youtu.be/Wnkzo14aA3o



The cover is divided into green and violet halves in order to reduce its occupied space in moving or to ease the manufacture.
The green half has two pink rollers rolling in blue runway.
The violet half has a pink roller rolling and a pink slider sliding in the runway.
Yellow conrod has revolute joints with the two halves and the slider. Length of the conrod is reduced to minimum due to the said reason.
Brown motor fixed to the slider has cyan pinion which engages with orange rack fixed to the runway. So driving force from the motor is applied to the slider.
The obtuse angle of blue runway is a key factor and it should be as large as possible to ease the motion.
Because of the moving motor, electric cable connected to it must be movable.
The mechanism is cut off half for easy understanding.

Cover for basement entrance 4

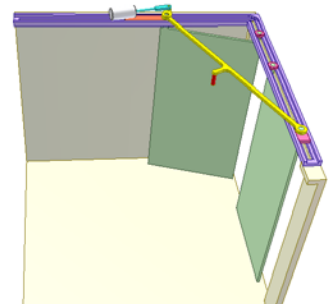
http://youtu.be/rfnXYbCxIQg



Yellow frame reciprocates linearly under action of grey cylinder.
Thanks to parallelogram mechanism of two orange rockers, the green cover can raise up to level of the floor.
In motion to the left the cover falls down due to the gravity.
Pay attention to two red pins, pink and brown plates that act as stoppers.
Gap between the floor and the cover is minimum.
The cover occupies small space during motion.
Center of mass of the cover moves up only a little so the mechanism is good in term of saving energy.
The mechanism is cut off half for easy understanding.
The mechanism of two opposite moving covers is possible.

Door for limited space 1

http://youtu.be/jWxtaYE_5n0

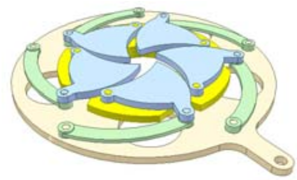


Each door panel has revolute joints with a slider and a roller. The sliders and rollers move in violet runway.
Yellow conrod has revolute joints with the sliders and cyan piston.
Grey cylinder has revolute joint with the orange left slider. So driving force from the cylinder is applied to the conrod.
Because of the moving cylinder, its hydraulic hoses must be movable.
In case of power interruption:
- Move red grip of the conrod to open the door.
- The door can not be opened from outside.
- At completely closed or opened positions of the door, force applied to the panels can not move them.

This mechanism can be applied for up & down garage doors.

Diaphragm shutter 1

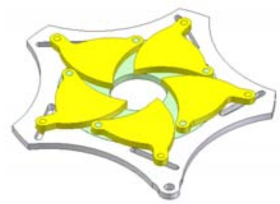
http://youtu.be/_P1ghKADv78



Turn outer disk to open or close the aperture of a camera.
The outter disk, yellow conrod and blue blade create a 4-bar mechanism.

Diaphragm shutter 2

http://youtu.be/msWygarinBs



Turn outer disk cam to open or close the aperture of a camera.
Green inner disk is fixed.
Yellow blades play role of cam followers.

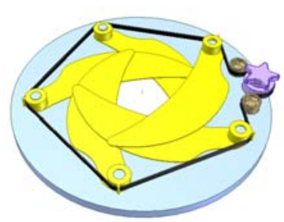
Diaphragm shutter 3

http://youtu.be/VUoVnl9PjPU

Turn glass outer disk cam to open or close the aperture of a camera.
Green inner disk is fixed.
Overlapping curved blades play role of cam followers.
See real colossal iris:
https://www.youtube.com/watch?v=jvEL3KahFsk

Diaphragm shutter 4

http://youtu.be/IW5Wbic1D64

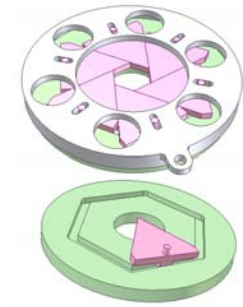


Turn violet knod to open or close the aperture.
Belt drive forces all yellow blades to rotate synchronuosly.
It is possible to replace belt drive with a gear one (internal gear ring and 5 pinions).
The mechanism can be used for windows:
https://www.youtube.com/watch?v=-qlgsCU2NJo

Diaphragm shutter 5a

http://youtu.be/k4m6TRTSzGo

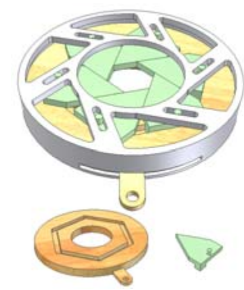
It is a disk cam mechanism of translation follower.
Turn grey disk cam to open or close the aperture.
Fixed green disk has a hexagon slot.
Each blade (follower) slides along one side of the hexagon.
Instead of the hexagon 6 symmetrical suitable curves are possible.
The mechanism can be used for control valves:
https://www.youtube.com/watch?v=3w7SSUFHjWE



Diaphragm shutter 5b

http://youtu.be/bWScqsHEvqc

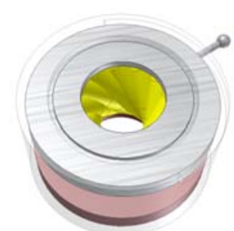
Turn orange disk of hexagon slot to open or close the aperture.
Instead of the hexagon 6 symmetrical suitable curves are possible.
The variable hexagon created by green blades rotates when expanded or contracted.



Diaphragm shutter 6

http://youtu.be/RoTgZw_nqPM

Yellow bars of flexible material are fixed to grey upper and brown lower disks.
Turn upper disk to open or close the aperture.
In practice the yellow bars are replaced with a flexible tube.
The mechanism finds application in valves for handling powder or granule materials. See:
https://www.youtube.com/watch?v=A-4V_V4Hi0g

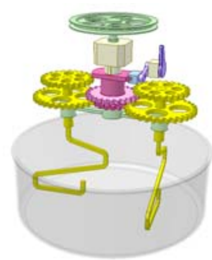


26. Mixing machines

Stirring Machine with Satellite Bevel Gear
http://www.youtube.com/watch?v=hRfGiRhzX-I

Mixing Machine 1
http://www.youtube.com/watch?v=E_QsGY1Rz7E
A second motor rotates the bowl.
The locus lower part of the mixing bar's lower end follows the bowl bottom profile.

Mixing machine 3
http://youtu.be/ZJdrYD-DPnM
A planetary drive is used for the machine. The block of two pink gears plays role of the sun. Move the block to change mixing speed.

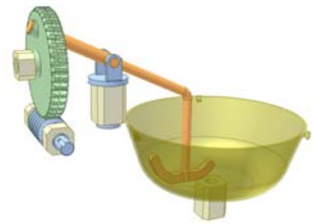


Mixing machine 4
http://youtu.be/6ktLcEOzY9o
Blue gear and violet worm are input links.

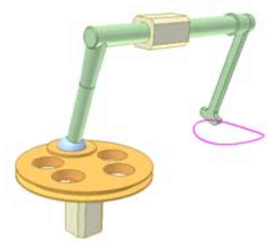
Mixing machine 5
http://youtu.be/iNI0R_26HSE
Blue gear and violet worm are input links.

Mixing machine 6
http://youtu.be/M4zgWuNkLrA
Green gears and orange bar create a parallelogram mechanism.
Pink gear and violet worm are input links.
The bar performs rotary translatory motion.

Dough-Kneading Mechanism
http://youtu.be/gYksowpfhFY
It is spherical 4R mechanism.
4R: 4 revolute joints.
Spherical: Joint center lines intersect at a common point.
The wobbling motion of the orange link is used to knead dough in the tank.



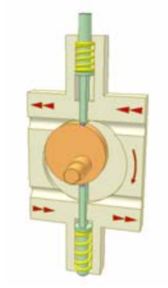
Agitator Mechanism
http://www.youtube.com/watch?v=aHEz0qNzyJ8
It is R-S-C-C space 4-bar mechanism.
R-S-C-C: Joint symbols from input to output joint.
R: revolute
S: sphere
C: cylinder
The output link rotates and translates, performs a twisting motion.



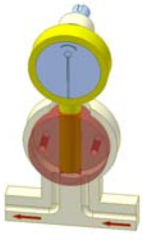
Mixing machine 2
http://youtu.be/FyOH3jwSDFY
Input is the orange shaft.
The yellow propeller has reciprocating linear translation and continuous rotation at the same time owing to the rack of ring teeth.

27. Pumps, engines

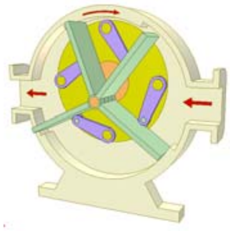
Pump with eccentric 1
http://www.youtube.com/watch?v=RVORJ91ELEE
The red arrows indicate the rotation direction of the eccentric shaft and the fluid moving direction.
The front half case is removed.



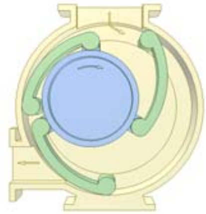
Pump with eccentric 2
http://www.youtube.com/watch?v=IvzHnE26P1o
The red arrows indicate the rotation direction of the eccentric shaft and the fluid moving direction.
The front half case is removed.



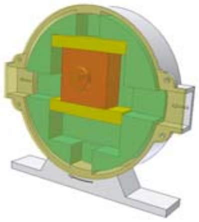
Pump with 4-bar mechanism 1
http://www.youtube.com/watch?v=RrDJzv699aA
The red arrows indicate the fluid moving direction.
The front half case is removed.
The space between adjacent sectors is expanded on the suction side and decreased on the discharge side.



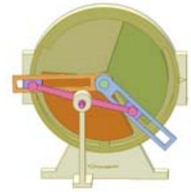
Pump with 4-bar mechanism 2
http://www.youtube.com/watch?v=YFb6tVo8rfg
The arrows indicate the fluid moving direction.
The front cover is removed.
An expanding cavity is created on the suction side and a decreasing cavity is created on the discharge side.



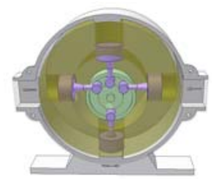
Pump with rotating square piston
http://www.youtube.com/watch?v=WiYK04vVPRY
Input: green disk.
Yellow slider slides in slot on the green disk.
Red piston slides in slot on the yellow slider.
The piston axle is fixed eccentrically on the yellow cover.
The arrows indicate the fluid moving direction.
The piston creates an expanding cavity on the suction side and a decreasing cavity on the discharge side.



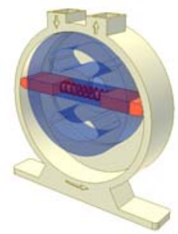
Pump with 4-bar mechanism 3
http://youtu.be/RSAyygL03po
The arrows indicate the rotation direction of the sectors and the fluid moving direction. Each sector is fixed with a coulisse.
The rotating sectors create an expanding cavity on the suction side and a decreasing cavity on the discharge side.



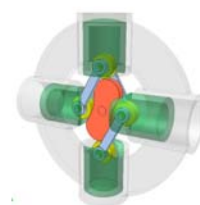
Pump with rotating cylinder
http://youtu.be/Bu7000931oQ
The arrows indicate the rotation direction of the yellow cylinder and the fluid moving direction. Green disk is fixed eccentrically on the case
The pistons create an expanding cavity on the suction side and a decreasing cavity on the discharge side.



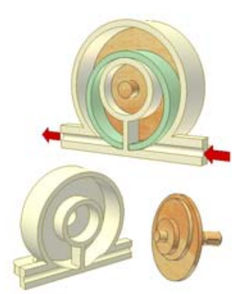
Pump with eccentric 3
http://www.youtube.com/watch?v=w8MDLutvcZo
The arrows indicate the rotation direction of the eccentric and the fluid moving direction.
The eccentric creates an expanding cavity on the suction side and a decreasing cavity on the discharge side. The front cover is removed.



Cam mechanism of follower's planar motion 2
http://youtu.be/sJoL85j44Ro
The blue followers, connecting rods of ellipse mechanisms, have planar motion. This mechanism can be used for air compressors or engines.



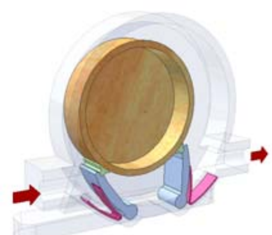
Pump with eccentric ring 1
http://youtu.be/LSkIEa4tjrk
Input: orange rotor.
Green ring is mounted eccentrically on the rotor.
A vertical wall of the base prevents the green ring from rotating.
There should be a soft contact (elastic seal) between the ring and the wall.
The arrows show fluid flows.
An amount of fluid is sucked into the pump during its first revolution and discharged during the next revolution.
The pump is cut off half for easy understanding.



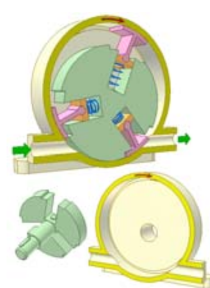
Scroll compressor
http://youtu.be/V5sXKMQWw9s
The grey disk with an Archimedean rib is fixed.
The green disk with the same rib receives motion from a pink eccentric shaft. Due to a Oldham mechanism with the orange disk the orientation of the green disk does not change during motion.
Suction place is at disk periphery and discharge one is at center of the fixed disk. For more see:
http://www.youtube.com/watch?v=NV1zAXKGkig
The eccentricity of the pink shaft e = (p – 2a)/2
p: pitch of Archimedean spiral
a: thickness of the Archimedean rib
Instead of Archimedean spiral, other spirals can be used, for example, involute one.

Pump with rollers 1
http://youtu.be/8AfzVEwOypQ
Input: green rotor that rotates eccentrically in the housing.
Three pink rollers can slide in the rotor slots.
Centrifugal forces push the rollers toward the interior cylindrical surface of the housing.
The arrows show fluid flows.
The pump is cut off half for easy understanding.

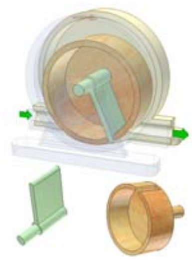
Pump with eccentric 3
http://youtu.be/f-0yLg63tmI
Input: orange rotor that rotates eccentrically in the housing.
Two blue levers with green cushions are forced toward the rotor by pink springs.
It is an application of a 4-bar linkage where green cushions are the connecting rods.
The arrows show fluid flows.
The pump is cut off half for easy understanding.



Pump with sliders 1a
http://youtu.be/S7qE55UJJXI
Input: green rotor that rotates eccentrically in the housing.
Orange sliders can slide in the rotor slots.
Pink sliders can slide in circular grooves of the housing.
There are revolution joints between orange sliders and pink ones.
It is an application of a coulisse mechanism where green rotor and pink sliders are the cranks.
The green arrows show fluid flows.
The pump is cut off half for easy understanding.

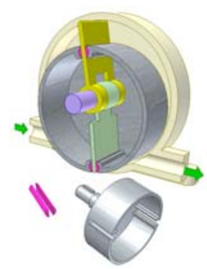


Pump with eccentric 4a
http://youtu.be/t5BQStcdqTo
Input: orange rotor that rotates eccentrically in the housing. Its bearing is located in the back half of the housing.
Green plate rotates concentrically in the housing. Its bearing is located in the front half of the housing.
There should be a soft contact (elastic seal) between the plate and the rotor.
The arrows show fluid flows.

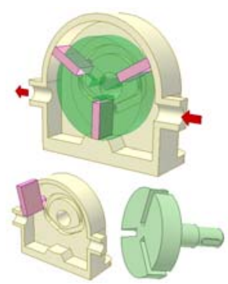


Pump of three shafts
http://youtu.be/jtWM5zclqfw
Input: green shaft
Curves on yellow and pink rotors are epitrochoids.
Tooth number of the green gear is twice the one of the other gears.
The arrows show fluid flows.
The pump is cut off half for easy understanding.

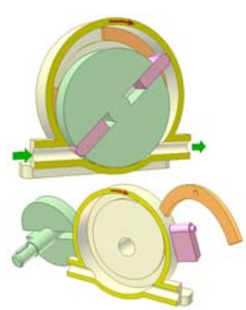
Pump with eccentric 4b
http://youtu.be/OiSO7FKtlTw
Input: grey rotor that rotates eccentrically in the housing.
Its bearing is located in the back half of the housing.
Green and yellow plates rotates concentrically in the housing. The pink parts have revolution joints with the rotor. The violet shaft is fixed to the front half of the housing (not shown).
The arrows show fluid flows.



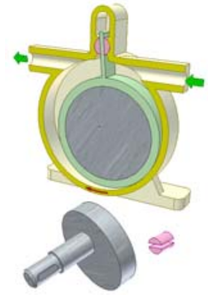
Pump of fixed disk cam
http://youtu.be/DHJiK1lfzNc
Input: green shaft
The pump housing has a groove (disk cam).
Each pink plate has pin sliding in the groove.
The arrows show fluid flows.
The pump is cut off half for easy understanding.



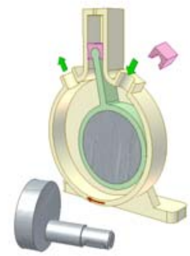
Pump with sliders 1b
http://youtu.be/4DtouBqxfSU
Input: green rotor that rotates eccentrically in the housing.
Pink sliders can slide in the rotor slots.
Orange sliders can slide in circular grooves of the housing.
There are revolution joints between orange sliders and pink ones.
It is an application of a coulisse mechanism where green rotor and pink sliders are the cranks.
The green arrows show fluid flows.
The pump is cut off half for easy understanding.



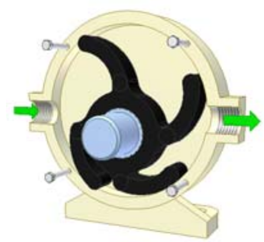
Pump with eccentric 5a
http://youtu.be/BoXO-7R51co
Input: grey rotor that rotates eccentrically in the housing.
Green conrod separates suction and discharge spaces of the pump.
The pink parts have revolution joints with the housing.
The arrows show fluid flows.
The pump is cut off half for easy understanding.



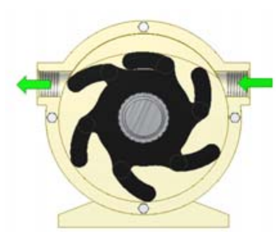
Pump with eccentric 5b
http://youtu.be/LJDs5Er6zJs
Input: grey rotor that rotates eccentrically in the housing.
Green conrod separates suction and discharge spaces of the pump.
The rotor, conrod and pink slider create a slider crank mechanism.
The arrows show fluid flows.
The pump is cut off half for easy understanding.



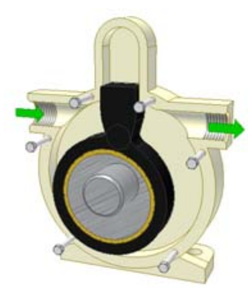
Flexible impeller pump 1a
http://youtu.be/JtQ-0ZYkH2c
Black rubber impeller, eccentrically rotating clockwise in the housing, transports fluid from inlet to outlet. The front half housing is removed for easy understanding.
Green arrows show fluid flow.



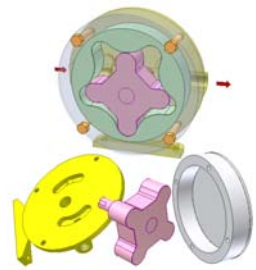
Flexible impeller pump 1b
http://youtu.be/x90OtAgbBp0
Black rubber impeller, concentrically rotating clockwise in the housing, thanks to inner noncircular profile of the housing, transports fluid from inlet to outlet. The front half housing is removed for easy understanding.
Green arrows show fluid flow.



Flexible impeller pump 2
http://youtu.be/rV1cdVGnU5Y
Grey shaft rotates anticlockwise in the housing. Black rubber impeller having revolution joint with an eccentric of the grey shaft, transports fluid from inlet to outlet. The front half housing is removed for easy understanding.
Green arrows show fluid flow.

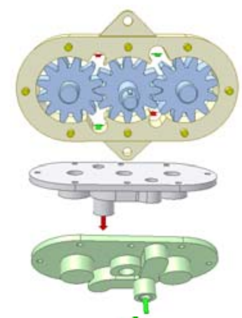


Trochoid gear pump
http://youtu.be/Xd3s5xEPSIA
A pin drive is applied for this pump. The pink driving rotor rotates 5 rev. while the green driven rotor rotates 4 rev.
Profile of the green rotor consists of trochoid curves.
If the pink driving rotor rotates clockwise the left space between teeth of the two rotors is of low pressure and the right one is of high pressure.
The two gears rotate clockwise. Red arrows show fluid flow.



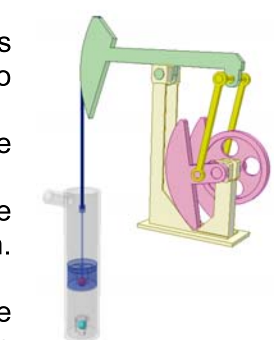
External gear pump
http://youtu.be/EPCI8poQAoI
Liquid between teeth and housing wall is transported from inlet to outlet.
The upper gear rotates anti-clockwise. Green arrows show fluid flow.

External gear pump 2
http://youtu.be/gp6SJiEsUu4
The driving middle gear rotates anti-clockwise.
Liquid between teeth and housing wall is transported from inlet (green arrows) to outlet (red arrows).
The inlet is on grey back cover.
The outlet is on green front cover.
In comparison with 2-gear pump, this 3-gear pump has double flow rate (like parallel connection of two 2-gear pumps).



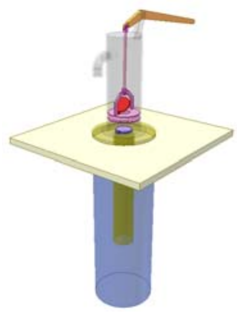
Internal gear pump
http://youtu.be/fZk87T9Tiy0
Liquid in the space between teeth, orange fixed crescent and housing wall is transported from inlet to outlet.
The two gears rotate anti-clockwise. Green arrows show fluid flow.

Cable drive 23
http://youtu.be/HoGTiXtCKmY
A liquid pumpjack. The 4-bar mechanism converts continuous rotation to reciprocating rotation that the cable drive converts to reciprocating translation of a pump piston.
The ball valves open and close automatically due to fluid pressure alteration in the space under the piston.
When the piston moves up, the lower valve opens, the upper valve closes. The outside liquid is sucked into the space under the piston. The liquid above the piston is pushed up.
When piston moves down, the lower valve closes, the upper valve opens. The liquid is pressed from the space under the piston into the space above the piston.
For more about valve action see:
http://www.youtube.com/watch?v=SFJFiyXTOa0



Hand water pump 1a

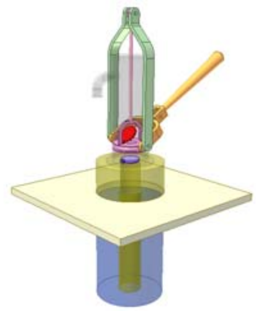
http://youtu.be/8xv21E7XKBU



Slider crank mechanism converts oscilation of orange crank to reciprocating translation of pink piston. Hand force is applied to the crank.
Disk valves open and close automatically due to fluid pressure alteration in the space under the piston.
When the piston moves up, the lower valve opens, the upper valve closes. The outside liquid is sucked into the space below the piston. The liquid above the piston is pushed up and flows outside. When piston moves down, the lower valve closes, the upper valve opens. The liquid is pressed from the space below the piston into the space above the piston.
For more about valve action see:
http://www.youtube.com/watch?v=SFJFiyXTOa0

Hand water pump 1b

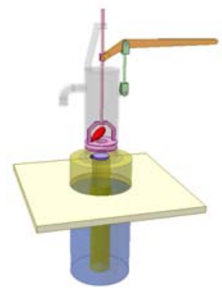
http://youtu.be/NtMIwYN7EeU



Slider crank mechanism converts oscilation of orange crank to reciprocating translation of pink piston. Hand force is applied to the crank.
Disk valves open and close automatically due to fluid pressure alteration in the space under the piston. When the piston moves up, the lower valve opens, the upper valve closes. The outside liquid is sucked into the space below the piston. The liquid above the piston is pushed up and flows outside. When piston moves down, the lower valve closes, the upper valve opens. The liquid is pressed from the space below the piston into the space above the piston.
For more about valve action see:
http://www.youtube.com/watch?v=SFJFiyXTOa0

Hand water pump 2a

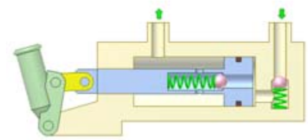
http://youtu.be/adMu9Yo0nCA



Slider crank mechanism converts oscilation of orange conrod to reciprocating translation of pink piston. Hand force is applied to the conrod.
Disk valves open and close automatically due to fluid pressure alteration in the space under the piston. When the piston moves up, the lower valve opens, the upper valve closes. The outside liquid is sucked into the space below the piston. The liquid above the piston is pushed up and flows outside. When piston moves down, the lower valve closes, the upper valve opens. The liquid is pressed from the space below the piston into the space above the piston.
For more about valve action see:
http://www.youtube.com/watch?v=SFJFiyXTOa0

Hand piston pump 1

http://youtu.be/5a-UdttYEVs

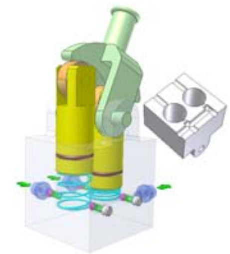


Spring ball valves are operated automatically thanks to fluid pressure.
The arrows show fluid flows.
The cylinder and the piston are cut off half for easy understanding.

Hand piston pump 2

http://youtu.be/cVwOS5cd4Oo

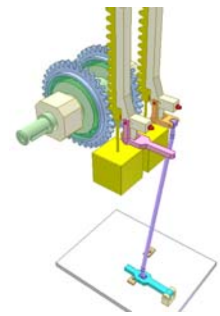
Green double cam lever controls two pistons.
Spring ball valves are operated automatically thanks to fluid pressure.
The arrows show fluid flows.



Gravity engine 1

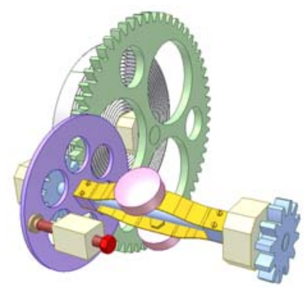
https://www.youtube.com/watch?v=tsT-MVZudV4

A way to bring some weights into action consecutively in a gravity engine.
Press pink arm, red slider moves back, to start the engine.
When the first yellow weight contacts cyan lever, it brings the second weight into action.
Turn the green shaft counterclockwise to get initial position.
Blue gears are connected to the output shaft by one-way clutches of ratchet pawl (or roller) type.
The output speed control device (retarder) is not shown.
Springs that force red sliders towards yellow racks are not shown.
Instead of rack pinion drive a cable drive can be used.



Speed control of spring motor

http://youtu.be/ehjgr3AYKvM



Orange leaf springs tend to get their neutral position and push violet flange to the left. Centrifugal forces of pink weights tend to move the violet flange to the right when the speed increases and cause the friction at the contact place between brown pad and violet flange.
Grey coil spring tends to free accumulated elastic energy and to make the blue output shaft rotate very fast.
The said friction reduces speed of the output shaft.
Red screw sets position of the pad. Move pad to the right to increase the output speed.
This mechanism is used in gramophones.
It is possible to replace the gear drive by a worm drive of large lead angle.

Flyball governor for flow control.

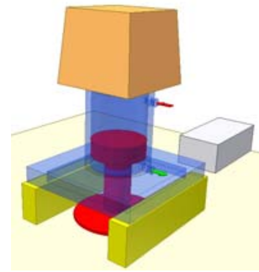
http://youtu.be/SiYEtnlZLSs

A water turbine spins the governor, which control the water flow, which feeds the turbine, creating a speed-regulated machine.
When the flow is too strong, the water turbine and the violet governor shaft rotates faster than the set velocity. By centrifugal force, the green arms regulates the orange valve to reduce the flow.

28. Hydraulic and pneumatic mechanisms

Hydraulic lift 1

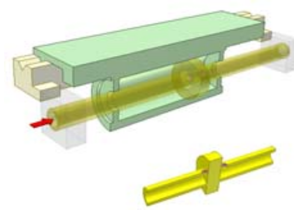
https://www.youtube.com/watch?v=ITnEJLjQsAk



This is a way to lift an object (in orange) to large height using cylinder of small stroke by alternately conducting pressure fluid into upper and lower spaces of the piston.
Yellow cushions support blue cylinder.
Grey cushions support red piston.
Arrows show fluid flows. Red arrow is for pressure flow.

Hydraulic cylinder with fixed piston

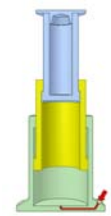
https://www.youtube.com/watch?v=yX_rCTcAPi4



Green cylinder with machine table reciprocates.
Pressure fluid is conducted into cylinder via holes on fixed piston rod. The hoses can be stationary.
In case using holes on the cylinder the hoses have to move with the cylinder.
The arrows show flows of pressure fluid.

Hydraulic telescopic cylinder

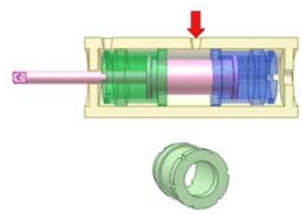
http://youtu.be/icaqvfAtccY



Red arrow shows pressure flow.
The gravity brings pistons to their lowest positions.

Hydraulic cylinder with three piston positions

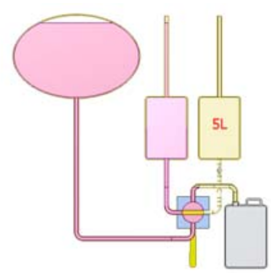
http://youtu.be/sPD62mJ_ViM



By alternately conducting pressure fluid into cylinder through its three holes the pink piston can reach one of its three stable positions: center, left and right.
Green and blue floating pistons are identical.
The arrows show flows of pressure fluid.
When pressure fluid enter through the medium hole, green and blue pistons are pushed apart from each other, pink piston gets center position.
When pressure fluid enter through the left hole, pink and blue pistons are pushed to the right, pink piston gets right position.
When pressure fluid enter through the right hole, pink and green pistons are pushed to the left, pink piston gets left position.

Liquid dispenser 1

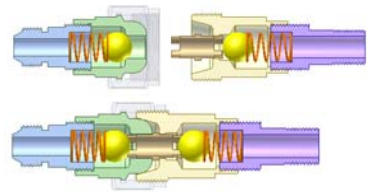
http://youtu.be/4fbcr1ISroU



Liquid from the ovan tank flows to two meter containers and then to the grey bottle alternately subject to handle positions of the blue four port valve.
The principle of communicating vessels is applied here.
No electricity is required.
Volume error depends on the oscilation of liquid level in the oval tank and the inside diameter (should be minimum) of the air pipes of the meter containers.

Pipe connection 1

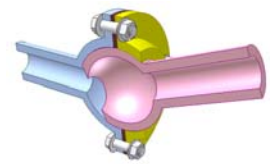
http://youtu.be/Nn4P3z589B4



In disconnected state the fluid can not flow out due to the contact of yellow balls with green and popcorn parts under spring forces.
In connected state brown part pushes the balls, thus prevent the above mentioned contact and the fluid flows through holes on the brown part.
Most parts are cut off half for easy understanding.

Pipe movable connection 1

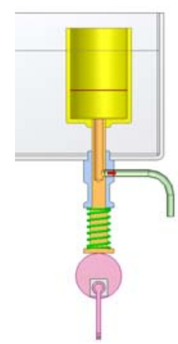
http://youtu.be/DwrlPPTBrPA



Spherical joint, arranged for tubing.
The brown gasket is for sealing.

Liquid dispencer 2

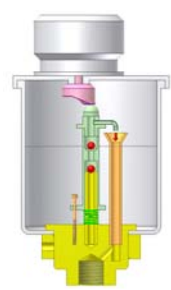
http://youtu.be/4E1AnCBeeQ4



The upper surface of yellow cup at its lowest position is lower than the liquid surface in the tank. So the cup is filled fully with the liquid.
Turn pink cam to raise the cup to its highest position to get:
1. The coincidence of cross holes on the orange bar and on the blue support.
2. The upper surface of yellow cup is higher than the liquid surface in the tank.
Then the liquid amount contained in the cup flows out through green pipe (red arrow). The red line shows liquid surface in the cup.
For dispencer of large liquid amount see “Liquid dispencer 1”:
http://youtu.be/4fbcr1ISroU

Liquid dispencer 3

http://youtu.be/m_8wjkpjYLY



Pink continuously rotating cam moves green cylinder to pump out a determined liquid amount during each revolution.
Ball valves are operated automatically thanks to fluid pressure and their own weights. Orange screw is for adjusting liquid amount to be pumped.
Red arrow shows time when the liquid flows out.

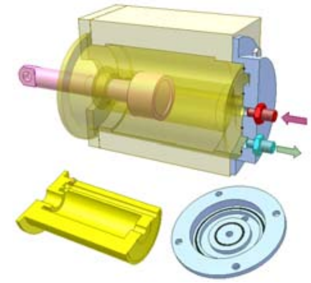
Swinging cylinder

http://youtu.be/Hlg3ZeaeoGU

A way to connect fluid to a swinging cylinder.
Fluid enters and leaves the swinging cylinder through its stationary pivot so flexible pipes are not needed.
All pink parts are stationary. The arrows show fluid flows.

Rotary cylinder

http://youtu.be/ytR2ku1wBgA

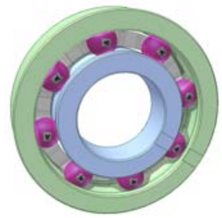


A way to connect fluid to a rotary cylinder.
The red fitting is connected to the rear cylinder space through rear center hole of the cylinder.
The cyan fitting is connected to the front cylinder space through circular groove on the inner face of the blue connector and long eccentric hole of the cylinder.
It is possible to arrange the groove on cylindrical surface.
The cylinder and the piston rotate together with an operational device (not shown). The arrows show fluid flows.

29. Study of mechanisms

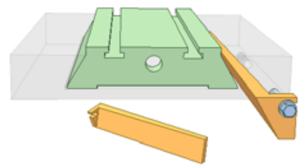
29.1. Mechanical joints

Ball bearing simulation 1
http://www.youtube.com/watch?v=hxUXX0tYMHM
Outer race stationary

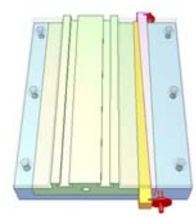


Ball bearing simulation 2
http://www.youtube.com/watch?v=hxUXX0tYMHM
Inner race stationary

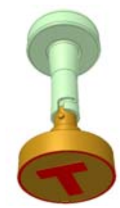
Wedge mechanism 17
http://youtu.be/_I3PPttljC8
The gap between the green slider and the runway is adjusted by moving the orange wedge. The slopes on the wedge and on the runway are equal.



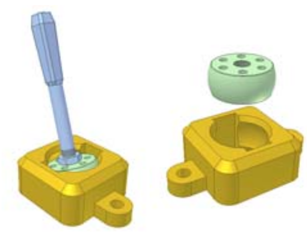
Wedge mechanism 28
http://youtu.be/rM8FcOcZ9M8
The gap between the green slider and the runway is adjusted by moving the orange and pink wedges. The slopes on the wedges are equal.



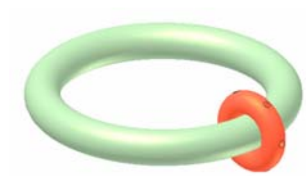
Stamp joint
http://youtu.be/Wk-JYJHr6u0
Insert and turn the brass stamp for fixing it to green handle.
Helical groove on the handle and a pin on the stamp are key factors.



Assembling sphere joint having unsplit outer part
http://youtu.be/gWzPxNvG0Dw
Length of rectangular slot on the yellow outter part must be larger than the diameter of green sphere.
For drawings see:
http://meslab.org/mes/showthread.php?p=93888#post93888

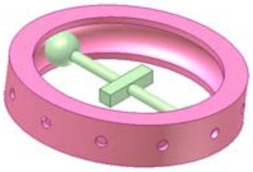


Mechanical Torus Joint 1
http://youtu.be/uCEPAw4jxCA
The joint allows two degrees of freedom (rotations) of relative movement.



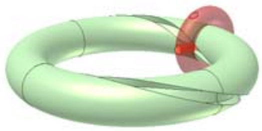
Mechanical Torus Joint 2
http://youtu.be/mHkdwnrhsPU
The joint allows two degrees of freedom (rotations) of relative movement.

Mechanical Torus Joint 3
http://youtu.be/BbsGHSC1i5c
The joint allows two degrees of freedom (rotations) of relative movement.

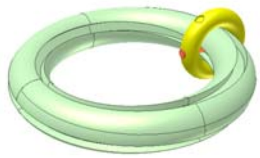


Helix torus joint 1a
http://youtu.be/3Yw3Hr9WKdg
There are a helix groove of half rev. (n = 1/2) on the big torus. The small torus makes 1 rev. around its axis during 2 rev. around the big torus axis. In other words, the small torus has two interdependent rotary motions.
It is case of Mobius strip (figure on the upper left corner), an ant must crawl two rev. to get the start point.

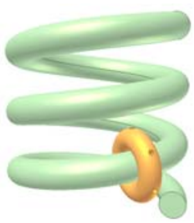
Helix torus joint 1b
http://youtu.be/CvsviKzNoqs
There are a helix groove of two rev. (n = 2) on the big torus. The small torus makes 2 rev. around its axis during 1 rev. around the big torus axis.



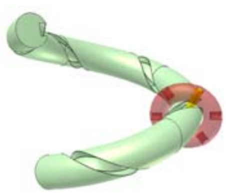
Helix torus joint 1c
http://youtu.be/6vWSI5JYUoI
There are a helix groove of one third rev. (n = 1/3) on the big torus. The small torus makes 1 rev. around its axis during 3 rev. around the big torus axis.



Helix torus joint 2
http://youtu.be/6s-giKB1TBE
The orange torus can turns around its own axis. It has also a helical motion around axis of the green spring-shaped part. So this joint has two degrees of freedom.

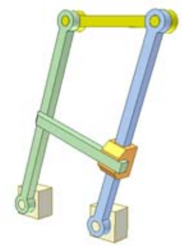


Helix torus joint 3
http://youtu.be/gIGF-C_5FNE
The red torus carrying a pin has two interdependent helical motions around its own axis and around axis of the green spring-shaped part. The pin slides in a helical groove of the green spring-shaped part.



29.2. Planar mechanisms

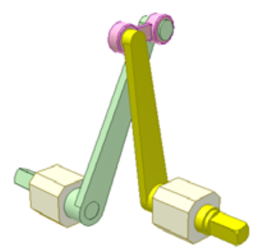
Equivalency of parallelogram and Oldham mechanisms
http://youtu.be/wi0NyZNd7I4
When removing orange slider, it is a parallelogram mechanism.
When removing yellow conrod, it is a Oldham mechanism.
For both cases the motion transmission between two rockers is the same.



Four bar linkage 8a
http://youtu.be/ADofvwxYImA
A special case of the 4-bar linkage.
Input: pink crank
Output: green crank.
The unusualness: a working cycle of the mechanism corresponds 2 revolutions of the input. Output oscillating angle is larger than 180 deg., a thing that is hard to get by using an ordinary 4-bar linkage. It happens because:

1. The sum of the lengths of the two adjacent links is equal to the sum of the lengths of the other two links.
A + B = C + D
A: length of pink crank (=10)
B: length of yellow conrod (=40)
C: length of green crank (=20)
D: distance between fixed axes of pink and green cranks (=30)
2. There are measures to overcome dead position (when green crank and yellow conrod are in line). For example, inertia of the green crank must be big enough.

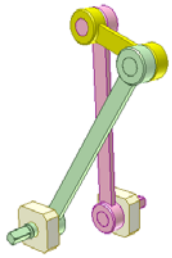
Four bar linkage 8b
http://youtu.be/Y5lMzmEPOX0
A special case of the 4-bar linkage.
Input: pink conrod.
Output: oscillating green and yellow cranks.
The unusualness: a working cycle of the mechanism corresponds 2 revolutions of the driving crank (in pink) Output oscillating angles are larger than 180 deg., a thing that is hard to get by using an ordinary 4-bar linkage. It happens because:



1. The sum of the lengths of the two adjacent links is equal to the sum of the lengths of the other two links.
A + B = C + D
A: length of green crank (=40)
B: length of pink conrod (=10)
C: length of yellow crank (=36)
D: distance between fixed axes of cranks (=14)
2. There are measures to overcome dead positions (when cranks are in line with pink conrod). For example, inertia of the cranks must be big enough.

Four bar linkage 8c

http://youtu.be/BOJSJvOUyAE



A special case of the 4-bar linkage.
Input: pink crank.
Output: green crank rotating irregularly.
The unusualness: a working cycle of the mechanism corresponds 2 revolutions of the input. It happens because:
1. The sum of the lengths of the two adjacent links is equal to the sum of the lengths of the other two links.
A + B = C + D
A: length of pink crank (=35)
B: length of yellow conrod (=15)
C: length of green crank (=40)
D: distance between fixed axes of cranks (=10)
2. There are measures to overcome dead positions (when the cranks are in line with yellow conrod). For example, inertia of the cranks must be big enough.

Four bar linkage 9a

http://youtu.be/nP_tGreHHEY

A special case of the 4-bar linkage.
Input: pink crank.
Output: oscillating green crank.
The unusualness: a working cycle of the mechanism corresponds 2 revolutions of the input. Output oscillating angles are larger than 180 deg., a thing that is hard to get by using an ordinary 4-bar linkage. It happens because:
1. The sum of the lengths of the two opposite links is equal to the sum of the lengths of the other two links.
A + B = C + D
A: length of pink crank (=10)
B: length of green crank (=40)
C: length of yellow conrod (=35)
D: distance between fixed axes of cranks (=15)
2. There are measures to overcome dead positions (when green crank is in line with yellow conrod). For example, inertia of the green crank must be big enough.

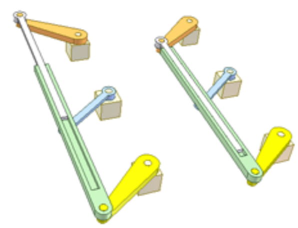
Four bar linkage 9b

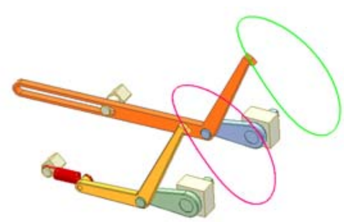
http://youtu.be/Aqg7tl4jfe8

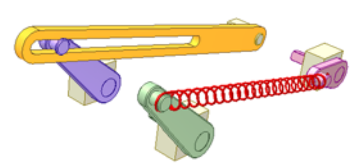
A special case of the 4-bar linkage.
Input: pink crank.
Output: green crank rotating irregularly.
The unusualness: a working cycle of the mechanism corresponds 2 revolutions of the input. It happens because:
1. The sum of the lengths of the two opposite links is equal to the sum of the lengths of the other two links.
A + B = C + D
A: length of pink crank (=15)
B: length of green crank (=35)
C: length of yellow conrod (=40)
D: distance between fixed axes of cranks (=10)
2. There are measures to overcome dead positions (when green crank is in line with yellow conrod). For example, inertia of the green crank must be big enough.

Four bar linkage 9c
http://youtu.be/4rTbsT7hTcg
A special case of the 4-bar linkage.
Input: pink conrod.
Output: oscillating cranks.

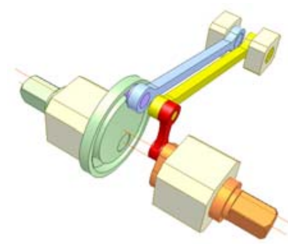
The unusualness: a working cycle of the mechanism corresponds 2 revolutions of the input. Oscillating angle of the yellow crank is larger than 180 deg., a thing that is hard to get by using an ordinary 4-bar linkage. It happens because:
1. The sum of the lengths of the two opposite links is equal to the sum of the lengths of the other two links. A + B = C + D
A: length of pink conrod (=10)
B: length of green crank (=35)
C: length of yellow crank (=15)
D: distance between fixed axes of cranks (=40)
2. There are measures to overcome dead positions (when cranks are in line with pink conrod). For example, inertia of the cranks must be big enough.

Study of parallelogram mechanism 1a
http://youtu.be/wraqhhhe-h8

Two mechanisms are identical.
Lengths of three cranks are equal.
Yellow, green and blue links create a parallelogram.
Input: yellow cranks. Output: orange cranks.
Besides the dead positions (when the cranks and the bars are in line) the mechanisms have unstable positions when the cranks are perpendicular to white and green bars.
When the mechanisms overcome unstable positions output motions may change.
The mechanisms can work stably in the range of less than 90 deg. of the input.
For the left mechanism the input and output turn in opposite directions.
For the right mechanism the input and output turn in the same direction.
This phenomenon depends on initial relative position between input and output cranks.

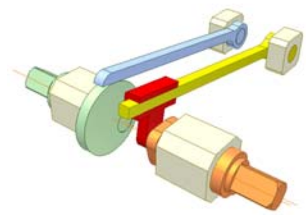
Spring linkage mechanism 1
http://youtu.be/XVoarCYMlVc

The behind is a coulisse mechanism. The front one is the same but the prismatic joint is replaced by a pull spring.
Tips of the orange levers trace similar curves.
However different loads applied to the orange lever of the spring mechanism may alter curve shape.

Spring linkage mechanism 2
http://youtu.be/wVKjmL3iOQo

The behind is a coulisse mechanism. The front one is the same but the prismatic joint is replaced by a pull spring.
The orange lever and the pink crank oscillate with similar motion rules.
However loads applied to the pink crank of the spring mechanism may alter its motion rule.

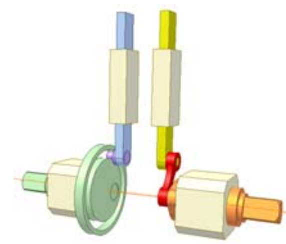
Equivalency of circular cam and linkage mechanisms 1
https://www.youtube.com/watch?v=AO_h10UqLIQ
Eccentricity of the green circular cam = length of the orange crank
Radius of cam pitch circle = length of the red conrod.
The blue follower and the yellow rocker have the same motion.



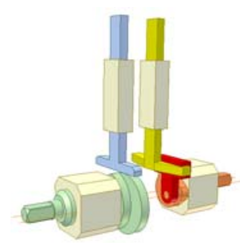
Equivalency of circular cam and linkage mechanisms 3
https://www.youtube.com/watch?v=4DyP4Vo6cVU
Eccentricity of the green circular cam = length of the orange crank
Radius of cam circle = length of the red conrod.
The blue follower and the yellow slider have the same motion.



Equivalency of circular cam and linkage mechanisms 2
http://youtu.be/DQB1pY3It08
Eccentricity of the green circular cam = length of the orange crank
Radius of cam pitch circle = length of the red conrod.
The blue follower and the yellow slider have the same motion.



Equivalency of circular cam and linkage mechanisms 4
http://youtu.be/DQB1pY3It08
Eccentricity of the green circular cam = length of the orange crank
Radius of cam circle = length of the red conrod.
The blue follower and the yellow slider have the same motion.



29.3. Spatial mechanisms

Space 4-bar mechanism 10
http://youtu.be/q433oAXwHuU
Bennett 4R mechanism
It is Bennett 4R mechanism (not spherical 4R mechanism)
4R: 4 revolute joints. It does not meet Kutzbach criterion.
The conditions that the mechanism must satisfy to be able to move:
1. The opposite sides of the mechanism (i.e. links that are not concurrent) have the same lengths, denoted by a, b.
2. The angles of twist are denoted by A, B and they are equal on opposite sides but with different sign.
3. The link lengths and link twist angles must satisfy the relation:
sinA/a = sinB/b
For the blue and yellow (fixed) link: a = 17.599, A= 15 deg.
For the orange and green link: b= 34, A= 30 deg.

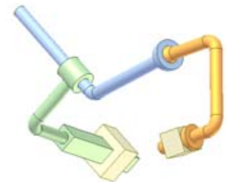
Space 4-bar mechanism 1
http://youtu.be/9mcEF2s8QZU
R-C-C-C mechanism. Input: the orange link. Output: the green link.
R-C-C-C: Joint symbols from input to output joint.
R: revolute
C: cylinder

Space 4-bar mechanism 2
http://youtu.be/nK66IwNJG78
P-C-C-C mechanism. Input: the orange link. Output: the green link.
P-C-C-C: Joint symbols from input to output joint.
P: prism
C: cylinder

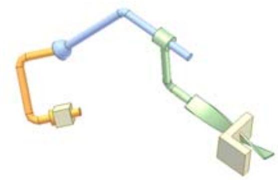
Space 4-bar mechanism 3
http://youtu.be/aUlLcT74mXM
H-C-C-C mechanism. Input: the orange link. Output: the green link.
H-C-C-C: Joint symbols from input to output joint.
H: helix
C: cylinder

Space 4-bar mechanism 4
http://youtu.be/xZcAUtW8XVc
R-S-C-R mechanism. Input: the orange link. Output: the green link.
R-S-C-R: Joint symbols from input to output joint.
R: revolute
S: sphere
C: cylinder

Space 4-bar mechanism 5
http://youtu.be/nJyS6zxSsMo
R-S-C-P mechanism. Input: the orange link. Output: the green link.
R-S-C-P: Joint symbols from input to output joint.
R: revolute
S: sphere
C: cylinder
P: prism

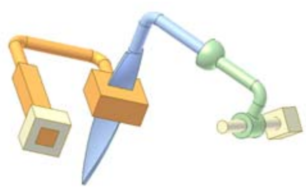


Space 4-bar mechanism 6
http://youtu.be/Gg8Q6nUZc1c
R-S-C-H mechanism. Input: the orange link. Output: the green link.
R-S-C-H: Joint symbols from input to output joint.
R: revolute
S: sphere
C: cylinder
H: helix

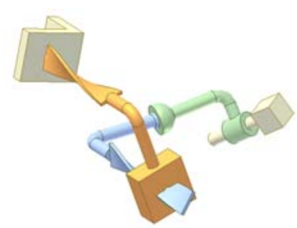


Space 4-bar mechanism 7
http://youtu.be/H_5D9wsdPM4
P-P-S-C mechanism. Input: the orange link. Output: the green link.
P-P-S-C: Joint symbols from input to output joint.
P: prism
S: sphere
C: cylinder

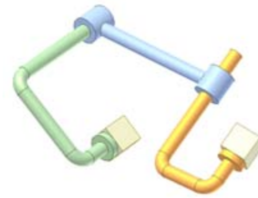
Space 4-bar mechanism 8
http://youtu.be/4k5WcYcqoQg
R-H-C-H mechanism. Input: the orange link. Output: the green link.
R-H-C-H: Joint symbols from input to output joint.
R: revolute
H: helix
C: cylinder



Space 4-bar mechanism 9
http://youtu.be/aiAdhly2Guo
H-H-S-C mechanism. Input: the orange link. Output: the green link.
H-H-S-C: Joint symbols from input to output joint.
H: helix
S: sphere
C: cylinder

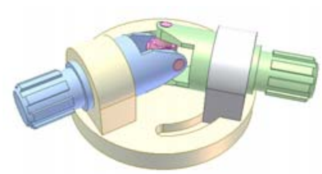


Space 4-bar mechanism 12
http://youtu.be/m0xG_u63WH0
R-C-C-R mechanism
R-C-C-R: Joint symbols from input to output joint.
R: revolute
C: cylinder
It does not meet Kutzbach criterion.

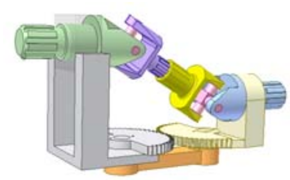


Space 4-bar mechanism 13
http://youtu.be/ccvYpANAWPE
P-C-C-P mechanism
P-C-C-P: Joint symbols from input to output joint.
P: prism
C: cylinder
It does not meet Kutzbach criterion.

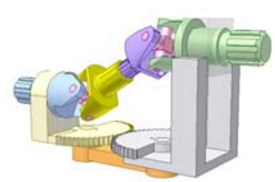
Study of Cardan universal joint 1
http://youtu.be/ZQt6cAmsgXQ
Universal joints allow to adjust A angle between input and output shafts even during rotary transmission. This case shows +/- 45 deg regulation. It is clear that single Cardan joint is not of constant velocity when A differs from 0 deg..



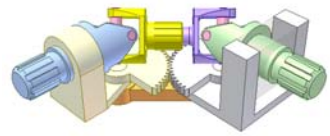
Study of double cardan universal joint 1a
http://youtu.be/gBoJT_PI-RA
Double Cardan drives allow to adjust relative linear positions between the input and output shafts even during rotary transmission. The output velocity is always equal to the input one (constant velocity joint) because their shafts are kept parallel each other.
The pin axles on the intermediate half shafts (in yellow and in violet) must be parallel each other.



Study of double cardan universal joint 1b
http://youtu.be/4CYnLyTsYOA
This is wrong case of a double Cardan joint: the pin axles on the intermediate half shafts (in yellow and in violet) are perpendicular each other.
The joint loses the feature of velocity constant when the input and output shafts are not in a straight line although they are kept parallel each other.
So pay attention to assembling the intermadiate shaft.

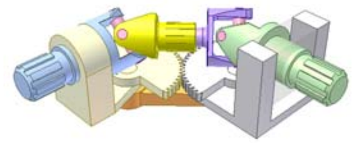


Study of double Cardan universal joint 2a
http://youtu.be/cydmR0IX2t8



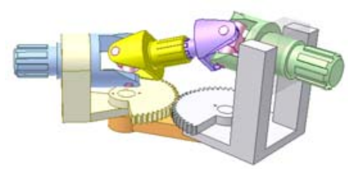
Double Cardan joints allow to adjust angle A between input and output shafts even during rotary transmission. This case shows +/- 90 deg regulation and proves that double Cardan joints are of constant velocity.
Due to the gear planetary drive of two gear sectors and orange crank, angle between input (or output) shaft and the yellow intermediate shaft is always equal to A/2.
The pin axles on the yellow-violet intermediate shaft must be parallel each other.

Study of double Cardan universal joint 2b
http://youtu.be/IttUsogU4AQ



This is wrong case of a double Cardan joint: the pin axles on the yellow-violet intermediate shaft are perpendicular each other.
Although due to the gear planetary drive of two gear sectors and orange crank, angle between input (or output) shaft and the yellow intermediate shaft is always equal to A/2 (A is angle between input and output shafts),
the joint loses the feature of velocity constant when the input and output shafts are not in a straight line (A differs from 0 deg.).
So pay special attention to assembling the intermadiate shaft.

Study of double Cardan universal joint 3
http://youtu.be/Qf88nPtm2h4

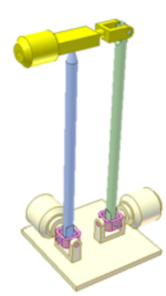


Double Cardan joints allow to adjust relative positions between the input and output shafts even during rotary transmission. This is case when the input and output shafts are skew. The joint loses the feature of velocity constant. The output velocity is not constant.

Study of spatial parallelogram mechanism 1a
http://youtu.be/uP6IyI5OqtY

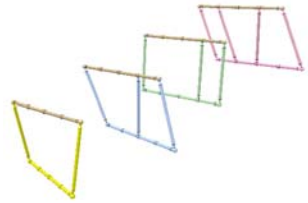
There are two spatial parallelogram mechanisms (lengths of opposite links are equal).
For the left one of 4 spherical joints the opposite links may be not parallel during motion.
For the right one of 2 spherical and 2 revolute joints the opposite links are always parallel.
Direction of longitudinal axis of the yellow conrod is kept unchanged during motion.

Study of spatial parallelogram mechanism 1b
http://youtu.be/DgVxKULp6zE



Blue and green rockers, yellow conrod and the base create a parallelogram.
The two rockers are connected to the base by universal joints of 2 degrees of freedom.
The yellow conrod is connected to the green rocker by a revolute joint and to the blue rocker by a spherical joint.
The mechanism has two degrees of freedom (by computer testing) so two actuators are needed for controling two pink frames.
Longitudinal axis direction of the yellow conrod is kept unchanged during motion. However its upper surface is not kept always horizontal.
The yellow conrod with two revolute joints has been tested but no success.

Study of spatial parallelogram mechanism 1c
http://youtu.be/KyBAxYmBmYA

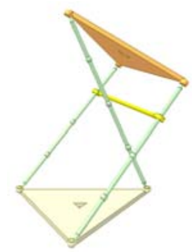


Long bars are identical.
Short bars are identical.
Brown bars are fixed.
All joints are spherical.
The video shows 4 mechanisms during motion.
1. The yellow one in general can not always gives a parallelogram.
2. The blue one in general can not always gives a parallelogram.
3. The green one always gives a variable parallelogram (distance between two long bars is variable).
4. The pink one of one DoF always gives a stable, invariable parallelogram.

Study of spatial parallelogram mechanism 2a
http://youtu.be/qnFIFyQqdm0

Lower and upper regular triangle plates are identical.
Green vertical bars are identical.
All joints are spherical.
When the upper plate moves, it may not be parallel to the lower plate.
Computer testing shows that the mechanism has 3 degrees of freedom (DoF) excluding passive DoF (rotation of each bar around the line joining its two joints).

Study of spatial parallelogram mechanism 2b
http://youtu.be/R38F202W0eY



Lower and upper plates are identical.
Green vertical bars are identical.
All joints are spherical.
Distance between two joints of the plates and of yellow horizontal bar are equal.
In general lower and upper plates are kept parallel but there is the case shown in this video.

Study of spatial parallelogram mechanism 2c
http://youtu.be/tttYnzX1t74

Lower and upper plates are identical.
Green vertical bars are identical.
All joints are spherical.
Distance between two joints of the plates and of yellow horizontal bars are equal.
Lower and upper plates are always parallel.
Computer testing shows that the mechanism has 2 degrees of freedom (DoF) excluding passive DoF (rotation of each bar around the line joining its two joints)..

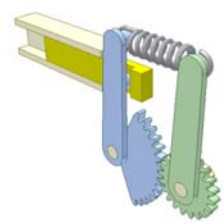
30. Sundries

30.1. Springs

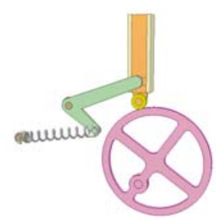
Using compression spring to bear tension 1
http://youtu.be/KU4JKCrpjGw
Reason: the hooks of a extension spring are difficult for production and easy to be broken in operation.

Using compression spring to bear tension 2
http://youtu.be/7QWoF76HuXs
Reason: the hooks of a extension spring are difficult for production and easy to be broken in operation.

Spring increased tension
http://youtu.be/m_XVJT-4T4o
Increased tension for the same movement is gained by providing a movable spring mount and gearing it to the other movable lever.



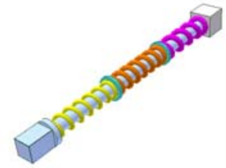
Constant tension from spring 1
http://youtu.be/YzvwrYgNOH0
The spring force applied along the orange slider is nearly constant because when the spring length is increased, the action radius of spring force around the pivot of green lever is reduced.



Constant tension from spring 2
http://youtu.be/W8R-BN6WXXg
Spring constant tension for large movement of the green lever is gained by providing a movable spring mount on the blue lever that is controlled by the yellow stationary cam.

Spring combination 2
http://youtu.be/HX0Rd2NpduY
This compressing mechanism has a dual rate for double-action compacting. In one direction pressure is high, but in the reverse direction pressure is low.

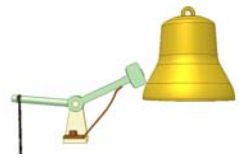
Spring combination 1
http://youtu.be/UOnMKvGGW3U
This mechanism provides a three-step rate change at predetermined positions. The lighter springs will always compress first, regardless of their position.



Spring damping mechanism 1
http://youtu.be/qaHBqI6ycaE
Two springs at both sides of a piston play anti-shock role well.

30.2. Sundries

Hammer for striking bell 1
http://youtu.be/gT-QpjkZ6dA
Arrangement of hammer for striking bells. Spring below the hammer raises it out of contact with the bell after striking and so prevents it from interfering with the vibration of the metal in the bell.

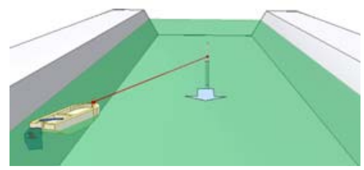


Hammer for striking bell 2
http://youtu.be/xikwuK-axb8
Input: green gear rotating continuously.
Output: pink oscillating shaft having a flat spring and a hammer.

Rotary table 1
http://youtu.be/JcLWmeCcTTI
Violet piston makes orange table go up and down.
At any height the table can receive the rotation from a stationary motor via belt drive and two long pins that can slide in two tubes of blue pulley.

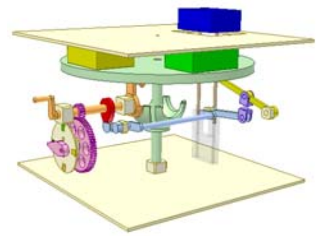
Rotary table 2
http://youtu.be/GhtIc-rLfbE
Bevel gear drive makes orange table go up and down.
At any height the table can receive the rotation from a stationary motor via belt drive and two long pins that can slide in two tubes of blue pulley.

Passing river by its flow
http://www.youtube.com/watch?v=ctT6mFDlHJI
Illustration of movement 447 in the book "507 mechanical movements", 1908



“This method of passing a boat from one shore of a river to the other is common on the Rhine and elsewhere, and is affected by the action of the stream on the rudder, which is carries the boat across the stream an the arc of a circle, the center of which is the anchor which is holds the boat from floating down the stream.”
The big arrow shows the flow direction.
The small arrow shows the direction of the flow’s force that applies to the rudder and pushes the boat.

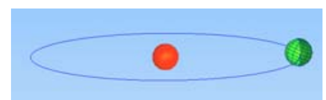
Magic chest 1
http://youtu.be/aJnnoExw77s



It is a toy. Once opening the chest (its cover and surrounding plates are not shown) a box among blue, green, yellow and orange ones appears. Turn orange crank to select the target box based on its color shown on the dial.
Spatial Geneva mechanism is applied here.
This toy was made on request of Mr. Mladen Radolovic from Croatia.

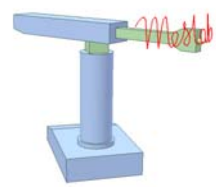
Inventor dragonfly
http://www.youtube.com/watch?v=iQEK0CuneTY
Stable balance. The center of gravity is lower than the fulcrum.

Inventor Earth motion
http://www.youtube.com/watch?v=atf-vuDhC58



When the Earth is on the right, it is Summer in the Northern hemisphere.

Inventor writing robot
http://www.youtube.com/watch?v=2RHYBQdwkzs



Meslab is the name of the Vietnamese forum of Materials, Mechanical, Automation and Industrial Engineering.
For details see:
http://meslab.org/mes/threads/21088-Robot-viet-chu-meslab